CS460 Fall 2022
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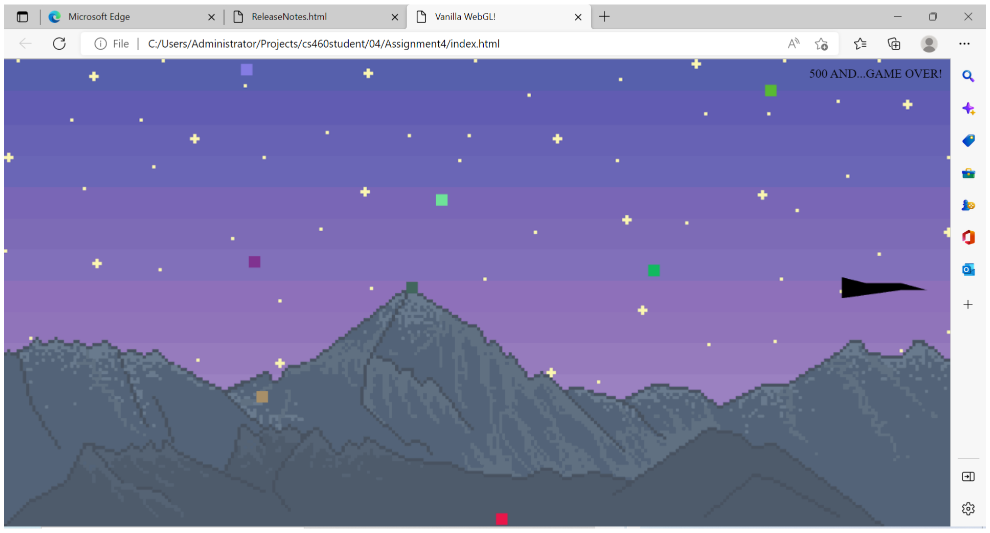
Assignment 4: A WebGL Game!

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

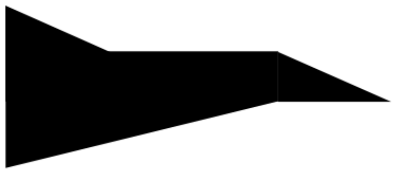
In class, we learned how to draw multiple objects (rectangles) with different properties (colors and offset). We also made the rectangles move! In this assignment, we will create a simple but fun video game based on the things we learned. In the game, the player can control an airplane using the `UP`,`DOWN`,`LEFT`,`RIGHT` 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).


Microsoft Edge
ReleaseNotes.html
Vanilla WebGL!
File | C:/Users/Administrator/Projects/cs460student/04/Assignment4/index.html
500 AND...GAME OVER!

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:

First, we check where are the calculateBoundingBox and the detectCollision methods are called, and that is in the animate function. The animate function deals with an array called objects whose indices each store an array which represents data structures for an airplane geometry and obstacle square and, or point geometries. These objects have the following properties stored inside arrays in the following order: object type; buffer; vertices; offset; color; and draw type. A for loop processes the object array list one index at a time, by storing the object's properties in respectively named variables, then checking whether the object's type which is either 'airplane' or 'obstacle'. If the object type is an 'airplane', then the proceeding code follows that the offset components are checked whether they touch the canvas' borders, and if so the respective direction is reversed, else simply proceed to adding the multiple of the input direction times the number of respective component steps (step$_x or step_y).This is all done, so that the current offset for the airplane object is updated and this is passed as the second$
$https://keymakr.com/blog/what-are-bounding-boxes/.$

This is done in the calculateBoundingBox by having instance variables that hold values greater or lesser than the expected range of values for running minimum and maximum value tests by calling the Math.min or Math.max methods on value pairs. The vertices array holds vertex x, y, z components in different indices in that order, so every next three indices represents a new vertex, hence there's a for loop that processes the next three indices in vertices array. The minimum and maximum x, y, z variables are then updated by every call to Math.min or Math.max for every new vertex being processed until there's no more to do so. Afterwards, the array representing the Bounding Box of the airplane geometry is returned.

Back to the for loop in the animate function, we check for the next objects in the objects array which are the obstacle type objects after airplane. When a obstacle type object is encountered, the method detectCollision is called, and this method checks whether the offset of the obstacle is found within the bounding box of the airplane returned as an array by calculateBoundingBox. This is done with a series of if statements in the detectCollision method which the x component of the offset of the obstacle/point is between the min and max x component values of the airplane's bounding box array. If so, then proceed to the next inner if statement that does the same checking process for y coordinates, and if that passes then onto the next inner if statement for z components. Failing any of these if statements means that there is no collision between the airplane and obstacle, but passing all three if conditionals means that a collision has occured, and thus a game over is returned.

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: `YOUR_GITHUB_PAGES_URL`

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!

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!

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 :).