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Research Philosophy for IT

*Science is **not** a collection of facts, but a way to view the world that results in methods and techniques for making it more understandable. In science there are no truths that cannot be challenged. (Except that reality exists and can be observed.)*

Mathematics is a logical system of axioms without contact with reality - it is not prescriptive but can be descriptive.
(Natural) Science is a collection of predictions of what happens in certain situations (i.e., experiments). The predictions are most often expressed mathematically.
Technology is the development of new techniques based on mathematics and science.

"Science is a way of thinking while technology is a way of doing." (E.A. Shneour)

History of methods in science in my minimal-vulgar-version:
- *Greeks - think about how it ought to be (don't worry about how it is).*
- *Renaissance - observe reality, but don't say Aristotle was wrong even if your observations indicate this. You could then lose your life. (Giordano Bruno was killed horribly, Galileo was lucky, and Kepler was very smart.)*
- *1700s - Collect huge amounts of data and try to find a pattern (Cf. von Linné)*
- *1800s - Get an idea and collect data to try to prove it (Cf. Darwin)*
- *1900s - Get an idea and try to disprove it (Cf. Einstein)*
- *2000s - Trying to prove things may not be so bad after all...*
- *2010s - ...and collecting huge amounts of data to find a pattern is popular again. (Cf. DNA and protein decoding, "deep" learning, NSA databases…)*

History of methods in mathematics in my minimal-vulgar-version:
- *Greeks - if I suppose A, B, and C, how **many** other things can I prove?*
- *Chinese - if I have all these different problems, how can I find the **one** method that solves all of them?*

Today only the Greek method is used…

***Insight:** It's often easier to disprove something that to prove it, for example: "All swans are white". You can look at thousands without proving it, but it is enough to see one black swan to disprove it. Use it if you can!*

***Insight:** The research tasks never end, as every answer leads to new questions. (Cf. the "balloon analogy": The bigger the mass of scientific knowledge is (the inside) the larger the border to the unknown where science happens. (This does not cover refining knowledge, but you cannot have everything in one analogy))*

IT *is a young technology (start ≈1960) in the intersection of mathematics, numerical analysis, statistics, signal and image processing, computer science, psychology... Sometimes we can use mathematical methods to prove that our techniques work, but more other we must make them plausible by well-constructed experiments, so we sit on the fence between mathematics and natural sciences. We must understand both views, and try to be hypothesis-driven to a larger degree than now.*

IT is also, in some aspects an immature science. For example, proving that something is wrong or does not work is not appreciated as it should be. In more mature sciences refutation is often what drives the discipline forward. For us, trying to publish negative results is still difficult.

On the other hand, as it is a young science the research front is not very far away and many relatively "simple" problems are still to be solved - even if they are getting fewer.

A problem we must always be aware of and try to counteract is the perception that much of what we do is not science as such, but "only" help to other disciplines - the applications take over.
- *Developing better computer interfaces? But what task are you trying to make easier?*
- *Developing new data base structures? But what will the database contain?*
- *Developing faster computing algorithms? But what are you going to compute?*
- *Developing more exact numerical methods? But what are you going to use them for?*
- *Developing better digital geometry concepts? But what images are you analysing and why?*

We collectively have the task to get respect for our subjects themselves - by not always taking the "easy way out" using the application as the motivation. This goes for written and oral presentations - at most 25% of the space should go to the application, the rest to what IT you have actually done. And theses in IT should not start with long explanations of the application - that should come after your own subject, which is IT.

Three types of hypotheses

(with thanks to Jonathan C. Smith)

*1. Hypotheses than **can** be tested*
(a.k.a. scientific hypothesis)

"Telepathy exists, at least in some individuals."
This can be tested by statistical analysis of experiments were rigorous controls are in place to prevent cheating or accidental clues. If the statistics show no significant results, then the hypothesis is rejected.

*2. Hypotheses that **cannot** be tested*
(a.k.a. "new age" beliefs)

"Telepathy exists, at least in some individuals but as soon as a sceptic is present or it is tested in a scientific way the effect disappears. It is a 'jealous' phenomenon."
There is no way to test such a hypothesis. Therefore it is a meaningless hypothesis.

*3. Hypotheses that **may** not be tested*
(a.k.a. religion)

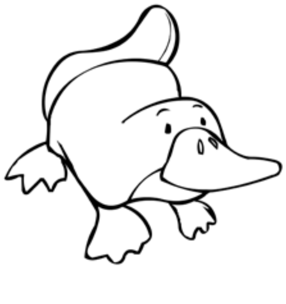
"Telepathy exists, at least in some individuals because my mother says so."
No matter how many experiments that fails to show any telepathic effects the hypothesis will still be considered true, because questioning it is not allowed.

In the same way, there are three types of believers – depending on what type of hypothesis they adhere to.

1. *I will believe in unicorns only if I see some clear evidence for them, preferable a live one in my garden. Until then I will not. (cf. James Thurber's short story: The unicorn in the garden)*
2. *I think it is a personal choice if you believe in unicorns or not. I feel in my heart that the beautiful, pink, invisible ones often visit my garden.*
3. *Unicorns exist and nothing you say or do or show will make me think otherwise. Even if every single square meter of the earth has been shown to be unicorn free I will not doubt.*

And of course sceptics also come in three versions.

1. *I will not believe there are egg-laying mammals with duck-bills unless some one shows me one, preferably a living one giving milk to its pups. (cf. platypus)*
2. *I will not believe there are egg-laying mammals with duck-bills if the only evidence is that some lumber-jacks "down under" say they have seen them and have send me aa alleged skin.*
3. *I will not believe there are egg-laying mammals with duck-bills even if a living one is put in my lap. I know already it must be a fake and will not waste my time on investigating it.*



How NOT to pursue science

(After A.R. Pratkanis: How to sell a pseudoscience, Skeptical Inquirer July/August 1995)

1. Create a Phantom
A phantom is an unavailable goal that looks real and possible.

2. Set a rationalisation trap
Get yourself and colleagues committed to the phantom from the start. Increase the commitment monotonically from easy concessions to stronger and more radical ones by small steps.

3. Manufacture source credibility and sincerity
Create a likeable leader or guru whose authority will be hard to challenge. Endow him/her/it with impressive titles and a historic success record.

4. Establish a granfallon
A granfallon is a "proud and meaningless association of human beings." Once established the granfallon defines reality and maintains social identity. Identify the people outside your granfallon as the evil ones, especially those that were once in it but now are out. The granfallon is kept together by: rituals and symbols; jargon and beliefs; shared phantom; specialised information; shared perceived enemies.

5. Use self-generated persuasion
Get people to persuade themselves by setting them the task to persuade others. Thus, recruit people using the newest in the group, to create a hierarchy and bind the new ones more strongly to the cause.

6. Construct vivid appeals
Use a single successful example (without giving statistics of success rates). Present it vividly and professionally (or even emotionally).

7. Use pre-persuasion
First, define the issue yourself, in such a way that it is impossible to fail. (E.g. create a problem that does not really exist.) Secondly, set expectations before going into results. Thirdly, specify decision criteria to suit your results (of lack of them).

8. Frequently use heuristics and commonplaces
Heuristics are simple if-then rules that are widely accepted (although not necessarily true), e.g., if it's more expensive/complex/new its better. They should be used as arguments even if not relevant (e.g., $e^{i\pi}-1 = 0$*, therefore my perpetuum mobile will work). Useful heuristics are: scarcity (rarer is more valuable); consensus (if most people believe it, it must be true); message length (the longer the stronger); representative (if two entities resemble each other, they most act similarly); natural (natural is always better than humanly produced).*

9. Attack opponents through innuendo and character assassination
Already Cicero said: "If you don't have a good argument, attack the plaintiff".

If there are many elements of this in a belief system - then it's NOT science!

Scientific work *should be*

1. Possible

A successful scientist works on solvable (but non-trivial) problems

2. Goal driven

Long term (thesis to life work)

what should results be in the (best/probable/worst) case?

Short term (weeks to months)

which partial problems should be worked on now?

Short term goals should be clear. Long term goals should be the lodestar and the inspiration, but the specific methodology is often unclear or unknown - otherwise it would not be research!

3. Hypothesis driven

First an idea
How should it be proven (maths) or disproved (science)?
First decide what is enough to discard the idea
Then test the idea

Research results *must be*

1. Repeatable *(on the same class of data)*

2. Discriminatory *(different results for different data)*

3. Meaningful *(the result is strongly correlated to an interesting property)*

4. Predictive *(if applied to this class of data or in this situation, this will happen)*

The Scientist *should be*
Dissatisfied
Creative
Sceptical
Independent
Optimistic
Questioning
Collaborative
Idealistic
but most of all Stubborn

... and remember to change the perspective occasionally!

Why the Zapf Chancery type? Because it has been scientifically proven that slowing down reading by using a "difficult" font make you remember more of what you read!

Some books that generated new thoughts on Life, the Universe and Everything

- Lucretius, T. Cari: De Rerum Natura [On the Nature of the Universe] (55)
  (to remember that we stand on the shoulders of the old Greeks)
- Hofstadter, Douglas R.: Gödel, Escher, Bach: An Eternal Golden Braid (1979)
  (why AI solves all problems and the Turtle is a holist)
- Hofstadter, Douglas R.: Metamagical Themas: Questing for the Essence of Mind and Pattern (1985)
  (why AI solves no problems and Achilles is a reductionist)
- Schumaker, John F.: Wings of Illusion: The Origin, Nature and Future of Paranormal Belief (1990)
  (how to differentiate between belief [=absolute truth] and science [=provisonary truth])
- Garwood, Christine: Flat Earth: The History of an Infamous Idea (2008)
  (how old ideas remain despite overwhelming evidence and the apparently hopeless struggle against pseudo-science)
- Gould, Stephen Jay: Wonderful Life: The Burgess Shale and the Nature of History (1989)
  (on the power of randomness in the in general and in evolution in particular and about slaughtering herds of sacred evolutionary cows)
- Pepperberg, Irene M.: Alex & Me - how a scientist and a parrot discovered a hidden world of animal intelligence (2008)
  (if you never ask a question because you know it will not get an answer - then you would miss talking to parrots and learning new things)
- Pääbo, Svante: Neanderthal Man - In search of lost genomes (2015)
  (on how obsessed and persistent you have to be in your research to succeed)
- Diamond, Jared: Guns, Germs, and Steel: A Short History of Everybody for the Last 13,000 Years (1997)
  (explains why Nobel prize winners are Euro-Asians not New Guinea natives - even though the latter are more intelligent)
- Finkel, Irving: The Ark before Noa - decoding the story of the flood (2014)
  (were you learn that pieces of the ark was sold as souvenirs long before the bible versions(!) of the story were written, how it would have looked, and why it is a fantasy)
- Ferguson, Kitty: Tycho and Kepler: The unlikely partnership that forever changed our understanding of the heavens (2002)
  (about the triumph of the heliocentric theory and why Kepler - differently from Galileo - never had problems with the inquisition (except when he saved his grandmother from being burned as a witch))
- Wootton, David: Bad Medicine: Doctors doing harm since Hippocrates (2006)
  (why doctors ignored new scientific results for centuries, which made it more dangerous to consult a doctor until 1865 and meaningless until the 1930s)
- Sokal, Alan D.:The Sokal Hoax: The Sham That Shook the Academy (2000)
  (the proof that apparently serious scientific journals can publish total crap - if well written. And the following attempts at whitewashing from the editors.)
- Hardy, G. H.: A Mathematician's Apology (1940)
  (a both naive and insightful description of the life of a scientist before Project Manhattan)
- Hitchens, Christopher: The Missionary Position: Mother Teresa in Theory and Practice (1995)
  (about a modern myth and what happens when bad conscience make people blind)

- Machiavelli, Niccoló: The Prince (1514)
  (about the art of politics and how to avoid its consequences by recognizing the methods)

- Bramson, Robert M.: Coping with Difficult People (1981)
  (because scientists are...)

- Ehrenreich, Barbara: Smile or Die (2009)
  (about the dangers to society and organisations that only accepts optimistic, smiling yes-men (and -women))

- Solnit, Rebecca: Men Explain Things to Me - and other essays (2014)
  (why you are not the only female scientist having your own work explained to you by an intellectually challenged man and other irritations on the professional woman's way)

- Truss, Lynne: Eats, Shoots & Leaves (2003)
  (a book about English (and American) punctuation that was the unlikely winner of "Book of the Year 2004" in the U.K. - people do care about apostrophes and commas)

- Foster, Don: Author unknown - on the trail on Anonymous (2000)
  (if you want to know who the evil reviewer of your paper is you get the methods here- nobody is "Anonymous" for the language detective)

- Kalder, Daniel: Lost Cosmonaut (2006)
  (about how fun it is to travel to the most boring places you can think of and find yourself there - travels to four European capitals you have never heard of)

- William Shakespeare: MacBeth (≈1600)
  (because Billy must appear in every book list and "The Scottish Play" because it warns about believing apparently positive predictions from uncertain sources - even if they happen to be true)

Suggested by Gunilla Borgefors
20160404

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Journal or Proceedings investigation, Itfm 2016

Every participant will investigate a scientific journal or a conference proceeding.
If you have a journal (J), your material consists of the six latest consecutive issues that are available.
If you have proceedings (P), your material is the proceedings of the latest conference in the series.

You should investigate the general contents, character, and quality of the J/P. In addition you should chose two interesting articles for further study. The results of your investigation should be presented to the participants, both as oral and written reports. Your two selected articles should be sent out to the other participants and me no later than one week before your oral presentation. Of course you should use what you learned during the course for both presentations.

<u>Written report</u>
Two A4 pages in font Times 10, containing
- statistics on the subject areas and author groups in the J/P
- statistics on article length and time to publication from submission
- information on acceptance rate and impact factors

One A4 page each for the two articles, containing
- short descriptions of the contents of the article
- comments on the article - imagine you are the reviewer!

Do not forget that *all* written reports and papers should contain your name and the date. All reports will be collected in an internal report and given to the participants after the course. I want pdf-files without page numbers *but* not send me the reports until *after* your oral presentation – you may get good suggestions for changes. See the following pages for layouts for the two types of pages.

<u>Oral presentation</u>
You should give an oral presentation, containing the same material as the written one. The time is 20 minutes exactly! (Not 19 minutes, nor 21 minutes.) This is a challenge, especially since you have too much to present. This is deliberate, as this is almost always the situation when presenting at conferences and elsewhere.

After each presentation there will be a question-and-answer session where everybody is expected to participate. All participants should have looked at the two papers beforehand and put at least one question.

As active participation is the examination for this course, those who are absent or inactive during more than one presentation lecture will get extra tasks.

Hopefully, this investigation task will become easier after the first five lectures.

Amendra Shrestha	P	Int. AAAI Conf. on Web & Social Media (ICWSM) 2015
Amit Suveer	P	Int. Conf. on Pattern Recognition (ICPR) 2014
Anders Persson	J	Ethics and Information Technology
Anton Axelsson	J	Topics in Conitive Science
Damian Matuszewski	J	BMC Bioinformatics
Fredik Nysjö	P	Int. Conf. on Medical Image… (MICCAI) 2015
Gerolf Neuwerk	P	ACM Conf. on Human-Computer Interaction (CHI) 2015
Maike Paetzel	P	ACM/IEEE Human-Robot Interaction (HRI) 2015
Marine Astruc	J	IEEE T on Medical Imaging (TMI)
Rebecca Andreasson	J	Cognition Technology and Work
Teo Asplund	J	IEEE T on Image Processing (TIP)

Your name
Date

Journal title

publisher

Here starts the text..

Article title

Authors
Affiliations

Here starts the text...