DSCI6003: Ultimatum Game

A machine learning approach to maximizing your earnings

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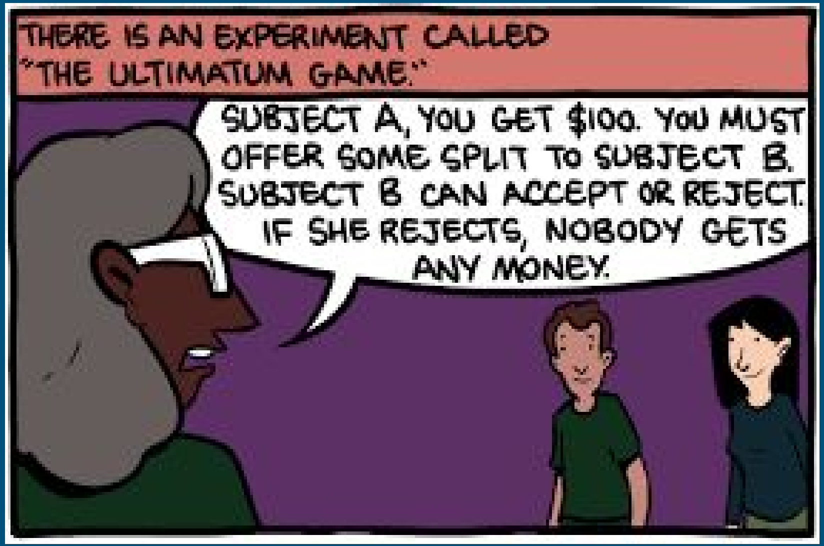
Overview

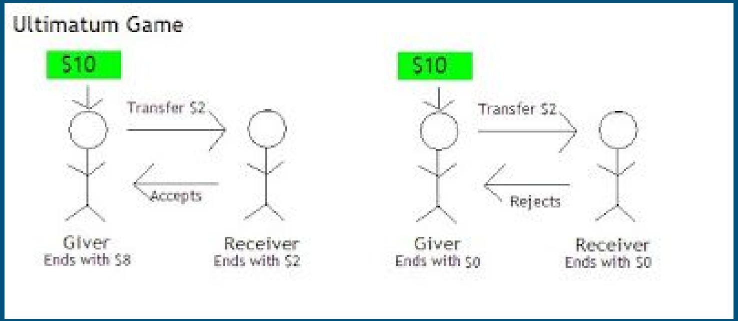
1) What is the ultimatum game?

2) What does the data look like?

3) How to maximize how much money we make?

Traditional Ultimatum Game





Empirical Results

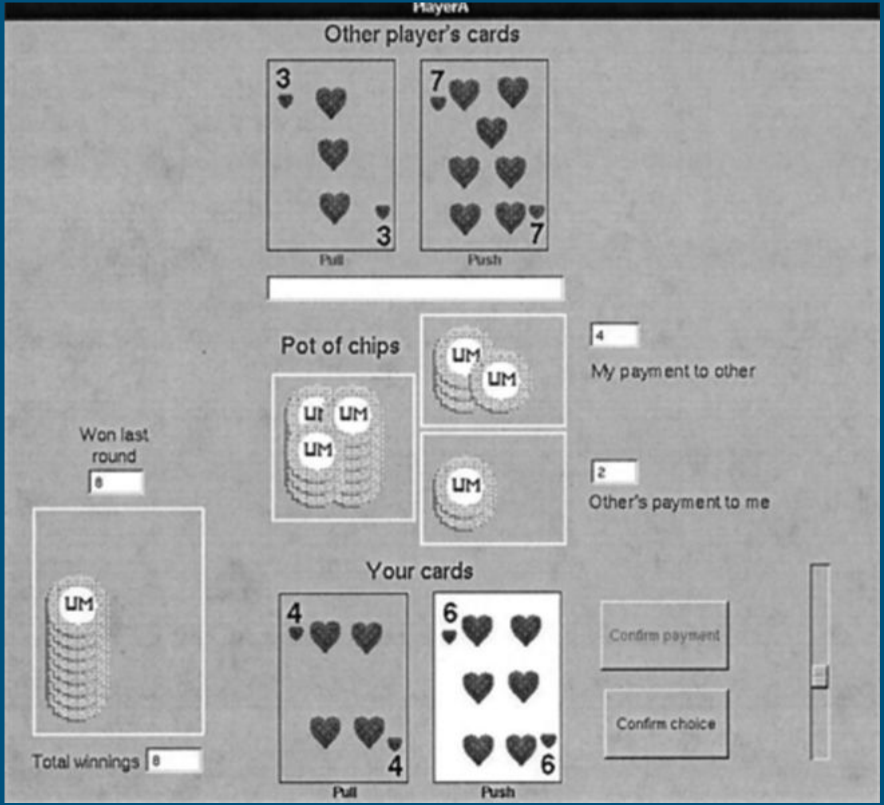
- Cooperation is very low (15-50%) even though nash equilibrium suggests responder should accept any offer.
- What is the accuracy for predicting our payoff playing this game?

Overview of game structure

1. Two rounds of experiments.
    - 1) First 15 rounds
        - Push : Give the other player money from the pot of money($6 or $7)
        - Pull : Take money from the pot ($3 or $4)
    - 2) Rounds past 15 allowed each player to make a side payment for the other to push
        - Typically offer between $1-$3 for other player to push
2. Three rounds of analysis
    - 1) Rounds without a side payment (rounds 1-15)
    - 2) Rounds with a side payment (rounds past 15)
    - 3) All rounds
3. Players played multiple rounds

Original Paper: http://www.pnas.org/content/96/19/10933.full

The experiment



The Data

- In total 1,920 rows. Each row was a full game experiment.
  - 720 without a side payment
  - 1200 with a side payment
- Features used (only use features available to you in the game).
  - Rd 1-15

	rd	myside	opptside	mypush	mypull	opptpush	opptpull	mychoice	mychoicecard	mypayoff	opptpayoff	totalpayoff
0	1	0	0	6	4	7	3	0	4	11	0	11
1	1	0	0	7	3	6	4	1	7	0	11	11

  - Past rd 15

	rd	myside	opptside	mypush	mypull	opptpush	opptpull	mychoice	mychoicecard	mypayoff	opptpayoff	totalpayoff
1915	40	4	3	6	4	7	3	0	4	7	4	11
1916	40	3	5	6	4	7	3	1	6	9	4	13

- Goal: Predict mypayoff

**Data was scaled for GLMnet due to binary choice for mychoice (0,1). All other features were in dollars.*

Algorithms Used

- Random Forest
- KNNregression
- Gradient Boosting
- Extreme Gradient Boosting
- GLM/Elastic Net

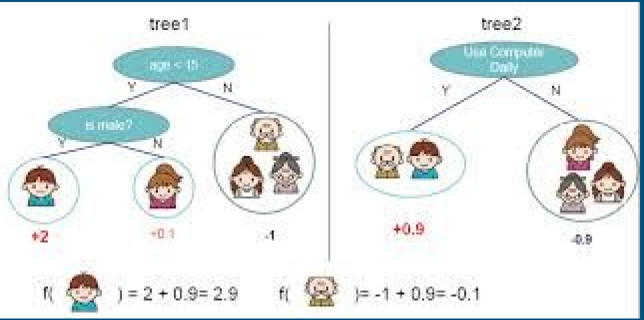
Ensembles

- Linear ensemble of all models
- GB ensemble of all models and all original features

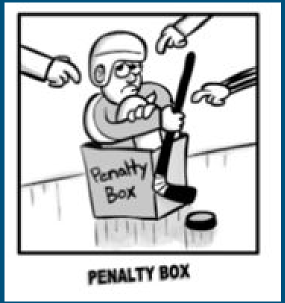
http://xgboost.readthedocs.io/en/latest/model.html

1) Random Forest

2) Boosting

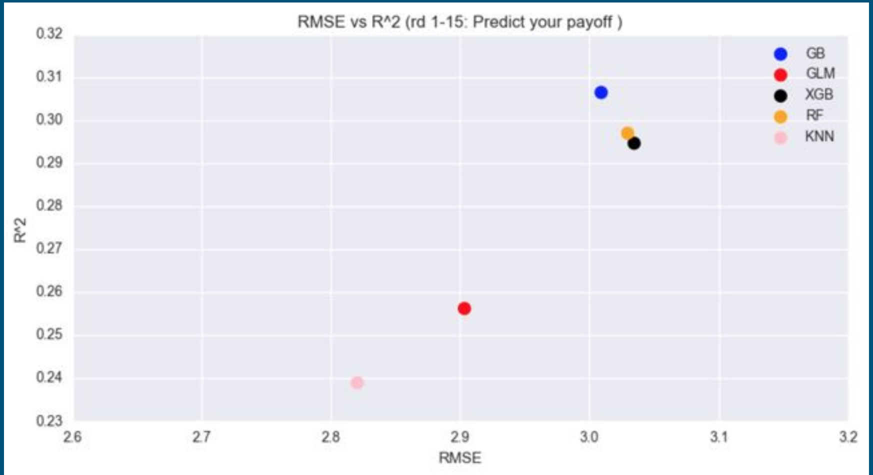


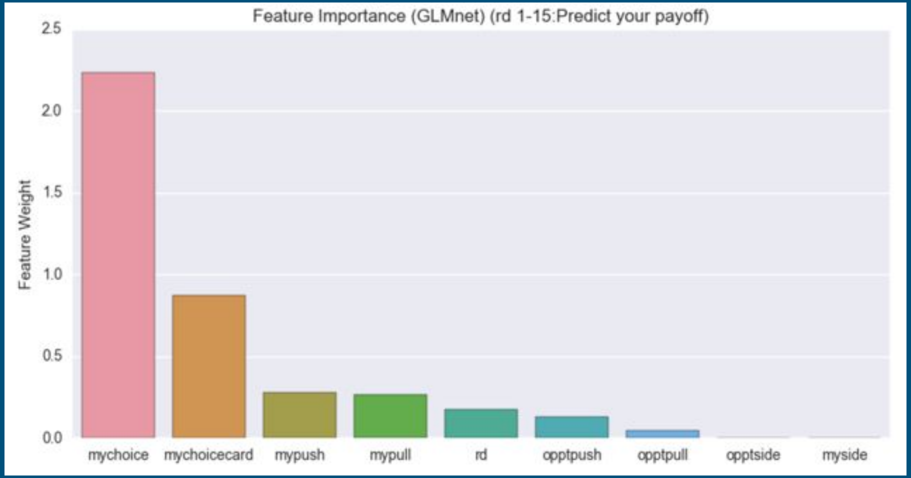
3) GLM/Elastic net



Rounds 1-15

- Results vary slightly based upon train test split

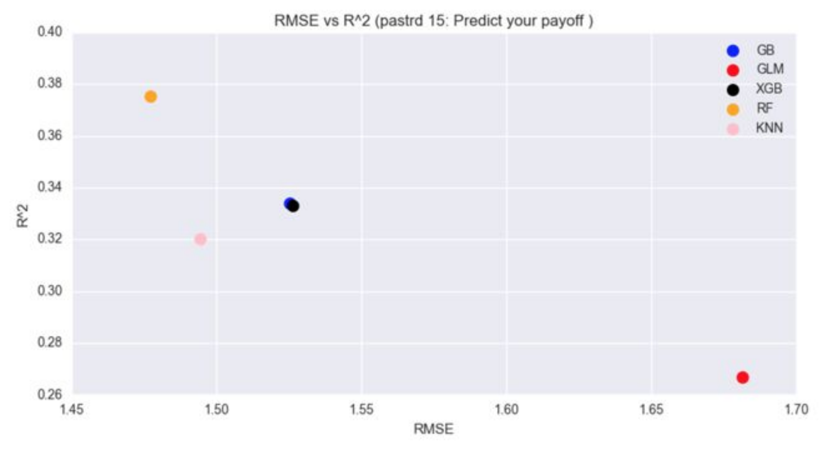


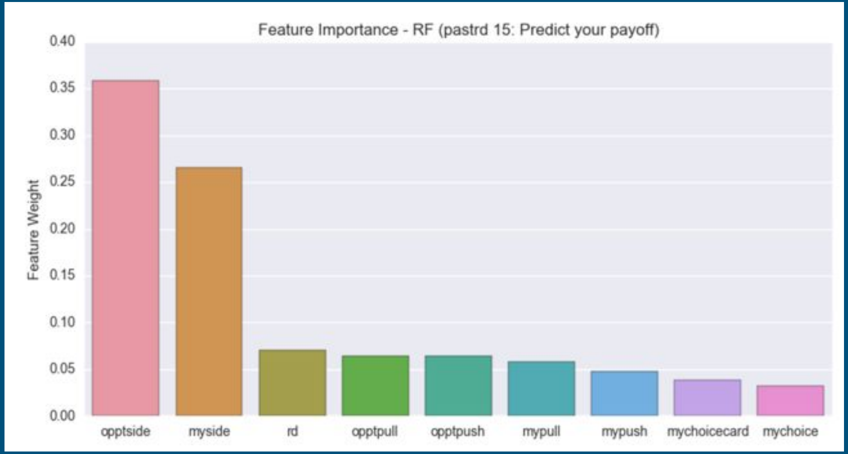


** Best parameters found from randomized gridsearch. Feature importance from glmnet.*

Rounds past 15

- Results vary slightly based upon train test split

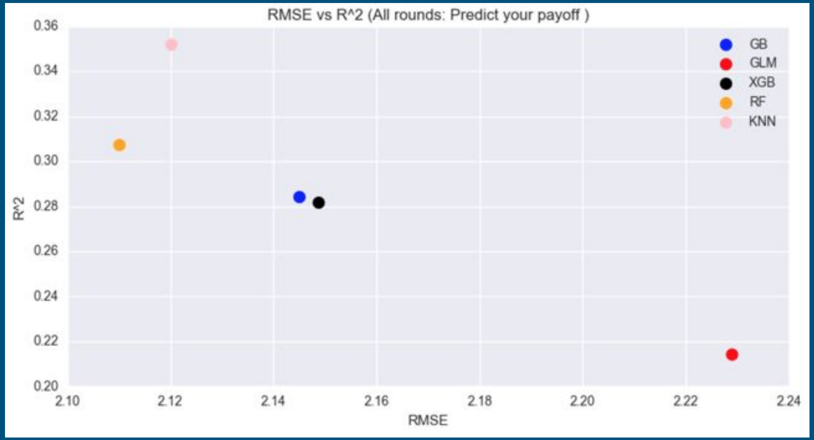


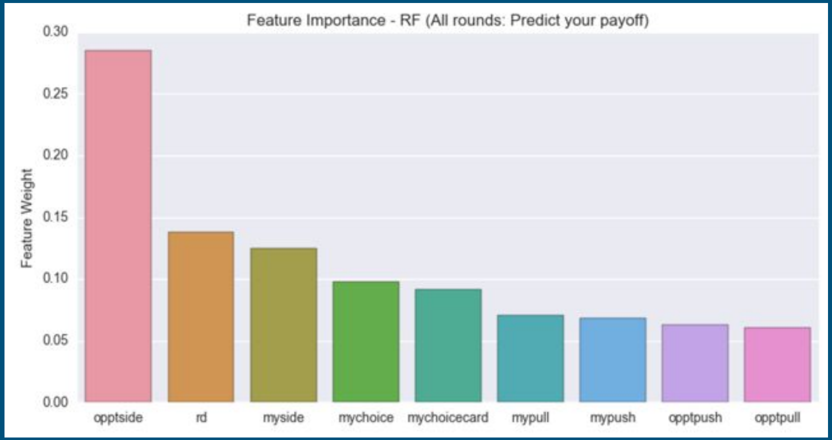


** Best parameters found from randomized gridsearch. Feature importance from RF.*

All rounds

- Results vary slightly based upon train test split





** Best parameters found from randomized gridsearch. Feature importance from RF.*

Ensemble

- Dataframe (linear):

	GLM_scaled_train	GB_train	RF_train	XGB_train	KNN_train	actual_training
0	5.342700	6.299544	6.238544	6.178087	5.53125	7
1	5.357743	6.536596	6.300855	6.752759	6.84375	7

- Dataframe (meta):

	rd	myside	opptside	mypush	mypull	opptpush	opptpull	mychoice	mychoicecard	GLM_scaled_test
count	384.000000	384.000000	384.000000	384.000000	384.000000	384.000000	384.000000	384.000000	384.000000	384.000000
mean	-0.092270	-0.141051	-0.078104	0.000000	0.000000	0.000000	0.000000	0.008464	0.027195	4.740063

- Weights per model (linear):
- Weights (meta):

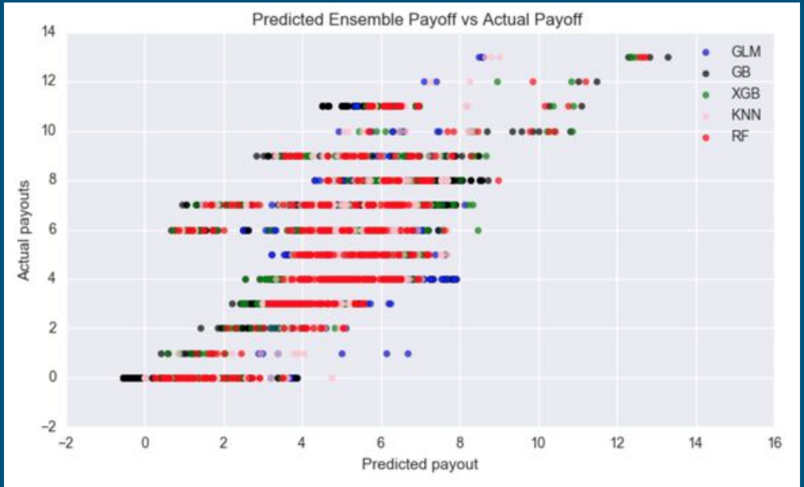
```
##Column order = GLM_scaled , GB, RF, XGB ,KNN
stacked_model.coef_
```

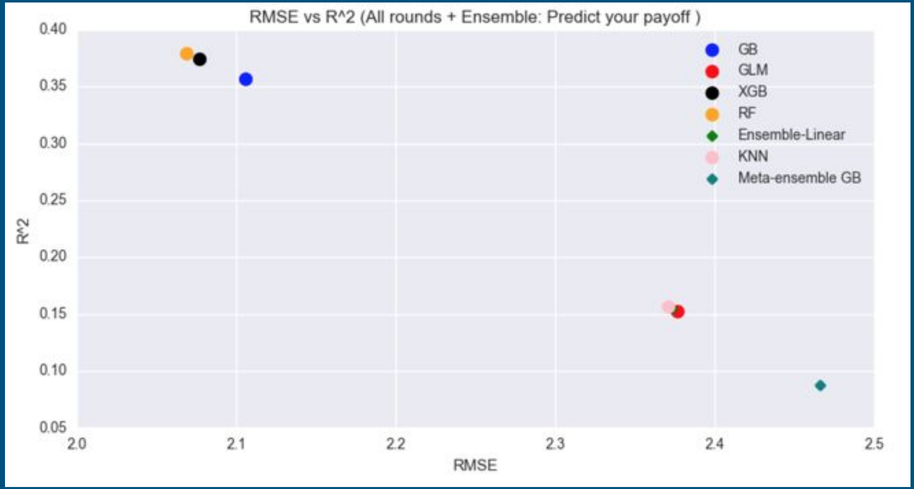
```
array([-0.12448028,  0.93010836,  0.28100216, -0.07034054, -0.05362199])
```

```
#Columns order - 'rd', 'myside', 'opptside', 'mypush', 'mypull', 'opptpush', 'opptpull',
       # 'mychoice', 'mychoicecard', 'GLM_scaled_train', 'GB_train', 'RF_train',
       # 'XGB_train', 'KNN_train'
stacked_model_gb.feature_importances_
```

```
array([ 0.38 ,  0.   ,  0.   ,  0.   ,  0.   ,  0.   ,  0.   ,  0.   ,
        0.004,  0.116,  0.204,  0.108,  0.064,  0.124])
```

Ensemble results






```
Linear Ensemble RMSE : 2.3735259857168507
Linear Ensemble R2: 15.46%
Meta-Ensemble GB RMSE : 2.4664525647799427
Meta-Ensemble GB R2: 8.71%
RF RMSE : 2.069208444284043
RF R2 : 37.89%
```

*Neither ensemble method could beat the final RF model.

Questions