

CSCI 1377

# Tools for Thought

# Multimedia I

## Communicating in Space

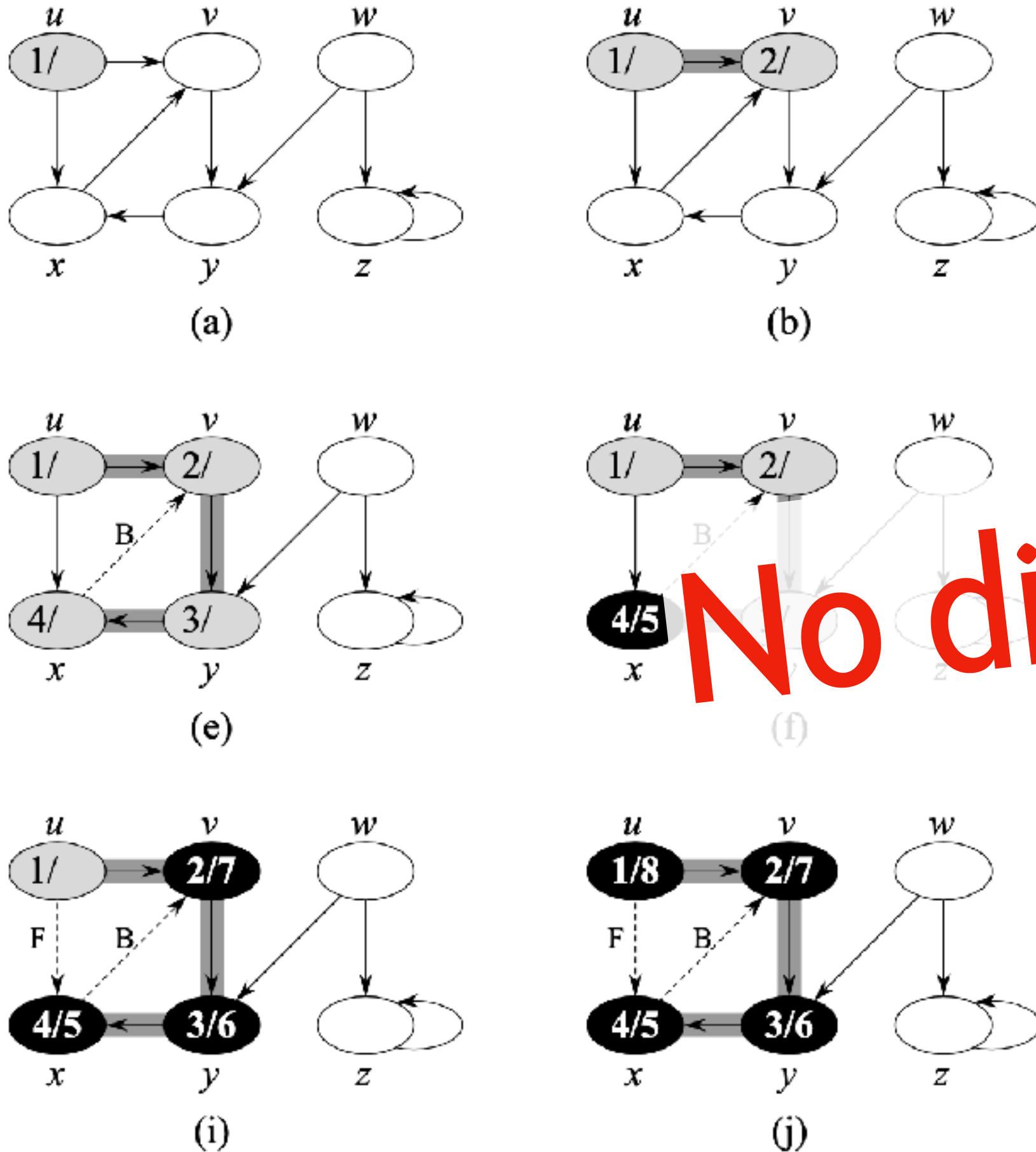


— Scott McCloud, *Understanding Comics* (1993)

“Perhaps the greatest advantage of electronic documents over paper ones is their ability to handle many more graphic elements. By combining a variety of media, electronic books can provide not only static images, but also dynamics (e.g., computer animations and computer-controlled video sequences), interactivity (e.g., ability to move objects, change and edit objects, and change states), and sound (e.g., computer-generated or audio disk recordings). These features all help in creating better *audiovisualization*.”

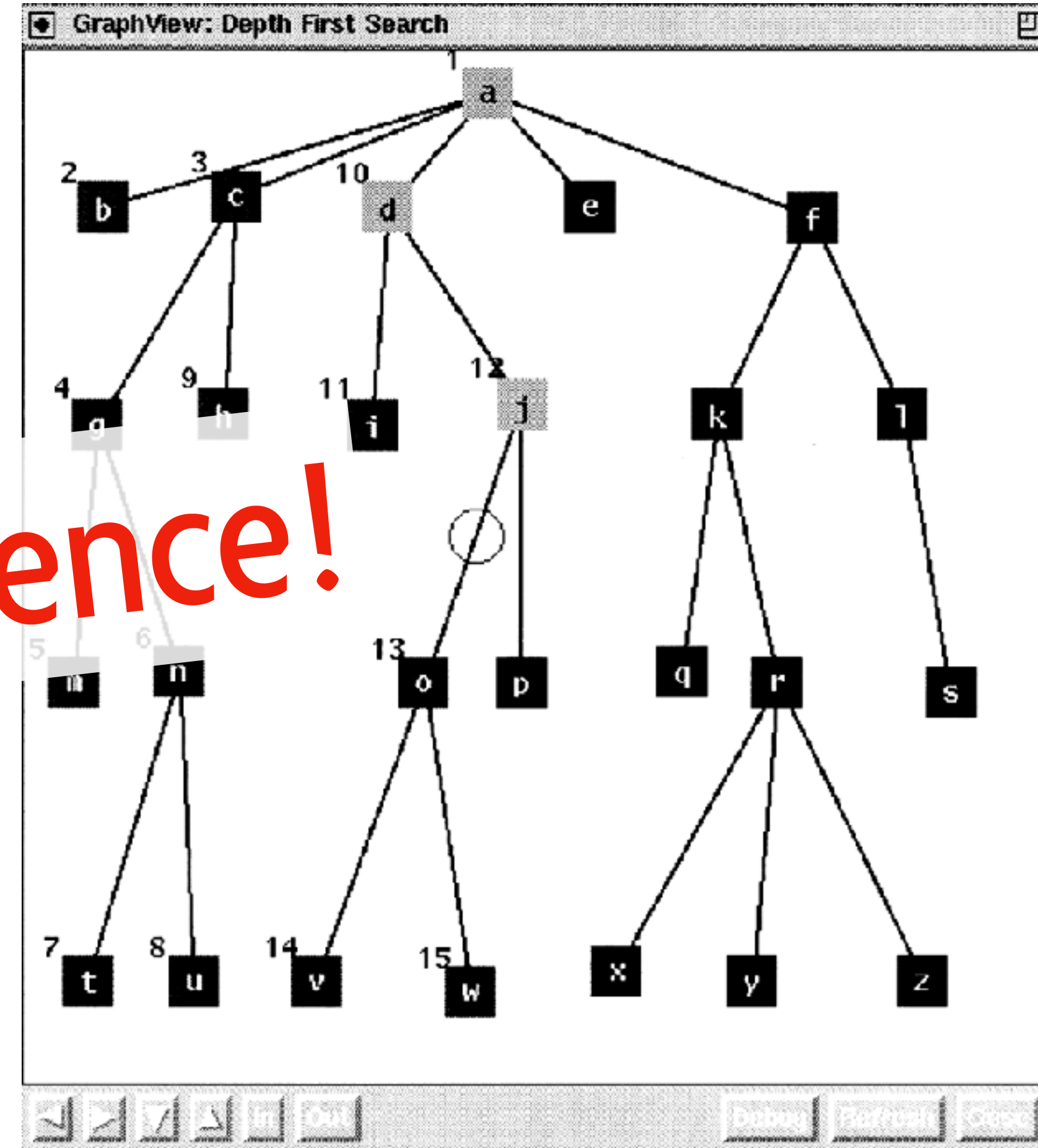
— Nicole Yankelovich, Norm Meyrowitz, and Andy van Dam.  
“Reading and Writing the Electronic Book” (1985)

# But when does multimedia actually help?



from CLRS

**No difference!**



“While static visualizations can provide people with the essence of how something looks, is laid out, or is constituted, animation appears better able to explain a dynamic, evolving process.”

**[https://www.youtube.com/  
shorts/scZSaFlX67o](https://www.youtube.com/shorts/scZSaFlX67o)**

# Diagrams have existed for thousands of years



Directions to a brothel in Ephesus, Greece (1st c. CE)




Domenico Nani Mirabelli, *Polyanthea* (1503)

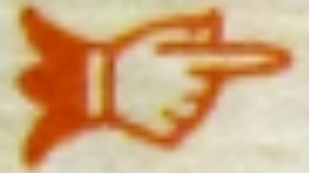

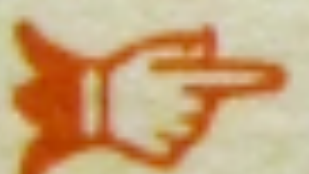
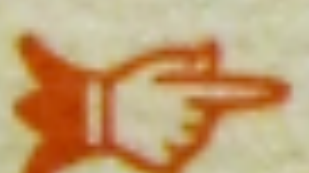
**How far could you go back and have someone recognize an arrow?**



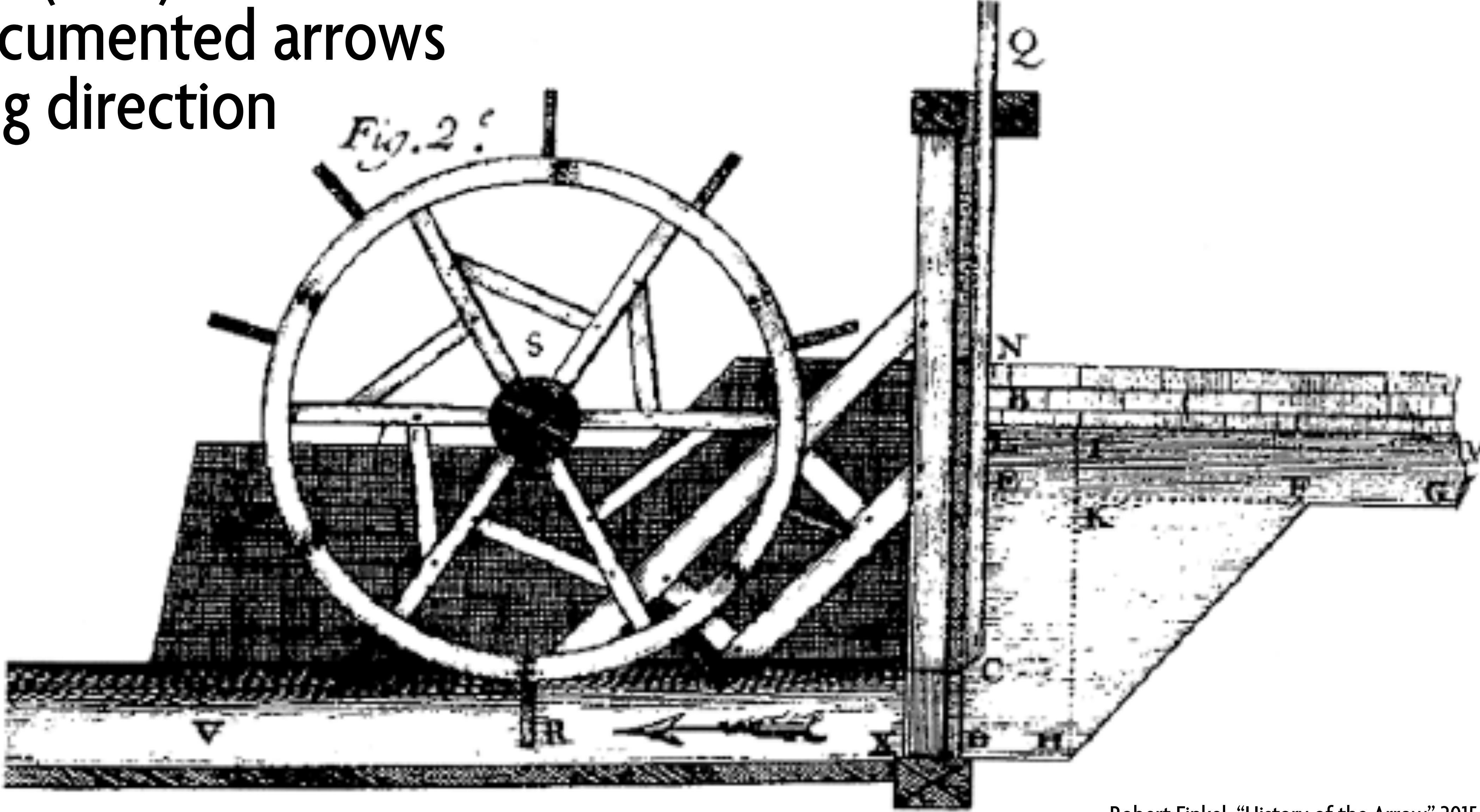
Pointing  
was often  
done with...  
fingers

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Bernard deBélidor's *Hydraulic Architecture* (1737) contains one of the first documented arrows representing direction



# The arrow-as-pointer is a recent invention

- Arrows didn't lose their fletchings until the late 1800s
- Arrows were introduced to mathematics by David Hilbert in 1922 to denote implication

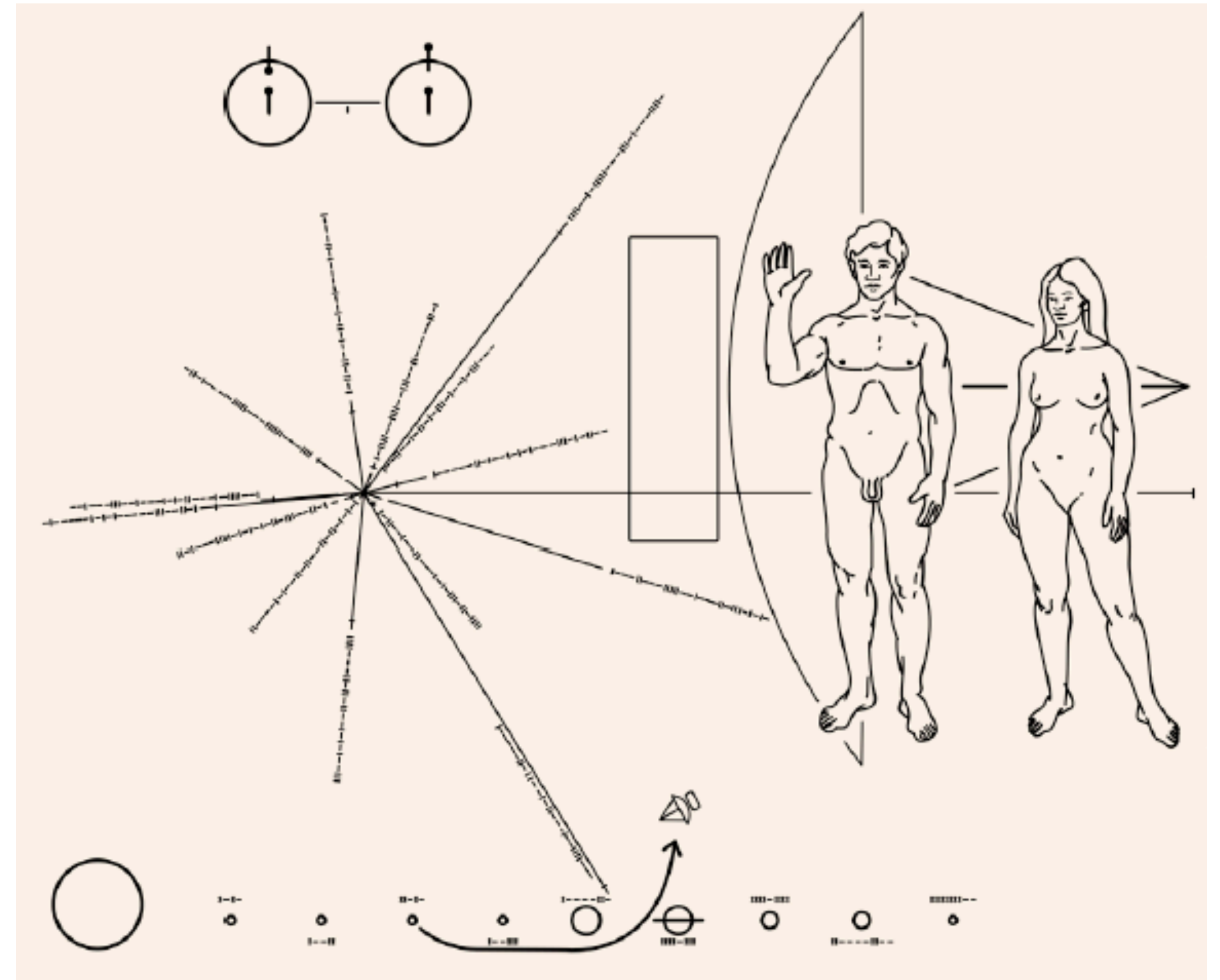


Image sent with the Pioneer 10 probe, 1976

# **Diagrams in scientific literature**

## Summary



People return to their baseline weight within 1.7 years on average after stopping treatment with any weight management medication, and just 1.5 years after using semaglutide or tirzepatide

## Study design



Systematic review and meta-analysis | Trials (randomised, non-randomised, single arm) and cohort studies (prospective or retrospective)

## Data sources



37 studies | 9341 participants ≥18 years old with overweight or obesity

## Comparison

### Intervention

Pharmacological interventions currently or previously licensed for weight loss

6322

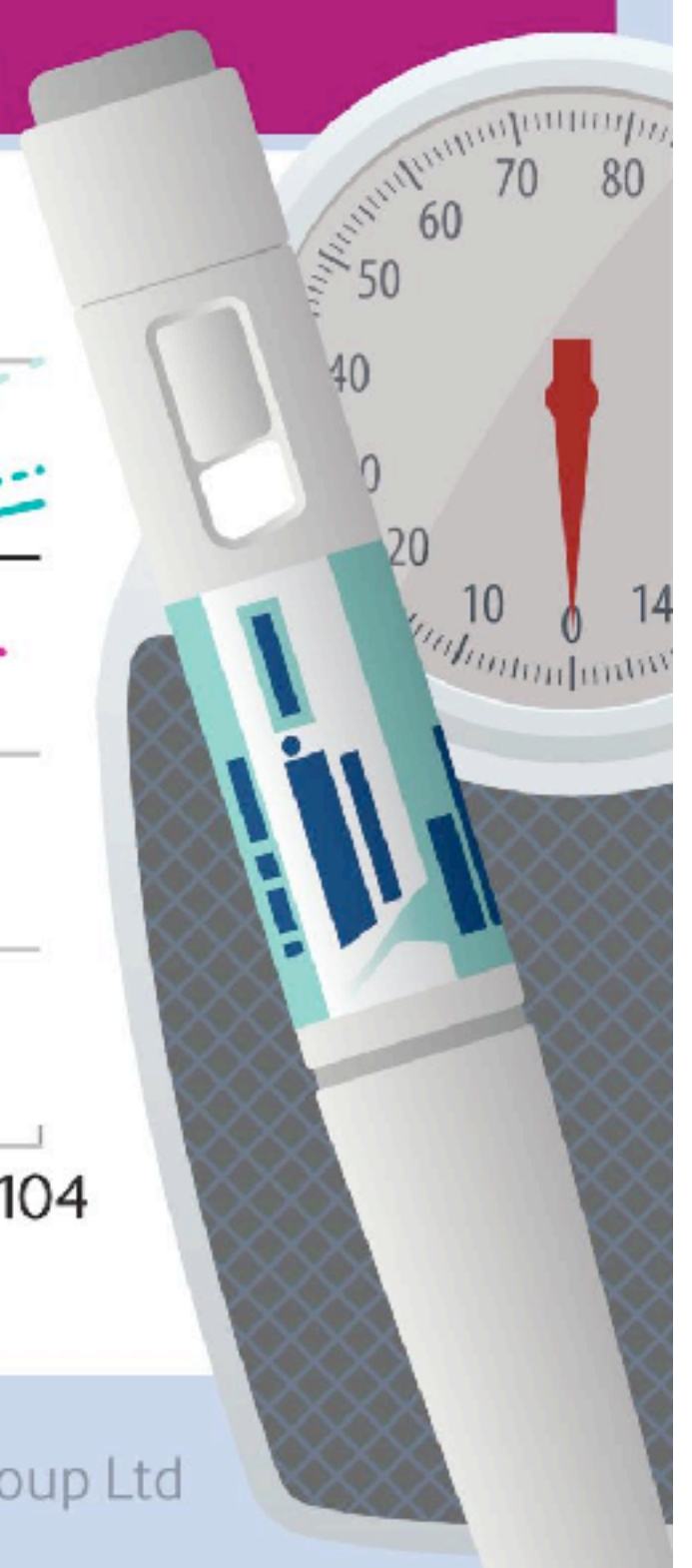
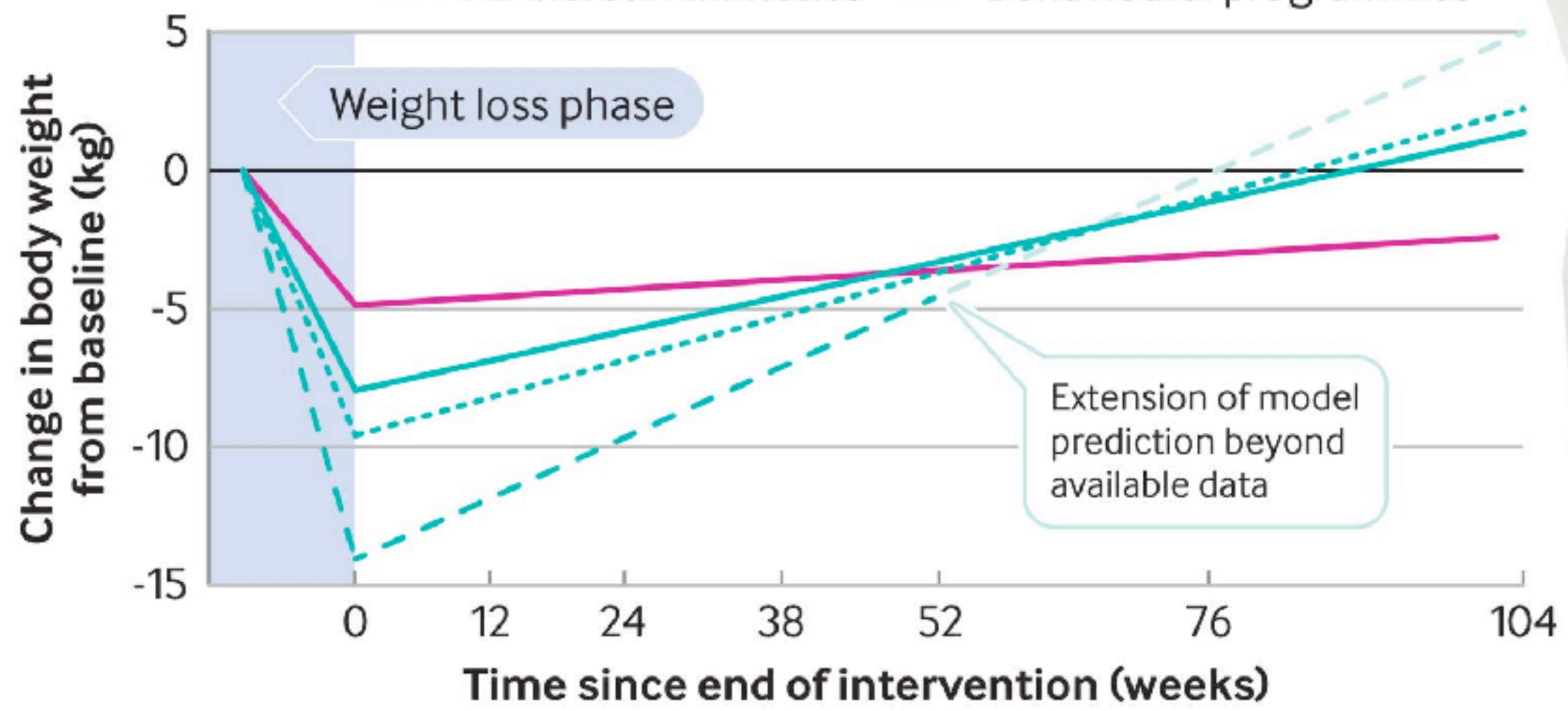
### Control

Non-pharmacological weight loss interventions or placebos

3019

## Outcomes

- All medication
- All incretin mimetics
- Newer incretin mimetics
- Behavioural programmes

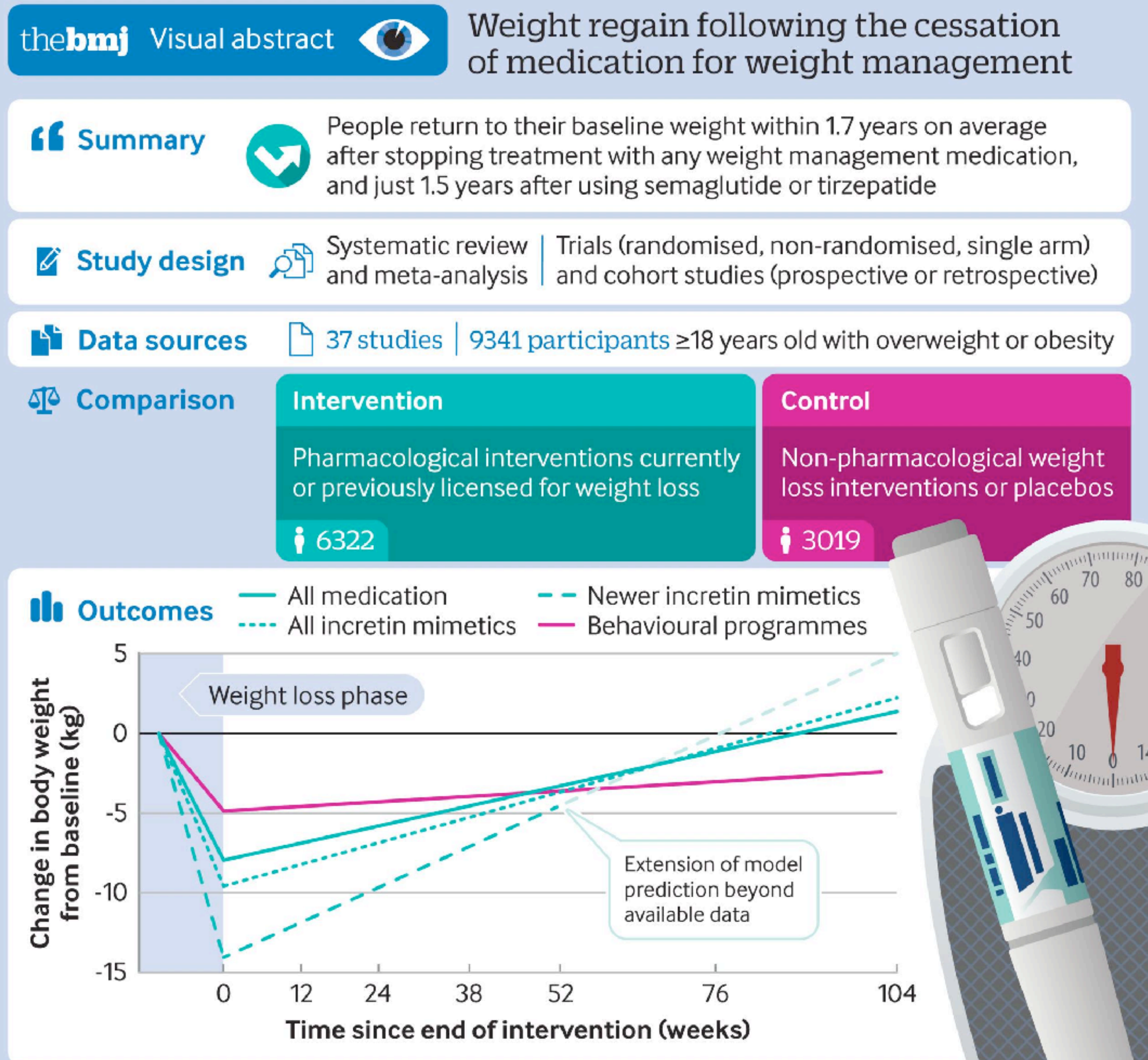


To help our readers to get a quick overview of research we publish, we started making visual abstracts...

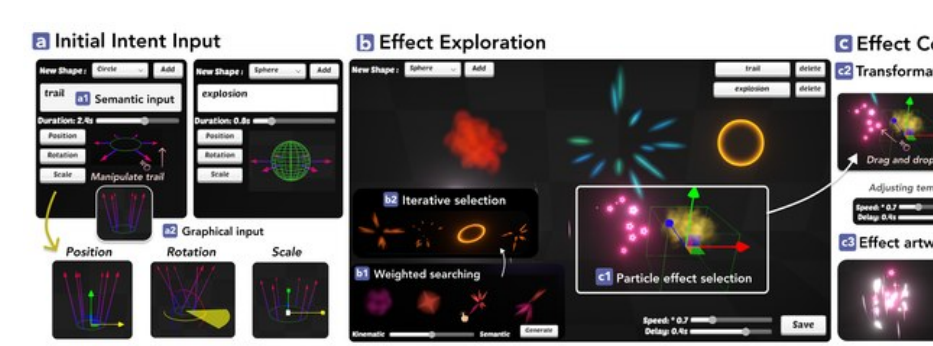
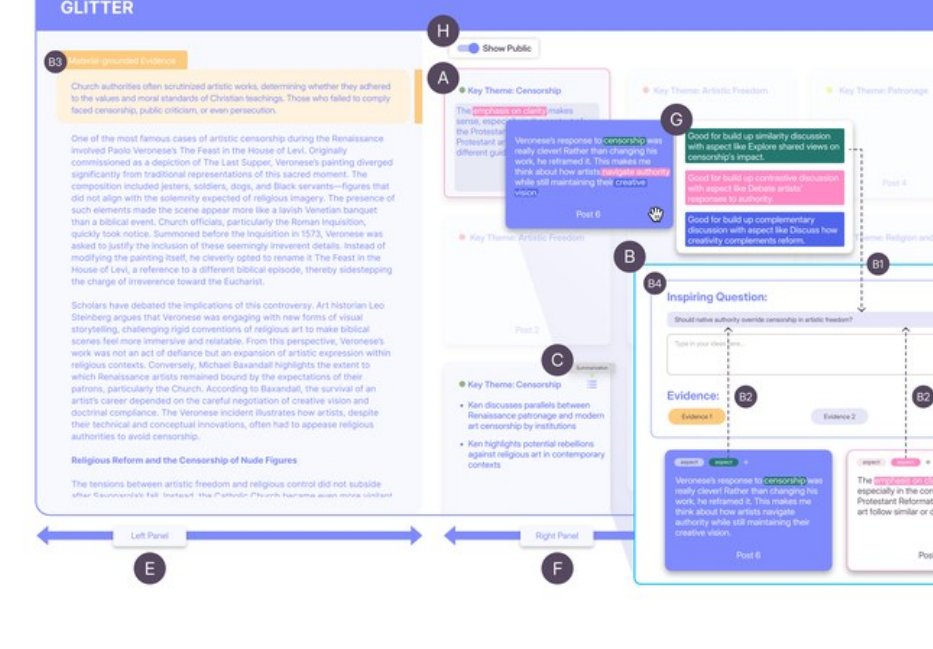
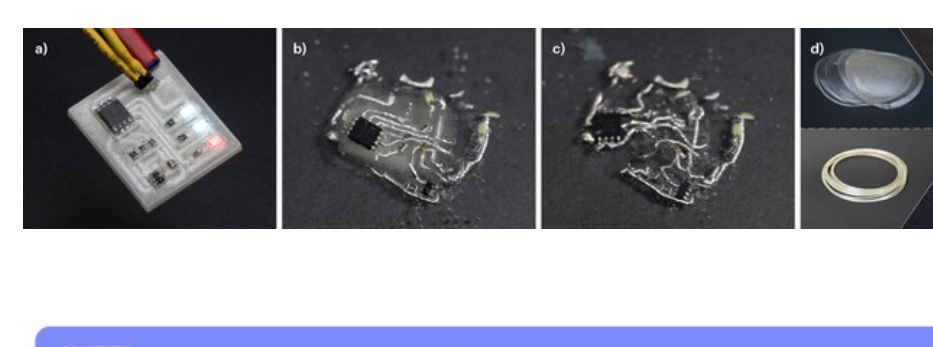
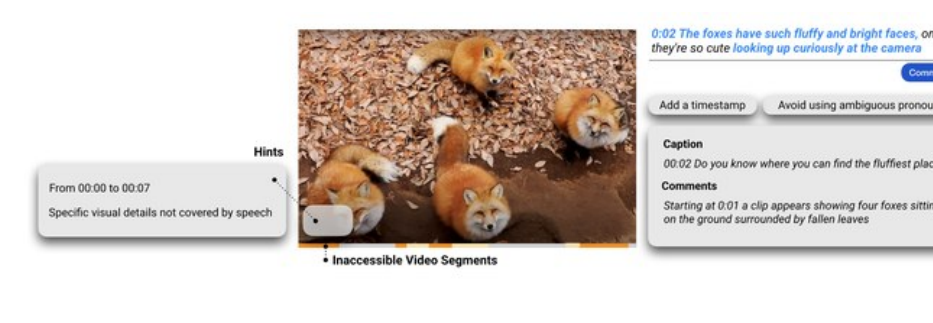
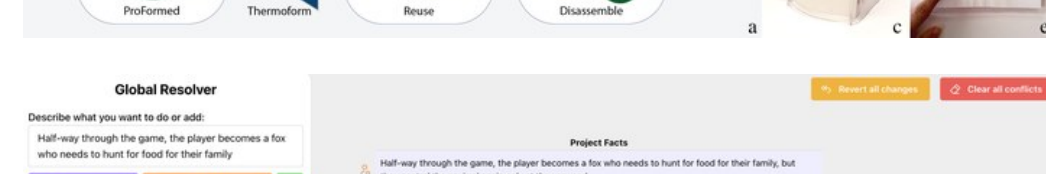
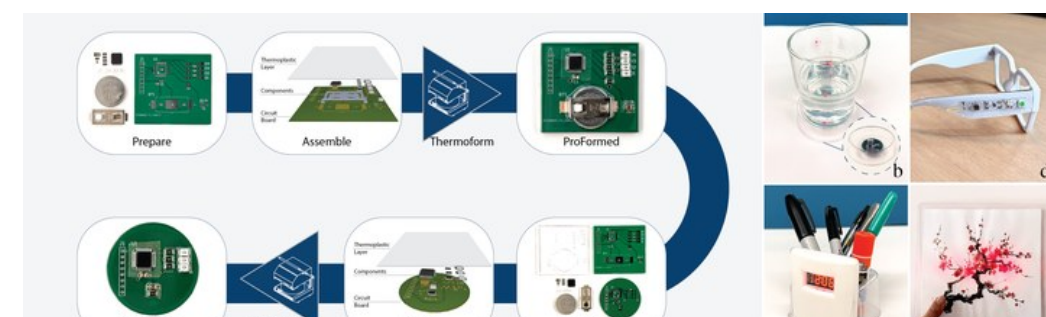
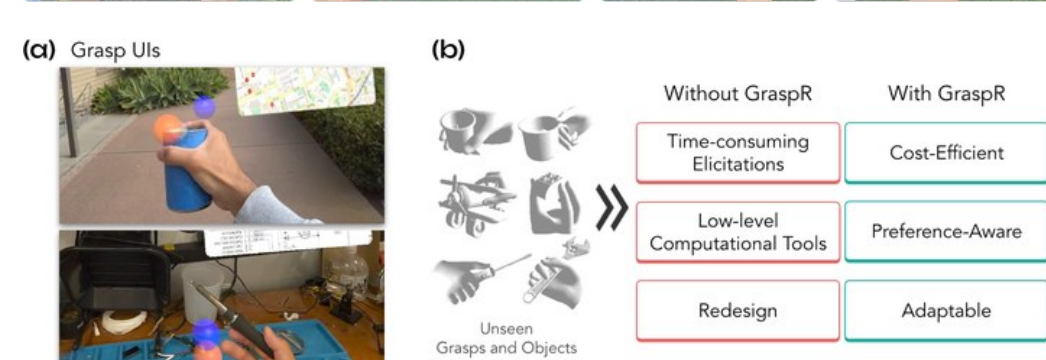
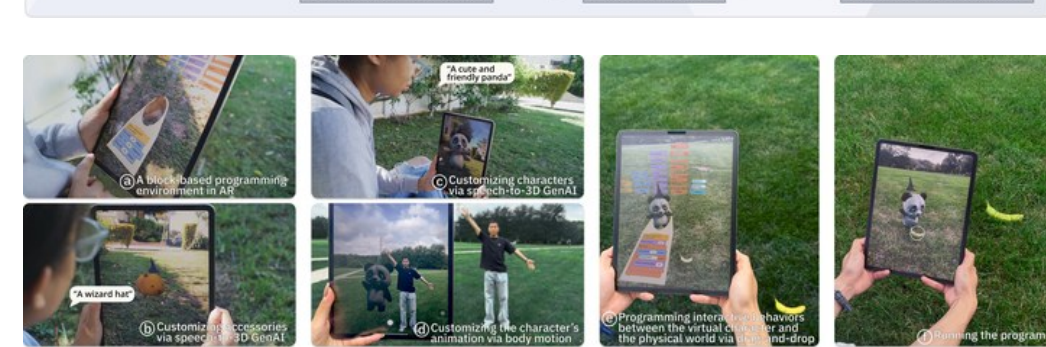
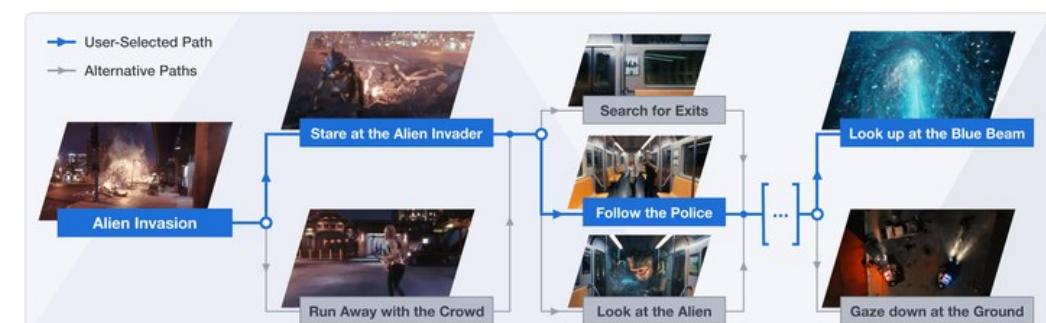
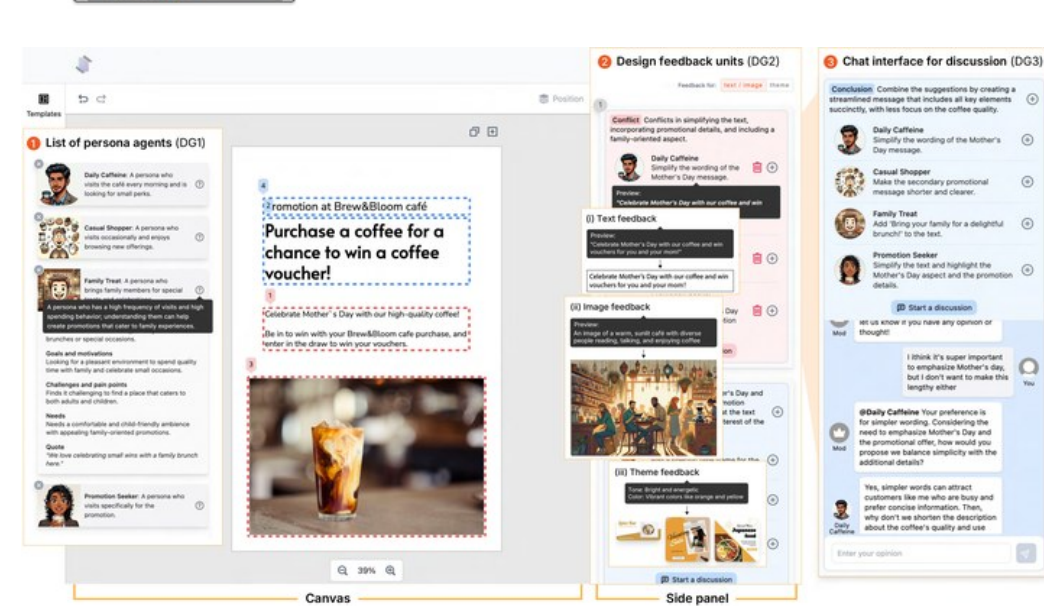
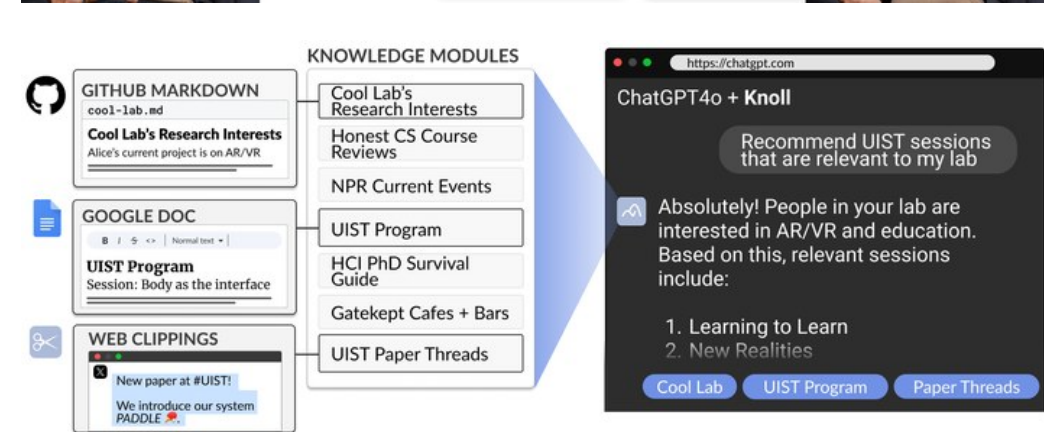
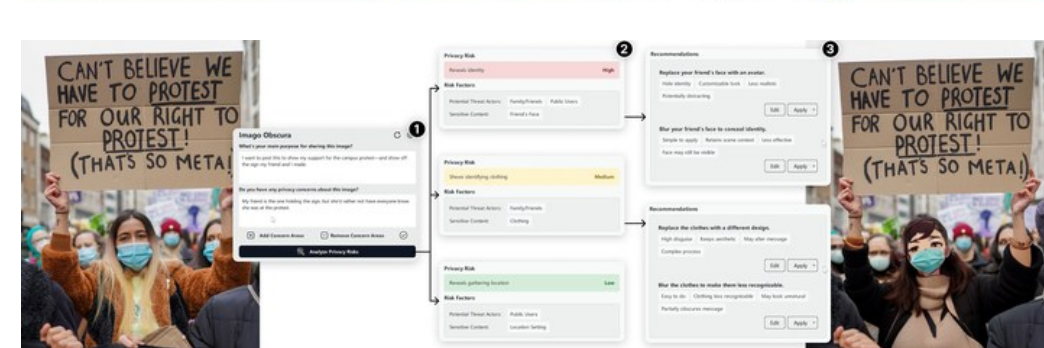
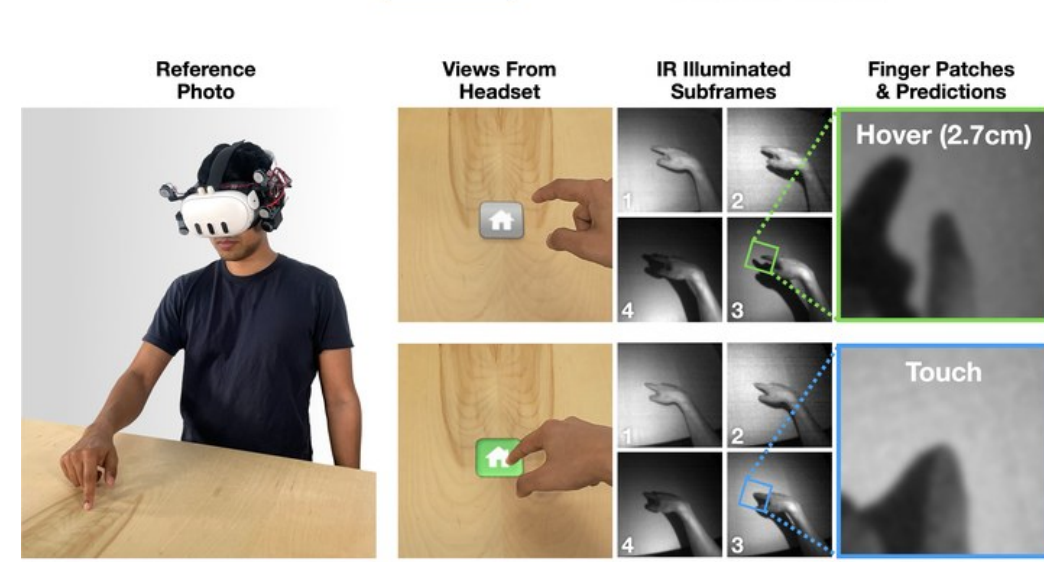
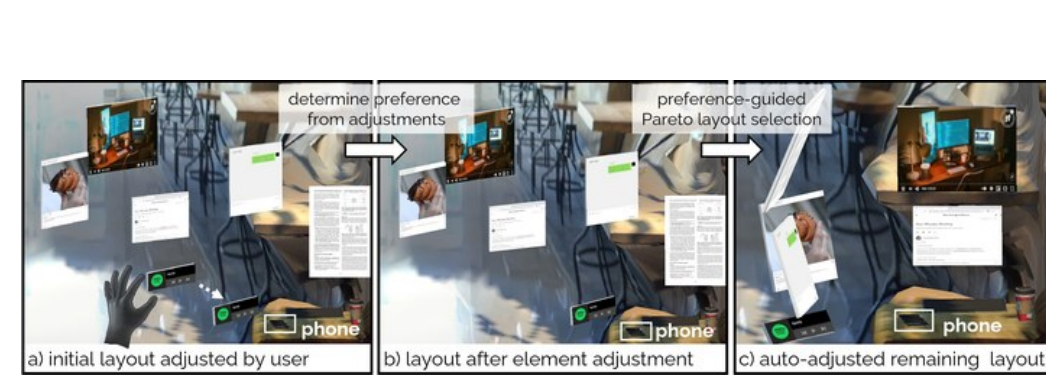
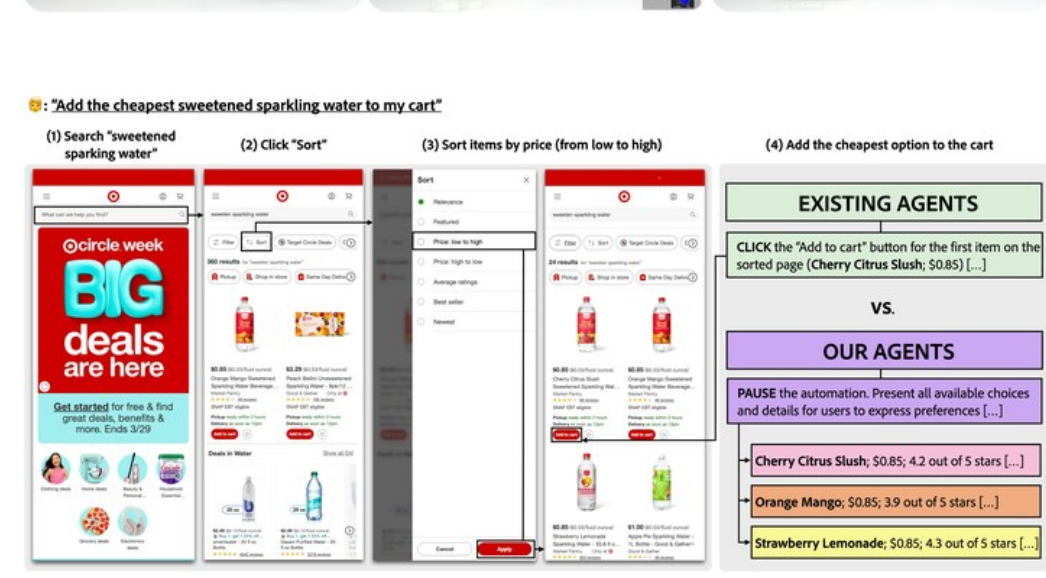
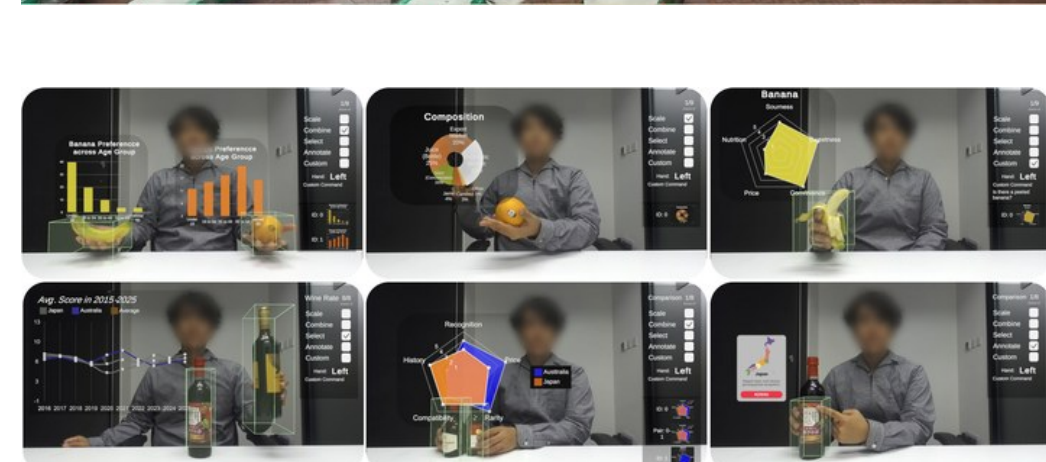
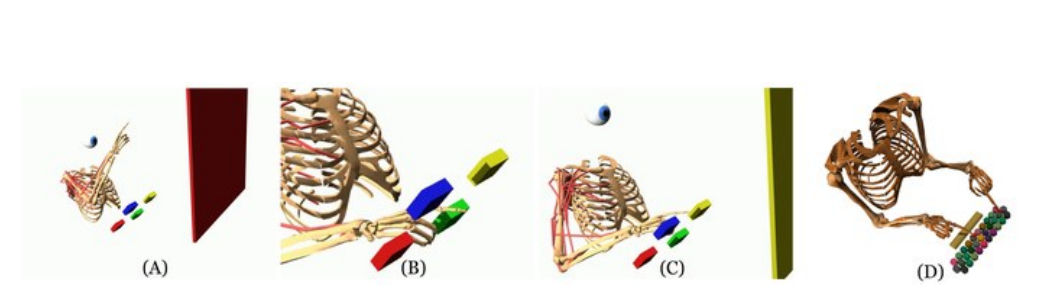
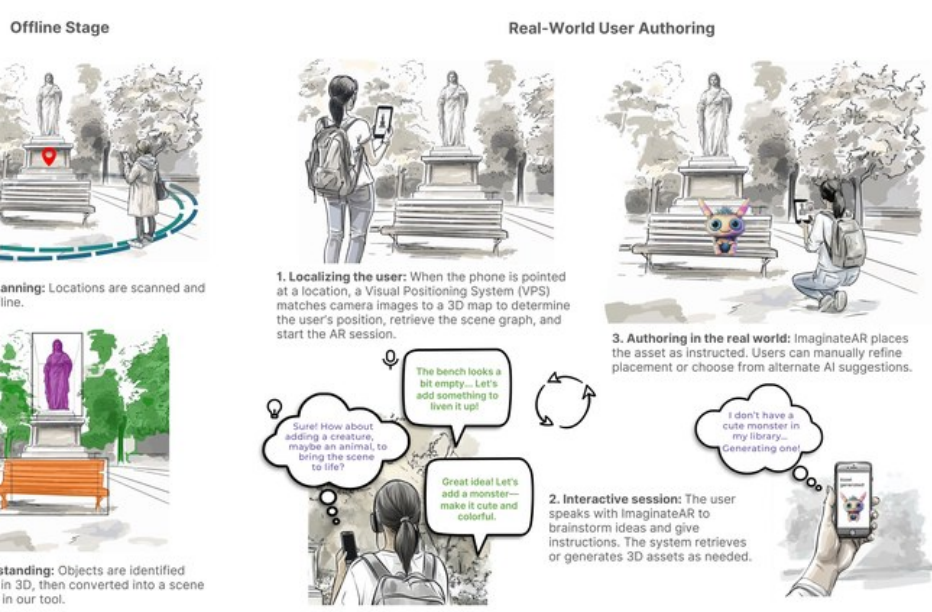
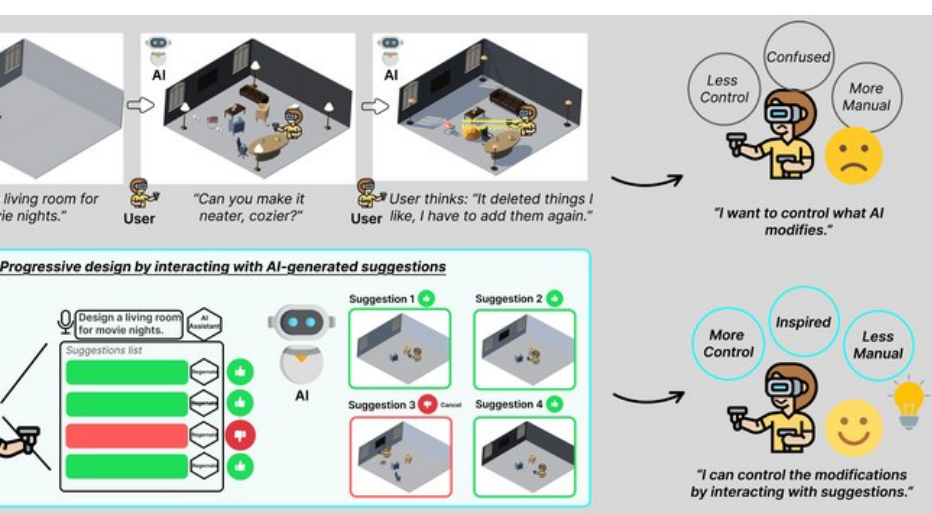
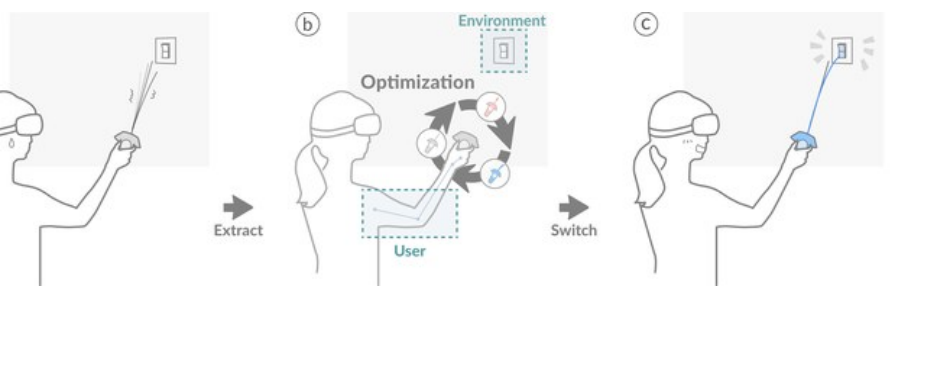
— BMJ

Visual Abstracts are eye-catching, graphical summaries of your research. Because they combine image and text, they are easy to read and very effective at engaging your audience, especially on social media channels. Think of a Visual Abstract as the business card for your research!

— Springer Nature



# The modern diagram takes many forms!



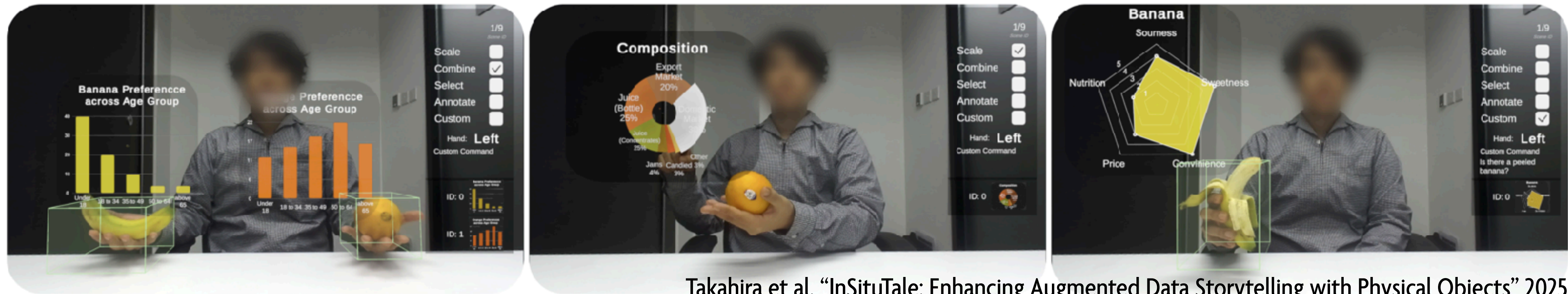
# Exercise: build a theory of HCI diagrams

- Goal: analyze the common structure of these diagrams
  - Clusters: which charts are related in form or function?
  - Components: what are common elements across the charts?
  - Efficacy: pick one chart you think is especially effective, and one ineffective
- Format: 5 min on your own, 5 min in small groups, 5 min discussion



`https://cel.cs.brown.edu/csci-1377-s26/11\_Multimedia\_I\_Exercise.pdf`

# Example gallery



Takahira et al. "InSituTale: Enhancing Augmented Data Storytelling with Physical Objects" 2025

## ▼ Flat Text Layout

```
const abs = (x) =>
  x < 0 ? -x
      : x;
```

## ▼ BOXES Layout

```
const abs = (x) =>
  x < 0 ? -x
      : x;
```

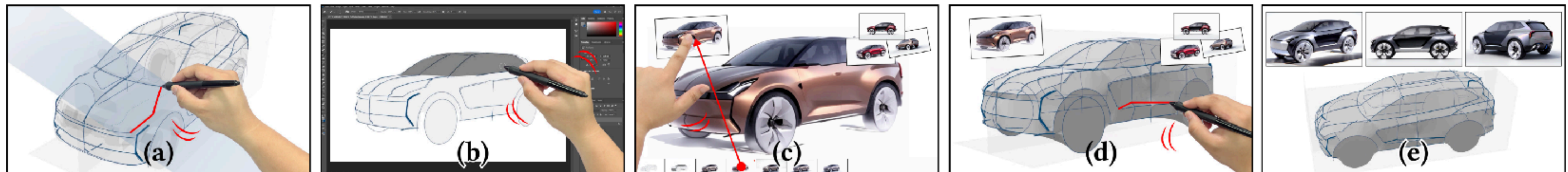
## ▼ Rocks Layout

```
const abs = (x) =>
  x < 0 ? -x
      : x;
```

## ▼ Rocks Layout, Simplified

```
const abs = (x) =>
  x < 0 ? -x
      : x;
```

Cohen and Chugh. "Ragged Blocks: Rendering Structured Text with Style" 2025



Lee et al. "3D Sketching + 2D Generative AI for Car Exterior Design" 2025

# Annotated screenshots

The screenshot displays the DataScout interface with several annotated components:

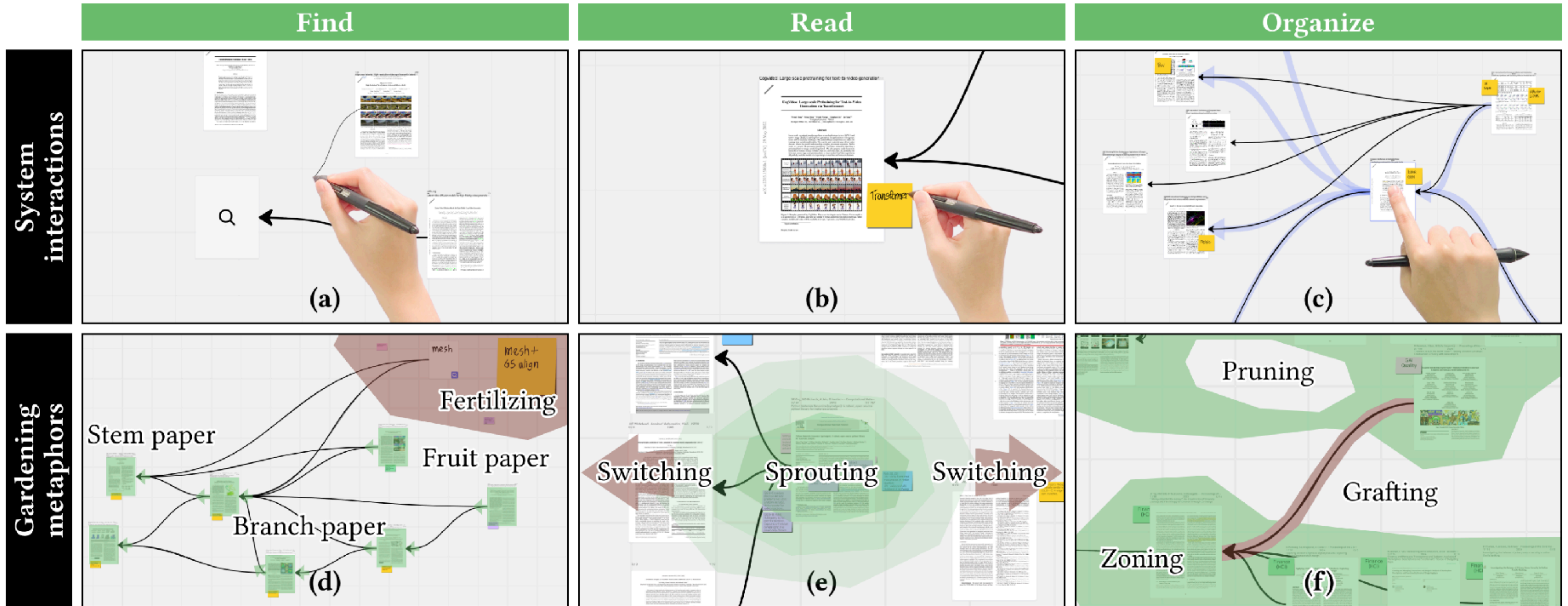
- Exact Match Filter:** A search bar at the top with the placeholder text "Enter keywords to filter sentences" and a "Tutorial Video" link.
- Aspects Panel:** A sidebar on the left with "Pre-Defined Aspects" (Methodology/Contribution, Results/Findings, Discussion/Conclusion) and "User-Defined" (a plus sign button).
- Cross-Sentence Relationships:** A central panel showing "Methodology", "Goal/Focus", "Participants", "Contribution", "System Characteristics", "Context/Status Quo", "Enumeration", and "Highlight All" tabs. The "Contribution" and "System Characteristics" tabs are active, showing a list of sentences with highlighted text.
- Abstracts:** A panel on the right showing a dropdown menu for "Show full abstract only" and a list of abstracts, including "#1 Seam Work and Simulacra of Societal Impact in Networking Research: A Critical Technical Practice Approach".
- Query Decomposition:** A panel on the left showing a task specification: "Evaluate the effects of remote work on quality of life through various periods of the pandemic". It includes suggestions to refine the search query and filters.
- Top Dataset Results:** A panel on the right showing a list of 8 datasets, including "Global Remote Work & Wellbeing Dataset", "Remote Work USA (COVID-19)", "Remote Work Productivity", "COVID-19 on Working Professionals", "Impact of COVID-19 on Working Professionals", "World time use, work hours and GDP", "Impact of Covid-19 on Employment - ILOSTAT", and "Annual Working Hours Dataset (1870-1970)".
- Global Remote Work & Wellbeing Dataset:** A detailed view of the selected dataset, showing its metadata (10 cols, 10000 rows, 133.3 kB), a description of its utility and limitations, and a dataset preview table.

**Annotations:** Letters A through H are placed around the interface to highlight specific features and components.

Gu et al. "AbstractExplorer: Leveraging Structure-Mapping Theory to Enhance Comparative Close Reading at Scale" 2025

Lin et al. "Rethinking Dataset Discovery with DataScout" 2025

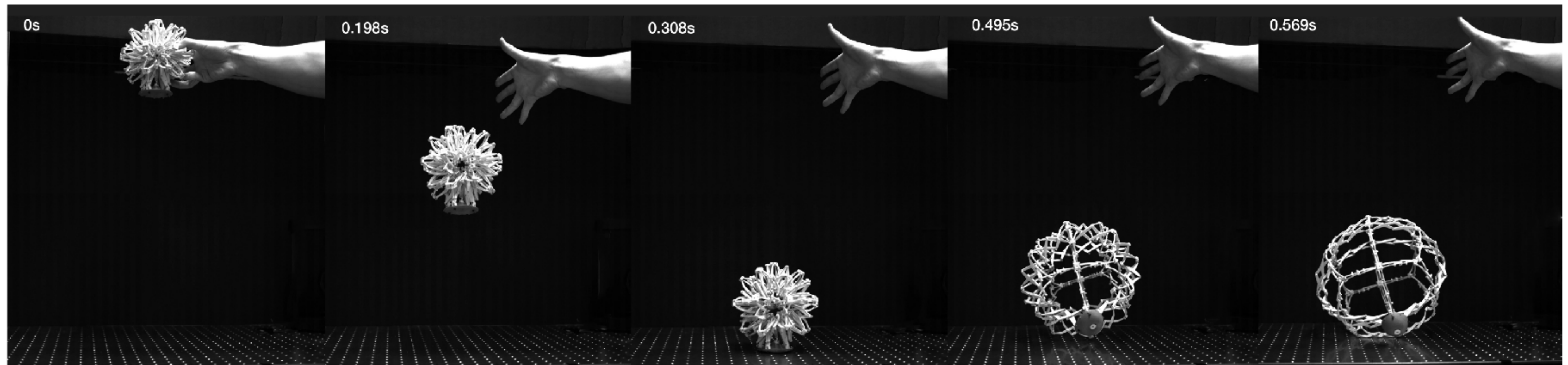
# Structured + annotated example gallery



# Video comics



Zhang et al. "BaroPoser: Real-time Human Motion Tracking from IMUs and Barometers in Everyday Devices" 2025



Fu et al. "DropPop: Designing Drop-to-Deploy Mechanisms with Bistable Scissors Structures" 2025

# Conceptual comics

## 1 Developer asks a reachability question

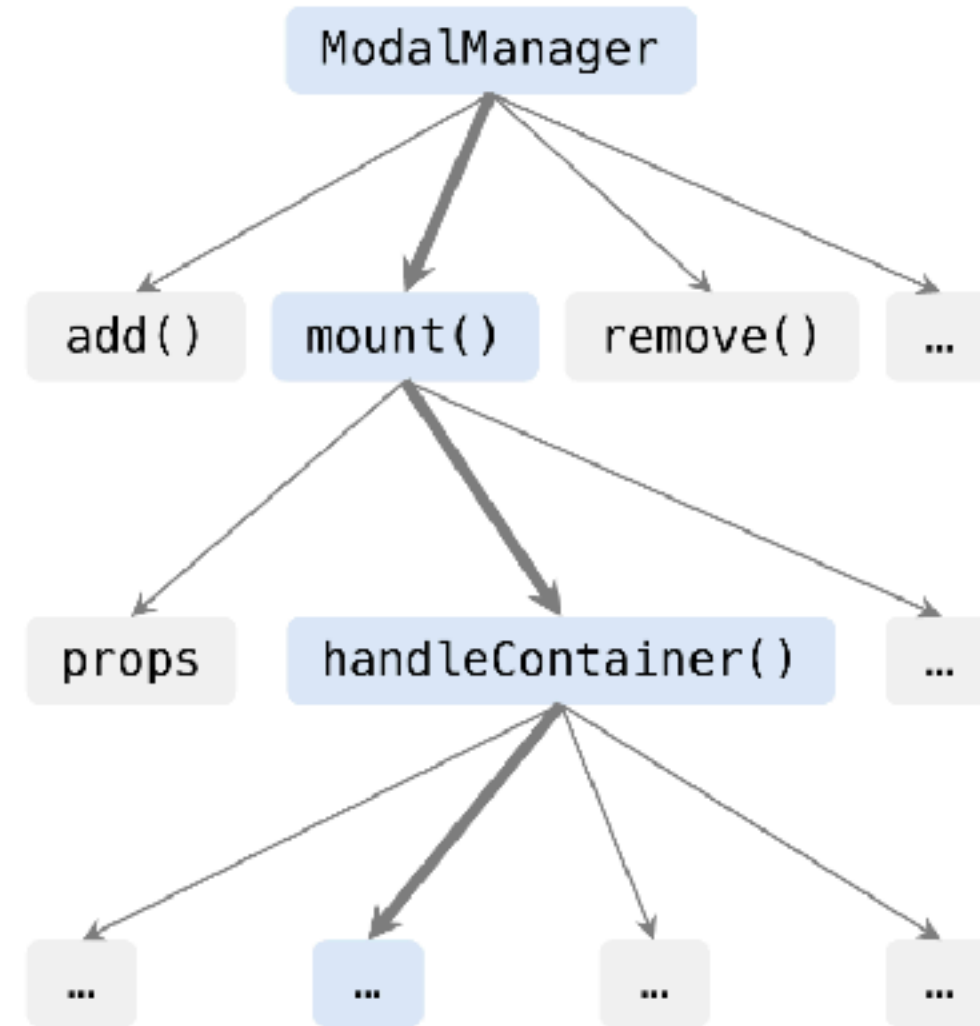
Q: How does the *ModalManager* prevent scrolling?

TS ModalManager.ts

```

206 export class ModalManager {
249   mount(modal: Modal, props:
251     const containerInfo = this.
      containers[containerIndex];
252
253   if (!containerInfo.restore) {
254     containerInfo.restore =
      handleContainer(containerInfo,
        props);
255   }
256 }
  
```

## 2 AI agent explores code



## 3 Agent answers questions with traces

Answer

It prevents scrolling by using the `handleContainer` ...

Descriptive tour of code

The code sets `scrollContainer.style.overflow` to `hidden` to lock scrolling ... walk me here

Replayable Walkthrough

I started here ...

`export class ModalManger {`

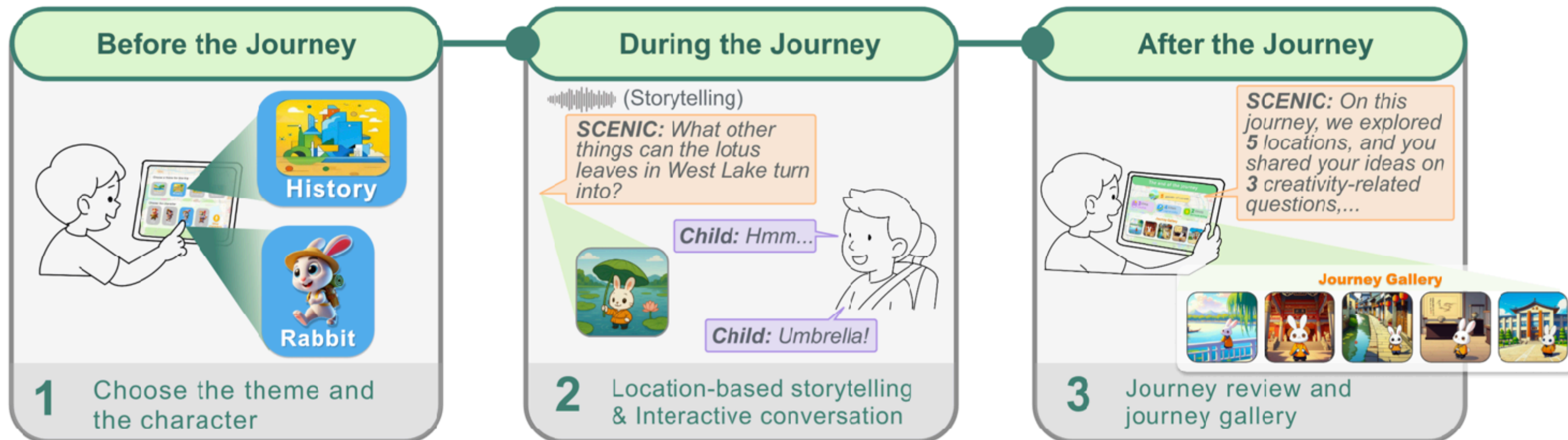
I decided to look for more info about `mount`

`mount (modal: Modal, props:`

`handleContainer(containerInfo,`

`handleContainer(containerInfo,`

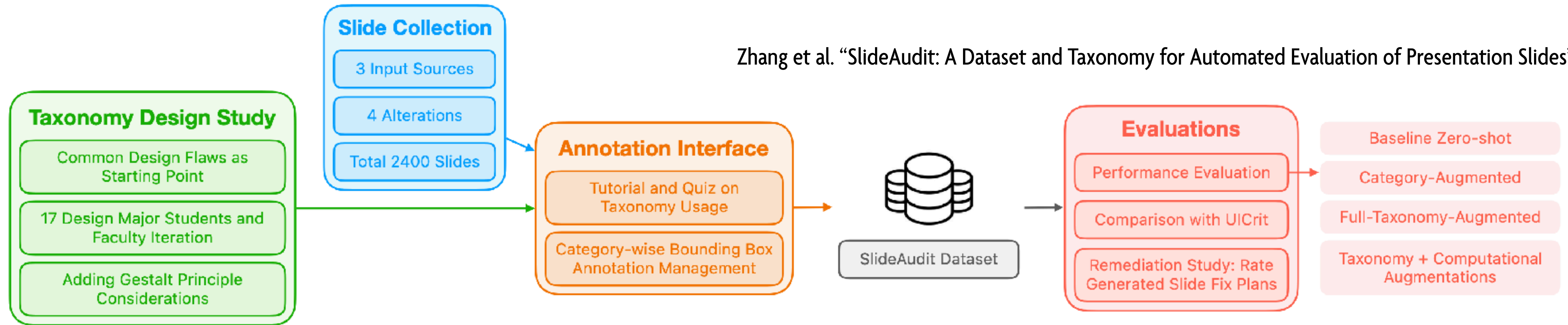
Yan et al. "Answering Developer Questions with Annotated Agent-Discovered Program Traces" 2025



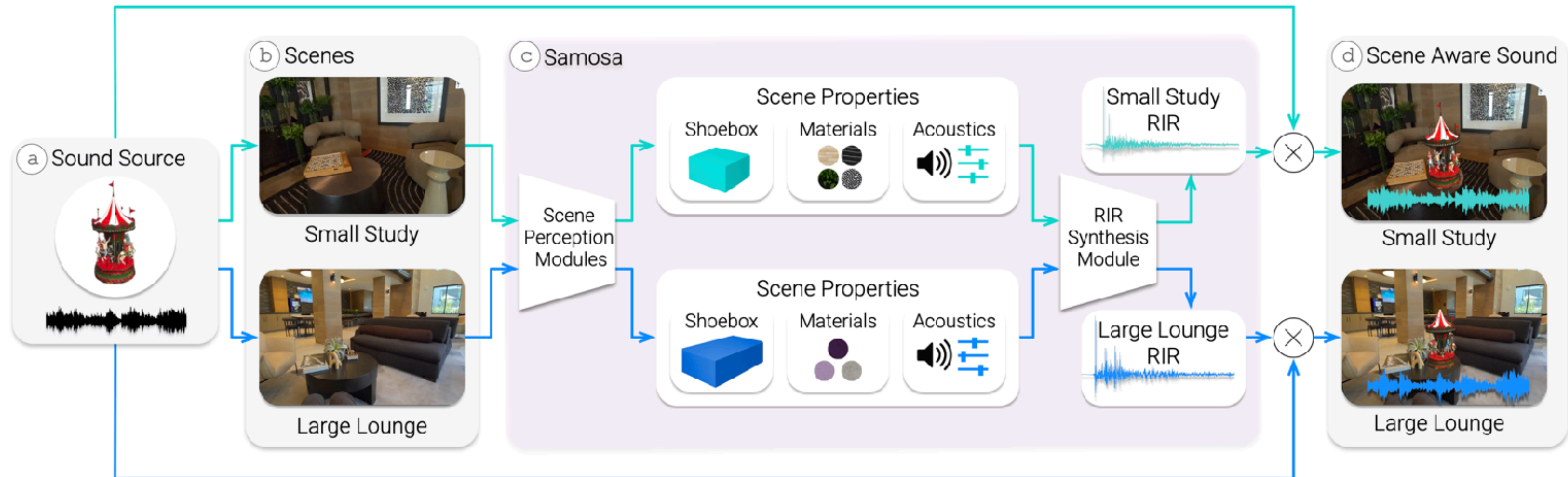
Chen et al. "SCENIC: A Location-based System to Foster Cognitive Development in Children During Car Rides" 2025

# System architecture

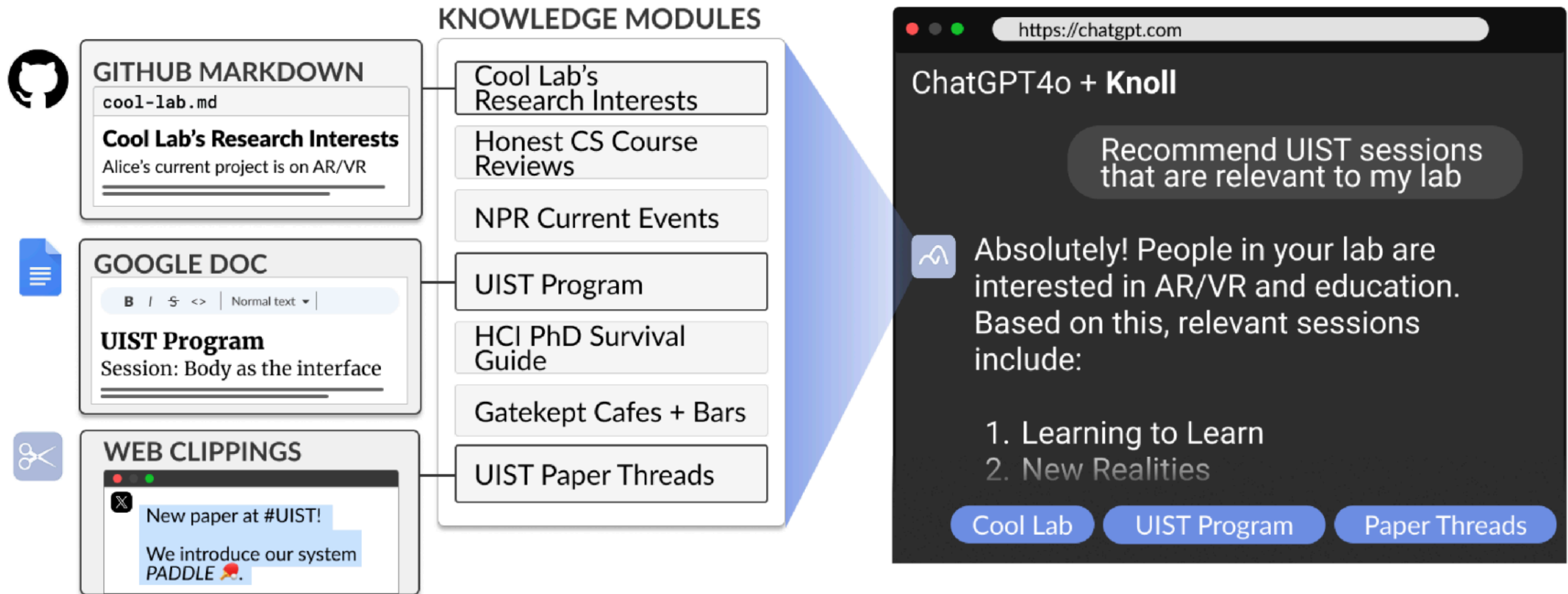
Zhang et al. "SlideAudit: A Dataset and Taxonomy for Automated Evaluation of Presentation Slides" 2025



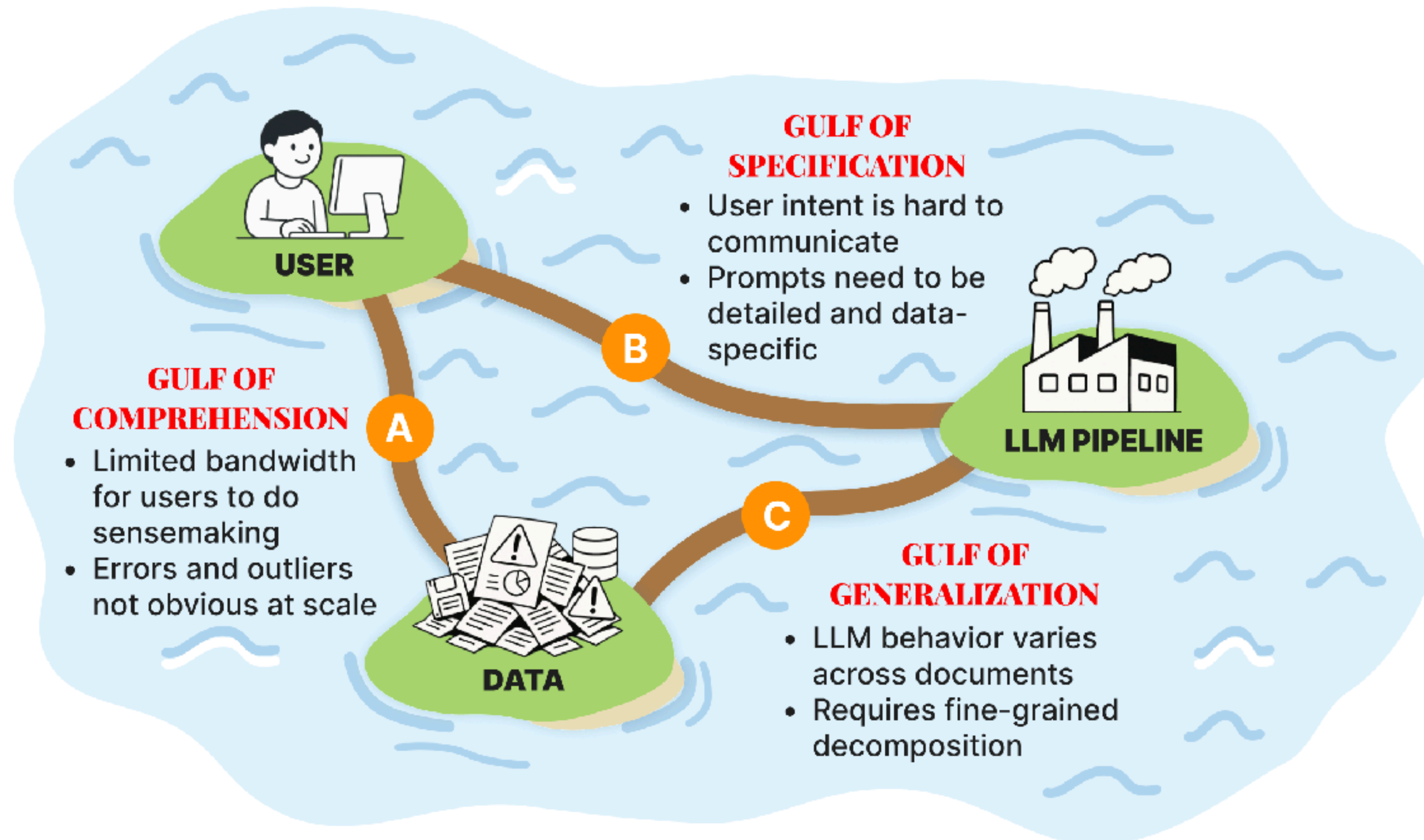
Xu et al. "Enhancing XR Auditory Realism via Multimodal Scene-Aware Acoustic Rendering" 2025



# System architecture?



# Visual metaphor

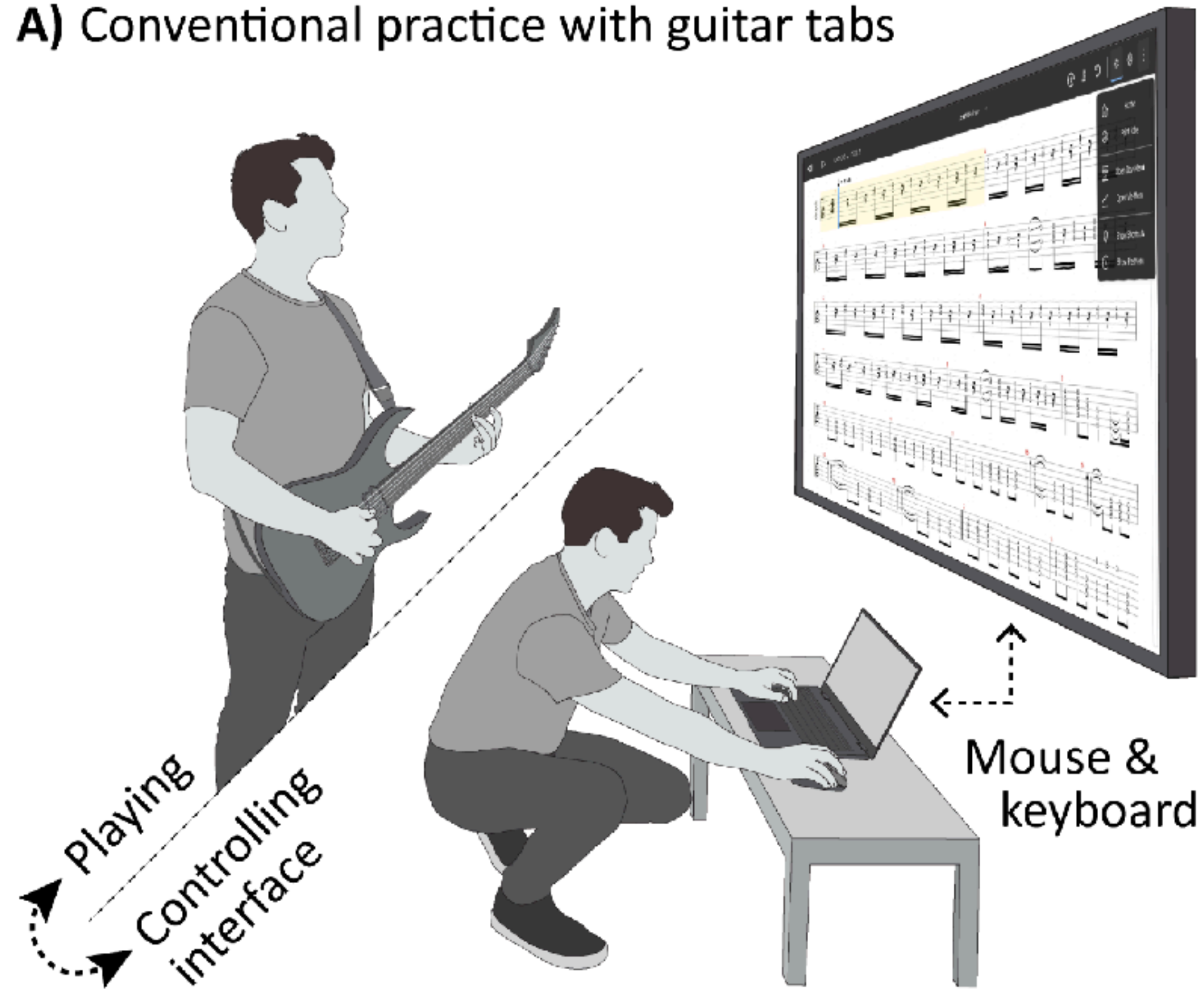


Three UI panels illustrating the gulfs:

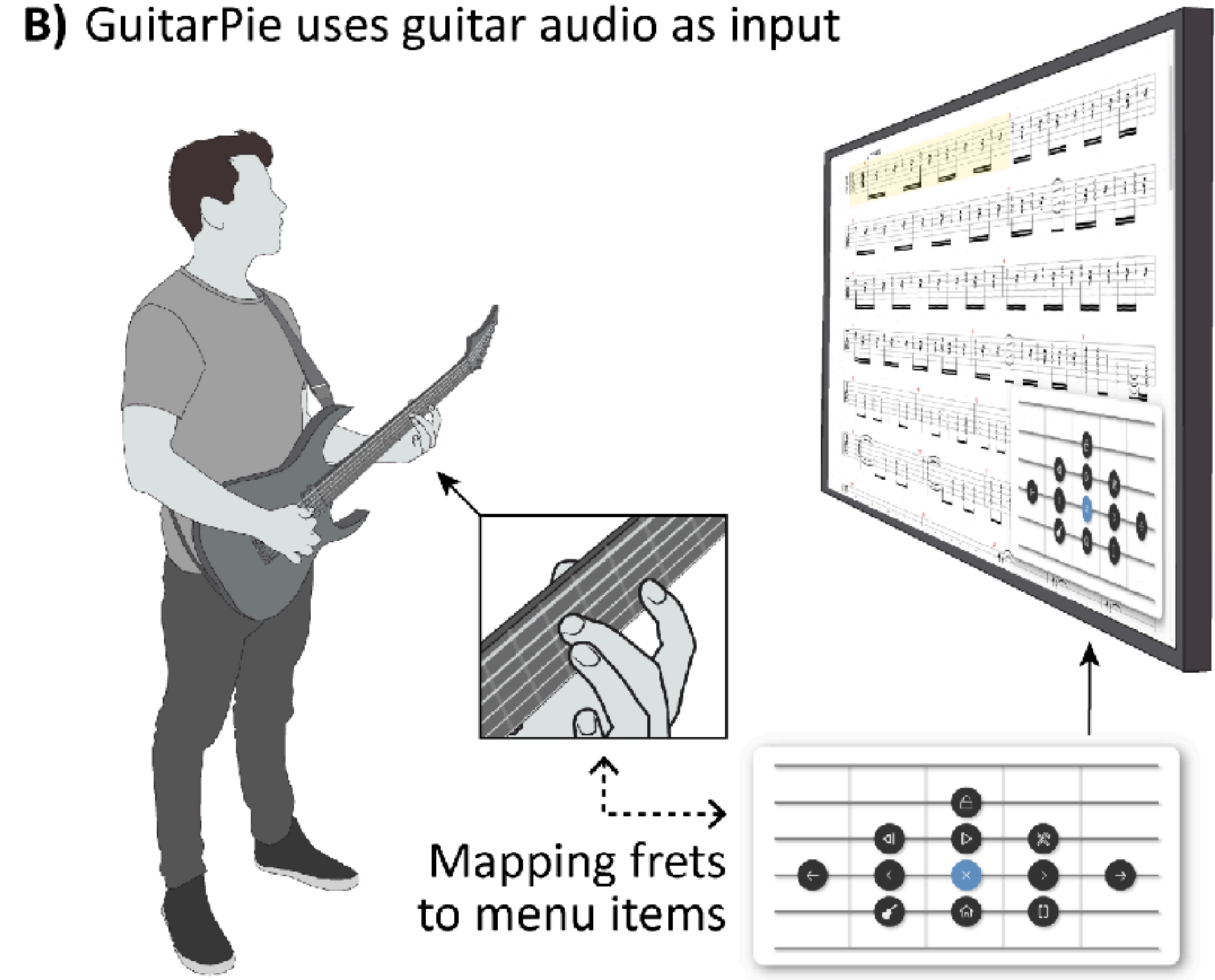
- A Docs & Outputs**: Shows a dashboard with charts for 'condition', 'discomfort\_level', and 'symptoms'. An 'In-Situ User Notes' box is overlaid on the 'discomfort\_level' chart, with an 'Add Note' button.
- B Prompt Refinement**: Shows a 'Suggested Modifications for Prompt' section with a list of modifications and buttons for 'Edit', 'Add Feedback', and 'Accept Changes'.
- C Operation Decomposition**: Shows a message 'Operation Too Complex! Consider decomposing extract\_discomfort because...' with a 'Decompose' button.

# Visual abstraction & zoom

A) Conventional practice with guitar tabs



B) GuitarPie uses guitar audio as input

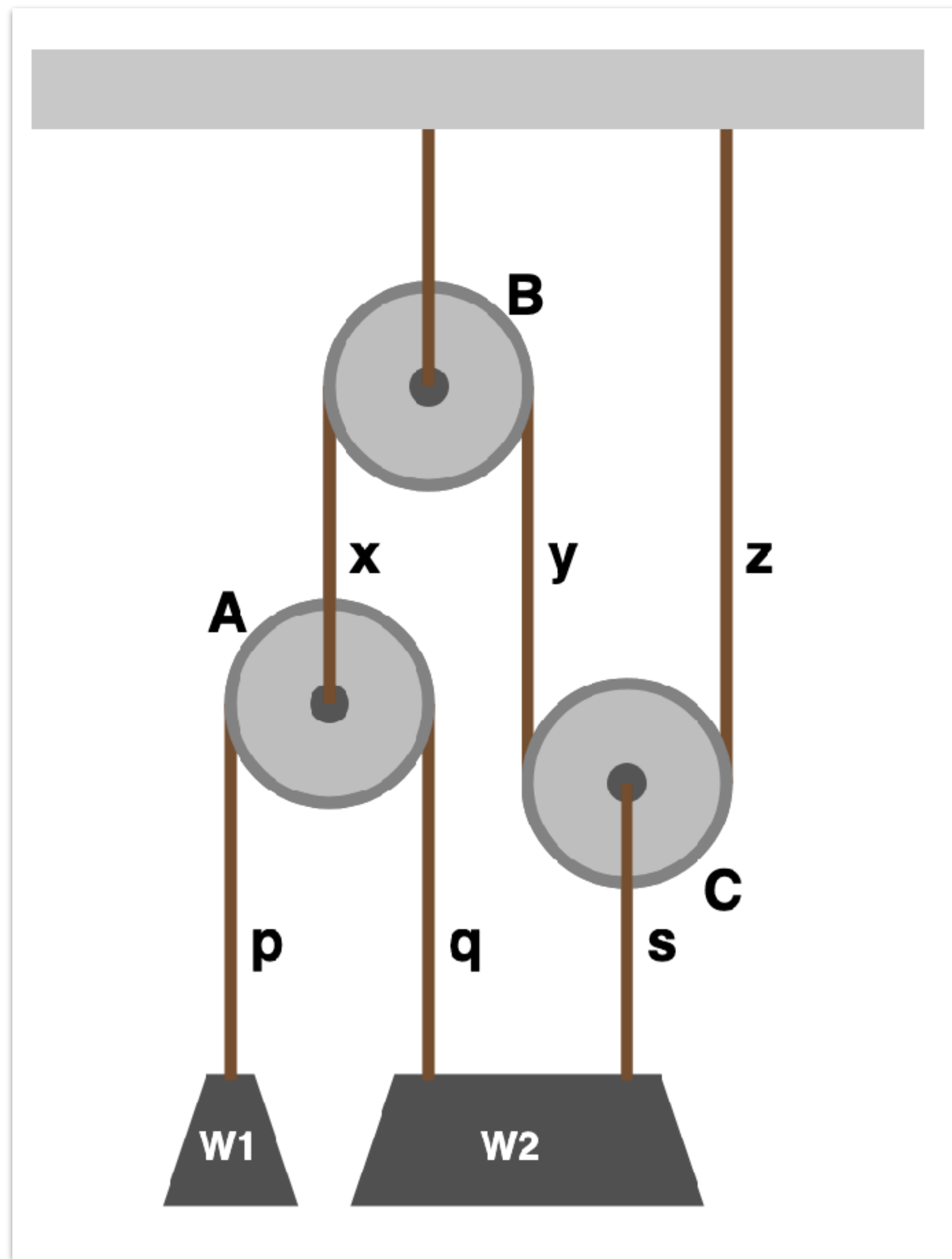


**Diagrams are about the effective  
use of space**

1. The first weight is suspended from the left end of a rope over Pulley A.
2. The right end of this rope is attached to, and partially supports, the second weight.
3. Pulley A is suspended from the left end of a rope that runs over Pulley B, and under Pulley C.
4. Pulley B is suspended from the ceiling.
5. The right end of the rope that runs under Pulley C is attached to the ceiling.
6. Pulley C is attached to the second weight, supporting it jointly with the right end of the first rope.

- Set  $W1 = 1$
- What is affected by  $W1$ ?
- [S1] Left end of rope over PA
- What is PA attached to?
- [S1  $\rightarrow$  S2] “this rope” = PA, so  $W2$
- [S2  $\rightarrow$  S3] PA suspended over PB under PC
- What is PC attached to?
- [S3  $\rightarrow$  S4] irrelevant
- [S4  $\rightarrow$  S5] PC supported by ceiling
- What is PA attached to again?

**Find the ratio of the second to the first weight, if the system is in equilibrium.**



- Set  $W1 = 1$
- What is affected by  $W1$ ?
- $[W1 \rightarrow PA]$   $W1$  goes over PA
- $[PA \rightarrow W1]$  to  $W2$
- $[PA \rightarrow B]$  and connected to B
- ...

**Find the ratio of the second to the first weight, if the system is in equilibrium.**

# Diagrams can efficiently encode relational information in space

- Sentential representation requires linear search to discover facts
  - “A points to B”, “B points to C”, “A points to C” what does A point to?
- Diagrammatic representation supports efficient lookups keyed to one element of a relation
  - “Everything that points to A” or “everything A points to” are simple perceptual tasks of following lines

**Diagrams are about visual  
abstraction**

FOR EXAMPLE, WHILE *MOST* CHARACTERS WERE DESIGNED *SIMPLY*, TO ASSIST IN *READER-IDENTIFICATION*--



--*OTHER* CHARACTERS WERE DRAWN MORE *REALISTICALLY* IN ORDER TO *OBJECTIFY* THEM, EMPHASIZING THEIR "*OTHERNESS*" FROM THE READER.



A PROP LIKE THIS *SWORD* MIGHT BE VERY *CARTOONY* IN *ONE* SEQUENCE--



--DUE TO THE "*LIFE*" IT POSSESSES AS AN EXTENSION OF MY CARTOON IDENTITY!

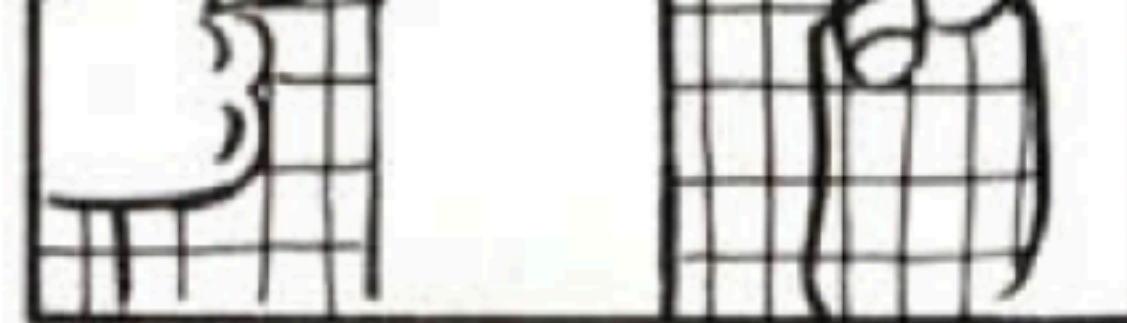


Scott McCloud. *Understanding Comics*. 1993

BUT

IN JAPANESE COMICS, THE SWORD MIGHT *NOW* BECOME VERY *REALISTIC*, NOT ONLY TO SHOW US

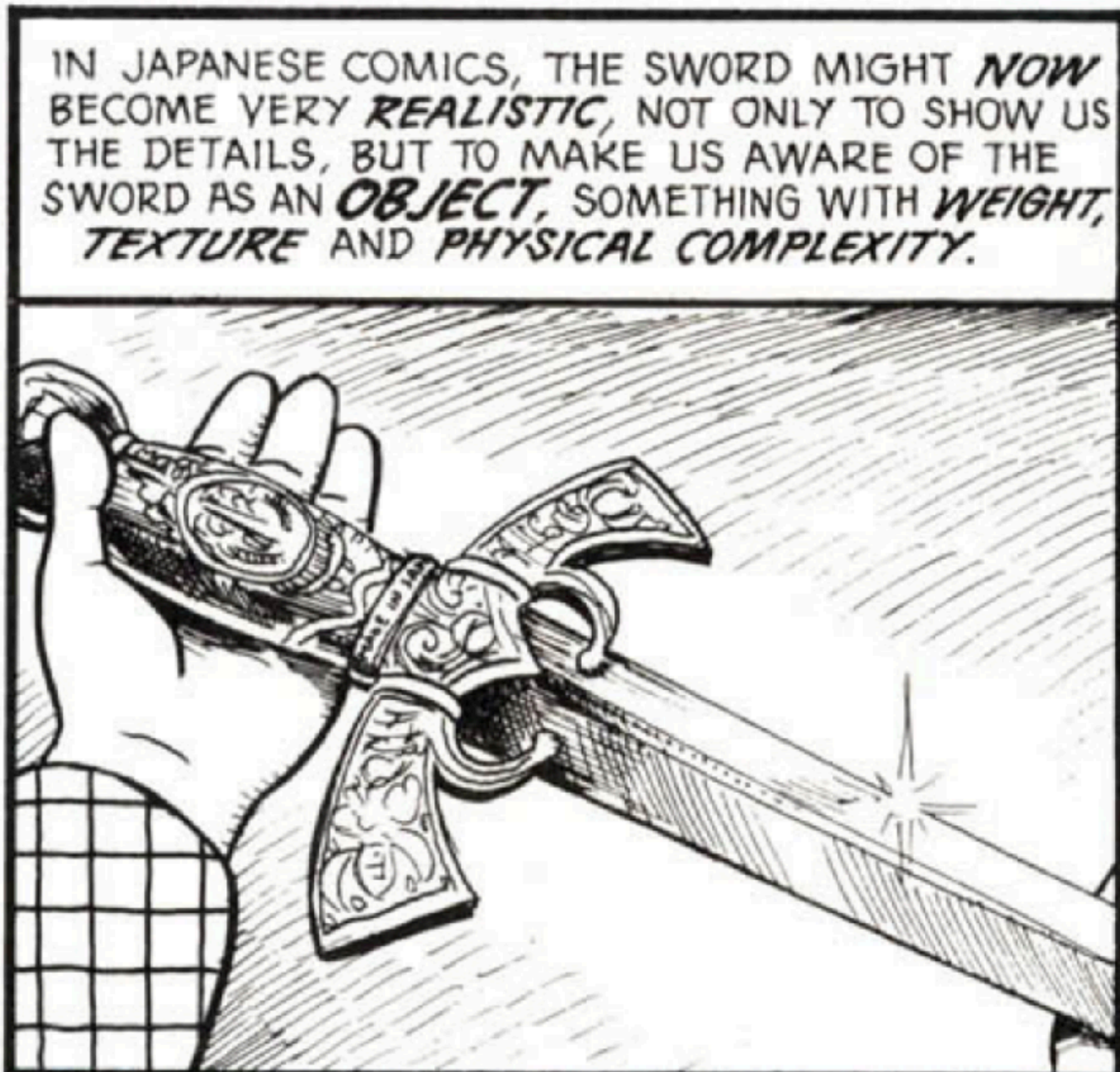
IN THIS AND IN *OTHER WAYS*, COMICS IN



Scott McCloud. *Understanding Comics*. 1993



BUT  
SUPPOSE  
I NOTICE SOME  
**MYSTERIOUS  
WRITING** CARVED  
ON THE SWORD'S  
**HILT.**



IN JAPANESE COMICS, THE SWORD MIGHT *NOW*  
BECOME VERY *REALISTIC*, NOT ONLY TO SHOW US  
THE DETAILS, BUT TO MAKE US AWARE OF THE  
SWORD AS AN **OBJECT**, SOMETHING WITH *WEIGHT*,  
*TEXTURE* AND *PHYSICAL COMPLEXITY*.



IN THIS AND IN *OTHER  
WAYS*, COMICS IN  
JAPAN HAVE EVOLVED  
VERY *DIFFERENTLY*  
FROM THOSE IN THE WEST.

WE'LL RETURN  
TO THESE DIFFERENCES  
SEVERAL TIMES  
DURING THIS BOOK.



# WARNING - ADVERTENCIA

AUTORIDAD DE ENERGIA ELECTRICA



VOLAR CHIRINGAS  
PROXIMO A LINEAS  
ELECTRICAS ES **PELIGROSO**

# Realism risks incorrect interpretation of details

 **WARNING - ADVERTENCIA**

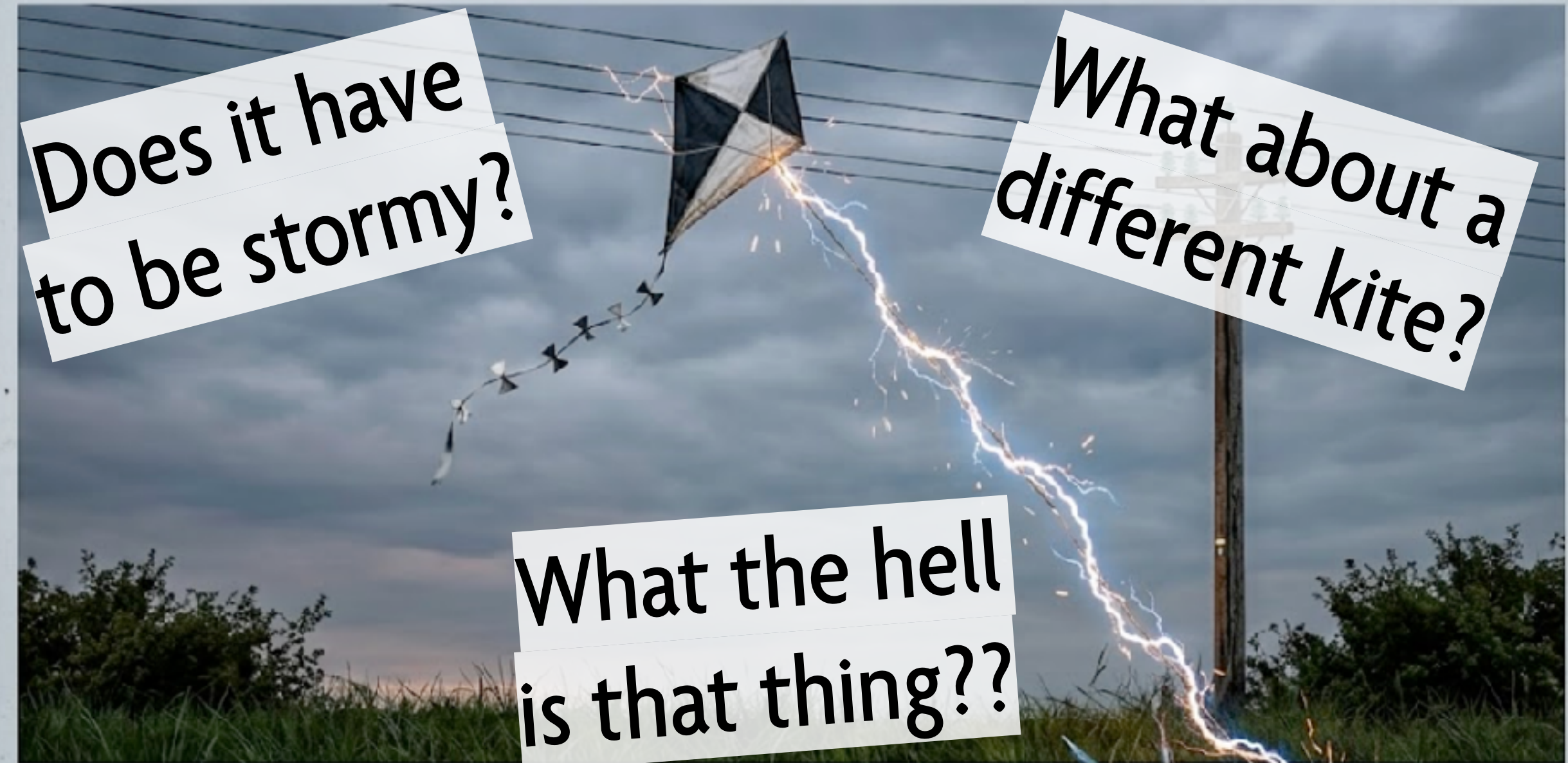
AUTORIDAD DE ENERGIA ELECTRICA



**VOLAR CHIRINGAS  
PROXIMO A LINEAS  
ELECTRICAS ES PELIGROSO**

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AUTORIDAD DE ENERGIA ELECTRICA

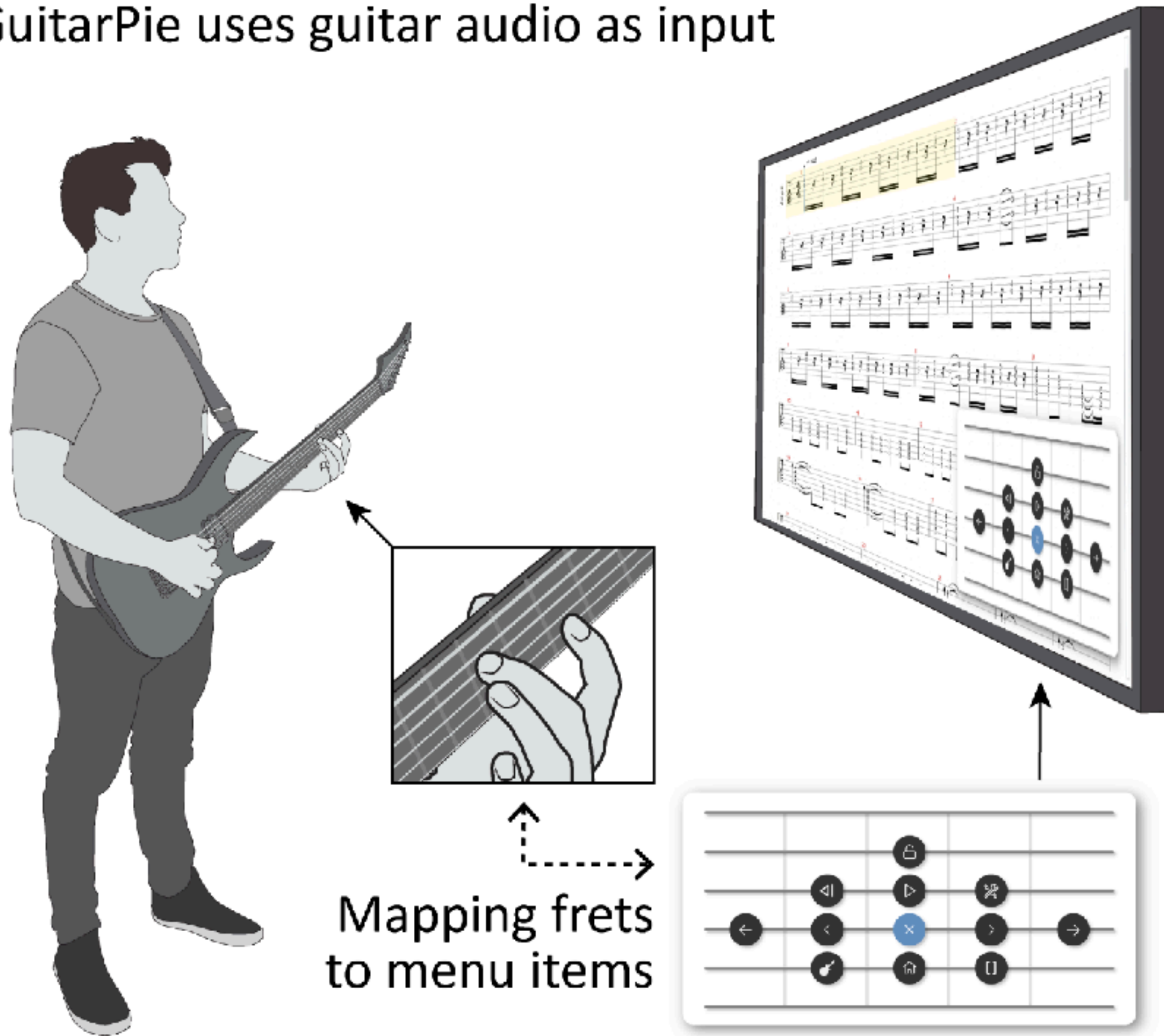


**VOLAR CHIRINGAS  
PROXIMO A LINEAS  
ELECTRICAS ES PELIGROSO**

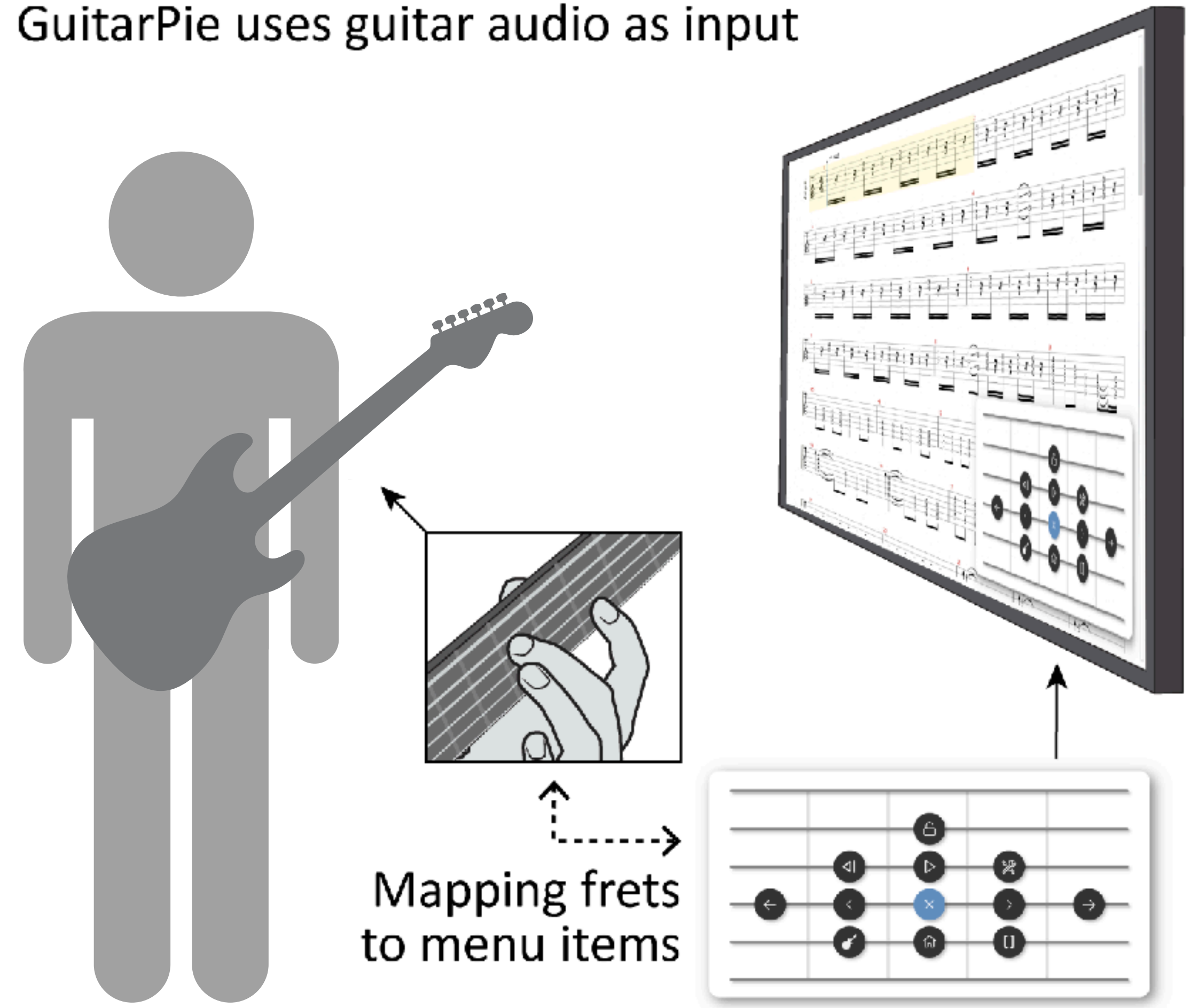


# Appropriate level of abstraction depends on context

B) GuitarPie uses guitar audio as input

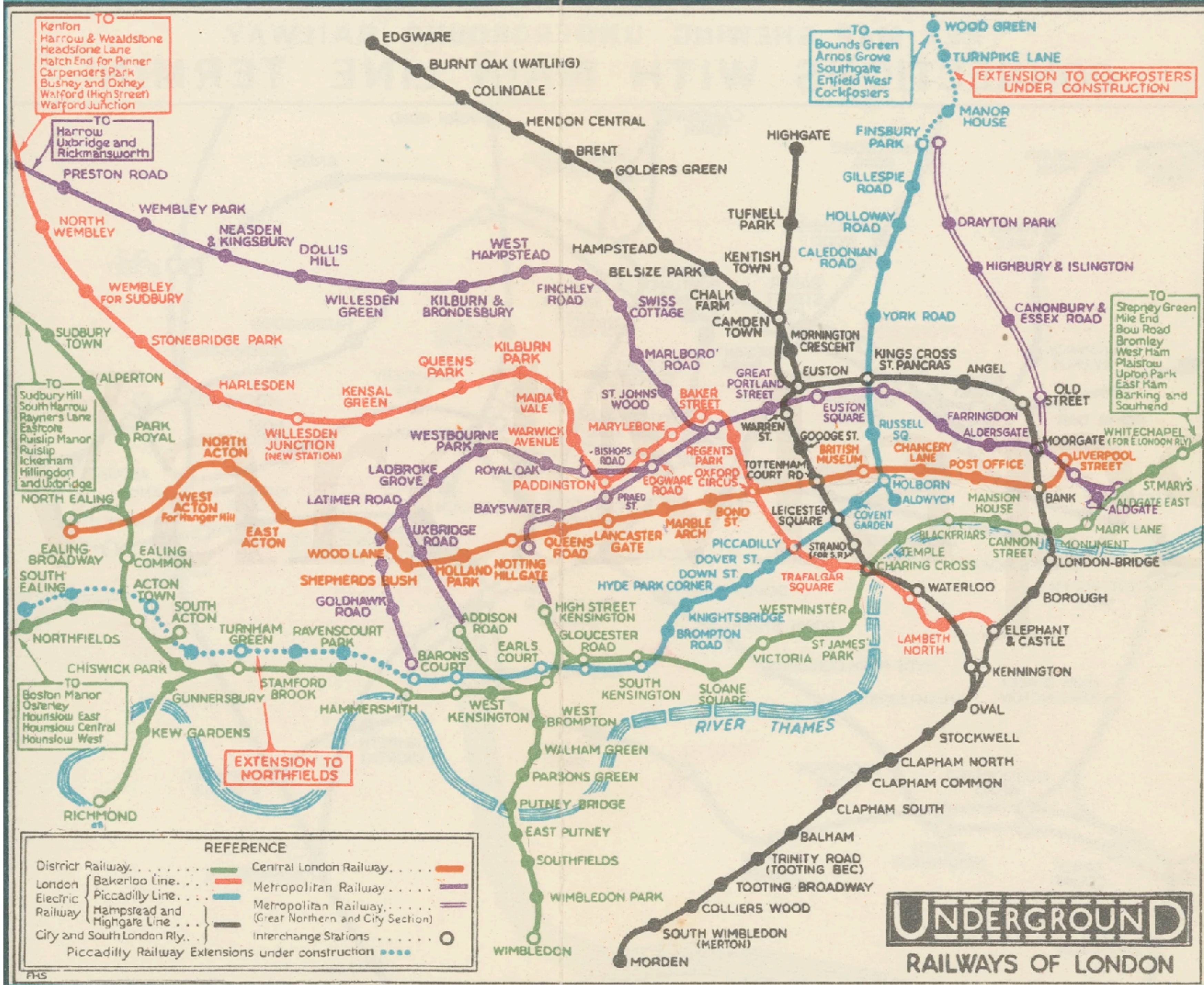


B) GuitarPie uses guitar audio as input



**Diagrams are about functional  
distortion**

# Map of the London Underground, 1931

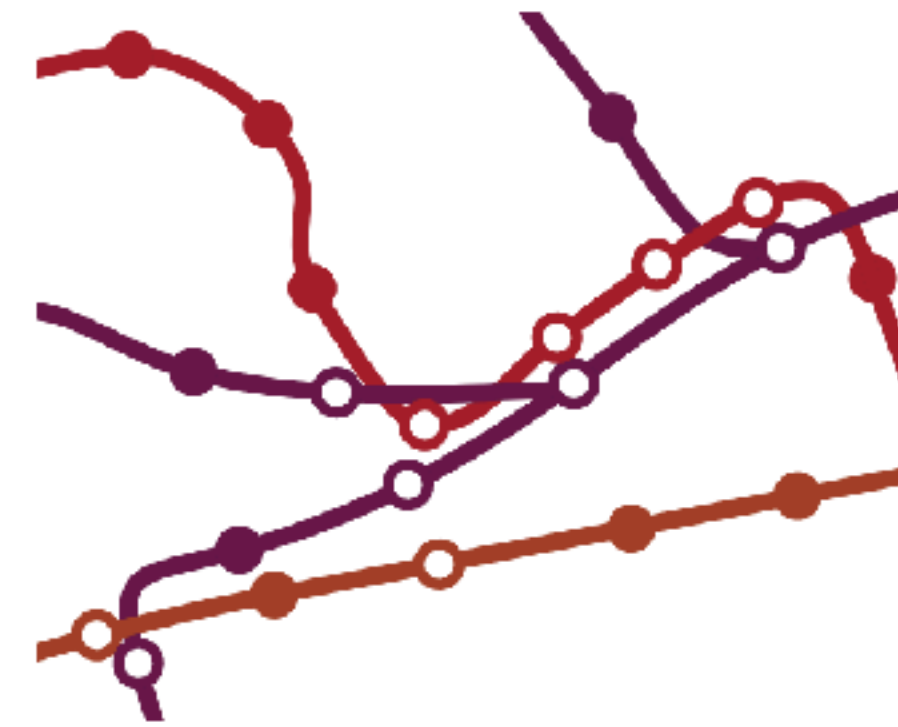


# Harry Beck's "octolinear" map, 1933

"If you're going underground, why do you need to bother about geography? It's not so important. Connections are the thing."



# Roberts' principles for effective schematic maps



1: geographical reality



2: Henry Beck's 1933 configuration

## Simplicity:

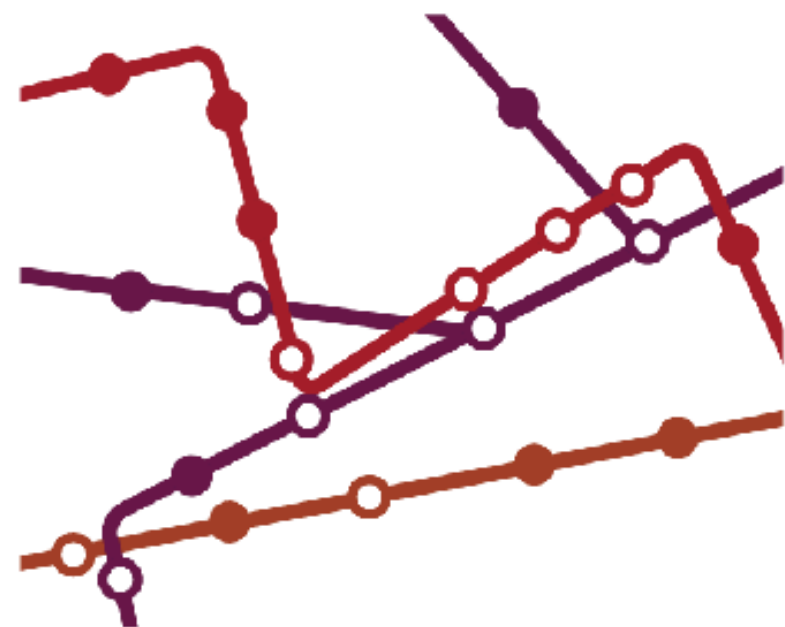
Individual trajectories are easy to follow



3: poor simplicity

## Coherence:

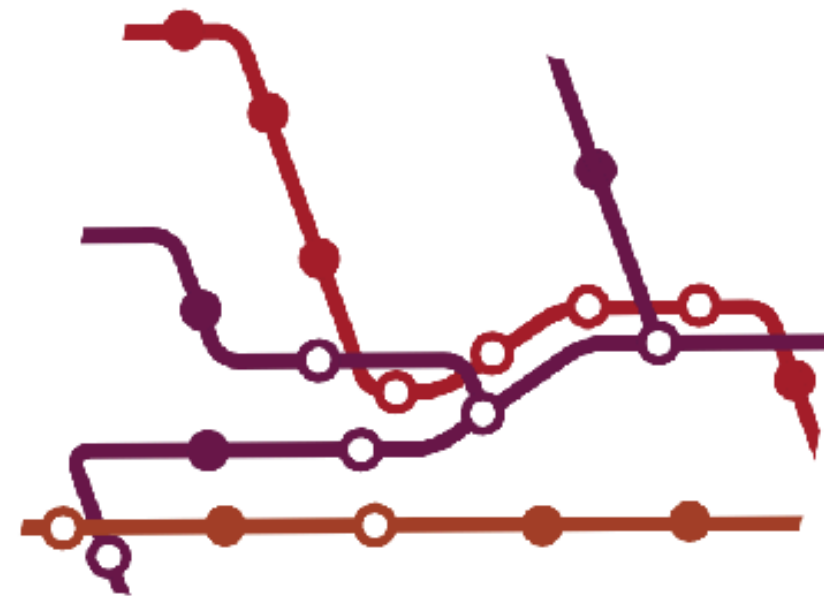
Map consists of regular, identifiable shapes



4: poor coherence

## Harmony:

Map is aesthetically pleasing to the eye



5: poor harmony

## Balance:

Stations are even across the map



6: poor balance

## Topographicity:

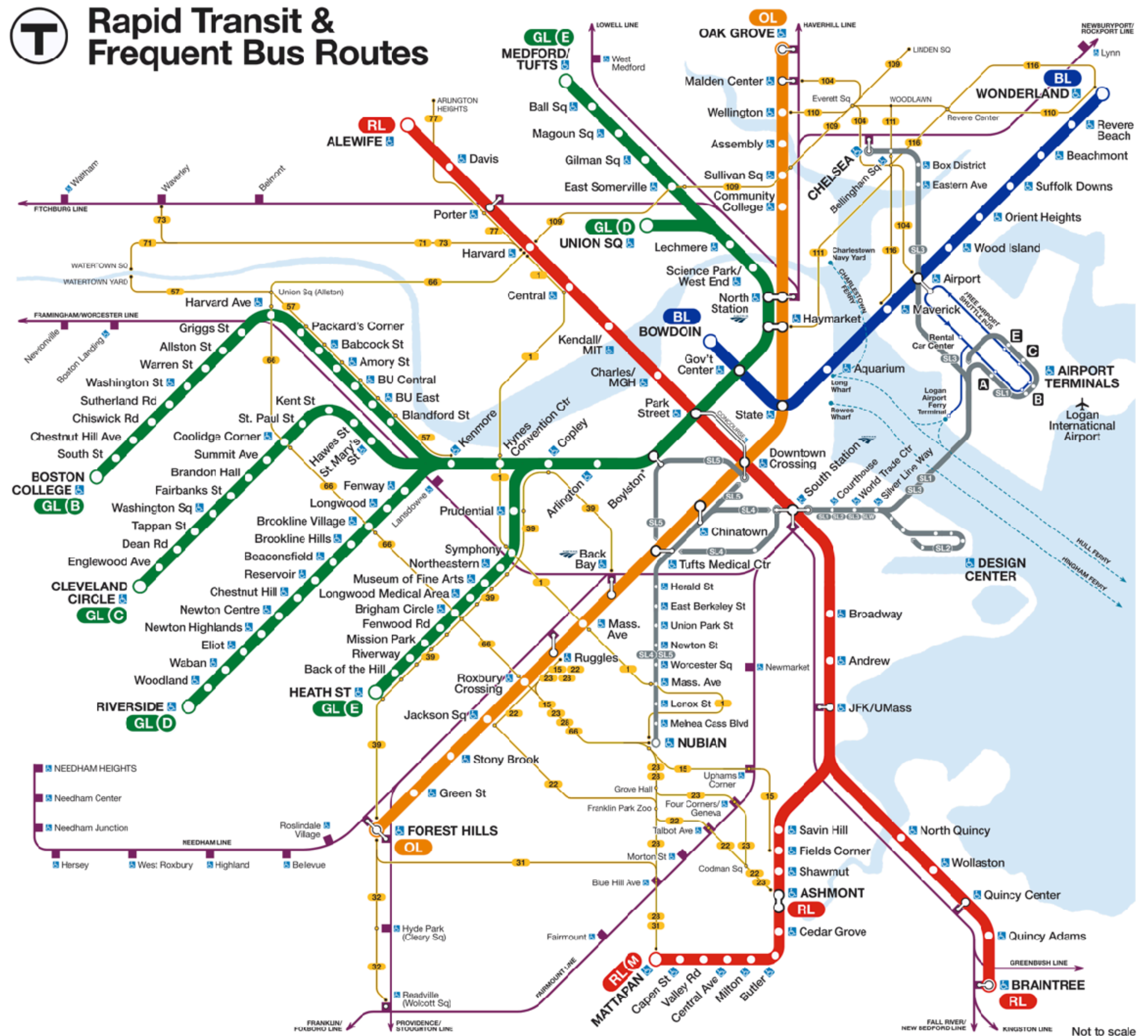
Map is not too heavily distorted wrt geography

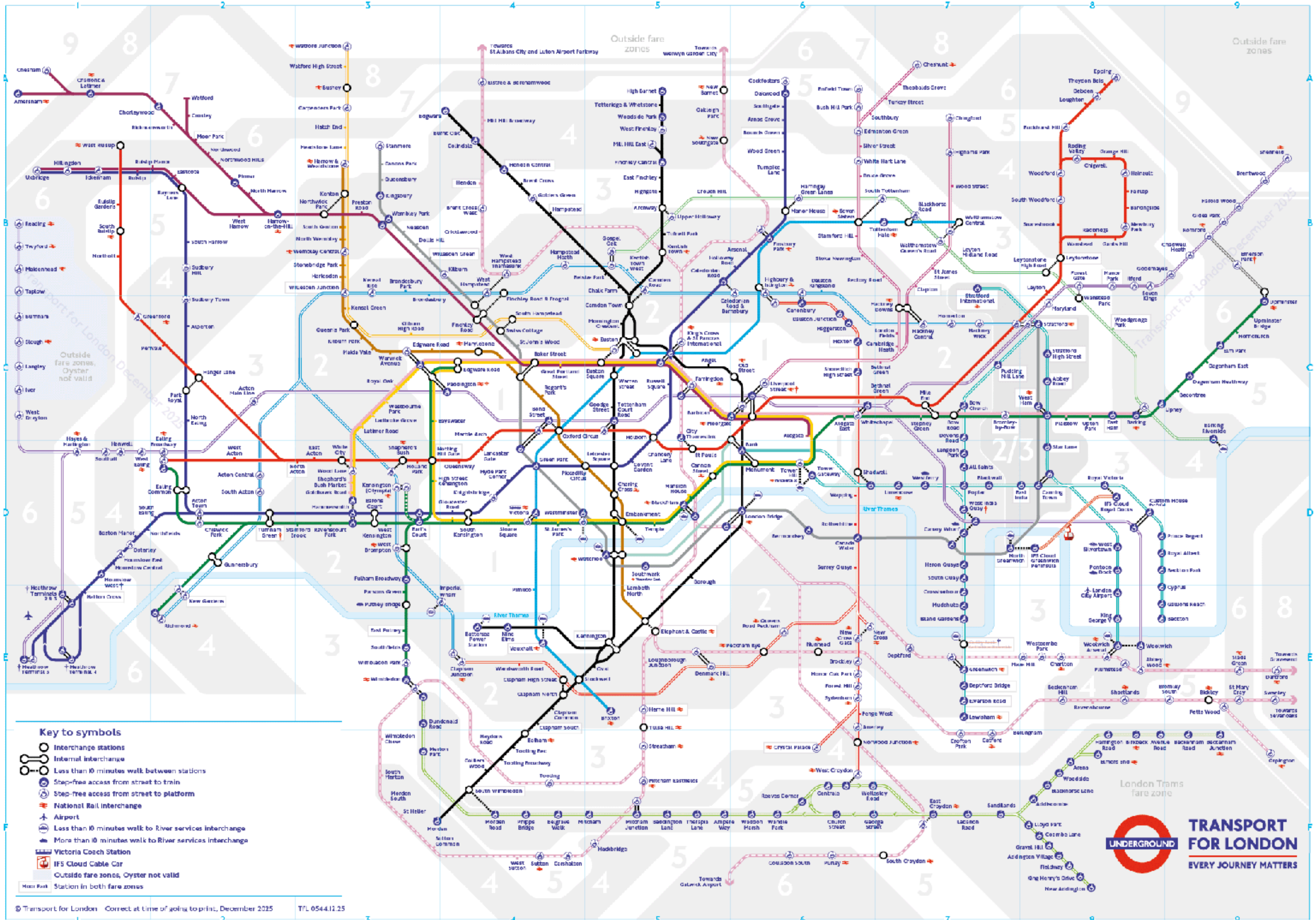


7: poor topographicity

# The octolinear transit map is everywhere!

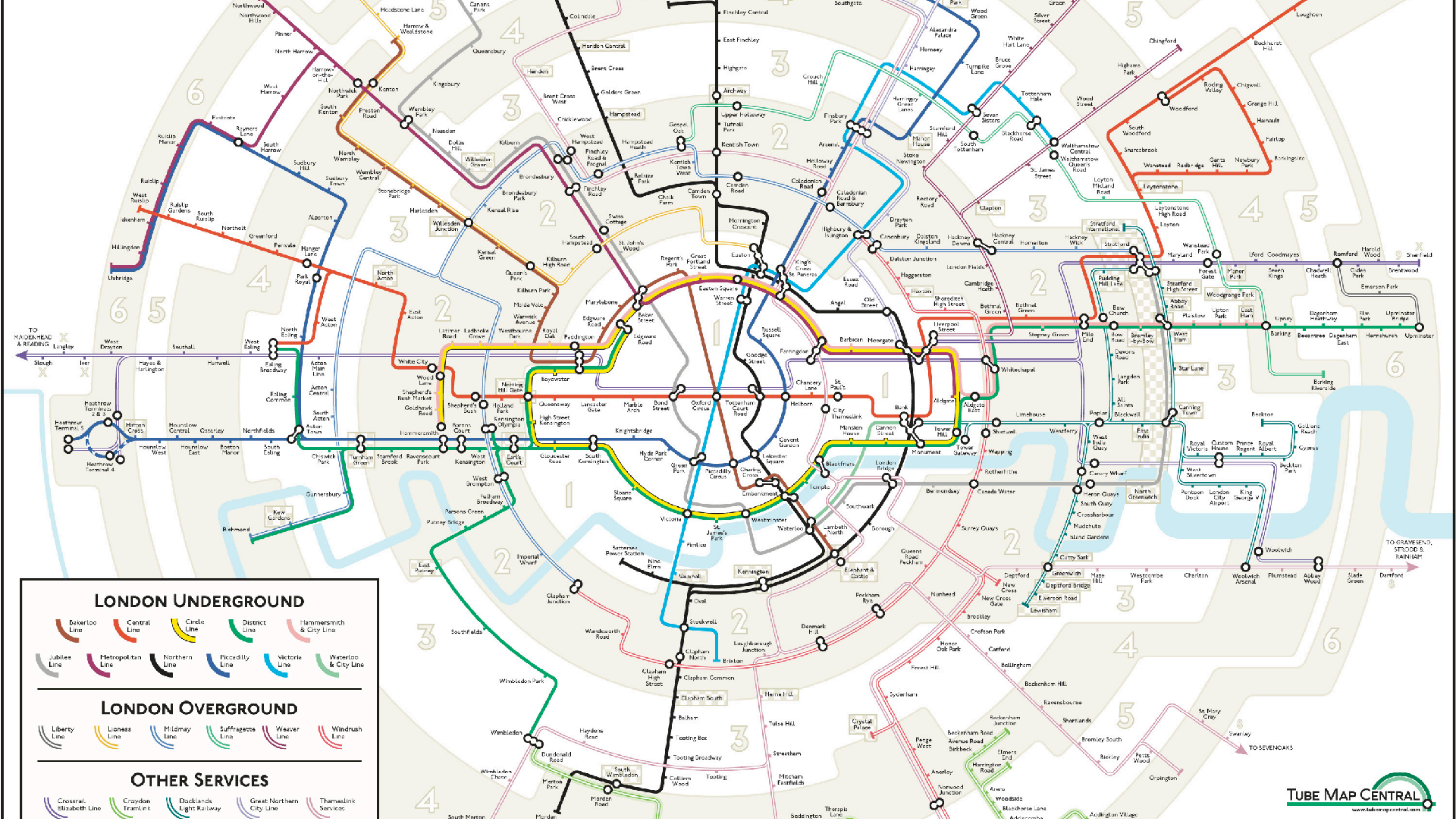
Boston MBTA map, 2026





**But does it scale?**

**London Underground map, 2026**



### LONDON UNDERGROUND

- Bakerloo Line
- Central Line
- Circle Line
- District Line
- Hammersmith & City Line
- Jubilee Line
- Metropolitan Line
- Northern Line
- Piccadilly Line
- Victoria Line
- Waterloo & City Line

### LONDON OVERGROUND

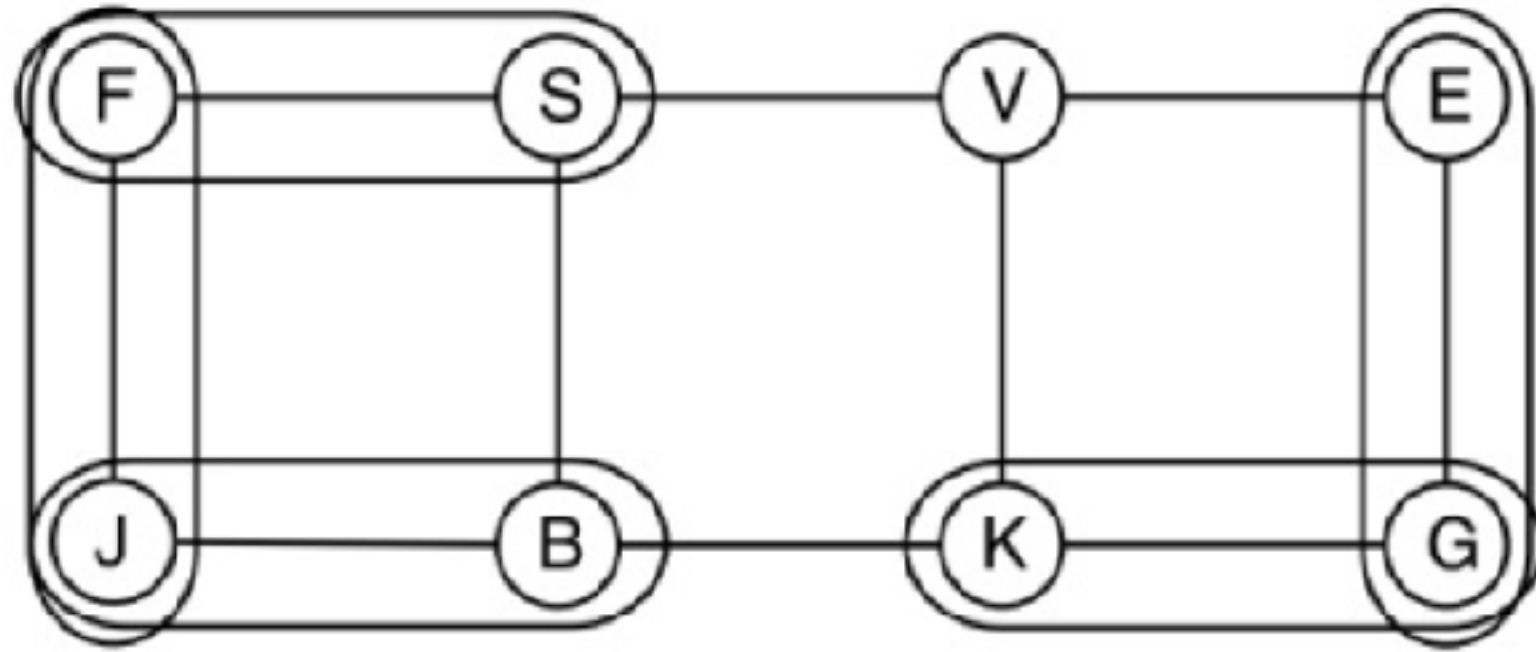
- Liberty Line
- Lioness Line
- Mildmay Line
- Suffragette Line
- Weaver Line
- Windrush Line

### OTHER SERVICES

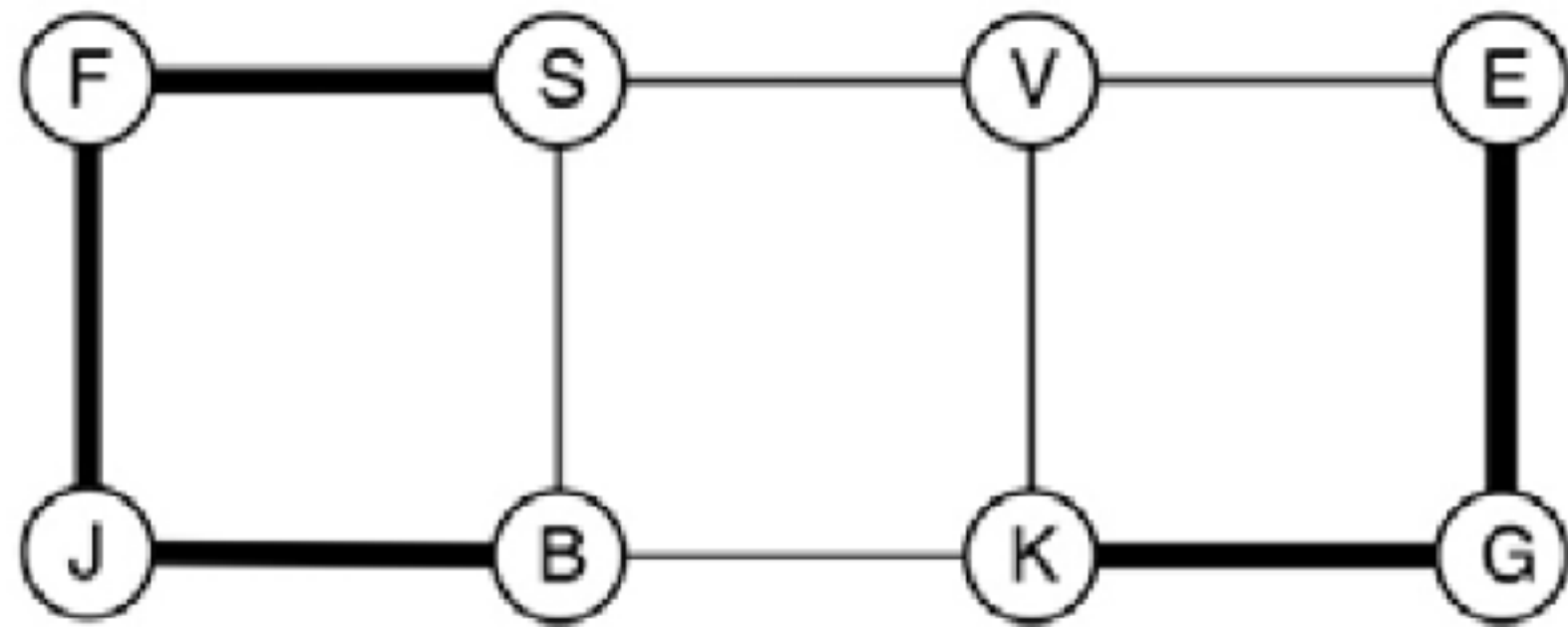
- Crossrail Elizabeth Line
- Croydon Tramlink
- Docklands Light Railway
- Great Northern City Line
- Thameslink Services

**Diagrams are about finding the  
right visual metaphor**

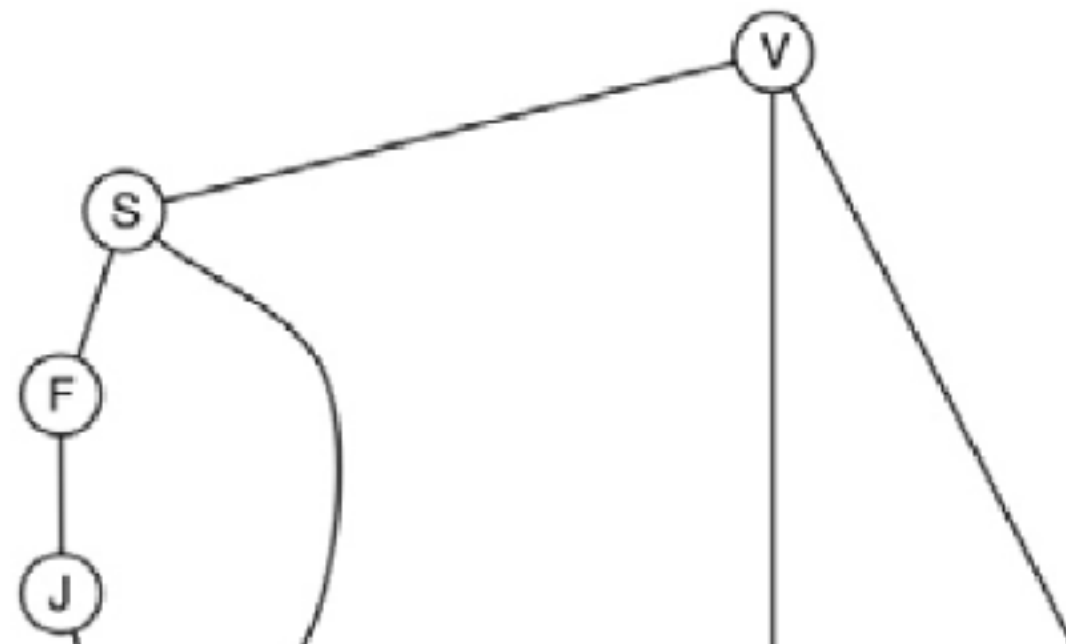
# Containment



# Thickness



# Distance

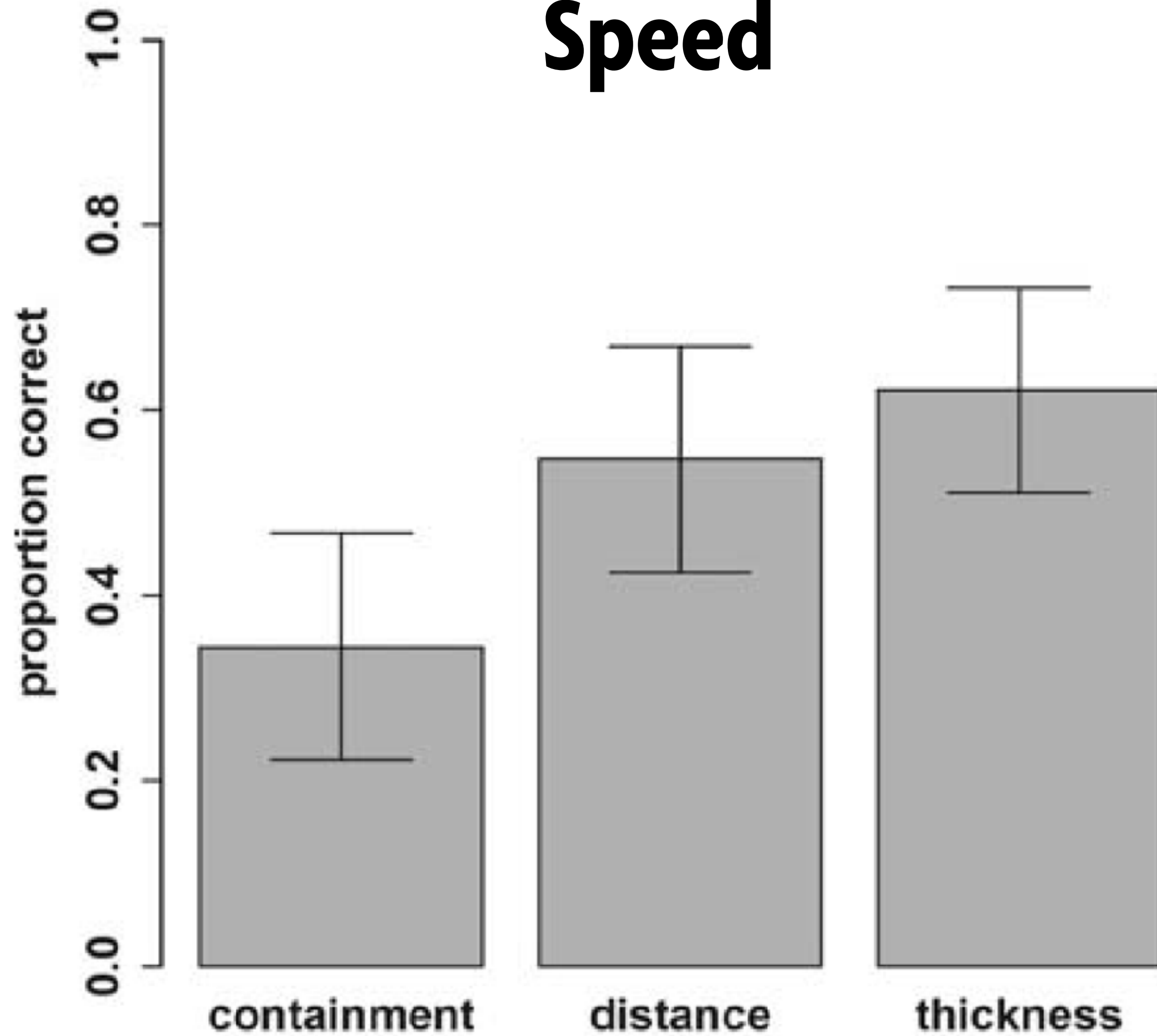


S needs to transmit to E.

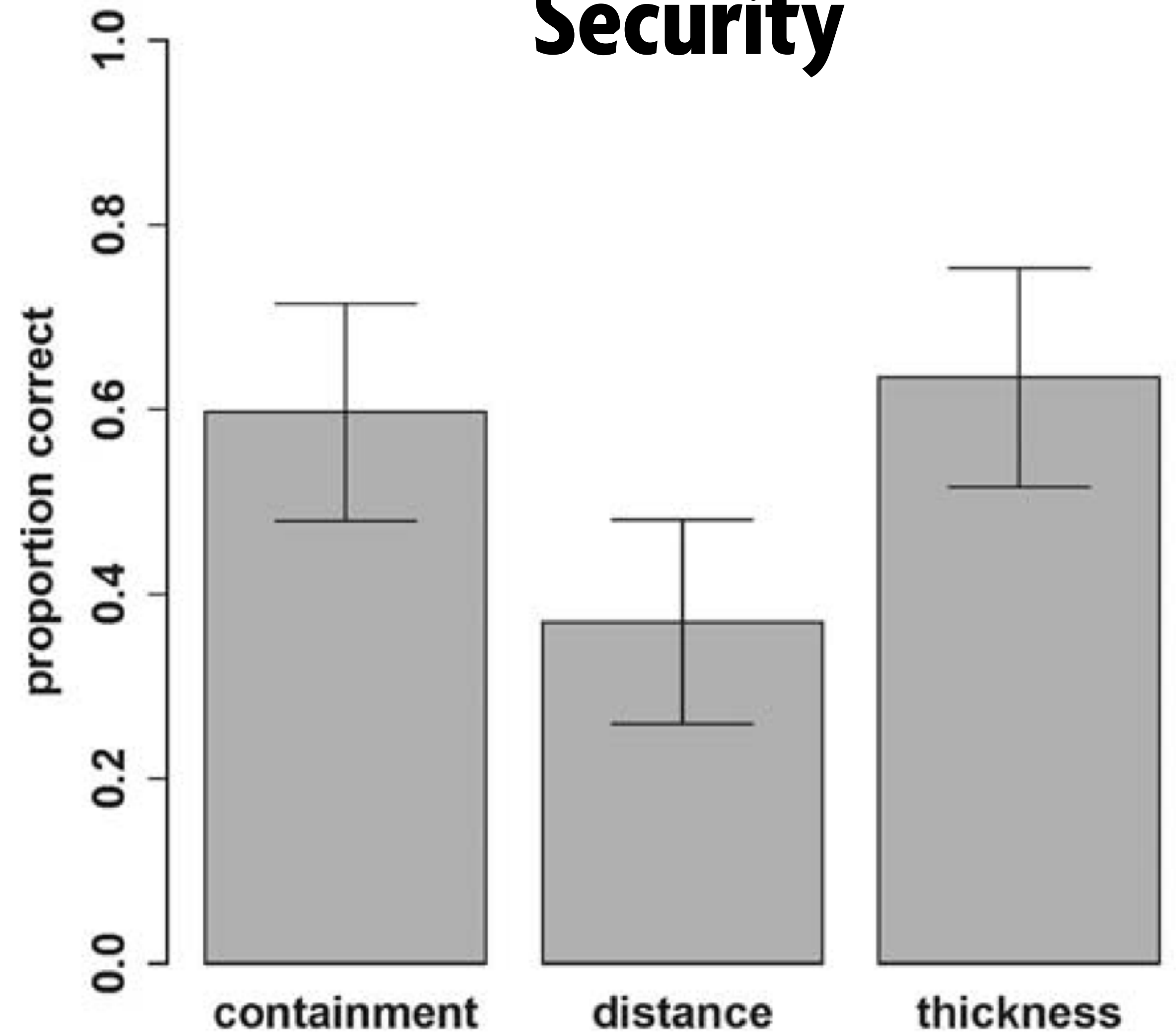
1. S and F communicate with each other six times a second. [...] Along which pathway will the message arrive first?
2. S and F are part of the same system, and six times as secure. [...] Which pathway is the most secure?

# Best representation depends on problem format

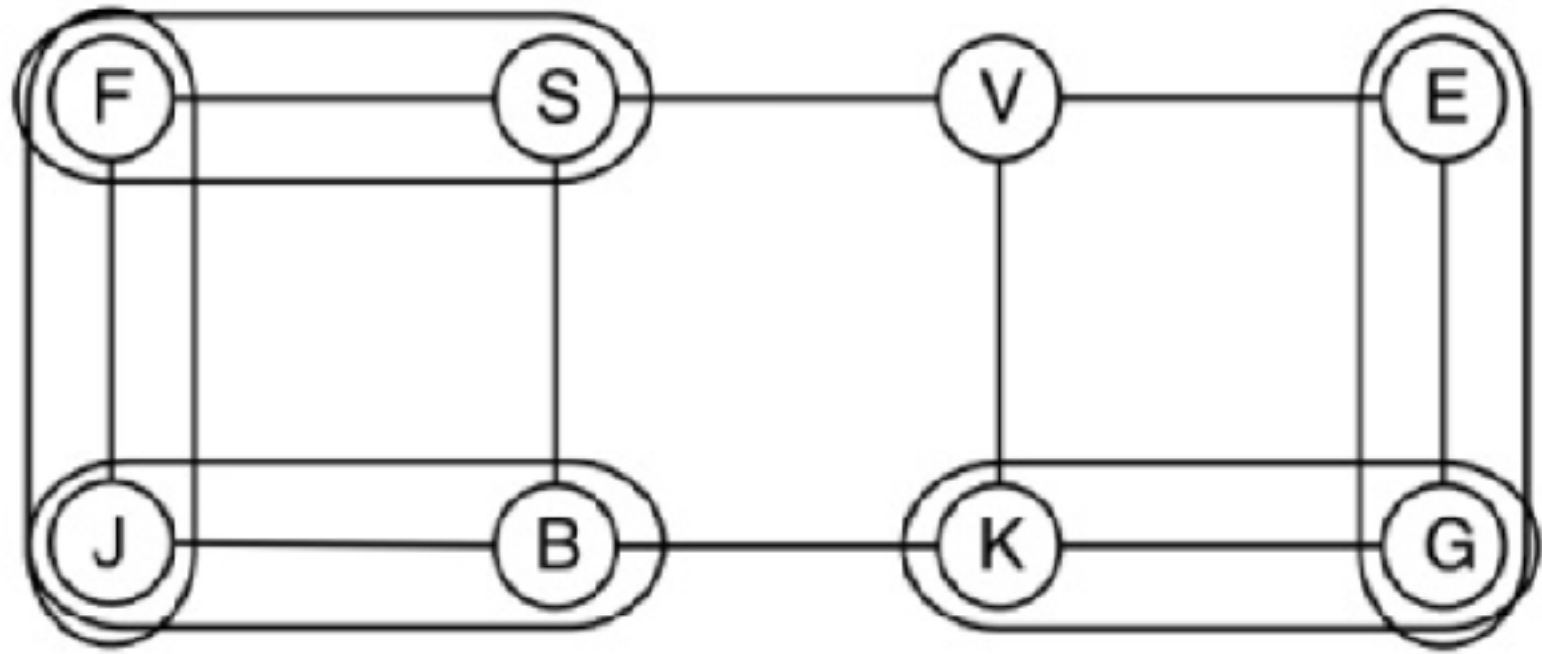
## Speed



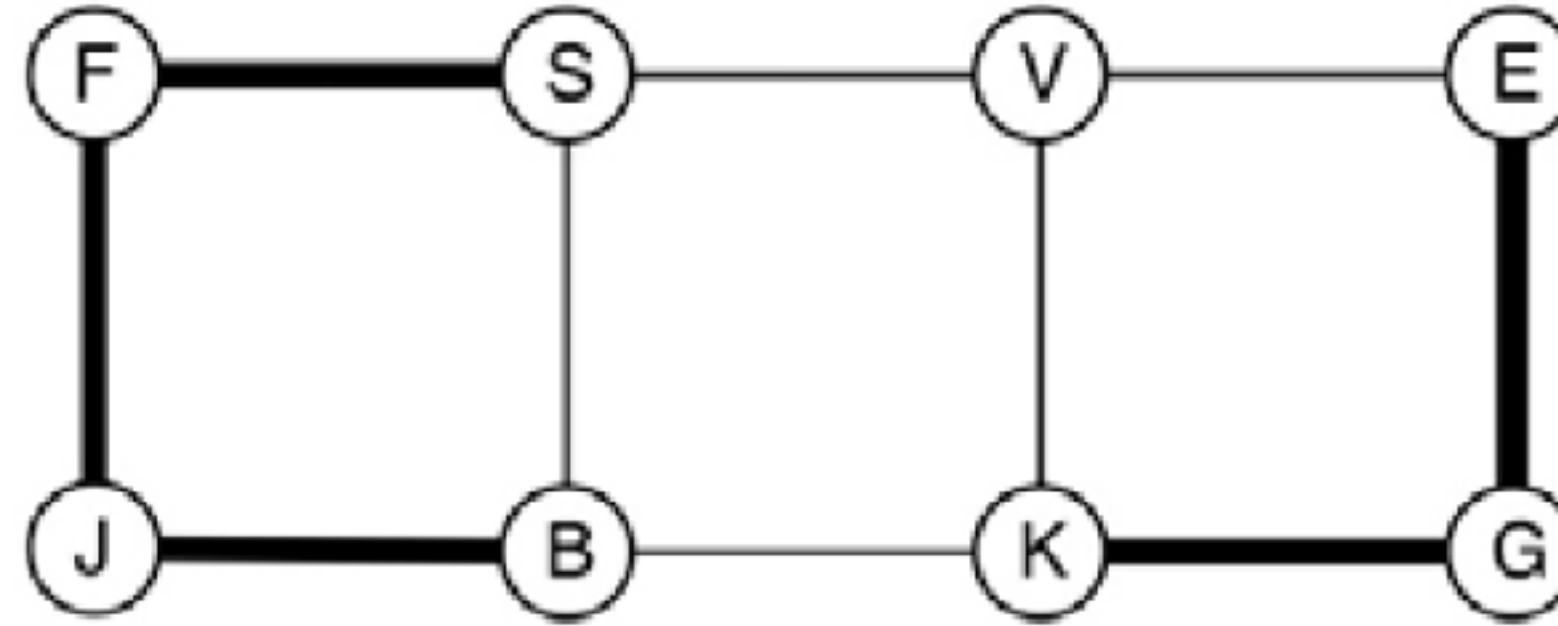
## Security



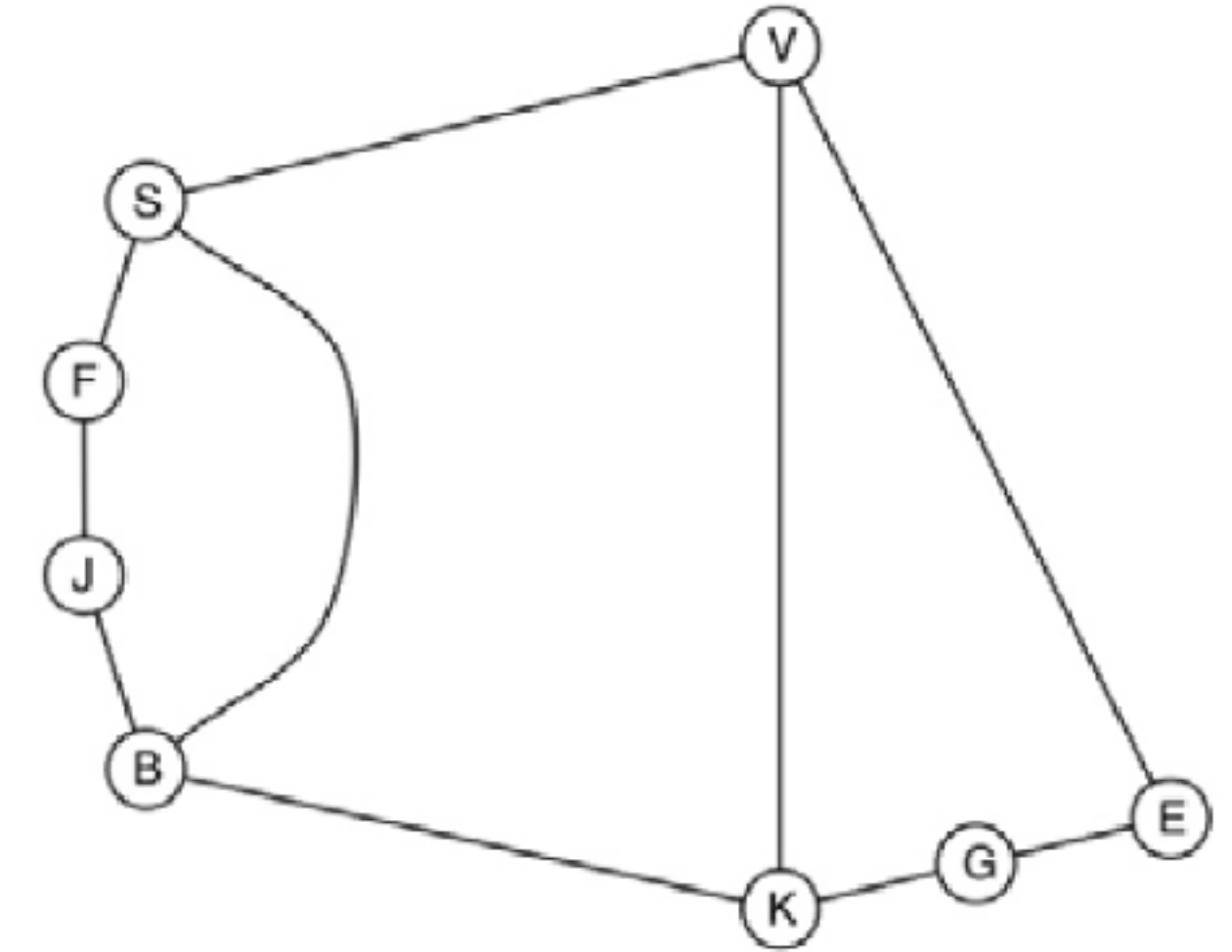
# Containment



# Thickness



# Distance



“communicate more often”

“part of the same system”

**Congruence:** “The structure and content of the external representation should correspond to the desired structure and content of the internal representation.”