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IPH 470: Final Project Writeup

The Effects of Strategy and Political Position on Presidential Primaries

1. Abstract

The problem that we have explored through research and the construction of a model is how a candidate's strategy during their campaign and positioning on the political spectrum affects their voter share throughout presidential primaries. In particular, we have focused on and studied the 2016 Republican Primaries and the 2020 Democratic Primaries, both of which highlighted a record breaking number of participants. Each of these primaries featured candidates with ideologies ranging from the extreme left to extreme right and everywhere in between on the political spectrum. These candidates applied elements of game theory to guide their actions throughout the primaries in an attempt to maximize their support from the voting populus and become the presidential candidate representing their respective parties. We have created a Netlogo model that aims to digitally recreate a presidential primary. Ideas that we implemented are game theory and Hotelling to represent strategy and positioning of political candidates during interactions throughout presidential primaries.

2. Literature Review

Background Information:

Based on "2016 Republican Party Presidential Primaries", these primaries began with 17 candidates which was the largest field of a presidential primary for either party in American history. Before the primaries began, this race seemed open for anyone to win. However, by the time voting started, Cruz, Rubio, Kasich and Trump became favorites, each with different strategies. The graph below shows a timeline of each candidate's campaign throughout these primaries.

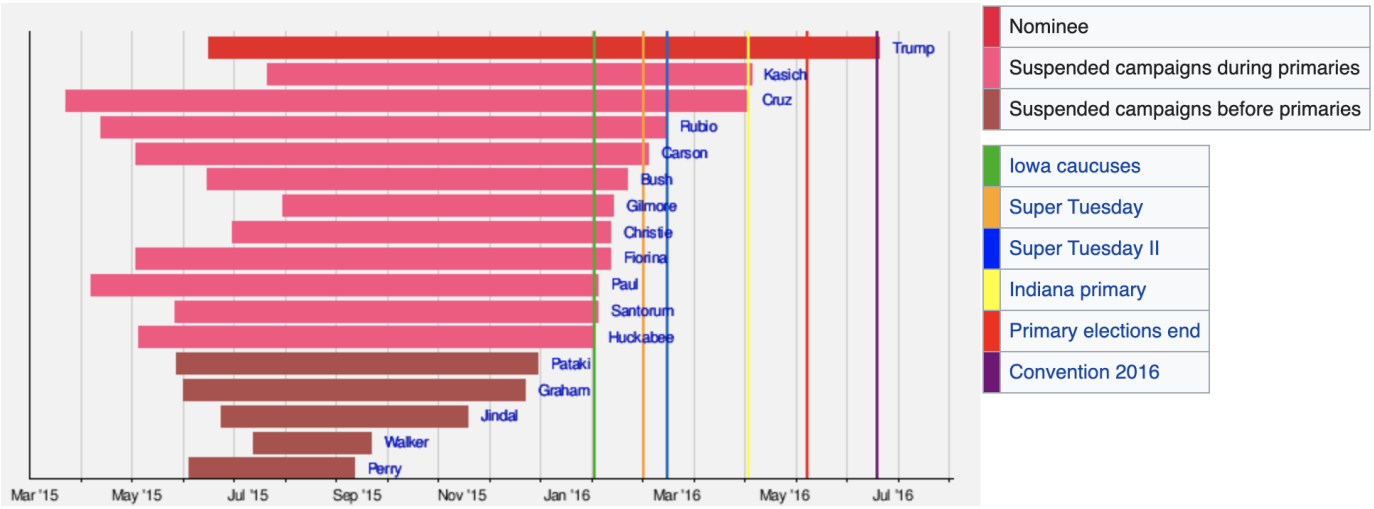

Figure 1: Timeline of candidates throughout the 2016 Republican Primaries

Trump created groups that loved him and hated him due to his polarizing policies with unapologetic speech among other actions that were appealing to many yet appalling to others. Rubio and Cruz highlighted their younger age as well as their allure to the Hispanic community.

Lastly, Kasich stuck with his moderate views even without a seemingly good chance to win. As more primaries occurred and more votes were cast, Trump pulled ahead in popularity and voting share. Cruz and Kasich made a united attempt to block Trump from being nominated but ended up being unsuccessful.

The 2020 Democratic field of candidates broke the record from 2016 with 29 but 18 withdrew before the primaries officially began according to "2020 Democratic Party Presidential Primaries". This pool of candidates was also incredibly diverse with a wide range of ideals and proposed agendas. Similar to the graph for the 2016 primaries, this figure shows the timelines of every campaign throughout the 2020 Democratic primaries.

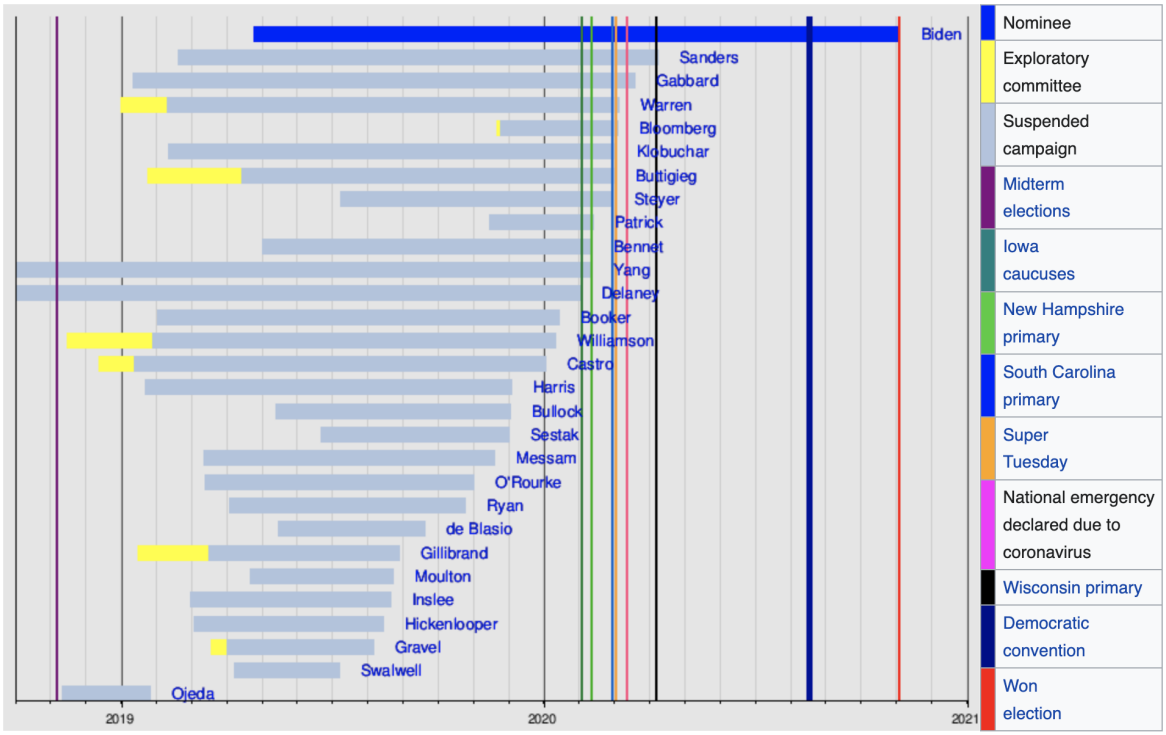

Figure 2: Timeline of candidate support throughout the 2020 Democratic Primaries

After Biden had lost a few states, with an endorsement from the congressmen, support from the African American community and concerns about Sanders, he had a big win in South Carolina. Before Super Tuesday, Biden gained more support as multiple candidates dropped out and

endorsed him which was said to be the moderate candidates consolidating. As he continued to pull away from Sanders, Warren and Bloomberg, the others began to drop out until Biden was the only candidate remaining.

Political Game Theory:

As discussed in "The Republican Primary and Game Theory" from Cornell University, there are various aspects that go into making decisions during primaries. Throughout debates and campaigns, strategies arise such as attacking a certain opponent based on voter share or ideology as well as focusing on promoting oneself. These strategies are particularly apparent throughout the 2016 Republican Primaries where 16 candidates seemed to have a good chance at victory while Donald Trump came out of nowhere with very little to no political experience and won over a lot of people. Out of fear of being on the receiving end of Trump's unapologetic commentary, the other candidates' strategies became avoiding attacking him and instead attacking one another. On the other hand, Trump's strategy was to attack anyone and everyone that got in his way. Because the other candidates chose to attack one another instead of fighting back against Trump, many viewed them as weak which resulted in losses. Trump's strategy proved superior in this race as he came out on top by a good margin.

Many similarities can be seen during the 2020 Democratic Primaries and throughout primaries in general. As Chris Smith from Vanity Fair states, debates are crucial in gaining supporters and votes. Each candidate is typically only able to speak for a few minutes each round of a debate so it is necessary that each one of them has a strategy that will result in the news and viewers speaking about them in a positive light. Because of the limited time to speak, the candidates have to prioritize what they talk about and whether they focus on promoting

themselves or attacking others that may be a threat to them. These strategies are becoming increasingly important as the media's influence on political races grows. In some cases, they even have the power to manipulate how candidates are viewed by the public. One way the media can do this is by taking bits and pieces of a speech or campaign that can make a candidate seem a certain way. Our country is changing everyday and politicians have to be aware of this when forming strategies that will help them gain the largest voter share in political races.

Hotelling:

Another factor in candidate behavior and decision making is a phenomenon called hotelling. Based on "Hotelling and Elections" written by a professor at Washington and Lee University, the idea behind hotelling in regards to politics is that voters are distributed along a line in a fixed position and candidates are spread out amongst them. In this model, voters vote for the candidate that is closest to them. Their positioning on the line represents political position and candidates will move along the line in order to maximize their voter share. Median voter share is an idea that if there are two candidates, one on each end of the spectrum, they will both end up moving towards the center of the line in order to gain voters. However, this idea is simplified as there are numerous factors that go into deciding where to position oneself on the political spectrum as well as how people choose who they vote for.

In "Strategic Tournaments" by Ayala Arad and Ariel Rubenstein, they discuss a tournament-like game that utilizes a payoff matrix to determine a winner. In each matchup between two players, they perform an action and gain or lose points depending on the actions of both parties. The players try to maximize their probability of winning the tournament by having the highest score at the end. There are several interpretations of this tournament model. However,

the one that relates most to the problem that we are studying is the social interpretation. This is a situation involving two-person interactions with an assumption that everyone wants to be superior to everyone else. In a model that represents this type of tournament, there is a set of players and two players would play against each other at a time. They each have an action chosen from a finite set that they will perform. Each will receive a certain score based on the given payoff matrix and the total scores will be tracked throughout each interaction. The player with the most points at the end of the tournament is the winner.

Example Models:

The Hotelling's Law Netlogo model implements and expands upon this phenomenon of hotelling. In this model, stores (turtles) move around either on a line or plane and change their prices in an attempt to maximize their profits while each consumer (patch) chooses a store based on location and prices. The stores try to move randomly but if their market share doesn't increase, they don't move and the same process occurs with price. While each store is adjusting, they do not have "knowledge" of other store's strategies. On the other hand, the consumers choose the store with the lowest sum of price and distance. The model allows the user to choose settings such as number of stores, layout (line or plane) and restricting the stores to only change their prices or only move location. We have taken some ideas from this model and catered them to the problem that we are studying.

In the Iterative Prisoner's Dilemma model created by Dr. Graham Sack, each player has a strategy associated with it such as all-cooperate, all-defect, random, tit for tat, etc. All of the players end up playing against everyone else a couple of times in a round robin style tournament. The model uses links to store the history of interactions between players. For every round, the

player decides to cooperate or defect based on what their assigned strategy is as well as interaction history. There are four possible scores based on the actions of both players that make up the payoff matrix. The scores of all of the players are also kept track of throughout the rounds. We have used pieces of code and ideas from the Iterative Prisoner's Dilemma model in order to implement strategies in the model that we created.

3. Model

Model Overview:

The model that we have designed employs Axelrod-esque ideas of game theory in a prisoner's dilemma situation on a Hotelling spatial competition line to further explore and display the phenomenon of candidate strategy throughout presidential primaries. The structure includes a line on which the candidates (turtles) move to represent their political position and the patches represent voters. Each candidate has a certain voter share (patches) that are associated with it which are the same color as that particular candidate. The model starts by the user choosing how many candidates are running for election (10-20 inclusive), randomly assigning each candidate a position on the political spectrum, and computing their corresponding vote share based on the amount of voters that are closest to each candidate. The sequential game of each candidate moving along the political spectrum to gain the highest share of voters followed by the individual candidate matchups based on political proximity follows. This game is played 3 times a round (modeling a debate/news cycle). After each round, the candidate (or candidates if there is a tie) with the lowest vote share is eliminated from contention and their voters are reassigned to their closest neighbor on the political spectrum (representing candidates dropping

out and endorsing someone else). These rounds repeat until there are only two candidates left in the race, representing the final vote to decide who moves on to the presidential election.

We implemented and modified code from the “Hotelling's Law” model found in NetLogo model libraries as a baseline for the visuals and spatial competition aspects of our model. We also implemented and modified code from the “Iterative Prisoner’s Dilemma” model posted to Canvas as a baseline for implementing candidate strategy into the model.

Game Theory:

There are four randomly assigned strategies that a candidate can have. All-Promote represents one always promoting themselves regardless of other people’s actions, all-attack is always attacking said candidate’s neighbor, random can either promote or attack and TFT is tit for tat, meaning the candidate chooses the same strategy that the person they are attacking has most recently performed (they choose All-Promote as their initial choice). We believe these four Axelrodian strategies act as good “umbrella-strategies” due to the fact that almost all of the possible derived strategies stem from or derive aspects from these four. Also, we believe that politicians generally adapt to one of these strategies both consciously when strategizing for their campaign and subconsciously in the midst of a fiery debate. Each case of two candidates making a decision has a corresponding value in a payoff matrix. If both choose to promote (“Real world equivalent”: the two candidates opt to promote their own actions/policy instead of regarding the other) they both maintain their current share of the finite pool of voters. If one chooses to promote and the other chooses to attack (“Real world equivalent”: one candidate opts to promote their own actions/policy while the other attacks that candidate’s actions/policy) the attacking candidate steals three voters from the promoting candidates’ total. If both candidates chose to

attack (“Real world equivalent”: both candidates opt to attack each other's actions/policies) one candidate will be randomly chosen to win the encounter and will steal three voters from the losing candidates’ total. This intentionally creates a Nash equilibrium incentivizing both candidates to attack. Our payoff matrix for this prisoner’s dilemma-esque situation is shown below.

(Candidate A, Candidate B)	(B) Promote	(B) Attack
(A) Promote	(0,0)	(-3,3)
(A) Attack	(3,-3)	(3,-3) or (-3,3) equally often

Table 1: Payoff matrix used in our model

We decided on this payoff matrix for a multitude of reasons. First, despite the common belief that self-promotion in these political landscapes does help you gain voters, our adaptation to the Hotelling line made it so we were working with a finite set of voters. That is why each possible payoff systematically speaking has a net loss/gain of zero voters. These could be modified with a finite but expandable voter set, which could be an interesting extension to this model to account for undecided voters. We opted to allow the user to enter a range of values from 1 to 5 inclusive for our payoff matrix. This range is for two main reasons: maximizing variety in the winner’s strategy and allowing the winner to win in multiple ways. If the +/- voter value for each action is large (>5) the “all-attack” strategy dominates much more than what is realistically acceptable and the effect of having a large amount of the voter share to begin with is minimized much more than what is realistically acceptable. If the +/- voter value is small (<1) the effect of having a large amount of the voter share is maximized much more than what is

realistically acceptable. Essentially, the competition becomes significantly less interesting and less realistic if either of these cases is true.

Model Visuals & User Interface:

Upon user entry of the number of candidates in the primary and payoff-value for candidate interactions, the user clicks set up to initiate the model. Each circle represents a candidate and the lines they sit on of the similar color represent the voters closest to them in political ideology that will consequently vote for them. Upon each interaction, a candidate can gain or lose a given number of voters, which is shown by the changing color of patches within these candidates' vote shares, an example is shown below:

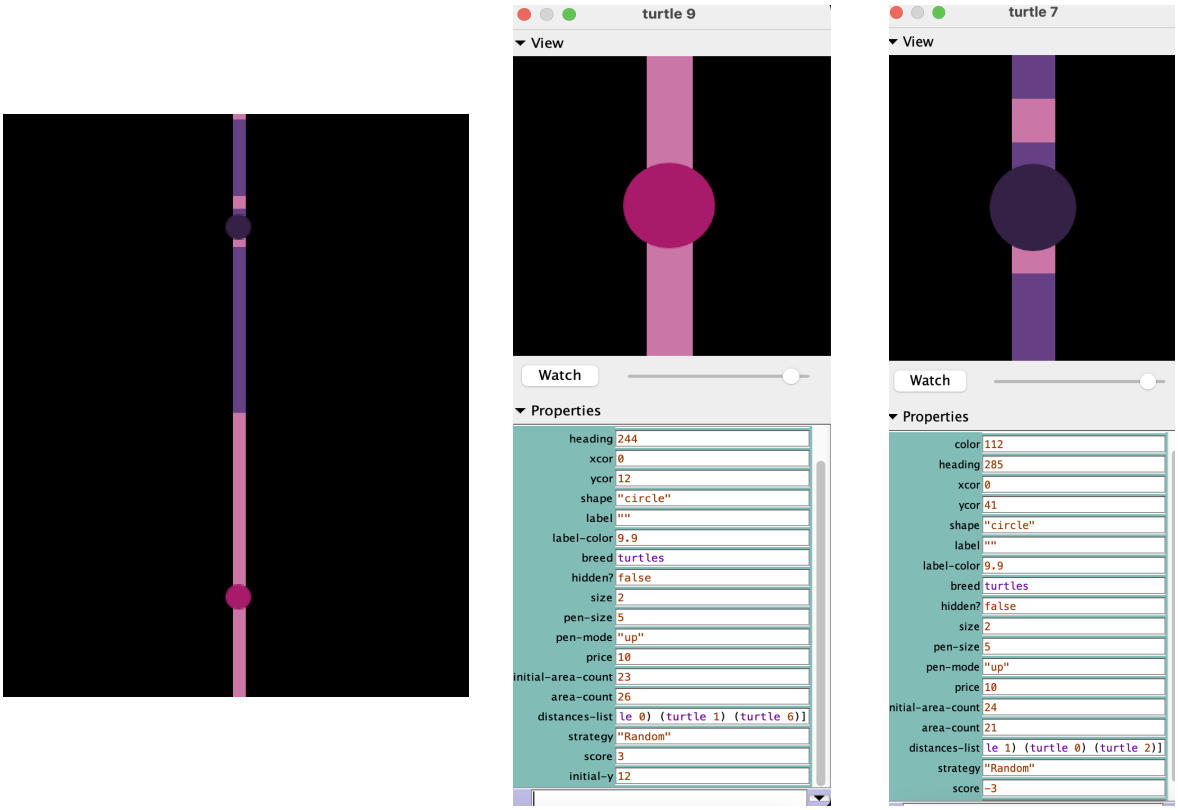

Figure 3: Example of an interaction between two candidates in our model

Here, the pink candidate won a battle against the purple candidate with a payoff value of 3. This is reflected by:

a) three of the purple candidate's patches turning pink

b) the differences in "initial-area-count" and "area-count" for both candidates

c) the differences in "score" for both candidates

Upon the elimination of a candidate, the next physically closest candidate on the line (i.e. their closest in political ideology) will gain all of their voters and turn them into their color. When a run is completed, the user is able to visually see both where on the spectrum the final two candidates have claimed voters as well as how many voters they gained from eliminated candidates (shown by splotches of other candidates' colors throughout their vote share line). While the model runs, there are four monitors and two plots that help guide analysis of results alongside the visual components.

4. Model Analysis

Behavior Space Experiment Description:

To analyze our model, we created a NetLogo Behavior Space and swept for the following parameters: initial leader in vote-share upon setup, final leader in vote-share upon completion, vote-share possessed by winner upon completion, strategy of winner, the initial vote-share possessed by the winner upon setup (not to be confused with the first parameter which is the leading candidate upon the model starting), and the initial y-coordinate of the winner ($-50 \leq x \leq$

50). We ran each combination of possible payoff values ($1 \leq x \leq 5$) with 10, 15, and 20 candidates 100 times each for a total of 1500 runs of the model. Our goals of the experiment were the following:

a) Analyze the importance of initial popularity amongst political candidates
b) Analyze the importance of initial polarity amongst political candidates
c) Analyze the importance of strategic decision making in conjunction with initial popularity and polarity amongst political candidates

Behavior Space Data:

Payoff value vs. Mean Initial Vote Share of Winning Candidate

Payoff Value	Mean initial vote share of winner
1	11.69
2	11.68
3	11.51
4	11.98
5	11.65

Average overall initial vote share held for all candidates: 7.29

Table 1: Shows the average starting vote share of the winner for payoff values 1-5

Payoff Value vs. Frequency of Winning Strategy

Payoff Value	All-Promote	All-Attack	Random	TFT
1	.150	.347	.247	.256
2	.173	.370	.220	.237
3	.190	.340	.247	.223
4	.120	.403	.250	.227
5	.127	.357	.283	.233

Table 2: Shows how often each strategy wins for payoff values 1-5

Payoff Value vs. Initial Position (y-coordinate) of Winner

Payoff Value	Percent of Winners where |initial y coordinate| > .25	Percent of Winners where |initial y coordinate| ≤ .25
1	.74	.26
2	.68	.32
3	.72	.28
4	.65	.35
5	.64	.26

Table 3: Shows the percent of winners based on location on the spectrum for payoff values 1-5

Payoff Value vs. Ending Vote-Share of Initial Vote Share Leader

Payoff Value	Percent of the time the initial vote-share leader wins the election	Percent of the time the initial vote-share leader places second	Percent of the time the initial vote share leader is outside the top 2
1	.25	.197	.553
2	.253	.16	.587
3	.237	.143	.62
4	.227	.173	.6
5	.237	.167	.597

Table 4: For each payoff value 1-5, shows how often the candidate with the largest initial vote share wins, places second and does not end in the top 2

Payoff Value vs. Winning When Initial Vote Share < Mean Vote Share

Payoff value	Percent of time winner started below the mean vote share
1	18%
2	16%
3	16%
4	18%
5	26%

Table 5: For each payoff value 1-5, shows how often the winner's voter share began below the average voter share of all of the candidates

Analysis of Data:

From analyzing the data above, we can immediately come to two conclusions. Firstly, there is a clear (expected) correlation between having a large initial vote share and election success. This is shown by results from both Table 1 and 4. This effect diminishes slightly as the payoff value increases which makes intuitive sense as well. It is very interesting to note that election winners are more likely to be the initial vote leader than any candidate below the initial vote share mean (unless the payoff value > 4). We can see this in Table 5. Secondly, there is a surprisingly strong correlation between polarization and election success as shown by Table 3. The fact that roughly ⅔-¾ of elections are won by a candidate on the outer two quarters of our political spectrum is very interesting and much higher than we initially expected it to be. This observation gives a lot of weight and validity to the idea of a Trumpian primary victory we discussed earlier. All-Attack seems to be the dominant strategy regardless of payoff value which makes sense considering the structure of the payoff matrix. It is interesting that all-promote wins with the frequency it does despite only being able to gain voters through absorbing other candidates' voters. Although it does not happen that often, it explains how, and in what way, a candidate like Biden could win the 2020 primary.

There are a few aspects of the data that are surprisingly inconclusive as well. The expected trend of some strategies becoming more prominent in winners while others fade is seemingly non-existent. There is significantly more noise in Table 2 than we anticipated, specifically regarding the somewhat bizarre bucking of each trend when the payoff value is equal to 4. This lack of strong pattern makes it difficult to analyze strategic impact outside of the fact that attacking is generally beneficial. We ultimately decided not to look at the number of

candidates under the same microscope we did payoff values due to the fact that we did not see any data that is not obvious to a user of the model (i.e. the mean initial vote share of the winner is smaller when there are more candidates). From the testing that we performed, we can conclude the following:

a) Initial popularity is extremely important: the one candidate with the initial voting lead is more likely to win than all candidates below the mean in initial voting lead combined (for all payoff values excluding 5)
b) Initial polarity is extremely important: A candidate is 30-50% more likely to win if they are ideologically on the outer quarters of the political spectrum
c) Choice of strategy is significantly less important than both popularity and polarity

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