WDS

DataScience@Web

WEB SCIENCE

Xiang Zhang

http://cse.seu.edu.cn/PersonalPage/x.zhang/

INTRODUCTION

Instructors

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Course Homepage

http://cse.seu.edu.cn/PersonalPage/x.zhang/web_science/

Schedule

- Lecture 1 – Sep.
  - Introduction, Teaming, Web and Semantic Web
  - Assignment 1, Self-study materials
- Lecture 2 – Nov.
  - Graph Analysis and Visualization, Student Presentations
  - Assignment 2
- Lecture 3 – Nov.
  - Community Detection, Student Presentation, Lab Works
  - Assignment 3
- Lecture 4 – Dec.
  - Lab Works

Teaming

- 3-4 students in a team
- One team leader
- Clear team roles
- Each enrolled student MUST be in one team
- No intersections among teams
- Due time: Sep. 25

Student Presentations

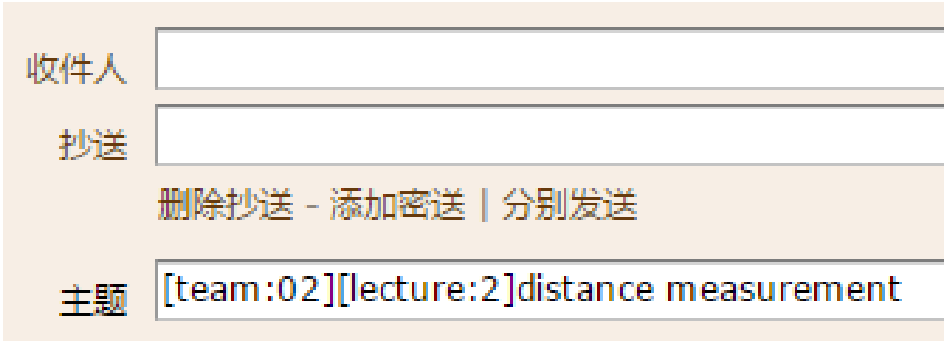
- Half of the teams will present their work in Lecture 2
- The other half of the teams will present in Lecture 3
- No more than 15min for one presentation

Grading

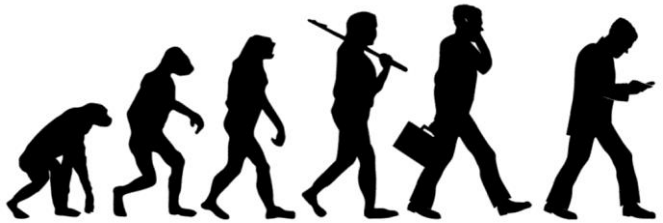
- Teamwork
- Presentations
- Paper Writing
- Personal Report
- *Final exam

Assignment Submission

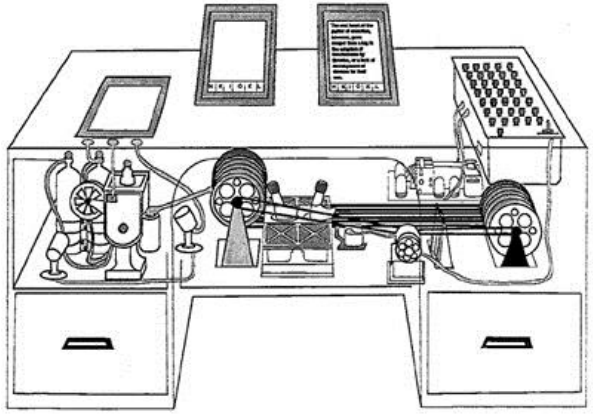
- webscience_zhang@163.com
- webscience_yang@163.com
- Title rules:



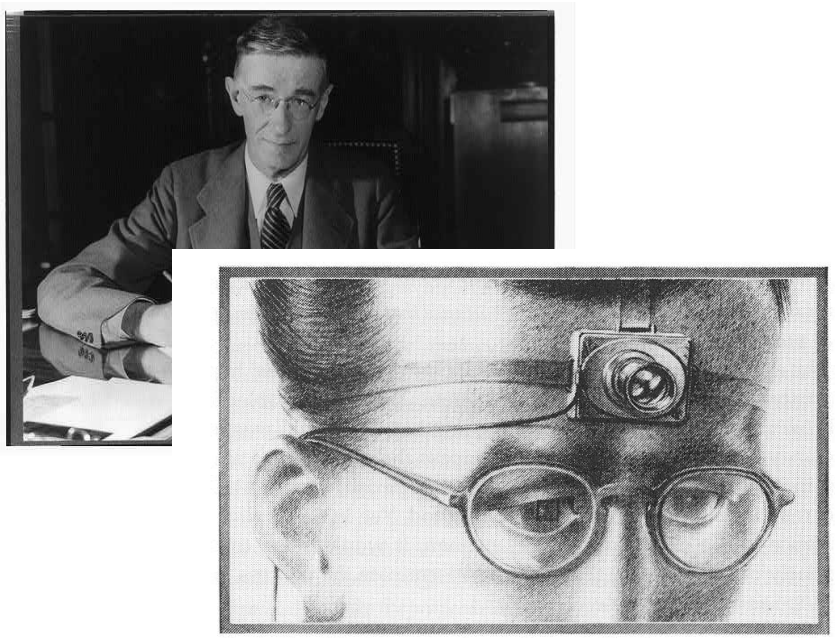
EVOLUTION OF THE WEB



As We May Think - 1945



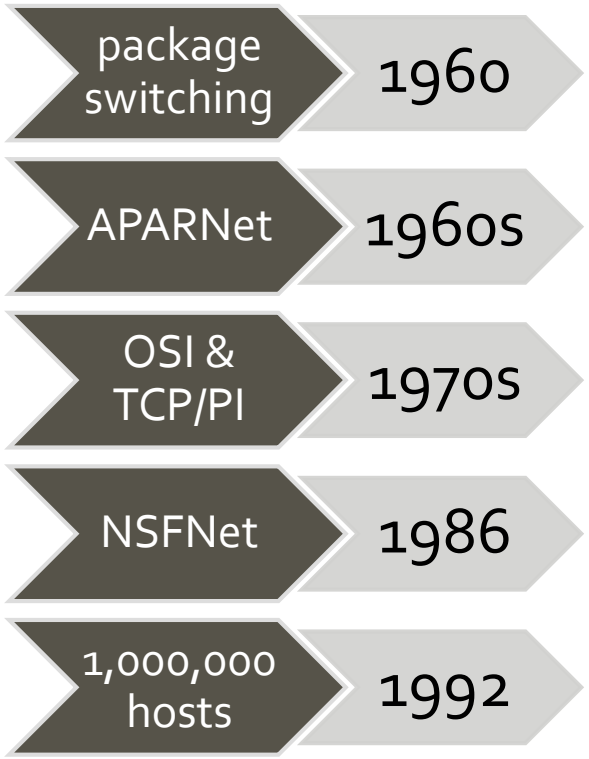
"A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."



A scientist of the future records experiments with a tiny camera fitted with universal-focus lens. The small square in the eyeglass at the left sights the object (*LIFE 19*(11), p. 112).

Building Internet – 1960s

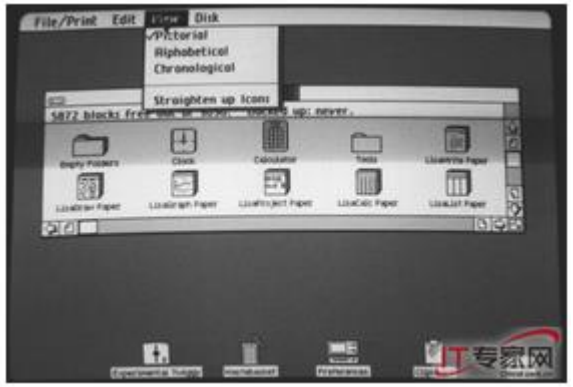
Developing Internet

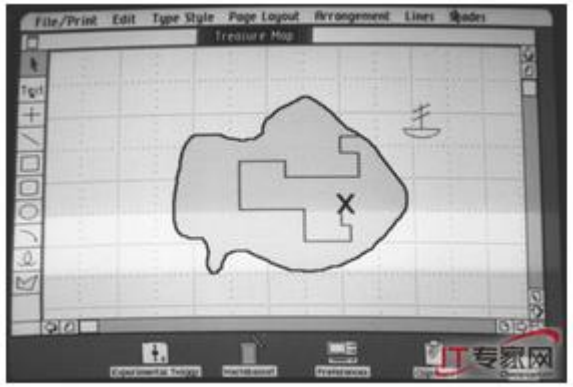


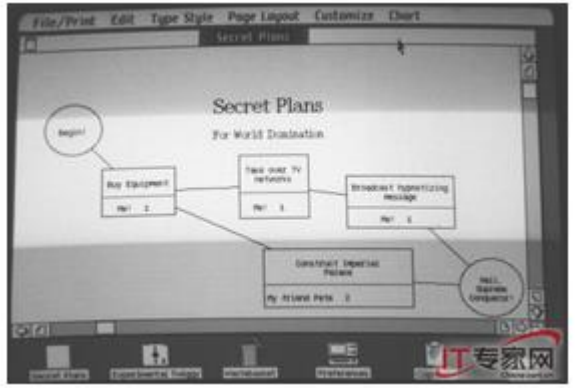
Doug Engelbart and His… - 1698

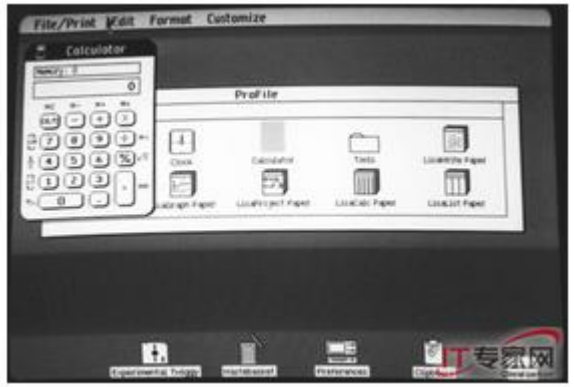
Steve Jobs and His… - 1983

And His LISA

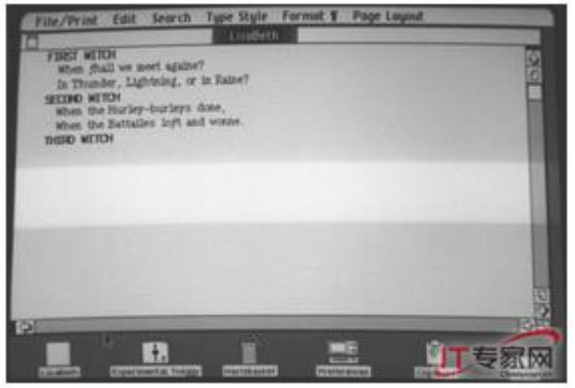

File/Print Edit View Disk
Pictorial
Alphabetical
Chronological
Straighten up Icons


File/Print Edit Type Style Page Layout Arrangement Lines Shades
Treasure Map

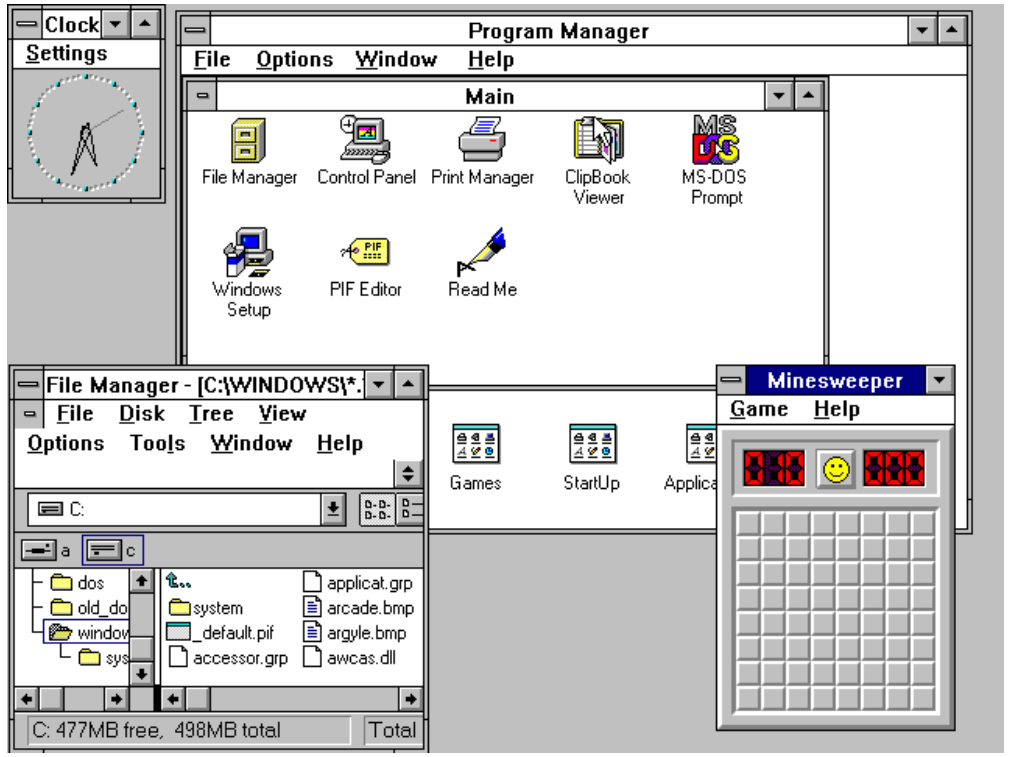

File/Print Edit Type Style Page Layout Customize Chart
Secret Plans
Secret Plans
For World Domination


File/Print Edit Format Customize
Calculator
Profile

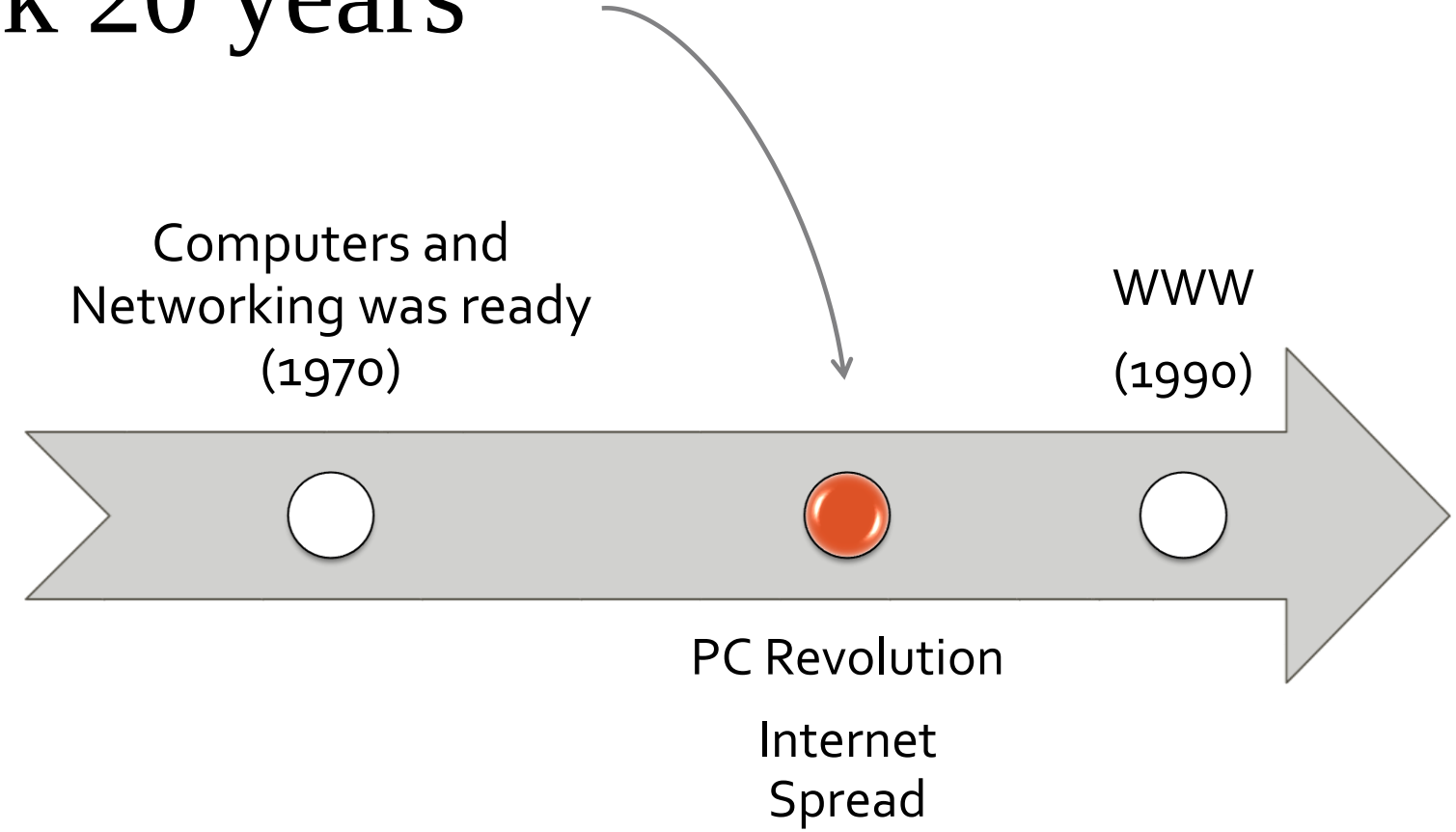

File/Print Edit Type Style Page Layout Format Protect Calculate
Untitled
Value (Blank):


File/Print Edit Search Type Style Format ¶ Page Layout
FIRST WITCH
When shall we meet again?
In Thunder, Lightning, or in Rain?
SECOND WITCH
When the Hurley-burleys done,
When the Battailes lost and won.
THIRD WITCH

Bill Gates and His Windows 3.1 - 1992



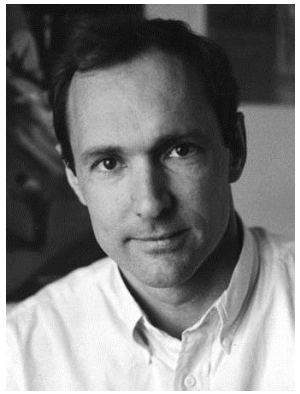
It took 20 years



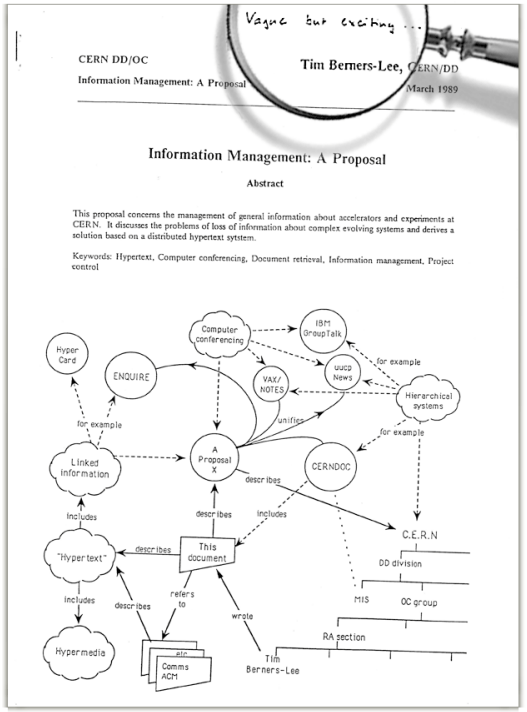
More and More People had PCs

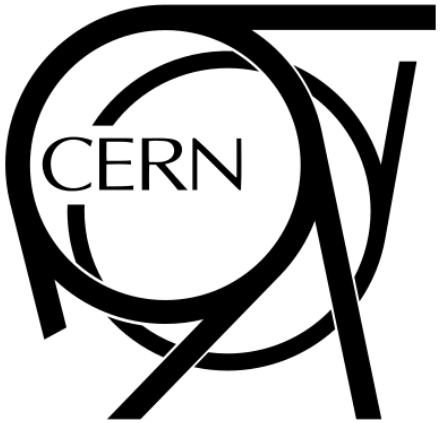
Apple II: $9,935

Something Happened in 1989

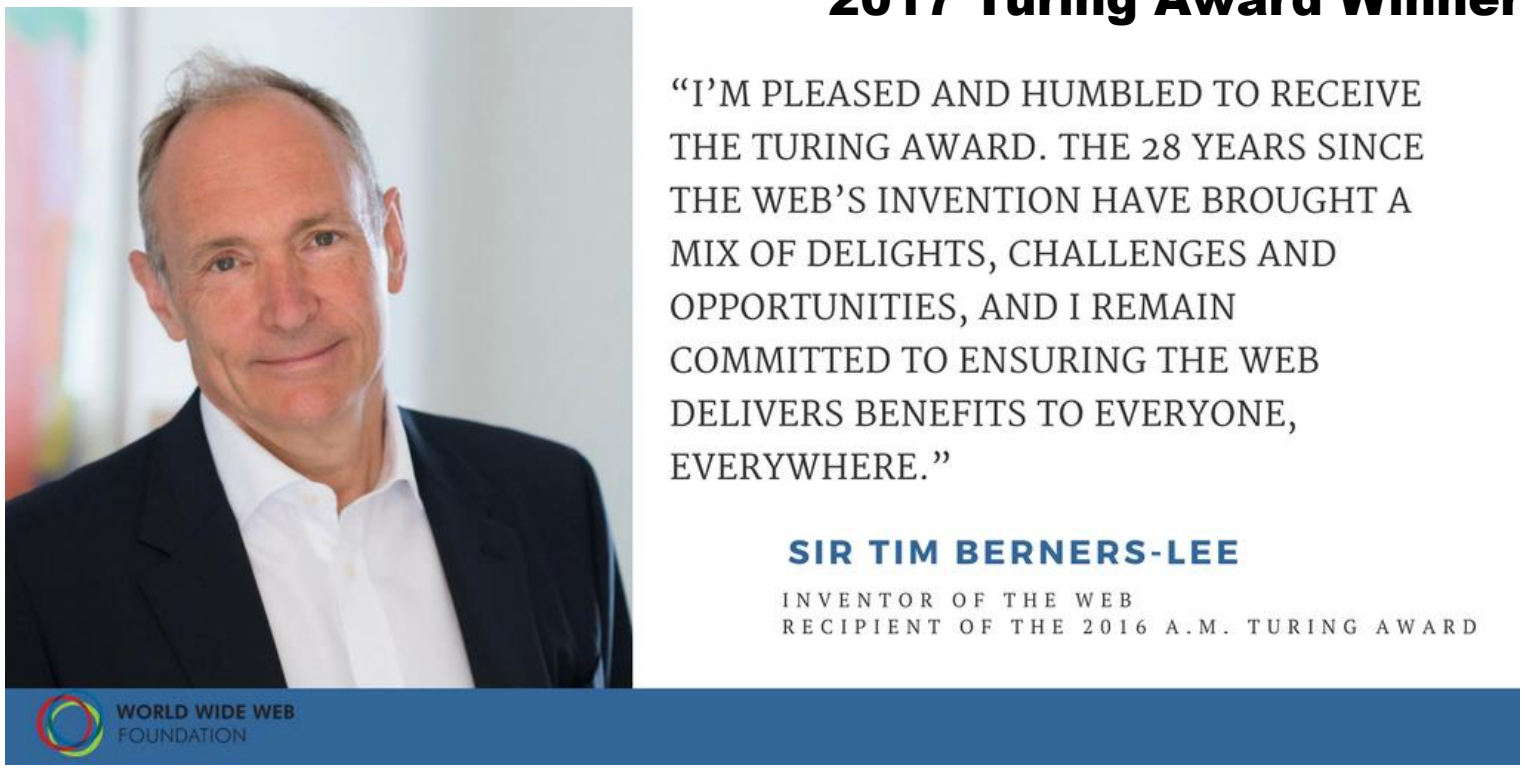


Sir Tim Berners-Lee



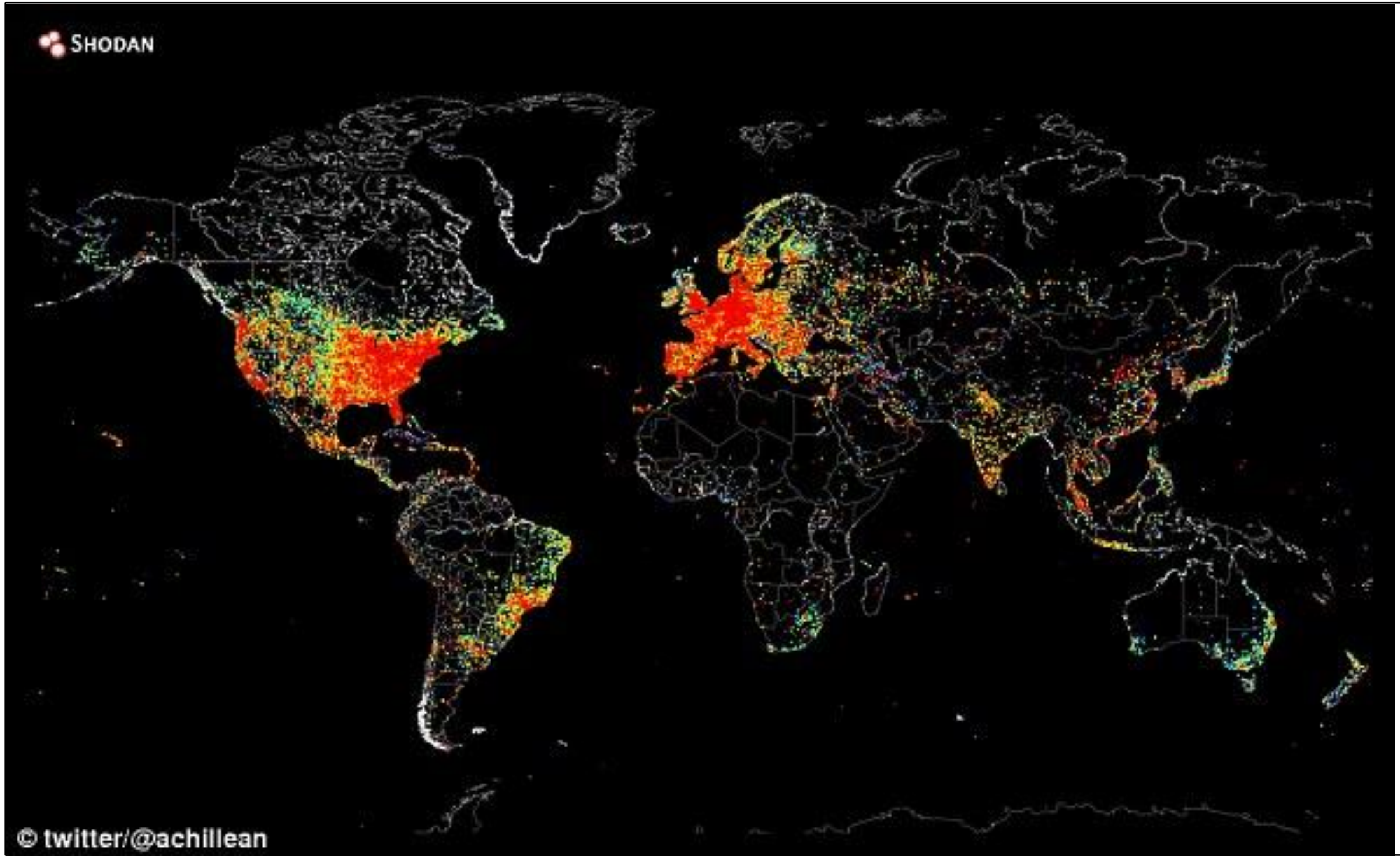


And Now…


2017 Turing Award Winner
"I'M PLEASED AND HUMBLED TO RECEIVE THE TURING AWARD. THE 28 YEARS SINCE THE WEB'S INVENTION HAVE BROUGHT A MIX OF DELIGHTS, CHALLENGES AND OPPORTUNITIES, AND I REMAIN COMMITTED TO ENSURING THE WEB DELIVERS BENEFITS TO EVERYONE, EVERYWHERE."
SIR TIM BERNERS-LEE
INVENTOR OF THE WEB
RECIPIENT OF THE 2016 A.M. TURING AWARD
WORLD WIDE WEB FOUNDATION

WWW is great

WDS
DataScience@Web



PING THE WWW

Discussion 1:

Why HTML not XML is adopted in WWW?

```
<html>
    <title>I am Zhang Xiang </Title>
    <body>
      <p>This is a paragraph
      <p>This is another pararaph</p>
</html>
```

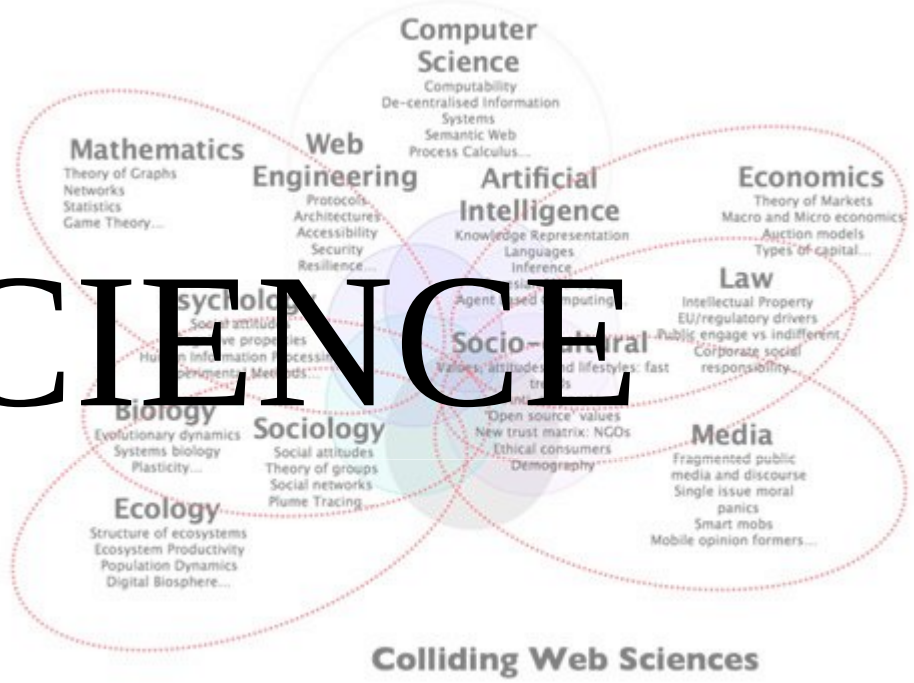
VS.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<note>
    <to>George</to>
    <from>John</from>
    <heading>Reminder</heading>
    <body>Don't forget the meeting!</body>
</note>
```

Discussion 2:

How to estimate the volume of WWW?

WEB SCIENCE


Computer Science
Computability
De-centralised Information Systems
Semantic Web
Process Calculus...
Mathematics
Theory of Graphs
Networks
Statistics
Game Theory...
Web Engineering
Protocols
Architectures
Accessibility
Security
Resilience...
Artificial Intelligence
Knowledge Representation
Languages
Inference
Economics
Theory of Markets
Macro and Micro economics
Auction models
Types of capital...
Law
Intellectual Property
EU/regulatory drivers
Public engage vs indifferent
Corporate social responsibility...
Biology
Evolutionary dynamics
Systems biology
Plasticity...
Sociology
Social attitudes
Theory of groups
Social networks
Plume Tracing
'Open source' values
New trust matrix: NGOs
Ethical consumers
Demography
Media
Fragmented public media and discourse
Single issue moral panics
Smart mobs
Mobile opinion formers...
Ecology
Structure of ecosystems
Ecosystem Productivity
Population Dynamics
Digital Biosphere...
Colliding Web Sciences

Impact of Web

- Economy
  - Bust effect of .com bubble in 2000/2001
- Politics
  - US president election
- Business
  - B2C, B2B, O2O
- Social Collaboration
  - Wikipedia
- Media
  - Twitter, Facebook, Instagram, YouTube…

What is Web Science

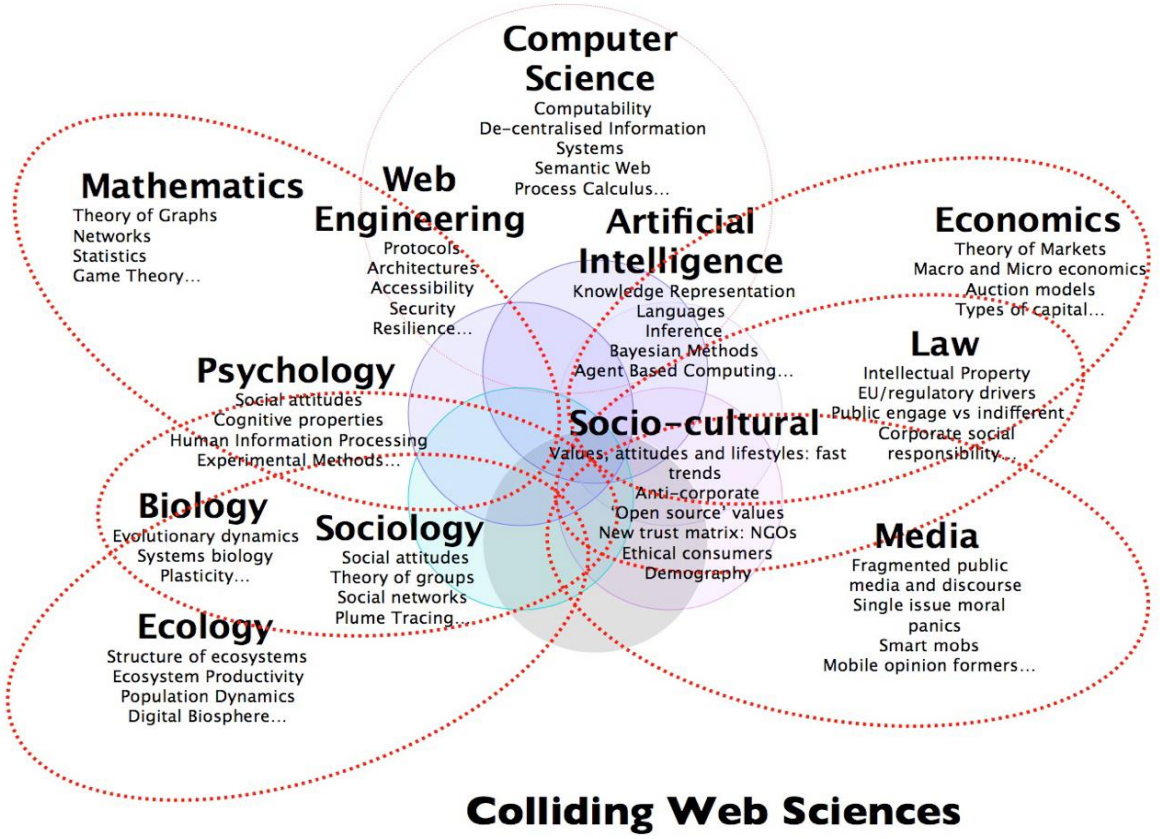
broader definition

"the process of designing things in a very large space" – Tim Berners-Lee, 2007.

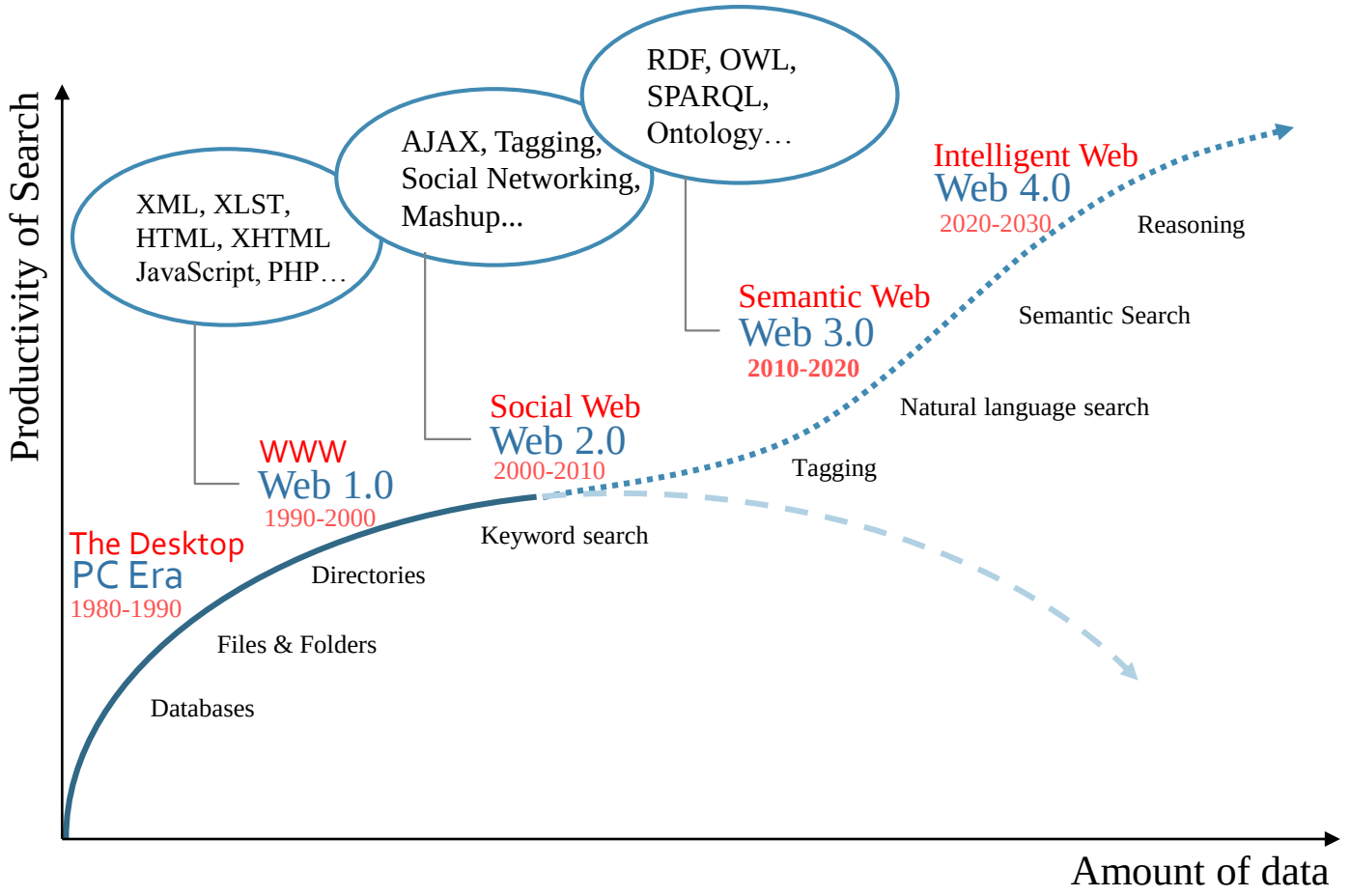
narrower definition

The process of enabling computers to understand the web.

Colliding Web Science



Trend of Web [Nova Spivack 2008]



Web 1.0 vs 2.0

Web 1.0	Web 2.0
Publishing	Participation
Personal Websites	Blogging, Social Networking
Read Only	Read and Write
Content Management Systems	Wikis
Britannica Online	Wikipedia
Directories (taxonomy)	Tagging (folksonomy)

Limitations

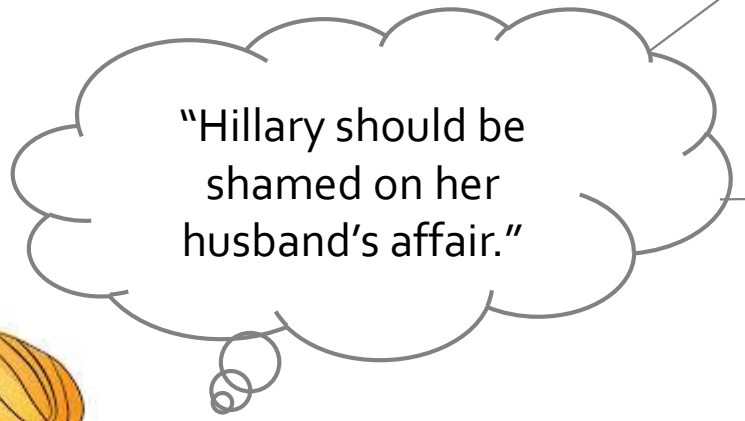
- Too much information vs. Too little structure
- Heterogeneous content
- Hidden information

SEMANTIC WEB

From WWW to Semantic Web

	WWW	Semantic Web
Analogy	A global file system	A global database
Designed for	Human consumption	Machine 1st, Human 2nd
Primary objects	Documents	Things
Links between	Documents	Things
Structure	Fairly low	High

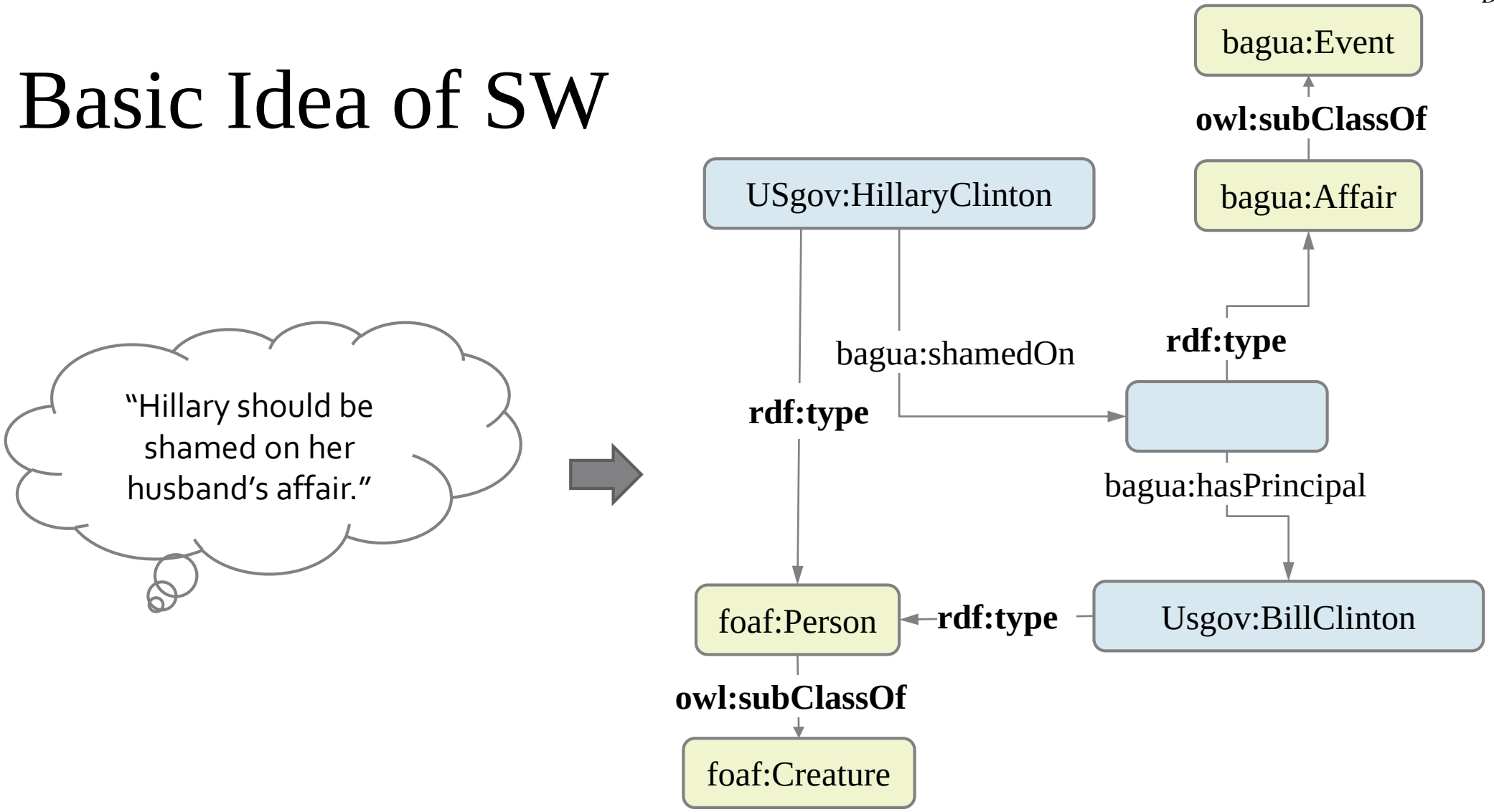
Basic Idea of SW



Syntax: the structure of language

Vocabulary: the common semantics of language

Basic Idea of SW



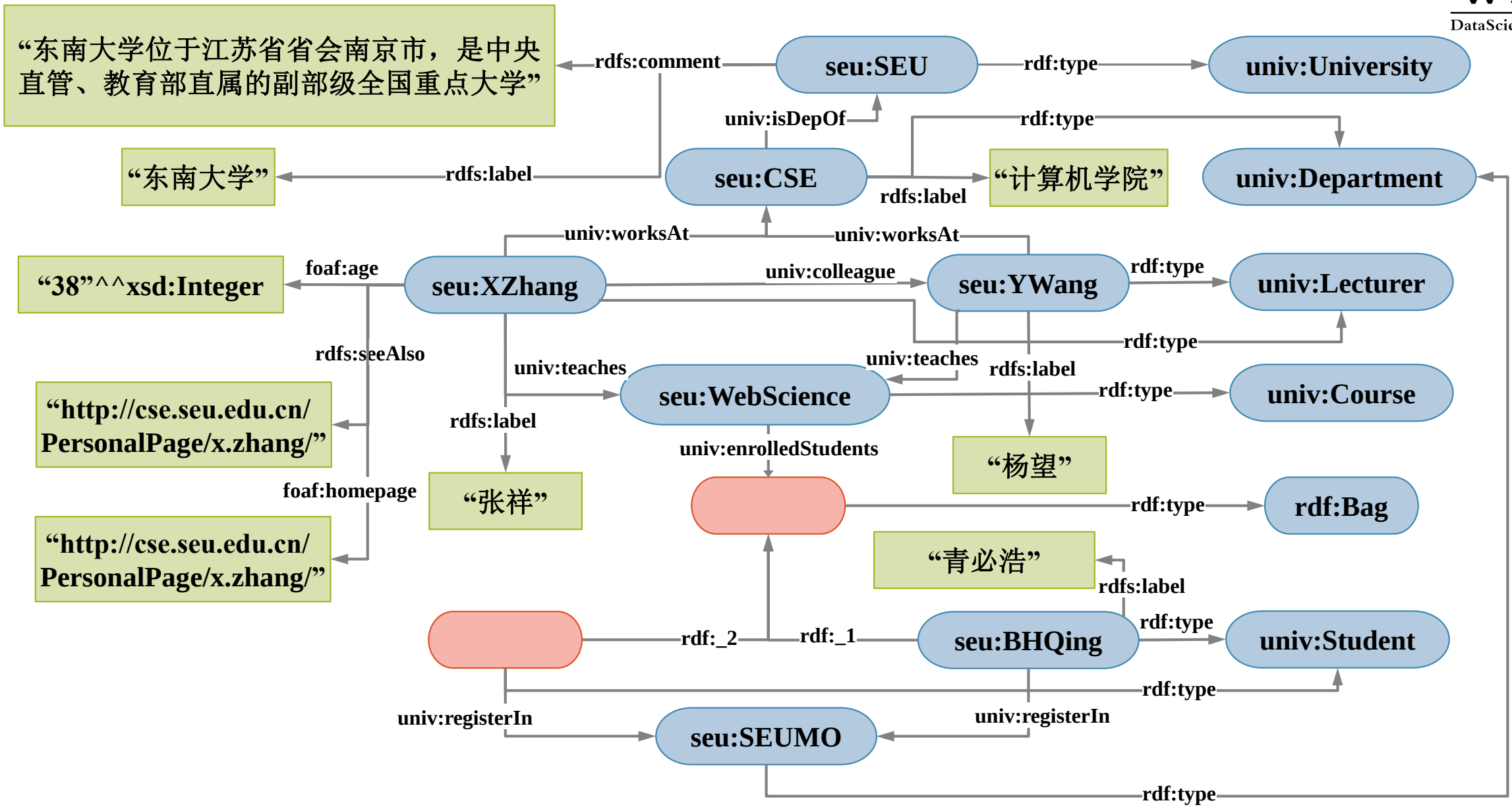
Syntax: RDF

- RDF: Resource Description Framework
- Graph Model
- Nodes: objects, identified by URI(IRI) / bnode / literal
- Edges: relations or attributes, identified by URI(IRI)
- A triple or statement is a <subject, predicate, object> structure similar to natural language.

Vocabulary: OWL

- Provides a language to define terms(concepts) in a vocabulary(ontology)
- Terms can be categorized into:
  - Classes
  - Properties
- The semantics in a vocabulary(ontology) defined in OWL is represented by description logic


RDF


“东南大学位于江苏省省会南京市，是中央直管、教育部直属的副部级全国重点大学”
rdfs:comment
seu:SEU
rdf:type
univ:University
univ:isDepOf
rdf:type
“东南大学”
rdfs:label
seu:CSE
“计算机学院”
rdfs:label
univ:Department
univ:worksAt
univ:worksAt
“38”^^xsd:Integer
foaf:age
seu:XZhang
univ:colleague
seu:YWang
rdf:type
univ:Lecturer
rdf:type
rdfs:seeAlso
univ:teaches
univ:teaches
rdfs:label
“http://cse.seu.edu.cn/PersonalPage/x.zhang/”
seu:WebScience
rdf:type
univ:Course
rdfs:label
univ:enrolledStudents
“杨望”
foaf:homepage
“张祥”
rdf:type
rdf:Bag
“http://cse.seu.edu.cn/PersonalPage/x.zhang/”
“青必浩”
rdfs:label
rdf:_2
rdf:_1
seu:BHQing
rdf:type
univ:Student
rdf:type
univ:registerIn
univ:registerIn
seu:SEUMO
rdf:type

Resource and Triples

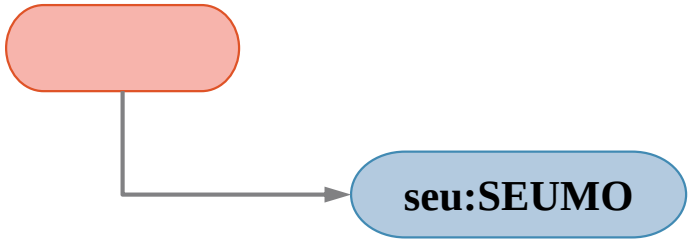
- Resource: nodes in RDF graph
- Triple = $\langle subject, predicate, object \rangle$ is an edge in RDF graph
- Triples = Statements
- #triples represents the scale of RDF graph
- For example: for Bio2RDF(Life Science), #triple is over 11 Billion

URI

- Universal Identification for Resources
- URI ≠ URL
- Accessible and non-accessible URI
- “http://www.seu.edu.cn/XZhang”
  - prefix/namespace: “http://www.seu.edu.cn/”
  - localname: “XZhang”
- Abbr: seu:XZhang

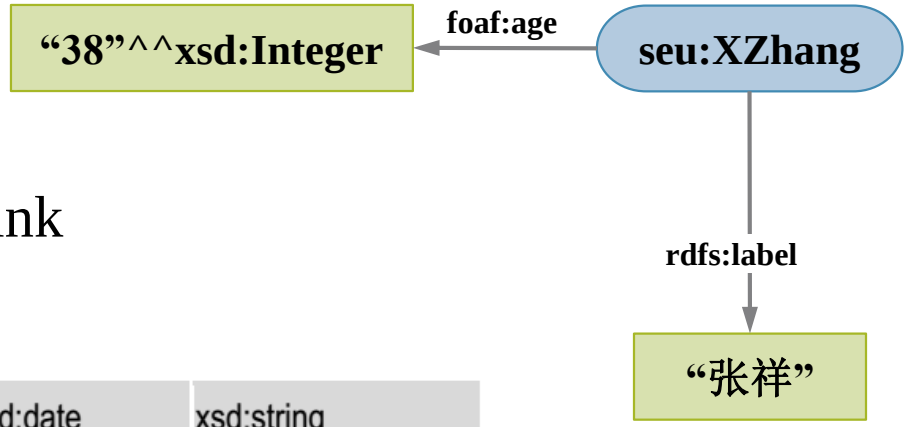
Blank nodes

- "There is a student from SEUMO, ***who*** enrolled in the course of Web Science."
- A resource without a URI
- Usually has an inner id: _:xxx



Literals and XML datatypes

- Like primary data types in Java and C++
- A text or data description of resources
- always have 1 in-coming link and no out-going link
- A literal could be
  - plain text
  - typed literals



xsd:decimal	xsd:negativeInteger	xsd:anyURI	xsd:date	xsd:string
xsd:double	xsd:positiveInteger	xsd:base64Binary	xsd:dateTime	xsd:normalizedString
xsd:float	xsd:nonPositiveInteger	xsd:boolean	xsd:time	xsd:token
xsd:int	xsd:nonNegativeInteger	xsd:byte	xsd:gYearMonth	xsd:language
xsd:integer	xsd:unsignedLong	xsd:hexBinary	xsd:gYear	xsd:NMTOKEN
xsd:long	xsd:unsignedInt	xsd:unsignedByte	xsd:gMonthDay	xsd:Name
xsd:short	xsd:unsignedShort		xsd:gDay	xsd:NCName
			xsd:gMonth	

rdf:type

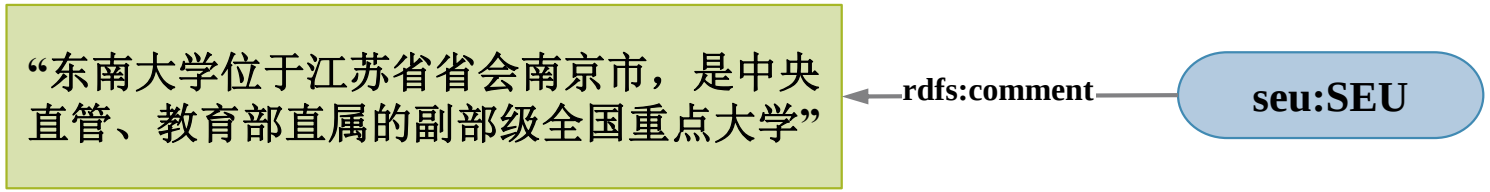
- The most important predicate
- $\langle instance, rdf:type, class \rangle$

rdfs:label

- An easy-to-read name of resources

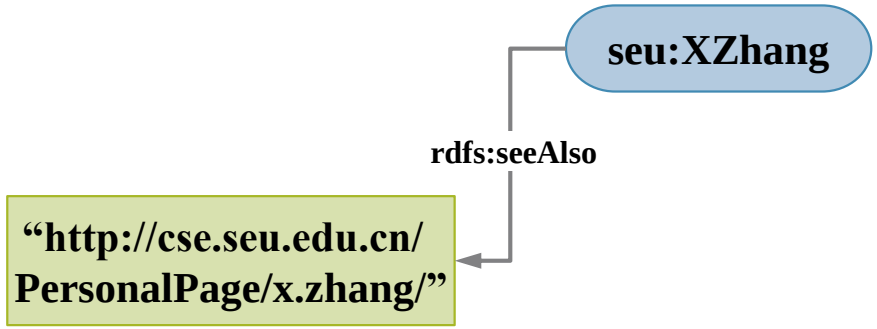
rdfs:comment

- A textual description of resources



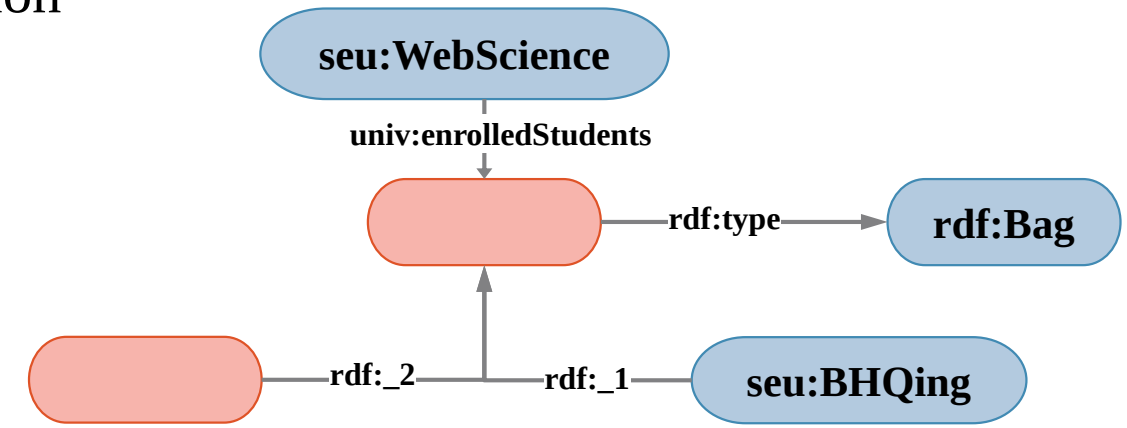
rdfs:seeAlso | rdfs:isDefinedBy

- *rdfs:seeAlso*
  - "Please refer to…"
  - provides more information or citation of a resource
- *rdfs:isDefinedBy*
  - *sub-property of rdfs:seeAlso*
  - "Please refer to the definition from…"



RDF Container

- Like java.util.Collection
- rdf:Bag
  - non-ordered
- rdf:Seq
  - ordered
- rdf:Alt



Writing RDF Graphs 1: N-triple

```
<http://example.org/bob#me> <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> <http://xmlns.com/foaf/0.1/Person> .
<http://example.org/bob#me> <http://xmlns.com/foaf/0.1/knows> <http://example.org/alice#me> .
<http://example.org/bob#me> <http://schema.org/birthDate> "1990-07-04"^^<http://www.w3.org/2001/XMLSchema#date> .
<http://example.org/bob#me> <http://xmlns.com/foaf/0.1/topic_interest> <http://www.wikidata.org/entity/Q12418> .
<http://www.wikidata.org/entity/Q12418> <http://purl.org/dc/terms/title> "Mona Lisa" .
```

Writing RDF Graphs 2: Turtle

```
BASE   <http://example.org/>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#
PREFIX schema: <http://schema.org/>
PREFIX dcterms: <http://purl.org/dc/terms/>
PREFIX wd: <http://www.wikidata.org/entity/>

<bob#me>
    a foaf:Person ;
    foaf:knows <alice#me> ;
    schema:birthDate "1990-07-04"^^xsd:date ;
    foaf:topic_interest wd:Q12418 .
```

Writing RDF Graph 3: JSON

```
{
  "@context": "example-context.json",
  "@id": "http://example.org/bob#me",
  "@type": "Person",
  "birthdate": "1990-07-04",
  "knows": "http://example.org/alice#me",
  "interest": {
    "@id": "http://www.wikidata.org/entity/Q12418",
    "title": "Mona Lisa",
    "subject_of": "http://data.europeana.eu/item/04802/243FA86
    "creator": "http://dbpedia.org/resource/Leonardo_da_Vinci"
  }
}
```

Writing RDF Graph 3: RDF/XML

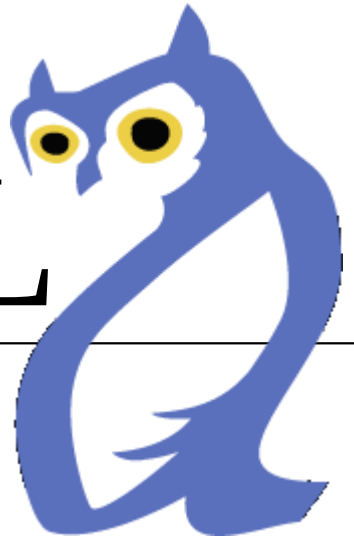
```
<?xml version="1.0" encoding="utf-8"?>
<rdf:RDF
        xmlns:dcterms="http://purl.org/dc/terms/"
        xmlns:foaf="http://xmlns.com/foaf/0.1/"
        xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:schema="http://schema.org/">
   <rdf:Description rdf:about="http://example.org/bob#me">
      <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
      <schema:birthDate rdf:datatype="http://www.w3.org/2001/XMLSchema#date">1990-07-04</schema:birthDate>
      <foaf:knows rdf:resource="http://example.org/alice#me"/>
      <foaf:topic_interest rdf:resource="http://www.wikidata.org/entity/Q12418"/>
   </rdf:Description>
   <rdf:Description rdf:about="http://www.wikidata.org/entity/Q12418">
      <dcterms:title>Mona Lisa</dcterms:title>
      <dcterms:creator rdf:resource="http://dbpedia.org/resource/Leonardo_da_Vinci"/>
   </rdf:Description>
   <rdf:Description rdf:about="http://data.europeana.eu/item/04802/243FA8618938F4117025F17A8B813C5F9AA4D619">
      <dcterms:subject rdf:resource="http://www.wikidata.org/entity/Q12418"/>
   </rdf:Description>
</rdf:RDF>
```

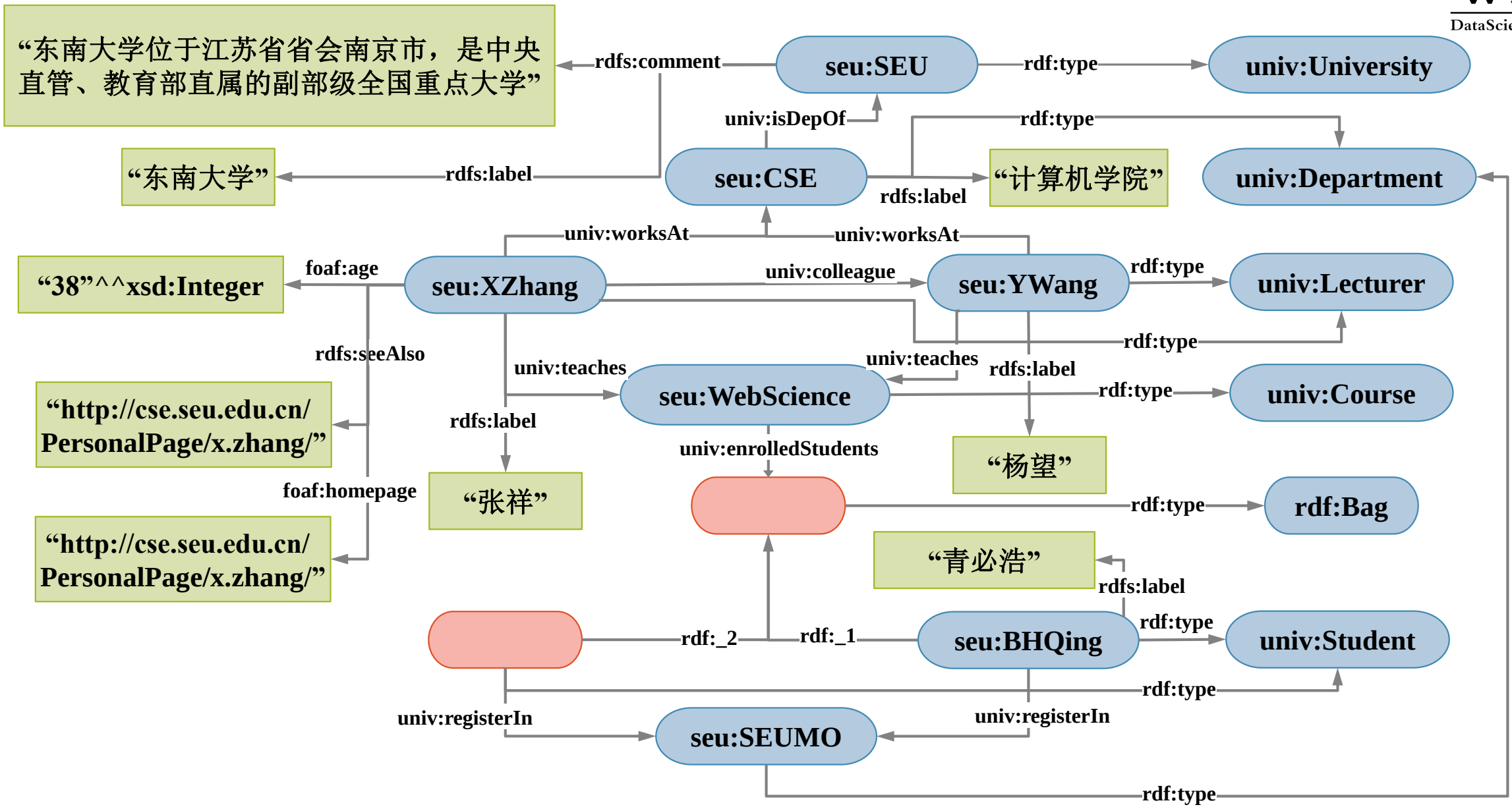
Parsing RDF using RDFLib

```
import rdflib

g = rdflib.Graph()
result = g.parse("http://www.w3.org/People/Berners-Lee/card")
# parse a given RDF graph in a remote file

print("graph has %s statements." % len(g))
# shows the number of triples in this graph

s = g.serialize(format='n3')
print s
# print all the triples in this graph
```

RDFLib:
http://rdflib.readthedocs.io/en/stable/

RDFS&OWL




“东南大学位于江苏省省会南京市，是中央直管、教育部直属的副部级全国重点大学”
rdfs:comment
seu:SEU
rdf:type
univ:University
univ:isDepOf
rdf:type
“东南大学”
rdfs:label
seu:CSE
“计算机学院”
rdfs:label
univ:Department
univ:worksAt
univ:worksAt
“38”^^xsd:Integer
foaf:age
seu:XZhang
univ:colleague
seu:YWang
rdf:type
univ:Lecturer
rdf:type
rdfs:seeAlso
univ:teaches
univ:teaches
rdfs:label
“http://cse.seu.edu.cn/PersonalPage/x.zhang/”
seu:WebScience
rdf:type
univ:Course
rdfs:label
univ:enrolledStudents
“杨望”
foaf:homepage
“张祥”
rdf:type
rdf:Bag
“http://cse.seu.edu.cn/PersonalPage/x.zhang/”
“青必浩”
rdfs:label
rdf:_2
rdf:_1
seu:BHQing
rdf:type
univ:Student
rdf:type
univ:registerIn
univ:registerIn
seu:SEUMO
rdf:type

How many vocabularies?

- *rdf:type*
- rdf:Bag
- *rdf:_1*
- *rdf:_2*
- *rdfs:label*
- *rdfs:comment*
- *rdfs:seeAlso*
- *foaf:age*
- *foaf:homepage*

RDF/RDFS/FOAF

Building Vocabularies

- univ:University
- univ:Department
- univ:Lecturer
- univ:Course
- univ:Student
- *univ:colleague*
- *univ:isDepOf*
- *univ:worksAt*
- *univ:enrolledStudents*
- *univ:registerIn*

University

User Defined Vocabularies

General Build-in Vocabularies

- RDF / RDFS
- OWL (Web Ontology Language) – vocabulary of description logic (描述逻辑)
- FOAF (Friend of a Friend) – vocabulary of social networking, personal information
- DC (Dublin Core) – vocabulary of web resources
- SKOS (Simple Knowledge Organization System) – a simplified vocabulary of things

Defining Vocabularies

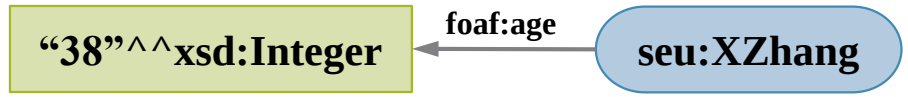
- Class
  - Defining hierarchical concepts
- *Property*
  - *Defining hierarchical relations or attributes*
- Instance
  - individuals

Defining Classes

- *rdfs:subClassOf*
  - ⟨univ: Lecturer, *rdfs: subClassOf*, foaf: Person⟩
  - ⟨univ: University, *rdfs: subClassOf*, foaf: Organization⟩
- *owl:equivalenClass*
  - ⟨univ: University, *owl:equivalenClass*, yago: University⟩
- *owl:disjointWith*
  - ⟨univ: MaleStudent, *owl:disjointWith*, univ: FemaleStudent⟩
- Others: *owl:one of*, *owl:intersectionOf*, *owl:unionOf*, *owl:complementOf*…

Data / Annotation/ Object Properties

- Predicates in RDF graph
- Data Property
  - properties whose objects are typed literals
  - also called: "data attributes"
  - *foaf:age*
- Annotation Property
  - properties whose objects are literals
  - also called: "annotation attributes"
  - rdfs:label / rdfs:comment
- Object Property
  - properties whose objects are URI / Bnodes
  - also called: "relations"
  - *univ:colleague*



Defining Properties

- *rdfs:subPropertyOf*
  - $\langle univ:isDepOf, rdfs:subPropertyOf, skos:isPartOf \rangle$
- *rdfs:domain / rdfs:range*
  - $\langle univ:registerIn, rdfs:domain, univ:Student \rangle$
  - $\langle univ:registerIn, rdfs:range, univ:Department \rangle$
- *owl:inverseOf*
  - $\langle univ:registerIn, owl:inverseOf, univ:hasRegisteredStudent \rangle$

Thing and *owl:sameAs*

- Thing is a super class of all classes
  - like java.lang.Object
- *owl:sameAs*： equivalence of instances
  - $\langle w3c{:}TimBL,\ owl{:}sameAs, dbpedia{:}TimBernersLee\rangle$

Special Types of Properties

- Functional Property
  - $\langle a, p, b\rangle, \langle a, p, c\rangle \rightarrow \langle b, owl{:}sameAs, c\rangle$ “我只有一个身份证”
- Symmetric Property
  - $\langle a, p, b\rangle \rightarrow \langle b, p, a\rangle$ “我和你成婚，所以你也和我成婚”
- Transitive Property
  - $\langle a, p, b\rangle, \langle b, p, c\rangle \rightarrow \langle a, p, c\rangle$ “先人之先人亦为先人”

Advanced Topic 1: Complex Class

⟨family: Mother, $owl:intersectionOf$, _: 001⟩
⟨_: 001, $rdf:first$, family: Female⟩
⟨_: 001, $rdf:rest$, family: Parent⟩

Advanced Topic 2: Property Restriction

⟨family: Parent, $owl: equivalentClass$, _: 001⟩
⟨_: 001, $rdf: type$, owl: Resriction⟩
⟨_: 001, $owl: onProperty$, family: hasChild⟩
⟨_: 001, $owl: someValuesFrom$, family: Children⟩

Advanced Topic 3: Cardinality Restriction

$\langle univ: hasRegisteredStudents, rdfs:domain, \text{univ: Department}\rangle$
$\langle univ: hasRegisteredStudents, rdfs:range, \text{univ: Student}\rangle$
$\langle univ: hasRegisteredStudents, owl:minCardinality, \text{"10"}\rangle$
$\langle univ: hasRegisteredStudents, owl:maxCardinality, \text{"150"}\rangle$

Reasoning in Description Logic

$$\texttt{Actor} \sqsubseteq \texttt{Artist}$$

$$\texttt{married} \sqsubseteq \texttt{loves}$$

$$\texttt{married(angelina,brad)}$$

$$\texttt{Polygamist} \sqsubseteq \geqslant 2.\texttt{Married}.\top$$

$$\exists \texttt{Married}.\{\texttt{brad}\} \sqsubseteq \{\texttt{angelina}\}$$

Comparing SW with OOP

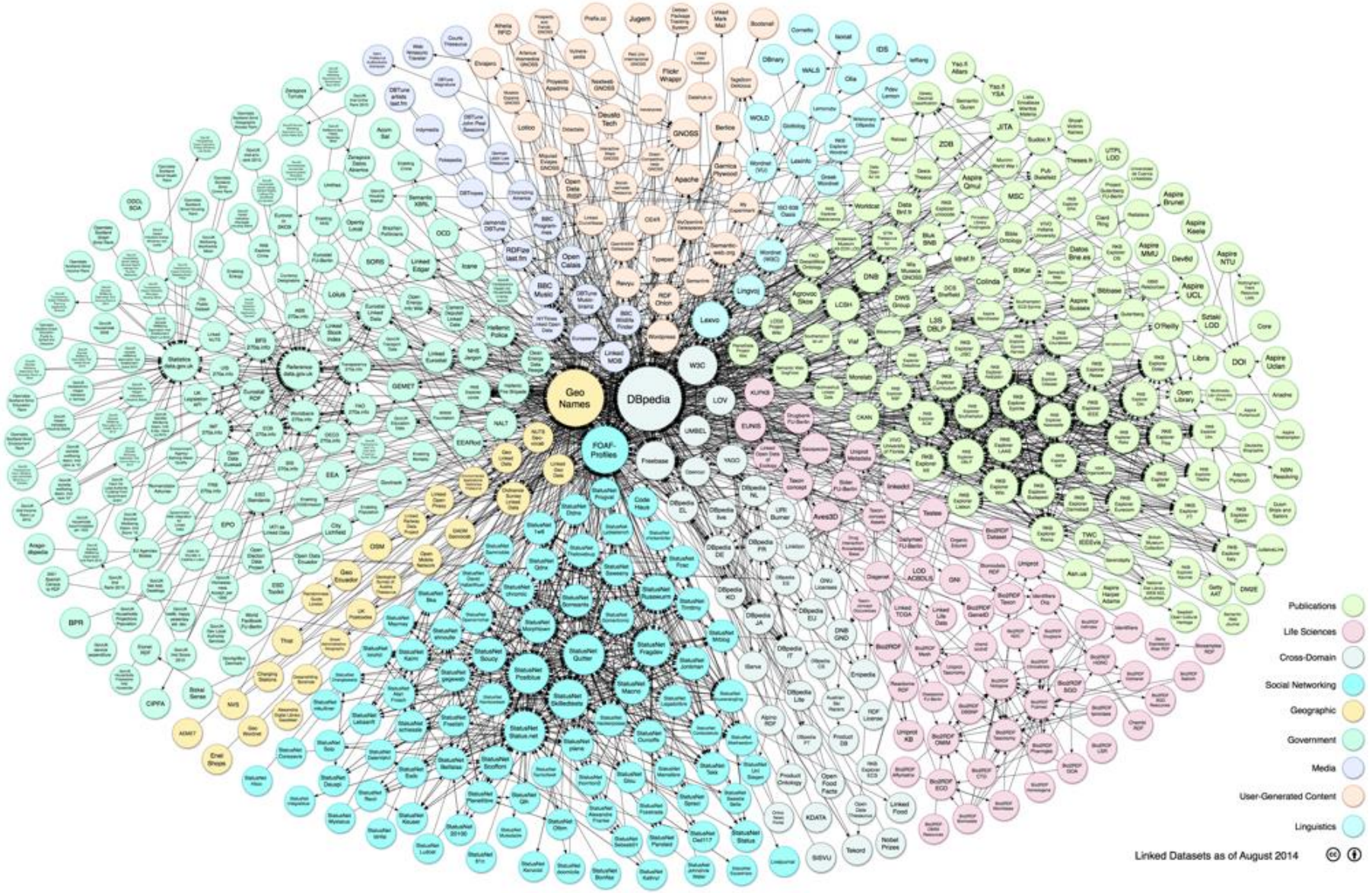
SW		OOP
instance	≈	object
Class	≈	Class
Property	≈?	methods
Thing	≈	java.lang.Object
Literal	≈	primary data type
RDF Container	≈	java.util.Collection

Two data models using RDF and OWL

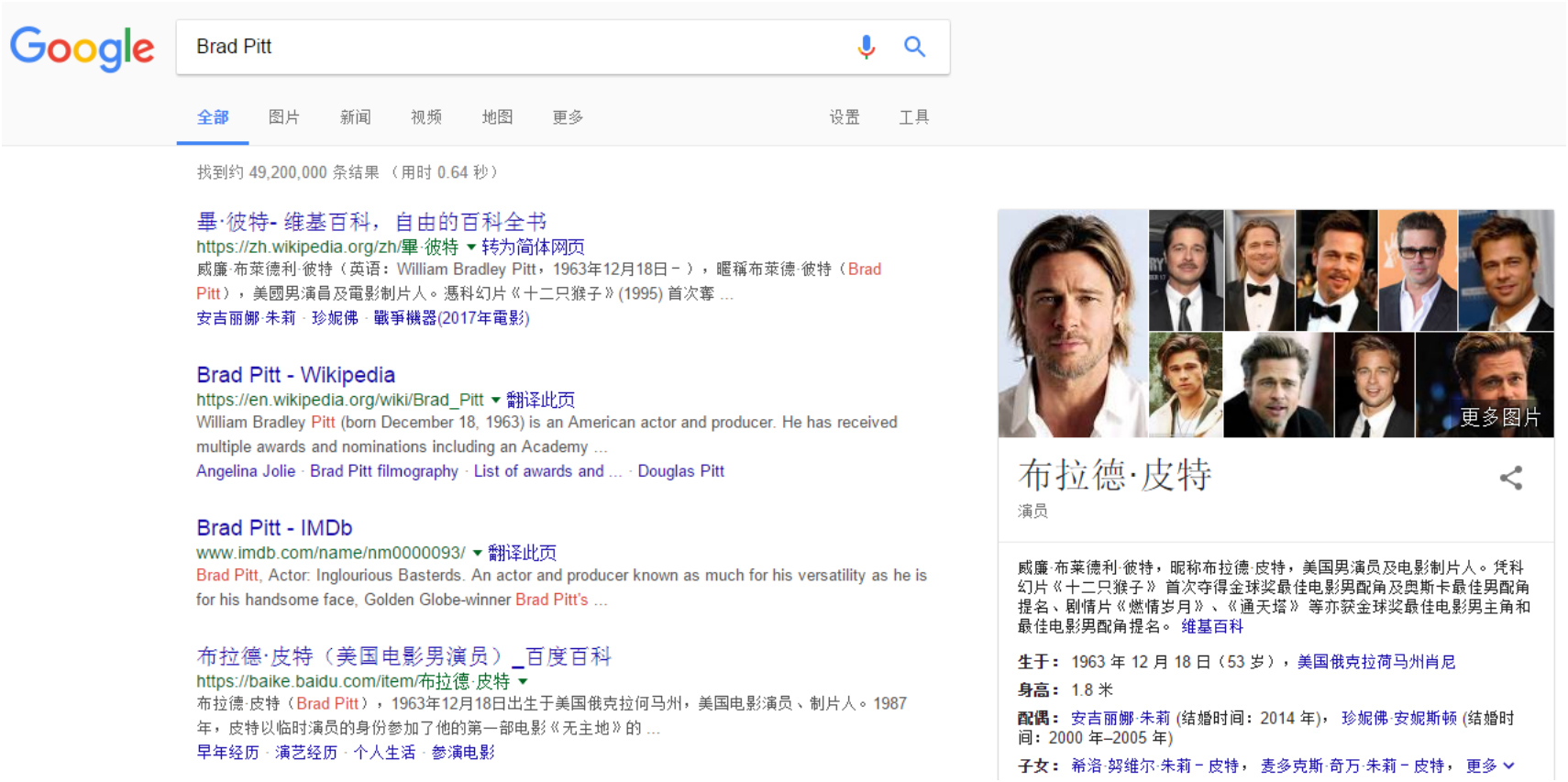
- Linked Data
  - proposed by academic community
- Knowledge Graph
  - proposed by industry

Linked Data

- Data is collected from database or knowledge base
- Four principles
  - use URIs as names for things
  - use HTTP URIs so that people can look up those names
  - when someone looks up a URI, provide useful information, using the standards (RDF*, SPARQL)
  - include links to other URIs. so that they can discover more things.


Geo Names
DBpedia
FOAF-Profiles
Publications
Life Sciences
Cross-Domain
Social Networking
Geographic
Government
Media
User-Generated Content
Linguistics
Linked Datasets as of August 2014

Knowledge Graph

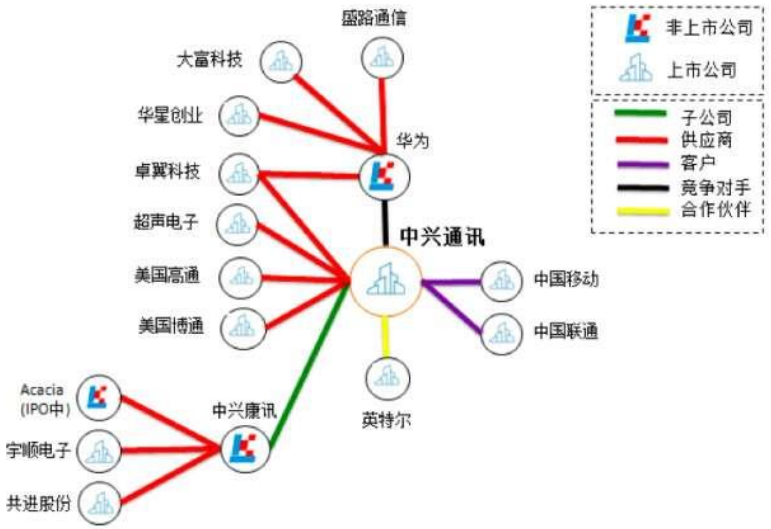


Knowledge Graph

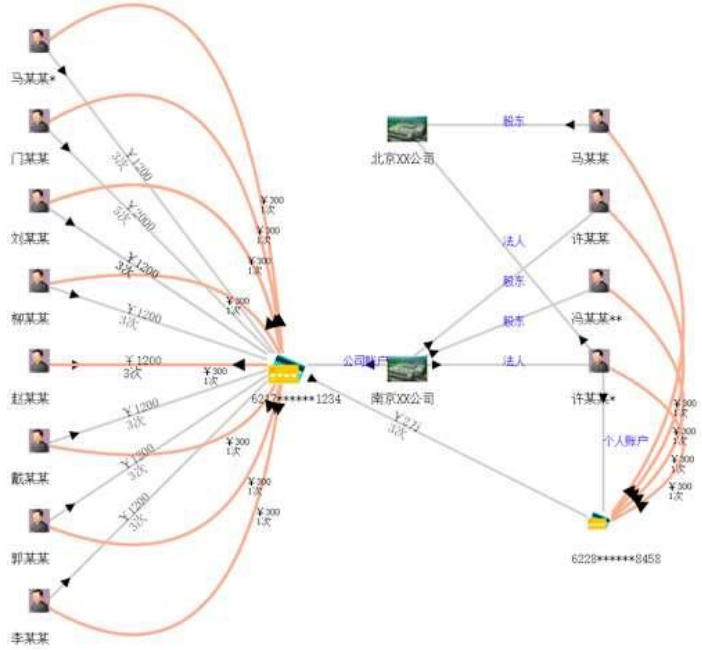
- proposed by Google
- extracted from un-structured or semi-structured data

Applications of Knowledge Graph

股票投资分析



公安情报分析

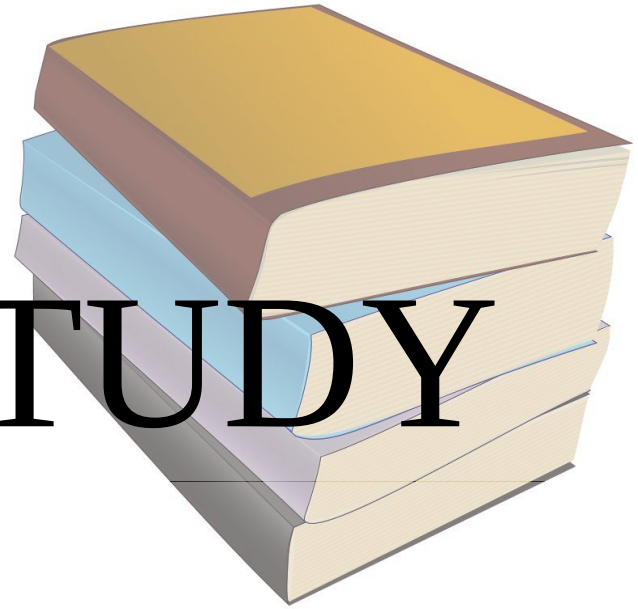


credit to:漆桂林

In the Future…

Everything is graph.

SELF-STUDY



Python

- “笨办法”学Python （零基础）
  - https://book.douban.com/subject/26264642/
- Python基础教程 （入门）
  - https://book.douban.com/subject/25880388/
- 利用Python进行数据分析
  - https://book.douban.com/subject/25779298/

Data Science

- 机器学习实战
  - https://book.douban.com/subject/24703171/
- 周志华：机器学习
  - https://book.douban.com/subject/26708119/
- 网络科学引论
  - https://book.douban.com/subject/25970086/

Web and Semantic Web (1)

- CCTV Documentary “互联网时代”
- TED Talk Playlist: Internet Origin Stories
  - https://www.ted.com/playlists/365/internet_origin_stories
- TED Talk – Tim Berners-Lee: The Next Web (2009)
  - https://www.ted.com/talks/tim_berners_lee_on_the_next_web
- TED Talk - Tim Berners-Lee: The Year Open Data Went Worldwide (2010)
  - https://www.ted.com/talks/tim_berners_lee_the_year_open_data_went_worldwide
- TED Talk - Tim Berners-Lee: A Magna Carta for the Web (2014)
  - https://www.ted.com/talks/tim_berners_lee_a_magna_carta_for_the_web

Web and Semantic Web (2)

- TED Talk – Larry Page: Where is Google Going Next?
  - https://www.ted.com/talks/larry_page_where_s_google_going_next
- IBM Watson and Jeopardy in 2011
  - How Watson works? | Jeopardy 2011 contest footage

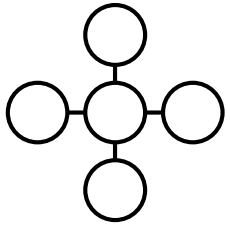
- TED Talk – Stephen Wolfram and WolframAlpha
  - https://www.ted.com/talks/stephen_wolfram_computing_a_theory_of_everything
  - http://www.wolframalpha.com/

Semantic Web

- RDF / RDFS
  - RDF Primer (in Chinese): http://zh.transwiki.org/cn/rdfprimer.htm
  - RDF Primer 1.1 (in English): https://www.w3.org/TR/2014/NOTE-rdf11-primer-20140624/
- OWL
  - OWL2 Primer (in Chinese): http://nkos.lib.szu.edu.cn/OWL2/OWL2PrimerSimplifiedChinese.htm
- SPARQL
  - SPARQL Overview(in Chinese): http://www.chinaw3c.org/REC-sparql11-overview-20130321-cn.html
- RDFLib / Jena
- DBpedia / YAGO

ASSIGNMENT

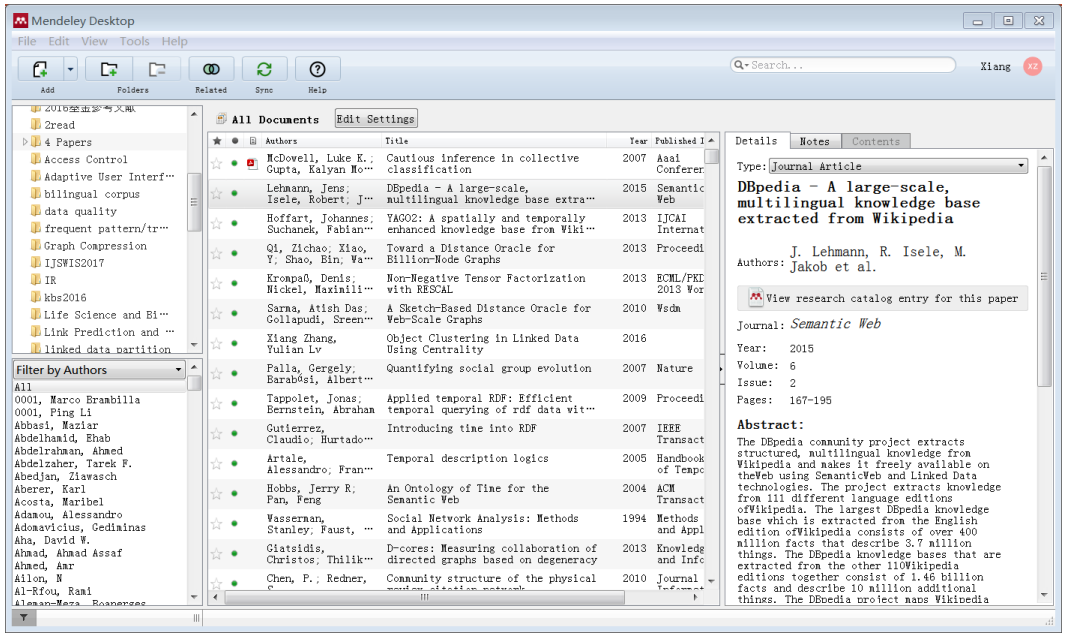
Distance Measurement



- Given two strings representing two entities, for example “LeBron James” and “Dwyane Wade”,
- How to automatically measure their distance $\mathcal{D}(x, y) \in [0,1]$?
- Preserving $\mathcal{D}(x, y) < \mathcal{D}(y, z)$ if x is more related to y than z.
- Paper writing: a team paper can be collaborated written including:
  - abstract / problem definition / approach overview
  - details of algorithms / experiments / related works / reference
- Format: Springer Lecture Notes in Computer Science (LNCS)
- Due: Oct. 31
- Half of teams will be randomly selected to present their work and demo in Lecture 2.

Google Scholar and Mendeley

Find and Manage Your Reference



WDS实验室

What Do We Do

- 大数据处理
- 数据质量分析
- 时空数据挖掘
- 图数据画像
- 社团的演化分析
- 关联挖掘
- 图的表示学习

What Will You Get

A tutorial for newbies

A complete training system for data scientists / data engineers

Evening salons

WDS library

A chance for top conference

Academic and industrial projects

Face-to-face supervision

What do we want

No background? No problem.

Familiar with Java or Python? Good!

Interested with data science and artificial intelligence? Great!

Be responsible / self-motivated / hard-working? Come and join us!

The only requirement: join in WDS in Nanjing in the next year.


欢
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