Lecture 1

What is philosophy of science?

Semmelweis

Introduction to scientific thinking by an example

Semmelweis

- Ignaz Semmelweis (1818-1865).

- In the years 1844-48 he worked at the main hospital in Vienna.

- There he faced a strange problem.

The problem

- The hospital had two maternity wards . At that time it was not uncommon that the mothers died of childbed fever (puerperal fever).

- But there was a strange difference between the two clinics. The first one had a death rate of 8.2%. The second one had a death rate of 2.3%.

- Why the difference?

Looking for an explanation

- So what is an explanation?

- Can everything be explained?

- We will talk more about this later in the course.

Methods for explaining

- We can form a hypothesis and see if it is correct.

- We can observe differences between the clinics and try to find an explantion.

- In science, we normally try to form a hypothesis first. Then we know how to look for relevant differences.

Some possible relevant differences

- We have to remember that at this time the medical knowledge was quite low.

- Something with the air. There was a concept called miasms that was believed to exist.

- Different types of patients.

- Different treatments.

- Psychological factors.

Experiments

- Semmelweis couldn't see any differences between the clinics.

- He started to experiment by introducing differences.

- One example of a possible psychological difference was that the patients could be scared by priests going through the room on their way to dying patients. (Or at least one thought it was possible.)

- These experiments actually raise an ethical question? Why?

A relevant difference

- Semmelweis found a difference that was more promising.

- He found that the patients in clinic one was visited by doctors going a round. Their previous stop had been for autopsy of corpses.

- This was not the case in the second clinic.

Forming a hypothesis

- An important clue for Semmelweis was that a friend of his had died after accidentally cutting himself in a finger during autopsy.

- Semmelweis framed the hypothesis that it was some "stuff" from the corpses that caused the fever.

- Remember that germs were unknown at this time.

Doing an experiment

- He told the doctors to wash their hands with calcium hypochlorite before going to clinic one.

- And the death rate was soon reduced to the same level as the one in clinic two.

- But the medical expertise was extremely skeptical about this mysterious "stuff".

- Semmelweis died some twenty years later, considered a quack by many.

The importance of Semmelweis

- Semmelweis experimenting is know considered one of the most beautiful examples of scientific reasoning.

- He started with a hypothesis and then did experiment to confirm it.

- He found a good explanation for the differences between the clinics.

- But why calcium hypochlorite helped remained a mystery until around 1870.

Different kinds of knowledge

- Technical knowledge - To know how a machine works

- Engineering knowledge - To be able to construct new machines

- Scientific knowledge - To understand the principles behind machines and their limitations

Engineering - Science

Engineering

We find solutions to certain classes of problems.

Science

We find theorems and general laws that apply to a large class of situations.

How to characterize science

There are at least three different "operations" that seem to be central to science

- Generalization

- Verification and validation

- Rigorous methodology

Generalizations

When doing science we often try to generalize results we have obtained. We try to formulate general laws that are independent of special conditions. We carefully try to test the suggested laws and, if possible, try to prove them.

Verification and validation

We can use scientific methods to prove special facts. (Even if they may not be classified as laws.)

"Now it is scientifically proved: Eating very little makes you hungry."

Verification is normally done with strict statistical methods.

We can also evaluate different engineering methods with similar methods.

Methodology

Scientific methodology can mean a lot things. We will largely focus on the rules for writing scientific papers and for working together with other scientists. Science is mainly a communal enterprise. It is one of the main strengths of science (possibly the greatest one).

Science in Computer Science

Computer science has a somewhat complicated role in the philosophy of science. The most scientific part is probably theoretical computer science with formal methods.

ADK

As an example of science in your education we mention Algorithms, Data structures and from Complexity. The course deals with generalizations simpler algorithm construction and establishes general laws for complexity.

The goals of science

There is a difference in opinions when it comes to the principal aims of science:

- Science is a way to find absolute truths about nature.

- Science is a tool for handling nature in an efficient way.

Finding truths

It seems obvious that science is about finding truths and that science is successful in doing that. The question what truth really is can, however, be more complicated than one first believes.

Science as a tool

Another philosophy is that scientific theories doesn't have to be strictly true. The important thing is that they give us a tool for predicting the future. This view is called Instrumentalism. Instrumentalists don't deny the existence of truth, they just say that truth is not that important.

History of science - why?

When we study philosophy of science we often look at moments in the history of science. Admittedly, these moments can be several hundred years old. But these are relatively simple examples of philosophical problems which illustrates main thoughts in science. It is not always easy to find equally clearcut modern examples. We give some highlights:

The scientific revolution
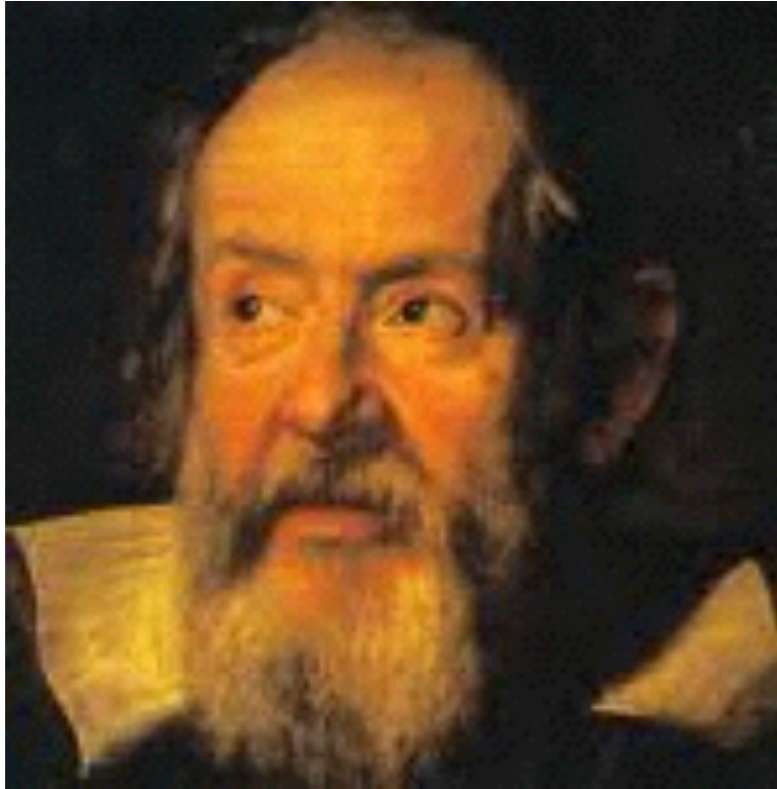
Galilei

Descartes

The scientific revolution

- Galileo Galilei makes experiments.
- He discovers a law for the movements of pendulums.
- Bodies with different weights fall equally fast.
- He constructs telescopes. He discovers mountains on the surface of the moon.
- and moons circling around Jupiter.
- and rings around Saturn.
- He becomes convinced by Copernicus' model.
- He gets punished by the church.

Newton's mechanics

- At the age of 23 Newton formulates three mechanical laws and the law of gravitation.
- He develops the Calculus (Differential-and Integral Calculus).
- The calculus and his mechanics form the cornerstone in the first modern science.
- At the end of the 17th century Newton's mechanics is internationally recognized.
- Newton is perhaps the first really socially esteemed scientist.

Evolution

- Charles Darwin makes his famous journey with *Beagle* during the years 1831-1836.
- In 1859 he publishes *On the Origin of Species.*During his trip Darwin becomes convinced the the species have developed.
- Other thinkers, for instance Lamarck, had already come to the same conclusion.
- Darwin found an explanation how and why they had evolved.
- *Natural Selection!*
- But objections where not late to arrive: For instance, a process governed by natural selection would take to much time.
- The discussion continues …

The theory of relativity

- Around 1900 it is generally believed that it exists something called the *ether.*
- Experiments are done for measuring the *ether wind.* But no ether wind is detected!
- Einstein makes the assumption that the speed of light is constant in all moving systems.
- and from this he creates his Special Theory of Relativity in 1905.
- Simultaneity is a relative concept!

Turing

- As we all know, Alan Turing defined the Turing Machine.

- He proved that there are natural problems which cannot be solved in an 'mechanical' way.

- An example is the halting problem.

- Another is the problem of finding proofs in first order logic.

Two aspects of science

If we do a philosophical study of science we can see that there are two somewhat conflicting components. They are:

- Observations of nature

- Logical deductions

Francis Bacon

He thought that you should observe nature and try to recognize patterns and formulate scientific laws.

René Descartes

He thought that you should use your own logical reasoning to understand the laws of nature.

The HD-Method

Is there a general scientific method?

A suggestion: It could be the Hypothetico-Deductive Method. It combines deductions with observations.

It is certainly used in physics and chemistry.

In a specialized sense it is used in mathematics.

It seems as if it used sometimes in Social Sciences.

The HD Method used for falsification

- We have a hypothesis and want to show that it is false.
- We have a set of observations E1, E2, …, En.
- Assume that there is an observation Ei such that H => not Ei.
- Then Ei falsifies H.

Observations that confirm

- We have H and E1, E2, ..., En.
- Assume that they are all rather improbable.
- Assume that we have a hypothesis A that we already believe is true and that H&A => E1&E2&…&En.
- Then the observations confirm H.

Course information

- HEM1 - Seminars, 1,5 hp, grades: P, F. Attendance required.

- HEM3 - Essay, 1,5 hp, grades: A,B,C,D,E

- TEN1 - Exam, 3,0 hp, grades: A, B, C, D, E, FX, F.