Analyzing children's interactions in a Repeated Prisoner's Dilemma Game

Final Presentation

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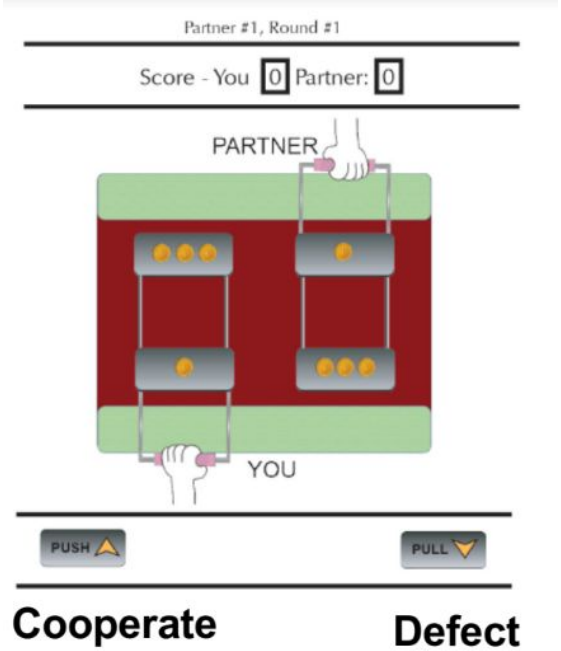
Objective

To study children's social interactions and understand what cognitive and social factors affect children's aggressive versus forgiving responses.

The prisoner's dilemma game

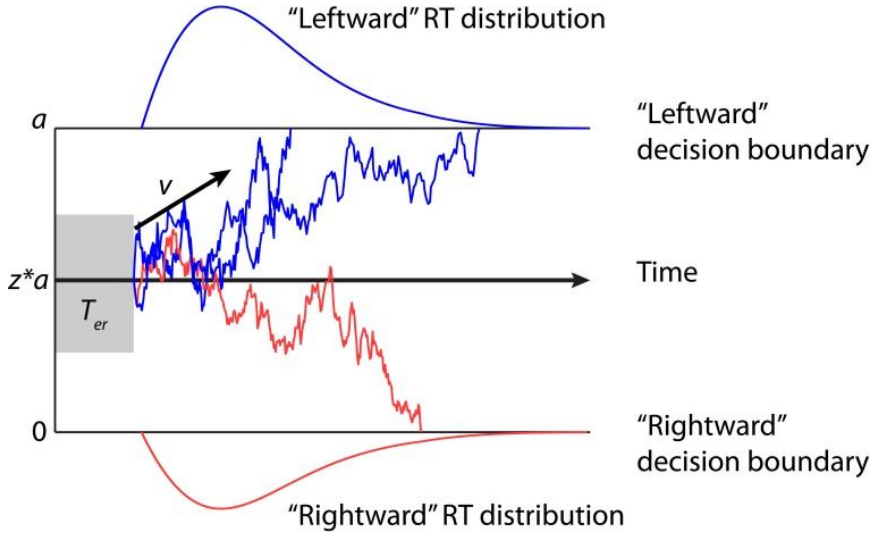
- 10 round game
- 3 types of pre-programmed partners:
  - Cooperative
    - Defects on rounds 3 and 7
  - Tit-for-tat
    - Cooperates in the 1st round and then just copies what the child did in the previous round.
  - Defecting
    - Cooperates on round 3 and 7



Moved away from Drift Diffusion Model

- Reaction times are much longer than 1000-1500 ms, which is the ideal range for the DDM

- The decisions made in this experiment are not one-step intuitive decisions but rather a process that requires reasoning and strategy planning



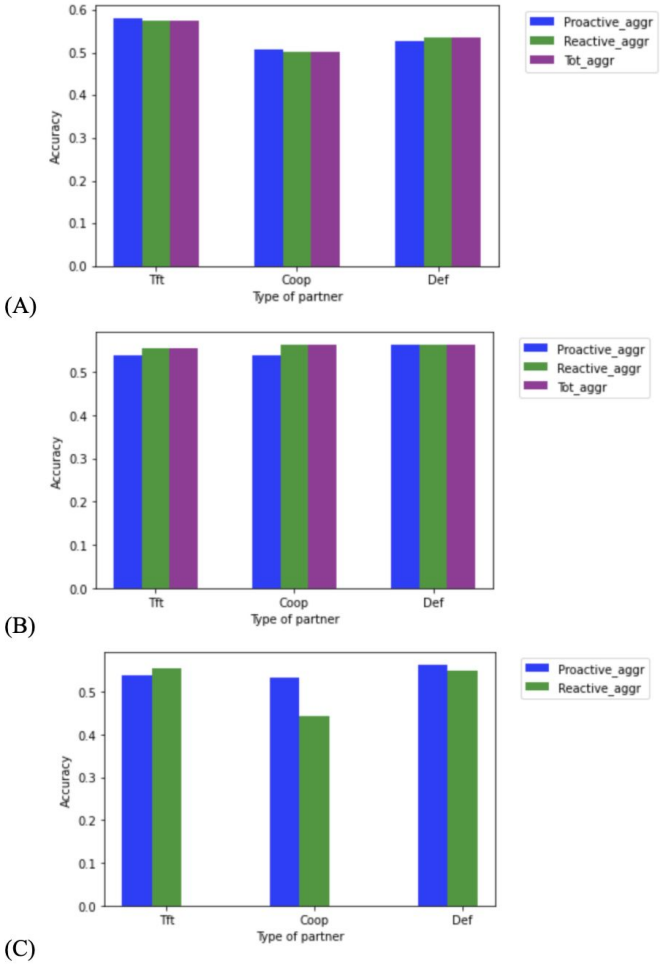
Models: Logistic Regression

I. We trained a logistic regression classifier to predict the aggression level (either above or below the median) of the children from their game decisions.

II. Accuracy calculated in five-fold cross validation experiments.

III. **Results:** Most trained classifiers had an accuracy between 0.5 and 0.6 (Figure 1).

- A. The classifier was trained using the kids' decisions from all 10 rounds.
- B. The classifier was trained using the kids' decisions from rounds 3 to 10.
- C. The classifier was trained using the kids' decisions on Round 3 and Round 7.

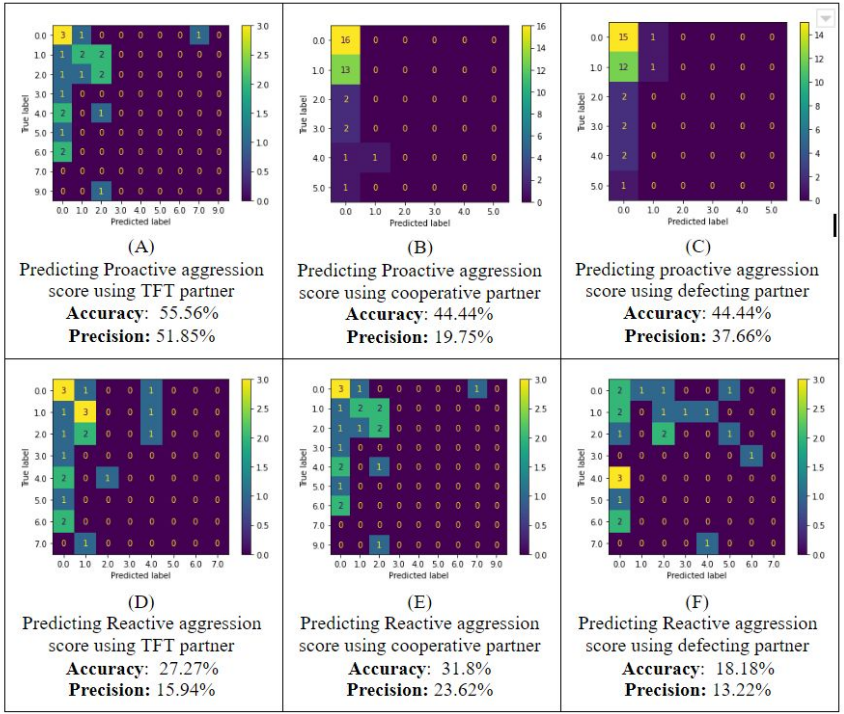


Models: Continuous Regression Methods

- We trained three continuous regression models to predict the continuous correlation between participant decisions and aggression scores
  - Support Vector Regression, Random Forest Regression, Linear Regression
  - No robust predictions were produced
  - Large overlap between all proactive or reactive aggression scores

Models: Naive Bayes

- Implemented a naive Bayes Classifier for Multivariate Bernoulli model to predict a child's proactive and reactive aggression score against all partners
- **Results:** precision score of 51.85% at most when trained to predict proactive aggression scores using a TFT partner



(A)
Predicting Proactive aggression score using TFT partner
Accuracy: 55.56%
Precision: 51.85%

(B)
Predicting Proactive aggression score using cooperative partner
Accuracy: 44.44%
Precision: 19.75%

(C)
Predicting proactive aggression score using defecting partner
Accuracy: 44.44%
Precision: 37.66%

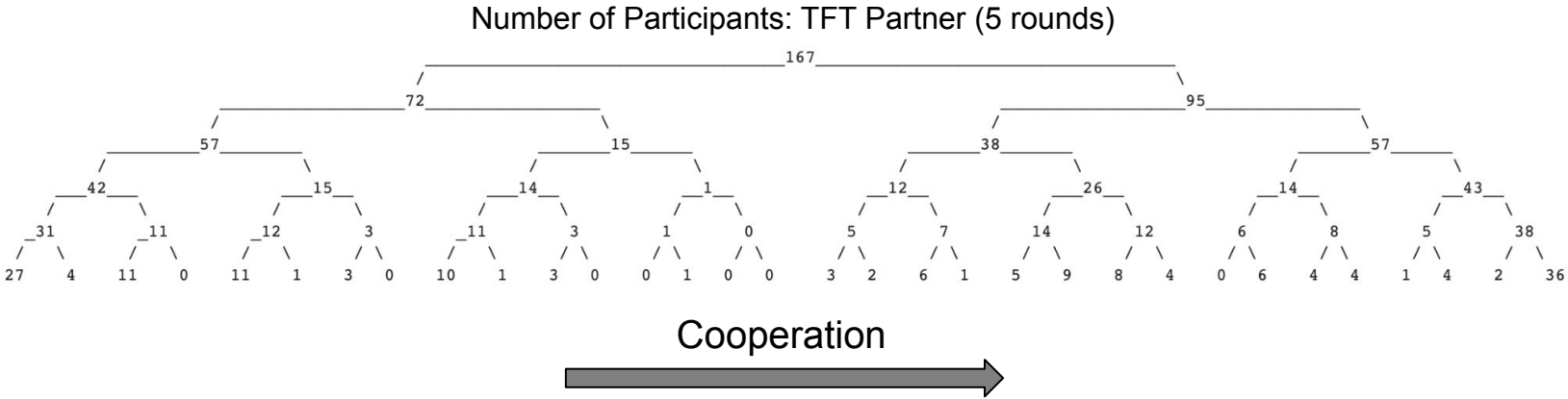
(D)
Predicting Reactive aggression score using TFT partner
Accuracy: 27.27%
Precision: 15.94%

(E)
Predicting Reactive aggression score using cooperative partner
Accuracy: 31.8%
Precision: 23.62%

(F)
Predicting Reactive aggression score using defecting partner
Accuracy: 18.18%
Precision: 13.22%

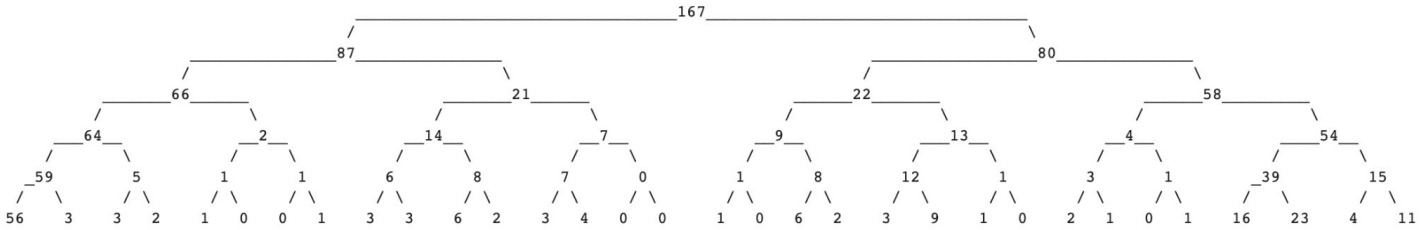
Decision Tree Visualization

- Visualization tool for identifying patterns in participant choice
  - Each node represents a distinct pattern of decisions
  - Visualizes number of players and likelihood of cooperation
  - Data at each node can be separated based on aggression



Cooperative Decision Tree

Number of Participants: Cooperative Partner (5 rounds)



	Path	Total Participants	Percent Cooperation	Low Aggression Participants	Low Aggression Percent Cooperation	High Aggression Participants	High Aggression Percent Cooperation
0	Start	167	0.479042	109	0.495413	58	0.448276
1	0	87	0.241379	55	0.254545	32	0.218750
2	1	80	0.725000	54	0.722222	26	0.730769
3	00	66	0.030303	41	0.024390	25	0.040000
4	01	21	0.333333	14	0.285714	7	0.428571
...	...	...	...	...	...	...	...
58	11011	1	0.000000	0	0.000000	1	0.000000
59	11100	16	0.437500	11	0.545455	5	0.200000
60	11101	23	0.826087	17	0.823529	6	0.833333
61	11110	4	0.250000	3	0.000000	1	1.000000
62	11111	11	0.454545	7	0.428571	4	0.500000

63 rows × 7 columns

Challenges along the way

Lack of technical knowledge on using:

-> Drift Diffusion Model

-> Bayesian Models

Limitations

1) Very small dataset ⟹ Difficult to train accurate models using the available data.
2) The Aggression scores obtained from the parent's questionnaire is based on the parent's impression and not formal evaluation. The scores are skewed towards lower scores with very few higher aggression scores in the dataset.

Next Steps

As data is still being collected, our models could be used later on the larger dataset which might show promising results.

If the reaction time is restricted to 1000-1500ms(ideal reaction times for Drift Diffusion Model) in the data that is currently being collected, then along with the models we have built, a DDM can also be used.

Some kind of aggression test for testing each kind of aggression can be designed as the aggression scores from Parent's Questionnaire that we have in the data seems biased(skewed towards lower scores) and not reliable.

References

[1] Ratcliff R and McKoon G (2008) The Diffusion Decision Model: Theory and Data for Two-Choice Decision Tasks. *Neural Comput.* 20: 873–922.
[2] Deng, X. and Deng, J (2015) A study of prisoner's dilemma game model with incomplete information. *Mathematical Problems in Engineering*, 1-10. doi:10.1155/2015/452042
[3] Lin B, Bouneffouf D, and Cecchi G (2020) Predicting Human Decision Making in Psychological Tasks with Recurrent Neural Networks. arXiv:2010.11413.