

Research projects. How to define your own proposal

1 Introduction

Ideally, your research projects should be a proto-research article (some research projects from past editions of the course have become published articles). For the research projects that you wish to propose or discuss, you have to think of the following structure:

1. Domain, background.
2. Aim(s) of the research
3. Hypotheses to be tested
4. Theoretical framework
5. Methods.

For a solid proposal, you should be able to fill as many section as possible from this template alone or with the help of one of the professors. A few lines may suffice for each section at this stage (this just an early outline).

Once you have tried to fill these sections, contact the professors of the course.

2 Example

This is an example from the research article

Albert-László Barabási, Réka Albert, Hawoong Jeong (1999). Mean-field theory for scale-free random networks, *Physica A: Statistical Mechanics and its Applications* 272, Issues 1–2, 173-187.

Note: the two articles mentioned in this section are attached.

1. Domain, background.

The Barabasi-Albert (BA) random network model:

Barabási, Albert-László; Albert, Réka (1999). Emergence of scaling in random networks. *Science*. 286 (5439), 509–512

The model has two ingredients: growth & preferential attachment) are strictly necessary.

2. Aim(s) of the research.

Primary goals

- (a) [explicitly in the intro of the article] Identify the scaling properties of the BA model (the degree distribution)
- (b) [explicitly in the intro] Compare those properties against with other network models intended to describe the large scale properties of random networks.
- (c) [explicitly in section 4] "To verify that both ingredients are necessary" "to test the hypothesis that the growing character of the model is essential to sustain the scale-free state observed in the real system"

Subgoal for (a): developing a mean field theory.

3. Hypotheses to be tested.

(implicit) The ingredients are necessary to produce the power-law degree distribution

4. Theoretical framework

Graph theory and the emerging field (at that time) of network science. The theory of random networks.

5. Methods

Computer simulations where one of the ingredients is suppressed; mathematical analysis (applying a mean-field approximation).