Political Prediction Markets: Can We Use Them to Predict Election Outcomes?

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Joanne Rodrigues
Vikram Vijayaraghavan
Matteo Chinazzi
Sanith Wijesinghe

Complex Systems Summer School 2012
Hypothesis

- The final expiry value of prediction market contracts can be predicted using a neural network
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Motivation

- To become independent researchers
  - No administrative duties
  - No grant writing
  - No departmental politics
Hypothesis

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*Dreams need to begin somewhere*
2012 US Presidential Election Market

- Contract underlier’s are deterministic true/false questions
- Contract pays $1 if event is true at time of expiry, $0 otherwise
- Traders buy/sell contracts depending on their expectation of the outcome
2012 US Presidential Election Market

What happened here?
2012 US Presidential Election Market

What happened here?

Market prices subjected to news/rumor shocks
Data

- 772 contracts
- Binary (True/False) outcome contracts only
- Covers events from 2003-2012
- Initially consider contracts across a wide spectrum
Artificial Neural Networks

- Computational technique used in AI/machine learning
  - Speech recognition, image analysis, adaptive control

- Use for pattern classification

- Supervised learning
  - Use a ‘training’ data set
  - Input: Characteristics of the prediction market time-series
  - Output: Market expiry contract payoff
Methodology

- FeedForward Neural network
  - Fully-connected network
- 3-layer (input/hidden/output)
- Sigmoid used for output layer
  - Output > 0.0 implies True
  - Output <= 0.0 implies False
- Data split 50-50 into training and test
- Training phase: 2000 iterations

Neural network configuration held constant for all runs
Methodology

- Training phase input variables
  - Mean / Mean + STD / Mean + STD + Skew

- State transition probability
  - Convert price series into 0/1 binary variables
  - Determine $\varepsilon$-Machine’s
  - Use $P(1|0)$, $P(1|1)$, $P(0|1)$, $P(0|0)$ as inputs

- Probability bins
  - $P(0<\text{price}<40)$, $P(40<\text{price}<60)$, $P(60<\text{price}<100)$
Test runs

- Test phase
  - Test data length $L$ varied between $0.5L - L$
Null Model(s)

1. Pick outcomes randomly with 50-50 chance

2. Pick outcomes randomly with biased chance based on outcomes observed in training data (65:35 ratio for 0/100)

3. Pick all False outcomes since they are in the majority
## Results

<table>
<thead>
<tr>
<th>Training Method</th>
<th>Test Data Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Mean</td>
<td>74%</td>
</tr>
<tr>
<td>Mean + STD</td>
<td>76%</td>
</tr>
<tr>
<td>Mean + STD + Skew</td>
<td>79%</td>
</tr>
<tr>
<td>State transition probabilities</td>
<td>68%</td>
</tr>
<tr>
<td>Probability bins</td>
<td>76%</td>
</tr>
<tr>
<td>Null Model 3</td>
<td>68%</td>
</tr>
</tbody>
</table>
Neural network appears to exploit some of the clustering seen for low mean and low std markets that expire at 0
As people do better, they start voting like Republicans - unless they have too much education and vote Democratic, which proves there can be too much of a good thing.”

-Karl Rove
INTRADE: Will Pres. Obama win the 2012 election?
POLL: Do you approve or strongly approve of Pres. Obama?
Pearson Correlation: .05
# Neural Net Model of Political Markets

<table>
<thead>
<tr>
<th>Model Description</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Random Model (Prior: No Knowledge of INTRADE Market)</td>
<td>50%</td>
</tr>
<tr>
<td>Null Model (Prior: Bias of the INTRADE training set)</td>
<td>56%</td>
</tr>
<tr>
<td>Trader’s Prediction Model (Final market’s prediction of the Outcome)</td>
<td>65%</td>
</tr>
<tr>
<td>Simple Neural Net Model (MEAN, STD, Skew)</td>
<td>79%</td>
</tr>
<tr>
<td>Complex Neural Net (MEAN, STD, Skew, Num. of Traders, Market Volume)</td>
<td>75%</td>
</tr>
</tbody>
</table>
How effective are our predictions?

Market-Volume Weighted Logistic Regression:

\[ y = \ln(p/1-p) = a + Bx + \ldots \]

- Holding all other factors constant, the odds of the Neural Net Model making a correct prediction is 2% higher for correct predictions of the Trader’s Prediction Model, (significant below the 1% level). (This suggests different underlying models).
Competitiveness

• Market Characterization: (based on bands of price probability)
  Uncompetitive: [0<price<15], [75<price<100]
  Moderately Competitive: [15<price<35], [45<price<75]
  Very Competitive: [35<price<45]

Market skewed down
What types of elections are we better at predicting?

<table>
<thead>
<tr>
<th>Odds Ratios</th>
<th>Neural Net Model</th>
<th>Trader’s Prediction Model</th>
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<tbody>
<tr>
<td>Market Type:</td>
<td>Baseline: 75-100 (Not Comp.)</td>
<td></td>
</tr>
<tr>
<td>0-15 (Not Competitive)</td>
<td>1.4172***</td>
<td>1.9195***</td>
</tr>
<tr>
<td>15-35 (Moderately Comp.)</td>
<td>1.6362***</td>
<td>.9320</td>
</tr>
<tr>
<td>35-45 (Very Comp.)</td>
<td>.3693***</td>
<td>4.8150***</td>
</tr>
<tr>
<td>45-75 (Very Comp.)</td>
<td>1.1754</td>
<td>.7763*</td>
</tr>
<tr>
<td>Political Market Types:</td>
<td>All Other Political Markets</td>
<td></td>
</tr>
<tr>
<td>US Presidential/ National Election</td>
<td>1.1095*</td>
<td>1.0998</td>
</tr>
<tr>
<td>US Congressional Election(House or Senate)</td>
<td>.8252**</td>
<td>0.9940</td>
</tr>
</tbody>
</table>
Market Competition

Moderately competitive:

Abu Musab al-Zarqawi to be captured/neutralised by 11/30/04

John Kerry to be 2004 Democratic Presidential Nominee
Market Types

- Very Competitive
Political Insights

• This suggests that the Neural Net model is worse at predicting Congressional elections (and perhaps better at predicting Presidential elections) than the Trader Prediction model.

• The Neural Net is better at predicting moderately competitive elections while worse at predicting very competitive elections compared to the Trader Prediction model.
Political Insights (cont.)

• This may be due to the inherent structure of the market. Individuals are geographically diverse (have less information about state level politics). Overtime as regional election/competitive election gets more and more attention, information increases and Trader Prediction model does better at regional and very competitive elections.
Particular Political Events that we Failed to Predict:

**Neural Net:** Massachusetts Special Election: Election between Scott Brown (tea party candidate) and Martha Coakley (democratic favorite. (Odds ratio 57% below the baseline)

**Trader Prediction Model:** Significantly worse at predicting Primary elections - 2008 Democratic Primaries and 2012 Republican primaries (22% and 34% below the baseline respectively)
MA Special Election

Democratic Party Candidate to Win MA Special Senate Election
Focus on Political Markets

- Train NN on a reduced set of 457 markets
  - Mean + STD + Skew

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In what types of elections do we do worse with time-varied Neural Nets?

• Holding other factors constant...
  - do worse with Congressional Elections with shorter lengths
  - do significantly better with the very competitive markets (most time spent in probability band of 35-45)

• **Paths forward:** Break neural net by type of market – Political type and degree of competitiveness
Paths forward (cont):

• Neural Net capped at around 80% Prediction: Can we improve this??
• Market Volume/Numbers of Traders: (greater numbers, less diversity – Scott Page 2012)
  - average number of traders for correctly and incorrectly predicted markets are the same
  - What is the effect of more people -> more herding behavior -> worse prediction? More diversity -> better prediction?
• What about foreign elections – similar to regional elections? Less information?

Can we use this knowledge to improve our neural?
Feedback much appreciated.....