Introduction to Visual Computing

Assignment# 7

Data Visualization

March 30, 2020

Description

In this session you will add a few data visualization views to your game application.

Objectives

- Visualize the top view of the game.
- Display the current score in real time.
- Visualize the score over time, with a bar chart.

Specific Challenges

To arrange the visualization views as well as the main game view on the display area.

Preliminary steps

Complete week 6 assignment if not already done, as this week's assignment builds on your previous work on the game.

Part I

Multiple Drawing Surfaces

Up to now, in this project, you have been drawing everything on the primary display window. However, all of the drawing features available in the display window can be applied to an off-screen drawing surface and then drawn back into the display window as an “image”. You can imagine a program as a stack of layers similar to the ones used typically in image editing software. Likewise, surfaces in Processing can be moved around, drawn using blending effects and transparency, and drawn in different orders to change how the layers combine.

In the following, we use the concept of multiple layers to create the visualization views, such that each view becomes an image that you place onto the primary display window.

Step 1 – PGraphics

Each drawing surface in Processing is an instance of the `PGraphics` class. The display window is the default surface to draw to, and this is why to draw a rectangle you only need to run `rect()` function. To draw the same shape onto a new surface, you need to first create a `PGraphics` object, and then draw onto it, by typing the name of the surface object and dot operator before the name of the function. The code below is a simple example:

```
PGraphics mySurface;
void settings() {
  size(400, 400, P2D);
}

void setup() {
  mySurface = createGraphics(200, 200, P2D);
}

void draw() {
  background(200, 0, 0);
  drawMySurface();
  image(mySurface, 10, 190);
}

void drawMySurface() {
  mySurface.beginDraw();
  mySurface.background(0);
  mySurface.ellipse(50, 50, 25, 25);
  mySurface.endDraw();
}
```

The `createGraphics()` function creates a surface with the size defined by the parameters. `beginDraw()` and `endDraw()` are needed each time you want to edit this surface. Finally, the `image()` function puts the surface on the display window, at the position defined by its parameters.

In practice, `PGraphics` layers are often declared as global, created inside `setup()` and modified in `draw()`.

Note

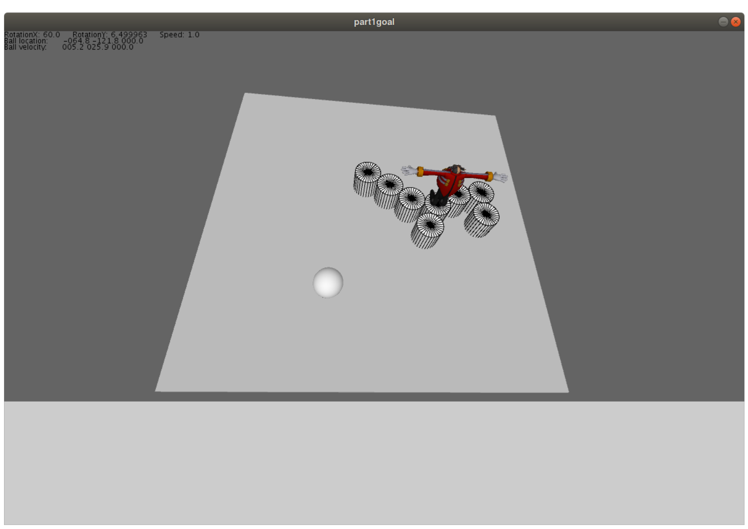
Be careful that to create a new graphics context, as suggested by Processing, you should use only the `createGraphics()` function and *not* `new PGraphics()`. This is also the reason why in the following steps we are not going to make each surface as a class that extends `PGraphics`, even though it would have been more modular.

Step 2 – A surface for data visualization background

For the main game part, you will define a `PGraphics` surface in the render mode `P3D` in which you will have your previously implemented game. For the data visualization part, however, you will make 4 new surfaces. The first one is simply a rectangle at the bottom of the display window. This would be the background for your data visualization area. In this step you should create the background bar as illustrated in the figure below. In the next parts, you will get more information about the other three surfaces, each being one visualization view.

Note

The rendering parameters of a surface such as `stroke` and `fill` do not reset every time `beginDraw()` is called (when a new frame is drawn). This means that if, for example, you set the `fill` field to 0 with `mySurface.fill(0)`, it remains 0 (black) even in the next frames, until the next time it is set to a different value, ex. `mySurface.fill(255)`.



Change the structure of your code, so that you draw your game on a new surface instead of the default surface. More concretely, you need to:

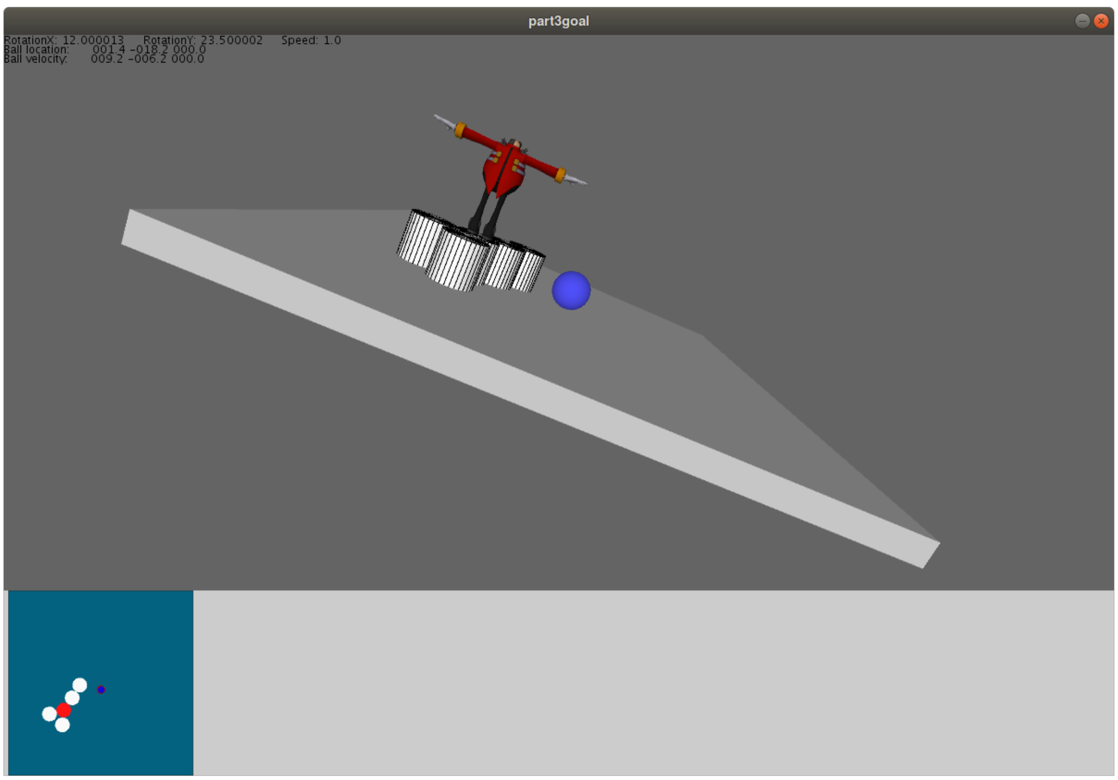
1. Declare a `PGraphics` surface (let's call it `gameSurface`).
2. Generate the surface with `createGraphics(width, height-300)` (`height-300` makes an empty space at the bottom of the display window).
3. Create a new function (called `drawGame()`), cut and paste the content of your current draw function in it, and add "`gameSurface.`" before each "drawing" function. Remember that "`gameSurface.`" must be added also in front of any function for the manipulation of the coordinate system (e.g. `pushMatrix`, `popMatrix`, `scale`, `translate`...)
4. In the `draw()` function, call `drawGame()` and `image(gameSurface, 0, 0)`.
5. Create another `PGraphics` surface to serve as the background for your scoreboard and draw it similarly to the `gameSurface`.

Part II

Top View

In this part you should make a new surface (let's call it `topView`). As illustrated in the figure below (the square on the left bottom corner), this surface should show a 2D view of the game from the top. The most straightforward way for doing this is to simulate the plate with a rectangle, the cylinders with large ellipses and the sphere with a small ellipsis (with the correct relative sizes). (You do not need to implement any 3D solution such as changing the camera position.)

Please note that the objective of this week's assignment is to examine different data visualization styles, rather than solving the technical challenge of, for example, making multiple cameras. Likewise, in the next parts the tasks could be merely to extract some interesting values and display them, in such a way that can facilitate the game play and increase user awareness.



Note

For the top view you can use the `P2D` rendering mode. However, it is important to consider the renderer used with `createGraphics()` in relation to the main renderer specified in `size()`. For example, it's only possible to use `P2D` or `P3D` with `createGraphics()` when one of them is defined in `size()`. "The exception to this rule is using the default renderer and P2D as alternate options when P3D is the main renderer defined in `size()`"—you can refer to `https://processing.org/tutorials/rendering/`.

Part III

Score Board

In this part you should make a simple score board on another surface and put it just next to the top view, as shown in the figure below.

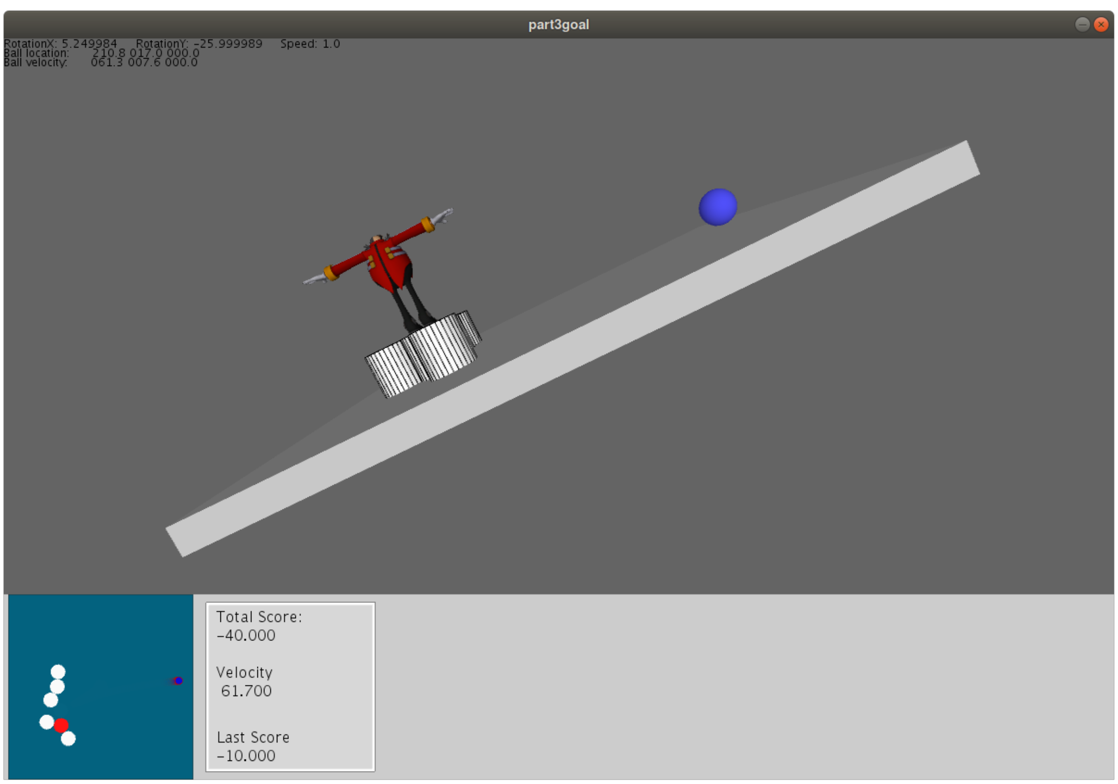
Step 1 – Collecting and losing points

Follow the rules below to calculate the scores:

- Every time the sphere hits a cylinder, the user gains points, with a multiplying factor proportional to the current ball velocity.
- Every time the villain creates a new cylinder, the user loses points.

Step 2 – Display the score

Create a new surface called `scoreboard`, and display the current score, current velocity magnitude of the sphere, as well as the points that the user achieved in the last (hitting) event. To draw text on the screen, you need to use the function `text()`. (`https://processing.org/reference/text_.html`)



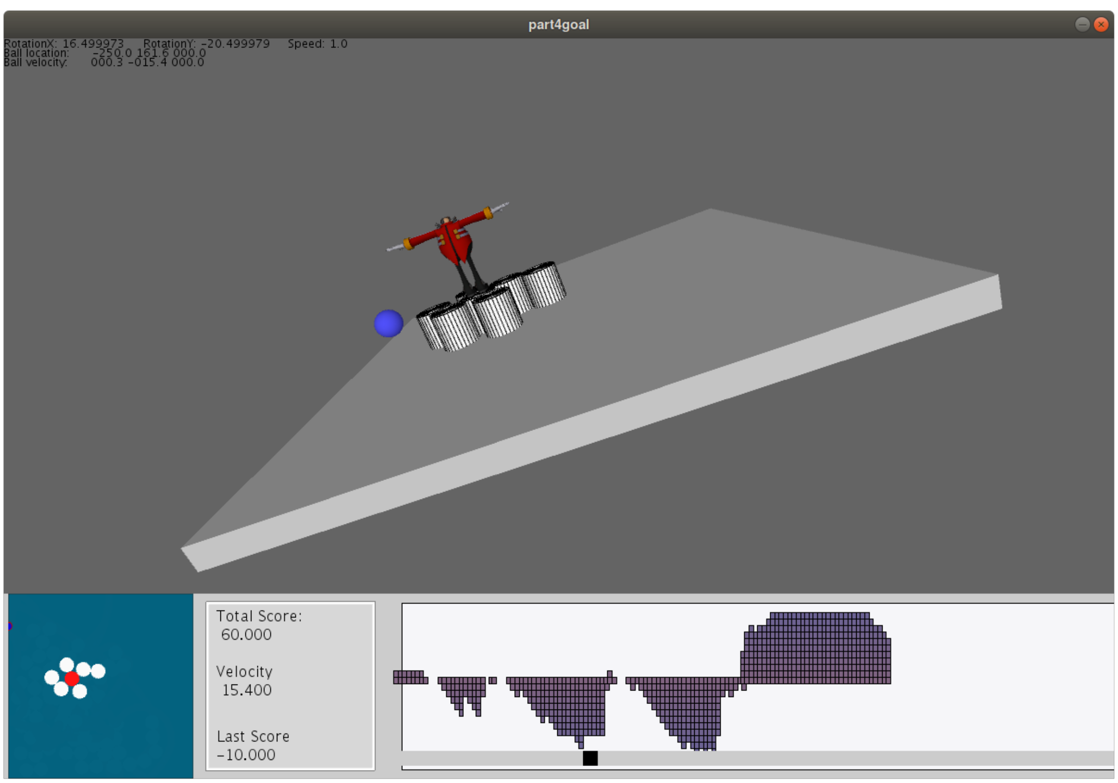
Part IV

Score Chart

Step 1 – Bar Chart

Make a new surface and call it `barChart`. This surface should show, similar to the figure below, the total score as time goes on. The score is represented with a number of stacked-up tiny rectangles. The graph is updated (i.e., a new bar is added) every second.

> **Note**
>
> Normally when visualizing data you use functions that are made available by the tool in hand. Nevertheless, in this assignment you should make the chart yourself. The advantage of crafting the chart from scratch, beside pedagogical reasons, is that you have the full control on how you would like to represent your data.

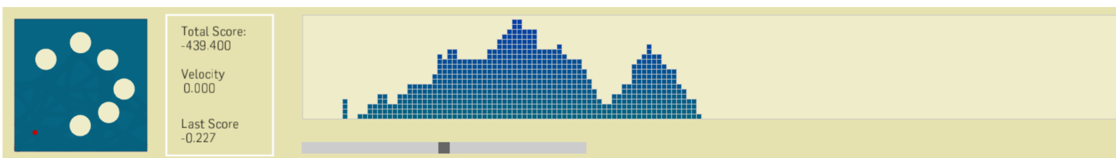


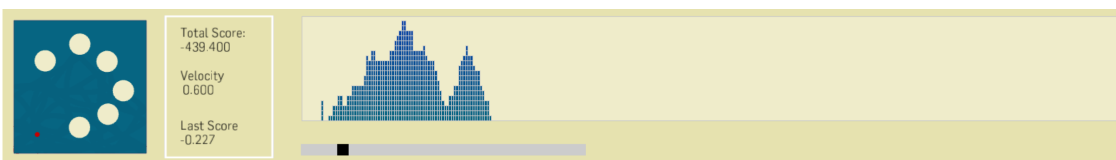
Step 2 – Horizontal Scroll bar

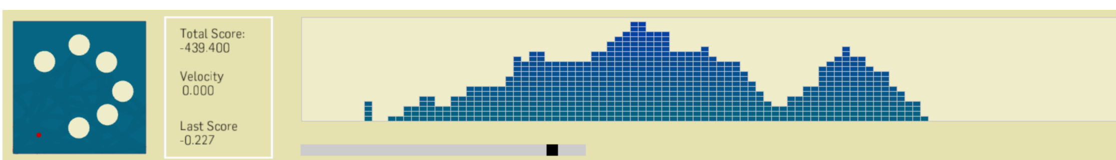
In this step you should make a scroll bar, using which the user can compress or expand the bar chart horizontally. This can be done by changing the width of the tiny rectangles in the bar chart, as depicted in the three figures below.

An example of how a scroll bar could be implemented in Processing is provided in the file *HScrollbar.pde* uploaded on Moodle. You only need to copy it into your project, instantiate it in your `setup()` function, call its `update()` and `display()` methods in your `draw()` function, and use its `getPos()` method to get the current position of the scroll, which is normalized to a value between 0 and 1. The of code given below is an example of how the `HScrollbar` should be used.

As you may have noticed `HScrollbar` is not compatible with the concept of multiple layers, as its `display()` functions draws only on the default surface. To simplify this assignment, you can use the `HScrollbar` as it is. You could, however, try modifying `HScrollbar` so that it can become part of a layer (*OPTIONAL*).







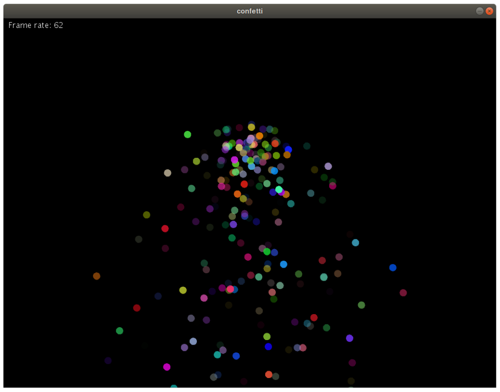

```
HScrollbar hs;

void settings() {
  size(400, 200, P2D);
}

void setup() {
  hs = new HScrollbar(50, 90, 300, 20);
}

void draw() {
  background(255);
  hs.update();
  hs.display();
  println(hs.getPos());
}
```

Part V

Bonus: Reward Animation

Now that you have your score and your data visualization, we are close to achieving a real playable game. Last week we explored a type of animation using particle systems. Particle systems are interesting to render complex matters while still using physics for computation of motion.

An important part of game design is its fun factor. A game should be entertaining and should urge the player to keep playing. Animation is in general perceived as much more entertaining than text or still images. And animation can also be used to motivate the player: it isn't unusual to find small rewarding animations in games.



In this bonus, we propose to use what you learned last week to create a confetti canon when the player hits Robotnik (and wins the game). You can simply use ellipses to create the confetti and play with the colors to make it beautiful.