Today’s Class

- Epistemic Network Analysis
Epistemic Network Analysis (ENA) (Shaffer, 2017)

- Studying relationships between elements in coded data

- Lots of applications

- Conference founded around this method (in large part)
  - International Conference on Quantitative Ethnography
Nodes and links

- Nodes = occurrences of the codes
- Links = co-occurrences of the codes
Let’s start with an example

- Chosen primarily because I understand it well
Analyzing Quitting Behavior (Karumbaiah et al., 2019)

- Comparing students who quit a level in the game *Physics Playground* to students who do not quit a game level
- In terms of the gameplay actions each group of students makes
Nodes and links

- Nodes are behaviors
- Links represent when a player demonstrates both behaviors in one session playing one level
Nodes and links

- When red students draw.freeform, they also erase
- Less commonly, when they draw.freeform, they also nudge

- When green students draw.freeform, they also ramp
- Less commonly, when they nudge, they also ramp
Comparing groups in data

In this case,
red = people who quit a game
green = people who do not quit
Can Compare Graphs Between Contexts (here: game levels)
Interpreting the graphs in (Karumbaiah et al., 2019)

- Can seem tricky
- Very powerful when you dig into the graphs
Key Themes identified by Karumbaiah et al. (2019)

- Identifying Key Action
- Missing Identification of Supporting Objects
- Over-reliance on Nudge
- Limited Early Action Expansion and Later Action Convergence
Identifying Key Action

Indicates their lack of conceptual understanding of Physics
Missing Identification of Supporting Objects
Over-reliance on Nudge

Indicates potential wheel spinning tendencies
Limited Early Action Expansion and Later Action Convergence

Need Fulcrum
We looked at these graphs qualitatively, but statistical analysis of differences is possible too.

- Is link A stronger than link B?
- Is link Q stronger in group R or group S?
Other examples
Studying connections between topics in meetings over time (Nash & Shaffer, 2013)
Studying Process of Successful and Unsuccessful Teams (Arastoopour et al., 2016)

Fig. 4. Mean network representations of student teams that generate low-quality devices (left) and teams that generate high-quality devices (right). Thicker lines indicate stronger and more frequent connections between elements. Teams that generate high-quality devices have networks with more connections to management, which is why the centroids in Fig. 2 are plotted higher on the first dimension than teams with low-quality devices.
Exploring Shifts in Student Identity over Time (Barany & Foster, 2019)
Important setup questions

- What makes a relationship “stronger”?
Important setup questions

- What are your codes?
- How did you derive those codes?
  - Behaviors in data
  - Text mining
  - Hand coding
  - Hand coding THEN text mining (nCoder+)
    (Cai et al., 2019)
Important setup questions

- Which codes do you display?
- What are your aggregation units (stanzas)?
  - Everything a learner does together
  - Everything a learner does on a specific level together
  - Everyone in a group of learners/team
  - Everything in a piece of content
  - Everything in a meeting
1. A set of objects
2. The way they relate to each other
3. Grouped into a set of stanzas
4. That reveal evidence about the relationships between the objects
Important setup questions

- One-directional relationships or bi-directional relationships?

- Usually bi-directional, but some work looks at one-directional relationships over time (Karumbaiah et al., in press)
Important setup questions

- What do the X and Y axes mean?
  - Typically determined empirically by collapsing the feature space using SVD, singular value decomposition
    - Similar to factor analysis (week 7)
  - This approach can make X and Y hard to interpret but best splits out the variables visually
Important method, growing in scope and community applying it
Knowledge Graphs/Spaces

- Another key application of network analysis
- We will discuss this in week 7 as well
Next week

- Visualization