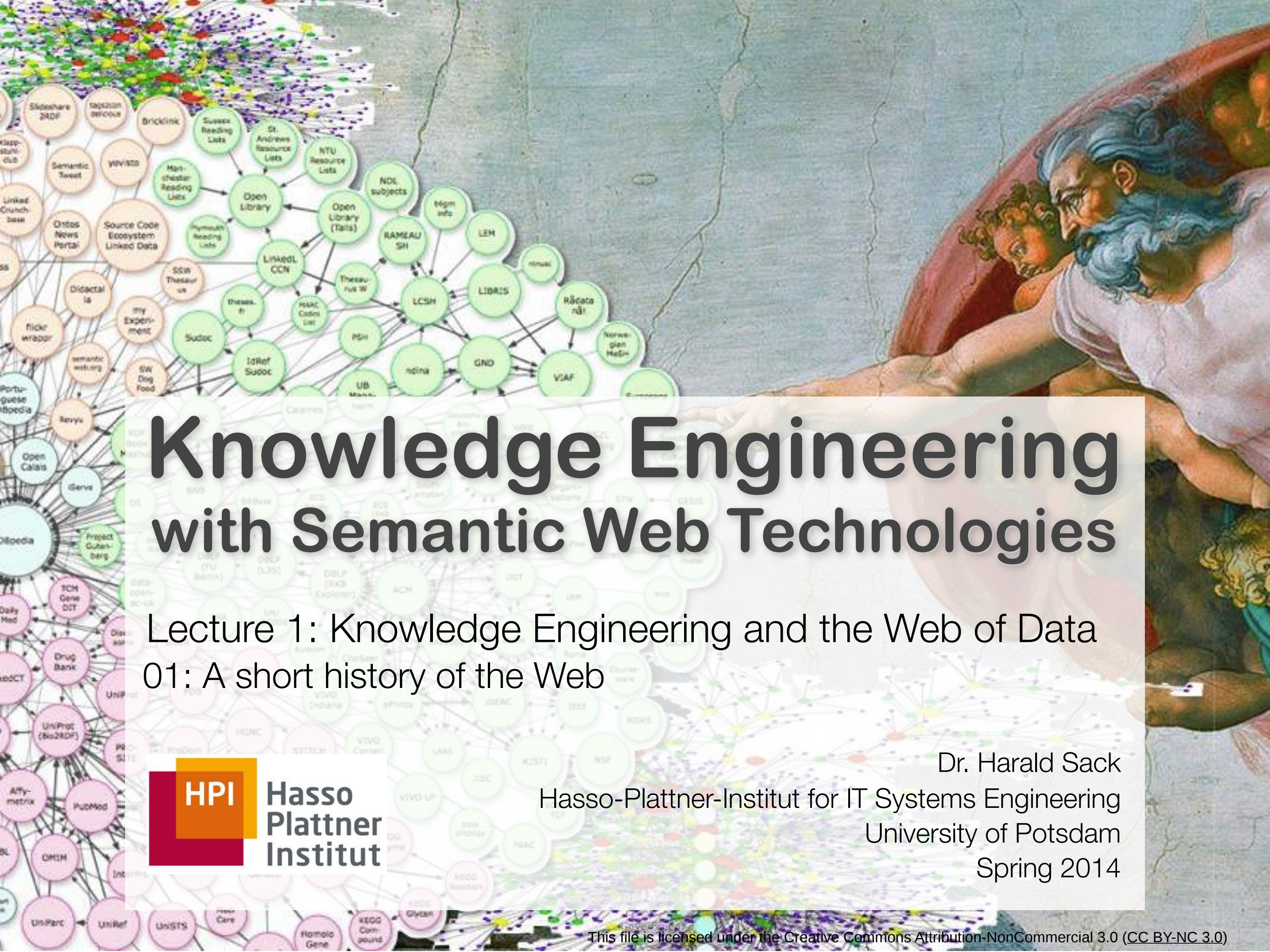




Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data
01: A short history of the Web



Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 1: Knowledge Engineering and the Web of Data

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies



01: A short history of the Web

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data



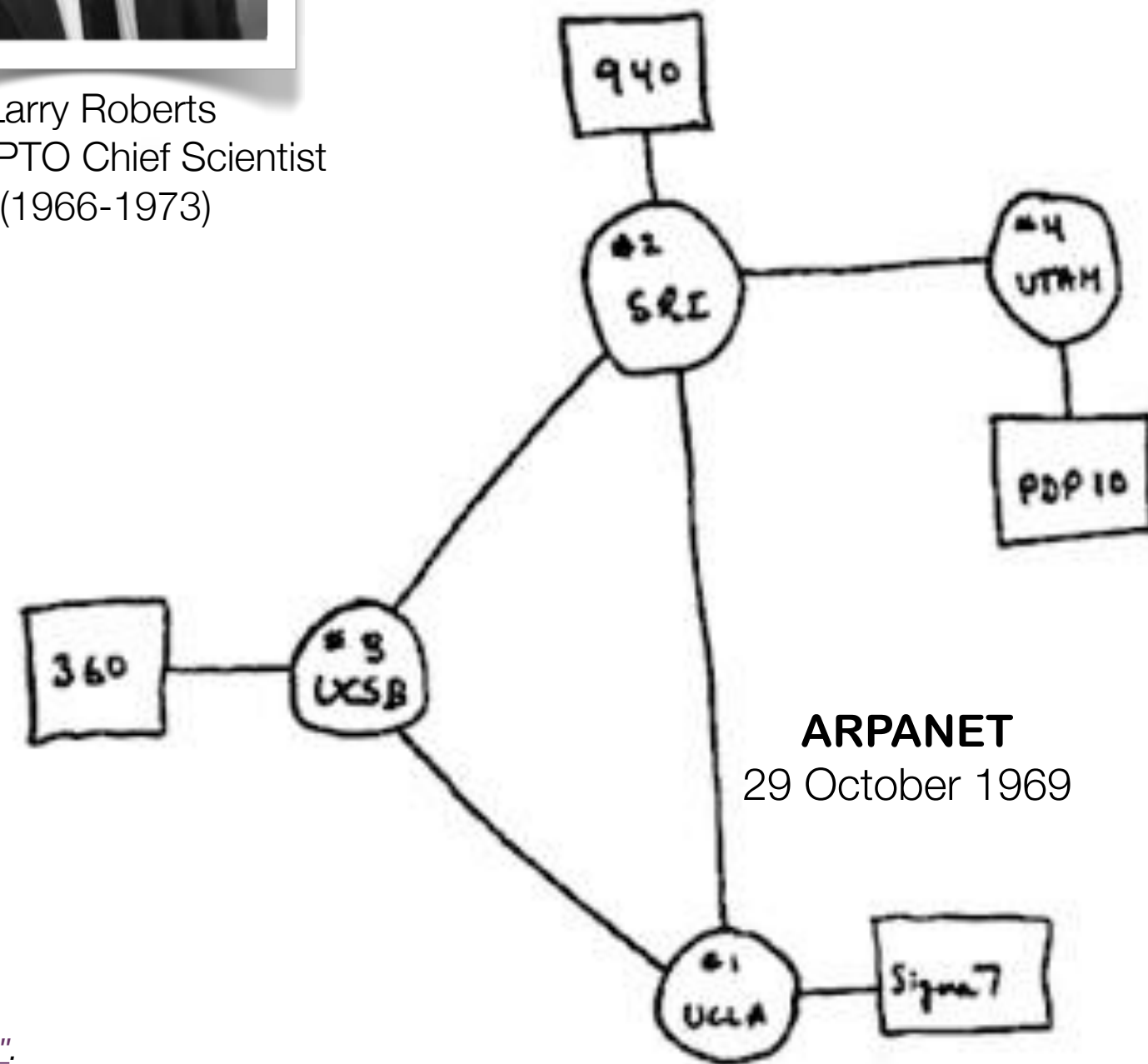
J.C.R. Licklider
ARPA IPTO Director
(1962-1964)

Robert Taylor
ARPA IPTO Director
(1966-1969)

Larry Roberts
ARPA IPTO Chief Scientist
(1966-1973)

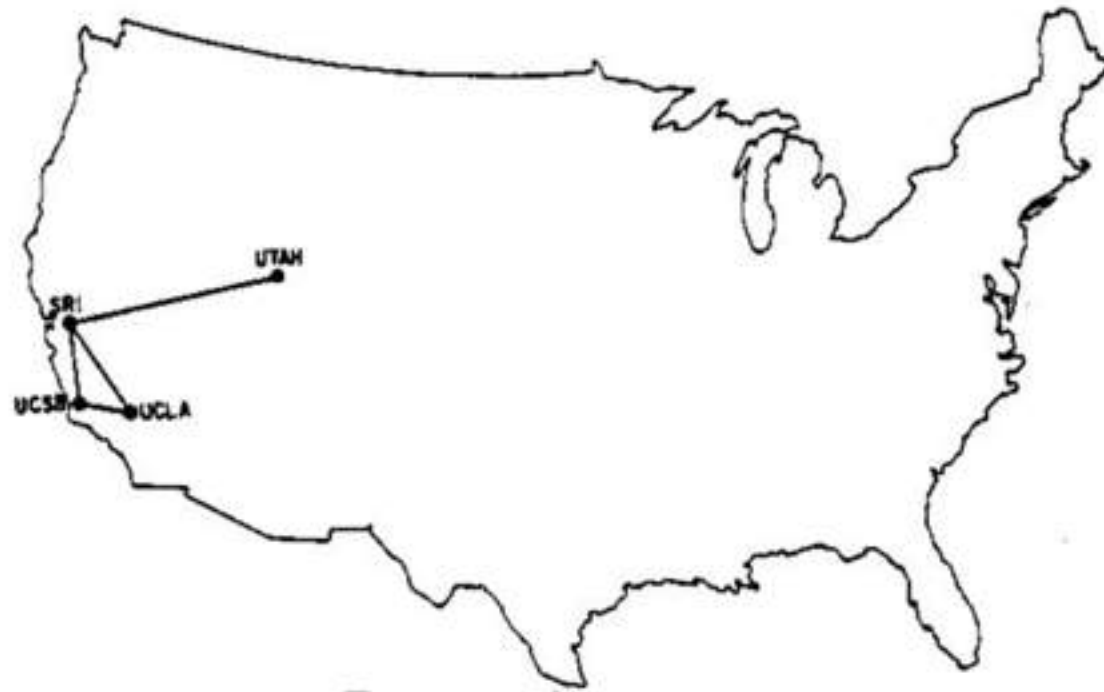
"[...] we are entering a technological age in which we will be able to interact with the richness of living information - not merely in the passive way that we have been accustomed to using books and libraries, but as active participants in an ongoing process, bringing something to it through our interaction with it, and not simply receiving something from it by our connection to it."

J.C.R. Licklider, Robert Taylor: *"The Computer as a Communication Device"*.
Science and Technology 76, pp. 21-31 April 1968.

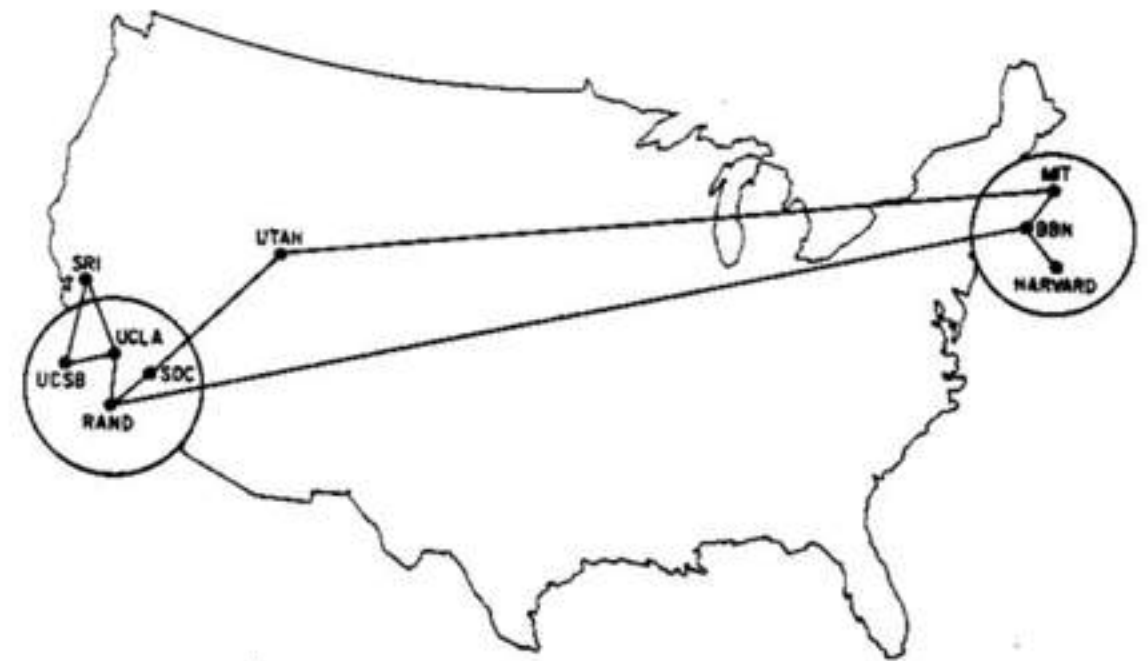


Knowledge Engineering with Semantic Web Technologies

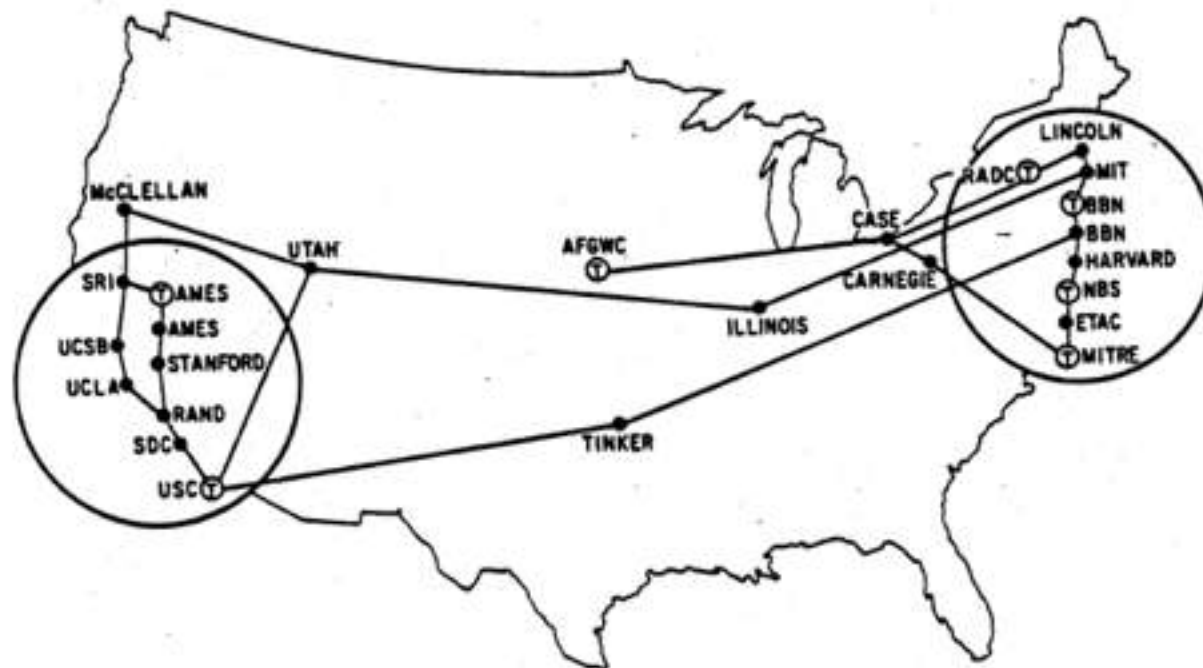
The Growth of the ARPANET



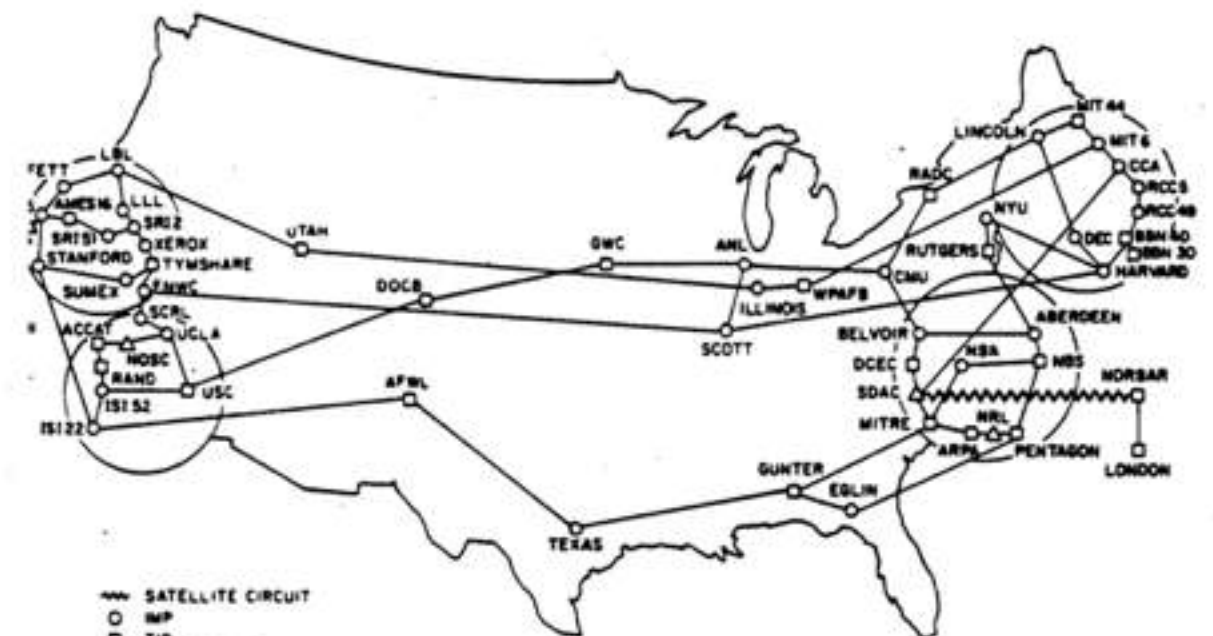
December 1969



June 1970



March 1972



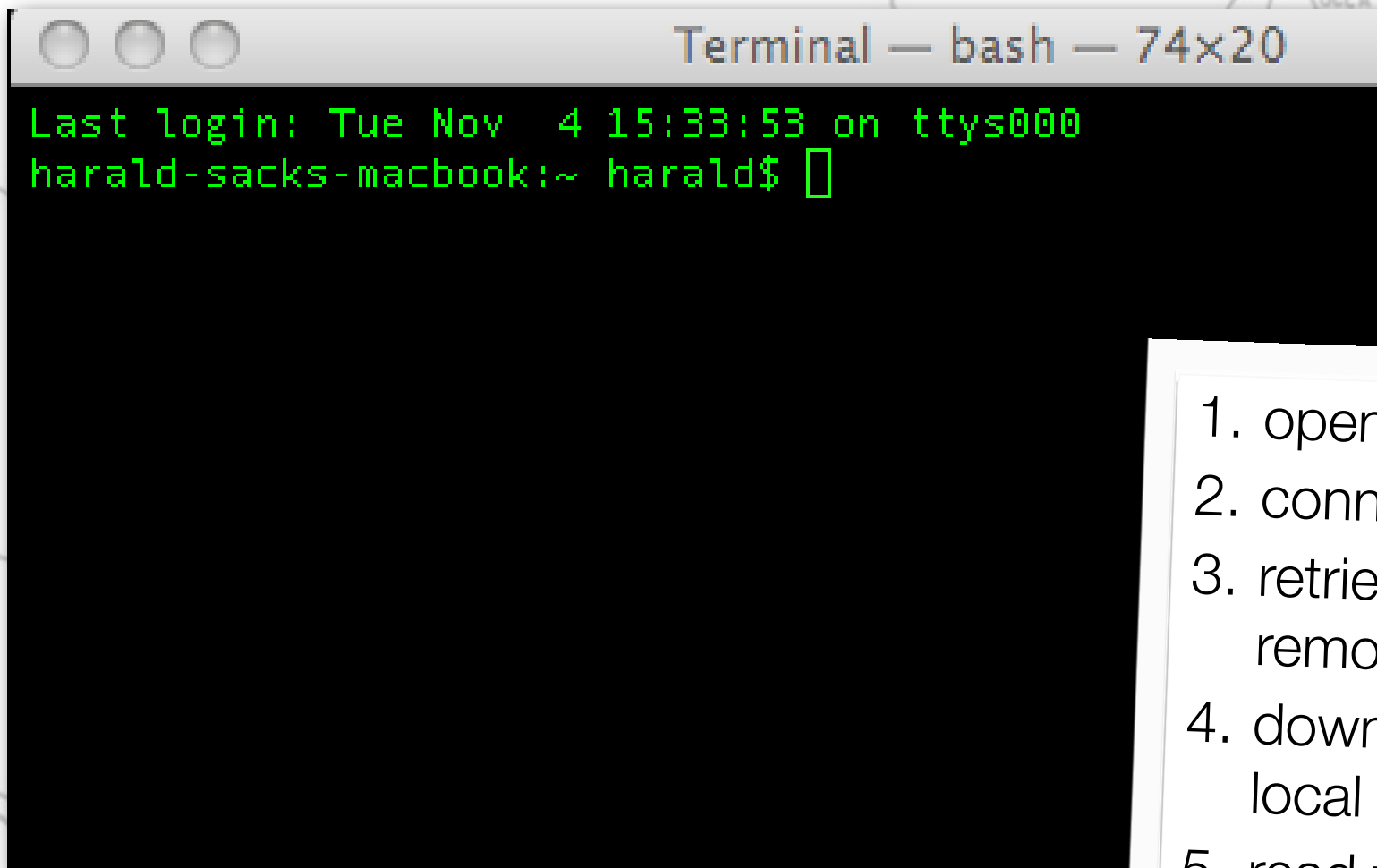
--- SATELLITE CIRCUIT
○ IMP
□ TIP
△ PLURIBUS IMP
(NOTE: THIS MAP DOES NOT SHOW ARPA'S EXPERIMENTAL SATELLITE CONNECTIONS)
NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

July 1977

First Generation: The Internet

Computer Centered Processing

- How did the user get the information?



```
Terminal — bash — 74x20  
Last login: Tue Nov  4 15:33:53 on ttys000  
harald-sacks-macbook:~ harald$
```

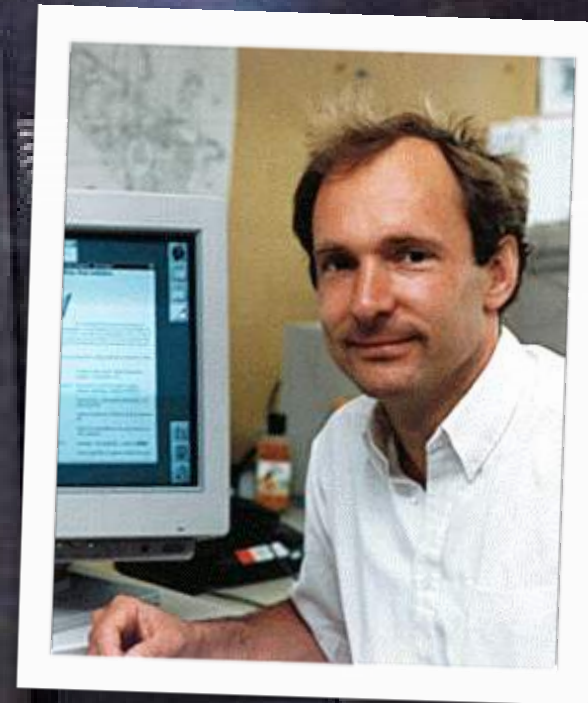
1. open terminal
2. connect to remote computer
3. retrieve file system data from remote computer
4. download file from remote to local computer
5. read file on local computer

Problem:

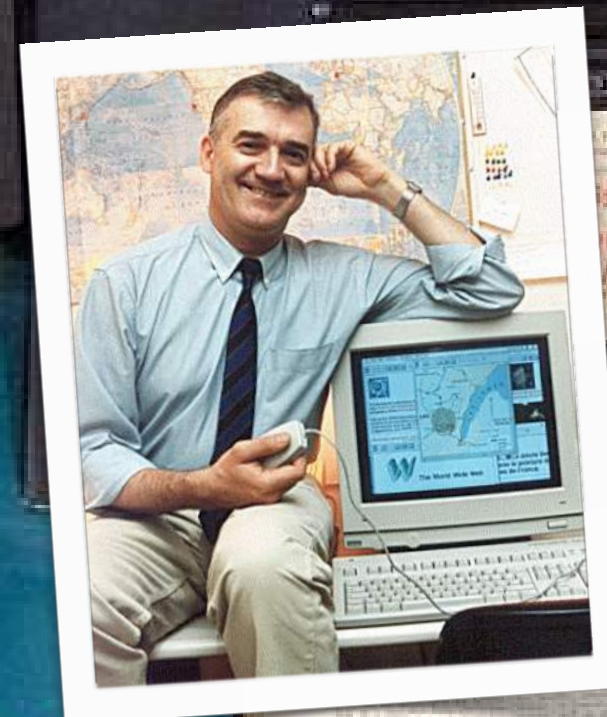
- Information access requires expert knowledge
- Information access is expensive...
- Information retrieval is very expensive...

März 1972

Juli 1977



Tim Berners-Lee



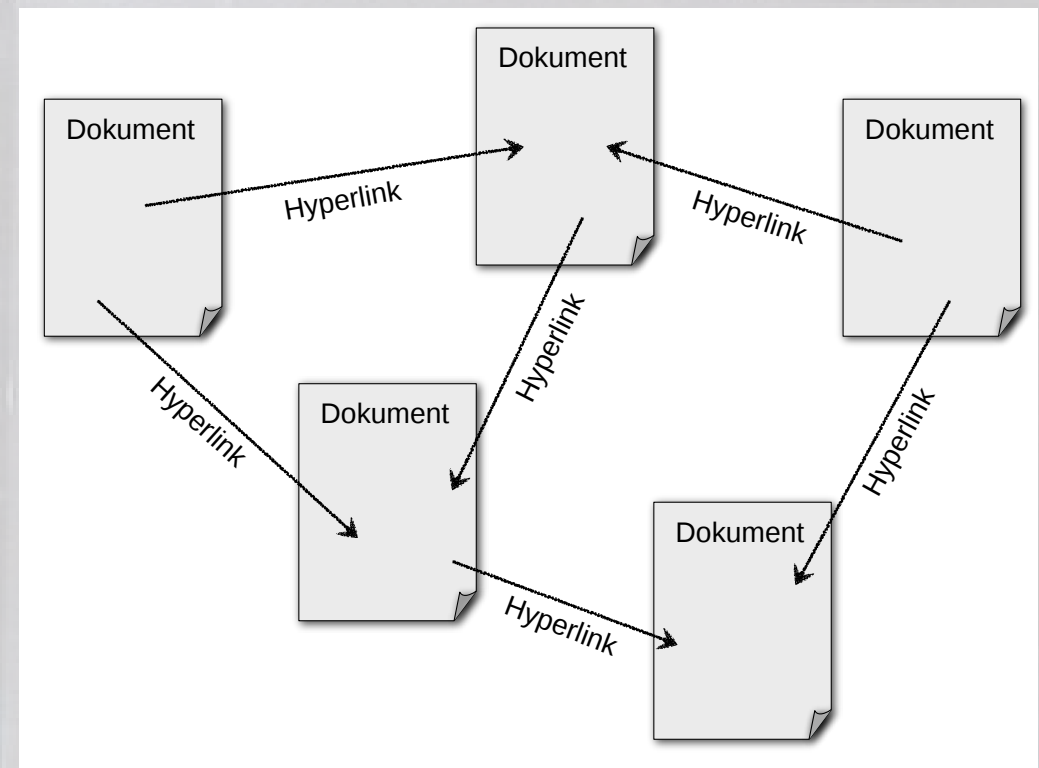
Robert Cailliau

The **World Wide Web** was born at the European Nuclear Research Center CERN in 1990...

Second Generation: The Web

Document Centered Processing

- How did the user get the information?



1. open browser
2. load document
3. click on next hyperlink
4. ...

Advantages:

- No expert knowledge required
- Simple information access
- Information retrieval via search engines

ENCYCLOPÉDIE,

O U

DICTIONNAIRE RAISONNÉ DES SCIENCES, DES ARTS ET DES MÉTIERS,

PAR UNE SOCIÉTÉ DE GENS DE LETTRES.

Mis en ordre & publié par M. *DIDEROT*, de l'Académie Royale des Sciences & des Belles-Lettres de Prusse; & quant à la PARTIE MATHÉMATIQUE, par M. *D'ALEMBERT*, de l'Académie Royale des Sciences de Paris, de celle de Prusse, & de la Société Royale de Londres.

*Tantum series juncturaque pollet,
Tantum de medio sumptis accedit honoris!* HORAT.

TOME PREMIER.



A PARIS,

Chez { *BRIASSON*, rue Saint Jacques, à la Science.
DAVID l'aîné, rue Saint Jacques, à la Plume d'or.
LE BRETON, Imprimeur ordinaire du Roy, rue de la Harpe.
DURAND, rue Saint Jacques, à Saint Landry, & au Griffon.

M. DCC. LI.

AVEC APPROBATION ET PRIVILEGE DU ROY.

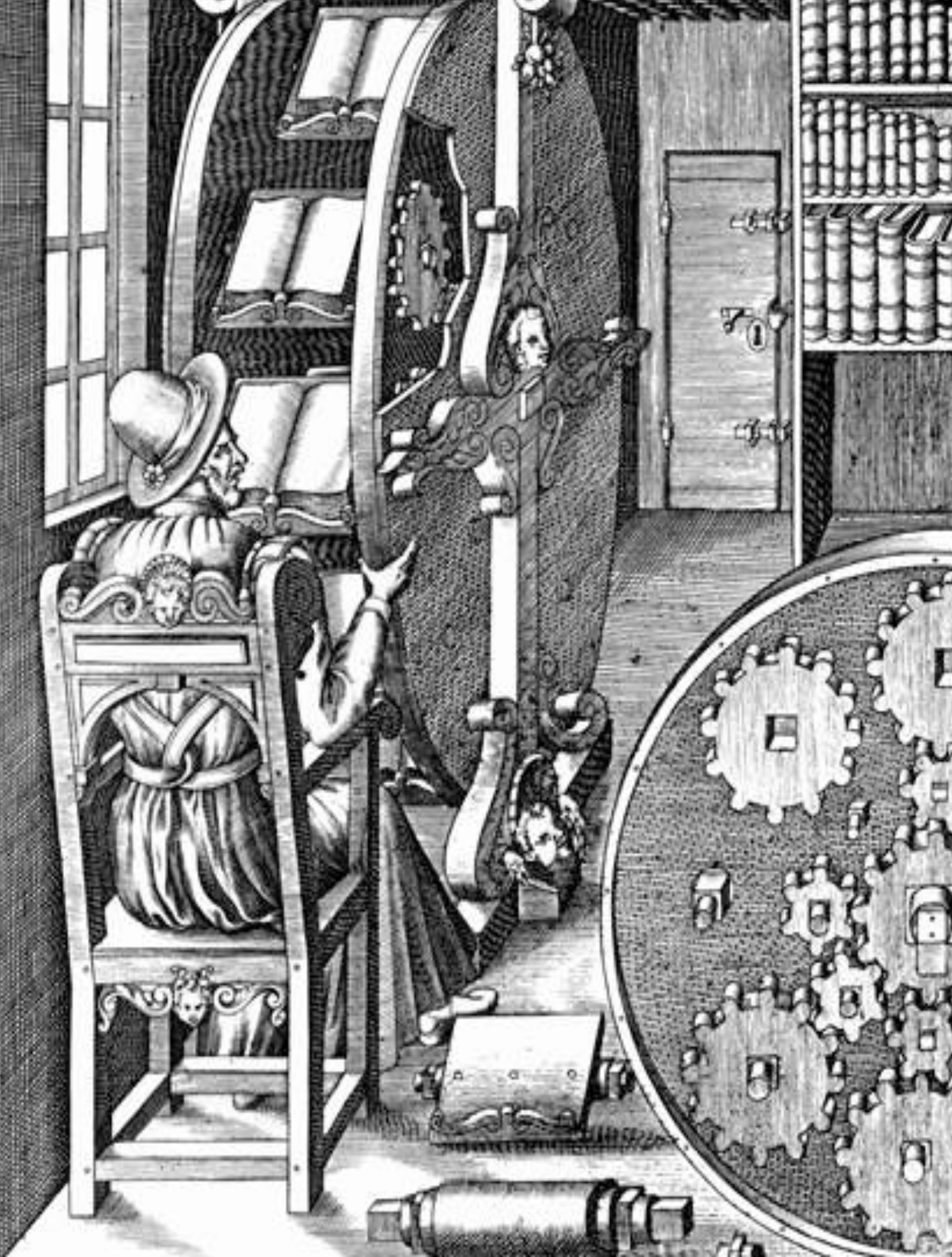
But the original idea is much older....



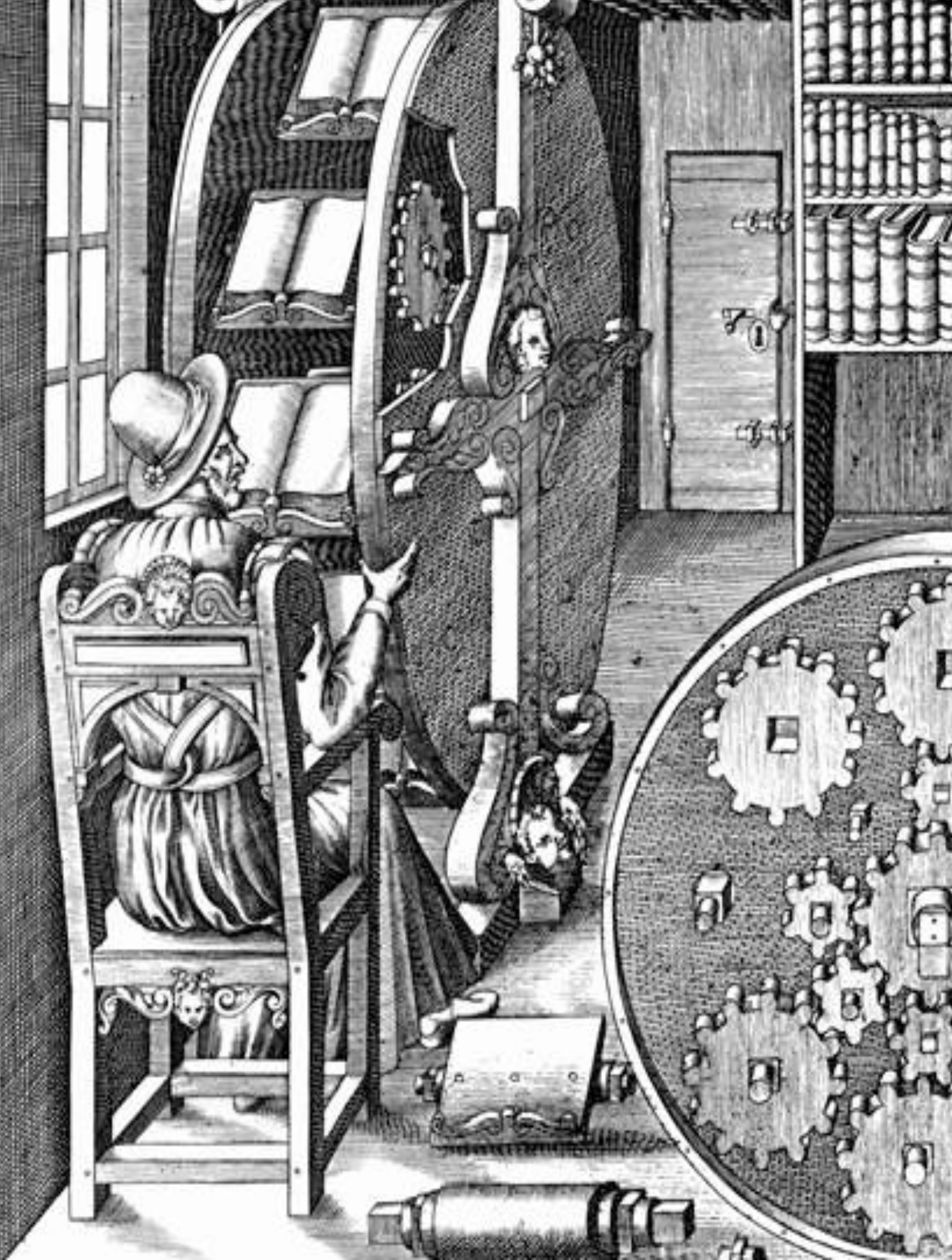
Denis Diderot
(1713-1784)



Jean-Baptiste
le Rond
d'Alembert
(1717-1783)



Agostino Ramelli (1588),
Le diverse et artificiose machine;
composte in lingua Italiana et Francese



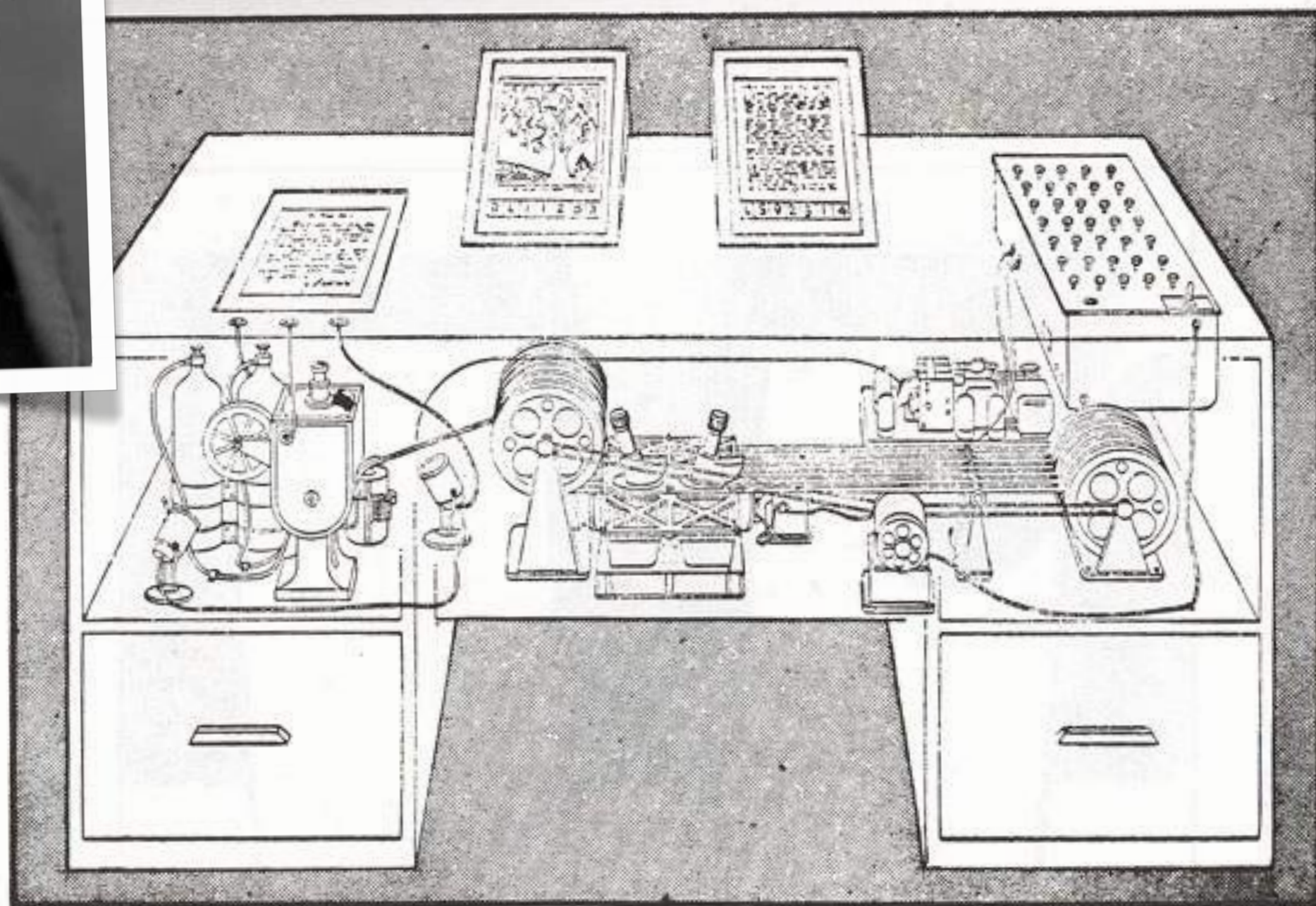
**What about
Usability...?**

Agostino Ramelli (1588),
Le diverse et artificiose machine;
composte in lingua Italiana et Francese



Vannevar Bush
(1890-1974)

Vannevar Bush proposed the first
Hypertext-System „MEMEX“ in 1945

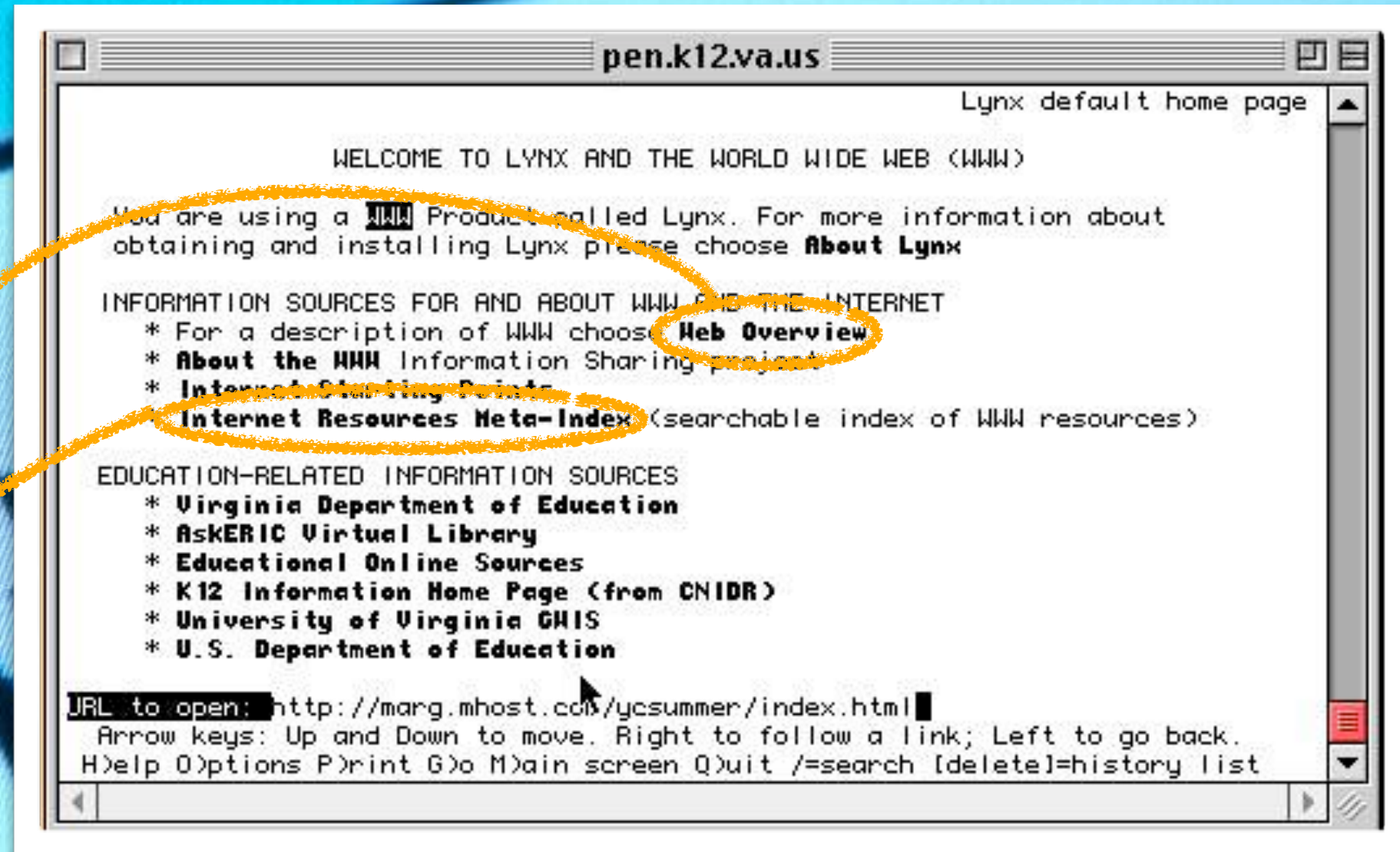


Memex in the form of a desk would instantly bring files and material on any subject to the operator's fingertips. Slanting translucent viewing screens magnify supermicrofilm filed by code numbers. At left is a mechanism which automatically photographs longhand notes, pictures and letters, then files them in the desk for future reference (*LIFE* 19(11), p. 123).

vgl. Vannevar Bush, *As we may think*,
The Atlantic Monthly, **1945**, July

Why was the Web such a big success ?

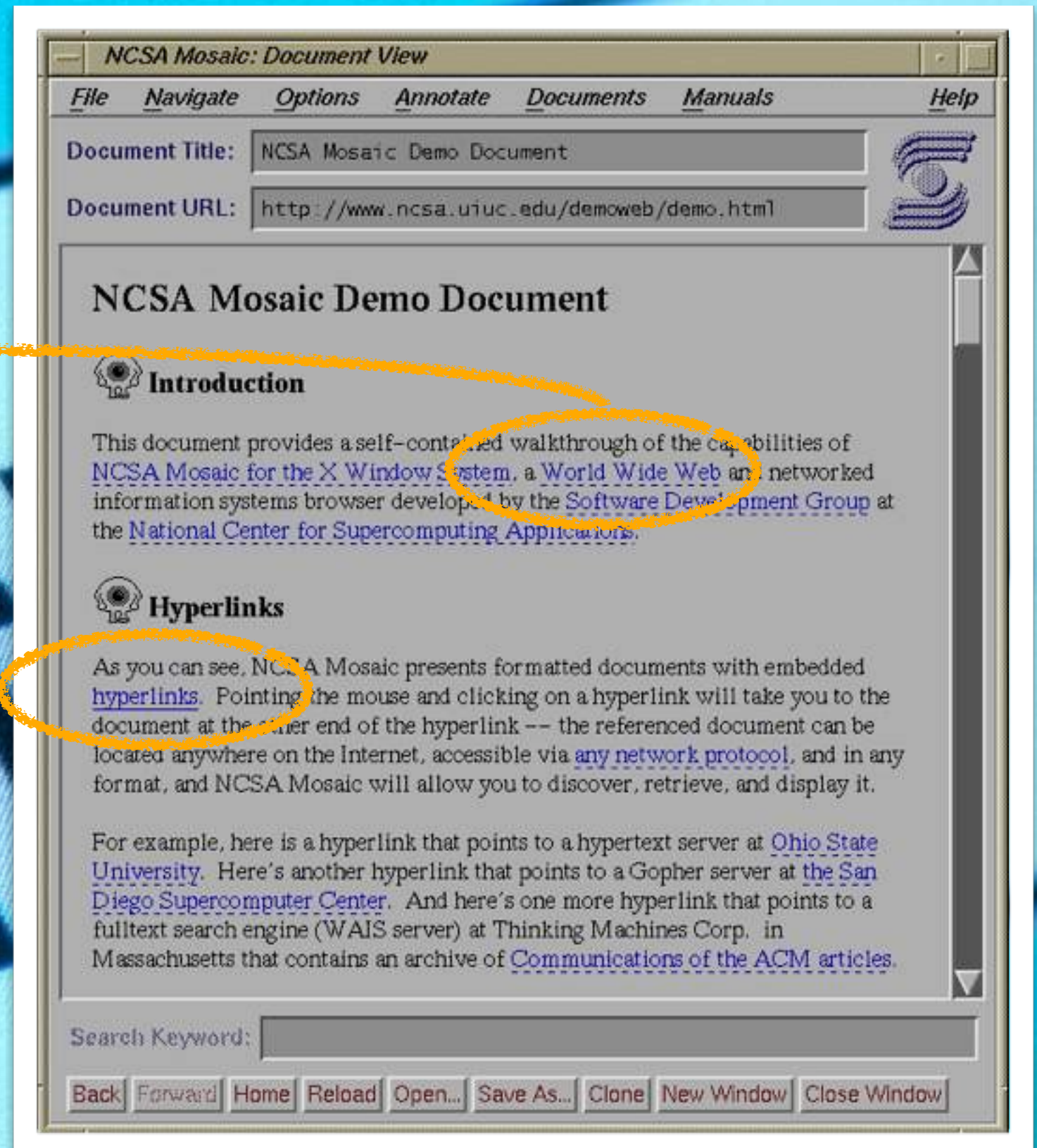
Lynx 1993



Why was the Web such a big success ?

NCSA Mosaic 1994

13



Why was the Web such a big success ?

14

IPad
Safari 2010



What's next...?

Google Glass
2013

15



There seem to be no Limits of Growth...

Internet Domain Survey Host Count

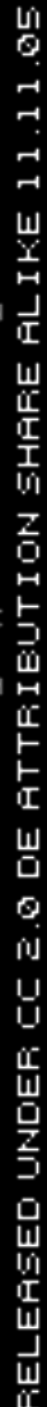


Source: Internet Systems Consortium (www.isc.org)

<http://www.isc.org/>
(update: 05/2014)

Web Content and Applications are Changing

-- Tim O'Reilly, 2003



Just keep in mind that the Web is based on public infrastructure, protocols, and data transfer...



SCORE 7040

LIVES



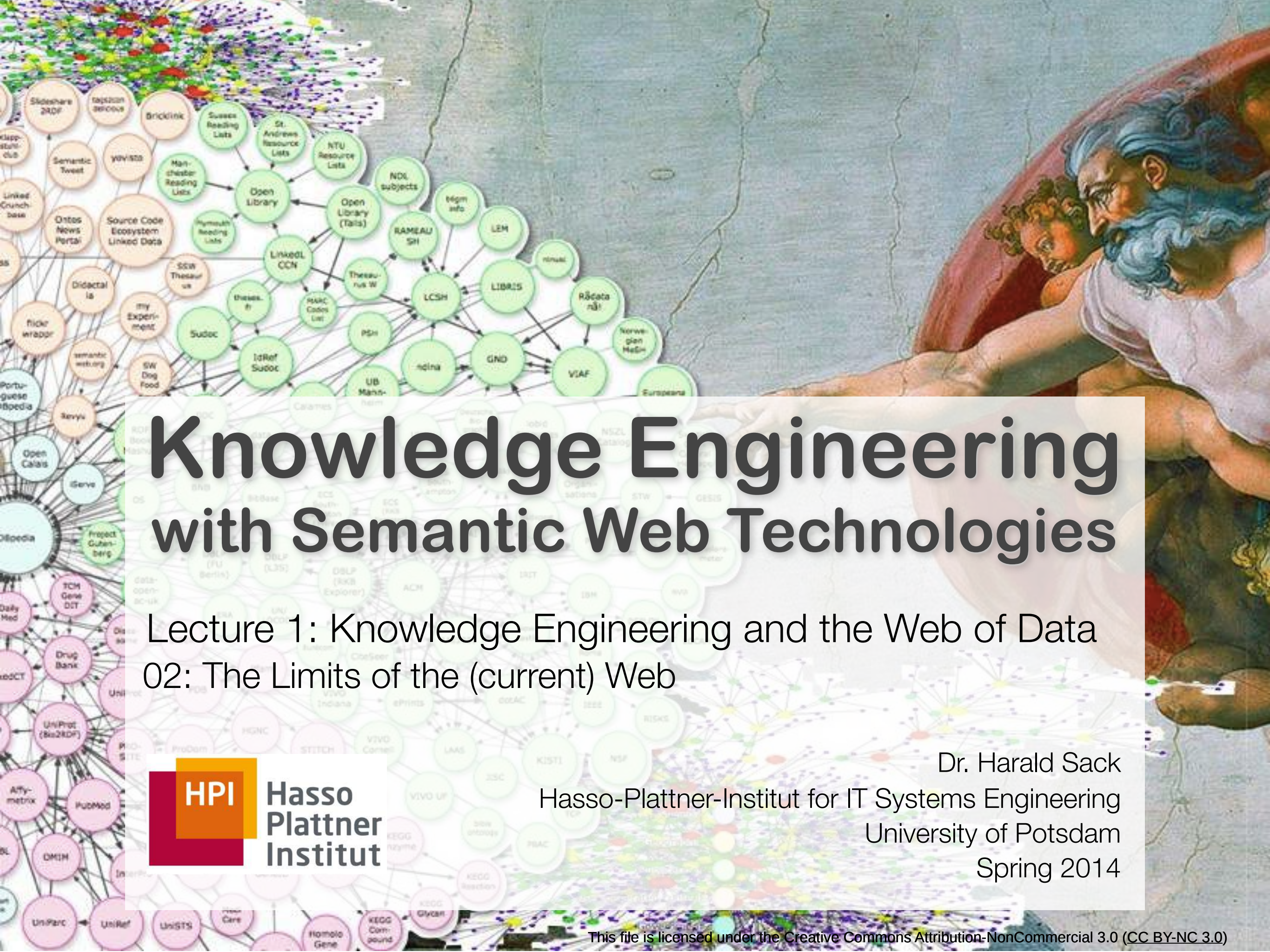
Next section



02: The Limits of the (current) Web ...

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data



Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data
02: The Limits of the (current) Web



Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 1: Knowledge Engineering and the Web of Data

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies

SCORE 7040

LIVES



02: The Limits of the (current) Web ...

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data

How can we find information in the Web?



current solution:

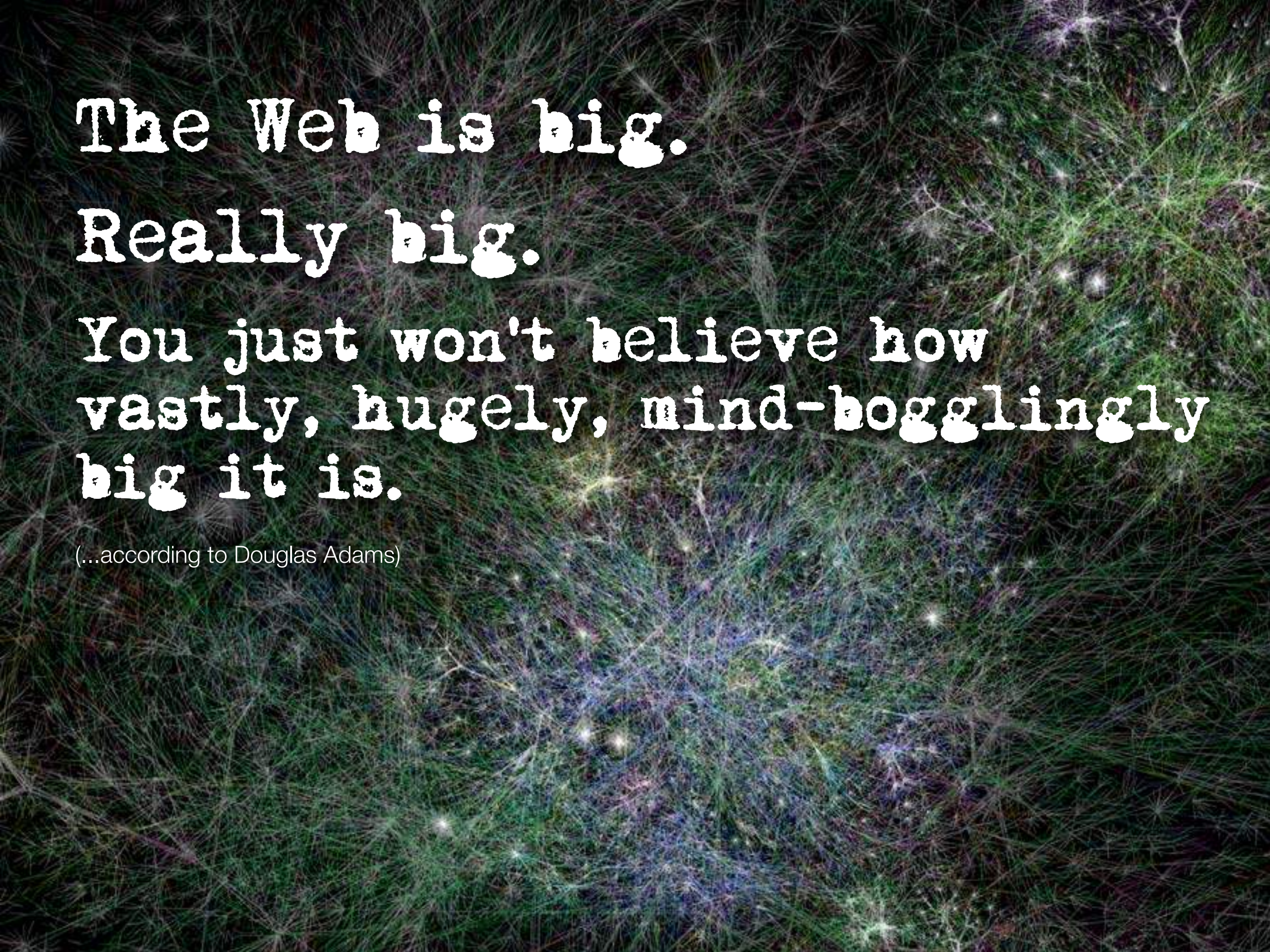
5



Google

Google Search

I'm Feeling Lucky

The background of the image is a complex, colorful web of fine, intersecting lines in shades of green, blue, and purple, set against a dark, starry space. These lines represent the cosmic web, a large-scale structure of the universe. Scattered throughout the background are numerous small, bright stars and larger, more diffuse nebulae, adding to the cosmic theme.

The Web is big.

Really big.

You just won't believe how
vastly, hugely, mind-bogglingly
big it is.

(...according to Douglas Adams)

The Web is really big...

- ca. 25×10^9 indexed documents in search engines
(TNL Blog: Google has 24 billion items index, considers MSN search nearest competitor, September 2005)
- Web Crawler: $> 10^{12}$ (1 trillion) documents
(The Official Google Blog: We knew the Web was Big....., Juli 25, 2008
<http://googleblog.blogspot.de/2008/07/we-knew-web-was-big.html>)
- Google Search Index Caffeine comprises ca. 100 Million Gigabytes i.e. 10^{17} Byte
(SMX Video: Google's Matt Cutts On Caffeine Launch, June 9, 2010,
<http://searchengineland.com/smx-video-googles-matt-cutts-on-caffeine-launch-43933>)
- DeepWeb (Darkweb) estimated to be about 550 times bigger than Surface Web



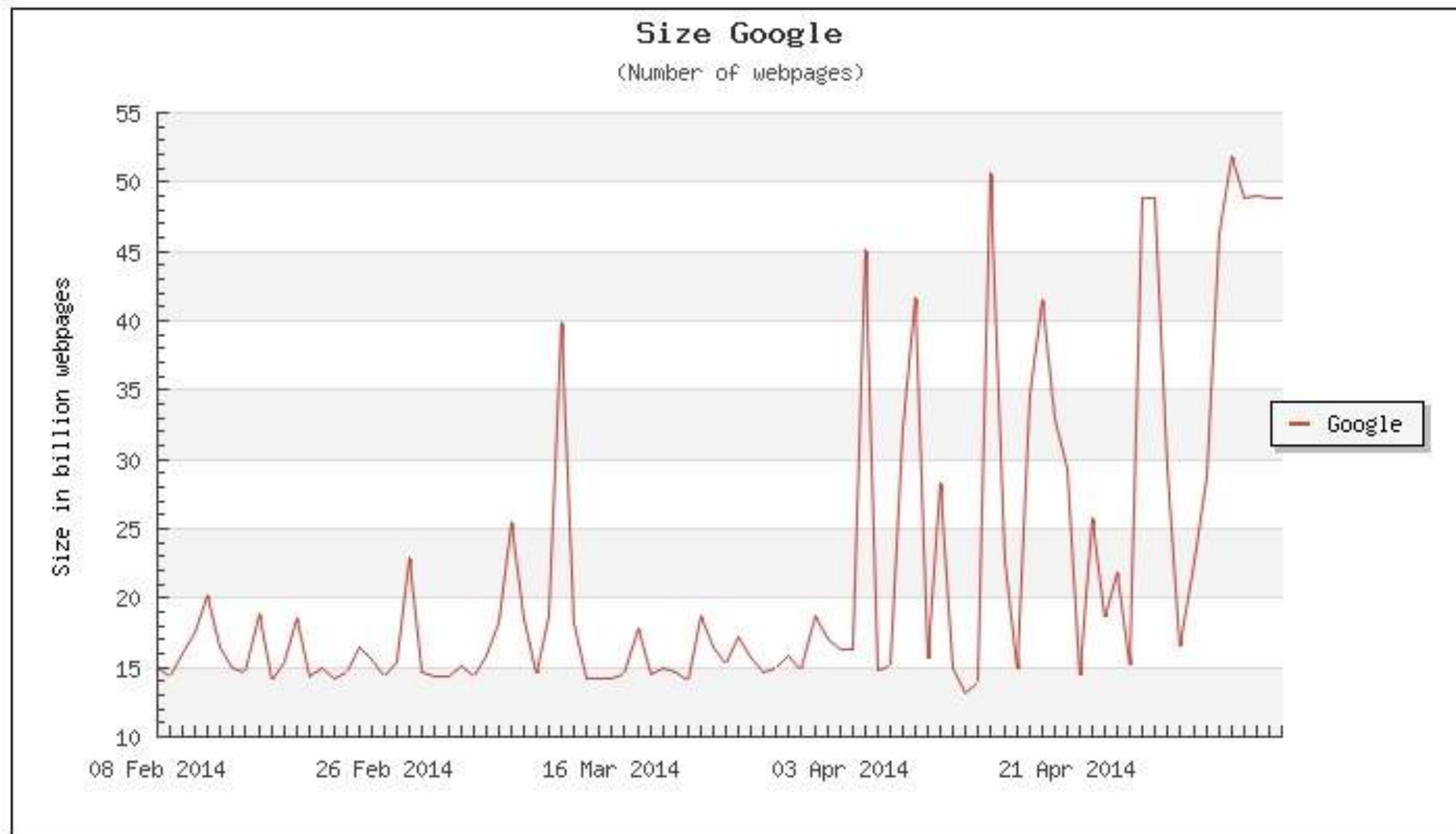
The size of the World Wide Web: Estimated size of Google's index

Last Month

Last Three Months

Last Year

Last Two Years



... and it's getting bigger
by the minute!

PINTEREST
USERS PIN

3,472
images.

VINE
USERS

SHARE

8,333

VIDEOS.

SKYPE
USERS

CONNECT FOR
23,300 HOURS.

YELP USERS POST

26,380
REVIEWS.

APPLE USERS
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USERS UPLOAD
72 HRS.
OF NEW
VIDEO.

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USERS SEND
204,000,000
MESSAGES.

Google
RECEIVES OVER
4,000,000
SEARCH
QUERIES.

FACEBOOK
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PIECES OF CONTENT.

TINDER
USERS SWIPE
416,667
TIMES.

WHATSAPP
— USERS SHARE —
347,222
PHOTOS.

TWITTER USERS

· EVERY ·
MINUTE
OF THE
DAY



**SKYPE
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CONNECT FOR
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PANDORA

USERS LISTEN TO



AMAZON



**INSTAGRAM
USERS »**



TWITTER USERS

TWEET

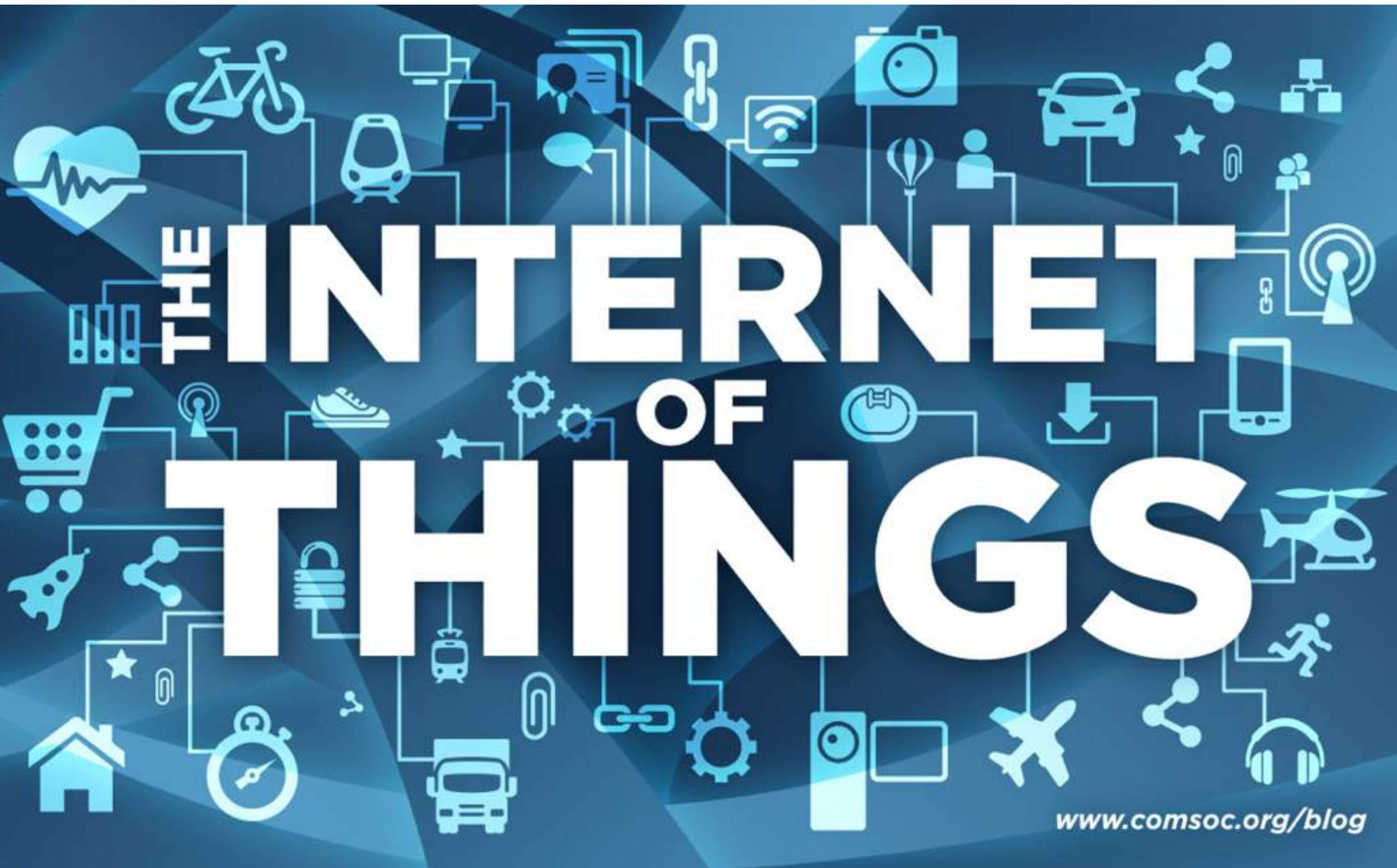
277,000



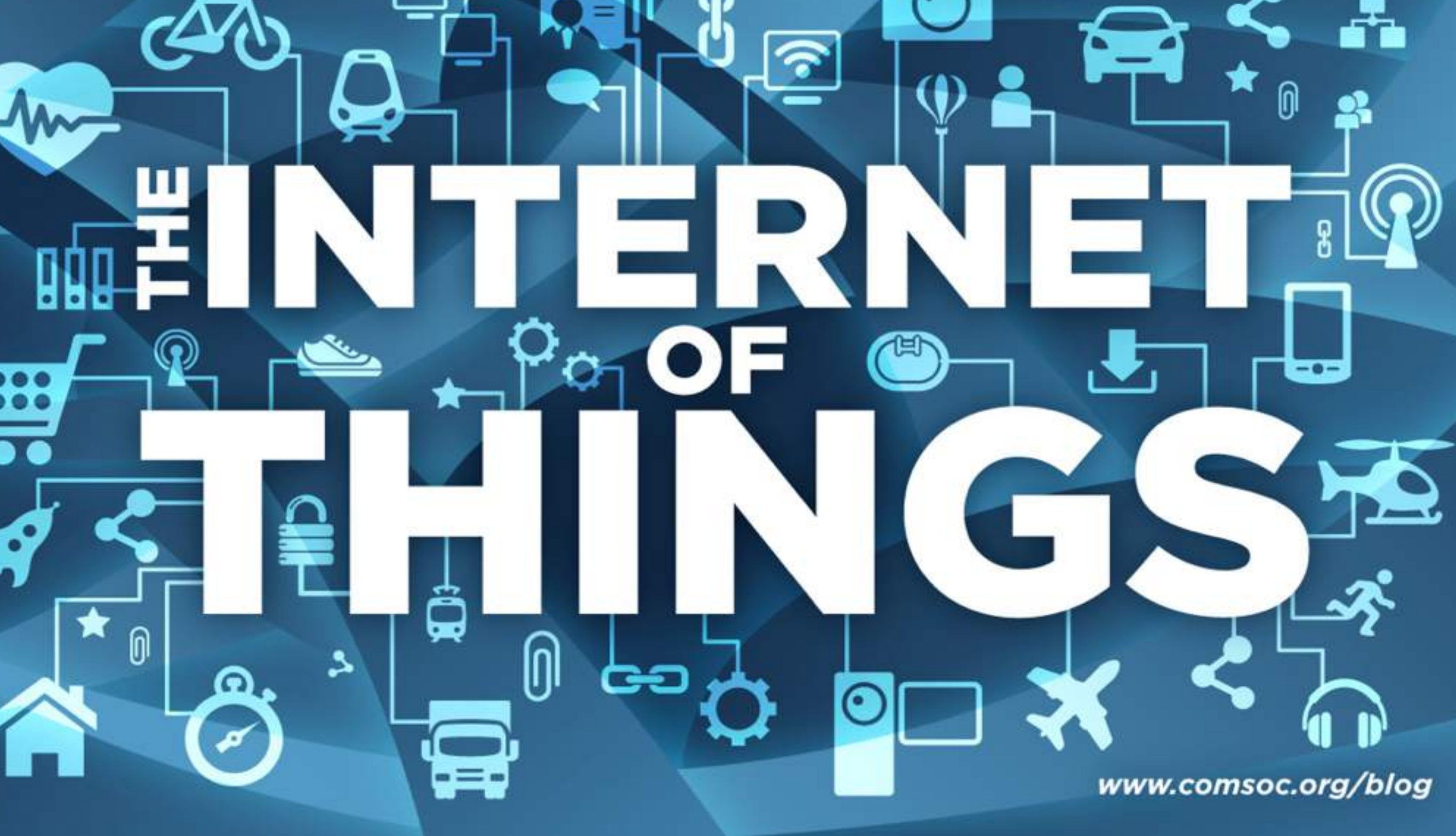
WHATSAPP

— USERS SHARE —

347,222
PHOTOS.



www.comsoc.org/blog



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From Data to Information in the WWW

From The New York Times

Monday, April 28, 2014

Today's Paper

Personalize Your Weather



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AT THE
SPEED
OF LIFE.



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All Sections

One Therapist, \$4 Million in Medicare Bills in One Year

By JULIE CRESWELL and ROBERT GEBELOFF

Physical therapy is a big recipient of national Medicare dollars — and physical therapists in Brooklyn are among the biggest billers of all, government data indicates.

33 Comments

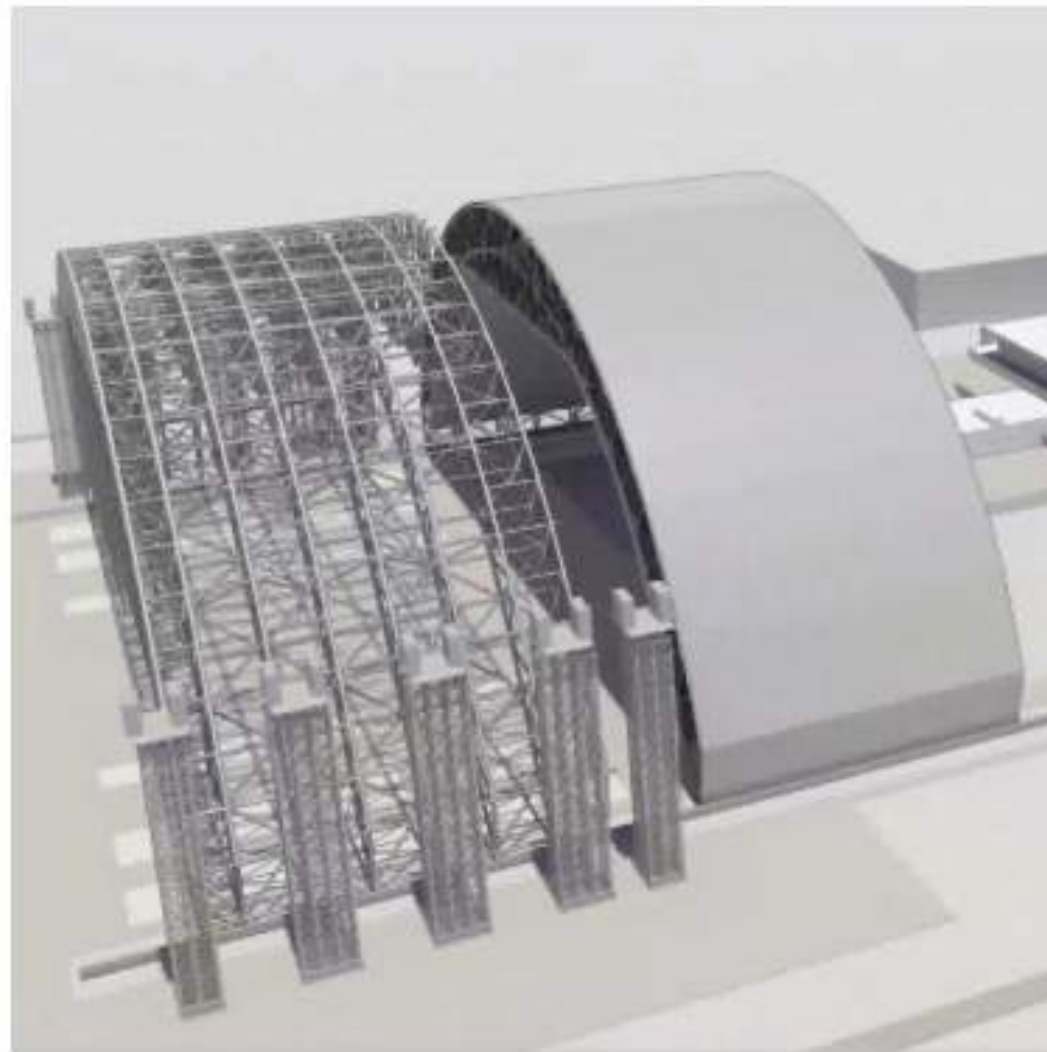
Obama Says More Sanctions Against Russia Are Coming

By MARK LANDLER and PETER BAKER 7 minutes ago

On the last stop of his Asian trip, President Obama said the United States would impose additional sanctions on Russia and freeze some exports of military technology.



Mayor of Ukraine's Second-Largest City Is Shot



Putting a 32,000-Ton Cap on Chernobyl

By HENRY FOUNTAIN

Chernobyl, Ukraine, is building a \$1.5 billion arch to all but eliminate the risk of further contamination at the site of the 1986 nuclear reactor explosion.

Photos: Years After Disaster, Building Progress

String of Deadly Storms Hits Midwest and South

By ALAN BLINDER and ASHLEY SOUTHALL 24 minutes ago

A violent weather system lashed the Midwest and



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The police should need a warrant to search mobile phones, because they contain enormous amounts of personal information.

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By JACOB SOLL

Our financial illiteracy is costing us much more than we realize.



- Room for Debate: Income and Affirmative Action
- Krugman: High Plains Moochers
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MARKETS »

At 9:09 AM ET

BUSINESS DAY »

Britain	Germany	France
FTSE 100	DAX	CAC 40
6,690.63	9,422.85	4,446.23
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+0.07%	+0.23%	+0.06%

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Why the Housing Market Is Still Stalling the Economy

Millions are living with parents or friends and just not setting up households.



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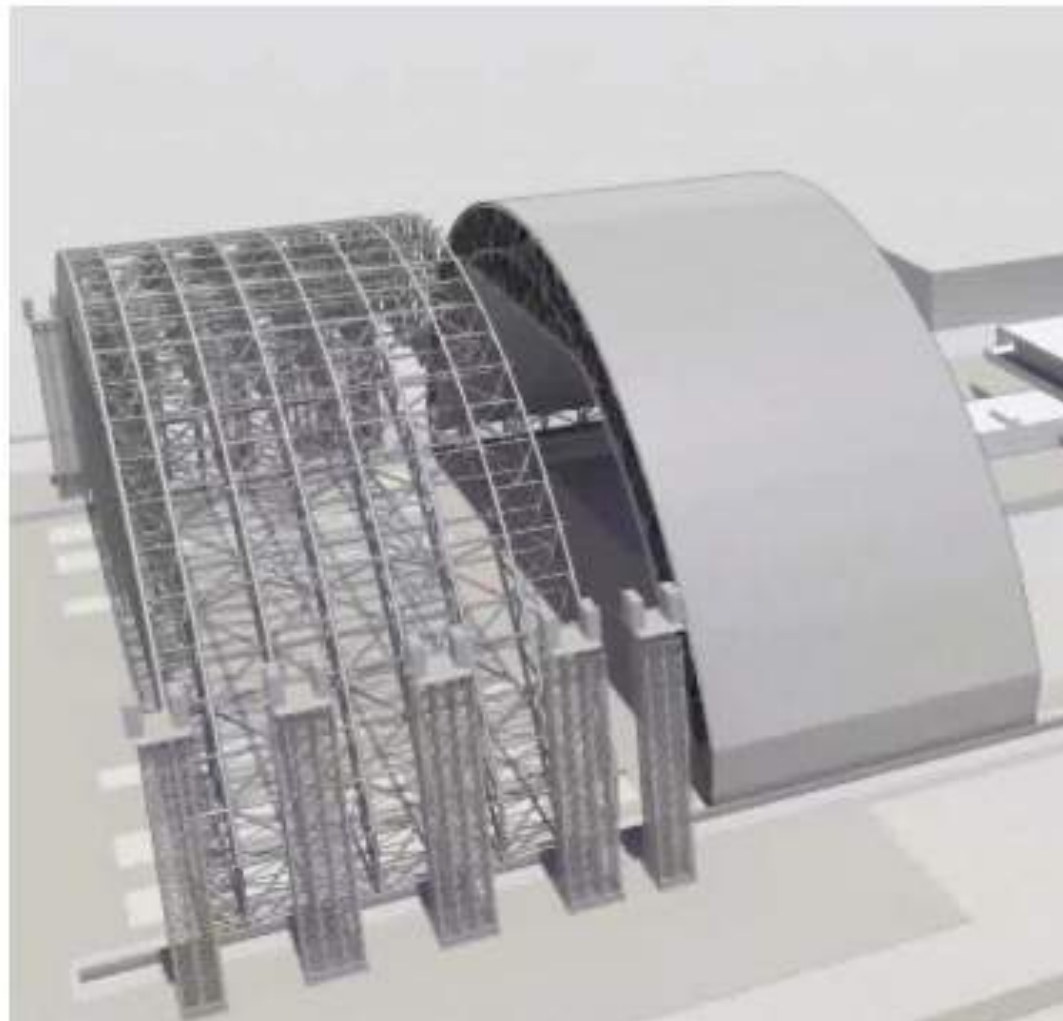
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MAKER 7 minutes

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What is important and how do you know?

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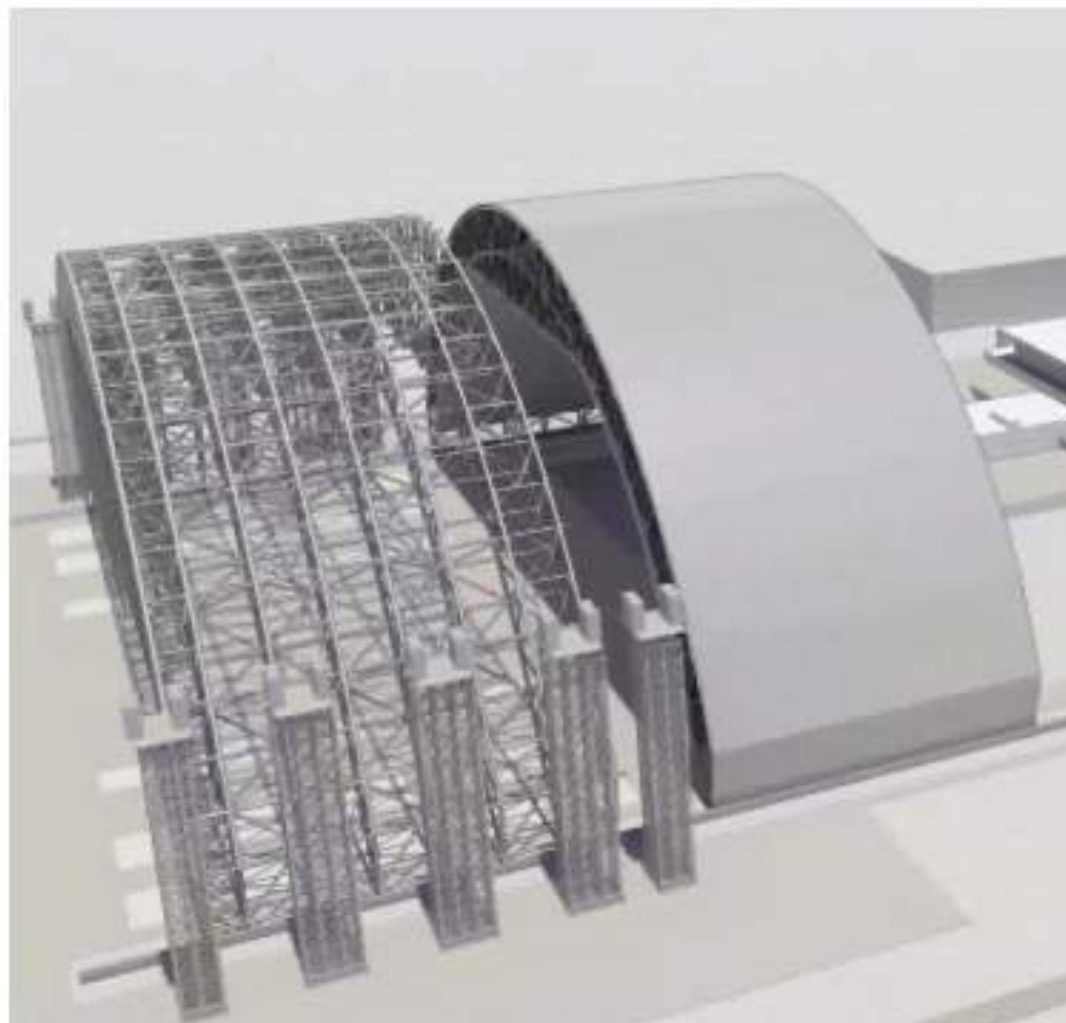
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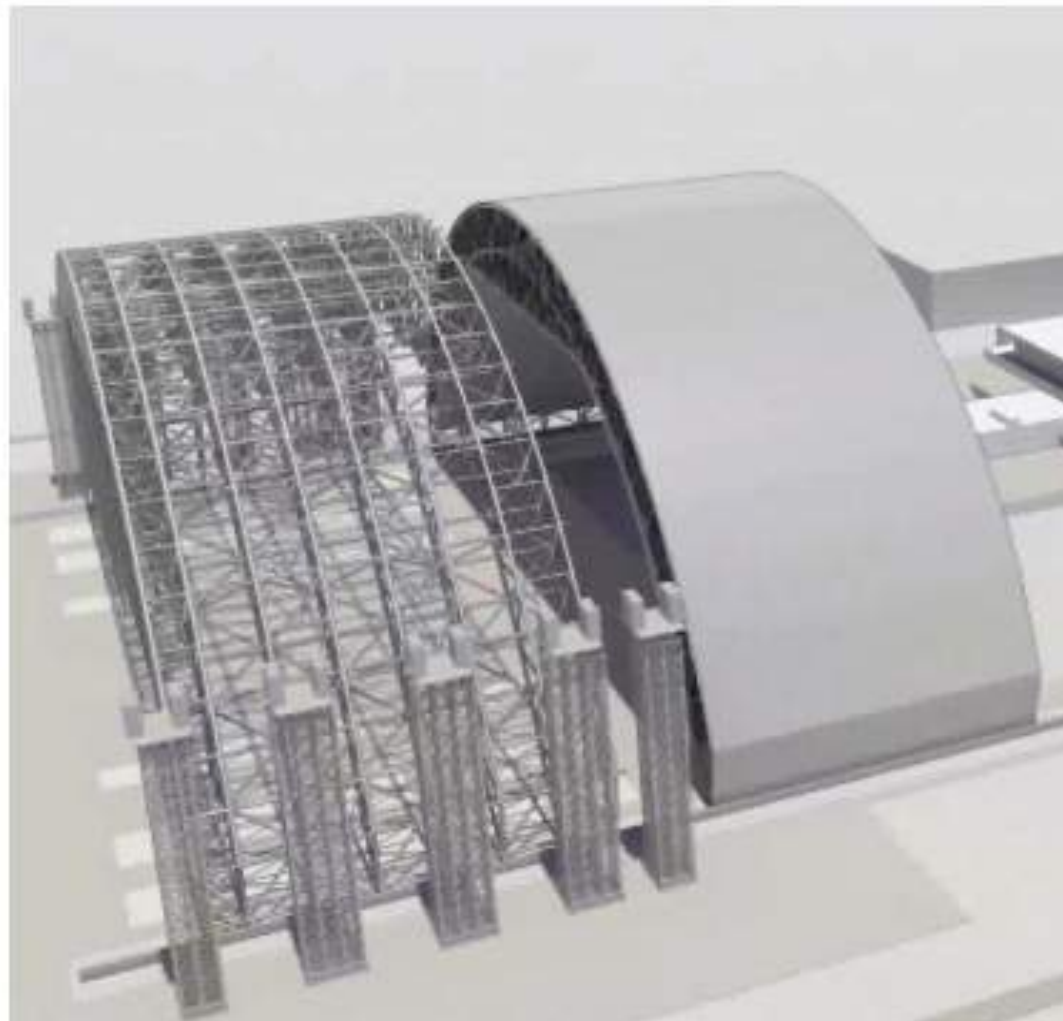
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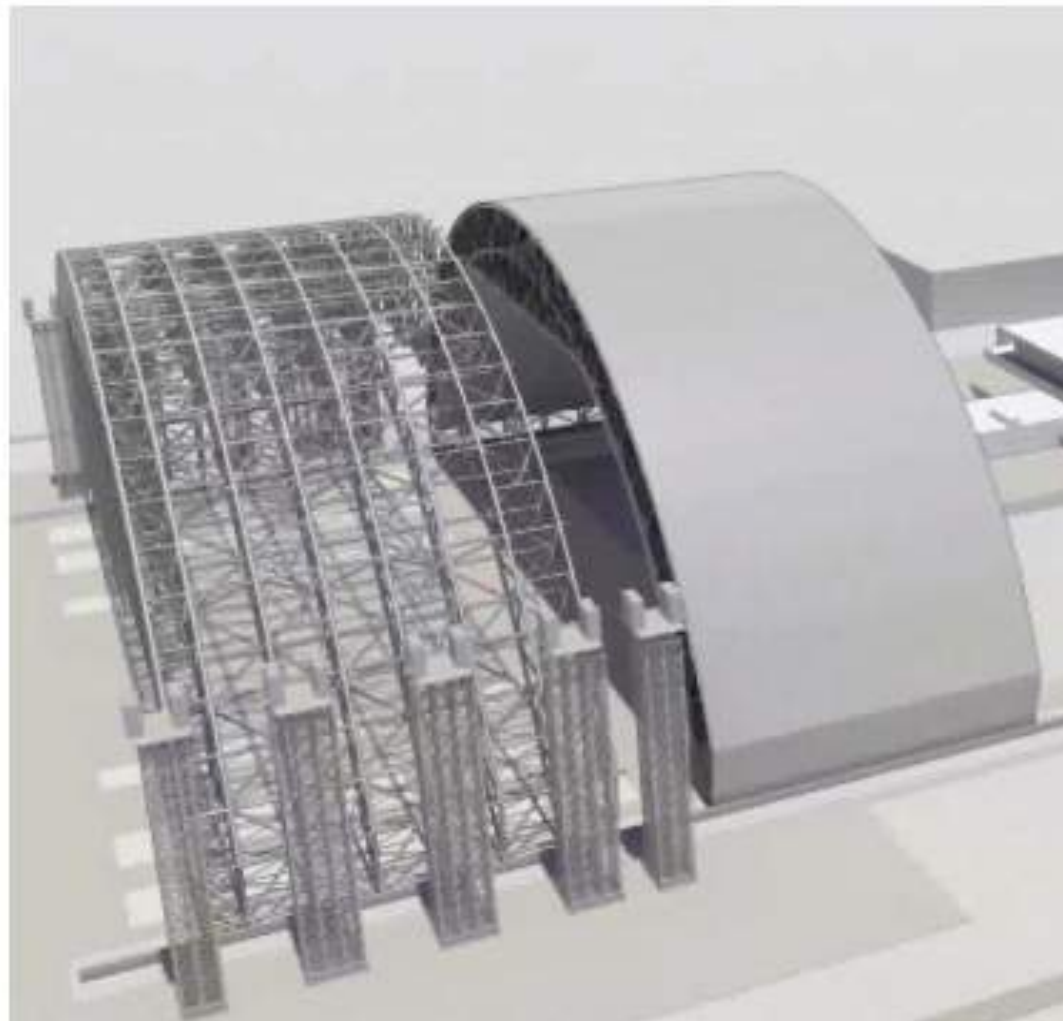
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»
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東奥日報電子版
長期割引あり

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求人

青年海外協力隊
シニア海外ボランティア

秋募集
受付期間
10月1日～11月5日まで



■青森県の天気予報
■各地の気象(22時)
気温(°C) 風向/風速
青森 17.2 南南西/3m
弘前 14.8 南/2m

天地人 | 社説 | 訃報 | お悔やみ | 青森
プロ野球 | MLB | Jリーグ | 大相撲 | 高校野球

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物件情報

■速報 19:46 床下から2体目の遺体

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保育所対抗チャンバラ交流大会



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テレビ

- ・ 風間浦で「同志社フェア」
- ・ 園児らチャンバラ交流/板柳
- ・ 染工場など全焼、2人死亡
- ・ 津軽の食と産業まつり開幕

>> 過去の動画ニュース

投稿動画 受け付けます

東北の電力使用 21時台
71%
0 20 40 60 80 100

■青森のニュース

2012年10月14日 22:37

RSS ブログパーツ

第10回 弘前・白神アップルマラソン写真特集



「滝めぐり」DVD発売

福島原発事故

東日本大震災

22:01 弘高、決勝へ/東北高校軟式野球

21:30 「生活」小沢代表が講演/十和田



不動産情報
中古車ネットガーデン
ネット住宅展示場
イメール申し込み
Miniガイド

ロレックス
正規品取扱店

マエバラ

人材派遣なら
東奥日報人材センター アウル

青森のセーフティネット

サンワアリーナ 青森

風家

あかちゃん・初宮参り

クレバーホーム

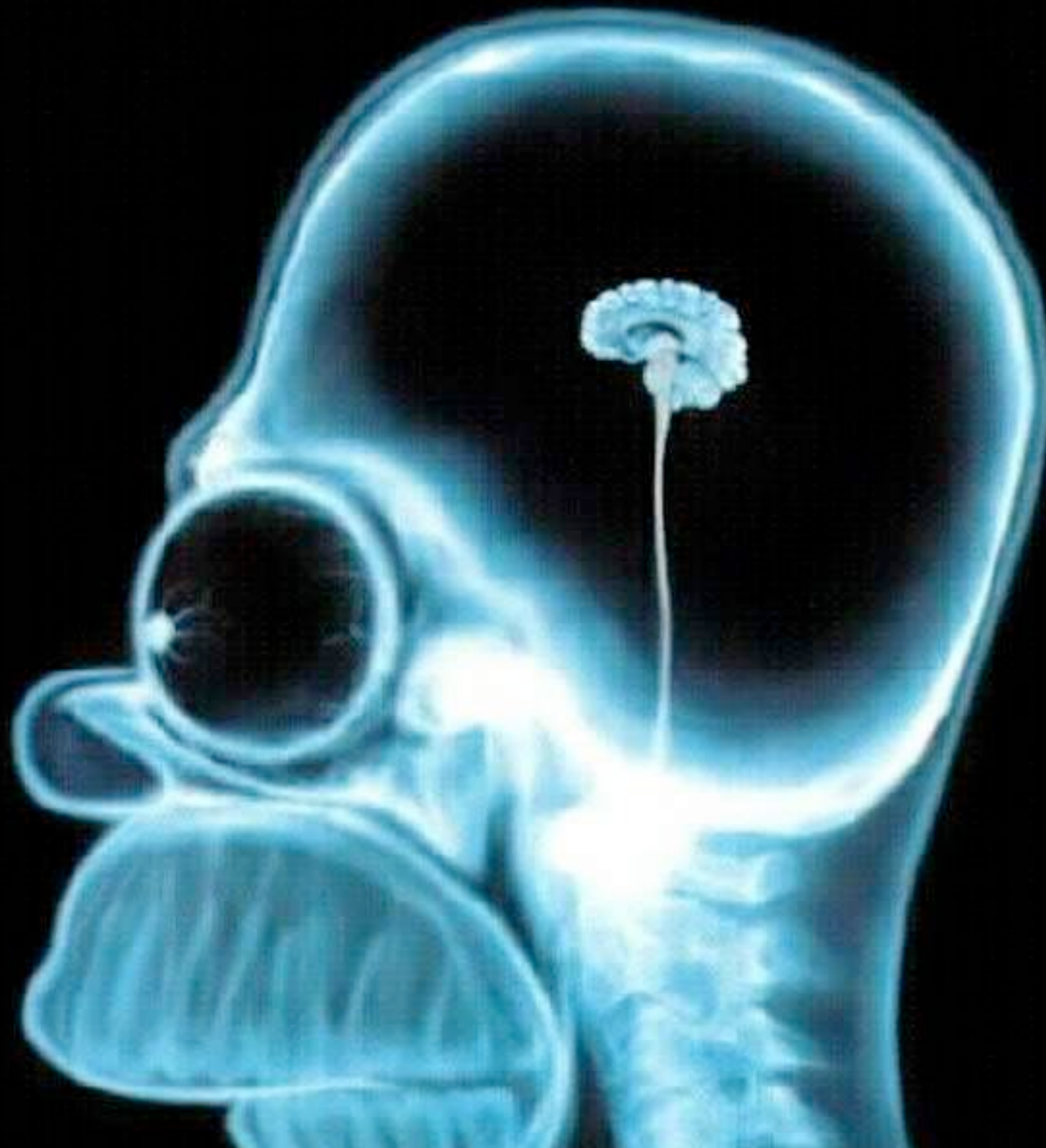
Cubic Four
建築工房 キュービック・フォー

弘前初登場

お得な情報はここから

NEW モデルハウス
オープン!!

日本直営



Humans have **contextual knowledge**, **world knowledge** and **experience** to solve the problem

The Web is Supposed to be Used by Humans

- The Web is based on the **markup language HTML**
- HTML describes
 - how information is **presented**
 - how information is **linked**
 - but **not**, what the information means

WHAT IS THE MEANING G

Next section

LIVES



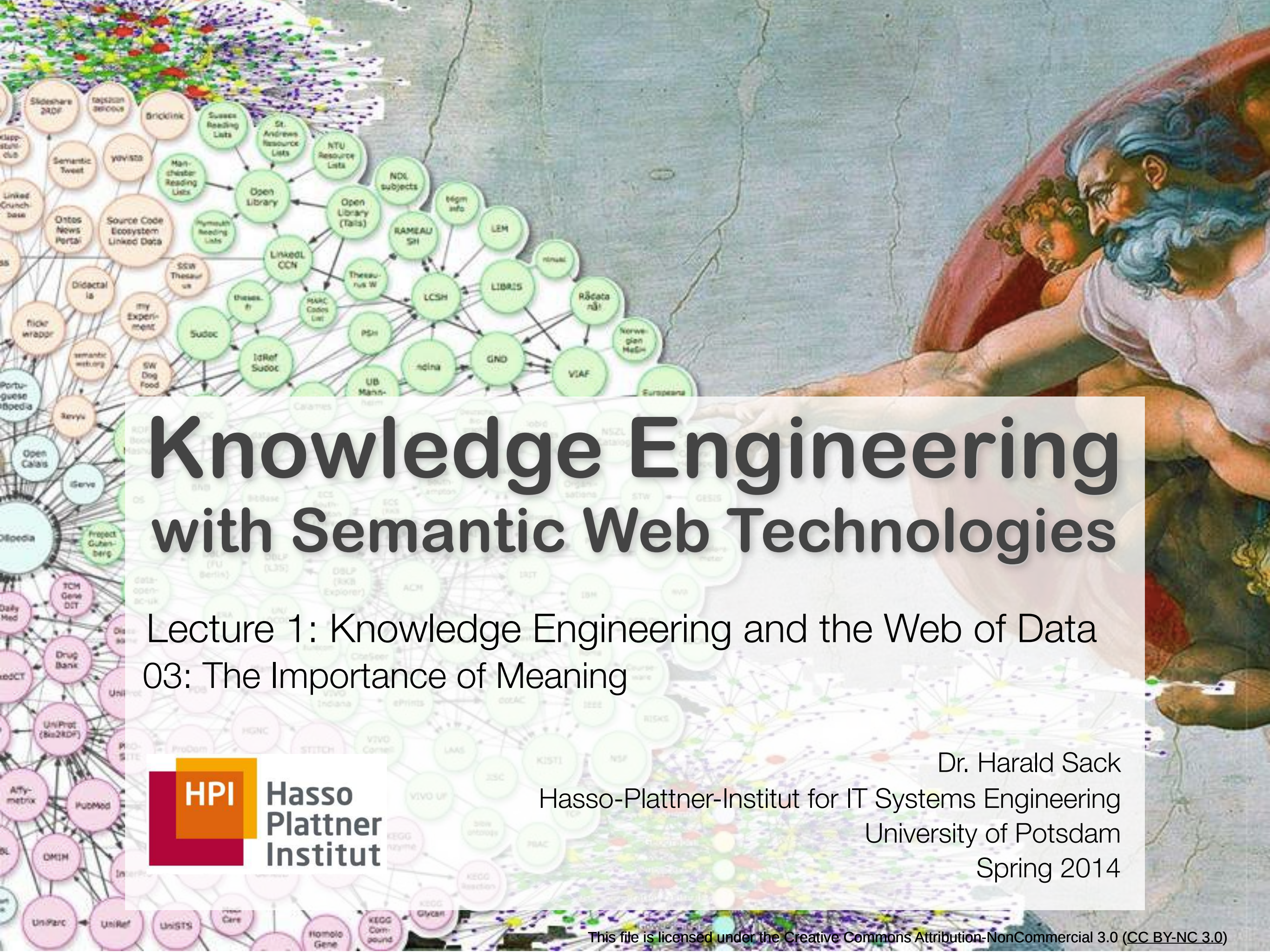
GAME OVER



03: The Importance of Meaning

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data



Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data
03: The Importance of Meaning



Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 1: Knowledge Engineering and the Web of Data

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies

WHAT IS THE IMPORTANCE

03: The Importance of Meaning

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data

WHAT IS THE 
LEARNING

Syntax
Semantics
Context
Pragmatics
Experience

Syntax

Syntax (greek $\sigma\psi\eta\tau\alpha\chi\iota\varsigma$ = *Arrangement, Ordering*)

5
*Semantics:
Determining Meaning*

Syntax

Syntax (greek $\sigma\psi\nu\tau\alpha\chi\iota\varsigma$ = *Arrangement, Ordering*)

- In **grammatics** denotes the study of the principles and processes by which sentences are constructed in particular languages.

*Semantics:
Determining Meaning*

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- In **formal languages**, syntax is just a set of rules, by which well formed expressions can be created from a fundamental set of symbols (alphabet).

Syntax

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- In **grammatics** denotes the study of the principles and processes by which sentences are constructed in particular languages.
- In **formal languages**, syntax is just a set of rules, by which well formed expressions can be created from a fundamental set of symbols (alphabet).
- In **computer science**, syntax defines the normative structure of data.

Semantics

Semantics (greek *σημαντικός* = *pertains to the character, the study of meaning*)

- is part of the linguistics focussed on
 - **Sense** and
 - **Meaning**

5
Semantics:
Determining Meaning

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- The semantics of a message depends on **context** and **pragmatics**.

Context

Context (lat. *contextus* = *interweaved*)

5
Semantics:
Determining Meaning

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- denotes the **surrounding of a symbol** (concept) in an expression resp. its **relationship with surrounding expressions** (concepts) and further related elements,

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 - **general contexts:**
place, time, interrelation of action in a message
 - **personal or social contexts:**
relation between sender and receiver of a message

Pragmatics

Pragmatics (greek. **πραγμα** = *action*)

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- reflects the **intention by which the language is used** to communicate a message.
- In linguistics pragmatics denotes the **study of applying language in different situations**.
- It also **denotes the intended purpose** of the speaker.
- Pragmatics studies **the ways in which context contributes to meaning**.

Experience

- **Experience** considers all information that you have learned and put in context with the world you are living in.
- Experience in this sense also often is referred to as **comon sense knowledge** or **world knowledge**.

Successful

Communication

For **successful communication**,

- information has to be correctly transmitted (**Syntax**)
- the meaning (**Semantics**) of the transmitted information must be interpreted correctly (= **understanding**)

Understanding depends on

- the **context** of both sender and receiver and
- the **pragmatics** of the sender
- the **context** of sender and receiver depends on
- the **experience** (knowledge of the world) of both sender and receiver

Meaning



sender

Experience

Concept

symbolizes

refers to

Symbol

stands for

Object

"Jaguar"



Pragmatics



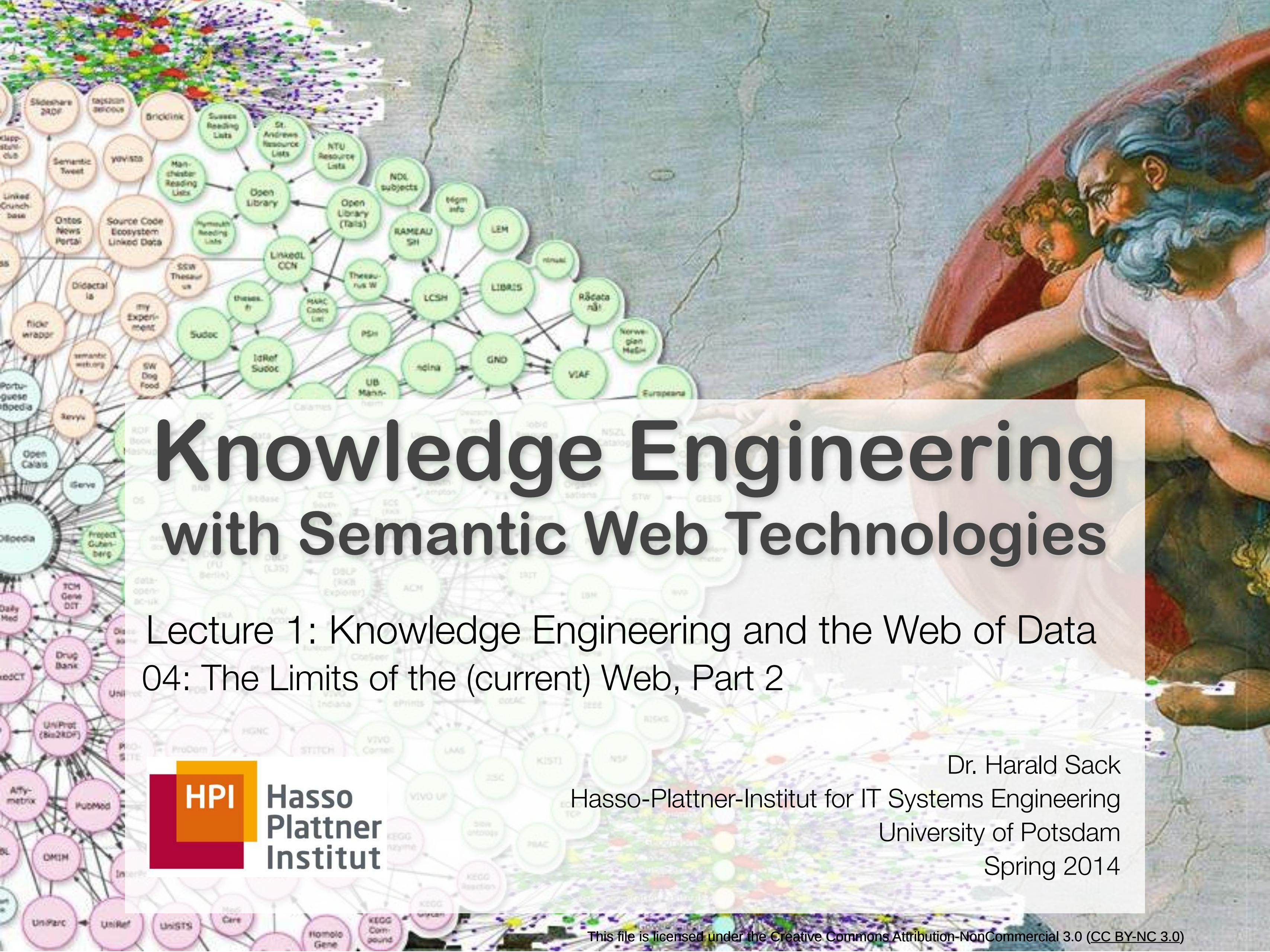
In the (traditional) Web there is no explicit semantics

Next section

http.

04: The Limits of the (current) Web Pt.2

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies
Lecture 1: Knowledge Engineering and the Web of Data



Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data
04: The Limits of the (current) Web, Part 2



Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 1: Knowledge Engineering and the Web of Data

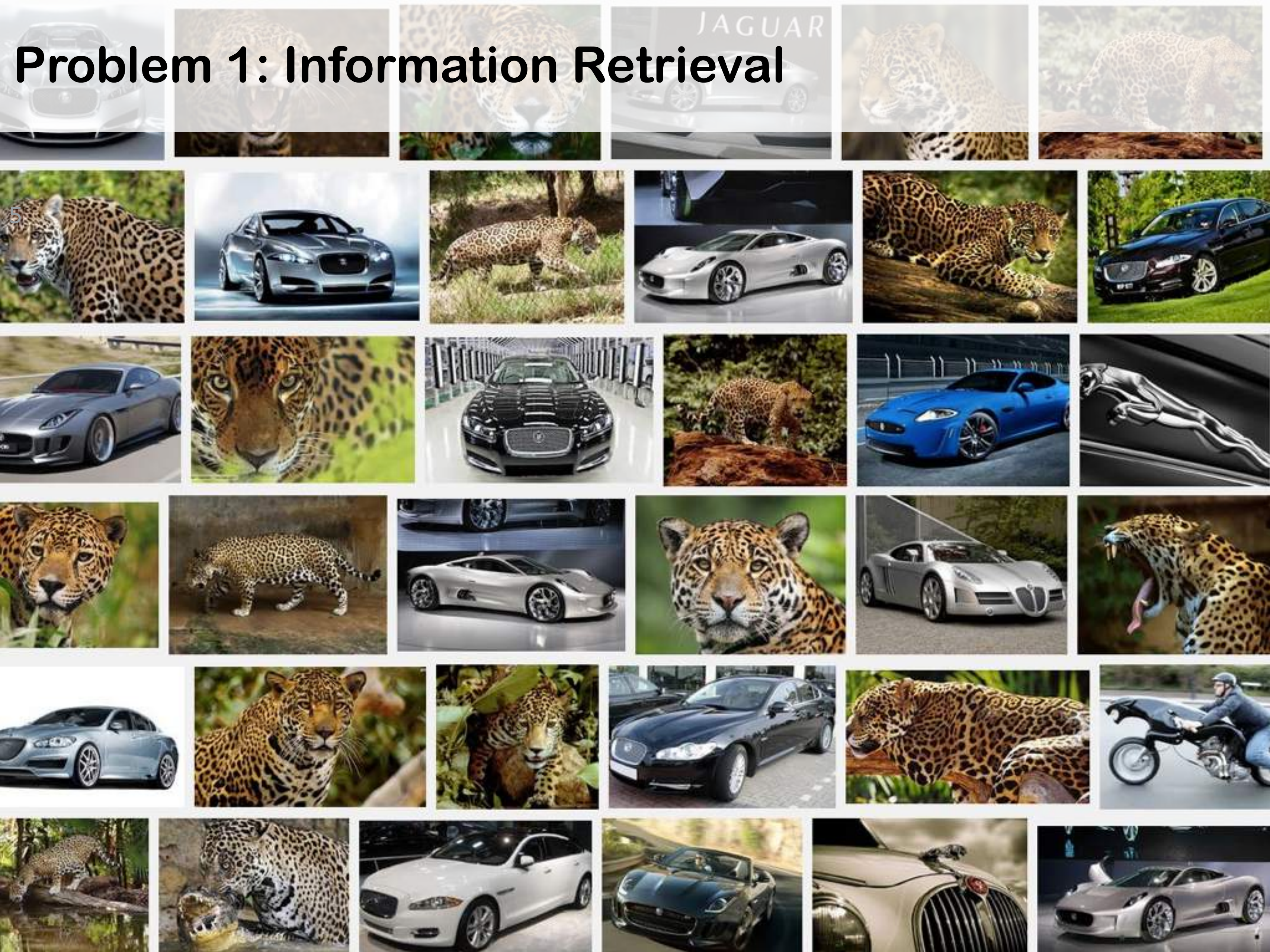
Open HPI - Course: Knowledge Engineering with Semantic Web Technologies



04: The Limits of the (current) Web Pt.2

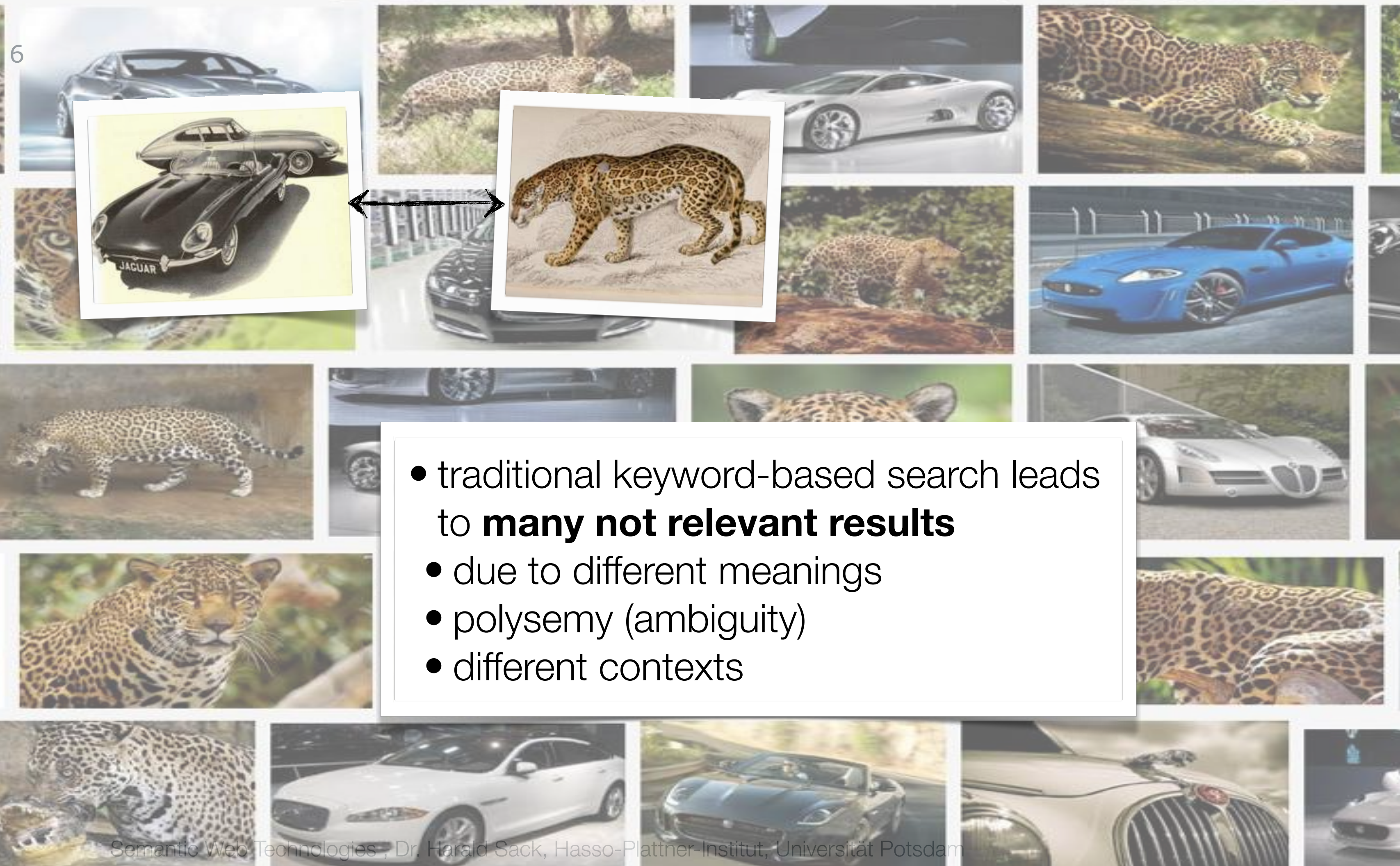
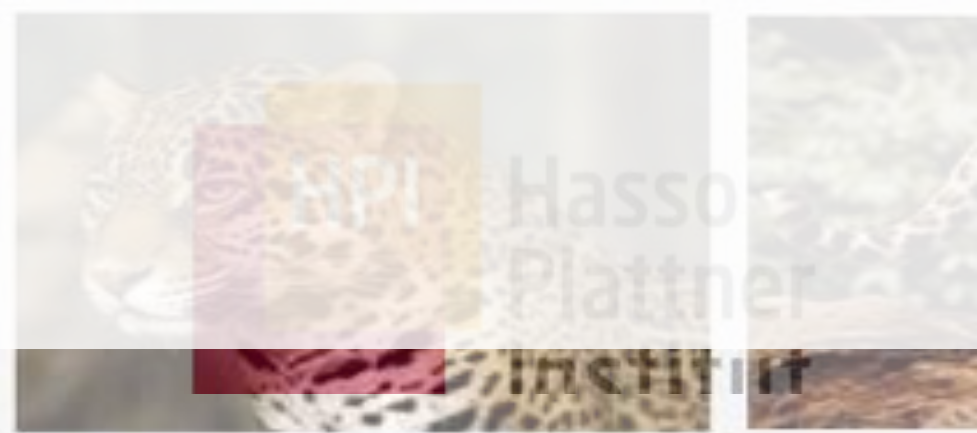
OpenHPI - Course Knowledge Engineering with Semantic Web Technologies
Lecture 1: Knowledge Engineering and the Web of Data

WHAT IS THE MANUAL G



Problem 1: Information Retrieval

Problem 1: Information Retrieval



- traditional keyword-based search leads to **many not relevant results**
 - due to different meanings
 - polysemy (ambiguity)
 - different contexts

Problem 1: Information Retrieval

Ad related to "Panthera onca" ⓘ

[Lion, Tiger, Jaguar Pics - Panthera Works to Save Wild Cats](#)

www.panthera.org/

See Pictures of all the Big Cats

[Jaguar - Wikipedia, the free encyclopedia](#)

en.wikipedia.org/wiki/Jaguar

...ca, is the only extant New World member of the Panthera genus. It shows the lion, tiger, leopard, jaguar, snow leopard, and ...

...le Jaguars - Jaguar (disambiguation) - Jaguarundi

Jaguar

Panthera Onca

[Panthera onca \(jaguar\)](#)

www.iucnredlist.org/details/15953/0

by A Caso - 2011 - Cited by 10 - Related articles

Panthera onca. Status_ne_off Status_dd_off

Status_vu_off Status_en_off Status_cr_off St

[ADW: Panthera onca: INFORMATION](#)

animaldiversity.ummz.umich.edu/accounts/Panthera_onca/

Panthera oncajaguar. By Jonathan Nogueira. Geographic Range; Habitat; Physical Description; Reproduction; Lifespan / Longevity. Behavior; Communication ...

[Panthera | Jaguars](#)

www.panthera.org/species/jaguar

The jaguar (**Panthera onca**) is the third largest cat in the world, but it is the largest feline in the Americas.

[Jaguar \(**Panthera onca**\) - thebigzoo.com](#)

www.thebigzoo.com/Animals/Jaguar

The Jaguar is the largest cat in the Americas. It is the third largest cat in the world (after the Lion and the Tiger).

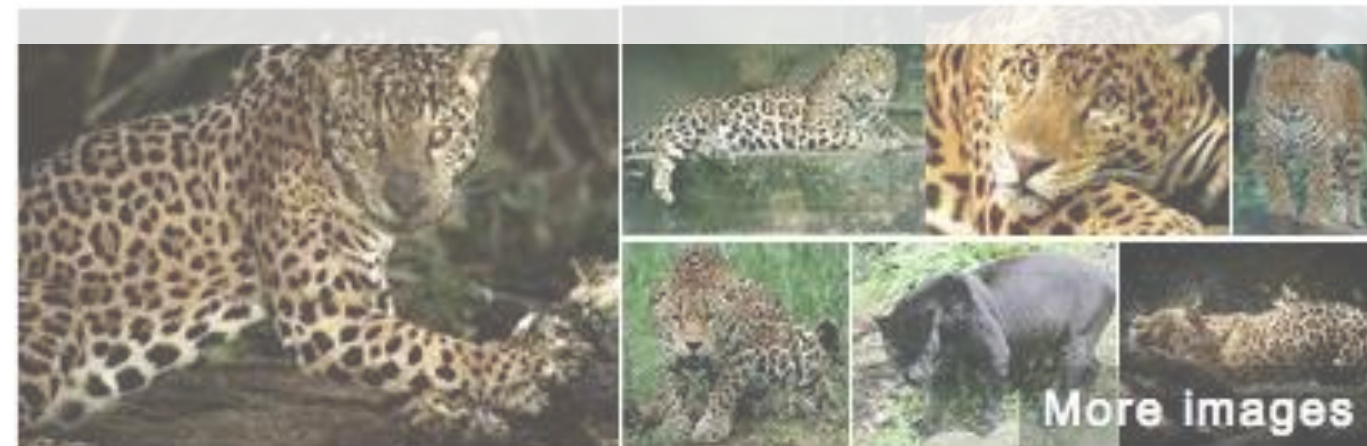
[Jaguar - Panthera onca - National Geographic](#)

www.nhptv.org/natureworks/jaguar

The jaguar is the largest cat in North America and the third largest cat in the world. It stands about three feet tall from shoulders to feet, 6½ to 7½ feet long from ...

[Jaguar videos, photos and facts - Panthera onca - ARKive](#)

www.arkive.org/Species/Mammals



More images

Jaguar

The jaguar is a big cat, a feline in the Panthera genus, and is the only species found in the Americas. The jaguar is the third-largest big cat, after the tiger and the lion, and the largest in the Western Hemisphere.

Wikipedia

Scientific name: Panthera onca

Rank: Species

Higher classification: Panthera

Feedback / More info

- traditional keyword-based search **does not find all results**
- synonyms and metaphors
- missing context definition

Problem 2: Information Extraction

What does the information mean?

Web 東奥

47 CLUB 47 CLUB
50人が食べてみた! 「押し商品」はコレ!!

天地人 | 社説 | 訃報 | お悔やみ | 育宮
プロ野球 | MLB | Jリーグ | 大相撲 | 高校野球

Goウェブ

エンタメ コラム・新刊本・新作映画・音楽CD・格闘技

車電日報と愛読者限定サービス!

住まいナビ

県外在住者の方向け
東奥日報電子版
長期割引あり

新聞に購読申し込み

広告のご案内
ウェブ | 新聞 | 折込

ドコモ・スマホサイト
new
ケータイ・スマホ情報

お店検索
イベント
展覧会

速報 19:46 床下から2体目の遺体 >>速報ニュース一覧

保育所対抗チャンバラ交流大会

第六回
保育所

TNT 東奥NET
テレビ

・ 風間浦で「同志社フェア」
・ 園児らチャンバラ交流/板橋
・ 染工場など全焼、2人死亡
・ 津軽の食と産業まつり開幕

不動産情報
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人材派遣なら
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青い鳥のセーラー

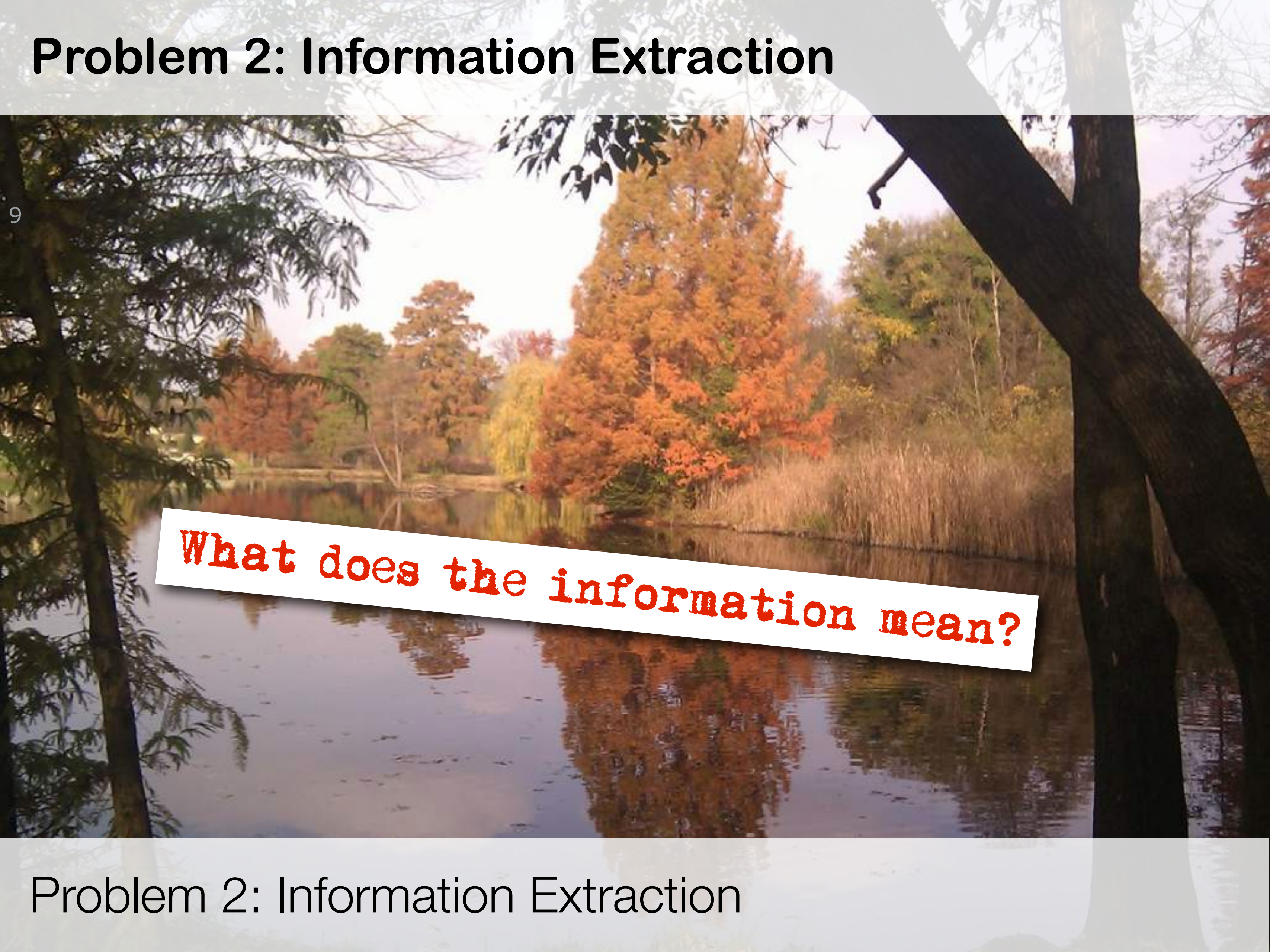
サンワアリーナ

風家

名物まん・知覚きり

Problem 2: Information Extraction

9



What does the information mean?

Problem 2: Information Extraction

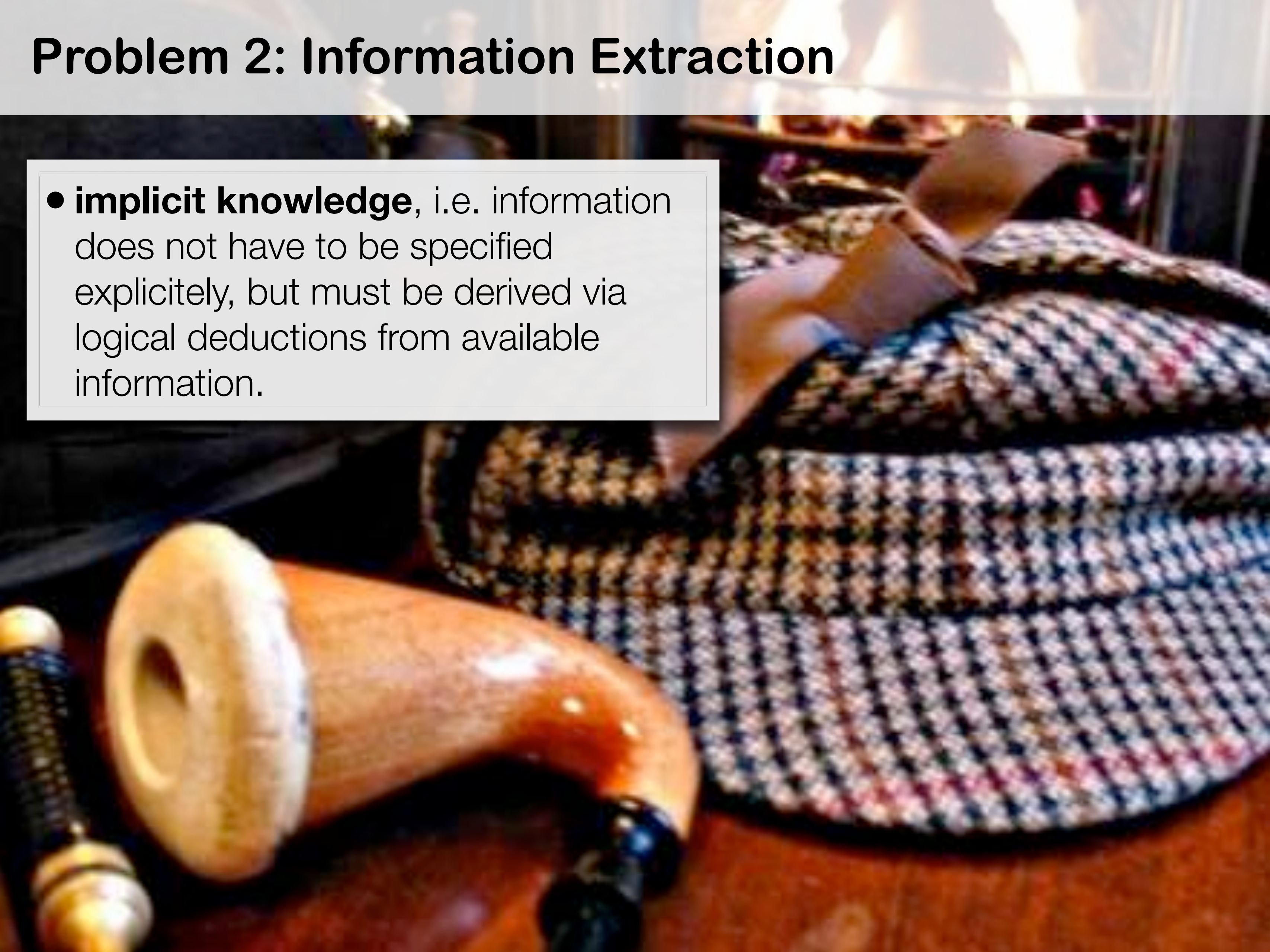
Problem 2: Information Extraction

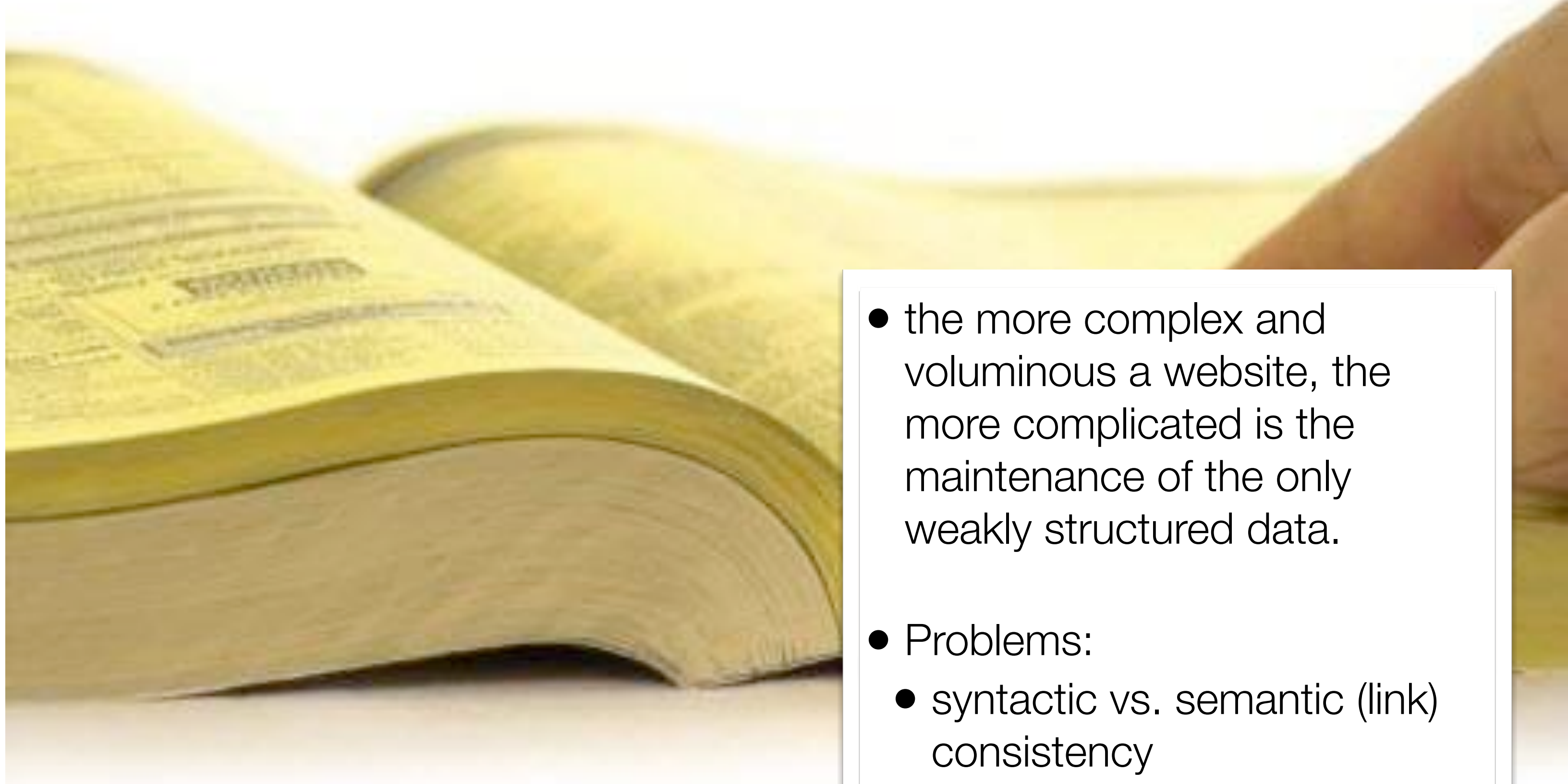
Information Extraction

- can only be solved ,*correctly*‘ by a human agent
- heterogeneous distribution and order of information
- a software agent does not have
 - sufficient knowledge of contexts
 - sufficient world knowledge and
 - sufficient experience to solve the problem

Problem 2: Information Extraction

- **implicit knowledge**, i.e. information does not have to be specified explicitly, but must be derived via logical deductions from available information.





- the more complex and voluminous a website, the more complicated is the maintenance of the only weakly structured data.
- Problems:
 - syntactic vs. semantic (link) consistency
 - correctness
 - timeliness

Problem 3: Maintenance

- Adaption of the presented information content to personal requirements
- Problems:
 - from where do we get the required (personal) information?
 - personalization vs. data security



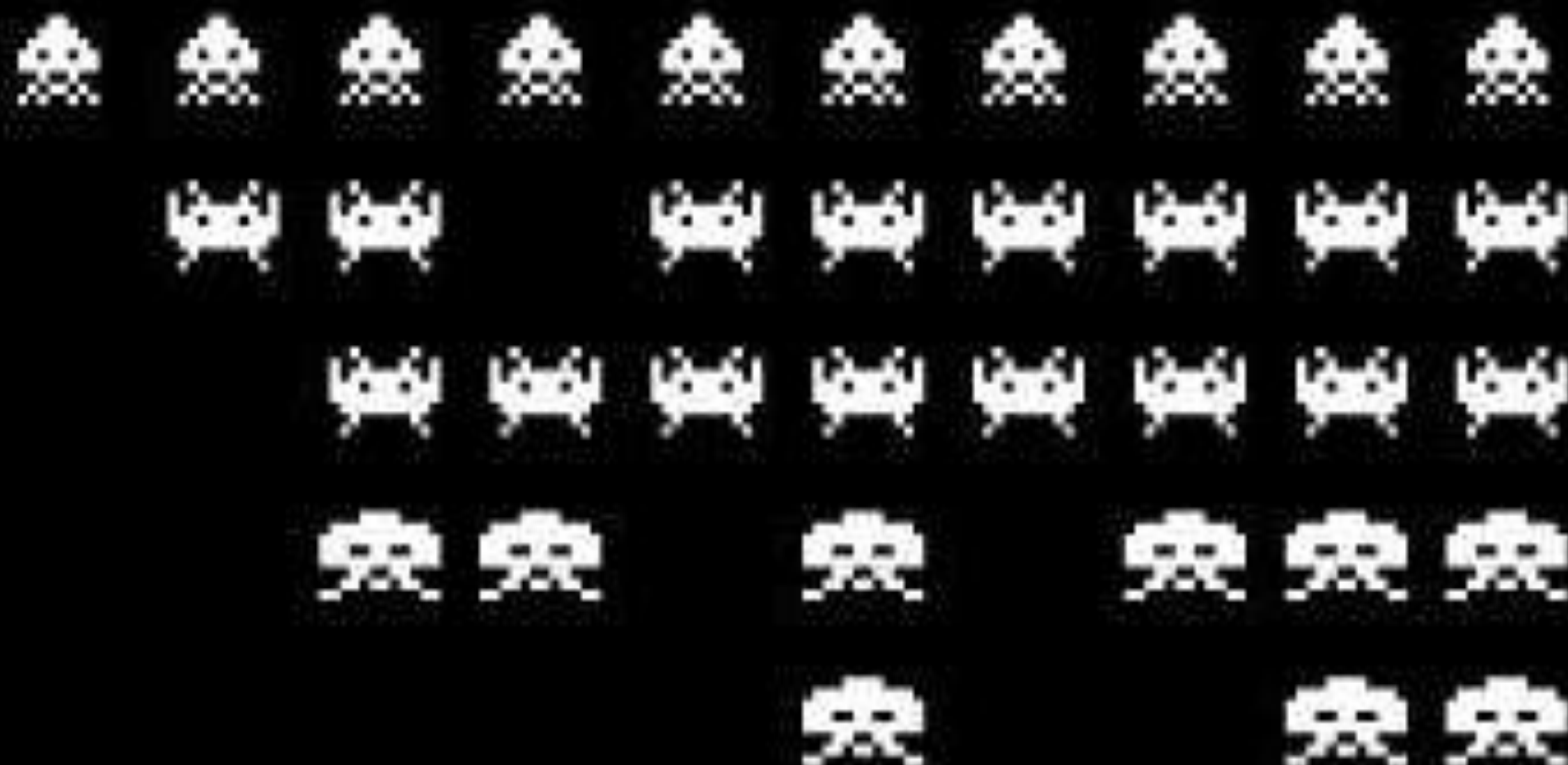
Problem 4: Personalization

SCORE 7040

LIVES



GAME OVER



e of cake...)

Next section

15

subset of the stack

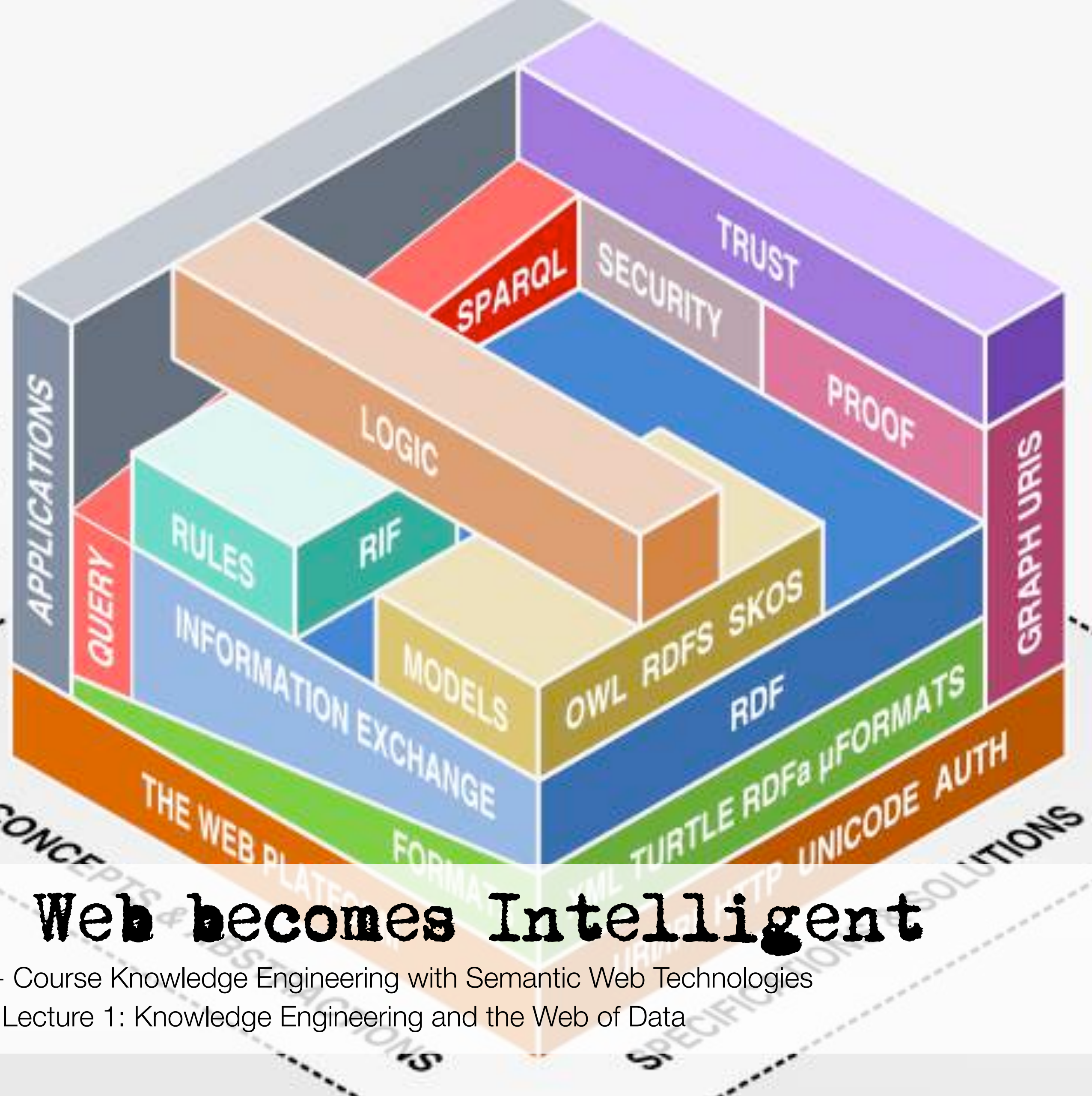
grained data access

ion exchange is key

y, but not too important

based on the Web

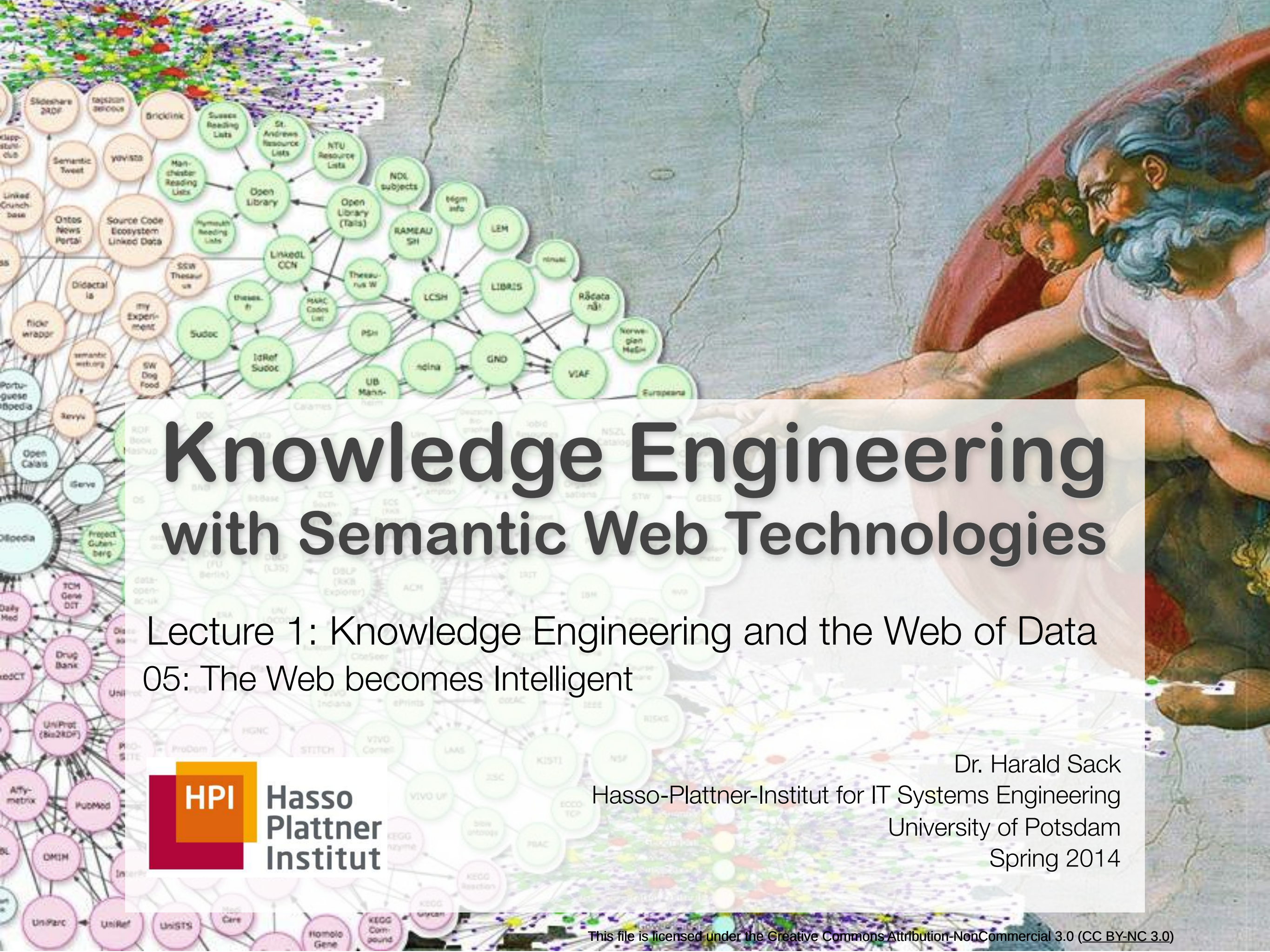
hall
ies



05: The Web becomes Intelligent

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data



Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data
05: The Web becomes Intelligent

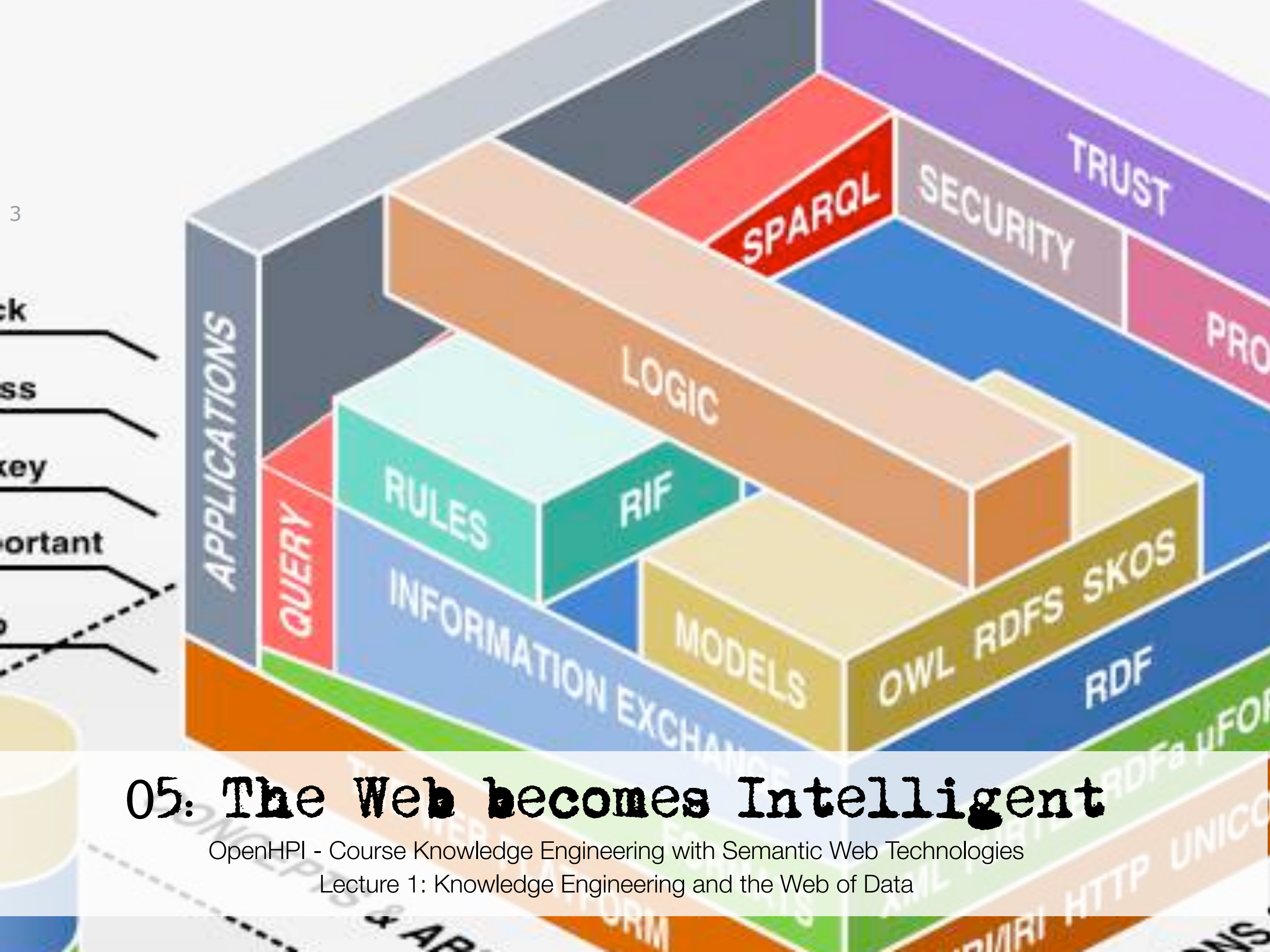


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Lecture 1: Knowledge Engineering and the Web of Data

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies



05: The Web becomes Intelligent

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data

From the World Wide Web to the Web of Data



- The **Web of Data** is an upgrade of the Web of Documents
- The Web as a huge decentralised database (knowledge base) of
- machine-accessible data

„The web of human-readable document is being merged with a web of machine understandable data. The potential of the mixture of humans and machines working together and communication through the web could be immense.“

Tim Berners-Lee, The World Wide Web: A very short personal history, May 1998

From the World Wide Web to the Web of Data



„The Web was designed as an information space, with the goal that it should be useful not only for human-human communication, but also that machines would be able to participate and help... “

Tim Berners-Lee, Semantic Web Roadmap, Sept 1998

From the World Wide Web to the Web of Data

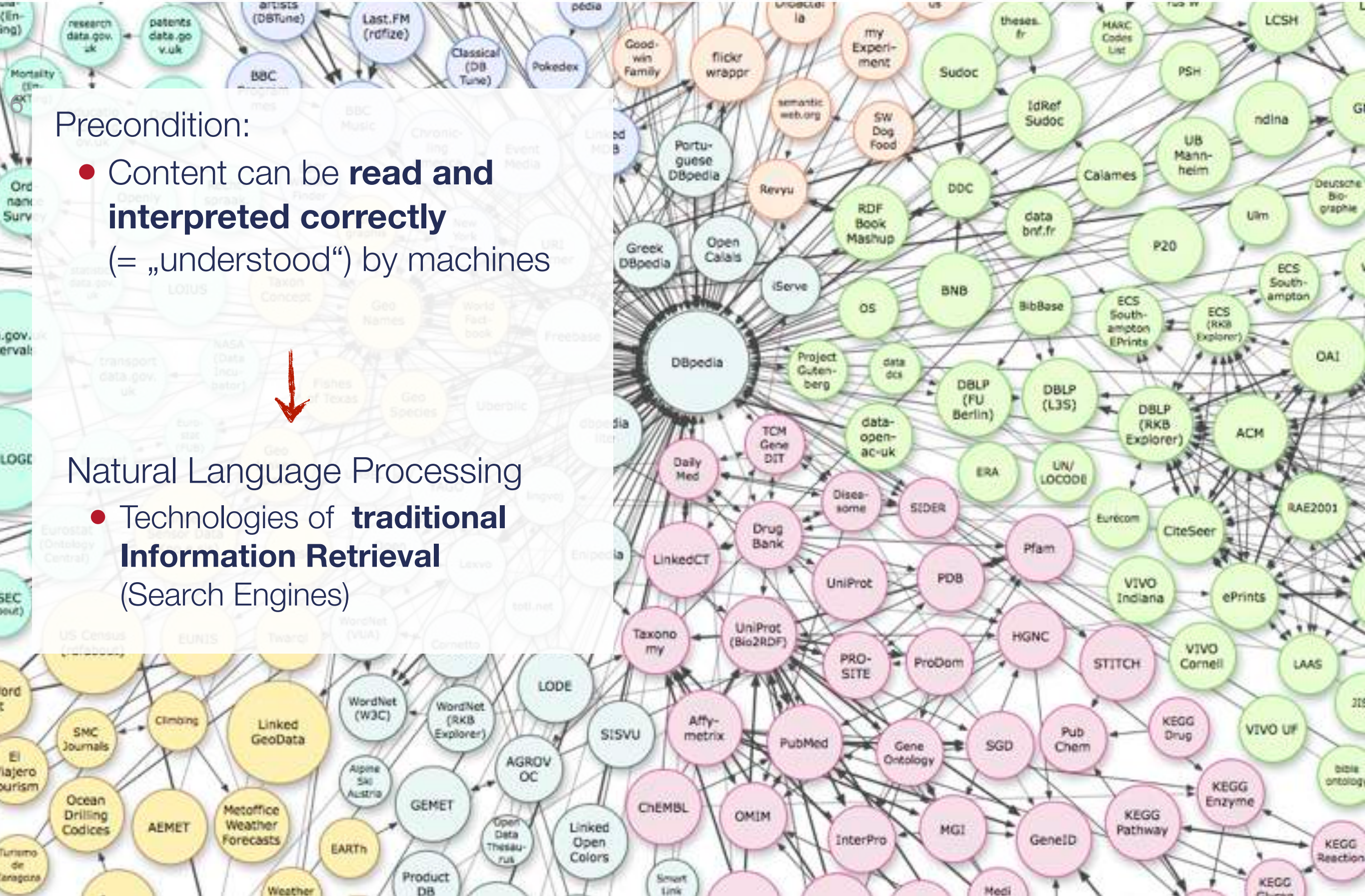
Precondition:

- Content can be **read and interpreted correctly** (= „understood“) by machines



Natural Language Processing

- Technologies of **traditional Information Retrieval** (Search Engines)



From the World Wide Web to the Web of Data

Precondition:

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Natural Language Processing

- Technologies of **traditional Information Retrieval** (Search Engines)

Semantic Web

- Natural language web content will be **explicitly annotated with semantic metadata**
- Semantic metadata encode the **Meaning (Semantics)** of the content and can be read and interpreted correctly by machines

P A R E N T A L

A D V I S O R Y

E X P L I C I T S E M A N T I C S

“Understanding” Content on the Web



**HEISENBERG
CAN WAIT.**

**SUNDAY NIGHT FOOTBALL
#SNF**

“Understanding” Content on the Web



Text: „**Heisenberg** can wait?“

Entity Mapping
Disambiguation



“Understanding” Content on the Web



Text: „**Heisenberg** can wait?“

Entity Mapping
Disambiguation

Benjamin Heisenberg ?

a film director

“Understanding” Content on the Web



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Benjamin Heisenberg ?

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Jochen Heisenberg ?

a physicist

“Understanding” Content on the Web



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Walter White

lead character of
Breaking Bad

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lead character of
Breaking Bad

- **Disambiguation**

solution of linguistic ambiguities

“Understanding“ Content on the Web



Text: „**Heisenberg** can wait?“



Walter White

Entity

- The **Meaning (Semantics)** of entities and classes must be defined explicitly.

“Understanding” Content on the Web



Text: „**Heisenberg** can wait?“



Walter White

Entity



is a

Fictional Character

Class

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“Understanding” Content on the Web



Text: „**Heisenberg** can wait?“



Walter White

Entity



is a

Fictional Character

Class



is subclass of

Person

Class

- The **Meaning (Semantics)** of entities and classes must be defined explicitly.

“Understanding” Content on the Web

- The Meaning (Semantics) is expressed with the help of well suited knowledge representations (**Ontologies**)



Walter White

(entity)



is a

Fictional Character

(class)

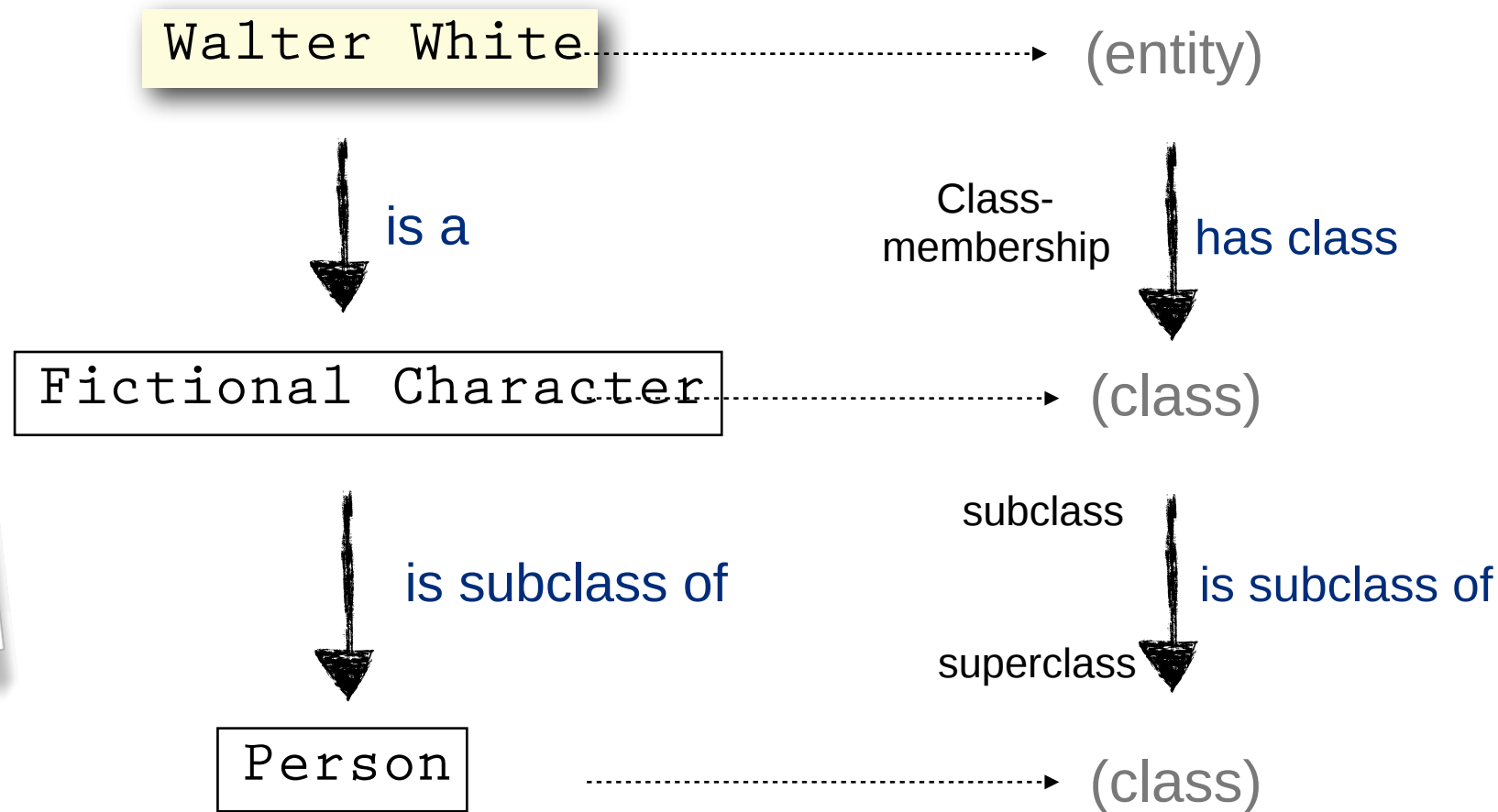
Class-
membership



has class

“Understanding” Content on the Web

- The Meaning (Semantics) is expressed with the help of well suited knowledge representations (**Ontologies**)



- The Meaning (Semantics) is expressed with the help of well suited knowledge representations (**Ontologies**)

Walter White

is a

Fictional Character
from New Mexico

Fictional Schoolteacher

Fictional Scientist

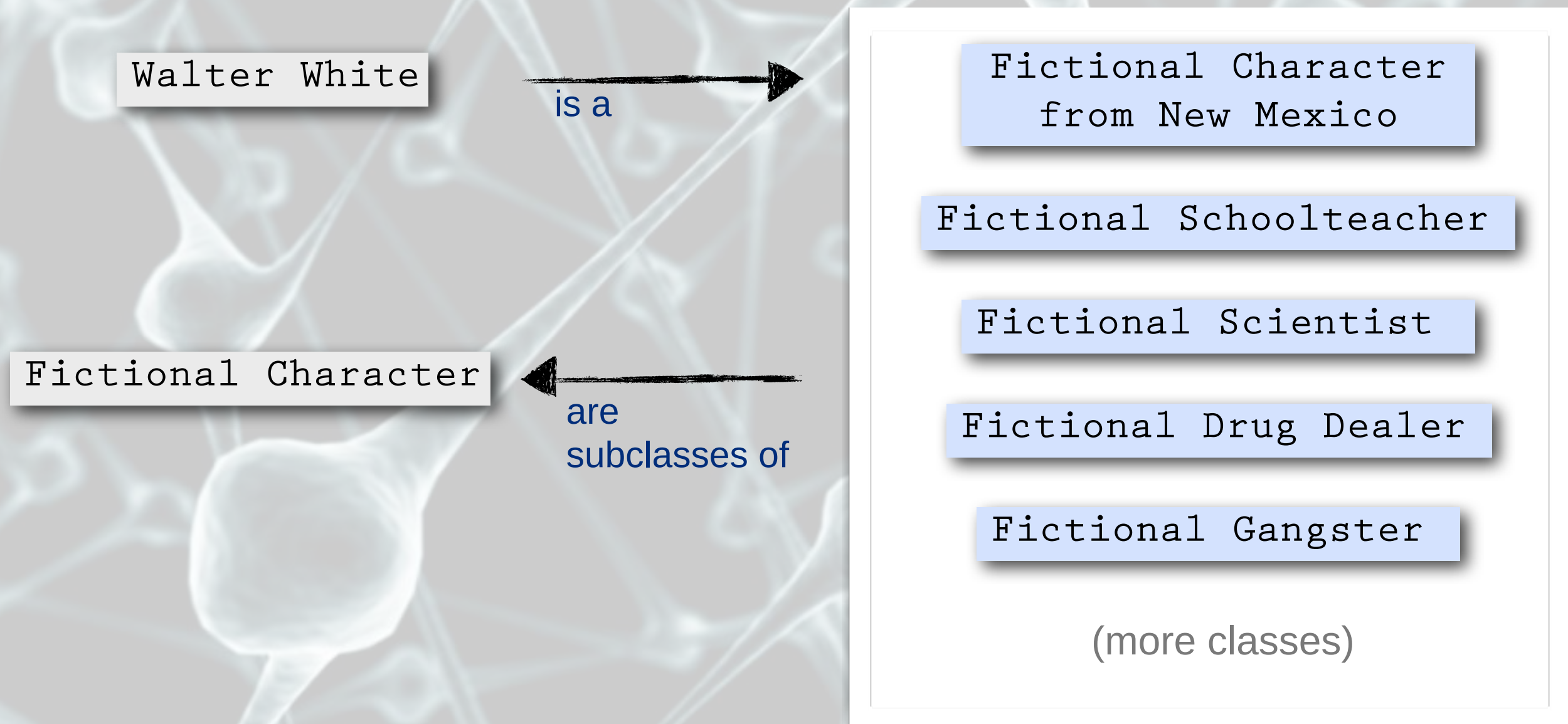
Fictional Drug Dealer

Fictional Gangster

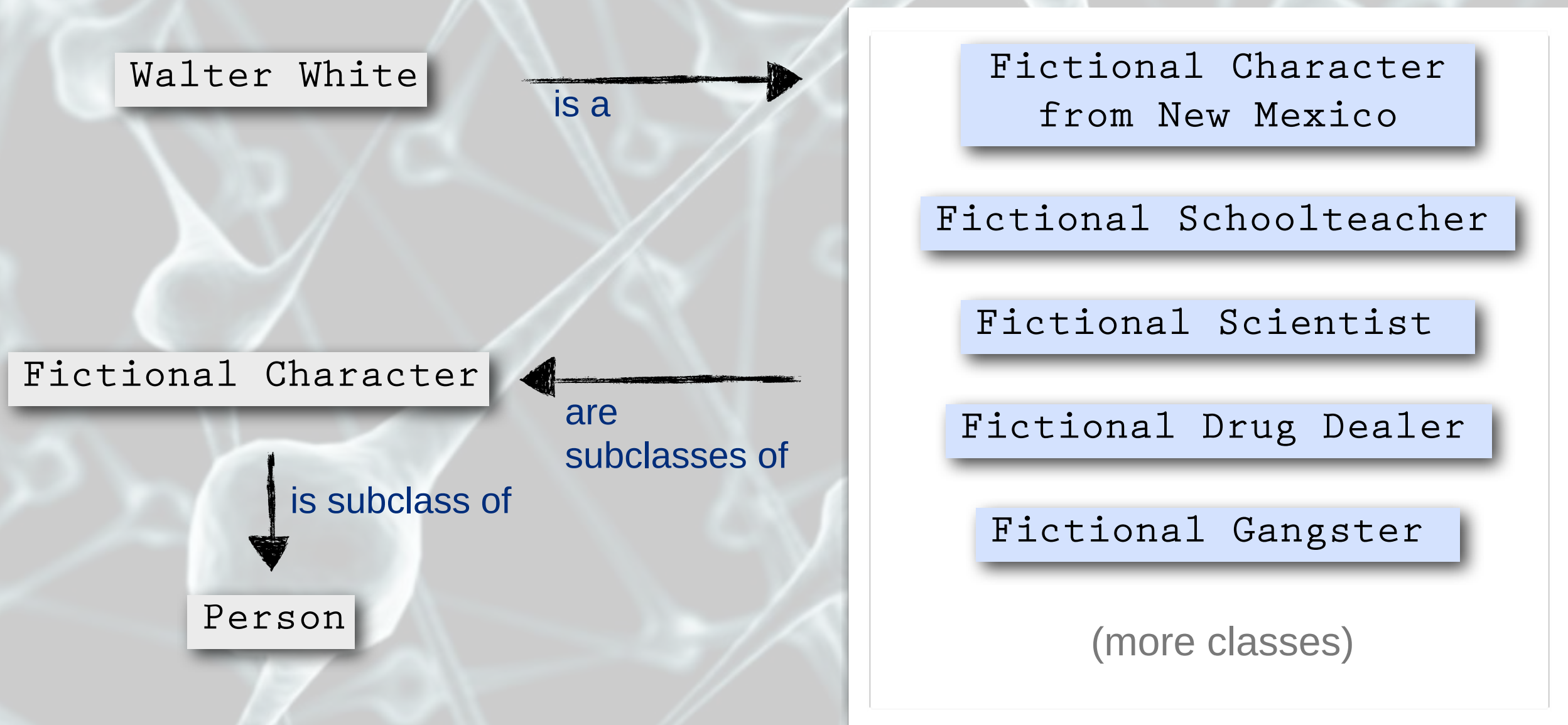
(more classes)

“Understanding” Content on the Web

- The Meaning (Semantics) is expressed with the help of well suited knowledge representations (**Ontologies**)

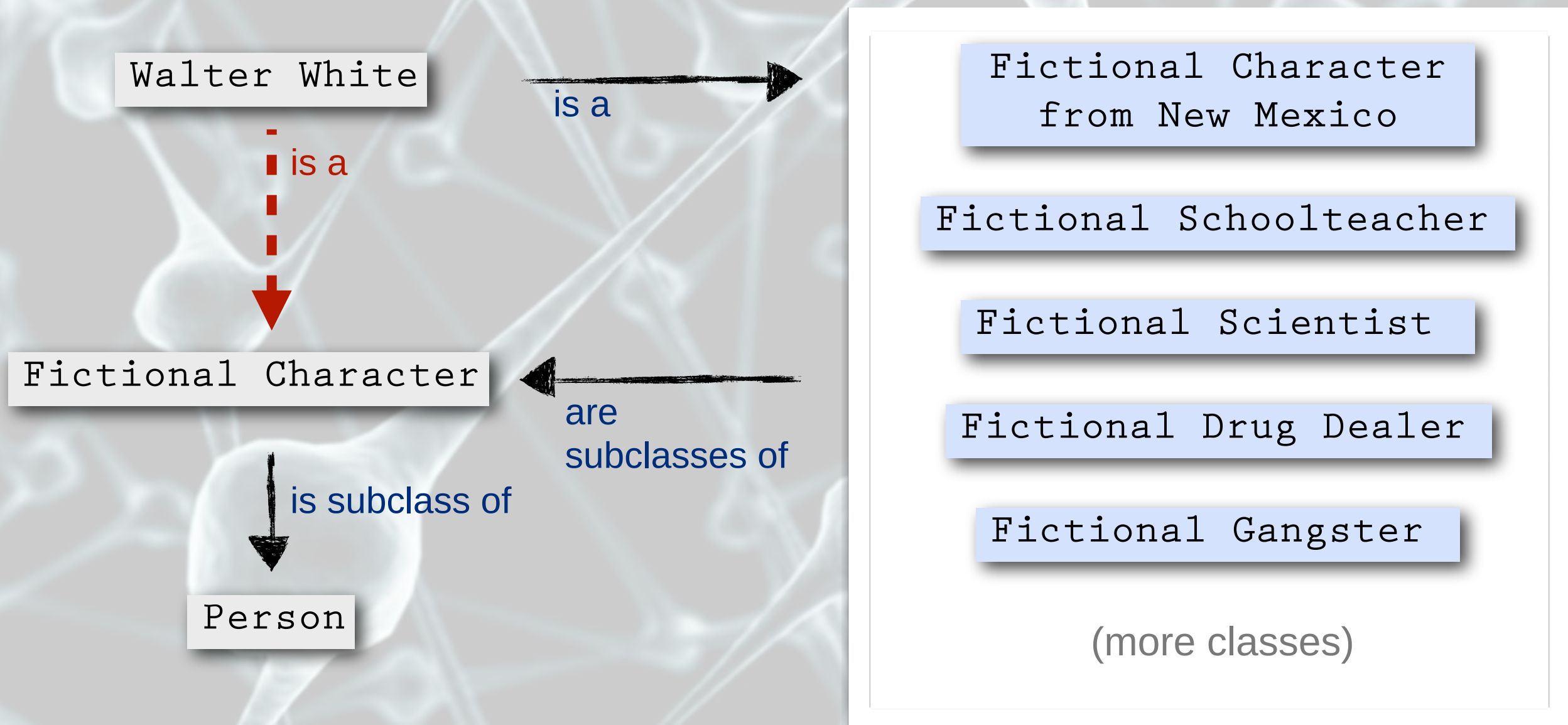


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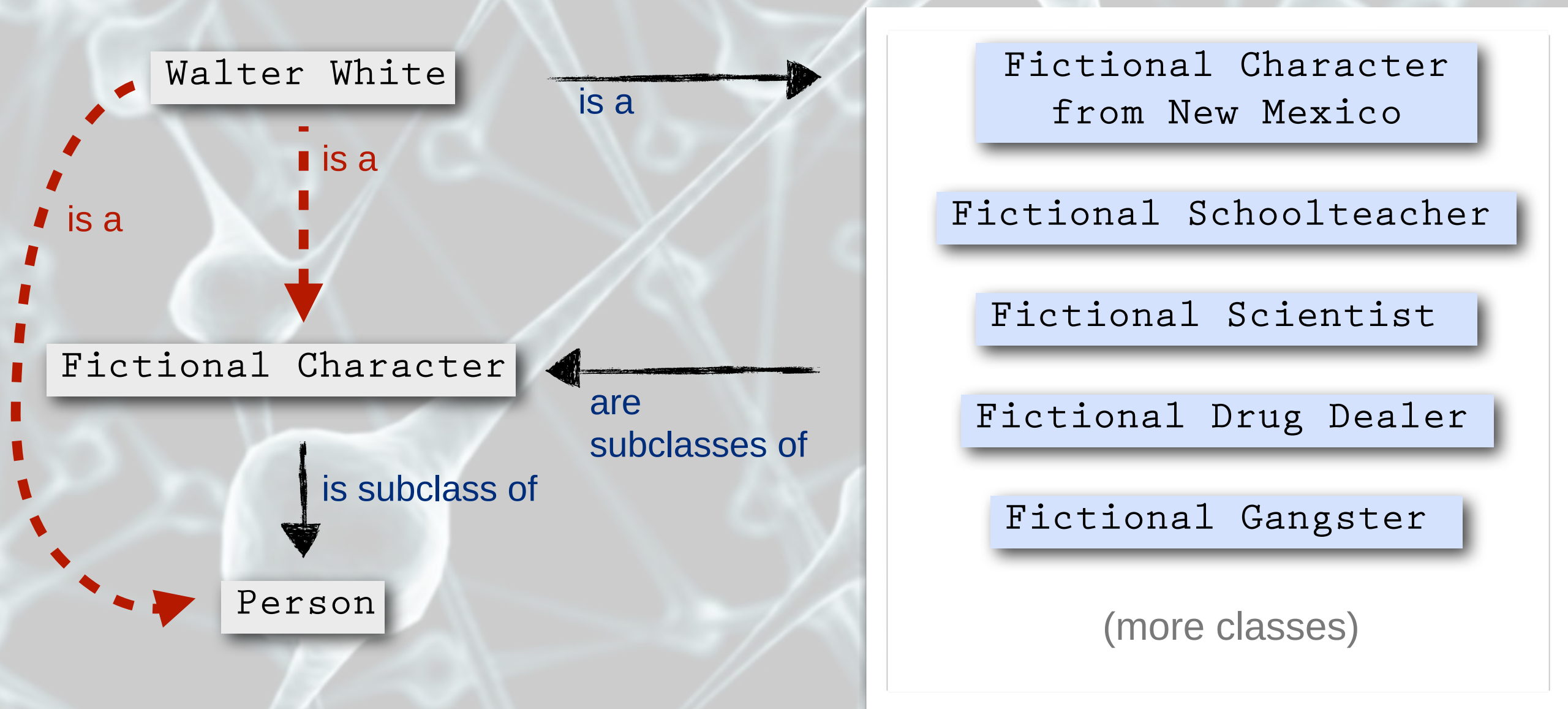
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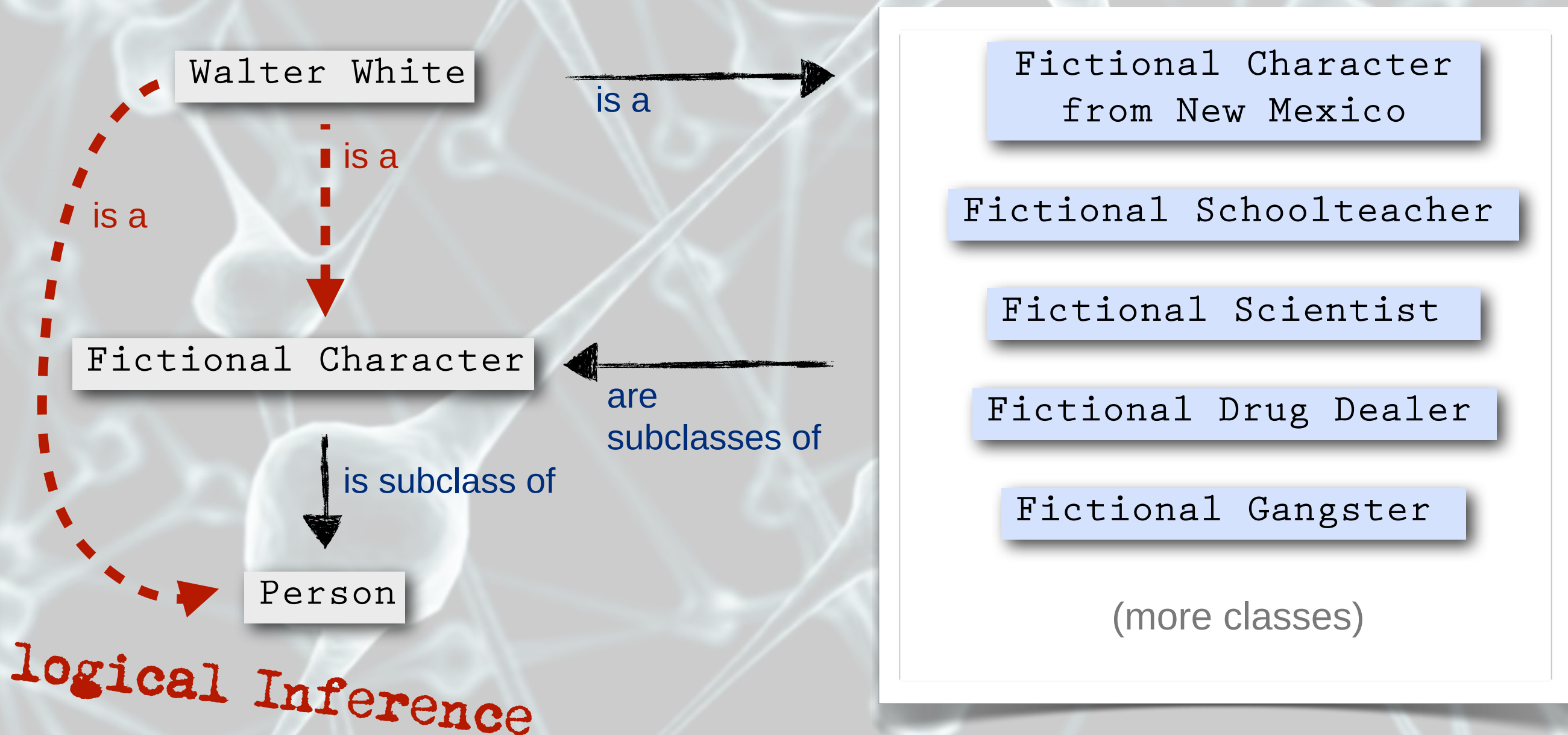
“Understanding” Content on the Web

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“Understanding” Content on the Web

- The Meaning (Semantics) is expressed with the help of well suited knowledge representations (**Ontologies**)



“Understanding” Content on the Web

- The Meaning (Semantics) is expressed with the help of well suited knowledge representations (**Ontologies**)

Walter White

is a

Person



birthPlace



Location

Person



birthDate



Date/Time

Person



mother



Person

Person



father



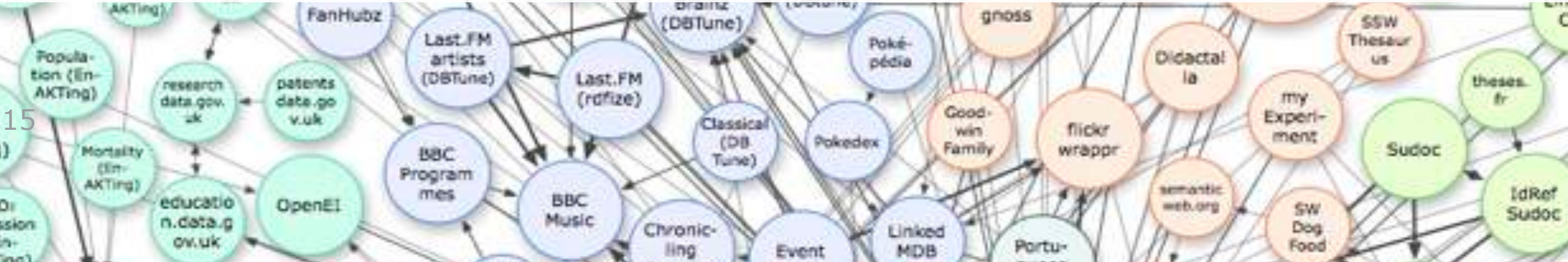
Person

(classes)

(properties)

(classes)

What is the Semantic Web?



„The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation"'

Tim Berners-Lee, James Hendler, Ora Lassila: *The Semantic Web*, Scientific American, 284(5), pp. 34-43(2001)



The Semantic Web - a Web of Data

- The Meaning of Information (Semantics) is made explicit by **formal (structured) and standardized knowledge representations (Ontologies)**.
- Thus it will be possible,
 - to process the meaning of information automatically
 - to relate and integrate heterogeneous data
 - to deduce implicate (not evident) information from existing (evident) information in an automated way

The Semantic Web is kind of a **global database** that contains a **universal network of semantic propositions**.

Semantic Web

...towards an „intelligent“ Web

17

The Semantic Web Technology Stack (not a piece of cake...)

Most apps use only a subset of the stack

Querying allows fine-grained data access

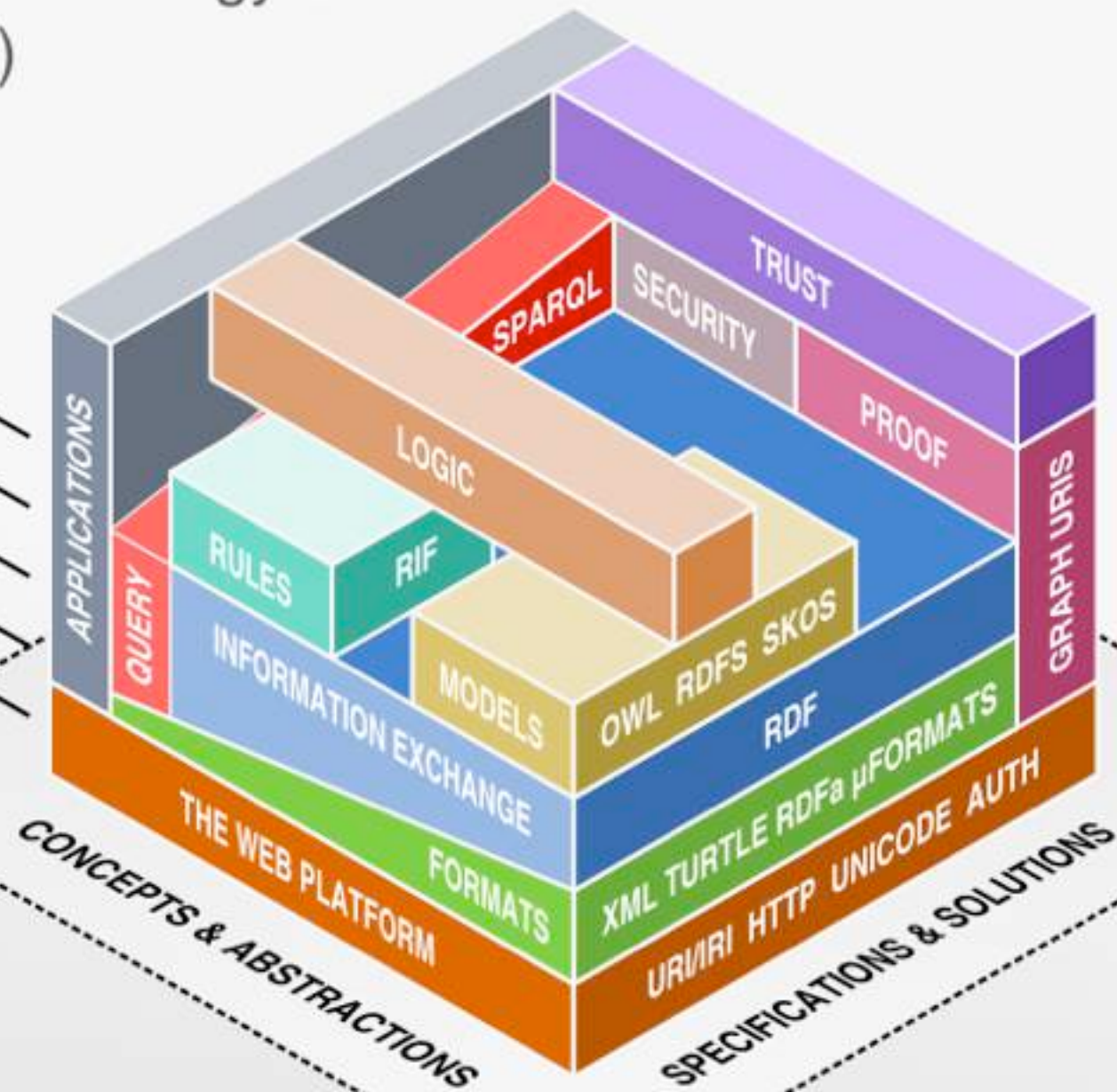
Standardized information exchange is key

Formats are necessary, but not too important

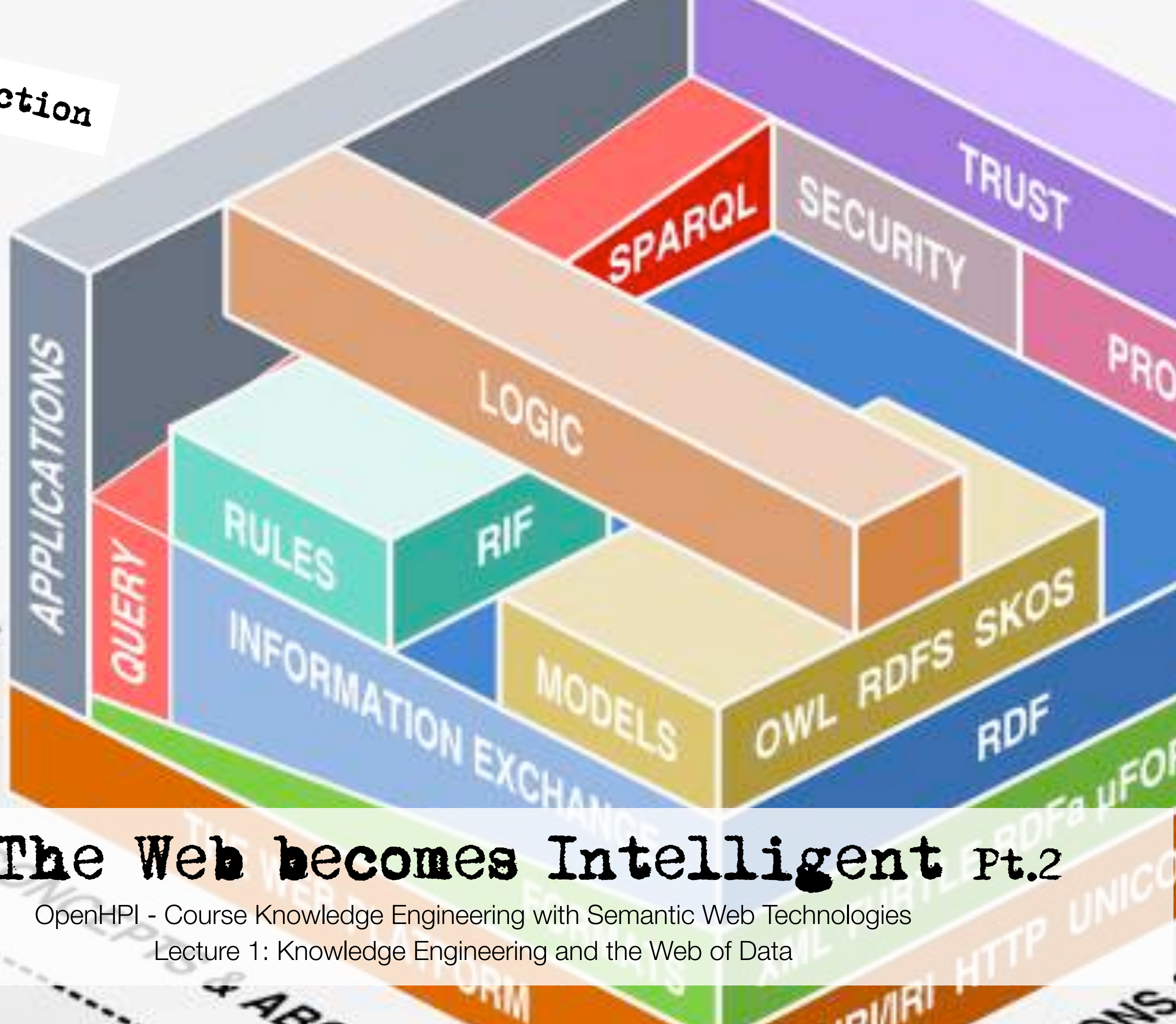
The Semantic Web is based on the Web

Linked Data uses a small
selection of technologies

LINKED DATA



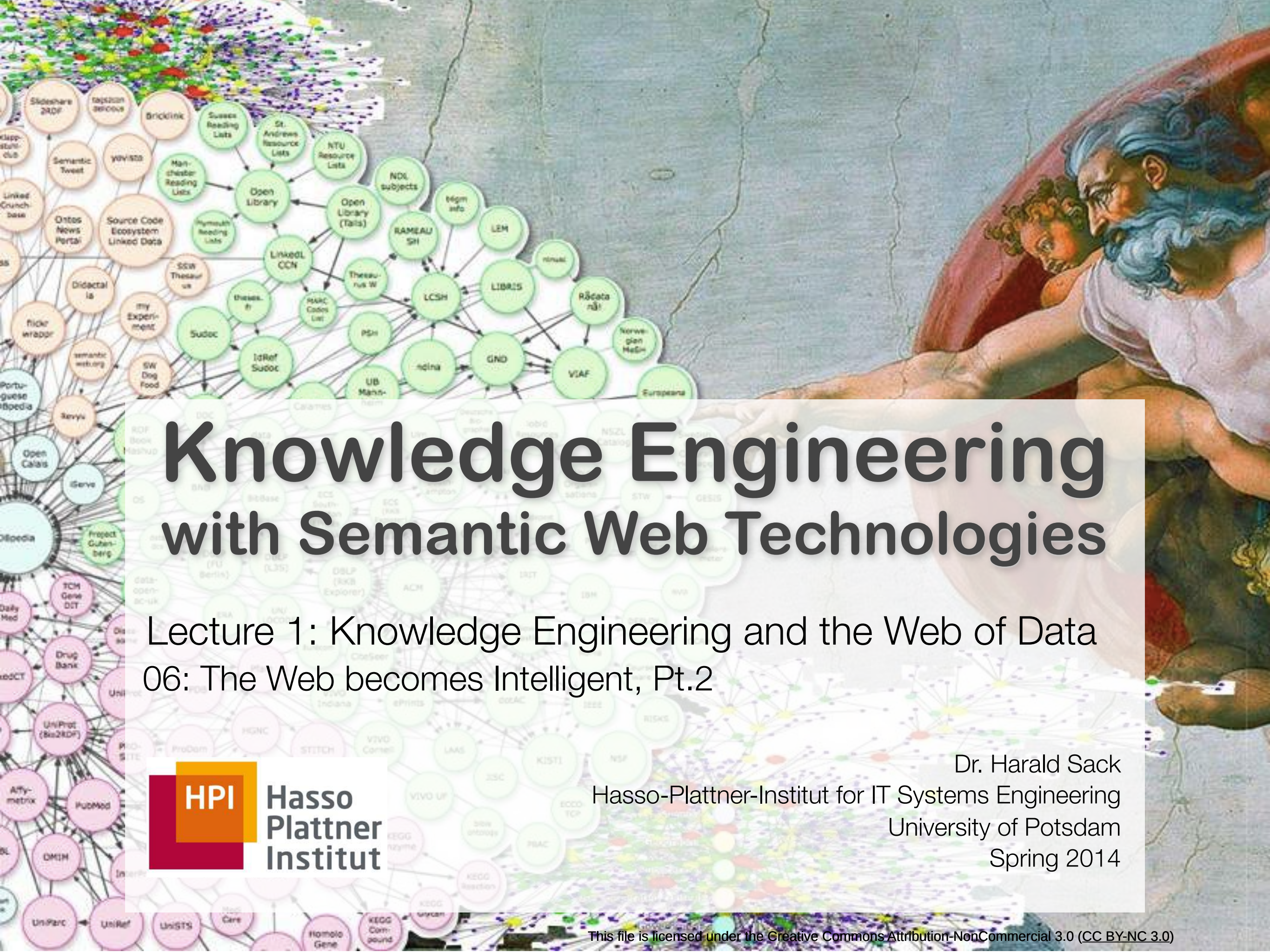
Next section



06: The Web becomes Intelligent Pt.2

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data



Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data
06: The Web becomes Intelligent, Pt.2

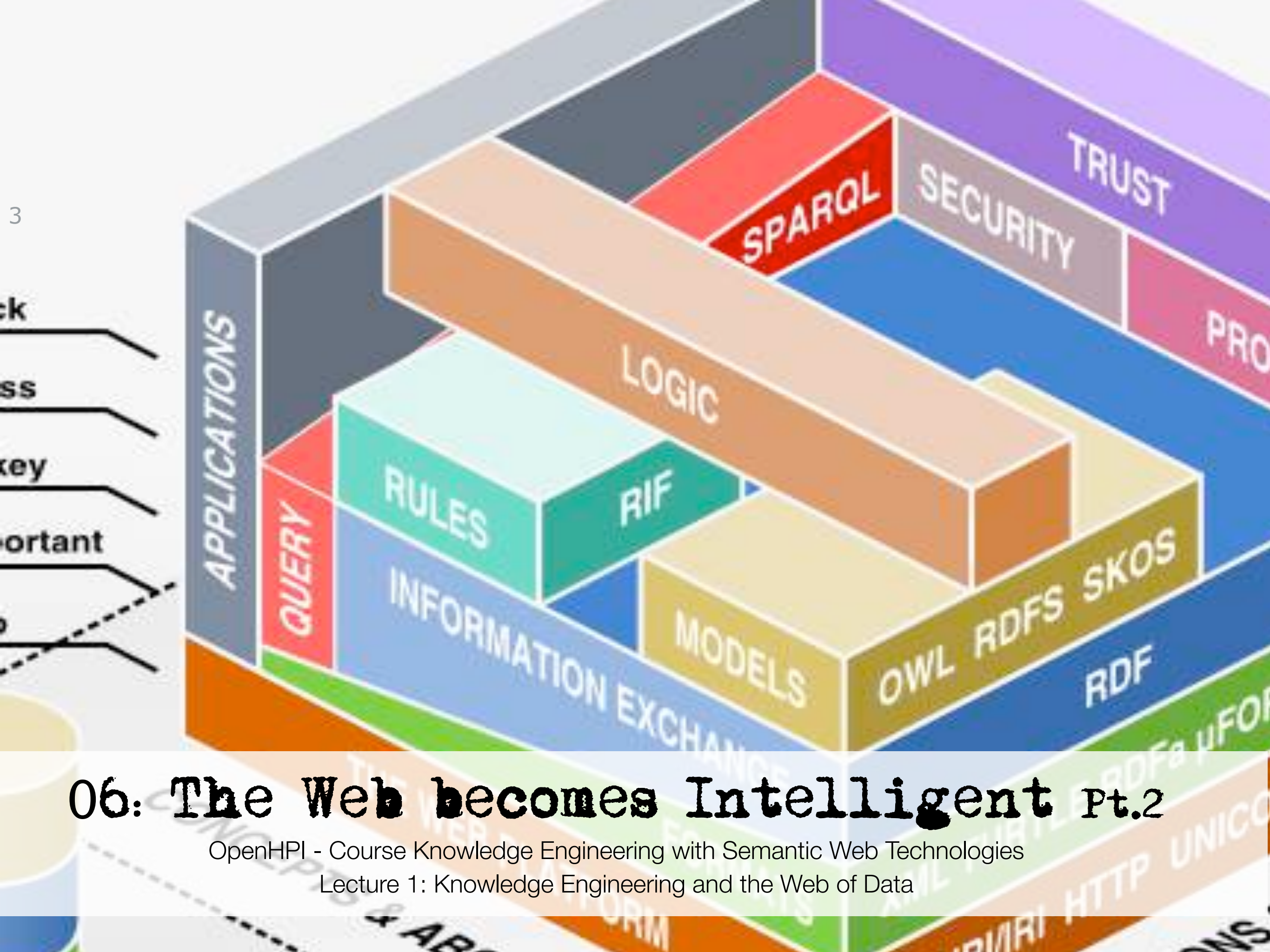


Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 1: Knowledge Engineering and the Web of Data

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies



06: The Web becomes Intelligent Pt.2

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data

Semantic Web

...towards an „intelligent“ Web

The Semantic Web Technology Stack (not a piece of cake...)

Most apps use only a subset of the stack

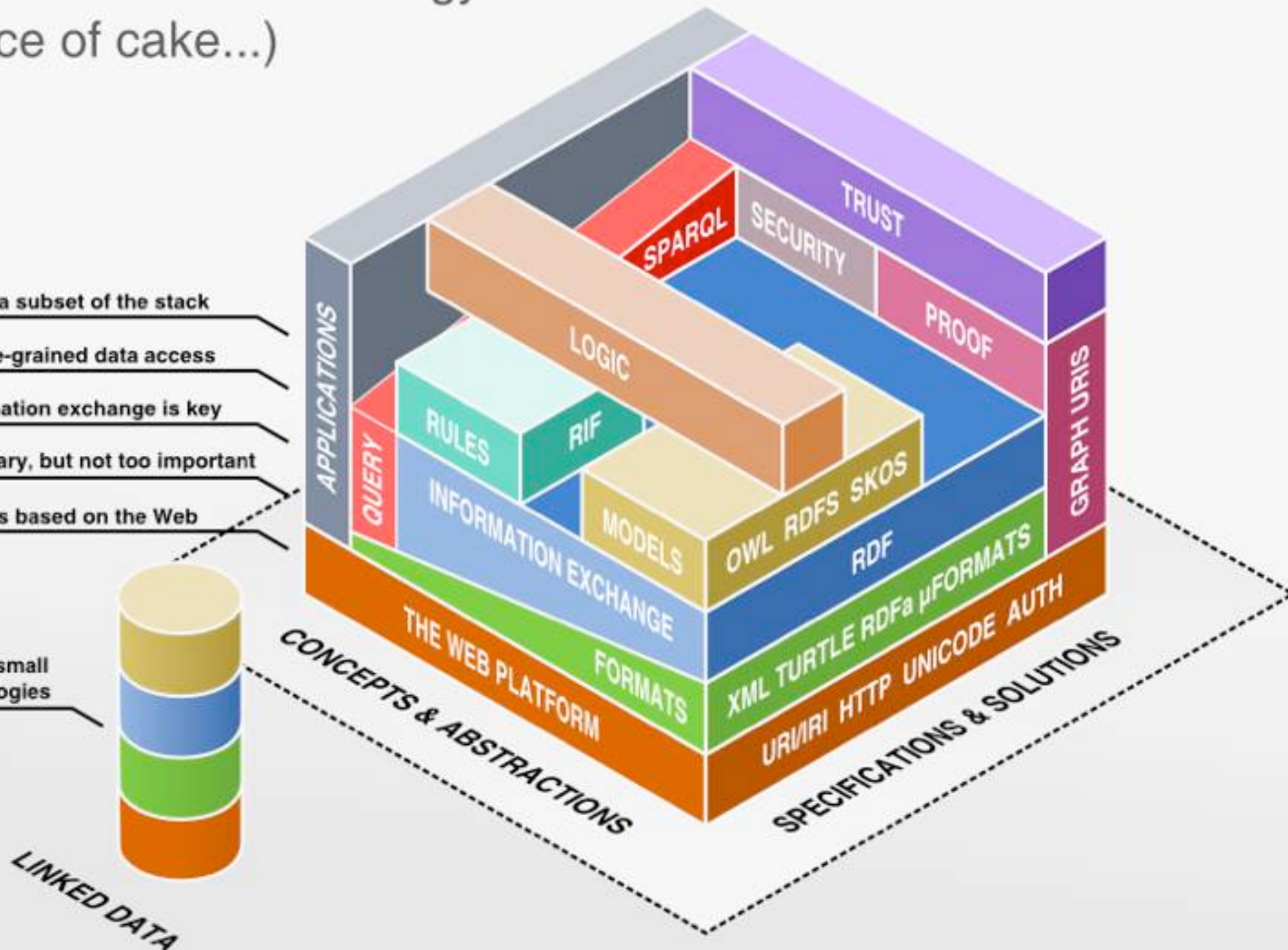
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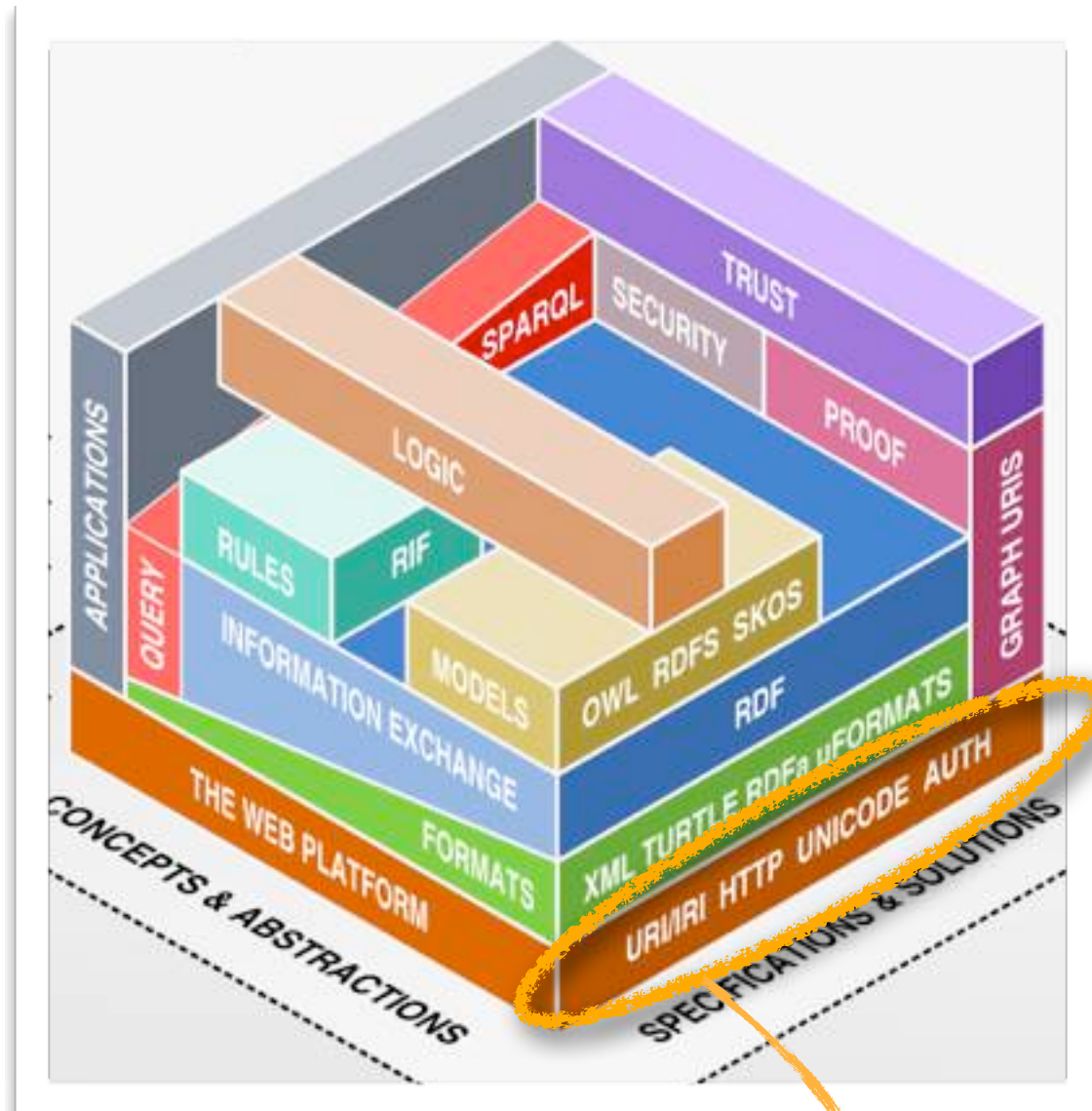
The Semantic Web is based on the Web

Linked Data uses a small selection of technologies



Semantic Web

...towards an „intelligent“ Web



URI - Uniform Resource Identifier

Walter White

[http://dbpedia.org/resource/Walter_White_\(Breaking_Bad\)](http://dbpedia.org/resource/Walter_White_(Breaking_Bad))

Semantic Web

...towards an „intelligent“ Web

http://en.wikipedia.org/wiki/Walter_White_(Breaking_Bad)



The screenshot shows the Wikipedia article for Walter White (Breaking Bad). The article is written in English and is part of the Breaking Bad character series. It provides a detailed biography of the character, including his background, personality, and the events of the series. The article is structured with a table of contents, a main body of text, and a sidebar with additional information.

Walter White (*Breaking Bad*)

From Wikipedia, the free encyclopedia

Walter Hartwell "Walt" White Sr. (also known by his clandestine alias, **Heisenberg**) is a fictional character in the American television drama series *Breaking Bad* on AMC. He was portrayed by Bryan Cranston and was created by series creator Vince Gilligan. Once a promising chemist who was one of the founding members of the multi-billion dollar company Gray Matter Technologies, Walter left the company for personal reasons and became an unhappy and disillusioned high school chemistry teacher. After being diagnosed with Stage IIIA lung cancer, he resorts to manufacturing methamphetamine to ensure his family's financial security when he dies. As the series progresses, Walter gradually becomes darker and takes on a more villainous role.

Although AMC officials hesitated to cast Cranston due to his previous comedic role on *Malcolm in the Middle*, Gilligan cast him based on the actor's past performance in the *X-Files* episode "Drive". Cranston has contributed much of his character, including Walter's *back story*, physical appearance, and personality traits. Gilligan had described his goal with Walter White as turning Mr. Chips into Scarface, and has deliberately made the character less and less sympathetic.

Both the Walter White character and Bryan Cranston's performance have received critical acclaim. Cranston won three consecutive *Primetime Emmy Awards* for Outstanding Lead Actor in a Drama Series, becoming the second actor to do so since *Bill Cosby* for *I Spy* in the 1950s.^{[1][2]}

In the Spanish-language remake *Metastasis*, his character is renamed Walter Blanco and is portrayed by Diego Trujillo.^[3]

Contents [hide]

- 1 Character biography
 - 1.1 Background and personality
 - 1.2 Season one
 - 1.3 Season two
 - 1.4 Season three
 - 1.5 Season four
 - 1.6 Season five
 - 1.6.1 Season 5a
 - 1.6.2 Season 5b
- 2 Development
- 3 Reception
 - 3.1 Reviews
 - 3.2 Awards
- 4 Obituary
- 5 References
- 6 Further reading
- 7 External links

Character biography [edit]

Background and personality [edit]

Walter White was a talented chemist who graduated with a Ph.D. in chemistry from the California Institute of Technology. He, along with colleague Vivek "Vodka" Kumar, contributed to research on proton radiography that helped a team win a Nobel Prize in Chemistry.^{[4][5]} After graduate school, Walter founded the firm Gray Matter Technologies with Elliott Schwartz, his former classmate and close friend.^[6] Around this time, Walter dated his lab assistant, Gretchen. However, he eventually left both Gretchen and Gray Matter Technologies, selling his fractional interest in the company to

Walter White
Breaking Bad character



Walter White

First appearance "Pilot"

Last appearance "Feluda"

Created by Vince Gilligan

Portrayed by Bryan Cranston

Information

Aliases Heisenberg
Mr. Lambert

Occupation Meth manufacturer
Drug kingpin
Chemist at Sandia National Laboratories
Co-founder of Gray Matter Technologies
High school chemistry teacher
Car wash cashier, proprietor, and manager

Semantic Web

...towards an „intelligent“ Web

http://en.wikipedia.org/wiki/Walter_White_(Breaking_Bad)

Wikipedia article for Walter White (Breaking Bad). The article includes a table of contents, a character biography, and a background and personality section. A red box highlights the infobox on the right, which contains a photo of Walter White and a table of information.

Walter White (Breaking Bad)

From Wikipedia, the free encyclopedia

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Walter White
Breaking Bad character

Photo of Walter White.

First appearance	"Pilot"
Last appearance	"Felina"
Created by	Vince Gilligan
Portrayed by	Bryan Cranston

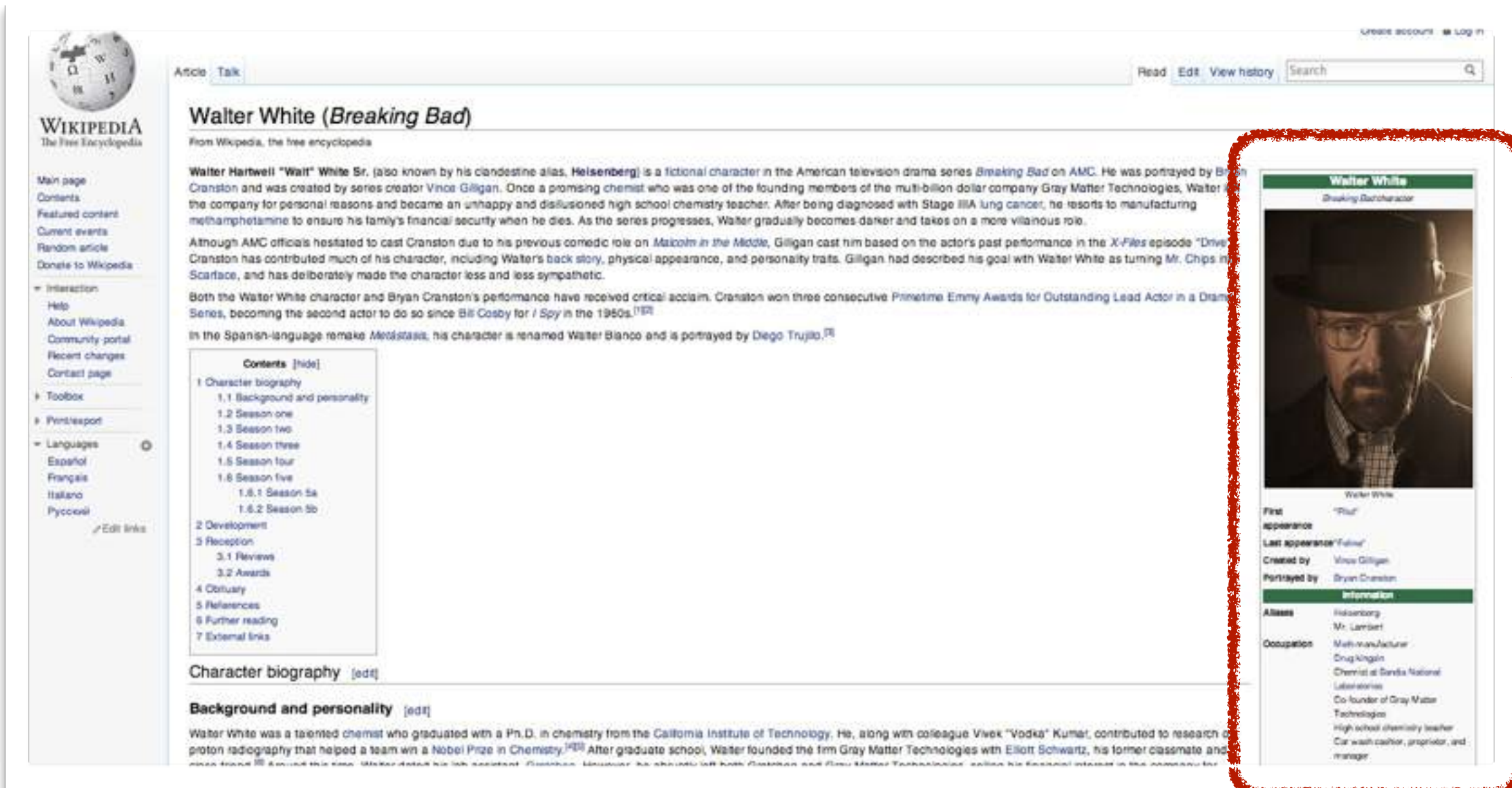
Information

Aliases	Helsenberg Mr. Lambert
Occupation	Meth manufacturer Drug kingpin Chemist at Sandia National Laboratories Co-founder of Gray Matter Technologies High school chemistry teacher Car wash cashier, proprietor, and manager

Semantic Web

...towards an „intelligent“ Web

6 [http://en.wikipedia.org/wiki/Walter_White_\(Breaking_Bad\)](http://en.wikipedia.org/wiki/Walter_White_(Breaking_Bad))



Walter White (*Breaking Bad*)

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Walter White
Breaking Bad character



Walter White

First appearance	"Pilot"
Last appearance	"Felina"
Created by	Vince Gilligan
Portrayed by	Bryan Cranston

Information

Aliases	Helsenberg Mr. Lambert
Occupation	Meth manufacturer Drug kingpin Chemist at Sandia National Laboratories Co-founder of Gray Matter Technologies High school chemistry teacher Car wash cashier, proprietor, and manager

[http://dbpedia.org/resource/Walter_White_\(Breaking_Bad\)](http://dbpedia.org/resource/Walter_White_(Breaking_Bad))

Semantic Web

...towards an „intelligent“ Web

7 [http://dbpedia.org/resource/Walter_White_\(Breaking_Bad\)](http://dbpedia.org/resource/Walter_White_(Breaking_Bad))

About: Walter White (Breaking Bad)
An Entity of Type : [fictional character](#), from Named Graph : <http://dbpedia.org>, within Data Space : [dbpedia.org](#)

Walter Hartwell "Walt" White (also known by his clandestine alias, Heisenberg) is a fictional character and the protagonist of the American television drama series Breaking Bad on AMC. He is portrayed by Bryan Cranston and was created by series creator Vince Gilligan.

Property	Value
dbpedia-owl:abstract	- Walter Hartwell White è il protagonista della serie televisiva Breaking Bad - Reazioni collaterali, interpretato da Bryan Cranston e doppiato da Stefano De Sando. - Walter Hartwell "Walt" White (also known by his clandestine alias, Heisenberg) is a fictional character and the protagonist of the American television drama series Breaking Bad on AMC. He is portrayed by Bryan Cranston and was created by series creator Vince Gilligan. Once a promising chemist who was one of the founding members of the fictional, now multi-billion dollar company "Gray Matter Technologies", Walter left the company for personal reasons and became an unhappy and disillusioned high school chemistry teacher. After being diagnosed with inoperable lung cancer, he resorts to manufacturing methamphetamine to ensure his family's financial security when he dies. As the series progresses, Walter gradually becomes darker and takes on a more villainous role. Although AMC officials hesitated to cast Cranston due to his previous comedic role on Malcolm in the Middle, Gilligan cast him based on the actor's past performance in an episode of The X-Files. Cranston has contributed to much of his character, including Walter's back story, physical appearance and personality traits. Gilligan had described his goal with Walter White as turning Mr. Chips into Scarface, and has deliberately made the character less and less sympathetic. Both the Walter White character and Bryan Cranston's performance have received critical acclaim. Cranston won three consecutive Primetime Emmy Awards for Outstanding Lead Actor in a Drama Series, becoming the second actor ever to do so and the first since Bill Cosby for I Spy in the 1960s. - Walter Hartwell = Walt = White est le personnage de fiction principal de la série Breaking Bad créé par Vince Gilligan. Il est interprété par Bryan Cranston et doublé en version française par Jean-Louis Faure. L'acteur Bryan Cranston fut récompensé à plusieurs reprises : dans la catégorie Meilleur acteur dans une série dramatique pour les Satellite Awards ; Meilleur acteur principal dans une série dramatique pour les Emmy Awards 2008, 2009 et 2010.
dbpedia-owl:alias	- Heisenberg - Mr. Lambert
dbpedia-owl:child	dbpedia:List_of_Breaking_Bad_characters
dbpedia-owl:creator	dbpedia:Vince_Gilligan
dbpedia-owl:firstAppearance	dbpedia:Pilot_(Breaking_Bad)
dbpedia-owl:occupation	dbpedia:Methamphetamine dbpedia:Sandia_National_Laboratories
dbpedia-owl:portrayer	dbpedia:Bryan_Cranston
dbpedia-owl:relative	dbpedia:Hank_Schrader dbpedia:List_of_Breaking_Bad_characters
dbpedia-owl:series	dbpedia:Breaking_Bad
dbpedia-owl:thumbnail	http://upload.wikimedia.org/wikipedia/commons/thumb/6/65/Walter_White2.jpg/200px-Walter_White2.jpg
dbpedia-owl:wikiPageExternalLink	http://www.amctv.com/shows/breaking-bad/cast/walter-white
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dbpedia-owl:wikiPageRevisionID	548300209 (xsd:integer)
dbpprop:affiliations	dbpedia:Jesse_Pinkman - Saul Goodman - Gustavo Fring



Semantic Web

...towards an „intelligent“ Web



[http://dbpedia.org/resource/Walter_White_\(Breaking_Bad\)](http://dbpedia.org/resource/Walter_White_(Breaking_Bad))

```
:Walter_White_(Breaking_Bad) rdf:type :FictionalCharacter .  
:Walter_White_(Breaking_Bad) dbpp:portrayer :Bryan_Cranston .  
:Bryan_Cranston dbpp:birthDate "1956-03-07" .  
:Bryan_Cranston rdf:type dbpo:Actor .  
:Bryan_Cranston rdf:type dbpo:Person .  
...
```



RDF Resource Description Framework



RDF Tripel

:Brian_Cranston



RDF Subject

rdf:type



RDF Property

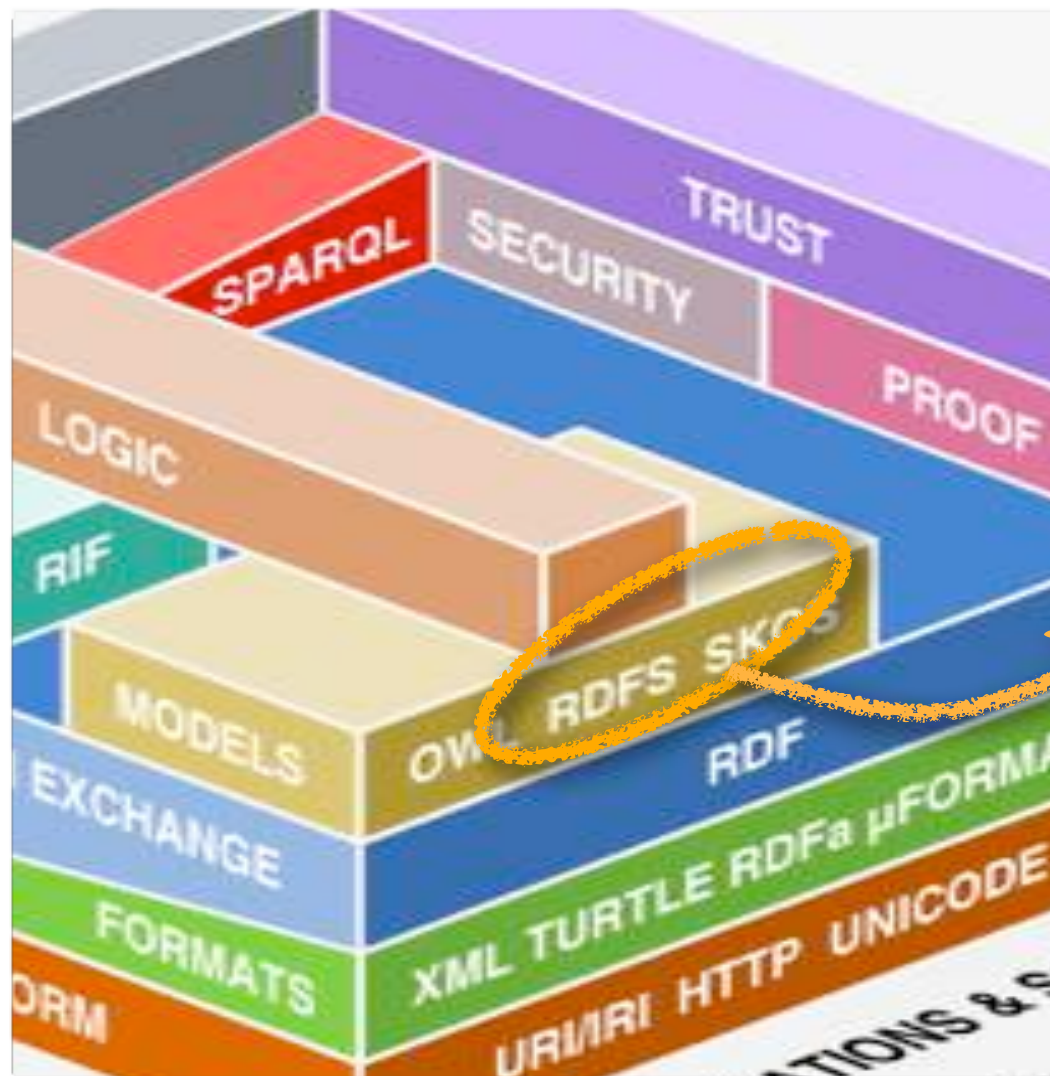
dbpo:Actor .



RDF Object

Semantic Web

...towards an „intelligent“ Web

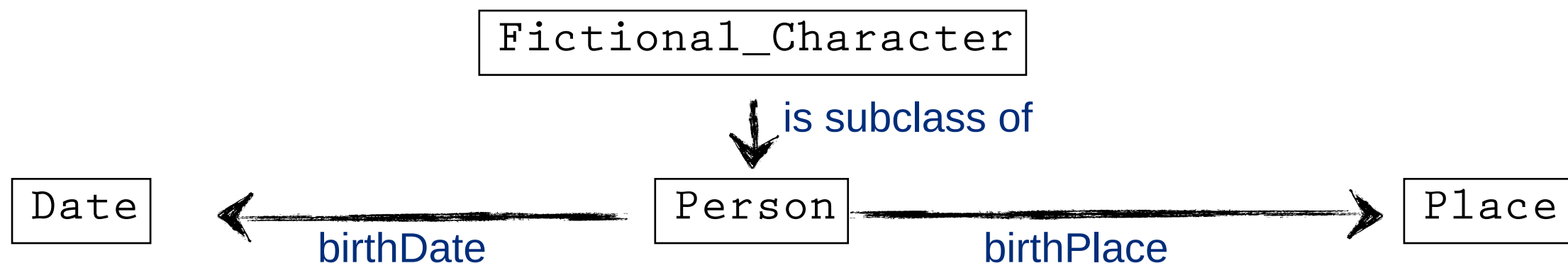


<http://dbpedia.org/ontology/FictionalCharacter>

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dbpo:FictionalCharacter rdf:type owl:class .
dbpo:FictionalCharacter rdfs:subClassOf dbpo:Person .
dbpo:FictionalCharacter rdfs:label "Fictional Character" .
dbpp:birthPlace rdf:type rdf:Property .
dbpp:birthPlace rdfs:domain dbpo:Person .
dbpp:birthPlace rdfs:range dbpo:Place .
dbpp:birthDate rdf:type rdf:Property .
dbpp:birthDate rdfs:domain :Person .
dbpp:birthDate rdfs:range xsd:date .
...
```

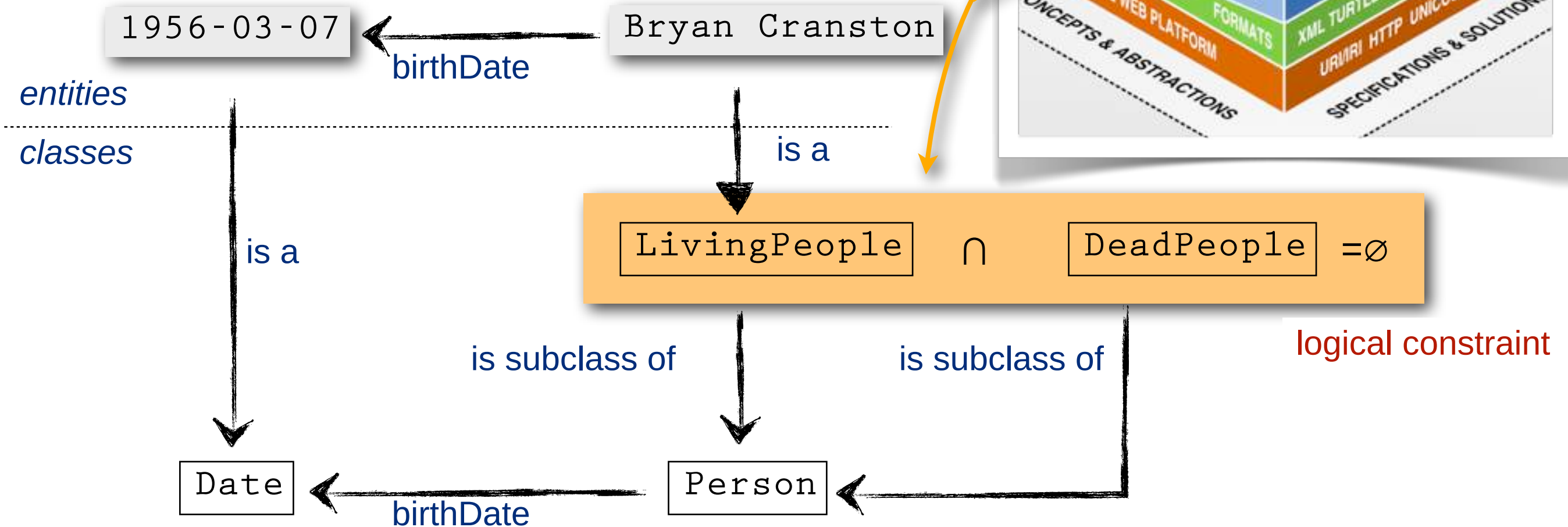
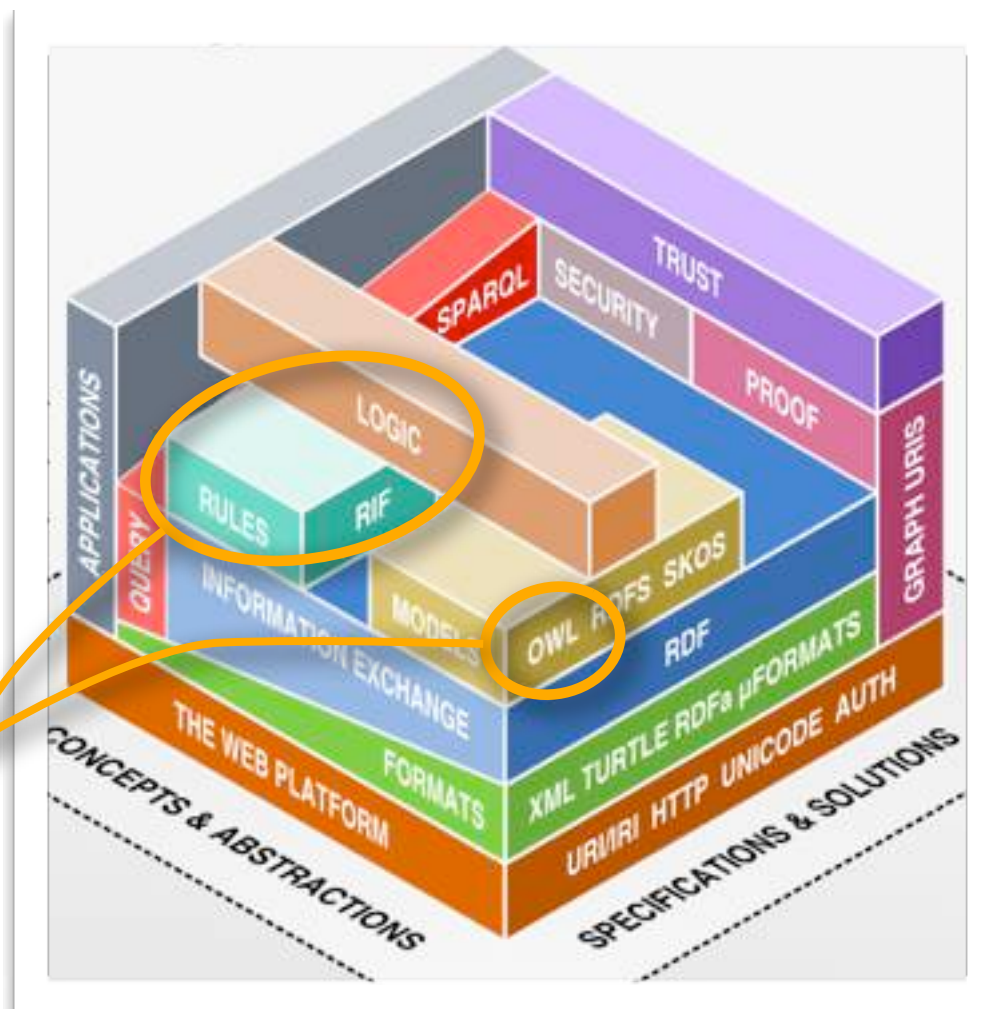


RDF Schema



Semantic Web

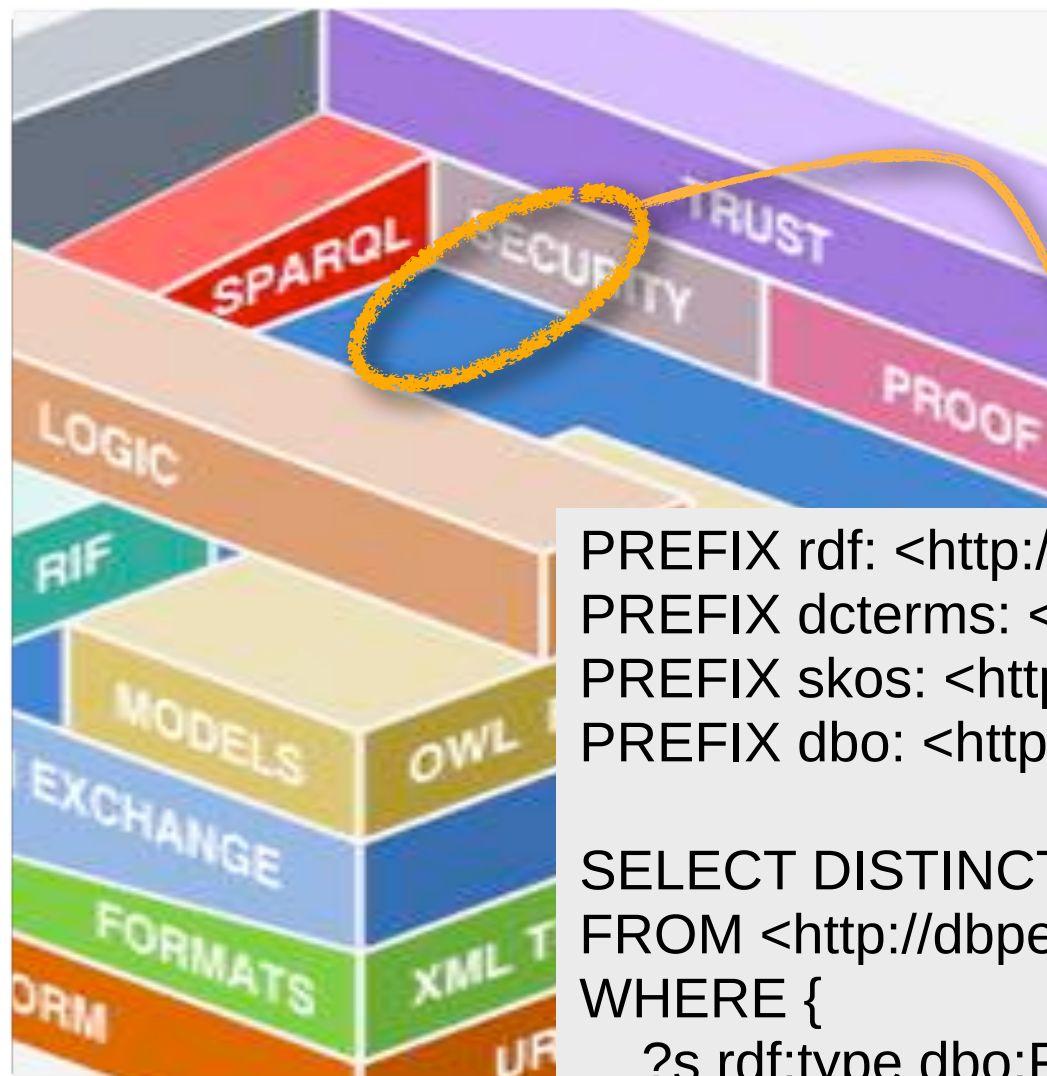
...towards an „intelligent“ Web



$\forall x.\exists y.\text{hasDeathDate}(x,y) \wedge \text{Person}(x) \wedge \text{Date}(y) \rightarrow \text{DeadPeople}(x)$ + Rules
(Description Logics)

Semantic Web

...towards an „intelligent“ Web



*Look for all Fictional
Characters whose portrayer
have won an Oscar .*

PREFIX rdf: <<http://www.w3.org/1999/02/22-rdf-syntax-ns#>>

PREFIX dcterms: <<http://purl.org/dc/terms/>>

PREFIX skos: <<http://www.w3.org/2004/02/skos/core#>>

PREFIX dbo: <<http://dbpedia.org/ontology/>>

SELECT DISTINCT ?s ?p

FROM <<http://dbpedia.org>>

WHERE {

 ?s rdf:type dbo:FictionalCharacter .

 ?s dbo:portrayer ?p .

 ?p rdf:type dbo:Person .

 ?p dcterms:subject/skos:broader*

 <http://dbpedia.org/resource/Category:Academy_Award_winners> .

}

ORDER BY ?p

Semantic Web

...towards an „intelligent“ Web

Look for all Fictional Characters whose portrayer have won an Oscar .



s	p
http://dbpedia.org/resource/Tony_Montana	http://dbpedia.org/resource/Al_Pacino
http://dbpedia.org/resource/Michael_Corleone	http://dbpedia.org/resource/Al_Pacino
http://dbpedia.org/resource/Carlito_Brigante	http://dbpedia.org/resource/Al_Pacino
http://dbpedia.org/resource/Inspector_Clouseau	http://dbpedia.org/resource/Alan_Arkin
http://dbpedia.org/resource/Fagin	http://dbpedia.org/resource/Alec_Guinness
http://dbpedia.org/resource/George_Smiley	http://dbpedia.org/resource/Alec_Guinness
http://dbpedia.org/resource/Maleficent	http://dbpedia.org/resource/Angelina_Jolie
http://dbpedia.org/resource/Sookie_Stackhouse	http://dbpedia.org/resource/Anna_Paquin
http://dbpedia.org/resource/Mia_Thermopolis	http://dbpedia.org/resource/Anne_Hathaway
http://dbpedia.org/resource/White_Queen_(Through_the_Looking-Glass)	http://dbpedia.org/resource/Anne_Hathaway
http://dbpedia.org/resource/Hannibal_Lecter	http://dbpedia.org/resource/Anthony_Hopkins
http://dbpedia.org/resource/Abraham_Van_Helsing	http://dbpedia.org/resource/Anthony_Hopkins
http://dbpedia.org/resource/Stanley_Kowalski	http://dbpedia.org/resource/Anthony_Quinn
http://dbpedia.org/resource/Judith_Traherne	http://dbpedia.org/resource/Barbara_Stanwyck
http://dbpedia.org/resource/List_of_View_Askewniverse_characters	http://dbpedia.org/resource/Ben_Affleck
http://dbpedia.org/resource/Sweeney_Todd	http://dbpedia.org/resource/Ben_Kingsley
http://dbpedia.org/resource/Fagin	http://dbpedia.org/resource/Ben_Kingsley
http://dbpedia.org/resource/Hood_(Thunderbirds)	http://dbpedia.org/resource/Ben_Kingsley
http://dbpedia.org/resource/Jack_Rafferty	http://dbpedia.org/resource/Benicio_del_Toro
http://dbpedia.org/resource/Larry_Talbot	http://dbpedia.org/resource/Benicio_del_Toro
http://dbpedia.org/resource/Baby_Jane_Hudson	http://dbpedia.org/resource/Bette_Davis
http://dbpedia.org/resource/Judith_Traherne	http://dbpedia.org/resource/Bette_Davis
http://dbpedia.org/resource/List_of_past_Casualty_characters	http://dbpedia.org/resource/Brenda_Fricker
http://dbpedia.org/resource/Blanche_DuBois	http://dbpedia.org/resource/Cate_Blanchett
http://dbpedia.org/resource/Scheherazade	http://dbpedia.org/resource/Catherine_Zeta-Jones
http://dbpedia.org/resource/Elena_Montero	http://dbpedia.org/resource/Catherine_Zeta-Jones

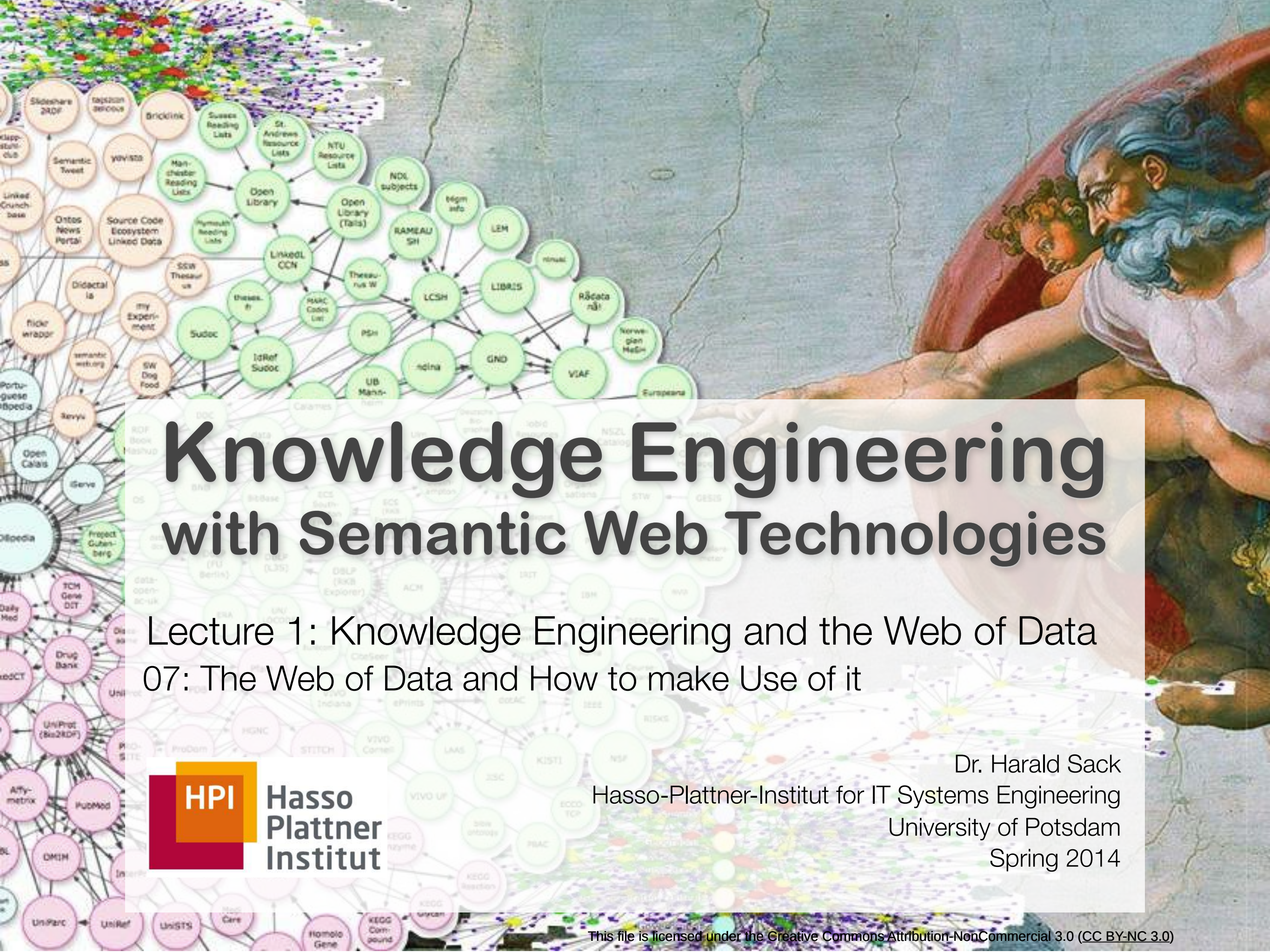
[Link to public DBpedia SPARQL endpoint including query](#)

Next section

13

07: The Web of Data and how to make use of it

OpenHPI - Course Semantic Web Technologies - Lecture 1: The Web of Data



Knowledge Engineering with Semantic Web Technologies

Lecture 1: Knowledge Engineering and the Web of Data
07: The Web of Data and How to make Use of it



Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 1: Knowledge Engineering and the Web of Data

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies

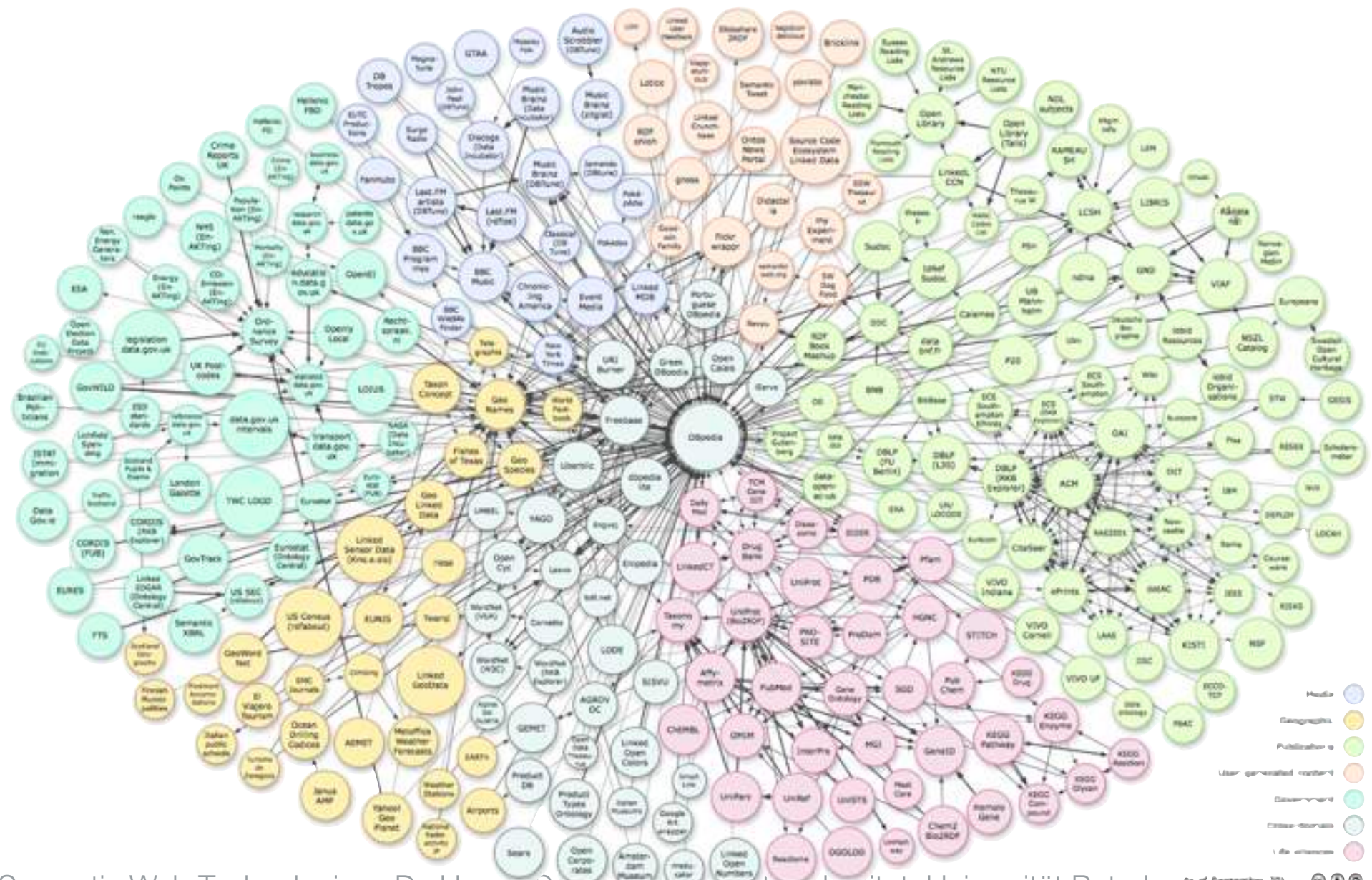
07: The Web of Data and how to make use of it

OpenHPI - Course Semantic Web Technologies - Lecture 1: The Web of Data

The Web of Data and how we make use of it

Linked Data

- Linked Open Data (LOD) denote publicly available (RDF) Data in the Web, identified via URI and accessible via HTTP. Linked data link to other data via URI.



The 'Web of Data'

- >81 billion facts
- >800 million links
(Mar. 2014)

Sack, Hasso-Plattner-Institut, Universität Potsdam

What is so special about the BBC Music Website?

- Information is dynamically aggregated from external, publicly available data (Wikipedia, MusicBrainz, Discogs,...)
- no Screen Scraping
- no specialized API
- all data available as Linked Open Data
- data access via simple HTTP Request

Links & Information

- data is always up-to-date without manual interaction

Wikipedia article on Johann Sebastian Bach

IMDb at imdb.com/name/nm0001925

Last.fm page on [Johann Sebastian Bach](http://www.last.fm/music/Johann+Sebastian+Bach)

Discogs at [discogs.com/artist/Johann Sebastian Bach](http://www.discogs.com/artist/Johann+Sebastian+Bach)

MusicBrainz entry on [Johann Sebastian Bach](http://musicbrainz.org/artist/Johann+Sebastian+Bach)

PERSONAL RELATIONSHIPS

Parent of [Johann Christoph Friedrich Bach](#), [Johann Christian Bach](#), [Wilhelm Friedemann Bach](#) and [Carl Philipp Emanuel Bach](#)

Clips From Latest Album Review



Keyboard Concertos (piano: Alexandre Tharaud)

- 1 Concerto for keyboard and orchestra BWV1054 in D minor - I Allegro
- 2 Concerto for keyboard and orchestra BWV1054 in D minor - II Adagio

Played By

Since December 2008



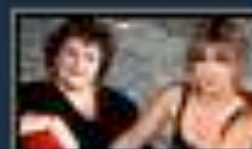
Breakfast
BBC Radio 3



Desert Island Discs
BBC Radio 4



In Tune
BBC Radio 3



The Early Music Show
BBC Radio 3

What about a Search Engine that understands your query...?

Search Engines - Document Retrieval

- Search Engine Query String: **"Jaguar of 2000"**



What about a Search Engine that understands your query...?

Search Engines - Document Retrieval

- Search Engine Query String:

"Jaguar" of 2000



- Refine ,jaguar'
CAR or ANIMAL or OPERATINGSYSTEM etc. ?
Refine: **CAR**

Search Engines - Document Retrieval

- Search Engine Query String: **"Jaguar of 2000"**



- Name: **Jaguar E Type**
- Category: **Car**
 - ...
 - ConstructionYear <Integer>
 - technicalParameter
 - CylinderCapacity <Integer>
 - Power <Integer>
 - ...
 - ...

Knowledge Representation
(Ontologie, Linked Data)

Search Engines - Document Retrieval

- Search Engine Query String: **"Jaguar of 2000"**



- Name: **Jaguar E Type**
- Category: **Car**
 - ...
 - ConstructionYear <Integer>
 - technicalParameter
 - CylinderCapacity <Integer>
 - Power <Integer>
 - ...
 - ...

- Refine ,2000'
ConstructionYear or technicalParameter ?
Refine: **ConstructionYear**

Knowledge Representation
(Ontologie, Linked Data)

Search Engines - Document Retrieval

- General Problems:
 - correct interpretation of query string
 - correct identification of entities
 - automatic disambiguation
 - usability
 - personalization



There is already semantic data out there....

jaguar



WebImagesMapsShoppingMore

Set your locationSort: DefaultView: List

Show only

☐ New items

Price

☐ Up to \$450

☐ \$450 – \$1,000

☐ \$1,000 – \$2,000

☐ Over \$2,000

\$

to

\$

Go

Seller

☐ eBay

☐ Guitar Center

☐ zZounds

☐ Musicians Friend

☐ Sweetwater

More



[2006 JAGUAR XK COUPE in Midnight Black by AUTOart in 1:18 Scale](#)
\$109.51 from Mint Models
Authentic replica with detailed interior. A finished model kit and work of art.



[Gucci new jackie jaguar print shoulder bag Size OS](#)
\$3,090.00 from Gucci.com
Instantly recognizable and unmistakably stylish, the contemporary flair of the New Jackie is fashion at its most vibrant.; animalier jaguar ...



[Tim Wolfe NFL Collection Jacksonville Jaguars Statue](#)
\$107.20 from 10+ stores
Talented wildlife artist and sculptor Tim Wolfe has turned his talents towards your #1 team! Crafted from alabaster stone and resin, this Wild ...
Other team options: [Arizona Cardinals \(\\$107\)](#) [Atlanta Falcons \(\\$107\)](#) [More](#)



[Jaguar Classic Black by Jaguar for Men - 3.4 oz EDT Spray](#)
\$14.95 from 25+ stores
Mens · Eau de Toilette · 3.4 ounce
Released in 2009 by Jaguar, this cologne for men uses an intoxicating blend of scents. Top notes of vetiver, green apple, nutmeg, and mandarin ...
Other style options: [Amber \(\\$15\)](#) [Gold \(\\$18\)](#) [Red \(\\$15\)](#)

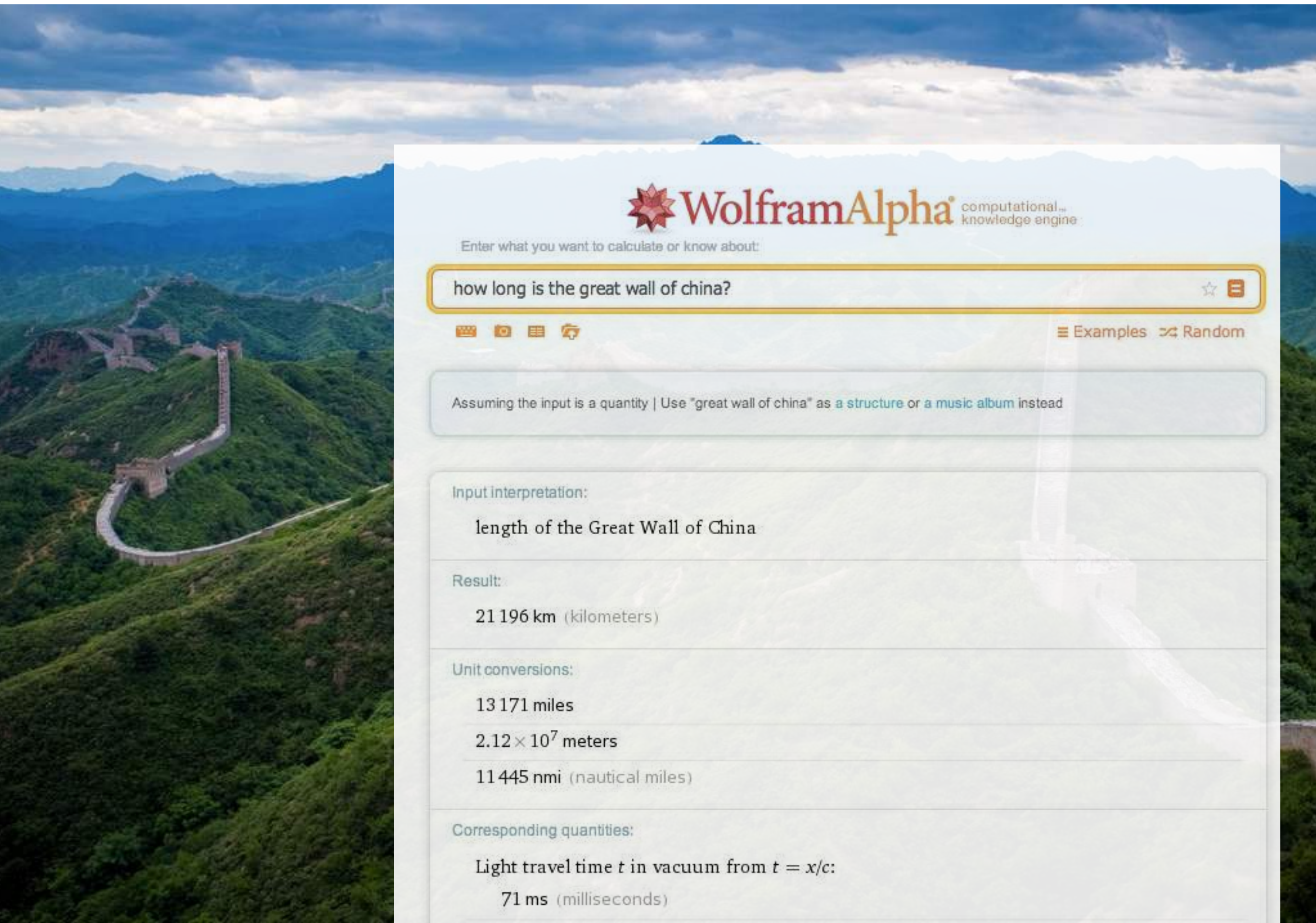


[Fender Kurt Cobain Jaguar - 3-Tone Sunburst Left Handed](#)
\$1,299.99 from 10+ stores

From Document Retrieval to Fact Retrieval



From Document Retrieval to Fact Retrieval



 **WolframAlpha** computational knowledge engine

Enter what you want to calculate or know about:

how long is the great wall of china?  

Assuming the input is a quantity | Use "great wall of china" as [a structure](#) or [a music album](#) instead

Input interpretation:
length of the Great Wall of China

Result:
21 196 km (kilometers)

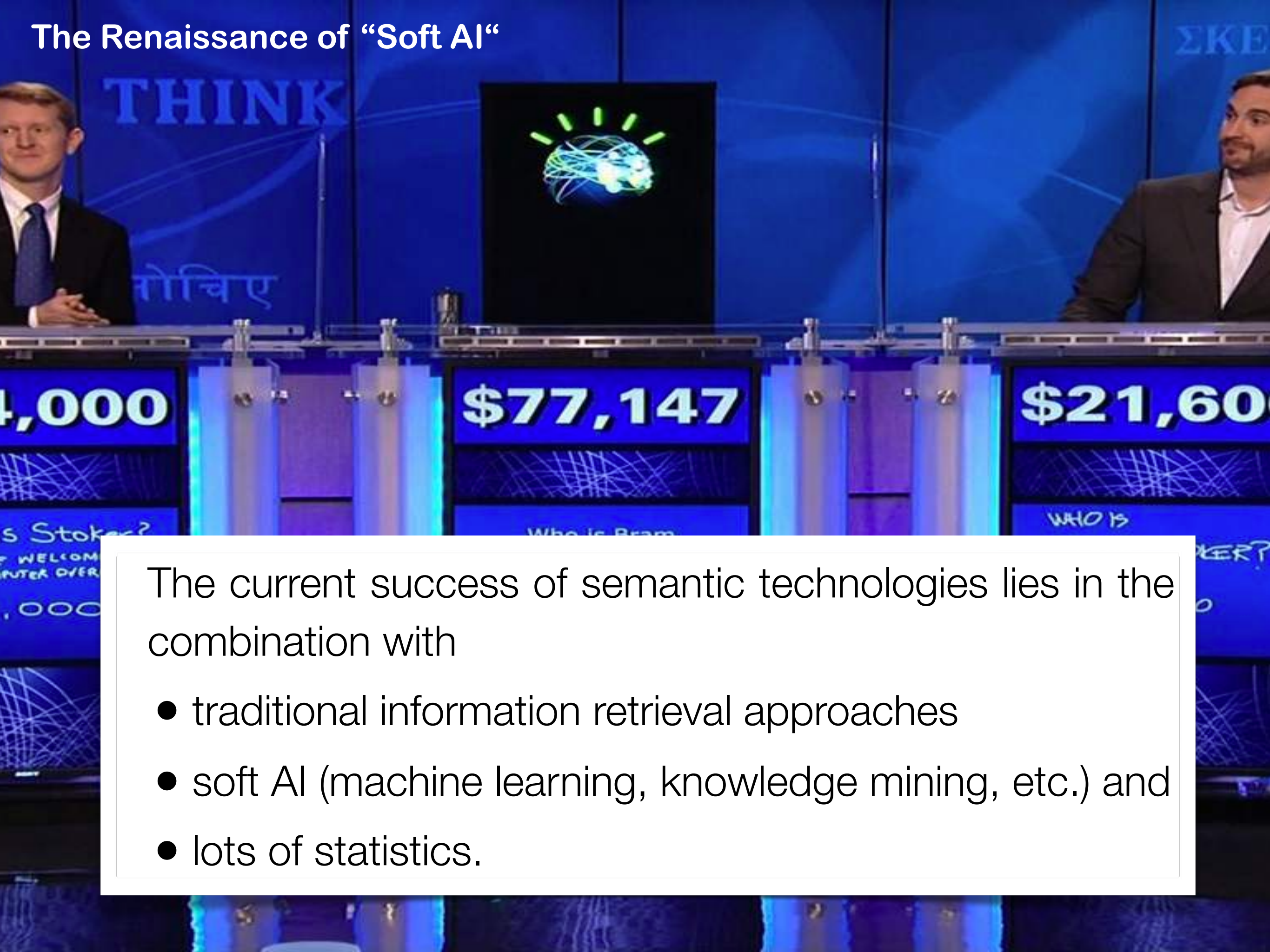
Unit conversions:
13 171 miles
 2.12×10^7 meters
11 445 nmi (nautical miles)

Corresponding quantities:
Light travel time t in vacuum from $t = x/c$:
71 ms (milliseconds)

The Renaissance of “Soft AI”



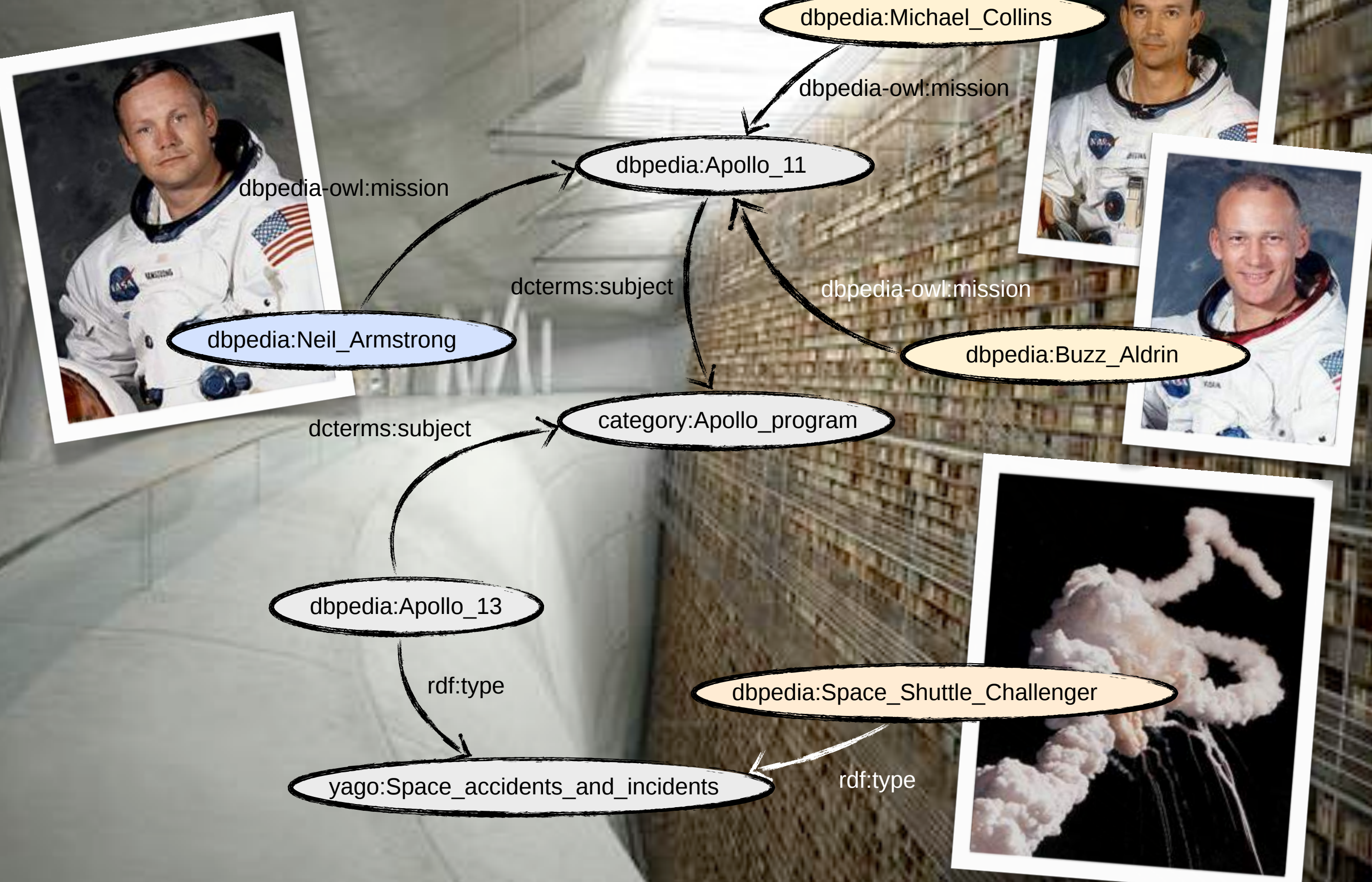
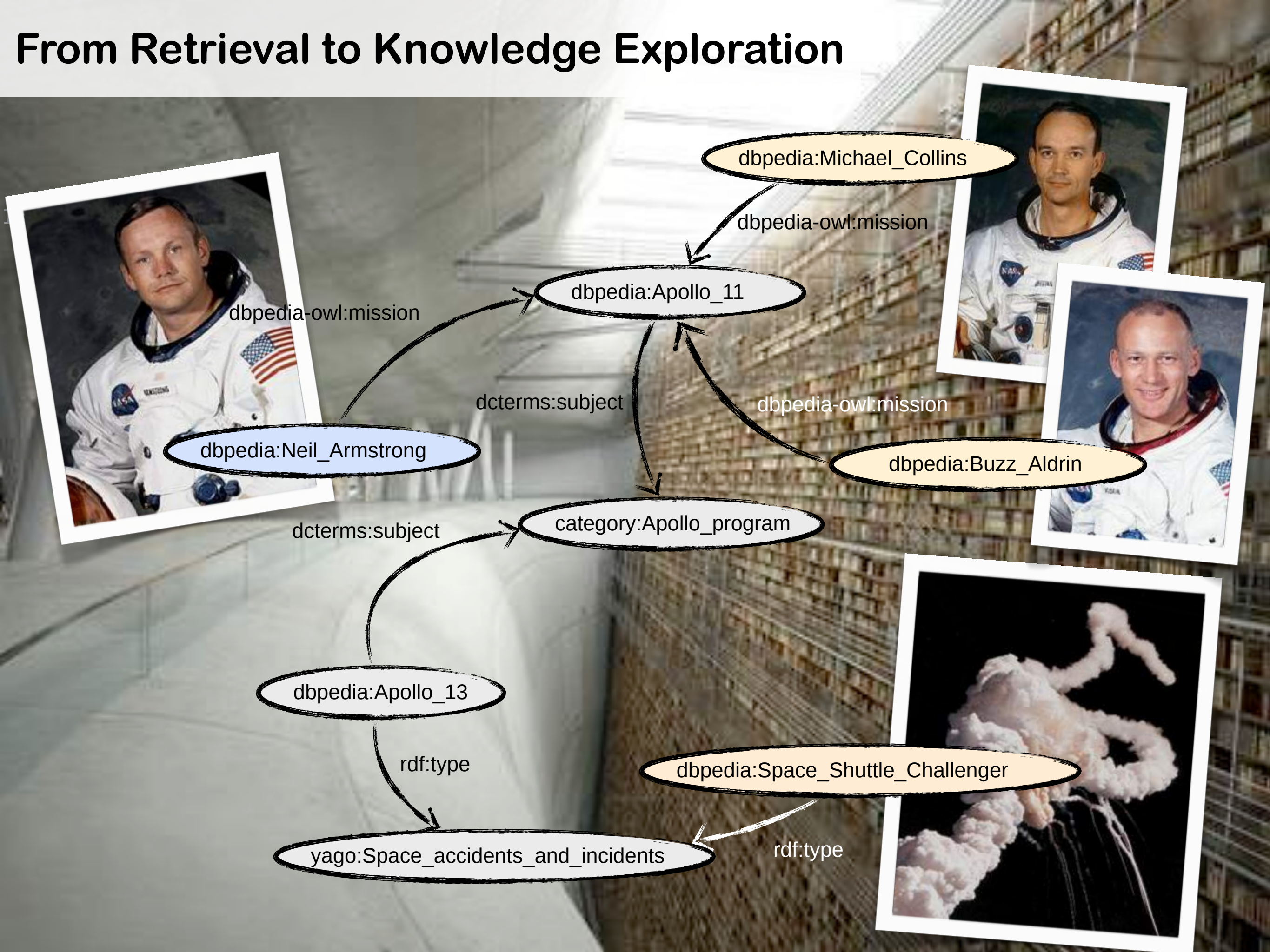
The Renaissance of “Soft AI”



The current success of semantic technologies lies in the combination with

- traditional information retrieval approaches
- soft AI (machine learning, knowledge mining, etc.) and
- lots of statistics.

From Retrieval to Knowledge Exploration

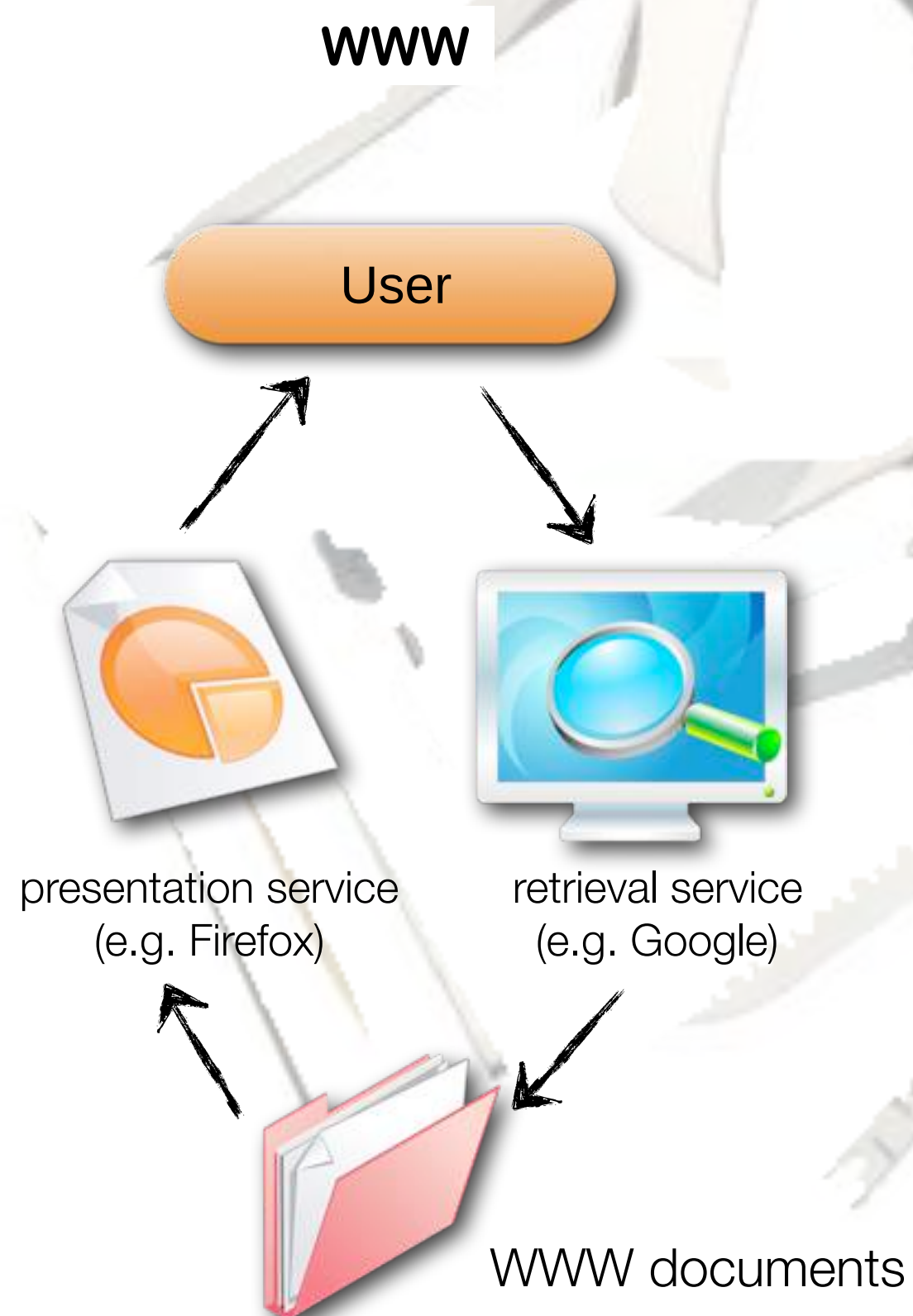




How is it like to Surf the Semantic Web?

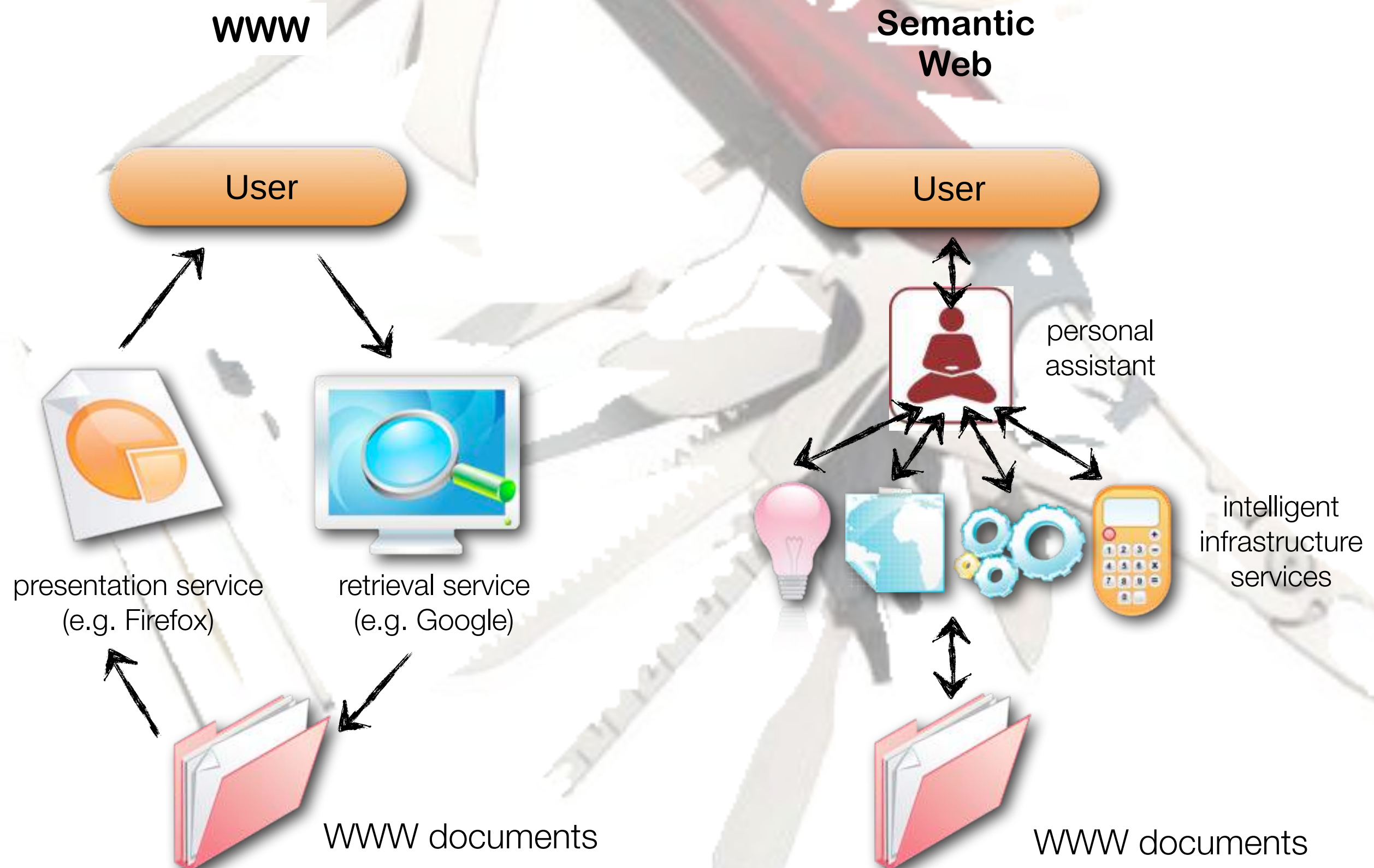
Intelligent Agents in the Semantic Web

15



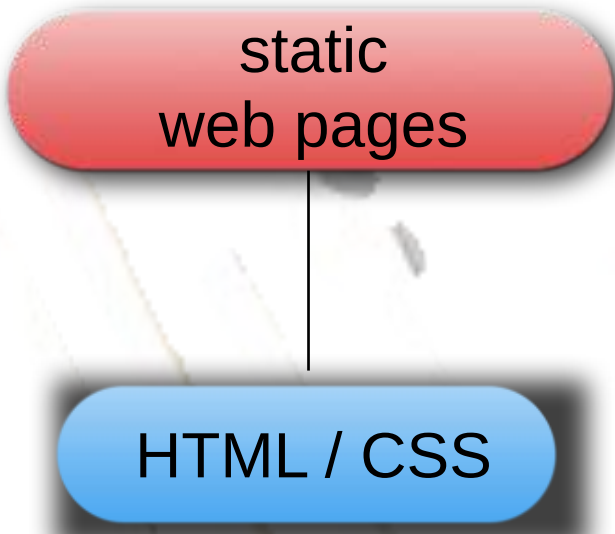
Intelligent Agents in the Semantic Web

15



3 Generations of Documents on the Web

16



static
web pages

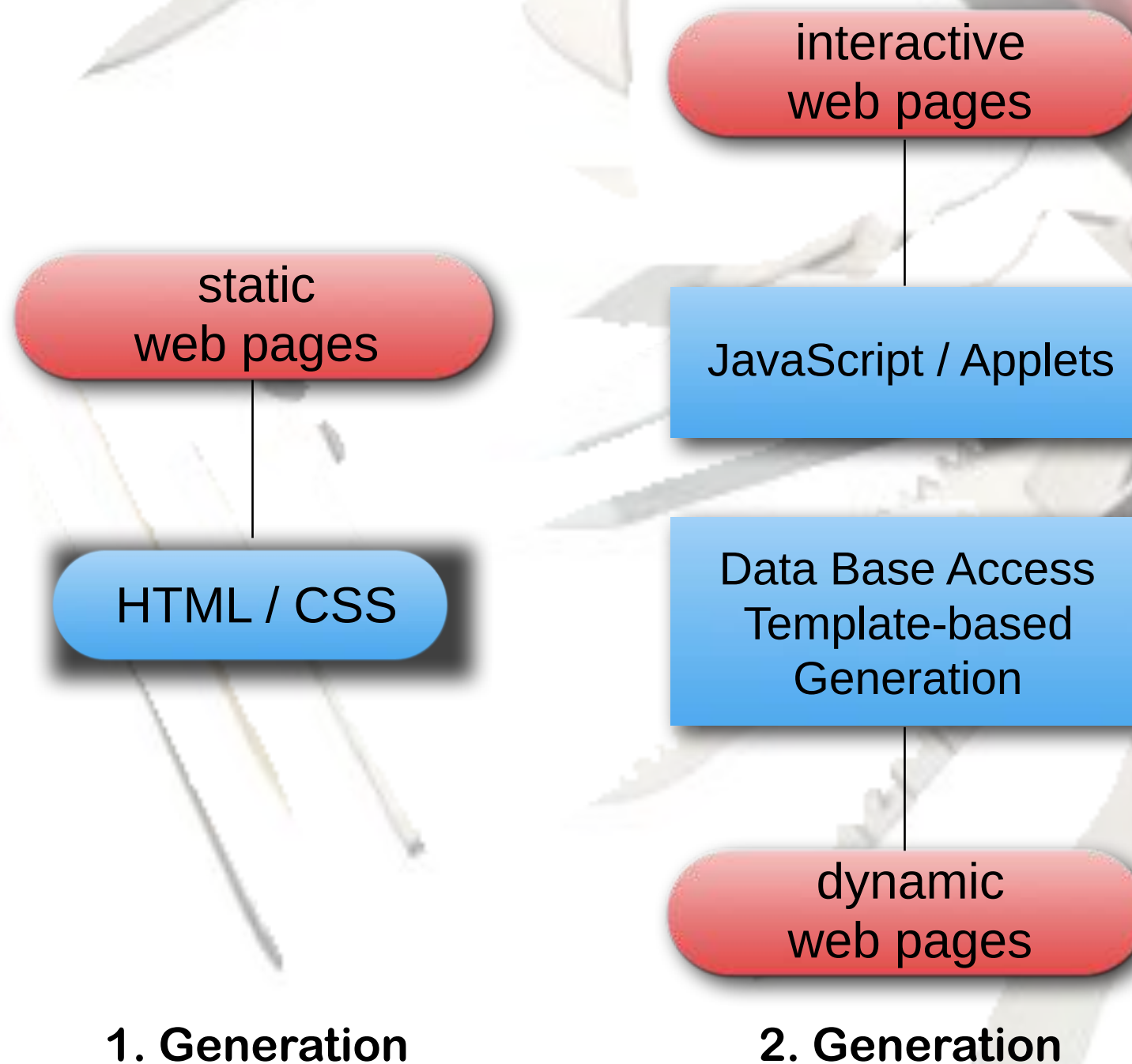
The diagram shows a red rounded rectangle containing the text 'static web pages'. A thin black vertical line extends downwards from the bottom center of this rectangle to a blue rounded rectangle below it. The background of the slide features a large, faint, red Swiss Army knife with various tools extended, symbolizing the versatility and simplicity of static web pages.

HTML / CSS

1. Generation

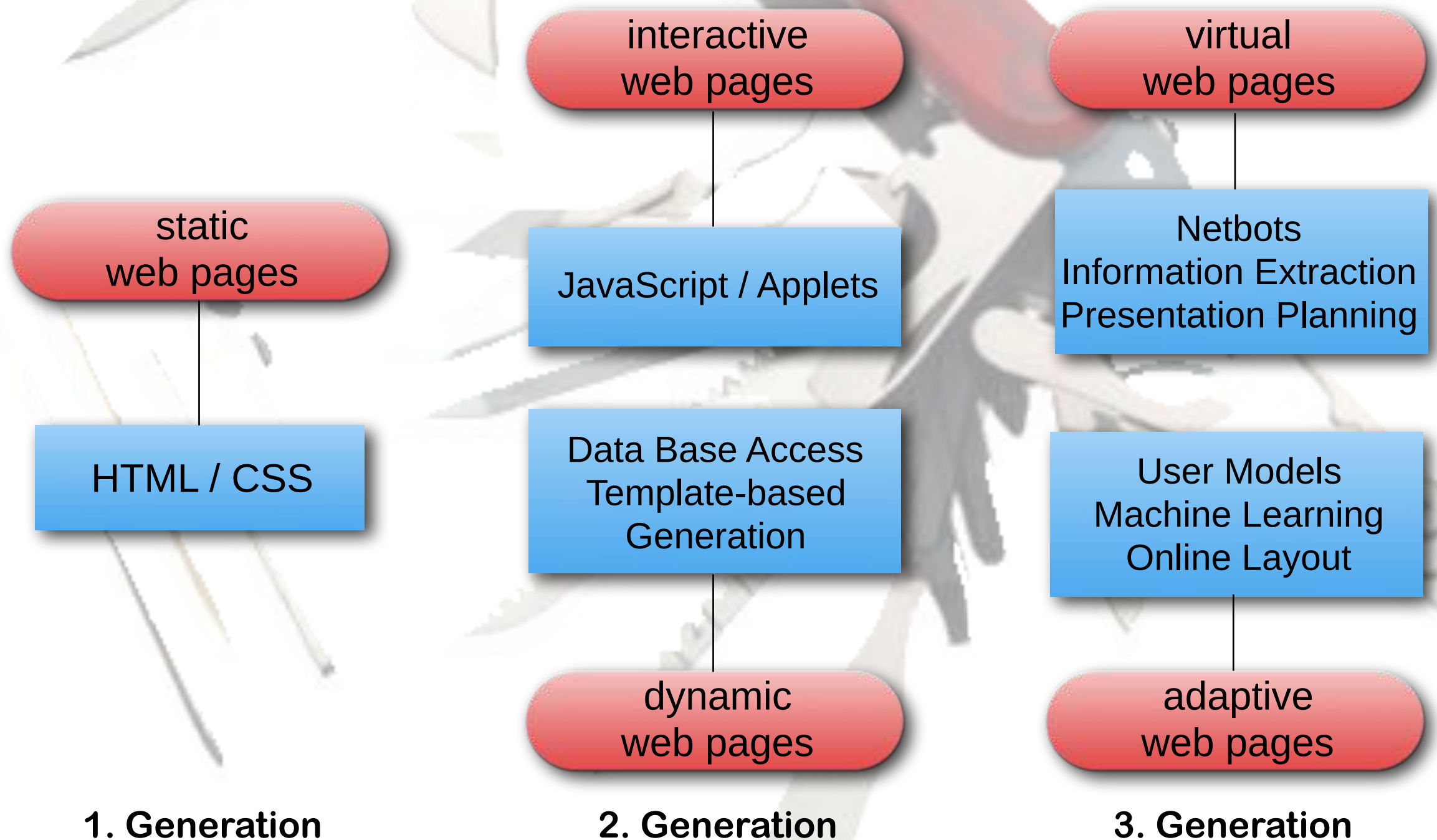
3 Generations of Documents on the Web

16



3 Generations of Documents on the Web

16



17 Toolbox of Semantic Technologies in the Web

- W3C standardized languages for knowledge representation in the Web (URIs, XML/XSD, RDF, RDFS, OWL, RIF)
- Tools to use semantic information in the Web (URIs, HTTP, RDFa, GRDDL, schema.org, ...)
- Contributions from various fields of computer science:
 - artificial intelligence
 - linguistics
 - cryptography
 - data bases
 - theoretical computer science
 - computer architecture
 - software engineering
 - systems theory
 - computer networks

Next Lecture



Lecture 2: Semantic Web Technologies - Part 1

Open HPI - Course: Semantic Web Technologies