The Complexity of Parikh et al.'s Model of Campaigning

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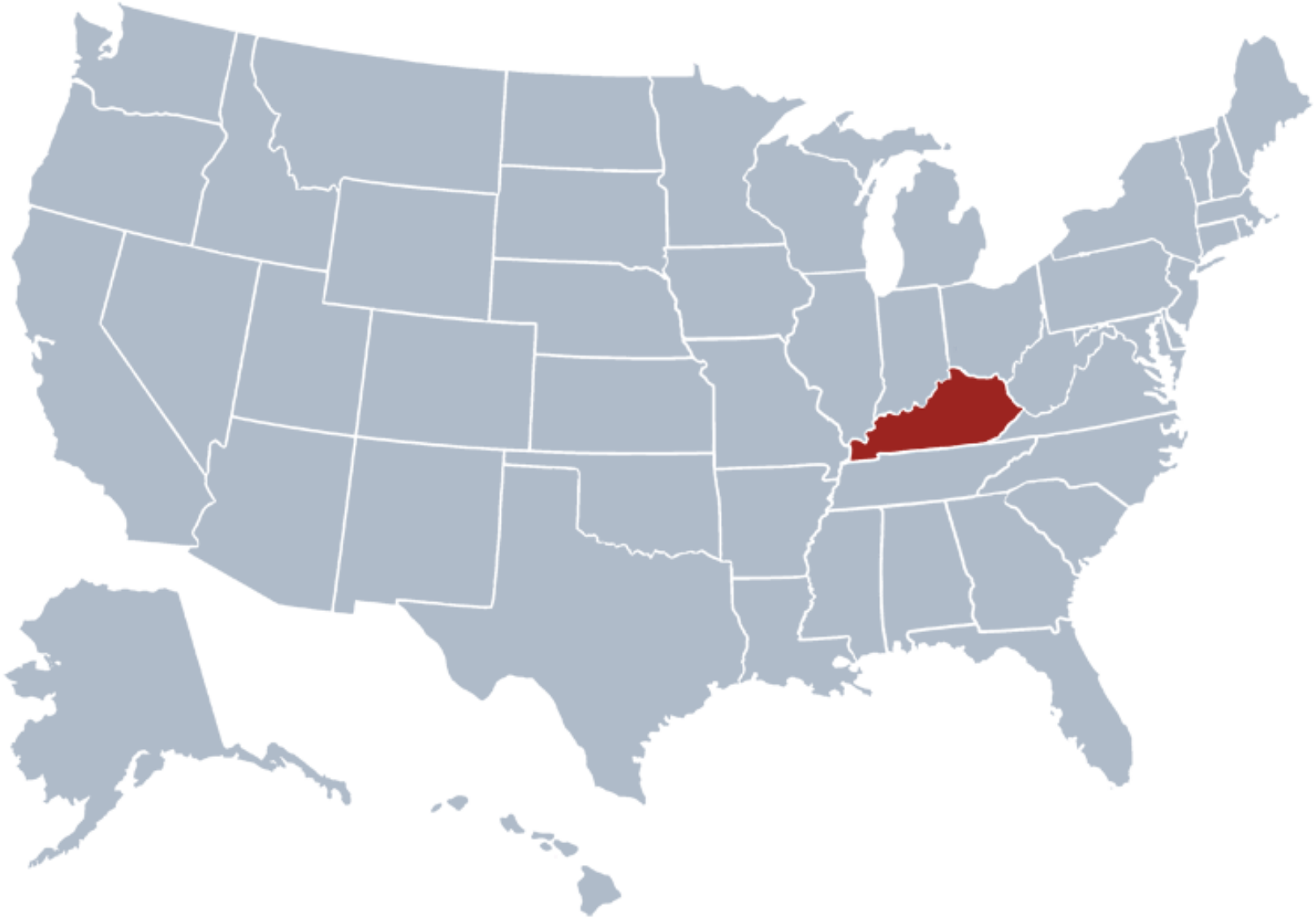
It's a long way...



Cory Siler

Unable to attend ☹️

Luke Miles

Me!

Judy Goldsmith

Unable to attend ☹️

Overview

1. Tomz and Houweling, 2009: Ambiguity experiment
2. Dean and Parikh, 2011: The Model
   - Candidates
   - Voters
3. Parikh and Tasdemir, 2015: Strategy
4. Our work: Complexity
   - Voters calculating utility of candidates
   - Candidates figuring out what to say
5. Further work

The Electoral Implications of Candidate Ambiguity

Experiment showing that candidates with vague positions are often more liked. But why?

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The Model: Candidates

The candidate's statements are formulas in terms of variables representing views on the issues, e.g.:

- 🐴 = "When I'm president, everyone gets a free pony"
- 🪥 = "Tooth-brushing should be required by law"
- 🧟‍♀️ = "We must harness zombies as a renewable energy source"

The Model: Candidates

The current theory T is a set of formulas describing what the voters know about the candidate's platform so far, e.g.,

$$T = \left\{ \text{🐴}, \neg \text{🧨} \vee \text{🧟‍♀️} \right\}$$

As the candidate makes statements, this set grows.

The Model: Candidates

The current theory induces a set of possible *worlds* (assignments consistent with the formulas) that the candidate may bring about; as the theory grows, the set of worlds shrinks.

Possible worlds when $T = \emptyset$:

- 🐴, 🧨, 🧟
- 🐴, 🧨, ¬🧟
- 🐴, ¬🧨, 🧟
- 🐴, ¬🧨, ¬🧟
- ¬🐴, 🧨, 🧟
- ¬🐴, 🧨, ¬🧟
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The Model: Voters

A voter possesses three objects:

- A vector of preferences over the issues, e.g. $(0.3, -0.2, 0.5)$
- An evaluation function from preferences and candidate statements to $\mathbb{R}$
- A get-out-of-bed threshold in $\mathbb{R}^+$

The Model: The utility of a world

🤔"What would it be like if there weren't free ponies, but toothrushing were mandatory, and the zombie thing was cancelled?"
If $\omega = (-1, 1, -1)$ and $p_v = (0.6, -0.1, 0.3)$, then

$$u_v(\omega) = \omega \cdot p_v = -0.6 - 0.1 - 0.3 = -1$$

Worst possible world!!

The Model: The evaluation of a theory

There are three varieties of voters (i.e. three evaluation functions)

- *Optimistic* voters evaluate candidate on best possible world compatible with their statements.
- *Pessimistic* voters evaluate candidate on worst possible world compatible with their statements.
- *Expected value* voters take the average utility over all consistent worlds.

The Model: Candidate knowledge

Candidates are all seeing all knowing

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Candidate Strategy

For a candidate who wants to increase favor among the voters, Dean and Parikh show:

- With optimistic voters, remain silent — eliminating worlds can't help, and eliminating the best world would hurt.

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For a candidate who wants to increase favor among the voters, Dean and Parikh show:

- With optimistic voters, remain silent — eliminating worlds can't help, and eliminating the best world would hurt.
- With pessimistic voters, take an explicit stance on every issue — eliminating worlds can't hurt, and eliminating the worst world would help
- **With expected value voters, also be explicit — if you are willing to tell voters what they want to hear**

Candidate Strategy

So why do candidates prefer to be vague?

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So why do candidates prefer to be vague?

- Many optimistic voters?
- Tradeoff between optimizing total utility among all voters and making sure individuals are satisfied enough to vote?
- Our suggestion: Under realistic assumptions, it is hard for a candidate to compute the best statements to make

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It's hard for a voter to know what to think.

Optimistic Threshold

Instance: A set T of consistent Boolean formulas over n issues, a preference vector p over n issues, and a threshold k.

Example: $T = \{$ 🐴 $\wedge$ 🧟‍♀️, 🪈 $\rightarrow$ 🧟‍♀️$\}$ and $p = (.1, .1, -.8)$ and $k = 0.5$

Question: Does the best consistent world exceed the threshold? i.e.,

$$\max\{\omega \cdot p : \omega \models T\} \geq k?$$

Complexity: NP-complete (mapping reduction)

Pessimistic Threshold

Instance: A set T of consistent Boolean formulas over n issues, a preference vector p over n issues, and a threshold k.

Example: $T = \{$ 🐴 $\wedge$ 🧟‍♀️, 🪈 $\rightarrow$ 🧟‍♀️$\}$ and $p = (.1, .1, -.8)$ and $k = 0.5$

Question: Does the *worst* consistent world exceed the threshold? i.e.,

$$\min\{\omega \cdot p : \omega \models T\} \geq k?$$

Complexity: coNP-complete (mapping reduction)

Expected value threshold

Instance: A set T of consistent Boolean formulas over n issues, a preference vector p over n issues, and a threshold k.

Example: $T = \{$  $\wedge$  ,  $\rightarrow$  $\}$ and $p = (.1, .1, -.8)$ and $k = 0.5$

Question: Does the *average* consistent world exceed the threshold? i.e.,

$$\text{avg}\{\omega \cdot p : \omega \models T\} \geq k?$$

Complexity: #P-complete! (Turing reduction)

It's hard for a voter to know what to think.
BUT it's usually easy for a candidate to decide what to say.

Our work: Maximizing total utility

Complexity of finding that theory which maximizes your total utility over all voters?
Optimists: $O(1)$. Don't say anything.
Pessimists: $O(nm)$ (n = number of issues; m = number of voters). Pick the best stance on each issue.
Expected value: $O(nm)$. Same strategy.

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Further work: Maximizing number votes

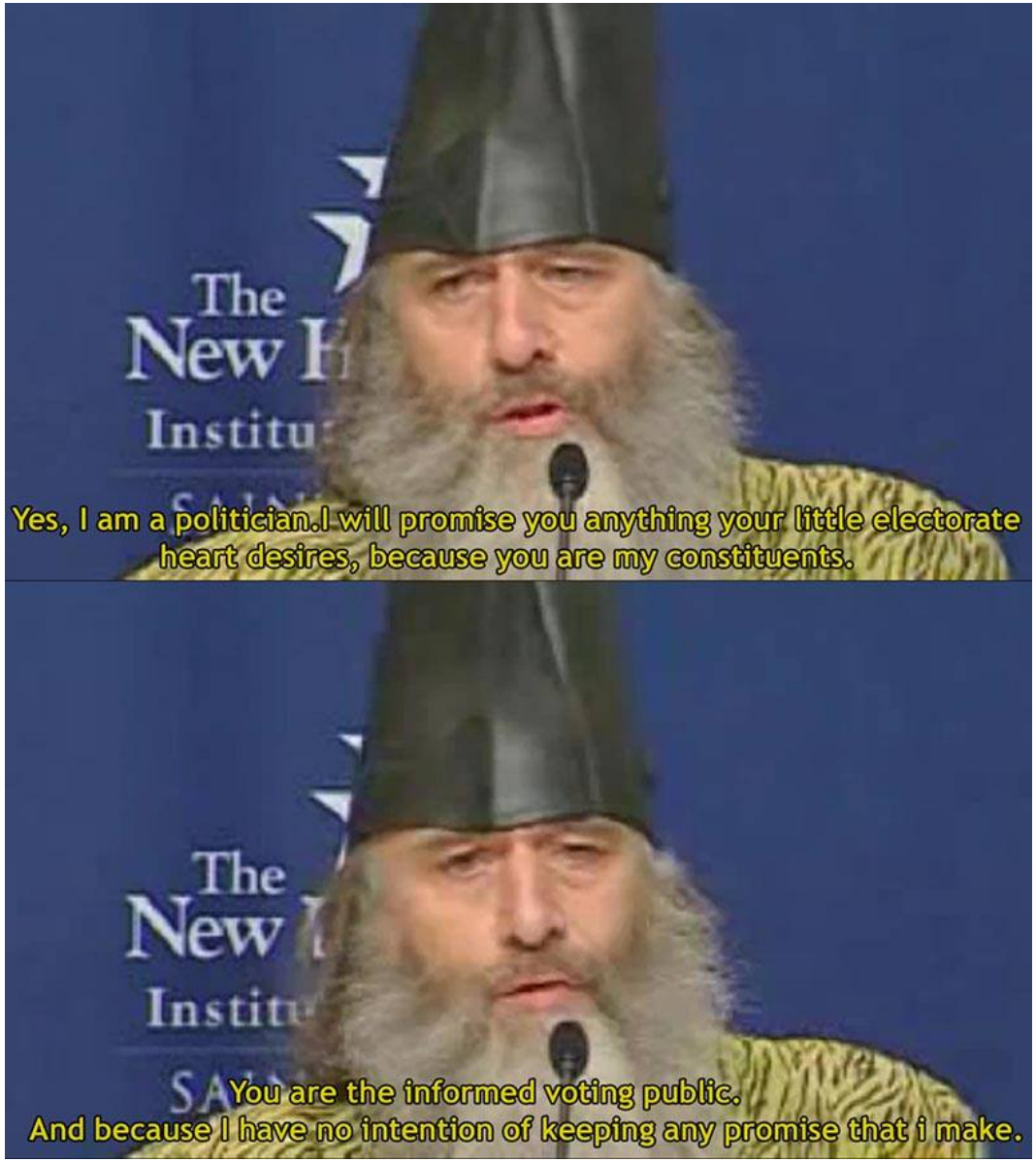
Counting is hard. NP-complete for pessimistic and expected value voters.
Finding the best is probably harder.
Important work!

Further work: Manipulation

How hard is it to manipulate/control evaluations or elections?

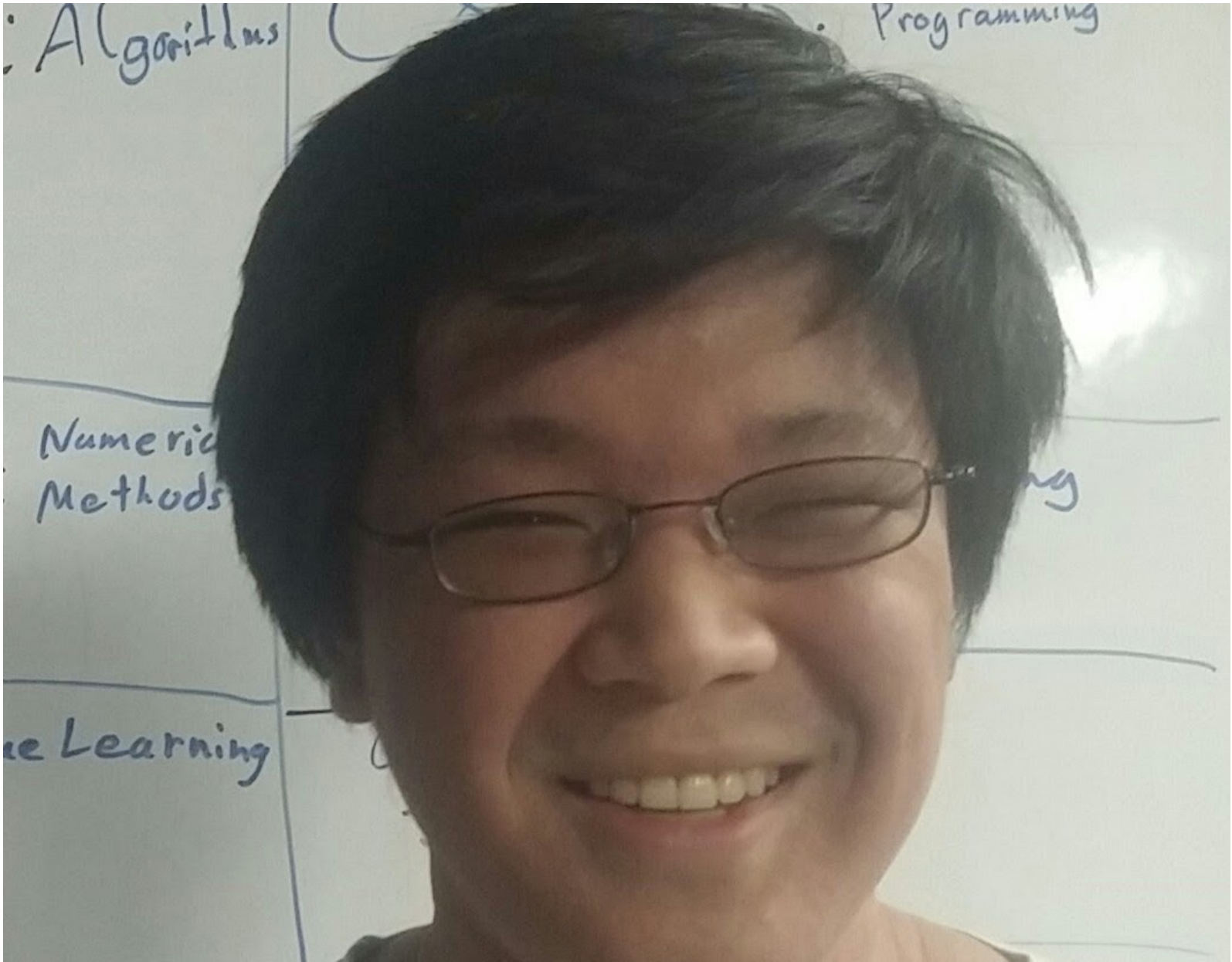
- by adding/deleting voters?
- by adding/deleting candidates?
- by small changes to politicians' utterances?

Vermin Supreme Speaks



And about the complexity of political utterances...

Austin Taing



Thank you!