

# **Web Semântica e Processamento de Linguagem Natural na prática**

**Newton Calegari**



**PUC-SP**

# **Web Semântica e contexto**

Os fundamentos da Web Semântica

A pilha tecnológica da Web Semântica

Ontologias e Vocabulários

Estado da arte e exemplos

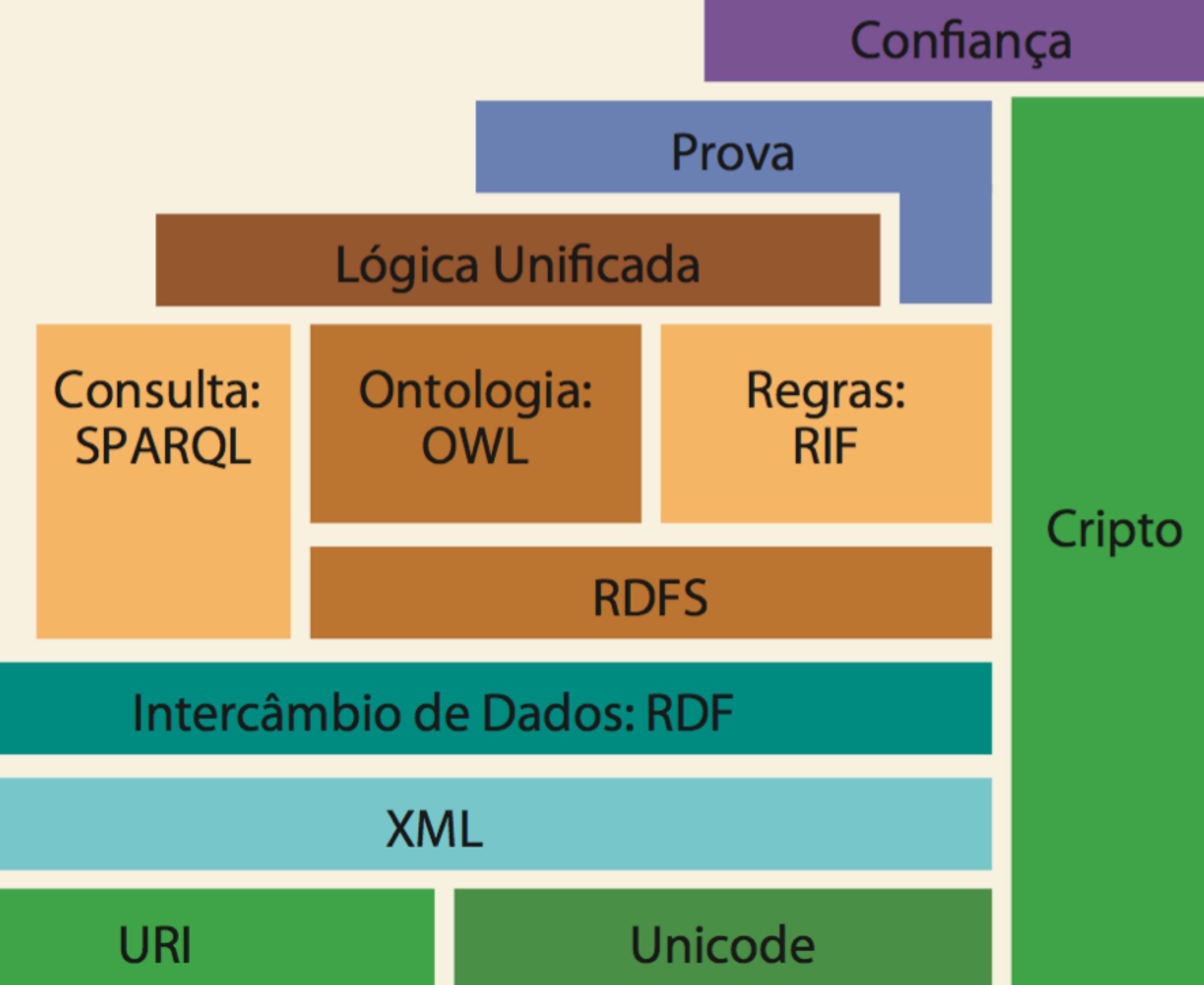
# Web Semântica

Berners-Lee et al., 2001

A Web Semântica tem por objetivo descrever o significado da informação publicada na Web com a finalidade de habilitar a realização de consultas baseadas no entendimento preciso da semântica daquela informação.

(RODRÍGUEZ-ROCHA et al., 2015)

## Interface do Usuário & Aplicações



# Semantic Web Stack

# Camadas

# **UNICODE e URI**

**URI** É uma sequência de caracteres que identifica um recurso físico ou abstrato. Teve sua sintaxe genérica definida na RFC 2396 (1998).

**IRI** A RFC 3987 (2005) propõe a padronização de uma extensão para URI, utilizando o conjunto de caracteres universais (Unicode/ISO 10646) a fim de permitir a internacionalização dos identificadores de recursos.

**URL** É um subconjunto do conjunto de URI. As URL fornecem a localização dos recursos descrevendo seu mecanismo de acesso primário. Portanto, quando recursos identificados na Web possuírem informação referente ao protocolo de acesso, seus identificadores serão definidos como URL.

<http://google.com>

<https://newtoncalegari.com.br/about>

<https://twitter.com/newtoncalegari>

<https://www.w3.org/People/Berners-Lee/>

<https://www.w3.org/People/Berners-Lee/#Bio>

# **XML** (Linguagens de serialização)

**XML** (*Extensible Markup Language*) como a linguagem de marcação para criação de documentos compostos de dados estruturados.

```
<Books>
  <Book ISBN="0553212419">
    <title>Sherlock Holmes: Complete Novels...
    <author>Sir Arthur Conan Doyle</author>
  </Book>
  <Book ISBN="0743273567">
    <title>The Great Gatsby</title>
    <author>F. Scott Fitzgerald</author>
  </Book>
  <Book ISBN="0684826976">
    <title>Undaunted Courage</title>
    <author>Stephen E. Ambrose</author>
  </Book>
  <Book ISBN="0743203178">
    <title>Nothing Like It In the World</title>
    <author>Stephen E. Ambrose</author>
  </Book>
</Books>
```

```
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  </Book>
  <Book ISBN="0743273567">
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</Book>
<Book ISBN="0743203178">
    <title>Nothing Like It In the World</title>
    <author>Stephen E. Ambrose</author>
</Book>
</Books>
```

**XML**

**JSON-LD**

**TURTLE**

**N3**

**RDFa**

# JSON-LD

```
{  
  "@context": "http://schema.org/",  
  "@type": "Person",  
  "name": "Jane Doe",  
  "jobTitle": "Professor",  
  "telephone": "(425) 123-4567",  
  "url": "http://www.janedoe.com"  
}
```

# **RDF** (Resource Description Framework)

# RDF



**sujeito**

Demi Getschko

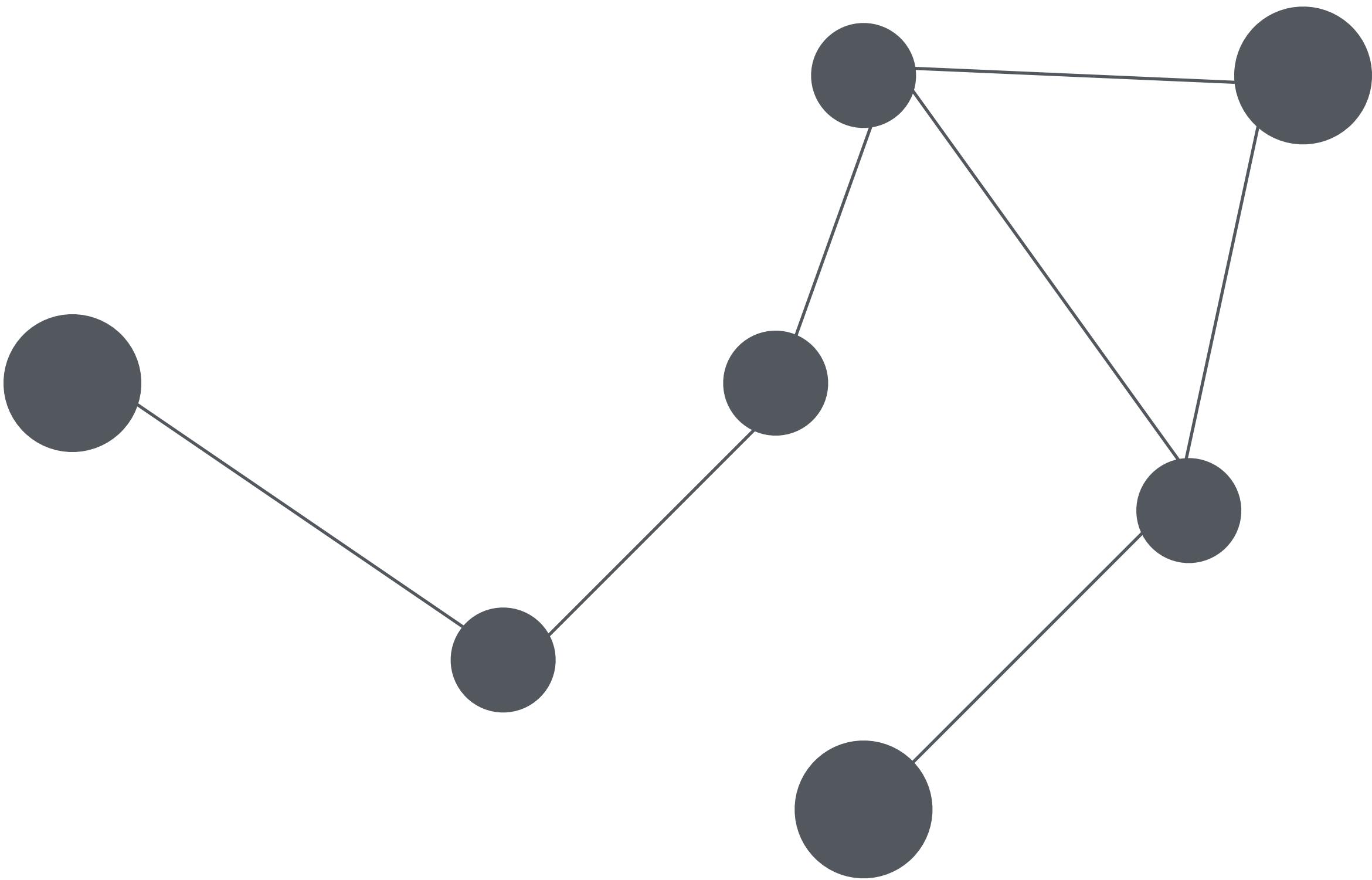
**predicado**

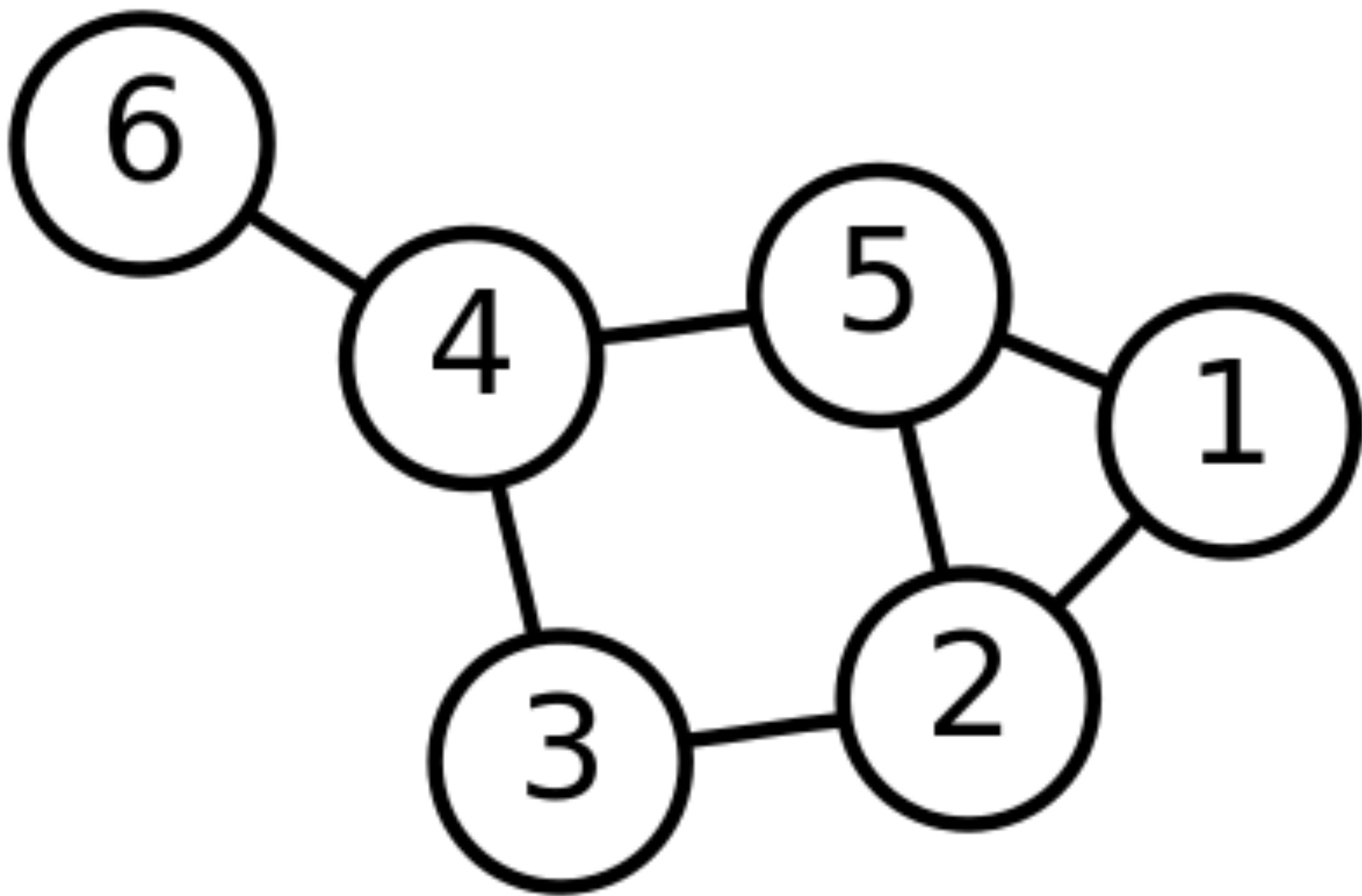
conhece

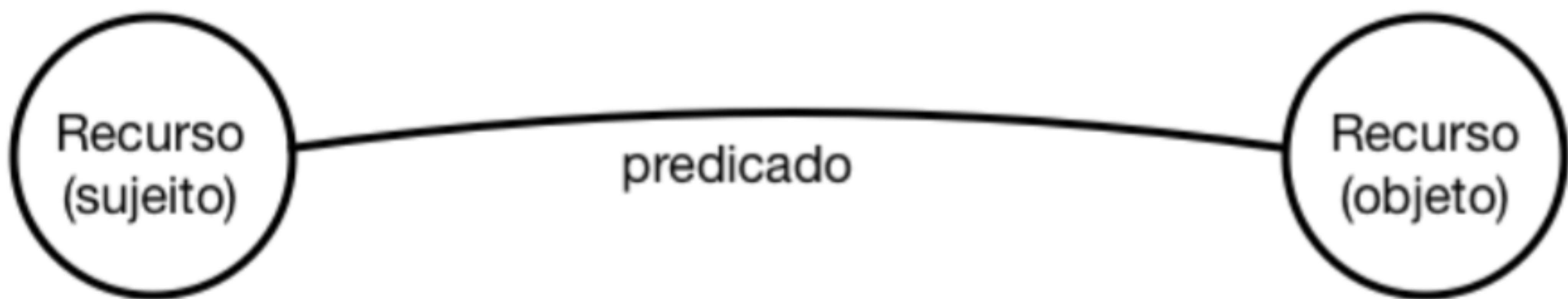
**objeto**

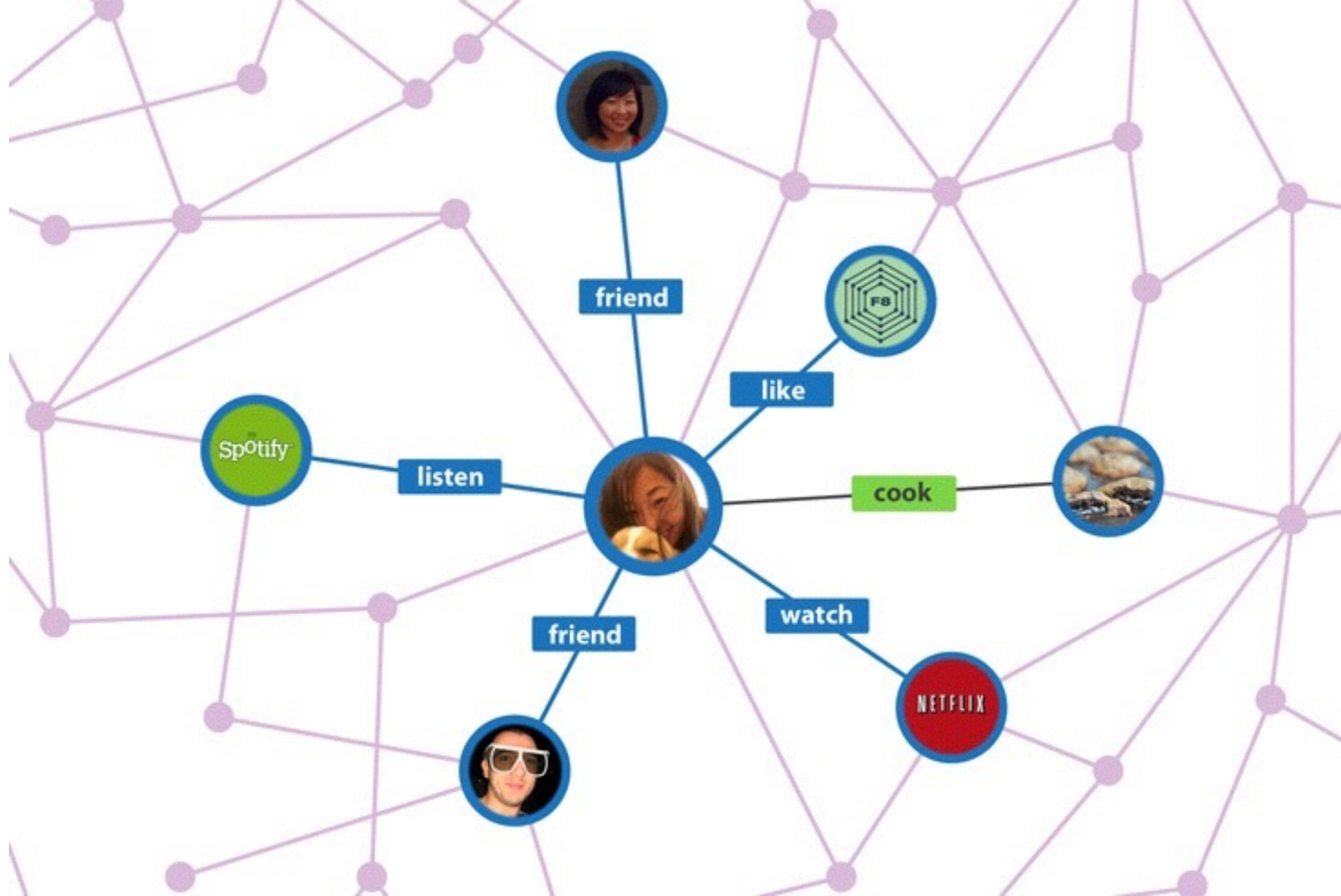
Vint Cerf

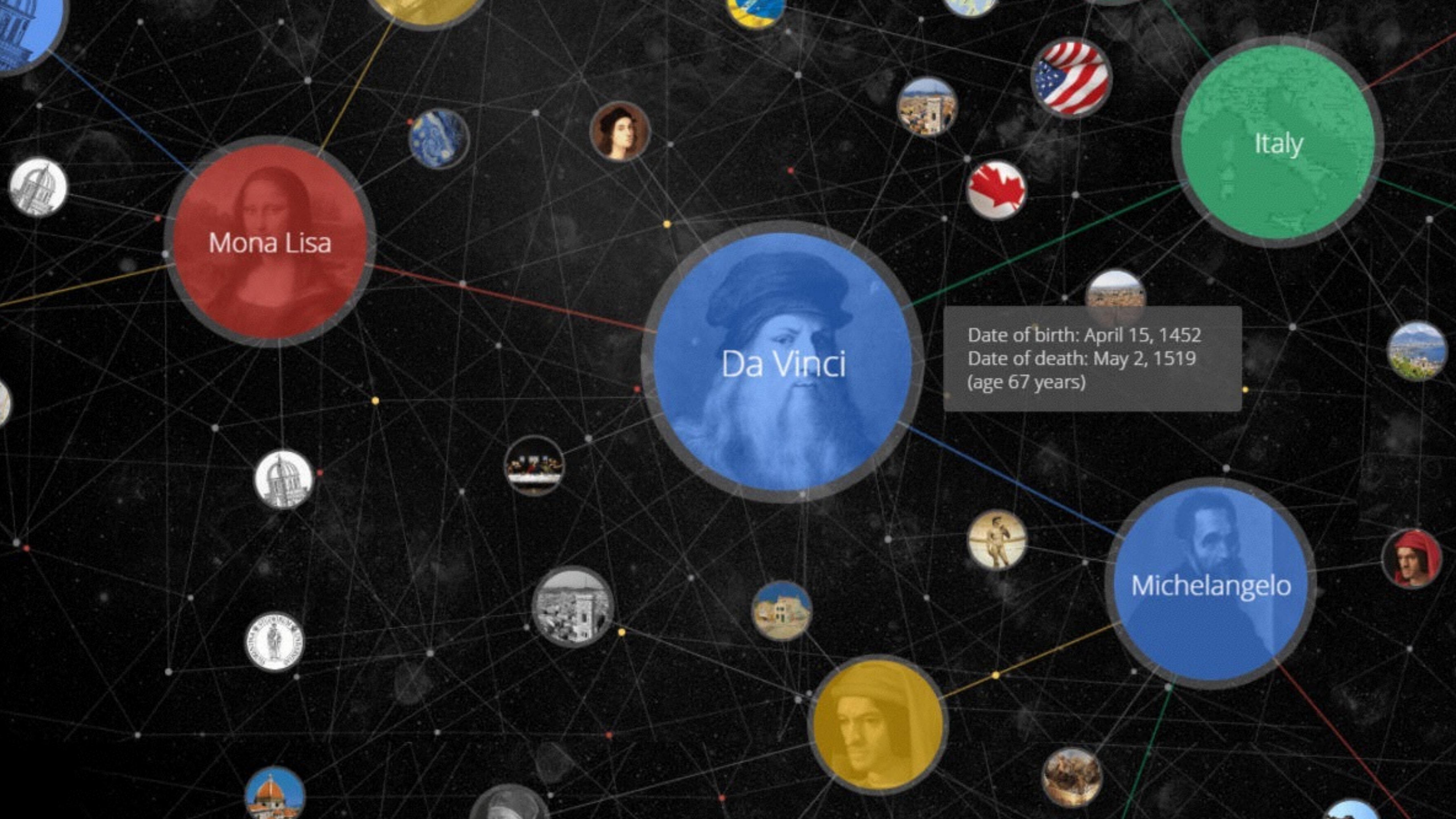












A network graph on a dark background showing connections between historical figures and their works. Nodes include large circles for 'Mona Lisa' (red), 'Da Vinci' (blue), 'Michelangelo' (blue), and 'Italy' (green). Smaller nodes include various artworks like the Vitruvian Man and the David, and flags of countries like the USA and Canada. A central node for Da Vinci is connected to a box containing his birth and death details.

Italy

Mona Lisa

Da Vinci

Michelangelo

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

**sujeito**

Newton

W3C

Tim Berners-Lee

**predicado**

trabalha

é uma

fundou

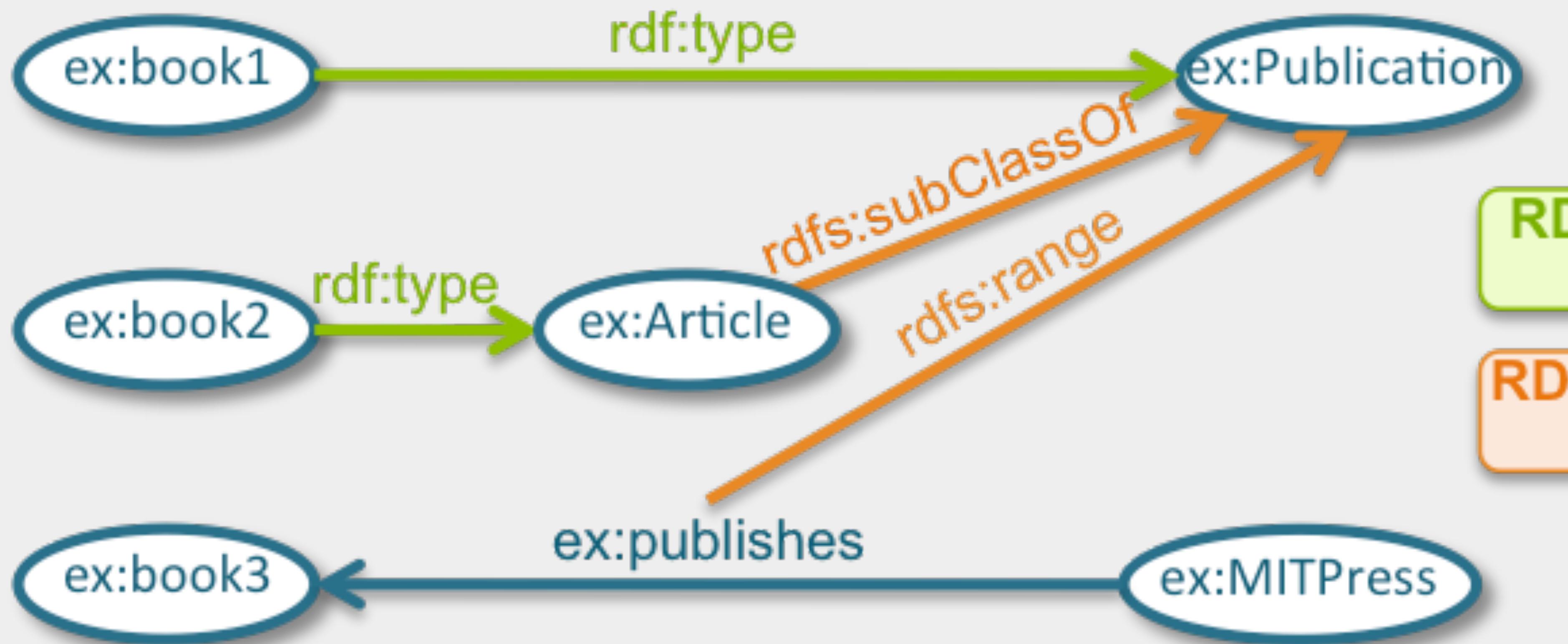
**objeto**

W3C

organização

W3C

# **RDFS**



**RDF** special terms

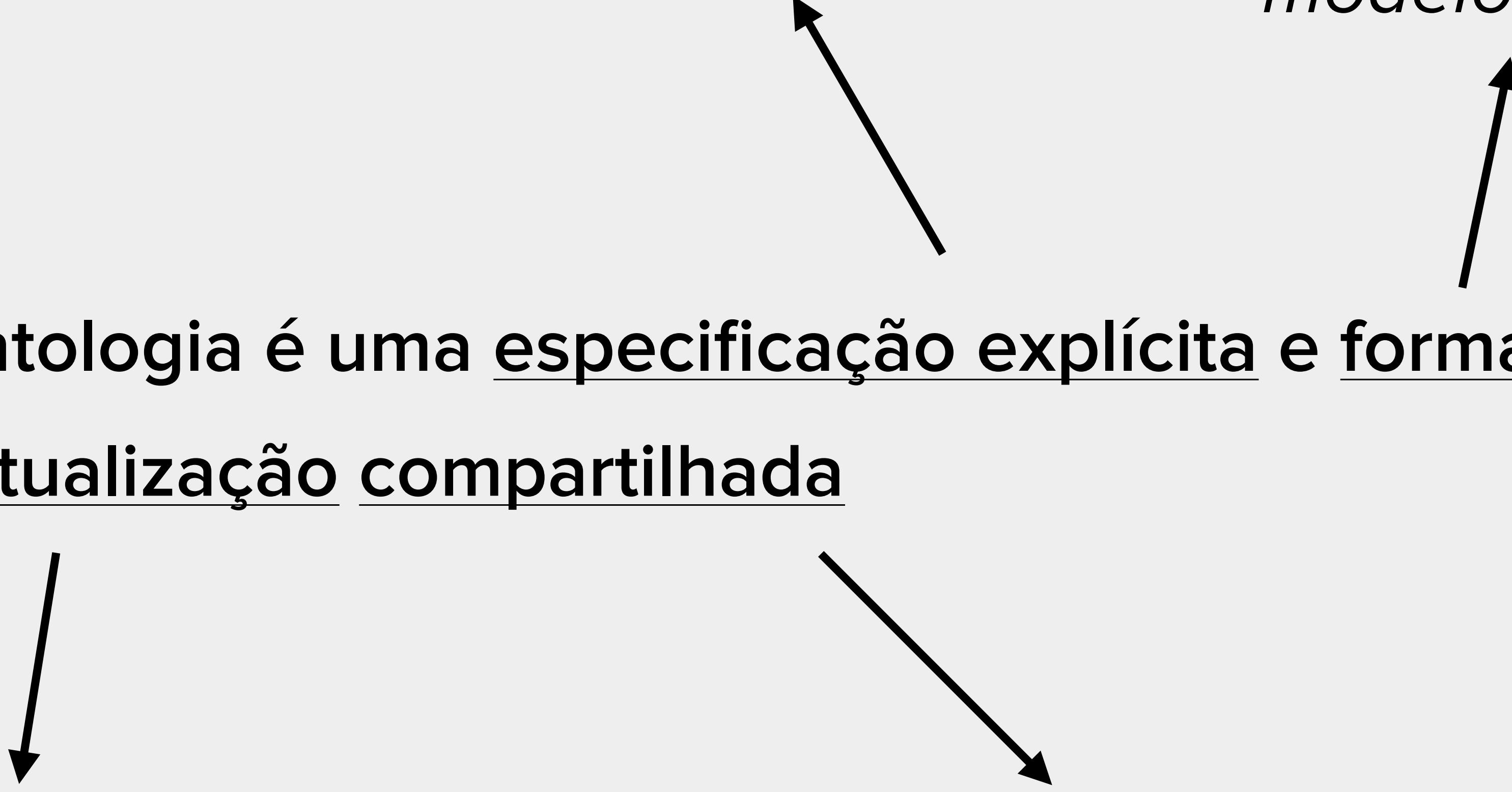
**RDFS** special terms

# **ONTOLOGIAS e VOCABULÁRIOS**

*machine-readable*

*modelo abstrato*

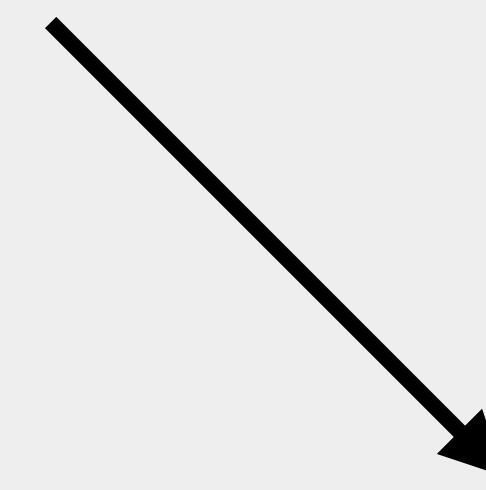
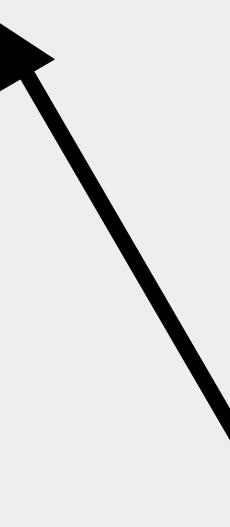
Uma ontologia é uma especificação explícita e formal de uma  
conceptualização compartilhada



```
graph TD; A[Uma ontologia é uma especificação explícita e formal de uma conceptualização compartilhada] --> B[expressa em termos (conceitos, propriedades)]; A --> C[baseada em consenso]; A --> D[mais legível por máquinas]; A --> E[mais abstrato]
```

*expressa em termos  
(conceitos, propriedades)*

*baseada em consenso*



**Utilizamos ontologias e vocabulários para descrever dados publicados na Web**

## Full Hierarchy

Schema.org is defined as two hierarchies: one for textual property values, and one for the things that they describe.

### Thing

This is the main schema.org hierarchy: a collection of types (or "classes"), each of which has one or more parent types. Although a type may have more than one super-type, here we show each type in one branch of the tree only. There is also a parallel hierarchy for [data types](#).

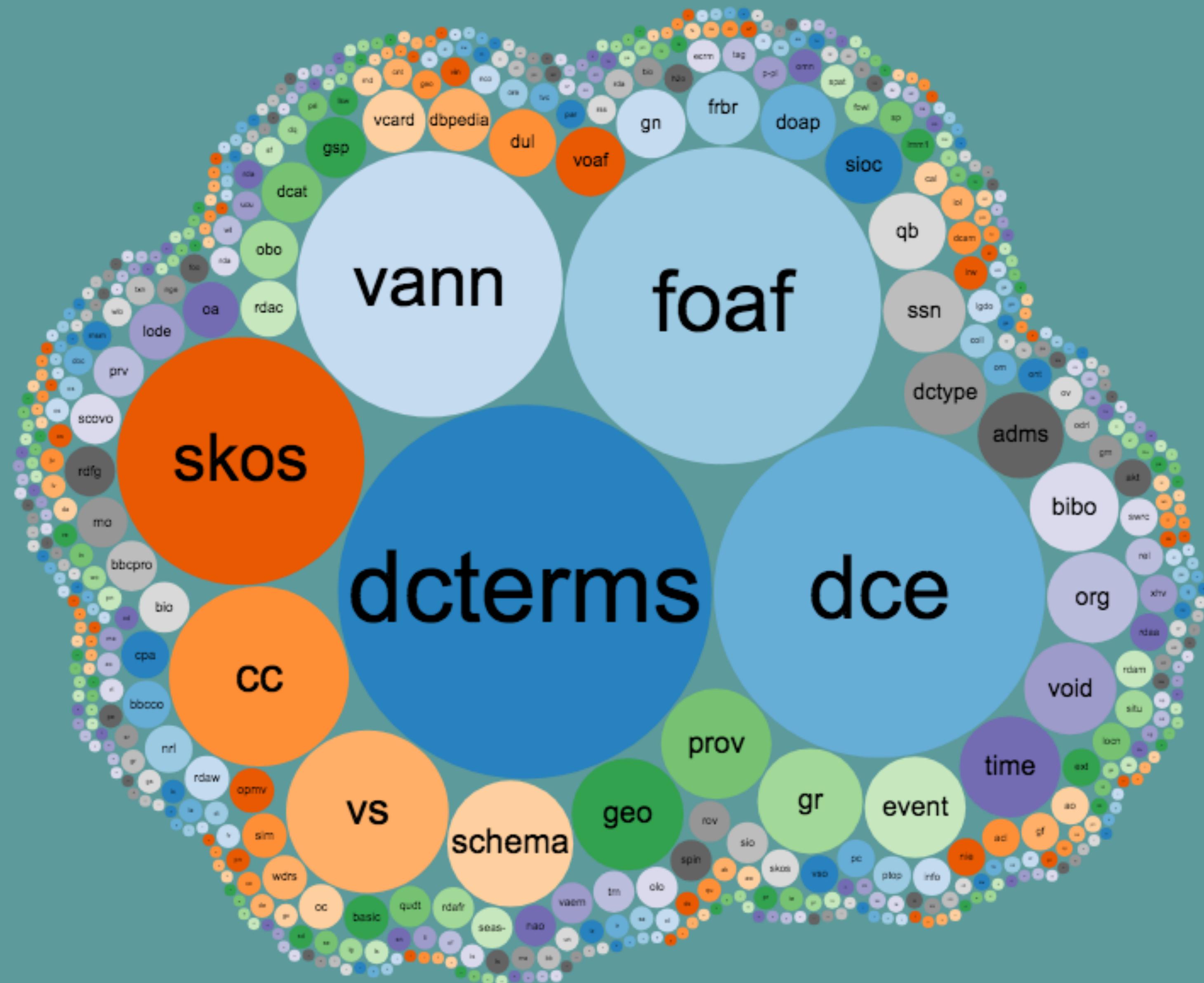
Select vocabulary view:

- Core vocabulary  Core plus all extensions

### Core plus extension vocabularies

- [Thing](#)
  - [Action](#)
    - [AchieveAction](#)
    - [LoseAction](#)
    - [TieAction](#)
    - [WinAction](#)
  - [AssessAction](#)

# Linked Open Vocabularies (LOV)



Linked Open Vocabularies  lov.okfn.org/dataset/lov/vocabs/foaf

VOCABS TERMS AGENTS SPARQL/DUMP

# Friend of a Friend vocabulary (foaf)

## Metadata

URI	<a href="http://xmlns.com/foaf/0.1/">http://xmlns.com/foaf/0.1/</a>
Namespace	<a href="http://xmlns.com/foaf/0.1/">http://xmlns.com/foaf/0.1/</a>
homepage	<a href="http://www.foaf-project.org/">http://www.foaf-project.org/</a>
Description	FOAF is a project devoted to linking people and information using the Web. Regardless of whether information is in people's heads, in physical or digital documents, or in the form of factual data, it can be linked. <a href="#">@en</a>
Language	

Libby Miller  
<http://data.semanticweb.org/person/libby-miller>

## Statistics

Classes	13
Properties	62
Datatypes	0
Instances	0

## Expressivity

RDF RDFS

Newton Calegari

**rdf:type**

**foaf:knows**

**foaf:Person**

Demi Getschko

# **SPARQL**

**SPARQL** é uma linguagem de consultas a fontes de dados no padrão RDF ou em formatos que possam ser convertidos para RDF, por meio de alguma outra aplicação *middleware*.

**SELECT** . . .

**WHERE** { . . . }

```
PREFIX dbo: <http://dbpedia.org/ontology/>
```

```
PREFIX dbp: <http://dbpedia.org/property/>
```

```
PREFIX dbr: <http://dbpedia.org/resource/>
```

```
SELECT ?obra
```

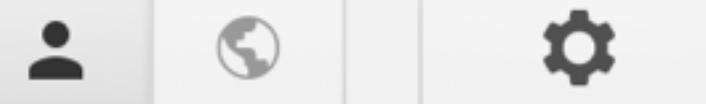
```
WHERE {
```

```
    ?obra dbp:artist dbr:Vincent_van_Gogh
```

```
}
```

# **Exemplos**

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## Stranger Things / Elenco



Winona Ryder  
Joyce



Natalia Dyer  
Nancy



Charlie Heaton  
Jonathan



David Harbour  
Chief Hopper



Gaten Matarazzo  
Dustin



Caleb McLaughlin  
Lucas



Noah Schnapp  
Will



Finn Wolfhard  
Mike



Matthew Modine  
Dr. Martin Brenner

## Stranger Things - Série 2016 - AdoroCinema

[www.adorocinema.com](http://www.adorocinema.com) › Séries › Melhores séries › Todas as séries › Séries Drama

Stranger Things, uma série criada por Matt Duffer, Ross Duffer com Winona Ryder, David Harbour: Ambientada em Montauk, Long Island, conta a história de um garoto que desaparece misteriosamente. Enquanto a ... [Elenco Stranger Things](#).

## Stranger Things: Elenco da 1ª temporada - AdoroCinema

[www.adorocinema.com/series/serie-19156/temporada-26101/elenco/](http://www.adorocinema.com/series/serie-19156/temporada-26101/elenco/)

David Harbour · Millie Brown Personagem: Eleven. Finn Wolfhard Personagem: Mike. Caleb McLaughlin. Personagem: Lucas. Gaten Matarazzo Personagem: ...

## Stranger Things

Seriado de ficção científica



## Stranger Things – Wikipédia, a enciclopédia livre

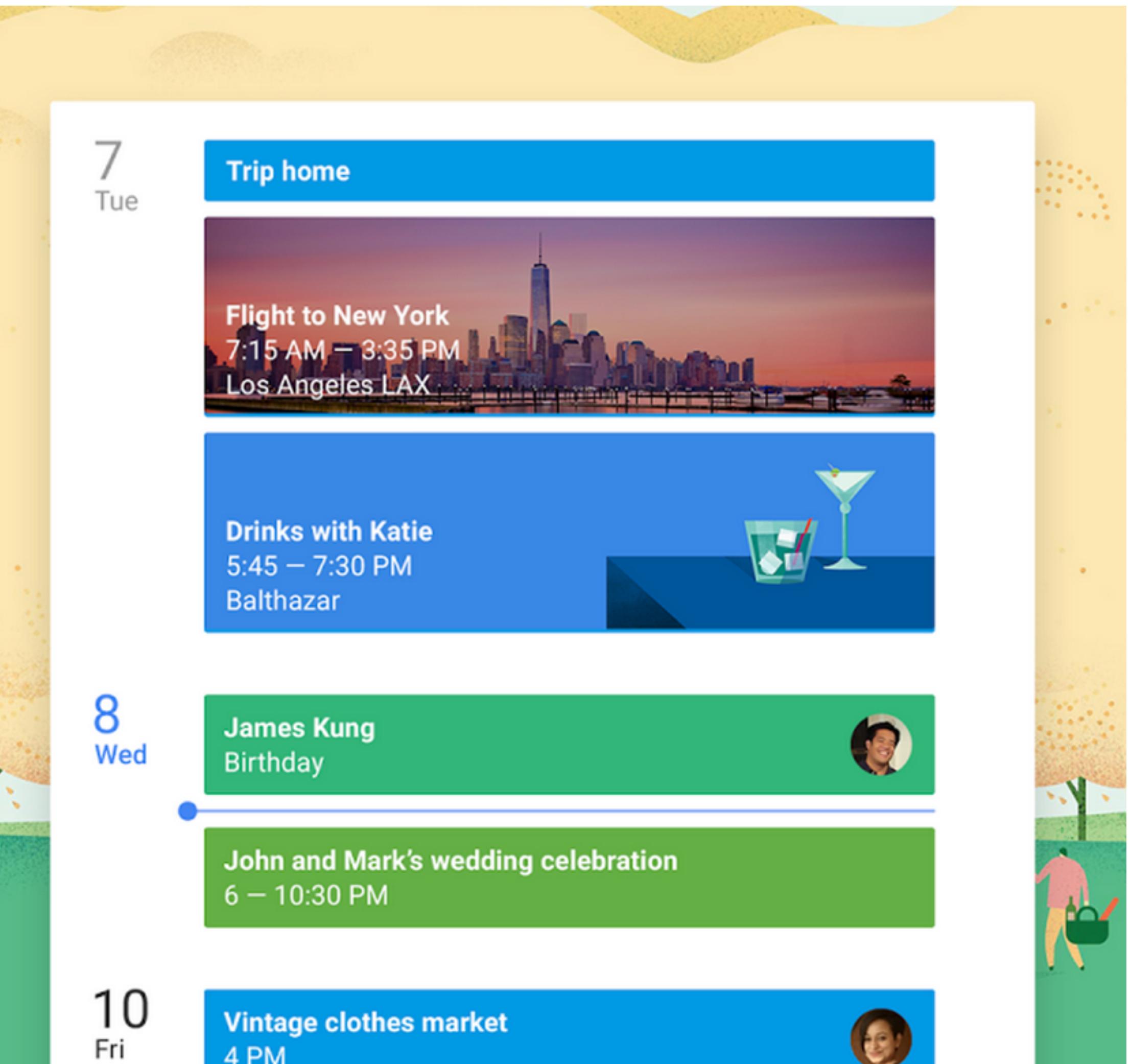
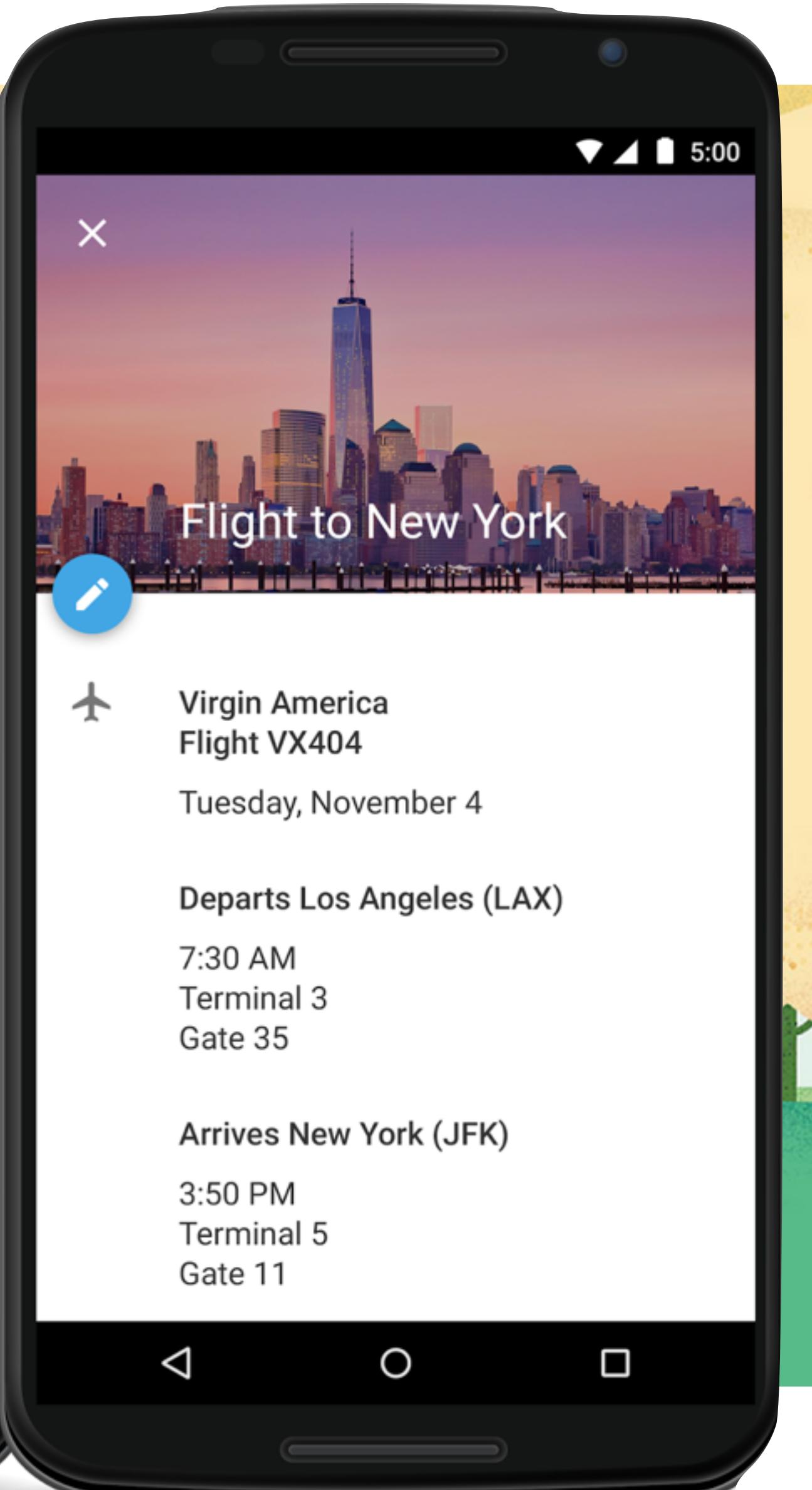
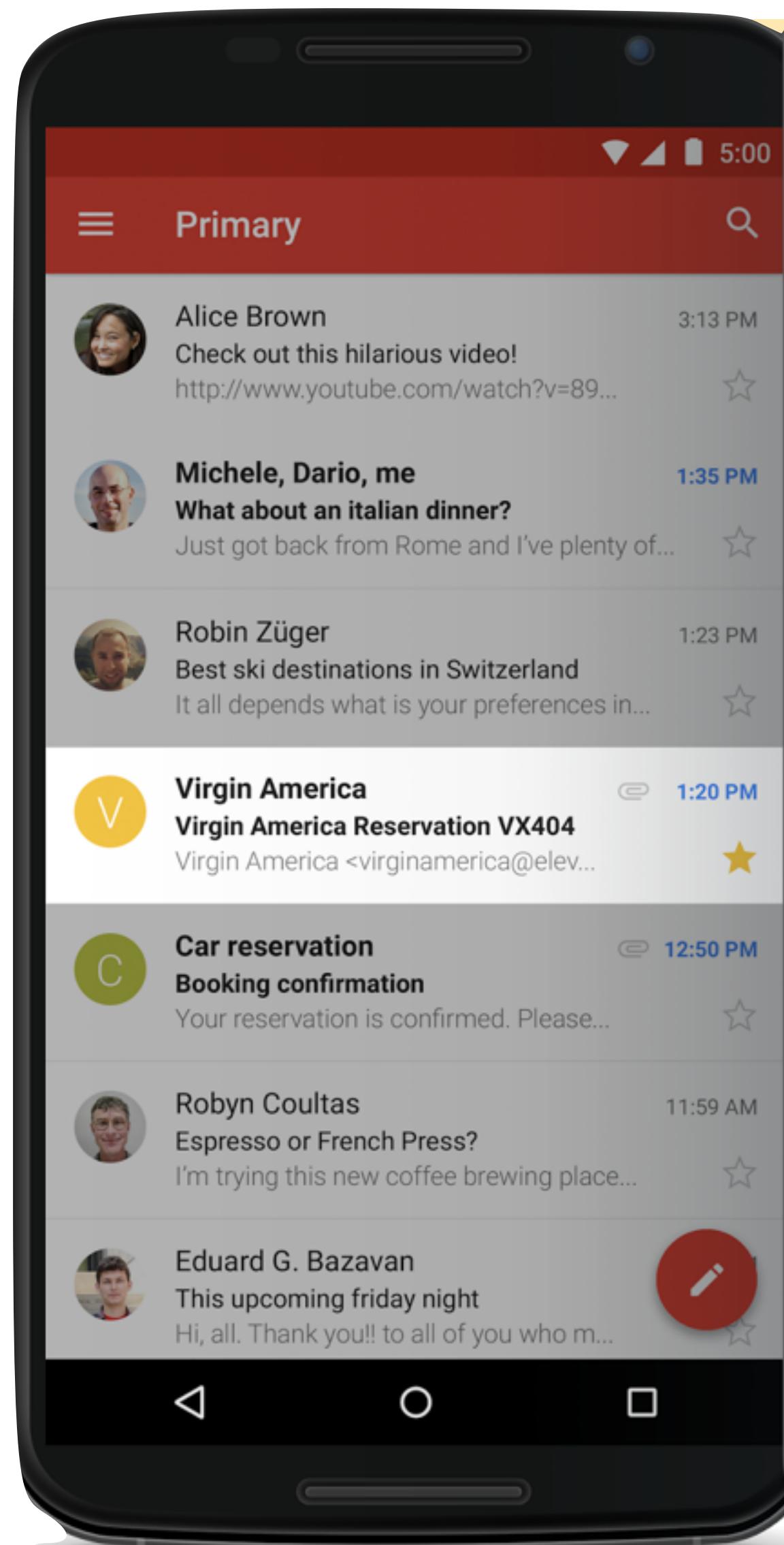
[https://pt.wikipedia.org/wiki/Stranger\\_Things](https://pt.wikipedia.org/wiki/Stranger_Things) ▾

Ir para [Elenco](#) - Divorciada de seu marido Lonnie, Joyce depende fortemente de Jonathan para cuidá-la. David Harbour como o Delegado Jim Hopper

Stranger Things é uma websérie americana dos gêneros suspense, ficção científica e terror criada pelos irmãos Matt e Ross Duffer e distribuída pela Netflix. [Wikipédia](#)

Emissora original: [Netflix](#)

Número De Episódios: 8



**Lava Lite Classic Lava Lamp, Purple/Blue - Walmart.com**

[Walmart](#) › [Lava-2118-Lava-Lite-Classic...](#)

**★★★★★** Rating: 3.5 - 60 votes - \$13.17 - In stock

Mobile-friendly - Buy Lava Lite Classic Lava Lamp, Purple/Blue at Walmart.com.

IBM

Computer hardware company



[ibm.com](#)

International Business Machines Corporation is an American multinational technology and consulting corporation, with corporate headquarters in Armonk, New York. [Wikipedia](#)

**Stock price:** IBM (NYSE) \$150.50 +1.35 (+0.91%)  
Apr 27, 5:33 PM EDT - Disclaimer

**CEO:** [Ginni Rometty](#)

**Customer service:** 1 (877) 426-6006

**Sales:** 1 (888) 746-7426

**Headquarters:** Armonk, North Castle, NY

**Founder:** [Charles Ranlett Flint](#)

**Founded:** June 16, 1911, [New York City, NY](#)

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Sep 17, 2014

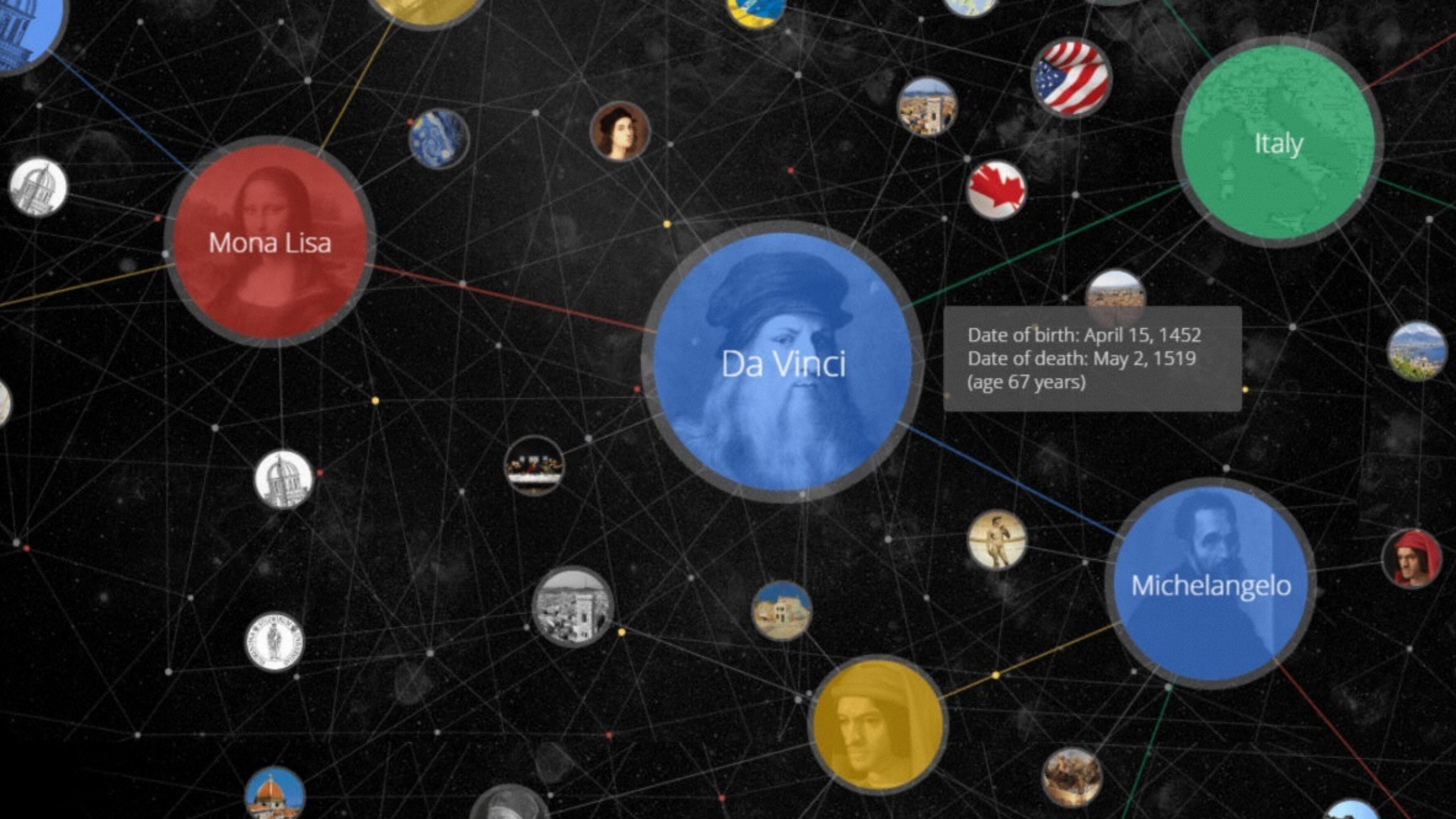
**View Pull Request ➔**

33

**View Issue ➔**

at! However, I

# *Dados estruturados no Google*



A network graph on a dark background showing connections between historical figures and their works. Nodes include large circles for 'Mona Lisa' (red), 'Da Vinci' (blue), 'Michelangelo' (blue), and 'Italy' (green). Smaller nodes include various artworks like the Vitruvian Man and the David, and flags of countries like the USA and Canada. A central node for Da Vinci is connected to a box containing his birth and death details.

Italy

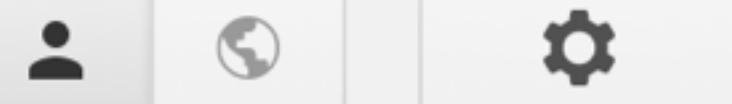
Mona Lisa

Da Vinci

Michelangelo

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

Todas Notícias Vídeos Imagens Shopping Mais ▾ Ferramentas de pesquisa



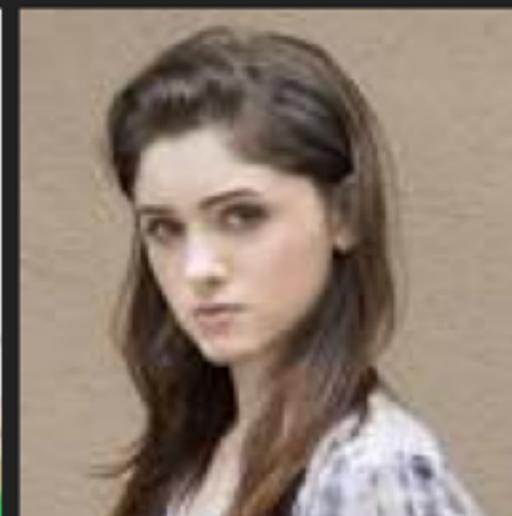
## Stranger Things / Elenco



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Joyce



Millie Brown  
Eleven



Natalia Dyer  
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Charlie Heaton  
Jonathan



David Harbour  
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Emissora original: [Netflix](#)

Número De Episódios: 8

Aproximadamente 386.000 resultados (0,47 segundos)

## Papa Francisco / Idade

# 79 anos

17 de dezembro de 1936



Papa Bento  
XVI  
89 anos



Donald Trump  
70 anos



Barack Obama  
55 anos

[Feedback](#)

## Papa Francisco – Wikipédia, a encyclopédia livre

[https://pt.wikipedia.org/wiki/Papa\\_Francisco](https://pt.wikipedia.org/wiki/Papa_Francisco) ▾

Francisco (em latim: Franciscus; Buenos Aires, **17 de dezembro de 1936**), nascido como Jorge ..... de implementar políticas que protejam os menores de idade e colaborar com as autoridades civis nas investigações de possíveis crimes.

[Infância e juventude](#) · [Companhia de Jesus](#) · [Episcopado](#) · [Pontificado](#)

## G1 - Papa Francisco diz que seu reinado será breve e que não se ...

[g1.globo.com/.../papa-francisco-diz-que-seu-reinado-sera-breve-e-que-nao-se-sente-s...](http://g1.globo.com/.../papa-francisco-diz-que-seu-reinado-sera-breve-e-que-nao-se-sente-s...) ▾

13 de mar de 2015 - Francisco, de 78 anos, descarta um limite de idade ao pontificado já que considera que "o papado tem algo de última instância", e que não ...

## Papa Francisco



Francisco, nascido como Jorge Mario Bergoglio, é o 266.º Papa da Igreja Católica e atual Chefe de Estado do Vaticano, sucedendo o Papa Bento XVI, que abdicou ao papado em 28 de fevereiro de 2013. [Wikipédia](#)

**Nascimento:** 17 de dezembro de 1936 (79 anos), Flores, Buenos Aires, Argentina

**Nacionalidade:** Argentino

**Cargo:** Soberano do Estado da Cidade do Vaticano desde 2013

**Educação:** [Milltown Institute of Theology and Philosophy](#) (1980–1980), mais

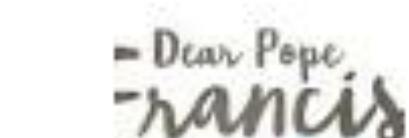
**Irmãos:** Alberto Bergoglio, Oscar Adrian Bergoglio, María Elena Bergoglio, Marta Regina Bergoglio

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## Obras



POPE  
FRANCIS



The name  
of God  
is Mercy



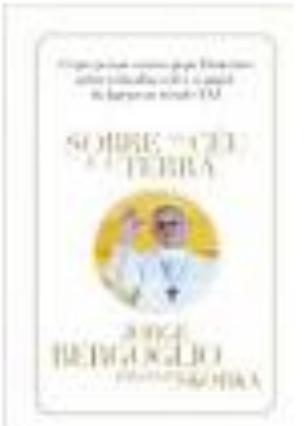
The Name  
of God  
Is  
Mercy  
2016



Evangelii  
Gaudium  
2013



Laudato si'  
2015



Sobre o  
Céu e a  
Terra  
2010

[Feedback](#)

# Knowledge Graph cards

 IBM

Computer hardware company

 [ibm.com](http://ibm.com)

International Business Machines Corporation is an American multinational technology and consulting corporation, with corporate headquarters in Armonk, New York. [Wikipedia](#)

**Stock price:** IBM (NYSE) \$150.50 +1.35 (+0.91%)  
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**CEO:** [Ginni Rometty](#)

**Customer service:** 1 (877) 426-6006

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**Founded:** June 16, 1911, [New York City, NY](#)

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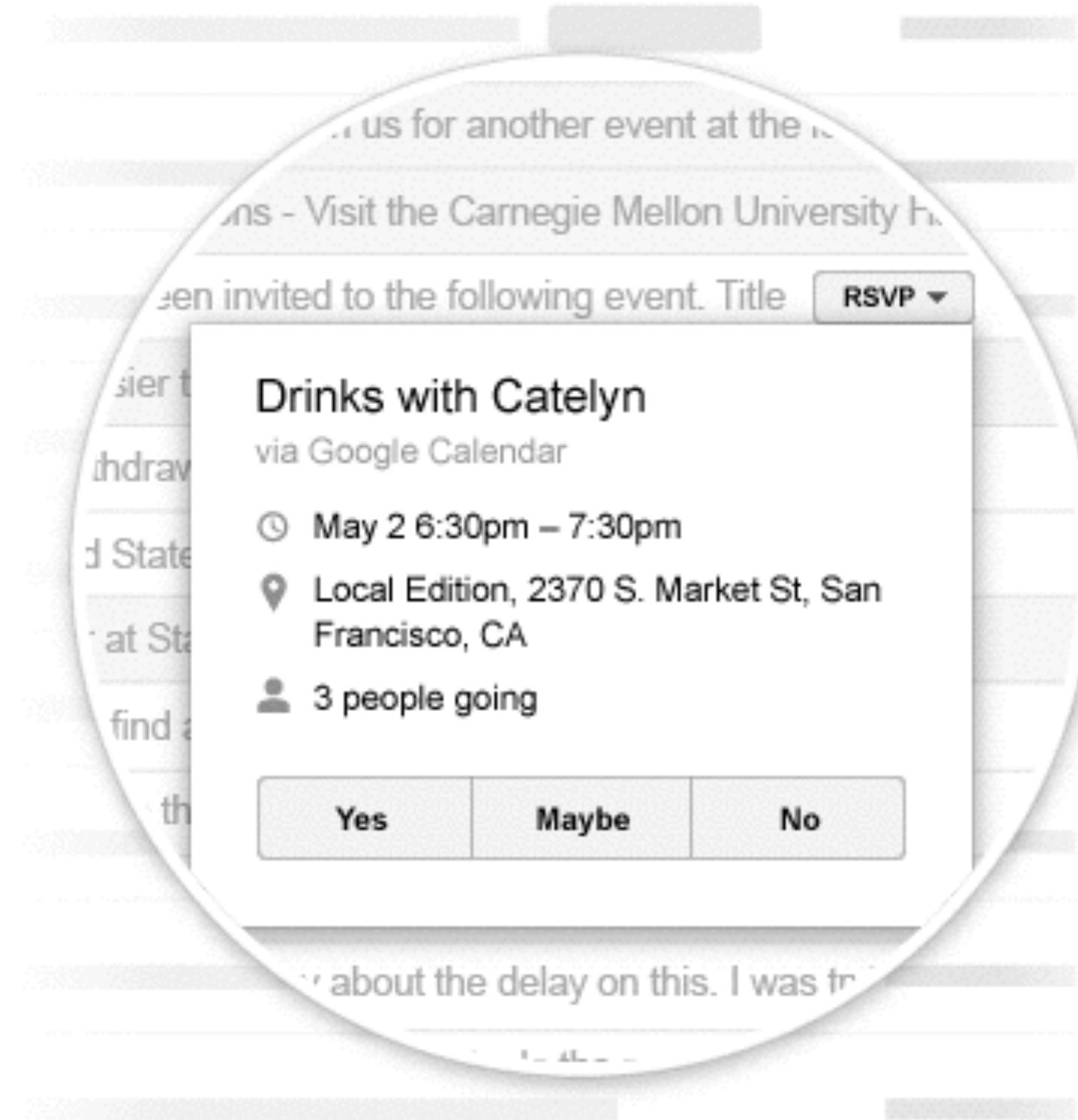
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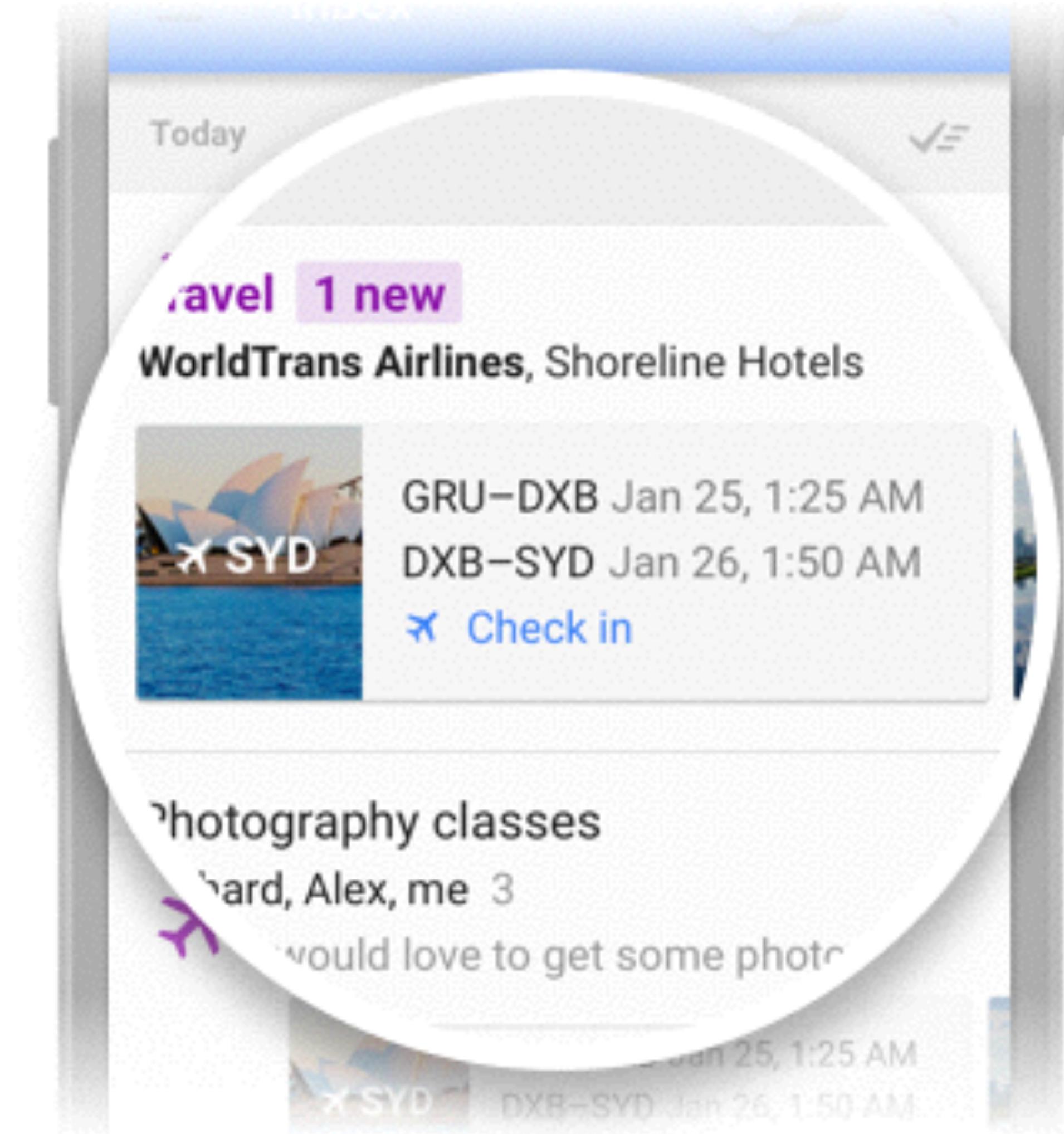
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# GMail Actions



# GMail Highlights



# Rich Snippets (Events)

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# Rich Snippets (Reviews)

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Walmart.com

[Walmart](#) › [Lava-2118-Lava-Lite-Classic-](#)...

 Rating: 3.5 - 60 votes - \$13.17 - In stock

Mobile-friendly - Buy Lava Lite Classic Lava Lamp, Purple/Blue at Walmart.com.

**Legal, como faz?**



# RDFa Lite 1.1 - Second Edition

W3C Recommendation 17 March 2015

**This version:**

<http://www.w3.org/TR/2015/REC-rdfa-lite-20150317/>

**Latest published version:**

<http://www.w3.org/TR/rdfa-lite/>

**Implementation report:**

<http://www.w3.org/2010/02/rdfa/wiki/CR-ImplementationReport>

**Previous version:**

<http://www.w3.org/TR/2014/PER-rdfa-lite-20141216/>

**Previous Recommendation:**

<http://www.w3.org/TR/2012/REC-rdfa-lite-20120607/>

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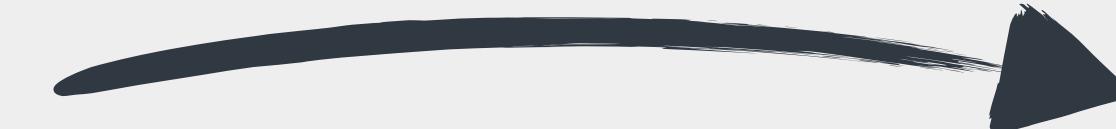
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## Abstract

RDFa Lite is a minimal subset of RDFa, the Resource Description Framework in attributes, consisting of a few attributes that may be used to express machine-readable Web information in HTML, SVG, and VML. While it is a simplification of the full RDFa language, it is designed to be a complete and self-contained language for expressing machine-readable Web information.

# RDFa (Lite)

**4 propriedades  
para começarmos**



**vocab**  
**property**  
**typeof**  
**content**

<p>

0 FrontInBH ocorre no dia 06/08/2016!

</p>

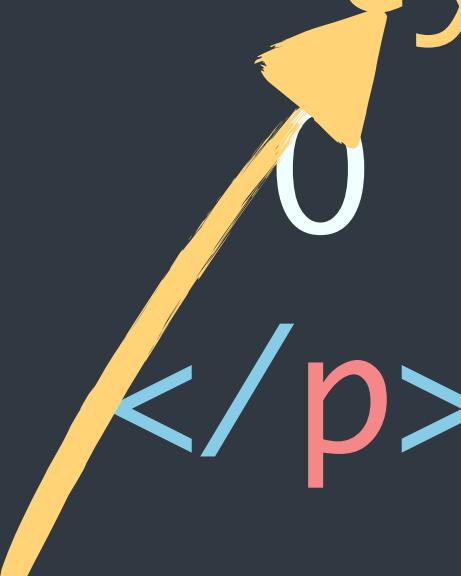
# @vocab



```
<p vocab="http://schema.org/">  
  0 FrontInBH ocorre no dia 06/08/2016!  
</p>
```

# @typeof

```
<p vocab="http://schema.org/"  
    typeof="Event">  
    FrontInBH ocorre no dia 06/08/2016!  
</p>
```



# @property

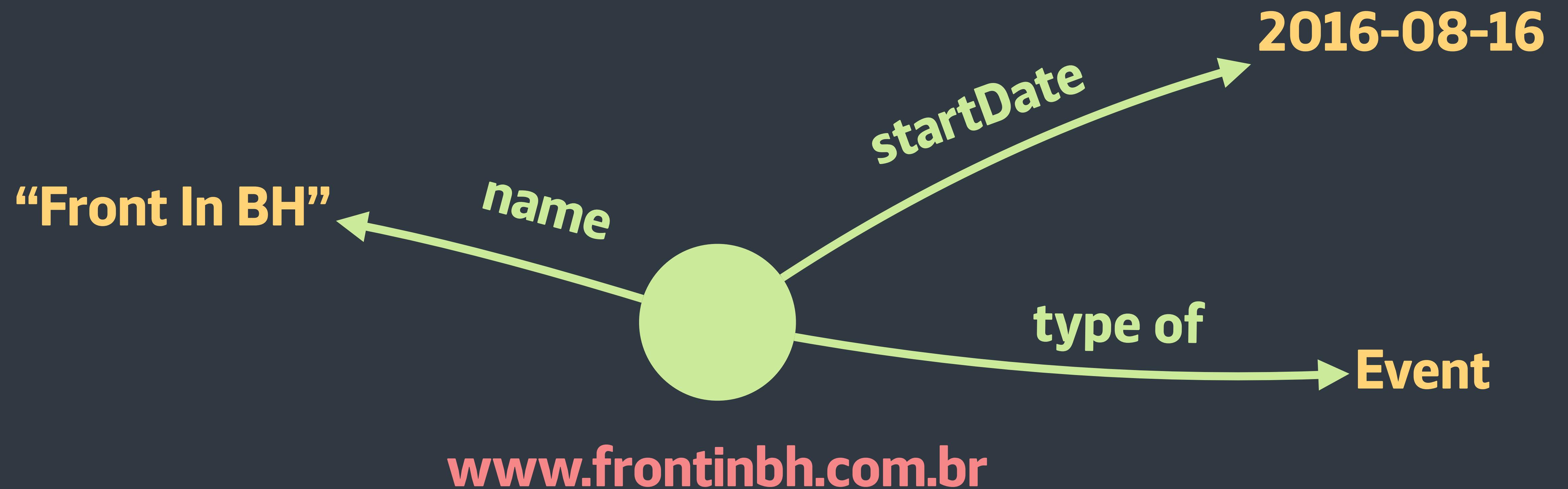
```
<p vocab="http://schema.org/"  
    typeof="Event">  
  0 <span property="name">FrontInBH</span>  
  ocorre no dia 06/08/2016!  
</p>
```



# @content

```
<p vocab="http://schema.org/"  
    typeof="Event">  
    0 <span property="name">FrontInBH</span>  
    ocorre no dia  
    <span property="startDate"  
        content="2016-08-16T08:00">  
        06/08/2016</span>!  
</p>
```







# JSON-LD 1.0

## A JSON-based Serialization for Linked Data

W3C Recommendation 16 January 2014

**This version:**

<http://www.w3.org/TR/2014/REC-json-ld-20140116/>

**Latest published version:**

<http://www.w3.org/TR/json-ld/>

**Previous version:**

<http://www.w3.org/TR/2013/PR-json-ld-20131105/>

**Editors:**

[Manu Sporny](#), [Digital Bazaar](#)

[Gregg Kellogg](#), [Kellogg Associates](#)

[Markus Lanthaler](#), [Graz University of Technology](#)

**Authors:**

[Manu Sporny](#), [Digital Bazaar](#)

[Dave Longley](#), [Digital Bazaar](#)

[Gregg Kellogg](#), [Kellogg Associates](#)

[Markus Lanthaler](#), [Graz University of Technology](#)

[Niklas Lindström](#)

Please refer to the [errata](#) for this document, which may include some normative corrections.

This document is also available in this non-normative format: [diff to previous version](#)

The English version of this specification is the only normative version. Non-normative [translations](#) may also be available.

# JSON for Linking Data

Data is messy and disconnected. JSON-LD organizes and connects it, creating a better Web.

## ⇄ Linked Data

Linked Data empowers people that publish and use information on the Web. It is a way to create a network of standards-based, machine-readable data across Web sites. It allows an application to start at one piece of Linked Data, and follow embedded links to other pieces of Linked Data that are hosted on different sites across the Web.

## A Simple Example

```
{  
  "@context": "http://json-ld.org-contexts/person.jsonld",  
  "@id": "http://dbpedia.org/resource/John_Lennon",  
  "name": "John Lennon",  
  "born": "1940-10-09",  
  "spouse": "http://dbpedia.org/resource/Cynthia_Lennon"  
}
```

## { } JSON-LD

JSON-LD is a lightweight Linked Data format. It is easy for humans to read and write. It is based on the already successful JSON format and provides a way to help JSON data interoperate at Web-scale. JSON-LD is an ideal data format for programming environments, REST Web services, and unstructured databases such as CouchDB and MongoDB.

## Documentation

GUIAS

DATA TYPES

ENVIAR COMENT

## Developer Checklist

Prepare Your Content

Create Quality Pages

Associate Your Online Resources

Use AMP HTML

Make Mobile-friendly Websites

Add Voice Actions

## Index Your Content

Introduction to Indexing

Create a List of URLs

Submit URLs to Google

## Help Google Present You

[Introduction to Structured Data](#)

Enhance Your Site's Attributes

Mark Up Your Content Items

Mark Up Your Lists

# Introduction to Structured Data



*Structured data* refers to kinds of data with a high level of organization, such as information in a relational database. When information is highly structured and predictable, search engines can more easily organize and display it in creative ways. *Structured data markup* is a text-based organization of data that is included in a file and served from the web. It typically uses the [schema.org](#) vocabulary—an open community effort to promote standard structured data in a variety of online applications.

Structured data markup is most easily represented in [JSON-LD](#) format, which stands for JavaScript Object Notation for Linked Data. The following is a simple JSON-LD structured data example you might use for contact information for your company:

```
<script type="application/ld+json">
{
  "@context": "http://schema.org",
  "@type": "Organization",
  "url": "http://www.your-company-site.com",
  "contactPoint": [
    {
      "@type": "ContactPoint",
      "name": "Customer Support",
      "telephone": "+1 800 555-1234",
      "email": "support@example.com"
    }
  ]
}</script>
```

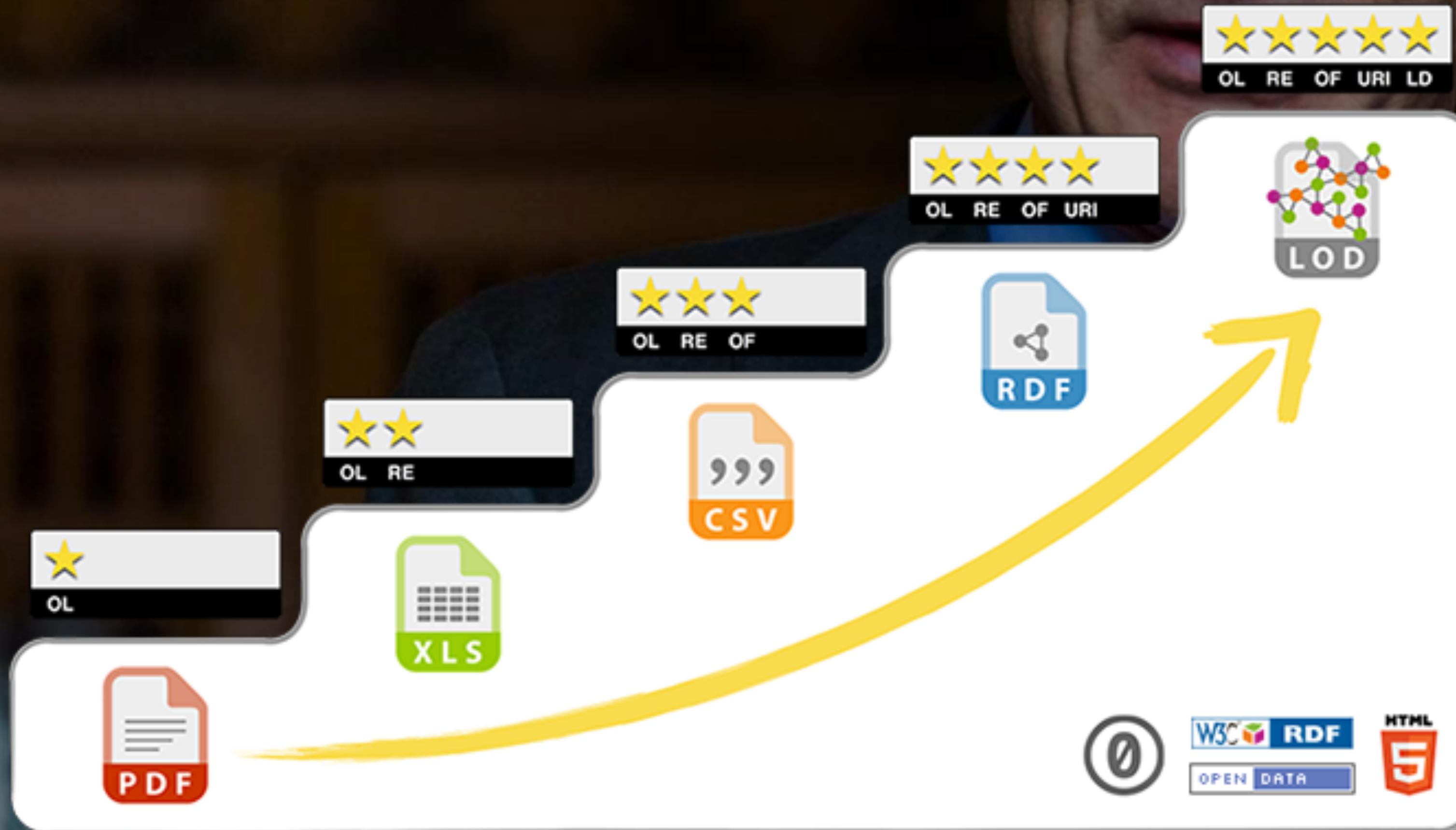
Índice

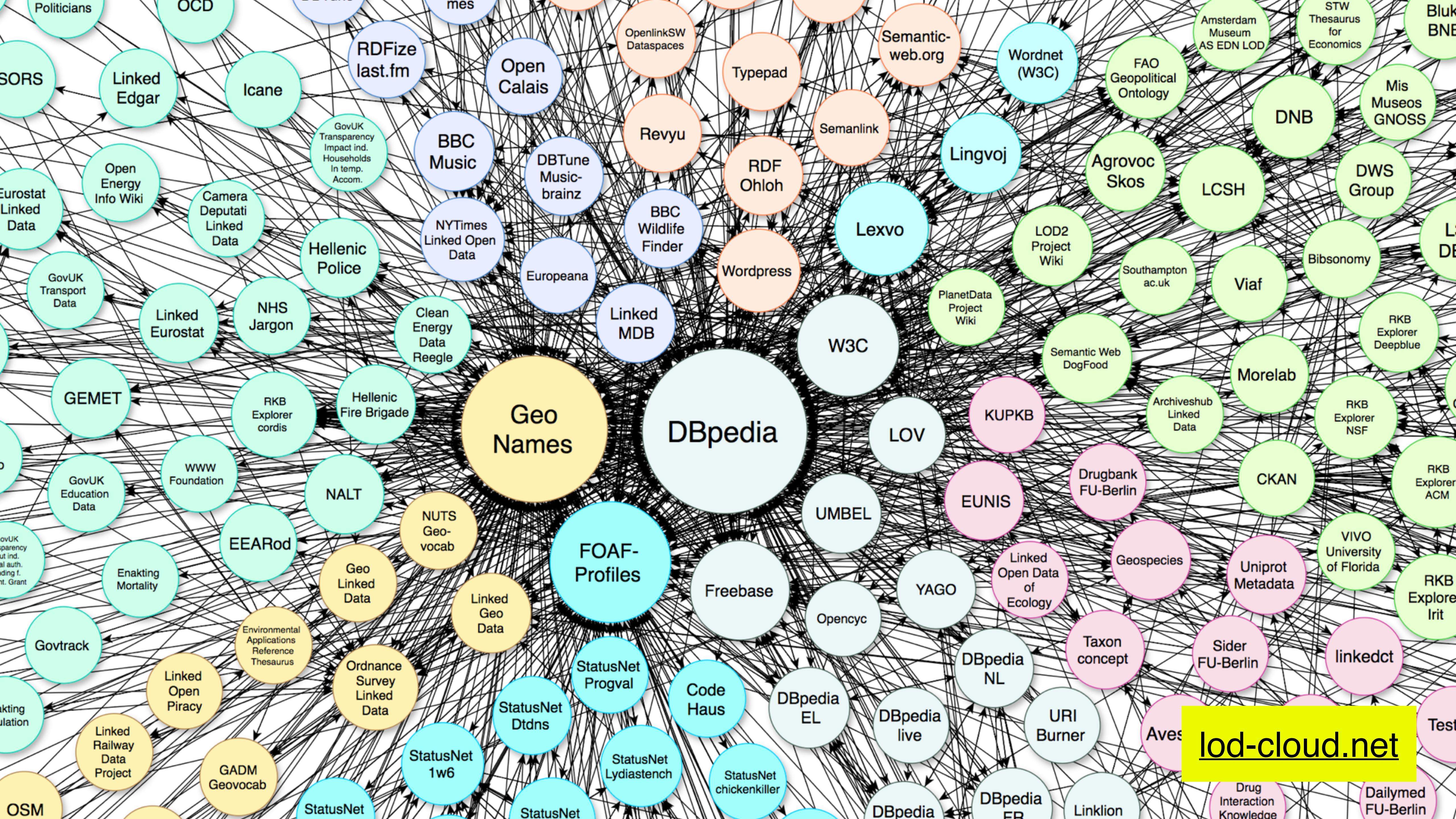
Common use cas

Markup formats a  
placementTesting and publis  
your markupStructured data  
guidelinesTechnical guide  
Quality guidelinMultiple entities  
same pageImage markup  
guidelines

# 5 ★ OPEN DATA

Tim Berners-Lee, the inventor of the Web and Linked Data initiator, suggested a 5-star deployment scheme for Open Data. Here, we give examples for each step of the stars and explain costs and benefits that come along with it.





What Happened to the Semantic Web

kidehen.blogspot.com.br/2015/09/what-happened-to-semantic-web.html

search

Classic Flipcard Magazine Mosaic Sidebar Snapshot Timeslide

OpenLink Structured Dat...

Generating 5-Star Linked...

What Happened to the S...

Beyond Bookmarking

DBpedia Pay-As-You-Go ...

Virtuoso Pay-As-You-Go ...

Data & Semantics

Conceptual Data Virtualiz...

# What Happened to the Semantic Web?

## Situation Analysis

Over the last 15+ years, the same question about the Semantic Web has been posed innumerable times: "*Are we there yet?*"

In this post, I will demonstrate that as expected [1][2], its arrival was without fanfare, but we are inarguably there.

### Semantic Web Illustration

Semantically Enhanced Linked Data Network (e.g., Semantic Web of Big Linked Open Data)

Dynamic Views theme. Powered by Blogger.

<http://kidehen.blogspot.com.br/2015/09/what-happened-to-semantic-web.html>

# **Web Semântica e Processamento de Linguagem Natural na prática**

**Newton Calegari**



**PUC-SP**