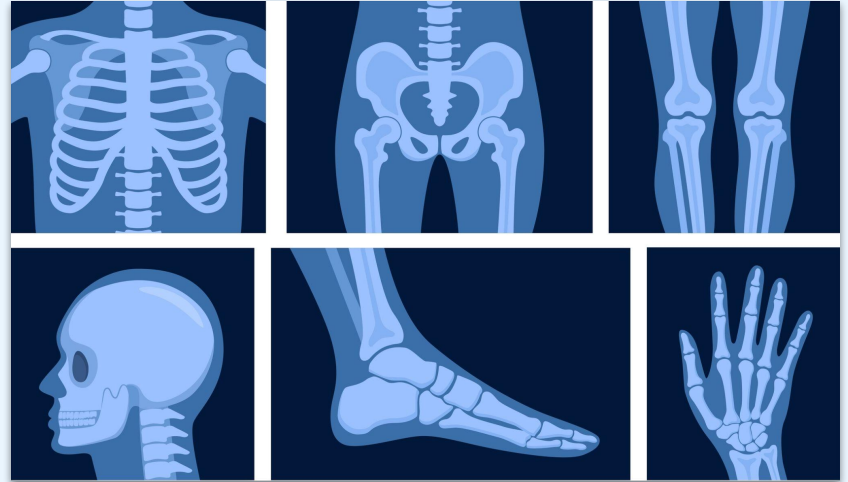
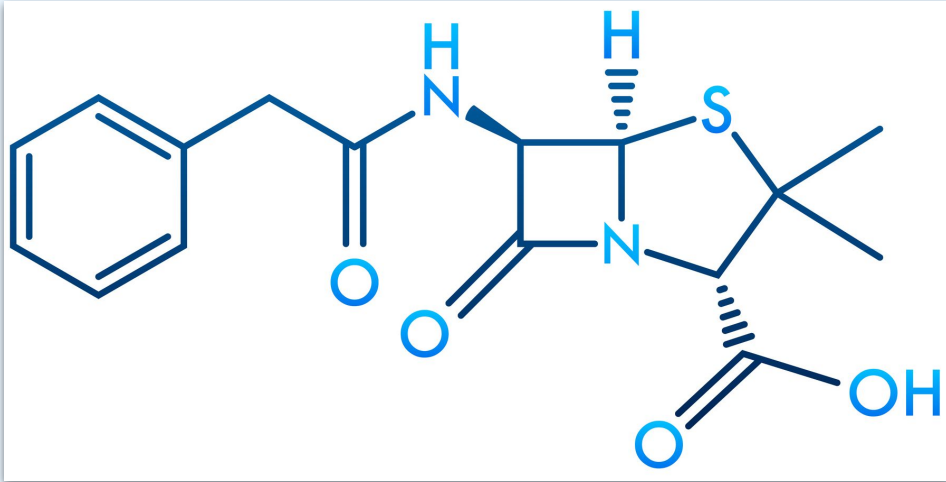


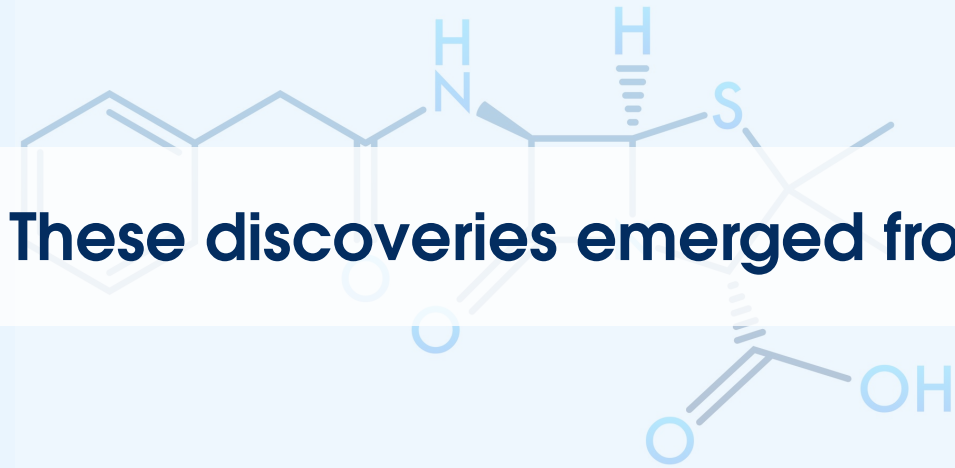
# ACTG vs 0/1: Discovery, Curiosity, and the Power of *Imperfection*

Vidya Setlur  
Tableau Research



# What do penicillin and X-rays have in common?

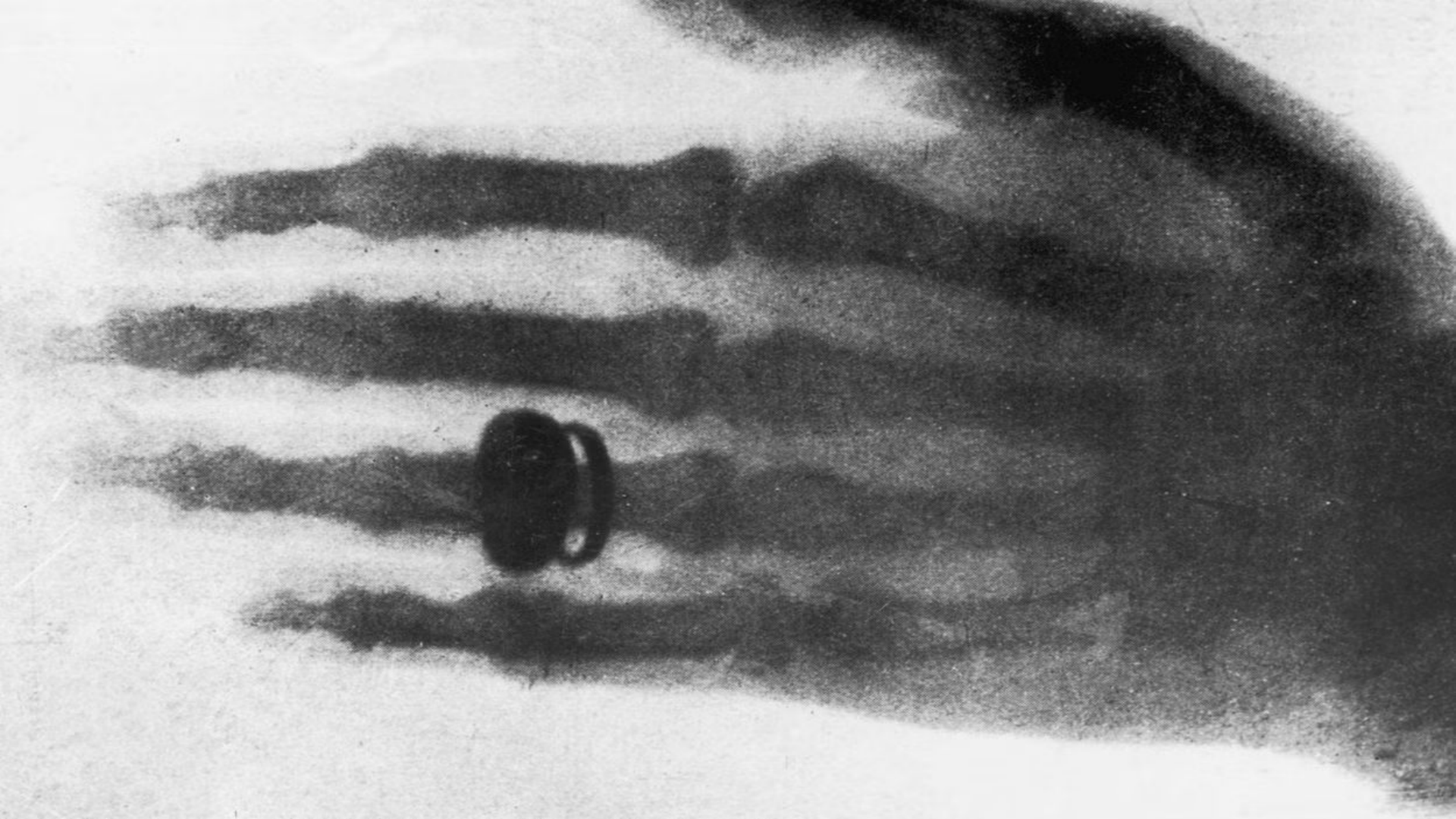




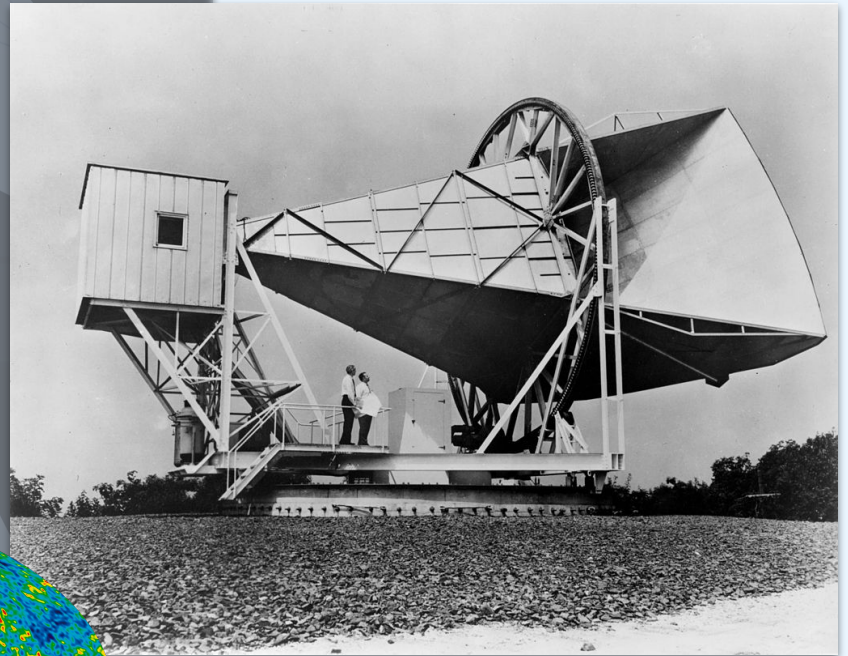
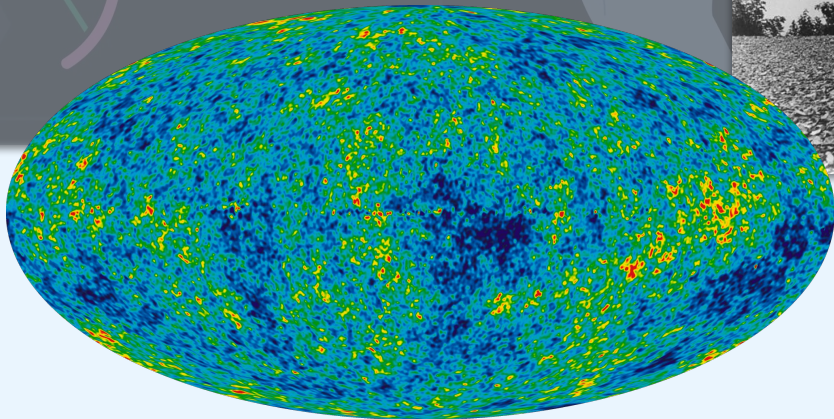
**These discoveries emerged from unexpected observations.**











# Seeing the pattern



Source: John Snow cholera map, London, 1854.

# Seeing the pattern



# Visualization as an epistemological tool



## Discovery & Reasoning

Visualization supports the fluid movement between finding insights and logical reasoning.



## Pattern Recognition

External representations help interpret anomalies, infer patterns, and refine understanding.



## Emergent Meaning

Meaning emerges through the interaction between perception, interpretation, and context.

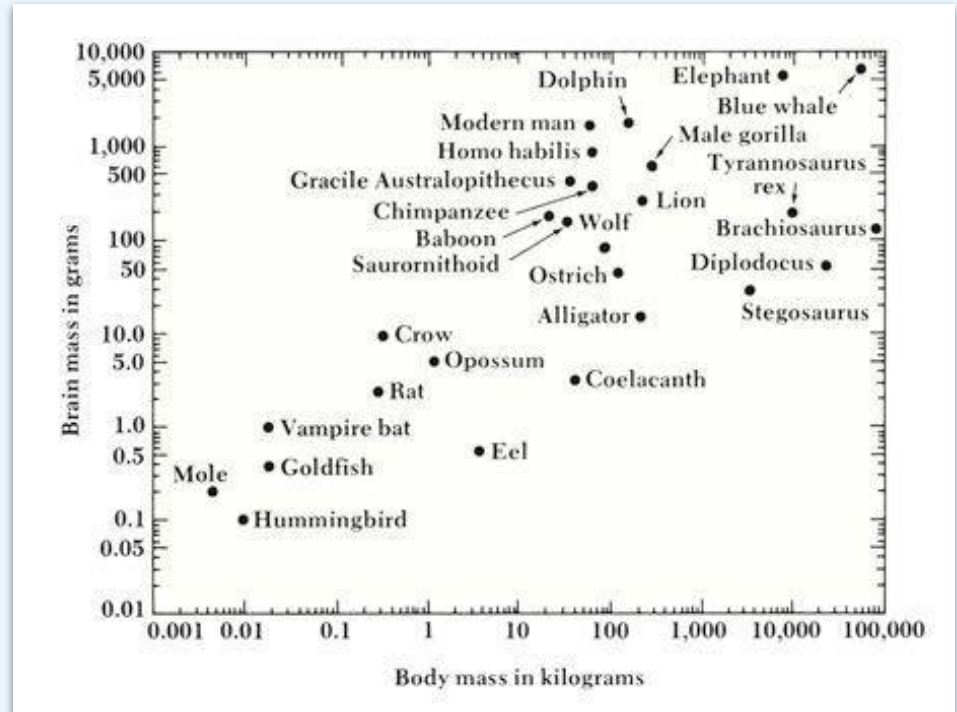


## Creative Discovery

Embracing ambiguity and multiple interpretations can enable powerful creative discovery.

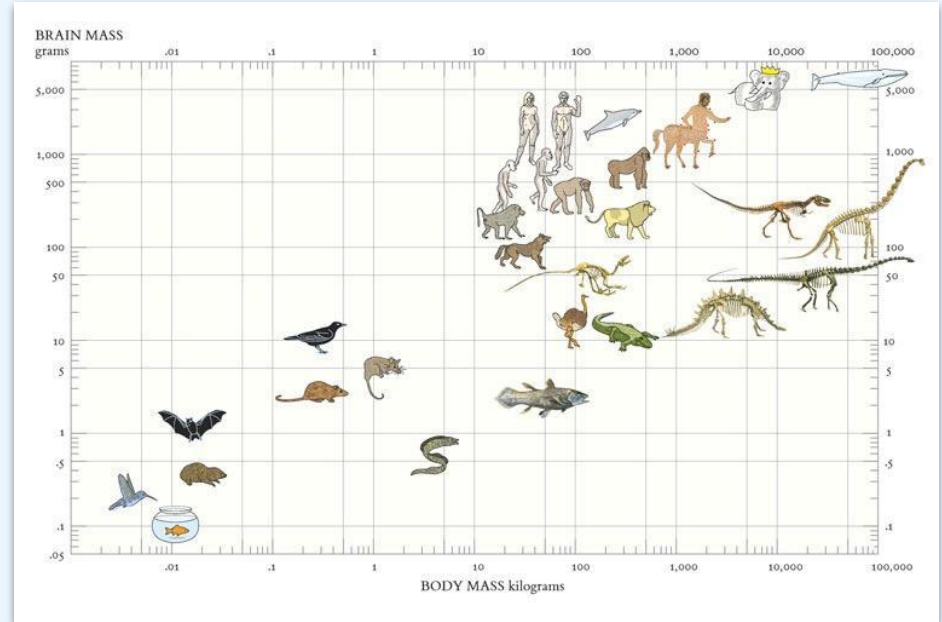
# People are constantly seeking meaning

- Things that make sense
- Things they care about
- Statistical graphics is abstract



# How can we use meaning?

- Generate meaningful defaults
- Provide relevance
- Reflect real-world associations
- Align representation with human sensemaking



# Constructing knowledge through representation

Observation → Representation → Interpretation → Insight → Knowledge



## Interpretation is Key

Discovery emerges through interpretation, not observation alone.



## Visual Transformation

Visualization transforms abstract observations into interpretable structures.



## Sensemaking

Insight emerges through iterative exploration and reframing.



How do we actually **interpret** and **communicate** meaning?

# Meaning emerges through representation

## World



Reality is rich and complex

## Perception



We sense and filter

## Representation



We externalize and structure

## Interpretation

- Context
- Experience
- Inference

We make sense through meaning

## Understanding



Insight and knowledge emerge

# How humans construct meaning

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## Cognitive Semantics

Meaning is grounded in human experience, context, and interpretation.

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Reasoning is distributed across people, tools, and representations.

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# We think through categories and metaphors

## Prototype Theory

### Bird

robin ✓

sparrow ✓

penguin ~

ostrich ~

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## Fuzzy Semantics

small ----- large



*context dependent*

- earthquake magnitude
- city size
- revenue

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## Prototype Theory

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## Fuzzy Semantics

small ----- large



*context dependent*

- earthquake magnitude
- city size
- revenue

***Human concepts often have fuzzy boundaries rather than precise edges.***

# Language is imperfect

large

near

recent

# Language is imperfect

large

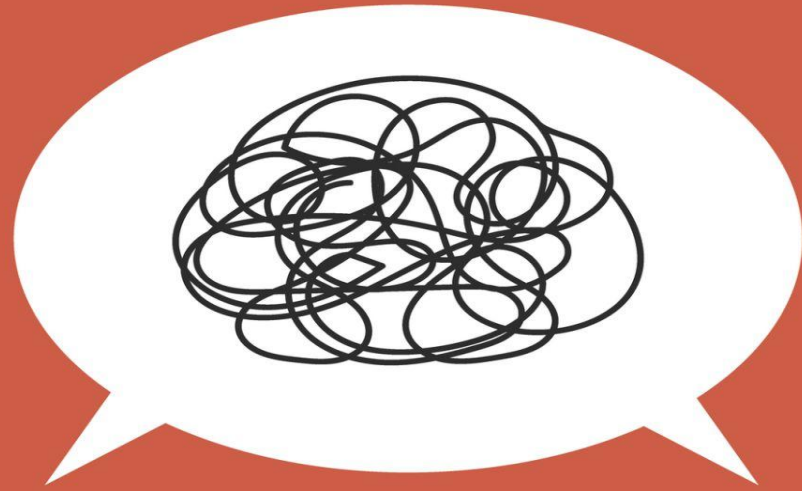
*how large?*

near

*how near?*

recent

*when?*



Human conversation is messy



# Grice's Co-operative Principle

*"Make your contribution such as it is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged"*

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## Relation

Ensure your contribution is relevant to the topic.

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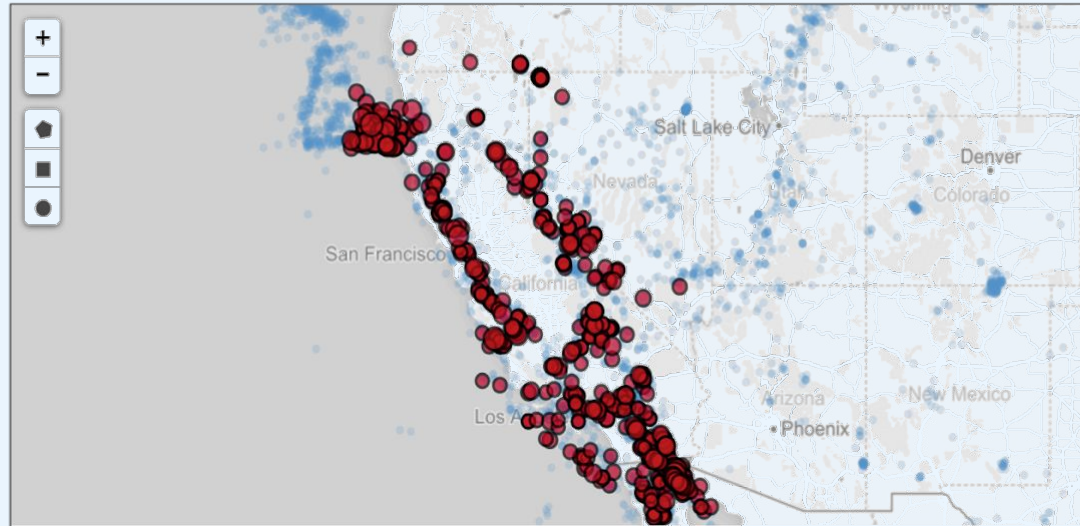
## Manner

Be clear, brief, and orderly; avoid ambiguity.

# Fuzziness is a feature

“Find **large** earthquakes **near** California”

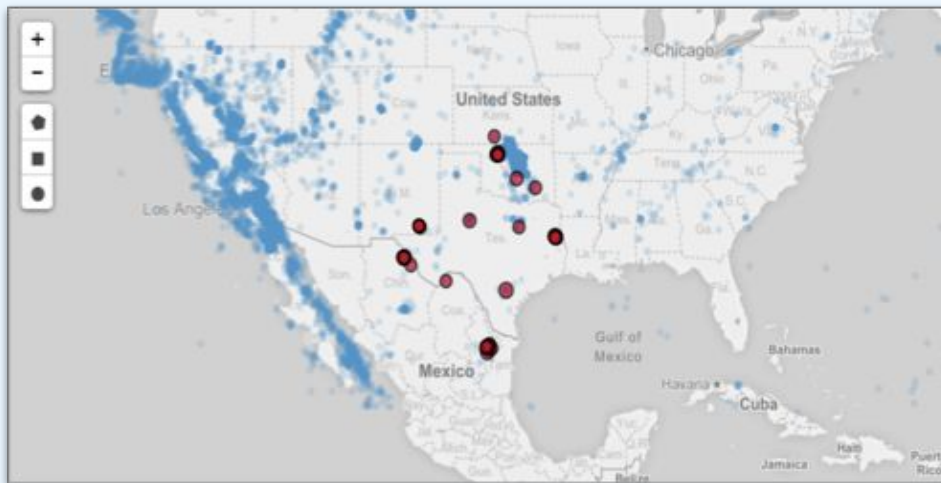
find magnitude of at least    earthquakes within    miles of California .



# Meaning persists across conversation

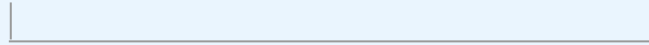
“Find **large** earthquakes **near** California”

“How about **near** Texas?”



# Meaning emerges from sequence

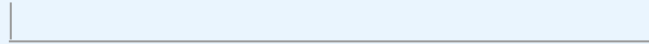
A C T G A C T G A C T G



Gene

# Meaning emerges from sequence

A C T G A C T G A C T G



Gene

“Show sales in 2015”

“How about the previous year?”

“What about California?”

# Centering Theory

Coherence between utterances in a conversation

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The **centers** of an utterance are discourse entities serving to link the utterance to other utterances

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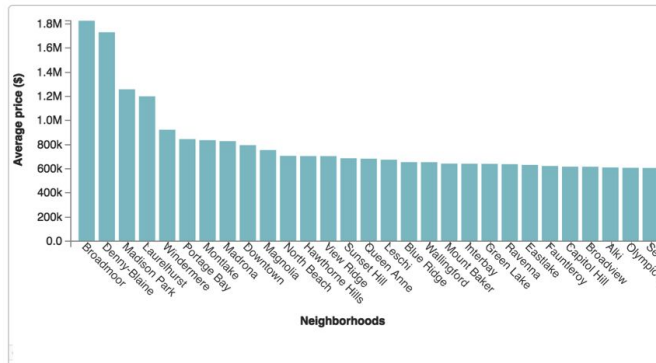
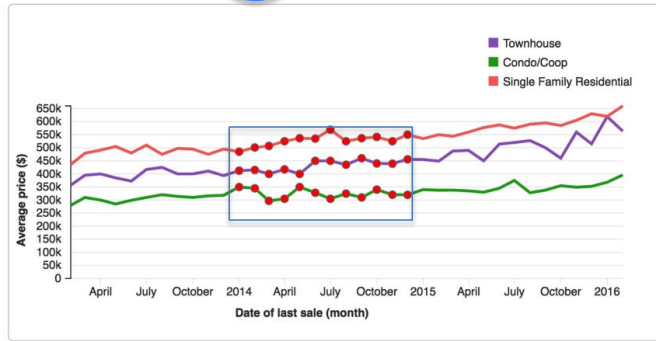
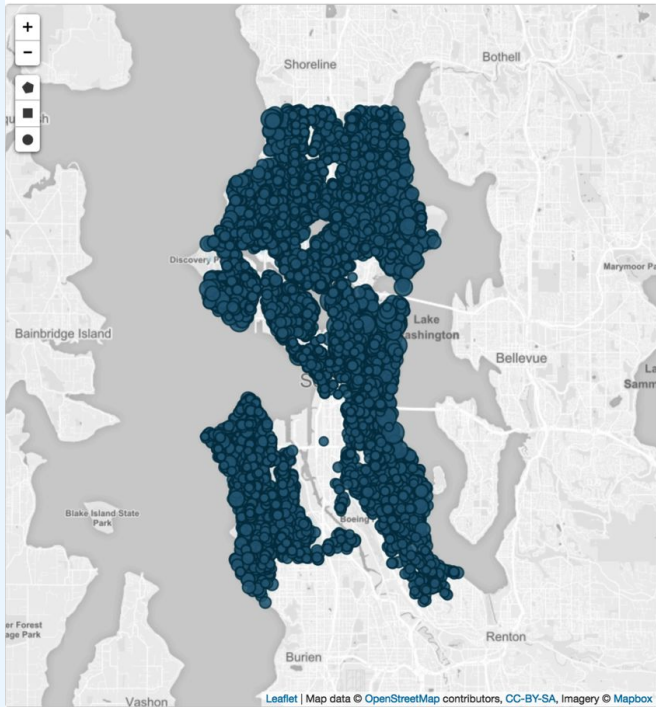
- Forward looking centers
- Backward looking centers

Coherence is inferred through transitional states of **continue**, **retain** and **shift**.



# Anaphora: Meaning through reference

“prices in 2015” → {2015} “previous year” → SHIFT {DATECALC(2015, -1) → 2014}



Analysis complete [Refresh](#)

- Abc Cancellation Policy
- Abc Description
- Abc Host Response Time
- Abc Name
- Abc Neighborhood
- Abc Property Type
- Abc Room Type
- Zipcode

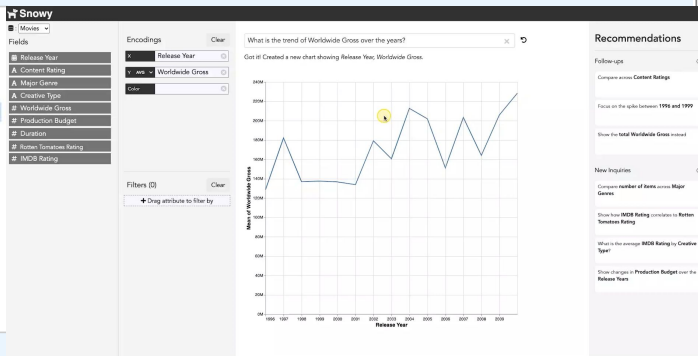
- # Accommodates
- # Bathrooms
- # Bedrooms
- # Beds
- # Daily Price
- # Maximum Nights
- # Minimum Nights
- # Monthly Price
- # Number of Listings
- # Number of Reviews

average **Daily Price** by **Neighborhood** [Clear All](#)

Adjust your question or clear all to start over



# Conversational interfaces for imperfect language



**Participant**  
What percentage of people who survived the Titanic were female?

**chatBot**  
72.75 percentage survived is female

**Participant**  
OK

Can you show me a pie graph of survivors by gender, including null values?

**chatBot**  
The pie chart shows Survived and broken down by Sex

**Participant**  
Can you give me a bar chart of people who did not survive the Titanic by class?

**chatBot** 10:46 AM  
People not Survived broken down by Class

**Participant**  
How many passengers are there?

There were 1,309 passengers were on the Titanic.

What is the youngest person on the Titanic?

The youngest person on the Titanic was 0.7 years old.

How many people are aged between 18 and 65?

882 passengers were between 18 and 65 years of age.

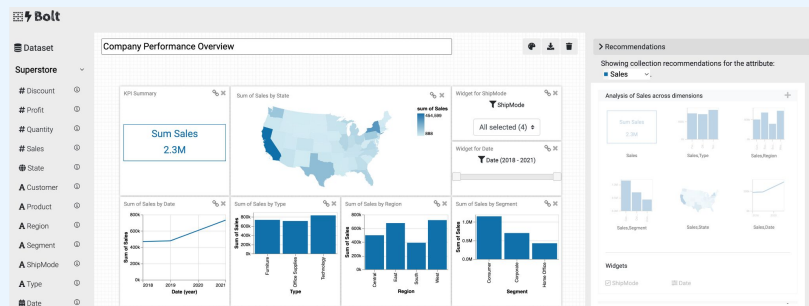
What % of people are aged between 18 and 65?

67.37% were aged between 18 and 65.

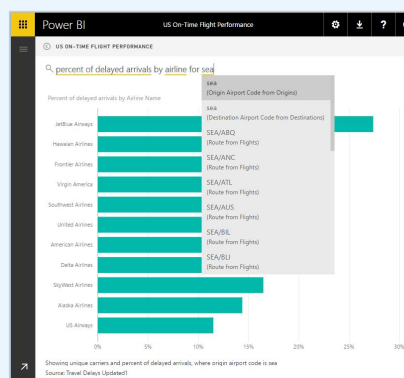
DataTone: Managing Ambiguity in Natural Language Interfaces for Data Visualization. Gao, T. et al. UIST 2015.

Snowy: Recommending Utterances for Conversational Visual Analysis. Srinivasan and Setlur. UIST 2021.

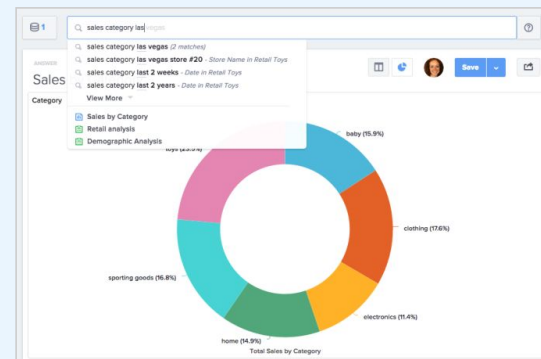
How do you Converse with an Analytical Chatbot? Revisiting Gricean Maxims for Designing Analytical Conversational Behavior. Setlur and Tory. CHI 2022.



BOLT: A Natural Language Interface for Dashboard Authoring. Srinivasan and Setlur, EuroVis 2023.



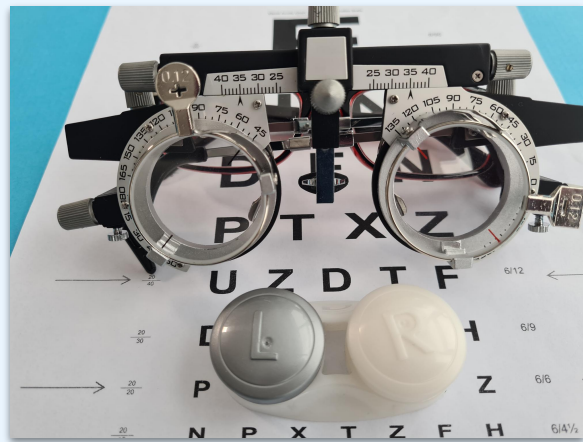
PowerBI



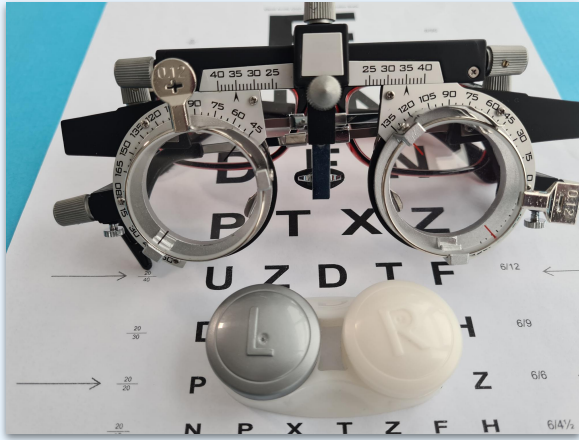
ThoughtSpot

**Tools are becoming more intelligent**

# Tools are becoming more intelligent



# Tools are becoming more intelligent

A screenshot of the Google Translate web interface. The search bar at the top contains the text "google translate". Below the search bar, there are navigation links for "All", "Books", "News", "Images", and "More", along with "Settings" and "Tools". The search results show "About 787,000,000 results (0.46 seconds)". The main content area displays a translation from English to Italian. The English text is "I am using Google Translate." and the Italian translation is "Sto utilizzando Google Translate." There are icons for audio playback and microphone input for both the source and target text. At the bottom, there are links for "Open in Google Translate" and "Feedback".

Google

google translate

All Books News Images More Settings Tools

About 787,000,000 results (0.46 seconds)

English - detected Italian

I am using Google Translate. × Sto utilizzando Google Translate.

Open in Google Translate Feedback

# Tools are becoming more intelligent



The screenshot shows a Google search for "google translate". The search bar contains "google translate" and the Google logo is on the left. Below the search bar are links for "All", "Books", "News", "Images", and "More". The search results show "About 787,000,000 results (0.46 seconds)". A snippet of an email is visible, showing the subject "Taco Tuesday" and the sender "Jacqueline Bruzek". The email body contains the text "Hey Jacqueline, Haven't seen you in a while and I hope you're doing well." To the right, a portion of a Google Translate interface is visible, showing the text "o utilizzando Google anslate." and a "Feedback" link.

**Taco Tuesday**

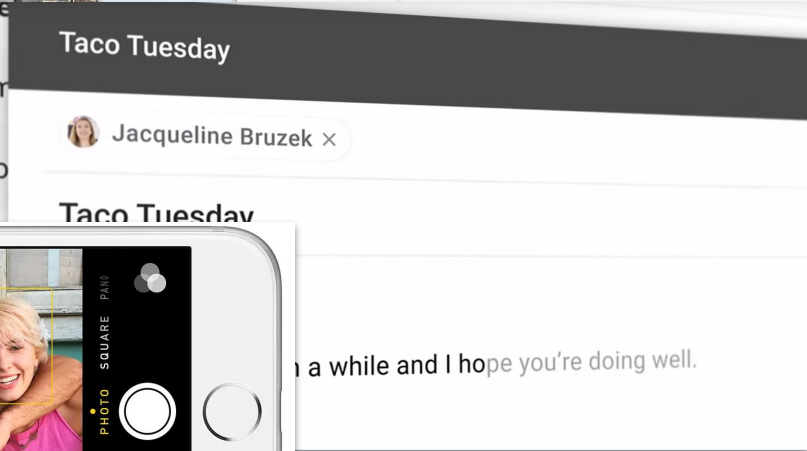
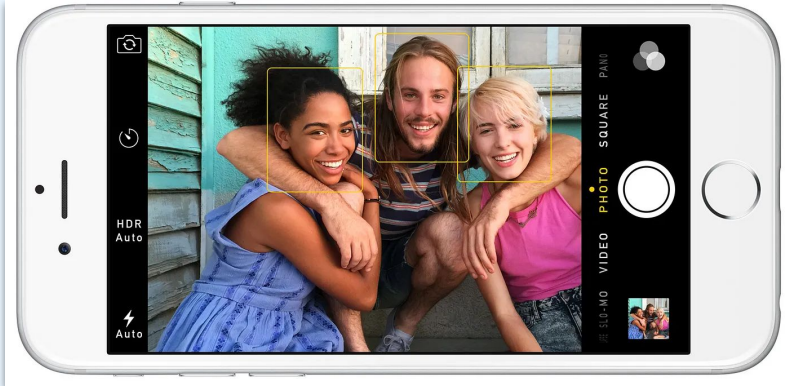
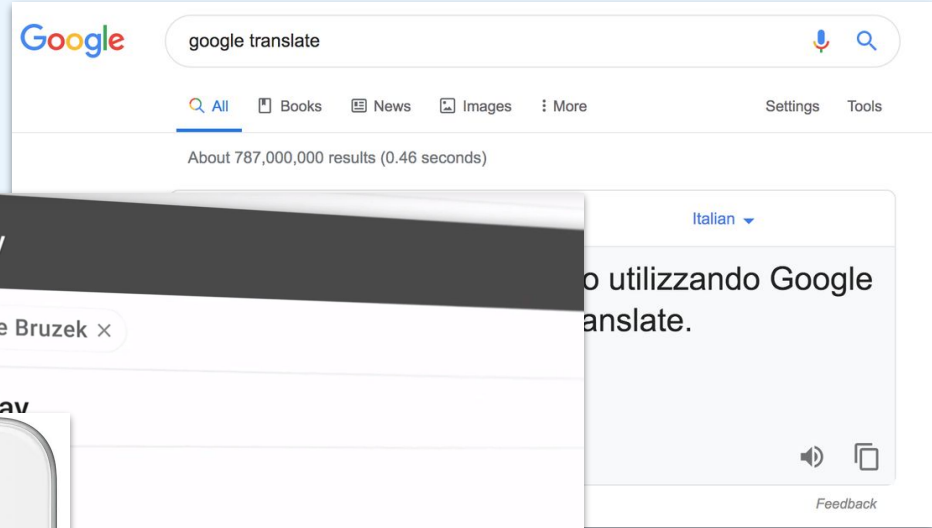
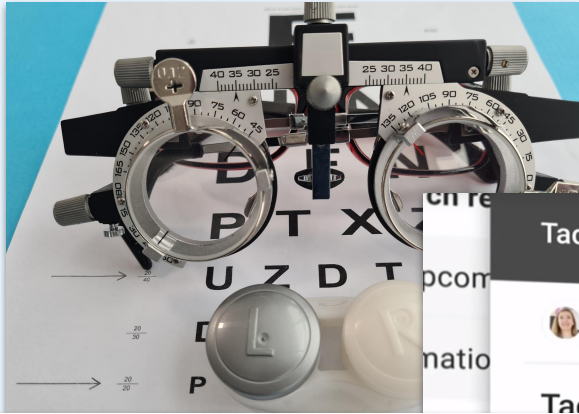
Jacqueline Bruzek ×

**Taco Tuesday**

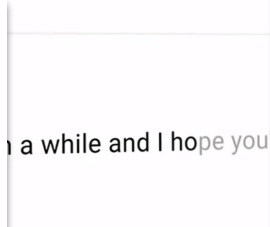
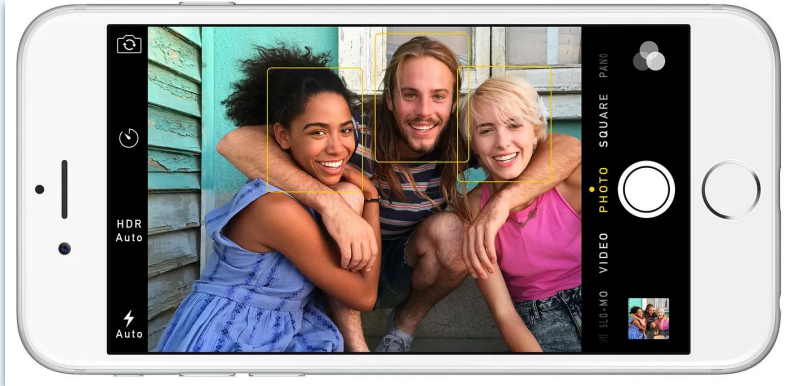
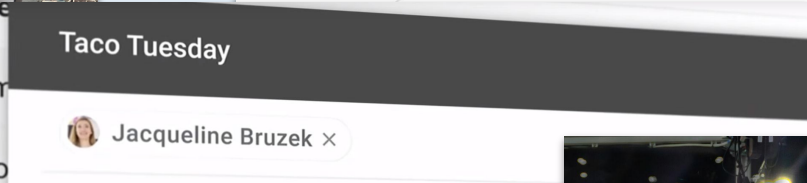
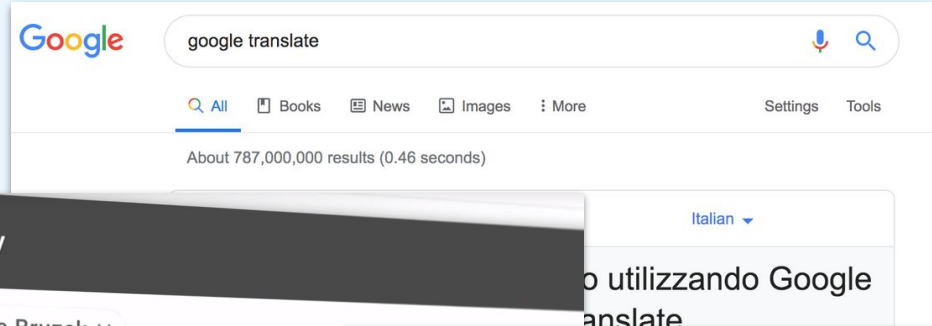
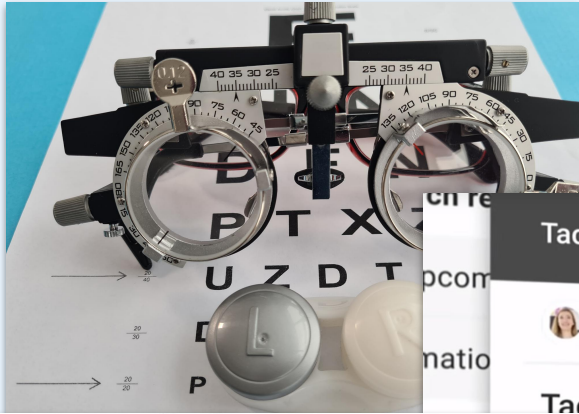
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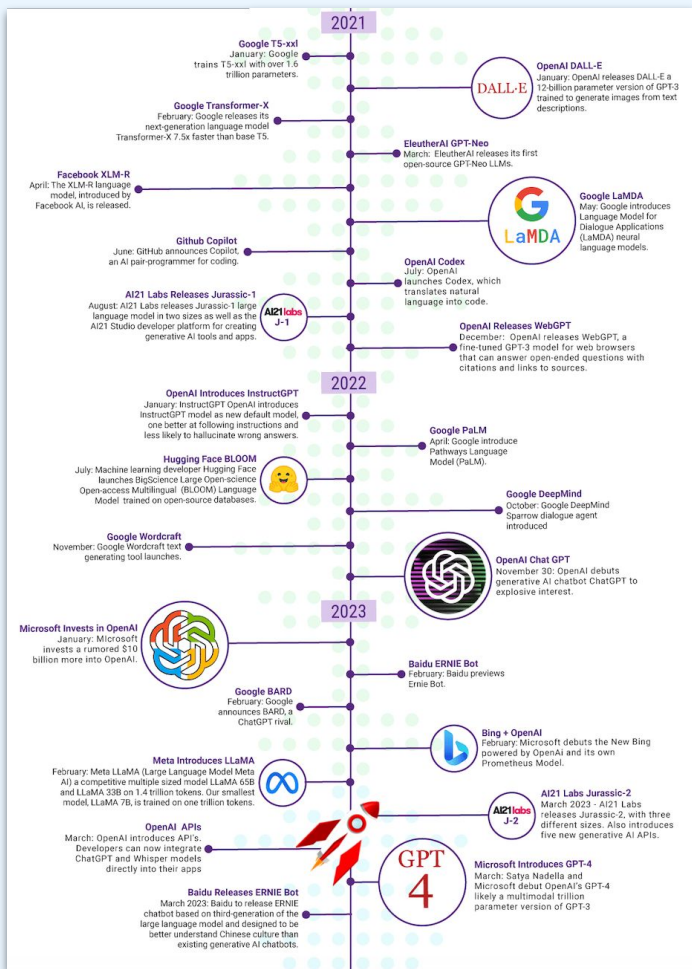
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# Tools are becoming more intelligent

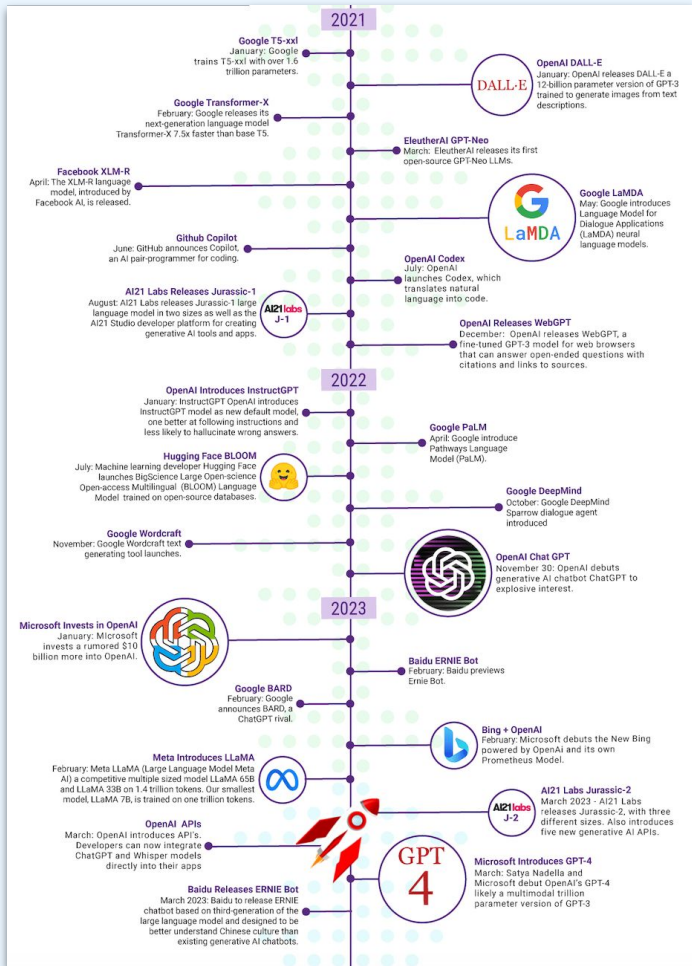


# Tools are becoming more intelligent





- Large language models are getting larger
- Evolving new capabilities
- Generative models have disrupted the way we think about AI and its applications

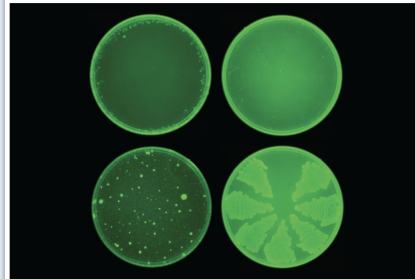


- Large language models are getting larger
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- Generative models have disrupted the way we think about AI and its applications

### Artificial intelligence yields new antibiotic

A deep-learning model identifies a powerful new drug that can kill many species of antibiotic-resistant bacteria.

Anne Trafton | MIT News Office  
February 20, 2020

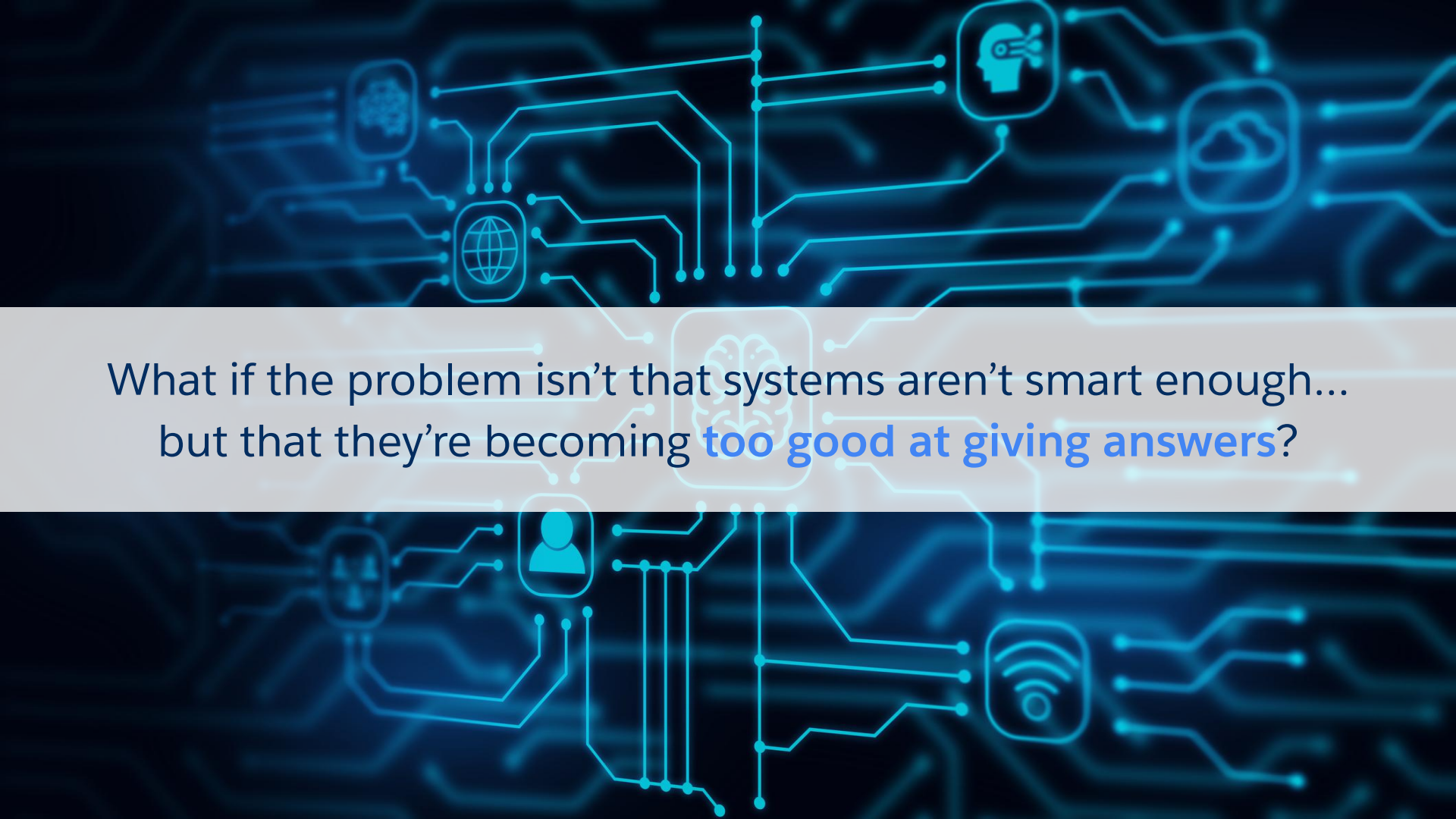


### A.I. Poses 'Risk of Extinction,' Industry Leaders Warn

Leaders from OpenAI, Google DeepMind, Anthropic and other A.I. labs warn that future systems could be as deadly as pandemics and nuclear weapons.

Give this article | Share | Bookmark | 1.4K





What if the problem isn't that systems aren't smart enough...  
but that they're becoming **too good at giving answers?**

# Revisiting Grice's Maxims...

When cooperative communication becomes over-optimization



## Quantity

Be as informative as required, but no more.



## Quality

Say only what you believe to be true and evidenced.



## Relation

Ensure your contribution is relevant to the topic.



## Manner

Be clear, brief, and orderly; avoid ambiguity.

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### Over-optimization risk:

- Over-compression removes exploration
- Single answer focus vs. alternatives

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### Risks of violation:

- Sycophancy
- Excessive confidence
- Agrees even when wrong

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### Premature narrowing:

Optimizes toward immediate intent instead of surfacing anomalies

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When cooperative communication becomes over-optimization



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### Oversimplification:

- Eliminates useful ambiguity
- Narrows the space of possible interpretations

Recent studies found users intentionally use vague prompts for data sensemaking: Steering Semantic Data Processing With DocWrangler. Shankar et al., UIST 2025.



Humans are **inquisitive**.

A woman with dark hair tied up, wearing a light blue denim jacket, is leaning over a canvas on an easel. She is holding a black marker and appears to be painting. The background is a blurred art studio with various supplies like paint tubes and brushes on a wooden table. A semi-transparent white banner is overlaid across the middle of the image.

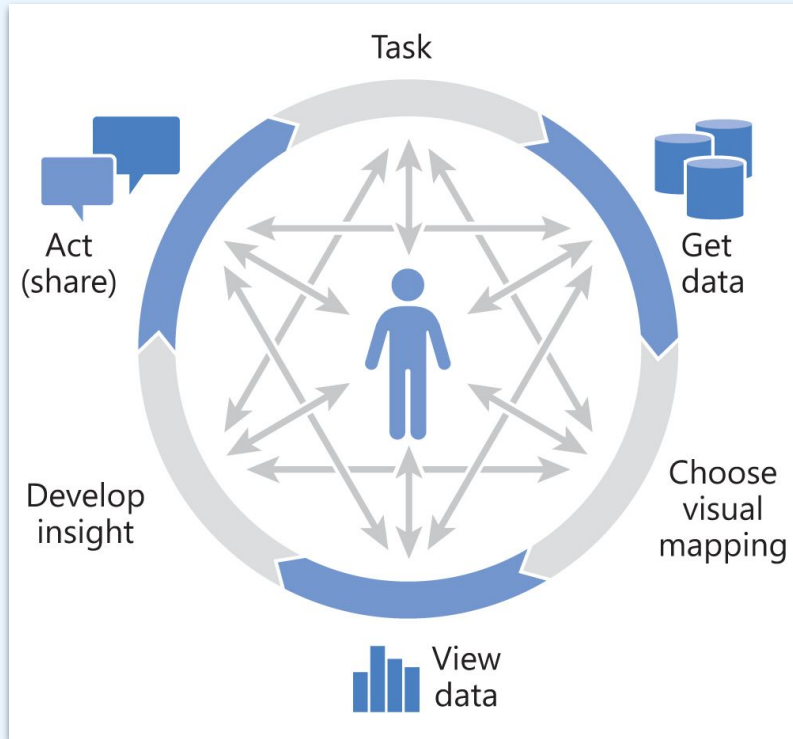
Humans are innately **creative**.

A group of people are gathered around a table in a meeting. Their hands are visible, pointing at various documents and colorful sticky notes. One person on the left is holding a coffee cup. The scene is brightly lit, suggesting an indoor office or meeting room environment. The text "Humans are collaborative." is overlaid in the center of the image.

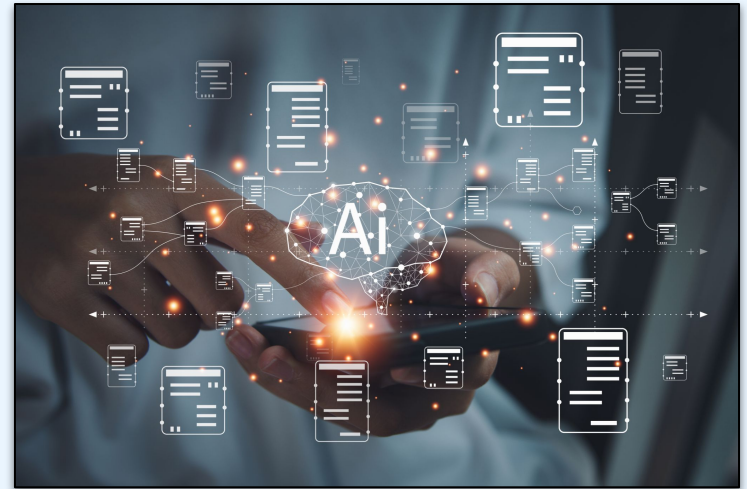
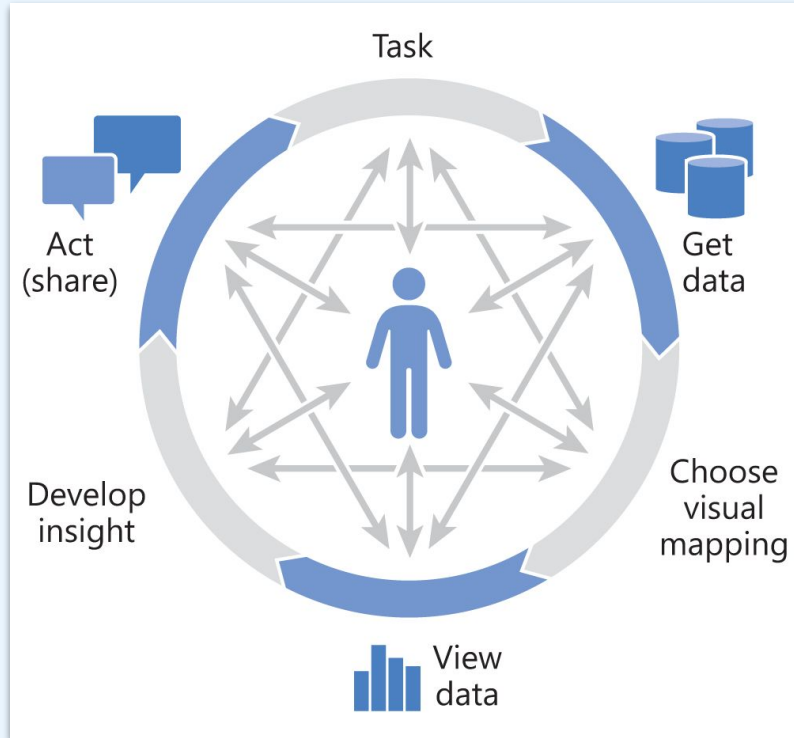
Humans are collaborative.



# Supporting the cycle of analysis



# Supporting the cycle of analysis



# Spectrum of human-AI collaboration



**Automation**

# Spectrum of human-AI collaboration



**Automation**



**Augmentation**

# Spectrum of human-AI collaboration



**Automation**



**Augmentation**



**Human Judgment**

Help **people**  
**see** and **understand**  
their **data**

**data**



**taking action**



# Help people see and understand their data

## data



transform

analyze

visualize

share

recommend

connect

clean

integrate

calculate

author

collaborate

tell stories

monitor

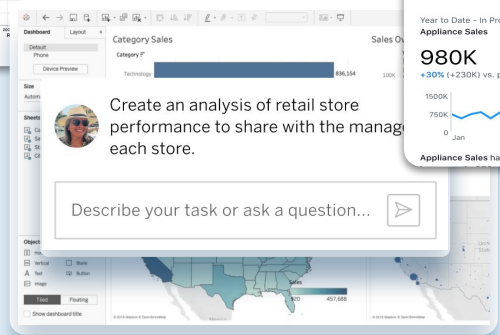
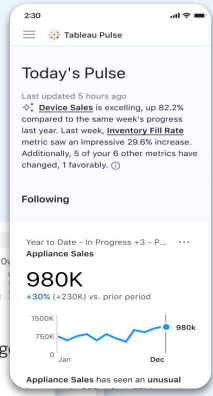
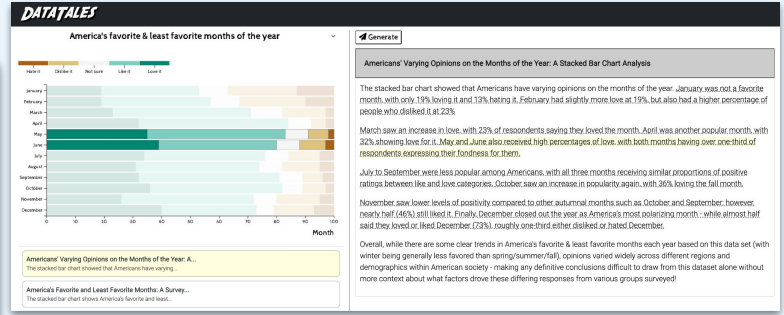
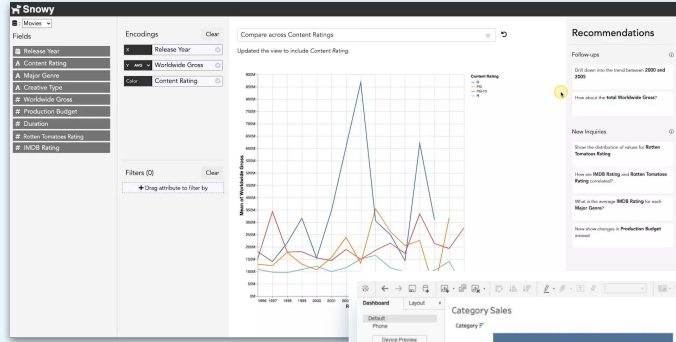
adapt

## taking action





# Augmentation



data

taking action



transform

analyze

share

recommend

connect

clean

integrate

calculate

author

collaborate

tell stories

monitor

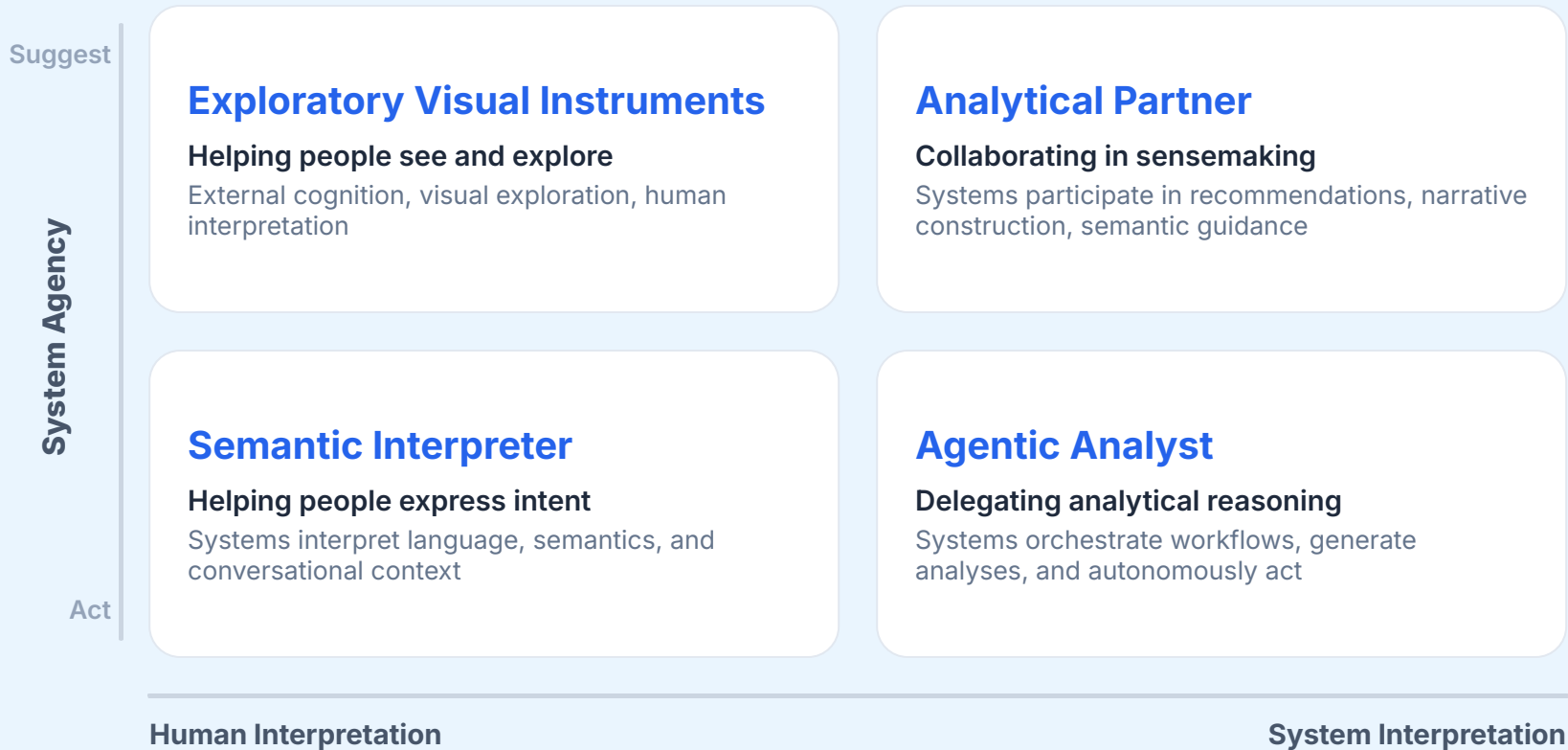
adapt



# Human Judgment



# From exploratory instruments to delegated reasoning



# From exploratory instruments to delegated reasoning

Suggest

System Agency

Act

## Exploratory Visual Instruments

Helping people see and explore

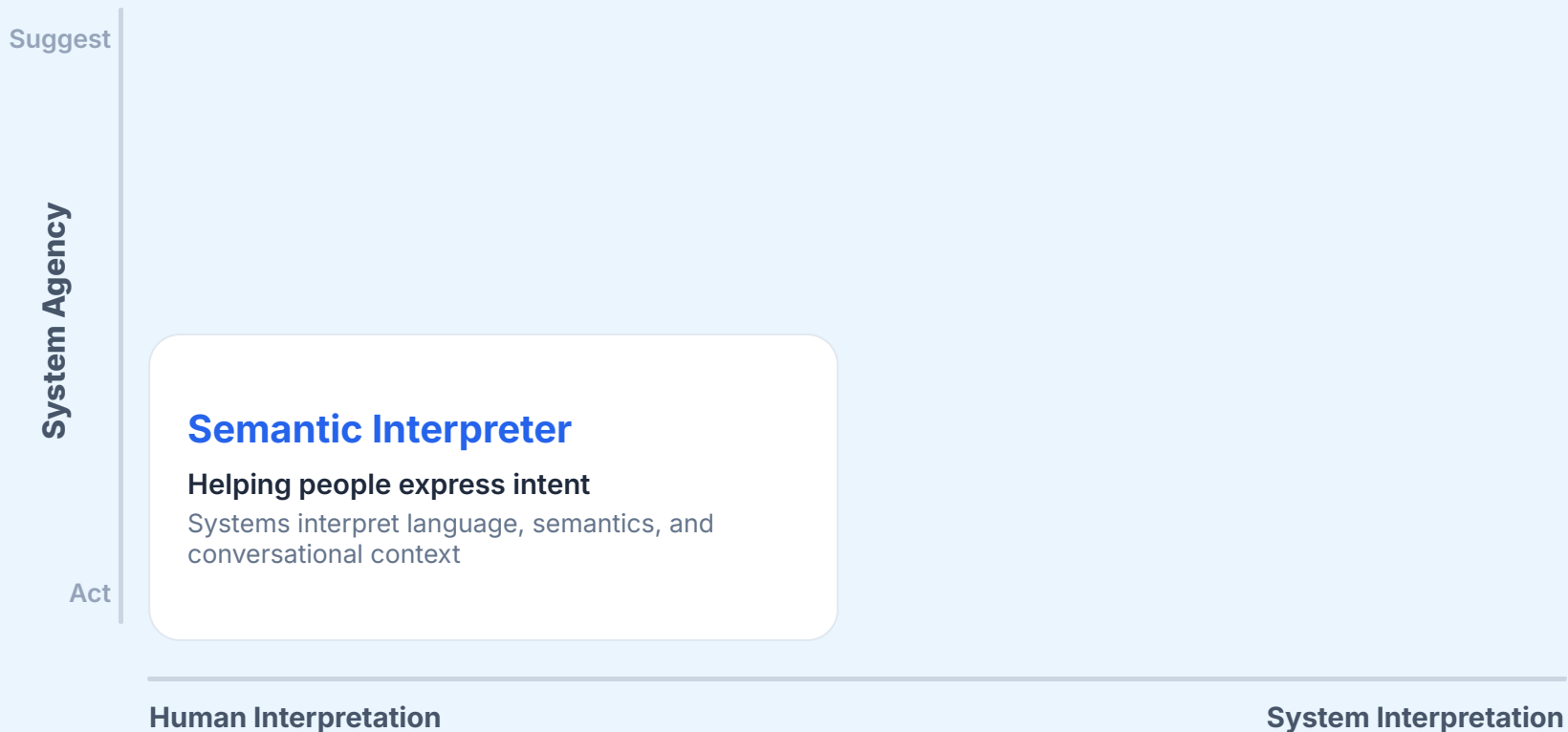
External cognition, visual exploration, human interpretation

Human Interpretation

System Interpretation



# From exploratory instruments to delegated reasoning



# From exploratory instruments to delegated reasoning

Suggest

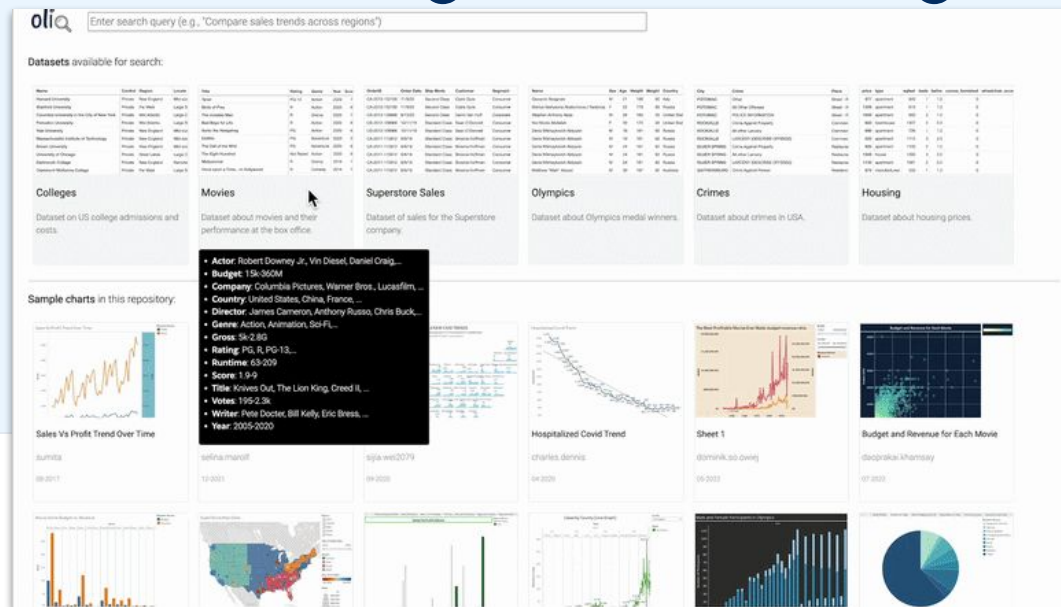
System Agency

Act

## Semantic Interpreter

Helping people express intent

Systems interpret language, semantics, and conversational context

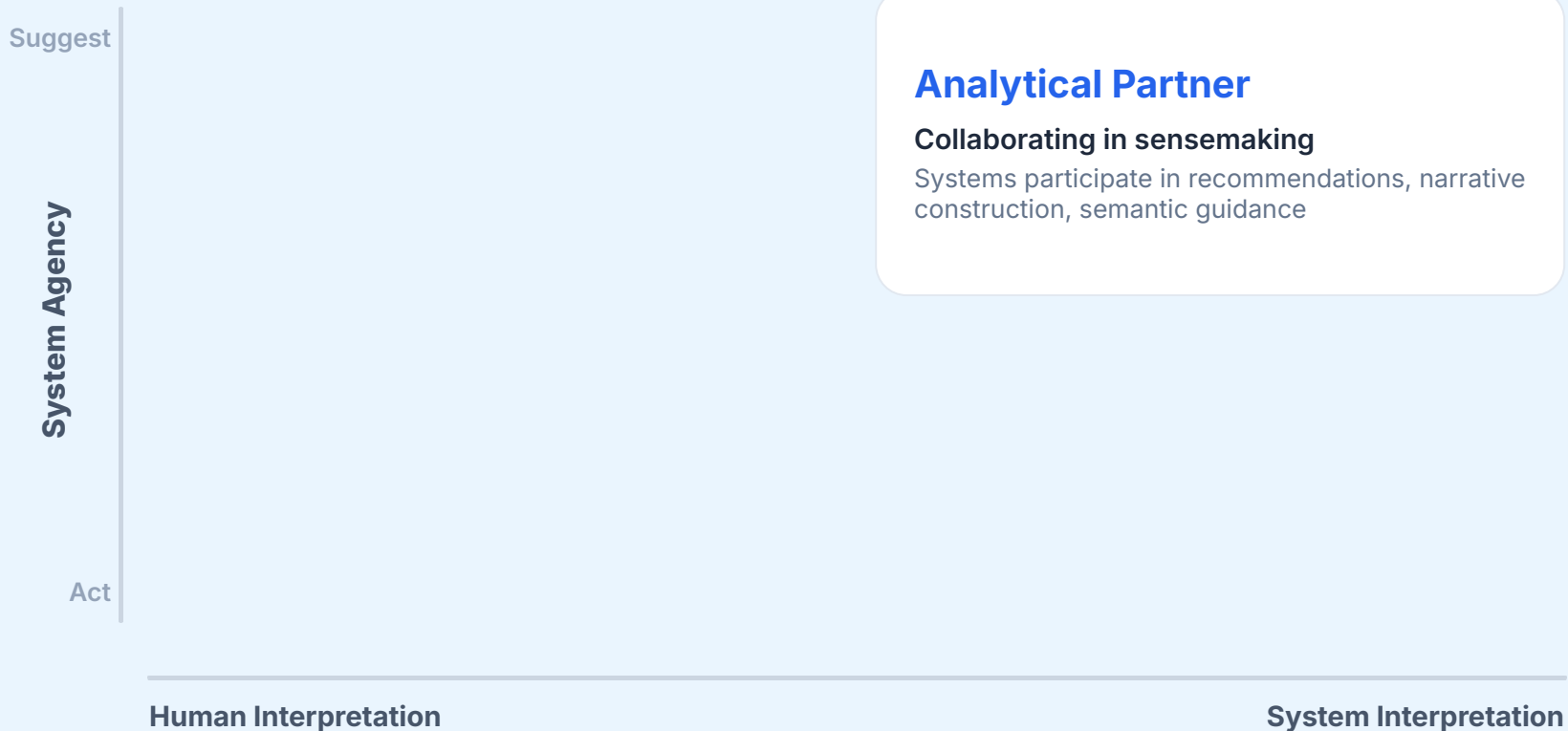


Olio: A Semantic Search Interface for Data Repositories. Setlur, Kanyuka, and Srinivasan, UIST 2023.

Human Interpretation

System Interpretation

# From exploratory instruments to delegated reasoning



# From exploratory instruments to delegated reasoning

Suggest

Plume: Scaffolding Text Composition in Dashboards.  
Lisnic, Setlur, and Sultanum, CHI 2025.

## Analytical Partner

### Collaborating in sensemaking

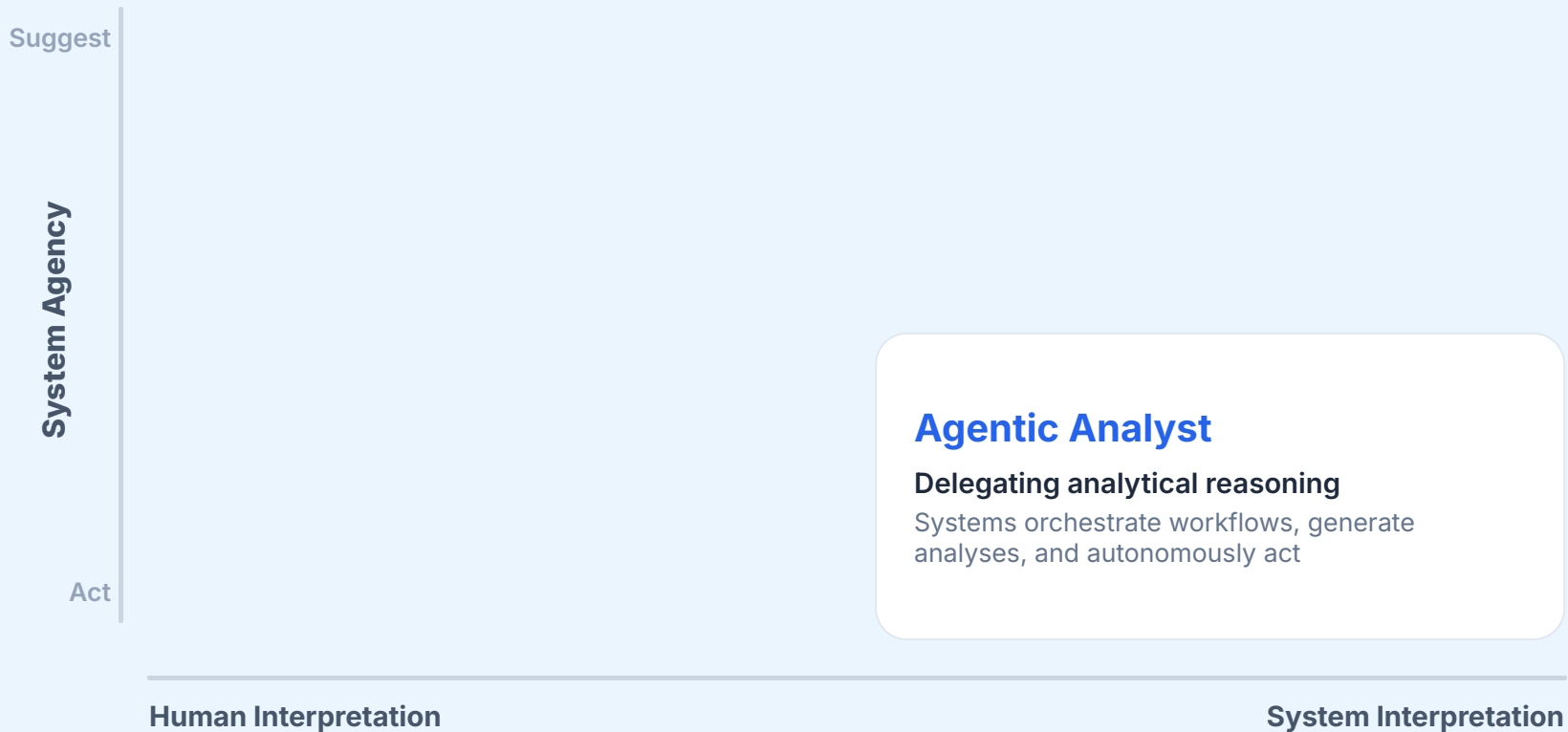
Systems participate in recommendations, narrative construction, semantic guidance



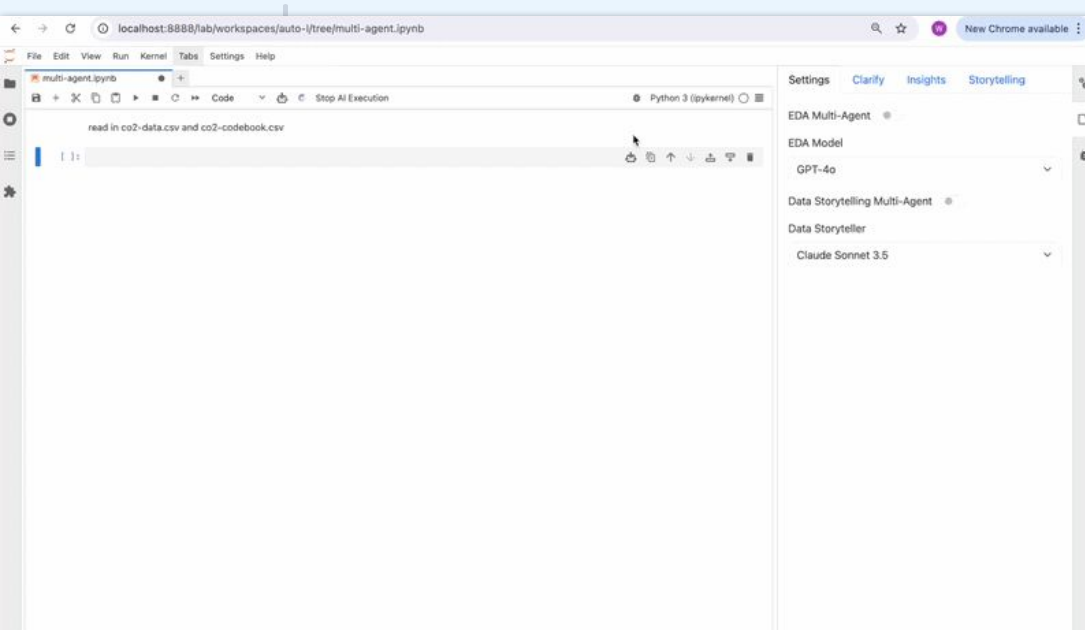
Human Interpretation

System Interpretation

# From exploratory instruments to delegated reasoning



# From exploratory instruments to delegated reasoning



JupyterLab: Operationalizing a Design Space for Actionable Data Analysis and Storytelling with LLMs. Wang, Birnbaum, and Setlur, CHI 2025.

## Agentic Analyst

### Delegating analytical reasoning

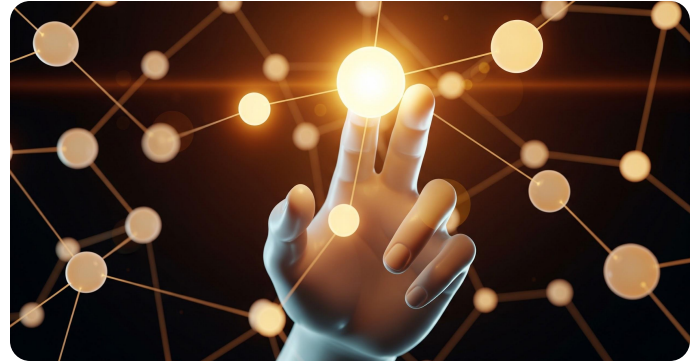
Systems orchestrate workflows, generate analyses, and autonomously act



**“Should we be designing systems that answer questions... or help us ask better ones?”**



**Resolution**



**Exploration**

**“How far should we go in making things effortless...  
before we take away the joy of insight?”**



**Optimization**



**Discovery**

**“As systems take action... where do we draw the line between expression and delegation?”**



**Expression**



**Delegation**

# Preserving human discovery

As analytical systems become more capable, what forms of imperfection should remain open to human interpretation?



## Thanks

Tableau Research, collaborators, and EuroVis organizers