Agents and Multi Agent Systems

Tragedy of the commons

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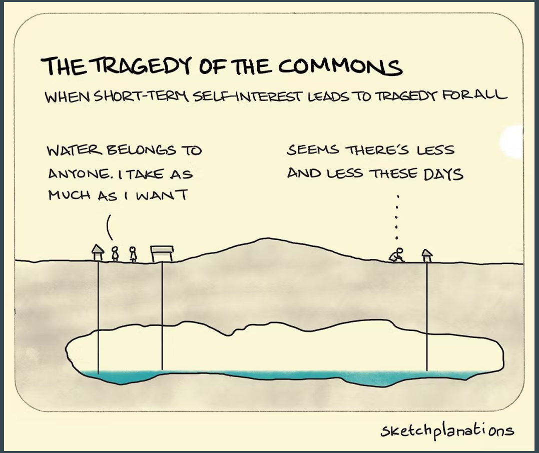
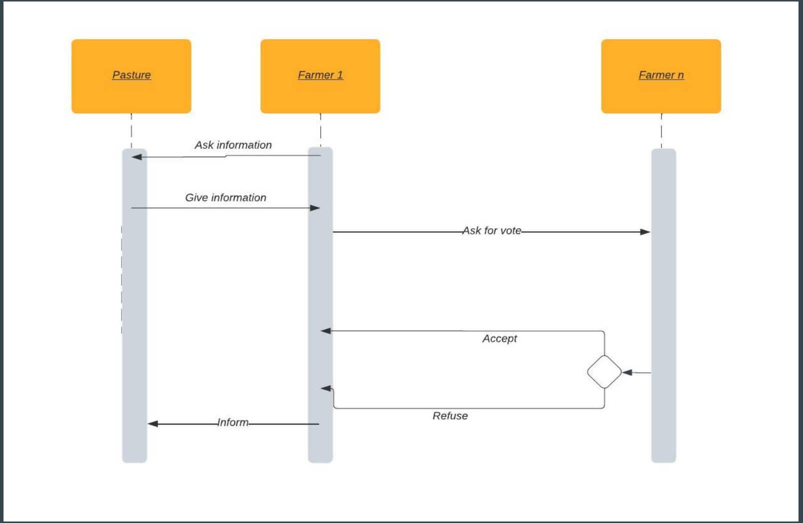
Problem Description

- Based on the original tragedy of the commons
- Farmers want to have the most cows possible to maximize profit
- Pasture is a shared resource
- If there are too many cows in the pasture, its health degrades and they may die
- Possible solution? -> Decision to add new cows is vote-based


THE TRAGEDY OF THE COMMONS
WHEN SHORT-TERM SELF-INTEREST LEADS TO TRAGEDY FOR ALL
WATER BELONGS TO ANYONE. I TAKE AS MUCH AS I WANT
SEEMS THERE'S LESS AND LESS THESE DAYS
sketchplanations

Global view

- Distributed: all agents are in the same level of the hierarchy
- Agents:
  - Farmer - Each farmer has a certain number of cows and communicates with other farmers and the pasture to get more
  - Pasture - Keeps track of the number of the pasture health, the number of cows and how they relate
- Behaviours:
  - InitiateVotebehaviour
  - ReceiveVoteBehaviour
  - PastureBehaviour



Variables

Independent Variables:

- Number of farmers
- Pasture health decay
- Cow health decrease rate
- Personality

Dependent Variables:

- Number of cows per farmer
- Cows health
- Pasture health

Interaction

1. Farmer agent wants to initiate a vote to add a new cow
2. Farmer agent asks the pasture for its information about health and number of cows
3. Farmer agent sends this information to other farmers and asks for them to vote based on this
4. Other farmers send yes/no based on their personality
5. Farmer agent checks if all the votes are sent, if they are he counts them. The majority vote decides the decision
6. Farmer agent sends decision to pasture

Farmer agent - Architecture

- Setup:
    - Registers agent in yellow pages and gets personality assigned
- Initiate vote behaviour:
    - Behaviour responsible for starting a new vote.
    - Runs every x seconds.
    - Searches for pasture in yellow pages and asks for information.
- Receive vote behaviour:
    - Cyclic Behaviour that deals with all the interactions except starting the vote.
    - Depending on the personality the agents takes different actions when faced with the decision to vote

Farmer agent - Strategies

4 different personalities that dictate how the agents behave:

- Greedy:
  - Advocates for pasture exploitation, will accept the offer as long as the pasture health isn’t too low. It also takes slight into account how many cows the farmer starting the vote has.
- Adaptive:
  - Adaptive takes into account the pasture and the farmers needs, refuting most votes when the pasture is saturated or accepting most votes from people who own no cows.
- Regulated:
  - Regulated acts like adaptive, but more relaxed. It starts to refute votes when the pasture is mildly occupied or when farmers start to have a mildly number of cows.
- Cooperative:
  - Focus in penalizing people with a lot of cows and favoring people with few cows.

Pasture agent - Architecture

- Setup:
  - Registers agent in yellow pages

- Pasture behaviour
  - Waits for farmer request for status and sends the current health of the pasture and current number of cows
  - Waits for farmers to inform of new cow and proceeds to add it

Other mechanisms - Yellow pages

- Farmer agent that initializes vote needs to find all the other farmers and the pasture
- All the agents are registered in the Yellow pages
- Farmer agents are registered with service type farming
- Pasture is registered with service type provide-info
- Agent searches for Pasture to ask for information and for other Farmers when asking for vote
- List of farmer agents is always updated before a new vote starts

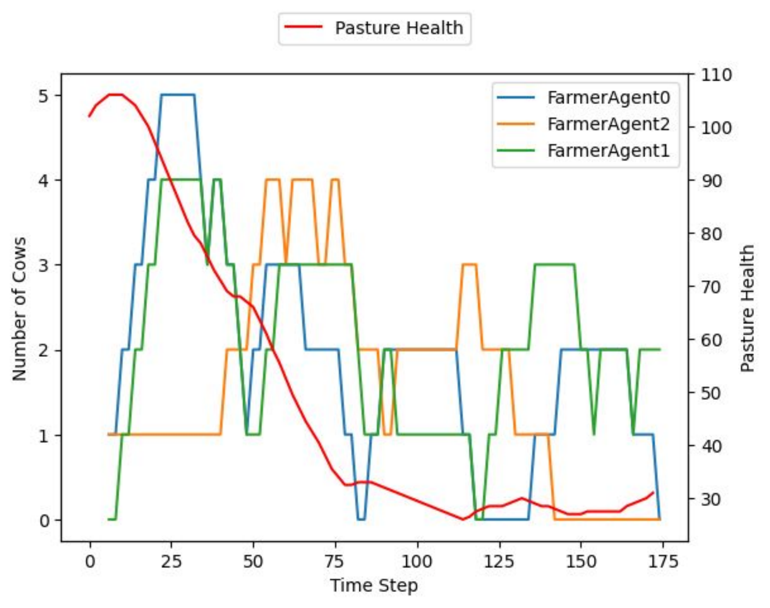
Experiments done & Results analysis

System Definition:

- 2 regulated and 1 greedy agent
- Variables definition (pasture health, pasture decaiment, cow's health, etc..)

Analysis:

- Starts by adding a lot of cows.
- Pasture health starts deteriorating fast.
- Cows start to die and new ones are not being added.
- Both pasture health and cows ownership start to stabilize.



Relation between pasture health and cow ownership

Conclusion

- Reaching equilibrium can be hard
- Small changes in parameters provoke a great change in the outcome of the system
- We can clearly visualize the effect of different strategies of agente in the evolution of the system.
- We believe the project we developed was simple but it encapsulated the important aspects of multi agent systems.

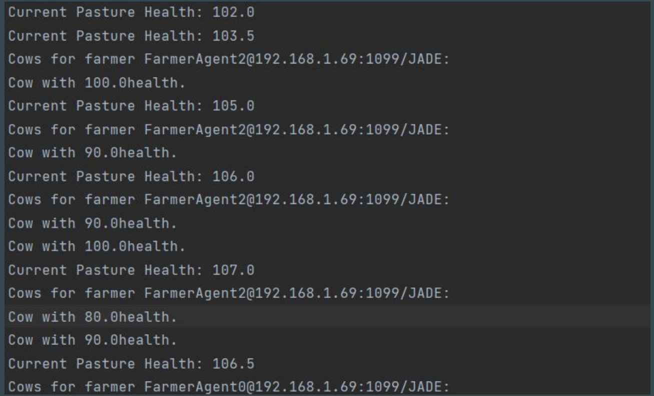
Future work

- Execute various simulation with different environment configurations
- Add different ways to influence votes like voting history

Additional Information

Running instructions

- To initiate execution is simply necessary to run the main class.
- All the values to the initial parameters are set on the Launch agents class
- The output.txt will keep records of the execution



```
Current Pasture Health: 102.0
Current Pasture Health: 103.5
Cows for farmer FarmerAgent2@192.168.1.69:1099/JADE:
Cow with 100.0health.
Current Pasture Health: 105.0
Cows for farmer FarmerAgent2@192.168.1.69:1099/JADE:
Cow with 90.0health.
Current Pasture Health: 106.0
Cows for farmer FarmerAgent2@192.168.1.69:1099/JADE:
Cow with 90.0health.
Cow with 100.0health.
Current Pasture Health: 107.0
Cows for farmer FarmerAgent2@192.168.1.69:1099/JADE:
Cow with 80.0health.
Cow with 90.0health.
Current Pasture Health: 106.5
Cows for farmer FarmerAgent0@192.168.1.69:1099/JADE:
```

Example of output.txt of last execution

Classes implemented

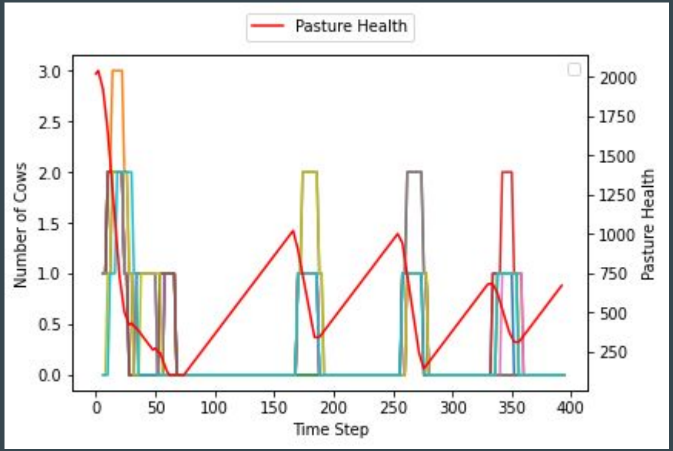
- **Pasture agent** - as explained previously manages the actions and attributes of the pasture
- **Farmer agent** - as explained previously manages the actions of the farmer
- **Cow** - manages cow information, mainly health
- **Launch Agents -** Initiates all the agents with the desired configurations
- **Receive vote behaviour -** as explained previously it manages the votes among Farmers
- **Pasture behaviour -** as mentioned previously it waits for farmer requests to manage the state of the pasture and give information about it

More Experiments

Systems with mixed agents

Systems definition (for all the experiments)

- 10 farmers.
- Votes start randomly.
- Cows lose health every 2 seconds.
- Pasture lose health every 2 seconds.

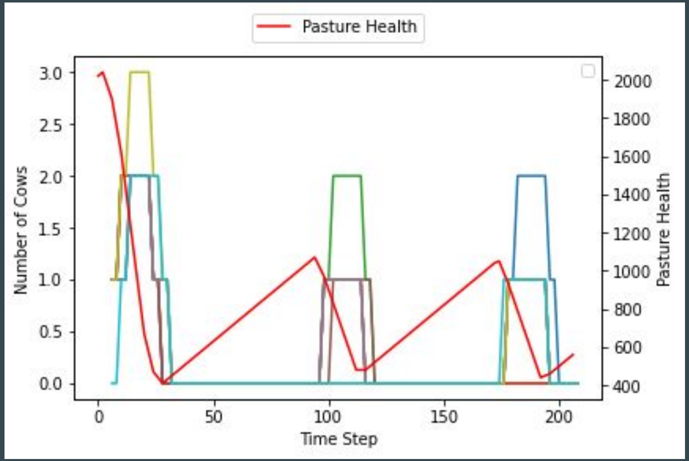


- Random personalities.
- At first, agents buy cows since pasture health is good.
- Health drops to low numbers, thus making agents buy less cows.
- Health never drops below 250.

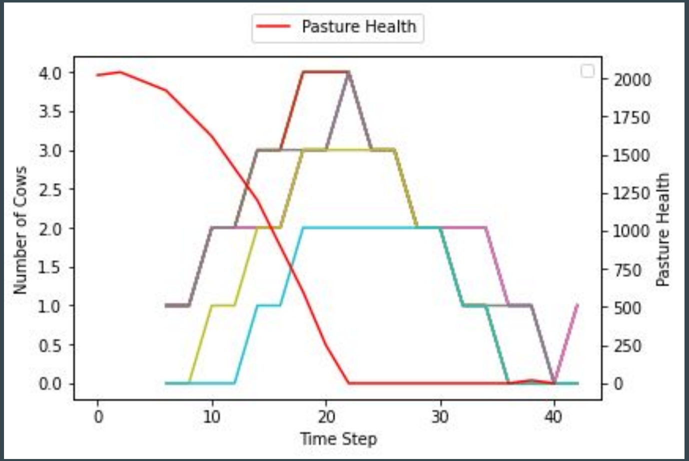
More Experiments

Systems with defined personalities

- System with 10 regulated agents.
- Pasture health is taken more into account (never goes under 400) rather than cows ownership.



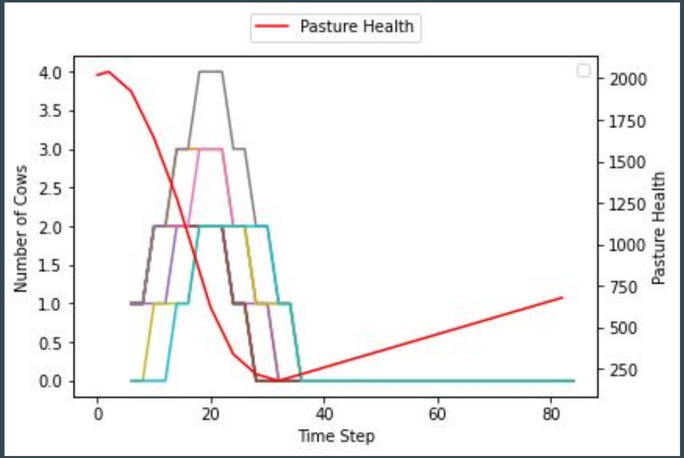
- System with 10 greedy agents.
- Pasture health isn't taking that much into account, thus completely destroying the pasture really early.



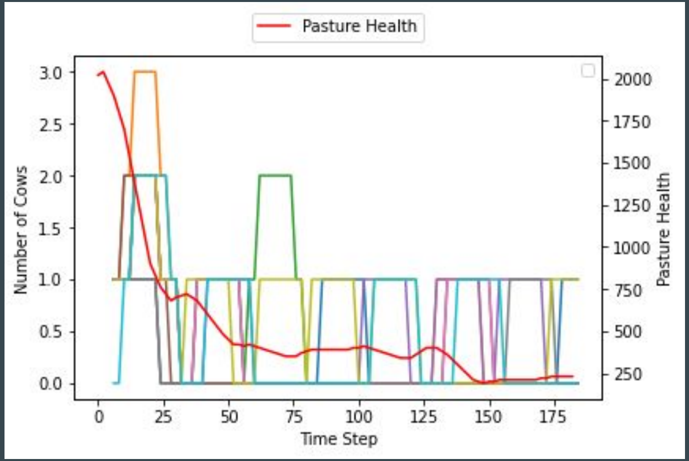
More Experiments

Systems with defined personalities

- System with 10 cooperative agents.
- By itself it doesn't sustain well, since it doesn't take pasture's health into account. Results similar to greedy.



- System with 10 adaptive agents.
- Needs are met - agents without a cow get one, agents with a cow get denied. Health never drops below 250.


Pasture Health
Number of Cows
Pasture Health
Time Step