Game Theory

Phil Arena

Empirical Evaluation

Introduction

- Three goals for this session
  1. Discuss pros and cons of treating models as complete DGP
  2. Discuss pros and cons of experimental tests of GT models
  3. Discuss pros and cons of quantal response equilibria

Models as Complete DGP

- Three interpretations of theoretical models
  - Complete data-generating process
  - Partial data-generating process
  - Unrelated to data-generating process
- Pros and cons of complete DGP
  - Straightforward interpretation of empirical results
  - Requires heroic assumptions for observational data
  - More defensible assumptions for experimental data?

Example: Conventional Deterrence

- Assume following model captures complete DGP
  - Iff C dissatisfied with status quo:
  - D can attempt to deter by building up military
  - C issues ultimatum/executes *fait accompli*
  - D accepts (peace) or rejects (war)
  - no actions taken otherwise
- Why we might get wrong answer even in simulated data
  - $\text{pr}(\text{war}|\text{satis}) < \text{pr}(\text{war}|\text{dissat, deter}) < \text{pr}(\text{war}|\text{dissat, no deter})$
  - Cannot measure satisfaction
  - Can only compare pr(war|build) to pr(war|no build)
  - D never builds up military when C satisfied
  - Difficult to solve prob even w/ proxies, sophisticated methods

Experimental Tests

- Classic trade-off b/w internal, external validity
  - Likely participants WEIRD
  - Also young, idealistic, eager for acceptance, and unpracticed at making decisions of great consequence w/ real tradeoffs
- Concerns about internal validity
  - Induced value theorem may only hold for very high stakes
  - Laboratory setting is itself a treatment
  - Important differences b/w field, lab experiments
  - Concerns about replication, small sample sizes, false positives

A Model of Asymmetric Nuclear Crises

- Consider the following game
- 1 chooses to attack or not
- Iff 1 attacks, 2 chooses b/w conventional, nuclear retaliation

Outcomes	u_C	u_D
Status quo	0	1
Conventional war	$w - c_C$	$1 - w - c_D$
Nuclear war	$-100c_C$	$1 - 2c_D$

Analysis

- Unique SPNE under complete information
  - D prefers conventional retaliation iff $c_D \geq w$
  - When $c_D \geq w$, C prefers SQ iff $c_C \geq w$
  - When $c_D < w$, C must prefer SQ

- Suppose $w = 0.5$, $c_D = 0.51$, $c_C = 0.49$
  - According to SPNE, C will attack
  - Many find this implausible
  - Suppose D chooses sub-optimal strategy w/ prob ϵ
  - $u_C(\text{not}) \geq E(u_C(\text{attack})) \Leftrightarrow 0 \geq \epsilon(-49) + (1-\epsilon)(0.01)$
  - C prefers to attack iff $\epsilon < \hat{\epsilon}$, where $\hat{\epsilon} \approx 0.0002$

Quantal Response Equilibria

- Quantal Response Equilibria
  - Actor i chooses strategy σ_k w/ probability $p_{i,k}$
  - Where $p_{i,k}$ is function of utilities at all outcomes
  - In logit QRE, $p_{i,k} = \dfrac{e^{\lambda u_i(\sigma_k)}}{\sum e^{\lambda u_i(\sigma)}}$
- LQRE to Model of Asymmetric Nuclear Crises
  - Again, let $w = 0.5$, $c_D = 0.51$ and $c_C = 0.49$
  - For now, let $\lambda = 100$
  - D chooses conventional w/ prob 0.731, nuclear w/ prob 0.269
  - Now let $\lambda = 1$
  - D chooses conventional w/ prob 0.502, nuclear w/ prob 0.498

Discussion

- Pros
  - Has greater face validity in many situations
  - Overcomes zero-likelihood problem in statistical estimation
  - Treats utility-maximization as variable
- Cons
  - Any set of data consistent w/ QRE for some λ
  - Is goal to have zero aberrant cases or to explain behavior?
  - Behavior may not always be optimal but is it truly random?
  - Some events do occur with 0 probability
  - Small diffs in u can be associated w/ large diffs in occurrence