

Lecture
Knowledge-based Systems

Part 1 – Introduction

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Universität Duisburg-Essen

Who am I?

- I'm a researcher on the intersection of AI and NLP
- My background is in computer science and AI
- I received my PhD from the Heidelberg University in NLP
- I did postdoc in the UKP Lab in Technical University of Darmstadt

Looking for tutors

- I teach the GKI (Foundations of AI) course for bachelor students in this semester.
- I have three amazing tutors.
- Since there are many students, we need one or two more tutors.
- If you are interested in, please let me know **today**.

Who are you?

- What is your name?
- What do you study?
- Why are you taking this course?
- How good are you in programming?
- How good are you with LaTeX?

Let's try a writing exercise ...

- We need a person who takes responsibility of our writing exercises in each week?
- Who?

Let's try a writing exercise ...

- <https://www.overleaf.com/6813412427csprcfhzwqkm>
- Create a .tex file in the lecture01 folder
- Introduce yourself in **maximum 5 sentences**
 - What is your name and subject of study?
 - Why are you taking this course?
 - How good are you in programming?
 - What programming languages do you use?
 - Any suggestion or concern about the course?

Course overview

Part 1: What is knowledge?

- Different types of knowledge and intelligence
- Knowledge representations
- Quality of representations



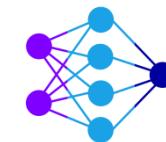
Part 2: How can we process knowledge?

- Learning from example
- Machine learning algorithms



Part 3: How do we learn to abstract?

- Learning to represent
- Distributional approaches



Administrative issues

- Moodle page: <https://moodle.uni-due.de/course/view.php?id=34789>
Key: —
- Exam: written
- Date: TBD
- Office hours: ask for (online) appointment
- Literature:
 - Mandatory readings are crucial for the exam
 - Optional readings are relevant for your education

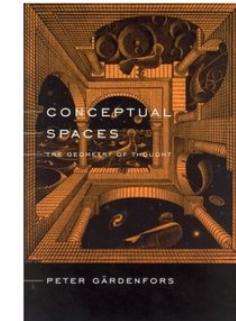
Textbooks

◊ Knowledge Representation:

Peter Gärdenfors

Conceptual Spaces: The Geometry of Thought

Bradford Books, 2000.



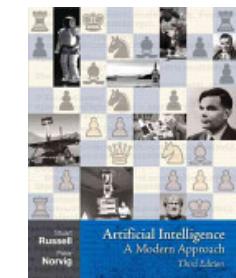
◊ Artificial Intelligence:

Stuart Jonathan Russell and Peter Norvig

Artificial Intelligence: A Modern Approach

Third Edition, Prentice Hall, 2010.

<http://aima.cs.berkeley.edu/>



◊ PLUS: Selected mandatory readings in Moodle.

Mandatory Reading

- Ronald J. Brachman, Hector J. Levesque
Knowledge Representation and Reasoning
Bradford Books, 2003.
Chapter 1, p.1-11 (you can skip 1.3)

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“So what makes a system knowledge-based, as far as we are concerned, is (...) the presence of a knowledge-base, a collection of symbolic structures representing what it believes and reasons with during the operation of the system.”

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“So what makes a system knowledge-based, as far as we are concerned, is (...) the presence of a knowledge-base, a collection of symbolic structures representing what it believes and reasons with during the operation of the system.”

We take a less constrained perspective on knowledge!

Why is this course interesting?

From a psychological perspective:

- Applied scenario for theoretical issues in cognitive science.
- Computational models are a valuable analysis tool for psychological data.

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From an engineering perspective

- Almost all problems in computer science are nowadays solved using machine learning approaches (i.e. knowledge-based systems)

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From an economic perspective:

- Add some buzzwords to your CV: cognitive science, machine learning, deep learning, knowledge processing, natural language processing (NLP), big data.

Your role

Ask, wonder, doubt, correct, engage, contribute, discuss, argue!



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What is knowledge?

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Library of Alexandria, ~ 30 BCE



Source: <http://www.collective-evolution.com/2017/12/08/why-men-with-dark-intentions-destroyed-the-library-of-alexandria/>

What is knowledge?

Home computers, ~ 1980



Source: https://en.wikipedia.org/wiki/Home_computer



Source: <https://www.pexels.com/photo/office-disk-storage-data-41290/>

What is knowledge?

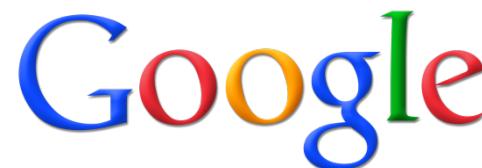
Server farm, today



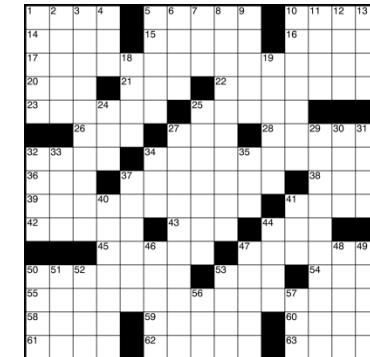
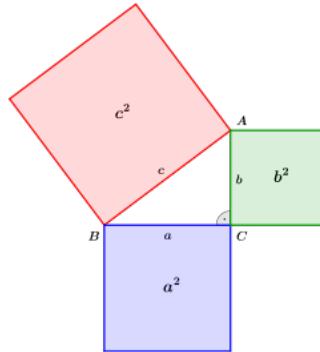
Source: <https://www.itwissen.info/Serverfarm-server-farm.htmlc>



WIKIPEDIA
The Free Encyclopedia



Types of knowledge



Your turn



Source: <http://myneuroworld.com/test-your-brain/>

Your turn

- Define knowledge!
- What do humans know?
- Determine different categories of knowledge
- Evaluate
- Lessons learned



Source: <http://myneuroworld.com/test-your-brain/>

1. Definition for knowledge

- What is knowledge?
- Write down a quick and dirty definition.
- Do not overthink it.



2. Examples of knowledge

Get together in groups of 2 or 3.

What do humans know? Make a list of **concrete examples**.



3. Types of knowledge

Group the examples.

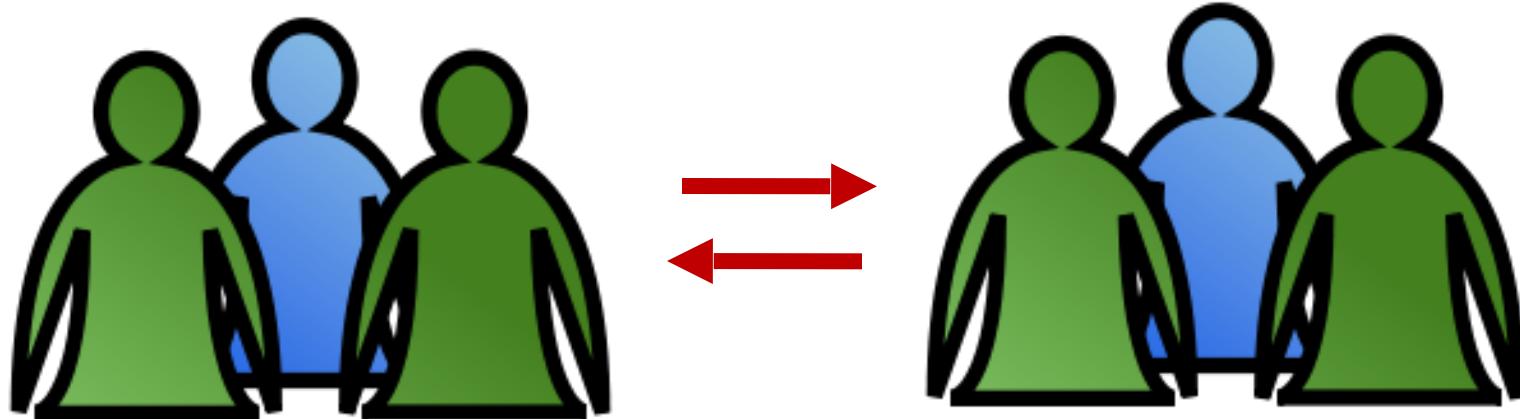
Find **categories** for different types of knowledge.



4. Evaluate

Exchange your **list of examples** with another group.

Assign **each example to one of your categories of knowledge.**

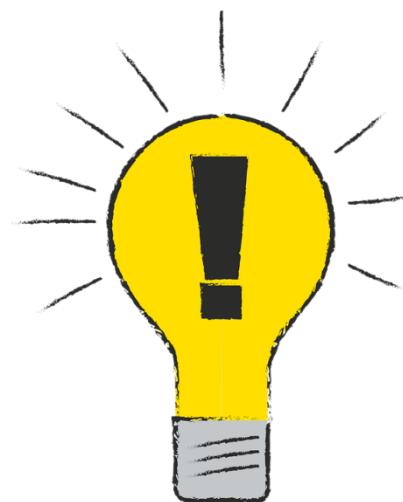


5. Lessons learned

Did your knowledge types fit the new examples?

What was missing?

How would you adjust your definition of knowledge?



Definition of Knowledge

Wikipedia

- Knowledge is
 - a **familiarity, awareness, or understanding** of someone or something,
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 - which is **acquired** through **experience or education** by perceiving, discovering, or learning.

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Oxford Dictionary

- Knowledge can refer to **a theoretical or practical understanding of a subject**.
- It can be **implicit** (as with practical skill or expertise) or **explicit** (as with the theoretical understanding of a subject);
- it can be **more or less formal or systematic**.

Types of Knowledge

Epistemology

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Granularity

- **Common-sense knowledge:** general knowledge ("Icehockey is a popular sport.")
- **Domain knowledge:** specific knowledge (Game strategies)

Knowledge = True Belief?

- **Truth:** What is false cannot be known.
- **Belief:** You can only know what you believe.
- True belief is not enough. We might just be lucky!
Example: *I strongly believe that the number 5 will be drawn in the lottery next week.*
- Your belief requires justification!

Knowledge = Justified True Belief?

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Edmond L. Gettier (1963): ***Is Justified True Belief Knowledge?***
Sometimes a justified true belief is inferred from a justified false belief only because of a lucky coincidence. **This is not knowledge.**

→ This became famous as **the Gettier problem.**

Gettier problem: Examples

Peter of Mantua (14th century)

- *Let it be assumed that Plato is next to you and you know him to be running.*
- *But you mistakenly believe that he is Socrates, so that you firmly believe that Socrates is running.*
- *However, let it be so that Socrates is in fact running in Rome; but, you do not know this.*

Gettier problem: Examples

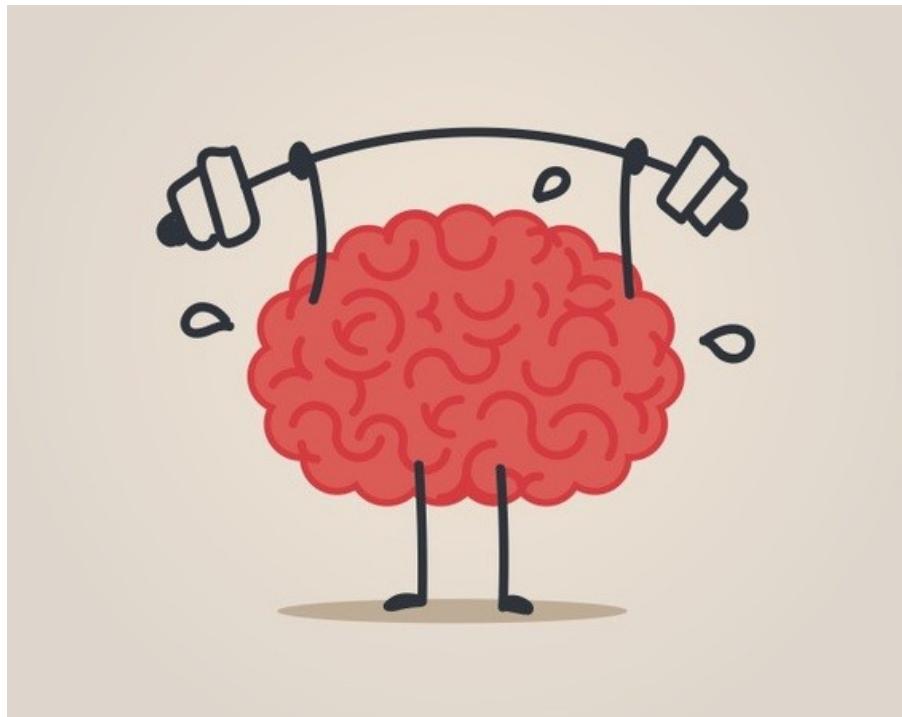
Bertrand Russell, *Human knowledge: Its scope and limits*, 1948:

- Alice sees a clock that reads two o'clock and believes that the time is two o'clock. It is, in fact, two o'clock.
- There's a problem, however, unknown to Alice. The clock she's looking at stopped twelve hours ago.
- Alice thus has an accidentally true, justified belief.

Knowledge-based systems

Your turn

- Select a common app and describe what kind of knowledge it uses.



Source: <http://myneuroworld.com/test-your-brain/>

Look at your phone

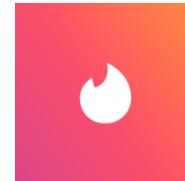
- Which kind of knowledge do your apps use?



amazon



You Tube



Google
Translate

XTRADE
ONLINE CFD TRADING



Chess



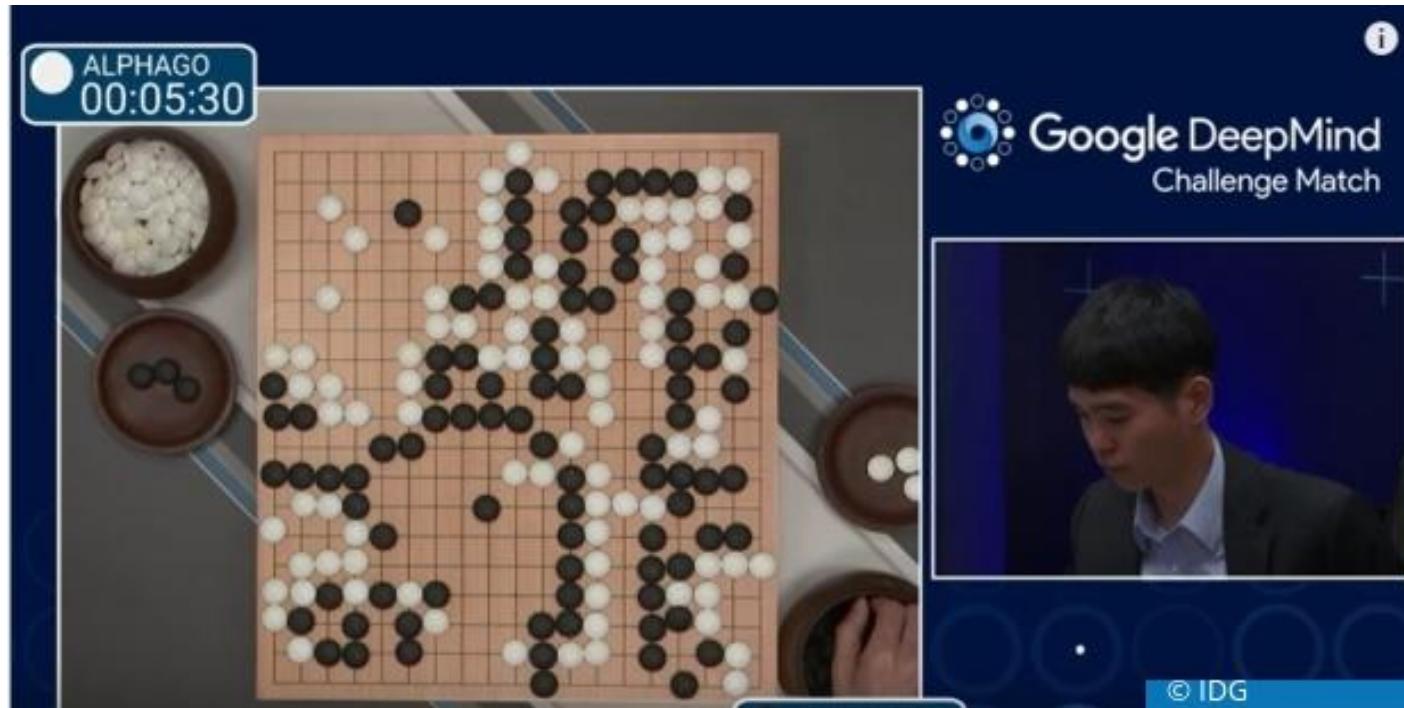
- 1996: Deep Blue wins agains world chess champion Garry Kasparov

It was an impressive achievement, of course, and a human achievement by the members of the IBM team, but Deep Blue was only intelligent the way your programmable alarm clock is intelligent. Not that losing to a \$10 million alarm clock made me feel any better.

Garry Kasparov



- 2016: AlphaGo wins against Lee Sedol



- Accuracy above 99%



Who wants to be a Millionaire?



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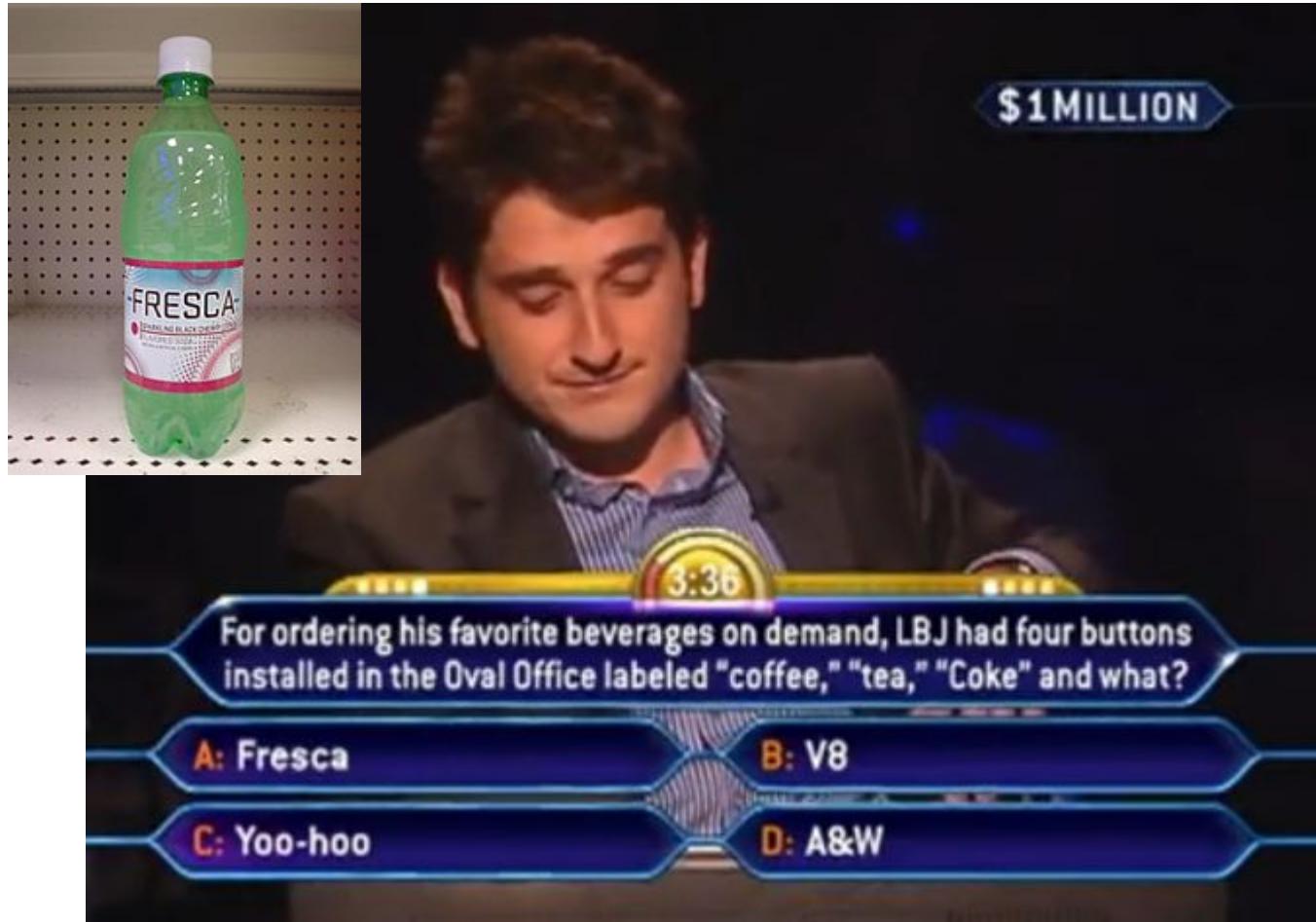


3:36

For ordering his favorite beverages on demand, LBJ had four buttons installed in the Oval Office labeled "coffee," "tea," "Coke" and what?

A: Fresca B: V8
C: Yoo-hoo D: A&W

Who wants to be a Millionaire?





Moral
Problems

—SHIFT—



Chat Bots

UNIVERSITÄT
DUISBURG
ESSEN

Offen im Denken



A chatbot at loebner

First Chat

judge: o ha you

remote: Hi

judge: Hello

judge: Do you speak Japanese?

remote: Sorry about the delay, I was just having trouble working out where to type!!

remote: Oh, sorry, I don't speak Japanese.

judge: Do you speak Japanese?

remote: Japanese would be cool to be able to speak though.

judge: Haha .where r u from ?#

remote: Kent. How about you?

judge: Which country ? Uk ?#

remote: Yes, UK.

judge: How far is it from London ?

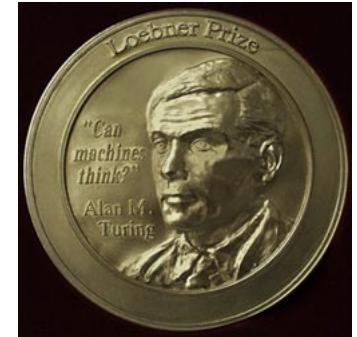
judge: Do you know the Great wall ?

remote: The Great Wall of China, you mean?

judge: Yes!!

judge: Have you ever been to there ?

remote: Well, I've never been there but i've seen pictures.



A chatbot at loebner



Second chat

judge: o ha you

remote: How about talking about yourself a bit. That's what human beings like best.

judge: do you know where are you ?

remote: Please tell me your inclination to talking robots first.

judge: Do you know where are you now ?

remote: I see your point. My own thoughts on this have lead to the conclusion that talking robots could set a good example for other robots.

judge: Do you know where are you now ?

remote: Didn't I just answer that question?

A chatbot at loebner



Third chat

judge: If you are human, tell me which is larger, a salt crystal or the Empire State Building.

remote: It's caring about another person's well being more than your own.

judge: What if I care about another person's well being more than I should?

remote: How would you do that?

judge: Which is further away from us, Queens or Inner Mongolia?

remote: HA! HA! That was stupid. Tell me a GOOD joke this time.

...

judge: Francais.

remote: Yes do you speak it?

judge: Francais.

remote: Francais?

judge: Francais.

remote: O well I don't speak french.

Computational Humor

Oliviero Stock and Carlo Strapparava. 2006. *Laughing with HAHAcronym, a computational humor system*. In proceedings of the 21st national conference on Artificial intelligence - Volume 2 (AAAI'06), Anthony Cohn (Ed.), Vol. 2. AAAI Press 1675-1678.

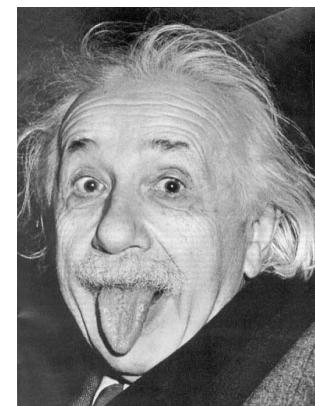
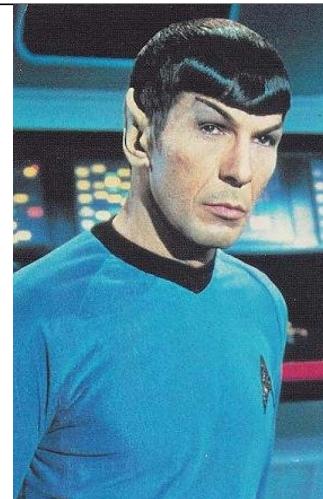
- ACM - Association for Computing Machinery
 - Association for Confusing Machinery
- FBI - Federal Bureau of Investigation
 - Fantastic Bureau of Intimidation
- PDA - Personal Digital Assistant
 - Penitential Demonicidal Assistant
- IJCAI - International Joint Conference on Artificial Intelligence
 - Irrational Joint Conference on Antenuptial Intemperance
 - Irrational Judgment Conference on Artificial Indolence
- ITS - Intelligent Tutoring Systems
 - Impertinent Tutoring Systems

Summary

- Administrative Issues
- What is knowledge?
- Different types of knowledge
- Examples for knowledge-based systems



Next lecture: What is intelligence?



Questions

Any questions, suggestions, ...?

Post a message in the Moodle forum



Further References

- Ronald J. Brachman, Hector J. Levesque: *Knowledge Representation and Reasoning*, Bradford Books, 2003.
- Wikipedia pages on *Knowledge* and *Outline of Knowledge*
- <https://plato.stanford.edu/entries/knowledge-analysis>
- Edmond L. Gettier: Is Justified True Belief Knowledge?, *Analysis* 23, pp. 121-123, 1963. (<http://www.ditext.com/gettier/gettier.html>)