Networks, Crowds, and Markets

Reasoning about a Highly Connected World

Book by David Easley and Jon Kleinberg

Networks, Crowds, and Markets

Outline

I. Graph Theory and Social Networks

II. Game Theory

III. Markets and Strategic Interaction in Networks

IV. Information Networks and the World Wide Web

V. Network Dynamics: Population Models

VI. Network Dynamics: Structural Models

VII. Institutions and Aggregate Behavior

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Outline

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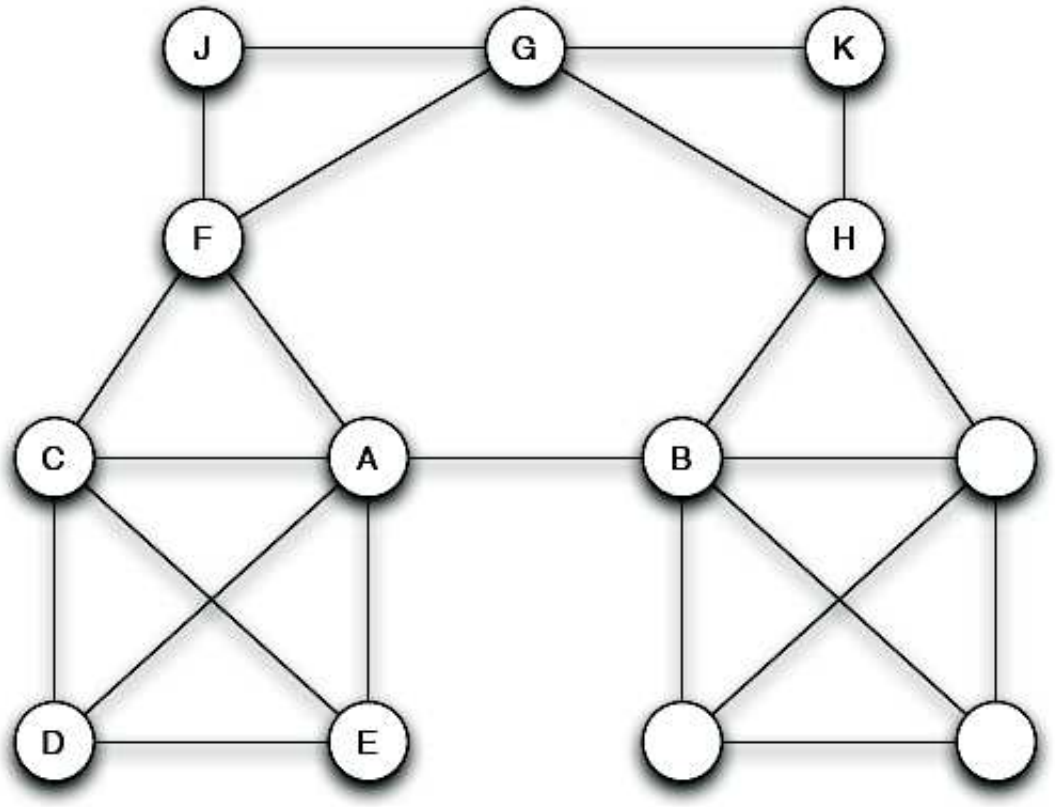
Graph Representation of a Network



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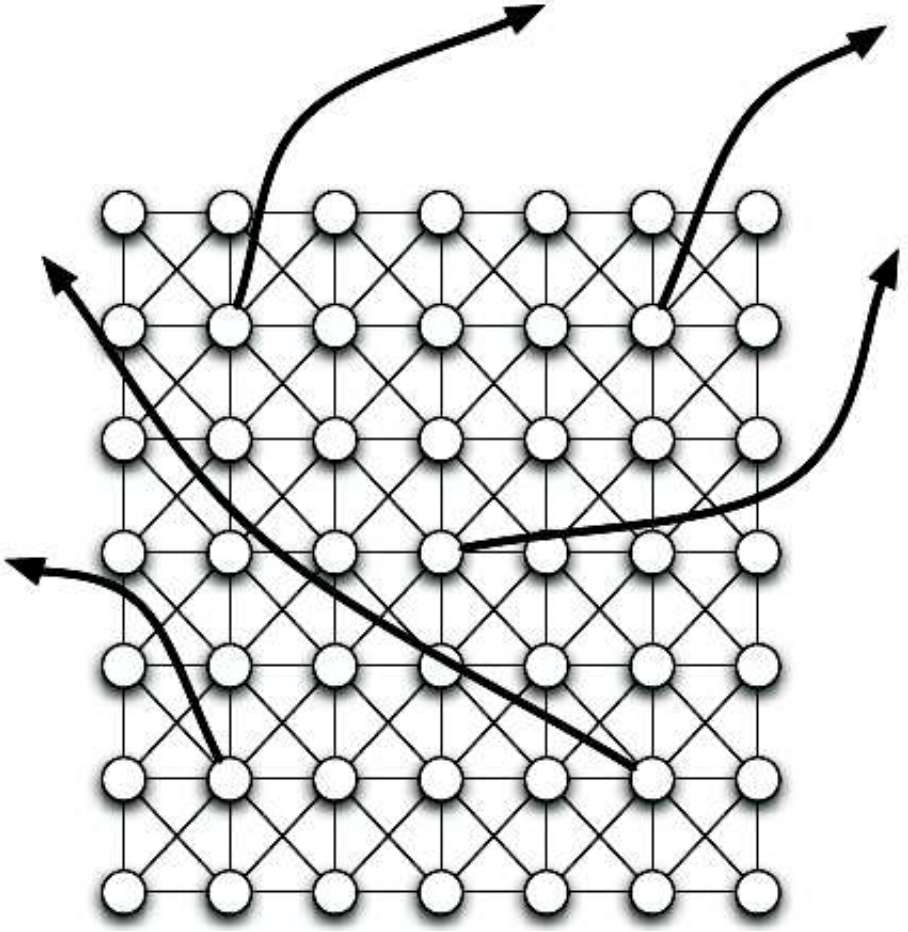
Small World Phenomenon: The Watts-Strogatz model



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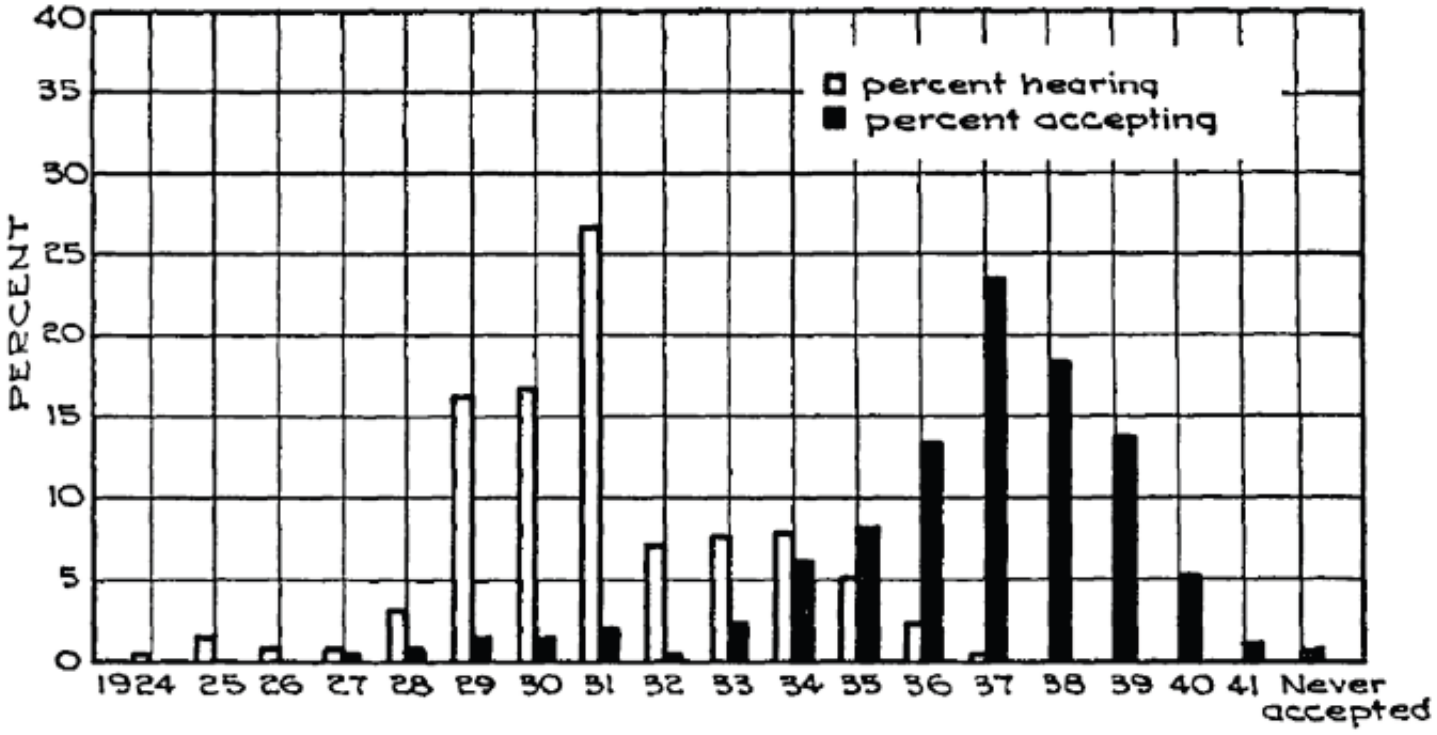
The Power of Weak Ties



The years of first awareness and first adoption for hybrid seed corn in the Ryan-Gross study.

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Outline

The Prisoners' Dilemma

Game:

Should I use performance-enhancing drugs in professional sports or not?

Payoff matrix:

		Athlete 2	
		Don't Use Drugs	*Use Drugs*
Athlete 1	*Don't Use Drugs*	3, 3	1, 4
	Use Drugs	4, 1	2, 2

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Outline

I. Graph Theory and Social Networks
II. Game Theory
III. Markets and Strategic Interaction in Networks
  - Matching Markets
  - Network Models of Markets with Intermediaries
  - Bargaining and Power in Networks

IV. Information Networks and the World Wide Web
V. Network Dynamics: Population Models
VI. Network Dynamics: Structural Models
VII. Institutions and Aggregate Behavior

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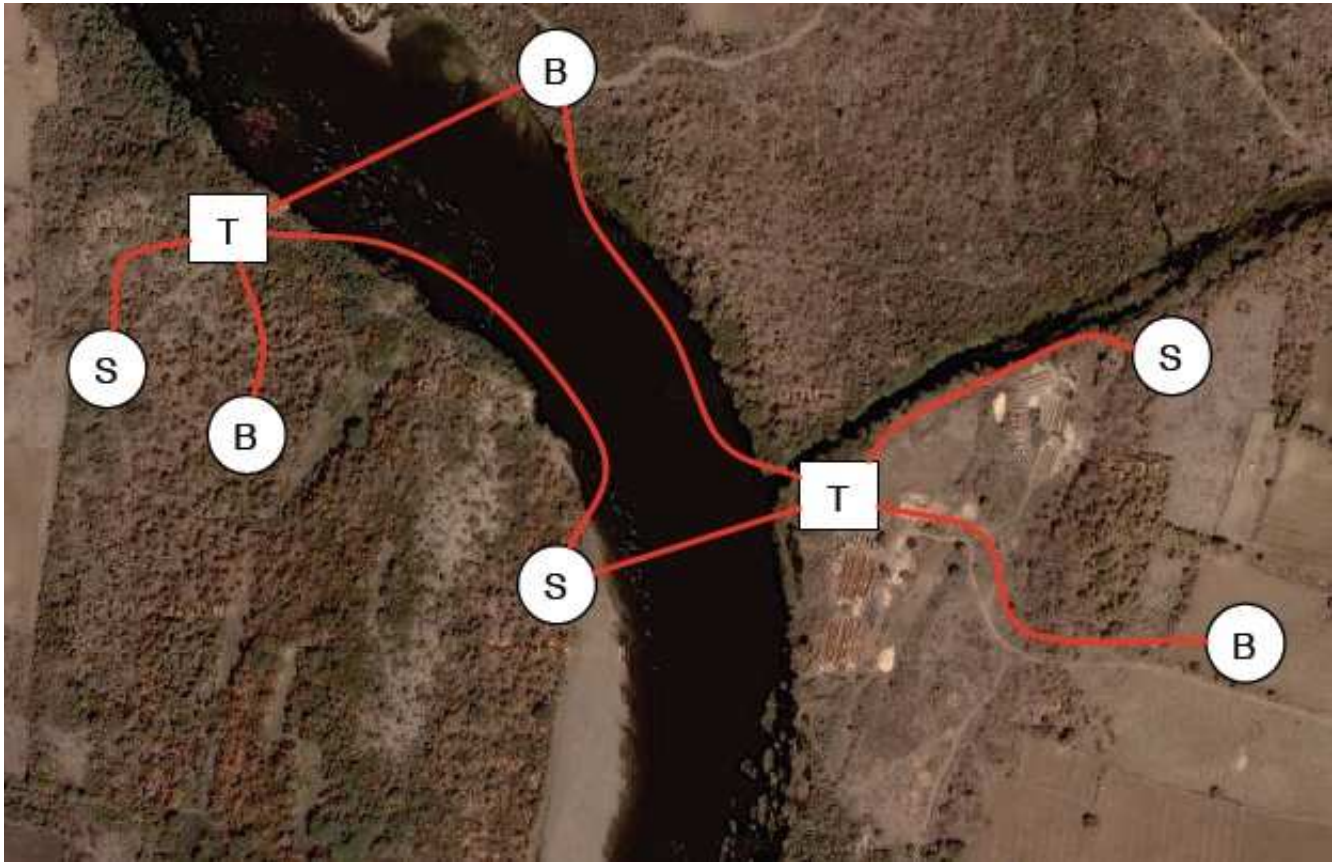
Markets and Trading

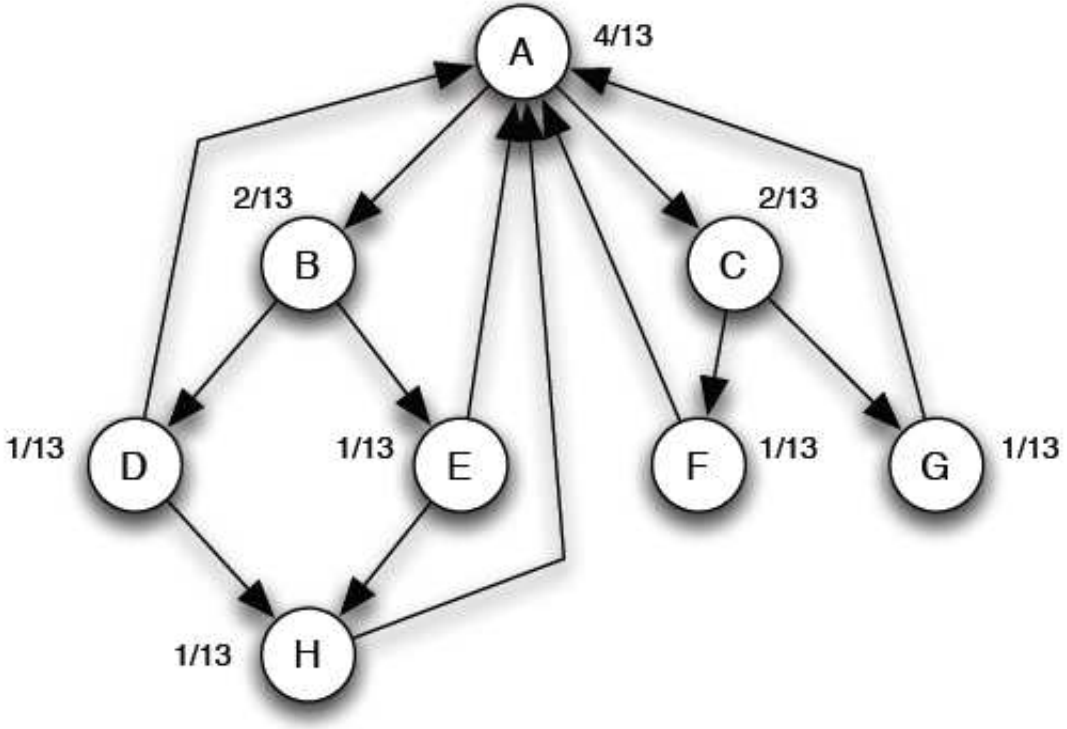


Networks, Crowds, and Markets

Outline

I. Graph Theory and Social Networks
II. Game Theory
III. Markets and Strategic Interaction in Networks
IV. Information Networks and the World Wide Web
  - The Structure of the Web
  - Link Analysis and Web Search
  - Sponsored Search Markets

V. Network Dynamics: Population Models
VI. Network Dynamics: Structural Models
VII. Institutions and Aggregate Behavior



Equilibrium PageRank values for a network of eight web pages.

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V. Network Dynamics: Population Models
   - Information Cascades
   - Network Effects
   - Power Laws and Rich-Get-Richer Phenomena
VI. Network Dynamics: Structural Models
VII. Institutions and Aggregate Behavior

Urns and Balls ...

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The Wisdom of the Crowd

To maximize the chance of guessing correctly, you should guess *majority-blue* if

$$Pr[\textit{ majority-blue } | \textit{ what you have seen }] > \frac{1}{2}$$

and guess *majority-red* otherwise.

Probabilities according to Bayes' Rule in the „Wisdom of the Crowd" szenario:

$$Pr[\textit{ majority-blue } | \textit{ blue }] = Pr[\textit{ majority-red } | \textit{ red }] = \frac{1/2 \times 2/3}{1/2} = \frac{2}{3}$$

Information Cascades

To maximize the chance of guessing correctly, you should guess *majority-blue* if

$$Pr[\textit{ majority-blue } | \textit{ what you have seen }] > \frac{1}{2}$$

and guess *majority-red* otherwise. If the probability is exactly 0.5, it doesn't matter what you choose. Let's suppose you choose the color of your private signal, then.

Probabilities according to Bayes' Rule in the „Information Cascade" szenario:

Person 1 $Pr[\textit{ majority-blue } | \textit{ blue }] = Pr[\textit{ majority-red } | \textit{ red }] = \frac{1/2 \times 2/3}{1/2} = \frac{2}{3}$

Person 2 $Pr[\textit{ majority-blue } | \textit{ blue,blue }] > \frac{2}{3}$

... now an information cascade is going to start ...

Person 3 $Pr[\textit{ majority-blue } | \textit{ blue,blue,red }] = \frac{4/27 \times 1/2}{1/9} = \frac{2}{3}$

All upcoming persons will reason just like Person 3.

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VI. Network Dynamics: Structural Models
- Cascading Behavior in Networks
- The Small-World Phenomenon
- Epidemics

VII. Institutions and Aggregate Behavior

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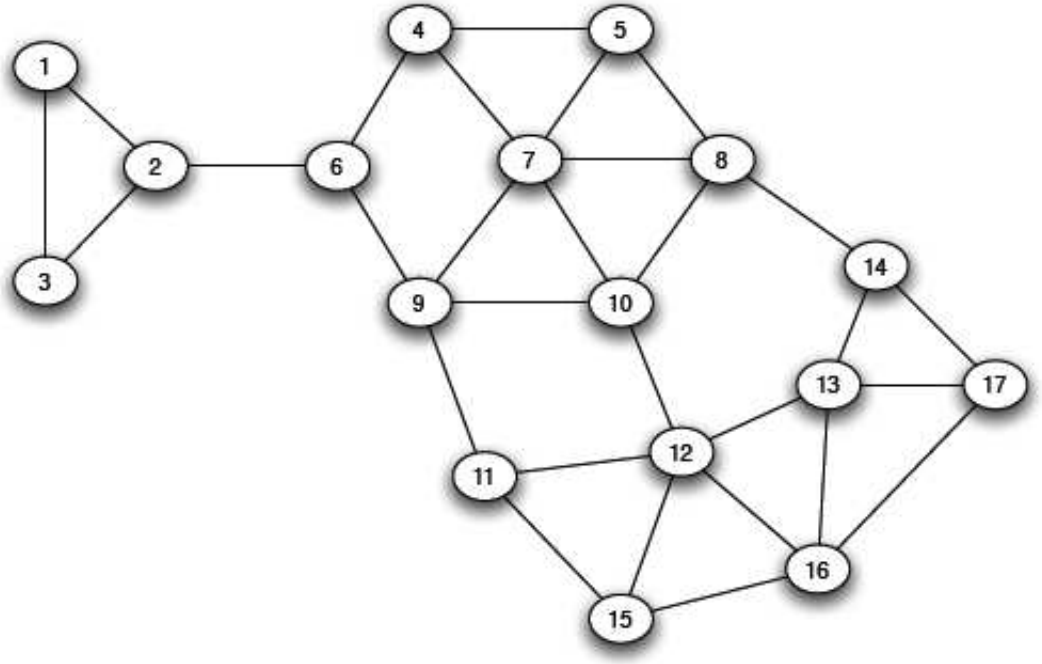
The Power of Strong Ties



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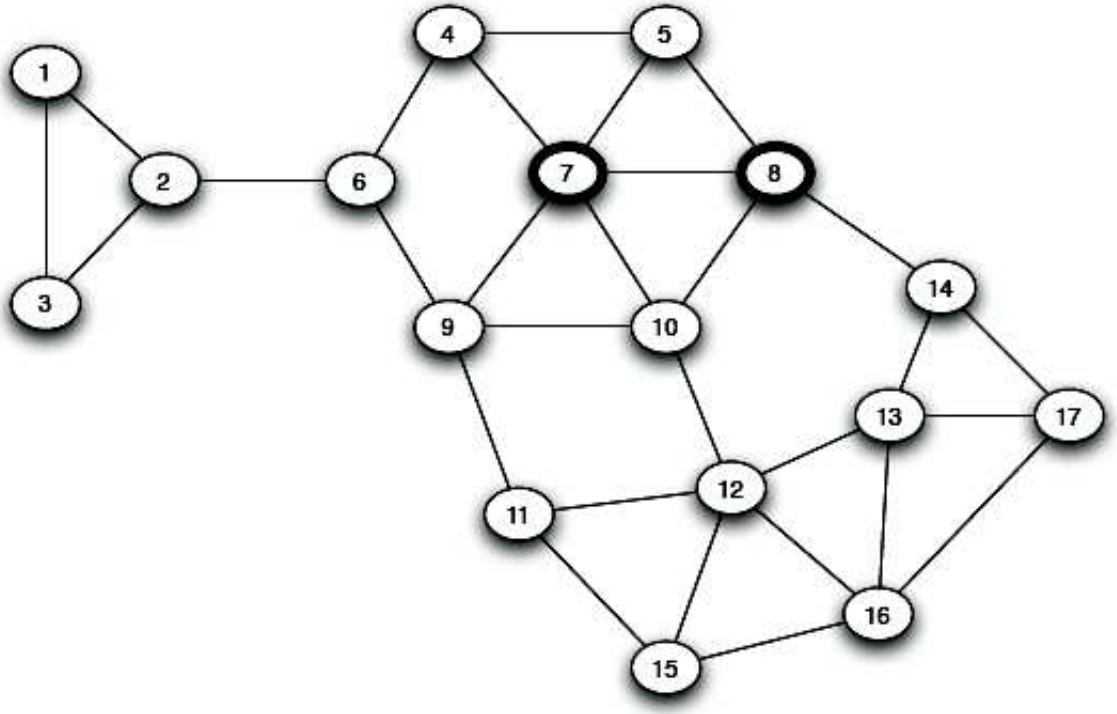
The Power of Strong Ties



(a) *Two nodes are the initial adopters*

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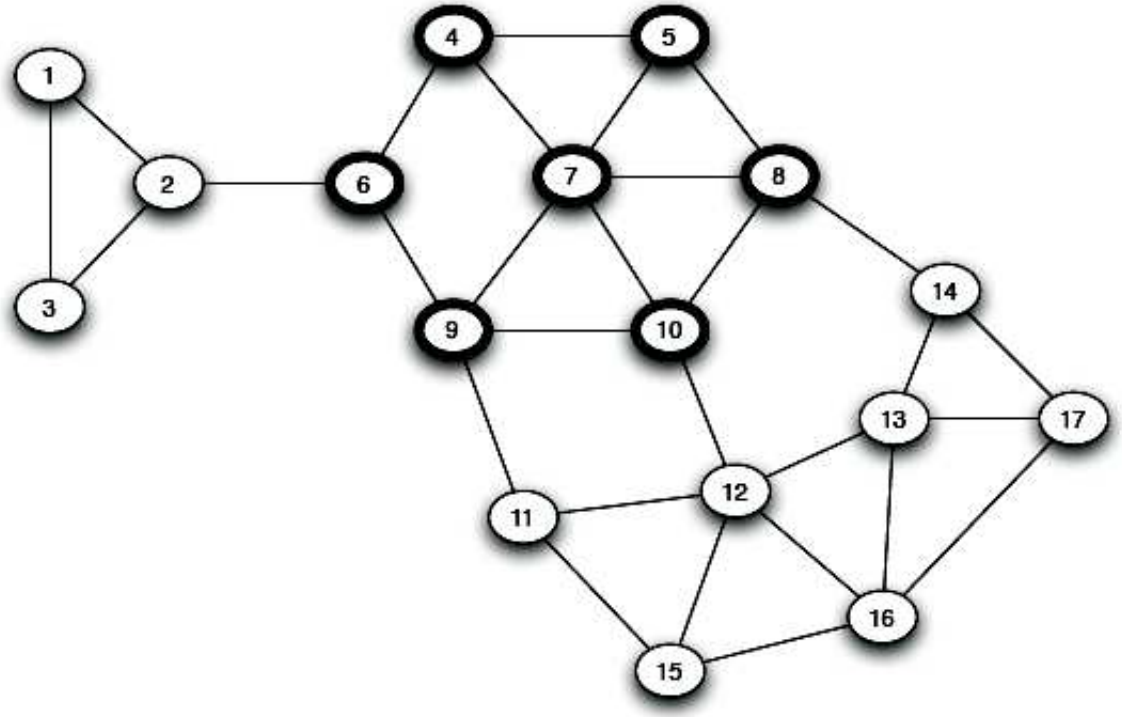
The Power of Strong Ties



(b) *The process ends after three steps*

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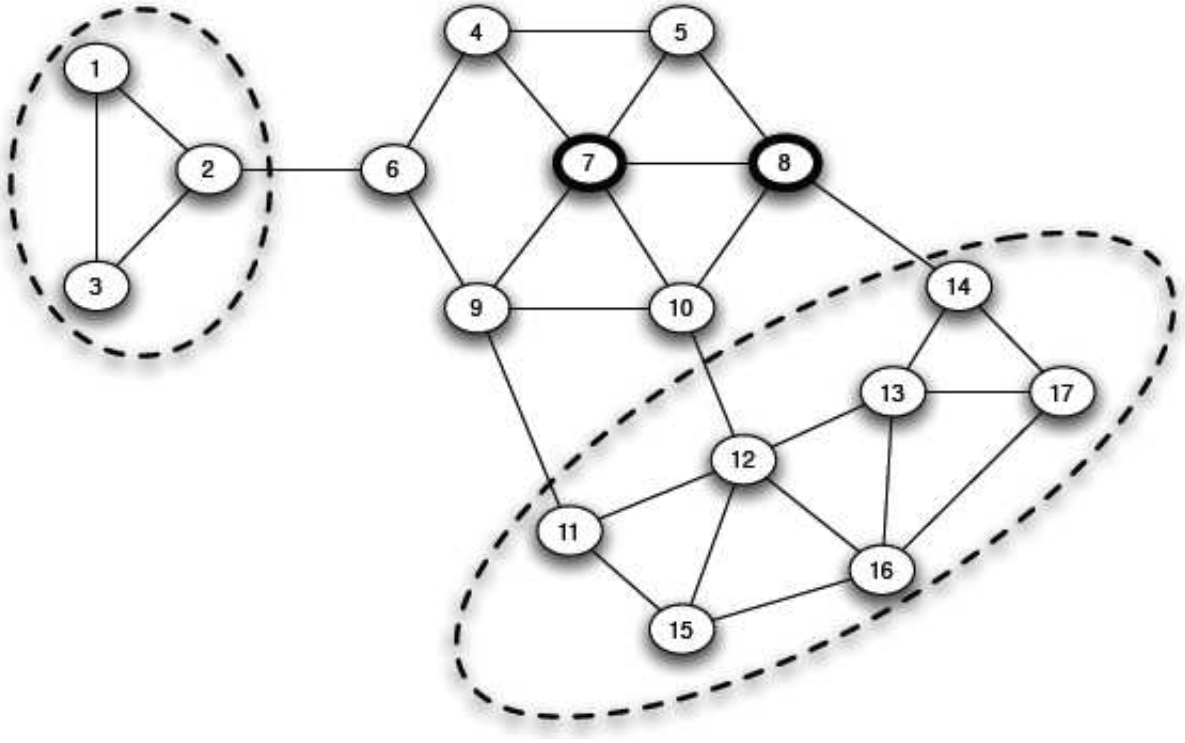

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- Markets and Information
- Voting
- Property Rights

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Covered Phenomena

- The Market for Lemons
- Arrows Impossibility Theorem
- The Tragedy of the Commons

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Book freely available online!

END.