CMPS 10 Lecture Notes: Lecture 5 (1-19-2016)

PARDIS/SNAP SEGMENT

Week Three: Loops and Custom Blocks CMPS10.

(As always, the videos posted on the class Piazza page are probably a better way to review this programming information, but feel free to use these notes as a supplemental resource!)

Drawing a Pentagon and a Hexagon Examples

- What is the degree of an angle in a pentagon? How can we compute that without having to memorize some formula?
- Let's say that we start with a square. How many triangles are in a square? 2 triangles. And we know that there are 180 degrees in each triangle, so total degrees in square is 360?
- What about pentagon? There are 3 triangles, at 180 degrees each, brings us to 540. And how many angles do we have? 5! So 540 divided by 5 is 108!
- And so then when we have a hexagon, we have 4 triangles. So 4 times 180 is 720, and 720 divided by 6 is 120.
- But when we want to draw them in snap, what we really care about is the OUTSIDE angle, because that is how much we are actually going to be turning by.
- And the way we compute the outside angle is by taking 180 and subtracting the inside angle from it
- Pentagon: 180 - 108 = 72
- Hexagon: 180 - 120 = 60.

We are going to start a new project (week 3 in class)

- Start with a move block (say, 30 steps)
- Then we add a turn block (72 degrees for pentagon)
- Put that in a repeat block (5 times for pentagon)
- And don't forget to put the pen down to actually make it draw!
- We can do the same thing for a hexagon, by changing the degrees to 60, and the loop to 6.

But let's make this a custom block

- Should this be a motion or a pen? Let's make it a motion, and have the 'pen down' command be outside of it.
- We can then drag our pentagon code into our pentagon custom block, and voila, easy as pie. We have a pentagon function.
- And now by having the point in direction block at the beginning and set to different degrees, you can combine pentagons to make a nice little flower shape.
- Pardis drew four of them in this nice 360 degree shape.
- So, we need to know how many degrees to turn to draw each PETAL (each pentagon is a petal in our flower drawing).
- And the amount to turn will be 360 divided by the number of petals.
  - So we add a turn block, and make it be 360 divided by 5
  - Question: why do we need to use the division operator? Why not just put the number of degrees in there directly
  - Answer: because it makes it much more general! It makes it much easier to accept different inputs.
    * Aside: when changing the 'type' of a custom block, make sure that you click outside! otherwise it won't let you change it.
- Homework is essentially going to be making flowers using a lot of different shapes.
  - Some things you can do: decide on the color. Maybe give it a random color.
    * Add another input to the custom block, call it color, and then add a 'change pen color by X' block, and then drag the color input into that change pen color block.
    * But maybe you don't want to pick a specific color. This is a good opportunity for randomization. Under operator there is a 'pick random X to Y block. And then every time you draw a shape it will be even more beautiful (and a different color)!

What about drawing a flower stem?

- Seems like it should be as easy as drawing your flower, pointing down, and then drawing your flower stem, and then lifting your pen up.
- Then you could go somewhere else and draw another flower.
- So a series of blocks like: go to 0, point in direction 180, pen down, move 100 steps, point in direction 0, then pen up.
  - Point in direction 180 means point down.
- And so then we can combine this with drawing a flower.
  - Go to a particular place, put your pen down, draw a flower (using our custom flower block that we already made!), point down, move 100 steps, and then bring your pen up!
    * It'll make it look nicer when you draw multiple flowers!
- What if we want our stem to be a different color? Where would we put that block.
  - After you are done drawing the petals, but before the move!
    * And voila, now we have a flower.
- Extra credit: If you draw leaves for your flower!
- Extra credit: Perspective: flowers in the "front" are bigger than the flowers in the back!
  - Hint: You can use if else blocks to figure this out. Maybe have three "tiers" of distances.

On the Snap project website there are a lot of 'build up' steps

- Recommend doing them (especially "Dancing Bug") but not strictly necessary for homework
- There is also a "starter project" with a fun background that you should use for your project.
  - But when you use those backgrounds, there will be things like "sky" that don't make sense to draw flowers on
  - So use that pick random operator block to limit the starting locations of your flowers!
    * You can experiment a little bit to pick the best range that works for you. Maybe -151 and 151 for the x value. Maybe -43 to 95 for the y. But play around and see what works for you!

Back to Criteria for drawing the flower

- Repeat
  - Go to a random location (within boundary)
  - Put the pen down
  - Draw a unique flower (shape, size, color)
  - Draw a stem
  - Pen up.
- Fancy flowers from last quarter
  - You can see they were drawn in a certain location, and they kinda had leaves.

Week 3 Lab Assignments:

- Assignment link is on commons.
- You can have a partner, you just need to mention that in your notes.
- Using custom blocks is a MUST (at least two nested custom blocks)
- use of randomness is a MUST. (e.g., random location for drawing a flower).
- Be mindful about where you are drawing the flowers.
- Due January 25th.

BREAK

Encoding Sound

Can someone tell the teacher how many grooves there are in an LP player? Those Vinyl Discs?

- Maybe a thousand? Maybe ten thousand?
- It actually only has one groove!
  - It is just a big spiral.
  - How does it work? Why do you hear music out of it? Where is the music?
    - There are little bumps in the groove. It has depth. It doesn't have uniform depth.
    - What does this depth capture?
      - Intensity of wave lengths!
- Who was the first to do this? Who invented this?
  - It was Edison! (And also a guy in France who did it at about the same time)
- How did they achieve recording?
  - Music was happening (or voice) and they managed to capture it or freeze it in time. How did they do that?
  - For centuries, people were trying to reproduce music, they had to create crazy complicated contraptions that had a different sound generator for every different instrument (and the thought of capturing voice was completely unthinkable).
    - But now we just turn on our phones and music comes out! How does that happen?
    - Ah, it is a speaker! A speaker is a magnet and it moves air!
- How complicated is a speaker?
  - Not very! Your phone only has one speaker or maybe two.
  - Why would you have two speakers? For stereo! Why does stereo mean?
    - More basic: why do you have two ears! It isn't for redundancy, it isn't a backup in case you lose one.
      - How is perception advanced if you have two eyes or two ears?
      - Why are they side by side instead of on top of each other?
      - It gives you more horizontal peripheral vision. Ah, but if you close one eye, you don't actually lose all that much.
      - The reason you have two eyes is for depth perception. the images you see from your two eyes is slightly different. Your brain takes the two images and takes the difference to create depth.
      - The flat object doesn't take depth. It takes two of them to create depth.
      - And the reason you don't have them on top of each other is because the world has more variability in the horizontal than the vertical. It's just a genetic thing.
- So, what about stereo music. Why do you have two ears?
  - It's the same principle!
  - Sound will reach one ear slightly sooner than it reaches the other ear. And your brain uses that differential to figure out where the source of the sound is coming from.
  - This is Echo Location.
    - This is when you generate sound and you use what it bounces off of to figure out where things are. Different echo come from different moments in time, and this is what you use to get a sense of the environment. Lots of marine mammals use this. Bats too.
    - GPS does the same idea! And Sonar!
    - So how does GPS work?
      - You have Satellites! But how do they satellites work? What is it that they are saying?
      - The receiver (e.g. your phone) gets a message from lots of different satellites, and it gets information like " I am satellite BLAH, and the time is X"
      - What is a basic axiom is physics that is being used for this to be useful? Speed of light (as in speed of electro magnetic radiation) is FINITE (and constant). You have to assume that the things coming from the satellite are traveling at the same speed.
- So the way GPS works is, one satellite sends you a number, because you are slightly closer to the satellite (i.e. it tells you what time it is, it gets to you), and then the number you get from another satellite takes a little bit longer because it is further away.
  - And it is telling us this within an accuracy of a few meters.

    * But the distance between us and the satellites is a million times that resolution.
    * Which means we are measuring a very very small minute difference (i.e. in the time that it takes)
    * More over, the counters in the satellites must be perfectly synchronized. What do they have to keep time in these satellites?
      * Atomic clocks! To keep time accurately enough, so that the difference in the amount of time it takes for light to get from there to there can be resolved down to the difference of a few meters.
    * What else uses atomic clocks?
      * Modern data centers use atomic clocks to keep time!
      * Why would you want to do this? Why don't they just rely on internet time? Well, it makes things much more efficient if everyone knows what time it is (but we'll cover that more later).

So going back to stereo.

- If you want to improve quality of stereo: put big piece of cardboard and stick it in front of you space, dividing your ears.
  - It will make it much better, because without it, some of the stuff from the left speaker will go into your right ear, and vice versa.
- What about headphones?
  - Headphones eliminate this problem completely, but it isn't perfect quality. It isn't like the orchestra is in front of you, it is all in your head (while if you have a stereo system that is really good it will feel like a whole orchestra in front of you; if you close your eyes you can't tell the difference).
    * Because sound is like a vibration. Edison managed to take a single number, and that number corresponds to sound pressure on your ear drum (which we can think of the location of your ear drum as a function of time). But why do you get the difference in quality from headphone to speaker?
    * Maybe it is a matter of attenuation? If the speakers are away from you there might be some things that are lost that aren't when the headphones are on you?
    * Maybe it is one of reflections? With headphones, it is a perfect coupling, sound goes directly in ear. With speakers, there are reflections. It bounces off of the walls and comes back to your ears.
      * So, could you simulate this with headphones?
      * Take the basic song, which has some frequency that represents what goes to your head directly from headphones.
      * And then 'scale it down' to represent the attenuation.
      * And then shift it a little bit in time because we want the sound to hit the wall and then hit our ear, to represent the time it takes to travel.
      * And then add the two
      * And then get the headphones to play *exactly* that.
      * And now we are simulating what the ears would actually hear in an orchestra setting.
      * And the thing is that our phones have enough processing power to figure this out in real time!
      * This is a great app, and professor just came up with it! Let him know if you want help making it!
  - More and more, computer science is being used to alter reality. That is the road we are going on and we are not turning back.

So how did Edison do it?

- Edison used wax.
  - A soft material. And mechanically attached to it was a sharp needle.
  - And the needle pressed down on the wax based on the sound, which is what captured it.
  - So you can have an entire symphony a 100 people, and what captures it is just this single number (the "depth" of the groove)
  - This works because hearing is equally simple!

Then we talked about music being turned into bits.

- So maximum music takes +1, minimum music takes 1, and on average it is 0.

- So we know that on a CD or on a hard disk, this is somehow a sequence of bits.
  - Maybe we have a Left channel and a right channel.
  - We have a finite hard disk.
  - And it has a finite number of bits in it.
  - But the phenonment that is somehow being captured appears to be a continuous phenomena.
  - How do you capture a continuous phenomena with finite precision?
- Time is continuous: your ear drum is CONSTANTLY moving. at any given moment it has a specific location.
  - So that specific location, if you want to capture it with full accuracy, you would need an infinite amount of information.
  - But teacher claims that if you listen to a CD, it is actually lossless. No information has been lost. But how can this be possible if the music is infinite?
    - Is it because our brain can't process it? No!
- How many of us have heard of the capacity of microphone? How many people know what a capacitor is?
  - You can think of a capacitor as a resevoir of electric charge, the capacity of which depends partly on the volume.
    - So, the charge in a capacitor creates in a field in the world.
    - So, imagine you have a capacitor in which three sides of the wall are fixed, but the fourth side is a membrane that can actually move in and out.
    - And the way this is typically achieved is there is a fluid in there that is partly compressible and that thing actually moves. In the course of moving, it alters the amount of volume, which in turn alters the amount of field induced
    - This is how we handle the transduction of sound.
      - In its movement, it changes the volume of a capacitor.
      - And so somewhere in here, the electrons moving mirrors the air molecules moving. So this is step 1, we have converted sound into electricity.

Okay, so now we are in a world where we are more comfortable with how electrons manipulate.

- So we can think of the electrons as moving from left to right. We can think of there being an electric flow.
- Looking at the frequency of our song again...
- So we can think that when things are negative they are moving in one direction, and positive the other direction, and the magnitude represents speed.
- Well, we could say that the electrons are finite, and thus we've achieved finitizaton
  - well, okay, sure, BUT it is a very big number, so let's sill consider that to be infinite.
- So instead, let's take a device that cuts up time into little intervals.
  - So at every timestep, it measures what the value of the function is.
    - And then, an interval later, it asks again, and an interval later it asks again.
  - So we have basically created a connect the dots situation.
    - Claim is, because we are talking about sound, in particular sound we are supposed to hear, there exists a density in time, such that if we sample densely enough in time (if we sampled with that density or greater), from the connect the dots picture, we can perfectly reconstruct the original.
      - And the reason why this is interesting is that we use the word PERFECTLY.
      - Becuase this is SOUND there exists a density of time in which there exists a signal that we can perfectly reconstruct the actual signal.
      - The cheat here is we are claiming that our measurements on the vertical axis are perfectly precise.
      - No ambiguity, we construct the dots.
      - So we if sample at a certain frequency we know it. Do we know what that frequency is?
      - What is a frequency that we've seen anywhere?
      - 50/60 Hertz for electric devices, that is for something else. That is for alternating currents.
      - It isn't bit rate, it isn't decibels. But on mp3 files there is another number you see often. What is it? 44.1.

- If you open an mp3 file, it will often say 44.1 KHz. Hz is short for Hertz (name for person). K is a generic symbol for 1,000 (just like kilograms is a 1,000 grams). So 44.1 KHz means 44,100 times per second.
- So when music is converted to digital function, they will measure the music 44,100 times per second!
- And the claim is that this is enough! We don't need to do it more than that!
- And this number is a peculiar number. It would take a long time to describe why we pick it.
- But let's approximate it to 40,000.
- And then divide it by 2 to get 20,000 (20 KHz)
- Is this a number that is meaningful to us?
- Yes this is the range of human hearing!
- But what the hell does that mean?
- What does it mean to say that the range of human hearing is 20 KHz.
- It means that we can't hear anything beyond it.
- But when music is played to us, where are the KHz?
- but the claim is we can get perfect reconstruction of music from finite sampling, which comes not from limitations of computation of human brain, but from density of our eardrums.
- To Be Continued next time!