MONASH University

Information Technology

FIT5190 Introduction to IT Research Methods

Lecture 1

The Nature of Research

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Learning objectives

- Understand
  - the nature of research
  - the research paradigms
  - inductive and deductive research
  - the stages of a research study

Preliminaries

- More than ever, society needs people with *critical minds*, people who can look at research, ask their own questions, and find their own answers.
- In a nontrivial way, the essence of a PhD study is to identify *an important gap* in the literature and contribute to its resolution.
- Doing research will help you understand the material you are studying in a way that no other kind of work can match.
- The skills of research and writing that you learn now will enable you to work on your own later.

Preliminaries (continued)

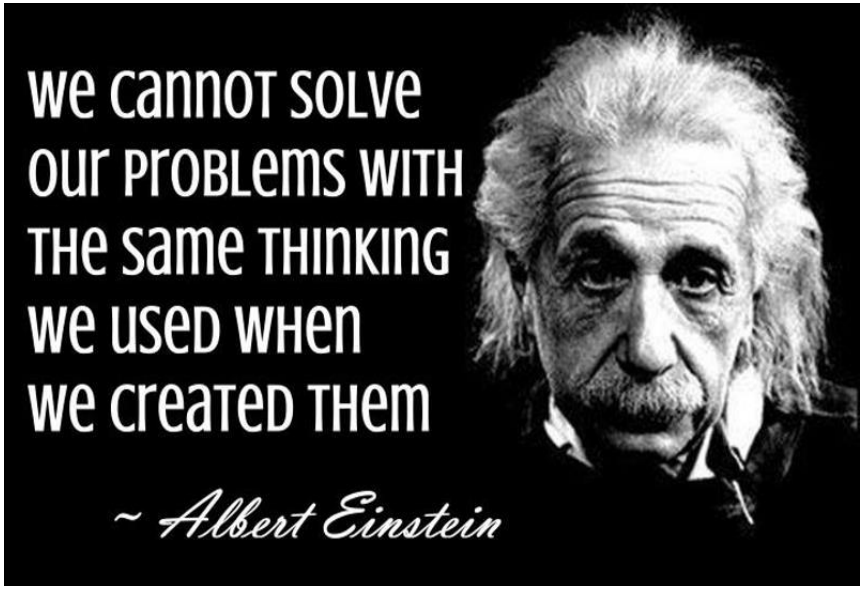
- Even experienced researchers feel a bit anxious when they undertake a new project, especially if it's of a new kind.
- So whatever concern you feel when conducting research, all researchers have felt, and many of us still do.
- The difference is that experienced researchers know what lies ahead – hard work, but also the pleasure of the chase; some frustration, but more satisfaction; periods of confusion, but confidence that, in the end, it will all come together.

- Booth et al. (2008) *The Craft of Research*.

Preliminaries (continued)

- “If we knew what it was we were doing, it would not be called research, would it?”

  Albert Einstein, 1879 – 1955.



- “Research is simply gathering the information you need to answer a question and thereby help you solve a problem.
- One reason research is fun and exciting is that no two people approach a question in the same way.
  - There are many ways of solving or addressing a research problem.
- All research involves risk.

What is research?

- "… a systematic, careful enquiry or examination to discover **new** information or relationships and to expand/verify existing knowledge for some specified purpose."

  - Bennet (1991)

- "Research is the careful search or inquiry for; endeavour to discover **new** facts, procedures, methods and techniques by the scientific study of a subject, course of critical investigation."

  - Concise Oxford Dictionary 4th ed**.**

Who does research?

- In short … everyone does research!
- People do research of one kind or another in almost any organisation:
  - Academics;
  - Students;
  - Government;
  - Corporations;
  - Consultants;
  - Managers;
  - Librarians;
  - Detectives, etc.

Research occurs in many contexts

- Factory owner
  - runs experiments to improve the output of a machine
- Driver
  - tries different routes to work
- Journalist
  - does background research about a TV star she is to interview
- Business consultant
  - prepares a report about the feasibility of a building project

Not just a job; a way of life

- **How serious are you about research?**
  - Do you lie awake at night thinking about
    - The latest movie?
    - The latest research article you read?
  - What do you think about in the shower?
    - The latest pop tune?
    - The design of your new experiment?
  - Where did you go on your honeymoon?
    - Hawaii?
    - A field trip?

Not just a job; a way of life

- **Think research**
  - Look for potential relevance in all you see or read
- **Keep a notebook**
  - Record ideas and observations
  - To get great photos you need to have a camera with you all the time
  - The same applies with research ideas

Theory and practice

Theory

- provides models and theories of reality
- the underlying concepts and methods for diagnosing and solving problems

Observation, Experiment (including simulation)

- provides ‘facts’
- evaluates theory

Application

- Puts theory to use
- “Looking to the profession for new questions to be answered using the methods and concepts of the social sciences; or starting with social scientific knowledge and looking at new applications in the professions.” Van House (1991) p.88.

Cycle

- Outcomes of observation, experiment and application stimulate new theory, which informs further observation, experiment and application

Research paradigms and traditions

- Paradigms
  - Different fields of research have their own concepts, principles and methods
- Scientific research: **positivist**
- Applied research: **practical**
- Social research: **interpretive**

Basic vs. applied research

- **Basic research** (pure, fundamental or theoretical research)
  - primarily concerned with deriving new knowledge
  - tends to focus on theory building and/or hypothesis testing.
- **Applied research**
  - concerned with solving specific problems in real life situations.
  - more pragmatic and emphasises information which is immediately usable in the solution of actual problems.

–Williamson et al. (2000)

Scientific research

- **Origins**
  - has the oldest tradition (classic Greeks)
  - flowered after the renaissance in Europe
  - influenced by Bacon, Galileo and others
  - applied mostly in natural sciences
  - often in opposition to religion
- **Approach**
  - seeks experimental validity and reliability;
  - influence of social causes NOT considered
  - based on empiricism
    - senses are the only source of knowledge;
  - positivism
    - based on trust in unbiased views

Scientific method

- Bacon, Galileo, Popper, Kuhn et al. …

  Step 1: Observe nature

  Step 2: Pose hypotheses to explain observations

  Step 3: Make predictions based on hypotheses

  Step 4: Test predictions

  - IF wrong, abandon the hypothesis and GO TO step 2
  - IF correct, retain and GO TO step 3

- Classical science has two phases:
  - **Induction**: steps 1 and 2
  - **Deduction**: steps 3 and 4

Induction and Deduction

- Example 1: **Inductive reasoning**
  1. I have visited many capital cities in China.
  2. The population of all capital cities I visited in China is more than 3 millions.
  3. Therefore, all capital cities in China have a population of more than 3 millions.

- Example 2: **Deductive logic**
  1. All big cities in China have a population of more than 3 millions.
  2. Suzhou is a big city in China.
  3. Therefore, Suzhou has a population of more than 3 millions.

Induction and Deduction

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Directions for research

Inductive research

- Aims to **derive** general rules, principles or theories **from** specific cases
- e.g. data mining, data exploration

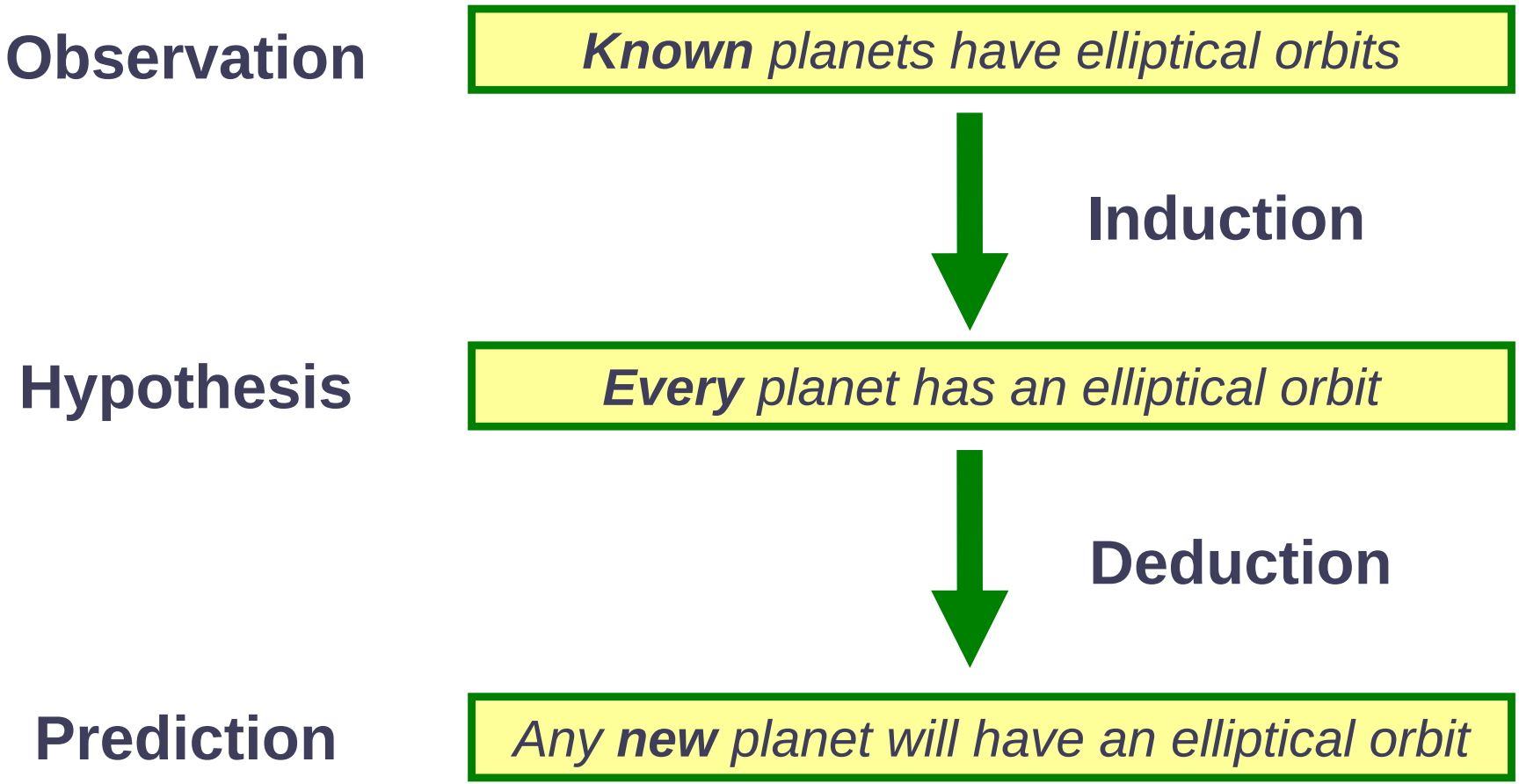
Deductive research

- Aims to **apply** general rules, principles or theories **to** specific cases
- e.g. hypothesis testing

Theories and hypotheses

- **Theories**
  - Ideas about how the world works
  - e.g. Newton's Law of gravity
- **Hypotheses**
  - Predict what will happen in given scenarios
  - Often deductions based on theories
  - e.g. gravity makes planets move in elliptical orbits

Induction and deduction in science



Stages of a research study

- Typical stages in **deductive research**

  Step 1: Formulate research questions

  Step 2: Plan the study

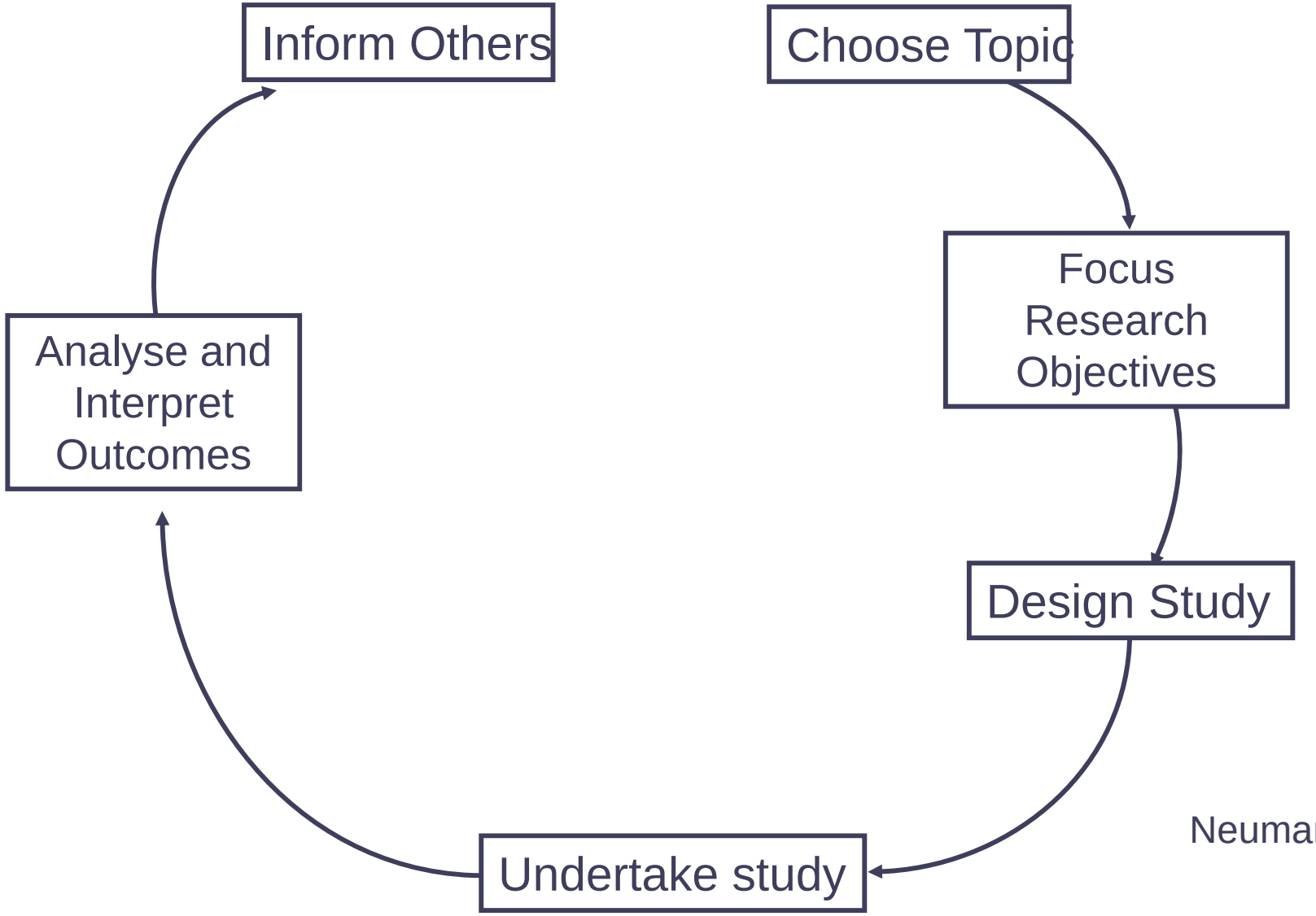
  Step 3: Gather evidence

  Step 4: Interpret/analysis evidence

  Step 5: Communicate results

- **Inductive research** reverses Steps 3 and 4.

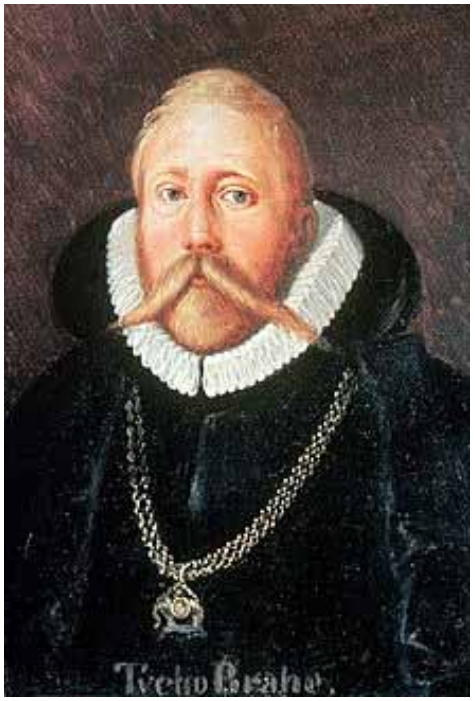
Steps in the research process



Neuman (1994)

Case study – motion of the planets

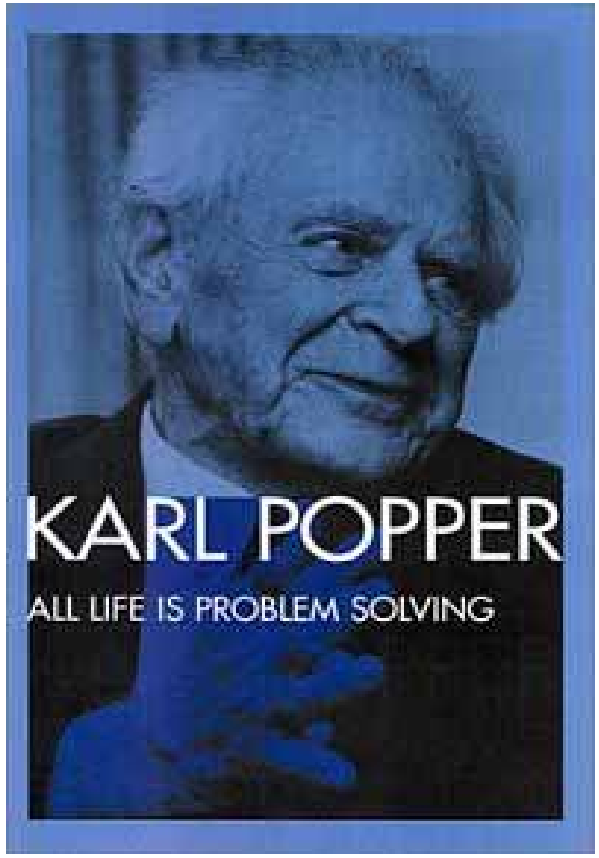
- Observation
  - Kepler use Tycho Brahe's data to deduce ellipses
- Theory
  - Newton's theory of gravity showed why
- Prediction
  - Adams and Le Verrier used the theory to predict a new planet
- Testing
  - Neptune was found where they predicted



Observers in science

- There are limits to what can be observed
  - Discoveries in 20th century science showed that there are limits, even in hard sciences like physics
- Heisenberg's Uncertainty Principle
  - Cannot measure both mass and velocity
- Godel's Incompleteness Theorem
  - Some assertions are not provable

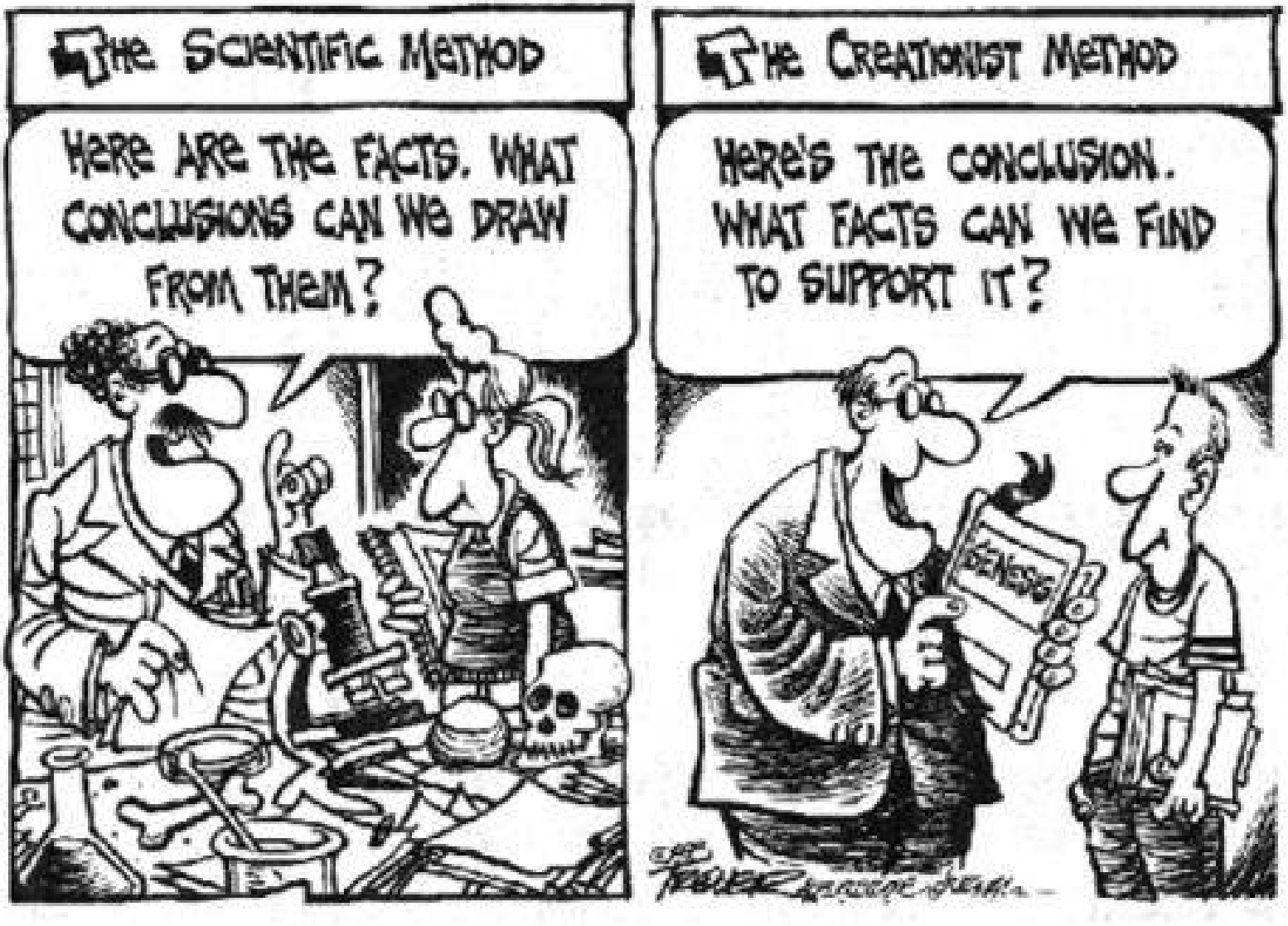
Scientific method



Falsification (Karl Popper)

- **Cannot** prove a theory correct
- **Can** prove a theory wrong
- Theories are continually tested:
  - **Correct** predictions - **retain** theory
  - **False** prediction - **reject** theory

Scientific method (continued)



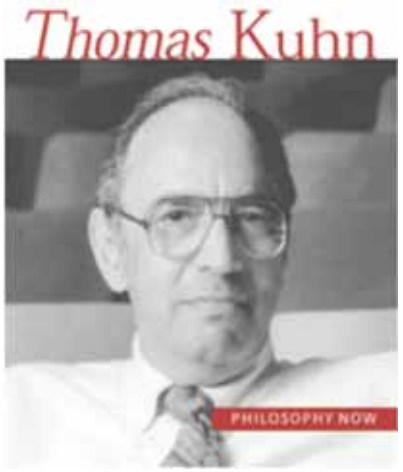
Interpretive research

- Interpretive research aims to build understanding about the world from the perspective of the individual researcher.
- “Interpretive studies assume that people create and associate their own subjective and inter-subjective meanings as they interact with the world around them.

  Interpretive researchers thus attempt to understand phenomena through accessing the meanings participants assign to them”

  - Orlikowski and Baroudi (1991)

Paradigms in science



- Successful theories become “paradigms” (Kuhn)
  - bodies of theory and methods that dominate thinking within a field of research
- Influence of paradigms
  - gaps in theories are often dismissed at first
  - gaps eventually lead to new paradigms (revolutions)

Social basis for research paradigms

- Industrial Revolution (1800s)
  - World seen as a great machine — Metaphor
  - Heart is a pump, etc.
  - Mechanistic theories
- Information Revolution (late 20th Century)
  - World is seen as “natural computation”
  - New approaches to scientific research
  - Computing borrows ideas from nature

Influence of IT on research paradigms

- Processing power
  - New kinds of studies are possible
  - e.g. virtual experiments (simulation, virtual reality)
- Data rich environment for research
  - New kinds of studies
  - e.g. data mining, social media
- The information paradigm
  - Looking at the world as information processing
  - Natural computing

Social science paradigm

- Attempts to gain a better understanding of human interactions
  - gathers information about actions and interactions,
  - reflects on their meaning,
  - arrives at and evaluates conclusions, and eventually puts forward an interpretation'

Marshall and Rossman (1995)

  - The main business of natural philosophy is to argue from phenomena

Newton, preface in Principia

- Uses *Interpretivist* paradigm

Post-positivism

- Approach
  - The researcher is the main research tool.
  - He/she observes, asks questions and interacts with research subjects.
  - Impact of observer bias on results replaces objectivity as a concern.
- Postmodernist issues ...
  - How does the historical and cultural context shape the researcher's preconceptions?
  - How do researcher and researched affect each other ('inter-subjectivity')?

– Glesne and Peshkin (1992) *Becoming Qualitative Researchers: An Introduction*. pp. 6 & 10

Organisational setting for research

- Who is it for?
- Who pays for it?
- Who will use/benefit from the results?
- Individuals versus teams
- Access to facilities

Research is a human activity

"This is Doctor Bagshaw, discoverer of the infinitely expanding research grant."

Practical issues in research

- Research is a human activity
- Practical issues need to be addressed
  - Ethics
  - Intellectual Property
  - Liability
  - Copyright
  - Plagiarism
  - Standardization
  - Custodianship
- The above issues will be discussed in Lecture 2.

Learn from the past

- Famous scientists, e.g.
  - Isaac Newton
  - Charles Darwin
  - Richard Feynman
- Famous discoveries, e.g.
  - The Burgess shale
  - The Double Helix

Famous scientists - Isaac Newton

- Discovered laws of gravity and motion
- Discovered nature of light
- Also experimented with alchemy!
- Invented calculus:
  - Kept it secret
  - Leibniz published his own version
  - Long controversy over precedence

Famous scientists - Charles Darwin

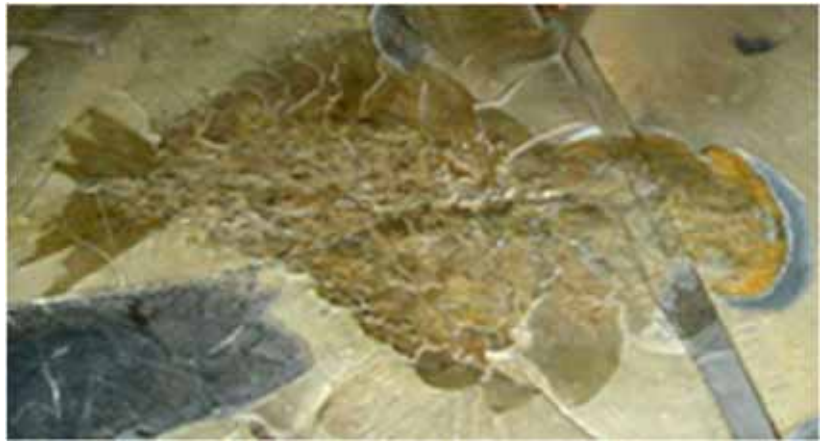
- Developed theory of natural selection
  - Observations during voyage of the Beagle
  - Drew idea from Thomas Malthus (1797) Essay on the Principle of Population
- Withheld publication of theory
  - Fear of religious backlash
  - Only published when Alfred Wallace proposed the same idea
  - Ethical dilemma, but they published jointly

Famous scientists – Richard Feynman

- American physicist (1918-1988)
- Worked mostly from “first principles”
  - Regarded as somewhat eccentric
  - Usually ignored published results
  - Drew inspiration from many sources
- Won Nobel Prize for Physics
  - Work on quantum electrodynamics
  - Only time he started from published literature

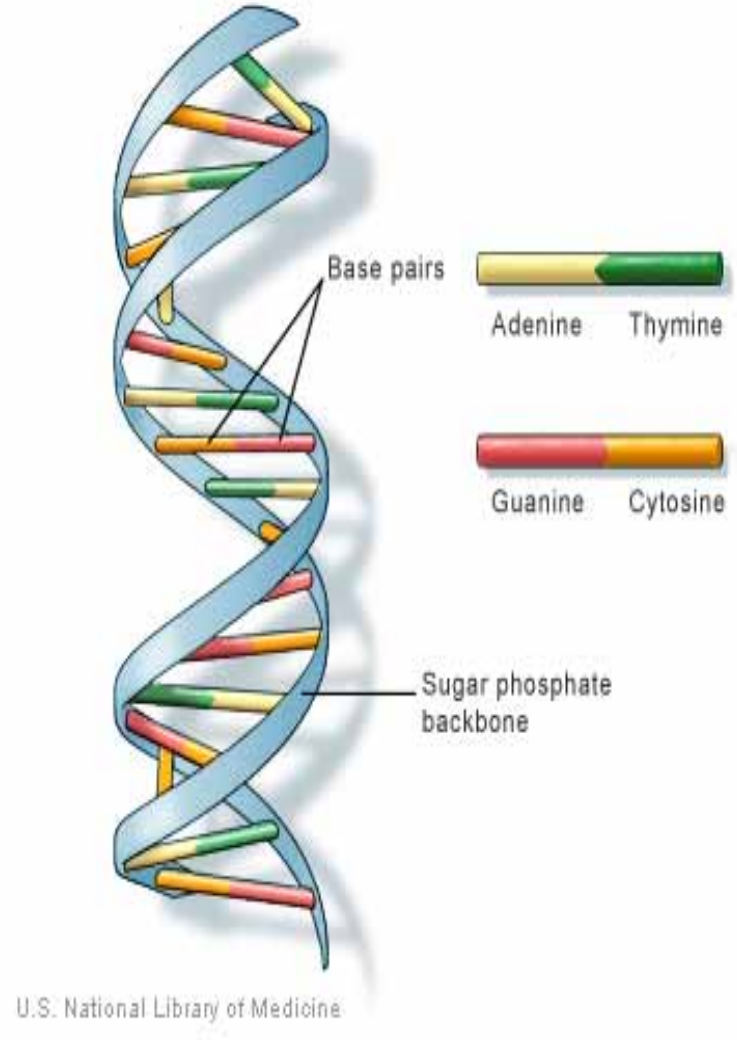
Burgess Shale

- Canadian site rich in early Cambrian fossils
- Walcott classified dozens of new species as members of known families
- Re-examination (~70 years later) showed they were really extinct phyla
- Enormous implications for evolution



The Double Helix

- Discovery of the structure of DNA
  - Watson & Crick (1953) published model
  - Based on data of Wilkins and Franklin
- Human issues featured heavily
  - Role of women in science
  - Theory versus experiment
  - Competition versus cooperation



References: Watson (1968), Maddox (2002)

Movie account: "*Life Story*"

Recommended reading

- Booth, W.C., Colomb, G.G., Williams, J.M. (2008). *The Craft of Research* (Third edition). The University of Chicago Press, Chicago.
- Clarke, R. (2000). *Appropriate Research Methods for Electronic Commerce*. http://www.anu.edu.au/people/Roger.Clarke/EC/ResMeth.html
- Myers, M.D. (1997). *Qualitative Research in Information Systems*. MISQ Discovery. http://www.qual.auckland.ac.nz
- Neumann, W.L (2006). *Social Research Methods* (6th edition). Pearson Education, Boston. (Chapter 2).
- Interpretive research: http://www.mathcs.duq.edu/~packer/IR/IRmain.html

Background reading re the human side of scientific research:

- Watson, J.D. (1968). *The Double Helix : a personal account of the discovery of the structure of DNA*. Penguin, London.
- Maddox, B. (2002). *Rosalind Franklin – the Dark Lady of DNA*. Harper Collins, London.