



NLP4Vis: Natural Language Processing for Information Visualization

Half-day Tutorial

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<https://nlp4vis.github.io/>

Tutorial Resources

NLP4Vis: Natural Language Processing for Information Visualization

Half-day tutorial at [IEEE Vis Conference 2023](#).

Overview

This tutorial will provide an introduction to natural language processing (NLP) to interested researchers in the visualization (Vis) community. It will first motivate why NLP4Vis is an important area of research and provide an overview of research topics on combining NLP and Vis techniques. Then an overview of deep learning models for NLP will be covered. A particular focus will be provided on highlighting the recent progress on large language models such as ChatGPT and how such models can be leveraged to solve various NLP tasks for visualizations. In the final part, we will focus on various application tasks at the intersection of NLP and Vis. We will conclude with an interactive discussion of future challenges for NLP+Vis applications. The audience will include researchers interested in applying NLP for visualizations as well as others who focus more generally at the intersection of AI and visualization.

Materials

Tutorial Overview

Introduction [15 mins]

- What is NLP?
- What is Vis?
- Why NLP + Vis?
- An overview of research topics on combining NLP and Vis techniques
- An overview of the tutorial

Coffee Break ☕

Deep Learning for NLP [60 mins]

- Introduction to NLP
- Language modeling
- Model Architectures
 - Transformer Architecture
 - Encoder, decoder, encoder-decoder
 - Pre-training and Fine-tuning
- Large language models (LLMs)
 - Scaling LMs to LLMs
 - Prompt Engineering
 - In context Learning
 - Instruction Tuning

NLP + Vis Applications [50 mins]

- Visual text analytics
- Natural language interfaces for visualizations
- ChartNLP (e.g., Chart question answering, Text2Chart)
- Natural language generation for visualization (e.g., Chart-to-text)
- Automated data-driven storytelling
- NLP for chart accessibility and inclusions
- Live demos

Future Challenges [25 mins]

- Building benchmarks for training and evaluation
- Data annotation challenges
- Addressing concerns of NLP models (e.g., bias, factual errors, hallucinations, explainability)



- Tutorial Overview
- Slides
- Reading materials

nlp4vis.github.io

Tutorial Overview

- **Part 1:** Introduction
 - Why NLP + Vis?
 - An overview of NLP + Vis Research
 - An overview of the tutorial
- **Part 2:** Deep Learning for NLP
 - Background
 - Large language models (LLMs)
- **Part 3:** NLP4Vis applications
- **Part 4:** Future challenges and research opportunities

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- **Part 4:** Future challenges and research opportunities [25 mins]

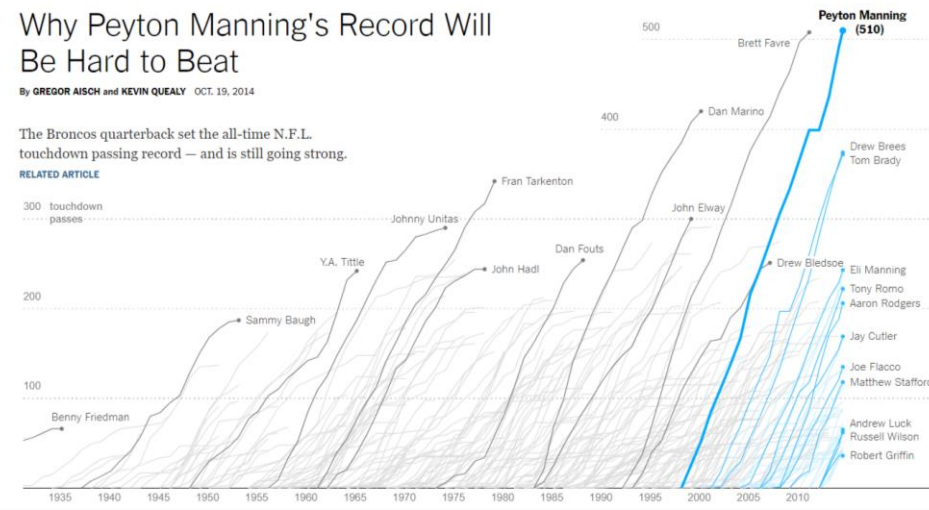
Why Integrate Natural Language with Visualizations?

Why Peyton Manning's Record Will Be Hard to Beat

By GREGOR AISCH and KEVIN QUEALY OCT. 19, 2014

The Broncos quarterback set the all-time N.F.L. touchdown passing record — and is still going strong.

RELATED ARTICLE



Published: February 2, 2018

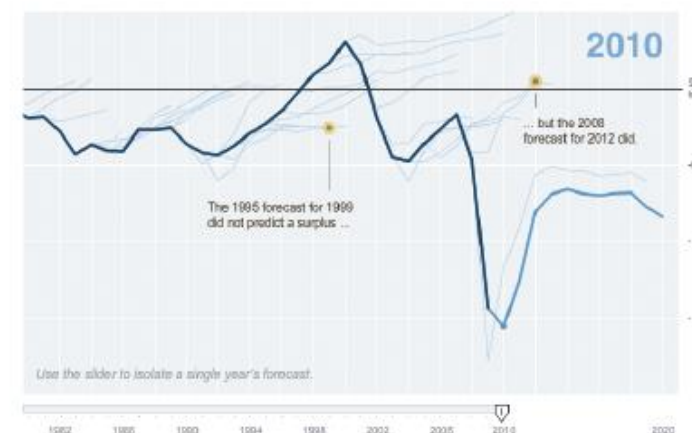
Budget Forecasts, Compared With Reality

Just two years ago, surpluses were predicted by 2012. How accurate have past White House budget forecasts been?

1 2 3 4 5 NEXT

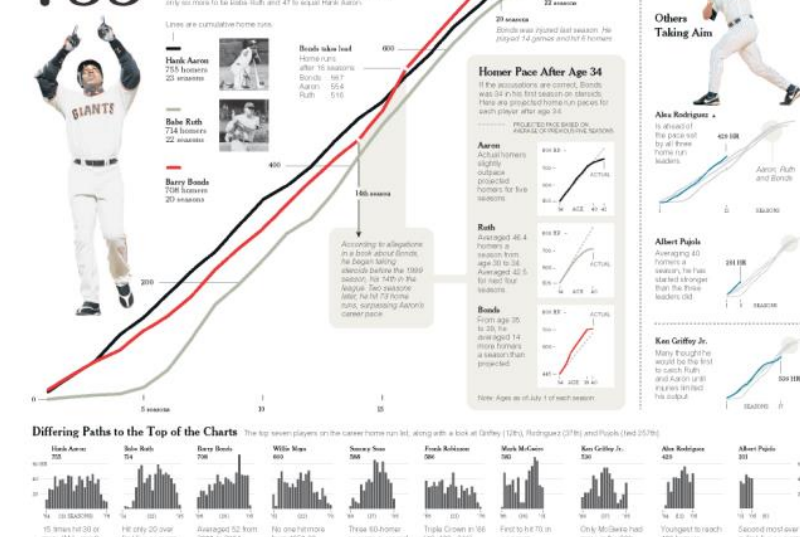
Latest forecast

Today, with a better understanding of the severity of the economic downturn, the deficit situation is much more dire.



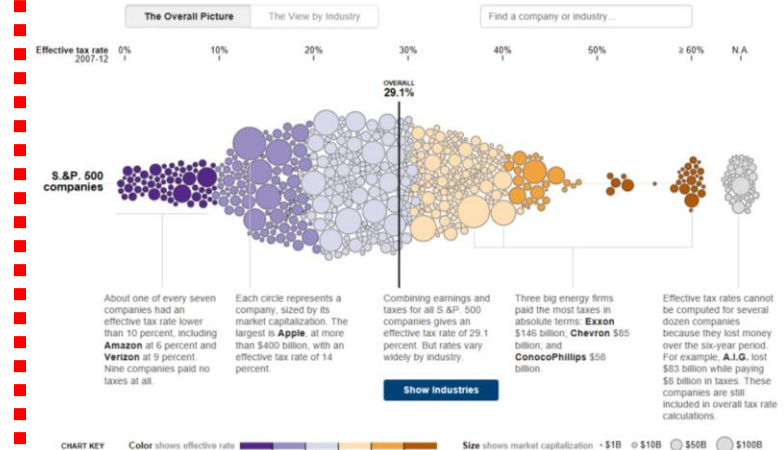
755 Steroids or Not, the Pursuit Is On

Barry Bonds is taking aim at the career home run record. He needs only six more to tie Babe Ruth and 47 to equal Mike Aaron.

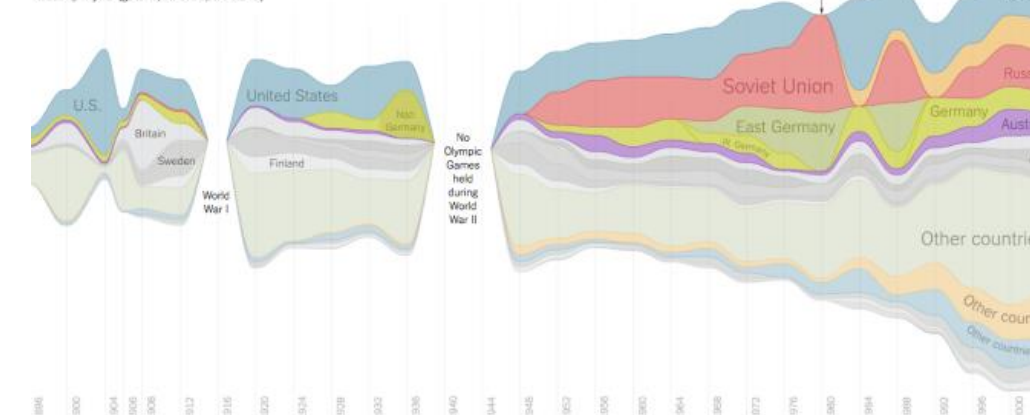


Across U.S. Companies, Tax Rates Vary Greatly

Last week, in a Congressional hearing, Apple got grilled for its low-tax strategy. But not every business can copy that approach. Here is a look at what S&P 500 companies paid in corporate income taxes — federal, state, local and foreign — from 2007 to 2012, according to S&P Capital IQ.



Streams sized by weighted Olympic medal count per year (gold: 3, silver: 2, bronze: 1)

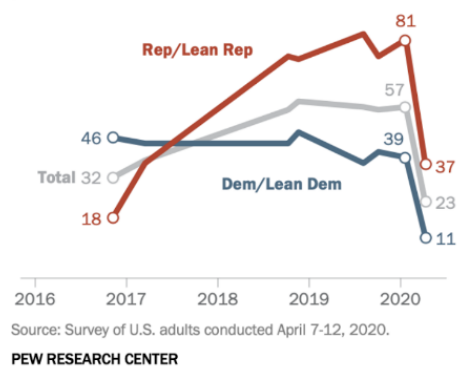


Amid record unemployment claims and the disruption of commercial activity caused by the [novel coronavirus outbreak](#), the public's assessments of the U.S. economy have deteriorated with extraordinary speed and severity. Just 23% of Americans now rate economic conditions in the country as excellent or good, down sharply from 57% at the start of the year.

Most now say the economy is in either only fair (38%) or poor (38%) shape. In January, just 9% of Americans said economic conditions were poor.

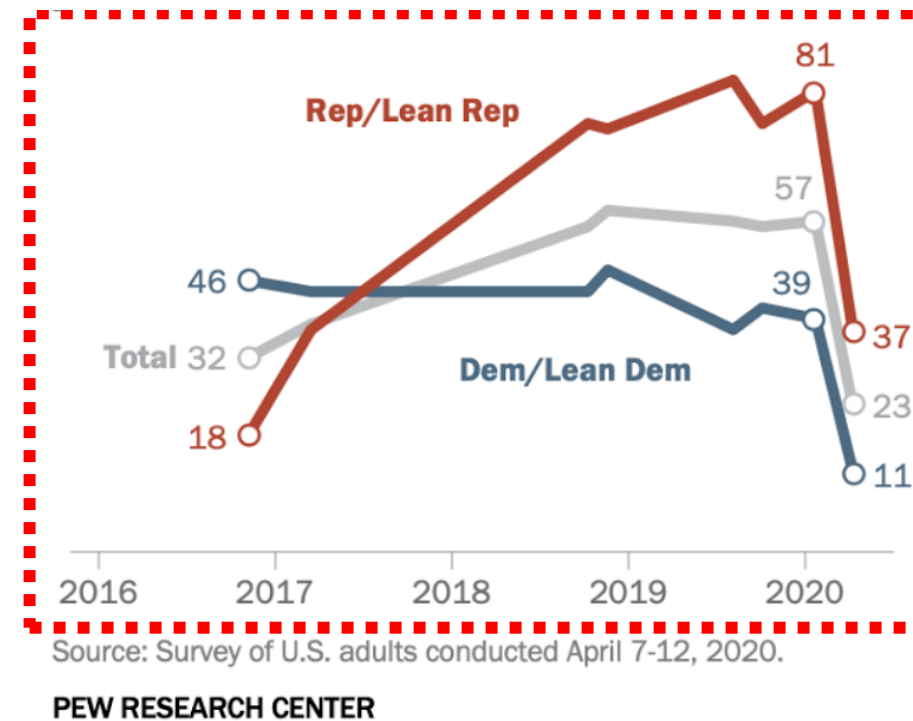
As coronavirus strikes the U.S., positive assessments of the economy plummet

% who rate national economic conditions as excellent or good



Why Integrate Natural Language with Visualizations?

- What's there in this visualization?



Why Integrate Natural Language with Visualizations?

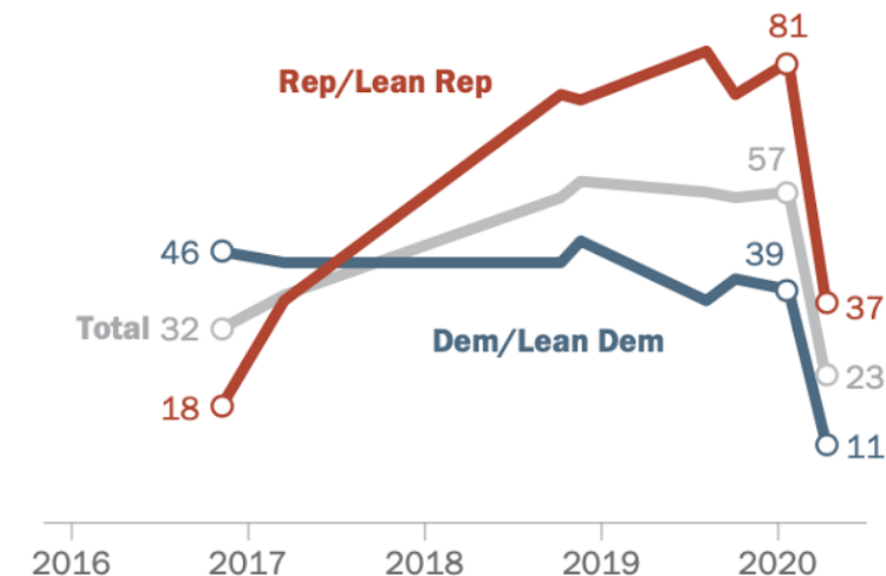
- **Language** and **Vision** are two powerful complementary communication channels for human

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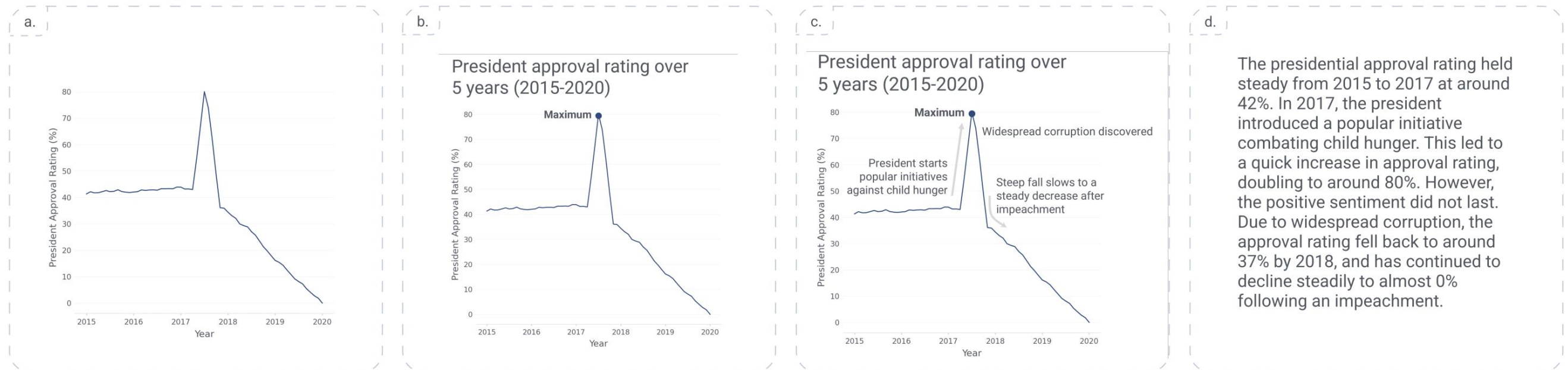


Source: Survey of U.S. adults conducted April 7-12, 2020.

PEW RESEARCH CENTER

Why Integrate Natural Language with Visualizations?

- Users prefer charts with **more textual** annotations explaining key points over charts with fewer annotations or text alone.



NLP4Vis

Applying NLP for various visualization-related tasks:

- Visual text analytics
- Natural language interfaces for visualizations
- Text generations for visualizations
- Automatic visual story generation
- Visualization retrieval and recommendation etc.

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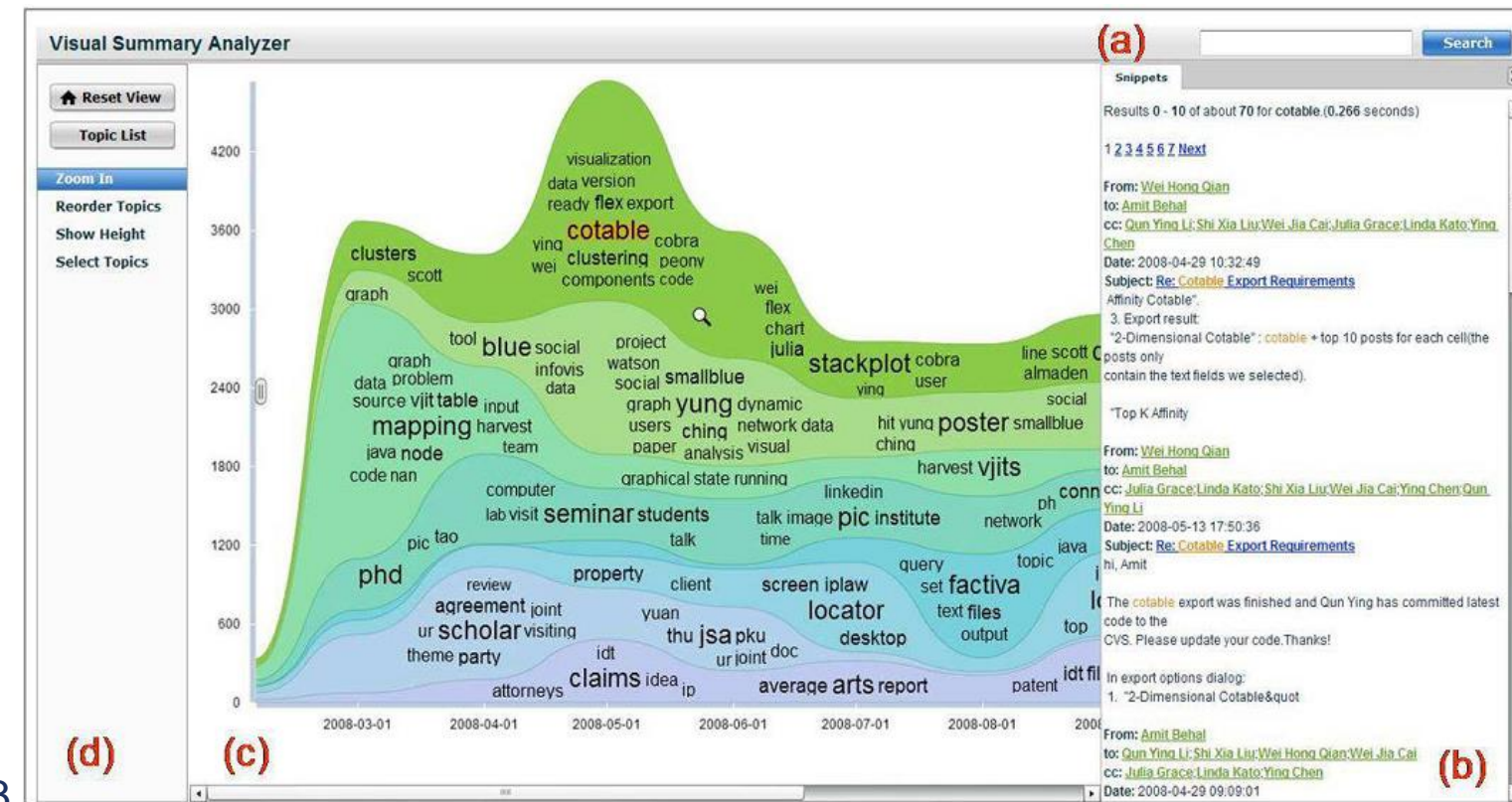
Visual Text Analytics

- Tightly integrates text analytics with Visualization



Obama's Health Care Speech to Congress, 2009

economix.blogs.nytimes.com/2009/09/09/obama-in-09-vs-clinton-in-93



F. Wei, S. Liu, Y. Song, S. Pan, M. X. Zhou, W. Qian, L. Shi, L. Tan, and Q. Zhang. *Tiara: a visual exploratory text analytic system*. In *Proc. ACM Conf. on KDD*, pages 153–162, 2010

Visual Text Analytics

- Platforms and Domains

Conversations



Meetings



Phone conversation



Social media conversations



Interview

Beyond conversations



Lecture



Broadcast news



Radio news



Scientific documents



Websites



News articles



Literature



Reviews

Visual Text Analytics

Various tasks:

- Understand
- Summarize
- Sentiment analysis
- Argument analysis
- Fact-check
- Rumor detection
- Plagiarism detection
- Abusive comments detection
- Topic controversy detection
- etc.

NLP4Vis

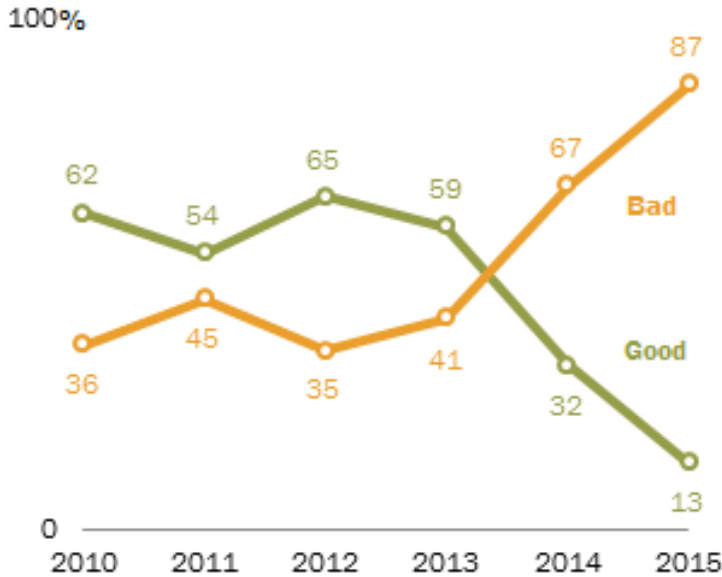
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Natural Language Interfaces for Visualizations

Rapid Decline in Brazilians' Assessment of Economy

Current economic situation in Brazil is ...



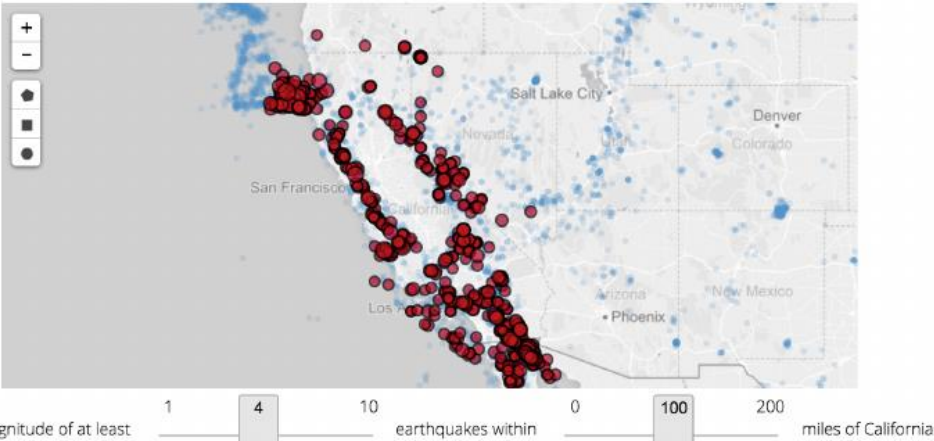
Question: Which year has the most divergent opinions about Brazil's economy?

Answer: 2015

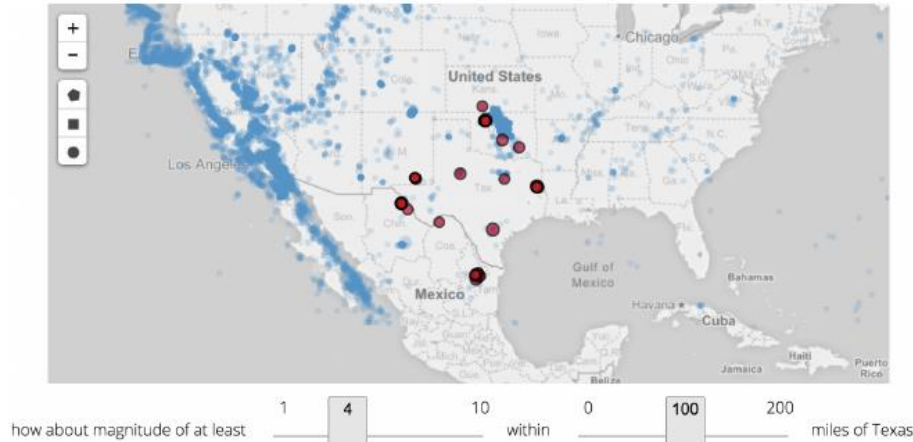
Question: What is the peak of the orange line?

Answer: 87

ChartQA (Masry et al., ACL 2022)



(a) Previous query: "Large earthquakes near California"



(b) Subsequent query: "how about near Texas?"

Eviza (Setlur et al., UIST 2016)

Natural Language Interfaces for Visualizations

Use natural language as an input modality to facilitate data analysis.

Benefits:



People can express information needs easily through language



Lower the threshold of required analytical skills



Reduce cognitive burden



Can improve chart accessibility

NLP4Vis

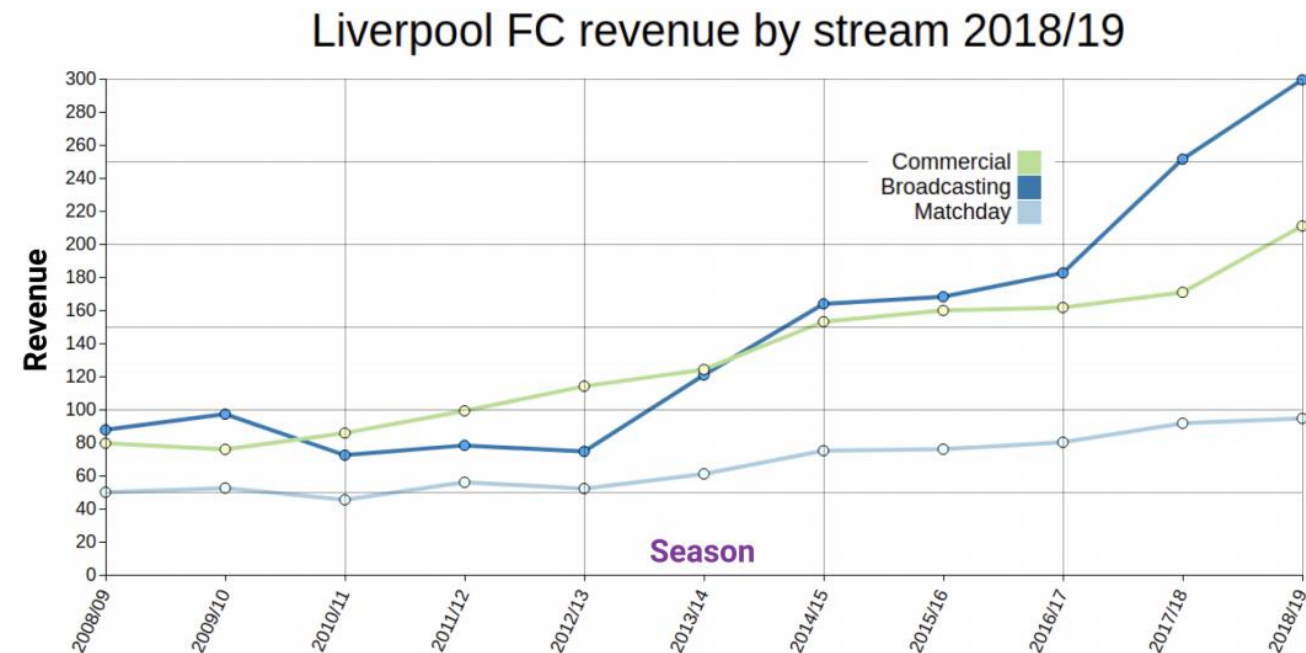
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Text Generations for Visualizations

- Generate texts to explain key insights from a chart

Broadcasting is the largest source of revenue for Liverpool FC. In 2018/2019, the club earned approximately 299.3 million euros from broadcasting, more than triple than in 2010/2011. The second biggest revenue stream is the commercial one.



Text Generations for Visualizations

Automatically summarize key data insights using texts.

Benefits:



Help readers in understanding data insights



Suggestions for writing data-driven articles



Can improve chart accessibility for people who are blind



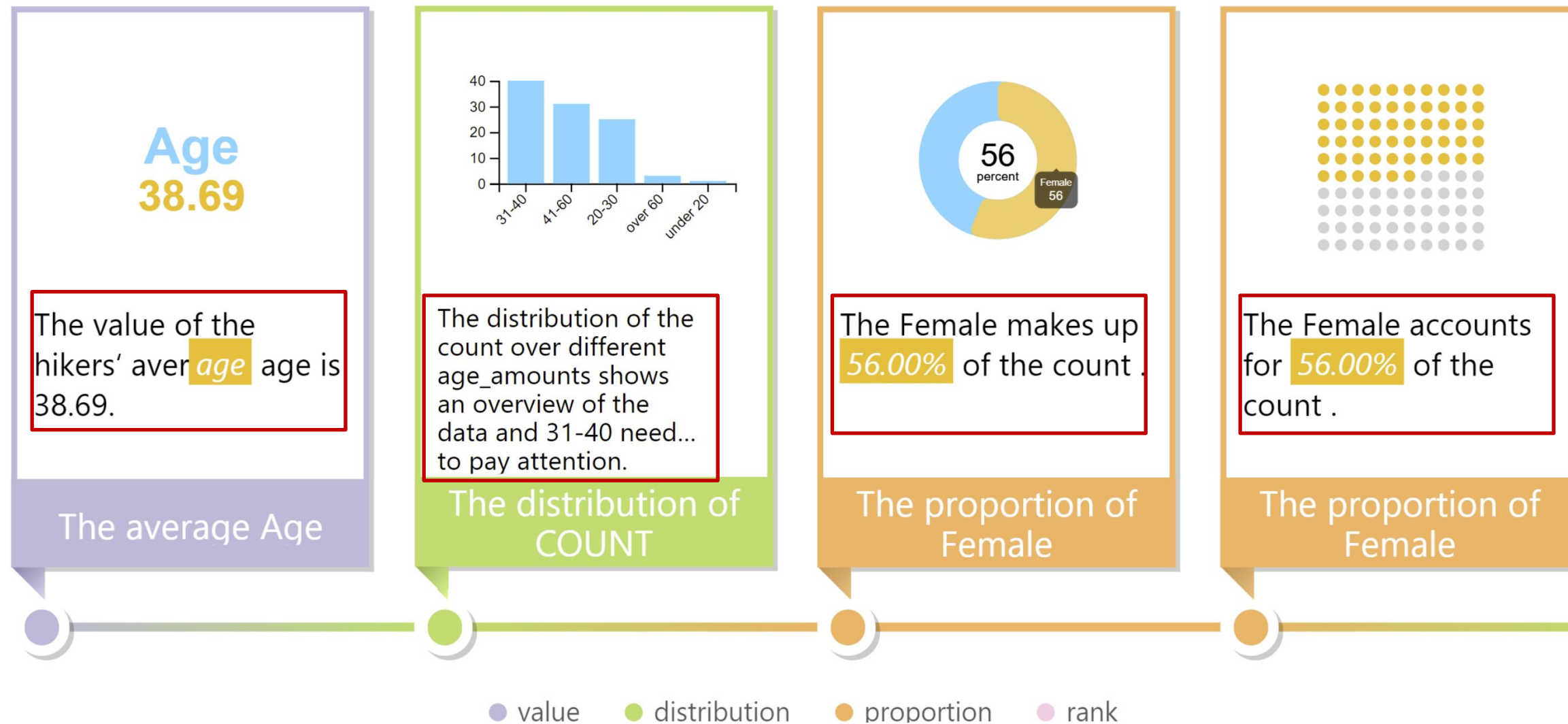
Improve visualization retrieval applications

NLP4Vis

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Automatic Visual Data-driven Story Generation



Calliope (Shi et al., IEEE Vis 2020)

NLP4Vis

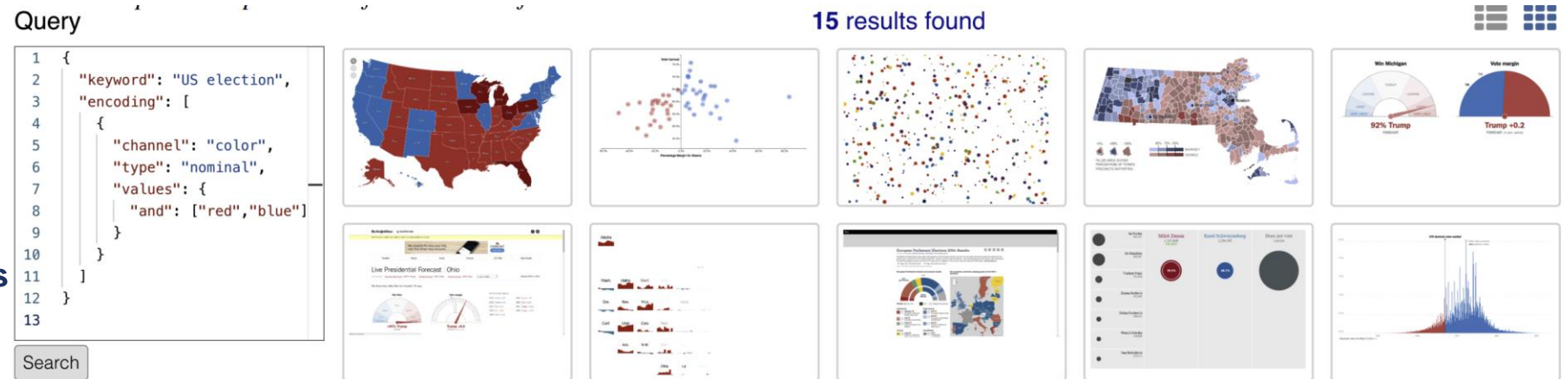
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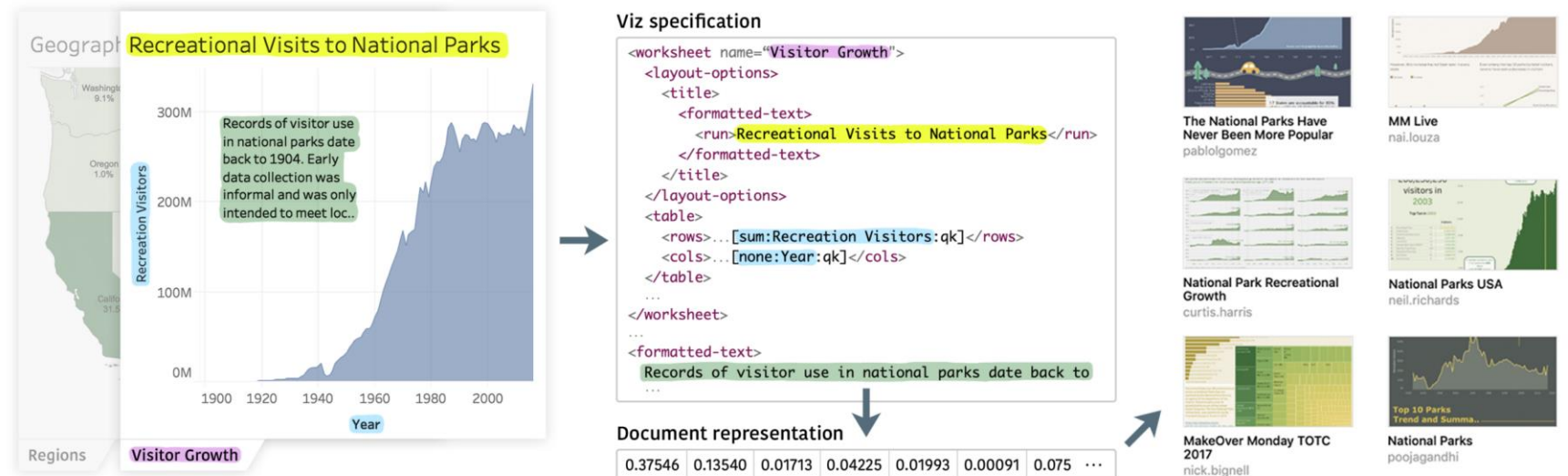
Visualization Retrieval and Recommendation

- Compute Text-based similarity for retrieval and recommendation

Enamul Hoque, Maneesh Agrawala
Searching the Visual Style and Structure of D3 Visualizations
IEEE Vis 2019.



Michael Oppermann, Robert Kincaid, and Tamara Munzner,
VizCommender: Computing Text-Based Similarity in Visualization Repositories for Content-Based Recommendations, *IEEE VIS Conf. (VAST), TVCG*, 27(2): 495-505, 2020.



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