CITS 3001 - 2022

Project: A game on operations in the information environment

Due Date: 13th October

Implementation: Java or Python

Game Scenario

There are four teams involved: Red, Blue, Green and Grey.

The scenario has been deliberately designed to represent the uneven playing field of the contested environment between the various teams. The scenario highlights the vulnerabilities of blue team in the contested information environment. The concept of blue and red teams is prevalent in cybersecurity related serious games or wargames. If you wish to get some background knowledge about the functioning of teams, you can read this article: https://csrc.nist.gov/glossary/term/red_team_blue_team_approach. However, this game is not related to cyber security, rather we are modelling the information environment in a country.

Red and **Blue** teams are the major geopolitical players in this fictitious country.

Red team is seeking geopolitical influence over Blue team. Of particular interest to Red team is influence over Green population and the Government. Blue is seeking to resist the Red teams growing influence in the country, and promote democratic government in the **Green** country.

A key challenge faced by the **Blue team**, that will become apparent in the exercise, is that their democratic values are leveraged against them. They are vulnerable to some forms of manipulation, yet their rules-of-engagement do not allow them to respond in equal measure: there are key limitations in the ways in which they respond and engage in this unique battlespace. The Blue team is bound by legal and ethical restraints such as free media, freedom of expression, freedom of speech.

The **Green team** lacks a diverse media sector, it is confused and there is a wide range of foreign news broadcasting agencies Green's population has subscribed to. ~~The Green population suffers from poor internet literacy, and the internet literacy can be modelled via pareto distribution. The government lacks resources to launch a decisive response to foreign influence operations and a lack of capability to discover, track and disrupt foreign influence activity.~~ This was background information and the description of the agents that was provided to you does not entail implementing this. However, if you want to make use of this information, you can do so

The **Red team**, an authoritarian state actor, has a range of instruments, tactics and techniques in its arsenal to run influence operations. The Green government can block websites and social media platforms and censor news coverage to its domestic population whilst maintaining the capability to run sophisticated foreign influence operations through social media.

The **Grey team** constitutes foreign actors and their loyalties are not known.

Election day is approaching and the Red team wants to keep people from voting.

Population Model:

An underlying network model that defines the probability of nodes interacting with each other. The majority of the nodes, over 90%, will belong to green team and they depict the population of the country. A small percentage will be grey and there will be one red and one blue agent. At the beginning, grey nodes are not part of the network.

Let G=(n,p), where G is the graph depicting the green network, n is the number of green nodes and p is the probability of an edge.

Agents have an opinion *(X)* and uncertainty *(U)* associated. In every simulation, round nodes will interact with each other and affect each others' opinions. The more uncertain an agent is, the more likely their opinion would change.

The uncertainty scale is [-1,1], however, if that scale is not easy to create a mental model, you can either flip the values or create a (0,1] scale for implementation. Please state your assumptions in the report.

For instance, two green nodes *i and k* have the following opinions and uncertainties:

$x_i = 1$ and $u_i = 0.2$ (meaning i wants to vote)

$x_k = 0$ and $u_k = -0.2$. (meaning k does not want to vote)

i *interacts with* k

Is $u_k < u_i$? Yes. Since uncertainty of k is less than that of i's, the new values will be as follows:

$x_i = 0$ and $u_i = ?$ (i's opinion has changed to not vote, but you need to think of a clever way to have a new uncertainty value here)

$x_k = 0$ and $u_k = -0.2$ (nothing will change there)

The probability of interaction is not uniform across all nodes. Some nodes (for instance those in a household), may have a higher probability to interact. You need to start with a simple graph and you can still finish the project with good marks, provided all the other features are working. If you implement complicated graphs such as the one described in the red text, you can score higher points. However, do not get stuck in this part. You can even use the graph provided to you in under the project link on LMS.

How teams are going to take turns:

Teams are going to take turns one by one.

1. Red Team: You need to create function where red team (only 1 agent) is able to interact with all members of the green team. The agent affects the opinions and uncertainty of the green team during the interaction. The catch is that you need to select from **5 levels of potent messaging (after class discussions we decided that it does not have to be 5 discrete levels. If you like, you can model this as a real number)**.

   The potency of the message can also be treated as uncertainty/certainity. I leave it up to the students how they would like to perceive potency and uncertainty.

If the red team decides to disseminate a potent message, during the interaction round, the uncertainty variable of the red team will assume a high value. A highly potent message may result in losing followers i.e., as compared to the last round fewer green team members will be able to interact with the red team agent. However, a potent message may decrease the uncertainty of opinion among people who are already under the influence of the red team (meaning they are sceptical about casting a vote). You need to come up with intelligent equations so that red team improves the certainty of opinion in green agents, but at the same time does not lose too many green agents. Think of it as a media channel trying to sell their narrative to people. However, if they may big, claim, lie too much, they might lose some neutral followers which they could indoctrinate with time.

2. Blue Team: Similarly, blue team can push a counter-narrative and interact with green team members. However, if they invest too much by interacting with a high certainty, they lose their "energy level". If they expend all their energy, the game will end. You need to model this in way that the game keeps going on while the blue team is changing the opinion of the green team members. Blue team also has an option to let a grey agent in the green network. That agent can be thought of as a life line, where blue team gets another chance of interaction without losing "energy". However, the grey agent can be a spy from the red team and in that case, there will be a round of an inorganic misinformation campaign. In simple words, grey spy can push a potent message, without making the red team lose followers.

Which things the students have to implement at the minimum

1. Implementing a green network where the nodes can interact
2. Implement one red, one blue and some grey agents
3. Every team (red, blue, green) takes a turn, one after another. You can start from any team.
4. Every agent has an opinion and uncertainty
5. An interaction function that determines the change in opinion and uncertainity
6. An implementation that caters for the Effect on the number of followers after red agent interacts with the green agents
7. An implementation that caters for the Effect on the life-line when the blue agent interacts with the green agents
8. An implementation where the blue agent can choose between inviting a grey agent or taking a normal turn
9. Implementation of grey agent: 1) if grey is a spy, it can act like a red agent without losing followers, 2) if it is an ally of blue, blue can take its turn, without losing an lifeline.
10. Human vs. computer play is possible, i.e., red/blue agent can be a human.
11. Some logical modelling of the agents that students can describe in the report
12. Possibility to pass parameters at the beginning of the game, e.g., percentage of grey nodes, starting uncertainties, percentage of nodes that want to vote and others described in earlier.

Students can be creative in their implementation regarding various aspects, e.g., but not limited to:

1. Green network creation/ updation
2. Weights on the links in the green network
3. Selecting an uncertainty (or potency) of red/blue nodes
4. Updating uncertainty of the affected node, after an interaction
5. Visualisation
6. Implementation language either python or java
7. Object Oriented or functional
8. Modeling of the agents i.e., how to make them intelligent

Q. Is this a scenario with full knowledge or hidden knowledge?
Q How much information do the red and blue agent know about the green agents?

Answer: The red and blue agents know the opinion of the green agents (i.e. the total number of agents who want to/do not want to vote.) but not their uncertainties. From that perspective the knowledge about the system is incomplete.

Q. Does the red/blue agent know exactly what opinions and uncertainties the green agents have? And the connections?

Answer: No, the red and blue agents do not know that

Q. Does the red agent know just the opinions of green agents?

Answer: Yes.

Q. Similarly, what do grey agents know?

Answer: Grey agents are also aware of the opinions of the green agents i.e. the total number of agents who want to/do not want to vote.

With the probabilities of connections between green nodes in the graph:

Q. Does this only affect the initial generation of the graph, and then the graph remains static after that?

Answer: In the base case, the graph will remain static once it is generated. However, if the design of AI technology of a group requires changing connections in the graph once the game has started, they can do so.
Interaction in the green network: The possibility of interaction is only allowed between nodes that have connections. However if your AI technology requires putting weights on the connections or associating probabilities of interaction, you can do that.

Rubric:

Criteria	Excellent	Good	Satisfactory	Inadequate	Comments	Max Marks
Selection and design of appropriate AI technology	Good choice of design, with clear explanation and complete justification	Suitable choice of design with clear explanation and some justification	Suitable design chosen and explained, but justification lacking	Design is unsuitable, or not clearly explained.		10pts
Validation of Agent, including answers to the questions	Comprehensive tests, with insightful metrics	Good coverage of performance and complexity.	Some tests given, but results inconclusive or incomplete	Few or no tests, or no meaningful metrics used.		20pts
Implementation of agent	Complete and correct implementation with best practice data structures used.	Complete and well formatted code with suitable data structures	Mostly correct code with adequate data structures and algorithms	Not formatted or incomprehensible code, with flawed data structure choice		10pts
Agent Design	Best practise data structures	Best practise data	Sound choice of data structures and	Substandard data structures and		10 pts

	and algorithms, challenging, non- trivial code and ability to learn strategies from the past simulations	structures and algorithms,	algorithms, pragmatic design decisions	algorithms, or trivial basic code.		
Performance of Agent when playing with a human	Runs and performs at an excellent level with challenging play	Runs and generates realistic strategic play	Runs with some non-trivial strategic play	Does not run or trivial strategy		10 pts
Extra credit	Excellent Visualisation on a grid, along with current parameters	Good visualisation and display of parameters	Weak attempt at visualisation/display of parameters	Not a satisfactory attempt at visualisation or display of parameters		10pts

Input:

In order to run automatic simulations you only need the following inputs:

1. Number of agents in the green team and probability of connections (n,p)
2. Number of agents in the grey team and proportion of agents who are spies from the red team
3. Uncertainty interval (e.g, a tight interval such as [-0.1, 0.1], or a broad interval such as [-0.5, 0.5]). To make it simple, the more positive a value is the more uncertain the agent is and the more negative the value is the more certain the agent is.
4. Percentage of agents (green) who want to vote in the election, at the start of the game.

In order to learn more about your agents, you can run multiple simulations on varying parameters and analyse the results.

For a human to play as a red or a blue agent, you need to display a list of options to the player at their turn. For a blue agent, the options will consist of a) - 10 correction messages (Please come up with some fictitious messages), uncertainty value and associated energy loss, b) a choice to introduce a grey agent in the game play. For a red agent, the options will consist of a) - 10 pieces of misinformation (Please come up with some fictitious messages), uncertainty value and followers loss.

Output:

- Working Code
- Snap shot of all parameters at any given time, should we desire to have a look.
- An approximately 3000 words essay describing your game, addressing the rubric and explicitly answering the following questions:

1. How does the game change if you have a *tight* uncertainty interval at the beginning of the game?
2. How does the game change if you have a *broad* uncertainty interval at the beginning of the game?
3. ~~What effect a zero uncertainty has on the game play.~~

Plot distribution of uncertainties for each of the above question.

4. In order for the Red agent to win (i.e., a higher number of green agents with opinion “not vote”, and an uncertainty less than 0 (which means they are pretty certain about their choice)), what is the best strategy?
    a. Discuss and show with simulation results how many rounds red agent needs in order to win?
5. In order for the Blue agent to win (i.e., a higher number of green agents with opinion “vote”, and an uncertainty less than 0 (which means they are pretty certain about their choice)), what is the best strategy?
    a. Discuss and show with simulation results how many rounds blue agent needs in order to win?
    b. What impact did grey agents have on the simulation?