Objectives and Scope

The overarching goal of this thesis aligns with the broader research objectives of the Social Network Analysis Project (SNAP) to understand faculty collaboration at Boise State University (BSU) in the context of Grand Challenges investments by the Department of Research and Economic Development (DRED). Specifically, the research questions are:

1. What does collaboration look like at Boise State prior to and throughout the Grand Challenges investments?
2. How does faculty collaboration network’s structure evolve over time, particularly in response to BSU’s Grand Challenges?
3. How do the Grant Challenges investments change the grant proposal networks’ inequality over time?
4. Which faculty members and departments form critical connections?

The long-term objective involves a temporal analysis of network and node-level metrics to assess the Grand Challenges investments’ impact on grant proposal submission and interdisciplinary collaborations. Data will be collected longitudinally, allowing for an in-depth analysis of collaboration trends over time.

Data Descriptions

Interviews

Two types of interviews have been conducted to gauge faculty perspectives on collaboration. In 2020, six different faculty *focus groups* were questioned about research communication and collaboration challenges. [How were participants selected?]

During the winter of 2022-2023, I completed *semi-structured interviews* of faculty in the Biology, Psychology, and Anthropology departments. [Is there a rationale behind the selection of these departments and faculty? I selected faculty whom I knew from my BSU student experience.] Questions were designed by SNAP members ranging from general collaboration to how close the interviewee feels to several of their collaborators. It also examined the interviewee’s barriers and accelerators to collaboration. Finally, there were questions asking the interviewee about their knowledge and participation in the Grand Challenges.

Small Team Networks

Two different small team networks are receiving treatment. The *IRA Teams* were formed by focal faculty (leads). The leads built their own teams. One requirement was that the teams were to be from a mix of disciplines. The outcome goal for the teams is to accelerate interdisciplinary research at Boise State. Teams received training on how to collaborate with researchers from different disciplines and funds.

The *Grand Challenge Teams* are funded by these grand challenge efforts to do a pilot project that will lead to a submission, but it is narrower in the sense that they are not getting the same collaborative venue to learn to develop their interdisciplinary collaboration skills. This is a different treatment than the IRA groups.

Grant Proposal Networks

DRED’s grant proposal data from 2016 and 2020 are used to create 17 different network objects, bound in various ways including funding status and time frame. [all grants, only funded grants, by year, and all nodes.] If a faculty member did not submit a grant proposal withing the bounds listed above, they are not included in that network.

The network objects have several edge attributes (shared grants, reciprocity, funded) and node attributes (PI, college, department, DRED team). [Explain why these specific attributes were chosen. Cite works that have used similar attributes.] The shared grants attribute is an integer value representing the number of shared grants between the two faculty members. The reciprocity attribute indicates whether the relationship between two faculty is reciprocal where 0 means neither faculty served as a PI, 1 means that one faculty member served as a PI, and 2 where both faculty members were a PI on a shared grant. The node attribute PI indicates if the faculty member was a PI on any grant. The college and department attribute names the faculty member’s college and department. Finally, the DRED team attribute defines whether the faculty member is participating in the DRED teams. Teams are defined as none, IRA, Grand Challenges, or Other (including SNAP).

Thesis Questions

**Question One**

In this thesis, I aim to set the groundwork for future longitudinal analysis by examining the current and historical research collaboration beliefs and activities of BSU faculty. To assist SNAP in answering the first question, I ask: *What does collaboration look like at Boise State University prior to the Grand Challenges investments?* I answer this question by analyzing diverse data types: faculty interviews, small team networks, and grant proposal networks.

Faculty interviews will be analyzed NVivo. The interviews will assist in understanding the overall topology of faculty collaboration networks (question two). To understand the topology of faculty collaboration networks, I use both pre-treatment network design to create small team networks and a whole-network retrospective research design to create grant proposal networks.

**Question Two**

SNAP’s second question, “How does faculty collaboration network’s structure evolve over time, particularly in response to BSU’s Grand Challenges?” is a narrower version of the first question. I use network-level metrics to describe the topology of the small team networks and grant proposal networks prior to Grand Challenges treatment. The metrics include Degree Mean, Tukey's five-number summary of Degree, Network size, Number of edges, Number of possible dyads, Density, Number of components, the largest component, and connectedness. [Define these metrics and what they can tell us about the topology] I will also create and discuss network visualizations of the small team networks.

We also use the ERGM – tells us about the factors that influence tie formation. We know from 2016 (all 2016 proposals, no isolates) that COAS has a greater volume of ties compared to other colleges and that homophily is not occurring by college (I.e., a bias toward having ties within the unit/identity). What happens in 2020 with the pandemic (harsh conditions)? Does this hold true when we only look at funded proposals? Do any edge attributes affect tie formation? (Does the volume of grant proposals (weighted edges) fall more between colleges or within?)

Are there differences between the colleges in terms of the volume of ties? Is there any kind of bias with the ties, homophily.

What attributes (node and edge) and why are we looking at them? ERGM edge attributes were not affecting tie formation in test 2016. We want to look at this more with the other years and with isolates. [Do isolates matter for ERGM?]

[This is from Tim Ingold: In food sharing studies, there is this U-shaped hypothesis where the x-axis is the condition or environment, and y-axis is the volume of sharing. When times are bad, people share. For those with great conditions, sharing is also common. In-between bad and great conditions, sharing declines. Sharing declines for middle class but is common in homeless population and very wealthy. We might be able to pick up on this in 2020, 2021. It went from normal to bad.] Hypothesis: As conditions get bad, we will see more sharing. The 2020 network will have more grant proposal sharing. We can look at this hypothesis by the Gini and ERGM.

This is more of a data exploration. Before we invest a lot of time writing up and doing literature review on this, we will look at the 5-year full network.

**Question Three**

"Scientific collaboration can be considered in the framework of knowledge capital" (Isfandyari 2023 # 35)  
The Grand Challenges investments should reduce inequality [of what? Number of ties (more proposals / Co-PIs)] because the teams were created with diversity in mind. By creating these groups, the idea was that DRED is trying to involve an inclusive group of people and not just entraining the already empowered [Improve wording]. More centralized communication networks are better problem solvers (Borgatti page 194).

[Describe the Gini-Coefficient. Why is it chosen to measure inequality in the network? Cite studies that have used the Gini-Coefficient with SNA: (Leydesdorff et al 2019; Chien et al., 2018; Liu et al. 2020)] We will calculate the Gini on the degree or betweenness centrality. [Why? The more evenly distributed the centrality measure is, the more equality is in the grant proposal network. More faculty share in the benefits of collaborating on creating grant proposals.]

SNAP proposes that there will be a shift in the Gini-Coefficient downward in future grand proposal networks as a result of the grand challenges and IRA teams. I assist in answering question three, “How do the Grand Challenges investments change the inequality in the grant proposal networks over time?” by examining the historical variation of inequality in the grant proposal networks. I ask: What is the variation of inequality in the Grant Proposal Networks prior to Grand Challenges investments?

To answer this question, I will use the Gini-Coefficient. I will look at the natural variation in the first five years. In preliminary data evaluation, we noticed that 2020 is odd compared to 2016 through 2019. There were far fewer grant proposals in 2020. This is likely due to the interruption of normal research activities during the COVID-19 pandemic. It is possible that inequality decreased in 2020 because the core group of faculty members was able to overcome the struggles. The core faculty are considered to have more resources and therefore, an increase of inequality because only those with more power and resources were able to overcome the challenges associated with the COVID-19 pandemic interruptions. To control this, we include all nodes found in the 5-year network in single year networks.

**Question Four**

I answer which faculty and departments form critical connections, I will evaluate the small team networks and the 5-year grant proposal network asking three preliminary questions.

First, I ask who are the central nodes in the grant proposal and small teams networks? Also, who is in a key position to influence the flow of creative work? To answer this question, I will use metrics Degree Centrality, Betweenness Centrality. Additionally, if the small team networks are directed, I will include Eigenvector Centrality. [Define metrics; Cite literature where these metrics have been applied.]

I will create a short list of the top 10% in centrality of each type of metric listed above in the 5-year grant proposal network. I will also consider which, if any, of the small team’s members are in this 10% grouping and how that might impact DRED’s goals for equality.

Second, I ask what is the impact on the overall network if a central faculty member leaves Boise State University? Induced centrality measures the importance of a node by removing it from the network and seeing how much the network changes. [Cite a relevant study that utilized induced centrality measures.] The greater the change, the greater impact that faculty members will have in leaving the network.

Third, I ask, which departments have the most / least interdepartmental ties? To examine this, I will not need social network analysis. Using the full 5-year faculty attribute list, I will create a faculty member attribute that counts the number of ties each individual has with faculty members from a different department. I’ll total the number of interdepartmental ties for specific departments of interest and compare. [Rationale for focusing on specific departments. I’m thinking at least Biology, Psychology, and Anthropology];[In R: I could have R look for a match between any of A’s department rows to any of B’s department rows.]

### Conclusion to Thesis Questions

My thesis work will serve as a foundational study for SNAP by providing a snapshot of the existing state of faculty collaboration networks. The metrics and analyses used in my thesis can serve as baseline data against which future changes can be compared. By aligning the research questions and methodologies of my thesis with those of DRED's broader objectives, I aim to create a robust and impactful study.