Visualization process

Thomas Torsney-Weir

Designing an effective visualization

- Last time: scenario
  - Users
  - Tasks
  - Data
- Today: rendering
  - Visual elements
  - Visualization pipeline

Designing an effective visualization

- Last time: scenario
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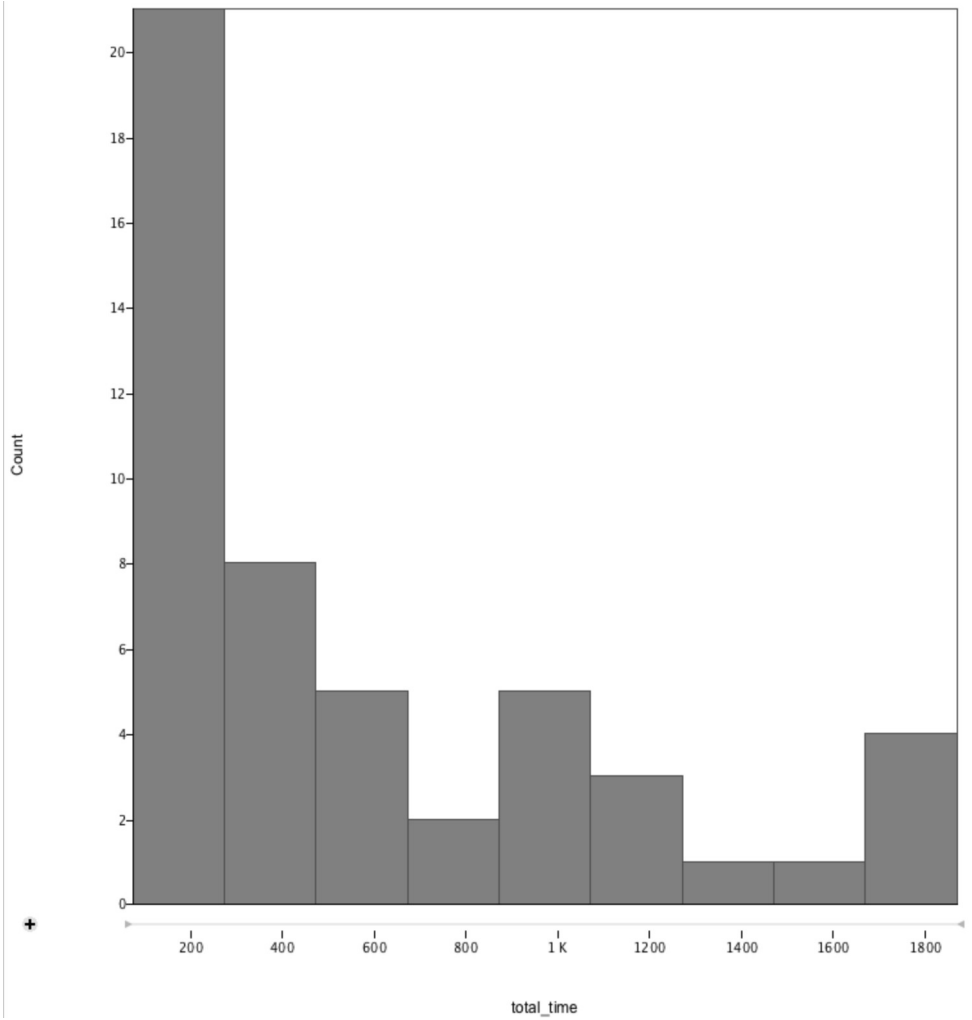
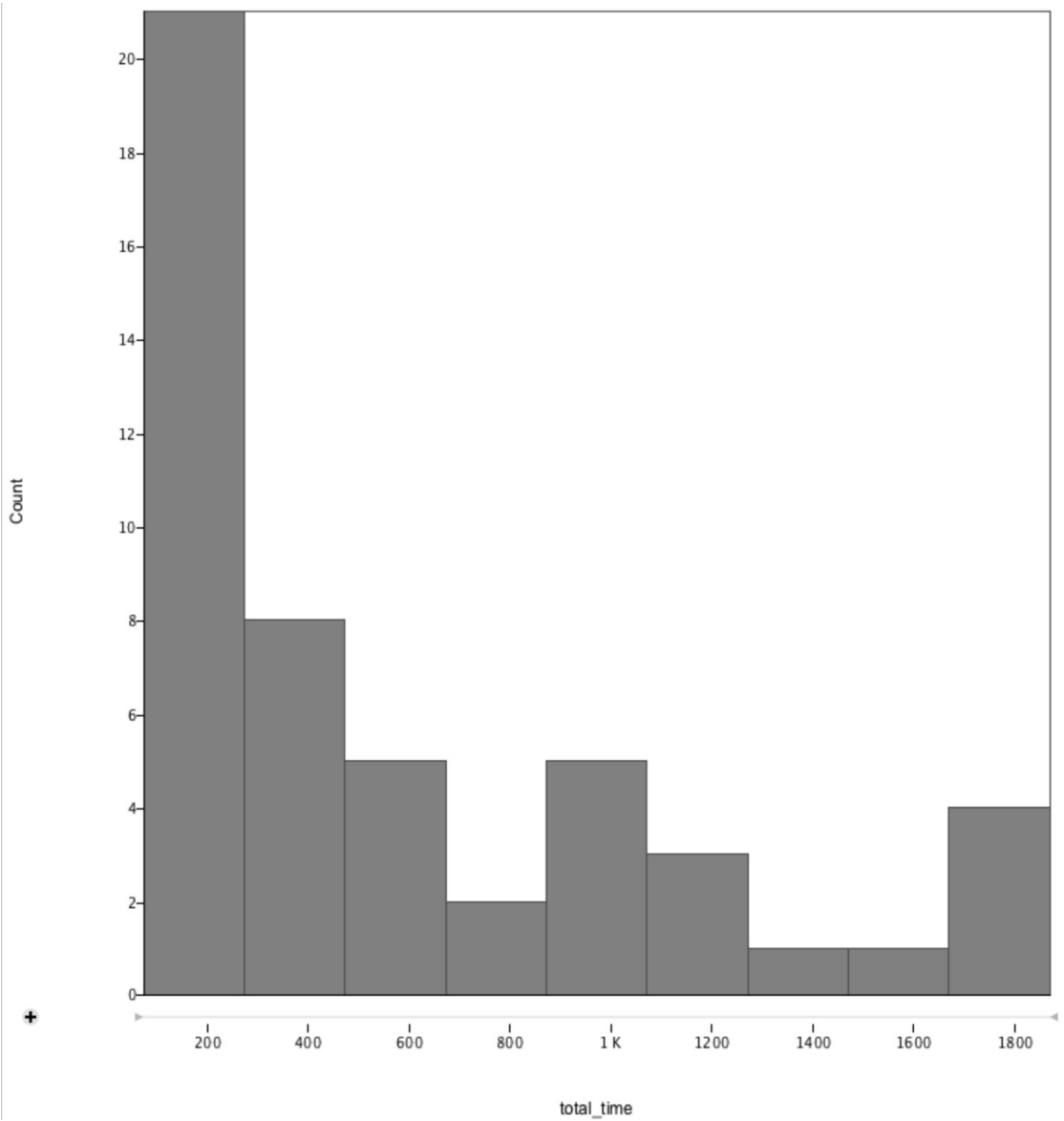
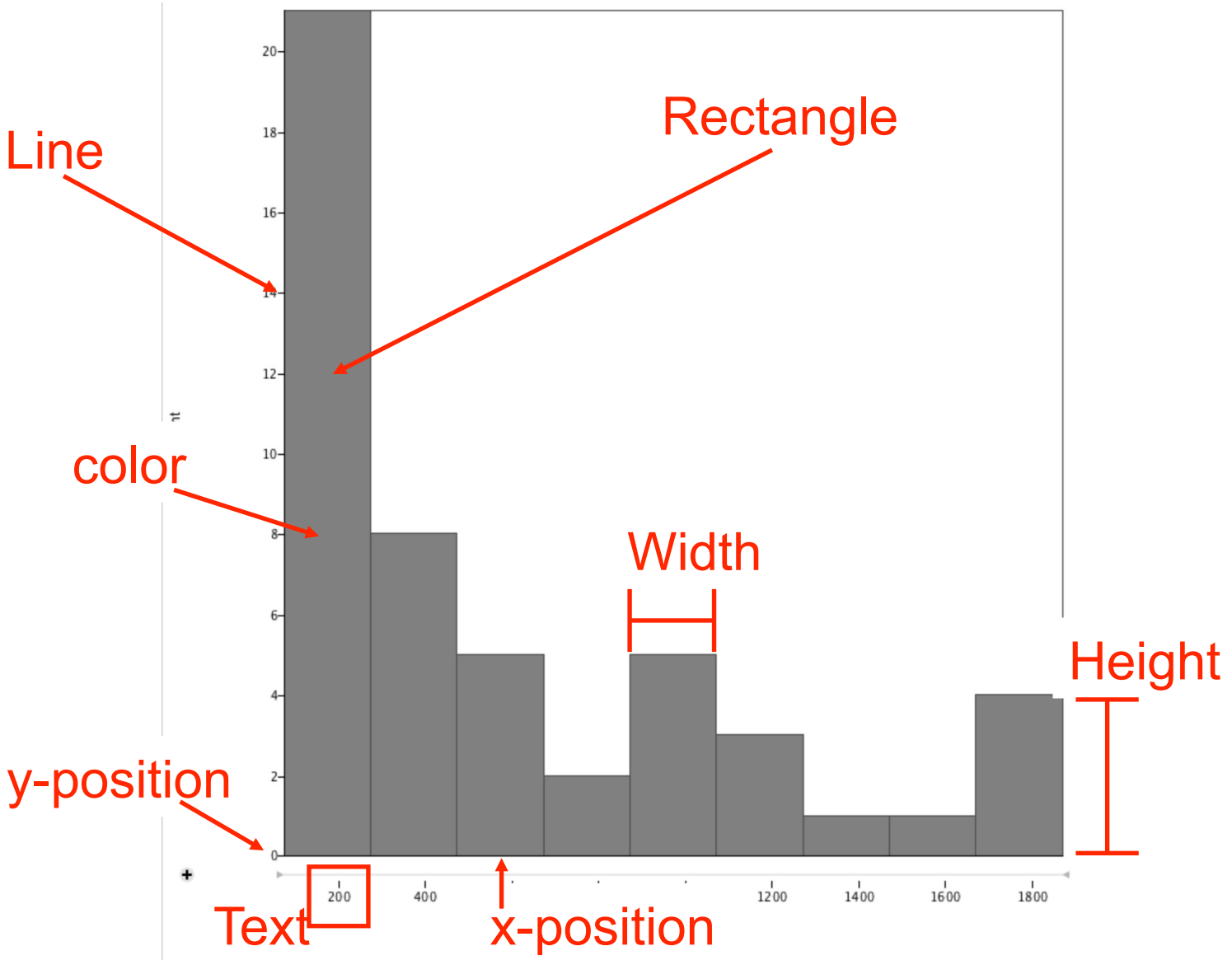
Visual encodings

Elements of a visualization

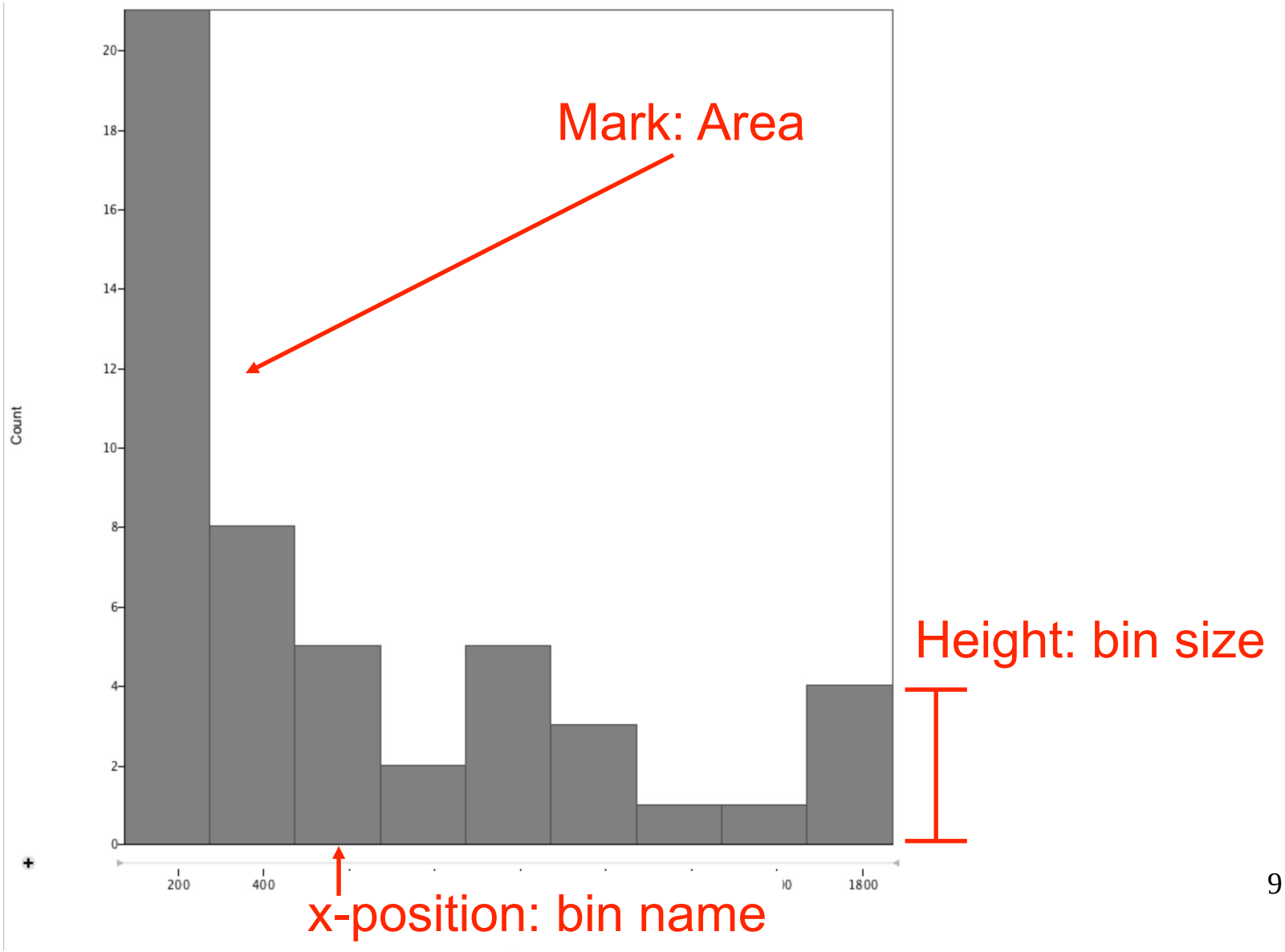



Count
20
18
16
14
12
10
8
6
4
2
0
200
400
600
800
1 K
1200
1400
1600
1800
total_time


Line
Rectangle
color
Width
Height
y-position
Text
x-position
20
18
16
14
12
10
8
6
4
2
0
200
400
1200
1400
1600
1800

What are visual encodings?

- Mappings between data and graphical elements
- Separated into
  - **Marks** : graphical primitives
  - **Channels** : attributes of marks


Mark: Area
Height: bin size
x-position: bin name
Count
20
18
16
14
12
10
8
6
4
2
0
200
400
1800

Marks and channels

Jacques Bertin

- French cartographer [1918-2010]
- Semiology of Graphics [1967]

- Image perceived as a set of signs
- Sender encodes information in signs
- Receiver decodes information from signs

Channel types

Position

Size

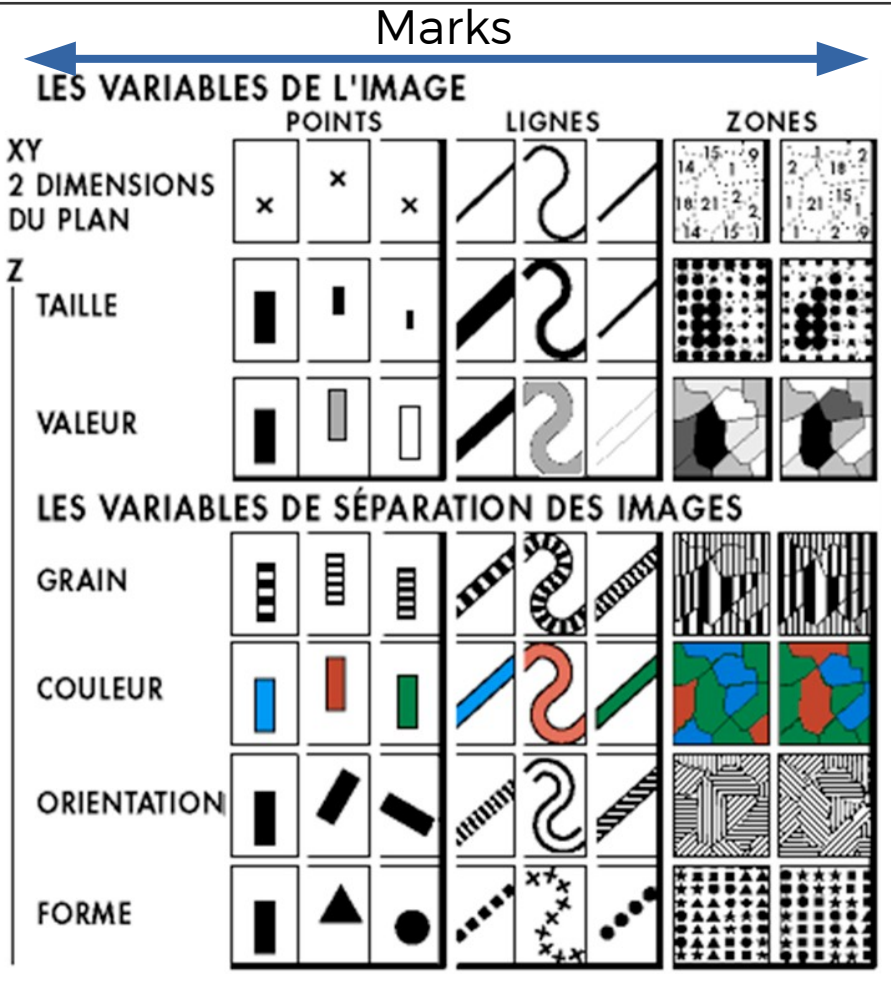
(Grey)Value

Texture

Color

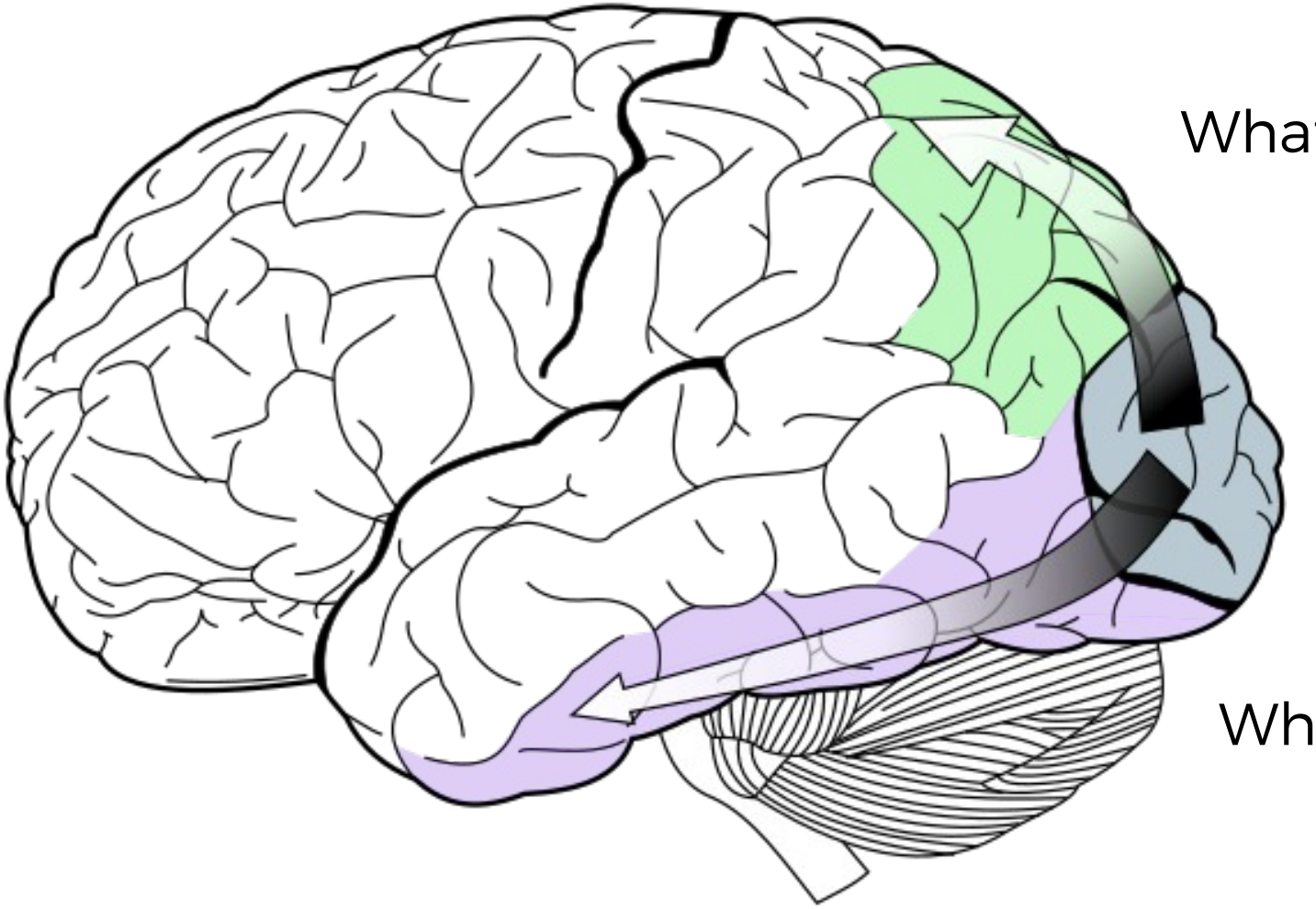
Orientation

Shape



Bertin, J. Semiology of graphics, ESRI press, 1967.

What vs how much channels



What vs how much channels

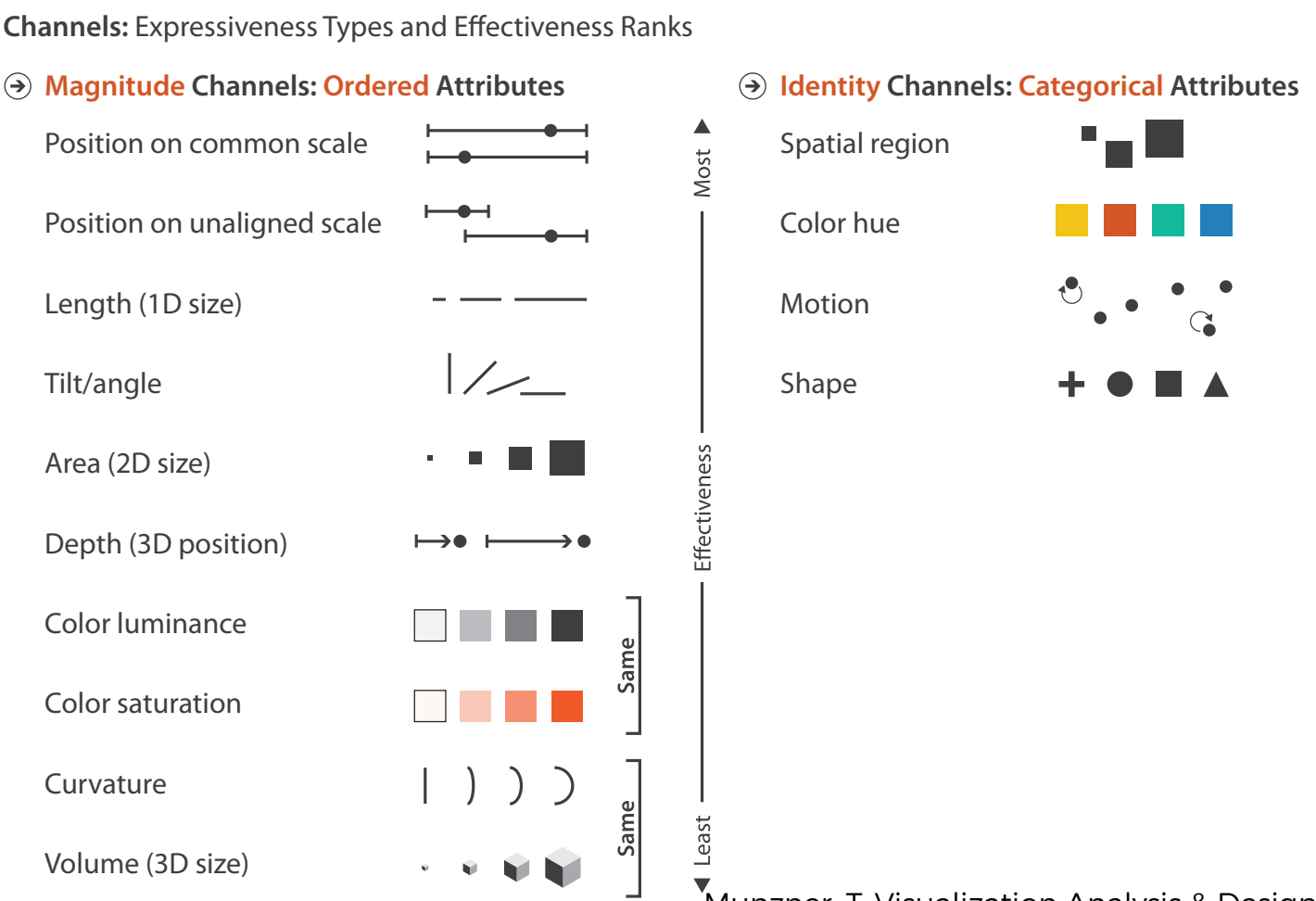
What: categorical

- Shape
- Spatial region
- Color (hue)

How much: ordered

- Length
- Area
- Volume
- Tilt
- Color (lightness)

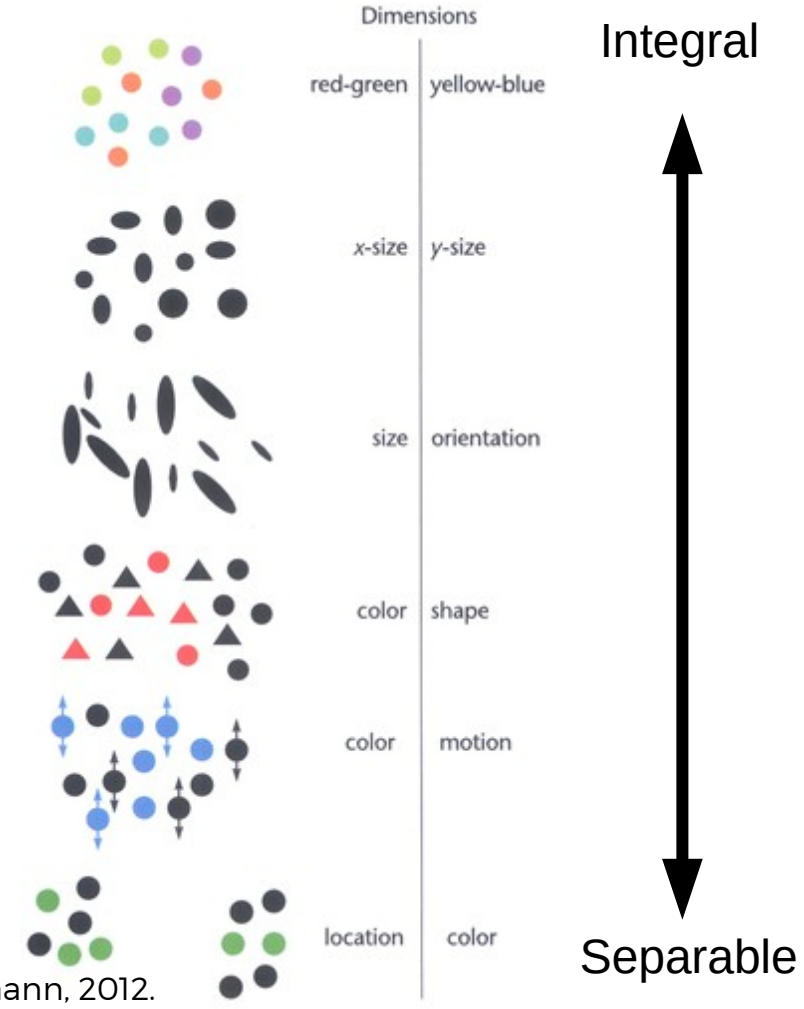
Effective visual encodings



Munzner, T. Visualization Analysis & Design. CRC press, 2014.

Separable channels

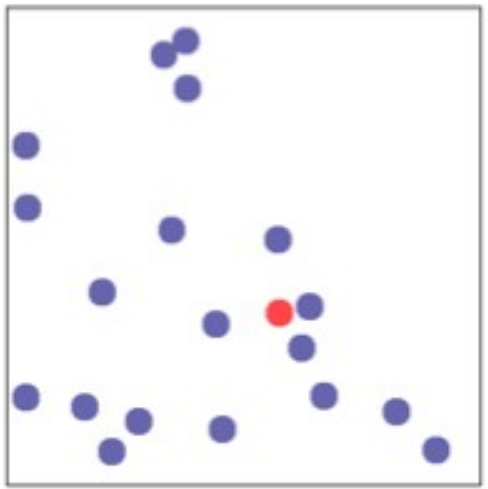
- **Integral**: two or more encodings perceived holistically
- **Separable**: separate judgements about each graphical dimension
- Many exceptions!



Ware, C. Information Visualization: Perception for Design. Morgan Kaufmann, 2012.

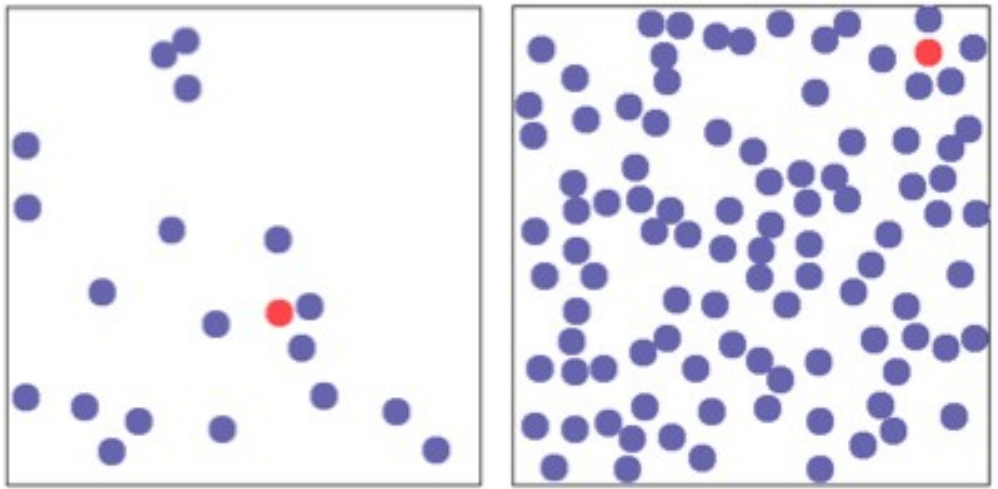
Popout

Parallel visual attention



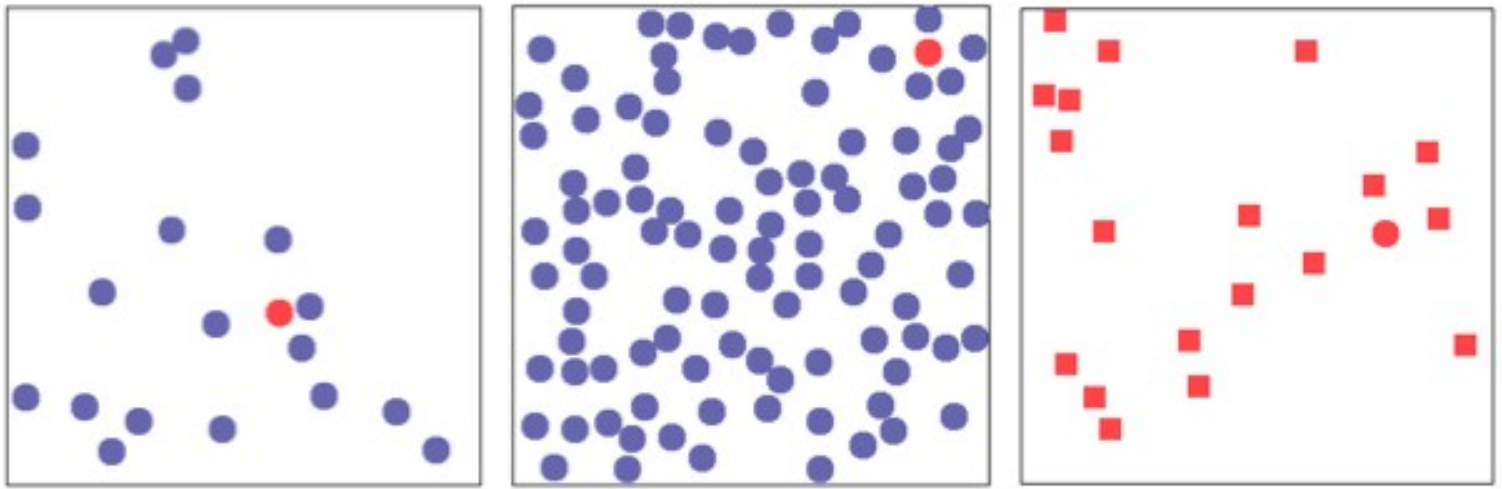
Popout

Parallel visual attention



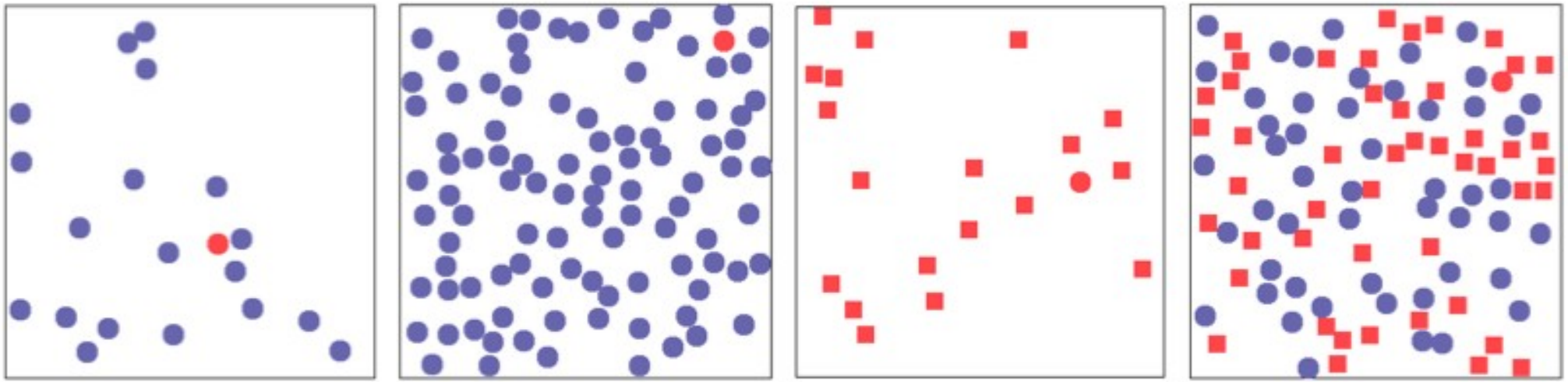
Popout

Parallel visual attention



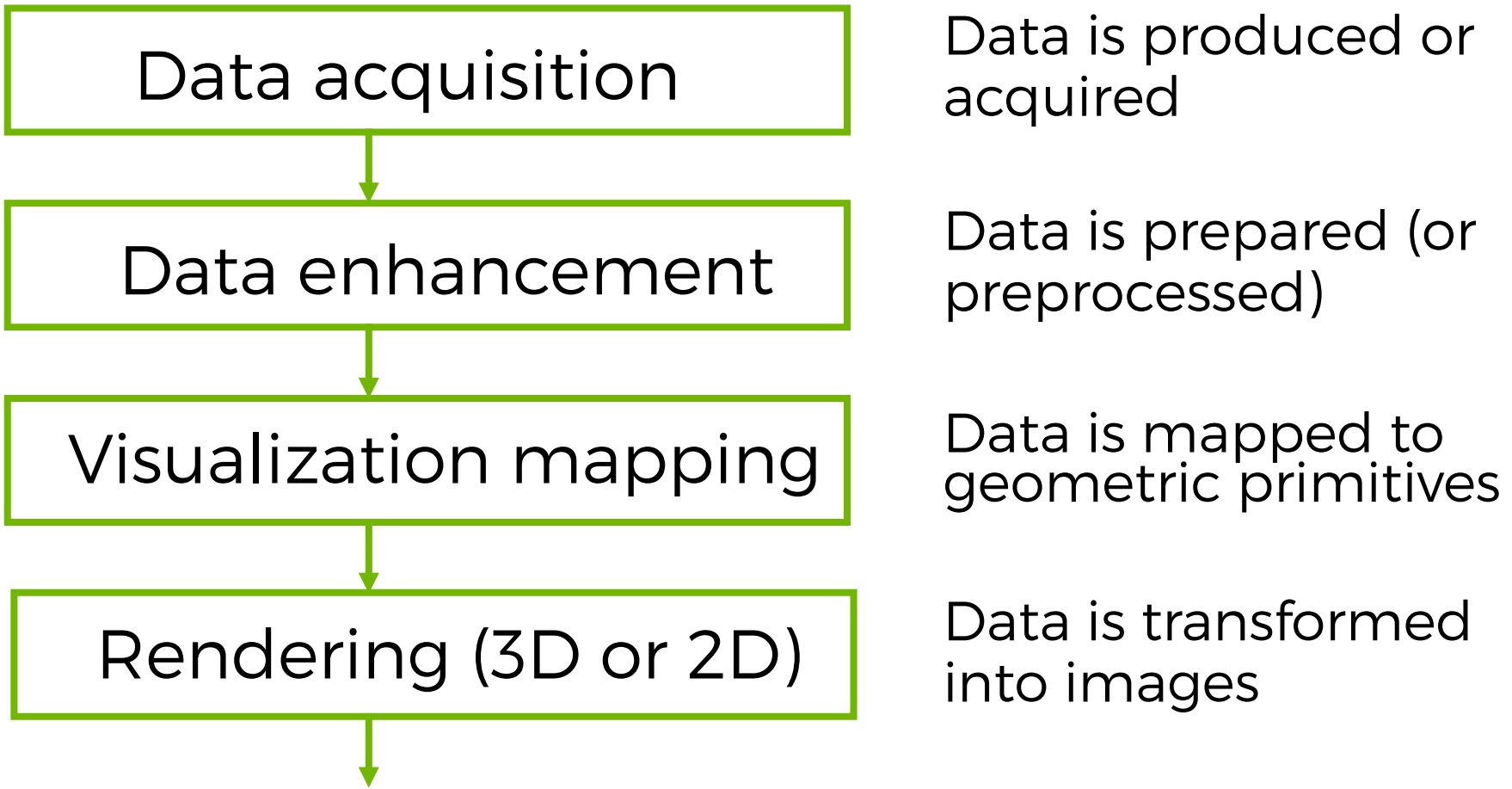
Popout

Parallel visual attention



Visualization pipeline

Overview



Data is produced or acquired

Data is prepared (or preprocessed)

Data is mapped to geometric primitives

Data is transformed into images

Step 1: get data

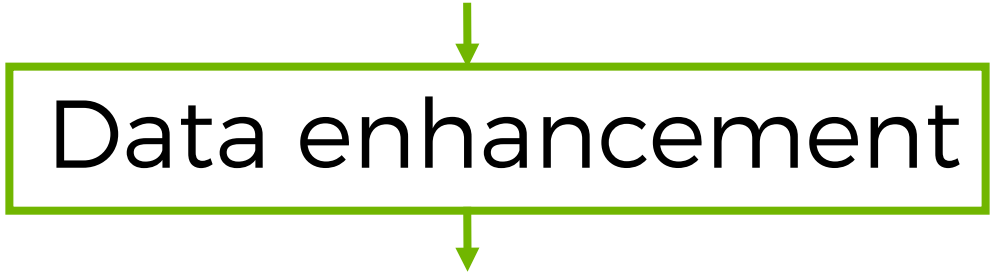
Data acquisition

Data is generated (or acquired)

Data is produced and archived. This is what everyone is good at.

- Measurement, e.g., CT, MRI
- Written down, scanned in as text
- User Input, into databases or spreadsheets
- Simulation, e.g., Computational Fluid Dynamics Simulation (CFD).
- Modeling, e.g., Computer Aided Design (CAD), dynamical systems
- Videos or images are recorded

Step 2: just what we need

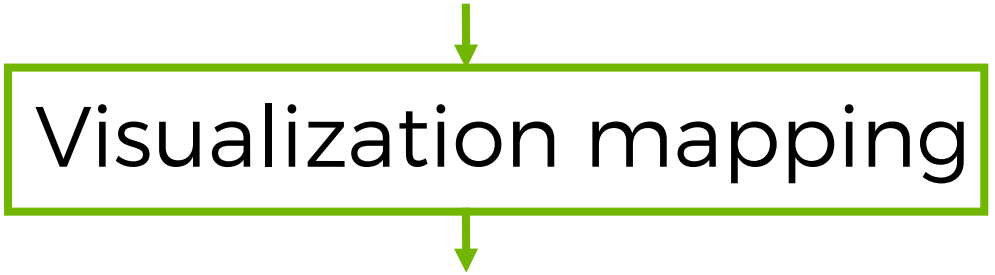


Data is prepared
(or “preprocessed”)

Data enhancement = Data preparation/preprocessing

- Filtering, e.g. smoothing (noise filtering)
- Errors are discovered and corrected
- Missing values may be handled
- Resampling or modify grid representation
- Derive new data, e.g., gradients
- Data interpolation

Step 3: what goes where



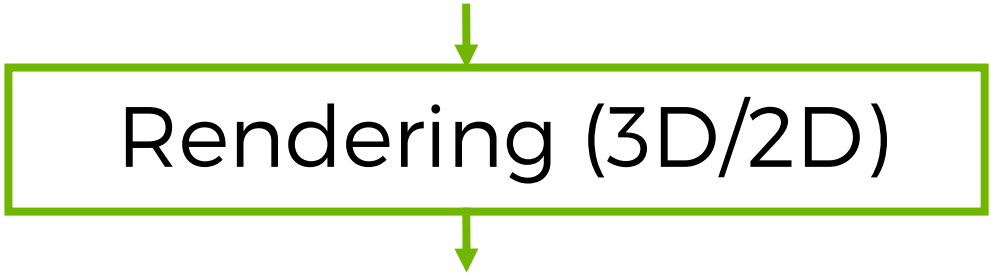
Data is mapped to geometry

Visualization mapping results in Data being visible

Data is represented by geometric primitives: points, lines, triangles, polygons, cubes, tetrahedra, of varying size, shape, color, transparency

- Compute isosurface
- Compute glyphs or icons
- Compute graph layout
- Compute voxel attributes: color, transparency, …

Step 4: draw!



Data becomes an image(s)

Rendering involves representation with Computer Graphics (CG)

- Projection (3D → 2D)
- Visibility calculation
- Shading
- Compositing (accumulate transparency and color values)
- Animation

Conclusion

Summary

- Visualizations are broken down into **marks** (elements) and **channels** (parameters)
- Data is linked to these channels
- A lot of care needed to choose which and how many channels to use
- Visualization pipeline helps organize software/notebooks