

# Lecture 3 – Open Data

*Open Data Management & the Cloud*

(Data Science & Scientific Computing / UniTS – DMG)

- Data and information are often used interchangeably, but relative to today's computers and transmission media, data is information converted into binary digital form
- Internet changed the way we use, share and access data
- These new technologies of sharing data provides unprecedented tools to get huge amounts of data to analyze
- Data can be private (e.g. restricted user access) or public
- “Public” in some context can be synonym of “open”, but there is not complete agreement on “open” definition
- There are several initiatives and consortiums that promote open data:
  - World Wide Web Consortium (W3C)
  - Open Society Foundations (OSF)
  - Open Knowledge International (OKI), formerly Open Knowledge Foundation (OKF)
  - Open Science as a Practice (openscienceASAP)
  - Research Data Alliance
  - ... and many others

# What does “open” mean?



- *The Open Definition* “Open means anyone can freely access, use, modify, and share for any purpose subject, at most, to requirements that preserve provenance and openness.” - Open Knowledge International
- *BOAI (Budapest Open Access Initiative)* “By 'open access' to this literature, we mean its **free availability** on the public Internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, **without financial, legal, or technical barriers** other than those inseparable from gaining access to the Internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited.” - Open Society Foundations
- Several fields where openness is applied, but they do not rely on the same exact definition of open:
  - Open Government
  - Open Source
  - Open Content
  - Open Science and Open Data Science
  - ... and many others

- Open Government is the governing doctrine which holds that citizens have the right to access the documents and proceedings of the government to allow for effective public oversight.
- There is a large number of areas where open government data are creating value, such as:
  - Transparency and democratic control
  - Participation
  - Improved efficiency and effectiveness of government services

- The Open Source Definition is a document published by the Open Source Initiative, to determine whether a software license can be labeled with the open-source certification mark.
- The distribution terms of open-source software must comply some criteria, such as:
  - Software must include Source Code
  - Free Redistribution
  - The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software.
  - No Discrimination Against Persons or Groups
  - No Discrimination Against Fields of Endeavor
  - Distribution of License The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties.
  - License Must Not Be Specific to a Product The rights attached to the program must not depend on the program's being part of a particular software distribution.
  - License Must Not Restrict Other Software The license must not place restrictions on other software that is distributed along with the licensed software.
  - License Must Be Technology-Neutral

- Open content, coined by analogy with "open source" describes any kind of creative work including articles, pictures, audio, and video that is published in a format that explicitly allows the copying and the editing of the information
- The term applies to copyrightable content that is made freely available and licensed according to permission for what are known as the 5R activities:
  - Retain: Users may freely download, copy, store and manage the content.
  - Reuse: The content may be reused freely, for example on a website or in a class or workshop.
  - Revise: It is lawful to make changes to the content itself, for example reformatting or translating it.
  - Remix: The content may be combined in a mashup with other open content.
  - Redistribute: The content may be freely shared either in its original form or after being subjected to any permitted alteration.
- A Creative Commons (CC) license is one of several public copyright licenses that enable the free distribution of an otherwise copyrighted work

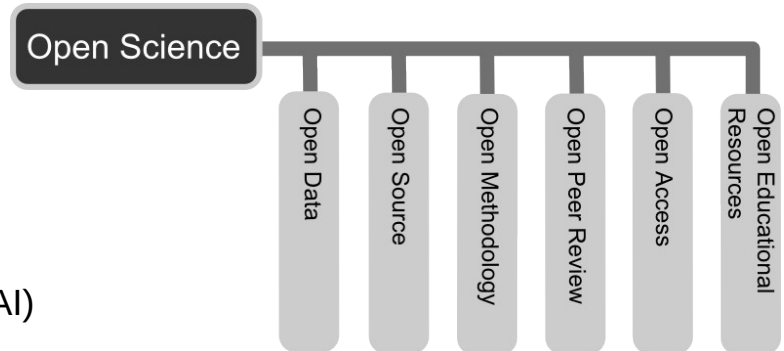
# Open Science and Open Science Data



- “Open science is the idea that scientific knowledge of all kinds should be openly shared as early as is practical in the discovery process.” - *Michael Nielsen OpenScience ASAP*

- 6 principles:

- Open Methodology: Document methods used
- Open Source: Use open source technology
- Open Data: Make available data freely available
- Open Access: Data accessible to everyone (see BOAI)
- Open Peer Review: Transparent and traceable quality assurance through open peer review
- Open Educational Resources: Use Free and Open Materials for Education and University Teaching



- Open Science Data focuses on publishing observations and results of scientific activities available for anyone to analyze and reuse
  - Allow the verification of scientific claims
  - Allow data discovery from many sources to be integrated to give new knowledge
- Citations, references and acknowledgments are used to measure both the productivity and citation impact of the publications of a scientist
  - Conflict between the desire of scientists to have access to shared resources versus the desire of individual entities to profit when other entities partake of their resources

- Different fields and communities have different needs about Open Data:
  - Transparency
  - Accessibility
  - Re-usability
  - Sharing
  - Knowledge distribution
  - Licensing issues
  - Citations and Acknowledgments
- Can we converge on a common definition of Open Data?



# 5 ★ Open Data



- Tim Berners-Lee, founder of the WorldWideWeb Consortium (W3C), suggested a 5-star deployment scheme for Open Data
  - ★ make your stuff available on the Web (whatever format) under an open license
  - ★★ make it available as structured data (e.g., Excel instead of image scan of a table)
  - ★★★ make it available in a non-proprietary open format (e.g., CSV instead of Excel)
  - ★★★★ use URIs to denote things, so that people can point at your stuff
  - ★★★★★ link your data to other data to provide context

# Example – Temperature Forecast



Temperature forecast for Galway, Ireland - Konqueror

File Modifica Visualizza Vai Segnalibri Strumenti Impostazioni Finestra Aiuto

https://5stardata.info/en/examples/gtd-5/ Duck Duck Go

Show embedded data

## TEMPERATURE FORECAST

Day	Lowest Temperature (°C)
Saturday, 13 November 2010	2
Sunday, 14 November 2010	4
Monday, 15 November 2010	7

Created: 2012-01-22 by [Michael](#) | Last updated: 2015-08-31 by [James](#) | Code available via [GitHub](#)  
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Temperature - Wikipedia - Konqueror

File Modifica Visualizza Vai Segnalibri Strumenti Impostazioni Finestra Aiuto

https://en.wikipedia.org/wiki/Temperature Duck Duck Go

WIKIPEDIA The Free Encyclopedia

Temperature

From Wikipedia, the free encyclopedia

This article is about the thermodynamic property. For other uses, see *Temperature (disambiguation)*.

**Temperature** is a physical quantity expressing hot and cold. It is measured with a thermometer calibrated in one or more temperature scales. The most commonly used scales are the Celsius scale (formerly called *centigrade*) (denoted °C), Fahrenheit scale (denoted °F), and Kelvin scale (denoted K). The kelvin (spelled with a lower case k) is the unit of temperature in the International System of Units (abbreviated SI), in which temperature is one of the seven fundamental base quantities. The Kelvin scale is widely used in science and technology.

The coldest theoretical temperature is absolute zero, at which

Annual Mean Temperature

★★ data available in EXCEL  
 ★★★★★ data available through the data RL

# Linked Data (1)



- There are many different types of Open Data we can use by itself: images, documents, videos, websites, etc.
- The web allows to make available images inside text, to mix different data together through link from one document to another
- Open Data can be combined into something more interesting than original pieces
- Computer does not really understand what links are about as an human
  - We need to deconstruct information and package it in a way understandable to a computer
  - We need to link this information it in a way understandable to a computer

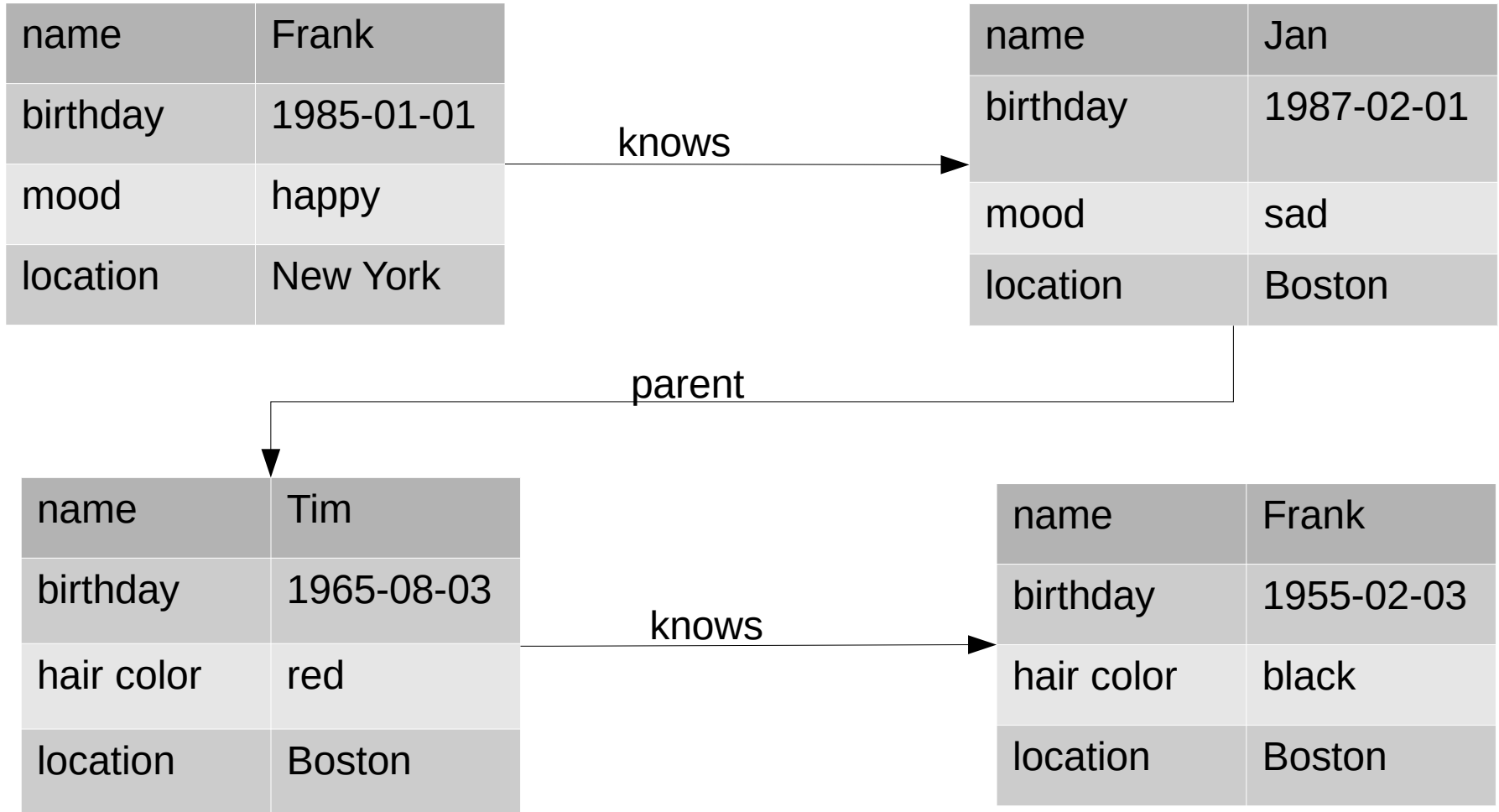
# Linked Data (2)



name	Frank
birthday	1985-01-01
mood	happy
location	New York

- Data are in a standard and usable format
- Common formats for data:
  - XML
  - Json
  - CSV
  - RDF
- How “Frank” is related with the rest of the world?

# Linked Data (3)



- Relations link “Frank” with the rest of the world

# Linked Data (4)



<http://mysite.com/frank>

name	Frank
birthday	1985-01-01
mood	happy
location	New York

<http://myweb.com/jan>

name	Jan
birthday	1987-02-01
mood	sad
location	Boston

<http://schema.org/knows>



<http://schema.org/parent>

<http://othersite.com/tim>

name	Tim
birthday	1965-08-03
hair color	red
location	Boston

<http://othersite.com/frank>

name	Frank
birthday	1955-02-03
hair color	black
location	Boston

<http://schema.org/knows>

- URL can specify which “Frank”
- URL can define relations

# Linked Data (5)



<http://mysite.com/frank>

name	Frank
birthday	1985-01-01
mood	happy
location	New York

<http://schema.org/knows>

<http://myweb.com/jan>

name	Jan
birthday	1987-02-01
mood	sad
location	Boston

<http://schema.org/lives>

<http://schema.org/lives>

<http://towns.com/newyork>

name	New York
latitude	40°43'N
longitude	74°00'W
state	New York

<http://towns.com/boston>

name	Boston
latitude	41°21'N
longitude	71°03'W
state	Massachusetts

- You can mix information from different vocabularies

# Linked Data (6)



- Three rules for Linked Data
  - Data are in a standard and usable format
  - Use unique identifiers for Data
  - Data are relationships
- It is not a top-down system: linked data does not need everybody agrees on all the terms
- When anybody communicates any kind of information, uses a mix of different vocabularies
- You cherry pick information from different set of terms from different vocabularies (ontologies)



# Example – Potato Chips



English Vocabulary

Japanese Vocabulary



Nutrition Facts Vocabulary

Food Industry Vocabulary

Retailer Vocabulary

“Mysterious” Vocabulary

Questions or Comments?  
1-800-352-4477  
Weekdays 9:00am to 4:30pm  
Central Time

Nutrition Facts	
Serving Size 1 oz. (28g) About 11 chips	
Servings Per Container About 2	
Amount Per Serving	
<b>Calories</b>	160
Calories from Fat	140
<b>% Daily Value*</b>	
<b>Total Fat</b> 7g, 15g	11% 23%
Saturated Fat 1g, 2g	5% 11%
Trans Fat 0g, 0g	
<b>Cholesterol</b> 0mg, 0mg	0% 0%
<b>Sodium</b> 210mg, 440mg	9% 18%
<b>Total Carbohydrate</b> 16g, 34g	5% 11%
Dietary Fiber 1g, 2g	4% 9%
Sugars 0g, less than 1g	
<b>Protein</b> 2g, 4g	
Vitamin A	0% 2%
Vitamin C	0% 0%
Calcium	0% 0%
Iron	0% 2%
Niacin	2% 4%

\*Percent Daily Values are based on a diet of 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

Calories:	2,000
Total Fat:	Less than 65g
Sat Fat:	Less than 20g
Cholesterol:	Less than 300mg
Sodium:	Less than 2,400mg
Total Carbohydrate:	300g
Dietary Fiber:	25g
Protein:	50g

**Ingredients:** Whole Corn, Vegetable Oil (Corn, Soybean, Canola and/or Sunflower Oil), Corn Maltodextrin, Salt, Monosodium Glutamate, Soy Sauce (Soybean, Wheat, Salt), Onion Powder, Sugar, Dextrose, Corn Syrup Solids, Hydrolyzed Soy Protein, Sodium Diacetate, Spices, Malic Acid, Garlic Powder, Autolyzed Yeast Extract, Gum Arabic, Sodium Caseinate (Milk), Horsearadish, Citric Acid, Artificial Color (Yellow 5 Lake, Blue 1 Lake), Wasabi, Natural and Artificial Flavors.  
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# Example – DBpedia (1)

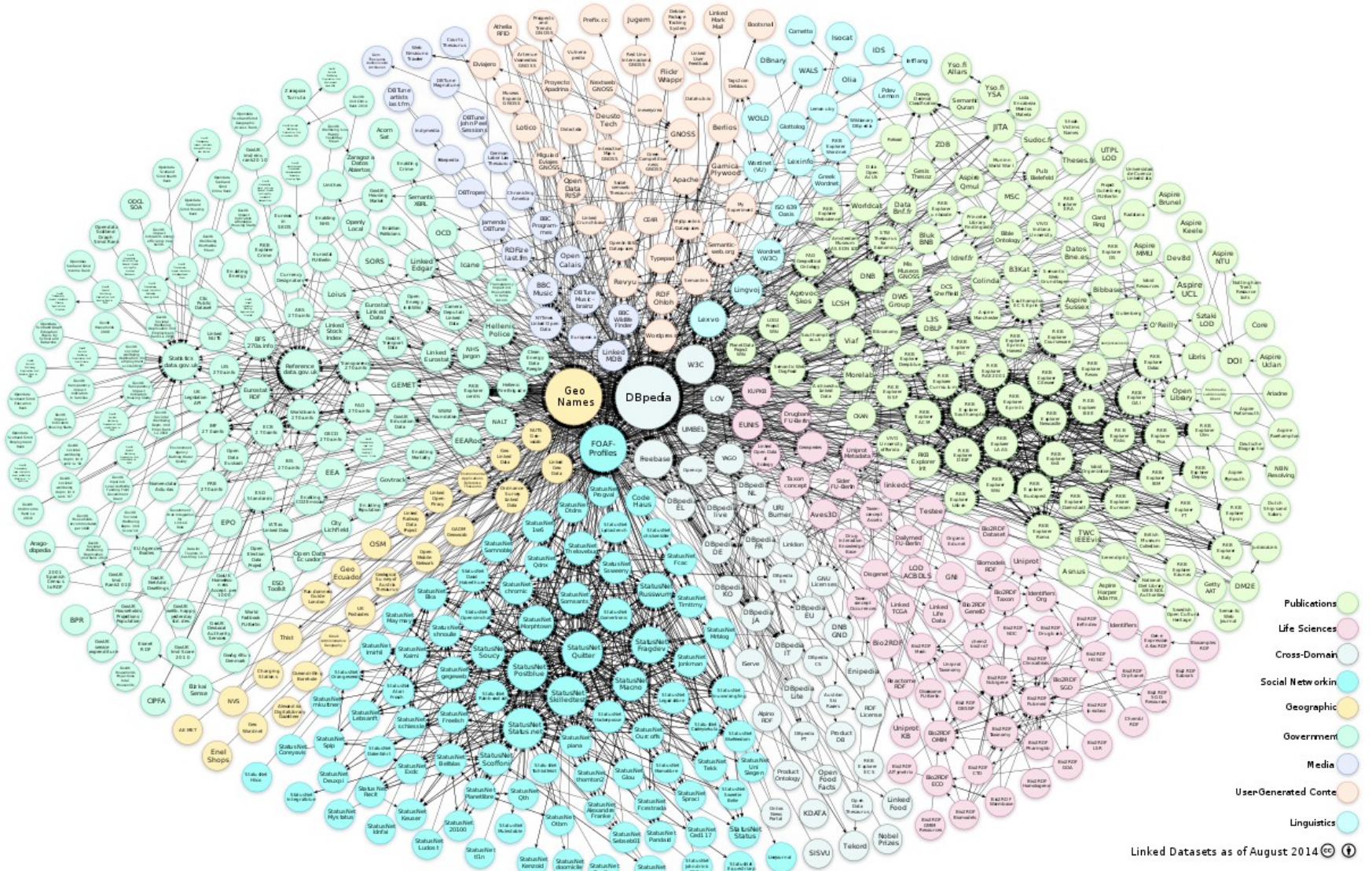


- The DBpedia project focuses on the task of converting Wikipedia content into structured knowledge
- Steps to build up DBpedia:
  - Convert Wikipedia content to RDF (Resource Description Framework) with metadata that describe the semantic context
  - Interlink DBpedia dataset with other open datasets
  - Develop interfaces and access modules

A screenshot of a web browser window displaying the DBpedia page for "Gaio Giulio Cesare". The browser's address bar shows the URL "http://dbpedia.org/page/Julius\_Caesar". The page title is "About: Gaio Giulio Cesare" and it identifies the entity as a "persona". Below the title is a paragraph of Italian text describing Caesar's role in Roman history. A table follows, listing properties and their values in a structured format. The table has two columns: "Property" and "Value".

Property	Value
<code>dbpedia:abstract</code>	<ul style="list-style-type: none"><li>▪ Gaius Julius Caesar (Classical Latin: [ˈɡa.i.us ˈju.li.us ˈkag.sar]; 13 July Latin prose. He played a critical role in the events that led to the demise of political alliance that dominated Roman politics for several years. Their ally Cato the Younger with the frequent support of Cicero. Caesar's victories in Caesar became the first Roman general to cross both when he had military power and threatened to eclipse the standing of Pompey the Great. The Senate ordered Caesar to step down from his power because he demanded too much influence.</li><li>▪ <code>dbpedia:Julius_Caesar</code></li><li>▪ <code>dbpedia:Gaius_Servilius_Vatia_Isauricus_(consul_48_BC)</code></li></ul>
<code>dbpedia:birthPlace</code>	<ul style="list-style-type: none"><li>▪ <code>dbpedia:Rome</code></li></ul>
<code>dbpedia:child</code>	<ul style="list-style-type: none"><li>▪ <code>dbpedia:Augustus</code></li><li>▪ <code>dbpedia:Caesarion</code></li><li>▪ <code>dbpedia:Julia_(daughter_of_Julius_Caesar)</code></li></ul>
<code>dbpedia:deathDate</code>	<ul style="list-style-type: none"><li>▪ <code>-100-07-13</code> (xsd:date)</li><li>▪ <code>-100-7-13</code></li></ul>
<code>dbpedia:deathPlace</code>	<ul style="list-style-type: none"><li>▪ <code>dbpedia:Rome</code></li></ul>

# Example – DBpedia (2)



# Example – Google's Knowledge Graph



Google

[All](#) [Images](#) [Maps](#) [News](#) [Videos](#) [More](#) [Settings](#) [Tools](#)

About 114,000,000 results (0.81 seconds)

## Taj Mahal - Wikipedia

[https://en.wikipedia.org/wiki/Taj\\_Mahal](https://en.wikipedia.org/wiki/Taj_Mahal)

The **Taj Mahal** is an ivory-white marble mausoleum on the south bank of the Yamuna river in the Indian city of Agra. It was commissioned in 1632 by the Mughal ...

Built: 1632–53 Architectural style(s): **Mughal architecture**  
Built for: Mumtaz Mahal Location: Agra, Uttar Pradesh, India

[Origins and architecture](#) · [Black Taj Mahal](#) · [Taj Mahal replicas](#) · [Taj Mahal](#)

## Images for taj mahal



[→ More images for taj mahal](#)

[Report images](#)

## Taj Mahal - SCN Wikipedia

[https://scn.wikipedia.org/wiki/Taj\\_Mahal](https://scn.wikipedia.org/wiki/Taj_Mahal)

Dà Wikipedia, la nciclopedia libbira. Jump to navigation Jump to search. Lu **Taj Mahal**. Lu Taj Mahal è lu munumentu cchiù celebri di l'India e sicuramente unu di ...

## Taj Mahal - Wikipedia

[https://it.wikipedia.org/wiki/Taj\\_Mahal](https://it.wikipedia.org/wiki/Taj_Mahal) [Translate this page](#)

Il **Taj Mahal** (in urdu: **تاج محل**; in hindi: **ताज महल**), situato ad Agra, nell'India settentrionale (stato di Uttar Pradesh), è un mausoleo fatto costruire nel 1632 ...

Scheda UNESCO: (EN) Scheda; (FR) Scheda **Riconosciuto dal: 1983**  
Tipo: Architetonico, funerario

[Mumtaz Mahal](#) · [Agra \(India\)](#) · [Mausoleo](#) · [Shah Jahan](#)

## People also ask

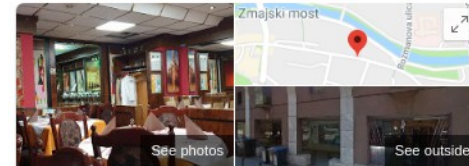
What is special about Taj Mahal?

What does Taj Mahal mean?

Why Taj Mahal was built?

Who is buried at the Taj Mahal?

[Feedback](#)



## Taj Mahal

[Website](#) [Directions](#) [Save](#)

4.0 ★★★★★ 230 Google reviews

€€ · Indian restaurant

**Address:** Poljanska cesta 14, 1000 Ljubljana, Slovenia

**Hours:** Open · Closes 10PM

**Reservations:** [tajmahal-ljubljana.com](#)

**Order:** [tajmahal-ljubljana.com](#)

**Phone:** +386 590 34390

[Suggest an edit](#) · [Own this business?](#)

**Know this place?** [Answer quick questions](#)

## Questions & answers

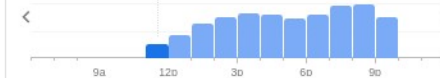
[See all questions \(3\)](#)

[Ask a question](#)

## Popular times

Tuesdays

11 AM: Usually not busy



## Plan your visit

People typically spend **45 min to 1.5 hr** here

[Send to your phone](#)

[Send](#)

# Costs & Benefits of Open Data

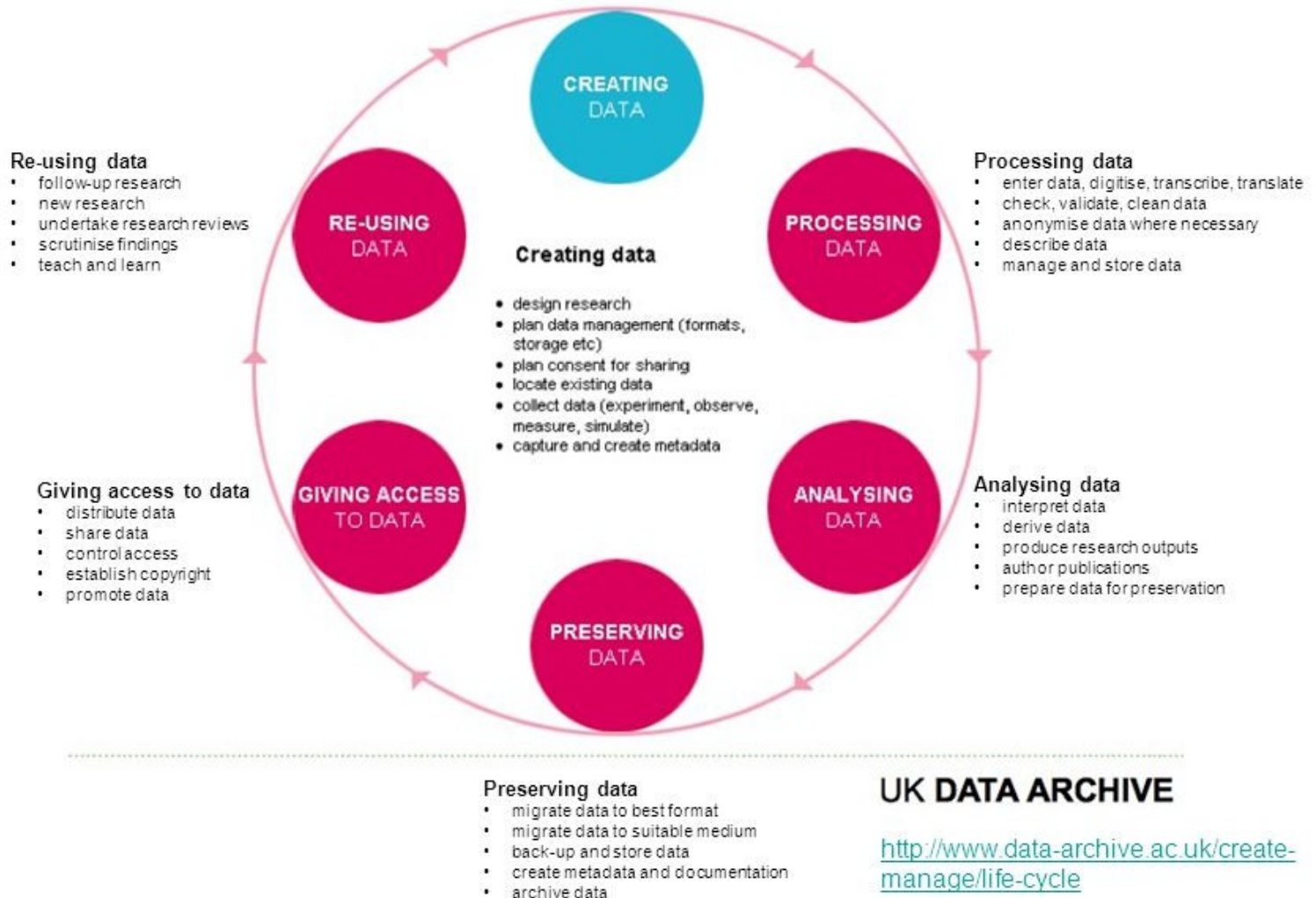


- As a consumer:
  - You can access, look, print, store locally, share data
  - You can process and manipulate the data in any way you like
  - You can link to it from any other place
  - You can combine the data safely with other data
  - You can discover more (related) data while consuming the data
- As a publisher:
  - You might need converters or plug-ins to export the data from the proprietary format
  - You'll need to assign URIs to data items and think about how to represent the data
  - You need to either find existing patterns to reuse or create your own
  - You'll need to invest resources to link your data to other data on the Web
  - You may need to repair broken or incorrect links

- Metadata are data that describe other data
- For example *author*, *date created* and *date modified* and *file size* are very basic document metadata
- Metadata are data themselves
- Metadata are essential for:
  - Data description
  - Data discovery
  - Data linking
- Metadata must store all information necessary to understand and use data

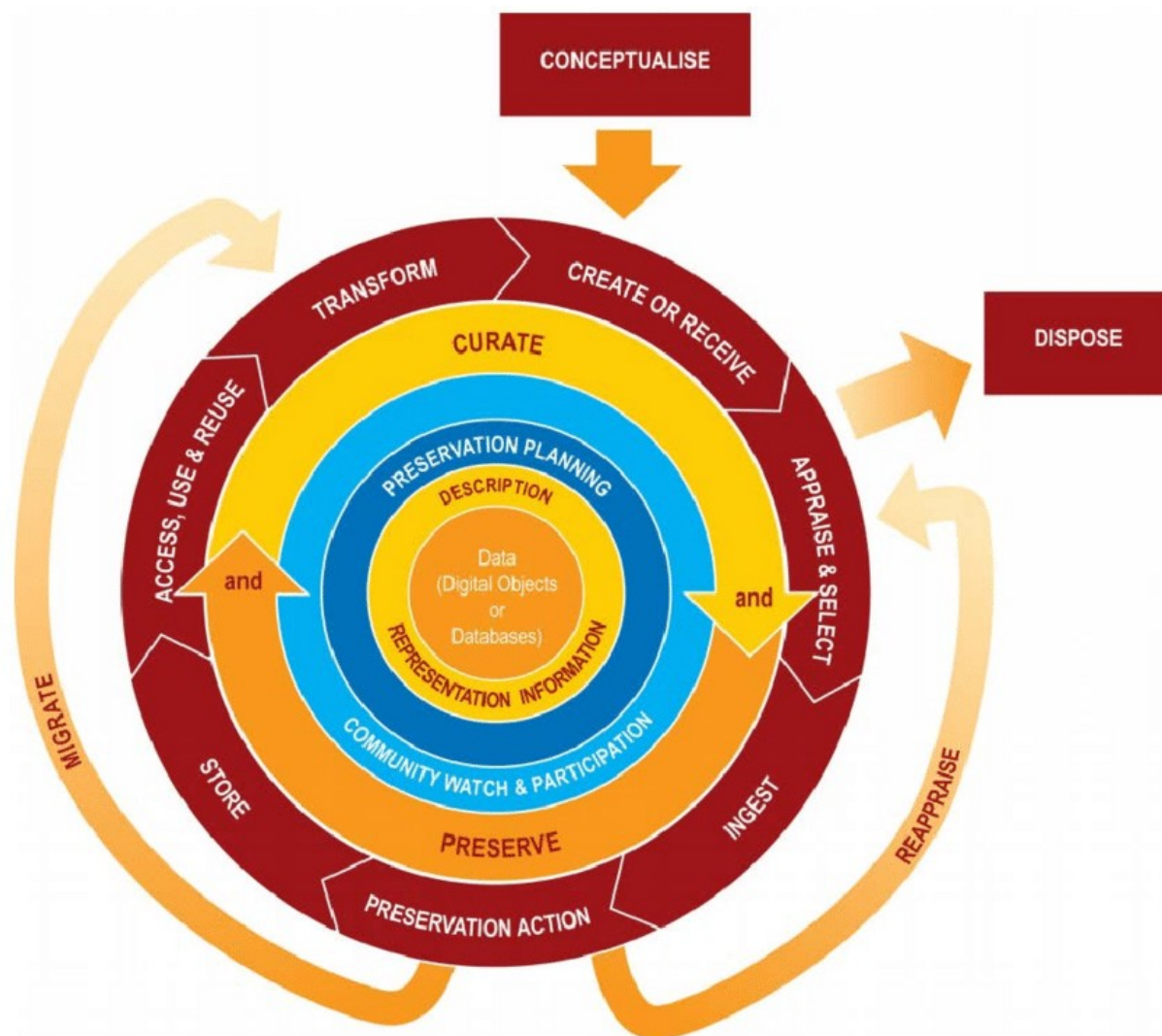
- Providing Open Data requires a careful consideration of Data Management issues along the full Data Life Cycle
- Data Life Cycle involves several steps: creation, ingestion, archive, analysis, publishing, reuse
- Metadata Model are adopted according to different communities and infrastructure requirements
- There are different Data Life Cycle Models, such as:
  - UK Data Archive
  - Digital Curation Centre
  - US Geological Survey
  - ...and many others

# Data Life Cycle – UK Data Archive

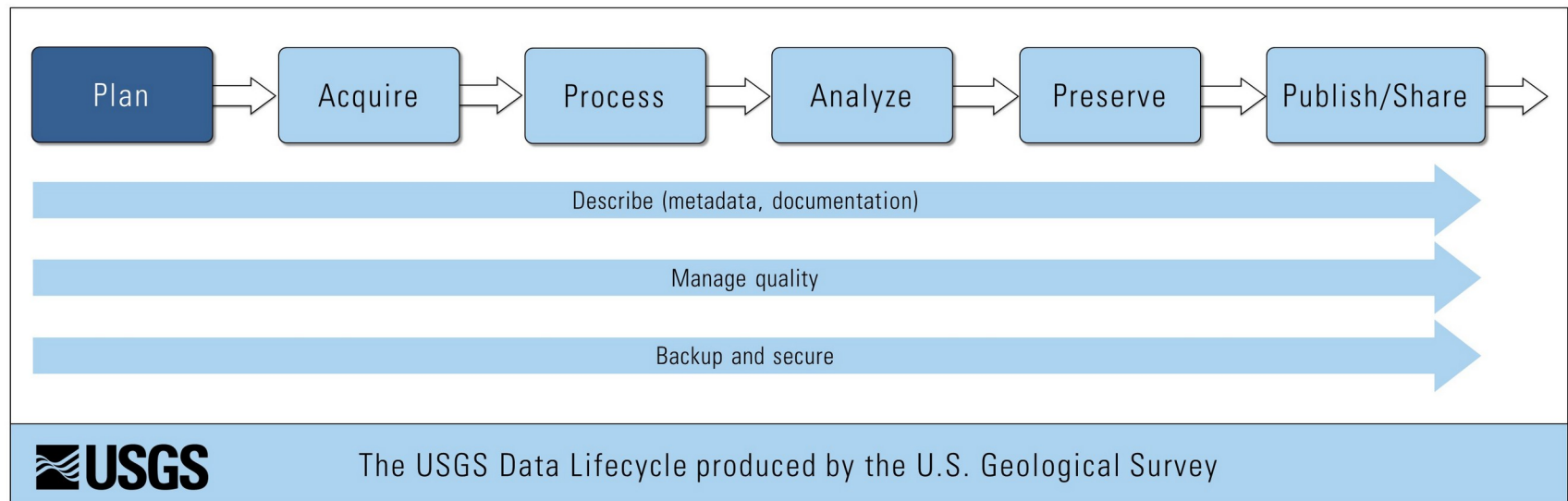




# Data Life Cycle – Digital Curation Centre



# Data Life Cycle – US Geological Survey

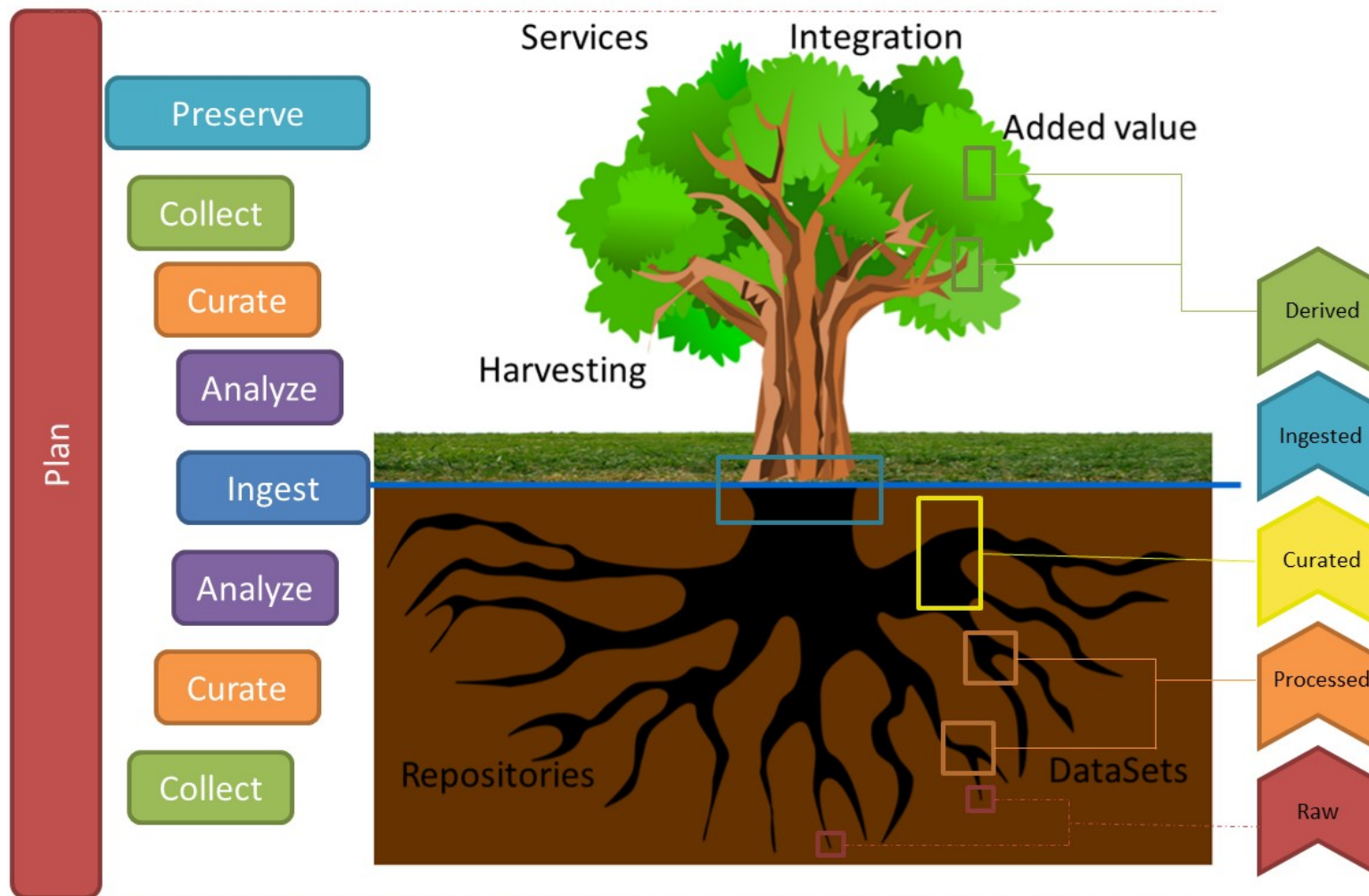


- INDIGO-DataCloud was an H2020 project aimed to develop an open source data and computing platform targeted at scientific communities, deployable on multiple hardware and provisioned over hybrid, private or public, e-infrastructures
- An unified view of the Data Life Cycle for all scientific communities is almost impossible given the high diversity in requirements, but INDIGO-DataCloud tried to define common practices to pave the way towards the European Open Science Cloud (EOSC)
- Six common stages (denominated 6S) in Data Life Cycle:
  - Stage 1 Plan: prepare a Data Management Plan (how gather data, metadata definition, preservation plan, etc.)
  - Stage 2 Collect: create and acquire raw data
  - Stage 3 Curate: perform actions on raw data to filter outliers, fix instrumental errors, and similar problems
  - Stage 4 Analyze: perform actions to give the data an added value and get new derived data
  - Stage 5 Ingest and Publish: associate data with metadata, assign persistent identifiers, publish in accessible repositories or catalogs
  - Stage 6 Preserve: store data, metadata and analysis for long-term



- Raw data: data taken by an instrument, sensor, human observation, etc. Instruments are usually considered to be calibrated before gathering data.
- Processed data: data is transformed in more useful units and some parameters (e.g. different sensors combination) are calculated.
- Curated data: data are filtered and all out-of-range data, human or instrument errors, outliers and other similar problems are corrected. Curation can be automatic or manual.
- Ingested data: datasets are prepared and transformed into a format suitable for distribution and re-use. A DOI (Digital Object Identifier) is assigned and proper metadata is associated to the dataset. The dataset can be published if desired, as it is also ready for external use
- Derived data: after applying an analysis method (model, simulation, statistical methods, etc.,) or integrating with other external or internal datasets, new derived data is generated, ready for publication, contributing to studies, or for further re-use. A new DOI and corresponding metadata may be assigned.

# INDIGO-DataCloud – Arbor Metaphor



# Flowers Metaphor



# References (1)



- World Wide Web Consortium <https://www.w3.org/>
- Open Society Foundations <https://www.opensocietyfoundations.org/>
- Open Knowledge International <https://okfn.org/>
- Research Data Alliance <https://www.rd-alliance.org/>
- Open Science as a Practice <http://openscienceasap.org/>
- The Open Definition <https://opendefinition.org/>
- Budapest Open Access Initiative <https://www.budapestopenaccessinitiative.org/>
- 5 ★ Open Data <https://5stardata.info/en/>
- Tim Berners-Lee: The next Web of open, linked data  
[https://www.youtube.com/watch?v=OM6XIICm\\_qo](https://www.youtube.com/watch?v=OM6XIICm_qo)
- Tim Berners-Lee: Open, Linked Data for a Global Community  
<https://www.youtube.com/watch?v=ga1aSjXCFe0>
- What is Linked Data? [https://www.youtube.com/watch?v=4x\\_xzT5eF5Q](https://www.youtube.com/watch?v=4x_xzT5eF5Q)

# References (2)



- Json <http://www.json.org/> and <http://json-ld.org>
- RDF <http://rdfa.info>
- DBpedia <https://wiki.dbpedia.org/>
- Google's Knowledge Graph <https://goo.gl/uu6bRM>
- UK Data Archive <http://www.data-archive.ac.uk>
- DCC Lifecycle Model  
<http://www.dcc.ac.uk/resources/curation-lifecycle-model>
- U.S. Geological Survey <https://www.usgs.gov/>
- INDIGO-DataCloud <https://www.indigo-datacloud.eu/>
- INDIGO-DataCloud Deliverables D2.7 and D2.11  
<https://www.indigo-datacloud.eu/documents-deliverables>