

30. Some More Issues about Science

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<http://st.inf.tu-dresden.de/teaching/asics>

1) Data, Information, Knowledge,
Wisdom (DIKW)

2) Value Systems

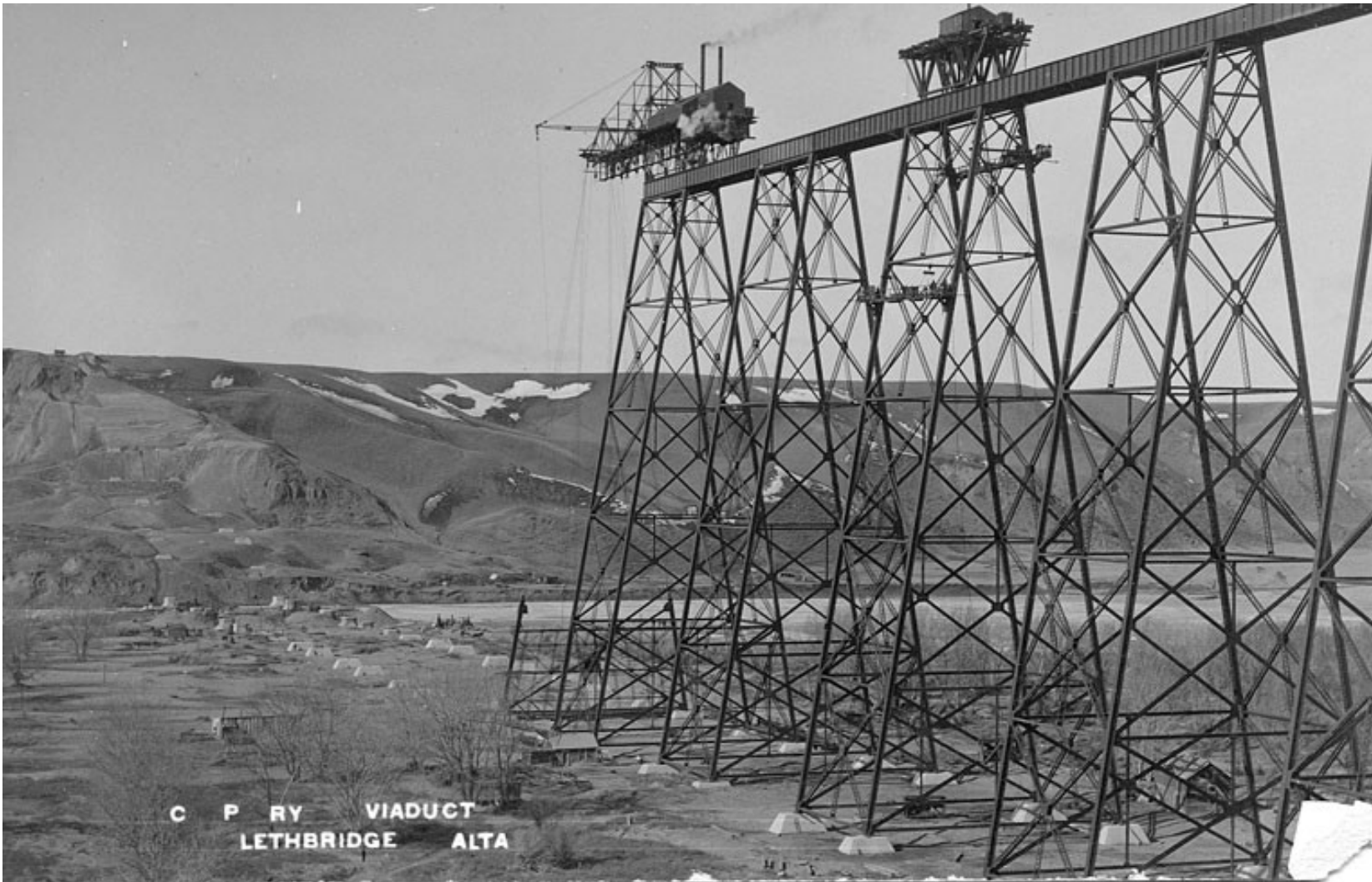
3) Code of Ethics

4) Dem Schönen Wahren Guten

A.1 The Ignorabimus Debate



Technical Science Solves Practical Problems



If I have seen further it is by standing on the shoulders of Giants.
Isaac Newton

Lethbridge high level bridge. Public domain.

<http://www.flickr.com/photos/galt-museum/3380760266/sizes/o/in/photostream/>

30.1 Data, Information, Knowledge, and Wisdom

- ▶ Science should produce knowledge, and technical science should solve problems

Where is the Life we have lost in living?

Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?

T.S. Eliot, "The Rock", Faber & Faber 1934. [Hey]



Communication as a Channel Model

Gedacht heißt nicht immer gesagt,
gesagt heißt nicht immer richtig gehört,
gehört heißt nicht immer richtig verstanden,
verstanden heißt nicht immer einverstanden,
einverstanden heißt nicht immer angewendet,
angewendet heißt noch lange nicht beibehalten.
Konrad Lorenz

Evas
Gedanke

Formu-
lieren

Sagen

Übertragen

Hören

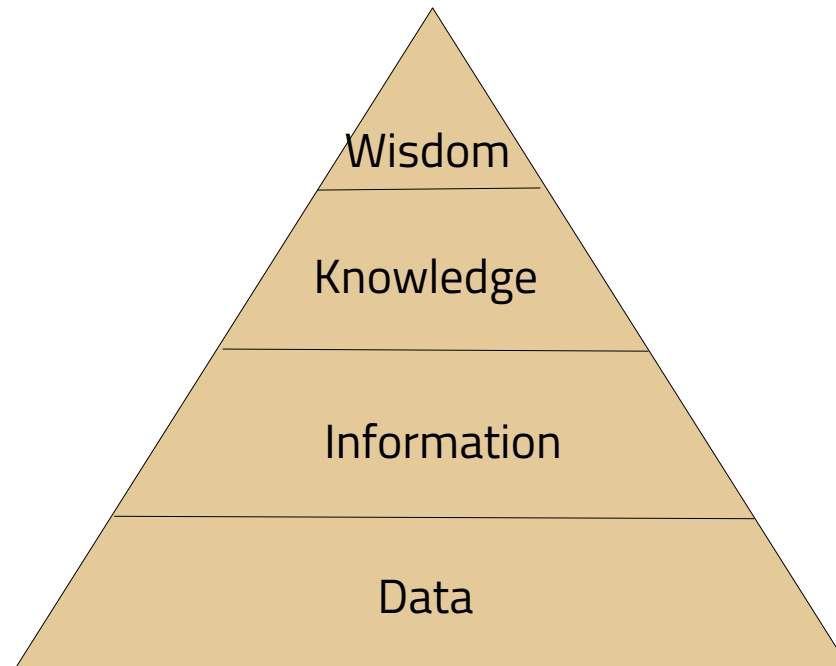
Verstehen

Peters
Anwenden

Kommunikation

Science is about DIKW (Data, Information, Knowledge, Wisdom)

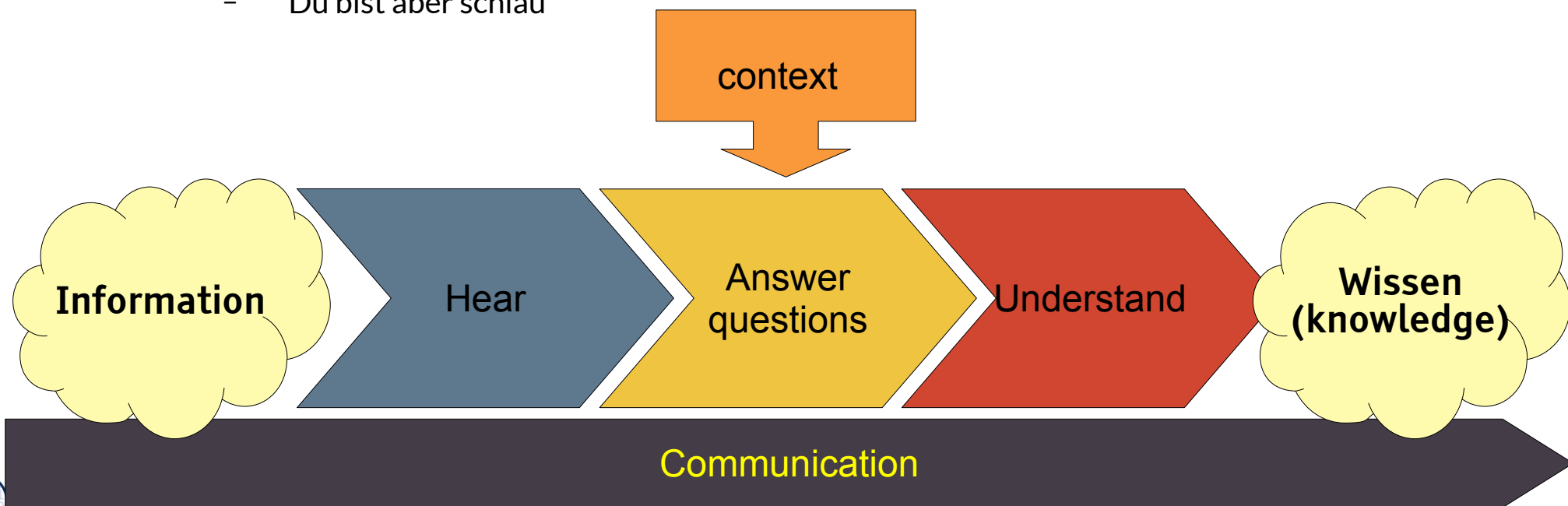
- ▶ Philosophy of Science (Wissenschaftstheorie) discusses the right model for DIKW.
- ▶ The relationship of DIK and W is important for science, because
 - Natural science finds data in the world and has to interpret them to knowledge
 - Technical science should use knowledge to solve problems, but needs to be wise, because technology can be dangerous (e.g., see the use of nuclear energy)
- ▶ One DIKW model is the DIKW pyramid:



The DIK Model from Spinner

6 Academic Skills in Computer Science (ASICS)

- ▶ Knowledge is context-dependent and gained from information by interpretation
[Prof. Helmut Spinner, Karlsruhe, Keynote at Fakultät Informatik, 1997]
- ▶ Every human being judges on a message immediately, answering 10-15 questions immediately
- ▶ Answering the questions creates knowledge
- ▶ What do I think about information such as:
 - “Das schmeckt gut.”
 - “Das ist aber interessant”
 - “Du Idiot”
 - “Du bist ein Schlingel”
 - “Du bist aber schlau”



Typical Questions for Interpretation

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Academic Skills in Computer Science (ASICS)

About the sender:

- ▶ In which emotional state is the sender? (angry, sad, happy, joking, serious)
- ▶ Is the sender trustworthy? (unknown, friend, competitor, enemy, have I been disappointed by him already?)
- ▶ Which personality has the sender? (serious human being, funny, thinker, superficial type, depressive,...)
- ▶ which channel has the sender used previously (facts, emotions, relations, etc.)?

About the receiver:

- ▶ Which are my current expectations? Which channel do I expect?
- ▶ My emotional state

About the context:

- ▶ In which state is the relationship (peace, quarrel, ..)
- ▶ the communication? (stress, hurry, joking, ..)

How Information Becomes Knowledge

- ▶ How do you interpret the remarks
 - “Das schmeckt gut.”
 - “Das ist aber interessant”
 - “Du Idiot”
 - “Du bist ein Schlingel”
 - “Du bist aber schlau”
- ▶ from your partner?
- ▶ from your friend?
- ▶ from your mother?
- ▶ from your competitor?
- ▶ from your boss?

Knowledge is what remains after answering questions.

Knowledge is what remains in the scientist after answering questions of his value system.

Exc.: What is “Chicken Soup for the Soul”?

- ▶ What is Chicken Soup?
- ▶ Why is it good?
- ▶ Why is it good for the soul?
- ▶ What does it really mean?
- ▶ Why is here data and information completely based on association?

30.2 The Ignorabimus Debate – The Limits of the Exact Sciences, Exact Knowledge, and Different Forms of Rationalising

**Has exact science limits?
How do we gain hard, exact, objective knowledge?**



**DRESDEN
concept**
Exzellenz aus
Wissenschaft
und Kultur

Bertrand Russel on “Know”

[Russel-Problems]

In daily life, we assume as certain many things which, on a closer scrutiny, are found to be so full of apparent contradictions that only a great amount of thought enables us to know what it is that we really may believe. In the search for certainty, it is natural to begin with our present experiences, and in some sense, no doubt, knowledge is to be derived from them.

But any statement as to what it is that our immediate experiences make us know is very likely to be wrong. It seems to me that I am now sitting in a chair, at a table of a certain shape, on which I see sheets of paper with writing or print. By turning my head I see out of the window buildings and clouds and the sun. I believe that the sun is about ninety-three million miles from the earth; that it is a hot globe many times bigger than the earth; that, owing to the earth's rotation, it rises every morning, and will continue to do so for an indefinite time in the future. I believe that, if any other normal person comes into my room, he will see the same chairs and tables and books and papers as I see, and that the table which I see is the same as the table which I feel pressing against my arm. All this seems to be so evident as to be hardly worth stating, except in answer to a man who doubts whether I know anything. Yet all this may be reasonably doubted, and all of it requires much careful discussion before we can be sure that we have stated it in a form that is wholly true.

Do you want to know why this text reads well? Then, visit the course.

30.1.2 Different Forms of “Know”

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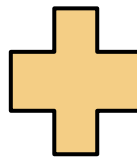
Academic Skills in Computer Science (ASICS)

- ▶ Give for all terms an example sentence
- ▶ Knowledge (Wissen)
- ▶ Faith (Glaube)
- ▶ Certitude (Gewissheit)
- ▶ Assumption (Annahme)

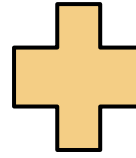
Different Forms of "Know"

Objective

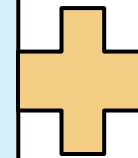
everybody
can prove
this himself
by
experiment
or proof



historically
well
established
sources or
eye-
witnesses



Experience
by
subjective
experiments



Only seen or
experienced
by me
Memory
Revelation

Knowledge

Well-founded
assumptions

Certitude

Faith

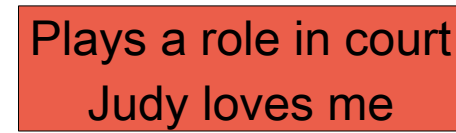
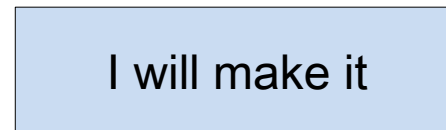
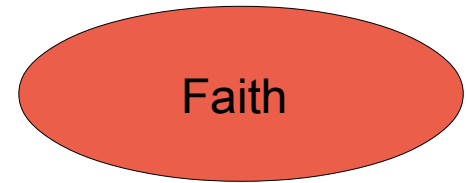
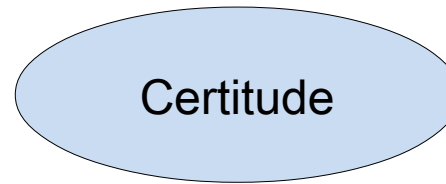
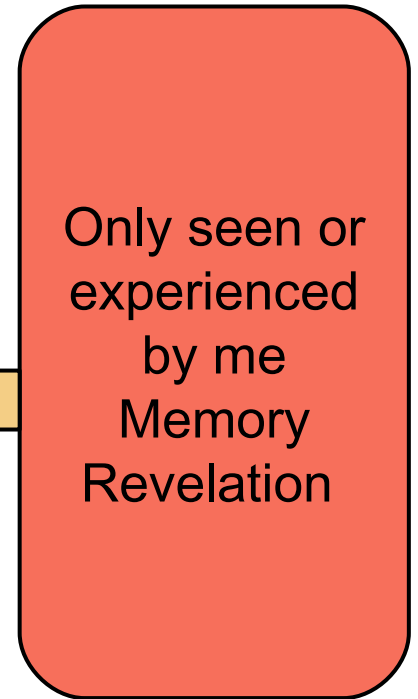
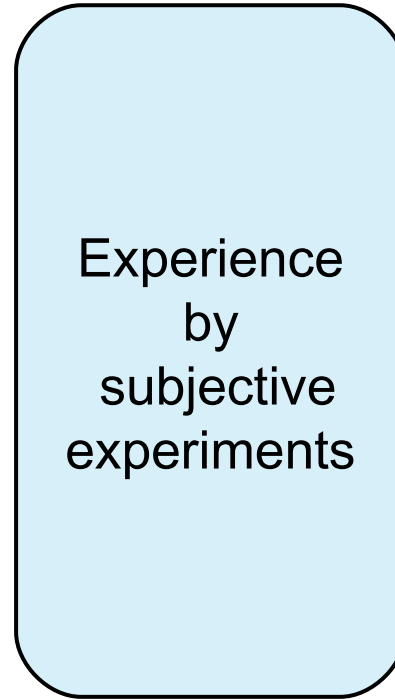
Exact Sciences
John is my father by
DNA test

Historical sciences
John is my father

I will make it

Plays a role in court
Judy loves me

Subjective



“Wir werden es nicht wissen” (“Ignorabimus”)



Heinrich Hertz

„Gegenüber den Rätseln der Körperwelt ist der Naturforscher längst gewöhnt, mit männlicher Entsagung sein „Ignoramus“ auszusprechen.

Im Rückblick auf die durchlaufene siegreiche Bahn trägt ihn dabei das stille Bewußtsein, daß, wo er jetzt nicht weiß, er wenigstens unter Umständen wissen könnte, und dereinst vielleicht wissen wird.

Gegenüber dem Rätsel aber, was Materie und Kraft seien, und wie sie zu denken vermögen, muß er ein für allemal zu dem viel schwerer abzugebenden Wahrspruch sich entschließen: „Ignorabimus“.
(E. du Bois-Reymond. Über die Grenzen des Naturerkennens, 1872, Seite 464)

The 7 World Riddles (7 Welträtsel)

Was ist Materie und Kraft? (*)

Woher kommt der Ursprung der Bewegung? (*)

Woher kommt das erste Leben?

Woher stammt der Zweck in der Natur?

Woher stammt die bewusste Empfindung in den unbewussten Nerven? (*)

Woher kommt das vernünftige Denken und die Sprache?

Woher stammt der „freie“, sich zum Guten verpflichtet fühlende Wille? (*)

(*) transzendent

Counterarguments by David Hilbert (1900)



http://de.wikipedia.org/wiki/David_Hilbert

Diese Überzeugung von der Lösbarkeit eines jeden mathematischen Problems ist uns ein kräftiger Ansporn während der Arbeit; wir haben in uns den steten Zuruf: Da ist das Problem, suche die Lösung. Du kannst sie durch reines Denken finden; denn **in der Mathematik gibt es kein Ignorabimus.** [20]

„Hilbert plädiert damit für einen Optimismus in der Forschung, der selbstgesetzte Beschränkungen des Denkens ablehnt. Das Motto findet sich auch auf seinem Grabstein:

Wir müssen wissen. Wir werden wissen.“

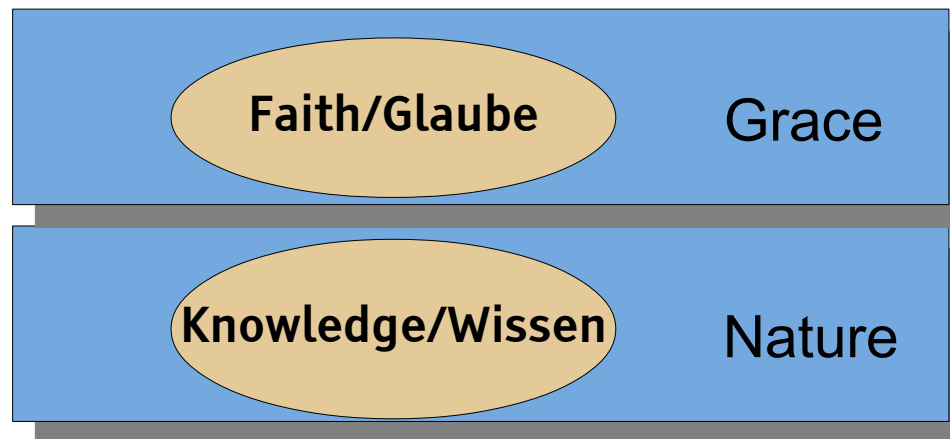
„Das ist es aber, was ich verlange: es soll in mathematischen Angelegenheiten prinzipiell keine Zweifel, es soll keine Halbwahrheiten und auch nicht Wahrheiten von prinzipiell verschiedener Art geben können..

Das Ziel, die Mathematik sicher zu begründen, ist auch das meinige; ich möchte der Mathematik den alten Ruf der unanfechtbaren Wahrheit, der ihr durch die Paradoxien der Mengenlehre verlorenzugehen scheint, wiederherstellen; aber ich glaube, dass dies bei voller Erhaltung ihres Besitzstandes möglich ist.“

Mathematische Probleme – Vortrag, gehalten auf dem internationalen Mathematiker-Kongreß zu Paris 1900.

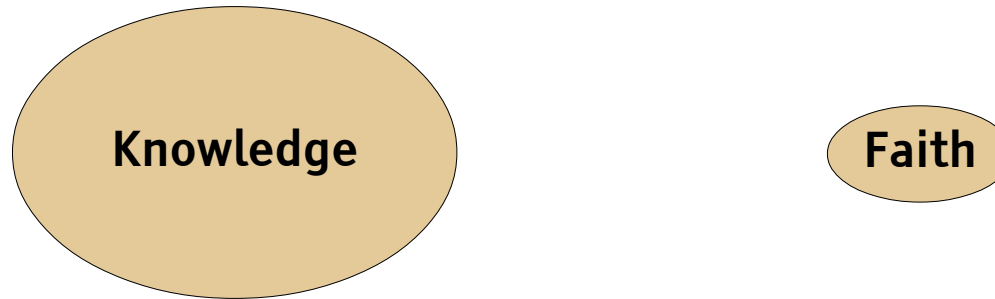
Traditional Models of the Relationship between Knowledge and Faith: Scholastics

- ▶ Thomas Aquinas distinguished knowledge by ratio and knowledge by revelation (faith).



Scholastics (Thomas von Aquin, 1200) [Hoye]

Traditional Models of the Relationship between Knowledge and Faith: Empiricism



Empiricism (John Locke:)
only the empirically or experimentally proven counts

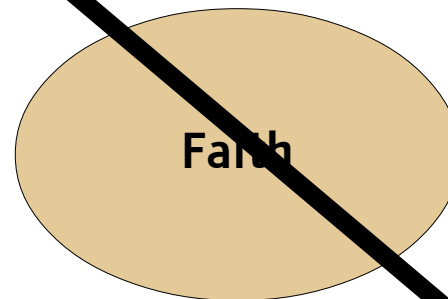
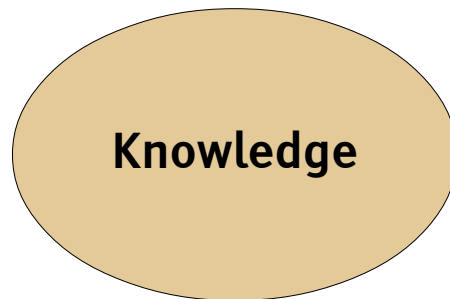
Empiricism (Empirism) is a theory of knowledge that asserts that knowledge comes only or primarily from sensory experience.

One of several views of epistemology, the study of human knowledge, along with rationalism, idealism, and historicism, empiricism emphasizes the role of experience and evidence, especially sensory perception, in the formation of ideas, over the notion of innate ideas or traditions; empiricists may argue however that traditions (or customs) arise due to relations of previous sense experiences.

<http://en.wikipedia.org/wiki/Empirism>

Traditional Models of the Relationship between Knowledge and Faith: Rationalism

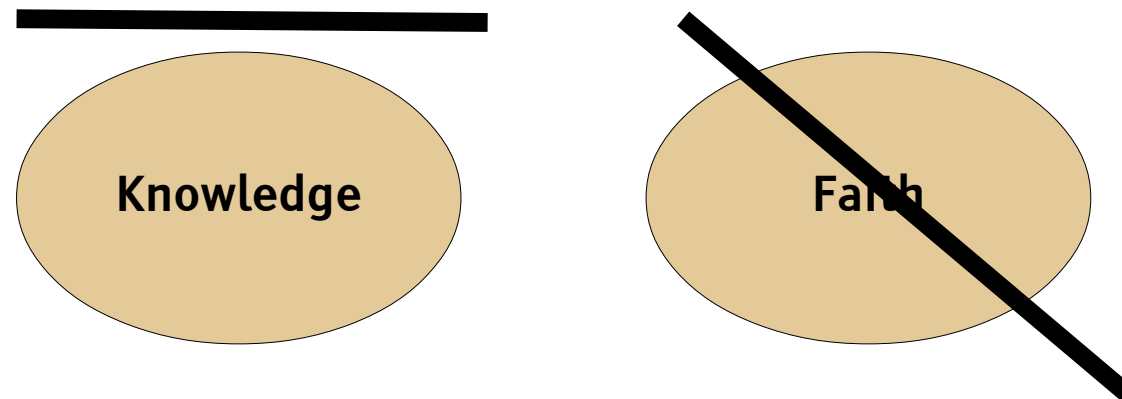
- ▶ <http://en.wikipedia.org/wiki/Rationalism>
- ▶ .. rationalism is "any view appealing to reason as a source of knowledge or justification." In more technical terms, it is a method or a theory "in which the criterion of the truth is not sensory but intellectual and deductive."
- ▶ Different degrees of emphasis on this method or theory lead to a range of rationalist standpoints, from
 - the moderate position "that reason has precedence over other ways of acquiring knowledge"
 - to the more extreme position that reason is "the unique path to knowledge."



Rationalism (Descartes a.m.m.):
only the logically proven counts

Traditional Models of the Relationship between Knowledge and Faith: “Ignorabimus” Rationalism

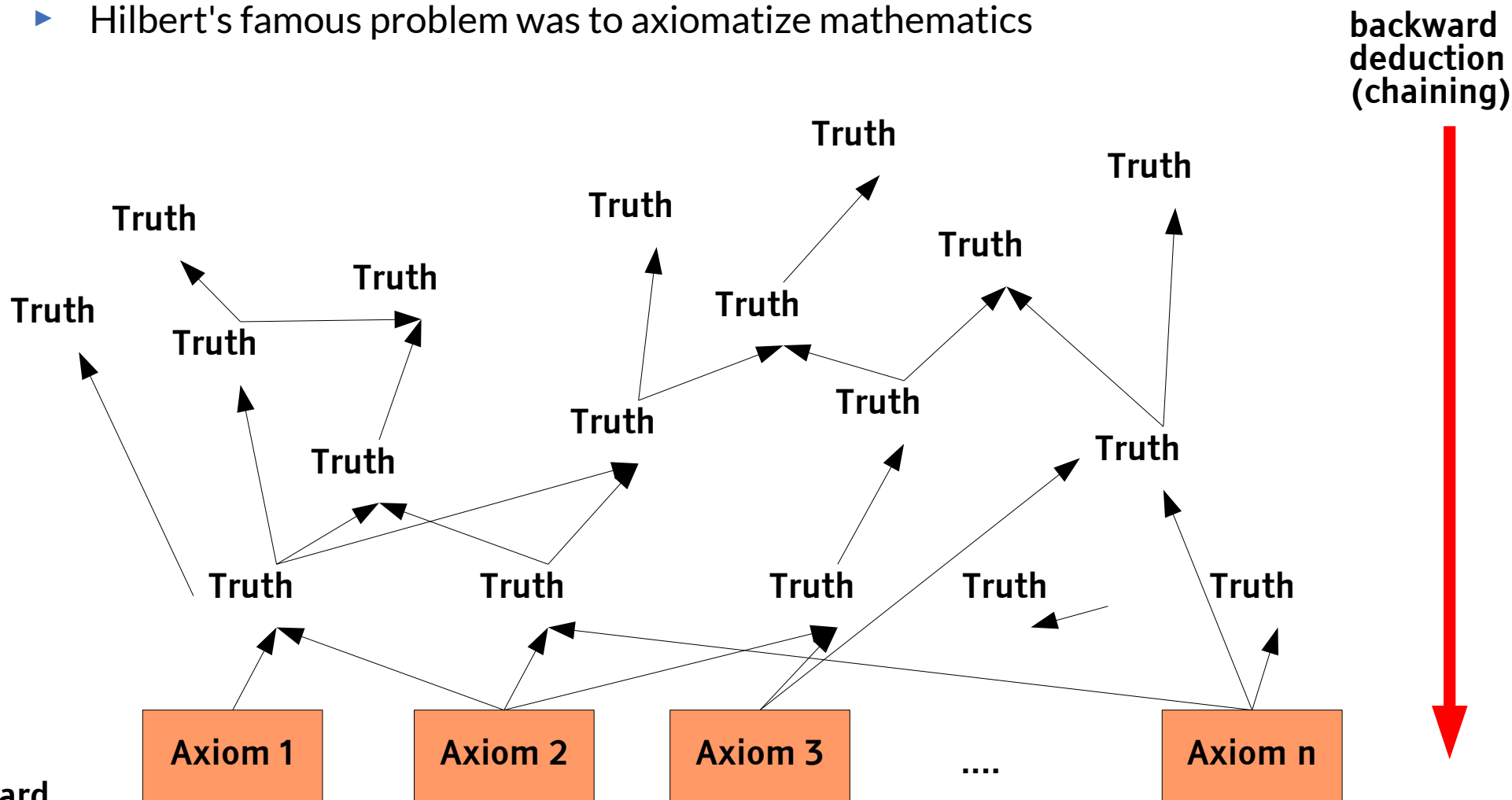
- ▶ was attacked by Hilbert, but confirmed by Gödel



Ignorabimus rationalism (du Bois-Reymond)
mechanistic world model, but limits of knowledge

Ignorabimus-Rationalism: Formal Science is Based on Unproven Axioms

- ▶ Since the 19th century, mathematics knows that without unproven axioms, thinking is not possible (axiomatic thinking)
- ▶ Hilbert's famous problem was to axiomatize mathematics

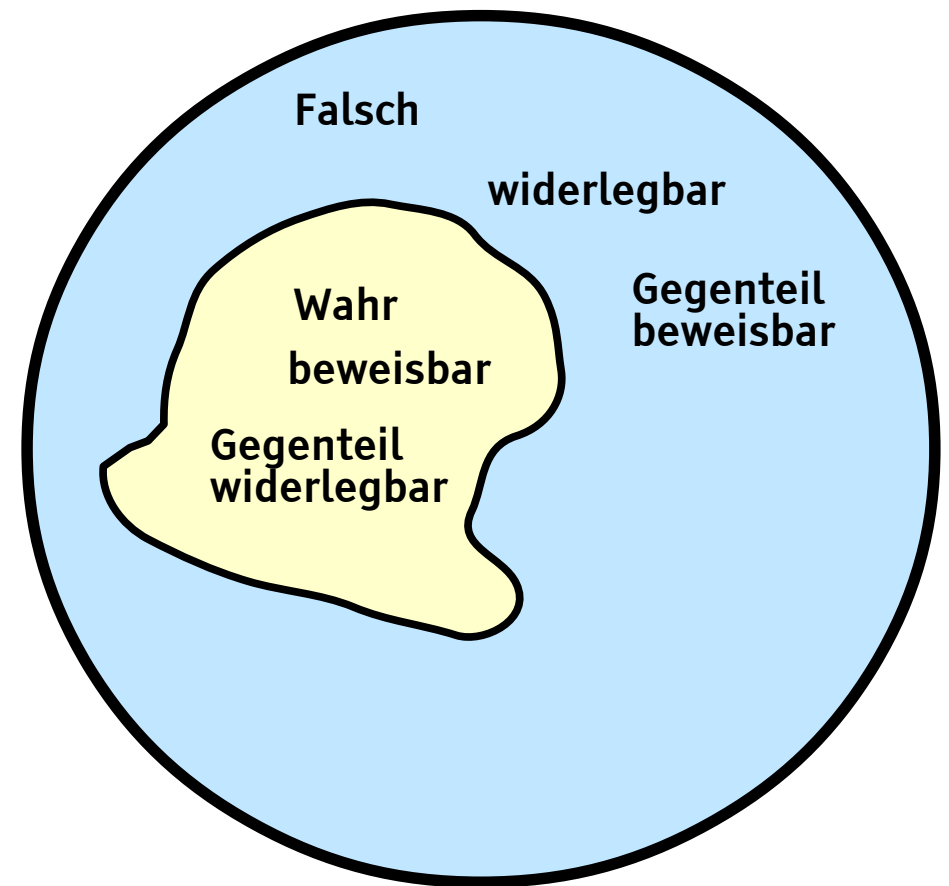
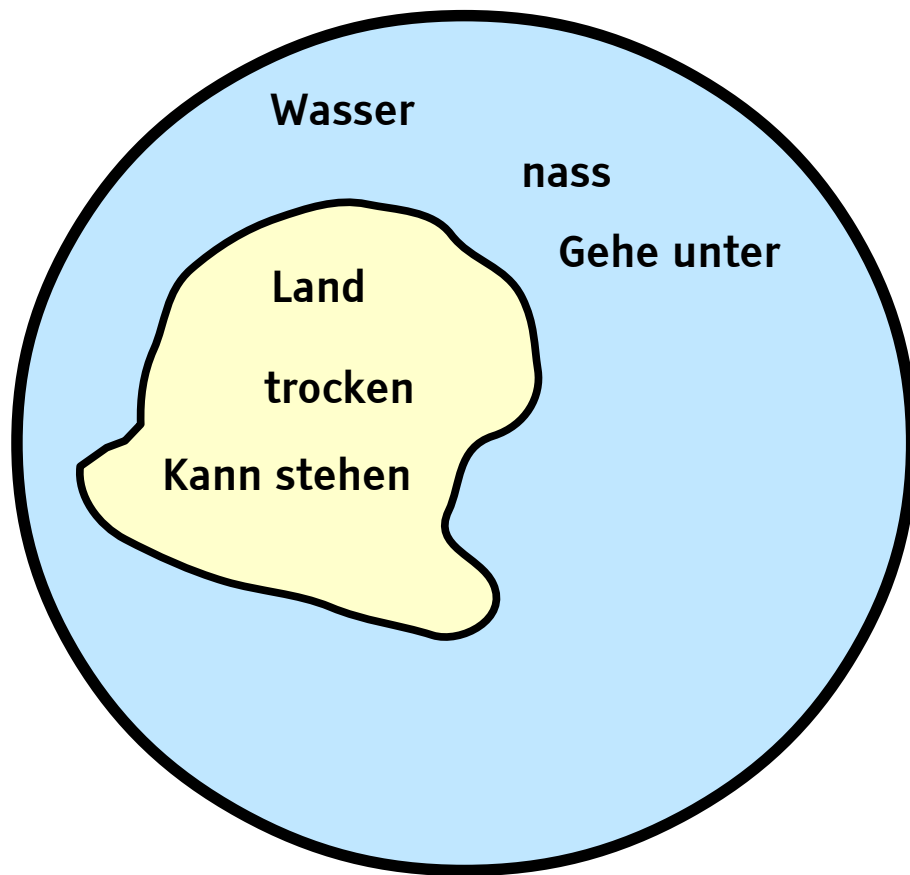


Axioms in Science

- ▶ Knowledge relies on proof by reasoning, experiment or empirics. But proofs rely on axioms
- ▶ Well-founded assumptions, Certitude and Faith means to assume some more unproven axioms

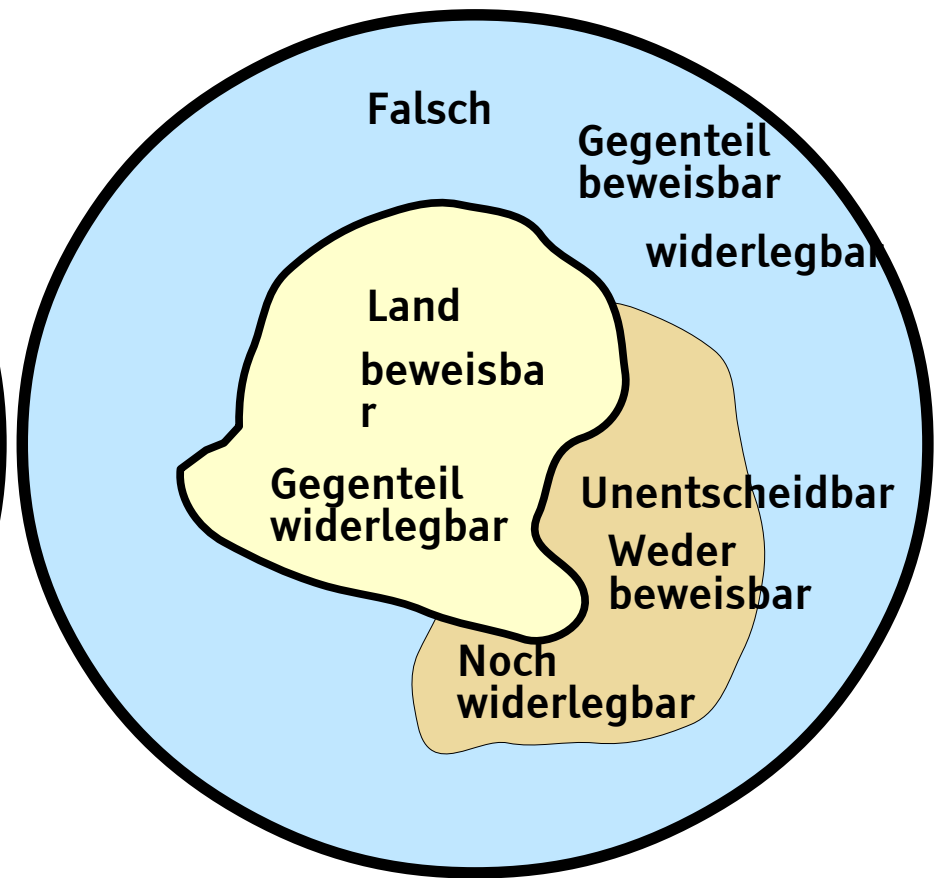
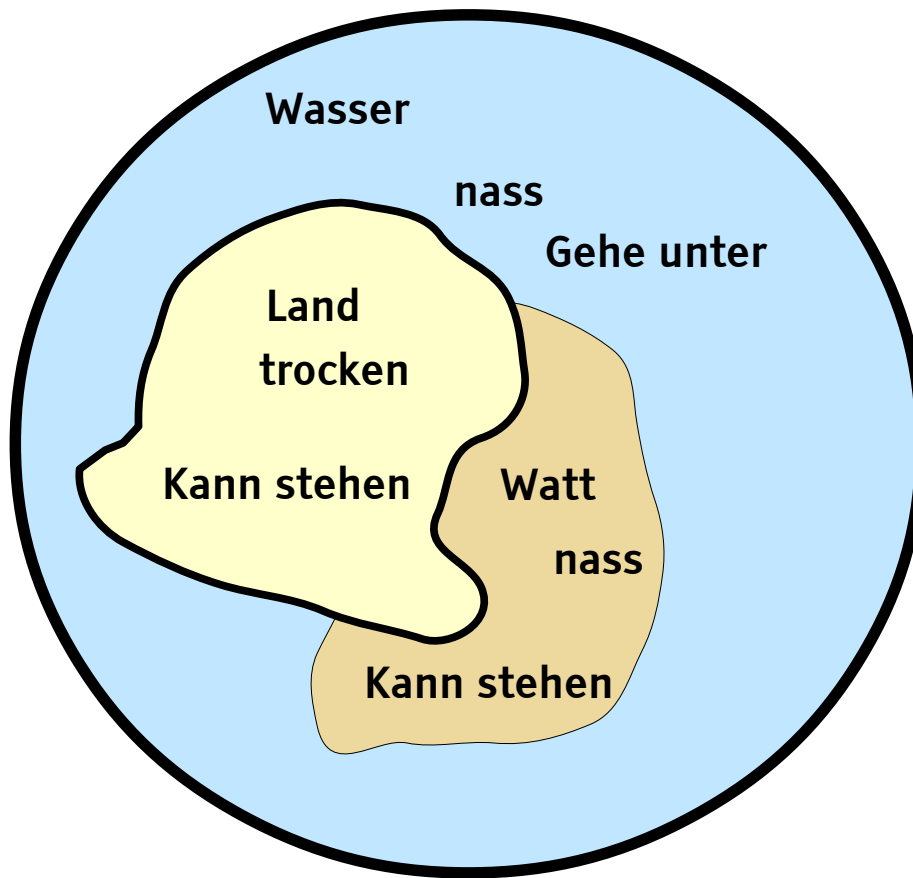
**I do not define time, space, place, and motion, as being well known to all.
Isaac Newton**

Before 1930 and Gödel: Everything is Decidable



After 1930: Undecidable Problems

- ▶ There are limits to the objectively provable knowledge (Gödel's Unvollständigkeitssatz 1933)
- ▶ du Bois-Reymond was right, not Hilbert!



- Translation of natural languages
- Covering infinite planes with tiling patterns

- Termination of programs
- Second order logics (the truth machine)

Limits of Exact Science

20th century has found out a lot of limits of exact science and rationalism (axiomatic thinking, decidability, falsificationalism etc.).

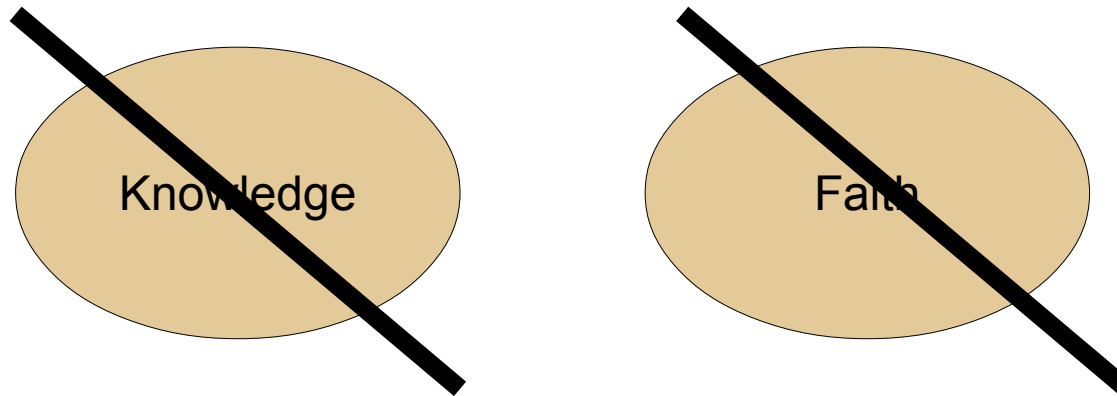
Science has not buried thinking about Value Systems, Faith, and Religion.

People should distinguish between the different types of science and knowledge.

Of course, blind faith is no option, but blind rationalism is neither...

Traditional Models of the Relationship between Knowledge and Faith: Critical Rationalism

- ▶ “Falsificationism” philosophy of science (Wissenschaftstheorie) according to Karl Popper (critical rationalism)
 - Science never finds the full truth, but works with models
 - Models are idealistic abstractions of reality
 - Science falsifies models, i.e., approaches the truth step by step
 - Objective knowledge is impossible, can only be approached, i.e., is model-based
 - Instead of objective knowledge, well-founded assumptions are possible



Critical rationalism (kritischer Rationalismus, Falsifikationsismus, Popper)

Models are being falsified, idealistic research, easy to become

30.2 Value Systems

**Has exact science limits?
How do we gain hard, exact, objective knowledge?**



**DRESDEN
concept**
Exzellenz aus
Wissenschaft
und Kultur

The Influence of Value Systems

- ▶ Science produces data and information. Knowledge and wisdom are gained by interpretation
- ▶ The reasons are mostly subjective and depend on
 - The past of the person (receiver): experience, crises, insight about oneself
 - The nature of the sender of some information: reports of trustworthy people and eye witnesses
 - The state of the receiver: personal goals, hope, values, transcendancy
 - The context of some information which is sent
- ▶ Scientific results (data, information) is interpreted by human beings to become knowledge, answering questions
- ▶ Scientific knowledge has limits

Interpretation, Value Systems, and World Models

- ▶ Thesis: Science is conducted in the context of the *value system* of the researcher
 - The researcher interprets the information, answering questions about his own state and the context, and thereby produces knowledge
 - The value system also forms the ethics and wisdom of science
 - Ex.: Nazi doctors didn't care about mistreated Jews because they considered them to be Untermenschen
- ▶ The *value system of a researcher* is determined by his *world model (Weltbild)* of God, Man, and Nature
 - Weltbild = Gottesbild + Menschenbild + Umweltbild
 - Motivation: Problems, Objectives, Utility
 - Das Wahre, Edle, Gute: Genuß, Schönheit, Kultur, Bildung
- ▶ In the 20th century in the Western Hemisphere, world models have been humanistic – christian – atheistic – heathen – social-darwinistic - sociologic
 - Also heathen religion played a role (Nazis)
 - and the sociology of communistic class fight

Examples For Value-Based Science (Christians)

- ▶ Thesis: also Natural Science is conducted under a value system and a world model
- ▶ Isaac Newton:
 - “It is the perfection of God's works that they are all done with the greatest simplicity. He is the God of order and not of confusion.”
 - “Truth is ever to be found in simplicity, and not in the multiplicity and confusion of things.”
 - “God created everything by number, weight and measure.”
- ▶ Galileo Galilei:
 - “I do not feel obliged to believe that the same God who has endowed us with senses, reason, and intellect has intended us to forgo their use and by some other means to give us knowledge which we can attain by them.”
 - (see more about the Christian value system of Galilei in [Sova-Galileo])

Examples For Value-Based Science (Atheists)

- ▶ Thesis: also Natural Science is conducted under a value system and a world model
- ▶ Richard Dawkins, a strong rationalist [wikiquote]
- ▶ It is often said, mainly by the 'no-contests', that although there is no positive evidence for the existence of God, nor is there evidence against his existence. So it is best to keep an open mind and be agnostic. At first sight that seems an unassailable position, at least in the weak sense of Pascal's wager. But on second thoughts it seems a cop-out, because the same could be said of Father Christmas and tooth fairies. There may be fairies at the bottom of the garden. There is no evidence for it, but you can't prove that there aren't any, so shouldn't we be agnostic with respect to fairies?
 - Speech at the Edinburgh International Science Festival, 1992-04-30. Frequently misattributed to The God Delusion. In "EDITORIAL: A scientist's case against God". The Independent (London): p. 17. April 20, 1992. and Paul Gomberg (2011-05-27). What Should I Believe?: Philosophical Essays for Critical Thinking. Broadview Press.
- ▶ The total amount of suffering per year in the natural world is beyond all decent contemplation. During the minute that it takes me to compose this sentence, thousands of animals are being eaten alive, many others are running for their lives, whimpering with fear, others are slowly being devoured from within by rasping parasites, thousands of all kinds are dying of starvation, thirst, and disease. It must be so. If there ever is a time of plenty, this very fact will automatically lead to an increase in the population until the natural state of starvation and misery is restored. In a universe of electrons and selfish genes, blind physical forces and genetic replication, some people are going to get hurt, other people are going to get lucky, and you won't find any rhyme or reason in it, nor any justice. The universe that we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil, no good, nothing but pitiless indifference.
 - "God's Utility Function", Scientific American: 85, November 1995, ISSN 0036-8733

- ▶ Jacques Monod, nobel laureate. http://todayinsci.com/M/Monod_Jacques/MonodJacques-Quotations.htm
- ▶ The scientific attitude implies—the postulate of objectivity—that is to say, the fundamental postulate that there is no plan; that there is no intention in the universe.
 - Quoted in Geraldine O. Browning (ed). Et al., Teilhard de Chardin: in Quest of the Perfection of Man (1972), p119.
- ▶ Chance alone is at the source of every innovaton, of all creation in the biosphere. Pure chance, only chance, absolute but blind liberty is at the root of the prodigious edifice that is evolution... It today is the sole conceivable hypothesis, the only one that squares with observed and tested fact.
 - Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology (1972), 112-113. In Holmes Rolston Genes, Genesis, and God (1999), p17.
- ▶ One of the great problems of philosophy, is the relationship between the realm of knowledge and the realm of values. Knowledge is what is; values are what ought to be. I would say that all traditional philosophies up to and including Marxism have tried to derive the 'ought' from the 'is.' My point of view is that this is impossible, this is a farce.
 - Quoted in John C. Hess, 'French Nobel Biologist Says World Based On Chance', New York Times (15 Mar 1971), p6.
- ▶ "Man at last knows he is alone in the unfeeling immensity of the universe, out of which he has emerged only by chance. His destiny is nowhere spelled out, nor is his duty. The kingdom above or the darkness below; it is for him to choose", 1971 [wikipedia entry]

Value Systems of Famous Engineers and Technical Scientists

- ▶ Poverty and laziness are a strong motivation for technical science
- ▶ John Harrison invented his H-3 clock because the Royal Society had put out a price of 10000 pounds for a precise ship clock.
 - Even after the clock proved to fulfil the criteria, the Royal Society changed the success criteria, and he fought for almost his entire life to get acknowledged and to get the reward [Sobel Longitude]
- ▶ Thomas A. Edison was driven by economic reasons: “Was soll ich forschen, wenn ich es nicht verkaufen kann”
 - Edison made more than 10000 light bulb variants before he found the right technique

Responsibility of a Software Engineer (ACM)

- ▶ Software Engineering Code of Ethics and Professional Practice (Version 5.2)
- ▶ <http://www.acm.org/about/se-code>
- ▶ Principle 1: PUBLIC
- ▶ Software engineers shall act consistently with the public interest. In particular, software engineers shall, as appropriate:
 - ▶ 1.01. Accept full responsibility for their own work.
 - ▶ 1.02. Moderate the interests of the software engineer, the employer, the client and the users with the public good.
 - ▶ 1.03. Approve software only if they have a well-founded belief that it is safe, meets specifications, passes appropriate tests, and **does not diminish quality of life, diminish privacy or harm the environment**. The ultimate effect of the work should be to the public good.
 - ▶ 1.04. **Disclose** to appropriate persons or authorities **any actual or potential danger** to the user, the public, or the environment, that they reasonably believe to be associated with software or related documents.
 - ▶ 1.05. Cooperate in efforts to address matters of grave public concern caused by software, its installation, maintenance, support or documentation.

Responsibility of a Software Engineer (ACM)

- ▶ Principle 3: PRODUCT
- ▶ Software engineers shall ensure that their products and related modifications meet the highest professional standards possible. In particular, software engineers shall, as appropriate:
 - ▶ 3.02. **Ensure** proper and **achievable goals** and objectives for any project on which they work or propose.
 - ▶ 3.03. **Identify**, define and address ethical, economic, cultural, legal and **environmental issues** related to work projects.
 - ▶ 3.04. Ensure that they are qualified for any project on which they work or propose to work by an appropriate combination of education and training, and experience.
 - ▶ 3.05. Ensure **an appropriate method is used** for any project on which they work or propose to work.
 - ▶ 3.06. **Work to follow professional standards**, when available, that are most appropriate for the task at hand, departing from these only when ethically or technically justified.

Code of Ethics in Germany

- ▶ Sicherung guter wissenschaftlicher Praxis (Safeguarding Good Scientific Practice).
Denkschrift - Memorandum (DFG)
 - [Http://www.dfg.de/download/pdf/dfg.../empfehlung_wiss_praxis_1310.pdf](http://www.dfg.de/download/pdf/dfg.../empfehlung_wiss_praxis_1310.pdf)
- ▶ Empfehlungen zu wissenschaftlicher Integrität (Wissenschaftsrat)
 - <http://www.wissenschaftsrat.de/download/archiv/4609-15.pdf>

30.3 Das Schöne, Wahre, Gute in der Wissenschaft



What is Science?



<http://www.flickr.com/photos/57198511@N00/3739119954/sizes/m/in/photo stream/>

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The Reason for Science: The Beauty

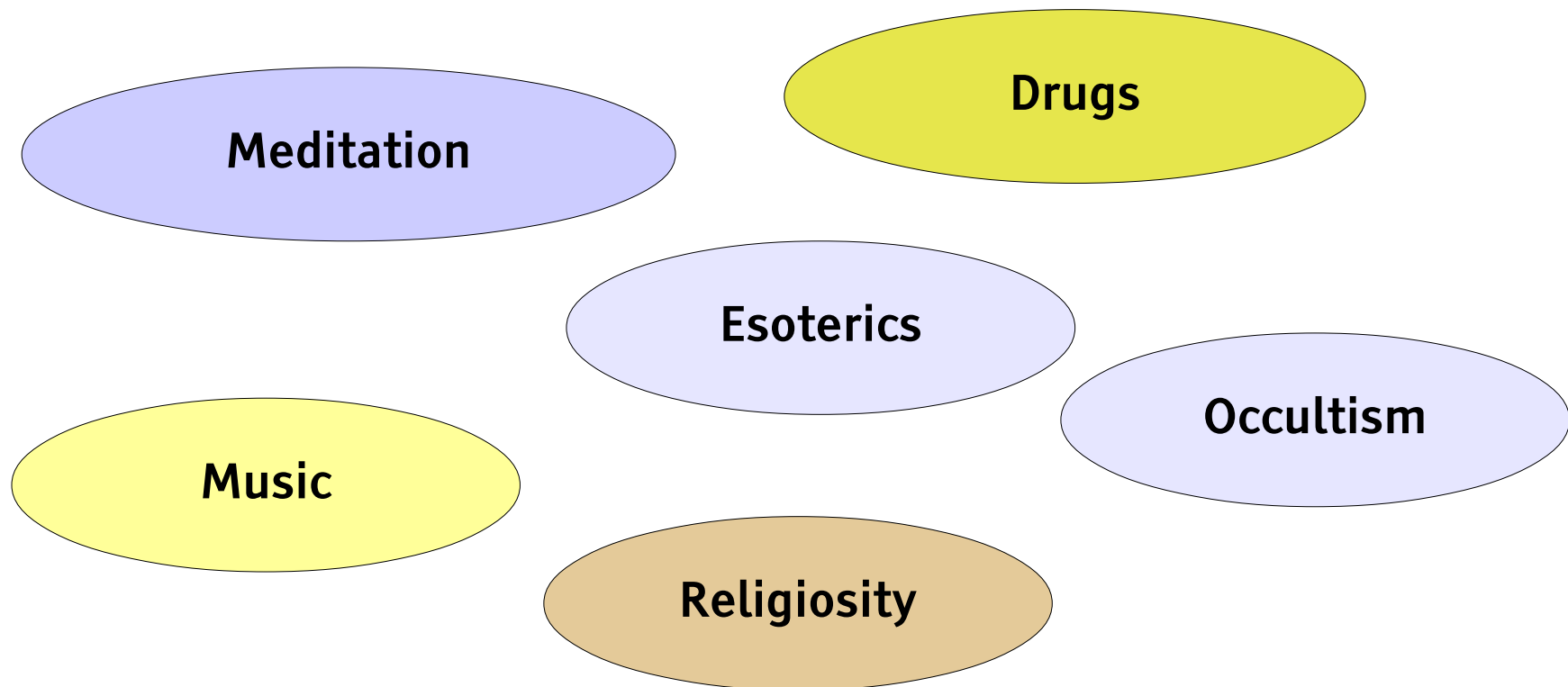
- ▶ In his essay “The weight of Glory” (“Das Gewicht der Herrlichkeit”), the philosopher C.S. Lewis claims that all we long is glory (das Schöne Wahre Gute).
 - <http://www.verber.com/mark/xian/weight-of-glory.pdf>
- ▶ Science helps to find it out
- ▶ He also claims that it has to do with the Godly, with the desire to be known by God.
- ▶ Science is about knowing. Knowing is something Godly.

E - Exercises

- ▶ Helmut Schmidt “Die gesellschaftl. Verantwortung des Wissenschaftlers” (DIE ZEIT Nr. 25 - 18. Juni 1982 - Seite 16)
- ▶ <http://www.zeit.de/1982/25/gesellschaftliche-moral-des-wissenschaftlers>
- ▶ Questions to answer:
 - What is his thesis, his claim? “The sting is in the tail”
 - How does he attempt to prove it?
 - Which paragraphs are the most impressive ones?
 - The pre-last one, because it is argumentative and dialectic
 - Why is the last paragraph impressive?
 - Because it has a strong appeal

A.1.3 The Problem of Transcendence

- ▶ Not all humans have become scientists to get knowledge. This was the dream of Scienticism
- ▶ Clearly, scientists don't know everything.
- ▶ Clearly, humans long for transcending, i.e., to meet the invisible things (Bewusstseinsweiterung, Transzendenz), and use many other things to “know”

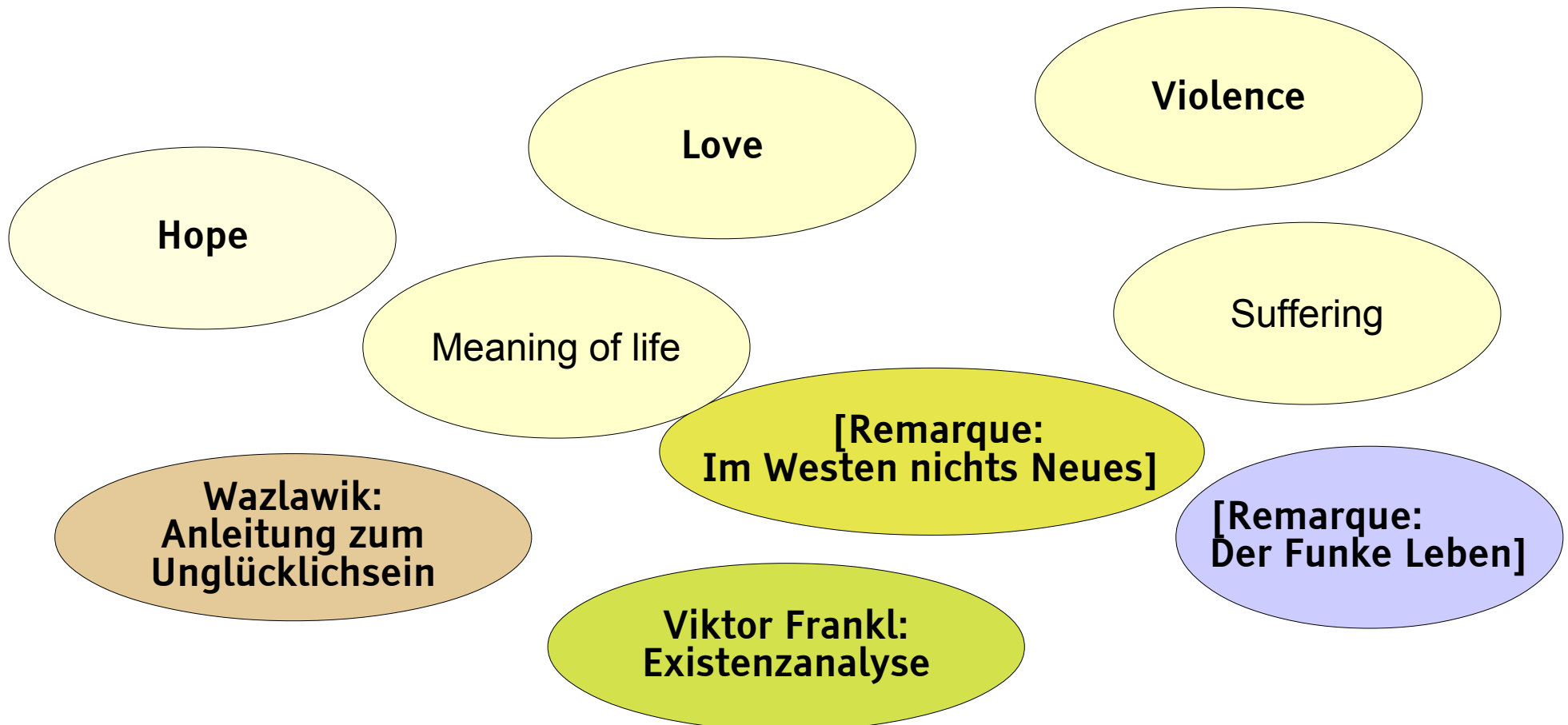


Questions for Transcendence

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Academic Skills in Computer Science (ASICS)

- ▶ Another strong motivation to assume limits of knowledge by science are the questions about how to transcend (leave this world and meet the invisible)



Knowledge can be created by different forms of science, but also by trust and subjective forms of „reasonable” evidence.

Exact science has limits (ignorabimus) and relies on unproven axioms.

Knowledge from scientific data and information is gained by interpretation under a value system and a world model of the researcher.

Probably, science cannot answer our questions for transcendency.

Technical science can lead to solved problems, but needs to be embedded into a value system to be employed wisely.

Portfolio-Diagram of Stokes

45 Academic Skills in Computer Science (ASICS)

- ▶ from Töpfers Materials
- ▶ Pure Basic Research
- ▶ Use-inspired Basic Research
- ▶ Curiosity-oriented Research
- ▶ Pure Applied Research