INF4820: Algorithms for Artificial Intelligence and Natural Language Processing

Introduction and Overview

Stephan Oepen & Murhaf Fares

Language Technology Group (LTG)

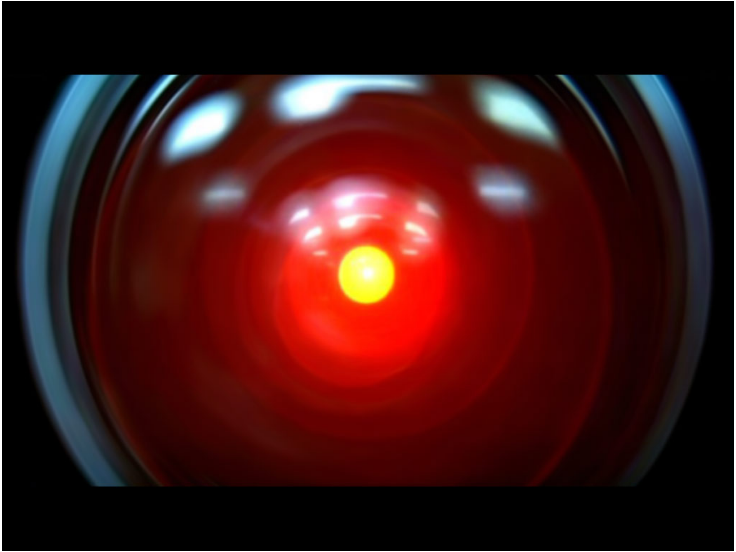
August 25, 2016

Topics for Today

Overview

- Course motivation and introduction:
- AI, NLP, ML — What are they?
- Common Lisp — What and why?
- Outline of lectures and learning goals.
- Practical details.

What is AI?



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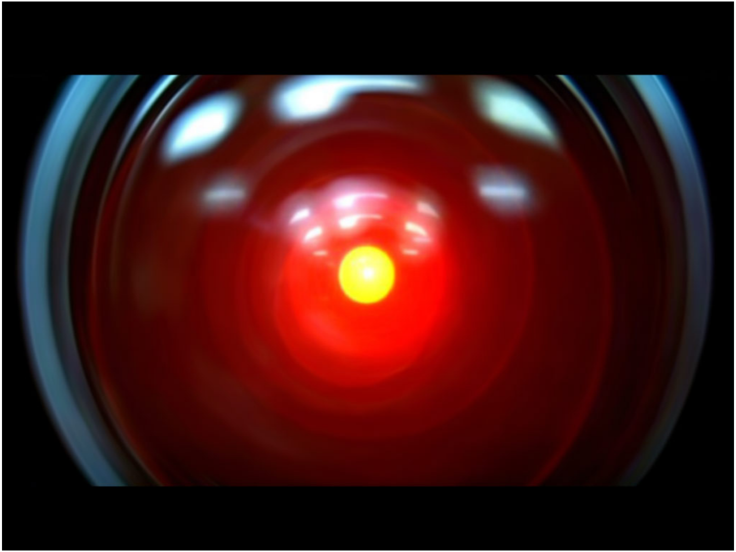

(HAL 9000 in *2001: A Space Odyssey*; 1968)

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- Stephen Hawking et al. in an op-ed in the Independent (spring 2014):
  - *it's tempting to dismiss the notion of highly intelligent machines as mere science fiction. But this would be a mistake, and potentially our worst mistake in history.*
  - *Whereas the short-term impact of AI depends on who controls it, the long-term impact depends on whether it can be controlled at all.*

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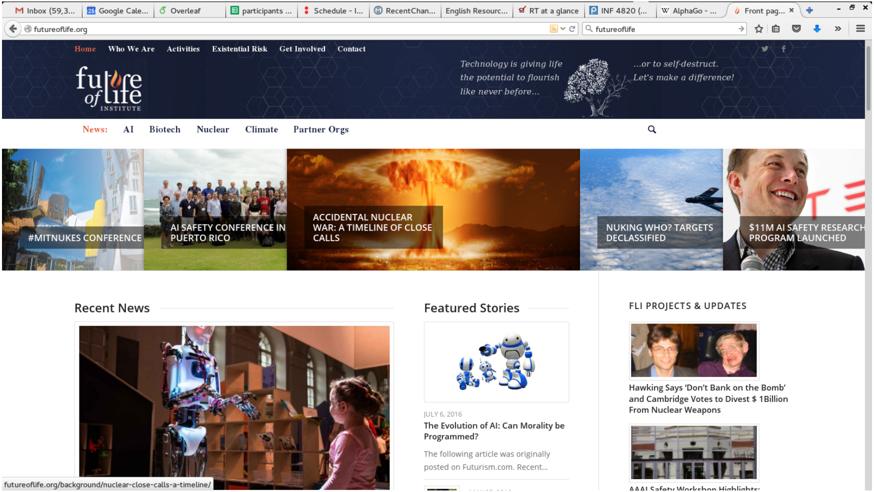
  - *Whereas the short-term impact of AI depends on who controls it, the long-term impact depends on whether it can be controlled at all.*
- Elon Musk (Tesla Motors, SpaceX) at a MIT talk (fall 2014):
  - *With AI we are summoning the demon.*

The Future of Life Institute



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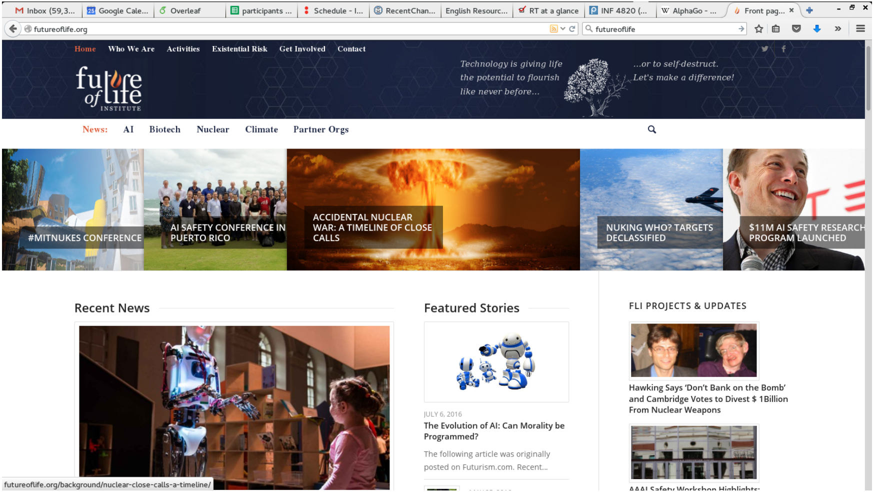

(Spring 2015: Alarm by Hawking, Musk, Norvig, Russel, Wozniak, etc.)

AI in Our Daily Lives (1 of 3)

https://www.theguardian.com/technology/2016/jun/30/tesla-autopilot-death-self-driving-car-elon-musk

Tesla

Tesla driver dies in first fatal crash while using autopilot mode

The autopilot sensors on the Model S failed to distinguish a white tractor-trailer crossing the highway against a bright sky

Danny Yadron and Dan Tynan in San Francisco

Friday 1 July 2016 00.14 BST

This article is 1 month old

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Save for later

Joshua Brown, the first person to die in a self-driving car accident. Photograph: Facebook

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The 7 May accident occurred in Williston, Florida, after the driver, Joshua Brown, 40, of Ohio put his Model S into Tesla's autopilot mode, which is able to control the car during highway driving.

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(July 2016: A Tesla driver dies while auto-pilot was in control)

AI in Our Daily Lives (2 of 3)

Technology

News | Reviews | Opinion | Internet security | Social media | Apple | Google

Technology

Robot security guard knocks over toddler at shopping centre

share

The 136kg robot is designed to patrol outdoor areas and secure them from thieves

CREDIT: KNIGHTSCOPE

TECHNOLOGY MOST VIEWED

1 iPhone 6 phones infected with 'Touch Disease' that makes screens useless
24 Aug 2016, 12:52pm

2 US attacks power grab by Brussels over Apple tax probe
24 Aug 2016, 6:23pm

3 WikiLeaks exposing data of sick children and abuse

AI in Our Daily Lives (2 of 3)

(July 2016: Minor injuries from run-in with security robot)

AI in Our Daily Lives (3 of 3)

www.wired.com/2016/05/google-alpha-go-ai/

WIRED The Rise of Artificial Intelligence and the End of Code

BY CADE METZ 05.19.16

WHAT THE AI BEHIND ALPHAGO CAN TEACH US ABOUT BEING HUMAN

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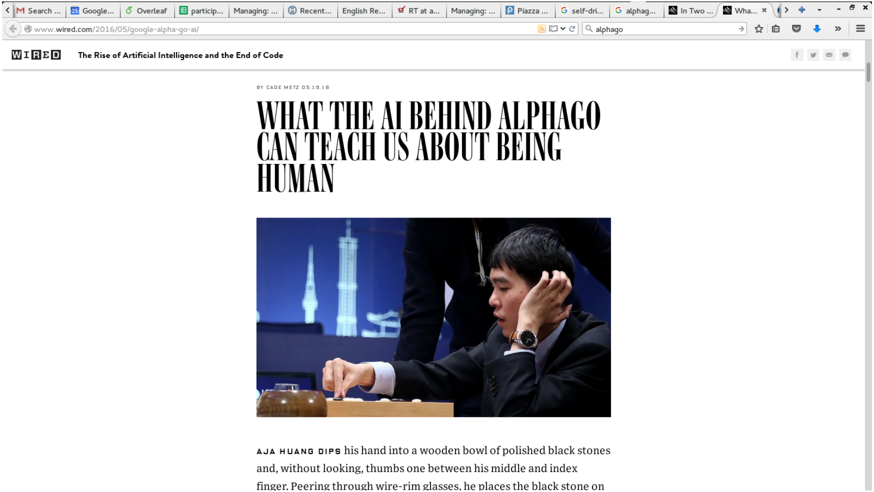
AI in Our Daily Lives (3 of 3)



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(March 2016: Nine-dan professional Go player Lee Sedol looses 4–1)

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- Language always in central place, cf. the Turing Test.

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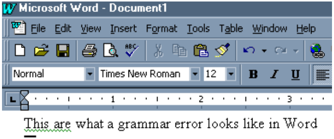
- For our purposes: AI is a toolkit of methods for representation and problem solving.

What is Natural Language Processing?

- Making computers 'understand' human language
- Aka language technology or computational linguistics
- Young and interdisciplinary field:
- Computer Science + Linguistics
- (+ Cognitive Science + Statistics + Information Theory + Machine Learning + ...)

Some Applications

- Grammar and/or spell checkers, auto-completion
- Machine translation
- Q&A systems
- Dialog systems
- Speech recognition and synthesis
- Intelligent information extraction
- Summarization
- Sentiment analysis
- Any application requiring an understanding of language. . .



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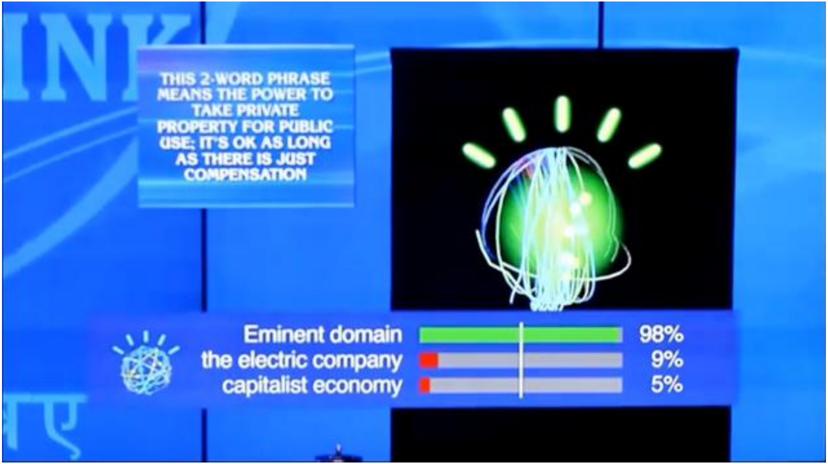
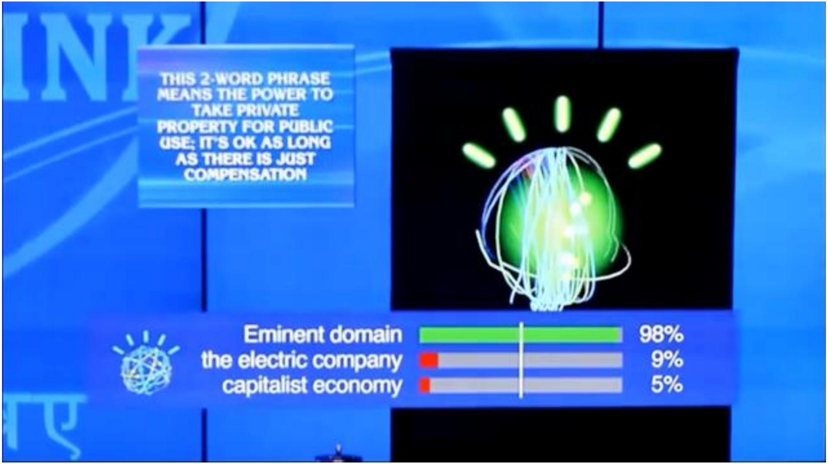


THIS 2-WORD PHRASE MEANS THE POWER TO TAKE PRIVATE PROPERTY FOR PUBLIC USE; IT'S OK AS LONG AS THERE IS JUST COMPENSATION
Eminent domain
98%
the electric company
9%
capitalist economy
5%



(IBM Watson beats long-time *Jeopardy!* champions; 2011)

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Ambiguity: Some examples

Word level ambiguity

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De hadde laget en deilig rett av grønnsaker.

Streken må være rett.

Kunden har alltid rett.

Du har rett til en advoktat.

Det er lovlig i henhold til norsk rett.

Slikt skjer rett som det er.

Vennligst rett disse prøvene!

Vi kjørte rett hjem.

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Referential Ambiguity

The authorities jailed the protesters because <u>they</u> $\begin{cases} \textit{advocated revolution.} \\ \textit{feared revolution.} \end{cases}$

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Acoustic Ambiguity

Let's talk about how to $\begin{cases} \textit{recognize speech} \\ \textit{wreck a nice beach} \end{cases}$

Some History: Different Approaches to AI and NLP

- Traditionally; two broad paradigms in NLP (and AI).
  - The rationalist approach, based on hand-crafted formal rules and manually encoded knowledge.
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- 1990s: NLP as whole sees a shift of interest from rationalist towards empirical approaches.
- 2000s: No longer conceived as opposing poles, but complementary approaches typically used together.

- The theoretical foundations are studied within the field of machine learning (ML) or statistical learning theory.

Machine Learning

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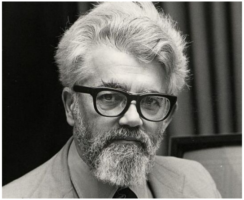
- Goal: Learn from examples, to make predictions about new data.
- Has applications in many other data-intensive sciences besides NLP, e.g. meteorology, biology, physics, robotics, signal processing, etc.
- An arsenal of methods: decision trees, support vector machines, maximum entropy models, naïve Bayes classifiers, artificial neural networks, genetic algorithms, …

- Powerful high-level language with long traditions.
- Especially strong support for symbolic and functional programming.
- “Discovered” by John McCarthy in 1958.



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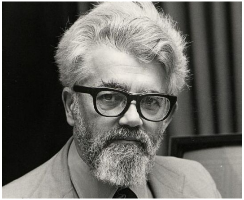

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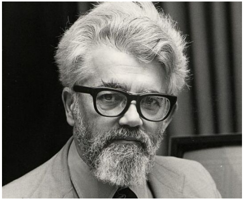
- Rather than Lisp becoming outdated, the tendency has been that other languages have developed towards Lisp.



```
(print "Hello world!")
```

- Several dialects; we will be using Common Lisp.
- Fully ANSI-standardized and stable.
- Rich language: multitude of built-in data types and operations.
- Easy to learn:
  - extremely simple syntax;
  - straightforward semantics.

The Factorial Function

$$n! \quad \equiv \quad \begin{cases} 1 & \text{for } n = 0 \\ n \times (n-1)! & \text{for } n > 0 \end{cases}$$

An Experiment in Live Programming

The Factorial Function

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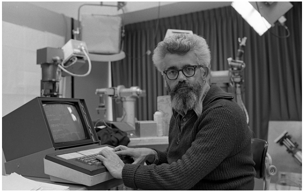
Common Lisp Implementation

```
(defun ! (n)
  (if (= n 0)
    1
    (* n (! (- n 1)))))
```

A Note on Lisp and AI

- Often hailed (or dismissed) as "the AI language".
- While not quite true, there are several reasons for this coupling:
- AI coined by McCarthy in the mid-1950s.
- Lisp conceived by McCarthy in the mid-1950s.



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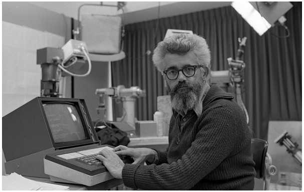
- AI coined by McCarthy in the mid-1950s.
- Lisp conceived by McCarthy in the mid-1950s.
- In addition to being fast and powerful, Lisp is particularly well suited for:
  - Explorative programming
  - Rapid prototyping
  - Incremental and interactive development
  - Extending the language itself

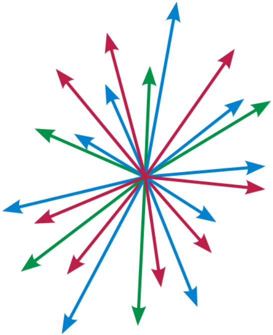


Lisp + Emacs = Good Match

- Steep learning curve, but with a big pay-off:
- Emacs is an unusually powerful editor.
- Written in Emacs Lisp.
- Highly customizable—the Emacs Lisp dialect is also used as an extension language.
- Different “modes” make Emacs sensitive to different editing needs, e.g. depending on the specific programming language used.
- Prerequisite for an enjoyable Emacs experience: Spend some time mastering basic key commands!

Overview of Lectures

- Common Lisp basics
- Vector space models
- Classification and clustering
- Probability theory
- Hidden Markov Models
- Statistical parsing



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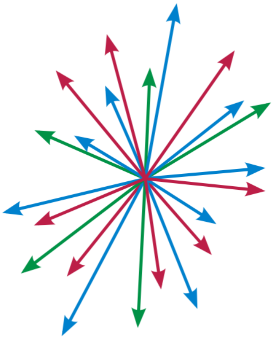
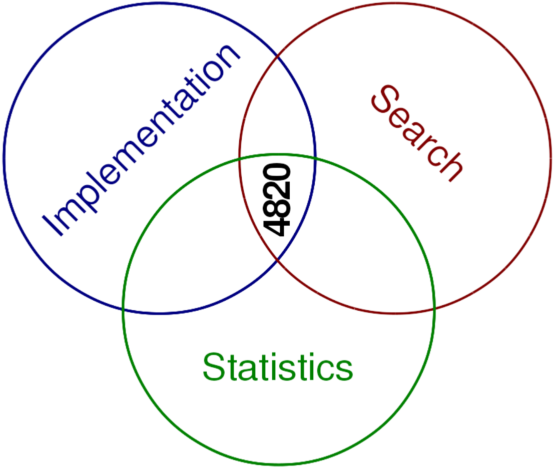


- Recurring themes: Machine learning, scalable data representations, search, dynamic programming.
- Two hours of lectures every week; two-hour laboratory weekly

Very High-Level Course Summary



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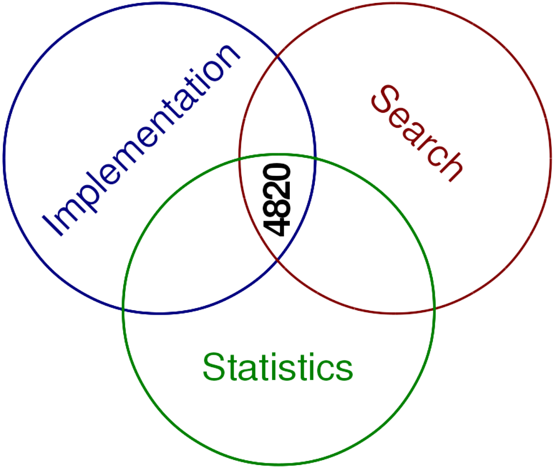

Efficient and Scalable Algorithms and Data Structures for Searching (Probabilistically) Weighted Solution Spaces

Obligatory Exercises

- Three obligatory exercises:
- Exercise (2) and (3) have two parts each;
- Five problem sets in total.
- In order to pass and qualify for the exam you need a least
  - 6 of 10 possible points for Exercise (1),
  - 12 of 20 possible points for (2a) + (2b),
  - 12 of 20 possible points for (3a) + (3b).
- Extensions can only be given in case of illness, and re-submissions will not be possible.
- See course page for the schedule (tba).

Infrequent Experiments in High-Tech Teaching

- For student involvement and incremental exam preparation:
- occassional short quiz sessions $\rightarrow$ extra points towards exercises.

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   A: yes; B: no

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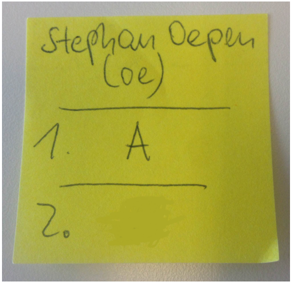

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Other recommended resources:

- Despite being 20 years old and long out-of-print *On Lisp* by Paul Graham is still a great read.
  - Freely available on-line: `http://www.paulgraham.com/onlisp.html`
- The Common Lisp 'HyperSpec':
  - `http://www.lispworks.com/documentation/HyperSpec/Front/`

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  - Elena Volkova (laboratory assistant);
  - {`murhaff` | `oe` | `elenavo`} `@ifi.uio.no`.
- Messages:
  - Check your UiO email regularly;
  - Subscribe to the RSS feed of the course page;
  - Participate in the on-line discussion board.