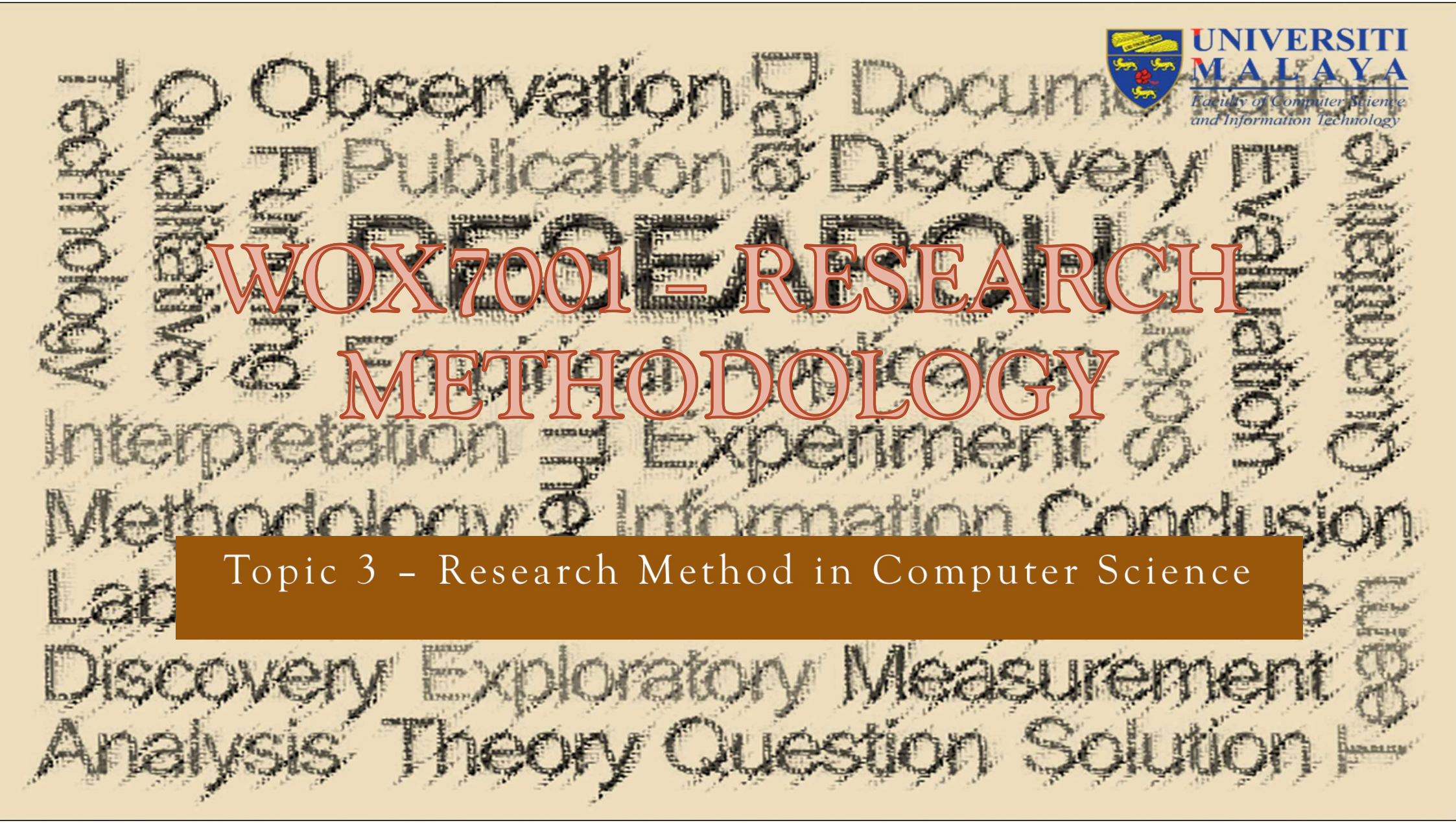

UNIVERSITI
MALAYA
Faculty of Computer Science
and Information Technology
WOX7001 – RESEARCH
METHODOLOGY
Topic 3 – Research Method in Computer Science

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Agenda

01 SCIENTIFIC METHOD

02 RESEARCH CLASSIFIER

03 RESEARCH METHODS

04 RESEARCH PARADIGM

05 CLASS ACTIVITIES

Prepared by: HSM, NAG and SUH

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Scientific method

- Scientists use observations and reasoning to develop technologies and propose explanations for natural phenomena in the form of hypotheses
- Predictions from these hypotheses are tested by experiment and further technologies developed
- Any hypothesis which is cogent enough to make predictions can then be tested reproducibly in this way
- Once it has been established that a hypothesis is sound, it becomes a theory.

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Elements of Scientific Method

- Characterisations (Quantifications, observations and measurements)
- Hypotheses (theoretical, hypothetical explanations of observations and measurements)
- Predictions (reasoning including logical deduction from hypotheses and theories)
- Experiments (tests of all of the above)

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Scientific Method discovers....

- What predictions does a theory make?
- What is the right hypothesis in a particular situation?
- What is the right experiment to conduct?

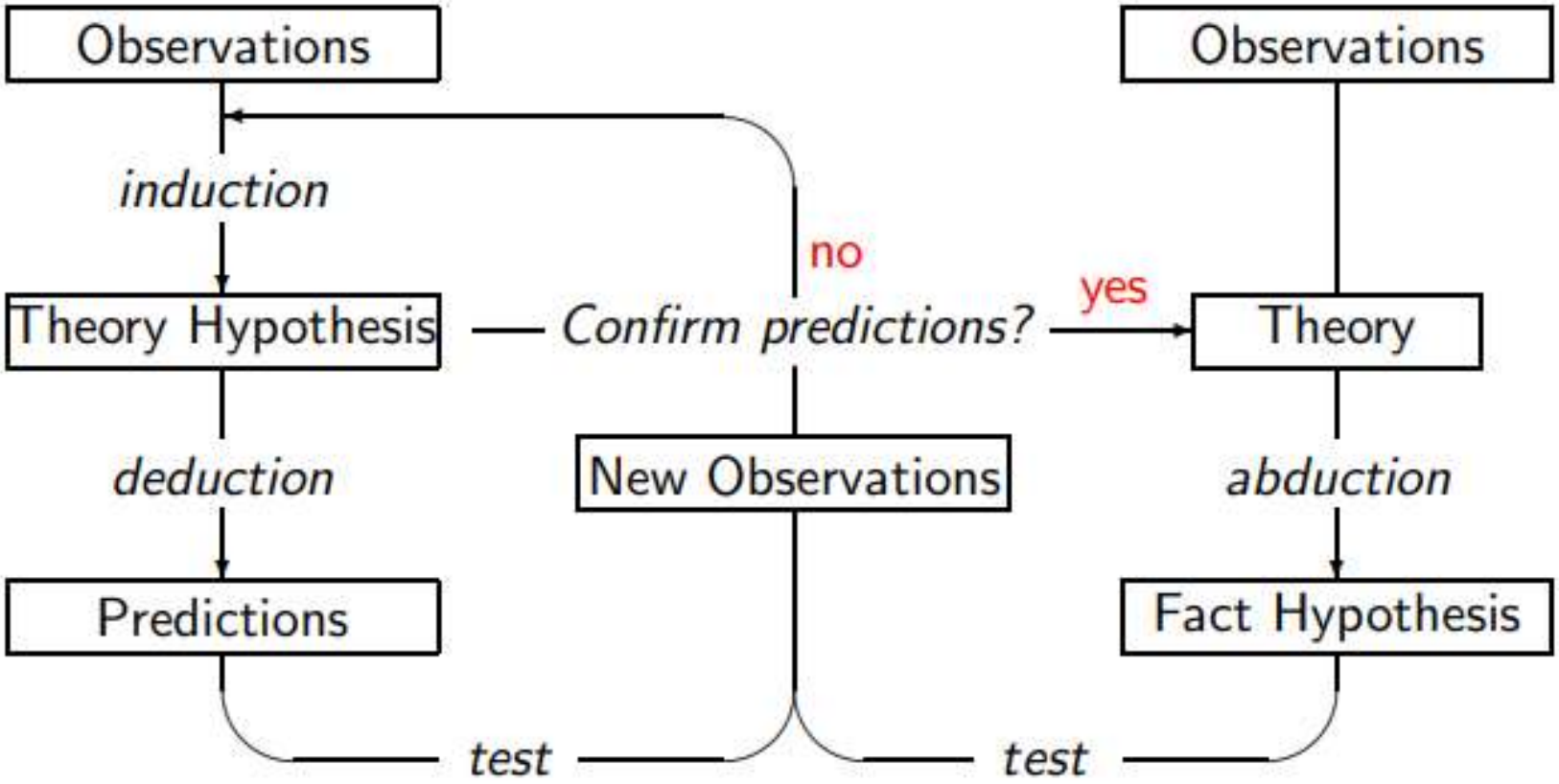
UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

The process involved in deriving the scientific method....

- Deductive reasoning (proceeds from our knowledge of the world (theories) and predicts 'likely' observations *Example: – Assume we know that A implies B. – A has been observed. – Then we should also obverse B. –* **often lead to new knowledge**
- Abductive reasoning (proceeds from observations to causes. *Example: – The phenomenon X is observed. – Among hypotheses A, B, C, and D, only A and B are capable of explaining X. – Hence, there is a reason to assume that A or B holds.* **Useful for hypothesis generation**
- Inductive reasoning (proceeds from a set of observations to a general conclusion *Example: – Tycho Brahe, a 16th century astronomer, collected data on the movement of the Mars.* **Useful for theory formation**

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

The model for scientific method



Research Classifier

Prepared by: HSM, NAG and SUH

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Research Perspective

Field (Position of the research within a hierarchy of topics)

Example:

Artificial Intelligence → Automated Reasoning →
First-Order Reasoning → Decidability

Approach (Research methods that are employed as part of the research process)

Examples:

Case study, Experiment, Survey, Proof

Nature (Pure theoretical development)

Review of pure theory and evaluation of its applicability

Applied research

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Research Classification

Pure Theory	Descriptive studies	Exploratory Studies
Explanatory studies	Causal studies	Normative studies
Empirical Research	Problem solving studies	Development and application studies

Research Methods

Prepared by: HSM, NAG and SUH

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Research Approach

Quantitative research methods Method

- associated with measurements (on numeric scales) Stemming from natural sciences
- Used to test hypotheses or create a set of observations for inductive reasoning
- Accuracy and repeatability of vital importance

Qualitative research Methods

- Methods involving case studies and surveys Stemming from social sciences
- Concerned with increasing understanding of an are, rather than an explanation
- Repeatability usually a problem

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Research Methods

Action research:

- Pursues action (or change) and understanding at the same time
- Continuously alternates between action and critical reflection, while refining methods, data and interpretation in the light of the understanding developed in the earlier cycles
- **Example: Reflective teaching**

Case study:

- In-depth exploration of a single situation
- Usually generates a large amount of (subjective) data
- Should not merely report the data obtained or behaviour observed but attempt to generalise from the specific details of the situation observed
- **Example: Case study of open source software development**

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Research Methods

Survey:

Usually undertaken using questionnaires or interviews
Questionnaire and interview design important!
Determination of sample size and sample elements important!
Example: Survey on the popularity or use of programming languages

Experiment:

Investigation of causal relationships using test controlled by the researcher
Usually performed in development, evaluation and problem solving projects
Example: Evaluation of processor performance

Research Paradigm in CS

Prepared by: HSM, NAG and SUH

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Research Paradigm in CS

Empirical:

Computer science is concerned with the study of a class of phenomena

Mathematical:

Computer Science is concerned with the study of algorithms and properties of information structures (abstraction from real objects)

Engineering:

managing the cost-effective design and construction of complex software-hardware systems (commercially and socially valuable)

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Experimental Techniques

Depending on the objective, various evaluation techniques shall be used

- Quantitative testing/experiments of algorithms/programs/databases/…
- Usability tests with users
- Questionnaires
- Surveys
- Case studies

Parameters……

- Runtime
- Preprocessing time
- Disk space (overhead)
- Memory
- Correctness of results
- Accuracy of approximation algorithms
- User satisfaction
- Usability

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

So, in order to experiment we need Data set

Real-world data

- Always good to have – show that system works in practice
- Sometimes difficult to obtain
- Do not allow to test all aspects of an algorithm/system

Synthetic data

- Allow to test specific aspects of the algorithm
- Often (very) difficult to generate
- If possible, try to use the same data as your competitors

It is easy to show that your approach is better if only very particular data is used

Describe the most important aspects of the data

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

After experiment, compare the solution (Benchmarks)

Use existing benchmarks as much as possible

Facilitates the comparison of different solutions

UNIVERSITI MALAYA
Faculty of Computer Science and Information Technology

Class Activity

Estimated time – 1 hour

Identify the following for your research title:

1. Which scientific method is suitable?
2. It falls under which research perspective?
3. The research classification?
4. Research approach?
5. Research method?
6. It belongs to which research paradigm in CS?
7. What technique to align with the selected research paradigm?

THANK YOU

Prepared by: HSM, NAG and SUH