Feedback on talks so far

• Very good so far, well done
• Speak to the audience: slides are on monitor and practice helps
• For a 10 minute presentation, you don’t need to spend a slide just on the plan
• Final slide – help discussion, not cute clipart
• Careful about font size: Figures should be re-drawn preferably, same applies for demos
• I’m not going to suggest dressing in any particular way but do bear this in mind for professional talks
Poor Research Design

What research problem can I think of, which involves a user study and would use my security software?

• What is wrong with this approach?
Research Design in Context

• Remember to follow the scientific method
  • Identify the research problem
  • Specify purpose of research
  • Determine hypotheses/research question
  • Carry out a literature review
• **Determine best research method**
  • **Study, develop software, mathematical proof**
• Carry out research - data collection
• Analyse data
• Report results
• Draw conclusions from research
• Adjust theory
Research Types

• Primary research
  • Using primary sources and/or data
  • Often used by historians – e.g. studying ancient documents
  • Analysis of raw data from existing or new studies

• Secondary research
  • Using secondary sources
  • Synthesis or analysis of existing discussions of primary sources
  • Case studies
  • Meta-analyses
  • Literature survey
Qualitative Research

• Often a fairly broad research question
• Good for exploratory research
• Address questions about human behaviour
• Data collected is usually word-type
• Used in social and management sciences
Qualitative Research

- Not quantifiably measuring variables
- Not looking for relationship between variables
- Expensive and time consuming to undertake
- Usually small sample sizes
NVivo
Quantitative Research

- Narrow research question
- Empirical investigation of quantitative properties and their relationships
  - Need to clearly identify variables for experiment
    - Different types of variables (see later slides)
- Data collected is numeric
Quantitative Research

• Data analysed with statistical methods
  • Correlations, regression, means, standard deviations, chi-square ($\chi^2$) for categorical data etc.

• Looking for relationships between variables
  • Correlation and causation
Tools for quantitative research

• Excel
  • Dangerous: easy to make errors, scales poorly, limited number of techniques

• R
  • Excellent set of libraries connected to mediocre programming language

• Python
  • Good set of libraries connected to good programming language

• Julia
  • Promising approach, but still in rapid development
Repeatability in analysis

• Repeatability is just as important in analysis as it is in performing experiments
• Tools can help here
• Minimum requirement: version control (e.g. Git, Subversion, Mercurial, Bazaar)
• Strongly recommended: tool to manage experimental runs: e.g Sumarta, Vistrails
  • Logs what tools were run and from where output came from (version and parameters)
Mixture of Methods

• Possible study #1
  • Code transcripts from focus groups (qualitative)
  • Answers from a survey (quantitative)
    • Categorical variables e.g. age, education
  • Investigate relationship between categorical variables and codes from transcripts
    • Chi-square analysis

• Possible study #2
  • Q methodology – identify different viewpoints
  • Participants order statements - “Q-sort”
  • Results of Q-sort undergo factor analysis
A Good Experiment

• **Reminder**: Experiments manipulate the topic under study
  • Different from observational study

• Provides sufficient data to support or refute the hypothesis – i.e. experiment is valid
A Good Experiment

- Only tests one variable
  - If more than one variable, which one affected result?
- Is unbiased – researcher does not let their opinions influence the experiment
- Is repeated – not a ‘one-off’
- Attempts to remove all external factors which may influence experiment
  - e.g. lab environment, time of day, equipment, etc.
  - Really difficult to achieve with human subjects
Variables

• Something in an experiment which can vary, or be deliberately changed by the experimenter
  • e.g. temperature of gas, height a ball dropped from, length of password in characters

• Sometimes researcher not aware of all variables influencing an experiment
  • e.g. Trying to measure affect of keyboard design on typing speed, but perhaps temperature of room influences participants’ typing speed.
Types of Variables

• Independent variable (sometimes called factor)
  • Manipulated by the researcher – e.g. password length
  • Experiment must only change one variable

• Dependent variable
  • Hypothesized to change if independent variable changes
  • Effect is observed and measured - data collected
  • State how dependent variable measured and units

• Controlled variable
  • Variable not allowed to change
Independent & Dependent Variables

• Charles’s Law – simply put
  • As temperature increases – volume of gas expands
  • As temperature decreases – volume of gas decreases

• Design the experiment
  • What could be the independent variable?
  • What could be the dependent variable?
  • What could be a controlled variable?
Control Group

• Some studies have a control group
  • Different from a controlled variable
• What happens if independent variable is not changed?
  • Not all experiments have control groups
  • Common in drug trials – use of placebos
• Could you have a control group with an information security experiment?
Within Subjects/Paired Design

- Each participant has one treatment and two measurements
  - One sample group of participants
    - e.g. time to complete a task before and after training
- Advantages
  - Few subjects – can be quicker
  - Removes risk of introducing confounding variables
- Disadvantages
  - Participants may drop out
    - Need to remove them from data set
  - Participants may suffer from fatigue and practice effects
Between Subjects/Independent Design

- Two or more groups of participants have same treatment and measured once
  - e.g. measure of privacy concern between old and young
  - Look for statistically significant difference between means of groups
- Advantages
  - Less risk of participants dropping out
  - Participants unlikely to suffer fatigue and practice effects
- Disadvantages
  - Higher risk of introducing confounding variables
  - More participants needed – takes more time
Sampling Bias

- Statistical term
- Important in surveys and user trials
- Sample population not representative of total population
  - Members of total population less likely to be included in sample
  - Non-random sample - all individuals not equally likely to be selected
Sampling Bias

• Examples
  • People at a local painting club used to determine views concerning funding of the arts in the UK – (qualitative)
  • Average male height in UK determined by measuring people in local basketball team – (quantitative)

• Aim to minimise bias
  • Papers likely to be criticised if there is obvious sampling bias

• Undermines ability to generalise to total population
• Also impacts between subjects/independent experiment design
WEIRD

- Experiments typically performed on:
  - Western
  - Educated
  - Industrialized
  - Rich
  - Democratic countries
- Around 12% of the population
Which line is longer? (Müller-Lyer illusion)
The weirdest people in the world? Henrich et al. (2010)
Selection Bias

• Selection bias leads to sampling bias
  • Terms often used interchangeably (incorrectly)
  • Sampling bias is a sub-type of selection bias
• Other types of selection bias:
  • Terminate trial when result achieved
  • Discounting drop outs