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Project: *2D Resource Competition Simulation*

Topic Area: Instrumented Simulation

Project Vision

Simulating a feedback loop among resources, agents, and the environment on a 2D grid:

- **Resource field**: The background is a grid of cells. Each cell carries a current resource amount and a regeneration rate. Resources recover over time.

- **Death feedback**: When an agent dies on a cell, that cell receives an immediate resource boost and a slight increase in its regeneration rate (both bound to avoid runaway growth).

- **Agent behavior**: Each agent repeatedly tries to harvest from its current cell, pays a baseline upkeep. If intake is slightly below upkeep, it performs short-range exploratory moves toward richer neighbors; if intake is far below upkeep, it stays put until recovery or death. When multiple agents share a cell, they follow a simple equal-share rule for resource competition.

- **Interaction**:
    - Players can configure the number of initial spawn points (agents).
    - The first agent is treated as a focus agent, and its baseline consumption or harvesting capacity can be adjusted by the user in real time.
    - A force-kill button demonstrates the local "death feedback" effect.
    - Simulation can be reset.

- **Visualization**:
    - Using points to represent agents.
    - Using rectangles to represent cells.
    - Each rectangle displays its current resource level using either color or numerical values.

- **Cells**:
    - Current resource: the amount of allocatable resources available in the current cell.
    - Maximum resource: the maximum amount of resources a cell can store.

- Regeneration rate: the regeneration rate of the resources (which can increase when an agent dies in the current cell).
- Maximum regeneration rate: the maximum regeneration rate of the resources.
- Consumption rate: the total consumption of all agents within the current cell.
- **Agents**:
  - Consumption: the amount of resources required for the agent's own survival.
  - Harvesting: the amount of resources an agent can obtain from the cell, which by default equals its consumption rate but is affected when multiple agents occupy the same cell.
  - Health: when the harvesting value remains low for an extended period, the agent's health decreases. Once health reaches zero, the agent dies and returns resources to its current cell.
- **World**:
  - Current agents: the agents currently alive in the scene.
  - Maximum agents: the maximum number of agents allowed in the scene.
  - Cells: the resource cells within the scene.

Issue of Concern

1. **Parameter stability**: some settings may cause collapse or explosion.
2. **Visualization choice**: learn how to use the *eframe/egui* crate to implement visualization effects.
3. **Agent exploration**: ensure that each point (agent) can determine whether it should move to another cell based on its consumption when resources are insufficient.

Git Repo URL

https://github.com/JS123524/2D-Resource-Competition-Simulation