UNIVERSITY OF TWENTE.

Philosophy of Engineering: Science

Lecture 1: Introduction

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General Aims

1. **Learning to critically think *about* Science**, e.g.
   a) Scientific knowledge: What is it? How to prove it?
   b) Scientific research, e.g. Engineering sciences: How?
   c) Science in society. How can claims be justified?

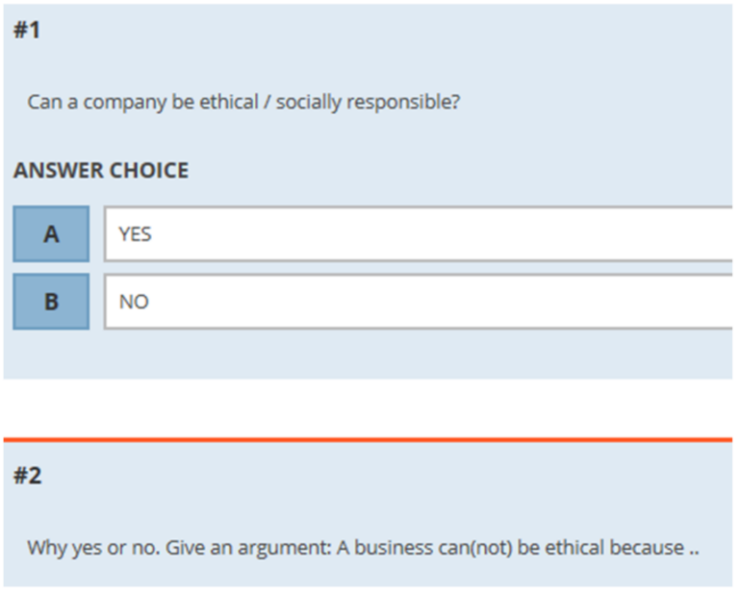
2. **This requires learning content and skills:**
   a) Content: A vocabulary / ideas / concepts to think and talk *about* science (= philosophy of science theory).
   b) Skills: Ability of philosophical reflection, including: articulation, analysis, argumentation, revealing presuppositions.

What is philosophical reflection?

- What are our *presuppositions*?
- How can we discover them?
- Why would this be important?

Example: Our ideas on 'The Nature of Business'

Example: The Nature of Business



Example: The Nature of Business

#1

Can a company be ethical / socially responsible?

1. Can a company be ethical / socially responsible?

63/76 (A) YES

13/76 (B) NO

#2

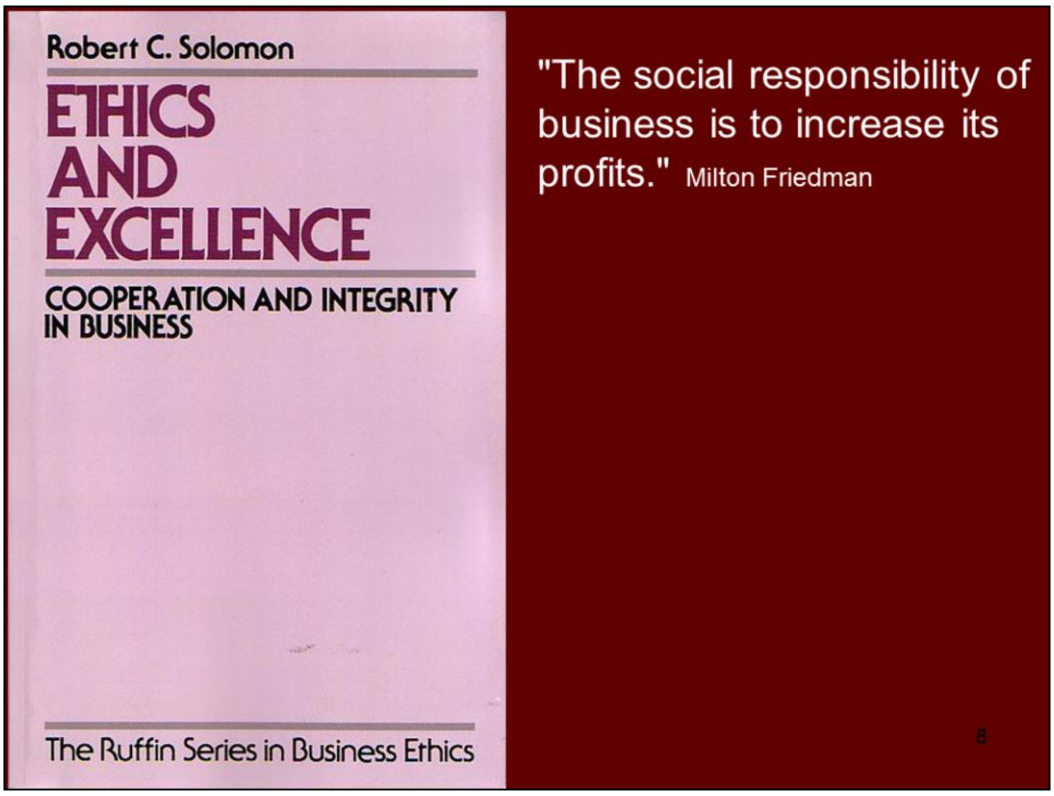
Why yes or no. Give an argument: A business can(not) be ethical because ..

socrative
by MasteryConnect

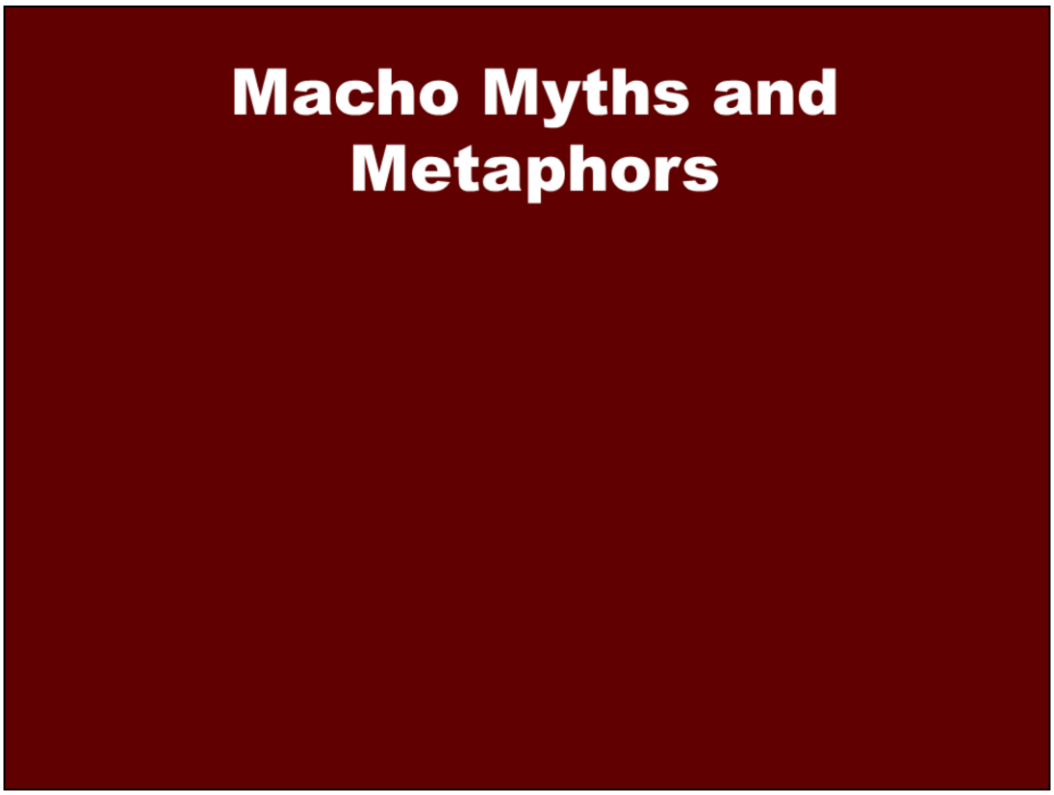
	YES /No?	Why Yes or No. Give an Argument: A business can(not) be ethical because ..
1	YES	It can be ethical, however, this is often not the case. Because it conflicts with the notion of business to maximize profit.
2	NO	Ethical/unethical decisions are ultimately made by humans and not by the company
3	YES	It can be ethically responsible because it consists of people who are capable of being ethically responsible (saying that the company is, is just an abbrevation). Those people can be responsible because they have freedom of choice in their actions.
4	NO	Because their main focus is to make money.
5	NO	The main goal of a company is making profit, in which ethics is not a priority

socrative
by MasteryConnect

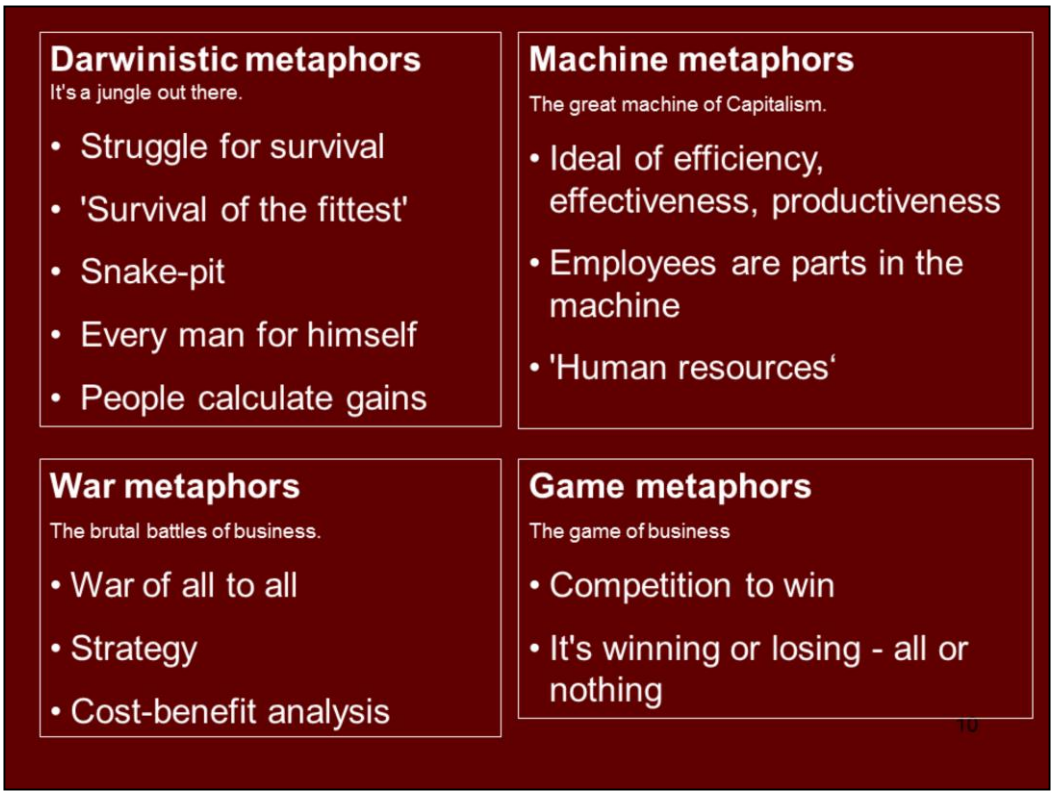
	YES /No ?	Why Yes or No. Give an Argument: A business can(not) be ethical because ..
6	NO	A business is always subject to competition and therefore always excludes and/or forces certain people to be submissive.
7	YES	Everything can be done, if a company really cares about this over profit. It is however not the usual procedure in which companies work.
8	YES	Yes because parallel to the goal of making profit the business can care about how to make the profit and even decide to make less profit but therefore act in an ethical correct way.
9	YES	A business can be ethical because, companies are not required to dismiss societial norms.
10	NO	Even ethical behaviour on the surface is ultimately driven by profit. Ethics is not the motivation of businesses, merely a possible means to an end.



Is it possible for a business to be ethical or responsible?

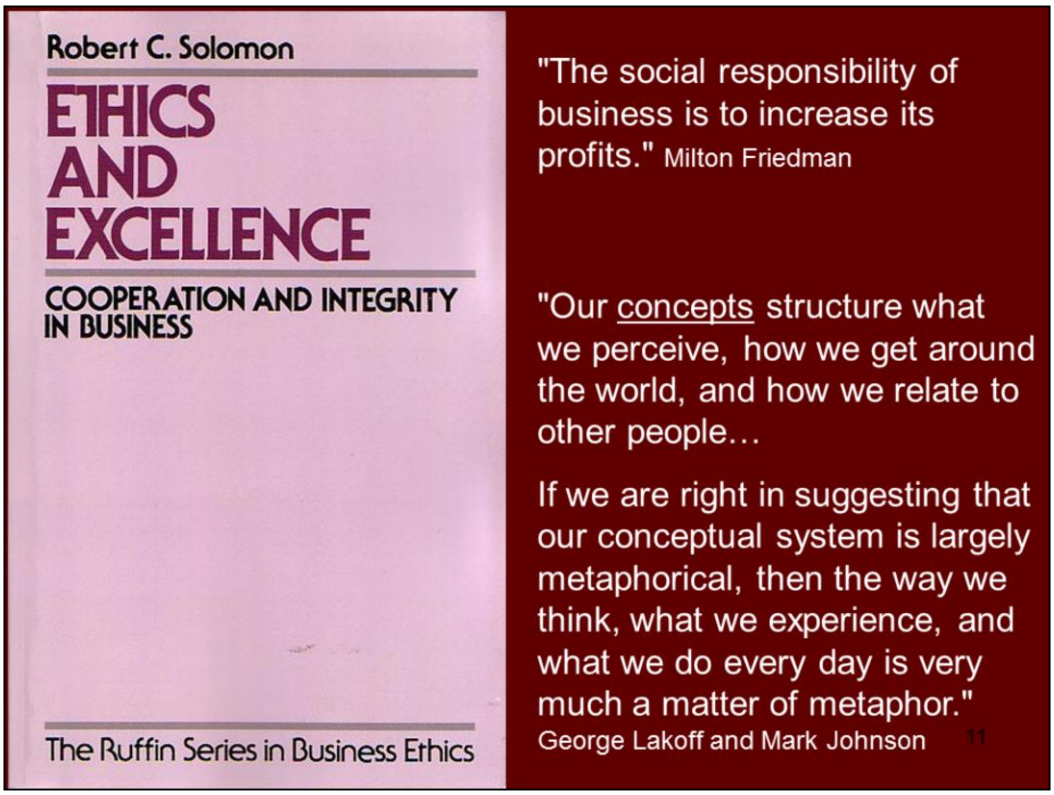


Chapter 2 in this book. This chapter summarizes all kinds of reasons people can have to deny this. The claim of the author is that these ‘reasons’ build on ‘macho myth’ and metaphors. How do we know that these reasons are true?



These metaphors play an important role in how we think about the possibility of companies being ethical. Often without us being aware of it (Solomon claims) these metaphors 'determine' what we see or think about a company. "Seeing as": We 'see' a business as a Darwinean system, or as a machine, or as an entity that is at war with other entities, etc.. We use these metaphors in our reasoning about the question of what a business can or cannot be or do. However, it has not been proven that these metaphors are correct or true about business. Still we use them as proofs. Solomon, the philosopher, starts to question them. That is 'doing philosophy.'

At this point, it is not clear how such 'questioning' and analysing goes about. This is what you may learn in this course.



The second quote (taken from the book) aims to make us aware of the role of **concepts**. It also aims to warn us for the enormous effect concepts (as expressed in the macho myth and metaphors) have.

Take home message

1. Fundamental ideas, pictures, concepts and metaphors are ‘commonly held truths / beliefs’. They *automatically* structure what we see and believe. Investigating them, initially, is a philosophical endeavour (non-empirical).
2. => Philosophy: Starts to ask questions about ‘common truths / beliefs.’ Next, philosophy performs reflection and analysis (e.g., what do we mean by ‘business’ and ‘ethical business’).

12

General Content

1. Introduction to Philosophy of Science.
2. Learning to apply these ideas to high-school examples of science.
3. What is Engineering Science?
4. Philosophy of science for the engineering sciences.

What is science?

Socrative:

Question 1-9:
Is … a science?

Question 10:
Why do you think it is a science (or Why not) – Try to give an argument.

	Is … a science?	A Yes	B	C ??	D	E No	Why (not)?
1	Mathematics						
2	Physics						
3	Applied Physics						
4	Nanotechnology						
5	Electrical engineering						
6	Computer sciences						
7	Chemistry						
8	Chemical Engineering						
9	Biology						
10	Biochemistry						
11	Biotechnology						
12	Medicine						
13	Pharmacy						
14	Health sciences						
15	Astronomy						
16	Climate sciences						
17	Geology						
18	Astrology						
	Psychology						
	Behavioral sciences						
	Managerial sciences						
	Communication sciences						
	Philosophy						

What is science?

#9

Is Astrology a science? (select one answer?)

ANSWER CHOICE

A	Strongly agree
B	Somewhat agree
C	Neither agree nor disagree
D	Somewhat disagree
E	Strongly disagree

#10

Describe why you do (not) agree that Mathematics, Physics, Chemistry, Nanotechnology, Electrical engineering, Medicine, Health sciences, Psychology, Astrology is a science. Try to introduce criteria or rules for calling something a science, and ideas you have of why it is not a science. Try to be concise.

Philosophical reflection: How?

1. We started answering the question (Is X as science?), which involves unreflected beliefs.
2. We then tried to articulate these beliefs about science (Why is X a science?).
3. We will now try to reflect on these beliefs, in order to find out how we can 'define' science. For instance:
   - Why should 'we' (e.g. society) accept / believe scientific knowledge?
   - How is scientific knowledge different form 'non-scientific claims'? What makes it 'scientific'?

What is scientific knowledge?

A asks: “Why should I believe scientific knowledge?”

B replies: “Scientific knowledge has been proven.

A asks: How?

B says: By means of scientific methodology!

A asks: Philosophical questions:

- How do we know that your methodology proofs knowledge?
- How can your methodology be justified?

Example of the role of scientific methodology

Scientific methodology

Example of scientific research in Health Sciences (GZW): Positional skull deformation in infants

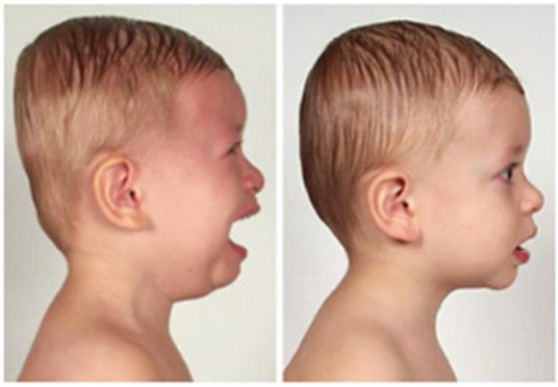
"Every day, young infants are presenting to child healthcare professionals with an odd shape of the skull.

…

In most cases … the shape of the infant's skull deforms as a result of prolonged prenatal or postnatal external forces.

This condition is known as positional skull deformation." [Renske M. van Wijk, 2014]

Claim about HElmet therapy: “It has been observed that in many cases skull deformation gets better after wearing a helmet.”



“HElmet therapy cures skull deformation”

Helmet therapy

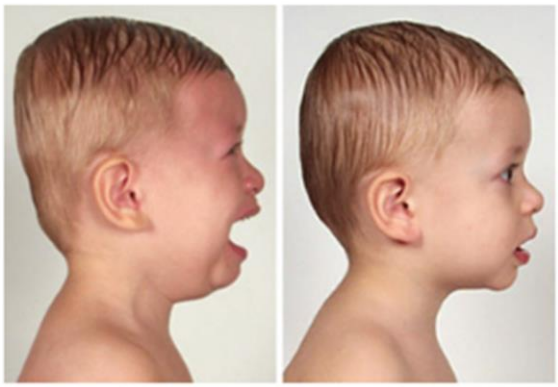
1. Many pediatric doctors and also parents claim that good results where achieved with their child after wearing the helmet - the baby must wear the helmet 9 month long, 23 hours a day. Would you, if you had a child with a moderate skull deformation, choose to wear the helmet? **YES/NO**

Helmet therapy

1. Many pediatric doctors and also parents claim that good results where achieved with their child after wearing the helmet - the baby must wear the helmet 9 month long, 23 hours a day. Would you, if you had a child with a moderate skull deformation, choose to wear the helmet? **YES/NO**

51/85	A	YES
30/85	B	NO

Scientific Research: HElmet therapy Assessment in infants with Deformed Skulls (HEADS):
EBM: Randomized controlled trial (RCT)



Conclusion of research: Helmet does not help

Scientific Method

EBM: Evidence Based Medicine

Randomized controlled trial (RCT)

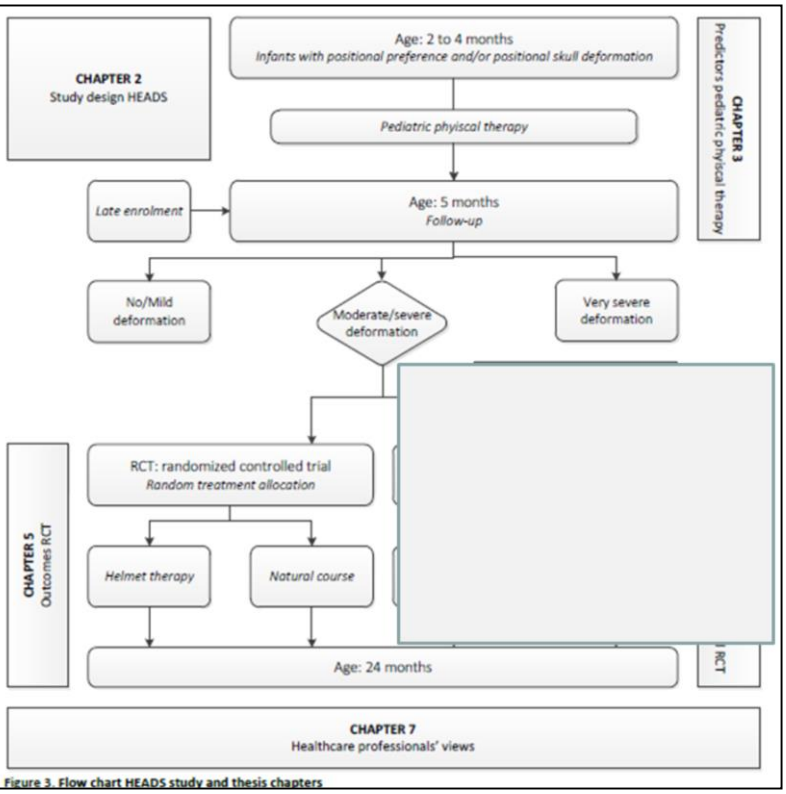


Figure 3. Flow chart HEADS study and thesis chapters

Helmet therapy

2. Many pediatric doctors and parents still strongly recommend the helmet therapy because it really helped their patient / child..

How would you explain this situation? (**Socrative survey**)

A. The set-up of this research was inadequate;

B. Parents are stupid (if they do not accept the results of scientific research)

C. Inadequate reasoning

3. Why?

Helmet therapy

How would you explain this situation (choose one answer)?

8/85	A	the set-up of this scientific research (EBM) was inadequate
7/85	B	parents and doctors are ignorant / studid (if they do not accept the results of scientific research)
47/85	C	inadequate reasoning

Scientific methodology: Why?

Many pediatric doctors and parents still strongly recommend the helmet therapy because it really helped their patient / child.

- Why should they believe the outcome of this scientific research?
- But how do we know that this methodology provides us with reliable results? How do we prove (justify) the scientific method. How can we prove that a scientific methodology is correct?
- Why is it important to do scientific research (such as RCT's in EBM)?

Scientific method: Empiricism

Francis Bacon(1561-1626)

Novum Organum (1620)

Inductive reasoning and observation

Scientific methodology

- **Observation and Inductive reasoning** is important as a scientific methodology.
- **Empiricism**: This scientific methodology defends the importance of empirical research.
- Justification of this scientific methodology claims that we only need observations and inductive reasoning for producing true knowledge.

Inductive argument Example 1

P_1: Raven 1 is black
P_2: Raven 2 is black
P_3: Raven 3 is black
.
P_n: Raven n (many) is black

Conclusion: All ravens are black (= knowledge)

- This is enumerative induction.

Inductive argument Example 2

P_1: The day before yesterday the sun rose
P_2: Yesterday the sun rose
P_3: Today the sun rose
.
.
P_n: Until now the sun rose every day

C: The sun rises every day

Inductive argument Example 3

P_1: Yesterday the clock stroke every hour
P_2: Today the clock stroke every hour
P_3: In the last 3 weeks the clock stroke every hour
.
P_n: ...

C: Tomorrow the clock will strike every hour

Inductive argument Example 4

P1: Iron conducts electricity

P_2: Copper conducts electricity

P_3: Gold conducts electricity

.

P_n: ...

C: All metals conduct electricity

Inductive argument Example 5

P_1: Aspirin relieved the head-ache of my neighbor
P_2: Aspirin relieved the head-ache of my mother
P_3: Aspirin relieved the head-ache of my friend
.
P_n: ...

C: Aspirin relieves head-ache of humans

Inductive argument Example 6

P_1: The helmet cured the child of A

P_2: The helmet cured the child of B

P_3:

.

.

P_n: So far, the helmet has cured (e.g.) 60% of the children I have treated,

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C: The helmet cures in (e.g.) 60% of the cases

The problem of induction

- Inductive reasoning is important in scientific methodology.
- It defends the importance of empirical research.
- It only requires observations and inductive inference.

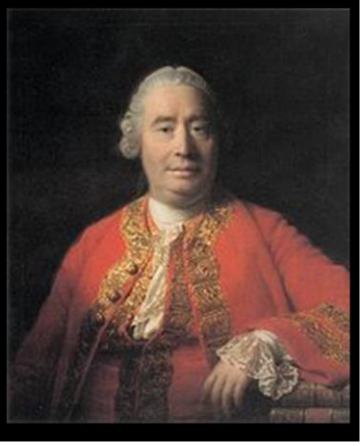
However

David Hume (1711 – 1776)

An enquiry concerning Human Understanding

Problems of Empiricism:

- Induction (logically invalid)
- Causality (cannot be observed)
- Necessary connection (,,)



Hume says that "We suppose that there is some connexion between them; some power in the one, by which it infallibly produces the other, and operates with the greatest certainty and strongest necessity." -- but there is no legitimate basis in our experience for this additional claim. Instead, that claim is derived simply from the habit of the mind "upon the appearance of one event, to expect its usual attendant,

David Hume (1711 – 1776)

An enquiry concerning Human Understanding

1. **Problem Induction**:
   Principal of induction is
   logically invalid.
2. **Problem of Observation**:
   Connection (causal
   relationship, 'hidden force')
   cannot be observed.

Hume's problem with causality is that 'the causal connection' (e.g., a force) cannot be observed. Think for instance of the following example. You see to circles on a screen. The number 1 moves and touches number 2, and at the same instance number 2 starts to move. Would you conclude that the movement of number 2 is caused by 1? How would you make the distinction between occurrences in which we see that two events (movement of 1, movement of 2) immediately follow up on one another, accidentally, or causally?

Important in experiments, is that we examine causal relationships by direct intervention with the cause. This is the manipulationist account of of causality. (So, rather than by passive observation, we learn about causal relationships

by active experimental interventions).

Helmet Therapy *Inadequate Reasoning*:

At level of presuppositions:

- Medical treatments are used because it has been proven.

At the level of logical reasoning:

- An illness will only get better when it is treated.
- There is an intervention (medical treatment) & there is a change after this intervention => the change is ***caused*** by this intervention.
- There is a *change*. Every change has a cause. So the change must be caused by the medical treatment.

Take home messages:

What is philosophy – Critical investigation of presuppositions:

- Example: presuppositions (e.g. metaphors) play a role in formation of our beliefs.
- Philosophy of science: learning to talk and critically think about science.
- We can 'discover' and articulate our presuppositions (e.g., about science).
- .Scientific methodology is important, but needs to be justified.
- Observation + Inductive reasoning as a methodology => Hume's problems..