

Network Epistemology

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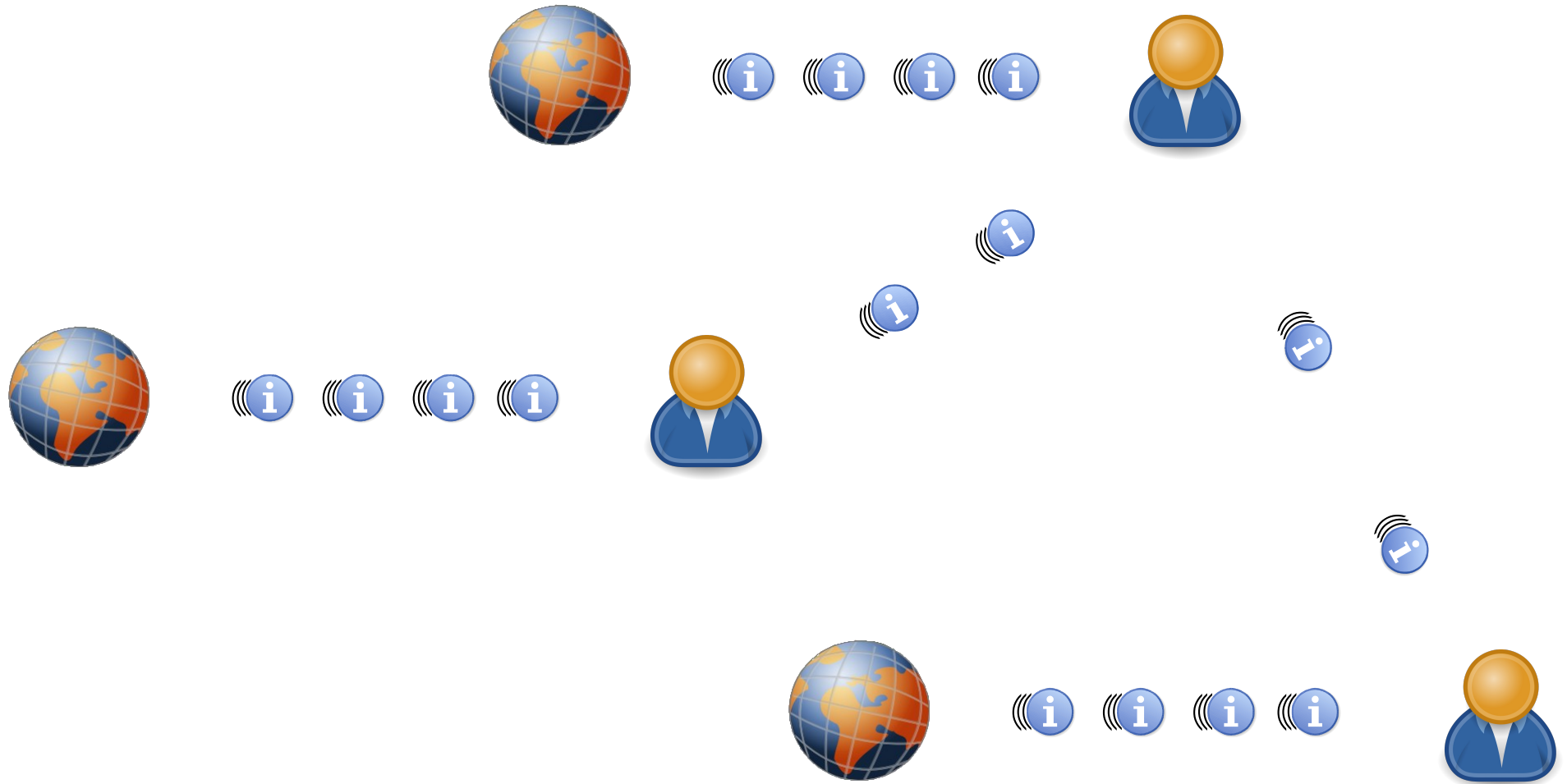
Traditional epistemology



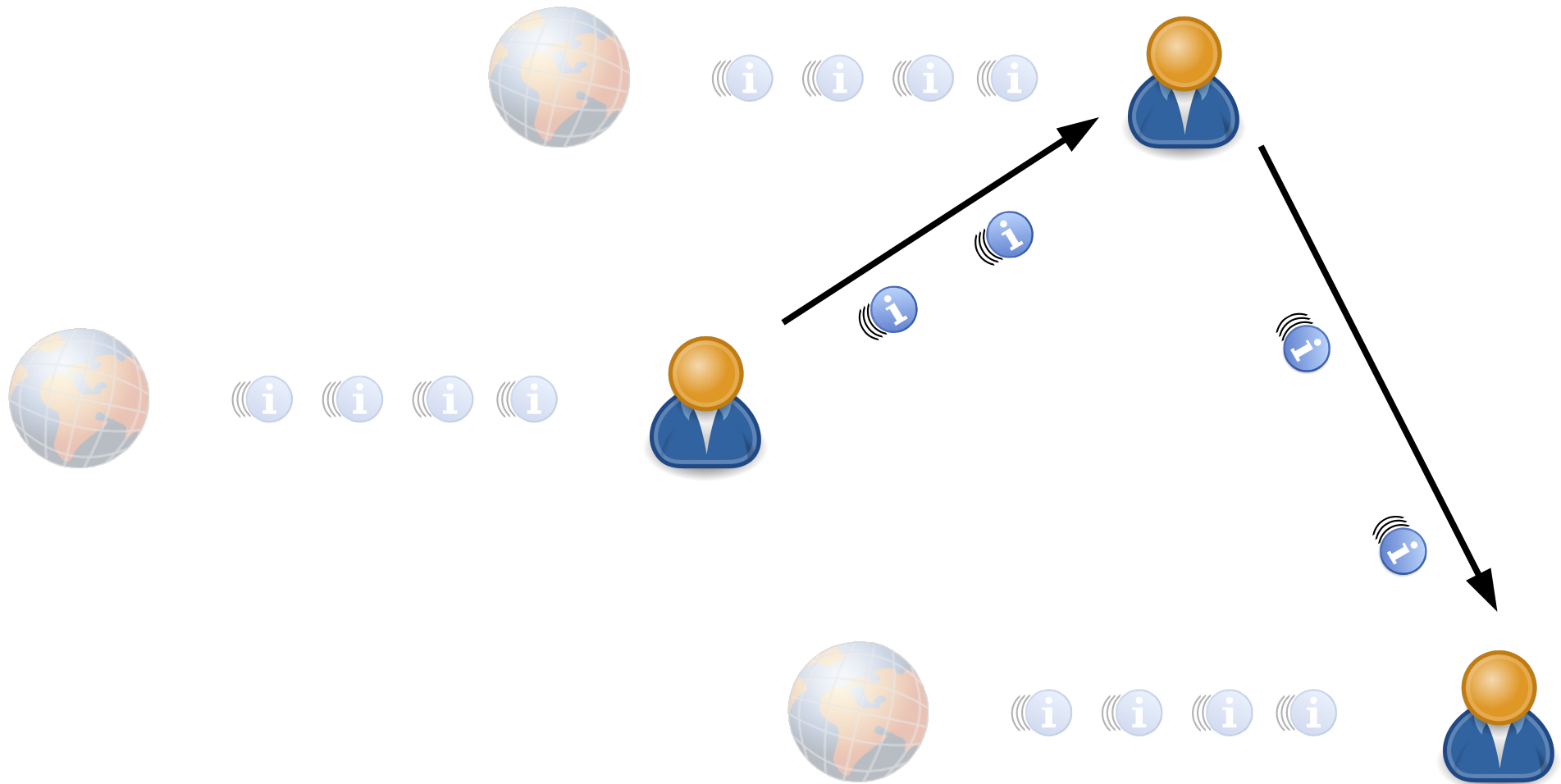
Social epistemology



Epistemic networks



Epistemic networks



Epistemic networks

From among all networks, what is the best network for a community to adopt?

Given a set of incentives, what network is best and what network is likely to arise?

Challenger



January 26, 1986

Challenger

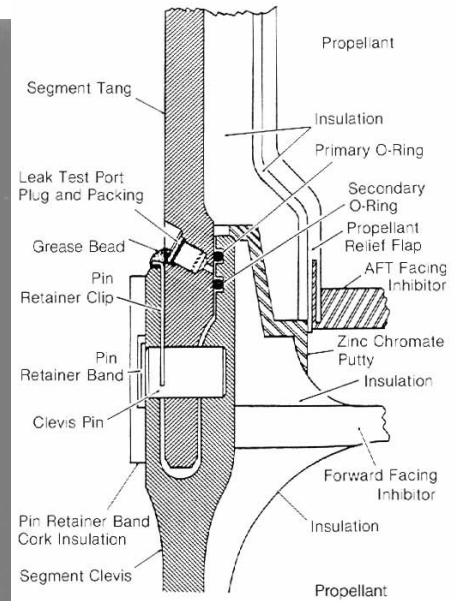
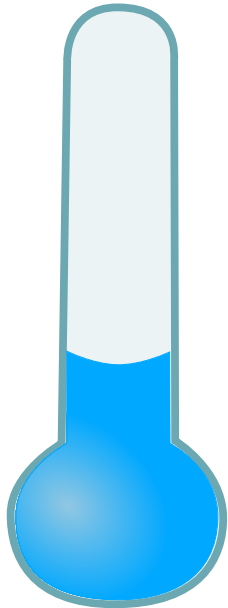
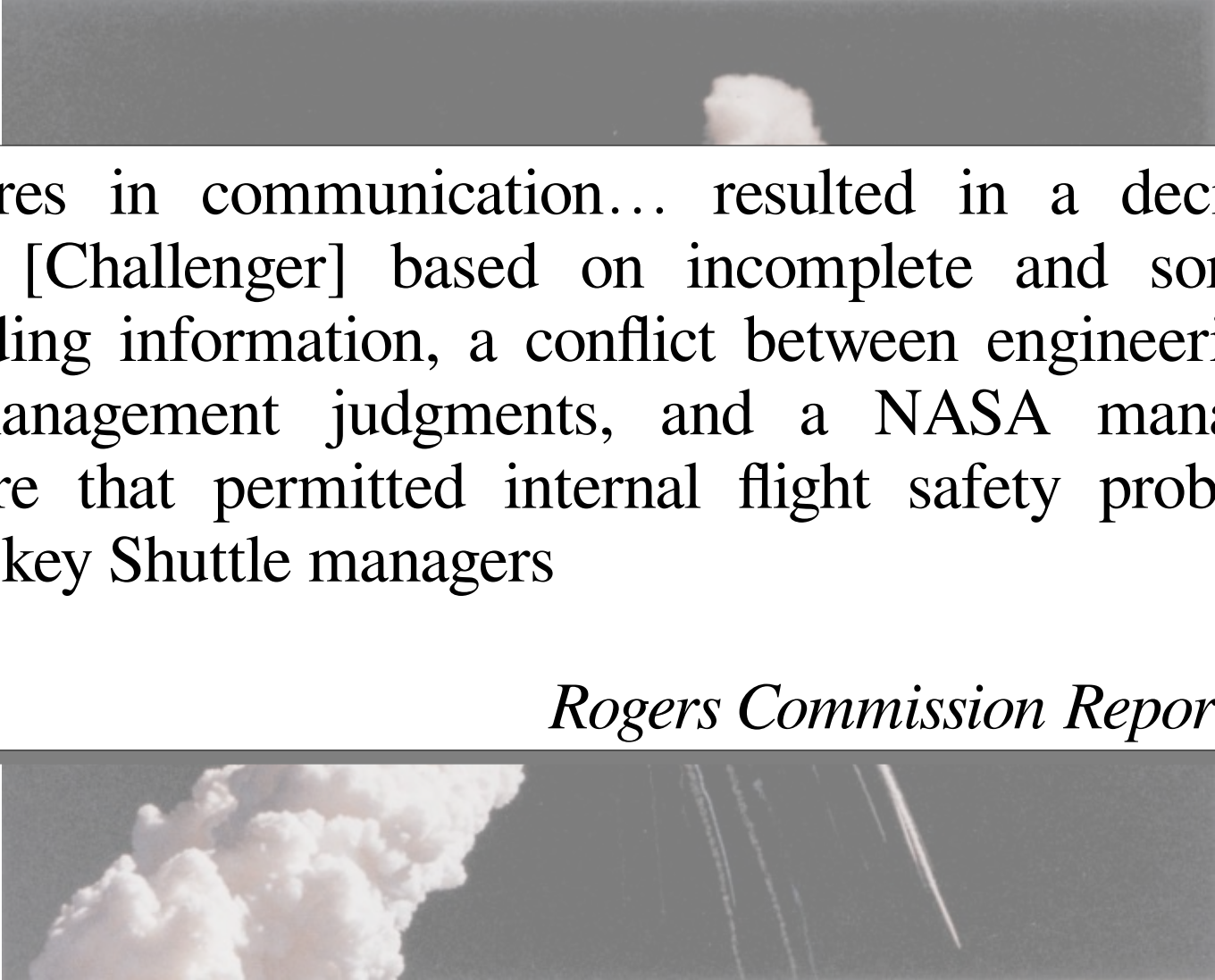


Figure 14
Solid Rocket Motor cross section shows positions of tang, clevis and O-rings. Putty lines the joint on the side toward the propellant.




Challenger

A composite image showing the Space Shuttle Challenger during launch. The top portion shows the shuttle ascending with a small plume of white smoke from the right Solid Rocket Booster. The bottom portion shows a larger, more developed plume of white smoke from the same booster, with the shuttle's trajectory visible as a thin line against the dark sky.

...failures in communication... resulted in a decision to launch [Challenger] based on incomplete and sometimes misleading information, a conflict between engineering data and management judgments, and a NASA management structure that permitted internal flight safety problems to bypass key Shuttle managers

Rogers Commission Report (1989)

Challenger

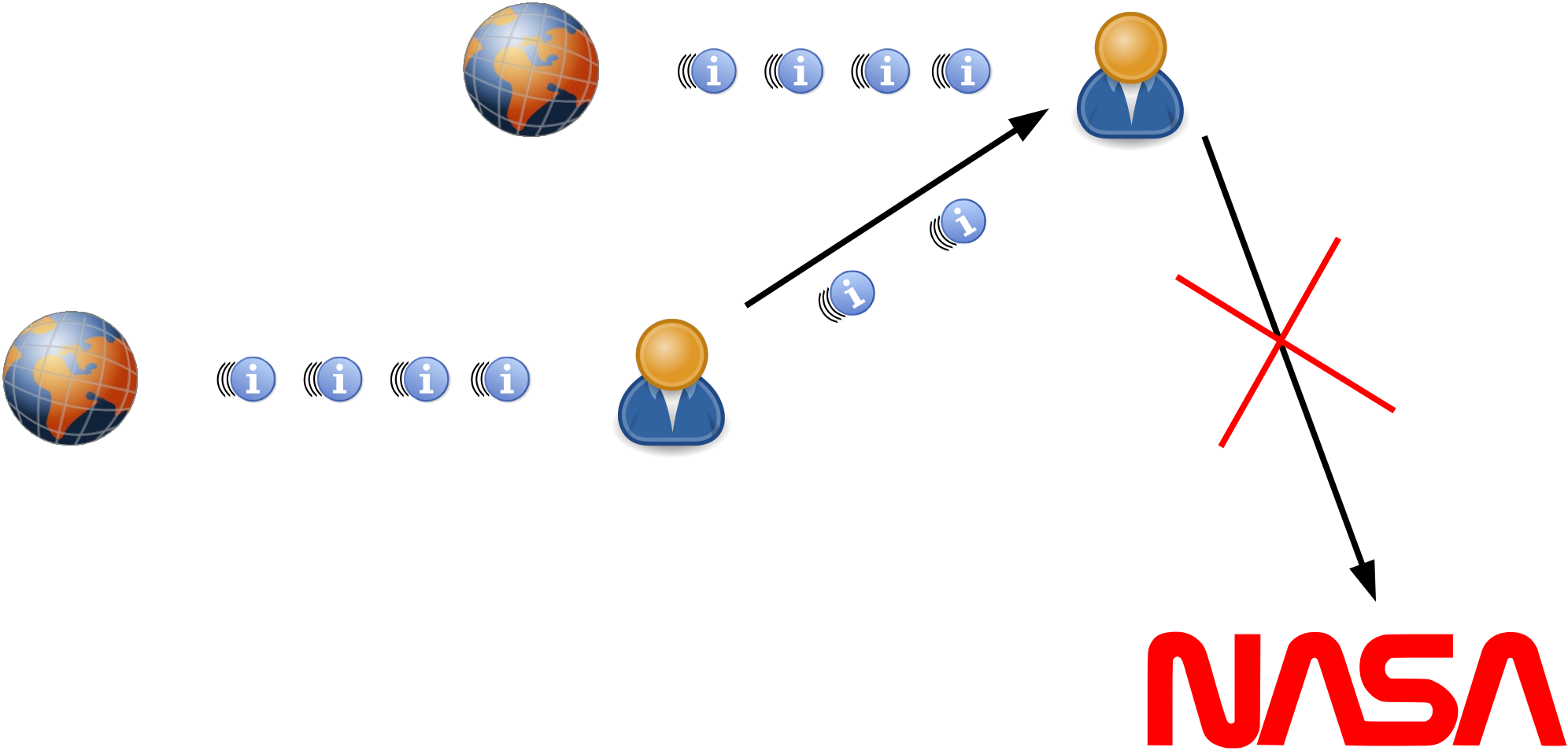


NASA's response to the Rogers Commission recommendation did not meet the Commission's intent: the Associate Administrator did not have direct authority, and safety, reliability, and mission assurance activities across the agency remained dependent on other programs and Centers for funding.

Columbia Accident Investigation Board (2003)



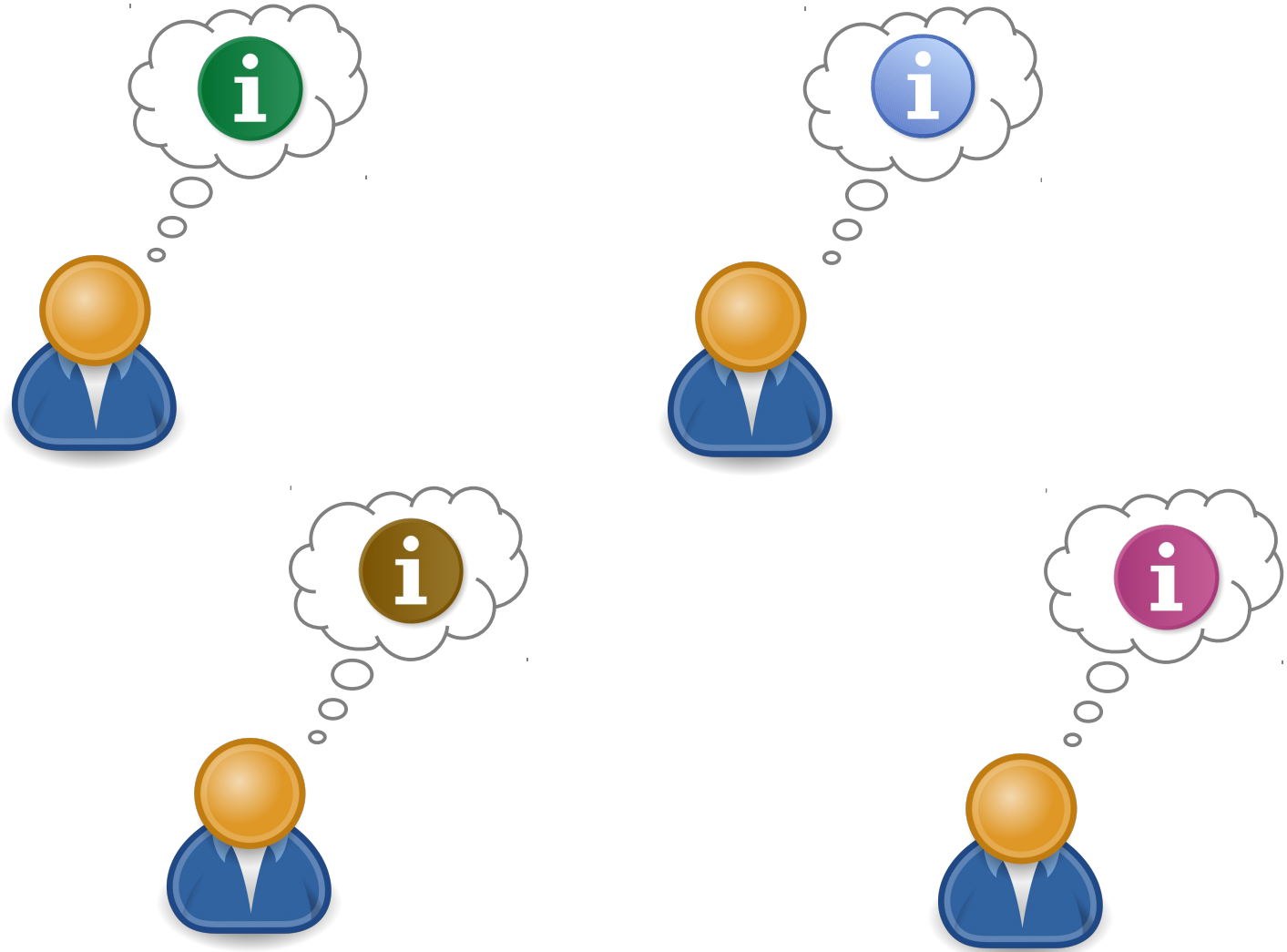
Network failure



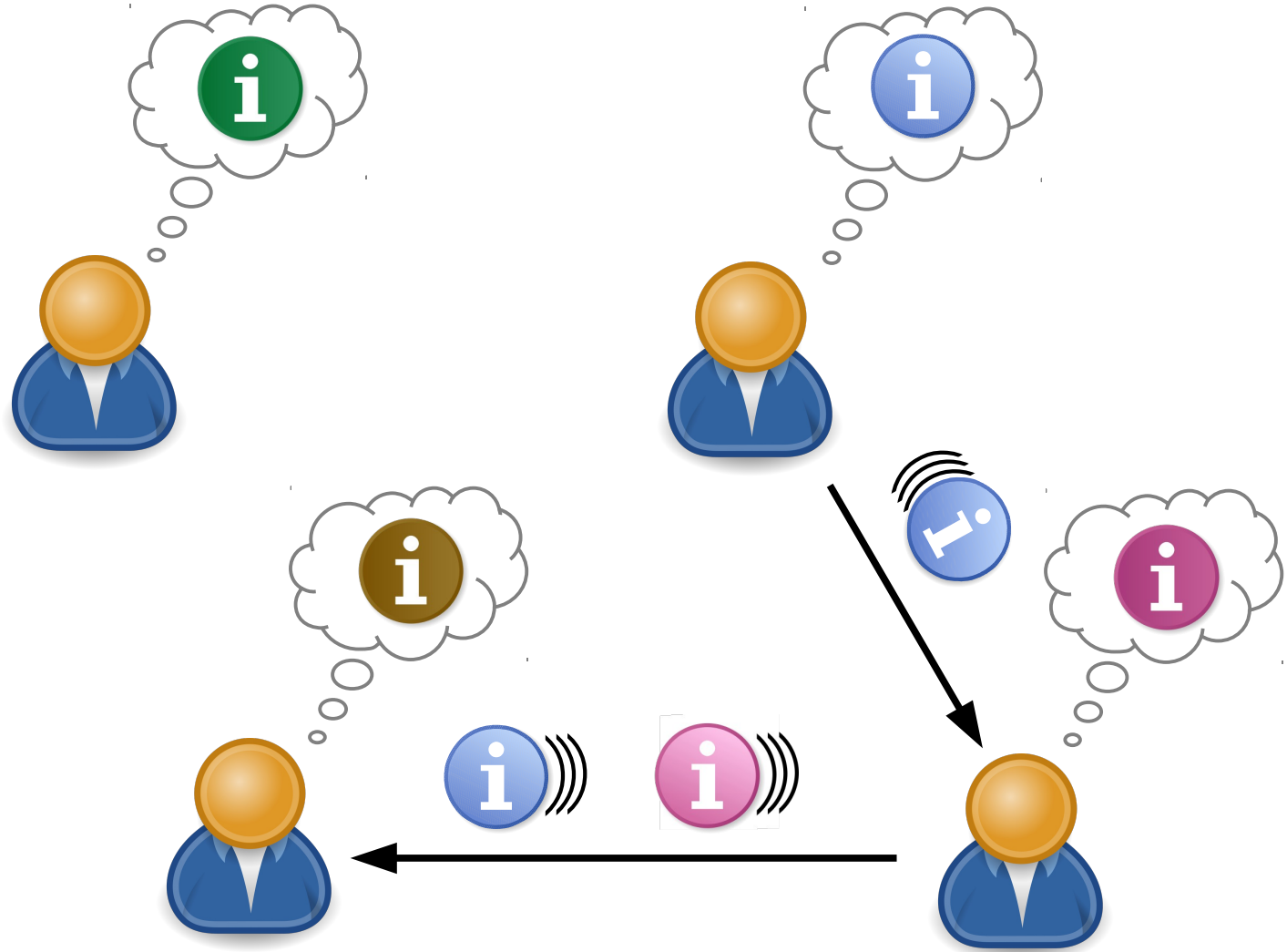
Network structure

Networks should be very dense – contain many connections

Non-overlapping knowledge



Second hand transmission



Four variations

No errors

Some errors

Information
transmission
is free

Information
transmission
is costly

Four variations

No errors

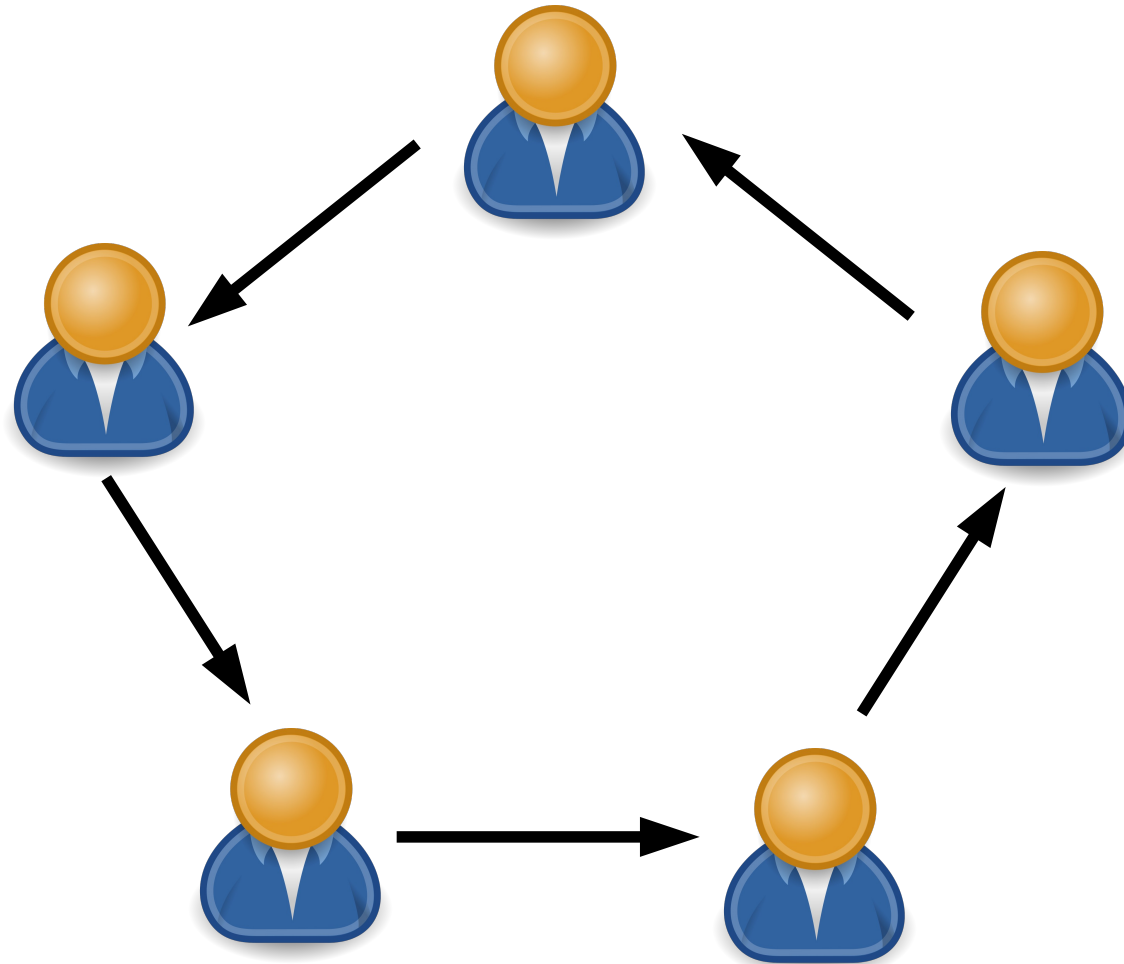
Some errors

Information
transmission
is free

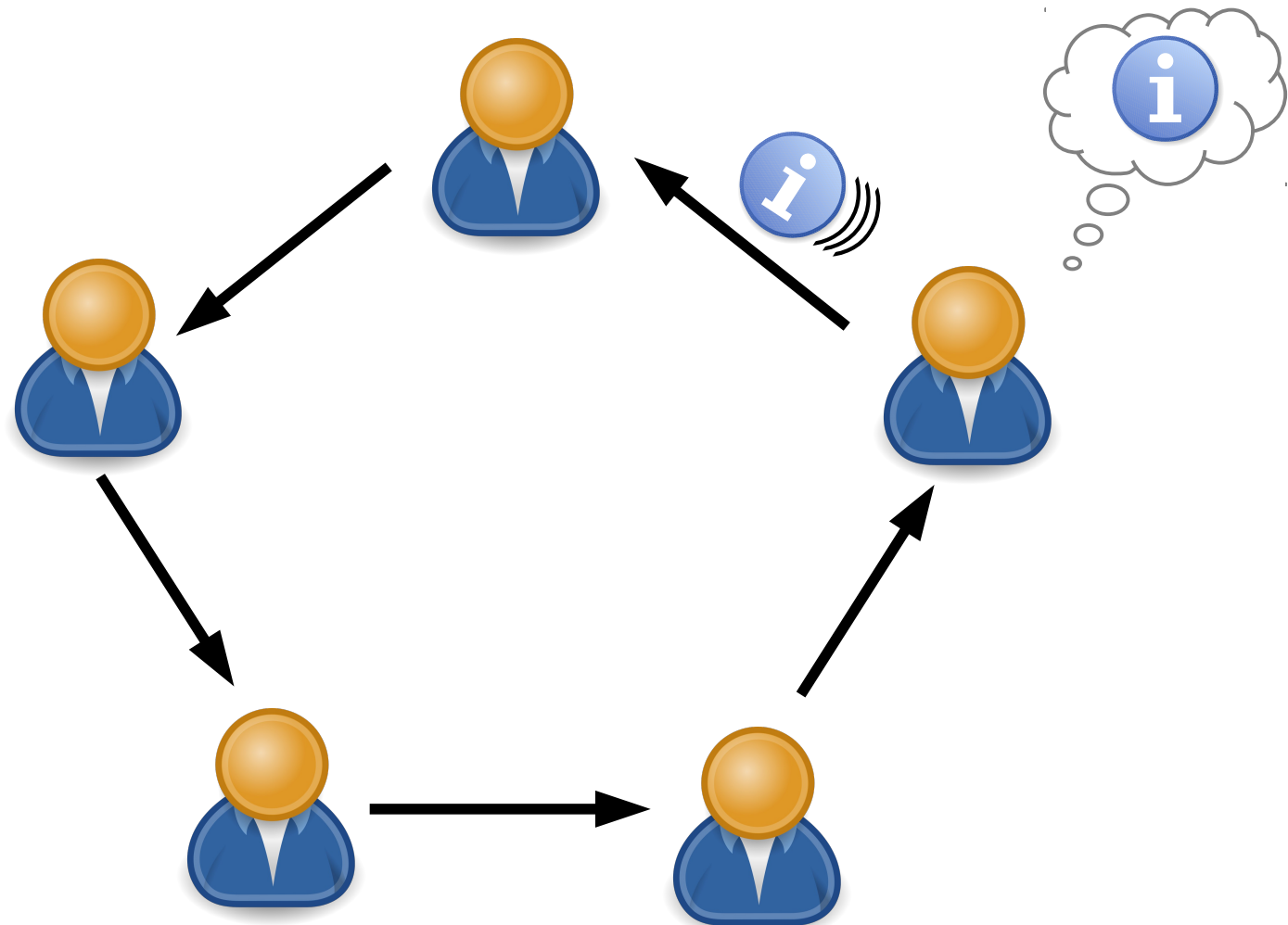
?

Information
transmission
is costly

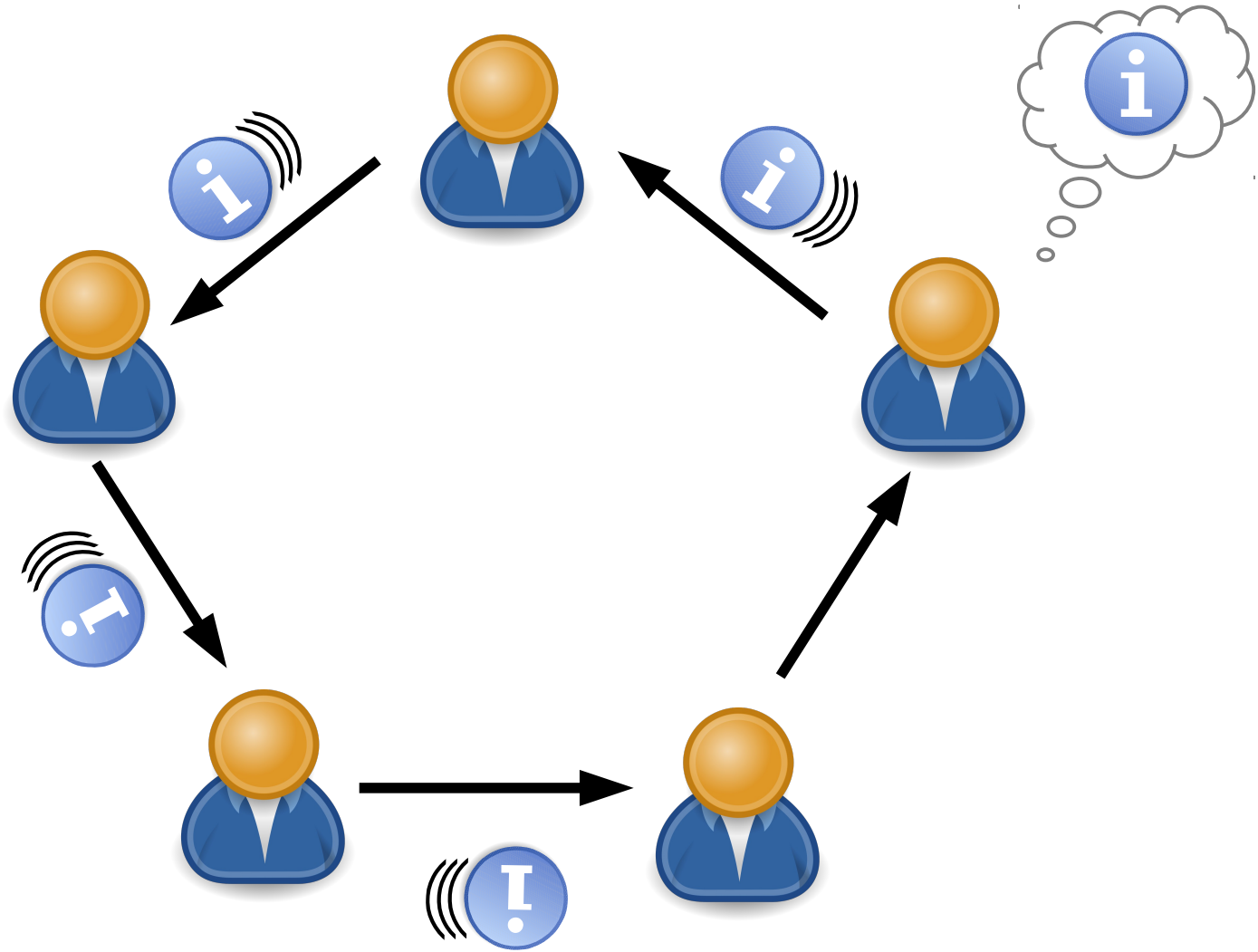
Sparse is fine



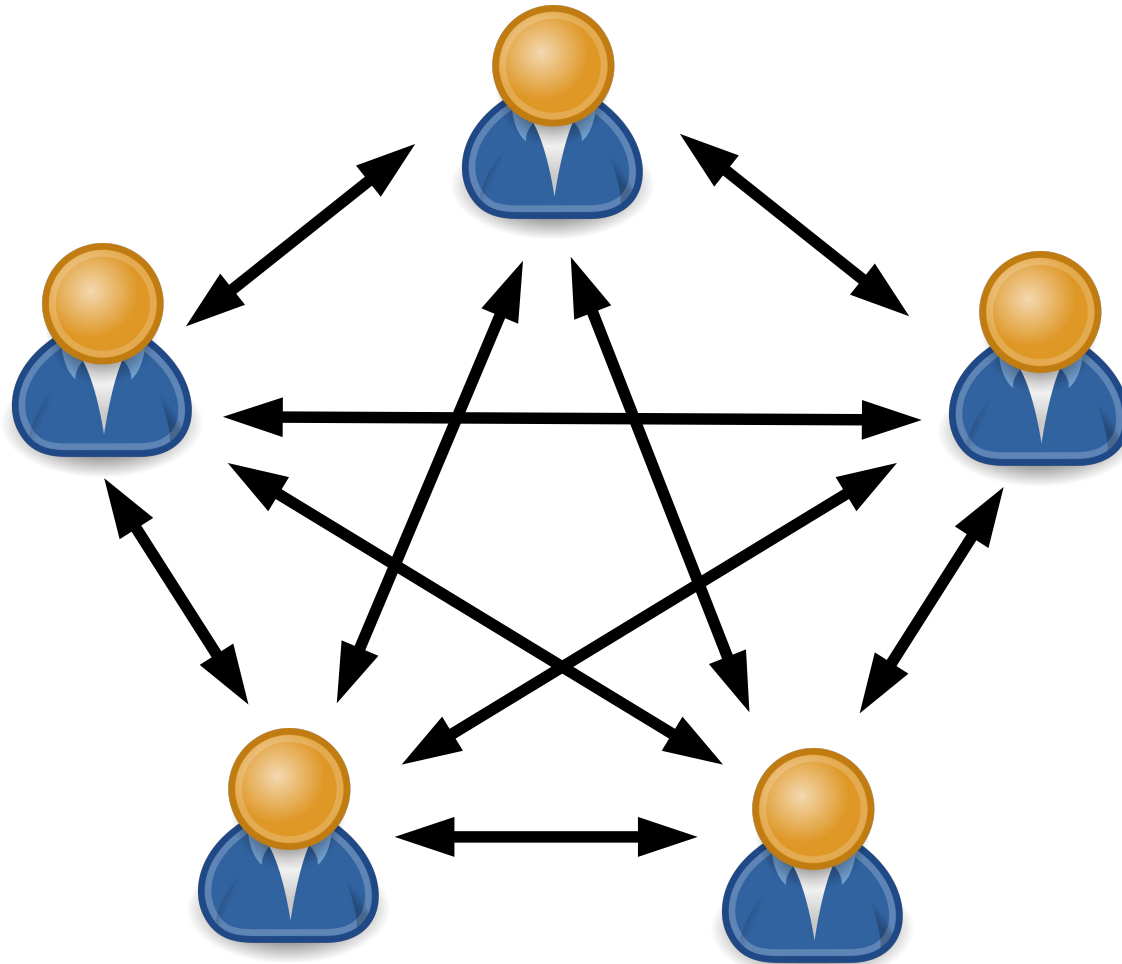
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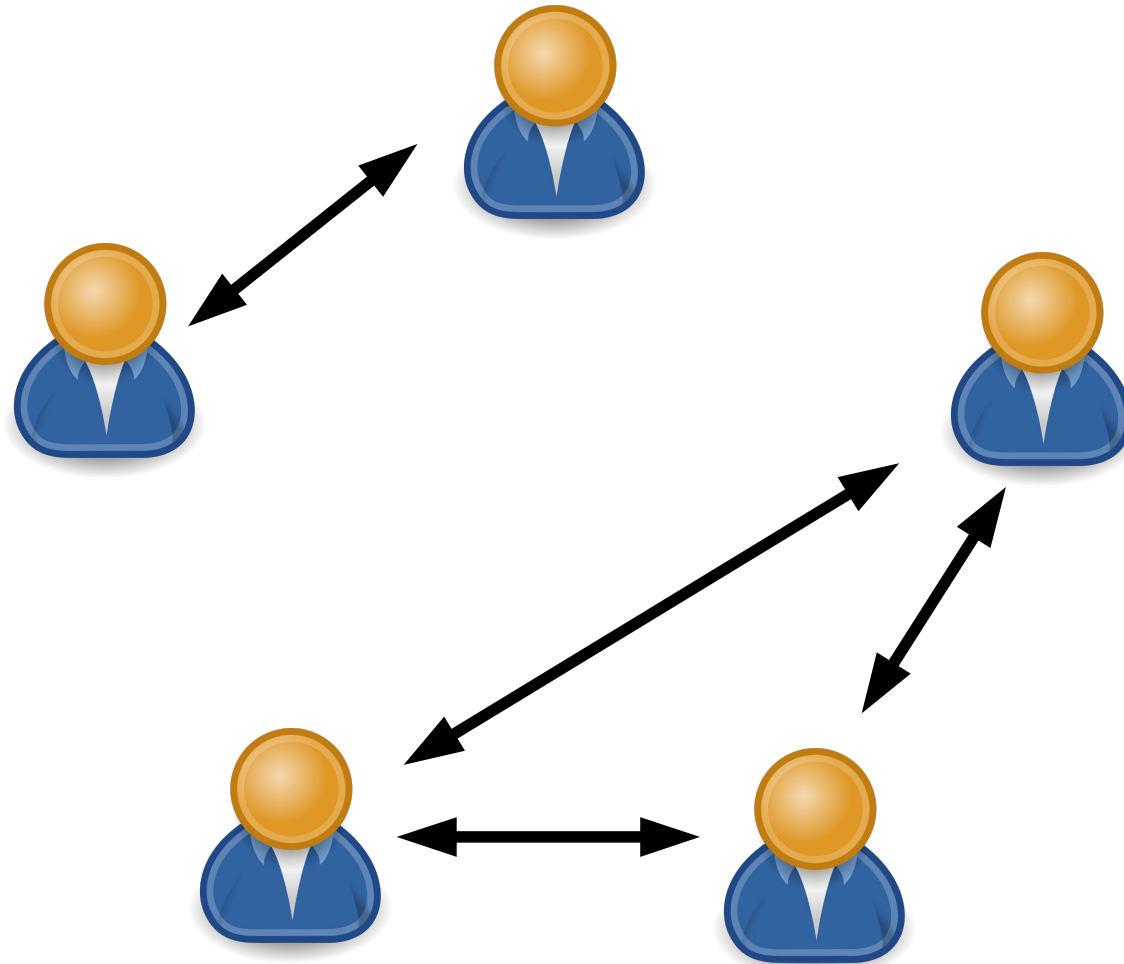
Sparse is fine



Dense is fine, too



Disconnected is bad



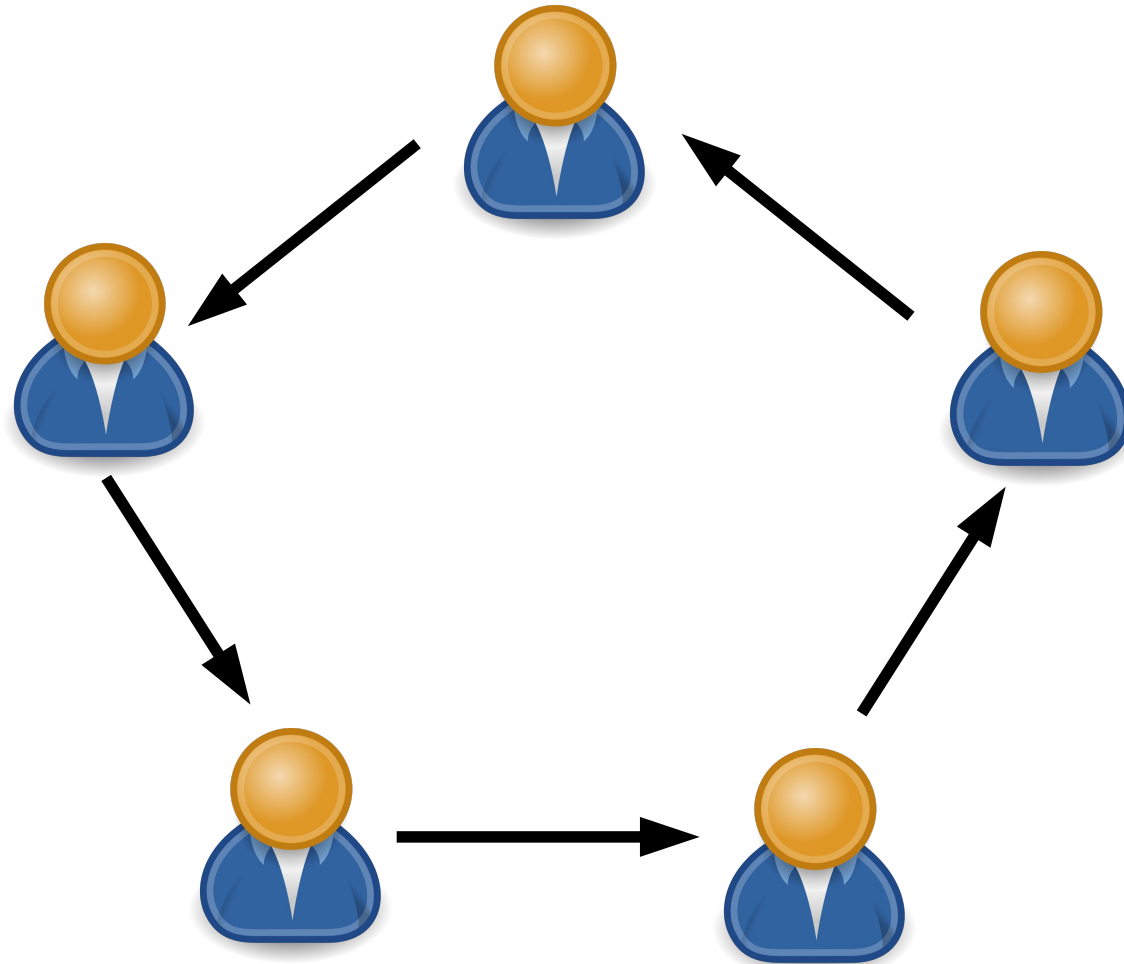
Four variations

	No errors	Some errors
Information transmission is free	Connected	
Information transmission is costly		

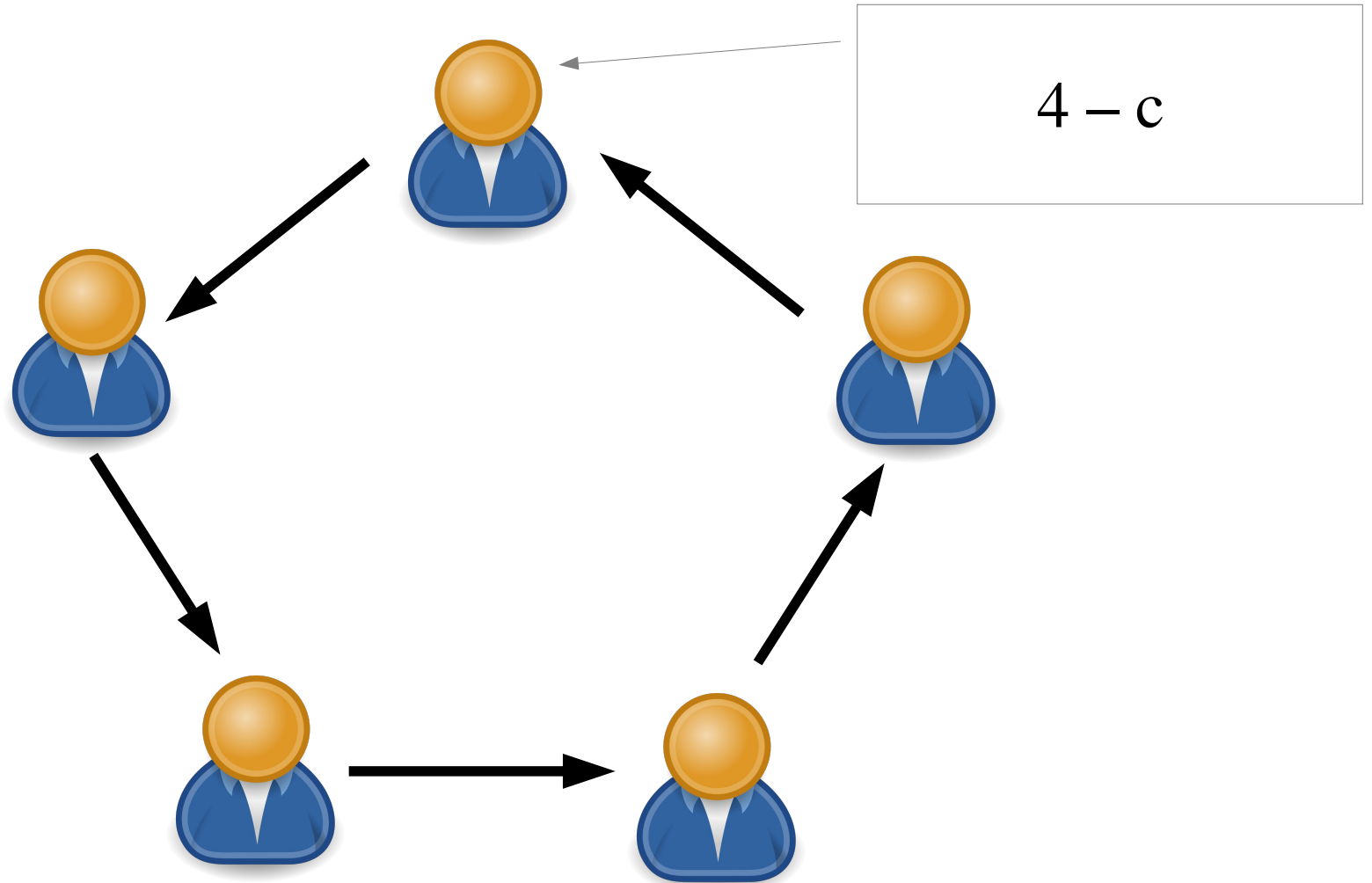
Four variations

	No errors	Some errors
Information transmission is free	Connected	
Information transmission is costly	?	

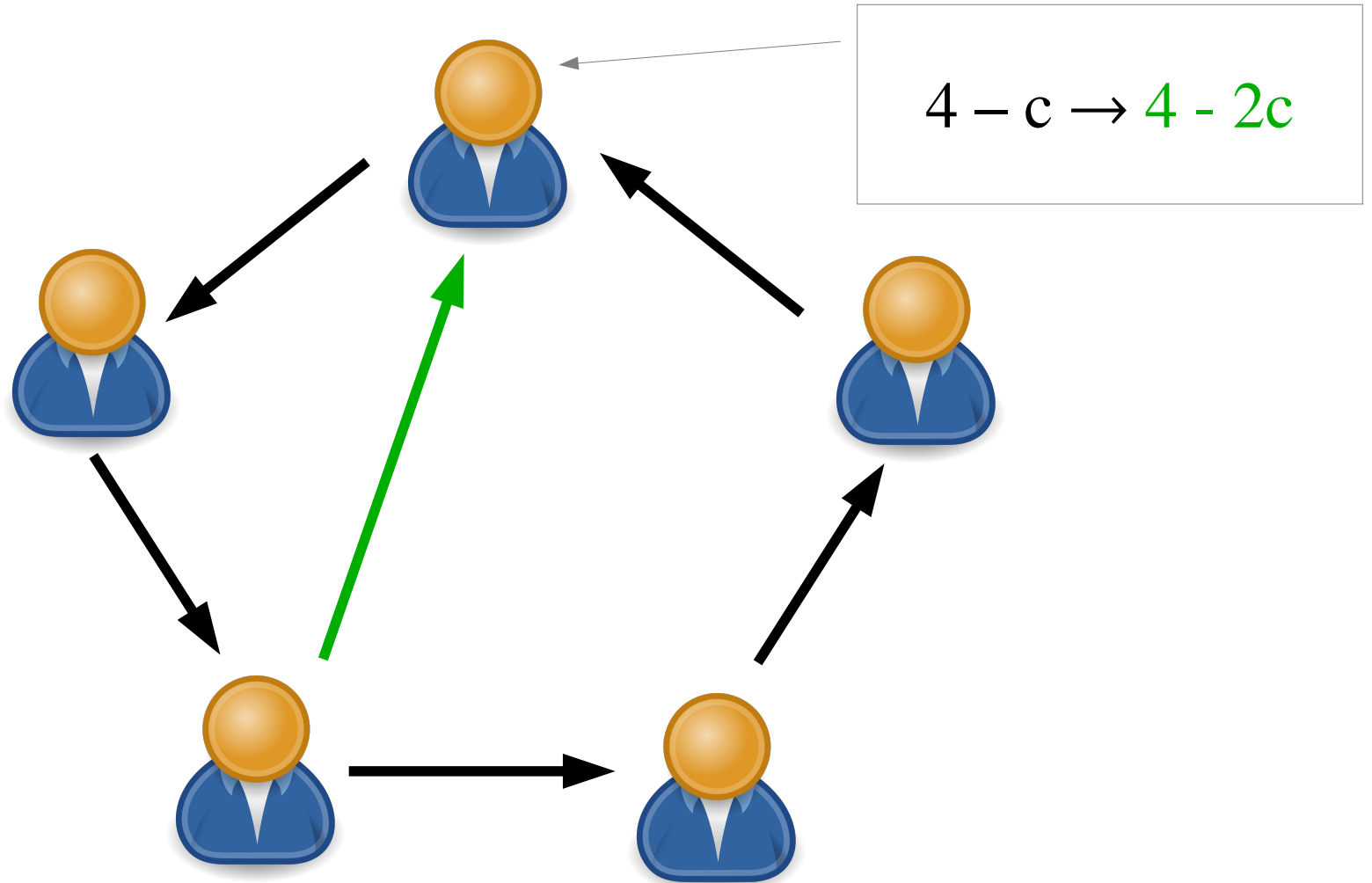
Sparse is good



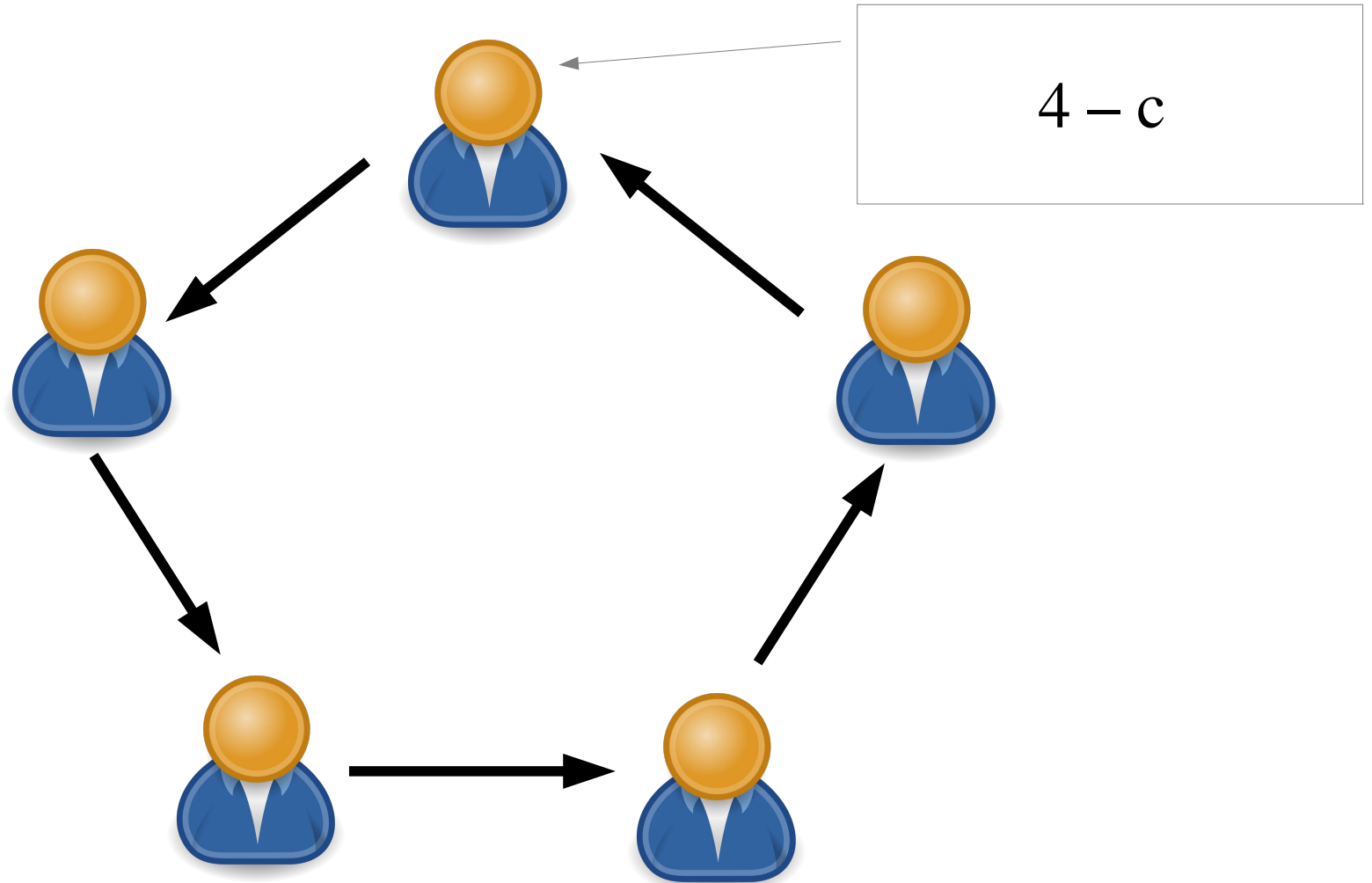
Sparse is good



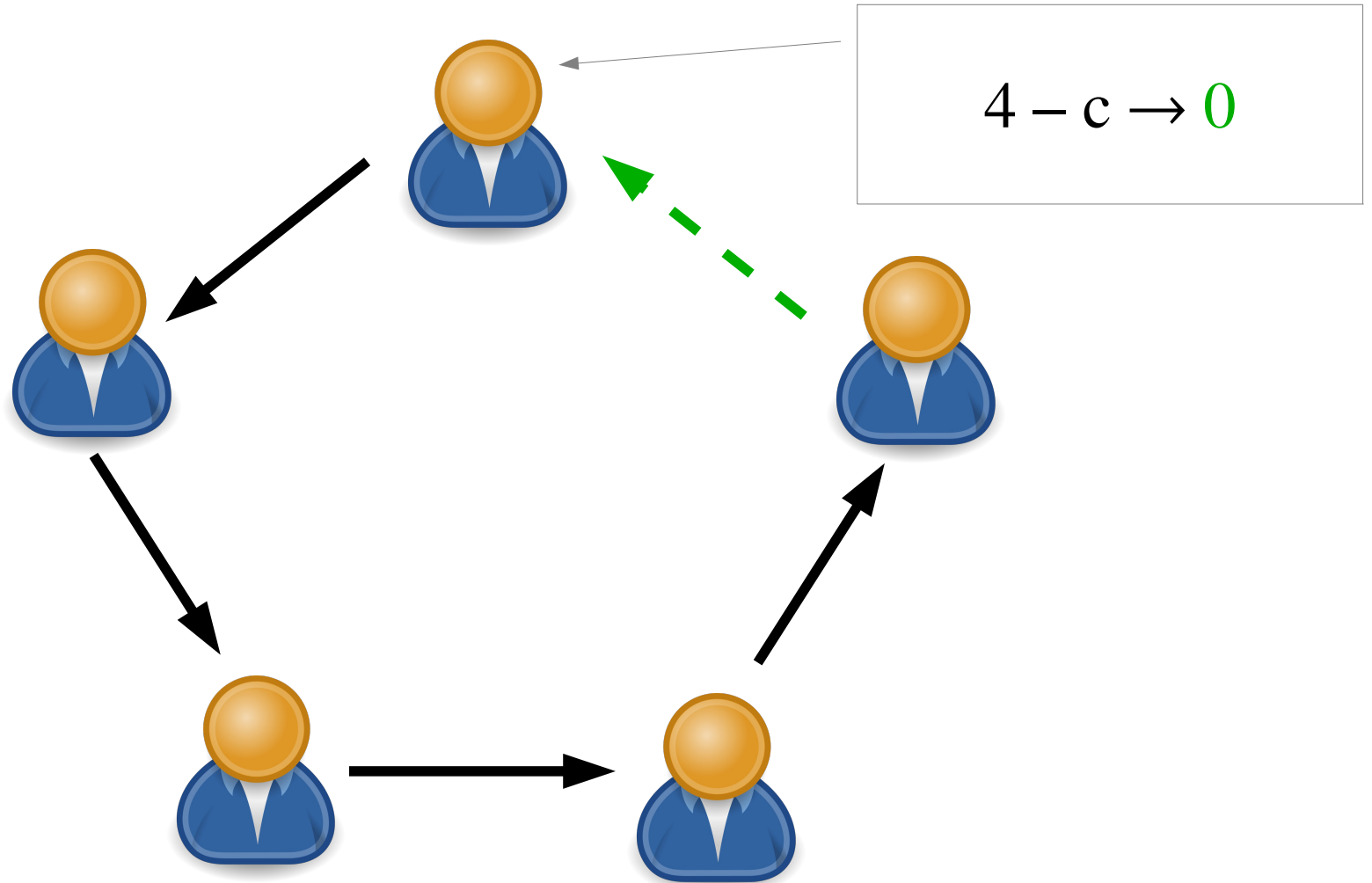
Sparse is good



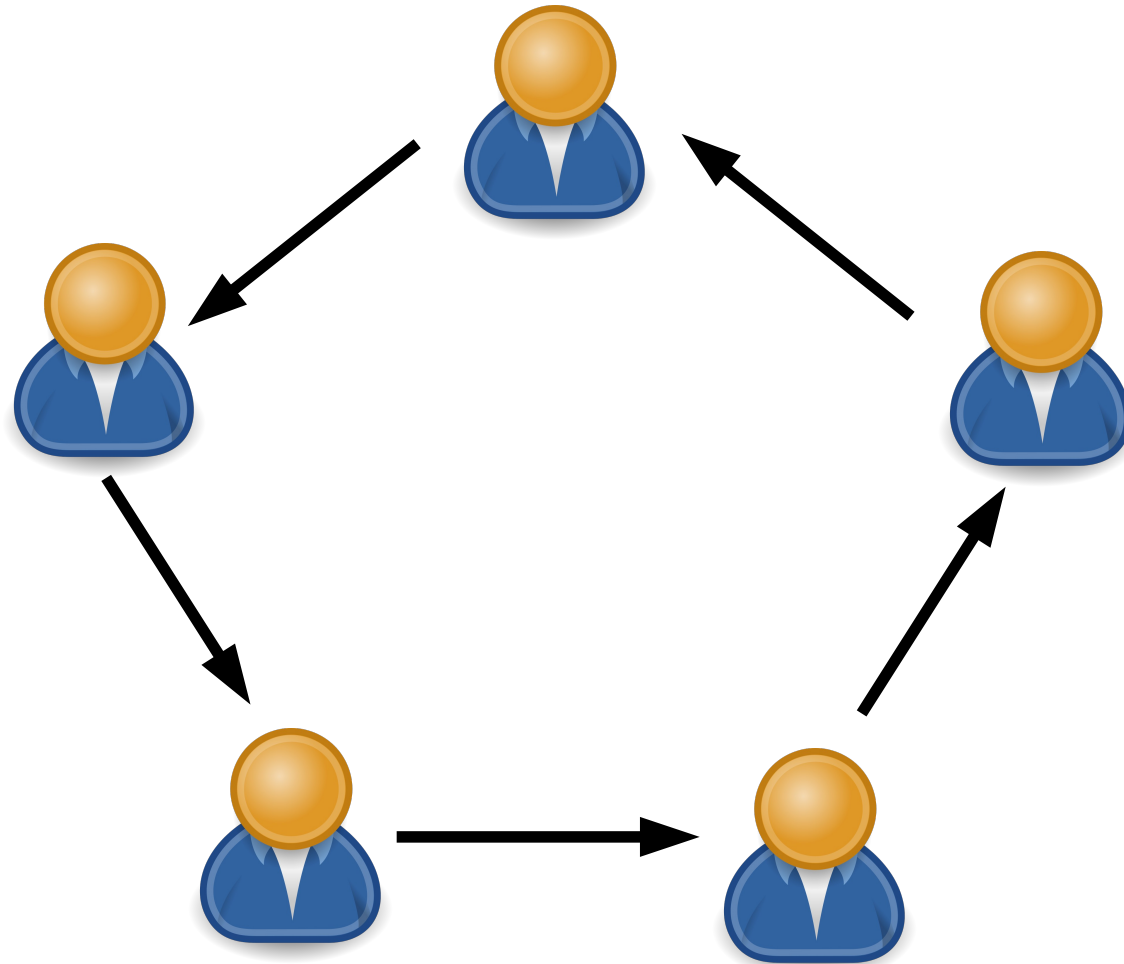
Sparse is good



Sparse is good



Uniquely good



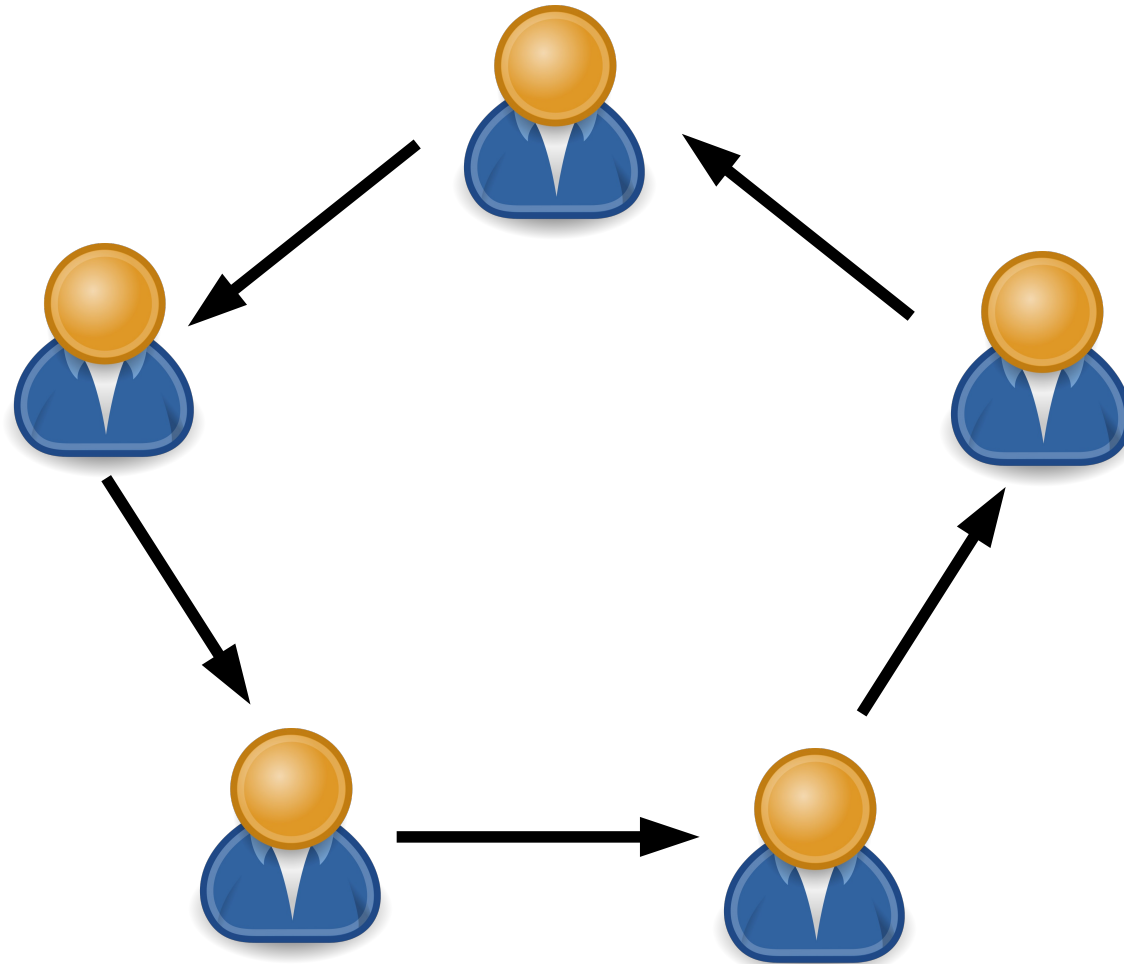
Four variations

	No errors	Some errors
Information transmission is free	Connected	
Information transmission is costly	Sparse and connected	

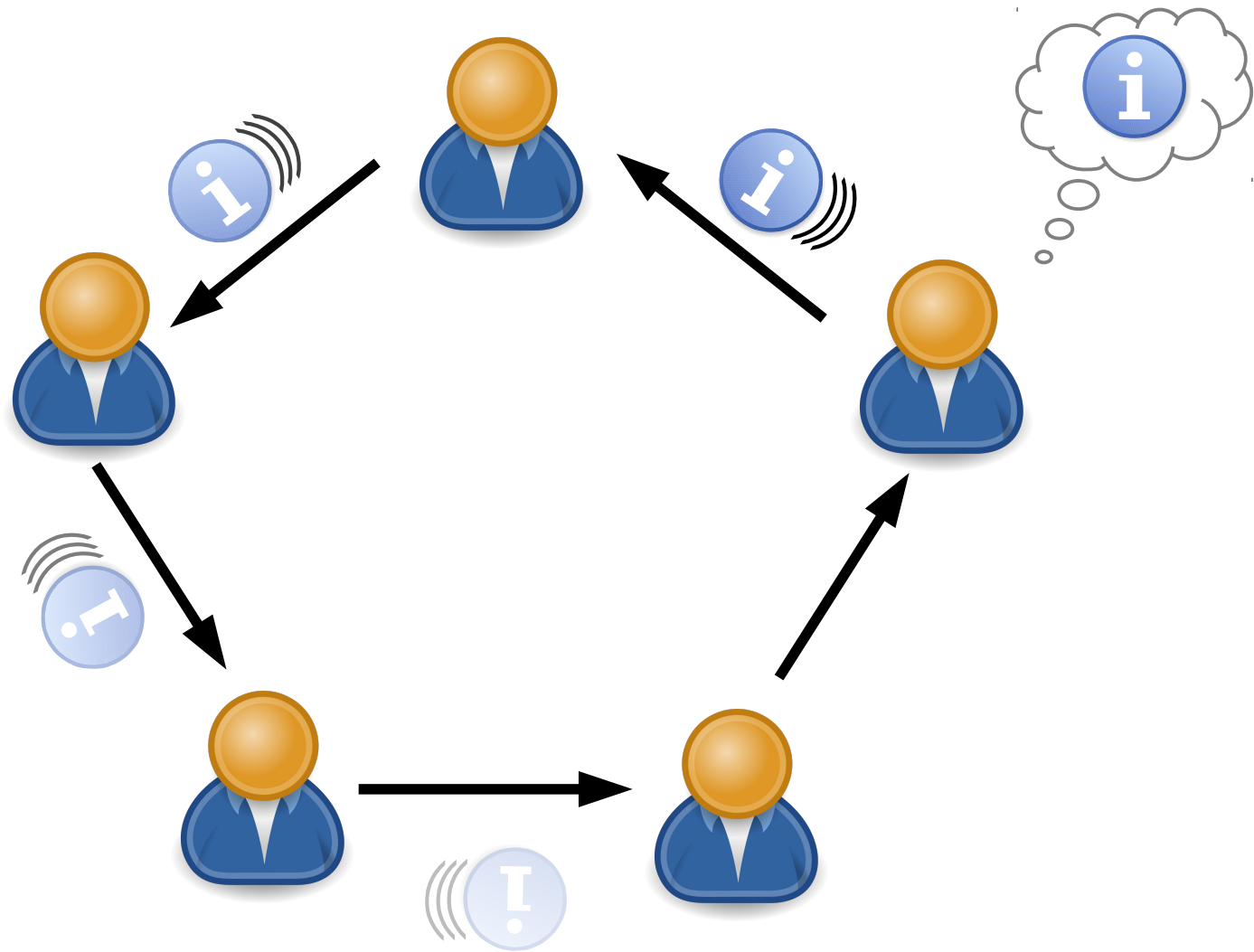
Four variations

	No errors	Some errors
Information transmission is free	Connected	?
Information transmission is costly	Sparse and connected	

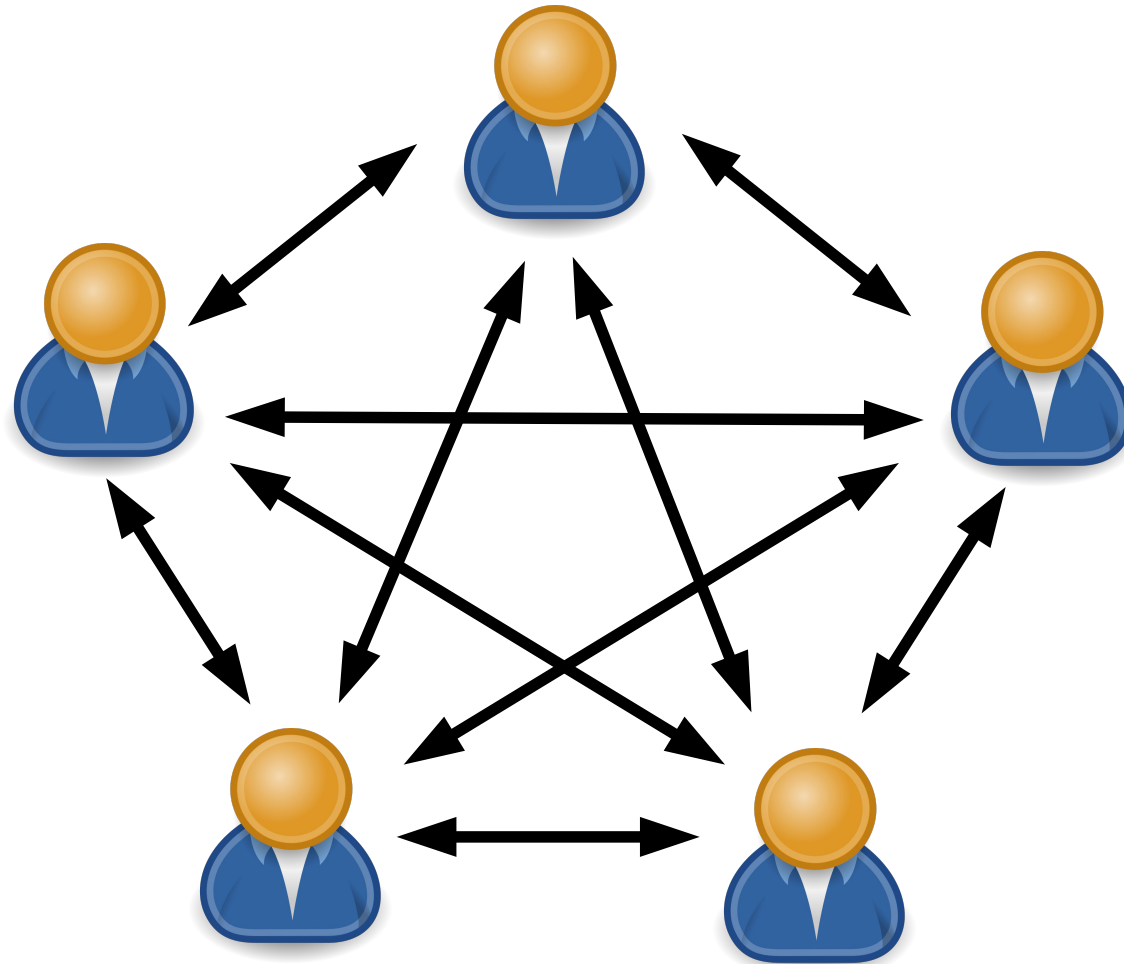
Sparse is bad



Sparse is fine



Dense is good



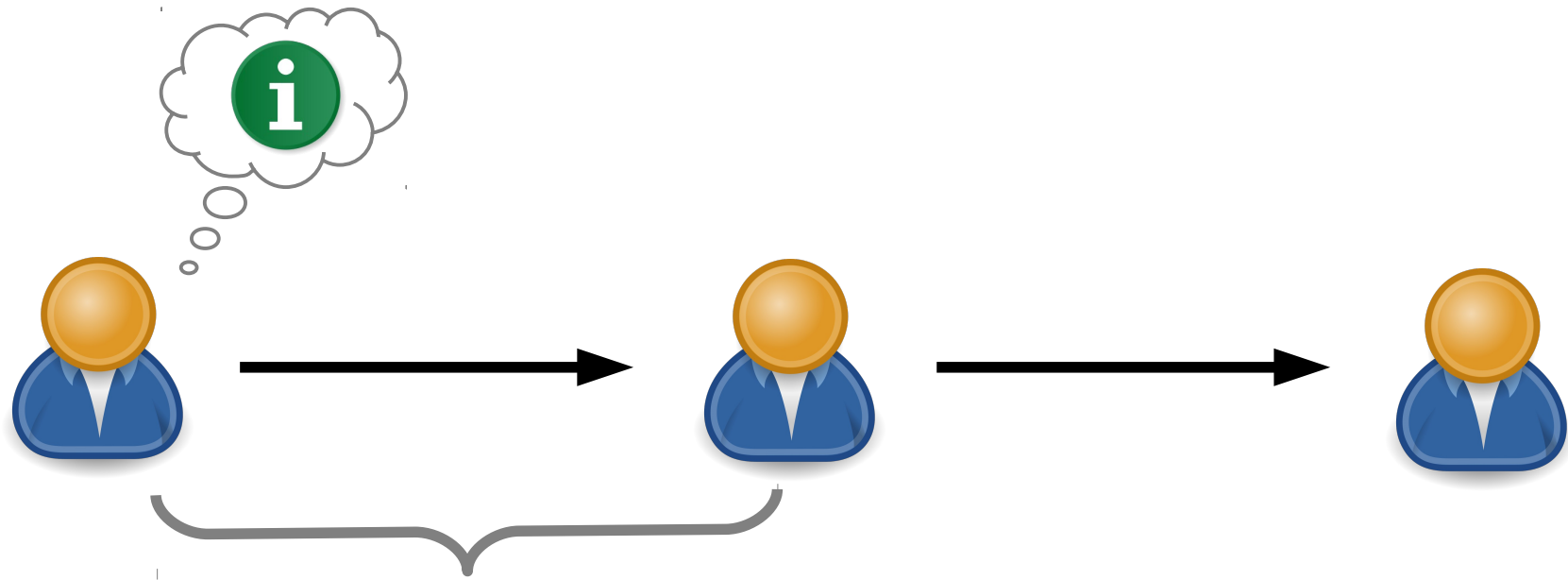
Four variations

	No errors	Some errors
Information transmission is free	Connected	Dense and connected
Information transmission is costly	Sparse and connected	

Four variations

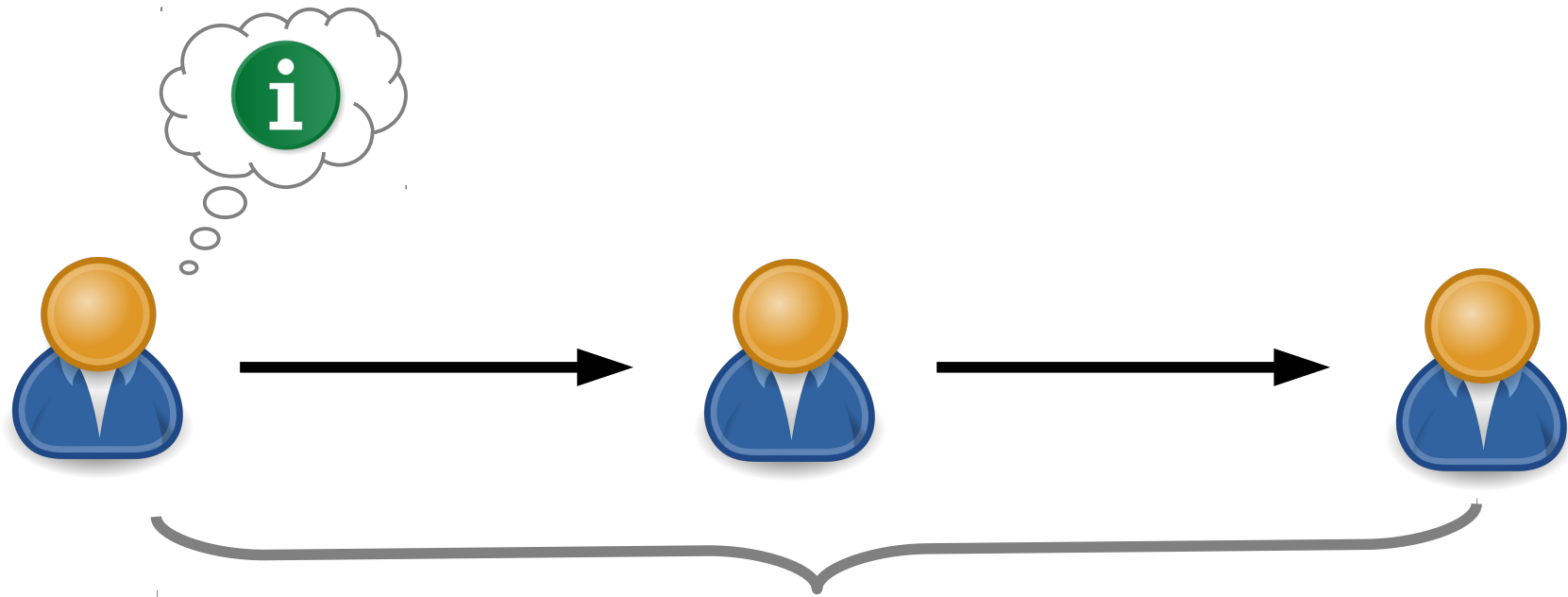
	No errors	Some errors
Information transmission is free	Connected	Dense and connected
Information transmission is costly	Sparse and connected	?

Information decay



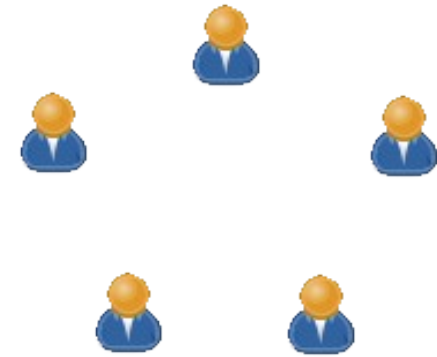
Probability of successful
transmission: e

Information decay

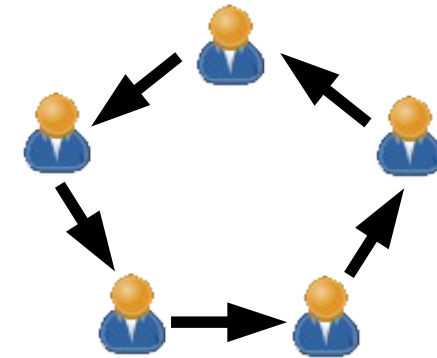


Probability of successful
transmission: e^2

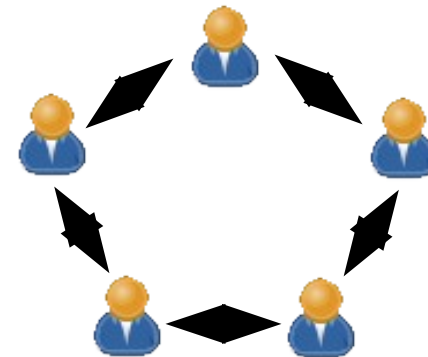
Best network?



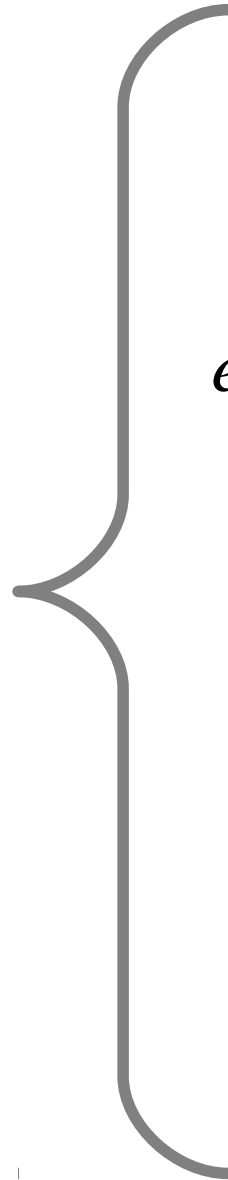
$$e + e^2 + e^3 + \dots$$



$$e - e^4$$



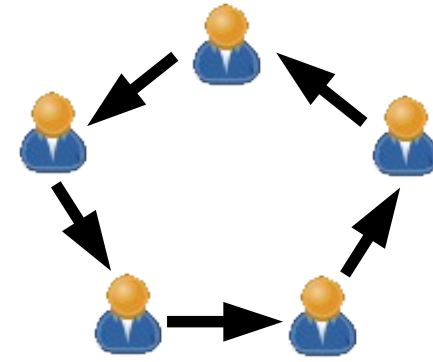
Cost of
information



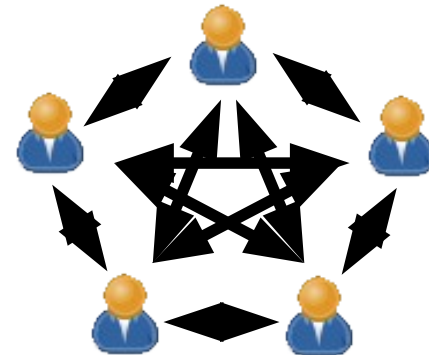
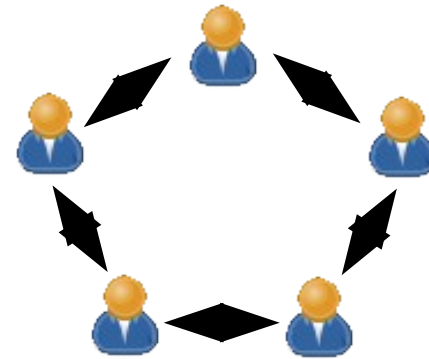
Best network?

Cost of
information

$$e - e^4$$



$$e - e^2$$



Four variations

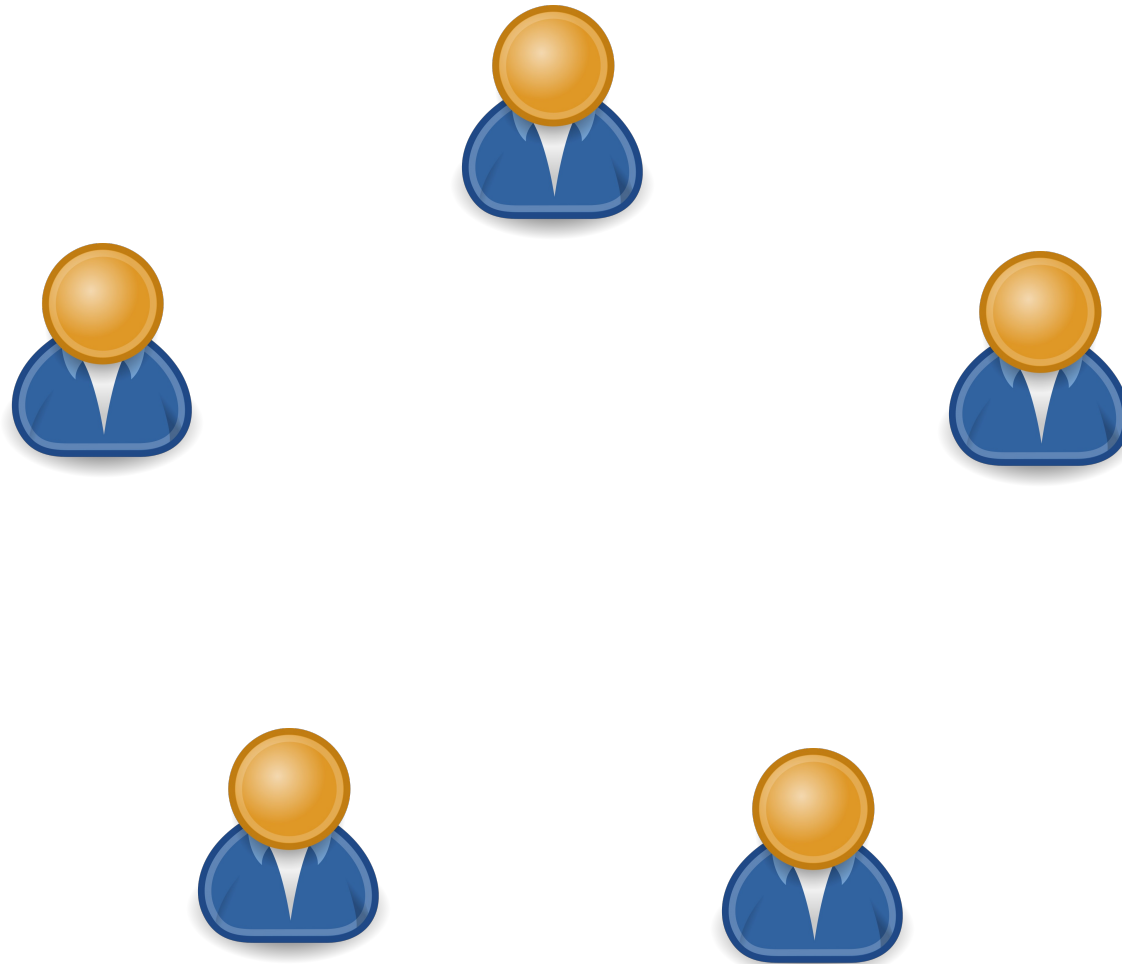
	No errors	Some errors
Information transmission is free	Connected	Dense and connected
Information transmission is costly	Sparse and connected	Depends on the cost of information

Endogenous formation

Q: If left to their own devices will people form the best networks?

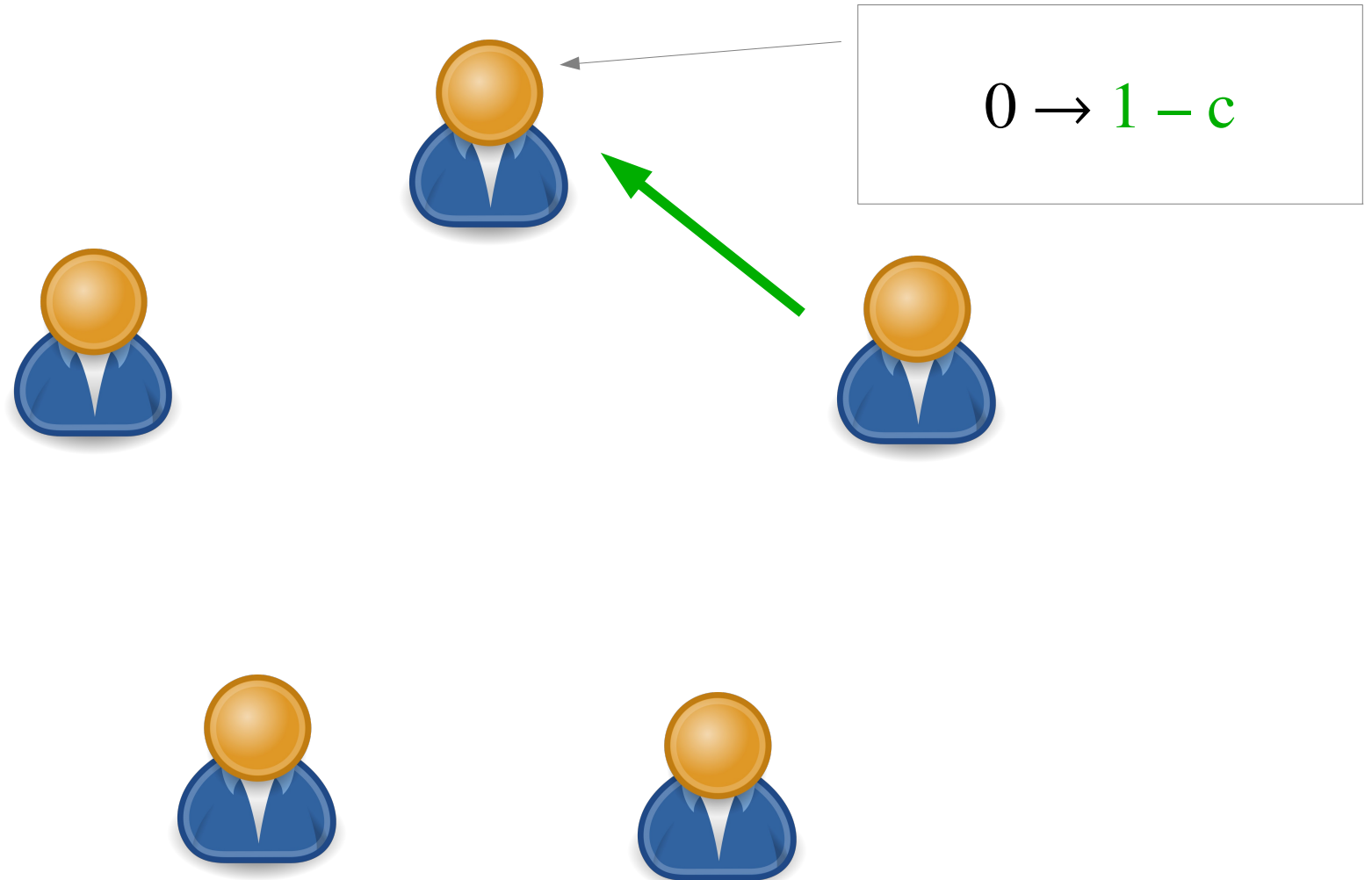
A: Sometimes, but not always

Equilibria



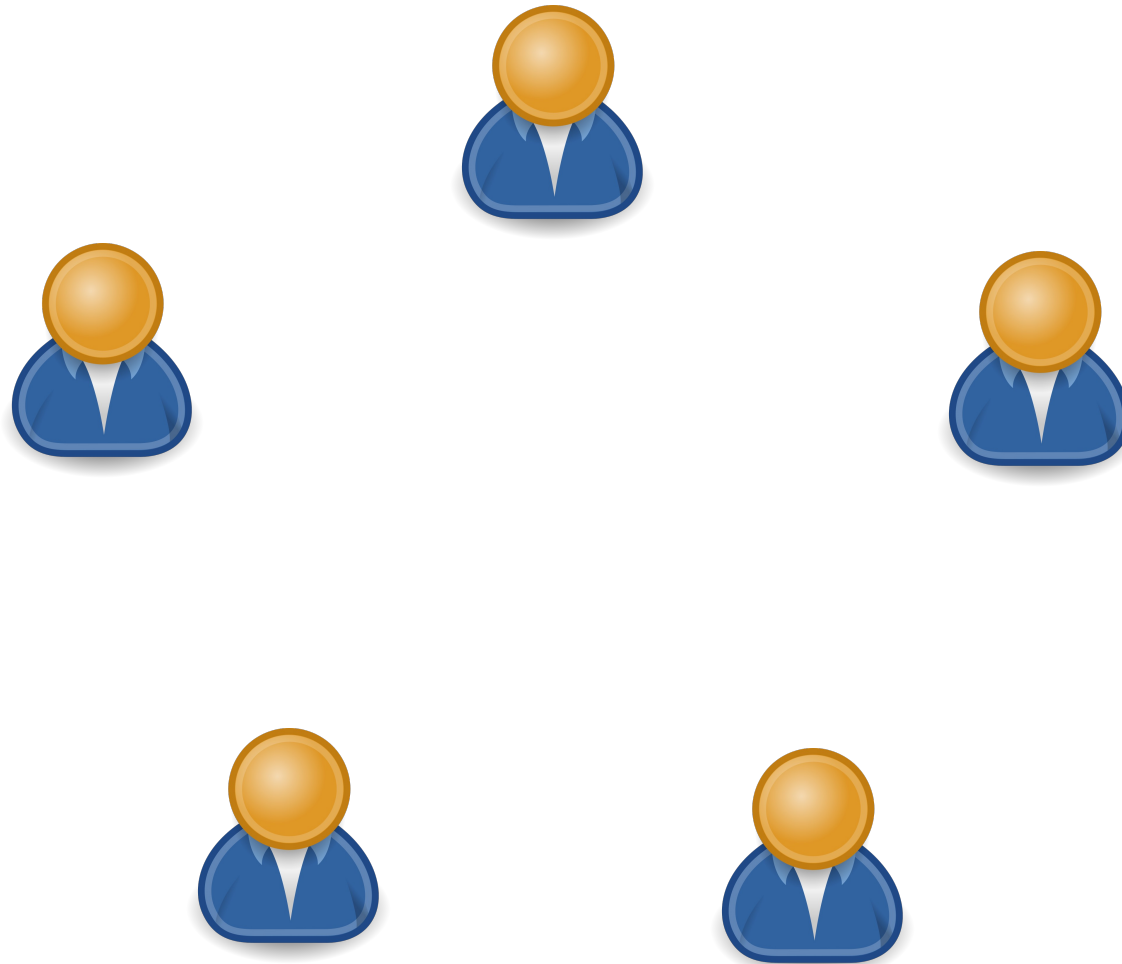
When $c >$ value of one piece of information

Equilibria



When $c >$ value of one piece of information

Equilibria

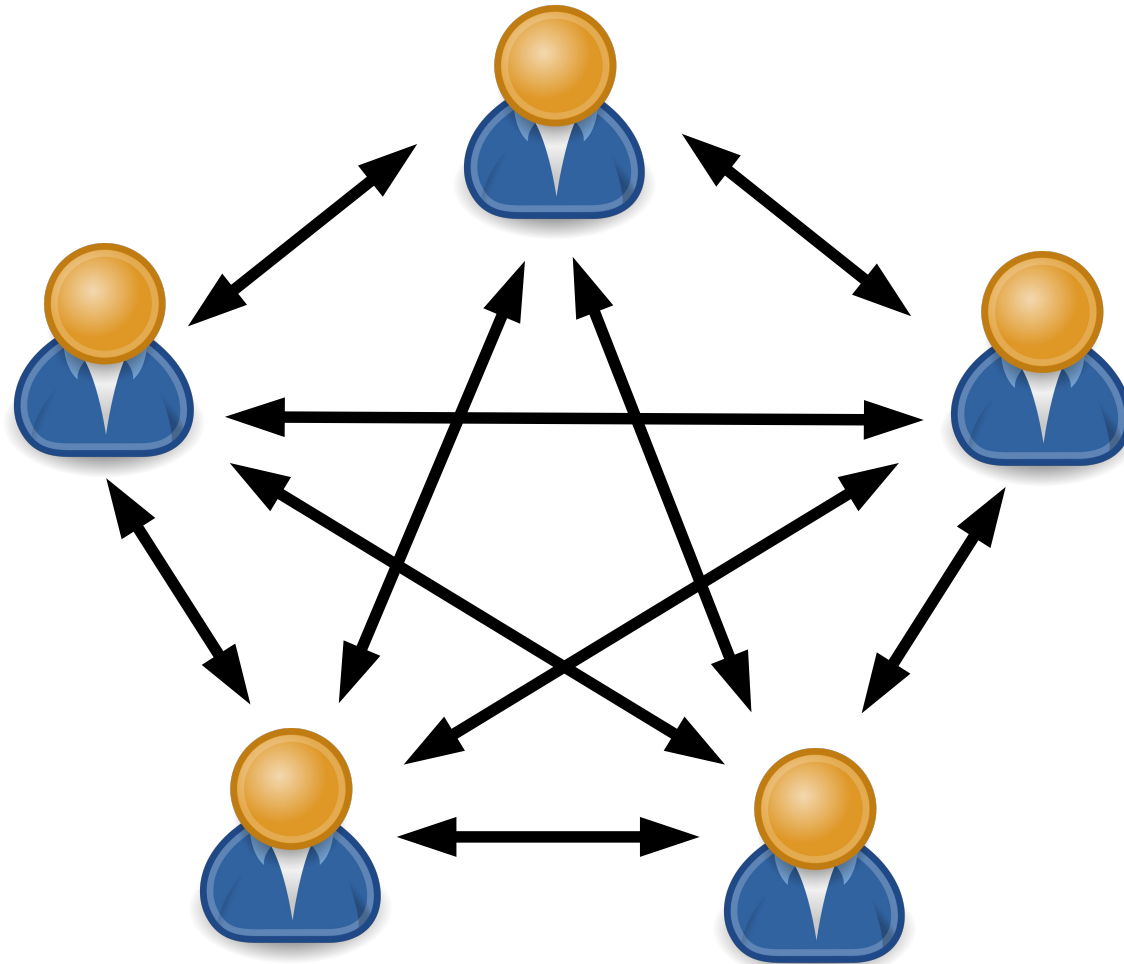


When $c >$ value of one piece of information

Belief updating

- Individuals cannot share evidence
- They do share their beliefs (no second hand sharing)
- Two methods of updating
 - Pooling (French, DeGroot, Lehrer and Wagner)
 - Bounded confidence (Hegselmann and Krause)

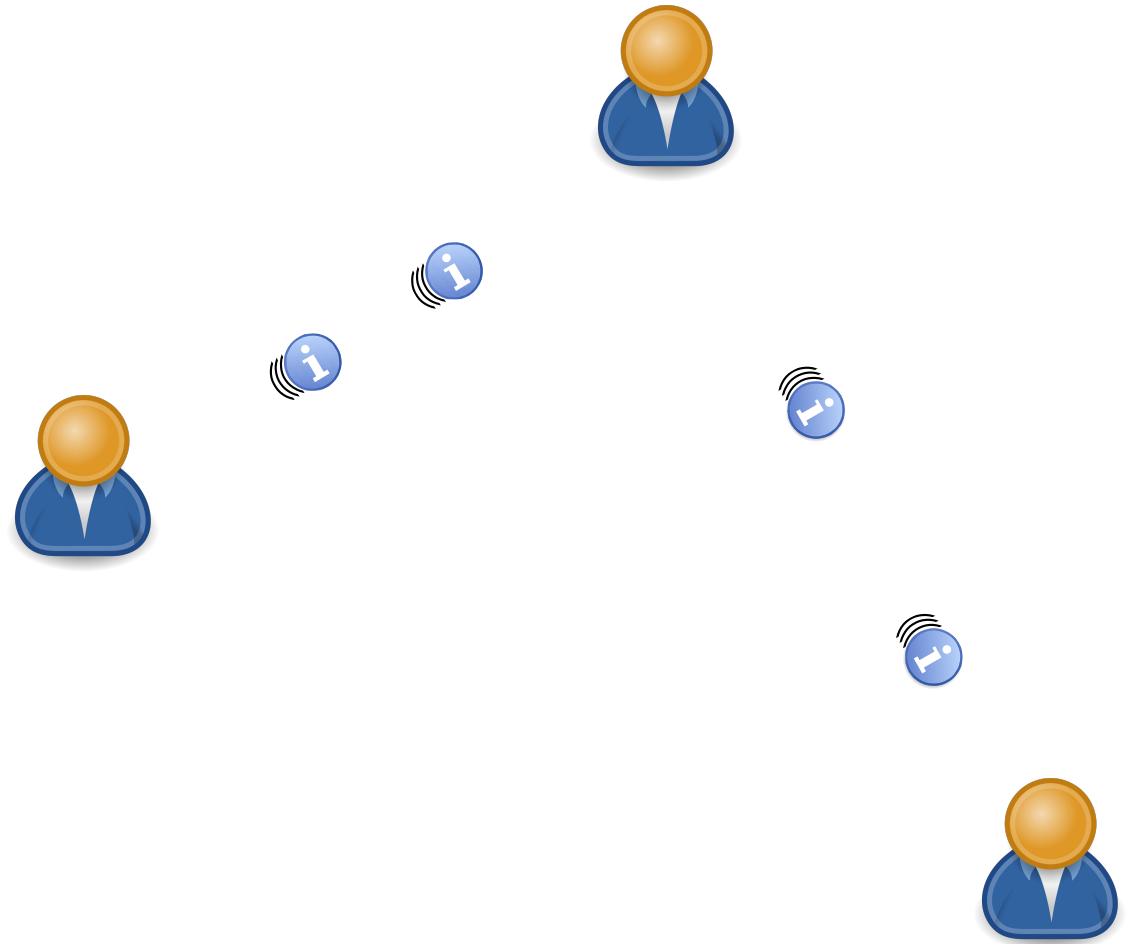
Dense is good



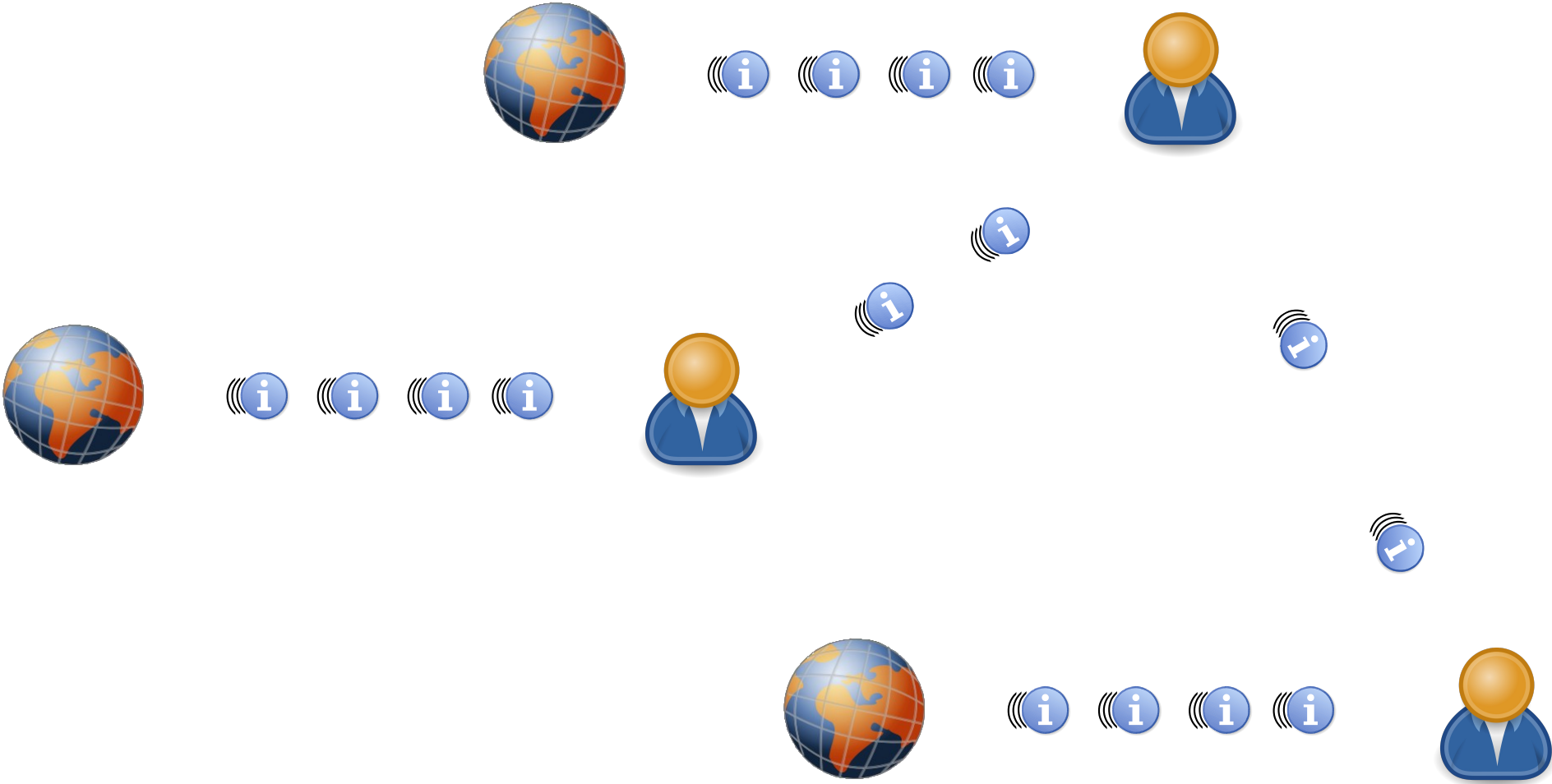
Type of social interaction



Type of social interaction



Types of social interaction



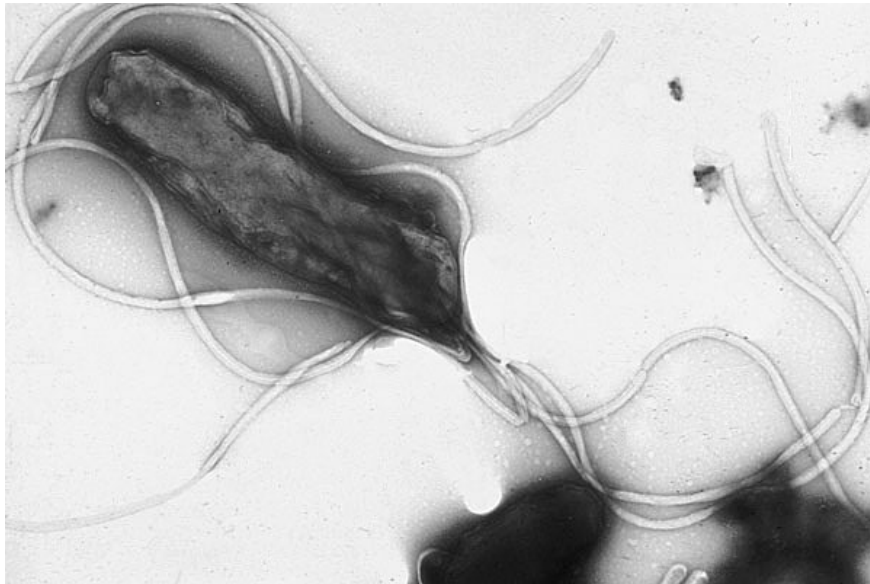
Peptic ulcer disease (before 1954)

- *Excess acid hypothesis*: Peptic ulcers are caused by a buildup of stomach acid which eats away at the lining of the stomach
- *Bacterial hypothesis*: Peptic ulcers are caused by a bacterium (or bacteria) that destroy the lining of the stomach

Palmer (1954)

His word ensured that the development of bacteriology in gastroenterology would be closed to the world as if frozen in ice... [It] established the dogma that bacteria could not live in the human stomach, and as a result, investigation of gastric bacteria attracted little attention for the next 20 years (Fukuda 2002).

Warren and Marshall

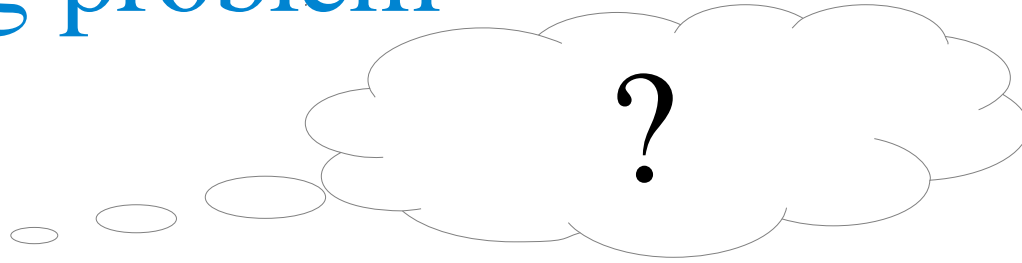


In 1983 two
researchers in
Australia successfully
proved the connection
between *Helicobacter
pylori* and PUD

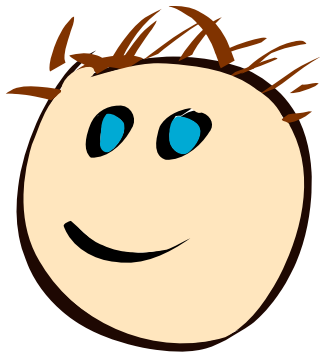
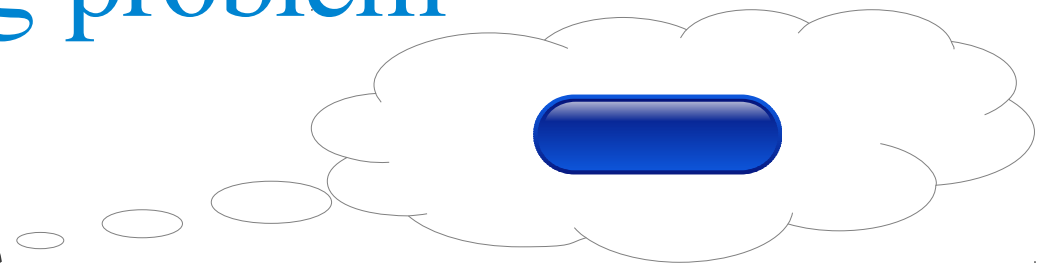
What about Palmer?

- Palmer did not engage in misconduct or fraud
- It was a good faith error that nobody noticed because of share (false) assumptions

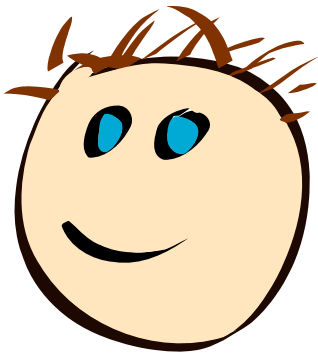
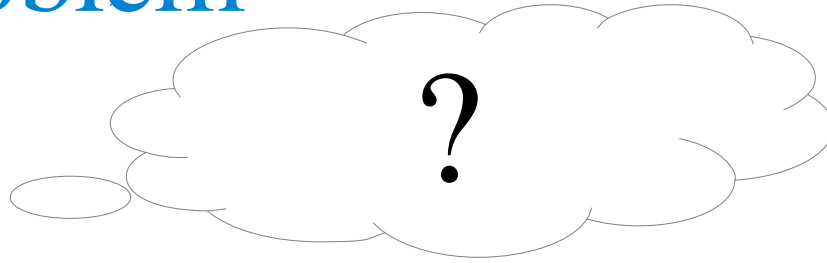
Learning problem



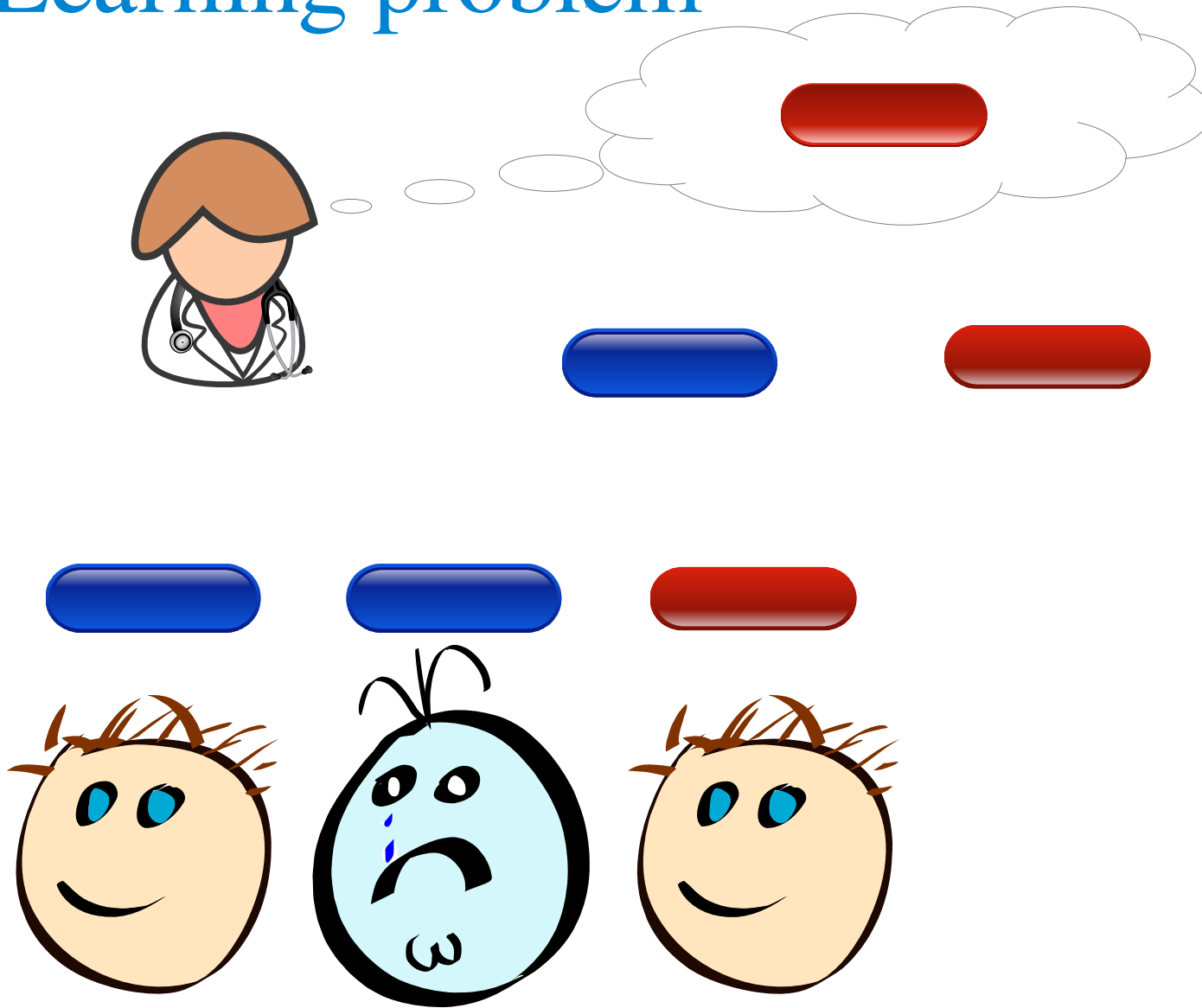
Learning problem



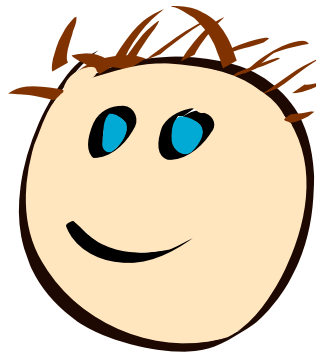
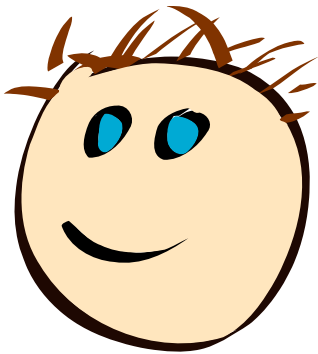
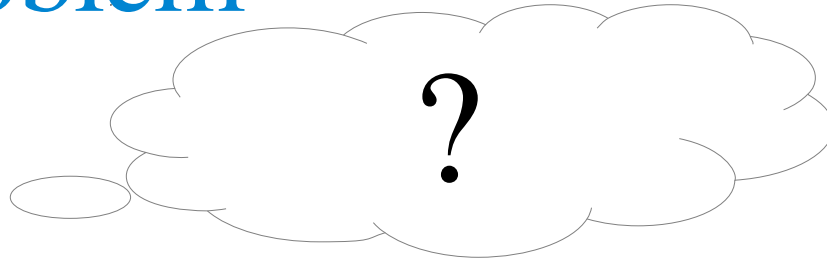
Learning problem



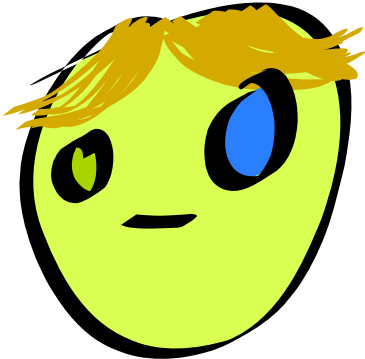
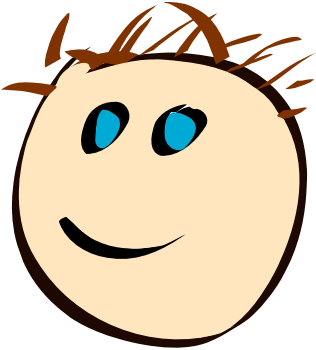
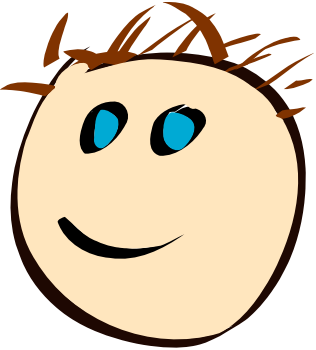
Learning problem



Learning problem



Learning problem



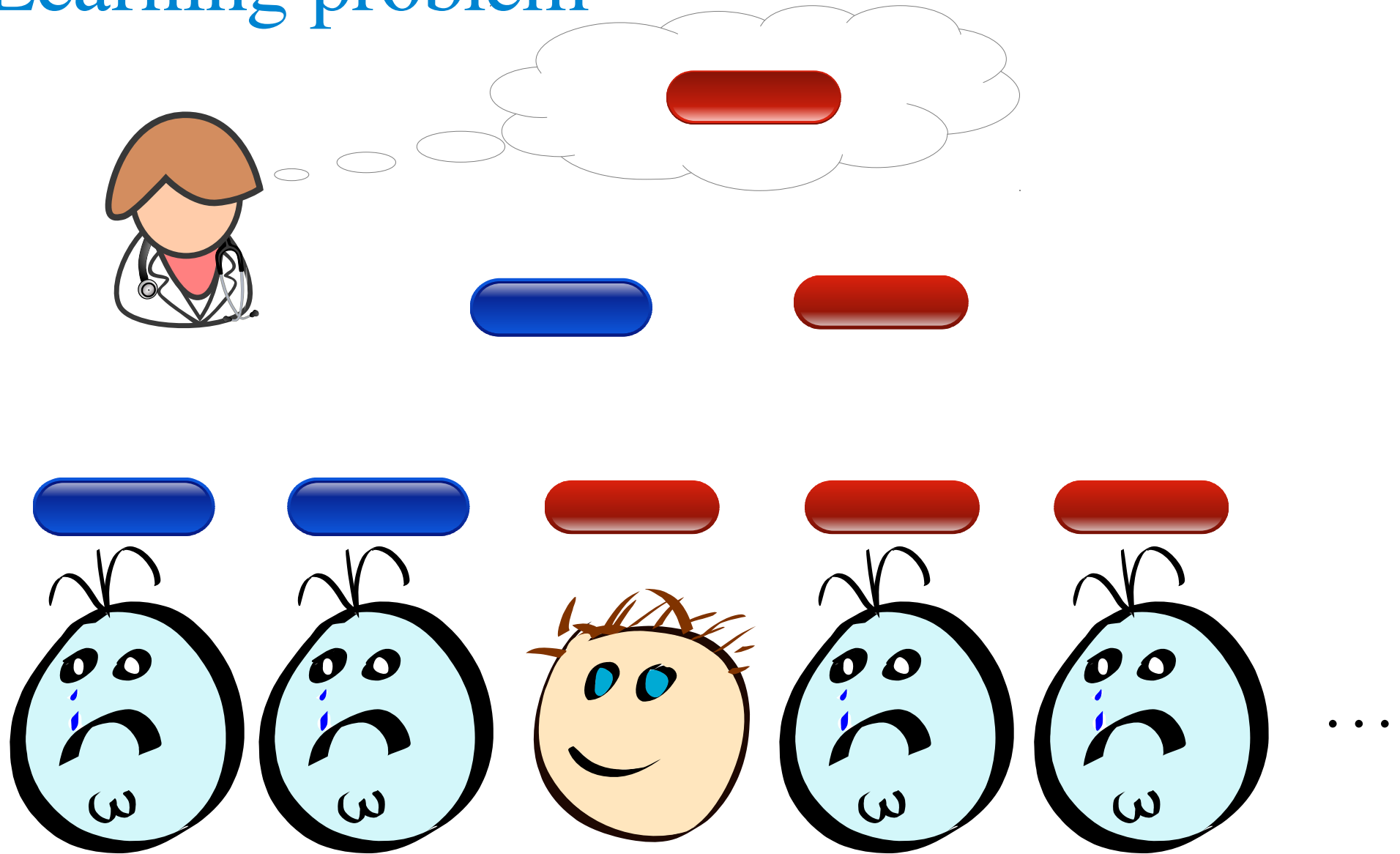
Learners

- Low exploration
 - Sticks with what seems best
 - Can get stuck with inferior option
- High exploration
 - Is willing to try the inferior treatment often
 - Can explore too much and harm patients

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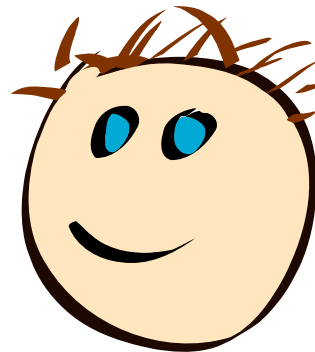
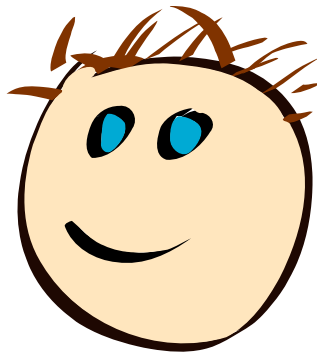
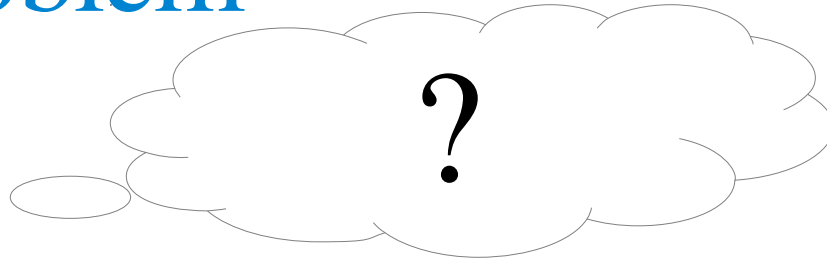
Learning problem



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Learning problem

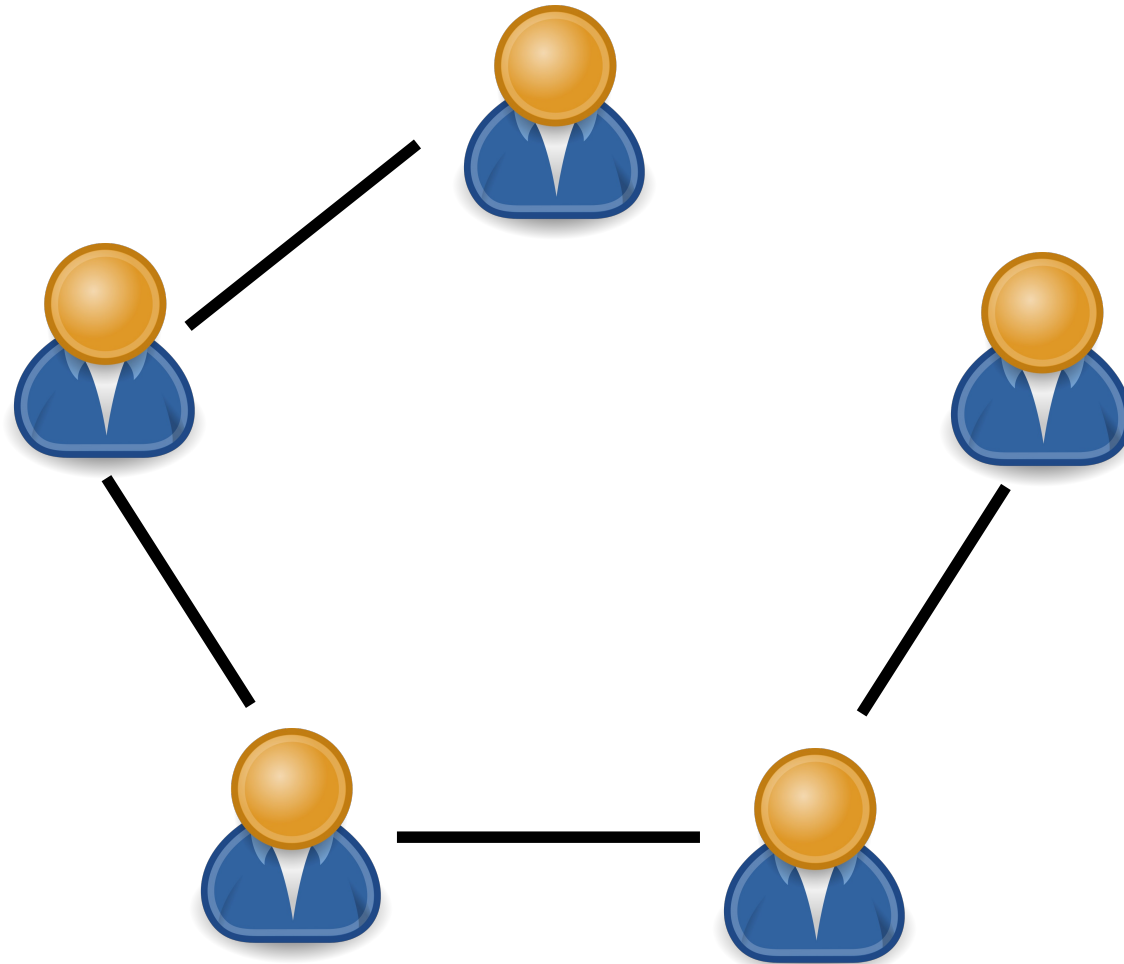


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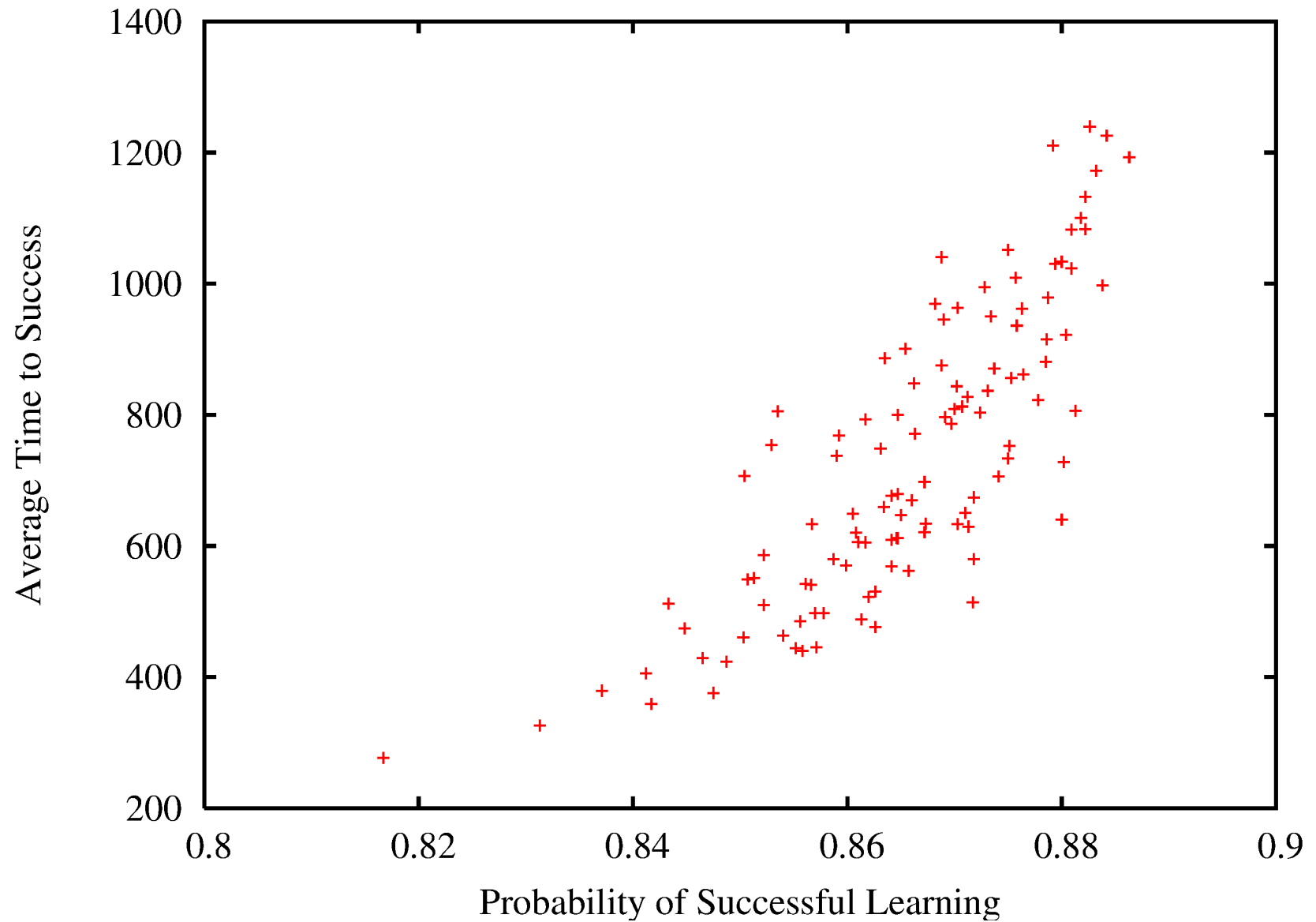
Communication

- Results are communicated
- No second hand communication
- No communication of beliefs

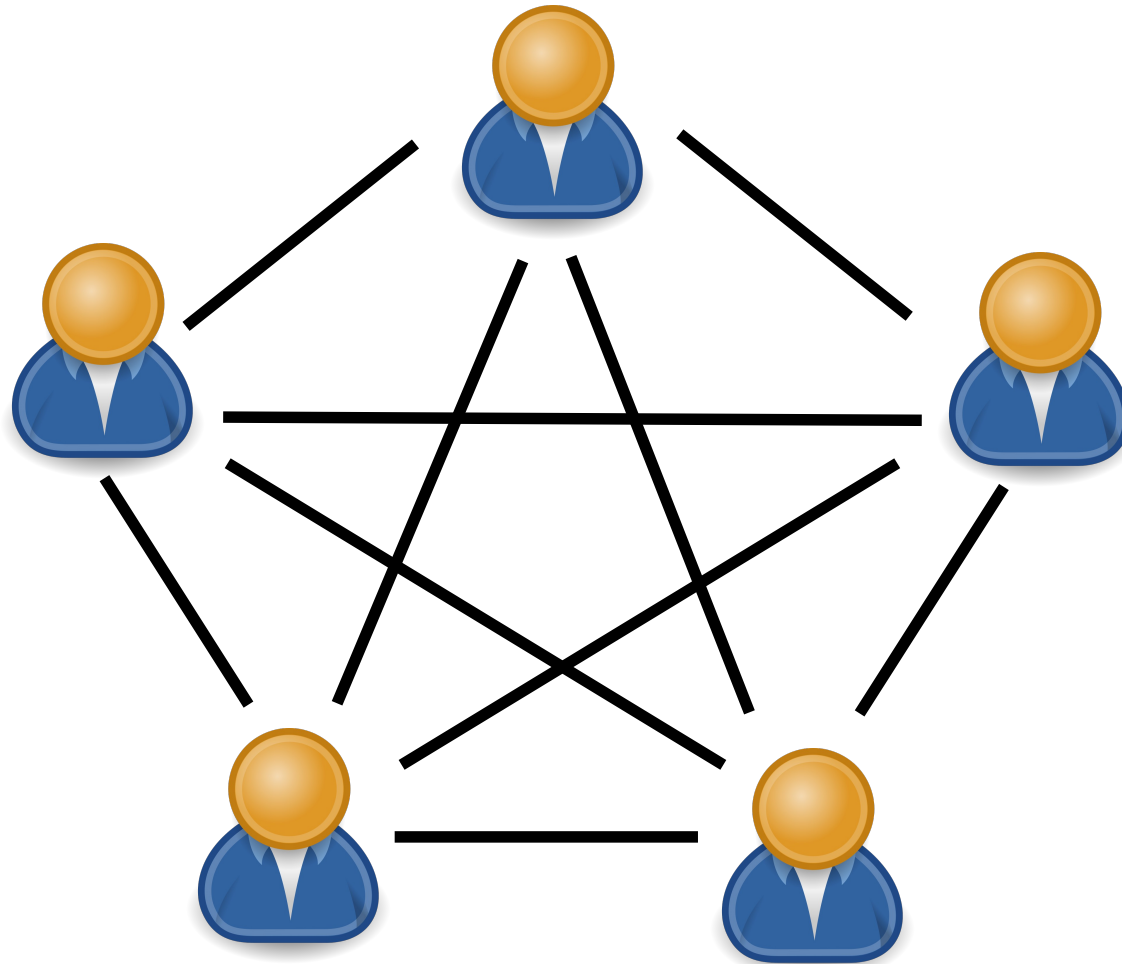
Low exploration



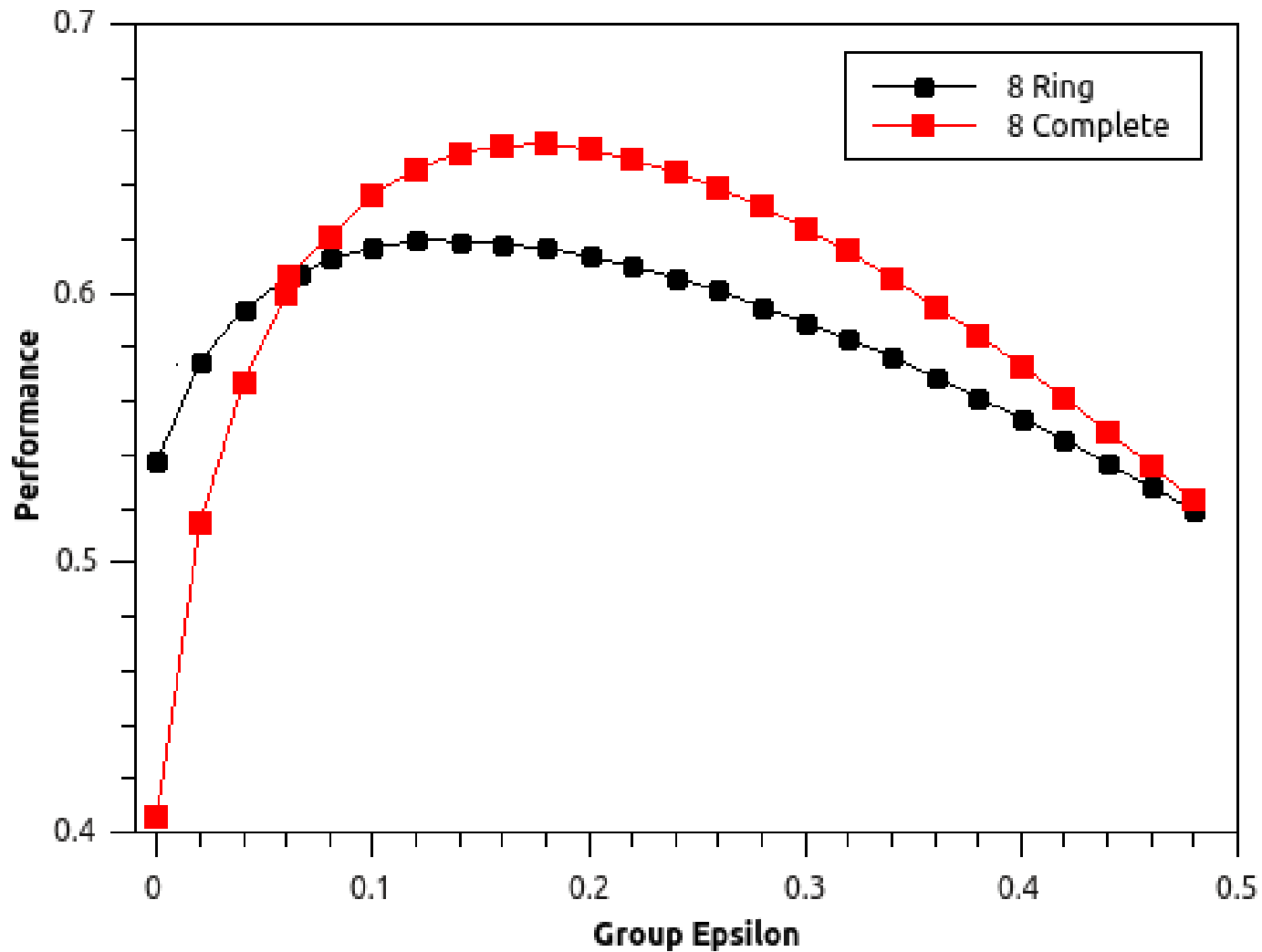
Diversity



High exploration



Overall performance



Range of possibilities

	High exploration	Low exploration
Dense	Best	Worst
Sparse	Second best	Third best

Peptic Ulcer Disease

	High exploration	Low exploration
Dense	Best	Worst
Sparse	Second best	Third best

Do scientists explore?

Colleges, universities, and research institutes have come to depend on federal research support, a dependence that is transmitted (and perhaps amplified along the way) to the scientists and scholars they employ, further limiting intellectual “free play.” New ideas must pass through the filter of peer review, which stimulates opposition and encourages applicants to be cautious, if not conservative, in their proposals. (Chubin and Hackett 1990, p. 10)

Conclusions

- No new information
 - Best network depends on costs, fidelity, and benefits of information
- New information
 - Best network depends on the willingness of individuals to explore

Conclusions

- Individual epistemology: What is the one best method for learning about the world?
- Network epistemology: There is no one best network for social groups.