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Project Topic Area: Instrumented biological simulation
Project Name: coral-reef-simulation
Github repository: https://github.com/arlysswest/coral-reef-simulation
The repo will have a `README.md` describing the project.
License: MIT + Apache2.0

Project Vision

This project would simulate a coral reef and coral reef restoration. It would include problems that coral reefs face and how they negatively affect the health of the reef. Additionally, it would include restoration efforts and how they positively affect the health of the reef.

The health of the reef would be measured by coral cover%, algae cover%, ph, and water temperature. Restoration tools would include artificial substrates, coral gardening, micro-fragmentation, and removing pollution. Problems would include pollution, invasive species, C02 emissions, physical damage from storms, and overfishing.

In this program time is going to be discrete. I am going to build a text-based version first. I will research giving it a visual representation and implement a visual version if I have the resources to do so. The visual version and text-based version will have their own branch on github.

The user would pick tools to improve the health of the reef. Problems will occur at random that negatively affect the health of the reef. As tools are applied and problems occur, the statistics will update with each. There will be a more info option if the user needs more information to make a decision. There will be positive messages when the user improves the health of the reef.

Key Aspects
Messages:
- It would display congratulatory messages when the coral reef improves
- It would display problem messages when a problem randomly occurs

More Ino:
- Gives user more info about problems
- Gives user more info about tools
- Gives user more info about statistics
- Asks users if they want more information about problems, tools, or statistics

<u>Tools:</u>

- User chooses tools
- Improve coral reef health
- artificial substrates / 3D printed modules
  - coral cover: inc
  - algae cover: no change
  - temp (c): no change
  - ph: no change
- coral gardening
  - coral cover: inc
  - algae cover: dec
  - temp (c): no change
  - ph: no change
- Micro-fragmentation
  - coral cover: inc
  - algae cover: dec
  - temp (c): no change
  - ph: no change

- Removing pollution
  - Removing pollution
  - coral cover: inc
  - algae cover: dec
  - temp (c): no change
  - ph: inc

<u>Statistics:</u>

- Improve when tools are applied
- Suffer when problems occur
- Outputs current statistics
- *Coral Cover % (int):*
  - Improve=increase
  - suffer=decrease
  - range= 0-100% (healthy Indo-Pacific reefs can be 25–50%; >40% now is considered quite good in 2020s)
  - starting point: 30–40%
- *Algae cover % (int):*
  - improve=decrease
  - suffer=increase
  - range=0–100% (really sick reefs go 40–70% algae)
  - starting point: 10%

- *Water PH (float):*
    - improve= increase
    - suffer= decrease
    - range=0–14 (ocean acidification is moving surface ocean toward 8.0 and lower)
    - starting point: 8.1
- *Water Temperature (C) (float).*
    - *starting point: 26–28°C*
    - improve=stays here
    - suffer= increase >30–31°C
    - range= 0–40°C

Problems:
- Randomly chosen
- Would make coral reef health suffer
- Pollution
    - coral cover: dec
    - algae cover: inc
    - temp (c): no change
    - ph: dec
- Invasive species
    - coral cover: dec
    - algae cover: inc
    - temp (c): no change
    - ph: no change
- Co2 emissions
    - coral cover: dec
    - algea cover: inc
    - temp (c): inc
    - ph: dec
- Storm or physical damage
    - coral cover: dec
    - algae cover: inc
    - temp (c): no change
    - ph: no change
- Over fishing
    - coral cover: dec
    - algae cover: inc
    - temp (c): no change
    - ph: no change

Text Based Version
- The program would loop through the following steps:
    1. Display current statistics
    2. Ask user if they would like to apply one of the tools or quit
        -> if they choose to quit end the simulation
        -> if they choose a tool continue to next step
    3. Adjust statistics based off selected tool
    4. Output updates statistics
    5. Output a congratulatory message
    6. Have program select a random problem to occur
    7. Update statistics based off random problem
    8. Repeat steps 1-7

Visual Version
- Complete only if I have time
- I would need to do additional research for how I might implement this
- Map:
    - The user could click on the map to expand the map
    - The user can click an exit button to leave the expanded map
    - The user can click on a different area of the map to focus on restoring a different area
- Image:
    - an image of a portion the coral reef
    - It would have more corals the higher the coral coverage % is
- Messages:
    - Would display the most recent message from the system including:
        - Congratulatory messages when reef improves
        - Problems would pop up here when they occur
- Statistics:
    - Display updated statistics in real time
- Tools:
    - Display different tools at all times
    - User can click on tools to apply a tool
- Example image:
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An image of the coral reef would appear here

Messages

Map

Tools

artificial substrates /
3D printed modules

coral gardening

Micro-fragmentation

Removing pollution

Statistics

Water PH: % Algae Cover:

Water Temperature: % Coral Cover