Algorithmic and Economic Aspects of Networks

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Networked Markets

Garmets Market

Marseille Fish Market

Labor Markets

Why Network

Trust, predicability, referrals,
incomplete contracts, friction,
moral hazard/adverse selection

price, reputation

Labor Markets

better

"You hear about jobs through your friends."

– Granovetter

Boorman's Model

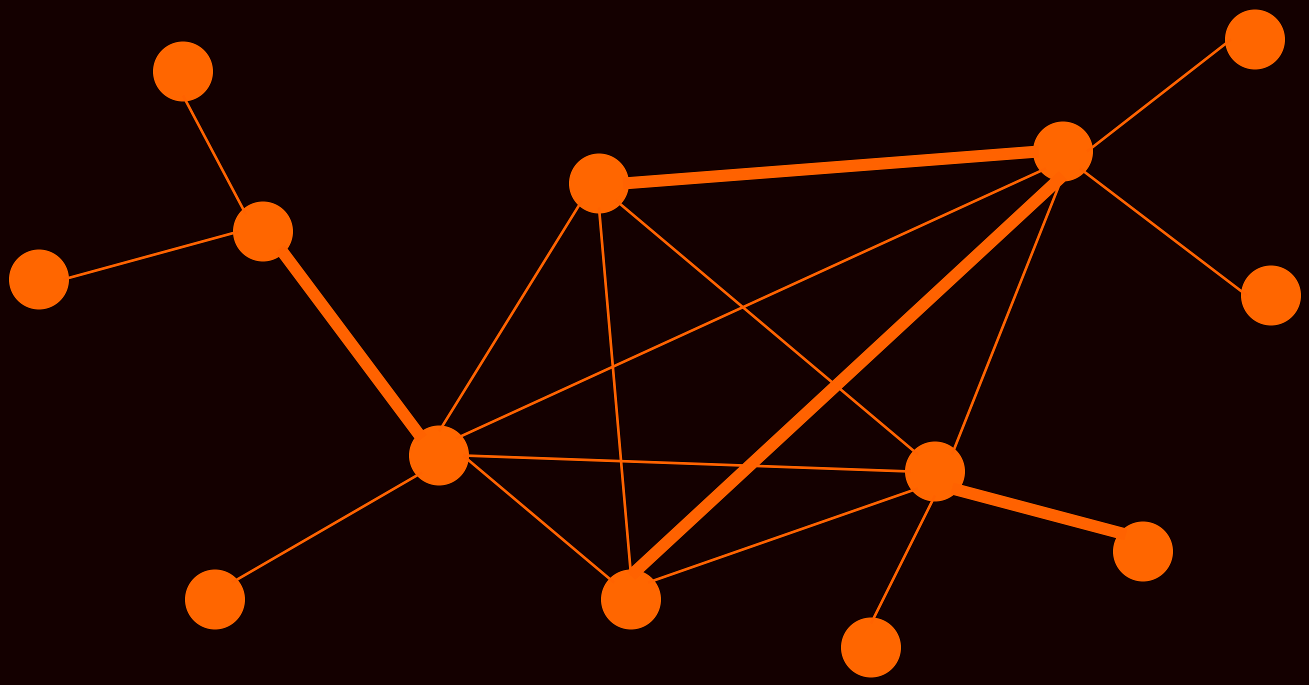
Network of strong and weak ties

Preferential flow of information about job opennings through network

Strong and Weak Ties

Weak + λ·Strong = Time

Information Flow



1) People need jobs with prob. μ.
2) People hear about jobs with prob. δ.
3) People tell (stronger) friends about jobs.

Boorman's Results

Study trees, fix degree of strong/weak ties, consider equilibria via simulation

1) As cost of strong ties ↑, # strong ties ↓.
2) As unemployment prob. ↓, # strong ties ↓.

What's Missing?

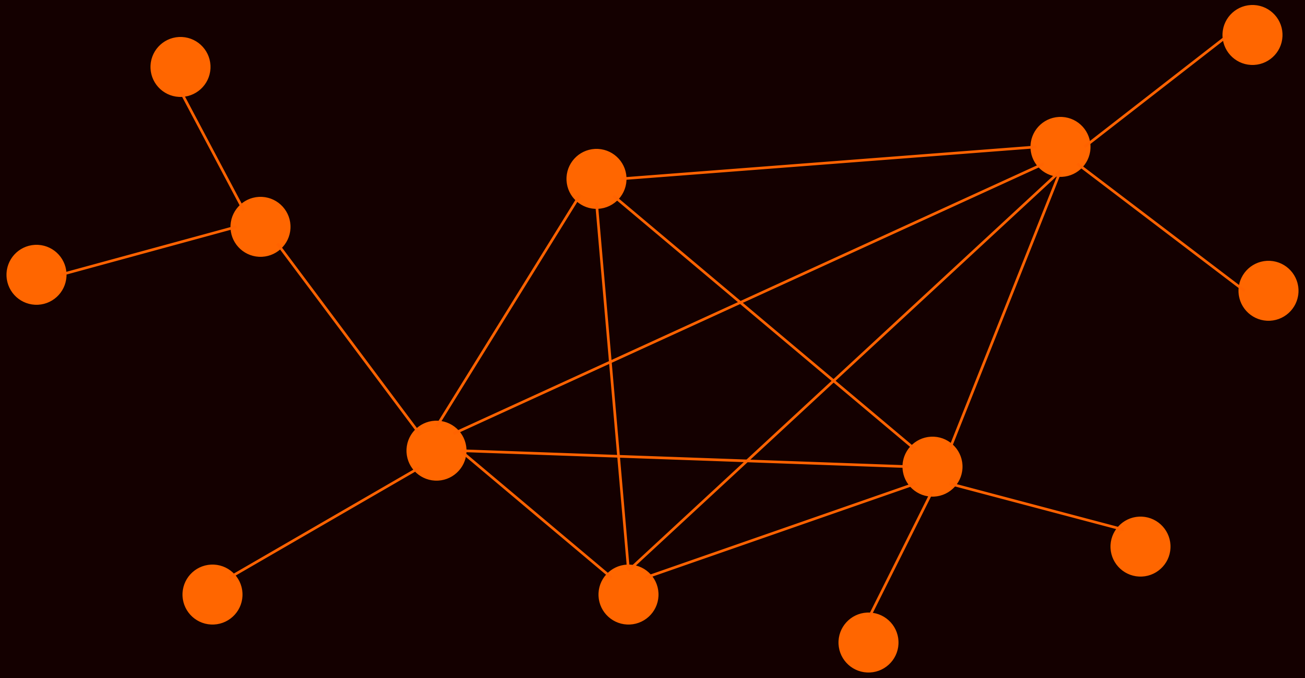
network architecture, e.g., weak ties more likely to be bridges

correlation in employment state over time and network structure

Carvo-Armengol & Jackson

Drop strong/weak distinction, but incorporate time.

Information Flow



1) People need jobs with prob. μ.
2) People hear about jobs with prob. δ.
3) People tell friends about jobs.

Tarred with the Same Brush

Time causes correlation in employment:

you are more likely to find a job if more of your friends have jobs

Persistance of (Lack of) Luck

The longer you are unemployed, the less likely you will find a job tomorrow:

because you are more likely to have more unemployed neighbors

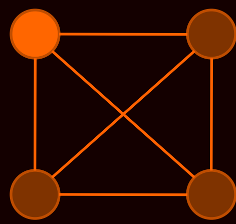
Education

Agents can pay cost c_i to be educated.

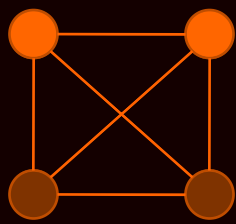
educated – apply previous model

uneducated – payoff zero

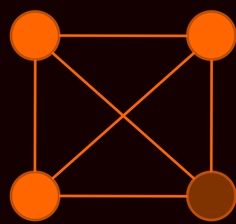
Poverty Traps



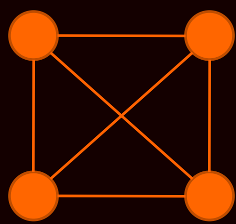
Payoff: $0.5 - c_i$



Payoff: $0.6 - c_i$



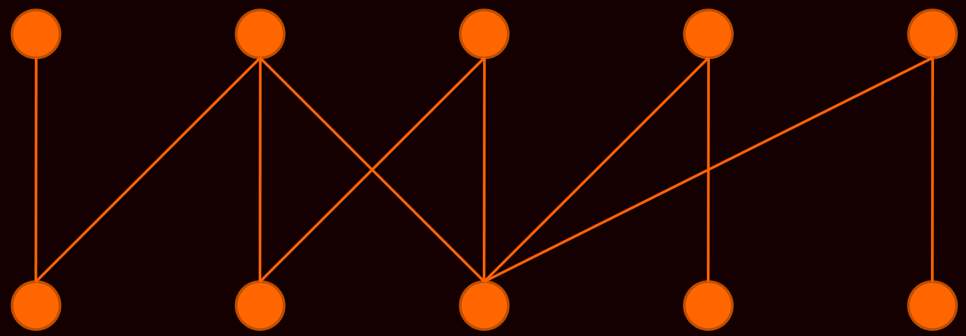
Payoff: $0.65 - c_i$



Payoff: $0.69 - c_i$

Networked Exchange Theory

Network represents potential trades



what prices result?

Nash Bargaining

How to split a dollar?

Matt ($0.50) Mykell ($0.50)

If negotiations fail, you get nothing.

Nash Bargaining

How to split a dollar?

Trevor ($0.70) William ($0.30)

If negotiations fail, Trevor gets $0.60, William gets $0.20.

Nash Bargaining

Any division in which each agent gets at least the outside option is an equilibrium.

Yet …. agents usually agree to split the surplus.

Nash Bargaining

If when negotiation fails,

- A gets \$a
- B gets \$b

Then when succeed,

- A gets \$(a + s/2)
- B gets \$(b + s/2)

s = (1 – a – b)
is the surplus

Nash Bargaining

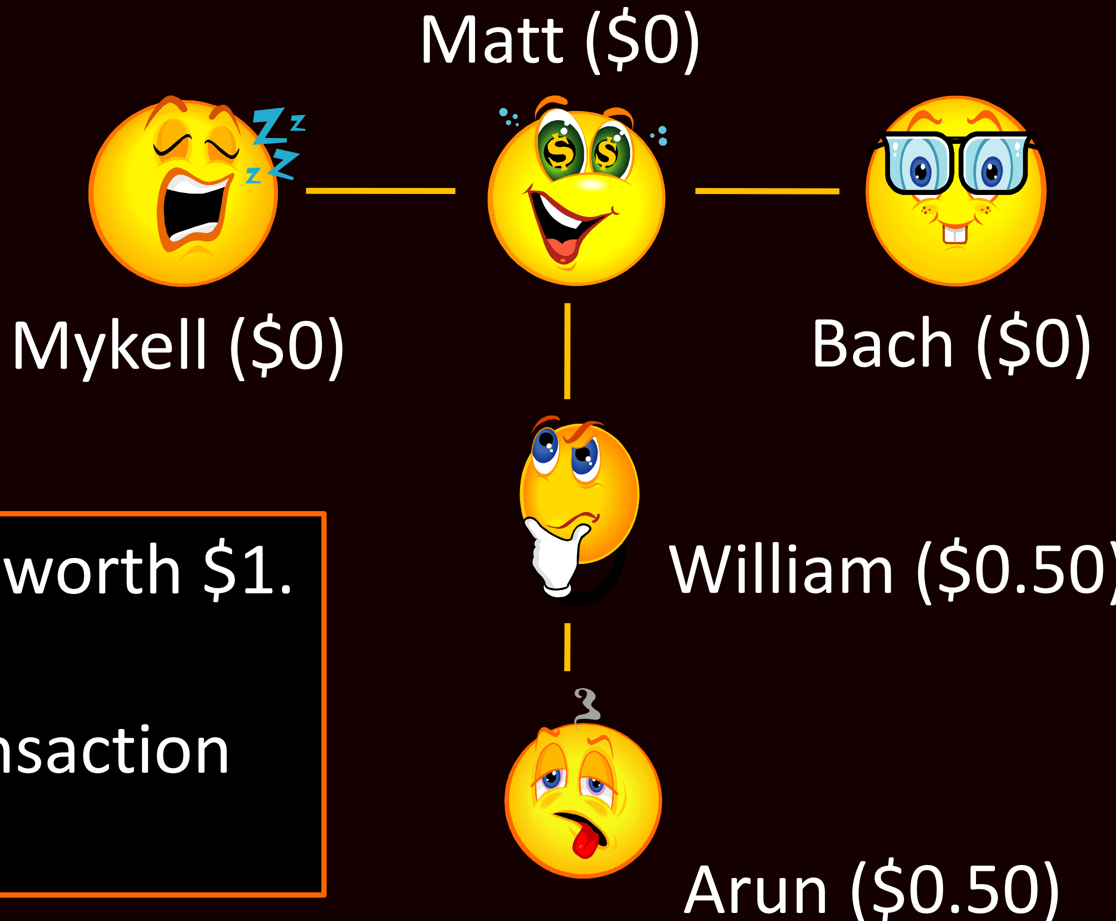
Nash: "Agents will agree to split the surplus."

Motivated by axiomatic approach, optimization approach, and outcome of particular game-theoretic formulations.

Bargaining in Networks

Value of outside option arises as result of network structure.

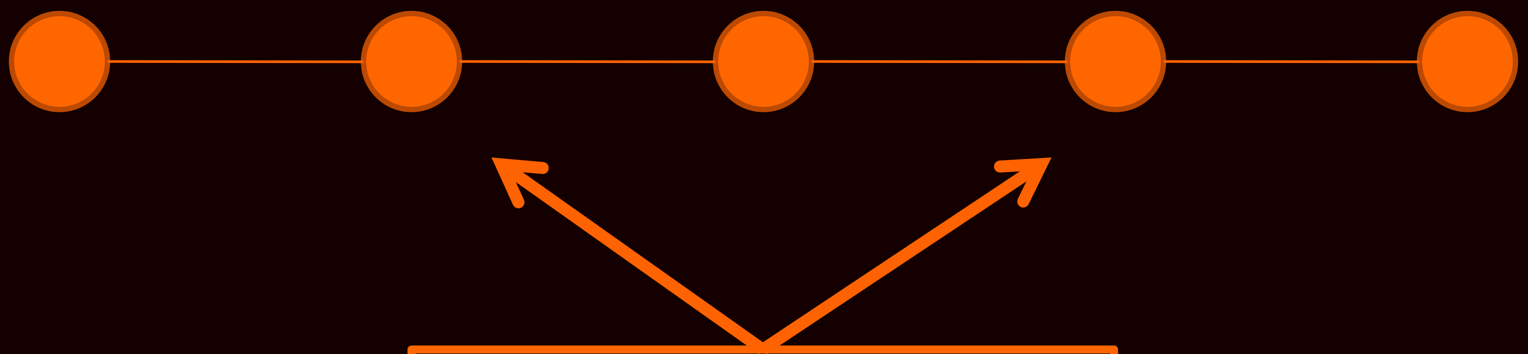
Bargaining in Networks



Transactions worth $1.

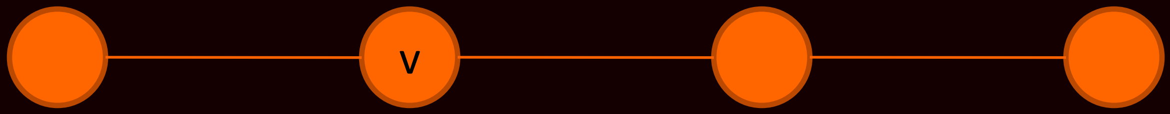
Only one transaction per person!

Bargaining in Networks



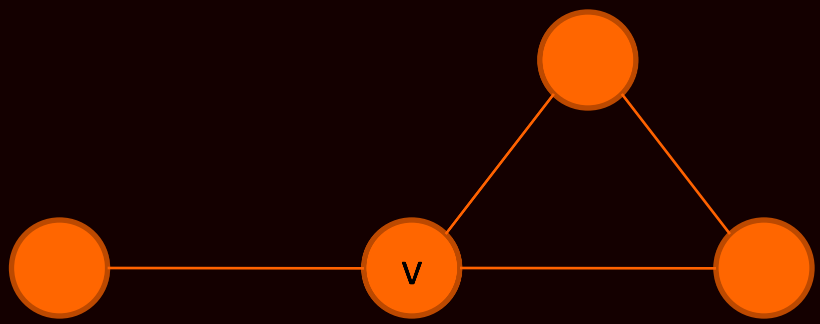
Almost all the money.

Bargaining in Networks



v gets between 7/12 and 2/3 in negotiation to left.

Bargaining in Networks



v gets between 1/2 and 1 in negotiation to left.

Cook and Yamagishi

A solution for a network G is a matching M and a set of values ν_u for each node u s.t.,

- For (u,v) in M, $\nu_u + \nu_v = 1$
- For unmatched nodes u, $\nu_u = 0$

Stable Outcomes

Node u could negotiate with unmatched neighbor v and get $(1 - \nu_v)$.

Outside option of u is α_u = maximum over unmatched neighbors v of $(1 - \nu_v)$.

Stable Outcomes

Defn. An outcome is stable if for all u, $\nu_u \geq \alpha_u$.

Notice there are many stable outcomes, so which one should we expect to find?

Balanced Outcomes

Each individual bargaining outcome should agree with the Nash bargaining solution.

$$s_{uv} = 1 - \alpha_u - \alpha_v$$

$$\nu_u = \alpha_u + s/2$$

And similarly for ν_v.

Computing Balanced Outcomes

A balanced outcome exists if and only if a stable outcome exists.

Balanced outcomes can be computed and characterized using Edmonds-Galai decompositions.

[Kleinberg-Tardos STOC'08]

Assignment:

- Readings:
  - Social and Economic Networks, Chapter 10
  - The two Kearns papers or a paper on labor markets of your choosing (see refs in book)
- Reaction to paper
- Presentation volunteers?