

# Knowledge Graph: Concepts, Applications and Challenges

from world wide web to knowledge graph

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School of Computer Science and Engineering

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# online open course: <https://github.com/npubird/KnowledgeGraphCourse>

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150

A systematic course about knowledge graph for graduate students, interested researchers and engineers.

东南大学《知识图谱》研究生课程

时间：2019年春季（2月下旬~5月中旬）

每周五下午2:00~4:30

地点：东南大学九龙湖校区，纪忠楼Y205

答疑/讨论/建议：请致信 pwang AT seu.edu.cn

## 课程内容

### 第1讲 知识图谱概论 (2019-3-1,2019-3-8)

1.1 知识图谱起源和发展

1.2 知识图谱 VS 深度学习

1.3 知识图谱 VS 关系数据库 VS 传统专家库

1.4 知识图谱本质和核心价值

1.5 知识图谱技术体系

1.6 典型知识图谱

1.7 知识图谱应用场景

课件下载:[partA](#) [partB](#) [partC](#)

### 第2讲 知识表示 (2019-3-15)

2.1 知识表示概念

2.2 知识表示方法



爱可可-爱生活

8-31 来自Mac客户端

'东南大学《知识图谱》研究生课程(资料)' by  
Peng Wang GitHub: [网页链接](#)

## 课程内容

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转发

微博

Qzone

微信

东南大学2019年最新研究生精品课程《知识图谱》资源分享

[原创] 深度学习与NLP 2019-09-15 09:50:50



# Outline

- 1. Knowledge Graph Concepts
- 2. Classical Knowledge Graphs
- 3. Knowledge Graph Applications
- 4. Challenges

# Historic AI events in last decades

cognitive intelligence

NLP  
ML  
IR  
QA  
knowledge graph  
.....



2011 IBM Watson



2011 Palantir



2016 Google AlphaGo



2017 CMU Libratus

cognitive intelligence

Big data  
Data visualization  
knowledge graph  
.....

perceived intelligence

DL  
MC-Tree

general intelligence

Game theory  
Nash equilibrium  
.....

## Historic AI events in last decades

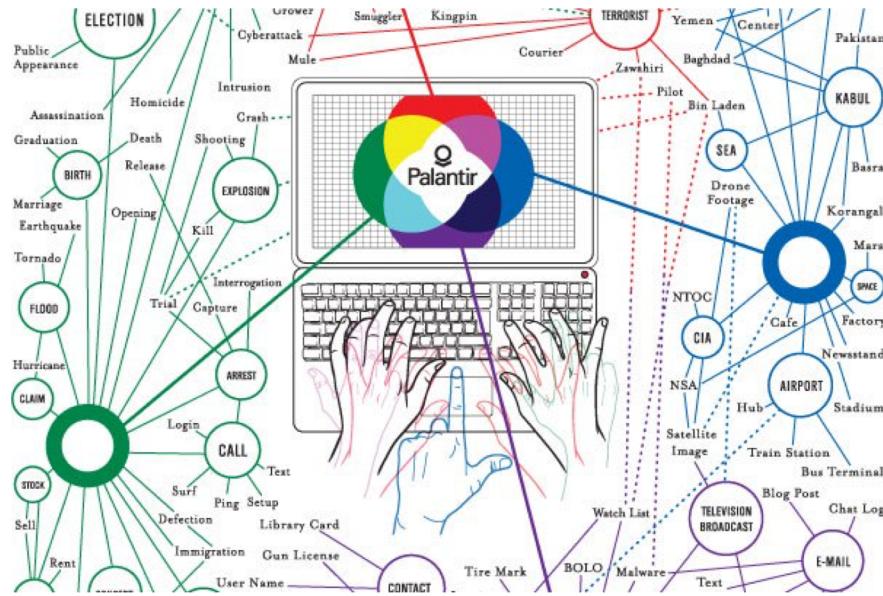
In February 2011, IBM's Watson Wins Practice Jeopardy Round.



- Beginning of the era of cognitive intelligence
  - Key techniques in Watson: **knowledge graph**, NLP, machine learning, information retrieve, question answer, ...

# Historic AI events in last decades

In 2011, Palantir helped in tracking down bin Laden.



- Intelligence big data analysis  
Palantir VS Google

Google: Organize the world's **public information** and make it universally **accessible** and useful

Palantir: Organize the world's **private information** and make it universally accessible and **useful**

- Key techniques in Palantir: big data analysis and visualization, **knowledge graph**, ...

# Historic AI events in last decades

In 2016, Google's AlphaGo AI defeats human champion in game of Go.

In 2017, more powerful AlphaZero

第一局 (3月9日)	第二局 (3月10日)	第三局 (3月12日)	第四局 (3月13日)	第五局 (3月15日)
 AlphaGo胜	 AlphaGo胜	 AlphaGo胜	 李世石胜	 AlphaGo胜



# Historic AI events in last decades

- Go has long been seen as final bastion of human intelligence.
- Key techniques in AlphaGo: deep learning (value network, policy network) 、 monte carlo tree search
- In 2006, Geoffrey Hinton, Yann LeCun and Yoshua Bengio broke the bottleneck of deep learning: simpler optimization, unsupervised training, bigger training dataset, more powerful computing.

## Historic AI events in last decades

In 2017, Libratus, an artificial intelligence developed by CMU, made history by defeating four of the world's best professional poker players in a marathon 20-day poker competition.



# Historic AI events in last decades

- Not perfect game
  - Key techniques: nash equilibrium, Reinforcement Learning  
NIPS2017 best paper

Cognitive  
intelligence

Understanding language, reasoning, using knowledge



Machine is beyond human in knowledge quantity, but is behind human in reasoning and understanding.

Perceived  
intelligence

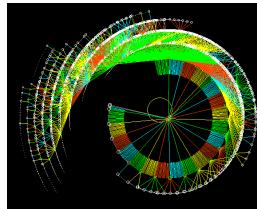
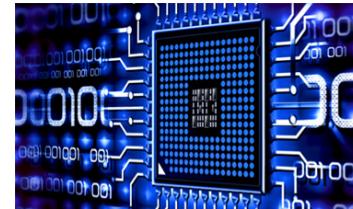
seeing, hearing



Machine is close to or beyond human in some tasks

Computing  
intelligence

processing data with rules and algorithms

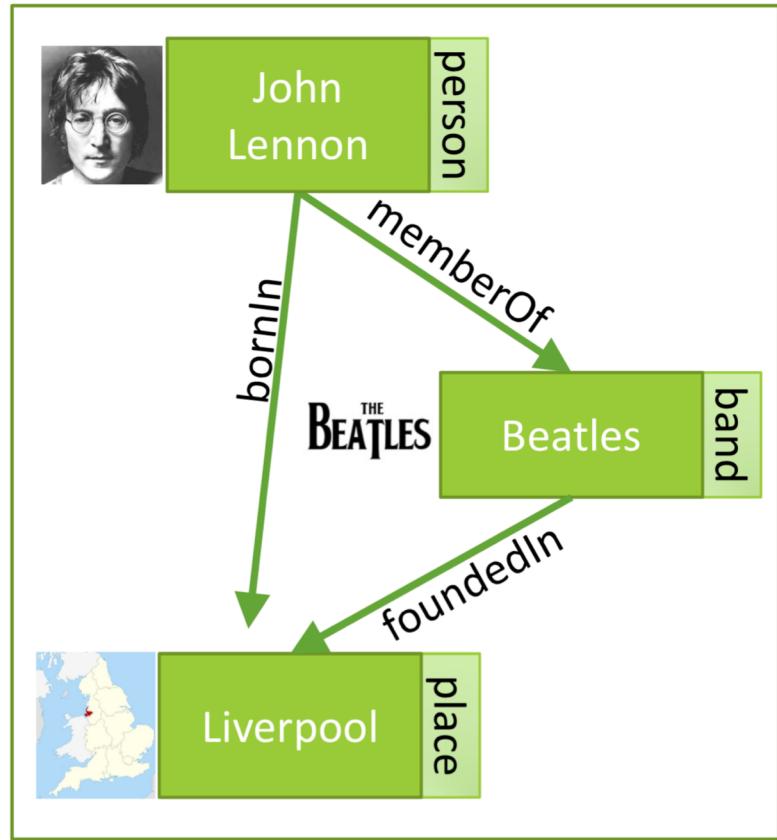


Machine is beyond human

# What is knowledge graph

## The graph representation of knowledge

- contains: concept, property, entity, relation
- Node is entity
- Node has concept/property label
- Edge is relation between entities



# knowledge graph vs deep learning



## Deep Learning



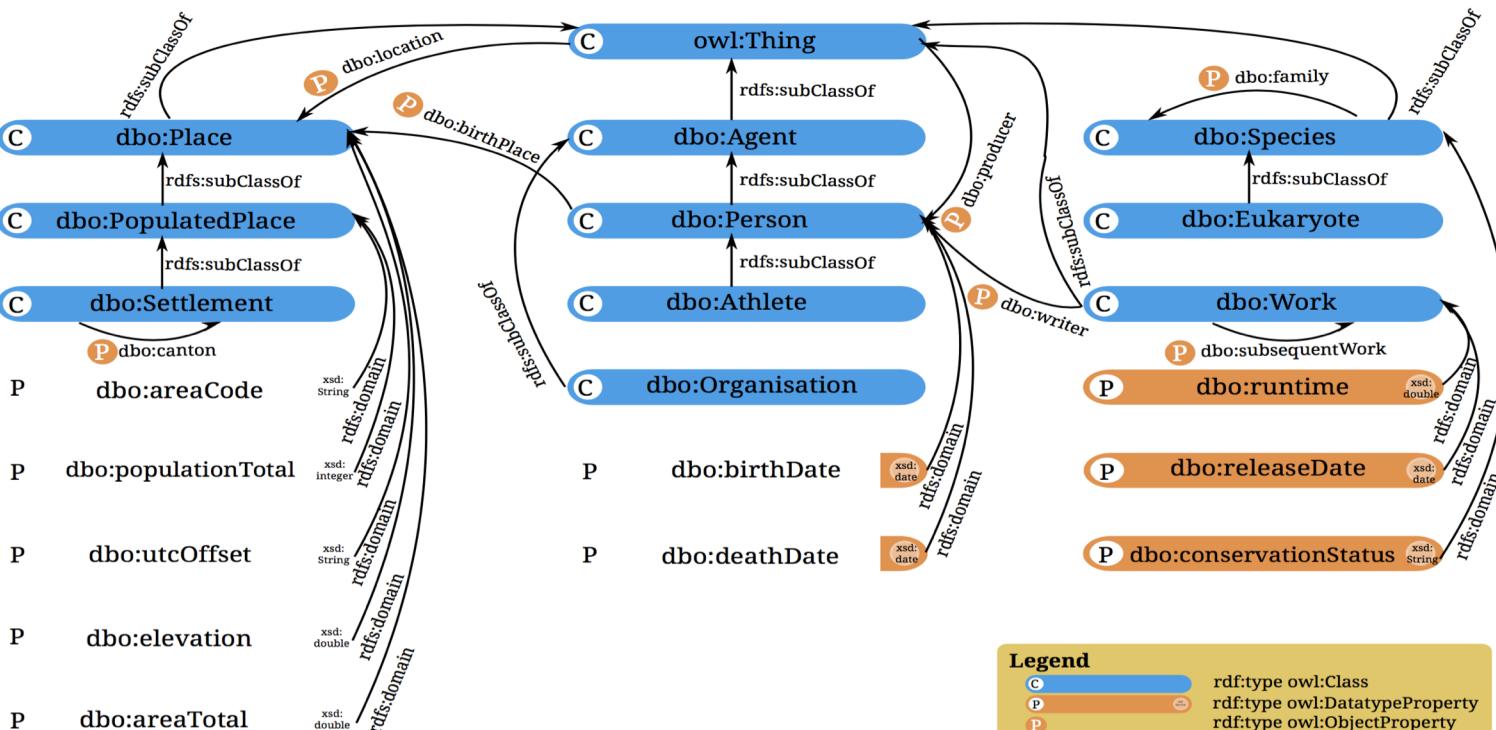
## Knowledge Graph

intelligence principle	<ul style="list-style-type: none"> <li>simple and implicit simulation for human brain</li> </ul>	<ul style="list-style-type: none"> <li>explicit simulation for human thinking</li> </ul>
scenario	<ul style="list-style-type: none"> <li>Tasks in perceived intelligence</li> <li>voice、image、video</li> </ul>	<ul style="list-style-type: none"> <li>General tasks</li> <li>Search, human-computer interaction</li> </ul>
features	<ul style="list-style-type: none"> <li>Big training data</li> <li>Powerful computing</li> <li>Hard interpretation</li> </ul>	<ul style="list-style-type: none"> <li>Mass knowledge</li> <li>Interpretable</li> </ul>
development	<ul style="list-style-type: none"> <li>Close or beyond human in some tasks</li> </ul>	<ul style="list-style-type: none"> <li>Beyond human in knowledge quantity</li> <li>Behind human in knowledge reasoning</li> </ul>
trend	<ul style="list-style-type: none"> <li>Deep fusion in the future</li> </ul>	

# knowledge graph vs knowledge base vs database

	semantic	data	application
<b>relational database</b>	no semantics	plentiful data	success
<b>knowledge base</b>	plentiful semantics	few instances	unsuccessful
<b>knowledge graph</b>	few semantics	plentiful instances	success

# knowledge graph vs knowledge base vs database



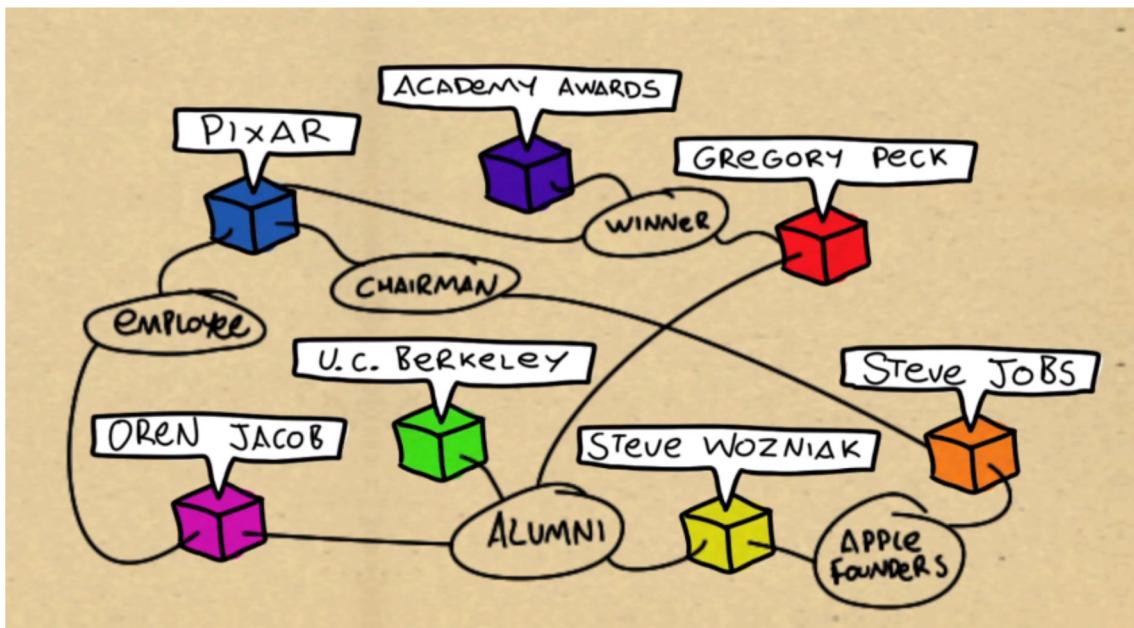
few semantics, plentiful instances

DBPedia: 685 concepts 2795 properties 4,233,000 instances

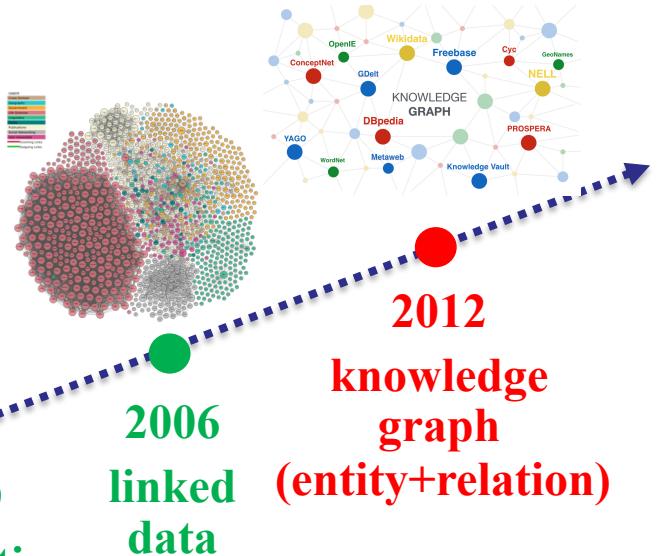
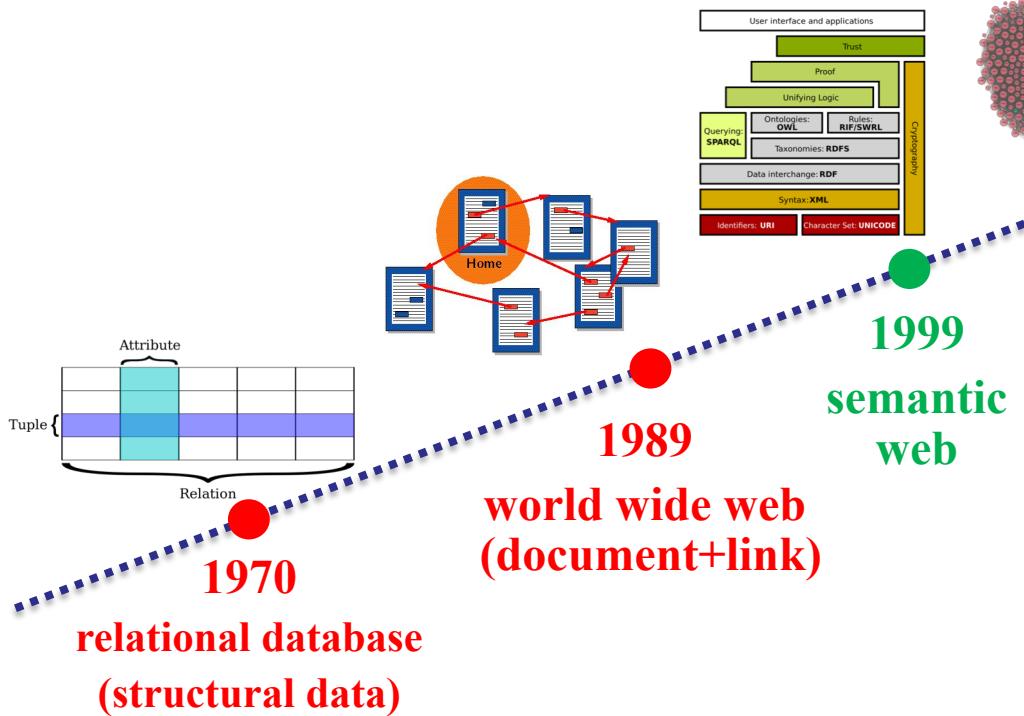
# The essential of knowledge graph

The world is **not** made of **strings** ,  
but is made of **things**

万物及其联系的网络



# The revolution of information organization



2012  
knowledge  
graph  
(entity+relation)

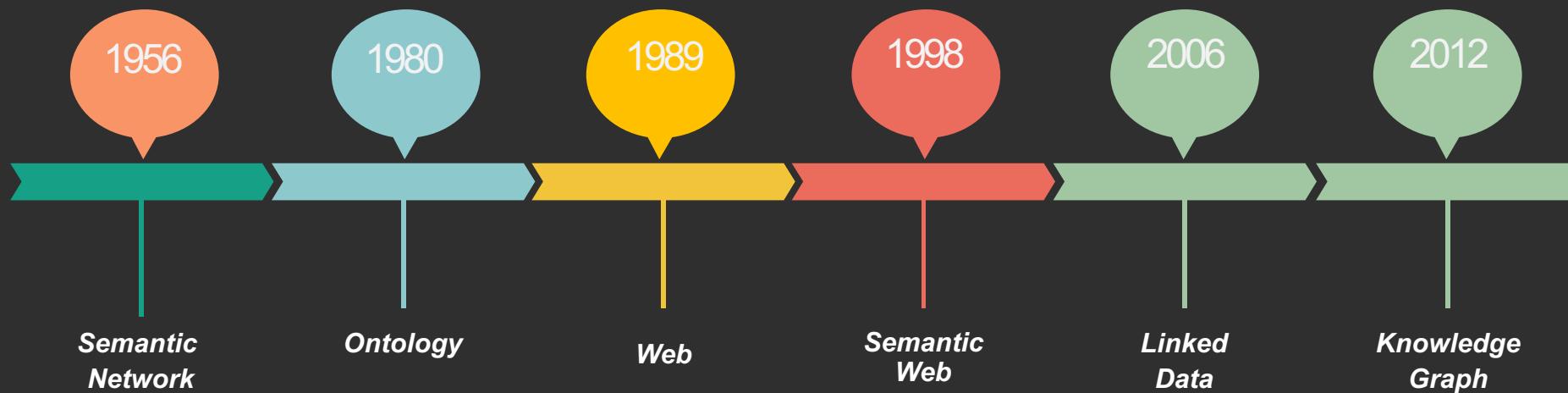
# What is knowledge

Knowledge is a **familiarity**, **awareness**, or **understanding** of someone or something, such as **facts**, **information**, **descriptions**, or **skills**, which is acquired through **experience** or **education** by **perceiving**, **discovering**, or **learning**.

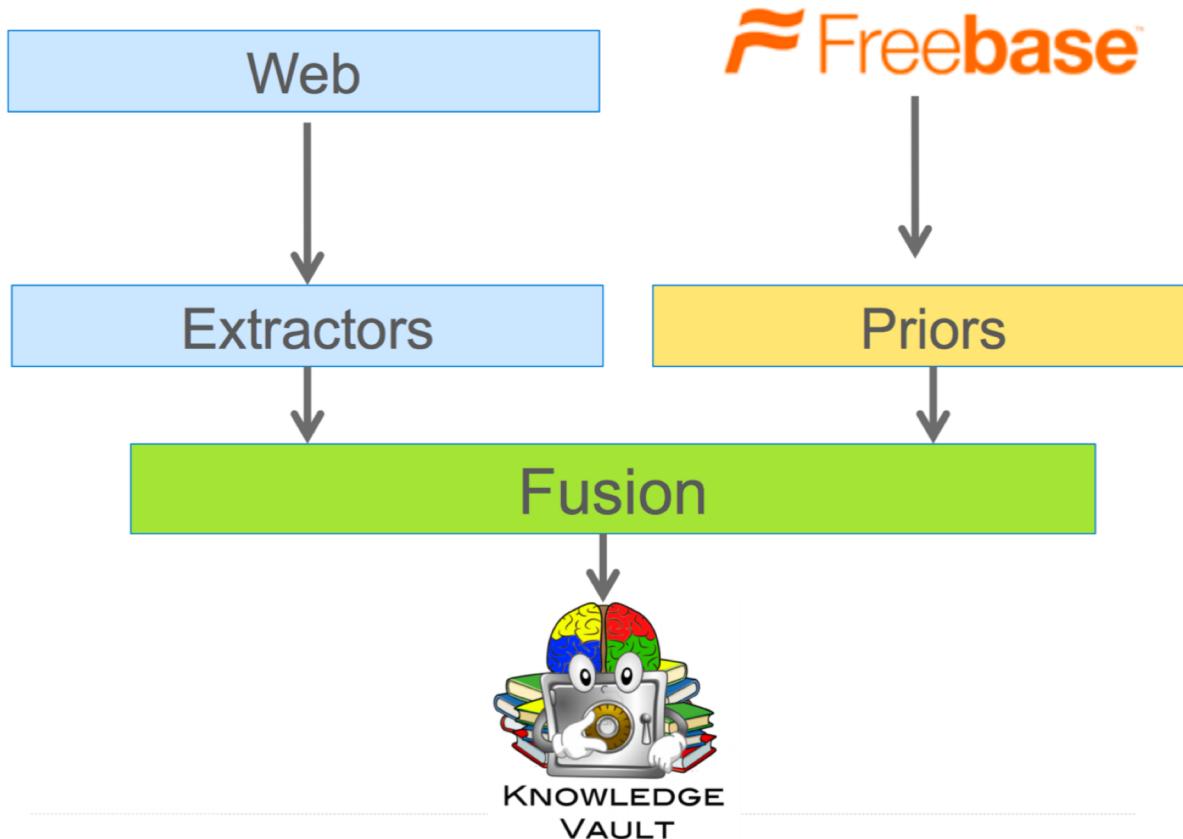
——wikipedia

# The evolution of knowledge graph

Google announced Knowledge Graph on May 16, 2012, as a way to significantly enhance the value of information returned by Google searches.



# Google knowledge graph



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# CYC

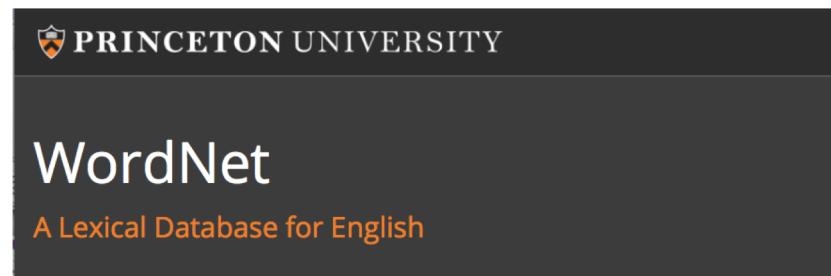
- Cyc is built from **1984-current**, leaded by Douglas Lenat
- Goal: The world's largest commonsense knowledge base. For example: Every tree is a plant, Plants die eventually, ...
- Cyc is composed of **Terms** and **Assertions**. Terms contains definitions of concepts, relations and entities. Assertions is relationships between terms, which include facts and rules.
- Current Cyc has **500,000 terms** and **7,000,000 assertions**.
- Cyc provides a open version: **OpenCyc**



# WordNet

- WordNet is the most famous lexical database, and built by princeton university from 1985.
- In WordNet, nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept. Synsets are interlinked by means of conceptual-semantic and lexical relations.
- WordNet 3.0 contains more than 150,000 words and 200,000 lexical relations.

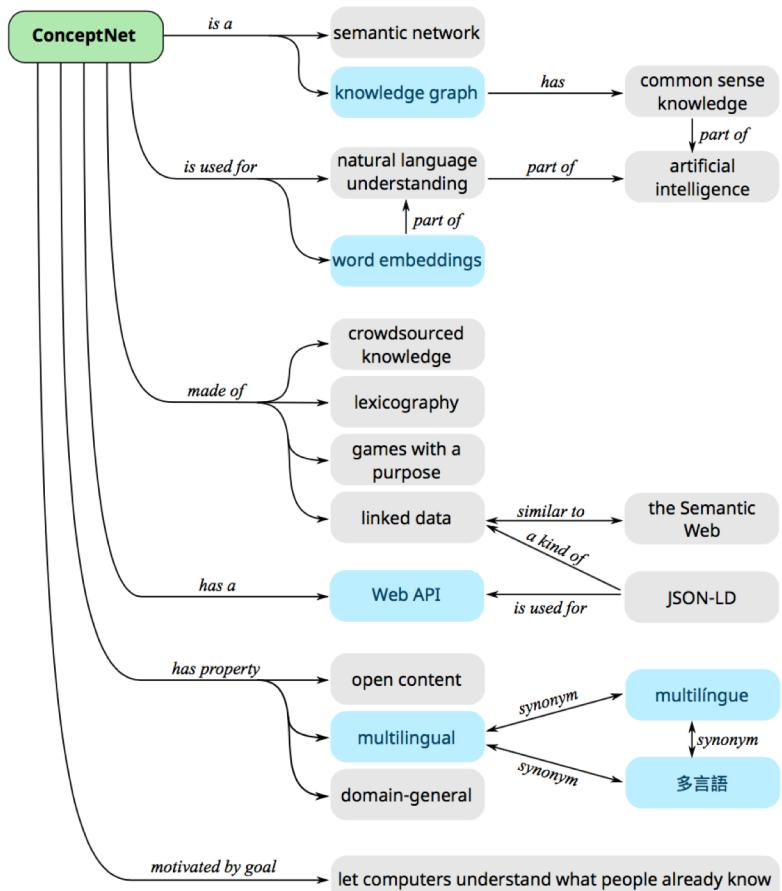
<https://wordnet.princeton.edu>



# ConceptNet

- ConceptNet is a commonsense knowledge base.
- ConceptNet originated from the crowdsourcing project Open Mind Common Sense, which was launched in 1999 at the MIT Media Lab (proposed by Marvin Minsky ). It has since grown to include knowledge from other crowdsourced resources, expert-created resources, and games with a purpose.
- ConceptNet is composed of triple style knowledge  $\langle s, r, t \rangle$ . ConceptNet5 contains more than 28,000,000 triples.
- 与Cyc相比，ConceptNet采用了非形式化、更加接近自然语言的描述，而不是像Cyc那样采用形式化的谓词逻辑
- 与链接数据和谷歌知识图谱相比，ConceptNet比较侧重于词与词之间的关系。从这个角度看，ConceptNet更加接近于WordNet，但是又比WordNet包含的关系类型多。此外，ConceptNet完全免费开放，并支持多种语言

# ConceptNet



## en marvin minsky

An English term in ConceptNet 5.5

Sources: Open Mind Common Sense contributors and DBpedia 2015

View this term in the API

### Synonyms

- ar مارفن مینسکی →
- az marvin minski →
- bn মার্ভিন মিনস্কি →
- ca marvin minsky →
- cs marvin minsky →
- de marvin minsky →
- es marvin minsky →
- et marvin minsky →
- fa مارفون مینسکی →
- fi marvin minsky →
- fr marvin minsky →
- gr marvin minsky →
- he חארווין מינסקי →
- is marvin lee minsky →
- it marvin minsky →
- ja マービン・ミンスキ →
- ko 마린 맘신키 →
- lt marvin minsky →
- lv marvin minsky →
- nl marvin minsky →
- pt marvin minsky →
- ru марвин мински →
- sv marvin minsky →
- tr marvin minsky →
- uk مارفین مینسکی →
- zh 马文·明斯基 →
- zh-hant 馬文·明斯基 →

marvin minsky is a type of...

- en a computer scientist →
- en an expert on artificial intelligence →
- en scientist (n) →

### Links to other sites

- dbpedia.org Marvin Minsky →
- wikidata.dbpedia.org Q204815 →

marvin minsky  
 /r/dbpedia/field

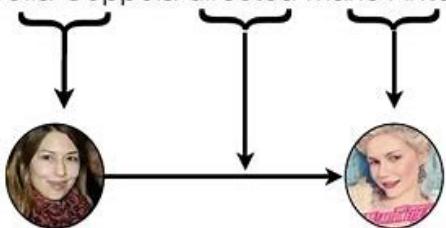
- en artificial intelligence →
- en cognitive science →
- en computer science →
- en philosophy of mind →

# Freebase

- Freebase is built by Metaweb, purchased by Google in July 16, 2010.
- Freebase aimed to create a global resource that allowed people to access common information more effectively.
- Freebase contains 1,900,000,000 triples.

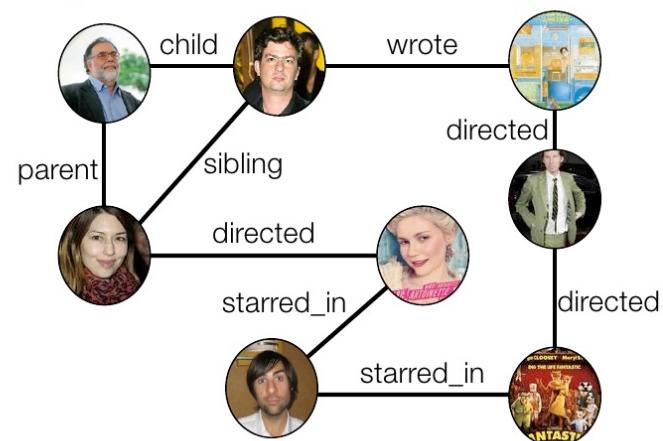
Freebase is a collection of facts

Sofia Coppola directed Marie Antoinette



Freebase only contains  
nodes and Links

Explore the Freebase Graph

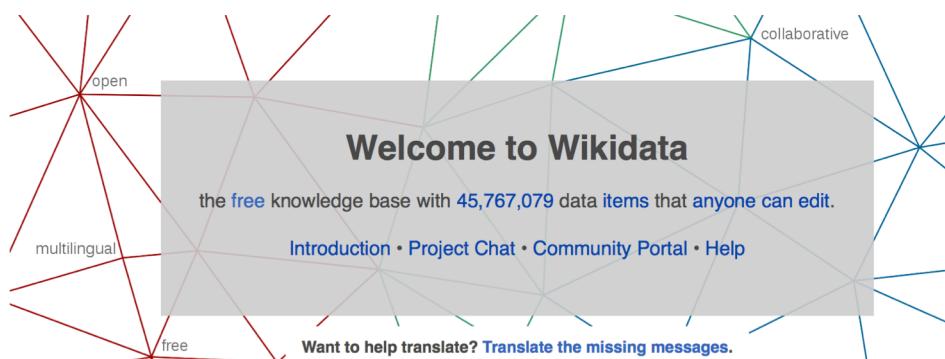


Wednesday, December 8, 2010

<https://developers.google.com/freebase/>

# Wikidata

- Wikidata is a collaboratively edited knowledge base hosted by the Wikimedia Foundation.
- Wikidata 是一个人人可编辑的知识库。其核心概念是 entity，可以指一个现实中的对象或一个抽象概念。每个 item 都有标签（label）、描述（description）、别名（aliases），使不同的 item 得以区分。而 item 中的具体数据被称为 statement，一个 item 可以有许多 statement。statement 的具体结构图中已经表示的很明白了，由属性（property）、数值（value）、修饰成分（qualifier）、参考资料（reference）等部分组成。



[https://www.wikidata.org/wiki/Wikidata:Main\\_Page](https://www.wikidata.org/wiki/Wikidata:Main_Page)

# DBpedia

- DBpedia is a project aiming to extract structured content from the information created in the Wikipedia project. DBpedia allows users to semantically query relationships and properties of Wikipedia resources, including links to other related datasets.
- Tim Berners-Lee described DBpedia as one of the most famous parts of the decentralized Linked Data effort.
- DBpedia uses RDF semantics, and contains 3,000,000,000 RDF triples.



<http://wiki.dbpedia.org>

# YAGO

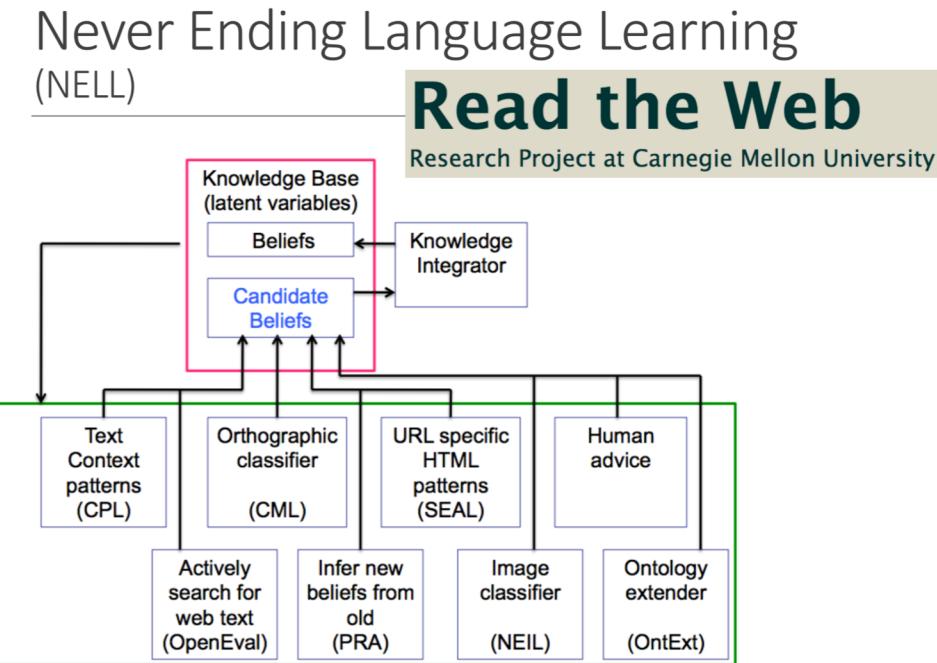
- YAGO is a huge semantic knowledge base, derived from Wikipedia WordNet and GeoNames.
- Currently, YAGO3 has knowledge of more than 17 million entities (like persons, organizations, cities, etc.) and contains more than 150 million facts about these entities.
- YAGO considers temporal and spatial knowledge.



<https://www.mpi-inf.mpg.de/departments/databases-and-information-systems/research/yago-naga/yago/#c10444>

# NELL

- NELL(Never-Ending Language Learner) is a semantic machine learning system developed by Carnegie Mellon University. NELL can automatically extract triple knowledge from Web.
- Currently, NELL has extracted 4,000,000 triples



<http://rtw.ml.cmu.edu/rtw/>

# OpenIE



## Open Information Extraction

[openie.allenai.org](http://openie.allenai.org)

Hosted by



Created at



Argument 1: entity:The Beatles

Relation:

Argument 2:

All

Search

all

location (21)

film location (18)

statistical region (16)

name source (15)

travel destination (14)

misc.

[more types](#)

were bigger than Jesus (100)

came to America (95)

appeared on **The Ed Sullivan Show** (88)

broke up in 1970 (56)

Here Comes the Sun (46)

came to America (45)

is for the future (44)

are a great band (42)

perform on **The Ed Sullivan Show** (39)

were **Musical ensemble** (36)

**are a great band** ►

**Extracted Synonyms:**

were  
is  
was

**Extracted from these sentences:**

are **The Beatles are the best band** , hands down but Oasis did make a great cover . (via ClueWeb12)

**The Beatles are a great band** . (via ClueWeb12)

**The Beatles are the best band** . (via ClueWeb12)

**The Beatles are the greatest band** ... Started 1 month ago by georgedcc Yeah , Songs in the Key of Life is a bit much for 1 listen . (via ClueWeb12)

**The Beatles** , arguably , are **the greatest band** , and may or may not have the greatest name . (via ClueWeb12)

The point is , from my view , **The Beatles are a good band** , but way behind the greatest artists to ever grace rock . (via ClueWeb12)

# Open IE Systems

2007

2010

2012

2014

2016



OpenIE v 1.0

TextRunner

v 2.0

ReVerb

v 3.0

OLLIE

OpenIE 4.0

OpenIE 5.0

CRF

Self-training

POS-tag

based  
relation  
extraction

Dependency

parse based  
extraction

SRL-based

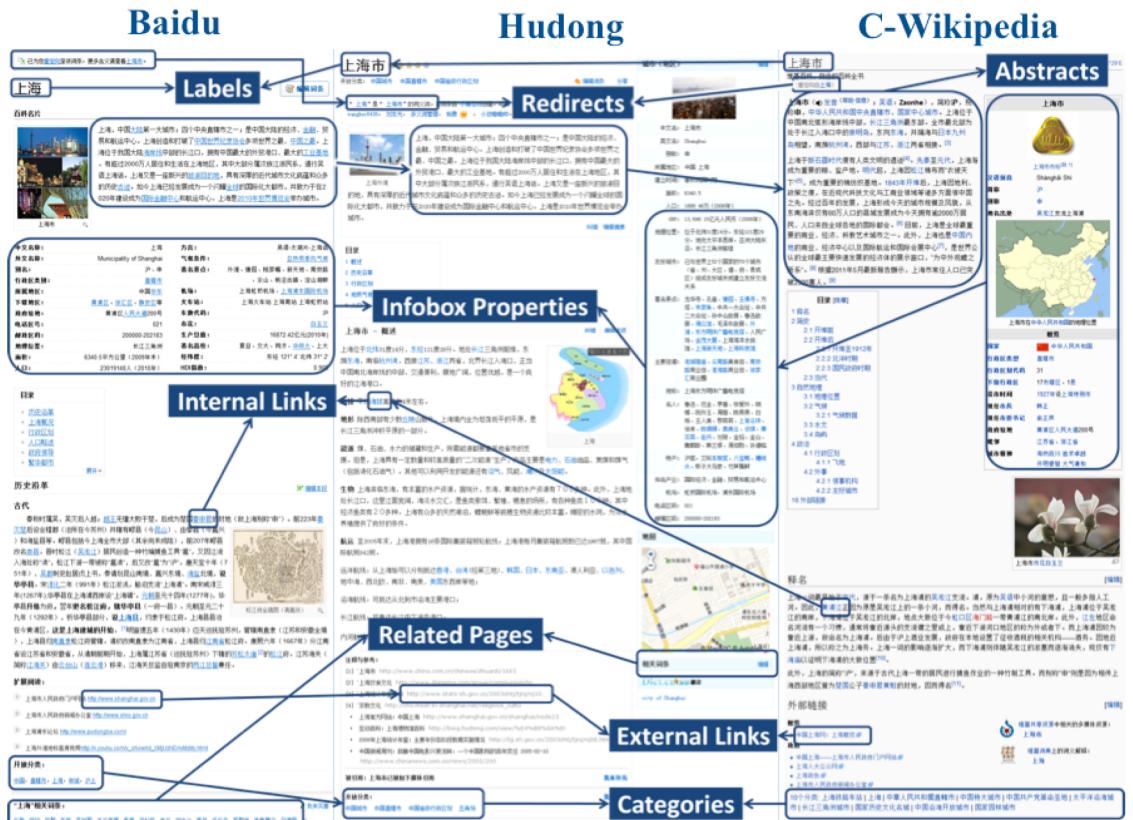
extraction;  
temporal,  
spatial  
extractions

Supports

compound  
noun  
phrases;  
numbers;  
listsA smaller green arrow pointing from left to right, spanning the years from 2007 to 2016.  
Increase in precision, recall, expressiveness

# ZhiShi.me

- ZhiShi.me is the first large scale Chinese knowledge graph based on wikipedia(Chinese part), baike and hudong.



# ZhiShi.me

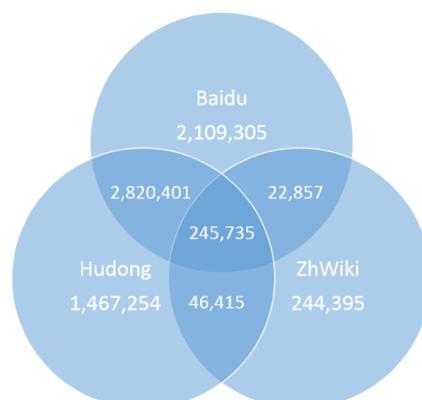


About  
Lookup  
SPARQL  
Publications  
Credits  
API

Zhishi.me is an effort to build Chinese Linking Open Data. Currently, it covers three largest Chinese encyclopedias:  
Baidu Baike, Hudong Baike and Chinese Wikipedia.

Dataset overview:

- 5,198,298 entities from Baidu Baike
- 4,579,805 entities from Hudong Baike
- 559,402 entities from Chinese Wikipedia (zhwiki)



<http://zhishi.me>

# BabelNet

- BabelNet is a multilingual lexicalized semantic network and ontology developed at the Sapienza University of Rome. BabelNet was automatically created by linking Wikipedia to the most popular computational lexicon of the English language, WordNet. The integration is done using an automatic mapping and by filling in lexical gaps in resource-poor languages by using statistical machine translation. The result is an "encyclopedic dictionary" that provides concepts and named entities lexicalized in many languages and connected with large amounts of semantic relations.
- Similarly to WordNet, BabelNet groups words in different languages into sets of synonyms, called Babel synsets. For each Babel synset, BabelNet provides short definitions in many languages harvested from both WordNet and Wikipedia.



# BabelNet

北京

CHINESE

6 SELECTED

TRANSLATE

 PREFERENCES

All

## Concepts

## Named Entities



8 results

## Noun



北京市、北京、北平市

北京市，简称“京”，是中华人民共和国首都、直辖市、中国国家中心城市和京津冀城市群的重要组成部分，是中国的政治、文化、科技创新和国际交往中心，具有重要的国际影响力。

EN Beijing, Peiping, Peking

FR Pékin, Beiping

DE Peking, Beijing

JA 北京, 北京市, ペキン

RU Пекин, Бэйцзин, Пекин

**ES** Pekín, Beijing, capital de China

bn:00009674n | Named Entity



大名府, 北京, 北京大名府

大名府又称北京大名府，中国古代的重要府衙之一，在今天的邯郸市大名县，辖境大约相当于今河北省邯郸市的一部分土地。河南省濮阳市南区、濮阳县、清丰县、南乐县、安

# BabelNet

Chinese

English

French

German

Japanese

Russian

Spanish

Arabic

Greek



all preferred languages

- Dictionary
- Images
- Translations
- Sources
- Categories
- Compounds
- Other forms
- External Links



• bn:00009674n • NOUN • Named Entity • Categories:  
1928年建立的行政区划, 1949年废除的行政区划, 中国历代国都, 中国特大城市...

ZH 北京市 (声) · 北京 (声) · 北平市 (声) · 京都特别市 (声) · 北平特别市 (声)

北京市, 简称“京”, 是中华人民共和国首都、直辖市、中国国家中心城市和京津冀城市群的重要组成部分, 是中国的政治、文化、科技创新和国际交往中心, 具有重要的国际影响力。 (声) [Wikipedia](#)

+ More definitions

IS A

首都 • 国都 • 国家中心城市



PART OF

中华人民共和国 • 华北地区 • 京津冀城市

群

故宫 • 故宫

CAPITAL OF

中华人民共和国 • 清朝 • 台湾



CONTAINS ADMINISTRA...

丰台 • 石景山 • 房山



CONTINENT

亚洲

COUNTRY

中华人民共和国 • 中华民国

EXECUTIVE BODY

北京市人民政府

+ More relations

HAS PART

故宫 • 故宫

CAPITAL OF

中华人民共和国 • 清朝 • 台湾



CONTAINS ADMINISTRA...

丰台 • 石景山 • 房山



CONTINENT

亚洲

COUNTRY

中华人民共和国 • 中华民国

EXECUTIVE BODY

北京市人民政府

EN Beijing (声) · Peiping (声) · Peking (声) · Beiping (声) · capital of Red China

Capital of the People's Republic of China in the Hebei province in northeastern China; 2nd largest Chinese city. [WordNet](#)

FR Pékin (声) · Beiping (Pékin)

Pékin, également appelée Beijing, est la capitale de la République populaire de Chine. [Wikipedia](#)

DE Peking (声) · Beijing

Peking ist die Hauptstadt der Volksrepublik China. [Wikipedia](#)

IS A

Hauptstadt • Kapitale



JA 北京 (声) · 北京市 (声) · ペキン

北京市 (ペキンし、中国語: 北京市、拼音: Bēijīng、英語: Beijing) は、中華人民共和国の首都である。 [Wikipedia](#)

RU Пекин (声) · Бэйцзин (声) · Пекин

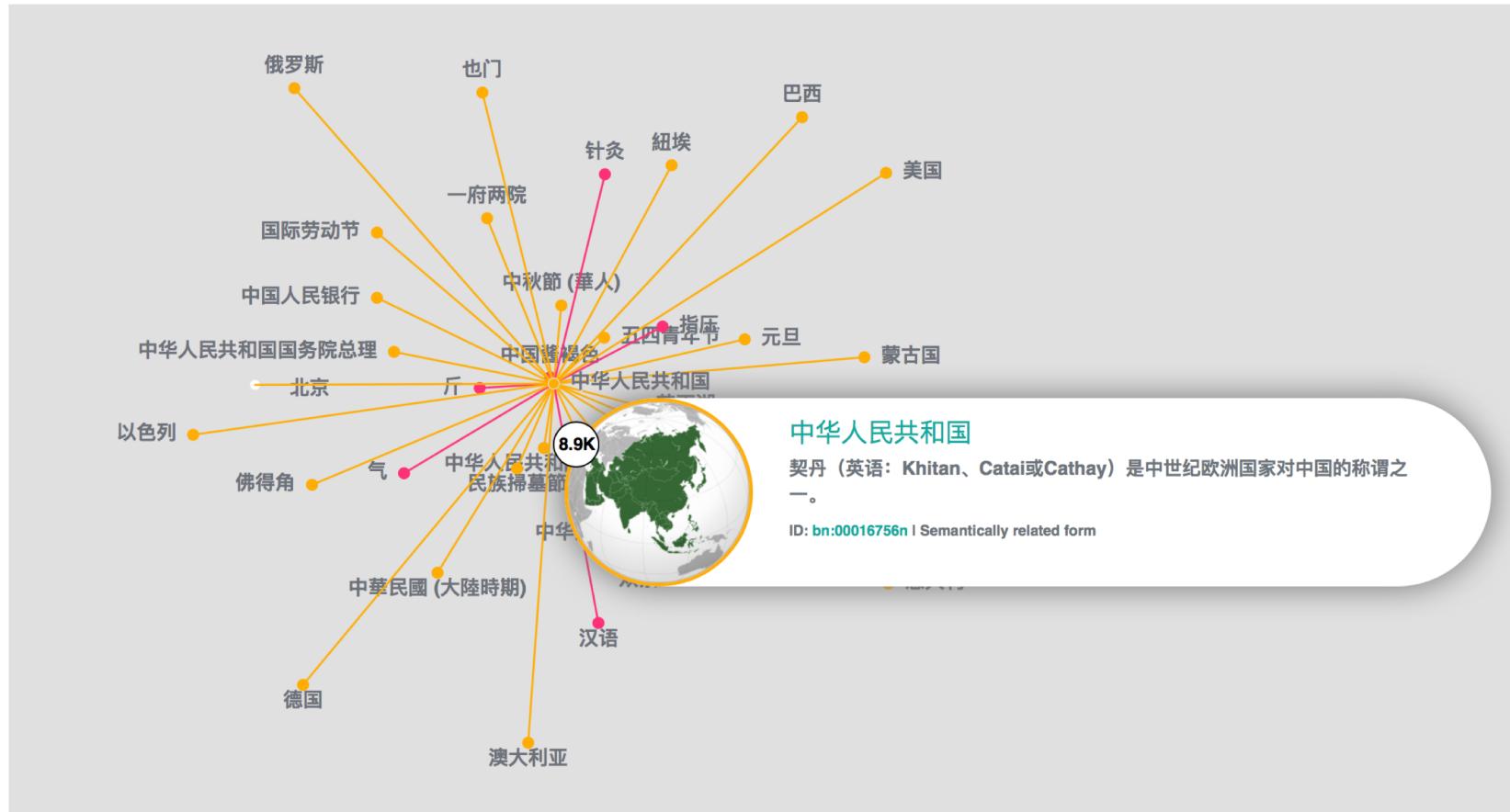
Пекин (кит. [Wikipedia](#))

IS A

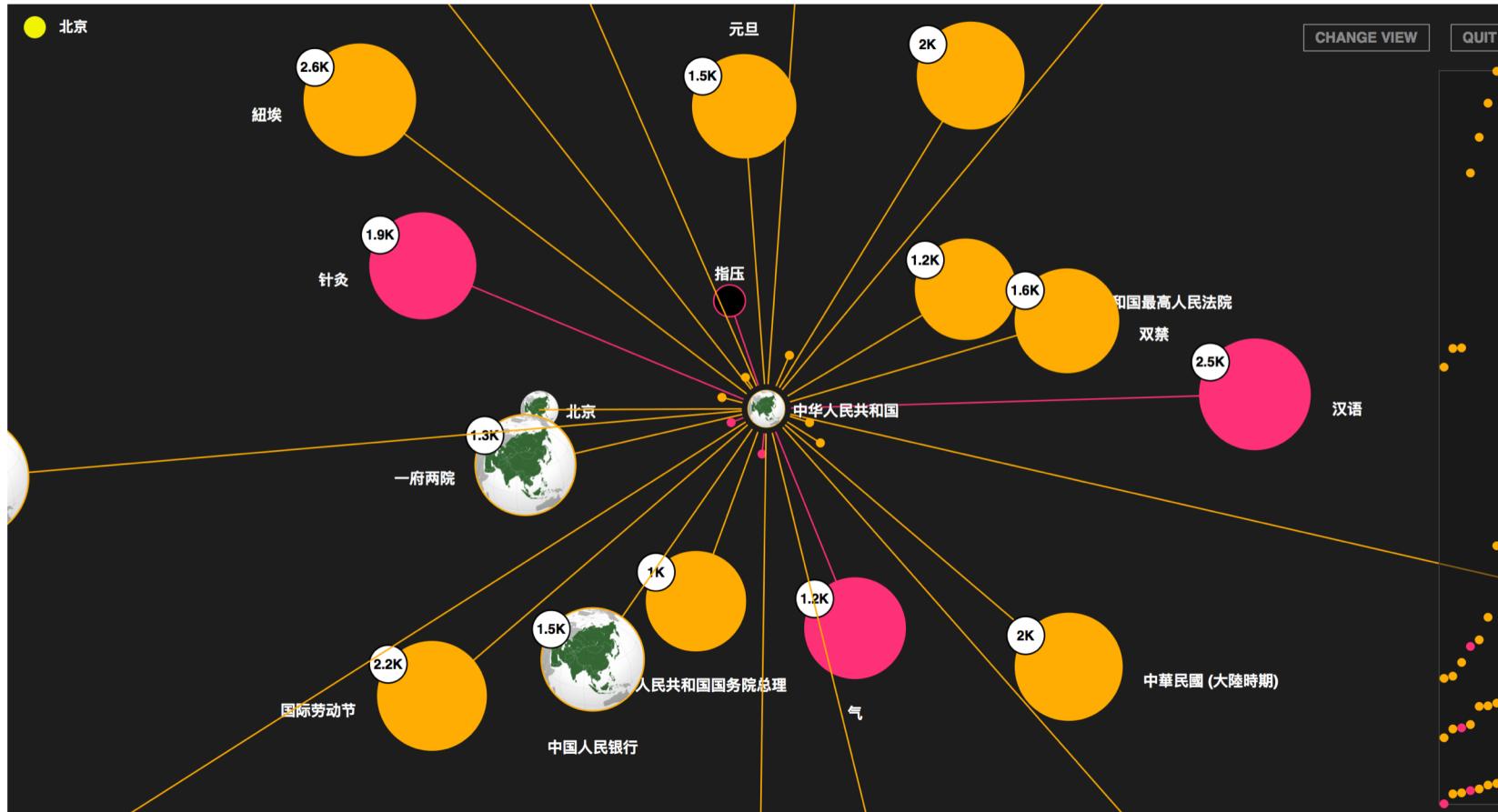
столица • столица государства

ES Pekín (声) · Beijing (声) · capital de la China (声) · Peking (声) · Pequín

# BabelNet



# BabelNet



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- 1. Knowledge Graph Concepts
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# KG application scenarios

## ● Semantic search

Google 中国江苏省会的人口数

全部 地图 新闻 图片 视频 更多

设置 工具

找到约 1,480,000 条结果 (用时 0.57 秒)

南京市 / 人口

**833.5 万**  
2017 年



用户还搜索了

 江苏省 8040 万	 北京市 2154 万	 上海市 2632 万
---	---	---

反馈

[江苏省- 维基百科, 自由的百科全书](https://zh.wikipedia.org/zh-hans/江苏省)  
<https://zh.wikipedia.org/zh-hans/江苏省>



南京市  
中华人民共和国的城市

南京市, 简称“宁”, 别称金陵, 是中华人民共和国江苏省省会、副省级城市和特大城市, 华东地区区域中心城市。地处长江下游沿岸, 位于江苏省西南部。是长江下游和长三角地区重要产业城市、长三角的副中心城市和中国东部暨江苏省的政治、经济、科教、文化、信息中心, 也是全国综合性交通和通信枢纽城市以及科教中心城市之一。[维基百科](#)

天气: 24°C, 风向北, 风速 1 米/秒, 湿度 66%

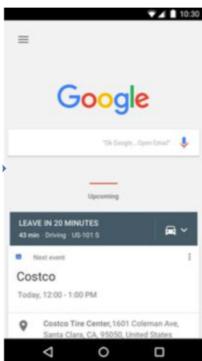
人口: 833.5 万 (2017 年)

The best way of using KG is using it!

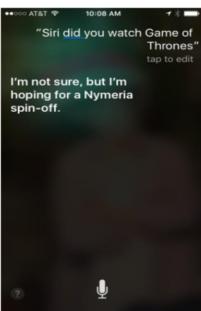
# KG application scenarios

## ● Question answer

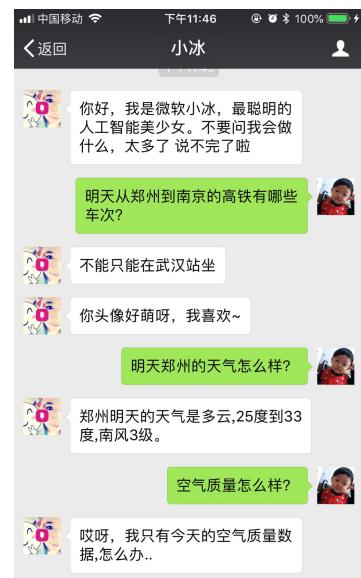
Google Now



Apple Siri

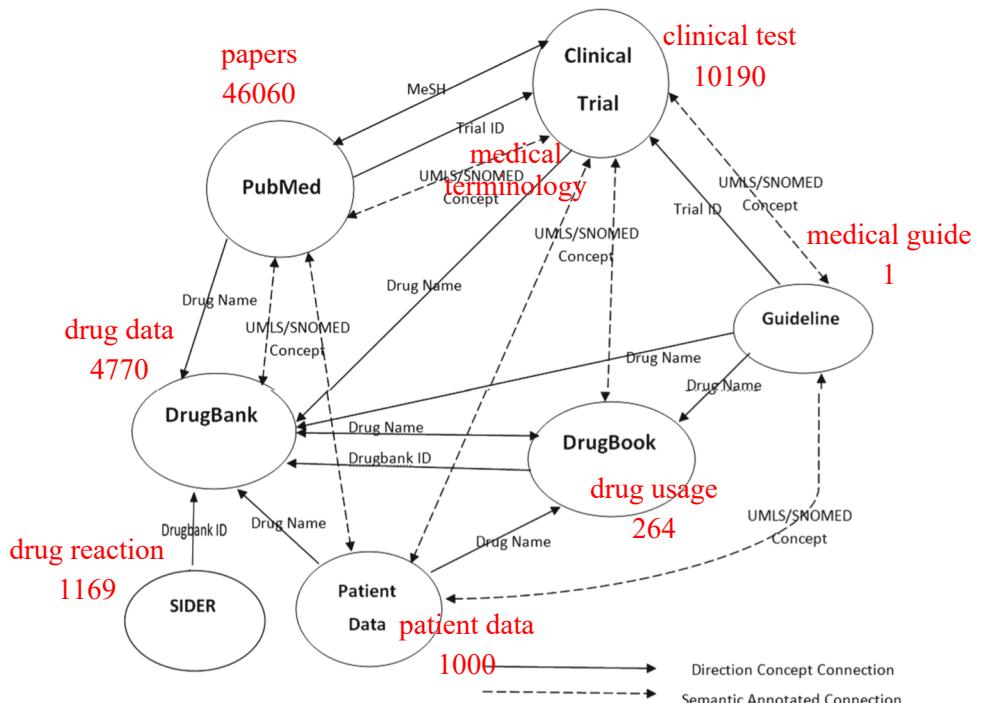


Amazon Alexa



# KG application scenarios

## ● Data fusion



# KG application scenarios

## ● Intelligence decision

- Link prediction
- knowledge mining
- knowledge discovering
- knowledge reasoning
- knowledge + NLU
- knowledge + AI

# Key technique value of KG

- relations between entities
- entity linking
- heterogeneous data integration
- large scale knowledge reasoning

# Google knowledge graph

成龙

全部 图片 视频

找到约 32,800,000 条结果 (用时 0.57 秒)

**integrate search results and knowledge**

**Results**

[议郎-维基百科，自由的百科王节](http://zaike.bilibili.com/bzhh-hans/成龙)  
<http://zaike.bilibili.com/bzhh-hans/成龙> 转为简体网页

拿督成龍博士，SBS, MBE, PMW, (Jackie Chan Kong Sang, 1954年4月7日-, 藝名成龍、元龍)，原名房仕龍。國際著名武打演員、導演和電影監製。其生父為房道龍，其妻子林鳳嬌為前中華民國演員，兩人育有一子房祖名。另有情人吳綺莉，私生女吳卓林。[成龙](#)曾經長時間是嘉禾電影有限公司旗下藝人，於1979年加盟，勉強填補 ...

[吳綺莉 · 林鳳嬌 · 英倫對決 · 房祖名](#)

**成龙 (中国香港演员、导演) \_百度百科**  
<https://baike.baidu.com/item/成龙>

成龙，1954年4月7日出生于香港中西区，祖籍安徽省芜湖，中国香港男演员、导演、动作指导、制作人、编剧、歌手。1971年以武术身份进入电影圈。1976年在动作片《新精武门》中担任男主角。1978年主演的动作片《蛇形刁手》、《醉拳》标志着功夫喜剧片的开端。1980年自编自导的动作片《师弟出马》获得...

[几器之血 · 中国游记 · 绝地逃亡 · 英伦对决](#)

**成龙的微博\_微博 - 微博台灣站**  
<https://weibo.com/jackiechan>

成龙，香港知名演员。[成龙](#)的微博主页、个人资料、相册。新浪微博，随时随地分享身边的新鲜事儿。

**成龙\_互动百科**  
[www.baike.com/wiki/成龙](http://www.baike.com/wiki/成龙)

成龙 (Jackie chan, 原名: 陈港生)，1954年4月7日出生于香港中西区，祖籍安徽芜湖，中国香港男演员、导演、动作指导、制作人、编剧、歌手。1986年自导自演的动作片《警察故事》获得第5届香港电影金像奖最佳影片奖。1993年凭借警匪片《重案组》获得第30届台湾电影金马奖最佳男主角奖。1995年凭借动作片《红番区》打入美国 ...

**如何评价成龙？ - 知乎**  
<https://www.zhihu.com/question/20985661>



**成龙**  
 演员

拿督成龍博士，SBS, MBE, PMW, 原名房仕龙。国际著名武打演员、导演和电影监制。其生父为房道龙，其妻子林凤娇为前中华民国演员，两人育有一子房祖名。另有情人吴绮莉，私生女吴卓林。成龙曾长长时间是嘉禾电影有限公司旗下艺人，于1979年加盟，勉强填补突然逝世的李小龙，期间他拍摄多部电影屡创佳绩。

[维基百科](#)

生于: 1954年4月7日 (63岁), 香港  
 香港太平山

身高: 1.74米

配偶: 林凤娇 (结婚时间: 1982年)

子女: 房祖名, 吴卓林

武术: 中国武术, 跆拳道, 合气道



# Google knowledge graph



达芬奇的出生日期


[全部](#) [图片](#) [新闻](#) [地图](#) [视频](#) [更多](#)
[设置](#) [工具](#)

找到约 6,300,000 条结果 (用时 0.63 秒)

列奥纳多·达·芬奇 / 出生日期

1452 年 4 月 15 日



用户还搜索了



阿尔布雷希特·  
丢勒  
1471 年 5 月  
21 日



米开朗基罗  
1475 年 3 月 6  
日



莱昂纳多·迪卡  
普里奥  
1974 年 11 月  
11 日

## 列奥纳多·达·芬奇

博学者

列奥纳多·达·芬奇，又译达文西，全名列奥纳多·迪·瑟皮耶罗·达·芬奇，是意大利文艺复兴时期的一个博学者：在绘画、音乐、建筑、数学、几何学、解剖学、生理学、动物学、植物学、天文学、气象学、地质学、地理学、物理学、光学、力学、发明、土木工程等领域都有显著的成就。维基百科

生于：1452 年 4 月 15 日，意大利山村安奇亚诺

逝世于：1519 年 5 月 2 日，法国昂布瓦斯克劳斯·吕斯城堡

画风：文艺复兴盛期，Early renaissance，文艺复兴，意大利文艺复兴，佛罗伦萨画派

全名：Leonardo di ser Piero da Vinci

逝世：1519年5月2日（67岁）；法兰西王室安德尔-卢瓦尔省昂布瓦斯

葬于：法国昂布瓦斯Chapel of Saint-Hubert

answer  
not links

列奥纳多·达·芬奇 维基百科 - 百度百科

<https://zh.wikipedia.org>

列奥纳多·达·芬奇（義大利語：[Leonardo da Vinci](#)；又譯...出生，李奧納多·迪·瑟皮耶羅·達·芬奇；1452年4月15日以阿諾河谷（Arno valley）出生；逝世：1519年5月2日，法蘭西王室安德烈-盧瓦爾省昂布瓦斯）

知名作品：《蒙娜麗莎》、《最後的晚餐》 国籍：意大利人

生平 · 童年 (1452–1466) · 科學與工程 · 代表性作品

蒙娜丽莎  
1503 年

最后的晚餐  
1498 年

救世主  
1500 年

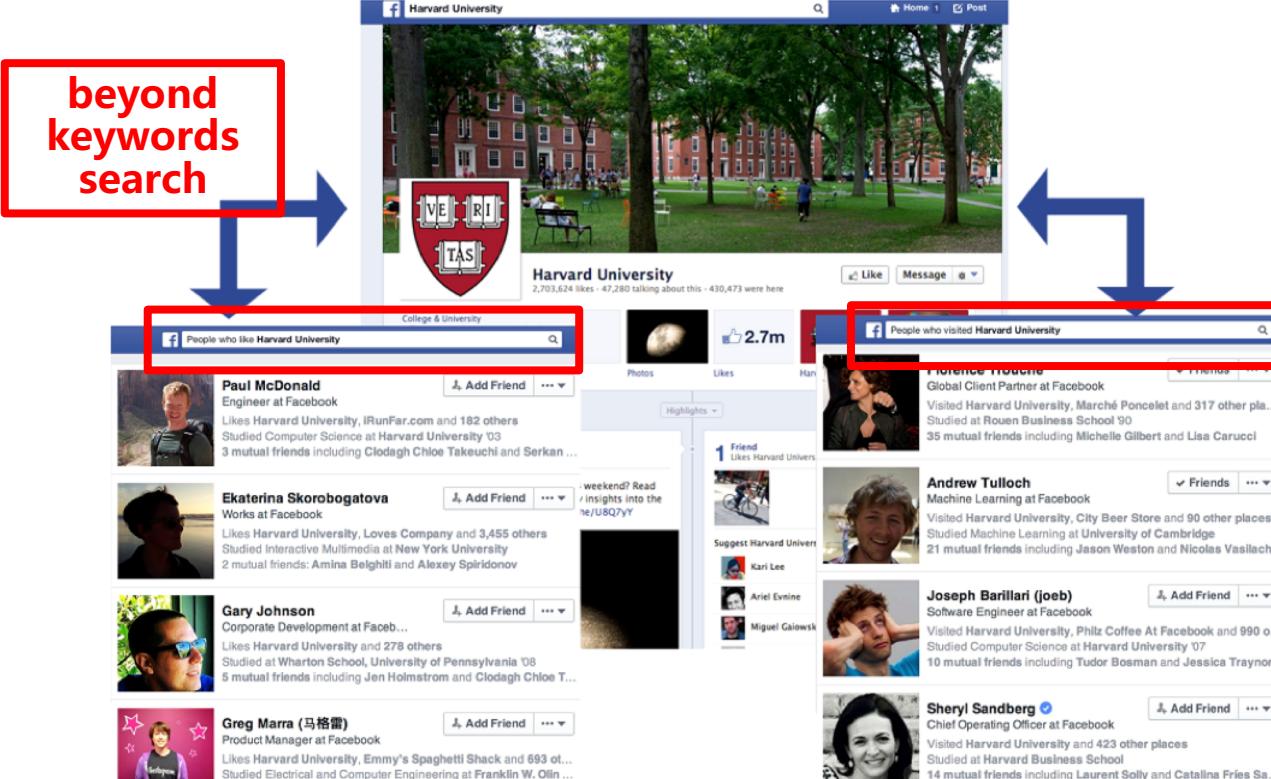
维特鲁威人  
1481 年

还有15+项



# Facebook graph search

beyond keywords search



The diagram illustrates a search process on Facebook. It starts with a general search for "Harvard University" on the homepage, which displays a large image of the university's campus and basic stats. From there, two arrows point down to specific search results:

- Left Path:** A search for "People who like Harvard University" leads to a list of users who have liked the page. Examples include Paul McDonald, Ekaterina Skorobogatova, Gary Johnson, and Greg Marra.
- Right Path:** A search for "People who visited Harvard University" leads to a list of users who have visited the university. Examples include Florence Trouche, Andrew Tulloch, Joseph Barillari (joeb), and Sheryl Sandberg.

# Microsoft concept graph



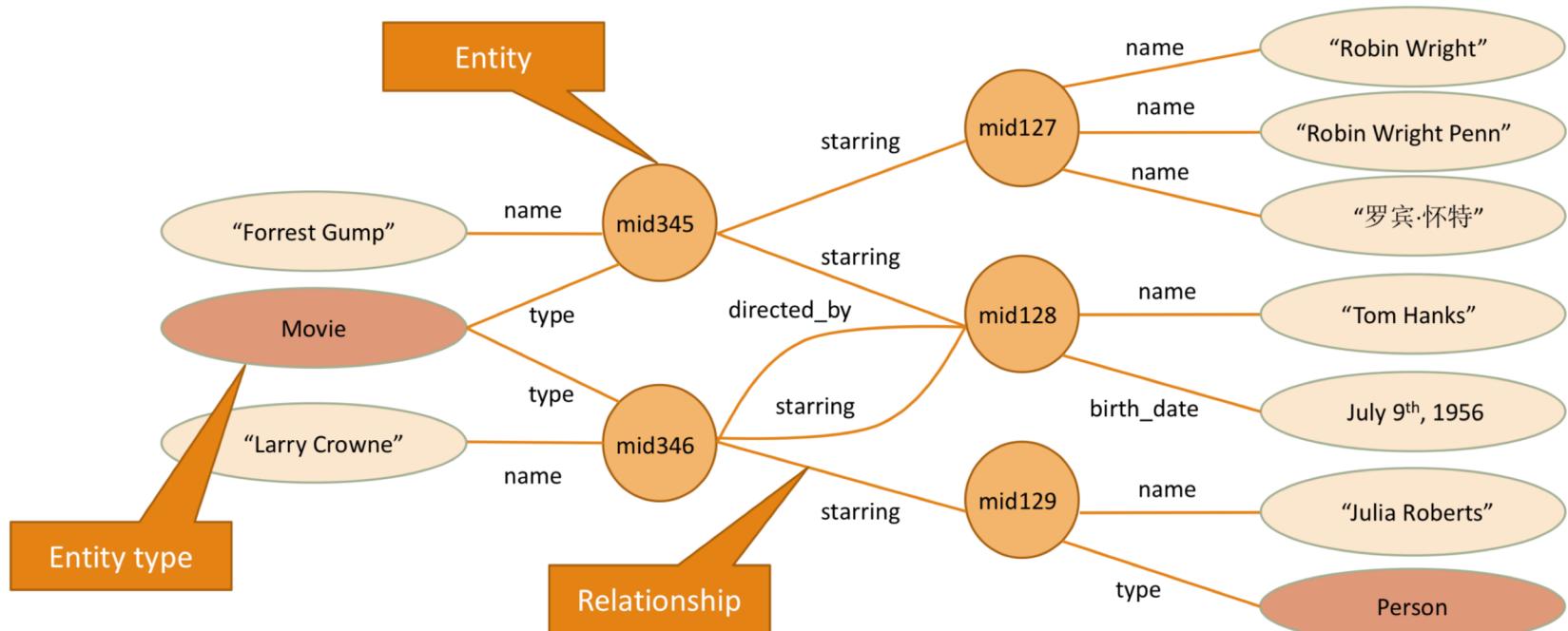
<https://concept.research.microsoft.com>



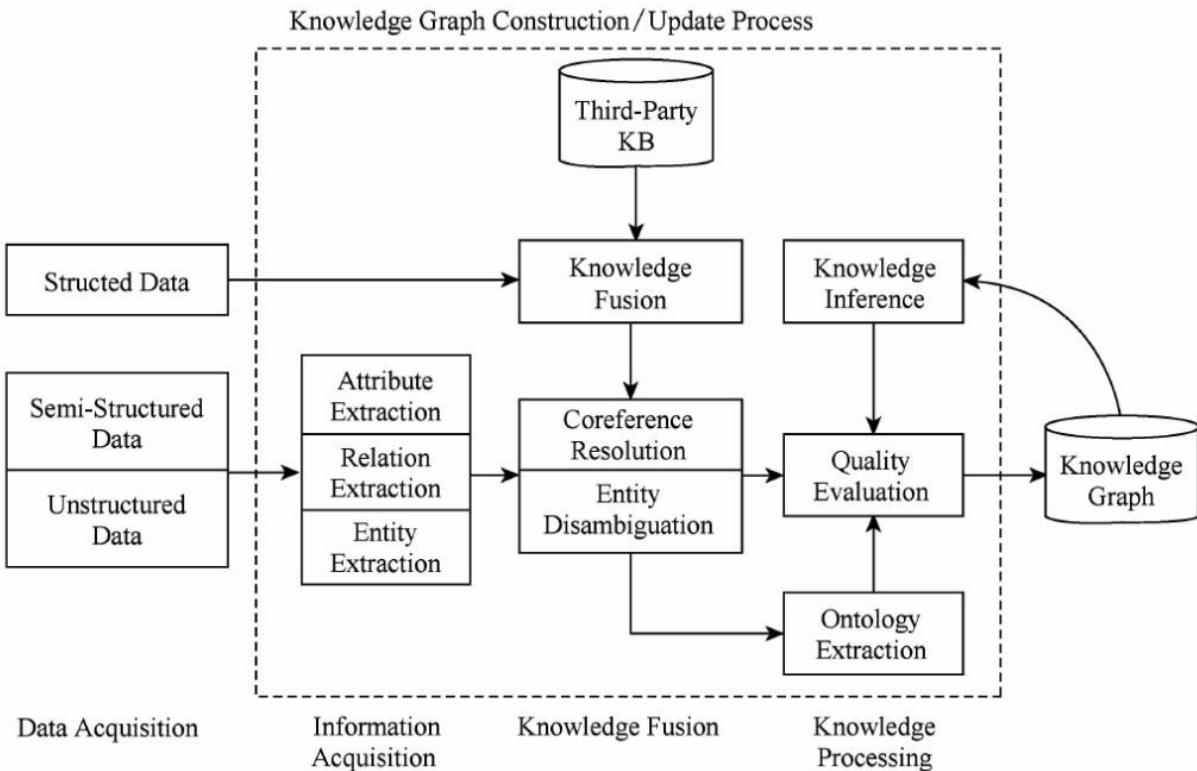
## LinkedIn Knowledge Graph



# Amazon product graph



# Alibaba knowledge graph



神马知识图谱  
 商品知识图谱  
 语义搜索  
 反欺诈  
 智能客户  
 天猫精灵  
 智能导购  
 智能推荐  
 平台治理

.....

# Meituan brain

- 大数据：

- 累计40亿的公开评价数据
- 3,450万全球商家
- 1.4亿店菜
- 10万个性化标签

人均：0元

老板请客，所以心情是极好的。特想夸夸老板：你怎么这么潇洒(愉快)BUT有点评上他也有点见谅-今年北京太热了，各种能喝水都有点评。今天想爆发一下，先苦后甜，先从不...



人均：

和门牌老火锅是极好的老人口的味道。老店长生的作品也是数一数二经典。老字号平民定位，也是一种情怀吧。店老经营真，服务质量也还可以，中午会有送汤水。下午也可以点三样听听相声。门口就有大圆杀虎，好像是公益性质，菜品也还不错。虽然的虾特别什么的不如其他品质更地道。但也胜在服务。



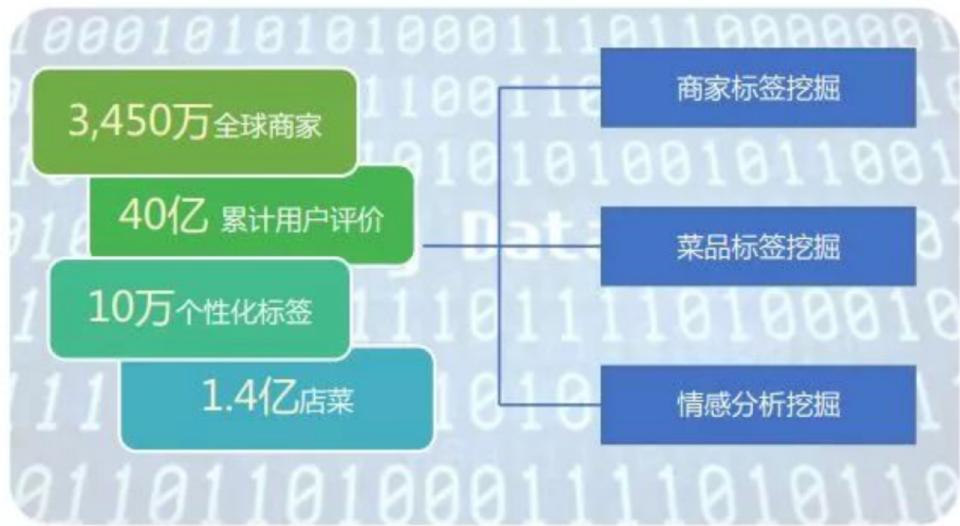
人均：

来这家店，你只能选择华远店100多个评价，据了解，和门牌老火锅的地址，又和120个评价的不一致，是哪个100...



- NLP算法模型：

- 统计语言模型 ( Language Model )
- 主题生成模型 ( Topic Model )
- 深度学习模型 ( Deep Learning Model )



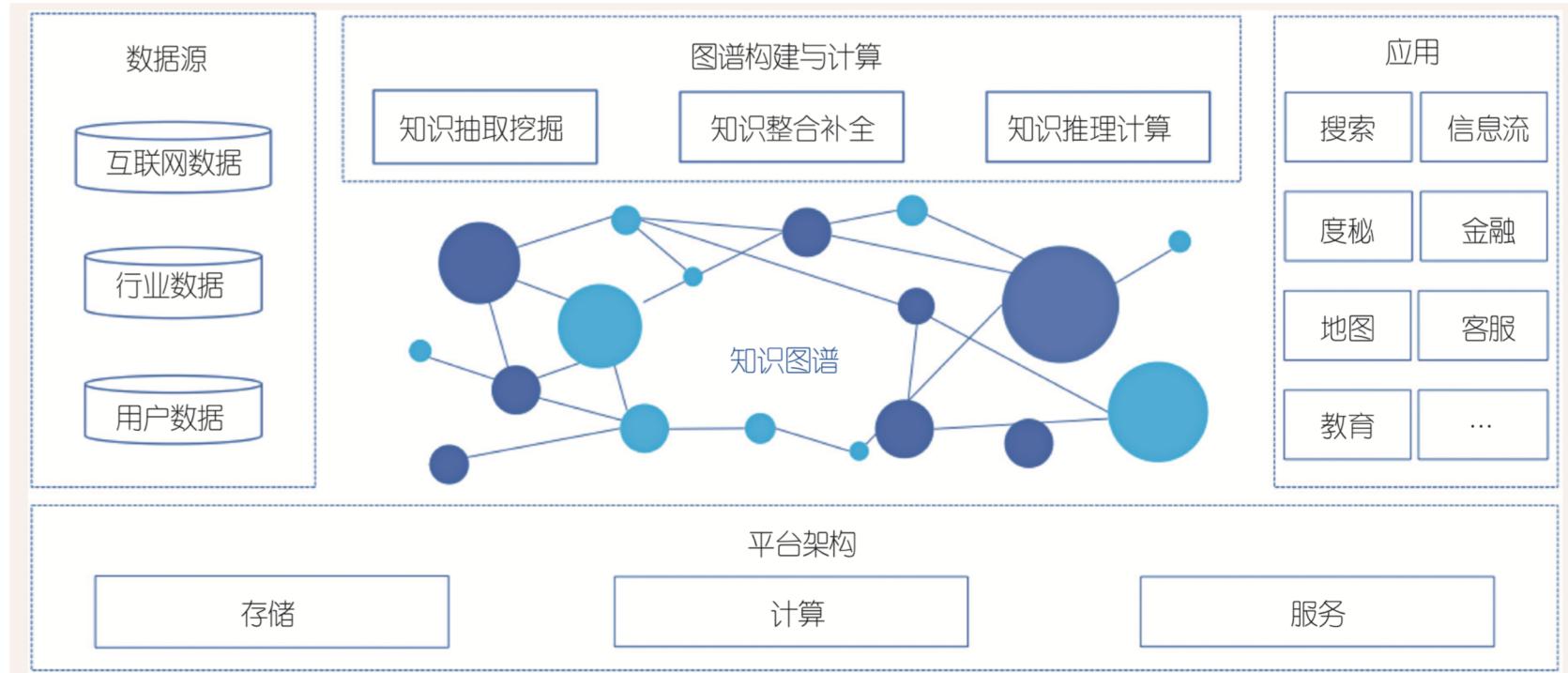
<https://mp.weixin.qq.com/s/3cwVqMM97HsMQJsFdLKAba>

# Baidu knowledge graph

- entity graph (实体图谱): precise QA/Search
- attention graph (关注点图谱): NLU
- intent graph (意图图谱): dialog

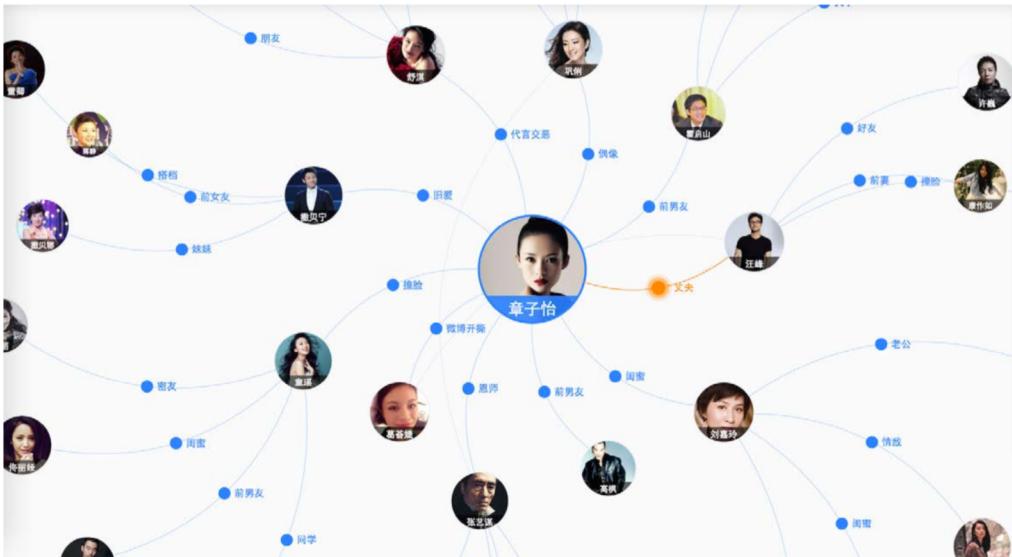


# Baidu knowledge graph



# Baidu knowledge graph

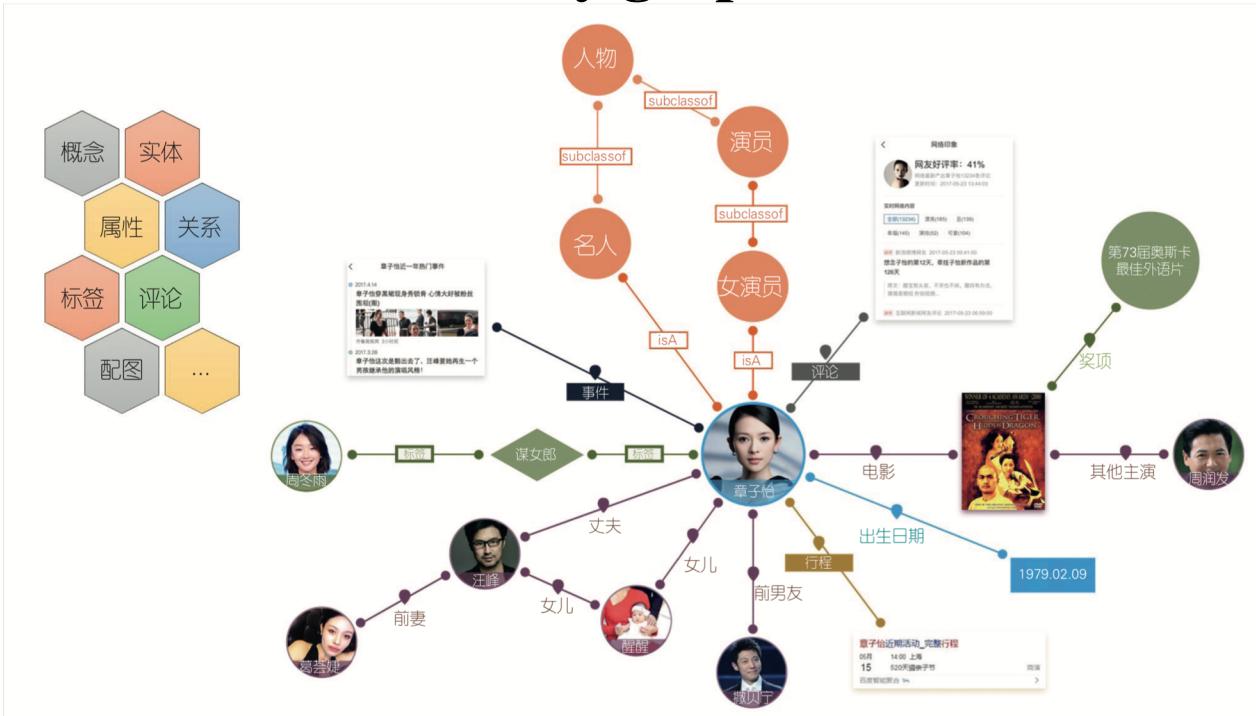
# entity graph



Hundreds of millions of **Entities**  
Tens of billions of **Attributes**  
Hundreds of billions of **Relations**

# Baidu knowledge graph

# entity graph



# Baidu knowledge graph

精准回答



The figure displays three separate Baidu search results, each with a red box highlighting the search query and a red arrow pointing to a central red box labeled "精准回答" (Precise Answer). The first result shows the query "高考还有多少天" (How many days until the college entrance exam?), with a card displaying the count down to June 7, 2018. The second result shows the query "一个木一个斤是什么字" (What Chinese character consists of one wood radical and one jin radical?), with a card showing the character "析" (Xi) with its definition. The third result shows the query "李白描写杨贵妃的诗" (Li Bai's poems about Yang Guifei), with a card showing a poem fragment and a link to Baidu Zhihu.

高考还有多少天

距今还有79天 (2018年05月07日 星期四, 戊戌年 (狗年) 四月廿四)

李白描写杨贵妃的诗

问 李白写杨贵妃的诗词，所有。\_百度知道

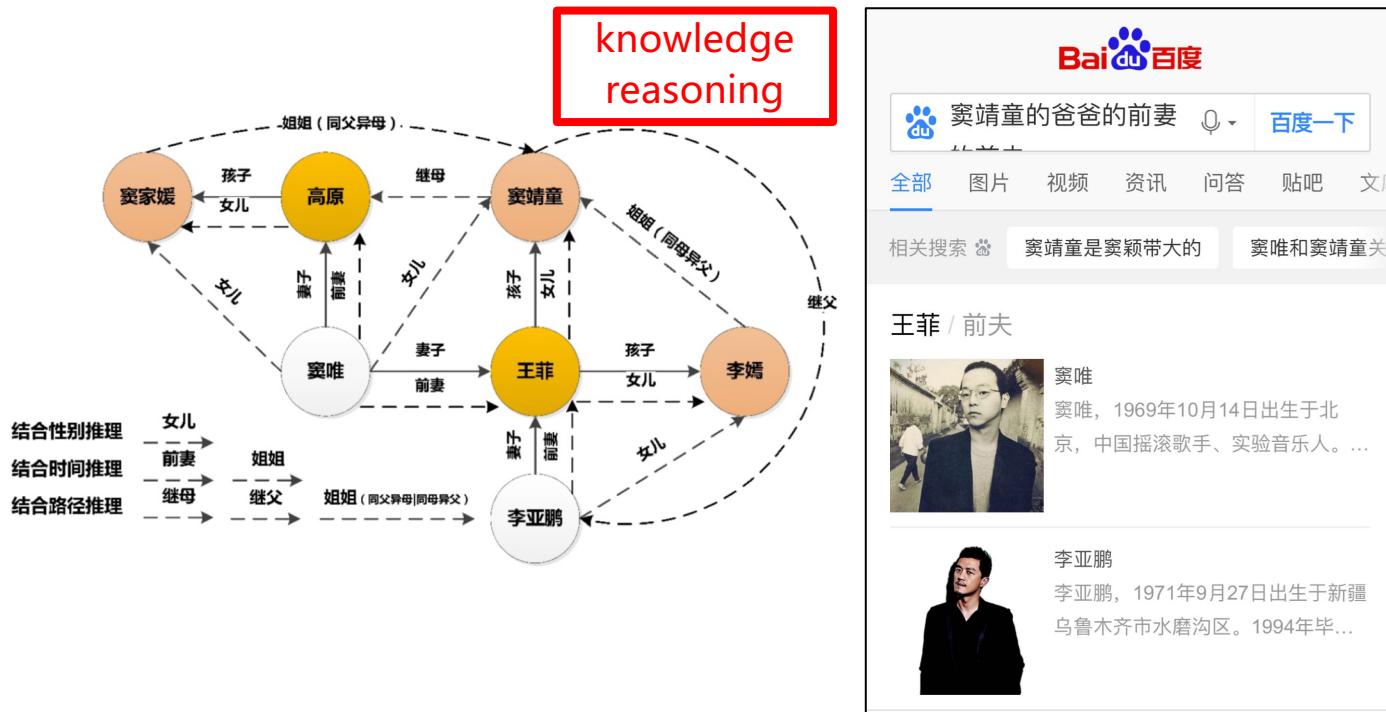
答 清平调词三首

云想衣裳花想容，  
春风拂槛露华浓。  
若非群玉山头见，  
会向瑶台月下逢。

一枝红艳露凝香， ... 详情>>

# Baidu knowledge graph

Who is Dou jingtong's father's ex-wife's ex-husband?  
窦靖童的爸爸的前妻的前夫是谁？



# Baidu knowledge graph

knowledge reasoning

今天离圣诞节还…

全部 图片 视频 资讯 贴吧 问答

2017年圣诞节 / 倒计时



距今还有39天  
2017年12月25日 星期一  
丁酉年（鸡年）冬月初八

公历12月25日是圣诞节（Christmas），又称“耶诞节”，西方传统节日。公历12月24日是平安夜（Silent Night），即圣诞前夕。

百度知识图谱

报错

zippo可以带上飞机吗

全部 问答 图片 贴吧 视频 资讯 文库

zippo可以带上飞机吗  
禁止随身携带: zippo

法律依据:

中国民用航空局相关规定

百度提示您：此内容是系统根据相关法律法规内容自动生成，仅供参考，建议咨询专业律师或相关部门。

百度规章

# Baidu knowledge graph

## entity recommendation 关于“杨幂”的实体推荐

杨幂的关系图



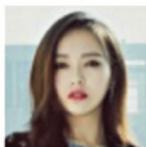
刘恺威

杨幂的老公



小糯米

刘恺威杨幂的亲生女儿



唐嫣

杨幂婚礼伴娘贴心闺蜜

展开 ▾



刘诗诗

从仙三结下的姐妹情缘

实体推荐结果

推荐理由

杨幂合作过的艺人



李易峰

古剑奇谭怦然星动合作



胡歌

曾经受瞩目的荧幕情侣



林心如

美人心计中饰演好姐妹

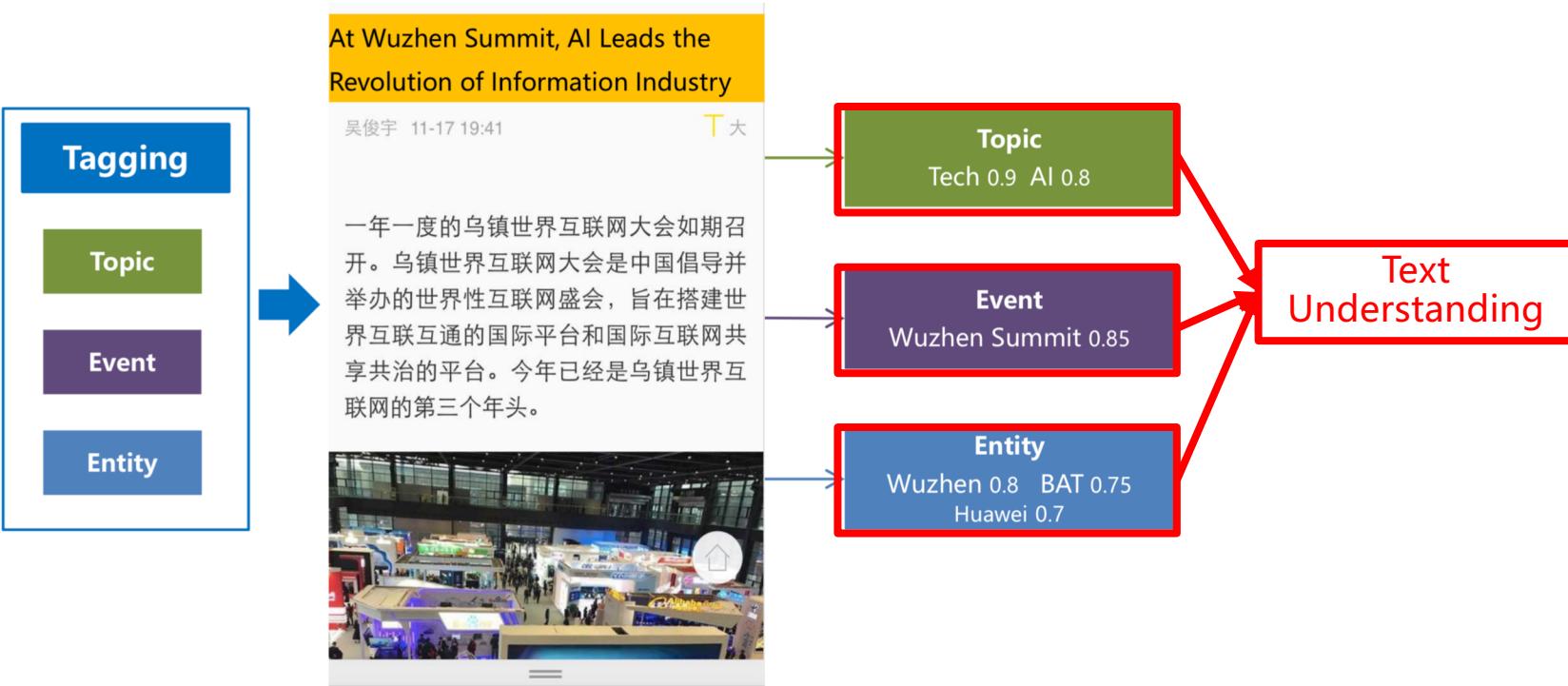


李晨

北爱中实现合作

语义关系

# Baidu knowledge graph



# Baidu knowledge graph

dialog guide



关于金毛，你想了解的是？

I want to have a golden retriever

金毛健康	如何给金毛美容	喂养金毛
怎么训练金毛	我想养金毛	哈士奇
波斯猫	吉娃娃	贵宾犬

Is it easy to feed a golden retriever?

金毛的智商排名情况
什么样的人适合养金毛
可以给金毛起哪些名字

How is the golden retriever in the dog IQ ranking?

金毛的智商排名情况	什么样的人适合养金毛	金毛好不好养
什么样的人适合养金毛	可以给金毛起哪些名字	可以给金毛起哪些名字
可以给金毛起哪些名字	怎么辨别金毛纯不纯	

multiple dialog



# Baidu knowledge graph

## Chinese language knowledge graph

上面是对下面是…

全部 问答 图片 贴吧 视频 资讯

怼\_百度汉语

[duì] ⓘ

部首：心

五笔：CFNU

笔画：9

繁体：懟

[释义] 怨恨。

百度汉语

美好的好多音字

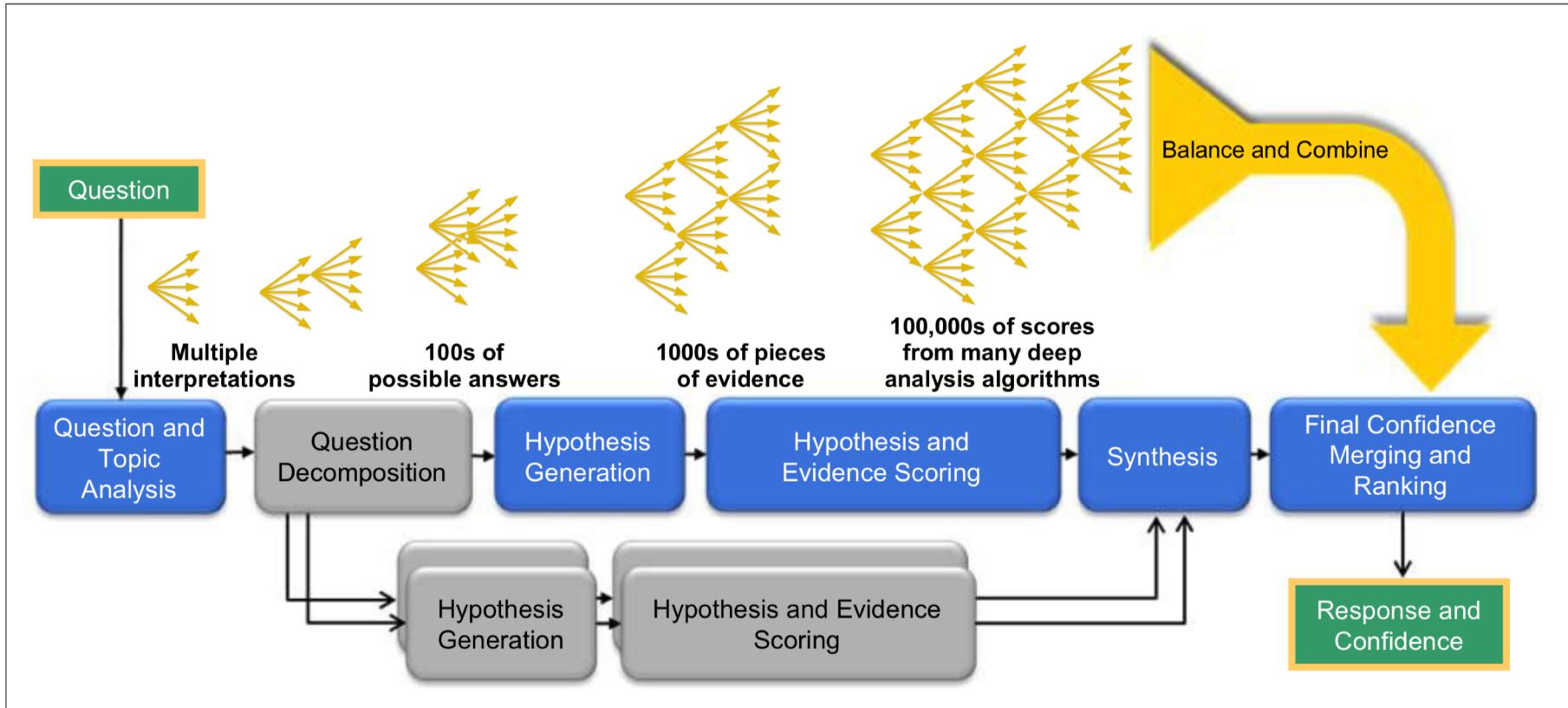
全部 图片 视频 资讯 贴吧 问答

美好的好多音字组词

hǎo ⓘ	好看	好像	刚好
	正好	你好	只好
hào ⓘ	爱好	好胜	好客
	好奇	游手好闲	好高骛远

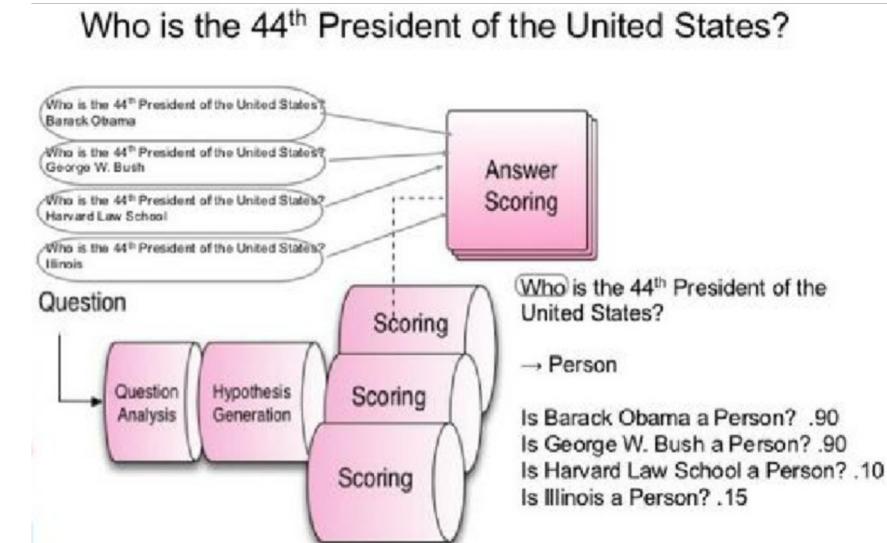
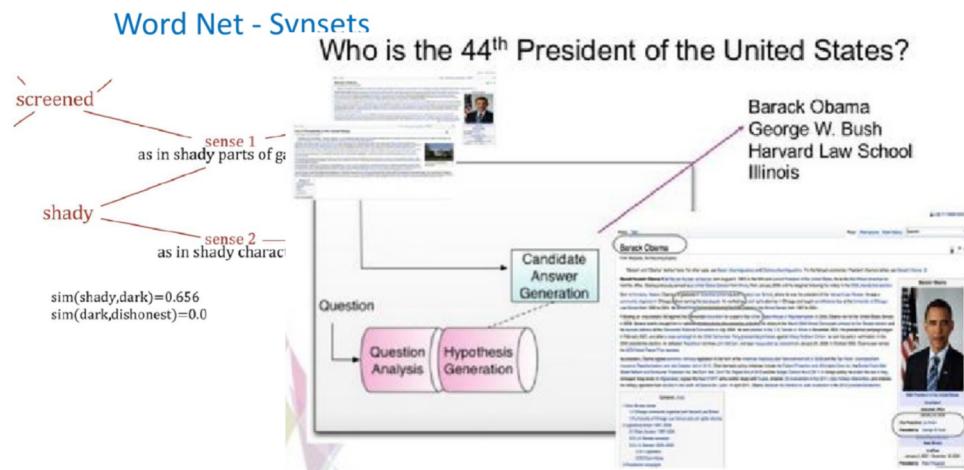
百度汉语

# IBM Watson QA system



# IBM Watson QA system

## Who is the 44<sup>th</sup> President of United States?



# 863 super brain project

## 863超脑计划

2017, AI VS human in mathematics subject

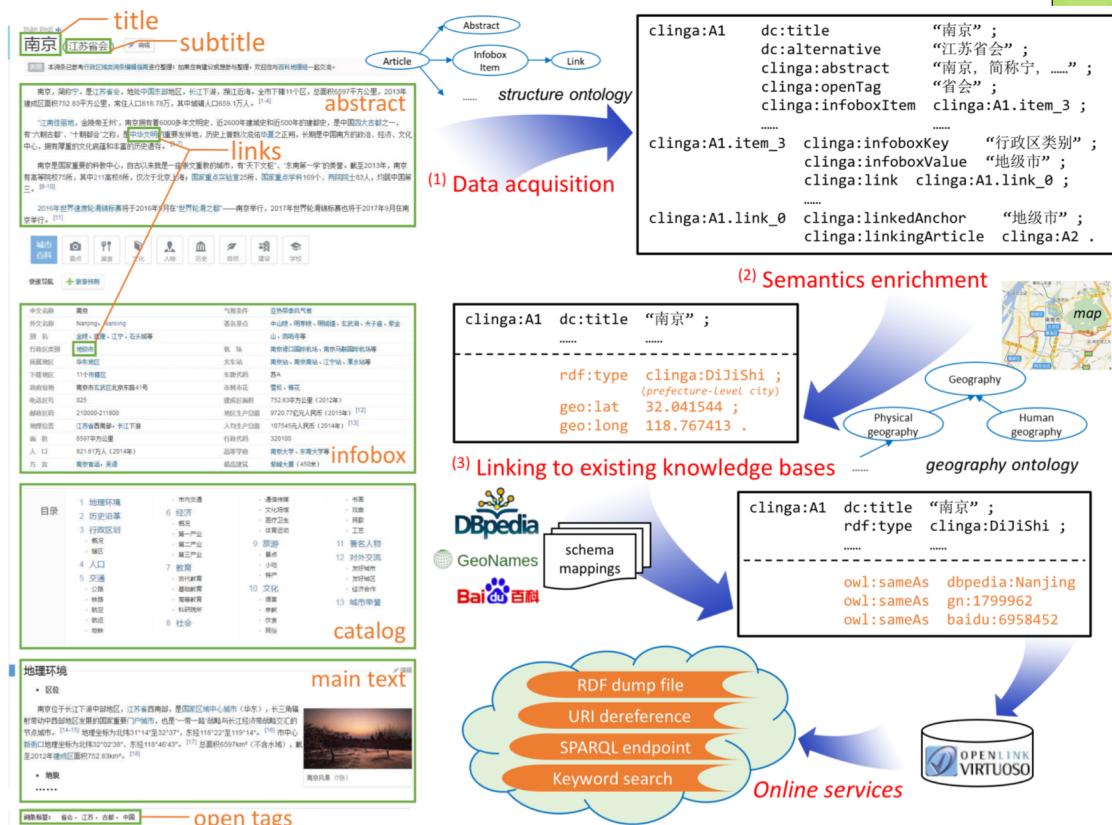


# 863 super brain project

2018年作文：中国内地著名青年作家张一一在6月7日上午的语文考试中，将接受谷歌公司研制的高考机器人“Champion”（状元）挑战其高考作文。高考机器人“Champion”(状元)二选一的高考作文《绿水青山图》获得了曾参加过高考作文阅卷的专家评审给出的100分满分，而作家张一一的高考作文《新时代新青年》仅获85分

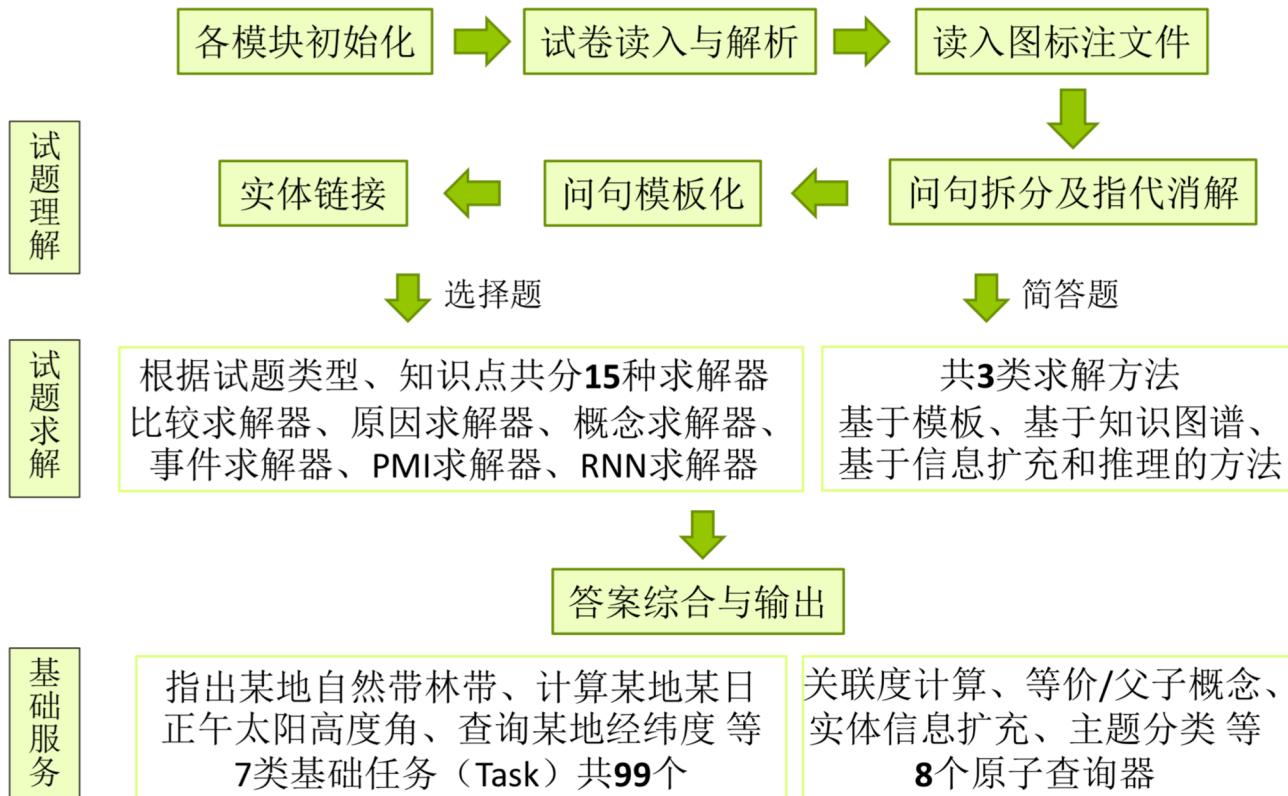
# 863 super brain project

## Geography knowledge graph



# 863 super brain project

## Geography GaoKao system principle



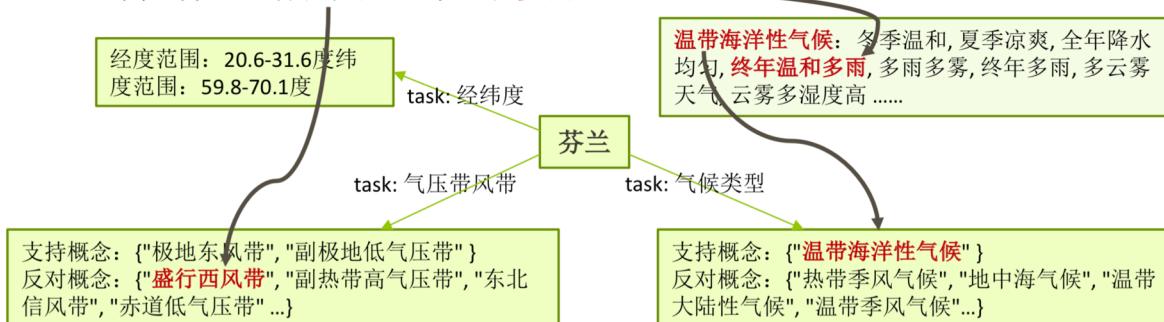
# 863 super brain project

## Example

### ● 选择题求解

- 概念求解器

- 发现问句中的重要实体，枚举该实体的所有Task，得到该实体的所有支持概念和反对概念，检查题目中出现的概念或描述是否与之吻合。
- 例：芬兰盛行西风，终年温和多雨



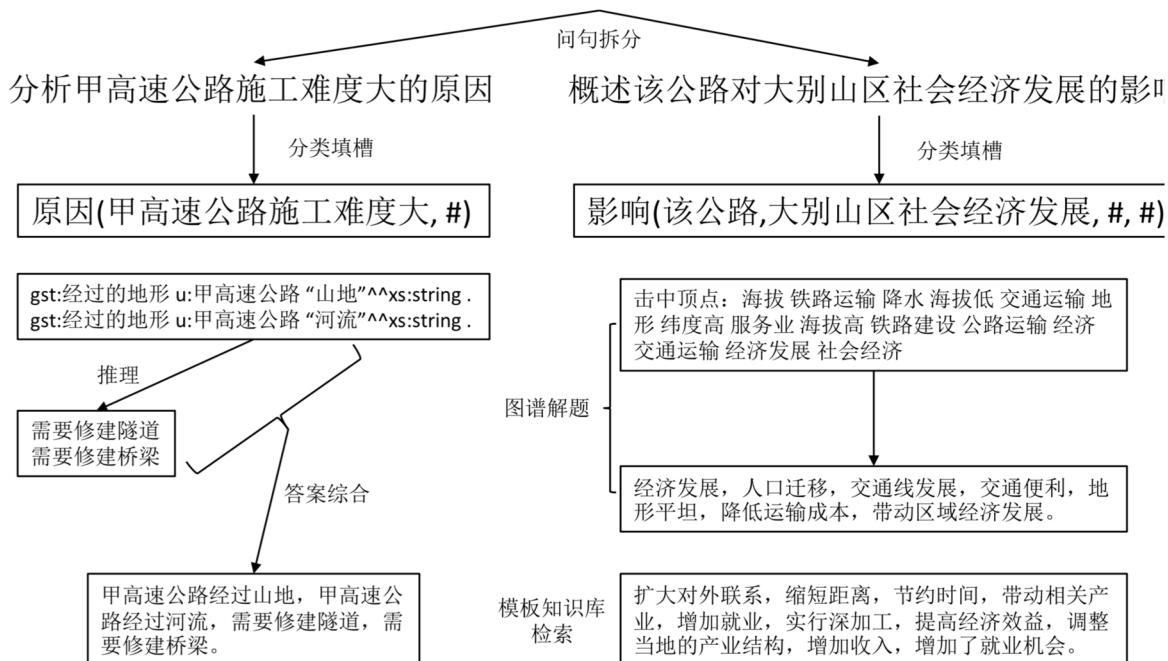
- 选项中出现“盛行西风”，是“盛行西风带”的等价概念，该选项前一半错误。
- 选项中出现“终年温和多雨”，是“温带海洋性气候”的特征描述，而“温带海洋性气候”出现在芬兰气候类型Task的支持概念中，该选项后一半正确。
- 目前已支持气候类型、自然带林带、岩石类型、地貌形态等15类概念

# 863 super brain project

## Example

### ● 简答题求解

分析甲高速公路施工难度大的原因，概述该公路对大别山区社会经济发展的影响。



# Financial knowledge graph

- Search and QA based on financial knowledge graph

文因互联

搜索

板块  三板基础  三板创新  主板公司  美股公司

行业 信息技术(9) 电信业务(1) 工业(1)

挂牌日期 2017(2) 2016(8) 2014(1)

做市商 渤海证券(1) 方正证券(1) 广州证券(2) 国金证券(1) 开源证券(1) 更多 +

主办券商 安信证券(2) 东北证券(1) 方正证券(1) 光大证券(1) 国金证券(1) 更多 +

所属地域 北京(2) 广东(4) 黑龙江(1) 江苏(1) 辽宁(1) 更多 +

默认
挂牌日<sup>升</sup>
总市值<sup>升</sup>

文因因为您搜到11个结果

«
1 / 1
»

**上海中兴 (870927)**

挂牌日期: 2017-02-21	所属行业: 通信设备及服务
总市值: 0.00元	市盈率: 0.00

公司介绍: 从事各种网络制式的室内覆盖、网络优化、WLAN业务及守护宝业务。公司主营业务为从事各种网络制式的室内覆盖、网络优化、WLAN业务及守护宝业务。公司作为拥有核心竞争力的能为客户提供一系列无线网络优化覆盖产品和传输的整体解决方案的供应商,其产品主要应用于电信运营商市场、政企市场等领域。公司具有上海市高新技术企业、通信信息网络系统集成企业甲级等资质,通过ISO-9001:2008质量管理体系认证。

文因主页

行业速递 您的行业推送帮手

本周热门周报一览

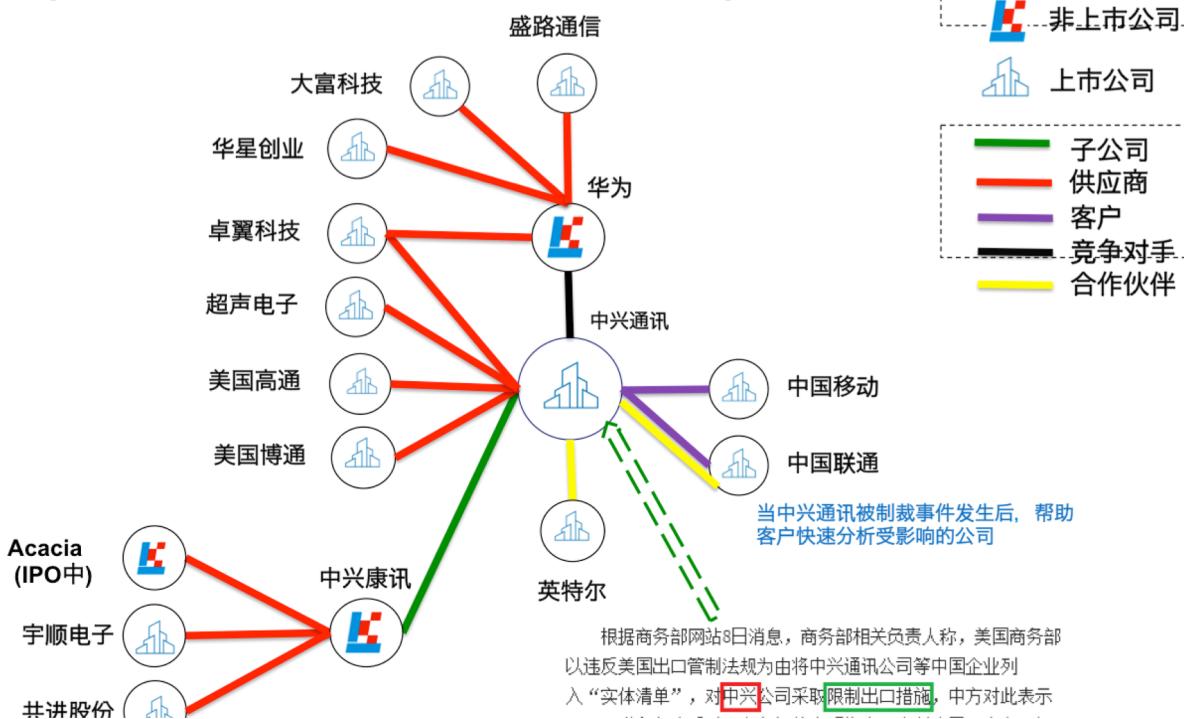
周报名称	热度
大数据	<div style="width: 80%; height: 10px; background-color: #0072BD;"></div>
SaaS	<div style="width: 75%; height: 10px; background-color: #0072BD;"></div>
环保	<div style="width: 85%; height: 10px; background-color: #0072BD;"></div>
石墨烯	<div style="width: 70%; height: 10px; background-color: #0072BD;"></div>
互联网	<div style="width: 60%; height: 10px; background-color: #0072BD;"></div>

文因行业速度, 细分行业领域, 每周为您推送精致研报一份。我们还支持搜索和自定义需求, 文因会在第一时间向反馈您的要求。

**进入行业速递**

# Financial knowledge graph

## 产品技术示例– 中兴关系链 (中兴概念股以及事件传递影响分析)



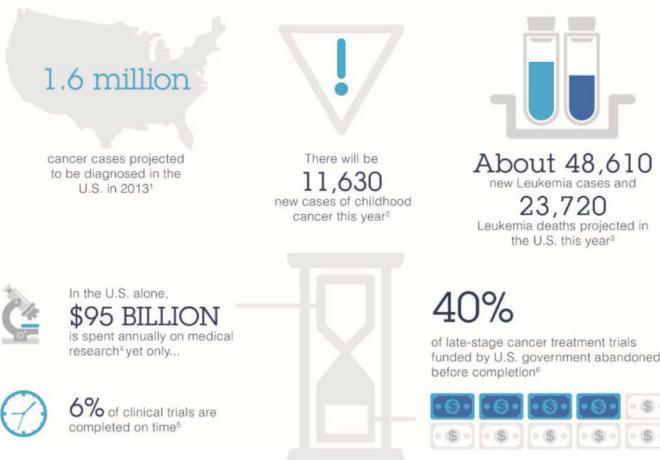
# Business intelligence knowledge graph



# Medical knowledge graph

## M.D. Anderson Cancer Center and IBM

### Going Up Against a Deadly Disease



### How Watson is Helping the Fight



# Academic knowledge graph

## Semantic Scholar

🔍
Semantic Scholar
BETA
Deep Learning
🔍
SIGN IN
?

**Filter Results:**

Overviews (4,214)

Publication Year:

Author:

- Yoshua Bengio (194)
- Geoffrey E. Hinton (83)
- Trevor Darrell (79)
- + More (7)

Key Phrase:

- DNN (272)
- RBM (250)
- Convolutional Neural Network (215)
- + More (7)

Data Set Used:

- ImageNet (291)
- VOC (264)
- Pascal VOC (210)

Page 1

Try your search on Google Scholar Sort by: Relevance

**Deep Learning in Neural Networks: An Overview**

Jürgen Schmidhuber · NN · 2015

In recent years, deep artificial neural networks (including recurrent ones) have won numerous contests in pattern recognition and machine learning. This historical survey compactly summarises relevant work, much of it from the previous millennium. Shallow and deep learners are distinguished by the depth of their credit assignment paths, which are chains of... [\(More\)](#)

Mentioned in 5 tweets:

Thanos Papaoikonomou @erwtokritos [Follow](#)

Deep Learning in Neural Networks: An Overview  
[arxiv.org/pdf/1404.7828v1.pdf](http://arxiv.org/pdf/1404.7828v1.pdf)  
 1:48 PM - 27 Apr 2016

1 1

1 82 | [View PDF](#) [More...](#) |

---

**Learning Deep Architectures for AI**

Yoshua Bengio · FTRL · 2009

Theoretical results suggest that in order to learn the kind of complicated functions that can represent high-level abstractions (e.g. in vision, language, and other AI-level tasks), one may need **deep** architectures. **Deep** architectures are composed of multiple levels of non-linear operations, such as in neural nets with many hidden layers or in complicated... [\(More\)](#)

22 604 | [View PDF](#) [More...](#) |

# Academic knowledge graph

## AMiner

AMiner deep learning Name Organization

Search Results for Keywords: deep learning, (1000 results, 490 ms)

<i>h</i> -index	>=60 (20)	50-59 (14)	40-49 (29)	30-39 (37)	20-29 (85)	10-19 (196)	<10 (619)			
Gender :	Male (947)	Female (53)								
Language :	English (228)	Chinese (228)	French (25)	Greek (20)	Korean (13)	German (9)	Japanese (7)	Indian (3)		
Location :	USA (168)	China (103)	United Kingdom (29)	Singapore (20)	Canada (17)	Australia (10)	Hong Kong (8)	India (8)	France (6)	Switzerland (5)

Relevance ⓘ | *h*-index | A-Index | Activity | Diversity | Rising Star | #Citation | #Paper

 **Yoshua Bengio** ⓘ

*h*-index: 74 | #Paper: 387 | #Citation: 33010

Full Professor  
University of Montreal

Neural Network | Neural Networks | Machine Learning | Neural Nets | Hidden Markov Model

5445 views

 **Geoffrey Hinton** ⓘ

*h*-index: 111 | #Paper: 375 | #Citation: 98994

Professor  
Department of Computer Science University of Toronto

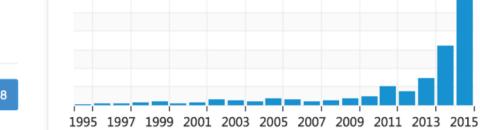
Boltzmann Machine | Unsupervised Learning | Speech Recognition | Neural Networks

472 views

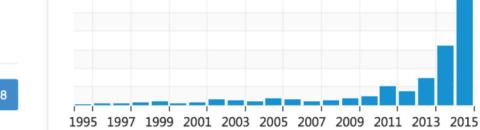
 **Ruslan Salakhutdinov** ⓘ

*h*-index: 35 | #Paper: 79 | #Citation: 11844

Assistant Professor  
Department of Statistics, Department of Computer and Mathematical Sciences, Department of Computer Science (by courtesy) University of Toronto

 **Deep learning** (深度学习)

Popularity Over Time:



Description:

Deep learning (deep structured learning, hierarchical learning or deep machine learning) is a branch of machine learning based on a set of algorithms that attempt to model high-level abstractions in data by using multiple processing layers, with complex structures or otherwise, composed of multiple non-linear transformations. Deep Machine Learning – A New Frontier in Artificial Intelligence Research – a survey paper by Itamar Arel, Derek C.

# Poetry knowledge graph

关于郑州  
的诗歌

唐詩別苑  
Garden of Tang Poetry

知识图谱语义搜索 知识图谱可视化

关于郑州的诗歌

搜索示例：诗仙 李白的作品 白居易的好友 写给李白的诗 李白的庐山诗 适合小学生背诵的诗歌 中学阶段描写秋天的诗歌 风格质朴的爱情诗 关于节气的诗歌

[其它主题] - 送郑州严员外

欲将刀笔润王猷，东去先分圣主忧。满扇好风吹郑圃，一车甘雨别皇州。尚书硕冷鸿声晚，仆射敲寒树影秋。从此文星在何处，武牢关外庾公楼。

[其它主题] - 送马使君赴郑州

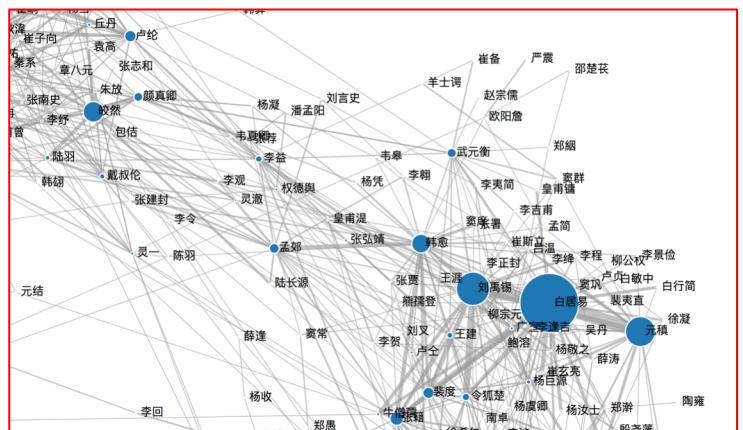
东土忽无事，专城复任贤。喜观班瑞礼，还在偃兵年。膏雨带荥水，归人耕圃田。遥知下车日，万井起新烟。

[其它主题] - 送李蕴赴郑州因献卢郎中倣

仆射敲西想到时，满川晴色见旌旗。马融闲卧笛声远，王粲醉吟楼影移。几日赋诗秋水寺，经年草诏白云司。唯君此去人多羡，却是恩深自不知。

[其它主题] - 观郑州崔郎中诸妓绣障（一作咏绣障）

日暮堂前花蕊娇，争拈小笔上床描。绣成安向春园里，引得黄莺下柳条。



# Intelligent manufacturing knowledge graph

## Challenges in our industry

### Isolated data silos 数据孤岛

- By owner (Siemens divisions, customers, ...)
- By subject (operating data, maintenance data, error information, customer data, ...)
- By media type (time series, images, PDFs, ...)

### Data inaccessibility 数据获取困难

- Access paths are too complicated for domain experts leading to high costs for data access
- No integrated view of data
- No or limited search functionalities

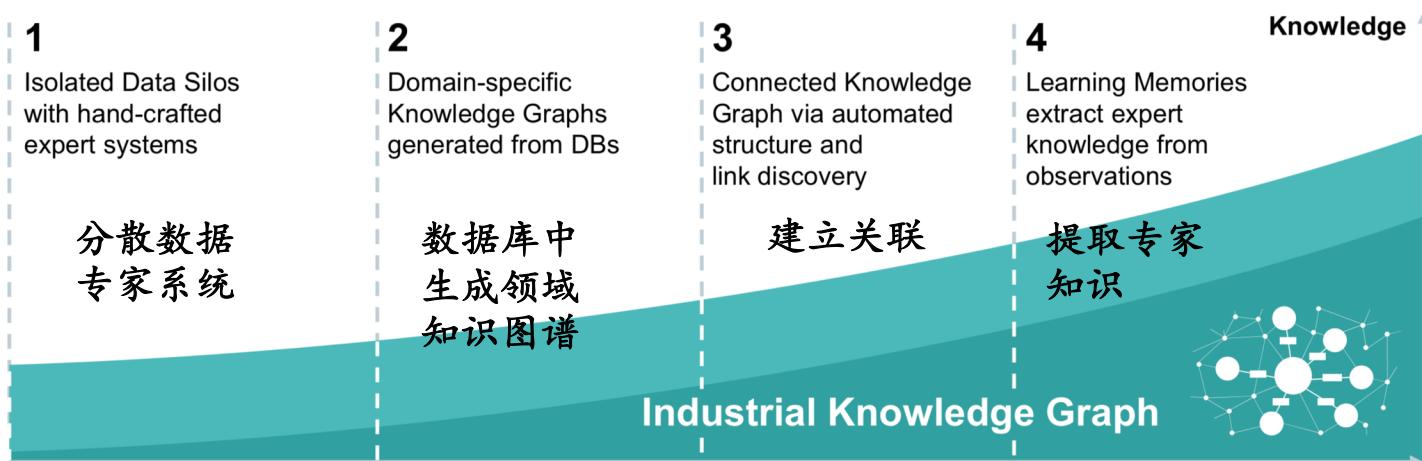
### Inefficient workflows 工作流低效

- Long delay from information needs to data access
- Data provisioning demands big capacities of IT experts
- Heterogeneous storage lead to complex data control

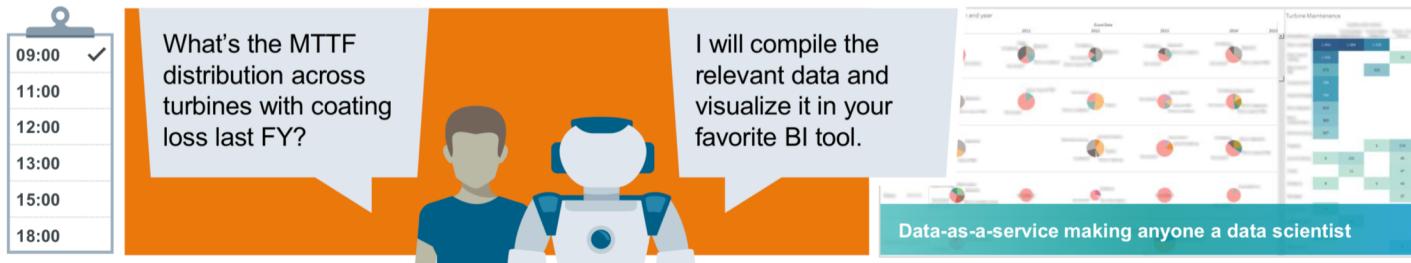
### Low data quality 数据质量低

- Outdated
- Duplicated
- Incorrect or contradictory

# Intelligent manufacturing knowledge graph



# Intelligent manufacturing knowledge graph



## Challenge

- Required **data is distributed** across multiple databases
- Source systems have highly **complex schemas**
- Need to **include unstructured information** into analyses
- Reactivity and efficiency needs call for **end-user access to data**



## Solution

- NLP** to make information from documents accessible for analytics
- Physical and virtual data integration** to provide unified view
- Access using a **domain ontology** and intelligent **query construction support**
- Connectors** providing data to existing tools in legacy format



## Value Generation

- Unified Data Hub:** All information accessible from one system, independent of source and type
- Empower domain experts:** Subject matter experts can use domain language to access data
- Enabler for analytics:** Foundation for fleet-level analytics

平均故障间隔时间分布-涡轮机-涂层损耗-上年度

# Intelligent manufacturing knowledge graph



## Challenge

- Product configuration information is **scattered** across spreadsheets, **inconsistent and redundant**
- Missing transparency** on technology interactions
- Information only on **HOW to design**, but **not on WHY** to do so



## Solution

- Use an Industrial Knowledge Graph to **store product configuration knowledge** with rich semantics
- For new order, **create constraint system on the fly** using knowledge graph information & **solve for feasible solutions**
- Use Industrial Knowledge Graph technology to **browse solutions**

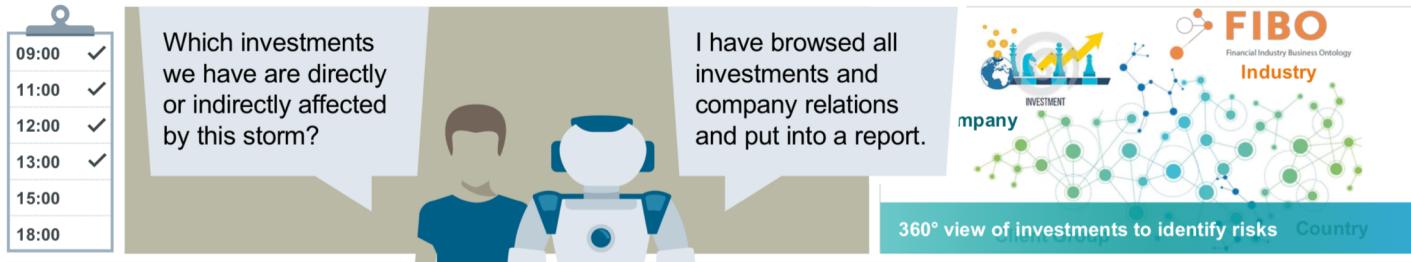


## Value Generation

- Introduce **knowledge management** into turbine configuration
- Integrated design process** across all components and technologies
- Semantics allow **explain the WHY** behind a design decision
- Speed-up** due to automation

如何匹配新涡轮机和用户的需求

# Intelligent manufacturing knowledge graph



09:00 ✓  
11:00 ✓  
12:00 ✓  
13:00 ✓  
15:00  
18:00

Which investments we have are directly or indirectly affected by this storm?

I have browsed all investments and company relations and put into a report.

FIBO  
Financial Industry Business Ontology  
Industry

360° view of investments to identify risks

## Challenge

- Siemens bank has a **wide range of investments** across industries
- Complex **networks of company relations** (own, partners, competitors)
- Limited transparency on risks** due to external events, fraud, partner and competitor activities, etc



## Solution

- Combine **internal and purchased information** on companies and projects in Knowledge Graph
- Highly **flexible query interface** to support arbitrary queries (structured and natural language search)
- Interfaces to **support analytics** on top of integrated data



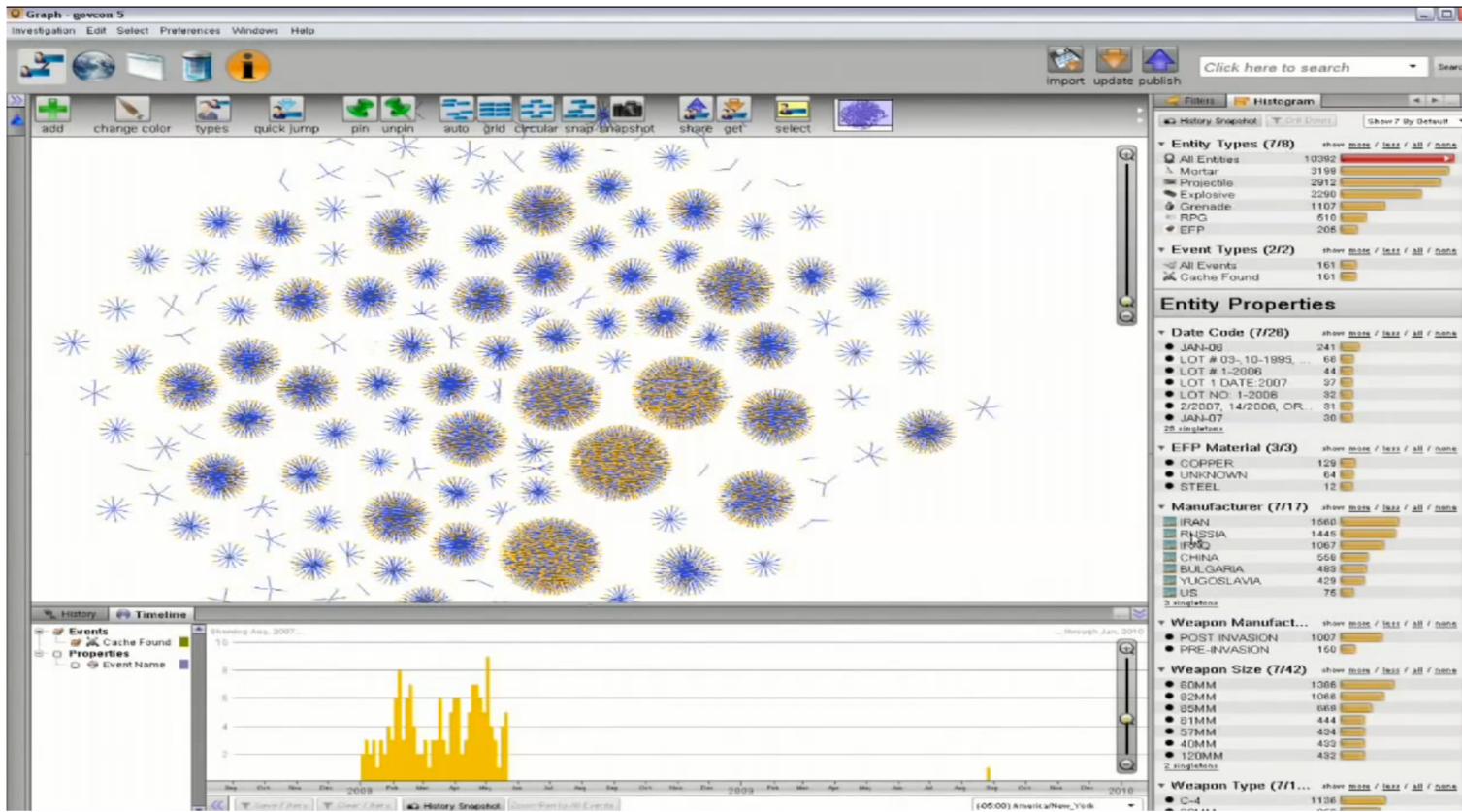
## Value Generation

- Highly agile analysis of risks** caused e.g. by unforeseen events
- Improved transparency** over partners and competitors
- Identification of **potentially fraudulent behavior patterns**

我们的那些资产直接或间接被这场风暴影响？

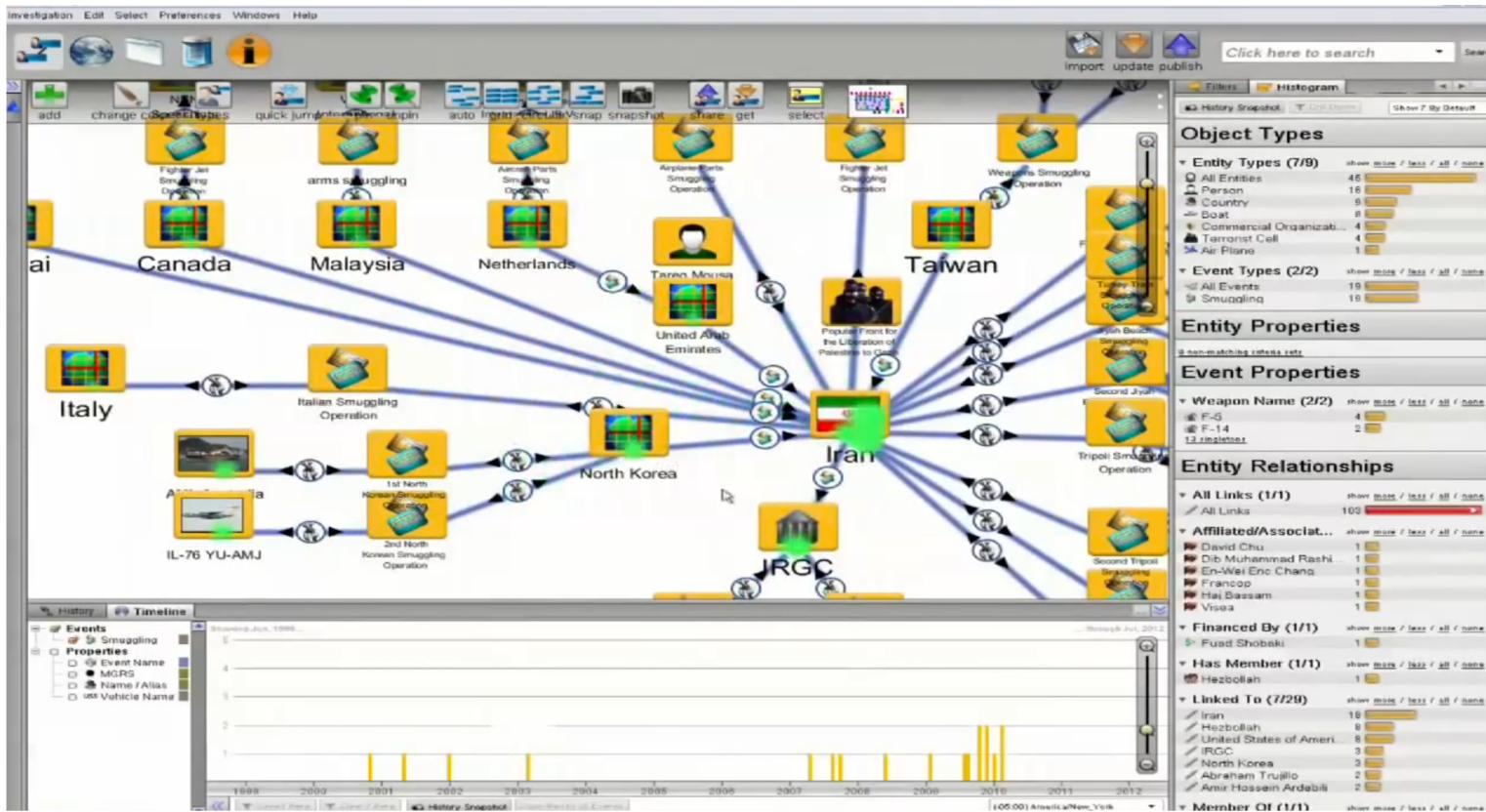
# Palantir intelligence knowledge graph

war resources: factory、weapon、equipment



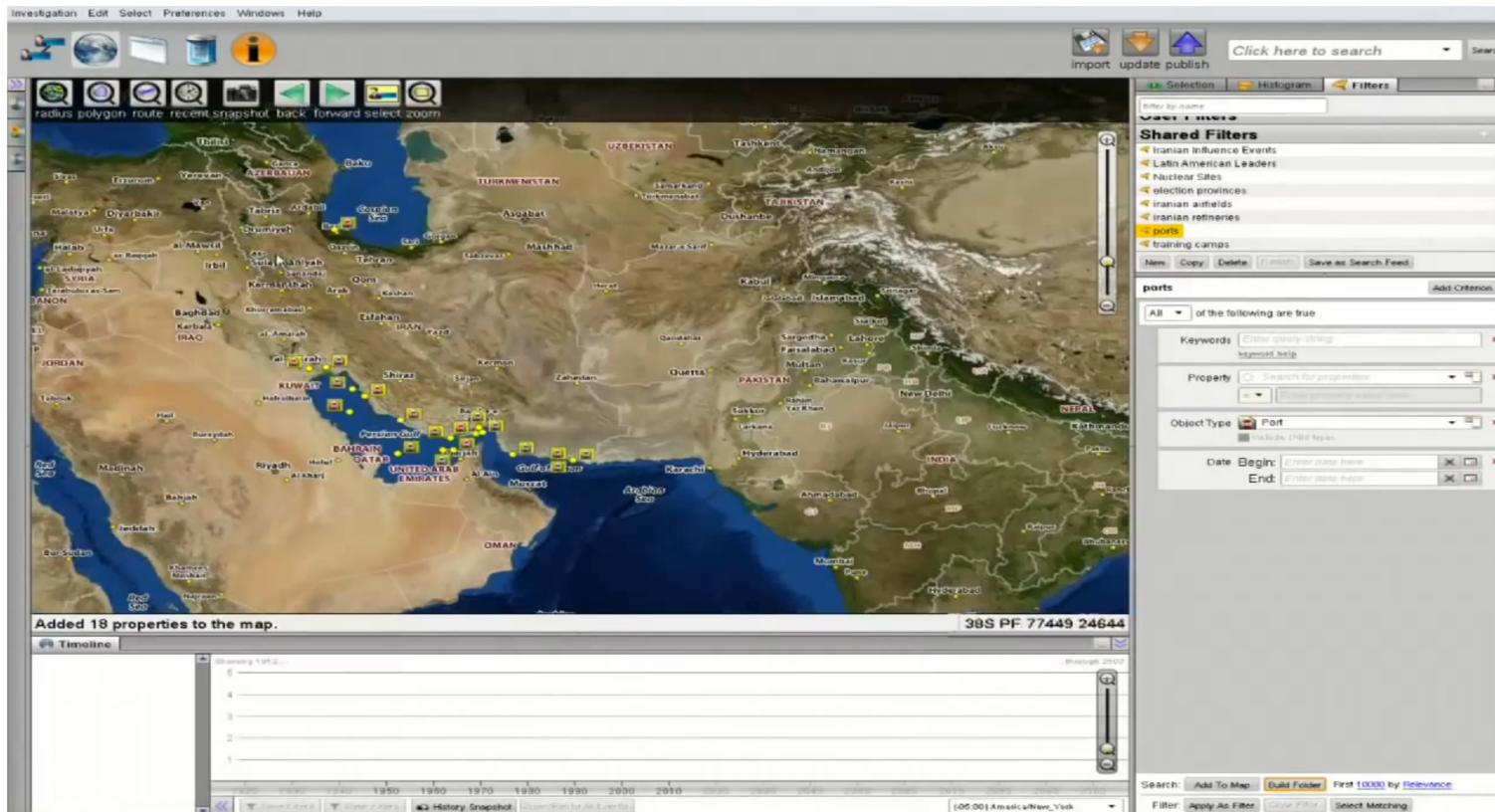
# Palantir intelligence knowledge graph

## international relationship



# Palantir intelligence knowledge graph

## important military facilities



The screenshot displays the Palantir Intelligence Knowledge Graph interface. The main view is a map of the Middle East and South Asia, with numerous yellow markers scattered across the region, likely indicating the locations of important military facilities. The map includes labels for countries like Iran, Iraq, Saudi Arabia, and India, along with various cities and geographical features.

At the top, there is a toolbar with icons for investigation, edit, select, preferences, windows, and help. To the right of the map is a search bar with the placeholder "Click here to search" and a dropdown menu for "Search". Below the search bar are buttons for import, update, and publish.

On the right side of the interface, there is a "Shared Filters" panel. It contains a list of filter criteria under the heading "Cover Criteria":

- Iranian Influence Events
- Latin American Leaders
- Nuclear Sites
- selected provinces
- iranian airfields
- iranian refineries
- ports** (highlighted in yellow)
- training camps

Below this is a "ports" filter configuration section:

All  of the following are true

Keywords

Property

Object Type  (Include Child Types)

Date Begin:  End:

At the bottom left, a "Timeline" section shows a vertical timeline from 1950 to 2010. A specific entry is highlighted: "Operation Iraqi Freedom" occurring between 2003 and 2007. The status bar at the bottom right indicates "First 10000 by Relevance" and "Select Matching".

Added 18 properties to the map.

38S PF 77449 24644

Timeline

Operation Iraqi Freedom

Search: Add To Map Build Folder First 10000 by Relevance Filter: Apply As Filter Color Filter Select Matching

# Palantir intelligence knowledge graph

## Leader analysis

The Sunday Times, Tali... Mahmoud Ahmadinejad

Two weeks ago (1)  
Ahmadinejad's name. Alex Johnson Add to Circles

**Media**



pt\_758110970... images%3Fq%3... pt\_662764117... pt\_430392779...

**Related Events**

Type	Relationship	Label	Text
Travel (29)			
Meeting (2)			
Iranian Influence Event (1)			
Held Office (1)			
Event (2)			

**Diagram:** A network graph showing connections between political leaders. Nodes include Fernando Lugo, Raúl Castro, Hugo Chávez, Daniel Ortega, Evo Morales, Luiz Inácio Lula da Silva, and others. Edges represent relationships like 'Chavez traveled with his men...' and 'Ahmadinejad Brazil Trip'.



# Knowledge graph in academic research

- **IJCAI2017 best paper**

**Foundations of Declarative Data Analysis Using Limit Datalog Programs**

描述性数据(知识)分析的逻辑基础

- **AAAI2017 outstanding paper**

**Label-Free Supervision of Neural Networks with Physics and Domain Knowledge**

先验领域知识可提高卷积神经网络的训练效率

- **AAAI2018 classic paper**

**PROMPT: Algorithm and Tool for Automated Ontology Merging and Alignment**  
**(AAAI 2000)**

知识（本体）融合的开创性工作

# Knowledge graph in academic research

- **IJCAI2017 prominent paper**

-BabelNet: The automatic construction, evaluation and application of a wide-coverage multilingual semantic network

多语言的语义网络

-YAGO2: A spatially and temporally enhanced knowledge base from Wikipedia  
YAGO2是YAGO的扩展版，增加了时空知识

- **IJCAI2018 distinguished paper**

-From Conjunctive Queries to Instance Queries in Ontology-Mediated Querying  
本体查询

-Commonsense Knowledge Aware Conversation Generation with Graph Attention  
将大规模常识知识图谱用于对话生成

# Knowledge graph in job market



【智言科技】诚聘自然语言处理 & 知识图谱算法研究员

月薪范围：340W+

工作经验不限，学历不限

工作地址：北京市海淀区

职位描述

- 1. 进行大规模开放领域知识图谱研发
- 2. 进行垂直领域的知识图谱研发
- 3. 研究基于图谱的算法和系统
- 4. 实施基于图谱的应用

任职要求：

投递简历



【知识图谱算法工程师】滴滴出行

月薪范围：3万-6万

工作经验不限，学历不限

工作地址：北京市海淀区

职位描述

- 1. 负责技术路线发展规划指导团队成员的能力提升，绩效激励、培养研发梯队，力量，建立规范的开发过
- 程管理体系，提升团队在行业内的技术水平。
- 2. 对行业产品及动向保持敏锐的感知度，预研最新技术并应用在产品中，解决研发过程疑难问题；

投递简历



【技术专家-人工智能-大数据】滴滴出行

月薪范围：4万-8万

工作经验不限，学历不限

工作地址：北京市海淀区

职位描述

- 1. 负责技术路线发展规划指导团队成员的能力提升，绩效激励、培养研发梯队，力量，建立规范的开发过
- 程管理体系，提升团队在行业内的技术水平。
- 2. 对行业产品及动向保持敏锐的感知度，预研最新技术并应用在产品中，解决研发过程疑难问题；

投递简历

# Knowledge graph group in China

## ● University

- Semantic Web: 东南大学（瞿裕忠、徐宝文）（南京大学）、清华大学、浙江大学、上海交大、武汉科技大学、华东理工、武汉大学、.....
- NLP: 哈工大、复旦大学、中科院、苏州大学、.....
- 目前大部分兄弟院校都有相关研究团队

## ● Enterprise

- IBM CRL, MSRA, Google
- BATJ、360、华为、中兴、云知声、科大讯飞、平安、烽火科技、.....
- 明略、元典、文因互联、狗尾草、乐言、中译语通、.....
- 目前大部分企业都有相关研发团队

# Outline

- 1. Knowledge Graph Concepts
- 2. Classical Knowledge Graphs
- 3. Knowledge Graph Applications
- 4. Challenges

# challenge

## ● knowledge graph construction

- 缺乏快速、高效、低成本的相对通用知识图谱构建平台

## ● large scale knowledge graph storage

- 缺少开源、易用、高性能、易扩展的图数据库

## ● knowledge graph applications

- 挖掘和发挥知识图谱在大量行业中的应用潜能

## ● large scale knowledge graph reasoning

- 知识图谱中数据稀疏，知识不全，大规模知识推理任重道远

धन्यवाद

Hindi  
Hindi

Спасибо

Russian

شُكْرًا

Arabic

Grazie

Italian

நென்றி

Tamil

Tamil

多謝

Traditional Chinese

Thank You

English

多謝

Simplified Chinese

ありがとうございました

Japanese

บุญคุณ

Thai

Gracias

Spanish

Obrigado

Brazilian Portuguese

Danke

German

Merci

French

감사합니다

Korean