FCIM.FIA16.1 Spring 2023
Lab 2: Flocking Behavior

Handed out: Monday, January 30, 2023
Due: Friday, March 3, 2023

Fighting with Sapient Rocks

Following your good results on your previous project, the manager asked you to help some colleagues at "LemML" with a problem (their emails take ages to answer – it's like they're in another universe!). In their neighbouring system, starships are being attacked by some strange creatures, living on asteroids and thrusting themselves towards people's ships. From the conversation that follows, you learn that they need some expertise to create a simulation of these attacks, to teach pilots how to deal with these creatures.

You are given a tool developed by a guy called Ijon (run it here), which should provide a good basis for the simulation, so you can expand on that. You learn that *Solanum tuberosum* (the name given to these creatures) exhibit flocking behaviour when undisturbed, as described in this paper. *S. tuberosum* also can exhibit evading behavior, thus trying to evade any unknown objects, like starships and their missiles, while still flocking (much like a school of fish attacked by a predator). When attacking, they thrust their asteroid towards a starship, aiming to collide and destroy them, while still evading collision with other asteroids (similar to a bunch of people trying to fit into a bus). What triggers them to switch between behaviors remains unknown, so it's up to you how your simulation will handle that.

You are asked to write a program that could simulate such behaviours. The mandatory task is to simulate their calm behavior which is their most encountered behavior. When finished with that, continue with their evading and attacking behavior, thus yielding a more complete simulation of *S. tuberosum*'s behavior patterns. Play around with different parameters (e.g. asteroid number and speed, or boid coherence, separation and alignment) to create a visually pleasant (if not truthful) simulation.

Reporting

At the end of this lab, you will need to submit a *report* describing what you have implemented. The *report* must be uploaded on Else, in the according assignment activity. You should use the provided template. Suggested development environments are Google Colab or JupyterLab.

Grading policy

Task 1 Implement the Vector class in Python that works on simple Python lists. The Vector class should implement the vector operations:

- Vector norm; **(0.4p.)**

- Vector addition; **(0.2p.)**
- Vector subtraction; **(0.2p.)**
- Multiplication with a scalar; **(0.2p.)**
- Division by a scalar; **(0.2p.)**
- Vector dot product; **(0.4p.)**
- Vector cross product. **(0.4p.)**

Note: If you also implement this class by using the NumPy library, it will not work with the game from Task 4, but you will get full marks for this task and an additional bonus. **(0.5p.)**

Task 2 Using the Vector class and the provided paper, implement the Boid class with the steering behaviors:

- Separation; **(1p.)**
- Alignment; **(1p.)**
- Cohesion. **(1p.)**

Task 3 Add the *calm* flocking behaviour to the Boid class according to the provided paper, using the 3 steering behaviours implemented in the Task 2. **(2p.)**

Task 4 Combine the Boid class with the behaviours implemented in previous tasks with the provided code for the simulation of *S. tuberosum* and run it in CodeSkulptor. The rocks should exhibit flocking behaviour as implemented in the Boid class. **(2p.)**
Note: The NumPy library will not work in CodeSkulptor. If you implemented the Vector class with NumPy, you should also add another implementation with lists or you can use the numeric library.

Bonus Task Implement 2 additional flocking behaviours to make the simulation more realistic:

- Evading behaviour; **(1p.)**
- Attacking behaviour. **(1p.)**

Report & Presentation Clear explanations, report formatting, code quality, visualisations if relevant etc. **(1p.)**

Do not publish the provided code online.
Plagiarism will not be tolerated.
Good Luck!