# three.JS

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## Home

Three.js is an open-source JavaScript library that you can use to create dynamic and interactive websites with 2D and 3D graphics. With Three.js, you can render 3D graphics directly inside the browser. You can do fantastic stuff using Three.js by adding animations or logic and even turning your website into a game. Ricardo Cabello (or mrdoob in GitHub) released Three.js in 2010 and maintained a great open-source community.

## Audience

This tutorial is for anyone who already knows JavaScript and wants to create 3D graphics that run in any browser. This tutorial makes you comfortable in getting started with Three.js and WebGL.

## Prerequisites

Creating 3D applications that run in a browser falls at the intersection of web development and computer graphics. You don't need to know anything about computer graphics or advanced math; all that is required is a general understanding of HTML, CSS, and JavaScript. If you are just getting started with JavaScript, I recommend completing this tutorial before proceeding with this one.

# Three.js – Introduction

All modern browsers became more powerful and more accessible directly using JavaScript. They have adopted WebGL (Web Graphics Library), a JavaScript API, which allows you to render high-performance interactive 3D and 2D graphics within any compatible web browser using the capabilities of the GPU (Graphics Processing Unit).

But WebGL is a very low-level system that only draws basic objects like point, square, and line. However, programming WebGL directly from JavaScript is a very complex and verbose process. You need to know the inner details of WebGL and learn a complex shader language to get the most out of WebGL. Here comes **Three.js** to make your life easy.

## What is Three.js?

Three.js is an open-source, lightweight, cross-browser, general-purpose JavaScript library. Three.js uses WebGL behind the scenes, so you can use it to render Graphics on an HTML `<canvas>` element in the browser. Since Three.js uses JavaScript, you can interact with other web page elements, add animations and interactions, and even create a game with some logic.

## Why use Three.js?

The following features make Three.js an excellent library to use.

- You can create complex 3D graphics by just using JavaScript.
- You can create Virtual Reality (VR) and Augmented Reality (AR) scenes inside the browser.
- Since it uses WebGL, it has cross-browser support. Many browsers support it.
- You can add various materials, textures and animate 3D objects.
- You can also load and work on objects from other 3D modeling software.

With a couple of lines of JavaScript and simple logic, you can create anything, from high-performance interactive 3D models to photorealistic real-time scenes.

These are some excellent websites created using Three.js:

- Moments of Happiness
- Garden Eight
- Interland
- Under Neon Lights

You can find many other examples on the official website of Three.js.

## Browser Support

All modern browsers on desktop, as well as on mobile, currently support WebGL. The only browser where you have to take care of is the mobile Opera Mini browser. For IE 10 and older, there is the

IEWebGL plugin, which you can get from https://github.com/iewebgl/iewebgl. You can find detailed information about the WebGL browser support here.

Once you understand what Three.js is, you can continue to the next chapter about setting up a project to start working with Three.js.

# Three.js – Installation

There are many ways to include Three.js in your project. You can use any of these following methods to get started using Three.js. Then open your favorite code editor and get going.

## Download the complete Three.js project

Download the complete Three.js project into your system. You can download it here or from GitHub. Extract the `three.js-master.zip` file and look inside the build folder. You can find two `three.js`, `three.min.js`, which is just a minified version. Add any of these two files into your project folder and link them to your HTML file. Now you are good to use Three.js in your project.

**Note:** We recommend using the minified version as it loads faster.

Insert the following `<script>` tag into the `<head>` element of your HTML with a path to the `threejs.min.js` file.

```
<script src='/path/to/threejs.min.js'></script>
```

## Use CDN links

You can link the files from a CDN (Content Delivery Network), a remote site dedicated to hosting files so that you can use them online. You can use any of these websites:

- cdnjs.com
- jsdelivr.com

Insert any of the following `<script>` tags into the `<head>` element of your HTML.

```
<script
src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r127/three.min.js"></sc
ript>
```

OR

```
<script
src="https://cdn.jsdelivr.net/npm/three@0.127.0/build/three.min.js"></script
>
```

## Install the package of Three.js

Three.js is also available as a package on NPM. If you have Node.js set up on your computer, you can install it using npm or yarn.

```
npm install three
```

or

```
yarn add three
```

Then, you can import Three.js from the `three.module.js` file into your JavaScript file.

```
import * as THREE from 'three'
```

You can use Three.js along with any JavaScript framework like React, Angular, Vue.

Once you finish setting up your project, let's start creating.

# Three.js – Hello Cube App

Like any other programming language, let's start learning Three.js by creating "Hello cube!" app.

## The HTML

```
/index.html
<!DOCTYPE html>
<html>
  <head>
    <meta name="viewport" content="width=device-width, initial-scale=1" />
    <meta charset="UTF-8" />
    <title>Three.js - Hello cube</title>
    <style>
      /* Our CSS goes here */
    </style>
    <script
src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r127/three.min.js"></sc
ript>
  </head>

  <body>
    <div id="threejs-container">
      <!-- Our output to  be rendered here -->
    </div>

    <script type="module">
      // our JavaScript code goes here
    </script>
  </body>
</html>
```

As you can see, it's just a simple HTML file with Three.js CDN.

## The CSS

```
<style>
* {
  margin: 0;
  padding: 0;
  box-sizing: border-box;
  font-family: -apple-system, BlinkMacSystemFont, "Segoe UI", Roboto,
Oxygen,
    Ubuntu, Cantarell, "Open Sans", "Helvetica Neue", sans-serif;
}

html,
body {
  height: 100vh;
  width: 100vw;
}

#threejs-container{
  position: block;
  width: 100%;
  height: 100%;
}
</style>
```

The above CSS is just the basic styling of the HTML page. The `threejs-container` takes up the whole screen.

## The JavaScript

This is where our three.js app comes into life. The code below renders a single cube in the middle of the screen. All these codes will go into the empty `<script>` tag in the HTML.

```
const width = window.innerWidth
const height = window.innerHeight
// Scene
const scene = new THREE.Scene()
scene.background = new THREE.Color('#00b140')

// Camera
const fov = 45 // AKA Field of View
```

```
const aspect = window.innerWidth / window.innerHeight
const near = 0.1 // the near clipping plane
const far = 100 // the far clipping plane

const camera = new PerspectiveCamera(fov, aspect, near, far)
camera.position.set(0, 0, 10)

// Renderer
const renderer = new THREE.WebGLRenderer()
renderer.setSize(window.innerWidth, window.innerHeight)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// Creating a cube
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshBasicMaterial({ wireframe: true })
const cube = new THREE.Mesh(geometry, material)
scene.add(cube)

// Rendering the scene
const container = document.querySelector('#threejs-container')
container.append(renderer.domElement)
renderer.render(scene, camera)
```

Let's discuss the code one step at a time, and then you can get more information about each element in the upcoming chapters. The first thing we need to do is to create a scene, a camera, and a renderer. These are the essential components that make up every Three.js app.

## The Scene

```
const scene = new THREE.Scene()
scene.background = new THREE.Color('#262626')
```

The `scene` serves as the container for everything we can see on the screen, without a `THREE.Scene` object, Three.js cannot render anything. The background color is dark gray so that we can see the cube.

## The Camera

```
const camera = new PerspectiveCamera(fov, aspect, near, far)
camera.position.set(0, 0, 10)
```

The camera object defines what we'll see when we render a scene. There are not many but different types of cameras, but for this example, you'll use a `PerspectiveCamera`, which matches the way our eyes see the world.

## The Renderer

```
const renderer = new THREE.WebGLRenderer()
renderer.setSize(window.innerWidth, window.innerHeight)
```

The renderer object is responsible for calculating what the scene looks like in the browser, based on the camera. There are different types of renderers, but we mainly use `WebGLRenderer` since most browsers support WebGL.

In addition to creating the renderer instance, we also need to set the size at which we want it to render our app. It's a good idea to use the width and height of the area we want to fill with our app - in this case, the width and height of the browser window.

## The Cube

```
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true,
})
const cube = new THREE.Mesh(geometry, material)
scene.add(cube)
```

The above code creates a simple cube at the center of the screen. We can make any object using `THREE.Mesh`. The Mesh takes two objects, `geometry` and `material`. The geometry of a mesh defines its shape, and materials determine the surface properties of objects.

To create a cube, we need BoxGeometry and a primary material (`MeshBasicMaterial`) with the color `0xffffff`. If the `wireframe` property is set to true, it tells Three.js to show us a wireframe and not a solid object.

## Rendering the Scene

```
const container = document.querySelector('#threejs-container')
container.append(renderer.domElement)
renderer.render(scene, camera)
```

Last but not least, we add the renderer element to our HTML document. The renderer uses an `<canvas>` element to display the scene to us. In this case, the renderer appends the `<canvas>` element to the reference container in the HTML.

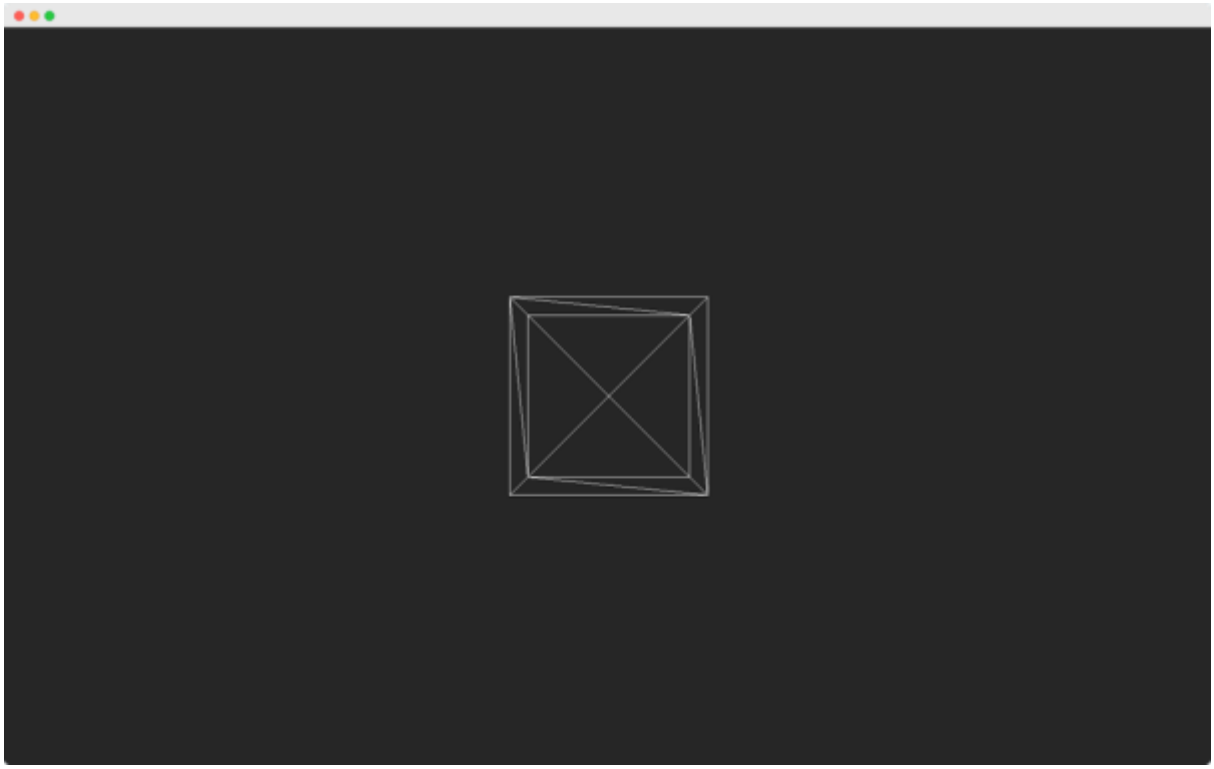
## hello-cube-app.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js – Hello cube</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        overflow: hidden;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Hello Cube App
      // Your first Three.js application
```

```
      // sizes
      const width = window.innerWidth
      const height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)

      // cube
      const geometry = new THREE.BoxGeometry(2, 2, 2)
      const material = new THREE.MeshBasicMaterial({
        color: 0xffffff,
        wireframe: true
      })
      const cube = new THREE.Mesh(geometry, material)
      scene.add(cube)

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
    </script>
  </body>
</html>
```

## Output

The output looks like this if everything is working correctly. Play around with the code to get a better understanding of how it works.



You have now completed creating your first three.js application. Let's go ahead and add more beauty to the app.

## Basic Functionality of a Scene

You know that Scene is a container for the camera, lights, and objects we want to render on the screen. Let's look at some basic functionality of the `Scene` object:

## Adding an Object

The function `add(object)` is used to an object to the scene.

```
const scene = THREE.Scene()
scene.add(cube) // adds the cube
scene.add(sphere) // adds a sphere
```

## Removing an Object

The function `remove(object)` removes an object from the scene.

```
scene.remove(cube) // removes the last added cube
scene.remove(sphere) // removes a sphere
```

## Children

In the `scene.children` return an array of all the objects in the scene, including the camera and lights.

```
console.log(scene.children)          // outputs all the objects in the scene
console.log(scene.children.length)   // outputs number of elements on the
scene
```

**Note:** We can give a name to any object using its `name` attribute. A name is handy for debugging purposes but can also directly access an object from your scene.

Check out the following example.

### scene.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
```

```
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js – The scene</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
        background-color: #262626;
        overflow: hidden;
      }
      #btn-conatiner {
        position: absolute;
        top: 0;
        left: 0;
        height: 10vh;
        width: 100%;
      }
      @media screen and (max-width:600px){
        #btn-container{
          display: flex;
          flex-direction: column;
        }
      }
      .btn {
        padding: 5px 15px;
        margin: 5px 15px;
        font-weight: bold;
        text-transform: uppercase;
```

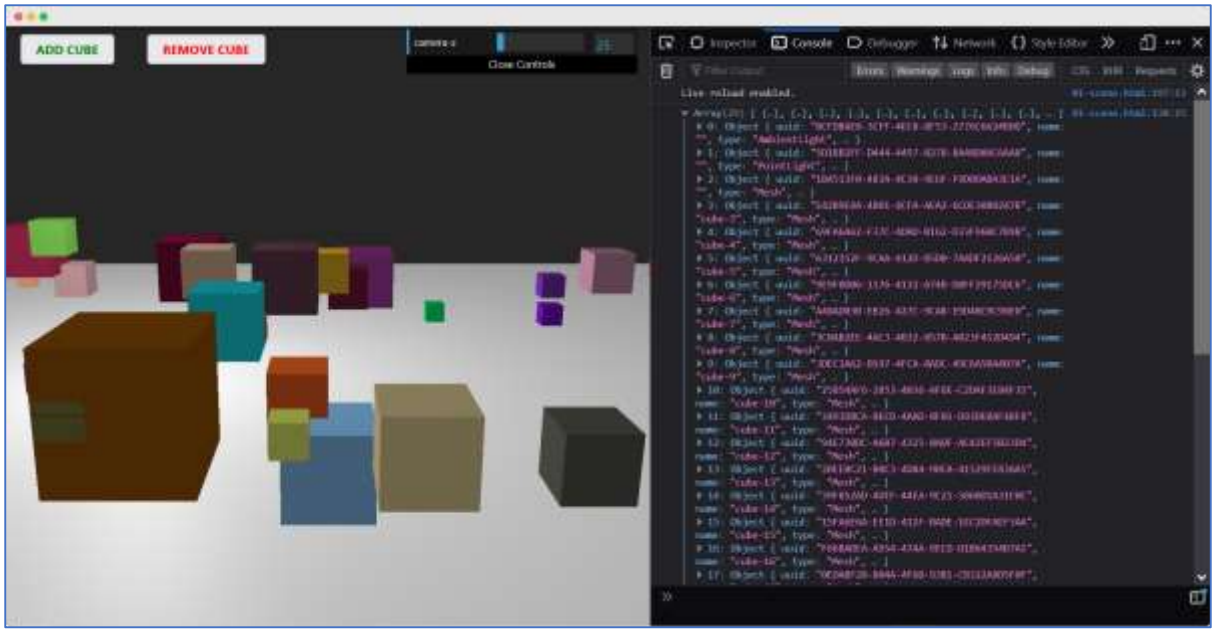
```
      }
      .add {
        color: green;
      }
      .rem {
        color: red;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="btn-conatiner">
      <button class="btn add">Add Cube</button>
      <button class="btn rem">Remove Cube</button>
    </div>
    <div id="threejs-container"></div>
    <script type="module">
      // Experimenting with different methods of scene
      // add, remove, children, getElementById

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      const gui = new dat.GUI()

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)
```

```
// lights
const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
scene.add(ambientLight)

const light = new THREE.PointLight(0xffffff, 0.5)
light.position.set(-10, 10, -10)

// for shadow
light.castShadow = true
light.shadow.mapSize.width = 1024
light.shadow.mapSize.height = 1024
light.shadow.camera.near = 0.1
light.shadow.camera.far = 1000
scene.add(light)

// camera
const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 1000)
camera.position.set(0, 10, 40)
camera.lookAt(0, 0, 0)
gui.add(camera.position, 'z', 10, 200, 1).name('camera-z')

// plane
const planeGeometry = new THREE.PlaneGeometry(100, 100)
const plane = new THREE.Mesh(
  planeGeometry,
  new THREE.MeshPhongMaterial({ color: 0xffffff, side: THREE.DoubleSide })
)
plane.rotateX(Math.PI / 2)
plane.position.y = -1.75
plane.receiveShadow = true
scene.add(plane)

// scene.add
function addCube() {
  const cubeSize = Math.ceil(Math.random() * 3)
  const cubeGeometry = new THREE.BoxGeometry(cubeSize, cubeSize, cubeSize)
```

```
    const cubeMaterial = new THREE.MeshLambertMaterial({
      color: Math.random() * 0xffffff
    })
    const cube = new THREE.Mesh(cubeGeometry, cubeMaterial)
    cube.castShadow = true
    cube.name = 'cube-' + scene.children.length
    cube.position.x = -30 + Math.round(Math.random() * 50)
    cube.position.y = Math.round(Math.random() * 5)
    cube.position.z = -20 + Math.round(Math.random() * 50)
    scene.add(cube)
}

const add = document.querySelector('.add')
add.addEventListener('click', () => {
  addCube()
  console.log('cube added')
})

// scene.remove
function removeCube() {
  const allChildren = scene.children
  const lastObject = allChildren[allChildren.length - 1]
  if (lastObject.name) {
    scene.remove(lastObject)
  }
}

const remove = document.querySelector('.rem')
remove.addEventListener('click', () => {
  removeCube()
  console.log('cube removed')
})

// scene.children
console.log(scene.children)

// responsiveness
```

```
      window.addEventListener('resize', () => {
        width = window.innerWidth
        height = window.innerHeight
        camera.aspect = width / height
        camera.updateProjectionMatrix()

        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)
        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

Open your console to see the elements on the scene.




## Using name attribute

The function `scene.getObjectByName(name)` directly returns the object, by specific name, from the scene.

You can also add another argument - `recursive`.

```
scene.getObjectByName(name, recursive)
```

If you set the recursive argument to true, Three.js will search through the complete tree of objects to find the thing with the specified name.

## Adding Fog to the scene

This property allows you to set the fog for the scene. The fog renders a haze that hides faraway objects.

```
scene.fog = new THREE.Fog(0xffffff, 0.015, 100)
```

This line of code defines a white fog (`0xffffff`). You can use the preceding two properties to tune how the mist appears. The `0.015` value sets the near property, and the `100` value sets the far property. With these properties, you can determine where the fog starts and how fast it gets denser.

With the `THREE.Fog object`, the fog increases linearly. There is also a different way to set the mist for the scene; for this, use the following definition:

```
scene.fog = new THREE.FogExp2(0xffffff, 0.01)
```

This time, we don't specify `near` and `far`, but just the color (`0xffffff`) and the mist's density (`0.01`). It's best to experiment a bit with these properties to get the effect you want.

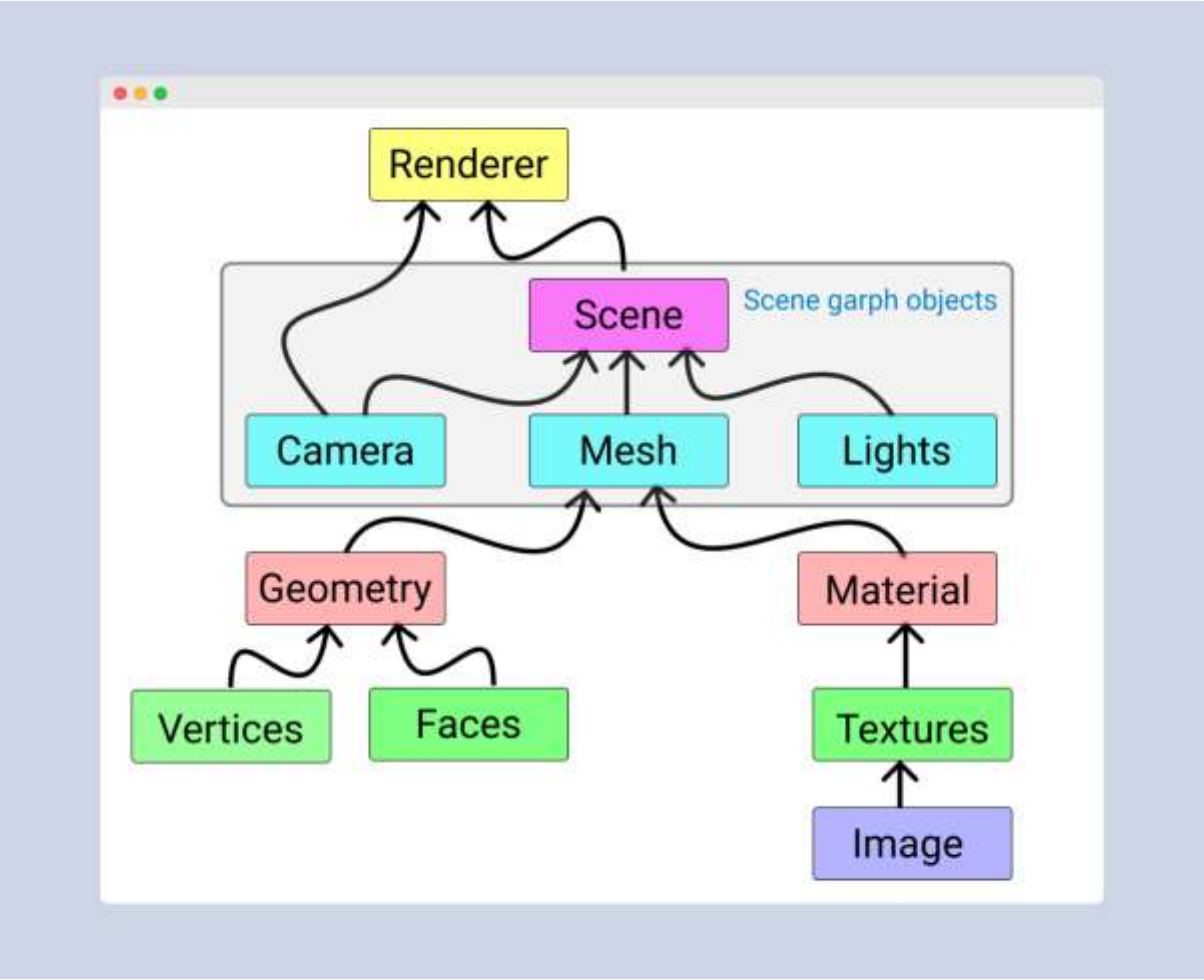
## Using the override material property

The `overrideMaterial` property forces all the objects in the scene to use the same material.

```
scene.overrideMaterial = new THREE.MeshLambertMaterial({ color: 0xffffff })
```

Here, all the objects on the scene of the same material, i.e., `MeshLambertMaterial`.

**Note:** `THREE.Scene` is a structure that is sometimes also called a **Scenegraph**. A scene graph is a structure that can hold all the necessary information of a graphical scene. In Three.js, this means that `THREE.Scene` contains all the objects, lights, and other objects needed for rendering.




## Renderer

The renderer uses the camera and the information from the scene to draw the output on the screen, i.e., `<canvas>` element.

In the Hello cube app, we used the `WebGLRenderer`. Some other renderers are available, but the `WebGLRenderer` is by far the most powerful renderer available and usually the only one you need.

**Note:** There is a canvas-based renderer, a CSS-based renderer, and an SVG-based one. Even though they work and can render simple scenes, I wouldn't recommend using them. They are not being developed actively, very CPU-intensive, and lack features such as good material support and shadows.

On resizing the screen, you can observe that the scene is not responsive. Making a web page responsive generally refers to the page displaying well on different sized displays from desktops to tablets to phones. In this chapter, you can see how to solve some fundamental problems of your Three.js app.

## Automatically resize the output when the browser size changes

When you resize the browser, we have to notify the Three.js to know how wide the `<canvas>` element should be. For the camera, we need to update the aspect property, which holds the aspect ratio of the screen, and for the renderer, we need to change its size.

```
window.addEventListener('resize', () => {
  // update display width and height
  width = window.innerWidth
  height = window.innerHeight

  // update camera aspect
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  // update renderer
  renderer.setSize(width, height)
  renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))
  renderer.render(scene, camera)
})
```

The above code gives responsiveness to your Three.js project.

### resize-browser.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js – Resizing browser</title>
```

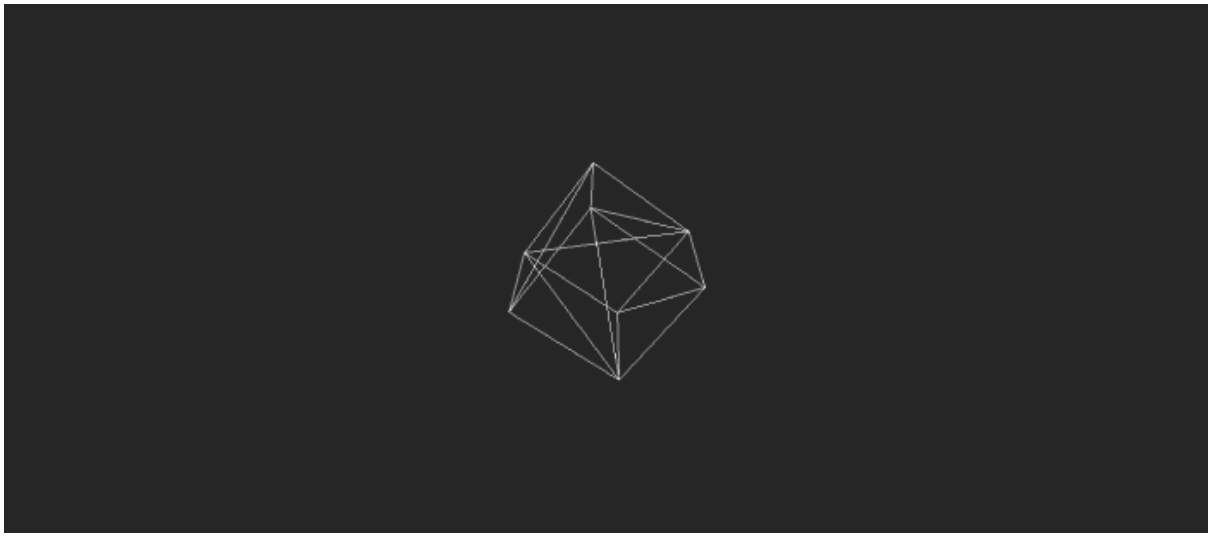
```
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Adding responsiveness for Three.js app


      // sizes
      let width = window.innerWidth
      let height = window.innerHeight


      const gui = new dat.GUI()
      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)
```

```
// camera
const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
camera.position.set(0, 0, 10)

// cube
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true
})
const cube = new THREE.Mesh(geometry, material)
scene.add(cube)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// animation
function animate() {
  requestAnimationFrame(animate)

  cube.rotation.x += 0.005
  cube.rotation.y += 0.01
```

```
        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output

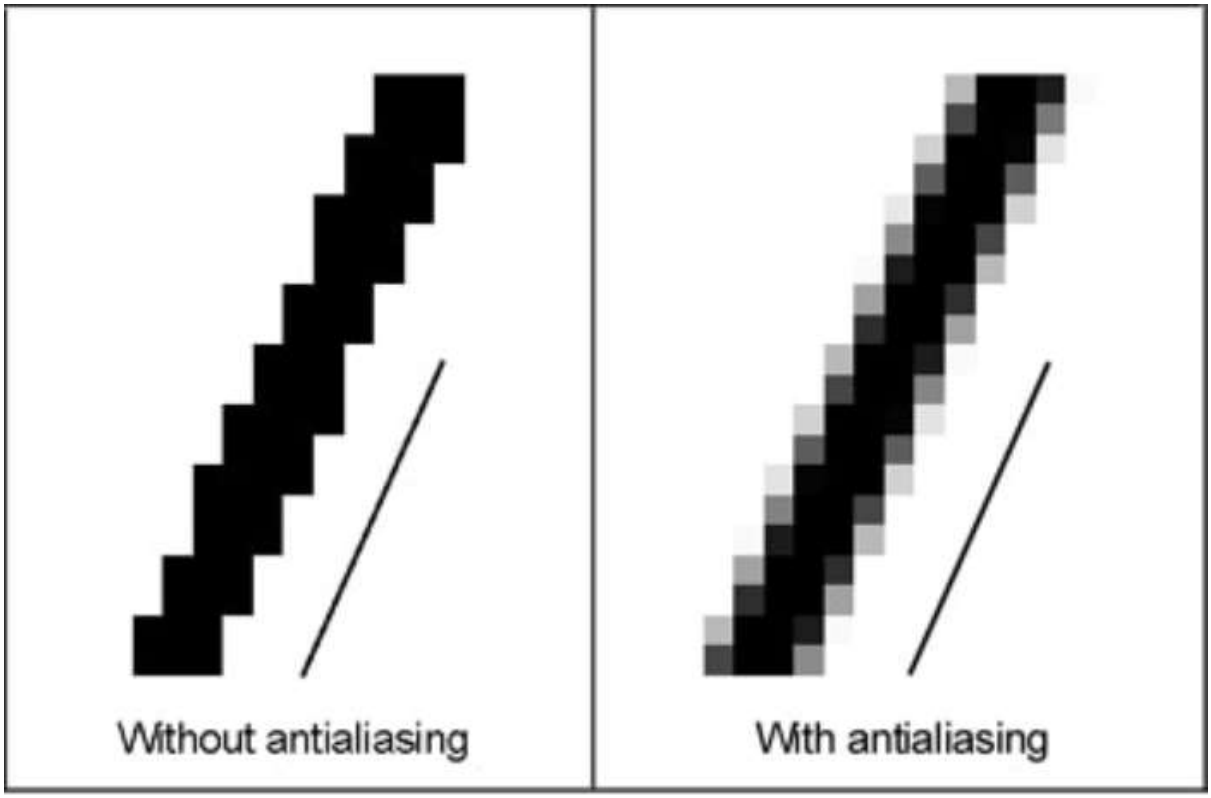
When you execute the code, it will produce the following output:



Now, resize the browser. Due to the responsive design, the object will always reposition itself at the center of the browser.

## Anti-aliasing

The **aliasing effect** is the appearance of jagged edges or "jaggies" (also known as stair-stepped lines) on edges and objects (rendered using pixels).




## antialiasing.html

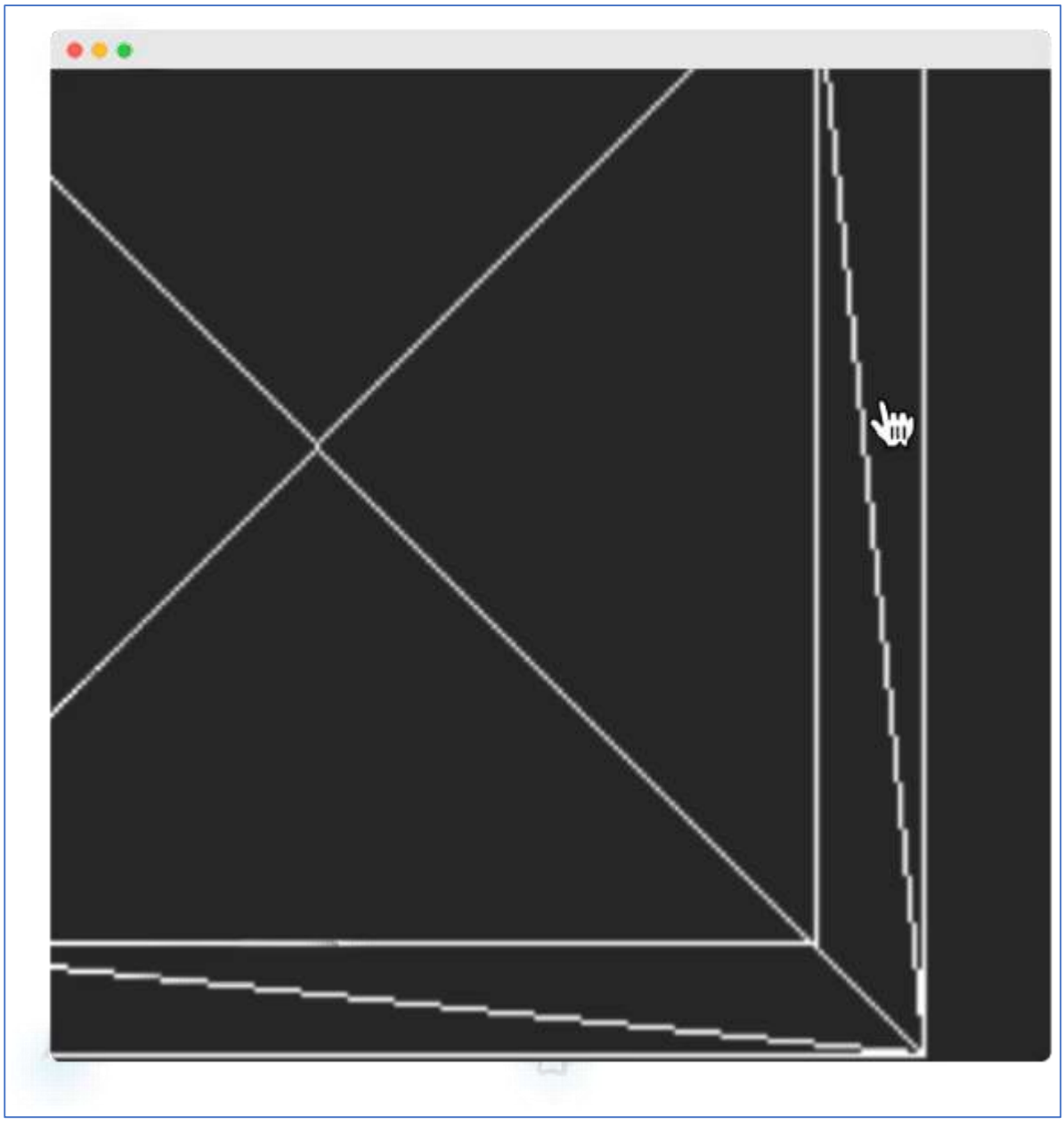
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Anti-aliasing</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
```

```
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Adding anti-aliasing to Three.js app for removing jaggies

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      const gui = new dat.GUI()

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)

      // cube
      const geometry = new THREE.BoxGeometry(2, 2, 2)
      const material = new THREE.MeshBasicMaterial({
        color: 0xffffff,
```

```
    wireframe: true
  })
  const cube = new THREE.Mesh(geometry, material)
  scene.add(cube)

  // responsiveness
  window.addEventListener('resize', () => {
    width = window.innerWidth
    height = window.innerHeight
    camera.aspect = width / height
    camera.updateProjectionMatrix()

    renderer.setSize(window.innerWidth, window.innerHeight)
    renderer.render(scene, camera)
  })

  // renderer - anti-aliasing
  const renderer = new THREE.WebGLRenderer({ antialias: true })
  renderer.physicallyCorrectLights = true
  renderer.setSize(width, height)
  renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

  // animation
  function animate() {
    requestAnimationFrame(animate)

    cube.rotation.x += 0.005
    cube.rotation.y += 0.01

    renderer.render(scene, camera)
  }

  // rendering the scene
  const container = document.querySelector('#threejs-container')
  container.append(renderer.domElement)
  renderer.render(scene, camera)
  animate()
```

```
    </script>
  </body>
</html>
```

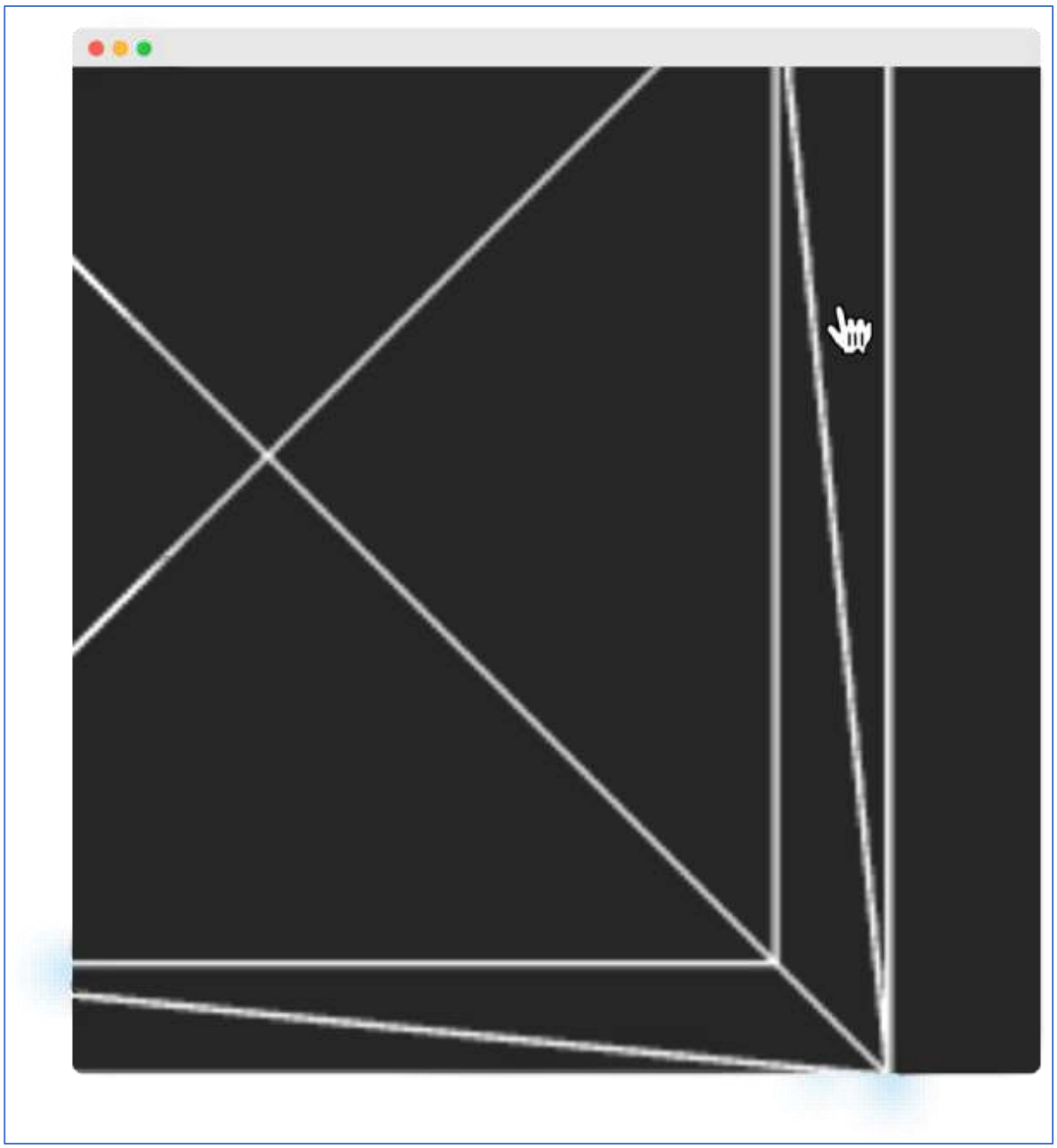
Aliasing in our `Hello cube` app looks like this.



We can turn on anti-aliasing by setting `antialias` property of the `WebGLRenderer` to `true`. By default, it is `false`. Here, we set the `antialias` parameter to `true`:

```
const renderer = new WebGLRenderer({ antialias: true })
renderer.physicallyCorrectLights = true
```

After antialiasing, it looks smooth without jaggies like the one below.



The property `physicallyCorrectLights` tells Three.js whether to use physically correct lighting mode. Default is `false`. Setting it to `true` helps increase the detail of the object.

## Using Dat.GUI

It is hard to keep experimenting with the values of variables, like the cube's position. In that case, suppose until you get something you like. It's a kind of slow and overwhelming process. Luckily, there is already a good solution available that integrates great with Three.js, `dat.GUI`. It allows you to create a fundamental user interface component that can change variables in your code.

## Installation

To use `dat.GUI` in your project, download it here and add the `<script>` tag to the HTML file.

```
<script type='text/javascript' src='path/to/dat.gui.min.js'></script>
```

Or you can use CDN, add the following `<script>` tag inside your HTML.

```
<script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
```

If you are using Three.js in a node app, install the npm package - `dat.GUI` and import it into your JavaScript file.

```
npm install dat.gui
```

OR

```
yarn add dat.gui
import * as dat from 'dat.gui'
```

## Usage

First, you should initialize the object itself. It creates a widget and displays it on the screen top right corner.

```
const gui = new dat.GUI()
```

Then, you can add the parameter you want to control and the variable. For example, the following code is to control the y position of the cube.

```
gui.add(cube.position, 'y')
```

Try adding other position variables. Refer to this working code example.

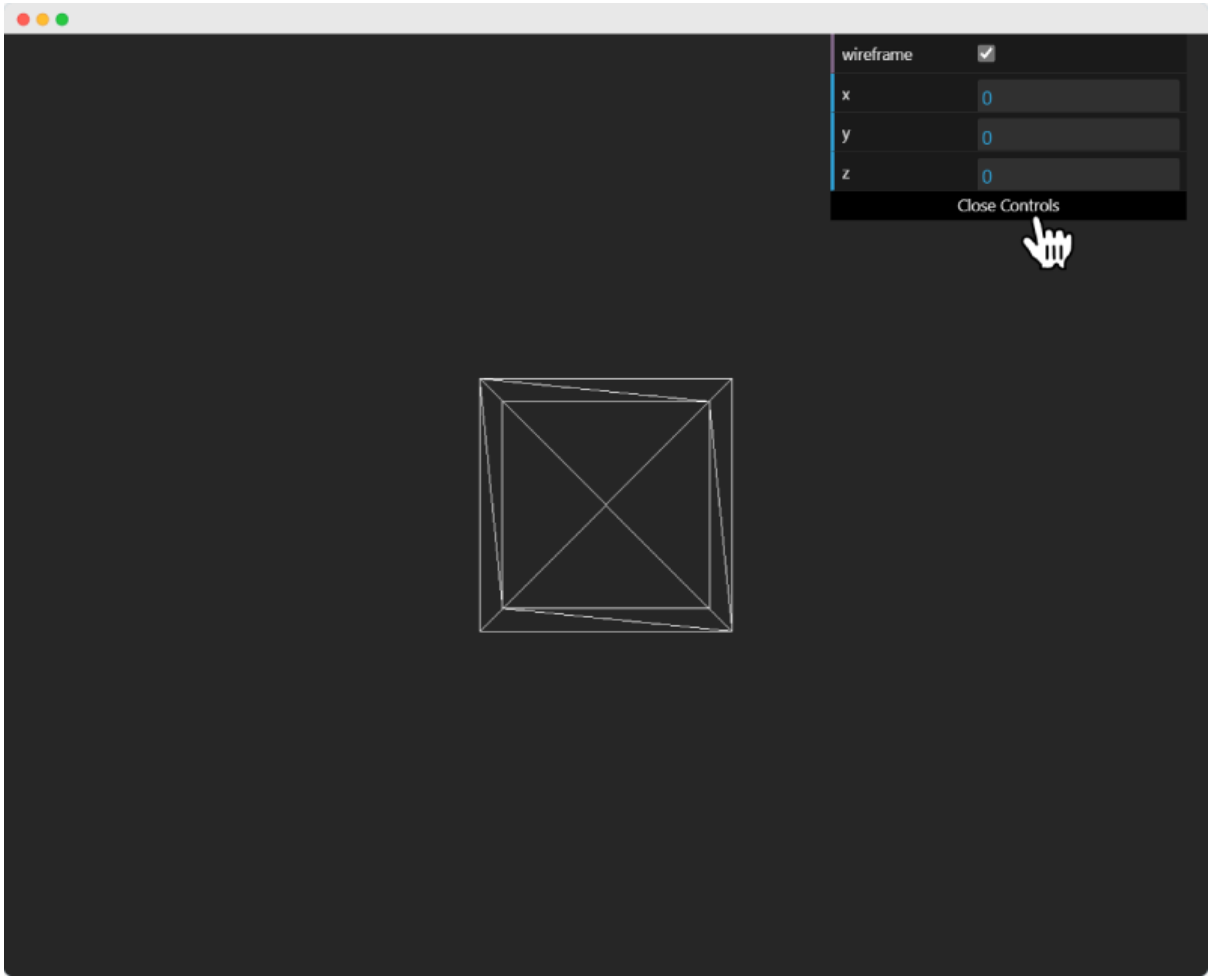
## cube.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Position GUI</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Adding UI to debug and experimenting different values
```

```
// UI
const gui = new dat.GUI()

// sizes
let width = window.innerWidth
let height = window.innerHeight

// scene
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// camera
const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
camera.position.set(0, 0, 10)

// cube
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true
})
gui.add(material, 'wireframe')

const cube = new THREE.Mesh(geometry, material)
scene.add(cube)

gui.add(cube.position, 'x')
gui.add(cube.position, 'y')
gui.add(cube.position, 'z')

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()
```

```
        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output




You can customize the label displayed using the `name` attribute. To change the label on the variable line, use `.name("your label")`.

```
gui.add(cube.position, 'y').name('cube-y')
```

You can set up min/max limits and steps for getting the slider. The following line allow values from 1 to 10, increasing the value by 1 at a time.

```
gui.add(cube.position, 'y').min(1).max(10).step(1)
// or
gui.add(cube.position, 'y', 1, 10, 1)
```

If there are many variables with the same name, you may find it difficult to differentiate among them. In that case, you can add folders for every object. All the variables related to an object be in one folder.

```
// creating a folder
const cube1 = gui.addFolder('Cube 1')
cube1.add(redCube.position, 'y').min(1).max(10).step(1)
cube1.add(redCube.position, 'x').min(1).max(10).step(1)
```

```
cube1.add(redCube.position, 'z').min(1).max(10).step(1)
// another folder
const cube2 = gui.addFolder('Cube 2')
cube2.add(greenCube.position, 'y').min(1).max(10).step(1)
cube2.add(greenCube.position, 'x').min(1).max(10).step(1)
cube2.add(greenCube.position, 'z').min(1).max(10).step(1)
```

Now, check the following example.

## gui-folders.html

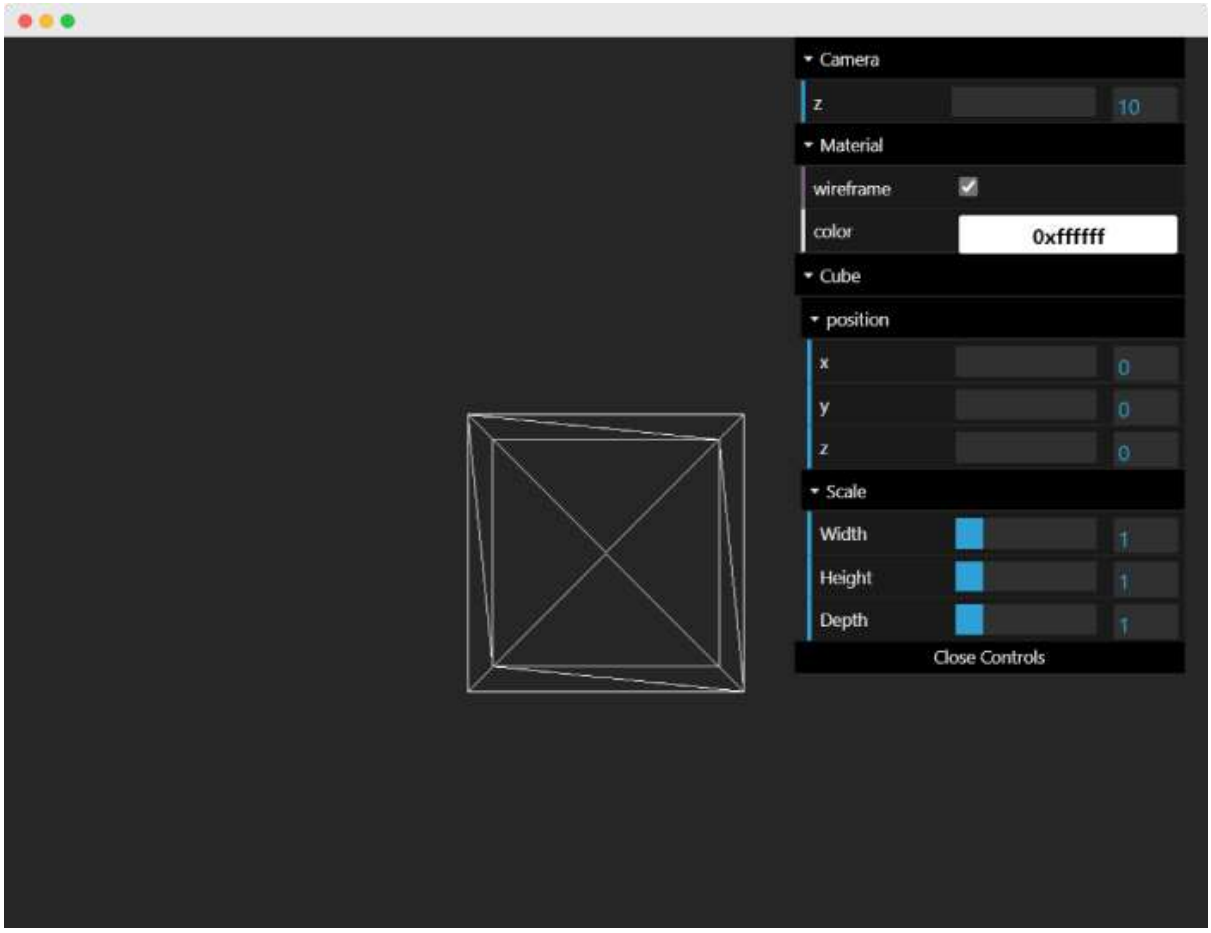
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - More variables</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
```

```
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Adding folders to distinguish between variables

      // controls
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z').min(10).max(60).step(10)

      // cube
      const geometry = new THREE.BoxGeometry(2, 2, 2)
      const material = new THREE.MeshBasicMaterial({
        color: 0xffffff,
        wireframe: true
      })

      const cubeColor = {
        color: 0xffffff
      }
```

```
const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.addColor(cubeColor, 'color').onChange(() => {
  // callback
  material.color.set(cubeColor.color)
})
materialFolder.open()

const cube = new THREE.Mesh(geometry, material)
scene.add(cube)

const cubeFolder = gui.addFolder('Cube')

// for position
const posFolder = cubeFolder.addFolder('position')
posFolder.add(cube.position, 'x', 0, 5, 0.1)
posFolder.add(cube.position, 'y', 0, 5, 0.1)
posFolder.add(cube.position, 'z', 0, 5, 0.1)
posFolder.open()

// for scale
const scaleFolder = cubeFolder.addFolder('Scale')
scaleFolder.add(cube.scale, 'x', 0, 5, 0.1).name('Width')
scaleFolder.add(cube.scale, 'y', 0, 5, 0.1).name('Height')
scaleFolder.add(cube.scale, 'z', 0, 5, 0.1).name('Depth')
scaleFolder.open()

cubeFolder.open()

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()
```

```
        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output




You can also add some callback functions. `onChange` is triggered once the value is changed.

```
gui.add(cube.position, 'y').onChange(function () {
  // refresh based on the new value of y
  console.log(cube.position.y)
})
```

Let's see another example of changing color using `dat.gui` and `callbacks`.

```
// parameter
const cubeColor = {
  color: 0xff0000,
}
gui.addColor(cubeColor, 'color').onChange(() => {
  // callback
  cube.color.set(cubeColor.color)
})
```

The above callback `onChange` notifies Three.js to change the cube color when the `color` from `cubeColor` changes.

We are going to use this `dat.gui` a lot from now. Make sure you get used to it by experimenting with the "Hello Cube!" app.

## Stats

Statistics play an important role in large-scale applications. Suppose you are creating a larger Three.js project with many objects and animations. It is good to monitor the performance of the code like fps (frames per second), memory allocated, etc. The creator of Three.js also created a small JavaScript library, `Stats.js`, to monitor the rendering.

## Installation

Like any other library, you can simply add it to your project in any of the three ways, as discussed previously.

You can download it from GitHub and import it to your HTML page.

Or you can add the CDN link to the HTML page.

```
<script
src="https://cdnjs.cloudflare.com/ajax/libs/stats.js/r17/Stats.min.js"></scr
ipt>
```

If you're using a node app, install the npm package and import it into your project.

```
npm install stats.js
```

or

```
yarn add stats.js
import * as stats from 'stats.js'
```

## Functionality

You can monitor the following properties using `Stats.js`.

- **FPS** - Frames rendered in the last second (0).
- **MS** - Milliseconds needed to render a frame (1).
- **MB** - MBytes of allocated memory (2) (Run Chrome with `--enable-precise-memory-info`)
- **CUSTOM** - you can define the thing you want to monitor—user-defined panel support (3).

## How does it work?

If you're monitoring the frame rate, it counts how often the update was called within the last second and shows that value. If you're tracking the render time, it just shows the time between calls and the update function.

## Usage

You can add this functionality to your code in a few simple steps.

Create the `stats` object and add it to the HTML page using the `DOM`.

```
const stats = new Stats()
stats.showPanel(1) // 0: fps, 1: ms, 2: mb, 3+: custom
document.body.appendChild(stats.dom)
```

**Note:** You can show the panel you want using `showPanel()`. By default, Stats.js displays the fps panel, and you can toggle between panels by clicking on the panel.

Select the code you want to monitor.

```
stats.begin()

// monitored code goes here
// in our case the render function
renderer.render(scene, camera)
stats.end()
```

If you are using animations, you should update the stats whenever the frame is rendered.

```
function animate() {
  requestAnimationFrame(render)
  // our animations
  renderer.render(scene, camera)
  stats.update()
}
```

Check this working example.

## stats.js

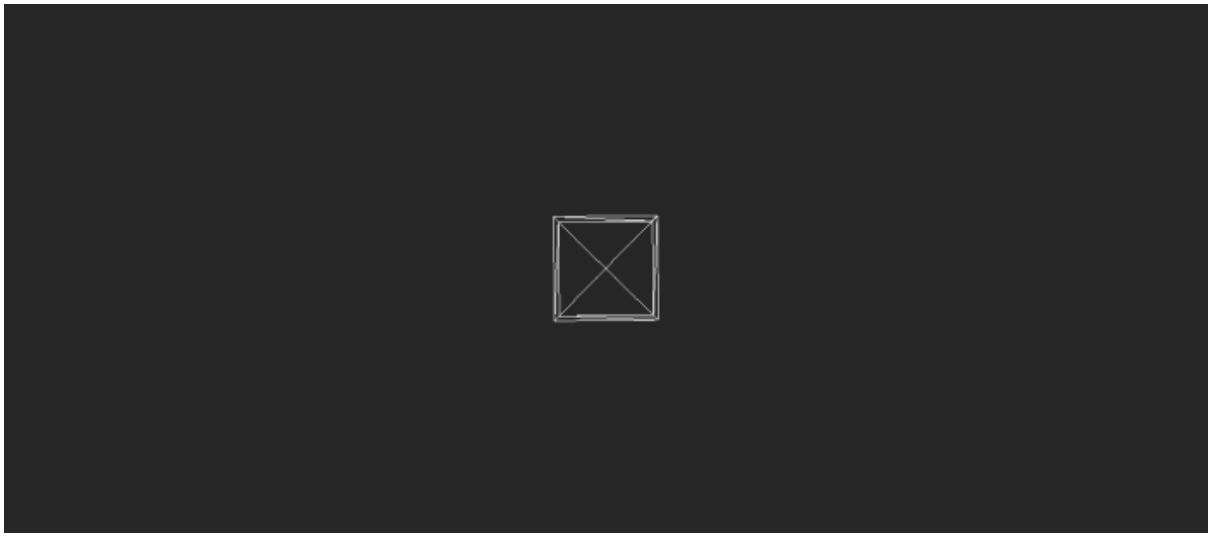
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Stats.js</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
```

```
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
    <script src="http://mrdoob.github.io/stats.js/build/stats.min.js"></scri
pt>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Adding stats panel to moniter application statistics

      const gui = new dat.GUI()
      const stats = new Stats()
      //stats.showPanel(0)
      //stats.showPanel(1)
      document.body.appendChild(stats.dom)

      // width, height
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
```

```
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// camera
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
camera.position.set(0, 0, 10)

// cube
const geometry = new THREE.BoxGeometry(1, 1, 1)
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true
})

const cube = new THREE.Mesh(geometry, material)
scene.add(cube)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// animation
function animate() {
  requestAnimationFrame(animate)
```

```
        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        renderer.render(scene, camera)
        stats.update()
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      stats.begin()
      renderer.render(scene, camera)
      stats.end()
      animate()
    </script>
  </body>
</html>
```

## Output



## PerspectiveCamera

There are different cameras in Three.js. The most common camera and the one we've been using is the `PerspectiveCamera`.

```
const camera = new THREE.PerspectiveCamera(fov, aspect, near, far)
```

The first attribute is the **Field of View** (FOV). FOV is the part of the scene that is visible on display at any given moment. The value is in degrees. Humans have an almost 180-degree FOV. But since a regular computer screen doesn't fill our vision, a smaller value is often chosen. Generally, for games, a FOV between 60 and 90 degrees is preferred.

```
Good default: 50
```

The second one is the **Aspect ratio**—the ratio between the horizontal and vertical sizes of the area where we're rendering the output.

```
Good default: window.innerWidth / window.innerHeight
```

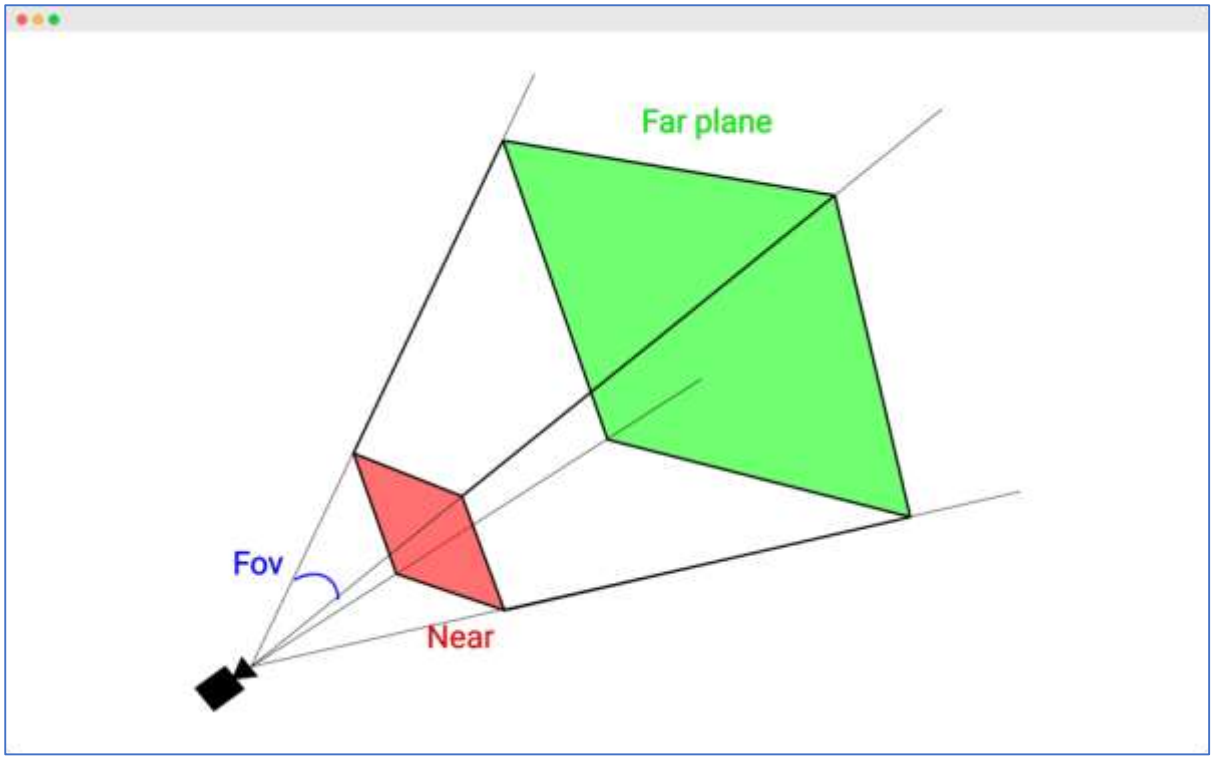
The following two attributes are the `near` and `far` clipping plane. The camera renders the area between the near plane and the far plane on the screen.

The `near` property defines by how close to the camera Three.js should render the scene. Usually, we set this to a minimal value to directly render everything from the camera's position.

```
Good default: 0.1
```

The `far` property defines how far the camera can see from the position of the camera. If we set this too low, a part of our scene might not be rendered, and if we set it too high, in some cases, it might affect the rendering performance.

```
Good default: 1000
```




Check out the following example and play around with variables.

## prespective-cam.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Prespective camera</title>
    <style>
      html,
      body {
        margin: 0;
        height: 100%;
      }
      #threejs-container {
        width: 100%;
        height: 100%;
        display: block;
      }
```

```
      .split {
        position: absolute;
        left: 0;
        top: 0;
        width: 100%;
        height: 100%;
        display: flex;
      }
      .split > div {
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <canvas id="threejs-container"></canvas>
    <div class="split">
      <div id="view1" tabindex="1"></div>
      <div id="view2" tabindex="2"></div>
    </div>


    <script type="module">
      // Three.js - Cameras - Prespective 2 views
      // from https://threejsfundamentals.org/threejs/threejs-cameras-
prespective-2-scenes.html


      import { OrbitControls } from "https://threejs.org/examples/jsm/contro
ls/OrbitControls.js"


      function main() {
        const canvas = document.querySelector('#threejs-container')
        const view1Elem = document.querySelector('#view1')
        const view2Elem = document.querySelector('#view2')
        const renderer = new THREE.WebGLRenderer({ canvas, antialias: true })
```

```
        const fov = 45
        const aspect = 2 // the canvas default
        const near = 5
        const far = 100
        const camera = new THREE.PerspectiveCamera(fov, aspect, near, far)
        camera.position.set(0, 10, 20)

        const cameraHelper = new THREE.CameraHelper(camera)

        class MinMaxGUIHelper {
          constructor(obj, minProp, maxProp, minDif) {
            this.obj = obj
            this.minProp = minProp
            this.maxProp = maxProp
            this.minDif = minDif
          }
          get min() {
            return this.obj[this.minProp]
          }
          set min(v) {
            this.obj[this.minProp] = v
            this.obj[this.maxProp] = Math.max(this.obj[this.maxProp], v + th
is.minDif)
          }
          get max() {
            return this.obj[this.maxProp]
          }
          set max(v) {
            this.obj[this.maxProp] = v
            this.min = this.min // this will call the min setter
          }
        }

        const gui = new dat.GUI()
        gui.add(camera, 'fov', 1, 180)
        const minMaxGUIHelper = new MinMaxGUIHelper(camera, 'near', 'far', 0.1)
```

```
        gui.add(minMaxGUIHelper, 'min', 0.1, 50, 0.1).name('near')
        gui.add(minMaxGUIHelper, 'max', 0.1, 50, 0.1).name('far')

        const controls = new OrbitControls(camera, view1Elem)
        controls.target.set(0, 5, 0)
        controls.update()

        const camera2 = new THREE.PerspectiveCamera(
          60, // fov
          2, // aspect
          0.1, // near
          500 // far
        )
        camera2.position.set(40, 10, 30)
        camera2.lookAt(0, 5, 0)

        const controls2 = new OrbitControls(camera2, view2Elem)
        controls2.target.set(0, 5, 0)
        controls2.update()

        const scene = new THREE.Scene()
        scene.background = new THREE.Color(0x262626)
        scene.add(cameraHelper)

        {
          const planeSize = 40

          const planeGeo = new THREE.PlaneGeometry(planeSize, planeSize)
          const planeMat = new THREE.MeshLambertMaterial({
            color: 0xffffff,
            side: THREE.DoubleSide
          })
          const mesh = new THREE.Mesh(planeGeo, planeMat)
          mesh.rotation.x = Math.PI * -0.5
          scene.add(mesh)
        }
        {
```

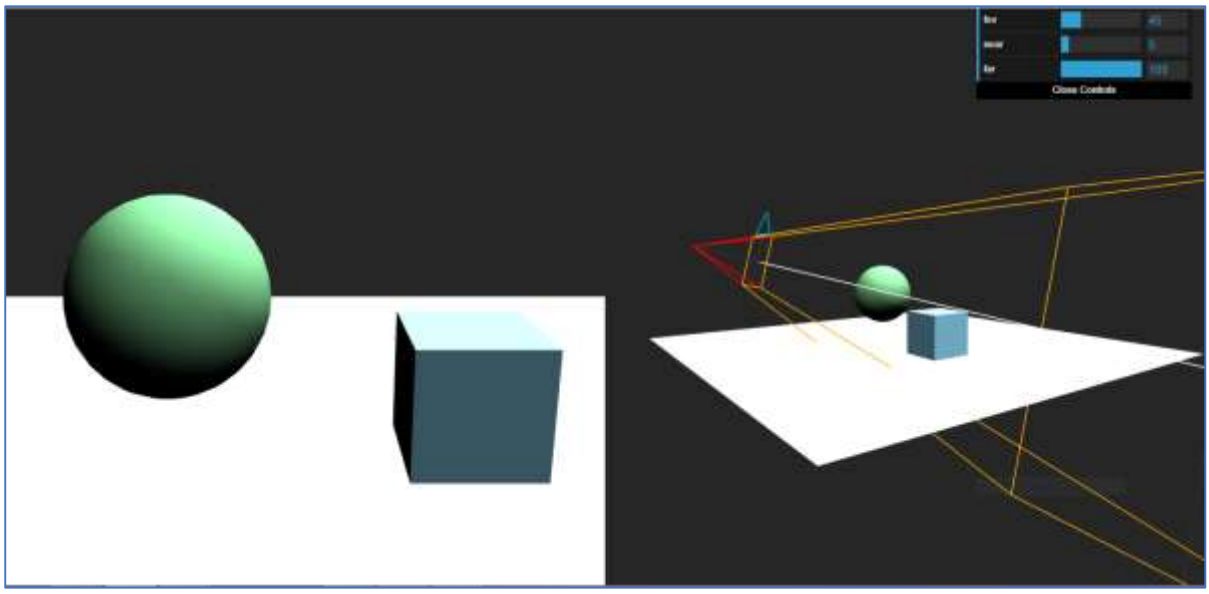
```
    const cubeSize = 4
    const cubeGeo = new THREE.BoxGeometry(cubeSize, cubeSize, cubeSize)
    const cubeMat = new THREE.MeshLambertMaterial({ color: 0x87ceeb })
    const mesh = new THREE.Mesh(cubeGeo, cubeMat)
    mesh.position.set(cubeSize + 1, cubeSize / 2, 0)
    scene.add(mesh)
  }
  {
    const sphereRadius = 3
    const sphereWidthDivisions = 32
    const sphereHeightDivisions = 16
    const sphereGeo = new THREE.SphereGeometry(
      sphereRadius,
      sphereWidthDivisions,
      sphereHeightDivisions
    )
    const sphereMat = new THREE.MeshLambertMaterial({ color: 0x71ba80 })
    const mesh = new THREE.Mesh(sphereGeo, sphereMat)
    mesh.position.set(-sphereRadius - 1, sphereRadius + 2, 0)
    scene.add(mesh)
  }

  {
    const color = 0xffffff
    const intensity = 1
    const light = new THREE.DirectionalLight(color, intensity)
    light.position.set(0, 10, 5)
    light.target.position.set(-5, 0, 0)
    scene.add(light)
    scene.add(light.target)

    const light2 = new THREE.DirectionalLight(color, intensity)
    light2.position.set(0, 10, -5)
    light2.target.position.set(-5, 0, 0)
    scene.add(light2)
    scene.add(light2.target)
  }
```

```
        function resizeRendererToDisplaySize(renderer) {
          const canvas = renderer.domElement
          const width = canvas.clientWidth
          const height = canvas.clientHeight
          const needResize = canvas.width !== width || canvas.height !== height
          if (needResize) {
            renderer.setSize(width, height, false)
          }
          return needResize
        }

        function setScissorForElement(elem) {
          const canvasRect = canvas.getBoundingClientRect()
          const elemRect = elem.getBoundingClientRect()

          // compute a canvas relative rectangle
          const right = Math.min(elemRect.right, canvasRect.right) - canvasR
ect.left
          const left = Math.max(0, elemRect.left - canvasRect.left)
          const bottom = Math.min(elemRect.bottom, canvasRect.bottom) - canv
asRect.top
          const top = Math.max(0, elemRect.top - canvasRect.top)

          const width = Math.min(canvasRect.width, right - left)
          const height = Math.min(canvasRect.height, bottom - top)

          // setup the scissor to only render to that part of the canvas
          const positiveYUpBottom = canvasRect.height - bottom
          renderer.setScissor(left, positiveYUpBottom, width, height)
          renderer.setViewport(left, positiveYUpBottom, width, height)

          // return the aspect
          return width / height
        }

        function render() {
```

```
        resizeRendererToDisplaySize(renderer)

        // turn on the scissor
        renderer.setScissorTest(true)

        // render the original view
        {
          const aspect = setScissorForElement(view1Elem)

          // adjust the camera for this aspect
          camera.aspect = aspect
          camera.updateProjectionMatrix()
          cameraHelper.update()

          // don't draw the camera helper in the original view
          cameraHelper.visible = false

          scene.background.set(0x262626)

          // render
          renderer.render(scene, camera)
        }

        // render from the 2nd camera
        {
          const aspect = setScissorForElement(view2Elem)

          // adjust the camera for this aspect
          camera2.aspect = aspect
          camera2.updateProjectionMatrix()

          // draw the camera helper in the 2nd view
          cameraHelper.visible = true

          scene.background.set(0x262626)

          renderer.render(scene, camera2)
```

```
          }

          requestAnimationFrame(render)
        }

        requestAnimationFrame(render)
      }

      main()
    </script>
  </body>
</html>
```

## Output



## OrthographicCamera

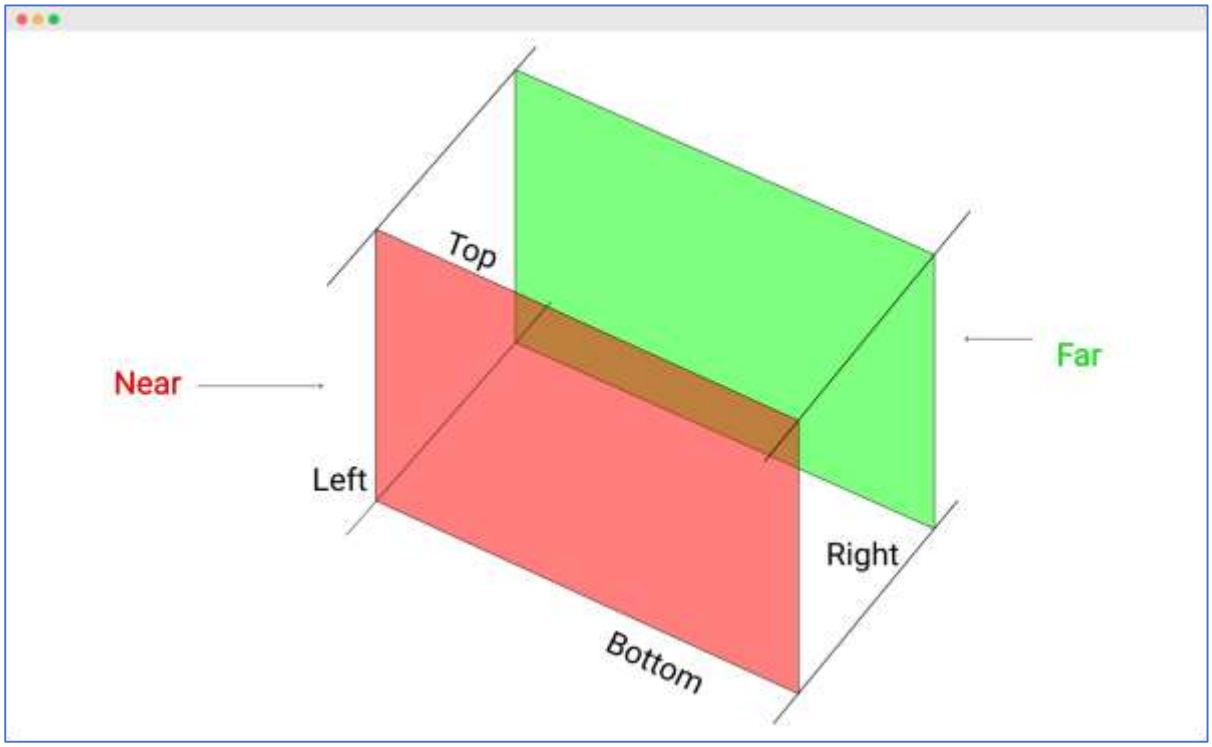
The 2nd most common camera is the `OrthographicCamera`. It specifies a box with the settings left, right top, bottom, near, and far. It represents three-dimensional objects in two dimensions.

```
const camera = new THREE.OrthographicCamera(left, right, top, bottom, near,
far)
```

All the six attributes are the borders of the box; The camera renders only the objects inside the box.

- `left` - Camera left the plane.
- `right` - Camera right plane.
- `top` - Camera top plane.

- `bottom` - Camera bottom plane.
- `near` - Camera near plane.
- `far` - Camera far plane.




Check out the following example:

## orthographic-cam.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Orthographic camera</title>
    <style>
      html,
      body {
        margin: 0;
        height: 100%;
      }
      #threejs-container {
        width: 100%;
```

```
        height: 100%;
        display: block;
      }
      .split {
        position: absolute;
        left: 0;
        top: 0;
        width: 100%;
        height: 100%;
        display: flex;
      }
      .split > div {
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <canvas id="threejs-container"></canvas>
    <div class="split">
      <div id="view1" tabindex="1"></div>
      <div id="view2" tabindex="2"></div>
    </div>

    <script type="module">
      // Three.js - Cameras - Orthographic 2 views
      // from https://threejsfundamentals.org/threejs/threejs-cameras-
orthographic-2-scenes.html

      import { OrbitControls } from "https://threejs.org/examples/jsm/contro
ls/OrbitControls.js"

      function main() {
        const canvas = document.querySelector('#threejs-container')
```

```
        const view1Elem = document.querySelector('#view1')
        const view2Elem = document.querySelector('#view2')
        const renderer = new THREE.WebGLRenderer({ canvas, antialias: true })

        const size = 1
        const near = 5
        const far = 50
        const camera = new THREE.OrthographicCamera(-size, size, size, -
size, near, far)
        camera.zoom = 0.2
        camera.position.set(0, 10, 20)

        const cameraHelper = new THREE.CameraHelper(camera)

        class MinMaxGUIHelper {
          constructor(obj, minProp, maxProp, minDif) {
            this.obj = obj
            this.minProp = minProp
            this.maxProp = maxProp
            this.minDif = minDif
          }
          get min() {
            return this.obj[this.minProp]
          }
          set min(v) {
            this.obj[this.minProp] = v
            this.obj[this.maxProp] = Math.max(this.obj[this.maxProp], v + th
is.minDif)
          }
          get max() {
            return this.obj[this.maxProp]
          }
          set max(v) {
            this.obj[this.maxProp] = v
            this.min = this.min // this will call the min setter
          }
        }
```

```
const gui = new dat.GUI()
gui.add(camera, 'zoom', 0.01, 1, 0.01).listen()
const minMaxGUIHelper = new MinMaxGUIHelper(camera, 'near', 'far', 0.1)
gui.add(minMaxGUIHelper, 'min', 0.1, 50, 0.1).name('near')
gui.add(minMaxGUIHelper, 'max', 0.1, 50, 0.1).name('far')

const controls = new OrbitControls(camera, view1Elem)
controls.target.set(0, 5, 0)
controls.update()

const camera2 = new THREE.PerspectiveCamera(
  60, // fov
  2, // aspect
  0.1, // near
  500 // far
)
camera2.position.set(16, 28, 40)
camera2.lookAt(0, 5, 0)

const controls2 = new OrbitControls(camera2, view2Elem)
controls2.target.set(0, 5, 0)
controls2.update()

const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)
scene.add(cameraHelper)

{
  const planeSize = 40

  const planeGeo = new THREE.PlaneGeometry(planeSize, planeSize)
  const planeMat = new THREE.MeshLambertMaterial({
    color: 0xffffff,
    side: THREE.DoubleSide
  })
  const mesh = new THREE.Mesh(planeGeo, planeMat)
```

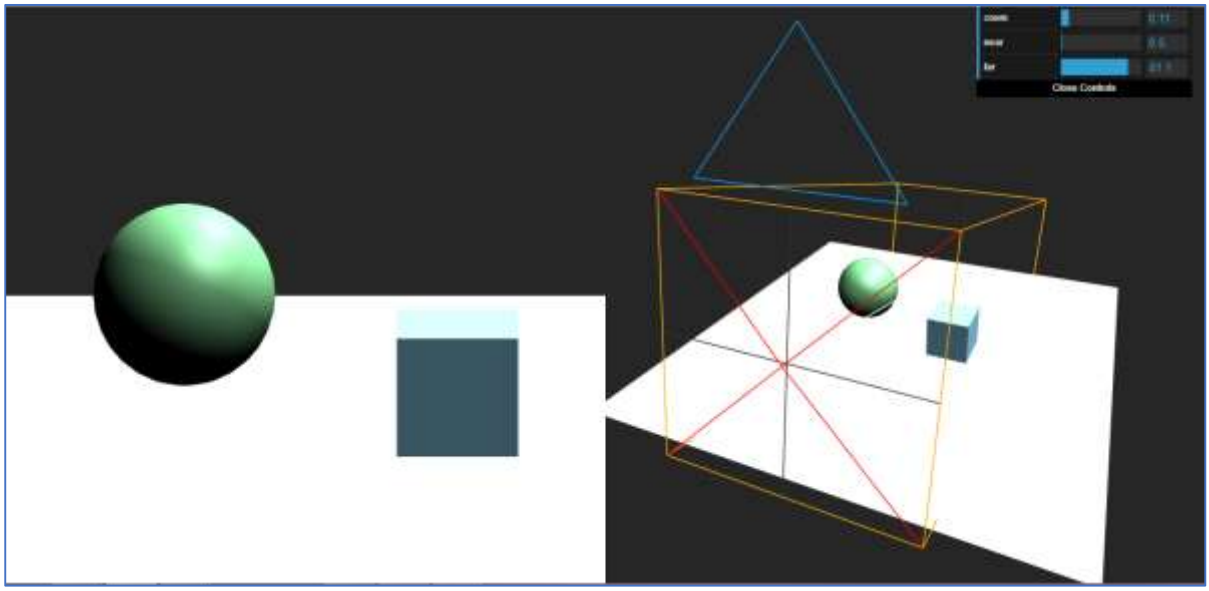
```
    mesh.rotation.x = Math.PI * -0.5
    scene.add(mesh)
  }
  {
    const cubeSize = 4
    const cubeGeo = new THREE.BoxGeometry(cubeSize, cubeSize, cubeSize)
    const cubeMat = new THREE.MeshPhongMaterial({ color: 0x87ceeb })
    const mesh = new THREE.Mesh(cubeGeo, cubeMat)
    mesh.position.set(cubeSize + 1, cubeSize / 2, 0)
    scene.add(mesh)
  }
  {
    const sphereRadius = 3
    const sphereWidthDivisions = 32
    const sphereHeightDivisions = 16
    const sphereGeo = new THREE.SphereGeometry(
      sphereRadius,
      sphereWidthDivisions,
      sphereHeightDivisions
    )
    const sphereMat = new THREE.MeshPhongMaterial({ color: 0x71ba80 })
    const mesh = new THREE.Mesh(sphereGeo, sphereMat)
    mesh.position.set(-sphereRadius - 1, sphereRadius + 2, 0)
    scene.add(mesh)
  }

  {
    const color = 0xffffff
    const intensity = 1
    const light = new THREE.DirectionalLight(color, intensity)
    light.position.set(0, 10, 5)
    light.target.position.set(-5, 0, 0)
    scene.add(light)
    scene.add(light.target)

    const light2 = new THREE.DirectionalLight(color, intensity)
    light2.position.set(0, 10, -5)
```

```
          light2.target.position.set(-5, 0, 0)
          scene.add(light2)
          scene.add(light2.target)
        }

        function resizeRendererToDisplaySize(renderer) {
          const canvas = renderer.domElement
          const width = canvas.clientWidth
          const height = canvas.clientHeight
          const needResize = canvas.width !== width || canvas.height !== height
          if (needResize) {
            renderer.setSize(width, height, false)
          }
          return needResize
        }

        function setScissorForElement(elem) {
          const canvasRect = canvas.getBoundingClientRect()
          const elemRect = elem.getBoundingClientRect()

          // compute a canvas relative rectangle
          const right = Math.min(elemRect.right, canvasRect.right) - canvasR
ect.left
          const left = Math.max(0, elemRect.left - canvasRect.left)
          const bottom = Math.min(elemRect.bottom, canvasRect.bottom) - canv
asRect.top
          const top = Math.max(0, elemRect.top - canvasRect.top)

          const width = Math.min(canvasRect.width, right - left)
          const height = Math.min(canvasRect.height, bottom - top)

          // setup the scissor to only render to that part of the canvas
          const positiveYUpBottom = canvasRect.height - bottom
          renderer.setScissor(left, positiveYUpBottom, width, height)
          renderer.setViewport(left, positiveYUpBottom, width, height)

          // return the aspect
```

```
    return width / height
  }

  function render() {
    resizeRendererToDisplaySize(renderer)

    // turn on the scissor
    renderer.setScissorTest(true)

    // render the original view
    {
      const aspect = setScissorForElement(view1Elem)

      // update the camera for this aspect
      camera.left = -aspect
      camera.right = aspect
      camera.updateProjectionMatrix()
      cameraHelper.update()

      // don't draw the camera helper in the original view
      cameraHelper.visible = false

      scene.background.set(0x262626)
      renderer.render(scene, camera)
    }

    // render from the 2nd camera
    {
      const aspect = setScissorForElement(view2Elem)

      // update the camera for this aspect
      camera2.aspect = aspect
      camera2.updateProjectionMatrix()

      // draw the camera helper in the 2nd view
      cameraHelper.visible = true
```

```
            scene.background.set(0x262626)
            renderer.render(scene, camera2)
          }

          requestAnimationFrame(render)
        }

        requestAnimationFrame(render)
      }

      main()
    </script>
  </body>
</html>
```

## Output



## Making the Camera Follow an Object

In the `animation` function, we use the `camera.lookAt` function to point the camera to the position function of the object. We do this in every frame that we render. It looks like the camera is exactly following the object's position.

```
function animate() {
  const object = scene.getObjectByName('sphere')
  renderer.render(scene, camera)
```

```
  camera.lookAt(object.position)
  requestAnimationFrame(render)
}
```

You can move the camera around the scene using camera controls. Three.js has many camera controls you can use to control the camera throughout a scene. You have to get the controls separately from GitHub. The Three.js library does not include these.

## Orbit Controls

Orbit controls allow the camera to orbit around the center of the scene. You can also provide a target to move around. You can add `Orbitcontrols` in a few simple steps.

Create a new instance of the orbit controls and pass the camera.

```
const controls = new THREE.OrbitControls(camera, render.domElement)
```

Update the controls for every frame. You can simply do it in your animation loop.

```
function animate() {
  // any other animations
  controls.update()
  requestAnimationFrame(render)
}
```

Refer to this example for some basic settings.

### orbit-controls.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Orbit Controls</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-system, BlinkMacSystemFont, 'Segoe UI', Roboto,
          Oxygen, Ubuntu, Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
```

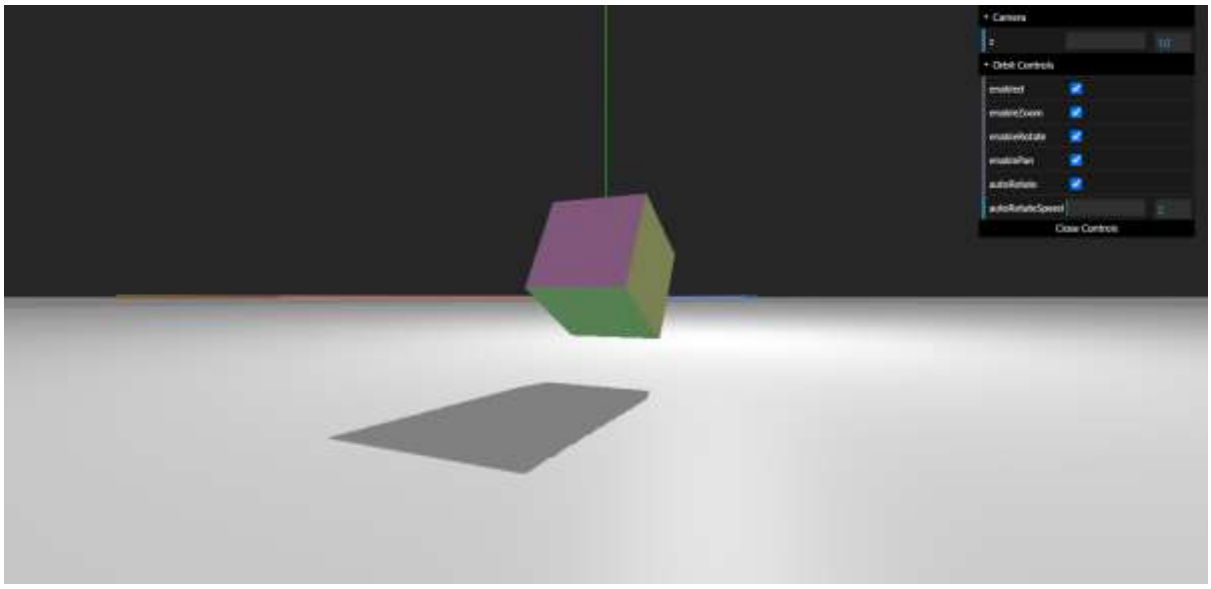
```
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>


  </head>
  <body>
    <div id="container"></div>
    <script type="module">
      // Adding orbit controls to Three.js application
      // In this example, autorotate is set to true, so the camera rotates a
round the cube


      import { OrbitControls } from "https://threejs.org/examples/jsm/contro
ls/OrbitControls.js"
      // controls
      const gui = new dat.GUI()
      console.log('start')


      // sizes
      let width = window.innerWidth
      let height = window.innerHeight


      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)
```

```
console.log(scene.children)

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(window.innerWidth, window.innerHeight)
renderer.shadowMap.enabled = true
renderer.shadowMap.type = THREE.PCFSoftShadowMap
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// lights
const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
scene.add(ambientLight)

const light = new THREE.PointLight(0xffffff, 0.5)
light.position.set(0, 10, 10)

// for shadow
light.castShadow = true
light.shadow.mapSize.width = 1024
light.shadow.mapSize.height = 1024
light.shadow.camera.near = 0.5
light.shadow.camera.far = 100
scene.add(light)

// camera
const camera = new THREE.PerspectiveCamera(60, width / height, 0.1, 1000)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z', 10, 80, 1)
camFolder.open()

const controls = new OrbitControls(camera, renderer.domElement)
controls.autoRotate = true

const ocFolder = gui.addFolder('Orbit Controls')
ocFolder.add(controls, 'enabled')
ocFolder.add(controls, 'enableZoom')
```

```
ocFolder.add(controls, 'enableRotate')
ocFolder.add(controls, 'enablePan')
ocFolder.add(controls, 'autoRotate')
ocFolder.add(controls, 'autoRotateSpeed', 1, 100, 1)
ocFolder.open()

// axes
const axesHelper = new THREE.AxesHelper(20)
scene.add(axesHelper)

// plane
const planeGeometry = new THREE.PlaneGeometry(1000, 1000)
const plane = new THREE.Mesh(
  planeGeometry,
  new THREE.MeshPhongMaterial({ color: 0xffffff, side: THREE.DoubleSide })
)
plane.rotateX(-Math.PI / 2)
plane.position.y = -1.75
plane.receiveShadow = true
scene.add(plane)

// cube
console.log('cube')
const geometry = new THREE.BoxGeometry(2, 2, 2)
const matArray = [
  new THREE.MeshPhongMaterial({ color: 0xff8b8b }),
  new THREE.MeshPhongMaterial({ color: 0xf5ffa2 }),
  new THREE.MeshPhongMaterial({ color: 0xb5dccd }),
  new THREE.MeshPhongMaterial({ color: 0xaaffa2 }),
  new THREE.MeshPhongMaterial({ color: 0x9fd1ff }),
  new THREE.MeshPhongMaterial({ color: 0xffaef7 }),
]

const cube = new THREE.Mesh(geometry, matArray)
cube.position.set(0, 0.5, 0)
cube.rotateX(Math.PI / 6)
cube.castShadow = true
```

```
      cube.receiveShadow = true
      camera.lookAt(cube.position)
      scene.add(cube)

      // responsiveness
      window.addEventListener('resize', () => {
        width = window.innerWidth
        height = window.innerHeight
        camera.aspect = width / height
        camera.updateProjectionMatrix()

        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // animation
      function animate() {
        requestAnimationFrame(animate)

        //cube.rotation.x += 0.005
        //cube.rotation.y += 0.01

        controls.update()

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
      console.log(scene.children)
    </script>
  </body>
</html>
```

## Output



There are many other settings to make your experience better. The code is well-documented; you can refer the codes here.

## Trackball Controls

TrackballControls is similar to Orbit controls. However, it does not maintain a constant camera up vector. That means that the camera can orbit past its polar extremes. It won't flip to stay the right side up. You can add it just like the previous one.

```
const controls = new THREE.TrackballControls(camera, render.domElement)
```

Check out the following example.

### trackball-controls.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <title>Three.js - Trackball controls</title>
    <meta charset="utf-8" />
    <meta
      name="viewport"
      content="width=device-width, user-scalable=no, minimum-
scale=1.0, maximum-scale=1.0"
    />
    <style>
      body {
        background-color: #ccc;
```

```
        color: #000;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      a {
        color: #f00;
      }
      #info {
        position: absolute;
        top: 0px;
        width: 100%;
        padding: 10px;
        box-sizing: border-box;
        text-align: center;
        -moz-user-select: none;
        -webkit-user-select: none;
        -ms-user-select: none;
        user-select: none;
        pointer-events: none;
        z-index: 1; /* TODO Solve this in HTML */
      }

      a,
      button,
      input,
      select {
        pointer-events: auto;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
    <script src="http://mrdoob.github.io/stats.js/build/stats.min.js"></scri
pt>
  </head>
  <body>
```

```
    <div id="info">
      <a href="https://threejs.org" target="_blank" rel="noopener">three.js</a> - trackball
      controls<br />
      MOVE mouse &amp;amp; press LEFT/A: rotate, MIDDLE/S: zoom, RIGHT/D: pan
    </div>

    <script type="module">
      // Adding trackball controls
      // You can rotate camera any direction you want using Trackball controls

      import { TrackballControls } from 'https://threejs.org/examples/jsm/controls/TrackballControls.js'

      let perspectiveCamera, orthographicCamera, controls, scene, renderer, stats

      const params = {
        orthographicCamera: false
      }

      const frustumSize = 400

      init()
      animate()

      function init() {
        const aspect = window.innerWidth / window.innerHeight

        perspectiveCamera = new THREE.PerspectiveCamera(60, aspect, 1, 1000)
        perspectiveCamera.position.z = 500

        orthographicCamera = new THREE.OrthographicCamera(
          (frustumSize * aspect) / -2,
          (frustumSize * aspect) / 2,
          frustumSize / 2,
          frustumSize / -2,
          1,
```

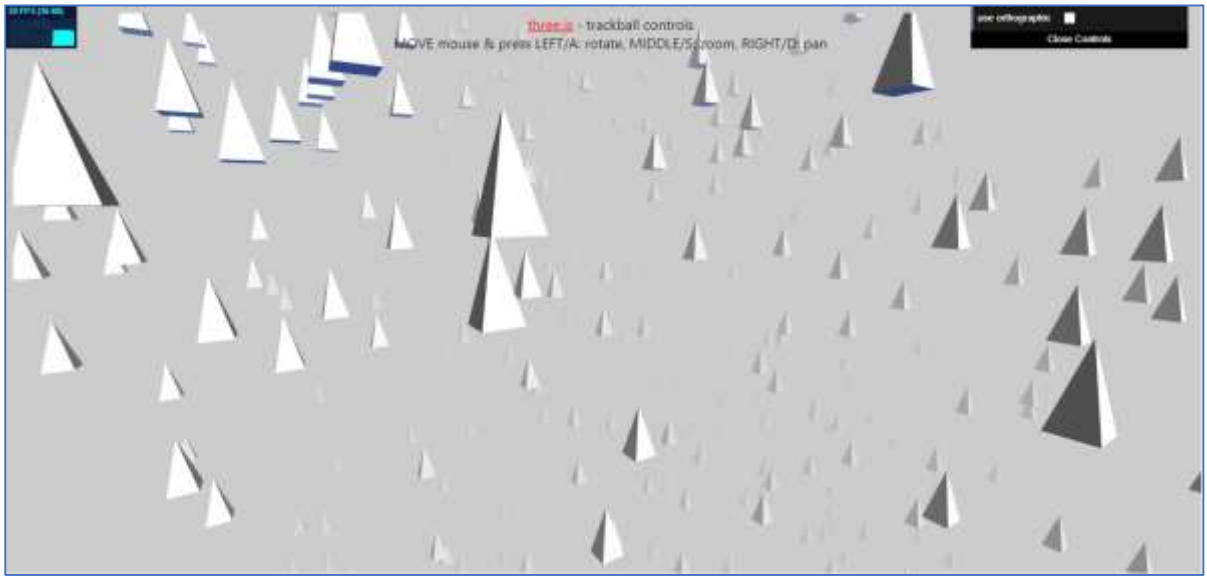
```
          1000
        )
        orthographicCamera.position.z = 500

        // world

        scene = new THREE.Scene()
        scene.background = new THREE.Color(0xcccccc)
        scene.fog = new THREE.FogExp2(0xcccccc, 0.002)

        const geometry = new THREE.CylinderGeometry(0, 10, 30, 4, 1)
        const material = new THREE.MeshPhongMaterial({ color: 0xffffff, flat
Shading: true })

        for (let i = 0; i < 500; i++) {
          const mesh = new THREE.Mesh(geometry, material)
          mesh.position.x = (Math.random() - 0.5) * 1000
          mesh.position.y = (Math.random() - 0.5) * 1000
          mesh.position.z = (Math.random() - 0.5) * 1000
          mesh.updateMatrix()
          mesh.matrixAutoUpdate = false
          scene.add(mesh)
        }

        // lights

        const dirLight1 = new THREE.DirectionalLight(0xffffff)
        dirLight1.position.set(1, 1, 1)
        scene.add(dirLight1)

        const dirLight2 = new THREE.DirectionalLight(0x002288)
        dirLight2.position.set(-1, -1, -1)
        scene.add(dirLight2)

        const ambientLight = new THREE.AmbientLight(0x222222)
        scene.add(ambientLight)
```

```
    // renderer

    renderer = new THREE.WebGLRenderer({ antialias: true })
    renderer.setPixelRatio(window.devicePixelRatio)
    renderer.setSize(window.innerWidth, window.innerHeight)
    document.body.appendChild(renderer.domElement)

    stats = new Stats()
    document.body.appendChild(stats.dom)

    //

    const gui = new dat.GUI()
    gui
      .add(params, 'orthographicCamera')
      .name('use orthographic')
      .onChange(function (value) {
        controls.dispose()

        createControls(value ? orthographicCamera : perspectiveCamera)
      })

    //

    window.addEventListener('resize', onWindowResize)

    createControls(perspectiveCamera)
  }

  function createControls(camera) {
    controls = new TrackballControls(camera, renderer.domElement)

    controls.rotateSpeed = 1.0
    controls.zoomSpeed = 1.2
    controls.panSpeed = 0.8

    controls.keys = ['KeyA', 'KeyS', 'KeyD']
```

```
      }

      function onWindowResize() {
        const aspect = window.innerWidth / window.innerHeight

        perspectiveCamera.aspect = aspect
        perspectiveCamera.updateProjectionMatrix()

        orthographicCamera.left = (-frustumSize * aspect) / 2
        orthographicCamera.right = (frustumSize * aspect) / 2
        orthographicCamera.top = frustumSize / 2
        orthographicCamera.bottom = -frustumSize / 2
        orthographicCamera.updateProjectionMatrix()

        renderer.setSize(window.innerWidth, window.innerHeight)

        controls.handleResize()
      }

      function animate() {
        requestAnimationFrame(animate)

        controls.update()

        stats.update()

        render()
      }

      function render() {
        const camera = params.orthographicCamera ? orthographicCamera : pers
pectiveCamera

        renderer.render(scene, camera)
      }
    </script>
  </body>
```

```
</html>
```

## Output




## Fly Controls

These are flight simulator-like controls. Move and steer with the keyboard and the mouse. You can arbitrarily transform the camera in 3D space without any limitations (e.g., focus on a specific target).

```
const controls = new THREE.FlyControls(camera, render.domElement)
```

## PointerLock Controls

The `PointerLockControls` implements the inbuilt browsers Pointer Lock API. It allows you to control the camera just like in a first-person in 3D games.

```
const controls = new PointerLockControls(camera, document.body)
```

### pointerlock-controls.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <title>Three.js - Pointerlock controls</title>
    <meta charset="utf-8" />
    <meta
      name="viewport"
      content="width=device-width, user-scalable=no, minimum-
scale=1.0, maximum-scale=1.0"
```

```
    />
    <link type="text/css" rel="stylesheet" href="main.css" />
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
      }
      #blocker {
        position: absolute;
        width: 100%;
        height: 100%;
        background-color: rgba(0, 0, 0, 0.5);
      }

      #instructions {
        width: 100%;
        height: 100%;

        display: -webkit-box;
        display: -moz-box;
        display: box;

        -webkit-box-orient: horizontal;
        -moz-box-orient: horizontal;
        box-orient: horizontal;

        -webkit-box-pack: center;
        -moz-box-pack: center;
        box-pack: center;

        -webkit-box-align: center;
        -moz-box-align: center;
        box-align: center;

        color: #ffffff;
        text-align: center;
```

```
        font-family: Arial;
        font-size: 14px;
        line-height: 24px;

        cursor: pointer;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
  </head>
  <body>
    <div id="blocker">
      <div id="instructions">
        <span style="font-size: 36px">Click to play</span>
        <br /><br />
        Move: WASD<br />
        Jump: SPACE<br />
        Look: MOUSE
      </div>
    </div>

    <script type="module">
      // Adding pointer lock controls to Three.js
      // You can move around the scene using mouse and keyboard

      import { PointerLockControls } from 'https://threejs.org/examples/jsm/
controls/PointerLockControls.js'

      let camera, scene, renderer, controls

      const objects = []

      let raycaster

      let moveForward = false
      let moveBackward = false
      let moveLeft = false
```

```
      let moveRight = false
      let canJump = false

      let prevTime = performance.now()
      const velocity = new THREE.Vector3()
      const direction = new THREE.Vector3()
      const vertex = new THREE.Vector3()
      const color = new THREE.Color()

      init()
      animate()

      function init() {
        camera = new THREE.PerspectiveCamera(75, window.innerWidth / window.
innerHeight, 1, 1000)
        camera.position.y = 10

        scene = new THREE.Scene()
        scene.background = new THREE.Color(0xffffff)
        scene.fog = new THREE.Fog(0xffffff, 0, 750)

        const light = new THREE.HemisphereLight(0xeeeeff, 0x777788, 0.75)
        light.position.set(0.5, 1, 0.75)
        scene.add(light)

        controls = new PointerLockControls(camera, document.body)

        const blocker = document.getElementById('blocker')
        const instructions = document.getElementById('instructions')

        instructions.addEventListener('click', function () {
          controls.lock()
        })

        controls.addEventListener('lock', function () {
          instructions.style.display = 'none'
          blocker.style.display = 'none'
```

```
        })

        controls.addEventListener('unlock', function () {
          blocker.style.display = 'block'
          instructions.style.display = ''
        })

        scene.add(controls.getObject())

        const onKeyDown = function (event) {
          switch (event.code) {
            case 'ArrowUp':
            case 'KeyW':
              moveForward = true
              break

            case 'ArrowLeft':
            case 'KeyA':
              moveLeft = true
              break

            case 'ArrowDown':
            case 'KeyS':
              moveBackward = true
              break

            case 'ArrowRight':
            case 'KeyD':
              moveRight = true
              break

            case 'Space':
              if (canJump === true) velocity.y += 350
              canJump = false
              break
          }
        }
```

```
        const onKeyUp = function (event) {
          switch (event.code) {
            case 'ArrowUp':
            case 'KeyW':
              moveForward = false
              break

            case 'ArrowLeft':
            case 'KeyA':
              moveLeft = false
              break

            case 'ArrowDown':
            case 'KeyS':
              moveBackward = false
              break

            case 'ArrowRight':
            case 'KeyD':
              moveRight = false
              break
          }
        }

        document.addEventListener('keydown', onKeyDown)
        document.addEventListener('keyup', onKeyUp)

        raycaster = new THREE.Raycaster(new THREE.Vector3(), new THREE.Vecto
r3(0, -1, 0), 0, 10)

        // floor

        let floorGeometry = new THREE.PlaneGeometry(2000, 2000, 100, 100)
        floorGeometry.rotateX(-Math.PI / 2)

        // vertex displacement
```

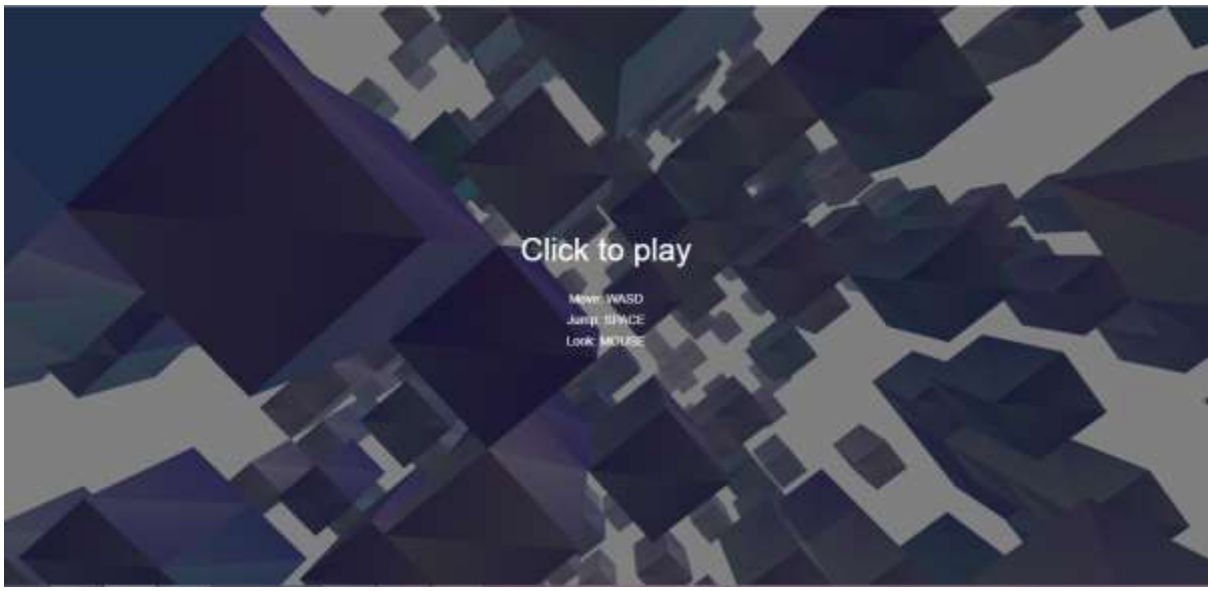
```
        let position = floorGeometry.attributes.position

        for (let i = 0, l = position.count; i < l; i++) {
          vertex.fromBufferAttribute(position, i)

          vertex.x += Math.random() * 20 - 10
          vertex.y += Math.random() * 2
          vertex.z += Math.random() * 20 - 10

          position.setXYZ(i, vertex.x, vertex.y, vertex.z)
        }

        floorGeometry = floorGeometry.toNonIndexed() // ensure each face has
 unique vertices

        position = floorGeometry.attributes.position
        const colorsFloor = []

        for (let i = 0, l = position.count; i < l; i++) {
          color.setHSL(Math.random() * 0.3 + 0.5, 0.75, Math.random() * 0.25
 + 0.75)
          colorsFloor.push(color.r, color.g, color.b)
        }

        floorGeometry.setAttribute('color', new THREE.Float32BufferAttribute
(colorsFloor, 3))

        const floorMaterial = new THREE.MeshBasicMaterial({ vertexColors: true })

        const floor = new THREE.Mesh(floorGeometry, floorMaterial)
        scene.add(floor)

        // objects

        const boxGeometry = new THREE.BoxGeometry(20, 20, 20).toNonIndexed()

        position = boxGeometry.attributes.position
```

```
        const colorsBox = []

        for (let i = 0, l = position.count; i < l; i++) {
          color.setHSL(Math.random() * 0.3 + 0.5, 0.75, Math.random() * 0.25 + 0.75)
          colorsBox.push(color.r, color.g, color.b)
        }

        boxGeometry.setAttribute('color', new THREE.Float32BufferAttribute(c
olorsBox, 3))

        for (let i = 0; i < 500; i++) {
          const boxMaterial = new THREE.MeshPhongMaterial({
            specular: 0xffffff,
            flatShading: true,
            vertexColors: true
          })
          boxMaterial.color.setHSL(Math.random() * 0.2 + 0.5, 0.75, Math.ran
dom() * 0.25 + 0.75)

          const box = new THREE.Mesh(boxGeometry, boxMaterial)
          box.position.x = Math.floor(Math.random() * 20 - 10) * 20
          box.position.y = Math.floor(Math.random() * 20) * 20 + 10
          box.position.z = Math.floor(Math.random() * 20 - 10) * 20

          scene.add(box)
          objects.push(box)
        }

        //

        renderer = new THREE.WebGLRenderer({ antialias: true })
        renderer.setPixelRatio(window.devicePixelRatio)
        renderer.setSize(window.innerWidth, window.innerHeight)
        document.body.appendChild(renderer.domElement)

        //
```

```
    window.addEventListener('resize', onWindowResize)
  }

  function onWindowResize() {
    camera.aspect = window.innerWidth / window.innerHeight
    camera.updateProjectionMatrix()

    renderer.setSize(window.innerWidth, window.innerHeight)
  }

  function animate() {
    requestAnimationFrame(animate)

    const time = performance.now()

    if (controls.isLocked === true) {
      raycaster.ray.origin.copy(controls.getObject().position)
      raycaster.ray.origin.y -= 10

      const intersections = raycaster.intersectObjects(objects)

      const onObject = intersections.length > 0

      const delta = (time - prevTime) / 1000

      velocity.x -= velocity.x * 10.0 * delta
      velocity.z -= velocity.z * 10.0 * delta

      velocity.y -= 9.8 * 100.0 * delta // 100.0 = mass

      direction.z = Number(moveForward) - Number(moveBackward)
      direction.x = Number(moveRight) - Number(moveLeft)
      direction.normalize() // this ensures consistent movements in all directions

      if (moveForward || moveBackward) velocity.z -= direction.z * 400.0 * delta
      if (moveLeft || moveRight) velocity.x -= direction.x * 400.0 * delta
```

```
          if (onObject === true) {
            velocity.y = Math.max(0, velocity.y)
            canJump = true
          }

          controls.moveRight(-velocity.x * delta)
          controls.moveForward(-velocity.z * delta)

          controls.getObject().position.y += velocity.y * delta // new behavior

          if (controls.getObject().position.y < 10) {
            velocity.y = 0
            controls.getObject().position.y = 10

            canJump = true
          }
        }

        prevTime = time

        renderer.render(scene, camera)
      }
    </script>
  </body>
</html>
```

## Output




In this chapter, we have seen the most useful controls. Some developers are creating more useful controls for Three.js. You can see some other controls here, well documented and easy to use.

Lights make the objects visible, similarly, in Three.js `THREE.Light` lights up the scene and makes some things visible. Not all materials are affected by lighting. The `MeshBasicMaterial` and `MeshNormalMaterial` are self-illuminating, so they don't need lighting to be visible within a scene. However, most of the other materials do, the `MeshLambertMaterial`, `MeshPhongMaterial`, `MeshStandardMaterial`, `MeshPhysicalMaterial`, and `MeshToonMaterial`. We'll discuss more materials in further chapters. In this chapter, we'll focus on different types of lights in Three.js.

Every light has `color` and `intensity` properties.

- `color` - (optional) hexadecimal color of the light. Default is 0xffffff (white).
- `intensity` - (optional) numeric value of the light's strength/intensity. Default is 1.

## Ambient Light

It is the most basic light, which illuminates the whole scene equally. Light is spread equally in all directions and distances, so it cannot cast shadows. Ambient light affects all lit objects in the scene equally, and it adds color to the object's material.

```
const light = THREE.AmbientLight(color, intensity)
```

Play around with the code in the following example with different colors and intensities.

### ambient.html

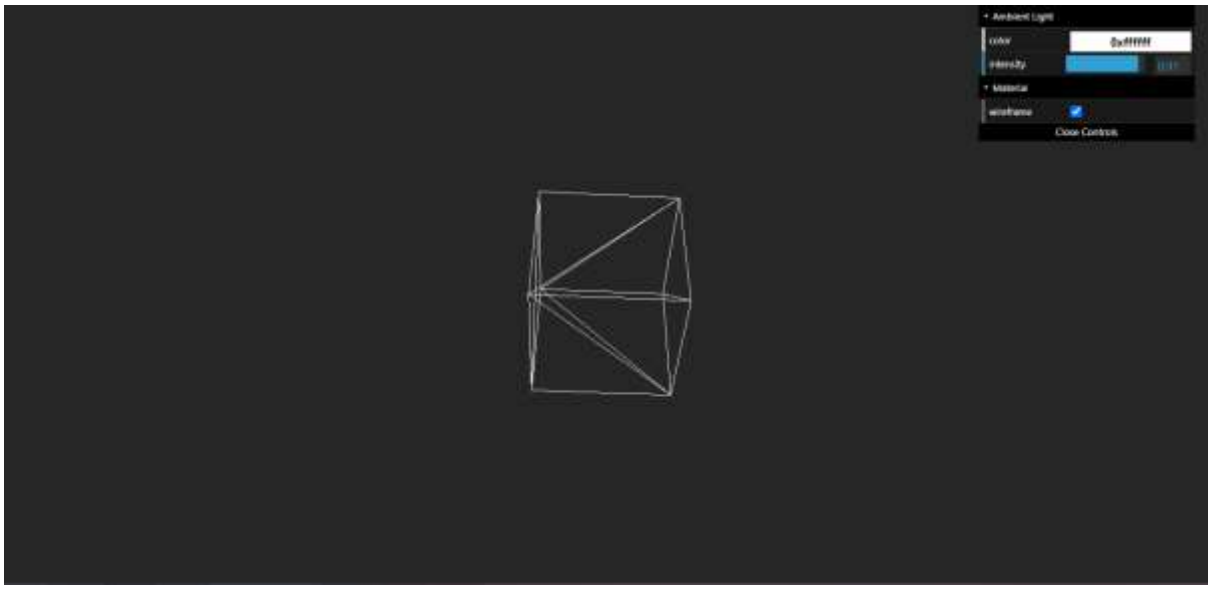
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - AmbientLight</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
```

```
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="container"></div>
    <script type="module">
      // Adding Ambient to the scene
      // without this light you cannot see the color of the cube

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
```

```
// lights
const light = new THREE.AmbientLight(0xffffff, 1)
scene.add(light)

// light controls
const lightColor = {
  color: light.color.getHex()
}
const lightFolder = gui.addFolder('Ambient Light')
lightFolder.addColor(lightColor, 'color').onChange(() => {
  light.color.set(lightColor.color)
})
lightFolder.add(light, 'intensity', 0, 1, 0.01)
lightFolder.open()

// cube
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshStandardMaterial({
  color: 0xffffff,
  wireframe: true
})
const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const cube = new THREE.Mesh(geometry, material)
scene.add(cube)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
```

```
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

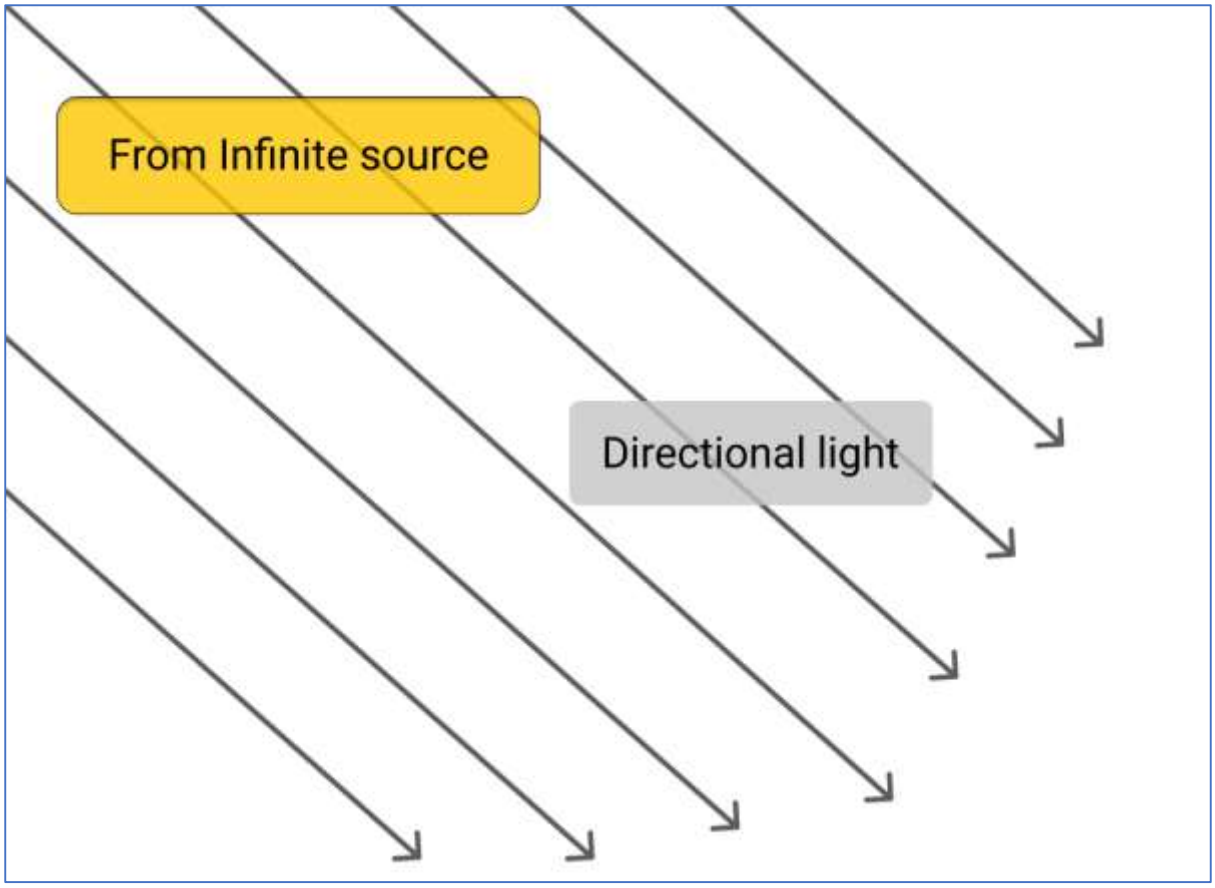
## Output



## Directional Light

Directional light comes from a specific point and is emitted directly from far away to the target. All the light rays it sends out are parallel to each other. An excellent example of this is the sun.

```
const light = THREE.DirectionalLight(color, intensity)
light.position.set(2, 3, 4)
```




## Casting Shadows

The light that is coming from a specific direction can cast shadows. First, we should make the scene ready for casting shadows.

### Step - 1

We should first tell the renderer that we want to enable shadows. Casting shadows is an expensive operation. `WebGLRenderer` only supports this functionality. It uses Shadow mapping, a technique specific to WebGL, performed directly on the GPU.

```
renderer.shadowMapEnabled = true
```

The above line of code tells the renderer to cast shadows in the scene.

**Note**: Three.js, by default, uses shadow maps. Shadow map works for light that casts shadows. The scene renders all objects marked to cast shadows from the point of view of the light.

If your shadow looks a bit blocky around its edges, it means the shadow map is too small. To increase the shadow map size, you can define `shadowMapHeight` and `shadowMapWidht` properties for the light. Alternatively, you can also try to change the `shadowMapType` property of `WebGLRenderer`. You can set this to `THREE.BasicShadowMap`, `THREE.PCFShadowMap`, or `THREE.PCFSoftShadowMap`.

```
// to antialias the shadow
```

```
renderer.shadowMapType = THREE.PCFSoftShadowMap

// or

directionalLight.shadowMapWidth = 2048
directionalLight.shadowMapHeight = 2048
```

## Step - 2

You should configure objects to cast shadows. You can inform Three.js which objects can cast shadows and which objects can receive shadows.

```
object.castShadow = true
object.recieveShadow = true
```

## Step - 3

All the above steps are the same for every light. The next step is to set up the shadow-related properties.

```
light.castShadow = true
light.shadow.camera.near = 10
light.shadow.camera.far = 100
light.shadow.camera.left = -50
light.shadow.camera.right = 50
light.shadow.camera.top = 50
light.shadow.camera.bottom = -50
```

The first property, `castShadow`, tells Three.js that this light casts shadows. As casting shadows is an expensive operation, we need to define the area where shadows can appear. You can do it with the `shadow.camera.near`, `shadow.camera.far`, and `shadow.camera.left`, etc. properties. With the above properties, we create a box-like area where Three.js render shadows.

Explore more in this example.

## directional.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Directional Light</title>
```

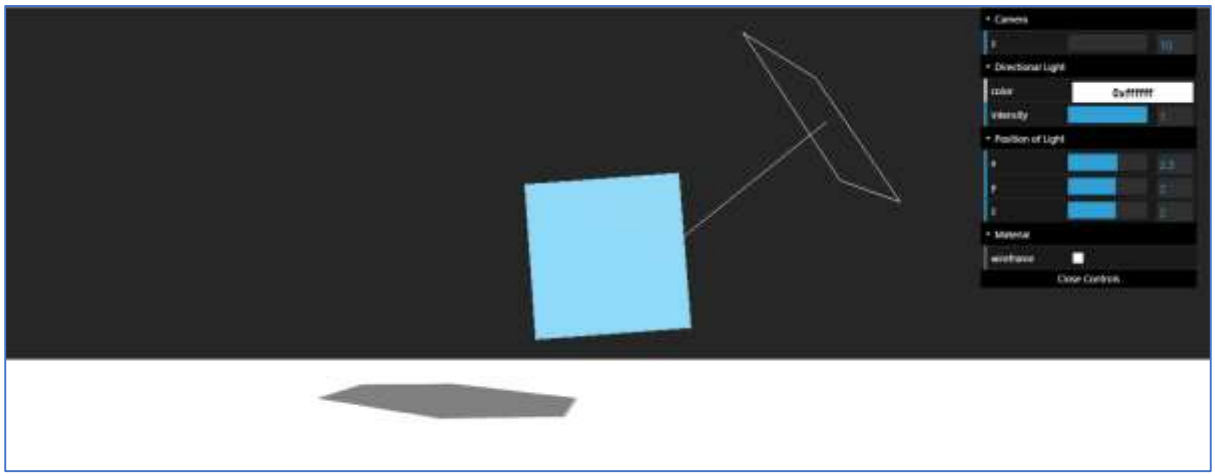
```
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="container"></div>
    <script type="module">
      // Adding directional light to the scene
      // The lights falls from the light only in one direction.
      // You can see the position of light using helpers provided in Three.j
s for debugging purposes

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
```

```
let height = window.innerHeight

// scene
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// camera
const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 1000)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z', 10, 80, 1)
camFolder.open()

// lights
const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
scene.add(ambientLight)
const light = new THREE.DirectionalLight()
light.position.set(2.5, 2, 2)
light.castShadow = true
light.shadow.mapSize.width = 512
light.shadow.mapSize.height = 512
light.shadow.camera.near = 0.5
light.shadow.camera.far = 100
scene.add(light)
const helper = new THREE.DirectionalLightHelper(light)
scene.add(helper)

// light controls
const lightColor = {
  color: light.color.getHex()
}
const lightFolder = gui.addFolder('Directional Light')
lightFolder.addColor(lightColor, 'color').onChange(() => {
  light.color.set(lightColor.color)
})
lightFolder.add(light, 'intensity', 0, 1, 0.01)
lightFolder.open()
```

```
      const directionalLightFolder = gui.addFolder('Position of Light')
      directionalLightFolder.add(light.position, 'x', -10, 10, 0.1)
      directionalLightFolder.add(light.position, 'y', -10, 10, 0.1)
      directionalLightFolder.add(light.position, 'z', -10, 10, 0.1)
      directionalLightFolder.open()

      // plane
      const planeGeometry = new THREE.PlaneGeometry(100, 20)
      const plane = new THREE.Mesh(planeGeometry, new THREE.MeshPhongMateria
l({ color: 0xffffff }))
      plane.rotateX(-Math.PI / 2)
      plane.position.y = -1.75
      plane.receiveShadow = true
      scene.add(plane)

      // cube
      const geometry = new THREE.BoxGeometry(2, 2, 2)
      const material = new THREE.MeshStandardMaterial({
        color: 0x87ceeb
      })
      const materialFolder = gui.addFolder('Material')
      materialFolder.add(material, 'wireframe')
      materialFolder.open()

      const cube = new THREE.Mesh(geometry, material)
      cube.position.set(0, 0.5, 0)
      cube.castShadow = true
      cube.receiveShadow = true
      scene.add(cube)

      // responsiveness
      window.addEventListener('resize', () => {
        width = window.innerWidth
        height = window.innerHeight
        camera.aspect = width / height
        camera.updateProjectionMatrix()
```

```
        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.shadowMap.enabled = true
      renderer.shadowMap.type = THREE.PCFSoftShadowMap
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

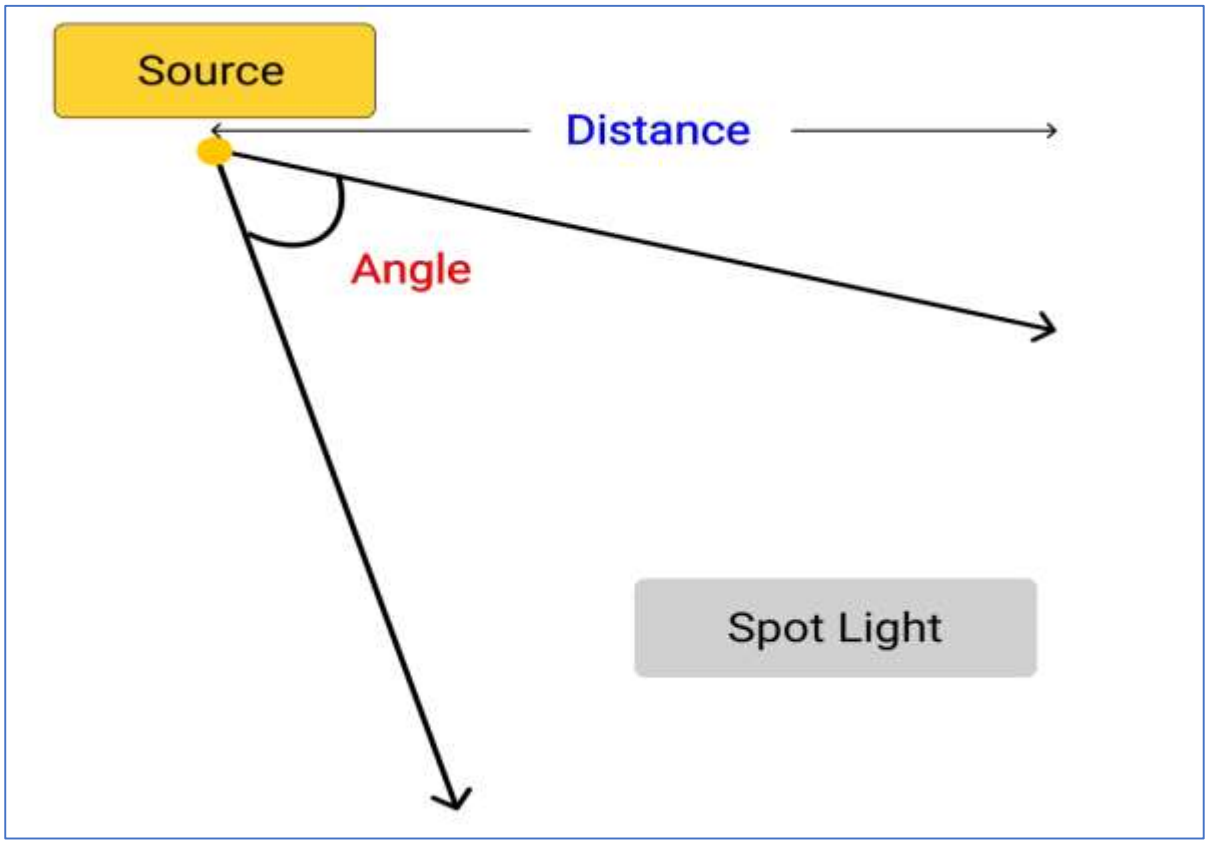
## Output



## Spotlight

It is another kind of light that comes from a specific direction in the shape of the cone.

- `distance` - Maximum range of the light. Default is `0` (no limit).
- `angle` - Maximum angle of light dispersion from its direction whose upper bound is `Math.PI/2`.
- `penumbra` - Percent of the spotlight cone attenuates due to penumbra. It takes values between zero and `1`. Default is `0`.
- `decay` - The amount the light dims along with the distance of the light.



```
const light = new THREE.SpotLight(color, intensity)
light.position.set(1, 10, 10)

light.castShadow = true
light.shadow.camera.near = 5
light.shadow.camera.far = 400
light.shadow.camera.fov = 30
```

The `shadow.camera.near`, `shadow.camera.far`, and `shadow.camera.fov` properties define the area where shadows can appear.

Check out the following example.

## spotlight.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - SpotLight</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
```

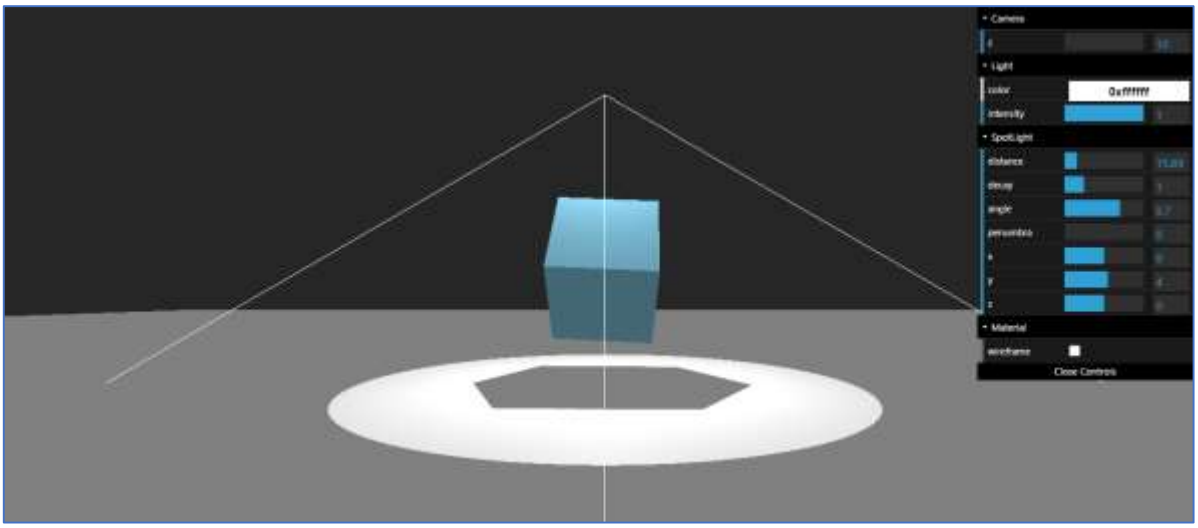
```
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="container"></div>
    <script type="module">
      // Adding spotlight in Three.js
      // You can control the properties of light using the GUI
      // You can see the position and the cone of light in this example

      // GUI
      const gui = new dat.GUI()

      // sizes
      const width = window.innerWidth
      const height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)
      console.log(scene.children)

      // camera
      const camera = new THREE.PerspectiveCamera(60, width / height, 0.1, 1000)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z', 10, 80, 1)
      camFolder.open()

      // lights
      const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
      scene.add(ambientLight)
      const light = new THREE.SpotLight()
```

```
light.position.set(0, 5, 0)

// for shadow
light.castShadow = true
light.shadow.mapSize.width = 1024
light.shadow.mapSize.height = 1024
light.shadow.camera.near = 0.5
light.shadow.camera.far = 100
scene.add(light)

const helper = new THREE.SpotLightHelper(light)
scene.add(helper)

// light controls
const lightColor = {
  color: light.color.getHex()
}
const lightFolder = gui.addFolder('Light')
lightFolder.addColor(lightColor, 'color').onChange(() => {
  light.color.set(lightColor.color)
})
lightFolder.add(light, 'intensity', 0, 1, 0.01)
lightFolder.open()

const spotLightFolder = gui.addFolder('SpotLight')
spotLightFolder.add(light, 'distance', 0, 100, 0.01)
spotLightFolder.add(light, 'decay', 0, 4, 0.1)
spotLightFolder.add(light, 'angle', 0, 1, 0.1)
spotLightFolder.add(light, 'penumbra', 0, 1, 0.1)
spotLightFolder.add(light.position, 'x', -50, 50, 1)
spotLightFolder.add(light.position, 'y', -50, 50, 1)
spotLightFolder.add(light.position, 'z', -50, 50, 1)
spotLightFolder.open()

// plane
const planeGeometry = new THREE.PlaneGeometry(100, 100)
```

```
      const plane = new THREE.Mesh(planeGeometry, new THREE.MeshPhongMateria
l({ color: 0xffffff }))
      plane.rotateX(-Math.PI / 2)
      plane.position.y = -1.75
      plane.receiveShadow = true
      scene.add(plane)

      // cube
      const geometry = new THREE.BoxGeometry(2, 2, 2)
      const material = new THREE.MeshStandardMaterial({
        color: 0x87ceeb
      })
      const materialFolder = gui.addFolder('Material')
      materialFolder.add(material, 'wireframe')
      materialFolder.open()

      const cube = new THREE.Mesh(geometry, material)
      cube.position.set(0, 0.5, 0)
      cube.castShadow = true
      cube.receiveShadow = true
      scene.add(cube)

      // responsiveness
      window.addEventListener('resize', () => {
        width = window.innerWidth
        height = window.innerHeight
        camera.aspect = width / height
        camera.updateProjectionMatrix()

        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.shadowMap.enabled = true
```

```
      renderer.shadowMap.type = THREE.PCFSoftShadowMap
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)

      animate()
    </script>
  </body>
</html>
```

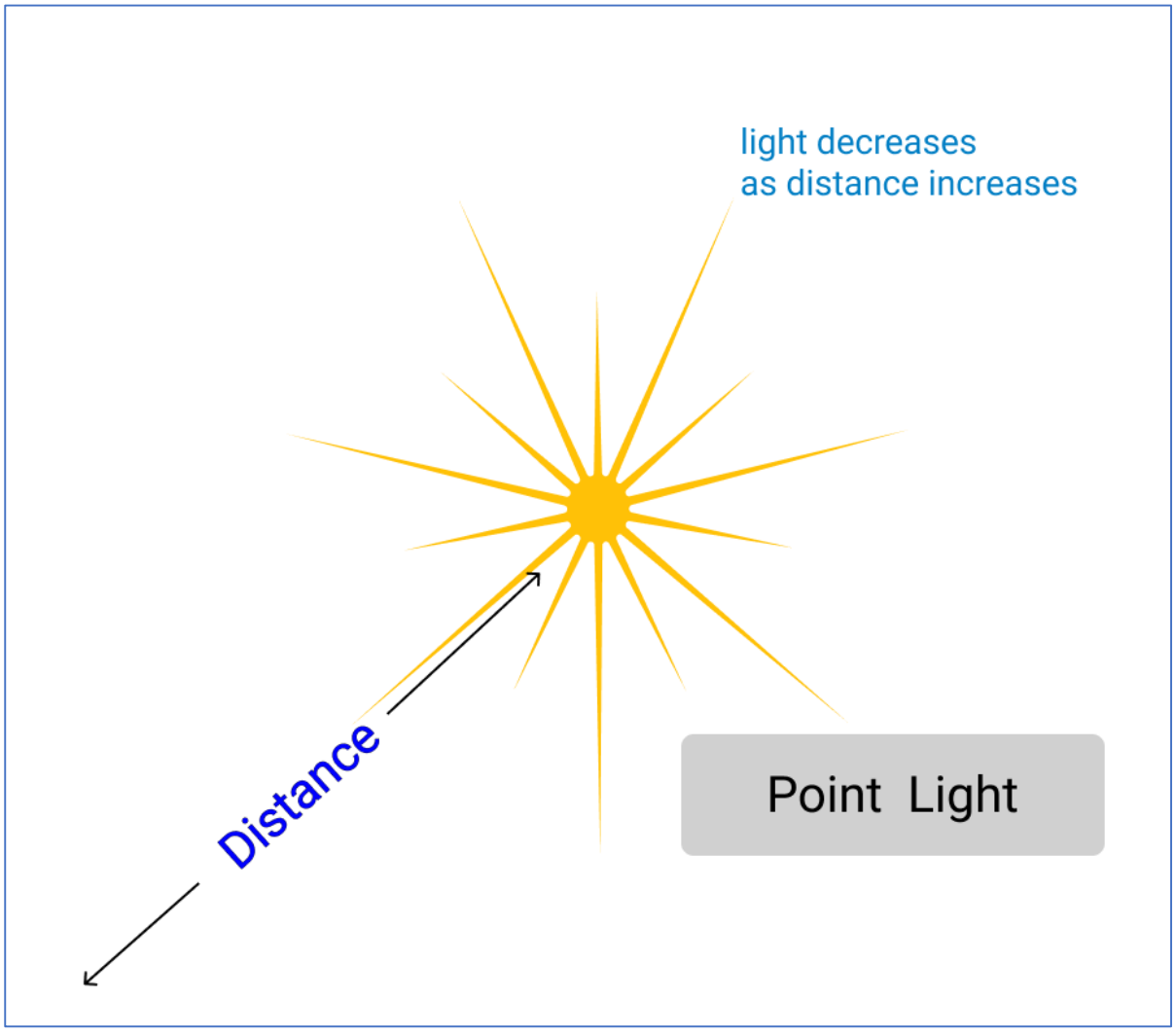
## Output



## Point Light

The point light is a light source that emits light in all directions from a single point. It is very similar to the light bulb in the ordinary world. It can cast shadows because it is a type of directional light.

```
const light = new THREE.PointLight(color, intensity, distance, decay)

light.castShadow = true
light.shadow.camera.near = 0.5 // default
light.shadow.camera.far = 500 // default
```




Check out the following example.

### pointlight.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
```

```
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - PointLight</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="container"></div>
    <script type="module">
      // Adding point light to Three.js scene
      // It is like a small sun, which emits light from a point in all directions


      // GUI
      const gui = new dat.GUI()
```

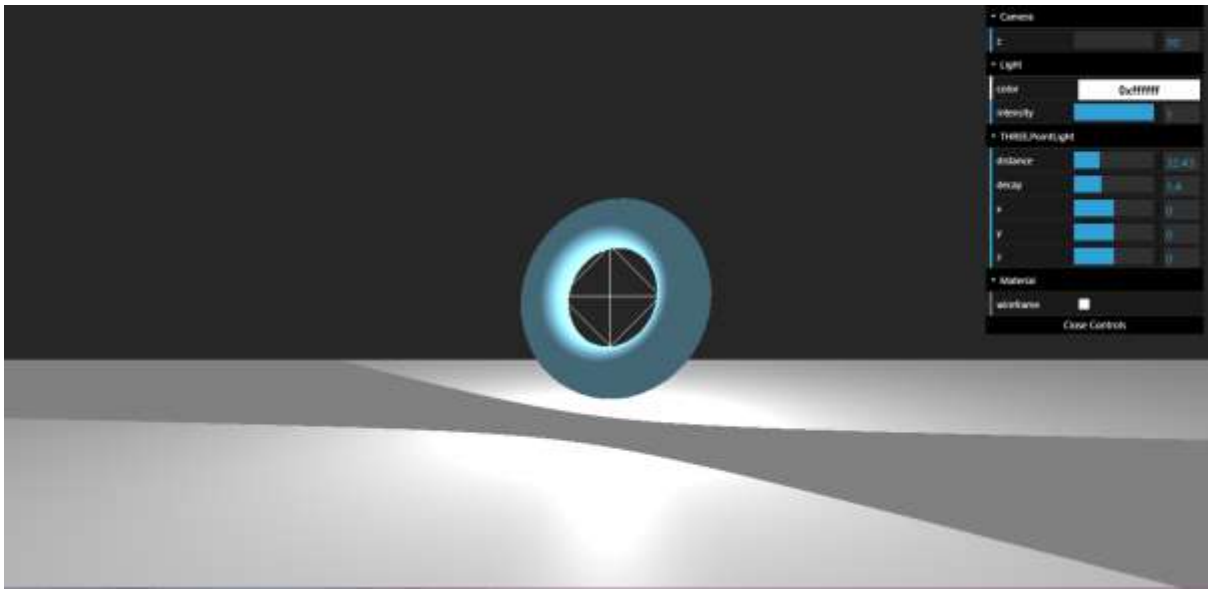
```
// sizes
let width = window.innerWidth
let height = window.innerHeight

// scene
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)
console.log(scene.children)

// camera
const camera = new THREE.PerspectiveCamera(60, width / height, 0.1, 1000)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z', 10, 80, 1)
camFolder.open()

// lights
const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
scene.add(ambientLight)

const light = new THREE.PointLight()
scene.add(light)

const helper = new THREE.PointLightHelper(light)
scene.add(helper)
// for shadow
light.castShadow = true
light.shadow.mapSize.width = 1024
light.shadow.mapSize.height = 1024
light.shadow.camera.near = 0.5
light.shadow.camera.far = 100
scene.add(light)

// light controls
const lightColor = {
  color: light.color.getHex()
}
```

```
      const lightFolder = gui.addFolder('Light')
      lightFolder.addColor(lightColor, 'color').onChange(() => {
        light.color.set(lightColor.color)
      })
      lightFolder.add(light, 'intensity', 0, 1, 0.01)
      lightFolder.open()

      const pointLightFolder = gui.addFolder('THREE.PointLight')
      pointLightFolder.add(light, 'distance', 0, 100, 0.01)
      pointLightFolder.add(light, 'decay', 0, 4, 0.1)
      pointLightFolder.add(light.position, 'x', -50, 50, 0.01)
      pointLightFolder.add(light.position, 'y', -50, 50, 0.01)
      pointLightFolder.add(light.position, 'z', -50, 50, 0.01)
      pointLightFolder.open()

      // plane
      const planeGeometry = new THREE.PlaneGeometry(100, 20)
      const plane = new THREE.Mesh(planeGeometry, new THREE.MeshPhongMateria
l({ color: 0xffffff }))
      plane.rotateX(-Math.PI / 2)
      plane.position.y = -2.5
      plane.receiveShadow = true
      scene.add(plane)

      // torus
      const geometry = new THREE.TorusGeometry(1.5, 0.5, 20, 50)
      const material = new THREE.MeshStandardMaterial({
        color: 0x87ceeb
      })
      const materialFolder = gui.addFolder('Material')
      materialFolder.add(material, 'wireframe')
      materialFolder.open()

      const torus = new THREE.Mesh(geometry, material)
      torus.castShadow = true
      torus.receiveShadow = true
      scene.add(torus)
```

```
    // responsiveness
    window.addEventListener('resize', () => {
      width = window.innerWidth
      height = window.innerHeight
      camera.aspect = width / height
      camera.updateProjectionMatrix()

      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.render(scene, camera)
    })

    // renderer
    const renderer = new THREE.WebGL1Renderer()
    renderer.setSize(window.innerWidth, window.innerHeight)
    renderer.shadowMap.enabled = true
    renderer.shadowMap.type = THREE.PCFSoftShadowMap
    renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

    // animation
    function animate() {
      requestAnimationFrame(animate)

      torus.rotation.x += 0.005
      torus.rotation.y += 0.01

      renderer.render(scene, camera)
    }

    // rendering the scene
    const container = document.querySelector('#container')
    container.append(renderer.domElement)
    renderer.render(scene, camera)

    animate()
  </script>
</body>
```

```
</html>
```

## Output



## Hemisphere Light

It is a special light for creating natural lighting. If you look at the lighting outside, you'll see that the lights don't come from a single direction. Earth reflects part of the sunlight, and the atmosphere scatters the other parts. The result is a very soft light coming from lots of directions. In Three.js, we can create something similar using `THREE.HemisphereLight`.

```
const light = new THREE.HemisphereLight(color, groundColor, intensity)
```

The first argument sets the color of the sky, and the second color sets the color reflected from the floor. And the last argument is its intensity.

It is often used along with some other lights, which can cast shadows for the best outdoor lighting effect.

Check out the following example.

## hemisphere.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - HemisphereLight</title>
    <style>
```

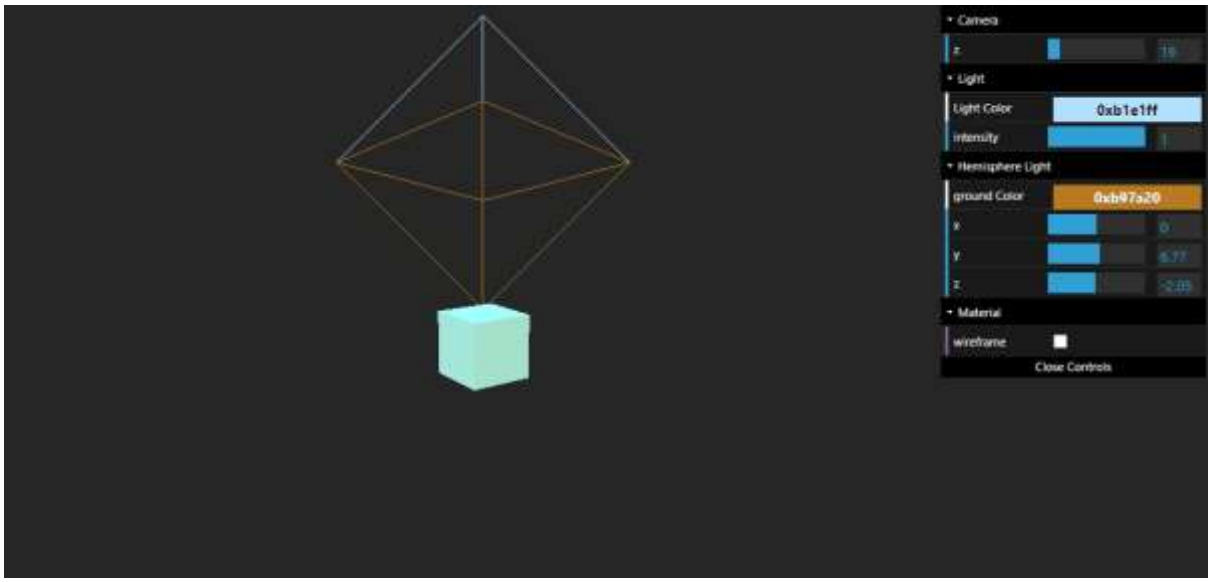
```
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="container"></div>
    <script type="module">
      // Adding hemisphere light in Three.js
      // It gives the lighting of physical world

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
```

```
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// camera
const camera = new THREE.PerspectiveCamera(60, width / height, 0.1, 1000)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z', 10, 80, 1)
camFolder.open()

// lights
const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
scene.add(ambientLight)

const skyColor = 0xb1e1ff // light blue
const groundColor = 0xb97a20 // brownish
const light = new THREE.HemisphereLight(skyColor, groundColor)
light.position.set(0, 5, 0)
scene.add(light)

const helper = new THREE.HemisphereLightHelper(light, 5)
scene.add(helper)

// light controls
const lightColor = {
  color: light.color.getHex(),
  groundColor: light.groundColor.getHex()
}
const lightFolder = gui.addFolder('Light')
lightFolder
  .addColor(lightColor, 'color')
  .name('Light Color')
  .onChange(() => {
    light.color.set(lightColor.color)
  })
lightFolder.add(light, 'intensity', 0, 1, 0.01)
lightFolder.open()
```

```
const hemisphereLightFolder = gui.addFolder('Hemisphere Light')
hemisphereLightFolder
  .addColor(lightColor, 'groundColor')
  .name('ground Color')
  .onChange(() => {
    light.groundColor.set(lightColor.groundColor)
  })
hemisphereLightFolder.add(light.position, 'x', -100, 100, 0.01)
hemisphereLightFolder.add(light.position, 'y', -100, 100, 0.01)
hemisphereLightFolder.add(light.position, 'z', -100, 100, 0.01)
hemisphereLightFolder.open()

// cube
console.log('cube')
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshStandardMaterial({
  color: 0x87ceeb
})
const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const cube = new THREE.Mesh(geometry, material)
cube.position.set(0, 0.5, 0)
cube.castShadow = true
cube.receiveShadow = true
scene.add(cube)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
```

```
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.shadowMap.enabled = true
      renderer.shadowMap.type = THREE.PCFSoftShadowMap
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



# Three.js – Geometries

Geometries are used to create and define shapes in Three.js. Three.js has many types of built-in geometries, both 2D and 3D.

In this chapter, we'll discuss basic built-in geometries. We'll first look at the 2D geometries, and after that, we'll explore all the basic 3D geometries that are available.

## Plane Geometry

The `THREE.PlaneGeometry` creates a simple 2D rectangle. It takes four arguments, the `width`, `height` is mandatory, and the `widthSegments`, `heightSegments` are optional.

- `width` - The width of the rectangle.
- `height` - The height of the rectangle.
- `widthSegments` - The number of segments the width should be divided. This defaults to 1.
- `heightSegments` - The number of segments the height should be divided. This defaults to 1.

```
const plane = new THREE.PlaneGeometry(
  width, height,
  widthSegments, heightSegments
)
```

Check out the following example.

### plane.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Plane</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
```

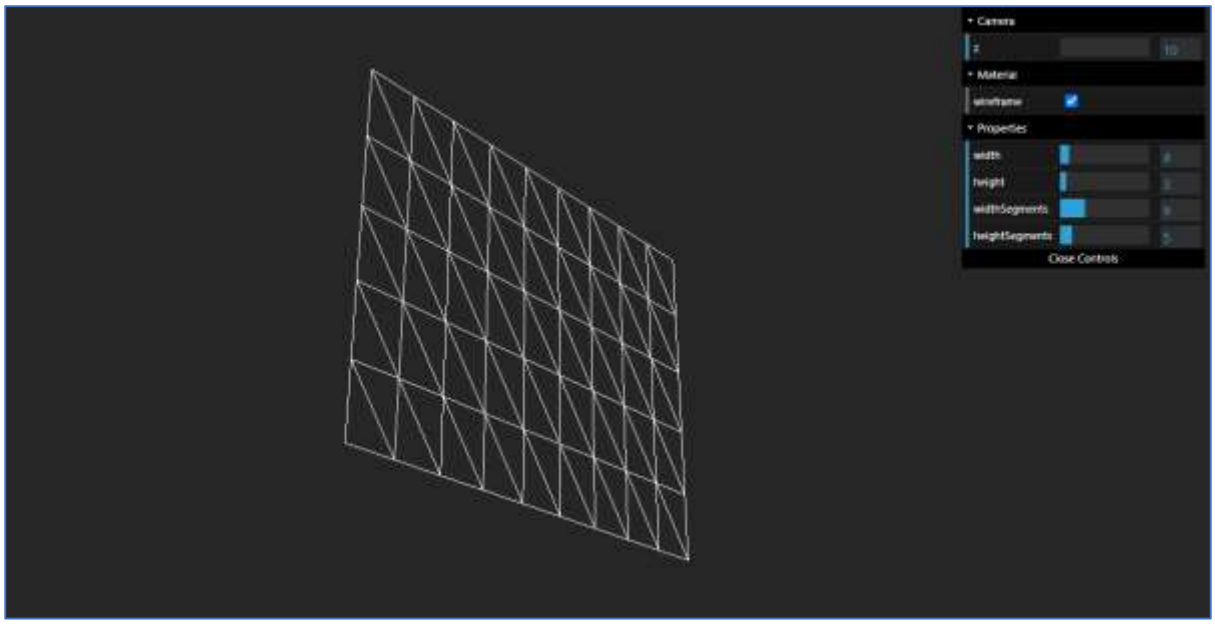
```
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Plane geometry
      // A rotating 2d rectangle in Three.js

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
```

```
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(60).step(10)
camFolder.open()

// Light
const ambientLight = new THREE.AmbientLight(0xffffff, 1)
scene.add(ambientLight)

const pointLight = new THREE.PointLight(0xffffff, 0.2)

pointLight.position.x = 2
pointLight.position.y = 3
pointLight.position.z = 4

scene.add(pointLight)

// plane
const geometry = new THREE.PlaneGeometry(1, 1)
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true,
  side: THREE.DoubleSide
})

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const plane = new THREE.Mesh(geometry, material)
scene.add(plane)

// experimenting plane properties
const planeProps = {
  width: 1,
  height: 1,
```

```
    widthSegments: 1,
    heightSegments: 1
  }
  const props = gui.addFolder('Properties')
  props
    .add(planeProps, 'width', 1, 30)
    .step(1)
    .onChange(redraw)
    .onFinishChange(() => console.dir(plane.geometry))
  props.add(planeProps, 'height', 1, 30).step(1).onChange(redraw)
  props.add(planeProps, 'widthSegments', 1, 30).step(1).onChange(redraw)
  props.add(planeProps, 'heightSegments', 1, 30).step(1).onChange(redraw)
  props.open()

  function redraw() {
    let newGeometry = new THREE.PlaneGeometry(
      planeProps.width,
      planeProps.height,
      planeProps.widthSegments,
      planeProps.heightSegments
    )
    plane.geometry.dispose()
    plane.geometry = newGeometry
  }

  // responsiveness
  window.addEventListener('resize', () => {
    width = window.innerWidth
    height = window.innerHeight
    camera.aspect = width / height
    camera.updateProjectionMatrix()

    renderer.setSize(window.innerWidth, window.innerHeight)
    renderer.render(scene, camera)
  })

  // renderer
```

```
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        plane.rotation.x += 0.005
        plane.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



## Circle Geometry

The `THREE.CircleGeometry` creates a simple 2D circle. It takes four arguments, and all are optional.

- `radius` - The radius of a circle defines its size. The default value is `1`.
- `segments` - the number of faces used to create the circle. The default value is `8`. The more segments, the smoother circle is.
- `thetaStart` - The position from which to start drawing the circle. This value can range from `0` to `2 * PI`, and the default value is `0`.
- `thetaLength` - This property defines to what extent the circle is completed. The default value is `2 * PI`.

```
const circle = new THREE.CircleGeometry(
  radius, segments,
  thetaStart, thetaLength
)
```

Check out the following example.

### circle.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Circle</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
```

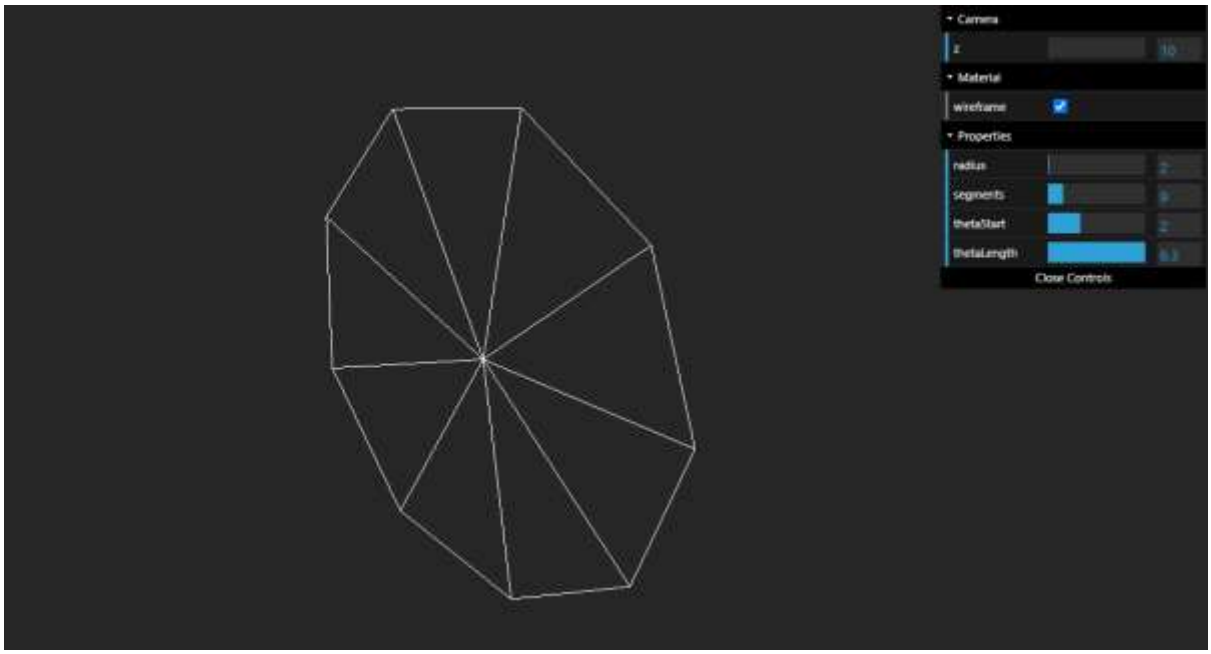
```
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Circle geometry
      // a 2d circle in Three.js

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z').min(10).max(60).step(10)
      camFolder.open()

      // Light
      const ambientLight = new THREE.AmbientLight(0xffffff, 1)
```

```
scene.add(ambientLight)

const pointLight = new THREE.PointLight(0xffffff, 0.2)
pointLight.position.x = 2
pointLight.position.y = 3
pointLight.position.z = 4
scene.add(pointLight)

// circle
const geometry = new THREE.CircleGeometry()
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true,
  side: THREE.DoubleSide
})

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const circle = new THREE.Mesh(geometry, material)
scene.add(circle)

const circleProps = {
  radius: 1,
  segments: 8,
  thetaStart: 0,
  thetaLength: 2 * Math.PI
}
const props = gui.addFolder('Properties')
props
  .add(circleProps, 'radius', 1, 50)
  .step(1)
  .onChange(redraw)
  .onFinishChange(() => console.dir(circle.geometry))
props.add(circleProps, 'segments', 1, 50).step(1).onChange(redraw)
props.add(circleProps, 'thetaStart', 0, 2 * Math.PI).onChange(redraw)
```

```
props.add(circleProps, 'thetaLength', 0, 2 * Math.PI).onChange(redraw)
props.open()

function redraw() {
  let newGeometry = new THREE.CircleGeometry(
    circleProps.radius,
    circleProps.segments,
    circleProps.thetaStart,
    circleProps.thetaLength
  )
  circle.geometry.dispose()
  circle.geometry = newGeometry
}

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// animation
function animate() {
  requestAnimationFrame(animate)

  circle.rotation.x += 0.005
  circle.rotation.y += 0.01
```

```
        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output




## Ring Geometry

The `THREE.RingGeometry` creates a D disc with a hole in the center. It is very similar to circle geometry.

- `innerRadius` - The inner radius of a circle defines the size of the hole in the center. `0` means no hole. The default value is `0.5`.
- `outerRadius` - The outer radius of a circle defines its size. The default value is `1`.
- `thetaSegments` - the number of diagonal segments used to create the circle. The default value is `8`. The more segments, the smoother circle is.
- `phiSegments` - the number of segments used along the length of the ring. The default value is `8`.

- `thetaStart` - The position from which to start drawing the circle. This value can range from `0` to `2 * PI`, and the default value is `0`.
- `thetaLength` - This property defines to what extent the circle is completed. The default value is `2 * PI`.

```
const ring = new THREE.RingGeometry(
    innerRadius, outerRadius,
    thetaSegments, phiSegments,
    thetaStart, thetaLength
  )
```

Check out the following example.

## ring.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Ring</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
```

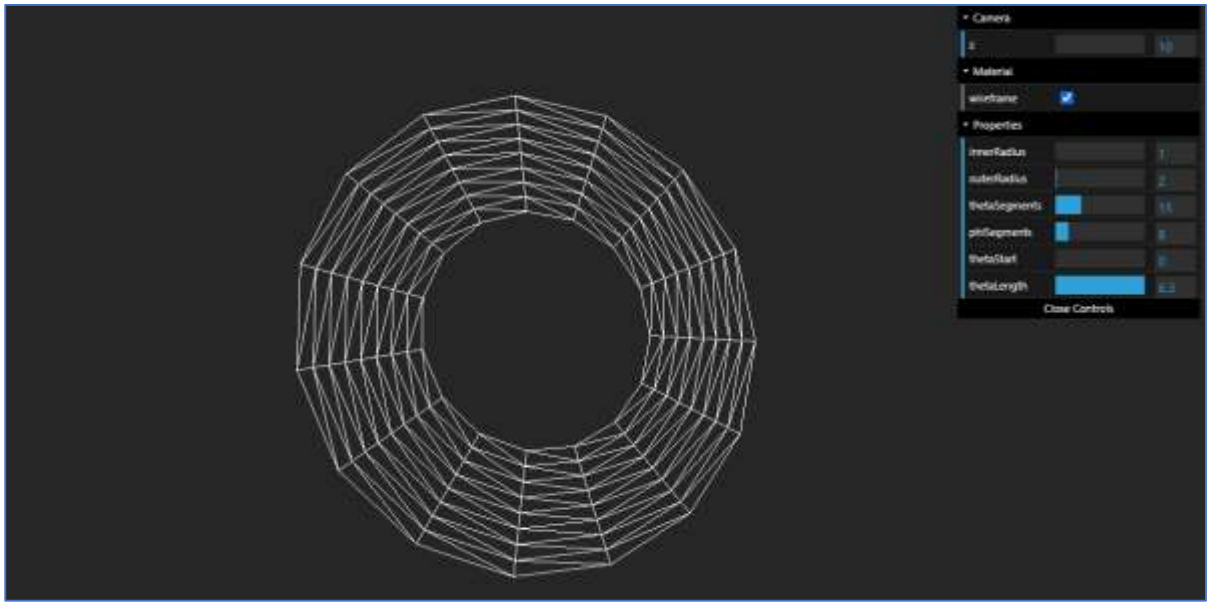
```
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Ring geometry
      // a simple 2d ring in Three.js

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z').min(10).max(60).step(10)
      camFolder.open()

      // Light
      const ambientLight = new THREE.AmbientLight(0xffffff, 1)
      scene.add(ambientLight)

      const pointLight = new THREE.PointLight(0xffffff, 0.2)
```

```
pointLight.position.x = 2
pointLight.position.y = 3
pointLight.position.z = 4
scene.add(pointLight)

// ring
const geometry = new THREE.RingGeometry()
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true,
  side: THREE.DoubleSide
})

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const ring = new THREE.Mesh(geometry, material)
scene.add(ring)

const ringProps = {
  innerRadius: 1,
  outerRadius: 5,
  thetaSegments: 8,
  phiSegments: 8,
  thetaStart: 0,
  thetaLength: 2 * Math.PI
}
const props = gui.addFolder('Properties')
props
  .add(ringProps, 'innerRadius', 1, 50)
  .step(1)
  .onChange(redraw)
  .onFinishChange(() => console.dir(ring.geometry))
props.add(ringProps, 'outerRadius', 1, 50).step(1).onChange(redraw)
props.add(ringProps, 'thetaSegments', 1, 50).step(1).onChange(redraw)
props.add(ringProps, 'phiSegments', 1, 50).step(1).onChange(redraw)
```

```
props.add(ringProps, 'thetaStart', 0, 2 * Math.PI).onChange(redraw)
props.add(ringProps, 'thetaLength', 0, 2 * Math.PI).onChange(redraw)
props.open()

function redraw() {
  let newGeometry = new THREE.RingGeometry(
    ringProps.innerRadius,
    ringProps.outerRadius,
    ringProps.thetaSegments,
    ringProps.phiSegments,
    ringProps.thetaStart,
    ringProps.thetaLength
  )
  ring.geometry.dispose()
  ring.geometry = newGeometry
}

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// animation
function animate() {
  requestAnimationFrame(animate)
```

```
        ring.rotation.x += 0.005
        ring.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



## Box Geometry

The `THREE.BoxGeometry` creates a simple 3D box with specified dimensions. This is the expanded version of `PlaneGeometry` in z axis as `depth`.

```
const box = new THREE.CubeGeometry(
    width, height, depth,
    widthSegments, heightSegments, depthSegments
  )
```

Check out the following example.

## cube.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Cube</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
```

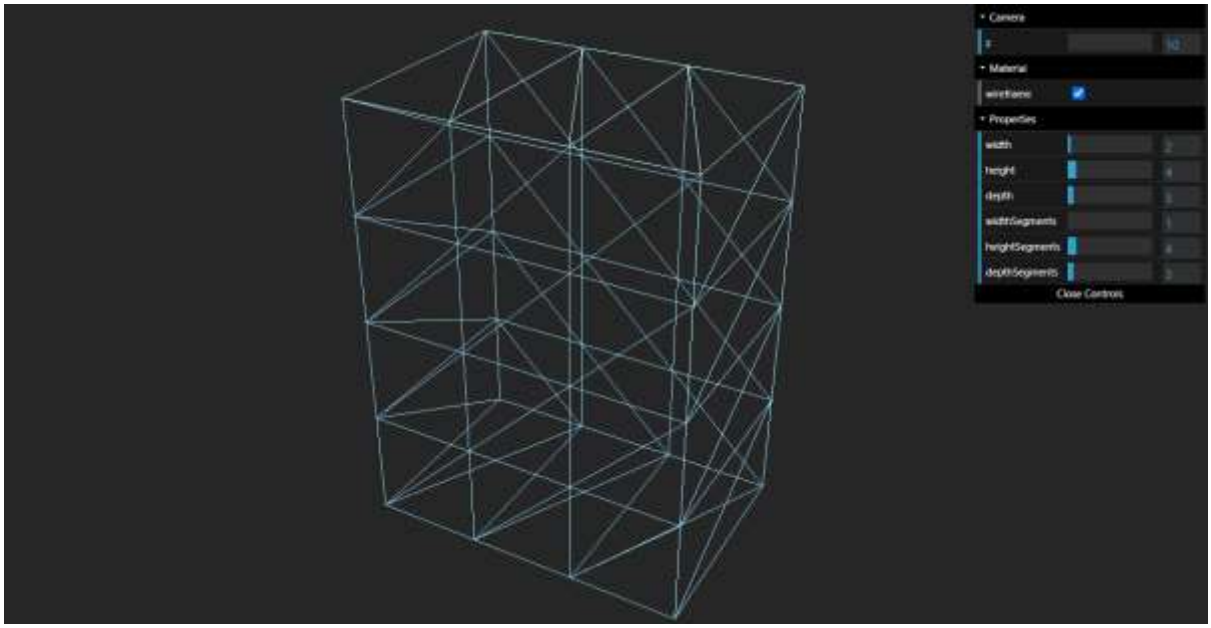
```
// Cube geometry
// A simple 3d cube in Three.js

// GUI
const gui = new dat.GUI()

// sizes
let width = window.innerWidth
let height = window.innerHeight

// scene
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// Light
const ambientLight = new THREE.AmbientLight(0xffffff, 1)
scene.add(ambientLight)

const pointLight = new THREE.PointLight(0xffffff, 0.5)
pointLight.position.x = 2
pointLight.position.y = 3
pointLight.position.z = 4
scene.add(pointLight)

// camera
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(60).step(10)
camFolder.open()

// cube
const geometry = new THREE.BoxGeometry(1, 1, 1)
const material = new THREE.MeshStandardMaterial({
  color: 0x87ceeb,
  wireframe: true
})
```

```
const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const cube = new THREE.Mesh(geometry, material)
scene.add(cube)
console.log(cube)
// cube properties
const cubeProps = {
  width: 1,
  height: 1,
  depth: 1,
  widthSegments: 1,
  heightSegments: 1,
  depthSegments: 1,
  wireframe: true
}

// GUI for exporimenting cube properties
const props = gui.addFolder('Properties')
props
  .add(cubeProps, 'width', 1, 30)
  .step(1)
  .onChange(redraw)
  .onFinishChange(() => console.dir(cube.geometry))
props.add(cubeProps, 'height', 1, 30).step(1).onChange(redraw)
props.add(cubeProps, 'depth', 1, 30).step(1).onChange(redraw)
props.add(cubeProps, 'widthSegments', 1, 30).step(1).onChange(redraw)
props.add(cubeProps, 'heightSegments', 1, 30).step(1).onChange(redraw)
props.add(cubeProps, 'depthSegments', 1, 30).step(1).onChange(redraw)
props.open()

function redraw() {
  let newGeometry = new THREE.BoxGeometry(
    cubeProps.width,
    cubeProps.height,
    cubeProps.depth,
```

```
        cubeProps.widthSegments,
        cubeProps.heightSegments,
        cubeProps.depthSegments
      )
      cube.geometry.dispose()
      cube.geometry = newGeometry
    }

    // responsiveness
    window.addEventListener('resize', () => {
      width = window.innerWidth
      height = window.innerHeight
      camera.aspect = width / height
      camera.updateProjectionMatrix()

      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.render(scene, camera)
    })

    // renderer
    const renderer = new THREE.WebGL1Renderer()
    renderer.setSize(width, height)
    renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

    // animation
    function animate() {
      requestAnimationFrame(animate)

      cube.rotation.x += 0.005
      cube.rotation.y += 0.01

      renderer.render(scene, camera)
    }

    // rendering the scene
    const container = document.querySelector('#threejs-container')
    container.append(renderer.domElement)
```

```
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



## Sphere Geometry

The `THREE.SphereGeometry` creates 3D sphere geometries. You can create different types of sphere-related geometries by passing the arguments.

- `radius` - The radius of a circle defines its size. The default value is `1`.
- `widthSegments` - number of segments used vertically. This defaults to `8`.
- `heightSegments` - the number of segments used horizontally. This defaults to `6`.
- `phiStart` - The position from which to start drawing the circle. This value can range from `0` to `2 * PI`, and the default value is `0`.
- `phiLength` - This property defines to what extent the circle is completed. The default value is `2 * PI`.
- `thetaStart` - The position from which to start drawing the circle. This value can range from `0` to `2 * PI`, and the default value is `0`.
- `thetaLength` - This property defines to what extent the circle is completed. The default value is `2 * PI`.

```
const sphere = new THREE.SphereGeometry(
    radius,
    widthSegments, heightSegments,
    phiStart, phiLength,
```

```
    thetaStart, thetaLength
  )
```

Check out the following example.

## sphere.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Sphere</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
```

```
</head>
<body>
  <div id="threejs-container"></div>
  <script type="module">
    // creating a sphere using Sphere geometry in Three.js

    // GUI
    const gui = new dat.GUI()

    // sizes
    let width = window.innerWidth
    let height = window.innerHeight

    // scene
    const scene = new THREE.Scene()
    scene.background = new THREE.Color(0x262626)

    // camera
    const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
    camera.position.set(0, 0, 10)
    const camFolder = gui.addFolder('Camera')
    camFolder.add(camera.position, 'z').min(10).max(60).step(10)
    camFolder.open()

    // Light
    const ambientLight = new THREE.AmbientLight(0x87ceeb, 1)
    scene.add(ambientLight)

    const pointLight = new THREE.PointLight(0xffffff, 0.2)
    pointLight.position.x = 2
    pointLight.position.y = 3
    pointLight.position.z = 4
    scene.add(pointLight)

    // sphere
    const geometry = new THREE.SphereGeometry()
    const material = new THREE.MeshStandardMaterial({ color: 0xffffff })
```

```
material.metalness = 0.7
material.roughness = 0.3

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const sphere = new THREE.Mesh(geometry, material)
scene.add(sphere)

const sphereProps = {
  radius: 1,
  widthSegments: 8,
  heightSegments: 6,
  phiStart: 0,
  phiLength: 2 * Math.PI,
  thetaStart: 0,
  thetaLength: 2 * Math.PI
}
const props = gui.addFolder('Properties')
props
  .add(sphereProps, 'radius', 1, 50)
  .step(1)
  .onChange(redraw)
  .onFinishChange(() => console.dir(sphere.geometry))
props.add(sphereProps, 'widthSegments', 1, 50).step(1).onChange(redraw)
props.add(sphereProps, 'heightSegments', 1, 50).step(1).onChange(redraw)
props.add(sphereProps, 'phiStart', 0, 2 * Math.PI).onChange(redraw)
props.add(sphereProps, 'phiLength', 0, 2 * Math.PI).onChange(redraw)
props.add(sphereProps, 'thetaStart', 0, 2 * Math.PI).onChange(redraw)
props.add(sphereProps, 'thetaLength', 0, 2 * Math.PI).onChange(redraw)
props.open()

function redraw() {
  let newGeometry = new THREE.SphereGeometry(
    sphereProps.radius,
    sphereProps.widthSegments,
```

```
        sphereProps.heightSegments,
        sphereProps.phiStart,
        sphereProps.phiLength,
        sphereProps.thetaStart,
        sphereProps.thetaLength
      )
      sphere.geometry.dispose()
      sphere.geometry = newGeometry
    }

    // responsiveness
    window.addEventListener('resize', () => {
      width = window.innerWidth
      height = window.innerHeight
      camera.aspect = width / height
      camera.updateProjectionMatrix()

      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.render(scene, camera)
    })

    // renderer
    const renderer = new THREE.WebGL1Renderer()
    renderer.setSize(width, height)
    renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

    // animation
    function animate() {
      requestAnimationFrame(animate)

      sphere.rotation.x += 0.005
      sphere.rotation.y += 0.01

      renderer.render(scene, camera)
    }

    // rendesphere the scene
```

```
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output


## Cylinder Geometry

To create a cylinder in Three.js, you can use the `Three.CylinderGeometry`.

- `radiusTop` - Radius of the cylinder at the top. Default is `1`.
- `radiusBottom` - Radius of the cylinder at the bottom. Default is `1`.
- `height` - Height of the cylinder. Default is `1`.
- `radialSegments` - the number of segments around the circumference of the cylinder. Default is `8`.
- `heightSegments` - Number of rows of faces along with the height of the cylinder. Default is `1`.
- `openEnded` - It's a Boolean indicating whether the ends of the cylinder are open or not. Default is `false`, meaning closed.
- `thetaStart` - Start angle for the first segment, defaults to `0`.
- `thetaLength` - The central angle, often called `theta`, of the circular sector. The default is `2* Math.PI`, which makes for a complete cylinder.

```
const cylinder = new THREE.CylinderGeometry(
    radiusTop, radiusBottom, height,
```

```
    radialSegments, heightSegments,
    openEnded,
    thetaStart, thetaLength
  )
```

Check out the following example.

## cylinder.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - cylinder</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
```

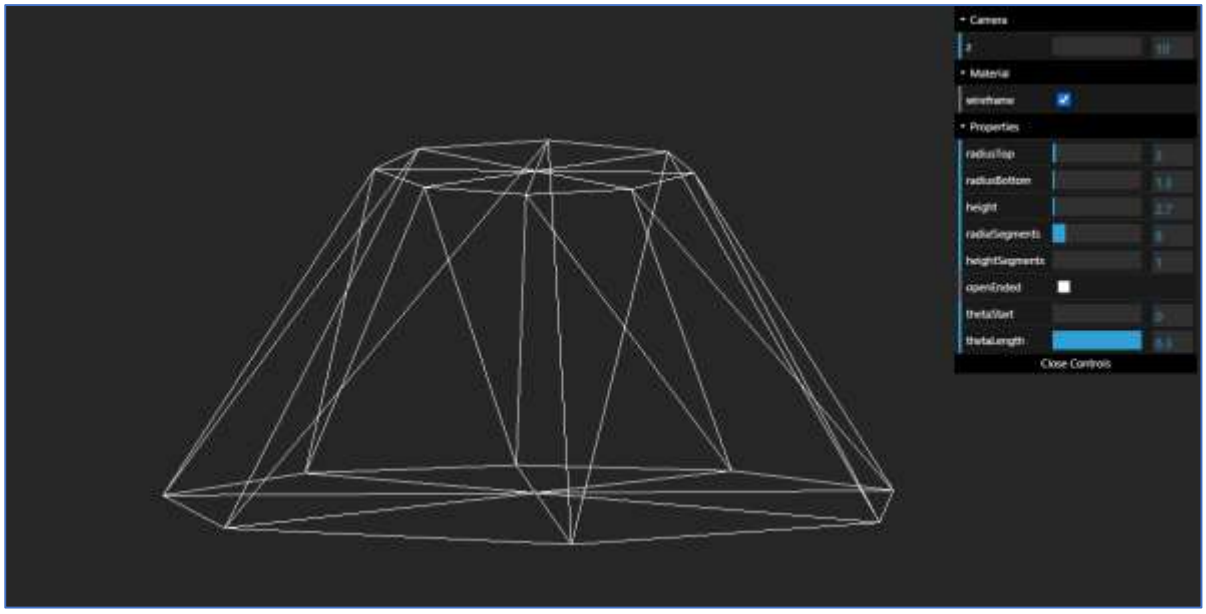
```
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Cylinder geometry in Three.js

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z').min(10).max(60).step(10)
      camFolder.open()

      // cylinder
      const geometry = new THREE.CylinderGeometry()
      const material = new THREE.MeshBasicMaterial({
        color: 0xffffff,
        wireframe: true
      })

      const materialFolder = gui.addFolder('Material')
      materialFolder.add(material, 'wireframe')
      materialFolder.open()
```

```
const cylinder = new THREE.Mesh(geometry, material)
scene.add(cylinder)

const cylinderProps = {
  radiusTop: 1,
  radiusBottom: 1,
  height: 1,
  radialSegments: 8,
  heightSegments: 1,
  openEnded: false,
  thetaStart: 0,
  thetaLength: 2 * Math.PI
}
const props = gui.addFolder('Properties')
props
  .add(cylinderProps, 'radiusTop', 1, 50)
  .step(1)
  .onChange(redraw)
  .onFinishChange(() => console.dir(cylinder.geometry))
props.add(cylinderProps, 'radiusBottom', 0, 50).onChange(redraw)
props.add(cylinderProps, 'height', 0, 100).onChange(redraw)
props.add(cylinderProps, 'radialSegments', 1, 50).step(1).onChange(redraw)
props.add(cylinderProps, 'heightSegments', 1, 50).step(1).onChange(redraw)
props.add(cylinderProps, 'openEnded').onChange(redraw)
props.add(cylinderProps, 'thetaStart', 0, 2 * Math.PI).onChange(redraw)
props.add(cylinderProps, 'thetaLength', 0, 2 * Math.PI).onChange(redraw)
props.open()

function redraw() {
  let newGeometry = new THREE.CylinderGeometry(
    cylinderProps.radiusTop,
    cylinderProps.radiusBottom,
    cylinderProps.height,
    cylinderProps.radialSegments,
    cylinderProps.heightSegments,
    cylinderProps.openEnded,
    cylinderProps.thetaStart,
```

```
        cylinderProps.thetaLength
      )
      cylinder.geometry.dispose()
      cylinder.geometry = newGeometry
    }

    // responsiveness
    window.addEventListener('resize', () => {
      width = window.innerWidth
      height = window.innerHeight
      camera.aspect = width / height
      camera.updateProjectionMatrix()

      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.render(scene, camera)
    })

    // renderer
    const renderer = new THREE.WebGL1Renderer()
    renderer.setSize(width, height)
    renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

    // animation
    function animate() {
      requestAnimationFrame(animate)

      cylinder.rotation.x += 0.005
      cylinder.rotation.y += 0.01

      renderer.render(scene, camera)
    }

    // rendecylinder the scene
    const container = document.querySelector('#threejs-container')
    container.append(renderer.domElement)
    renderer.render(scene, camera)
    animate()
```

```
    </script>
  </body>
</html>
```

## Output




## Cone Geometry

You can use `THREE.ConeGeometry` to create a cone. It is very similar to `CylinderGeometry`, except it only allows you to set the `radius` instead of `radiusTop` and `radiusBottom`.

```
const cone = new THREE.ConeGeometry(
    radius, height,
    radialSegments, heightSegments,
    openEnded,
    thetaStart, thetaLength
  )
```

Check out the following example.

## cone.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
```

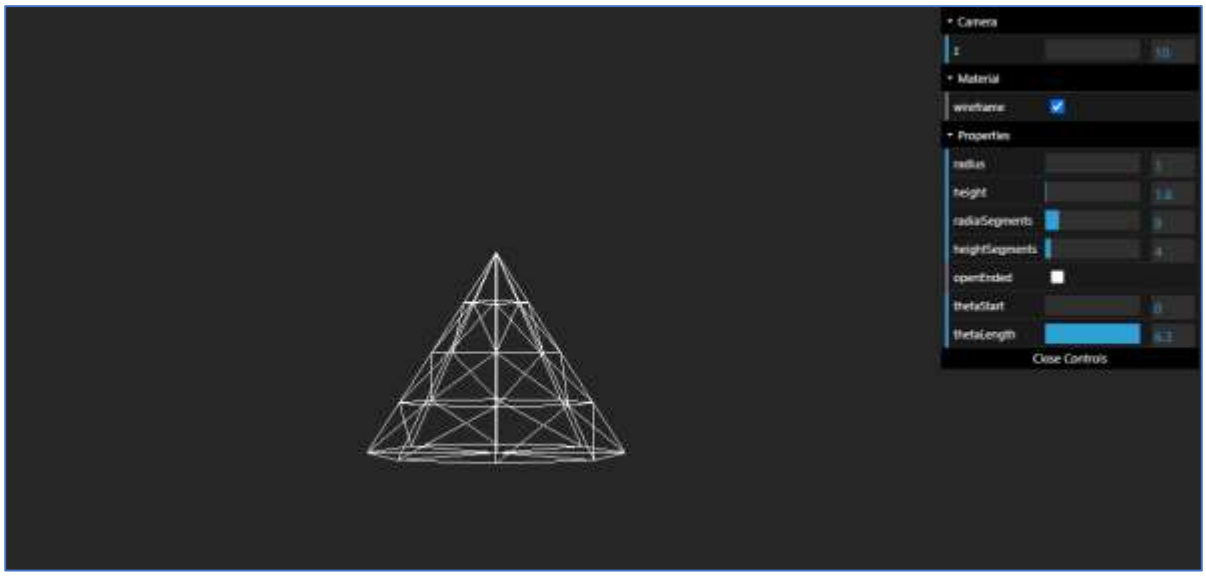
```
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Cone</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Cone geometry in Three.js


      // GUI
      const gui = new dat.GUI()


      // sizes
      let width = window.innerWidth
      let height = window.innerHeight
```

```
// scene
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// camera
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(60).step(10)
camFolder.open()

// cone
const geometry = new THREE.ConeGeometry()
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true
})

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const cone = new THREE.Mesh(geometry, material)
scene.add(cone)

const coneProps = {
  radius: 1,
  height: 1,
  radialSegments: 8,
  heightSegments: 1,
  openEnded: false,
  thetaStart: 0,
  thetaLength: 2 * Math.PI
}
const props = gui.addFolder('Properties')
props
```

```
    .add(coneProps, 'radius', 1, 50)
    .step(1)
    .onChange(redraw)
    .onFinishChange(() => console.dir(cone.geometry))
  props.add(coneProps, 'height', 0, 100).onChange(redraw)
  props.add(coneProps, 'radialSegments', 1, 50).step(1).onChange(redraw)
  props.add(coneProps, 'heightSegments', 1, 50).step(1).onChange(redraw)
  props.add(coneProps, 'openEnded').onChange(redraw)
  props.add(coneProps, 'thetaStart', 0, 2 * Math.PI).onChange(redraw)
  props.add(coneProps, 'thetaLength', 0, 2 * Math.PI).onChange(redraw)
  props.open()

  function redraw() {
    let newGeometry = new THREE.ConeGeometry(
      coneProps.radius,
      coneProps.height,
      coneProps.radialSegments,
      coneProps.heightSegments,
      coneProps.openEnded,
      coneProps.thetaStart,
      coneProps.thetaLength
    )
    cone.geometry.dispose()
    cone.geometry = newGeometry
  }

  // responsiveness
  window.addEventListener('resize', () => {
    width = window.innerWidth
    height = window.innerHeight
    camera.aspect = width / height
    camera.updateProjectionMatrix()

    renderer.setSize(window.innerWidth, window.innerHeight)
    renderer.render(scene, camera)
  })
```

```
      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cone.rotation.x += 0.005
        cone.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendecone the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



## Torus Geometry

Torus is a tube-like shape that looks like a donut. You can use `THREE.TorusGeometry` to create a torus in Three.js. The arguments, `radialSegments,` and `tubularSegments` are the number of segments along the radius and tube. With `arc` property, you can control whether the torus has drawn a full circle.

```
const torus = new THREE.TorusGeometry(
    radius, tubeRadius,
    radialSegments, tubularSegments,
    arc
  )
```

Check out the following example.

### torus.html

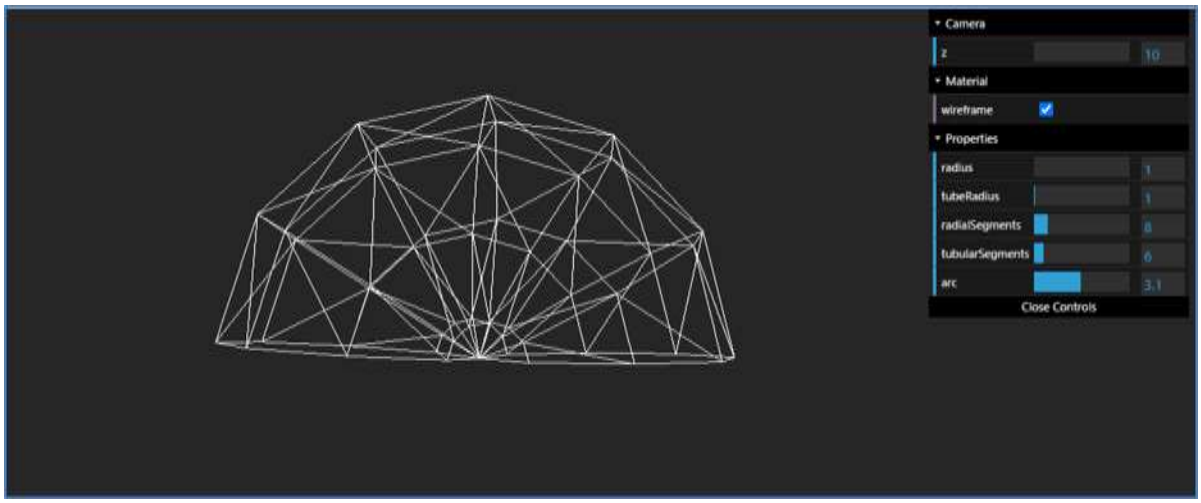
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Torus</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
```

```
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Torus geometry
      // creating a torus, a donut like shape in Three.js

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z').min(10).max(60).step(10)
      camFolder.open()

      // torus
      const geometry = new THREE.TorusGeometry()
      const material = new THREE.MeshBasicMaterial({
        color: 0xffffff,
        wireframe: true
```

```
})

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const torus = new THREE.Mesh(geometry, material)
scene.add(torus)

const torusProps = {
  radius: 1,
  tubeRadius: 0.5,
  radialSegments: 8,
  tubularSegments: 6,
  arc: 2 * Math.PI
}
const props = gui.addFolder('Properties')
props
  .add(torusProps, 'radius', 1, 50)
  .step(1)
  .onChange(redraw)
  .onFinishChange(() => console.dir(torus.geometry))
props.add(torusProps, 'tubeRadius', 0.1, 50).step(0.1).onChange(redraw)
props.add(torusProps, 'radialSegments', 1, 50).step(1).onChange(redraw)
props.add(torusProps, 'tubularSegments', 1, 50).step(1).onChange(redraw)
props.add(torusProps, 'arc', 0, 2 * Math.PI).onChange(redraw)
props.open()

function redraw() {
  let newGeometry = new THREE.TorusGeometry(
    torusProps.radius,
    torusProps.tubeRadius,
    torusProps.radialSegments,
    torusProps.tubularSegments,
    torusProps.arc
  )
  torus.geometry.dispose()
```

```
        torus.geometry = newGeometry
      }

      // responsiveness
      window.addEventListener('resize', () => {
        width = window.innerWidth
        height = window.innerHeight
        camera.aspect = width / height
        camera.updateProjectionMatrix()

        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer()
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        torus.rotation.x += 0.005
        torus.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output




## TorusKnot Geometry

A torus knot is a special kind of knot that looks like a tube that winds around itself a couple of times. You can create a torus-knot using `THREE.TorusKnotGeometry`. It's pretty similar to `TorusGeometry` with additional properties, the `p` and `q`.

- `p` - It defines how many times the geometry winds around its axis of rotational symmetry. Default is `2`.
- `q` - It defines how many times the geometry winds around the interior of the torus. This defaults to `3`.

```
const torusKnot = new THREE.TorusKnotGeometry(
    radius, tubeRadius,
    tubularSegments, radialSegments,
    p, q
  )
```

Check out the following example.

### torus-knot.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Torus Knot</title>
    <style>
```

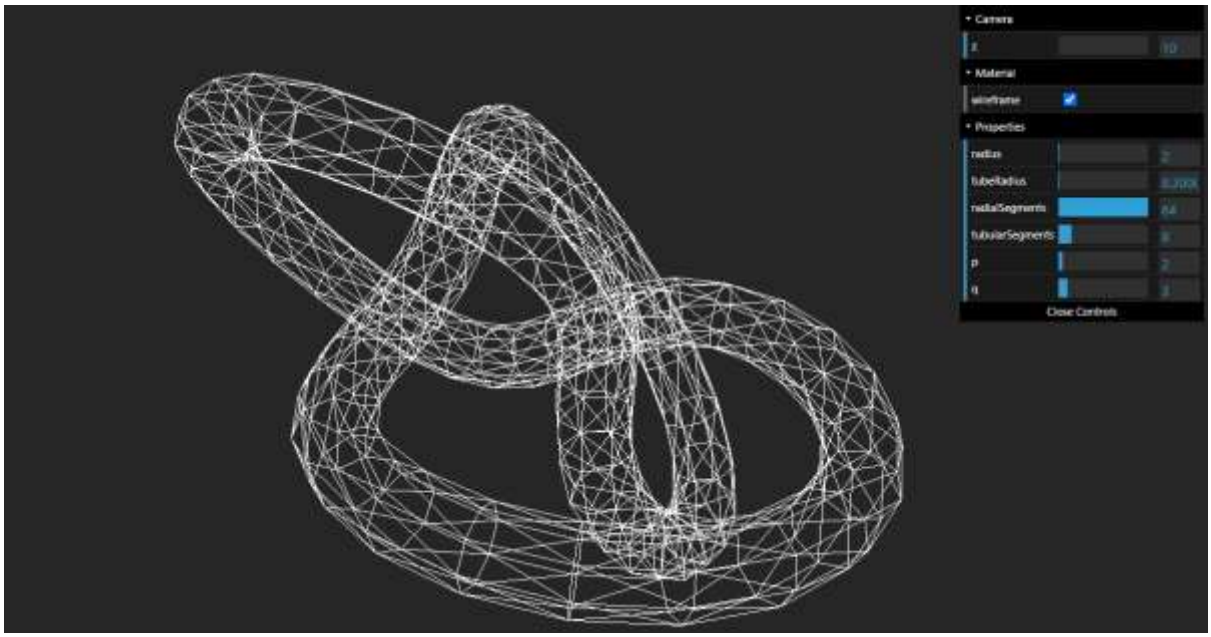
```
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Torus knot geometry in Three.js

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
```

```
scene.background = new THREE.Color(0x262626)

// camera
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(60).step(10)
camFolder.open()

// torusKnot
const geometry = new THREE.TorusKnotGeometry()
const material = new THREE.MeshBasicMaterial({
  color: 0xffffff,
  wireframe: true
})

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const torusKnot = new THREE.Mesh(geometry, material)
scene.add(torusKnot)

const torusKnotProps = {
  radius: 1,
  tubeRadius: 0.5,
  radialSegments: 64,
  tubularSegments: 8,
  p: 2,
  q: 3
}
const props = gui.addFolder('Properties')
props
  .add(torusKnotProps, 'radius', 1, 50)
  .step(1)
  .onChange(redraw)
  .onFinishChange(() => console.dir(torusKnot.geometry))
```

```
props.add(torusKnotProps, 'tubeRadius', 0.1, 50).step(0.1).onChange(redraw)
props.add(torusKnotProps, 'radialSegments', 1, 50).step(1).onChange(redraw)
props.add(torusKnotProps, 'tubularSegments', 1, 50).step(1).onChange(redraw)
props.add(torusKnotProps, 'p', 1, 20).step(1).onChange(redraw)
props.add(torusKnotProps, 'q', 1, 20).step(1).onChange(redraw)
props.open()

function redraw() {
  let newGeometry = new THREE.TorusKnotGeometry(
    torusKnotProps.radius,
    torusKnotProps.tubeRadius,
    torusKnotProps.radialSegments,
    torusKnotProps.tubularSegments,
    torusKnotProps.p,
    torusKnotProps.q
  )
  torusKnot.geometry.dispose()
  torusKnot.geometry = newGeometry
}

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHlet
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// animation
```

```
      function animate() {
        requestAnimationFrame(animate)

        torusKnot.rotation.x += 0.005
        torusKnot.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



## Polyhedron Geometry

A polyhedron is a geometry that has only flat faces and straight edges. You can draw different types of polyhedrons by specifying `vertices` and `indices`.

- `vertices` - Array of points that make up the polyhedron.
- `indices` - Array of indices that make up the faces from the vertices.
- `radius` - The radius of the final shape. This defaults to `1`.
- `detail` - How many levels to subdivide the geometry. The more detail, the smoother the shape.

The following code creates a polyhedron with `four` faces.

```
const vertices = [
    1, 1, 1,
    -1, -1, 1,
    -1, 1, -1,
    1, -1, -1
  ]

const indices = [
    2, 1, 0,
    0, 3, 2,
    1, 3, 0,
    2, 3, 1
  ]
const geometry = new THREE.PolyhedronGeometry(vertices, indices, radius,
detail)
```

Check out the following example.

## polyhedron.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Polyhedron</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
```

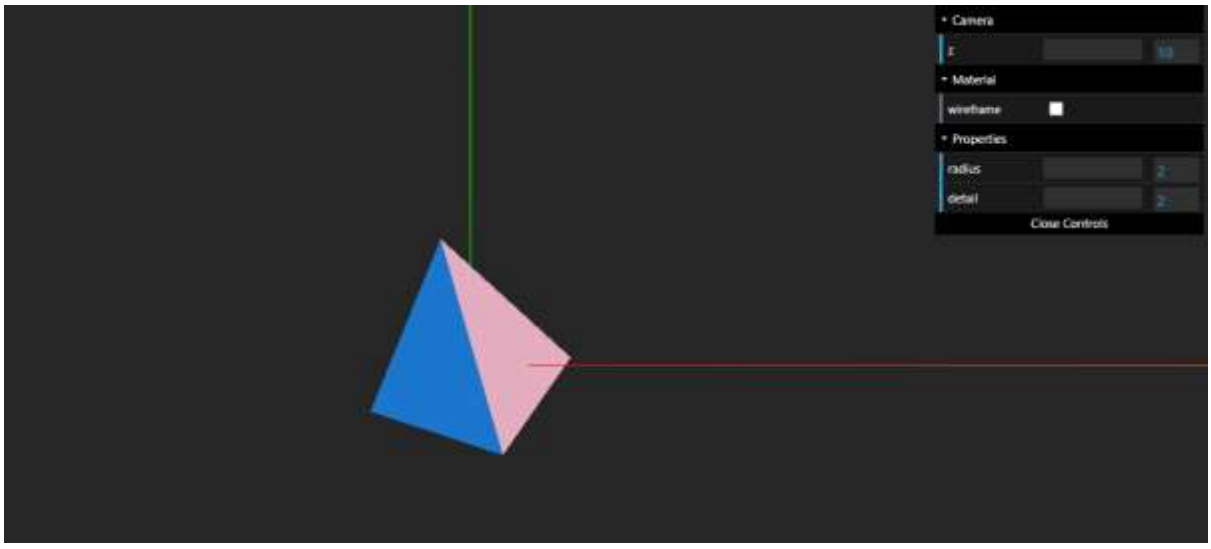
```
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Creating a tetrahedron using Polyhedron geometry in Three.js


      // GUI
      const gui = new dat.GUI()


      // sizes
      let width = window.innerWidth
      let height = window.innerHeight


      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)


      const axesHepler = new THREE.AxesHelper(10)
      scene.add(axesHepler)
```

```
// camera
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(60).step(10)
camFolder.open()

// prettier-ignore
const vertices = [
  1, 1, 1,
  -1, -1, 1,
  -1, 1, -1,
  1, -1, -1
]

// prettier-ignore
const indices = [
  2, 1, 0,
  0, 3, 2,
  1, 3, 0,
  2, 3, 1
]

const geometry = new THREE.PolyhedronGeometry(vertices, indices)
const material = new THREE.MeshNormalMaterial({
  color: 0xffffff
})

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const plane = new THREE.Mesh(geometry, material)
scene.add(plane)

// experimenting plane properties
const planeProps = {
```

```
    radius: 1,
    detail: 1
  }
  const props = gui.addFolder('Properties')
  props
    .add(planeProps, 'radius', 1, 30)
    .step(1)
    .onChange(redraw)
    .onFinishChange(() => console.dir(plane.geometry))
  props.add(planeProps, 'detail', 1, 30).step(1).onChange(redraw)
  props.open()

  function redraw() {
    let newGeometry = new THREE.PolyhedronGeometry(
      verticesOfCube,
      indicesOfFaces,
      planeProps.radius,
      planeProps.detail
    )
    plane.geometry.dispose()
    plane.geometry = newGeometry
  }

  // responsiveness
  window.addEventListener('resize', () => {
    width = window.innerWidth
    height = window.innerHlet
    camera.aspect = width / height
    camera.updateProjectionMatrix()

    renderer.setSize(window.innerWidth, window.innerHeight)
    renderer.render(scene, camera)
  })

  // renderer
  const renderer = new THREE.WebGL1Renderer()
  renderer.setSize(width, height)
```

```
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        plane.rotation.x += 0.005
        plane.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output




Three.js also has geometries for some common polyderons.

| Polyhedron | No. of faces | Code |
|---|---|---|
| Tetrahedron | 4 | THREE.TetrahedronGeometry |
| Octahedron | 8 | THREE.OctahedronGeometry |
| Dodecahedron | 12 | THREE.DodecahedronGeometry |
| Icosahedron | 20 | THREE.IcosahedronGeometry |

Check out the following example.

## polyhedrons.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Polyhedrons</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
```

```
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Various built-in polyhedron geometries in Three.js
      // Tetrahedron, Octahedron, Dodecahedron, Icosahedron

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z').min(10).max(60).step(10)
      camFolder.open()

      // tetrahedron
      const geometry = new THREE.TetrahedronGeometry()
      const material = new THREE.MeshNormalMaterial()

      const materialFolder = gui.addFolder('Material')
      materialFolder.add(material, 'wireframe')
      materialFolder.open()
```

```
      const tetrahedron = new THREE.Mesh(geometry, material)
      tetrahedron.position.set(-5, 0, 0)
      scene.add(tetrahedron)

      const tetrahedronProps = {
        radius: 1,
        detail: 1
      }
      const tetraProps = gui.addFolder('Tetrahedron')
      tetraProps
        .add(tetrahedronProps, 'radius', 1, 50)
        .step(1)
        .onChange(redrawTetrahedron)
        .onFinishChange(() => console.dir(tetrahedron.geometry))
      tetraProps.add(tetrahedronProps, 'detail', 1, 50, 1).onChange(redrawTe
trahedron)
      tetraProps.open()

      function redrawTetrahedron() {
        let newGeometry = new THREE.TetrahedronGeometry(
          tetrahedronProps.radius,
          tetrahedronProps.detail
        )
        tetrahedron.geometry.dispose()
        tetrahedron.geometry = newGeometry
      }

      // octahedron
      const geometry1 = new THREE.OctahedronGeometry()
      const octahedron = new THREE.Mesh(geometry1, material)
      octahedron.position.set(-2.5, 0, 0)
      scene.add(octahedron)

      const octahedronProps = {
        radius: 1,
        detail: 1
```

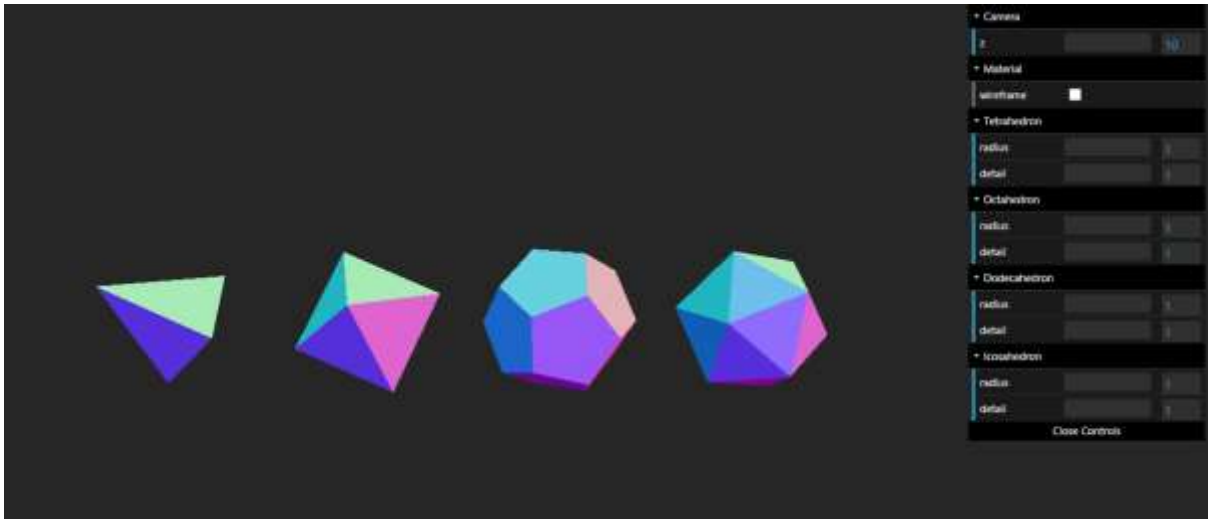
```
      }
      const octaProps = gui.addFolder('Octahedron')
      octaProps
        .add(octahedronProps, 'radius', 1, 50)
        .step(1)
        .onChange(redrawOctahedron)
        .onFinishChange(() => console.dir(octahedron.geometry))
      octaProps.add(octahedronProps, 'detail', 1, 50, 1).onChange(redrawOcta
hedron)
      octaProps.open()

      function redrawOctahedron() {
        let newGeometry = new THREE.OctahedronGeometry(
          octahedronProps.radius,
          octahedronProps.detail
        )
        octahedron.geometry.dispose()
        octahedron.geometry = newGeometry
      }

      // dodecahedron
      const geometry2 = new THREE.DodecahedronGeometry()

      const dodecahedron = new THREE.Mesh(geometry2, material)
      dodecahedron.position.set(0, 0, 0)
      scene.add(dodecahedron)

      const dodecahedronProps = {
        radius: 1,
        detail: 1
      }
      const dodecaProps = gui.addFolder('Dodecahedron')
      dodecaProps
        .add(dodecahedronProps, 'radius', 1, 50)
        .step(1)
        .onChange(redrawDodecahedron)
        .onFinishChange(() => console.dir(dodecahedron.geometry))
```

```
      dodecaProps.add(dodecahedronProps, 'detail', 1, 50, 1).onChange(redraw
Dodecahedron)
      dodecaProps.open()

      function redrawDodecahedron() {
        let newGeometry = new THREE.DodecahedronGeometry(
          dodecahedronProps.radius,
          dodecahedronProps.detail
        )
        dodecahedron.geometry.dispose()
        dodecahedron.geometry = newGeometry
      }

      // icosahedron
      const geometry3 = new THREE.IcosahedronGeometry()

      const icosahedron = new THREE.Mesh(geometry3, material)
      icosahedron.position.set(2.5, 0, 0)
      scene.add(icosahedron)

      const icosahedronProps = {
        radius: 1,
        detail: 1
      }
      const icosaProps = gui.addFolder('Icosahedron')
      icosaProps
        .add(icosahedronProps, 'radius', 1, 50)
        .step(1)
        .onChange(redrawIcosahedron)
        .onFinishChange(() => console.dir(icosahedron.geometry))
      icosaProps.add(icosahedronProps, 'detail', 1, 50, 1).onChange(redrawIc
osahedron)
      icosaProps.open()

      function redrawIcosahedron() {
        let newGeometry = new THREE.IcosahedronGeometry(
          icosahedronProps.radius,
```

```
        icosahedronProps.detail
      )
      icosahedron.geometry.dispose()
      icosahedron.geometry = newGeometry
    }

    // responsiveness
    window.addEventListener('resize', () => {
      width = window.innerWidth
      height = window.innerHeight
      camera.aspect = width / height
      camera.updateProjectionMatrix()

      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.render(scene, camera)
    })

    // renderer
    const renderer = new THREE.WebGL1Renderer()
    renderer.setSize(width, height)
    renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

    // animation
    function animate() {
      requestAnimationFrame(animate)

      const polyhedrons = [tetrahedron, octahedron, dodecahedron, icosahedron]
      polyhedrons.forEach((hedron) => {
        hedron.rotation.x += 0.005
        hedron.rotation.y += 0.01
      })

      renderer.render(scene, camera)
    }

    // rendetetrahedron the scene
    const container = document.querySelector('#threejs-container')
```

```
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



Learn more about geometries here.

# Three.js – Materials

Material is like the skin of the object. It defines the outer appearance of the geometry. Three.js provides many materials to work. We should choose the type of material according to our needs. In this chapter, we'll discuss the most commonly used materials in Three.js.

## MeshBasicMaterial

It is the very basic material in Three.js. It is used to create and display objects of solid color or wireframe. It is self-illuminating and is not affected by lighting.

```
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshBasicMaterial({
  color: 0x87ceeb,
  wireframe: true,
  wireframeLinewidth: 2,
})

const cube = new THREE.Mesh(geometry, material)
```

Sometimes it's hard to distinguish between two adjacent surfaces of the same color. If you create a sphere, it appears like a 2D circle. Although it seems 2D, it should be 3D.

## MeshDepthMaterial

It uses the distance from the camera to determine how to color your mesh in a greyscale. White is nearest, and black is farthest.

```
const geometry = new THREE.TorusKnotGeometry()
const material = new THREE.MeshDepthMaterial()
const torusKnot = new THREE.Mesh(geometry, material)
```

You can understand better in this example.

### mesh-depth.html

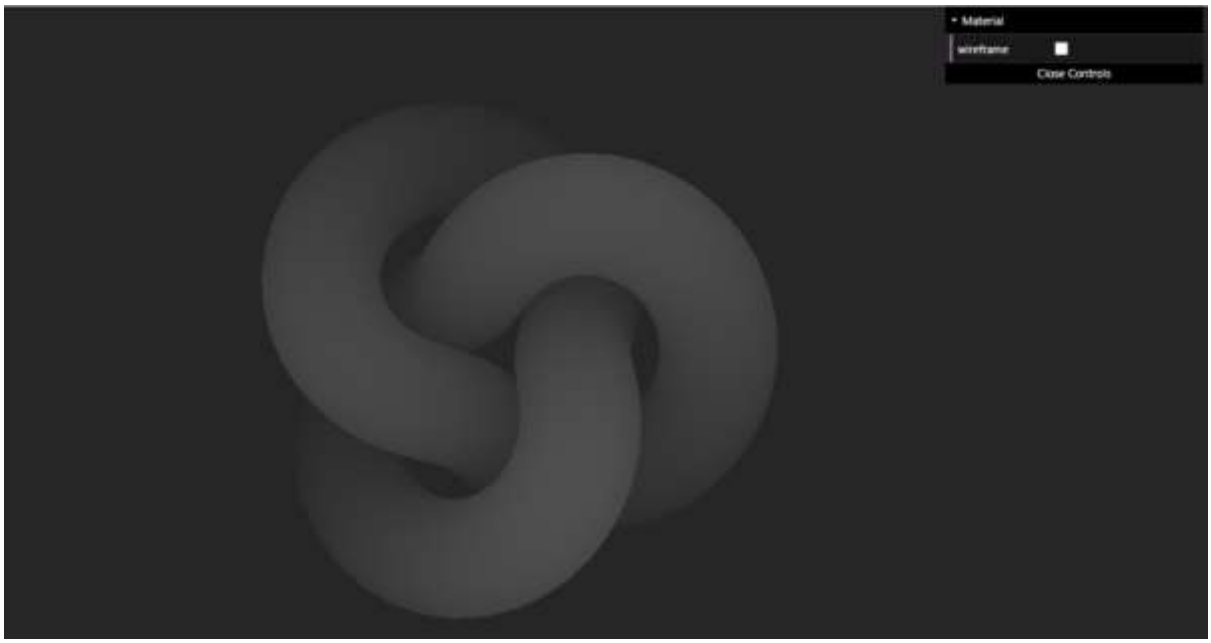
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
```

```
    <title>Three.js - MeshDepthMaterial </title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Using mesh depth material
      // white means, top point. black means, bottom point


      // GUI
      const gui = new dat.GUI()


      // sizes
      let width = window.innerWidth
      let height = window.innerHeight
```

```
// scene
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// Light
const ambientLight = new THREE.AmbientLight(0xffffff, 1)
scene.add(ambientLight)

const pointLight = new THREE.PointLight(0xffffff, 0.5)
pointLight.position.x = 2
pointLight.position.y = 3
pointLight.position.z = 4
scene.add(pointLight)

// camera
const camera = new THREE.PerspectiveCamera(30, width / height, 250, 550)
camera.position.z = 450

// torusKnot
const geometry = new THREE.TorusKnotGeometry(50, 20, 128, 64, 2, 3)
const material = new THREE.MeshDepthMaterial()

const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const torusKnot = new THREE.Mesh(geometry, material)
scene.add(torusKnot)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHlet
  camera.aspect = width / height
  camera.updateProjectionMatrix()
```

```
        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer({ logarithmicDepthBuffer: true })
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        torusKnot.rotation.x += 0.005
        torusKnot.rotation.y += 0.01

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output




## MeshNormalMaterial

This material uses the magnitude of the x/y/z values of the faces' normal vectors to calculate and set the red/green/blue values of the colors displayed on the face.

**How does it work?** - x is `red`, y is `green`, and z is `blue`, so things facing to the right are `pink`, to the left are `aqua`, up are `light green`, down are be `purple`, and toward the screen are be `lavender`.

```
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshBasicMaterial()

const cube = new THREE.Mesh(geometry, material)
```

In the following example, you can see that every face has its color based on the normal of the face.

## mesh-normal.html

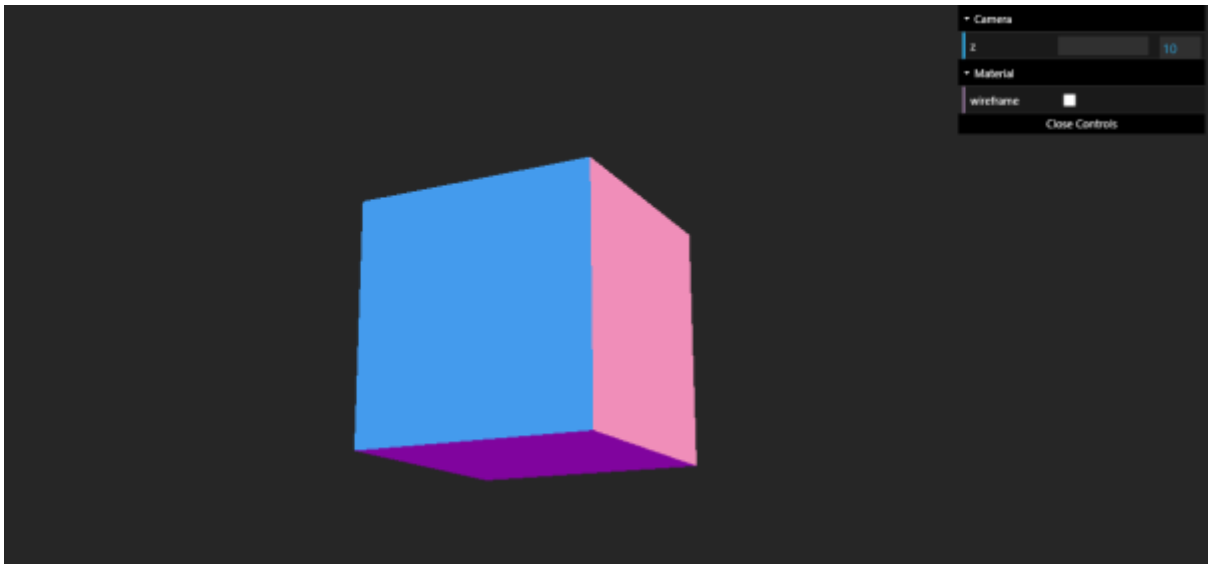
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Cube</title>
    <style>
```

```
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Using mesh normal material
      // each face has different color


      import { OrbitControls } from "https://threejs.org/examples/jsm/contro
ls/OrbitControls.js"


      // GUI
      const gui = new dat.GUI()


      // sizes
      let width = window.innerWidth
```

```
let height = window.innerHeight

// scene
const scene = new THREE.Scene()
scene.background = new THREE.Color(0x262626)

// camera
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 100)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(60).step(10)
camFolder.open()

// cube
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshNormalMaterial()
const materialFolder = gui.addFolder('Material')
materialFolder.add(material, 'wireframe')
materialFolder.open()

const cube = new THREE.Mesh(geometry, material)
scene.add(cube)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
```

```
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))
      const controls = new OrbitControls(camera, renderer.domElement)

      // animation
      function animate() {
        requestAnimationFrame(animate)

        cube.rotation.x += 0.005
        cube.rotation.y += 0.01

        controls.update()
        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



## MeshLambertMaterial

You can use this material to create dull-looking, non-shiny surfaces. It is a very easy-to-use material that responds to the lighting sources in the scene. It has two main properties:

- `color` - This is the color of the material.
- `emissive` - This is the color that the material emits. You can use this to create objects that look like they glow.

```
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshLambertMaterial({ color, emissive })

const cube = new THREE.Mesh(geometry, material)
```

## MeshPhongMaterial

This material is similar to `MeshLambertMaterial` but can create more shiny surfaces. If you use this material without lighting, the camera shows nothing, and it is in black. You can use a white `AmbientLight` to make it visible.

```
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshPhongMaterial({ color, emissive, shininess })

const cube = new THREE.Mesh(geometry, material)
```

## MeshStandardMaterial

It is similar but gives a more accurate and realistic looking result than the `MeshLambertMaterial` or `MeshPhongMaterial`. Instead of `shininess`, it has two properties: `roughness` and `metalness`.

```
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshStandardMaterial({ color, roughness, metalness })

const cube = new THREE.Mesh(geometry, material)
```

## MeshPhysicalMaterial

It is pretty similar to `MeshStandardMaterial`. You can control the reflectivity of the material. The default reflectivity is `0.5`, and you can vary it between `0` and `1`.

```
const geometry = new THREE.BoxGeometry(2, 2, 2)
const material = new THREE.MeshPhysicalMaterial({
  color,
  roughness,
  metalness,
```

```
  reflectivity,
})

const cube = new THREE.Mesh(geometry, material)
```

In this example, you can experiment and understand the differences between `MeshLambertMaterial`, `MeshPhongMaterial`, `MeshStandardMaterial`, and `MeshPhysicalMaterial`.

Now, check out the following example.

## materials.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Materials</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
```

```
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Comparision between MeshLambert, MeshPhong, MeshStandard and MeshPhysical materials

      import { OrbitControls } from "https://threejs.org/examples/jsm/controls/OrbitControls.js"

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // lights
      const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
      scene.add(ambientLight)

      const light = new THREE.PointLight()
      light.position.set(0, 10, 10)
      scene.add(light)
      // for shadow
      light.castShadow = true
      light.shadow.mapSize.width = 1024
      light.shadow.mapSize.height = 1024
      light.shadow.camera.near = 0.5
      light.shadow.camera.far = 100
```

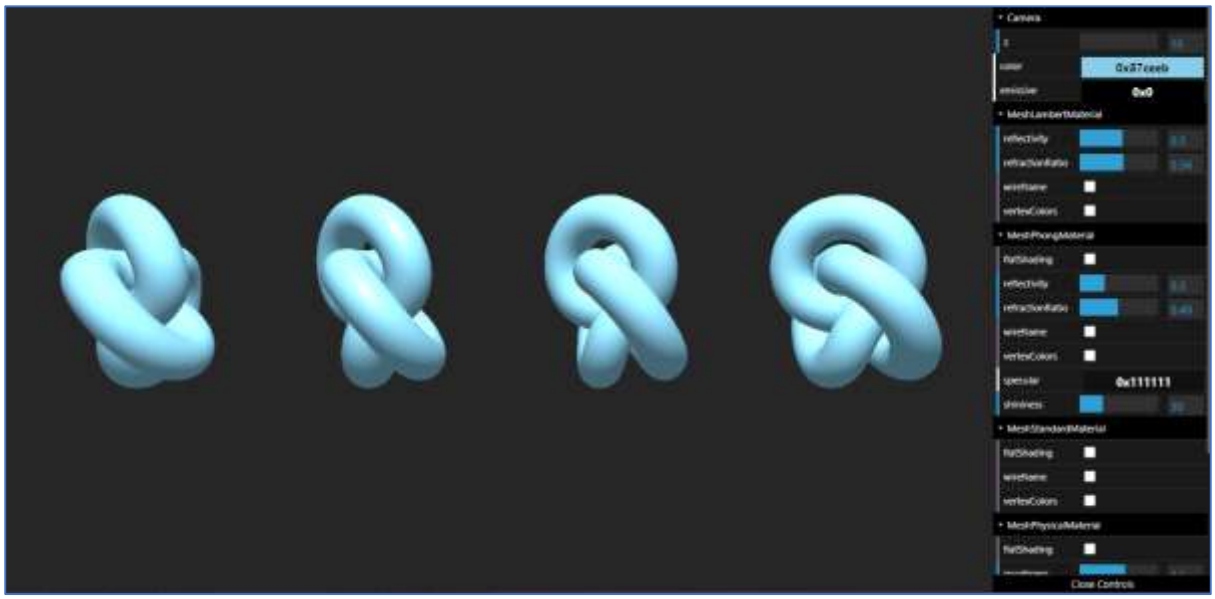
```
scene.add(light)

// camera
const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
camera.position.set(0, 0, 10)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(60).step(10)
camFolder.open()

// geometies
const materials = [
  new THREE.MeshLambertMaterial({ color: 0x87ceeb }),
  new THREE.MeshPhongMaterial({ color: 0x87ceeb }),
  new THREE.MeshStandardMaterial({ color: 0x87ceeb }),
  new THREE.MeshPhysicalMaterial({ color: 0x87ceeb })
]

const geometry = new THREE.TorusKnotGeometry(0.7, 0.28, 128, 64, 2, 3)
const meshes = [
  new THREE.Mesh(geometry, materials[0]),
  new THREE.Mesh(geometry, materials[1]),
  new THREE.Mesh(geometry, materials[2]),
  new THREE.Mesh(geometry, materials[3])
]
meshes.forEach((mesh, i) => {
  mesh.position.set(-6 + 3 * i, 0, 0)
  scene.add(mesh)
})

const objColor = {
  color: materials[0].color.getHex(),
  emissive: materials[0].emissive.getHex(),
  specular: materials[1].specular.getHex()
}
gui.addColor(objColor, 'color').onChange(() => {
  materials.forEach((material) => {
    material.color.set(objColor.color)
```

```
    })
  })
  gui.addColor(objColor, 'emissive').onChange(() => {
    materials.forEach((material) => {
      material.emissive.set(objColor.emissive)
    })
  })

  // gui folders
  const folders = [
    'MeshLambertMaterial',
    'MeshPhongMaterial',
    'MeshStandardMaterial',
    'MeshPhysicalMaterial'
  ]
  folders.forEach((fol, i) => {
    let folder = gui.addFolder(fol)
    let temp = folders[i]
    folders[i] = folder
    //folder.open()
  })

  for (let i = 0; i < materials.length; i++) {
    if (i != 0) {
      folders[i].add(materials[i], 'flatShading')
    }
    if (i < 2) {
      folders[i].add(materials[i], 'reflectivity', 0, 1)
      folders[i].add(materials[i], 'refractionRatio', 0, 1)
    }
    if (i > 2) {
      folders[i].add(materials[i], 'roughness', 0, 1)
      folders[i].add(materials[i], 'metalness', 0, 1)
    }
    folders[i].add(materials[i], 'wireframe')
    folders[i].add(materials[i], 'vertexColors')
  }
```

```
folders[1].addColor(objColor, 'specular').onChange(() => {
  materials[1].specular.set(objColor.specular)
})
folders[1].add(materials[1], 'shininess', 1, 100)

folders[3].add(materials[3], 'reflectivity', 0, 1)
folders[3].add(materials[3], 'clearcoat', 0, 1)
folders[3].add(materials[3], 'clearcoatRoughness', 0, 1)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))
const controls = new OrbitControls(camera, renderer.domElement)

// animation
function animate() {
  requestAnimationFrame(animate)

  meshes.forEach((mesh) => {
    mesh.rotation.x += 0.005
    mesh.rotation.y += 0.01
  })

  controls.update()
```

```
        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



There are many other materials in Three.js. You can learn more here.

## Using Multiple Materials

Until now, while creating a `Mesh`, you added a single material to it. There are also cases where you want to combine multiple materials. You can do that by passing an array of materials. But you should not use `Mesh`. Instead, you can use `createMultipleMaterialObject` of `SceneUtils`. For example, the following code combines `THREE.MeshLambertMaterial` with a material that shows you the wireframe of the geometry.

```
const geometry = new THREE.BoxGeometry(1, 1, 1)

const material1 = new THREE.MeshLambertMaterial({
```

```
  color: 0xff0000,
  transparent: true,
  opacity: 0.7,
})
const material2 = new THREE.MeshBasicMaterial({ wireframe: true })

const cube = THREE.SceneUtils.createMultiMaterialObject(cylinderGeometry, [
  material1,
  material2,
])
```

# Three.js – Textures

The texture is an image or color added to the material to give more detail or beauty. The texture is an essential topic in Three.js. In this section, we'll see how to apply a basic texture to our material.

## Basic Texture

First, you should create a `loader`. Three.js has a built-in function `TextureLoader()` to load textures into your Three.js project. Then you can load any texture or image by specifying its path in the `load()` function.

```
const loader = new THREE.TextureLoader()
texture.load('/path/to/the/image')
```

Then, set the map property of the material to this texture. That's it; you applied a texture to the plane geometry.

Textures have settings for repeating, offsetting, and rotating a texture. By default, textures in three.js do not repeat. There are two properties, `wrapS` for horizontal wrapping and `wrapT` for vertical wrapping to set whether a texture repeats. And set the repeating mode to `THREE.ReaptWrapping`.

```
texture.wrapS = THREE.RepeatWrapping
texture.wrapT = THREE.RepeatWrapping
texture.magFilter = THREE.NearestFilter
```

In Three.js, you can choose what happens both when the texture is drawn larger than its original size and what happens when it's drawn smaller than its original size.

For setting the filter, when the texture is larger than its original size, you set `texture.magFilter` property to either `THREE.NearestFilter` or `THREE.LinearFilter`.

- `NearestFilter` - This filter uses the color of the nearest texel that it can find.
- `LinearFilter` - This filter is more advanced and uses the color values of the four neighboring texels to determine the correct color.

And, you can add how many times to repeat the texture.

```
const timesToRepeatHorizontally = 4
const timesToRepeatVertically = 2
texture.repeat.set(timesToRepeatHorizontally, timesToRepeatVertically)
```

Check out the following example.

## texture.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Checker Board</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Creating a checker-board using Textures
```

```
      // applying the texture to 2d plane geometry

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(75, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z').min(10).max(60).step(10)
      camFolder.open()

      // Light
      const ambientLight = new THREE.AmbientLight(0xffffff, 1)
      scene.add(ambientLight)

      // texture
      const planeSize = 10

      const loader = new THREE.TextureLoader()
      const texture = loader.load(' https://cloud-nfpbfxp6x-hack-club-
bot.vercel.app/0height.png ')
      texture.wrapS = THREE.RepeatWrapping
      texture.wrapT = THREE.RepeatWrapping
      texture.magFilter = THREE.NearestFilter

      const repeats = planeSize / 2
      texture.repeat.set(repeats, repeats)
```

```
class StringToNumberHelper {
  constructor(obj, prop) {
    this.obj = obj
    this.prop = prop
  }
  get value() {
    return this.obj[this.prop]
  }
  set value(v) {
    this.obj[this.prop] = parseFloat(v)
  }
}

const wrapModes = {
  ClampToEdgeWrapping: THREE.ClampToEdgeWrapping,
  RepeatWrapping: THREE.RepeatWrapping,
  MirroredRepeatWrapping: THREE.MirroredRepeatWrapping
}

function updateTexture() {
  texture.needsUpdate = true
}

gui
  .add(new StringToNumberHelper(texture, 'wrapS'), 'value', wrapModes)
  .name('texture.wrapS')
  .onChange(updateTexture)
gui
  .add(new StringToNumberHelper(texture, 'wrapT'), 'value', wrapModes)
  .name('texture.wrapT')
  .onChange(updateTexture)
gui.add(texture.repeat, 'x', 0, 5, 0.01).name('texture.repeat.x')
gui.add(texture.repeat, 'y', 0, 5, 0.01).name('texture.repeat.y')

// plane for board
const geometry = new THREE.PlaneGeometry(planeSize, planeSize)
const material = new THREE.MeshPhongMaterial({
```

```
      map: texture,
      side: THREE.DoubleSide
    })
    const board = new THREE.Mesh(geometry, material)
    board.position.set(0, 0, 0)
    scene.add(board)

    // responsiveness
    window.addEventListener('resize', () => {
      width = window.innerWidth
      height = window.innerHeight
      camera.aspect = width / height
      camera.updateProjectionMatrix()

      renderer.setSize(window.innerWidth, window.innerHeight)
      renderer.render(scene, camera)
    })

    // renderer
    const renderer = new THREE.WebGL1Renderer()
    renderer.setSize(width, height)
    renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

    // animation
    function animate() {
      requestAnimationFrame(animate)

      renderer.render(scene, camera)
    }

    // rendering the scene
    const container = document.querySelector('#threejs-container')
    container.append(renderer.domElement)
    renderer.render(scene, camera)
    console.log(scene.children)
    animate()
  </script>
```

```
  </body>
</html>
```

## Output

# Texture Mapping

## base color map

It is the basic colored image you add to the object to the texture. With a base `color map` we add colors to the surface.

```
const textureMap = new THREE.TextureLoader().load('/path/to/texture-map')
material.map = textureMap
```

You can add the effect of depth using a `bump map` or `normal map` or `distance map`.

## bump map

A bump map is a grayscale image, where the intensity of each pixel determines the height. You can just set the material `bumpMap` property to the texture. It adds fine details to the texture.

```
const textureBumpMap = new THREE.TextureLoader().load('/path/to/bump-map')
material.bumpMap = textureBumpMap
```

## normal maps

A normal map describes the normal vector for each pixel, which should be used to calculate how light affects the material used in the geometry. It creates an illusion of depthness to the flat surface.

```
const textureNormalMap = new THREE.TextureLoader().load('/path/to/normal-map')
```

```
material.normalMap = textureNormalMap
```

## displacement map

While the normal map gives an illusion of depth, we change the model's shape, with a displacement map based on the information from the texture.

```
const textureDisplacementMap = new THREE.TextureLoader().load(
  '/path/to/displacement-map'
)
material.displacemetMap = textureDisplacementMap
```

## roughness map

The roughness map defines which areas are rough and that affects the reflection sharpness from the surface.

```
const textureRoughnessMap = new THREE.TextureLoader().load(
  '/path/to/roughness-map'
)
material.roughnessMap = textureRoughnessMap
```

## ambient occlusion map

It highlights the shadow areas of the object. It requires a second set of UVs.

```
const textureAmbientOcclusionMap = new THREE.TextureLoader().load(
  '/path/to/AmbientOcclusion-map'
)
material.aoMap = textureAmbientOcclusionMap
// second UV
mesh.geometry.attributes.uv2 = mesh.geometry.attributes.uv
```

If you compare the objects with roughness map and ambient occlusion map, you can observe that The shadows are more highlighted after using `aoMap`.

## metalness map

It defines how much the material is like a metal.

```
const textureMetalnessMap = new THREE.TextureLoader().load(
  '/path/to/metalness-map'
)
material.metalnessMap = textureMetalnessMap
```

Now, check out the following example.

## texture-maps.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Texture Mapping</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Using different types of texture maps
```

```
      import { OrbitControls } from "https://threejs.org/examples/jsm/contro
ls/OrbitControls.js"

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0xffffff)

      // lights
      const ambientLight = new THREE.AmbientLight(0xffffff, 0.5)
      scene.add(ambientLight)

      const light = new THREE.DirectionalLight(0xffffff, 4.0)
      light.position.set(0, 10, 20)
      light.castShadow = true
      light.shadow.mapSize.width = 512
      light.shadow.mapSize.height = 512
      light.shadow.camera.near = 0.5
      light.shadow.camera.far = 100
      scene.add(light)

      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 10)

      // textures
      const loader = new THREE.TextureLoader()
      const texture = loader.load('https://cloud-nfpbfxp6x-hack-club-
bot.vercel.app/5basecolor.jpg')
      const normalmap = loader.load('https://cloud-nfpbfxp6x-hack-club-
bot.vercel.app/2normal.jpg')
      const heightmap = loader.load('https://cloud-nfpbfxp6x-hack-club-
bot.vercel.app/0height.png')
```

```
      const roughmap = loader.load('https://cloud-nfpbfxp6x-hack-club-
bot.vercel.app/3roughness.jpg')
      const ambientOcclusionmap = loader.load('https://cloud-nfpbfxp6x-hack-
club-bot.vercel.app/4ambientocclusion.jpg')
      const metallicmap = loader.load('https://cloud-nfpbfxp6x-hack-club-
bot.vercel.app/1metallic.jpg')

      // plane
      const planeGeometry = new THREE.PlaneGeometry(100, 100)
      const plane = new THREE.Mesh(
        planeGeometry,
        new THREE.MeshPhongMaterial({ color: 0xffffff, side: THREE.DoubleSide })
      )
      plane.rotateX(-Math.PI / 2)
      plane.position.y = -2.75
      plane.receiveShadow = true
      scene.add(plane)

      // object
      const geometry = new THREE.SphereGeometry(1, 64, 64)
      const material1 = new THREE.MeshStandardMaterial({
        map: texture,
        side: THREE.DoubleSide
      })
      const object1 = new THREE.Mesh(geometry, material1)
      object1.position.set(-2.5, 1.5, 0)
      object1.castShadow = true
      scene.add(object1)

      // normal map
      const material2 = new THREE.MeshStandardMaterial({
        color: 0xffffff,
        map: texture,
        side: THREE.DoubleSide,
        normalMap: normalmap
      })
      const object2 = new THREE.Mesh(geometry, material2)
      object2.position.set(0, 1.5, 0)
```

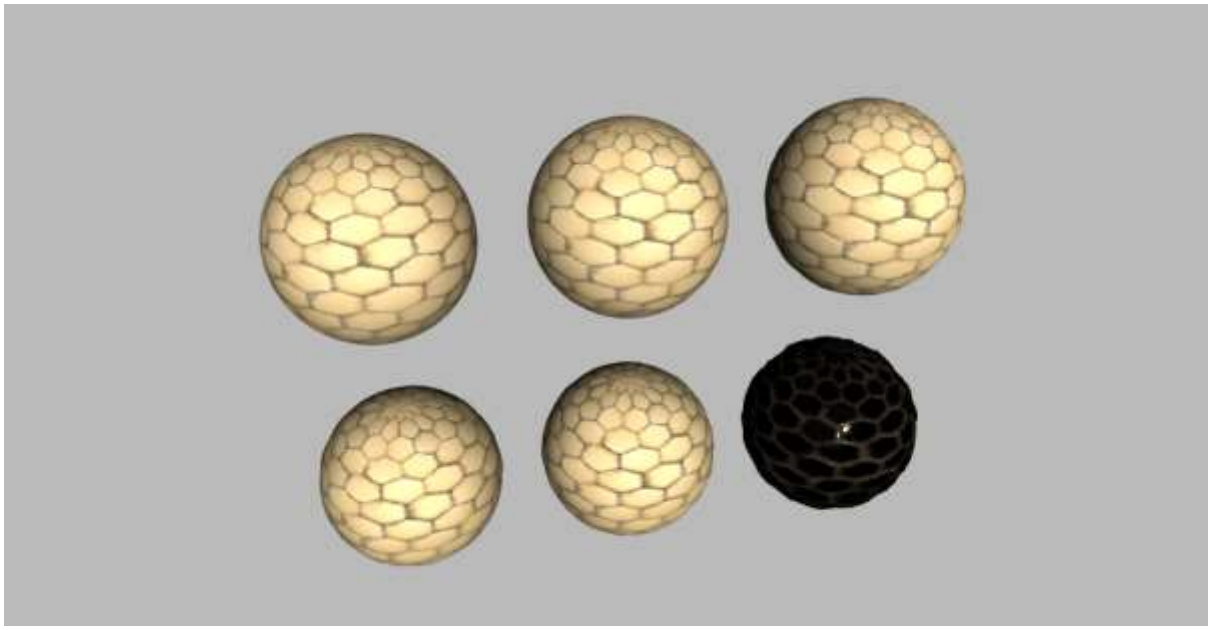
```
object2.castShadow = true
scene.add(object2)

// displacement map
const material3 = new THREE.MeshStandardMaterial({
  color: 0xffffff,
  map: texture,
  side: THREE.DoubleSide,
  normalMap: normalmap,
  displacementMap: heightmap,
  displacementScale: 0.05
})
const object3 = new THREE.Mesh(geometry, material3)
object3.position.set(2.5, 1.5, 0)
object3.castShadow = true
scene.add(object3)
console.log(object3)

// roughness map
const material4 = new THREE.MeshStandardMaterial({
  color: 0xffffff,
  map: texture,
  side: THREE.DoubleSide,
  normalMap: normalmap,
  displacementMap: heightmap,
  displacementScale: 0.05,
  roughnessMap: roughmap,
  roughness: 0.5
})
const object4 = new THREE.Mesh(geometry, material4)
object4.position.set(-2.5, -1.5, 0)
object4.castShadow = true
scene.add(object4)
console.log(object4)

// ambient occlusion map
const material5 = new THREE.MeshStandardMaterial({
```

```
    color: 0xffffff,
    map: texture,
    side: THREE.DoubleSide,
    normalMap: normalmap,
    displacementMap: heightmap,
    displacementScale: 0.05,
    roughnessMap: roughmap,
    roughness: 0.1,
    aoMap: ambientOcclusionmap
  })
  const object5 = new THREE.Mesh(geometry, material5)
  object5.position.set(0, -1.5, 0)
  object5.geometry.attributes.uv2 = object5.geometry.attributes.uv
  object5.castShadow = true
  scene.add(object5)
  console.log(object5)

  // for env maps
  const cubeRenderTarget = new THREE.WebGLCubeRenderTarget(128, {
    format: THREE.RGBFormat,
    generateMipMaps: true,
    minFilter: THREE.LinearMipmapLinearFilter,
    encoding: THREE.sRGBEncoding
  })

  const cubeCamera = new THREE.CubeCamera(1, 10000, cubeRenderTarget)
  cubeCamera.position.set(0, 100, 0)
  scene.add(cubeCamera)

  // metallic map
  const material6 = new THREE.MeshStandardMaterial({
    color: 0xffffff,
    map: texture,
    side: THREE.DoubleSide,
    normalMap: normalmap,
    displacementMap: heightmap,
    displacementScale: 0.15,
```

```
    roughnessMap: roughmap,
    roughness: 0.1,
    aoMap: ambientOcclusionmap,
    metalnessMap: metallicmap,
    metalness: 1,
    envMap: cubeRenderTarget.texture
})
const object6 = new THREE.Mesh(geometry, material6)
object6.position.set(2.5, -1.5, 0)
object6.geometry.attributes.uv2 = object6.geometry.attributes.uv
object6.castShadow = true
scene.add(object6)
console.log(object6)

cubeCamera.position.copy(object6.position)

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer - anti-aliasing
const renderer = new THREE.WebGLRenderer({ antialias: true })
renderer.physicallyCorrectLights = true
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

const controls = new OrbitControls(camera, renderer.domElement)

// animation
function animate() {
```

```
        requestAnimationFrame(animate)

        let objects = [object1, object2, object3, object4, object5, object6]

        objects.forEach((i) => {
          //i.rotation.x += 0.005
          i.rotation.y += 0.01
        })
        controls.update()
        cubeCamera.update(renderer, scene)

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



There are some other maps for creating a real-world model in computer graphics. You can learn more here.

# Three.js – Drawing Lines

You have learned about quite a lot of materials in Three.js. Now let's see some unique materials used in drawing lines. We can draw various shapes and patterns using lines.

## Using BufferGeometry

`THREE.BufferGeometry` is the base class of all the built-in geometries in Three.js. You can create your geometry by passing an array of vertices of the geometry.

Learn more about `BufferGeometry` here.

```
const points = []
points.push(new THREE.Vector3(-10, 0, 0))
points.push(new THREE.Vector3(0, -10, 0))
points.push(new THREE.Vector3(10, 0, 0))
```

These are some additional elements Three.js provides us to create our geometries. `THREE.Vector3(x, y, z)` - It makes a point in 3D space. In the above code, we are adding 3 points to the `points` array.

```
const geometry = new THREE.BufferGeometry().setFromPoints(points)
```

`THREE.BufferGeometry()`, as mentioned before it creates our geometry. We use the `setFromPoints` method to set the geometry using the array of points.

**Note**: Lines are drawn between each consecutive pair of vertices, but not between the first and last (the line is not closed.)

```
const material = new THREE.LineBasicMaterial({
  // for normal lines
  color: 0xffffff,
  linewidth: 1,
  linecap: 'round', //ignored by WebGLRenderer
  linejoin: 'round', //ignored by WebGLRenderer
})

// or
const material = new THREE.LineDashedMaterial({
  // for dashed lines
  color: 0xffffff,
  linewidth: 1,
```

```
  scale: 1,
  dashSize: 3,
  gapSize: 1,
})
```

These are the unique materials for lines. You can use any one of `THREE.LineBasicMaterial` or `THREE.LineDashedMaterial`.

```
const line = new THREE.Line(geometry, material)
```

Now, instead of using `THREE.Mesh`, we use `THREE.Line` for drawing lines. Now, you see a "V" shape drawn using lines on the screen.

## linebasic.html

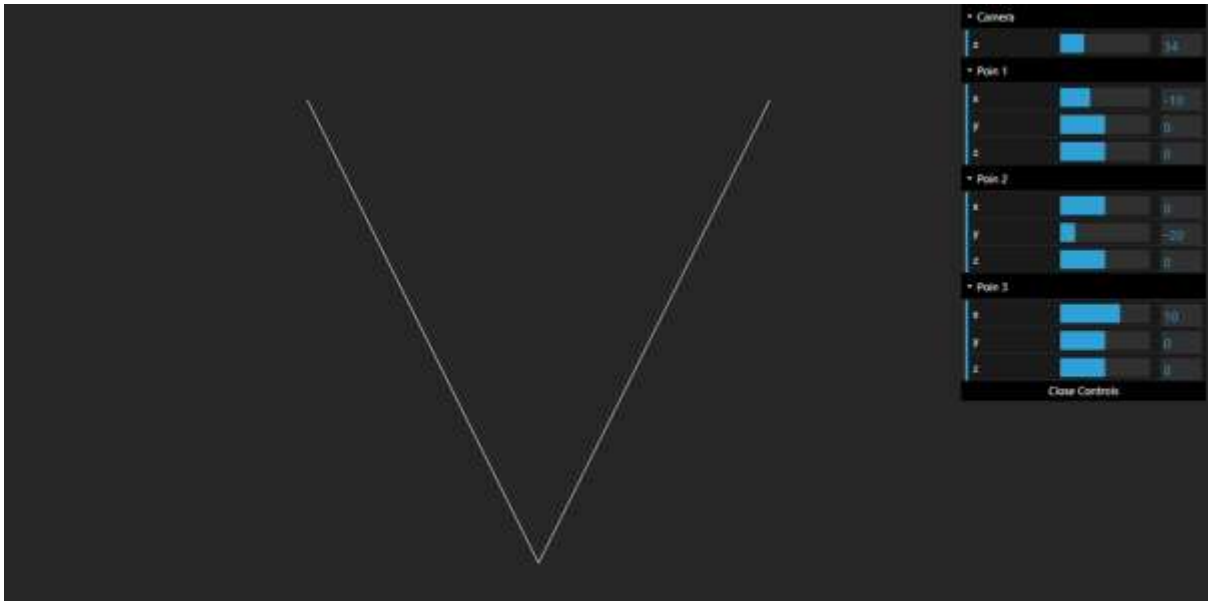
```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Line basic</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
```

```
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Creating a line using LineBasicMaterial


      // GUI
      const gui = new dat.GUI()


      // sizes
      let width = window.innerWidth
      let height = window.innerHeight


      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)


      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 50)
      camera.lookAt(0, 0, 0)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z', 10, 100)
      camFolder.open()


      // Line
      const points = []
      points.push(new THREE.Vector3(-10, 0, 0))
      points.push(new THREE.Vector3(0, -20, 0))
      points.push(new THREE.Vector3(10, 0, 0))


      const folders = [gui.addFolder('Poin 1'), gui.addFolder('Poin 2'), gui
.addFolder('Poin 3')]
```

```
folders.forEach((folder, i) => {
  folder.add(points[i], 'x', -30, 30, 1).onChange(redraw)
  folder.add(points[i], 'y', -30, 30, 1).onChange(redraw)
  folder.add(points[i], 'z', -30, 30, 1).onChange(redraw)
  folder.open()
})

const geometry = new THREE.BufferGeometry().setFromPoints(points)
const material = new THREE.LineBasicMaterial({
  color: 0xffffff,
  linewidth: 2
})
const line = new THREE.Line(geometry, material)
line.position.set(0, 10, 0)
scene.add(line)

function redraw() {
  let newGeometry = new THREE.BufferGeometry().setFromPoints(points)
  line.geometry.dispose()
  line.geometry = newGeometry
}

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))
```

```
      // animation
      function animate() {
        requestAnimationFrame(animate)

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output



You can create any type of geometry wireframe using lines by specifying the vertices. Check out the following example where we are drawing dashed lines.

## dashedline.html

```
<!DOCTYPE html>
```

```
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - Dashed line</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Creating dashed line using LineDashedMaterial


      // GUI
      const gui = new dat.GUI()
```

```
      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // camera
      const camera = new THREE.PerspectiveCamera(45, width / height, 0.1, 100)
      camera.position.set(0, 0, 50)
      camera.lookAt(0, 0, 0)
      const camFolder = gui.addFolder('Camera')
      camFolder.add(camera.position, 'z', 10, 100)
      camFolder.open()

      // Line
      const points = []
      points.push(new THREE.Vector3(-10, 0, 0))
      points.push(new THREE.Vector3(0, -20, 0))
      points.push(new THREE.Vector3(10, 0, 0))

      const folders = [gui.addFolder('Poin 1'), gui.addFolder('Poin 2'), gui
.addFolder('Poin 3')]
      folders.forEach((folder, i) => {
        folder.add(points[i], 'x', -30, 30, 1).onChange(redraw)
        folder.add(points[i], 'y', -30, 30, 1).onChange(redraw)
        folder.add(points[i], 'z', -30, 30, 1).onChange(redraw)
        folder.open()
      })

      const geometry = new THREE.BufferGeometry().setFromPoints(points)
      const material = new THREE.LineDashedMaterial({
        color: 0xffffff,
        linewidth: 2,
        scale: 1,
```

```
    dashSize: 3,
    gapSize: 2
})

const line = new THREE.Line(geometry, material)
line.computeLineDistances()
line.position.set(0, 10, 0)
scene.add(line)

console.log(line)
function redraw() {
  let newGeometry = new THREE.BufferGeometry().setFromPoints(points)
  line.geometry.dispose()
  line.geometry = newGeometry
}

// responsiveness
window.addEventListener('resize', () => {
  width = window.innerWidth
  height = window.innerHeight
  camera.aspect = width / height
  camera.updateProjectionMatrix()

  renderer.setSize(window.innerWidth, window.innerHeight)
  renderer.render(scene, camera)
})

// renderer
const renderer = new THREE.WebGL1Renderer()
renderer.setSize(width, height)
renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

// animation
function animate() {
  requestAnimationFrame(animate)

  renderer.render(scene, camera)
```

```
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output

# Three.js – Animations

Animations give life to our websites, as you can see that most of the examples use animations. Let's see how to add basic animations to our Three.js web application.

If you want to add animations to your Three.js scene, you'll need to render the scene multiple times. To do that, you should use the standard HTML5 `requestAnimationFrame` functionality.

```
function animate() {
  // schedule multiple rendering
  requestAnimationFrame(animate)

  renderer.render(scene, camera)
}
```

The above code executes the argument passes to `requestAnimationFrame`, `animate` function, at regular intervals, and also renders the scene multiple times (every 60ms).

You now have your animation loop, so any changes made to your model, camera, or other objects in the scene can now be done from within the `animate` function.

Let's create a simple rotating animation.

```
function animate() {
  requestAnimationFrame(animate)
  // rotating the cube
  cube.rotation.x += 0.005
  cube.rotation.y += 0.01
  renderer.render(scene, camera)
}
```

The above code creates a rotating cube. Every time the `animate` renders, the cube rotates by the specified values, which repeats as an infinite loop.

You can also add animation to any other element in the scene. Check out this example and play around the scene exploring different animations.

You can also use different animation libraries like `Tween.js`, `Greensock,` to create professional animations using Three.js.

In the following section, let's use `tween.js` to add animations to our 3D objects.

## Using Twee.js in the Three.js project

First things first, you should include the library in your project. Add a script tag or install from npm.

```
<script src="path/to/tween.js"></script>
```

To use this library, we need to first create an instance of a TWEEN.Tween object.

```
const initial = { x: 0, y: 1.25, z: 0, rot: 0 }
const final = { x: 5, y: 15, z: -10, rot: 2 * Math.PI }
const tween = new TWEEN.Tween(initial)
```

It creates a `TWEEN.Tween` instance. We can use this instance to move the provided properties from the initial value to the final value.

```
tween.to(final)
```

With **`to`** function, we tell the tween object that we want to change the initial values to final values slowly. So, we vary the `x` property from `0` to `5`. The second parameter, which is `5000`, defines how many `milliseconds` this change should take.

You can also choose how the value changes over time. For instance, you can use a linear easing function. It changes the values at a constant rate, which starts with small changes and quickly increases. Many more easing functions are predefined in `TWEEN`.

```
tween.easing(TWEEN.Easing.Elastic.InOut)
```

To make the 3D object animate, we need to be notified at every change. This is done with `onUpdate()`. If you want to be notified at the end of the tween, use `onComplete()`.

```
tween.onUpdate(function () {
  cube.position.set(this.x, this.y, this.z)
  cube.rotation.set(this.rot, this.rot, this.rot)
})
```

There are several other settings you can use on the `tween` object to control how the animation behaves. In this case, we tell the `tween` object to repeat its animation `indefinitely` and use a `yo-yo` effect that reverses the animation.

```
tween.repeat(Infinity)
tween.yoyo(true)
```

Finally, we can start the tween object by calling the start function.

```
tween.start()
```

At this point, nothing happens. You have to update the `tween` so that it is updated whenever the text the scene renders. You can call it in the `animate` function.

```
function animate() {
  requestAminationFrame(animate)
```

```
  TWEEN.update()
}
```

Now, you can see the effect. Similarly, you can use any animation library with Three.js.

# Three.js – Creating Text

Often you need to add text to your scene. In this chapter, let's see how to add 2D and 3D text to our scene.

## Draw Text to Canvas and Use as a Texture

This is the easiest way to add 2D text to your scene. you can create `canvas` using JavaScript andd add it to the dom.

```
const canvas = document.createElement('canvas')
const context = canvas.getContext('2d')
```

The code above creates a `canvas` element, and we set the context to `2d`. The `canvas.getContext()` method returns an object that provides methods and properties for drawing on the canvas, which it can use to draw text, lines, boxes, circles, and more.

```
context.fillStyle = 'green'
context.font = '60px sans-serif
context.fillText('Hello World!', 0, 60)
```

The `fillText()` is a method of a 2D drawing context. The `fillText()` method allows you to draw a text string at a coordinate with the fill (color) derived from the `fillStyle` you provided. You can set the font of the text using the `font` property.

The above code set the font to `60-pixel-tall san-serif` and the fill style to `green`. The text `'Hello, World!'` is drawn starting at the coordinates `(0, 60)`.

```
// canvas contents are used for a texture
const texture = new THREE.Texture(canvas)
texture.needsUpdate = true
```

To create a texture from a canvas element, we need to create a new instance of `THREE.Texture` and pass in the `canvas` element we made. The code above creates a texture using the canvas (in this case, our text). The `needsUpdate` parameter of the texture is set to `true`. It informs Three.js that our canvas texture has changed and needs to be updated the next time the scene is rendered.

Now, create a plane geometry and add this as a texture to the material.

```
var material = new THREE.MeshBasicMaterial({
  map: texture,
  side: THREE.DoubleSide,
})
material.transparent = true
var mesh = new THREE.Mesh(new THREE.PlaneGeometry(50, 10), material)
```

## Using Text Geometry

`THREE.TextGeometry` is another type of geometry that generates text as a single geometry. It takes two arguments, `text` - the text you want to render, and other `parameters`.

### Parameters

- `font` - This is the name of the font.
- `size` - Size of the text. Default is `100`.
- `height` - The height property defines the depth of the text; in other words, how far the text extrudes to make it 3D. This defaults to `50`.
- `curveSegments` - Number of points on the curves. Default is `12`.
- `bevelEnabled` - A bevel provides a smooth transition from the front of the text to the side. If you set this value to true, it adds a bevel to the rendered text. By default, it is `false`.
- `bevelThickness` - If you've set bevelEnabled to true, it defines how deep the bevel is. Default is `10`.
- `bevelSize` - It determines how high the bevel is. Default is equal to `8`.
- `bevelOffset` - How far from text outline bevel starts. Default is `0`.
- `bevelSegments` - The number of bevel segments. Default is `3`.

You need to use `THREE.FontLoader` to load fonts from their `typeface.json` files.

```
const loader = new THREE.FontLoader()

loader.load('fonts/helvetiker_regular.typeface.json', function (font) {
  const geometry = new THREE.TextGeometry('Hello Three.js!', {
    font: font,
    size: 3,
    height: 0.2,
    curveSegments: 12,
    bevelEnabled: false,
    bevelThickness: 0.5,
    bevelSize: 0.3,
    bevelOffset: 0,
    bevelSegments: 5,
  })
})
```

Now, you should add some material to it and create a mesh.

```
const material = new THREE.MeshFaceMaterial([
  new THREE.MeshPhongMaterial({
    color: 0xff22cc,
```

```
    flatShading: true,
  }), // front
  new THREE.MeshPhongMaterial({
    color: 0xffcc22
  }), // side
])
const mesh = new THREE.Mesh(geometry, material)
mesh.name = 'text'
scene.add(mesh)
```

**Note:** There is one thing you need to take into account when working with `THREE.TextGeometry` and materials. It can take two materials as an array: one for the front of rendered text and another for the side of the text. If you just pass in one material, it gets applied to both the front and the side.

Now, you can see the text rendered to the scene. Check out the following example.

## 2d-text.html

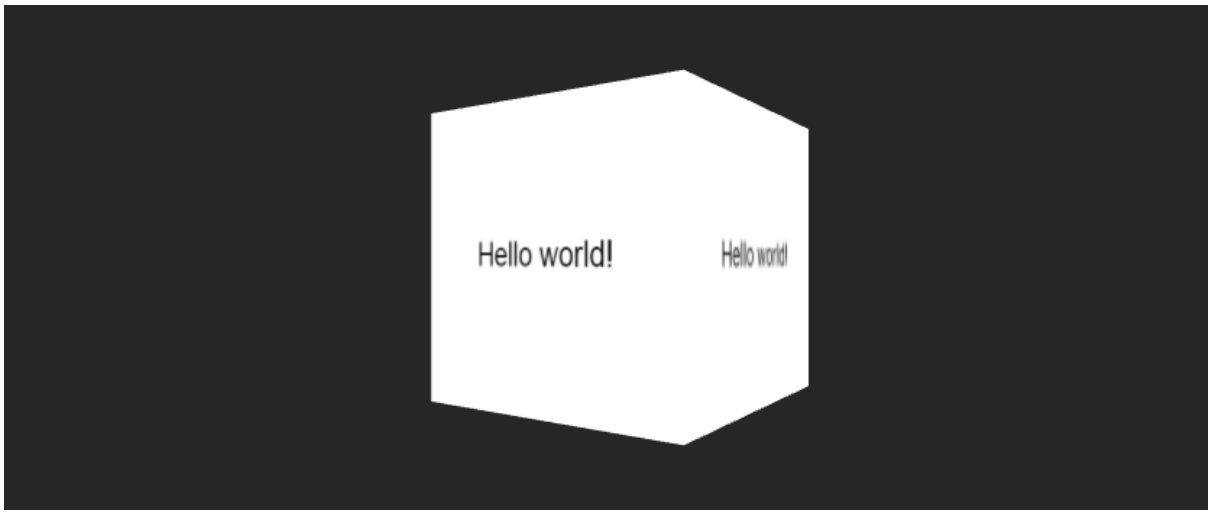
```
<!DOCTYPE html>
<html>
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - 2d text</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
```

```
      #threejs-container {
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Adding 2d text to Three.js scene
      // Writing on canvas and then adding the canvas as a texture to material

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight
      const size = 256

      const container = document.querySelector('#threejs-container')
      const canvas = document.createElement('canvas'),
        ctx = canvas.getContext('2d')

      function changeCanvas() {
        ctx.font = '20pt Arial'
        ctx.fillStyle = 'white'
        ctx.fillRect(0, 0, canvas.width, canvas.height)
        ctx.fillStyle = 'black'
        ctx.textAlign = 'center'
        ctx.textBaseline = 'middle'
        ctx.fillText('Hello world!', canvas.width / 2, canvas.height / 2)
```

```
    }

    // scene
    const scene = new THREE.Scene()
    scene.background = new THREE.Color(0x262626)

    // lights
    const ambientLight = new THREE.AmbientLight(0xffffff, 1)
    scene.add(ambientLight)

    const pointLight = new THREE.PointLight(0xffffff, 0.5)
    pointLight.position.x = 20
    pointLight.position.y = 30
    pointLight.position.z = 40
    scene.add(pointLight)

    // camera
    const camera = new THREE.PerspectiveCamera(70, width / height, 1, 1000)
    camera.position.z = 500
    scene.add(camera)

    // renderer
    const renderer = new THREE.WebGL1Renderer({ antialias: true })
    renderer.setSize(width, height)
    renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

    container.append(renderer.domElement)
    renderer.render(scene, camera)

    // cube
    const texture = new THREE.Texture(canvas)
    const material = new THREE.MeshStandardMaterial({ map: texture })
    const geometry = new THREE.BoxGeometry(200, 200, 200)
    const mesh = new THREE.Mesh(geometry, material)
    scene.add(mesh)

    canvas.width = canvas.height = size
```

```
      // responsiveness
      window.addEventListener('resize', () => {
        width = window.innerWidth
        height = window.innerHeight
        camera.aspect = width / height
        camera.updateProjectionMatrix()

        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // animation
      function animate() {
        requestAnimationFrame(animate)

        changeCanvas()
        texture.needsUpdate = true
        mesh.rotation.y += 0.01
        renderer.render(scene, camera)
      }
      animate()
    </script>
  </body>
</html>
```

## Output




Let us now take another example to see how to add 3D text in a scene.

## 3d-text.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Three.js - 3d text</title>
    <style>
      * {
        margin: 0;
        padding: 0;
        box-sizing: border-box;
        font-family: -apple-
system, BlinkMacSystemFont, 'Segoe UI', Roboto, Oxygen, Ubuntu,
          Cantarell, 'Open Sans', 'Helvetica Neue', sans-serif;
      }
      html,
      body {
        height: 100vh;
        width: 100vw;
      }
      #threejs-container {
```

```
        position: block;
        width: 100%;
        height: 100%;
      }
    </style>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/three.js/r128/three.
min.js"></script>
    <script src="https://cdnjs.cloudflare.com/ajax/libs/dat-
gui/0.7.7/dat.gui.min.js"></script>
  </head>
  <body>
    <div id="threejs-container"></div>
    <script type="module">
      // Creating 3d text using Text Geometry in Three.js

      // GUI
      const gui = new dat.GUI()

      // sizes
      let width = window.innerWidth
      let height = window.innerHeight

      // scene
      const scene = new THREE.Scene()
      scene.background = new THREE.Color(0x262626)

      // lights
      const ambientLight = new THREE.AmbientLight(0xffffff, 1)
      scene.add(ambientLight)

      const pointLight = new THREE.PointLight(0xffffff, 0.5)
      pointLight.position.x = 20
      pointLight.position.y = 30
      pointLight.position.z = 40
      scene.add(pointLight)

      // camera
```

```
const camera = new THREE.PerspectiveCamera(30, width / height, 0.1, 1000)
camera.position.set(0, 0, 50)
const camFolder = gui.addFolder('Camera')
camFolder.add(camera.position, 'z').min(10).max(500).step(10)
camFolder.open()

function createMaterial() {}

const loader = new THREE.FontLoader()
// promisify font loading
function loadFont(url) {
  return new Promise((resolve, reject) => {
    loader.load(url, resolve, undefined, reject)
  })
}

async function doit() {
  const font = await loadFont(
    'https://threejs.org/examples/fonts/helvetiker_regular.typeface.json'
  )

  let text = 'Hello World !'
  const geometry = new THREE.TextGeometry(text, {
    font: font,
    size: 3,
    height: 0.2,
    curveSegments: 12,
    bevelEnabled: true,
    bevelOffset: 0,
    bevelThickness: 0.5,
    bevelSize: 0.3,
    bevelSegments: 5
  })
  const material = [
    new THREE.MeshPhongMaterial({
      color: 0xff22cc,
      flatShading: true
```

```
    }), // front
    new THREE.MeshPhongMaterial({
      color: 0xffcc22
    }) // side
  ]
  const mesh = new THREE.Mesh(geometry, material)
  geometry.computeBoundingBox()
  geometry.computeVertexNormals()
  geometry.boundingBox.getCenter(mesh.position).multiplyScalar(-1)
  mesh.position.x = -geometry.boundingBox.max.x / 2

  const parent = new THREE.Object3D()
  parent.add(mesh)

  scene.add(parent)

  const opts = geometry.parameters.options
  console.log(opts)
  const geoProps = {
    font: opts.font,
    size: opts.size,
    height: opts.height,
    curveSegments: opts.curveSegments,
    bevelEnabled: opts.bevelEnabled,
    bevelOffset: opts.bevelOffset,
    bevelThickness: opts.bevelThickness,
    bevelSize: opts.bevelSize,
    bevelSegments: opts.bevelSegments
  }
  console.log(geoProps)

  // GUI for exporimenting cube properties
  const props = gui.addFolder('Properties')
  props
    .add(geoProps, 'size', 1, 30)
    .step(1)
    .onChange(redraw)
```

```
        .onFinishChange(() => console.dir(mesh.geometry))
      props.add(geoProps, 'height', 0, 30).step(0.1).onChange(redraw)
      props.add(geoProps, 'curveSegments', 1, 30).step(1).onChange(redraw)
      props.add(geoProps, 'bevelEnabled').onChange(redraw)
      props.add(geoProps, 'bevelOffset', 0, 1).onChange(redraw)
      props.add(geoProps, 'bevelThickness', 0, 3).onChange(redraw)
      props.add(geoProps, 'bevelSize', 0, 3).onChange(redraw)
      props.add(geoProps, 'bevelSegments', 1, 8).step(1).onChange(redraw)
      props.open()

      function redraw() {
        camera.position.set(0, 0, 80)
        let newGeometry = new THREE.TextGeometry(text, {
          font: geoProps.font,
          size: geoProps.size,
          heigth: geoProps.height,
          curveSegments: geoProps.curveSegments,
          bevelEnabled: geoProps.bevelEnabled,
          bevelOffset: geoProps.bevelOffset,
          bevelThickness: geoProps.bevelThickness,
          bevelSize: geoProps.bevelSize,
          bevelSegments: geoProps.bevelSegments
        })
        mesh.geometry.dispose()
        mesh.geometry = newGeometry
        mesh.geometry.parameters.options.depth = 0.2
        console.log(mesh.geometry.parameters.options)
      }
    }
    doit()

    // responsiveness
    window.addEventListener('resize', () => {
      width = window.innerWidth
      height = window.innerHeight
      camera.aspect = width / height
      camera.updateProjectionMatrix()
```

```
        renderer.setSize(window.innerWidth, window.innerHeight)
        renderer.render(scene, camera)
      })

      // renderer
      const renderer = new THREE.WebGL1Renderer({ antialias: true })
      renderer.setSize(width, height)
      renderer.setPixelRatio(Math.min(window.devicePixelRatio, 2))

      // animation
      function animate() {
        requestAnimationFrame(animate)

        renderer.render(scene, camera)
      }

      // rendering the scene
      const container = document.querySelector('#threejs-container')
      container.append(renderer.domElement)
      renderer.render(scene, camera)
      animate()
    </script>
  </body>
</html>
```

## Output


You can add custom fonts by using their `typeface` files. You can find some at http://typeface.neocracy.org/fonts.html. You can add different textures to the text, just like we added to other materials.

# Three.js – Loading 3D Models

3D models are available in many formats. You can import most of the models into Three.js and work with them quickly. Some formats are difficult to work with, inefficient for real-time experiences, or simply not fully supported by Three.js at this time. Let's discuss some of the standard formats and how to load them into the Three.js file.

**Note:** Only a few format loaders are built-in in Three.js. For loading other format models, you need to include their JavaScript files. You can find all the different loaders in the Three.js repo in the three/examples/jsm/loaders directory.

For loading any model, we use these simple three steps:

1. Include [NameOfFormat]Loader.js in your web page.
2. Use [NameOfFormat]Loader.load() to load a URL.
3. Check what the response format for the callback function looks like and render the result.

## OBJ Model Loader

The `OBJ` file defines the geometry of the material in the form of text. Many other 3D Model software can create models in `OBJ` format. In Threejs, when importing an OBJ, the default material is a white `MeshPhongMaterial.` You need at least one light in your scene. You can use `OBJLoader` to load the models in `OBJ` format.

To use `OBJLoader` in your Three.js project, you need to add the `OBJLoader` JavaScript file.

```
<script type="text/javascript" src="../scripts/OBJLoader.js"></script>
```

Then, you can load the model just like you loaded the texture using `.load` method.

```
const loader = new THREE.OBJLoader()
loader.load('path/to/your/.obj file', (object) => {
  scene.add(object)
})
```

In this code, we use OBJLoader to load the model from a URL. Once the model is loaded, the callback we provide is called, and we can customize the loaded mesh if you want.

## MTL Model Loader

`OBJ` and `MTL` are companion formats and often used together. The `MTL` file defines the materials used for the geometry in `OBJ` files. The `MTL` is also in a text-based format.

```
<script type="text/javascript" src="../scripts/MTLLoader.js"></script>
```

We'll use MTLLoader and OBJLoader together in this code snippet.

```
const mtlLoader = new THREE.MTLLoader()
mtlLoader.load('/path/to/your/.mtl file', (materials) => {
  materials.preload()

  // loading geometry
  const objLoader = new THREE.OBJLoader()
  objLoader.setMaterials(materials)
  objLoader.load('path/to/your/.obj file', (object) => {
    mesh = object
    scene.add(mesh)
  })
})
```

It loads the materials first. Then we set the materials of the OBJ file to load as the loaded material and then load the OBJ file. It creates the mesh we needed to render an object to the scene, customizing the mesh or material just like those in the Three.js projects.

## GLTF Model Loader

A glTF file may contain one or more scenes, meshes, materials, textures, skins, skeletons, morph targets, animations, lights, and cameras. **It is the recommended format by official Three.js**. Both .GLB and .GLTF versions of the format are well-supported by Three.js. Because glTF focuses on runtime asset delivery, it is compact to transmit and fast to load.

```
<script src="../scripts/GLTFLoader.js"></script>
```

Using the GLTFLoader object, you can import either JSON (.gltf) or binary (.glb) format.

```
const loader = new THREE.GLTFLoader()
// loading model
loader.load('path/to/model.glb', (gltf) => {
  scene.add(gltf.scene)
})
```

The scene of the imported glTF model is added to our Three.js project. The loaded model may contain two scenes; you can specify the scene you want to import.

## DRACO Loader

The DRACOLoader is used to load geometry (.drc format files) compressed with the Draco library. Draco is an open-source library for compressing and decompressing 3D meshes and point clouds.

glTF files can also be compressed using the DRACO library, and they can also be loaded using the glTFLoader. We can configure the glTFLoader to use the DRACOLoader to decompress the file in such cases.

```
<script src="../scripts/GLTFLoader.js"></script>
<script src="../scripts/DRACOLoader.js"></script>
```

Like any other model, you can easily load the .drc files using DRACOLoader. And then, you can add Material to the geometry loaded and render the Mesh to the scene.

```
const loader = new THREE.DRACOLoader()
loader.setDecoderPath('/scripts/draco/')

// Load a Draco geometry
loader.load('path/to/your/.drc file', (geometry) => {
  const material = new THREE.MeshStandardMaterial({ color: 0xffffff })
  const mesh = new THREE.Mesh(geometry, material)
  scene.add(mesh)
})
```

This code snippet is used when you want to impoprt glTF file format that has geometry compressed using Draco library.

```
const dracoLoader = new THREE.DRACOLoader()
dracoLoader.setDecoderPath('/scripts/draco/')
dracoLoader.setDecoderConfig({ type: 'js' })

// loading glTF model that uses draco library
const loader = new THREE.GLTFLoader()
loader.setDRACOLoader(dracoLoader)
loader.load('models/monkey_compressed.glb', (gltf) => {
  scene.add(gltf.scene)
})
```

## STL Model Loader

The STL model format is widely used for rapid prototyping, 3D printing, and computer-aided manufacturing.

STL files describe only the surface geometry of a 3D object without any representation of color, texture, or other common 3d modeling attributes. You can add them to the callback function.

```
<script src="../scripts/STLLoader.js"></script>
```

We use the geometry from the `.stl` file and add material to it before adding it to the scene.

```
const material = new THREE.MeshPhysicalMaterial({ color: 0xaaaaaa })

const loader = new THREE.STLLoader()
loader.load('path/to/your/.stl file', (geometry) => {
  const mesh = new THREE.Mesh(geometry, material)
  scene.add(mesh)
})
```

There are many other formats you can load into your Three.js project. The above mentioned are the standard formats. The Loader files are well-documented and easy to use.

## Troubleshooting

If you cannot load your model correctly or it is distorted, discolored, or missing entirely. These are some troubleshooting steps mentioned in official Three.js site:

1. Check the JavaScript console for errors, and make sure you've used an `onError` callback when calling `.load()` to log the result.

2. View the model in another application. For `glTF`, drag-and-drop viewers are available for `Three.js` and `Babylon.js`. If the model appears correctly in one or more applications, file a bug against `Three.js`. If the model cannot be shown in any application, You should file a bug with the application used to create the model.

3. Try scaling the model up or down by a factor of `1000`. Many models are scaled differently, and large models may not appear if the camera is inside the model.

4. Try to add and position a light source. The model may be hidden in the dark.

5. Look for failed texture requests in the network tab, like `C:\\Path\To\Model\texture.jpg`. Use paths relative to your model instead, such as `images/texture.jpg` - this may require editing the model file in a text editor.

## Asking for Help

Suppose you've gone through the troubleshooting process above, and your model still isn't working. In that case, the right approach to asking for help gets you to a solution faster. Post a question on the Three.js forum and, whenever possible, include your model (or a simpler model with the same problem) in any formats you have available. Include enough information for someone else to reproduce the issue quickly - ideally, a live demo.

# Three.js – Libraries and Plugins

Official three.js examples are maintained as part of the three.js repository and always use the latest version of three.js.

Listed here are externally developed compatible libraries and plugins for three.js.

## Physics

- Oimo.js
- enable3d
- ammo.js
- cannon-es
- cannon.js

## Postprocessing

In addition to the official three.js postprocessing effects, support for some additional effects and frameworks are available through external libraries.

- postprocessing

## Intersection and Raycasting Performance

- three-mesh-bvh

## File Formats

In addition to the official three.js loaders, support for some additional formats is available through external libraries.

- urdf-loader
- 3d-tiles-renderer-js
- WebWorker OBJLoader
- IFC.js

## 3D Text and Layout

- troika-three-text
- three-mesh-ui

## Particle Systems

- three-nebula

## Inverse Kinematics

- THREE.IK
- fullik

## Game AI

- yuka
- three-pathfinding

## Wrappers and Frameworks

- A-Frame
- react-three-fiber
- ECSY

It is the list maintained by the Three.js official community. Apart from these, there are many other libraries and plugins to add beautiful effects easier.