Modeling Complex Software system -SWEN 90004- Assignment 2 - Proposal

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Introduction

The aim of this project is to explore the “Gaia Hypothesis”, which states that Earth is a system with both living and nonliving parts. These individual parts each act independently according to their needs and physical properties. However in spite of the simplistic nature of each part, the emergent behaviour of the system is complex. According to this hypothesis, the emergent behaviour should be both synergistic and self-regenerating; it should be a system that helps to maintain and continue life on Earth.

This proposal will introduce the Daisyworld model used to explore system behaviour, it will describe the initial software design, detail the proposed experiments, and give an overview of our initial project plan, work distribution and delivery schedule.

Overview of the Daisyworld Model

To explore the “Gaia Hypothesis”, the Earth is simplified to the Daisyworld model. In this model, the system only contains 2 living organisms: white daisies and black daisies, and 1 environmental factor: temperature. If this hypothesis is correct, then it is expected that overtime, the system will reach an equilibrium and life will continue indefinitely in Daisyworld. This model also aims to examine the importance of temperature and its impact on the survival of living organisms.

This model makes the following assumptions about the system:

- The system is a closed world system, where only parts in the system will impact the behaviour
- The temperature of the system resembles the conditions on Earth.

The Design of the Existing System

The Daisy model contains black daisies, white daisies and empty patches. These have different albedo, allowing each to gain a different amount of energy from absorbing the same amount of sunlight. Because of this, the temperature around these will be different. The reproduction of daisies is affected by the temperature of the empty patches.

Rules of daisies:

Daisies' age over time, to a maximum of 25. They can sprout when there are empty patches adjourning them, and if the temperature is suitable. The relationship between daisy growth factor and temperature is demonstrated in Figure 1 below.

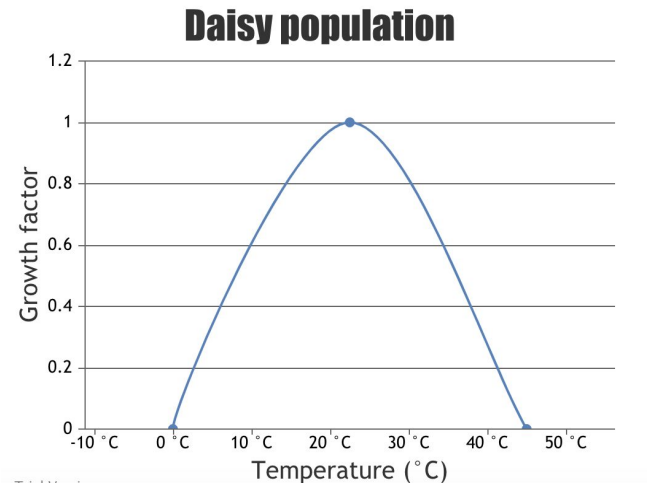

Figure 1

The most suitable temperature is 22.5℃. The growth of new daisies can only happen when the local temperature range is between 5℃ and 40℃. When the temperature is outside this range, daisies will halt and eventually die.

Temperature changes:

Daisyworld can operate in one of the 4 solar-luminosity types: "ramp-up-ramp-down", "low solar luminosity", "our solar luminosity" and "high solar luminosity".

There are two types of daisies: black daisies and white daisies. The major difference between them is their reliance on albedo, which is the proportion of the absorbed heat from the sunlight. The white daisies have a high ability to absorb the heat and the light from the Sun, therefore cooling the area around them. Whereas, the black daisies have a low ability to absorb the heat and the light from the Sun, therefore heating the area around them. Local temperature is also affected by the diffusion of heat, which is 50% of temperature value at the empty patches and their neighbours. So when the numbers of daisies and empty patches change, the temperature will change. The relationship between Local-heating and absorbed-luminosity is shown in Figure 2.

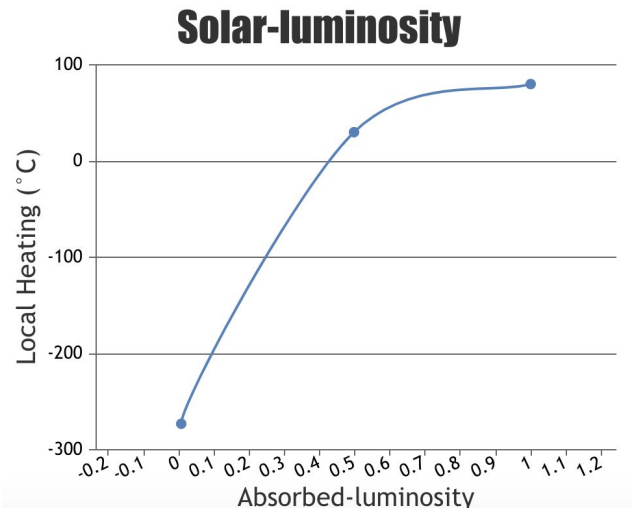

Figure 2

The Design of the Model in java

The model of Daisyworld will be implemented in Java. The initial design of the model contains classes described in Figure 3.

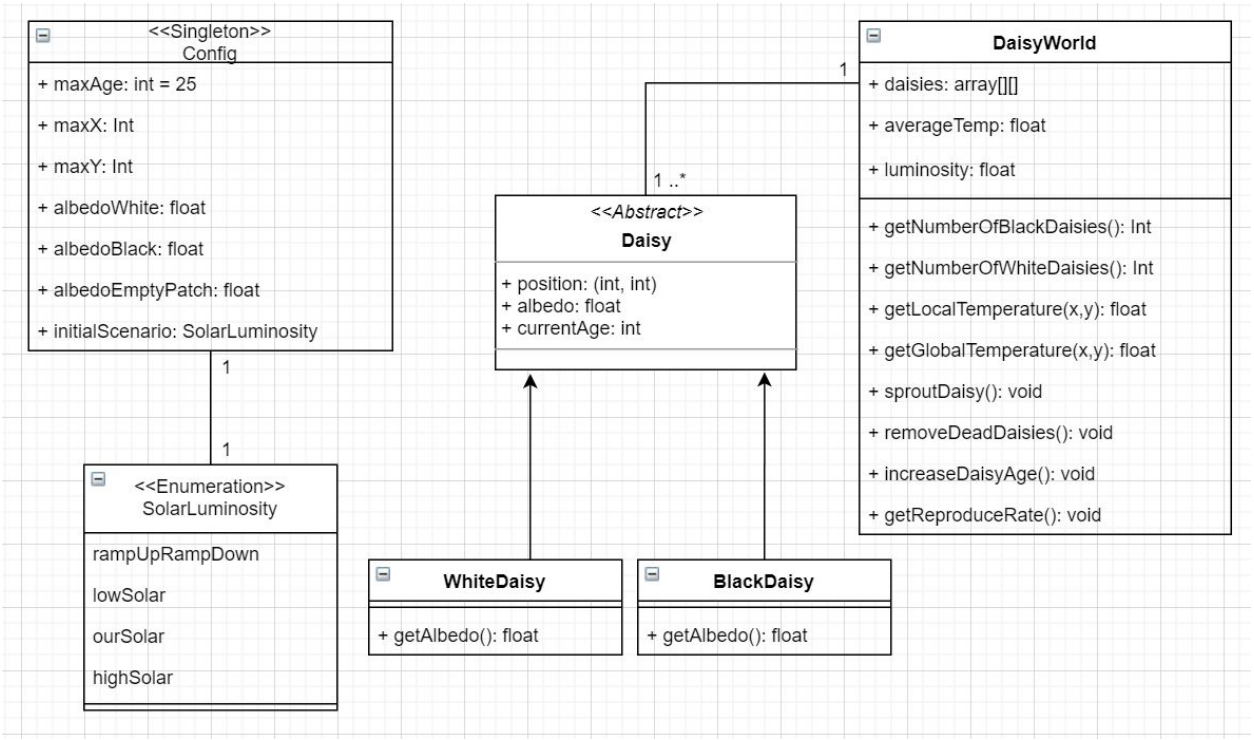

Figure 3

The “DaisyWorld” class represents the world in Daisyworld, it is the object in which all the daisies live. The world controls the temperature and luminosity.

The “Black Daisy” and the “White Daisy” classes both extend the “Daisy” class as they are both types of daisies. They represent the living organism in the system. Each daisy knows about their location, albedo and age. Daisies interact with the “World” by growing, dying, reproducing and changing surrounding temperature.

The “Config” singleton class is used to configure the properties in the system. By changing these configurations, we can explore how these factors affect the survival of daisies.

The “SolarLuminosity” enum is used to limit the scenarios the world can exhibit, to only valid luminosity scenarios.

The Proposed Experiments

The experiments we plan to do contain three groups, including results analysis, behaviours comparison, and extension feature exploration.

The first group of experiments would analyse the output of the existing model to explore its features, and then we can better understand the existing model. These results and parameters would be used in the second experiment group.

The second experiment group would compare the behaviours of the existing model and replicated model with the same parameters, in order to check whether the new model can behave similar to the original model.

The third experiment group would analyse the outputs of the replicated model with the extension feature, and evaluating its results and behaviors would be used to assess how closely this feature makes the model reality.

Project Plan and Schedule

Table 1 below details the break down of this project, who will be performing the task and the expected completion date.

Table 1

Tasks	Assignee	Expected Completion
Explore the existing behavior of DaisyWorld Model	All	May 10, 2020
Design and Implement an equivalent DaisyWorld Model in Java	Lu	May 20, 2020
Experiment with our new model on the effects of model parameters on model behaviour Compares with the NetLogo model	All	May 22, 2020
Extend our model with a new behavior/feature	Huijie	May 24, 2020
Formulate a question and experiment with the new feature to address the question	Ashwaq	May 24, 2020
In the Final Report: Write a brief background review and potential uses of the Model	Ashwaq Huijie	May 14, 2020
In the Final Report: 1. Experiments on our model and the NetLogo Model 2. Compare and discuss on two models' behaviours	All	May 22, 2020
In the Final Report: 1.Formulate a question for the extended model 2. Experiments with the new model and discuss the question	All	May 24, 2020
In the Final Report: an appendix outlining how our group worked together to achieve the project	All	May 28, 2020