

Norwegian University  
of Life Sciences

# BioSim – Simulation of Population Dynamics on Rossumøya Island

*INF200 – Advanced Programming, June 2021 Block*

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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

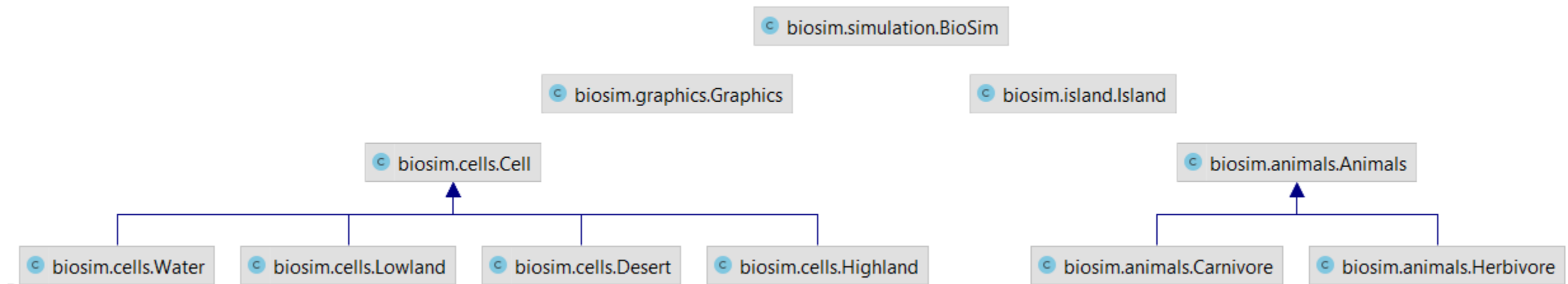
## Object-Oriented Programming!

- Easy to use and efficient simulation software
- Programming language: Python 3
- IDE: PyCharm 2021.1 Professional Edition
- Version control: Gitlab



# Solution

## BioSim: Population Dynamics Simulation

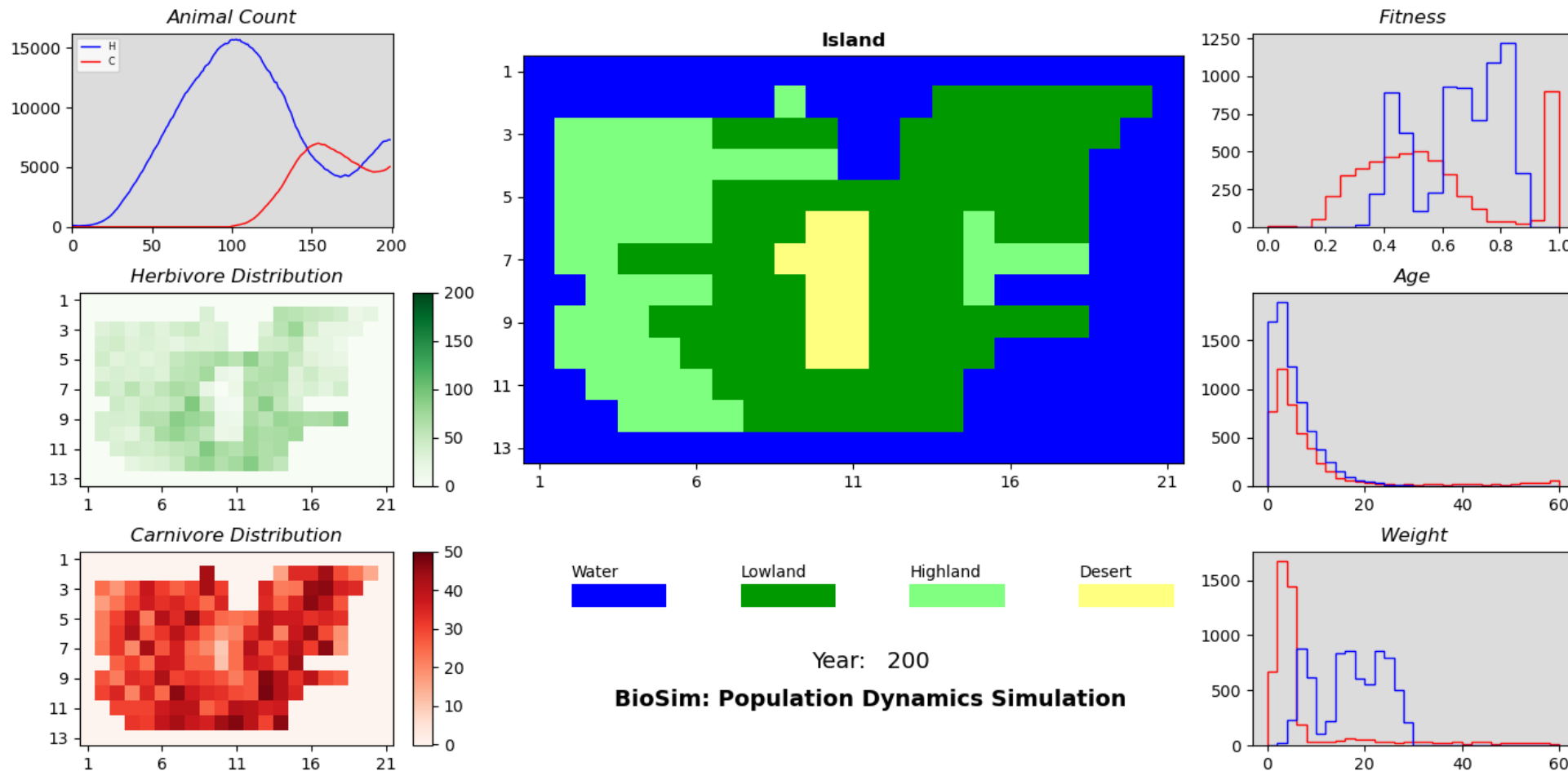


Powered by yFiles

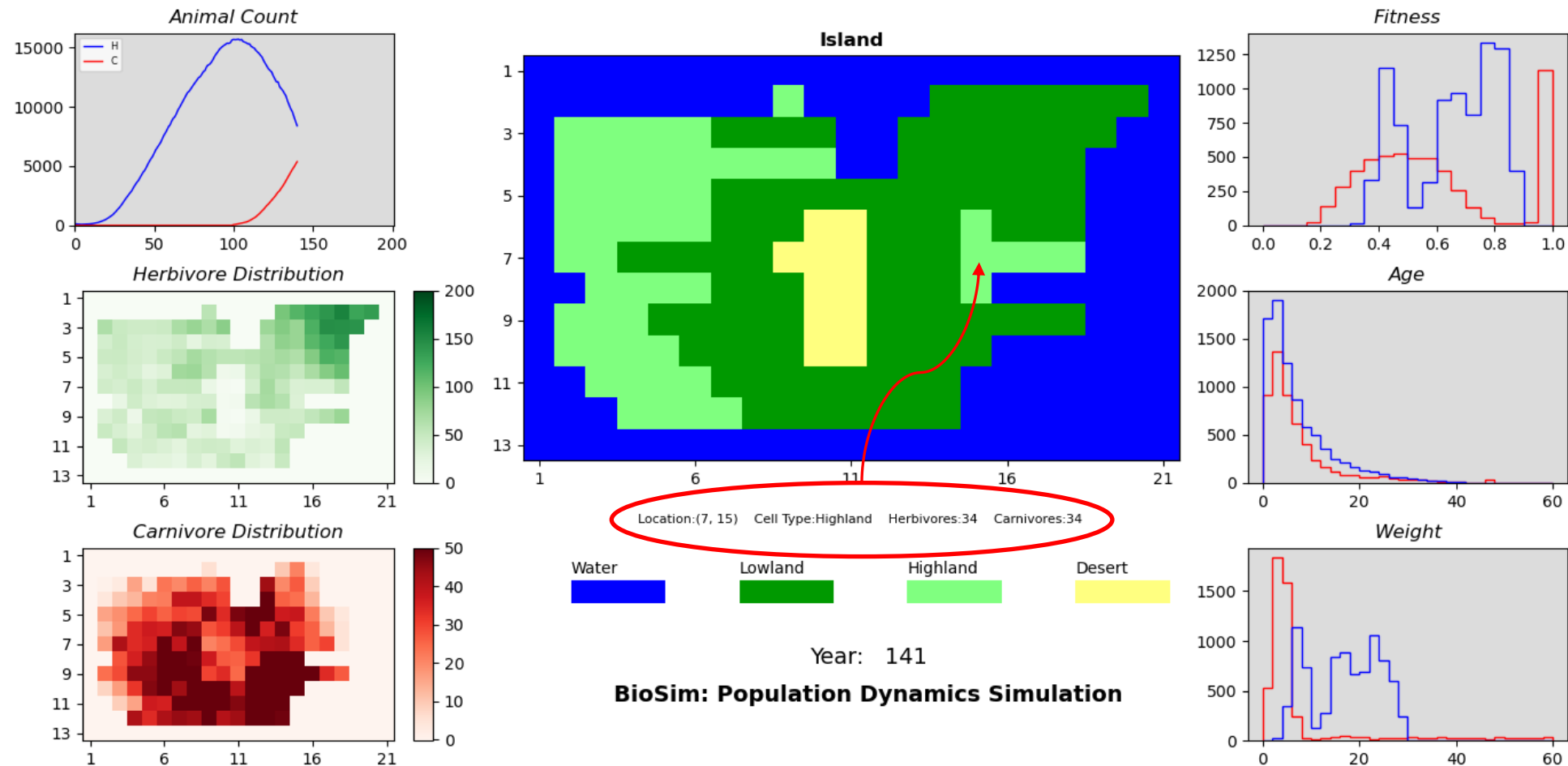
# The software package offers...

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

# Accurate model and visualization



# Graphical user interface





# 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%

```

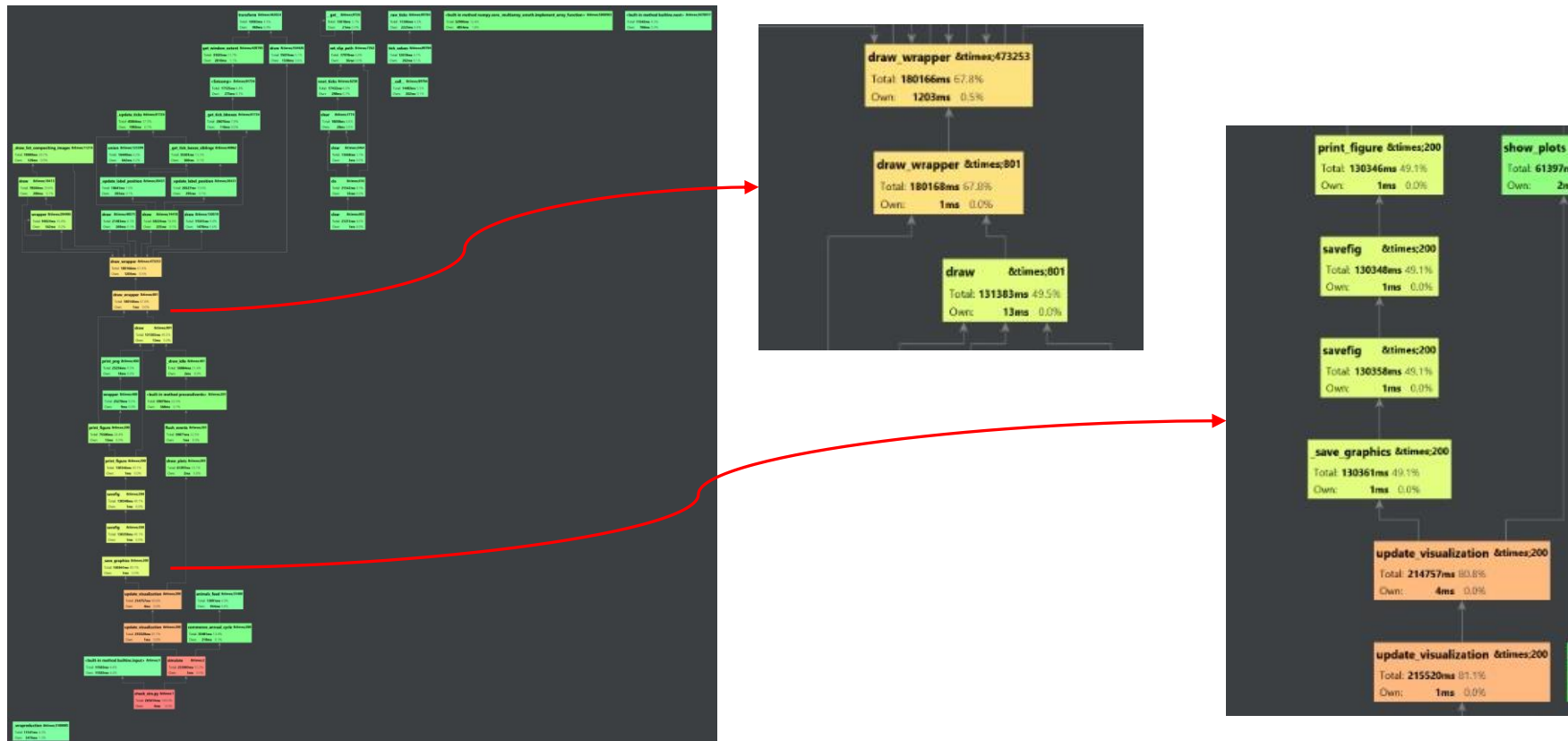
# Quality assurance

- Automated testing on Gitlab to ensure quality

Status	Pipeline	Triggerer	Commit	Stages
passed	<a href="#">#321824877</a> latest		main  f7556880 last minute docstring co...	
passed	<a href="#">#321818975</a>		main  d0a5d8c0 last minute docstring co...	
passed	<a href="#">#321656218</a>		main  052524ec BioSim final commit	

# Performance

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



# Performance

- Runtime:
  - 24.04 seconds (*without visualization*)
  - 83.99 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) 64-bit edition running on AMD Ryzen™ 7 4700U CPU  
~ 2.00 GHz with 16 GB of DDR4 RAM; 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](#)

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Quick search

## 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](#)
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  - [The simulation module](#)

## Indices and tables

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```
get_migration_possibilities()
```

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()
```

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)
```

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

