COMP 516
Research Methods in Computer Science

Othon Michail

Department of Computer Science
University of Liverpool

with material from Ullrich Hustadt, Rahul Savani, and Dominik Wojtczak

Introduction and Overview

Delivery of the Module (1)

- Module Coordinators
  - Othon Michail (Othon.Michail@liverpool.ac.uk)
  - Fawada Qaiser (fawada.qaiser@liverpool.ac.uk)
- Lectures
  Thursdays 15:00-16:00, Weeks 1-4, On campus lecture
  Fridays 10:00-12:00, Weeks 1-4, On campus lecture
- Group Presentations
  Days/times TBD, Weeks 5-11, On campus
- Lab
  Days/times TBD, Weeks 2-11, 2-hour Drop-in Lab Session
  Demonstrators/Presentations: Nikolaos Theofilis Sobrino, Estelle Varloot, and Tansholpan Zhanabekova
- Research seminars (departmental, research groups), https://www.csc.liv.ac.uk/research/seminars/

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  Email or MS Teams

- Module homepage

  202223-COMP516 - Research Methods in Computer Science course on CANVAS

- detailed information about assessments, all assessment submissions, recorded lectures, practical handouts, lecture notes, useful resources can be found on CANVAS

- Attendance to be monitored according to the University's Student Attendance Project

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Recommended Texts

- Christian W. Dawson: Projects in Computing and Information Systems (A Student's Guide). Addison Wesley, 2005.
  Harold Cohen Library, Class No 518.561.D27

  Earlier edition:
  Christian W. Dawson: The essence of computing projects (A student's guide). Prentice Hall, 2000.
  Harold Cohen Library, Class No 518.561.D27

- Justin Zobel: Writing for Computer Science. Springer, 2004.
  Harold Cohen Library, Class No 378.962.Z81

- F. Bott: Professional Issues in Information Technology. British Computer Society (latest edition).

- J. M. Kizza: Ethical and Social Issues in the Information Age. Springer (latest edition).

Aims

1. To provide a deep and systematic understanding of the nature and conduct of Computer Science research
2. To enable students to undertake independent research
3. To enhance existing transferable key skills
4. To develop high-order transferable key skills
5. To remind students of the Legal, Social, Ethical and Professional (LSEP) issues applicable to the computer industry

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Learning Outcomes (1)

1. Have an understanding of how established techniques of research and enquiry are used to extend, create and interpret knowledge in Computer Science
2. Have a conceptual understanding sufficient to:
   - (i) evaluate critically current research and advanced scholarship in Computer Science, and
   - (ii) propose possible alternative directions for further work

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Learning Outcomes (2)

3. Be able to:
   1. deal with complex issues at the forefront of the academic discipline of Computer Science in a manner, based on sound judgments, that is both systematic and creative,
   2. demonstrate self-direction and originality in tackling and solving problems within the domain of Computer Science,
   3. act autonomously in planning and implementing solutions in a professional manner, and
   4. define, plan, and/or carry out a project related to research and to communicate conclusions clearly to both specialists and non-specialists

Learning Outcomes (3)

4. Make use of the qualities and transferable skills necessary for employment requiring:
   1. the exercise of initiative and personal responsibility,
   2. decision making in complex and unpredictable situations,
   3. scientific risk identification, assessment and control, and
   4. the independent learning ability required for continuing professional development
5. Understand and participate within the professional, legal, social and ethical framework within which they would be expected to operate as professionals within the IT industry
6. Have the skills set to be able to continue to advance their knowledge and understanding, and to develop new skills to a high level, with respect to continuing professional development as a "self-directed life-long learner" across the discipline of Computer Science

Learning Outcomes (4)

In short, you should learn to

1. understand research and research methods in Computer Science
2. be able to plan, and conduct your own research, taking into account ethical, legal, and professional limitations
3. be able to communicate its results

Learning Outcomes (4)

In short, you should learn to

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This module is preparation for COMP702.

British Computer Society

- BCS (British Computer Society), The Chartered Institute for IT
- Recognised as a professional engineering institute for the registration of information systems and software engineers
- Chartered Scientist is a professional qualification in the UK
- the required standard for Chartered Scientist registration is MSc qualification (or equivalent) with four years of postgraduate work experience

Assessments Overview and Module Structure (1)

No final examination (but there is an online CANVAS test)

Group Project Related to Research

- Groups (of 5-7 students; depending on final numbers), will work on a research-related project throughout the semester
- Self-form and let us know of your **group** and chosen **project type** by **October 5th (a google sheet will be made available)**
  - Groups of **6 students** for the time being
- Any half-filled groups and unassigned students shall be filled/assigned randomly
- Assignment is confirmed and groups start working on their project, from week 2 to 11

Assessments Overview and Module Structure (2)

- End of week 4, groups submit their slides and other material related to their presentation
- Presentations shall take place weeks 5 to 11
- Groups shall continue working on their projects to be submitted beginning of week 12
- Final deliverable for most types of projects will be one or two documents

Expected Schedule

- weeks 1-4: lectures
- week 2: propose groups/topic, confirmed, start working on projects
- week 4: submit presentation material (e.g., PDF/Powerpoint slides)
- weeks 5-11: group oral presentations on campus
- week 6: class test: online CANVAS quiz
- week 12: submit project deliverables/outputs (e.g., 1-2 documents)
- Enjoy Christmas

Assessments (1)

CA1: Group Oral Presentation related to Project (20%)

- presentation material to be submitted, e.g., slides in PDF/Powerpoint, a video, ...
- presentation 20 minutes, questions 5 minutes, per group
- submit week 4, present within weeks 5-11

CA2: Online CANVAS quiz on the material covered in the lectures (20%)

- Week 6
- More specific instructions shall be provided in due course

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Assessments (2)

CA3: Research Project (60%)

- Research-related project
- Should be strongly related to Computer Science research
- Weeks 2 to 11, Submit 1-2 documents, week 12

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Each group will pick ONE of the following types:

1. Carrying out research, or
2. Literature review, or
3. MSc project specification, or
4. Teaching and communications methods of research, or ...

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Important: Pass mark is 50% (standard for MSc modules)

1. Carrying out Research

First experience on:

- working within a group on a concrete research problem
  - basic or applied research
- present their results in the form of a paper draft

Suitable for research-oriented students (e.g., research MSc, thinking about a PhD)

- Could be any problem/topic related to CS that qualifies as an open research question

How to Pick Problem

Approaches that typically work:

- Go through the "Past MSc Projects" on CANVAS
- Pick latest papers from CS conferences (e.g., within last 2 years) in your areas of interest
  - problems/questions/directions that they leave open
  - https://en.wikipedia.org/wiki/List_of_computer_science_conferences

Expected from you: Preliminary ideas and solutions and not a publishable piece of research

Deliverables

Deliverables:

1. A paper draft (10 A4 pages max including everything, $\geq$ 11pt font, $\geq$ 1 inch margins)
2. An accompanying report (5 A4 pages max)

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Examples of papers:

- http://www.cs.yale.edu/publications/techreports/tr1281.pdf
- https://cgi.csc.liv.ac.uk/~michailo/Documents/Papers/Conferences/icalp13.pdf
- https://core.ac.uk/download/pdf/131155846.pdf
- https://arxiv.org/pdf/1707.04282.pdf

Assessment

- Expected from you: Preliminary ideas and solutions and not a publishable piece of research
- Not assessed on the basis of actually solving the chosen problem
- Mostly on the basis of
  - Following a concrete plan of potential strategies to solve it
  - Attempting some of those strategies
  - Making observations on why they do or do not work
  - Modifying them accordingly or trying to follow alternative approaches, etc.

2. Literature Review

Gain experience on:

- Working within a group on exploring/studying/understanding a research area
  - landmark traditional topic
  - modern, state of the art area
  - also a list of examples provided on CANVAS
- Transferring/communicating the acquired knowledge to others

Good opportunity for students who want to explore a research area

- Could build a strong background for their COMP702 project
- Could be any CS research area

What to Do

An Approach:

- Pick a topic that you like
  - e.g., deep learning/deep neural networks
- Pick a "top" paper on that topic
  - e.g., Silver, David, et al. "Mastering the game of Go without human knowledge." *Nature* 550.7676 (2017): 354.
- Use that paper as a starting point to explore the area around it
  - Its references
  - Papers that cite it
  - Find out other related papers

Deliverables

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1. A review article (10 A4 pages max including everything, $\geq$ 11pt font, $\geq$ 1 inch margins) introducing the reader to the area
2. An accompanying report (5 A4 pages max)

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Examples of review articles:

- http://www.cs.yale.edu/homes/aspnes/papers/minema-survey.pdf
- https://cacm.acm.org/magazines/2018/2/224637-elements-of-the-theory-of-dynamic-networks/fulltext
- https://theory.stanford.edu/~tim/papers/ec14_exchanges.pdf
- http://erikdemaine.org/papers/AlgGameTheory_GONC3/paper.pdf

3. MSc Project Specification

- Any current research topic or current technological development in Computer Science
- 10 A4 pages max including everything, $\geq$ 11pt font, $\geq$ 1 inch margins
- Requirements are the same as the "Specification and Proposed Design" assessment of COMP702, see `http://pcwww.liv.ac.uk/~iken/teaching/COMP702/2022/`
- Your MSc topic for COMP516 is not related to final MSc project (COMP702)
- MSc project is usually picked from a list (available at the end of semester 2)

Clarification about the topic (1)

- It is sometimes possible to propose a new MSc project, but that requires finding a suitable supervisor
- We may be able to help you find a suitable supervisor if you like to continue with your project
- If you pick a topic (or closely related one) suggested by someone who is still in the department, it should be no problem
- Continuing with the same project would give you some extra time in COMP702
- The topic that you select in COMP516 can be anything that interests you in CS
- COMP516 "Past MSc Projects" page on CANVAS lists many MSc topics proposed in recent years

Clarification about the topic (2)

- comment on ethical and professional issues of your proposal
- going one step further than specification and actually start designing, e.g., producing a software, is encouraged in COMP516

4. Teaching and Communicating Research

Develop skills on:

- Working within a group on a topic related to research
- developing material and strategies in order to effectively teach the subject in class

Submit:

- a report (5 A4 pages max) and
- a 50-minute video lecture

The Presentation (1)

- at most 20 min + 5 min questions
- all of them will take place in weeks 5-11
- On campus, supervised by Fawada Qaiser and GTAs
- Timetabling TBD
- aim:
  - communicate the topic of your project
  - demonstrate that you have chosen an interesting research topic
  - that you have a good plan or are on track to carry out the work required

The Presentation (2)

- try to minimise text
- avoid full sentences
- just key points or very short phrases
- try to include pictures, animations, ...
- prepare well for your presentation
- when submitting, your presentation file should be named Group*ID*.???, where ??? is pdf (or ppt or pptx only if necessary)
- no reassessment opportunity for this one

The Presentation (3)

A good presentation will:

- Provide a high-level view of your project
- Clearly identify a well-defined research question/application/teaching subject
- Demonstrate that you have
  - well-defined goals
  - clear plan towards achieving them
  - discuss progress and next steps

Groups

- All students in the group should have an as equal contribution as possible in the preparation and delivery of the group presentation
  - The same holds for the research project as a whole
- Still, their roles could differ, e.g., for the presentation: one of the students might be primarily presenting, another mainly writing on a virtual board, another having main responsibility of preparing the slides, figures, tables, or other visual material

Group Marking: Unless an issue of unequal contribution is reported to us, by default all members of the group shall be equally marked (i.e., one mark/feedback per group).

Peer-feedback/marking might also be employed this year (to be decided).

Lab

- Starting week 2
- Opportunity to drop in and ask questions to demonstrators

Also:

- Practical handouts can be found on CANVAS
  - Go through these in your own time and ask questions at the drop-in session
  - Allow you to familiarise in a guided way with practical issues, e.g., Gantt charts, referencing, retrieving literature, interview skills, ...

Academic English Classes

- for all international students and staff members
- many more classes: Academic Writing, Academic Reading, Academic Speaking & Pronunciation, Academic Listening, Britain Today, Grammar & Vocabulary
- 1:1 ACADEMIC WRITING CONSULTATIONS, up to 40 minutes long

`http://www.liverpool.ac.uk/english-language-centre/in-sessional-support/`
or “Additional Resources”, page “Free English Language Courses”, on COMP516’s CANVAS course

Academic English classes for International Students

- discipline-specific language classes
- for MSc Computer Science students only
- all overseas students are expected to enroll on this module

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Research

What Is 'Research'?

Research (http://en.wikipedia.org/wiki/Research from 4th October 2005)

- an active, diligent, and systematic process of inquiry in order to discover, interpret or revise facts, events, behaviours, or theories, or to make practical applications with the help of such facts, laws, or theories.
- a collection of information about a particular subject.
- derives from the Middle French and the literal meaning is "investigate thoroughly".

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What Is 'Research'?

Research into http://en.wikipedia.org/wiki/Research

- more than 250 edits in 2012
- the article has completely changed since 2011, not to mention 2005
- one would expect the etymology of the word to remain the same
  - 2005: Middle French and the literal meaning is "investigate thoroughly"
  - 2012: Middle French "recherche", which means "to go about seeking"
  - 2012: the term itself being derived from the Old French term "recerchier" a compound word from "re-" + "cerchier", or "sercher", meaning 'search'.
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- more than 250 edits in 2012
- the article has completely changed since 2011, not to mention 2005
- one would expect the etymology of the word to remain the same
    - 2005: Middle French and the literal meaning is "investigate thoroughly"
    - 2012: Middle French "recherche", which means "to go about seeking"
    - 2012: the term itself being derived from the Old French term "recerchier" a compound word from "re-" + "cerchier", or "sercher", meaning 'search'.
    - literally taken from `http://www.merriam-webster.com`
    - the Oxford Dictionary: from obsolete French recerche (noun), recercher (verb), from Old French re- (expressing intensive force) + cerchier 'to search'

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Wikipedia

- unlike for most websites one can see the whole revision history of any given article
- good for quickly learning about something, but not for referencing
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What Is 'Research'?

Research and experimental development (R&D) (Frascati Manual 2002)

"Creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."

What Is 'Research'?

Basic research (Frascati Manual 2002)

"Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view."

Applied research (Frascati Manual 2002)

"It is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective."

Experimental development (Frascati Manual 2002)

Systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

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What Is 'Research'?

Research (a maxim)

"Copying from one source is plagiarism, copying from several sources is research".

Gain

Research (HEFCE): Original investigation undertaken in order to gain knowledge and understanding

Contribution

Research is supposed to add to the world's body of knowledge and understanding (in contrast to adding to the researcher's knowledge and understanding)

Knowledge

Epistemology

- What is knowledge?
- How is knowledge acquired?
- To what extent is it possible for a given subject or entity to be known?

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Knowledge: A Hierarchy

Knowledge is a particular level in a hierarchy:

1. Data
2. Information
3. Knowledge
4. Wisdom

Knowledge: Data and Information

Datum/Data

- statements accepted at face value (a 'given') and presented as numbers, characters, images, or sounds.
- a large class of practically important statements are measurements or observations of variables, objects, or events.
- in a computing context, in a form which can be assessed, stored, processed, and transmitted by a computer.

Knowledge: Data and Information

Information

- Data on its own has no meaning, only when interpreted by some kind of data processing system does it take on meaning and becomes information

Example:
The human genome project has determined the sequence of the 3 billion chemical base pairs that make up human DNA
⇝ identifying base pairs produces data
⇝ information would tell us what they encode!
⇝ knowledge would tell us what they do!
⇝ wisdom would tell us what part of this knowledge is important to what we do!
In analogy to OSI model of networking: Physical layer, Data link layer, Presentation layer, Application layer

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Knowledge: Alternative Definitions (1)

Knowledge (Dawson 2005)

- higher level understanding of things
- represents our understanding of the ‘why’ instead of the mere ‘what’
- interpretation of information in the form of rules, patterns, decisions, models, ideas, etc.

In natural sciences, understanding ‘why’ is too ambitious most of time; understanding ‘how’ is usually what we aim for

In other areas, understanding ‘why’ is trivial, understanding ‘how’ is challenging

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Knowledge and Theories: Definition

Scientific knowledge is often organised into theories.

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

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- formulated, developed, and evaluated according to the scientific method

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Knowledge and Theories: Criteria

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

1. 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
2. is supported by many strands of evidence rather than a single foundation, ensuring that it's probably a good approximation if not totally correct

Knowledge and Theories: Criteria

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

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

Knowledge and Theories: Facts versus Theories

'This (e.g. evolution) is only a theory not a fact'

Fact

1. a truth (statement conforming to reality)

or

2. data supported by a scientific experiment

- Status of a 'truth' is by and large unachievable
- A theory is formulated, developed, and evaluated according to the scientific method

  Given enough experimental support a theory can be (a scientific) fact

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Investigation

- Scientists use observations and reasoning to 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 established that a hypothesis is sound, it becomes a theory
- Sometimes scientific development takes place differently with a theory first being developed on the basis of its logic and principles

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Originality

Research and Originality (1)

Research (HEFCE): Original investigation undertaken in order to gain knowledge and understanding

Originality

Doing something that has not been done before

Dawson (2005):
There is no point in repeating the work of others and discovering or producing what is already known

Only true for what is truly known (i.e. very little)

- Theories make predictions, which need to be tested
- Those performing the tests are neither infallible nor trustworthy
- Tests need to be repeated and results replicated

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(In)Fallibility

Cold fusion (http://en.wikipedia.org/wiki/Cold_fusion)

- Cold fusion: Nuclear fusion reaction that occurs well below the temperature required for thermonuclear reactions, that is, near ambient temperature instead of millions of degrees Celsius
- First reported to have been achieved by Pons (University of Utah) and Fleischmann (University of Southampton) in 1989
- Scientists tried to replicate results shortly after initial announcement
- Teams at Texas A&M University and the Georgia Institute of Technology first confirmed the results, but then withdraw those claims due to lack of evidence
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(Un)Trustworthiness

Jan Hendrik Schön

(`http://en.wikipedia.org/wiki/Jan_Hendrik_Schon`)

- Researcher at Bell Labs working in the field of condensed matter physics and nanotechnology
- In 2001, he was listed as an author on an average of one research paper every eight days
- Claimed to have produced a transistor on the molecular scale
- Published (and peer reviewed) papers were suspected to contain duplicated and anomalous data
- Dismissed after an investigation found 24 cases of misconduct
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Research and Originality (2)

Areas of originality (Cryer 1996)

- Exploring the unknown
  Investigate a field that no one has investigated before
- Exploring the unanticipated
  Obtaining unexpected results and investigating new directions in an already existing field
- The use of data
  Interpret data in new ways
- Tools, techniques, procedures, and methods
  Apply new tools/techniques to alternative problems
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Summary

What Is 'Research'?

In summary, what are the three key aspects of research?

What is 'Research'?

http://en.wikipedia.org/wiki/Research

Systematic investigation to establish facts

Higher Education Funding Council for England

Original investigation to gain knowledge and understanding

Sharp et al. (2002)

Seeking through methodical process to add to one's own body of knowledge and to that of others, by the discovery of non-trivial facts and insights.

Who is Who in Computer Science Research

Prizes and Awards

- Scientific achievement is often recognised by prizes and awards
- Conferences often give a best paper award, sometimes also a best student paper award

  Example:
  ICALP Best Paper Prize (Track A, B, C)
  For the best paper, as judged by the program committee

- Professional organisations also give awards based on varying criteria

  Example:
  British Computer Society Roger Needham Award
  Made annually for a distinguished research contribution in computer science by a UK based researcher within ten years of their PhD

- Arguably, the most prestigious award in Computer Science is the A. M. Turing Award

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Alan M. Turing (1912-1954)

- "The father of modern computer science"
- In 1936 introduced Turing machines, as a thought experiment about limits of mechanical computation (Church-Turing thesis)
  Gives rise to the concept of Turing completeness and Turing reducibility
- In 1939/40, Turing designed an electromechanical machine which helped to break the german Enigma code
  His main contribution was an cryptanalytic machine which used logic-based techniques
- In the 1950 paper 'Computing machinery and intelligence' Turing introduced an experiment, now called the Turing test
- 2012 was the Alan Turing year!

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an individual selected for contributions of a technical nature made to the computing community. The contributions should be of lasting and major technical importance to the computer field.

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Turing Award Winners

What contribution have the following people made?
Who among them has received the Turing Award?

- Frances E. Allen
- Leonard M. Adleman
- Leonard Kleinrock
- Timothy J. Berners-Lee (!)
- Vinton G. Cerf
- Edmund Clarke
- Edgar F. Codd
- Stephen A. Cook
- Edsger W. Dijkstra
- Lawrence J. Ellison
- Douglas Engelbart
- Paul Erdös
- William H. Gates III
- James A. Gosling
- Stephen Hawking
- Alan Kay
- Donald E. Knuth
- Robin Milner
- John Nash
- Lawrence Page
- Alan J. Perlis
- Amir Pnueli
- Dennis M. Ritchie
- Ronald R. Rivest
- Adi Shamir
- Richard M. Stallman
- Ken Thompson
- Leslie Valiant
- Moshe Vardi
- 姚期智

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What contribution have the following people made?
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Frances E. Allen	✓	Alan Kay	✓
Leonard M. Adleman	✓	Donald E. Knuth	✓
Leonard Kleinrock	✗	Robin Milner	✓
Timothy J. Berners-Lee	✓(!)	John Nash	✗
Vinton G. Cerf	✓	Lawrence Page	✗
Edmund Clarke	✓	Alan J. Perlis	✓
Edgar F. Codd	✓	Amir Pnueli	✓
Stephen A. Cook	✓	Dennis M. Ritchie	✓
Edsger W. Dijkstra	✓	Ronald R. Rivest	✓
Lawrence J. Ellison	✗	Adi Shamir	✓
Douglas Engelbart	✓	Richard M. Stallman	✗
Paul Erdös	✗	Ken Thompson	✓
William H. Gates III	✗	Leslie Valiant	✓
James A. Gosling	✗	Moshe Vardi	✗
Stephen Hawking	✗	姚期智	✓

Sir Timothy John Berners-Lee

- Received the Turing award in 2016

  "for inventing the World Wide Web, the first web browser, and the fundamental protocols and algorithms allowing the Web to scale"

Frances E. Allen

- Received the Turing award in 2006

  > *"For pioneering contributions to the theory and practice of optimizing compiler techniques that laid the foundation for modern optimizing compilers and automatic parallel execution."*

- First woman to receive the award
- Her 1966 paper on 'Program Optimization' and a 1971 paper with John Cocke provide the conceptual basis for the systematic analysis and transformation of computer programs
- Basis for modern machine- and language-independent program optimizers

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Vinton G. Cerf, Robert E. Kahn

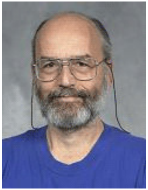
 

- Received the Turing award in 2004

  "For pioneering work on internetworking, including the design and implementation of the Internet's basic communications protocols, TCP/IP, and for inspired leadership in networking."

- Led the design and implementation of the Transmission Control Protocol and Internet Protocol (TCP/IP)
- Basis for current internetworking

Leonard M. Adleman, Ronald R. Rivest, Adi Shamir

- Received the Turing award in 2002

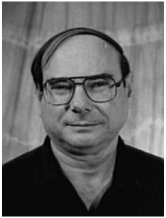
  "For their ingenious contribution for making public-key cryptography useful in practice."

- Created most widely used public-key cryptography system, RSA, in 1977
- Clifford Cocks described an equivalent system in an internal GCHQ document in 1973, but it was never deployed and kept secret until 1997

Amir Pnueli

- Received the Turing award in 1996

  "For seminal work introducing temporal logic into computing science and for outstanding contributions to program and system verification."



- Major breakthrough in the verification and certification of concurrent and reactive systems
- Landmark 1977 paper 'The Temporal Logic of Programs' in Proc. 18th IEEE Symp. Found. of Comp. Sci., 1977, pp. 46–57.
  - Focus: ongoing behaviour of programs (cf. input/output behaviour)
  - Easily specify qualitative progress properties of concurrent programs
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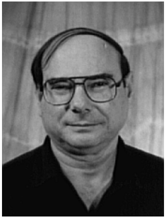

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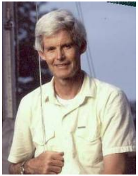

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  For his advancement of our understanding of the complexity of computation in a significant and profound way.

- Seminal paper 'The Complexity of Theorem Proving Procedures' at 1971 ACM SIGACT Symposium on the Theory of Computing
- Laid the foundations for the theory of NP-completeness
- $P \neq NP$ is still one of the most fundamental open problems
- Starting point for complexity theory

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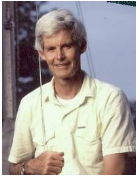

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How to Become a Turing Award Winner

To increase your chances to become a Turing award winner it might be advantageous to work in one of the following fields:

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  (Backus, Floyd, Hoare, Milner, Naur, Iverson (APL), Dijkstra, Naur, Perlis (Algol), Fortran (Backus), Pascal, Modula (Wirth), Dahl, Nygaard (Simula), Kay (Smalltalk))
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Choosing or proposing a project

Questions

1. What sources of information could be used to devise a research-oriented project?
2. Given a collection of proposals for research-oriented projects, what criteria could you use to select the most suitable one?

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- Past projects
- Brainstorming
- Your own goals and learning objectives
- Reading about / working in the subject area
- Systematic analysis of the subject area

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Choosing a Project

- The project needs to be within your capabilities
- The project needs to have sufficient scope
- The project needs to interest you
- The project needs to have a serious purpose
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- 2006 Chemistry: "Ultrasonic Velocity in Cheddar Cheese as Affected by Temperature".
- 2006 Mathematics: for calculating the number of photographs that must be taken to (almost) ensure that nobody in a group photo will have their eyes closed.
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Suitability Tests for Projects

- 'So what?' test
  Is the topic meaningful?
  Will it be of value for anyone?
  What contribution will it make?
- Justification
  Can you explain your project and justify it in simple terms?
- Estimating your understanding
  Can you put a figure on what you know about your chosen subject?
- Contacts
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Project proposals

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  - Sets the context for the project
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- Overview of current research in the area
  - Demonstrates current activities in the subject area
  - Shows your understanding of current research
- Identify a gap
  - Identify a need for further investigation or re-interpretation
- Identify how your work fills the gap
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Preparing a Project Proposal: Explicit Structure (1)

- Title
  Clear, Concise, Preferably no acronyms
- Aims and Objectives

Aims:	Broad statement(s) of intent Identify the project's purpose
Objectives:	Identify specific, measurable achievements Quantitative and qualitative measures by which completion of the project can be judged

- Expected outcomes/deliverables
  Identify what will be produced/submitted in the project
- Keywords
  Identify the topic areas that the project draws on

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Objectives:	Identify specific, measurable achievements Quantitative and qualitative measures by which completion of the project can be judged

- Expected outcomes/deliverables
  Identify what will be produced/submitted in the project
- Keywords
  Identify the topic areas that the project draws on

Preparing a Project Proposal: Explicit Structure (1)

- Title

  Clear, Concise, Preferably no acronyms

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Preparing a Project Proposal: Explicit Structure (2)

- Introduction/Background/Overview
  - Overview of the project (Identification of research questions and hypotheses, elaboration of aims)
  - Motivation for the project
  - Motivation for you conducting the project
- Related Research
  Identifies other work and publications related to the topic
- Methods
  Identifies the research methods and project methods that will be used (e.g. theoretical investigation, case study)

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Preparing a Project Proposal: Explicit Structure (3)

- Research Requirements
  Identifies the resources that will be needed for the project (e.g. hardware, software, data, personnel)
- Project Plan
  - More or less detailed 'timetable' for the project
  - Deadlines for deliverables

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Conclusion

- Choosing the right project is an important stage crucial to your success
- There are a number of techniques that can assist you
- In a project proposal or project specification
  - stick to the required structure and
  - address all the guiding questions as precisely as possible

Further reading:
Sharp et al. (2002) proposes five questions that might help you to choose a project supervisor; see (Dawson 2005; p. 52).

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COMP 516
Research Methods in Computer Science

Othon Michail

Department of Computer Science
University of Liverpool

with material from Ullrich Hustadt, Rahul Savani, and Dominik Wojtczak

Literature and Referencing

Literature sources

Searching for Literature

- What are you trying to find out?
  $\rightsquigarrow$ Try to specify exactly what you need to know
- What type of information do you want to find?
  $\rightsquigarrow$ An answer to a specific question?
  $\rightsquigarrow$ An overview of a subject area?
  $\rightsquigarrow$ A specific document?
- Why do you need this information?
  $\rightsquigarrow$ Literature survey: Information needs to be comprehensive
  $\rightsquigarrow$ Short essay: Limited number of sources is sufficient
- How quickly do you need the information?
  $\rightsquigarrow$ Immediately: Internet
  $\rightsquigarrow$ In a day: Library
  $\rightsquigarrow$ In a week: Inter Library Loans

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Searching for Literature

Consider the following tasks:

1. Obtain a paper copy of the following article:

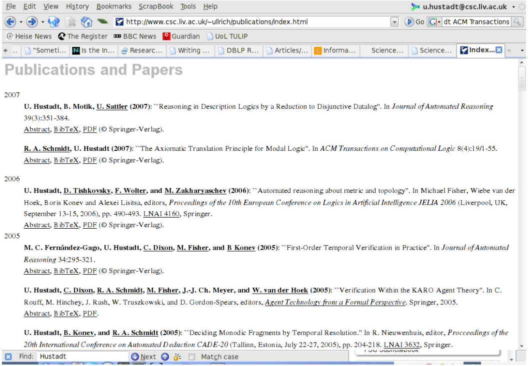
   P. McBurney, S. Parsons and M. Wooldridge (2002): Desiderata for agent argumentation protocols. In: C. Castelfranchi and W. L. Johnson (Editors): Proceedings of the First International Joint Conference on Autonomous Agents and Multi-Agent Systems (AAMAS 2002), pp. 402–409, Bologna, Italy. July 2002. New York, USA: ACM Press.

2. Find out which other publications refer to the article above.

How would you accomplish these tasks?

Sources for literature on the internet:

- Freely available collections (personal/institutional)



Publications and Papers

2007

U. Hustadt, B. Motik, U. Sattler (2007): ``Reasoning in Description Logics by a Reduction to Disjunctive Datalog''. In *Journal of Automated Reasoning* 39(3):351-384.
Abstract, BibTeX, PDF (© Springer-Verlag).

R. A. Schmidt, U. Hustadt (2007): ``The Axiomatic Translation Principle for Modal Logic''. In *ACM Transactions on Computational Logic* 8(4):19/1-55.
Abstract, BibTeX, PDF (© Springer-Verlag).

2006

U. Hustadt, D. Tishkovsky, F. Wolter, and M. Zakharyaschev (2006): ``Automated reasoning about metric and topology''. In Michael Fisher, Wiebe van der Hoek, Boris Konev and Alexei Lisitsa, editors, *Proceedings of the 10th European Conference on Logics in Artificial Intelligence JELIA 2006* (Liverpool, UK, September 13-15, 2006), pp. 490-493. LNAI 4160, Springer.
Abstract, BibTeX, PDF (© Springer-Verlag).

2005

M. C. Fernández-Gago, U. Hustadt, C. Dixon, M. Fisher, and B Konev (2005): ``First-Order Temporal Verification in Practice''. In *Journal of Automated Reasoning* 34:295-321.
Abstract, BibTeX, PDF (© Springer-Verlag).

U. Hustadt, C. Dixon, R. A. Schmidt, M. Fisher, J.-J. Ch. Meyer, and W. van der Hoek (2005): ``Verification Within the KARO Agent Theory''. In C. Rouff, M. Hinchey, J. Rash, W. Truszkowski, and D. Gordon-Spears, editors, *Agent Technology from a Formal Perspective*. Springer, 2005.
Abstract, BibTeX, PDF.

U. Hustadt, B. Konev, and R. A. Schmidt (2005): ``Deciding Monodic Fragments by Temporal Resolution.'' In R. Nieuwenhuis, editor, *Proceedings of the 20th International Conference on Automated Deduction CADE-20* (Tallinn, Estonia, July 22-27, 2005), pp. 204-218. LNAI 3632, Springer.

- Publishers' websites/databases
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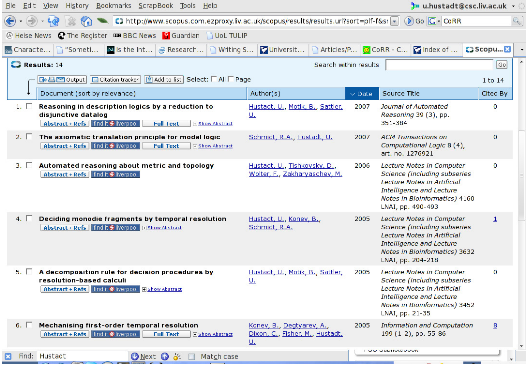

Where to Search: Interrelationship of Sources

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
   - add additional information (references with links, citation index)
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Databases and search engines

Databases and Search Engines: Publishers

Our 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 InterScience	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

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/`
DISCOVER (UoL)	Meta search engine for ACM Digital Library, IEEE Explore, etc but also Scopus, Web of Science and Google Scholar `http://libguides.liverpool.ac.uk/library/`

Adding `.ezproxy.liv.ac.uk` to the server name again allows access from outside the campus using your MWS login and password for authentication

Databases and Search Engines: Web Search Engines

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/`
Microsoft Academic	Searches academic journals and content for article titles, author names, article abstracts, and conference proceedings. `https://academic.microsoft.com/`

Databases and Search Engines: Comparison

- All these databases and search engines, and many more, are accessible from one central point:

  `http://atoz.ebsco.com.ezproxy.liv.ac.uk/Customization/Tab/11404?tabId=8591`

- The library's own catalogue is available at

  `http://library.liv.ac.uk/`

- 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

Databases and Search Engines: Comparison

- Literature databases cover a vast number of journals and conferences, but they
  - do not cover all journals and conference
  - do not cover textbook, handbooks, collections of articles in book form
  - do not cover workshops and similar scientific meetings
  - 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
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Queries

Queries (1)

- 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

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Queries (2)

- 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

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Keywords

- 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

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   enough information for someone to be able to find it again
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Conducting a Search

1. Construct a query
2. Search the databases, starting with the literature databases then moving to web search engines
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`http://www.liv.ac.uk/library/research/refworks.html`
`http://www.liv.ac.uk/library/research/endnote.html`

Mendeley

http://www.mendeley.com/

1. an offline/online reference manager
2. synchronisation between computers
3. drag-and-drop publications
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Other (only online) systems with similar functionality are
http://www.citeulike.org/ and
http://www.zotero.org/

Referencing

Today's Questions

Discuss the following questions:

1. Why do we cite the work of others?
2. What constitutes a good source?
3. What information about a source should be included in a list of references?

References (1)

Why do we cite the work of others?

1. To acknowledge the work of other writers and researchers
2. To demonstrate the body of knowledge on which our work is based
3. To enable the reader to trace our sources easily and lead her/him on to further information

We do NOT cite to indicate that we have copied text from another source! That's plagiarism!

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Plagiarism

According to the University's definition, plagiarism is:

- the verbatim (word for word) copying of another's work without appropriate and correctly presented acknowledgement;
- the close paraphrasing of another's work by simply changing a few words or altering the order of presentation, without appropriate and correctly presented acknowledgement;
- unacknowledged quotation of phrases from another's work;
- the deliberate and detailed presentation of another's concept as one's own.

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Copying of another's work, then adding a reference to that work,
is **NOT** considered an
'appropriate and correctly presented acknowledgement'

Verbatim copying is only allowed in the context of proper quotation

References (2)

- What constitutes a good source?

  1. Precise location
     ⇝ Sufficient information must be given for a third person to be able to locate your source
  2. Longevity of source
     (Journals → Proceedings → Technical Reports → Web sources)
  3. Accessibility of source
     ⇝ Completely free → Free subscription → Paid
     ⇝ Avoid 'private communication'
  4. Reputation / Quality of source

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- What constitutes a good source?
  5. 'Originality'
     Original paper $\rightarrow$ secondary paper / translation
  6. 'Language'
     If possible, a source should be in the language you write in
  7. Readability of source
     Well written $\rightarrow$ badly written

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Vocabulary

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: Formally recognising, within your text, the sources from which you have obtained information

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: A passage or words quoted within your text, supported with a reference to its source

Reference
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List of references
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Citing: Rules of Thumb (Zobel 2004)

- If you discuss a paper in detail or note some particular contribution it makes, it must be cited
- Claims, statements of fact, discussions of previous work should be supported by references, if not supported by your current work
  But: Do not cite to support common knowledge; do not end every sentence with a reference
- References to your own previous work is allowed if it is relevant to your current work
  But: Gratuitous self-reference is counterproductive
- Attribute work correctly, in particular, when relying on secondary sources

  Bad: According to Dawson (1981), stable graphs have been shown to be closed

  Good: According to Kelly (1959; as quoted by Dawson, 1981), stable graphs are closed

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References: Types of Work

Book

- Author(s) or editor(s)
- Title and subtitle
- Edition, if not the first, for example 2nd ed.
- Series and individual volume number (if any)
- Publisher
- (Place of publication)
- Year of publication

Examples:

A. A. Fraenkel, Y. Bar-Hillel, and A. Levy. *Foundations of Set Theory*, 2nd revised edition. Studies in Logic and The Foundations of Mathematics 67. North-Holland, Amsterdam, 1973.

A. Robinson and A. Voronkov, editors. *Handbook of Automated Reasoning*. Elsevier, 2001.

Examples

Bad:

Marco Dorigo and Thomas Stutzle, Ant Colony Optimization.

Examples

Bad:

Marco Dorigo and Thomas Stutzle, Ant Colony Optimization.

Good:

Marco Dorigo and Thomas Stützle. Ant Colony Optimization. Bradford Book, 2004.

Examples

Bad:
JAVA, JAVA, JAVA by Ralph Morelli

Examples

Bad:

JAVA, JAVA, JAVA by Ralph Morelli

Good:

Ralph Morelli. Java, Java, Java: Object-Oriented Problem Solving, 2nd edition. Prentice Hall, 2003.

References: Types of Work

Chapter/section of a book

- Author(s) of the chapter/section
- Title and subtitle of the chapter/section
- Author/editor of collected work
- Title and subtitle of collected work
- Chapter/section referred to
- Page numbers of chapter/section referred to
- Publisher
- (Place of publication)
- Year of publication

Example:

W. Bibel and E. Eder. Methods and calculi for deduction. In C. J. Hogger, D. M. Gabbay and J. A. Robinson, editors, *Handbook of Logic in Artificial Intelligence and Logic Programming, Volume 1*, chapter 3, pages 67–182. Oxford University Press, 1993.

References: Types of Work

Conference proceedings

- Editor(s) of proceedings
- Name and number of conference
- Location of conference (if appropriate)
- Time of conference
- Title of published work; if different from the name of the conference
- Series and individual volume number (if any)
- Publisher
- Place of publication
- Year of publication

Example:

D. A. Basin and M. Rusinowitch, editors. *Automated Reasoning - Second International Joint Conference, IJCAR 2004, Cork, Ireland, July 4–8, 2004, Proceedings*. Lecture Notes in Computer Science 3097. Springer, 2004.

Examples

Bad:

Marco Dorigo, Gianni Di Caro, Michael Samples, Ant Algorithms, third international workshop, Ant 2002, Brussels, Belgium, September 2002, Proceedings.

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Conference paper

- Author(s) of the paper
- Title and subtitle of the paper
- All information on the conference proceedings plus
- Page numbers of the paper

Example:

Volker Weispfenning. Solving Constraints by Elimination Methods. In D. A. Basin and M. Rusinowitch, editors. *Automated Reasoning - Second International Joint Conference, IJCAR 2004, Cork, Ireland, July 4–8, 2004, Proceedings*. Lecture Notes in Computer Science 3097, p. 336–341. Springer, 2004.

References: Types of Work

Journal article

- Author(s) of the article
- Title and subtitle of the article
- Title of the journal
- Volume and part number
- Page numbers of article
- Date, month or season of the year, if appropriate
- Year of publication

Note: Information on publisher is typically not required

Examples:

R. MacGregor. Inside the LOOM description classifier. *SIGART Bulletin*, 2(3):88–92, 1991.

A. Seager. Energy subsidy plan for home runs out of cash. The Guardian, 21 October 2006, p. 6.

References: Types of Work

Thesis and dissertation

- Author of the work
- Title and subtitle of the work
- Type of work
- Awarding institution including its address
- Year, possibly month, of publication

Examples:

G. Rosu. *Hidden Logic*. PhD thesis, Department of Computer Science and Engineering, University of California, San Diego, CA, USA, August 2000.

R. A. van der Goot. *Strategies for modal resolution*. Master's thesis, Faculty of Technical Mathematics and Informatics, Delft University of Technology, The Netherlands, 1994.

References: Types of Work

Web pages

- Author(s) of the web page(s)
- Title and subtitle
- URL
- Date of last modification, if available
- Date of access

Examples:

The PHP Group. PHP: Hypertext preprocessor. `http://www.php.net/`. 22 October 2006.

The International DOI Foundation. The Digital Object Identifier System. `http://www.doi.org/`. 25 July 2006 (accessed 22 October 2006).

Examples

Bad:

`http://www.cut-the-knot.org/blue/Stern.shtml`

Examples

Bad:

`http://www.cut-the-knot.org/blue/Stern.shtml`

Good:

Alexander Bogomolny. Stern-Brocot Tree.
`http://www.cut-the-knot.org/blue/Stern.shtml`.
Last modification June 17, 2000. Accessed October 26, 2006.

Conclusions

- why do we cite the work of others
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"I shall never be ashamed of citing a bad author if the line is good."

– Seneca

Bibliography styles

Bibliography styles

- We will cover some of the standard bibliographic styles
- For your essay, the most important thing is that you use one consistently

Styles: Ordinal Number

- Sources listed in the bibliography are sorted according to some ordering, typically based on the authors' names, and numbered consecutively
- References in the text are given as (lists of) numbers cross-referencing the bibliography, enclosed in square brackets

Example:
Key techniques for utilising temporal logic specifications have been investigated, including verification via proof [3] and verification via model-checking [1,2].

Bibliography

1. E. Clarke, O. Grumberg, and D. A. Peled. *Model Checking*. MIT Press, 2000.
2. K. L. McMillan. *Symbolic Model Checking*. Kluwer, 1993.
3. M. Vardi and P. Wolper. Reasoning about infinite computations. *Inform. and Computat.*, 115:1–37, 1994.

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- Sources in the reference list are arranged alphabetically by the authors' names;
  where there is more than one work by the same authors, they are arranged by year of publication, starting with the earliest;
  where there is more than one work with the same authors and date, a letter is added to the year of publication to distinguish them

Example:

Bibliography

P. Wolper (1996a). Where is the Algorithmic Support? *ACM Comput. Surv.* 28(4): 58.

P. Wolper (1996b). The Meaning of "Formal". *ACM Comput. Surv.* 28(4): 127.

Styles: Author-Date (2)

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Example of quoting:

The following is an extract from (Wolper 1996a):

> *Consider, for instance, the issue of compositionality in proof systems for concurrency. I am not going to argue that compositionality is undesirable, but that achieving it without algorithmic support (in a broad sense) is easy and mostly useless.*

Example of citing:

While Wolper (1996a) does not argue that compositionality in proof systems for concurrency is undesirable, he claims that achieving it without algorithmic support is mostly useless.

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Examples:

Recent work (Wolper 1996a, 1996b) stresses the importance of algorithmic support for formal methods.

Wolper (1996a, 1996b) stresses the importance of algorithmic support for formal methods.

The completion procedure may fail in general, but has been extended to a refutationally complete theorem prover (cf. Lankford 1975, Hsiang and Rusinowitch 1987, and Bachmair, Dershowithz and Plaisted 1989). Completion procedures for conditional equations have been described by Kounalis and Rusinowitch (1988), and by Ganzinger (1987a, 1987b).

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Wolper (1996a, 1996b) stresses the importance of algorithmic support for formal methods.

The completion procedure may fail in general, but has been extended to a refutationally complete theorem prover (cf. Lankford 1975, Hsiang and Rusinowitch 1987, and Bachmair, Dershowithz and Plaisted 1989). Completion procedures for conditional equations have been described by Kounalis and Rusinowitch (1988), and by Ganzinger (1987a, 1987b).

Styles: Abbreviation (1)

- Mix of ordinal number style and author-date style
- Sources in the bibliography are presented like in ordinal number style, but instead of numbering them, each source is given a unique identifier based on authors' names and year of publication, with additional letters to disambiguate duplicate abbreviations

Example:

Bibliography

[CGP00] E. Clarke, O. Grumberg, and D. A. Peled. *Model Checking*. MIT Press, 2000.

[vdG94] R. A. van der Goot. *Strategies for modal resolution*. Master's thesis, Delft University of Technology, The Netherlands, 1994.

[Wol96a] P. Wolper. Where is the Algorithmic Support? *ACM Comput. Surv.* 28(4):58, 1996.

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Styles: Abbreviation (2)

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Examples:

Key techniques for utilising temporal logic specifications have been investigated, including verification via proof [VW94] and verification via model-checking [CGP00,McM93].

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Using EndNote for Citations and Bibliographies

Organising References

- There are myriads of styles for references and bibliographies
- You should maintain information on your sources in a ‘neutral’ format
- Ideally, you should use a tool which
  - supports such a ‘neutral’ format
  - allows to add, delete, modify references
  - allows to search for references
  - interacts with your word processor/text editor
  - generates a list of references in any desired format

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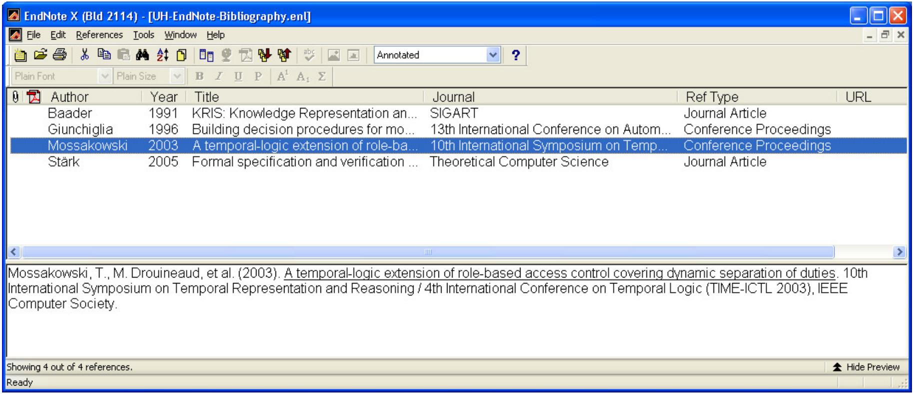
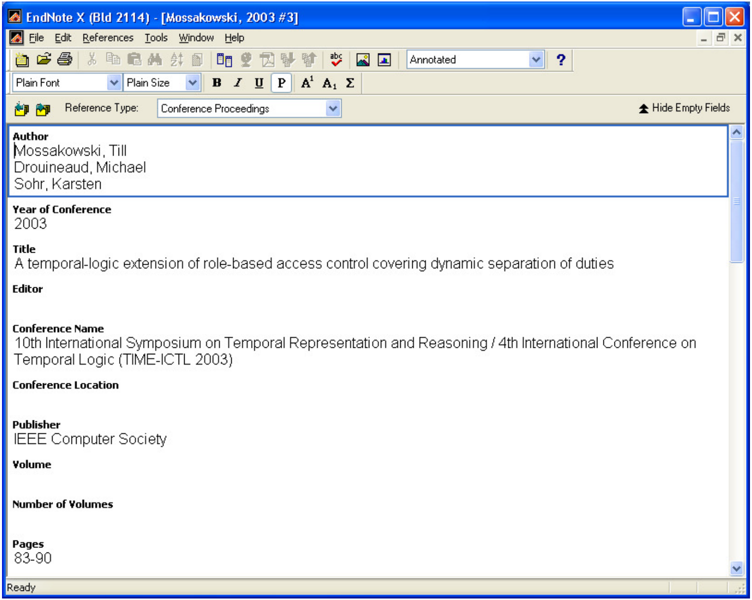
EndNote is a reference manager available for Microsoft Windows and Mac OS X which interfaces with Microsoft Word

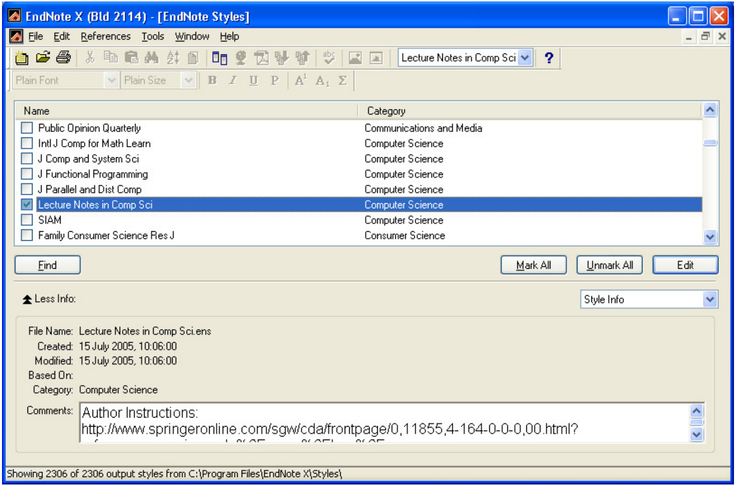


EndNote: Entering References



EndNote: Choosing Bibliography Styles (1)

EndNote allows you to format your citations and your bibliography in a number of styles



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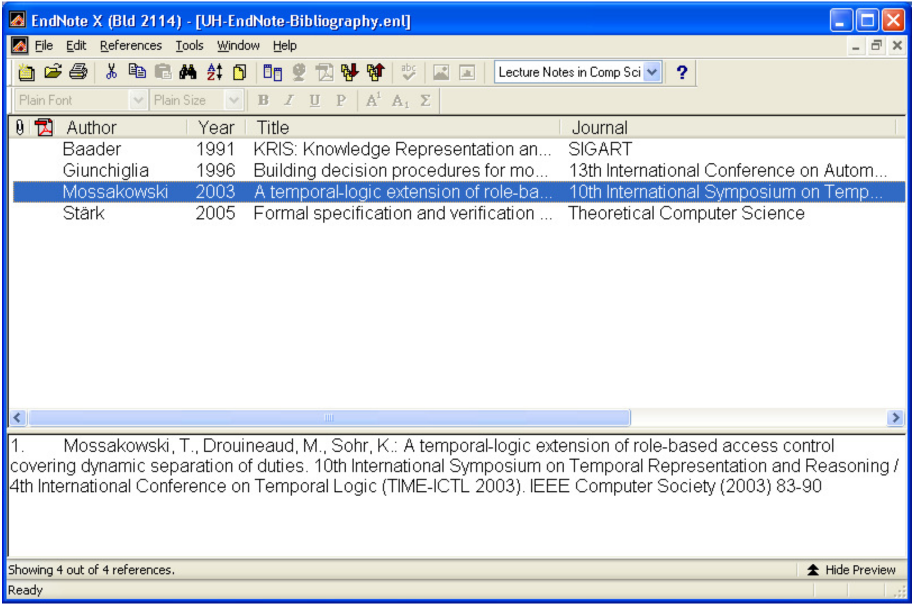
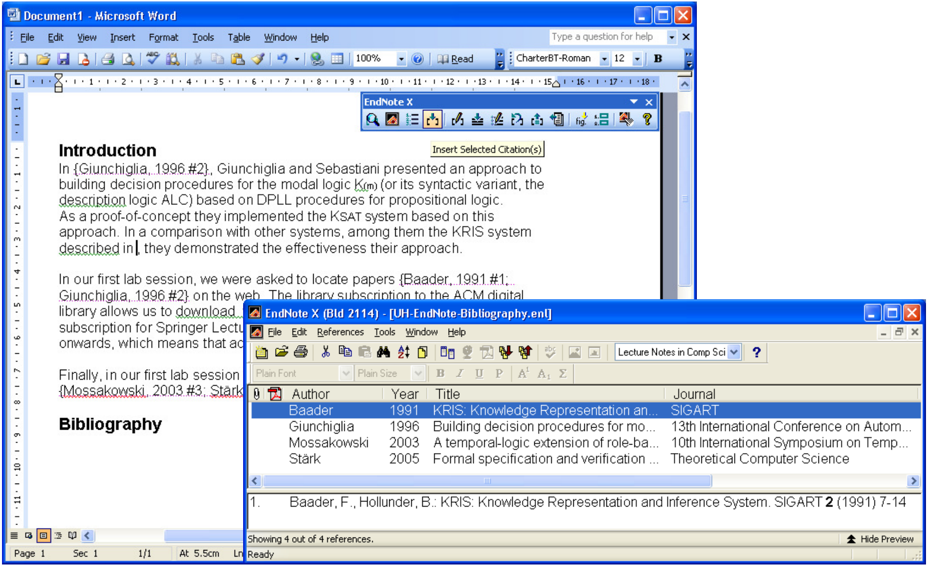


EndNote: Interacting with Word (1)



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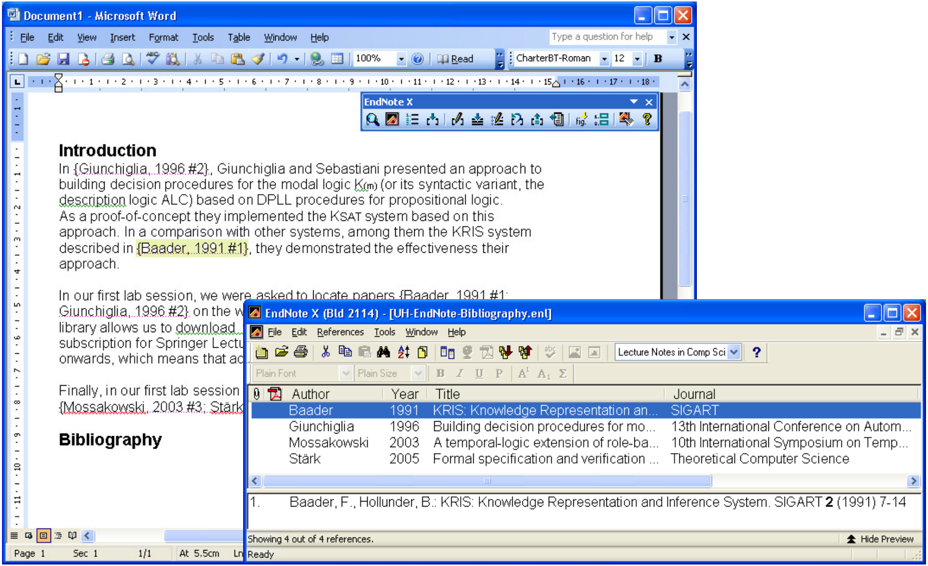

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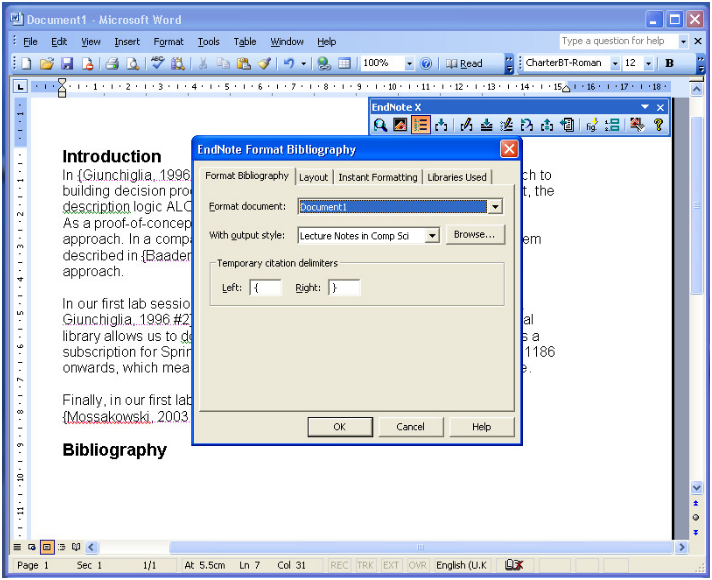

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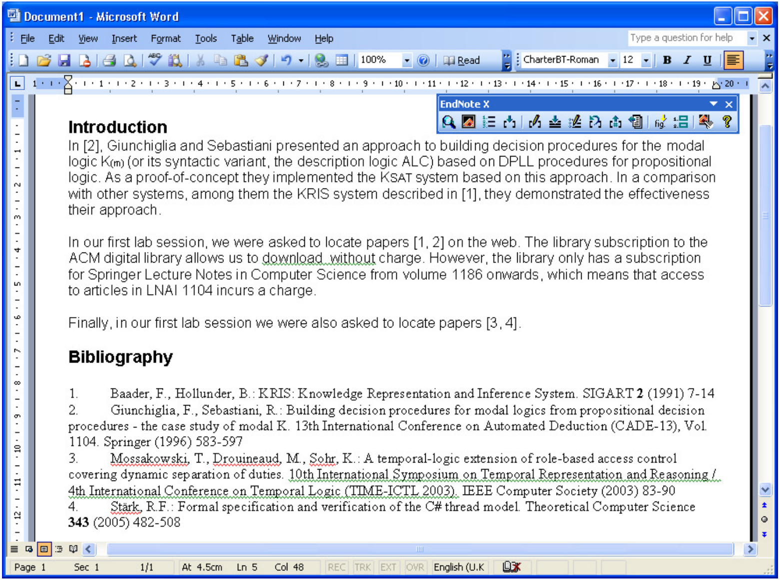

Introduction

In [2], Giunchiglia and Sebastiani presented an approach to building decision procedures for the modal logic $K_{(m)}$ (or its syntactic variant, the description logic ALC) based on DPLL procedures for propositional logic. As a proof-of-concept they implemented the KSAT system based on this approach. In a comparison with other systems, among them the KRIS system described in [1], they demonstrated the effectiveness their approach.

In our first lab session, we were asked to locate papers [1, 2] on the web. The library subscription to the ACM digital library allows us to download without charge. However, the library only has a subscription for Springer Lecture Notes in Computer Science from volume 1186 onwards, which means that access to articles in LNAI 1104 incurs a charge.

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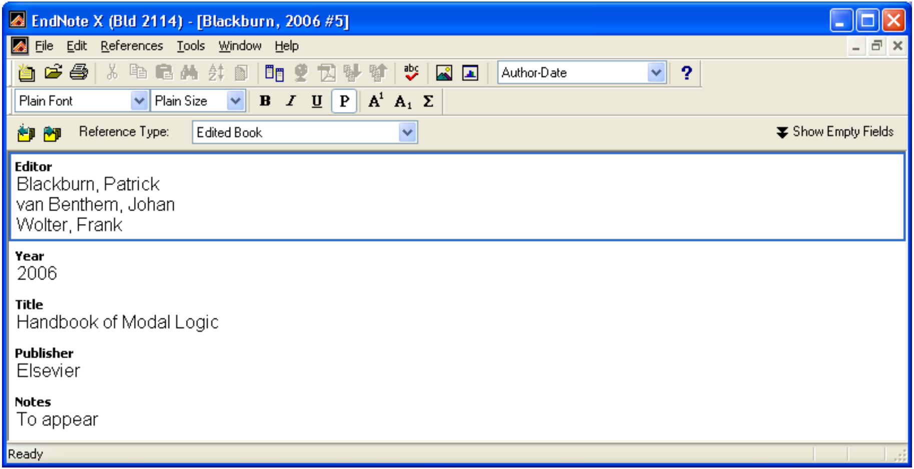
Bibliography

1. Baader, F., Hollunder, B.: KRIS: Knowledge Representation and Inference System. SIGART **2** (1991) 7-14
2. Giunchiglia, F., Sebastiani, R.: Building decision procedures for modal logics from propositional decision procedures - the case study of modal K. 13th International Conference on Automated Deduction (CADE-13), Vol. 1104. Springer (1996) 583-597
3. Mossakowski, T., Drouineaud, M., Sohr, K.: A temporal-logic extension of role-based access control covering dynamic separation of duties. 10th International Symposium on Temporal Representation and Reasoning / 4th International Conference on Temporal Logic (TIME-ICTL 2003). IEEE Computer Society (2003) 83-90
4. Stärk, R.F.: Formal specification and verification of the C# thread model. Theoretical Computer Science **343** (2005) 482-508

EndNote: Entering More References



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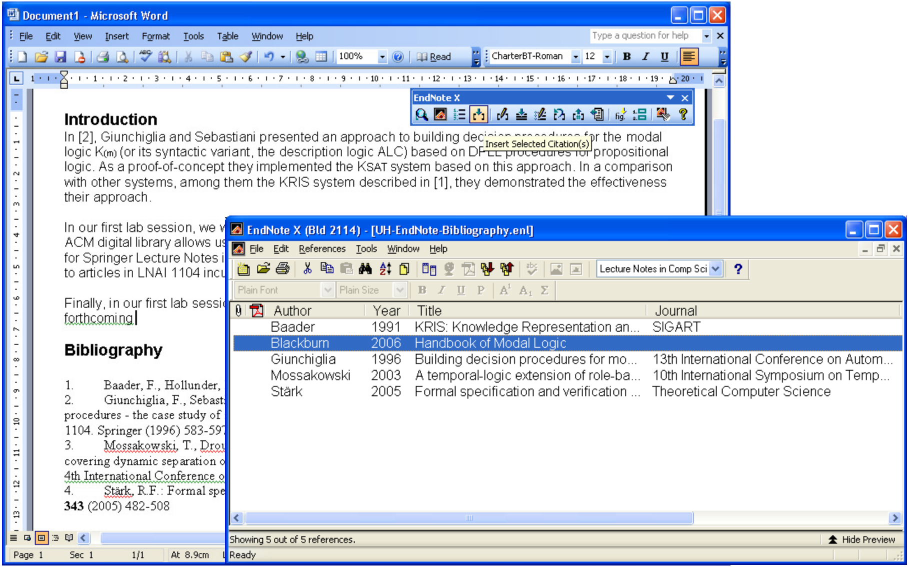

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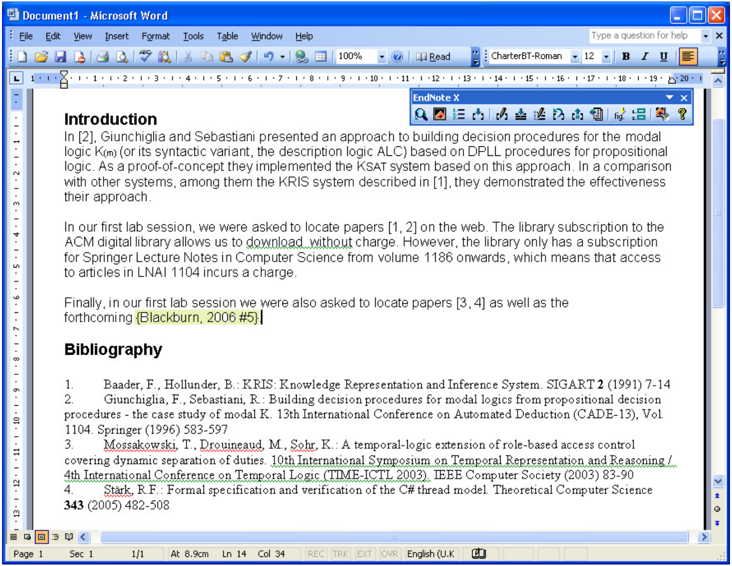

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Bibliography

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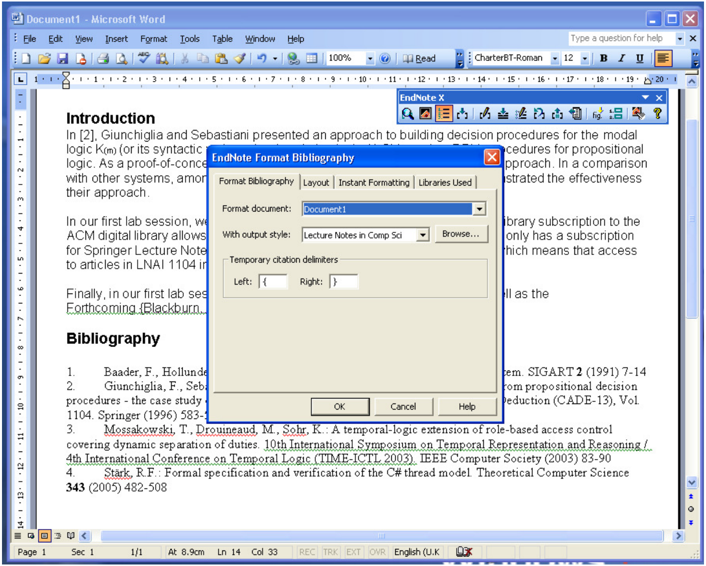
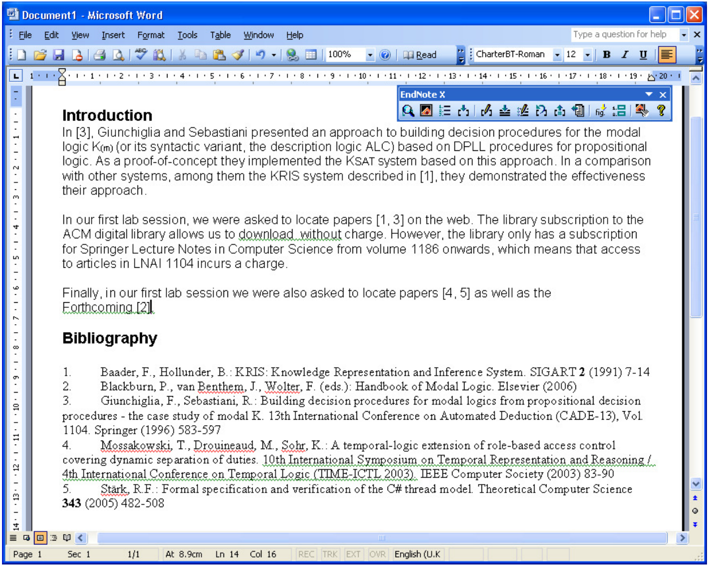
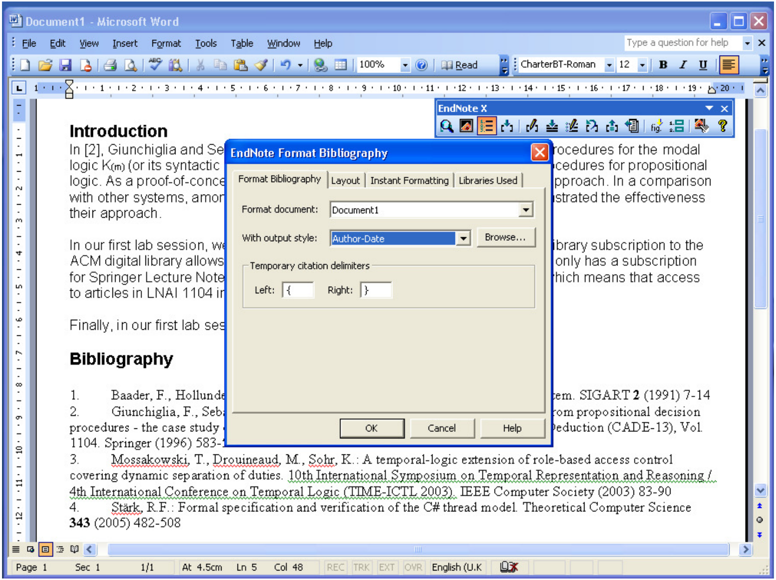
EndNote: Updating a Bibliography (1)



EndNote: Updating a Bibliography (2)



EndNote: Re-formatting a Bibliography (1)



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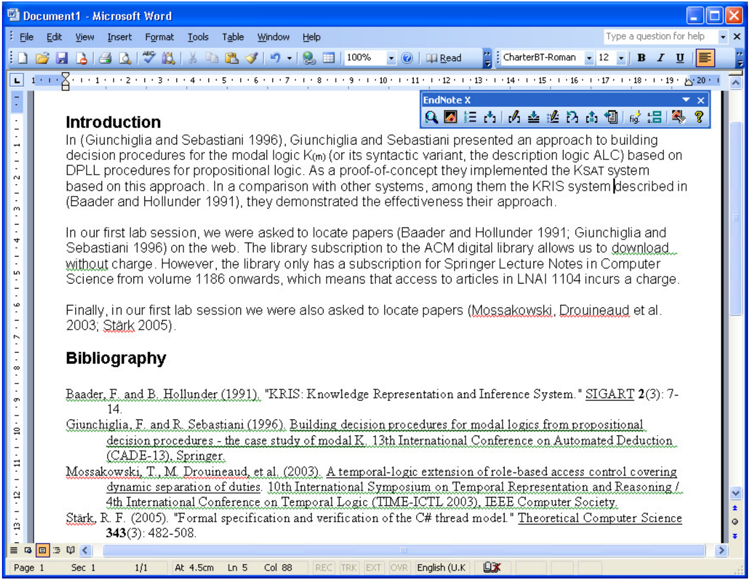

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Bibliography

Baader, F. and B. Hollunder (1991). "KRIS: Knowledge Representation and Inference System." SIGART **2**(3): 7-14.

Giunchiglia, F. and R. Sebastiani (1996). Building decision procedures for modal logics from propositional decision procedures - the case study of modal K. 13th International Conference on Automated Deduction (CADE-13), Springer.

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The Alternatives

- RefWorks
- Mendeley
- Zotero
- Delicious
- CiteULike

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Conclusion

- Tools like EndNote, RefWorks, Citeulike, Mendeley and Zotero help you maintain a large set of bibliographic references
- They ease the burden of referencing and generating lists of references according to a specific style
- If no specific style is requested, then a providing all the necessary information about each of your sources in a consistent way is the most important aspect of a bibliography
- Beware that the way you formulate sentences which include references depends on the referencing style; changing that style later on is time-consuming and error-prone

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Citing

Citing: Rules of Thumb (Zobel 2004)

- If you discuss a paper in detail or note some particular contribution it makes, it **must** be cited
- Claims, statements of fact, discussions of previous work **should** be supported by references, if not supported by your current work
  But: Do not cite to support common knowledge; do not end every sentence with a reference
- References to your own previous work is **allowed** if it is relevant to your current work
  But: Gratuitous self-reference is counterproductive
- Attribute work correctly, in particular, when relying on secondary sources

  Bad: According to Dawson (1981), stable graphs have been shown to be closed

  Good: According to Kelly (1959; as quoted by Dawson, 1981), stable graphs are closed

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Original text [19]:	Student's text:
KNOWITALL is an autonomous system that extracts facts, concepts, and relationships from the web. KNOWITALL is seeded with an extensible ontology and a small number of generic rule templates from which it creates text extraction rules for each class and relation in its ontology. The system relies on a domain- and language-independent architecture to populate the ontology with specific facts and relations.	An example of the described system is KNOWITALL [19]. It is an autonomous system that extracts facts, concepts, and relationships from the web. KNOWITALL [19] is seeded with an extensible ontology and a small number of generic rule templates from which it creates text extraction rules for each class and relation in its ontology. The system relies on a domain- and language-independent architecture to populate the ontology with specific facts and relations.

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References are not meant to indicate copying! This is wrong!

Citing (1)

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Citing (2)

- A reference in ordinal-number style never starts a sentence

  Wrong: [9] Disaster rescue is a serious social issue.

  Correct: Disaster rescue is a serious social issue [9].

- In ordinal-number style a list of references is a comma-separated list of numbers enclosed in one pair of square brackets

  Wrong: The humanoid soccer robots are fully autonomous [5][9].

  Correct: The humanoid soccer robots are fully autonomous [5,9].

- A reference never occurs in a section heading

  Wrong: Section 5. The History of RoboCup [9]

  Wrong: Section 5. The History of RoboCup (Henry 2006)

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Citing (2)

- A reference never comes after a full stop

  Wrong: 2-on-2 teams of autonomous mobile robots play games in a rectangular field color-coded in shades of grey. [9]

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Example taken from a student's text:

> *Such dangers are catered for by ensuring the closure of the function set. Koza [1992] states that:*
>
> > *The closure property requires that each of the functions in the function set be able to accept, as its arguments, any value and data type that may possibly be assumed by any terminal set. That is, each function in the function set should be well defined and closed for any combination of arguments that it may encounter.*
>
> *Without closure, many individuals could have their fitness drastically lowered as a result of minor syntactic errors.*

Direct quotation from Koza [1992]; clearly indicated as such; restricted to (less than) one paragraph; source stated.

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Examples taken from a student's text:

> *Bickle [1996] states that "[t]he superior method to obtain compact and accurate solutions is the method of adaptive parsimony pressure [. . .]".*

Quotation clearly indicated by quotation marks; alterations indicated in square brackets; source stated.

> *Day [2005] reports that "GP shows great promise in creating robust classifiers for [Automatic Speaker Verification] purposes" where programs attempt to recognise the voice of a known individual.*

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> *A Wiki is in Ward Cunningham's [43] original description:*
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Support

Evidence and Support

Example taken from a student's text:

> *Intelligent agents, autonomous or semi-autonomous systems that take decisions and perform tasks in complex, dynamically changing environments, revolutionized the field of AI.*

- This is stating an opinion not a generally known and accepted fact
- As such it needs support which it currently lacks
- Support could be provided by statistical evidence or a reference
- (Made-up) example of statistical evidence:

> *The concept of intelligent agents was first introduced in 1983. By 2003, more than half of all papers published in the main forums of AI referred to the concept or made use of intelligent agents, and it has spawned a world wide industry worth 5 billion US$ [2].*

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In the sentences above, the author agrees with Lenat (1995)

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COMP 516
Research Methods in Computer Science

Othon Michail

Department of Computer Science
University of Liverpool

with material from Ullrich Hustadt, Rahul Savani, and Dominik Wojtczak

Research Methods

Reading research papers

Reading Research Papers

- Research aims to add the world's body of knowledge
  $\rightsquigarrow$ Requires a researcher to be aware of what the world's body of knowledge (in the area s/he works in)

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

	journal articles	
reliability $\uparrow$	conference papers	
	workshop papers	$\downarrow$ timeliness
	technical reports	

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  2. What was/were the main issue(s) that the author identified?
  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?

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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?

Evaluating Research Papers

- 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

Structure of research papers: Questions

1. What elements constitute the structure of the papers?
2. Are the elements and their order identical for all the papers?
3. What characterises each of the elements of the papers?

Structure of research papers

Structure of a Research Paper

1. Title
2. List of authors (and their contact details)
3. Abstract
4. Introduction
5. Related work (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

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  $\rightsquigarrow$ introduced the notion of 'NP-Completeness'
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  $\leadsto$ 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')

Authors (1)

- 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

- Order of authors may depend on
  - subject area: pure theory $\rightsquigarrow$ often alphabetical
    applied research $\rightsquigarrow$ often based on contribution
  - research assessment
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  - cultural context

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Authors (2)

- 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

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
  $\rightsquigarrow$ 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

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

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

Outline 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.)

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

Conclusion and/or 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

Acknowledgements

- 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

See lectures on citing and referencing

Hints

Top-down design: Start with an outline, then fill in the details

Inside-out writing: Fill in the body of the paper first, then write introduction, related work, conclusion; finally, write the abstract

Diagrams/Tables: Are all diagrams and tables readable? Can they be understood?

Dependency analysis: Is the paper self-contained and are notions presented in the correct order?

Factuality: Make sure everything stated in the paper is factually correct

Interpretability: For each sentence check whether it could be misread; if so, try to fix it

Optimisation: Remove unnecessary parts, shorten exposition

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Additional Guidance

- Alan Bundy. How to Write an Informatics Paper.
  http://homepages.inf.ed.ac.uk/bundy/how-tos/writingGuide.html
  (accessed 17 October 2011).
- Simon Peyton Jones. How to write a great research paper.
  http://tinyurl.com/6xry58
  (accessed 17 October 2011).
- Jennifer Widom. Tips for Writing Technical Papers.
  http://infolab.stanford.edu/~widom/paper-writing.html
  (accessed 17 October 2011).

Research process models

Research Process Models

All definitions agree that research involves a systematic or methodical process

Dawson (2005), following Baxter (2001), identifies four common views of the research process:

- Sequential
- Generalised
- Circulatory
- Evolutionary

Research Process Models: Sequential (1)

Research process as

- Series of activities
- Performed one after another (sequentially)
- In a fixed, linear series of stages

Example:
Research process model of Greenfield (1996):

1. Review the field
2. Build a theory
3. Test the theory
4. Reflect and integrate

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Research Process Models: Sequential (2)

Example:

Sharp et al (2002):

1. Identify the broad area of study
2. Select a research topic
3. Decide on an approach
4. Plan how you will perform the research
5. Gather data and information
6. Analyse and interpret these data
7. Present the result and findings

Research Process Models: Sequential (3)

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What do you think about this research process model?
What is wrong with it?

Research process models: Sequential (4)

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Problems with the sequential (and generalised) process model:

1. Stages not subject specific
2. No repetition or cycles

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  Data gathering and data analysis play no role for research in pure mathematics and large parts of computer science

  Instead researchers make conjectures which they prove mathematically

Research Process Models: Generalised (1)

- The generalised research process model recognises that the stages of the research process depend on the subject and nature of the research undertaken

  Example:
  Data gathering and data analysis play no role for research in pure mathematics and large parts of computer science
  Instead researchers make conjectures which they prove mathematically

- The generalised research process model provides alternative routes depending on the subject and nature of the research undertaken

- But each route is still sequential

Research Process Models: Generalised (2)

Example:

(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	
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Problems with the generalised process model:

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Research Process Models: Circulatory

- 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

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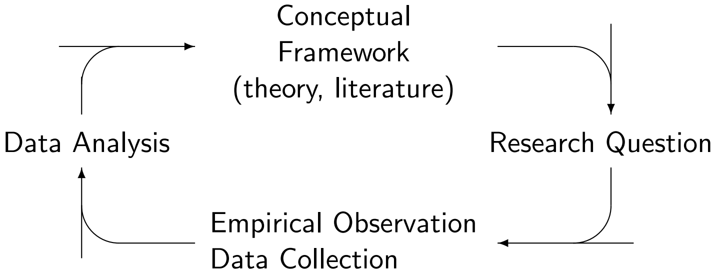
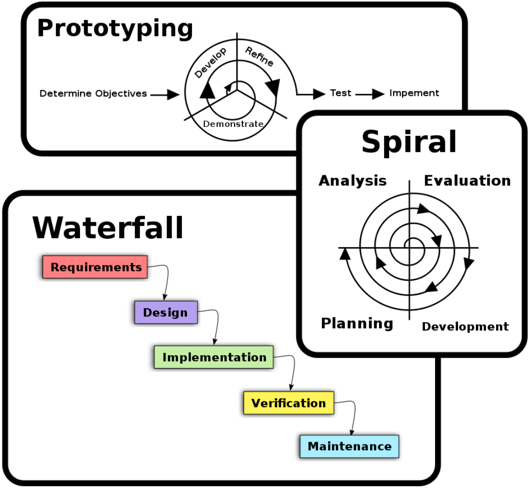


Analogy to Software Development Patterns



Research Process Models: Evolutionary (1)

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

  That is, over time our concept of

  - What research questions are admissible
  - What extent 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 changes

Research Process Models: Evolutionary (2)

- The evolutionary research process model recognises that research (methods) itself evolve and change over time
- As an example, we can consider research in mathematics, in particular, its use of computers
- With respect to mathematical proofs we can make the following distinctions:
  (1) Proofs created solely by humans
  $\rightsquigarrow$ typically ‘sketchy’, omitting steps that are considered ‘obvious’
  (2) Computer-aided mathematical proofs
  $\rightsquigarrow$ Structure and deductive steps still provided by humans, but certain computations are delegated to a computer
  (3) Fully formal, computer generated and validated proofs
  $\rightsquigarrow$ Every step of a proof is conducted and validated by a computer, possibly under guidance by humans

Research Process Models: Evolutionary (3)

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Computer-aided mathematical proofs (1)

Four colour theorem

> *Any planar map can be coloured with at most four colours in a way that no two regions with the same colour share a border.*

Conjectured in 1852 by Guthrie. Proved in 1976 by Appel and Haken. Proof involves a case analysis of about 10,000 cases for which the help of a computer was used

Proof seems generally accepted, but not by all mathematicians

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Research Process Models: Evolutionary (4)

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

Computer-aided mathematical proofs (2)

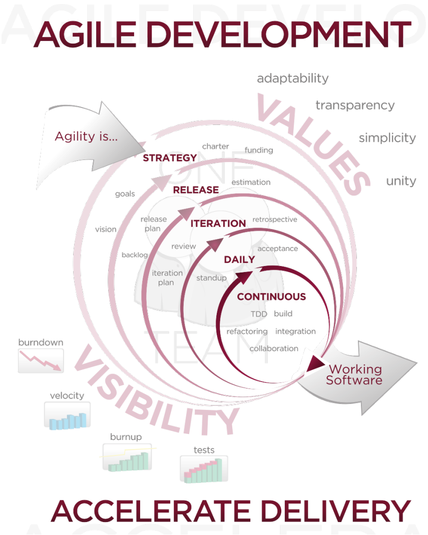
Sphere packing theorem

Close packing is the densest possible sphere packing.

Conjectured in 1611 by Kepler. Hayes published a proof plan in (1997).
Execution of the plan involved solving about 100,000 linear optimisation problems using a computer. The computer files for the related programs and data requires more than 3GB of space

At one point it was suggested that the proof will be published with a disclaimer, saying that it is impossible for a human to check its correctness

Analogy to Software Development Patterns (2)



Research Process Models: Conclusion

- Among the four common views of the research process
  - Sequential
  - Generalised
  - Circulatory
  - Evolutionary

  the evolutionary research process model best describes the 'real' research process
- While the evolutionary research process model allows for the 'rules of the game' to change over time, this does not imply there aren't any rules

Scientific method

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.
- 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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Elements of a Scientific Method

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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Intellectual discovery

Intellectual Discovery

- Knowing what the elements of a scientific method are does not tell us how to come up with the right instances of these elements
  - What predictions does a theory make?
  - What is the right hypothesis in a particular situation?
  - What is the right experiment to conduct?

- These are commonly derived by a process involving
  - Deductive reasoning
  - Abductive reasoning
  - Inductive reasoning

Classification by Charles Sanders Peirce (1839-1914)
See http://plato.stanford.edu/entries/peirce/ for additional details

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Intellectual Discovery: Deduction (1)

- 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.

- Useful for experiment generation for theories

  Example:

  Newton's theory of gravity versus Einstein's theory of relativity

  - Largely make the same predictions
  - Both predict that the sun's gravity should bend rays of light
  - However, Einstein's theory predicts a greater deflection
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Intellectual Discovery: Deduction (2)

- Deductive reasoning is often said not to lead to new knowledge (Note: This implies pure mathematicians largely waste their time)
  - ⇝ Seriously underestimates the computational effort involved in deductive reasoning
  - ⇝ Most theories are undecidable (There is no algorithm that even given infinite time could determine whether a statements follows from a theory or not)
  - ⇝ Thus, establishing that a statement follows from a theory extends our knowledge

Intellectual Discovery: Abduction

- 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.

  ⇝ Requires a theory linking A, B, C, D to X

- Useful for hypothesis generation
- Hypotheses must then be confirmed / eliminated through further observation
- It is not easy from the outside to decide whether someone uses deduction or abduction

  ⇝ The two are often confused

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Intellectual Discovery: Induction (1)

- 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.
  – Johannes Kepler analysed that data which was consistent with Mars moving in an elliptic orbit around the sun.
  – Inductive conclusion:
  Mars, and all other planets, move in elliptic orbits around the Sun, with the Sun at one of the focal points of the ellipse.

- Primary tool for theory formation

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- Primary tool for theory formation

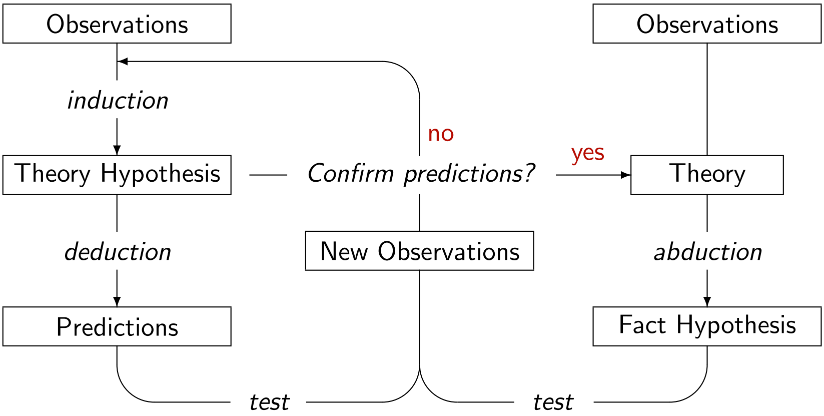
Intellectual Discovery: Induction (2)

- An incomplete set of observations can easily lead to incorrect inductive conclusions

  Example:

  – All swans I've ever seen are white
  – Inductive conclusion: All swans are white

Scientific Method: A Model



Problem solving

Intellectual Discovery: Problems

- Deductive reasoning tells us that from 'A' and 'A implies B' we can conclude 'B'
  However, it cannot tell us whether 'A' or 'A implies B' holds, nor whether 'B' is what we want to show
- Abductive reasoning tells us that from 'B' and 'A implies B' we may conclude 'A'
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To overcome these problems we need additional techniques.

Problem Solving

- Analogy: Look for similarity between one problem and another one already solved
- Partition: Break the problem into smaller easier sub-problems
- Random/Motivated Guesses: Guess a solution 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 restrictions than the more general case
- Subtract: Drop some of the complicating features of the original problem

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Classifying research

Classifying Research (1)

Research can be classified from three different perspectives:

1. Field
   Position of the research within a hierarchy of topics

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

2. Approach
   Research methods that are employed as part of the research process

   Examples:
   Case study, Experiment, Survey, Proof

3. Nature
   - Pure theoretical development
   - Review of pure theory and evaluation of its applicability
   - Applied research

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  Developing theories and working on their consequences, with regard to experimentation or application
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  Investigating an 'entirely' new area of research, exploring a situation or a problem
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Research methods

Quantitative and Qualitative Research Methods

- Quantitative research methods
  - Methods associated with measurements (on numeric scales)
  - Stemming from natural sciences
  - Used to test hypotheses or create observations for inductive reasoning
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  - Methods involving case studies and surveys
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Research Methods (1)

- 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

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Research Methods (2)

- Survey:
  - Usually undertaken using questionnaires or interviews
  - Questionnaire and interview design important!
    (See Dawson 2005 for details)
  - Determination of sample size and sample elements important!
    (See specialist literature for details)

  Example: Survey on popularity or use of programming languages

- Experiment:
  - Investigation of causal relationships using tests controlled by the researcher
  - Usually performed in development, evaluation and problem solving projects

  Example: Evaluation of processor performance

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- 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
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Research Methods in CS
COMP 516

Part 5

Othon Michail

UNIVERSITY OF LIVERPOOL

Presentations and Presentation Skills

Overview

- Some hints/advice on giving talks
- More information on CANVAS

- Purpose of presentations
- How to prepare one
- During a talk
- Advice on your MSc presentations
- Some examples - To do/Not to do (throughout)
- Discussion (throughout)
- To take home

Purpose of Presentations

To communicate a subject to some audience

- Different types of (subject, audience)
  - Research paper to expert researchers
  - Research to non-expert audience
  - MSc dissertation to supervisors
  - Scientific topic to undergraduates
  - Same topic to postgraduates
  - Same topic to lay audience

Preparation (1/4)

- Clear identification of (subject, audience) pair
  - What is to be communicated?
  - In what detail?
  - To whom?
  - What is their background and/or interests?

- Examples of what **not** to do:
  - Extremely technical talk to non-experts
  - An informal talk in a formal occasion
  - or the opposite

Example

Teaching a mathematical proof technique to undergraduate students (1 hour)

e.g.,

- how to analyse the worst-case running time of sequential algorithms
- how to prove that a problem is **NP**-complete

Question: How would you cover this?

More Examples

Discussing the various Internet Communication Protocols, undergraduate students (1 hour)

Question: How would you cover this?

Comparing the features of programming languages, undergraduate students (2 hours)

Question: How would you cover this?

Example

Demonstrating your MSc project, supervisors (20 minutes)

e.g., project includes:

- research, software development, evaluation

Question: How would you cover this?

Preparation (2/4)

- Study the subject well
  - Don’t have to know everything
  - Depth of study proportional to intended coverage detail
  - e.g., I don’t have to know all the theories of learning to give practical advice on presentations

Useful Advice

Audience rarely knows what the speaker knows about the presented subject

- Even experts or your supervisors

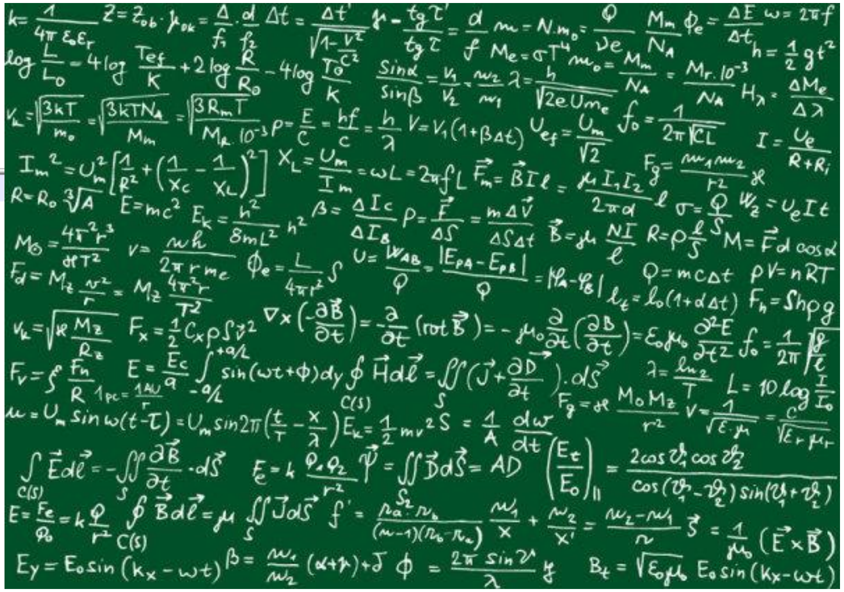
Audience cannot follow all the details in a talk

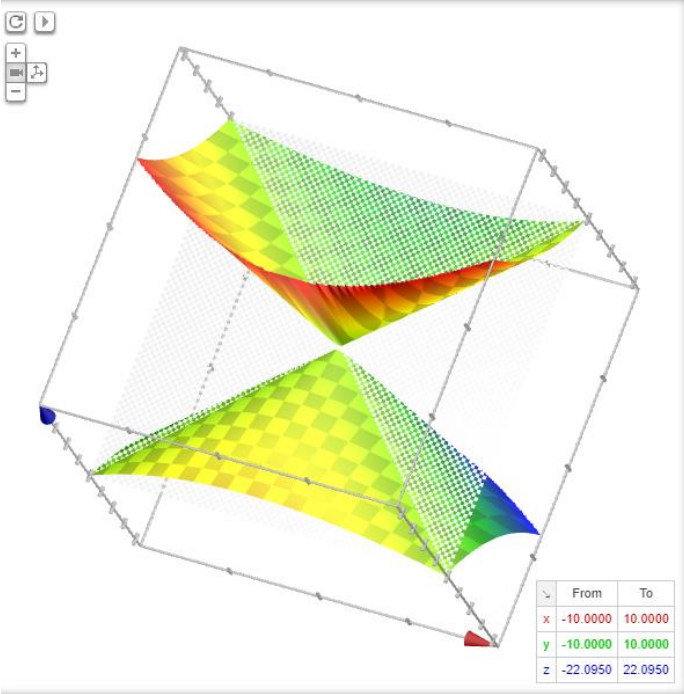
Helps to regard the audience as unintelligent!

- No point to keep going through complicated algorithms, formulas, proofs, code, …
  - At most one to show deepness and spend time on it

Only for Impression!

```java
import java.io.*;
import java.net.*;

public class KnockKnockClient {
    public static void main(String[] args) throws IOException {

        if (args.length != 2) {
            System.err.println(
                "Usage: java EchoClient <host name> <port number>");
            System.exit(1);
        }

        String hostName = args[0];
        int portNumber = Integer.parseInt(args[1]);

        try (
            Socket kkSocket = new Socket(hostName, portNumber);
            PrintWriter out = new PrintWriter(kkSocket.getOutputStream(), true);
            BufferedReader in = new BufferedReader(
                new InputStreamReader(kkSocket.getInputStream()));
        ) {
            BufferedReader stdIn =
                new BufferedReader(new InputStreamReader(System.in));
            String fromServer;
            String fromUser;

            while ((fromServer = in.readLine()) != null) {
                System.out.println("Server: " + fromServer);
                if (fromServer.equals("Bye."))
                    break;

                fromUser = stdIn.readLine();
                if (fromUser != null) {
                    System.out.println("Client: " + fromUser);
                    out.println(fromUser);
                }
            }
        } catch (UnknownHostException e) {
            System.err.println("Don't know about host " + hostName);
            System.exit(1);
        } catch (IOException e) {
            System.err.println("Couldn't get I/O for the connection to " +
                hostName);
            System.exit(1);
        }
    }
```





Preparation (3/4)

- Decide
  - What to cover
  - In what detail
  - How to present (e.g., visual aids: board, slides)
- Depends on
  - Subject/Purpose
  - Audience
  - Time

Preparation (4/4)

- Prepare slides and/or notes
- Practice your talk
  - Go through the slides/notes trying to act as if in front of the audience
  - Prepare what to be said for each item included
  - Speak out loud if that helps
  - The more you practice the more you will remember
  - If there is a chance to forget leave hints on slides

Slides (1/2)

- Choose a software and a style
  - Latex, Powerpoint, Keynote
- Emphasise with colour
  - Be careful with the selection of colours and fonts
- Structure the slides
  - Title/Speaker/Venue
  - Overview
  - Main body: Start from more simple/abstract, make it deeper as it goes and if needed
  - Conclusions

Slides (2/2)

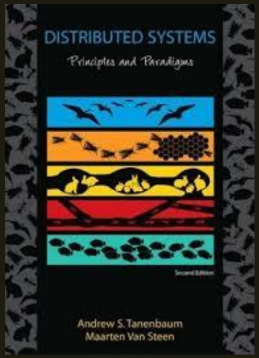
- Expect on average no more than 1 slide/minute
- Don't make the slides too dense
- Improve focus by
  - making items appear one at a time or
  - by using a pointer

a slide that does not serve its purpose.

A distributed system is: A collection of *independent* computers that app-ears to its users as a *single coherent system.*

A distributed system is one in which the failure of a computer you didn't even know existed can render your own computer unusable

- Examples of Distributed Systems: University computer network, The Internet, Workflow in-formation system, Distributed manufacturing system, Hadoop (http://hadoop.apache.org/), computer clusters , distributed file systems, Banks (Cash machines), Ticket reservation systems.
- More Examples:
  - Example 1.
    - More on example 1.
      - A few more things.
        - » *Further Clarifications* on this.
  - Example 2.
    - More on example 2.
  - Example 3.
    - More on example3.
  - Example 4.
  - Example 5.



Being Prepared for the Worst

Things can go wrong

- Usually happens when it shouldn't!

Scenario:

- Top international conference
- Slides appear like a mesh (incompatibility)
- Time pressure

What would you do?

About You

- Giving a talk is a performance
- Be relaxed
  - Being stressed during the talk doesn’t help
  - But don’t be indifferent
  - Cannot avoid some stress before and in the first minutes
- Whatever happens stay calm
  - Humour also helps
- Communicate your enthusiasm about the topic
  - If you do have
  - Even if not, try to make the audience feel enthusiastic about it

You and the Audience (1/2)

- Remember: People are there to get something from you
- Even your supervisors are curious to see
  - What did you implement?
  - How?
  - Any novelties, challenges
- Be prepared for all types of questions
  - Don’t treat any question as “stupid”
  - Your role is just to answer them
  - Don’t pretend that you know everything
  - Much better to say “maybe” or “could be a possibility” than support something you are not sure about

You and the Audience (2/2)

- Be fair
  - Treat people equally
- Be polite and friendly
  - People attending are not your enemies
  - They shall spend some time listening to you therefore they deserve respect
- Get them involved if possible and if time permits
  - But don't put pressure on them
  - Maybe they are not prepared or have not followed your talk
  - Could leave it on a voluntary basis

Example

Speaker A

- Expert
- Not well prepared
- Strict
- Feels insulted by "stupid" questions

Speaker B

- Non-expert but informed
- Well prepared
- Friendly
- Loves to trigger questions/discussion

Question: Who has better chances to effectively communicate the subject?

Example

Speaker A

- Indifferent for the subject
- Knows what may enthuse the audience
- Emphasises these without missing the rest
- Relaxed but not boring

Speaker B

- Loves the subject
- Very enthusiastic
- Stressed to cover as much as possible
- Speaks fast
- No pauses or time for thought

Question: Who has better chances to effectively communicate the subject?

Your MSc Presentations

- Don’t forget to make absolutely clear:
  - What you’ve done
  - How you did it
  - Anything exceptional, any challenges, deviations from what was planned
  - Give the “big picture” without missing important details
- In case of the final demonstration
  - Don’t forget to do the demonstration!
  - Remember: This is an important day for you; treat it as such
- Keep track of time
  - Don’t spend all your time on 5/20 slides
  - Don’t finish too early
  - Practice at home and have a watch

To Take Home (1/2)

- Be well informed and well prepared
- Take into account the (subject, audience) pair
- Make nice/clear/simple slides
- Practice a lot
- Be aware that some “talent” is also involved
  - Don’t be disappointed if others can do better with less effort
  - Just achieve your own maximum

To Take Home (2/2)

- Don’t be nervous and don’t panic
  - Remember: You are the expert on your subject
  - Keep it as simple and clear as possible
  - Always give the “big picture”: Don’t let the audience get lost in details
  - Instead of showing them 100 individual trees, show them the forest
- Treat your audience fairly, politely, and friendly
- Experience helps all these

"My teacher said I don't pay enough attention in class.
At least, that's what I think she said."

COMP 516
Research Methods in Computer Science

Othon Michail

Department of Computer Science
University of Liverpool

with material from Ullrich Hustadt, Rahul Savani, and Dominik Wojtczak

Academic Writing

The format of your MSc project specification

- sections should be of roughly equal size
  sections that are reasonably balanced are easier to read
- figures & tables should have a caption
  and must be referred to in the text
- too many footnotes can be problematic because the reader is distracted by jumping to the bottom of the page and back to the main text
- remarks in parentheses tend to distract and should be used sparingly; they can often be omitted, or the parentheses removed

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- for longer technical documents, most readers never go beyond it
- if the introduction is good, they may feel encouraged to read on
- the introduction is also the hardest part to write, and has to be rewritten several times
- good rule structuring arguments: answer sequences of what - why - how questions
- always state what you are talking about first before justifying it or diving into details

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- if the introduction is good, they may feel encouraged to read on
- the introduction is also the hardest part to write, and has to be rewritten several times
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The introduction: common mistakes

- Exaggerated claims, which may sound naive

  Adopt a neutral tone, and remain careful and factual

- Assuming too much knowledge from your reader

  You have immersed yourself in the topic, but your reader has not

  Be aware of that, and explain and introduce your topic in a comprehensible way

- Unclear medley of exposition, subject history, and related work

  Deal with these aspects separately, postpone exposition

  State early what you intend in your project

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The references and citations

- mandatory that you cite your sources; otherwise, you plagiarise
- do not present something obtained from someone else as new
- also avoid making that impression inadvertently
- if you use someone else's wording verbatim, say so explicitly

  "The following definition is taken verbatim from [X]."
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- an expert reader will recognise familiar references quickly, and also notice omissions
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The writing process

- main writing effort goes into organisation and re-writing
- it is impossible to write a perfect proposal in one go
- you have to start somehow, and will produce a version that you do not like
- however, you need that mediocre version as a basis for writing a better one
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What do I want to say?

- in most cases, when you get stuck when writing, you do not know exactly what you want to say
- make that idea clear in your mind first, then write it
- often, you can be unhappy with a piece of text because one thought led to another, but you wound up somewhere unintended
- if you know what you want to say, then you know early if you are going in the right direction

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- dedicate one paragraph to one topic at a time
- get directly to the point
- do not worry too much about gluing the new paragraph to the previous one
- a clear structure holds the text together, not phrases
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- A reference should be as close as possible to the statement that it supports (but do not repeat the same reference over and over after each statement)
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- A reference never comes after a full stop (exception: block quotes)
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A good project should support its claims and only state considered opinions.

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Polishing Your Writing

- Our goals
  Clarity, coherence, authority, and readability
- Keep sentences short
  - Keep your sentences 15-20 words long on average
  - Rule of thumb: only two lines for a sentence
  - Use only one idea in a sentence
- Prefer the simple to the complex
  - Go for simplicity in writing: simple words and simple ideas
  - The KISS principle, Keep It Simple and Straightforward
- Think of unnecessary words as redundancies

Weasel words

Words that sound good without conveying information; they obscure precision.

http://en.wikipedia.org/wiki/Weasel_word

- salt and pepper words
- beholder words
- lazy words

Salt and pepper words

Look and feel like technical words, but convey nothing.

Examples: various, a number of, fairly, quite, ...

Sentences that cut these words out become stronger

- Bad: It is quite difficult to find untainted samples.
- Better: It is difficult to find untainted samples.

- Bad: We used various methods to isolate four samples.
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Beholder words

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Examples: interestingly, surprisingly, remarkably, clearly

- Bad: False positives were surprisingly low.
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- Even better: To our surprise, false positives were low (3%).

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Are inserted to avoid making a quantitative characterization.

Make the science feel infirm and unfinished.

Worst offenders: very, extremely

Never use these in technical writing

More examples: several, exceedingly, many, most, few, vast

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Many readers are not aware that the
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Read that same text again, but with different line breaks:

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- are there conflicting goals in a certain piece of text (e.g., two different types of audience)?
- are you getting lost in details on a side point?
- do you need a new piece of terminology here and should you introduce it much earlier?
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– Michael Crichton

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COMP 516
Research Methods in Computer Science

Othon Michail

Department of Computer Science
University of Liverpool

with material from Ullrich Hustadt, Rahul Savani, and Dominik Wojtczak

Legal, Social, Ethical and Professional Issues

Relevant module aims and learning outcomes

Module aim:
To introduce students to concepts of professional ethics
as well as social and legal aspects of computing

Module learning outcome:
Appraise professional, ethical, legal and social issues
related to the work of a professional within the IT industry
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IT Context

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- Development and application of information technology happens in a
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  - Social
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- This in turn implies that knowledge of these constraints is necessary
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Social Context

- Ownership
  - What can you own? Things, Rights, Ideas?
  - Can you fully or partially transfer ownership?
    How? To whom? When? With what restrictions?
  - What rights, responsibilities, and liabilities does ownership carry?
- Participation
  - What rights to participate in society does an individual have?
  - What rights, responsibilities, and liabilities come with participating in or being part of a society?
- Employment
  - What contractual arrangements are allowed?
  - What rights, responsibilities, and liabilities do employers and employees have?

Social Context

- Governance
  - What mechanisms are there to adjust cultural, social, and legal constraints
    in a changing social context?
  - What mechanisms are used to enforce cultural, social, and legal constraints?
- Security and Privacy
  - How many of your rights and those of others are you willing to sacrifice for your safety?
  - How much privacy are you entitled to?

Social Context

IT professionals

- need to have an awareness of these questions and a rough idea what the answers are, possibly for a range of different societies
- might need to work out the answers to these questions from first principles due to the innovative nature of information technology
- can affect the answers to these questions due to the disruptive nature of information technology

Ethics

Morality and Ethics

- It is a commonly held belief that actions can be classified into right or wrong
- Is also a commonly held belief that in every society there are rules which tell you in advance whether an action is right or wrong
- These rules are called morality
- Ethics is the philosophical study of morality, a rational examination into peoples moral beliefs and behaviour.
- If there is no society then are there no rules?
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Ethical Theories

1. Subjective relativism
2. Cultural relativism
3. Divine command
4. Kantianism
5. Act utilitarianism
6. Rule utilitarianism
7. Social contract theory
8. . . .

The perfect ethical theory

- A perfect ethical theory would tell us once and for all how we ought to behave in all kinds of situations
- However, so far nobody has been able to devise such a perfect ethical theory
- Thus, moral behaviour is still something to strive for without unequivocal guidance on what is right or wrong

Professional Ethics

Professions: Characteristics

- Substantial education and / or training are required in order to practise a profession
- The members of a profession themselves decide the nature of this education and training
- The members of a profession sometimes also control entry to the profession
- A profession is typically organised into one or more professional bodies
- A profession lays down standards of conduct with which its members must comply

Professional Bodies in Computing

- Institute of Electrical and Electronic Engineers Computer Society (IEEE-CS) founded in 1946 in the USA
  $\rightsquigarrow$ "world's leading computing membership organization and the trusted information and career-development source for a global workforce of technology leaders"

- Association for Computing Machinery (ACM) founded in 1947 in the USA
  $\rightsquigarrow$ "world's largest educational and scientific computing society, uniting educators, researchers and professionals"

- BCS (British Computer Society), The Chartered Institute for IT, formed in 1957; received a royal charter in 1984
  - Recognised as a professional engineering institute for the registration of information systems and software engineers
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Professional Bodies in Computing

- Institute of Electrical and Electronic Engineers Computer Society (IEEE-CS) founded in 1946 in the USA
  - $\rightsquigarrow$ "world's leading computing membership organization and the trusted information and career-development source for a global workforce of technology leaders"
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British Computer Society

- Chartered Scientist is a professional qualification in the UK, holders can use the post-nominal letters CSci
- the required standard for Chartered Scientist registration is MSc qualification (or equivalent) with four years of postgraduate work experience

To be a Student Member the fee is 30 pounds per year and

- you have to be a student on a BCS accredited degree programme

To become a Professional Member (MBCS): 106 pounds per year

- 5 years IT work experience, or
- 2–3 years IT work experience plus relevant recognised qualifications (depending on level of qualification), or
- an Honours degree with BCS exemption

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Professional Ethics

- More restrictive than universal ethics because
  - it involves the more restrictive society/culture of work and commerce
  - it determines right/wrong in cases where a general ethical theory might not do so
- Applies also to other restrictive social contracts such as study
- Many flavours of professional ethics exist:
  medical, engineering, banking, etc
- Often associated with formal structure
  BMA (medicine), IET (engineering), BCS (computing)
- Often formally constructed rules and codes of conduct
  Hippocratic oath taken by doctors

The IT Professional Context

- Legal obligations
- Social obligations
- Ownership/sharing obligations
- IP obligations

- Product development process obligations
- Product quality obligation
- Product consequence obligations

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BCS Code of Conduct

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Four component parts:

1. Public Interest
2. Professional Competence and Integrity
3. Duty to Relevant Authority
4. Duty to Profession

(http://www.bcs.org/upload/pdf/conduct.pdf)

- Contents of the Code of Conduct changes frequently
  $\rightsquigarrow$ BCS members need to keep up to date with such changes
- Code of Conduct is complemented by a Code of Good Practice
  http://www.bcs.org/upload/pdf/cop.pdf

Public Interest

- Safeguarding public health and safety
- Have due regard for the legitimate rights of third parties
- Conduct your professional activities without discrimination
- Promote equal access to the benefits of IT

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Professional Competence and Integrity

- Only undertake work that is within your professional competence
- Do not claim any level of competence that you do not possess
- Upgrade and maintain knowledge, skills and competence on a continuing basis
- Respect and value alternative viewpoints and, seek, accept and offer honest criticism of work
- Avoid injuring others, their property, reputation, or employment by false or malicious or negligent action or inaction
- Reject and do not make any offer of bribery or unethical inducement

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Duty to Relevant Authority

- Carry out your professional responsibilities with due care and dilligence in accordance with the Relevant Authority's requirements whilst exercising your professional judgement
- Avoid any situation that may give rise to a conflict of interest between you and your Relevant Authority and clients
- Accept professional responsibility for your work and for the work of colleagues under your supervision
- Respect confidential information
- Be honest about products and services and do not take advantage of a lack of knowledge or inexperience of others

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Duty to the Profession

- Accept your personal duty to uphold the reputation of the profession
- Seek to improve professional standards through participation in their development, use and enforcement
- Uphold the reputation and good standing of BCS, the Chartered Insitute for IT
- Act with integrity towards other professionals
- Notify BCS if convicted of a criminal offence or becoming bankrupt or disqualified as a Company Director
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Standards and Standardisation

Standards and Standardisation

- Standards are written agreements on some technical matter that seeks to ensure that what is governed is fit for purpose
- In information technology, standards deal with
  - Protocols
  - Data formats
  - (Programming) Languages
    - Syntax
    - Semantics
    - Technical aspects
- (Proper) standards are devised by standards organisations
- Proprietary 'standards' are typically devised by companies and accepted due to the company's market power

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Standards Organisations

- ISO — International Standards Organisation
  `http://www.iso.org/`
- ANSI — American National Standards Institute
  `http://www.ansi.org/`
- CEN — Comitté Européen de Normalisation
  `http://www.cenorm.be/cenorm/`
- BSI — British Standards Institute
  `http://www.bsonline.bsi-global.com`
- IETF — Internet Engineering Task Force
  `http://www.ietf.org/`

ISO: International Standards Organisation

- A federation of national standards bodies from some 130 countries
- Non-governmental
- Established in 1947
- ISO's work results in international agreements which are published as International Standards
- Among those are standards for programming languages (C, C++, Ada) and processes (quality assurance ISO 9001)

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Enforcement of standards

- Some standards are enshrined in (national) laws and regulations
  $\rightsquigarrow$ mainly measurements and safety standards
  $\rightsquigarrow$ enforcement overseen by standards organisation or other (government) organisations, and the legal system

  Examples: 'Kilogram', 'Metre', 'Class 1 banana'

- Proprietary 'standards' as well as standards devised by standards organisations can be enforced using trademarks

  Example: 'Java' and 'Wi-Fi' are both trademarks
  Products (Java Virtual Machines, Wireless devices) have to pass compliance tests before vendors are allowed to use these trademarks

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- Some standards are enforced by the requirement for interoperability in the market

  Example: An e-mail client that does not correctly implement RFC 2821 (Simple Mail Transfer Protocol) and RFC 3501 (IMAP) will not succeed in the market

  Enforcement is often only partial

  Example:
  SQL is standardised
  Currently SQL:2011 (ISO/IEC 9075(1-4,9-11,13,14):2011)
  Vendors (Oracle, Microsoft) implement
  a 'superset of a subset' of SQL:2008 (precursor of SQL:2011)
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Legal issues

Legal Issues

- Copyright, Designs and Patents Act, 1988
- The Copyright and Related Rights Regulations, 2003
- Electronic Commerce (EC Directive) Regulations, 2002
- The Privacy and Electronic Communications (EC Directive) (Amendment) Regulations, 2011
- Conspiracy to Defraud
- Computer Misuse Act, 1990
- Data Protection Act, 1984, 1998
- Equality Act, 2010

Intellectual Property

Intellectual Property (Oxford Dictionaries Online)

A work or invention that is the result of creativity, such as a manuscript or a design, to which one has rights and for which one may apply for a patent, copyright, trademark, etc

Intellectual Property (Wikipedia)

A term referring to a number of distinct types of creations of the mind for which a set of exclusive rights are recognised—and the corresponding fields of law.

Common types of intellectual property rights include

- copyrights
- industrial design rights
- patents
- trade marks

Intellectual Property

	Patents	Trade marks	Designs	Copyright
What is protected	Inventions	Brand identity, including words, logos, and other signs	What a product looks like	Music, art, film, literary works and broadcasts
Protects against	invention being used, sold, manufactured	use of trade mark by others without permission	product being manufactured, sold or improved	work being copied or reproduced in communication or performance
Term	Up to 20 years (annual renewal)	Rights can last forever (renewal very 10 years)	Up to 25 years	Life plus 70 years

Copyright, Designs and Patents Act, 1988

Copyright is a property right which applies to

- original literary, dramatic, musical or artistic works

  literary work covers computer programs, song lyrics

  dramatic work covers work of dance or mime

  musical work covers music exclusive of lyrics, dance, mime

- sound recordings, films, broadcasts or cable programmes

  sound recording is a recording of sounds, from which the sounds may be reproduced, regardless of the medium

- the typographical arrangement of published editions

Copyright lies with the author of a work, or, if the work has been created by an employee in the course of his employment, with the employer

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Duration of copyright

- literary, dramatic, musical or artistic works
  - 70 years from the end of the calendar year in which the last remaining known author of the work dies, or
  - 70 years from the end of the calendar year in which a work was created or made public, whichever occured later, if the work is of unknown authorship

But, if the work is computer-generated copyright expires at the end of the period of 50 years from the end of the calendar year in which the work was made

An author is unknown if it is not possible for a person to ascertain his identity by reasonable inquiry

Note: These rules also apply if the owner of the copyright is the employer of the authors

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  - 50 years from the end of the calendar year in which the work was created, or,
  - 50 years from the end of the calendar year in which the work was first released, if the work is released within 50 years of being created
- films
  - 70 years from the end of the calendar year in which the last known principal director, author or composer dies, or
  - 70 years from the end of the calendar year in which the film was created or made public, whichever occured last, if neither principal director, author or composer are known
- typographical arrangement of published editions
  - 25 years from the end of the calendar year in which the work was first published

The Copyright, Designs and Patents Act, 1988

- Copyright restrictions what actions one might perform with copyrighted work
- The owner of the copyright in a work has the exclusive right
  (a) to copy the work
  (b) to issue copies of the work to the public
  (c) to rent or lend the work to the public
  (d) to perform, show or play the work in public
  (e) to communicate the work to the public

What is a copy? What is copying?

- In most cases, copying does not mean the production of a facsimile
- In most cases, copying does not mean the reuse of ideas or information

- Copying in relation to
  - a literary, dramatic, musical or artistic work
    means reproducing the work in any material form,
    including storing the work in any medium by electronic means
  - a film or broadcast
    includes making a photograph of the whole or any substantial part of any image forming part of the film or broadcast
  - the typographical arrangement of a published edition means making a facsimile copy of the arrangement

The Copyright, Designs and Patents Act, 1988

States

The owner of the copyright has exclusive right to copy the work

- There are no fair use or private copy exceptions in UK law
- But fair dealings with copyright works in the form of quotations and excerpts are allowed provided
  - quoted material is justified
  - the source of the quoted material is acknowledged

  and the quotations and excerpts are used
  - for the purpose of a critical review or news reporting
  - for the purpose of non-commercial research or education
- Incidental copies
  (e.g., incidental recording of images or music in a home movie)
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The owner of the copyright has exclusive right to copy the work

It follows that it is illegal to

- copy or distribute software or its documentation without the permission or licence of the copyright owner
- run purchased software on two or more computer simultaneously unless the licence specifically allows it
- knowingly or unknowingly to allow, encourage or pressure employees to make or use illegal copies within an organisation
- infringe laws against unauthorised software copying because a superior, colleague or friend compels or requests it
- loan software in order that a copy be made of it

Copyright, Designs and Patents Act, 1988

States

> *The making of an adaptation of the work is an act restricted by the copyright in a literary, dramatic or musical work*

- In relation to a computer program, adaptation means an arrangement or altered version of the program or a translation of it

  Translation includes a version of the program in which it is converted into or out of a computer language or code or into a different computer language or code

- In relation to a database, adaptation means an arrangement or altered version of the database or a translation of it

Changing identifiers or swapping lines of code in a computer program creates an adaptation
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Exceptions for computer programes

But you can't do anything with a computer program without copying it!

- installing requires download or transfer from a storage medium
- execution requires copying into computer memory

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Lawful users of computer programs are guaranteed the right

- to use computer programs (includes transferring, installing, and running of programs)
- to make backup copies (only as necessary)
- to decompile computer programs in order to obtain information necessary to create an interoperable program (but not a similar program)
- to observe, study or test the functioning of the program in order to determine the ideas and principles which underlie any element of the program

Copyright, Designs and Patents Act, 1988

Other stipulations of the act deal with

- importing infringing copy other than for personal use – illegal
- providing means for making infringing copies – illegal
- devices designed to circumvent copy-protection – illegal

Copyright, Designs and Patents Act, 1988

- Patents in the UK cannot describe algorithms or mathematical methods, these are discoveries (also, laws of nature)
- But software that makes a technical contribution or solves a technical problem can be patented (e.g., the software that controls the engine or the brakes of your car)
- Software can be patented in some countries, most notably, the USA
- More than 40k software patents are issued each year in the USA
- Intended to give exclusive rights for a particular software technique
- Several infamous patents for software techniques exist that most experienced programmers consider to be trivial (e.g., using XOR to draw a cursor on a bitmap display)
- Becomes a problem if you export software or services to the USA

Trade marks

- A trade mark is a sign which can distinguish the goods and services of one organisation from those of another
- A sign includes words, logos, pictures or a combination of these
- Typically used as a marketing tool so that customers can recognise your products or services
- A trade mark gives the owner the legal right to take action against anyone who uses their mark or a similar mark on the same, or similar goods and services
- However it is allowed to use another person's trade mark to accurately identify the source of goods or services

Designs

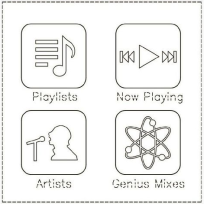
- Designs relate to the physical appearance of an industrial or handcrafted item
- Physical appearance includes lines, contours, colours, shape, texture, material
- To qualify, a design must be new and individual in character

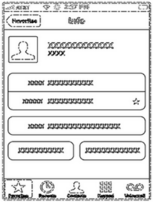
Designs: Apple iPad versus Samsung Galaxy Tab 10.1

A rectangular handheld mobile digital electronic device
with rounded corners
with colours grey, silver, and black
the colour grey appears as rectangle at the front, centre of the device (the screen)
substantial black borders on all sides of the grey rectangle being roughly equal in width
the colour silver appears as the outer border and sides of the device
a display of a grid of colorful square icons with uniformly rounded corners
a bottom row of square icons set off from the other icons and that do not change as the other pages of the user interface are viewed

Designs: Examples

Not only the design of devices can be protected, but also graphical user interfaces (GUIs) and their elements (e.g. icons)





Copyright and Related Rights Regulations, 2003

- Makes a whole series of amendments to the Copyright, Designs and Patents Act, 1988
- But also introduces a number of new provisions
- circumvention of a technical device for copyright protection – illegal
- removal or alteration of electronic rights management information – illegal
- distribution of a copyright work from which electronic rights management information has been removed – illegal
- An injunction can be granted against a service provider, where that service provider has actual knowledge of another person using their service to infringe copyright
  - actual knowledge may come about by receiving a notice of the copyright infringement under related regulations

⇝ see 'Injunctions Against Service Provides' (later)

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  The owner of the copyright has exclusive right to communicate the work to the public

- The Copyright and Related Rights Regulations, 2003 clarifies the notions of communication to the public (and of a broadcast)

Communication to the public

Includes

(a) the broadcasting of a work

(b) the making available to the public of a work by electronic transmission in such a way that members of the public may access it from a place and at a time individually chosen by them

Item (b) covers YouTube, BBC iPlayer, and similar services

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Copyright and Rights in Databases Regulations, 1997

- Databases are also literary works under the Copyright, Designs and Patents Act
- Additional protection is offered by the Copyright and Rights in Databases Regulations of 1997
- Applies to databases where a substantial amount of work was required to create the contents of the database
- Rights last for 15 years from the last substantial change
- Rights are infringed if
  - most or all of a database is extracted and reused without the consent of the owner, or
  - if small portions of a database are repeatedly extracted and reused without the consent of the owner

Electronic Commerce (EC Directive) Regulations 2002

Information society service (ISS)

Any service normally provided for remuneration, at a distance, by means of electronic equipment for the processing (including digital compression) and storage of data, and at the individual request of a recipient of a service

Service Provider

A person (company) providing an information society service

Electronic Commerce (EC Directive) Regulations 2002

- Regulations 6 to 16 deal with e-commerce activities of an ISS provider
- Regulations 17 to 18 limit the liability of an ISS provider in case they act
  - as mere conduit
  - in a caching role
  - as host
- Successful defense: David M. Rock and David P. Overton — TV-Links
  LINK TO THE ARTICLE

Electronic Commerce Regulations 2002: Mere Conduit

A service provider acts as mere conduit for a transmission if it

- did not initiate the transmission
- did not select the receiver of the transmission
- did not select or modify the information contained in the transmission

The transmission may include the automatic, intermediate and transient storage of the information transmitted where

- this takes place for the sole purpose of carrying out the transmission in the communication network
- the information is not stored for any period longer than is reasonably necessary for the transmission

A mere conduit is not liable for damages or for any other pecuniary remedy or for any criminal sanction as a result of that transmission

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Electronic Commerce Regulations 2002: Host

A service provide acts as host if

- it provides a service which which consists of the storage of information provided by a recipient of the service, and
- the recipient does not act under the authority of the service provider
- the service provide
  - does not have actual knowledge of unlawful activity or information and, where a claim for damages is made, is not aware of facts or circumstances from which it would have been apparent to the service provider that the activity or information was unlawful; or
  - upon obtaining such knowledge or awareness, acts expeditiously to remove
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The 'Cookie Law'

- Officially called 'The Privacy and Electronic Communications (EC Directive) (Amendment) Regulations 2011'
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  $\rightsquigarrow$ transactions often require (authenticated) sessions
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Information Commissioner's Office Guidance: LINK TO THE ARTICLE

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Injunctions Against Service Providers

Copyright, Designs and Patents Act 1988, Section 97A

The High Court (in Scotland, the Court of Session) shall have power to grant an injunction against a service provider, where that service provider has actual knowledge of another person using their service to infringe copyright

- 'Service provider' has the meaning given to it in the Electronic Commerce (EC Directive) Regulations 2002
- 'Actual knowledge' is also defined in terms of the provisions of the Electronic Commerce (EC Directive) Regulations 2002

Example:
Used by copyright holders to shut down sites or to force UK ISPs to block access to a site (e.g., Newzbin and The Pirate Bay)
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Conspiracy to Defraud

Conspiracy to Defraud is a common law criminal offence

A person is guilty of conspiring to defraud if

(a) that person agrees with any other person or persons that a course of conduct shall be pursued and

(b) that course of conduct will necessarily amount to or involve the commission of any offence or offences by one or more of the parties to the agreement if the agreement is carried out in accordance with their intentions

Example: A car mechanic helps a car dealer to reduce the mileage on a used car in order to obtain a better prize for it

Contention: Someone maintaining a link farm with links to copyrighted material is guilty of conspiracy to defraud

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- However, private prosecutions, initiated by an individual or private organization, are possible even where the CPS declines to prosecute
- The Federation Against Copyright Theft (FACT) is an organisation actively pursuing alleged cases of copyright infringement
- FACT will hire private investigators or use the police to gain access to information and computer hardware
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Computer Misuse Act, 1990

Defines three offences:

(1) Unauthorised access to computer material
Occurs if

(a) someone causes a computer to perform any function with intent to secure access to any program or data held in any computer,

(b) the access he intends to secure is unauthorised, and

(c) he knows at the time when he causes the computer to perform the function that this is the case

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Like (1) but with the intent to commit an offence or to facilitate the commission of such an offence

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Defines three offences:

(3) Unauthorised modification of computer material

Occurs if

(a) someone performs any act which causes an unauthorised modification of the contents of any computer; and

(b) at the time when he does the act he has the requisite intent and the requisite knowledge

Data Protection Act, 1998

- Repeals an earlier 1984 act
- Defines

  data is information which can be electronically processed or is recorded as part of a relevant filing system

  personal data means data which relate to a living individual who can be identified from that data (possibly together with other information)

  sensitive personal data is personal data relating to race, ethnicity, political opinions, etc.
- Regulates who may keep it, how, and who as access, especially the data subject
- Defines registration of data controllers and the role of audit
- Defines exemptions, charges and penalties, disclosure

Equality Act, 2010

The protected characteristics:
age; disability; gender reassignment;
marriage and civil partnership; pregnancy and maternity;
race; religion or belief; sex; sexual orientation.

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COMP 516
Research Methods in Computer Science

Othon Michail

Department of Computer Science
University of Liverpool

with material from Ullrich Hustadt, Rahul Savani, and Dominik Wojtczak

Project Planning and Risk Management

Introduction

Project Planning: Overview

- All projects consume resources including time and money in order to deliver a product of a particular scope and quality
- There is always a tension between the extent of resource input and the extent of product output
- There is also tension between project management activities and project development activities

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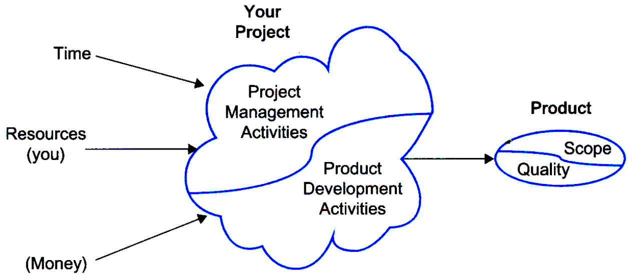

Main Project Activities

Project management

Concerned with

- planning the conduct of the project
- controlling and checking project progress
- monitoring milestones and deliverables
- managing risk

Should account for not more than 10% of overall effort

$\rightsquigarrow$ not evenly distributed; spend most of it towards the start!

'Product' development

Concerned with

- achieving the aims and objectives of the project
- producing the deliverables in accordance with the project plan
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From a project management perspective, projects proceed in five stages:

1. Definition
   Deciding on a project; making a project proposal
2. Planning
   Detailed planning of the project
3. Initiation
   Organising work (in particular, group work); literature survey
4. Control
   Monitoring the progress of the project
5. Closure
   Delivering/deploying result of the project; preparing final presentation; writing up reports

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Project definition

Project Definition: Aims and Objectives (1)

Clear specification of what the project is to achieve
$\leadsto$ definition of aims and objectives

Aims: Broad statement(s) of intent
Identify the project's purpose

Examples:

- Design a methodology for GUI development of technical courseware material
- Develop and evaluate an Artificial Neural Network to predict stock market indices

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Example aim:

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Objectives: Identify specific, measurable achievements
Quantitative and qualitative measures by which completion of the project can be judged

Example:

1. Complete a literature search and literature review of existing stock market prediction techniques
2. Develop a suitable Artificial Neural Network model
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4. Evaluate the model using appropriate statistical techniques
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Project Definition: SMART Objectives (1)

Each objective should be

- Specific
- Measurable
- Appropriate
- Realistic
- Time-related

Project Definition: SMART Objectives (2)

Example:

1. Complete a literature search and literature review of existing stock market prediction techniques

- Is it specific? Does it tells us what will be done?
- Is it measurable? How will we know to what extent and to what quality the objective has been completed?
- Is it appropriate? Is it related to and in support of our aims?
- Is it realistic? Can we realistically expect to achieve this objective?
- Is it time-related? Have we identified how long the task will take and when we will complete it?

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Project planning

Project Planning

Objectives of project planning

- Identifying the tasks that need to be done
- Clarifying the order in which tasks need to be done
- Determining how long each task will take
- (Redefining the project if there are problems)

Steps of project planning

1. Work breakdown
2. Time estimates
3. Milestone identification
4. Activity sequencing
5. Scheduling
6. Replanning

Project Planning

Objectives of project planning

- Identifying the tasks that need to be done
- Clarifying the order in which tasks need to be done
- Determining how long each task will take
- (Redefining the project if there are problems)

Steps of project planning

1. Work breakdown
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Running Example

Example aim:

Develop and evaluate an Artificial Neural Network to predict stock market indices

Example objectives:

1. Complete a literature search and literature review of existing stock market prediction techniques
2. Develop a suitable Artificial Neural Network model
3. Identify and collect suitable data for analyses and evaluation
4. Evaluate the model using appropriate statistical techniques
5. Complete final report

Steps of project planning

1. Work breakdown
2. Time estimates
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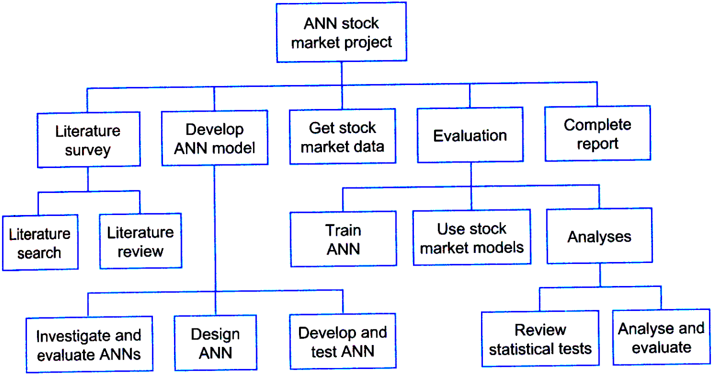
Work Breakdown (1)

- First step of project planning: Identify the tasks that need to be done
- Starting point(s) should be the objectives of the project;
  Then break your objectives down into lower and lower levels of detail
- Work breakdown structures are used to visualise the process of breaking down the project

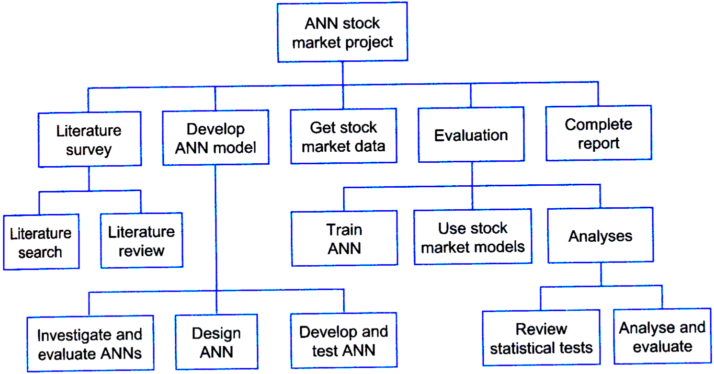
Work Breakdown (1)

- First step of project planning: Identify the tasks that need to be done
- Starting point(s) should be the objectives of the project;
  Then break your objectives down into lower and lower levels of detail
- Work breakdown structures are used to visualise the process of breaking down the project



Work Breakdown (2)

- Tasks at all levels need to be separate from one another
- Continue to break down your project into smaller tasks until each task takes up no less than 5% of the total effort



Steps of project planning

1. Work breakdown
2. Time estimates
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Terminology

The effort required to complete a task is the actual number of hours we need to spend on the task to get the job done.

The duration spans from when the task was first started until is is completed. So a task may require 96 hours (4 days) of work, but it may have a duration of

- 2 weeks if only one person works on it 8 hours a day 6 days per week;
- 1 week if two persons work on it in parallel with that workload.

Terminology

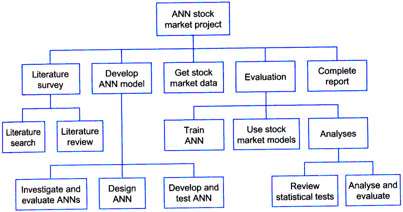
Every task is important, but only some of them are critical. The critical path is a chain of linked tasks that directly affects the project finish date. If any task on the critical path is late, the whole project is late.

Float (also known as slack) helps you find those tasks that can be delayed without changing the end date of your project. It is defined as the amount of time a task can be delayed for without affecting the critical path.

Time Estimates

- Make reasonably accurate predictions of
  - the effort needed for completion and
  - the duration until completion

  of each leaf node of the work breakdown structure
- If the estimate exceeds the total time available for the project, then either modify the objectives and work breakdown or reduce and reallocate time between tasks



Activity	Effort	Duration
Literature search	2 weeks	8 weeks
Literature review	2 weeks	4 weeks
Investigate and evaluate ANNs	2 weeks	4 weeks
Design ANN	2 weeks	4 weeks
Develop and test ANN	2 weeks	2 weeks
Get stock market data	1 week	1 week
Train ANN	1 week	1 week
Use stock market models	1 week	2 weeks
Review statistical tests	1 week	2 weeks
Analyse and evaluate	4 weeks	4 weeks
Complete report	8 weeks	8 weeks
Total	26 weeks	40 weeks

Steps of project planning

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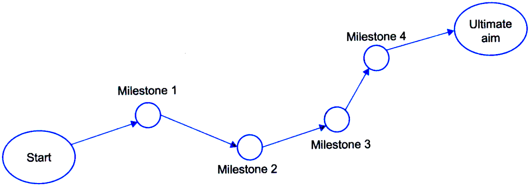
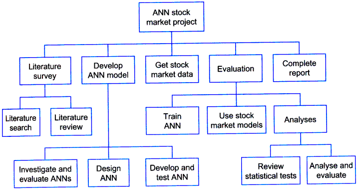
Milestone Identification

- Milestones are significant steps towards the completion of the project
  ⇝ intermediate goals at which to aim

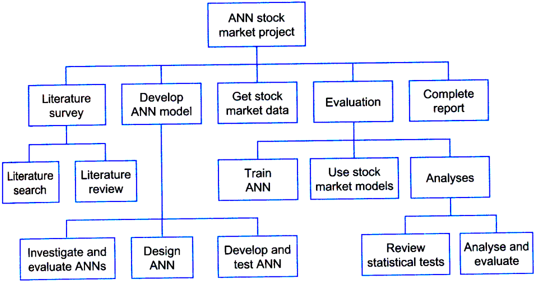




M1	Completion of literature review
(M2	Completion of ANN development)
(M3	Completion of evaluation)
M4	Completion of project/report

Activity Sequencing

- The work breakdown structure does not state in which order tasks are performed

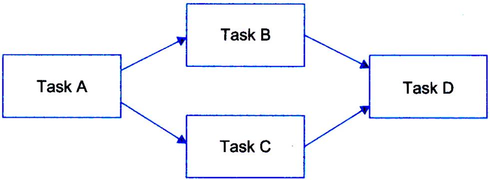


- To represent the order and inter-dependency of tasks we can use activity networks
  - Activity-on-the-node diagrams
  - Activity-on-the-arrow diagrams

Activity-on-the-node Diagrams

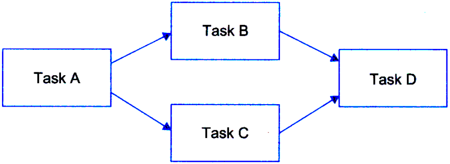
- Tasks are represented by rectangular nodes
- Milestones are represented by diamond-shape nodes
- Arrows indicate the order in which they need to be performed

Example:



- Task A has to be completed before tasks B and C can start
- Task B and C can be done independently (in parallel)
- Task D can only start once both tasks B and C have been completed

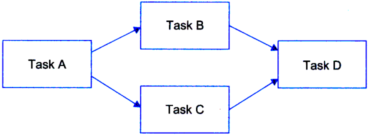
Activity-on-the-node Diagrams: Start and End Dates



- Assume we estimate effort and duration for the four tasks as follows

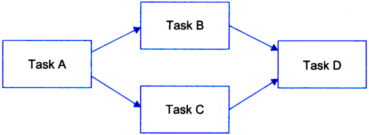
Activity	Effort	Duration
Task A	2 weeks	4 weeks
Task B	2 weeks	4 weeks
Task C	2 weeks	4 weeks
Task D	2 weeks	3 weeks

- Also assume
  - the project starts on 1 January
  - each month has four weeks
  - there are no breaks, holidays, etc
- What is the start date for each of the tasks?



Activity	Effort	Duration
Task A	2 weeks	4 weeks
Task B	2 weeks	4 weeks
Task C	2 weeks	4 weeks
Task D	2 weeks	3 weeks

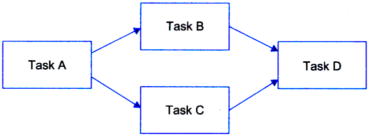
Activity	Start Date
Task A	Jan 1
Task B	Feb 1
Task C	Feb 1
Task D	Mar 1



Activity	Effort	Duration
Task A	2 weeks	4 weeks
Task B	**3 weeks**	4 weeks
Task C	2 weeks	4 weeks
Task D	2 weeks	3 weeks

Activity	Start Date
Task A	Jan 1
Task B	Feb 1
Task C	Feb 1
Task D	Mar 1 or Mar 8?

We need to consider our ability to do activities in parallel



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Activity-on-the-node diagrams: Critical Path

- Critical path: Longest-duration path through a network
  $\rightsquigarrow$ identifies the tasks in the project that must not be delayed
- Determination of critical paths:
  - Determine earliest start dates for activities
  - Work backwards from the end to the start
  - As long as there is only one preceding task, this task must be on the critical path
  - If there is more than one preceding tasks, only the task(s) which force the start time of the next task are on the critical path

  $\rightsquigarrow$ there can be more than one critical path

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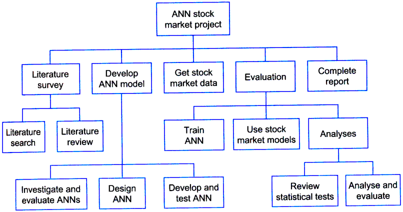
Developing an activity diagram

Example

- Our goal is to construct an activity-on-the-node diagram for the example stock market project based on our example project



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Total	26 weeks	40 weeks

Dependencies

$2 \to 1$	$7 \to 5 \to 4 \to 3$	$8 \to 6$
$11 \to 10 \to 9 \to 8$	$9 \to 7 \to 6$	$8 \to 2$

Milestones

M1	Completion of literature review
M4	Completion of project/report

- Determine start dates for each task
- Determine the critical path(s) for this project

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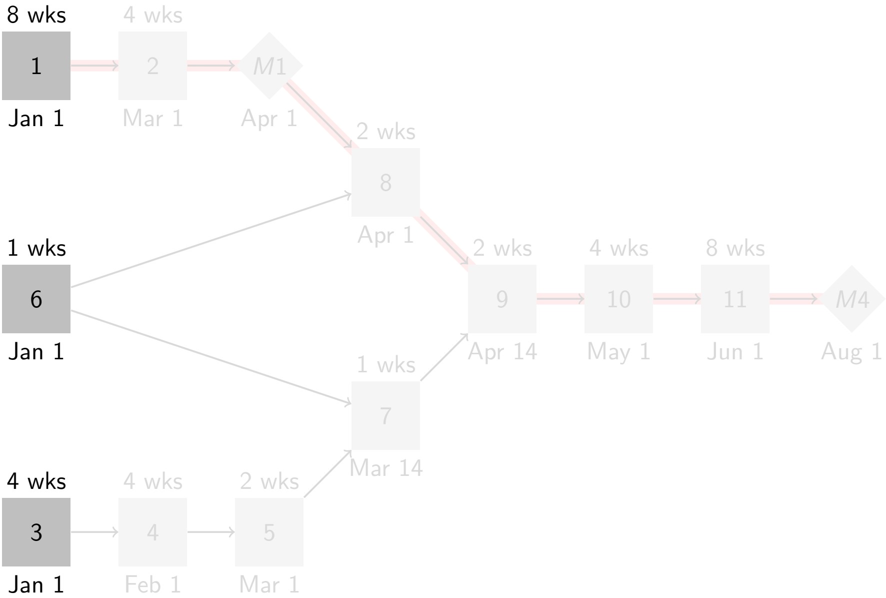
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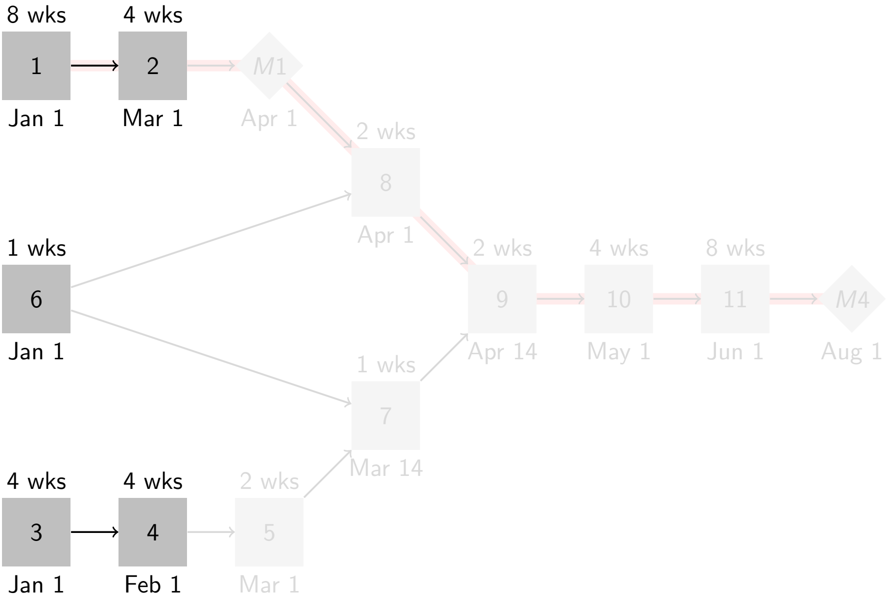
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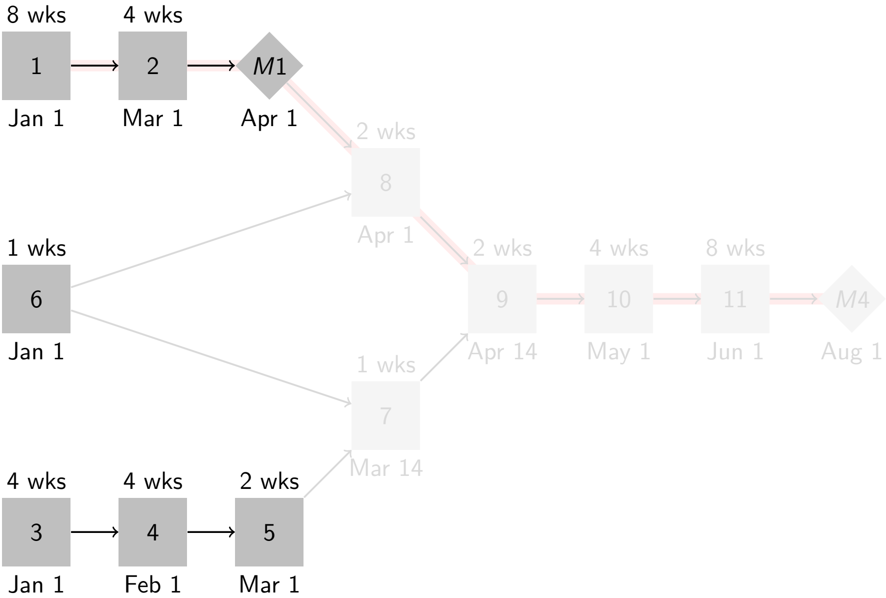
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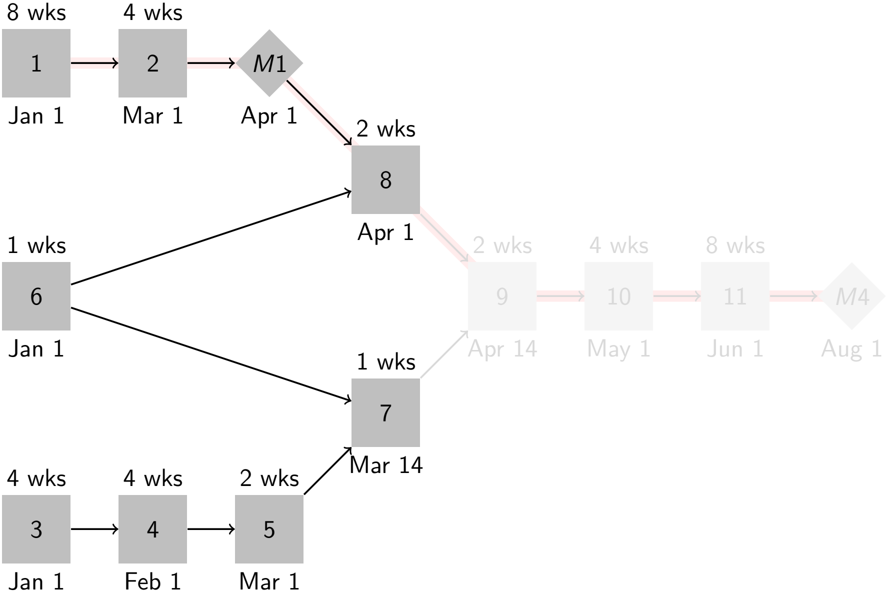
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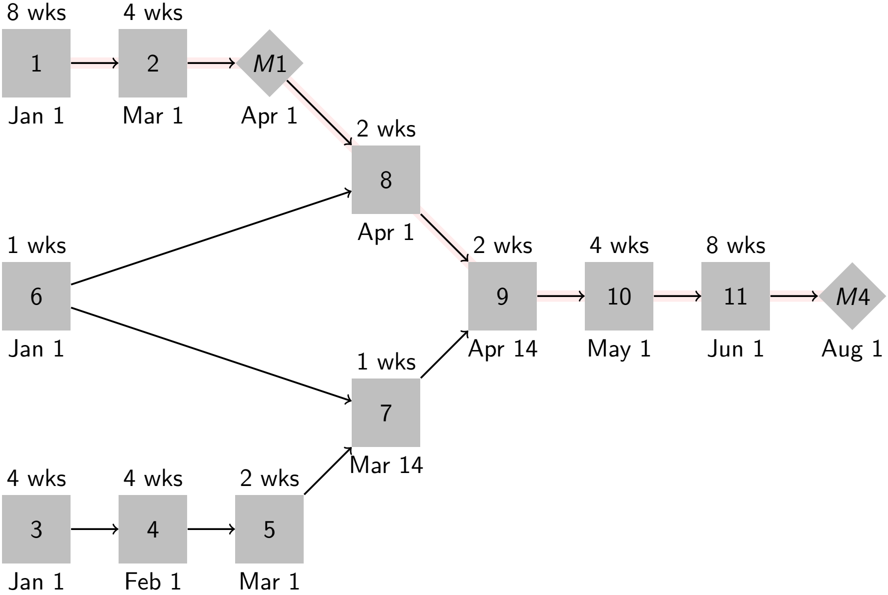
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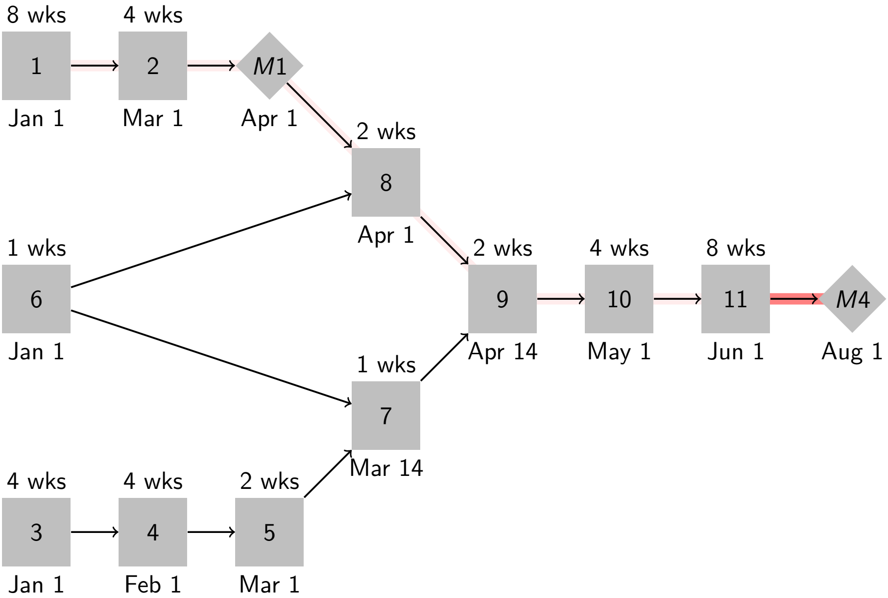
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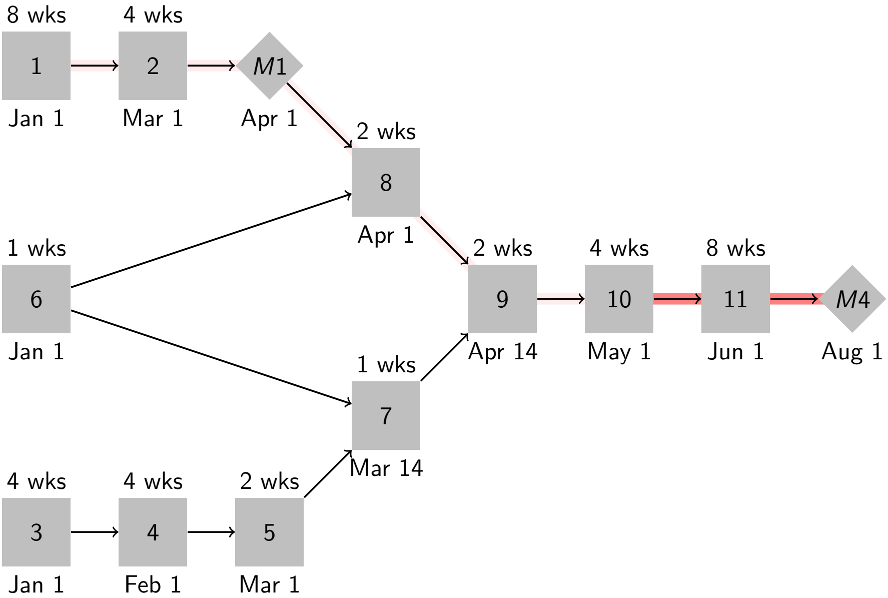
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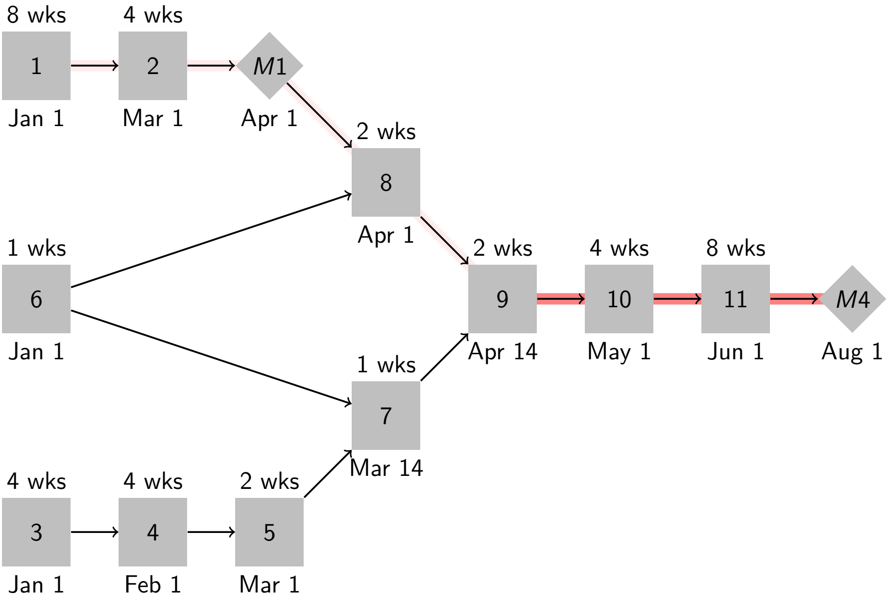
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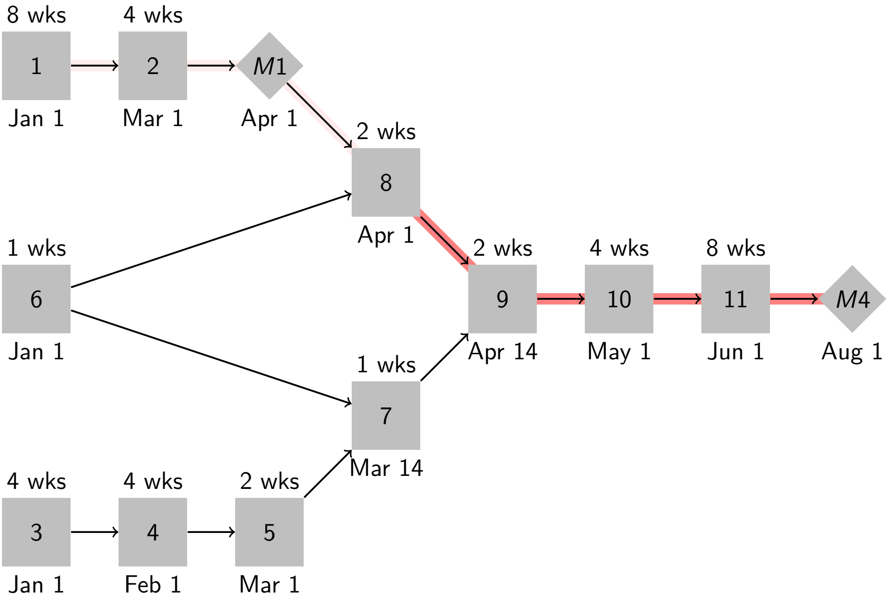
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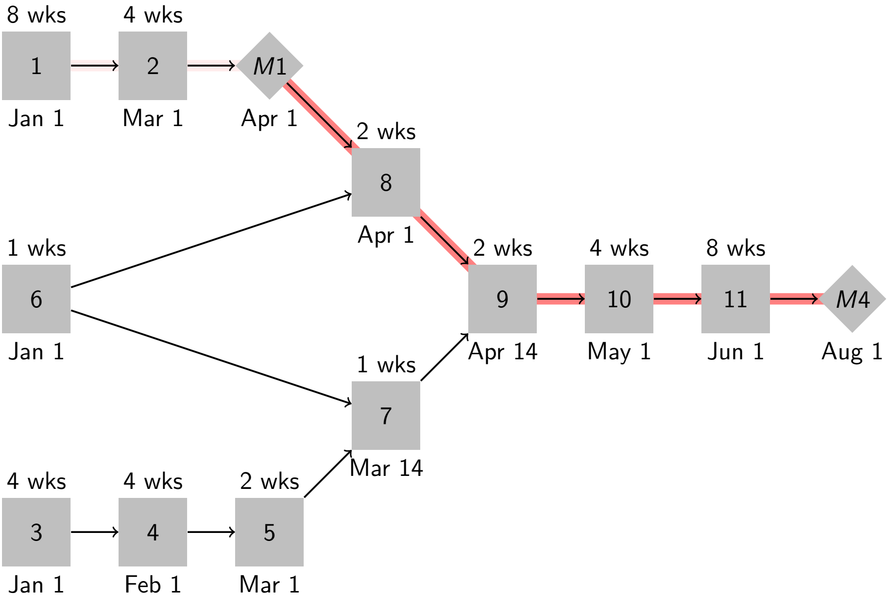
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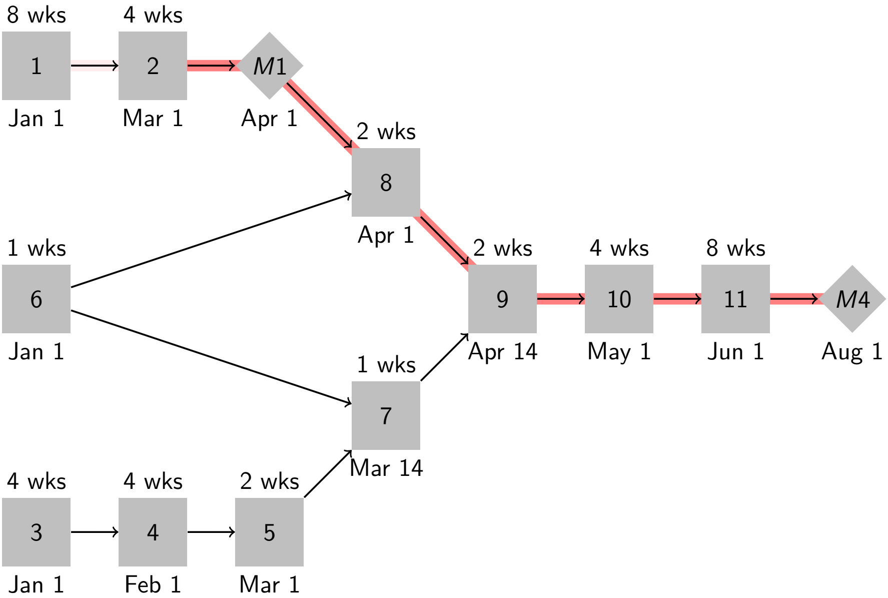
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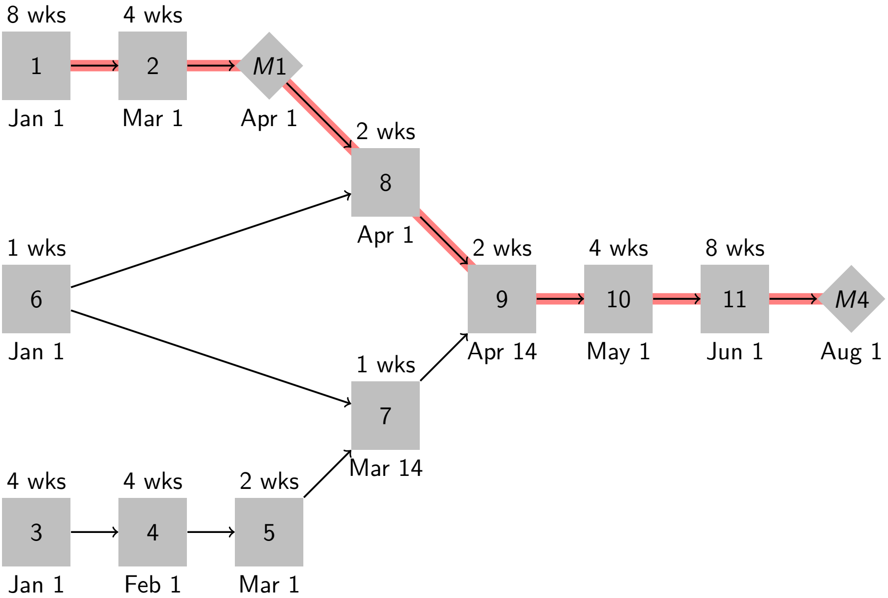
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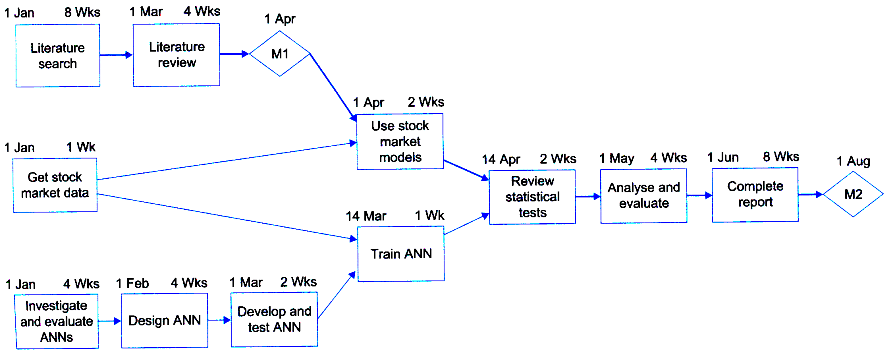
Solution



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M2

Problems with Activity Diagrams

- Correctness of activity diagrams is difficult to check

  Example:

Activity	Effort	Duration
Task A	1 week	4 weeks
Task B	1 week	4 weeks

Question: Can tasks A and B be done in parallel and both be finished within 4 weeks?

Answer: Information is insufficient to tell

- Do not allow to express distribution of effort within a task
- Do not reflect the duration/effort of each task well (all nodes are of equal size)
- Do not allow to indicate slack
- Simplistic view of activities/tasks: No loops, no conditions

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Literature review	2 weeks	4 weeks
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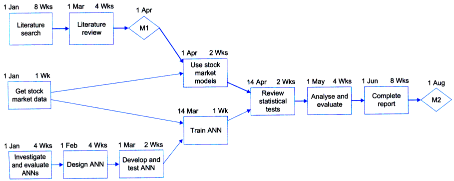
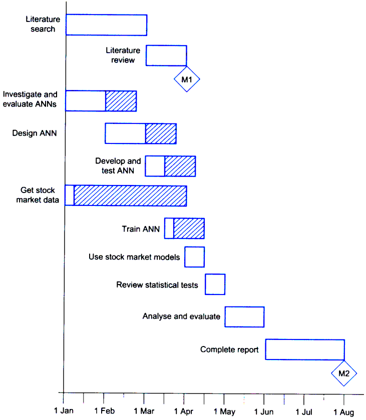
Complete report	8 weeks	8 weeks
Total	26 weeks	40 weeks

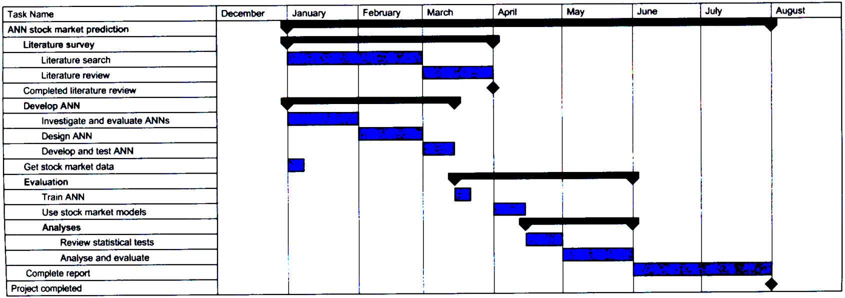


Gantt Chart



- Activities are represented by rectangles
- Milestones are represented by diamonds
- Size indicates duration relative to the timeline
- Shaded areas indicate slack

MS Project Gantt Chart



MS Project

- allows to represent the hierarchy of the work breakdown structure
- allows to represent activities and milestones (in the expected way)
- does not allow to represent slack
- does not allow to represent interdependencies across high-level tasks

Replanning

- Needs to be done if you try to achieve too much in too little time
- Approach: Iterate the following steps until happy with the schedule
  - Rethink the interdependencies between activities
  - Redo estimates for effort and duration of each tasks
  - Reschedule tasks
  - Rethink the aims and objectives of your project
  - Redo work breakdown structure
- No plan is perfect; no plan is set in stone

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Rolling Wave Planning

- Phased iterative approach to project planning
  ⇝ fits well for incremental development
- Approach:
  1. Define planning packages for your project with
     - resource requirements
     - macro level deliverables
     - macro level dependencies
  2. Execute the following loop
     1. Determine which planning package has to be done next (first)
     2. Make a detailed plan for this planning package
     3. Execute the plan
     4. Re-adjust the remaining planning packages based on what happened

Risk management

Risk Management: Introduction

Risk management

- involves the identification of risks at the project's outset
- control of those risks as the project progresses

$\rightsquigarrow$ risk management process

Four main stages of the risk management process

1. Identify risks
2. Assess impact of risks
3. Alleviate critical risks
4. Control risks

Identifying Risks: Types of Risk

	Event-driven	Evolving
Technical	Project requirements change; Hard disk crashing	Project beyond your technical capability; Problem dependent on developing a complex algorithm
Non-Technical	Supervisor leaving; Illness	Underestimating effort required for a task; Literature not arriving on time

Identifying Risks

Risk triggers (risk symptoms)

Events happening during the course of a project that might indicate problems or that one of the identified risks is increasingly likely to occur

Examples:

- Missing preliminary milestones in your project
- Struggling with a straightforward implementation of a component
- Problems with arranging a meeting a client

Assessing the Impact of Risks (1)

Risk impact $=$ Likelihood $\times$ Consequence

Example: Severe earthquakes in Britain

- Likelihood is low
- Residential building $\rightarrow$ Consequences are low
  Nuclear power plant $\rightarrow$ Consequences are catastrophic

$\leadsto$ Nuclear power plants are earthquake proof,
residential buildings are not

Assessing the Impact of Risks (2)

1. Assess each risk according to the following scales:

Risk Likelihood	Score
Low	1
Medium	2
High	3

Risk Consequence	Score
Very low	1
Low	2
Medium	3
High	4
Very high	5

2. Compute risk impact for each risk using the formula

$$\text{Risk impact} = \text{Likelihood} \times \text{Consequence}$$

3. Rank all risks according to their risk impact

Assessing the Impact of Risks (3)

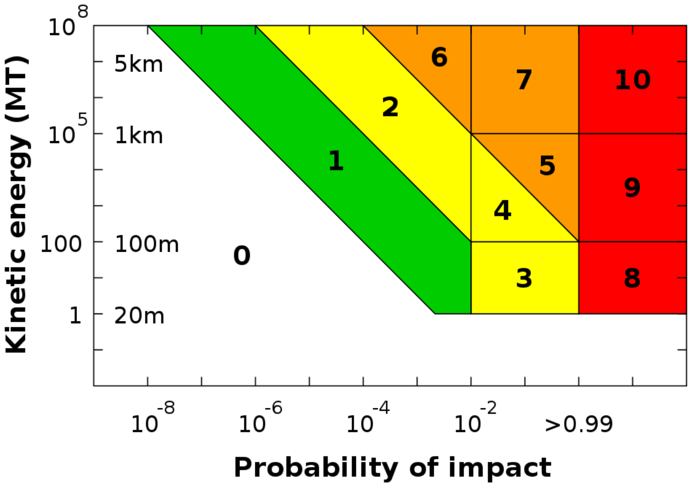
4. Determine critical risks
   (a) 80/20 rule:

   20% of your risks cause 80% of your problems
   $\rightsquigarrow$ 20% top ranking risks are critical

   (b) RAG grading:

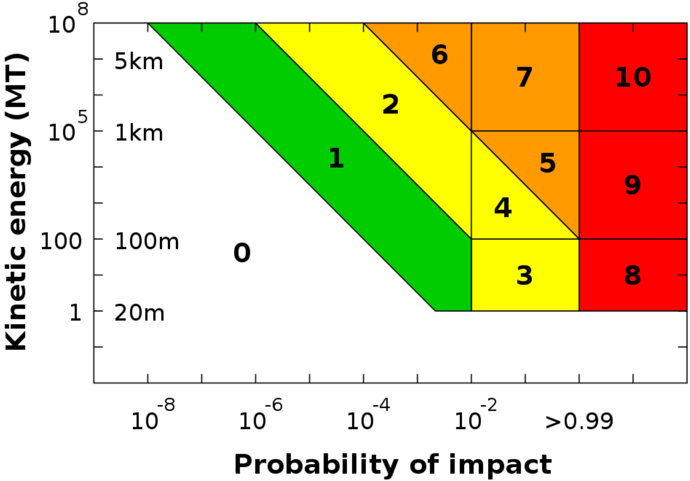
Red	Risks with impact greater than 10 $\rightsquigarrow$ critical risks
Amber	Risks with impact between 6 and 10 $\rightsquigarrow$ deserve some attention
Green	Risks with impact smaller than 6 $\rightsquigarrow$ can be ignored

Torino scale



- 99942 Apophis – the only object that had grade 4 for a short time in 2004; will pass quite closely to Earth on the 13th April 2029

Torino scale



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Alleviating Critical Risks (1)

- Contingency
  Accepting that the risk is going to occur and putting something in place to deal with it when it does

  Examples:

  - Hard disk crash → have a backup
  - Time over-run → allow slack for each task

- Deflection
  Passing the risk on to someone or something else

  Example:

  - Required software → use of existing software instead of developing it yourself

Alleviating Critical Risks (2)

- Avoidance
  Reducing the likelihood that the risk will occur at all

  Examples:

  - Use of programming languages
    $\rightarrow$ use one that you know instead of one that you don't
  - Development of a complex algorithm
    $\rightarrow$ modify an existing algorithm

Risk Assessment Report

Project: Introduction of IT-assisted teaching at a college

Risk	Likelihood	Consequence	Risk management approach	Risk symptoms
Infrastructure				
IT infrastructure cannot cope with requirements	Med(2)	High(4)	Equip sufficiently and involve IT Dept	Speed of equipment response
Data projector failing during teaching	Low(1)	Very High(5)	Have a stand-by data projector	None
Staff				
Lack of commitment by staff	Med(2)	High(4)	Clear communication plan; staff development events	Non- or variable attendance of events
Loss of key staff	Med(2)	Med(3)	Succession planning; critical procedures should be documented in a manual	Notice period / Request to attend interview
Delivery				
Staff not available at times training is delivered	High(3)	High(4)	Flexible delivery and session on different days and at different times	Timetables

Controlling Risks

Planning a risk strategy

- How will you go about managing/controlling the risks identified?

  E.g. how and when would you notice a time over-run?

  Checkpoints: Checking critical risks

  - at regular intervals (e.g. weekly)
  - at the end of particular project stages
  - at meetings with your supervisor

- How and when will you check the risk triggers identified?
- How and when will you invoke your contingency plans?
- How and when will you update your critical risk list?

  Risk likelihood and risk consequences change over time

Take-home Question

Consider our running example, that is, the project with the aim to

> *Develop and evaluate an Artificial Neural Network to predict stock market indices*

which is conducted by undertaking the following tasks

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What might a risk assessment report look like for this project?

Project Planning: Summary

- Project planning consists of two stages:
  1. Defining what it is you want to achieve
  2. Planning how you will achieve it
- Project planning proceeds in six steps
  1. Work breakdown
  2. Time estimates
  3. Milestone identification
  4. Activity sequencing
  5. Scheduling
  6. Replanning

Risk Management: Summary

- Risk management is performed in parallel with project management and involves four stages:
  1. Risk identification
  2. Risk quantification
  3. Risk alleviation
  4. Risk control