Bayes Net Based Combinatorial Prediction Markets

Robin Hanson
George Mason University,
Consensus Point
With: Charles Twardy, Kathryn Laskey, Wei Sun, Shou Matsumoto
Will a *significant Israeli military force invade or enter the Gaza strip between 19 November and 30 November 2012? (1175)

Current Estimate

- 20%
+ 0%

1 edit this week. Last edit: Mon Nov 26
Question created Mon Nov 19 17:16:27 2012.
Settlement on Fri Nov 30 12:00:00 2012.

Show All Questions
Will a *significant Israeli military force invade or enter the Gaza strip between 19 November and 30 November 2012? (1175)

Current Estimate:
- 16% IF TRUE
+ 1088 (-32.2)
IF FALSE 1127 (+7)
Will a *significant* Israeli military force invade or enter the Gaza strip between 19 November and 30 November 2012? (1175)

**Current Estimate** | **If True** | **If False**
--- | --- | ---
- 16% | 1087 | 1127

**Local Edit History**

[Graph showing probability distribution]

- **My Last Edit:** 16%
- 2 edits this week. Last edit: Wed Nov 28
- Settlement on Fri Nov 30 12:00:00 2012.
Will a *significant Israeli military force invade or enter the Gaza strip between 19 November and 30 November 2012? (1175)

Current Estimate

If True | If False
--- | ---
1087 | 1127

My Last Edit: 16%
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Show All Questions | Equalize
DAGGRE vs. SciCast

*Same funder: IARPA*

**DAGGRE**
- On foreign events
- Live 9/’11 to 5/’13
- ~100 claims at a time
- ~300 users/mo.
- Users paid $3000/mo.
- No performance pay

**SciCast**:
- On science, technology
- To go live ~11/’13
- ~1000 claims at a time
- ~3000 users/mo.
- No user pay
Market Scoring Rule (MSR)

• Scoring rule: if report $r$, state is $x$, get $s_x(r)$
  – Proper if: $p$ in $\text{argmax}_r \sum_x p_x \ s_x(r)$
• MSR: user $t$ gets change $\Delta s_x = s_x(p^t) - s_x(p^{t-1})$
  "Anyone can use scoring rule if pay off prior user”
• Invert $s_x(p)$ for inventory market maker $p_x(s)$:
  – Tiny sale $e_x$ if $x$  fee: $p_x(s) \ e_x \ (s_x \ s_x + e_x)$
  – Big sale $s(1) - s(0)$ fee: $\int_0^1 \sum_x p_x(s(t)) \ s_x'(t) \ dt$
Log Market Scoring Rule

• Log MSR: \( s_x(r) = \ln(r_x)/\alpha \)

• With log, cost bounded, changes uniquely modular

• Compute: state is probs \( p_x \), assets \( S_x^u \) per user \( u \)
  - If \( u \) edits \( p_x \to p'_x \), do \( S'_x^u = S_x^u + \ln(p'_x/p_x)/\alpha \), if all \( \geq 0 \)
  - Helps to show market value of portfolio: \( S^u = \sum_x p_x S_x^u \)
  - PROBLEM: If many vars, way too many states \( x \)!
Prediction Market Issues

• **Problem**: What we know depends on context
• **Solution**: Let tell relational, conditional info

• **Problem**: Too many combos to store/update
• **Solution**: Bayes nets store/update probs well

• **Problem**: Also need store/update assets, find expected assets, ensure assets not go negative
• **Solution**: In Bayes net LMSR, ways to store/update/find-min for probs also does assets
Edit-Based Combo System Needs

1) User u chooses assumptions A, target event T
2) Find & show to user u (who has assets $S^u$):
   a) Current consensus $p(T|A)$
   b) Now long/short? Via: $E_p[S^u|A&T]-E_p[S^u|A&\neg T]$
   c) Limits $[\min,\max]$ of new $p'(T|A)$, to ensure $S^u \geq 0$
3) User u aborts or picks a $p'(T|A)$ in $[\min,\max]$
4) Update p to reflect $p(T|A) \rightarrow p'(T|A)$
5) Update assets $S^u$ to reflect bet for $p'$ over p
6) Periodically show how $S^u = E_p[S^u]$ vary with u
Reusing Assets

Belief:

P(B|A1) > x
P(B|A2) > x
P(B|A3) > x

Supporting Trade:

$x \rightarrow$ $1$ if B&A1
$x$ if not A1

$x \rightarrow$ $1$ if B&A2
$x$ if not A2

$x \rightarrow$ $1$ if B&A3
$x$ if not A3

$x \rightarrow$ $1$ if B&A9
$x$ if not A9

$9x \rightarrow$ $1$ if B

$x$ if not B

$8x$
Bayes/Markov Nets

\[ P(\text{Clique} \mid \text{Rest of Net}) = \frac{\prod_c p_c(x_c)}{\prod_s p_s(x_s)} \]

lets update \( p(x) \), find min, via JT alg

- Let \( q_x^u = \exp(S_x^u/b) \), so \( q'/x = p'/x/p_x \), \( q_x^0 = \text{constant} \)
- \( q_x = \prod_c q_c(x_c) / \prod_s q_s(x_s) \), so can update \( q(x) \), find min, via JT alg
- Implies \( S_x = \Sigma_c S_c(x_c) - \Sigma_s S_s(x_s) \), \( S = \Sigma_c S_c - \Sigma_s S_s \)
- If edit \( p(T|A) \) -> \( p'(T|A) \), need T,A in same clique
- \([\min, \max] = [p/\min_{(x \in A\&notT)}q_x, 1-((1-p)/\min_{(x \in A\&T)}q_x)]\)
Edit-Based Combo System Needs

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2) Find & show to user u (who has assets $S^u$):
   a) Current consensus $p(T|A)$
   c) Limits $[\text{min}, \text{max}]$ of new $p'$ ($T|A$), to ensure $S^u \geq 0$

3) User u aborts or picks a $p'$ ($T|A$) in $[\text{min}, \text{max}]$

4) Update $p$ to reflect $p(T|A) \rightarrow p'(T|A)$

5) Update assets $S^u$ to reflect bet for $p'$ over $p$

6) Periodically show how $S^u = E_p[S^u]$ vary with $u$
DAGGRE vs. SciCast

- **DAGGRE**
  - ~100 claims at a time
  - Network treewidth ~5
  - Show expect long/short
  - Only local edits allowed
  - < 5 values per variables

- **SciCast**
  - ~1000 claims at a time
  - Network treewidth 50?
  - Show min long/short
  - Allow arbitrary edits?
  - Value trees, cont. distr.
What Field 2013 Physics Nobel?

- bio
- geo
- astro
- particle
- atomic
- molecular
- condensed
- optical

- Neutrino: 30%
- Neutrino mixing angle: 0.4%
- other fields: 15%
- 2%
When 1000 qubits?

Probability

Assets
What If A Is Far from T?

• **Option 1:** Find nearest changes to ideal LMSR edit of $P(T|A)$ that fit network constraints.

• **Option 2:** Translate far assumptions $A$ into local clique assumptions $L$, let user edit $P(T|L)$.
Can Users Edit Links?

- Add link => bigger cliques
  - Costs system more space/time to store/update
  - Allow if users willing to make big supporting edit?

- Delete link => some old assets can’t be sold
  - Allow if edit creates conditional independence?

- How control compute costs while allowing structure changes?
  - Require combine add, delete links so same cost?