



UNIVERSITY
OF ABERDEEN

CS3025 Knowledge-Based Systems



Introduction

8ec62e36

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Lecture Outline

- Knowledge-Based Systems
 - What and Why
 - Semantic Web – call for modern KBS
- CS3025
 - Structure
 - Assessment

Knowledge-Based Systems

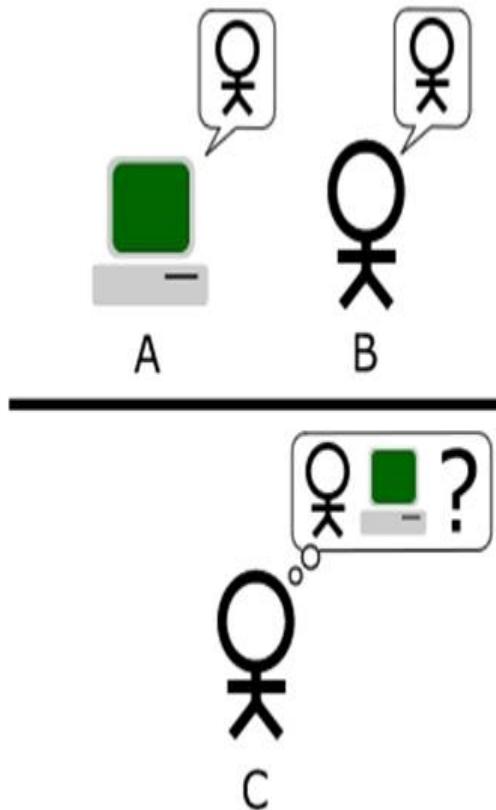
- A knowledge-based system (KBS) is:
 - a program;
 - capable of making use of knowledge about certain domain(s) to make inference;
 - with a view to solving problems and giving advice.

Apple's Siri



- Siri is an intelligent personal assistant and knowledge navigator:
 - uses a natural language user interface to answer questions;
 - uses a knowledge base to make recommendations;
 - uses web services to perform actions.

Turing Test



5min, 30% cheat



JIMI



小i



公子小白



Rokid



开心熊宝

在线客服

Online custom service



Siri



小度



viv

娱乐

Entertainment



Google Now



出门问问

教育

Education



IBM Waston

个人助理

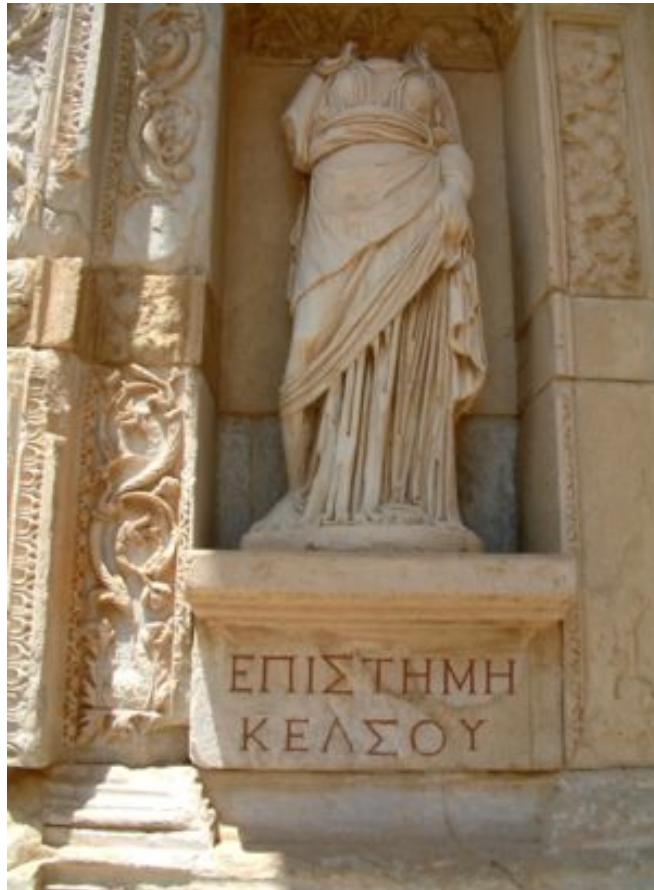
Personal assistant

智能问答

Intelligent QA

What is Your Definition of Knowledge?

Knowledge



- What is knowledge?
 - Something is known
 - Structured information
 - About certain aspects of the (real) world

Example



- For example, take this list:
 - (31 28 24 23 16)
- This mere data becomes knowledge
 - if you knew that these were temperatures of five successive days
 - $\text{Temp}(\text{day1}, 31), \dots, \text{Temp}(\text{day5}, 16)$
- Knowing this allows you to answer questions about the data
 - Such as “Is it getting cooler?”

Knowledge Representation

[Temp(day1, 31), ..., Temp(day5, 16)]



- KR is a surrogate
 - A substitute for the thing itself
- It requires a set of ontological commitments, and hence
 - A language for representation
 - A set of efficient inferences the representation sanctions and recommends
- KR is central to AI

Reasoning

- Infer **implicit** knowledge from **explicit** knowledge
(please don't worry about the syntax of the statements below for now)

$$Koala \sqsubseteq \forall eat.(\exists partof.Eucalypt)$$
$$Eucalypt \sqsubseteq Plant$$
$$Koala \sqsubseteq \forall eat.\exists partof.Plant$$
$$Plant \sqcup \exists partof.Plant \sqsubseteq VegeFood$$
$$Koala \sqsubseteq \forall eat.VegeFood$$
$$\forall eat.VegeFood \sqsubseteq Herbivore$$
$$Koala \sqsubseteq Herbivore$$

Trade-off



- Problem:
 - balance between two key aspects
 - Expressive power of the language for representing the knowledge needed
 - Efficiency of inference
 - One size does not fit all
- Solution: Standard OWL language
 - A family of ontology languages
 - OWL 2 DL (full language) – DL for **Description Logics**
 - OWL 2 profiles

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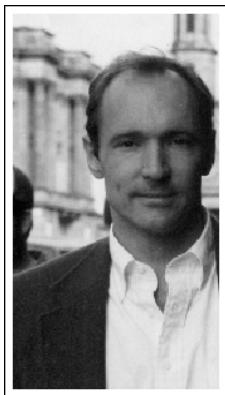
Internet and WWW



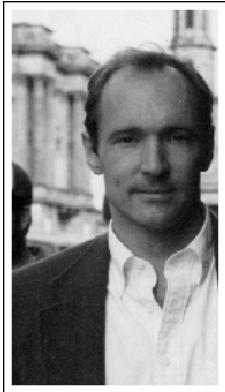
- World Wide Web [Berners-Lee 1991]
 - (began life in 1989 at the European centre for nuclear research – CERN)
 - An Internet application for publishing and accessing resources
 - Major social impacts like other inventions
 - 1870s: telephone
 - 1920/1930: radio and TV

Father of the Web: Sir Tim Berners-Lee

- The inventor of the Web, Tim Berners-Lee, has been awarded a knighthood for his pioneering work.

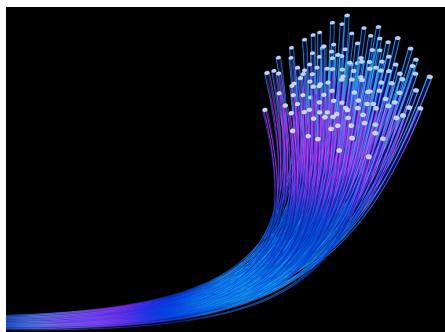


Tim's Dream of the Web



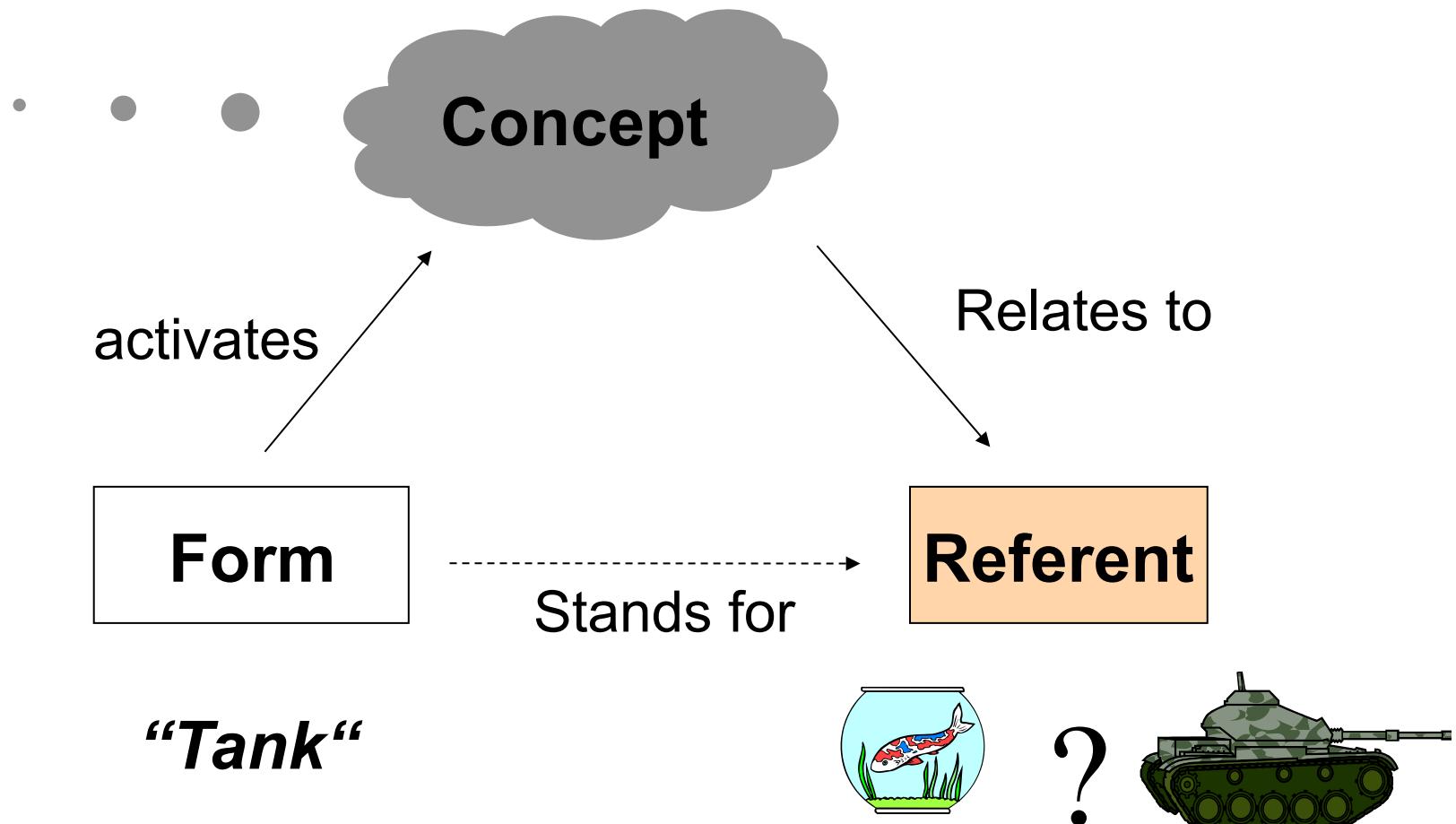
- Allow people to share knowledge
 - To work together better
- Allow programs to handle the shared knowledge and data
 - In a meaningful way
 - To help people analysis and manage activities

Vision of the Semantic Web



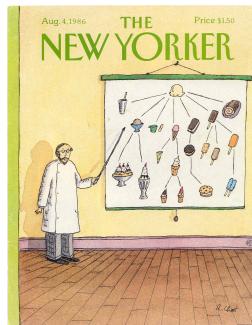
- To enable machine/program understandability
 - Create a network of machine understandable resources
 - Create a knowledge Web co-existing with the current Web
- To provide intelligent programs to represent users
 - Understand the contexts (background knowledge)

Annotations are Simply Labels



[Ogden, Richards, 1923]

Ontology



- Ontology is a model of (some parts of) the world, containing
 - key vocabulary used to describe (a particular view of) some domain
 - definitions and constraints so as to capture the intended meaning of the vocabulary
- Ontology languages are based on Description Logics

At roughly the same time ...

- Breakthrough around 2000-2007
 - Highly optimisation algorithms for ontology reasoners
 - By Prof. Ian Horrocks (Oxford U.) and colleagues
 - FaCT reasoner (Ian Horrocks)
 - FaCT-DG reasoner (Jeff Pan and Ian Horrocks)
 - FaCT++ reasoner (Dmitry Tsarkov and Ian Horrocks)
- Some recent breakthrough (2008-2016)
 - TrOWL: Approximate reasoning (Jeff Pan)
 - ...



Spring of Knowledge Technology

- Many related research projects
 - Wonder Web [EU]
 - DAML [US]
 - AKT [UK]
 - Knowledge Web [EU]
 - K-Drive [EU]
 - Whatif [UK]
 - ...
- Knowledge Technology standards
 - **RDF** (Resource Description Framework)
 - **OWL** (Web Ontology Language)
 - RIF (Rule Interchange Format)



Knowledge Graph

Web Images News Videos Books More Search tools

About 156,000,000 results (0.33 seconds)

Barack Obama

www.barackobama.com/

Sign the petition to say it's time to give America a raise. Sign the petition. "You and I, as citizens, have the power to set this country's course." —President Obama.

Barack Obama - Wikipedia, the free encyclopedia

en.wikipedia.org/wiki/Barack_Obama

Barack Hussein Obama II is the 44th and current President of the United States, and the first African American to hold the office. Born in Honolulu, Hawaii, ...

Michelle Obama - Ann Dunham - Barack Obama, Sr. - Occidental College

News for Obama



European Reassurance Initiative: Obama announces \$1bn ...

BBC News - 31 minutes ago

President Barack Obama announces plans for a \$1bn fund to increase US military deployments to Europe, during a visit to Poland.

Obama assures eastern Europe that the US will not abandon it
The Guardian - 5 hours ago

Obama urges Russia's Putin to make choice over Ukraine ...
CNN - 6 hours ago

More news for Obama



White House

The United States. His story is the American class upbringing in a strong ...

on Twitter

(ama). This account is run by Organizing for Change-bo. Washington, DC.



[More images](#)

Barack Obama

4,269,608 followers on Google+

Barack Hussein Obama II is the 44th and current President of the United States, and the first African American to hold the office. [Wikipedia](#)

Born: August 4, 1961 (age 52), Honolulu, Hawaii, United States

Spouse: Michelle Obama (m. 1992)

Parents: Ann Dunham, Barack Obama Sr.

Children: Natasha Obama, Malia Ann Obama

Siblings: Malik Abongo Obama, Maya Soetoro-Ng, Auma Obama, more

Education: Harvard Law School (1988–1991), more

Recent posts

The new carbon pollution standards are a big deal in the fight against climate change: <http://ofa.bo/lIE> 2 hours ago

People also search for

[View 15+ more](#)



Michelle Obama



Vladimir Putin



George W. Bush



Mitt Romney



Hillary Clinton

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Roadmap



- Foundation
 - KR, ontology and rule; set theory
- Knowledge capture
- Knowledge representation
 - Ontology: Semantic Web standards RDF and OWL, Description Logics
 - Rule: Jess
- Knowledge reasoning
 - Ontology: formal semantics, tableaux algorithm
 - Rule: forward chaining, backward chaining
- Knowledge reuse and evaluation
- Meeting the real world
 - Legal ontologies, Jess and Java, Invited talk

Assessments



- 25% Continuous Assessment
 - Demonstrate practical skills related to ontology and rule, including building a **reasoner**



- **The TrOWL Award**
 - **for the best reasoner among the assessment submissions**
 - **to be announced at the revision lecture**

Assessments



- 75% Exam
 - Apply CS3025 learning outcomes in **two** questions
 - 2 hours
 - Some sample exam questions will be provided before the revision lecture

Summary



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- Knowledge-Based System
 - a program capable of making use of knowledge about certain domain(s) to make inference
- Ontology and rule
 - Capture
 - Representation
 - Reasoning
 - Reuse and evaluation