Imperial College London -- Department of Electrical & Electronic Engineering

ELEC97105: Self-Organising Multi-Agent Systems (SOMAS) – Assessment

Assigned: October 2022 **Submission for Assessment: 16 December 2022**

Escape the Dark Pit(t)

Aims

The aim of the SOMAS Assessed Coursework is to specify, design and implement a self-organising multi-agent system that can solve a large(ish)-scale, long(ish)-term, inter-dependent collective action problem, using a range of techniques that have been presented in the lectures.

Scenario

It is medieval times. For reasons that are not obvious to them, or anyone else, (there was absolutely no evidence, it was a clear travesty of justice, etc. etc. etc.), a bunch of *N* radical and rebellious peasants with all sorts of dangerous Marxist ideas about the self-organisation of the proletariat, but all previously unknown to each other, have been thrown into a cell on the bottom level of a deep, dark pit. However, for reasons that are equally not obvious (lockdown memory, getting on a bit, etc. etc. etc.), the gaoler has generously left the cell doors unlocked some initial equipment, giving the peasants a chance to escape.

However, each level of the pit is guarded by some mythical Perilous Beast of differing resilience, viciousness, disruptive ability, and stash. Each one will have to be overcome in mortal combat for a successful escape. However, the Perilous Beasts are nothing if not fair, and will cheerfully do the crossword while allowing the peasants enough time to self-organise before combat occurs.

Furthermore, only if *M* peasants ($M \leq N$) escape the pit will they have sufficient numerical superiority to lead a glorious rebellion establishing the Peasant's Democratic Republic etc. etc. etc. The objective of the peasants is therefore: to "win", individually, by escaping the pit as healthily as possible; and to "survive", collectively, by ensuring enough peasants escape to lead the rebellion.

Rules of the Game *(Note these rules are optional and can, within reason, be changed.)*

Each peasant starts on level 1, with 4 properties, health points (*HP*), action points (*AP*), attack strength (*AT*), and shield value (*SH*). It may or may not be known how deep Level 1 is.

As the peasants ascend, on each new level, they encounter a Perilous Beast with *X* resilience and *Y* damage potential. Combat occurs, which proceeds in a series of rounds.

Optionally, before each round of combat, the peasants may negotiate amongst themselves what action each one will choose. This may be negotiated at the time, or the peasants might follow some previously agreed rules, or they might have a leader who assigns actions, etc...

Then, each peasant must choose an action, either:

- Cower, forgetting that their colleagues are being turned into chutney, in which case they recover 1 Health Point; or
- Fight, in which case they must decide how many of their action points they use for attack and defence, subject to $AP \geq AT + SH$ (note that a peasant may have an attack or defence

s/he cannot use because s/he does not have enough *AP*, and may be too weak to use all her/his *AP* because s/he does not have enough *AT* + *SH*).

At the end of each round, the peasants $p_1, \ldots, p_n$ who chose to fight do the sum of $AT(p_i)$ ($1 \leq i \leq n$) damage to the resilience of Perilous Beast, which is killed if its resilience is less than or equal to zero. If not, the Perilous Beast inflicts *Y* minus the sum of $SH(p_i)$ ($1 \leq i \leq n$) damage divided equally amongst each of the peasants who fought; it might also apply its disruptive ability which may adversely affect *HP*, *AP*, *AT* or *SH* (e.g. current value or max value) of a combatant.

If no-one fights, then all the peasants suffer *Y* damage (distributed evenly).

Combat continues for either a certain number of rounds or the Perilous Beast is slain (vanquished) and the peasants win, or all the peasants have been brutally dismembered (or survivors < *M*).

At the end of combat, if the peasants win, they can loot the Perilous Beast's stash, and may find items which can recover *HP*, or increase (temporarily or permanently) *AP*, *AT* or *SH*. It is up to the peasants to decide a system of distributive justice which allocates the rewards to the peasants (e.g. according to need, to merit, etc.).

Finally, before ascending to the next level, the peasants may trade items, propose and decide rules about combat, or contribute HP to a "hp-gift pool". On ascending to the next level, if the hp-gift pool is greater than the Perilous Beast's resilience, the Perilous Beast allows the peasants to pass without combat, and will even gift the peasants some of their stash.

Process

This is a full class exercise and requires everyone to be involved in the analysis, specification, design, implementation and experimental simulation. You must organise yourselves into teams. Each team will implement an agent framework, instantiate a number of agents based on that framework, and encode a strategy for playing the game. Each must contribute to group tasks, including technical (e.g. specifying protocols and APIs, implementing common platform, etc.) procedural (e.g. defining environmental parameters and 'game' rules), and organisational (meetings, minutes, project wiki, etc.). You must decide collectively amongst yourselves what programming language to use and which tasks you each will do, although every team should participate in platform implementation and implement an agent.

Requirements and Assessment

Students will be evaluated on 5 criteria: Management, Technical Achievement, Demonstration, Presentation and Written Report. Credit will be given according to will be a group component, which will be relative to overall contribution, and an individual component, which will be relative to personal contribution. There will also be some element of self-assessment. Particular credit will be given to use of ideas presented in the lectures to solve the problem.

Deadline for all components will be at the end of the Autumn Term (subject to negotiation).

Recommendation

Define the rules of the game. Design and build an MVP (Minimum Viable Platform) for that game by 11th November (when lectures finish). Decide a baseline for the scenario and a default agent strategy, which in the first instance could be entirely random. This will establish a benchmark for both average utility and average "life expectancy". The questions then are whether mechanisms such as communication (however limited between levels), memories of past encounters, economies based on esteem and reciprocity, learning, common-pool resource management, collective risk, and self-organised governance can be deployed to improve on the benchmark.