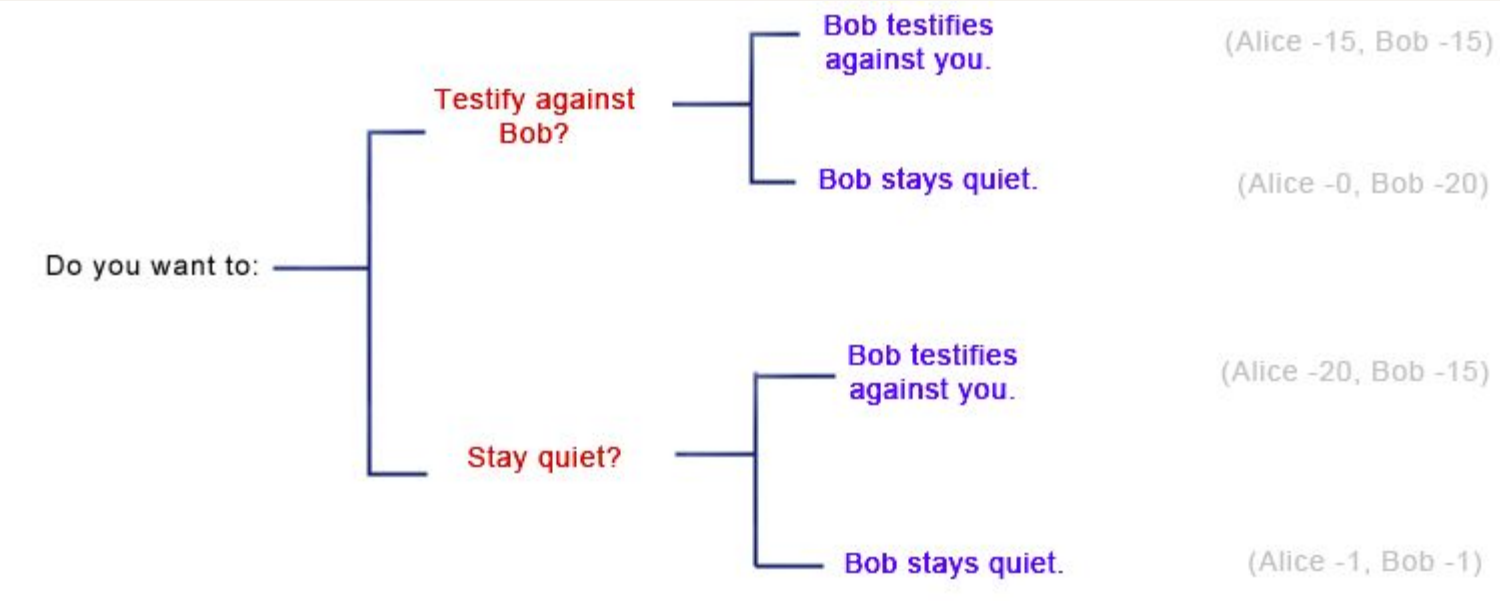
Genetic algorithms ft. Prisoners' dilemma

MAS Mandate 3

Intent of this mandate

To showcase something we found interesting and to correlate those concepts through simulations covering concepts discussed in class.

Prisoners' dilemma

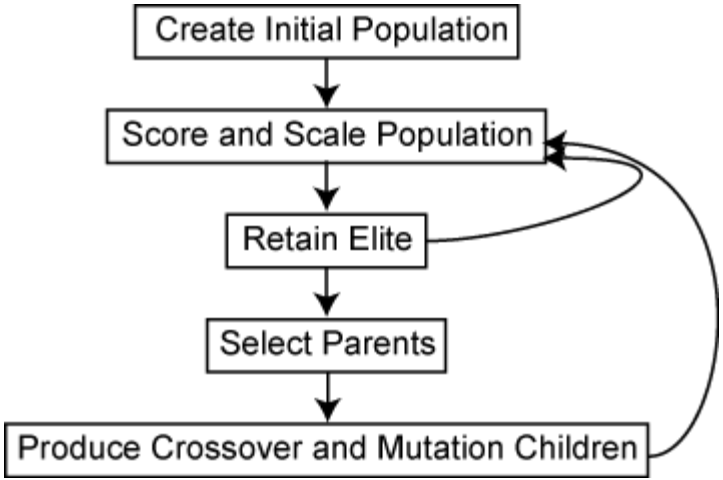

Do you want to:
Testify against Bob?
Bob testifies against you.
(Alice -15, Bob -15)
Bob stays quiet.
(Alice -0, Bob -20)
Stay quiet?
Bob testifies against you.
(Alice -20, Bob -15)
Bob stays quiet.
(Alice -1, Bob -1)

Prisoners' dilemma

```
# Score matrix represented as (agent, antagonist)
SCORE_MATRIX = {
    ('C', 'C'): (5, 5),
    ('C', 'D'): (0, 10),
    ('D', 'C'): (10, 0),
    ('D', 'D'): (3, 3)
}
```

Designation	Description
ALLC	Strategy always plays cooperation
ALLD	Strategy always plays defection
RAND	Strategy has a 50% probability to play cooperation or defection
GRIM	It starts with cooperation, but after the first defection of its opponent continues with defection
TFT	It starts with cooperation and then it copies the moves of the opponent
TFTT	As TFT but defects after two consecutive defections
STFT	As TFT but starts with defection
TTFT	As TFT but for each defection retaliates with two defections
Pavlov	Action results are divided into 2 groups, positive actions are T and R and negative actions are P and S - if the result of previous action belonged to the first group, action is repeated and if the result was in the second group, then the action was changed, it is also called win-stay, lose shift

Genetic algorithms



The genetic algorithm is a method for solving both constrained and unconstrained optimization problems that is based on natural selection, the process that drives biological evolution. The genetic algorithm repeatedly modifies a population of individual solutions.

Key elements of a genetic algorithm

- Genetic representation of a solution
- A function to generate new solutions
- Fitness function
- Selection function
- Crossover function
- Mutation function

Game theory and genetic algorithms

Hassan, et al.

We found that Game Theory is tightly related to Evolutionary Algorithms, especially Genetic Algorithm. Genetic Algorithm was mainly utilized for finding an absolute optimal strategy by virtually applying a game against a known strategy.

Code review + Results

Hyperparameters

N_EPISODES = 20_000

POPULATION_SIZE = 250

GENE_SIZE = 100

K = 25

```
P_MUTATION = 0.25
P_CROSSOVER = 0.75
```

References

- Introduction to PD: https://www.lesswrong.com/posts/QdXrkWoK2Pp6XhNuQ/introduction-to-prisoners-dilemma
- IPD strategies: https://www.semanticscholar.org/paper/A-review-of-iterated-prisoner%27s-dilemma-strategies-Jurisic-Kermek/e4334e8b798416bb58e335226d9f55779aeb33a3
- MAS slides: https://drive.google.com/file/d/1Xx8W2iKCDkJddiQnIOEze_1YxXd7e4Tq/view
- Introduction to genetic algorithms: https://in.mathworks.com/help/gads/what-is-the-genetic-algorithm.html
- Hassan, et al. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=5561648
- Genetic algorithms in Python: https://machinelearningmastery.com/simple-genetic-algorithm-from-scratch-in-python/
- Kai codes YT: https://www.youtube.com/watch?v=XP8R0yzAbdo

Thank you!

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