A Gentle Introduction

Babylon.js Overview and Worked Example

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WebGL Workshop

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Part 1. Agenda

Well, take a look at the table of contents.

- Intro to Babylon.js:
  - look at the Babylon.js website
  - look at some of resources available
- Review the basic sample app from the Babylon.js web site
- Using Glitch.com for editing
- Make a few minor changes:
  - material/colour
  - control
- Properties to change:
  - position
  - rotation
  - scale
  - colour
- Factors/functions to derive values to use to control the above
  - step
  - cos, sin
  - sqrt
  - abs
  - PI

Part 2. Babylonjs.com

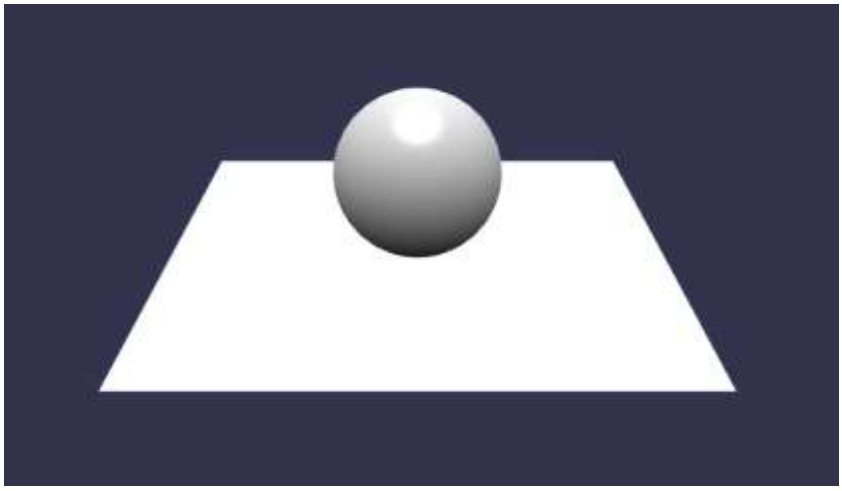
Part 3. Preparation

https://doc.babylonjs.com/

The Babylon.js site has the following sample HTML/JavaScript to create a simple scene, a sphere above a plane.

```
<!DOCTYPE html>
<html>
<head>
  <meta http-equiv="Content-Type" content="text/html" charset="utf-8"/>
  <title>Babylon - Getting Started</title>
  <!--- Link to the last version of BabylonJS --->
  <script src="https://cdn.babylonjs.com/babylon.js"></script>
  <style>
    html, body {
      overflow: hidden;
      width   : 100%;
      height  : 100%;
      margin  : 0;
      padding : 0;
    }

    #renderCanvas {
      width   : 100%;
      height  : 100%;
      touch-action: none;
    }
  </style>
</head>
<body>
  <canvas id="renderCanvas"></canvas>
  <script>
    window.addEventListener('DOMContentLoaded', function(){
      // get the canvas DOM element
      var canvas = document.getElementById('renderCanvas');

      // load the 3D engine
      var engine = new BABYLON.Engine(canvas, true);

      // createScene function that creates and return the scene
      var createScene = function(){
        // create a basic BJS Scene object
        var scene = new BABYLON.Scene(engine);

        // create a FreeCamera, and set its position to (x:0, y:5, z:-10)
        var camera = new BABYLON.FreeCamera('camera1', new BABYLON.Vector3(0, 5,-10), scene);

        // target the camera to scene origin
        camera.setTarget(BABYLON.Vector3.Zero());

        // attach the camera to the canvas
        camera.attachControl(canvas, false);

        // create a basic light, aiming 0,1,0 - meaning, to the sky
        var light = new BABYLON.HemisphericLight('light1', new BABYLON.Vector3(0,1,0), scene);

        // create a built-in "sphere" shape; its constructor takes 6 params: name, segment, diameter, scene,
updatable, sideOrientation
        var sphere = BABYLON.Mesh.CreateSphere('sphere1', 16, 2, scene);

        // move the sphere upward 1/2 of its height
        sphere.position.y = 1;

        // create a built-in "ground" shape;
        var ground = BABYLON.Mesh.CreateGround('ground1', 6, 6, 2, scene);

        // return the created scene
```

```
        return scene;
      }

      // call the createScene function
      var scene = createScene();

      // run the render loop
      engine.runRenderLoop(function(){
        scene.render();
      });

      // the canvas/window resize event handler
      window.addEventListener('resize', function(){
        engine.resize();
      });
    });
  </script>
</body>
</html>
```



Glitch.com

We'll be using Glitch.com as it provides an online editor and lets us share our work. You don't need to create an account, but it would probably help.

There's a basic project based on the code above set up at **https://glitch.com/~babylon-intro-mar19-a**

The code is split into three parts (index.html, style.css and script.js), because this is the way glitch.com organises things.

index.html

```
<!DOCTYPE html>
<html>
  <head>
    <meta http-equiv="Content-Type" content="text/html" charset="utf-8"/>
    <title>Babylon - Getting Started</title>

    <!-- import the webpage's stylesheet -->
    <link rel="stylesheet" href="/style.css">

    <!-- import Babylon.js -->
    <script src="https://cdn.babylonjs.com/babylon.js"></script>

    <!-- import the webpage's javascript file -->
    <script src="/script.js" defer></script>
  </head>
  <body>
    <canvas id="renderCanvas"></canvas>
```

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

style.css

```
html, body {
  overflow: hidden;
  width   : 100%;
  height  : 100%;
  margin  : 0;
  padding : 0;
}

#renderCanvas {
  width   : 100%;
  height  : 100%;
  touch-action: none;
}
```

script.js

```
window.addEventListener('DOMContentLoaded', function(){
  var canvas = document.getElementById('renderCanvas');

  var engine = new BABYLON.Engine(canvas, true);

  var createScene = function(){
    var scene = new BABYLON.Scene(engine);

    var camera = new BABYLON.FreeCamera('camera1', new BABYLON.Vector3(0, 5,-10), scene);
    camera.setTarget(BABYLON.Vector3.Zero());
    camera.attachControl(canvas, false);

    var light = new BABYLON.HemisphericLight('light1', new BABYLON.Vector3(0,1,0), scene);

    var sphere = BABYLON.Mesh.CreateSphere('sphere1', 16, 2, scene);
    sphere.position.y = 1;

    var ground = BABYLON.Mesh.CreateGround('ground1', 6, 6, 2, scene);

    return scene;
  }

  var scene = createScene();

  engine.runRenderLoop(function(){
    scene.render();
  });

  window.addEventListener('resize', function(){
    engine.resize();
  });
});
```

Shapes

https://doc.babylonjs.com/how_to/set_shapes

```
var box = BABYLON.MeshBuilder.CreateBox("box", {height: 5}, scene);
var sphere = BABYLON.MeshBuilder.CreateSphere("sphere", {diameter: 2, diameterX: 3}, scene);
var cone = BABYLON.MeshBuilder.CreateCylinder("cone", {diameterTop: 0, tessellation: 4}, scene);
var plane = BABYLON.MeshBuilder.CreatePlane("plane", {width: 5}, scene);
var ground = BABYLON.MeshBuilder.CreateGround("gd", {width: 6, subdivsions: 4}, scene);
var disc = BABYLON.MeshBuilder.CreateDisc("disc", {tessellation: 3}, scene);
var torusKnot = BABYLON.MeshBuilder.CreateTorus("torus", {thickness: 0.2}, scene); var torus =
BABYLON.MeshBuilder.CreateTorusKnot("tk", {}, scene);
var ground = BABYLON.MeshBuilder.CreateGroundFromHeightMap("gdhm", url, {width: 6, subdivisions: 4}, scene);
var tiledGround = BABYLON.MeshBuilder.CreateTiledGround("tgd", {subdivsions: {w:4, h:6} }, scene);
```

Mesh vs MeshBuilder

The newer MeshBuilder method favours named parameters in an options list.

e.g.

```
var sphere = BABYLON.Mesh.CreateSphere('sphere1', 16, 2, scene);

var sphere = BABYLON.MeshBuilder.CreateSphere("sphere", {diameter: 2, diameterX: 3}, scene);
```

Part 4. Resources

Note: All these are accessible from the Babylon.js homepage.

Examples

https://doc.babylonjs.com/examples/

Playground

https://playground.babylonjs.com/indexStable.html

Create Your Own Shader

https://cyos.babylonjs.com/

Documentation

https://doc.babylonjs.com/

Forum

https://forum.babylonjs.com/

Source

https://github.com/BabylonJS/Babylon.js

Sandbox

https://sandbox.babylonjs.com/

Part 5. It's Editing Time!

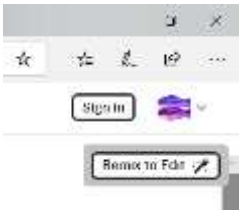
Moar Preparation (Sorry)

We still need to make a few more changes before we're ready to get stuck in. You can skip to the next section if this looks like too much like busy work.

Remix!

Reminder: The basic project is at **https://glitch.com/~babylon-mar19-b**

Click on the Remix to Edit button in the top right.



This will create your own version of the project to work on.

Take (Interactive) Control!

To the **JavaScript** replace with the camera code with the following:

```
var camera = new BABYLON.ArcRotateCamera("Camera", 0, 0, 10, new BABYLON.Vector3(0, 0, 0), scene);
camera.setPosition(new BABYLON.Vector3(0, 0, 20));
camera.attachControl(canvas, true);
```

Now we can control the position and orientation of the box with the mouse.

Add a Pile of Boxes

We need something to work with. Let's add a "pile" of boxes!

Replace

```
var sphere = BABYLON.Mesh.CreateSphere('sphere1', 16, 2, scene);
sphere.position.y = 1;

var ground = BABYLON.Mesh.CreateGround('ground1', 6, 6, 2, scene);
```

with

```
var shapes = [];
var numBoxes = 9;

for (let x = -numBoxes; x <= numBoxes; x++) {
  for (let y = -numBoxes; y <= numBoxes; y++) {
    var mat = new BABYLON.StandardMaterial("whiteMat", scene);

    var shape = BABYLON.MeshBuilder.CreateBox("box", {}, scene);
    shape.material = mat;
    shape.material.diffuseColor = new BABYLON.Color3(0, 1, 0);
    shape.position.x = x * 1.1;
    shape.position.y = y * 1.1;

    shapes.push(shape);
  }
}
```

Add a function to update the boxes, with a step parameter to control the speed of any changes we make. We need a way to make changes over time, a simple counter/step will suffice. This is just a skeleton function and doesn't anything just yet.

```
let step = 0;
function updateShapes(step) {
  for (let i = 0; i < shapes.length; i++) {

  }
}

engine.runRenderLoop(function(){
  step += 0.05;
  updateShapes (step);

  scene.render();
});
```

Functions

To produce interesting effects, maths functions are very useful, particularly: cos and sin. Since we'll be using them a lot let's alias the Math functions, we'll be using.

```
var cos = Math.cos;
var sin = Math.sin;
var sqrt = Math.sqrt;
var abs = Math.abs;
var PI = Math.PI;
```

Part 6. Animation

Messing about with values.

To get something interesting to happen on screen there are a number of properties we can influence:

Position, Scale, Rotation, Color*

* Please forgive the Americanism, I find it avoids confusion later on.

Position

```
function setShapePosZ(shape, step) {
  let x = shape.position.x;
  let y = shape.position.y;
  let md = abs(x) + abs(y);
  let d = sqrt(x*x + y*y);

  shape.position.z = x;
  shape.position.z = cos(x/2) + cos(y/2);
  shape.position.z = cos(d);
  shape.position.z = cos(d + step);
  shape.position.z = d;
}
```

Scale

```
function setShapeScaleZ(shape, step) {
  let x = shape.position.x;
  let y = shape.position.y;
  let md = abs(x) + abs(y);
  let d = sqrt(x*x + y*y);

  shape.scale.z = (d);
  //position.z = d;//cos(abs(x) - abs(y) + step);
}
```

Rotation

```
function setShapeRotZ(shape, step) {
  let x = shape.position.x;
  let y = shape.position.y;
  let md = abs(x) + abs(y);
  let d = sqrt(x*x + y*y);

  shape.rotation.z = ((step*5+d)*Math.PI/45);
  //position.z = d;//cos(abs(x) - abs(y) + step);
}
```

Color

```
function setShapeColor(shape, step) {
  let x = shape.position.x;
  let y = shape.position.y;
  let md = abs(x) + abs(y);
  let d = sqrt(x*x + y*y);

  shape.material.diffuseColor.r = cos(d+step);
}
```

Play time

Change shapes (sphere, torus, cylinder, cone).

We now have control of an array of attributes to create interesting effect.

We can now combine the different property changes, and tweak the functions for different effects.

Try changing to a positional spotlight, control its position.

Standard material has some nice additional attributes, such as shininess. Try changing them.

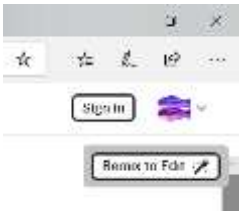
Part 7. Vertices

OK! We're finally ready to get something interesting going.

Remix Reminder!

There's a starter project setup at **https://glitch.com/~babylon-intro-mar19-d**

Click on the Remix to Edit button in the top right.



Fun Stuff or Something A Bit Different, SDF

Rather than playing around with whole objects, we can just as easily manipulate the individual vertices that make up an object.

```
var cos = Math.cos;
var sin = Math.sin;
var sqrt = Math.sqrt;
var abs = Math.abs;
var PI = Math.PI;

var ground;

window.addEventListener('DOMContentLoaded', function(){
  var canvas = document.getElementById('renderCanvas');

  var engine = new BABYLON.Engine(canvas, true);

  var createScene = function(){
    var scene = new BABYLON.Scene(engine);

    var camera = new BABYLON.ArcRotateCamera("Camera", 1, 1, 10, new BABYLON.Vector3(0, 0, 0), scene);
    camera.setTarget(BABYLON.Vector3.Zero());
    camera.attachControl(canvas, false);

    var light = new BABYLON.HemisphericLight('light1', new BABYLON.Vector3(0,1,0), scene);

    var mat = new BABYLON.StandardMaterial("whiteMat", scene);
    //mat.wireframe = true;
    mat.backFaceCulling = false;

    ground = BABYLON.MeshBuilder.CreateGround("gd", {width: 6, height: 6, subdivisions: 40, updatable:true},
scene);
    ground.material = mat;
    ground.rotation.x = 1;

    let positions = ground.getVerticesData(BABYLON.VertexBuffer.PositionKind);

    return scene;
  }

  var scene = createScene();

  let step = 0;

  engine.runRenderLoop(function(){
    step += 0.05;
    //console.log(ground);
```

```
    updateGround(ground, step);
    scene.render();
  });

  window.addEventListener('resize', function(){
    engine.resize();
  });
});

function updateGround(ground, step) {
  //if(ground === undefined || ground === null) return;
  let positions = ground.getVerticesData(BABYLON.VertexBuffer.PositionKind);
  flo2(positions, step);
  ground.updateVerticesData(BABYLON.VertexBuffer.PositionKind, positions);
  var indices = ground.getIndices();

  var normals = [];

  //Calculations of normals added
  BABYLON.VertexData.ComputeNormals(positions, indices, normals);

  ground.updateVerticesData(BABYLON.VertexBuffer.NormalKind, normals);
}

function wave(vertices, step){
  var length = vertices.length/3;
  for (var i = 0; i < length; i++) {
    let x = vertices[i*3];
    let y = vertices[i*3+2];
    let r1 = Math.sqrt(x*x+y*y)*3;
    let r2 = (Math.abs(x)+Math.abs(y))*2;
    let r3 = Math.abs(Math.abs(x)-Math.abs(y));
    let rad = Math.atan2(y, x)
    //vertices[i*3+1] = (Math.cos(r1*r2+step)/30);
    vertices[i*3+1] = (Math.cos(r3));
  }
}

function sqwave(vertices, step){
  var length = vertices.length/3;
  for (var i = 0; i < length; i++) {
    let x = vertices[i*3];
    let y = vertices[i*3+2];
    let r1 = Math.sqrt(x*x+y*y)*3;
    let r2 = (Math.abs(x)+Math.abs(y));
    let r3 = Math.abs(Math.abs(x)-Math.abs(y));
    let rad = Math.atan2(y, x)
    let b = Math.abs(x)<Math.abs(y)?Math.abs(x):Math.abs(y);
    //vertices[i*3+1] = (Math.cos(r1*r2+step)/30);
    //vertices[i*3+1] = Math.ceil(Math.cos(r1+step/20));
    vertices[i*3+1] = Math.ceil(Math.cos(Math.ceil(r2)+step/2));
    //vertices[i*3+1] = Math.cos(b*1+step);
    //vertices[i*3+1] = Math.cos(r2+b+step)/2;

  }
}

function hemi(vertices, step){
  var length = vertices.length/3;
  for (var i = 0; i < length; i++) {
    let x = vertices[i*3];
    let y = vertices[i*3+2];
    let r = Math.sqrt(x*x+y*y);//Math.abs(x) + Math.abs(y);//
    // r += Math.sqrt(x*x+y*y);
    x=1-(r+1)%2;
     r = Math.sqrt(1-x*x);
    vertices[i*3+1] = r;//Math.cos(r*2)/5;
    //vertices[i*3+1] += Math.sin(r*5)/5;
```

```
  }
}

function manhat(vertices, step){
  var length = vertices.length/3;
  for (var i = 0; i < length; i++) {
    let x = vertices[i*3];
    let y = vertices[i*3+2];
    let r1 = (Math.abs(x)+Math.abs(y));
    let r2 = ( Math.abs(x) + Math.abs(y) );
    let r3 = Math.abs(x)>Math.abs(y)?Math.abs(x):Math.abs(y);
    let r = Math.sqrt(x*x+y*y);
    if(x<0 && y<0)
    vertices[i*3+1] = Math.cos(r+step);
    else
    vertices[i*3+1] = Math.cos(r3+step);
    //vertices[i*3+1] = Math.cos(r3+step);
  }
}

function mix(vertices, step){
  var length = vertices.length/3;
  for (var i = 0; i < length; i++) {
    let x = vertices[i*3];
    let y = vertices[i*3+2];
    let r1 = (Math.abs(x)+Math.abs(y));
    let r2 = x+y;
    let r3 = Math.max(Math.abs(x),Math.abs(y));
    let r = Math.sqrt(x*x+y*y);

    vertices[i*3+1] = Math.cos(-r1+r3-r+step);
  }
}

function heart(vertices, step){
  var length = vertices.length/3;
  for (var i = 0; i < length; i++) {
    let x = Math.abs(vertices[i*3]);
    let y = Math.abs(vertices[i*3+2]);
    let r1 = Math.pow((x*x + y*y - 1), 3) - x*x*x*y*y*y;
    let r2 = (x*x*x*x+y*y*y*y) - 2*x*x*y;
    let r3 = Math.max(Math.abs(x),Math.abs(y));
    let r = Math.sqrt(Math.abs(r2));

    let d = Math.pow((x*x+ y*y), 2) + 4*Math.abs(x)*(x*x+y*y)-4*y*y;


    vertices[i*3+1] = Math.cos(r)/2;
  }
}

function flo2(vertices, step){
  var length = vertices.length/3;
  for (var i = 0; i < length; i++) {
    let x = vertices[i*3];
    let y = vertices[i*3+2];
    let r = Math.sqrt(x*x+y*y);
    let m = (Math.abs(x)+Math.abs(y));
    let b = Math.max(Math.abs(x),Math.abs(y))*.707;


    vertices[i*3+1] = Math.cos(2.5*(m+b-r+step/2))/2;
  }
}


function flo(vertices, step){
  var length = vertices.length/3;
```

```
  for (var i = 0; i < length; i++) {
    let x = vertices[i*3];
    let y = vertices[i*3+2];
    let r = Math.sqrt(x*x+y*y);
    let m = (Math.abs(x)+Math.abs(y));
    let b = Math.max(Math.abs(x),Math.abs(y))*.707;

    vertices[i*3+1] = Math.cos(2.5*(b-r+step/4))/2;
  }
}
```

Part 8. More advanced stuff

Wing it?