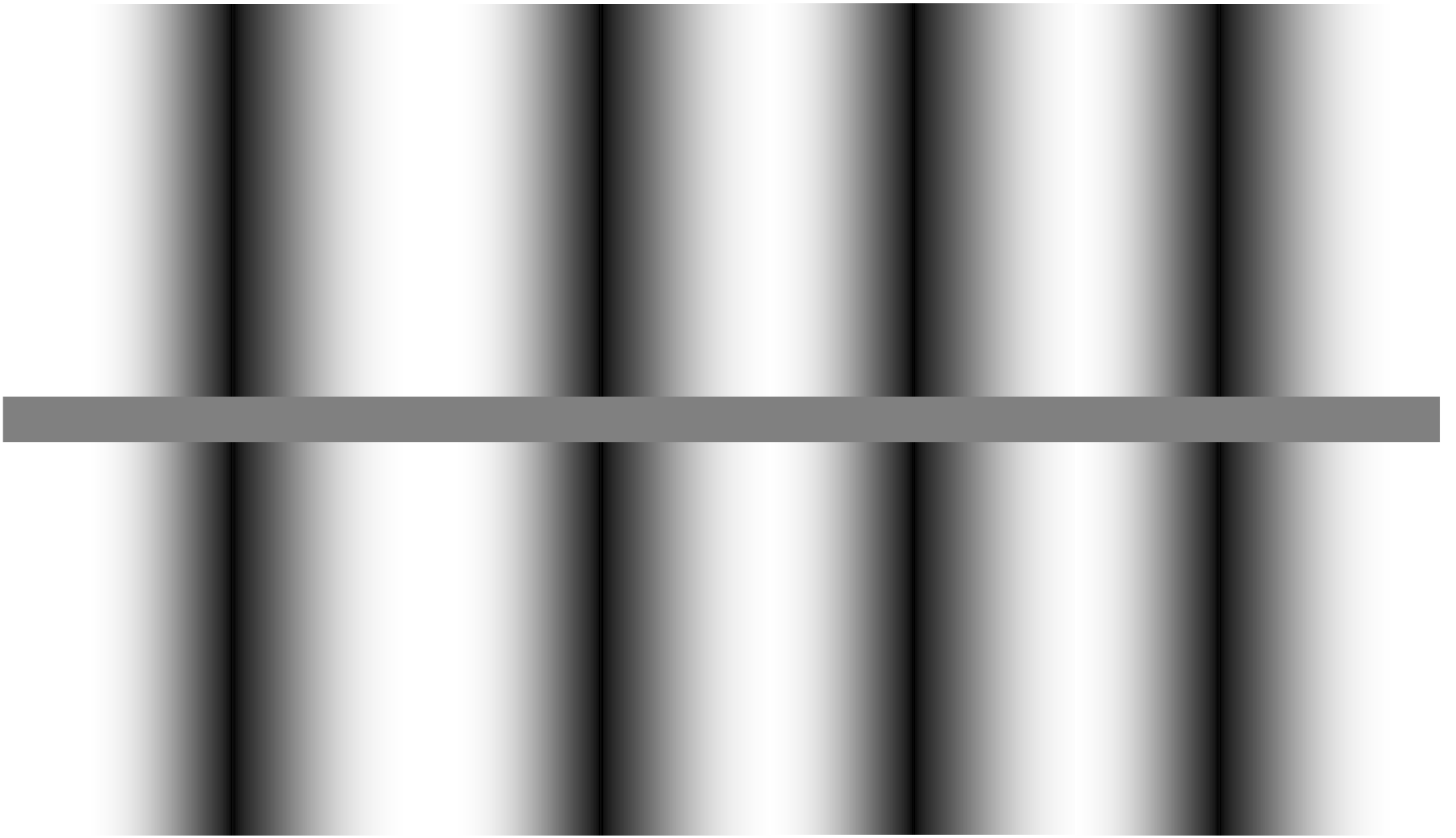
Visual Perception

- Based on sampled visual information
  - Need-to-know basis
- Optimization of resource allocation
  - Physical action
    - Eye movement, head movement.
  - Cognitive actions
    - Relying on working memory to retain visual images
    - Analyzing and interpreting visual images with the help of short-term and long-term memory.
- Goal-oriented
  - Intentionally or unintentionally
- What we see is a distorted version of the physical world.

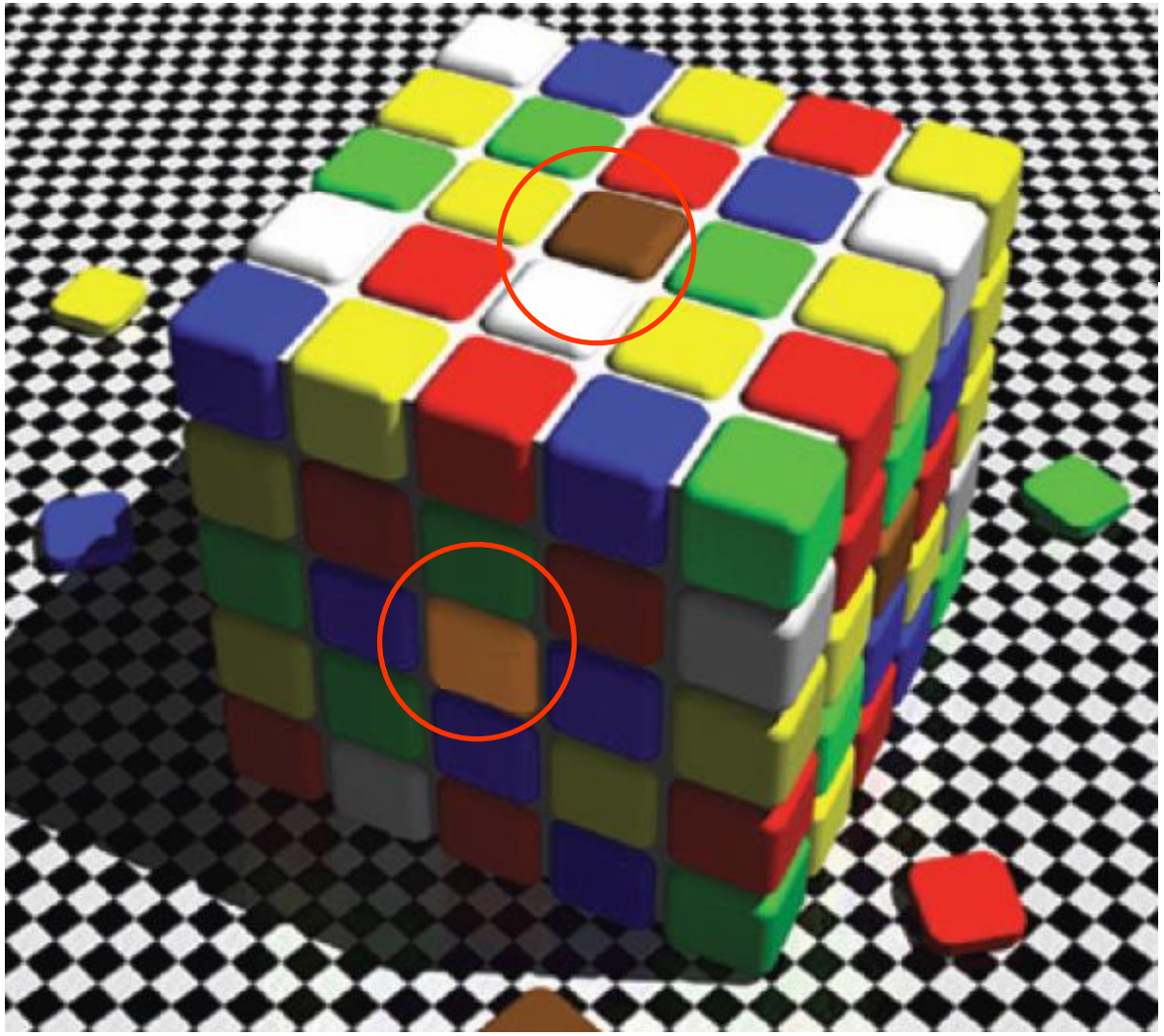
Goal-Driven

- The goal is usually predefined and with an action plan.
- Actions are often visually guided.
  - Eye movement
- Visual attention follows the action plan.
- Often very contextual.
  - Prior knowledge, training, etc.

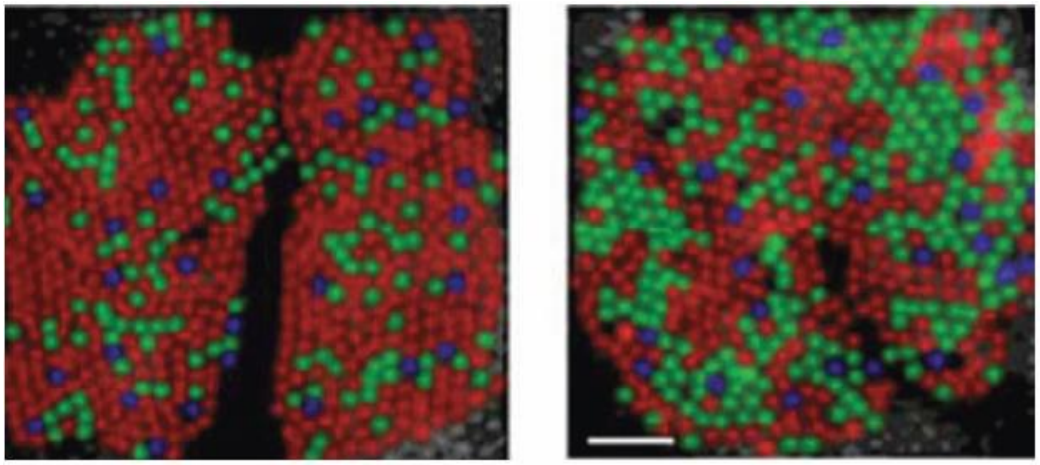


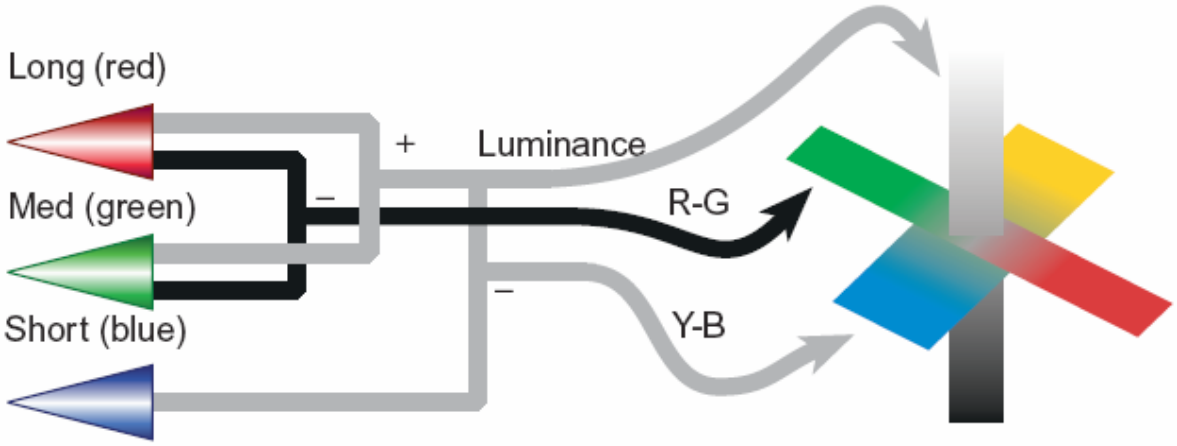
Key Messages

- Our eyes capture optical information from the external worlds, just as photo sensors do.
- However, our overall visual system, involving eyes and brain, is good at catching difference in luminance, rather than the absolute value of luminance.



Opponent Process Theory



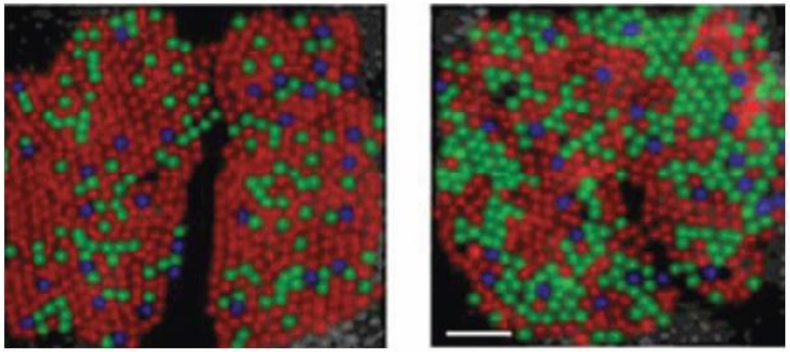


Black and White Is the Best.

Some natural philosophers Suppose that these colors arise from the accidental vapours diffused in the air, which communicates their own hues to the shadow

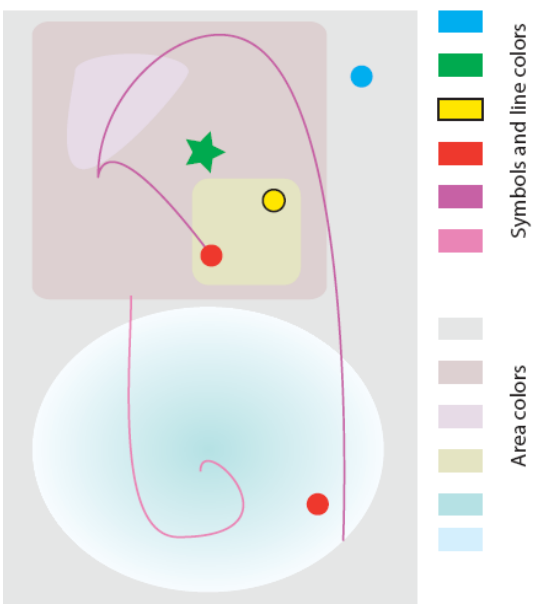
Some natural philosophers Suppose that these colors arise from the accidental vapours diffused in the air, which communicates their own hues to the shadow

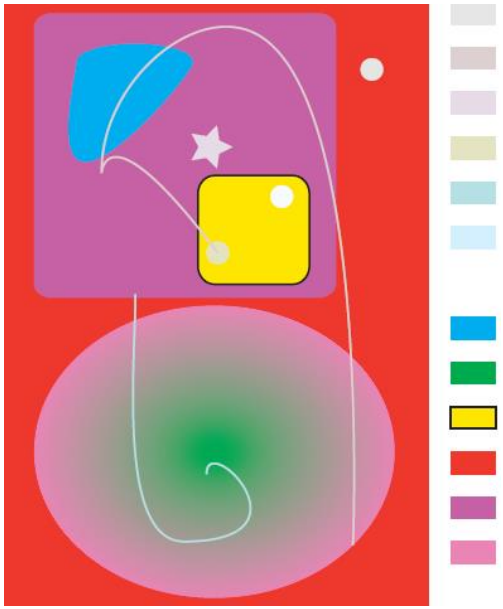
- Black and white
  - Only require two types of cones
    - They are distributed widely.



Large and Small Areas

- Small areas of interest: saturated colors.
  - Background colors: less saturated.





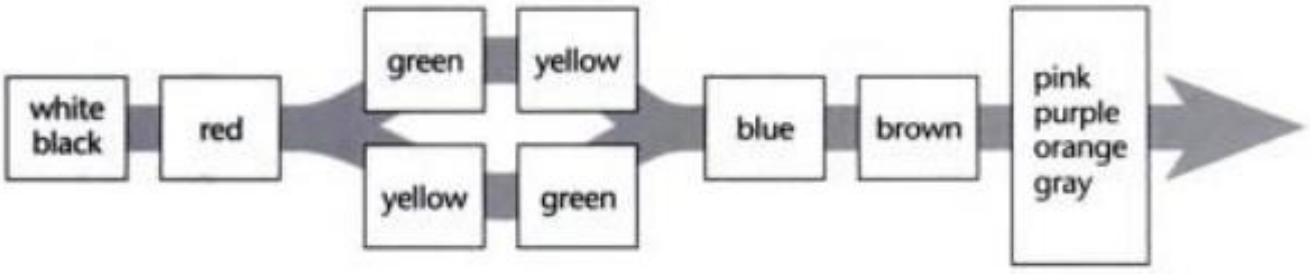
Color Coding

- Using colors to distinguish object types
  - Learnability
    - Using the unique hues first
      - Red, green, yellow, blue
    - Limited number of different colors.

Unique Hues

- Six basic colors

- Cross-Culture Names

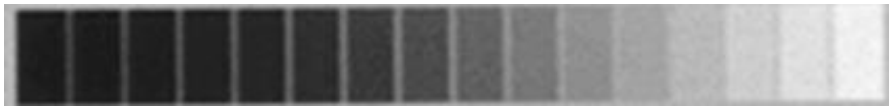


Spectrum Sequence

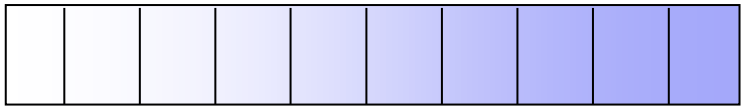
- The whole spectrum sequence is not perceptually ordered.
  - Part of the spectrum is.
- Provide color keys.
  - Ordering colors according to their luminance.

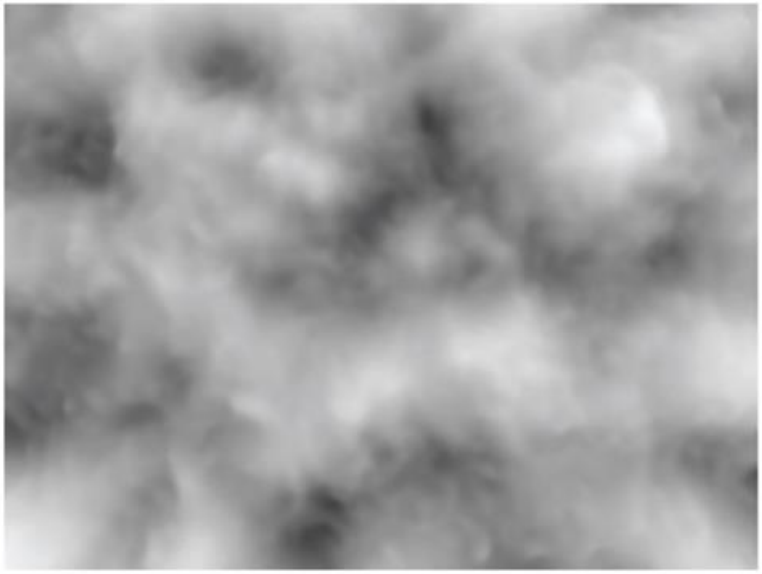
Quantitative Comparison

- Perceptually ordered colors
  - Grayscale



  - Same color, different saturations



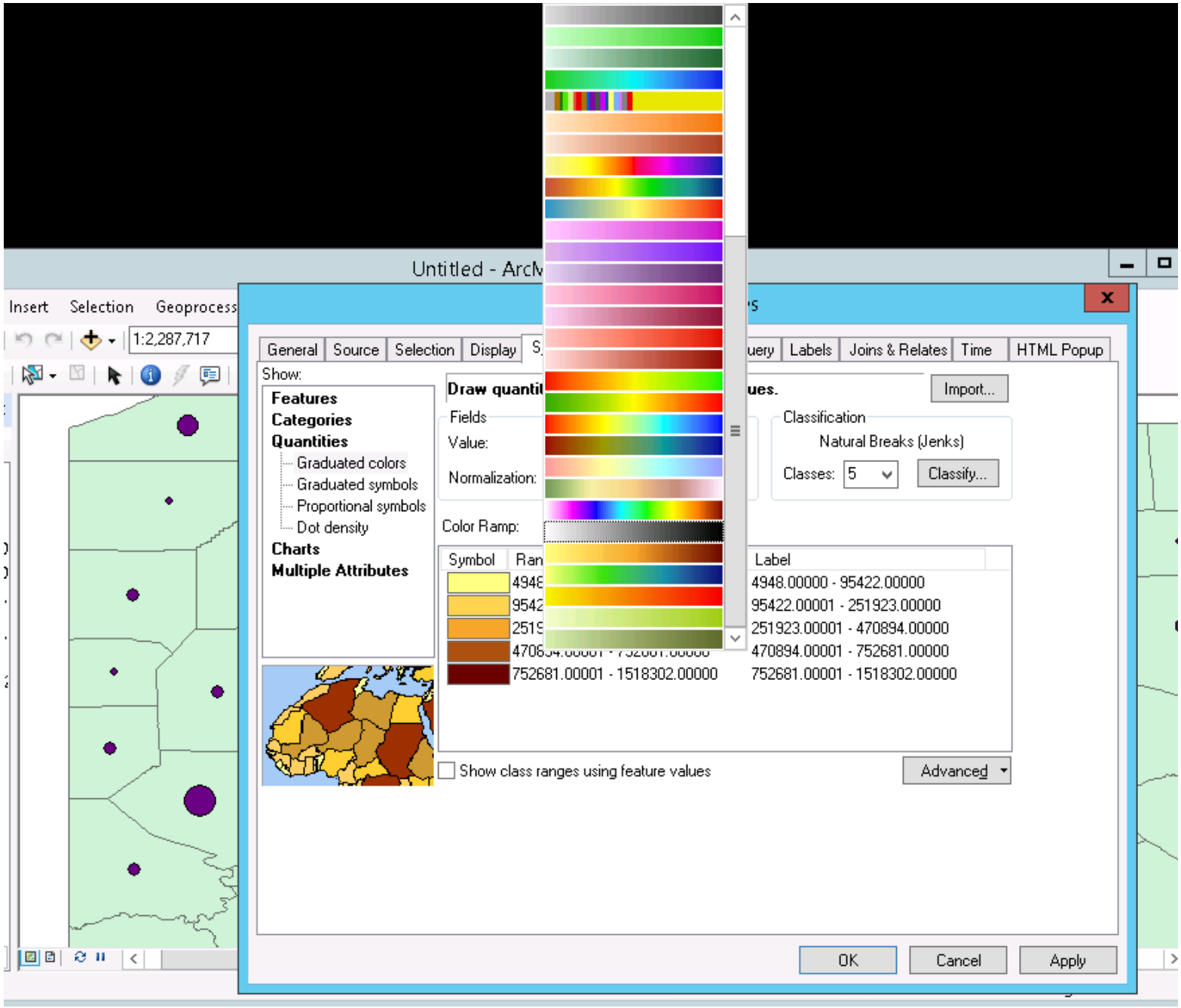


Semantics of Color

- Could be culture-dependent

What Color Is This Dress?

What Happed to the Market?


Untitled - ArcM
Insert
Selection
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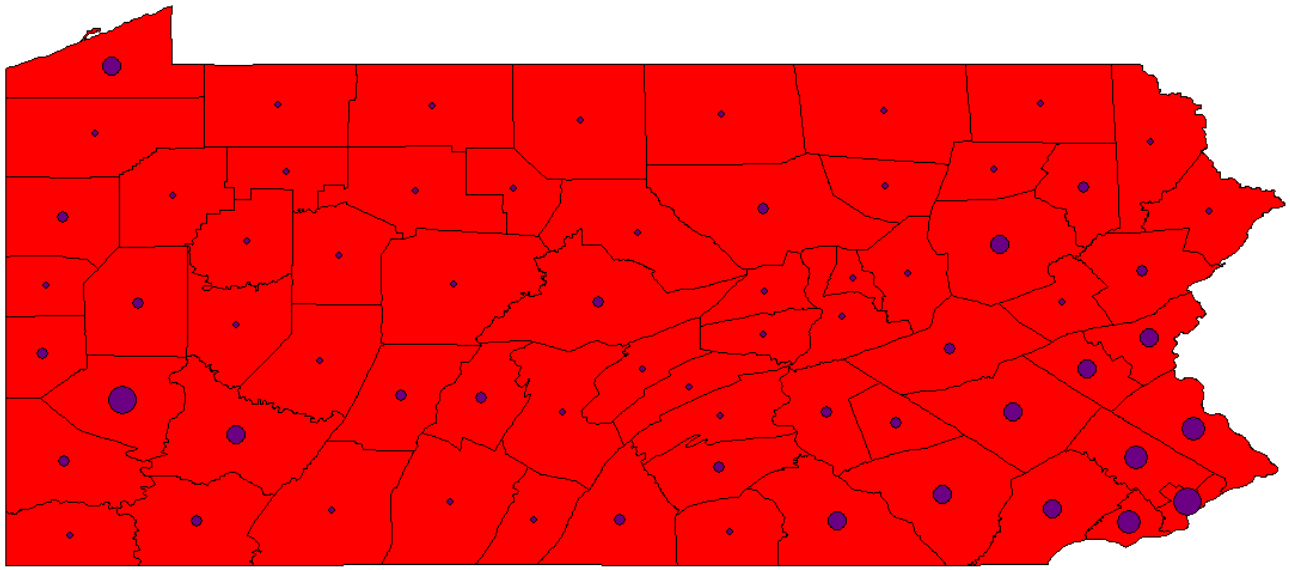
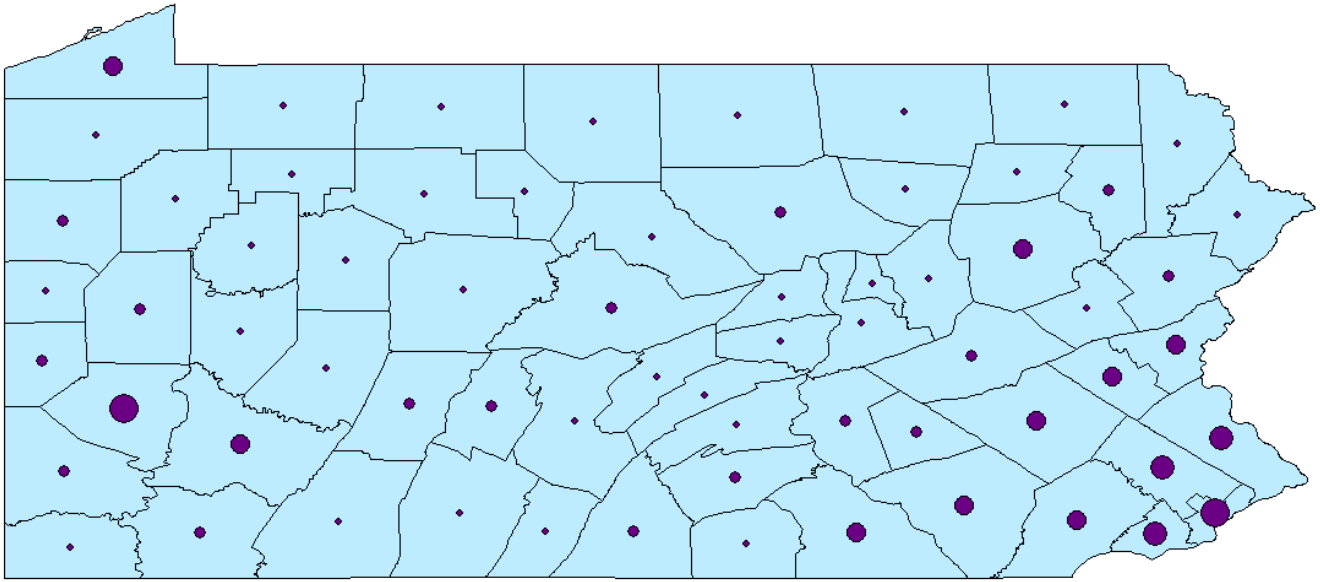
1:2,287,717
General
Source
Selection
Display
Labels
Joins & Relates
Time
HTML Popup
Show:
Features
Categories
Quantities
Graduated colors
Graduated symbols
Proportional symbols
Dot density
Charts
Multiple Attributes
Fields
Value:
Normalization:
Color Ramp:
Import...
Classification
Natural Breaks (Jenks)
Classes: 5
Classify...
Symbol
Label
4948.00000 - 95422.00000
95422.00001 - 251923.00000
251923.00001 - 470894.00000
470894.00001 - 752681.00000
752681.00001 - 1518302.00000
Show class ranges using feature values
Advanced
OK
Cancel
Apply

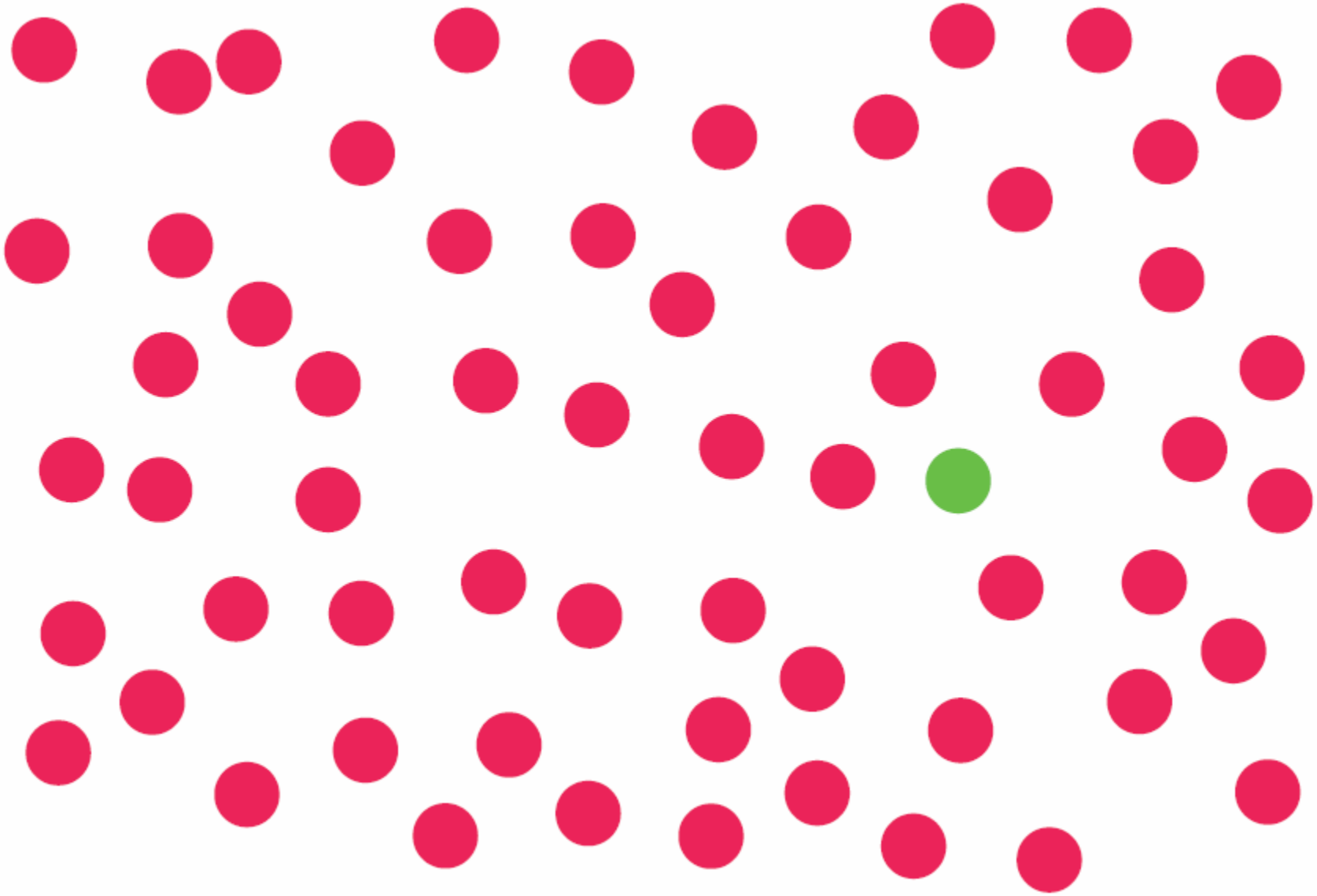
Two Different Designs

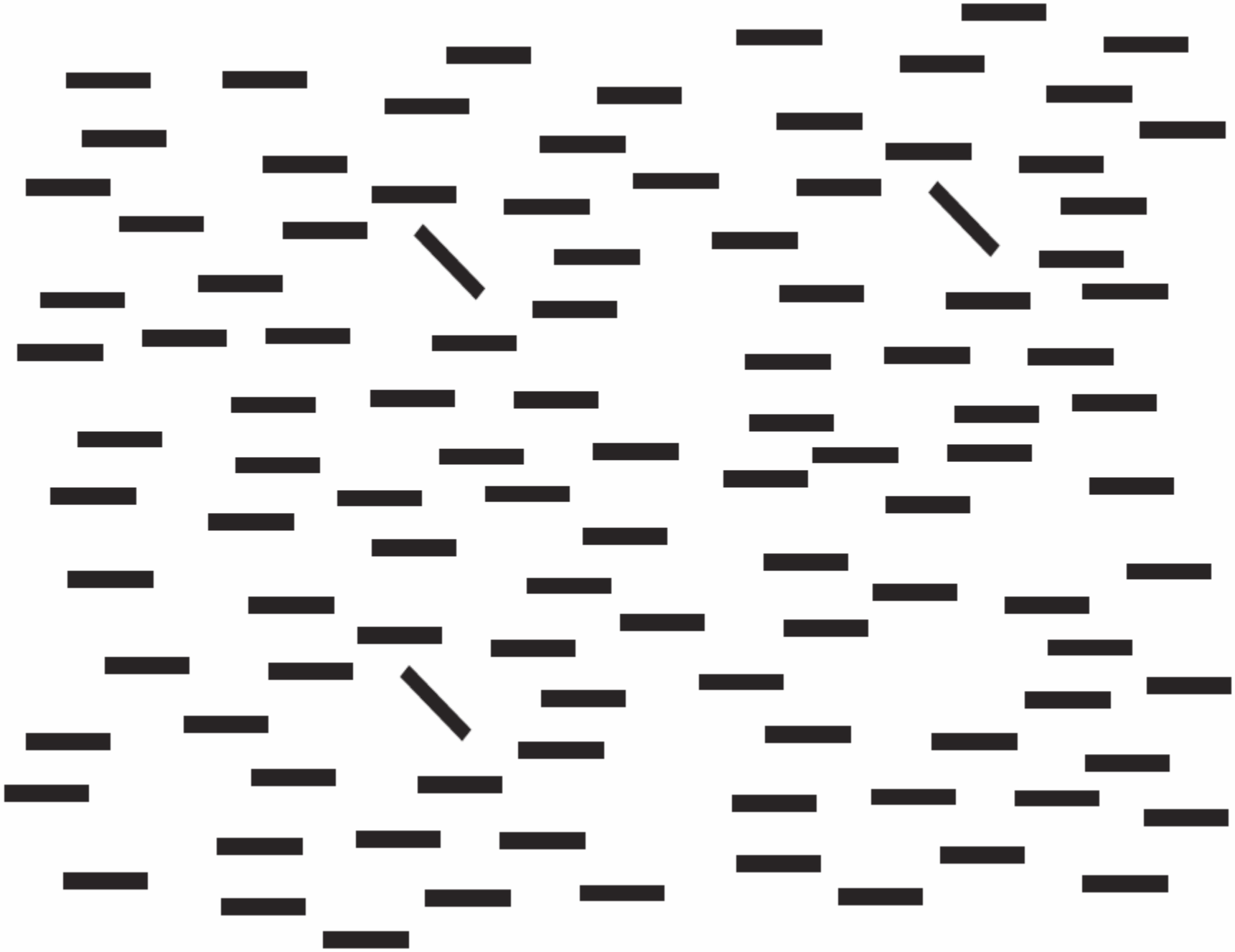


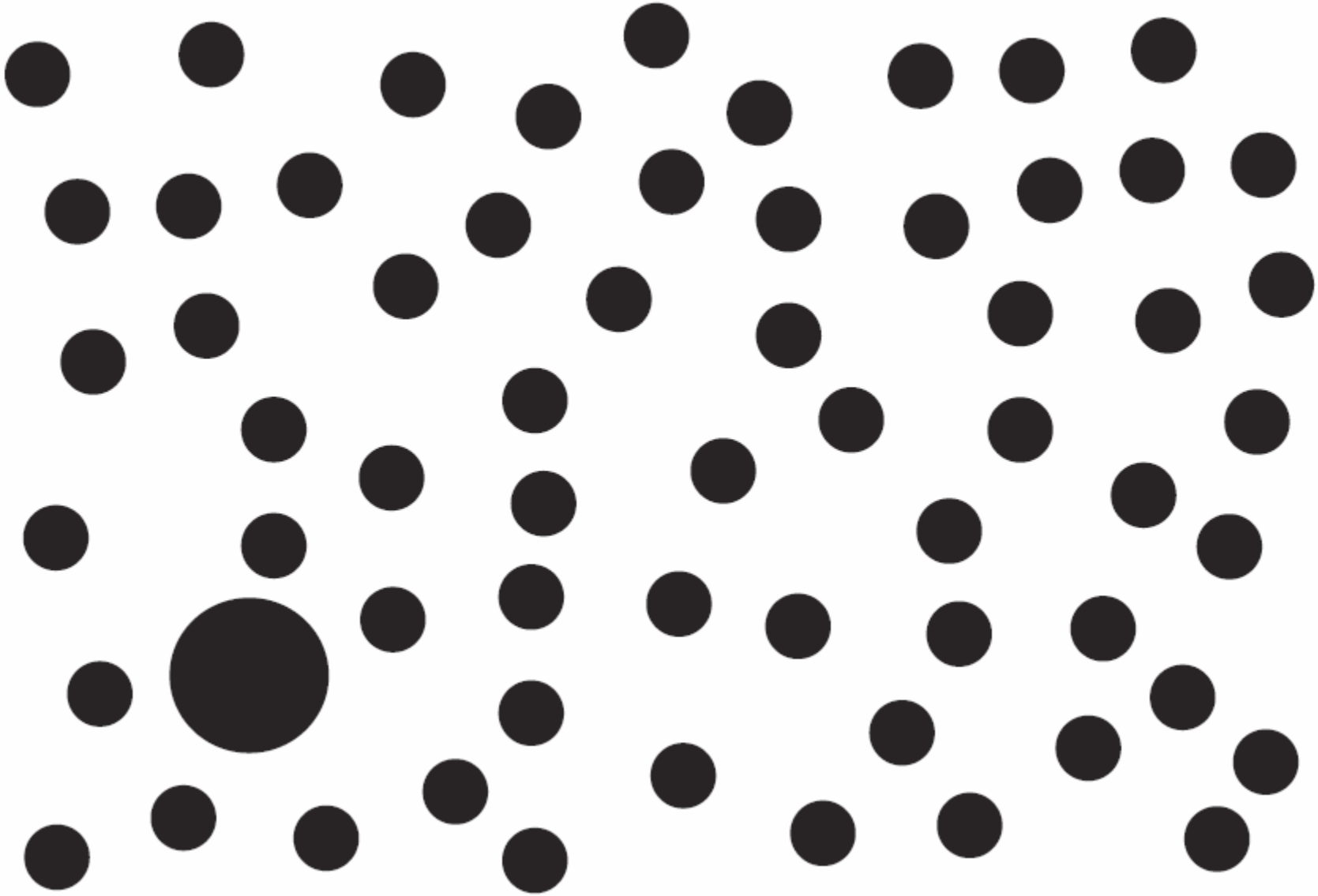


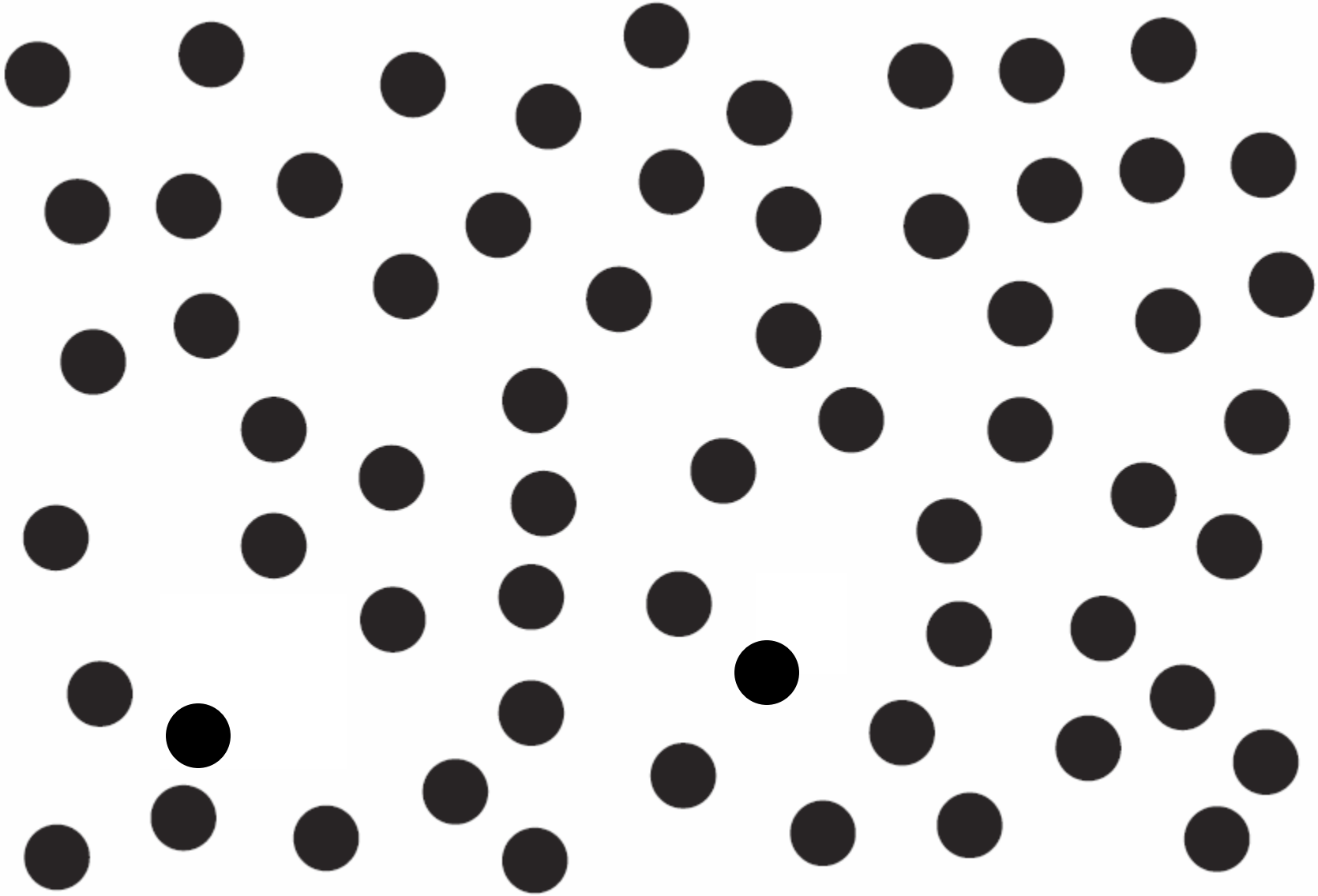
Cognitive Foundation for Visualization -- II

More Pictures









What Stands Out?
(What We Can Easily See)

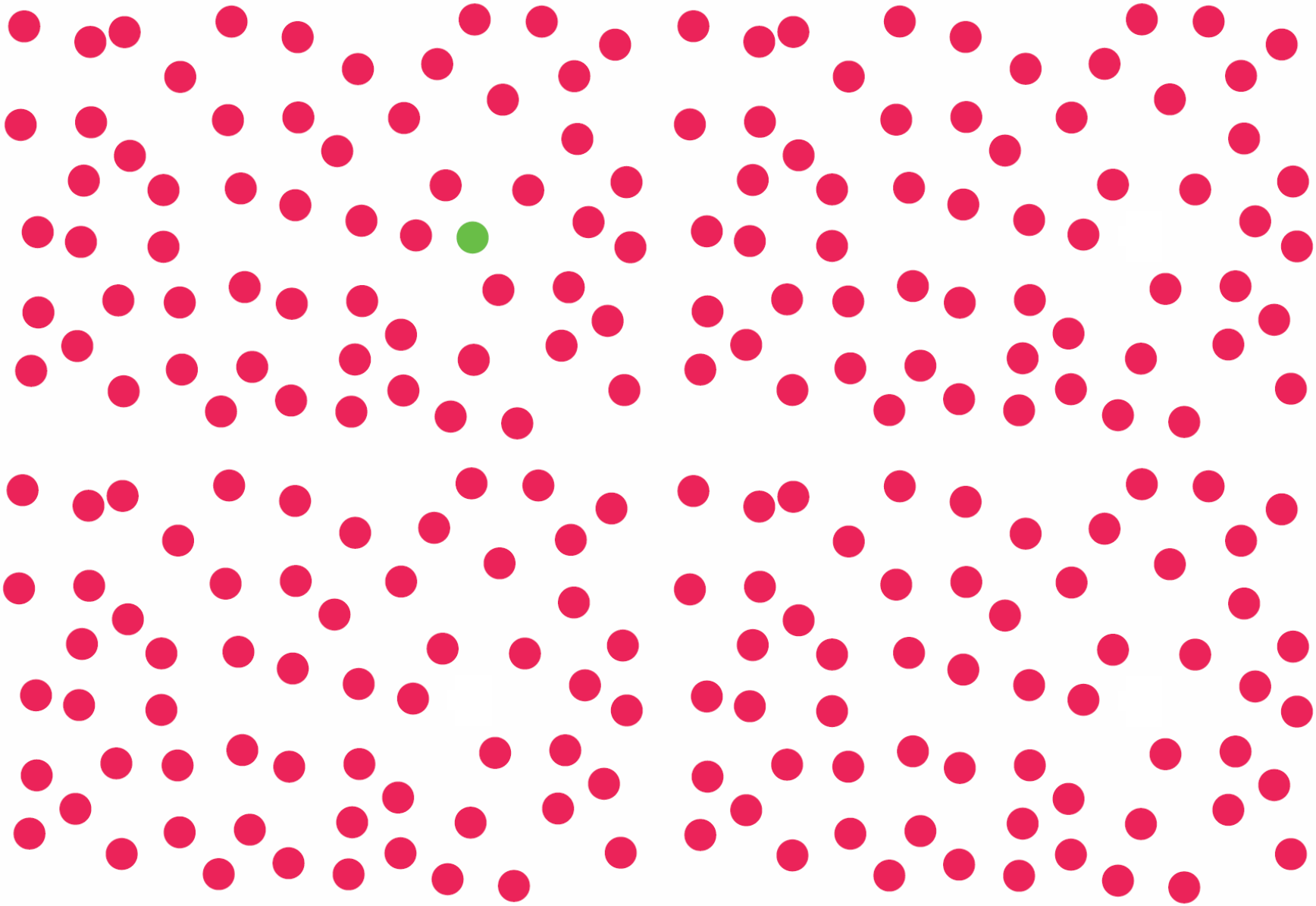
Pop-out Effect

- Certain unique visual features make an object pop out of the distracters in the background.
  - The number of distracters does not matter.
- Very quick
  - 0.1 second

Pop Out Effect

- Certain unique features make an object pop out of the distracters in the background.
  - The number of distracters does not matter.
- Very quick
  - 0.1 second

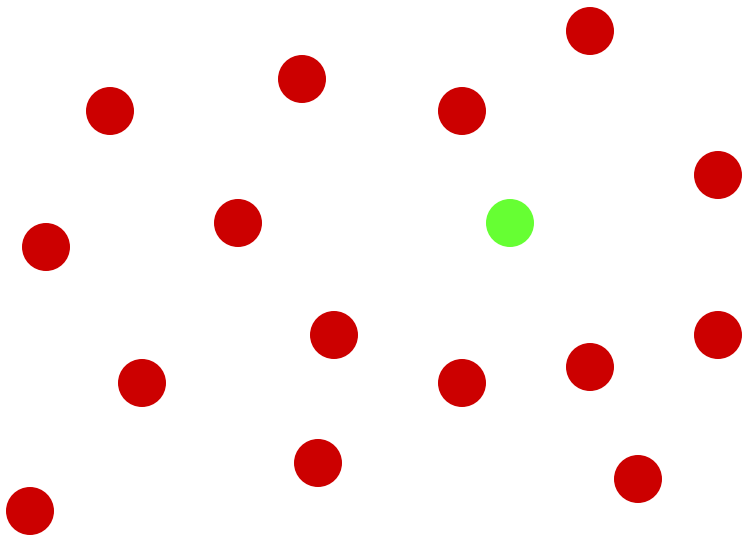
- Visual distinction between the target and the distracters should be large enough.



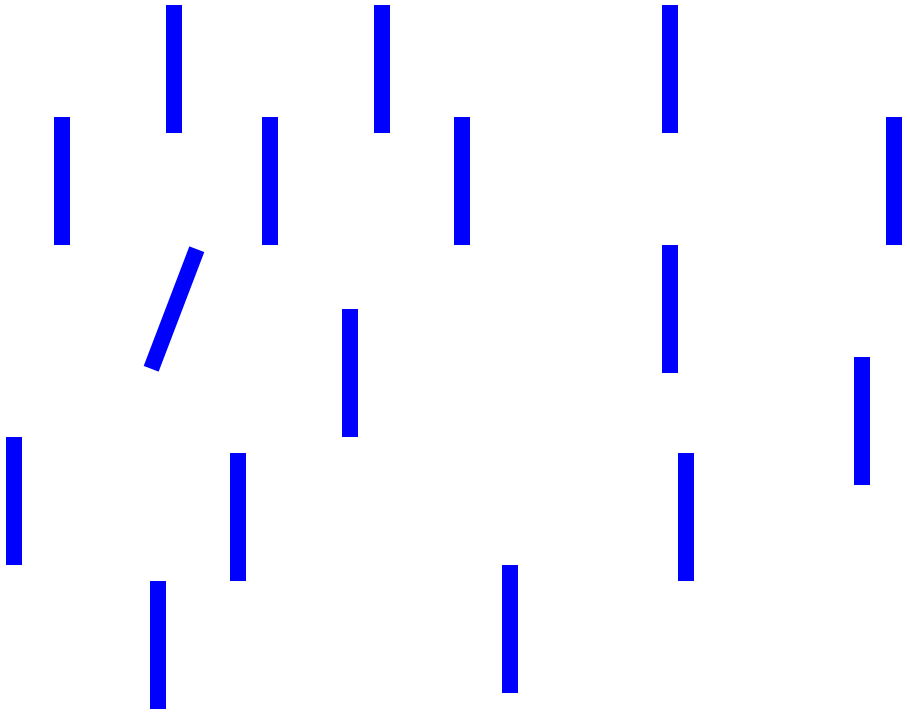
Pop-out Channels

- Prominent channels
  - Form (orientation/size)
  - Color
  - Simple motion/blinking
  - Spatial, stereo depth, shading, position

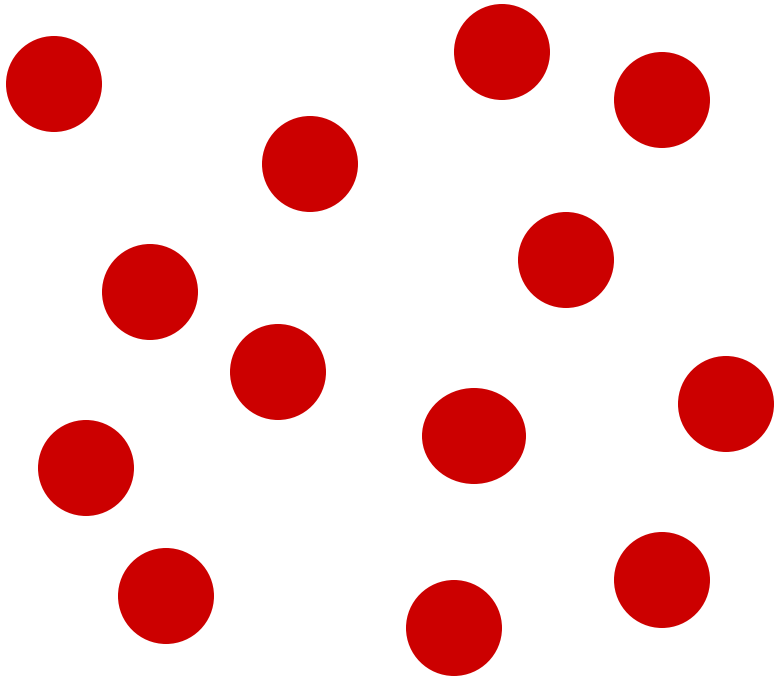
Color



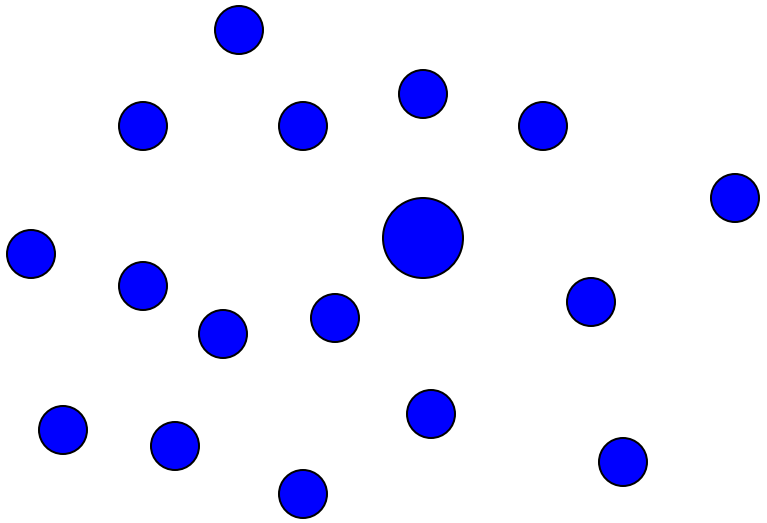
Orientation



Motion



Size

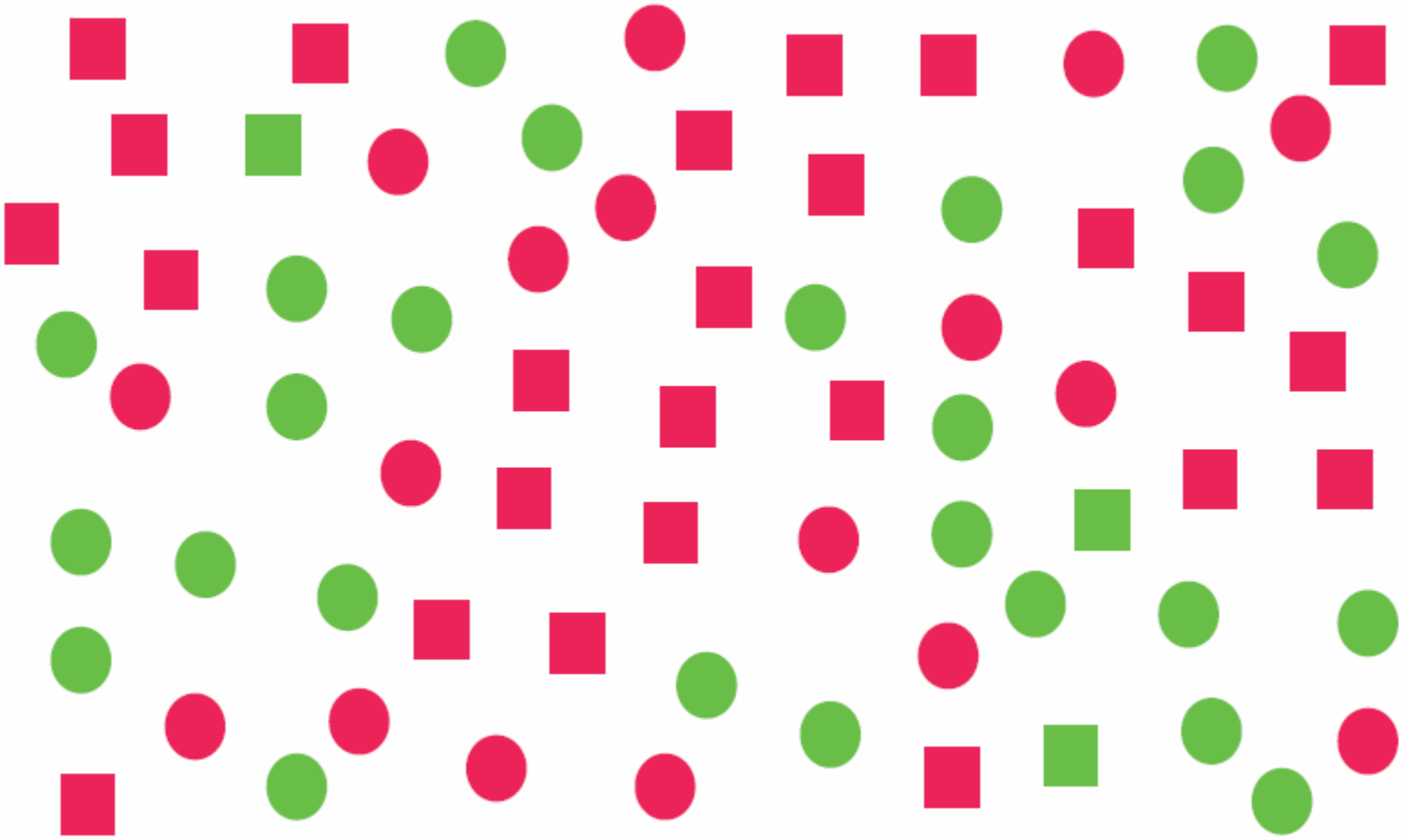


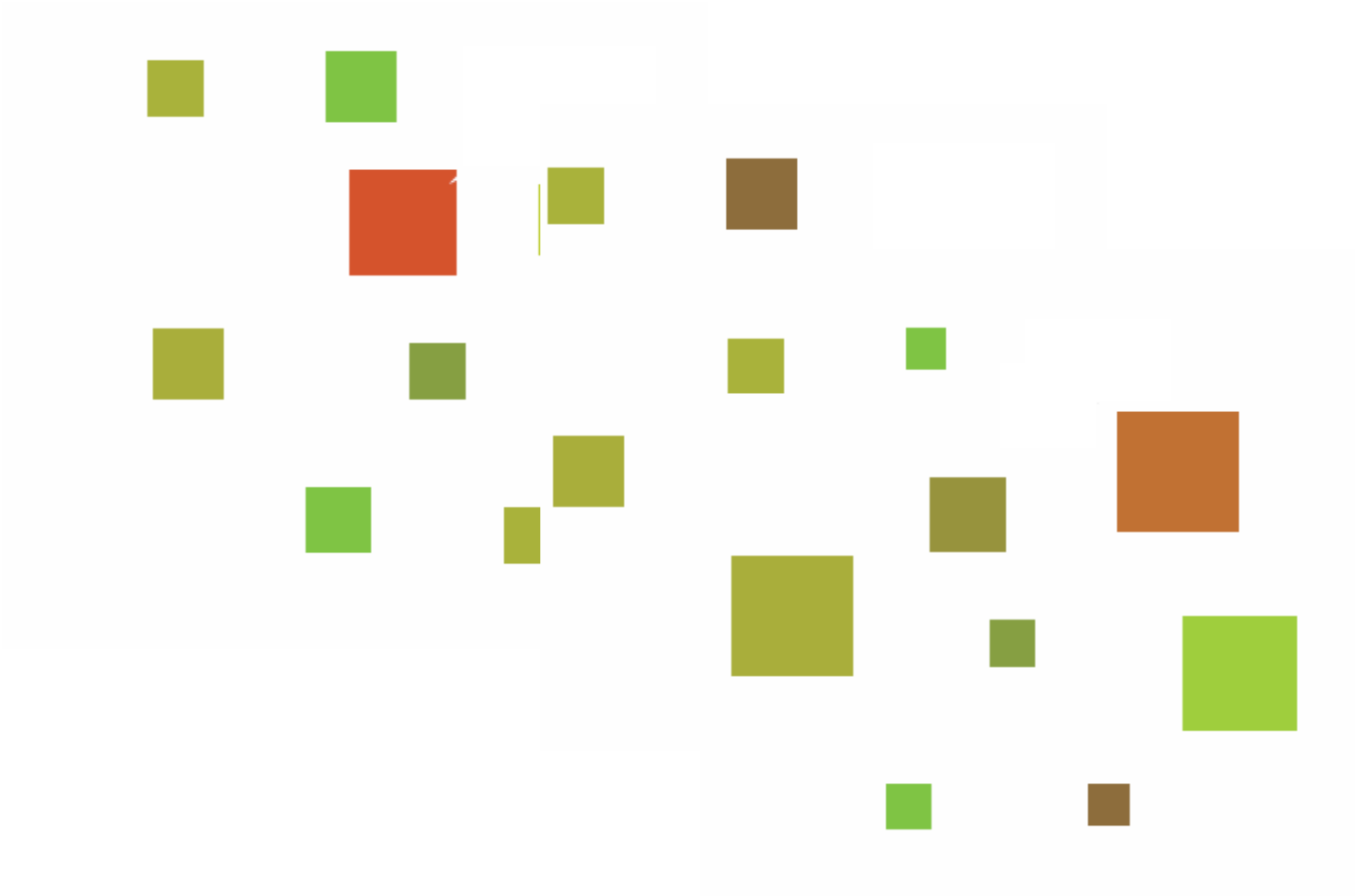
Pop-out Conjunctions

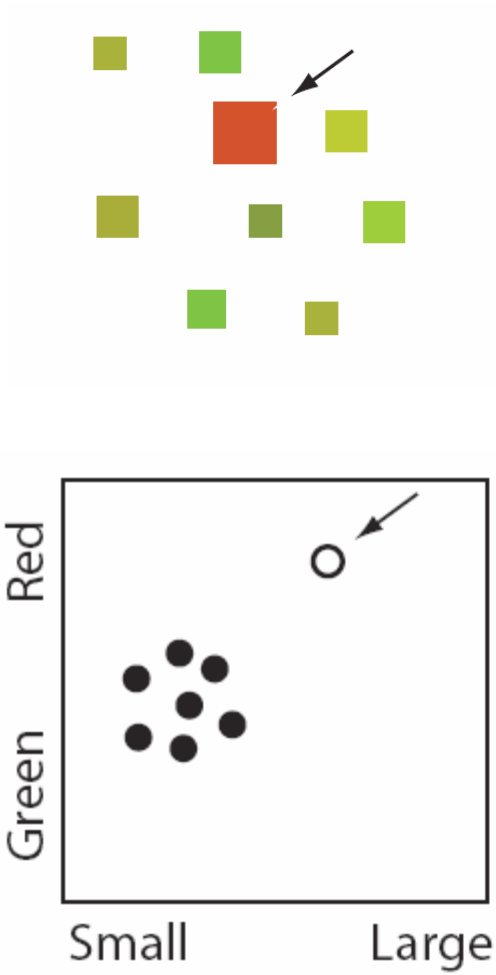
- In general: spatial feature and some aspect of form
  - Color and motion
  - Color and position
  - Shape and position

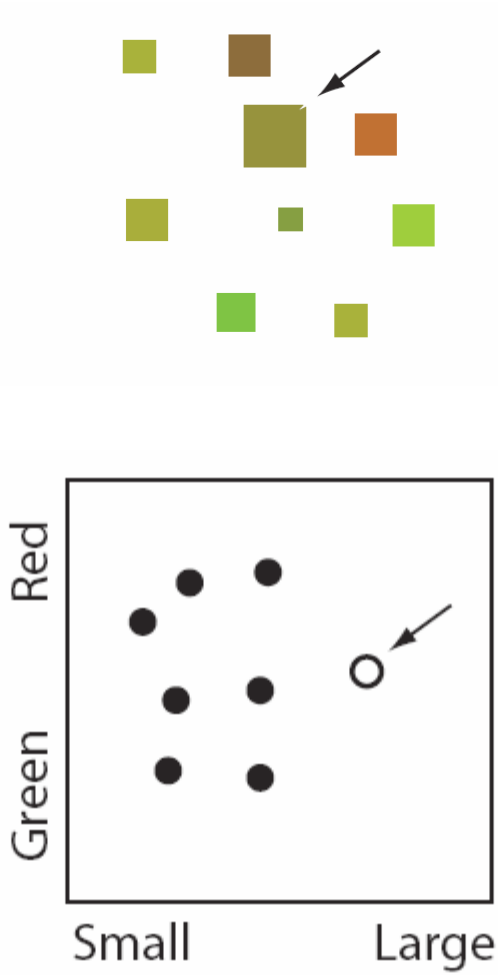
Design of Pop-out Conjunctions

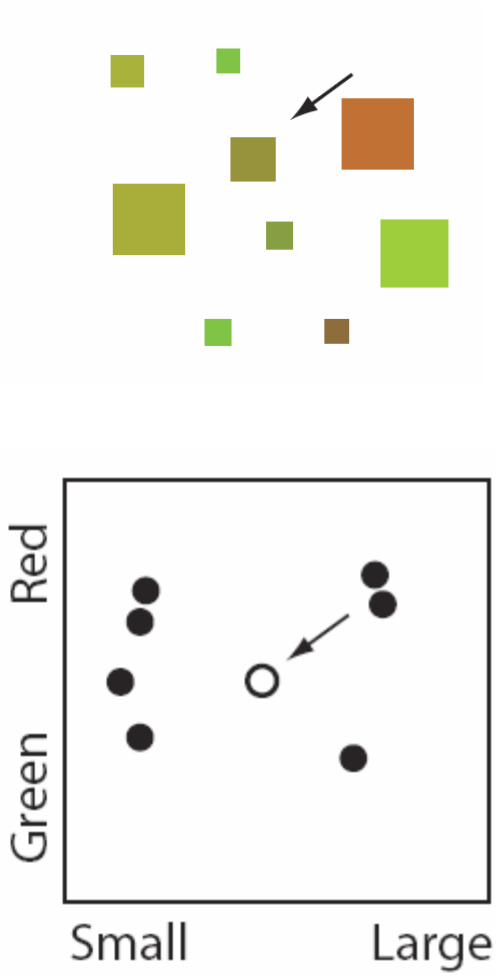
- Good design
  - Sufficient differences in feature dimensions
- Otherwise, hard to use.
  - Learning does not help much.





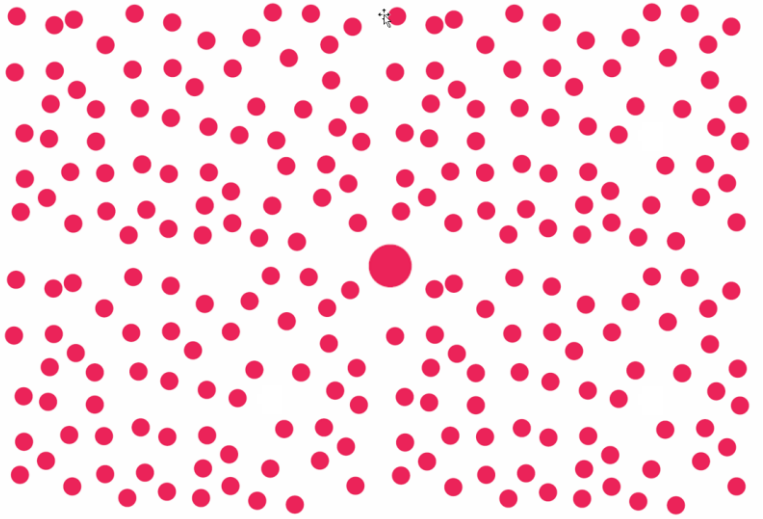

Red
Green
Small
Large


Red
Green
Small
Large


Red
Green
Small
Large

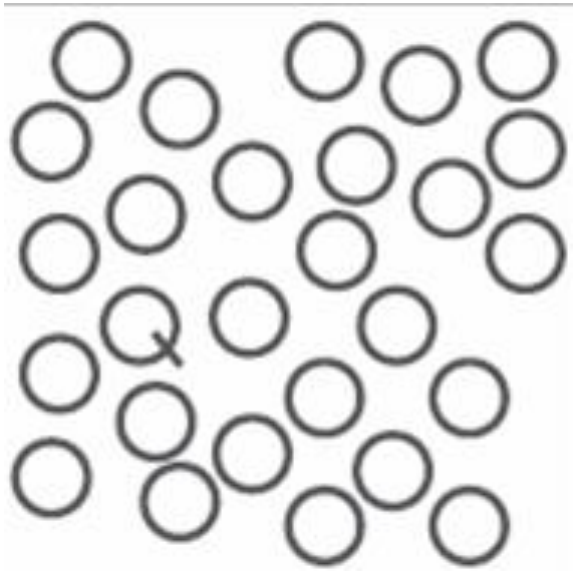
Visibility Enhancement Is Asymmetric

- Large size vs. small size



Visibility Enhancement Is Asymmetric

- Large size vs. small size
- Adding an extra part vs. taking a part away.

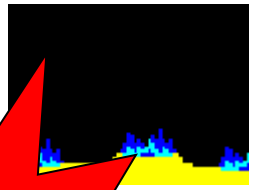


Motion

- Very powerful pop-out effect.
- In particular, things that emerge into the view.
- Abuse of motion
  - Online commercials
    - High-frequency, rapid motion
  - TV commercials

BANDWIDTH SPEEDS -

WARNING!



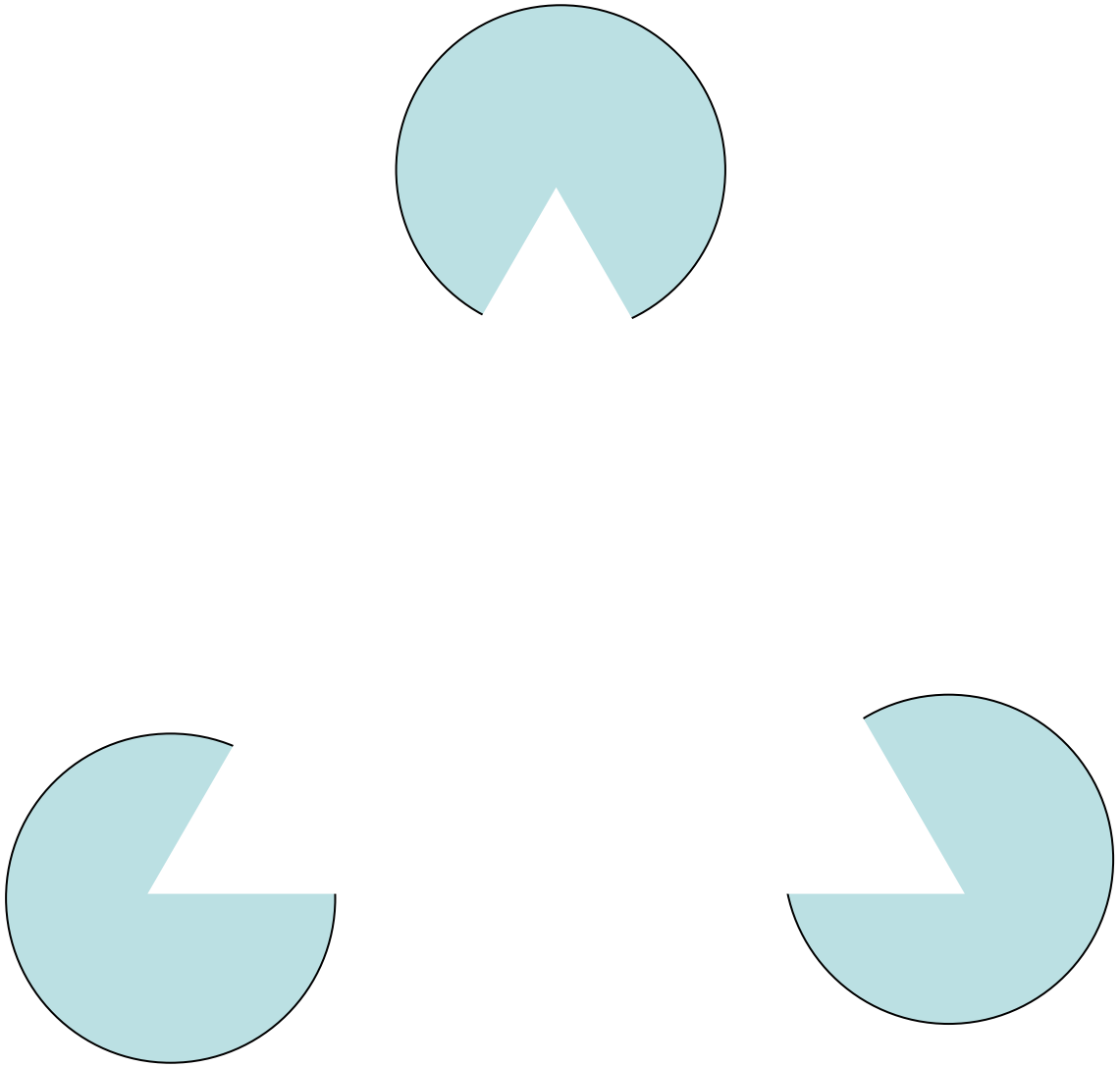
You are visitor #857336 to this site

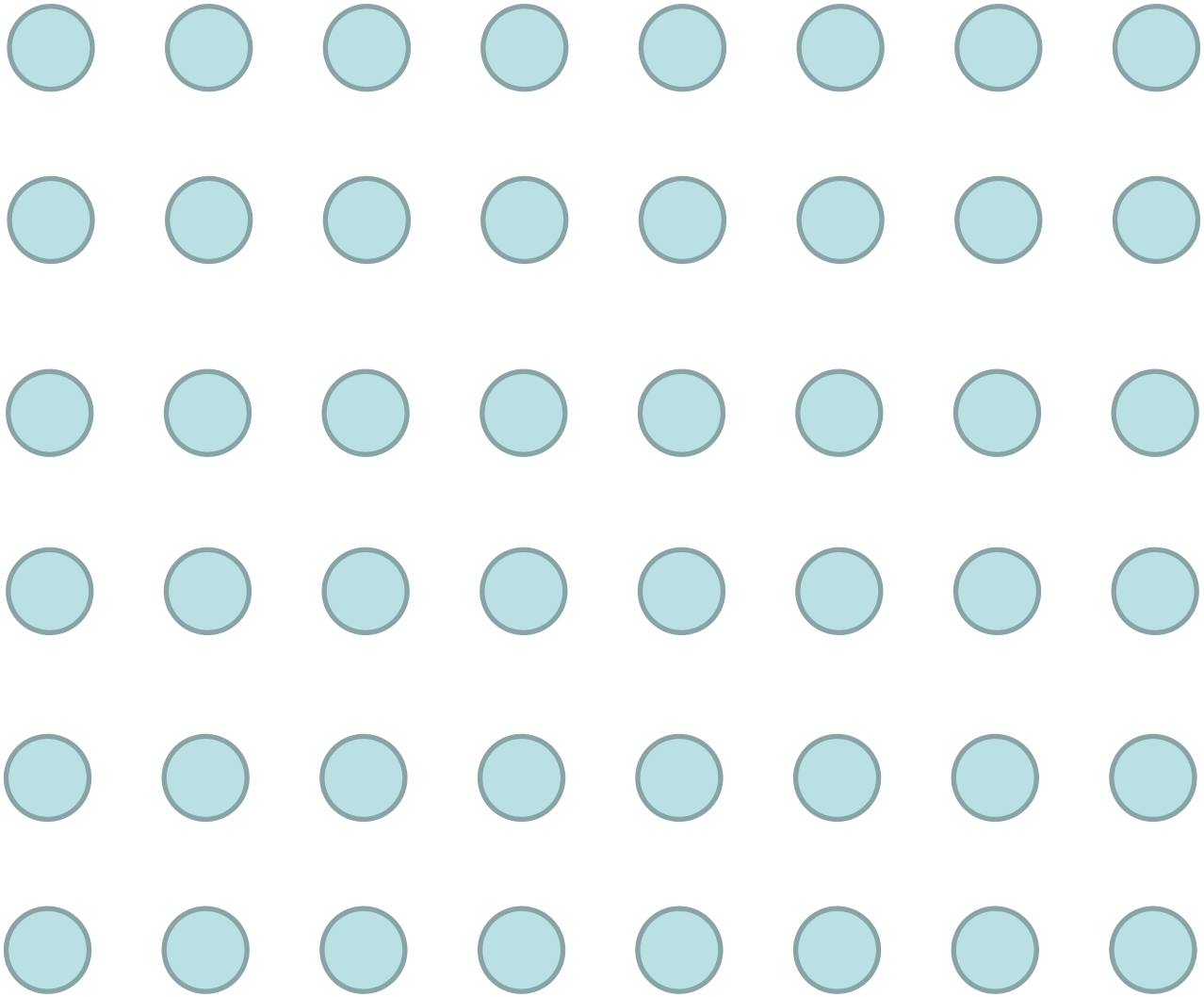
CONGRATULATIONS! YOU'VE WON! Click Here

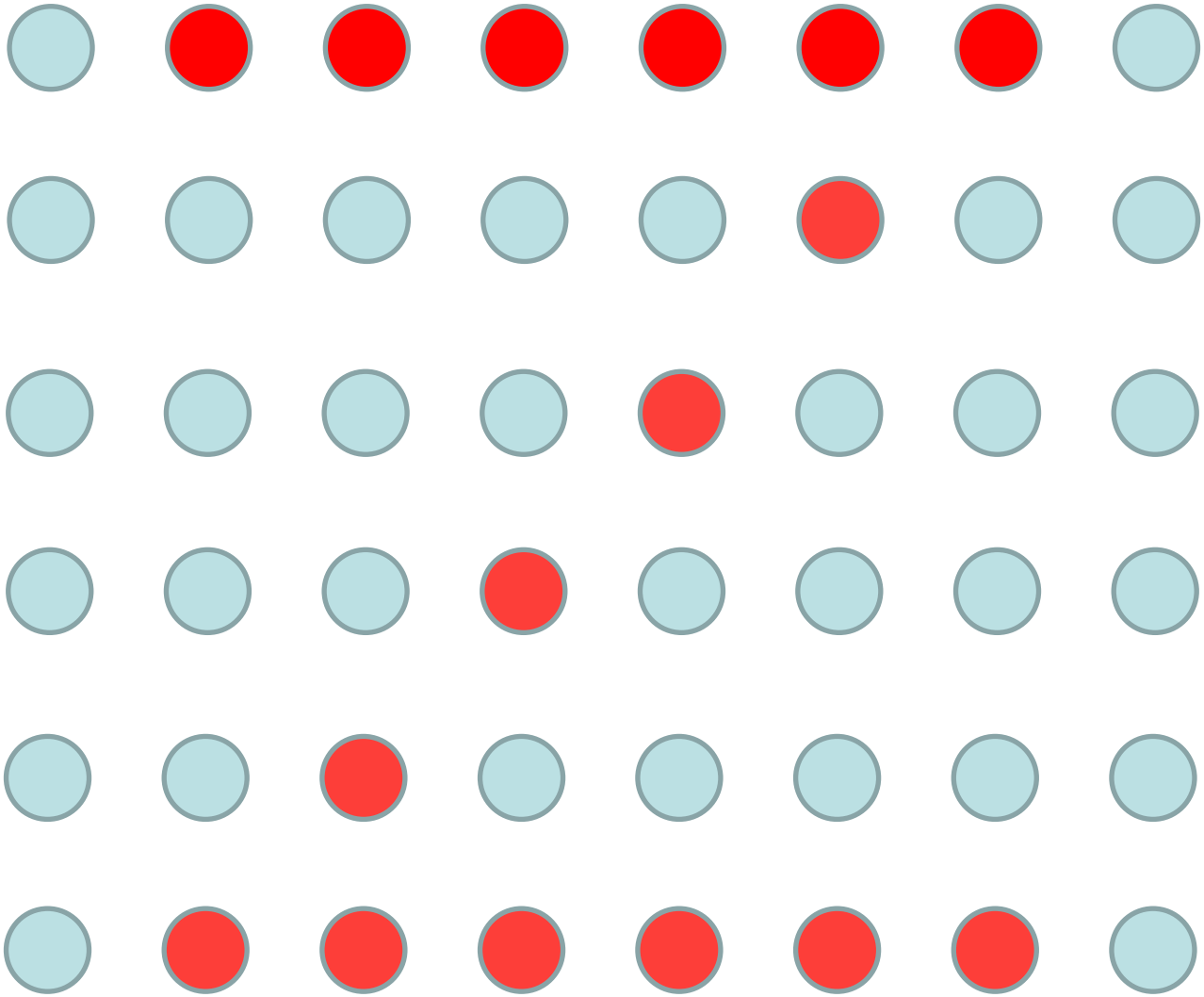
Implications for Design

- Making objects of interest different from its surroundings
- More complex search: combining different channels
  - Form, color, motion

More Pictures







Visual Patterns

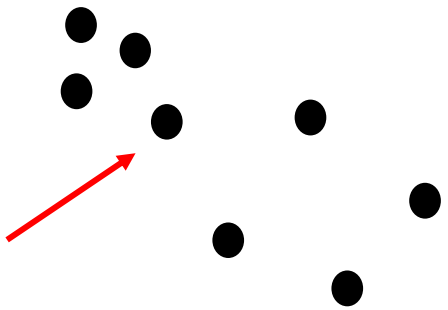
Visual Patterns Are Important!

- Finding patterns is key to information visualization.
- Expertise often is about seeing visual patterns.

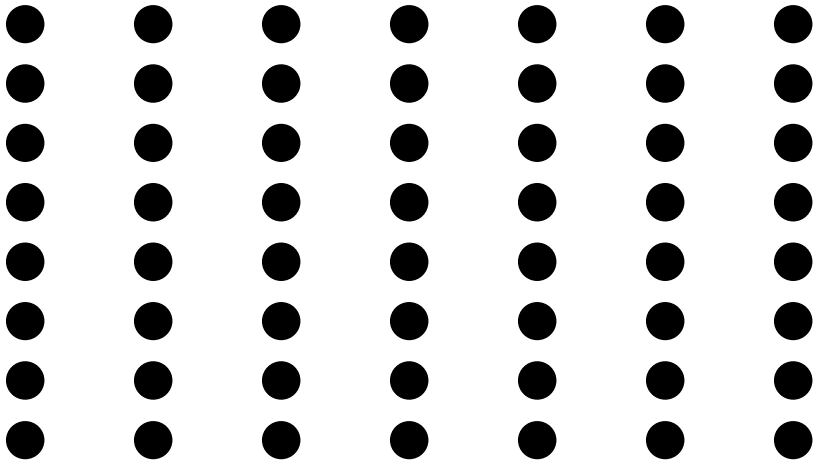
Static Patterns

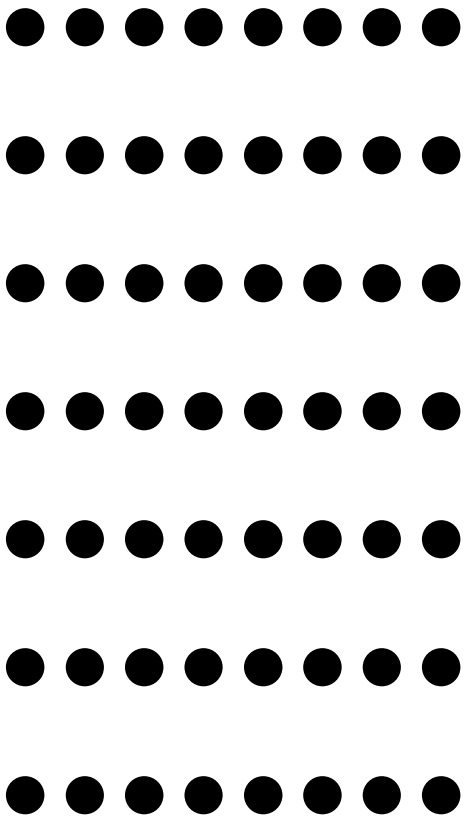
- Gestalt Laws
  - Proximity
  - Similarity
  - Continuity
  - Symmetry
  - Closure
  - Relative Size
  - Figure and Ground

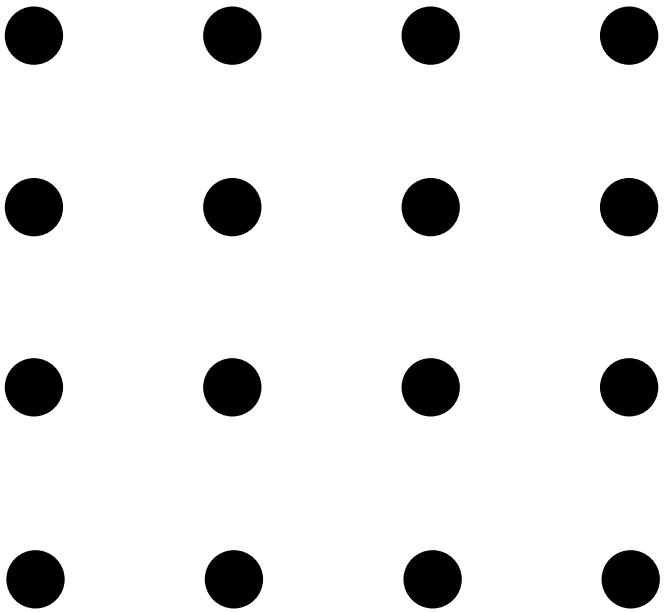
Proximity



Proximity

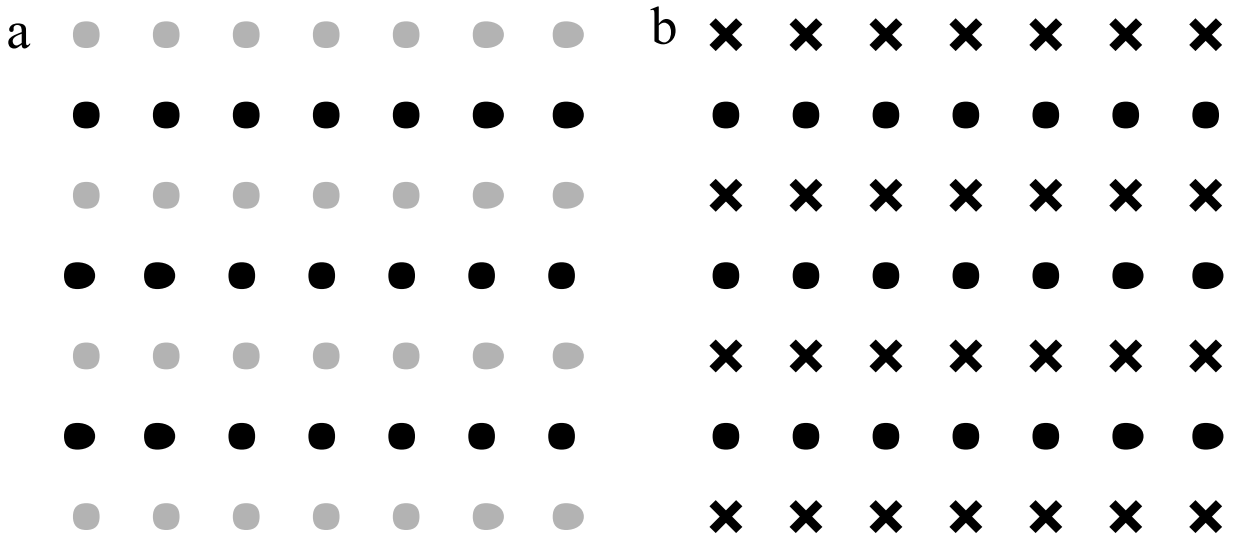


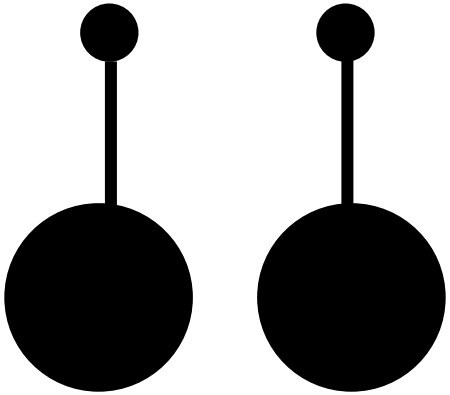




Similarity

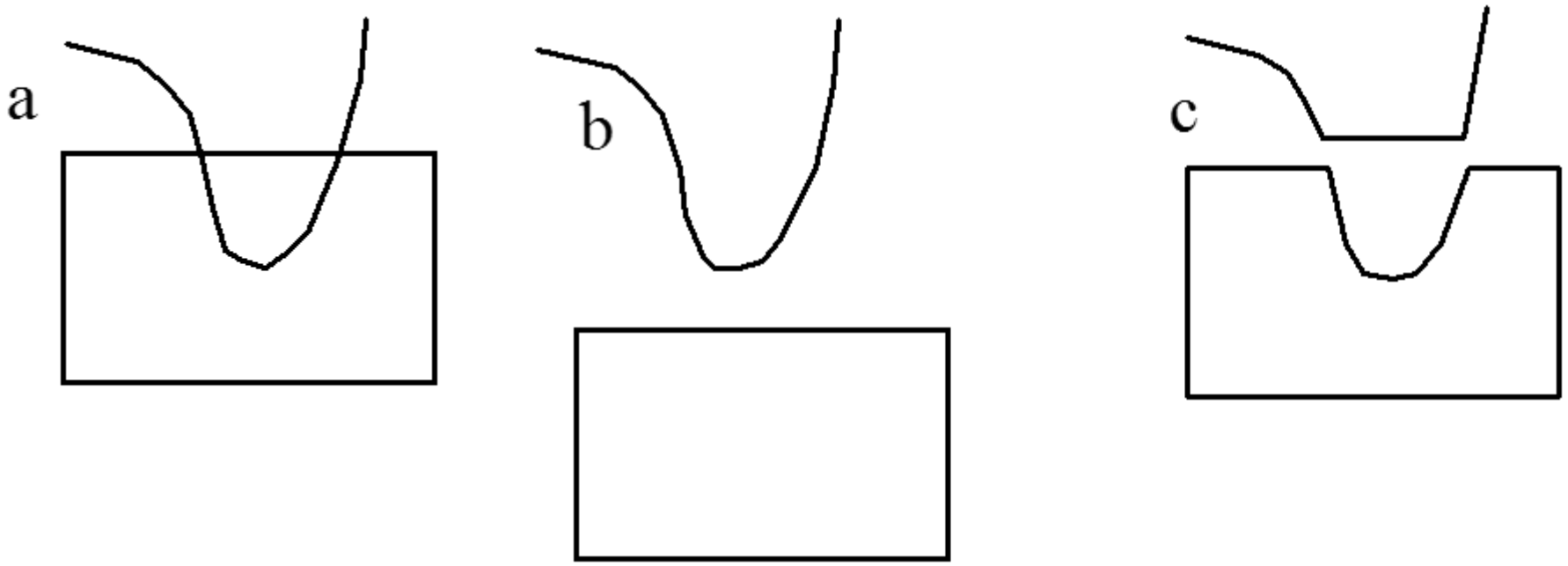
- Visual Grouping by similarity





Continuity

- Visual entities tend to be smooth and continuous

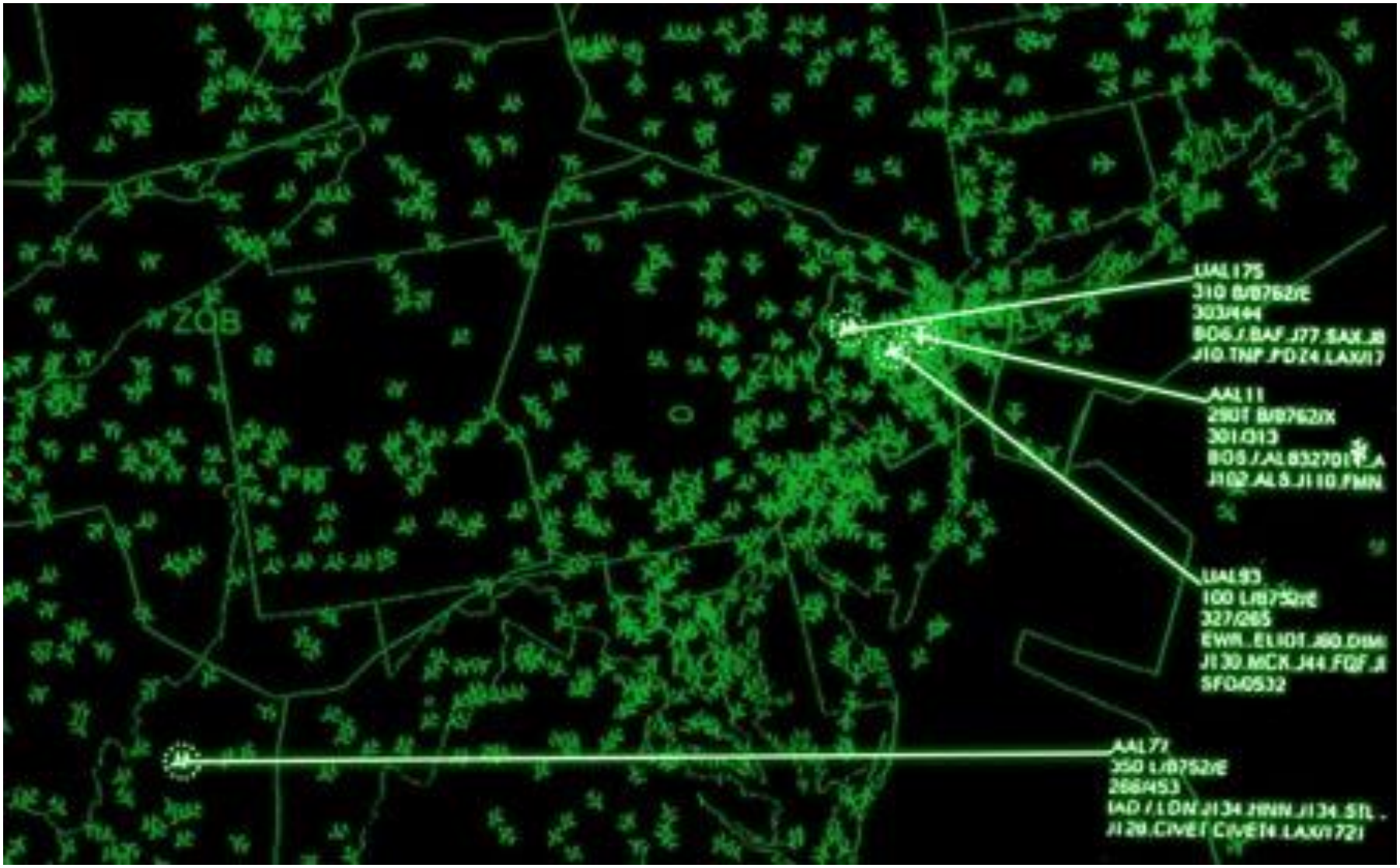


Closure

Such Pattern Recognition

- Very important to our perception and cognition

- “The whole is greater than the sum of its parts!”


ZOB
UAL175
310 B/B762/E
303/444
BOS.J.BAF.J77.SAX.J8
JIO.TNP.PDZ4.LAX/17
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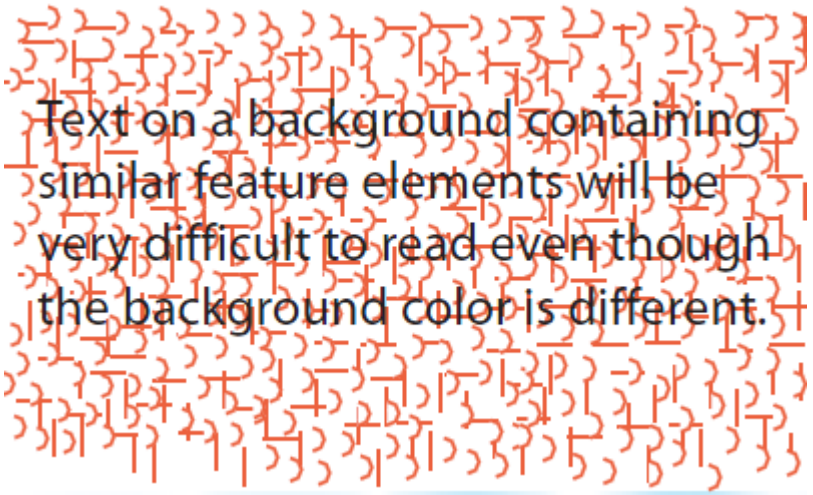
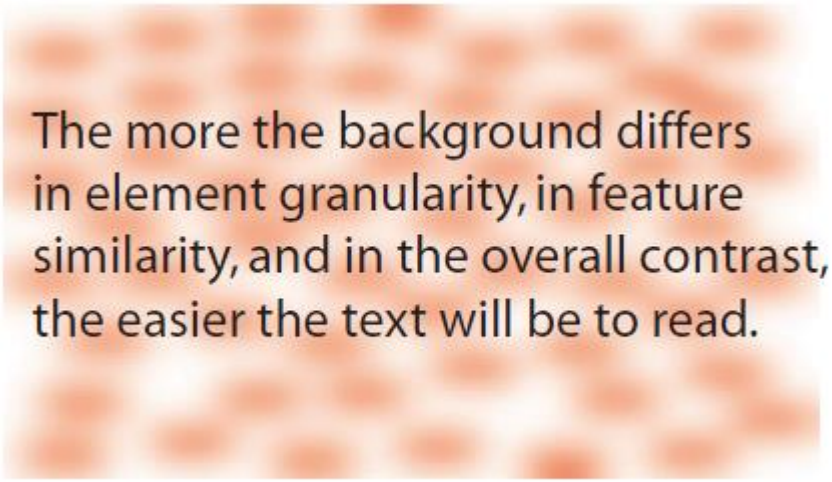
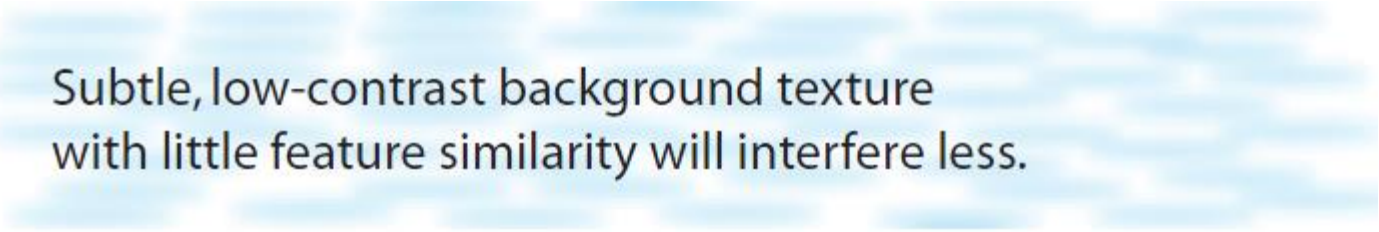
290T B/B762/X
301/313
BOS/.AL832701.A
JI02.ALS.JI10.FMN
UAL93
100 L/B752/E
327/285
EWR..ELI01.J60.DIM
JI30.MCK.J44.FQF.J
SFO/032
AAL77
350 L/B752/E
286/453
IAD/.LDN.JI34.JINN.JI34.STL.
JI28.CIVET.CIVET4.LAX/21

Pattern Interference







Pattern Recognition as High-Level Activities

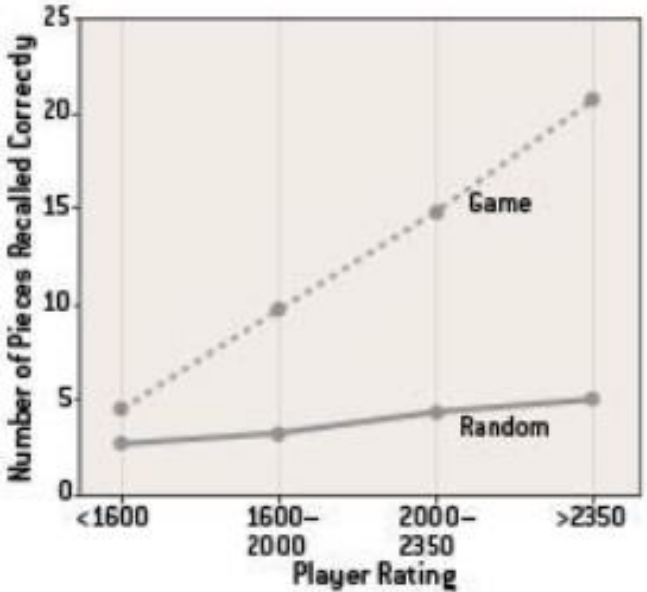
- Can be learned and trained.
  - Intelligence analysts
  - Air traffic controllers
  - Chess grandmasters
- Complex patterns can be encoded for rapid processing.

a

b

a

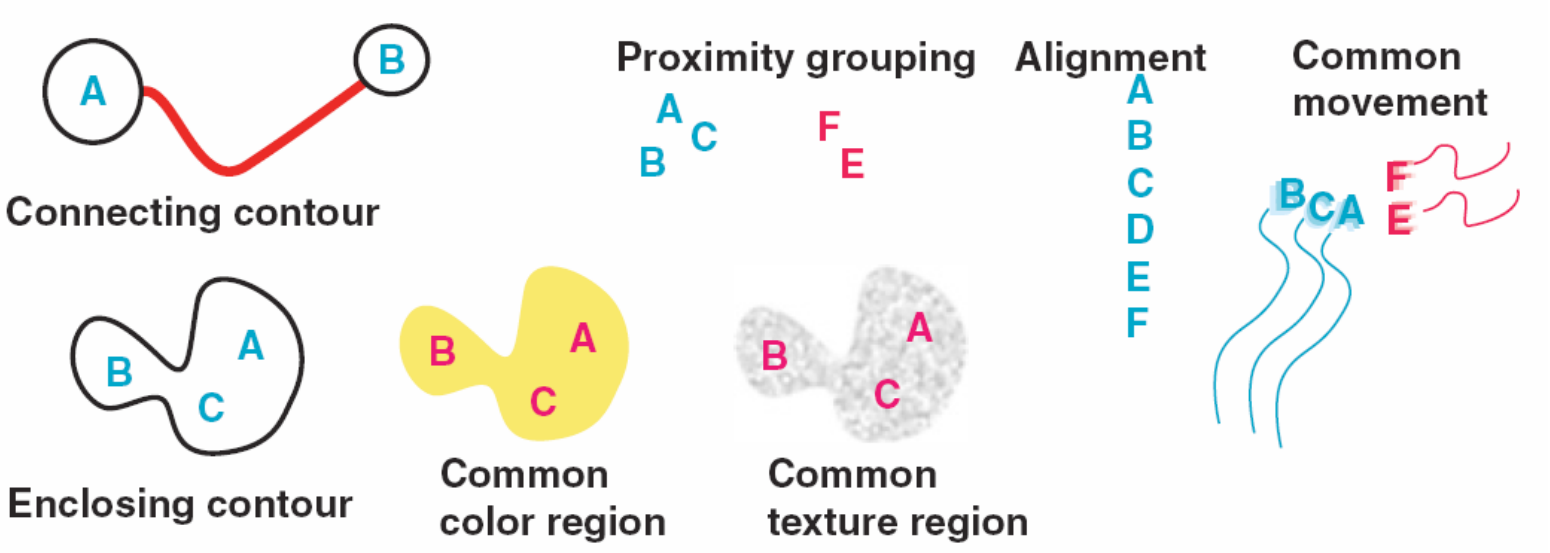
b



A structured knowledge of chess positions enables a grandmaster to spot the correct move quickly. The position at the right comes from a famous 1889 game between Emanuel Lasker (*white*) and Johann Bauer (*black*). Although a novice player would have to analyze the position extensively to see the winning move for white, any grandmaster would immediately recognize it. The correct move is shown on page 71.

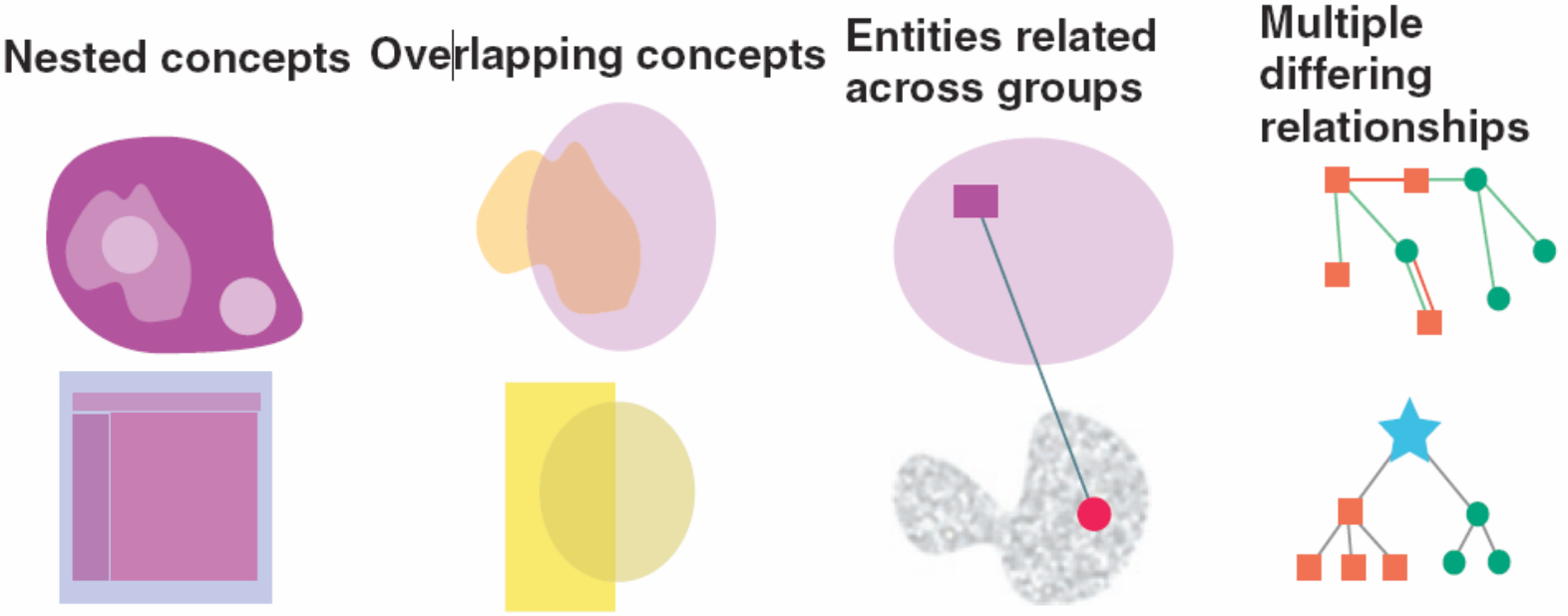
Design Implications

- Patterns are about spatial relationship among objects.
  - Same group



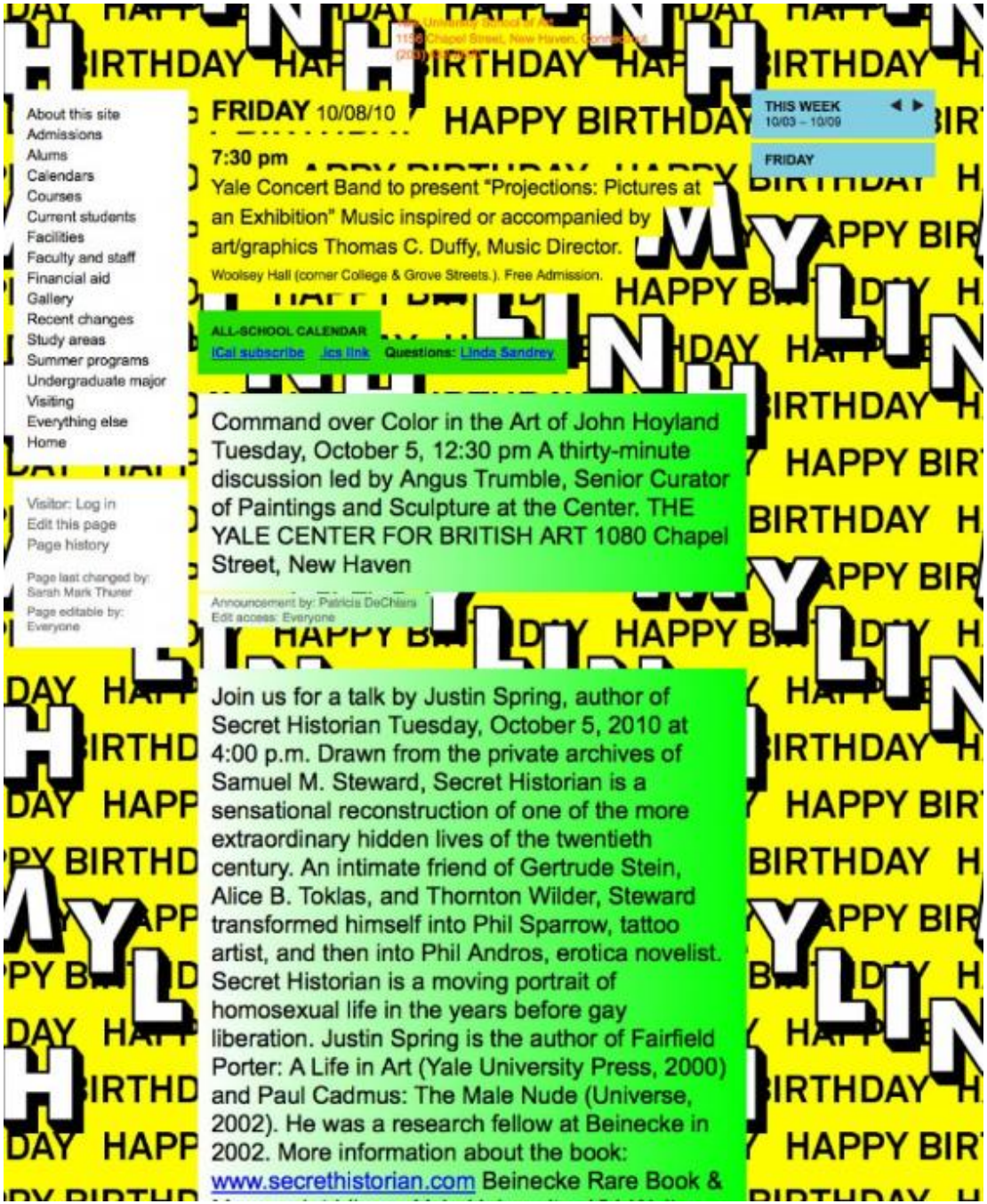
Design Implications

- Patterns are about spatial relationship among objects.
  - Same group
  - More complex relationship



Design Implications

- Patterns are about spatial relationship among objects.
  - Same group
  - More complex relationship
  - Apprehendable chunks in web design
    - News web sites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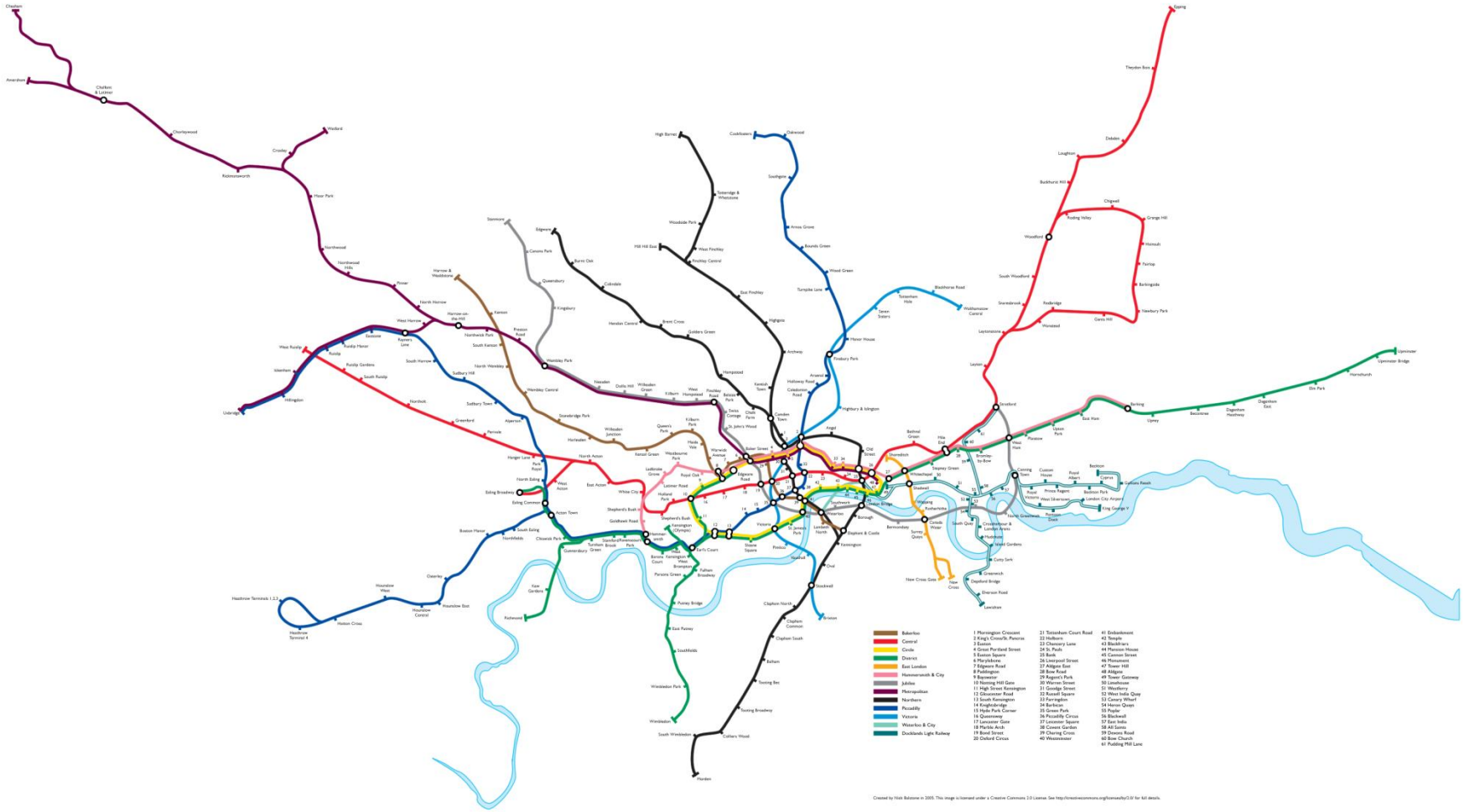
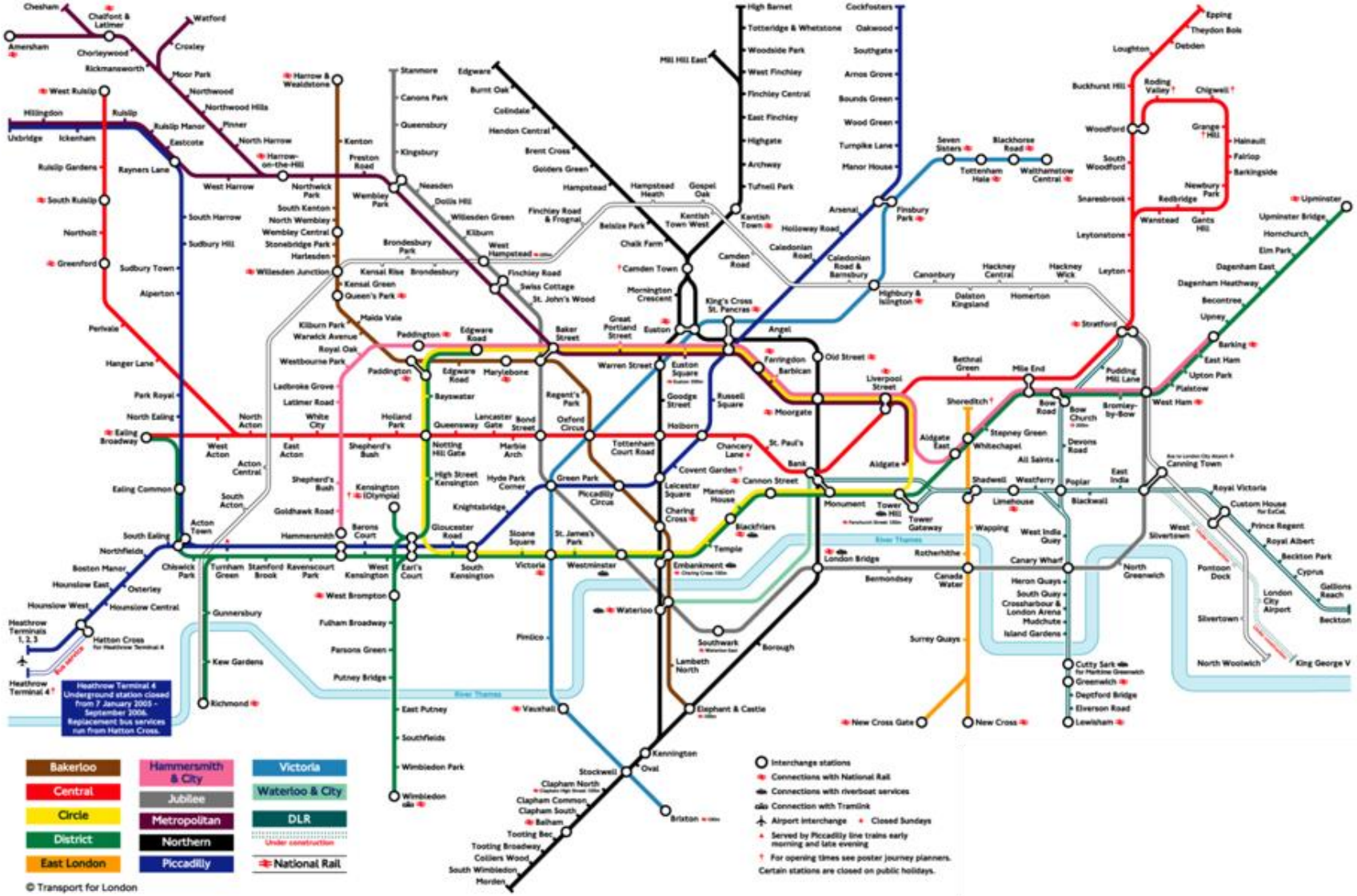
FRIDAY 10/08/10
7:30 pm
Yale Concert Band to present "Projections: Pictures at an Exhibition" Music inspired or accompanied by art/graphics Thomas C. Duffy, Music Director.
Woolsey Hall (corner College & Grove Streets.). Free Admission.
ALL-SCHOOL CALENDAR
iCal subscribe Jcs link Questions: Linda Sandrey
THIS WEEK
10/03 – 10/09
FRIDAY
Command over Color in the Art of John Hoyland Tuesday, October 5, 12:30 pm A thirty-minute discussion led by Angus Trumble, Senior Curator of Paintings and Sculpture at the Center. THE YALE CENTER FOR BRITISH ART 1080 Chapel Street, New Haven
Announcement by: Patricia DeChiara
Edit access: Everyone
Join us for a talk by Justin Spring, author of Secret Historian Tuesday, October 5, 2010 at 4:00 p.m. Drawn from the private archives of Samuel M. Steward, Secret Historian is a sensational reconstruction of one of the more extraordinary hidden lives of the twentieth century. An intimate friend of Gertrude Stein, Alice B. Toklas, and Thornton Wilder, Steward transformed himself into Phil Sparrow, tattoo artist, and then into Phil Andros, erotica novelist. Secret Historian is a moving portrait of homosexual life in the years before gay liberation. Justin Spring is the author of Fairfield Porter: A Life in Art (Yale University Press, 2000) and Paul Cadmus: The Male Nude (Universe, 2002). He was a research fellow at Beinecke in 2002. More information about the book: www.secrethistorian.com Beinecke Rare Book &

Design Implications

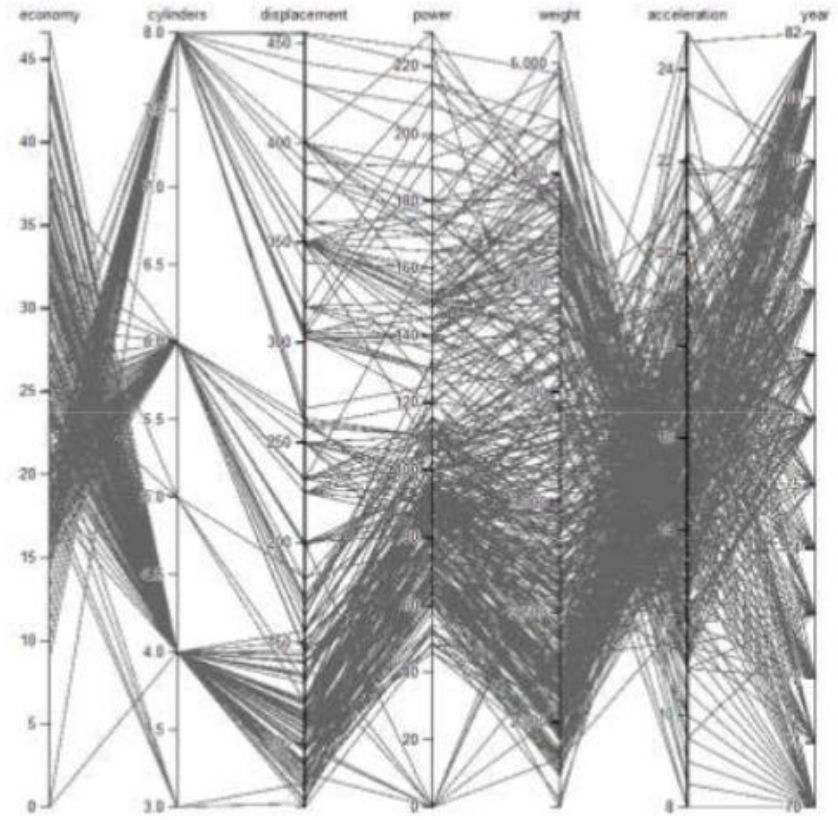
- Patterns are about spatial relationship among objects.
  - Same group
  - More complex relationship
  - Apprehendable chunks in web design
    - News web sites
  - Semantic pattern mappings
    - Considering user tasks and needs in spatial layout

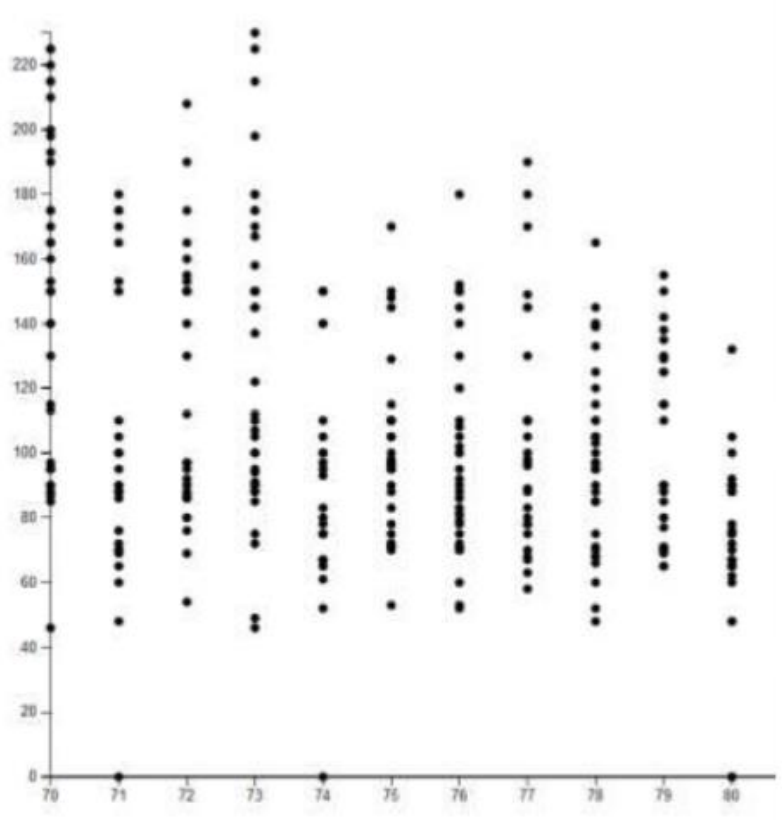
Can You Recognize This Map?




Bakerloo
Central
Circle
District
East London
Hammersmith & City
Jubilee
Metropolitan
Northern
Piccadilly
Victoria
Waterloo & City
DLR
Under construction
National Rail
Interchange stations
Connections with National Rail
Connections with riverboat services
Connection with Tramlink
Airport interchange
Closed Sundays
Served by Piccadilly line trains early morning and late evening
For opening times see poster journey planners.
Certain stations are closed on public holidays.
Heathrow Terminal 4 Underground station closed from 7 January 2005 - September 2008. Replacement bus services run from Hatton Cross.
© Transport for London

Programming Assignment 3





name	economy	cylinders	displacem	power	weight	acceleration	year
AMC Ambassador	13	8	360	175	3821	11	73
AMC Ambassador	15	8	390	190	3850	8.5	70
AMC Ambassador	17	8	304	150	3672	11.5	72
AMC Concord DL 6	20.2	6	232	90	3265	18.2	79
AMC Concord DL	18.1	6	258	120	3410	15.1	78
AMC Concord DL	23	4	151	0	3035	20.5	82
AMC Concord	19.4	6	232	90	3210	17.2	78
AMC Concord	24.3	4	151	90	3003	20.1	80
AMC Gremlin	18	6	232	100	2789	15	73
AMC Gremlin	19	6	232	100	2634	13	71
AMC Gremlin	20	6	232	100	2914	16	75
AMC Gremlin	21	6	199	90	2648	15	70
AMC Hornet Sport	18	6	258	110	2962	13.5	71
AMC Hornet	18	6	199	97	2774	15.5	70
AMC Hornet	18	6	232	100	2945	16	73
AMC Hornet	19	6	232	100	2901	16	74
AMC Hornet	22.5	6	232	90	3085	17.6	76

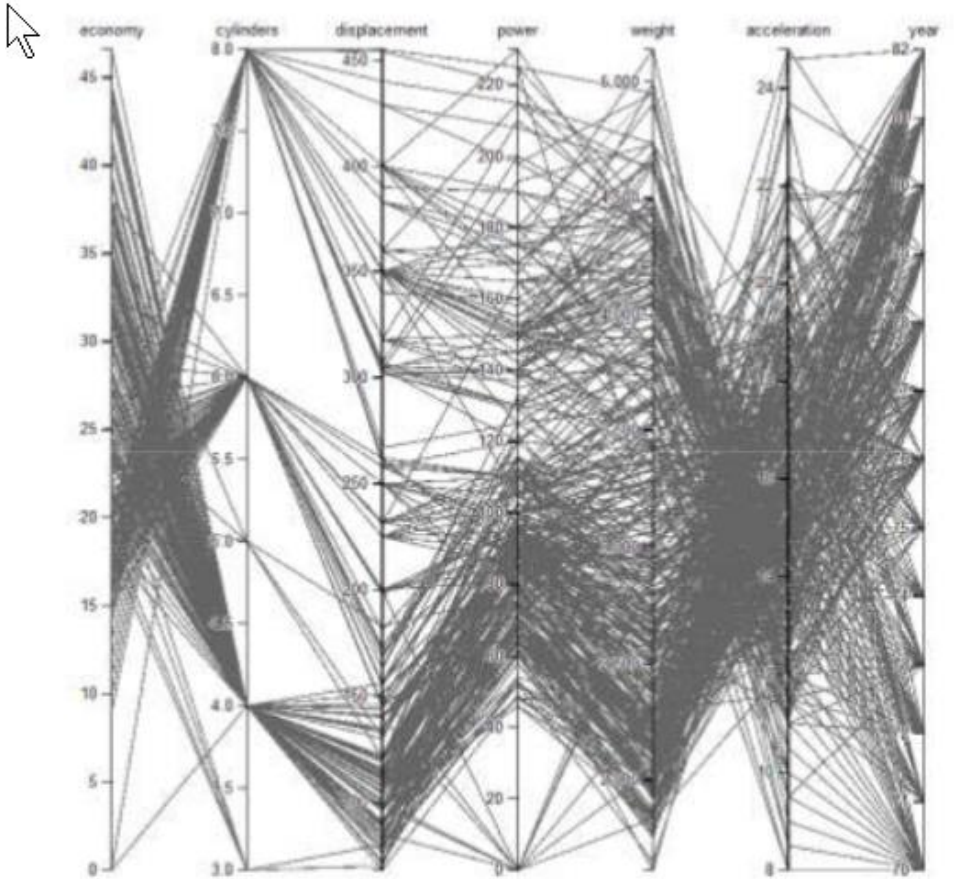
Goals

- Visualizing multi-dimensional data
  - Cars: maker, cylinder #, power, weight, year, etc.
- Understand the overall patterns
- Understand the relationships among selective dimensions.

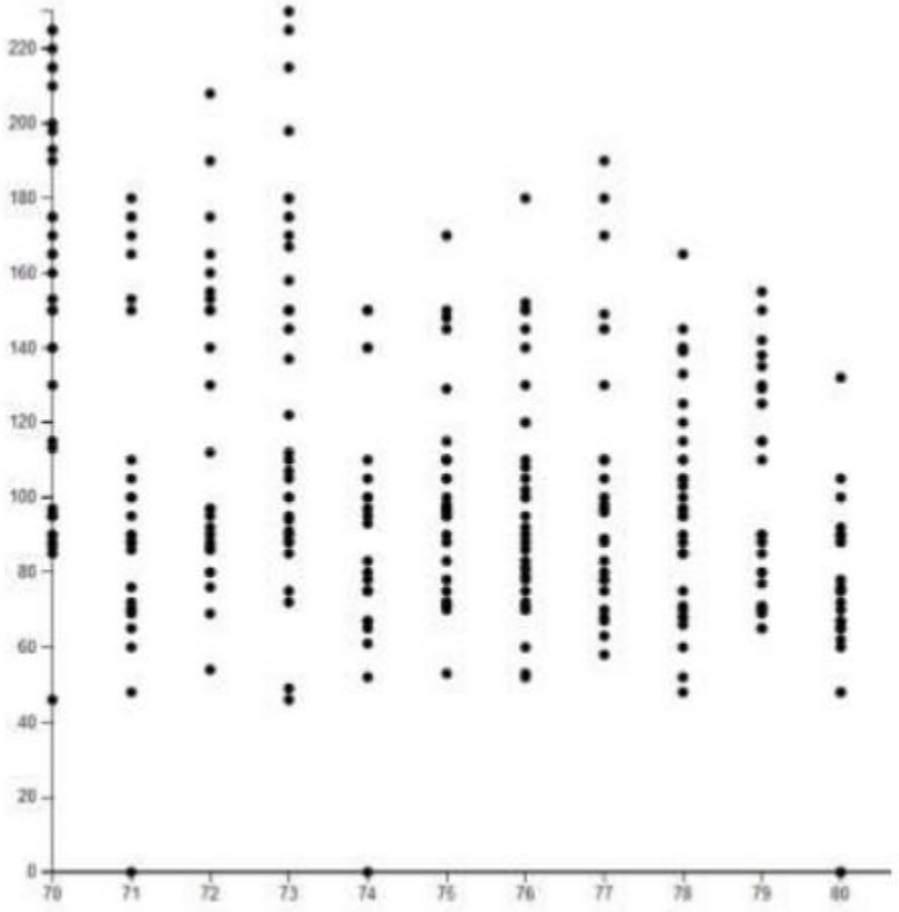
- Two graphs in one view
  - Parallel Coordinates + Scatter Plot

Parallel Coordinates

- Popular tools for multi-dimensional data



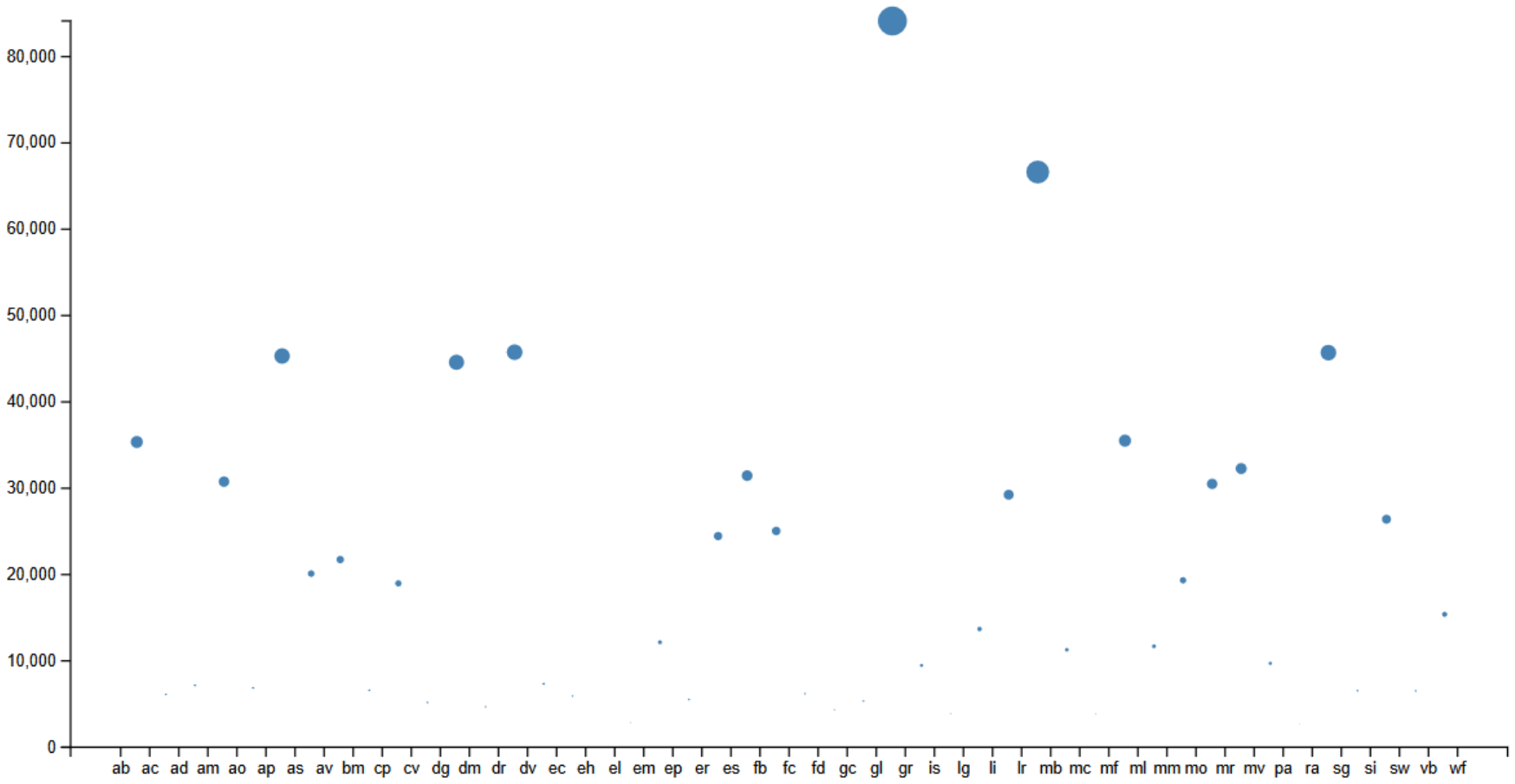
Scatter Plot



Scatter Plot

- Location and size of individual dots
  - Circles: x, y, r
- One step further from bar charts

```
chart.selectAll(".bar")
    .data(bardata)
    .enter().append("circle")
    .attr("class", "bar")
    .attr("cx", function(d) { return x(d.name); })
    .attr("cy", function(d) { return y(d.value); })
    .attr("r", function(d) { return (height - y(d.value))/50; });
```


80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
ab ac ad am ao ap as av bm cp cv dg dm dr dv ec eh el em ep er es fb fc fd gc gl gr is lg li lr mb mc mf ml mm mo mr mv pa ra sg si sw vb wf

Group Project

- Progress report 1 due this week
- Four sections
  - Introduction, Data, Tasks and Visualization, Collaboration Plan

- See the description on CANVAS