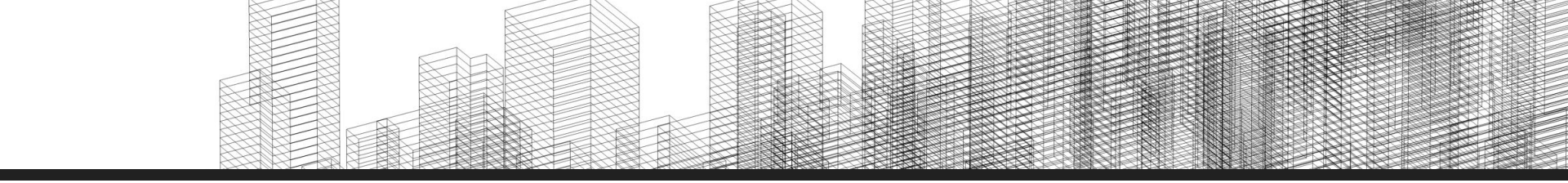

CS551 Project Presentation

iyibiAgent

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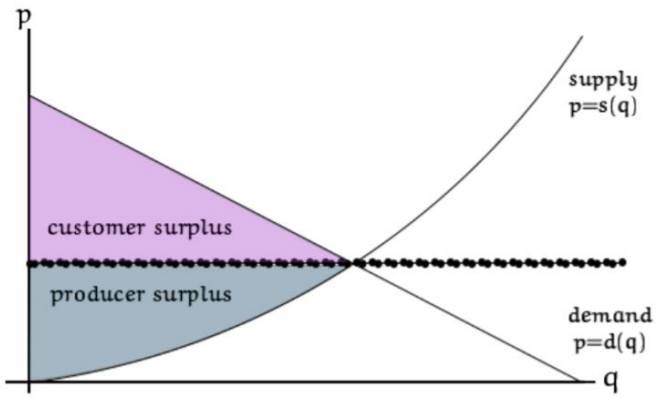
Outline

Problem Statement

- A novel agent, "iyibiAgent", for 2021 Supply Chain Management League (SCML-Standard)
- Factory manager
- Risk-averse agent, minimize its cost of production, keeps its negotiations at the minimum, JIT manufacturing.
- Use of economic surplus model in each transaction [1].
- Adjusts its price factor according to this adapted economic surplus model.



The Graph of Economic Surplus

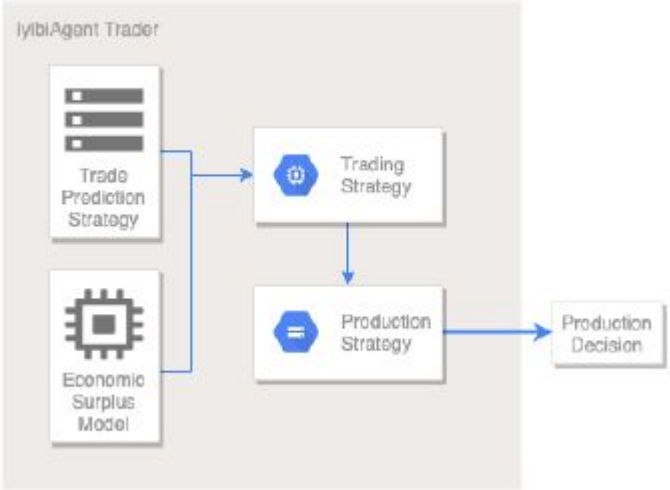
Outline

Production Strategy

- Inspired by the Just in Time manufacturing philosophy [2]
- Decision is made by finding whether the production of item is feasible until the given deadline. No excess production.
- Only demand is considered while producing an item.
  - DemandDrivenProductionStrategy
    - takes into account the demands during production.
- Production schedule using a prediction module.
- Looking demands for the next day, keeps the volume low.

Trading Strategy

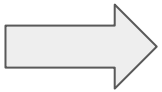
- Divides negotiation into 3 time-frames:
- Elicitation phase
  - first 20% of total steps / time
- Trading phase
  - between 20% to 80% of total steps / time
- Post-trading
  - last 20% of the total steps / time



Trading Strategy

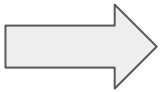
Elicitation Phase

- Tries to increase the market price of the items by accepting bids with high prices



Trading Phase

- Behaves market neutral
- Healthy price dynamics for its input and output
- Acts according to economic surplus mechanism



Post Trading Phase

- Aims to produce with a certain loss
- A loss aversion technique is implemented

Market Analysis

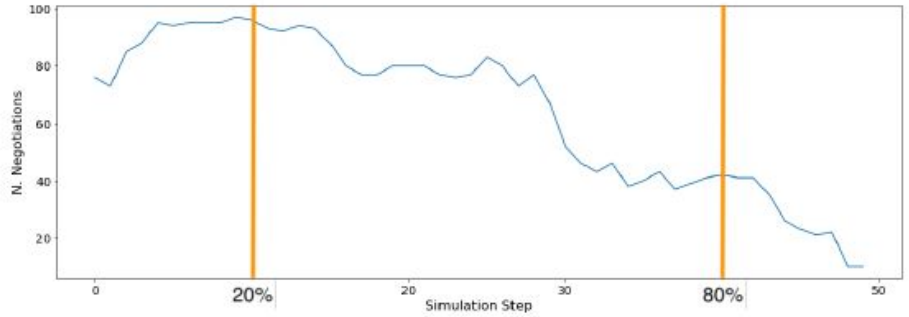


Figure 2: Number of negotiations at each step

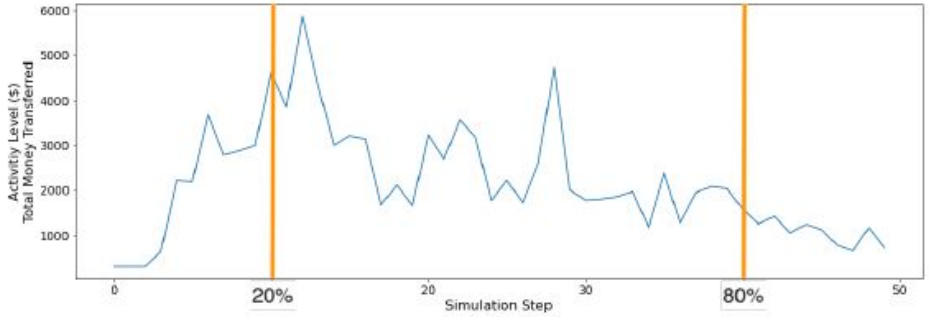


Figure 3: Market volume at each step

Trading Strategy

- Trading Pricing
  - Evolves around catalog price, determined by the progress of the negotiation and the trade prediction
- Economic Surplus
  - Increase/decrease the price with a dynamic ratio determined with ratio of bought/sold count if successful
  - Decrease/increase the price by 5% if the transaction is successful

Algorithm 1: Trading pricing mechanism

```
Data: contracts array
Result: buy/sell action
for contract in contracts do
    progress = current step / total steps;
    if sell contract then
        if unit price is less than max(progress, 0.8) * catalog price then
            cancel transaction;
    else if buy contract then
        if unit price is less than min(progress * 2, 1.2) * catalog price
         then
            cancel transaction;
    else
        continue with the transaction (truncated for brevity)
```

Algorithm 2: Economic Surplus mechanism

```
Data: contracts array
... output and input calculations omitted;
for contract in contracts do
    if seller surplus and sold count then
        increase acceptable output price in ratio with surplus amount;
    else
        decrease acceptable output price by 5%;
    if buyer surplus and bought count then
        decrease acceptable input cost in ratio with surplus amount;
    else
        increase acceptable input price by 5%;
```

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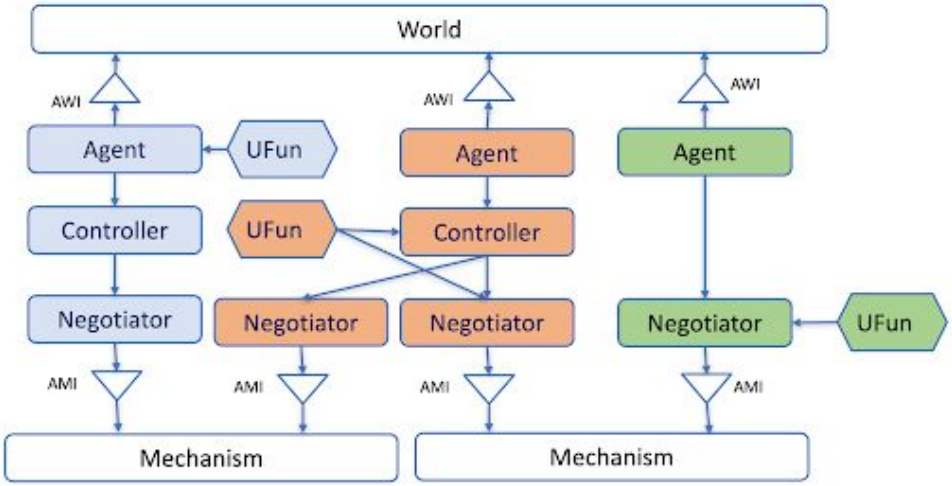
2. Agent Design and Negotiation Strategy
   - 2.1. Bidding Strategy
     - 2.1.1. Production Strategy
     - 2.1.2. Trading Strategy
   - **2.2. Negotiation & Negotiator**
   - 2.3. Acceptance Strategy
   - 2.4. Opponent Modelling & Learning Model
3. Evaluation
4. Conclusion & Future Work
5. References

Negotiation & Negotiator

- A modified version of StepNegotiationController module from NEGMas
- Opponent Model applied version of the NEGMas's AspirationNegotiator is used
- It takes a defined "aspiration" from bidding strategy and can be a simple time based conceder, boulware or simply linear.



Taken from http://www.yasserm.com/scml/scml2020docs/

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Acceptance Strategy

- A modified version of ACnext [3]
  - The condition of accepting when the opponent's last offer is better than the predicted offer of the agent.
- Finds the acceptable price by using economic surplus [1]
  - Linear Utility function takes from economic surplus.
    - Buyers utility function is designed to be >0
    - Sellers utility function is designed to be <0
- Target Quantity and Target Price are altered according to the current negotiation step due to the market analysis

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Opponent Modelling

- Keeps track of the past negotiations and analyzes them to label the opponent.
- A simple heuristic is used for prediction.
- All of their bids are taken and then combined to fit a linear curve according to the utilities of our agent’s bids.
- The slope of this curve is used in determining the type of the opponent.

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3. **Evaluation**
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Evaluation of our agent

Table 1: Statistics for the first 100 tournaments

	N	Mean	Std. Dev.	Min	1st Q.	Median	3rd Q.	Max
iyibiAgent	100	-0.0273	0.0168	-0.0757	-0.0381	-0.0257	-0.0757	0.0000
SavingAgent	100	-0.101	0.0515	-0.357	-0.132	-0.097	-0.357	-0.015
SteadyMgr	100	-0.0829	0.0568	-0.239	-0.1194	-0.0735	-0.2391	0.0000
MMM	100	-0.1107	0.0481	-0.2290	-0.1445	-0.1071	-0.2290	-0.0055

Table 2: Statistics for the second 100 tournaments

	N	Mean	Std. Dev.	Min	1st Q.	Median	3rd Q.	Max
iyibiAgent	100	-0.0263	0.0165	-0.0725	-0.0371	-0.0259	-0.0725	0.0000
ASMASH	100	-0.1150	0.0473	-0.2617	-0.141	-0.1076	-0.2617	-0.0074
BARGentCovid19	100	-0.0968	0.0462	-0.2180	-0.1207	-0.0927	-0.2180	-0.0034
Merchant	100	0.4797	0.6480	-0.3035	-0.0825	0.3349	-0.3035	3.4132

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Conclusion

- Our experiments show that iyibiAgent is able to outperform greedy competitors by adopting a more robust model which yields reasonable profits for any negotiation setup.

Future Work

- Build a better market awareness in our agent.
- Estimate the market phase using a time series model.
- An improvement in opponent modelling is needed.

References

- [1] R. Staneld, \A Revision of the Economic Surplus Concept,"
- Review of Radical Political Economics 6, 69, pp. 69{74, 1974.
- [2] JIT retrrieved from https://www.investopedia.com/terms/j/jit.asp
- [3] T. Baarslag, K. V. Hindriks, C. M. Jonker, Acceptance Condi-
- tions in Automated Negotiation, 2011.

Thank you for listening!