WIKIMEDIA FOUNDATION

How Knowledge Representation is changing in a world of Large Language Models

Denny Vrandečić, Wikimedia Foundation
SWIB24 – 16th Semantic Web in Libraries
25 November 2024

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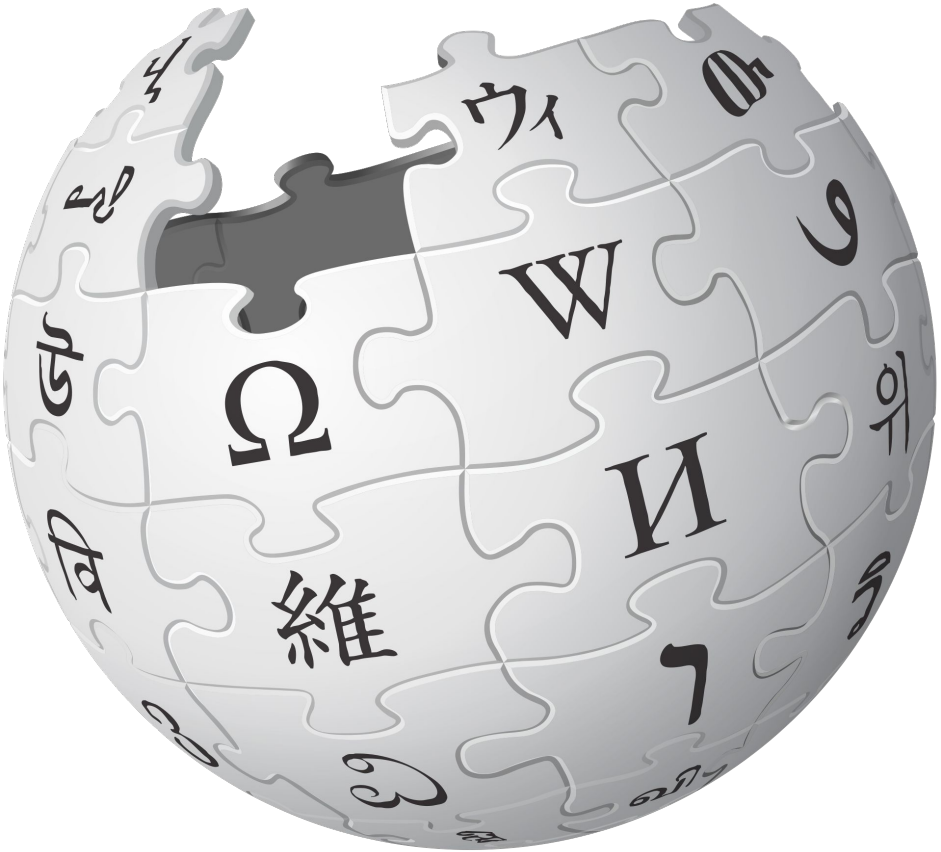
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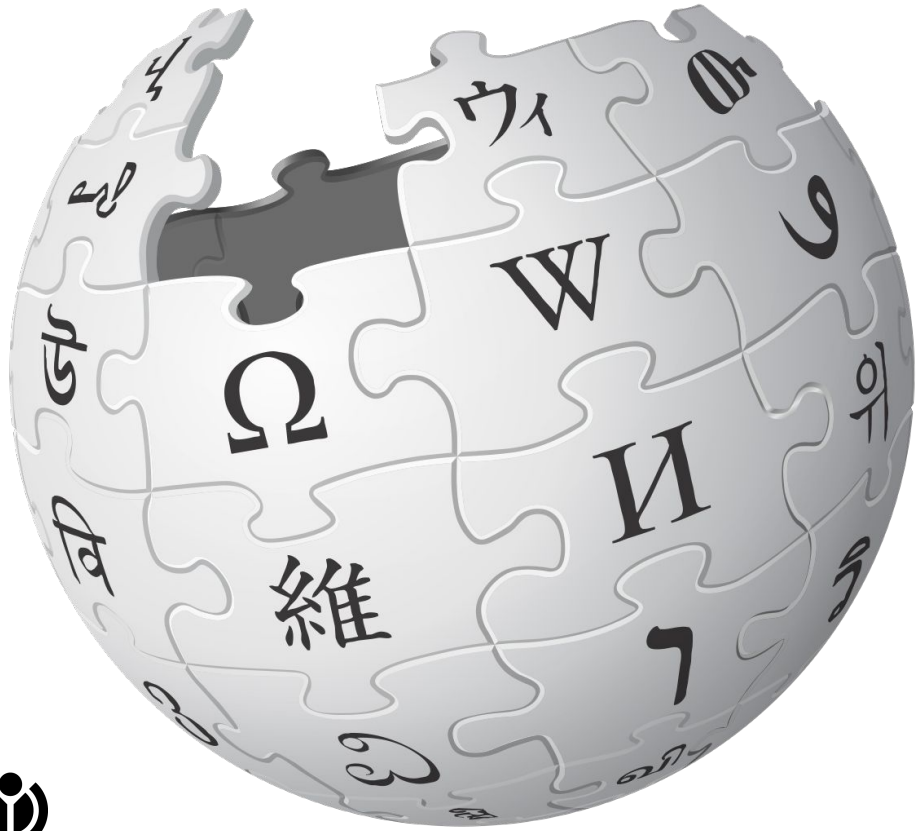
Imagine a world where everyone can share in the sum of all knowledge

Wikipedia today

334 language editions

63.7 million articles



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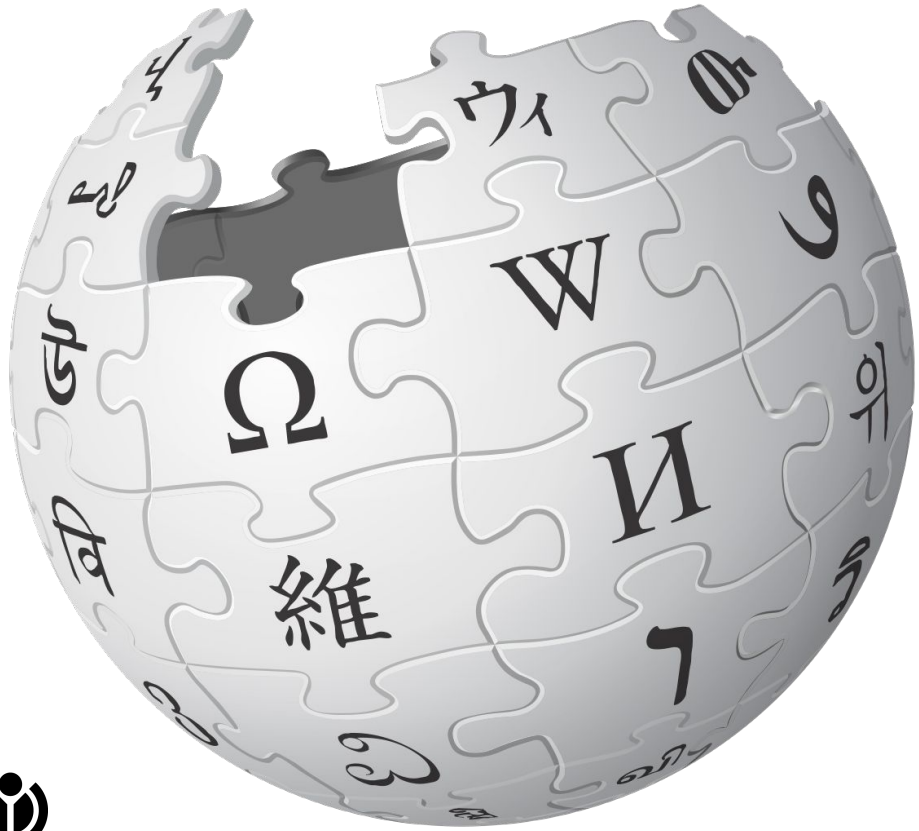

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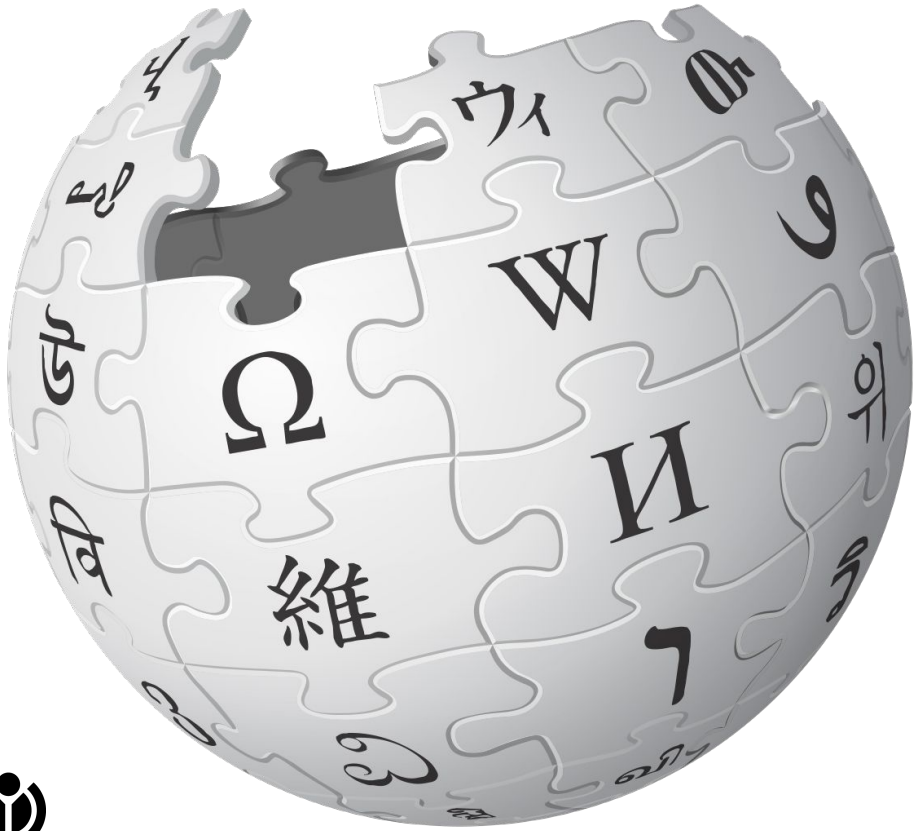
Very unevenly distributed



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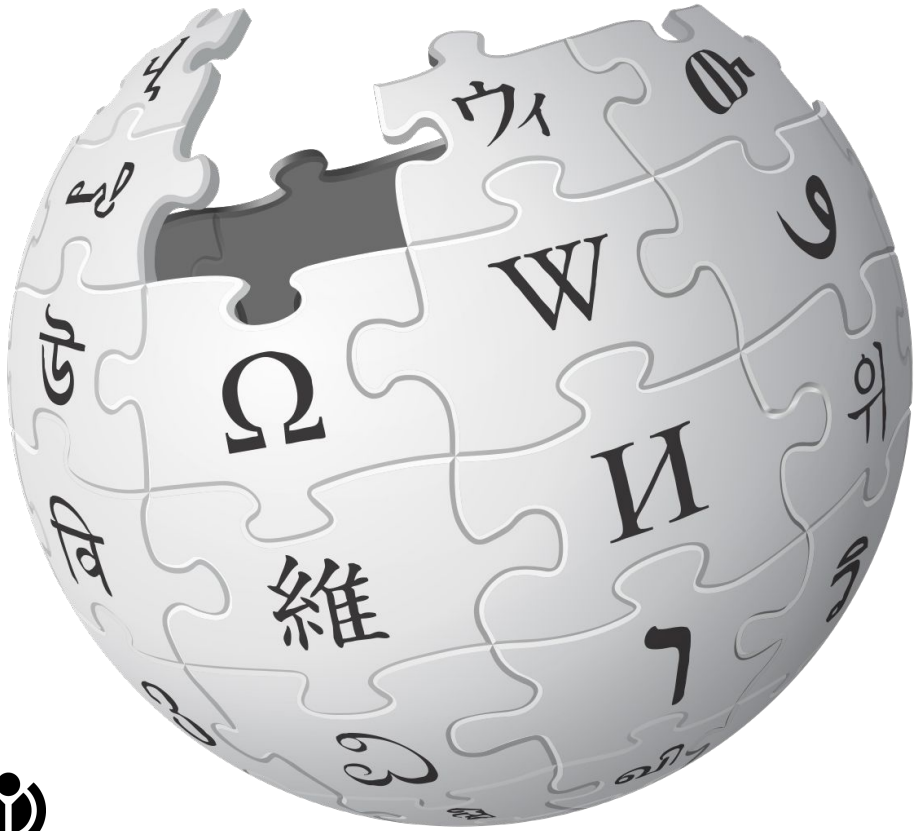
Very unevenly distributed

English: 6,487,359



WIKIMEDIA
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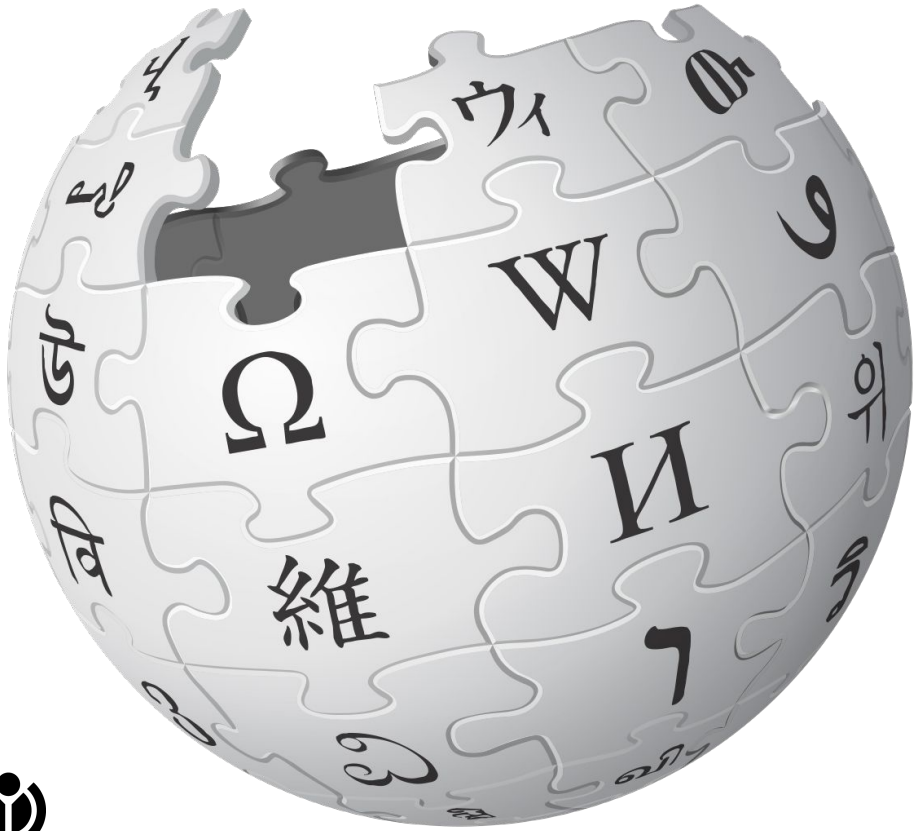
Very unevenly distributed

English: 6,487,359

Turkmen:



WIKIMEDIA FOUNDATION

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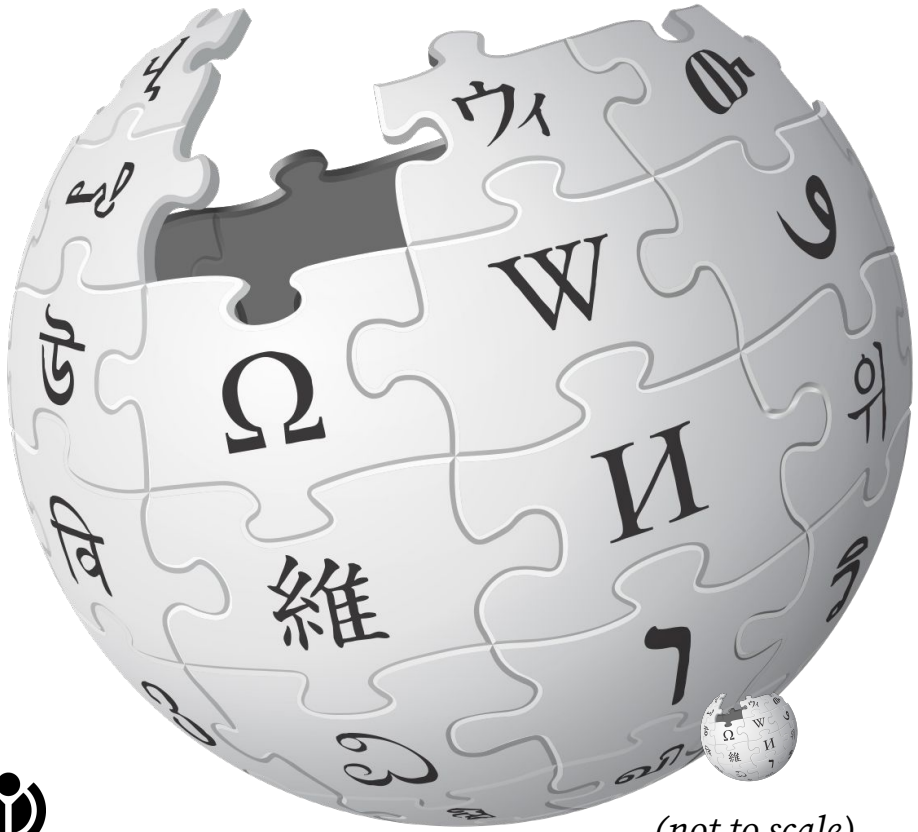
English: 6,487,359

Turkmen: 6,888



(not to scale)

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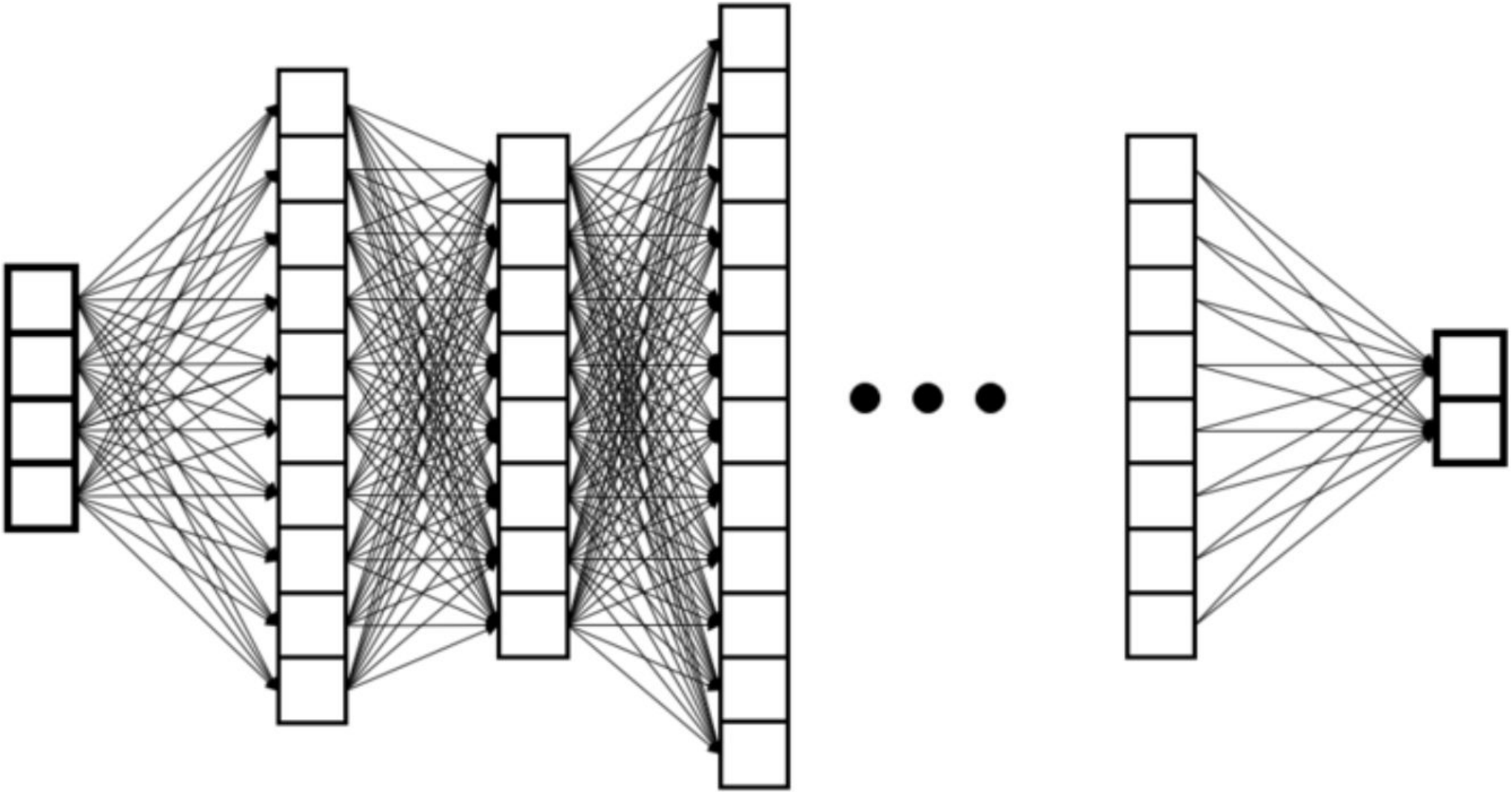

ChatGPT

Share

Where was Denny Vrandečić born?

Denny Vrandečić, the founder of Wikidata, was born in **Stuttgart, Germany**.

ChatGPT

Share

Gdje je rođen Denny Vrandečić?

Denny Vrandečić je rođen u Splitu, Hrvatska.

ChatGPT

Share

What does the Croatian sentence "Gdje je rođen Denny Vrandečić?" mean in English?

The Croatian sentence "Gdje je rođen Denny Vrandečić?" translates to "Where was Denny Vrandečić born?" in English.

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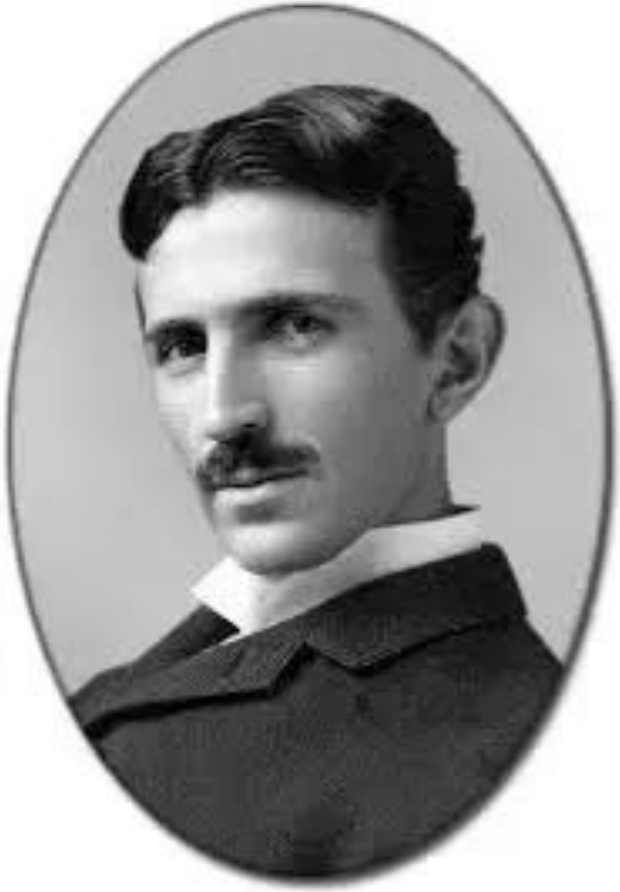

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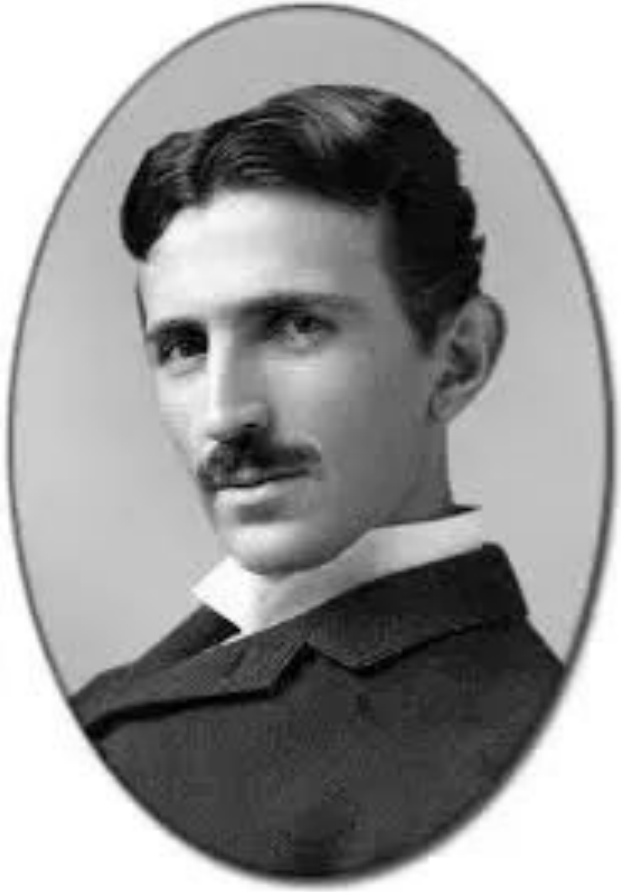

NEW LINES MAGAZINE

/Newsletter Week in Review | 5 MIN READ

The True Origins of Hummus

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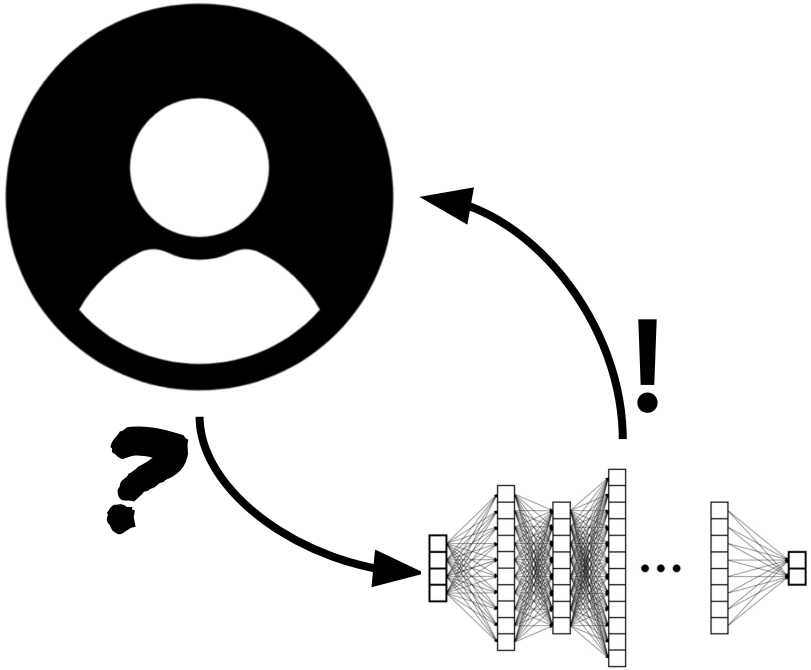

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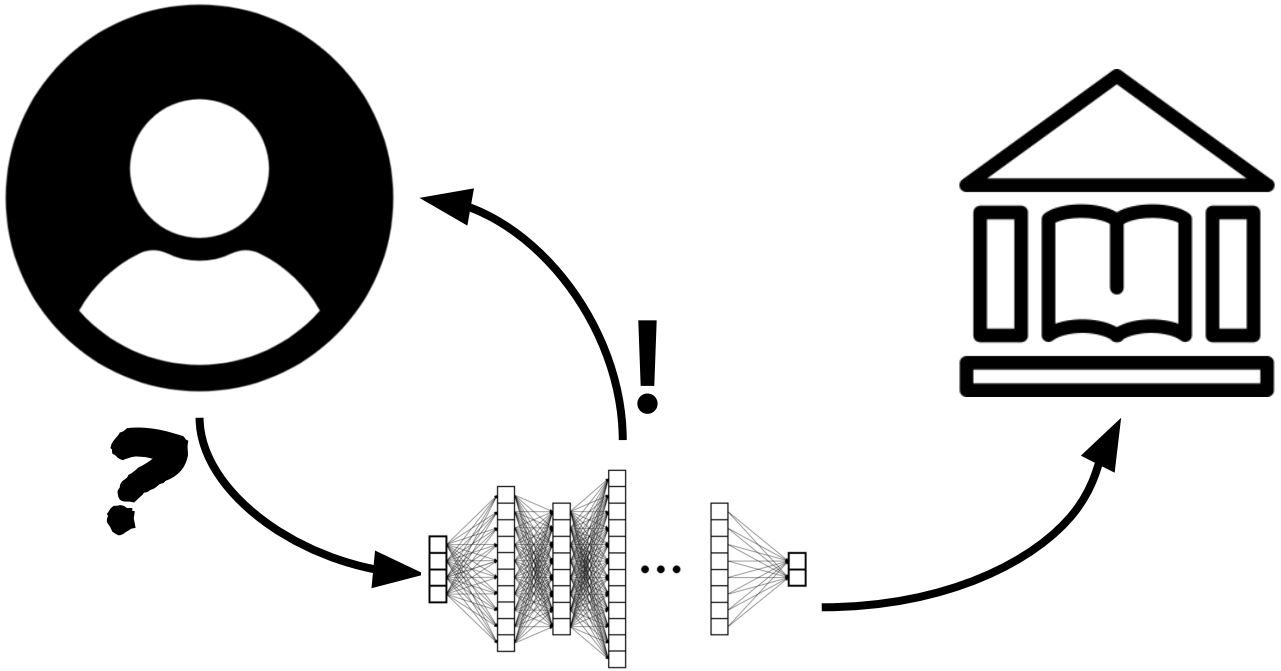

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Retrieval-Augmented Generation (RAG)

What are the ten largest cities with a female mayor?

Searched 6 sites

Here are ten of the largest U.S. cities currently led by female mayors:

1. **Los Angeles, CA** - Mayor Karen Bass (since 2022), population ~3.97 million
2. **Phoenix, AZ** - Mayor Kate Gallego (since 2019), population ~1.7 million
3. **Philadelphia, PA** - Mayor Cherelle Parker (since 2024), population ~1.57 million
4. **Jacksonville, FL** - Mayor Donna Deegan (since 2023), population ~950,000
5. **Fort Worth, TX** - Mayor Mattie Parker (since 2021), population ~928,000
6. **Charlotte, NC** - Mayor Vi Alexander Lyles (since 2017), population ~900,000
7. **San Francisco, CA** - Mayor London Breed (since 2018), population ~867,000
8. **Washington, D.C.** - Mayor Muriel Bowser (since 2015), population ~713,000
9. **Boston, MA** - Mayor Michelle Wu (since 2021), population ~692,000
10. **Las Vegas, NV** - Mayor Carolyn Goodman (since 2011), population ~662,000

(Wikipedia)(Ballotpedia)(Women Mayors).

What are the ten largest cities with a female mayor world wide?

Searched 2 sites

Here are ten of the largest cities worldwide currently led by female mayors:

1. **Tokyo, Japan** – Yuriko Koike
2. **Mexico City, Mexico** – Claudia Sheinbaum (until recently)
3. **Paris, France** – Anne Hidalgo
4. **Bangkok, Thailand** – Aswin Kwanmuang (acting mayor)
5. **Sydney, Australia** – Clover Moore
6. **Montréal, Canada** – Valérie Plante
7. **Rome, Italy** – Virginia Raggi
8. **Berlin, Germany** – Franziska Giffey
9. **Warsaw, Poland** – Hanna Gronkiewicz-Waltz (former mayor)
10. **Madrid, Spain** – Manuela Carmena (former mayor)(Women Mayors)(Ballotpedia).

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can you list their populations?

Searched 3 sites

Here are ten of the largest cities worldwide currently led by female mayors, along with their estimated populations:

1. **Tokyo, Japan** - Governor Yuriko Koike: Approximately 14 million residents.
2. **Paris, France** - Mayor Anne Hidalgo: Around 2.1 million people.
3. **Mexico City, Mexico** - Mayor Claudia Sheinbaum: 9.2 million people.
4. **São Paulo, Brazil** - Mayor Marina Helou: About 12.4 million people.
5. **Lima, Peru** - Mayor Patricia Chirinos: 9.7 million people.
6. **Hong Kong, China** - Chief Executive Carrie Lam: Around 7.5 million people.
7. **Melbourne, Australia** - Lord Mayor Sally Capp: Population around 5 million.
8. **Barcelona, Spain** - Mayor Ada Colau: Approximately 1.6 million people.
9. **Stockholm, Sweden** - Mayor Karin Wanngård: About 975,000 people.
10. **Montreal, Canada** - Mayor Valérie Plante: Roughly 1.8 million people(C40 Cities) (World Bank Blogs).

These mayors are also recognized for their roles in various global initiatives, including climate action and urban development.

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(World Bank Blogs).

WORLD MAYOR 2023
All the winners of the 2023 World Mayor Prize and Awards

Largest cities in the world and their mayors

Largest cities with women mayors

IN THIS SECTION: Introduction to largest cities and their mayors ||| Largest cities and their mayors: 1 to 300 ||| Largest cities and their mayors in alphabetical order ||| Largest cities and their mayors country by country ||| Largest cities with women mayors ||| Capital cities and their mayors (A to Z by cities) ||| Capital cities and their mayors (A to Z by countries) |||

ON OTHER PAGES: Women mayors 2022 ||| World's capital cities with women mayors ||| Women mayors in Europe ||| Europe's most powerful female mayors ||| American women mayors |||

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IN OTHER SECTIONS

Women in US local government
World Mayors and politics
Voter turnout - an international comparison

Salaries of German mayors
Salaries of British mayors

Largest cities in the world and their mayors (2017)
Largest cities with women mayors (2017)
Capital cities and their mayors (2017)

Mayors in Europe and their powers (2018)

African American Mayors
Belgian Mayors (2020)
British Mayors (2020)
Canadian Mayors (2021)
French Mayors (2020)
German mayors (2021)
Indian mayors (2021)
Italian mayors (2021)
Japanese mayors (2020)
Polish mayors (2020)
Spanish mayors (2020)

The largest cities in the world with women mayors

July 2017: The table lists the largest cities in the world with women mayors. Of the world's largest 300 cities only 25 are governed by women, although a number of European capitals, including Rome, Madrid, Paris, Warsaw and Stockholm, have women mayors. The world's most powerful woman in local government is Yuriko Koike the Governor (Mayor) of Tokyo. Other influential female city leaders include the mayors of Sydney, Surabaya, Havana, Perth, Barcelona and Cape Town.

Tokyo Mayor
Yuriko Koike

Surat Mayor
Ashmita Shiroya

Sydney Mayor
Clover Moore

The research was carried out during May and June 2017. For the population data, the researchers consulted numerous national and international sources and in cases of large statistical inconsistencies elected to publish cautious averages. The figures for city populations comprise the number of residents within the unified administrative areas of cities, while the data for metro populations include residents of urban areas that are socially, culturally and economically dependent on the core city. (Please note, there is no internationally agreed definition of metro areas.) Readers and scholars are invited to inform of any discrepancies and/or provide missing facts and figures.

Largest cities with women mayors

World rank	City (caps denote capital cities)	Country	City population	Metro population	Mayor
6	**TOKYO**	Japan	**13,617,000**	37,800,000	**Yuriko Koike (Ms)**
56	**Sydney**	Australia	**5,005,000**	5,005,000	**Clover Moore (Ms)**
62	**Surat**	India	**4,467,000**	4,591,000	**Ashmita Shiroya (Ms)**
74	**Yokohama**	Japan	**3,733,000**	3,733,000	**Fumiko Hayashi (Ms)**

what are the largest cities with a female mayor in the south of Germany?

Searched 3 sites

In southern Germany, several significant cities currently have female mayors:

1. **Munich (München)** - Eva Weber has been the mayor of Augsburg since 2020, representing the conservative CSU party. With a population of around 297,000, it is one of the largest cities in Bavaria with a female leader GERMAN BRIEF WIKIPEDIA .
2. **Regensburg** - Gertrud Malts-Schwarzfischer, affiliated with the SPD (center-left), has been mayor since 2020. Regensburg has a population of approximately 154,000 GERMAN BRIEF WIKIPEDIA .
3. **Freiburg im Breisgau** - Though smaller than Munich, it is a key city in Baden-Württemberg with a population of about 237,000. However, its current mayor is not female WIKIPEDIA RU GELD .

These examples highlight a growing presence of female leadership in prominent southern German cities, especially in Bavaria. Let me know if you want more details about their tenure or political background!

Was sind die zehn größten Städte im Süden Deutschlands mit einem weiblichen Bürgermeister, sortier nach Bevölkerungszahl?

Searched 5 sites

In Süddeutschland gibt es nur wenige Großstädte mit einer weiblichen Bürgermeisterin, da Frauen in solchen Positionen immer noch unterrepräsentiert sind. Hier sind die zehn größten Städte mit weiblichen Stadtoberhäuptern, soweit verfügbar, basierend auf der Einwohnerzahl (Stand: 2024):

1. **München, Bayern** – Dietlind Grabe-Bolz (*Beispiel für den Frauenanteil in städtischen Gremien*)
2. **Karlsruhe, Baden-Württemberg** – Frank Mentrup (*Männlich, kein Beispiel von Frauen – geringe Dichte Frauen Spitzenämter)*

Die Liste deckt nur Städte unter 80k.., Sind Flexibilisiert wenn gezeigt können overz'''

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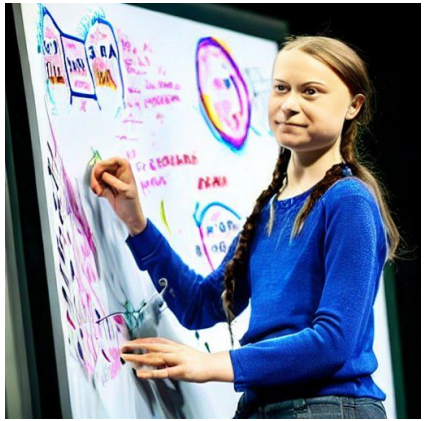
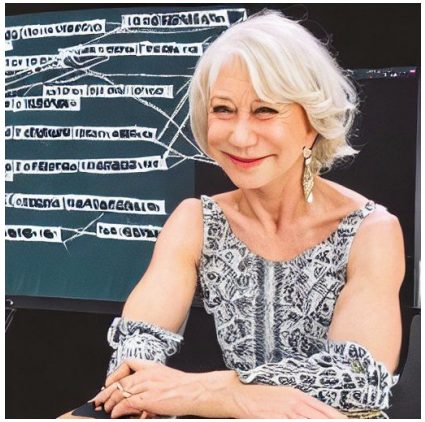
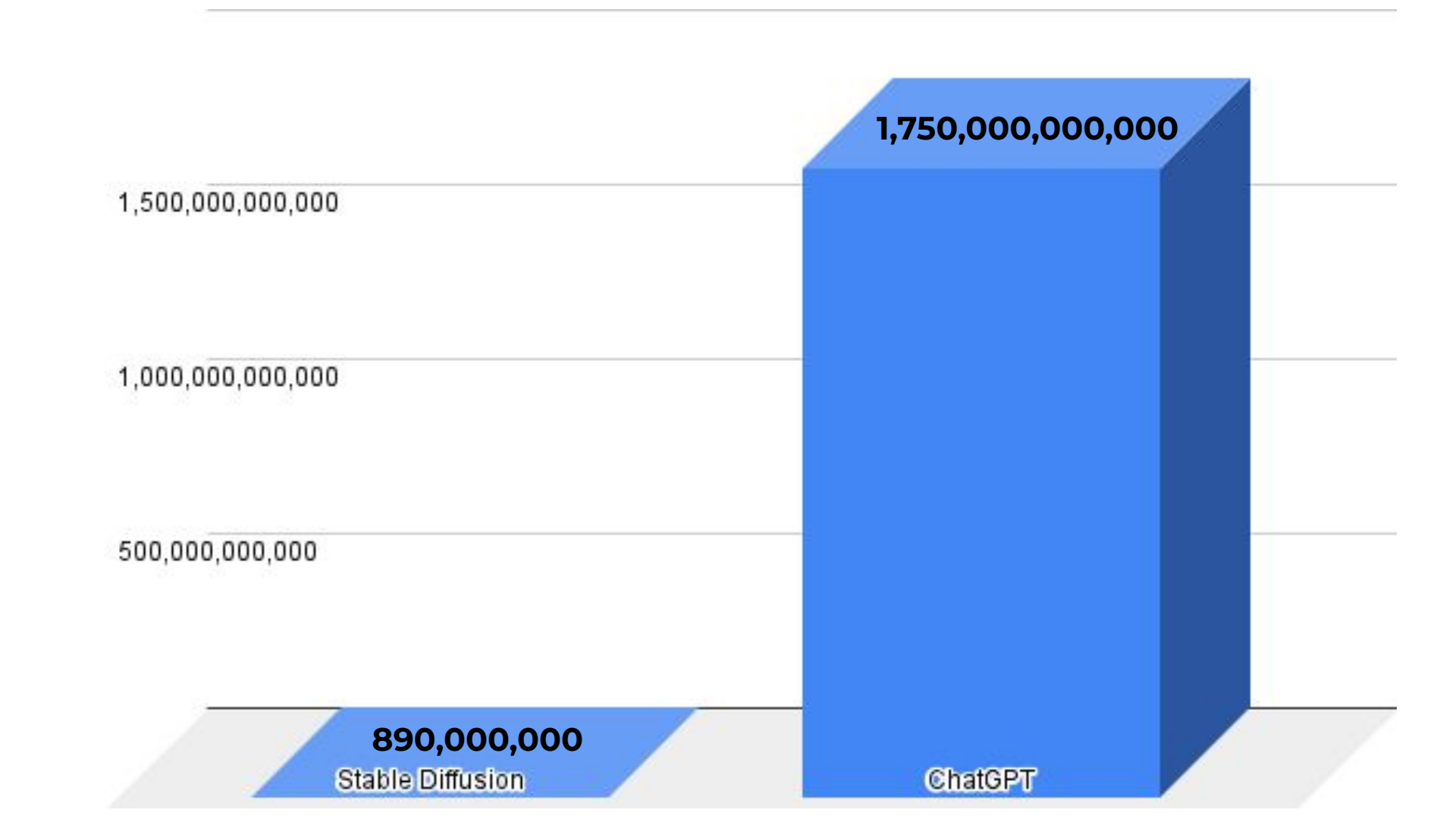
Stable Diffusion





Public Domain, All images generated by Stable Diffusion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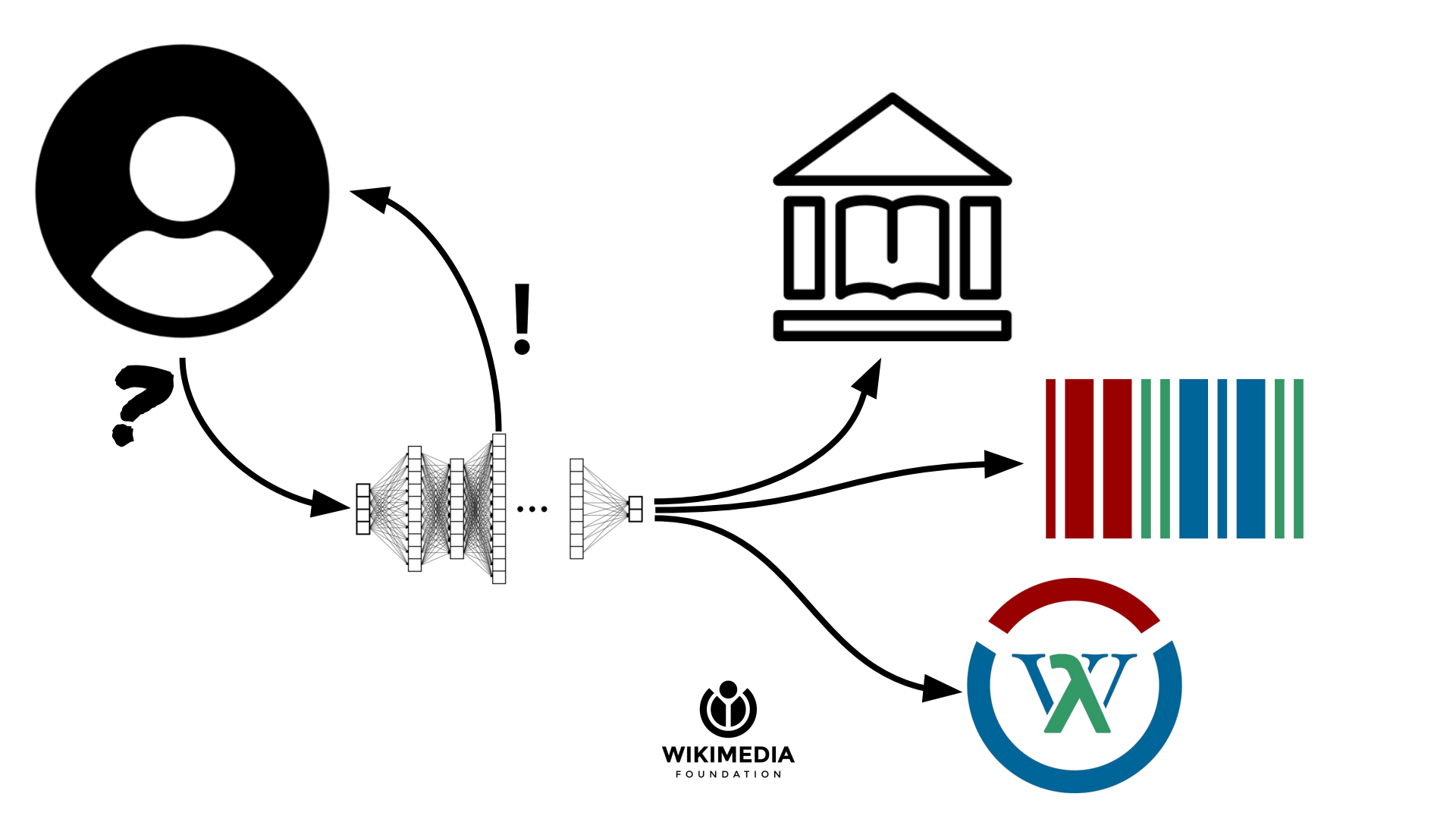
Stable Diffusion
ChatGPT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- Open Knowledge Graph
- Launched 2012
- Structured linked data
- Persistent identifiers
- Multilingual
- Used by Wikipedia

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metaphacts

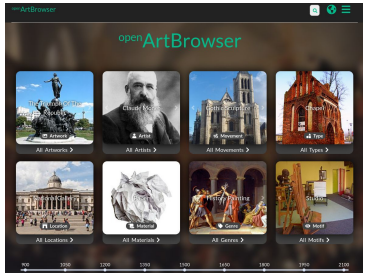
BBC

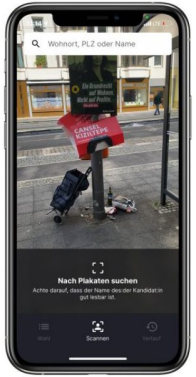
Google

OPEN LIBRARY

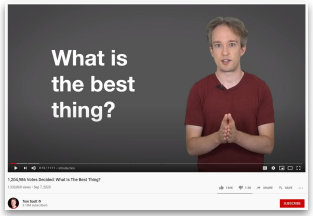
mySociety

Lufthansa





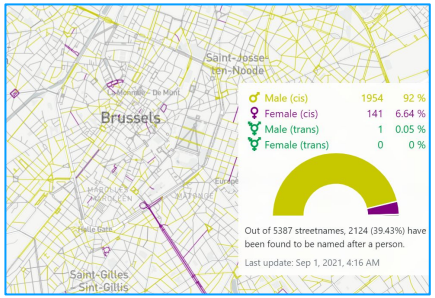
OCCRP



Quora

amazon

reddit



WolframAlpha

Microsoft

ontotext

114,580,647 items

1,623,612,796 statements

494 languages

24,757
monthly contributors

500,000+ contributors in total

2,278,893,801 edits

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Can I ask Wikidata for a list of the world’s ten largest cities with a female mayor?

Can I ask Wikidata for a list of the world's ten largest cities with a female mayor?

city	cityLabel	population	mayorLabel
wd:Q1353	Delhi	26495000	Shelly Oberoi
wd:Q1490	Tokyo	14264798	Yuriko Koike
wd:Q42956	Harbin	10009854	Sun Zhe
wd:Q2887	Santiago	6257516	Irací Hassler
wd:Q3624	Addis Ababa	5228000	Adanech Abebe
wd:Q34647	Johannesburg	4434827	Mpho Phalatse
wd:Q65	Los Angeles	3898747	Karen Bass
wd:Q7903	Casablanca	3499000	Nabila Rmili
wd:Q245023	Taichung	3033885	Lu Shiow-yen
wd:Q1475	Quezon City	2960048	Joy Belmonte

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wd:Q3624	Addis Ababa	5228000	Adanech Abebe
wd:Q34647	Johannesburg	4434827	Mpho Phalatse
wd:Q65	Los Angeles	3898747	Karen Bass
wd:Q7903	Casablanca	3499000	Nabila Rmili
wd:Q245023	Taichung	3033885	Lu Shiow-yen
wd:Q1475	Quezon City	2960048	Joy Belmonte
wd:Q172	Toronto	2794356	Olivia Chow

can you write a SPARQL query for wikidata asking for the ten largest cities with a female mayor in the world?

Here is a SPARQL query you can use to retrieve the ten largest cities with a female mayor from Wikidata:

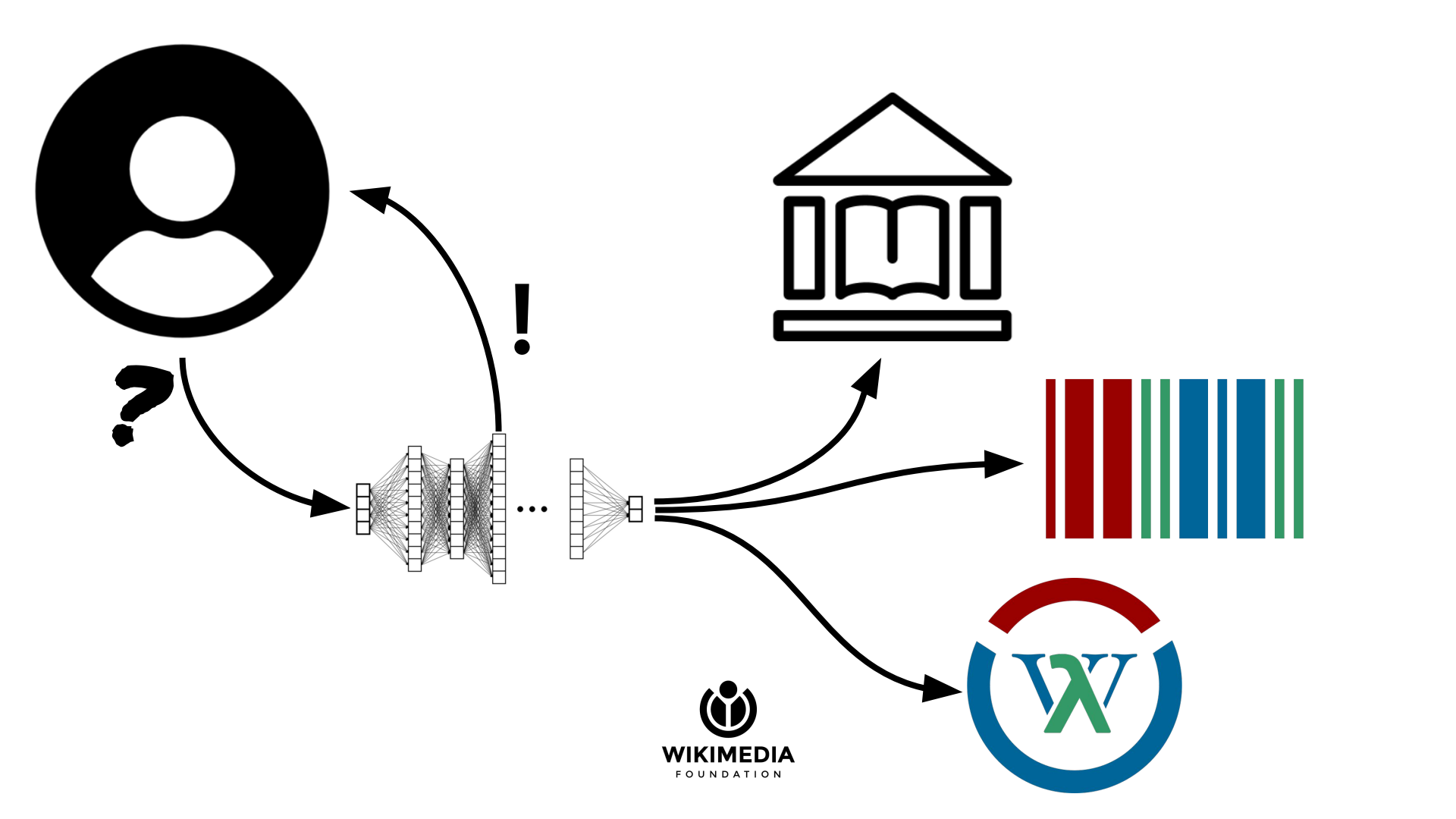
sparql Copy code

```sparql
SELECT ?cityLabel ?population ?mayorLabel ?countryLabel WHERE {
  ?city wdt:P31 wd:Q515;              # Find cities
        wdt:P6 ?mayor;                # Get their mayor
        wdt:P1082 ?population;        # Get population
        wdt:P17 ?country.             # Get the country

  ?mayor wdt:P21 wd:Q6581072.         # Filter to only female mayors

  SERVICE wikibase:label {            # Get the labels (names)
    bd:serviceParam wikibase:language "[AUTO_LANGUAGE],en".
  }
}
ORDER BY DESC(?population)            # Order by population (largest first)
LIMIT 10                              # Limit to 10 results
```

You can run this query on Wikidata's Query Service to get up-to-date information.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WIKIFUNCTIONS

- First new Wikimedia project since 2012
- Started last year
- Multilingual (natural & programming)
- Library of functions

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Functions are knowledge

Caesar cipher (Latin alphabet) Z12812

Function

Help

Page Discussion Read Edit source View history Tools

About

English

Caesar cipher (Latin alphabet)

rotates letters in the Latin alphabet forward by a defined number of places

Caesar shift

Inputs

string: String

shift: Natural number

Output

String

10 languages

Try this function

Enter inputs

- string •••

SWIB

- shift •••

11

Run function

Result

- "DHTM"

Details

Implementations

Name	Status	Language	Passed tests
Caesar cipher in Python	Connected	Python	5/5

encode NATO phonetic alphabet code Z10309

Function

About

English
encode NATO phonetic alphabet code

requires ALLCAPS input, e.g. EXAMPLE

No aliases provided.

Inputs

value: String

Output

String

8 languages

Try this function

Enter inputs

- value •••

SWIB

Run function

Result

- "SIERRA WHISKEY INDIA BRAVO"

Details

Implementations

Name	Status	Language	Passed tests
Python encode NATO phonetic alphabet	Connected	Python	4/5
Javascript encode NATO phonetic alphabet	Disconnected	JavaScript	5/5

Is Gregorian year leap year? Z20181

Function

Help

About

English
Is Gregorian year leap year?

No description or aliases provided.

Inputs

Year: Gregorian year

Output

Boolean

1 language

Try this function

Enter inputs

- Year •••
  - type •••
    - Gregorian year
  - era •••
    - AD
  - number •••
    - 1900

Run function

Result

false

Details

Celsius to Fahrenheit Z16487

Function

Help

Page Discussion Read Edit source View history Tools

About

English
Celsius to Fahrenheit

Converts Celsius (°C) to Fahrenheit (°F)

No aliases provided.

Inputs

Celsius (°C): String

Output

String

3 languages

Try this function

Enter inputs

- Celsius (°C) •••

-3

Run function

Result

- "26.6"

Details

Implementations

Name	Status	Language	Passed tests
°C to °F, python	Connected	Python	2/3

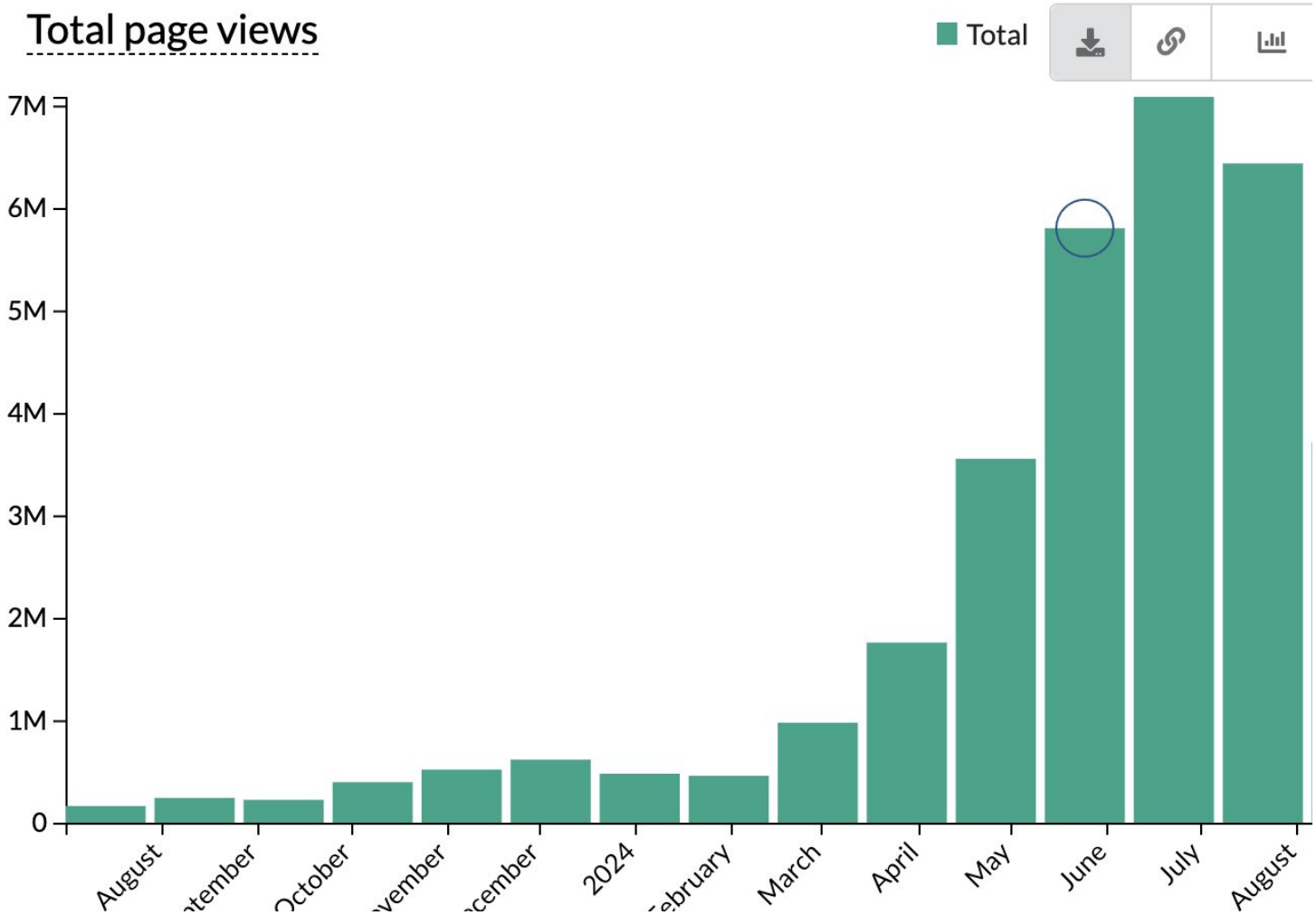
How to search for functions?

1792 functions

126 languages

WIKIMEDIA
FOUNDATION

52
countries



WIKIMEDIA FOUNDATION

Wikifunctions

- Allow everyone access to functions
- Allow implementations without knowing English
- Natural language generation library for 300+ languages
- … to create Wikipedia text

Suffix a verb to get it imperative form (Igbo) Z11353

Function

About

English

Suffix a verb to get it imperative form (Igbo)

Suffixing a verb to get it imperative verb as long as the verb ends with any vowel letter. E.g imperative form of 'ga' is 'gaa'

Igbo imperative verb

Igbo add suffix to form imperative verb

Inputs

Enter verb: String

Output

String

5 languages

Try this function

Enter inputs

- Enter verb •••

gụ

Run function

Result

- "gụọ"

Details

Implementations

Name	Status	Language	Passed tests
Get the imperative form	Connected	JavaScript	3/3

plural form of lexeme as monolingual text Z19260

Function

Help

About

English
plural form of lexeme as monolingual text

returns the first listed plural form of a lexeme as monolingual text

No aliases provided.

Inputs

lexeme: Wikidata lexeme

Output

Monolingual text

2 languages

Try this function

Enter inputs

lexeme

goose

Run function

Result

EN geese

Details

Implementations

Name	Status	Language	Passed tests
plural form of lexeme, composition	Connected	Composition	3/3
plural form of lexeme as monolingual string, JS	Connected	JavaScript	3/3

English possessive Z11302

Function

About

English
English possessive

makes a noun or pronoun (either subjective or objective) possessive, but use a different function for possessive determiners. see https://en.wikipedia.org/wiki/English_possessive

No aliases provided.

Inputs

noun or pronoun to be made possessive: String

Output

String

6 languages

Try this function

Enter inputs

- noun or pronoun to be made possessive •••

Germany

Run function

Result

- "Germany's"

Details

Implementations

	Name	Status	Language	Passed tests
☐	add ' if it ends with "s", otherwise add 's	Disconnected	Composition	2/7
☐	English possessive, python	Connected	Python	7/7

Tests

cardinal direction of a location(South, Germany, English) →
“the south of Germany”

cardinal direction of a location(South, Germany, German) →
“der Süden Deutschlands”

cardinal direction of a location(South, Germany, Croatian) →
“jug Njemačke”

cardinal direction of a location(South, Germany, French) →
“le sud de l'Allemagne”

cardinal direction of a location(South, Germany, Malayalam) →
“ജർമ്മനിയുടെ തെക്ക്”

class with qualifier(mayor, female, English) →
“female mayor”

class with qualifier(mayor, female, German) →
“weiblicher Bürgermeister”

class with qualifier(mayor, female, Croatian) →
“ženski gradonačelnik”

class with qualifier(mayor, female, French) →
“femme maire”

class with qualifier(mayor, female, Malayalam) →
“വനിതാ മേയർ”

“female mayor
in southern Germany”

“Käthe Winkelmann was the first female mayor in southern Germany.”

WIKIDATA

WIKIFUNCTIONS

```
FirstWho
  Person: Käthe Winkelmann
  Role: Role
    Role: SpecifiedClass
      Specifier: female
      Class: mayor
    Location: CardinalLocation
      Cardinal: South
      Location: Germany
```

```
“$Person was
the first $role
in $location.”
```

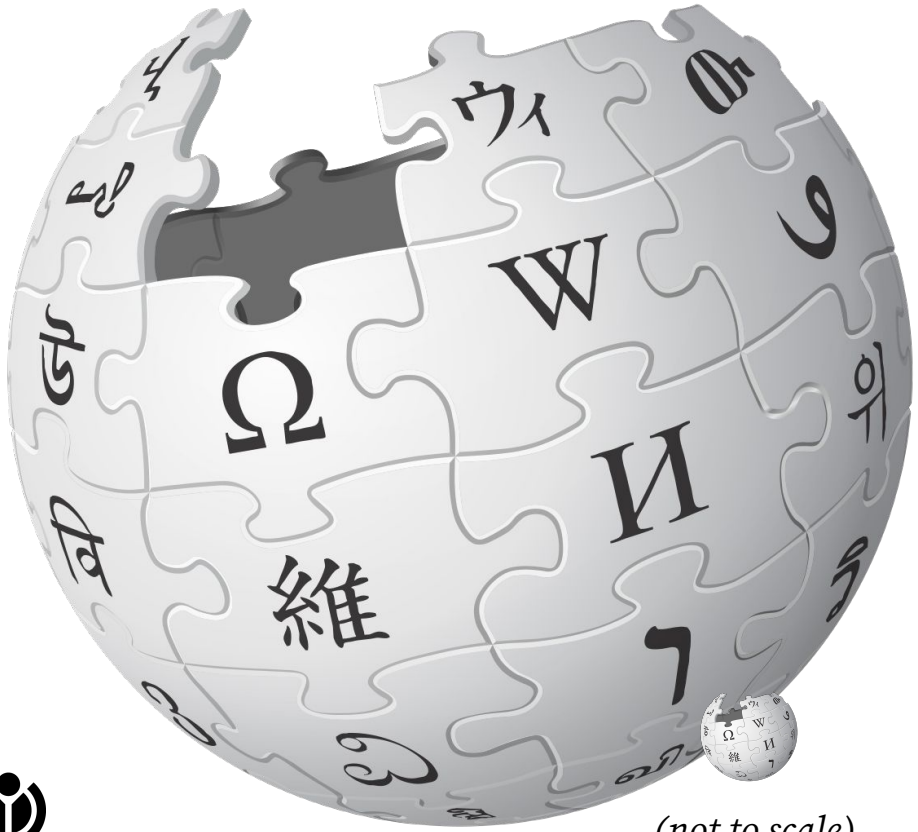
Käthe Winkelmann is the first female mayor in the south of Germany.

WIKIMEDIA FOUNDATION

Very unevenly distributed

English: 6,487,359

Turkmen: 6,888



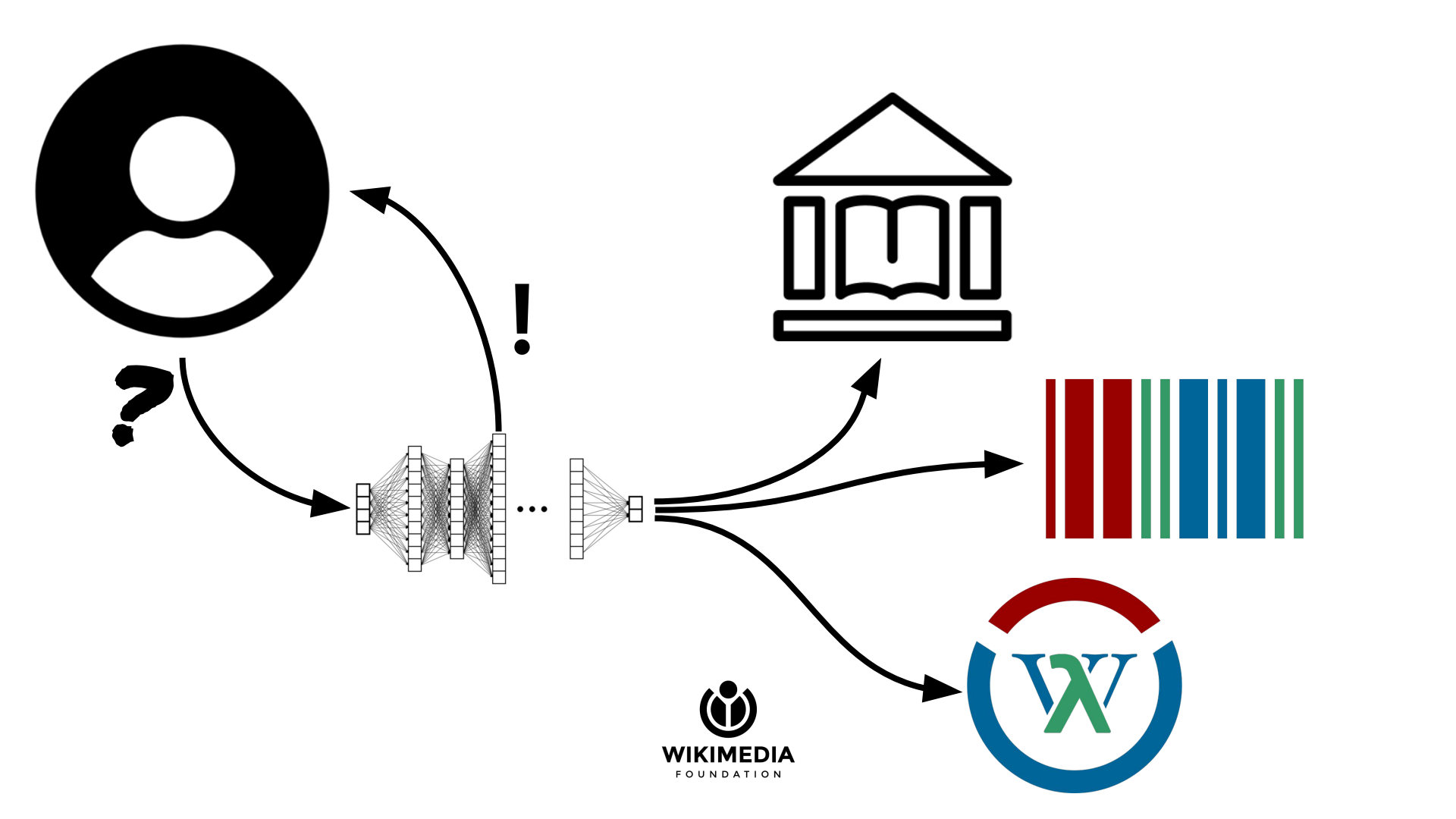
(not to scale)

WIKIMEDIA FOUNDATION

How can LLMs help with Knowledge Representation

- LLMs: good formal translators
- Example: questions to SPARQL
- Allows complex formalisms
- Beyond brittleness of Wikidata
- Cover exceptions and fuzziness
- Less training required

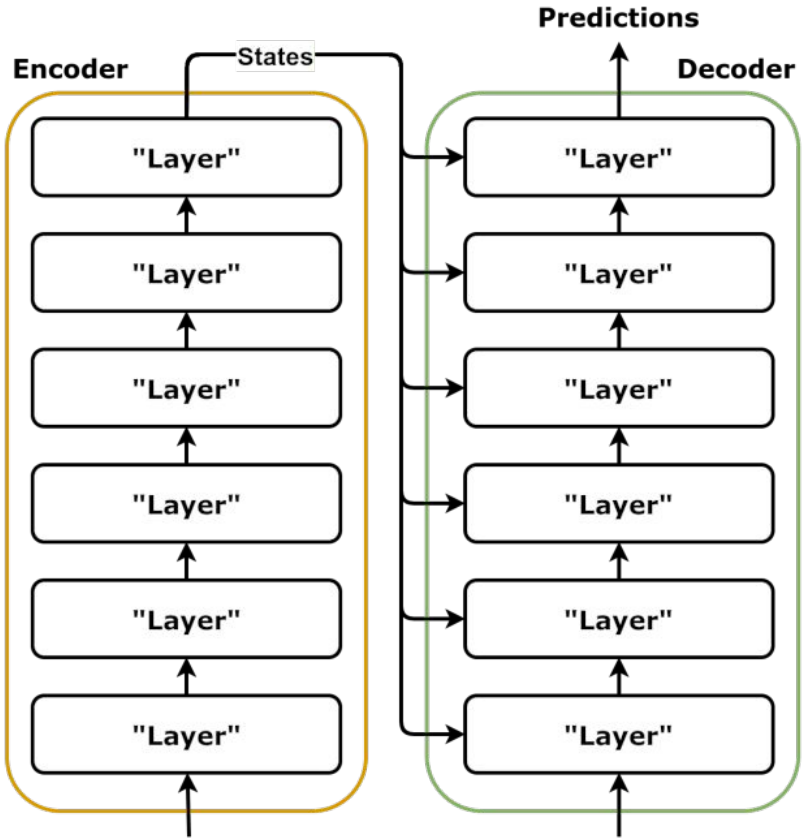
WIKIMEDIA
FOUNDATION


?
!
...
WIKIMEDIA
FOUNDATION

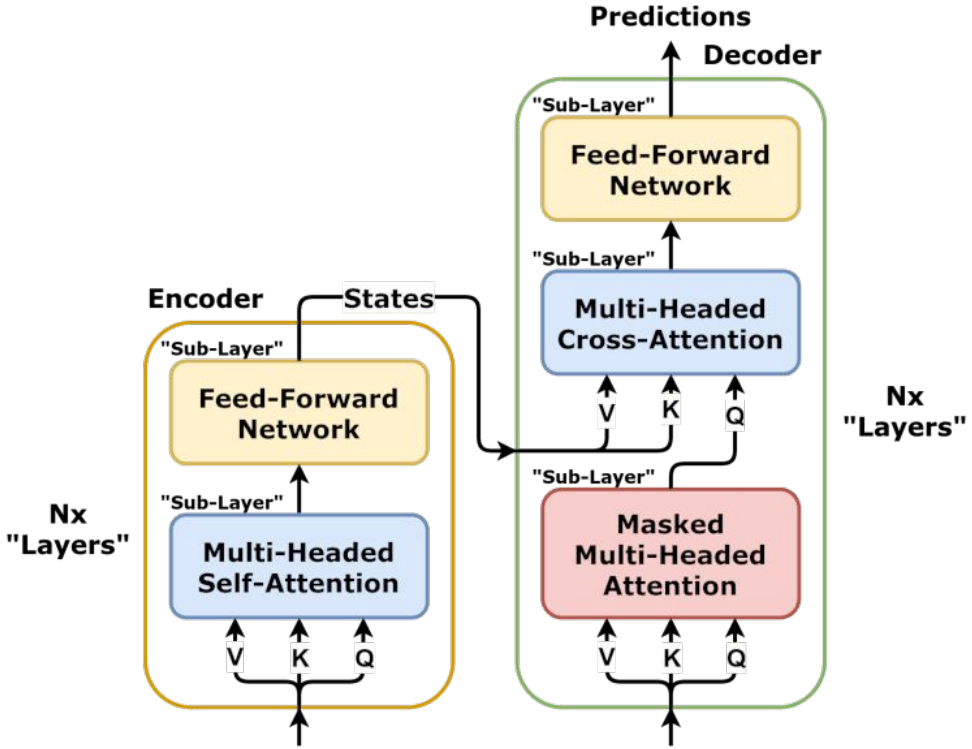
Imagine a world where everyone can share in the sum of all knowledge

Contact me
denny@wikimedia.org

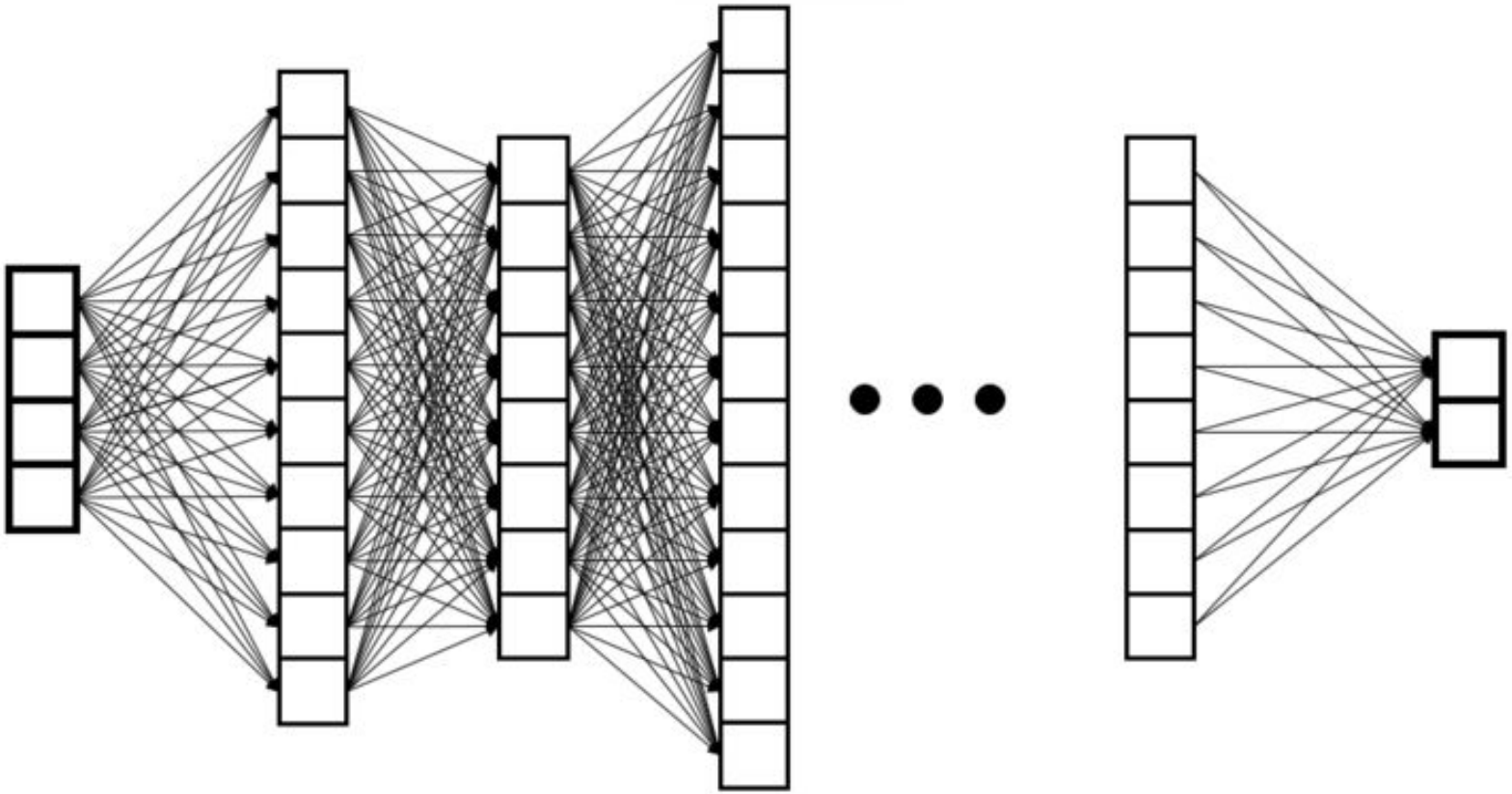
Contact me
denny@wikimedia.org



(a) Stacked "Layers"



(b) Stacked "Layers" in detail



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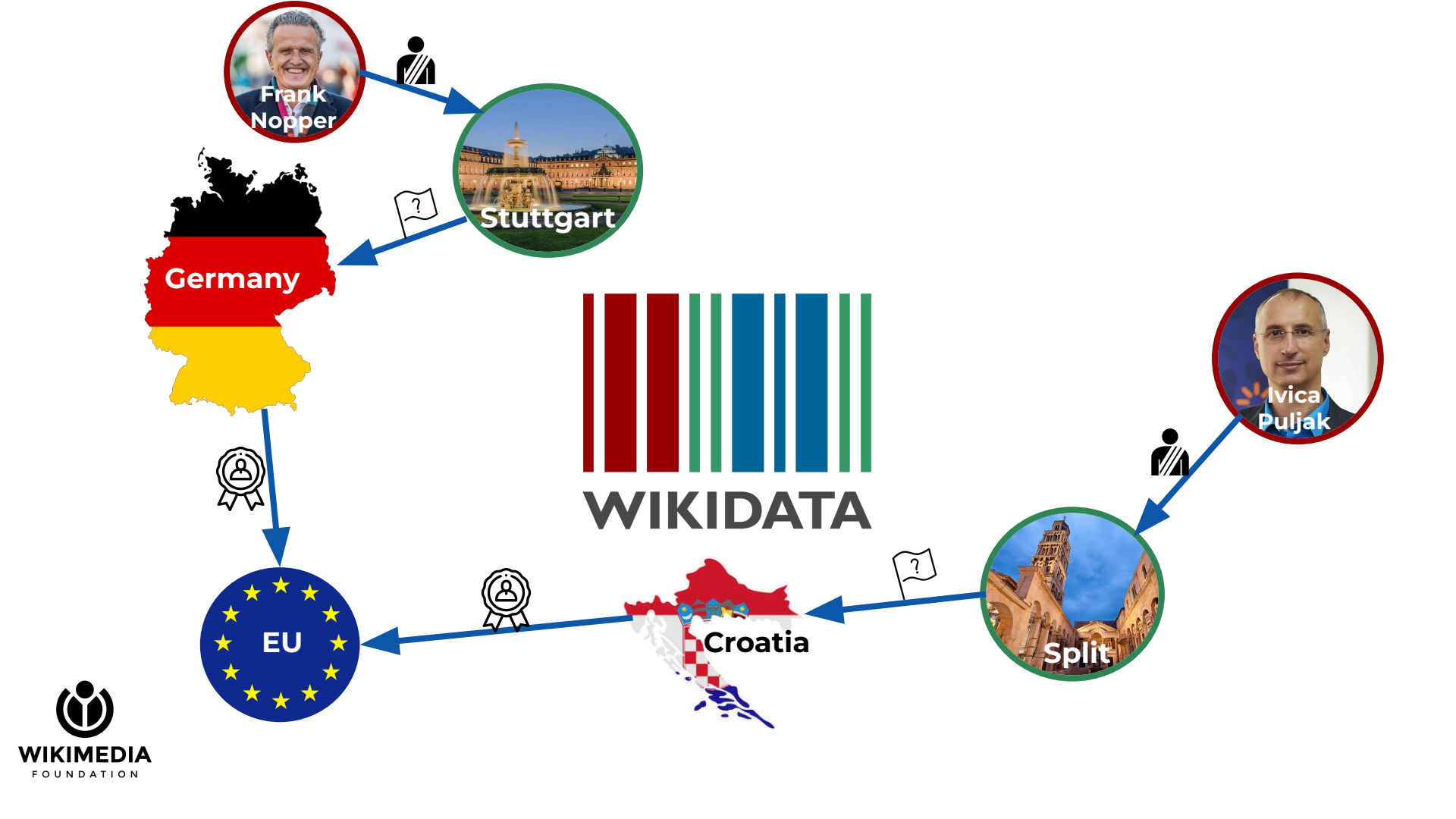
Frank Nopper
Stuttgart
Germany
WIKIDATA
Ivica Puljak
EU
Croatia
Split
WIKIMEDIA
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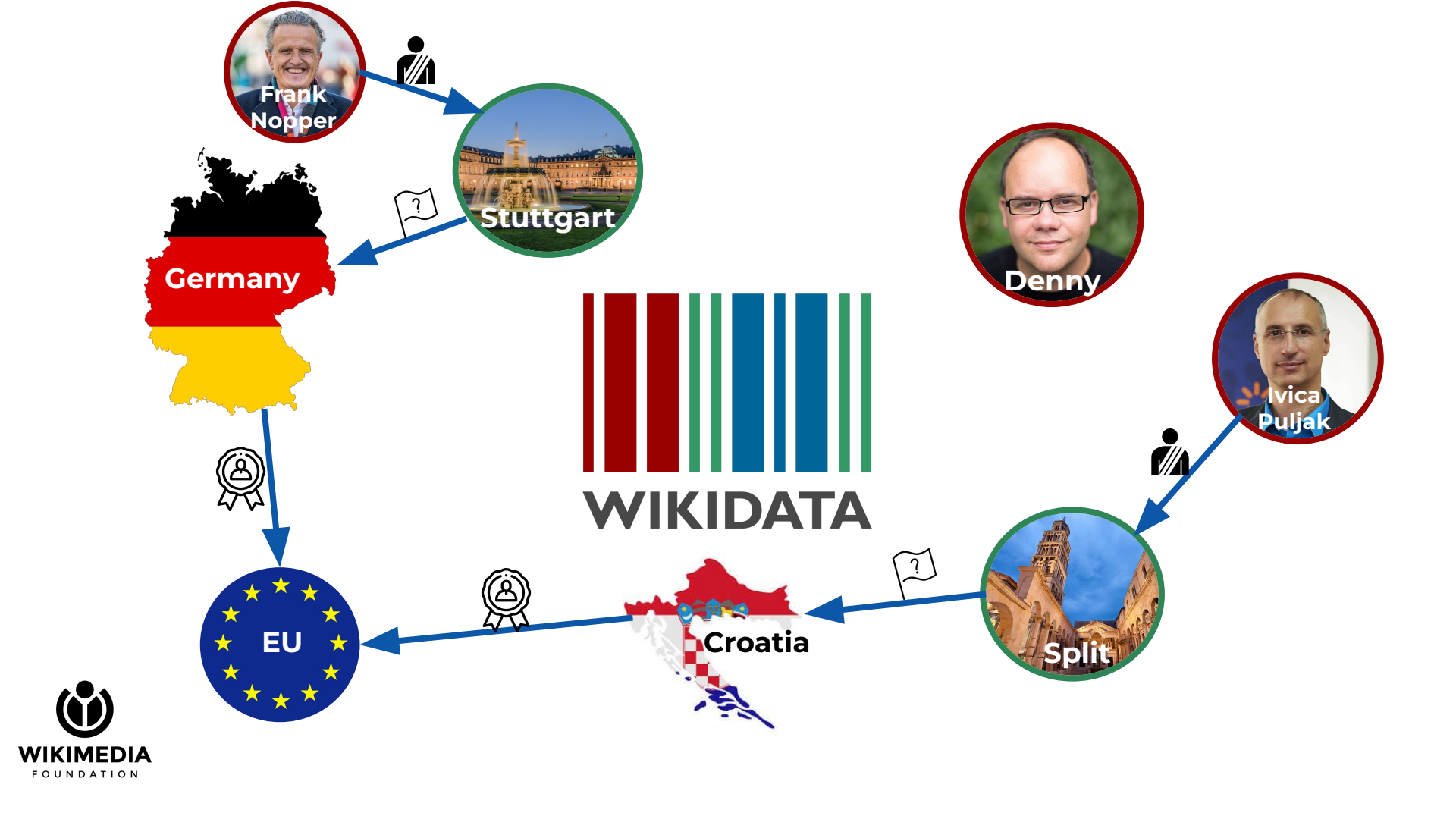
Frank Nopper
Stuttgart
Germany
Denny
Ivica Puljak
WIKIDATA
EU
Croatia
Split
WIKIMEDIA
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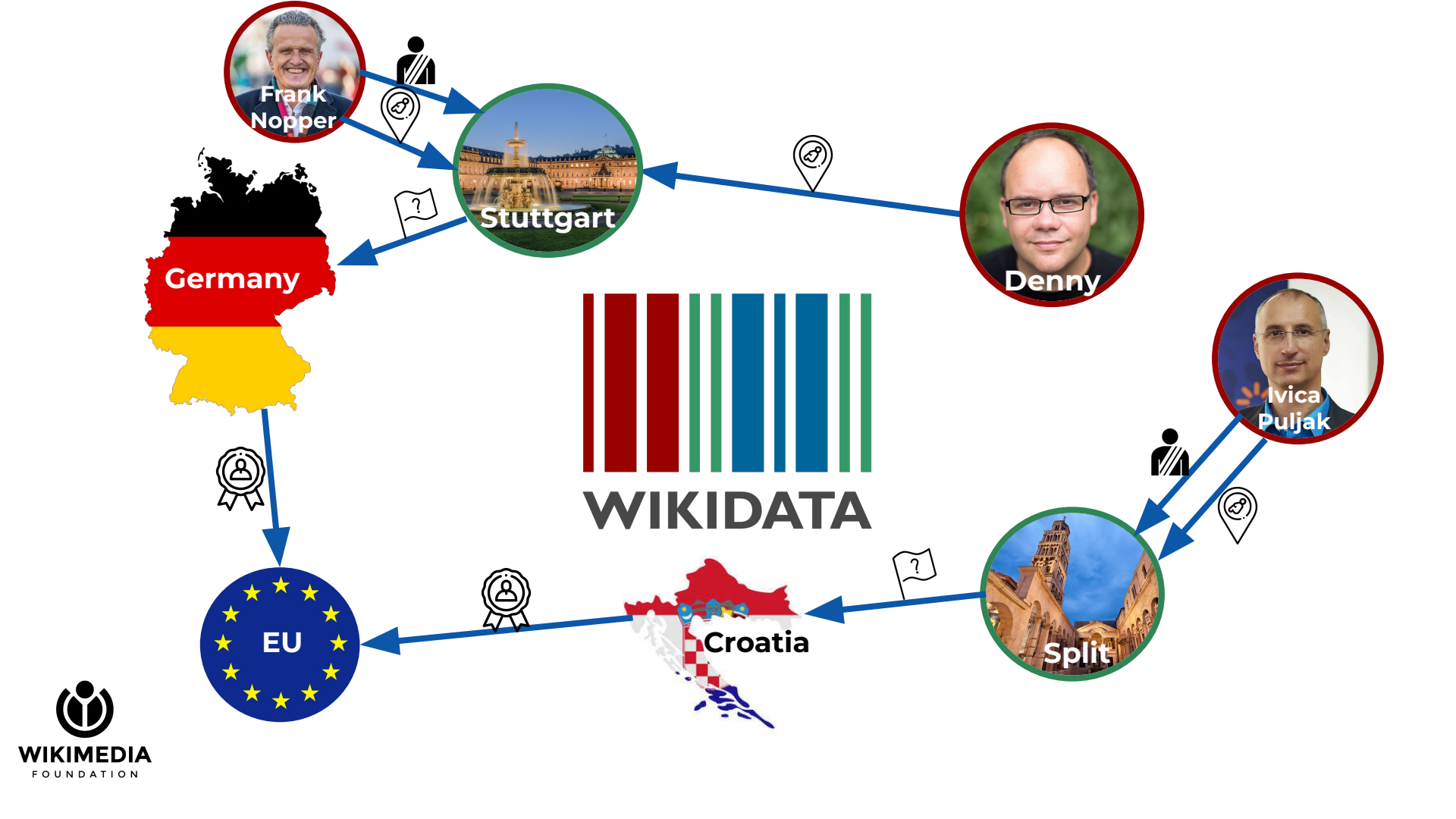
Frank Nopper
Stuttgart
Denny
Germany
WIKIDATA
Ivica Puljak
EU
Croatia
Split
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SHARP
10 Digit
ELSI MATE EL-377T
TWIN POWER CALCULATOR
RATE SET
RATE RECALL
+TAX
−TAX
R·CM
M−
M+
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C·CE
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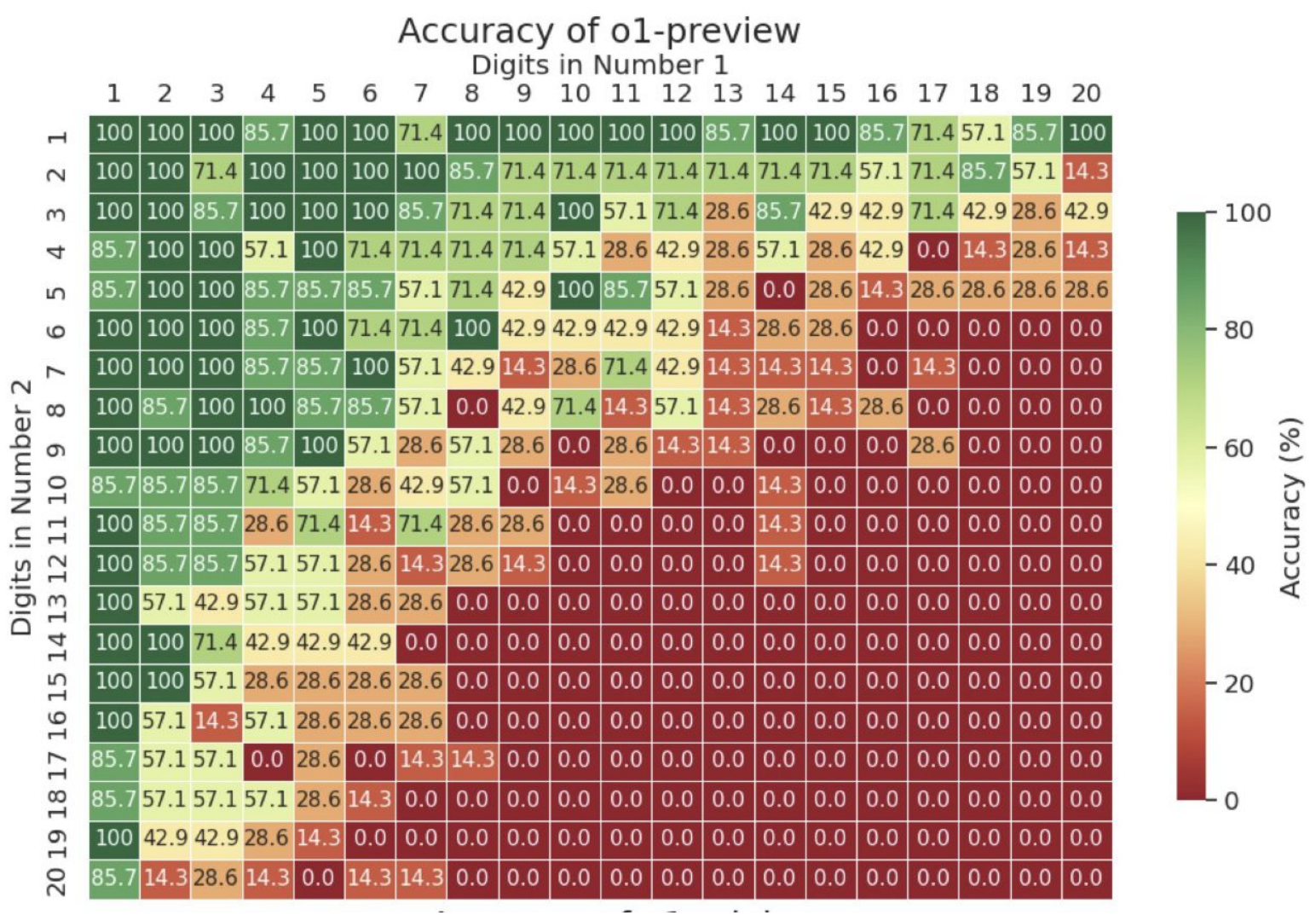
Accuracy of o1-preview
Digits in Number 1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Digits in Number 2
1 100 100 100 85.7 100 100 71.4 100 100 100 100 100 85.7 100 100 85.7 71.4 57.1 85.7 100
2 100 100 71.4 100 100 100 100 85.7 71.4 71.4 71.4 71.4 71.4 71.4 71.4 57.1 71.4 85.7 57.1 14.3
3 100 100 85.7 100 100 100 85.7 71.4 71.4 100 57.1 71.4 28.6 85.7 42.9 42.9 71.4 42.9 28.6 42.9
4 85.7 100 100 57.1 100 71.4 71.4 71.4 71.4 57.1 28.6 42.9 28.6 57.1 28.6 42.9 0.0 14.3 28.6 14.3
5 85.7 100 100 85.7 85.7 85.7 57.1 71.4 42.9 100 85.7 57.1 28.6 0.0 28.6 14.3 28.6 28.6 28.6 28.6
6 100 100 100 85.7 100 71.4 71.4 100 42.9 42.9 42.9 42.9 14.3 28.6 28.6 0.0 0.0 0.0 0.0 0.0
7 100 100 100 85.7 85.7 100 57.1 42.9 14.3 28.6 71.4 42.9 14.3 14.3 14.3 0.0 14.3 0.0 0.0 0.0
8 100 85.7 100 100 85.7 85.7 57.1 0.0 42.9 71.4 14.3 57.1 14.3 28.6 14.3 28.6 0.0 0.0 0.0 0.0
9 100 100 100 85.7 100 57.1 28.6 57.1 28.6 0.0 28.6 14.3 14.3 0.0 0.0 0.0 28.6 0.0 0.0 0.0
10 85.7 85.7 85.7 71.4 57.1 28.6 42.9 57.1 0.0 14.3 28.6 0.0 0.0 14.3 0.0 0.0 0.0 0.0 0.0 0.0
11 100 85.7 85.7 28.6 71.4 14.3 71.4 28.6 28.6 0.0 0.0 0.0 0.0 14.3 0.0 0.0 0.0 0.0 0.0 0.0
12 100 85.7 85.7 57.1 57.1 28.6 14.3 28.6 14.3 0.0 0.0 0.0 0.0 14.3 0.0 0.0 0.0 0.0 0.0 0.0
13 100 57.1 42.9 57.1 57.1 28.6 28.6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
14 100 100 71.4 42.9 42.9 42.9 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
15 100 100 57.1 28.6 28.6 28.6 28.6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
16 100 57.1 14.3 57.1 28.6 28.6 28.6 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
17 85.7 57.1 57.1 0.0 28.6 0.0 14.3 14.3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
18 85.7 57.1 57.1 57.1 28.6 14.3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
19 100 42.9 42.9 28.6 14.3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
20 85.7 14.3 28.6 14.3 0.0 14.3 14.3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Accuracy (%)
100
80
60
40
20
0

Inc.

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ARTIFICIAL INTELLIGENCE

How Many R's in 'Strawberry'? This AI Doesn't Know

Though this very powerful technology remains full of promise, a recently discovered glitch shows AI is imperfect, so keep double-checking its results.

BY KIT EATON @KITEATON

AUG 28, 2024

multiply two natural numbers Z13539

Function

Help

Page Discussion Read Edit source View history Tools

About

English

multiply two natural numbers

calculate the product of two natural numbers

multiplication product * +2

Inputs

multiplicand: Natural number

multiplier: Natural number

Output

Natural number

6 languages

Try this function

Enter inputs

- multiplicand •••
  - type •••
    - Natural number
  - value •••
    - 111
- multiplier •••
  - type •••
    - Natural number
  - value •••
    - 111

Run function

Result

- type
  - Natural number
- value
  - "12321"

Details

WIKIMEDIA FOUNDATION

count substrings Z14450

Function

Help

Page Discussion Read Edit source View history Tools

About

English
count substrings

returns the number of times a substring occurs in a string

string.count

Inputs

string: String

substring: String

Output

Natural number

5 languages

Try this function

Enter inputs

- string •••

strawberry

- substring •••

r

Run function

Result

- type

Natural number

- value

"3"

Details

WIKIMEDIA FOUNDATION

ChatGPT

Share

What's 37635674386 times 985344389348?

The product of 37,635,674,386 and 985,344,389,348 is 37,084,100,595,573,334,840,328.

Analysis

python

Always show details | Copy code

```python
# Calculating the product
result = 37635674386 * 985344389348
result
```

Result

```
3708410059557333484032 8
```