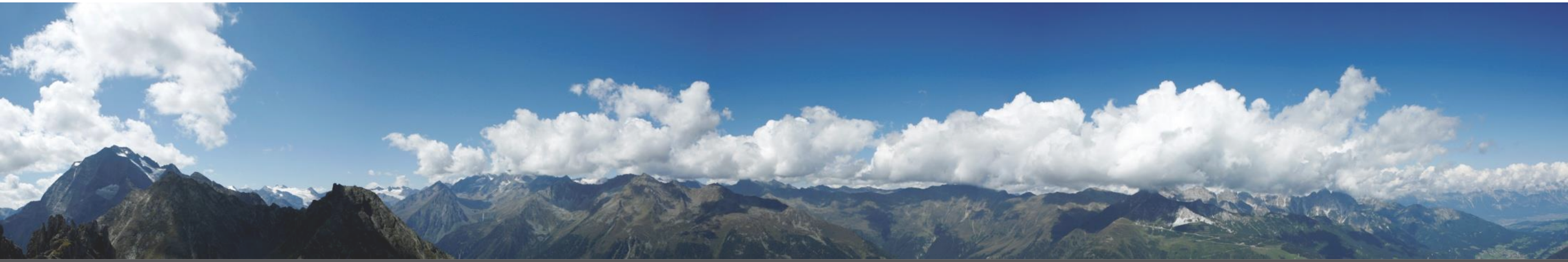
Steps towards a Data Value Chain

Dieter Fensel, University of Innsbruck

Salzburg, June 2013



Contents

1. Big Data
2. Public Open Data
3. Linked (Open) Data
4. Data Economy

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BIG Data

What is Big Data?

- Every day, we create 2.5 quintillion* bytes of data — so much that 90% of the data in the world today has been created in the last two years alone.
- These data come from everywhere: sensors used to gather climate information, posts to social media sites, digital pictures and videos, purchase transaction records, and cell phone GPS signals to name a few.
- These data are **big data.****

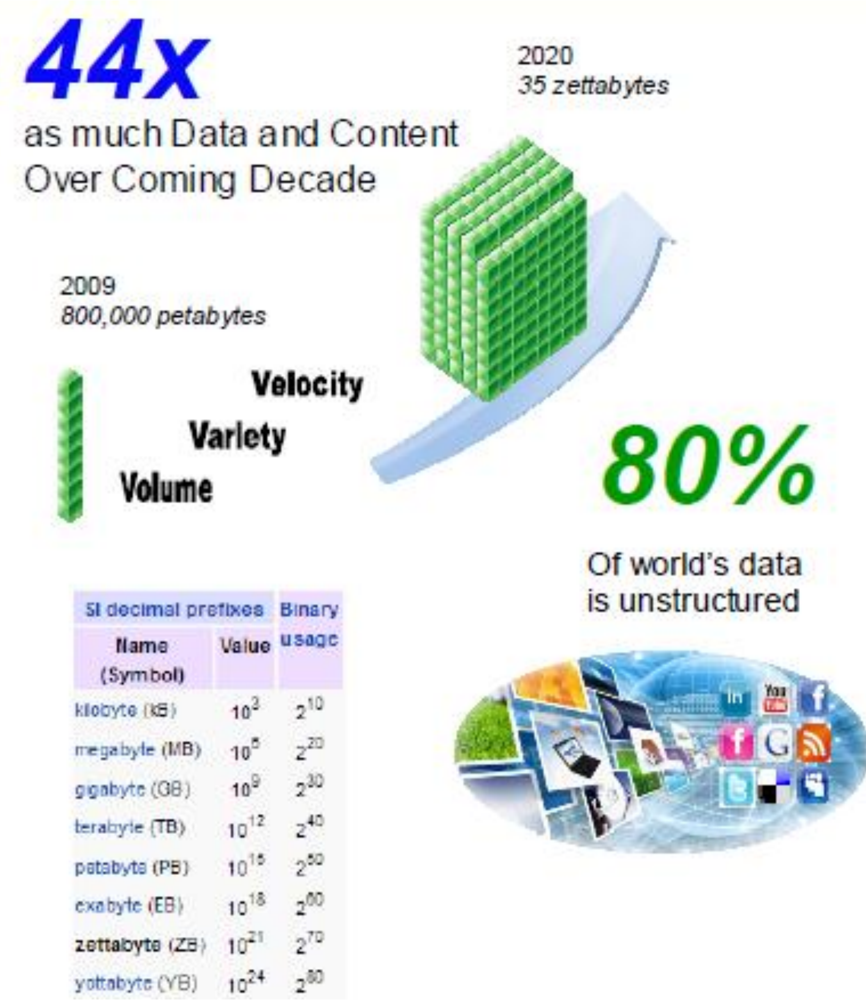
* 10^{30}

** http://www-01.ibm.com/software/data/bigdata

What is Big Data?

- **“Big data”** is a loosely-defined term
- used to describe data sets so large and complex that they become awkward to work with using on-hand database management tools.
  - – White, Tom. Hadoop: The Definitive Guide. 2009. 1st Edition. O'Reilly Media. Pg 3.
  - – MIKE2.0, Big Data Definition http://mike2.openmethodology.org/wiki/Big_Data_Definition

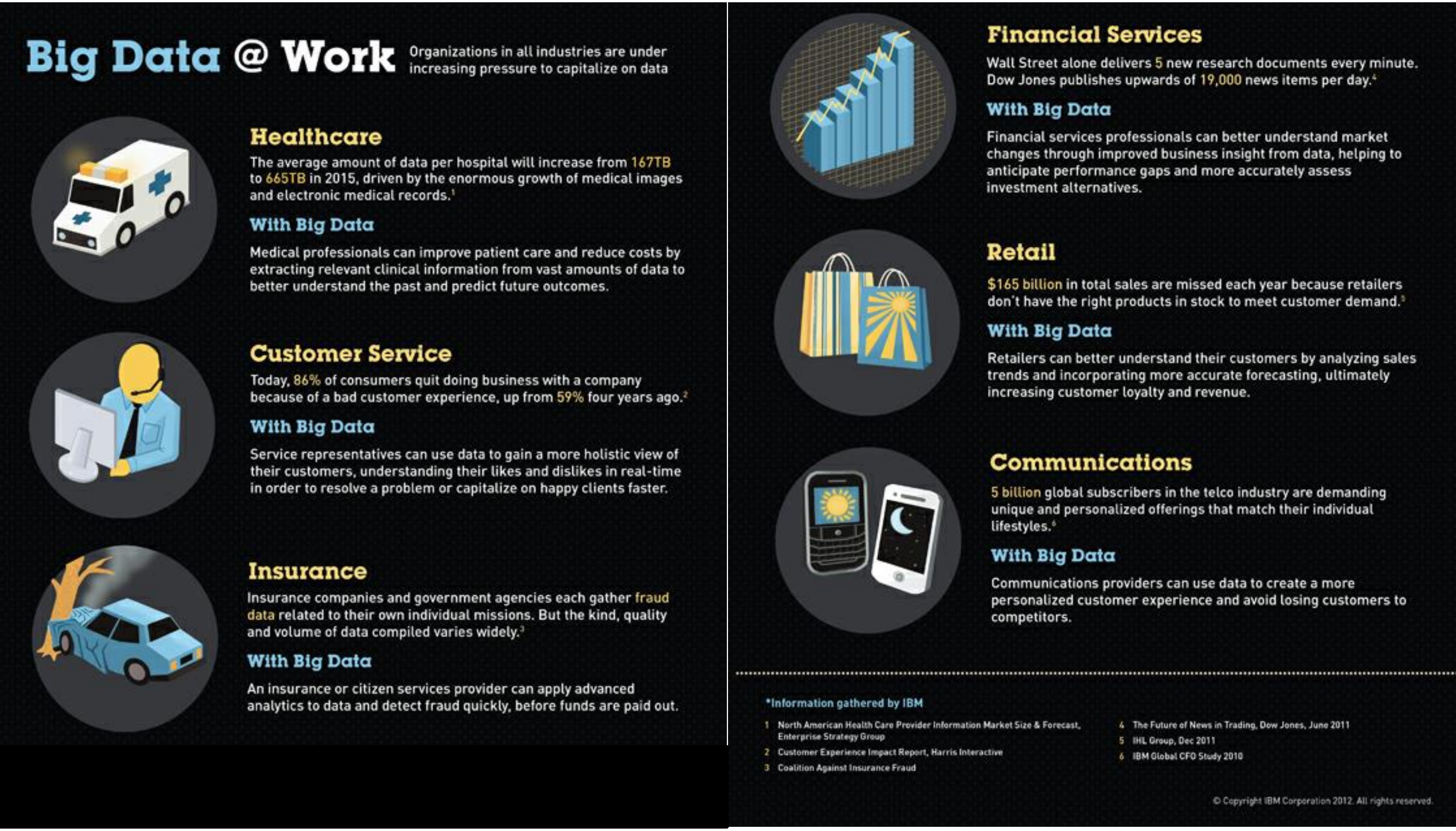
Infromation Explosion in data and real world events (IBM)



44x
as much Data and Content Over Coming Decade
2020
35 zettabytes
2009
800,000 petabytes
Velocity
Variety
Volume
80%
Of world’s data is unstructured

SI decimal prefixes		Binary usage
Name (Symbol)	Value	
kilobyte (kB)	10^3	2^{10}
megabyte (MB)	10^6	2^{20}
gigabyte (GB)	10^9	2^{30}
terabyte (TB)	10^{12}	2^{40}
petabyte (PB)	10^{15}	2^{50}
exabyte (EB)	10^{18}	2^{60}
zettabyte (ZB)	10^{21}	2^{70}
yottabyte (YB)	10^{24}	2^{80}

Big Data Application Areas



Big Data @ Work

Organizations in all industries are under increasing pressure to capitalize on data

Healthcare

The average amount of data per hospital will increase from 167TB to 665TB in 2015, driven by the enormous growth of medical images and electronic medical records.[1]

With Big Data

Medical professionals can improve patient care and reduce costs by extracting relevant clinical information from vast amounts of data to better understand the past and predict future outcomes.

Customer Service

Today, 86% of consumers quit doing business with a company because of a bad customer experience, up from 59% four years ago.[2]

With Big Data

Service representatives can use data to gain a more holistic view of their customers, understanding their likes and dislikes in real-time in order to resolve a problem or capitalize on happy clients faster.

Insurance

Insurance companies and government agencies each gather fraud data related to their own individual missions. But the kind, quality and volume of data compiled varies widely.[3]

With Big Data

An insurance or citizen services provider can apply advanced analytics to data and detect fraud quickly, before funds are paid out.

Financial Services

Wall Street alone delivers 5 new research documents every minute. Dow Jones publishes upwards of 19,000 news items per day.[4]

With Big Data

Financial services professionals can better understand market changes through improved business insight from data, helping to anticipate performance gaps and more accurately assess investment alternatives.

Retail

$165 billion in total sales are missed each year because retailers don't have the right products in stock to meet customer demand.[5]

With Big Data

Retailers can better understand their customers by analyzing sales trends and incorporating more accurate forecasting, ultimately increasing customer loyalty and revenue.

Communications

5 billion global subscribers in the telco industry are demanding unique and personalized offerings that match their individual lifestyles.[6]

With Big Data

Communications providers can use data to create a more personalized customer experience and avoid losing customers to competitors.

*Information gathered by IBM

[1] North American Health Care Provider Information Market Size & Forecast, Enterprise Strategy Group

[2] Customer Experience Impact Report, Harris Interactive

[3] Coalition Against Insurance Fraud

[4] The Future of News in Trading, Dow Jones, June 2011

[5] IHL Group, Dec 2011

[6] IBM Global CFO Study 2010

Picture taken from http://www-01.ibm.com/software/data/bigdata/industry.html

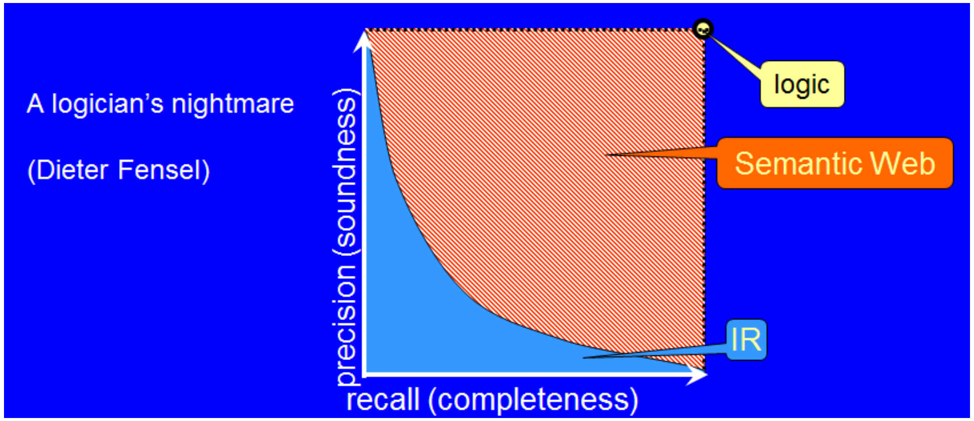
Use case : Climate Research

- Eiscat and Eiscat 3D are multimillion reserch projects doing environmental research as well as evaluation of the built infrastructures.
  - Observation of climate: sun, troposphere, etc.
  - Simulations, e.g. Creation of artificial Nothern light
  - Run by European Incoherent Scatter Association

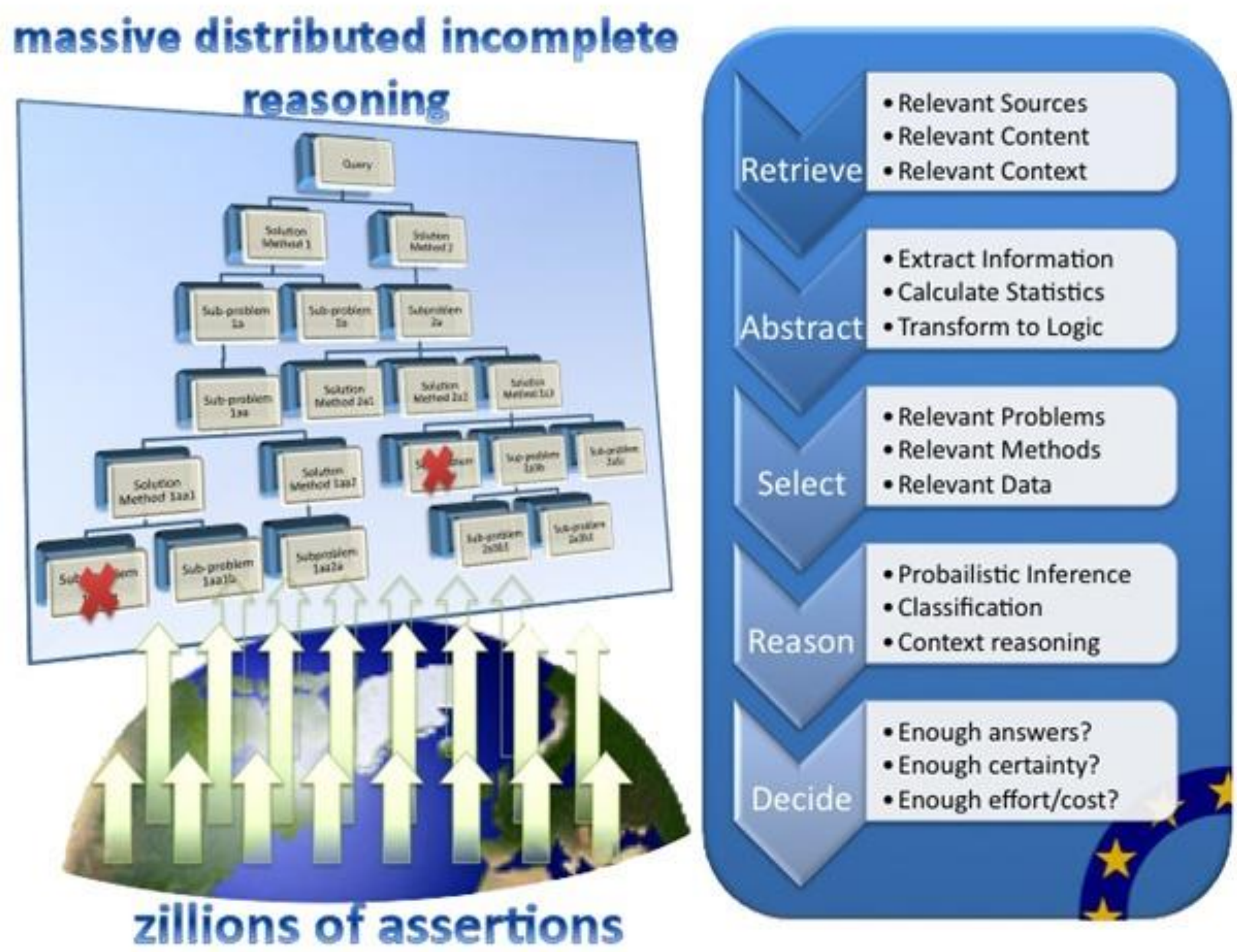
- 1,5 Petabytes of data are generated daily (1,5 Million Gigabytes).
  - Processing of this data would require 1K petaFLOPS performance
  - Or 1 billion Euro electricity costs p.a.

Large Scale Reasoning

- Performing deductive inference with a given set of axioms at the Web scale is practically impossible
  - Too manyRDF triples to process
  - Too much processing power is needed
  - Too much time is needed
- LarKC aimed at contributing to an ‘infinitely scalable’ Semantic Web reasoning platform by
  - Giving up on 100% correctness and completeness (trading quality for size)
  - Include heuristic search and logic reasoning into a new process
  - Massive parallelization (cluster computing)



Large Scale Reasoning



Retrieve
- Relevant Sources
- Relevant Content
- Relevant Context

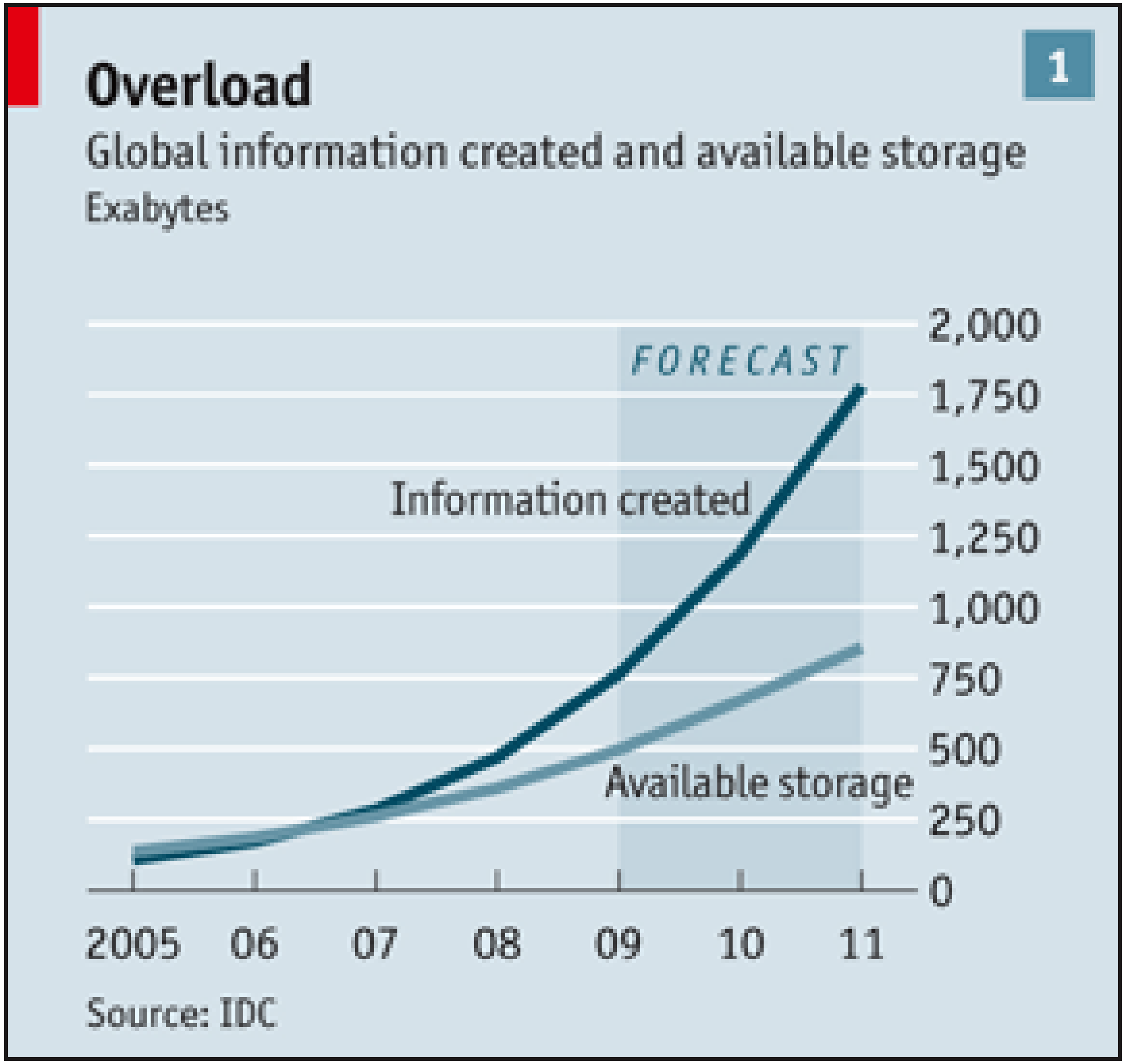
Abstract
- Extract Information
- Calculate Statistics
- Transform to Logic

Select
- Relevant Problems
- Relevant Methods
- Relevant Data

Reason
- Probailistic Inference
- Classification
- Context reasoning

Decide
- Enough answers?
- Enough certainty?
- Enough effort/cost?

Volumes of Data Exceed the Availale Storage Volume Globally



Source: IDC

There is a need
to throw the data
away due to
the limited storage
space.

Data Stream Processing for Big Data

- Before throwing the data away some processing can be done at run-time
  - Processing streams of data as they happen

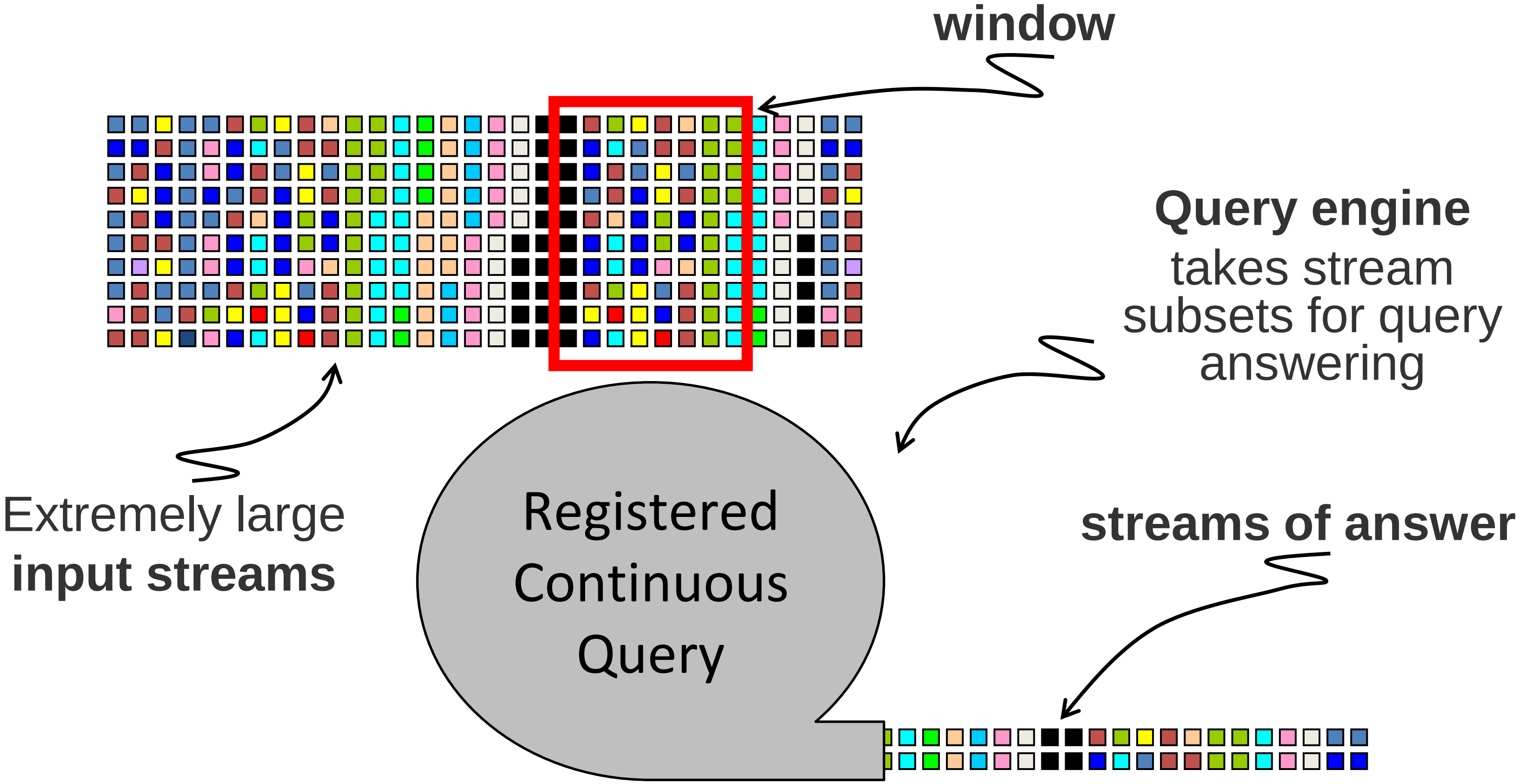
- Embracing the streaming model
  - Data is seen as a constant flow (sequence) of transient elements
  - Fits naturally with many application domains (sensors, social media, etc.)

- “Big data” is bringing an inherent set of complexities
  - Data structures exceeding the available memory
  - Approximate/incomplete results are taken as granted
    - Always look at the latest part of a dataset

Data Stream Processing for Big Data

- Logical reasoning in real time on multiple, heterogeneous, gigantic and inevitably noisy data streams in order to support the decision process…

-- S. Ceri, E. Della Valle, F. van Harmelen and H. Stuckenschmidt, 2010


window
Query engine
takes stream subsets for query answering
Extremely large
input streams
Registered Continuous Query
streams of answer

Picture taken from Emanuele Della Valle "Challenges, Approaches, and Solutions in Stream Reasoning", Semantic Days 2012

Conclusions

- Big Data describes datasets so large and complex that they become awkward to work with using on-hand database management tools.
- Big data application domains are diverse
  - Embracing a big data processing strategy can have a significant impact
- Tacking the issues of big data processing requires to loose the requirements on completeness and precision
- Big data on Web scale suffers from an inherent heterogeneity and different levels of expressiveness
- **Complexity is more than just size!**

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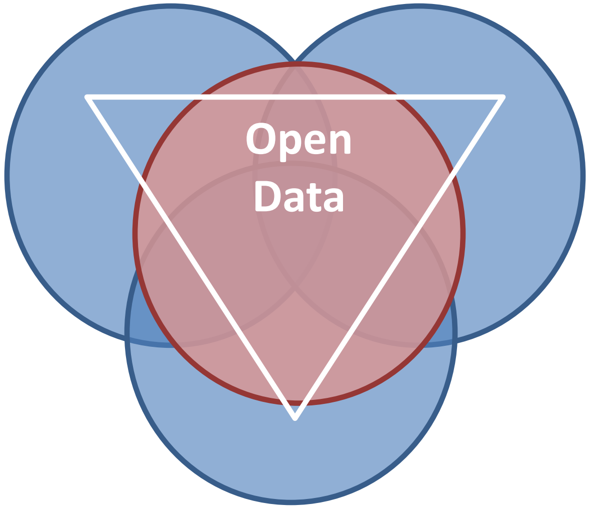
Public Open Data



Public Open Data: What is Open Data?

Definitions:

- Open data is non-personally identifiable data produced in the course of an organisation’s ordinary business, which has been released under an unrestricted licence (like the Open Government Licence).

- Open public data is underpinned by the philosophy that data generated or collected by organisations in the public sector should belong to the taxpayers, wherever financially feasible and where releasing it won’t violate any laws or rights to privacy (either for citizens or government staff).

[linkedgov project]
http://linkedgov.org

Public Open Data: What is Open Data?

Definitions:

The idea behind open data is that information held by government should be freely available to use and re-mix by the public. It's a movement to make non-personal data:

- open so that it can be turned into useful applications
- support transparency and accountability
- make sharing data between public sector partners more efficient.

The Government is committed to making much more public data openly available. On 22 March 2010, the Prime Minister announced that the Government was going to:

"...use digital technology to open up data with the aim of providing every citizen in Britain with true ownership and accountability over the services they demand from government."

http://www.idea.gov.uk/

Public Open Data: Features of Open Data

Open Data principles [1]:

1. **completeness** – all data that can be open (w.r.t. privacy and security) should be open

2. **primary source** – all open data should be gathered at their source in raw format

3. **temporal closeness** – all open data should be up-to-date

4. **easy access** – all open data should be easily accessible

5. **machine readability** – all open data should be structured for machine processing

[1] Source [Kaltenböck M., Thurner T., (Hg.): Open Government Data Weißbuch, 2011]

Public Open Data: Features of Open Data

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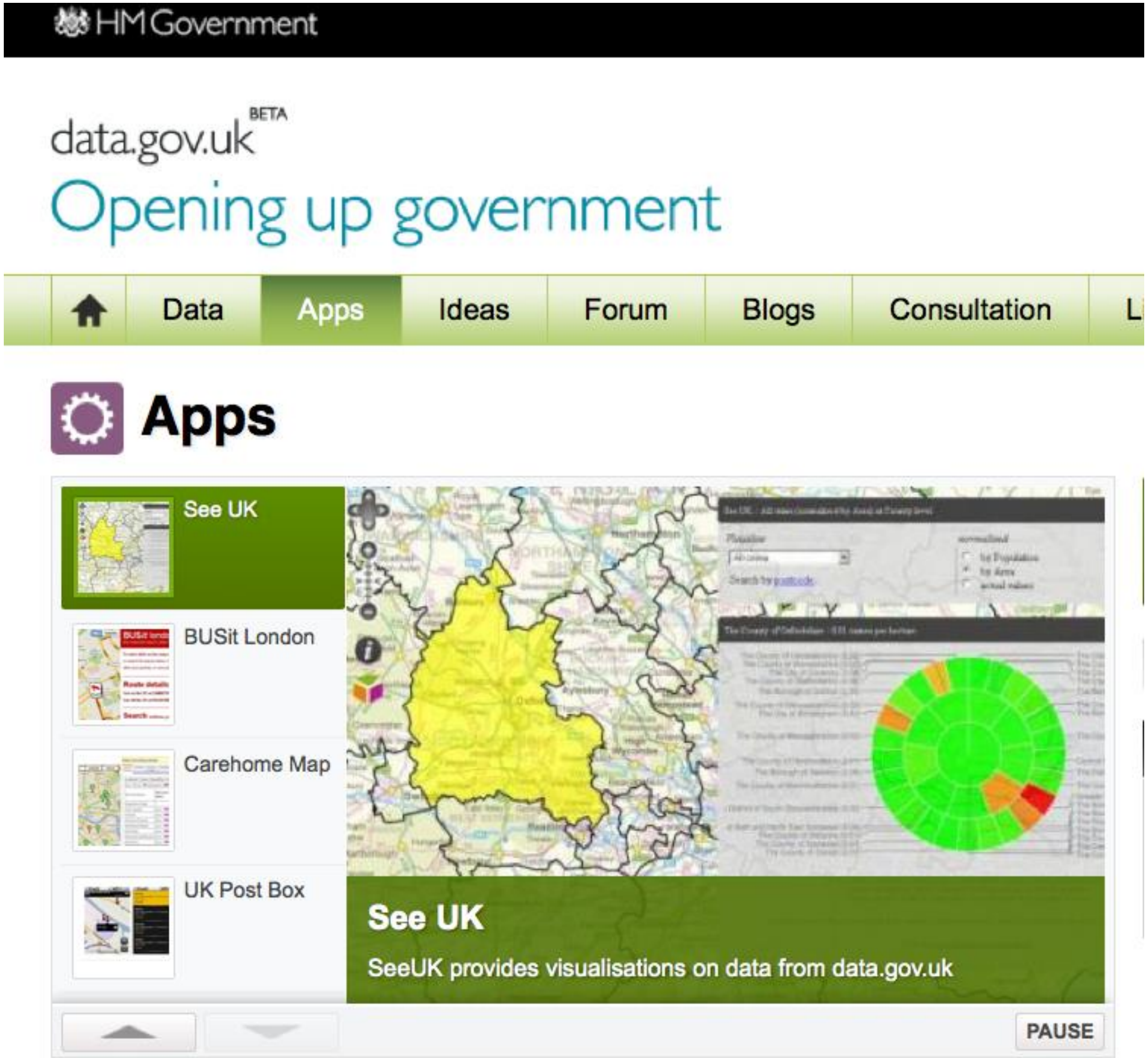
Open Data principles [1]:

6. **non-discriminating** – all open data should be accessible for everyone
7. **open standards** – all open data should use open standards
8. **liberal licensing** – all open data should use a liberal licensing without huge obligations for potential users

9. **durability** – all open data should be available on a long term basis
10. **non-discriminating usage costs** – some open data might involve usage costs. These should be kept as low as possible.

[1] Source [Kaltenböck M., Thurner T., (Hg.): Open Government Data Weißbuch, 2011]

Public Open Data: And it works (SeeUK)



HM Government

data.gov.uk BETA

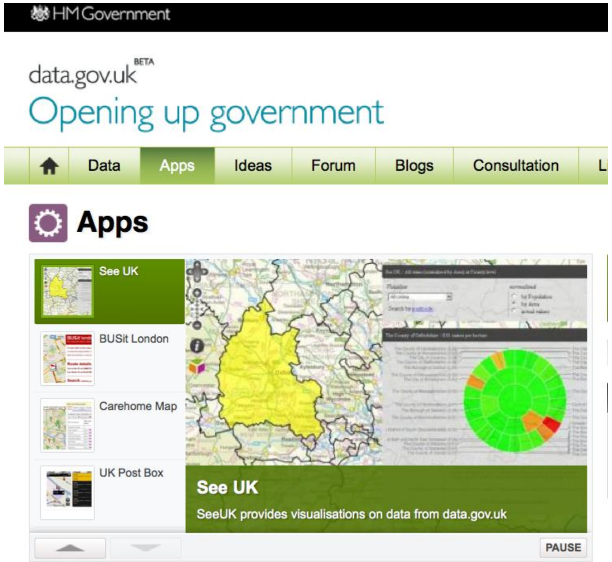
Opening up government

Apps

See UK

SeeUK provides visualisations on data from data.gov.uk

Public Open Data: And it works (SeeUK)



HM Government

data.gov.uk BETA

Opening up government

Data | Apps | Ideas | Forum | Blogs | Consultation | L

Apps

See UK

BUSit London

Carehome Map

UK Post Box

See UK

SeeUK provides visualisations on data from data.gov.uk

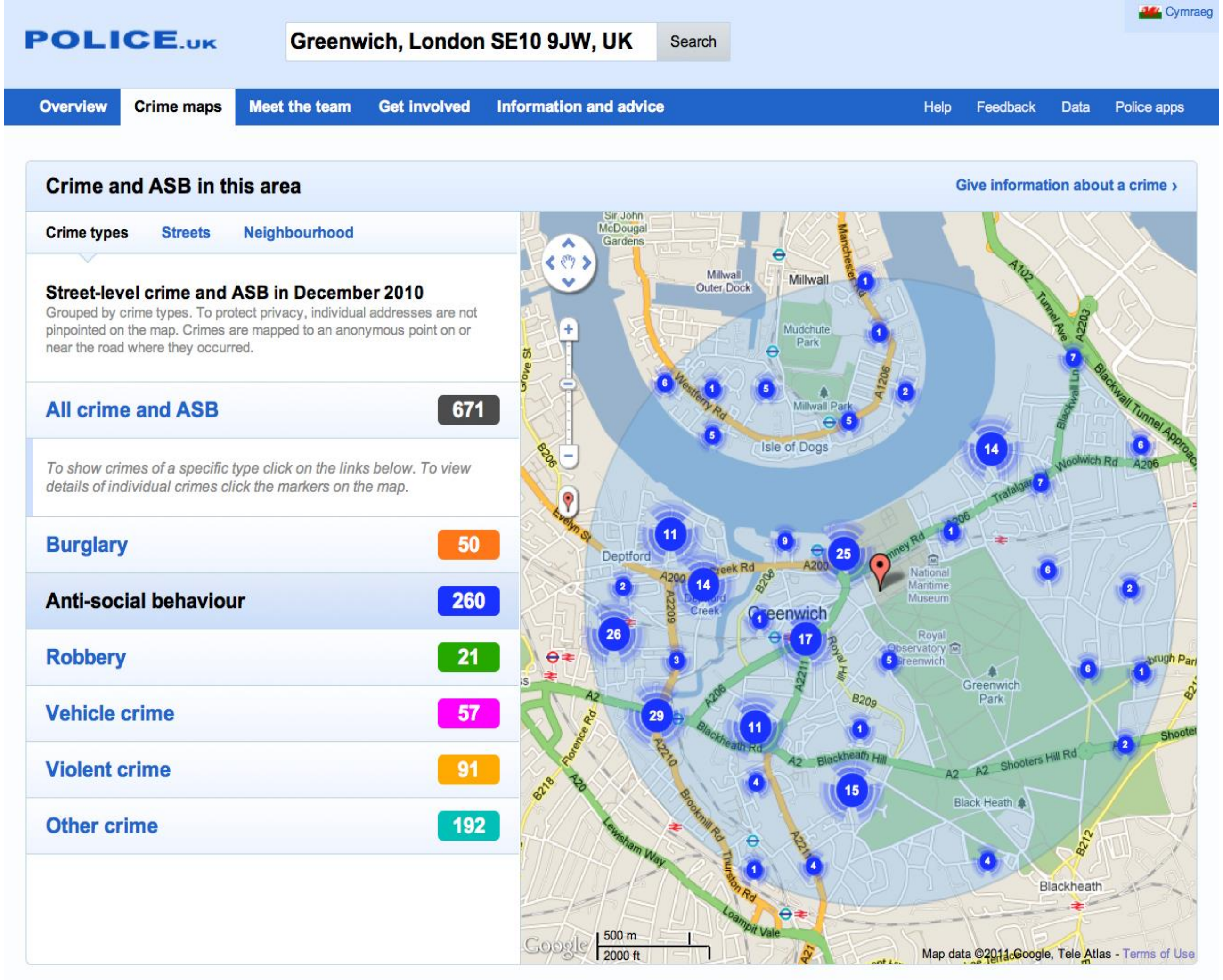
PAUSE

- See UK uses data that have been sourced from data.gov.uk and processed into Linked Data .

- All the datasets are enriched and cross-linked to additional sources.

- The visualisation provides a view centred on a chosen region of the specified size, and most noticeably gives a "pie-chart" that shows the viewer how that region compares with similar regions around it.

Public Open Data: And it works (police.uk)



POLICE.UK

Greenwich, London SE10 9JW, UK

Crime and ASB in this area

Give information about a crime ›

Street-level crime and ASB in December 2010

Grouped by crime types. To protect privacy, individual addresses are not pinpointed on the map. Crimes are mapped to an anonymous point on or near the road where they occurred.

All crime and ASB	671

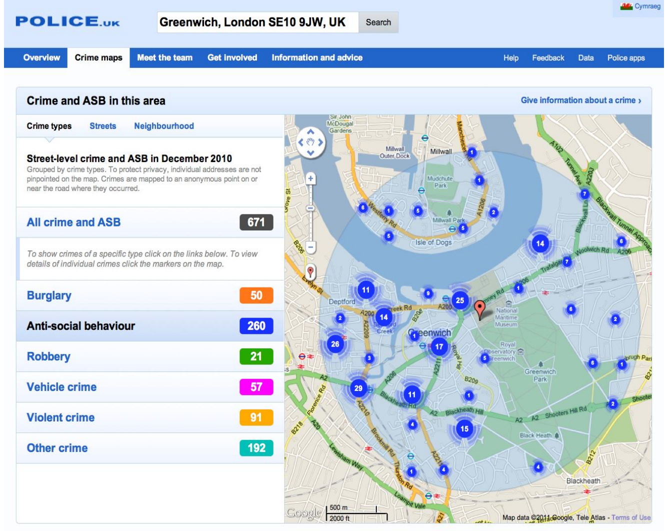
To show crimes of a specific type click on the links below. To view details of individual crimes click the markers on the map.

Burglary	50
Anti-social behaviour	260
Robbery	21
Vehicle crime	57
Violent crime	91
Other crime	192

Public Open Data: And it works (police.uk)

- Different apps such as „Vehicle Crime & Road Accident Map", „Crime Sounds" and „UK Crimeview" are provided

- The user can get a quick idea about different areas of cities and towns and their crime statistics.



Crime and ASB in this area

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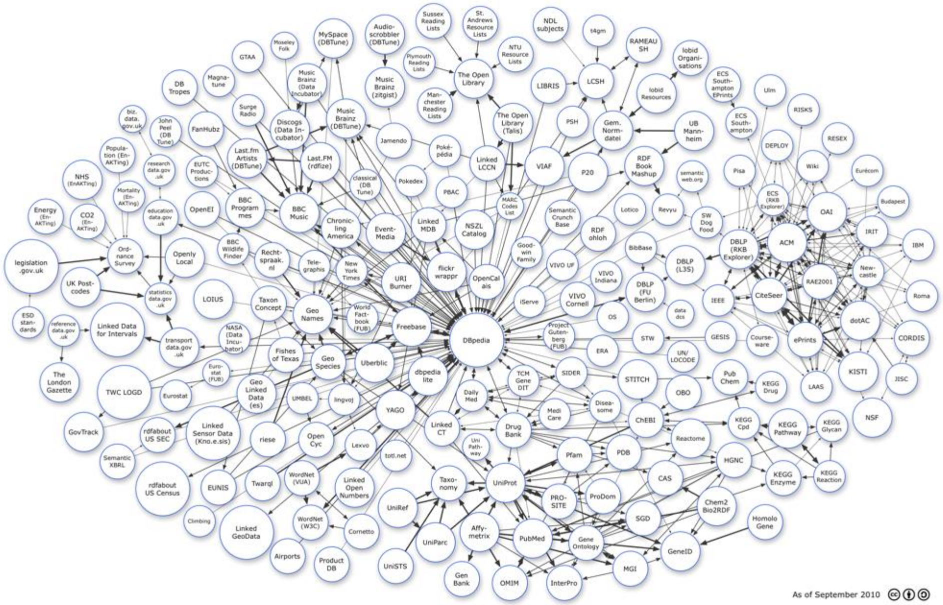
Public Open Data

- **Openess**:
  Open Data is about changing behaviour
- **Heterogenity**:
  Different vocabularies are used
- **Interlinkage**:
  Need to link these data sets to prevent data silos

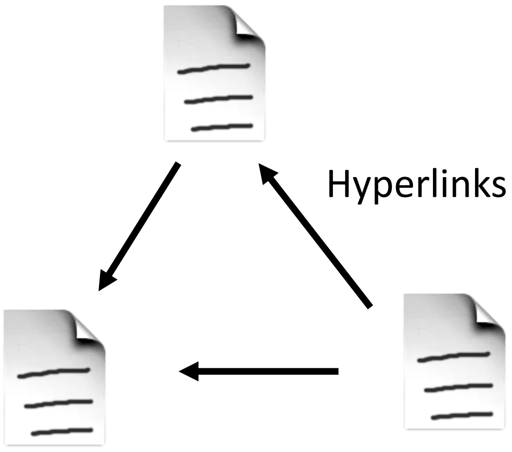
- → **Linked** Open Data

Linked Open Data



Motivation: From a Web of Documents to a Web of Data

- Web of Documents

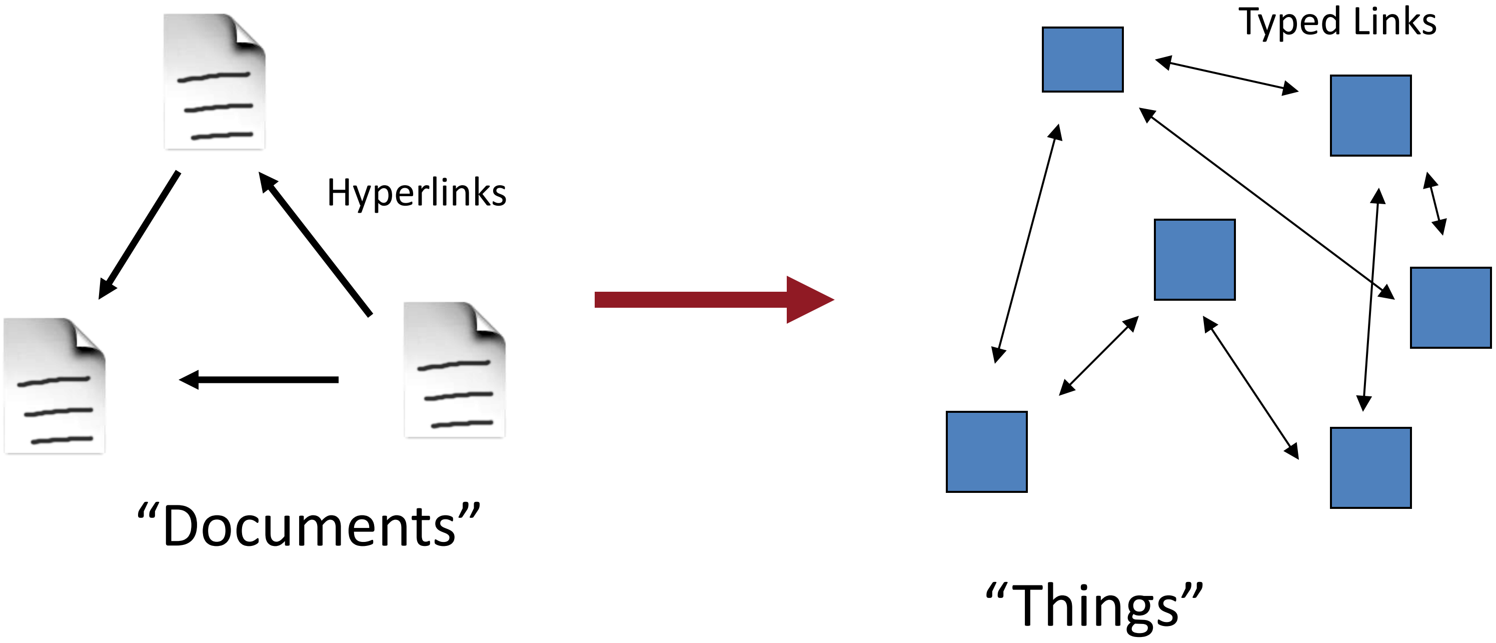


“Documents”

- Fundamental elements:
  1. Names (URIs)
  2. Documents (Resources) described by HTML, XML, etc.
  3. Interactions via HTTP
  4. (Hyper)Links between documents or anchors in these documents
- Shortcomings:
  - Untyped links
  - Web search engines fail on complex queries

Motivation: From a Web of Documents to a Web of Data

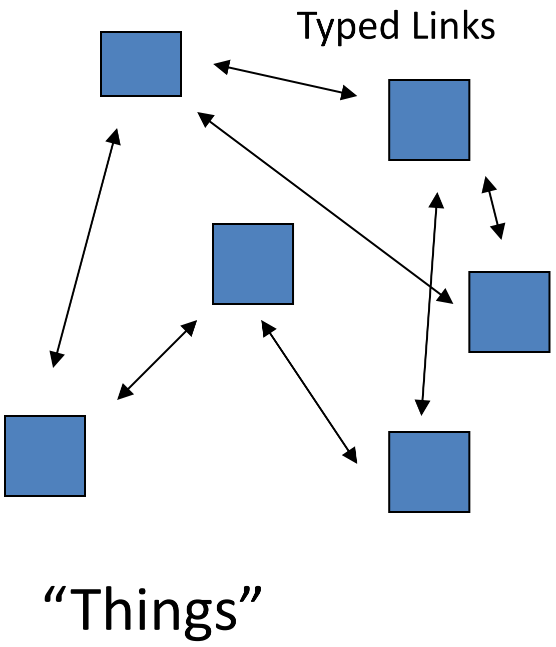
- Web of Documents
- Web of Data



Motivation: From a Web of Documents to a Web of Data

- Characteristics:
  - Links between arbitrary things (e.g., persons, locations, events, buildings)
  - Structure of data on Web pages is made explicit
  - Things described on Web pages are named and get URIs
  - Links between things are made explicit and are typed

- Web of Data



Google Knowledge Graph

- *"A huge knowledge graph of interconnected entities and their attributes"*.

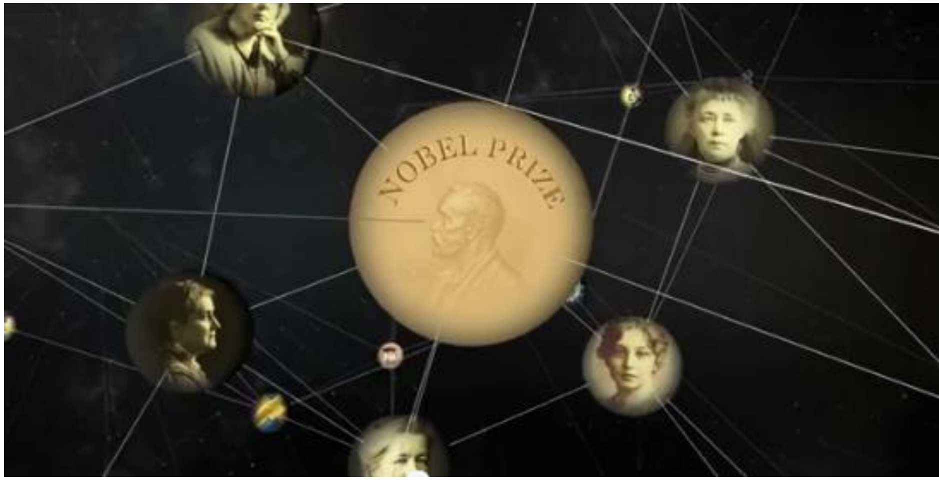
  Amit Singhal, Senior Vice President at Google

- *"A knowledge based used by Google to enhance its search engine's results with semantic-search information gathered from a wide variety of sources"*

  http://en.wikipedia.org/wiki/Knowledge_Graph

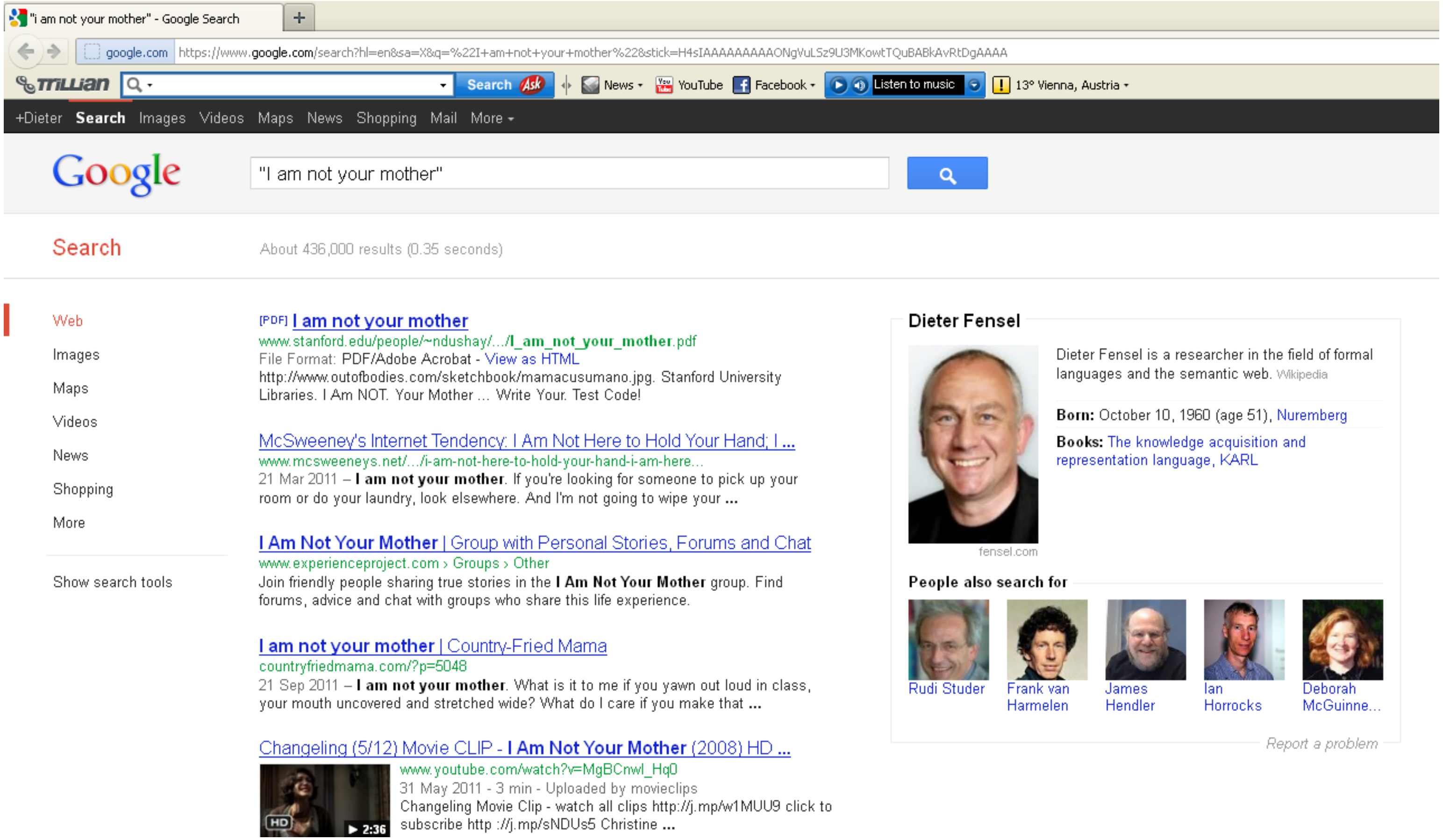
- Based on information derived from many sources including *Freebase*, *CIA World Factbook*, *Wikipedia*

- Contains about 3.5 billion facts about 500 million objects



Google Knowledge Graph

https://www.google.com/search?hl=en&sa=X&q=%22I+am+not+your+mother%22&stick=H4sIAAAAAAAAAONgVuLSz9U3MKowtTQuBABkAvRtDgAAAA



About 436,000 results (0.35 seconds)

[PDF] **I am not your mother**
www.stanford.edu/people/~ndushay/.../**I_am_not_your_mother**.pdf
File Format: PDF/Adobe Acrobat - View as HTML
http://www.outofbodies.com/sketchbook/mamacusumano.jpg. Stanford University Libraries. I Am NOT. Your Mother ... Write Your. Test Code!

McSweeney's Internet Tendency: I Am Not Here to Hold Your Hand; I ...
www.mcsweeneys.net/.../i-am-not-here-to-hold-your-hand-i-am-here...
21 Mar 2011 – **I am not your mother**. If you're looking for someone to pick up your room or do your laundry, look elsewhere. And I'm not going to wipe your **...**

I Am Not Your Mother | Group with Personal Stories, Forums and Chat
www.experienceproject.com › Groups › Other
Join friendly people sharing true stories in the **I Am Not Your Mother** group. Find forums, advice and chat with groups who share this life experience.

I am not your mother | Country-Fried Mama
countryfriedmama.com/?p=5048
21 Sep 2011 – **I am not your mother**. What is it to me if you yawn out loud in class, your mouth uncovered and stretched wide? What do I care if you make that **...**

Changeling (5/12) Movie CLIP - **I Am Not Your Mother** (2008) HD **...**
www.youtube.com/watch?v=MgBCnwl_Hq0
31 May 2011 - 3 min - Uploaded by movieclips
Changeling Movie Clip - watch all clips http://j.mp/w1MUU9 click to subscribe http ://j.mp/sNDUs5 Christine **...**

Dieter Fensel

Dieter Fensel is a researcher in the field of formal languages and the semantic web. Wikipedia

fensel.com

Born: October 10, 1960 (age 51), Nuremberg

Books: The knowledge acquisition and representation language, KARL

People also search for

Rudi Studer

Frank van Harmelen

James Hendler

Ian Horrocks

Deborah McGuinne...

Report a problem

Linked Data – a definition and principles

- **Linked Data** is about the use of Semantic Web technologies to publish structured data on the Web and set links between data sources.

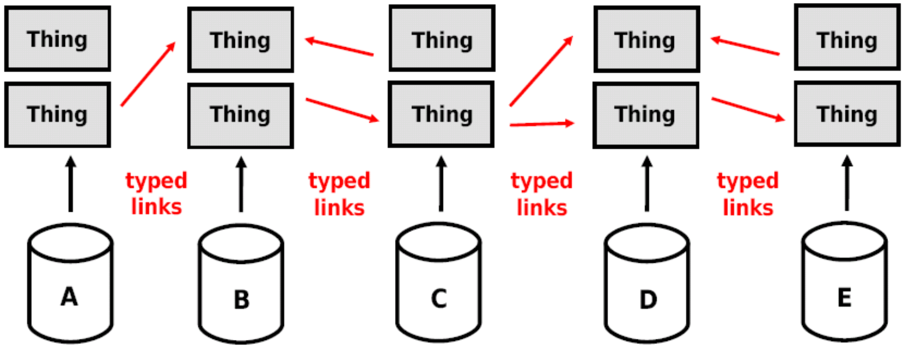


Figure from C. Bizer

LOD Cloud May 2007

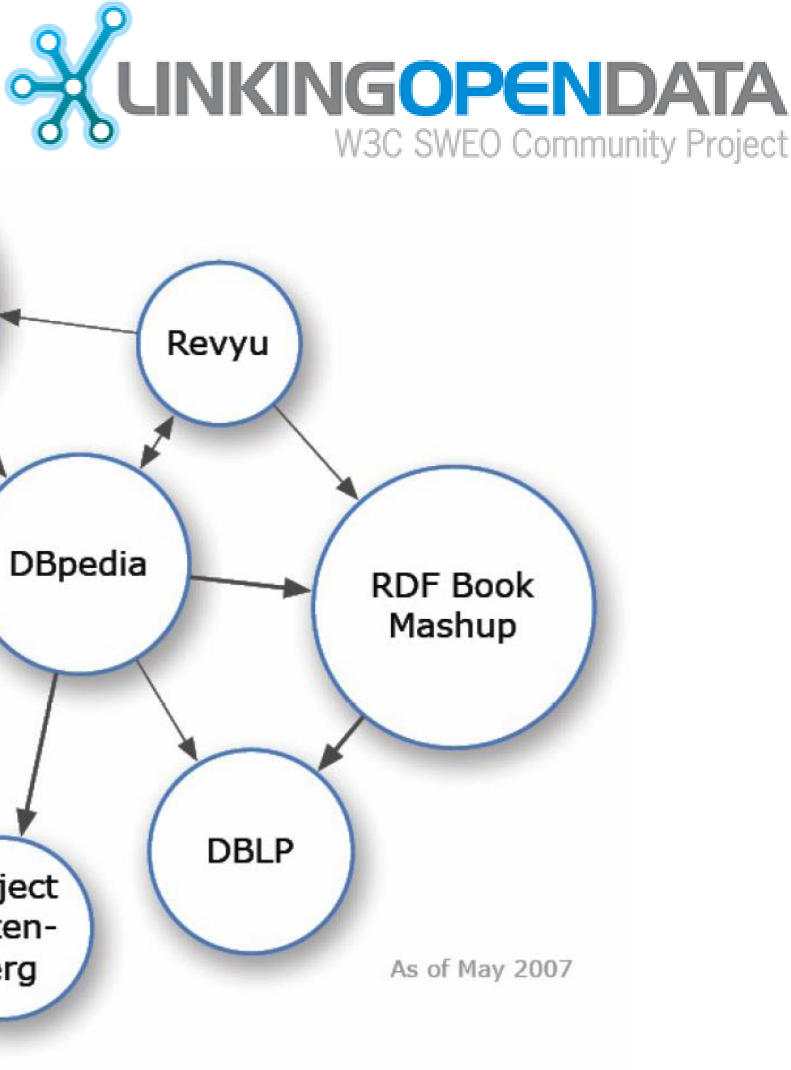
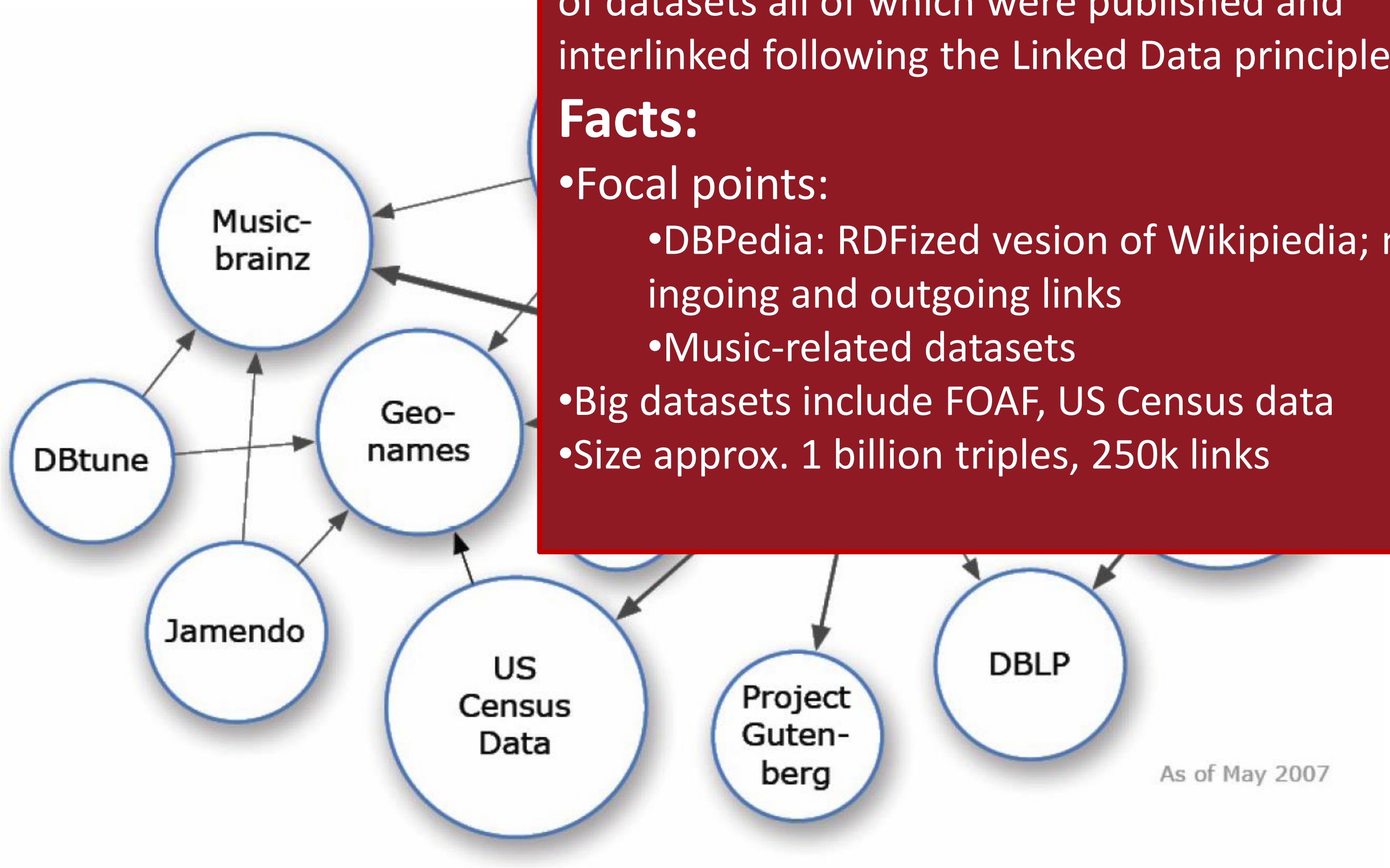


Figure from http://linkeddata.org/

LOD Cloud May 2007



Basics:

The Linked Open Data cloud is an interconnected set of datasets all of which were published and interlinked following the Linked Data principles.

Facts:

- Focal points:
  - DBPedia: RDFized vesion of Wikipiedia; many ingoing and outgoing links
  - Music-related datasets
- Big datasets include FOAF, US Census data
- Size approx. 1 billion triples, 250k links

Figure from http://linkeddata.org/

LOD Cloud March 2009

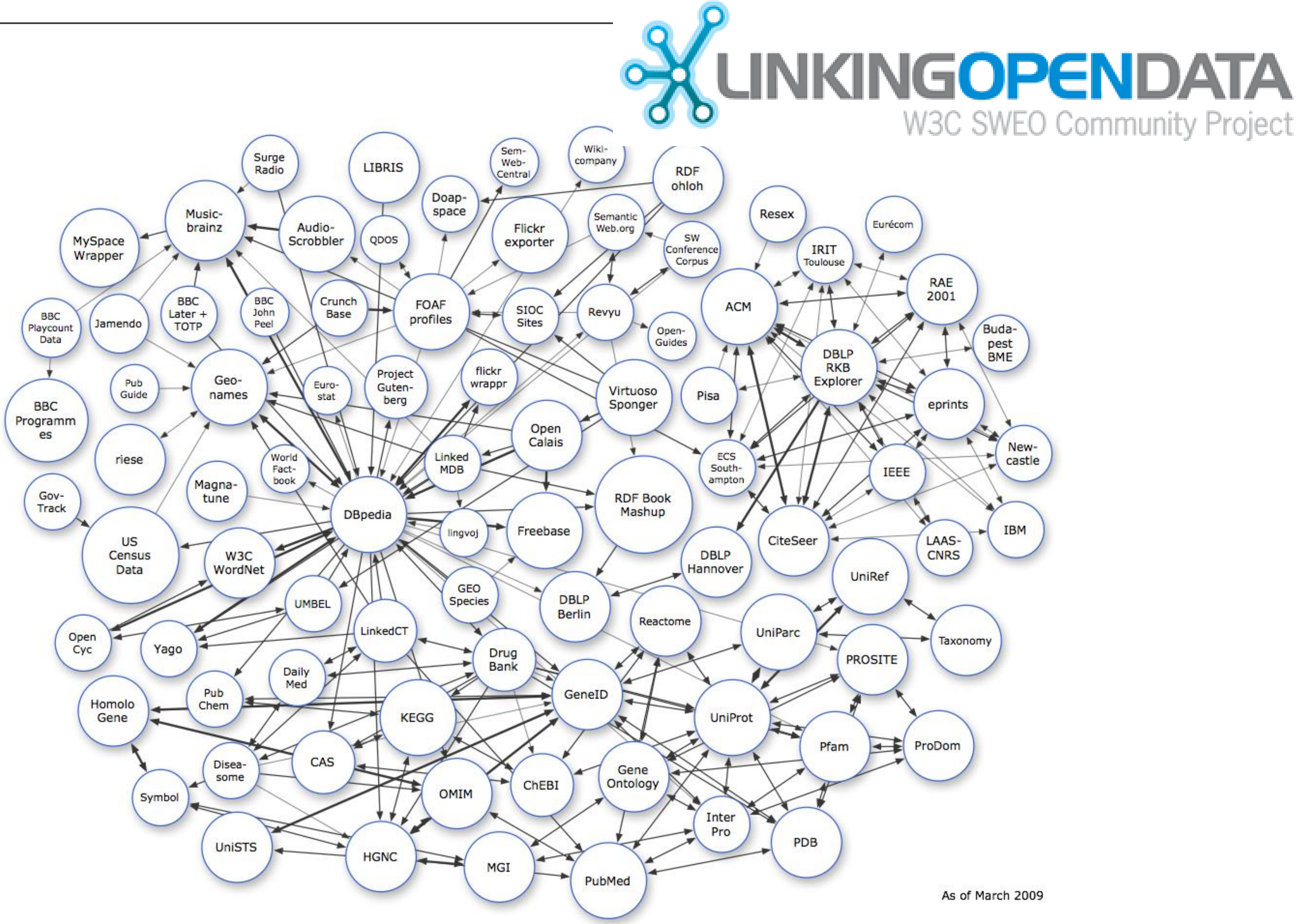


Figure from http://linkeddata.org/

LOD Cloud September 2011

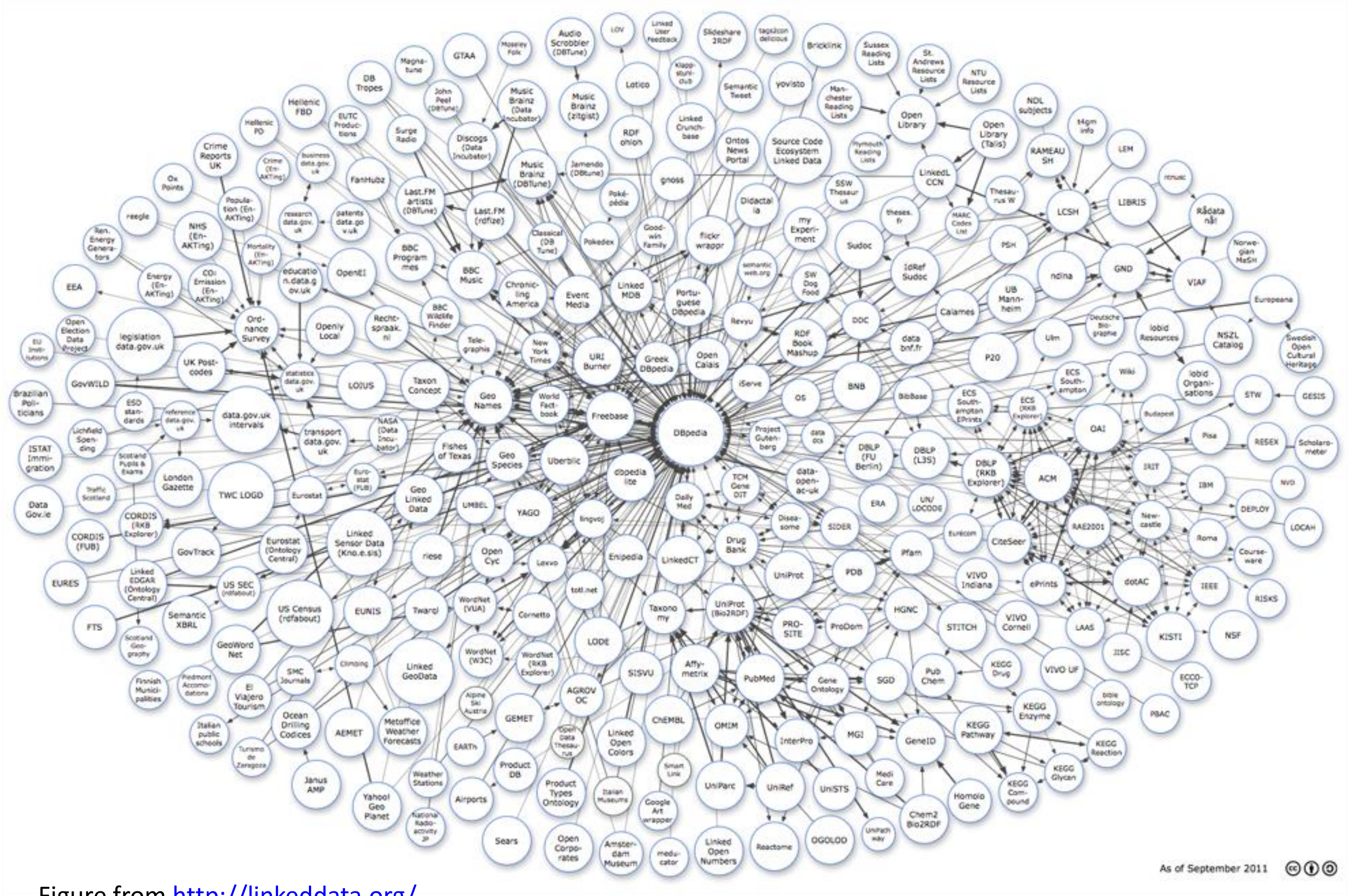
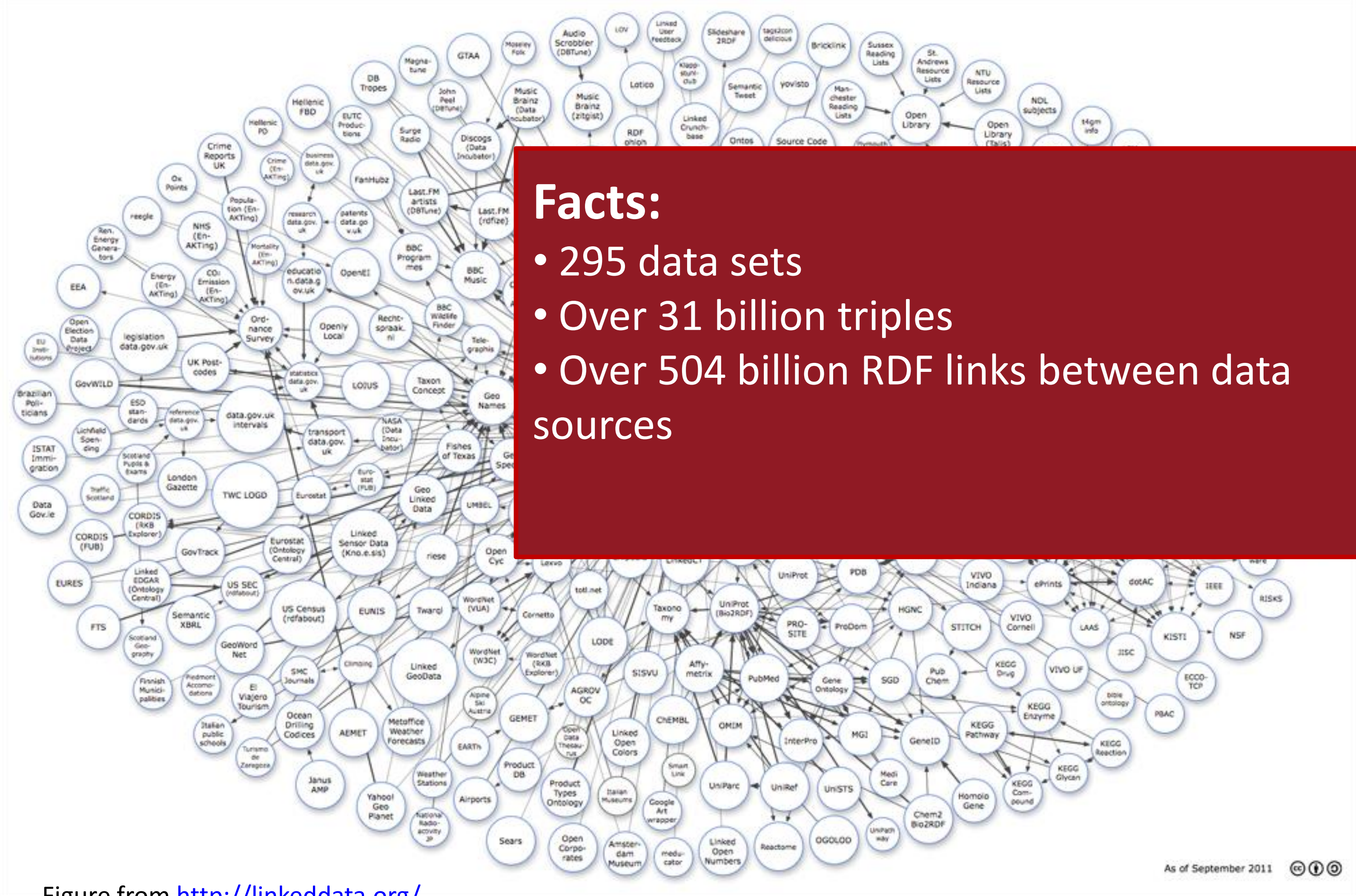


Figure from http://linkeddata.org/

LOD Cloud September 2011



Facts:

- 295 data sets
- Over 31 billion triples
- Over 504 billion RDF links between data sources

Figure from http://linkeddata.org/

Linked Open Data – silver bullet for data integration

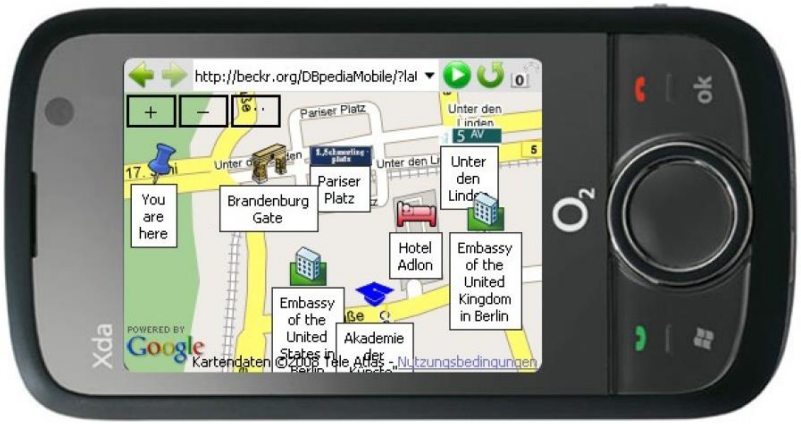
- Linked Open Data can be seen as a global data integration platform
  - Heterogeneous data items from different data sets are linked to each other following the Linked Data principles
  - Widely deployed vocabularies (e.g. FOAF) provide the predicates to specify links between data items

- Data integration with LOD requires:
  1. Access to Linked Data
     - HTTP, SPARQL endpoints, RDF dumps
     - Crawling and caching
  2. Normalize vocabularies – data sets that overlap in content use different vocabularies
     - Use schema mapping techniques based on rules (e.g. RIF, SWRL) or query languages (e.g. SPARQL Construct, etc.)
  3. Resolve identifies – data sets that overlap in content use different URIs for the same real world entities
     - Use manual merging or approaches such as SILK (part of Linked Data Integration Framework) or LIMES
  4. Filter data
     - Use SIVE ((part of Linked Data Integration Framework)

See: http://www4.wiwiss.fu-berlin.de/bizer/ldif/

Example - Mashup: DBPedia Mobile

- Geospatial entry point into the Web of Data.
- It exploits information coming from DBpedia, Revyu and Flickr data.
- It provides a way to explore maps of cities and gives pointers to more information which can be explored


http://beckr.org/DBpediaMobile/?lat
+
–
Pariser Platz
Unter den Linden
You are here
Brandenburg Gate
Pariser Platz
Unter den Linden
Hotel Adlon
Embassy of the United Kingdom in Berlin
Embassy of the United States in Berlin
Akademie der Künste
POWERED BY Google
Kartendaten ©2008 Tele Atlas - Nutzungsbedingungen
Xda
O2
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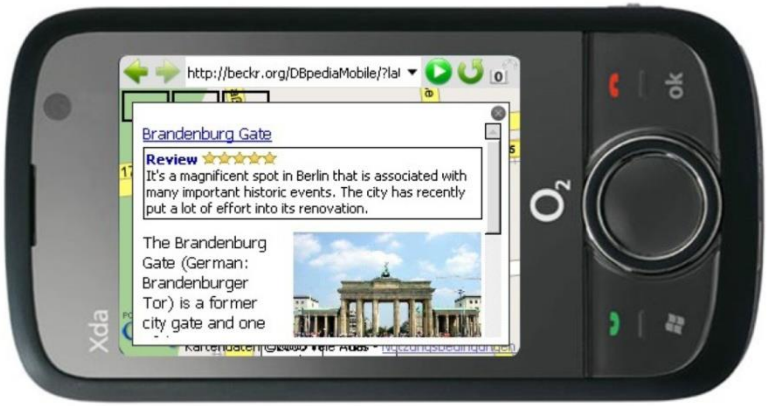
Pictures from DBPedia Mobile

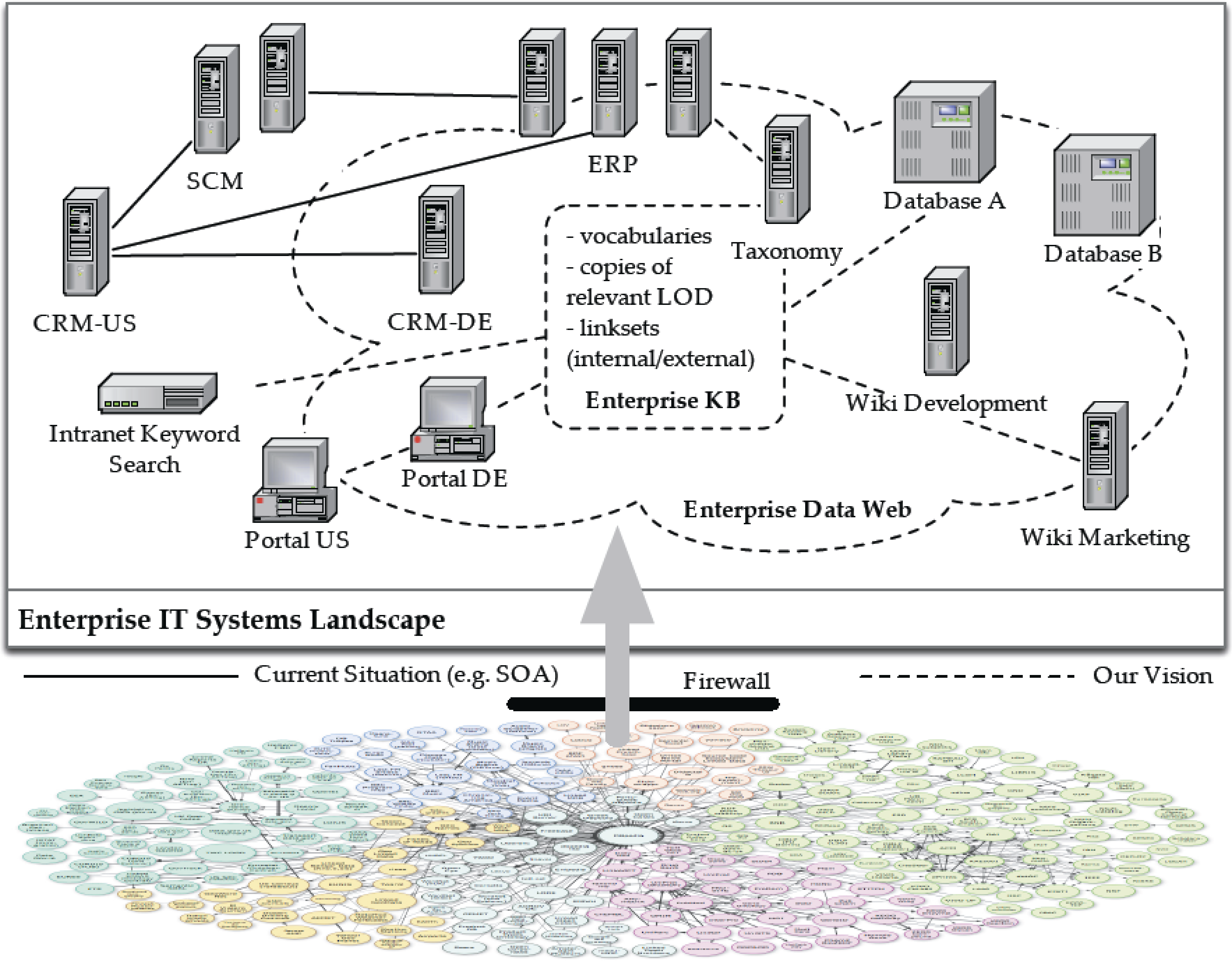


It's a magnificent spot in Berlin that is associated with many important historic events. The city has recently put a lot of effort into its renovation.

The Brandenburg Gate (German: Brandenburger Tor) is a former city gate and one

Try yourself: http://wiki.dbpedia.org/DBpediaMobile

From Intranet to Enterprise Data Web around a knowledge hub



Data Economy

"Your data is worth more if you give it away."

Commission Vice President

Neelie Kroes

What is Data Economy?

- Non tangible assets (i.e. data) play a significant role in the creation of economic value
- Data is nowadays more important than, for example, search or advertisement
- The value of the data, its potential to be used to create new products and services, is more important than the data itself

Why a Data Economy?

- Total market for public sector information **€ 28 billion in 2008** for the EU27
- Annual growth of 7% leading to around **€ 32 billion in 2010**
- Estimated **€40 billion annual** boost for the European economy.
- The total direct and indirect economic gains across the whole EU27 economy would be in the order of **€ 140 billion annually**.

See: Review of recent studies on PSI re-use and related market developments, G. Vickery, August 2011.

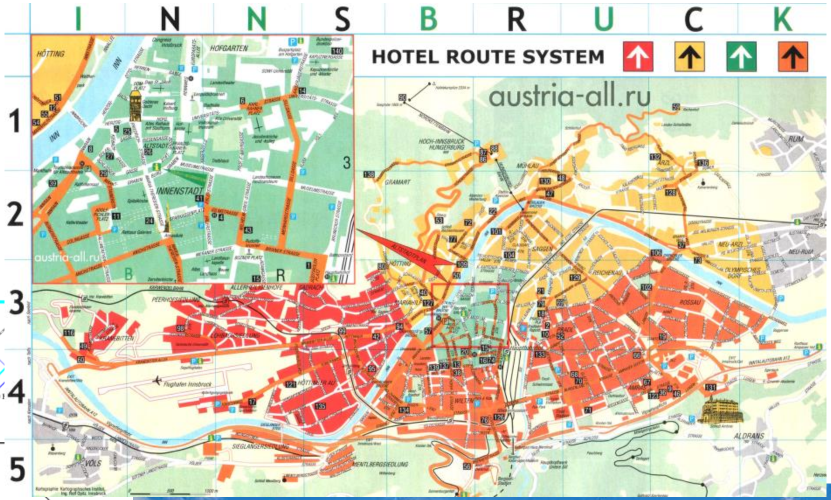
Why a Data Economy?

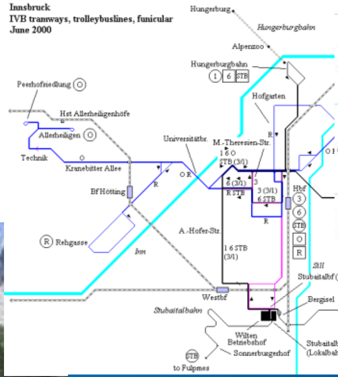
- **New businesses can be built on the back of these data**: Data are an essential raw material for a wide range of new information products and services which build on new possibilities to analyse and visualise data from different sources. Facilitating re-use of these raw data will create jobs and thus stimulate growth.
- **More Transparency**: Open data is a powerful tool to increase the transparency of public administration, improving the visibility of previously inaccessible information, informing citizens and business about policies, public spending and outcomes.
- **Evidence-based policy making and administrative efficiency**: The availability of solid EU-wide public data will lead to better evidence-based policy making at all levels of government, resulting in better public services and more efficient public spending.

See: http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO11/891&format=HTML&aged=0&language=EN&guiLanguage=en

Combining Open Data and Services – Tourist Map Austria

- Use LOD to integrate and lookup data about
  - places and routes
  - time-tables for public transport
  - hiking trails
  - ski slopes
  - points-of-interest

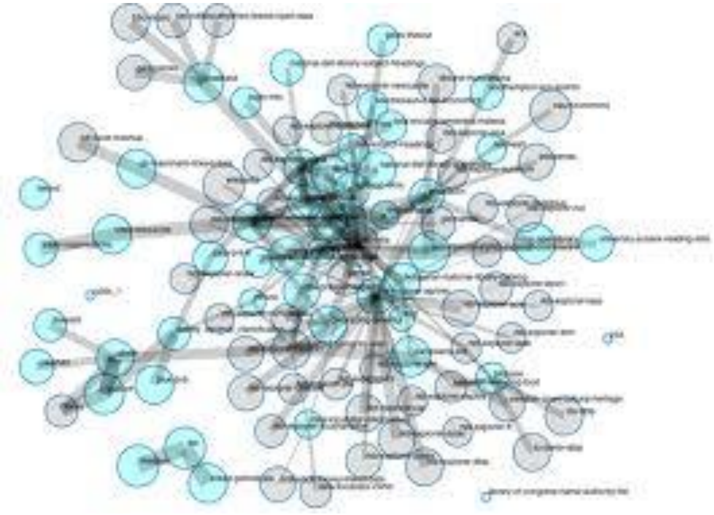




Combining Open Data and Services – Tourist Map Austria

LOD data sets

- Open Streetmap
- Google Places
- Databases of government
  - TIRIS
  - DVT
- Tourism & Ticketing association
- IVB (busses and trams)
- OEBB (trains)
- Ärztekammer
- Supermarket chains: listing of products
- Hofer and similar: weekly offers
- ASFINAG: Traffic/Congestion data
- Herold (yellow pages)
- City archive
- Museums/Zoo
- News sources like TT (Tyrol's major daily newspaper)
- Statistik Austria



- Innsbruck Airport (travel times, airline schedules)
- ZAMG (Weather)
- University of Innsbruck (Curricula, student statistics, study possibilities)
- IKB (electricity, water consumption)
- Entertainment facilities (Stadtcafe, Cinema...)
- Special offers (Groupon)

Combining Open Data and Services – Tourist Map Austria

- Data and services from destination sites integrated for recommendation and booking of
  - Hotels
  - Restaurants
  - Cultural and entertainment events
  - Sightseeing
  - Shops

Combining Open Data and Services – Tourist Map Austria

- **Web scraping** integration
  - Create wrappers for current web sites and extract data automatically
  - Many Web scraping tools available on the market

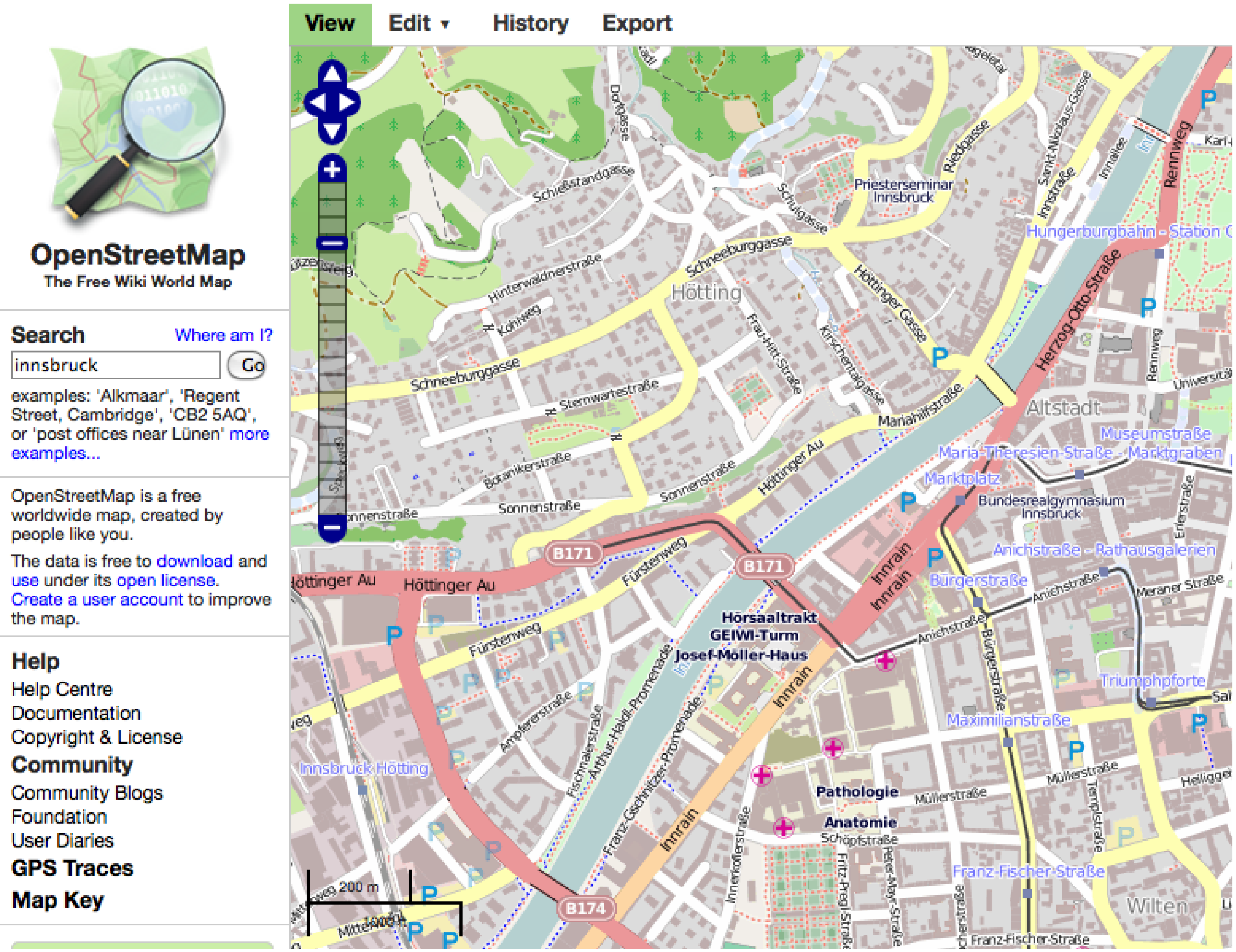
Combining Open Data and Services – Tourist Map Austria

- Integration into a comprehensive map of ***multi-channel communication***, ***seekda booking engine, Linked Open Data*** and ***on the fly service integration as you pay*** to generate added value for businesses as well as customers

- Combination of multi channel communication and yield management
  - Semantic Communication Engine Innsbruck (SCEI)
  - seekda booking solutions
- enriched with Linked (Open) Data
  - Machine understandable interlinked data
  - Bike and hiking trails, sight information, etc.
- and on the fly service integration as you pay
  - Solutions for ad-hoc service integration for touristic destination sites
  - Bike rental, ski passes, etc.
  - Services are quickly integrated through scraping (and later through legal frameworks and backend integration in case of business volumes)

Combining Open Data and Services – Tourist Map Austria

- Based on **Open Street Map**



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examples: 'Alkmaar', 'Regent Street, Cambridge', 'CB2 5AQ', or 'post offices near Lünen' more examples...

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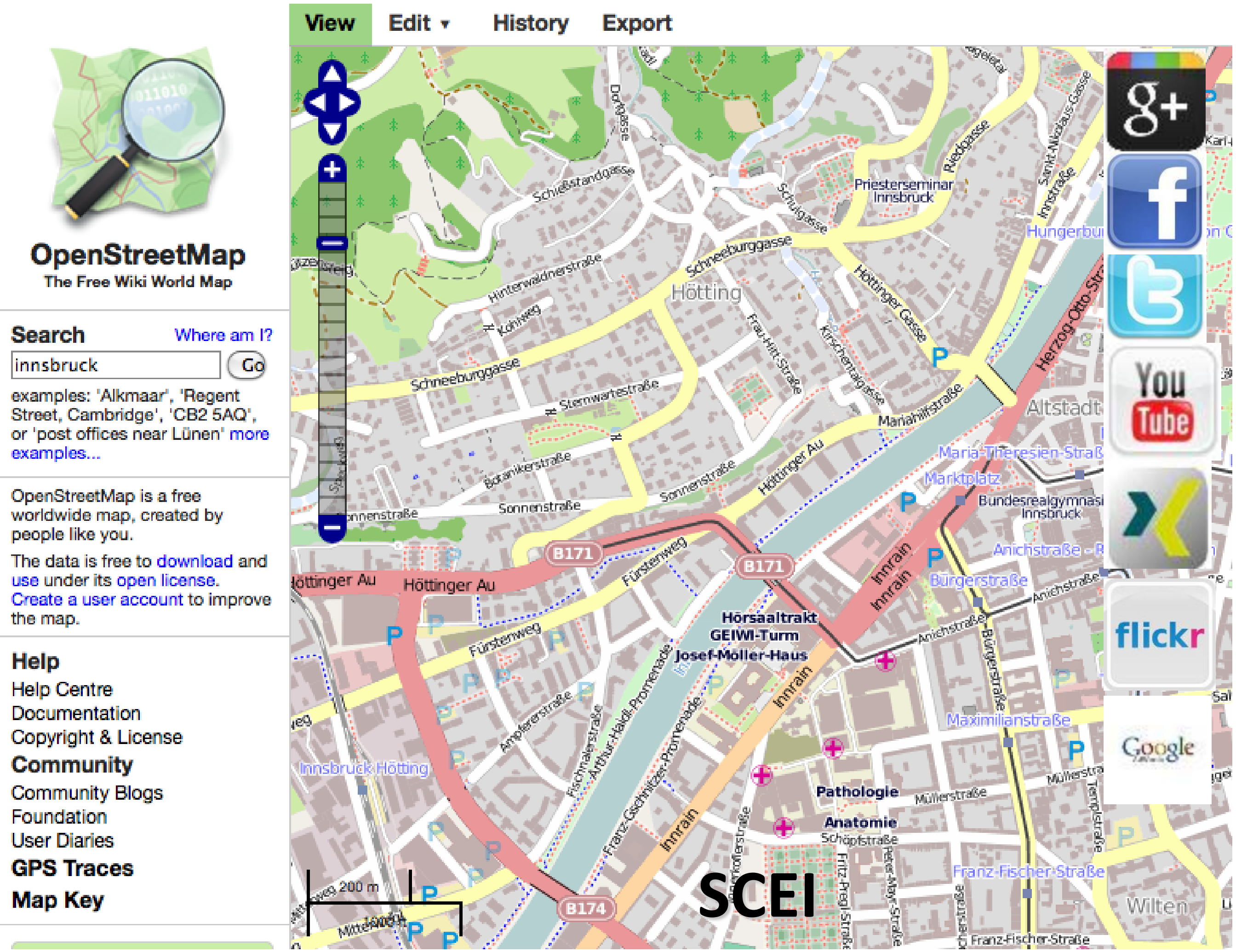
Combining Open Data and Services – Tourist Map Austria

- Based on **Open Street Map**
- Increase on-line visibility for hotels and destinations via **multi-channel communication – SCEI**



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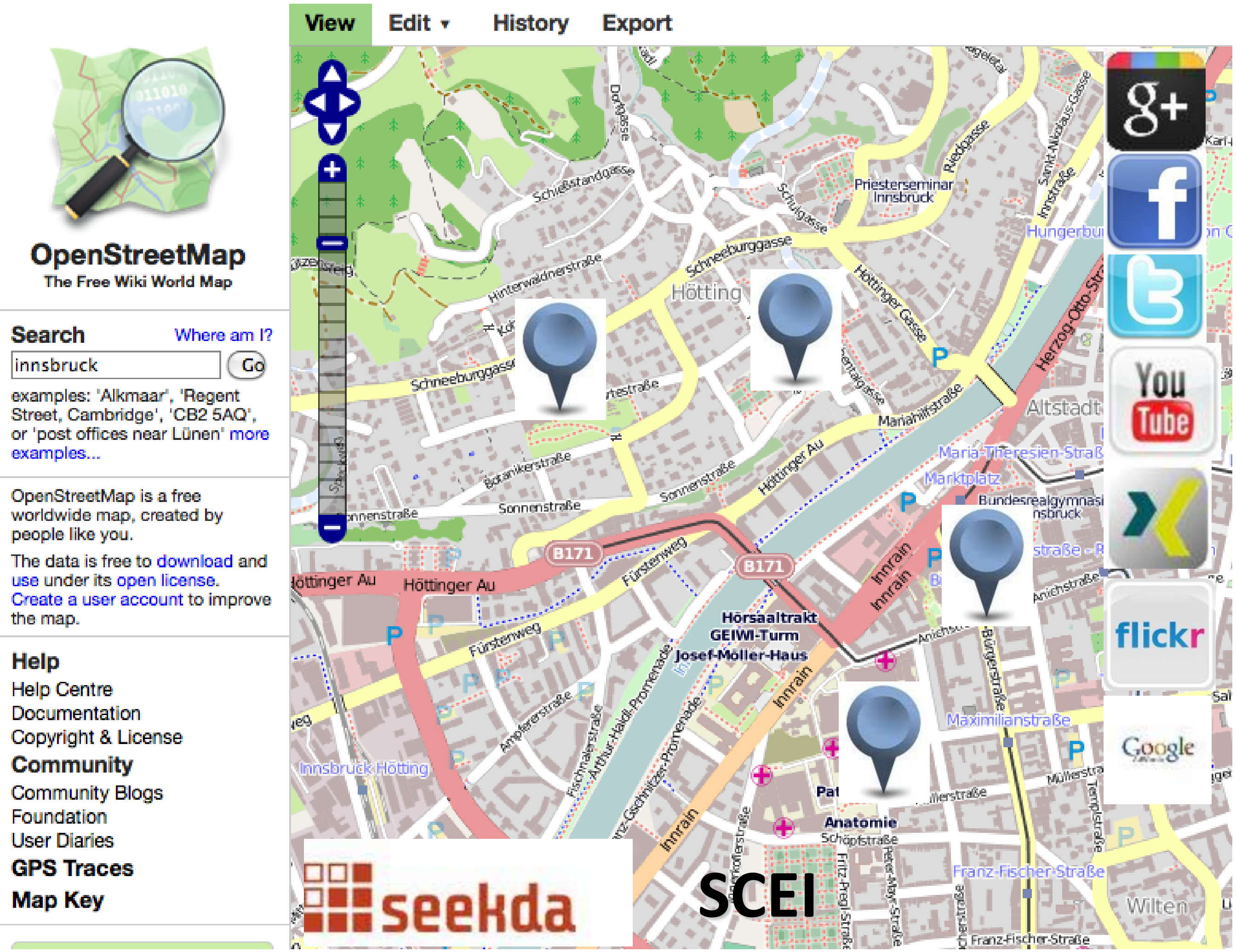

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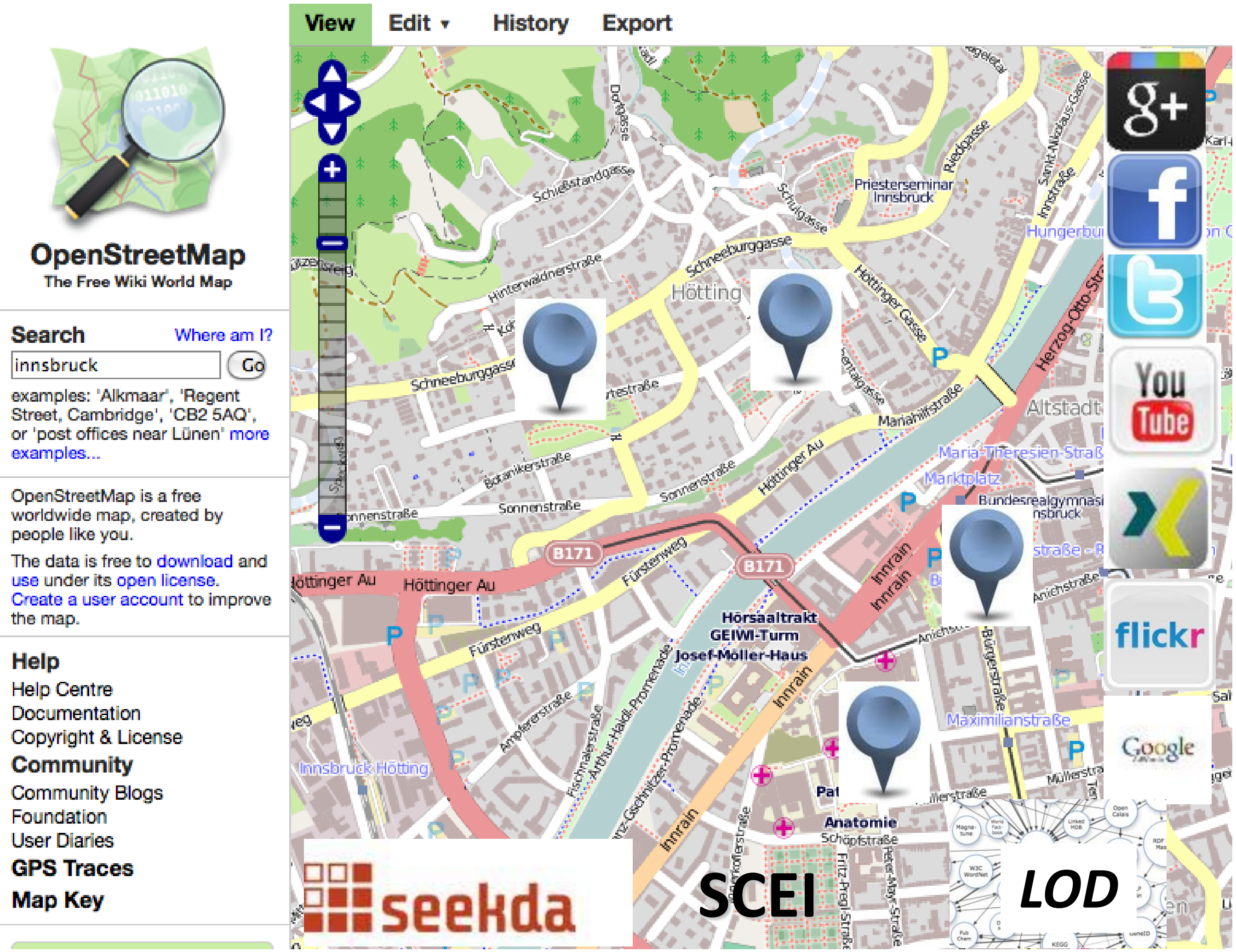

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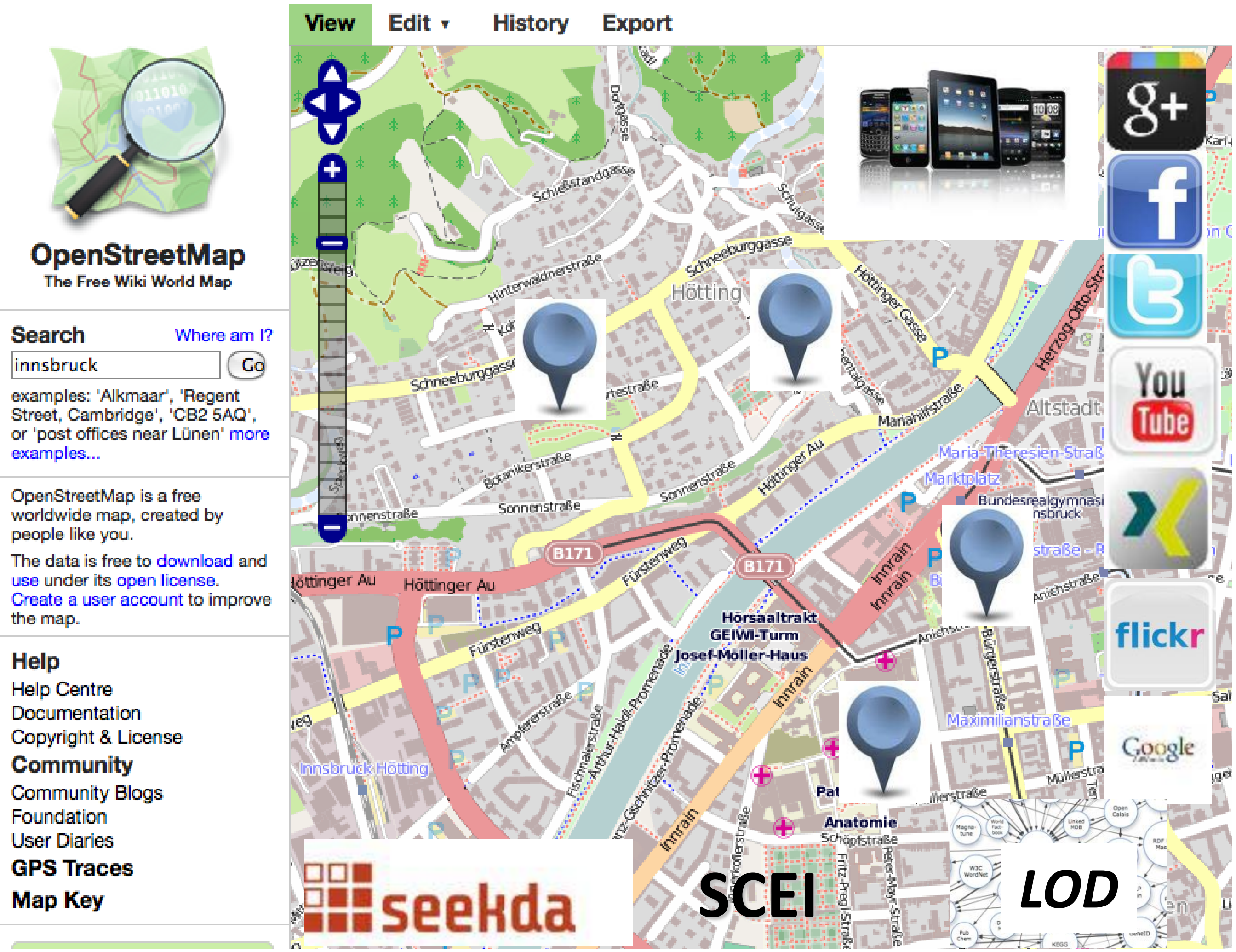

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“There's No Money in Linked (Open) Data”

http://knoesis.wright.edu/faculty/pascal/pub/nomoneylod.pdf

- It turns out that using LOD datasets in realistic settings is not always easy.
  - Surprisingly, in many cases the underlying issues are not technical but legal barriers erected by the LD data publishers.
  - Generally, mostly non-technical but socio-economical barriers hamper the reuse of date (do patents and IPR protections hamper or facilitate knowledge reuse?).
  - Business intelligence
  - Dynamic Data
  - On the fly generation of data