Cognitive Systems 303

3.1: Experiment Design

“Argumentation cannot suffice for the discovery of new work, since the subtlety of Nature is greater many times than the subtlety of argument.”

—Francis Bacon

Focus: Learning about the world in a systematic way.

Experiment: Show how an independent variable affects a dependent variable.

A. Stages of investigation (ideally)
   1. Find an effect (get a description; e.g., map out structure)
      - show that it really exists
   2. Find an explanation for it (e.g., determine whether it fits data; get predictions)
      - show that proposed explanation is best available choice
   3. If something is incomplete, to go back to 2 and try again
      - repeat until everything is understood (as much as possible)

B. Phases of activity (applies to each of above stages)
   1. Exploratory studies (Exploratory data analysis – learn about the effect)
      - goal: discover patterns, discover hypotheses
      - “playing around”
   2. Confirmatory studies (Confirmatory data analysis – official demo for public)
      - Goal: show that the structure / cause really exists
      - important: data should be independent of that used in exploratory study

Design of Controlled Experiments - Guidelines

1. Select the right factors (variables)
   - aspect of behavior and structure that can be measured
   - need operational definition of terms
   - aspect of behavior and structure that is relevant
   - can’t be all of behaviour and structure; only capture the right aspects

2. Minimize the effects of extraneous variables
   - minimize confounding factors
   - extraneous variables that could be correlated with independent variable
   - minimize noise
   - extraneous variables that are uncorrelated with independent variable

3. Vary the right factors in the right way
   - basis of research: differences (single measurement doesn’t do much)
     • make sure the pattern found is likely to be real, and not due to chance / noise
       • control condition
     • make sure different hypotheses give rise to different predictions
       • independent variables should be easy to control