Econometric Promise Theory

part 2

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Living with uncertainty

WE HAVE MET THE ENEMY AND HE IS US.
Promises have value

- In terms of what is received
- In terms of what it costs to implement
- Involves an exchange of trust
  - Can a promise be exploited?

promise
Exploited or spoiled?
Value is important in autonomy

- The nodes can do whatever they please
- Why should they make/keep their promises?
- Give away value – want something in return?
  - What is the currency of exchange?
  - e.g. promise me web-service, promise you money
  - e.g. promise to forward your packets (both ways)
  - Reliability
Cooperation - bargaining

- Bargaining or trade of valuable promises is a basis for understanding the probability of cooperative behaviour.

- **Cooperative dilemma**: do we or don't we?
  - Autonomy: why should I?
  - “You scratch my back, I'll scratch yours”

- **Cooperation**: obey policy and keep promises

- **Defection**: fail to obey policy
Game theory

• Economics and bargaining are described using game theory
  – Rational agents, base judgement on perceived value
  – Selfish (autonomous) individuals, place their own gains first

• Archetypal example
  – Prisoner's dilemma
  – Bargaining games (Nash equilibrium)
Multi-agent systems

- Have “commitments”
- The idea seems to be like promises, except
  - A model of distributed computation
  - Task oriented
  - More like programming
  - More about dependency and delegation than autonomy
- This is not a model of voluntary cooperation
- Has no notion of value judgement
Promises and games

- A 2 player game involves moves and responses by its players
- Two choices: keep or break promise
  - Cooperate / Defect

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Typed/labelled graph

• Promise types:
  – Service promises (promise to constrain behaviour)
  – Cooperative promise (promise to do the same as)
  – Usage promise (promise to make use of)

• Atomicity rule:
  – Only one promise of a given type per pair:
  – Broken promise => two different promises

\[ X \neq Y \]
Cooperation and 3\textsuperscript{rd} parties

- When two nodes agree to cooperate $C(p)$ it can be viewed as something that can be verified by a third party – or monitor.
- Trust is a form of valuation of agreement.
- Adjudicator = 3\textsuperscript{rd} party.
Roles and 3\textsuperscript{rd} parties

- Works both ways: pledge allegiance to a 3\textsuperscript{rd} party also implies local cooperation.
- Thus common promises to an external agent imply harmonization of roles
- Define a role
  - Appointed role (observer)
  - Cooperative role (allegiance)
- Roles can tell us a lot
- *(Hold this thought)*
How is value measured?

- Promises are initially *typed constraints*
- The currency of value transfer is a *function* of the constraint – what does it mean to the agent
  - Different agents can measure differently
  - Local policy determines the importance
- Global measures with respect to an imaginary third party can be computed using graph theory
  - Centrality <-> objective to external observer
  - Topological valuations <-> reliability
- Common currency graph
Example: BGP

• Autonomous peer system
  – Access promises
  – Transit promises

• Peering agreements
  – “Once a customer, never a peer”
  – (See W.B. Norton analysis of peering)
Social importance - Centrality

• Measure of scalar importance, based on social importance – global statistical **roles**
• Prototype tool for computing - Archipelago
Adjacency matrix

- Adjacency matrix contains the whole structure of the graph

\[ A_{ij} = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \]

- Use two characteristics that relate to security and reliability
  - Eigenvector decomposition (importance)
  - Percolation (connectivity)
Eigenvector centrality

• Matrix $A$ sums neighbours recursively
• Gives eigenvector equation
  • Principal eigenvector = centality

$$A \vec{v} = \lambda \vec{v}$$
Scan of student system

Isolated work groups with autonomous cooperation
Scan of staff system

Staff “trust” each other far more (distrust only students!)
Staff + student system

Implicit links in previously separate groups
Gnutella peer-to-peer
Summary

- Promises (as games) describe steady equilibria, not causal development
- Cooperative agreement builds stability
- Common currency graph $\leftrightarrow$ reliability
- Warfare in peering promises – experience BGP
  - Predict these problems before they arise
  - Determine a policy to minimize uncertainty