Abstract:
This project's goal is to see how visuals that enable intuitive learning can be made. There are many ways to learn a topic, and oftentimes people are able to understand something by seeing patterns or learning of new patterns when shown a few examples. Using Processing(a Java based language for creating visuals), visualizations were made regarding cellular automata patterns, stippling art, and rock paper scissors. Surveys were sent to students, but there was no sufficient data at the time of writing this report to generate definitive conclusions.

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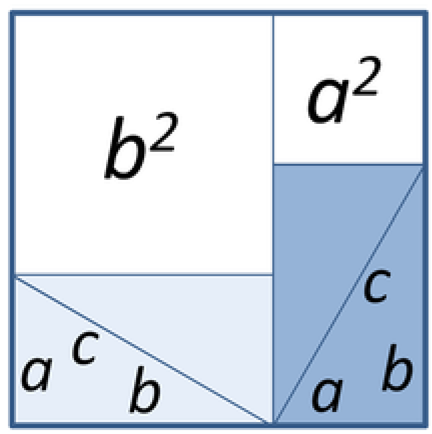
Problem Statement:

There are many ways to learn, and it's important to see if visuals with patterns help with understanding. For example, if someone sees examples of how to solve a math problem without explanation, do they usually figure out how to solve it on their own? What visualization will help? For example, the Pythagorean theorem becomes more clear when looking at the adjacent figure[1], rather than just memorizing a squared plus b squared equals c squared. Can computer visuals help with reinforcing patterns and helping people to learn?

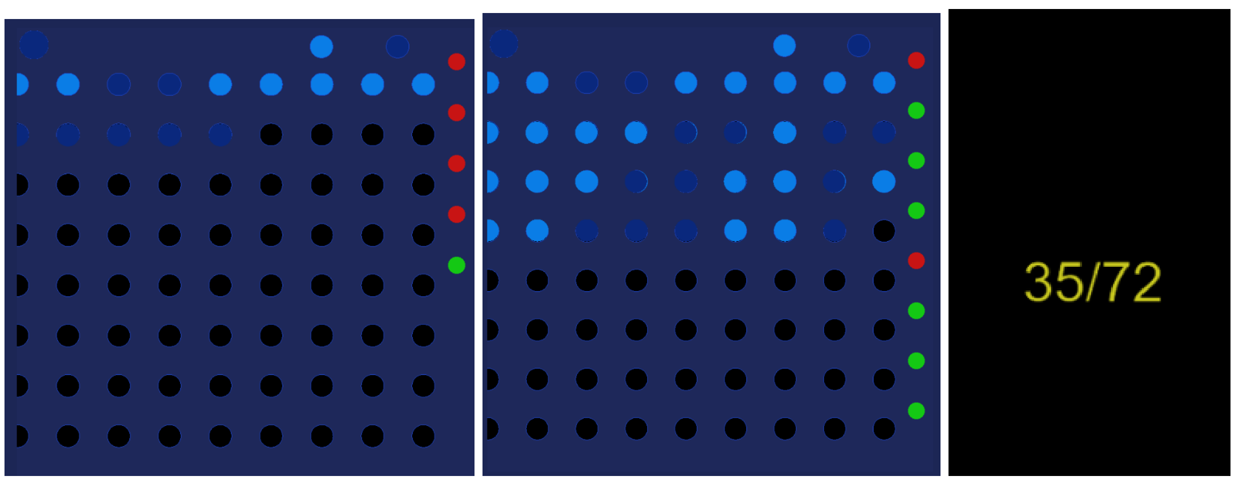


[1] Source: "What is the most elegant proof of the Pythagorean theorem? [closed]" *Stack Exchange*, 2010, https://math.stackexchange.com/questions/803/what-is-the-most-elegant-proof-of-the-pythagorean-theorem,. Accessed 5 April 2023.

Method Description:

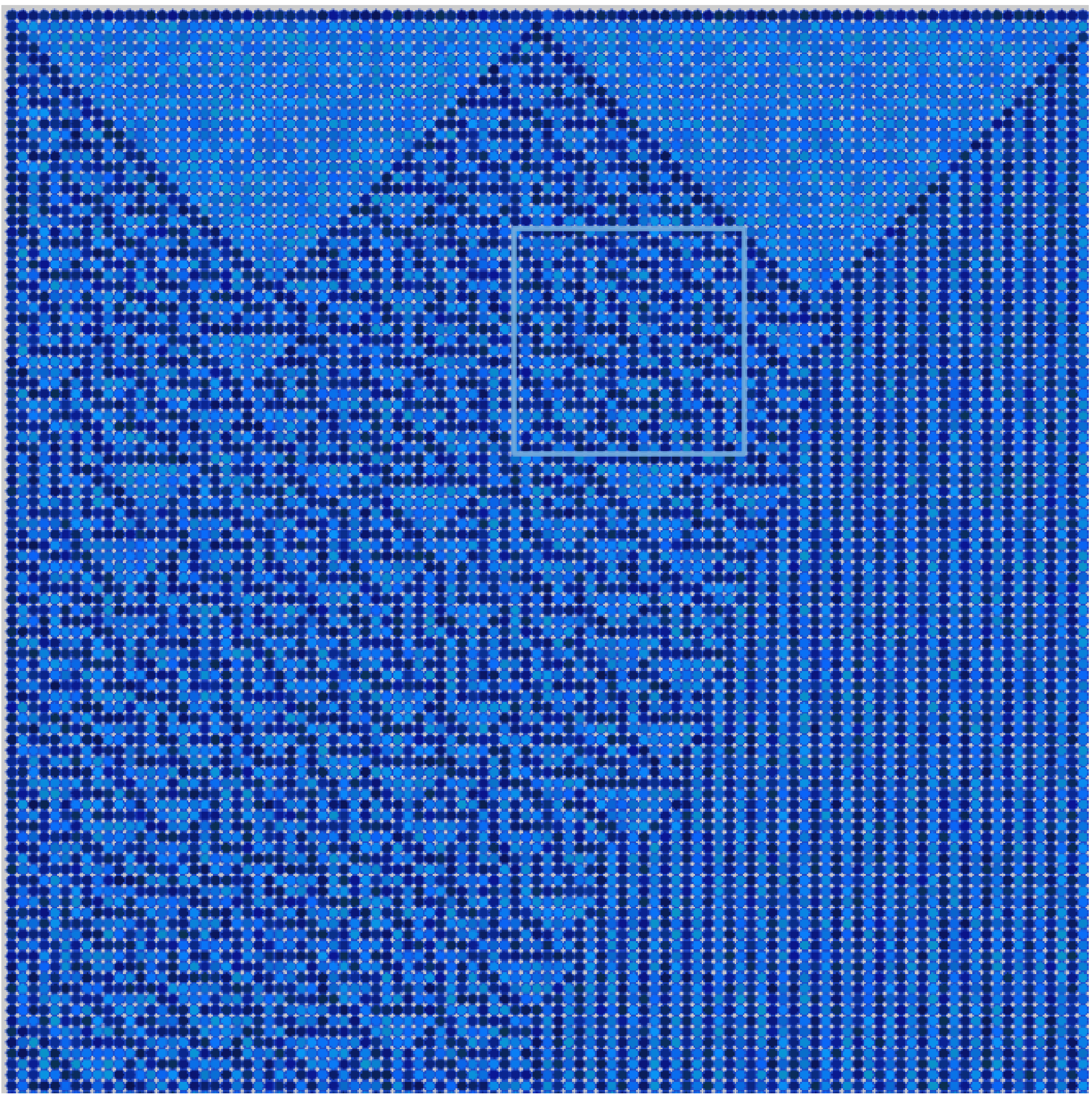
Visualizations relating to cellular automata patterns, stippling art, rock paper scissors were made to see if simple computer generated visuals with a pattern would lead to better than expected scores. For example, in rock paper scissors there is a 50% chance of winning if ties are counted, but if the computer opponent has a pattern, could participants intuitively guess what to play to win?

<u>Cellular Automata Patterns:</u>



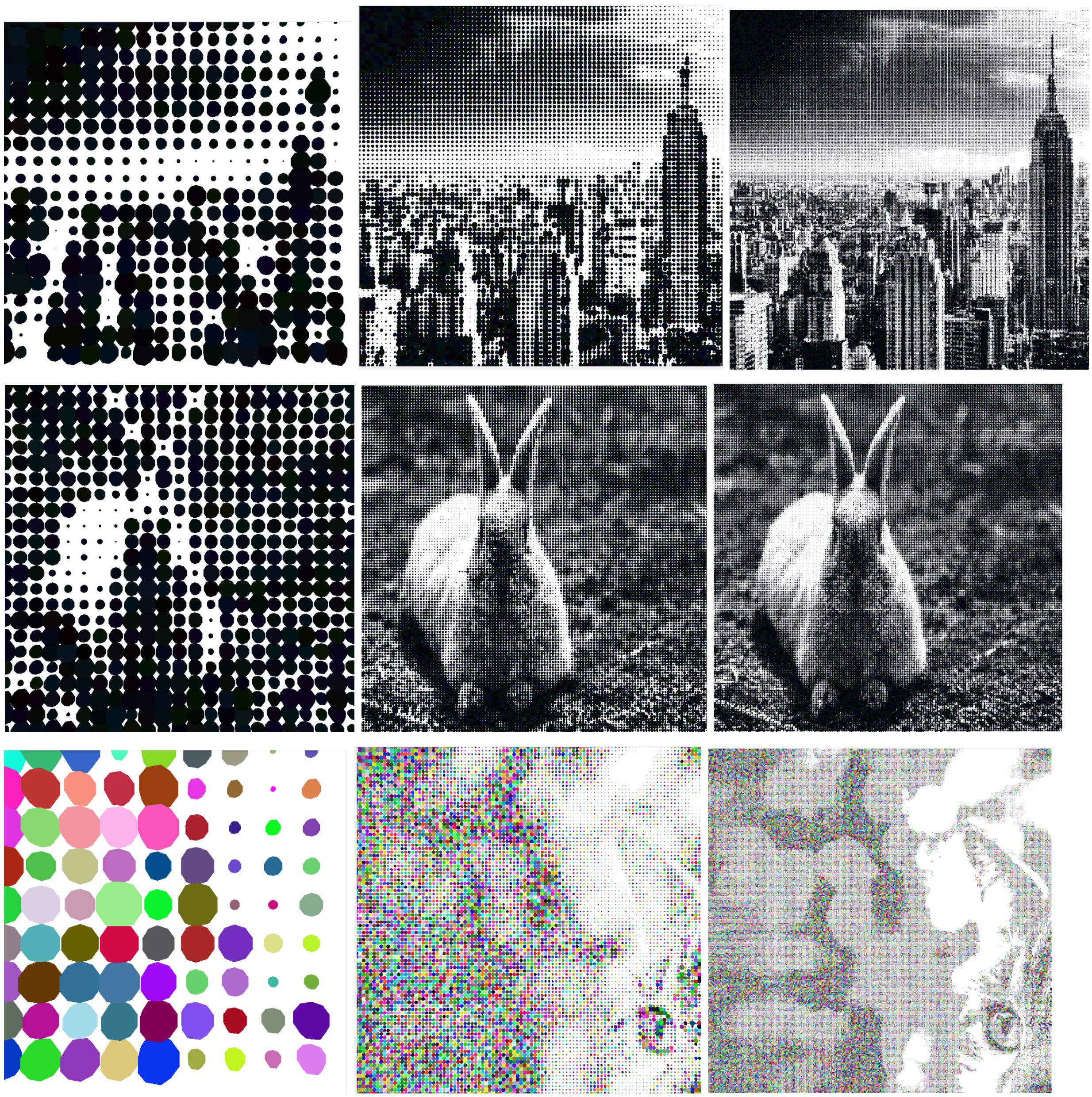
The user fills in rows of circles based on the row above. For each right answer a green circle appears, and for each wrong answer a red circle appears. Once a row is filled in, a correct version of the row is shown. At the end, the user sees how many circles/answers they got right in total.

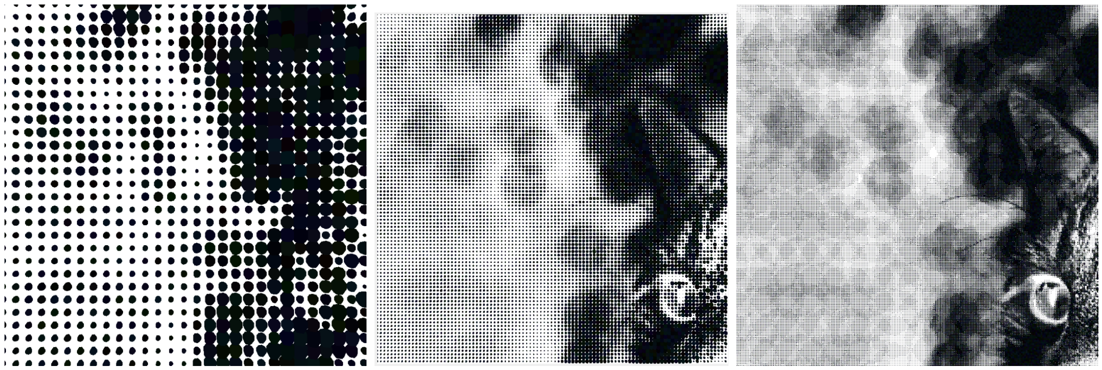
The goal is to see if based on intuition, the user gets more than half of the answers right. The rows they need to fill out are based on a cellular automata pattern. For example, 3 light blue circles together might make a light blue circle underneath. The user does not know this, but can somewhat intuitively start seeing patterns. By doing this the user fills out a section of a bigger cellular automata pattern. For example, a 9 by 9 part of a cellular automata pattern is taken:



Stippling Art:

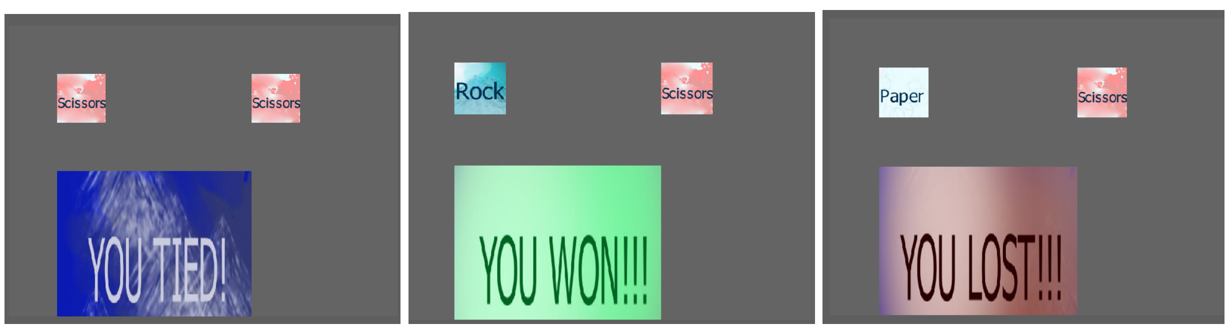
There are many ways to learn art, and stippling art can be generated with Processing. The user clicks on an image to subdivide it, and see how circles are drawn to represent values. Stippling art is when an image is made with different sized dots based on the values extracted from the original image to create the whole image. In this sketch the user presses space to move to the next image, and the mouse to increase the amount of division the image has.





It shows how circles of different sizes can be used to create an image, and that the more divisions there are the clearer the image becomes. It also shows that the color of the circle does not necessarily matter, because it’s the value not the color that makes up the shape.

Rock Paper Scissors:



I. The user tries to "intuitively" get more answers right than 50% in rock paper scissors when the computer has a pattern. The computer has a higher than 1/3 chance of selecting a certain answer after choosing "rock", "paper" or "scissors". So the purpose of this is to see if people pick up on a pattern and get more than 50% right(ties count as ½).

The user clicks the right, down, or left arrow to make a choice of rock paper or scissors.

The user doesn’t necessarily know certain percentages, for example, that there is a 60% chance of choosing rock after the computer has chosen paper, but rather the user may infer that intuitively.

Results from the Surveys:

Openprocessing.org was used to put the Processing sketches on a website so that links could be shared in surveys.

The survey was sent to several classes, but there was not enough data to form definitive results. From the 3 responses given, one person got 29/72 on the cellular automata, one person got 37/72 and the other person got 46/72.

For the stippling art, the responses said that the program helped them visualize stippling art and that they found it interesting.

For the rock paper scissors game, one response got a score of 46.5, another 53, and another 55 out of 100.

Future work:

A better way to collect data from more people is needed. I plan on coming to classes in person. I think this should help getting better responses and get the kids more engaged.

In the future programs relating to math such as probability can be made to see if users can learn some math efficiently with just visualization. It’s really interesting how patterns can be used to learn something intuitively.

There was another version of a rock paper scissors game made, using data from the user to make the computer's decision. For example, if the user chose 50% of the time rock after paper, then the computer could have a higher chance of choosing paper after the user had chosen paper.(the computer would try to win against the user based on the previous choice.) But it could be better adapted for the user's choice, for example, taking two to three choices also into consideration rather than one as well. Such as looking at the probability of choosing rock after scissors and paper are chosen.

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Thank you to Mr. Jensen for information about the SuperComputing challenge and encouragement!

Thank you to Mrs. Lozano for help and support throughout the years!

Thank you to Mrs. Lozano, my art teacher, and math teachers for sending a survey to their students!