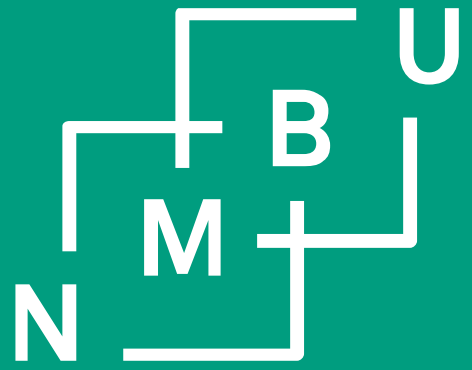

Norwegian University
of Life Sciences

BioSim – Simulation of Population Dynamics on Rossumøya Island

INF200 – Advanced Programming, June 2021 Block

Muntazir Naqvi & Talha Naveed

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Problem

Model the Ecosystem on Rossumøya Island

- Animals
  - *Carnivores*
  - *Herbivores*
- Geography
  - *Water*
  - *Desert*
  - *Lowland*
  - *Highland*

The properties and behavior over time is dictated by a set of defined rules and conditions

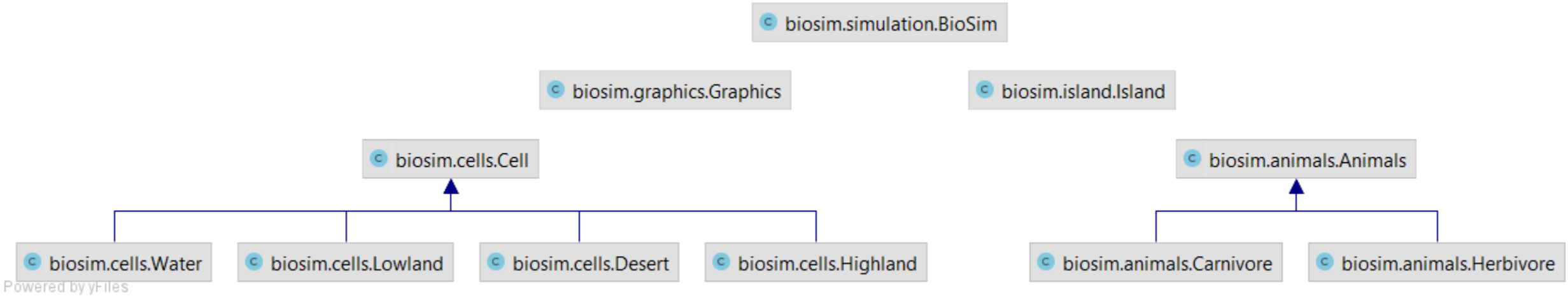
Solution

Object-Oriented Programming!

- Easy to use and efficient simulation software that is built using:
  - Classes and objects
  - Inheritance
  - Abstraction
  - Polymorphism
- Programming language: Python 3

Solution

BioSim: Population Dynamics Simulation



The software package offers…

- Quality assurance
- Accurate model and visualization
- Graphical User Interface
- Performance
- Documentation

Quality assurance

- PEP8 Guidelines: *flake8* check
- Testing covers 84% of the code:
  - *Tests for methods in classes*
  - *Usage of fixtures*
  - *Statistical tests*

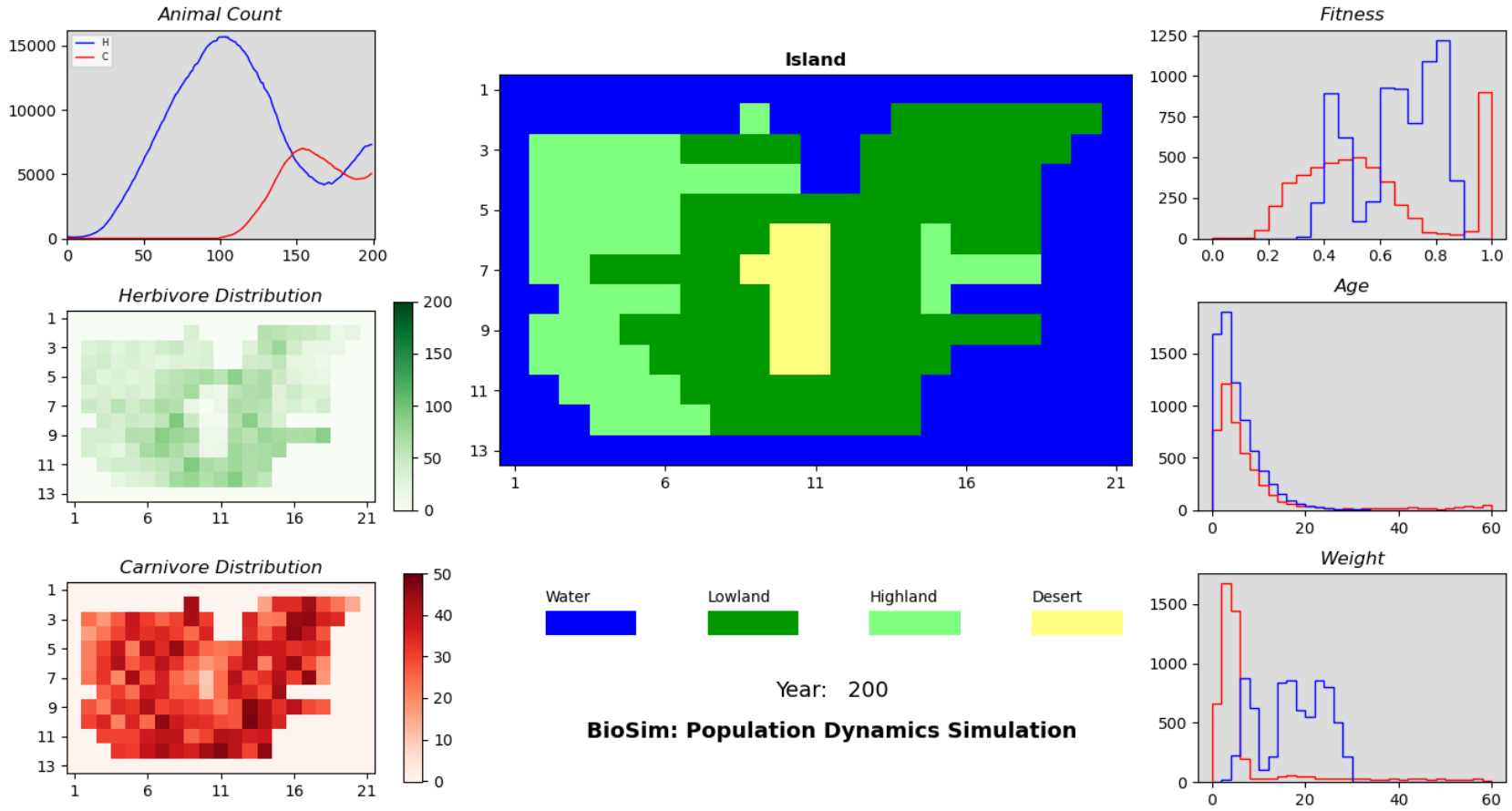
```
---------- coverage: platform win32, python 3.8.10-final-0 -----------
Name                                                  Stmts   Miss  Cover
-------------------------------------------------------------------------
.tox\py38\Lib\site-packages\biosim\__init__.py            3      0   100%
.tox\py38\Lib\site-packages\biosim\animals.py           120     21    82%
.tox\py38\Lib\site-packages\biosim\cells.py             127     23    82%
.tox\py38\Lib\site-packages\biosim\graphics.py          205     37    82%
.tox\py38\Lib\site-packages\biosim\island.py            177     28    84%
.tox\py38\Lib\site-packages\biosim\simulation.py         65      2    97%
-------------------------------------------------------------------------
TOTAL                                                   697    111    84%
```

Quality assurance

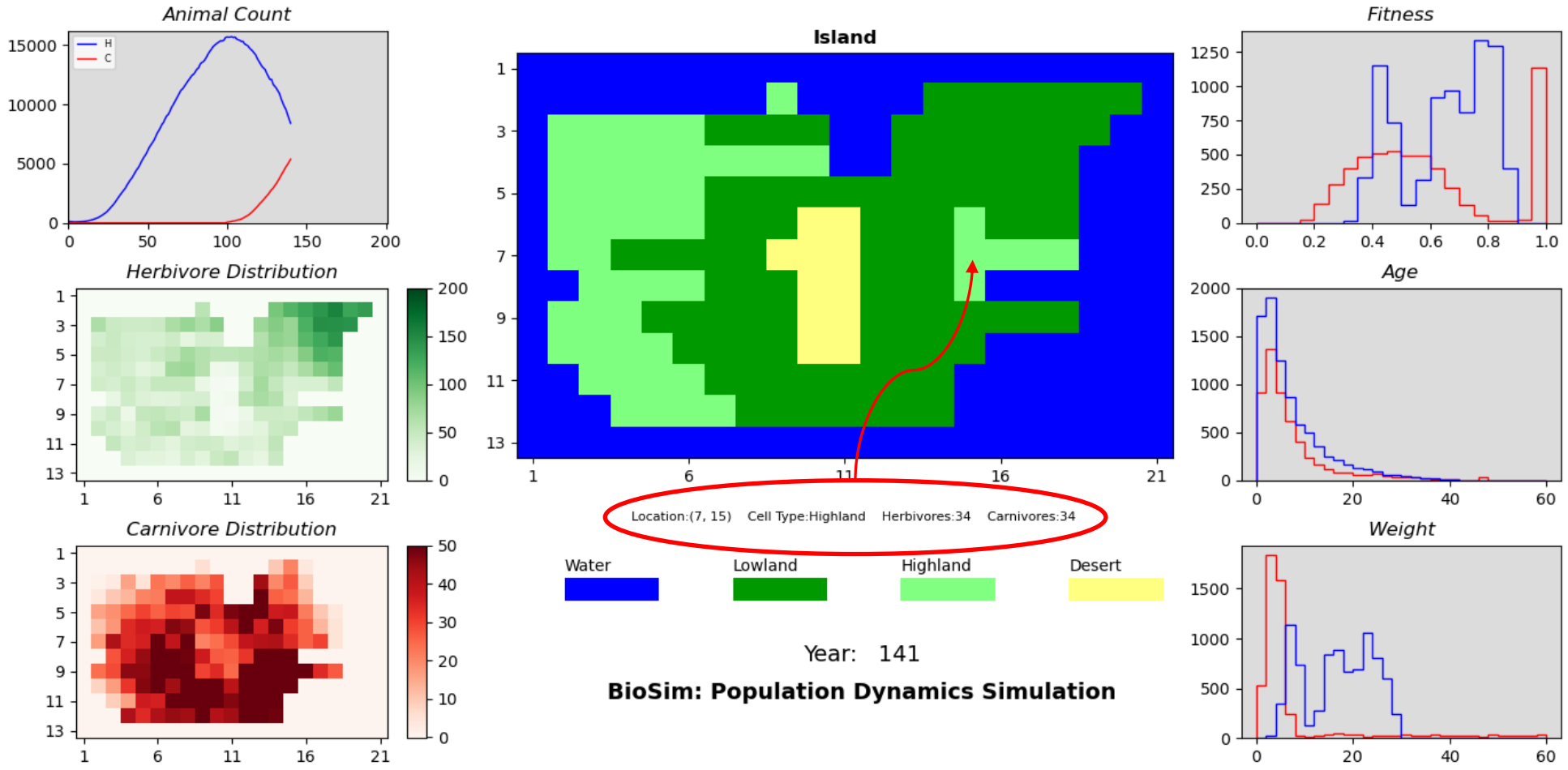
- Automated testing on Gitlab to ensure quality

Status	Pipeline	Triggerer	Commit	Stages
passed	#321824877 latest		main f7556880 last minute docstring co...	
passed	#321818975		main d0a5d8c0 last minute docstring co...	
passed	#321656218		main 052524ec BioSim final commit	

Accurate model and visualization



Graphical user interface



Performance

- Visualization and saving image files have the highest computation cost.

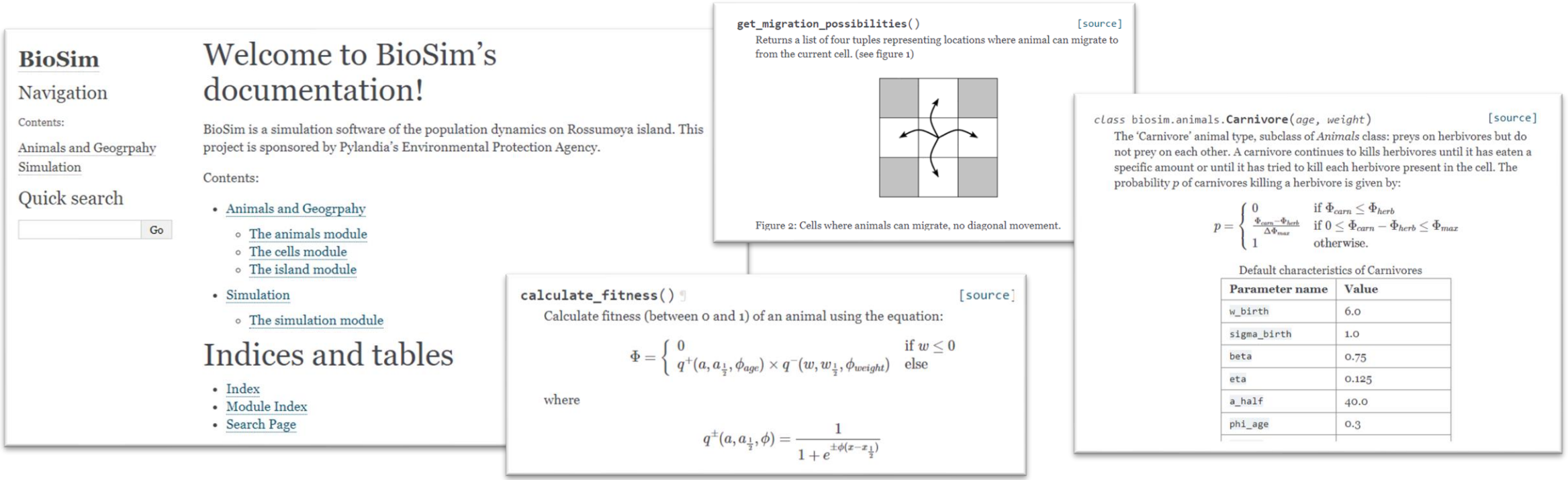
Performance

- Runtime:
  - 27.89 seconds *(without visualization)*
  - 93.40 seconds *(with real-time visualization and without saving images)*
  - 167.38 seconds *(with real-time visualization and with saving images)*

Calculated on Windows 10 Home (OS Build 19042.1052) running on AMD Ryzen 7 4700U CPU ~ 2.00 GHz with 15.4 GB of usable random access memory; storage media is a solid-state drive.

Documentation

- Documentation generated using Sphinx 4.0.1
  - *Figures, math, tables, code examples etc.*



BioSim

Navigation

Contents:

Animals and Geogrpahy Simulation

Quick search

Go

Welcome to BioSim's documentation!

BioSim is a simulation software of the population dynamics on Rossumøya island. This project is sponsored by Pylandia's Environmental Protection Agency.

Contents:

- Animals and Geogrpahy
  - The animals module
  - The cells module
  - The island module
- Simulation
  - The simulation module

Indices and tables

- Index
- Module Index
- Search Page

`get_migration_possibilities()` [source]

Returns a list of four tuples representing locations where animal can migrate to from the current cell. (see figure 1)

Figure 2: Cells where animals can migrate, no diagonal movement.

`calculate_fitness()` [source]

Calculate fitness (between 0 and 1) of an animal using the equation:

$$\Phi = \begin{cases} 0 & \text{if } w \leq 0 \\ q^{+}(a, a_{\frac{1}{2}}, \phi_{age}) \times q^{-}(w, w_{\frac{1}{2}}, \phi_{weight}) & \text{else} \end{cases}$$

where

$$q^{\pm}(a, a_{\frac{1}{2}}, \phi) = \frac{1}{1 + e^{\pm\phi(x - x_{\frac{1}{2}})}}$$

class biosim.animals.**Carnivore**(*age*, *weight*) [source]

The 'Carnivore' animal type, subclass of *Animals* class: preys on herbivores but do not prey on each other. A carnivore continues to kills herbivores until it has eaten a specific amount or until it has tried to kill each herbivore present in the cell. The probability p of carnivores killing a herbivore is given by:

$$p = \begin{cases} 0 & \text{if } \Phi_{carn} \leq \Phi_{herb} \\ \frac{\Phi_{carn} - \Phi_{herb}}{\Delta\Phi_{max}} & \text{if } 0 \leq \Phi_{carn} - \Phi_{herb} \leq \Phi_{max} \\ 1 & \text{otherwise.} \end{cases}$$

Default characteristics of Carnivores

Parameter name	Value
w_birth	6.0
sigma_birth	1.0
beta	0.75
eta	0.125
a_half	40.0
phi_age	0.3

Future Development

- Additional features, e.g. data logging to a .csv file
- Testing to cover 100% of the code
- Optimization to reduce runtime
- More informative and interactive GUI
- More comprehensive documentation

Thank you