CMPSC 383
Multi-Agent and Robotic Systems
Spring 2015
Janyl Jumadinova

Lab 4
24 February 2015
Due Tuesday, 3 March by midnight

This laboratory assignment will be completed in groups of 2 or 3. You may choose your own team member(s), as long as your chosen team member was not your team member for lab 2 or 3.

Objectives

- Get practical experience with multi-agent learning interactions.
- Study an implementation of a realistic agent-based model.
- Learn to develop learning strategies used by agents.
- Observe and analyze collective agent behavior as a result of various agent learning strategies.
- Continue to build on the experimentation with agent modeling tool, Repast, and Eclipse IDE.

Rebellion Model Description

In this assignment you will experiment with the Rebellion Repast model, which was implemented by Grace Lin, and this implementation is provided for you through the course repository. This project models the rebellion of a subjugated population against a central authority. It is an adaptation of Joshua Epstein's model of civil violence (2002) - see his paper in the course repo for reference.

The Rebellion model consists of the police officers and the general population. The general population wanders around randomly. If their level of grievance against the central authority is high enough, and their perception of the risks involved is low enough, they openly rebel. A separate population of police officers ("cops"), acting on behalf of the central authority, seeks to suppress the rebellion. The cops wander around randomly and arrest people who are actively rebelling.

Each person in the general population can be in one of the three states:

- **active**: red color; person decides to rebel (see equations below for becoming an active person)
- **jailed**: black color; active person arrested by cops; remain in jail until jail term expires
- **quiet**: green color; neither active nor jailed

The cops (blue color) will randomly arrest active people within the visibility area. To become an active (rebel), the person calculates his/her level of grievance as follows:
`grievance = perceived hardship` $\times$ `(1 - government legitimacy)`.
The intuition behind this functional form is simple. If legitimacy is high, then hardship does not induce political grievance. Similarly, if people are suffering (high hardship), then the revelation of government corruption (low legitimacy) maybe expected to produce increased levels of grievance
Then the person calculates his/her arrest probability as:
`arrest probability = 1 - exp(-k` $\times$ `floor(num of cops / num of active people))`

Then the person rebels if `(grievance - risk aversion` × `arrest probability) > threshold` In the given implementation, the `perceived hardship = 1.0` (fixed for lifetime), `government legitimacy = between 0 and 1` (user specified), `k = constant`, set to 2.3. The constant `k` is set to ensure a plausible estimate (of `P = 0.9`) when `num of cops = 1` and `num of active people = 1`. `Risk aversion = 1.0` (fixed for lifetime), and `threshold = 0.1`.

Part 1

Explore the given Rebellion model, vary the parameters in the simulation (government legitimacy, cops and people initial density, visibility, jail term) and observe each outcome. As you run your experiments, save graphs from each output and analyze your results to answer the following questions:

1. If the government legitimacy is very high (close to 1), is the general population able to operate in peaceful coexistence (without cops)?
2. Describe what happens in the situations of corruption by reducing the legitimacy variable?
3. What is the effect of lessening of government oppression by reducing the number of cops?

Part 2

In the second part of the lab you will extend or add a learning component to either a cop agent or a general population agent. First of all, you should choose which agent's behavior you would like to modify. Secondly, you need to decide how you will either extend or add the learning behavior to that agent type. For example, if you choose to extend the rebellion agent, then you may decide to incorporate the reward structure, where the agent not only calculates its arrest probability based on cop and active agent population, but also gets rewarded based on the arrest probability and if it was active and did not caught. This type of agent then chooses to rebel or not based on which action gives it the highest reward. On the other hand, if you choose to modify the cop agent behavior, then you will need to change its random selection of active agents to a more smart behavior using some learning strategy (e.g. keeping track of the past active agents and its past location, and catching as many agents from that location without doing its random moving). These are just examples, you should incorporate your own learning behavior to your selected agent type. After you have implemented the learning behavior, run some experiments and observe the changed behavior of the model.

Required Deliverables

For this assignment please submit electronic versions of the following deliverables to your Bitbucket repository:

1. A properly commented and formatted version of your final `Rebellion` project.
2. Outputs (graphs) from running experiments in part 1 and part 2 of the assignment.
3. The documentation describing the answers to the questions posed in part 1, the specific details of the learning strategy you have decided to implement (justify what makes it learning) and your analysis of the performance of your strategies. Also comment on the biggest learning take aways from this assignment and any challenges that you have encountered.

Grading Distribution

40% Source code with the complete implementation of the new learning strategy.

60% Documentation with the analysis of the model and graphs for part 1, a description and justification of your implementation, and analysis of the results and the graphs for part 2.