Phương pháp nghiên cứu khoa học

Phương pháp luận

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Nội dung[1]

[1] Dựa trên bài giảng Research Methods in Computer Science của GS Ullrich Hustadt (University of Liverpool)

Nội dung

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Nghiên cứu là gì?

Research (https://en.wikipedia.org/wiki/Research)

- Collection, organization and analysis of evidence to increase understanding of a topic, in accounting and controlling for biases. A research project may be an expansion on past work in the field.
- The primary purposes of basic research (as opposed to applied research) are documentation, discovery, interpretation, and the R&D of methods and systems for the advancement of human knowledge.
- Several forms of research: scientific, humanities, artistic, economic, social, business, marketing, practitioner research, life, technological, etc. The scientific study of research practices is known as meta-research.
- Etymology: from Middle French (earliest recorded use in 1577)

Tri thức: Mô hình kim tự tháp DIKW

Mô hình phân cấp/mô hình tháp DIKW

- Data
- Information
- Knowledge
- Wisdom: +insight

Tri thức: định nghĩa khác

Knowledge (http://en.wikipedia.org/wiki/Knowledge)

- the awareness and understanding of facts, truths or information gained in the form of experience or learning (a posteriori), or through deductive reasoning (a priori)
- an appreciation of the possession of interconnected details which, in isolation, are of lesser value
- both knowledge and information consist of true statements, but knowledge is information that has a purpose or use (information plus intentionality)

Tri thức và lí thuyết

Tri thức khoa học thường được tổ chức thành các lí thuyết

Theory (http://en.wikipedia.org/wiki/Theories)

- a logically self-consistent model or framework describing the behaviour of a certain natural or social phenomenon, thus either originating from observable facts or supported by them
- formulated, developed, and evaluated according to the scientific method

Tri thức và lí thuyết: tiêu chí (1)

Theory (http://en.wikipedia.org/wiki/Theories)

A body of (descriptions of) knowledge is usually only called a theory once it has a firm empirical basis, that is, it

- is consistent with pre-existing theory to the extent that the pre-existing theory was experimentally verified, though it will often show pre-existing theory to be wrong in an exact sense,
- is supported by many strands of evidence rather than a single foundation, ensuring that it probably is a good approximation if not totally correct,

Tri thức và lí thuyết: tiêu chí (2)

Theory (http://en.wikipedia.org/wiki/Theories)

A body of (descriptions of) knowledge is usually only called a theory once it has a firm empirical basis, that is, it

- makes (testable) predictions that might someday be used to disprove the theory, and
- has survived many critical real world tests that could have proven it false,
- is a/the best known explanation, in the sense of Occam's Razor, of the infinite variety of alternative explanations for the same data.

Tính chất

- Originality
- (In)Fallibility
- (Un)Trustworthiness

Nội dung

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Quy trình nghiên cứu : mô hình tuần tự tổng quát hoá

Mô hình ví dụ:

(1) Identify the broad area of study
(2) Select a research topic

In natural sciences:	In mathematics:
(3) Decide on an approach	(3') Make a conjecture
(4) Plan the research	(4') Prove the conjecture
(5) Gather data and information	
(6) Analyse and interpret these data	

(7) Present the result and findings

Quy trình nghiên cứu : mô hình tuần hoàn

- The circulatory research process model recognises that any research is part of a continuous cycle of discovery and investigation that never ends
- It allows the research process to be joined at any point
- One can also revisit (go back to) earlier stages

Quy trình nghiên cứu : mô hình tiến hoá

The evolutionary research process model recognises that research (methods) itself evolve and change over time

- What research questions are admissible
- What extend and methods of data collection are possible, necessary, ethical, or reliable
- What methods are data analysis are available
- What constitutes sufficient evidence for a hypothesis
- What we mean by a systematic approach to research

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Nội dung

Phương pháp khoa học

- 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.
- Sometimes scientific development takes place differently with a theory first being developed gaining support on the basis of its logic and principles

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Các yếu tố của một phương pháp khoa học

The essential elements of a scientific method are iterations, recursions, interleavings and orderings of the following:

- 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)

Both characterisations and experiments involve data collection

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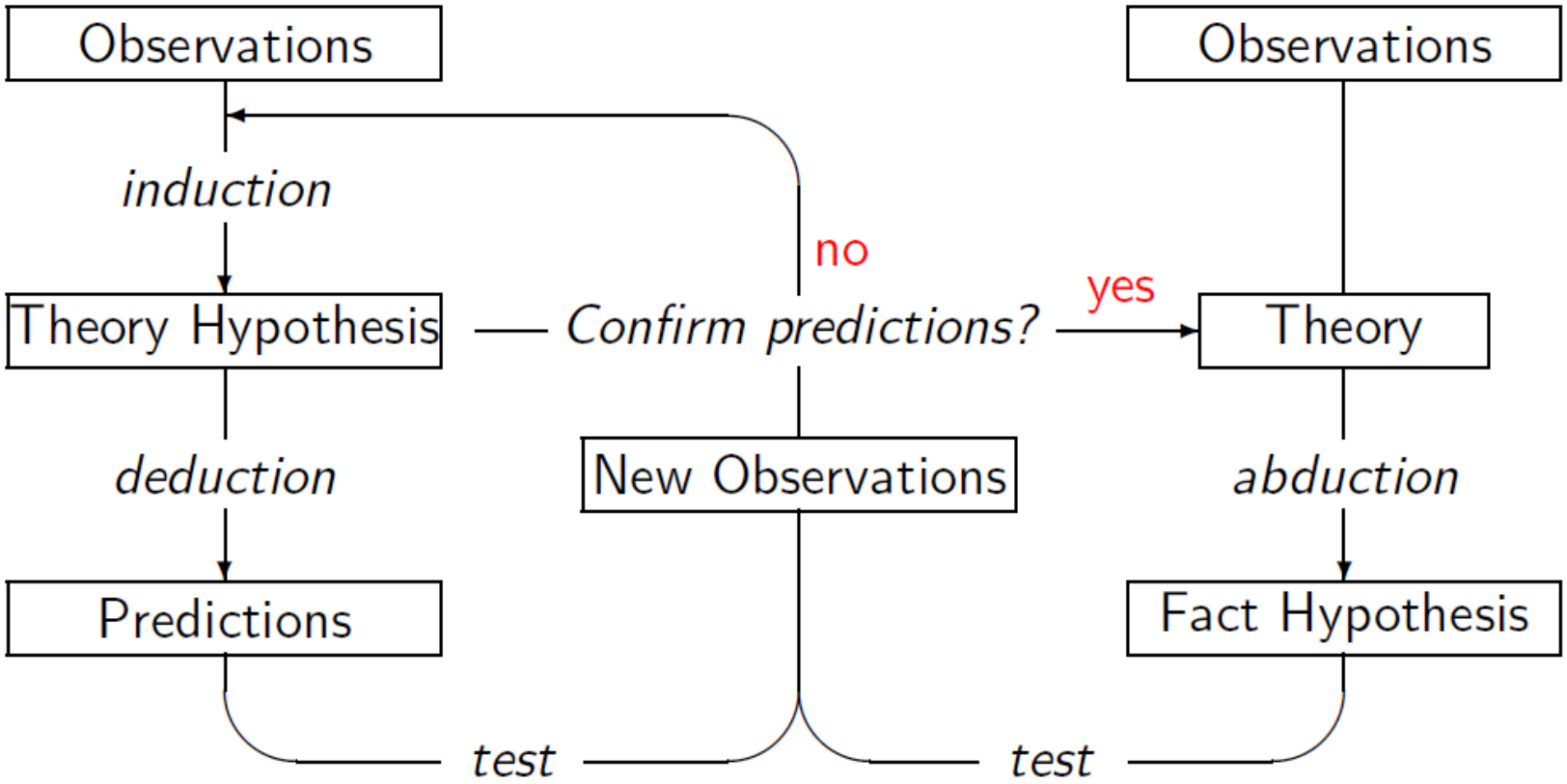
Phương pháp khoa học: mô hình



Phương pháp lập luận

- Deductive reasoning tells us that from 'A' and 'A implies B' we can conclude 'B'
- Abductive reasoning tells us that from 'B' and 'A implies B' we may conclude 'A'
- Inductive reasoning tells us that from '$A(o_1), \cdots, A(o_n)$' and '$B(o_1), \cdots, B(o_n)$' we may conclude '$\forall x.A(x) \Rightarrow B(x)$'.

Giải quyết vấn đề

- Analogy: Look for similarity between one problem and another one already solved
- Partition: Break the problem into smaller sub problems which are easier to solve
- Random/Motivated Guesses: Guess a solution to the problem then prove it correct
- Generalise: Take the essential features of the specific problem and pose a more general problem
- Particularise: Look for a special case with a narrower set of restriction than the more general case
- Subtract: Drop some of the complicating features of the original problem
- Add: A difficult problem may be resolved by adding an auxiliary problem

Nội dung

Phân loại nghiên cứu

Research can be classified from three different perspectives:

- 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

Phân loại nghiên cứu (tiếp)

- Pure theory:
  Developing theories and working on their consequences, with regard to experimentation or application
- Descriptive studies:
  Reviewing and evaluating existing theories, including describing the state of the art, comparing predictions with experimental data
- Exploratory studies:
  Investigating an 'entirely' new area of research, exploring a situation or a problem
- Explanatory studies:
  Explaining or clarifying some phenomena or identifying the relationship between things

Phân loại nghiên cứu (tiếp)

- Causal studies:
  Assessing the causal relationship between things
- Normative studies:
  Producing a theory of design (or of other development) like recommendations, rules, standards, algorithms, advices or other tools for improving the object of study
- Problem-solving studies:
  Resolving a problem with a novel solution and/or improving something in one way or another Development and Application studies: Developing or constructing something novel

Nội dung

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Phương pháp định lượng và định tính

- Quantitative research methods
  - Methods 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 area, rather than an explanation
  - Repeatability usually a problem

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Các phương pháp nghiên cứu

- 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
- 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

Các phương pháp nghiên cứu (tiếp)

- Survey:
  - Usually undertaken using questionnaires or interviews
  - Questionnaire and interview design important!
  - Determination of sample size and sample elements important!
- Experiment:
  - Investigation of causal relationships using test controlled by the researcher
  - Usually performed in development, evaluation and problem solving projects

Các yếu tố quan trọng của một nghiên cứu thực nghiệm

- A precise hypothesis that the experiment will confirm or refute
- A completely specified experimental system, which will be modified in some systematic way to elicit the effects predicted by the hypothesis
- Quantitative measurement of the results of modifying the experimental system
- Use of controls to ensure that the experiment really tests the hypothesis
- Analysis of the measured data to determine whether they are consistent with the hypothesis
- Report of procedures and results so that others can replicate the experiment

Các vấn đề chính với bảng câu hỏi/phiếu điều tra

- Determining the target audience
- Determining the most appropriate medium
- Achieving an acceptable response rate
- Ensuring anonymity if necessary
- Obtaining additional information about the respondents
- Questionnaire design
  - Layout and size (not too long, uncluttered)
  - Question types

(1) Quantity or information
How many hours ...

(2) Classification
Gender

(3) List or multiple choice
How do you keep informed?

(4) Scale
How easy is ...

(5) Ranking
Rank in order of importance

(6) Complex grid or table
Multiple classifications

(7) Open-ended
What do you think about ...

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