Methoden Wetenschappelijk Onderzoek

Introduction
About myself

• Bart de Boer
  bart@ai.vub.ac.be
  – Artificial Intelligence laboratory

• Research: evolution of speech
  – Computer modeling
  – Experimental work
Practicalities

• Course description and rules are found on the ARTI website
  – https://ai.vub.ac.be/courses/2012-2013/methods-scientific-research

• Publication of documents and assignments (publication, handing in, feedback) will be through Pointcarre
  – Make sure you are enrolled!

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About the course

• “Methoden wetenschappelijk onderzoek”
• How to do science
  – Some background
  – Mostly practical

• 8 lectures
  – From 9 to 12 (not 10 to 12)
• 4 assignments
  – Two weeks for each assignment
Themes

1. Introduction
2. Reading papers – literature survey
3. Collecting data
4. Setting up an experiment – research proposal
5. Describing data
6. Analyzing data – statistics assignment
7. Exchange with industry
8. Writing a paper – extended abstract
9. Conclusion – paper review

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Course evaluation

• Aim is mostly practical
  – Final mark based on assignments
  – No exam

• The real test will be your thesis!

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Why?

• Most of you will not become scientists

• But a university degree is a scientific degree

• Practical reasons:
  – Our society is thoroughly scientific
  – Scientific way of doing things pervasive in business, education, (public) management politics
  – Even anti-scientific groups (religious, new-age, climate-change deniers) use scientific method and jargon

• For any job at university level you need scientific skills

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What is science?

• A **structured** way to learn to **understand** the world
• With checks and balances to prevent us from **fooling ourselves**

• Understanding the checks and balances helps to **understand others’ results** (or claims)

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Science and technology

• Science’s popularity in the 19th century closely related to *technological progress*
  – Progress was partly due to science
  – But partly due to tinkering (e.g. steam engine)

• Scientific method *helps* technology
• But does all science need to be *application-oriented*?

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Science and Society

• We live in a **scientific society**
  – Even though most political ideology is based on 19th century science

• It is important to be able to think and write scientifically for all kinds of **political and management** work

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Computer “science”

Tichy (1998) noticed that computer scientists hardly do experiments at all

– He calls BS on their arguments not to do so
Tichy’s list of excuses (1)

• “Traditional scientific method is not applicable”
  – “We investigate information”

• A lot of claims should still be tested
  – For example: “C++ is better than C”

• And performance of models can also be tested using standard scientific methods

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Tichy’s list of excuses (2)

• “The current level of experimentation is good enough”
  – Tichy: 40-50% of 1993 CS papers with empirical claims had no support whatsoever
  – Sjøberg et al. (2005) looked at 5453 software engineering articles and found only 103 with controlled experiments

• This would be unacceptable in any other branch of science

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Tichy’s list of excuses (3)

- “Experiments cost too much”
  - (It is too much work)
  - Get off your lazy behinds, other sciences do it, too
  - At the university level, you have to go beyond mere programming

- “Demonstrations will suffice”
  - Demonstrations are an excellent means to fool yourself and your audience
  - Avoiding this is what scientific method is for

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Tichy’s list of excuses (4)

• “You’ll never get it published”
  – = Your thesis supervisor won’t have it (or doesn’t require it)
  – As for publication, it is probably untrue

• As for theses:
  0 out of ~16 theses I saw this year had statistical analysis of their results
  – Which means: all of them would have failed at the psychology department…

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Full disclosure

• I used to have **shaky methodology**, too
  – I don’t think my PhD thesis contains a **single statistical test**
  – I was trained as a computer scientist (1988-1994): no methodology whatsoever

• But times are changing:
  – It becomes **more and more important** to follow good methodology
  – Subject areas with good methodology become **dominant**
    • Think bioinformatics
How computer science is done

• (Tongue in cheek)
• Be fascinated by a subject
• Start programming
• Find a problem to solve
• Make a demo
• Make a “happy graph”
• Write your paper/report/thesis

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How computer science is done

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Me

The competition

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Why this is bad

• Be fascinated by a subject
  – Other people probably are, too.

• Start programming - Shift of focus, messiness

• Find a problem to solve - Bias

• Make a demo
  – Designed to fool yourself and your audience

• Make a “happy graph”
  – Selected results, lucky run, no idea of variation

• Write your paper/report/thesis
  – You forgot half of what you did

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How science is done (1)

• It starts with **observation and curiosity**
  – How does something work?
  – How can something be made better?
  – Etc.

• This leads to a **research question**

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http://my2008blog.wordpress.com/2008/04/14/remains-of-a-feast/
How science is done (2)

• The next step is formation of a hypothesis
  – This is essentially a creative process
  – It is always good to have multiple hypotheses
• A useable hypothesis makes testable predictions

• Formulating good hypotheses requires knowledge and experience
• As does formulating interesting research questions
How science is done (3)

- Then one has to formulate experiments to test one’s hypotheses
  - Only in mathematics can things be proven
  - Experiments are generally aimed at falsification
  - But they can also be meant to increase qualitative understanding (descriptive studies)

- What do we measure, how do we measure it, how accurate will this be, how many measurements do we need to make etc.

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How science is done (4)

- Then we run the experiment

- Depending on the field this can be more or less **difficult** and more or less **work**
  - Scientists like to save work, so focus on relatively easy experiments (?)
How science is done (5)

• The results are then analyzed and interpreted
  – Coding the data
  – Analyzing with statistics

• Done so to prevent one from fooling oneself

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How science is done (6)

- You then **communicate** your results
  - Present it at a **conference**
  - Publish it in a **journal**
  - Tell it to the **general public**

- Using the correct **style**
- Referring to **previous work**

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How science is done (7)

• But publishing isn’t easy
  – Almost everything is peer-reviewed
  – Colleagues read your work, and comment on it – anonymously
  – Usually about 3 reviewers per paper
  – If not rejected, revisions
  – This can take a long time
How science is done (8)

• Other scientists can then read your work
  – Discuss it
  – Disagree with it
  – Agree with it
  – Use it for their own work
  – Etc.

• For this reason, you must be open and precise about your work, and about your sources
Openness and precision

• Openness and precision make it possible for science to be cumulative
  – “Standing on the shoulders of giants” as Newton put it

• But not without being critical of other work
  – Convinced by data, not by rhetoric
  – Scientists have very sensitive BS-detectors
Science in practice (1)

• Science is done by people
  – People have prior beliefs and convictions
  – People have their likes and dislikes
  – People have their pride
  – People need to eat
Science in practice (2)

- Science is done in a social network
  - Students are trained by older scientists
  - Schools of research form (which can compete or cooperate)

- This can lead to science being stuck in a paradigm
  - Only shift when older generation disappears (Kuhn, The structure of scientific revolutions)

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Science in practice (3)

• Science costs a lot of money
  – Not everything that is interesting can be done
• Independent scientists do not exist anymore
  – You need an affiliation
• Therefore: a lot of competition for limited resources
  – Scientists spend a lot of time on grant proposals
  – Funding agencies have their own agenda
• In many countries, permanent positions are now nearly non-existent
  – Even very smart young people cannot continue their research
  – While older researchers dominate

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Science in practice (4)

• Research is **not** just done because it is good
  – But also because:
    • Other people **like** it
    • It fits in a **paradigm**
    • It fits the **priorities** of a funding agency
    • Etc.

• However, science is **self-correcting**
  – If an old paradigm does not work, it **will** be replaced
  – The **real world** has the **last word**
Science in practice (5)

• Science is fun
  – You work very independently
  – You get to work with smart people
  – You discover stuff that nobody knows
  – Scientific work is creative work

• That is why people do it even though working conditions are not what they used to be

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What will we do? (1)

• Aim to **introduce** you to a number of practices that scientists have developed over the years
  – (Or refresh your memory)
  – And explain why these are **useful**

• Make assignments so that you can **practice the practices**
What will we do? (2)

• The exercises are partly pretend-play
  – Make a literature list
  – Write a proposal
  – Write a review

• Unavoidable if you want to practice

• But if you choose your topic wisely, it may be useful for your MSc thesis
What will we not do (1)

• Philosophy of science
  – Fascinating, but not very practical
  – We will encounter some as we go along
What will we not do (2)

• Postmodern criticism of scientific method
  – (Everything is a cultural construct)
  – There really is a reality outside of science

– But I will discuss convention from time to time
– Scientific method is a way of critical thinking
  • Critical thinking about the method is good, but we first must be very familiar with it

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What do I expect from you?

• Scientific thinking/working/writing requires experience
  – 10 000 hours to become an expert (Malcolm Gladwell)
  – The course is only 3x28 = 84 hours

• There is some theory
  – 8x3 = 24 hours of lecture

• But practical exercise is most important
  – An extra 60 hours for 4 assignments
  – 15 hours per person per assignment

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What do I expect from you?

• For assignments 1, 2 and 3 you need to work in teams of two
• Assignment 4 you will do alone

• I will suggest topics, but it is useful (and more fun) to choose topics that are related to what you want to do for your thesis
  – And choose your partner accordingly

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Next session

• October 12
• Literature study
  – How to get information from literature
  – And how to show you used it
  – As well as the first part on data collection
  – Plus: your first assignment

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