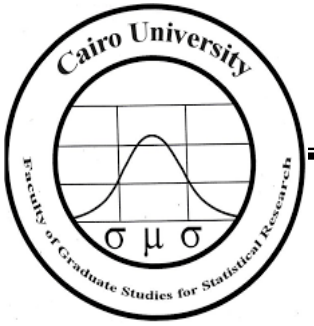


Cairo University

SE201

Principles and Methodologies of Scientific Research

Lecture 3

Recap: Research Process - 1

1. **Finding a Topic and Beginning Research**
2. **Finding a Research Advisor/Guide**
3. **Formulating The Research Problem**
4. **Extensive Reading and Reviewing The Literature**

❖ Finding Research Papers

- The research must keep reading throughout the research projects
- It is ok to start with books and surveys
- After you master the main techniques, then search for relevant work on good repositories

Repositories

- Scholar (`http://scholar.google.com`)
- Scopus (`http://www.scopus.com`)
- Web of Science (`http://www.webofknowledge.com`)
- ...

Recap: Research Process - 2

1. **Finding a Topic and Beginning Research**
2. **Finding a Research Advisor/Guide**
3. **Formulating The Research Problem**
4. **Extensive Reading and Reviewing The Literature**

- Measure of Good Research
  - Systematic, logical, empirical and replicable.
  - Contribution:
    - ✓ Originality (Significance: novel/interesting , Impact)
    - ✓ Validity (Verification: proof/analysis/modelling/ experiment/simulation/several of these methods)

Research Process - 1

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

1. Authors submit paper to conference/journal for peer review
2. If accepted, the paper is revised by the authors and submitted to conference/journal editor
3. The paper is processed to bring it into the publisher's format (typesetting/layout)
4. The paper is then
   - included in the publisher's database,
   - made available on-line via the publisher's website, and
   - possibly published in printed form

   (not necessarily in that order)
5. Literature databases
   - collect the bibliographic information from several publishers, and
   - add additional information (references with links, citation index)
   - link back to publisher for full-text of papers

Research Process - 2

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

Freely available (scholarly) web search engines include:

Citeseer	Digital library of 750k freely available papers in computer and information science `http://citeseer.ist.psu.edu`
Google	General internet search engine `http://www.google.co.uk`
Google Scholar	Searches scholarly literature on the web. `http://scholar.google.com`
Scirus	Searches journals (ScienceDirect) and web resources `http://www.scirus.com/`
Windows Live Search Academic	Academic search engine - search academic journals and content for article titles, author names, article abstracts, and conference proceedings. `http://academic.live.com/`

Research Process - 3

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

Sources for literature on the internet:

- Freely available collections (personal/institutional)

- Publishers' websites/databases
- Literature databases

Research Process - 4

4. Extensive Reading and Reviewing The Literature

- Finding Research Papers

Sources for literature on the internet:

- Freely available collections (personal/institutional)
- Publishers' websites/databases

- Literature databases

Research Process - 5

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

The University Library has subscriptions to many publishers' databases:

ACM Digital Library	Full-text of all ACM journals and conference proceedings `http://portal.acm.org.ezproxy.liv.ac.uk/dl.cfm`
IEEE Xplore	Full-text of IEEE journals, conference proceedings, and books `http://ieeexplore.ieee.org.ezproxy.liv.ac.uk/`
ScienceDirect	Full-text of Elsevier journals `http://www.sciencedirect.com.ezproxy.liv.ac.uk`
SpringerLink	Full-text of Springer journals, conference proceedings, and books `http://www.springerlink.com.ezproxy.liv.ac.uk/`
Wiley Inter-Science	Full-text of Wiley journals and books `http://www.interscience.wiley.com.ezproxy.liv.ac.uk/`

Access to full-text requires authentication by MWS login and password

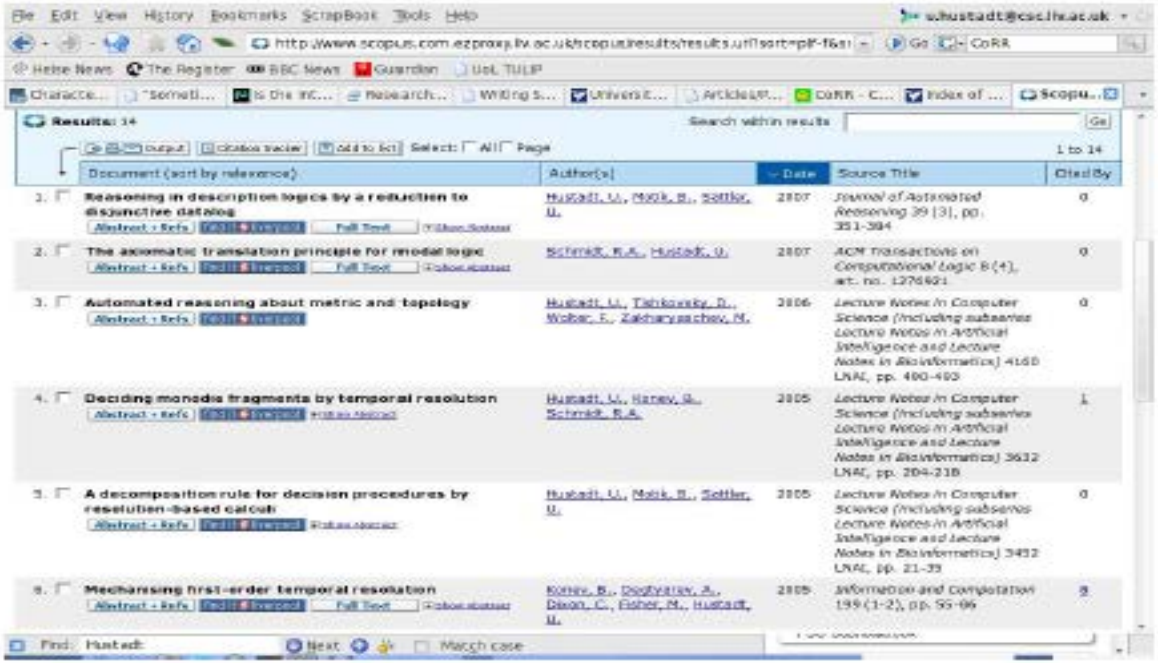
Research Process - 6

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

Sources for literature on the internet:

- Freely available collections (personal/institutional)
- Publishers' websites/databases
- Literature databases



Research Process - 7

4. Extensive Reading and Reviewing The Literature

- Finding Research Papers

The University Library has subscriptions to many literature databases:

Scopus	Covers 14,000 journals and proceedings series; incl. ACM, Elsevier, IEEE, Springer http://www.scopus.com/
Web of Knowledge	Covers 22,000 journals and 192,000 proceedings; incl. ACM, Elsevier, IEEE, Springer http://isiknowledge.com/
Metalib (UoL)	Meta search engine for ACM Digital Library, IEEE Explore, etc but also Scopus, Web of Science and Google Scholar http://www.liv.ac.uk/library/electron/

Research Process - 8

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

- There is an important difference to remember:

Library catalogue: Allows to search for a journal, but not for journal articles

Publishers' and literature databases: Allow to search for journal articles, but not in the full-text journal articles

Web search engines: Allow to search in the full-text of journal articles, but have difficulties with their structure

Research Process - 9

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

- Literature databases cover a vast number of journals and conferences, but
  - they do not cover all journals and conference
  - they do not cover textbook, handbooks, collections of articles in book form
  - they do not cover workshops and similar scientific meetings
  - they do not cover technical reports and pre-prints
- Web search engines provide much better coverage of these types of publications, but
  - typically also return a lot of irrelevant material to a query
  - leave it to the user to distinguish high quality from low quality material

Research Process - 10

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

- Search terms might be simple keywords, phrases, or consist of field identifiers, modifiers, operators, and keywords

  Examples: induction
  "mathematical induction"
  induct*
  author = Ambuhl
  author like Ambuhl
  author soundex(Maier)

- Queries are typically constructed from search terms using boolean operators

  Examples: induction AND mathematical
  induction OR deduction
  induction AND NOT recruitment

Research Process - 11

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

- Queries are typically constructed from search terms using boolean operators
  - AND retrieves records where ALL of the search terms are present, induction AND mathematical
  - OR retrieves records containing either one term OR another induction OR deduction
  - NOT retrieves records NOT containing a particular term NOT recruitment
- The set of all correct queries for a particular search engine is its query language
- Typically, different search engines use different query languages

Research Process - 12

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

- Only the right keywords will correctly identify useful information
- Mode of search is very important:
  - narrow: you are looking for exactly one record
    - ⇝ use a search term which is as specific as possible
      "cell microprocessor" instead of cell
    - ⇝ use additional criteria
      - publication date year = 2006
      - type type = journal
      - language language = english
      - publisher publisher = Springer
  - wide: you are looking for all records relating to a subject

Research Process - 13

4. Extensive Reading and Reviewing The Literature

❖ Finding Research Papers

- Only the right keywords will correctly identify useful information
- Mode of search is very important:
  - narrow: you are looking for exactly one record
  - wide: you are looking for all records relating to a subject
    - ⇝ try alternative words/phrases
      microprocessor / computer processor / computer chip
    - ⇝ try alternative spellings
      judgement / judgment
    - ⇝ try wildcards
      gene* for genes, genetics, genetically

Research Process - 14

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Reproducibility and replicability

1. Closeness of the agreement between the results of measurements of the same measurand carried out under changed conditions of measurement.

2. A proper scientific work should be described so that to be reproducible/replicable

3. Some journals already encourage/require that the original data from which the results and plots are generated is made available

Research Process - 15

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Publication types

1. Technical report
2. Extended abstract in events
3. Book chapter
4. Full paper in conferences
5. Full paper in journal

Research Process - 16

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Full paper in journals

1. Journals are the most prestigious publishing option
2. Has editorial board and reviewing committee
3. There is competition and rigorous acceptance criterion (which usually depends on the assigned editor)
4. Due to reputation, and wider readership, there is more impact potential

Research Process - 17

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Full paper in conference

1. Disseminate research to other researchers with publication of full paper
2. Usually results in a faster publication with significative impact (this impact depends on the conference and quality of the paper)
3. Can help researcher to be exposed to different ideas and criticism
4. Depending on the case, may result in feedback about the paper and the presentation
(but can also be a frustrating experience)

Research Process - 18

4. Extensive Reading and Reviewing The Literature

- Evaluating Research Paper

Book chapter

1. Focus on presenting some subject in a didatic way

2. Usually does not include original/novel results

Research Process - 19

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Extended abstract

1. Disseminate and discuss initial results
2. Impact is low since the text is short and with reduced readership
3. If presented in a conference, may be important to know other researchers, discuss and have new ideas

Research Process - 20

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Technical report

1. Usually has a detailed description of methods and experiments
2. Initial results of reproduction of existing methods
3. Helps as a writing exercise, which may be included in a future document

Research Process - 21

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Frontiers of the world's body of knowledge are not documented in text books, but in

journal articles

reliability ↑ conference papers

workshop papers ↓ timeliness

technical reports

Research Process - 22

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Impact Factor

1. Yearly average number of citations to recent articles
2. Computed since 1975, and listed at the Journal Citation Reports (JCR), for each year relative to the previous two years.
3. Can result in different ranges for different areas
4. A good journal usually has FI ≥ 1

Research Process - 23

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

H Index

1. Created to evaluate researchers based on their most cited papers

2. Can also be employed for departments, universities, journals and conferences

3. A researcher with some *h* index, has *h* papers with at least *h* citations.

Research Process - 24

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Computer Science research

- Theoretical,
- Empirical,
- Exploratory.

Research Process - 25

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

1: "Product or implementation"

- Can be innovative or not
  - If lacking a hyphotesis, then it is not
- When innovative, it is usually exploratory
- If it is a system or reproduction, can be reported in a "Technical Report"
- Acceptable for undergraduate final project (TCC), but hardly for Master or Doctorate degrees

Research Process - 26

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

Exploratory

- It is acceptable to not compare with previous work

System or implementation

- Can be justified when there is a clear application, not yet explored
  - Health,
  - Education,
  - Agronomy,
  - ...
- But, if so, then it is important to compare with previous work at least qualitatively!

Research Process - 27

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

2: "Something different"

- proposes a "different approach" to some problem, or a "different" implementation or application
- require literature review and qualitative comparison

- **Can be a different approach**, *not necessarily better*
- It is usual in problems that are well studied, but not sufficiently
- Can result in case studies

Research Process - 28

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

- It is valid to propose "something different" when there is scarce data or time escassos.
- A well defined case study can be a good way to start
- But, make sure
  - **premises** are convincing
  - there is some hyphotesis

Deep Learning

- For a while (~ 4 years), just approaching something with deep learning was enough
- Now those need more rigor

Research Process - 29

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

3: "Something supposedly better"

- A problem that is well studied, there is available data and papers reporting results on those well known datasets
- Need to follow protocol, evaluation measures, that are previosly defined by the literature

- When there are already many solutions: you must justify why your approach is valid or better in some sense
- Often results in an incremental contribution.
  - need a better discussion on the drawbacks and advantages

Research Process - 30

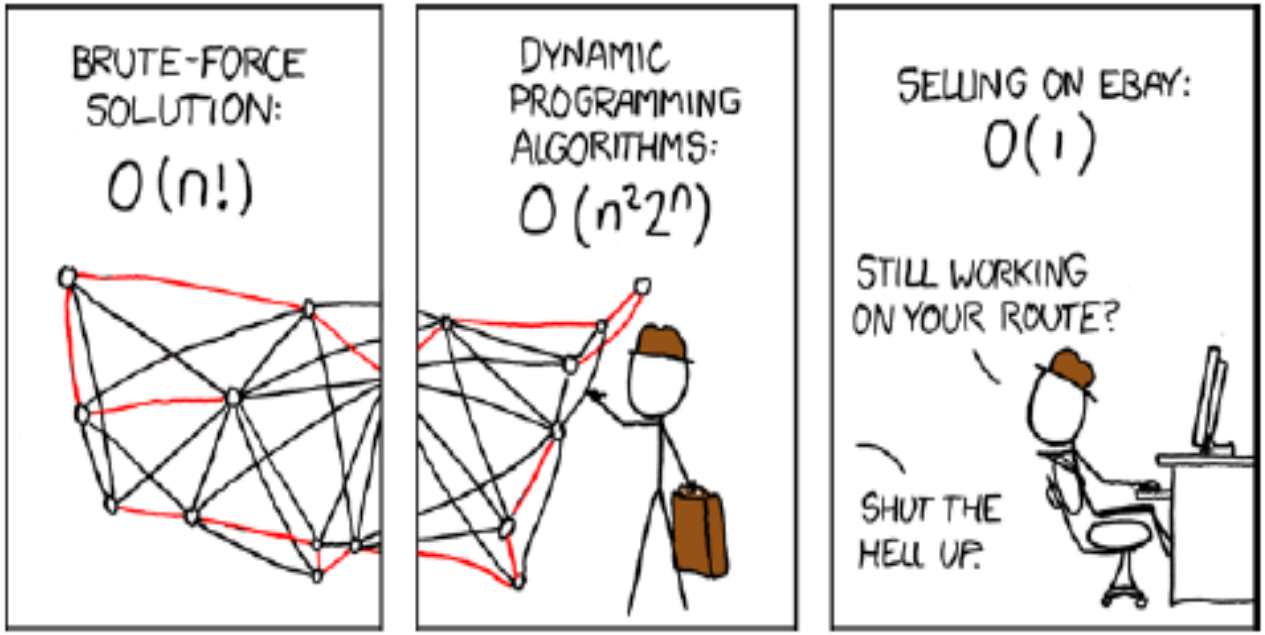
4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

Travelling salesman problem

- Formulated in 1930, NP-hard. Brute-force solution is $O(n!)$



Research Process - 31

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

P vs. NP

- A problem for which there is an algorithm that **finds a solution** in polynomial time: class P
- A problem for which there is an algorithm that **verifies a solution** in polynomial time: class NP
- Prove if P = NP is one of the most relevant open problems in computer science.

Research Process - 32

4. Extensive Reading and Reviewing The Literature

- Evaluating Research Paper

Research levels/tipes in Computer Science

Example: image denoising

Noisy image

State-of-the-art

Our method

Research Process - 33

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

4: "Something better"

- New results are better considering standard tests
- Datasets that are known and widely used in the literature
- Comparison is direct since everyone follows the same protocol
- Advances the state of the art

e.g. image classification

- Benchmark: Caltech-101, ImageNet

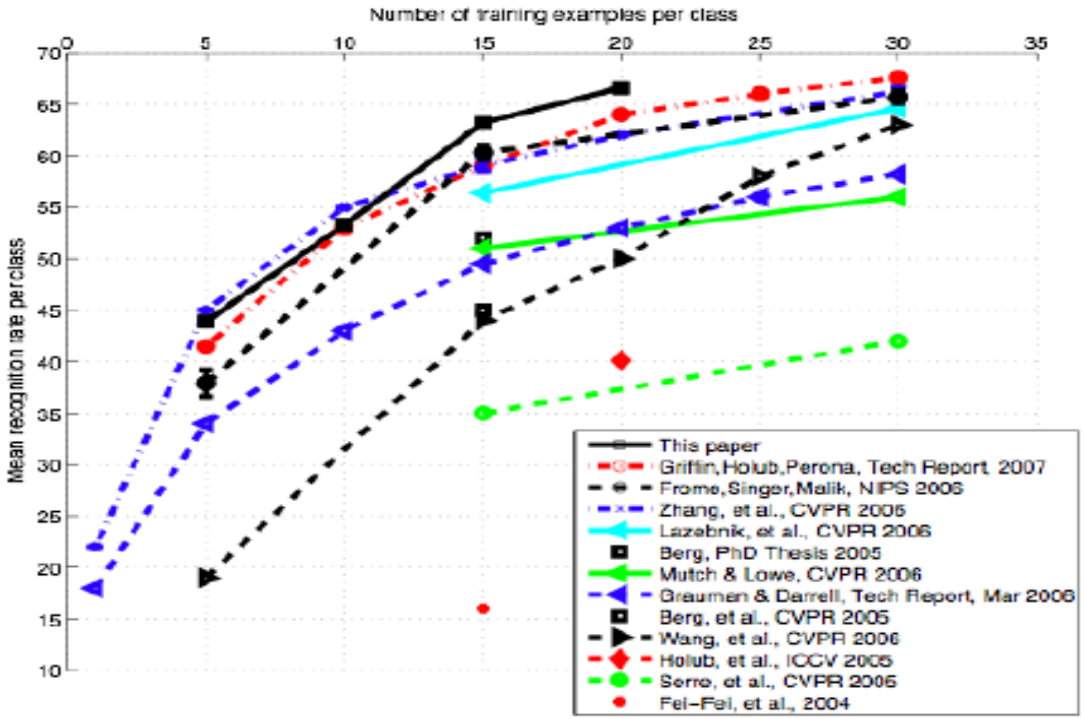
Research Process - 34

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

- If your method is better, then you add a new 'line' among the most relevant ones



Research Process - 35

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

Research levels/tipes in Computer Science

5: "Proof"

- Need a good theoretical background
- Involves the use of theorems, lemmas, in order to address some problem under some premises

- Following some theoretical framework, write a proof based on induction, deduction, contradiction, etc.

- Modern computer science was born with such types of research, in the decades of 1930-1940
- First themes were: computability, algorithms, complexity, information theory, optimization, artificial intelligence, etc.

Research Process - 36

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

- Maintain a database of all the books and papers you read
- Data stored should at least include title, author, place of publication, and storage location
- Preferably you should also keep a record of the answers to some or all of the following questions:
  1. What is the main topic of the article?
  2. What was/were the main issue(s) the author said they want to discuss?
  3. Why did the author claim it was important?
  4. How does the work build on other's work, in the author's opinion?
  5. What simplifying assumptions does the author claim to be making?

Research Process - 37

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

- Maintain a database of all the books and papers you read
- Data stored should at least include title, author, place of publication, and storage location
- Preferably you should also keep a record of the answers to some or all of the following questions:
  6. What did the author do?
  7. How did the author claim they were going to evaluate their work and compare it to others?
  8. What did the author say were the limitations of their research?
  9. What did the author say were the important directions for future research?

Research Process - 38

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

- Whenever you read a research paper, you should try to evaluate at the same time.
- Try to answer the following questions:
  1. Is the topic of the paper sufficiently interesting (for you personally or in general)?
  2. Did the author miss important earlier work?
  3. Are the evaluation methods adequate?
  4. Are the theorems and proofs correct?
  5. Are arguments convincing?
  6. Does the author mention directions for future research that interest you?
- Given the answers to these questions for a number of research papers, you should be able to construct a research proposal by considering how you could improve the work presented in them

Research Process - 39

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

1. Title
2. List of authors (and their contact details)
3. Abstract
4. Introduction
5. Related Work (either part of or following introduction or before summary).
6. Outline of the rest of the paper
7. Body of the paper
8. Summary and Future Work (often repeats the main result)
9. Acknowledgements
10. List of references

Research Process - 40

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ Title

- As short as possible, but without abbreviations or acronyms
  (unless they are commonly understood)
- As specific as necessary and as general as possible
  (e.g. 'The Complexity of Theorem-Proving Procedures'
  $\rightsquigarrow$ introduced the notion of 'NP-Completeness'
  $\rightsquigarrow$ starting point of complexity theory)
- Include key phrases which are likely to be used in a search on the topic of the paper
  (e.g. 'modal logic', 'calculus', 'decision procedure')
- Avoid phrases which are too common
  (e.g. 'novel')
- Use phrases that describe distinctive features of the work
  (e.g. 'Real-world Reasoning with OWL')

Research Process - 41

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ List of Author(s)

- An author of a paper is an individual who
  1. made a significant intellectual contribution to the work described in the paper
     (in contrast, for example, to a monetary contribution);
  2. made a contribution to drafting, reviewing and/or revising the paper for its intellectual contribution
     (in contrast, for example, to spell checking or typesetting); and
  3. approved the final version of the paper including references

Some organisations / publishers have strict rules regarding authorship

Research Process - 42

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ List of Author(s)

- Order of authors may depend on
  - subject area: pure theory ⇝ often alphabetical
    applied research ⇝ often based on contribution
  - research assessment
    (e.g. bibliographic measures associating order with contribution)
  - cultural context
- In Computer Science, academic degrees and membership of professional organisations are typically not indicated
- List of authors is typically followed by contact information consisting of affiliation and e-mail address (not postal address)
- Some journals allow authors to provide longer descriptions of themselves including photographs

Research Process - 43

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ Abstract

- Typically not more than 100–150 words
- Should aim to motivate people to read the paper
- Highlight the problem and the principal results
- The abstract will be included in literature databases
  - ⇝ Make sure key phrases which might be used in searches are included (same principle as for titles)
- Keep references to a minimum
- Keep equations and other mathematical expressions to a minimum

Research Process - 44

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ Introduction

- State the general area of research
  (unless this is obvious from the context in which the paper appears)
- Introduce the problem
  state why the problem is important and/or interesting
- Outline the approach taken to solve the problem
- Outline the solution or principal results
  state why the results are important and/or interesting
- Do not repeat the abstract
- Avoid platitudes and cliches

Research Process - 45

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ Related Work

- Related work is previous work by the same or other authors which addresses the same or closely related problems / topics
- Section on related work gives credit to such work and establishes the originality of the current work
- Extent depends on the space available and relevance of the related work to the work presented in the paper

  Within these two constraints, make sure all related work is cited and correctly described
- Failure to give credit can result in a bad evaluation and kill your paper
- Section on related work is either part of the introduction or is placed at the end of the body of the paper

Research Process - 46

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ Outline of The Rest of The Paper

- Typically at the end of the introduction
- Describes the content of the body of the paper section by section

Example:

The remainder of the paper is organised as follows. In Section 2, we introduce . . . Section 3 describes . . . Finally, we describe future work in Section 5.

(Note that 'Section' is capitalised.)

Research Process - 47

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ Body of The Paper

- Depends strongly on subject area and topic of the paper
- Typical structure of a Computer Science paper on theoretical research:
  1. Basic definitions
  2. Description of a new algorithm, calculus, or formalism
  3. Sequence of theorems accompanied by proof or proof sketches
  4. Applications / consequences of the results (optional)
- Typical structure of a Computer Science paper on applied research:
  1. Architecture of a new system
  2. Description of the realisation
  3. Evaluation
- Combinations of the two are possible and quite typical
- Papers on action research, case studies, surveys, experiments are also common and have their own structure

Research Process - 48

4. Extensive Reading and Reviewing The Literature

❖ Evaluating Research Paper

➢ Structure of a Research Paper

✓ **Summary (Conclusion) and Future Work**

- Summarises the contributions of the paper
- Describes the implications and/or applications of the contributions made by the paper
- Outlines future directions of research

✓ **Acknowledgments**

- Acknowledges external funding sources
- Thanks non-authors that made a significant contribution
  - colleagues or fellow researchers with which the authors had discussions related to the topic of the paper
  - anonymous referees provided they have given exceptional level of feedback or important insights

✓ **List of References**

The End

Questions?