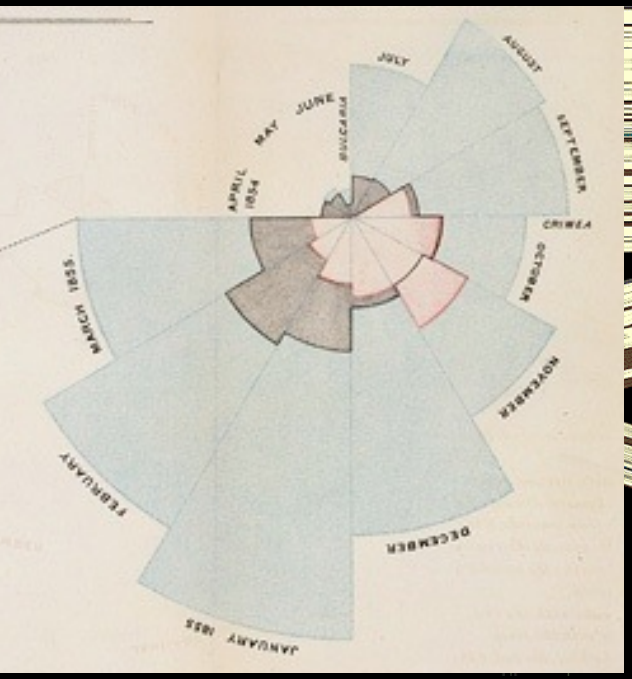
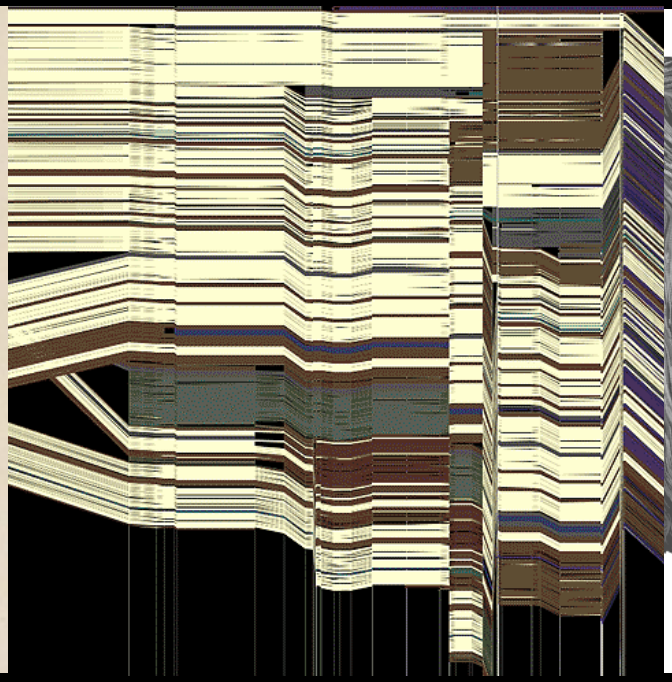
CSE 412 - Intro to Data Visualization

Animation





Jane Hoffswell University of Washington

Guest Lecture: Ethical & Deceptive

Friday Jan. 29 - Guest: Michael Correll (Tableau)

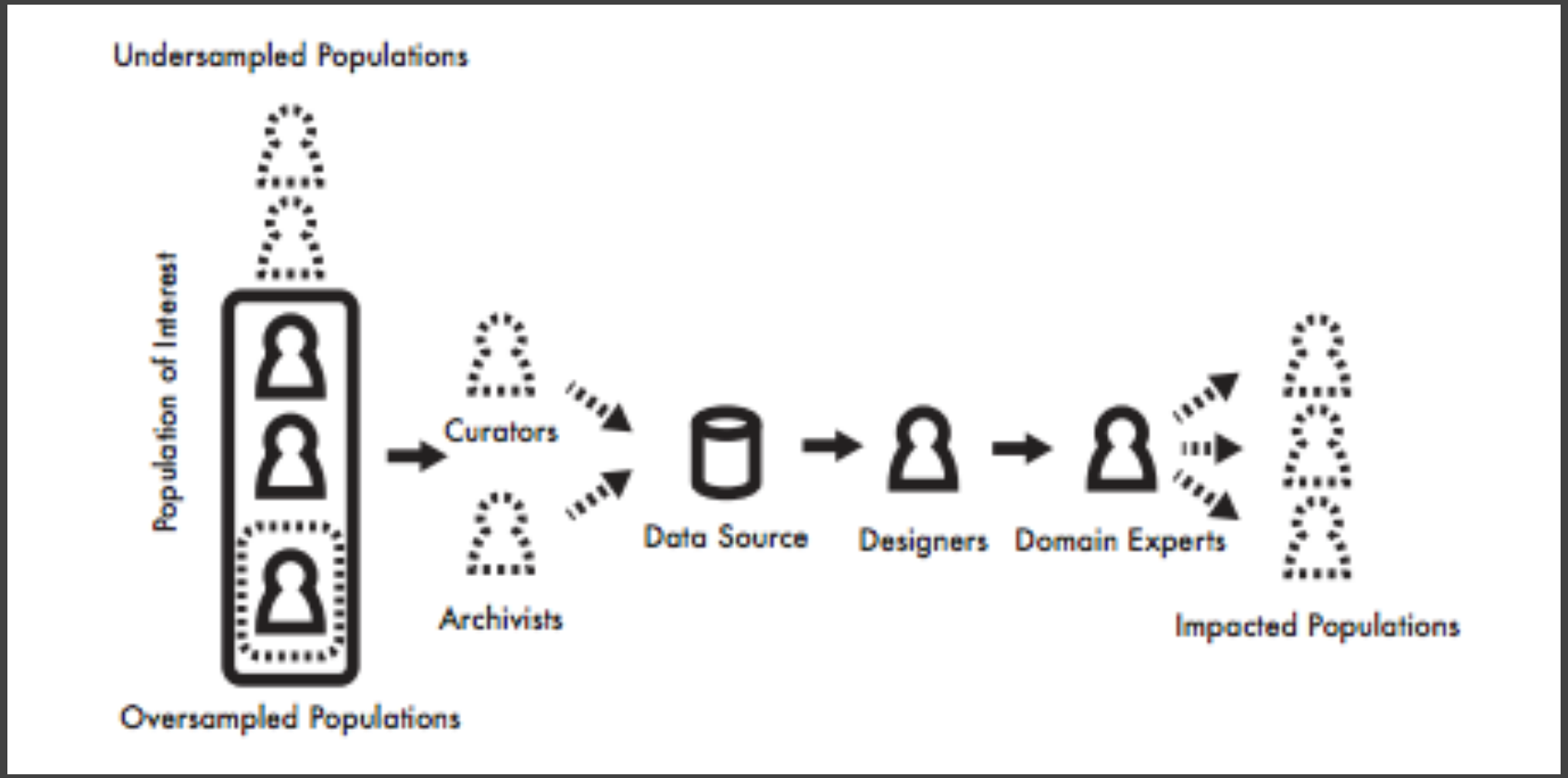


Image: "Ethical Dimensions of Visualization Research." Michael Correll. CHI 2019

Why Use Motion?

Visual variable to encode data

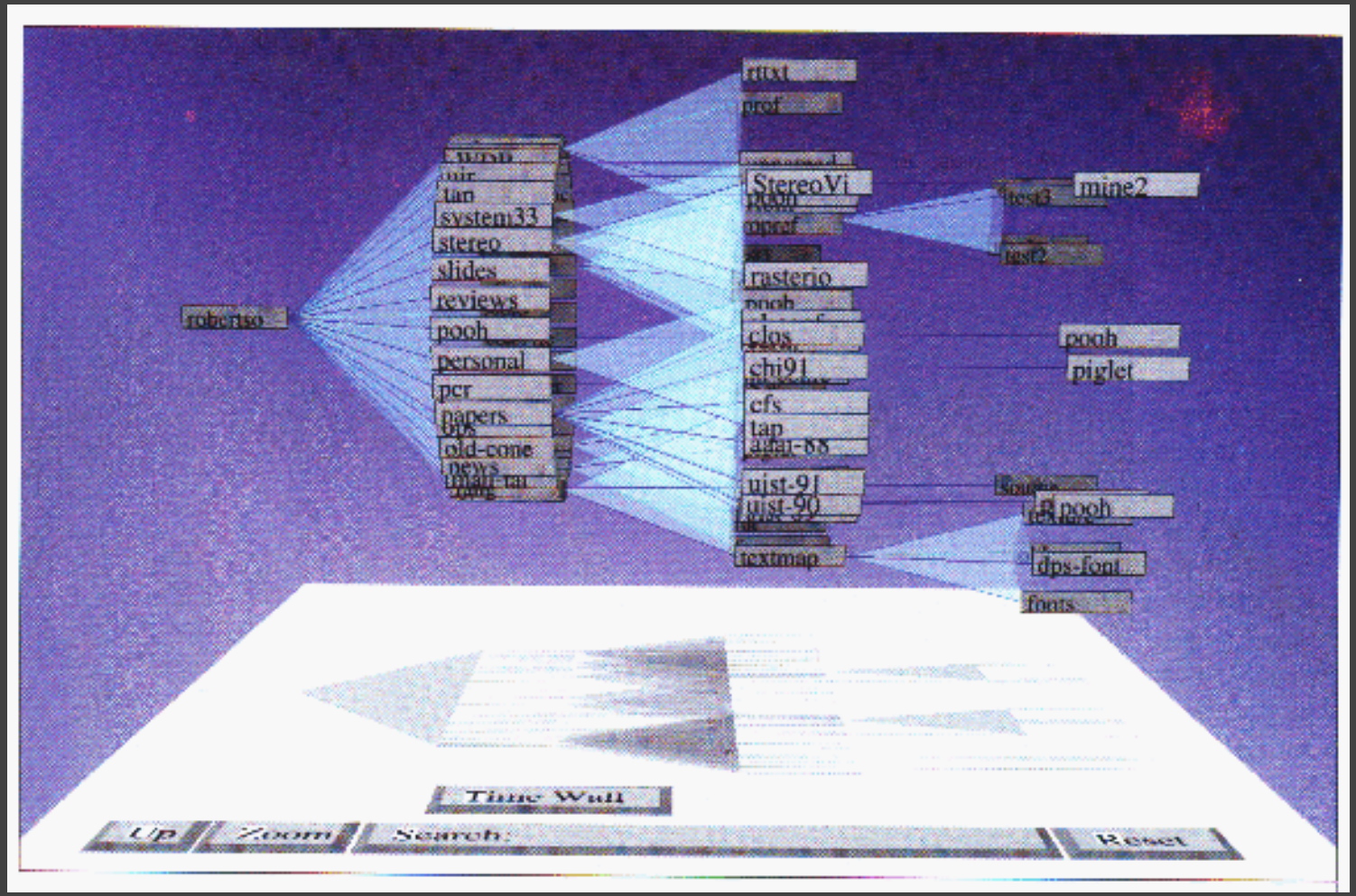
Direct attention

Understand system dynamics

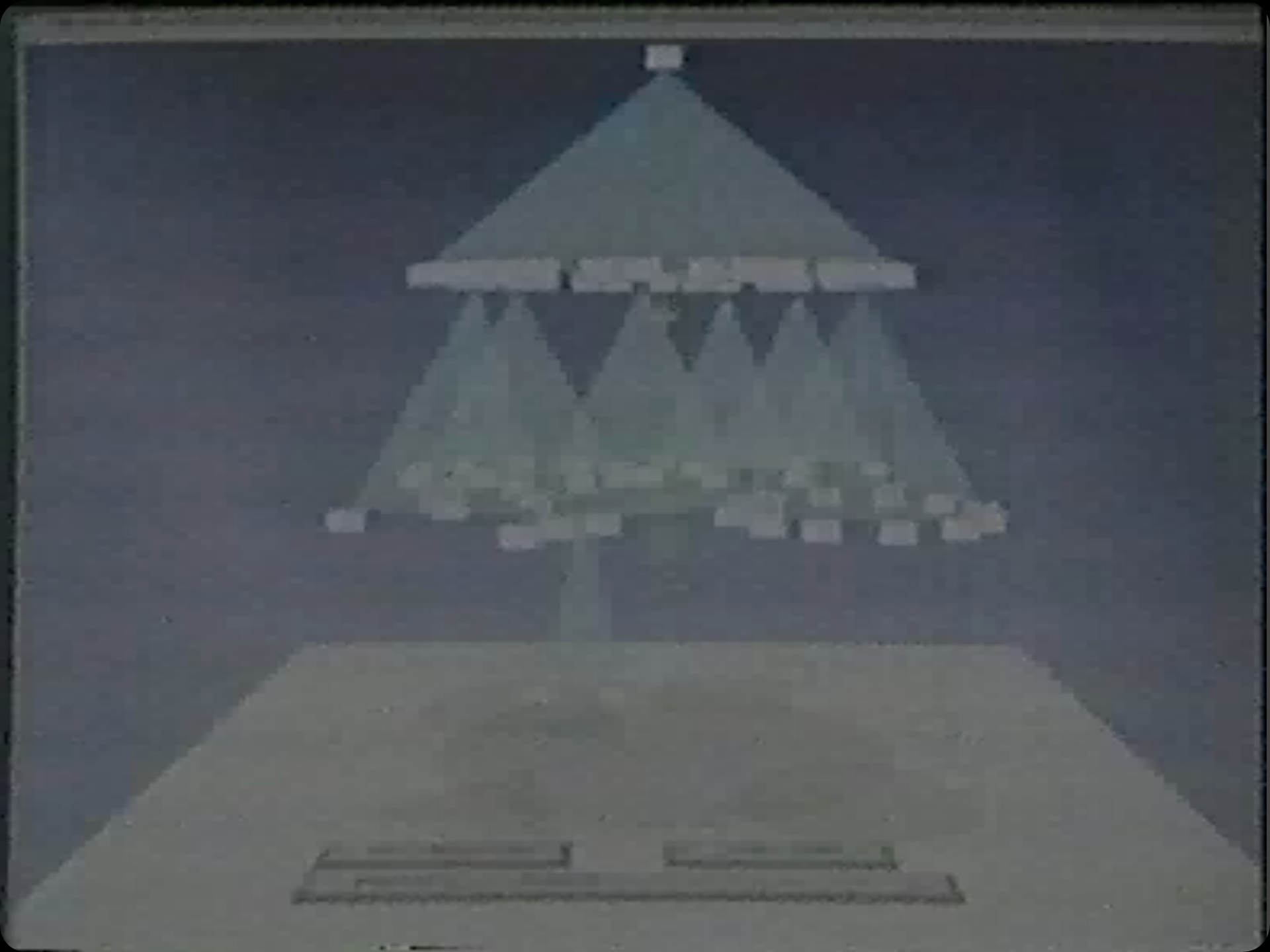
Understand state transition

Increase engagement

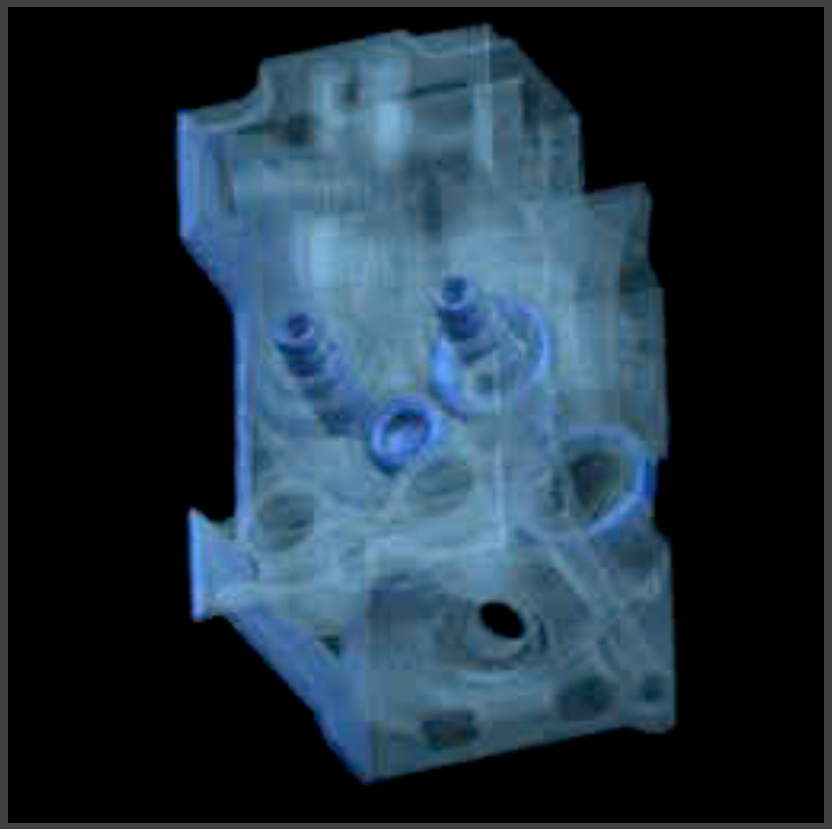
Cone Trees [Robertson 91]



Video

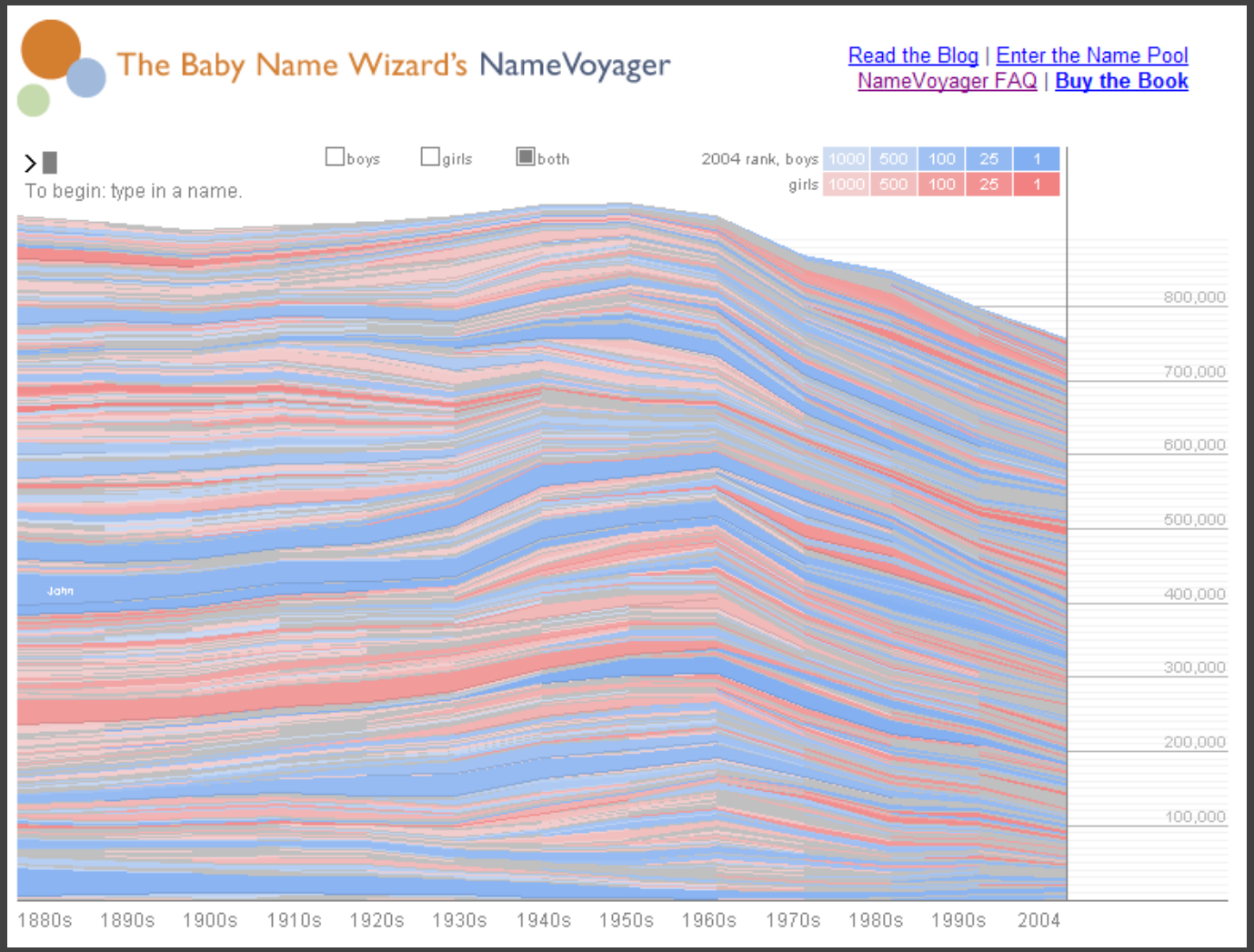


Volume Rendering [Lacroute 95]



Video

NameVoyager [Wattenberg 04]



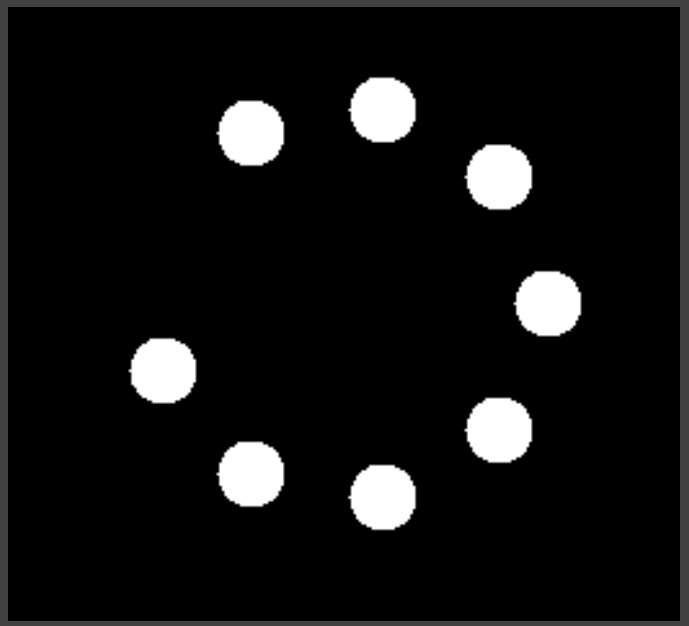
http://www.babynamewizard.com/namevoyager/lnv0105.html

Motion Perception

Perceiving Animation

Under what conditions does a sequence of static images give rise to motion perception?

Motion is perceived at about ~10 frames/sec (100 ms).



Motion as Visual Cue

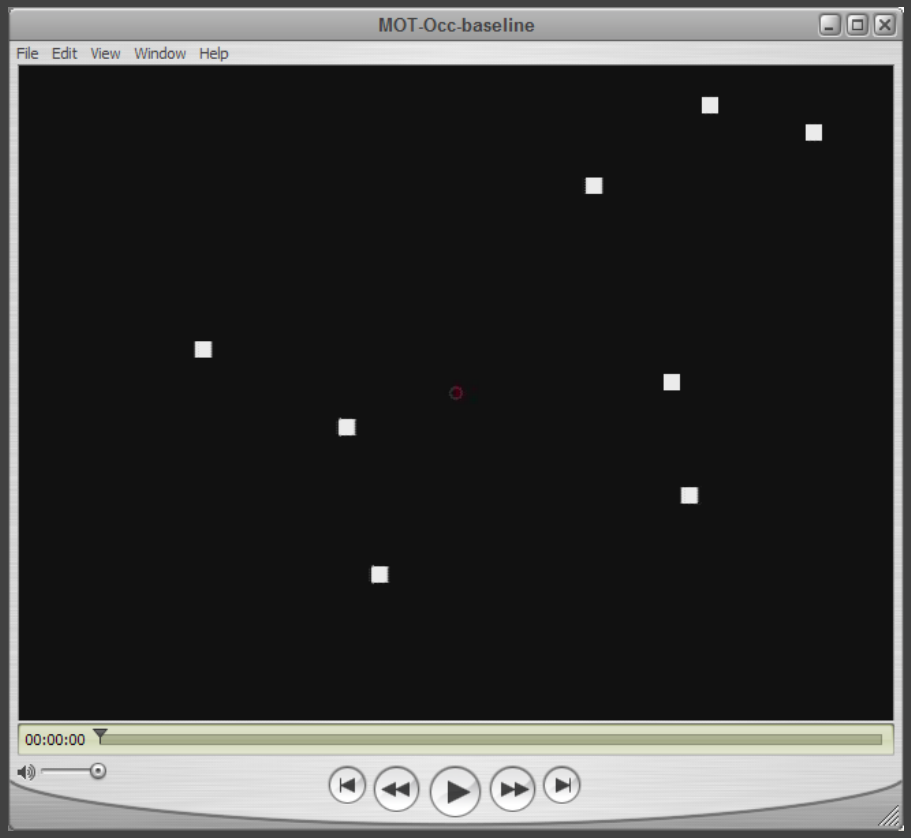
Pre-attentive, stronger than color, shape, …

More sensitive to motion at periphery

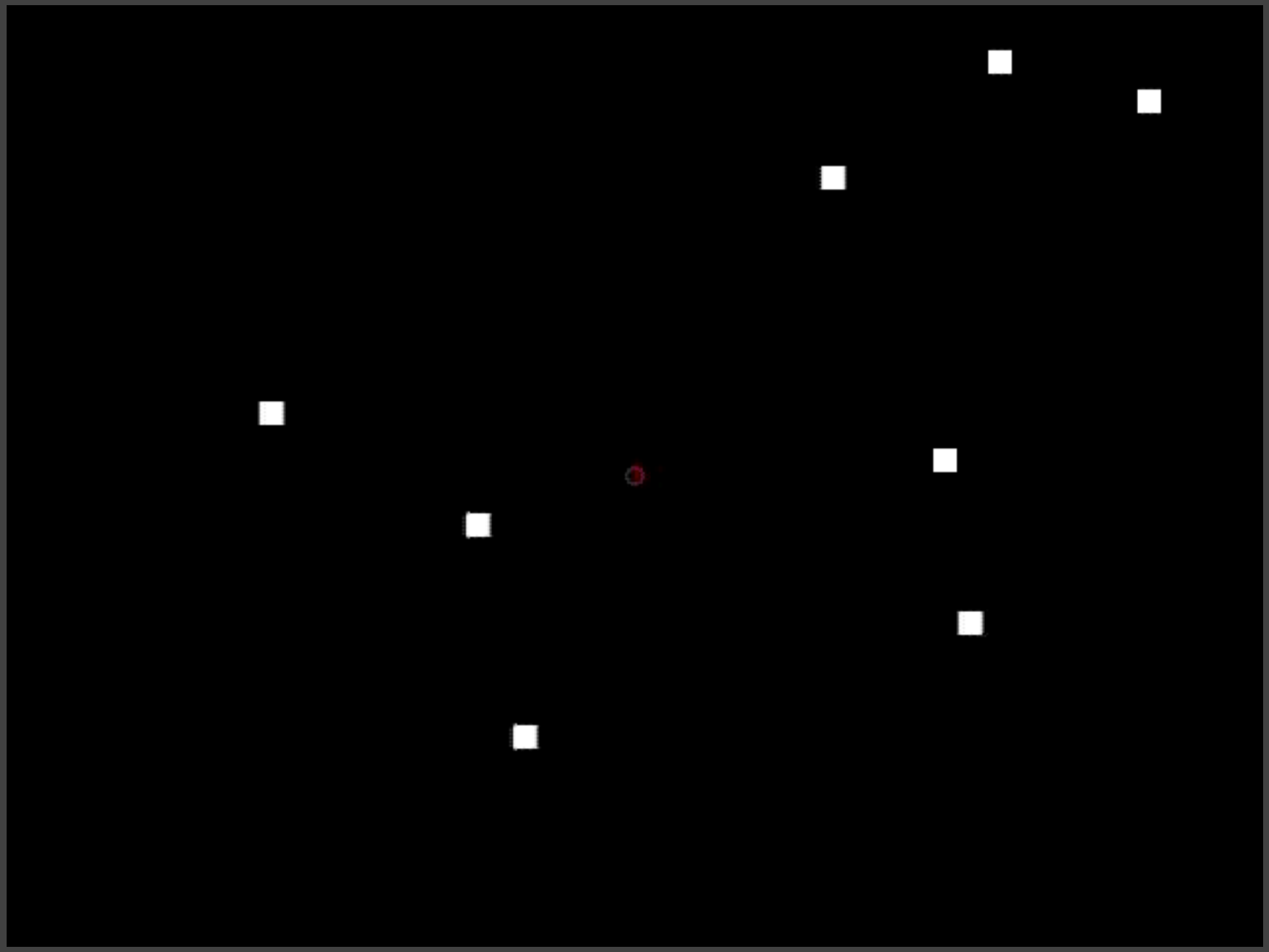
Similar motions perceived as a group

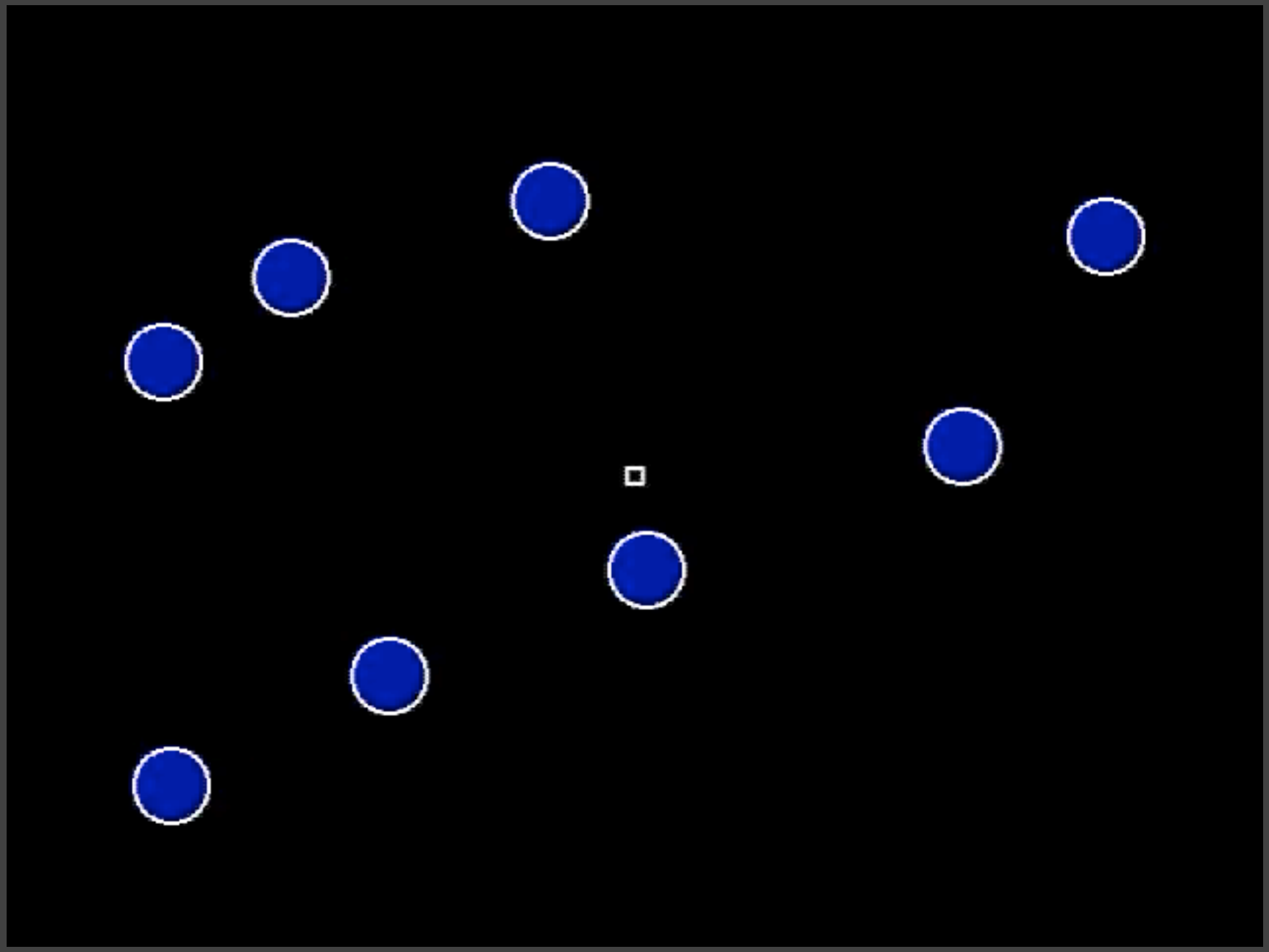
Motion parallax provide 3D cue (like stereopsis)

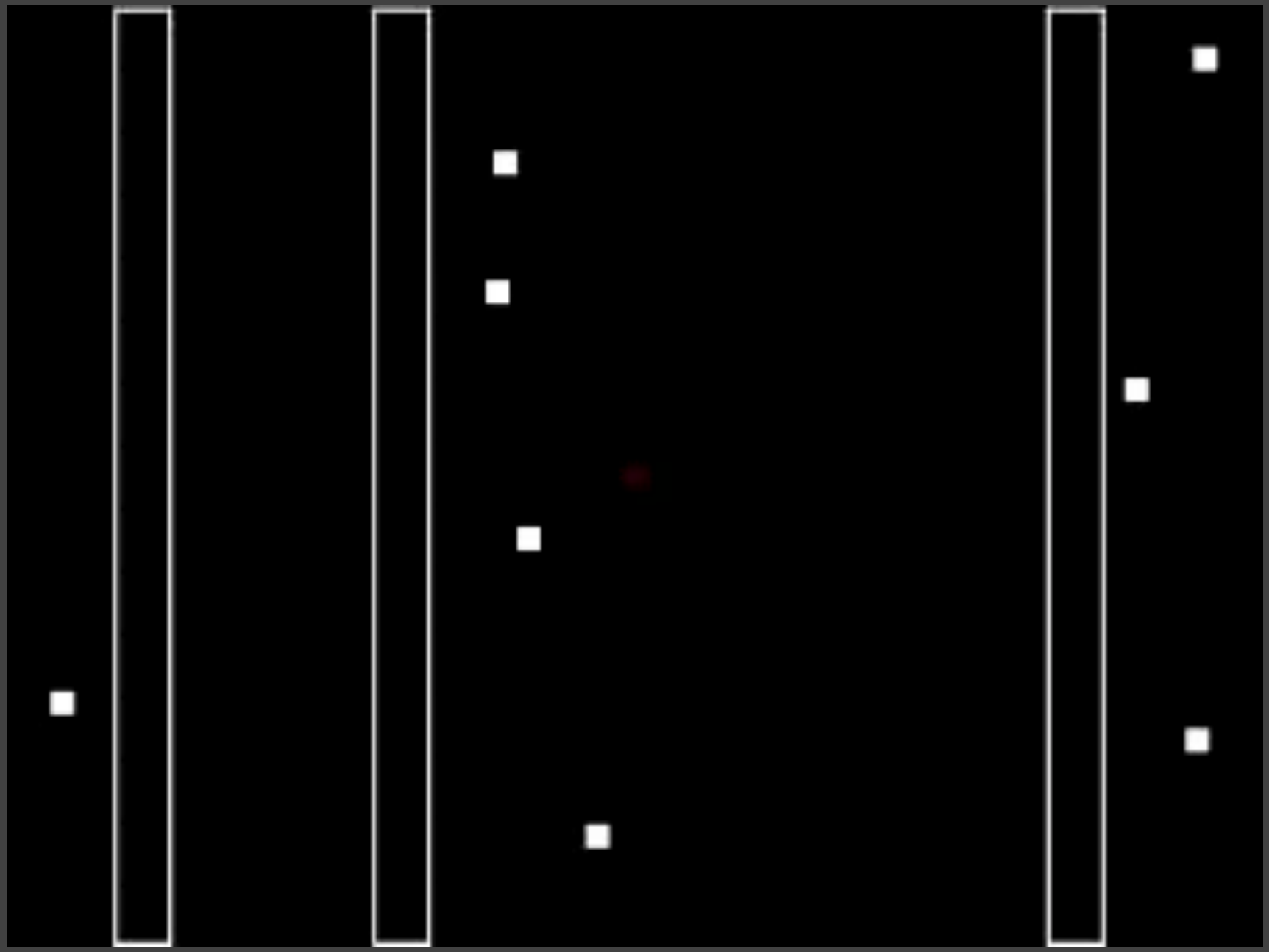
Tracking Multiple Targets

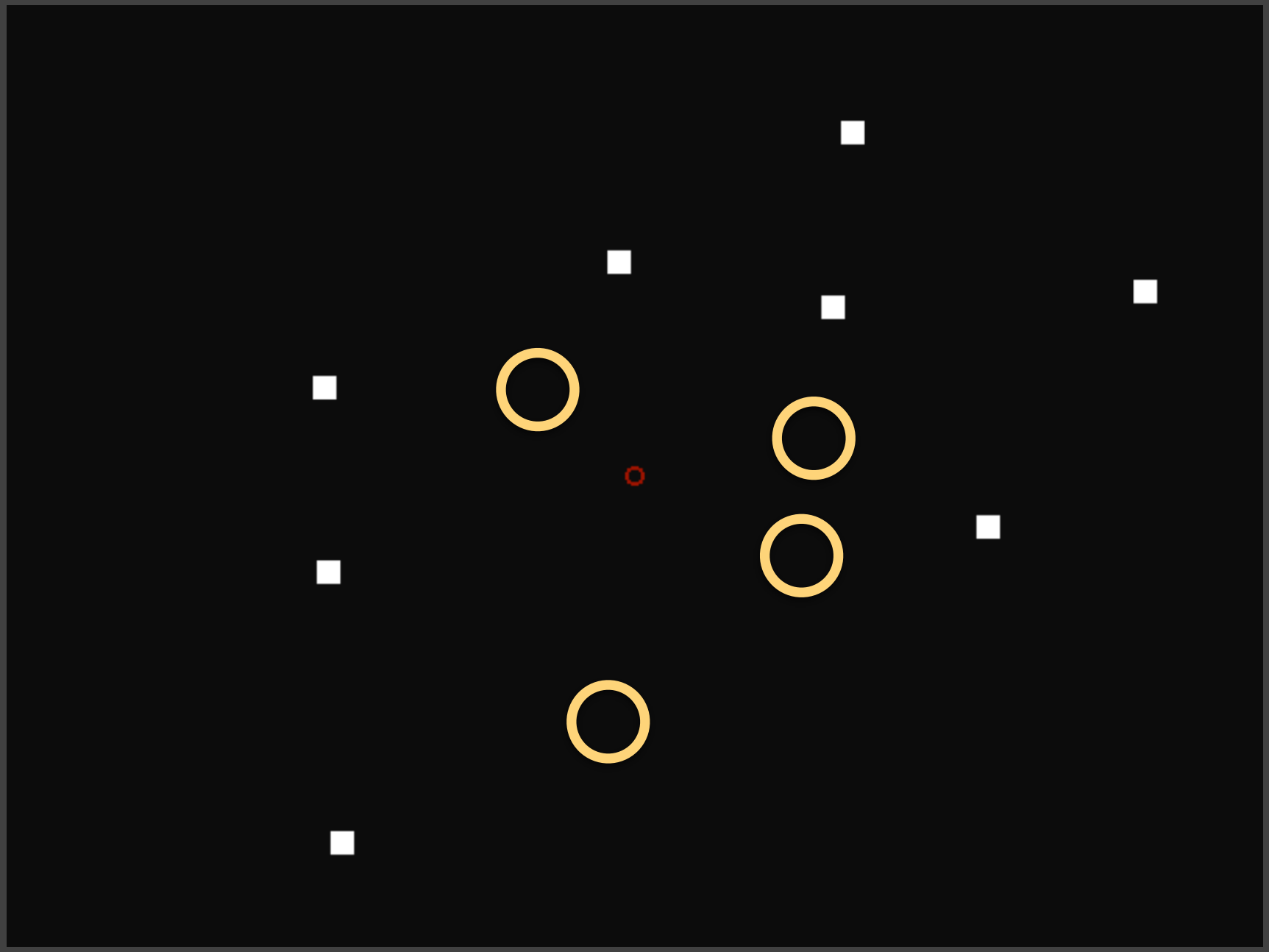


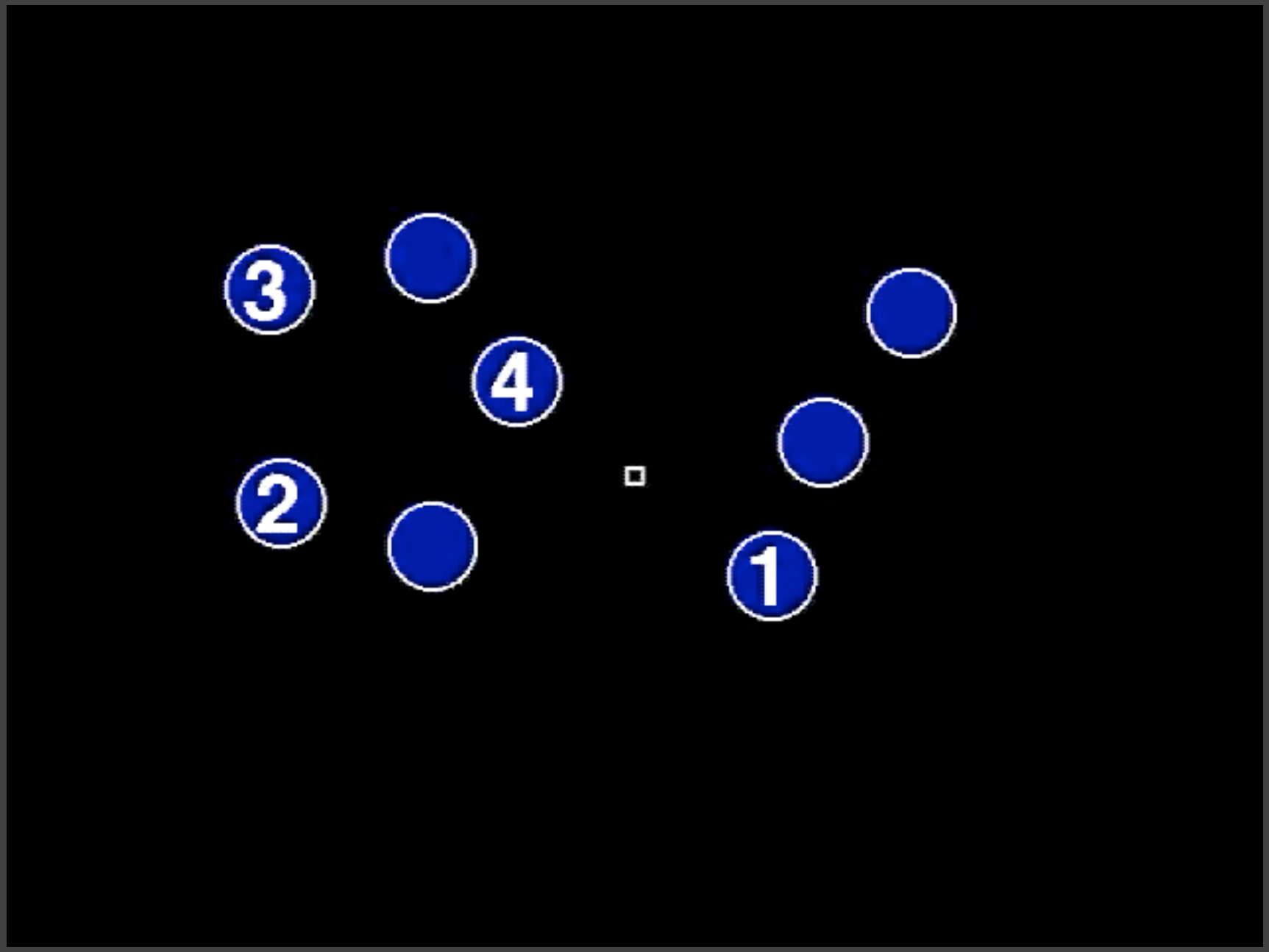
How many dots can we simultaneously track?







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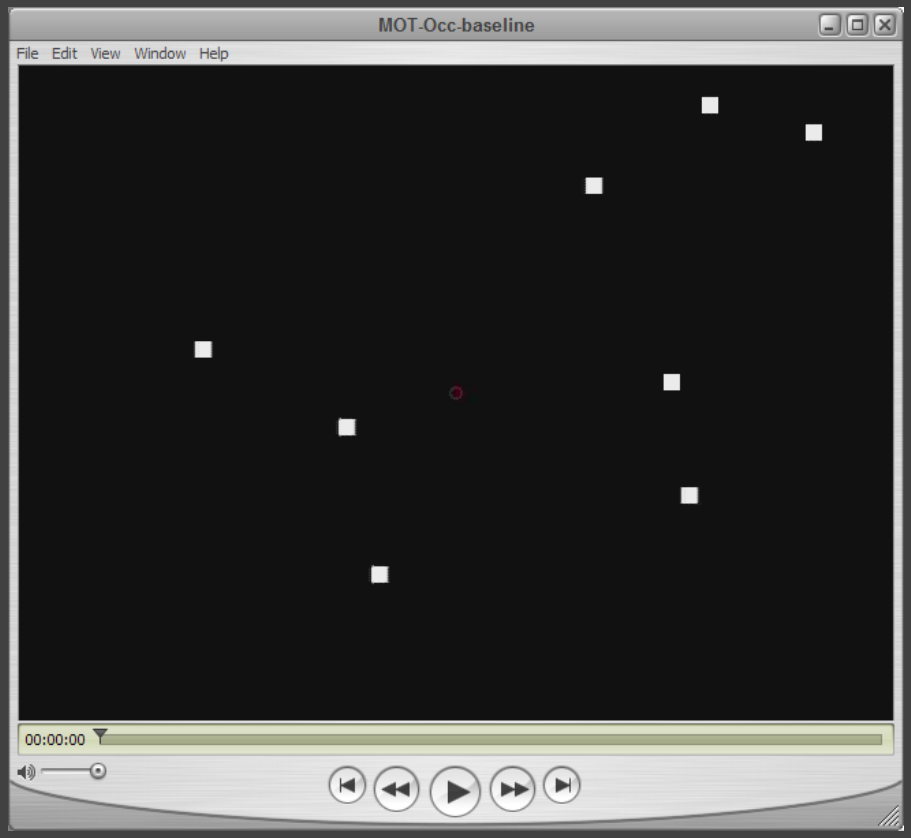
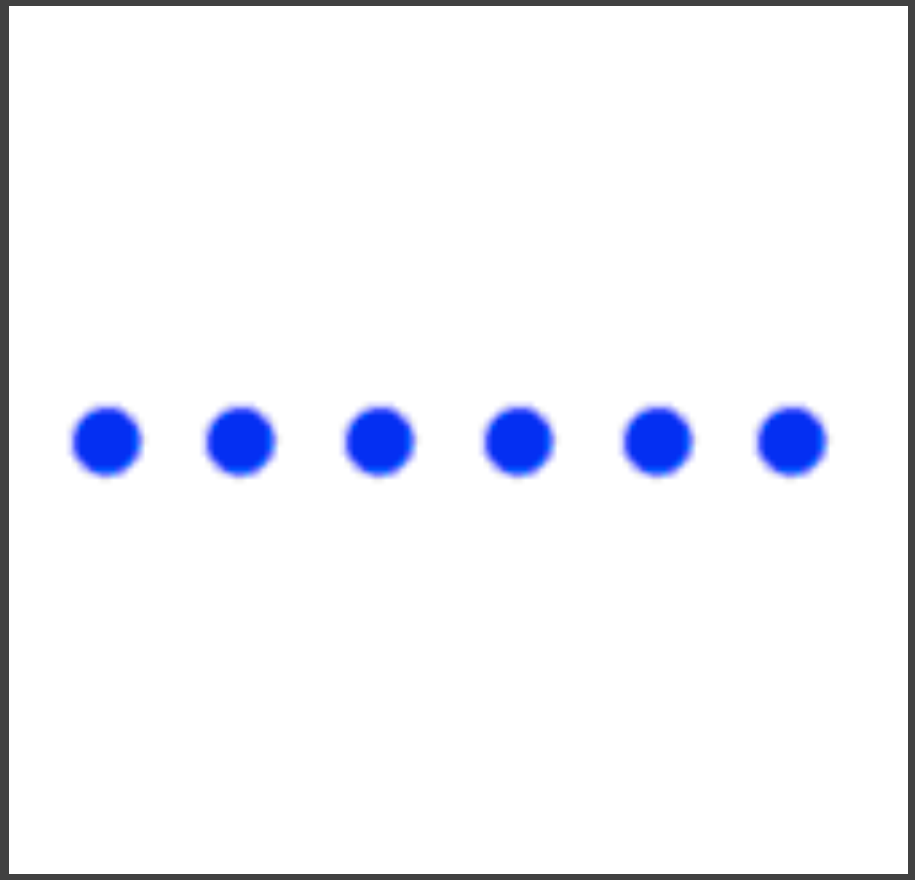
Tracking Multiple Targets



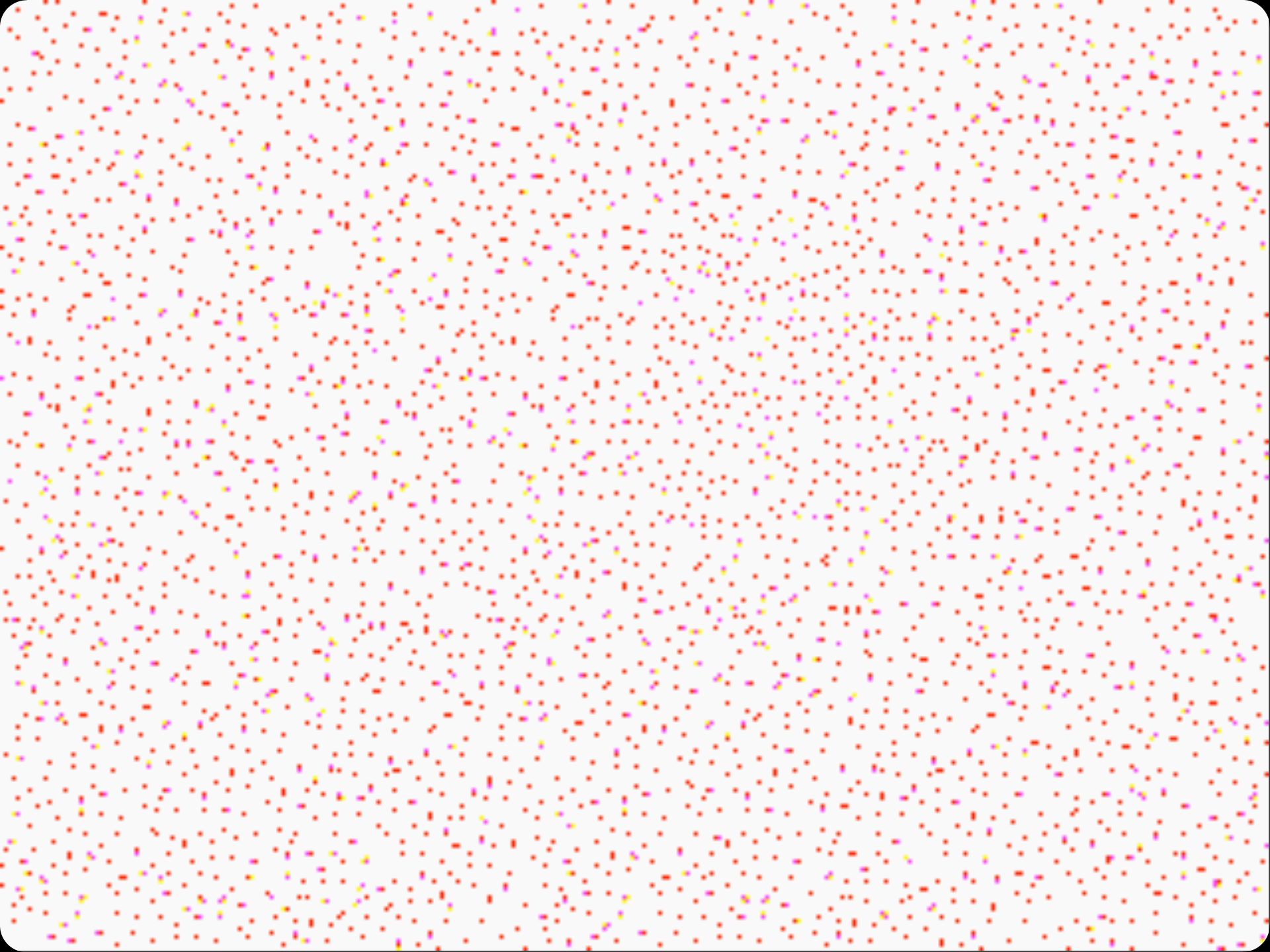
How many dots can we simultaneously track?

~4-6. Difficulty increases sig. at 6. [Yantis 92, Pylyshn 88, Cavanagh 05]

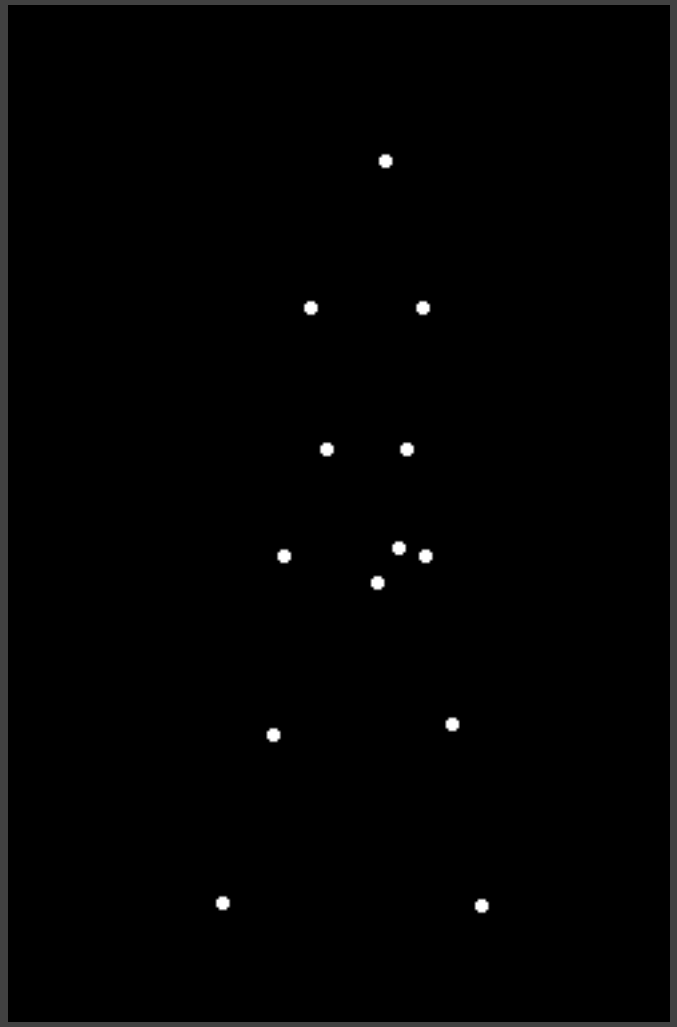
Grouped Dots Count as 1 Object



Dots moving together are grouped



Grouping of Biological Motion



[Johansson 73]

http://www.lifesci.sussex.ac.uk/home/George_Mather/Motion/WALK.MOV

Motions Show Transitions

See change from one state to next

start

Motions Show Transitions

See change from one state to next

end

Motions Show Transitions

See change from one state to next

start end

Shows transition better, but

Still may be too fast, or too slow

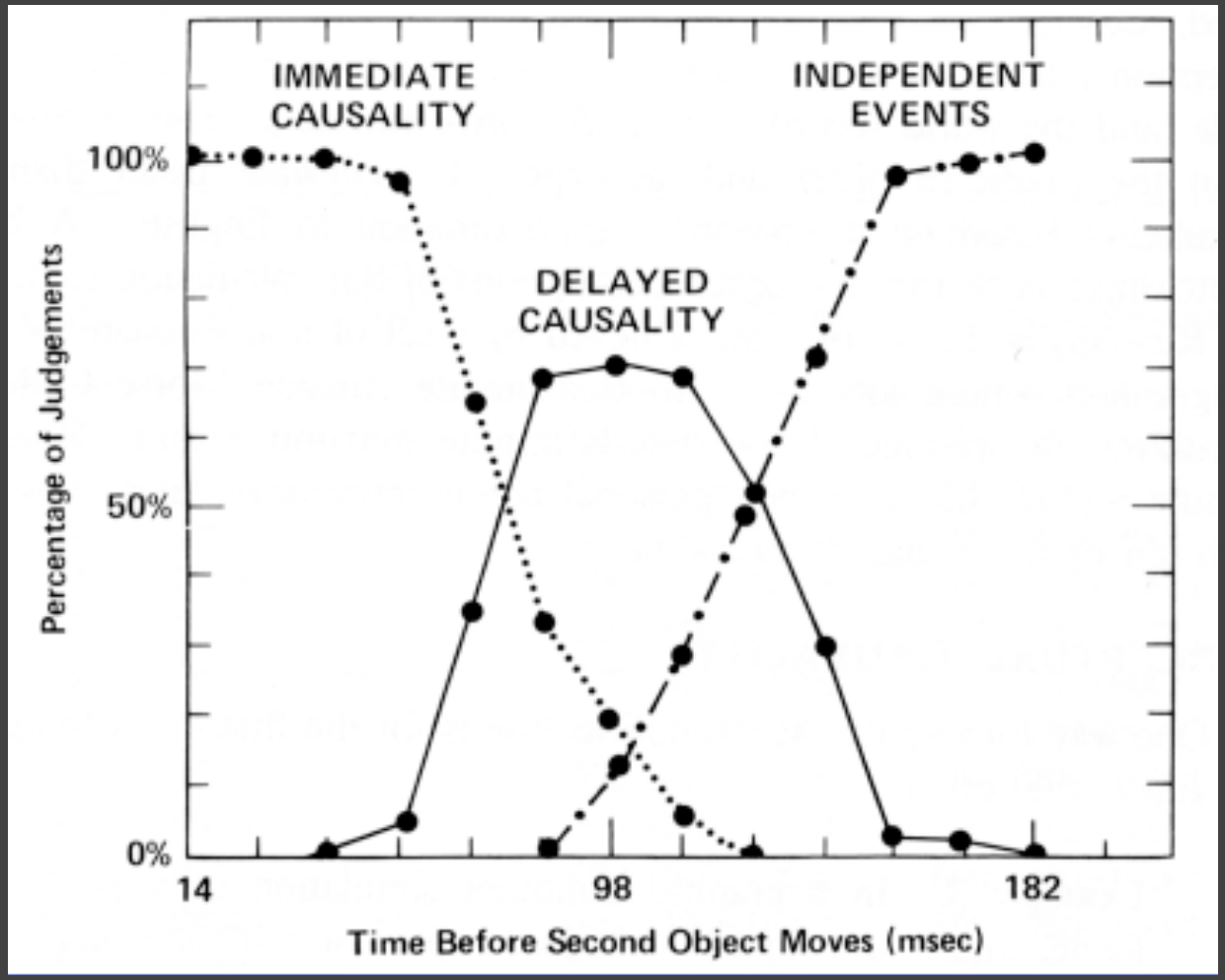
Too many objects may move at once

Attribution of Causality [Michotte 46]

Michotte demonstration 1. What do you see? Most observers report that "the red ball **hit** the blue ball." The blue ball moved "**because** the red ball hit it." Thus, the red ball is perceived to **"cause"** the blue ball to move, even though the balls are nothing more than color disks on your screen that move according to a programme.

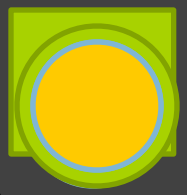
http://cogweb.ucla.edu/Discourse/Narrative/michotte-demo.swf

Attribution of Causality [Michotte 46]



[Reprint from Ware 04]

Animation	Helps?	Hurts?
Attention	direct attention	distraction
Constancy	change tracking	false relations
Causality	cause and effect	false agency
Engagement	increase interest	“chart junk”
Calibration		too slow: boring
		too fast: errors



Problems with Animation [Tversky]

Difficult to estimate paths and trajectories

Motion is fleeting and transient

Cannot simultaneously attend to multiple motions

Parse motion into events, actions and behaviors

Misunderstanding and wrongly inferring causality

Anthropomorphizing physical motion may cause confusion or lead to incorrect conclusions

Administrivia

A3: Ethical & Deceptive Visualization

Use visualizations to communicate and influence insights

Design both an ethical and deceptive visualization

Ethical Visualization: honestly and transparently communicate the data with an effective and expressive visualization design that is easy to interpret for viewers

Deceptive Visualization: intentionally influence viewer's perception to mislead their insights, without revealing it's role as the deceptive design

Due by **11:59 pm PST, Monday February 8**

A3: Ethical & Deceptive Visualization

Deliverables (upload via Canvas; see A3 page)

Image of your visualization (PNG or JPG format)

Image file names **should not give away which design is which**

Write-up including a short description + design rationale

Due by **11:59 pm PST, Monday February 8th**

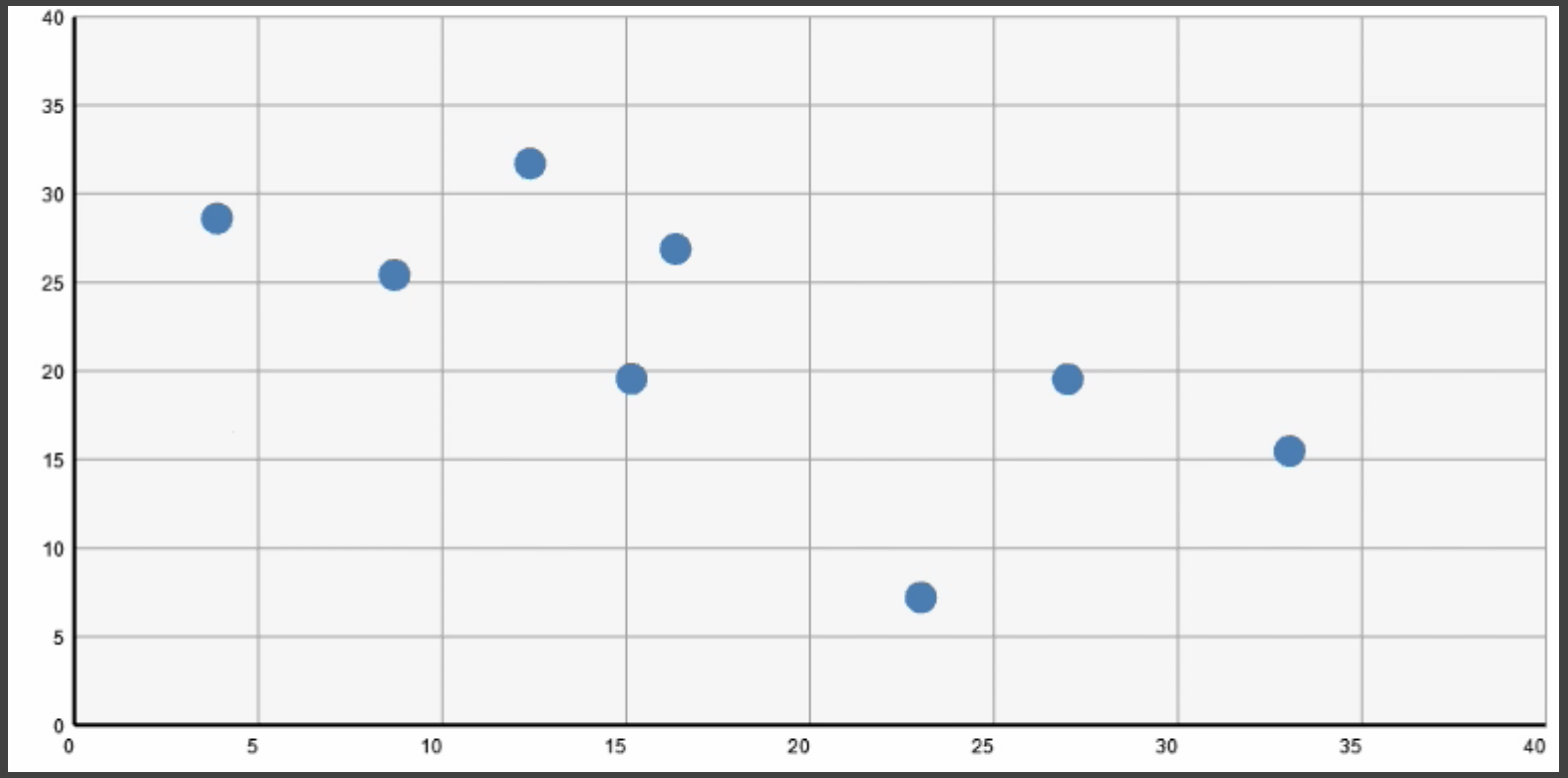
Assignment A3b: Peer Evaluation (see course website)

Provide constructive feedback on **four peer designs**

Guess which visualization designs are deceptive and ethical

Due by 11:59pm PST, Monday February 15th

Animated Transitions in Statistical Graphics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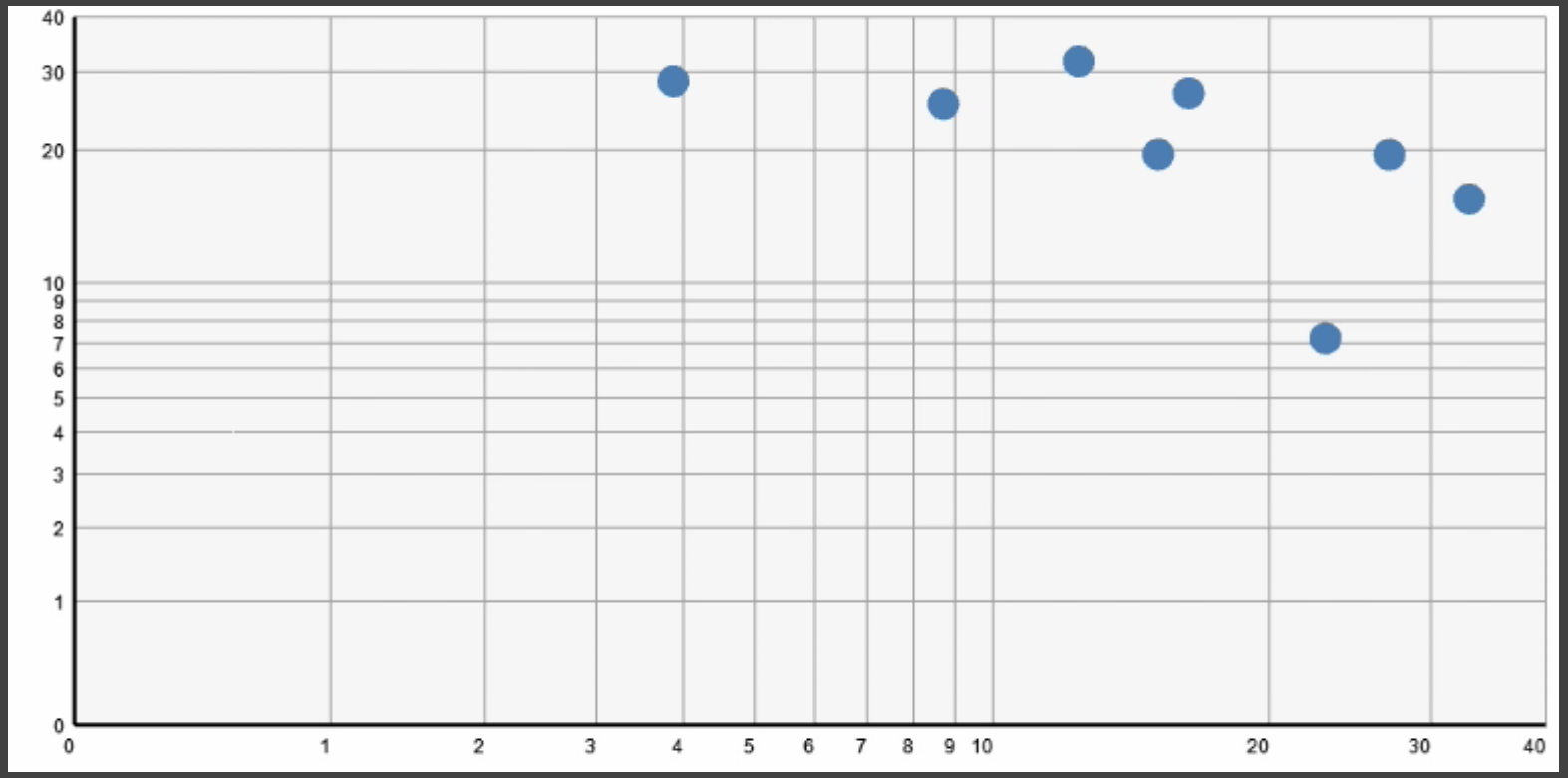
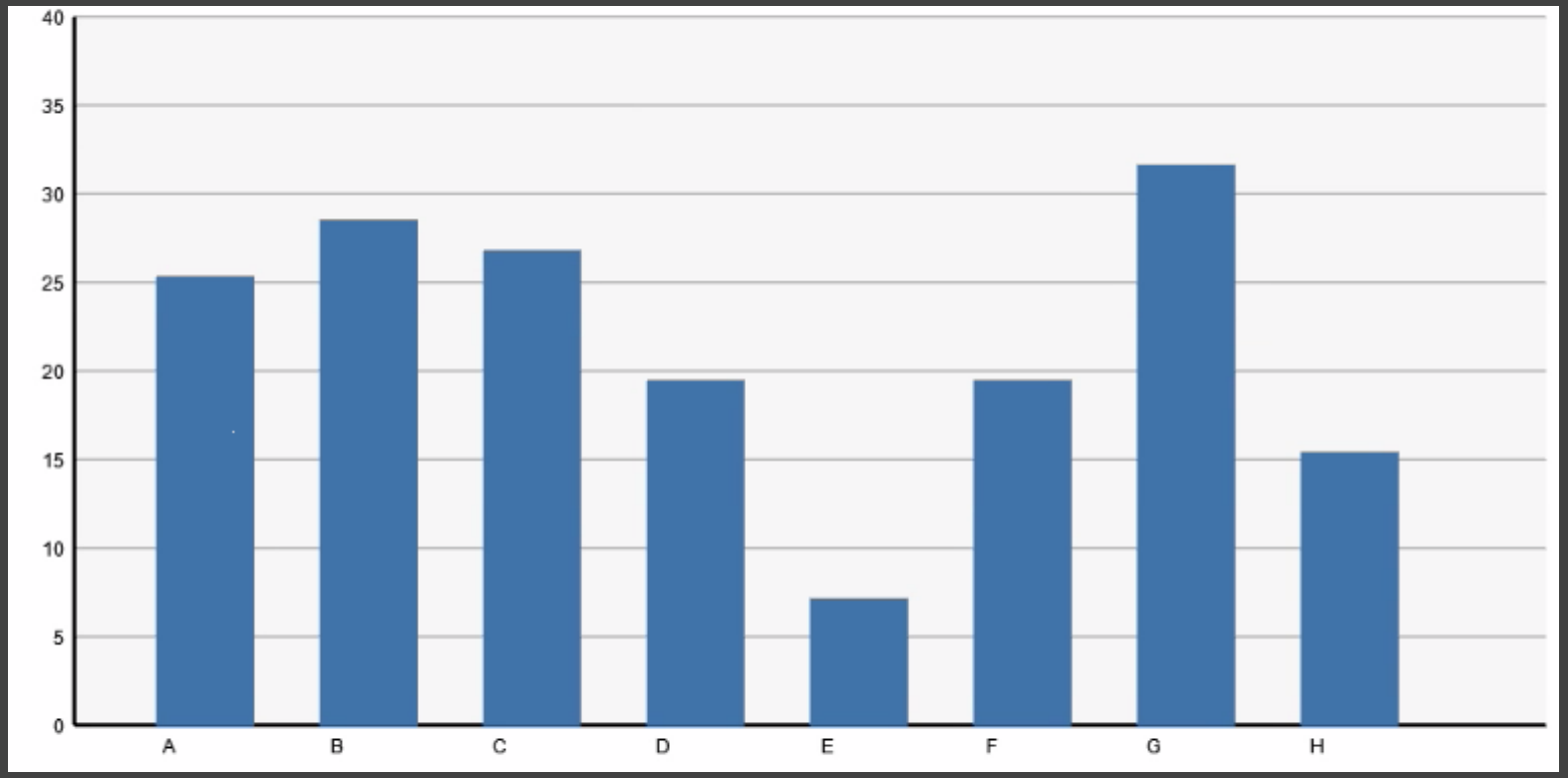
Log Transform

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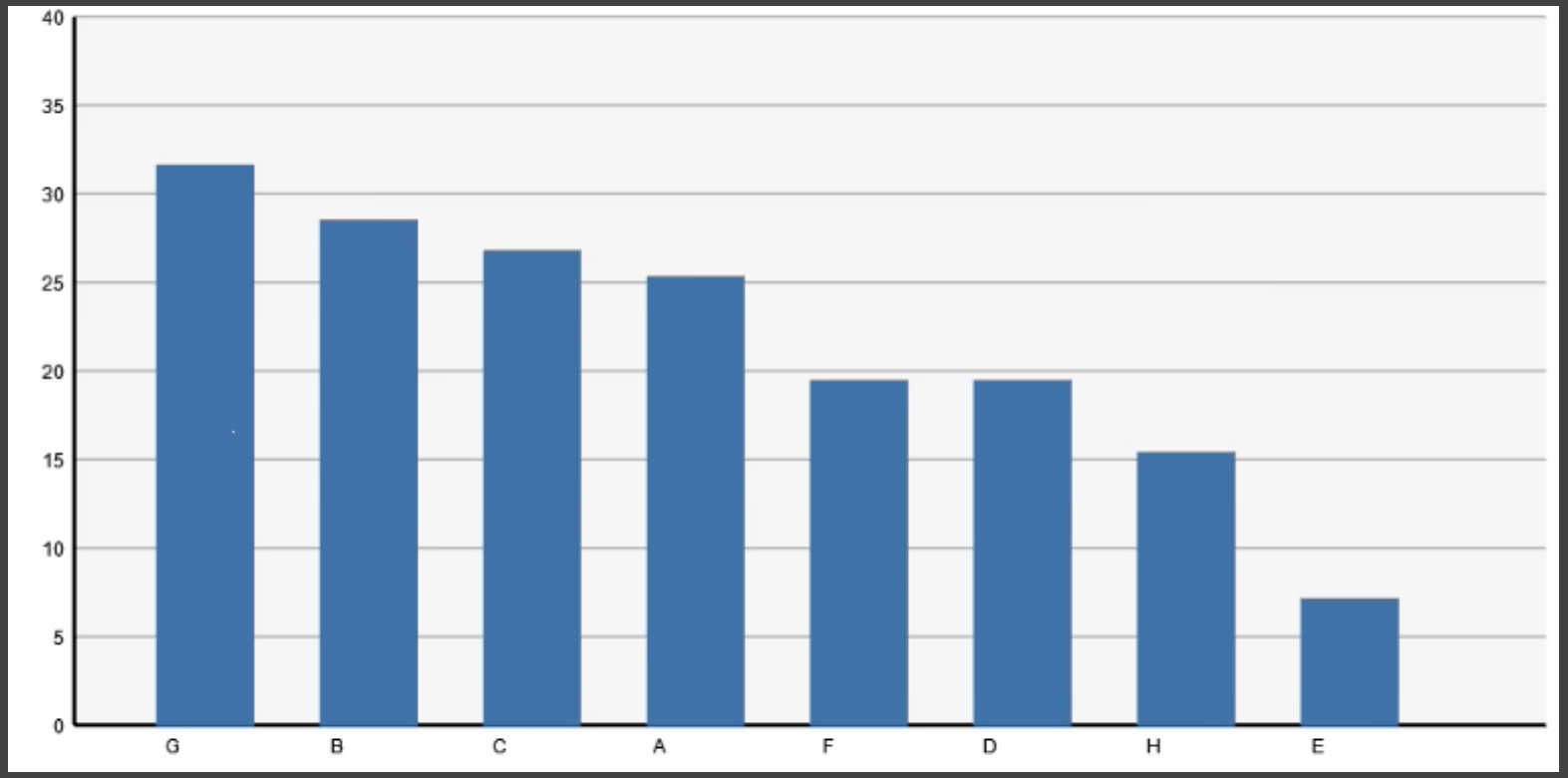
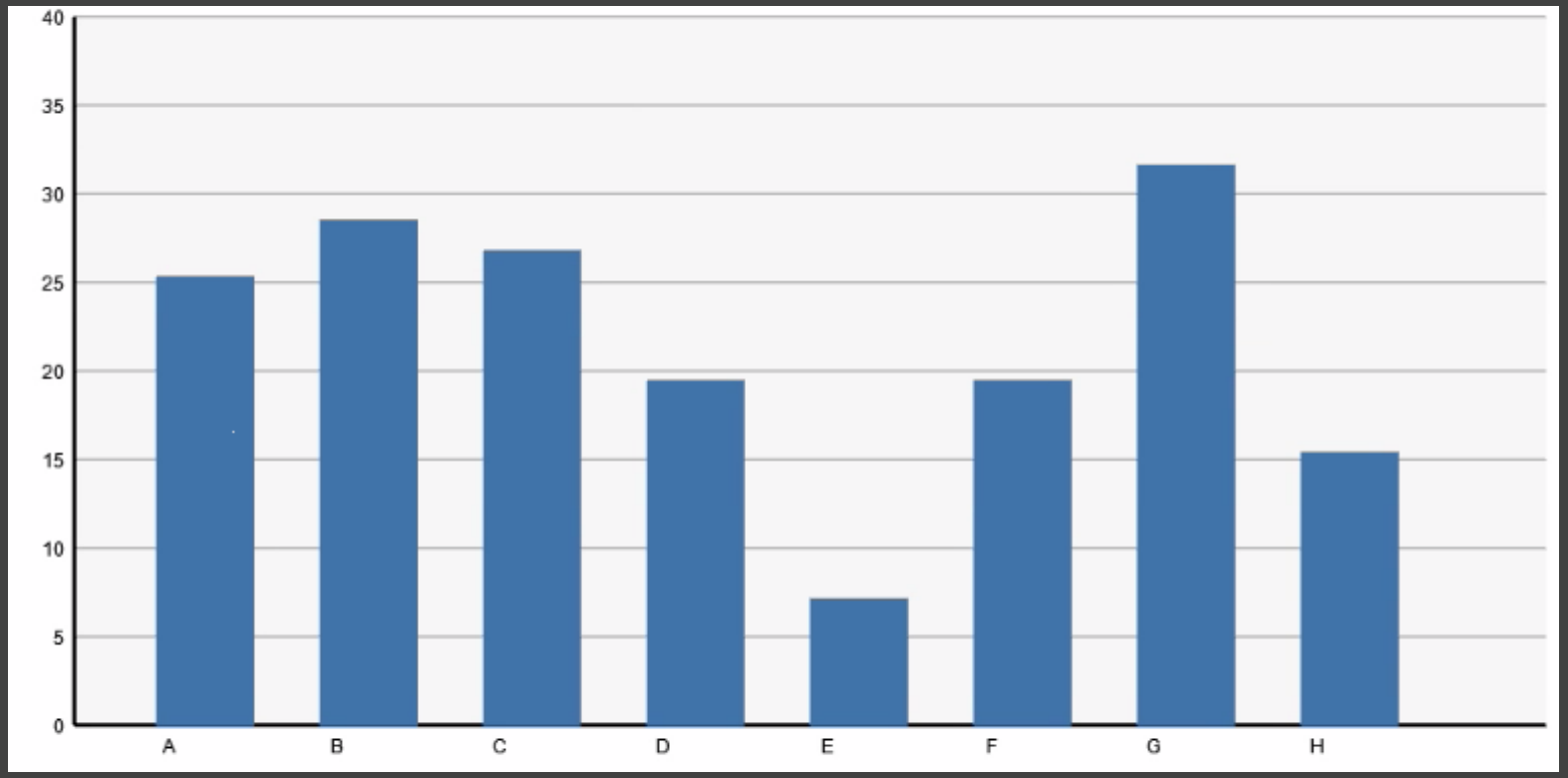
Sorting

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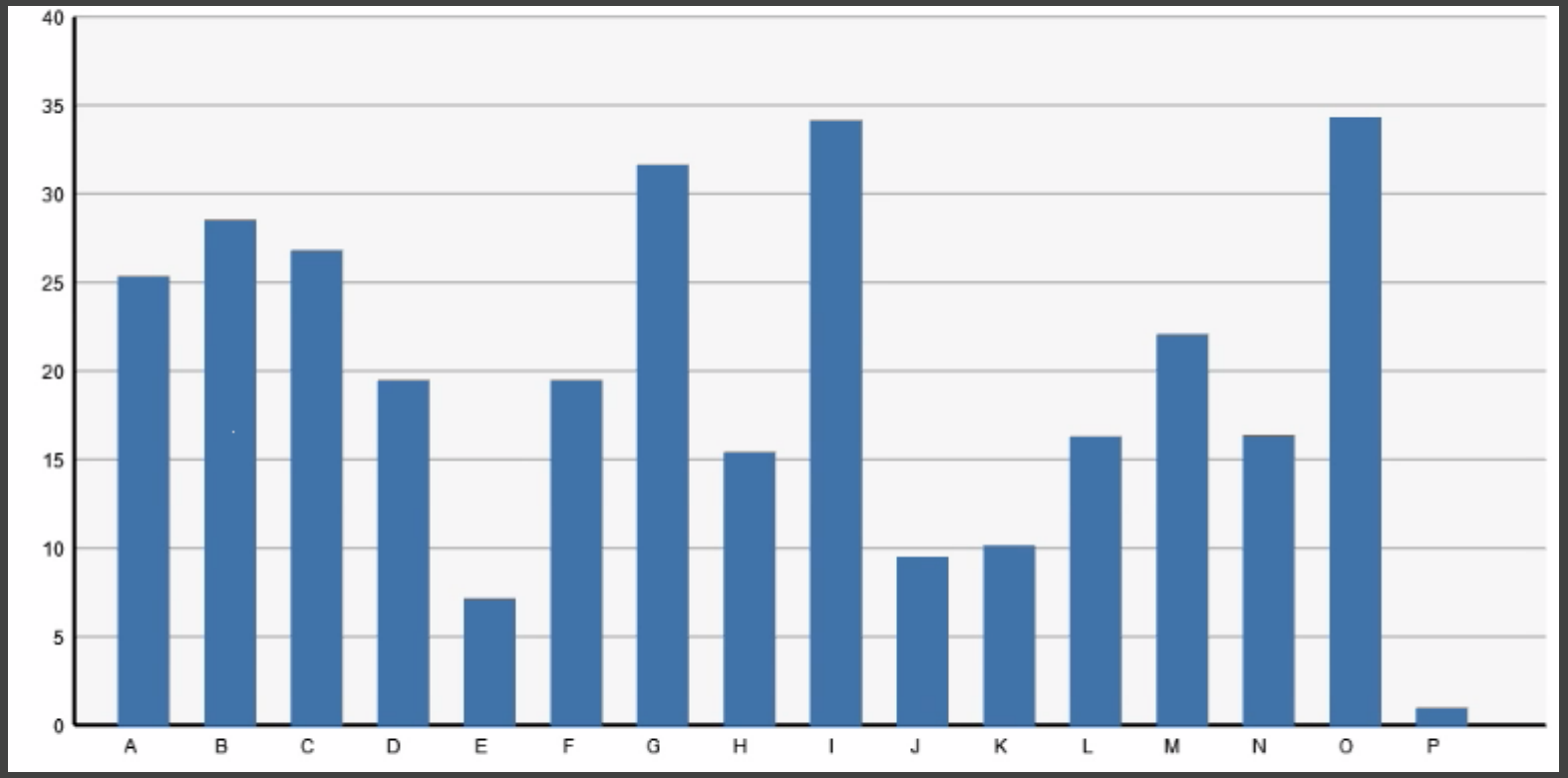
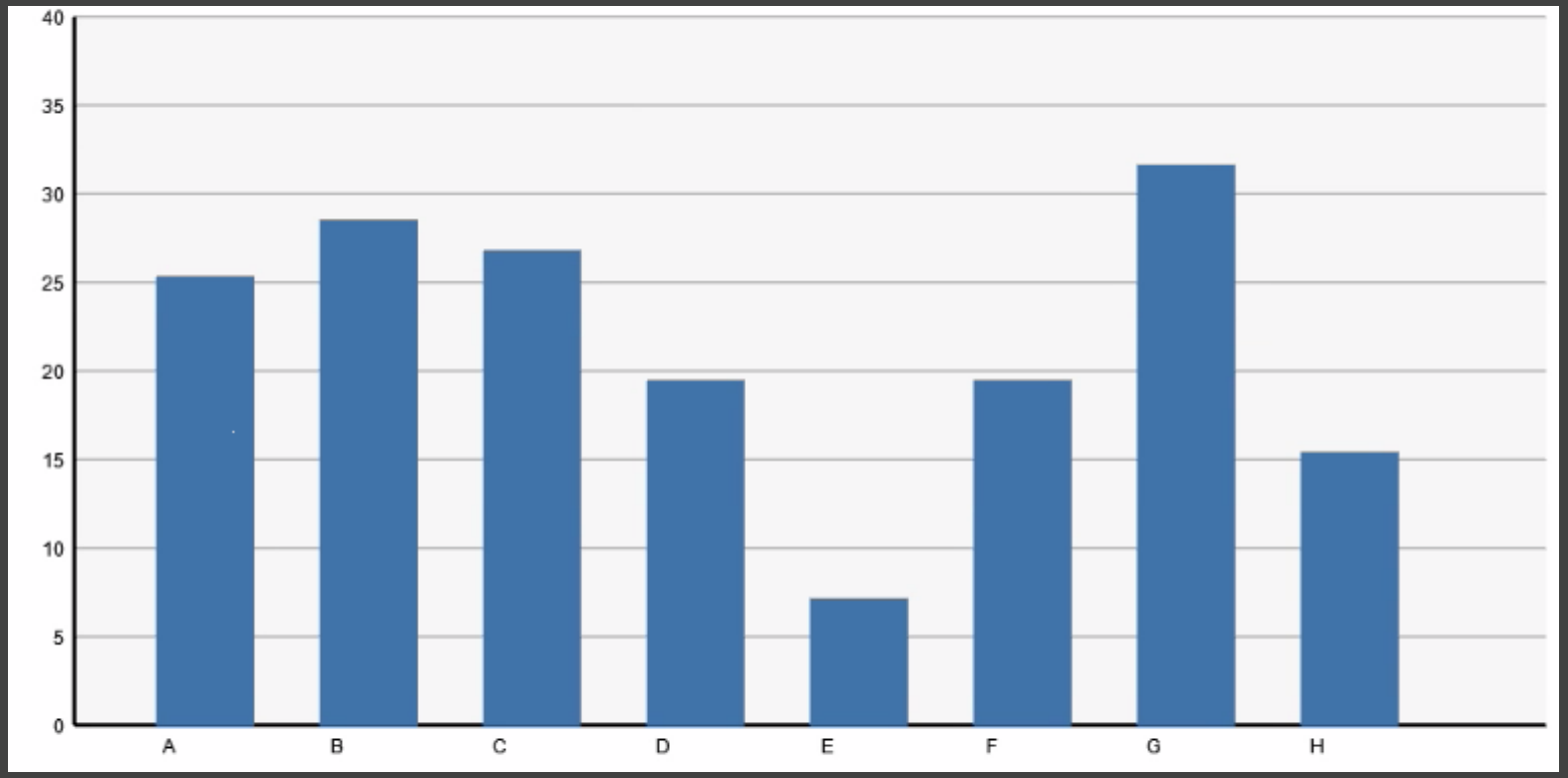
Filtering

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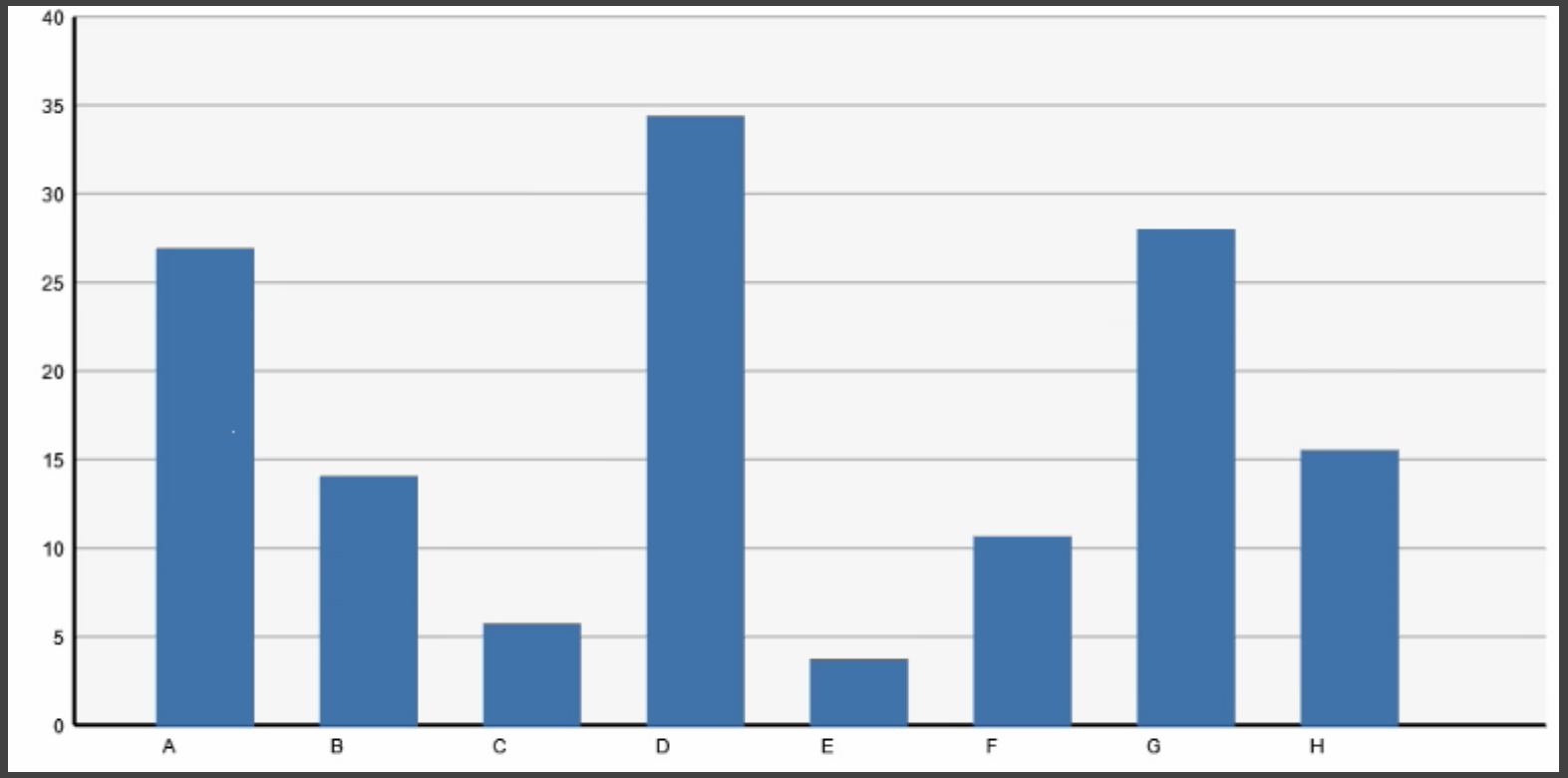
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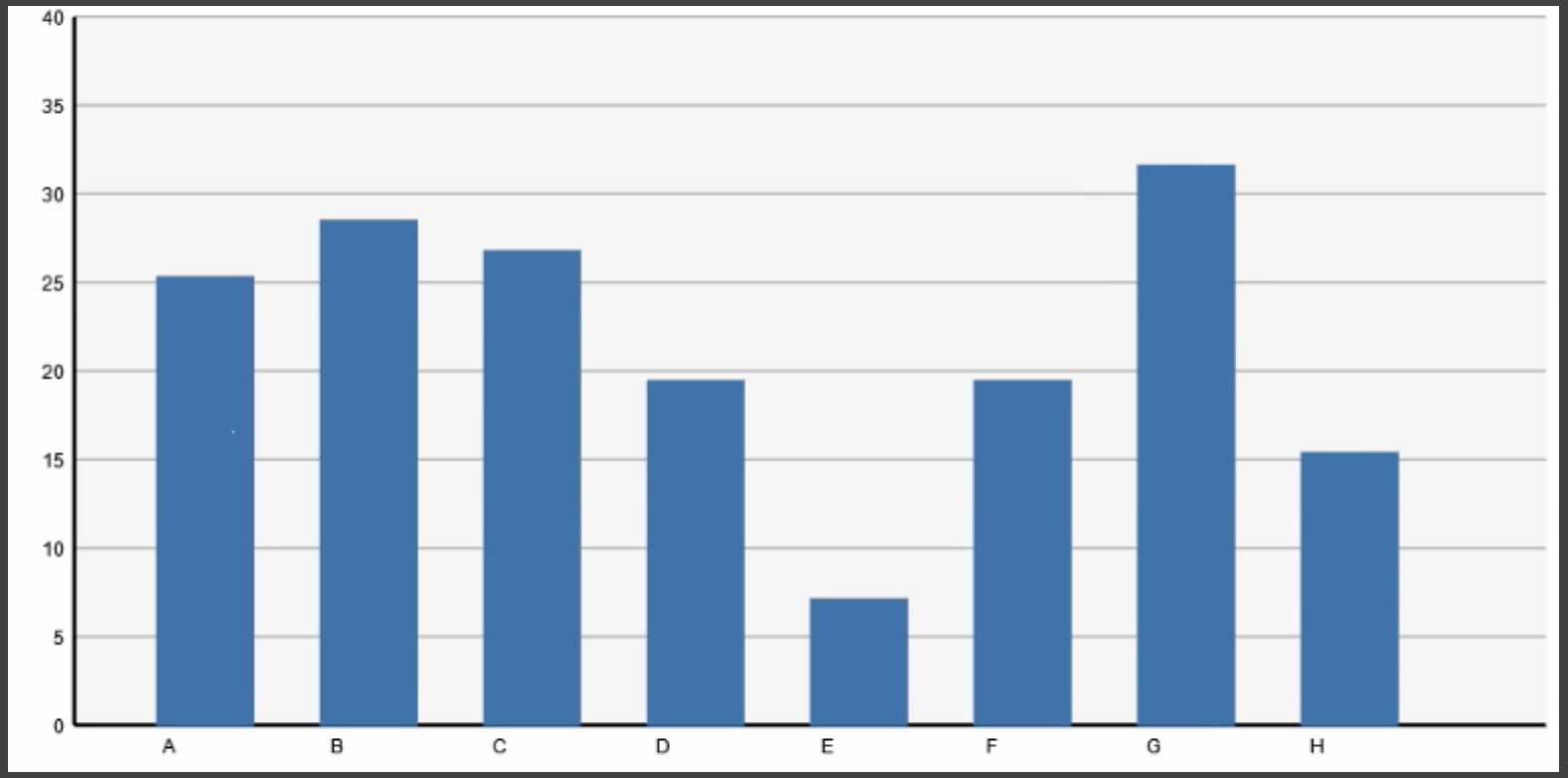
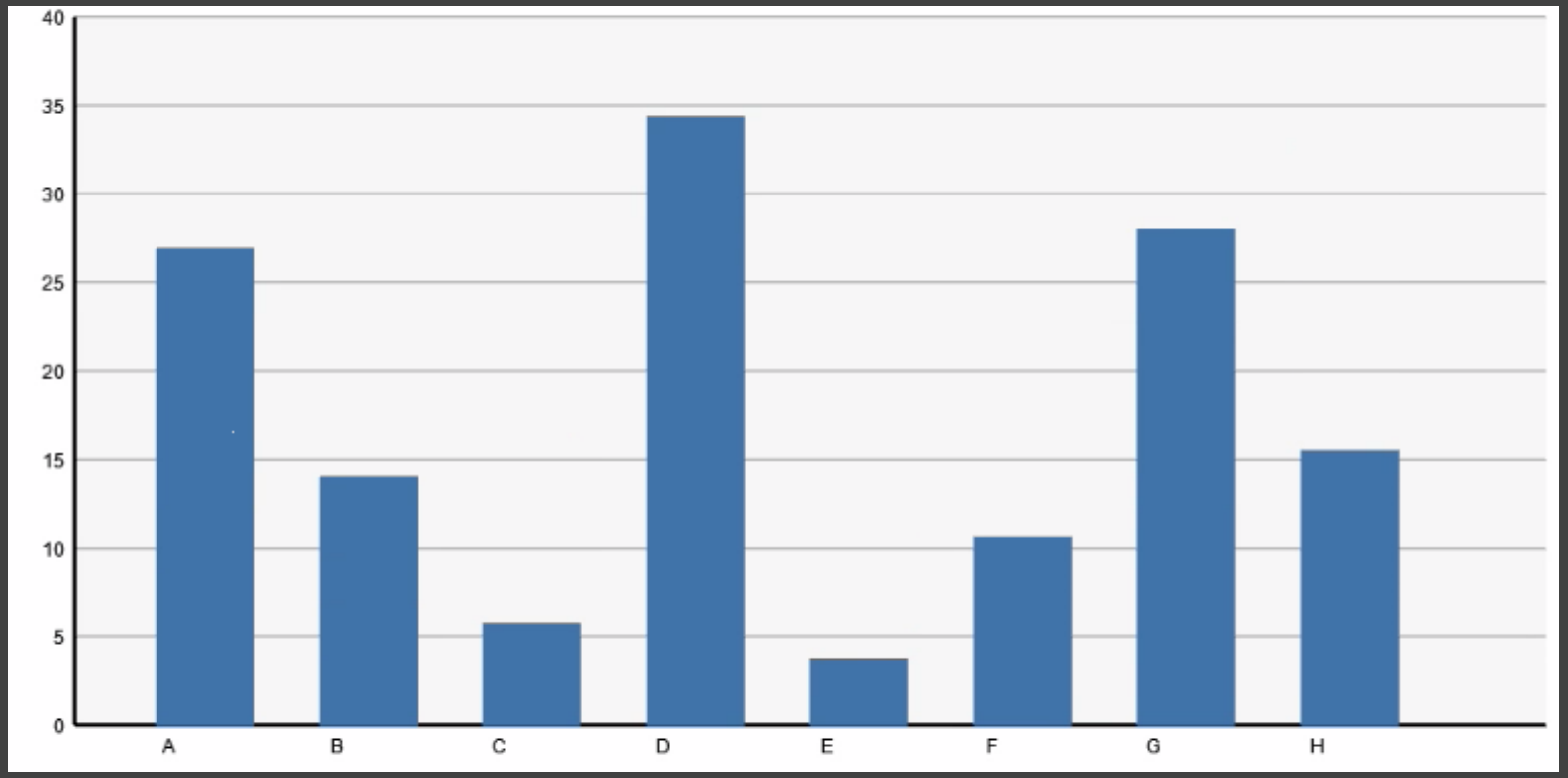
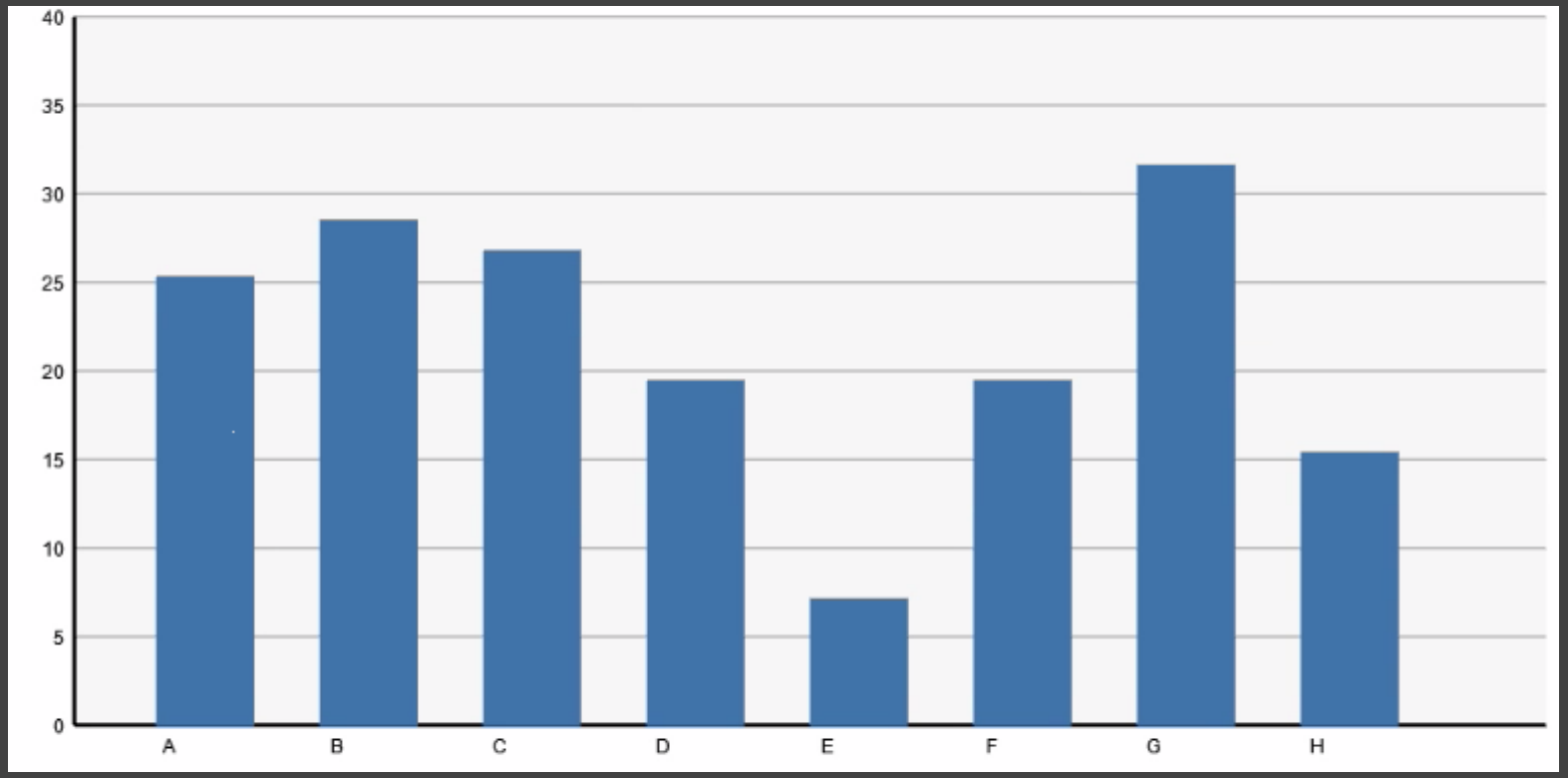


Month 1

Timestep



Month 2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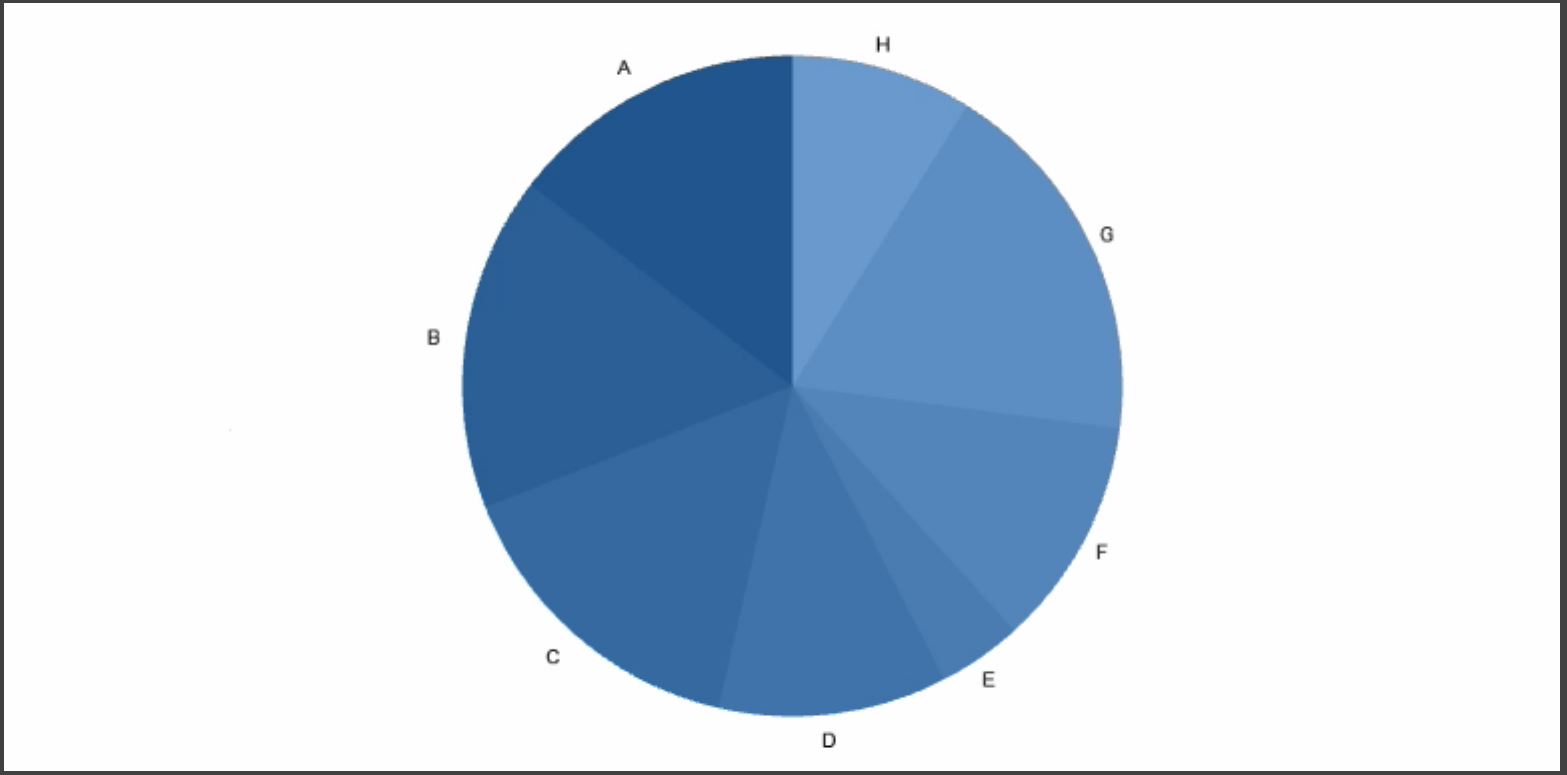
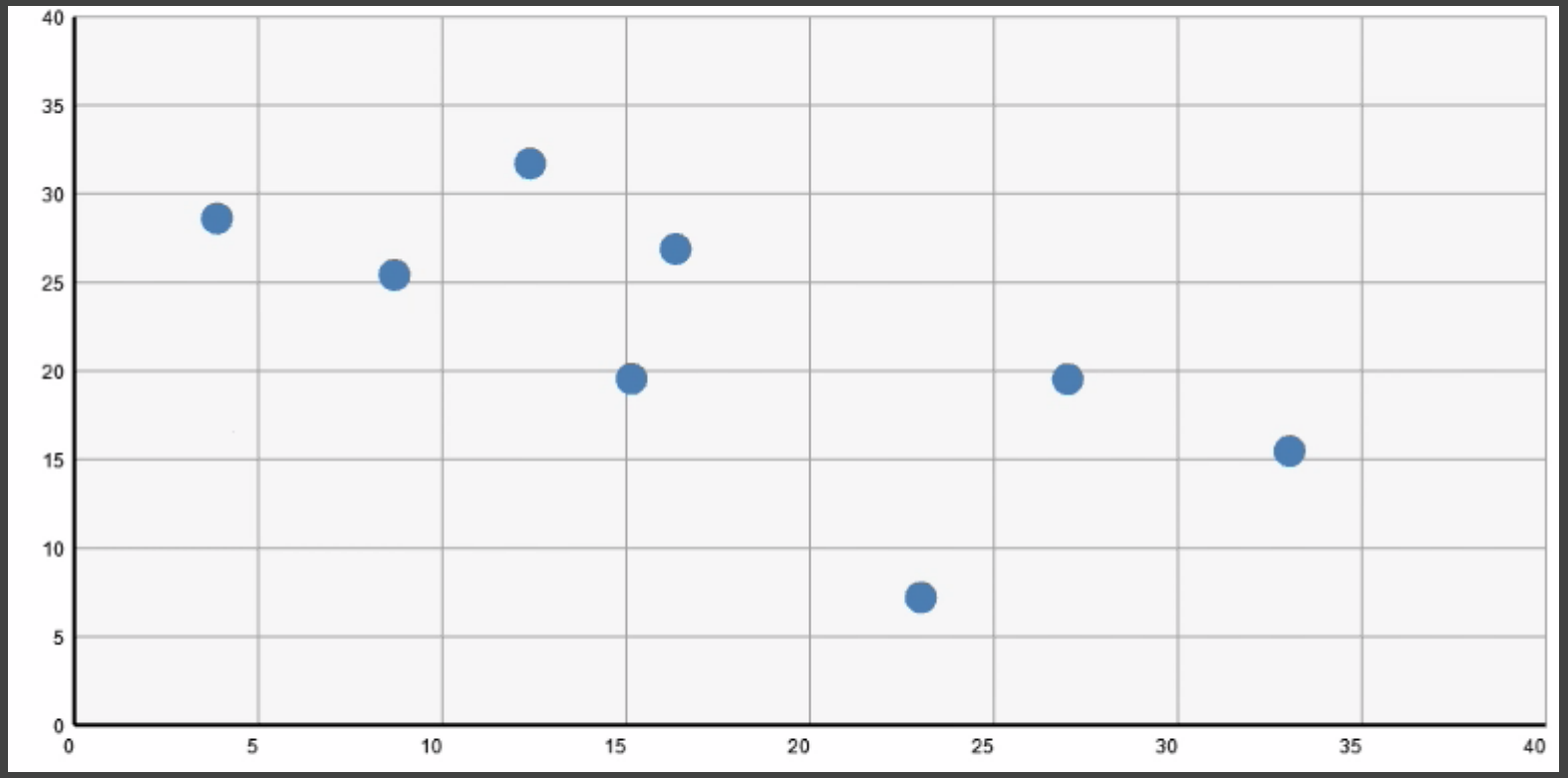
Change Encodings

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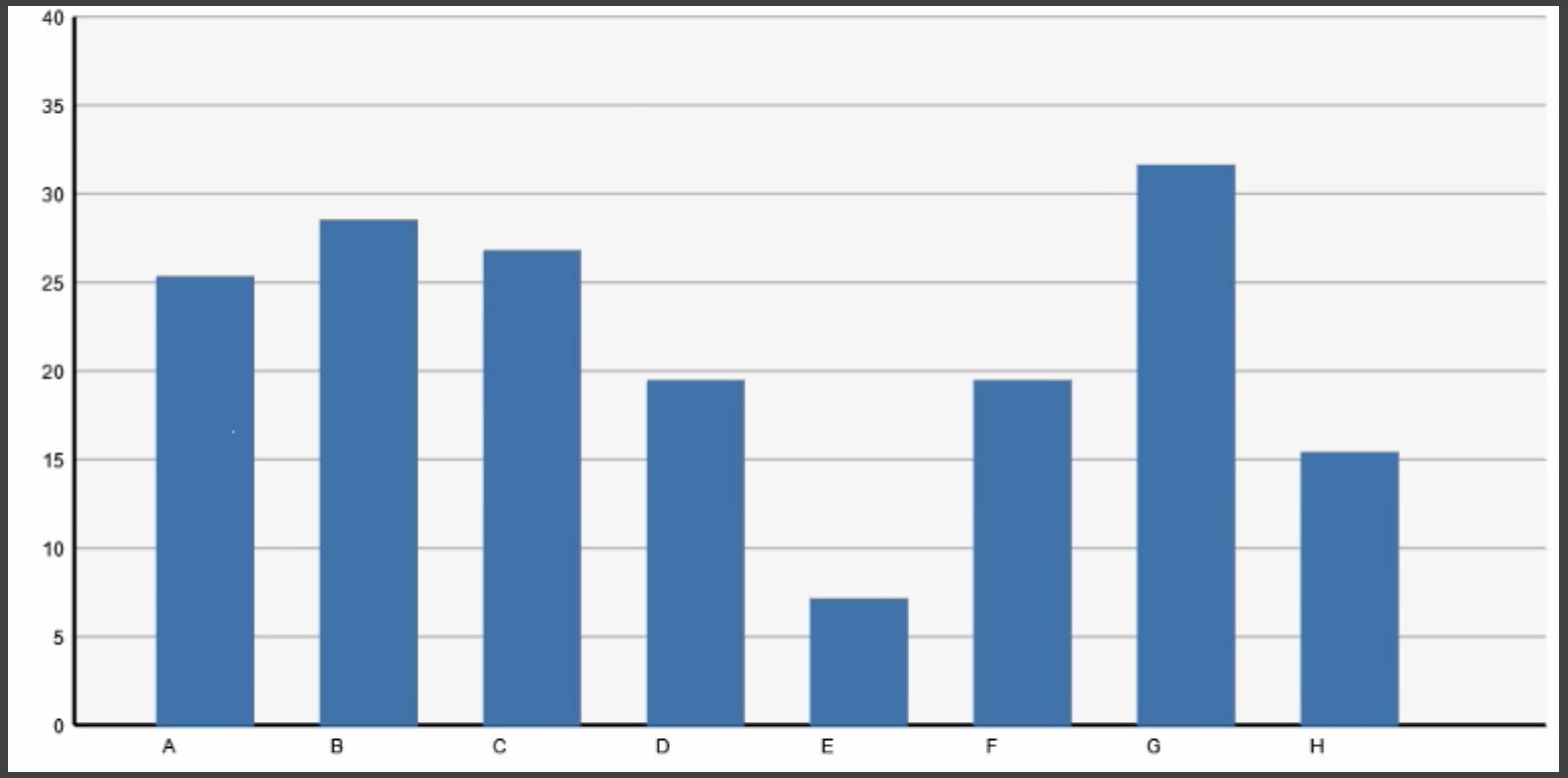
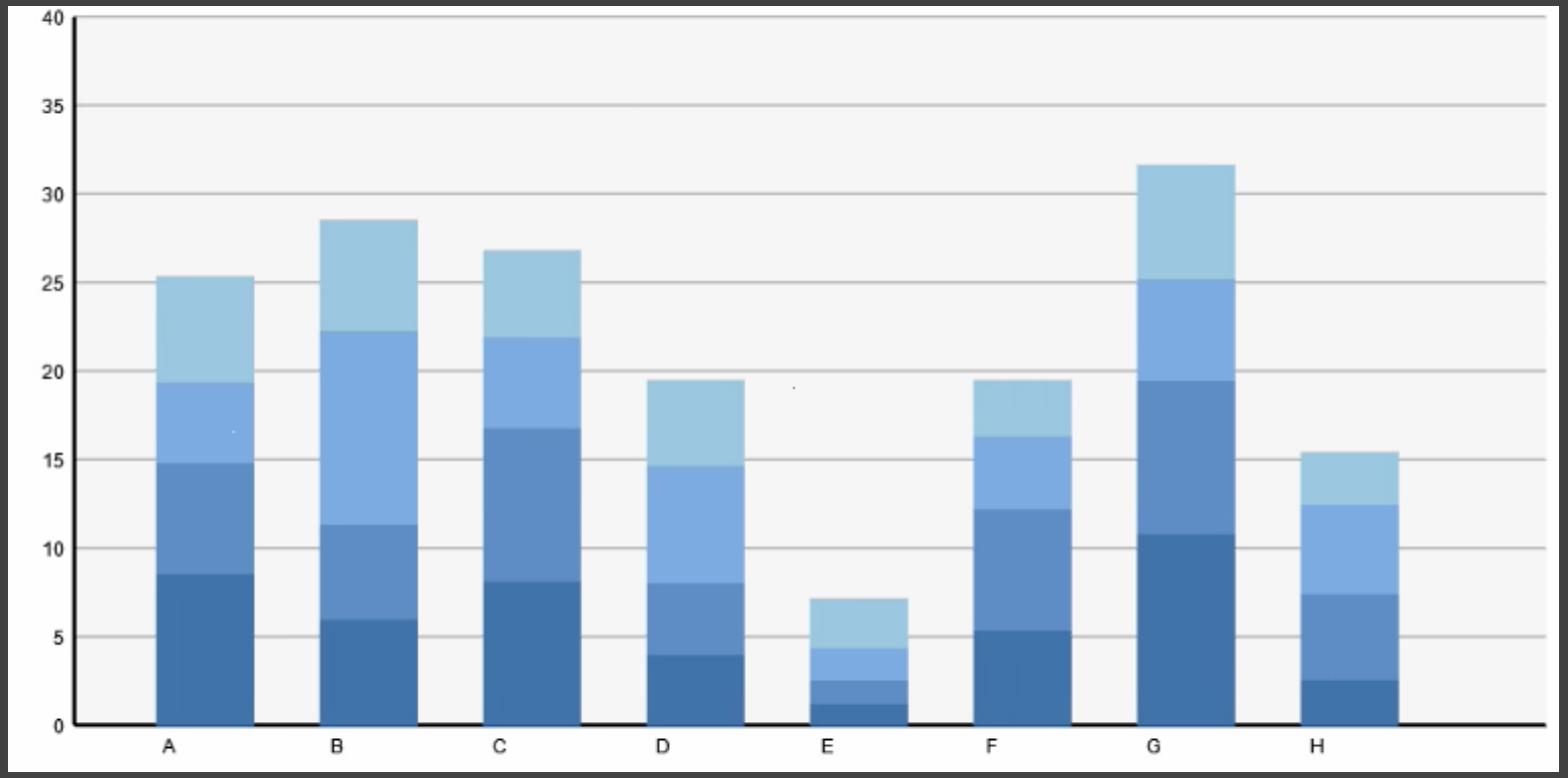
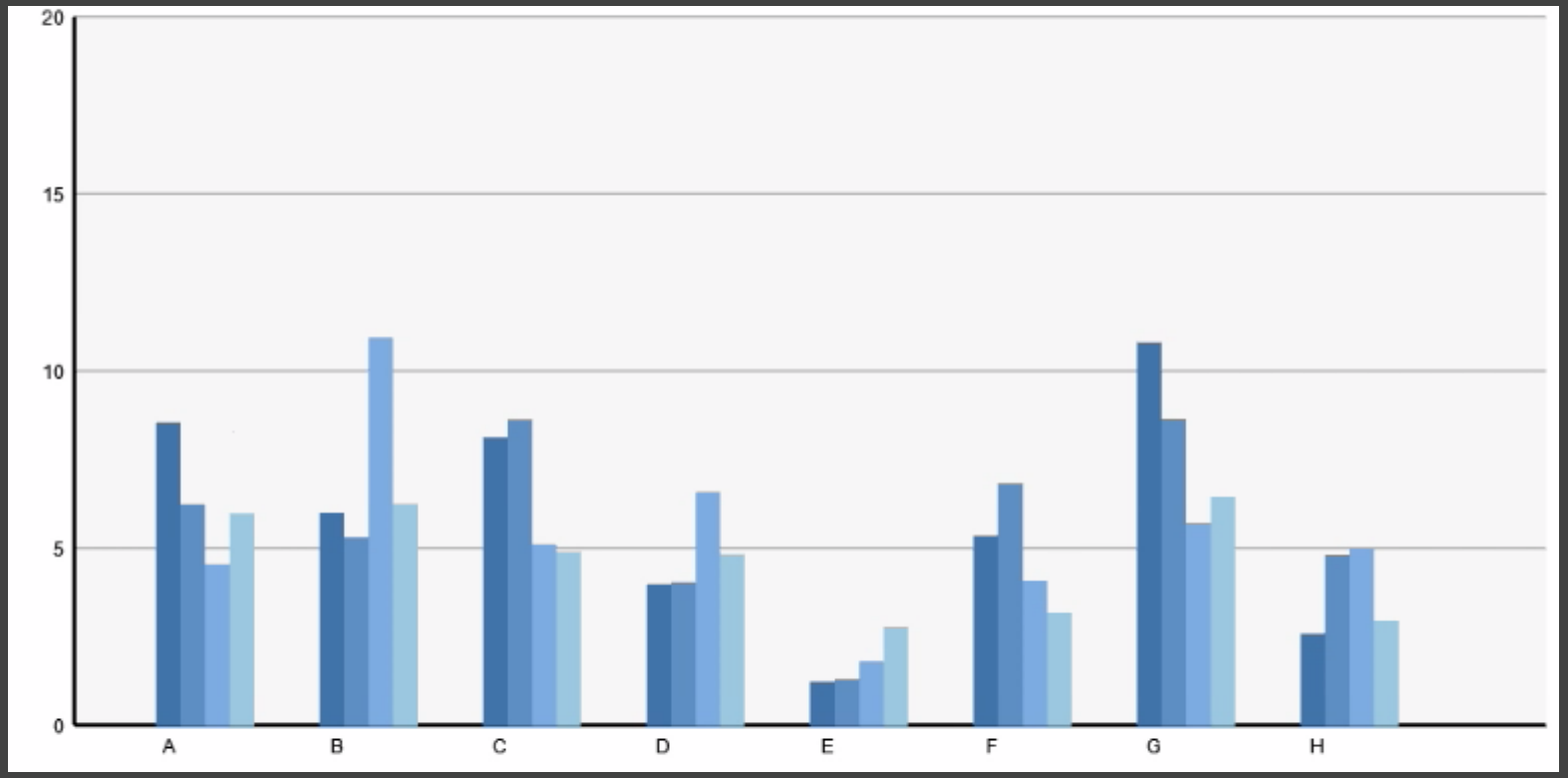
Change Data Dimensions



Change Data Dimensions



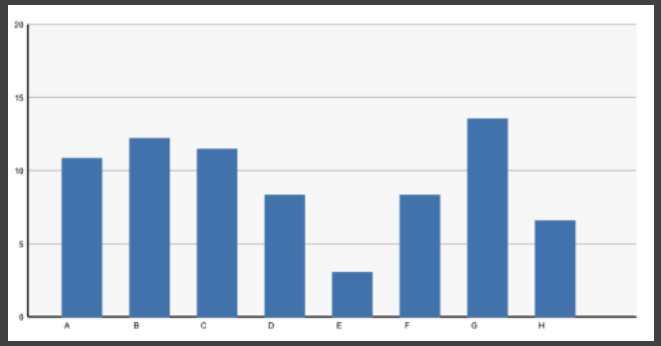
Change Encodings + Axis Scales



Data Graphics & Transitions

Category	Sales	Profit
A	11	7
B	13	10
C	12	6
D	8	5
E	3	1

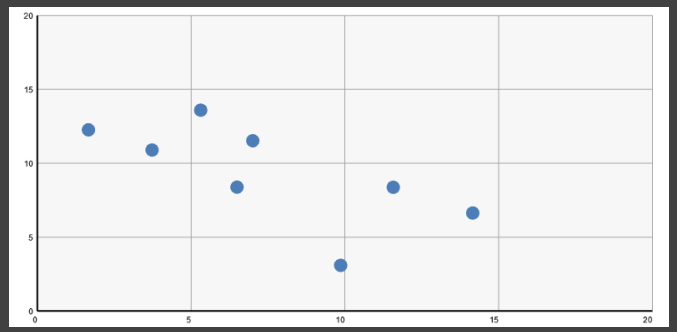
Visual Encoding



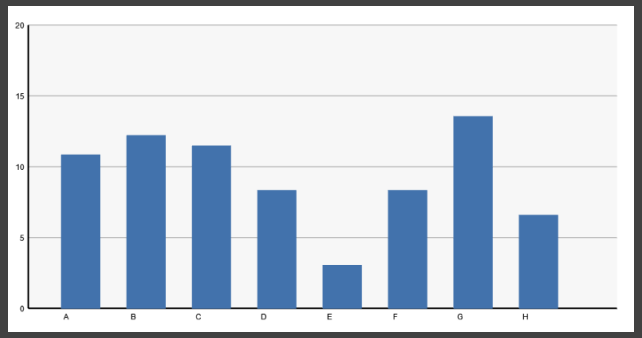
Change selected data dimensions or encodings

Animation to communicate changes?

Category	Sales	Profit
A	11	7
B	13	10
C	12	6
D	8	5
E	3	1



Transitions between Data Graphics



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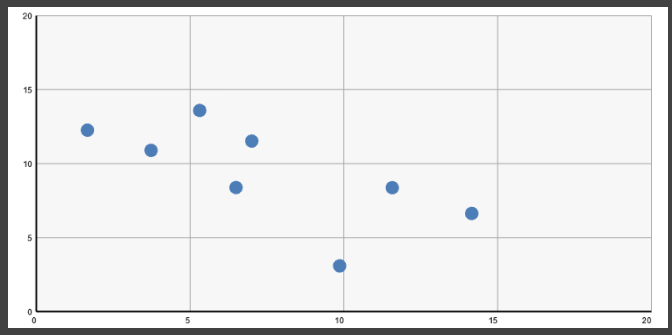

During analysis and presentation it is common to transition between *related* data graphics.

Can animation help?
How does this impact perception?

Principles for Animation

Congruence *Expressiveness?*

The structure and content of the external representation should correspond to the desired structure and content of the internal representation.

Apprehension *Effectiveness?*

The structure and content of the external representation should be readily and accurately perceived and comprehended.

[from Tversky 02]

Principles for Animation [Heer]

Congruence
Maintain valid data graphics during transitions ←
Use consistent syntactic/semantic mappings
Respect semantic correspondence
Avoid ambiguity

Apprehension
Group similar transitions
Minimize occlusion
Maximize predictability
Use simple transitions
Use staging for complex transitions
Make transitions as long as needed, but no longer

Principles for Animation [Heer]

Congruence
Maintain valid data graphics during transitions
Use consistent syntactic/semantic mappings
Respect semantic correspondence
Avoid ambiguity

Visual marks should always represent the same data tuple.

Apprehension
Group similar transitions
Minimize occlusion
Maximize predictability
Use simple transitions
Use staging for complex transitions
Make transitions as long as needed, but no longer

Principles for Animation [Heer]

Congruence
Maintain valid data graphics during transitions
Use consistent syntactic/semantic mappings
Respect semantic correspondence
Avoid ambiguity

Different operators should have distinct animations.

Apprehension
Group similar transitions
Minimize occlusion
Maximize predictability
Use simple transitions
Use staging for complex transitions
Make transitions as long as needed, but no longer

Principles for Animation [Heer]

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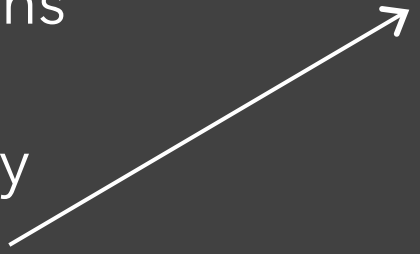


Keep animation as simple as possible. If complicated, break into simple stages.

Animated Transitions in Statistical Data Graphics

Jeffrey Heer
George G. Robertson

Microsoft Research

Study Conclusions

Appropriate animation improves graphical perception

Simple transitions beat "*do one thing at a time*"

Simple staging was preferred and showed benefits

but timing important and in need of study

Axis re-scaling hampers perception

Avoid if possible (use common scale)

Maintain landmarks better (delay fade out of lines)

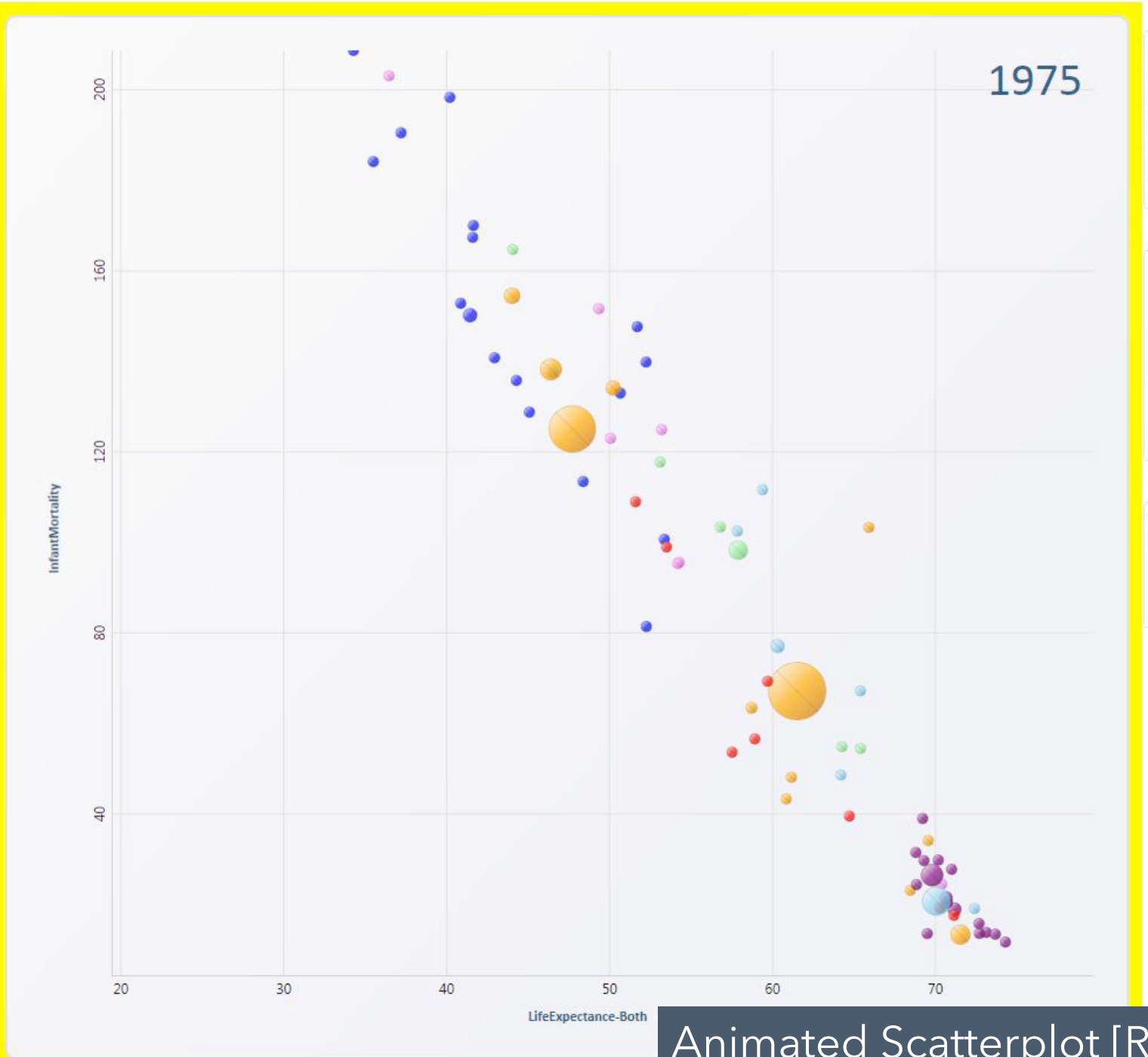
Subjects preferred animated transitions

Animation in Trend Visualization

Heer & Robertson study found that animated transitions are better than static transitions for estimating changing values.

How does animation fare vs. static time-series depictions (as opposed to static transitions)?

Experiments by Robertson et al, InfoVis 2008
(10 Year Test-of-Time Award at InfoVis 2018!)



Color Legend (continent)

- Africa
- Asia
- Europe
- Middle East
- North America
- Oceania
- South America

Task

Select two countries with decreasing InfantMortality, but little change in life expectancy.

Ctrl-Click on a country (in chart) to set an answer.

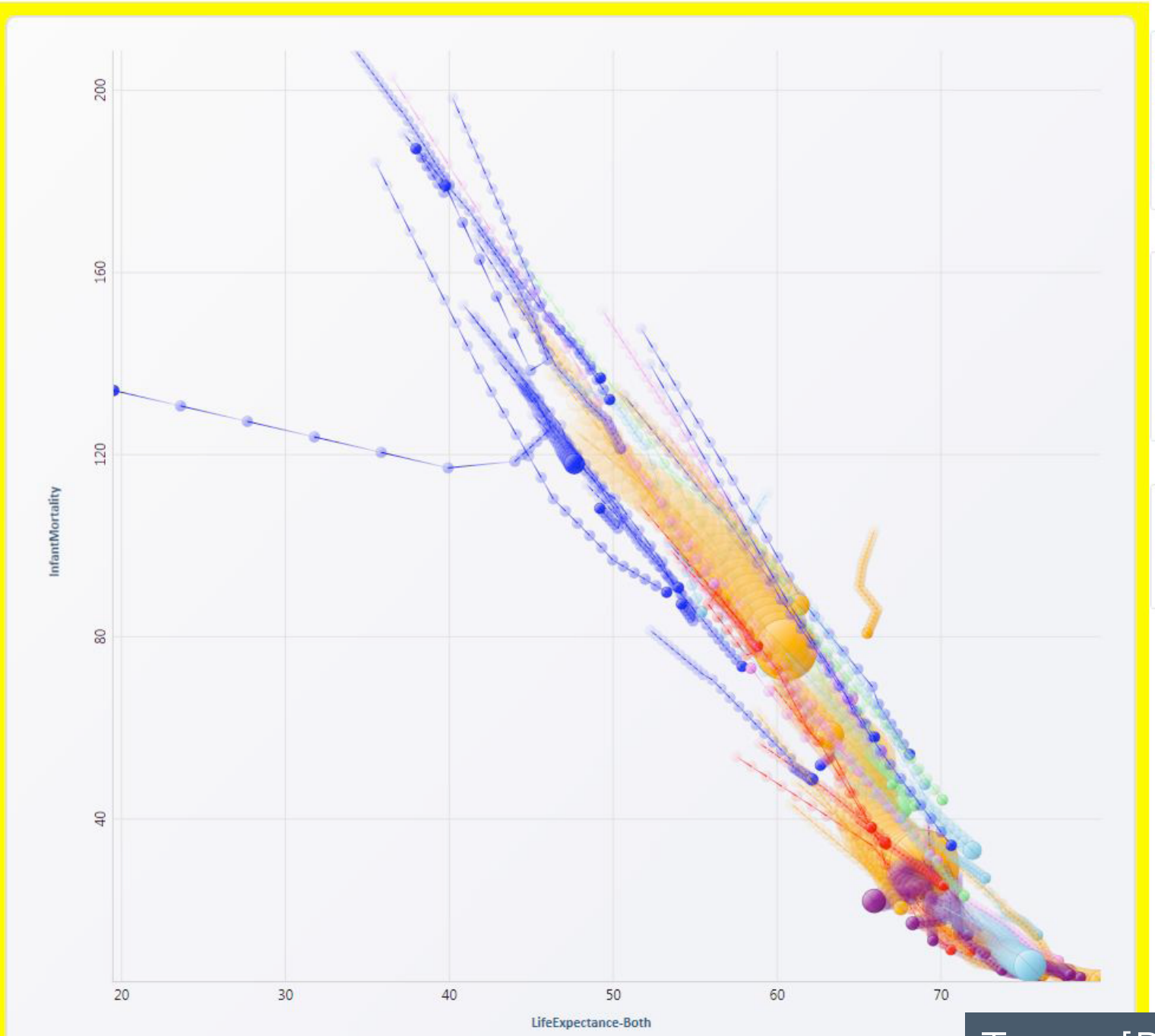
Answers set: 0/2

Next

Click on "Next" when finished (or "Give Up" if you cannot find all the answers)

Give Up | Next

Animated Scatterplot [Robertson 08]



Color Legend (continent)

- Africa
- Asia
- Europe
- Middle East
- North America
- Oceania
- South America

Task

Select two countries whose InfantMortality dropped first, then increased later.

Ctrl-Click on a country (in chart) to set an answer.

Answers set: 0/2

Next

Click on "Next" when finished (or "Give Up" if you cannot find all the answers)

Give Up | Next

Traces [Robertson 08]

Color Legend (continent)

- Africa
- Asia
- Europe
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- North America
- Oceania
- South America

Task

Select two countries whose InfantMortality dropped first, then increased later.

Ctrl-Click on a country (in chart) to set an answer.

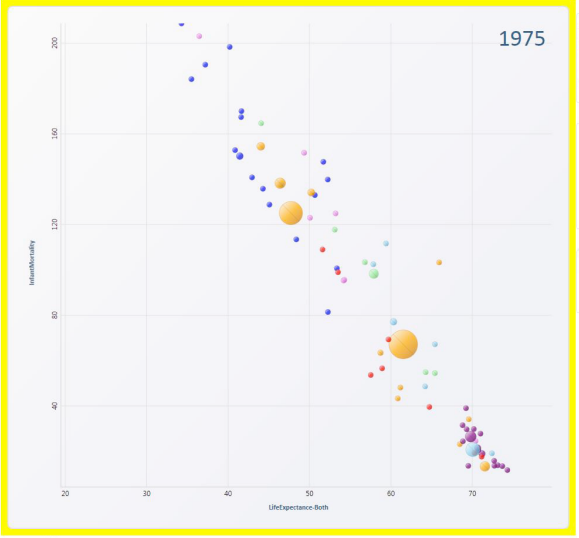
Answers set: 0/2

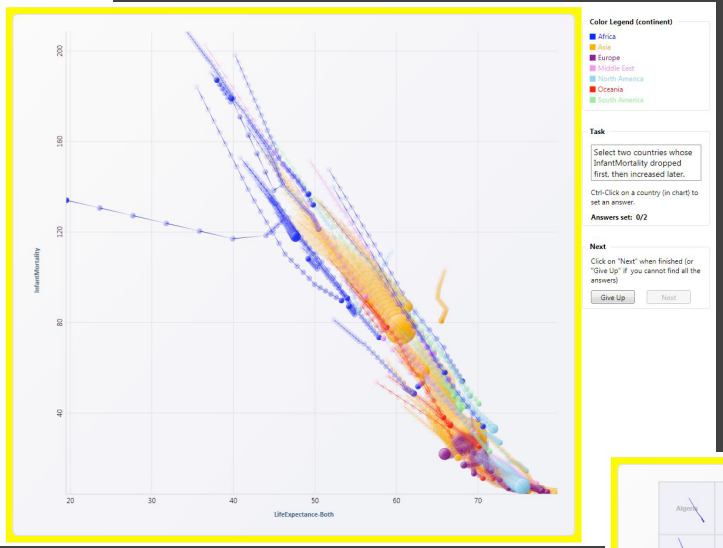
Next

Click on "Next" when finished (or "Give Up" if you cannot find all the answers)

Give Up | Next

Small Multiples [Robertson 08]





Which to prefer for analysis?
For presentation?

Study: Analysis & Presentation

Subjects asked comprehension questions.
Presentation condition included narration.

Multiples 10% *more accurate* than animation

Presentation: Anim. 60% *faster* than multiples
Analysis: Animation 82% *slower* than multiples

User preferences favor animation (even though less accurate and slower for analysis!)

Summary

Animation is a salient visual phenomenon
Attention, object constancy, causality, timing
Design with care: congruence & apprehension

For processes, **static images** may be preferable

For transitions, animation has demonstrated benefits, but **consider task and timing**