



# **Module #2:**

# **Introduction to Visualization Techniques**



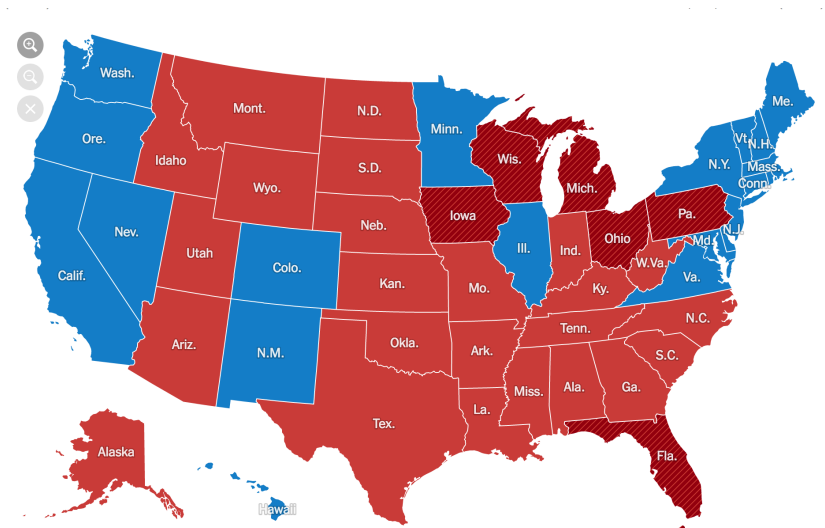
# Objectives

- Describe the basic data types
- Describe the pros/cons of some of the basic visualization techniques
- Discuss how basic visualization techniques can be extended to incorporated multiple variables

# What is Data Visualization?

- A mapping of data attributes to visual attributes

Vote by county	Trump	Clinton
Wake	193,607	298,353
Mecklenburg	154,303	292,258
Guilford	97,461	147,949
Forsyth	74,793	92,488
Durham	27,879	118,783
Buncombe	55,339	74,937
Cumberland	50,593	70,523
New Hanover	54,665	50,219
Union	66,265	34,051
Gaston	61,467	30,982
Cabarrus	53,224	35,048
Johnston	54,082	28,153
Iredell	54,164	24,441
Orange	18,373	59,105
Pitt	35,191	40,967
Davidson	52,870	17,328
Catawba	48,062	21,050
Alamance	38,235	29,268
Brunswick	42,440	23,117
Randolph	49,156	13,074
Rowan	42,388	19,208
Henderson	35,535	19,664
Onslow	36,342	17,156
Wayne	27,360	21,520
Moore	30,273	16,148
Nash	23,142	23,024
Craven	27,556	17,481

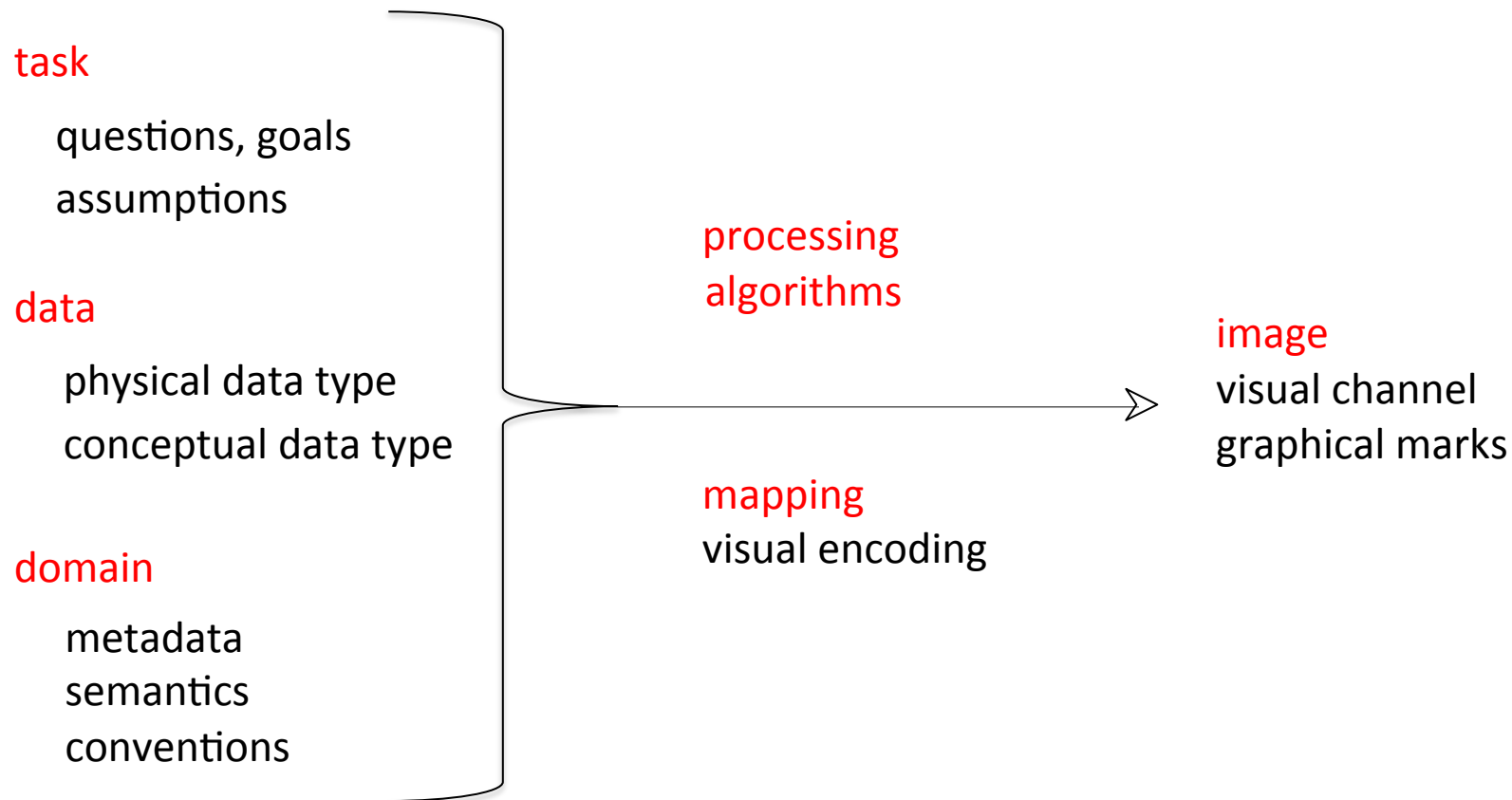


What are data attributes?

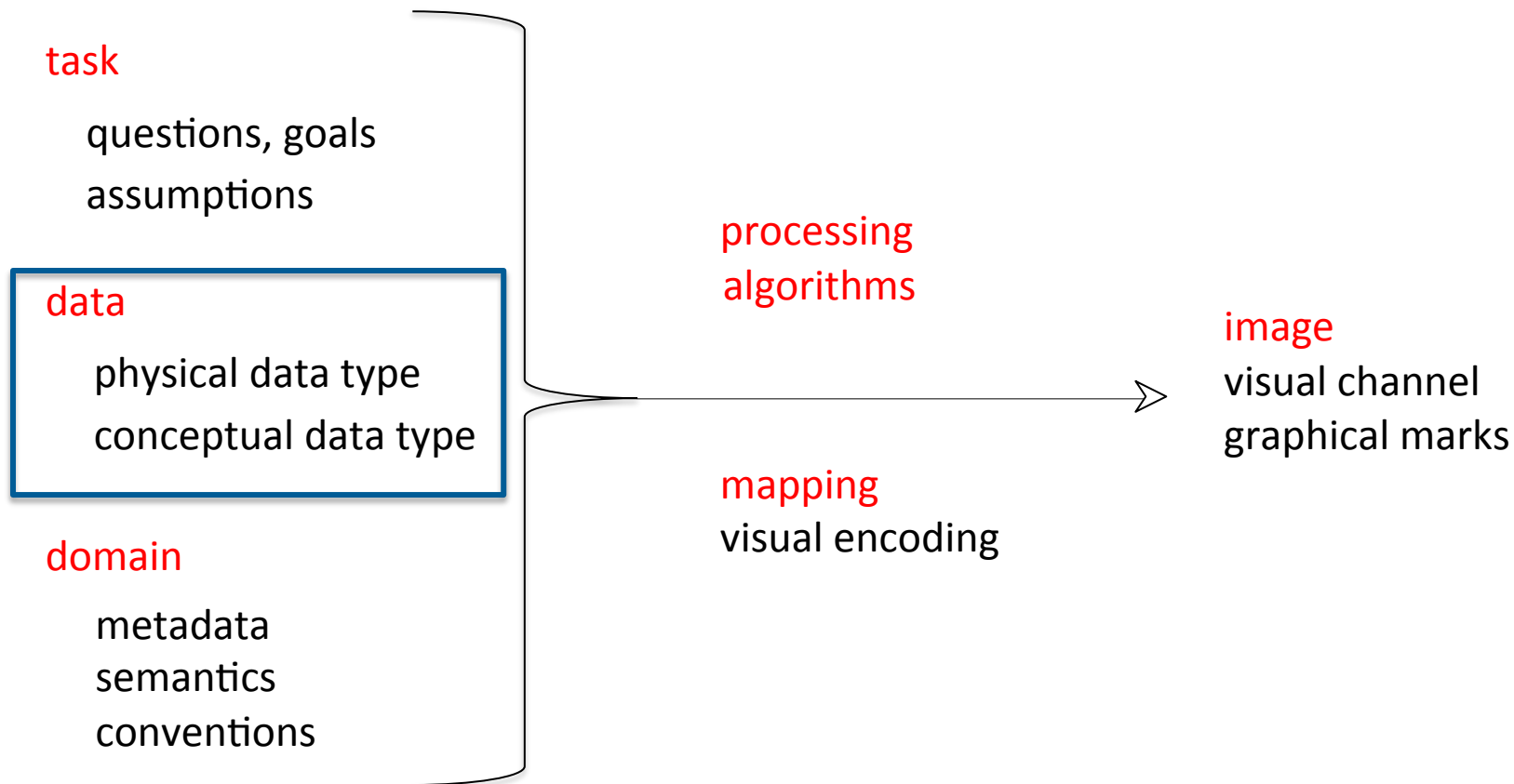
What are visual attributes?



# Visualization Process



# Visualization Process





# Data Definition

- A typical dataset in visualization consists of  $n$  records
  - $(r_1, r_2, r_3, \dots, r_n)$
- Each record  $r_i$  consists of  $m$  ( $m \geq 1$ ) observations or variables
  - $(v_1, v_2, v_3, \dots, v_m)$
- A variable may be either independent or dependent
  - An *independent variable* is the variable that is changed or controlled in a scientific experiment to test the effects on the dependent variable.
    - Not affected by another variable
    - Ex. Time in a time-series dataset
  - A *dependent variable* is the variable being tested and measured in a scientific experiment
    - Affected by variation in one or more associated independent variables
    - Ex. Temperature of a region



# Taxonomy of Data Types

1. 1D/Linear
  - lists of data items, organized by a single feature (e.g., alphabetical order)
2. 2D/Planar (incl. Geospatial)
  - maps
3. 3D/Volumetric
  - medical imaging
4. Temporal
  - T=time series
5. nD/Multidimensional
  - category proportions
6. Tree/Hierarchical
  - Computer file structure
7. Network
  - internet



# Basic Data Types

1. Nominal
2. Ordinal
3. Quantitative
  1. Interval
  2. ratio





# Basic Data Types

## 1. Nominal

## 2. Ordinal

## 3. Quantitative

### 1. Interval

### 2. ratio

**Nominal data:** A set of not-ordered and non-numeric values

For example:

- Categorical (finite) data
  - Fruit: {apple, orange, pear}
  - Color: {red, green, blue}
- Arbitrary (infinite) data
  - Address:
    - {“12 Main St. Boston MA”,
    - “45 Wall St. New York NY”,
    - ...}
  - Staff:
    - {“John Smith”,
    - “Jane Doe”,
    - ...}



# Basic Data Types

1. Nominal

2. Ordinal

3. Quantitative

1. Interval

2. ratio

**Ordinal Data:** an ordered set

For example:

1. Numeric  $\langle 2, 4, 6, 8 \rangle$

2. Binary  $\langle 0, 1 \rangle$

3. Non-numeric  $\langle G, PG, PG-13, R \rangle$



# Basic Data Types

1. Nominal

2. Ordinal

3. Quantitative

1. Interval

2. ratio

**Quantitative Data:** A numeric range

1. Interval

- Ordered numeric elements on a scale that can be mathematically manipulated, but cannot be compared as ratios
- For example: date, current time  
(Sept 14, 2010 cannot be described as a ratio of Jan 1, 2011)

2. Ratio

- where there exists an “absolute zero”
- For example: height, weight



# Operations: Nominal, Ordinal & Quantitative

N - Nominal (labels or categories)

- Operations: =,  $\neq$

O - Ordinal

- Operations: =,  $\neq$ ,  $<$ ,  $>$

Q - Interval

- Operations: =,  $\neq$ ,  $<$ ,  $>$ , -
- Can measure distances or spans

Q – Ratio

Operations: =,  $\neq$ ,  $<$ ,  $>$ , -, %

- Can measure ratios or proportions

Microsoft Excel - fischer.iris.2.xls

File Edit View Insert Format Tools Data Window Help

Type a question for help

	A	B	C	D	E	F	G	H	I	J
1	ID	Case	Species_No	Species	Organ	Width	Length			
2	1	1	1	I. Setosa	Petal	2	14			
3	2	1	3	I. Verginica	Petal	24	56			
4	3	1	2	I. Versicolor	Petal	13	45			
5	4	1	1	I. Setosa	Sepal	33	50			
6	5	1	3	I. Verginica	Sepal	31	67			
7	6	1	2	I. Versicolor	Sepal	28	57			
8	7	2	1	I. Setosa	Petal	2	10			
9	8	2	3	I. Verginica	Petal	23	51			
10	9	2	2	I. Versicolor	Petal	16	47			
11	10	2	1	I. Setosa	Sepal	36	46			
12	11	2	3	I. Verginica	Sepal	31	69			
13	12	2	2	I. Versicolor	Sepal	33	63			
14	13	3	1	I. Setosa	Petal	2	16			
15	14	3	3	I. Verginica	Petal	20	52			
16	15	3	2	I. Versicolor	Petal	14	47			
17	16	3	1	I. Setosa	Sepal	31	48			
18	17	3	3	I. Verginica	Sepal	30	65			
19	18	3	2	I. Versicolor	Sepal	32	70			
20	19	4	1	I. Setosa	Petal	1	14			
21	20	4	3	I. Verginica	Petal	19	51			
22	21	4	2	I. Versicolor	Petal	12	40			
23	22	4	1	I. Setosa	Sepal	36	49			
24	23	4	3	I. Verginica	Sepal	27	58			
25	24	4	2	I. Versicolor	Sepal	26	58			
26	25	5	1	I. Setosa	Petal	2	13			
27	26	5	3	I. Verginica	Petal	17	45			
28	27	5	2	I. Versicolor	Petal	10	33			
29	28	5	1	I. Setosa	Sepal	32	44			
30	29	5	3	I. Verginica	Sepal	25	49			
31	30	5	2	I. Versicolor	Sepal	23	50			
32	31	6	1	I. Setosa	Petal	2	16			

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Ready

**Questions:**

Is the data N, O, Q(I) or Q(R)?

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File Edit View Insert Format Tools Data Window Help

Type a question for help

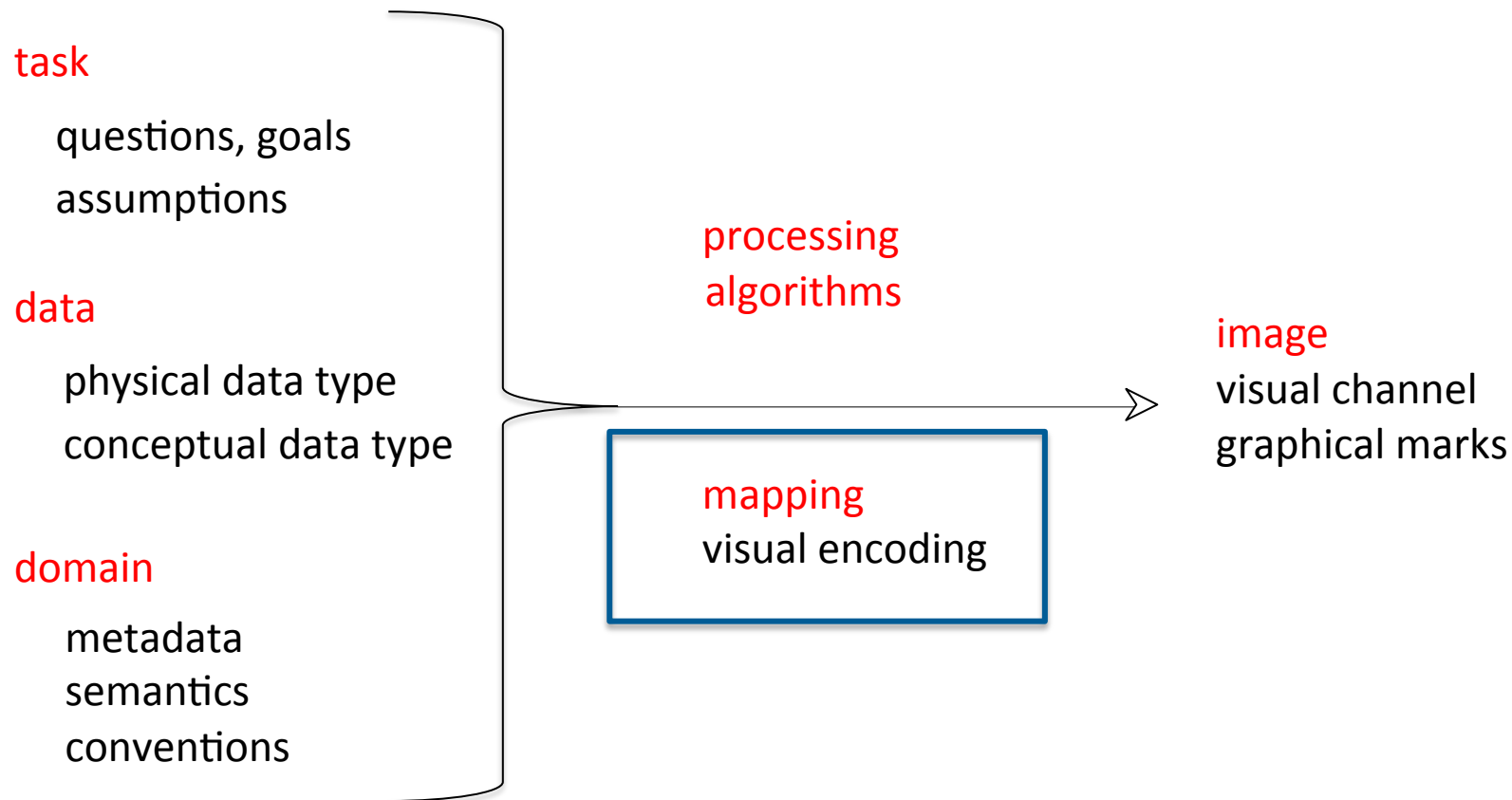
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Ready

# Visualization Process





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*of* ENGINEERING

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