Paths Ahead @ LIDS: Networks & Information

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Social network models

- Lots of social network models
  - Social network formation
  - Evolution of convention
  - Social learning
  - Belief diffusion
  - …
Challenge: Influencing social networks

• Motivating scenarios:
  – Competing for customers
  – Influencing political mindsets & beliefs

• Example:
  – Network of customers
  – Competing firms
  – Firms spend resources on customers
  – Customers’ propensity to buy product:
    • Propensity of neighbors
    • Received resources
    • Intrinsic compliance

• Benefits of feedback (Astrom):
  – Reliable behavior from unreliable components
  – Mitigate disturbances & component variations
  – Stabilize & shape dynamic behavior
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  – Reliable behavior from unreliable components
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Maybe not…
Starting point

• Model:

\[ \text{Propensities}^+ = F(\text{Propensities}, \text{Neighbors}, \text{Resources}, \text{Intrinsic}) \]

• Control problem:

*How should a firm expend limited resources over time to maximize network propensity?*

• Game problem:

*In presence of competing firm?*
Contrasts & issues

• **Repeatable first principles:**
  – When I press accelerator, then … ?
  – When I curb rioting through deployment of military force, then … ?

• **Hidden states/beliefs of beliefs:**
  – System dynamics depends on beliefs about controller

• Model uncertainty:
  – Network structure? Agent compliance? Influence measure? Hidden dynamics?

• Sensing:
  – Measured quantities are not physical variables. What can we measure?
  – Aggregate vs individual?

• Actuation:
  – What measures are available to exert influence?
  – How will this affect dynamics?

• Time constants:
  – What is the time frame for influence to evolve?
Contrasts & issues

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• **Hidden states/beliefs of beliefs:**
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• **Model uncertainty:**
  – “Thus unless we know quite a lot about the topology of interaction and the agents’ decision-making processes, estimates of the speed of adjustment could be off by many orders of magnitude.”

  H.P. Young, “Social Dynamics: Theory and Applications”
  & Individual Strategy and Social Structure
Existing work & limitations

• Parsimony:
  – Models tailored towards analytical tractability
  – *Deliberate* limitation on degrees of freedom to gain insights

• Asymptotic:
  – Models typically characterize long term emergent behavior
  – Lacking “real time” analysis

• Nash equilibrium:
  – *Can place unreasonable demands on rationality*

• Disequilibrium:
  – Evolving and unfamiliar landscape limits applicability of equilibrium concepts
Why not?

Sequential decision making in dynamic & uncertain environments

- Challenges underscore relevance of feedback control
  - Reliable behavior from unreliable components
  - Mitigating disturbances & component variations
  - Stabilize & shape dynamic behavior