Evaluation and Review

DSC 106: Data Visualization

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UC San Diego

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slido.com

#5829

Announcements

Final Project video due this Friday.

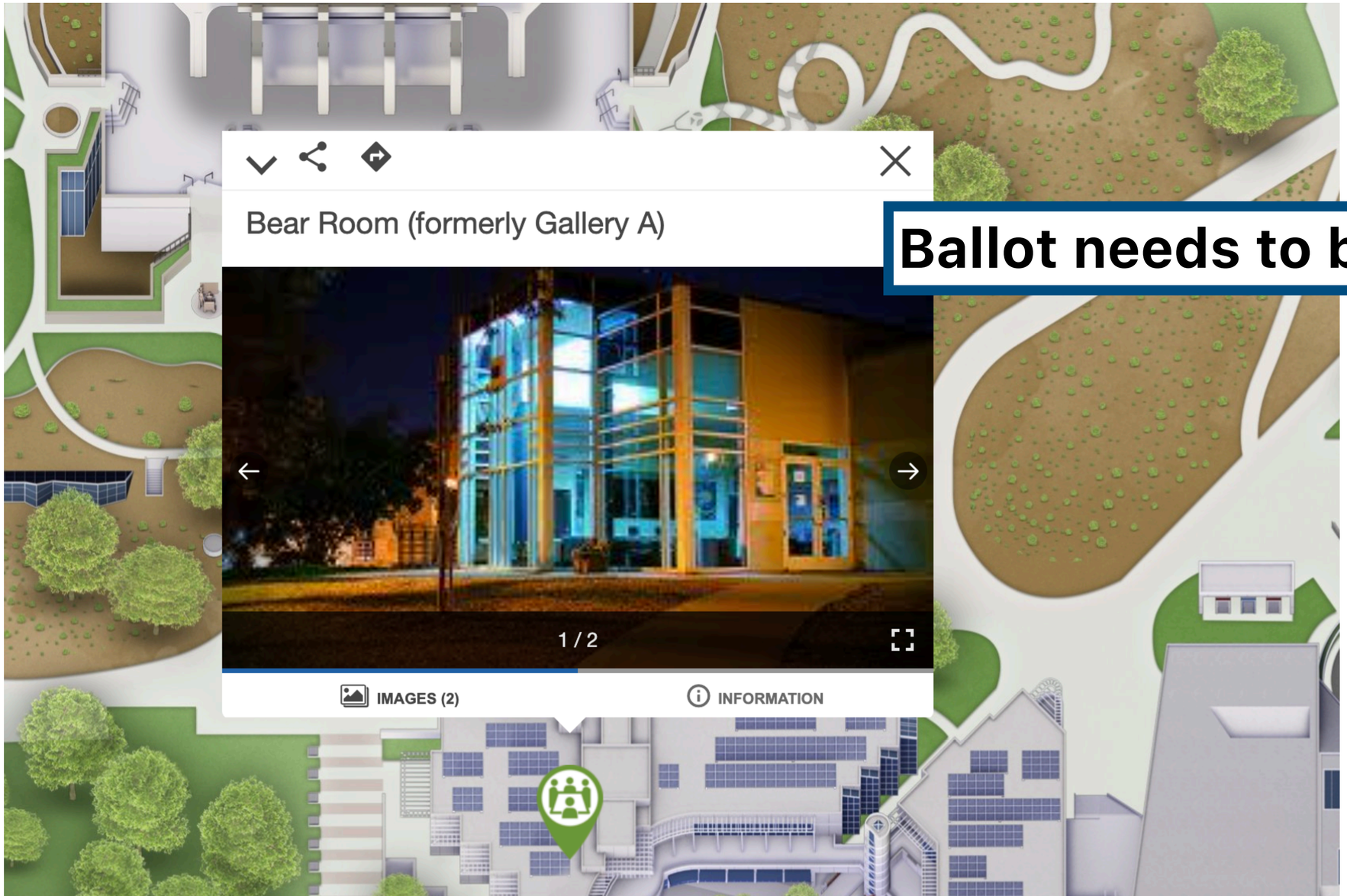
This is the last lecture (of content).

Thu Mar 7: Final Project feedback session 3:30pm-5:30pm

Tue Mar 12: Final Project video showcase

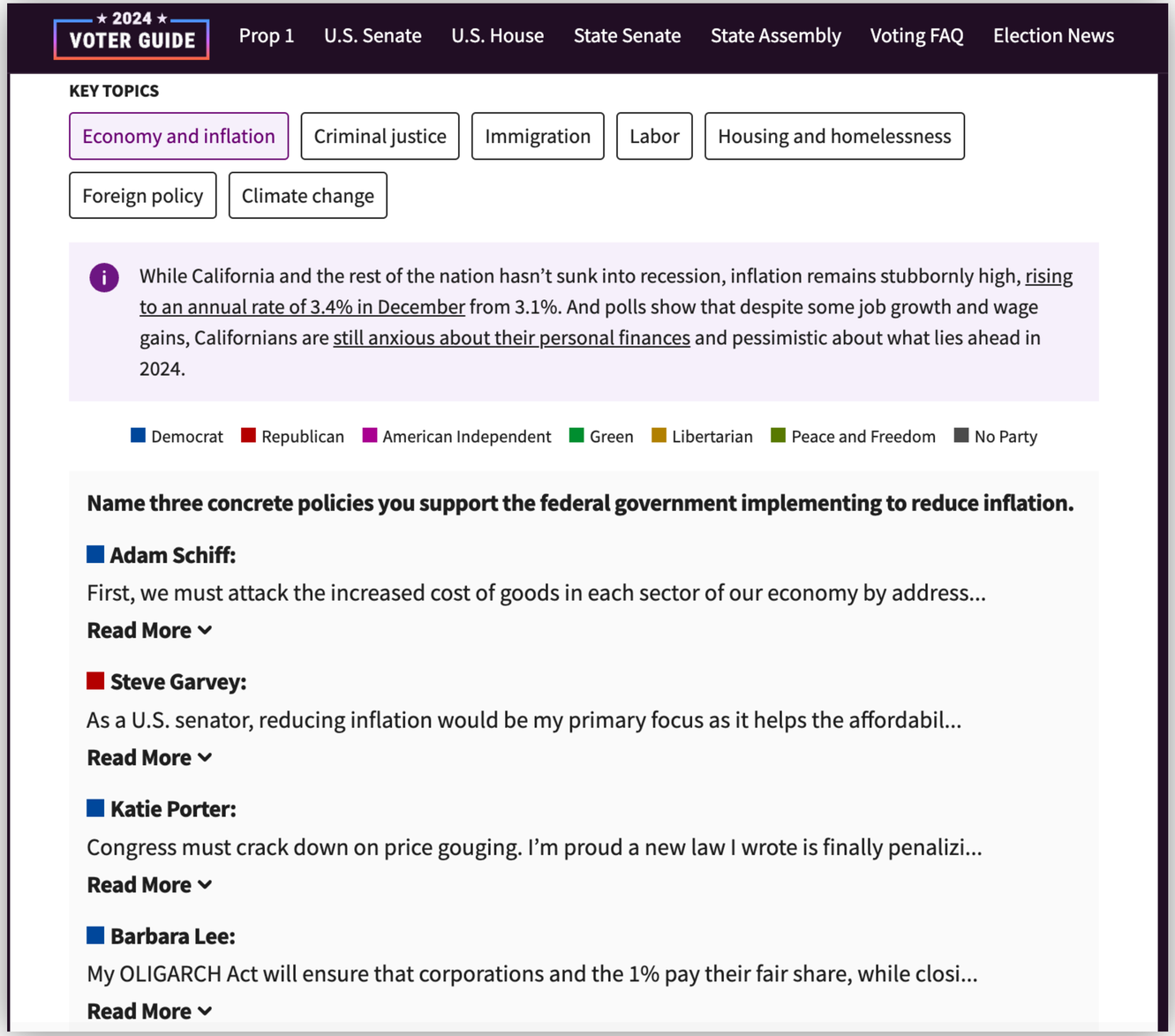
Tue Mar 14: Final Project feedback session 3:30pm-5:30pm

Go Vote!



Ballot needs to be in by 8pm today!

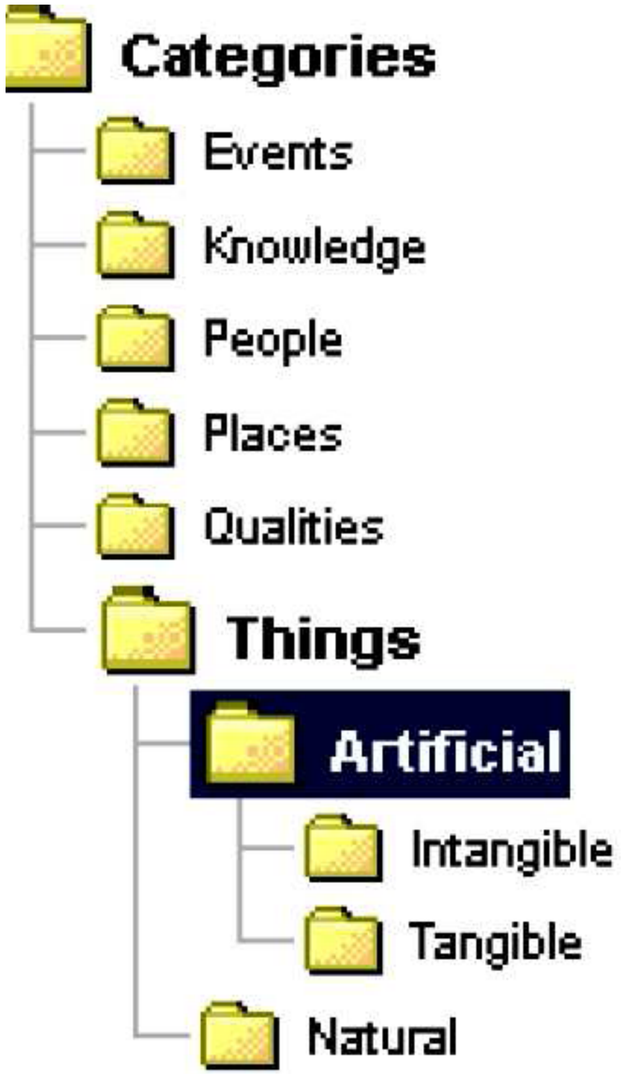
Cal Matters



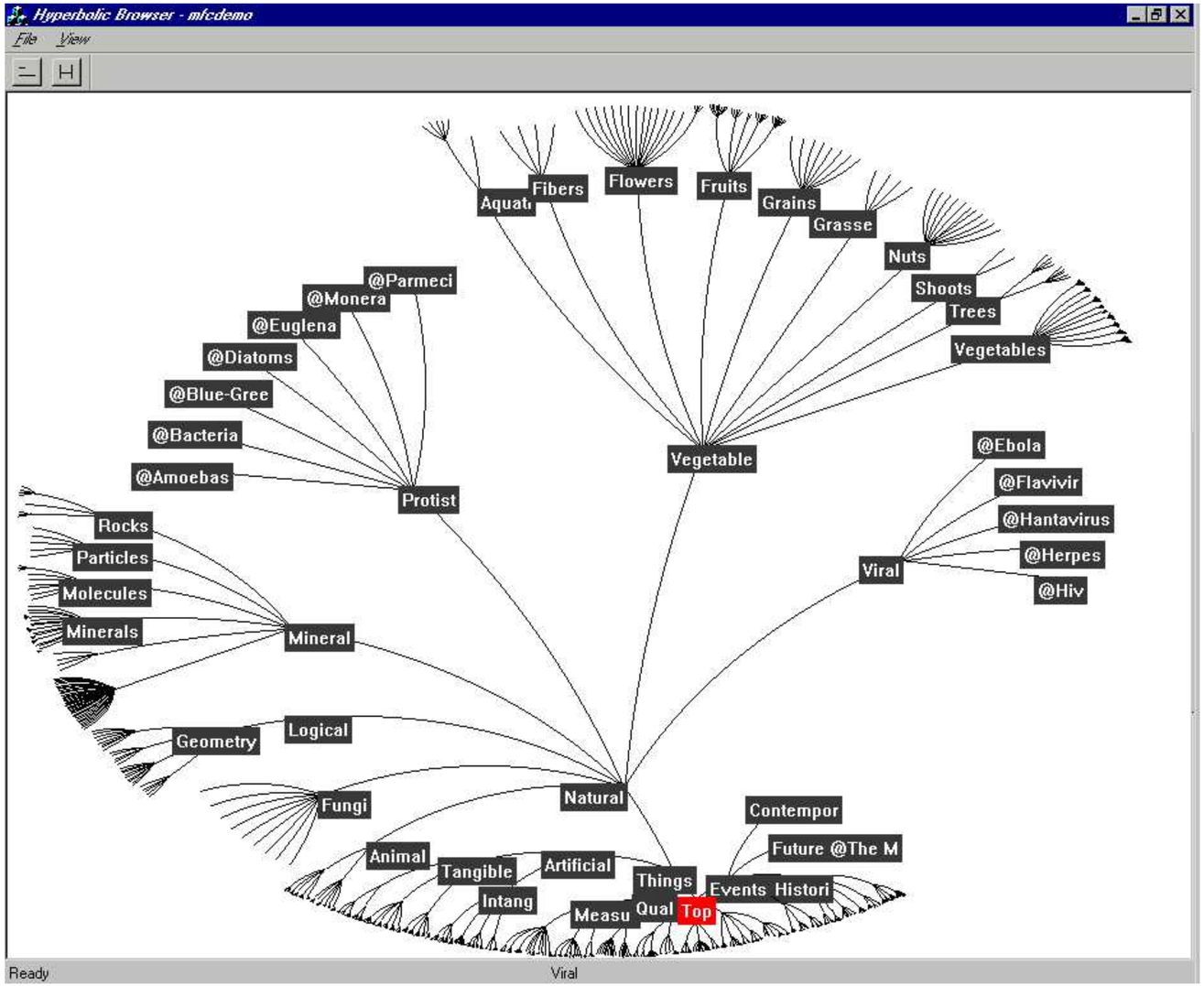
Non-partisan resource:

https://calmatters.org/california-voter-guide-2024/

How do we determine whether a visualization is *effective*?


Categories
Events
Knowledge
People
Places
Qualities
Things
Artificial
Intangible
Tangible
Natural

vs


Hyperbolic Browser - mfcdemo
File View
Aquat
Fibers
Flowers
Fruits
Grains
Grasse
Nuts
Shoots
Trees
Vegetables
Vegetable
@Parmeci
@Monera
@Euglena
@Diatoms
@Blue-Gree
@Bacteria
@Amoebas
Protist
@Ebola
@Flavivir
@Hantavirus
@Herpes
@Hiv
Viral
Rocks
Particles
Molecules
Minerals
Mineral
Geometry
Logical
Fungi
Natural
Contempor
Future @The M
Animal
Tangible
Artificial
Things
Events
Histori
Intang
Measu
Qual
Top
Ready
Viral

Evaluation Methods

Inspection or Principled Rationale
Apply design heuristics, perceptual principles

Informal User Study
Have people use visualization, observe results

Controlled Experiment
Choose appropriate tasks / users to compare
Choose metrics (time, error, what else?)

Evaluation Methods

Field Deployment or Case Studies
Observation and Interview
Document effects on work practices

Theoretical Analysis
Algorithm time and space complexity

Benchmarks
Performance (e.g., interactive frame rates)
Scalability to larger data sets

Today

Evaluating Trees

Evaluating Spatial Navigation

Data Density of Time Series

Conclusion

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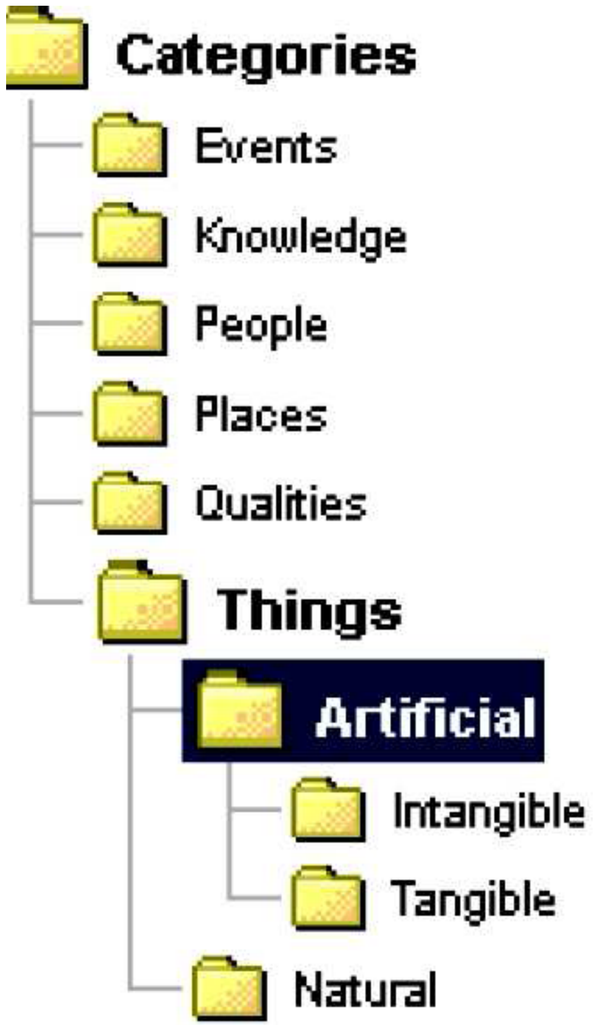
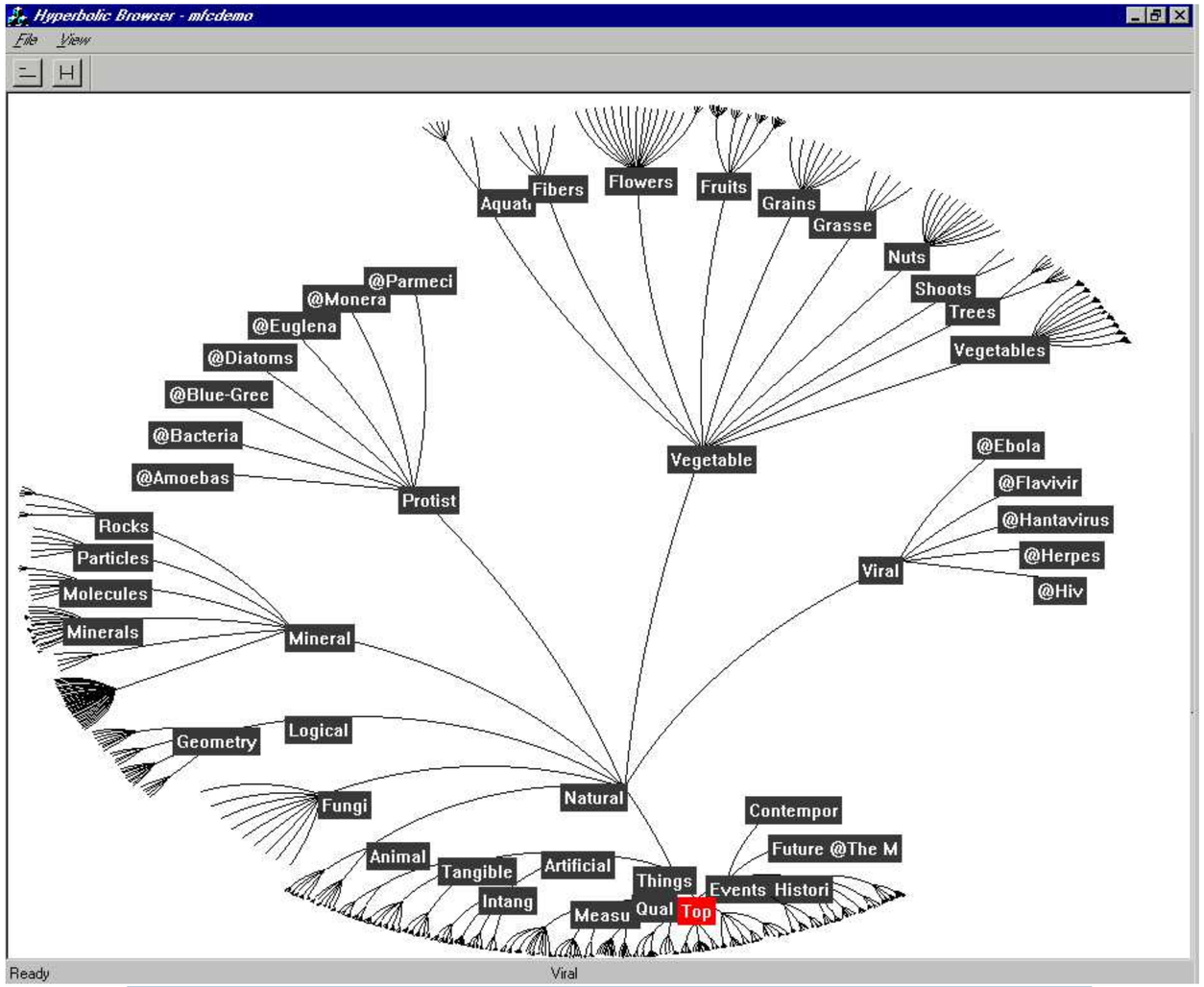
The Great Browse-Off! [CHI 97]

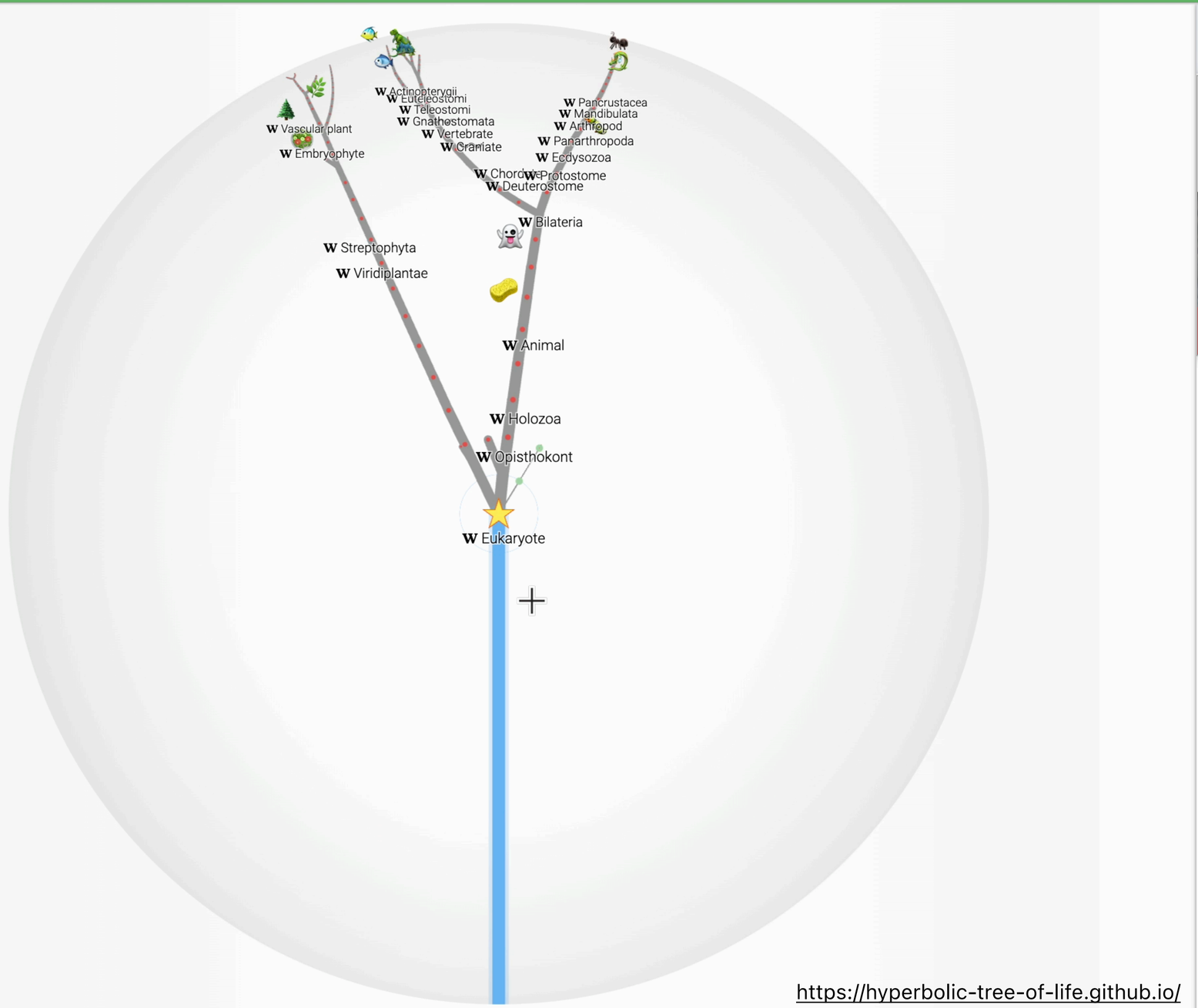


vs



Microsoft File Explorer

Xerox PARC Hyperbolic Tree



https://hyperbolic-tree-of-life.github.io/

WIKIPEDIA

Wiki Loves FOLKLORE

Photograph your local culture, help Wikipedia and win!

Eukaryote

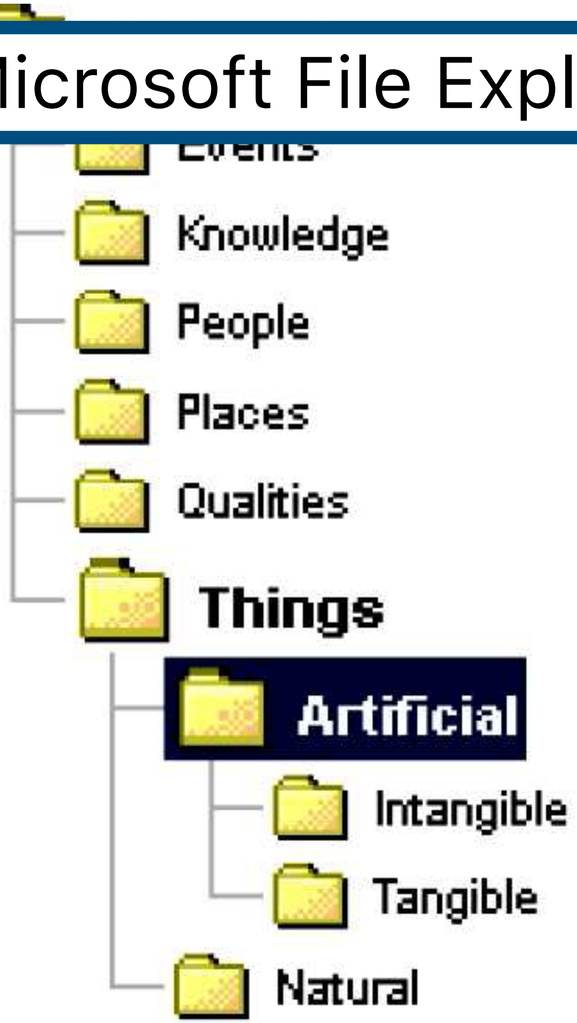
Article Talk

"Eukaryotic cell" redirects here. For the journal, see Eukaryotic Cell (journal).

The **eukaryotes** (/juːˈkærioʊts, -əts/ *yoo-KARR-ee-ohts, -əts*) constitute the domain of **Eukarya**, organisms whose cells have a membrane-bound nucleus. All animals, plants, fungi, and many unicellular organisms are eukaryotes. They constitute a major group of life forms alongside the two groups of prokaryotes: the Bacteria and the Archaea. Eukaryotes represent a small minority of the number of organisms, but given their generally much larger size, their collective global biomass is much larger than that of prokaryotes.

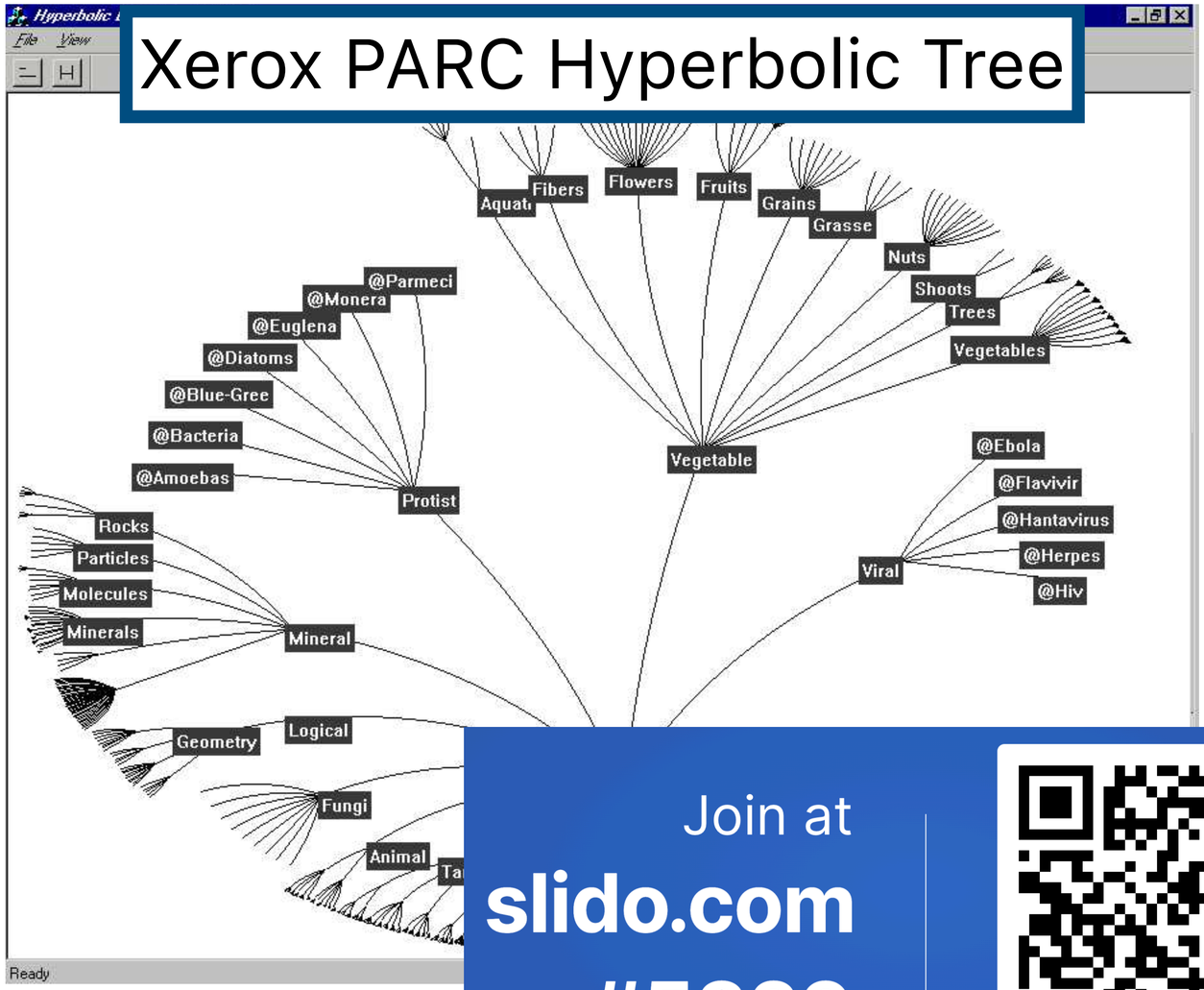
How can we decide if one is better?

Microsoft File Explorer



vs

Xerox PARC Hyperbolic Tree



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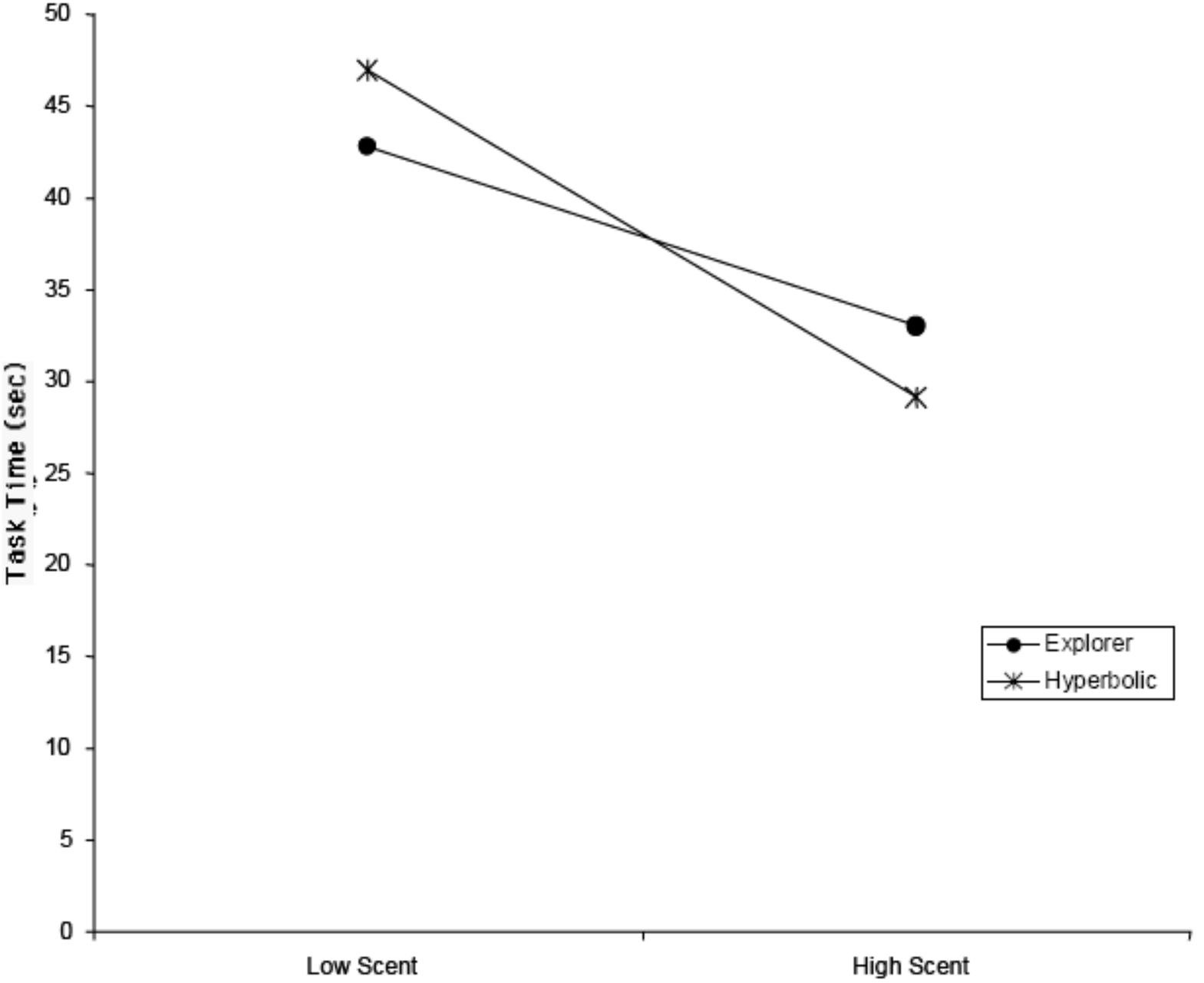
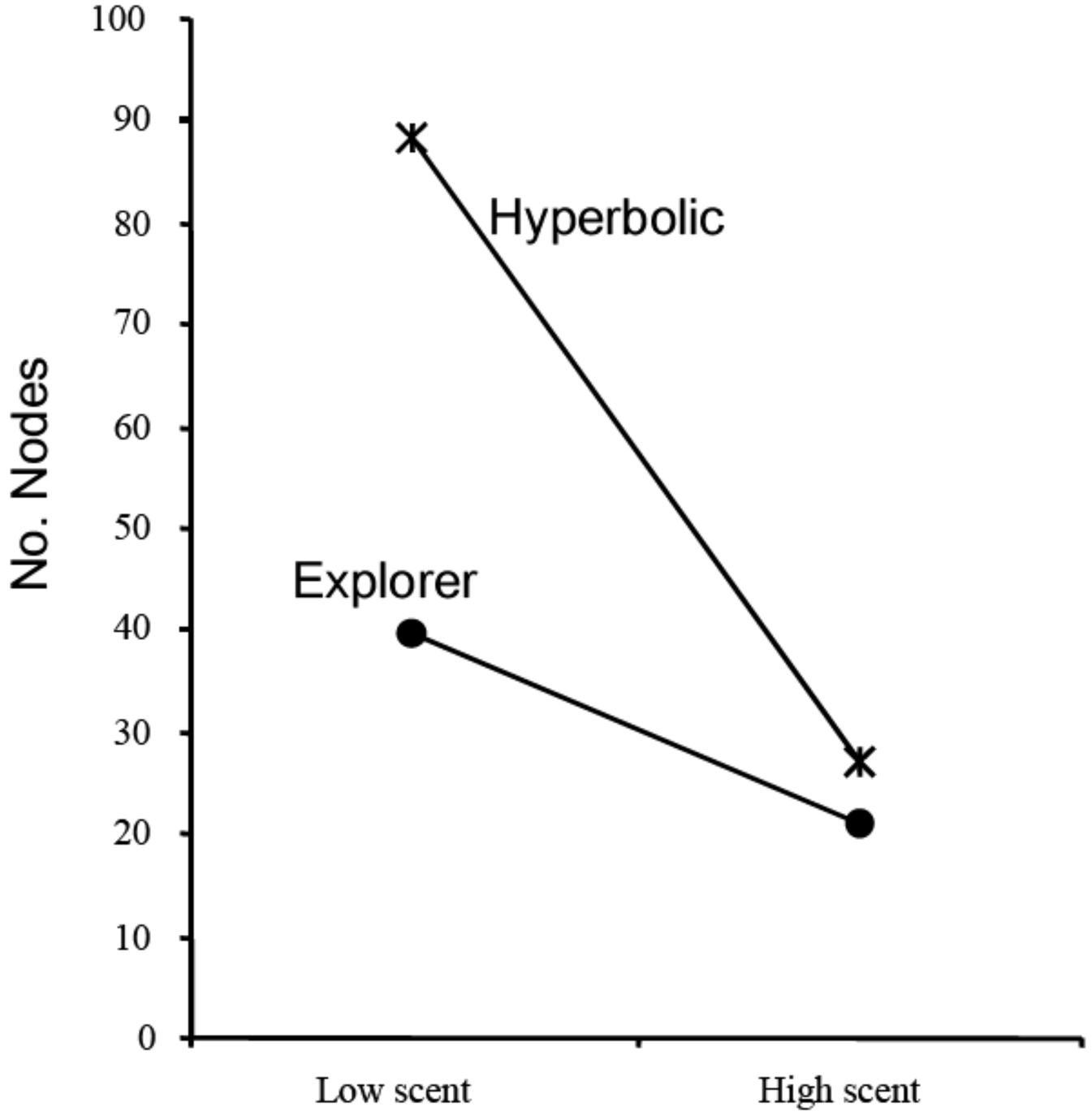
How do users navigate the tree?

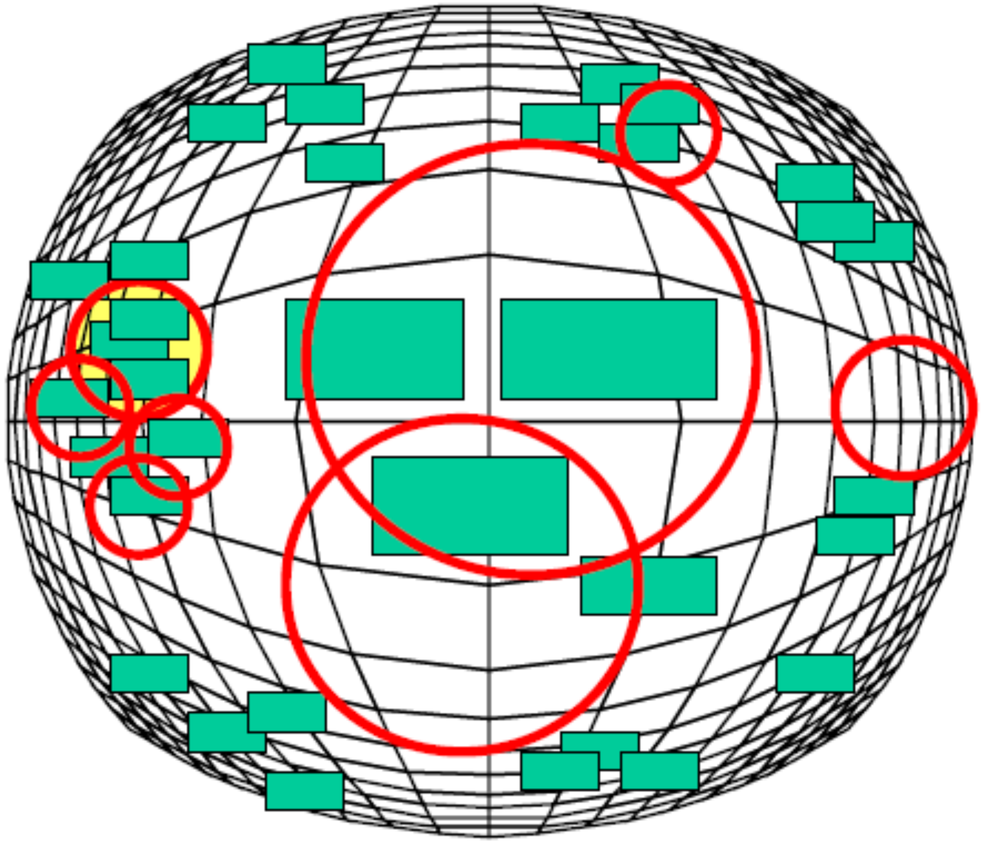
Information Scent: A user's (imperfect) perception of the value, cost, or access path of information sources obtained from proximal cues. [Pirolli & Card 99]

Operationalize as: the proportion of participants who correctly identified the location of the task answer from looking at upper branches in the tree.

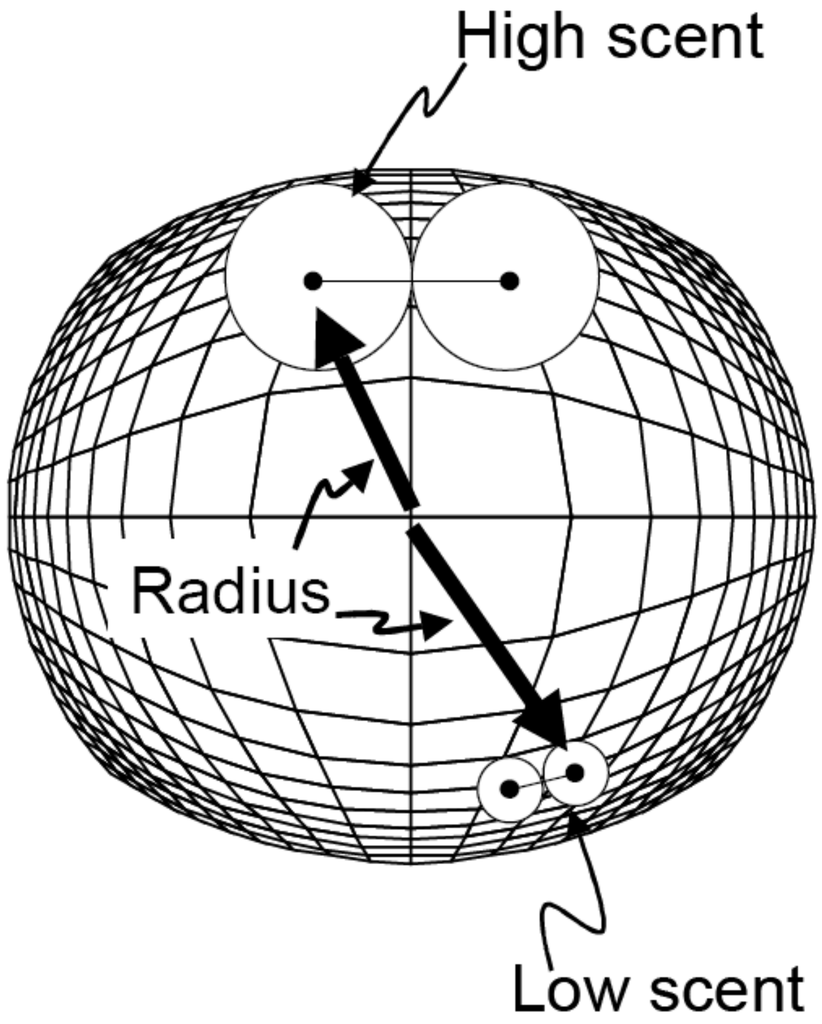

50
45
40
35
30
25
20
15
10
5
0
Task Time (sec)
Low Scent
High Scent
Explorer
Hyperbolic

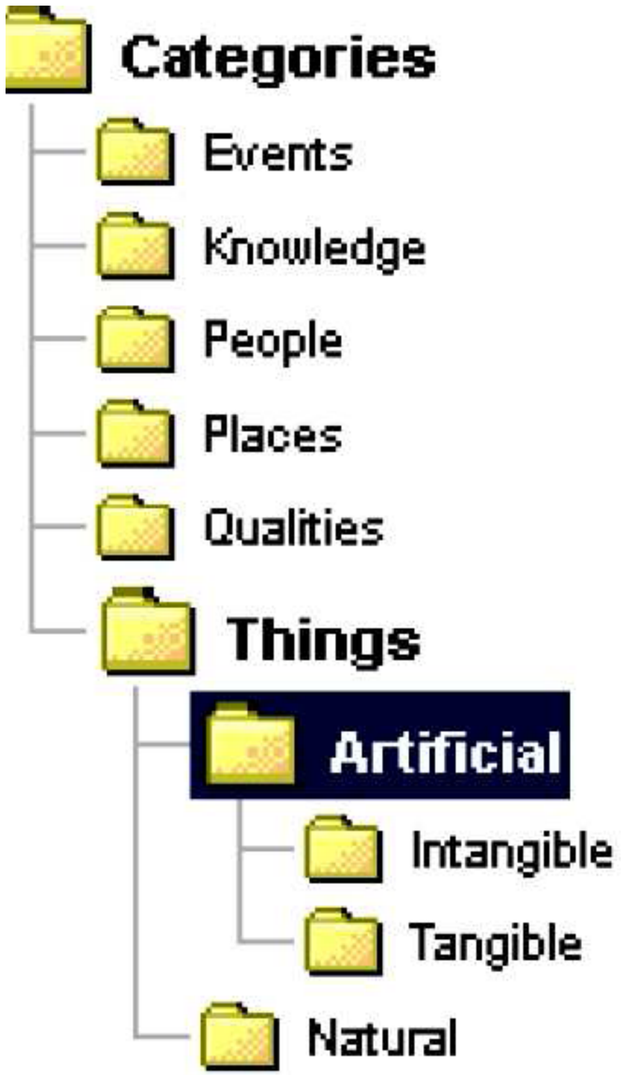

100
90
80
70
60
50
40
30
20
10
0
No. Nodes
Hyperbolic
Explorer
Low scent
High scent

An Adaptive Field of View?



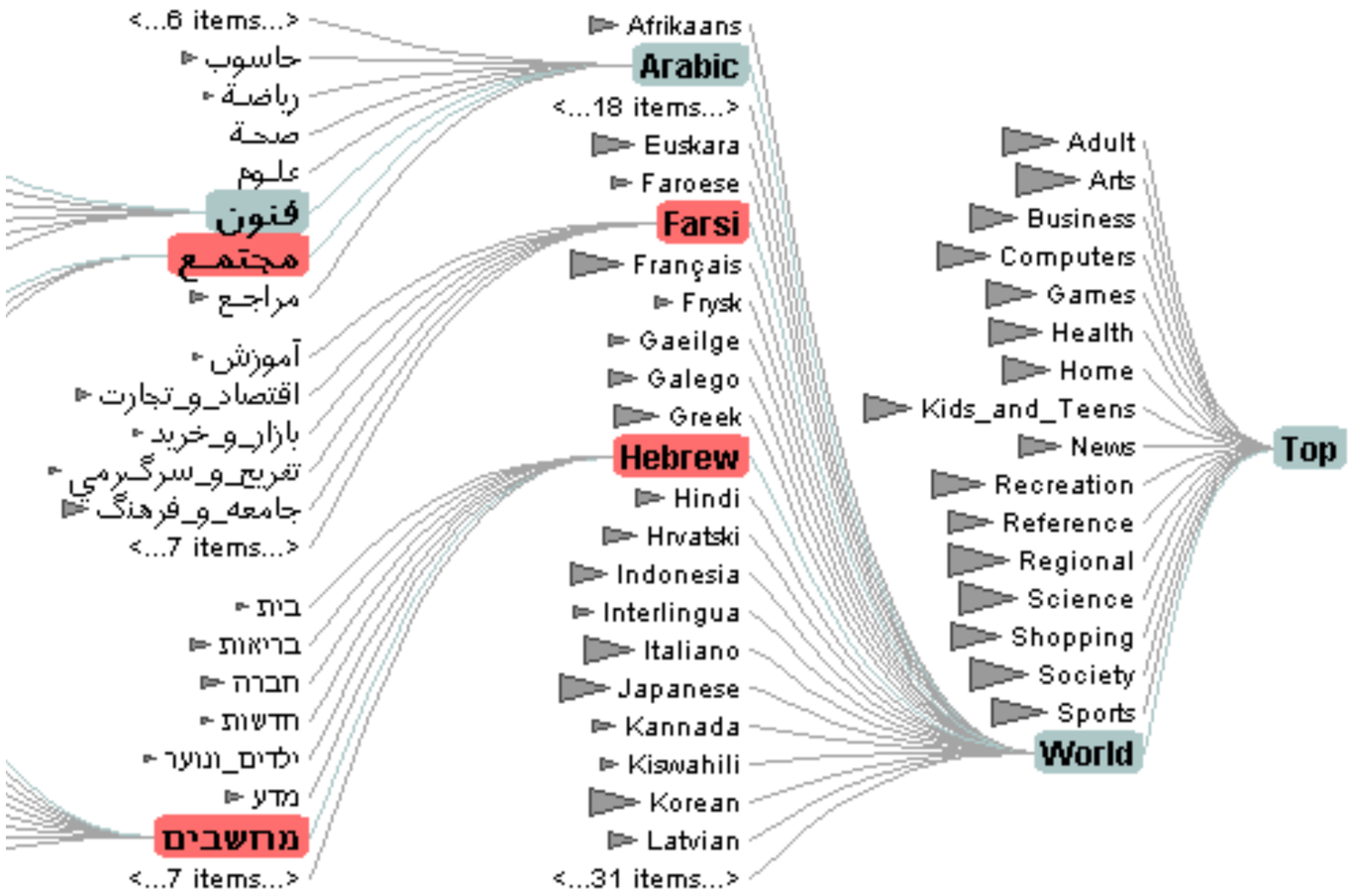
(c)





vs

Degree-of-interest Tree



Evaluation of DOI Trees

DOITree vs. Windows Explorer [Budiu, AVI 06]

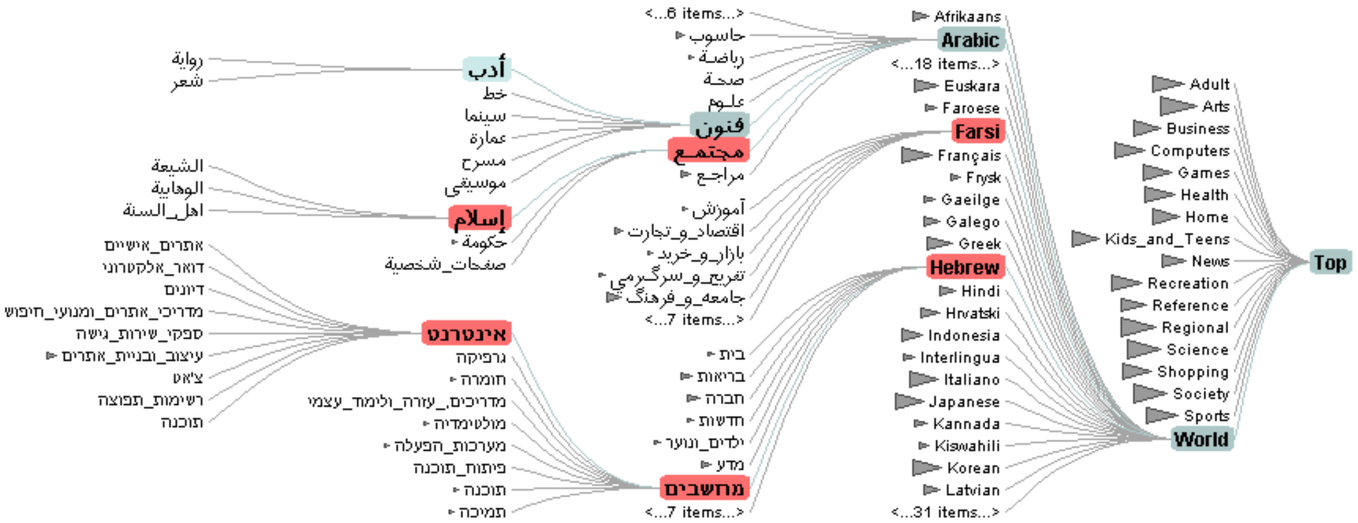
Nodes visited (avg)	DOI:83	Exp:53	p<.005
Revisitation (avg)	DOI:6.6	Exp:8.2	p<.005
Divergence (avg)	DOI:4.6	Exp:3.9	p<.001

DOITree more forgiving to navigation errors
BUT no significant difference in task time

DOITree vs. Google Directory [Pirolli, CHI 06]
DOITree has superior task knowledge transfer

Design Guidelines

Support rapid visual scanning
Most people don’t read in circles!



Design Guidelines

Support rapid visual scanning
Most people don’t read in circles!

Showing more is not always better
Distractors can decrease task performance
Interaction with quality of information scent

Navigation cues critical to search
Informative labels or landmarks needed
Poor information scent undermines search

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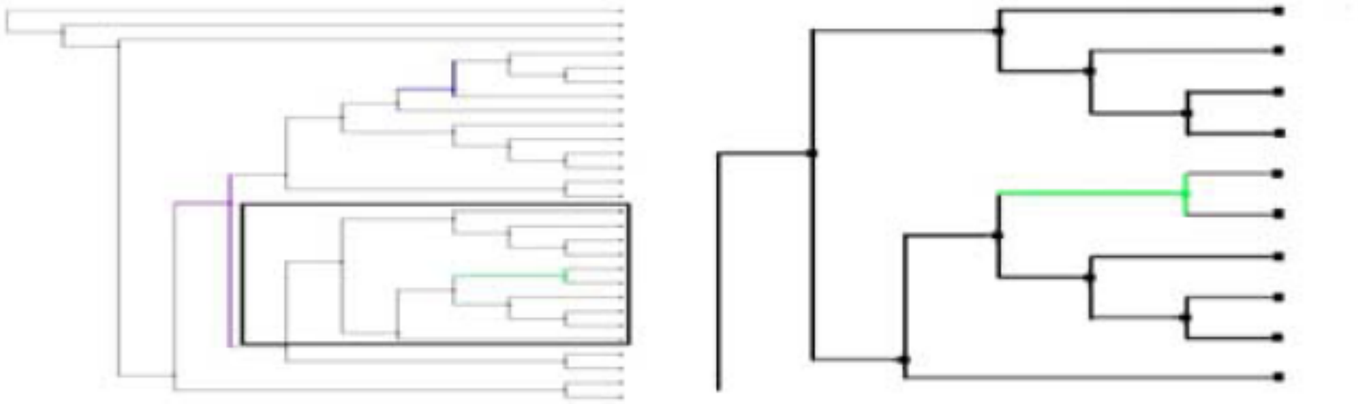
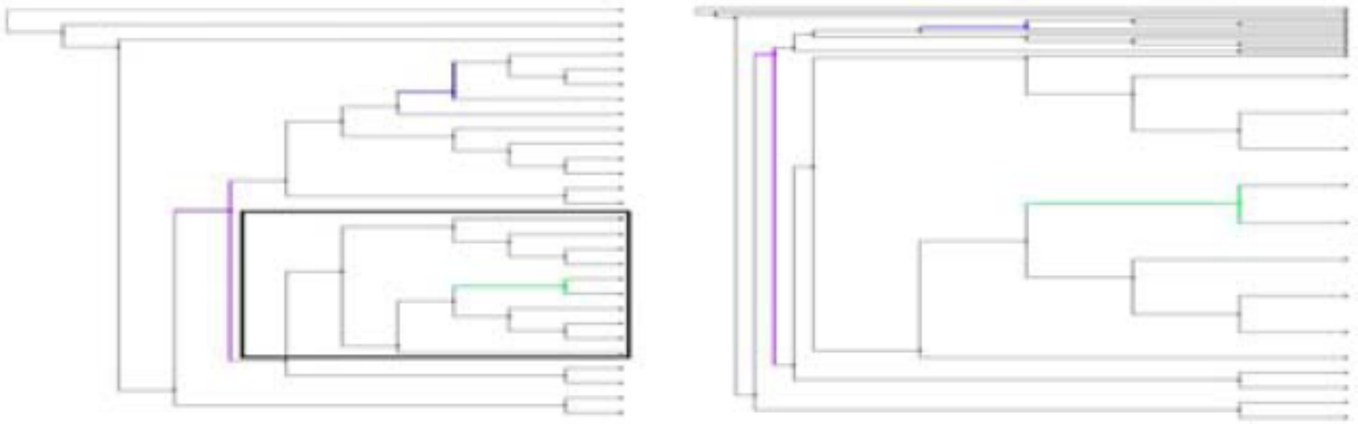
Pan & Zoom vs. Rubber Sheet



(i) PZN



(ii) RSN

Nekrasovski, Dmitry, et al. "An evaluation of pan & zoom and rubber sheet navigation with and without an overview." 2006

How can we decide whether one is better?

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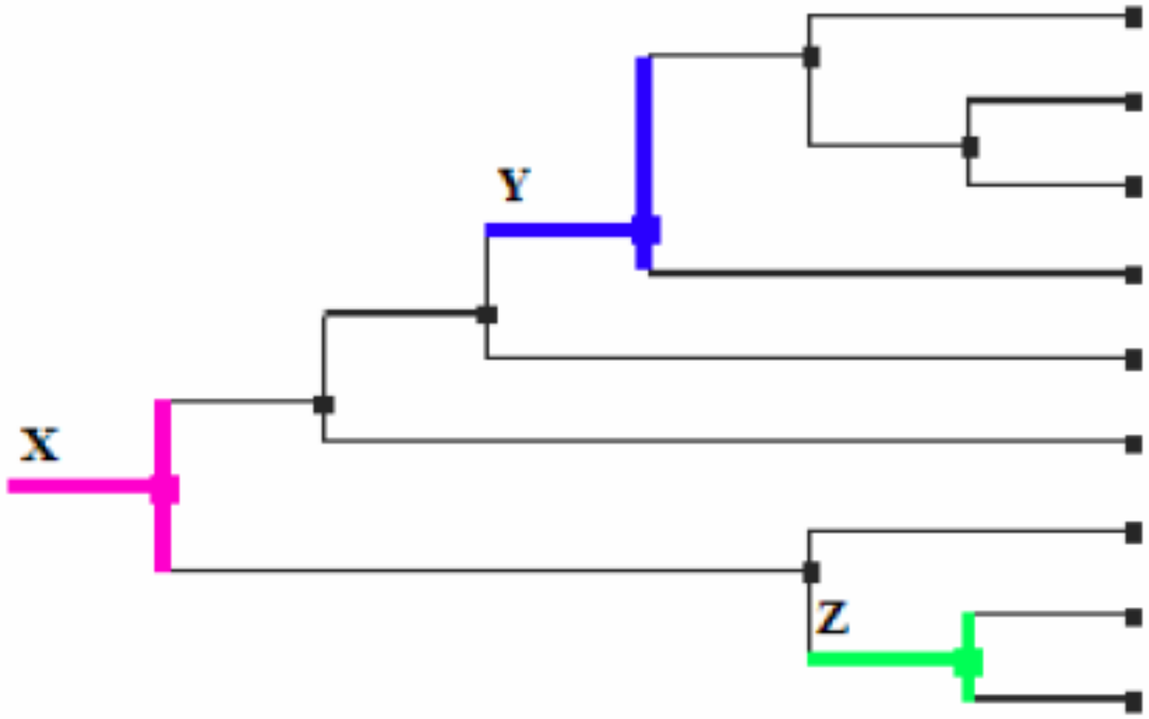
Experimental Task

Compare topological distance between nodes in a dendrogram.

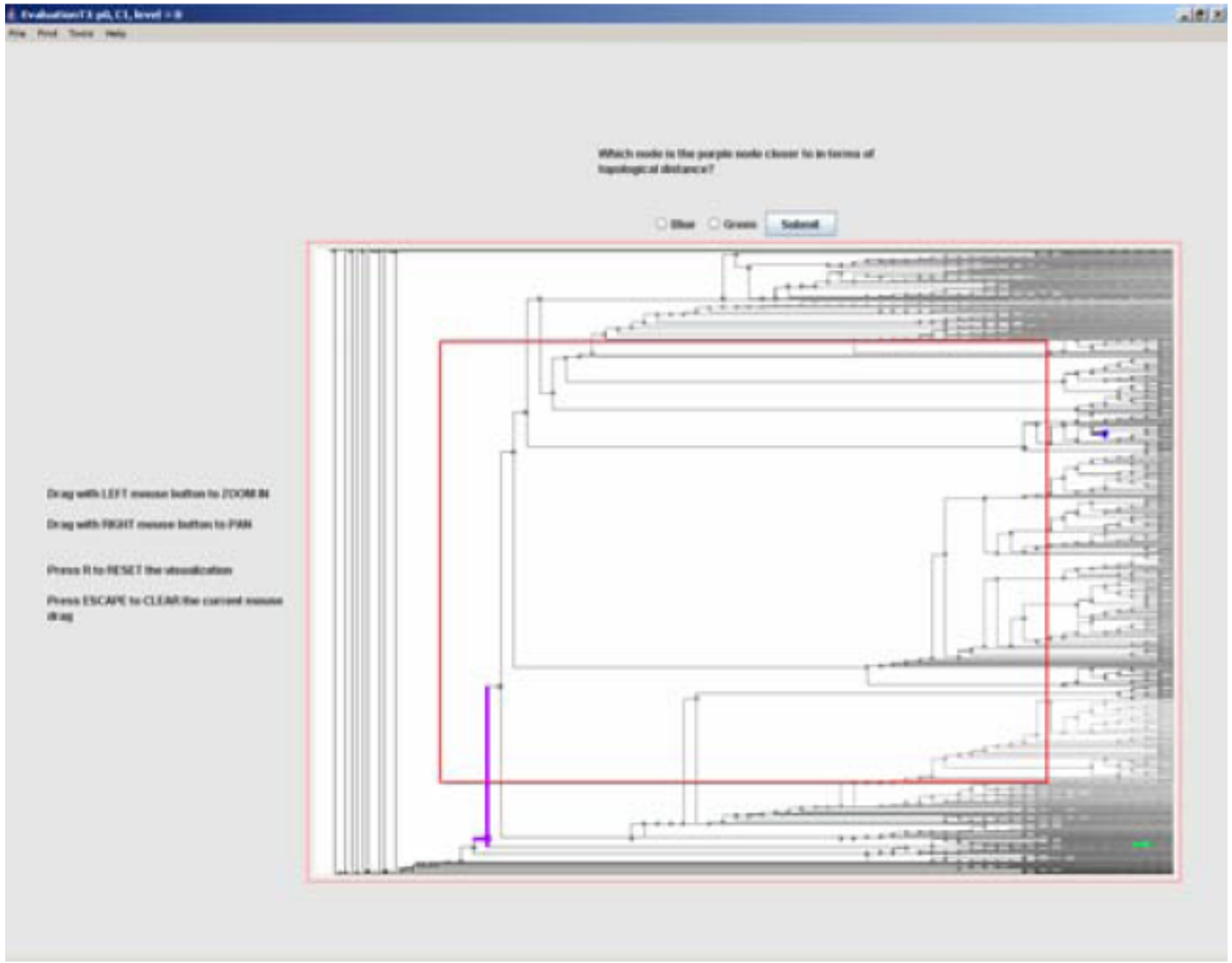


Experimental

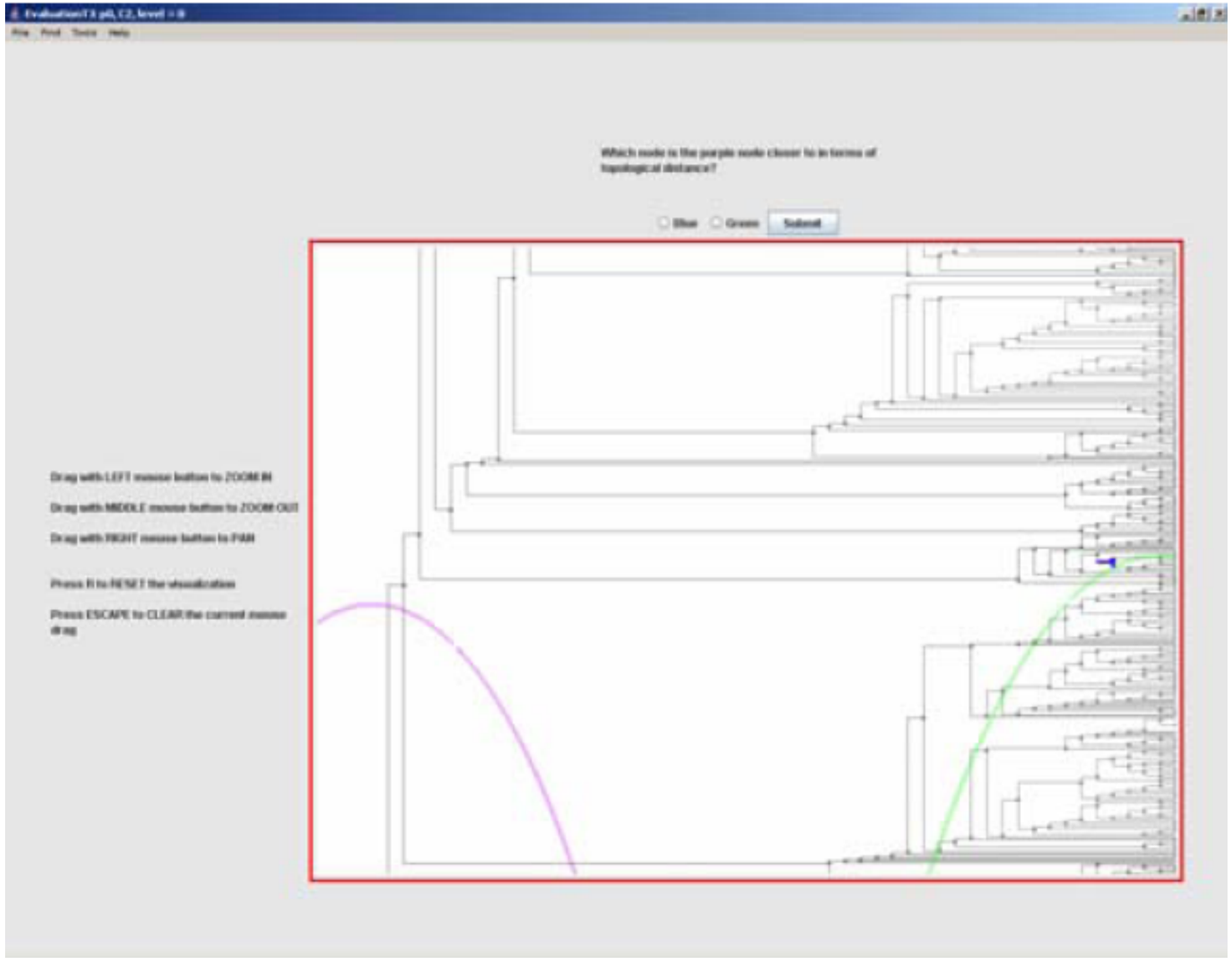
Compare performance in 4 conditions:
1. Pan & Zoom (no overview)
2. Pan & Zoom (with overview)
3. Rubber Sheet (no overview)
4. Rubber Sheet (with overview)

40 subjects (24F/16M), between 18-39 years old.
Right-handed, normal vision.
Between-subjects design.

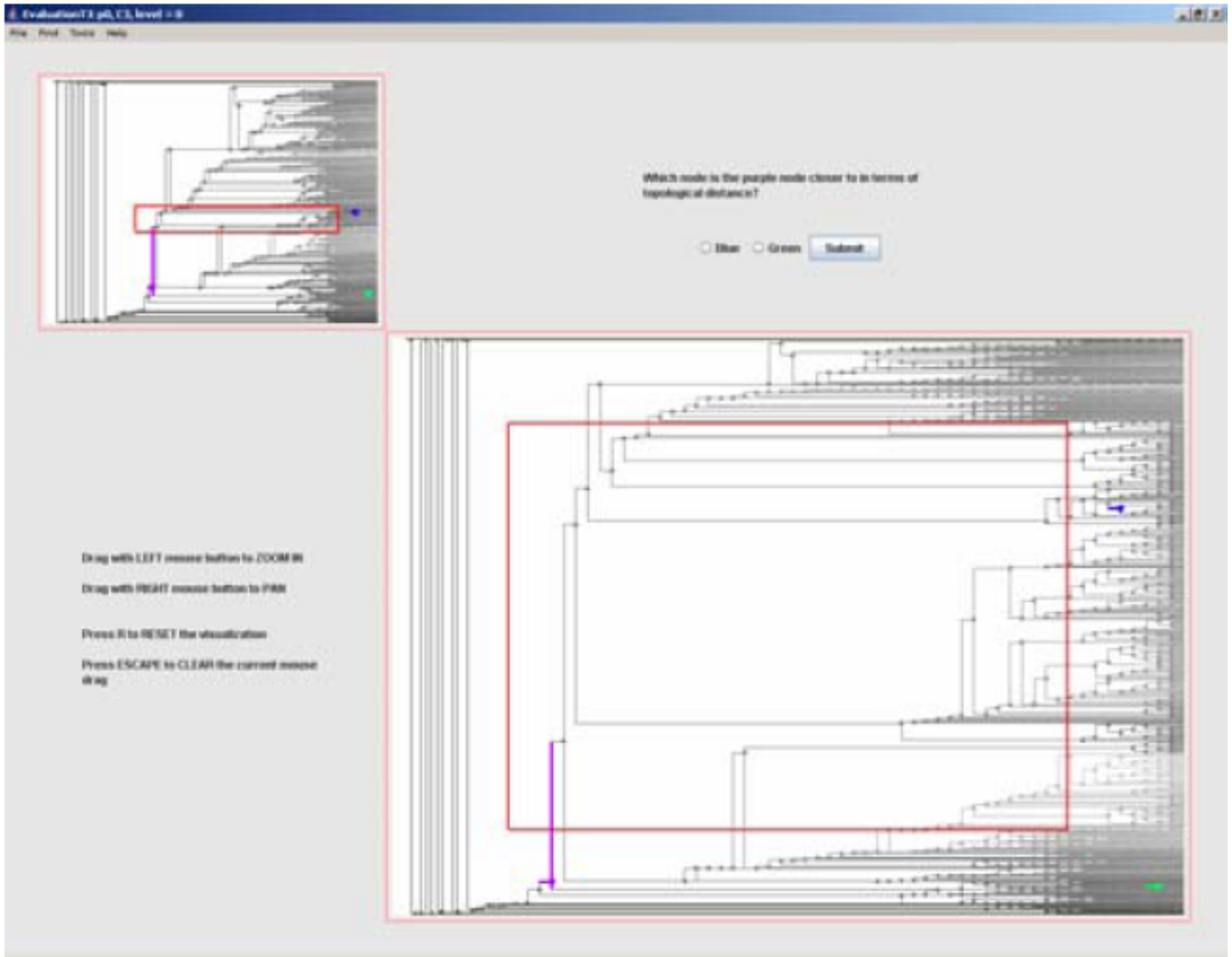
1. Rubber Sheet / No Overview



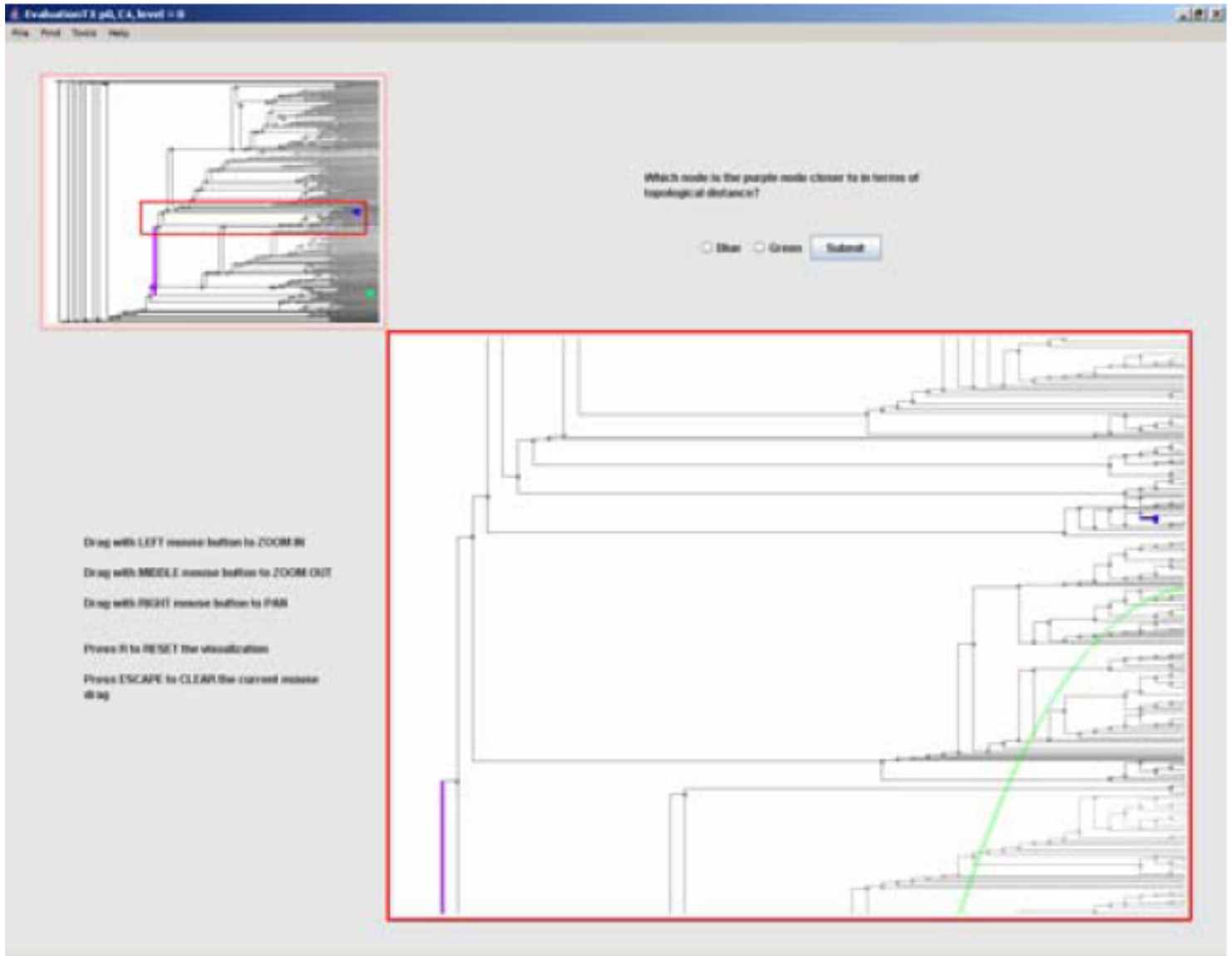
2. Pan & Zoom / No Overview



3. Rubber Sheet / Overview



4. Pan & Zoom / Overview



Hypotheses

H1: RSN interfaces perform better than PZN interfaces independently of the presence or absence of an overview.

H2: For RSN, the presence of an overview does not result in better performance.

H3: For PZN, the presence of an overview results in better performance.

Results: H1 False

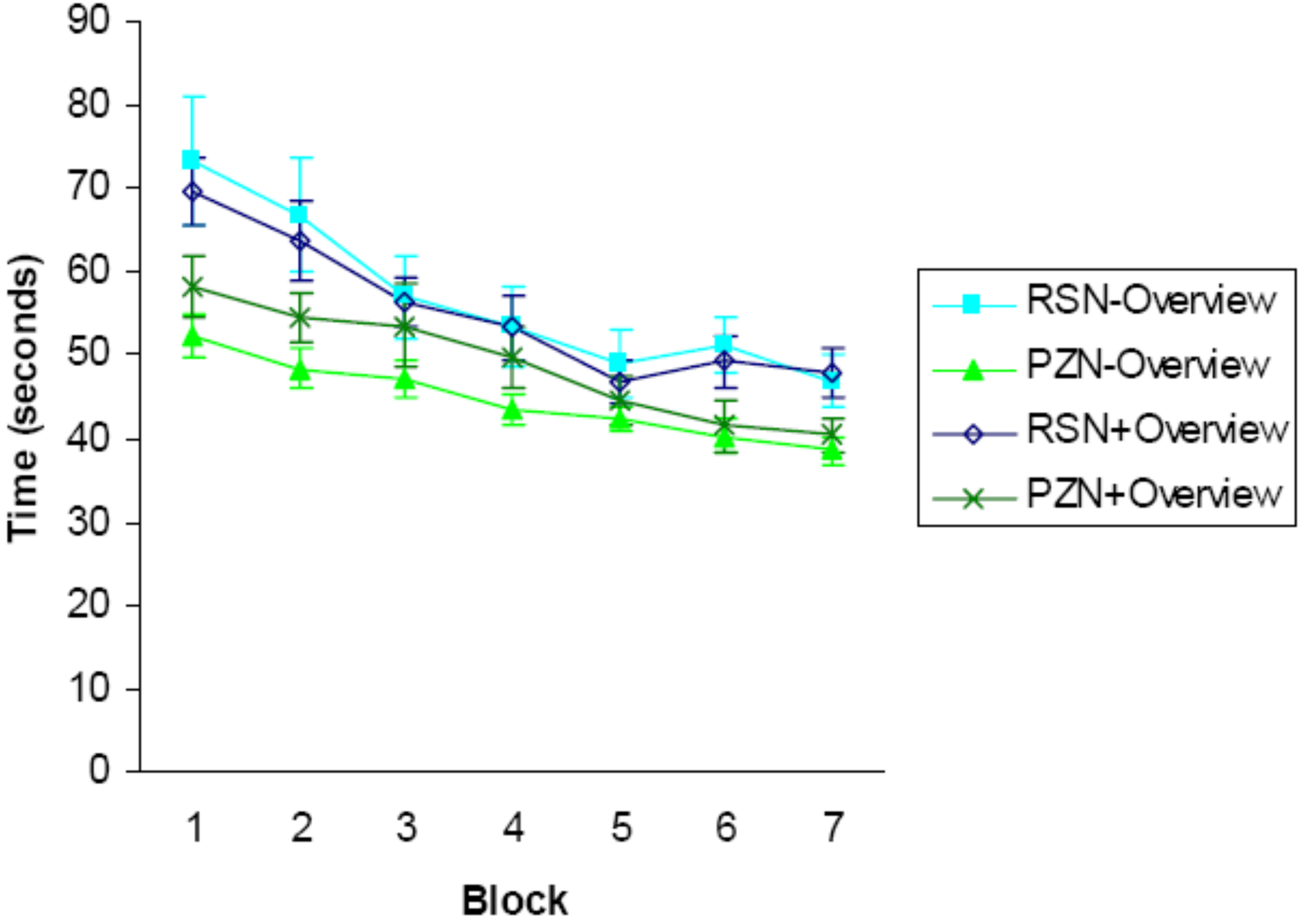


Figure 7: Mean completion times per trial for each interface by block in seconds (N=40).

Results: H2 True, H3 False

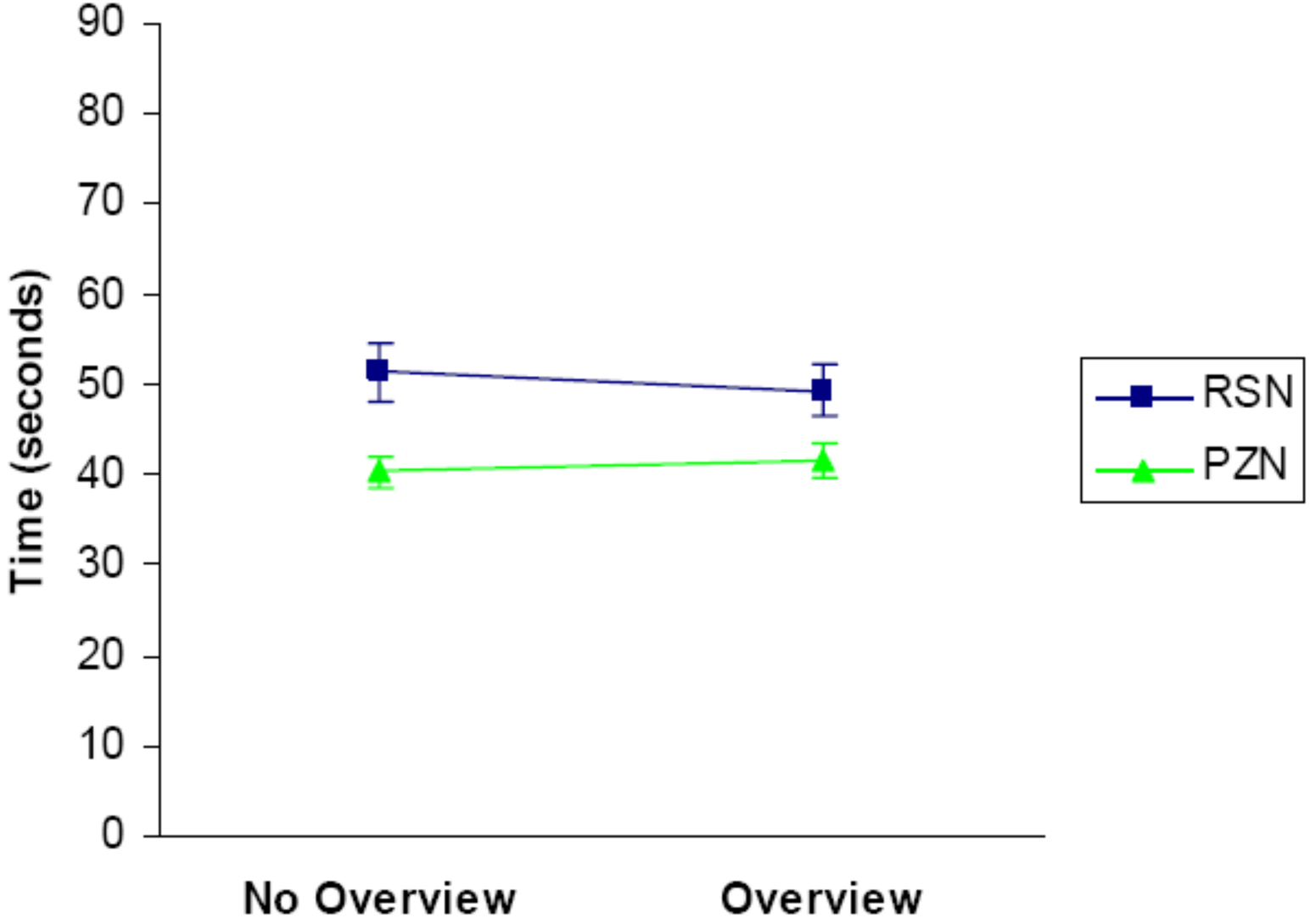


Figure 9: Block 7 mean per-trial completion times in seconds by navigation technique with and without an overview.

Results

R1. Pan & Zoom had lower completion times, navigation actions, resets, and reported mental demand.

R2. Overview has no significant impact on rubber sheet navigation, though it was reported to reduce physical demand.

R3. Overview has no significant impact on pan & zoom navigation, though it was reported to reduce physical demand.

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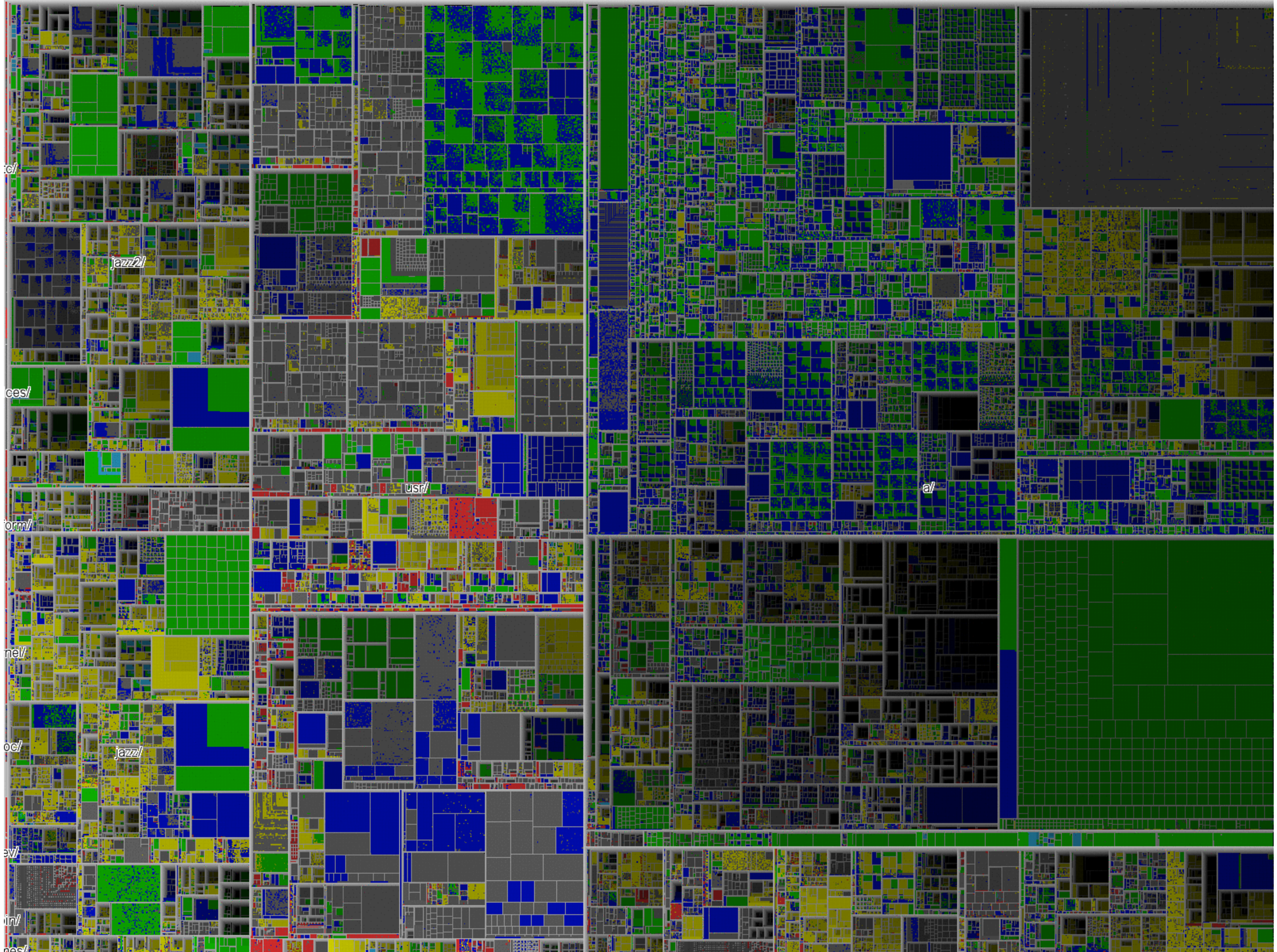
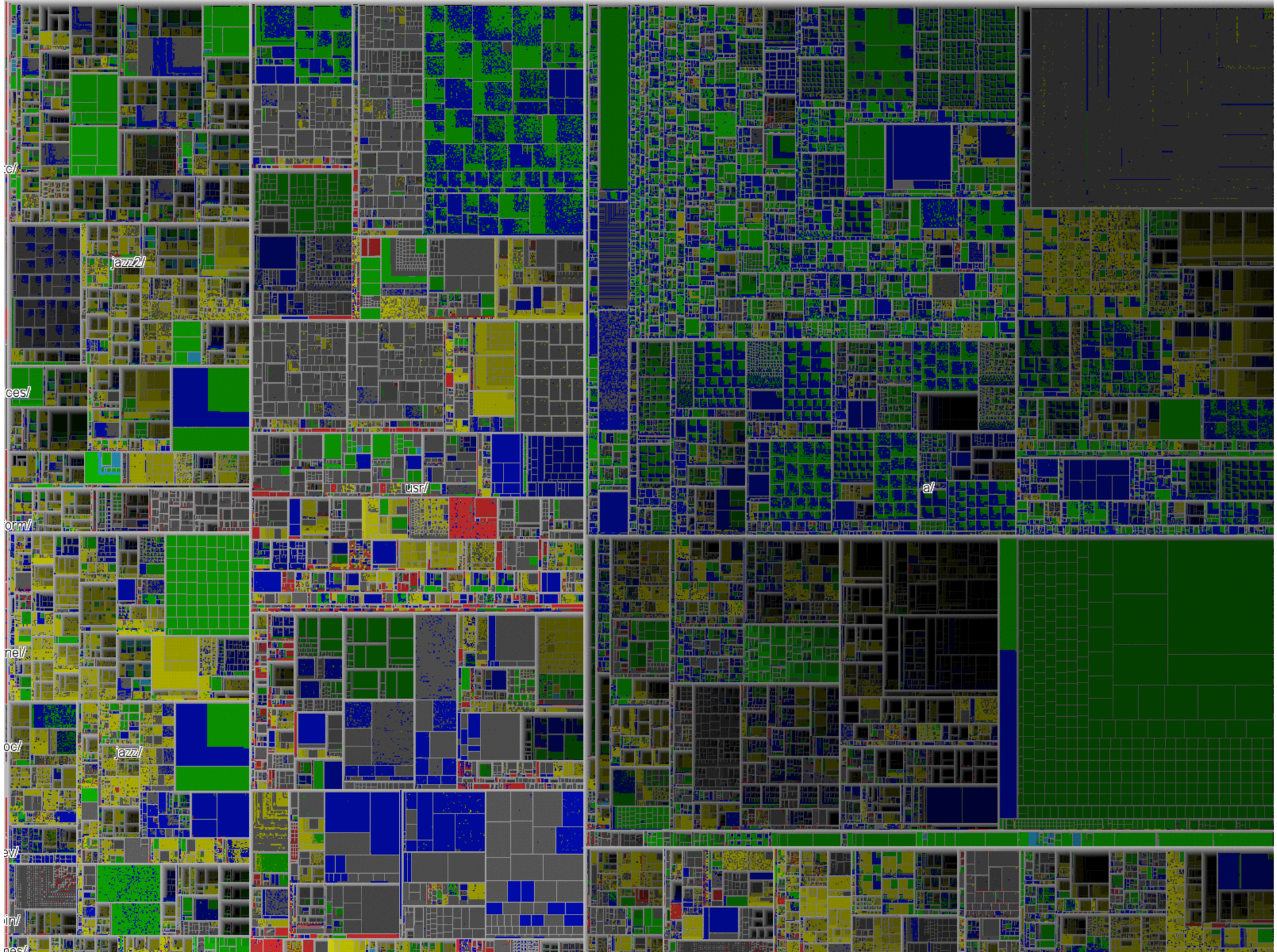

jazz2/
usr/
a/
jazz/

$$\text{Data Density} = \frac{\text{(\# entries in data)}}{\text{(area of graphic)}}$$

“Graphical excellence… gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space”

[Tufte 83]


jazz2/
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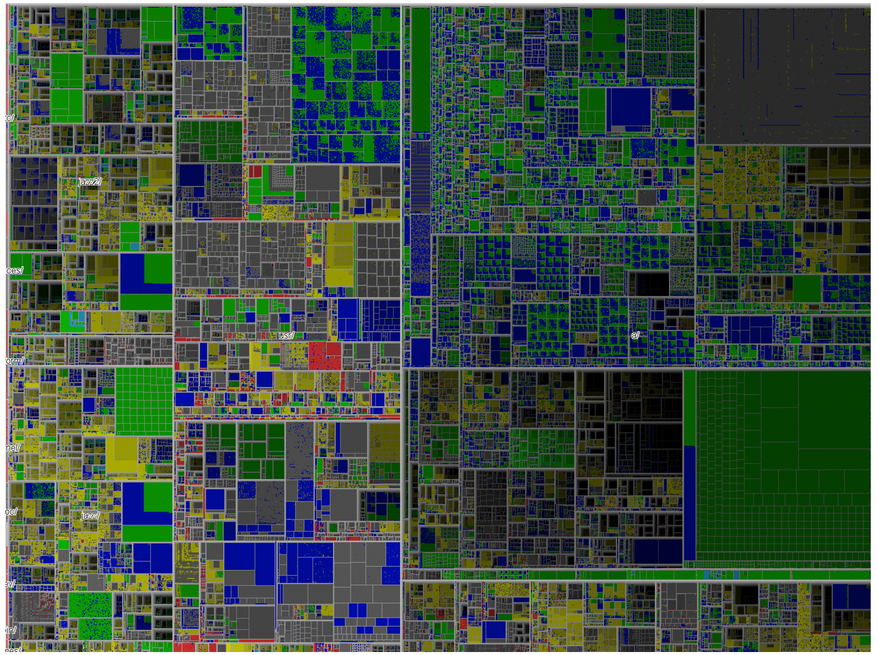

Relative Technology Stock Performance: Jan 2008 - Present

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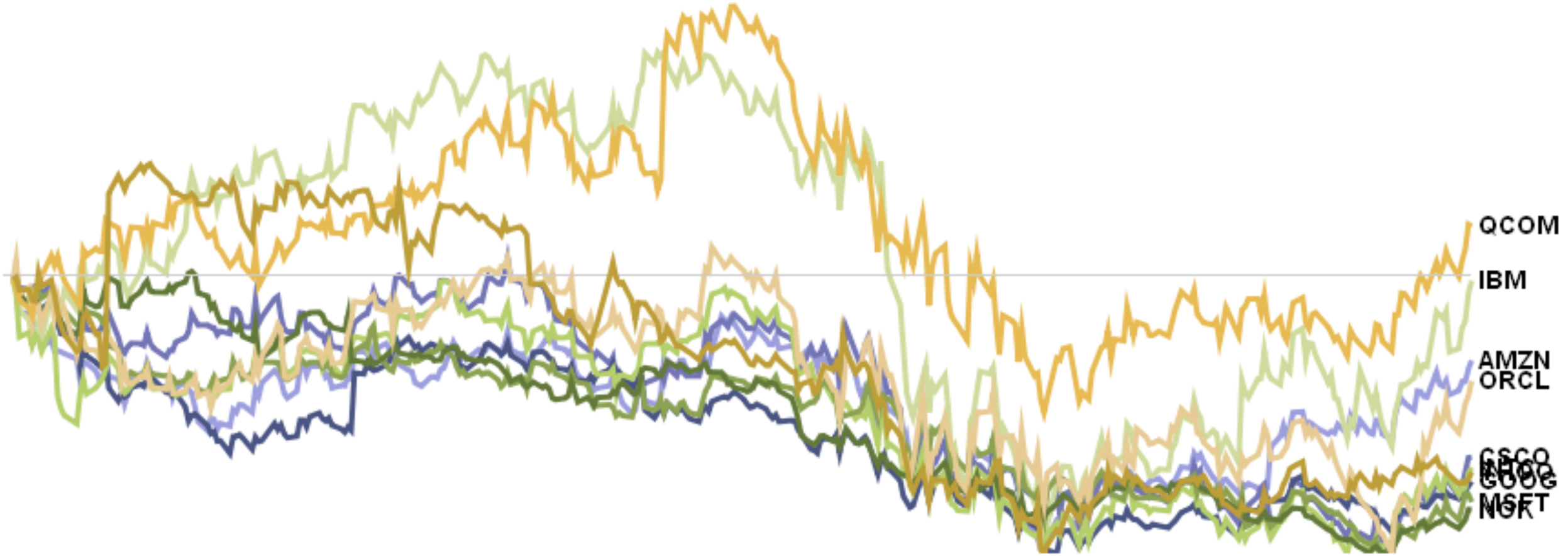

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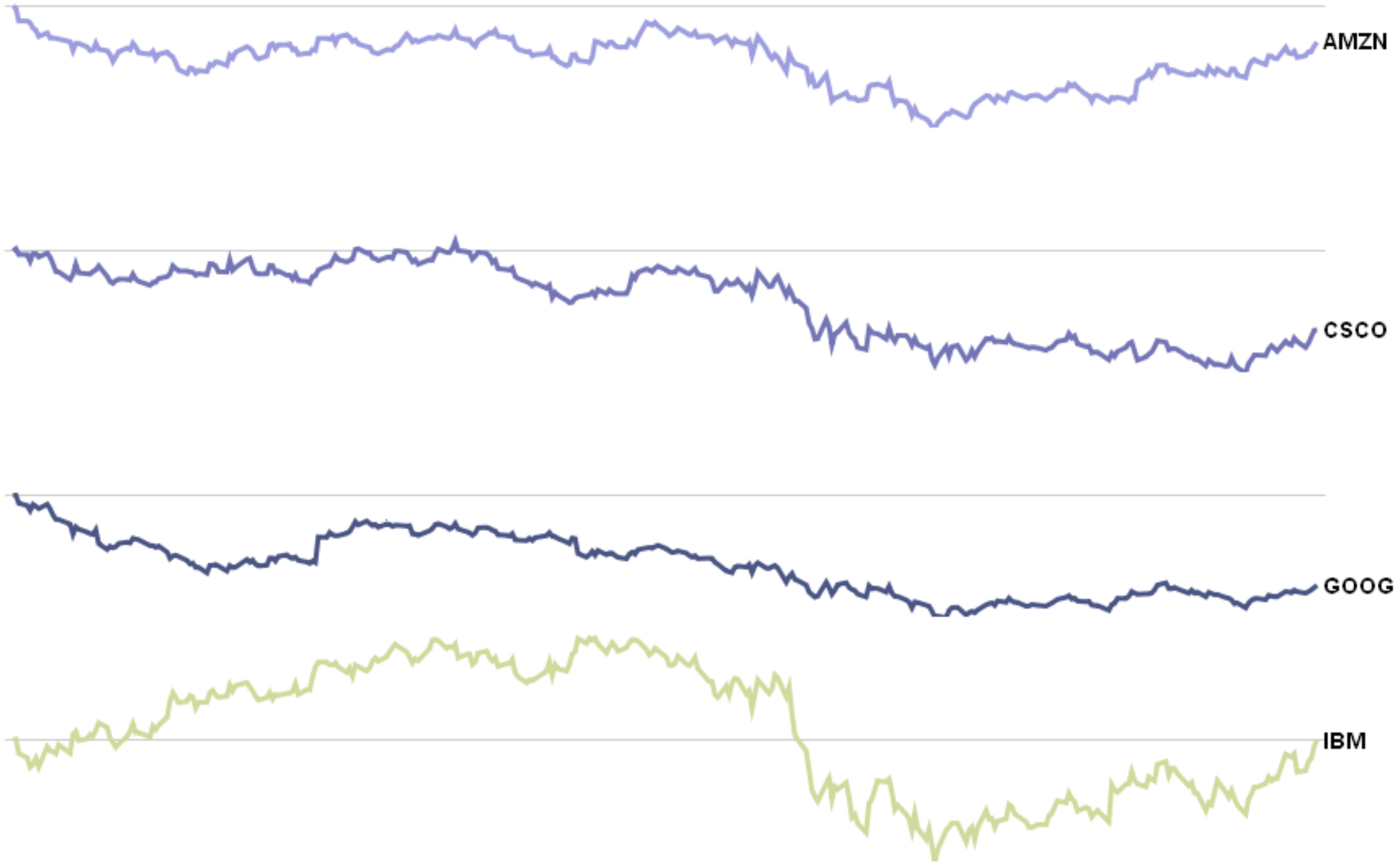

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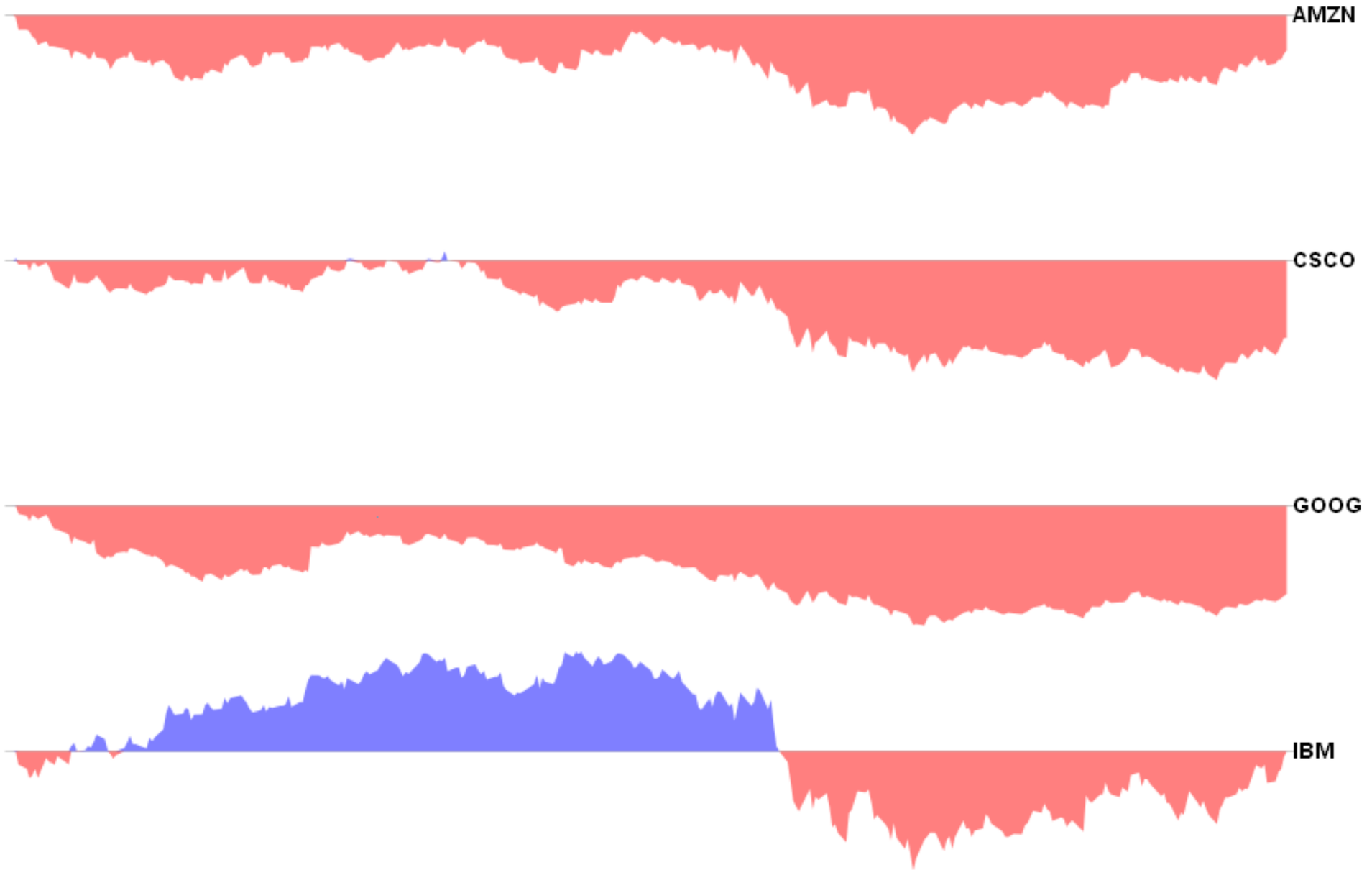

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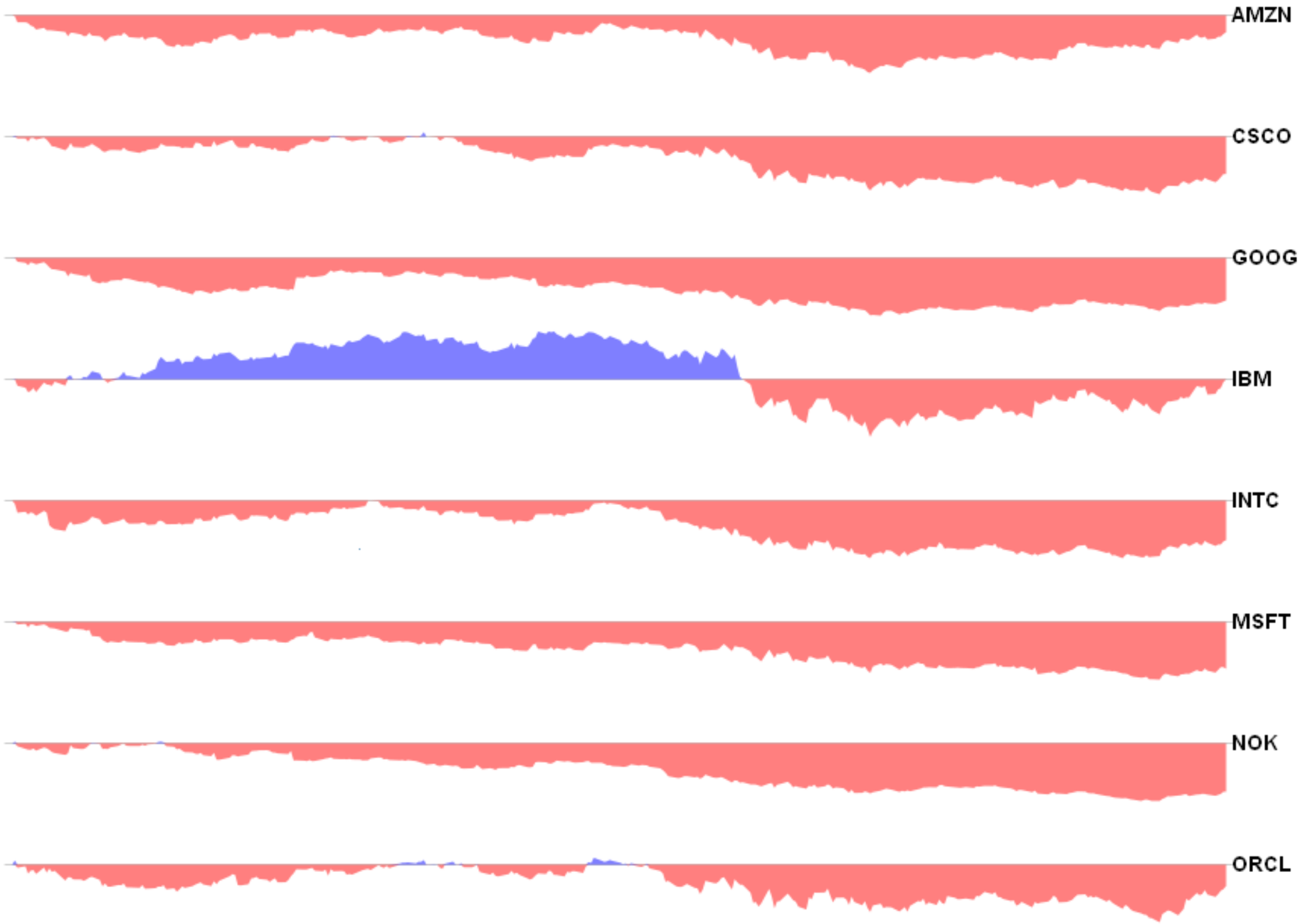

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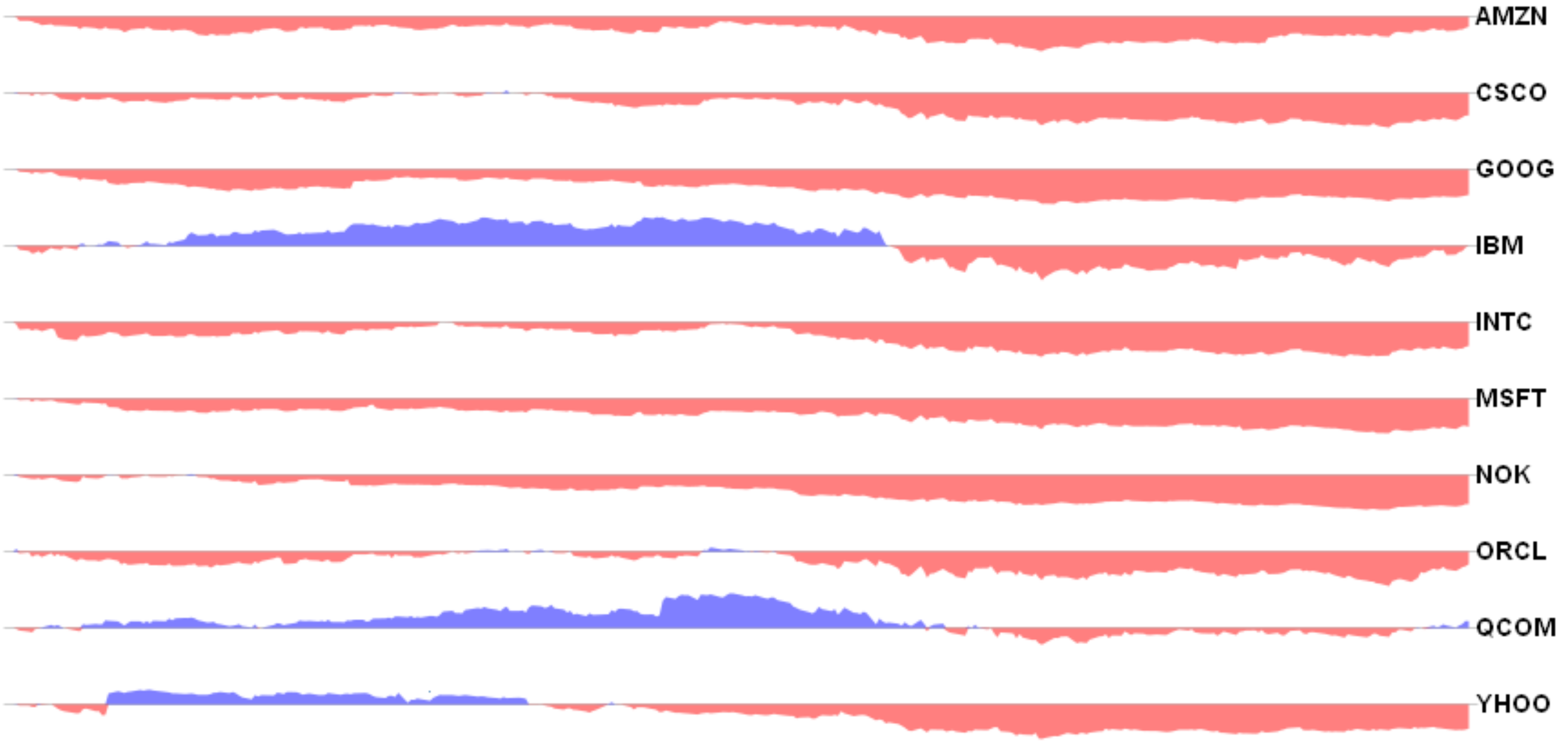

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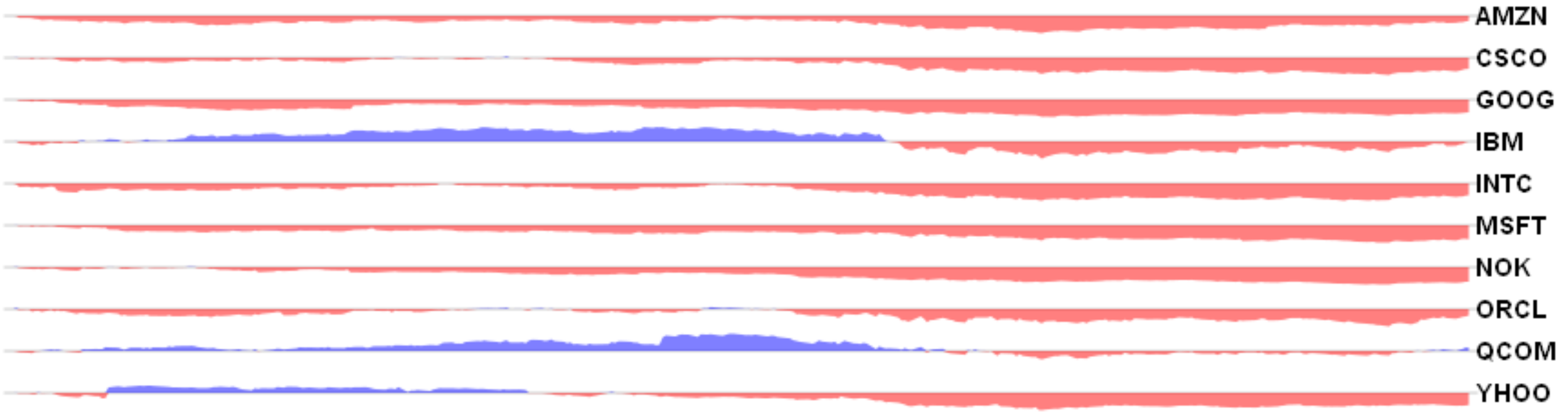

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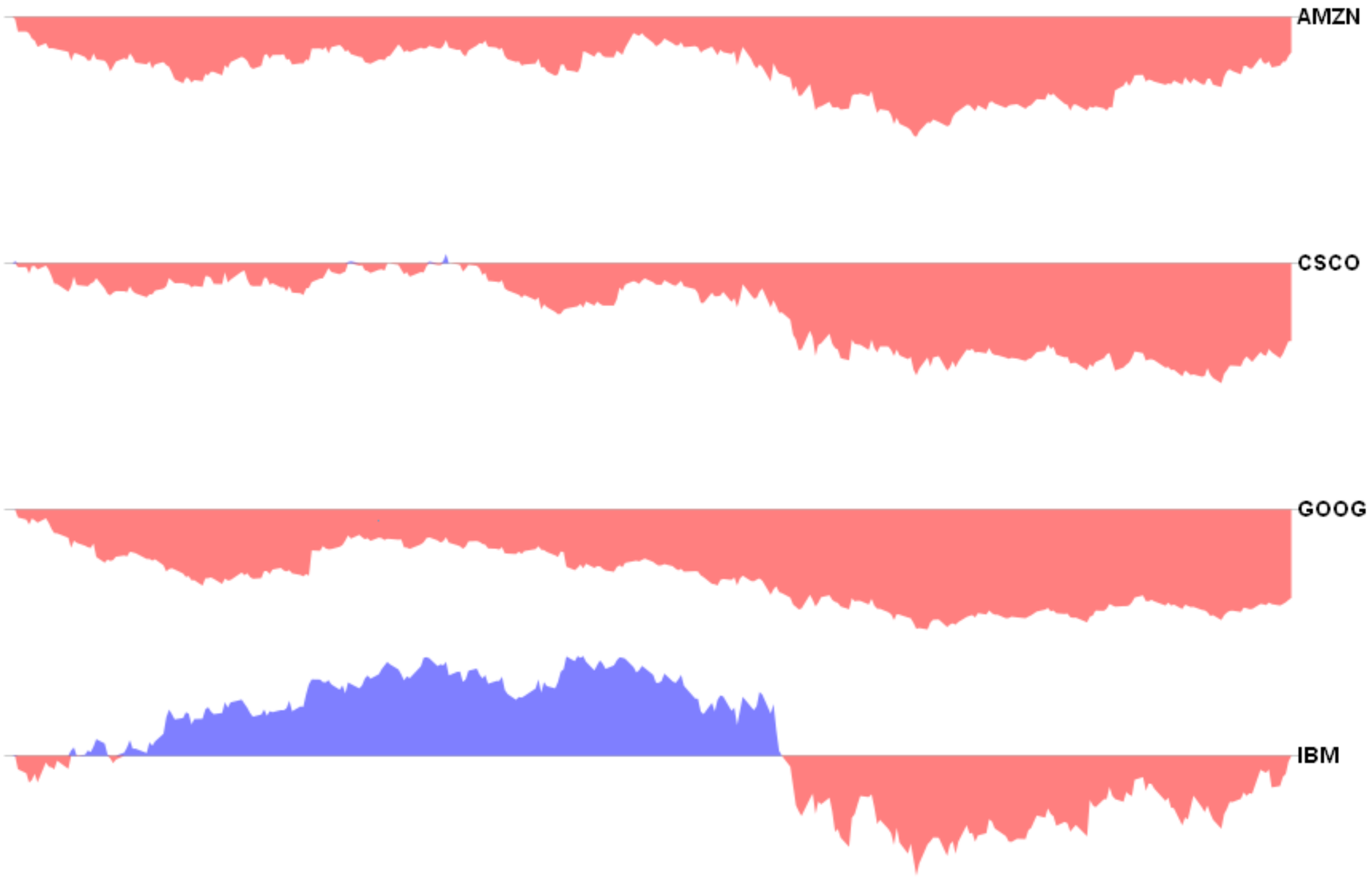
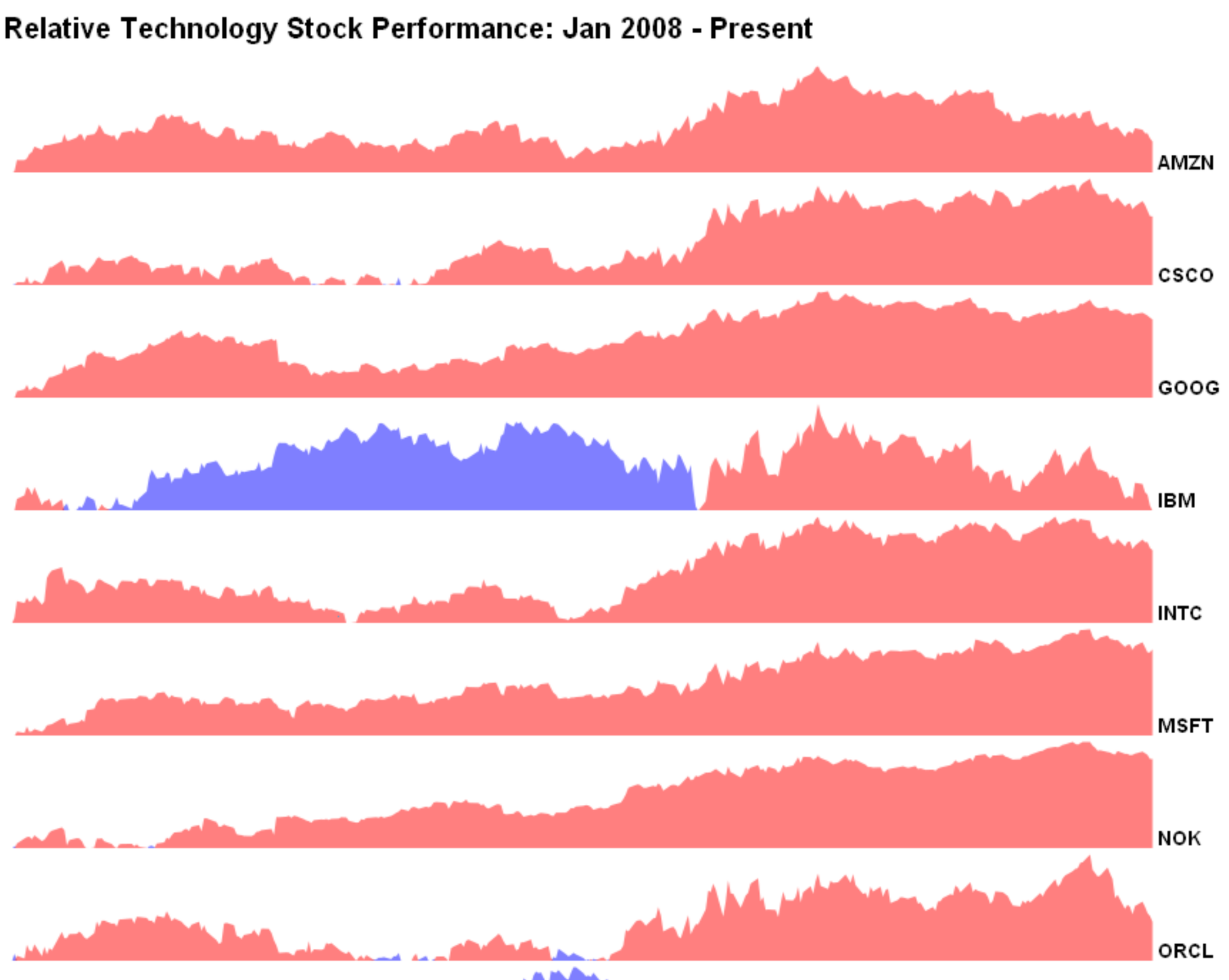
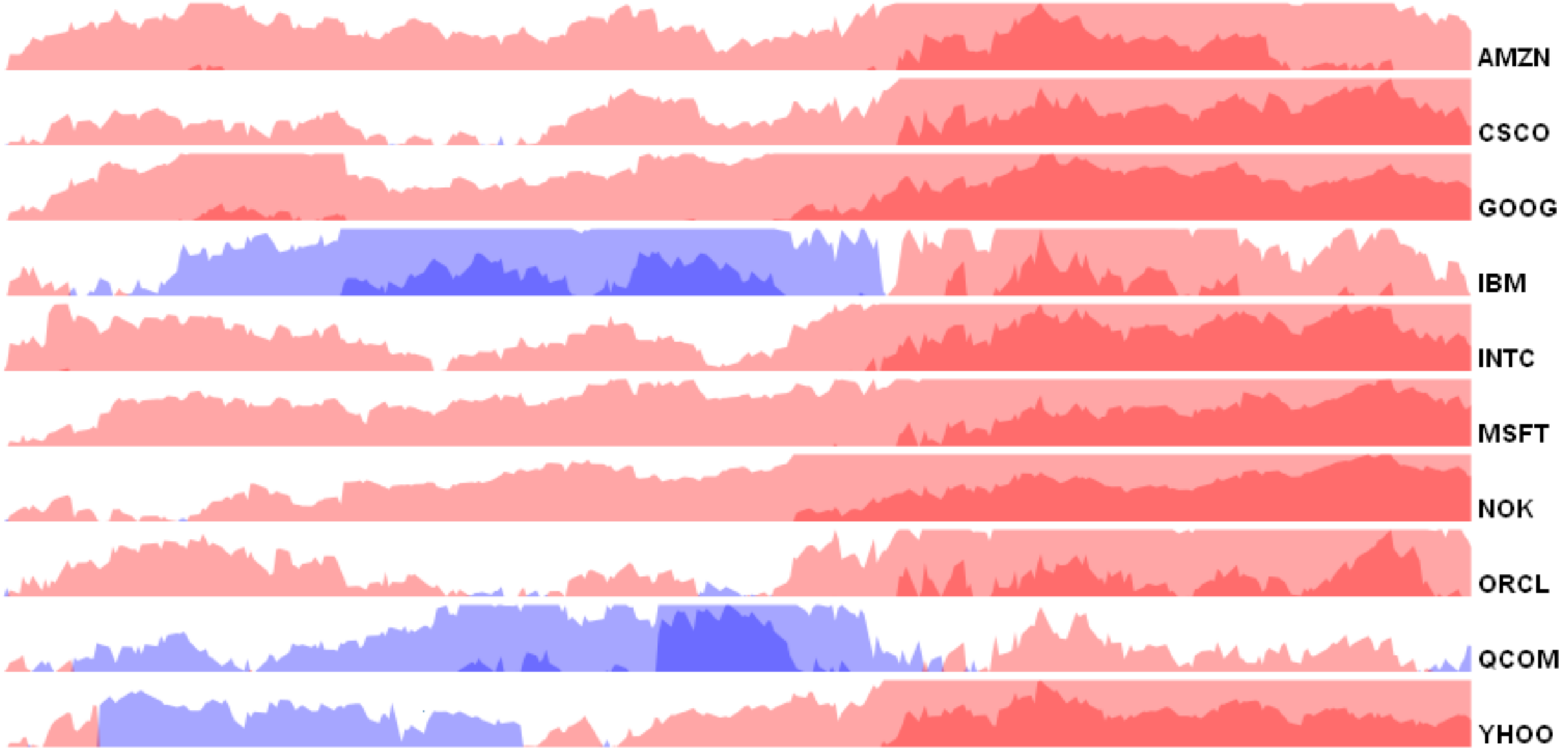
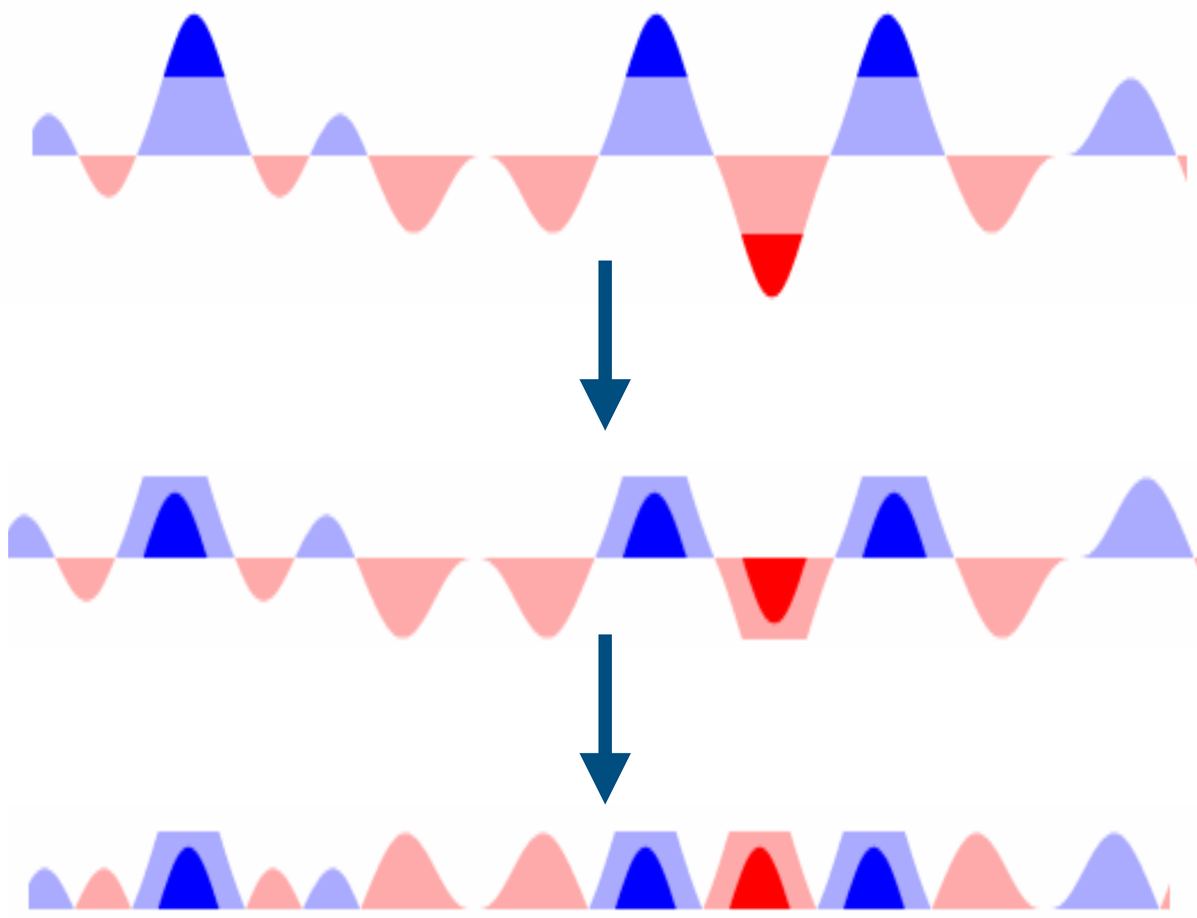



Relative Technology Stock Performance: Jan 2008 - Present
AMZN
CSCO
GOOG
IBM
INTC
MSFT
NOK
ORCL

Relative Technology Stock Performance: Jan 2008 - Present



Horizon graphs

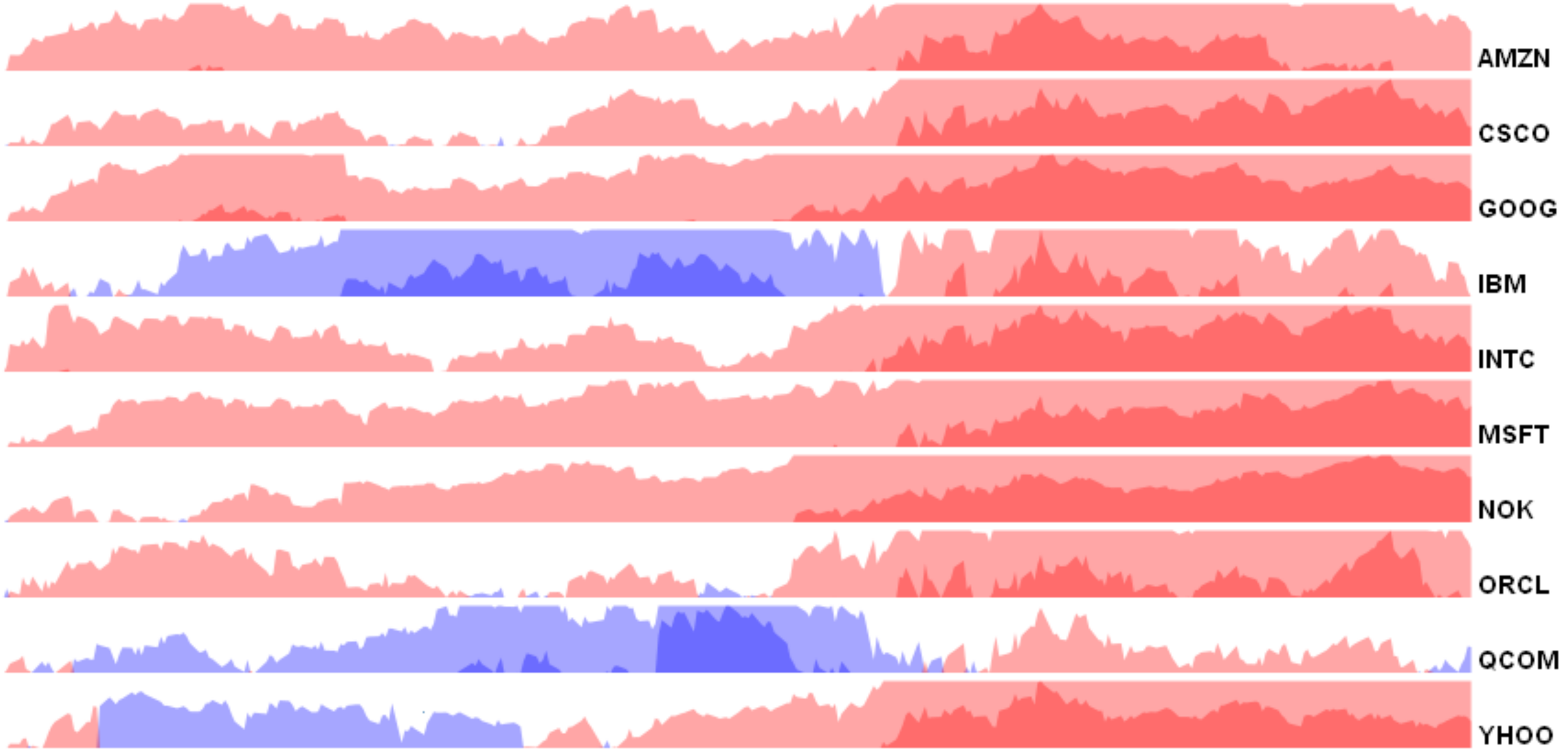


Segment Peaks

Layer segments

Mirror negative values

Relative Technology Stock Performance: Jan 2008 - Present



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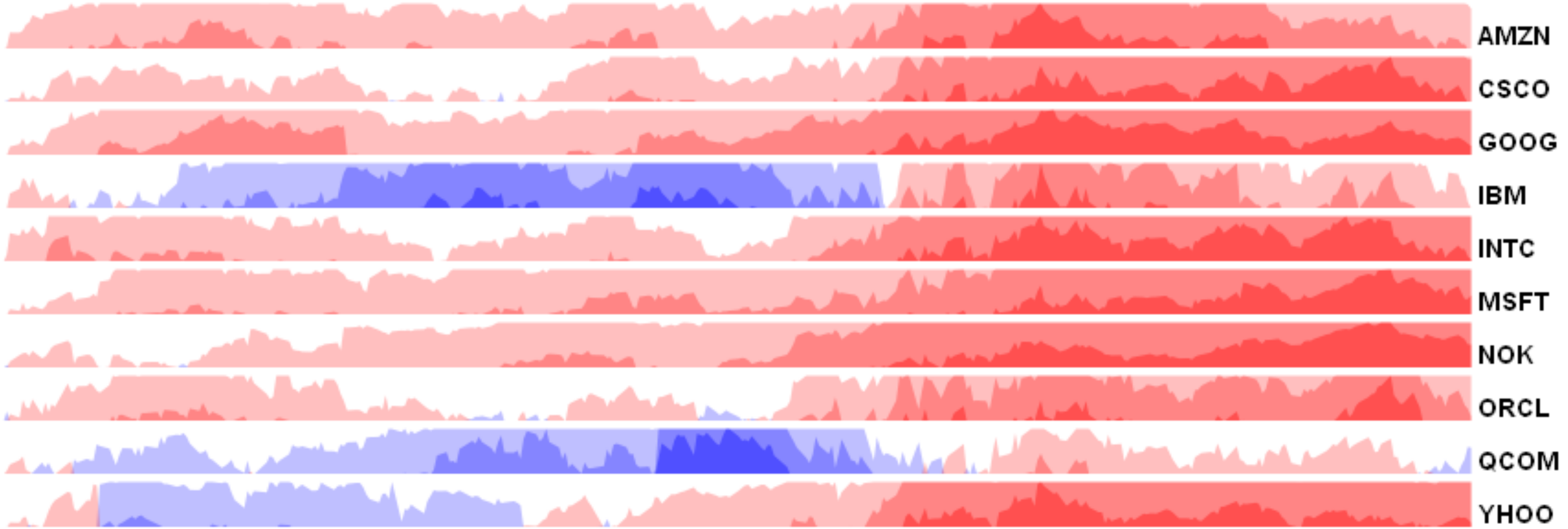

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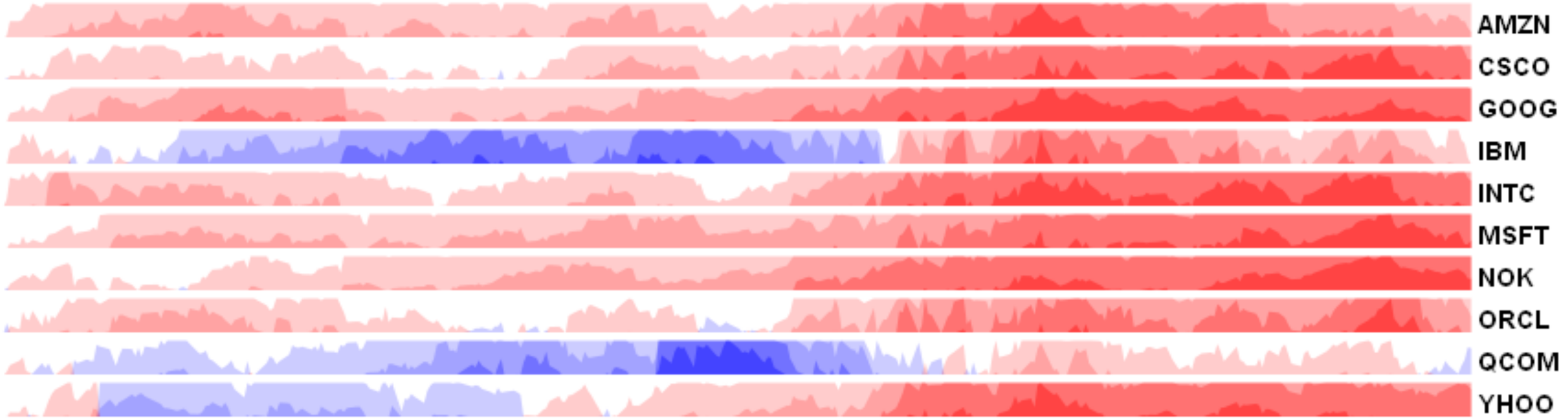

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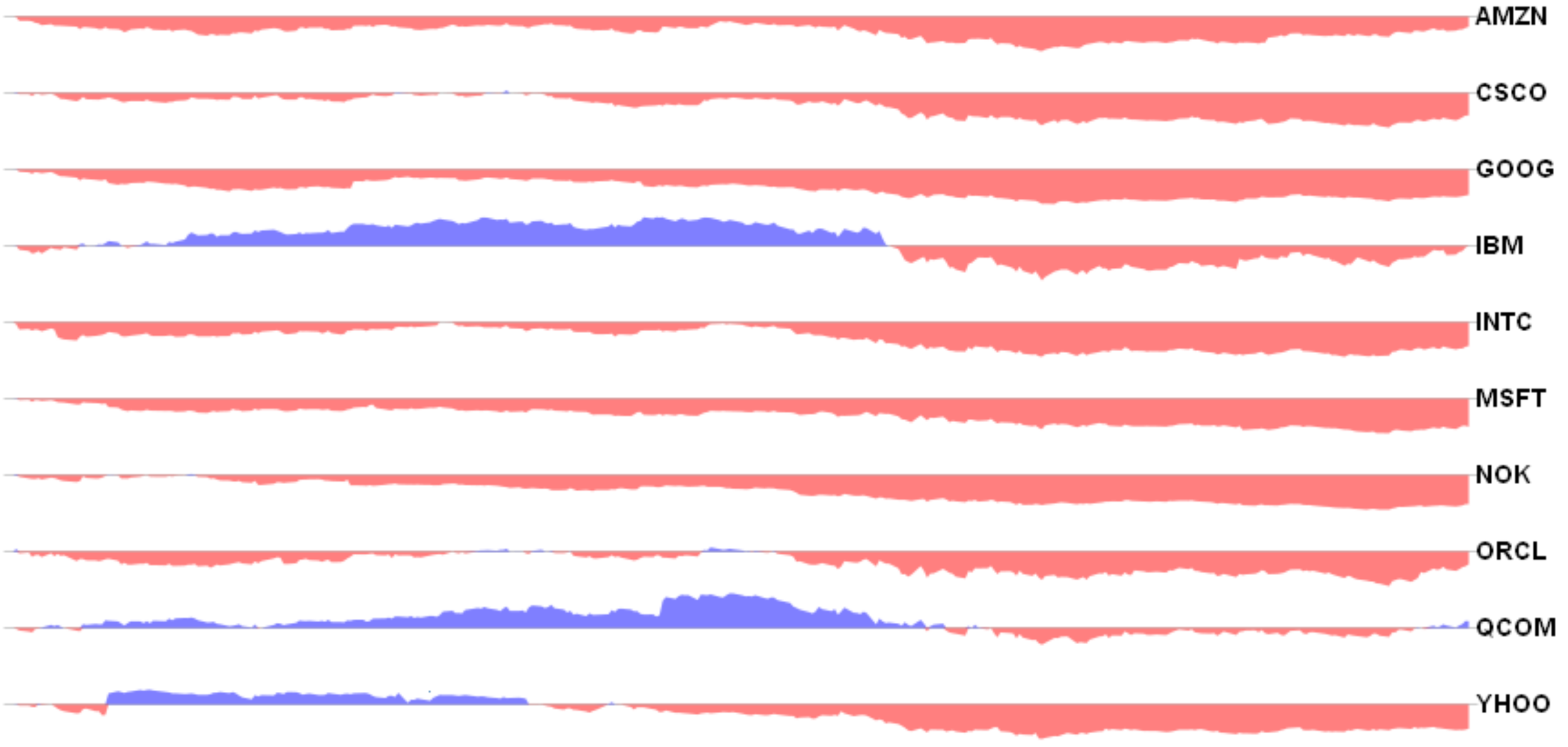
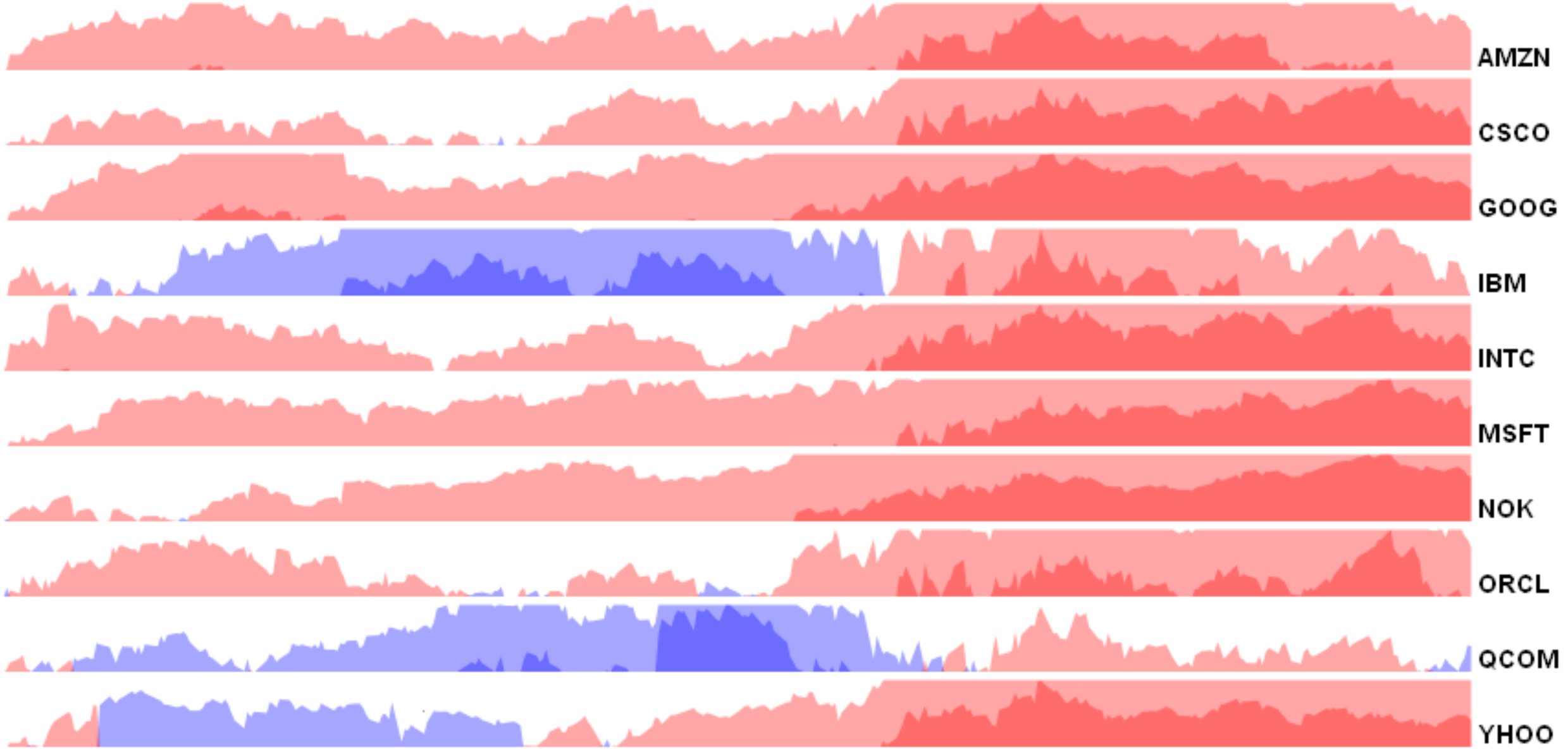
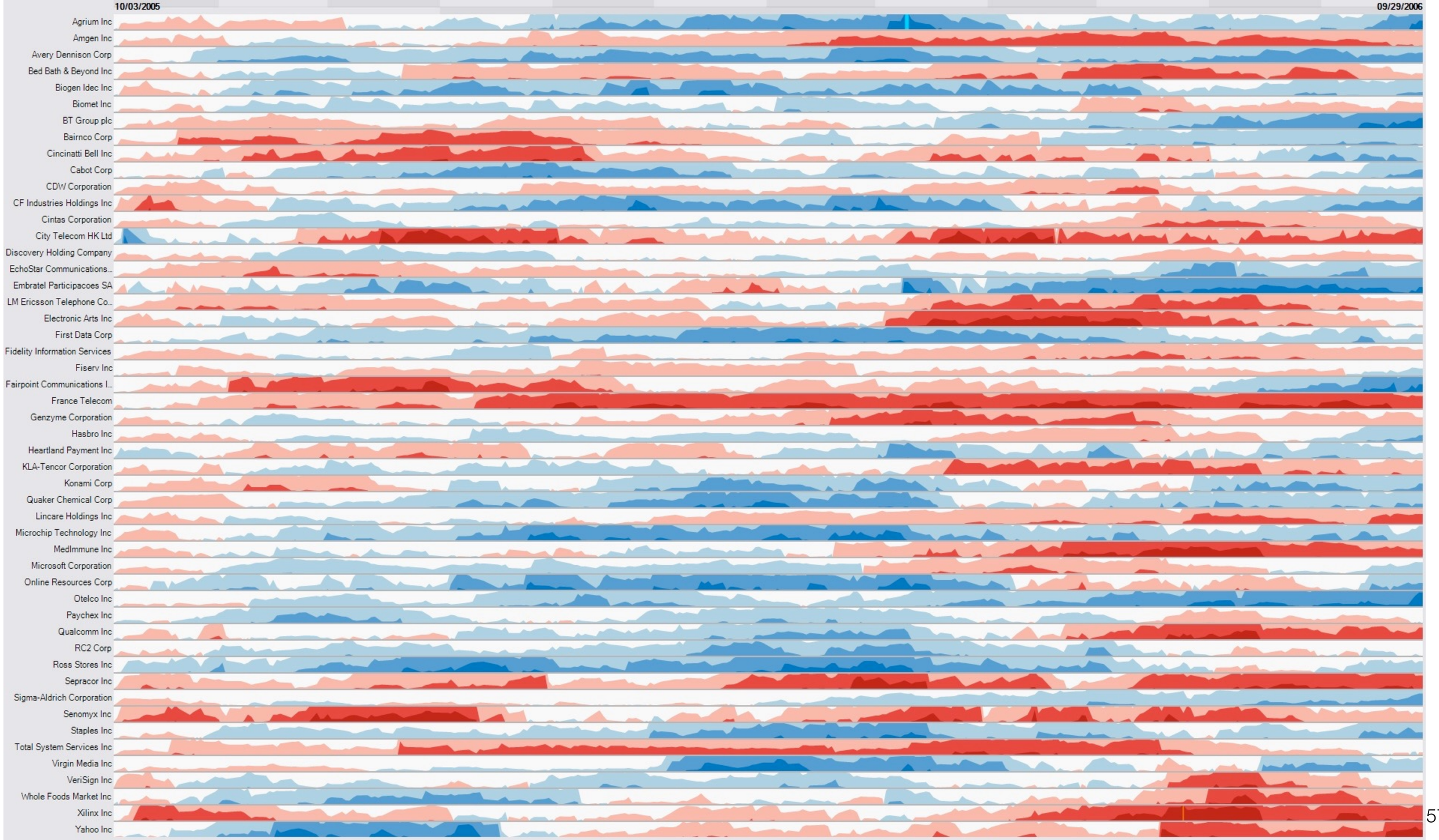


Relative Technology Stock Performance: Jan 2008 - Present




10/03/2005
09/29/2006
Agrium Inc
Amgen Inc
Avery Dennison Corp
Bed Bath & Beyond Inc
Biogen Idec Inc
Biomet Inc
BT Group plc
Bairnco Corp
Cincinatti Bell Inc
Cabot Corp
CDW Corporation
CF Industries Holdings Inc
Cintas Corporation
City Telecom HK Ltd
Discovery Holding Company
EchoStar Communications...
Embratel Participacoes SA
LM Ericsson Telephone Co...
Electronic Arts Inc
First Data Corp
Fidelity Information Services
Fiserv Inc
Fairpoint Communications I...
France Telecom
Genzyme Corporation
Hasbro Inc
Heartland Payment Inc
KLA-Tencor Corporation
Konami Corp
Quaker Chemical Corp
Lincare Holdings Inc
Microchip Technology Inc
MedImmune Inc
Microsoft Corporation
Online Resources Corp
Otelco Inc
Paychex Inc
Qualcomm Inc
RC2 Corp
Ross Stores Inc
Sepracor Inc
Sigma-Aldrich Corporation
Senomyx Inc
Staples Inc
Total System Services Inc
Virgin Media Inc
VeriSign Inc
Whole Foods Market Inc
Xilinx Inc
Yahoo Inc

What are some possible strengths / weaknesses of horizon graphs?

Join at

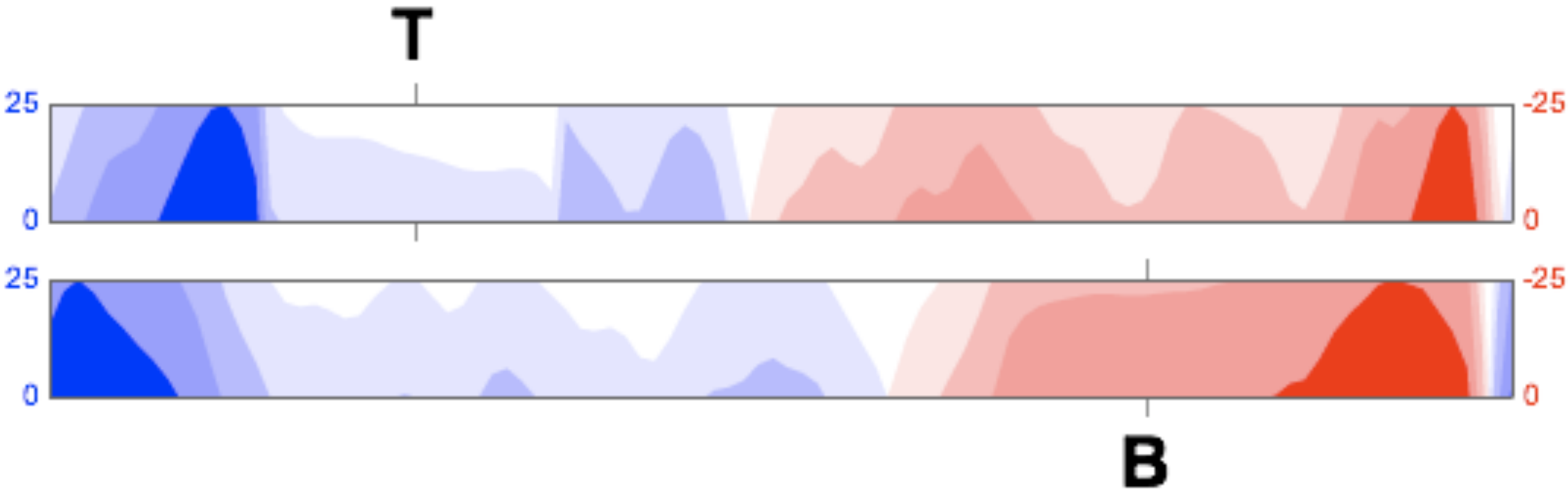
slido.com

#5829

Experiment: Chart Type & Size

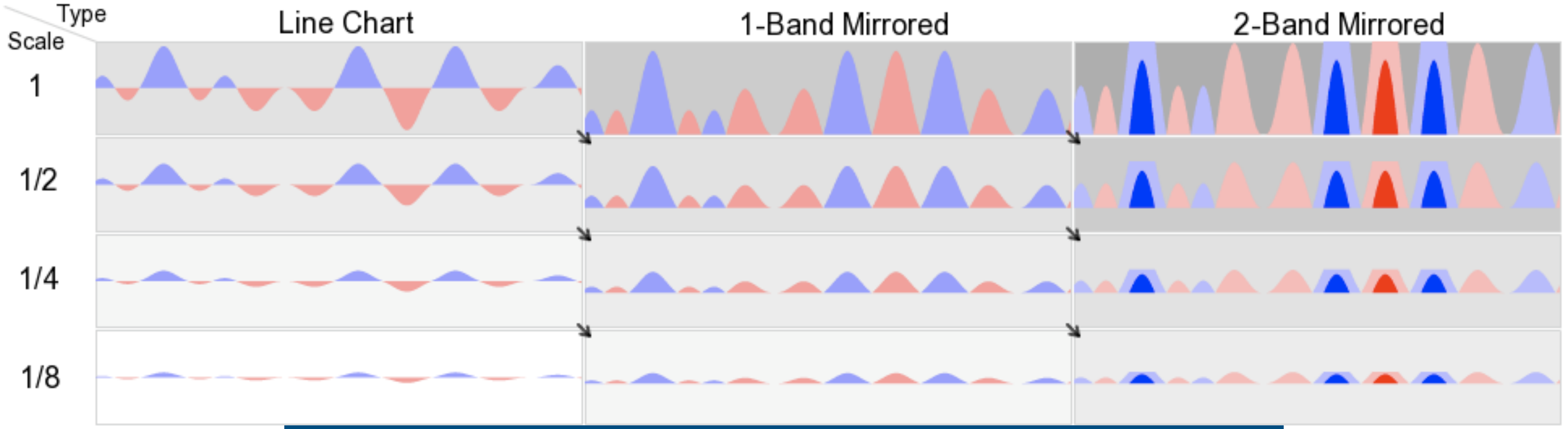
Q1: How do mirroring and layering affect estimation time and accuracy compared to line charts?

Q2: How does chart size affect estimation time and accuracy?



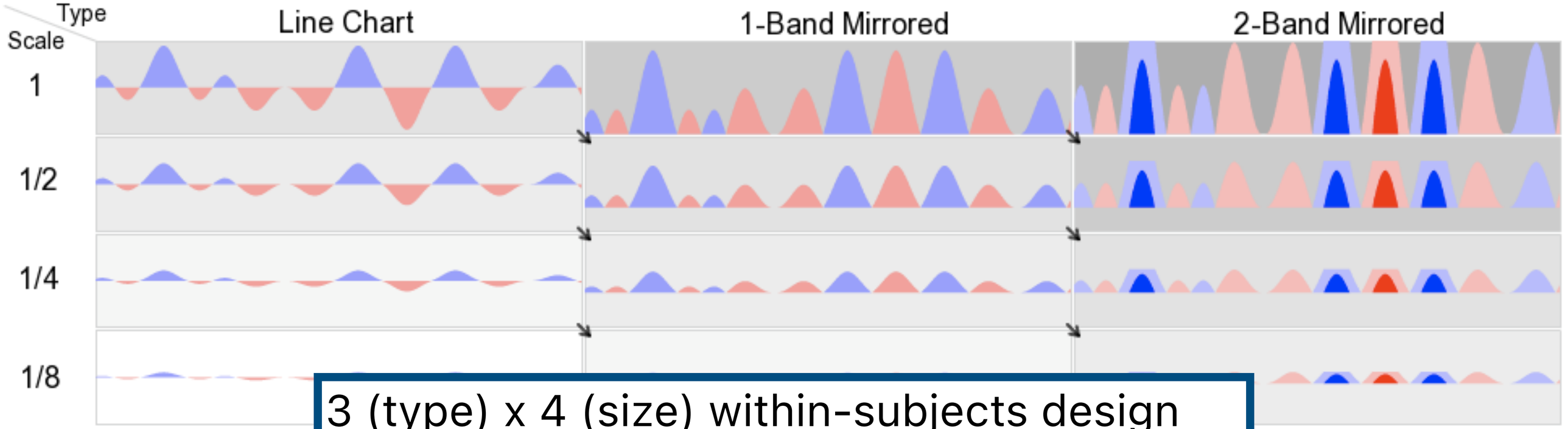
Estimate the difference between T and B (0-200) to within 5 values.

Experiment Design



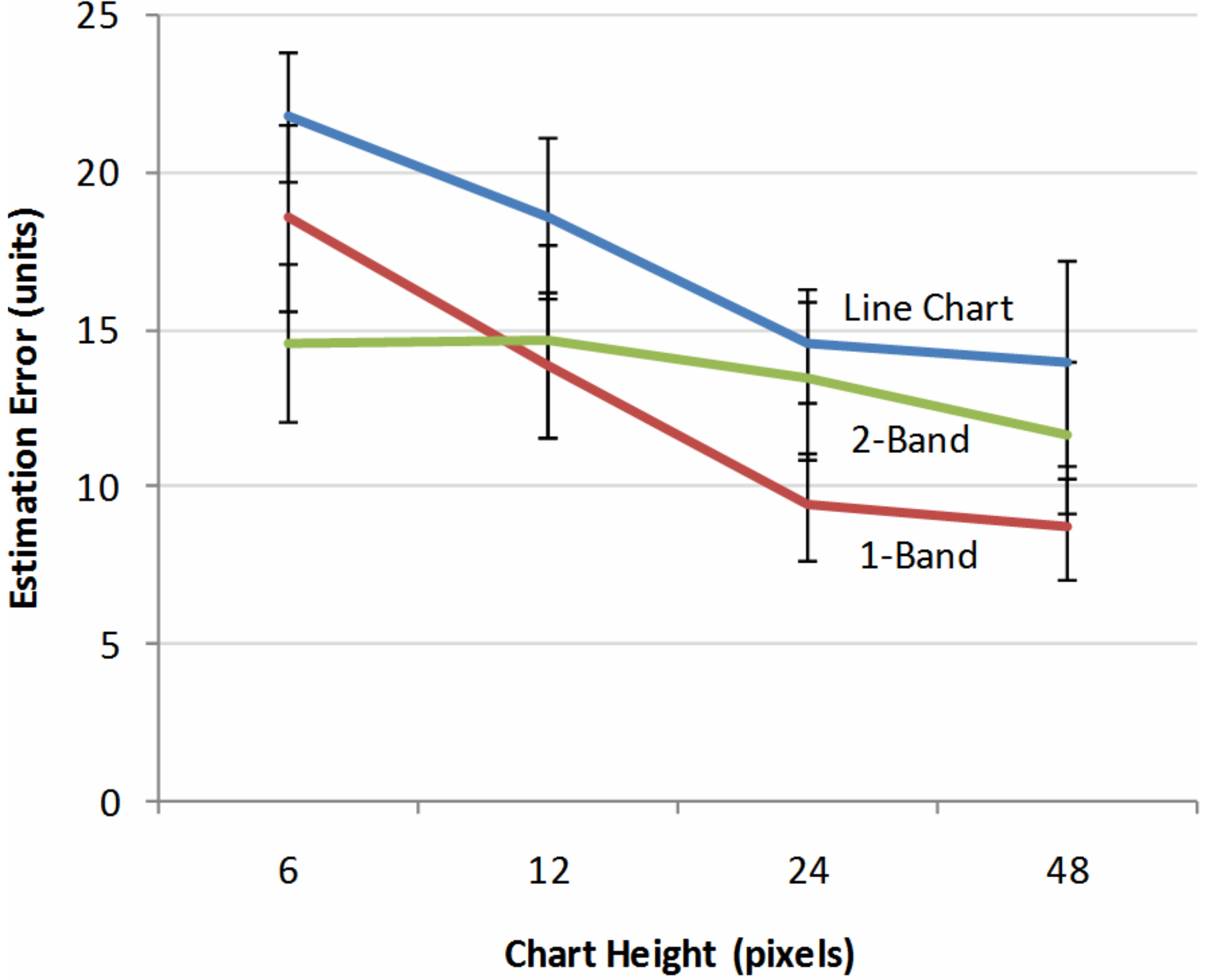
3 (chart type) x 4 (size) within-subjects design
N = 30 (17 male, 13 female), undergrads
14.1 inch LCD display, 1024 x 768 resolution
At scale = 1, chart is 13.9 x 1.35 cm (48 px)

Experiment Design



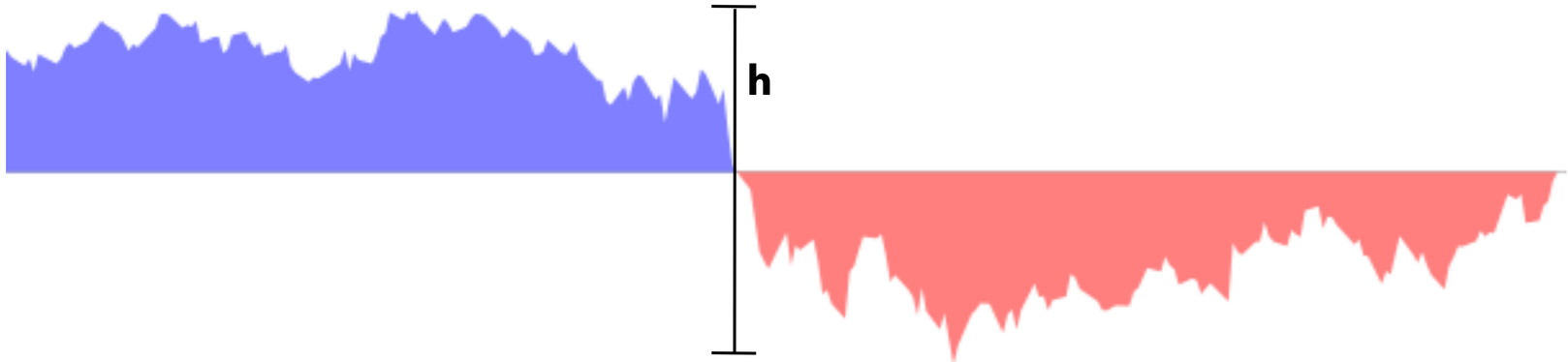
3 (type) x 4 (size) within-subjects design
N = 30 (17 male, 13 female), undergrads

2 (type) x 3 (size:1/8, 1/12, 1/24) follow-up
N = 8 (6 male, 2 female), engineering grads

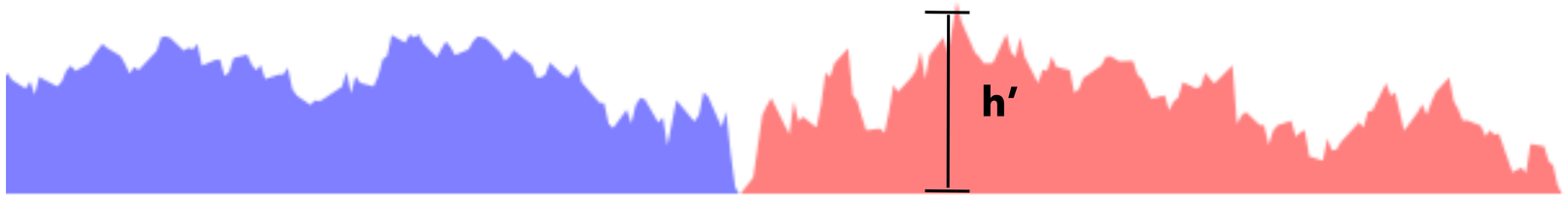

Estimation Error (units)
25
20
15
10
5
0
6
12
24
48
Chart Height (pixels)
Line Chart
2-Band
1-Band

Virtual Resolution (VR)

The un-mirrored, un-layered height of a chart

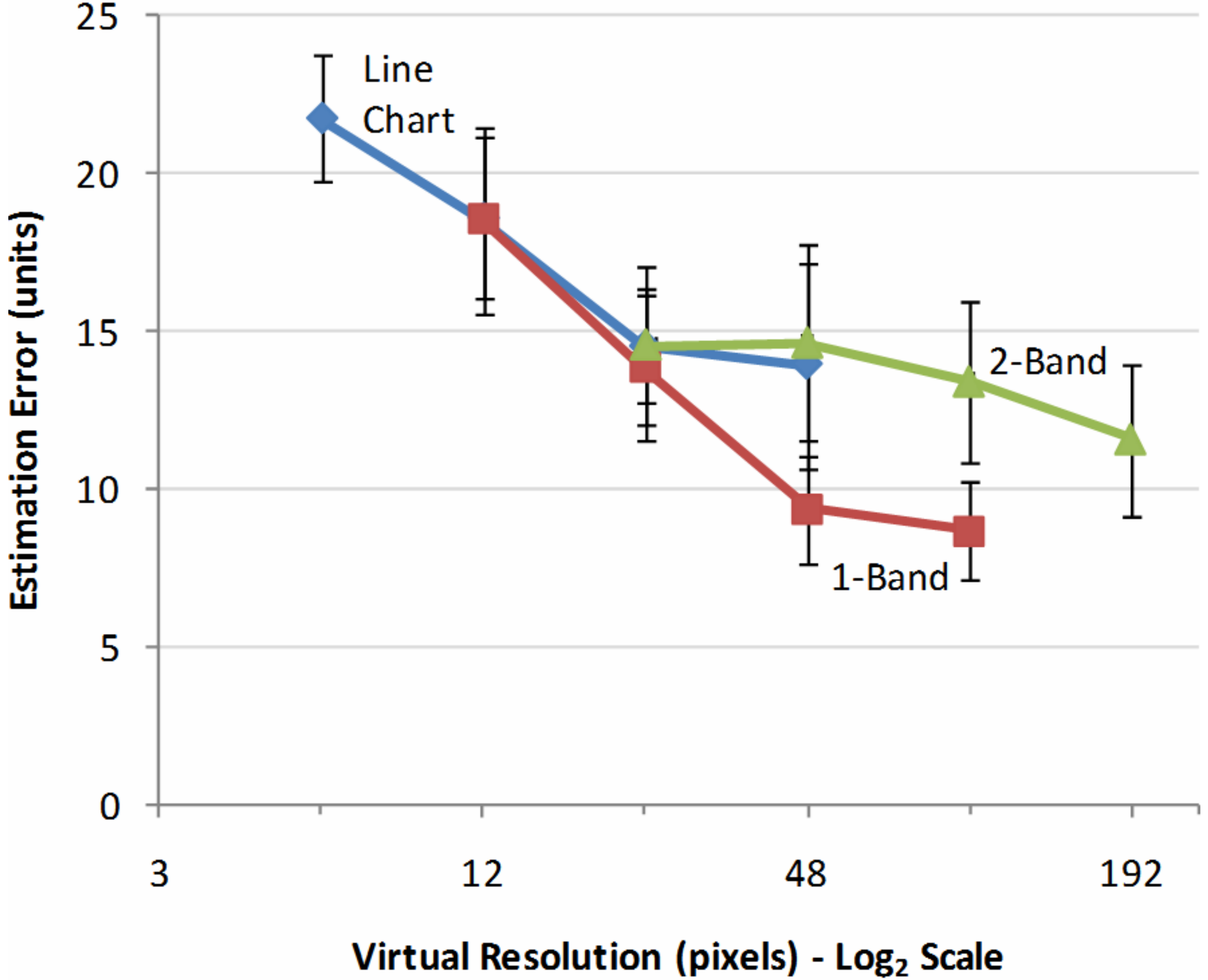


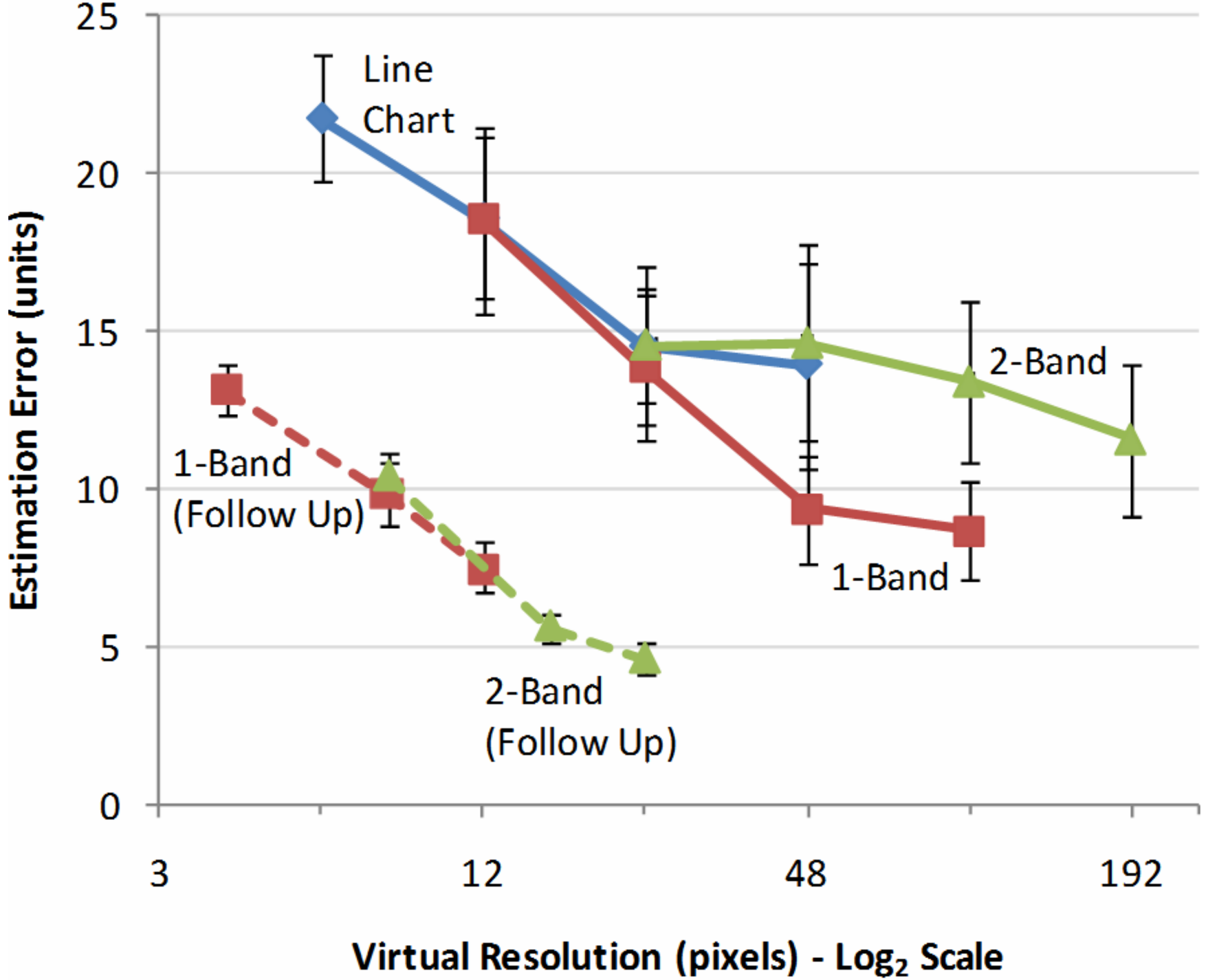
VR = h

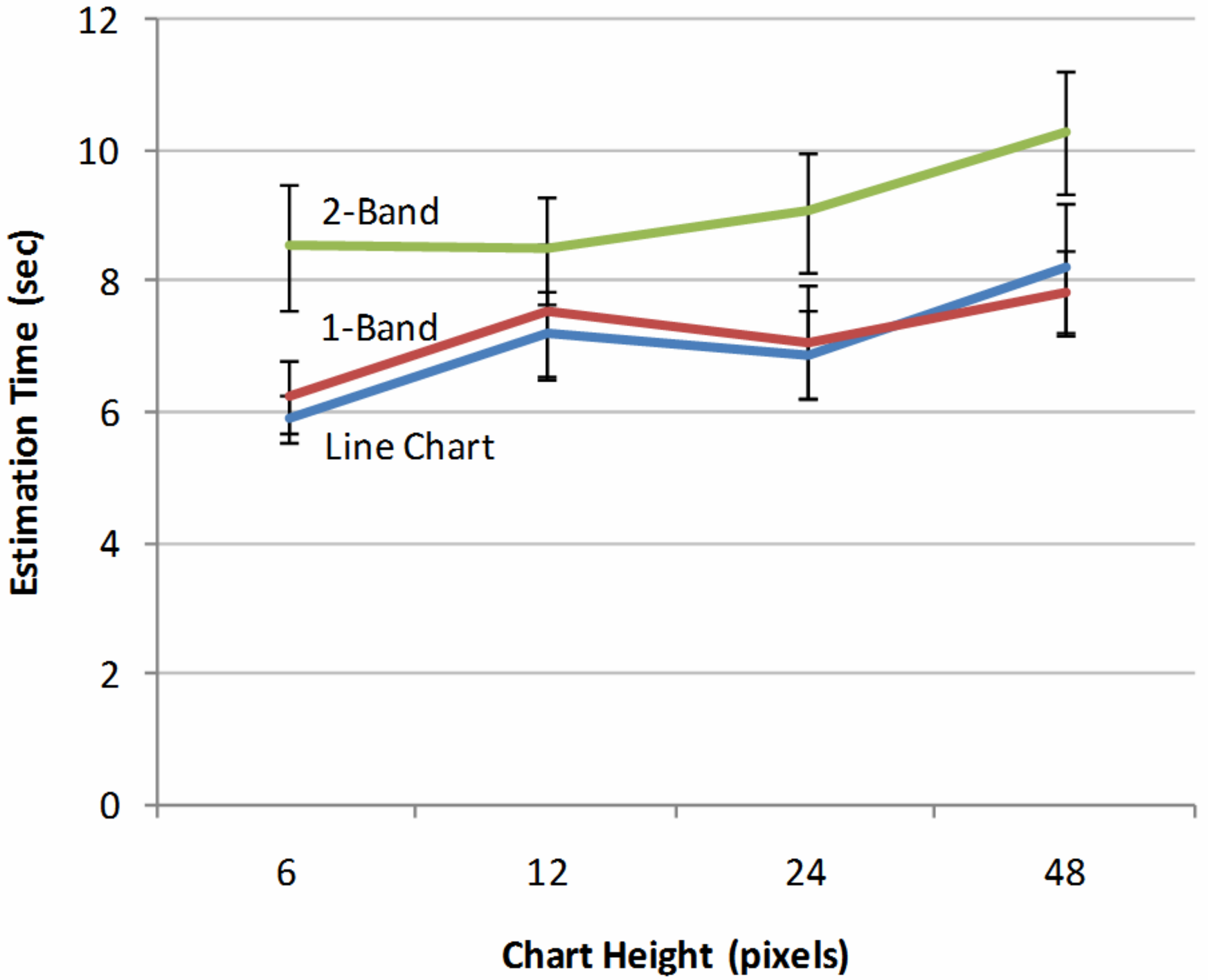


VR = 2h' = h

VR = 4h'' = h


25
20
15
10
5
0
Estimation Error (units)
Line
Chart
2-Band
1-Band
3
12
48
192
Virtual Resolution (pixels) - Log2 Scale


25
20
15
10
5
0
Estimation Error (units)
Line
Chart
2-Band
1-Band
1-Band
(Follow Up)
2-Band
(Follow Up)
3
12
48
192
Virtual Resolution (pixels) - Log2 Scale


12
10
8
6
4
2
0
Estimation Time (sec)
2-Band
1-Band
Line Chart
6
12
24
48
Chart Height (pixels)

Results

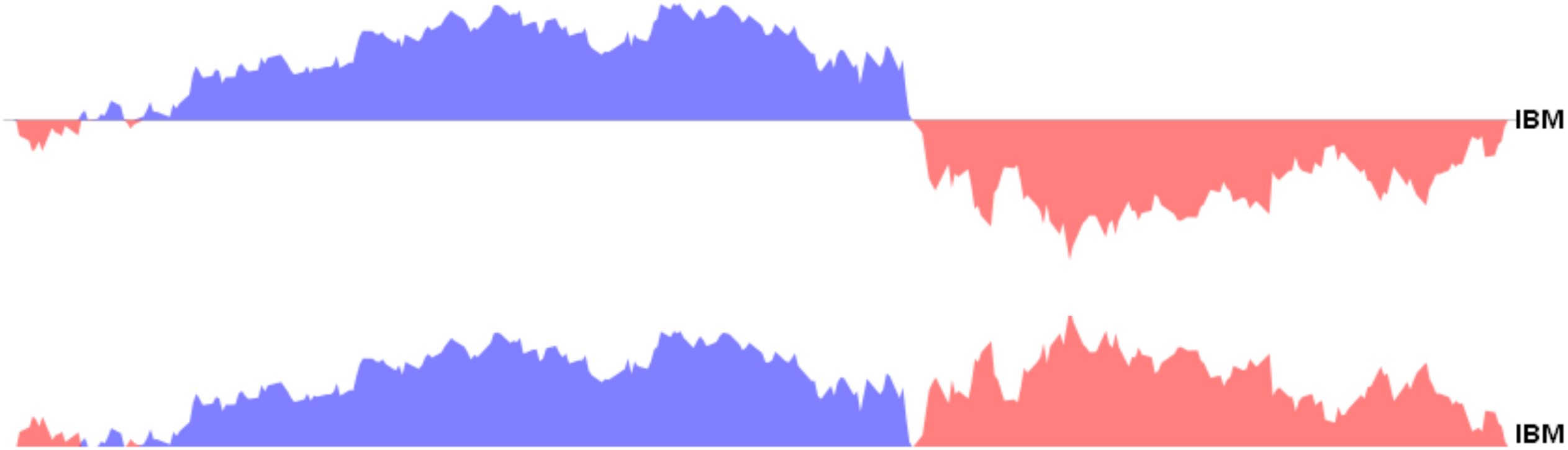
Q1: 2-band horizon graph (but not mirrored graph) has higher baseline estimation time and error.

Q2: Estimation error increases as the *virtual resolution* decreases.

Estimation time decreases as the *physical height* decreases.

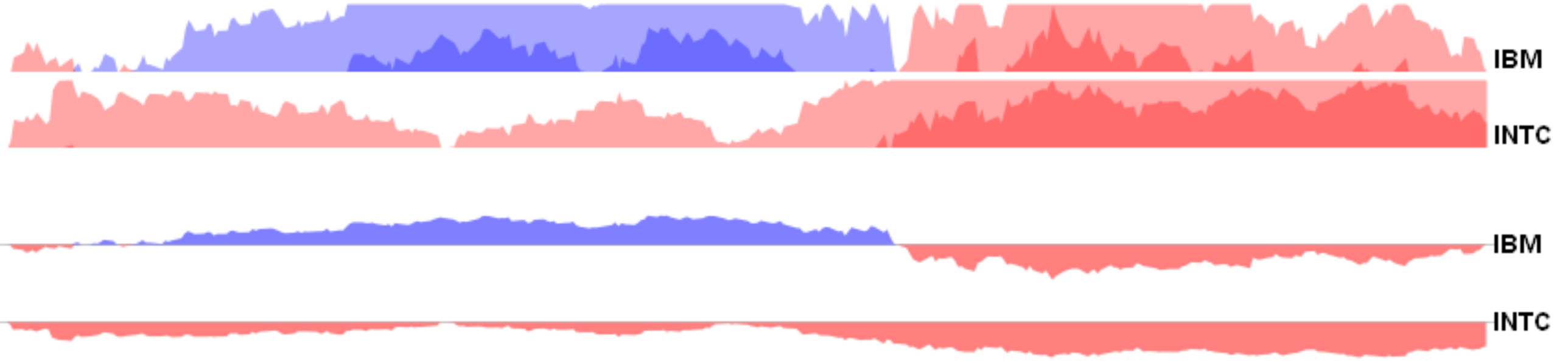
Design Guidelines

Mirroring does not hamper perception



Design Guidelines

Mirroring does not hamper perception
Layered bands beneficial for smaller charts



Design Guidelines

Mirroring does not hamper perception
Layered bands beneficial for smaller charts
Optimal chart sizing

Sweet spots in time/error curves
6.8mm (24 px) for line chart & mirrored chart
3.4mm (12 px) for 2-band horizon graph

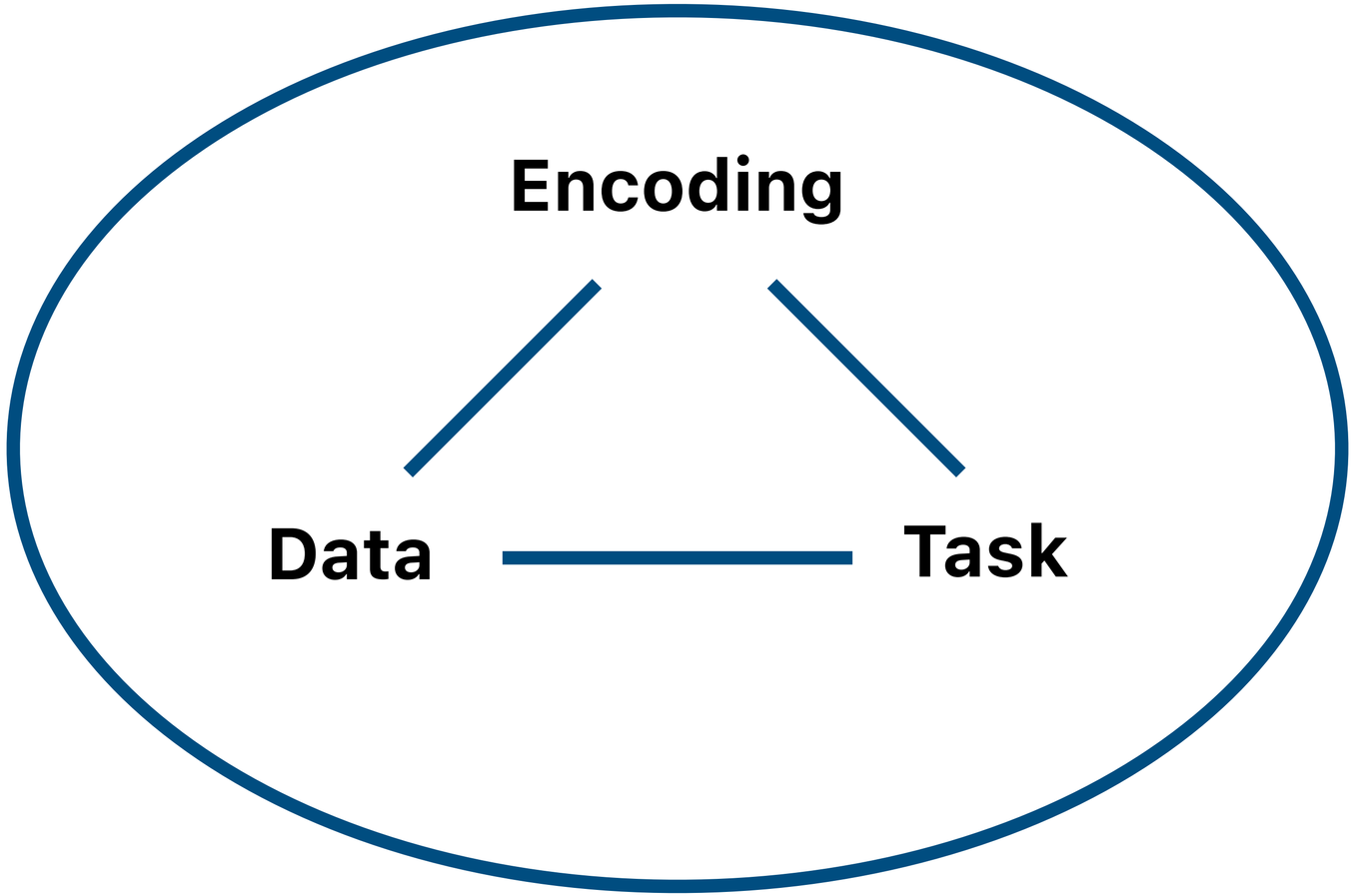
Today

Evaluating Trees

Evaluating Spatial Navigation

Data Density of Time Series

Conclusion



Users & Domain

Today

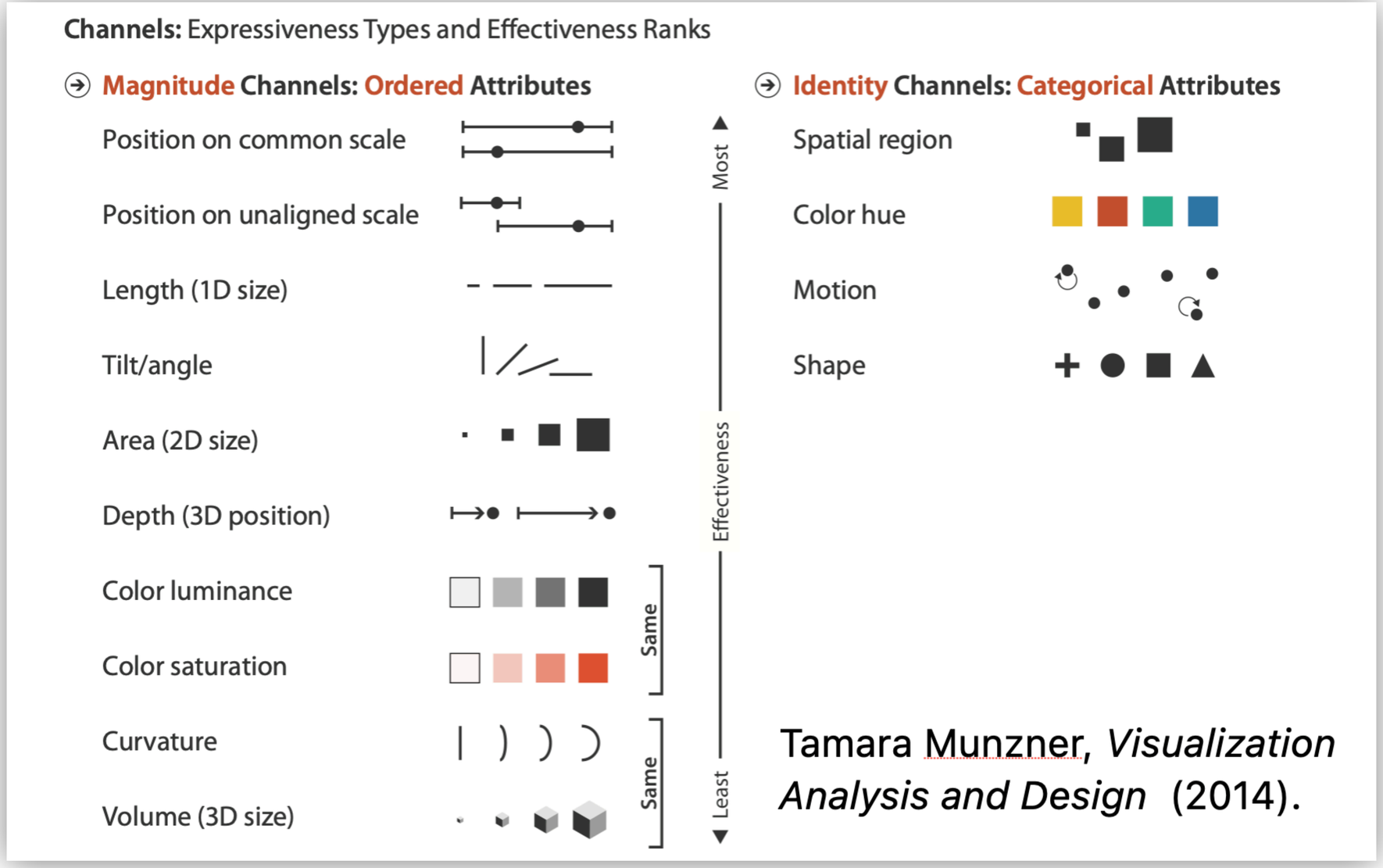
Evaluating Trees

Evaluating Spatial Navigation

Data Density of Time Series

Conclusion

Data and Image Models



Visual Encoding and Dark Patterns

Truncating the y-axis?

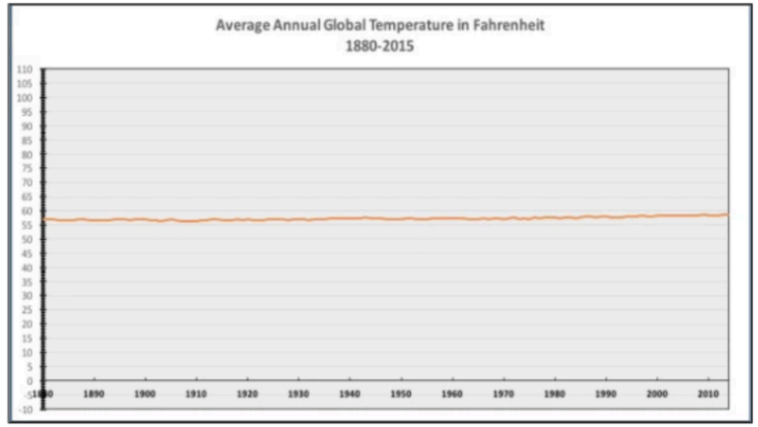
To emphasize Q-interval (vs. Q-ratio)
If the zero value doesn't make much sense.
If it is the norm (e.g., stock charts).

National Review
@NRO

Follow

The only #climatechange chart you need to see. natl.re/wPKpro

(h/t @powerlineUS)

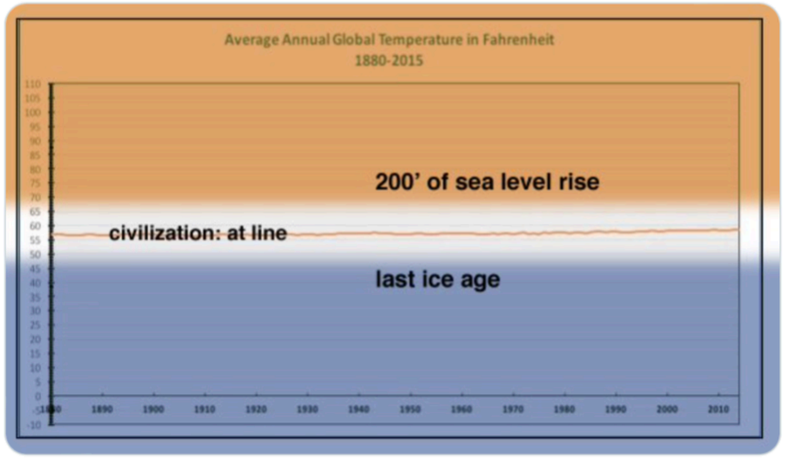


12:36 PM - 14 Dec 2015

City Atlas
@cityatlas

Replying to @NRO

.@NRO @powerlineUS @bradplumer I'm sure someone else has fixed this for you, but here you go. Great idea, thx --



5:28 PM · Dec 14, 2015

78 Retweets **1** Quote Tweet **208** Likes

39

Perception

Graphical Perception Studies

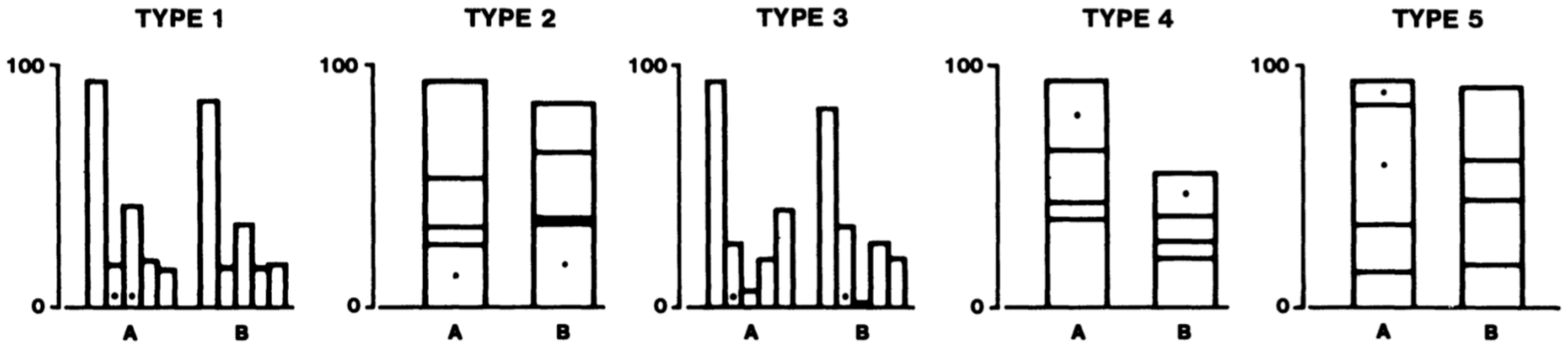


Figure 4. Graphs from position–length experiment.

What proportion is the smaller marked section of the larger?

Cleveland, William S., and Robert McGill. "Graphical perception: Theory, experimentation, and application to the development of graphical methods." 1984

23

Color

CIE XYZ Color Space

Display gamut = portion of the color space that can be reproduced by a display.

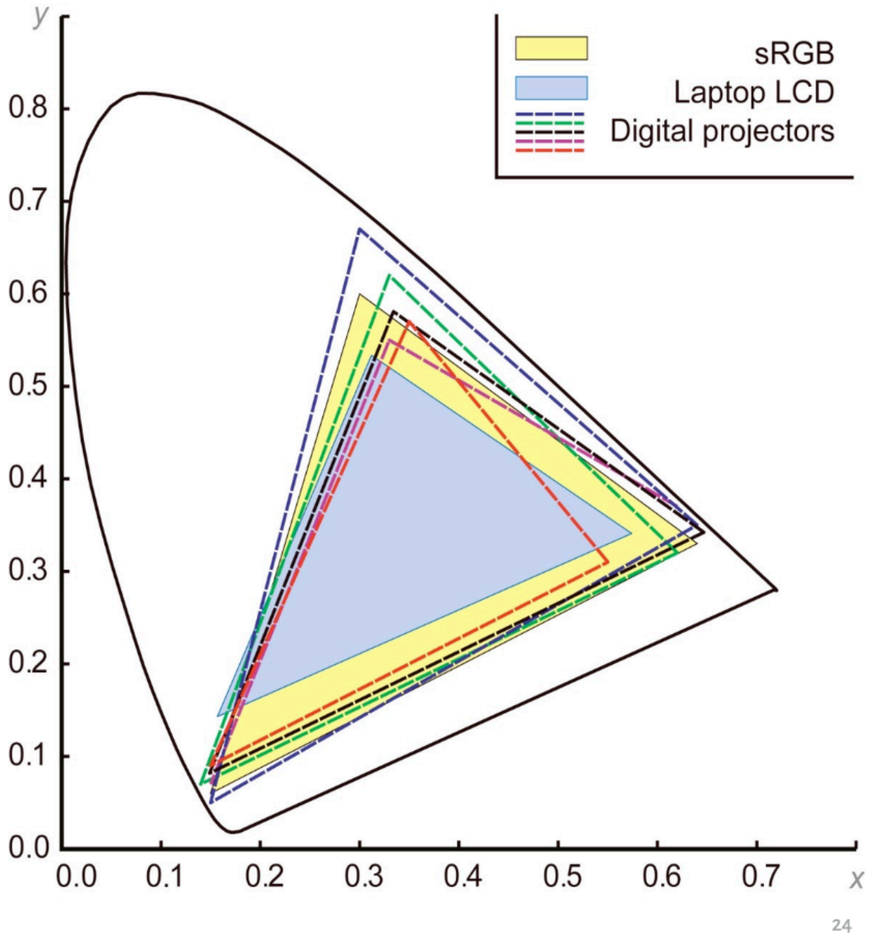
The angry rainbow in sRGB.

Corners of sRGB

Photoshop grayscale

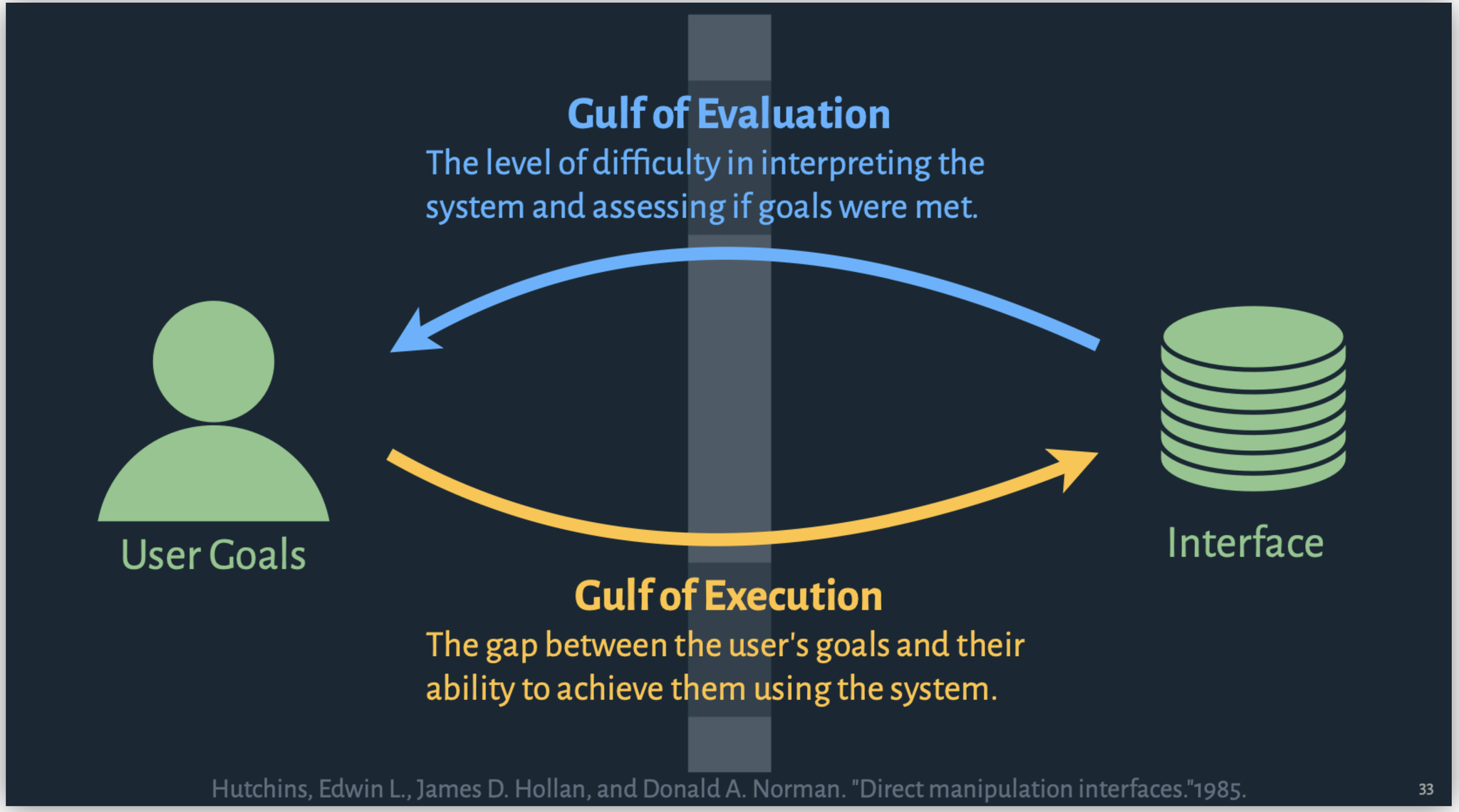
No linear brightness gradient within a single hue.

[Greeor Aisch How to Avoid Equidistant HSV Colors.]

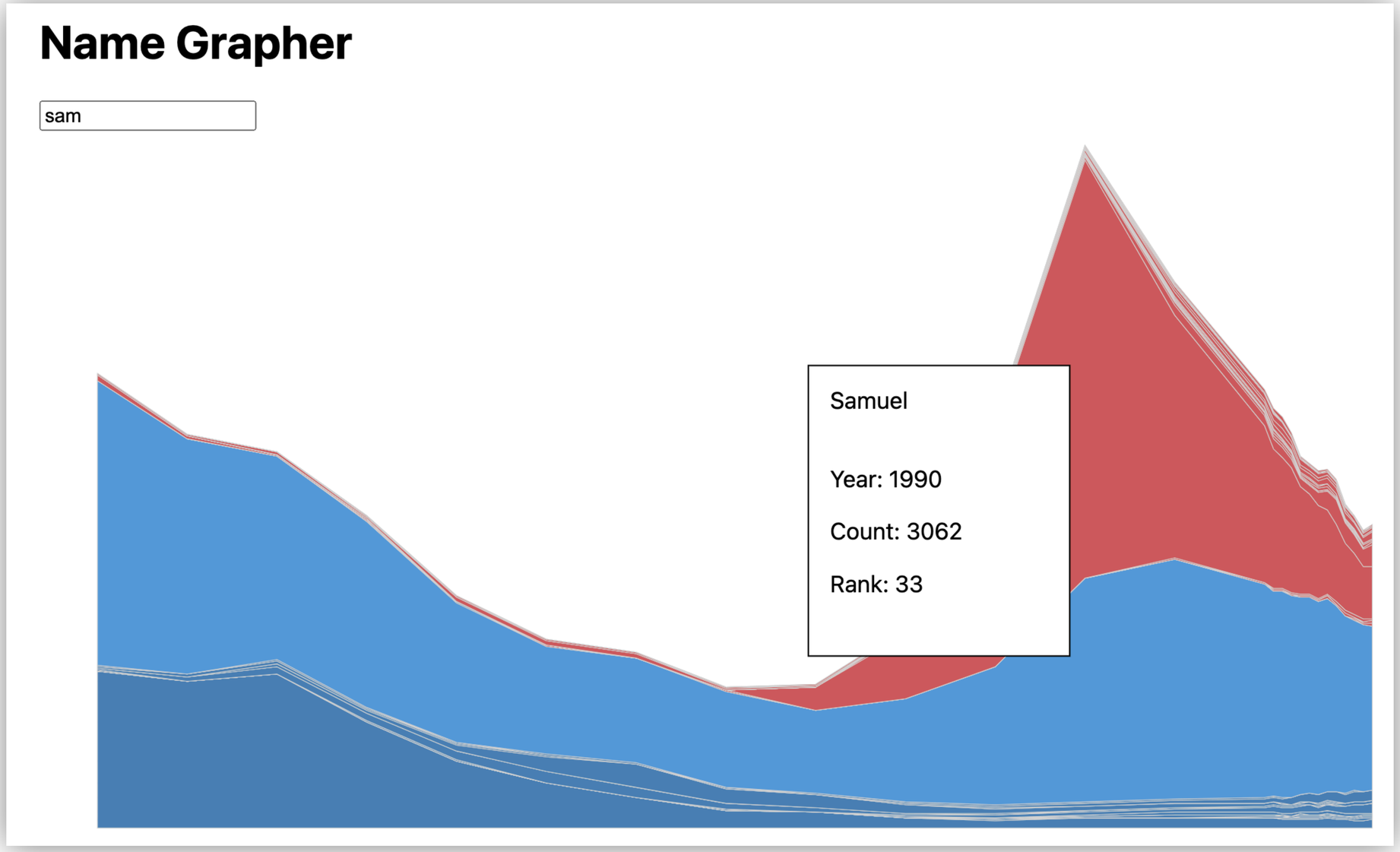


24

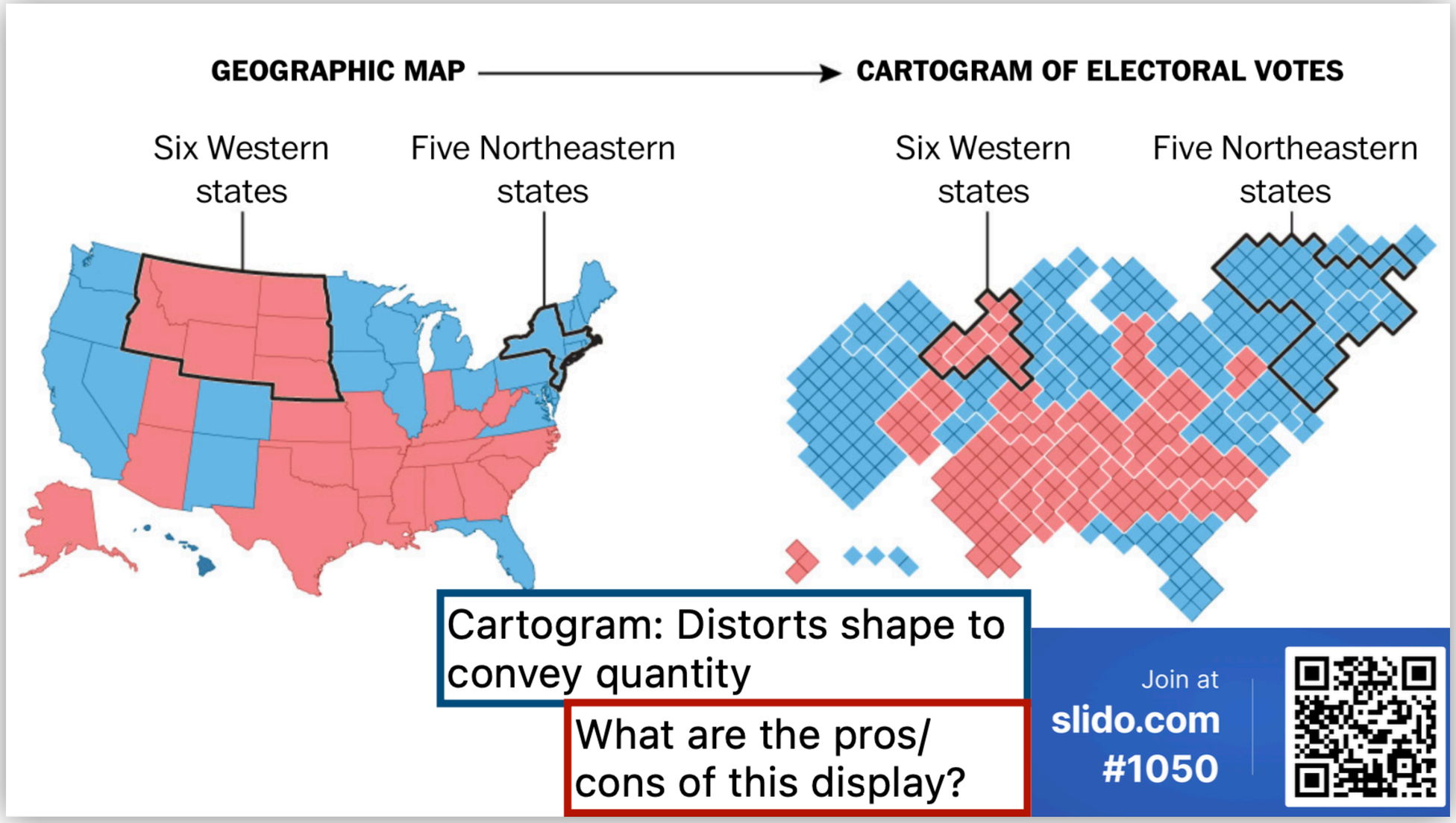
Interaction



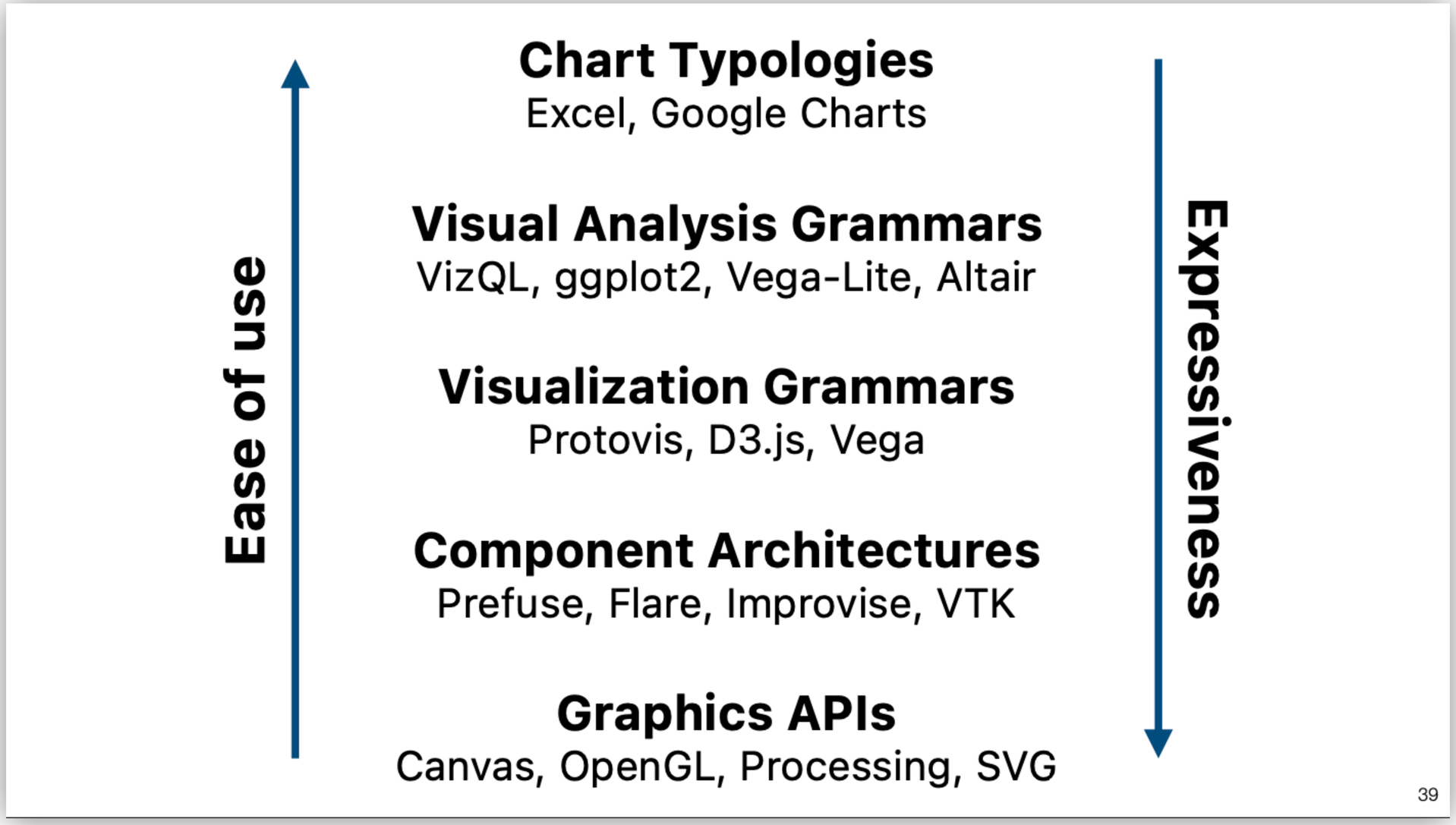
JavaScript, Svelte, D3



Maps

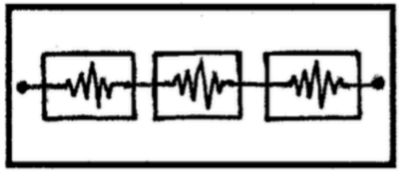

GEOGRAPHIC MAP
CARTOGRAM OF ELECTORAL VOTES
Six Western states
Five Northeastern states
Six Western states
Five Northeastern states
Cartogram: Distorts shape to convey quantity
What are the pros/ cons of this display?
Join at
slido.com
#1050

Tools


Ease of use
Chart Typologies
Excel, Google Charts
Visual Analysis Grammars
VizQL, ggplot2, Vega-Lite, Altair
Visualization Grammars
Protovis, D3.js, Vega
Component Architectures
Prefuse, Flare, Improvise, VTK
Graphics APIs
Canvas, OpenGL, Processing, SVG
Expressiveness
39

Narrative

Interactive Slideshow



R2
D3

A visual introduction to machine learning

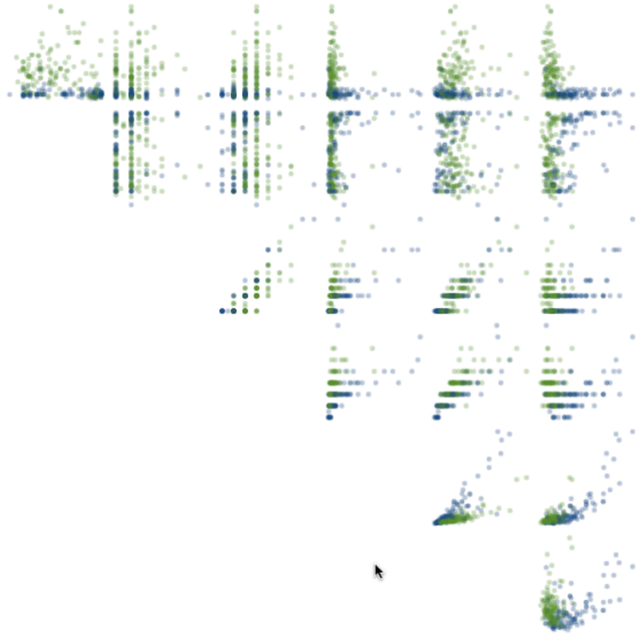
English

In machine learning, computers apply **statistical learning** techniques to automatically identify patterns in data. These techniques can be used to make highly accurate predictions.

Keep scrolling. Using a data set about homes, we will create a machine learning model to distinguish homes in New York from homes in San Francisco.

"Scrolly"-telling

SCROLL



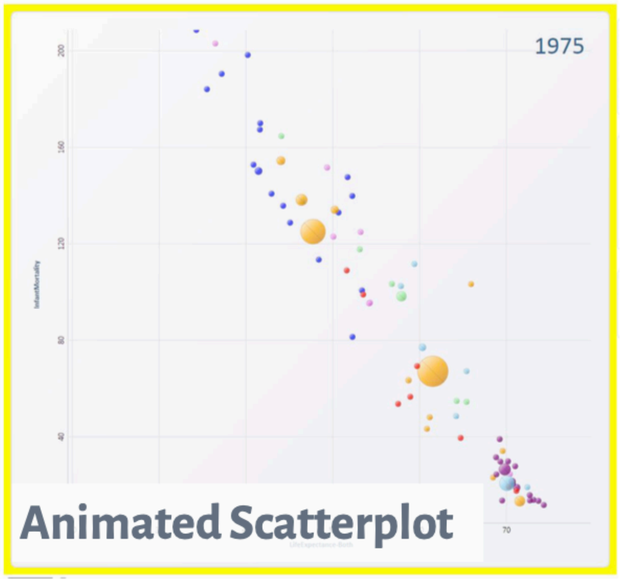
http://www.r2d3.us/visual-intro-to-machine-learning-part-1/

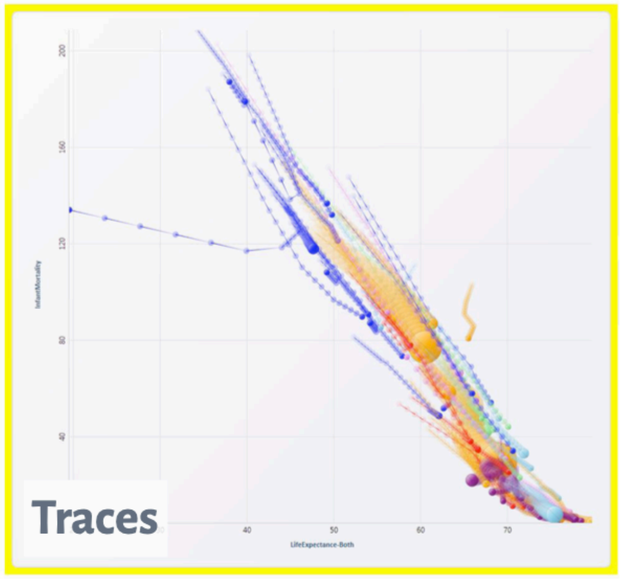
41

Animation

Study Conclusions

Analysis Task and Presentation Task.
Presentation condition included narration.
Subjects asked comprehension questions.



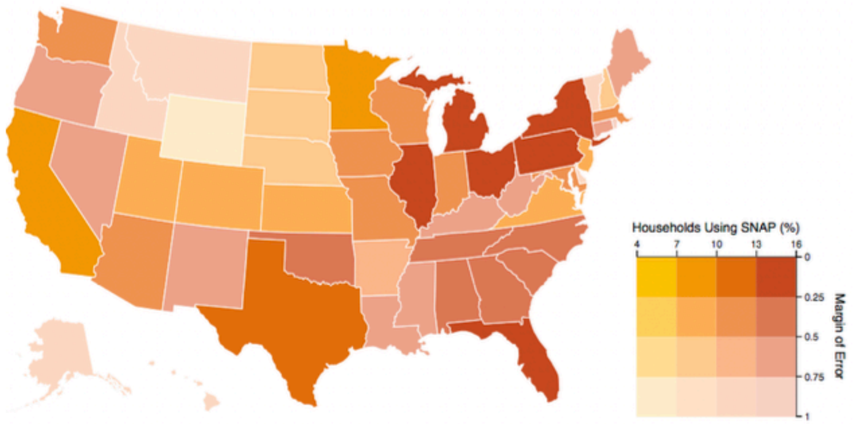


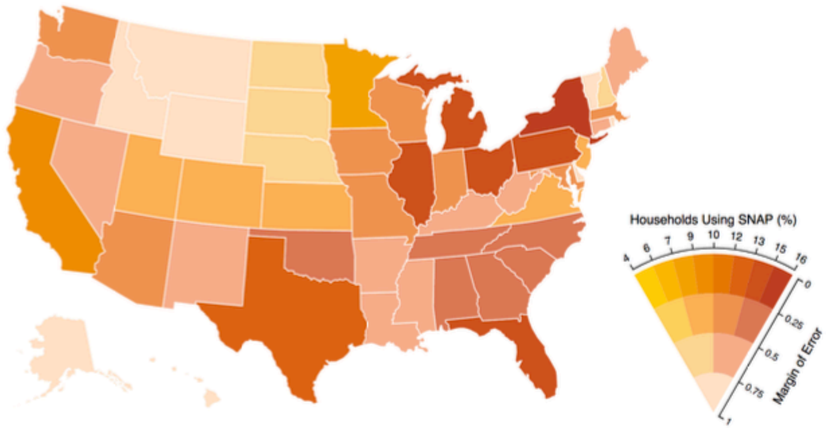
Which condition would participants:
be more **accurate**, be **faster**, and **prefer**?

Join at
slido.com
#4918

Uncertainty

For uncertainty, use **visual variables** instead of visualizing point estimates





Bivariate Map (Data + Uncertainty)

Value-Suppressing Uncertainty Map

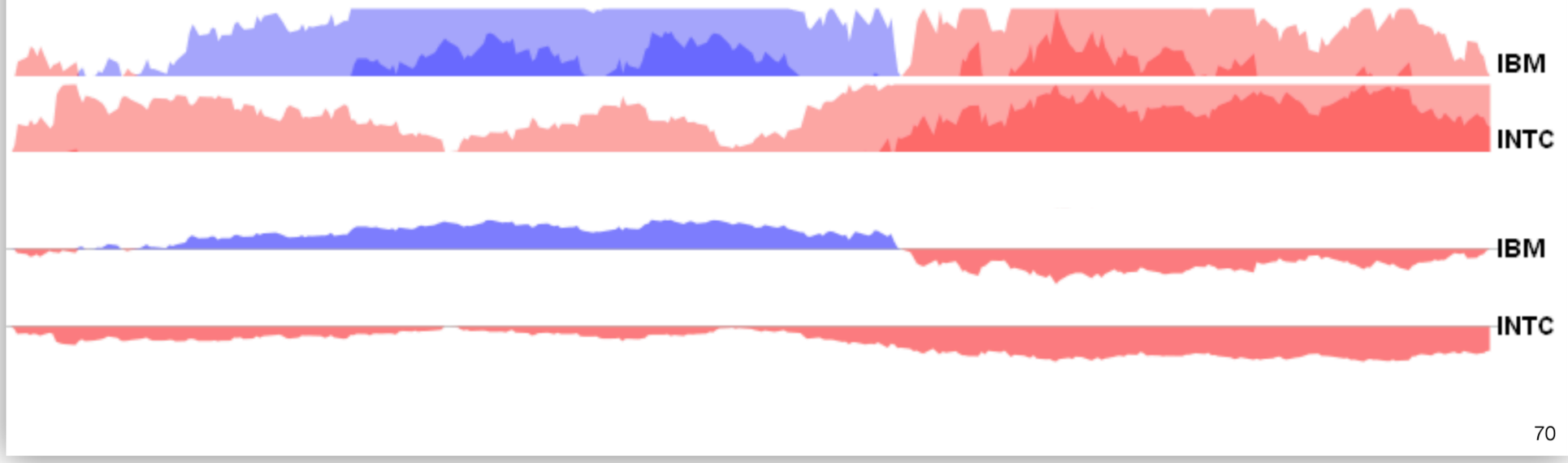
[Correll, Moritz, & Heer, 2018]

36

Evaluation

Design Guidelines

Mirroring does not hamper perception
Layered bands beneficial for smaller charts



Thank You!