Reducing Plastic Waste

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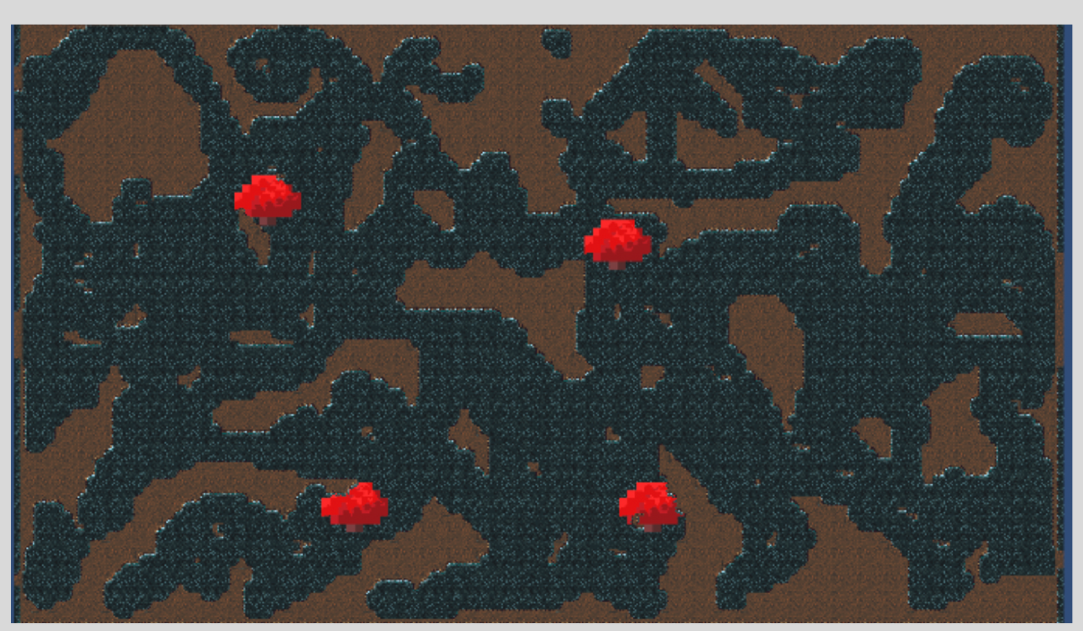
Abstract

Plastic pollution continues to exponentially grow every year, and it negatively impacts our environment with no successful way of dealing with the material after use (D. Cressey et al., 2016). Our team has created a virtual simulation by code to show how effective fungi degrades plastic. Variables, such as temperature, moisture, light, etc., have an effect on the speed of the fungus' microbes degrading plastic. The purpose of creating this virtual simulation is to allow college students and professors to experiment with altering the variables and see which alterations result in the fastest and most effective degradation rate.

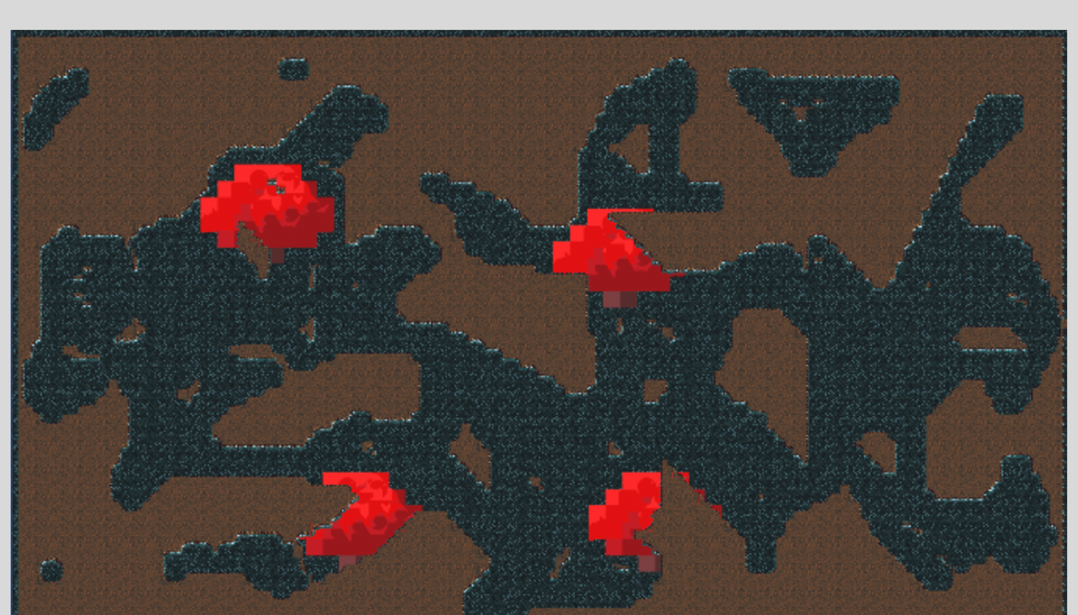
Introduction

- Grand Challenge: reducing plastic waste in environment
- Current plastic degradation processes produce harmful greenhouse gasses while also contributing to climate change (Vishwakarma 2020)
- Use fungus, Aspergillus Tubingensis, to degrade plastic
  - Fungus uses mycelium and produces enzymes that break down molecular bonds in plastic
- Our team is virtually simulating the plastic degradation process by the fungus through Unity



Stage 1

Fungus (red) is placed on plastic (blue) in petri dish (orange)



Stage 2

Fungus is growing and plastic is degrading and decreasing in size

Acknowledgements

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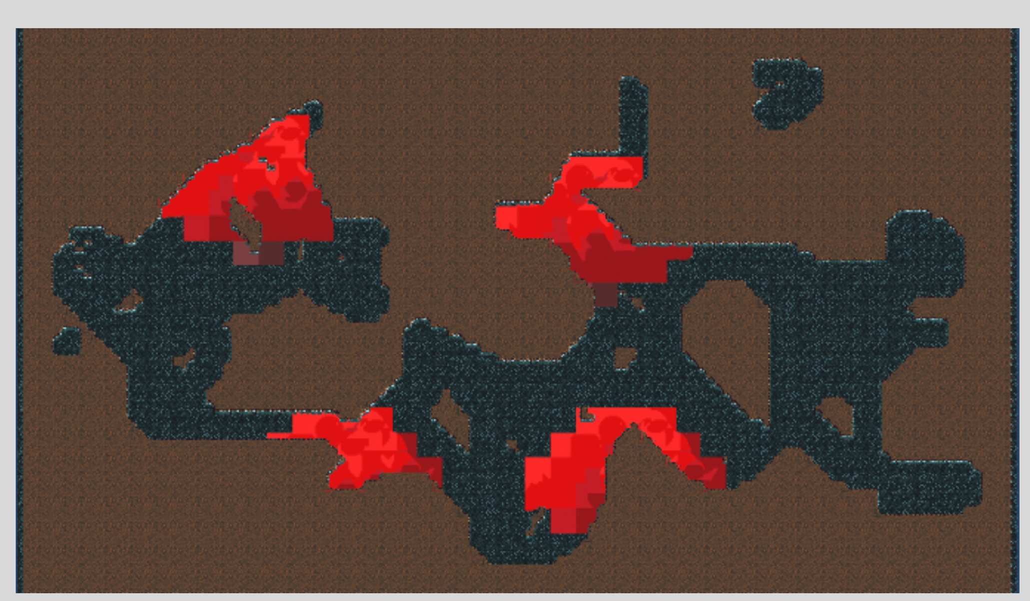
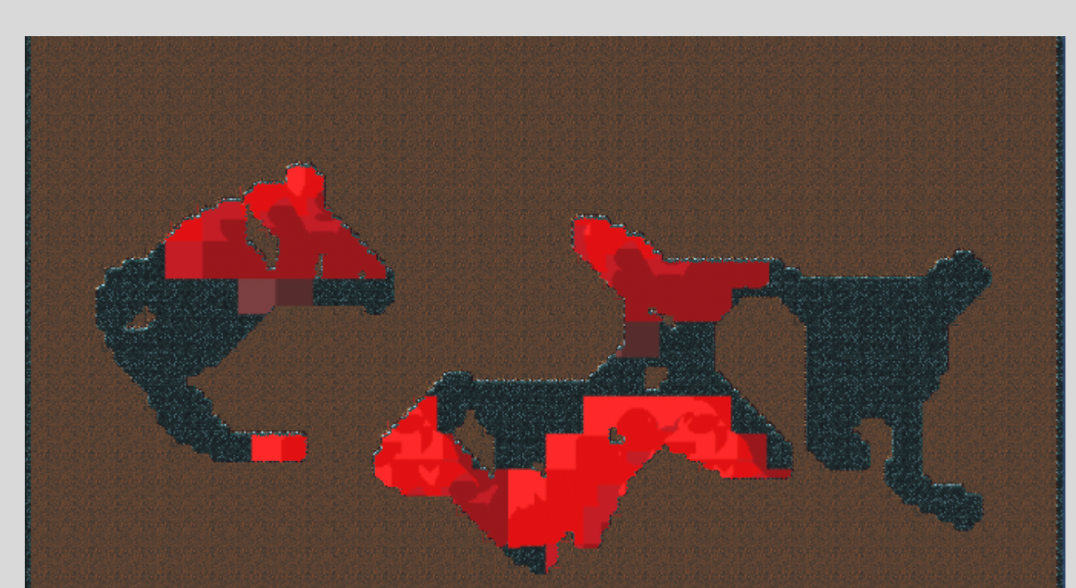
Methods

- Using a game engine, Unity, to stimulate fungus degrading plastic
  - Includes four main scripts that control the simulation
    - PlacerMainFungus
      - Places fungus inside the petri dish
    - Spawner script
      - Controls an operation that spawns 5 game objects inside petri dish
      - Game objects affect fungus' growth rate and rate of decay
    - Timer script
      - Controls how often spawner script is called
      - Default time: 5 seconds
    - Growth script
      - Takes object fungus is attached to and makes it scale up by 1 pixel every couple of seconds
  - Game objects that spawn every 5 seconds are prefabs
    - These prefabs are meant to look like pieces of fungus
    - Prefabs are objects Unity remembers
      - Every time object is placed in the petri dish, Unity remembers the number of scripts on game object and duplicates it
  - Game Objects are labeled either plastic or fungus
    - The scripts themselves define the physical characteristics of plastic or fungus
    - Depending on what the scripts are attached to the labeled objects, the object will behave as their labels



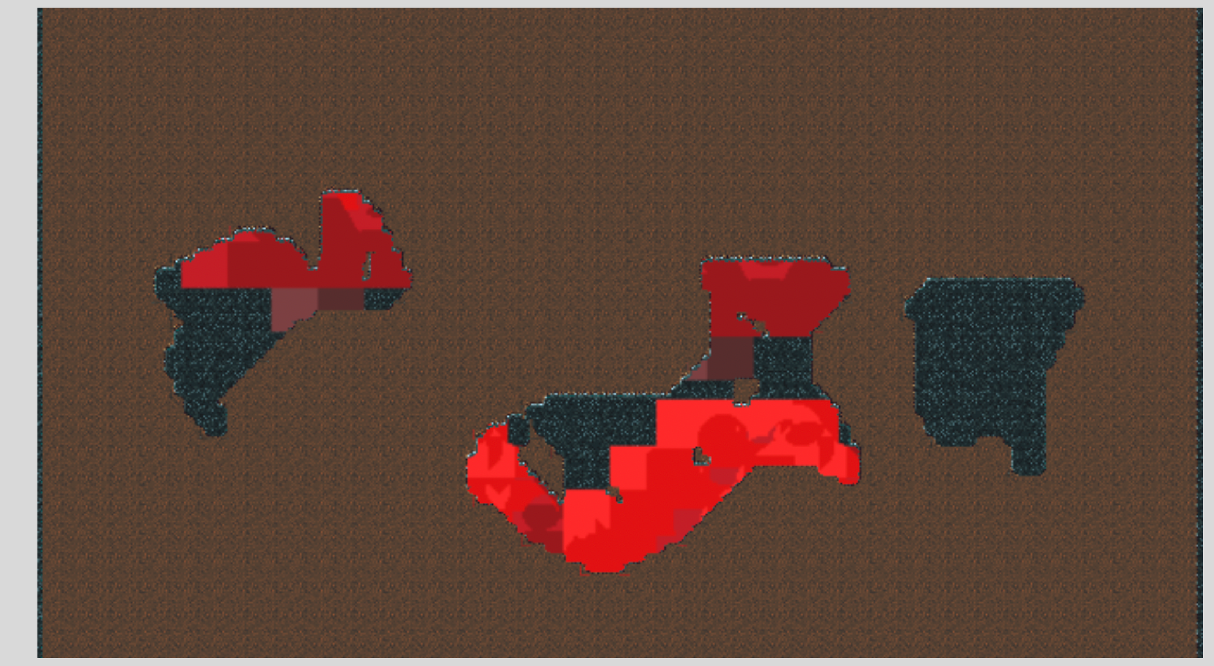
Stage 3

Less plastic is present in petri dish after fungus starts increasing in size



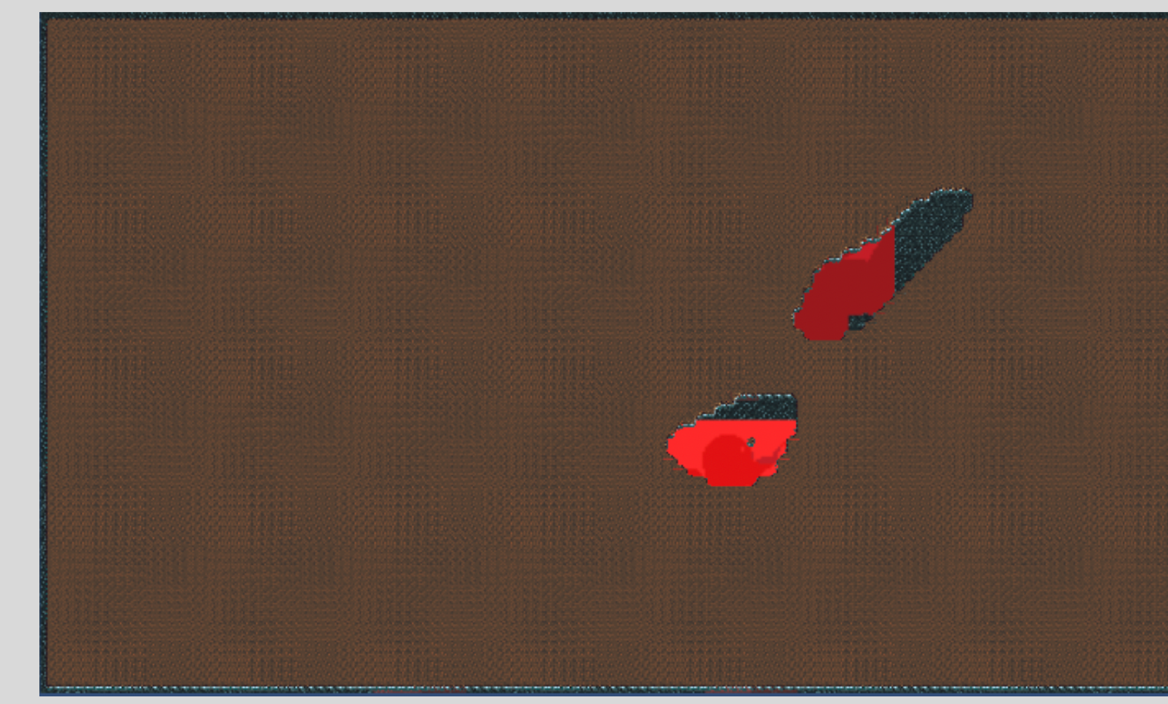
Stage 4

Fungus keeps growing, and plastic keeps shrinking



Stage 5

Almost all of the plastic has been weakened and eaten by the fungus



Stage 6

Only a very small amount of plastic remains in the petri dish, but the fungus is still thriving

Results

By using an auto generated tile map, we can randomly generate the rate the fungus grows and plastic degrades. By using a tile map, the experiment is made clear to the user. The results will show what amount of plastic is left and how much fungus has grown, as well as the time it took to reach the max capacity. The tile map we have created allows the user to see how much the fungus grew, and as a result, how much plastic has been degraded and what still remains. By altering the variables, different reactions will occur, providing different outcomes.

Conclusion

Throughout the process of solving our grand challenge of reducing plastic waste, our team has concluded Aspergillus Tubingensis is one of the most efficient fungi in degrading plastic (Devi et al., 2015). Our simulation visually shows the degradation process and rate of this fungus on plastic material.

Using a virtual simulation is a step forward in creating accessible education in both biology and computer science. From our own simulation, we learned different ways we could affect the growth of fungus. We were able to code the properties of plastic, fungus, and variables affecting growth. This was a learning process for all of us as we decided to make an attempt at a challenge that is outside most of our majors.