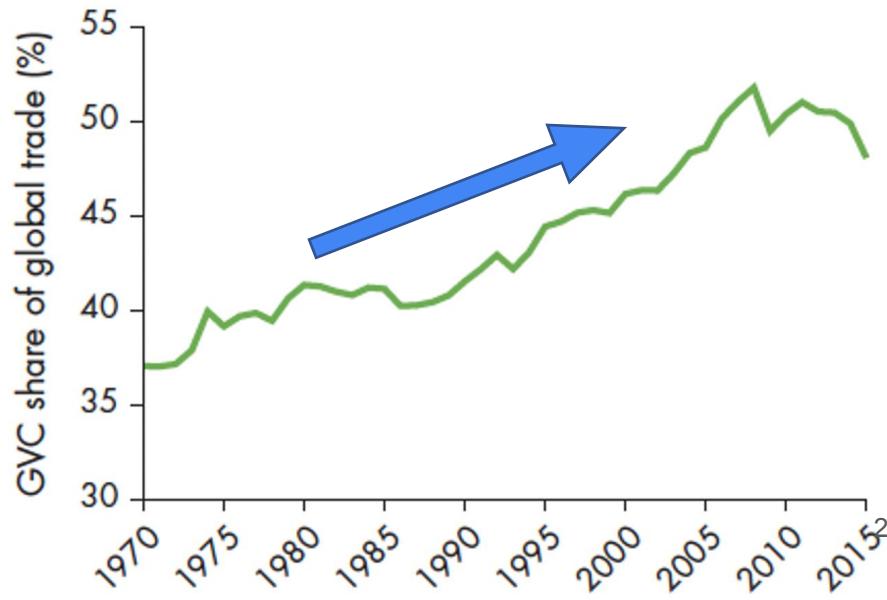
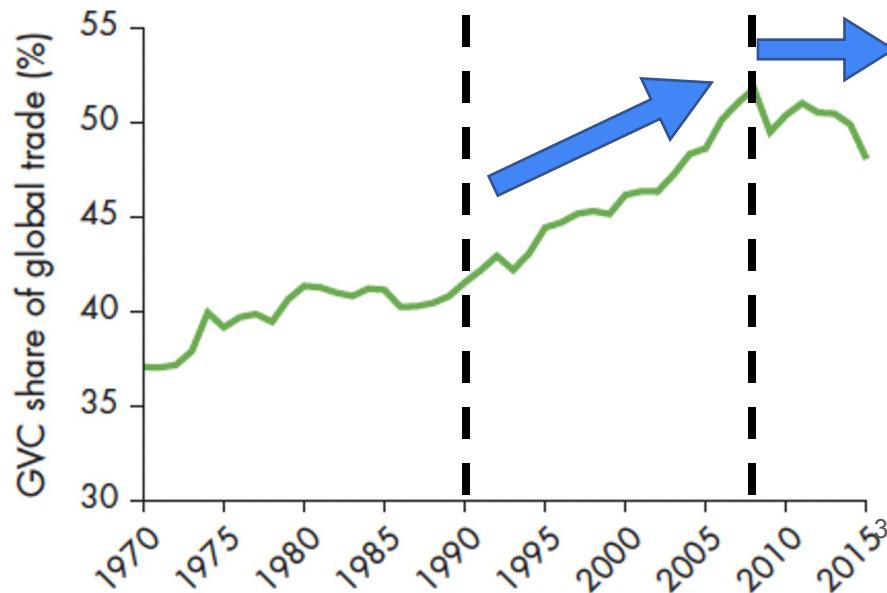


# Visualizations & NLP

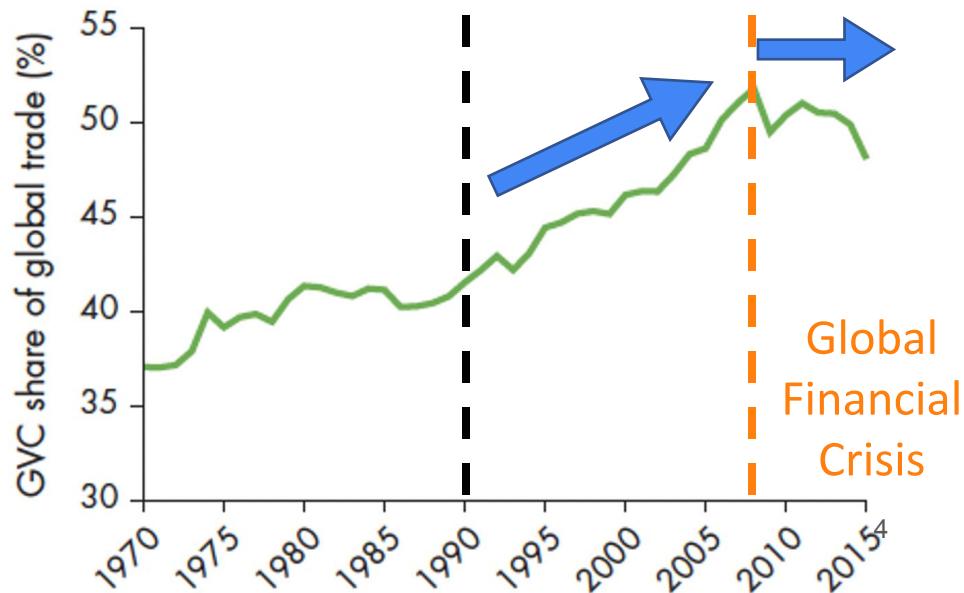
Dae Hyun Kim, Vidya Setlur



**Figure 1.2** GVC trade grew rapidly in the 1990s but stagnated after the 2008 global financial crisis



**Figure 1.2** GVC trade grew rapidly in the 1990s but stagnated after the 2008 global financial crisis





## Bookmarks

- Cover
- Title
- Copyright
- Contents
- Foreword
- Preface
- Acknowledgments
- Abbreviations
- > Part I: Overview
- > Part II: Global value chains: What are they?
- > Part III: What are the effects of GVCs?
- > Part IV: How domestic policies facilitate fruitful participation?
- > Part V: How can international cooperation help?
- Appendix A: Databases used in this Report
- > Appendix B: Glossary
- Boxes
- Figures
- Maps
- Tables

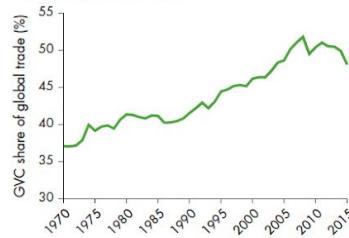
## The evolution of GVC participation

The overall share of GVC trade in total world trade—encompassing both forward and backward linkages—grew significantly in the 1990s and early 2000s, but it appears to have stagnated or even declined in the last 10 years (figure 1.2). Still, about half of world trade appears to be related to GVCs.

What explains the remarkable rise in GVC participation in the 1990s and 2000s? And why has this process stalled since the financial crisis?

The global wave of fragmentation of production in the 1990s and 2000s was driven by a combination of factors. The information and communication technology (ICT) revolution brought forth cheaper and more reliable telecommunications, new information management software, and increasingly powerful personal computers (figure 1.3, panel a). Manufacturing firms then found it easier to outsource and coordinate complex activities at a distance and ensure the quality

**Figure 1.2** GVC trade grew rapidly in the 1990s but stagnated after the 2008 global financial crisis



Sources: WDR 2020 team, using data from Fora26 database; Borin and Mancini (2015, 2019); and Johnson and Noguera (2017). See appendix A for a description of the databases used in this Report.

Note: Unless otherwise specified, GVC participation measures used in this and subsequent figures throughout the Report follow the methodology from Borin and Mancini (2015, 2019). The Fora26 database is used because it offers the largest country coverage: 190 countries between 1990 and 2019. GVC participation corresponds to the share of world exports that flow

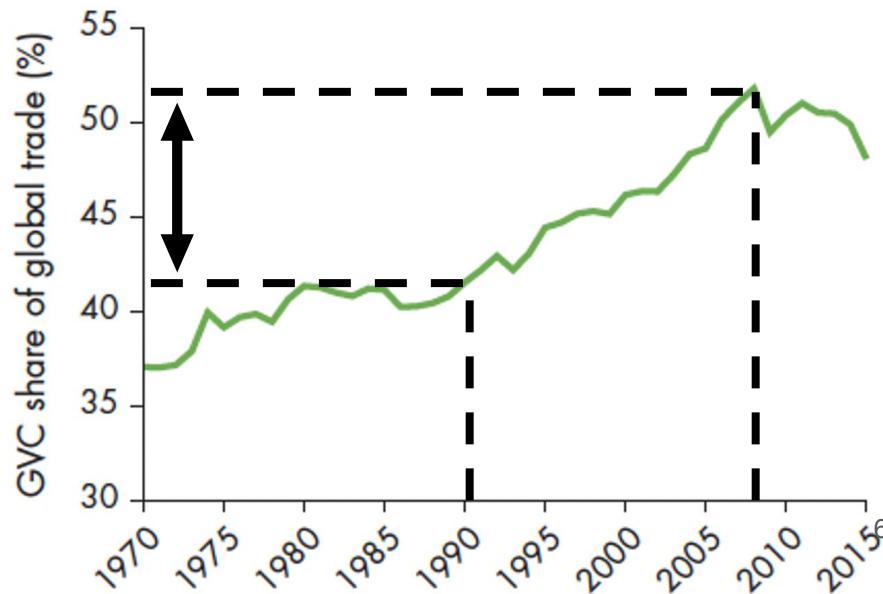
of their inputs. In addition, firms were able to disperse production across the world because transport costs fell significantly (figure 1.3, panel b). Declining air and sea freight costs boosted the trade in goods, while services benefited from cheaper communication costs.

Successive rounds of trade liberalization have resulted in rapidly falling barriers to trade and investment for both developed and developing countries. Tariffs have declined, especially for manufactured goods, and the gradual, although still insufficient, lowering of nontariff barriers has facilitated the international trade of goods and services (figure 1.4). Finally, the creation of the European single market—together with the integration of China, India, and the Soviet Union into the global economy—created huge new product and labor markets, and so firms could sell the same goods to more people and take advantage of economies of scale leading to the further deepening of GVCs. The new supply of cheap labor encouraged profit-seeking companies to either reallocate their production facilities or find local suppliers in low-wage countries.<sup>3</sup>

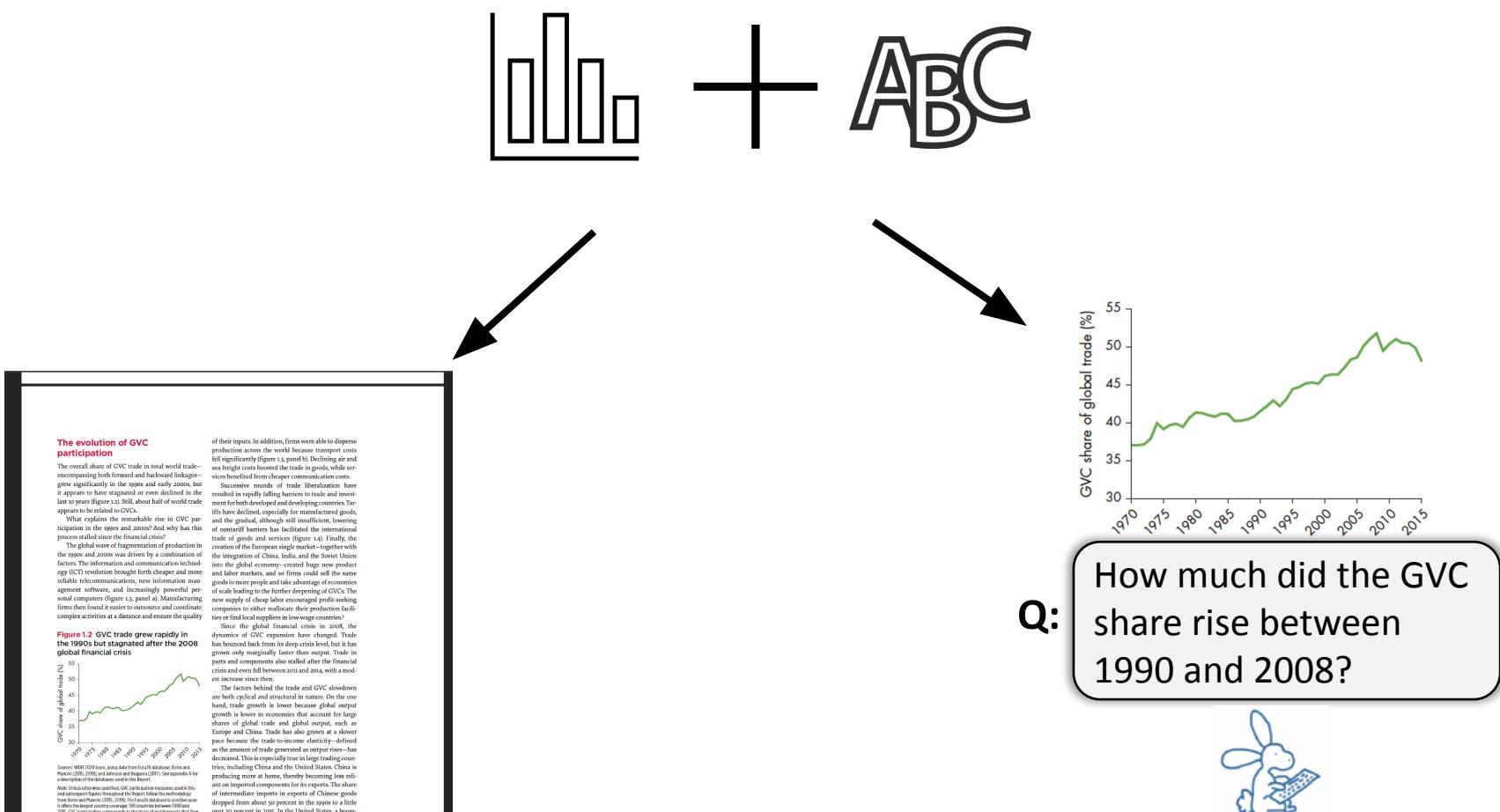
Since the global financial crisis in 2008, the dynamics of GVC expansion have changed. Trade has bounced back from its deep crisis level, but it has grown only marginally faster than output. Trade in parts and components also stalled after the financial crisis and even fell between 2011 and 2014, with a modest increase since then.

The factors behind the trade and GVC slowdown are both cyclical and structural in nature. On the one hand, trade growth is lower because global output growth is lower in economies that account for large shares of global trade and global output, such as Europe and China. Trade has also grown at a slower pace because the trade-to-income elasticity—defined as the amount of trade generated as output rises—has decreased. This is especially true in large trading countries, including China and the United States. China is producing more at home, thereby becoming less reliant on imported components for its exports. The share of intermediate imports in exports of Chinese goods dropped from about 50 percent in the 1990s to a little over 30 percent in 2015. In the United States, a boom

**Figure 1.2** GVC trade grew rapidly in the 1990s but stagnated after the 2008 global financial crisis



Question: *How much did the GVC share rise between 1990 and 2008?*



*“Words and pictures belong together.”*

[Tufte, 1983]

# Facilitating Document Reading by Linking Text and Tables

[Kim et al. 2018]

An overwhelming majority of chaplains who responded to these questions say that inmates' requests for religious texts (82%) and for meetings with spiritual leaders of their faith (71%) are usually approved. And about half of chaplains say that requests for a special religious diet (53%) or for permission to have sacred items or religious clothing such as crucifixes, eagle feathers and turbans (51%) also are usually granted.

### Requests for Religious Accommodation

% saying requests from inmates for each of the following are ...

- Usually approved
- Sometimes approved/sometimes denied
- Usually denied



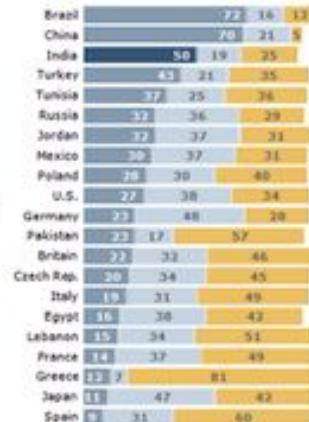
Q29a-e. Based on all answering. Those who responded that the request had not come up or did not give an answer are excluded. Figures may not add to 100% due to rounding.

PEW RESEARCH CENTER'S FORUM ON RELIGION & PUBLIC LIFE

People may think their personal situation is better than economic conditions in their nation, but only in Brazil (72%) and China (70%) do large majorities think their families are better off than they were five years ago. On balance, Indians (50%) and Turks (43%) also say their situations have improved.

### Compared to Five Years Ago, Are You Financially...

- Better off
- About the same
- Worse off



PEW RESEARCH CENTER Q3B

[Kong et al. 2014]

## Part 6.

## **Issues about computers and the internet: Awareness, interest, attitudes, aptitude, self-confidence**

The *Tele Journal-Post* has printed stories of the tribal issues concerning how it will develop its lands, and those past years, we have added a variety of controversial "local" concerns, as Indian issues and Antiochians, and those very general topics in technology and the future. We have used these local issues' processes approach and self-sufficiency in dealing with corporate interests, so far as possible, not applicable. We also added some other data attitudes toward the Internet and the media is added to our focus.

But does we know systems suggest that are more concerned and aware about the world of technology and their own options work from imagination to innovation.  
Thus by more than things, from experience or otherwise - like a lateral entrepreneurship from your mind edge about making it the best work. Thus realising, Where is manufacturing, innovation, business, etc. doing a business, or What makes us partners, etc. work.

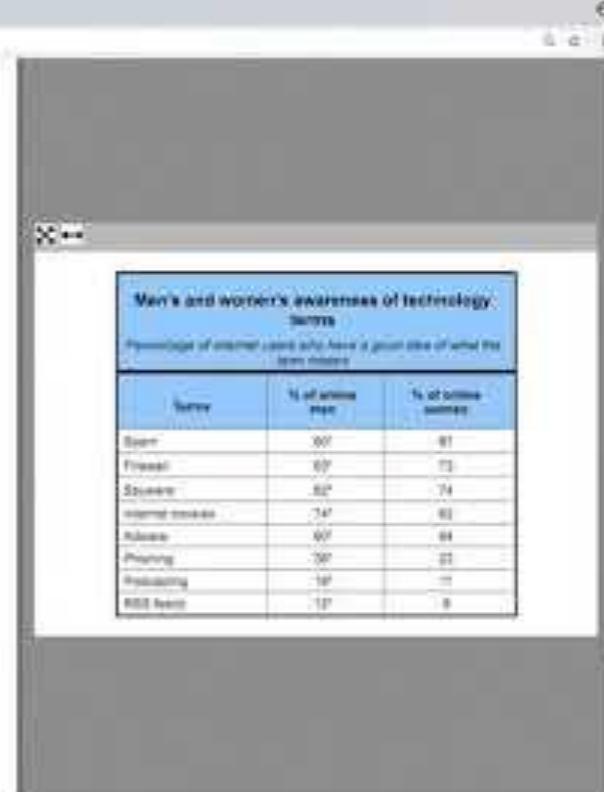
Men and women were in agreement on what the norms were for their roles, particularly in caring, men being more efficient and requesting more social information. Men were to make these largely local to the context of the activities of care. Women, in contrast, while wanting better care, also wanted to control the consequences of their work more broadly, through communication.

The following table summarizes the main results. Many more local sources are available with their names and sources.

El tardi 2010, va venir acompanyat per la Dami, que fa gairebé 100 anys d'edat i sempre ha estat una figura molt important en el seu entorn. Més aviat, havia viscut els seus últims dies a l'Hospitalet de Llobregat, però havia fet tota la seva vida al Poblenou. Va ser un home molt humà, sempre benhumorat, sempre amable, sempre benintencionat.

In February 2004, I wrote an article from 80% of memory, 10%, full record of Vivian-new-  
born Formula in 2000 before.

In most cases, significantly more than 60% of the women (57%) were aware of the difference between past or present oral contraceptives.



*Automatically extract references between sentences and tables*

# Automatic Reference Extraction Pipeline

# Automatic Reference Extraction Pipeline

Women are more likely than men to cite some reasons for not using the internet		
Major reasons	% of online men	% of online women
Don't need it	45	58
Don't have time	29	29
Too expensive	25	34

Equal numbers of men and women said they lack time.

# Automatic Reference Extraction Pipeline

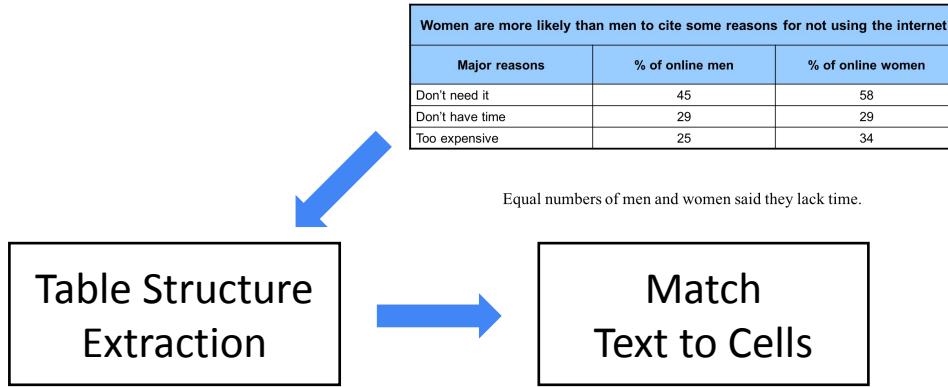
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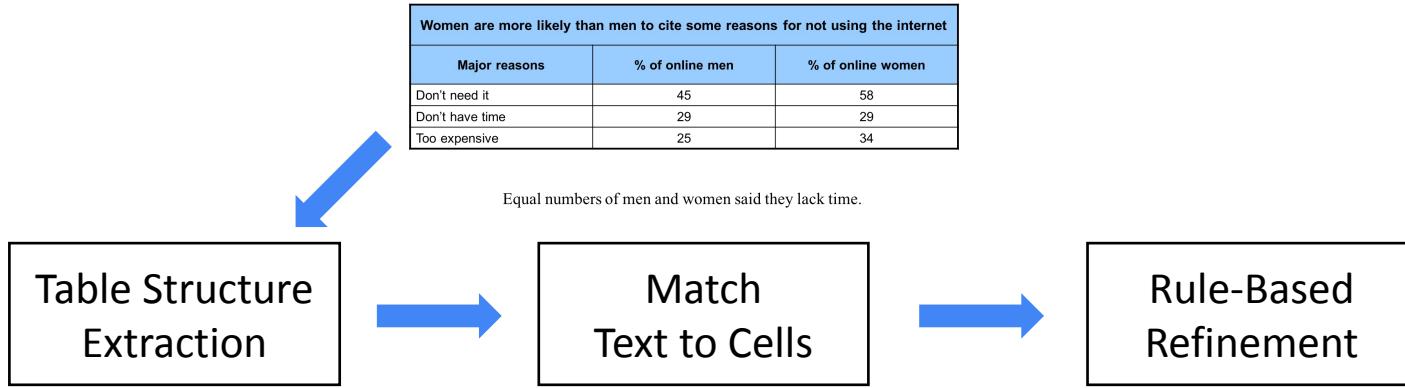
Table Structure  
Extraction



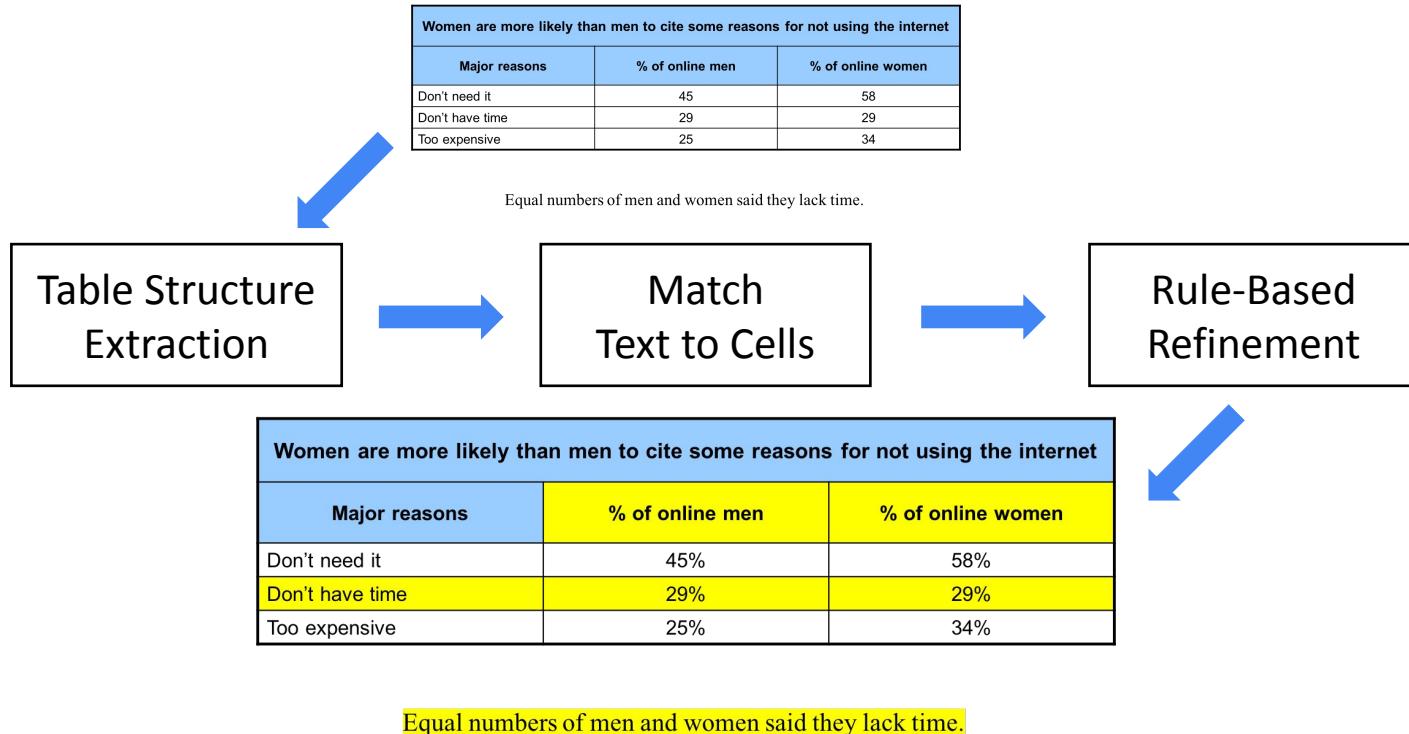
# Automatic Reference Extraction Pipeline



# Automatic Reference Extraction Pipeline



# Automatic Reference Extraction Pipeline



**Women are more likely than men to cite some reasons for not using the internet**

Major reasons	% of online men	% of online women
Don't need it	45	58
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# Stage 1: Table Structure Extraction

Women are more likely than men to cite some reasons for not using the internet		
Major reasons	% of online men	% of online women
Don't need it	45	58
Don't have time	29	29
Too expensive	25	34

Diagram illustrating the structure of the table:

- Title Cell:** The first row, "Women are more likely than men to cite some reasons for not using the internet", is labeled as the Title Cell.
- Column Headers:** The second row, "Major reasons", "% of online men", and "% of online women", are labeled as Column Headers.
- Data Cells:** The remaining rows, "Don't need it", "45", "58", "Don't have time", "29", "29", "Too expensive", "25", and "34", are labeled as Data Cells.
- Row Headers:** The first two rows are grouped as Row Headers.

# Stage 1: Table Structure Extraction

Women are more likely than men to cite some reasons for not using the internet		
Major reasons	% of online men	% of online women
Don't need it	45	58
Don't have time	29	29
Too expensive	25	34

Diagram illustrating the structure of the table:

- Title Cell:** The first row, "Women are more likely than men to cite some reasons for not using the internet", is highlighted with a green background.
- Column Headers:** The second row, "Major reasons", "% of online men", and "% of online women", are highlighted with a light gray background.
- Data Cells:** The remaining rows, "Don't need it", "45", "58", "Don't have time", "29", "29", "Too expensive", "25", and "34", are highlighted with a light orange background.
- Row Headers:** The first column, "Major reasons", is labeled as a Row Header.

# Stage 1: Table Structure Extraction

Women are more likely than men to cite some reasons for not using the internet		
Major reasons	% of online men	% of online women
Don't need it	45	58
Don't have time	29	29
Too expensive	25	34

Diagram illustrating the structure of the table:

- Title Cell:** The first row containing the main statement.
- Column Headers:** The second row containing the column names.
- Data Cells:** The remaining rows containing the data values.
- Row Headers:** The first column of the data cells, which are colored orange.

# Stage 1: Table Structure Extraction

Women are more likely than men to cite some reasons for not using the internet		
Major reasons	% of online men	% of online women
Don't need it	45	58
Don't have time	29	29
Too expensive	25	34

Diagram illustrating the structure of the table:

- Title Cell:** The first row containing the main statement.
- Column Headers:** The second row containing the column names.
- Data Cells:** The remaining rows containing the data values.
- Row Headers:** The first column containing the category names.

# Stage 1: Table Structure Extraction

Women are more likely than men to cite some reasons for not using the internet		
Major reasons	% of online men	% of online women
Don't need it	45	58
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Diagram illustrating the structure of the table:

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- Data Cells:** The remaining rows, "Don't need it", "45", "58", "Don't have time", "29", "29", "Too expensive", "25", and "34".
- Row Headers:** The first column, "Major reasons".

# Stage 1: Table Structure Extraction

Women are more likely than men to cite some reasons for not using the internet		
Major reasons	% of online men	% of online women
Don't need it	45%	58%
Don't have time	29%	29%
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Diagram illustrating the structure of the table:

- Title Cell:** The first row, "Women are more likely than men to cite some reasons for not using the internet".
- Column Headers:** The second row, "Major reasons", "% of online men", and "% of online women".
- Data Cells:** The remaining rows, "Don't need it", "45%", "58%", "Don't have time", "29%", "29%", and "Too expensive", "25%", "34%".
- Row Headers:** The first column, "Major reasons", which serves as a header for the three columns.

## Stage 2: Match Sentence Text to Table Cells

<b>Women are more likely than men to cite some reasons for not using the internet</b>		
<b>Major reasons</b>	<b>% of online men</b>	<b>% of online women</b>
Don't need it	45%	58%
Don't have time	29%	29%
Too expensive	25%	34%

Equal numbers of men and women said they lack time.

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# Stage 3: Rule-based Refinement of Matches

Women are more likely than men to cite some reasons for not using the internet		
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# Pipeline Evaluation

# Pipeline Evaluation

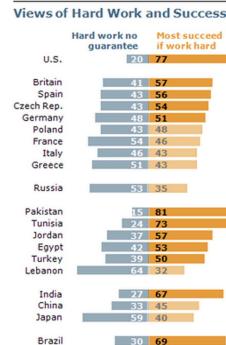
- Corpus
  - Pew Research Reports
  - ACL and CVPR papers

# Pipeline Evaluation

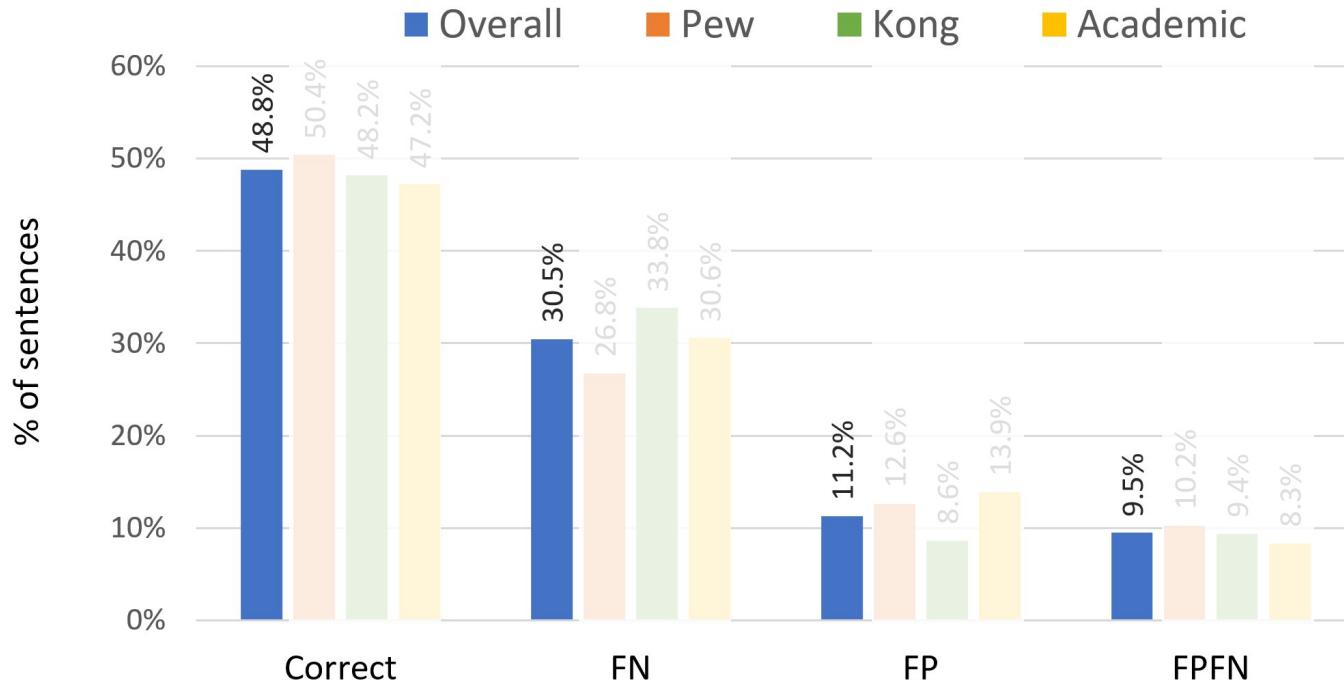
- Corpus

- Pew Research Reports
- ACL and CVPR papers
- Kong et. al (2014)

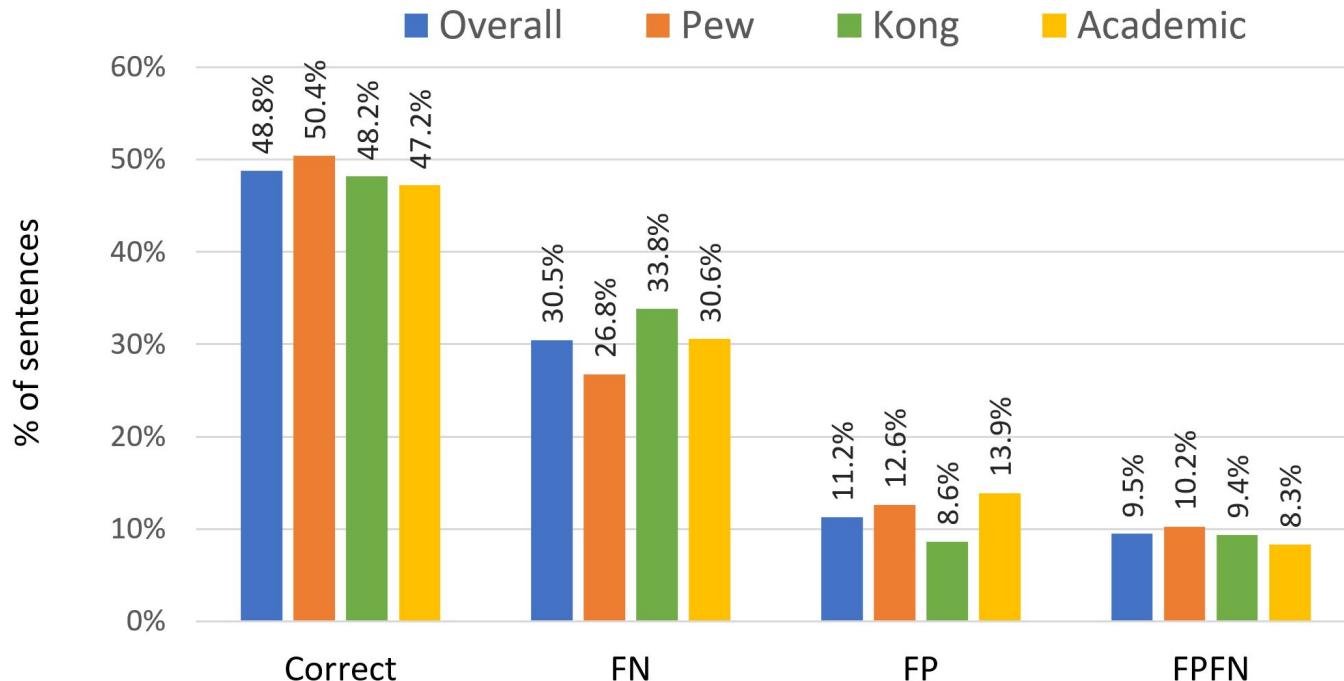
Half or more in 13 of the 21 nations surveyed believe that most people can succeed if they are willing to work hard. This includes Pakistan (81%) and the U.S. (77%). It also includes Tunisia (73%), Brazil (69%), India (67%) and Mexico (65%).



# Results



# Results



# User Study

# User Study

- Hypothesis

*Our interface facilitates reading documents with tables*

# User Study

- Within-subject study
- 14 adult volunteers, all fluent in English
- Task: Annotate references with/without our interface

# Findings of User Study

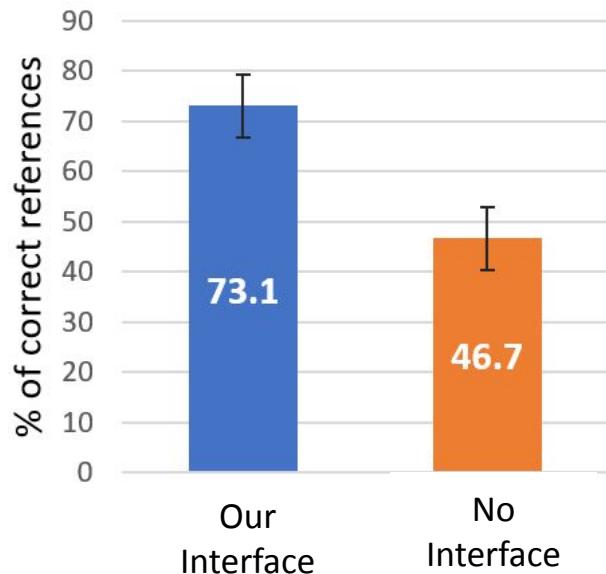
- Hypothesis

*Our interface facilitates reading documents with tables*

# Findings of User Study

- Hypothesis

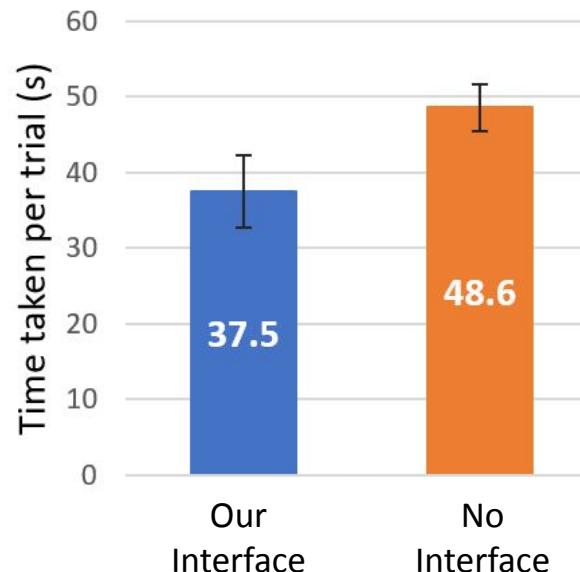
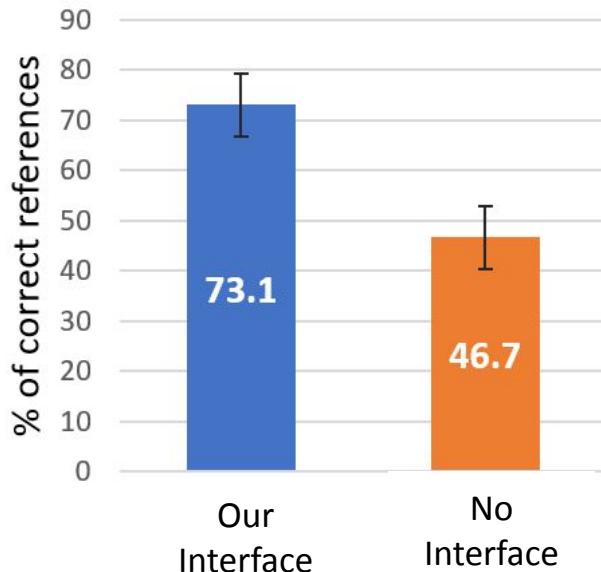
*Our interface facilitates reading documents with tables*



# Findings of User Study

- Hypothesis

*Our interface facilitates reading documents with tables*



# Findings of User Study

*“The interface allows me to read the table while reading the text ...”*

---

### PRINCIPLE 1

A mutation to a place is a mutation to all conflicting places.

### THEOREM 3.1

Let:

- $\pi_{\text{mut}} = \pi_{\text{mut}}^{\square}[x], \sigma$  where  $\sigma \vdash \pi_{\text{mut}} \Downarrow \_ \times \mathcal{V}$
- $v, \bar{\sigma} = \sigma[x \mapsto \mathcal{V}[v]]$
- $\pi_{\text{any}}$  be any place

Then  $\sigma(\pi_{\text{any}}) \neq \bar{\sigma}(\pi_{\text{any}}) \implies \pi_{\text{any}} \sqcap \pi_{\text{mut}}$ .

As described in Section 3.3, a mutation to a place is represented by updating a variable  $x$  in a stack  $\sigma$  by plugging a value  $v$  into a value context  $\mathcal{V}$ . To denote a conflict, we reuse the notation from Oxide that  $\pi_1 \# \pi_2$  means " $\pi_1$  and  $\pi_2$  do not conflict", or more formally:

$$x_1.q_1 \# x_2.q_2 \stackrel{\text{def}}{=} x_1 \neq x_2 \vee ((q_1 \text{ is not a prefix of } q_2) \wedge (q_2 \text{ is not a prefix of } q_1))$$

Conversely, we use the shorthand  $\pi_1 \sqcap \pi_2 \stackrel{\text{def}}{=} \neg(\pi_1 \# \pi_2)$ . So if a place  $\pi_{\text{any}}$  is changed when  $\pi_{\text{mut}}$  is mutated, then it must be that  $\pi_{\text{any}} \sqcap \pi_{\text{mut}}$ .

---

Part of Nota's inspiration was my attempts to visually encode correspondences between objects (see page 10 of the PDF). LaTeX's brittle abstractions made it frustratingly hard to do something as simple as "draw a colored underline beneath a piece of math."

By contrast, implementing this feature was trivial in HTML/CSS/Javascript. And we could extend the idea with interactions like drawing attention to corresponding objects on hover.

# How Readers Integrate Information in Visualizations & Text

[Kim et al. 2020]









The 30-year fixed mortgage rate increased slightly from 1997 to 1999.

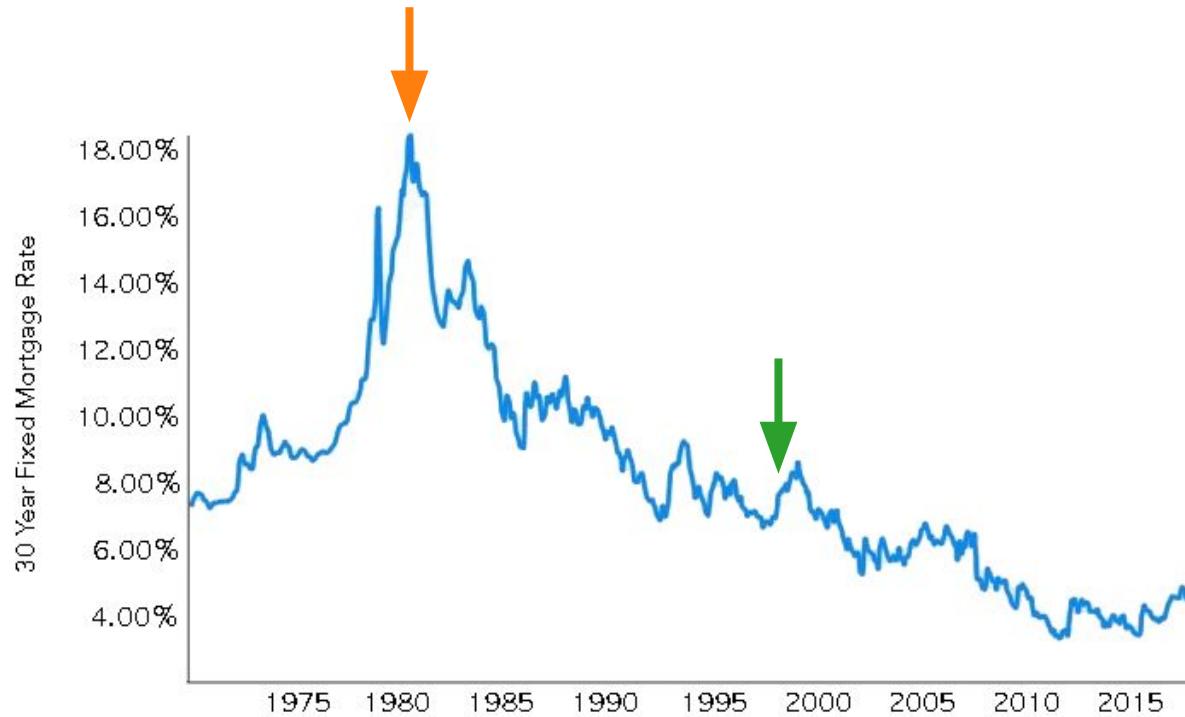




The 30-year fixed mortgage rate increased slightly from 1997 to 1999.



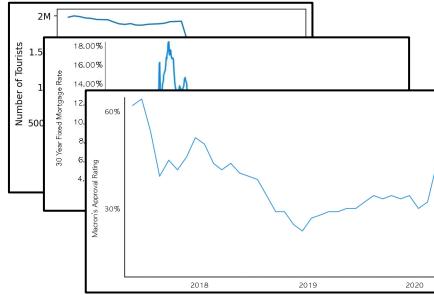
The 30-year fixed mortgage rate increased slightly from 1997 to 1999.



The 30-year fixed mortgage rate increased slightly from 1997 to 1999.

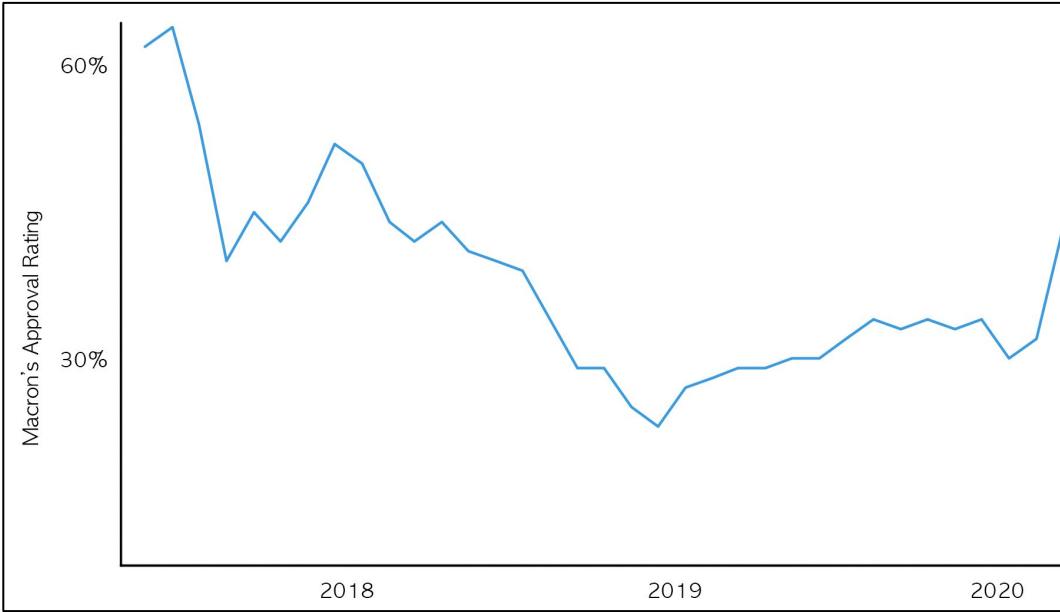
*Do readers rely more on the chart or captions for their takeaways?*

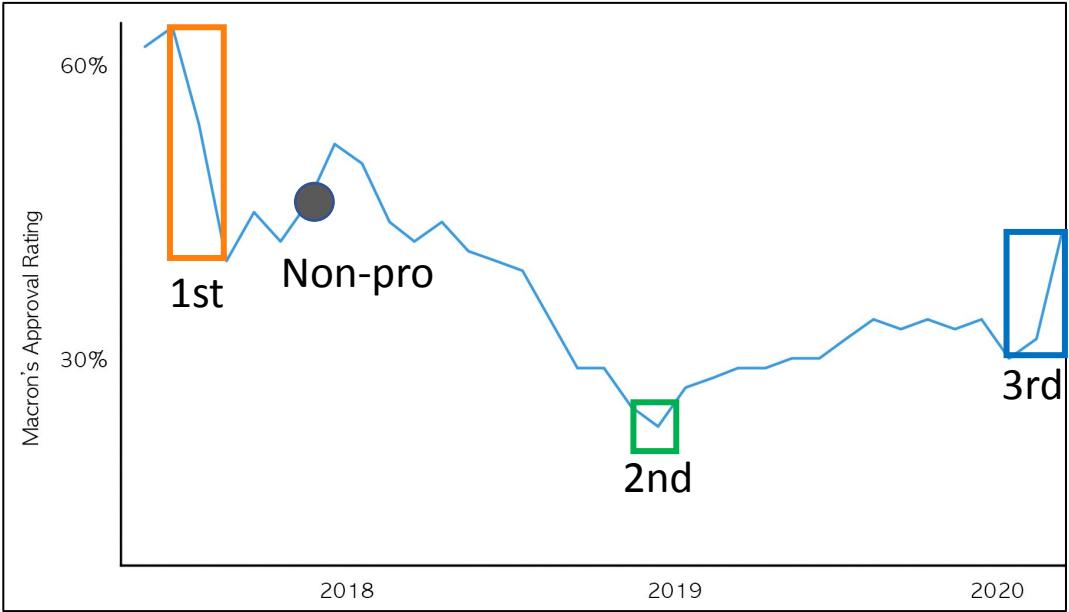
# User Study

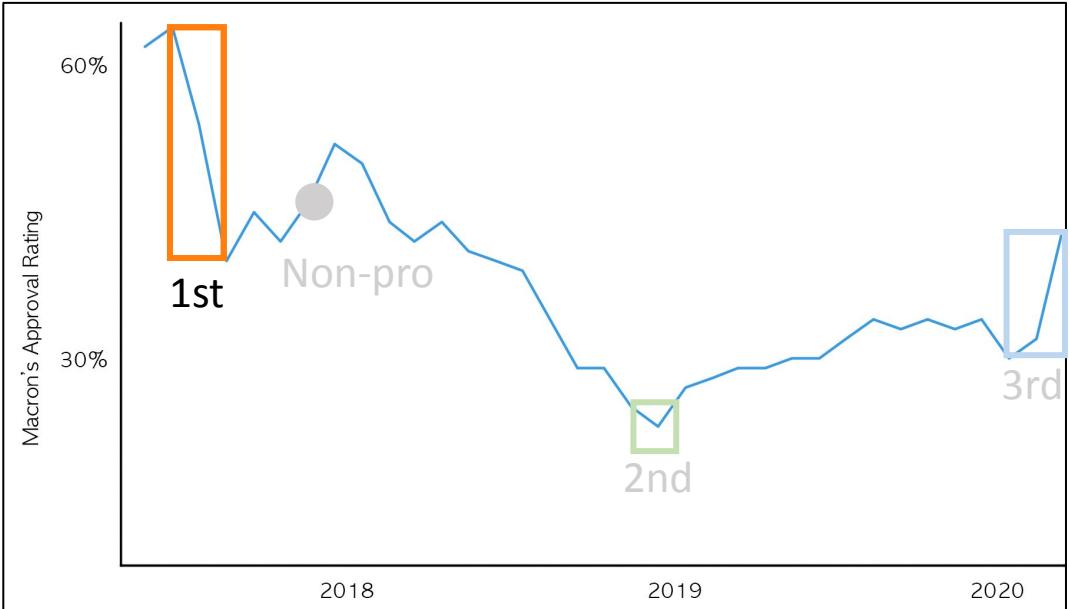


Charts









[DOMAIN] [FEATURE] between  
[START DATE] and [END DATE].



Macron's approval rating steeply dropped between June and August of 2017.

# Results



The 30-year fixed mortgage rate increased slightly from 1997 to 1999.



The 30-year fixed mortgage rate increased slightly from 1997 to 1999.



The 30-year fixed mortgage rate reached its peak of 18.5% in 1981.

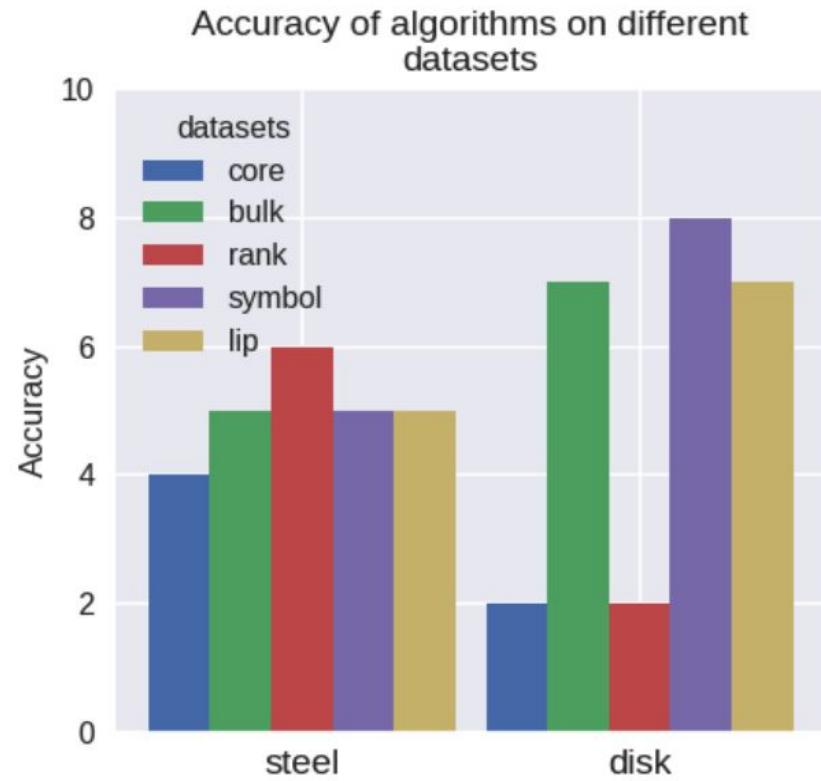
*When text and visualization emphasis **mismatch**,  
readers rely **more on the chart** and  
can **miss information in the caption**.*

# Chart Question Answering with Explanations

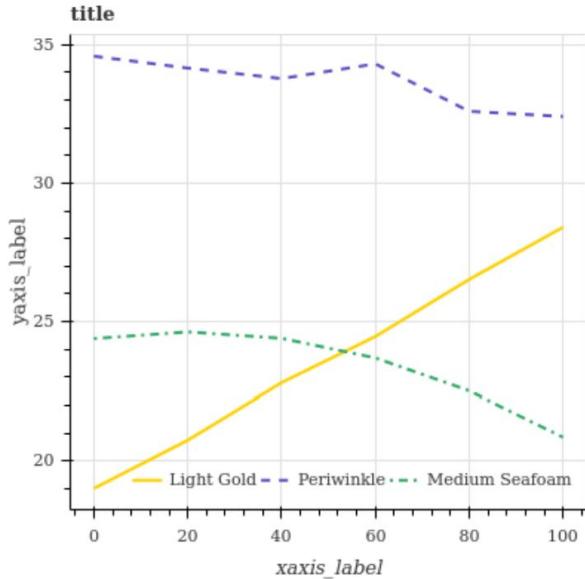
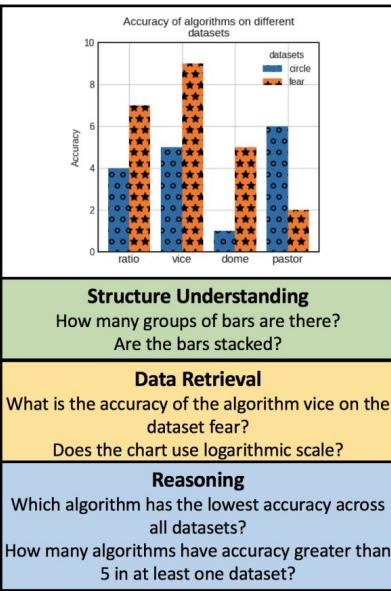
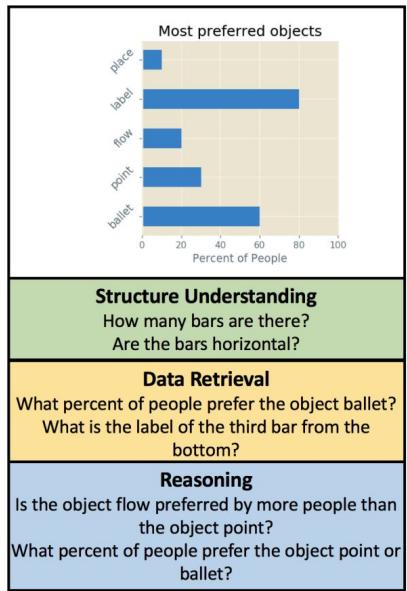
[Kim et al. 2021]



[Kafle et al. 2018]



[Kafle et al. 2018]



# DVQA

[Kafle et al. 2018]

# FigureQA

[Kahou et al. 2018]

**Q:** Does Medium Seafoam intersect Light Gold?

**A:** Yes

**Q:** Is Medium Seafoam the roughest?

**A:** No

**Q:** Is Light Gold less than Periwinkle?

**A:** Yes

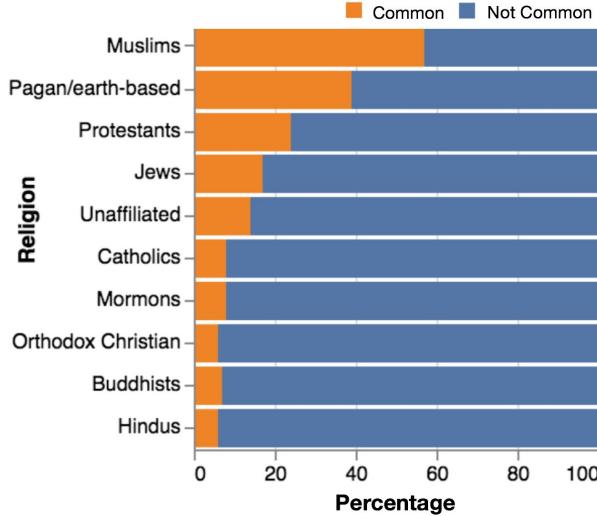
**Q:** Does Periwinkle have the maximum area under the curve?

**A:** Yes

**Q:** Does Medium Seafoam have the lowest value?

**A:** No

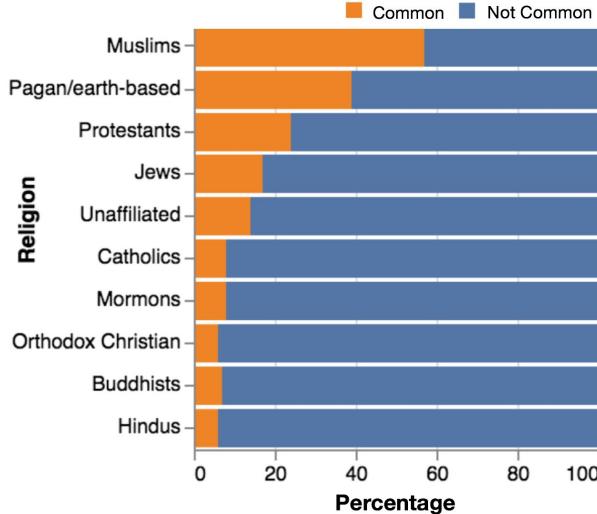
## Chart



## Question

*For which religion did the fewest chaplains think that religious extremism is common?*

## Chart



## Answer

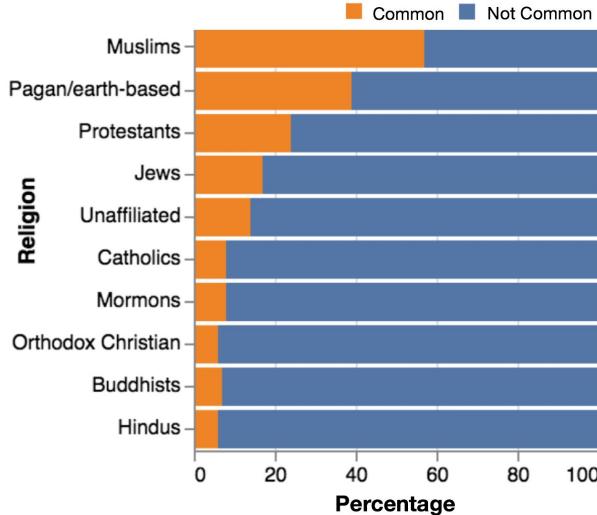
*Orthodox Christians, Hindus.*

Chart QA

## Question

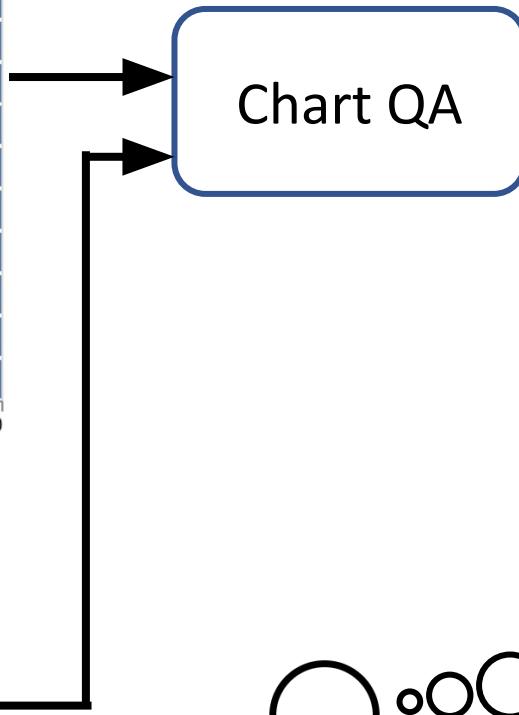
*For which religion did the fewest chaplains think that religious extremism is common?*

## Chart



## Question

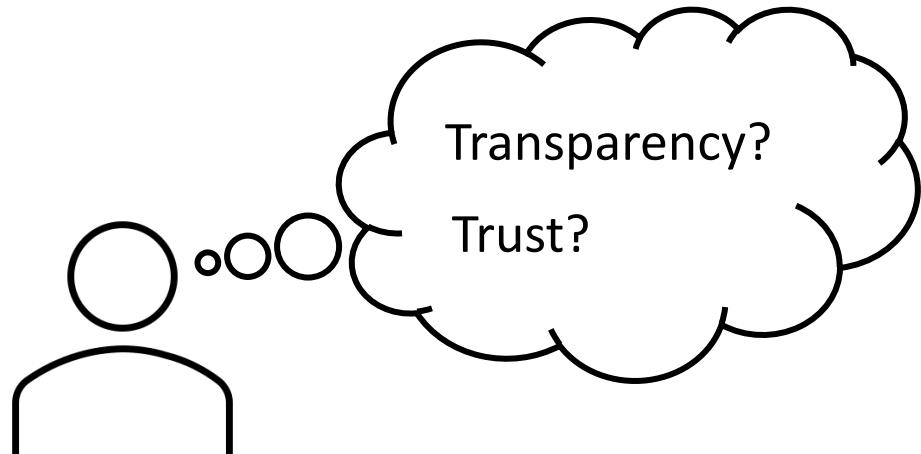
*For which religion did the fewest chaplains think that religious extremism is common?*



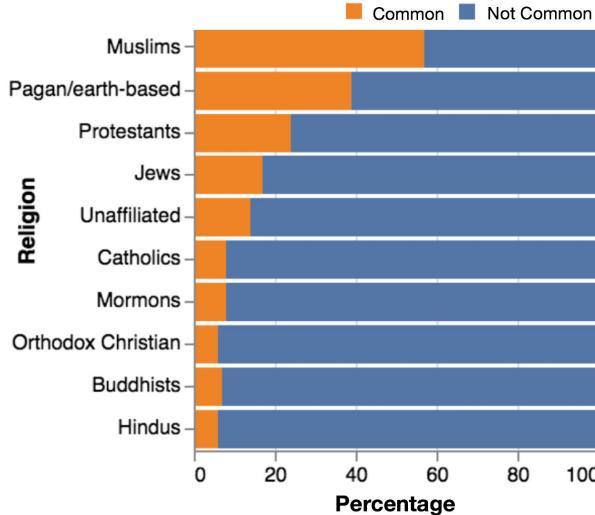
## Answer

*Orthodox Christians, Hindus.*

Chart QA



## Chart



## Question

*For which religion did the fewest chaplains think that religious extremism is common?*

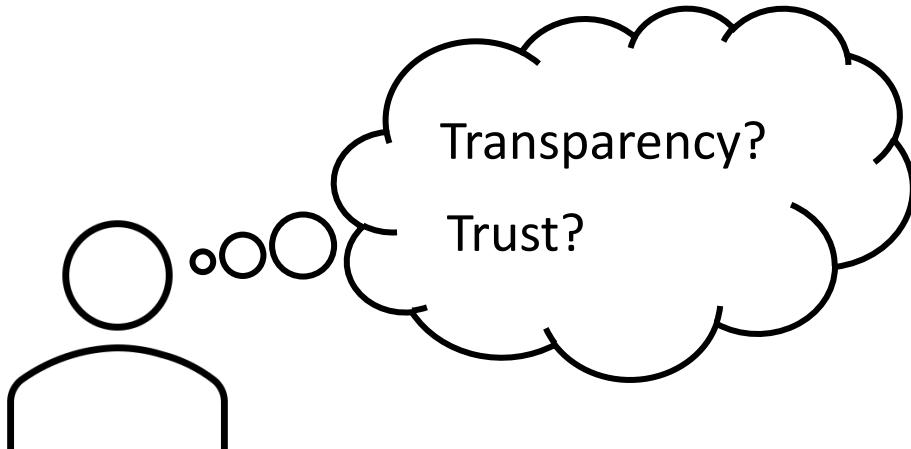
Chart QA

## Answer

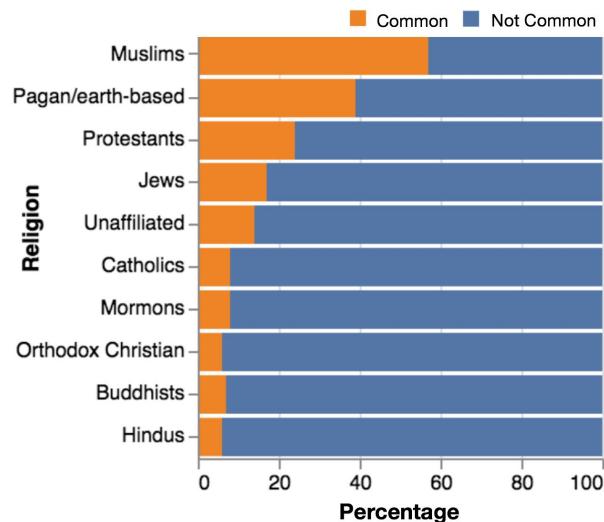
*Orthodox Christians, Hindus.*

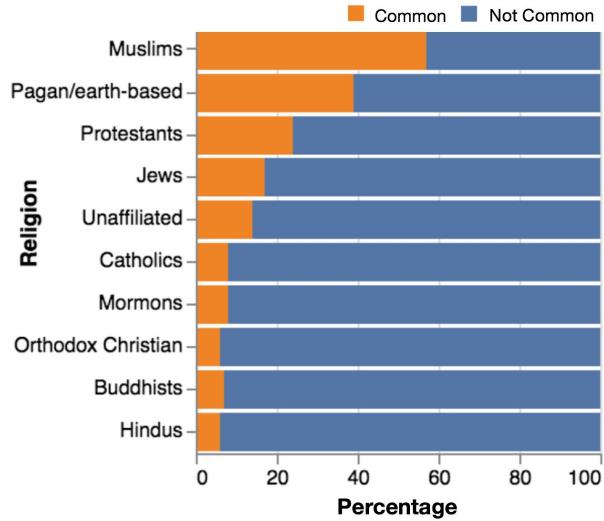
## Explanation

*I looked up 'Religion' for the shortest orange bars.*



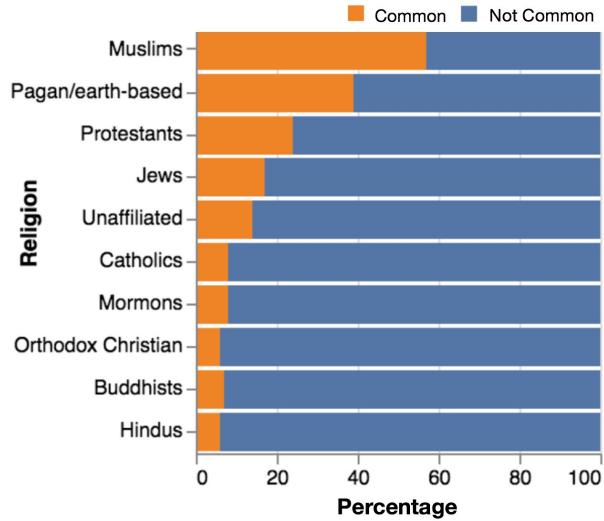
# Formative Study





## Question

Which religion has the greatest value for Common?



## Question

Which religion has the greatest value for Common?



## Answer

Muslims

## Explanation

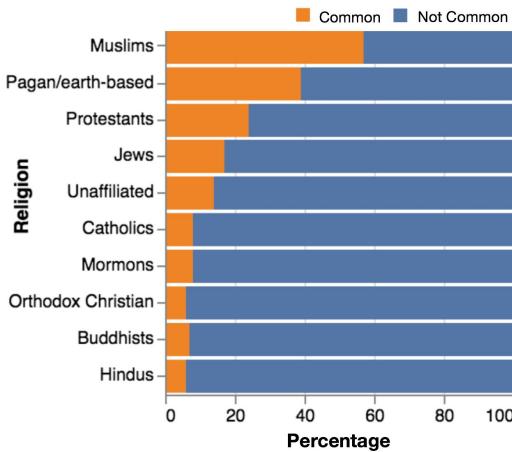
I picked religions with the greatest orange percentage.

# Formative Study Results

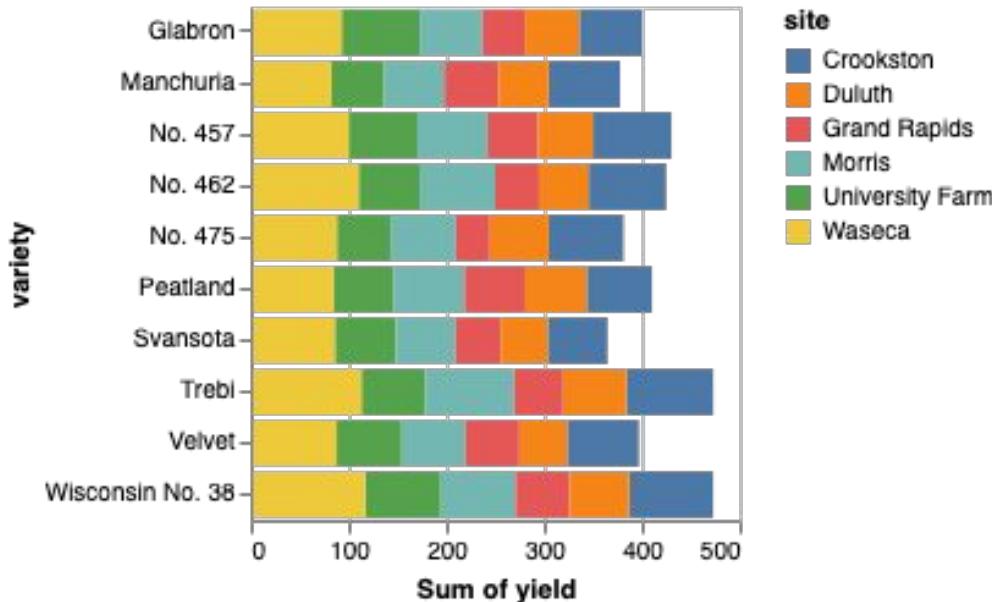
- Explanations describe procedure for computing answer

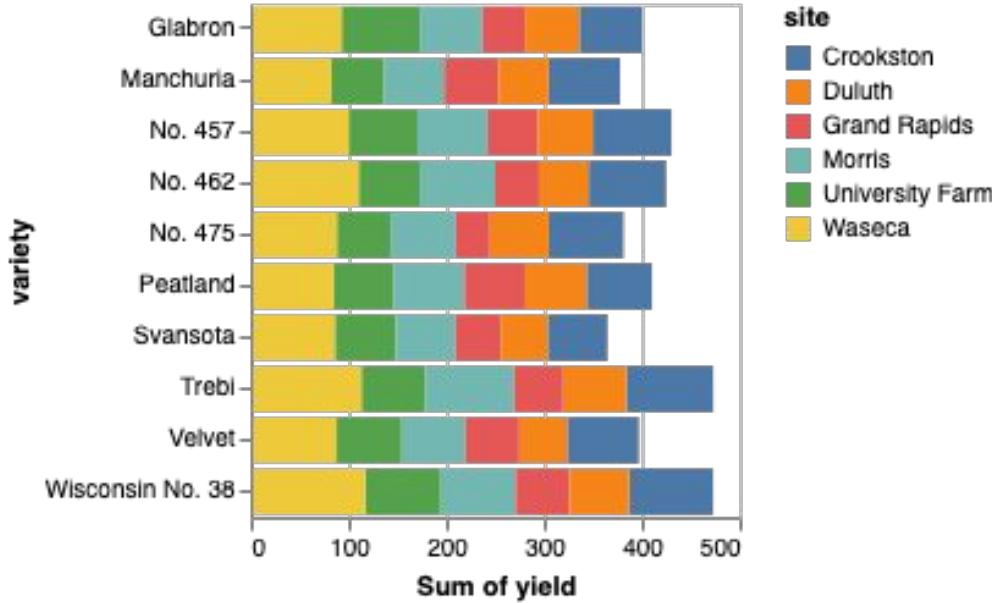
- Explanations describe procedure for computing answer
- Half of the explanations referred to visual features of chart

- Explanations describe procedure for computing answer
- Half of the explanations referred to visual features of chart

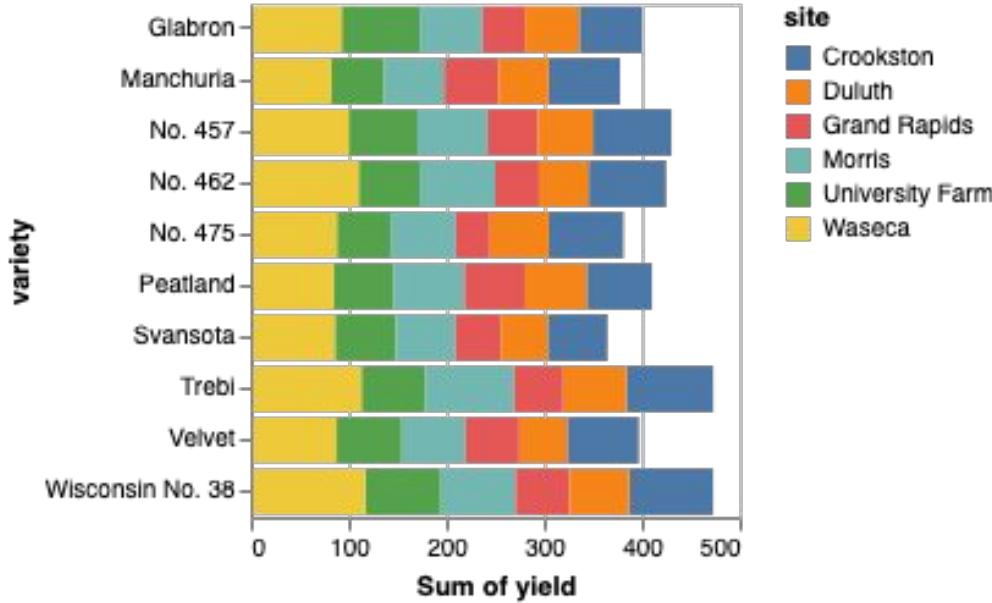


*"I picked religions with the greatest orange percentage."*





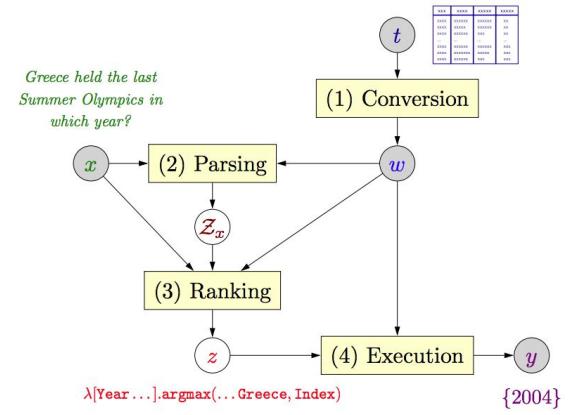
*Glabron at University Farm*



*Glabron at University Farm*

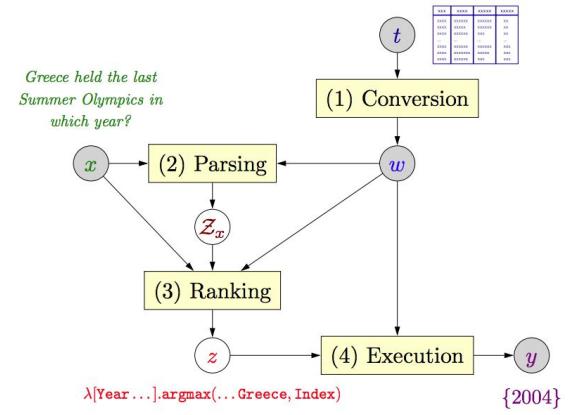
*Green component in the top bar*

# Chart QA Pipeline and Generating Explanations



## Compositional Semantic Parsing on Semi-Structured Tables

Pasupat and Liang (2015)



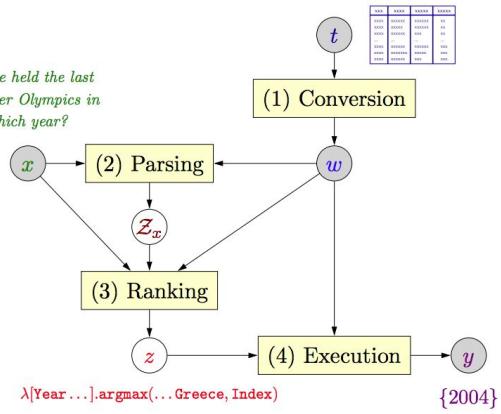
## Compositional Semantic Parsing on Semi-Structured Tables

Pasupat and Liang (2015)

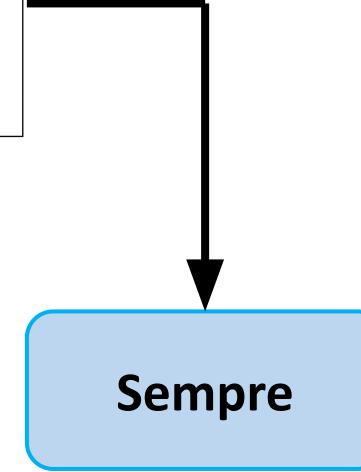
Sempre

# Table

Greece held the last Summer Olympics in which year?



Year	City	Country	Nations
1896	Athens	Greece	14
1900	Paris	France	24
1904	St. Louis	USA	12
...	...	...	...
2004	Athens	Greece	201
2008	Beijing	China	204
2012	London	UK	204



Compositional Semantic  
Parsing on Semi-Structured  
Tables

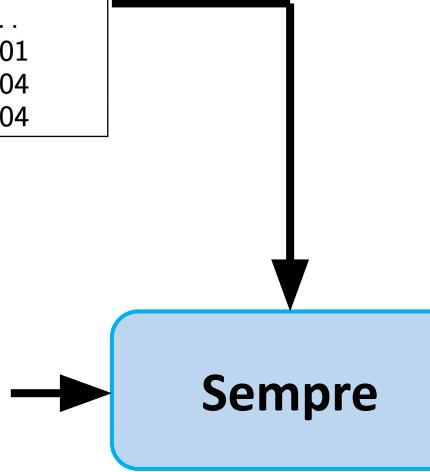
Pasupat and Liang (2015)

# Table

Year	City	Country	Nations
1896	Athens	Greece	14
1900	Paris	France	24
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...	...	...	...
2004	Athens	Greece	201
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## Question

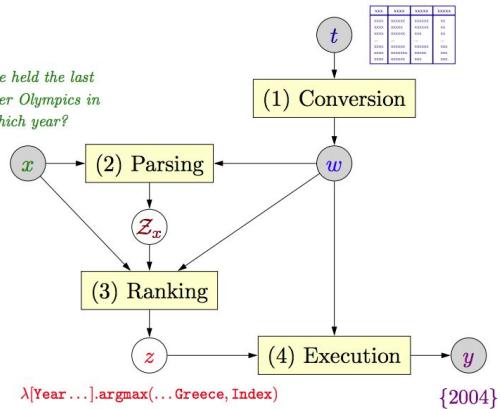
*Greece held its last  
Summer Olympics in  
which year?*



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Summer Olympics in  
which year?*

**Compositional Semantic  
Parsing on Semi-Structured  
Tables**

Pasupat and Liang (2015)



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Year	City	Country	Nations
1896	Athens	Greece	14
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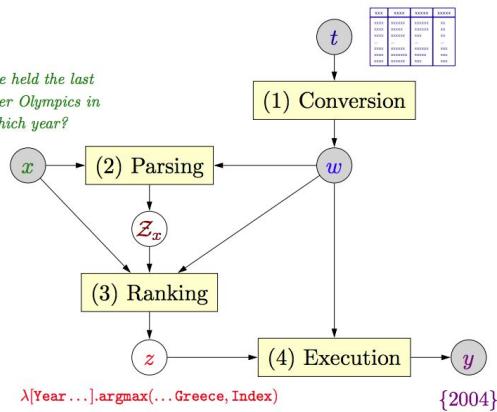
## Question

*Greece held its last  
Summer Olympics in  
which year?*

Sempre

Answer  
2004

*Greece held the last  
Summer Olympics in  
which year?*



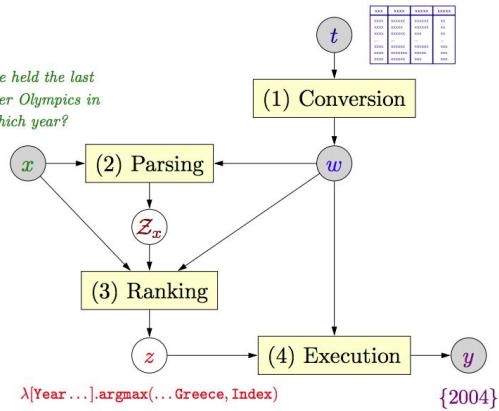
**Compositional Semantic  
Parsing on Semi-Structured  
Tables**

Pasupat and Liang (2015)

# Table

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1896	Athens	Greece	14
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## Compositional Semantic Parsing on Semi-Structured Tables

Pasupat and Liang (2015)

## Question

*Greece held its last Summer Olympics in which year?*

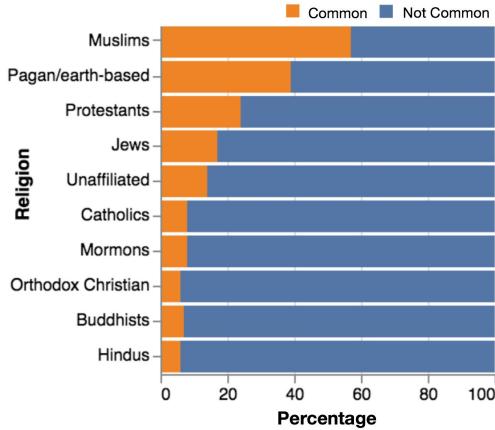
Sempre

Answer  
2004

## Lambda Expression

$R[\lambda x[\text{Year}.Date.x]]$   
.argmax(Country.Greece,  
Index)

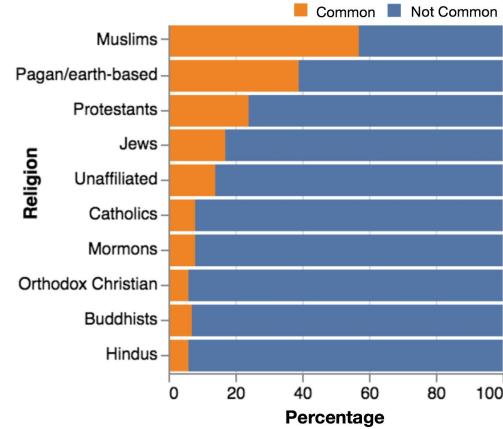
# Chart



## Question about Chart

*Which religion has the shortest orange component?*

# Chart



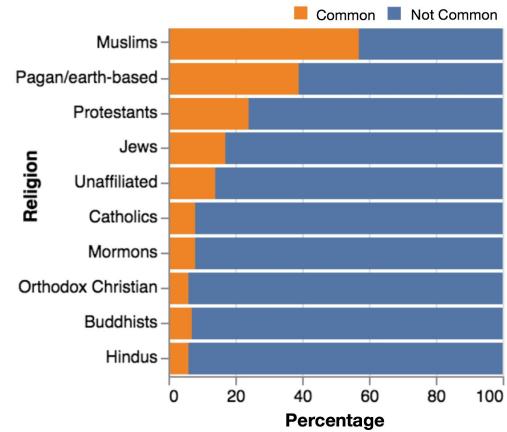
## Question about Chart

*Which religion has the shortest orange component?*

Sempre

# Chart

# Data



# Table

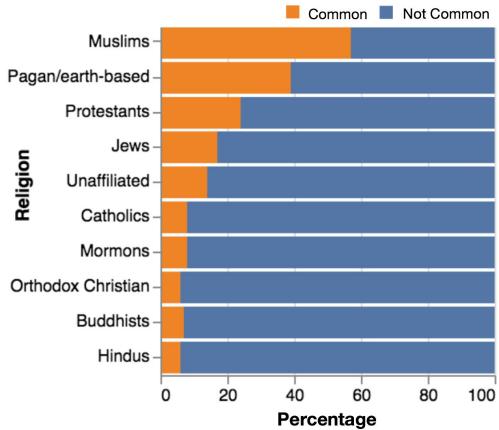
Religion	Common	Not common
Muslims	57	43
Pagan/earth-based	39	61
Protestants	24	76
Jews	17	83
:	:	:
Buddhists	7	93
Hindus	6	94

## Question about Chart

*Which religion has the shortest orange component?*

Sempre

# Chart



# Data

## Table

Religion	Common	Not common
Muslims	57	43
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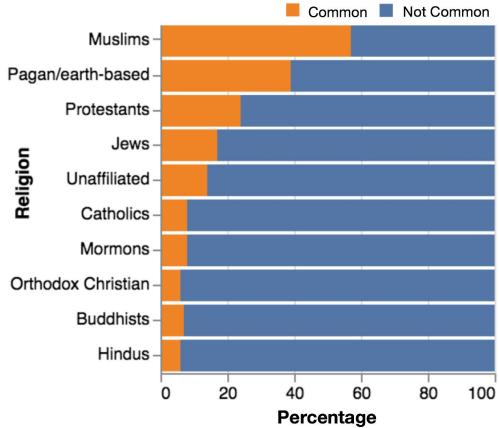


## Question about Table

*Which religion has the least 'Common' Percentage?*

Sempre

# Chart



# Data

## Table

Religion	Common	Not common
Muslims	57	43
Pagan/earth-based	39	61
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## Question about Chart

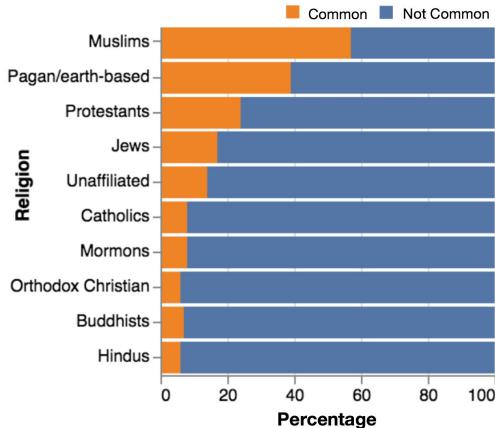
*Which religion has the shortest orange component?*

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*Which religion has the least 'Common' Percentage?*

Sempre

# Chart



# Data

## Table

Religion	Common	Not common
Muslims	57	43
Pagan/earth-based	39	61
Protestants	24	76
Jews	17	83
:	:	:
Buddhists	7	93
Hindus	6	94

# Answer

Orthodox Christians,  
Hindus.

# Question about Chart

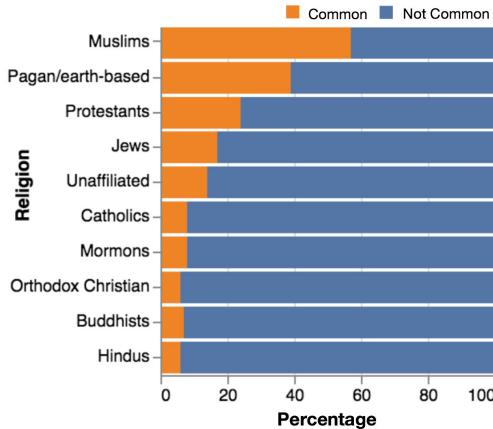
Which religion has the shortest orange component?

# Question about Table

Which religion has the least 'Common' Percentage?

Sempre

# Chart



# Data

## Table

Religion	Common	Not common
Muslims	57	43
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Which religion has the shortest orange component?



## Lambda Expression

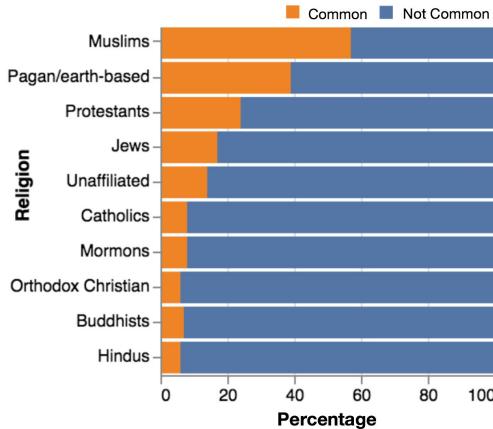
```
argmin[R[Religion].Row,  
R[λx(R[Number].R[Common].  
Religion.x)]]
```

## Question about Table

Which religion has the least 'Common' Percentage?

Sempre

# Chart



# Data

## Table

Religion	Common	Not common
Muslims	57	43
Pagan/earth-based	39	61
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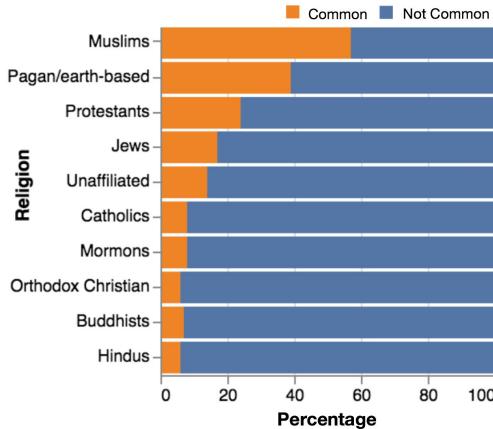
Which religion has the least 'Common' Percentage?

Sempre

# Non-Visual Explanation

I looked up 'Religion' with the least 'Percentage' of 'Common'.

# Chart



# Data

## Table

Religion	Common	Not common
Muslims	57	43
Pagan/earth-based	39	61
Protestants	24	76
Jews	17	83
:	:	:
Buddhists	7	93
Hindus	6	94

# Answer

Orthodox Christians,  
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## Question about Chart

Which religion has the shortest orange component?



## Lambda Expression

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argmin[R[Religion].Row,  
R[λx(R[Number].R[Common].  
Religion.x)]]
```

## Question about Table

Which religion has the least 'Common' Percentage?

Sempre

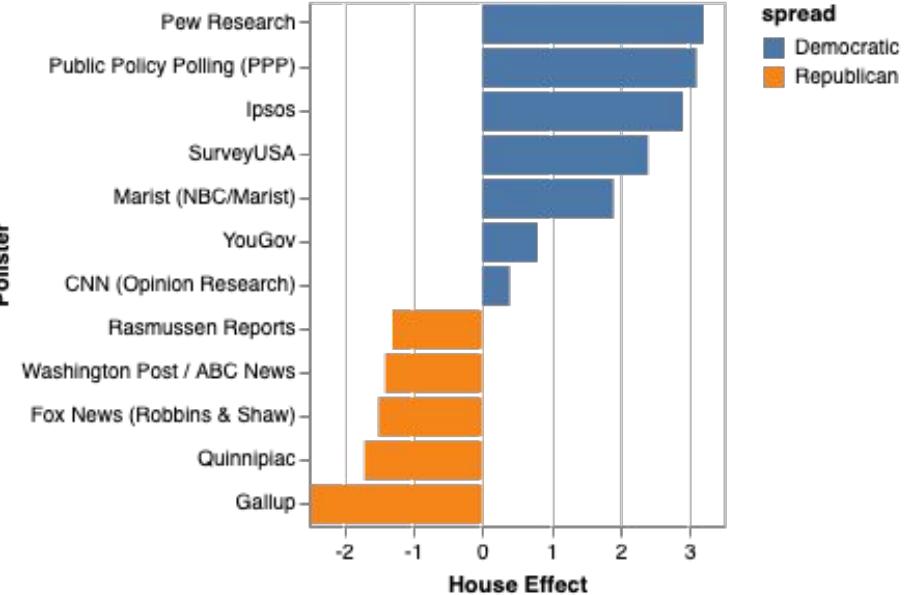
## Non-Visual Explanation

I looked up 'Religion' with the least 'Percentage' of 'Common'.

## Visual Explanation

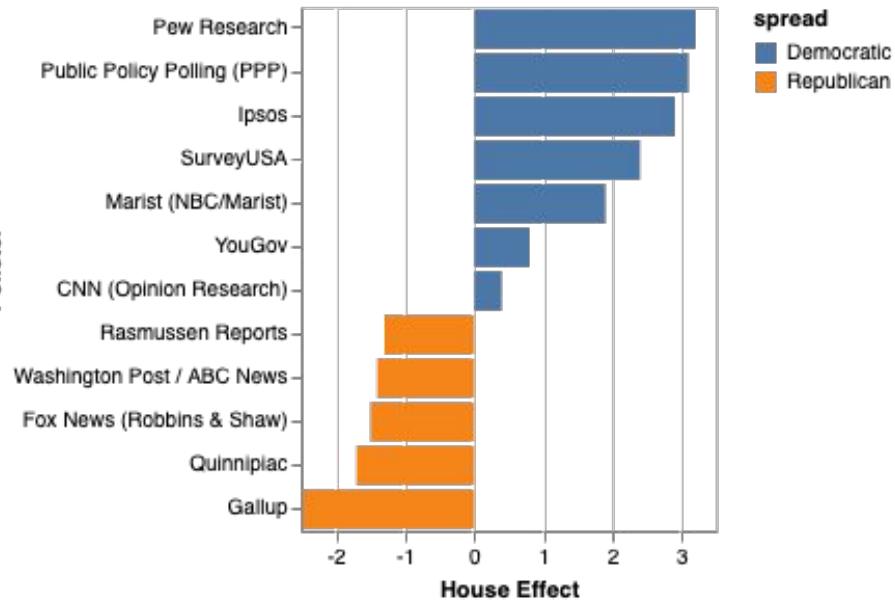
I looked up 'Religion' for the shortest orange bar.

# Example Explanations



# Question

*What is the difference between the value of Gallup and Quinnipiac?*

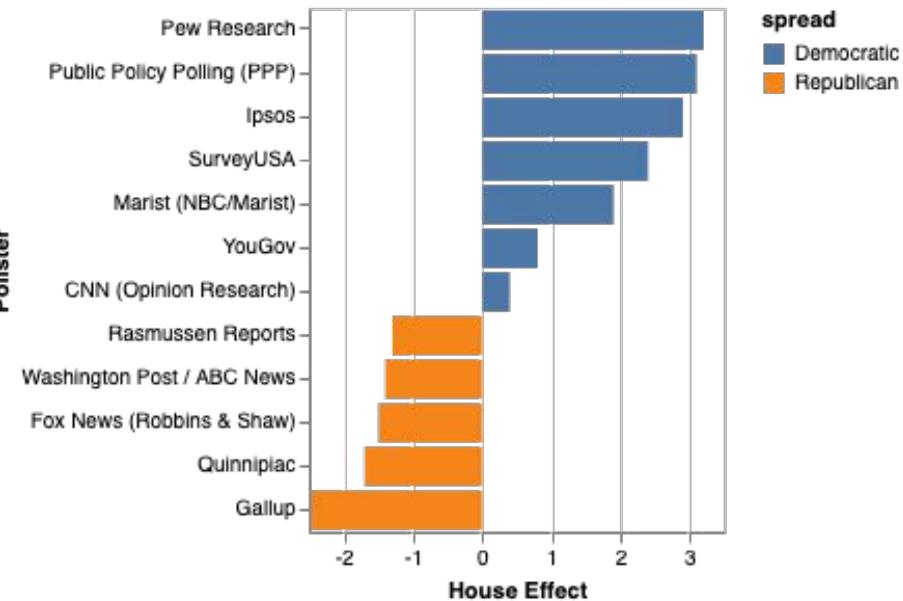


## Question

*What is the difference between the value of Gallup and Quinnipiac?*

## Answer

0.8

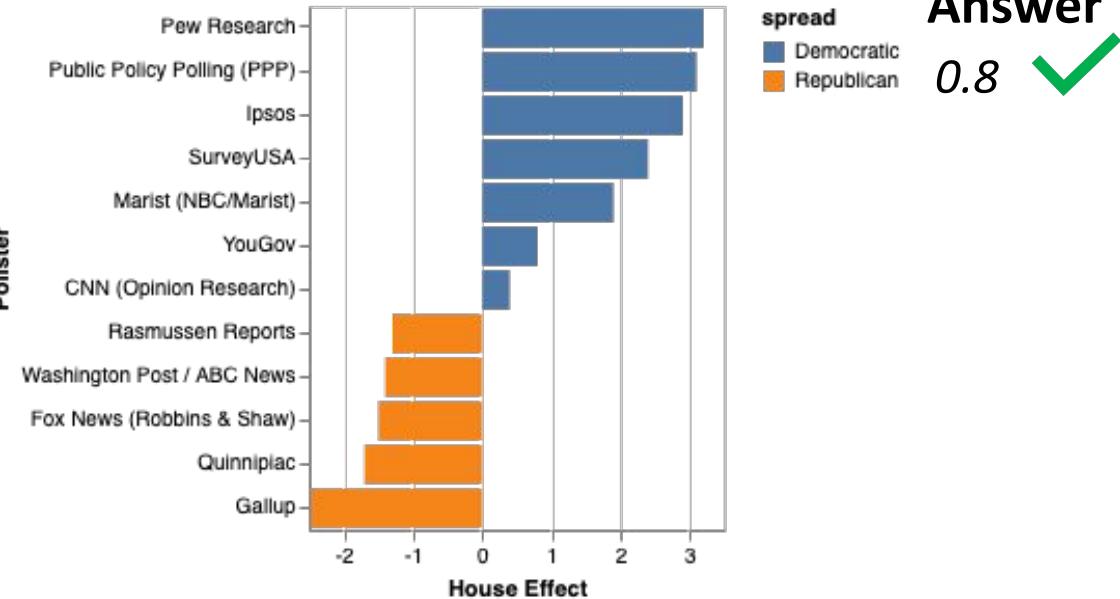


# Question

*What is the difference between the value of Gallup and Quinnipiac?*

# Answer

0.8 ✓



## Question

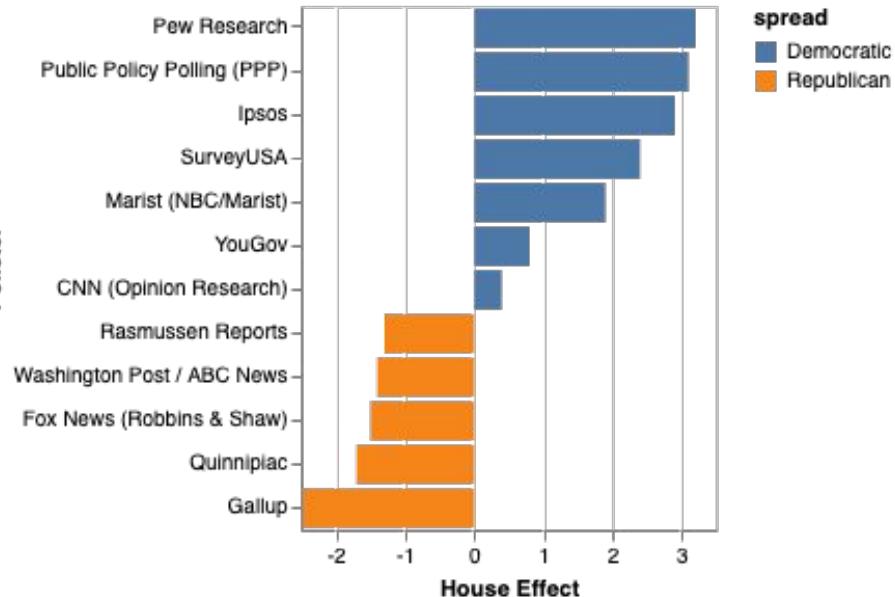
*What is the difference between the value of Gallup and Quinnipiac?*

## Answer

0.8 ✓

## Explanation

*I computed the difference between the length of the bar for 'Gallup' and 'Quinnipiac'.*



## Question

*What is the difference between the value of Gallup and Quinnipiac?*

## Answer

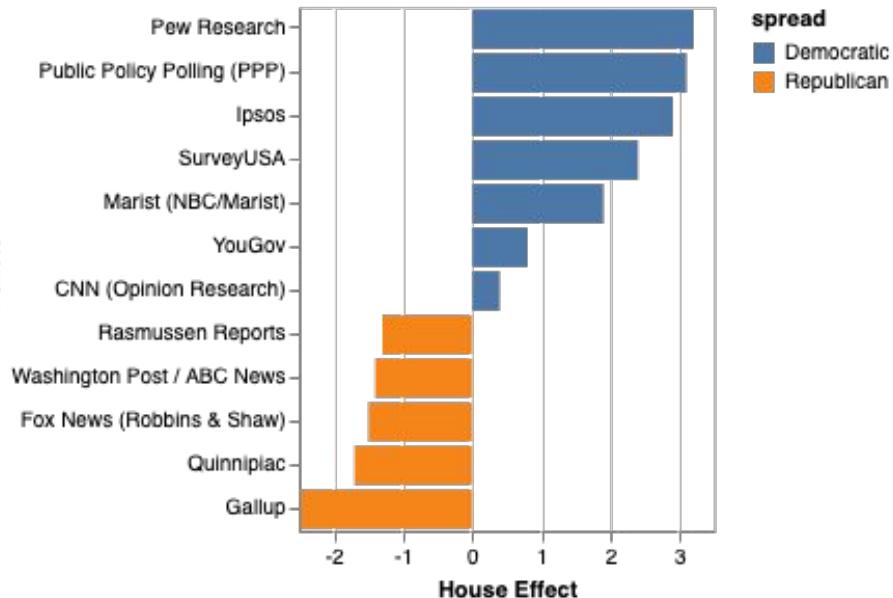
0.8 ✓

## Explanation

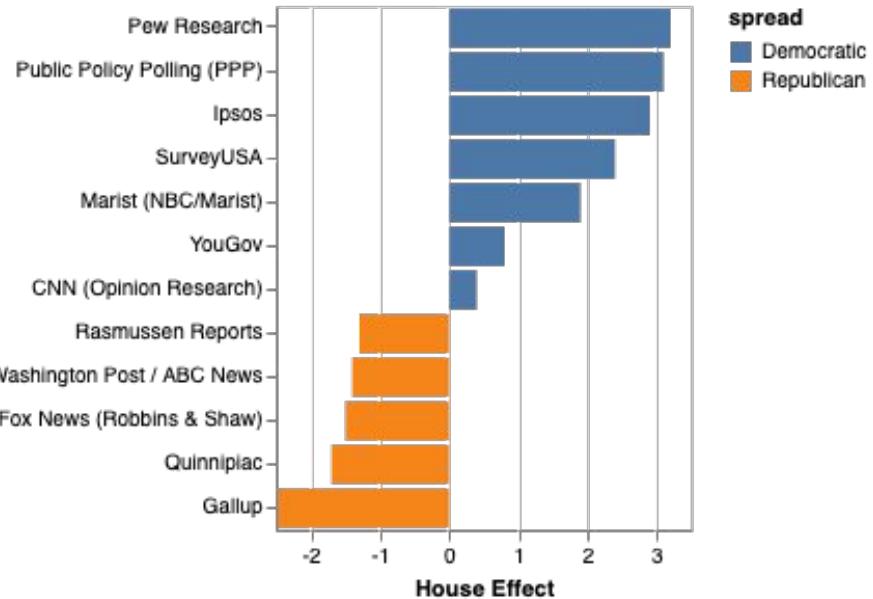
*I computed the difference between the length of the bar for 'Gallup' and 'Quinnipiac'.*

## Question

*What position is Ipsos in?*



Pollster



## Question

*What is the difference between the value of Gallup and Quinnipiac?*

## Answer

0.8



## Explanation

*I computed the difference between the length of the bar for 'Gallup' and 'Quinnipiac'.*

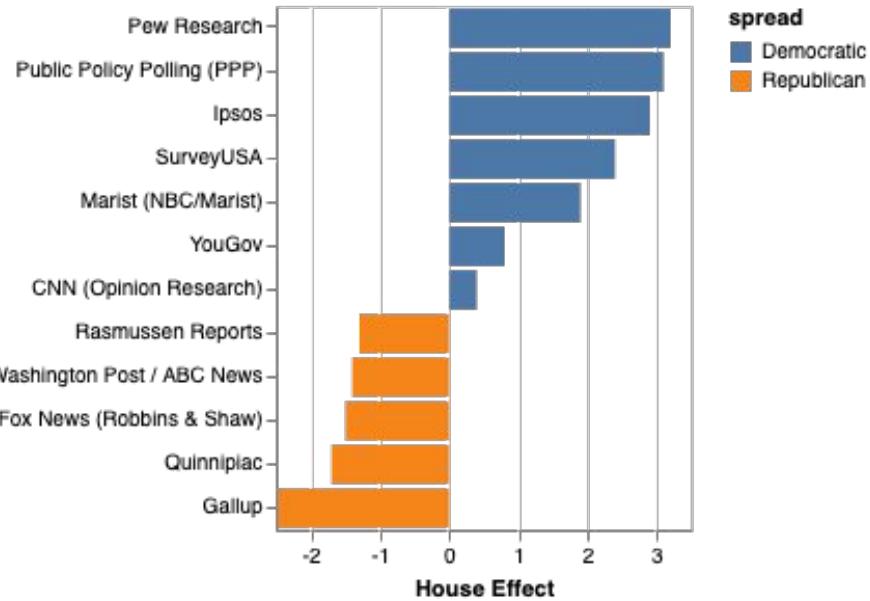
## Question

*What position is Ipsos in?*

## Answer

2.9

Pollster



## Question

*What is the difference between the value of Gallup and Quinnipiac?*

## Answer

0.8



## Explanation

*I computed the difference between the length of the bar for 'Gallup' and 'Quinnipiac'.*

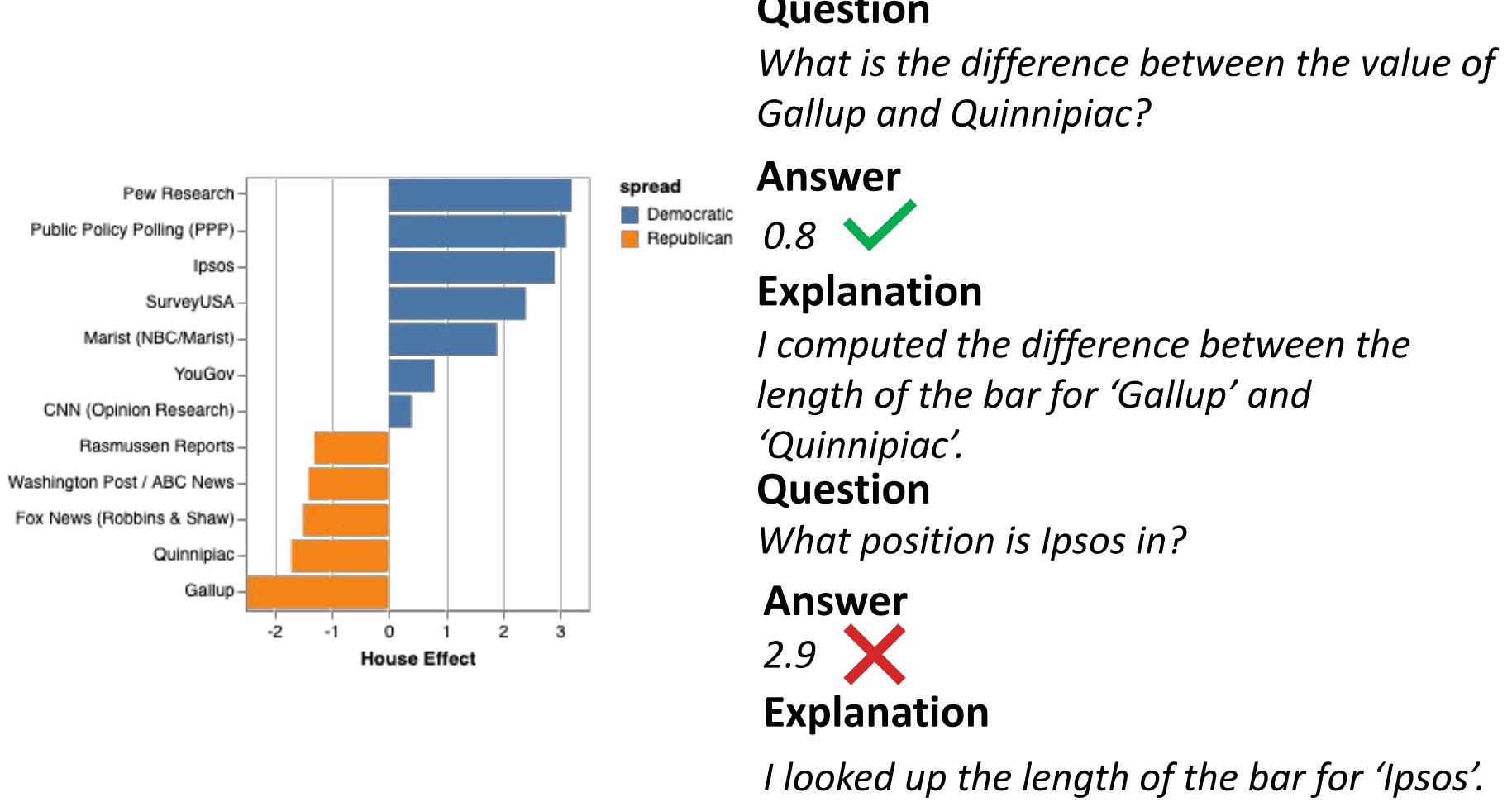
## Question

*What position is Ipsos in?*

## Answer

2.9

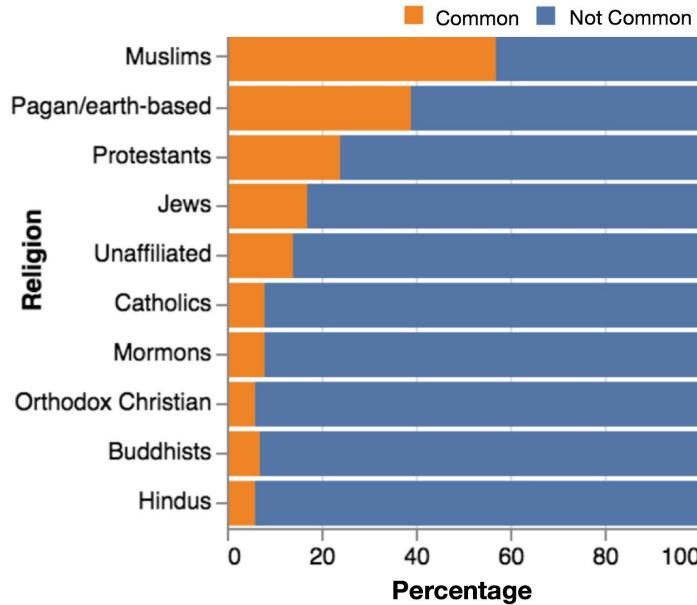




# User Study

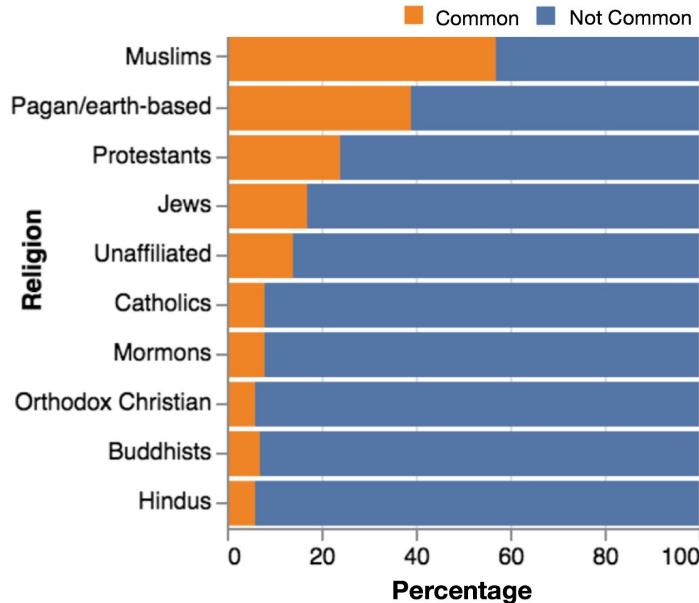
Hypothesis: Visual explanations increase transparency and trust

# Hypothesis: Visual explanations increase transparency and trust



*For which religion did the fewest chaplains think that religious extremism is common?*

# Hypothesis: Visual explanations increase transparency and trust

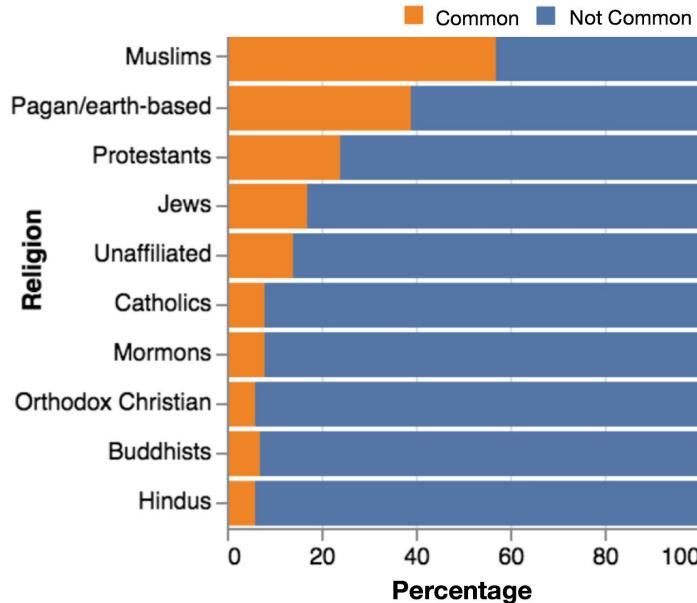


A1 (vis):

*Orthodox Christians, Hindus. I looked up 'Religion' for the shortest orange bar.*

*For which religion did the fewest chaplains think that religious extremism is common?*

# Hypothesis: Visual explanations increase transparency and trust



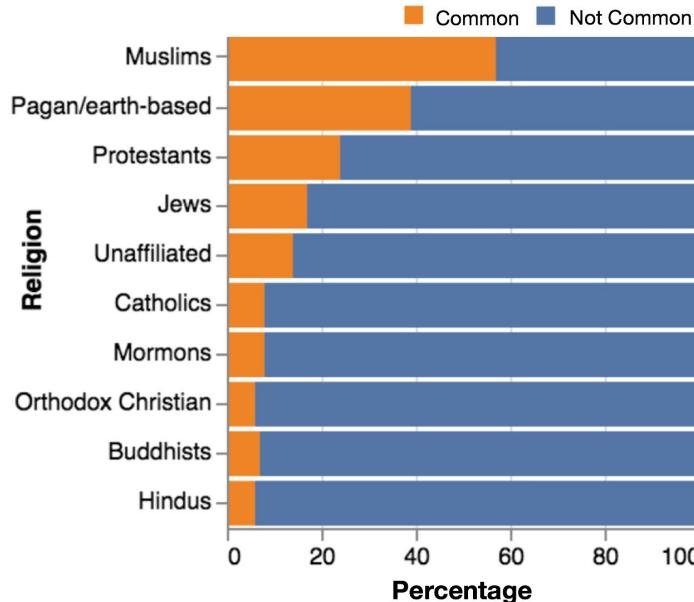
A1 (vis):

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A2 (no-exp): *Orthodox Christians, Hindus.*

Q: *For which religion did the fewest chaplains think that religious extremism is common?*

# Hypothesis: Visual explanations increase transparency and trust



A1 (vis):

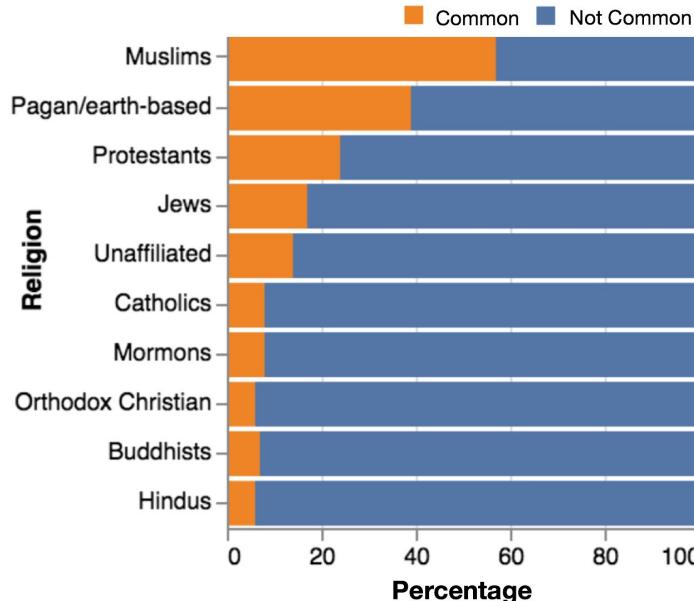
*Orthodox Christians, Hindus. I looked up 'Religion' for the shortest orange bar.*

A2 (no-exp): *Orthodox Christians, Hindus.*

A3 (non-vis): *Orthodox Christians, Hindus. I looked up 'Religion' with the lowest value for 'Common'.*

Q: *For which religion did the fewest chaplains think that religious extremism is common?*

# Hypothesis: Visual explanations increase transparency and trust



A1 (vis):

*Orthodox Christians, Hindus. I looked up 'Religion' for the shortest orange bar.*

A2 (no-exp): *Orthodox Christians, Hindus.*

A3 (non-vis): *Orthodox Christians, Hindus. I looked up 'Religion' with the lowest value for 'Common'.*

A4 (human): *Orthodox Christians, Hindus. They have lowest values for 'Common'.*

Q: *For which religion did the fewest chaplains think that religious extremism is common?*

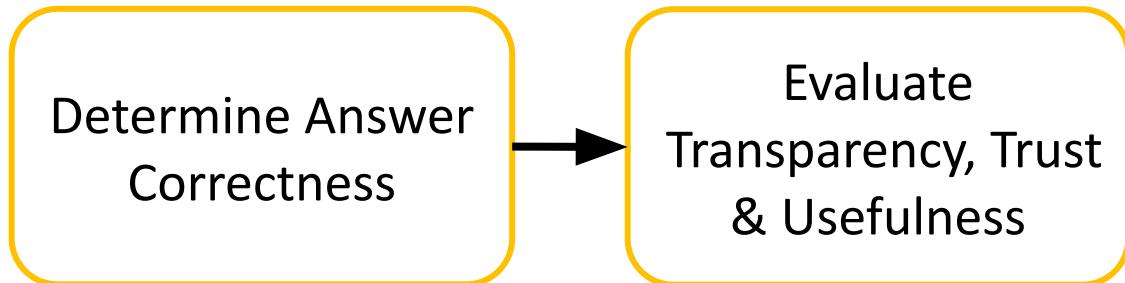
- 16 participants

- 16 participants
- 20 Chart-Question-Answer-Explanation tuples (5 per explanation type)

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Determine Answer  
Correctness

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- 20 Chart-Question-Answer-Explanation tuples (5 per explanation type)



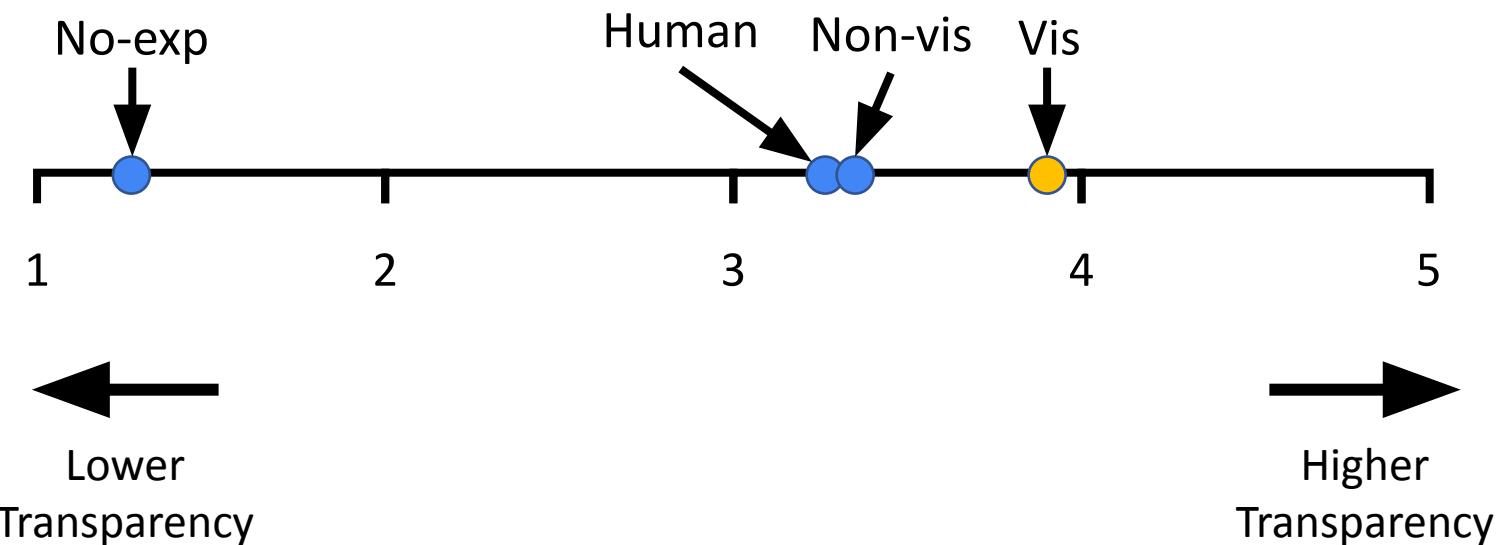
- 16 participants
- 20 Chart-Question-Answer-Explanation tuples (5 per explanation type)



# Study Results

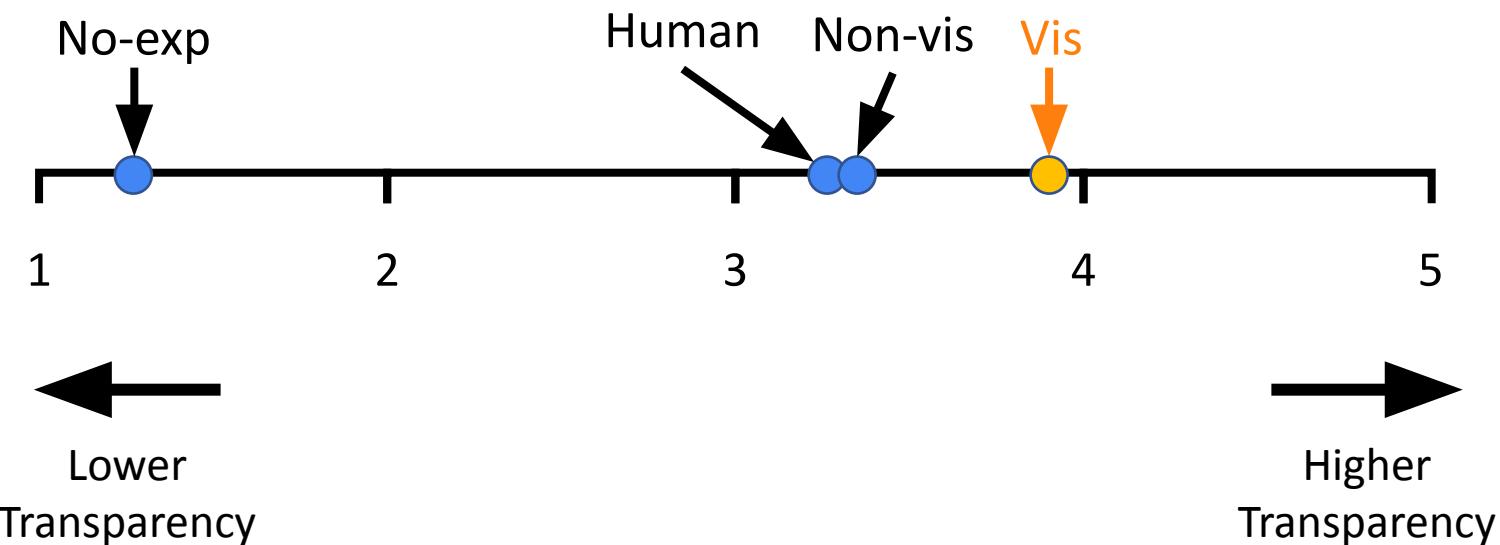
# Transparency

- Presence of explanations



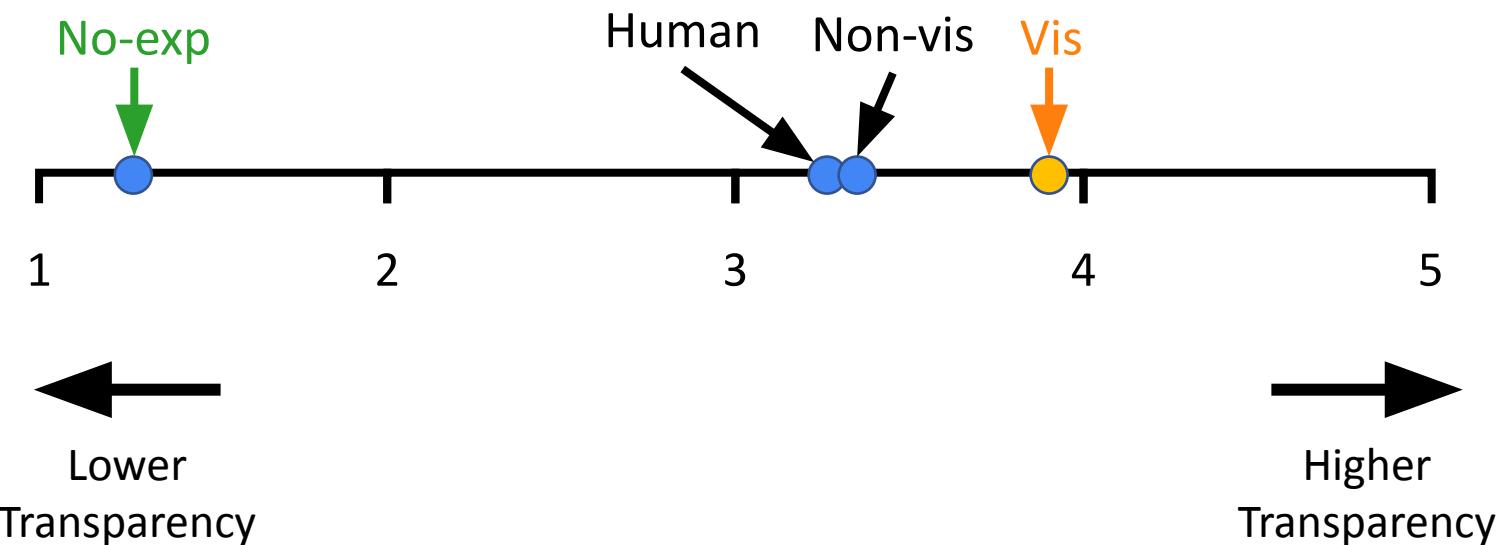
# Transparency

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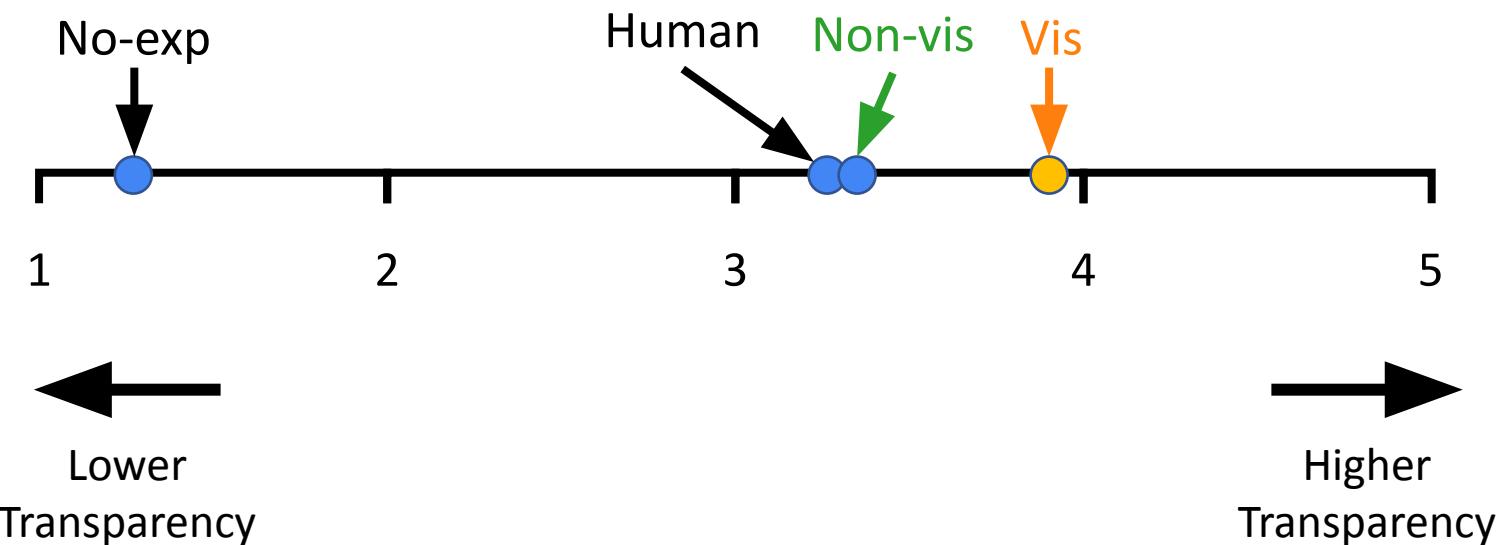
# Transparency

- Presence of explanations



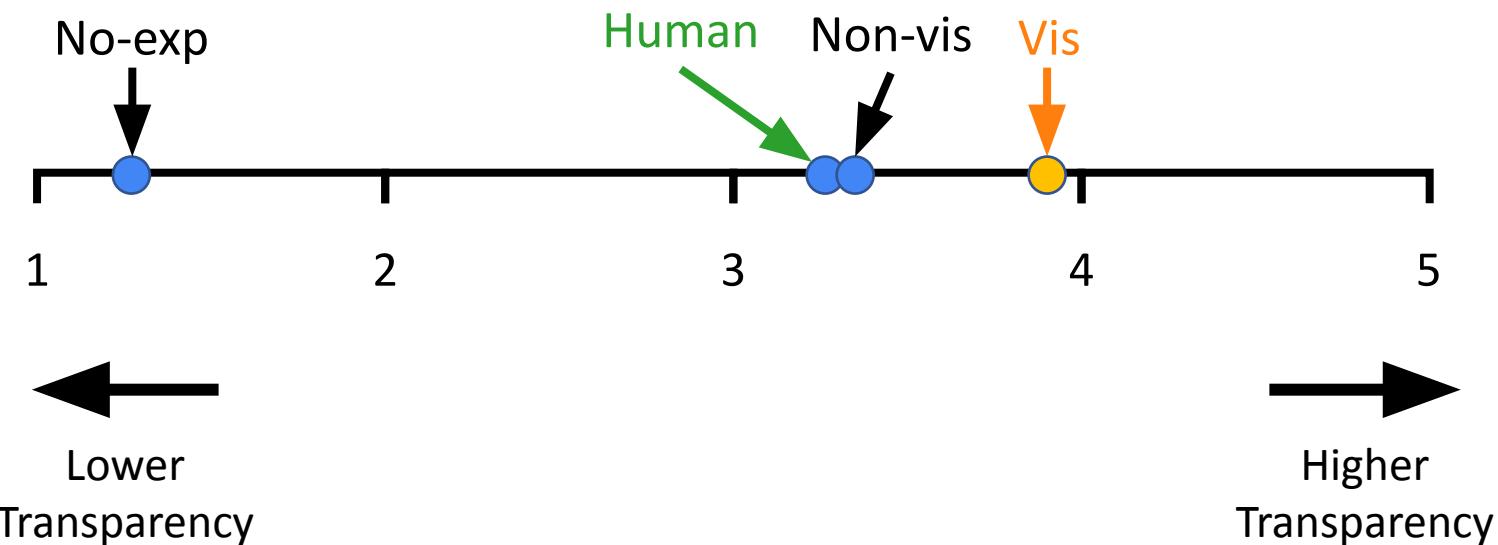
# Transparency

- Presence of explanations



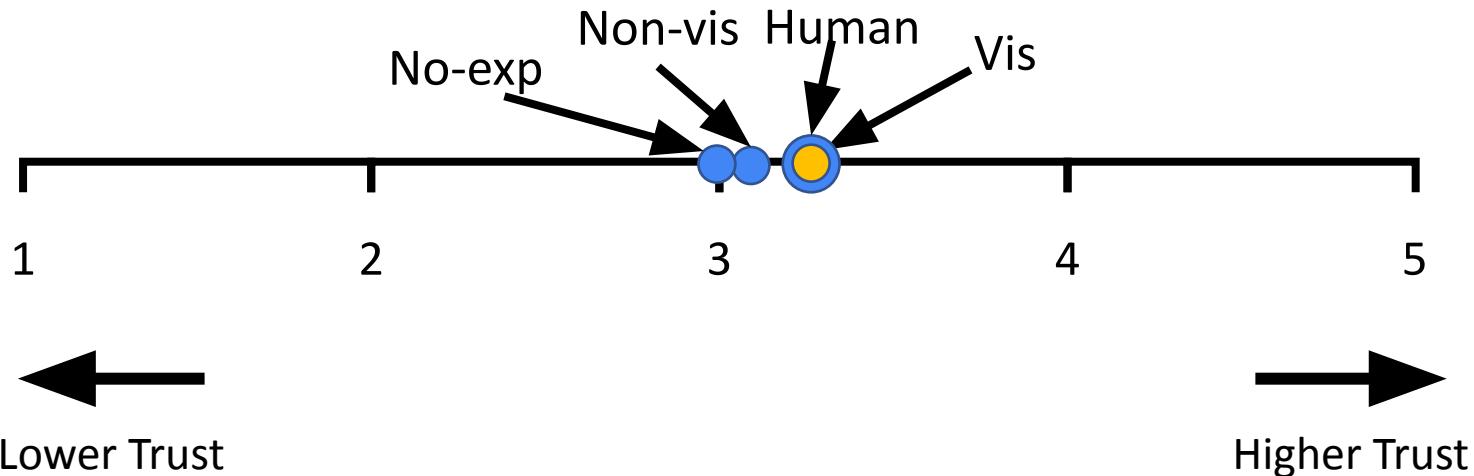
# Transparency

- Presence of explanations



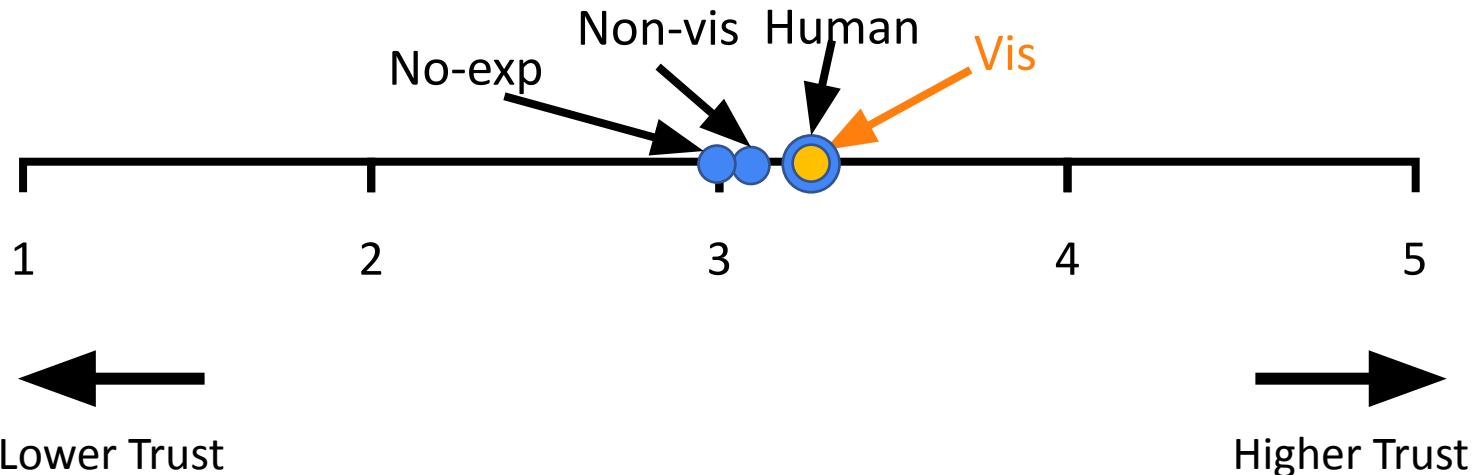
# Trust

- Accuracy of answers
- Explanation-answer match



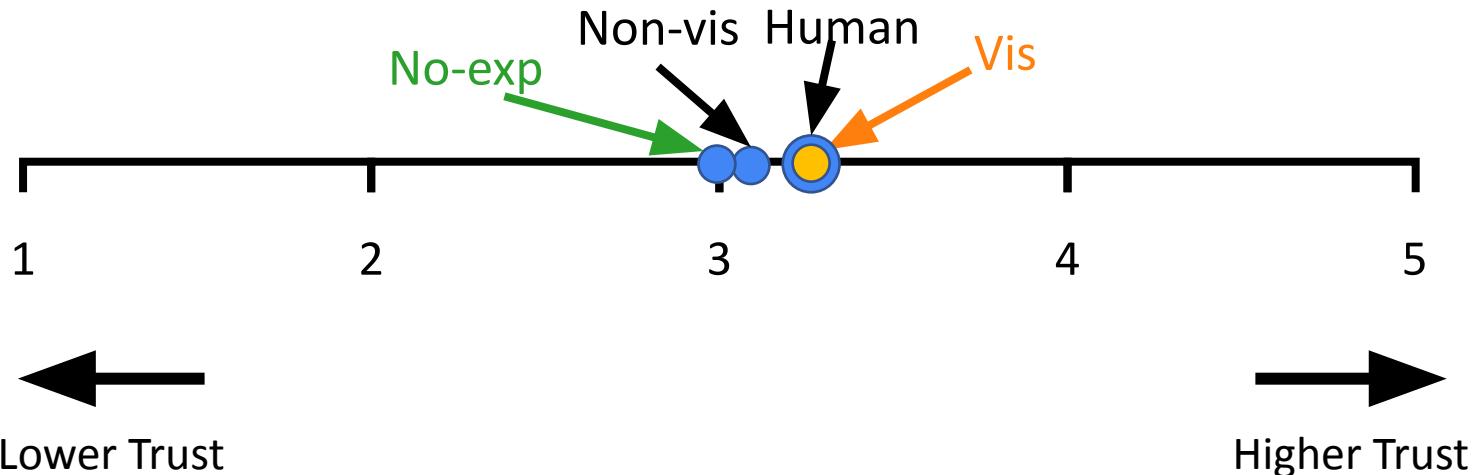
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- Accuracy of answers
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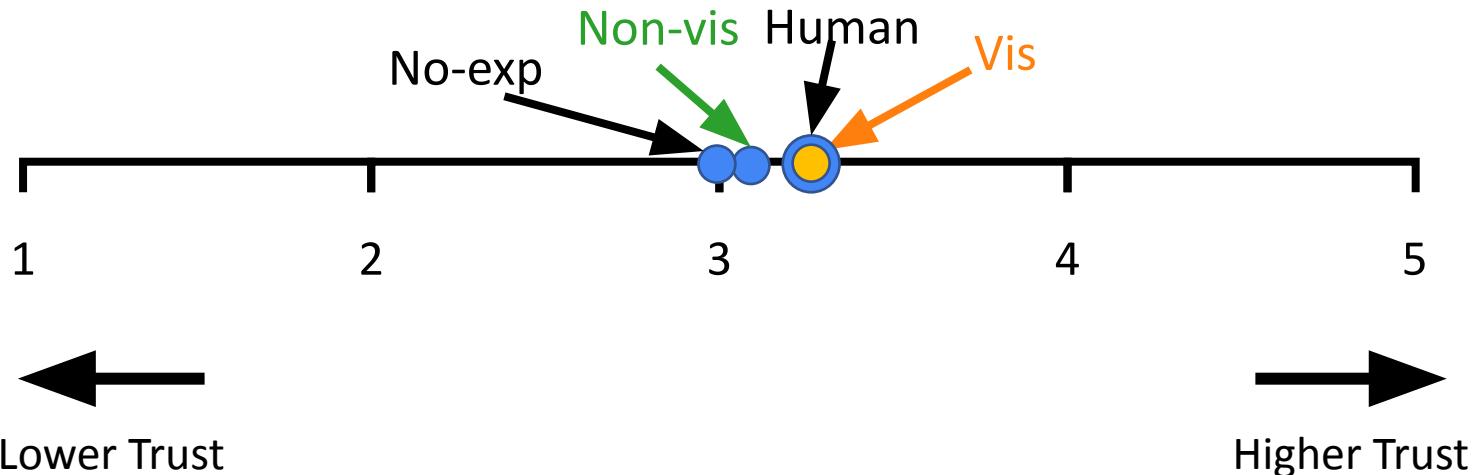
# Trust

- Accuracy of answers
- Explanation-answer match



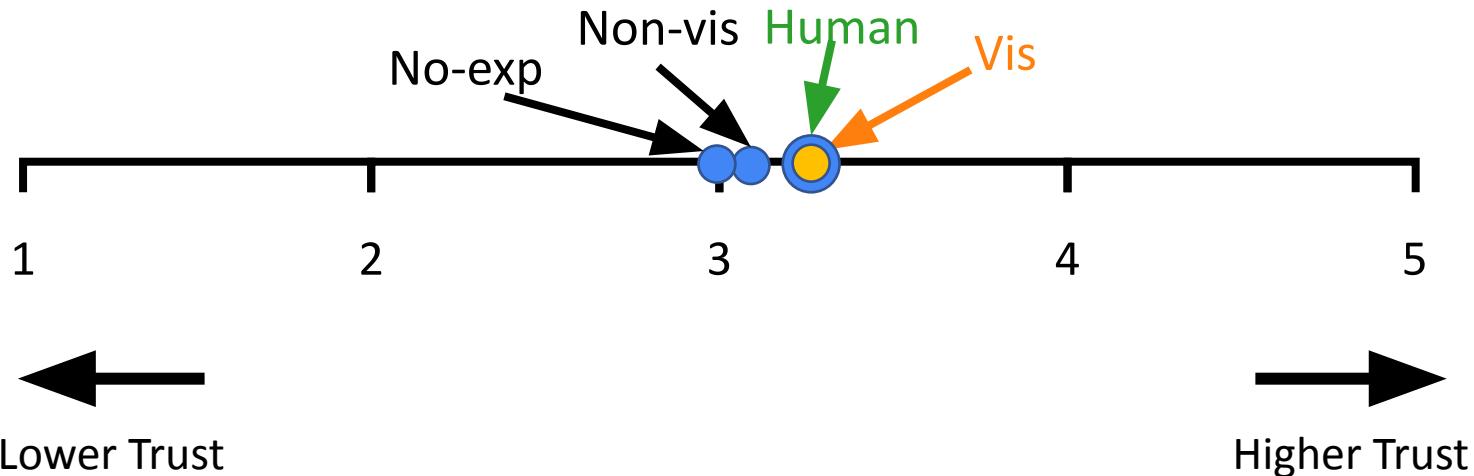
# Trust

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# Trust

- Accuracy of answers
- Explanation-answer match



# Eviza: A Natural Language Interface for Visual Analysis

[Setlur et al. 2016]

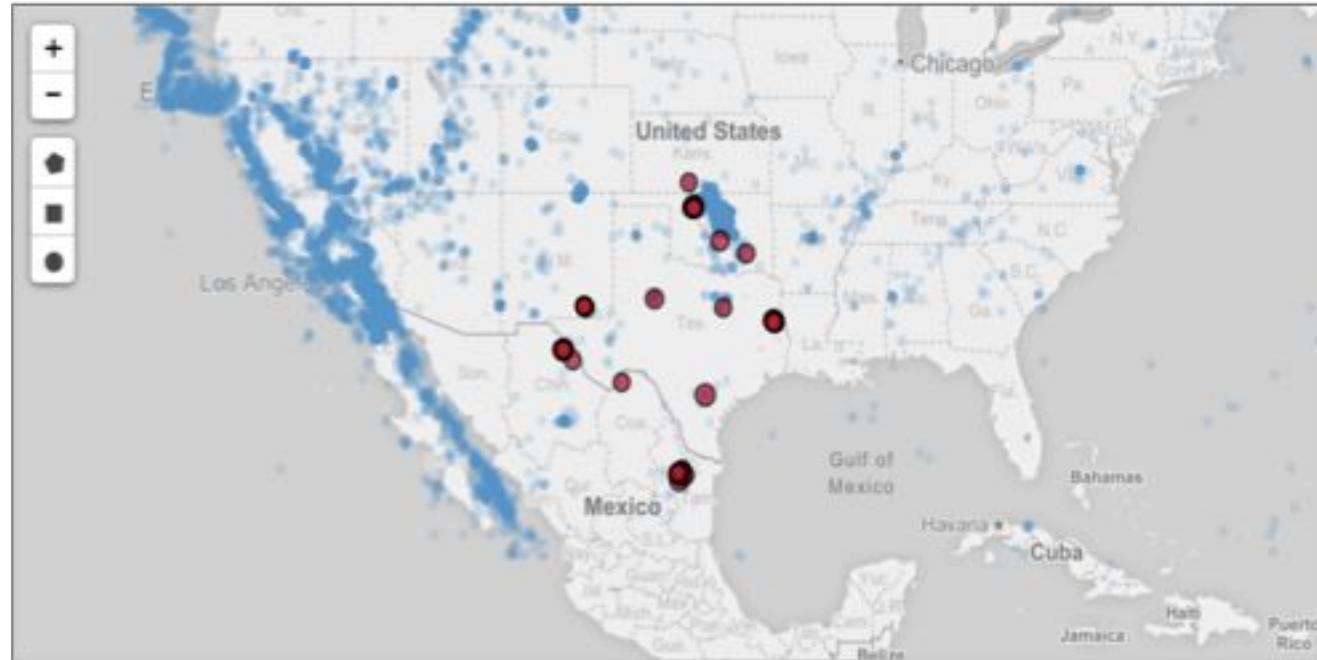
# Supporting an analytical conversation

“Find large earthquakes near California”



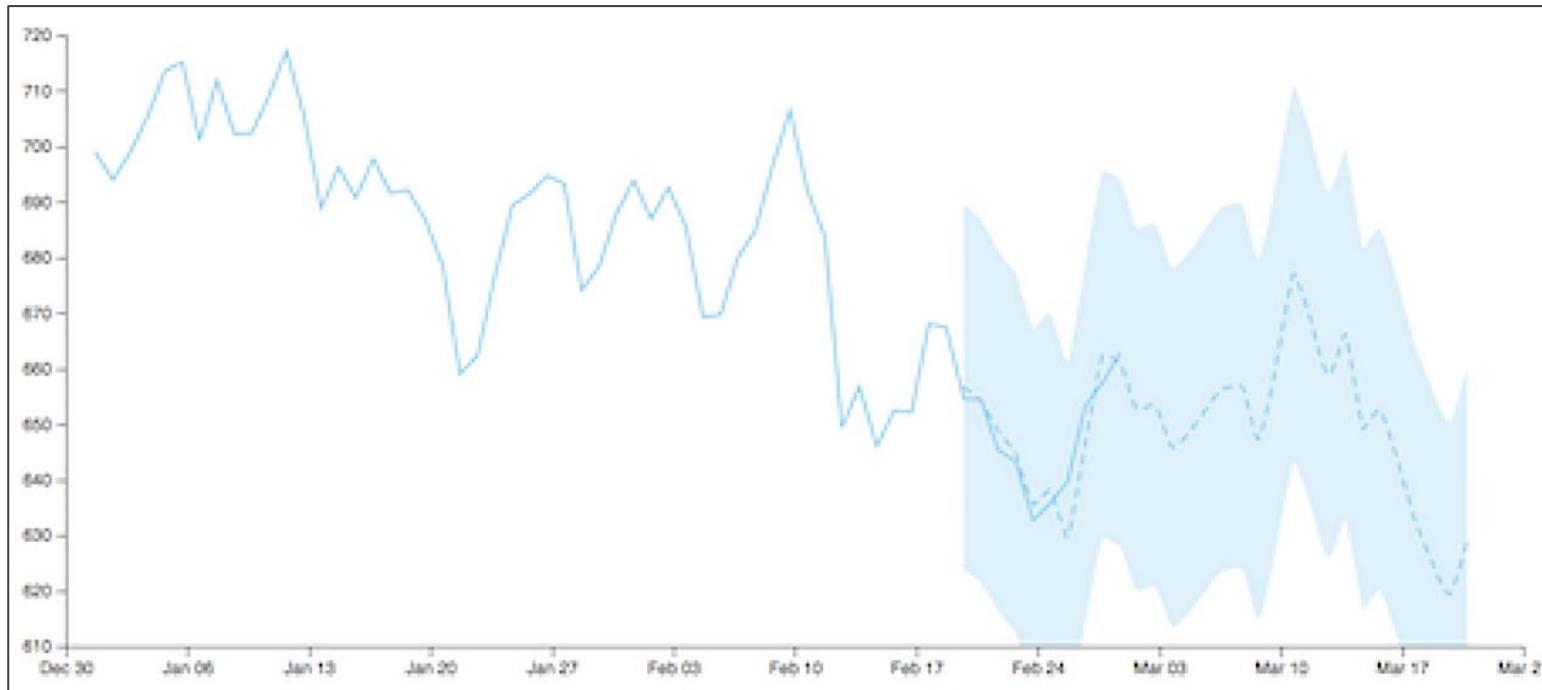
# Eviza

“Find large earthquakes near California”  
“How about near Texas”



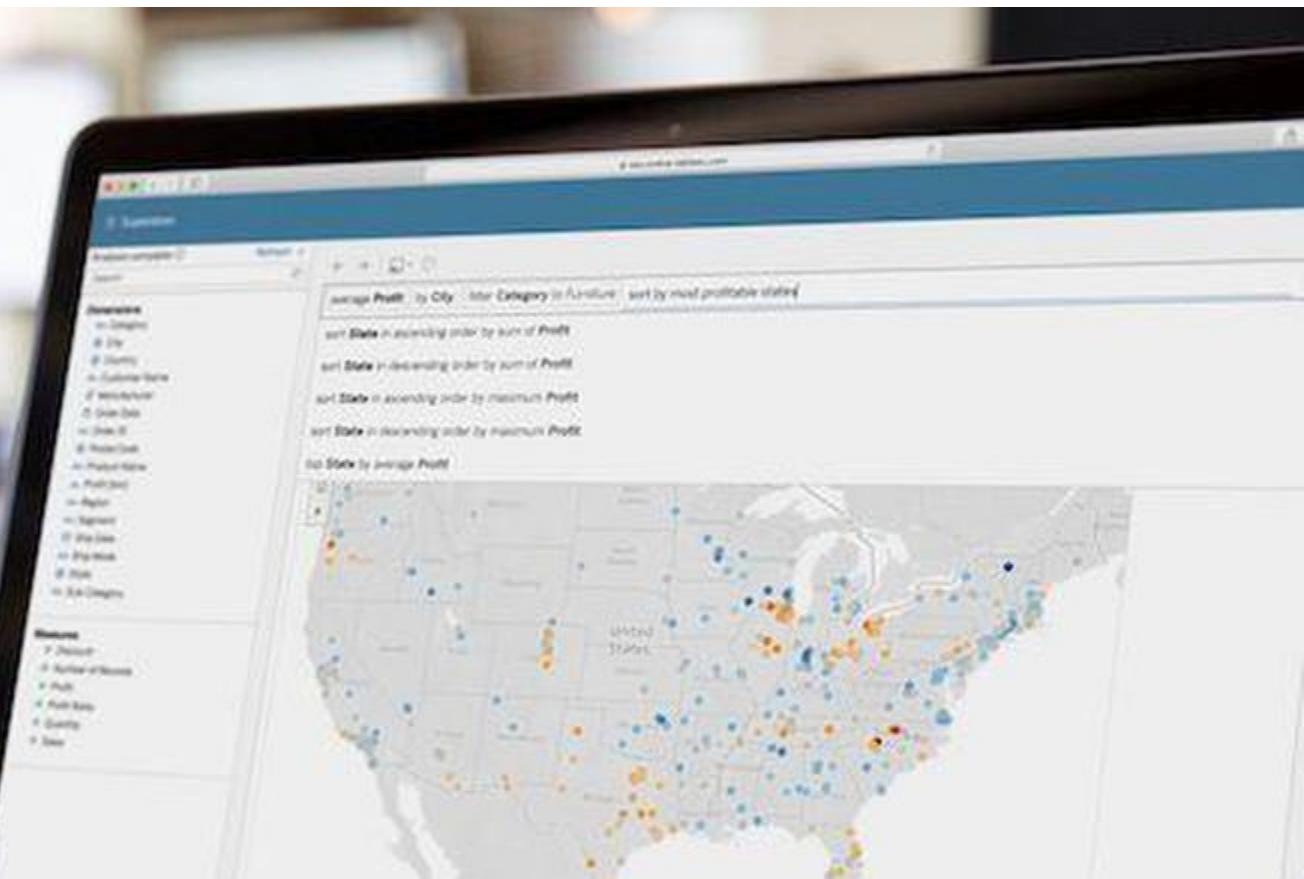
# Deeper analytical conversation

“show me the trends for next month”



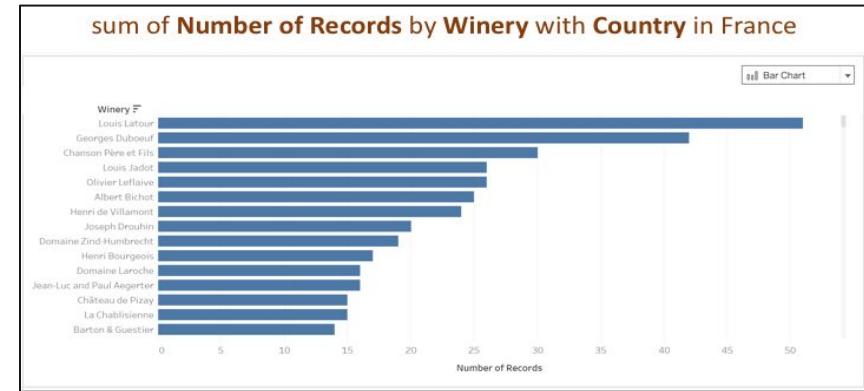
# Ask Data

<https://www.tableau.com/products/new-features/ask-data>

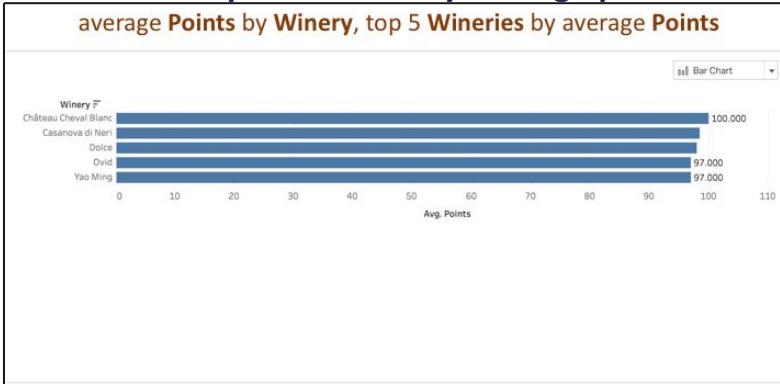


# Analytical functions supported

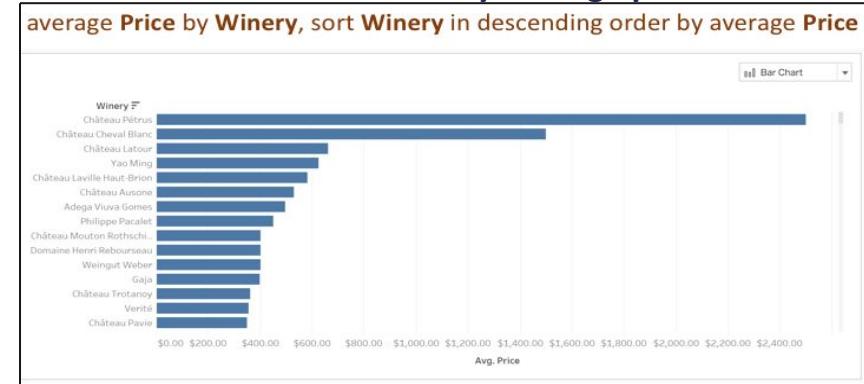
“what's the sum of price for each country?” “wineries in france”



## **“top 5 wineries by average points”**



**“sort wineries by average price”**



# AUGMENTING SEMANTICS

Datetime	price	Latitude	Longitude	area	#beds	openhouse_time	Source
1/4/2016	600000	38.8977	77.0365	5320	3	3:00pm	<a href="re.us/dfj3.php">re.us/dfj3.php</a>
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

“Show me house prices”

# “Show me house prices” in Ask Data

Prices ≈ price

Datetime	price	Latitude	Longitude	area	#beds	openhouse_time	Source
1/4/2016	600000	38.8977	77.0365	5320	3	3:00pm	<a href="#">re.us/dfj3.php</a>
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

# “Show me **expensive** house prices” in Ask Data

**Expensive** refers to **price**

Datetime	price	Latitude	Longitude	area	#beds	openhouse_time	Source
1/4/2016	600000	38.8977	77.0365	5320	3	3:00pm	<a href="#">re.us/dfj3.php</a>
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

**Expensive**: adjective; entailing great expense; very high **priced**; costly

# “Show me house cost”

**Cost is a synonym of price**

Datetime	price	Latitude	Longitude	area	#beds	openhouse_time	Source
1/4/2016	600000	38.8977	77.0365	5320	3	3:00pm	<a href="#">re.us/dfj3.php</a>
:	:	:	:	:	:	:	:

**Cost:** amount, charge, damage, **price**, expenditure...

# “Show me large houses”

**Large** refers to size, which can be measured as area

Datetime	price	Latitude	Longitude	area	#beds	openhouse_time	Source
1/4/2016	600000	38.8977	77.0365	5320	3	3:00pm	<a href="#">re.us/dfj3.php</a>
:	:	:	:	:	:	:	:

**Large**: adjective; ample in dimensions, quantity, or number. Having much size or **extent**, capacity, scope, length, breadth etc., or relatively being of more than common **measure** wide, broad, spacious, great, big, or bulky

**Area**: noun; a **measure** of the **extent** of a surface it is measured in square units

# “Show me sqft of houses”

## Sqft measures area

Datetime	price	Latitude	Longitude	area	#beds	openhouse_time	Source
1/4/2016	600000	38.8977	77.0365	5320	3	3:00pm	re.us/dfj3.php
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

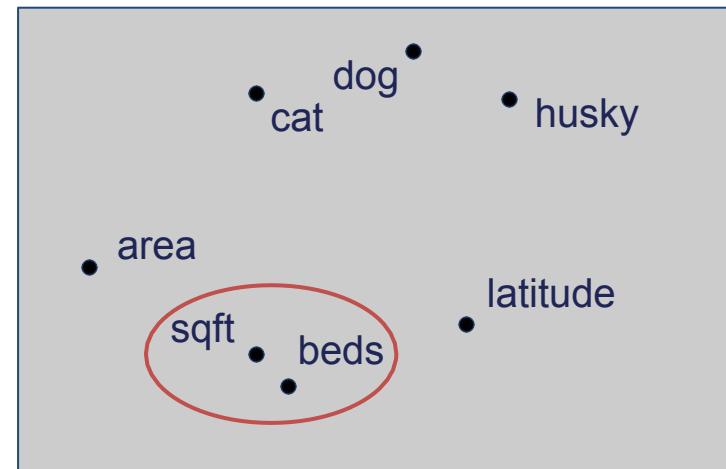


# Using word similarity

“The house is 5000 sqft.”

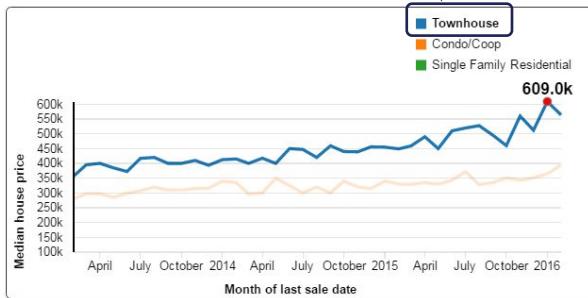
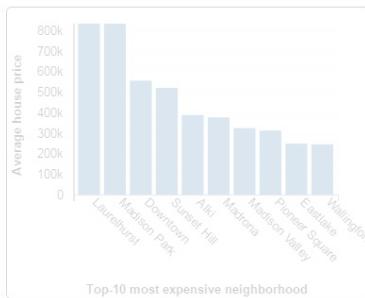
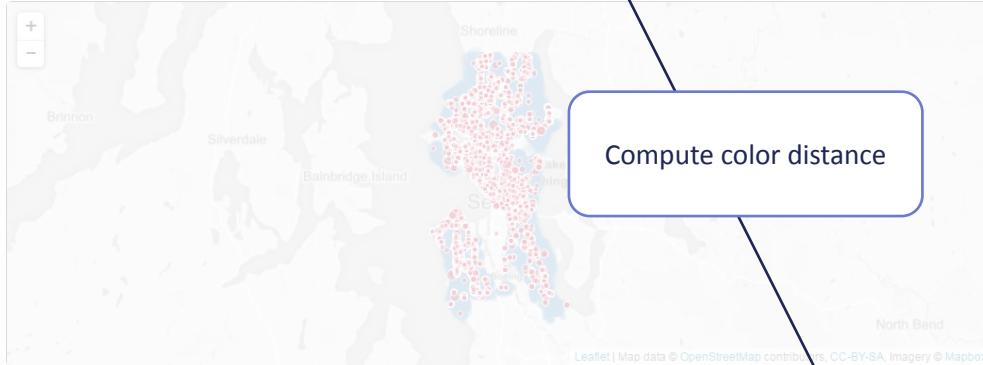
“The house has 5 beds.”

“I have a pet cat.”



# Visualization properties

Query: what's the *spike* in that **blue** line?



Neighborhood

How have sale prices changed?

# External knowledge

WolframAlpha What would you like to know about?

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Portal Talk Read View source View history Search Wikipedia

## Portal:Current events

From Wikipedia, the free encyclopedia Edit instructions

Topics in the news

- In the [Battle of Mosul](#), the [Great Mosque of al-Nuri](#) is destroyed.
- In Saudi Arabia, [Mohammad bin Salman](#) is appointed Crown Prince after the king deposes [Muhammad bin Nayef](#).
- [A vehicle driven into pedestrians](#) near the [Finsbury Park Mosque \(pictured\)](#), London, injures at least 10 people.
- In golf, [Brooks Koepka](#) wins the [U.S. Open](#).
- In cricket, the [ICC Champions Trophy](#) concludes with [Pakistan](#) defeating [India](#) in the final.

Worldwide current events · Sports events

Finsbury Park Mosque

Ongoing: [Battle of Raqqa](#)

Recent deaths: Con Sciaccia · Otto Warmbier · Tim Hague · Baldwin Lonsdale

June 22, 2017 (Thursday) edit history watch Time: 07:22 UTC | Day: 22 June | Purge

June 21, 2017 (Wednesday) edit history watch

Armed conflicts and attacks

- Moro conflict
  - Maute rebels storm a school in [Pigcawayan](#), North Cotabato, Philippines, and take civilians hostage. ([The Sydney Morning Herald](#))
- Iraqi Civil War (2014–present)
  - Battle of Mosul (2016–present)

<< June 2017 >>

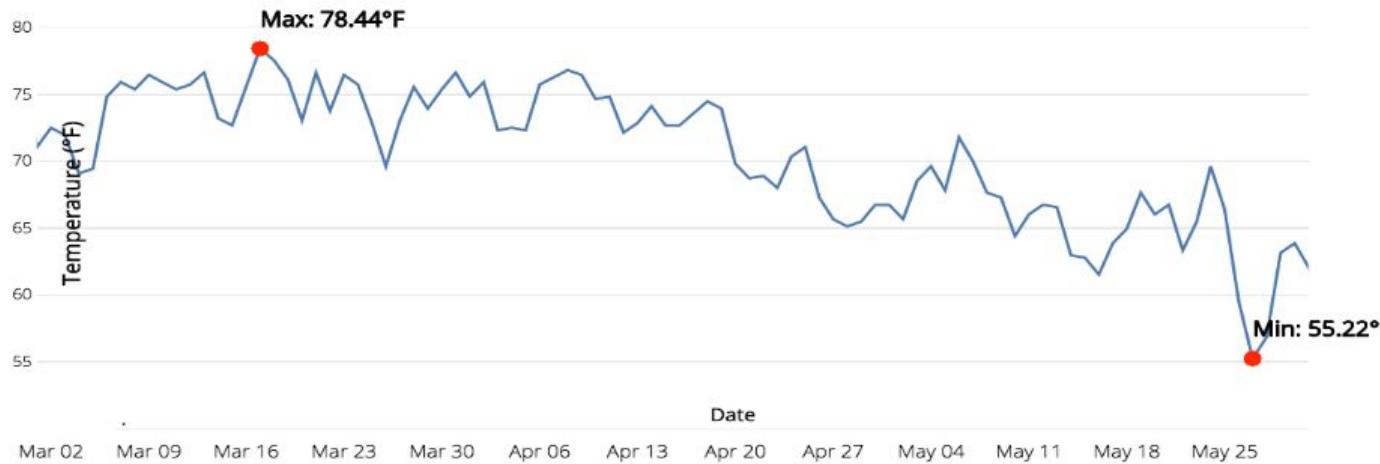
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

More June 2017 events...

equivalents  
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equivalents  
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o a specified system  
11 shoe in Japanese size  
OLE SIZES »  
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dle

# “highest and lowest temperatures in Fahrenheit over fall”

Temperatures in 2014



highest and lowest temperatures in Fahrenheit over seasons in Southern Hemisphere

fall is from 03/01/2014 to 05/31/2014 fall .

“what is the drop in july 2016?”

## Pound vs dollar



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About 3,020,000 results (0.66 seconds)

### Brexit Britain: Pound drops to \$1.28 - Jul. 6, 2016 - CNN Money

[money.cnn.com/2016/07/06/investing/brexit-pound-drops/index.html](http://money.cnn.com/2016/07/06/investing/brexit-pound-drops/index.html) ▾  
Jul 6, 2016 - by Ivana Kottasova @ivanakottasova July 6, 2016: 1:21 AM ET ... The pound has dropped roughly 15% since the referendum day, when it ...

### Pound slumps to 31-year low following Brexit vote | Business | The ...

<https://www.theguardian.com/business/stern> ▾  
Jun 24, 2016 - A woman in New York watches the pound fall on a laptop. Photograph: Andrew ... Friday 24 June 2016 02.55 EDT First published on Thursday 23 June 2016 18.15 EDT. The value of ... Pound v dollar. Value of £1 in US\$. ▾

### British Pound to US Dollar Exchange rate history: 10 July 2016 (10/07 ...

<https://www.poundsterlinglive.com/.../british-pound-to-us-dollar-exchange-rate-on-20...> ▾  
Jul 10, 2016 - On the 10th July 2016 the spot inter-bank market saw: Open: 1 GBP = 1.2908 USD. Close: 1 GBP = 1.2963 USD. Average: 1 GBP = 1.2944 ...

### British Pound to US Dollar Exchange rate history: 04 July 2016 (04/07 ...

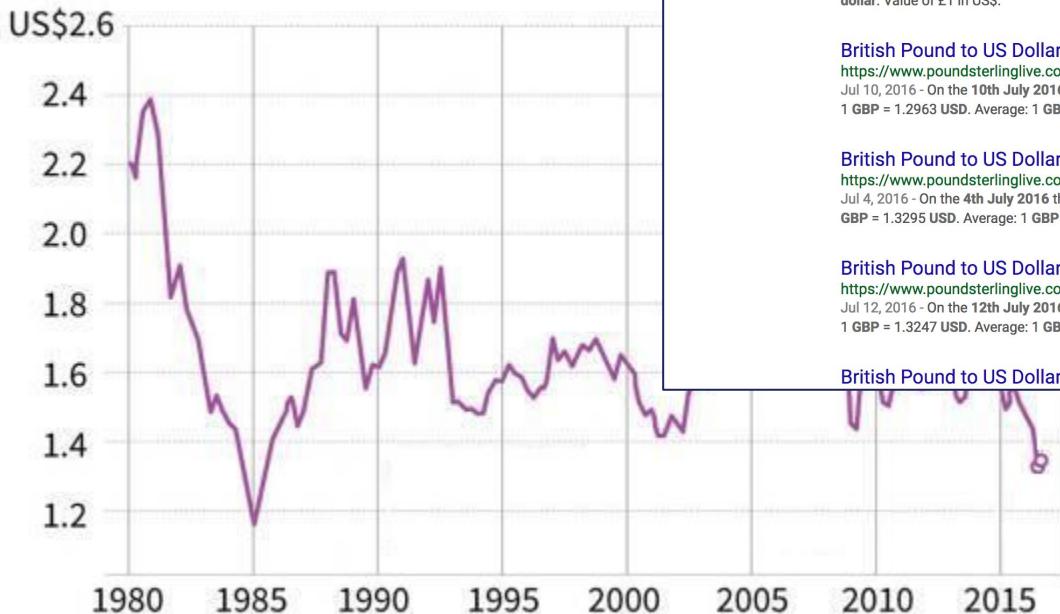
<https://www.poundsterlinglive.com/.../british-pound-to-us-dollar-exchange-rate-on-20...> ▾  
Jul 4, 2016 - On the 4th July 2016 the spot inter-bank market saw: Open: 1 GBP = 1.325 USD. Close: 1 GBP = 1.3295 USD. Average: 1 GBP = 1.3287 USD.

### British Pound to US Dollar Exchange rate history: 12 July 2016 (12/07 ...

<https://www.poundsterlinglive.com/.../british-pound-to-us-dollar-exchange-rate-on-20...> ▾  
Jul 12, 2016 - On the 12th July 2016 the spot inter-bank market saw: Open: 1 GBP = 1.3002 USD. Close: 1 GBP = 1.3247 USD. Average: 1 GBP = 1.3156 ...

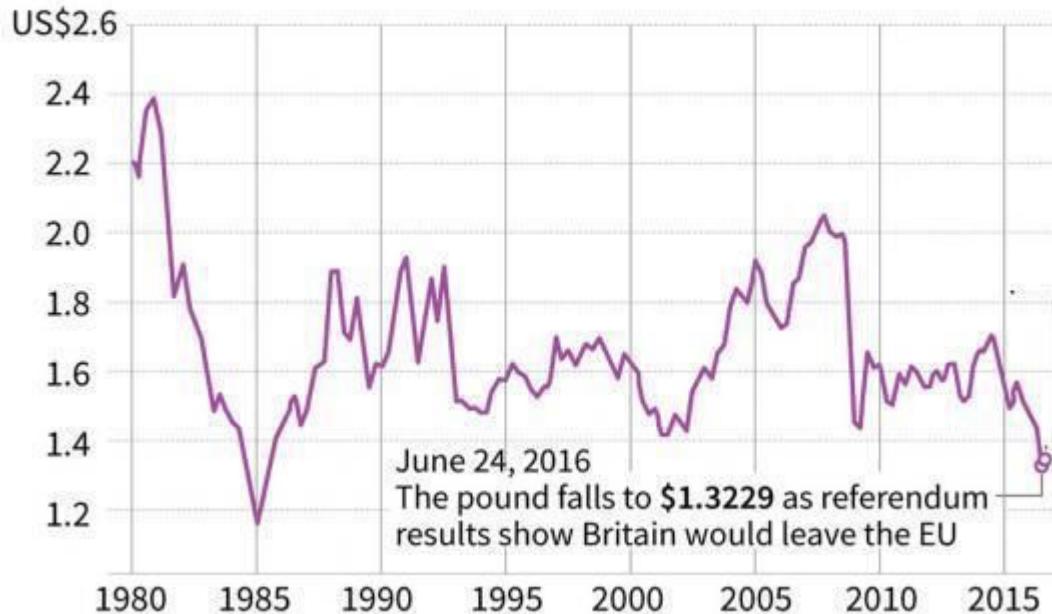
### British Pound to US Dollar Exchange rate history: 06 July 2016 (06/07 ...

## “what is the drop in Pound vs dollar



“what is the drop in july 2016?”

## Pound vs dollar



# Summary

Text and language play an important role in visual analysis

- Linking text with visualization
- Understanding how readers integrate charts and captions
- Visual question and answering
- Natural language interfaces