Administrative Issues

- Everyone should have access to →Open.UP
- Revised Syllabus uploaded to →Open.UP (more changes in the near future)
- Anyone in the Classroom *Without* Registration on PULS? (non-Japanese participants only)

Modeling Political Decisions for Sustainability

Module 2: The Predictioneer's Game – Logic & Overview

24 Oct. 2024, 8:45-10:15h

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Goals

- Why use simulation in the social sciences?
- The Predictioneer's Game: logic & overview
- Case: Predicting Paris

Why use simulation in the social sciences?

- Keywords, up to 3 entries
- Mentimeter:
  - mentimeter.com
  - Code: 4506 2085

Why use simulation in the social sciences?

- Simulation is the simplified representation of a structure or system, often by way of software
  - replication (of the past)
  - trajectories (past & future)
  - forecast (future)
- Why simulate?
  - system representation
  - formalization
  - theory development, but also "understanding"
  - non-human experimentation ("computer experiments")
  - training (of executives, students, etc.)
  - prediction
  - preparation/exploration of policy options
  - discovery (e.g., transition to a "climate-neutral" economy)

Recap

- Which core "components" are necessary for simulations of political negotiations?
  - think of the Predictioneer's Game
  - Up to 3 keywords or very short phrases only
  - Mentimeter:
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Recap

- Rationality/self-interest
- Best responses (to each other actor)
- Actors: Who?
- Position: What (they want)?
- Salience: How important?
- Influence: How much potential influence?
- Flexibility (Resolve): How flexible?
- Veto: Legal or formal right to induce the status quo ante?

The Predictioneer's Game: Logic & Overview

- Developer
  - Prof. Bruce Bueno de Mesquita
    - Political Science Department, New York University
    - Selectors Ltd.
- Purposes
  - predict outcomes of multi-actor negotiations
  - intervene into decisions, given knowledge of the model outputs
    - social engineering
- Accuracy: >90%, >1,700 forecasts
- Running Example (→videos for various modules)

The Predictioneer's Game: Logic & Overview

- Logic:
  - builds on non-cooperative game theory
    - strategic interaction among actors
    - Nash Bargaining Solution (NBS)
      - best responses to each other actor
        - A knows that B knows, that A knows… for all actors…
    - assumes selfishness
      - incentives: rewards (carrots) or sticks (costs) such as to influence their decision in one's own favor
    - coerce, compromise, accept offer, etc.
    - expected utility reasoning
  - dynamic
    - potentially many rounds, until the "end rule" kicks in (→Module 4)
    - all variable/input scores are newly computed per negotiation round (→Module 4)
  - Bayes rule/Bayesian updating of beliefs of each other (→later slides)
  - Solution Concept: Perfect Bayesian equilibrium (→later slides)

Components of the Predictioneer's Game

- Actors
- Position
- Potential Influence
- Salience (importance)
  - multiplied with potential influence ≡ "power"
- Flexibility (resolve)
- *(legal or formal)* Veto Power

- We will learn more about each of these components →Module 3

Short Break

Questions

- coerce, compromise , etc. →Module 4

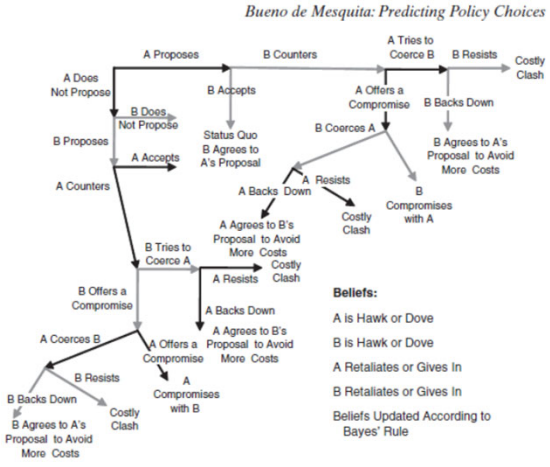


Figure 2. Structure of the Game: Sketch of One of N^2–N Stage Games Played Simultaneously Information sets are not displayed, N = number of players/stakeholders.

Case Study: Predicting Paris

Case Study: Predicting Paris (Sprinz et al. 2016)

Ex ante predictions and ex post assessments

	Ex Ante Predictions				Ex Post Assessment
Issue	Average of Ex Ante Experts (range; s.d.)	Inclusive Exchange Model	Restrictive Exchange Model	Predictioneer's Game	Our Coding of COP-21 Texts
Differentiation	39 (0-75; 23.03)	38	35	58	50
Mitigation—MRV & Compliance	43 (0-75; 27.54)	44	58	50	70
Mitigation—Legal Form	60 (0-70; 19.42)	45	51	53	70
Adaptation—Legal Framework	44 (0-100; 18.76)	79	79	60	50
Adaptation—Institutions	52 (0-60; 20.55)	65	65	67	50
Climate Finance—Volume	17 (0-100; 17.10)	60	41	55	20
Climate Finance—Who Pays?	33 (0-80; 20.49)	39	21	27	20
Adaptation Reserved Finance	30 (0-100; 27.54)	53	68	66	40
Loss & Damage	29 (0-70; 16.63)	10	15	45	30
Ambition Level—Mitigation Mechanism	42 (0-100; 21.68)	30	43	35	65
Mitigation—2050	29 (0-100; 25.39)	69	58	47	10
Mitigation—2100	33 (0-100; 35.10)	91	86	85	80
Ex Ante Assessment of Future (I)NDCs	42 (0-100; 29.15)	7	9	47	20

Note: The Ex Ante Expert survey contains responses from 38 experts, each of whom predicted the outcomes on almost all of the 13 issues.

Sprinz et al. (2016, 178)

Perfect Bayesian Equilibrium

- imperfect and perfect information models
  - full information: everyone knows everyone knows about everyone…
    - i.e., best responses to each other (Nash Bargaining Solution for all parts of a decision tree)
  - limited information: player's *type* is not known to others
    - e.g., *Hawk* or *Dove*
  - subgame perfect solution
    - Nash Bargaining Solution (best responses to each other) for all parts of a decision tree *forward* under perfect information
- Perfect Bayesian Equilibrium is the equilibrium under *imperfect* information, i.e., probabilistic outcome guided by the beliefs of the type of actor encountered in terms of best responses to each other

Bayes Rule

Example 4. A screening test for a disease is both sensitive and specific. By that we mean it is usually positive when testing a person with the disease and usually negative when testing someone without the disease. Let's assume the true positive rate is 99% and the false positive rate is 2%. Suppose the prevalence of the disease in the general population is 0.5%. If a random person tests positive, what is the probability that they have the disease?

answer: As a review we first do the computation using trees. Next we will redo the computation using tables.

Let's use notation established above for hypotheses and data: let $\mathcal{H}_+$ be the hypothesis (event) that the person has the disease and let $\mathcal{H}_-$ be the hypothesis they do not. Likewise, let $\mathcal{T}_+$ and $\mathcal{T}_-$ represent the data of a positive and negative screening test respectively. We are asked to compute $P(\mathcal{H}_+|\mathcal{T}_+)$.

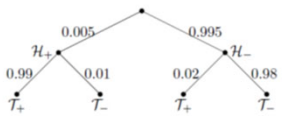
We are given

$$P(\mathcal{T}_+|\mathcal{H}_+) = 0.99, \quad P(\mathcal{T}_+|\mathcal{H}_-) = 0.02, \quad P(\mathcal{H}_+) = 0.005.$$

From these we can compute the false negative and true negative rates:

$$P(\mathcal{T}_-|\mathcal{H}_+) = 0.01, \quad P(\mathcal{T}_-|\mathcal{H}_-) = 0.98$$

All of these probabilities can be displayed quite nicely in a tree.



source: https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/readings/MIT18_05S14_Reading11.pdf

Bayes Rule

Bayes' theorem yields

$$P(\mathcal{H}_+|\mathcal{T}_+) = \frac{P(\mathcal{T}_+|\mathcal{H}_+)P(\mathcal{H}_+)}{P(\mathcal{T}_+)} = \frac{0.99 \cdot 0.005}{0.99 \cdot 0.005 + 0.02 \cdot 0.995} = 0.19920 \approx 20\%$$

Now we redo this calculation using a Bayesian update table:

hypothesis	prior	likelihood	Bayes numerator	posterior
$\mathcal{H}$	$P(\mathcal{H})$	$P(\mathcal{T}_+\|\mathcal{H})$	$P(\mathcal{T}_+\|\mathcal{H})P(\mathcal{H})$	$P(\mathcal{H}\|\mathcal{T}_+)$
$\mathcal{H}_+$	0.005	0.99	0.00495	0.19920
$\mathcal{H}_-$	0.995	0.02	0.01990	0.80080
total	1	NO SUM	0.02485	1

The table shows that the posterior probability $P(\mathcal{H}_+|\mathcal{T}_+)$ that a person with a positive test has the disease is about 20%. This is far less than the sensitivity of the test (99%) but much higher than the prevalence of the disease in the general population (0.5%).

source: https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/readings/MIT18_05S14_Reading11.pdf