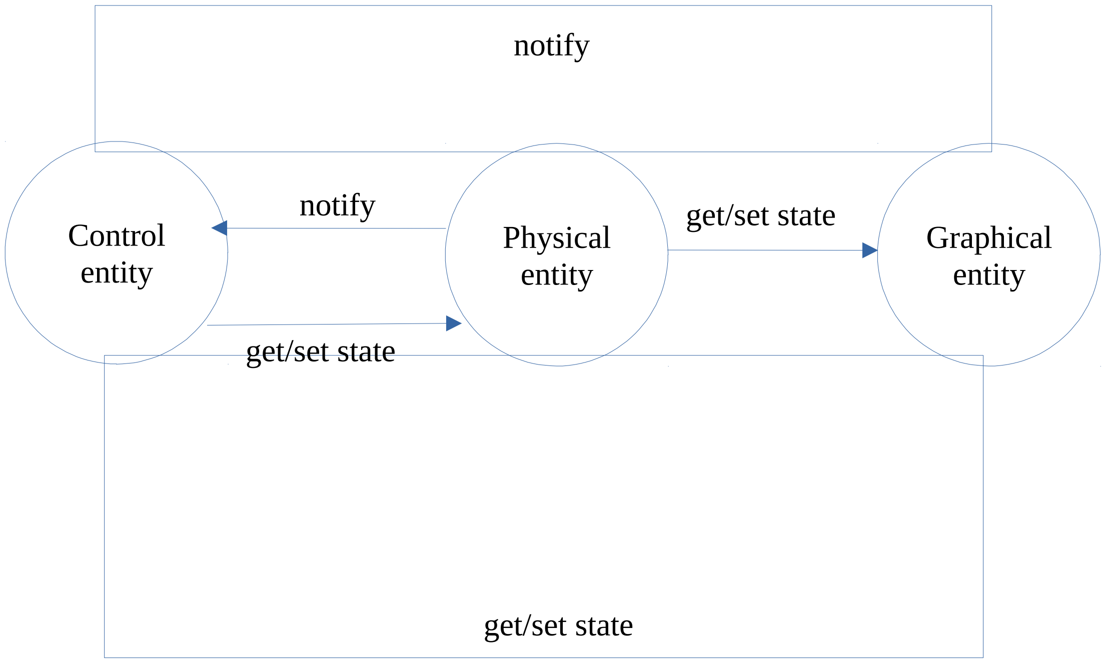
# WebGL Sandbox/Game Engine

## Common terms

1. The system consists of minimum 3 **layers**: **graphical**, **physical** and **control**;
2. The function of **graphical layer** is about drawing and animating pictures: **graphical primitives** such as circle, rectangle, polygon etc. with color, texture etc. (to be described later);
3. The function of **physical layer** is about calculating physical state of objects (form, size, position, rotation) that affects appearance of **graphical entity(ies)**;
4. The function of **control layer** is about maintaining state that's defined by game programmer/designer, and this can affect both **graphical** and **physical** layers;
5. Flow of data between those layers is one-directional, MS. State of object can be changed either by this object, or by its controller. Controllables can notify their controllers about changing their state:



# Graphical layer

1.  **WebGL program** can be divided in two phases: <u>**initialization**</u> and <u>**drawing frame**</u>;

2. <u>**Initialization phase**</u> requires compiling **shaders** (**vertex** and **fragment**), retrieving **attribute/uniform locations,** buffer initialization for each shape;
// TODO: texture initialization;
NB: **vertex shader** is called per vertex and its goal is to make clip space (i.e. boundary polygons for filling pixels), and **fragment shader** is called per pixel after applying vertex shader and its goal is to draw pixels in grid;

3. <u>**Drawing frame phase**</u> requires following steps:
3.1. Clear viewport;
3.2. Bind **GLSL program** to **WebGL Context** that is associated with current shape;
3.3. For each attribute of the program enable vertex attribute array, bind buffer, setup vertex attribute pointer, initialize bufferData (optional, most shapes did not intend to be deformed), setup bufferData;
3.4. For each uniform of the program set uniform with its location;
3.5. Call drawArrays;
3.6. Repeat process from 3.2. if there's next shape;
3.7. For each shape modify the state of attributes and uniforms, specified by **client program** (physics engine, user-defined controllers);
3.8. Repeat 3.1.

4. <u>**shape**</u> is an geometric object, that's initialized with  form (a method to draw a shape, bound to shaders or native program), position point, rotation angle, scale (bounding rectangle with respect to viewport bounds), flip state (with respect to horizontal and vertical axes), color/gradient/texture (TODO). They can be modified during **drawing frame phase** . These parameters define attribute and uniform values of shape;

5. <u>**viewport (canvas)**</u> is main object of graphical layer, that holds all shapes in scene and has particular size (to which dimensions of shapes are normalized);

6. Basic transformation matrices (column major order):

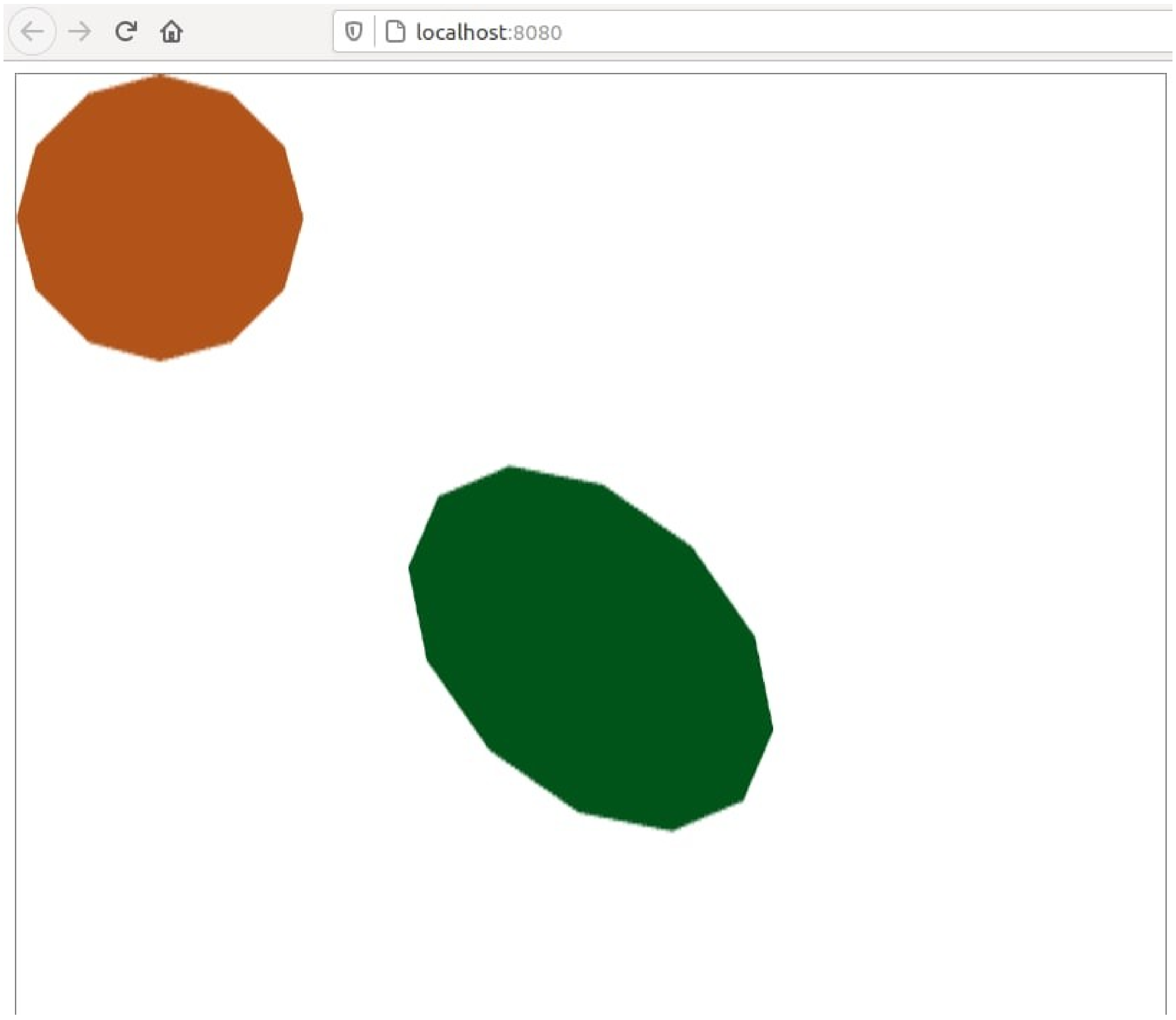
```
[
  1, 0, 0, 0,
  0, 1, 0, 0,
  0, 0, 1, 0,
  dx, dy, 0, 1
] - position;

[
  cos a, sin a, 0, 0,
  -sin a, cos a, 0, 0,
  0, 0, 1, 0,
  0, 0, 0, 1
] - rotation;
```

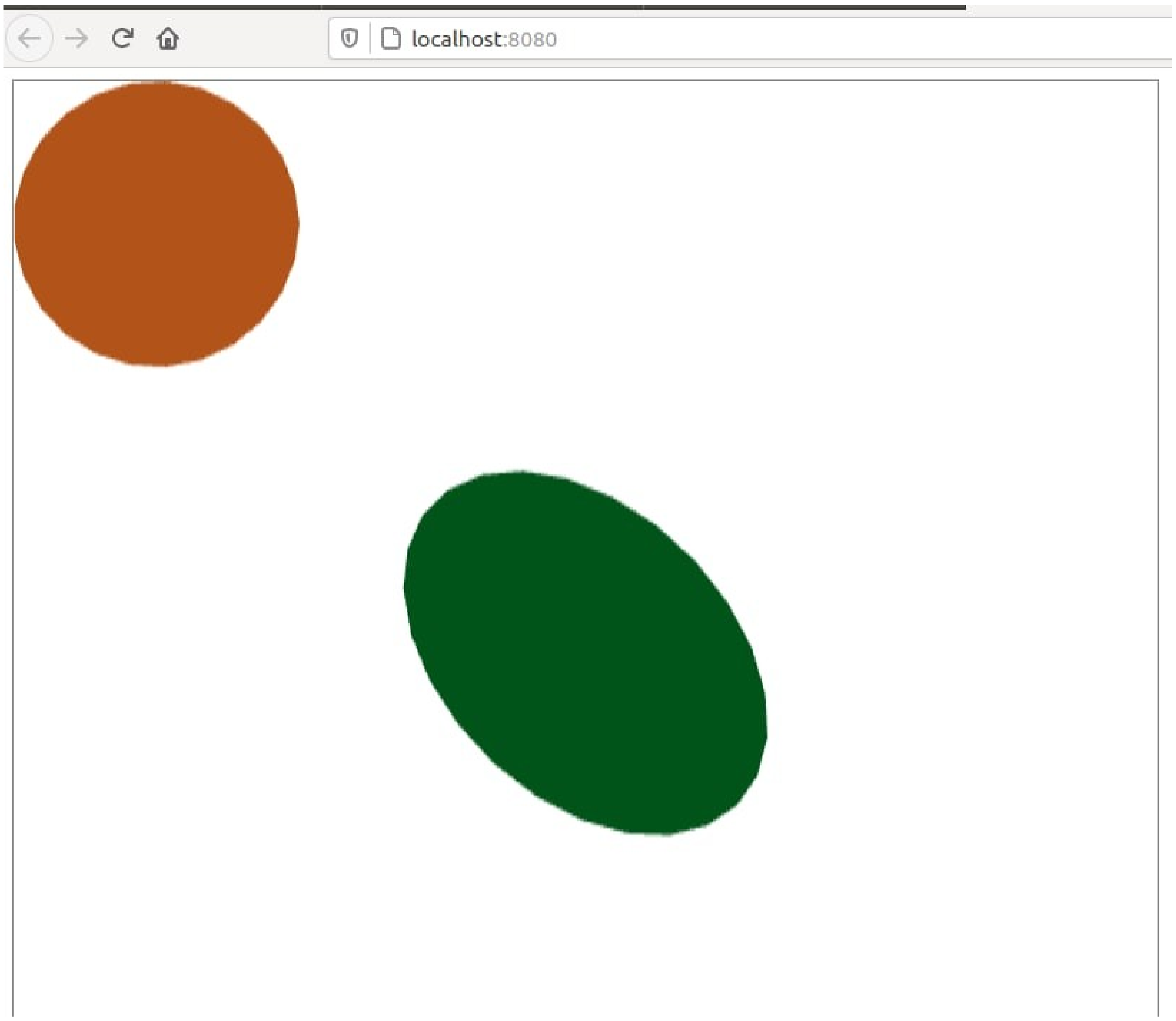
```
[
  sx, 0, 0, 0,
  0, sy, 0, 0,
  0, 0, 1, 0,
  0, 0, 0, 1
] - scale;
```

Order of application: scale → rotation → position

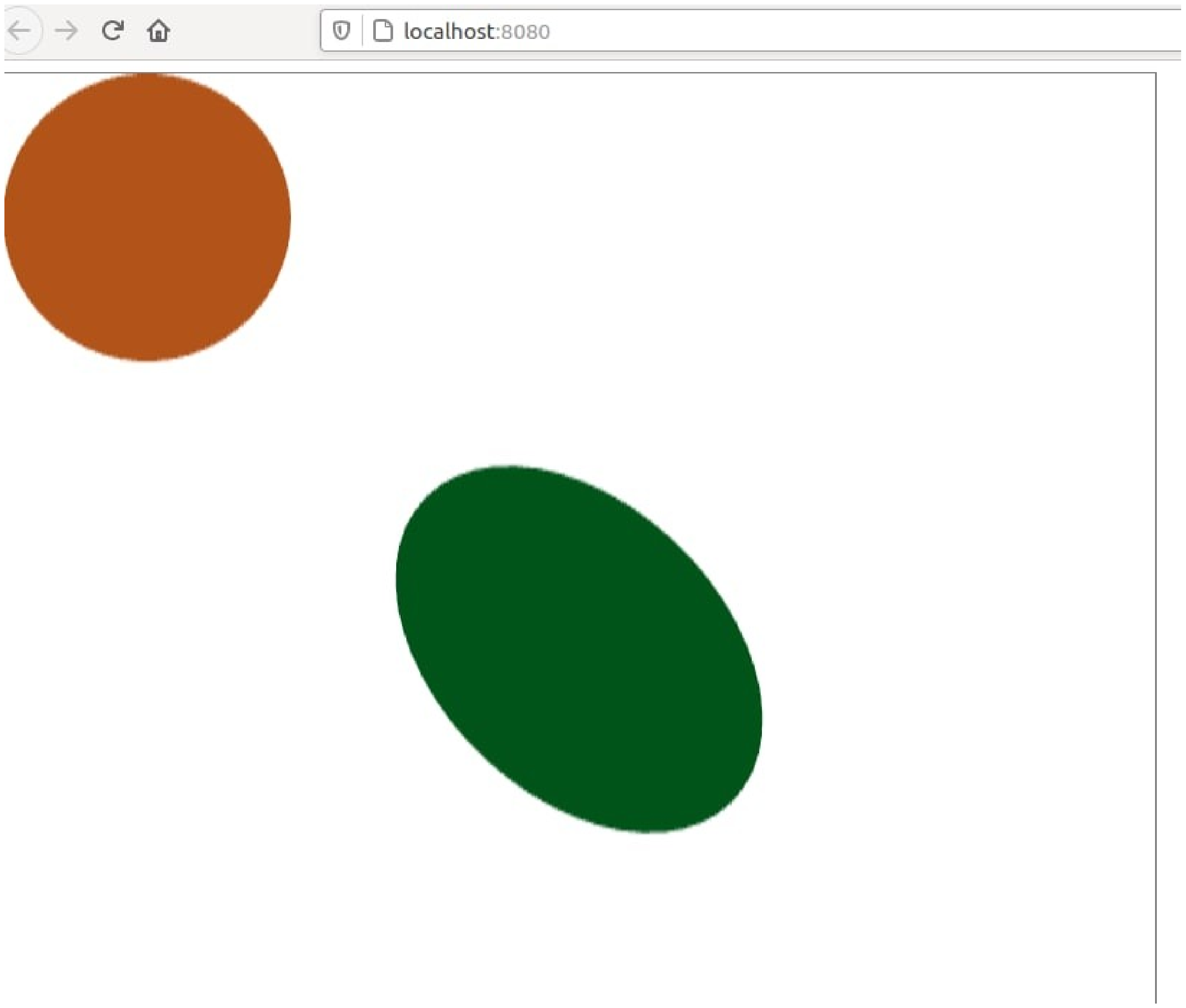
7. **Ellipse** is generated with triangles for simplicity purposes. Number of triangles is defined by formula (v): **radius * 2 * pi / f / f** . **f** – is compression factor (optimum is measured in 8x or 16x), **radius** – is a radius of prototype, big enough to draw smoothly



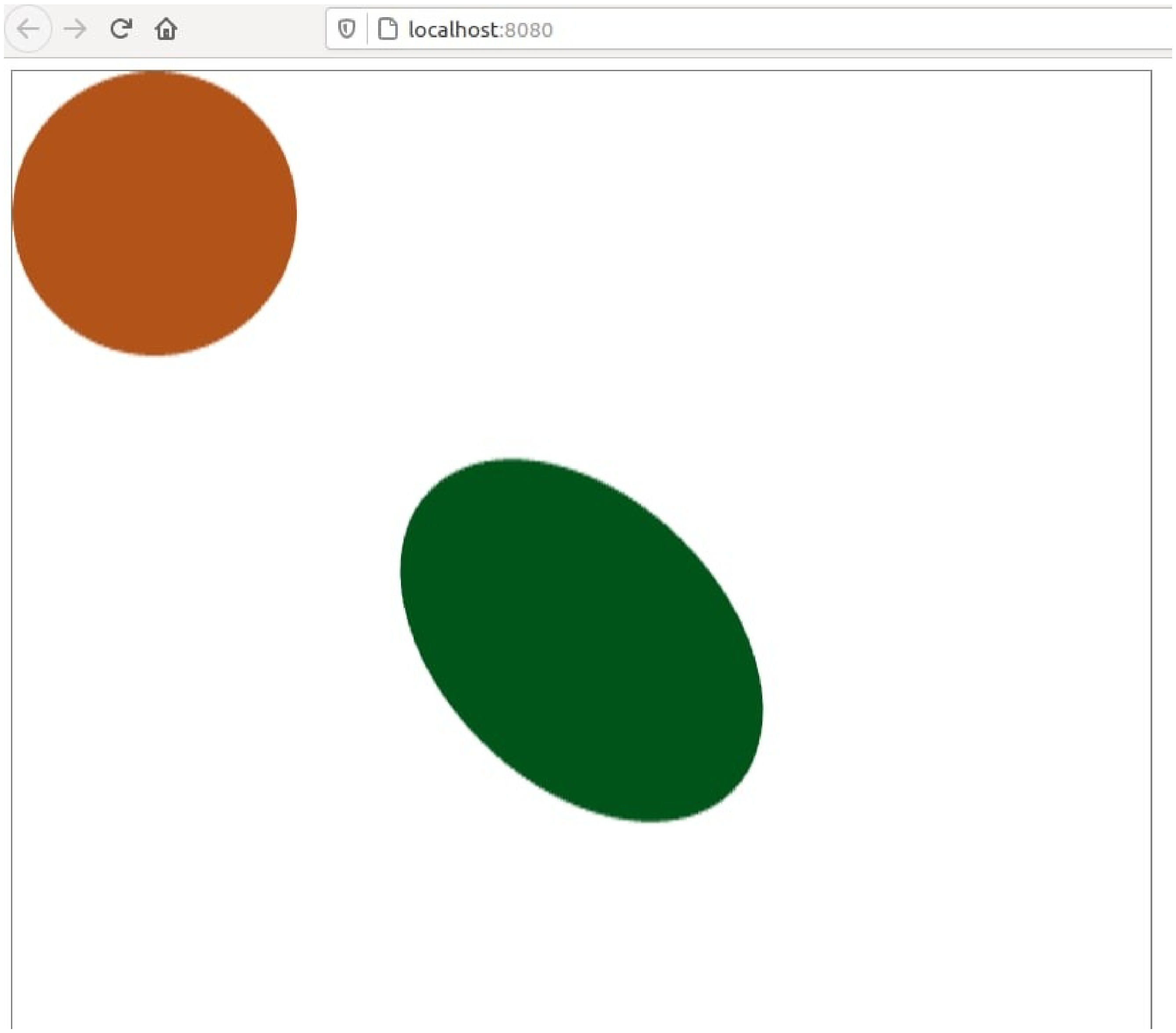
64x



32x



16x



8x