For intelligence in search
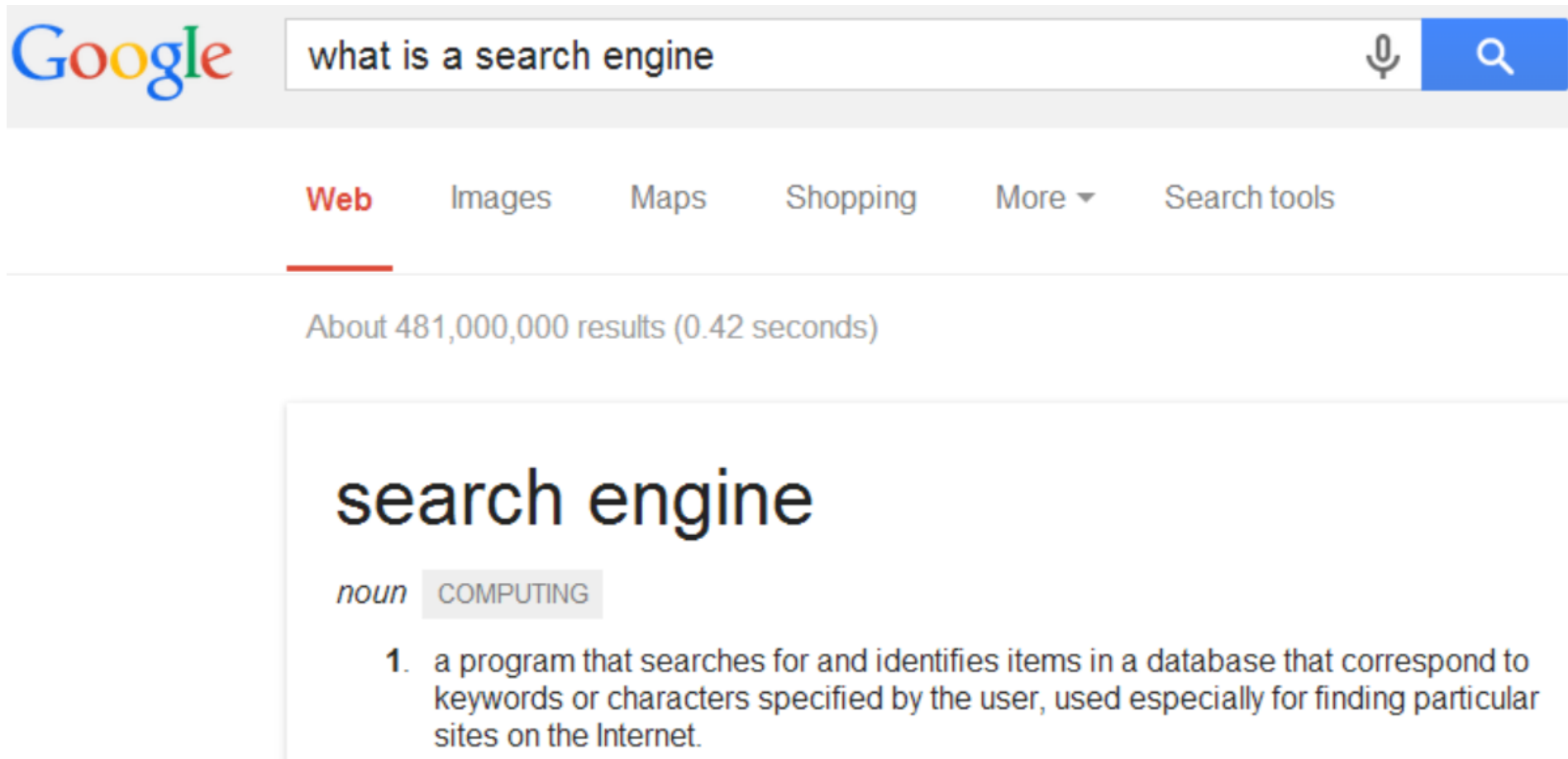
- In search for intelligence

Keynote at EGC 2014

by Fabian M. Suchanek

Google is doing a great job

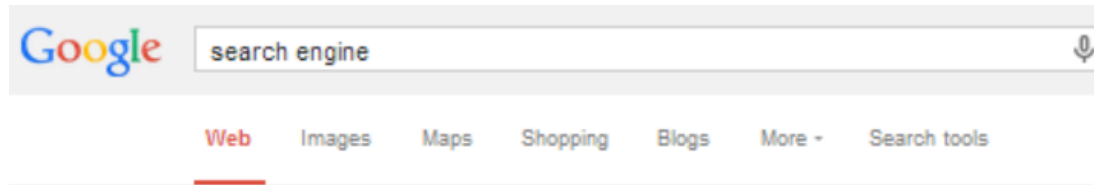Google [what is a search engine]

Web   Images   Maps   Shopping   More ▾   Search tools

About 481,000,000 results (0.42 seconds)

search engine

noun COMPUTING

1. a program that searches for and identifies items in a database that correspond to keywords or characters specified by the user, used especially for finding particular sites on the Internet.

2

Google is doing a great job

Google is doing a great job - mostly

"search engine"

Google is doing a great job - mostly

"search engine"

DuckDuckGo

Google is doing a great job - mostly
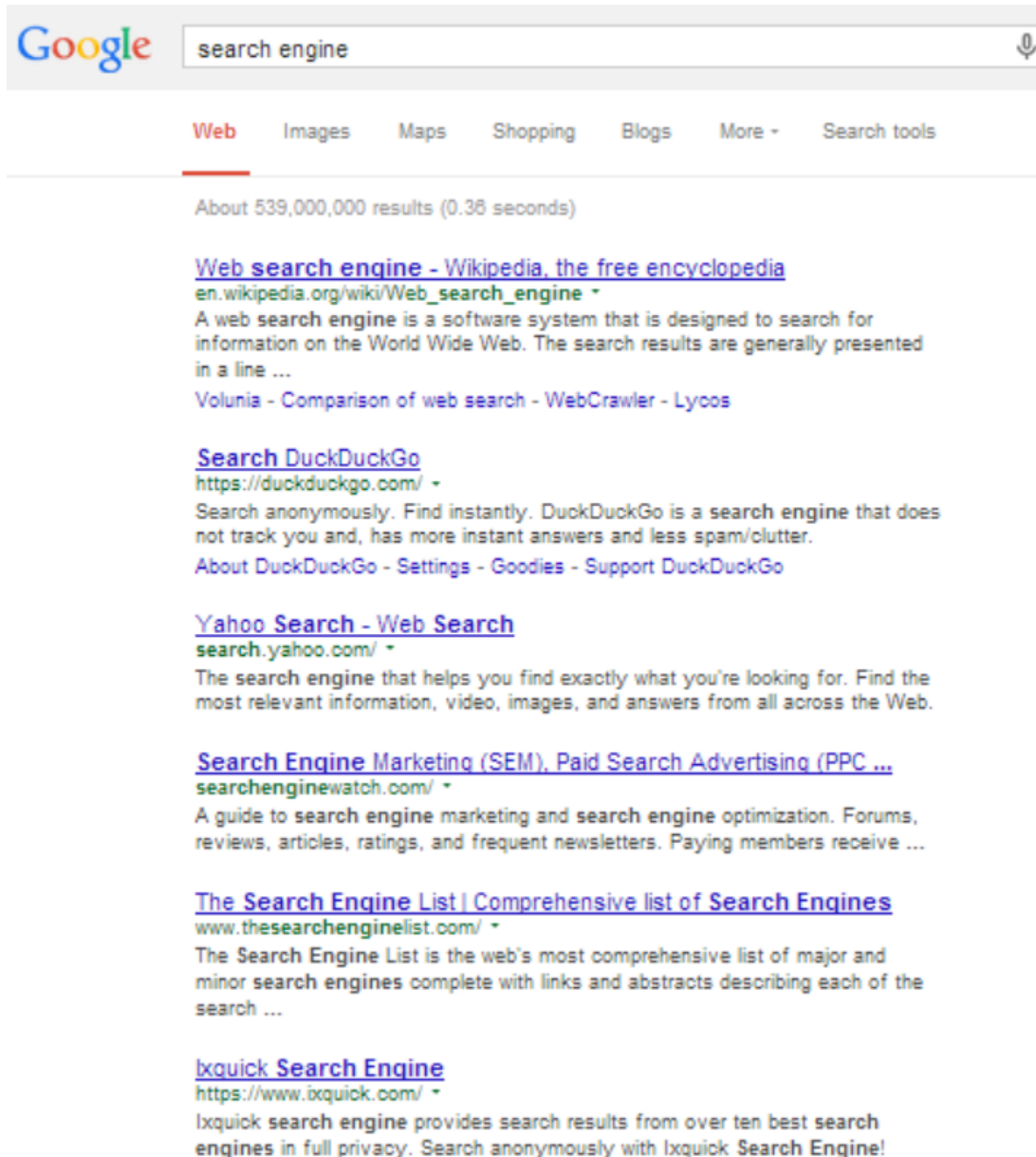
"search engine"

DuckDuckGo

Yahoo!

Google is doing a great job - mostly
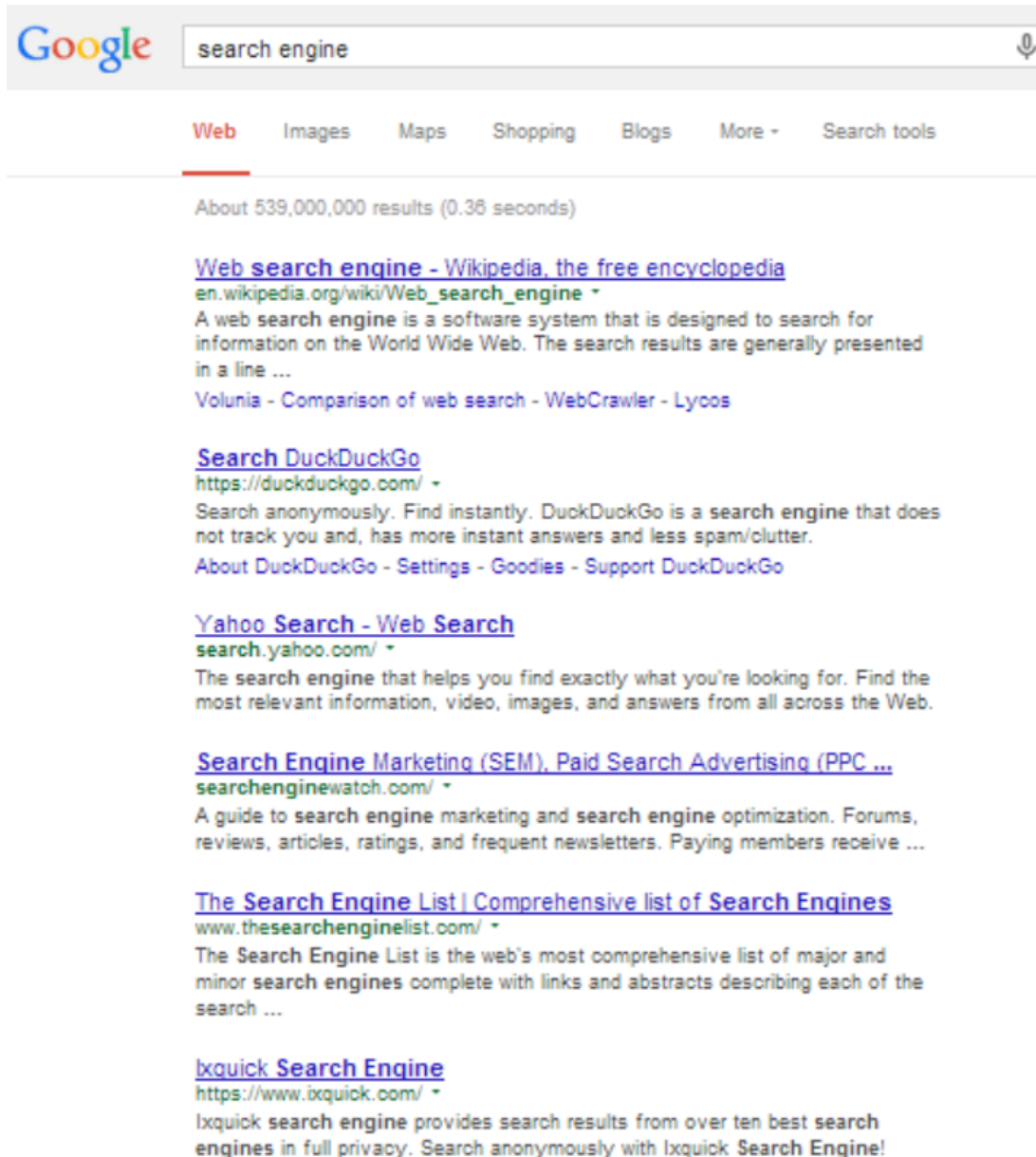
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Yahoo!

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Google is doing a great job - mostly
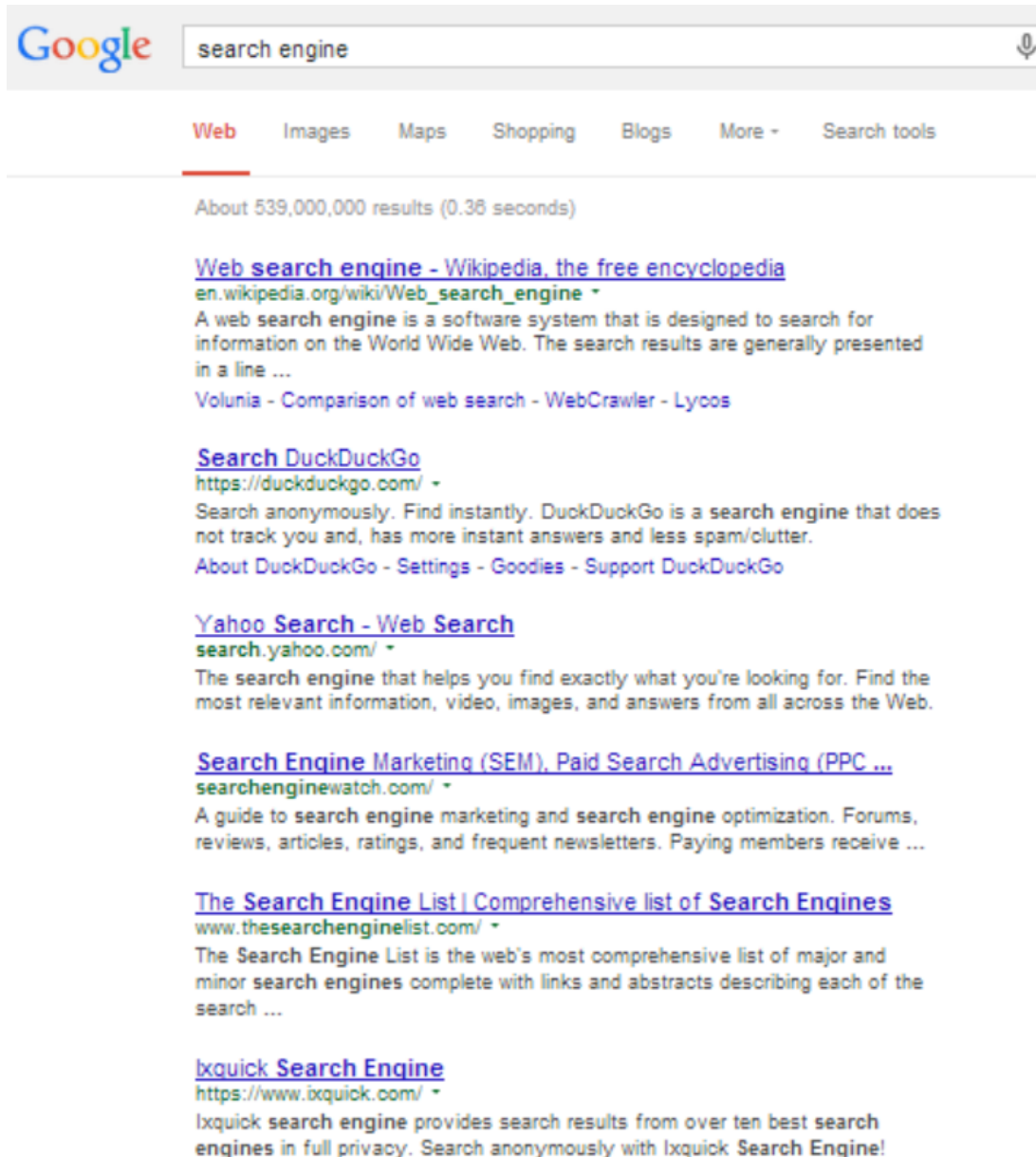
"search engine"

DuckDuckGo

Yahoo!

Ixquick

Google?

Google is doing a great job - mostly

begin{document}

...

includegraphics{formula.png}[???]

...

Google is doing a great job - mostly

Google   latex images   🎤

Web   Images   Maps   Shopping   More ▾   Search tools

begin{document}

...

includegraphics{formula.png}[???]

...

Google is doing a great job - mostly

Our dream: Make computers smart

Artificial Intelligence

"the theory and development of computer systems able to perform tasks normally requiring human intelligence"

Google's definition

- knowing
- reasoning
- understanding
- speaking
- acting
- ...

Artificial Intelligence since 1956

(lambda (arg)
  (+ arg 1))

vehicle

car   bicycle
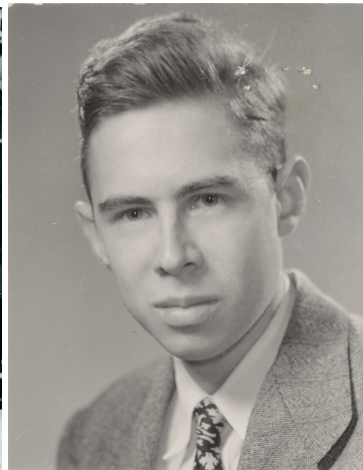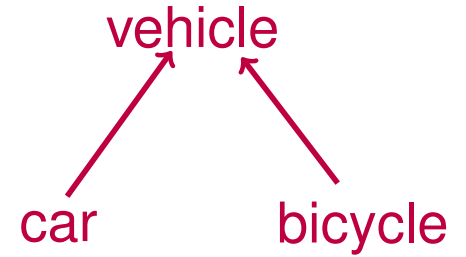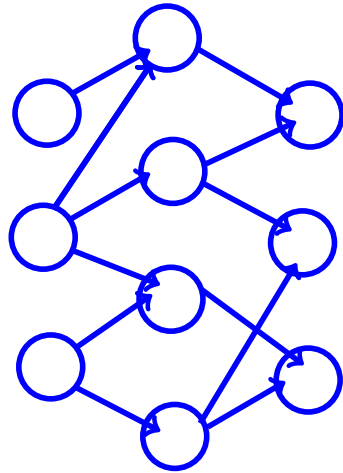
John McCarthy   Frank Rosenblatt   Herbert Simon   Marvin Minsky

Also: Natural Intelligence

Turing Award (1971)

IEEE introduced Frank Rosenblatt Award

Turing Award (1975)
Nobel Prize in Economics (1978)

Turing Award (1969)
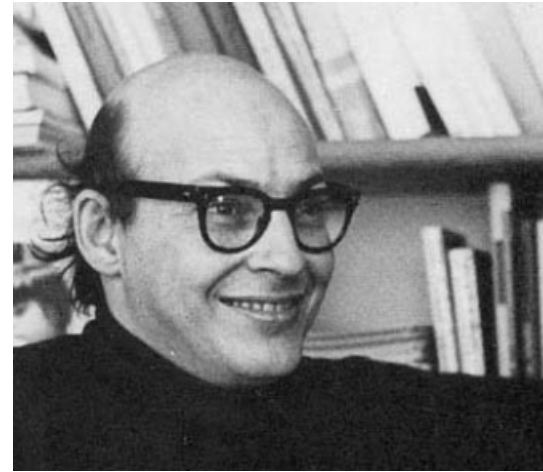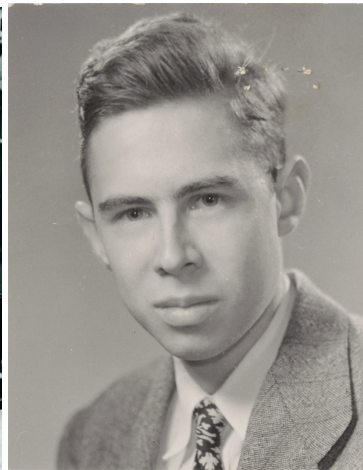
John McCarthy

Frank Rosenblatt

Herbert Simon

Marvin Minsky

Great hopes in the 1960's

"machines will be capable, within twenty years, of doing any work a man can do"
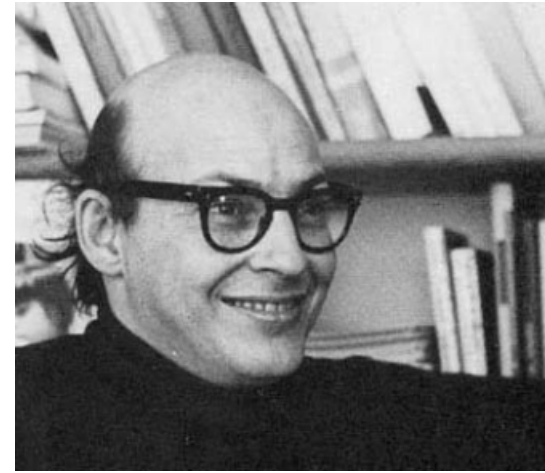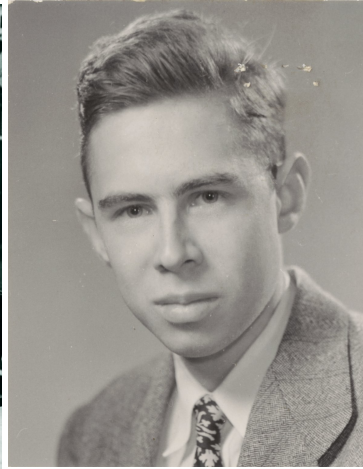
John McCarthy   Frank Rosenblatt   Herbert Simon   Marvin Minsky

Great hopes in the 1960's

"within a generation the problem of creating 'artificial intelligence' will substantially be solved"
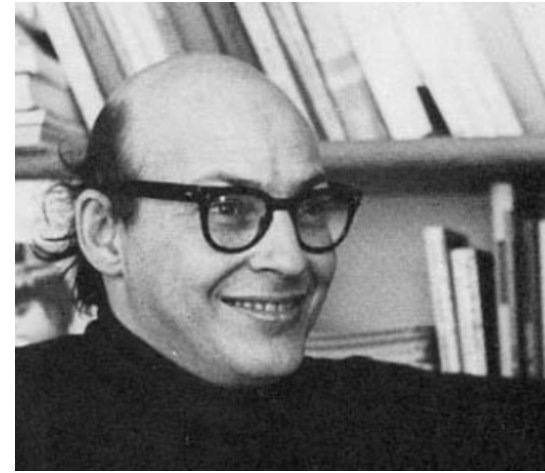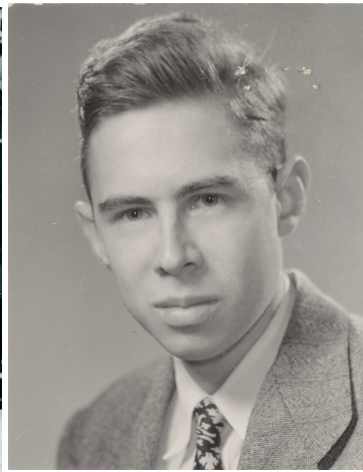
John McCarthy   Frank Rosenblatt   Herbert Simon   Marvin Minsky

Great hopes in the 1960's

NEW NAVY DEVICE LEARNS BY DOING; Psychologist Shows Embryo of Computer Designed to Read and Grow Wiser

[DISPLAYING ABSTRACT]

WASHINGTON, July 7 (UPI) -- The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence.

The New York Times
7 July 1958
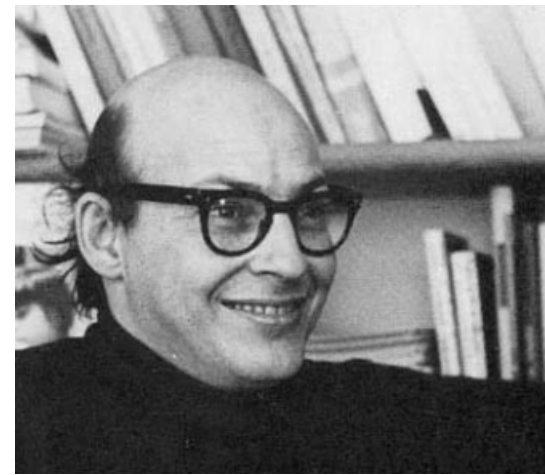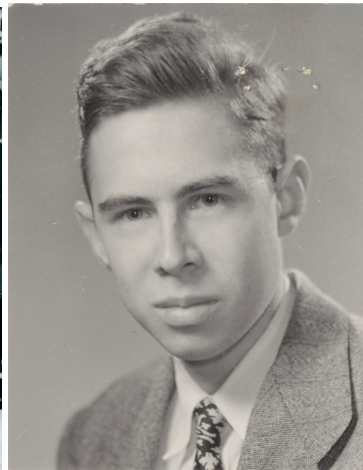
John McCarthy

Frank Rosenblatt

Herbert Simon

Marvin Minsky

18

1. Expert Systems

IF

  X reports heart palpitations AND

  X reports muscle fatigue AND

  X reports suspicious coughing

THEN

  X is a hypochondriac

2. Cyc

(isa Hollande president)

(implies (and

(isa ?X president)

(citizen ?X France)) (and

(exists ?Y (isa ?Y firstlady))

(exists ?Y (isa ?Y secondlady))))

Douglas Lenat

CYcorp   http://www.cyc.com/

2. Cyc

"A person makes 2 rules per day.
We need 250,000 rules."

(isa Hollande president)

(implies (and

    (isa ?X president)

    (citizen ?X France)) (and

(exists ?Y (isa ?Y firstlady))

(exists ?Y (isa ?Y secondlady))))

Douglas Lenat

cYcorp   http://www.cyc.com/

Example: Cyc on "Love"

Strong affection for another agent arising out of kinship or personal ties.

#$Love is a collection, as further explained under #$Happiness. Specialized forms of #$Love are #$Love-Romantic, platonic love, maternal love, infatuation, agape, etc.

guid: bd589433-9c29-11b1-9dad-c379636f7270

direct instance of: #$FeelingType

direct specialization of: #$Affection

direct generalization of: #$Love-Romantic

3. WordNet

partner

ex-partner

woman

significant other

insignificant other

ex-wife

wife
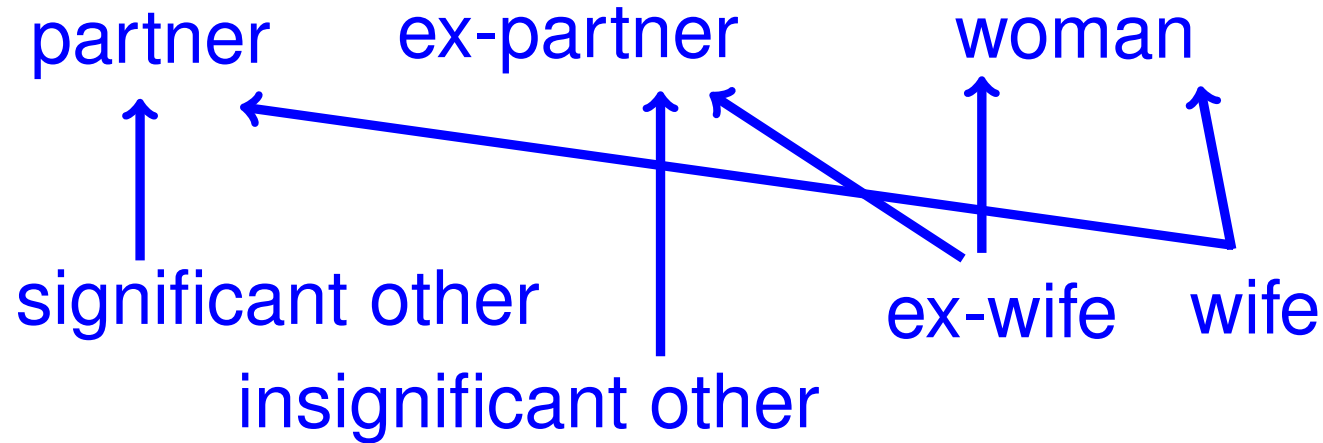
George Miller

WordNet
A lexical database for English

3. WordNet

partner   ex-partner   woman

significant other

insignificant other

ex-wife   wife

George Miller

WordNet
A lexical database for English

http://wordnet.princeton.edu/

24
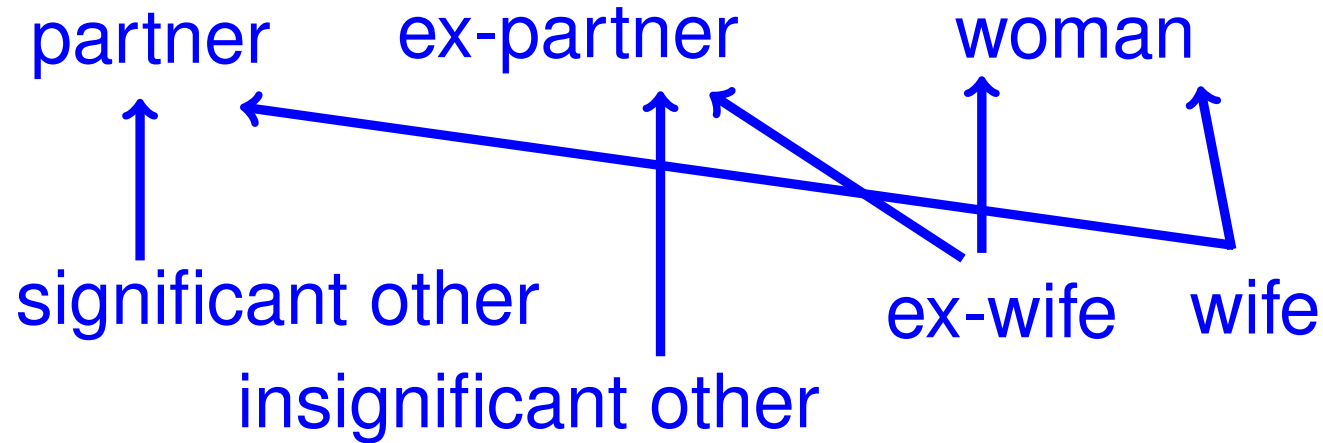
GOFAI means and ends

Some of the means and ends of early AI ("GOFAI") were as follows:

Means:
- gather lexical knowledge
- gather factual knowledge (assertions)
- gather commonsense knowledge (rules)

Ends:
- understand language
- understand world
- answer questions

AI Winters

"Due to the combinatorial explosion, AI can only ever solve toy problems"

James Lighthill

AI Winters

"Due to the combinatorial explosion, AI can only ever solve toy problems"

James Lighthill

- funding stopped
- LISP machines gone
- expert systems abandoned
- "AI" became bad word

But let's leave AI...

... and see what happened elsewhere

The Advent of the Internet in 1981

"Imagine you turn on your computer and read the news. This idea may not be as far-fetched as it seems."

The Advent of the Internet in 1981

"Imagine you turn on your computer and read the news. This idea may not be as far-fetched as it seems."

Richard Halloran
Owns Home Computer

"You can actually save the news on your computer,[...] which I think is the future."

The Advent of the Internet in 1981

"There are 3000 computer users in the Bay Area, and 500 have subscribed."

The Advent of the Internet in 1981

"There are 3000 computer users in the Bay Area, and 500 have subscribed."

"However, the new service may not yet be competitive: It takes 2h to download the newspaper, at a charge of $5/h"

The Growth of the Web since 1990

Total number of websites (linear scale)

Legend:
- Hostnames (blue)
- Active sites (red)

Y-axis: 0, 250 000 000, 500 000 000, 750 000 000, 1 000 000 000

X-axis: août 1995, nov. 1996, févr. 1998, mai 1999, août 2000, nov. 2001, févr. 2003, mai 2004, août 2005, nov. 2006, févr. 2008, mai 2009, août 2010, nov. 2011, févr. 2013

Labels on chart: A B C D E F G H I J K L M N O P Q R S T U

http://www.netcraft.com/

33
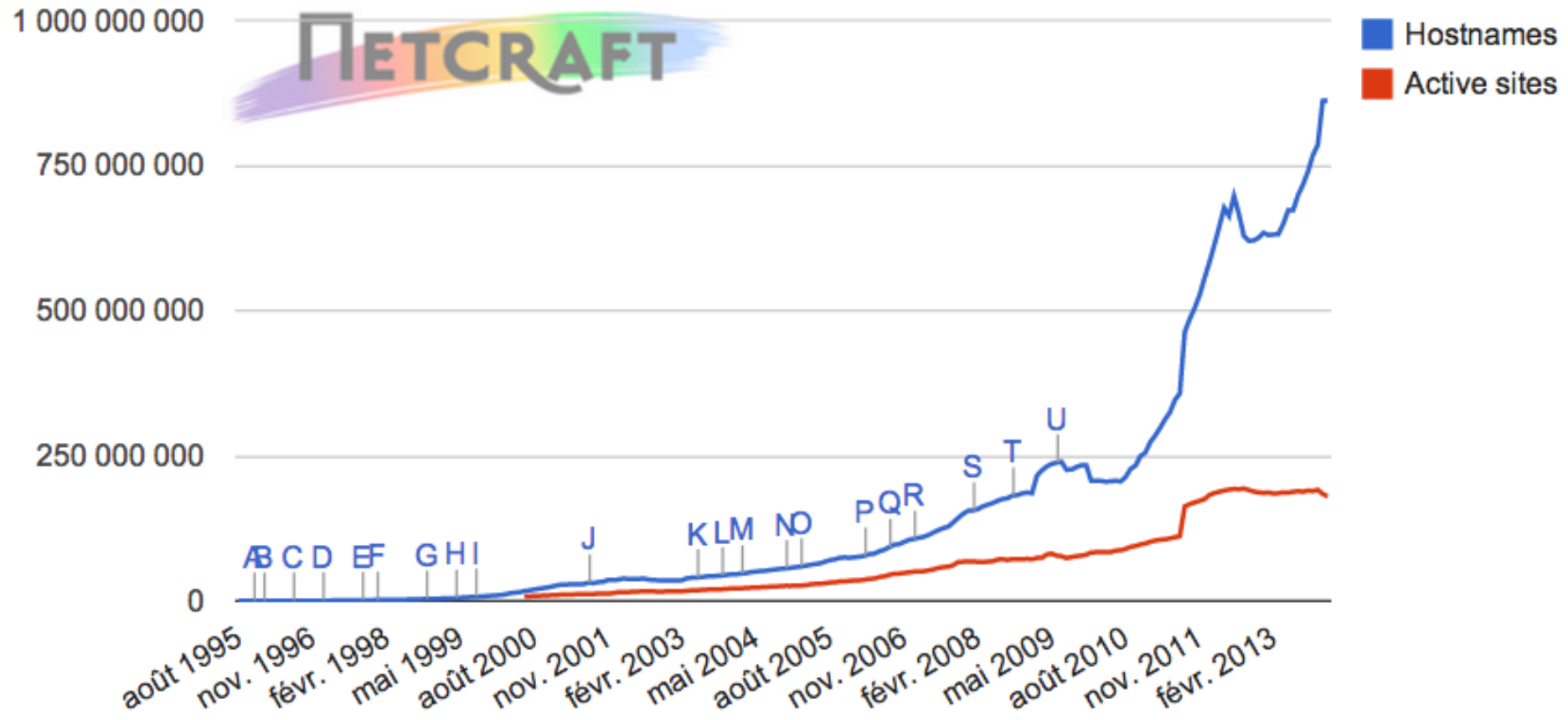
The Birth of Wikipedia in 2001

Number of articles on en.wikipedia.org
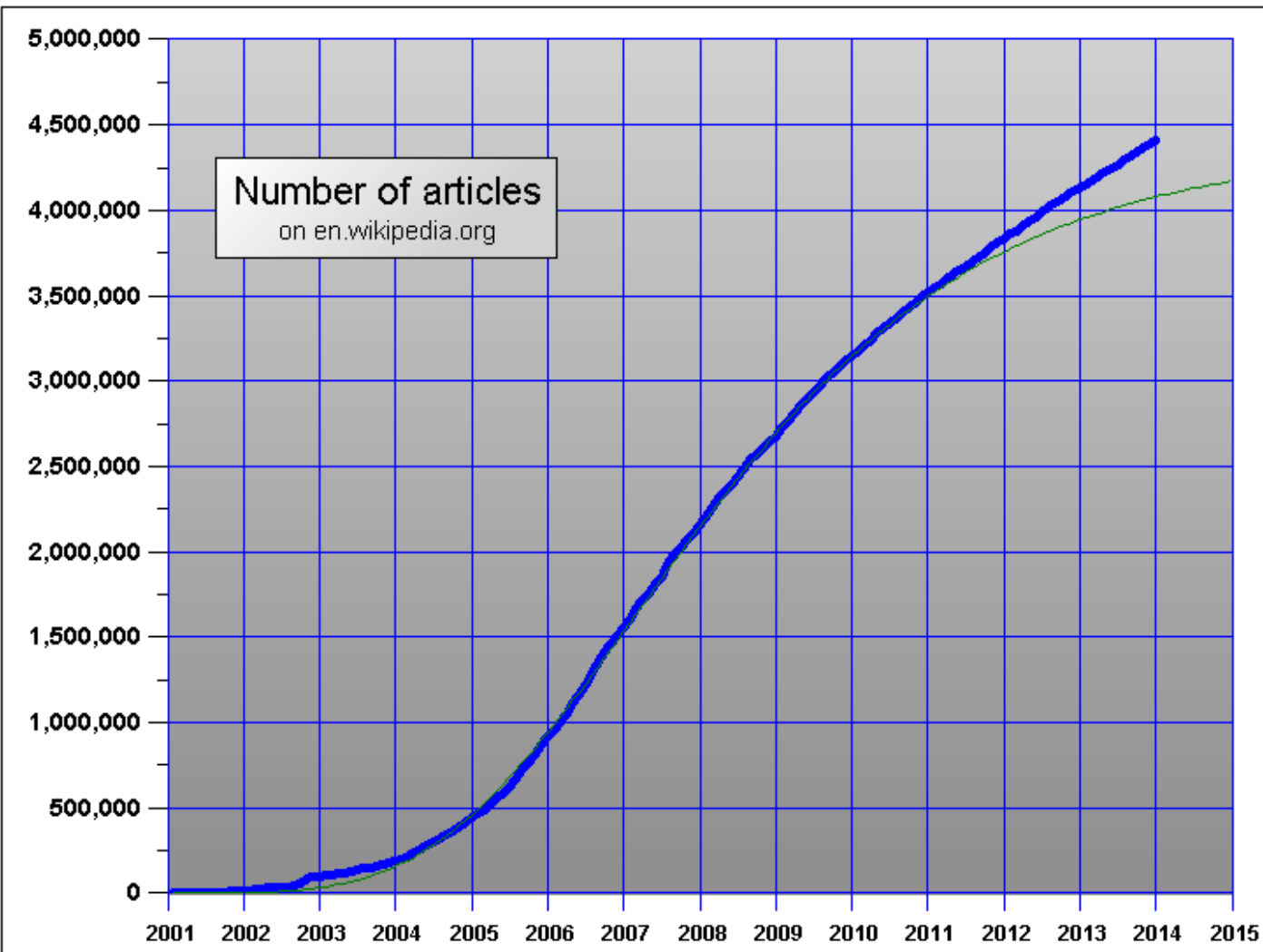
The world has changed...

since the early days of AI, because now we have
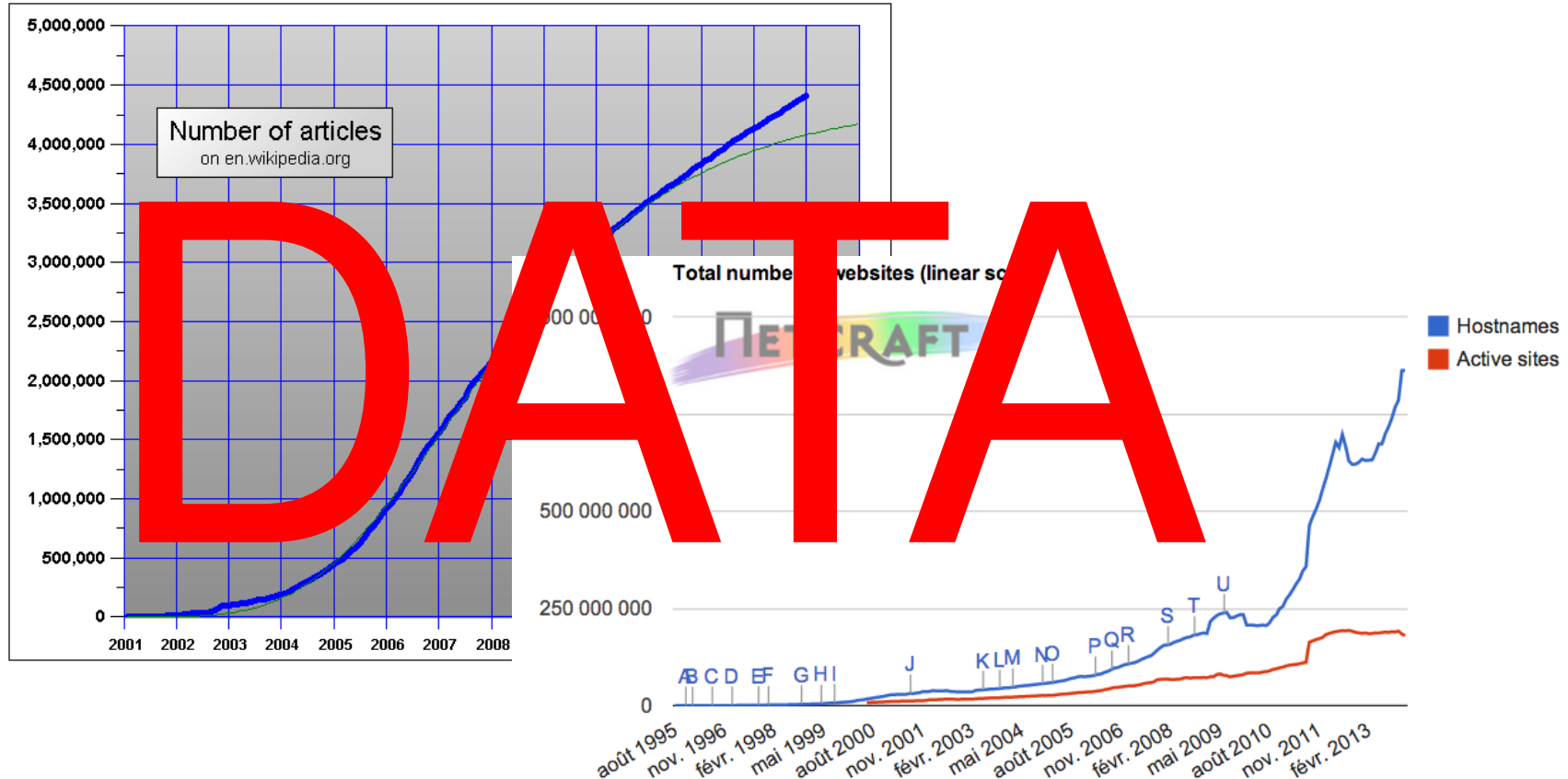
DATA

GOFAI means and ends

Means:
- gather lexical knowledge
- gather factual knowledge (assertions)
- gather commonsense knowledge (rules)

Ends:
- understand language
- understand world
- answer questions

Lexical knowledge

All stars, including singers and actors, love money.

+

X, including Y1, ..., Yn

Lexical knowledge

All stars, including singers and actors, love money.

+

X, including Y1, ..., Yn

=

star

singer   actor

Lexical knowledge

All stars, including Betelgeuse and Antares, ...

+

X, including Y1, ..., Yn

=

star

singer   actor

Lexical knowledge

All stars, including Betelgeuse and Antares, ...

+

X, including Y1, ..., Yn

=

star   ?

singer   actor   Antares   Betelgeuse
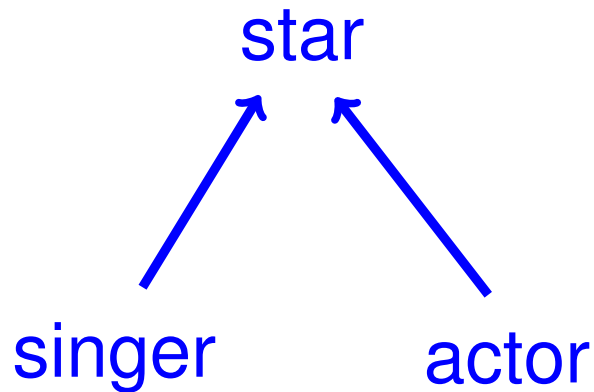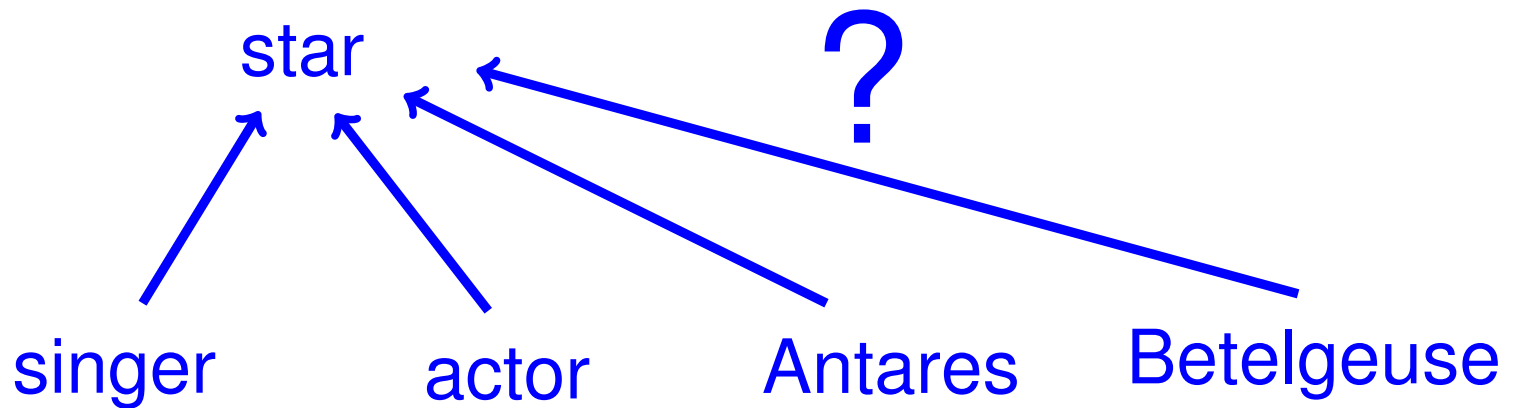
ProBase builds a large Taxonomy

All stars, including Betelgeuse and Antares, ...

+

X, including Y1, ..., Yn

=

ProBase
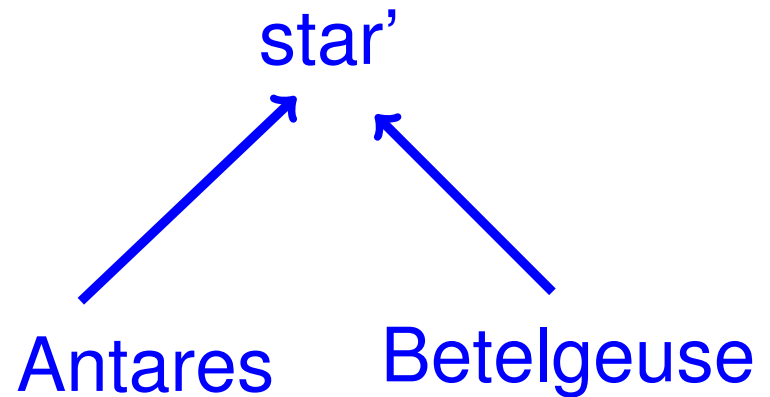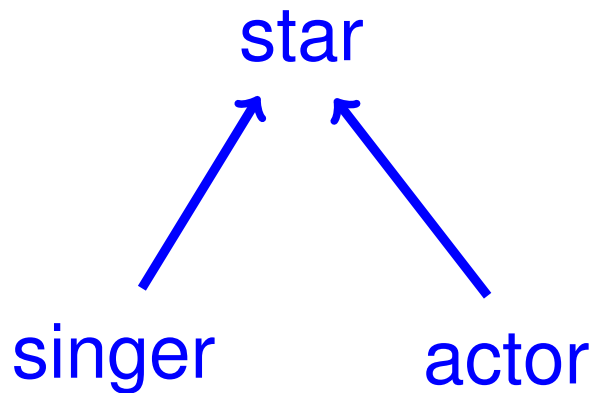
star   star'

singer   actor   Antares   Betelgeuse

Lexical knowledge

Elvis married Priscilla

Barack married Michelle

N. Nakashole, G. Weikum, F. M. Suchanek: "PATTY", EMNLP 2012

Lexical knowledge

Elvis married Priscilla

Barack married Michelle

↓

Relationship "married"

N. Nakashole, G. Weikum, F. M. Suchanek: "PATTY", EMNLP 2012

Lexical knowledge

Elvis married Priscilla

Barack married Michelle

Elvis' wife Priscilla

↓

Relationship "married"

Lexical knowledge

Elvis married Priscilla

Barack married Michelle

Elvis' wife Priscilla

↓

Relationship "married"

Synonyms: "married", " 's wife"

PATTY collects verb phrases

Elvis married Priscilla

Barack married Michelle

Elvis' wife Priscilla

Elvis got to know Priscilla

Relationship "married"

Synonyms: "married", " 's wife"

Super-relationship: "got to know"

N. Nakashole, G. Weikum, F. M. Suchanek: "PATTY", EMNLP 2012

Lexical knowledge bases

Probase (Microsoft Research Asia)

● builds a taxonomy of nouns

ProBase

PATTY (Max Planck Institute)

● builds a taxonomy of verbs

BabelNet (U Sapienza of Rome)

● builds a multilingual taxonomy

BabelNet 2.0

A very large multilingual encyclopedic dictionary and semantic network

WebChild (Max Planck Institute)

● builds a collection of adjectives

UWN (Tsinghua University)

● builds a multilingual WordNet

por: "entidade" → entity

heb: "ישות" ↑ ...
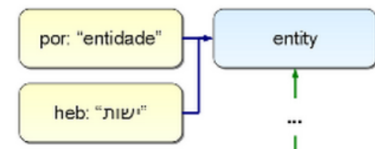
Lexical knowledge: Challenges

- go beyond nouns (verbs, adjectives, etc.)
- go beyond words (phrases, idioms, etc.)
- go beyond one language (do the above for multiple languages)
- go beyond one corpus (attack social media, query logs, Web tables etc.)
- detect and disambiguate entity names in noisy data (tweets, short texts, etc.)

GOFAI means and ends

Means:

- gather lexical knowledge

    ProBase, PATTY, UWN, BabelNet, WebChild

- gather factual knowledge (assertions)
- gather commonsense knowledge (rules)

Ends:

- understand language
- understand world
- answer questions

Factual knowledge: Wikipedia

Elvis Presley

WIKIPEDIA
The Free Encyclopedia

Elvis Presley was one
of the best blah blah
blub blah don't read
this, listen to the
speaker! blah blah blah
blubl blah you are still
reading this! blah blah
blah blah blabbel blah

Born: 1935
In: Tupelo
...

Categories:

Rock&Roll, American Singers,

Academy Award winners...

Factual knowledge: Wikipedia

Elvis Presley

Elvis Presley was one of the best blah blah blub blah don't read this, listen to the speaker! blah blah blah blubl blah you are still reading this! blah blah blah blah blabbel blah

Born: 1935
In: Tupelo
...

ElvisPresley

Categories:

Rock&Roll, American Singers,

Academy Award winners...

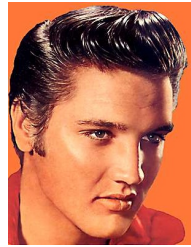# Factual knowledge: Wikipedia

Elvis Presley

Elvis Presley was one of the best blah blah blub blah don't read this, listen to the speaker! blah blah blah blubl blah you are still reading this! blah blah blah blah blabbel blah

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In: Tupelo
...

Categories:

Rock&Roll, American Singers,

Academy Award winners...

ElvisPresley

born

bornIn

1935

Tupelo

Factual knowledge: Wikipedia

Elvis Presley

Elvis Presley was one of the best blah blah blub blah don't read this, listen to the speaker! blah blah blah blubl blah you are still reading this! blah blah blah blah blabbel blah

Born: 1935
In: Tupelo
...

Categories:
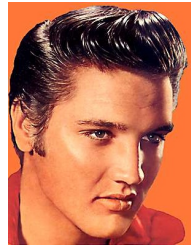Rock&Roll, American Singers, Academy Award winners...

AmericanSinger

type

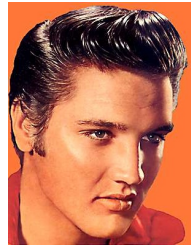ElvisPresley

born

bornIn

1935

Tupelo

Factual knowledge: Wikipedia

Elvis Presley

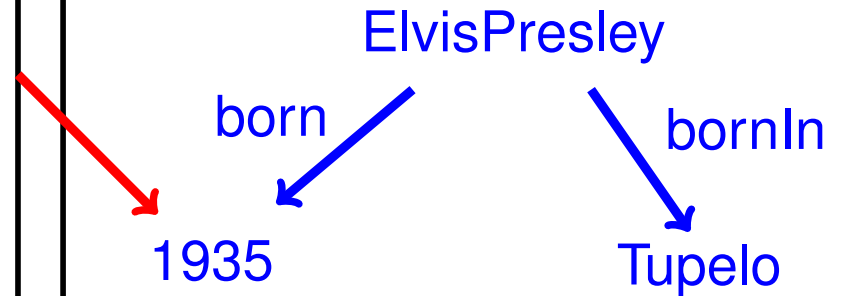WIKIPEDIA
The Free Encyclopedia

Elvis Presley was one of the best blah blah blub blah don't read this, listen to the speaker! blah blah blah blubl blah you are still reading this! blah blah blah blah blabbel blah

Born: 1935
In: Tupelo
...

Categories:
Rock&Roll, American Singers, Academy Award winners...

AmericanSinger

type

ElvisPresley

born

bornIn

1935

Tupelo

won

AcAward

Factual knowledge: Wikipedia

Elvis Presley

Elvis Presley was one of the best blah blah blub blah don't read this, listen to the speaker! blah blah blah blubl blah you are still reading this! blah blah blah blah blabbel blah

Born: 1935
In: Tupelo
...

Categories:
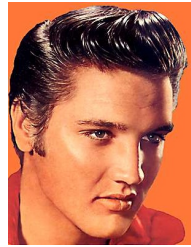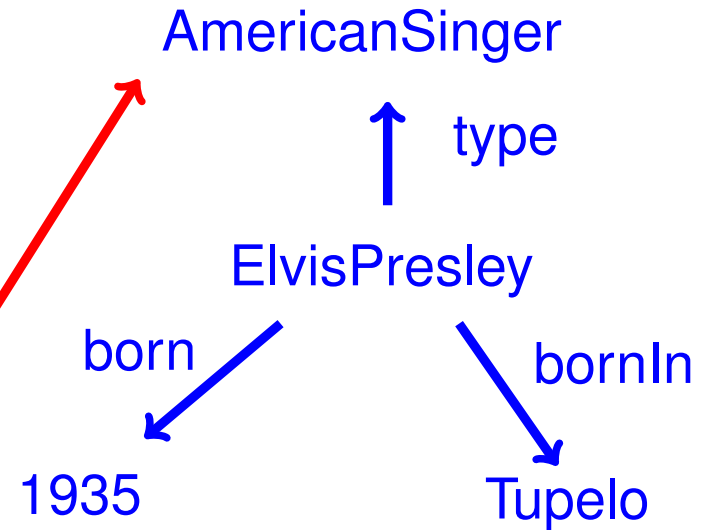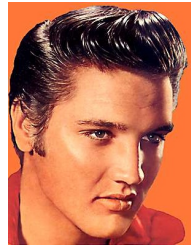Rock&Roll, American Singers, Academy Award winners...

AmericanSinger
type
ElvisPresley
born
bornIn
1935
Tupelo
won
locatedIn
AcAward
USA

Factual knowledge: Wikipedia+

Combine and check previous results

Try it online
Try locally

Example: YAGO about Elvis

<Elvis_Presley>

YAGO is a large knowledge base

100m facts

10m entities

95% accuracy

100 Web site visitors/day

1000 citations

linked to Freebase and DBpedia

http://yago-knowledge.org

KBs from Wikipedia

- combines WordNet and Wikipedia
- has time and space
- has an evaluated accuracy of 95%

- nucleus of the Web of Linked Data
- available in 119 languages
- developed by community

- nourished by community
- bought by Google
- many sources beyond Wikipedia

- enhances Wikipedia by text snippets from other sources

Factual Knowledge: Tables

My super heroes

Batman	Gotham City	Batgirl
Elvis Presley	Tupelo	Priscilla
Badman	Pyong Yang	Badgirl
...		

G. Limaye, S. Sarawagi, S. Chakrabarti. "Annotating and searching web tables". VLDB 2010

Factual Knowledge: Tables

My super heroes

Batman	Gotham City	Batgirl
Elvis Presley	Tupelo	Priscilla
Badman	Pyong Yang	Badgirl
...		

+ yago select knowledge   DBpedia

G. Limaye, S. Sarawagi, S. Chakrabarti. "Annotating and searching web tables". VLDB 2010

Factual Knowledge: Tables

My super heroes

Batman	Gotham City	Batgirl
Elvis Presley	Tupelo	Priscilla
Badman	Pyong Yang	Badgirl
...		

+ yago select knowledge DBpedia

= TABLE(Hero, City, Heroine)
Relations: livesIn, marriedTo

G. Limaye, S. Sarawagi, S. Chakrabarti: "Annotating and searching web tables", VLDB 2010

Factual Knowledge: Tables

Who deserves the title "The **King of Rock and Roll**"?

http://www.musicbanter.com/**rock**...**roll**...**rock**...**rock**/32418-who-des

Elvis Presley	Chuck Berry	Little Richard	Neither

Show less (4 rows / 3 columns total) - Import data - created: 18 Aug

Elvis Presley	92	42.20%
Chuck Berry	64	29.36%
Little Richard	10	4.59%

Google Tables
See Alon Halevy's work

Factual Knowledge: Tables

Who deserves the title "The **King of Rock and Roll**"?

http://www.musicbanter.com/**rock...roll...rock...rock**/32418-who-des

Elvis Presley	Chuck Berry	Little Richard	Neither

Show less (4 rows / 3 columns total) - Import data - created: 18 Aug

Elvis Presley	92	42.20%
Chuck Berry	64	29.36%
Little Richard	10	4.59%

File   View   Edit   Visualize   Merge

Filter   Aggregate   Choose columns

Country   =

Add condition   ?

Apply   Clear filter

Current view: **All** - Hide options
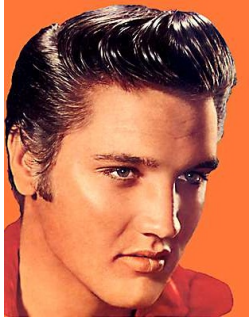
Image: CC by-nc-sa Information Aesthetics

64

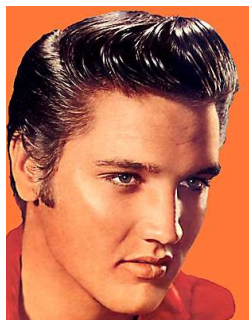# Factual Knowledge: Text

Elvis alive forever

Elvis was born in Tupelo.

He went to school in Memphis.

Elvis was a great rock star.

Factual Knowledge: Text

Elvis alive forever

Elvis was born in Tupelo.

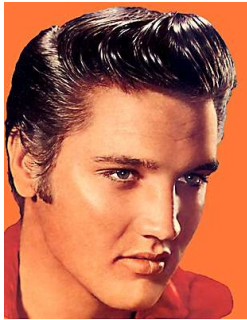He went to school in Memphis.

Elvis was a great rock star.

+

NounPhrase VerbPhrase NounPhrase

Factual Knowledge: Text

Elvis alive forever

Elvis was born in Tupelo.

He went to school in Memphis.

Elvis was a great rock star.

+

NounPhrase VerbPhrase NounPhrase

=

Elvis	was born in	Tupelo
He	went to school in	Memphis
...		

Factual Knowledge: Text

Elvis alive forever

Elvis was born in Tupelo.

He went to school in Memphis.

Elvis was a great rock star.

+

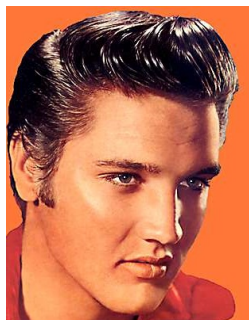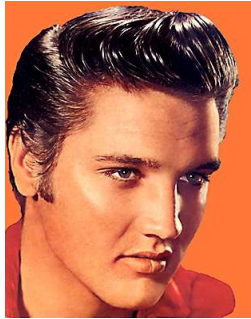NounPhrase VerbPhrase NounPhrase

∩

Freebase

=

Elvis was born in Tupelo

...

Open Information Extraction

was the king (134)

left the building (68)

was in the army (52)

was born in Tupelo, Mississippi (43)

is in the house (26)

faked his death (16)

shook his hips (14)

is God (13)

is Alive (12)

is Dead (11)

married Priscilla Presley (9)
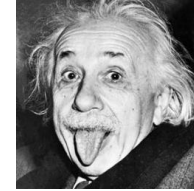
has left Living room (2)
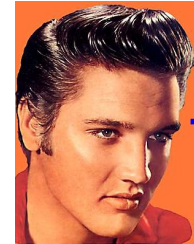

OpenIE at UW

Factual Knowledge: Reasoning

Elvis died in 528

Factual Knowledge: Reasoning
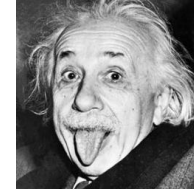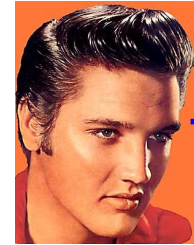
Elvis died in 528

died → 1955

born → 1935

Factual Knowledge: Reasoning

Elvis died in 528
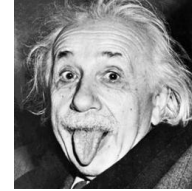

died → 1955

born → 1935

occurs("Elvis","died in",528)

Factual Knowledge: Reasoning

Elvis died in 528

Einstein died in 1955

yago
select knowledge

died → 1955

born → 1935

occurs("Elvis","died in",528)

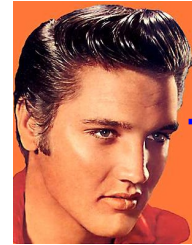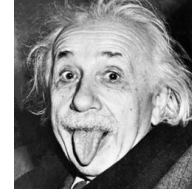occurs("Einstein","died in",1955)

Factual Knowledge: Reasoning

Elvis died in 528

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yago
select knowledge

died → 1955

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occurs("Einstein","died in",1955)

died(Einstein,1955), born(Elvis, 1935)

Factual Knowledge: Reasoning

Elvis died in 528

Einstein died in 1955

died → 1955

born → 1935

occurs("Elvis","died in",528)

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died(Einstein,1955), born(Elvis, 1935)

occurs(X',P,Y) & means(X',X) & R(X,Y) => pattern(P,R)

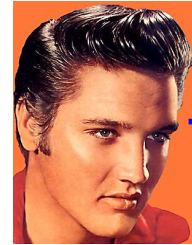occurs(X',P,Y) & means(X',X) & pattern(P,R) => R(X,Y)

Factual Knowledge: Reasoning
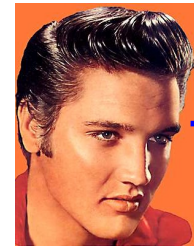
Elvis died in 528

Einstein died in 1955

died → 1955
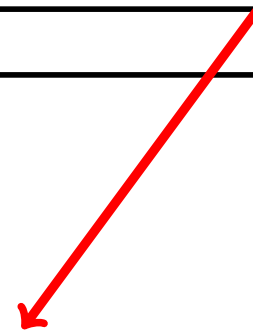
born → 1935

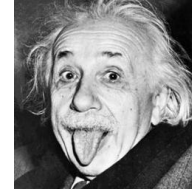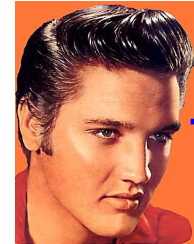occurs("Elvis","died in",528)

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occurs(X',P,Y) & means(X',X) & R(X,Y) => pattern(P,R)

occurs(X',P,Y) & means(X',X) & pattern(P,R) => R(X,Y)

born(X,Y) & died(X,Z) => Z>Y

...

SOFIE extracts by Reasoning

Elvis died in 528

Solving a
Weighted MAX SAT
problem at scale

occurs("Elvis","died in",528)

occurs("Einstein","died in",1955)

died(Einstein,1955), born(Elvis, 1935)

occurs(X',P,Y) & means(X',X) & R(X,Y) => pattern(P,R)

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...

SOFIE extracts by Reasoning
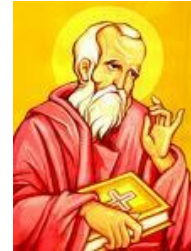
Elvis died in 528

died → 528

occurs("Elvis","died in",528)

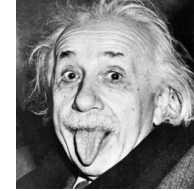occurs("Einstein","died in",1955)

died(Einstein,1955), born(Elvis, 1935)

occurs(X',P,Y) & means(X',X) & R(X,Y) => pattern(P,R)

occurs(X',P,Y) & means(X',X) & pattern(P,R) => R(X,Y)

born(X,Y) & died(X,Z) => Z>Y

...

KBs built from the Web

KnowItAll / TextRunner / ReVerb / OpenIE
(University of Washington)
- extracts arbitrary relationships ("open")

SOFIE / PROSPERA (Max Planck Institute)
- does disambiguation and reasoning

NELL / Read the Web (CMU)
- combines different extractors,
  morphosyntax, reasoning etc.

Knowledge Vault (Google)
- large-scale Information Extraction

Factual Knowledge: Challenges

- extract from different languages

- extract incrementally

  (for continuous KB growth & maintenance)

- go beyond binary relations

  (events in context: who did what to whom when, why, ...)

- tackle the long tail of entities & facts

  (beyond Wikipedia: music, book characters, products, ...)

- handle new entities

  (is "Lady Gaga" a new entity or just a new name?)

GOFAI means and ends

Means:

- gather lexical knowledge

  ProBase, PATTY, UWN, BabelNet, WebChild

- gather factual knowledge (assertions)

  from Wikipedia: DBpedia, YAGO, Freebase

  from the Web: SOFIE, NELL, KnowItAll, GKV

- gather commonsense knowledge (rules)

Commonsense knowledge

"If you have a child,

your wife is probably his mother"

$$married(x, y) \wedge hasChild(x, z) \Rightarrow hasChild(y, z)$$
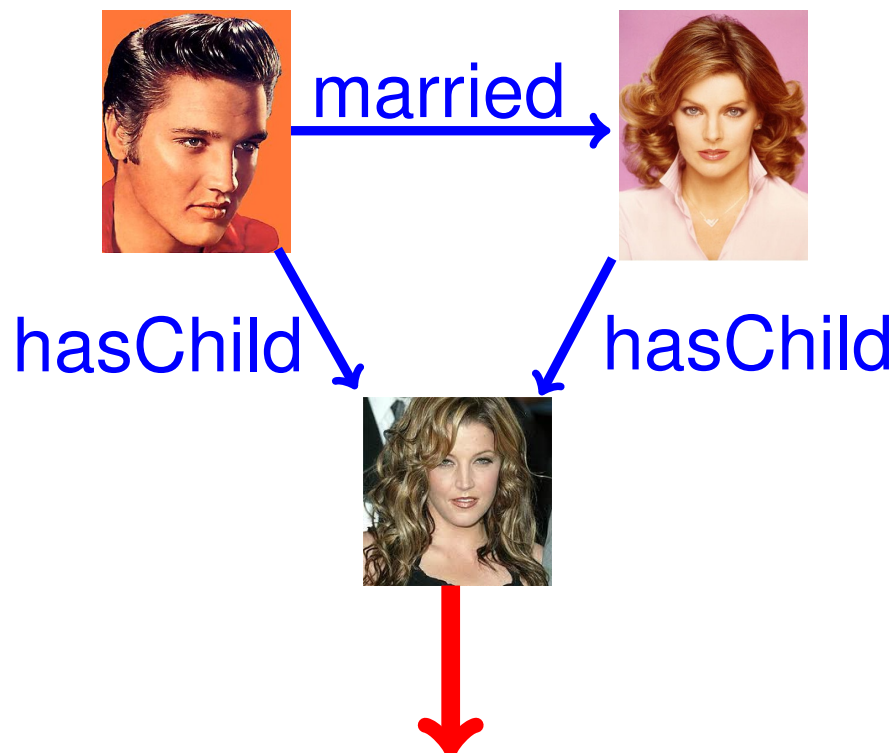
Commonsense knowledge

$$married(x, y) \land hasChild(x, z) \Rightarrow hasChild(y, z)$$

Commonsense knowledge
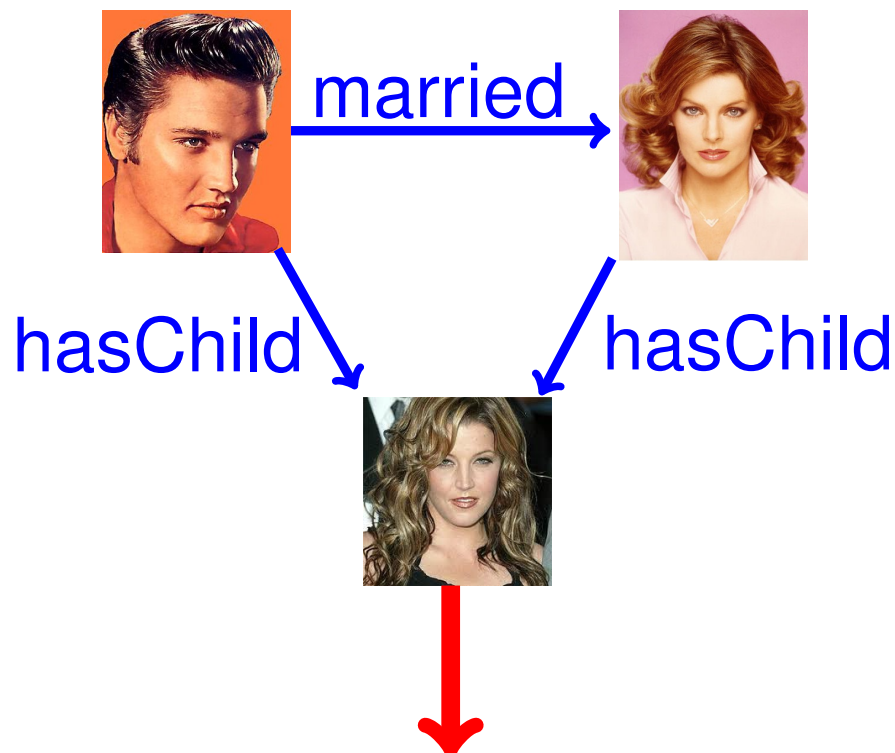
$$married(x, y) \wedge hasChild(x, z) \Rightarrow hasChild(y, z)$$

But: Rule mining needs counter examples
and RDF ontologies are positive only

Partial Completeness Assumption

hasChild

Assumption:

If we know r(x,y1),..., r(x,yn),

then all other r(x,z) are false.

(Partial closed-world assumption)

Partial Completeness Assumption

hasChild

Assumption:

If we know r(x,y1),..., r(x,yn),

then all other r(x,z) are false.

(Partial closed-world assumption)

L. Galárraga et al: "AMIE", WWW 2013

Partial Completeness Assumption

hasChild

Assumption:

If we know r(x,y1),..., r(x,yn),

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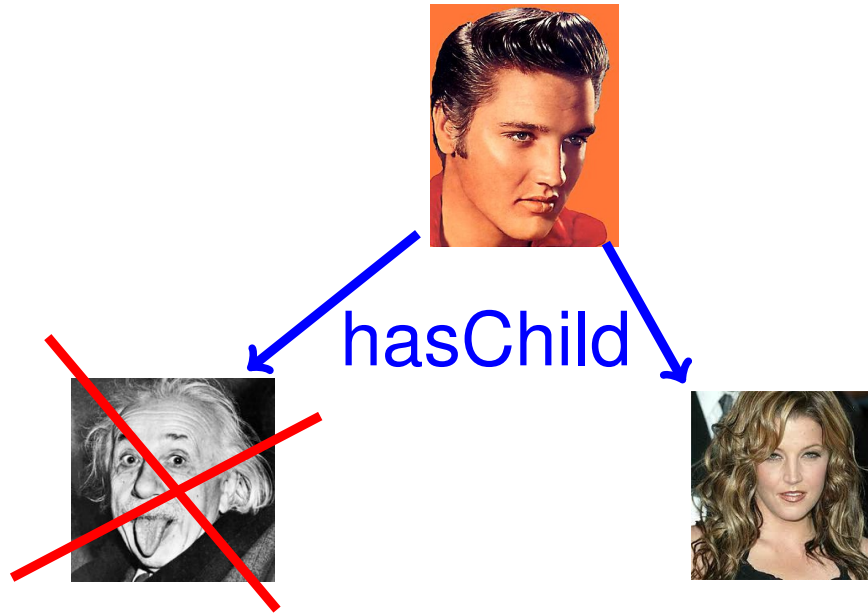
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Partial Completeness Assumption

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If we know r(x,y1),..., r(x,yn),
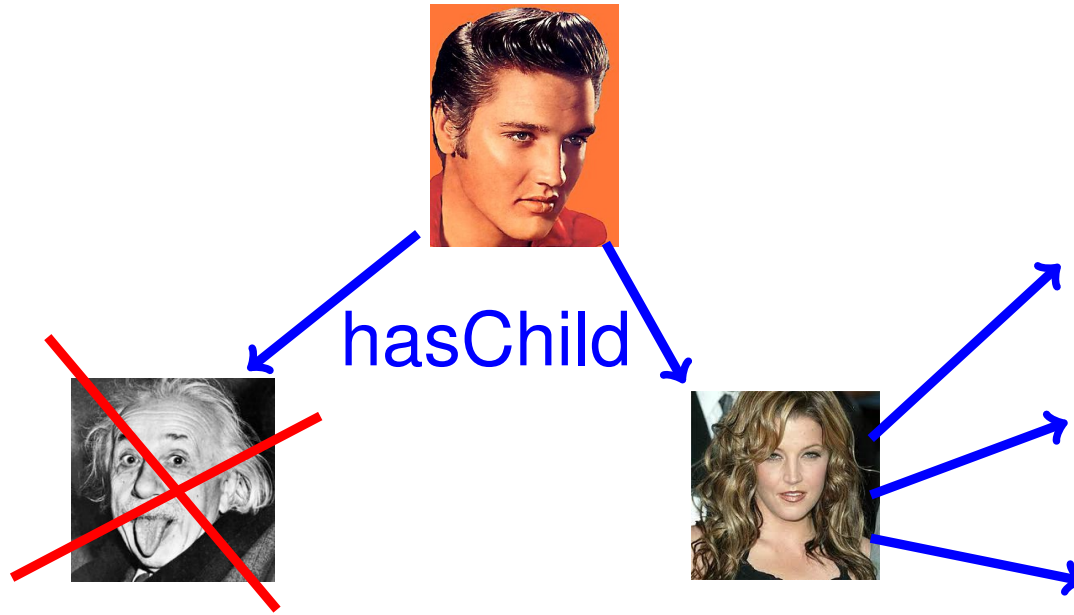
then all other r(x,z) are false.

+ an efficient implementation

(Partial closed-world assumption)

AMIE finds rules in ontologies
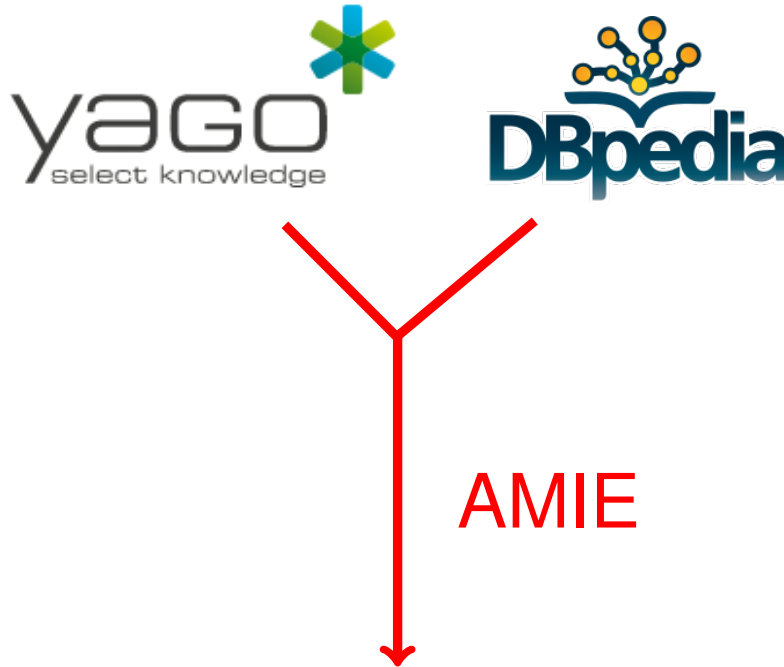
$$type(x, pope) \Rightarrow diedIn(x, Rome)$$

$$livesIn(x, y) \wedge isMarriedTo(x, z) \Rightarrow livesIn(z, y)$$

$$imports(x, chemicals) \Rightarrow hasLanguage(x, English)$$

(with confidence values)

Commonsense KB projects

AMIE (Max Planck Institute / Télécom ParisTech)

- mines logical rules from knowledge bases

ConceptNet 5
Computers just got smarter.

ConceptNet (MIT)

- learns commonsense knowledge

  through crowdsourcing

WebChild (Max Planck Institute)

- extracts commonsense knowledge

  from Web corpora

Commonsense Knowledge: Challenge

- make use of the commonsense knowledge

- involve time

- bridge knowledge with knowledge from other KBs

- revisit subsymbolic approaches?

  (Deep Learning)

"Google buys UK artificial intelligence start-up DeepMind"

BBC News 2014-01-27

DEEPMIND

GOFAI means and ends

Means:

- gather lexical knowledge

  ProBase, PATTY, UWN, BabelNet, WebChild

- gather factual knowledge

  from Wikipedia: DBpedia, YAGO, Freebase

  from the Web: SOFIE, NELL, KnowItAll, GKV

- gather commonsense knowledge

  AMIE, ConceptNet WebChild

GOFAI means and ends

Means:

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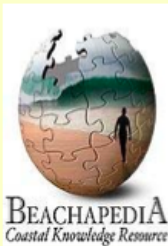
- gather commonsense knowledge

  AMIE, ConceptNet WebChild

So then, how about our ends?

Landscape

Landscape

Factual Search

AboutThisDay.com ^{BETA} *Learn about what happened on this day*

| January 8 | ? |

<< Yesterday Today Tomorrow >>

▼ Search filter

Domain: | All | Media | War | Politics | Literature | Business | Art | Religion | S

Year (range): | [   ] | (or) | From | [   ] | To | [   ]

| **All** | **Persons** | **Events** | **Holidays** |

Like us on 🅵 Facebook to get daily updates

Tweet | 230 | 8+1 | 75 | Stumble | 30 | Share | 2204 | Contact

Stephen Hawking
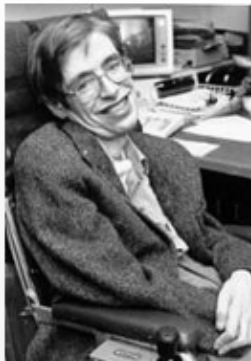
Born 1942

Elvis Presley

Born 1935

Galileo Galilei

Died 1642

96

Factual + textual search

Broccoli

"singers who are alive"

Your Query:

Singer
— occurs-with — alive +

Hits:

Elvis Presley

YAGO Ontology

Elvis Presley is a Singer.

Elaine Dundy

... that **Elvis** was **alive** ...

Grasping of words

best places to visit in new zealand

Web   Images   Maps   News   Videos   More

New Zealand > Points of interest

Milford Sound   Bay of Islands   Lake Taupo
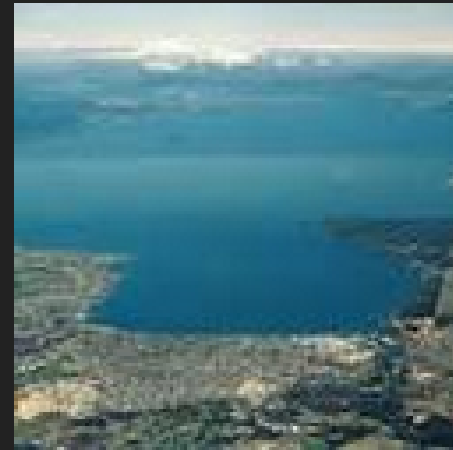
Understanding questions

Google   who was Elvis' wife?

Web   Images   Videos   Shopping   News   More ▾   Search tools

About 29,600,000 results (0.33 seconds)

Priscilla Presley (m. 1967–1973)

Elvis Presley, Spouse

Understanding questions

Who played in Casablanca and was married to a writer born in Rome | Submit

Show Intermediate Output

Download Graph

Structured Query

?m type wordnet_person_100007846 . ?m isMarriedTo ?n . ?n type
wordnet_writer_110794014 . ?m actedIn Casablanca_\u0028film\u0029 . ?n wasBornIn
Rome .

Understanding questions

fromSiriFunny

10

Understanding questions

WolframAlpha

Where do babies come from?

Input interpretation:

Where do babies come from?

Result:

From their mothers.

(through the processes of fertilization, prenatal development, and birth)

Computed by **Wolfram** *Mathematica*

Analyzing History

Le Monde + yago *select knowledge*

"Importance of foreign companies"

T. Huet, J. Biega, F. M. Suchanek: "Mining History with Le Monde", AKBC 2013
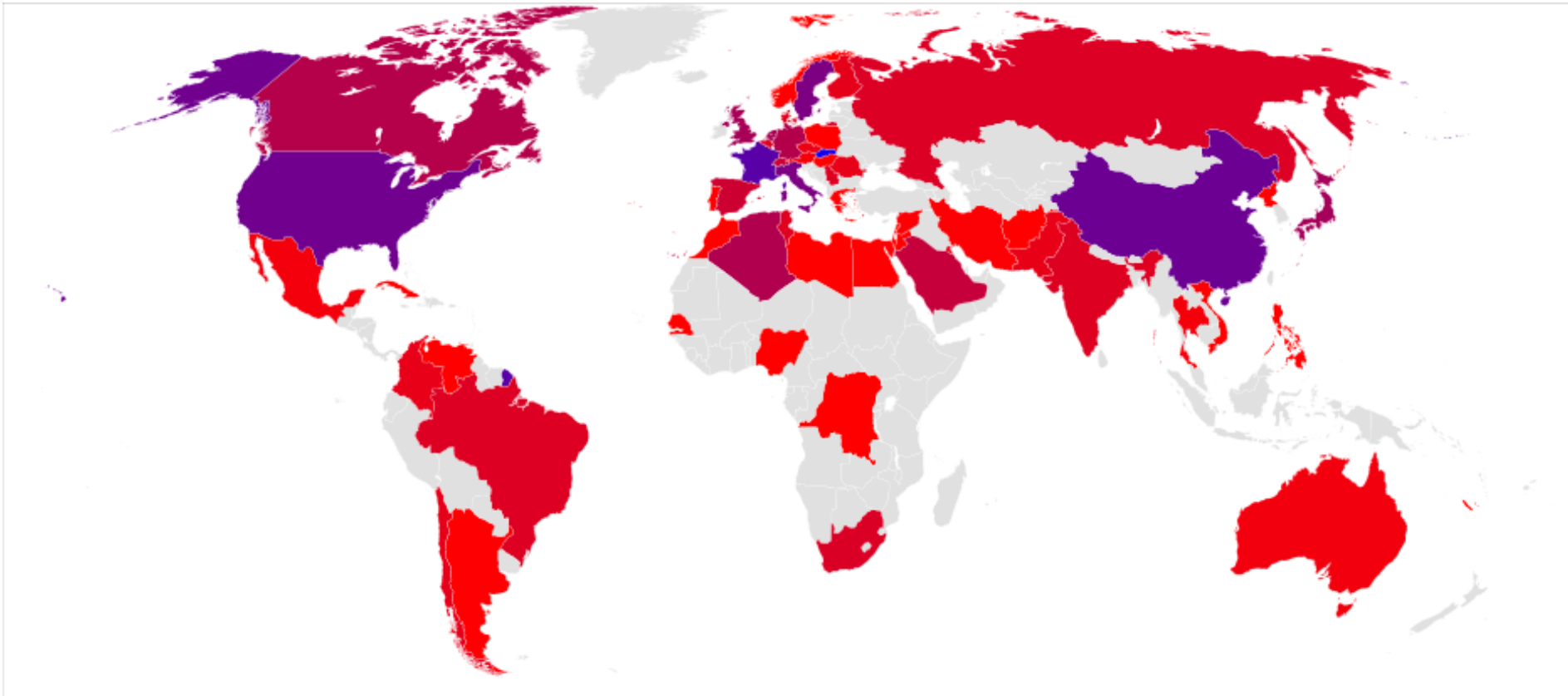
Analyzing History
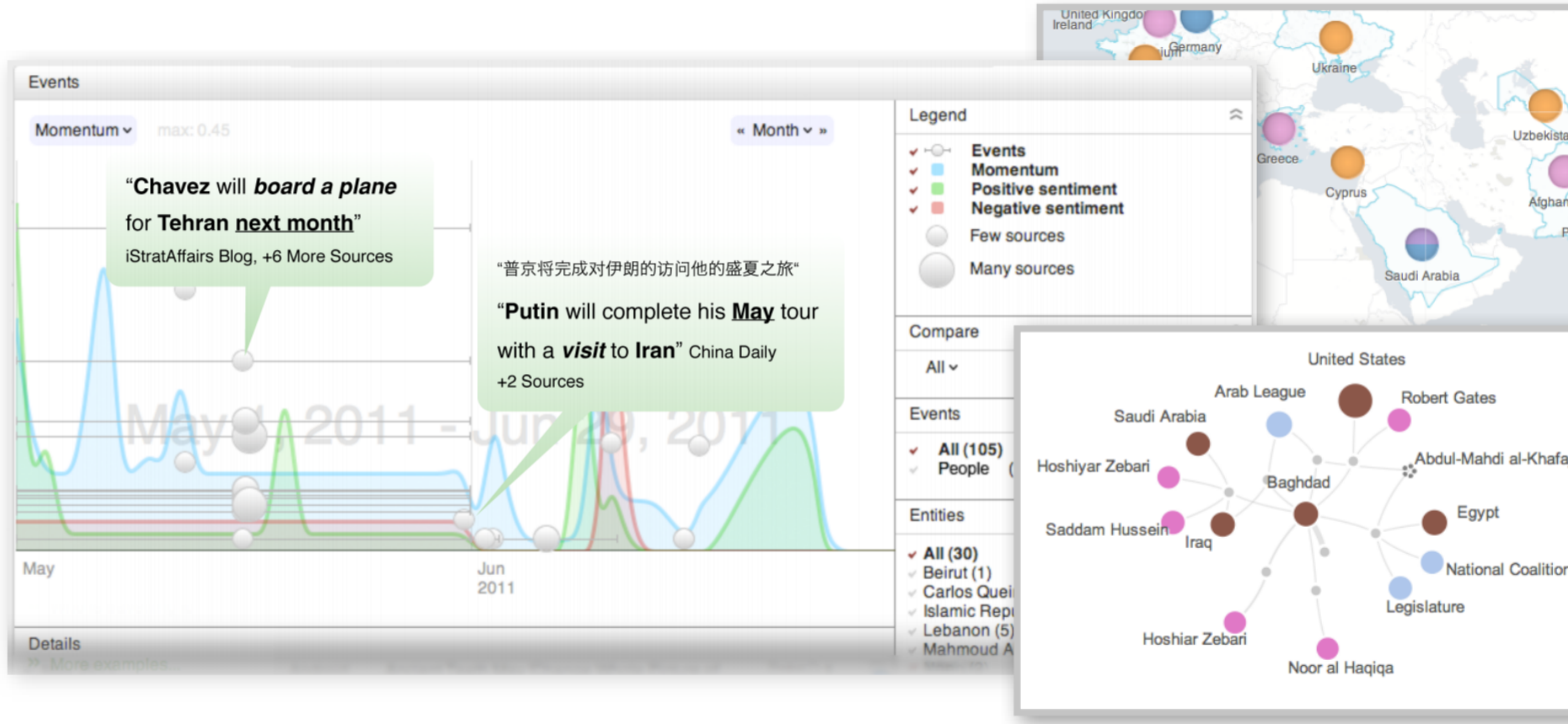
Information extracted from the news can help model and analyze political events.

RecordedFuture

Annotating Reality

5,988' (1,825 m)
Brooklyn Bridge,
Total length

Beating Humans in QA

IBM Watson is a question answering system based on many sources (i.a. YAGO & DBpedia).

It outperformed the 74-fold human winner of the Jeopardy! quizz show.

GOFAI Means and Ends

Means:

- gather lexical knowledge

- gather factual knowledge

- gather commonsense knowledge

Ends:

- understand language

  Google, Siri, Deanna

- understand world

  Wolfram Alpha, Google KG, RecordedFuture

- answer questions

  IBM Watson

Are Computers Intelligent?

- Computers can answer factual questions

- ... in natural language

- Computers can analyze events

- Computers beat humans in QA

- Oh, and computers drive cars, airplanes
  and space shuttles, and play better chess

Are Computers Intelligent?

- Computers can answer factual questions

  Yes, but this is just from a database

- ... in natural language

  Yes, but this is just database+parsing

- Computers can analyze events

  Yes, but this is just joining databases

- Computers beat humans in QA

  Yes, but this is just more of the above

- Oh, and computers drive cars, airplanes

  and space shuttles, and play better chess

  Yes, but after all, it's all computation

AI Effect

Once you have done it, it all seems obvious.

Or:

"Artificial Intelligence

is always that which

has not been done yet."

AI Effect

Once you have done it, it all seems obvious.

Or:

"Artificial Intelligence

is always that which

has not been done yet."

=> There is always

something for us to do!

Slides done with PowerLine, the free SVG slide editor with LaTex support