Modelling Complex Software Solutions - Assignment 2 Proposal

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Model: Wealth Distribution

Overview of The Model

We plan to explore and replicate NetLogo's Wealth Distribution model, which is an agent-based simulation of wealth distribution in a simplified society. We will use Python for the implementation.

In the model grid, the colored patches represent the landscape, where darker areas indicate less available resources (grain) and lighter areas more abundance. Agents (or "turtles") are scattered across the landscape, each with individual attributes including vision (how far they can see to find resources), metabolism (how much grain they consume per tick), and life expectancy. This model vividly demonstrates how inequality can emerge naturally from individualistic behaviours in a resource-limited environment.

This simulation invites discussions on how initial conditions, geographic luck, or agent capabilities can lead to systemic inequality.

Metrics

Class Plot & Histogram: These show the distribution and evolution of classes, agents categorised as low, mid, or upper class based on wealth. Over time, we observe a rise in the lower class and a significant reduction in the middle and upper classes, indicating increasing inequality.

Lorenz Curve: This plots the cumulative wealth distribution. A sharp curve away from the diagonal (line of equality) signals substantial inequality. In simulations, the red curve diverges significantly from the diagonal line, suggesting that a small portion of the population holds most of the wealth.

Gini Index: The Gini coefficient quantifies inequality (0 = perfect equality, 1 = maximum inequality). This is derived from the difference between the area under the Lorenz curve and the 45-degree perfect equality line.

Model Design

Patch (Tile) Class

Attributes - x_coord, y_coord, current_grain_amount, max_grain_amount
Methods - grow_grain, harvest, get_grain_amount

Agent (People/Turtle) Class

Attributes - id, x_coord, y_coord direction, age, wealth, life_expectancy, metabolism, vision
Methods - spawn, move_forward, consume_grain, increment_age, add_to_wealth, is_dead

World (Simulation Environment) Class

Attributes - num_people, percent_best_land, max_vision, max_metabolism, life_expectancy_minimum, life_expectancy_maximum, grid, agents, current_tick, lorenz_list, gini_list

The Experiments

Experiment 1: Uniform Initial Wealth

Objective: Assess impact of uniform initial wealth endowment on wealth inequality emergence and speed.

Approach: All newly created or reborn agents are endowed with a fixed, identical amount of grain. This amount could be:

- The average initial wealth observed in the baseline model.
- A predefined value (e.g., 50 units of grain).

Experiment 2: Higher Initial Endowments / Inheritance

Objective: Examine how the possibility of starting life with substantial wealth (simulating inheritance or advantage) affects wealth distribution and class stability.

Approach: Investigate variations where new or reborn agents may start with significantly higher wealth:

- **Simulated Inheritance:** A percentage of a rich/middle agent's wealth is transferred to a reborn agent.
- **High Random Endowment:** Initial wealth drawn from a much wider range (e.g., metabolism + random 200) upon rebirth.
- **Class-Based Rebirth Wealth:** A small chance for reborn agents to start with wealth typical of the middle or rich class.

Task Breakdown and Timeline

The following table outlines the key tasks, responsible team members, and tentative deadlines for the project timeline.

Task	Responsible	Tentative Deadline
Initial Project Setup & Planning	David, Kamal, Akassh	15-05-2025
Implement the core model in Python	David, Kamal, Akassh	19-05-2025
Refine Model Parameters & Logic	David, Kamal	21-05-2025
Implement Experiment 1: Uniform Wealth	David, Kamal	22-05-2025
Implement Experiment 2: Inheritance/Endowments	David, Akassh	23-05-2025
Perform exhaustive tests & Generate visualisations	David, Kamal	24-05-2025
Data Analysis & Interpretation	David, Kamal	26-05-2025
Write Draft Report Sections	Akassh, David	28-05-2025
Final Review and Editing	All	29-05-2025
Write and submit the final report	David, Kamal, Akassh	30-05-2025