



Master in Planning and  
Management of Tourism Systems



# Internet of Things & Linked Open Data

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## INTRODUCTION

A more appropriate name for "Internet of Things" (IoT) is "Network of Things" or "Network of Objects"



## DEFINITION OF IOT

IoT is a network of physical objects with sensors, processors and/or software. Each object has a unique identifier

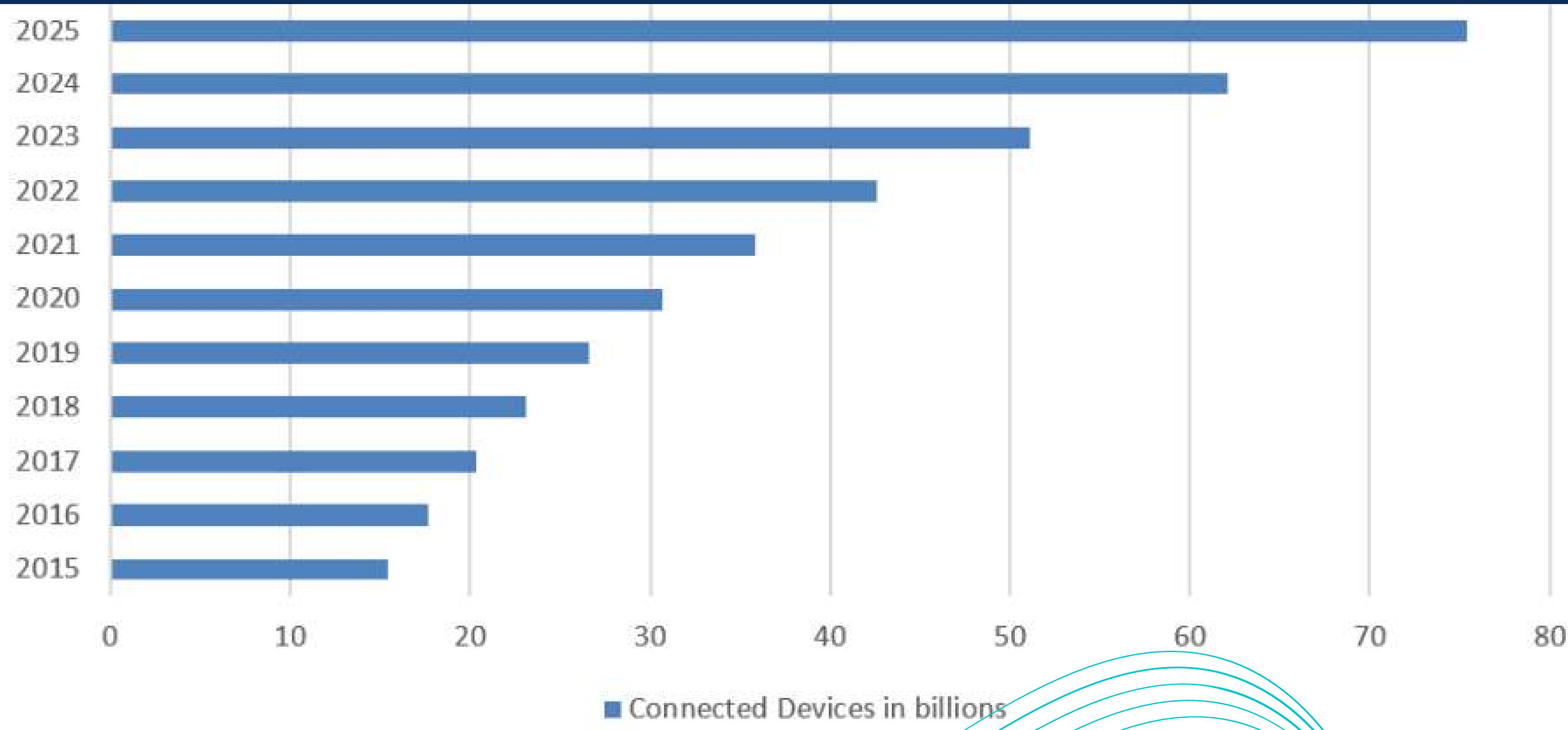


## DEFINITION OF IOT

They connect and exchange data between them, over the Internet or other networks



# NUMBER OF CONNECTED DEVICES



The number of connected devices is increasing exponentially

Source: Amit Verma et al. (2021) Convergence of IOT in Tourism Industry: A Pragmatic Analysis

# APPLICATIONS OF IOT

IoT is mainly used in the industry for monitoring industrial systems and equipment (e.g: predict when maintenance is needed, finding small items)

## APPLICATIONS OF IOT

IoT is also used in medicine, to monitor patients outside hospitals (e.g: elder people or chronicle diseases like diabetes)



# APPLICATIONS OF IOT

IoT combines with Artificial Intelligence to monitor the number of vehicles and change traffic lights accordingly to minimize congestions



# APPLICATIONS OF IOT

IoT can also be used to create apps with real-time maps of available parkings (smart parking)





And also to monitor and control lighting, heating, air conditioning, media systems and security systems (**Smart Homes**)

In many houses the reading of the electricity meter or the gas meter is already done from remote

Mesh systems bring wifi connection to every corner of the house



They are better than a simple wifi extender because they **communicate between them**, sharing the same network and passwords



5G wireless network was designed to connect a large number of IoT devices, even when they are on the move



5G should finally solve the issue of low or null downloading speeds when many tourists are in the same location





All benefits of Smart Homes are also available for Smart Hotels





- Switch off lights when no one is present in the room
- Open/close window curtains
- AI regulates temperature and it remembers guests' preferences
- TV welcomes guests with their own names. They can automatically access Netflix / Spotify with their own account
- Play your favourite music

Electronic key cards can be sent by the hotel on the guests' smartphones to open the room directly without wasting their time in the reception





- The hotel's app also allows the guests to make restaurant reservations, book spa appointments, and order additional activities within the hotel



The **voice assistant** of the hotel is installed on the room's speakers and it listen to guests' needs through **voice commands** and accomplish them instantly and quickly.

In **restaurants**, sensors can alert restaurant staff to the arrival of a customer and automatically provide the correct table number





**AirTag** is a small device connected to a smartphone that allows its owner to **locate important objects** (wallet, bag, keys, suitcase, backpack, car, etc.)



Airplanes could be equipped with sensors that capture and track passengers' body temperature, heart rate and anxiety level to offer help in case of emergency

A composite image with a blue and teal digital aesthetic. On the left, a white jet airplane is shown in flight. In the center, a large, glowing shield icon with a white checkmark is superimposed over the scene. On the right, a woman with dark hair, wearing a white blouse and a dark blazer, is seated at a desk, smiling as she works on a laptop. A white coffee cup on a saucer sits on the desk in front of her. The background is filled with abstract digital patterns, including a grid of small squares and glowing lines, suggesting a high-tech or data-driven environment.

Many flight companies are also introducing **free onboard wifi connection** thanks to satellite megaconstellations



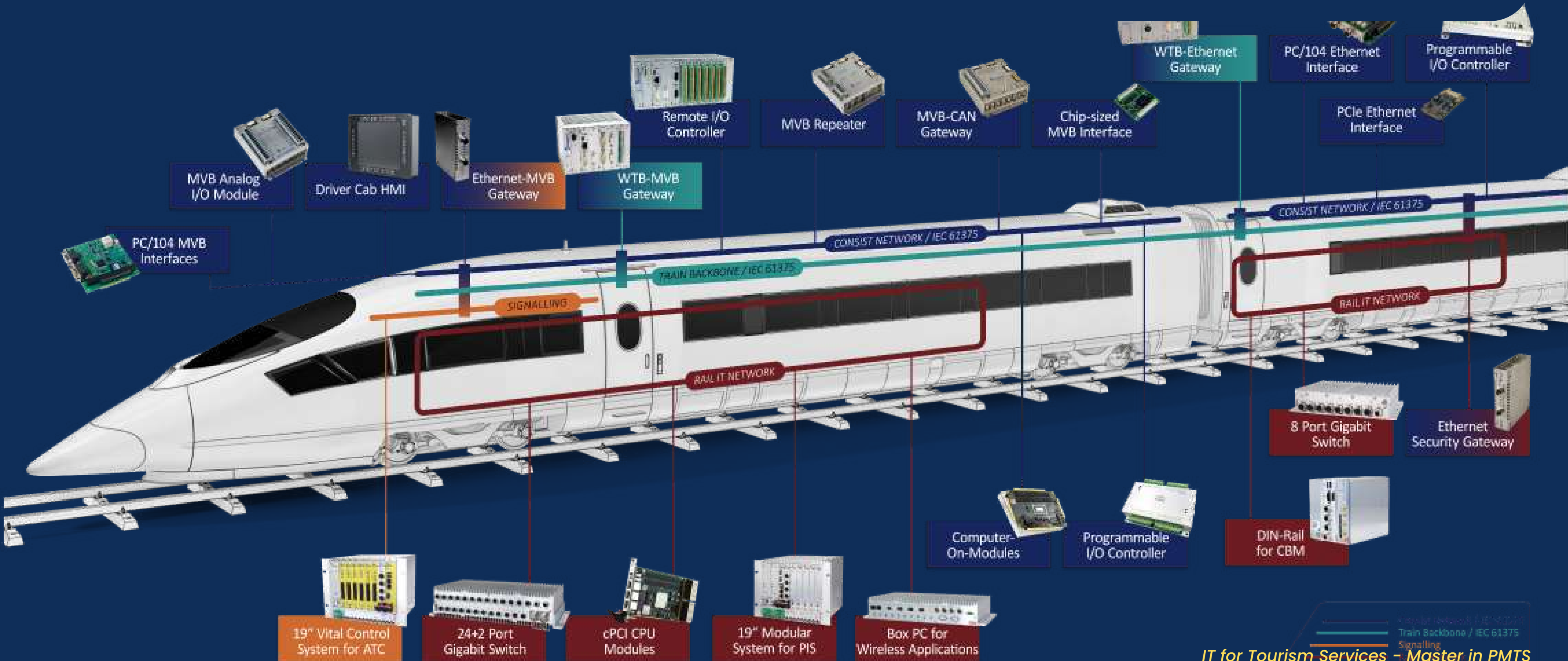
Starlink is a network of thousands of satellites in low-orbit that delivers ultra-broadband connection all over the world



Thanks to it, flight companies are removing the seatback screens on commercial flights, as many people already bring their own devices that connect to the plane's wifi



# Smart Trains collect data from thousands of sensors to control all the operations in an efficient and reliable way





Small devices called **beacons** that send to the smartphones of the tourists **specific information**, when they are close to a particular location.



Beacons need a **bluetooth** connection to work and can send messages to all users in a range of 60-100 m

Imagine you are doing shopping and you google the word "jacket" on your smartphone



The app checks if there are nearby **beacons** from shops that sell jackets. If yes, the app sends you a notification



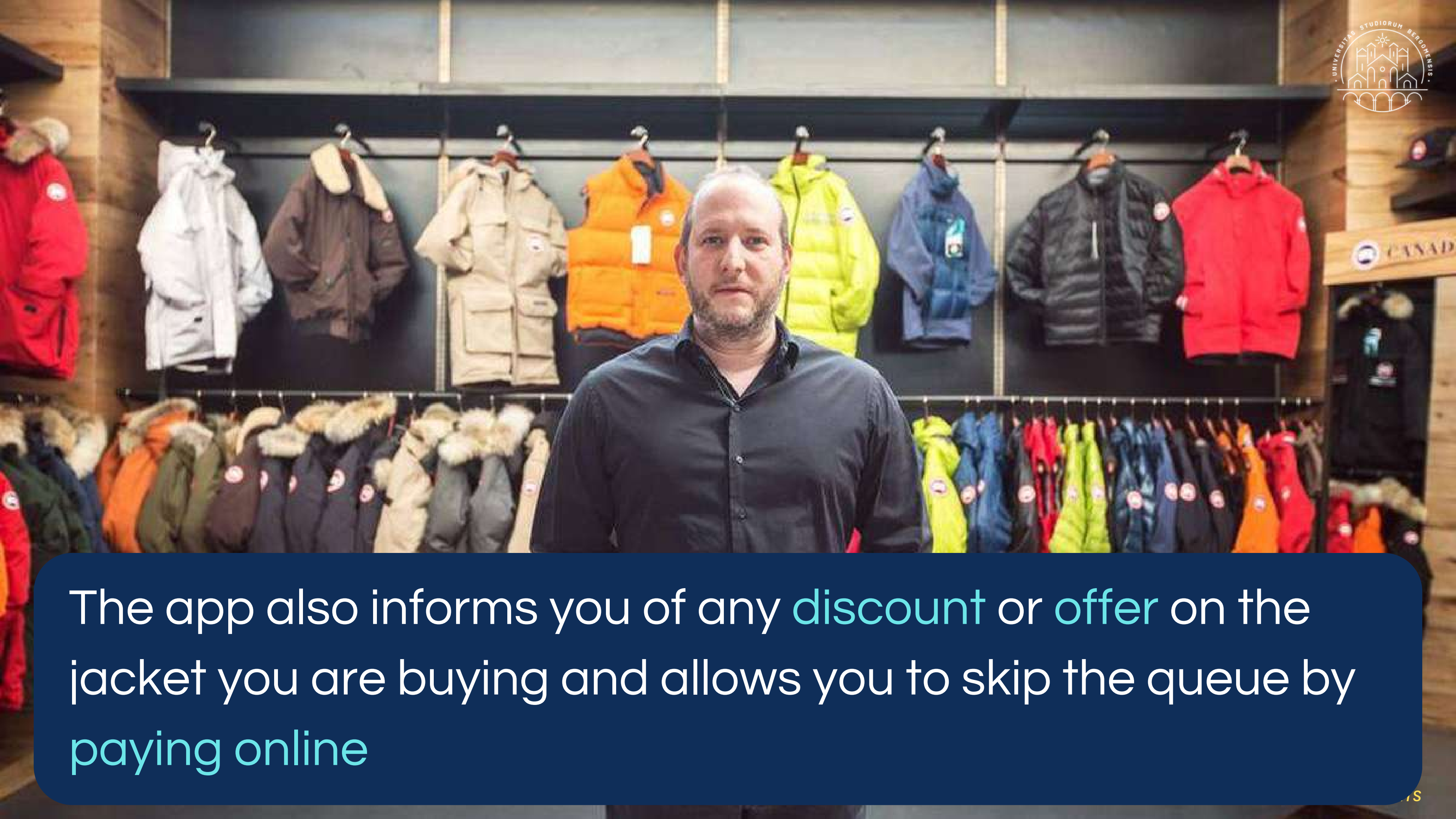
While you are guided to the shop by the app, it also **contacts the shop** to warn of your arrival and that you're looking for a jacket







When you arrive there, a shop employee is already waiting for you and ready to show you jackets of your size

A man with a beard, wearing a black button-down shirt, stands in the center of a clothing store. Behind him are several racks of jackets in various colors including white, brown, tan, orange, yellow, blue, black, and red. The store has a wooden interior. A dark blue rounded rectangle is overlaid at the bottom of the image, containing white and light blue text.

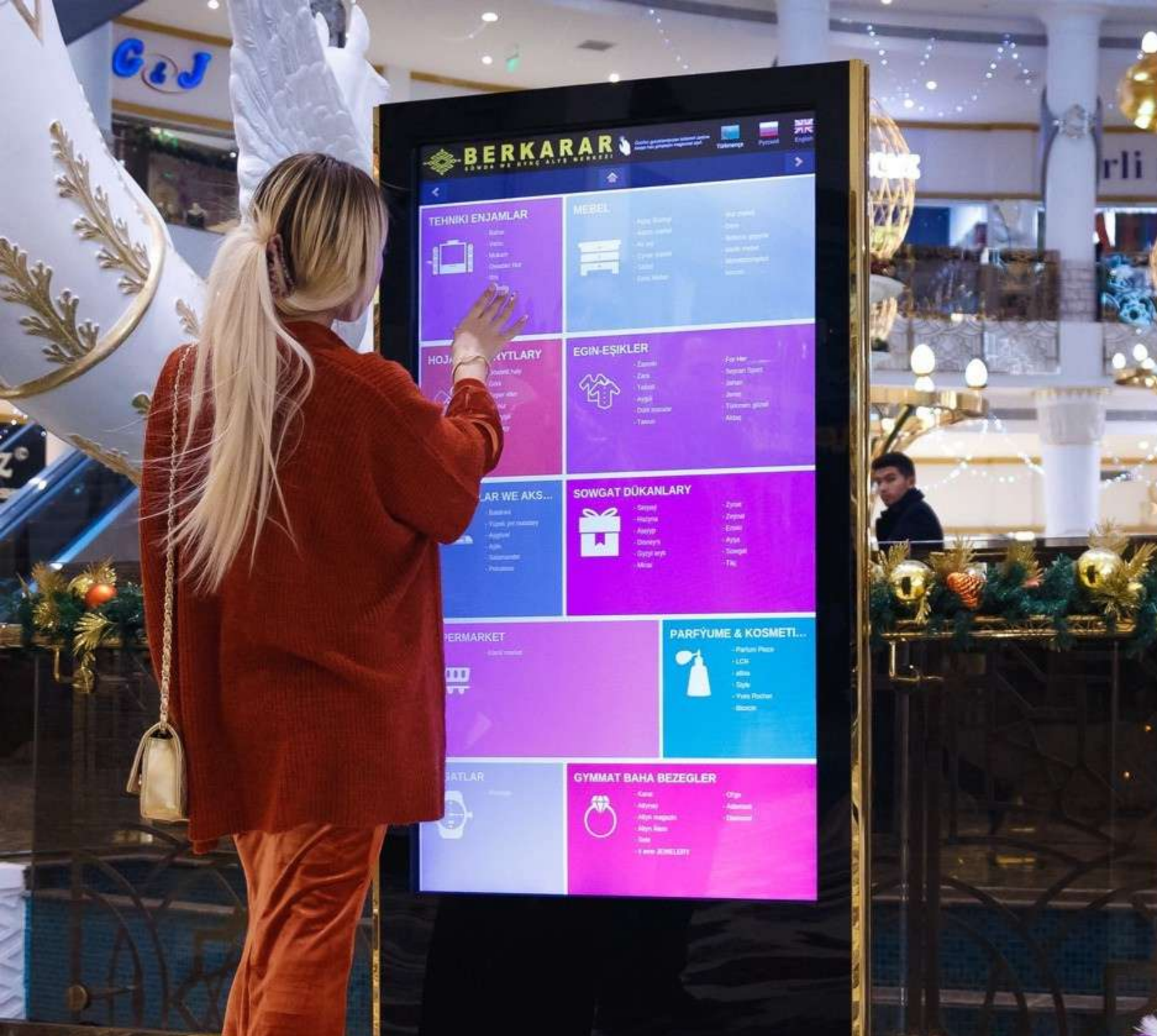
The app also informs you of any discount or offer on the jacket you are buying and allows you to skip the queue by paying online

A photograph of four students in a school setting. A boy on the left and a girl in the center are looking at their green smartphones. A girl to the right is looking at a green smartphone held by the girl in the center. A boy on the far right is looking at a blue smartphone. They are all wearing backpacks.

Beacons could also be used to **block Whatsapp and Instagram** use of students while at school and to detect if they are in class



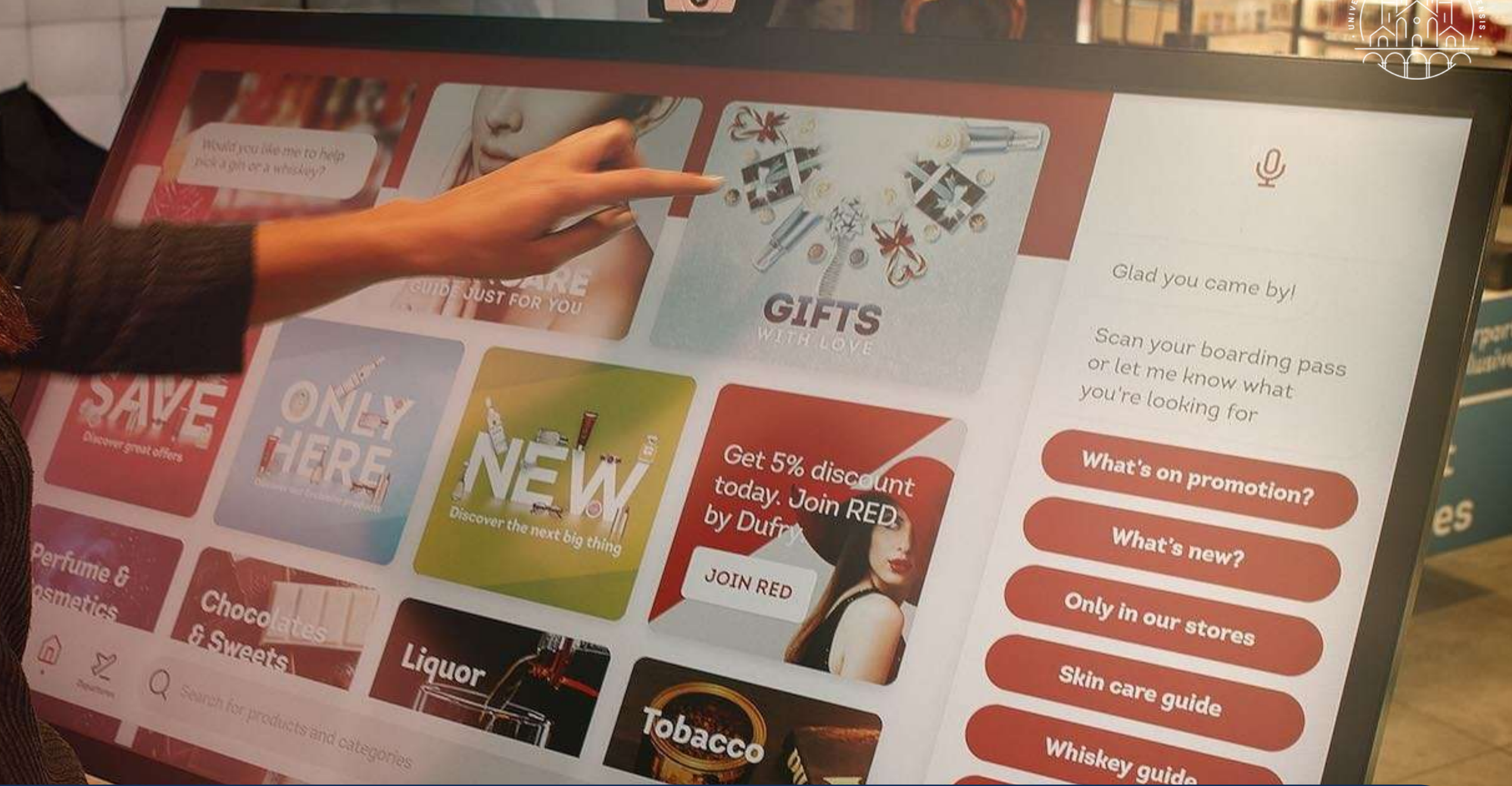
Beacons also tell you when a bus is arriving to your bus stop



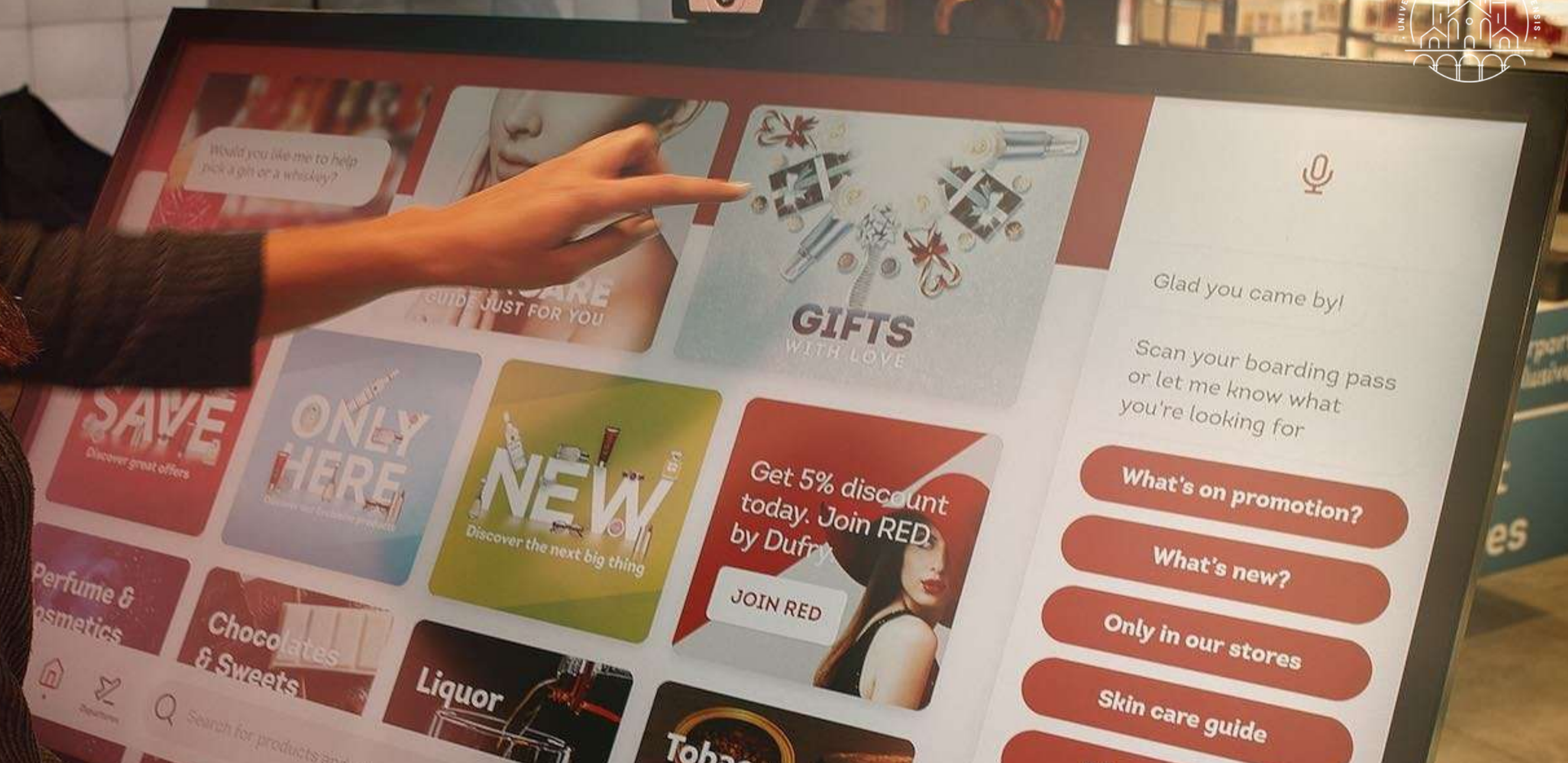
Digital kiosks or Totems are standalone screens that passersby or customers can interact with on the spot



Totems allow customers to complete purchases, to guests to check in by themselves, or enable visitors to look up answers to their questions on their own



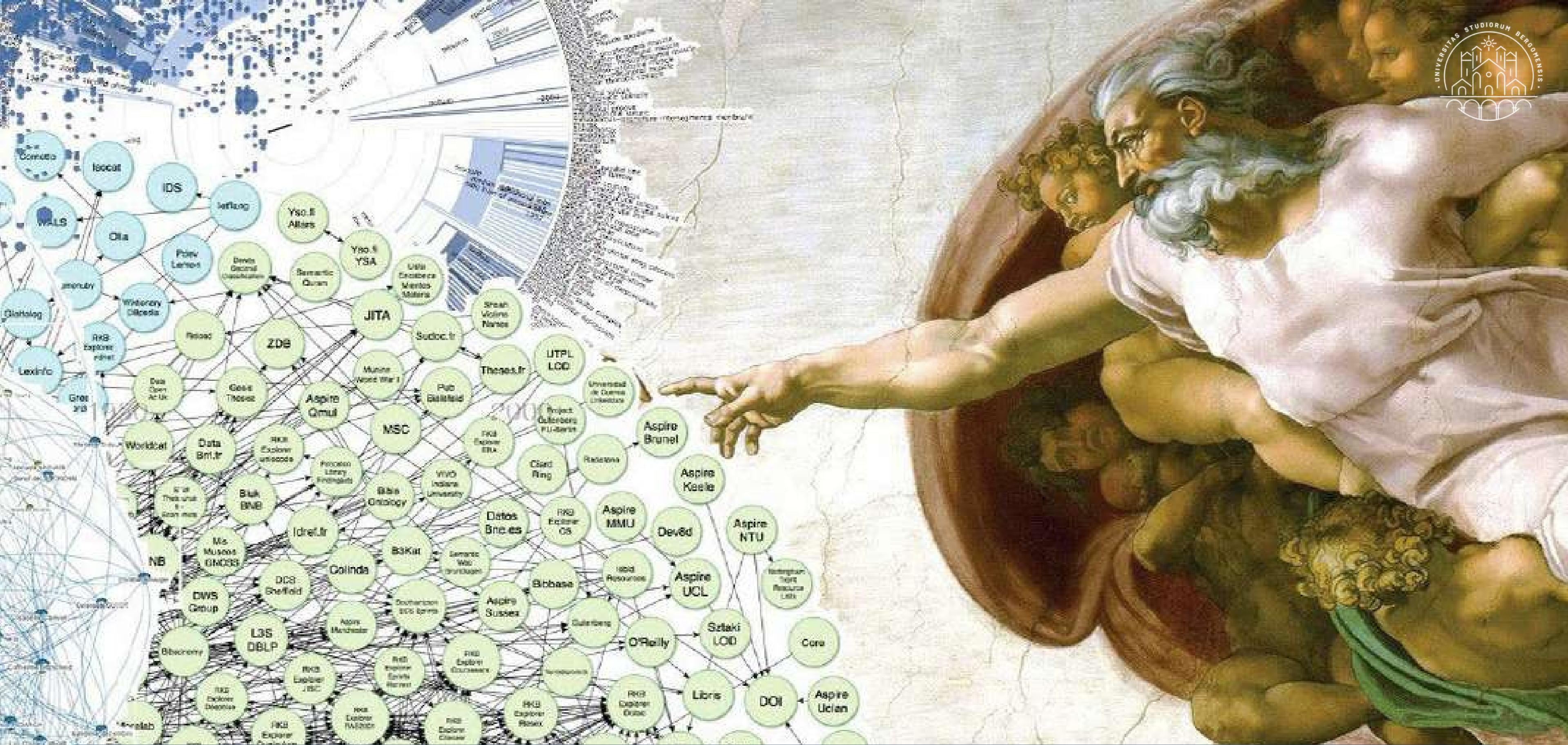
They automate many mundane tasks that your staff don't really need to be spending any more efforts



This allow to schedule fewer employees per shift, thereby reducing the operating costs. Clients don't have to wait in line to speak with an employee when they have a question



Big data is usually generated by all the sensors of IoT. Big data is then used for Artificial Intelligence, Smart Destinations, Smart Cities, etc. So IoT is the main technology behind all these innovations



# Linked Open Data



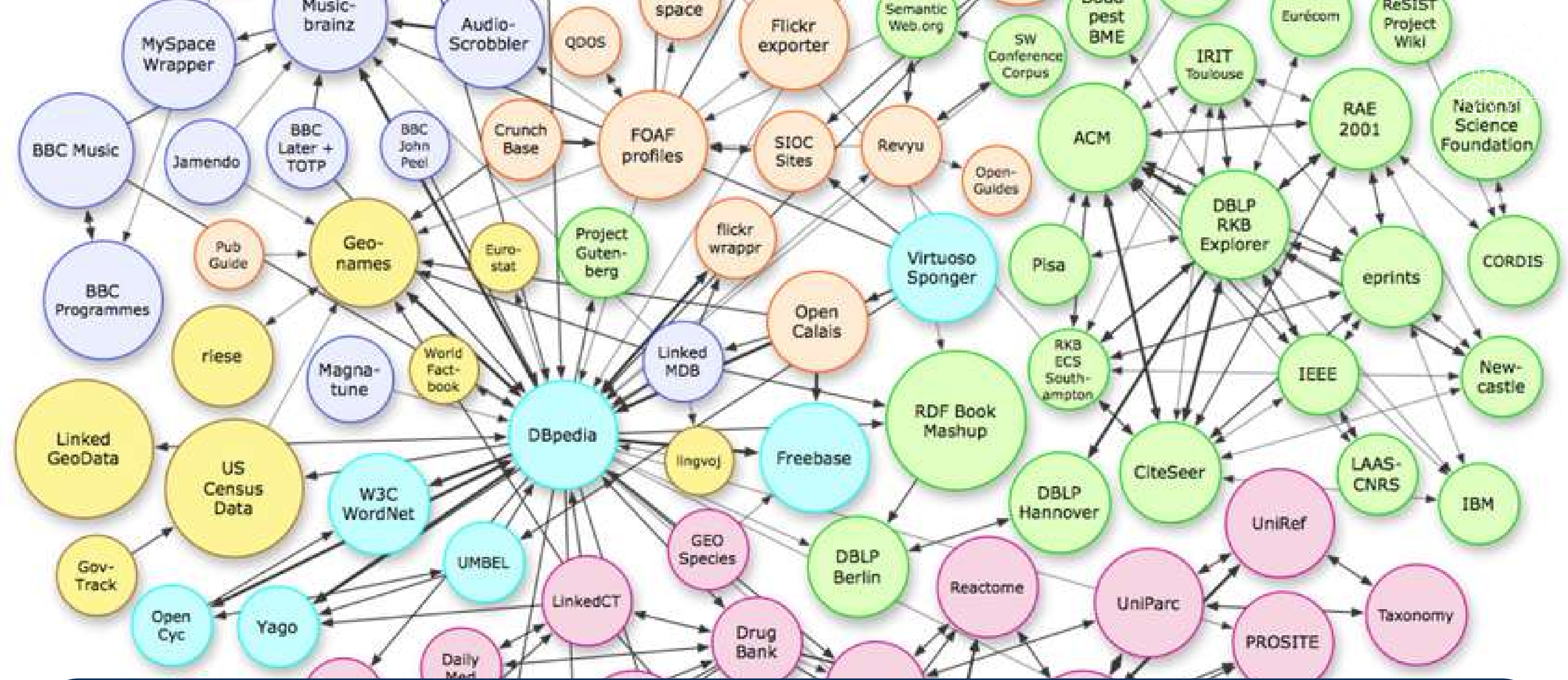
To find the answer to many questions of our times we don't need new discoveries or new instruments, but only to exploit the data we already have

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      </linearGradient>
    </defs>
  </svg>
</div>
```

At present most of the data in the Web is not really in form of data, but in form of **hypertext** of images or video



Hypertexts are only useful to read them or to follow their links, while with dataset computers can do much more things



Open Linked Data is just another Web made up by linking datasets between them instead of hypertext, a dataset made up by pages that are not read by humans but by computers

How many tourists visited Bergamo in may 2017 and visited Brescia i



Tutti Notizie Immagini Maps Video Altro Strumenti

Circa 89.200 risultati (0.50 secondi)

[https://en.wikipedia.org/wiki/Tourism\\_in\\_Italy](https://en.wikipedia.org/wiki/Tourism_in_Italy)

### Tourism in Italy - Wikipedia

Rome is the 3rd most visited city in Europe and the 12th in the world, with 9.4 million arrivals in 2017 while Milan is the 27th worldwide with 6.8 million ...

<https://heretotravel.com/bergamo> · Traduci questa pagina

### Bergamo, Italy: 6 Reasons Why You Should Visit

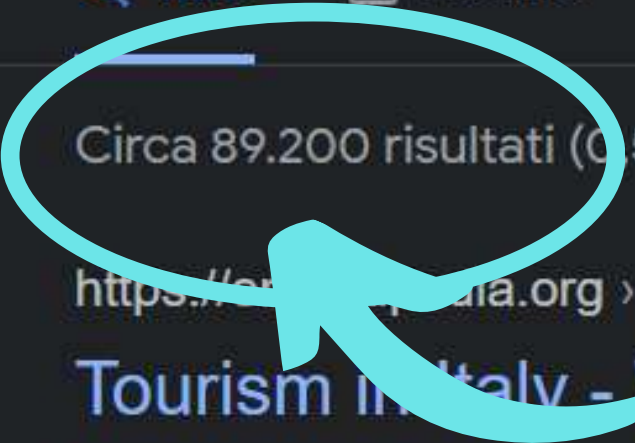
If you're visiting Milan and the wider Lombardy region, you should also visit Bergamo. Here are six reasons why Bergamo is such a great city to visit

E.g: googling "How many tourists visited Bergamo in may 2017 and also visited Brescia in 2018?", this search provides 89.200 answers but no one is right



How many tourists visited Bergamo in may 2017 and visited Brescia i

Tutti Notizie Immagini Maps Video Altro Strumenti



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If Google were searching inside Linked Open Data instead, the exact answer would have been found immediatly because it'd have found the datasete with the relevant information by performing a semantic query





Date of birth: April 15, 1452  
Date of death: May 2, 1519  
(age 67 years)



That's why the Web of Linked Open Datasets is also called **Semantic Web** (definition by Tim Berners-Lee)



# World Wide Web

The WorldWideWeb (W3) is a wide-area hypermedia information retrieval initiative aiming to give universal access to a large univers

Everything there is online about W3 is linked directly or indirectly to this document, including an executive summary of the project, M

## What's out there?

Pointers to the world's online information, subjects , W3 servers, etc.

## Help

on the browser you are using

## Software Products

A list of W3 project components and their current state. (e.g. Line Mode ,X11 Viola , NeXTStep , Servers , Tools , Mail robot ,

## Technical

Details of protocols, formats, program internals etc

## Bibliography

Paper documentation on W3 and references.

## People

A list of some people involved in the project.

## History



The first web page

H  
G

He is the english informatic that invented both the **World Wide Web** in 1991 and the **Semantic Web** in 2001



He also gave a good speech at **TED Talk**, like this one of the Semantic Web:

[https://www.youtube.com/watch?v=OM6XIIcm\\_qo&t=322s](https://www.youtube.com/watch?v=OM6XIIcm_qo&t=322s)

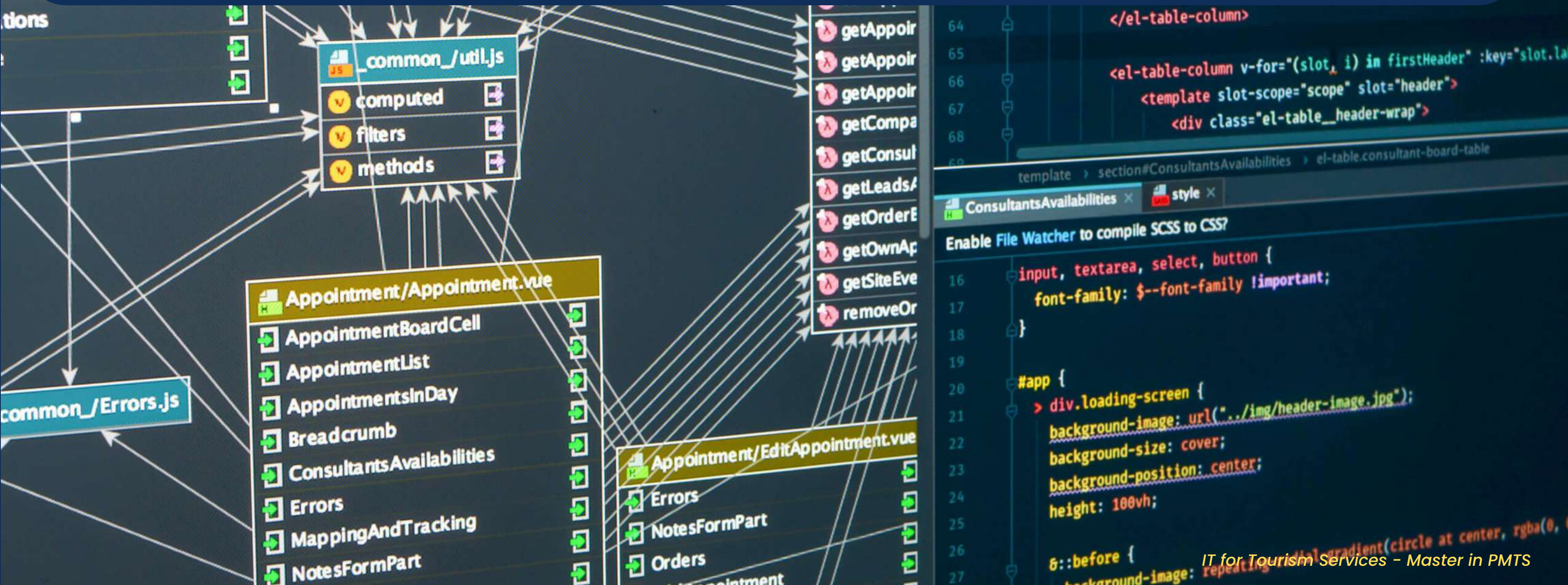


If data are also licensed under an **open license**, then they are called **Linked Open Data**

Most of human knowledge is now in the form of databases stored in private computers and servers that are not shared with the rest of the world

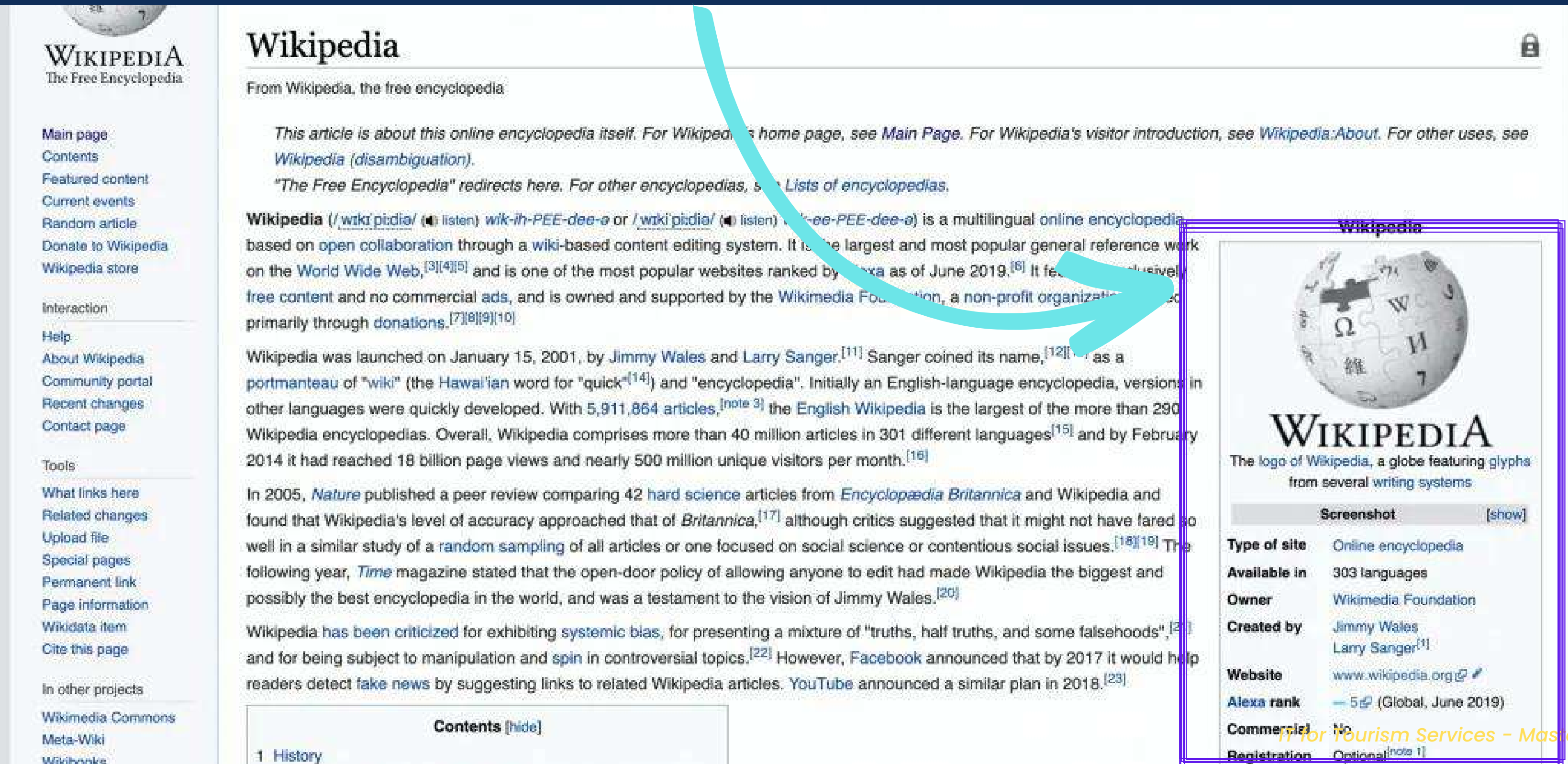


You have no idea of the number of excuses people come up with to hang on to their data and not giving it to you even if you paid for it with your taxes



The more data are connected between them, the more powerful they become. It doesn't happen with hypertext

E.g: all the info boxes at the right side of the Wiki pages now form a Linked Open Data called DBpedia



**Wikipedia**

From Wikipedia, the free encyclopedia

*This article is about this online encyclopedia itself. For Wikipedia's home page, see Main Page. For Wikipedia's visitor introduction, see Wikipedia:About. For other uses, see Wikipedia (disambiguation).*

*"The Free Encyclopedia" redirects here. For other encyclopedias, see Lists of encyclopedias.*

**Wikipedia** (/ˈwɪkiˈpiːdiə/ ( listen) *wik-ih-PEE-dee-ə* or /ˈwɪkiˈpiːdiə/ ( listen) *wik-ee-PEE-dee-ə*) is a multilingual online encyclopedia based on open collaboration through a wiki-based content editing system. It is the largest and most popular general reference work on the World Wide Web,<sup>[3][4][5]</sup> and is one of the most popular websites ranked by Alexa as of June 2019.<sup>[6]</sup> It features exclusively free content and no commercial ads, and is owned and supported by the Wikimedia Foundation, a non-profit organization funded primarily through donations.<sup>[7][8][9][10]</sup>

Wikipedia was launched on January 15, 2001, by Jimmy Wales and Larry Sanger.<sup>[11]</sup> Sanger coined its name,<sup>[12]</sup> as a portmanteau of "wiki" (the Hawai'ian word for "quick"<sup>[14]</sup>) and "encyclopedia". Initially an English-language encyclopedia, versions in other languages were quickly developed. With 5,911,864 articles,<sup>[note 3]</sup> the English Wikipedia is the largest of the more than 290 Wikipedia encyclopedias. Overall, Wikipedia comprises more than 40 million articles in 301 different languages<sup>[15]</sup> and by February 2014 it had reached 18 billion page views and nearly 500 million unique visitors per month.<sup>[16]</sup>

In 2005, *Nature* published a peer review comparing 42 hard science articles from *Encyclopædia Britannica* and Wikipedia and found that Wikipedia's level of accuracy approached that of *Britannica*,<sup>[17]</sup> although critics suggested that it might not have fared so well in a similar study of a random sampling of all articles or one focused on social science or contentious social issues.<sup>[18][19]</sup> The following year, *Time* magazine stated that the open-door policy of allowing anyone to edit had made Wikipedia the biggest and possibly the best encyclopedia in the world, and was a testament to the vision of Jimmy Wales.<sup>[20]</sup>

Wikipedia has been criticized for exhibiting systemic bias, for presenting a mixture of "truths, half truths, and some falsehoods",<sup>[21]</sup> and for being subject to manipulation and spin in controversial topics.<sup>[22]</sup> However, Facebook announced that by 2017 it would help readers detect fake news by suggesting links to related Wikipedia articles. YouTube announced a similar plan in 2018.<sup>[23]</sup>

**Contents** [hide]

1 History

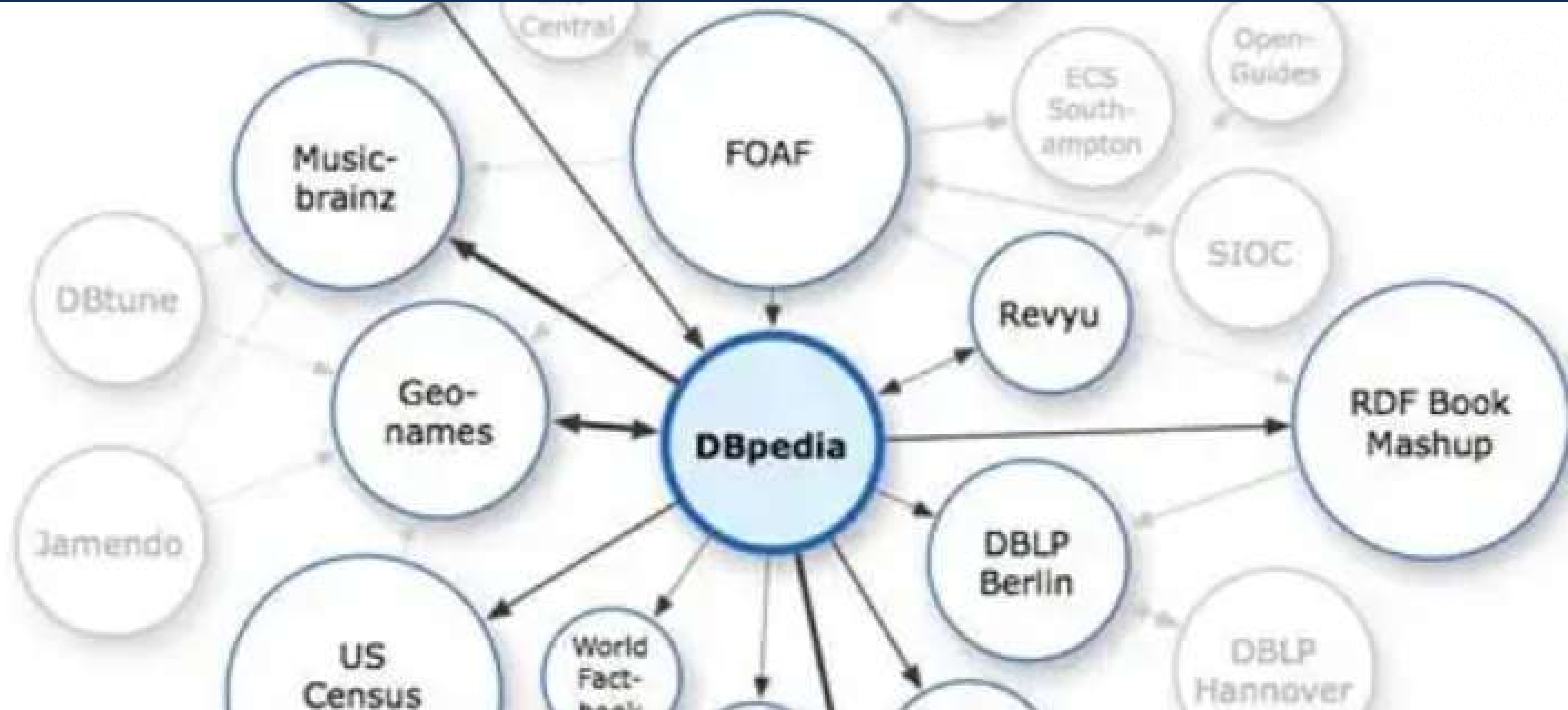
**Wikipedia**

The logo of Wikipedia, a globe featuring glyphs from several writing systems

**Screenshot** [show]

<b>Type of site</b>	Online encyclopedia
<b>Available in</b>	303 languages
<b>Owner</b>	Wikimedia Foundation
<b>Created by</b>	Jimmy Wales Larry Sanger <sup>[1]</sup>
<b>Website</b>	<span>www.wikipedia.org</span> <span><span></span></span> <span><span></span></span>
<b>Alexa rank</b>	<span>—</span> 5 <span><span></span></span> (Global, June 2019)
<b>Commercial</b>	No
<b>Registration</b>	Optional <sup>[note 1]</sup>





It was born in 2007 when only a few others Linked Open Data were available:





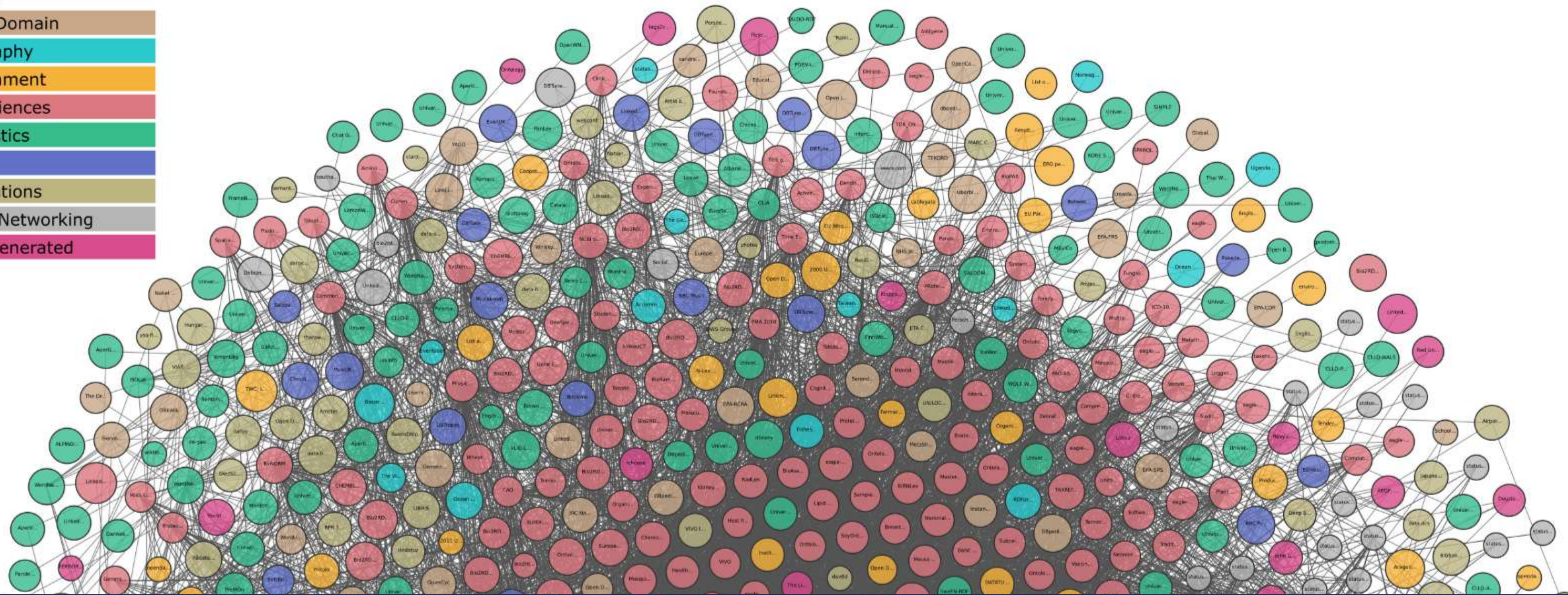
Unfortunately, most of the **tourism data** are still closed and with **few Linked Open Datasets** available

# The Linked Open Data Cloud



## Legend

Cross Domain
Geography
Government
Life Sciences
Linguistics
Media
Publications
Social Networking
User Generated



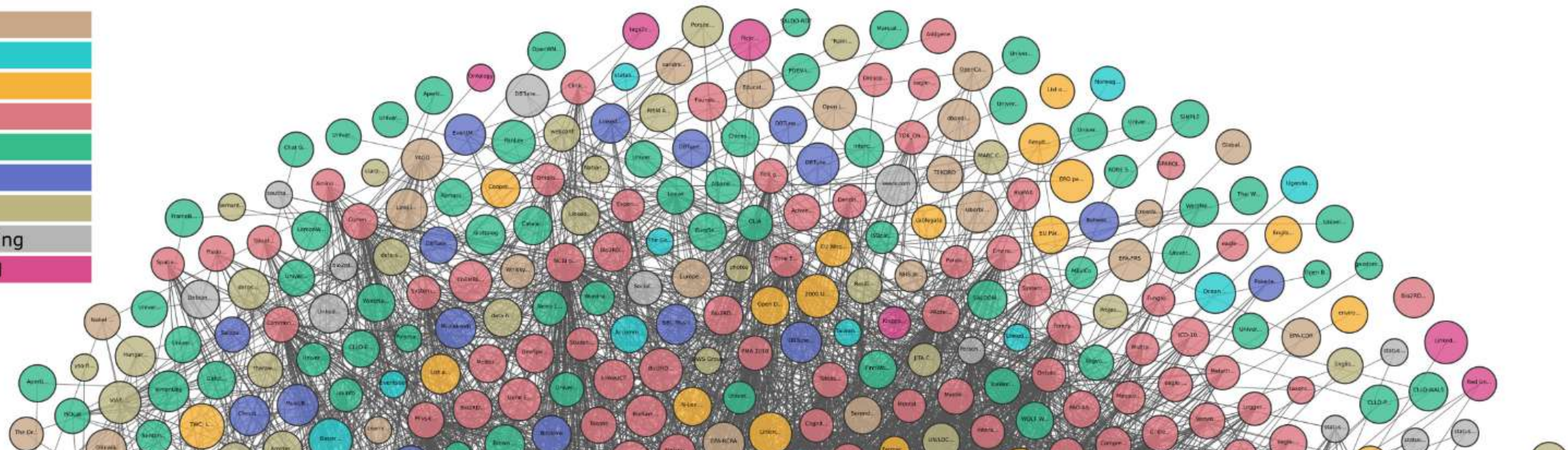
The types of Linked Opened Datasets available at present are mainly geographical, scientific and administrative

# The Linked Open Data Cloud



## Legend

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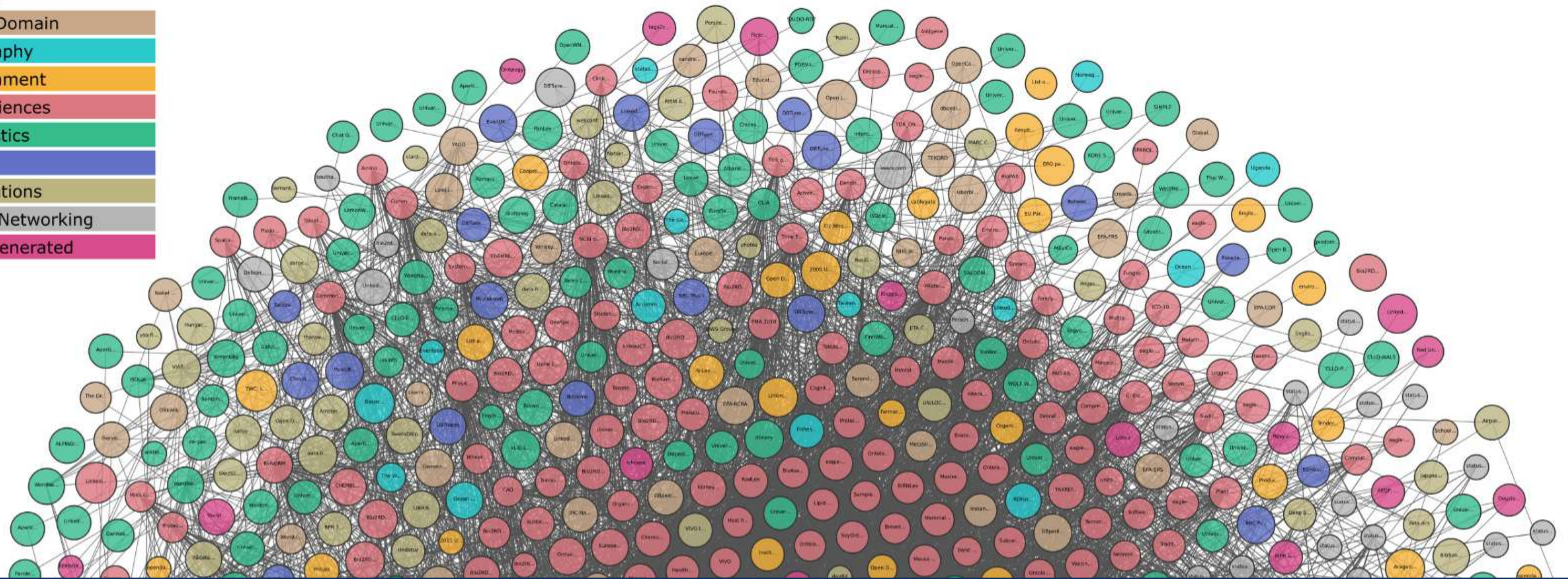
If many tourism datasets were available, we could get answers to important questions like: "Does the war in Ukraine influence the travelling behaviour of German tourists within Europe?"

# The Linked Open Data Cloud



## Legend

Cross Domain
Geography
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Life Sciences
Linguistics
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User Generated



Or even: "Do mass-tourism arrivals to Spain impact the environment of the host country?"

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- ▶ Guestbook
- ▶ Related links
- ▶ **Login**
- ▶ Imprint
  
- ▶ TourMIS white paper
- ▶ TourMIS Manual
- ▶ Eurocity Manual
- ▶ Definitions in city tourism
- ▶ Excel form for ETC
- ▶ Excel form for CityDNA
  
- ▶ Next TourMIS Workshop
- ▶ CityDNA Benchmarking R.
- ▶ TourMIS Charts API

### **Welcome to TourMIS!**

TourMIS is a **Marketing-Information-System for tourism managers**. The major aim of TourMIS is to provide information and decision support for tourism managers and scholars. TourMIS provides on-line tourism survey data, as well as various tools to transform data into precious management information.

Since 2000 this initiative has provided the tourism industry with predominantly **free** access to overall data and functions of TourMIS (registration is required).

TourMIS is open to all authorized tourism organizations, societies, tourism consultants, companies, tourism training centres, pressure groups, etc. in Austria and abroad. By covering maintenance costs, a **consortium** of the most important initiators of market research projects in Austria and Europe guarantee the continuous updating of the comprehensive data.

The programme modules contained in the method-base are developed according to the specific requirements of tourism managers at the Department of Tourism and Service Marketing at **University Vienna** led by Prof. Dr. Karl Wöber.

The development of TourMIS is financially supported by the **Austrian National Tourist Office** and the **European Travel Commission**.

### **Technical Components**

Data in TourMIS is maintained in form of a relational database. Inserting and maintaining data is done by means of a web-based user interface. All pages in TourMIS are generated dynamically. TourMIS is located on a virtual server and managed by a team of tourism research experts at Modul University Vienna (1190 Vienna, Am Kahlenberg 1, Austria, Europe).

### **Software**

TourMIS has been developed with various software products:

Database server: MS SQL Server

Web server: MS Internet Information Server

Application: **Strawberry Perl**.

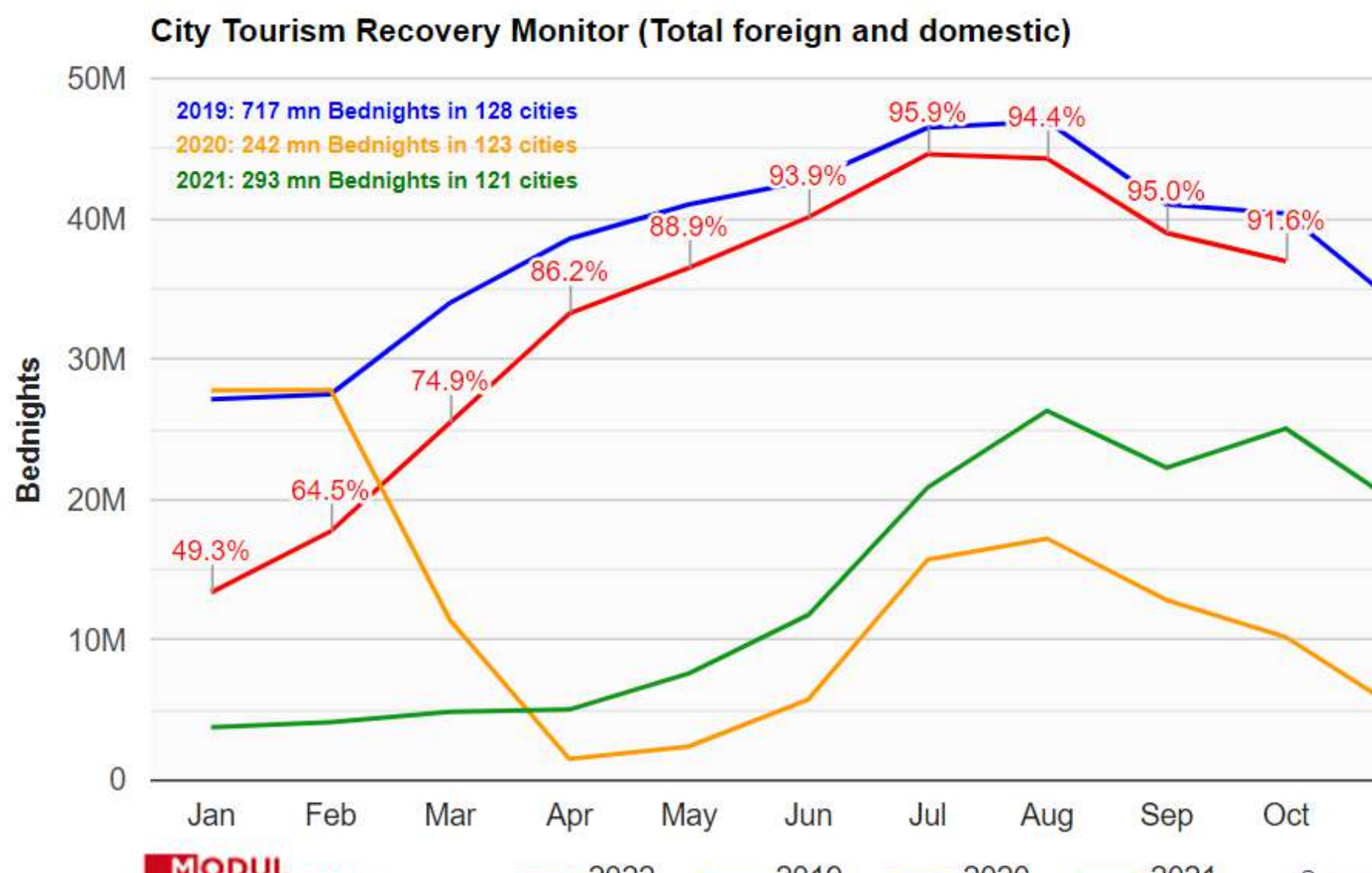
The first Linked Open Dataset for **Tourism** was created in 2003 by the **Austrian Tourist Office** and it is called **TourMIS**

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European Countries			
Trends in Important Markets January - September 2022			
Market	Arrivals (1)	Bednights (1)	(2)
Austria	126.7	131.1	13/16
Canada	503.6	426.7	13/15
Switzerland	131.5	144.4	14/18
China	307.3	255.1	12/15
Germany	119.5	110.5	14/18
Denmark	183.7	193.6	14/17
Spain	184.0	178.4	14/18
France	136.9	162.5	14/18
India	493.3	306.9	11/14
Italy	171.7	143.1	14/18
Japan	316.9	296.9	12/15
Netherlands	135.5	161.9	14/18
Norway	458.1	432.2	13/16
Poland	116.2	96.6	13/15
Sweden	255.6	242.8	14/16
Russia	141.4	122.2	12/16
United Kingdom	513.0	449.3	14/18
United States	312.1	274.6	13/16
Australia	1043.2	1058.3	13/16
Brazil	557.7	441.7	12/14

Trends in Total Europe January - September 2022			
Market: Total foreign			
Arrivals	120.5	862008	118.4
Bednights	118.4	118.4	118.4



It includes data from over 100 European cities. Its dataset consists of bednights spent at a destination, arrivals at accommodations, capacity and occupancy rates

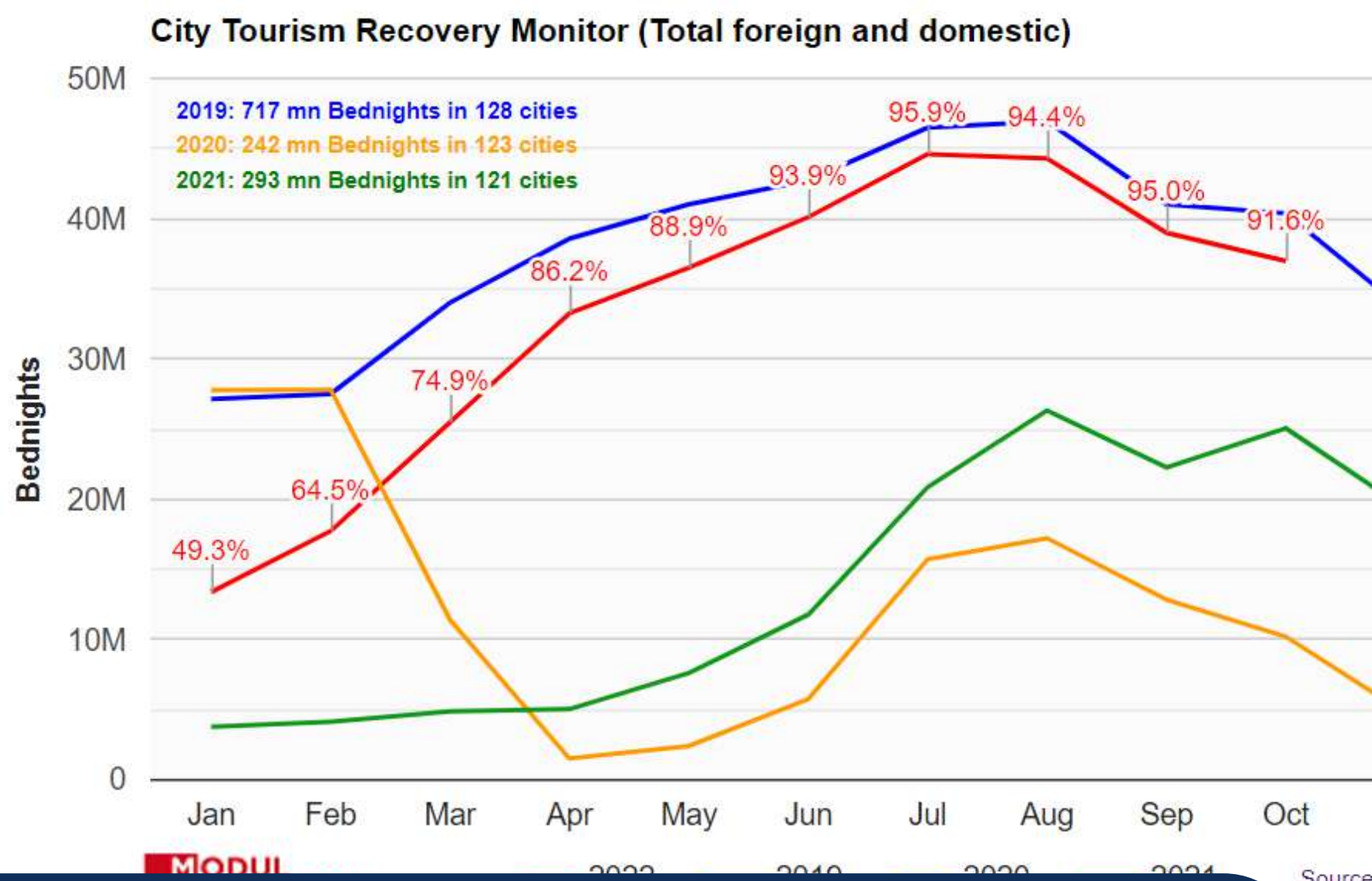


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Trends in Total Europe January - September 2022			
Market: Total foreign			



TourMIS was linked to other Linked Open Datasets on economy and sustainability, creating the first online tourism decision support system to answer more complex questions



Best results are obtained combining Linked Open Data with Blockchain, to form a decentralized semantic web that is able to detect hidden relationships across all the open datasets of the world


You may be able to ask: "Siri, please find where it's better to **open a restaurant** in Lombardy". "Alexa, I'd like to go to Paris one week but I'm **on a budget**. Could you try to book an accommodation for less than 500 euro and it is in the **view of Tour Eiffel**?"




If this IT exists and it is mature enough to use, why it is not mainstream yet?

The background of the slide is a world map with glowing blue nodes and connecting lines, symbolizing global connectivity and the internet. The map is centered on the Atlantic Ocean, with North and South America on the left and Europe, Africa, and Asia on the right. The nodes are bright blue dots, and the lines are thin, glowing white arcs that connect the nodes across the globe.

Also the first million web pages were published with considerable effort, and the benefits were close to zero

The background of the slide is a world map with glowing blue nodes and connecting lines, symbolizing global connectivity and technology. The map is centered on the Atlantic Ocean, with North and South America on the left and Europe, Africa, and Asia on the right. The nodes are bright blue dots, and the lines are thin, white, curved paths connecting them across the globe.

Only when the tools improved, time and costs went down.  
Web content platform like WordPress and Social Media  
reduced the costs to publish to zero

The background of the slide is a world map with a blue and white color scheme. The map is overlaid with a network of glowing blue lines and dots, representing data connections or a global network. The lines are curved and connect various points across the globe, suggesting a complex, interconnected system.

Linked Data is at a similar inflection point. A new set of tools is emerging to publish a Linked Open Dataset without having to become an expert

## SEMANTIC WEB

Tools for publishing Linked Open Datasets are on their way. Web searches are done in a language called **SPARQL**, that is very close to SQL





## IMPACT ON TOURISM



The impact of Linked Open Data on Tourism is still limited, but in the near future may become as useful as the introduction of the google search engine in 1996

## BIBLIOGRAPHY

In the Moodle there are two articles:

- Amin Verma et al. (2021) Convergence of IOT in Tourism Industry: a Pragmatical Analysis
- Azar et al (2016) Linked Open Data Search Engine

And the link to the speech of Tim Berners-Lee on the **Semantic Web**:

- [https://www.youtube.com/watch?v=OM6XIIcm\\_qo&t=322s](https://www.youtube.com/watch?v=OM6XIIcm_qo&t=322s)