Nash Ramblers Final Project Summary

Samuel Lindvall, Joel Mohrmann, Caleb Zatorski

Project Idea: Gold Mining

A Simple Treasure-hunting Scenario

Environment

- Environment will be a grid that will contain veins of gold with varying amounts and varying values.
- Every vein of gold on the map will have the same detection radius, which is the distance from the gold vein that an agent can sense the presence of one.
- The radii strength will take the form of an exponential decay function: $M=A*e\uparrow-d/2$
- Many agents will be exploring the environment and mining for gold simultaneously.

Agents

- Agents will be seeking to maximize their earnings from the environment, i.e., the amount of gold that they mine.
- All agents will have the ability to collaborate and work together if they choose. An agent who is an "owner" of a gold vein will offer the collaborating agent a cut of the profit from that gold vein.
- Agents cannot mine a vein that another agent is currently mining.
- Each agent will also have a level of stamina that allows them to continue moving on the map and mining. If an agent's stamina becomes depleted, they will have to rest in order to have it replenished.
- There will be two types of agents: risk-seeking and risk-averse. Risk-averse agents will be more likely to collaborate and will mine a vein until it is gone whereas risk-seeking agents will be less likely to collaborate and might abandon a vein for one that is worth more.

Emergent Behavior

- The emergent behavior is to observe how single agents can maximize their earnings. How do both luck and strategy contribute to an agent discovering the most gold in comparison to other agents in the same environment at the same time? What decisions do they make toward this end? Do they finish the vein they are working on or abandon it part of the way through to go to a nearby, seemingly stronger vein, not knowing how pure the gold is? Do they collaborate and ask for help from another agent on a dense gold vein? If they are not having success, do they offer to help someone else who has found a vein already? How long do they take to rest? They won't want to sit out too many rounds to miss out on opportunities, but they don't want to have to continually stop to rest because of low stamina levels. Which type of agent, either risk-averse or risk-taking will generally do better at accumulating the most earnings? Do different environments (in amount of gold, amount of agents, or detection radii) help favor one agent type over the other?

Hypotheses

- Low gold levels on the map:
  - We expect that the agents will finish mining quickly unless the veins prove to be too isolated and it takes agents a long time to find them. We also expect that only a few agents will receive substantial incomes while others may be mired in continual searching with low reward.
- High gold levels on the map:
  - We expect the mining to take a medium amount of time and for the earnings among agents to be fairly uniform as gold is readily available.

Hypotheses

- Few agents:
  - We expect the time taken to completely mine the gold to be high and the earnings distribution to be fairly unequal because agents will have to rely more on luck of detection than on collaboration.
  - However, agents may each get involved in their own veins and become isolated, making the income distribution fairly equal.
- Many agents:
  - We expect a fairly uniform structure to the process with high chances of collaboration between agents. Because of the abundance of agents and potential collaboration, the earnings should be fairly uniform, but the high number of agents may effectively "lock out" other agents from finding much gold and produce a system of poor and rich agents at the end.

Hypotheses

- Small detection radii:
  - We expect the scenario to behave similarly to the one for low amount of gold on the map, with it taking more time for agents to completely mine the gold as veins are isolated. We also expect it to produce uneven earnings among agents due to the fact that some may find little to no veins.
- Large detection radii:
  - We expect the time taken to mine the gold will be significantly lower because the detection of gold will be much easier, and earnings will be more uniform, but it could be the case that since detection is easier, some agents could take advantage better than others and be able to earn significantly more.

Experiments

- Experiments will involve varying each of these parameters in combination:

Gold Amount	Agents	Detection Radius
Low Density (25%)	Few (~15)	2 grid squares
Medium Density (50%)	Many (~30)	4 grid squares
High Density (80%)		6 grid squares

Local Decisions & Global Coherence

- Each agent makes **local decisions** based on maximizing its own gain in gold mining, and will choose where to mine and which agents to work with along the way.
- In taking these actions, the **global coherence** arises as agents are furthering the objective of "clearing the map," e.g., finding all of the treasure that is available to be found. The efficiency at which this occurs and he system of wealth that develops among the agents will be studied.