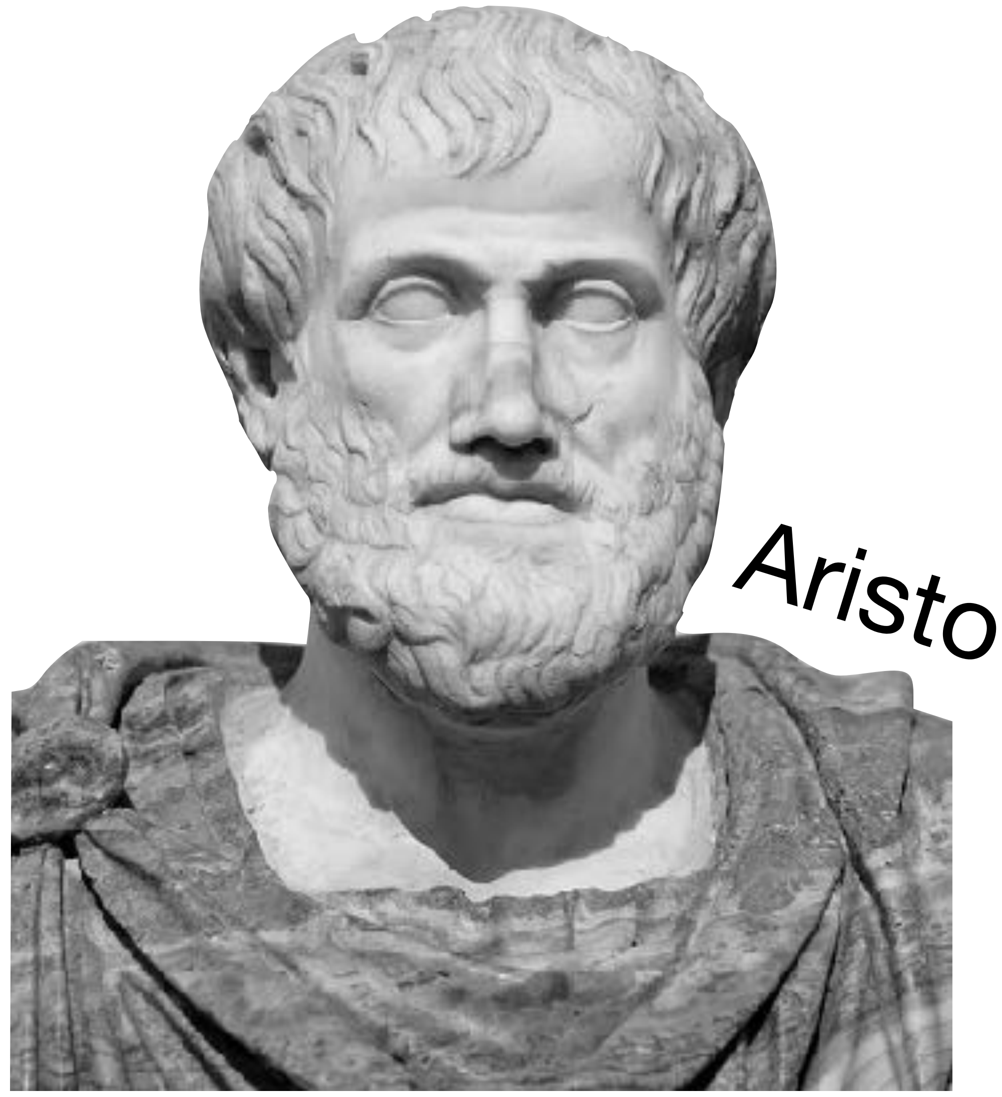
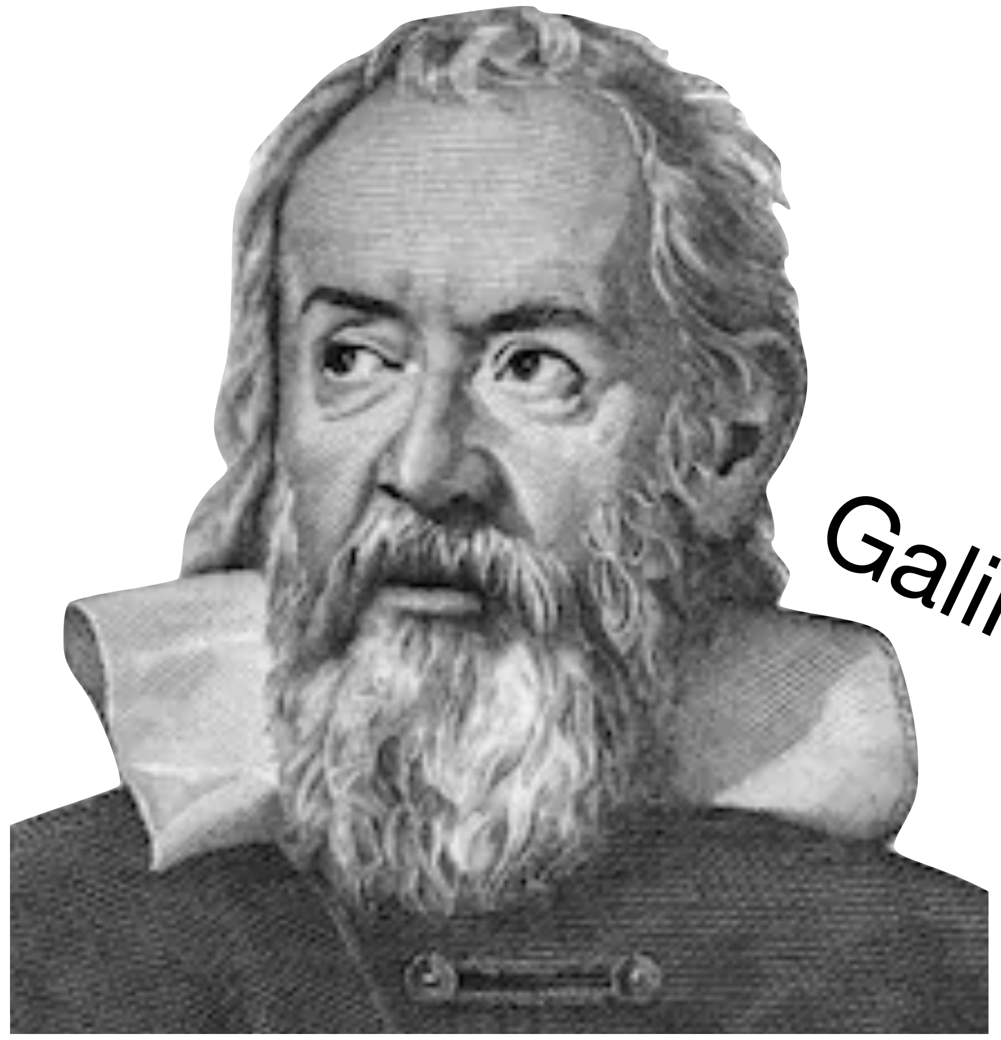
Research Design (also, How to read a research paper)

Introduction to the scientific (publication) method



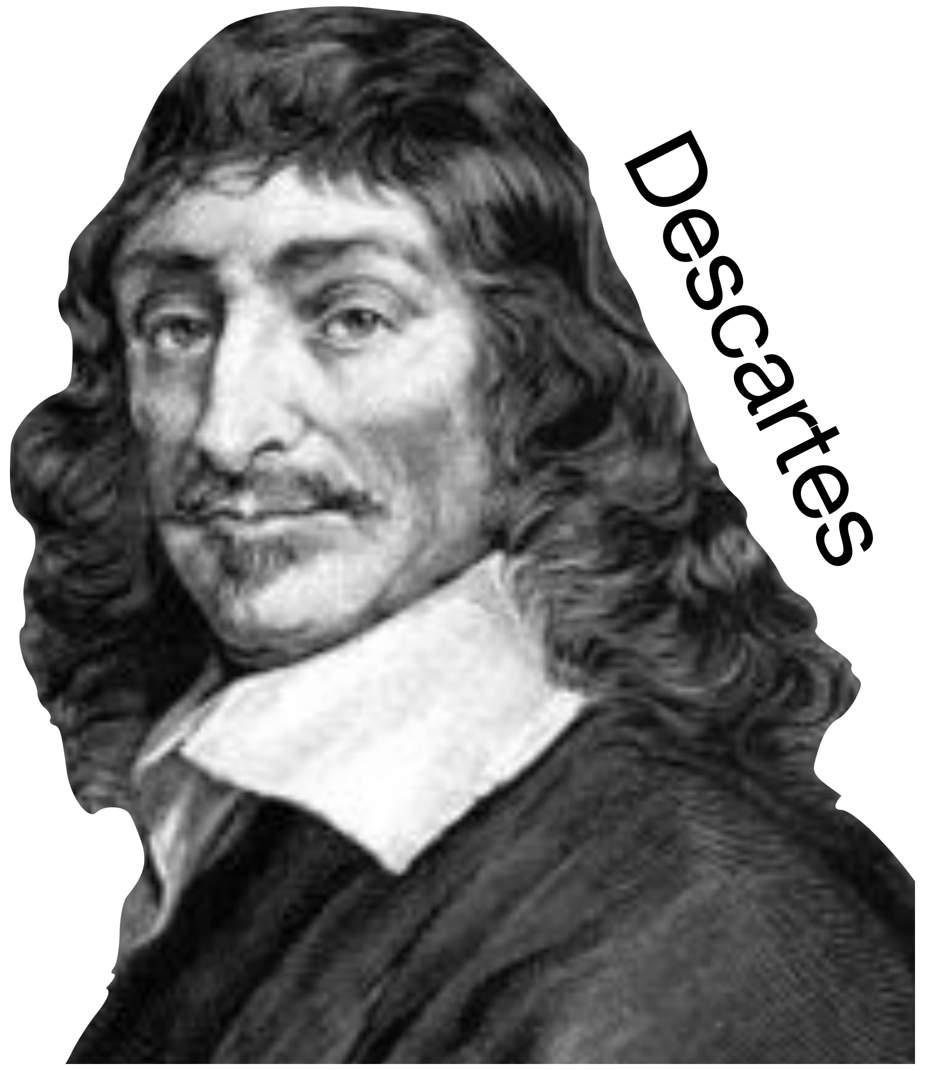
Knowledge from the
rational analysis of nature

Experiments
and reproducibility



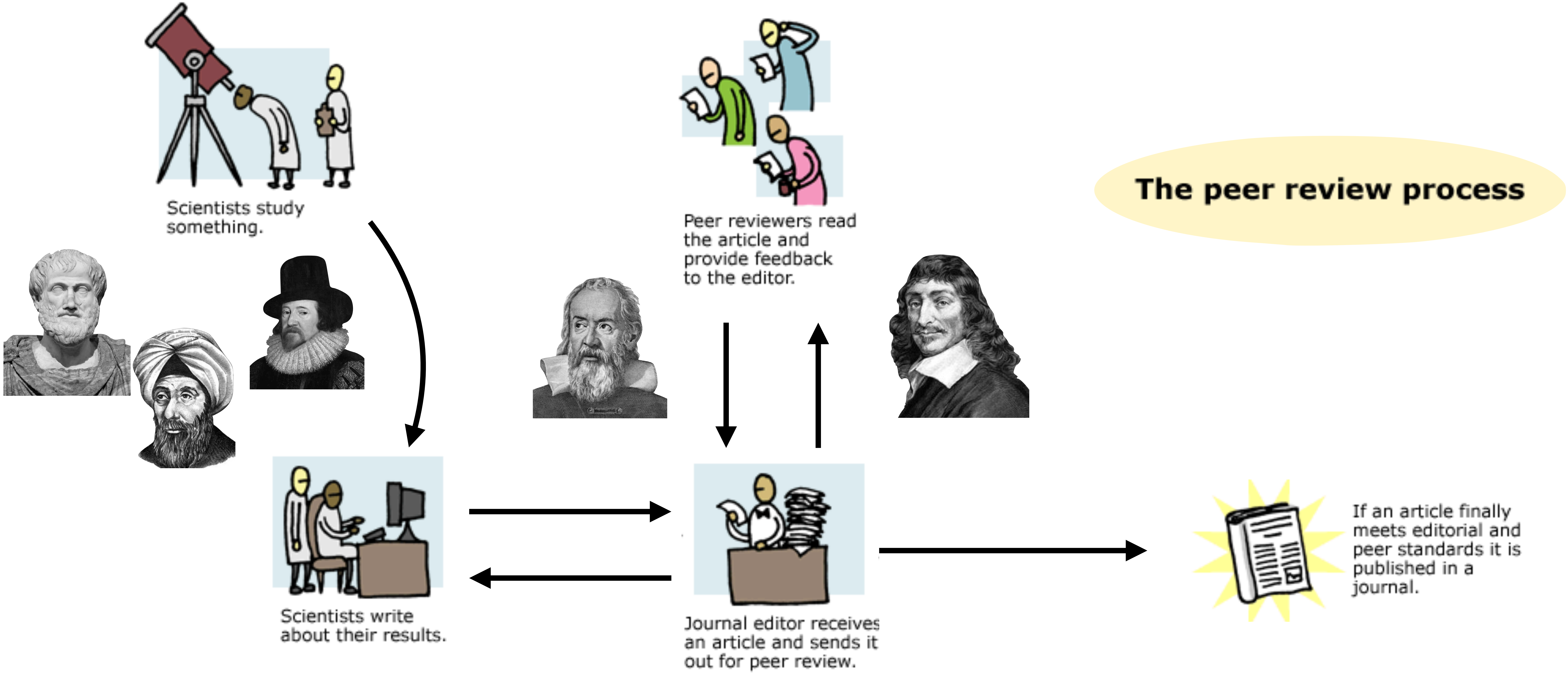
Independent, rational
Confirmation

First-hand
Experience



How do we know
what we know?
(Math can help)

Introduction to the scientific (publication) method



Scientists study something.

Scientists write about their results.

Journal editor receives an article and sends it out for peer review.

Peer reviewers read the article and provide feedback to the editor.

The peer review process

If an article finally meets editorial and peer standards it is published in a journal.

Elements of a Research Paper: Context

What is the general context of the paper?

The context include:

- the general field (e.g., literature, history, archeology, tourism, biology, forensics, religious studies);
- the specific application (e.g., literary analysis, quantitative history, genetics, virology, forensics intelligence, tourism planning, biblical quantitative studies).

Elements of a Research Paper: Problem/Motivation

- What are the problems the authors want to address?
- Why are those problems important (impact, theoretical and/or practical needs, etc.)?
- What are the main contributions of the paper?

Elements of a Research Paper: Data

- How did the authors gather their data?
- Did they digitise their data? How? Is the material publicly available?
- What tools did they use 1) to handle (store, manipulate) the data and 2) to compute measures on the data?
- What measures did they apply?

Elements of a Research Paper: Results

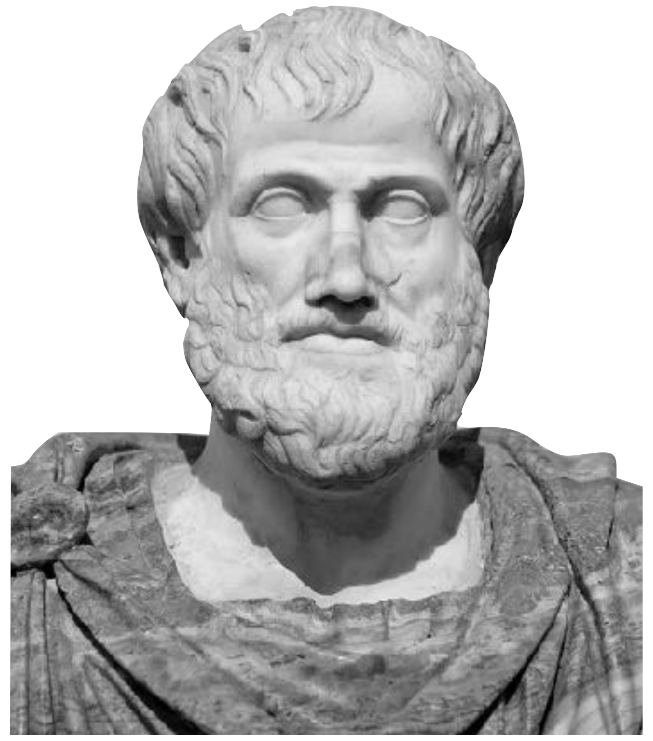
- What is the connection among:
  - the gathered data;
  - the applied measures;
  - the properties found.

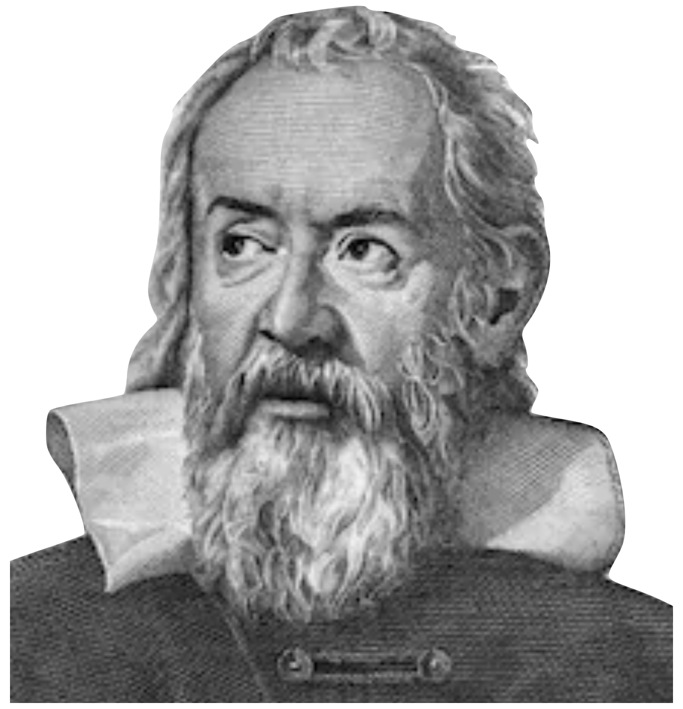
Peer-reviewing: Critique

- What is your opinion/critique on the paper?
- Do you think the contributions solve the problems they presented?
    - To which extent (completely, what parts)?
    - Why?
- What could the authors have done differently to answer their research problems (e.g., gather data with additional information, build their model differently, apply alternative measures)?

Elements of Network Analysis Research

There is a common denominator to all network analysis research: the usage of a tool from discrete mathematics, called **graph theory**, to *reduce and draw conclusions from naturally-occurring (network) phenomena*





Whole-network and Personal-network Research Design

Two fundamental kinds of network research designs:

Whole network: we study the set of ties among all pairs of nodes in a given set, e.g., we study who is friends with whom among all members of a given organisation - there, the relation being measured is a dyadic variable that has a value for every pair of nodes (every dyad might be assigned a 1 or a 0, whether they are friends or not).
Whole-network designs enable researchers to employ the full set of network concepts and techniques, which often assume that the entire network is available. However, the cost of assembling and managing the network can quickly rise due to the whole-network scope.

Personal network: we study a set of nodes called "egos" and their ties to others, called "alters" (not necessarily among the set of egos). Personal-network designs have the advantage of simplifying the gathering and management of the network.

Sources of Network Data

Primary sources: the researcher collects the data first-hand, e.g., by asking questions to or observing the behaviour of the interviewees, from a survey, probing a (computer) network or applying other kinds of first-hand measures on the focussed network.

Secondary sources: the researcher gathers data that already exists somewhere, whether in paper records (e.g., fish records, historical marriage records), or electronic databases (e.g., emails, social networking sites). Secondary data is often easier and quicker to collect but imposes strong and arbitrary limits on the type of relations studied. Some of the computer-based data generated by social media such as Facebook and even email represents a transitional form between primary and secondary data. Although the data is collected directly, as in primary research, there are limitations on the types of relations available for study, as in secondary research.

Types of nodes and types of edges/ties: relational states

When ties are **co-occurrences**, they relate nodes of different types, e.g., a person present at a given event; members of the same organisation, etc.. Co-occurrences are relatively easy to collect, e.g., this type of data is often not private or sensitive and it is available via archival sources (e.g., list of board directors, the cast of films on IMDB, etc.).

Relational roles or relational cognition ties represent relational states of continuous nature between nodes of the same type. Relational roles are often institutionalised (e.g., being married) and can be collected from sources other than the nodes directly involved (e.g., community, family members, archival records). Relational cognition ties are a perception of the individuals and do not have an independent existence (e.g., feeling affection for someone, thinking someone is happy, etc.) and they have to be obtained by surveying the perceiver.

Types of nodes and types of edges/ties: relational events

Interactions can be either directly observed or reported on by respondents. Although interactions are often directly observable, there are *always issues of interpretation*.

In a network study of a fish camp, Johnson and Miller (1983) observed two Italian fishers engaged in what appeared to be a heated discussion. Johnson asked a younger Italian fisher, who was also observing, what the conflict was all about. The younger Italian explained that there was no conflict, but that the two men—who were brothers—were simply having a friendly discussion about a nephew. Johnson was interpreting that interaction from his cultural perspective rather than from the perspective of the two Italians engaged in the interaction.

Types of nodes and types of edges/ties: relational events

When surveying **interactions**, the higher the level of abstraction (e.g., passing from a “friendly conversation” or a “heated argument” to “had a face-to-face interaction”) the more theoretically useful the data is likely to be.

However, it is important to balance specificity and abstraction, as higher levels of abstraction diminish the specificity of the results of the study.

More abstract interactions are *proxies for unseen underlying social relations*, e.g., who-talks-to-whom outside of work **might** be a proxy to mean the speakers are friends. The same can happen when acquiring data through archived text exchanges (e.g., chat messages, emails), where it is not always clear what is the kind of relationship that ties the two writers.

Types of nodes and types of edges/ties: relational events

Flow ties can be seen as the outcome of interactions that “pass” something, tangible or not, between nodes. Examples of flows are people exchanging information as well as subsistence hunters sharing food.

Flows data is difficult to obtain at the individual level and follow a more perpetual pattern the less tangible the observed flow is—e.g., how do we track the amount of information passed in a conversation?

Material exchanges between individuals are simpler to record, as we just need the account of one of the two nodes in the relation to establish it (e.g., A lent 5€ to B). Material, organisation-level flows are even easier to obtain, thanks to (public) ledgers and records, e.g., the dollar-value of flows of raw materials and manufactured goods between countries, people flowing between companies, etc.

Types of nodes and types of edges/ties

Relational states							Relational events	
Similarities/Co-occurrences			Relational roles		Relational cognition			
Location	**Participation**	**Attribute**	**Kinship**	**Other roles**	**Affective**	**Perceptual**	**Interactions**	**Flows**
Same spatial and temporal space	Same clubs, same events	Same gender, same attitude	Mother of, sibling of	Friend of, boss of, student of, competitor	Likes, hates	Knows, knows of, sees as happy	Sold to, talked to, helped, fought with	Information, beliefs, money

Types of nodes and types of edges/ties

Category	Varieties and examples
Similarities/Co-occurrences	Co-membership in groups Co-participation in events Physical distances Similarities in attributes (e.g., political view)
Relational roles and cognition	Kinship relations Affective relations (e.g., dislikes) Perceptual relations (e.g., knows)
Interactions	Transactions (e.g., ‘sells to’) Activities (e.g., ‘sleeps with’)
Flows	Ideas and information Goods Infections

Sampling and bounding

When is enough (data) enough?

More specifically (to network analysis), **what is the boundary that determines the set of nodes to be included in a study**?

The problem is subtle and ***it does not really concern the size of the network*** but rather the nature of the research question. E.g., if we want to determine what are the main actors determining the choices into a company, what is the scope we consider? Just the company? Should we consider the families of the employees? What about their friends and clubs? Other employees in competing companies? Governments?

Sampling and bounding, guidelines

When the research cannot restrict the set of alters that a respondent could name, use a personal-network research design. In a sense, the boundary specification problem involves two sets of actors to which we need to set inclusion boundaries: the egos (in whose ties we are interested) and the alters (those with whom egos have ties to).

Consider whether the object of the study is a sociological group or not. Groups are recognised by their members and they have boundaries: part of the concept of a group is that there are members and non-members, even if in fact the boundaries are fuzzy and/or contested. If one is studying the internal network of a group, then getting the boundaries more or less right is important. Also artificial groups, defined by the researcher, do not necessarily threaten the validity of the research design, as long as the grouping choice is rationally defined/explained by the research question.

Strategies for finding group boundaries

Most groups have fuzzy boundaries.
Even formal groups such as corporations, can have fuzzy boundaries, e.g., does a corporation include part-timers? Sub-contractors? New hires? Applicants? Retirees? Consultants?

Snowballing is a technique for group discovery where sampled individuals recruit new subjects from among their “ties”. This sampling technique is often used in hidden populations that are difficult for the researcher to access. However, snowball samples are subject to numerous biases (e.g., people with many ‘ties’ are more likely to be recruited into the sample).
If the purpose of the study is to *discover the nature of ties* that connect the areas of high redundancy or density in social networks, then ties that bridge these areas of high density need to be pursued and a *redundancy criteria* may need to be applied across several waves of a snowball sample.

Strategies for finding group boundaries

Nominalist and realist criteria, respectively called also “etic” and “emic” criteria, help in determining the members of the studied group. The term “etic” indicates a universal (nominalist) objective, a third-person criterium that classifies individuals. The term “emic” indicates the recognition (realist) of belonging in a group—either by its members or by a set of ideologies and behaviours recognised as characteristics by the members of the group.

For example, in a study on innovations through a network of commercial fishers, to define the boundaries between professional and hobbyist fishers, the researchers used the fishers’ own perceptions (emic) to refine the sample, asking all licensed fishers (etic) to identify other fishers that they considered full-time professionals.

Sources of data, reliability and validity issues

Reliability

Same conditions, same results

and

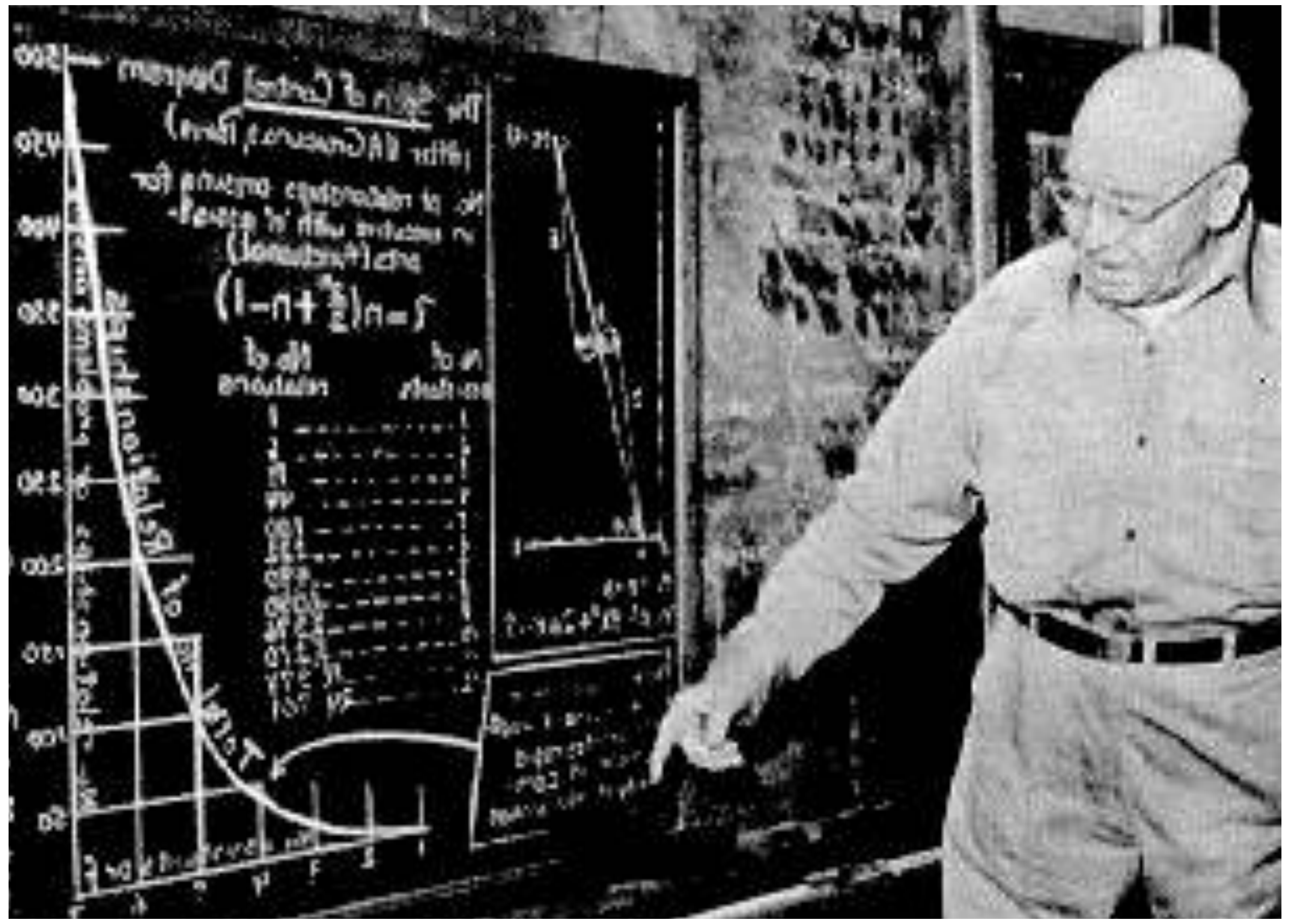
Validity

Measure what we intend to measure

Sources of data, reliability and validity issues

Validity asks the question “are we measuring what we intend to measure?” In a network study this entails understanding how closely our model represents reality.

A **map *is not* the territory** it represents, but, **if correct**, **it has a *similar structure*** to the territory, which accounts for its usefulness.



A Non-Aristotelian System and its Necessity for Rigour in Mathematics and Physics
Korzybski 1931

Sources of data, reliability and validity issues

Validity asks the question “are we measuring what we intend to measure?” In a network study this entails understanding how closely our model represents reality. Validity errors include:

- **Omission errors:** missing edges and nodes have huge impacts on errors in network variables (e.g., in centrality measures), by making the network appear more/less disconnected than it really is or make nodes and edges in the network appear to be more “important” than they really are.

- **Commission errors:** dual to omission errors, the erroneous inclusion of nodes and edges can affect the ultimate determination of node-level measures and the identification of key nodes.

Sources of data, reliability and validity issues

Validity asks the question “are we measuring what we intend to measure?” In a network study this entails understanding how closely our model represents reality. Validity errors include:

- **Data collection and retrospective errors:** we should take care when we use network data collected from individuals where the network-elicitation question deals with reports of behaviour, in particular when we have to do with social interactions of a temporally discrete nature. We need to avoid ambiguous questions that leave too much room to interpretation. Also, since people can both make commission and omission errors when describing their behaviours (e.g., "whom did they interact with yesterday?") cross-checking (if possible) assertions between nodes is essential for the validity of the model.

Sources of data, reliability and validity issues

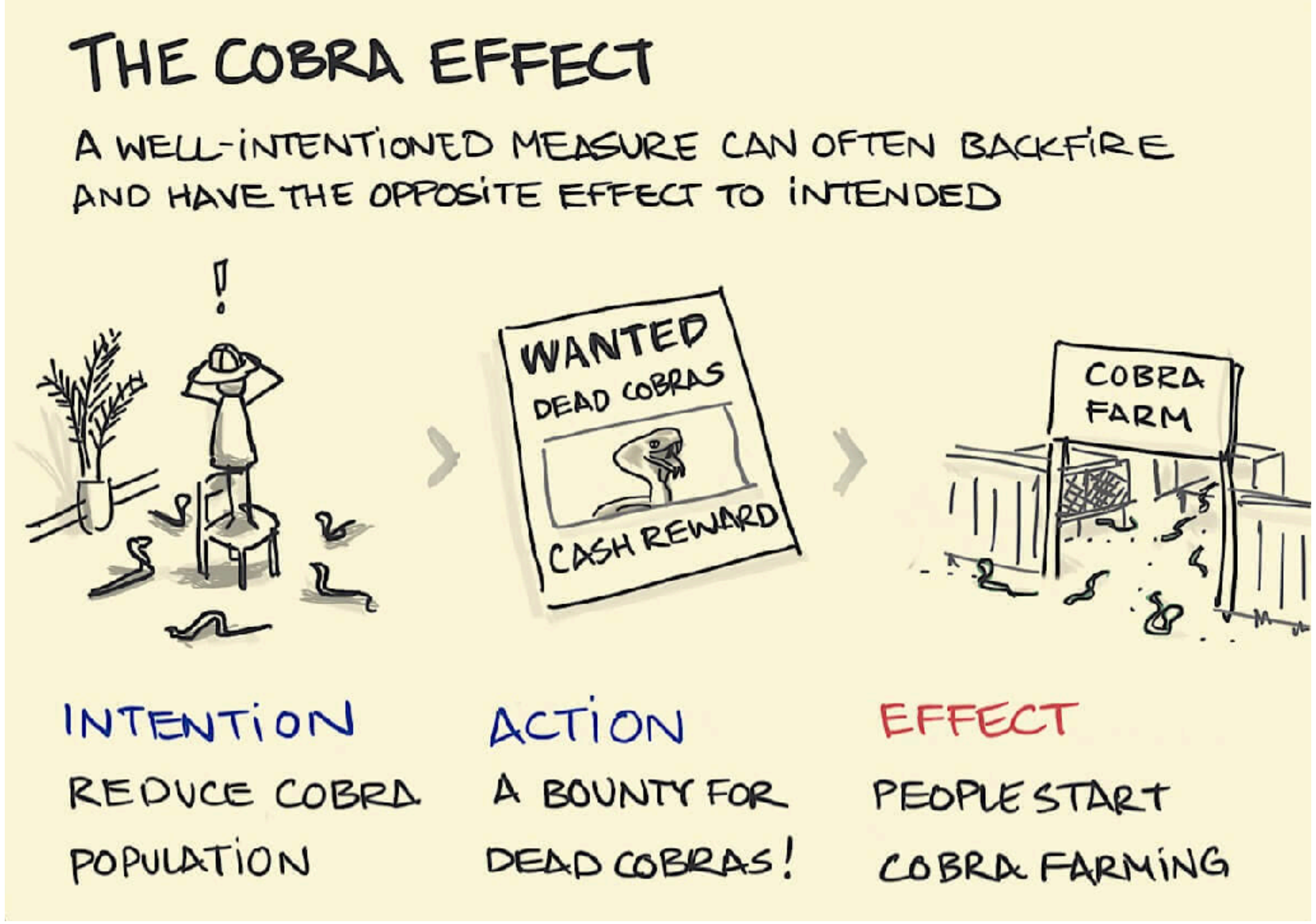
Validity asks the question “are we measuring what we intend to measure?” In a network study this entails understanding how closely our model represents reality. Validity errors include:

- **Edge/node attribution errors:** mis-assignment of a behaviour to a node can yield linkages that in reality do not exist. For example, two students may co-attend a large number of elective courses. Given the chances, we might assume a connection of friendship between the two. However, the phenomenon could be casual and the two could live situations which never allowed them to interact, e.g., one is a student who always goes to parties, the other is a student worker who have no time to hang out. Treating high levels of co-attendance as friendship ties is, in this case, too broad and we need other data to help us determine the existence of the tie.

Sources of data, reliability and validity issues

Edge/node attribution errors

Timeo mediatores et clausolas ferentes


THE COBRA EFFECT
A WELL-INTENTIONED MEASURE CAN OFTEN BACKFIRE AND HAVE THE OPPOSITE EFFECT TO INTENDED
!
WANTED
DEAD COBRAS
CASH REWARD
COBRA FARM
INTENTION
REDUCE COBRA POPULATION
ACTION
A BOUNTY FOR DEAD COBRAS!
EFFECT
PEOPLE START COBRA FARMING

Sources of data, reliability and validity issues

Reliability ask the question “given the same conditions, if we repeated our study, would we obtain the same results?”

The question to ask is “If I let someone else perform this study, would we have the same results as if conducted it by myself?”

If we rely on objective data (public records as well as perceptions of the nodes) and we apply objective measures (e.g., through formulae and algorithms) we increase the reliability of the study—we are removing subjective factors from the process of data collection and analysis. On the contrary, with measures based on *our* perceptions, our results are less reliable, as other researchers could perceive things differently than us—even our own perceptions can change in time, e.g., with education, age, etc.

Sources of data, reliability and validity issues

Reliability ask the question “given the same conditions, if we repeated our study, would we obtain the same results?”
Threats to reliability include:

- **Data fusion/aggregation:** when aggregating data on different temporal, relational or spatial scales, it is possible that we exclude important nodes and edges because they have lost their importance in the network. Thus, there should be some guiding principles—preferably of a theoretical nature—for making aggregation decisions (e.g., before and after a hypothesised important event). E.g., if we aggregate data on stable relationships, we want to adopt a principle that defines that tie on a fixed temporal scale (e.g., a valid tie must have lasted at least 1 year).

Sources of data, reliability and validity issues

Reliability ask the question "given the same conditions, if we repeated our study, would we obtain the same results?"
Threats to reliability include:

- **Errors in secondary sources and data mining:** secondary-source data may have inherent biases, which should be considered in any analysis. Second-source data might be easier to collect than primary one, but it can be fraught with errors at a variety of levels. When adopting secondary data, it is important to probe the consistency of the model, asking questions like "if we asked a survey question, what survey question would the tie(s) in the model correspond to?"

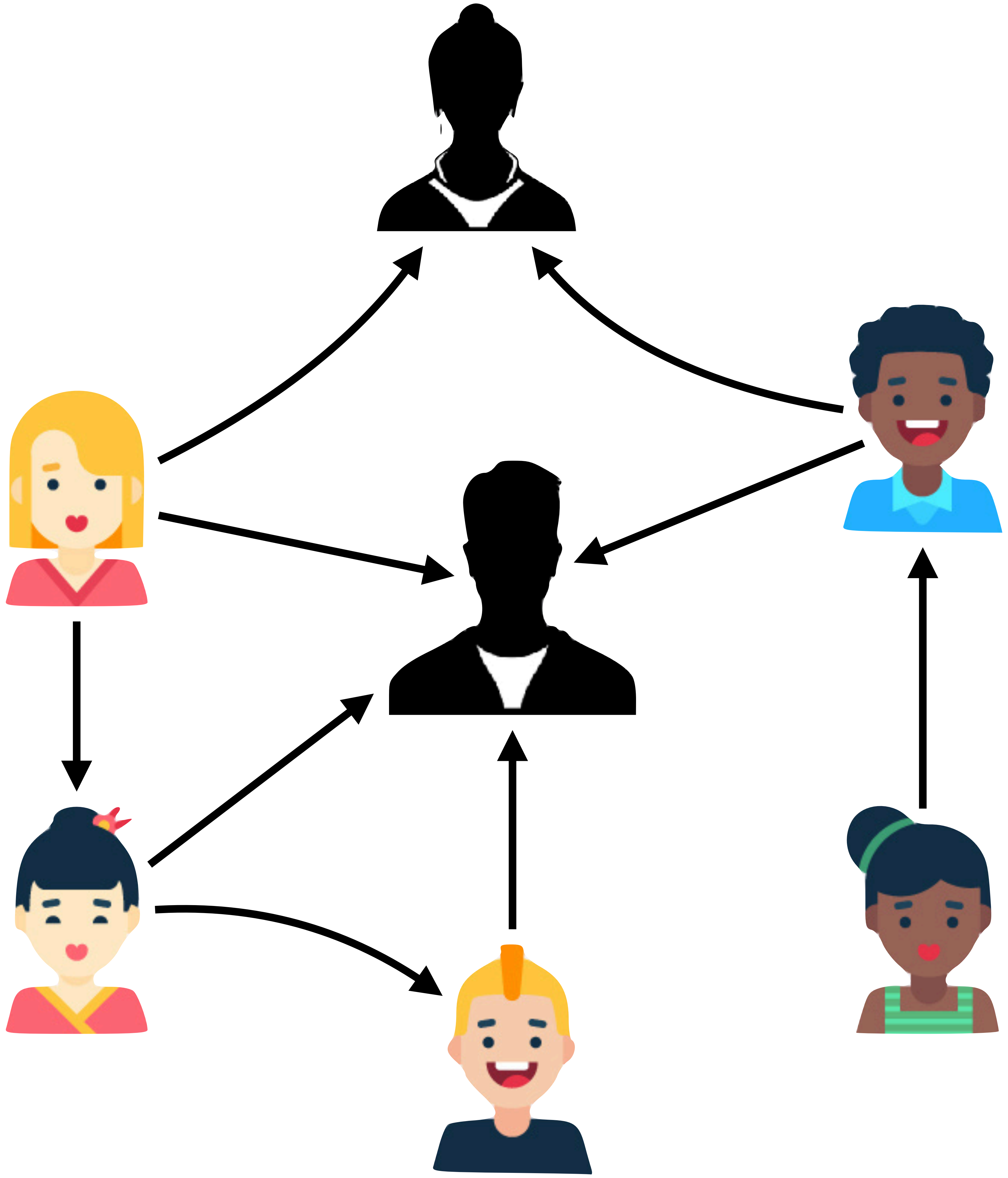
Sources of data, reliability and validity issues

Reliability ask the question “given the same conditions, if we repeated our study, would we obtain the same results?”
Threats to reliability include:

- **Formatting errors:** when mining data (or the Web) errors can derive from (unexpected) differences in document formatting. These errors can lead to the over- or under-representation of terms, actors, attributes, etc. in the data retrieval process. We should take care that any relations assigned among nodes is not an artefact of formatting errors. In addition, Web scraping and automated data mining methods should be scrutinised for consistency of study-important concepts. The (general) bottom line is that the quality of a study is a function of the quality of the data: garbage in, garbage out.

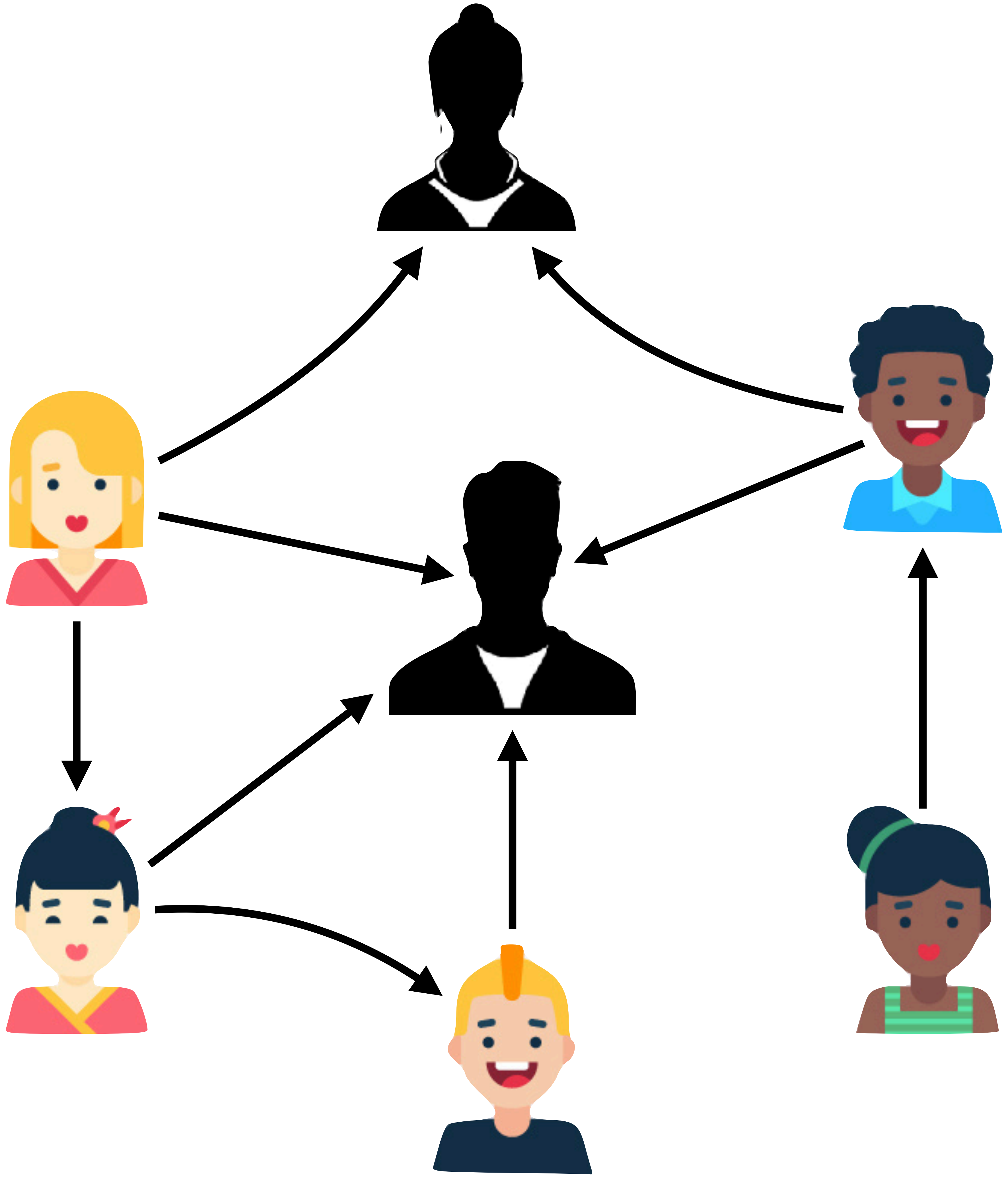
Ethical Considerations

A key data-collection issue of network studies is the impossibility of anonymity: the **respondent must identify themselves**, which means **the researcher can only offer confidentiality**. This makes it imperative to make it clear to the respondent who will see the raw data and what we can reasonably predict to happen to the respondent, as a result of an accidental breach of confidentiality.



Ethical Considerations

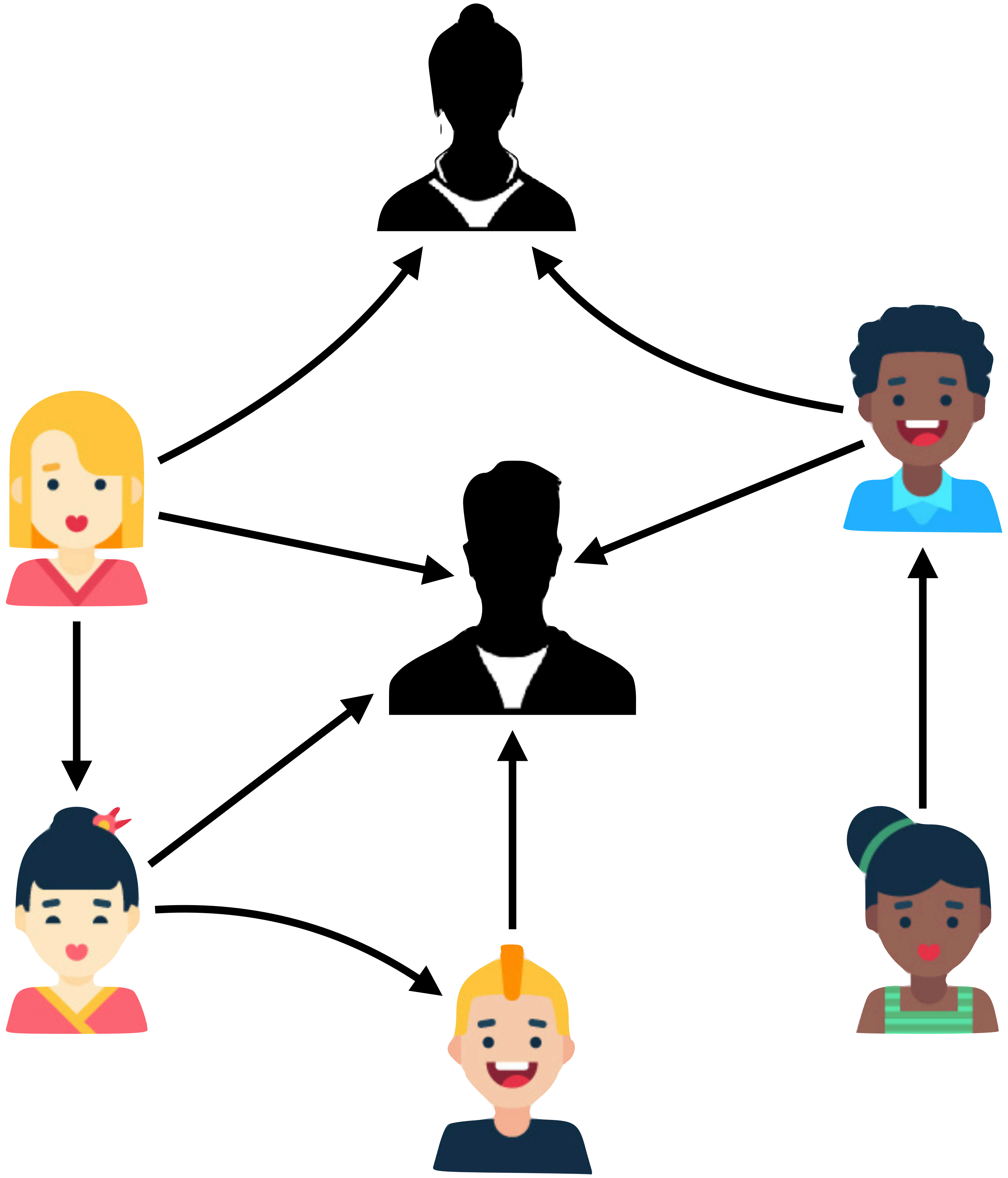
Corollary. **non-participation by a respondent in a network study does not necessarily mean that they are not included in the study**, as other respondents may still list that person as a friend, enemy, etc. E.g., a person who does not wish to be embarrassed by their poor standing in the group will still be found to be the person most often named as difficult to work with.



Ethical Considerations

We can eliminate all explicit non-respondents from the dataset altogether, however this may lower the quality and representativeness of the data.

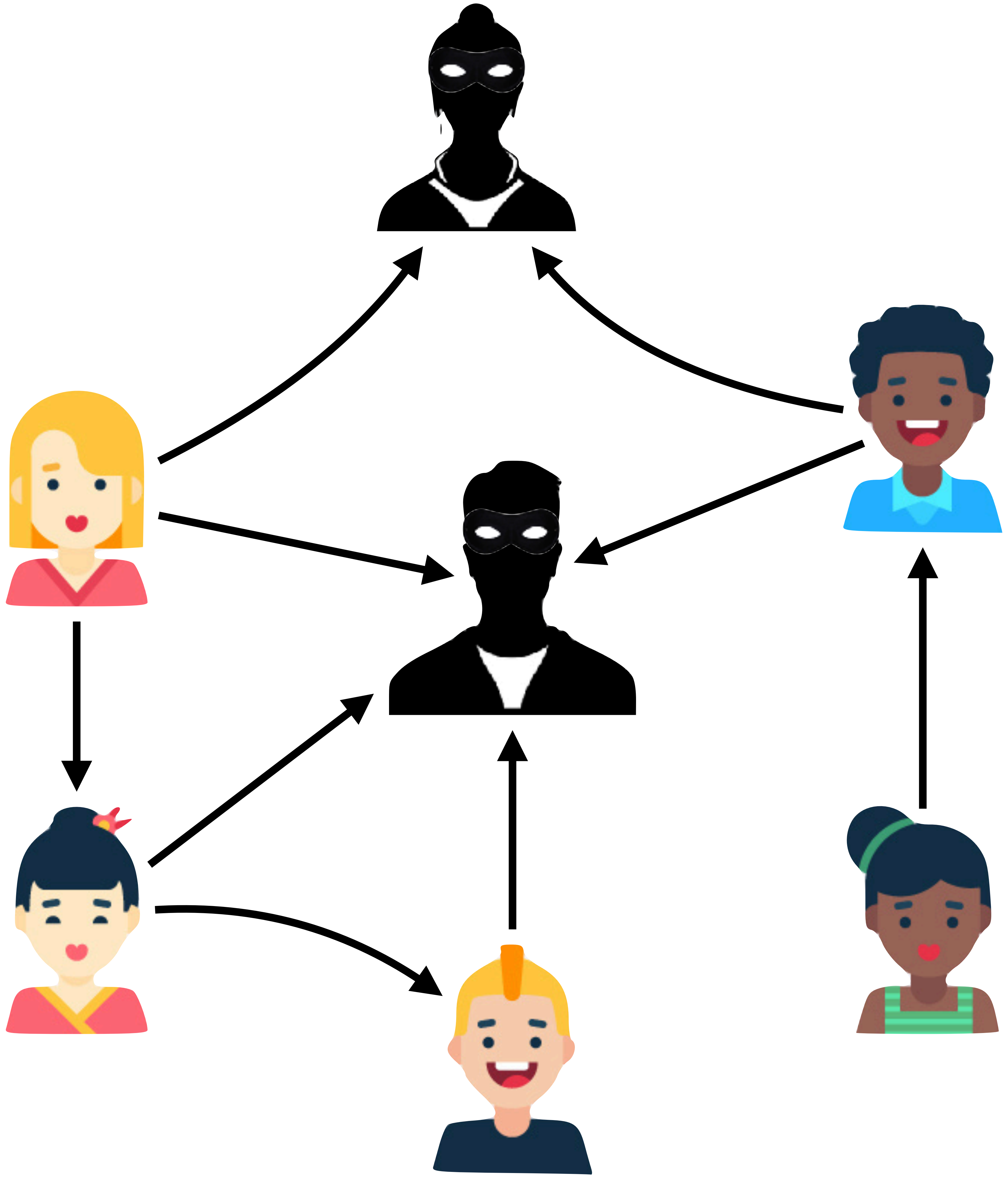
This is particularly evident in applied settings, where decisions are based on the results of the study. The researcher can warn the management of the problem, but it is likely they do not have the sensibility to appreciate the depth of the problem—they might also need the information that the researcher is trying to suppress to understand the problem.



Ethical Considerations

This issue is at the foundation of network studies, as respondents report on their relationships with other people, some of whom may not wish to be reported on.

While the matter does not seem unethical per-se—the respondents are free to own and report her own perceptions—in peculiar cases, e.g., when dealing with illegal activities, there is a clear implication that the named party engages in **illegal actions**, from stealing to sexual harassment.



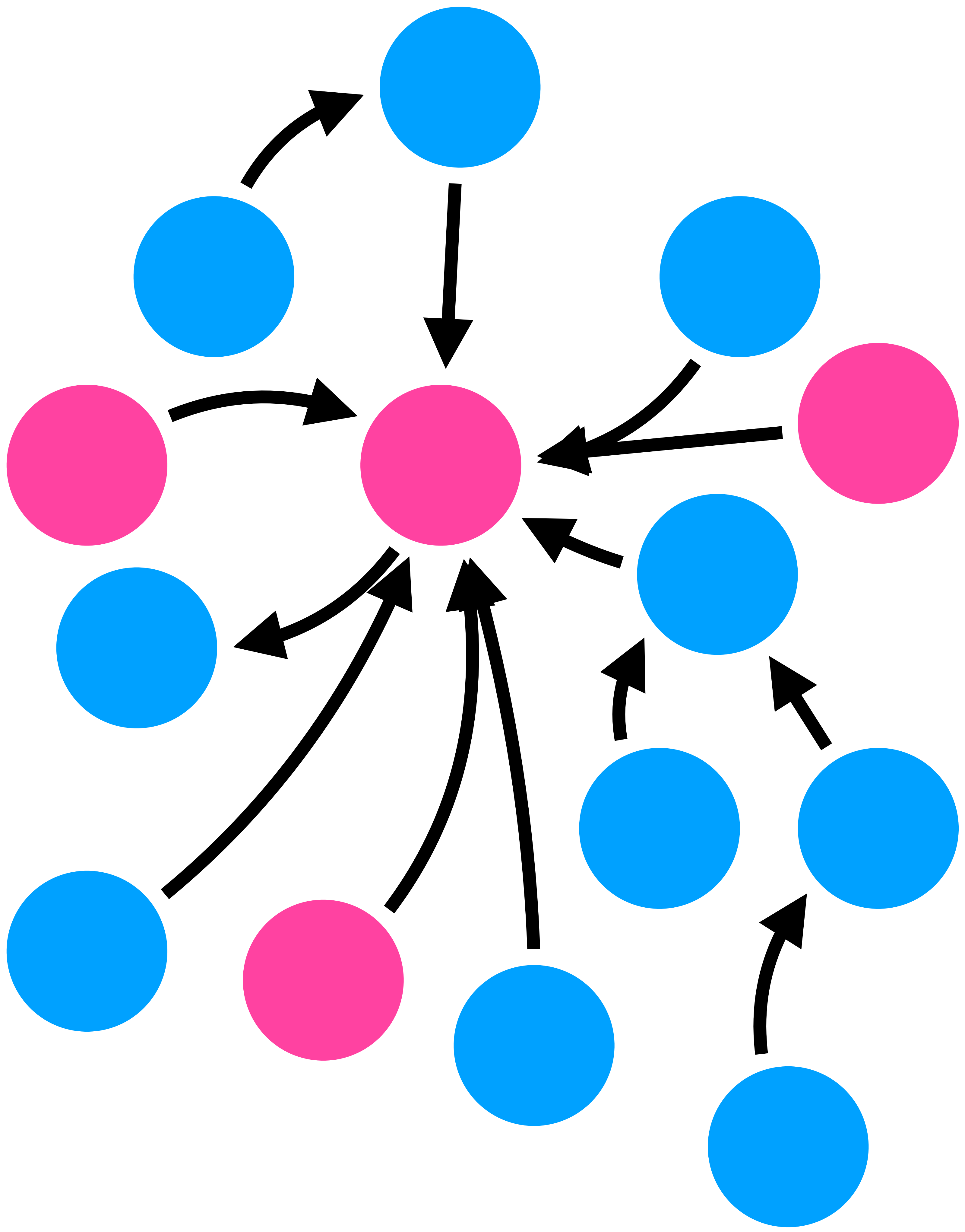
Ethical Considerations

In network studies missing data is exceptionally troublesome, e.g., when a few highly-central players are missing, the resulting network could be sensibly different than if those people responded.

This creates incentives for researchers to **“press” respondents to participate**, underestimating their risks and coercing them (e.g., though management’s pressure) to participate unwillingly, possibly tainting their mood/feelings towards the study and their responses.

Ethical Considerations

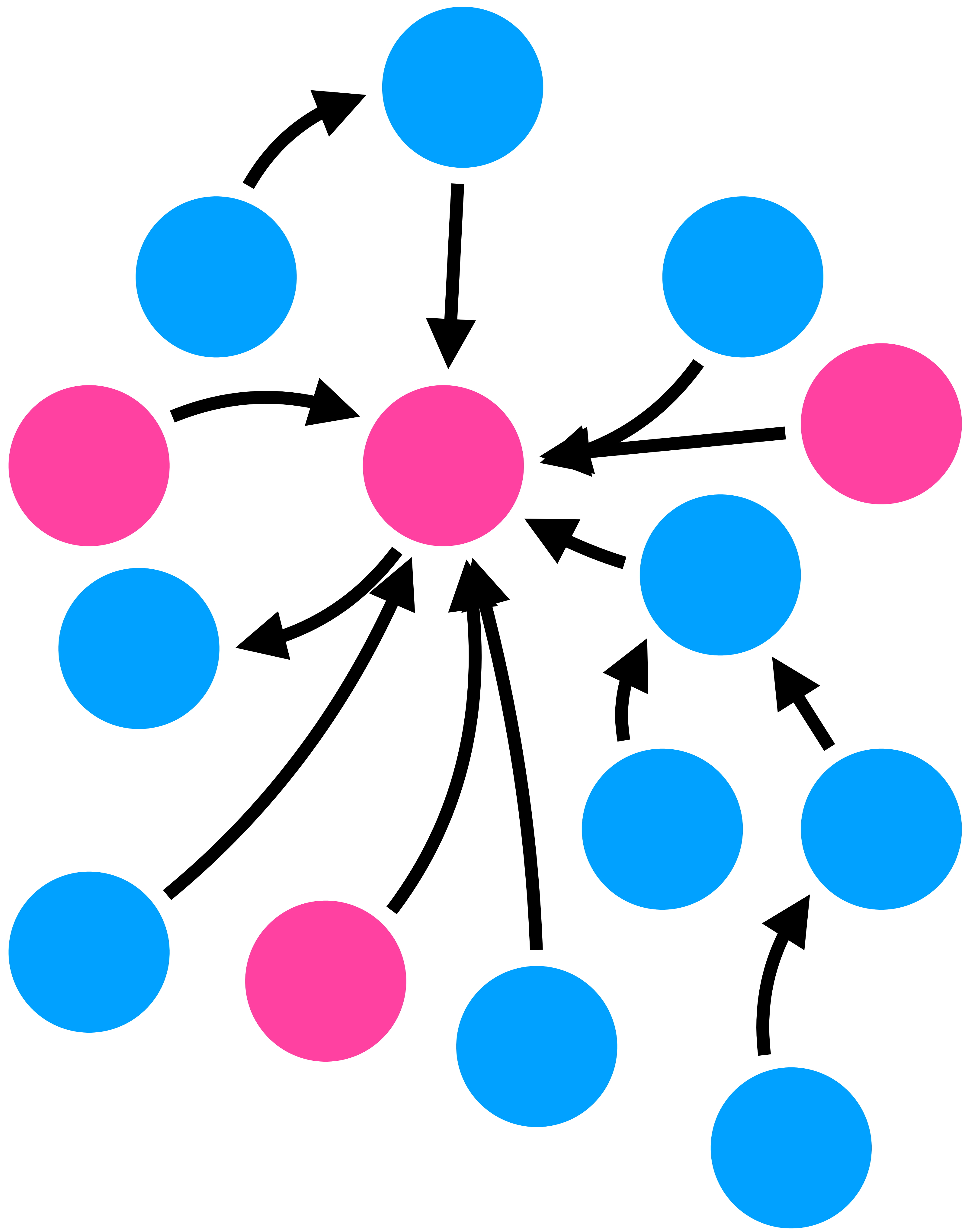
In network analysis, it is common to present a network diagram that shows whom is connected to whom. When doing so, using a low-level display with un-labelled nodes that represent the raw data might not be enough to ensure the responders' privacy: e.g., organisational **members can deduce the identity of one person** (e.g., the only high-ranking woman in the Boston office) and once that person has been identified, their known associates can sometimes be deduced as well, eventually unraveling the whole network.



Ethical Considerations

Most respondents have neither participated in a network study nor have an intuitive understanding of the ramifications of their responses. This is true also for the management, that could need guidance in understanding the subtleties of the conclusions from the study.

This puts an **ethical burden** on the researchers to be clear and provide enough background about the risks and implications of their study.



Let’s read and analyse our first scientific paper