MONASH University

Information Technology

FIT5190 Introduction to IT Research Methods Lecture 2

Research Project Design and Planning, and Research Proposals

Slides prepared by

David Green, Frada Burstein, Jacques Steyn, Geoff Webb, Chung-Hsing Yeh

Learning objectives

- Understand the nature of a research problem and associated research questions
- Be able to pose and formulate research questions and objectives
- Understand the dangers of thinking “inside the square”
- Understand the use of abstraction, generalisation, association in framing research questions
- Understand link between critical thinking and research questions
- Understand the influence of paradigms when framing research questions
- Understand the role of methodologies in addressing research questions
- Know some common methodologies in research
- Be able to write a research proposal and summary
- Be aware of major issues that affect research projects

Overview

- This lecture deals with the challenging issue of beginning a project.
- The main challenge for a researcher is to frame significant research questions to address a research problem.
- This requires a number of skills, such as creative thinking. Research project design and planning involves setting out a clear path from a research question you have already identified to the answer.
- It involves setting sub-questions, and identifying appropriate paradigms and approaches to provide a clear path to show how you will answer those questions.

Overview (continued)

- As part of the planning process, the lecture also deals with how to lay out and write a research proposal.
- In addition, the lecture will examine some major research issues in information technology, which have inspired many research projects.
- The lecture will also cover the important issues of ethics and copyright, which concern every researcher and every project.

What is a research problem?

- A research project starts with a research problem to be solved or addressed.
- A research problem is a question or matter involving doubt, uncertainty or difficulty that is proposed for solution or discussion.

- Problem – any question or matter involving doubt, uncertainty or difficulty
- Problem – a question proposed for solution or discussion

- Macquarie Dictionary

The research problem

- The research problem should address *an important question* so that the answer will make a difference.
- The research problem should advance the frontiers of knowledge by leading to new ways of thinking, suggesting possible applications, or paving the way for further research in the field.
- Problems that result in a yes or no answer are not suitable problems for research.

- Leedy and Ormrod (2013) *Practical Research: Planning and Design,* Chapter 2.

The research problem (continued)

- For your research project, the research problem is typically a topic or phenomenon that you are interested in and have (or can acquire) the knowledge and skills to investigate.
- The research problem is the core of your research project and the heart of the whole research process.
  - It determines what you will do, how you will do it, and what you may achieve!
- The research problem defines the research objectives (goals) and the associated research questions (issues or hypotheses).

How is a research problem selected?

- Researchers interest in a topic
- National or agency priorities
- Urgency of an issue
- Availability of research funds
- Availability of collaboration
- Availability of supervision

Defining a research problem

- Identify a broad topic
  - Think of the BIG PICTURE!
- Identify a narrow topic (issue) within the broad topic
  - Think how it can contribute towards solving the BIG PROBLEM!
- Identify research questions
  - Think what you want to know about the topic
- Formulate research objectives
  - Use action-oriented words
    - To develop; to evaluate; to investigate…

What is a research question?

- A **research question** is a way of describing what you want to know in a research problem or topic.
- To address a research problem, one or more research questions are to be answered, e.g.
  - The problem: How to deal with climate change?
  - The questions:
    - How to reduce the CO_2 emissions
    - How to reduce the energy use
    - How to develop renewable energy
- The research questions should be clear, specific, focused, and relevant to the research problem.
- The research questions should be significant, feasible, and answerable.

Research objectives

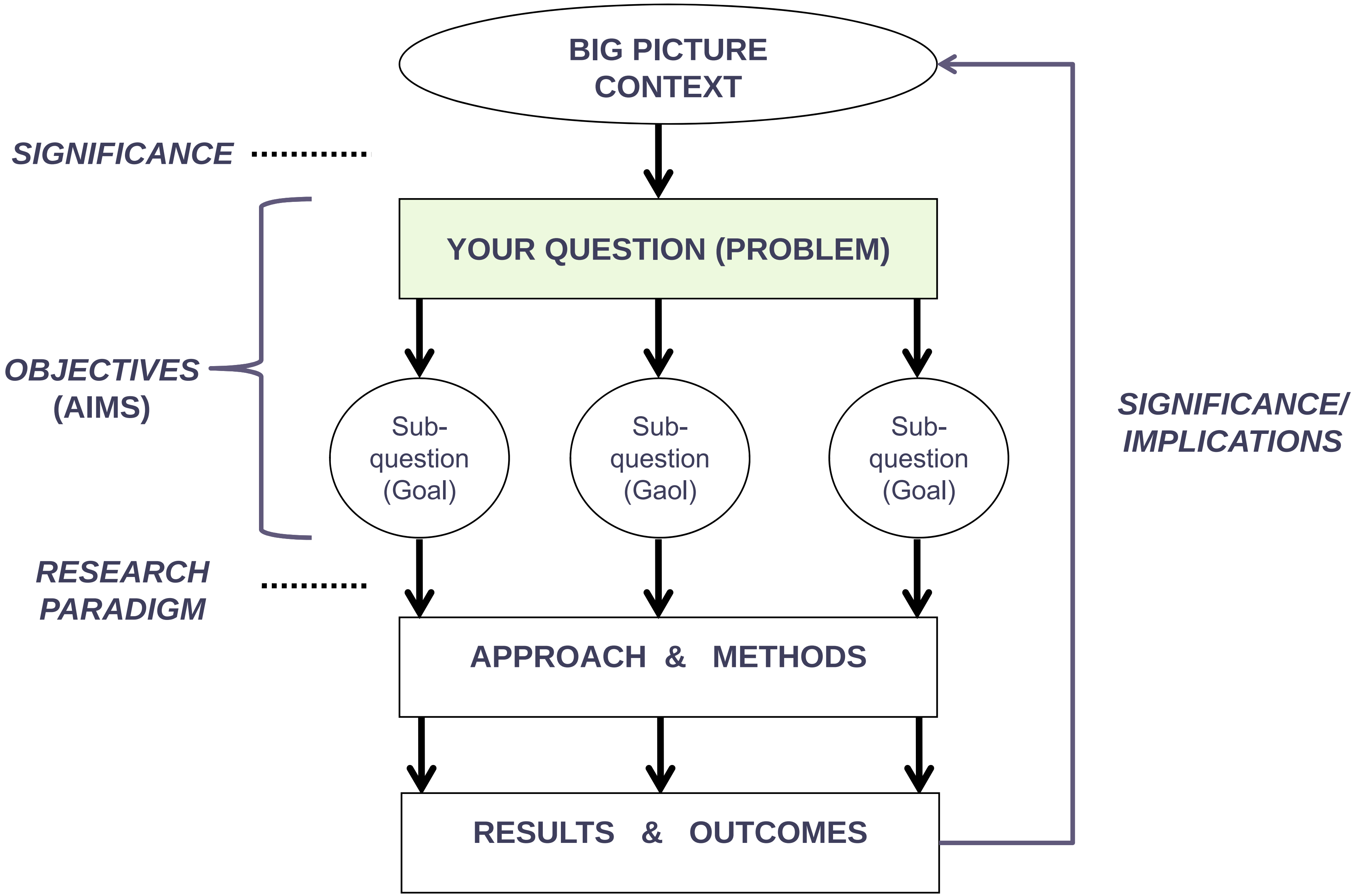
- Research objectives specify the anticipated outcomes of the research.
- The objectives of research could be classified as:
  – Exploratory: seeking new understandings
  – Descriptive: describing better or alternatively exemplifying what is already known in a new context
  – Confirmatory: testing/validating hypotheses

Example – inventing the wheel

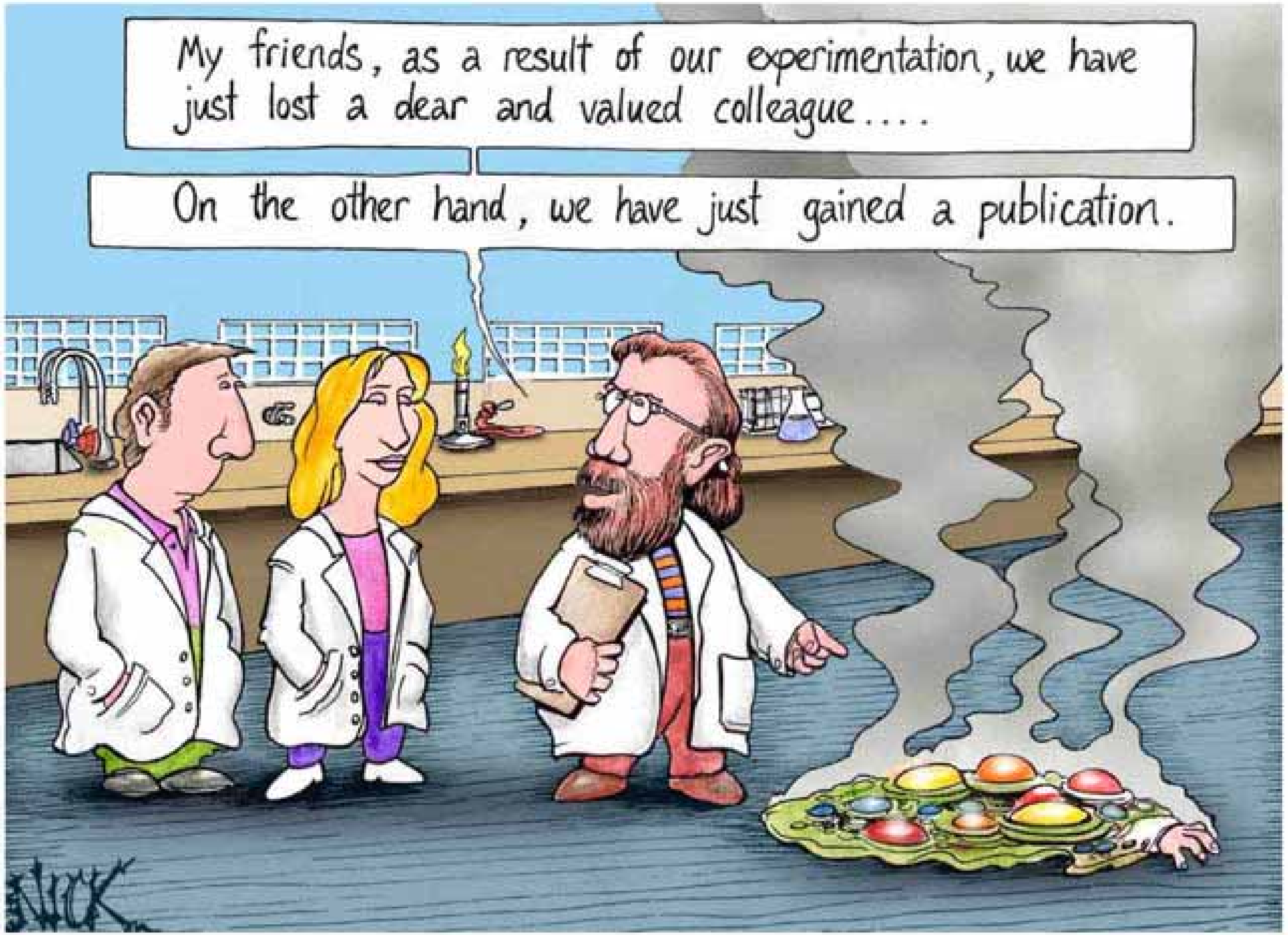
- BIG PICTURE CONTEXT
  - Need for more efficient transport
- THE QUESTION (The Research Problem)
  - Can the wheel provide efficient locomotion?
- THE OBJECTIVE
  - To develop a strong, light, safe, and efficient wheel
- SPECIFIC Sub-questions
  - How to make a wheel that is strong but light?
  - How to attach a wheel?
  - Is the result robust, safe and more efficient?

Getting research ideas

Research centres around questions



Always keep your research in mind



SOURCE: *Nearing Zero* (Science cartoons)
http://www.lab-initio.com/

Some rules of thumb

- “Invention is 1% inspiration and 99% perspiration”

  \- Thomas Edison

- Necessity is the mother of invention
- Fortune favours the prepared mind
- “If I have seen further than others, it is because I stood on the shoulders of giants.”

  \- Isaac Newton

"To be honest, I would have never invented the wheel if not for Urg's ground breaking theoretical work with the circle."

Understanding the five ‘Ws’

- When you start to think about you research project, a useful ways of asking the important questions is to think of the five ‘Ws’
  - What?
  - Why?
  - Who?
  - Where?
  - When?
- You also need to think about ‘*how*’ you are going to undertake your research project.

- Dawson (2009) *Introduction to Research Method*

Some sources of ideas

- Abstraction, association and generalisation
- Thinking outside the square
- Creative thinking
  - Crossing boundaries
- Grand challenges

Systematic exploration of ideas

- Exploit Object-Oriented relations
- Generalisation
  - Is-A (Genspec)
  - e.g. A computer IS A machine
- Association
  - Has-A (Whole-Part)
  - e.g. A computer HAS A central memory

Association of ideas

- Take any idea or result
  - Is it valid? Are there gaps?
  - Is it useful? Applications? Tested?
  - What other ideas are related?
  - Does it form part of a bigger picture?

Association and context

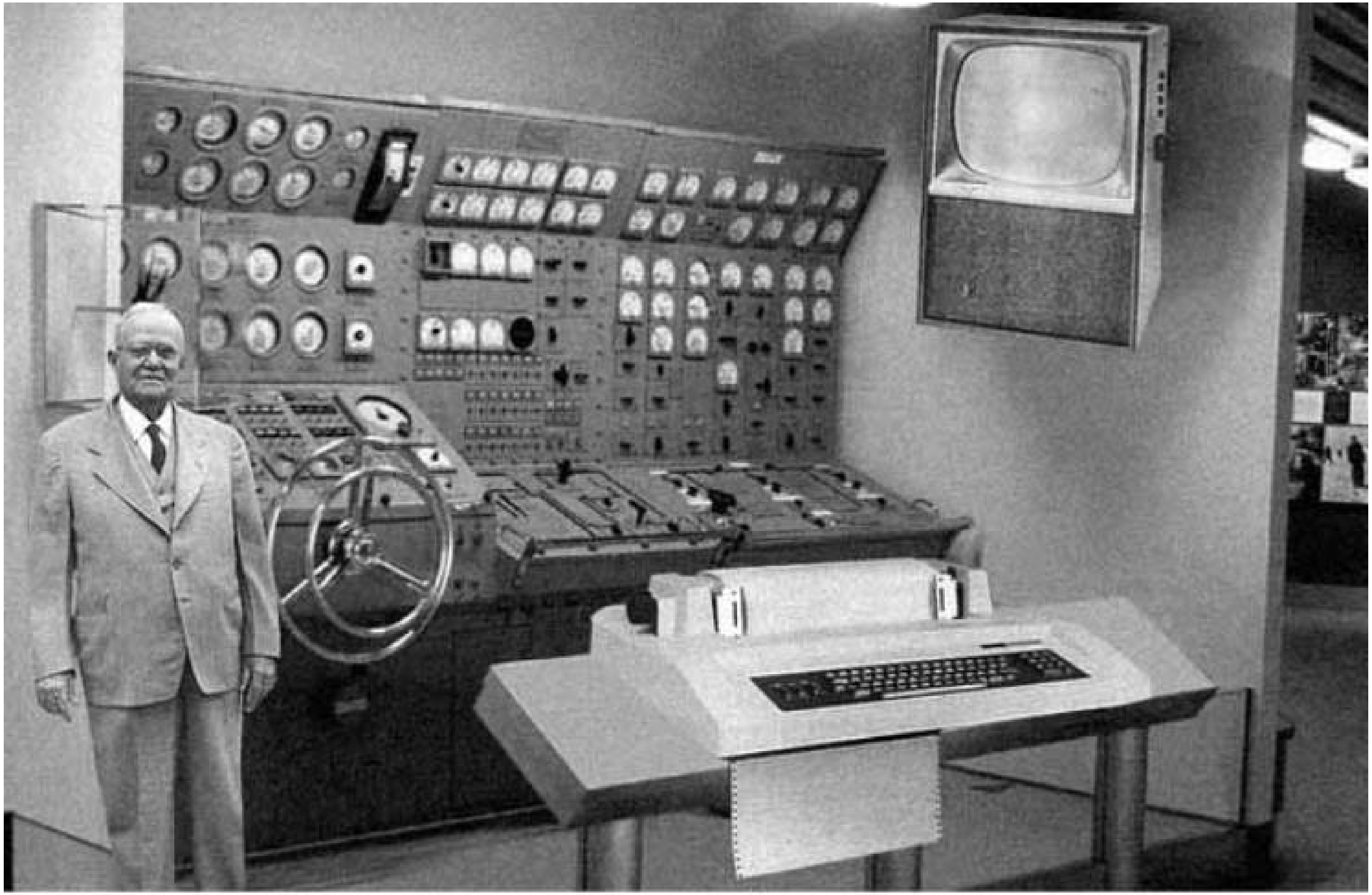
- Be aware of the wider implications and relevance of your research ("Big Picture").
  - Ideas and inspiration often come from unexpected sources
  - Noticing associations between ideas is an essential skill
- How do the following news reports relate to IT?
  - There was a sharp increase in the number of web searches for "cheap engagement rings" in the run up to Valentine's Day
  - Following Victoria's Black Saturday bushfires in 2009, many displaced residents complained that they had no warning of approaching fire fronts
  - Customers who use an automatic teller machine (ATM) of a rival bank will now be charged a "disloyalty fee" by their own bank, as well as a service fee by the rival
  - Experts predict that blogs, wikis and social networks will soon become standard within the workplace, replacing email within five years
  - A new software application can turn a mobile phone into a heart monitor and fitness tracking system
- What research questions do the above reports suggest?

Avoid limited thinking

- Lateral Thinking
  - Avoid fixed approaches ("Outside the square")
  - Look at problems from fresh perspectives

    Edward de Bono (1990). *Lateral Thinking: Creativity Step by Step*. HarperCollins London.
  - Learn from limited thinking by others, e.g.
    - "There is a need for perhaps five computers in the world" Tom Watson, chairman of IBM, 1947

1950s concept of a “home computer” ?



Scientists from the RAND Corporation have created this model to illustrate how a “home computer” could look like in the year 2004. However the needed technology will not be economically feasible for the average home. Also the scientists readily admit that the computer will require not yet invented technology to actually work, but 50 years from now scientific progress is expected to solve these problems. With teletype interface and the Fortran language, the computer will be easy to use.

IQ tests

Expect people to think "inside the square"

What is the next number in this sequence?

1 2 3 …

Select the correct answer: (a) 4 (b) 5 (c) 6 (d) 7

Every answer is possible!

(a) $X(n+1) = X(n) + 1$ (the expected answer)

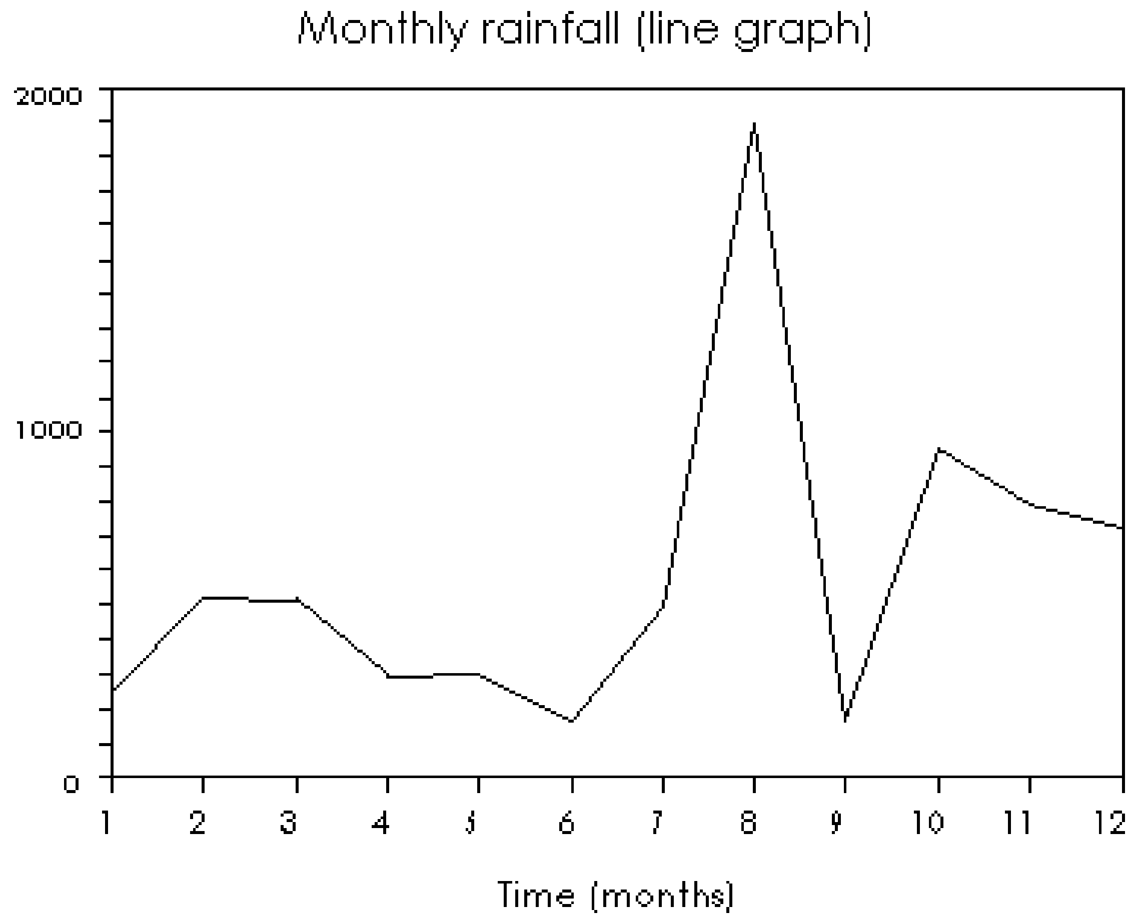
(b) $X(n+1) = X(n) + X(n-1)$, $n>1$

(c) $X(n+1) = \sum_{i=1,n} X(i)$, $n>1$

(d) $X(n+1) = X(n+1)^2 - n$, $n>1$

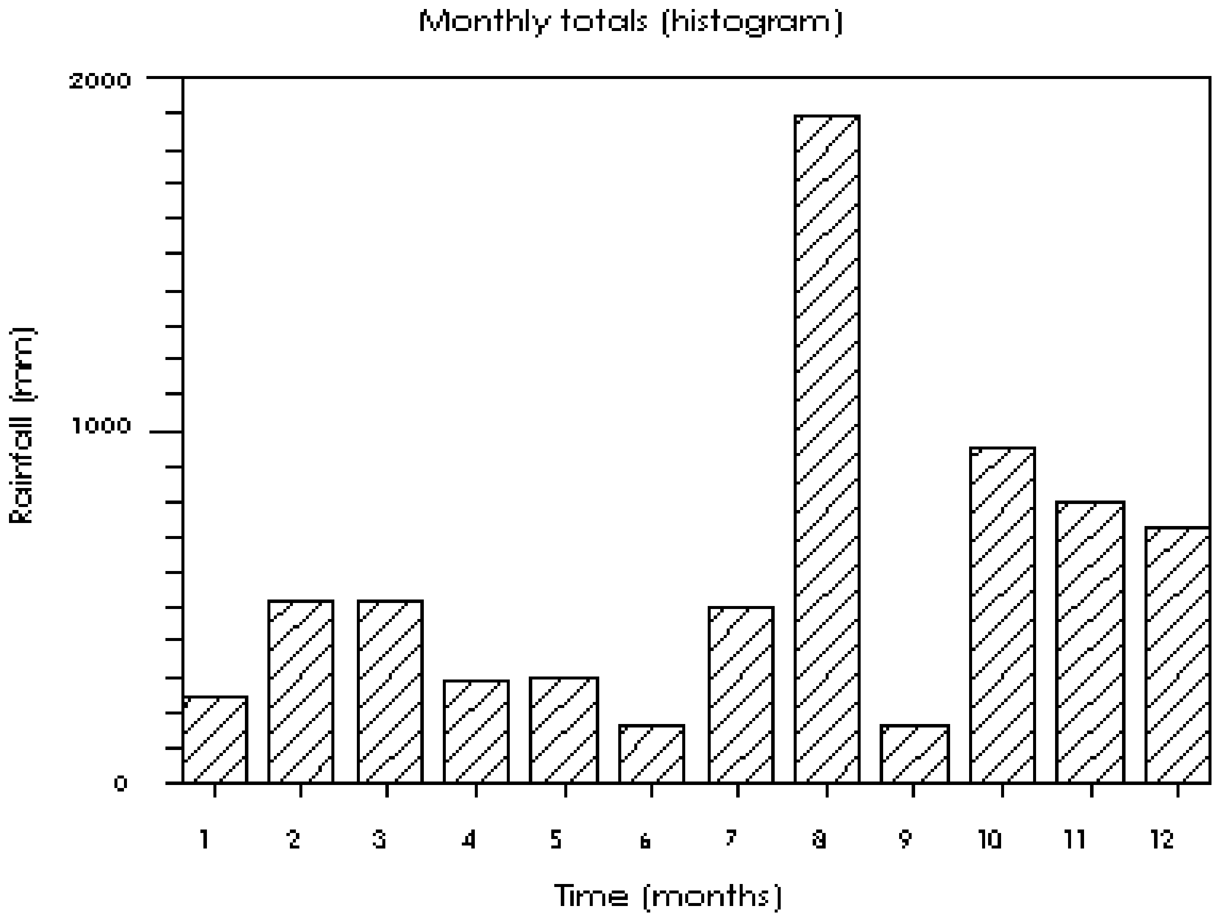
Question the evidence

- What is wrong with this rainfall chart?



Question the evidence

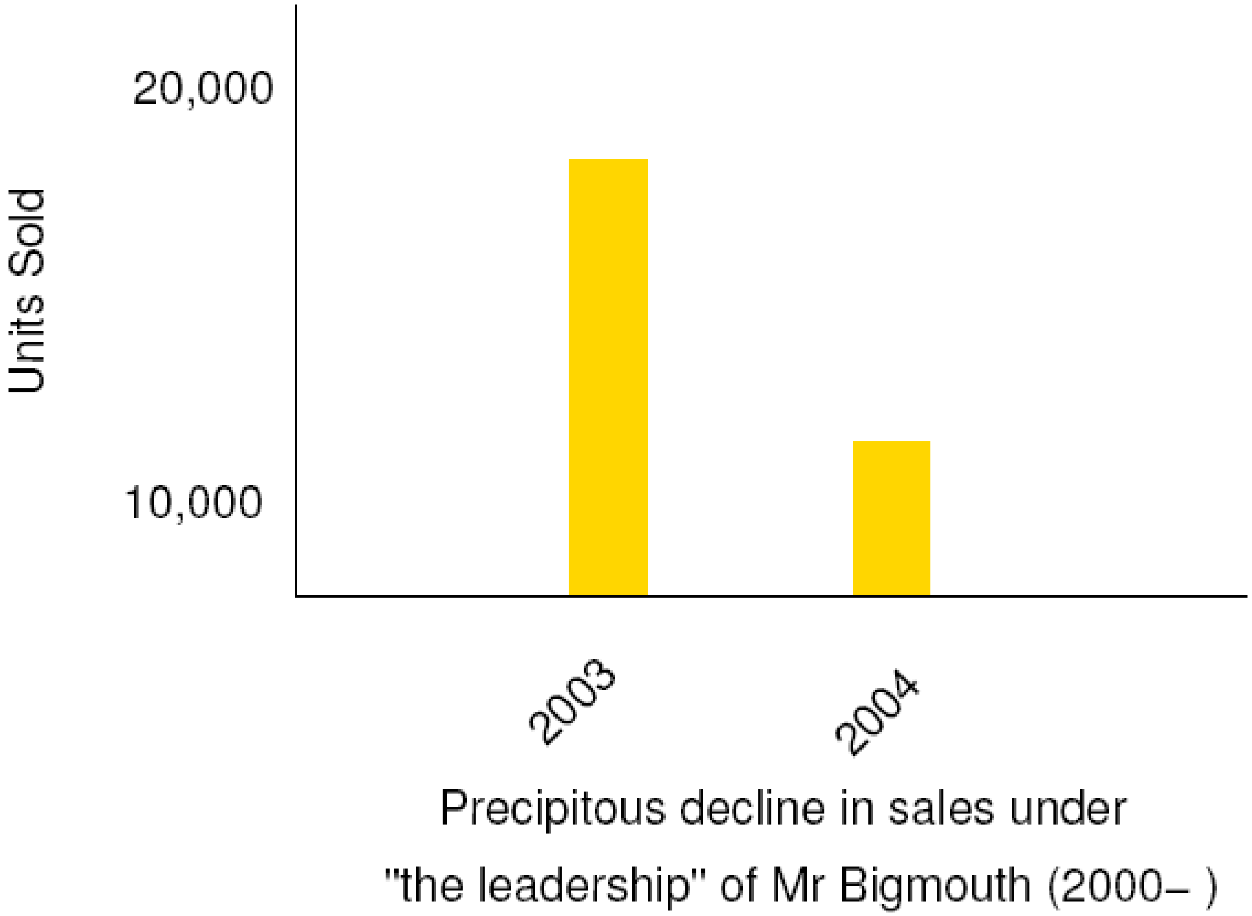
- Why is this version better?



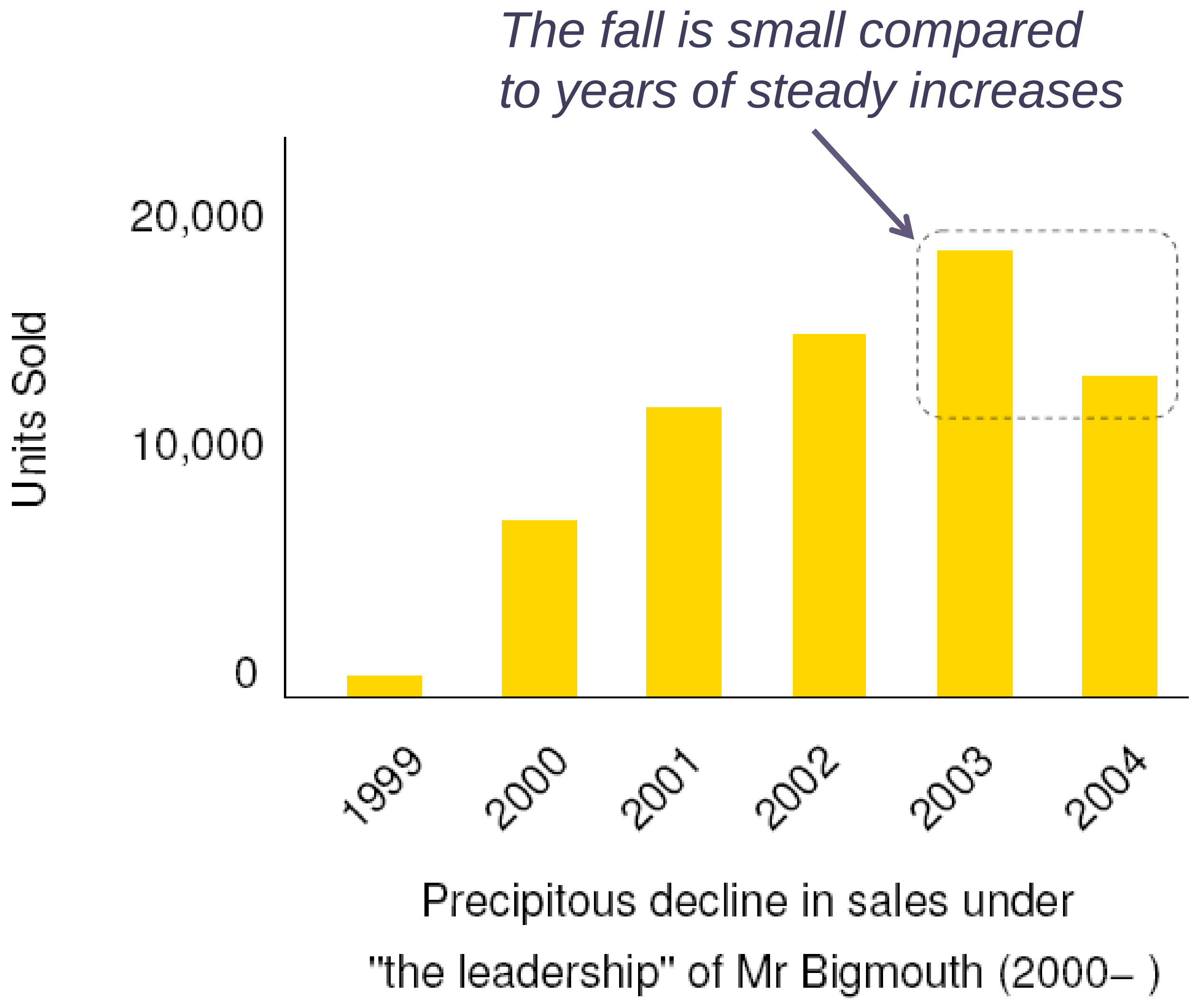
Question everything!

- Do you believe everything you read in the newspapers?
- Hear in the media?
- Compare histories of the American revolution
  - Written in America
  - Written in Britain
- "If it's peer-reviewed, it must be true."
- The best source of research ideas is a critical spirit
  - Applied to research reading
  - Applied with good judgment!

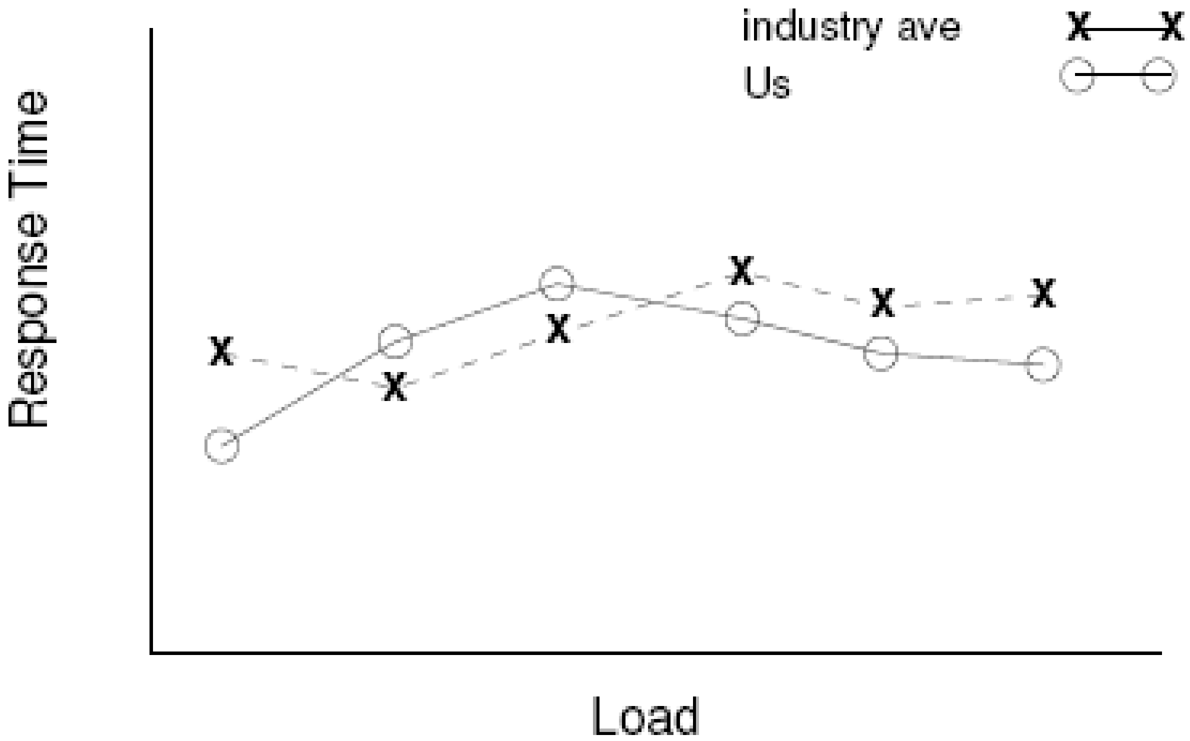
What’s wrong with this picture?



Beware of generalising from limited data



What's wrong with this figure?



Vendor's claim:

"Tests demonstrate our response time holds up better than average."

"There are three kinds of lies: lies, damned lies and statistics."
— Mark Twain

Keep your eye on the BIG picture

- Top researchers
  - Do small studies that answer big questions
- Know your context
  - Why is it significant?
  - Where is it leading?
- See the wood for the trees
  - Avoid getting too close to your work
  - The most common fault in theses

Context is concerned with the background of existing research, knowledge and understanding that informs new and ongoing research projects.

What is a "Grand Challenge"?

- Problems that rank highly on four criteria:
  - Significance
  - Impact
  - Scale
  - Timeliness
- Serve as targets that
  - Focus effort on big problems
  - Encourage collaboration

Some grand challenges in science

- Put a man on the moon within ten years (done, 1960s)
- Cure cancer within in ten years (failed, 1970s)
- Prove Fermat's last theorem (done)
- Map the Human Genome (done)
- Map the Human Proteome (too difficult for now)
- Find the Higgs boson (under investigation)
- Find Gravity waves (under investigation)
- Unify the four forces of Physics (under investigation)
- Complete Hilbert's programme (nearly complete)

Some grand challenges in computing

- Prove that P is not equal to NP (open)
- The Turing test (inactive)
- The verifying compiler (abandoned, 1970s)
- A championship chess program (done)
- A GO program at professional standard (too difficult) (done! 2015/2016)
- Automatic translation of Russian to English (failed, 1960s)
- A mathematical model of the evolution of the web (new)
- A wearable computer serving as a guide dog for the blind (new)

Source: http://www.ukcrc.org.uk/grand-challenge/

Revising research ideas

- Grand ideas are fine. . .
- But most research ideas are more modest
- How to revise your research ideas? Consider
    1. Is it achievable?
    2. Do you have a clear question/idea?
    3. Do you have (or can acquire) the right skills? background? (perhaps through collaboration)
    4. Is it significant (enough)?
    5. Is it original?
    6. Does it have a unity?
    7. Is it comprehensive?
    8. Is it testable?

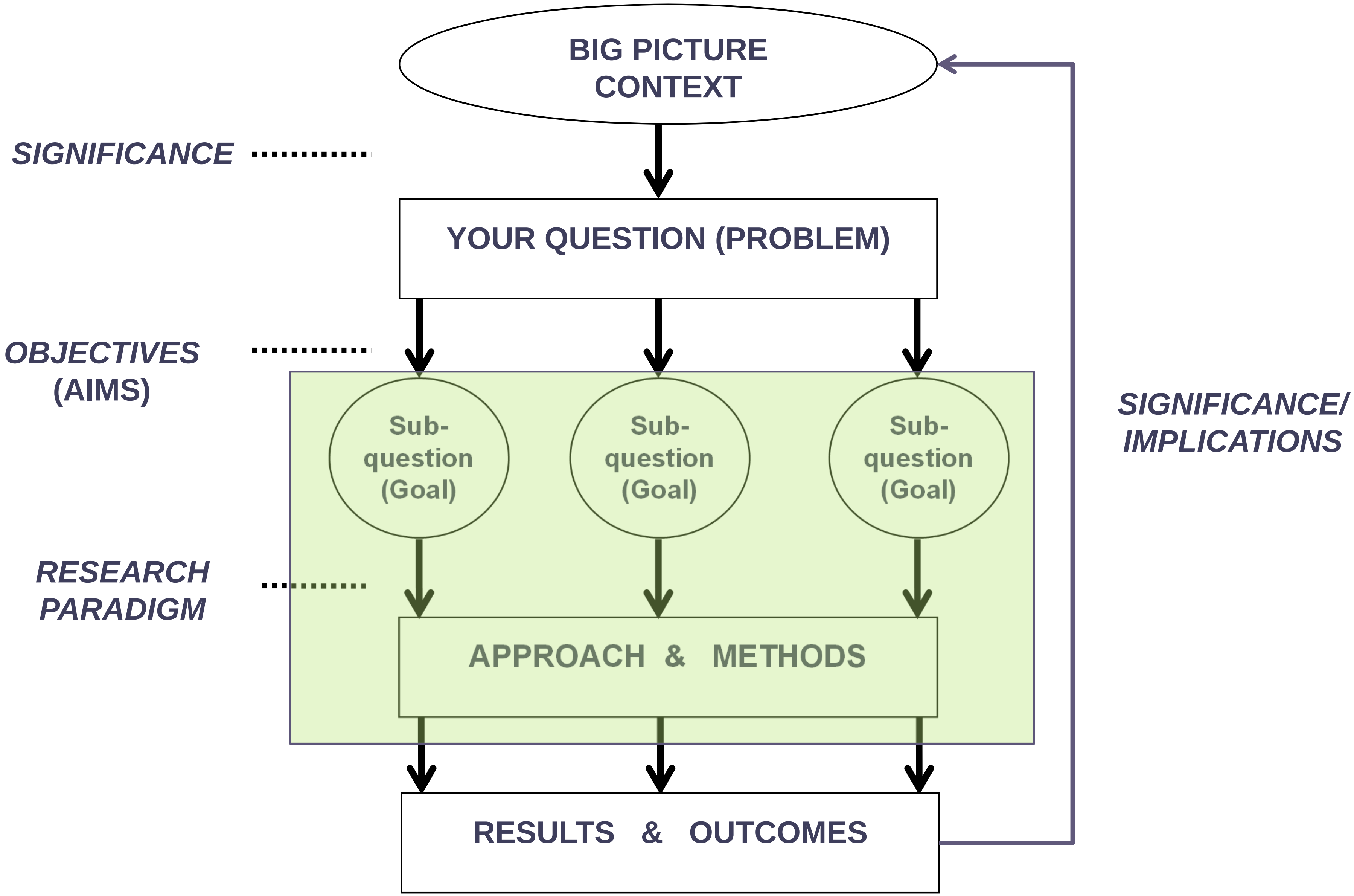
Research project planning

- Understand the role of methodologies in addressing research questions
- Know some common methodologies in research
- Be able to convert research questions into specific objectives and approaches that a study can deal with
- Be able to write a research proposal and summary
- Be aware of major issues that affect research projects

The nature of a research study

"This 'Wheel' thing of yours – Does it have to be round or will any shape do?"

Research centres around questions



Setting the context

- What is the context?
- Research questions sit within a context
  - Social, technical or other needs that inspired the question
  - Previous research
  - Relevant paradigms and methodologies
  - Potential implications
- These contexts provide the big picture
  - Implications for what you do and how you do it.

Context is concerned with the background of existing research, knowledge and understanding that informs new and ongoing research projects.

Setting the context – an example

- Example question
  - How to make a database that answers queries faster?
- Bigger picture/context
  - Economic:
    - Business efficiency and profitability
  - Technical:
    - Flaws in existing methods
    - Potential applications elsewhere

Planning research

Start with the questions:

- What do we already know about the problem?
- Who else looked at this (or a similar) problem?
- How did they investigated it?
- What did they find?
- Do their findings make sense?
- What can we learn about the problem from these investigations?

Planning a research study – an example

- **Big picture context**
  – Need for more efficient transport
- **The question**
  – Can the wheel provide efficient locomotion?
- **The objective**
  – To develop a strong, light, safe, and efficient wheel
- **Specific sub-questions**
  – Q1: How to make a wheel that is strong but light?
  – Q2: How to attach a wheel?
  – Q3: Is the result robust, safe and more efficient?

Planning a research study – an example (continued)

- **Paradigm**
  - A choice of this can lead to many different ways your study is undertaken.
  - Proof of concept, experiments, metrics, benchmarks are defined on the basis of the set of rules and values that researcher has taken as his/her philosophical paradigm within a set value system.
- **Approach**
  - Q1: Experiment with design and materials
  - Q2: Experiment with attachment methods
  - Q3: Comparison tests against existing standards (positivist paradigm) or How do the users of the wheel defining efficiency and what are the parameters of their concern? (interpretive study)

Scientific (research) paradigm

- As stated by Thomas S. Kuhn in early 1960s the term ‘paradigm’ “… stands for the entire constellation of beliefs, values, techniques, and so on shared by the members of the given community…
- On the other [hand], it denotes one sort of element in that constellation, the concrete puzzle-solutions which, employed as models or examples, can replace explicit rules as a basis for the solution of the remaining puzzles of normal science”

http://en wikipedia org//wiki/Thomas_Kuhn

Paradigms in science

- Science is like a drunk who's lost his car keys late at night:
  - He searches under the street lamp.
  - It's far from where he dropped them, but
  - It's the only place where he can see.
- Paradigms simplify research ...
  - but limit thinking to certain kinds of ideas and methods.
  - However, research eventually identifies the anomalies.

Role of paradigms

- Provide recipes for asking questions
- Scenario
  - A large company wants to “computerise” its record handling and storage
  - What questions might a manager ask about this plan from the following perspectives:
    - Information technology?
    - Sociological?
    - Economic?

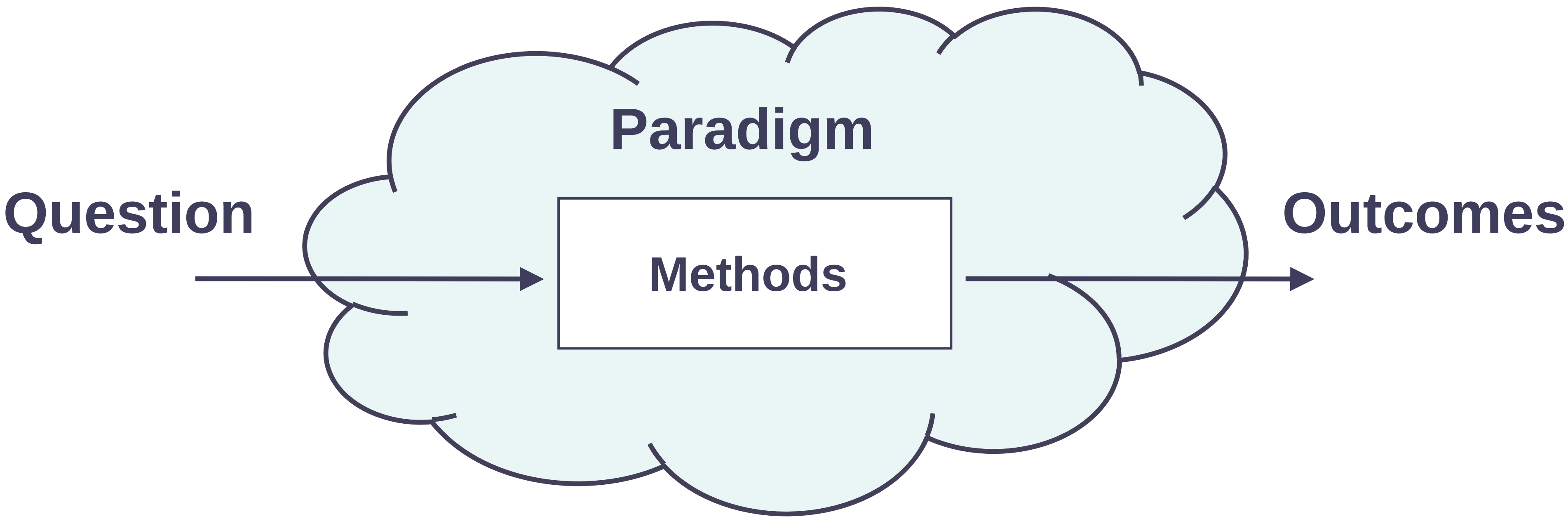
Some research paradigms and methods

Paradigm	Approach	Methods	Examples
Positivism	Quantitative	Surveys: longitudinal, experimental, and quasi-experimental and ex-post facto research	• Systems development and simulation • Relationship between people's use of computers and their attitudes to social interaction
Anti-positivism	Qualitative	Information Systems, Management, Social Science, Biographical; Phenomenological; Ethnographical; case study	• A case study of e-health implementation in India • A study of attitudes of people undertaking IT studies • A study of traditional ways of knowledge management in indigenous communities
Critical theory	Critical and action-oriented	Ideology critique; action research	• A critical-interpretive case study of an ERP implementation • A study of an organisation executing a "virtualisation" strategy

adapted from:
http://www.celt.mmu.ac.uk/researchmethods/Modules/Selection_of_methodology/index.php

Planning and executing a study

- What is the question?
- How do you answer that question?
- What outcomes do you expect?



Answering questions

- Ask questions that can be answered
- Identify the steps from question to answer
- Convert the question to objectives (aims) and sub-questions (goals)
  - Objective = Answer to the question
  - Sub-question = Steps to the answer
- Research questions should relate to the kinds of evidence
- Paradigms provide ready made pathways

From question to answer

- Step 1: Interpret the question
  - Make vague/general terms specific
- Step 2: Identify sub-questions
  - What are the sub-questions/stages involved?
- Step 3: Decide on an approach
  - Apply a paradigm
- Step 4: Choose a methodology
  - What evidence do you need to answer the question?
  - Where can this evidence be collected from?
  - What are the resources available for your research?

Step 1: Interpret the question

- Make vague/general terms specific:
  - What are the key words?
  - What do they mean?
- e.g. “How have mobile phones affected teen culture?”
  - **Key words**: “affected”, “teen”, “culture”
  - **Affect** --- Implies a change or difference
    - Suggests possible approaches, e.g.
    - Before and after phones? With and without phones?
  - **Teen** --- What age group?
  - **Culture** --- Needs to be specific. e.g.
    - Music? Language? Social behaviour?
    - Suggest kinds of evidence needed.

Example - Interpret the question

- Refined questions
  - How has phone usage by teen changed?
  - Have mobile phone changed teen social behaviour?
- Some issues to address
  - Feasibility of obtaining adequate data
  - Complicating effect of other factors
  - What are indicators of “culture” ?
    - Language? Religion? Music and other interests?
  - What paradigm to use?
    - Positivist? Interpretive?

Example – Positivist approach

- THE QUESTION
  - How has phone usage by teen changed?
- PARADIGMS
  - Positivist, Experiments, Metrics, Benchmarks
- SPECIFIC Sub-questions
  - Q1: Do teens use phone more often today?
  - Q2: Do teens use phones more than other age groups?
- APPROACH
  - Hypotheses:
    - More teens have mobile phones than other groups
    - Teens send text more often than other groups
  - Analyse usage data to test for changes in usage patterns over time and between groups.

Example – Interpretive approach

- THE QUESTION
  - Have mobile phone changed teen social behaviour?
- PARADIGMS
  - Interpretive
- SPECIFIC Sub-questions
  - Q1: Do teens use phones differently today?
  - Q2: How does teen behaviour differ?
  - Q3: Is there any link between usage and behaviour?
- APPROACH
  - Hypothesis:
    - Mobile phones allow teens to have more fluid meeting and social arrangements
  - Survey different age groups for their opinions.

Some common kinds of questions in IT

- Filling a gap in theory/practice
  - How to meet a clear need?
  - New application for an existing idea/method
  - Characterising features of an idea/method
  - Provide better explanation of a phenomenon and the use of artifact (ICT) within such phenomenon
- Does your idea/method work?
- Can your idea/method be improved?
- Enhancing performance
  - e.g. optimisation, efficiency, error reduction, usability, usefulness

Step 2: Identify sub-questions

- Does the question have different aspects?
  – e.g. different issues involved

- Are different stages involved?

  e.g.
  – set up experiment
  – run experiment
  – gather evidence
  – interpret evidence

Example - Identify sub-questions

- Objective:
  - To investigate a new algorithm
- Some possible sub-questions …
  - Does it work?
    - Tests using representative examples
  - Is it efficient?
    - Compare (say) its speed versus similar algorithms
  - Is it robust?
    - Try extreme cases to find where/when it fails?

Best of both worlds
In practice it is often desirable to undertake both theoretical and experimental evaluation.

Questions based on data

- What is the pattern?
  - How many people use my web site?
  - What items do users download?
- What is the process?
  - Do users from .EDU download tutorials notes?
  - Does the number of users show a daily or weekly or seasonal pattern?
  - Can you approach this study in an interpretive way?

Explore the dimensions

- Example - How to increase processing power?
  - Improving CPUs?
  - e.g. Increasing speed, caching, memory
- More processors?
  - Parallel processors
  - Clusters, grids
  - Networked processors
- Multi-agent systems?
  - Distributed & mobile agents
  - Agent swarms

Step 3: Decide on an approach

- Paradigms help
  – They provide recipes for addressing questions
- What kind of study will provide the answer?
  – e.g. proof of concept? experiments?
- What kinds of evidence do you need?
  – What is implied by the terms in your question?

Example - Is an organisation successful?

Test criteria might include:

- Numerical measures of performance (positivist)
  - Income
  - Output
  - Growth in size and activity
- Notable achievements
- Attitudes (interpretive)
  - Of members
  - Of outsiders

The reductionist paradigm

- "Divide and rule"
  - Break down the study of a large system (or problem) into smaller, simpler parts that can be studied and understood more easily
  - e.g. understand a forest by studying individual trees
- Analysis
  - The process of understanding by identifying simple component patterns or processes
  - Modular design applies this approach to building systems

The reductionist paradigm

- Drawbacks of reductionism
  - Assumes a system or problem can be broken into smaller, simpler ones independent of each other
  - Ignores features that emerge when components interact
  - Tends to ignore cross-scale effects
  - Inhibits cross-disciplinary research

Step 4: Choose a methodology

- How will you gather the evidence?
- How will you interpret the evidence?
- What the resources available to you?

- Give some consideration to time and the scope of the study – no need to plan five year project for a one year honours degree; and a PhD does not have to win a Nobel prize.

Some research methods in computing and information technology

- Experiments
  - Laboratory experiments
  - Field work
- Simulation studies
  - Virtual experiments
  - Scenarios and sensitivity
- Proof of concept
  - Build a working example
  - Formal mathematical proofs
- These are normally approached in a positivist - scientific paradigm

Some methods in information management research

- Survey – can be interpretive or positivist
- Experiments - positivist
- Case study - can be interpretive or positivist
- Systems Development - can be interpretive or positivist
- Action Research - can be interpretive or positivist
- Ethnography - interpretive
- Historical Research - interpretive
- Delphi method - can be interpretive or positivist

Experimental methods

- Dependent variables
  – Attributes whose values change and are observed.
- Independent variable
  – Values do not depend on other variables (e.g. time);
  – Introduced, changed, or otherwise manipulated;
  – Effects on other variables are observed.
- Parameters
  – Other relevant aspects that are controlled (eliminated, held steady)

Common kinds of evaluation in IT

Aspect	Focus
Theoretical	Underlying structure and function
Technical	System characteristics
Empirical	Objective measures of performance
Subjective	Users' perception of the system

See more in:	Yin (case studies)
	Miles and Huberman (qualitative research)
	Cook and Campbell (experimentation)

Generic criteria for evaluating research

- Significance
  - Theoretical and/or practical
- Internal validity
  - Credibility of your arguments, authenticity, plausibility, adequacy
  - Applies both to method/system and arguments for its worth
- External validity (generalisability)
  - Do findings confirm prior theory?
  - Are methods applicable in other settings?
  - Are scope and boundary defined?

Criteria for evaluating research design

- Reliability/dependabilty/auditability
  - Quality control
  - Are research questions clear?
  - Is role and status of researcher clear?
  - Are basic constructs clearly specified?
- Objectivity/confirmability (not biased)
  - Relative neutrality and freedom from bias, or explicitness about biases that do arise
  - Have feelings of the researcher influenced the evaluation of the outcome?

Overarching principles

- There are many radically different forms of research, but some universal principles apply
  - Research should be informed by a detailed understanding of the relevant state-of-the-art
  - Research outcomes should be evaluated using appropriate techniques

Be alert for serendipity

- We are doing research
- By definition this means we cannot be certain of what the outcomes will be
- Always be alert for the potential significance of unexpected outcomes
- Don’t get so bound up in your initial research plan that you ignore significant discoveries!

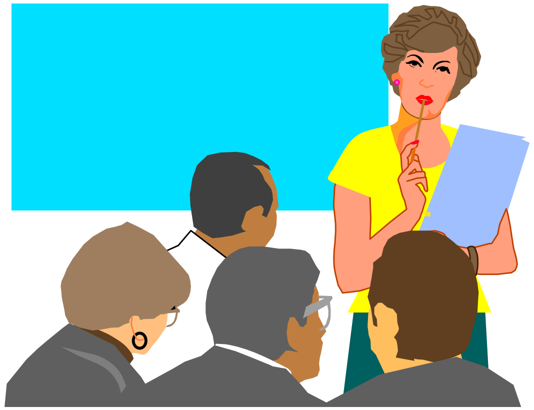
Serendipity

Many great discoveries are made by accident ….

- Researchers investigating a potential drug for treating angina noticed that it caused an unexpected side-effect on male subjects, thereby discovering the primary modern use of Viagra
- Dr Percy Spencer, testing a magnetron (vacuum tube) noticed that the chocolate in his pocket melted. He further investigated the phenomenon and ended up inventing the microwave oven.
- Sir Alexander Fleming was studying Staphylococcus and noticed that a blue-green mould prevented it from growing. Instead of throwing out the petri dish as a failed experiment, he grew a culture of the mould, discovering penicillin.

Many hands make light work

- Many important problems are interdisciplinary
  - Drafting colleagues is quicker than learning a new field
- Collaboration works
  - Get more results
  - Stimulating ideas
  - Best way to develop a network of colleagues



Research proposals

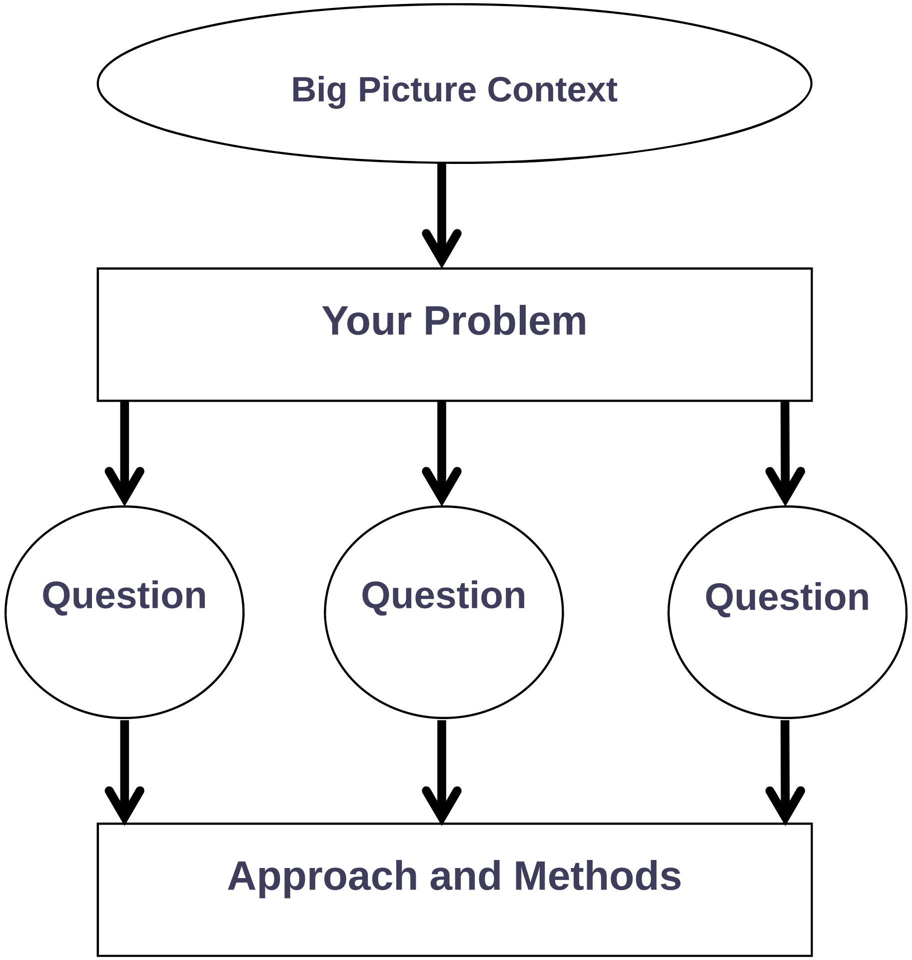
Purpose of a research proposal

- Introduce your research
  - Formulate your problem (question), objectives, and questions
  - Sketch out relevant background (literature review)
- ‘Sell’ your idea
  - Explain the motivation
  - Explain its significance (insights, innovation etc)
  - Describe the expected outcomes and implications
- Demonstrate the feasibility of your study
  - Sketch a clear path from question to answer
  - Explain the planned procedures - plan and actions
  - Identify resources
  - Describe how you will deal with practical issues

Structure of a research proposal

- Research proposals have sections similar to articles
  - Summary
  - Introduction
  - Literature review
  - Approach (proposed evidence, methods and interpretation)
- They omit results and discussion
- They add sections on planning and capacity, e.g.
  - Budget
  - Facilities available
  - Track record of the applicants
  - Personnel and organisation of the work
  - Expected outcomes and the resulting benefit

Organisation of a research proposal



Section

Significance, also background

Introduction

Background and Objectives

Approach

Structure of a research proposal

- TITLE
- INVESTIGATOR(S)
- SUMMARY
  - Give a brief overview of the project – why, what, how, where.
- INTRODUCTION
  - Describe the context and motivation for the project.
  - Describe the overall objective, the main research problem addressed by the project.
  - Describe any specific research questions by which the project will answer the problem.
- BACKGROUND
  - Describe how the research is significant and how it addresses an important problem.
  - Briefly describe the current state of this field and how it relates to this project.
  - Review the relevant literature.
- METHODS
  - Outline the project's design and methods.
  - Explain how they address the project's objective and questions.
  - Describe the expected outcomes and likely impact of the proposed research.
- REFERENCES

Titles and abstracts are important

- Most readers see only your title and abstract
  - Bibliographies, conference programmes etc. usually list title and abstract only.
  - Readers search these when seeking articles of interest.
- Crucial that they convey the important issues
  - A good title and abstract can greatly increase the impact of a study.
  - Poor ones get ignored.

What's in a title?

- ORIGINAL TITLE
  - The distributional ecology of
    Lemna minor and Lemna salicina
  - Obscure, boring and apparently trivial
- FINAL TITLE
  - Lakes as islands - the distributional ecology of freshwater duckweeds
  - Touched on the "hottest" issue in the field at that time
- RESULT
  - Accepted by the top journal in the field
  - Widely cited
  - Launched the author on a successful career

A formula for writing summaries

Background

WHY is it significant?

Question

WHAT are you doing?

Approach

HOW are you doing it?

Outcome

WHERE will it get us?

A failed grant application

Previous research has demonstrated that elongated cylindrical structures exhibit efficient conversion of circumferential traction into horizontal translation. It is believed that planar toroids will prove efficacious in overcoming deficiencies evident in extant versions. It is anticipated that the resulting device will be capable of both positive and retrograde translation. Our programme will include investigation of material composition as well as implementation of specific prototypes. We anticipate that the outcomes will include applications in several priority areas.

Pompous, obscure and vague

A successful summary

Transporting heavy loads is a major problem for industry. Previous research shows that cylinders make a usable base, but they are awkward, heavy and dangerous. This study will test our claim that the wheel is a more effective base for vehicles. We will investigate methods of attaching wheels as well as ways of making them strong but light. The results will lead to vehicles that are easier and safer to move.

Easy to understand, clear, to the point

Structure of the summary

- WHY
  – Transporting heavy loads is a major problem for industry.
  – Previous research shows that cylinders make a usable base, but they are awkward, heavy and dangerous.
- WHAT
  – This study will test our claim that the wheel is a more effective base for vehicles.
- HOW
  – We will investigate methods of attaching wheels as well as ways of making them strong but light.
- WHERE
  – The results will lead to vehicles that are easier and safer to move.

A successful grant application

A Unified Grid Programming Methodology for Global e-Science

(ARC Discovery Prof DA Abramson, 2007-2011)

Modern science requires huge computational resources and has become Global e-Science. Going far beyond individual super computers, Grids harness geographically distributed resources: dozens of super computers, workstations, clusters of computers, data bases, together with scientific instruments, such as telescopes or synchrotrons. Currently, Grids are difficult to use because they lack key software infrastructure. We shall develop this by both extending available Grid services and by building new software tools. Australian e-Science case studies will be pursued in environmental sciences, life and health sciences, and geo-sciences and will link to global Grids extending Australia's scientific capabilities globally.

Example - structure

Background

Modern science requires huge computational resources and has become Global e-Science. Going far beyond individual super computers, Grids harness geographically distributed resources: dozens of super computers, workstations, clusters of computers, data bases, together with scientific instruments, such as telescopes or synchrotrons.

The question

Currently, Grids are difficult to use because they lack key software infrastructure.

Approach

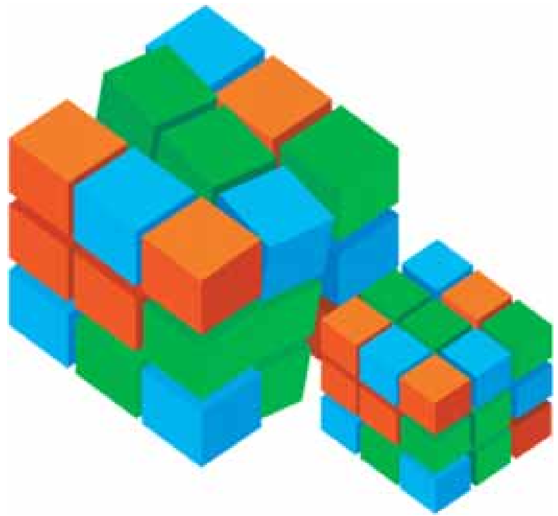
We shall develop this by both extending available Grid services and by building new software tools. Australian e-Science case studies will be pursued in environmental sciences, life and health sciences, and geo-sciences ....

Outcomes

.... and will link to global Grids extending Australia's scientific capabilities globally.

Issues affecting research projects

- In any form of research you need to be aware of issues that concern any project
  - Ethics
  - Legal liability
  - Copyright
  - Intellectual Property
  - Defence Restrictions
  - Ownership and custodianship

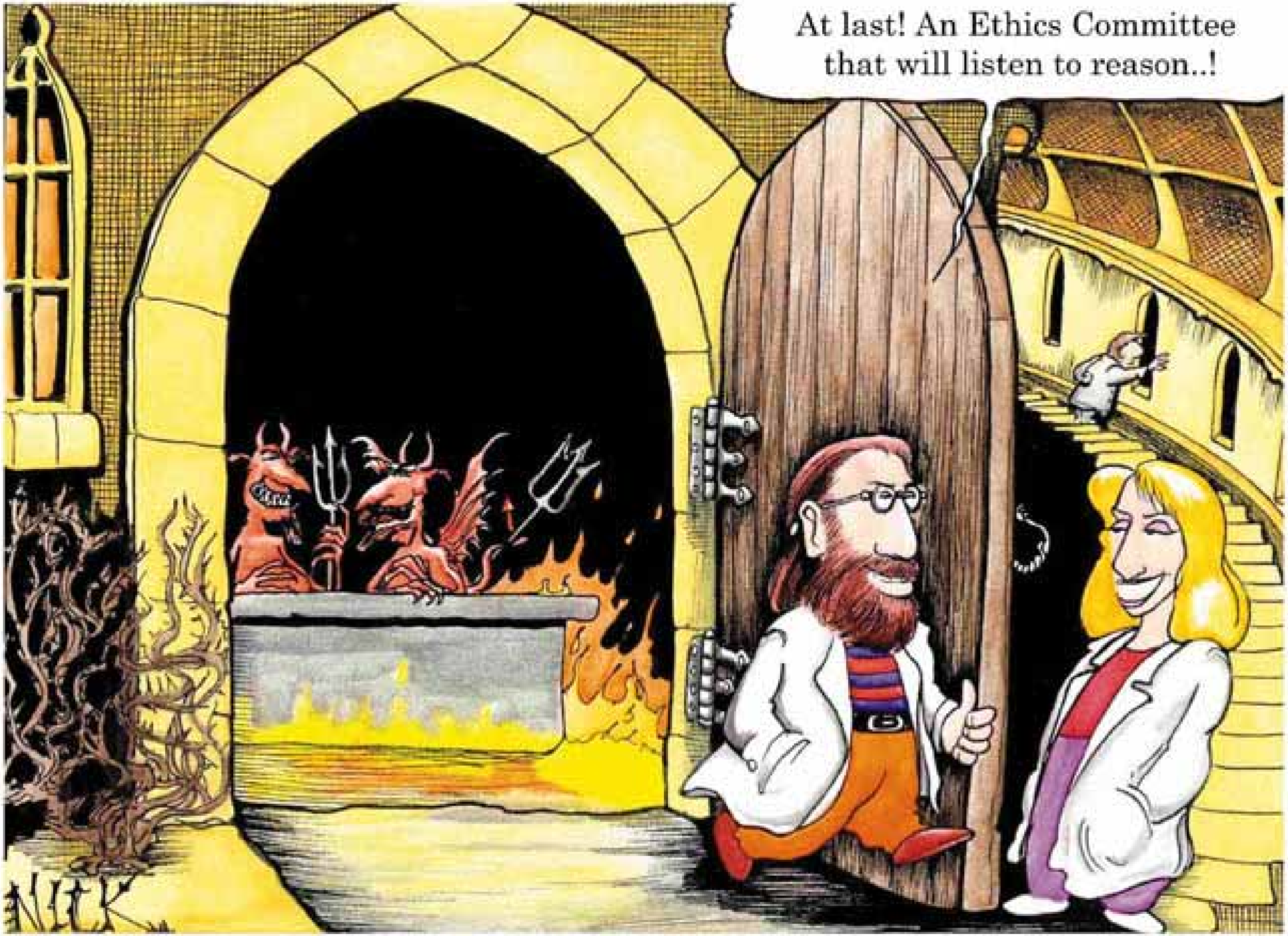


Research ethics

- Application of social standards of behaviour to research activity
- Social values, morals and attitudes govern research and set the boundaries for what is acceptable
- Universities require clearance for
    - Research involving humans
    - Experimentation on animals
    - Biosafety
    - Quarantine

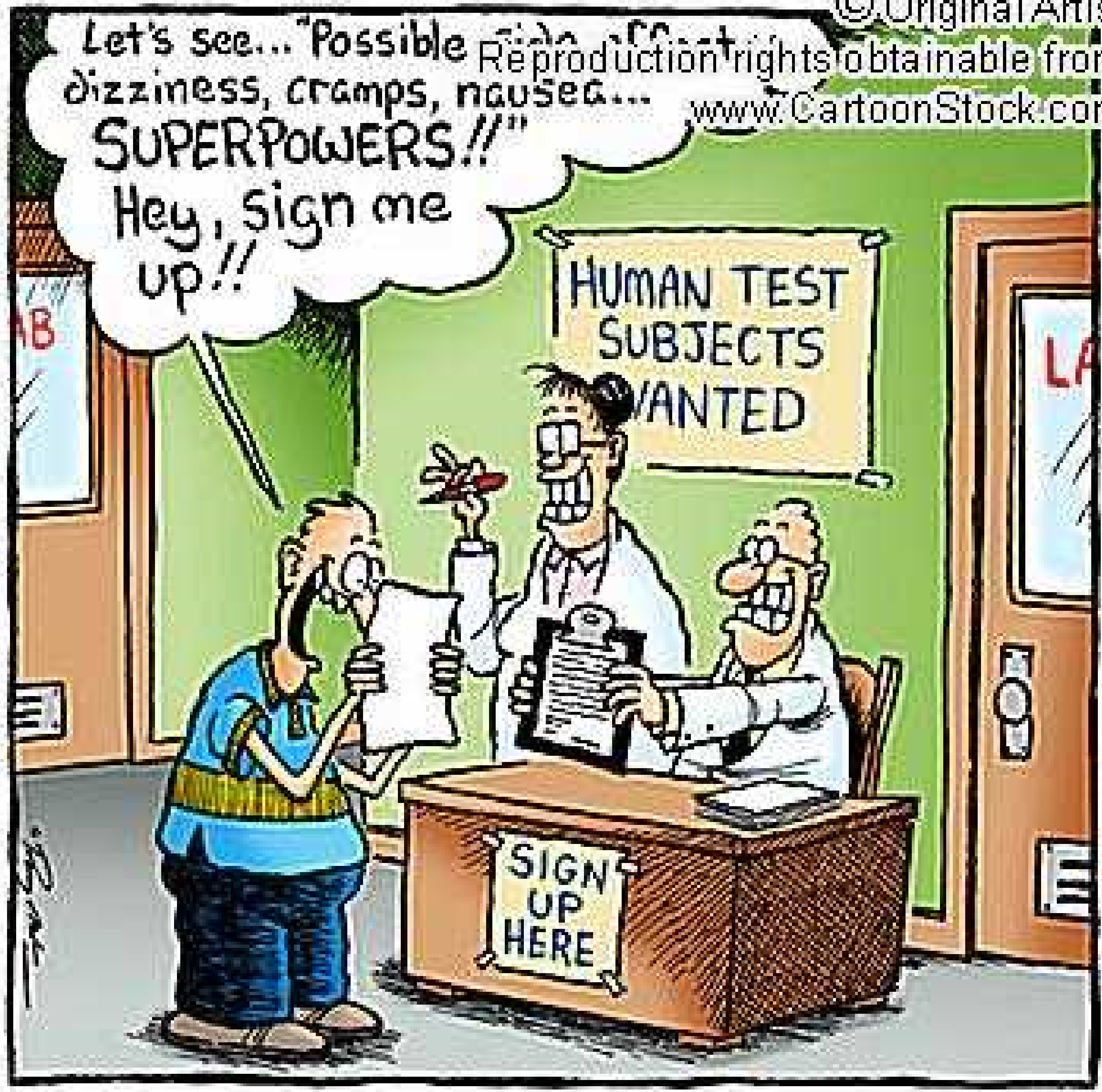
Ethics approval

- The application form for Ethics approval contains 33 pages of questions
  - longer than many grant applications
  - longer than many honours theses
- Research ethics references
  - http://www.monash.edu.au/researchoffice/ethics.php
  - *http://intranet.monash.edu.au/researchadmin/human/form-1.html*


At last! An Ethics Committee that will listen to reason..!
NICK

Unethical research practices

- Problems in dealing with test subjects
  – Physical harm or abuse (human and animal)
  – Psychological abuse
  – Invasion of privacy
  – Deception and Coercion
  – Illegal practices
  – Covert observation? (subjects unaware - grey area)
- Other unethical practices
  – Falsifying data and results
  – Misappropriating ideas and information
  – Biased reviewing



Another successful recruitment drive for the Collins University Medical Research Center.

Beware of these practices

- The easiest way to get a good idea is to steal one
  - Plagiarism
  - Usurping research
  - Failure to assign credit
- The easiest way to make yourself look good is to make someone else look bad
  - Beware “Rambo” reviewers
  - Showing off by ripping into written research and giving withering reviews
  - You can make any article look good or bad
  - Asking scathing questions in conferences and in seminars
  - Bullying students and other inexperienced researchers

Examples of unethical behaviour

- Case study 1 - PLAGIARISM
  - Scientist A reviewed a grant application by scientist B
  - Scientist A copied ideas from the application in a research paper and published it in a journal
  - Scientist B read the article and made a formal complaint to A’s university
  - Following an enquiry, scientist A was dismissed

Examples of unethical behaviour

- Case study 2 – USURPING RESEARCH
  - Scientist C found a good idea in an article by scientist D, which was published in a minor journal
  - Using network contacts, Scientist C published an article using the idea in a major journal
  - The article failed to cite the earlier work by scientist D
  - Hundreds of subsequent studies credited scientist C with the idea
  - Scientist D published a best-selling book on the topic providing the full story and reclaimed the credit

Examples of unethical behaviour

- Case study 3 – FALSIFYING DATA
  - Scientist E was director of a major research institute
  - Scientist E had a pet idea that attracted lots of research funding
  - Results of experiments proved inconclusive, so E falsified data so that it appeared to support the theory
  - An assistant who queried the data was dismissed on spurious grounds
  - TV journalists uncovered the case, which resulted in a major scandal and E was forced to resign

Examples of unethical behaviour

- Case study 4 – BIASED REVIEWING
  - Scientist F was a prominent researcher who had published articles and books about a pet theory
  - Scientist G submitted an article to a journal. The article clearly refuted scientist F's pet theory
  - Editors of the journal asked scientist F to review the article by scientist G. Scientist F provided a scathing review so the editors rejected the article
  - Using influence, scientist F blocked publication of scientist G's arguments, but G eventually published the results in an obscure journal
  - Rival scientists eventually saw the article, picked up the theme and F's idea was eventually discredited

Intellectual property (IP)

- Ideas, methods and results derived by researchers
- Crucial issue where research has commercial implications
- Includes copyright
- Funding organisations sometimes demand to acquire ownership of research IP

Copyright

- Any published material is subject to copyright
- Variations on copyright
  - Public domain
  - Copyleft
  - Shareware
  - Freeware
- References
  - GNU Project categories, http://www.gnu.org/philosophy/categories.html

Copyright Do's and Don'ts

- Copying published matter
  - Within reason, material can be copied for research
  - You cannot copy published matter for material gain
- Figures
  - Published figures are subject to copyright, so you need permission to reproduce them
  - You can redraw a diagram, but should cite the original e.g. "Redrawn after Nurk (1996)".
  - There is no copyright on data, so you can use it, but should cite its source

Copyright and the Web

- See the World Wide Web Consortium (W3C) and national authorities
- Placing material on a web site is a form of publishing and therefore subject to copyright
- Be careful of making links – some sites have policies about linking to particular resources, especially if the source is not cited

Plagiarism

- Presenting ideas and material as your own
- Plagiarism is stealing
- Examples
  - Copying published text without citation
  - Copying figures, photos etc without permission
  - Presenting other people’s ideas as if they are yours
  - Reprinting text without using quotes

Proper citing

- Original published text

    The ways in which social order emerges from communication in human networks provides a model from which to draw lessons about the design of computing networks.

    from Bransden & Green (2005)

- Properly quoted and cited

    "The ways in which social order emerges from communication in human networks provides a model from which to draw lessons about the design of computing networks." (Bransden & Green, 2005)

- Properly cited, but not copied

    Simulation studies of communication in human networks have implications for the design of computing networks (Bransden & Green, 2005).

Custodianship

- Who owns data?
  - Researchers have traditionally been possessive about hard-won results, but who really owns it?
    - Researchers who collect it?
    - Agency that funds the research?
  - Increasing need for more cost efficiency in research
  - Information is power!
- Who maintains data?
  - People who collect it?
  - Collating agencies?

Custodianship

- Need to recycle data
  - In many areas of research, data are recycled to enrich future research.
  - Examples include:
    - Genomic information
    - Astronomical observations
    - Biodiversity and environmental data
- Issues include
  - Quality assurance
  - Standardisation
  - Dissemination

Custodianship - example

- Case study – Government data
  - Agency X was charged with producing crucial information of national importance
  - They also were required to recover costs
  - To meet the demands, they onsold data at the full cost of producing it
  - The cost was beyond the budget of other government agencies that needed it
  - The result? The government could not afford to use its own data!!

Recommended readings

- Dawson, C. (2009). Introduction to Research Methods. How to Books Ltd., Begboke, Oxford, UK.
- Holz, H.J., Applin, A., Haberman, B., Joyce, D., Purchase, H., Reed C. (2006). Research Methods in Computing: What are they, and how should we teach them? *ACM SIGCSE Bulletin*, 38(4), 96-114.
- Johnson, R.B., Onwuegbuzie, A.Z. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, 33, 14-26.
- Leady, P.D., Ormrod, J.E. (2013) *Practical Research: Planning and Design.* Pearson, Chapters 2, 4 and 5.
- Miles, M.B., Huberman, A.M. (1994). *Quantitative Data Analysis: An Expanded Sourcebook*. 2nd ed. Sage, Thousand Oaks, CA.
- Roberts, R.M. (1989). Serendipity: *Accidental Discoveries in Science*, Wiley, 1989.
- Williamson, K., Bow, A., et al. (2002). *Research Methods for Students, Academics and Professionals: Information Management and Systems*, Charles Sturt University, Chapters 2 and 3.

Recommended readings (continued)

- Zikmund, W.G., Babin, B.J., Carr, J.C., Griffin, M. (2010). *Business Research Methods* (8th edition), South-Western, Parts 1 and 2.
- National Academy of Sciences, National Academy of Engineering, Institute of Medicine (1995). *On Being a Scientist - Responsible Conduct in Research*, published by. National Academy Press, Washington, D.C.
  - http://books.nap.edu/catalog.php?record_id=4917#toc
- Web Center for Social Research Methods
  - http://www.socialresearchmethods.net/kb/contents.php
  - See sections on Ethics, Design, Sampling
- Monash University Library - Academic Integrity
  - http://monash.edu/library/skills/resources/tutorials/academic-integrity/
- Free Software Foundation (2008). Categories of Free and Non-Free Software. http://www.gnu.org/philosophy/categories.html
- Getting ideas and issues in computing
  - Edward de Bono (1990). *Lateral Thinking: Creativity Step by Step*. HarperCollins London.
  - Green, D. (2004). *The Serendipity Machine*. Allen and Unwin, Sydney.
- Grand challenges in computing research
  - UK Computing Research
    - http://www.ukcrc.org.uk/grand-challenge/

Readings and resources

- Purdue University Writing Lab (1999).
    - http://owl.english.purdue.edu/
- Gopen. G.D., Swan, J.A. (1990). The Science of Scientific Writing. *American Scientist* 78, 550-558.
    - http://www.americanscientist.org/issues/feature/the-science-of-scientific-writing/9
- Procter, M. (2007). *Advice on Academic Writing*. University of Toronto. http://www.utoronto.ca/writing/advise.html
- Tischler, M.E. (2007). *Scientific Writing Booklet*. University of Arizona
    - http://www.biochem.arizona.edu/marc/Sci-Writing.pdf
- Monash University Library: Citing, referencing and plagiarism:
    - Quiz: http://lib.monash.edu/tutorials/citing/citing-quiz/quiz.html
    - Tutorial: http://lib.monash.edu/tutorials/citing/