

CS460 Fall 2022

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Due Date: 10/10/2022

Assignment 4: A WebGL Game!

WebGL without a framework is hard. But this makes it even more rewarding when we create cool stuff!

In class, we learned how to draw multiple objects (rectangles) with different properties (colors and offset). We also made the rectangles move! In this assignment, we will create a simple but fun video game based on the things we learned. In the game, the player can control an airplane using the UP, DOWN, LEFT, RIGHT arrow keys in a scene to avoid obstacles. The longer the player can fly around without colliding with the obstacles, the more points are awarded. Once the player hits an obstacle, the game is over and the website can be reloaded to play again. The screenshot below shows the black airplane roughly in the center and multiple square obstacles in different colors. The mountains, sky, and stars are a background image that is added via CSS (as always, feel free to replace and change any design aspects).



Starter code: Please use the code from <https://cs460.org/shortcuts/16> and copy it to your fork as 04/index.html.

Part 1 Coding: Extend the `createAirplane` method. (25 points)

First, we need to create the airplane. Take a look at the existing `createAirplane` method. **This method needs to be extended.** We will use triangles to create a shape similar to the one pictured below. Please figure out the triangles we need and set the `vertices` array. We can assume that the center of the airplane is `0, 0, 0` in viewport coordinates. Then, please setup the vertex buffer `v_buffer` (and remember `create`, `bind`, `put data in`, `unbind`). There is no need to change the `return` statement of the method. This returned array contains the name of the object, the vertex buffer, the vertices, an offset, a color, and the primitive type—the drawing code of the `animate` method needs this array in this exact order.



Part 2 Coding: Extend the `createObstacle` method. (25 points)

Now we will extend the `createObstacle` method. This method creates a single square obstacle. There are different ways of rendering a square but the simplest is to use a single vertex and the `gl.POINTS` primitive. Make sure that `gl_PointSize` is set appropriately in the vertex shader! We use `0,0,0` as our vertex and then control the position of the obstacle using the `offset` vector. Please modify the code to set the `x` and `y` offsets to random values between `-1` and `1` (viewport coordinates). The color of an obstacle is already set to random and the `return` statement follows the same order as in Part 1. Once this method is complete, multiple obstacles should appear at random positions on the screen (9 in total as added to the `objects` array after linking the shaders).

Part 3 Explaining: Detect collisions using the `calculateBoundingBox` and `detectCollision` method. (20 points)

In class we learned about bounding boxes. The starter code includes collision detection using bounding box calculation of the airplane and the offset of an obstacle. Please study the existing `calculateBoundingBox` and `detectCollision` methods and describe how it works and when the collision detection is happening:

The `calculateBoundingBox()` function is called once per rendering frame and it accepts the vertices array that encodes the airplane as well as the airplane's offset, itself a `Vec3`, that represents a deviation from the vertices' positions. This function computes the `x,y,z` coordinates, respectively, for each vertex associated with the plane object, by use of its arguments. The function also computes the minimum and maximum `x, y, and z` coordinates between some huge-valued initialized `x, y, z` limits (e.g., `minx = 1000`) and the corresponding coordinates for all of the airplane's vertices. In other words, the function outputs a 'global' set of minimum and maximum `x,y,z` coordinates with respect to all of the plane's vertices.

The function `detectCollision()` is passed the output of the aforementioned function as well as the coordinates associated with one obstacle instance. This function simply checks if each of the obstacle's 3D coordinates are within range of the corresponding dimension's min and max coordinates generated by `calculateBoundingBox()`; since this is done for each of the `x,y, and z` dimensions, thusly it is only if 'overlap' across all three dimensions is found that the function outputs a collision value of `true` which leads to the program terminating.

Part 4 Coding: Extend the `window.onkeyup` callback. (20 point)

We want to allow the player to use the arrow keys to move the airplane. Please take a look at the existing `window.onkeyup` method. The `if` statement checks which arrow key was pressed. Please extend this method to move the airplane. Hint: Like in class, we just need to set the `step_x, step_y` values and the `direction_x, direction_y` based on which arrow key was pressed.

Part 5 Cleanup: Replace the screenshot above, activate Github pages, edit the URL below, and add this PDF to

your repo. Then, send a pull request for assignment submission (or do the bonus first). (10 points)

Link to your assignment: <https://pabloendiksen.github.io/cs460student/04/>

Bonus (33 points):

Part 1 (11 points): Please add code to move the obstacles! Flying the airplane around static obstacles is half the fun. The obstacles should really move! Please write code to move the obstacles every frame. The obstacles should just move in x direction from right to left to create a flying illusion for the airplane. This can be done with little code by modifying the offsets accordingly at the right place!

Done!

Part 2 (11 points): Make the obstacles move faster the longer the game is played! Right now, the game is not very hard and a skilled pilot can play it for a very long time. Currently, the scoreboard updates roughly every 5 seconds. What if we also increase the speed of the obstacles every 5 seconds? Please write code to do so. This can be done in one line-of-code!

Done!

Part 3 (11 points): Save resources with an indexed geometry! As discussed in class, an indexed geometry saves redundancy and reduces memory consumption. Please write code to introduce a `gl.ELEMENT_ARRAY_BUFFER` for the airplane. Of course, we do not need to change anything for the obstacles since a single vertex does not need an index :).

Done!