

Statistical Analysis of Networks

Introduction to Network Analysis

Learning Goals

- ❖ Understand the difference between *individual* vs. *network* approaches to research.
- ❖ Introduce basic data elements in network analysis.

Individual vs. Network approaches to research

Why do people get the flu?



What is the contrast?

- ❖ The old familiar...
- ❖ Variable-based approaches to research focusing on **individuals**.
- ❖ The *explanan* is variation between individual units.
 - ❖ For example: variation in susceptibility or resistance to the flu.
 - ❖ Premised on static “thing-concepts” as their primary unit of analysis.

Another view of research

- ❖ What is network *science*?
- ❖ An approach to science that views the world as being composed of systems of actors connected through relational ties (i.e. a **network**).
- ❖ The *explanan* and *explanadum* is network **structure**.
 - ❖ For example: the properties of flu virus transmission.
 - ❖ Is it dense? Sparse? Modular?

Now, *more* questions

- ❖ For example, consider two different questions:
 - ❖ Are kids who are risk-seeking more likely to drink alcohol?
 - ❖ Are kids who have friends that drink alcohol more likely to drink alcohol?
- ❖ The causal logic of these questions is quite different (as are the policy implications).

Network Science

- ❖ These are all questions that require a different way of thinking about the world.
- ❖ Network science takes network **structure** as the primary domain of interest.
 - ❖ **Structural variables** are quantities that measure structure.

Network Science

- ❖ As with research from an individualistic perspective, network research identifies concepts and relationships among concepts.
- ❖ For example: Power, embeddedness, integration, ...
- ❖ A key difference, though, is that network research **operationalizes** theoretical concepts by drawing on the formal properties of graphs.

NEWS IN BRIEF

Sudden Death Of Aunt Creates Rupture In Family Gossip Pipeline

11/23/15 8:45am • SEE MORE: LOCAL ▾



<https://local.theonion.com/sudden-death-of-aunt-creates-rupture-in-family-gossip-p-1819578447>

Sudden Death Of Aunt Creates Rupture In Family Gossip Pipeline

VIRGINIA BEACH, VA—Grieving family members of local aunt Laurie Shelton confirmed Monday that the 48-year-old woman's unexpected death had caused a major breach in their gossip pipeline, suddenly disrupting access to the latest dirt on all their relatives. "Since Aunt Laurie passed, news about how Stephanie's new boyfriend can't hold down a job and updates on Uncle Jeff's gambling habit have slowed to a trickle," said Shelton's niece Arielle, mourning the loss of a woman who for years had reportedly ensured a steady stream of the juiciest tidbits about relatives' layoffs, unplanned pregnancies, personal bankruptcies, and misdemeanor shoplifting charges. "All the best gossip flowed through her, and now she's gone. For all I know, the twins in North Carolina could have been caught smoking pot, Grandma could be back together with Leon, and Uncle Mike could be considering a vasectomy. It's a devastating loss for the whole family." Several in the family expressed hope that, for the time being, a sufficient supply of idle chatter could be rerouted through Cousin Staci to meet their immediate needs.

Sudden Death Of Aunt Creates Rupture In Family Gossip Pipeline

Conceptually, what does this story tell us about the **structure** of information transmission in the Shelton family?

Can you think of a **structural variable** that could measure Laurie's importance?

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Network Analysis

- ❖ This course is about network **analysis**, which is the set of tools used to study *structural variables*.

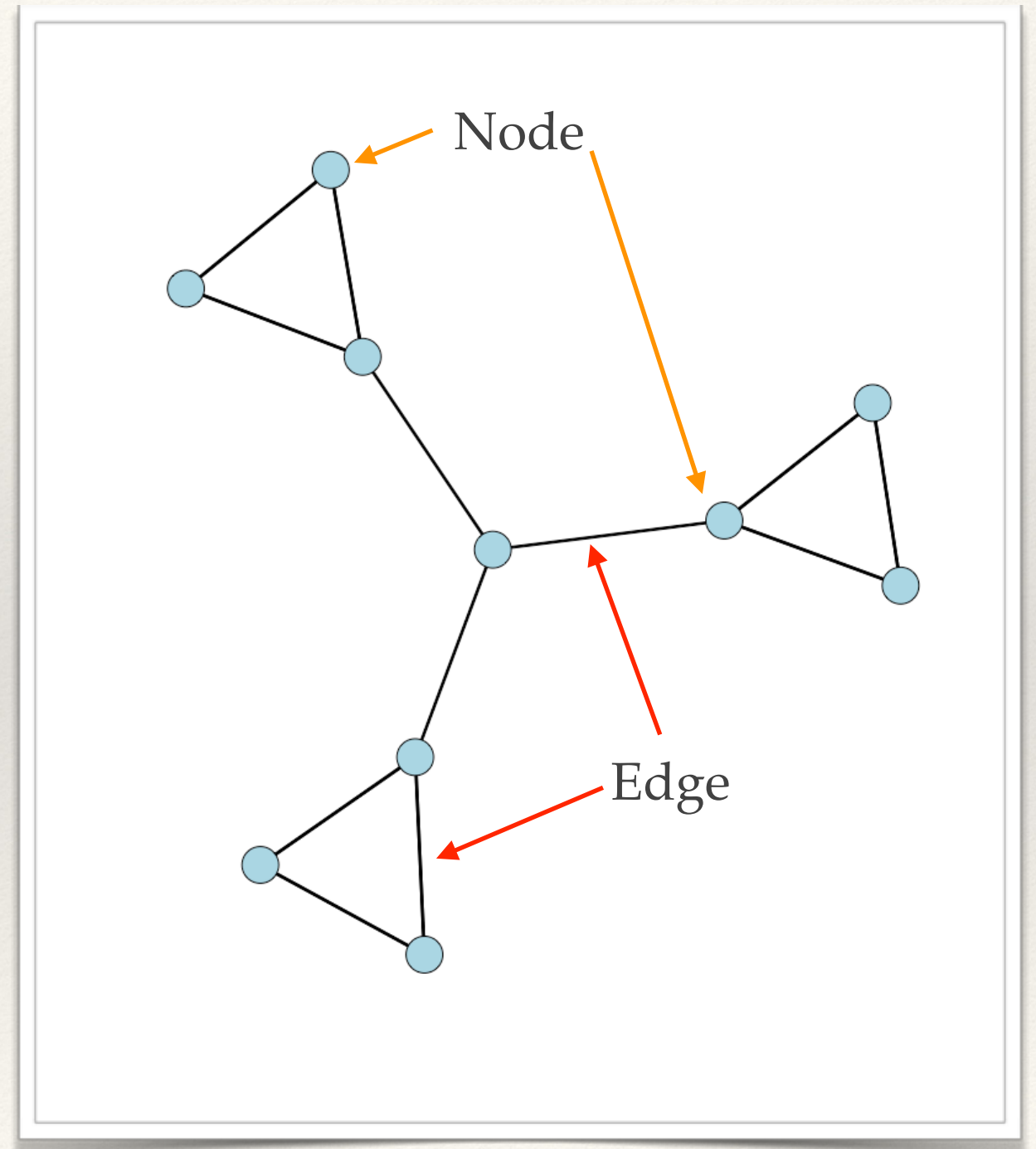
Basic Data Elements

Basic Data Elements

- ❖ Network (relational) data represent:
 - ❖ **Connections** (aka ties, arcs, edges, lines, ties) among,
 - ❖ **Entities** (aka nodes, vertices, actors, points).
- ❖ I will use *node* to mean **entities** and *edge* to mean **connections**.
 - ❖ A *node* can be anything that can link to something else and an *edge* can be anything that can record a connection between nodes.
 - ❖

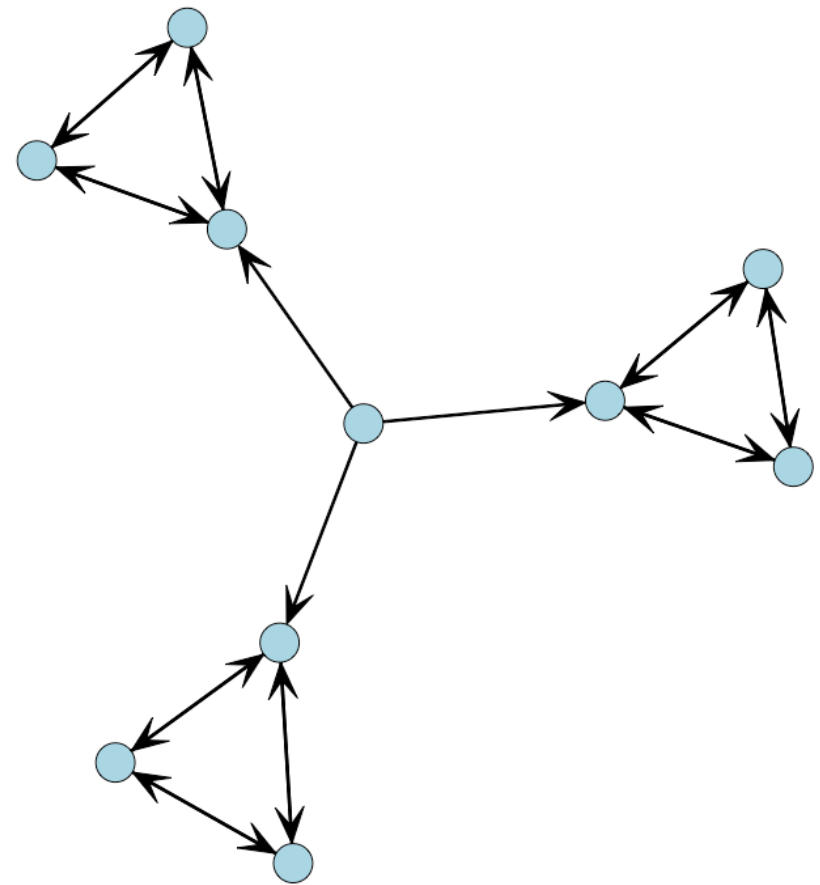
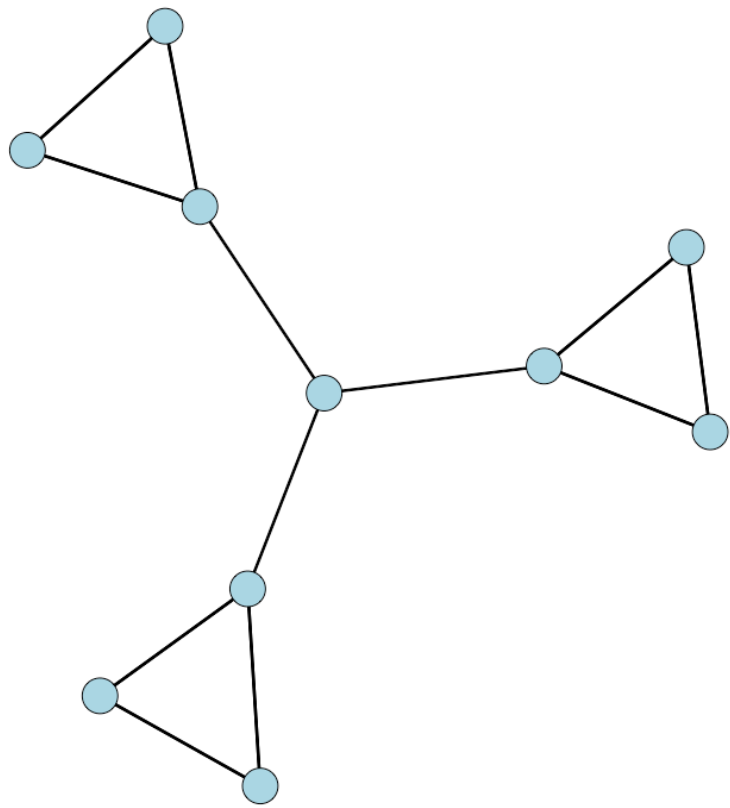
Basic Data Elements

- ❖ On a graph, nodes are represented by *points* and edges are represented by *lines*.



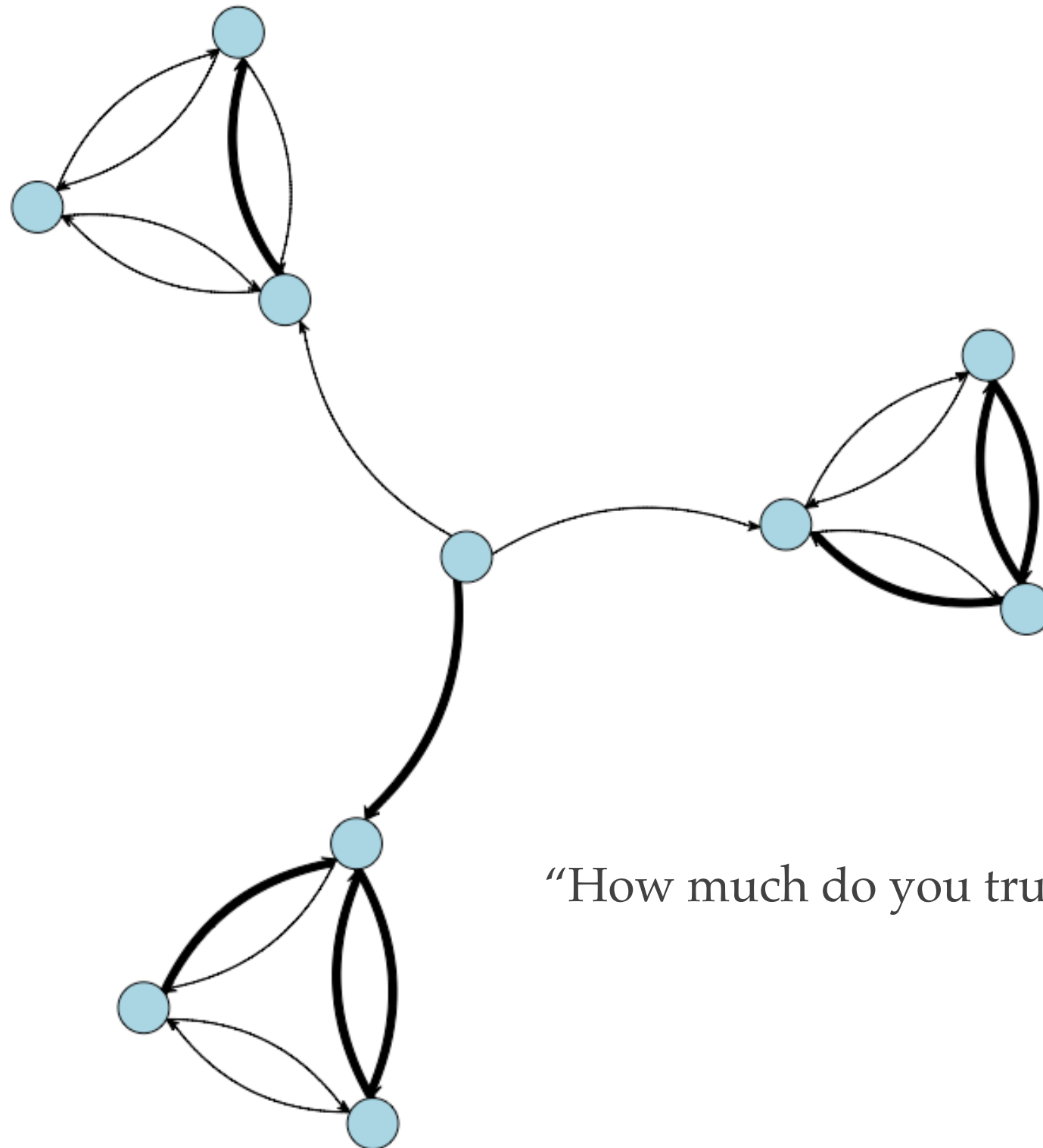
Basic Data Elements

- ❖ Edges can be:
 - ❖ Directed or Undirected.

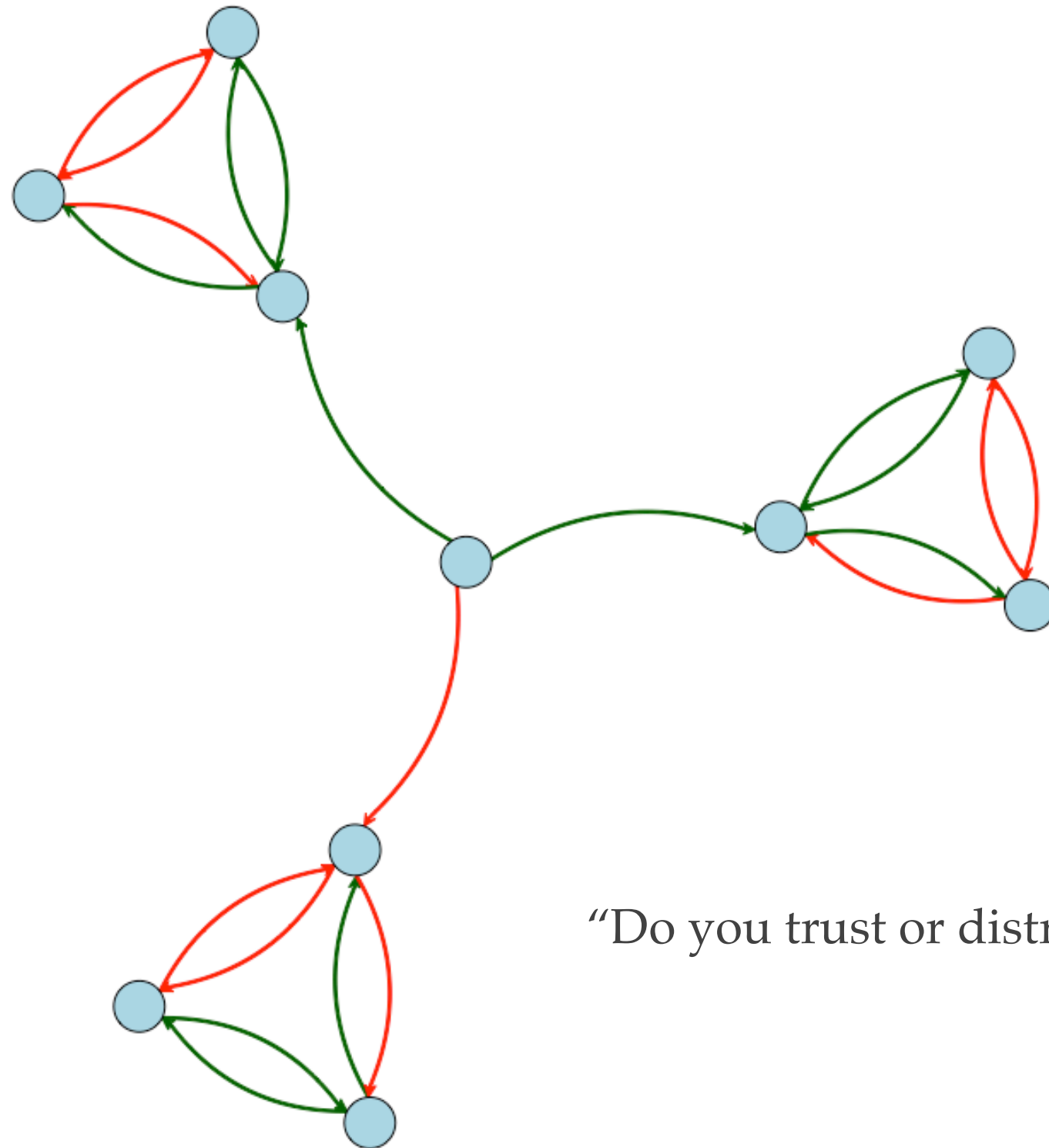


Basic Data Elements

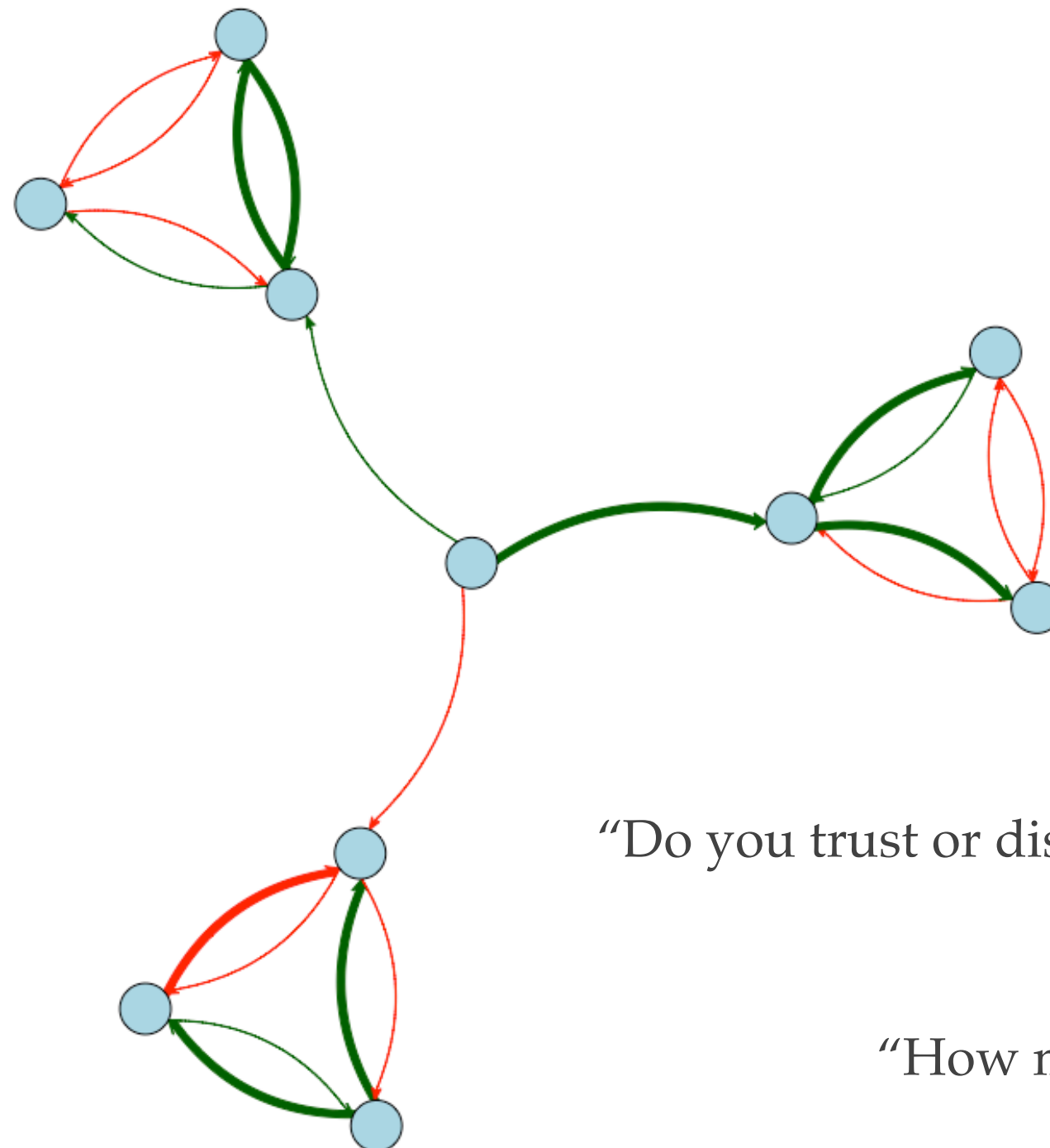
- ❖ **Edges** can be:
 - ❖ Binary (0 / 1; present / absent); Valued (0 / 1 / 2...); Signed (+ / -).



“How much do you trust this person?”



“Do you trust or distrust this person?”

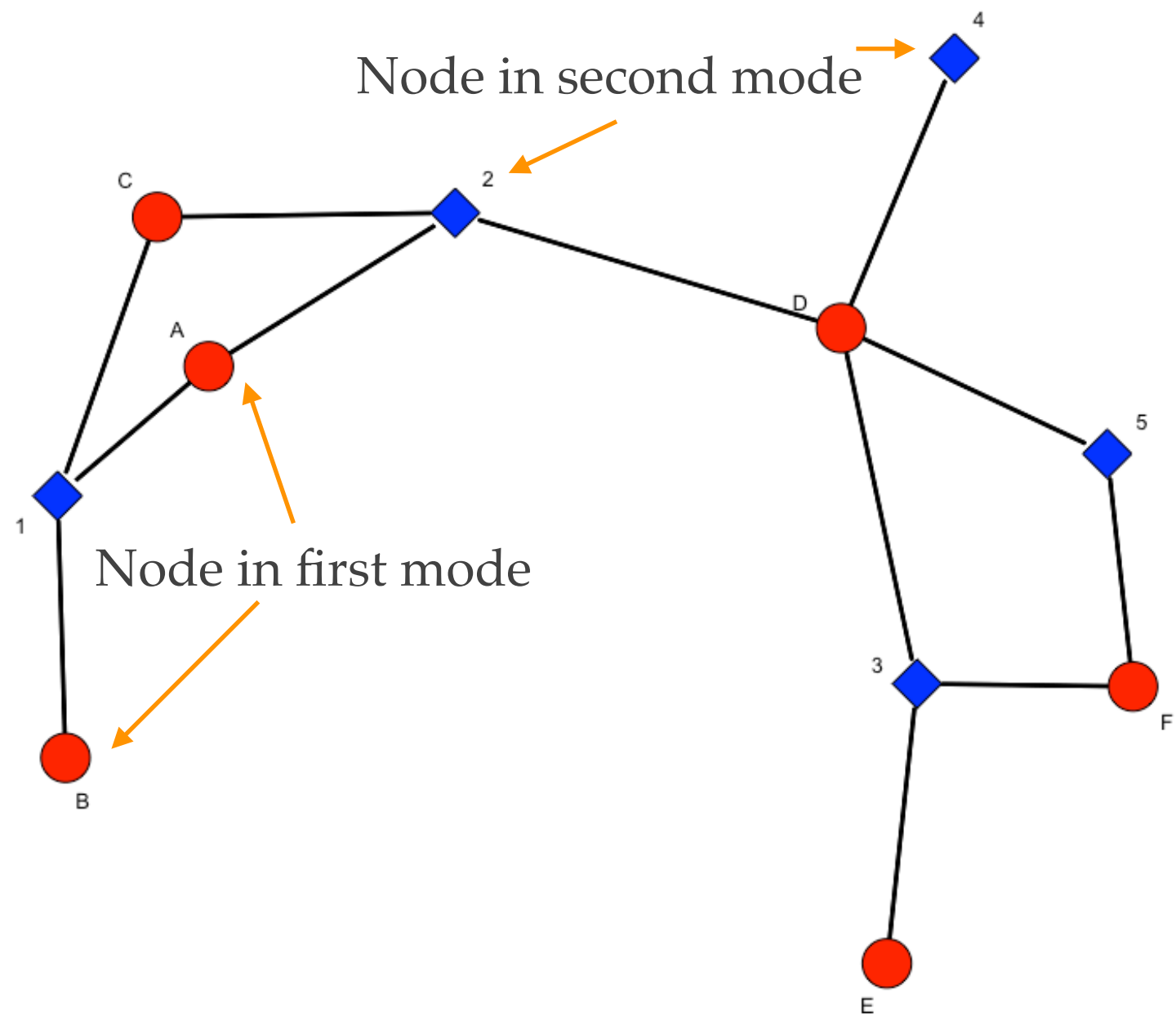


“Do you trust or distrust this person?”

“How much?”

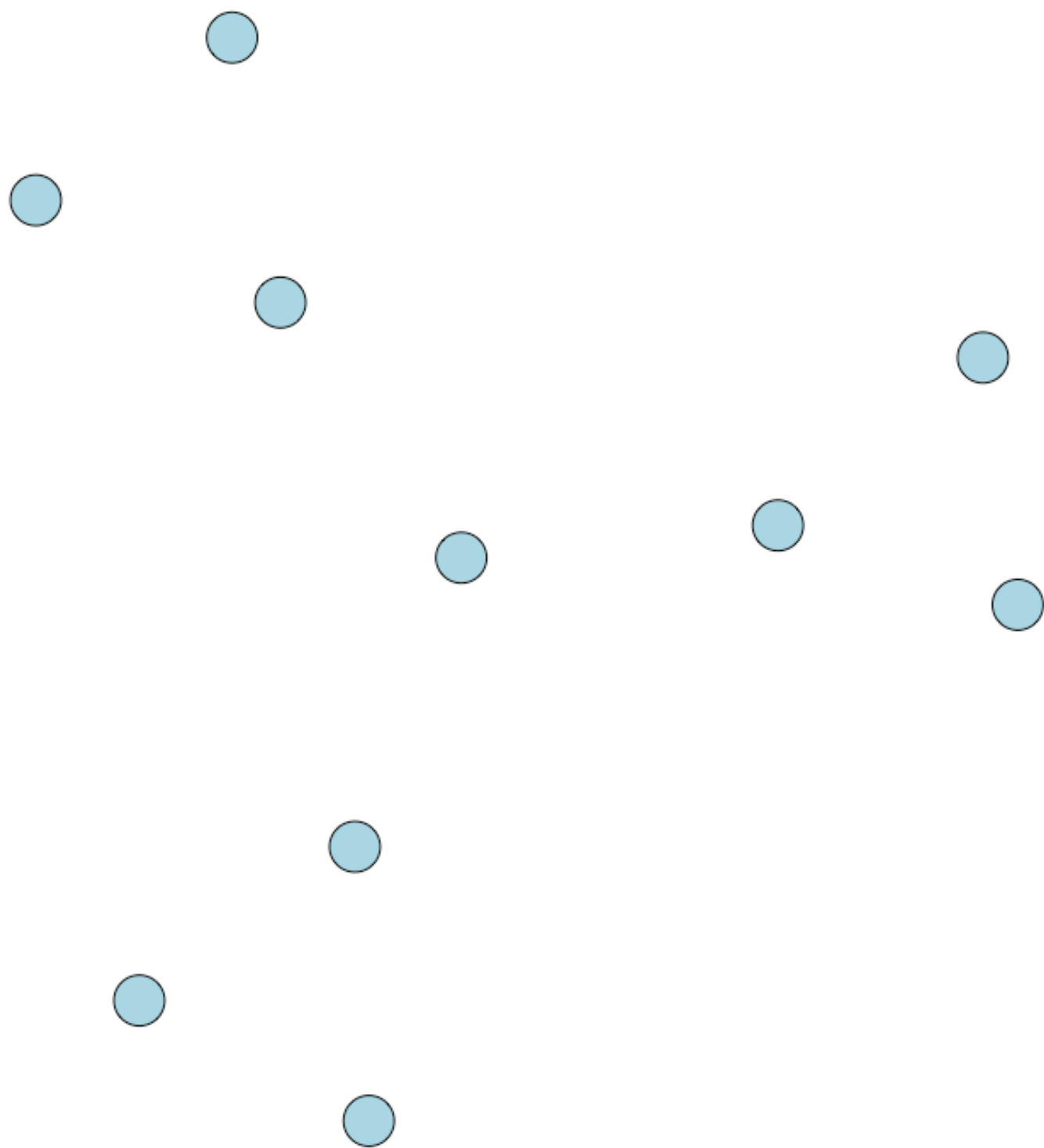
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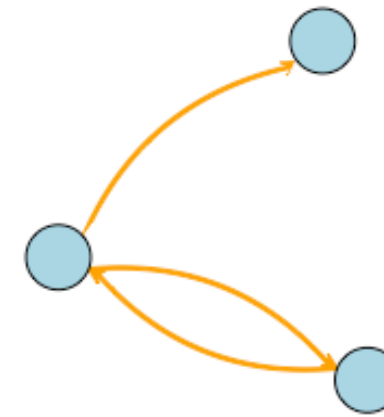
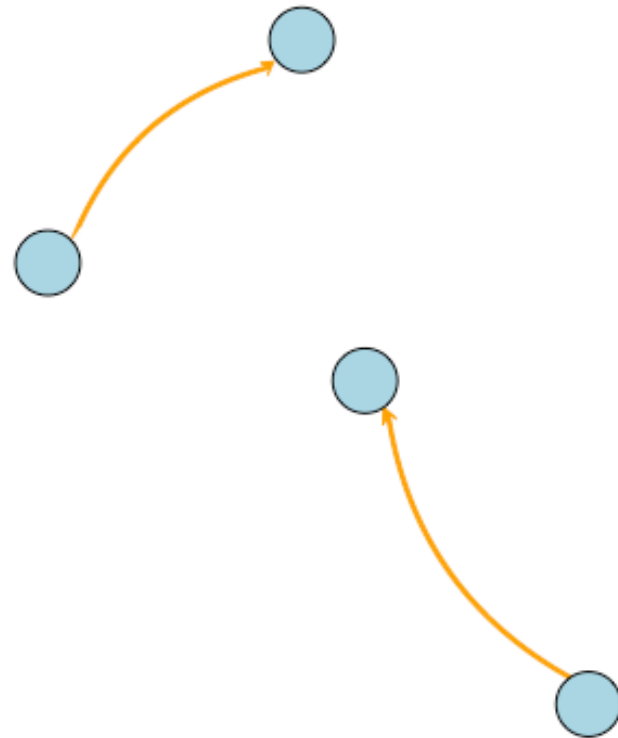
- ❖ *Networks* can differ with respect to their **nodes**:
 - ❖ One-mode / uni-partite (connections among one type of node).
 - ❖ Multi-mode / multi-partite (connections among two or more types of nodes).



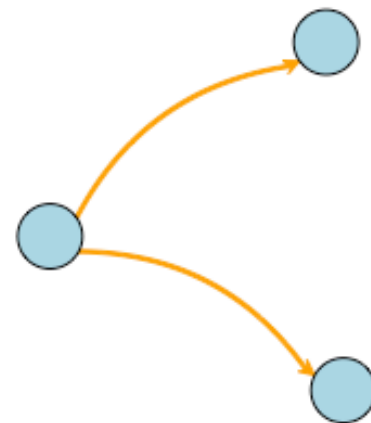
Basic Data Elements

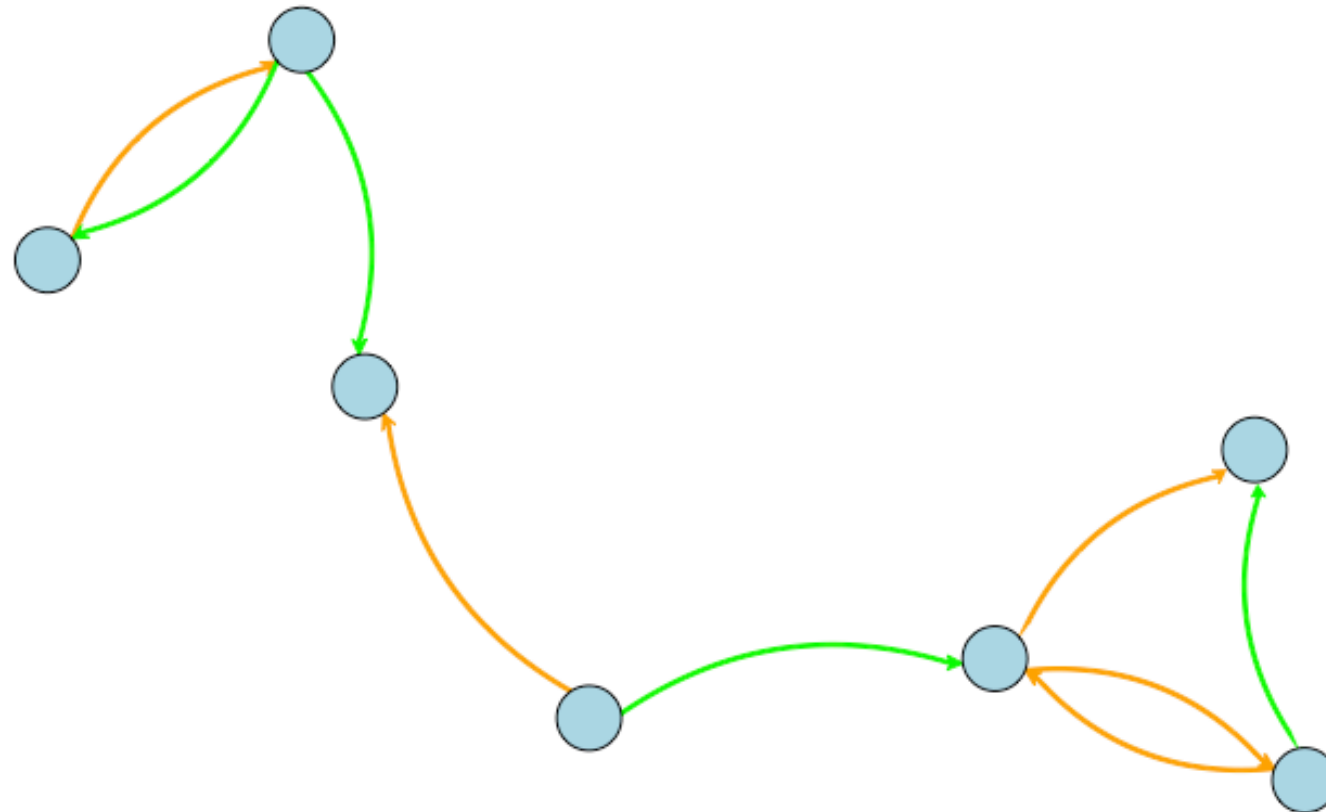
- ❖ *Networks* can differ with respect to their **edges**:
 - ❖ Simplex (connections among nodes are of one type).
 - ❖ Multiplex (connections among nodes are of multiple types).





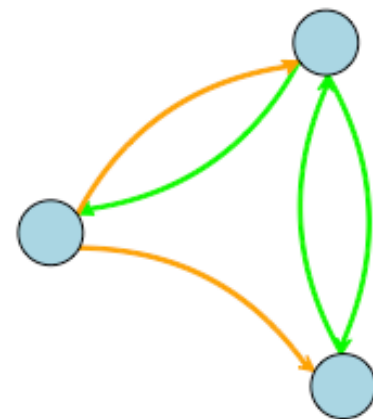
“Do you get along with this person?”

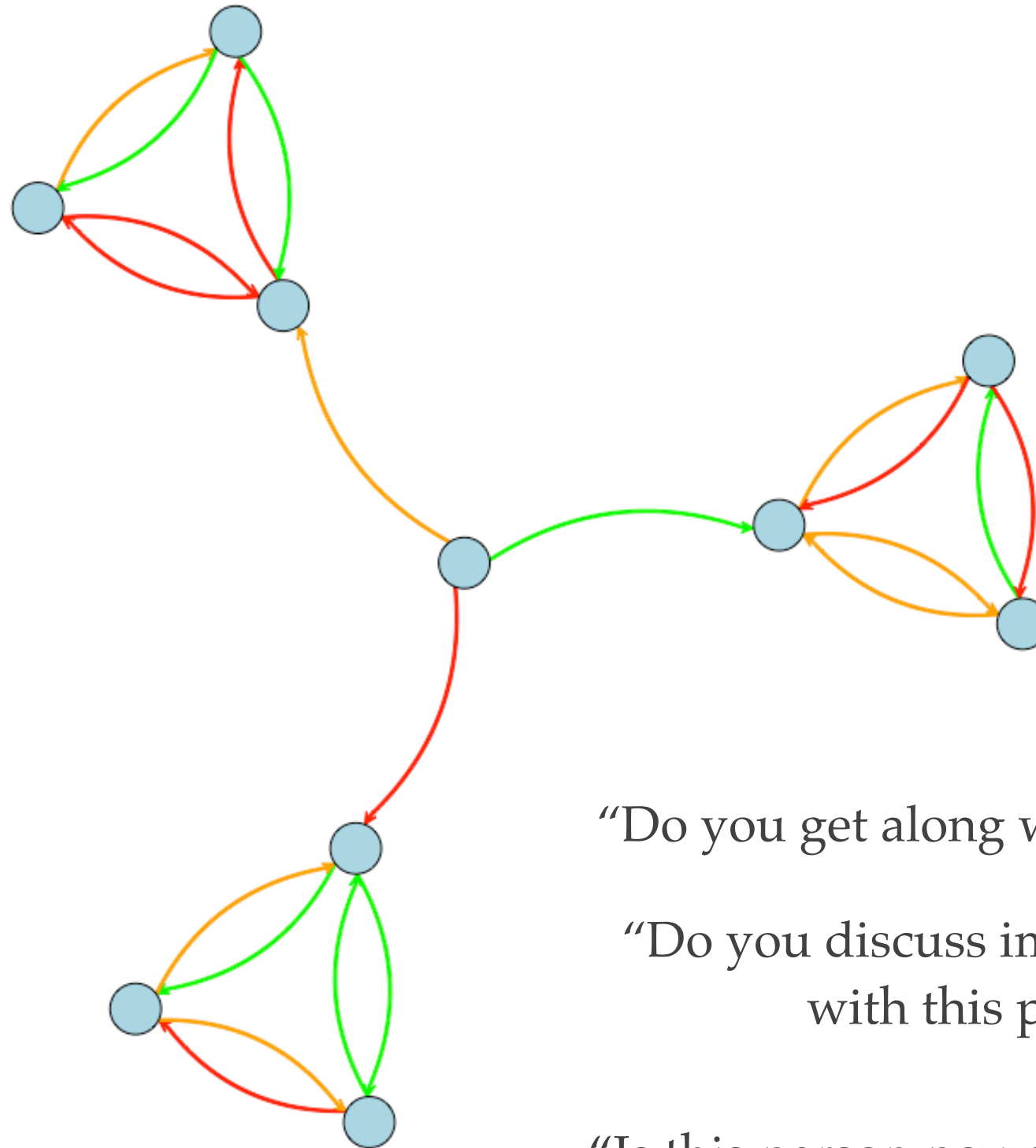




“Do you get along with this person?”

“Do you discuss important matters
with this person?”





“Do you get along with this person?”

“Do you discuss important matters
with this person?”

“Is this person powerful / influential?”

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Questions?