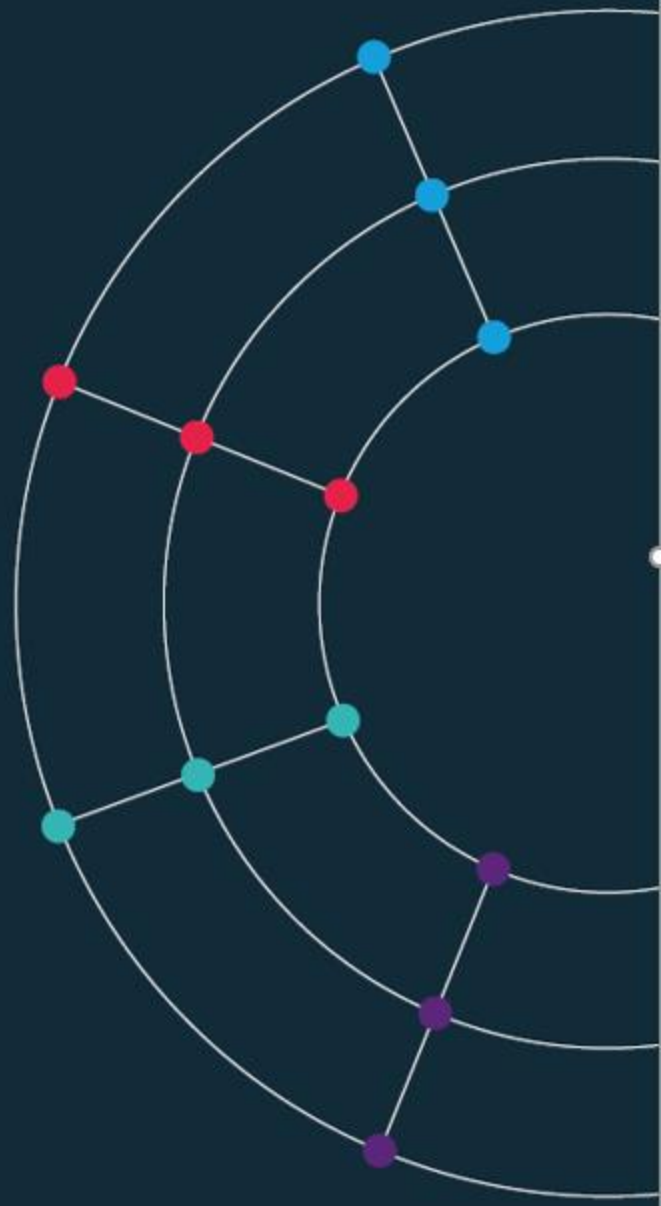
Session 4.

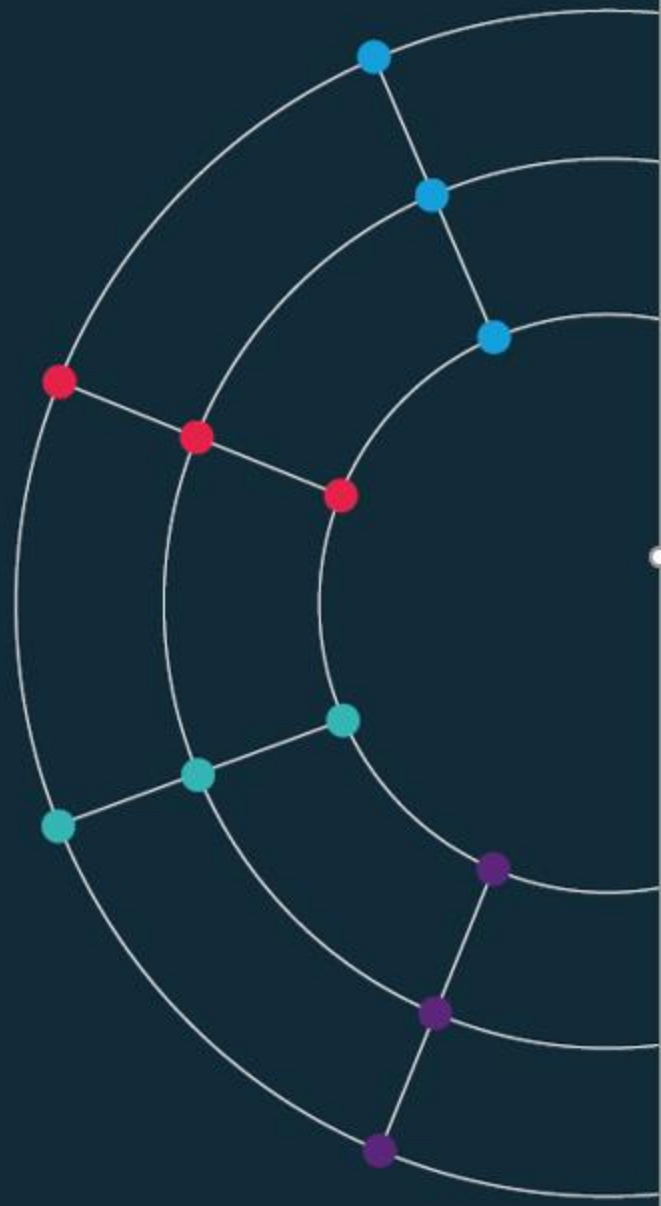
Advanced visualisations



Session 4.

Advanced visualisations

The grammar of graphics

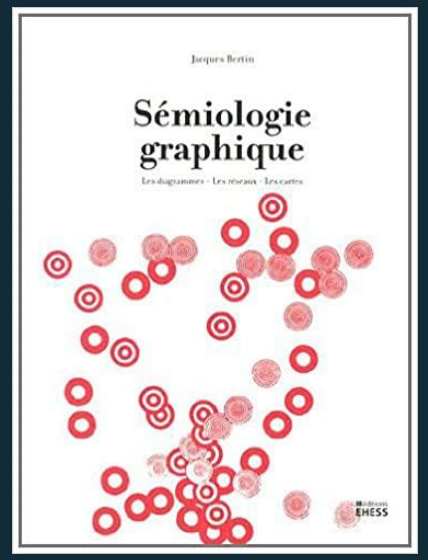


What is Data Science?

- Artificial Intelligence?
- Machine Learning?
- Deep Learning?
- Big Data?

https://twitter.com/TamaraMcCleary/status/1061197523610550272

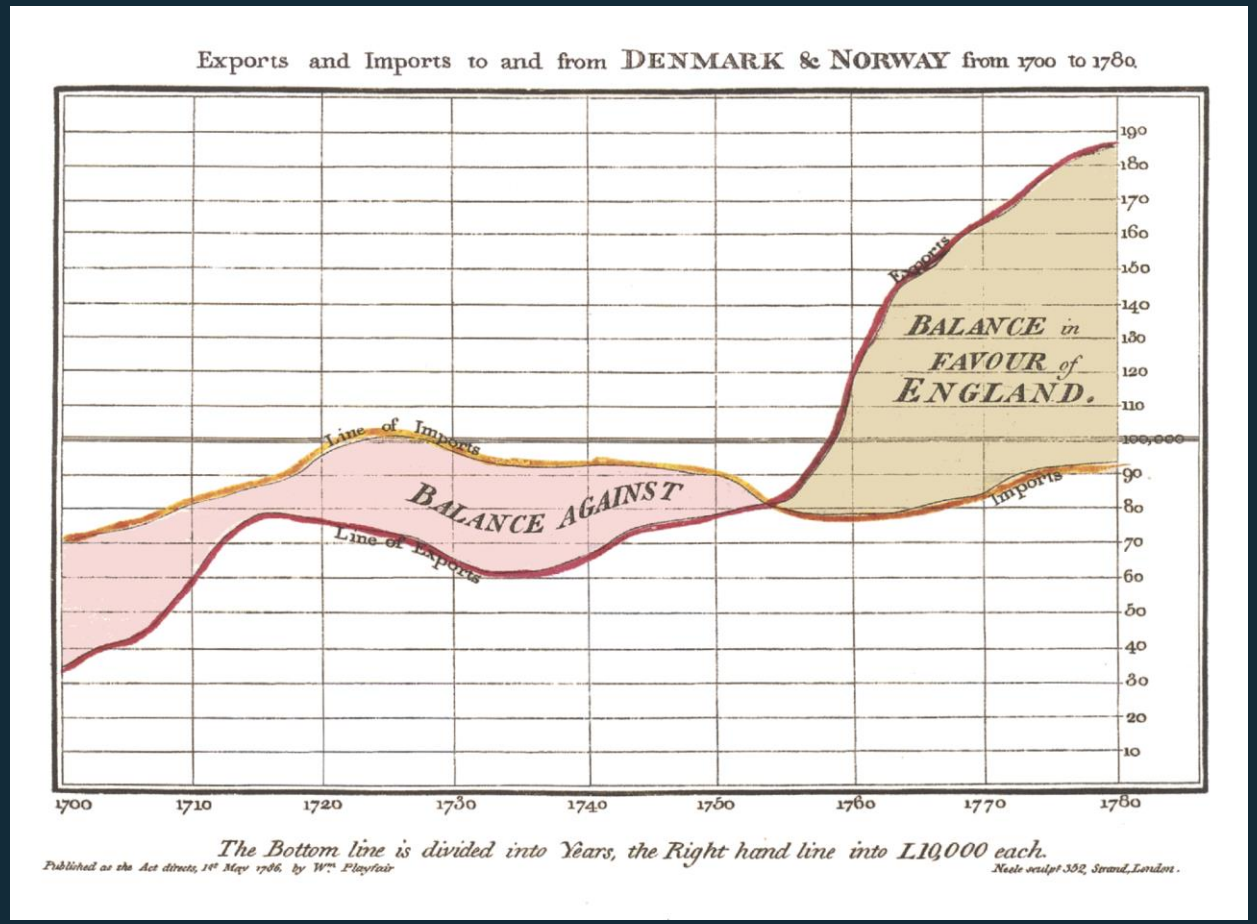
Visual language is a sign system.

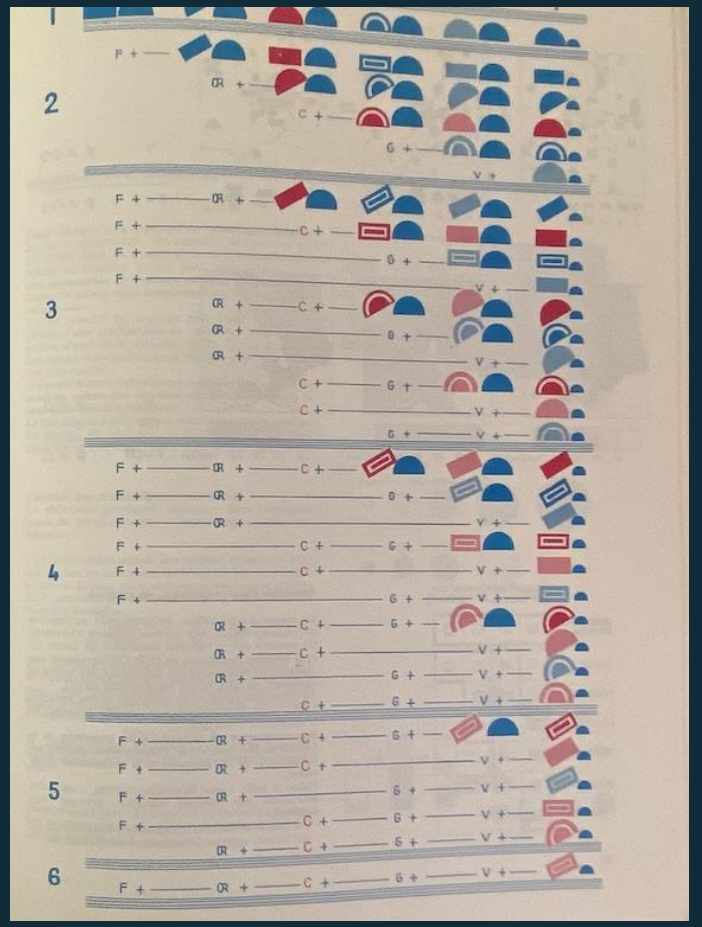


- Images perceived as a set of signs
- Sender encodes information in signs
- Receiver decodes information from signs
- In his foreword to the 1983 English translation, Howard Wainer called Bertin's work “the most important work on graphics since the publication of Playfair's Atlas”

Jacques Bertin, Semiologie Graphique, 1967

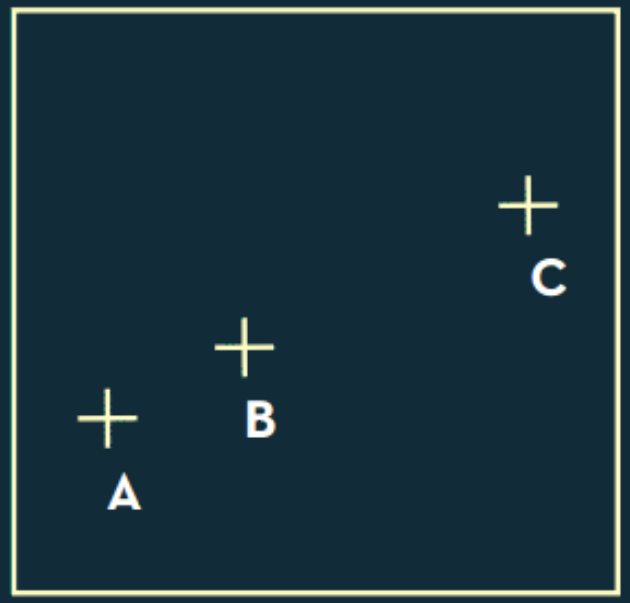
Visual language is a sign system.





William Playfair, The Commerical and Political Atlas, 1785 and Jacques Bertin, Semiologie Graphique, 1967
both collected from Jemery Norman's HistoryOfIformation.com, 2021

Bertin's semiology of graphics.



1. A, B, C are distinguishable
2. B is between A and C.
3. BC is twice as long as AB.

∴ Encode quantitative variables

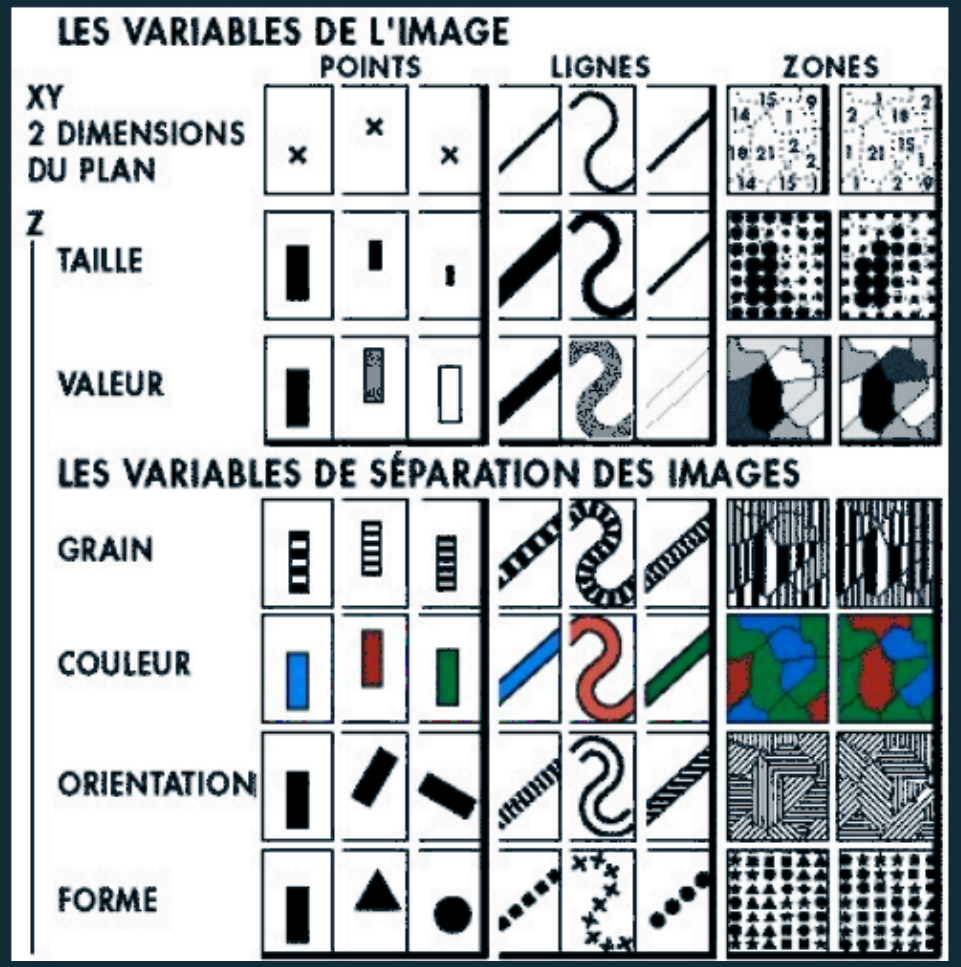
"Resemblance, order and proportion are the three signifieds in graphics." - Bertin

Adapted from Jeffrey Heer, 2018, UW CSE442, after Jacques Bertin, Semiologie Graphique, 1967

Visual encoding variables.

Visual grammar

- Position (x2)
- Size
- Value (Saturation)
- Texture
- Colour
- Orientation
- Shape
- (Time/Animation, Focus, Opacity)



Adapted from Jeffrey Heer, 2018, UW CSE442, after Jacques Bertin, Semiologie Graphique, 1967

Position	N	O	Q
Size	N	O	Q
Value	N	O	Q
Texture	N	O	
Color	N		
Orientation	N		
Shape	N		

Nominal
Ordered
Quantitative
Note: Q < O < N

- Bertin's list: based on theoretical considerations of semiology

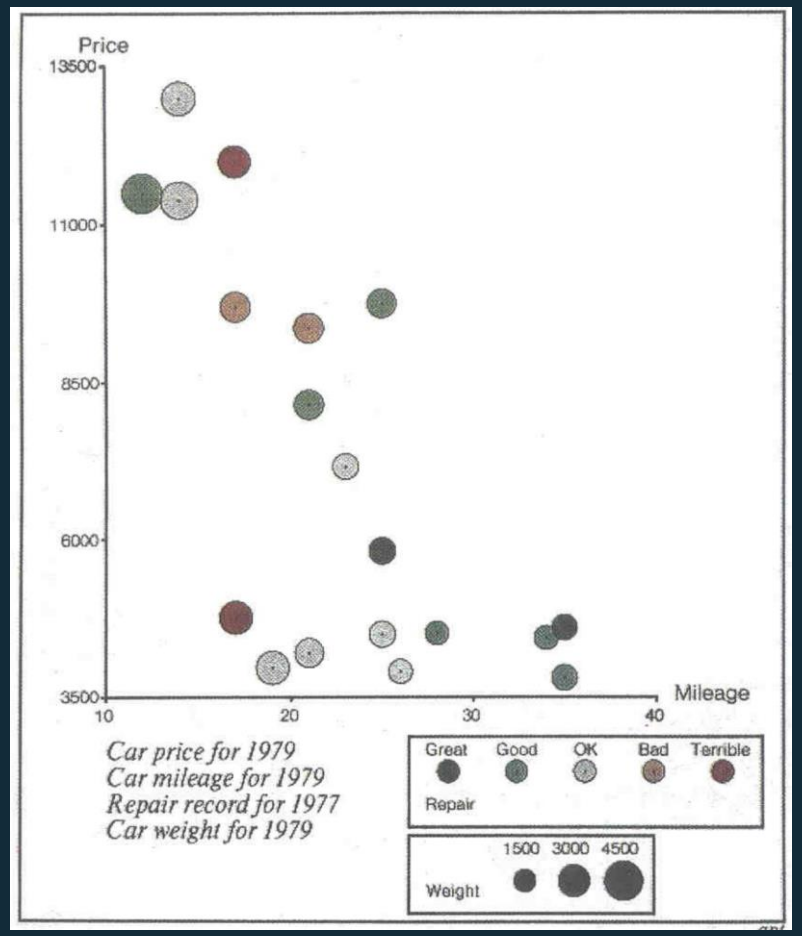
Bertin's

"Levels of Organisation"

Adapted from Jeffrey Heer, 2018, UW CSE442, after Jacques Bertin, Semiologie Graphique, 1967

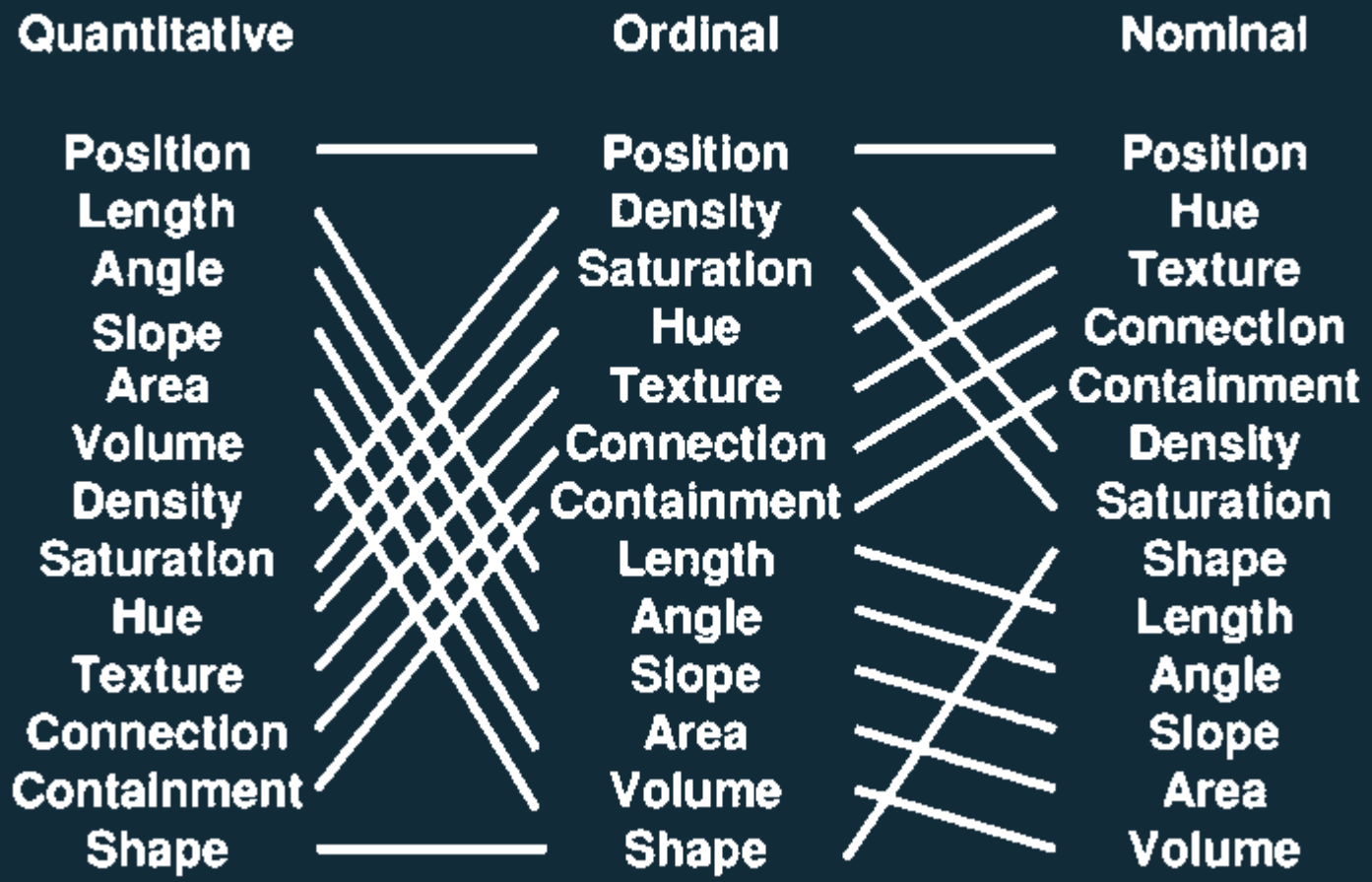
Mackinlay design criteria.

- Formalizes Bertin for machines.
- Expressiveness A set of facts is expressible in a visual language if the sentences (i.e. the visualisations) express all the facts in the set of data, and only the facts.
- Effectiveness A visualisation is more effective than another if the information conveyed by one visualisation is more readily perceived than the information in the other visualization.



Adapted from Jeffrey Heer, 2018, UW CSE442 and Jock Mackinlay's presentation at Ohio State University, 2005, both based on Jock Mackinlay, Tableau/Xerox PARC/Stanford 1986

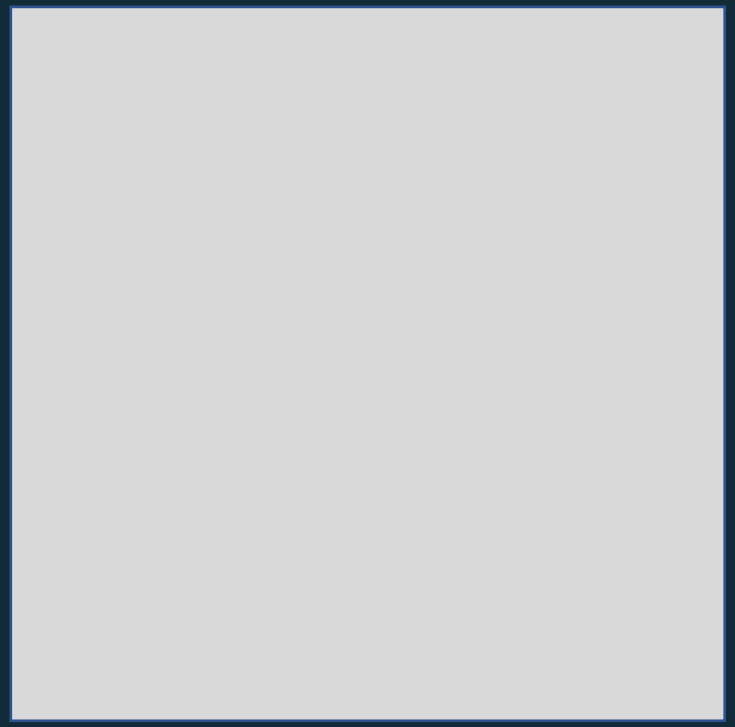
Mackinlay design criteria.

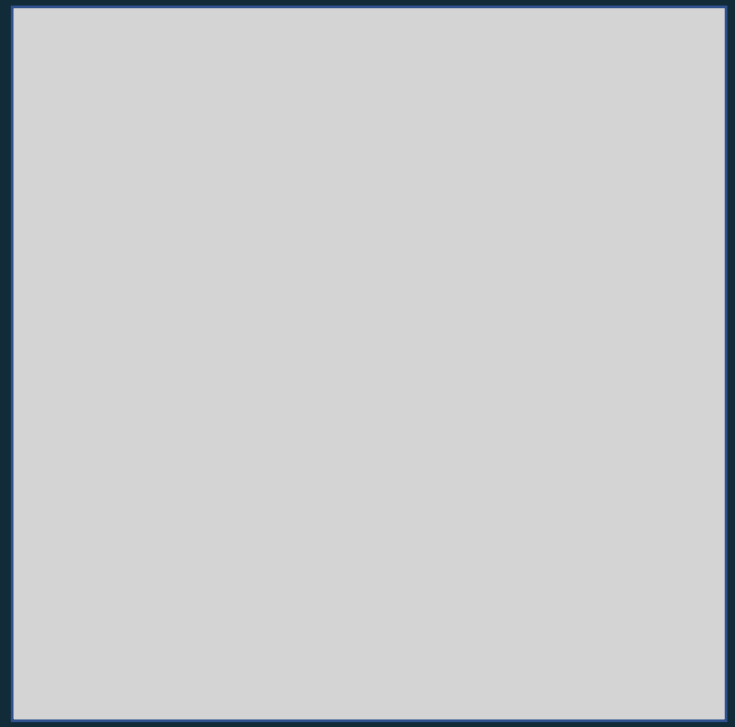


Jock Mackinlay, Tableau/Xerox PARC/Stanford 1986

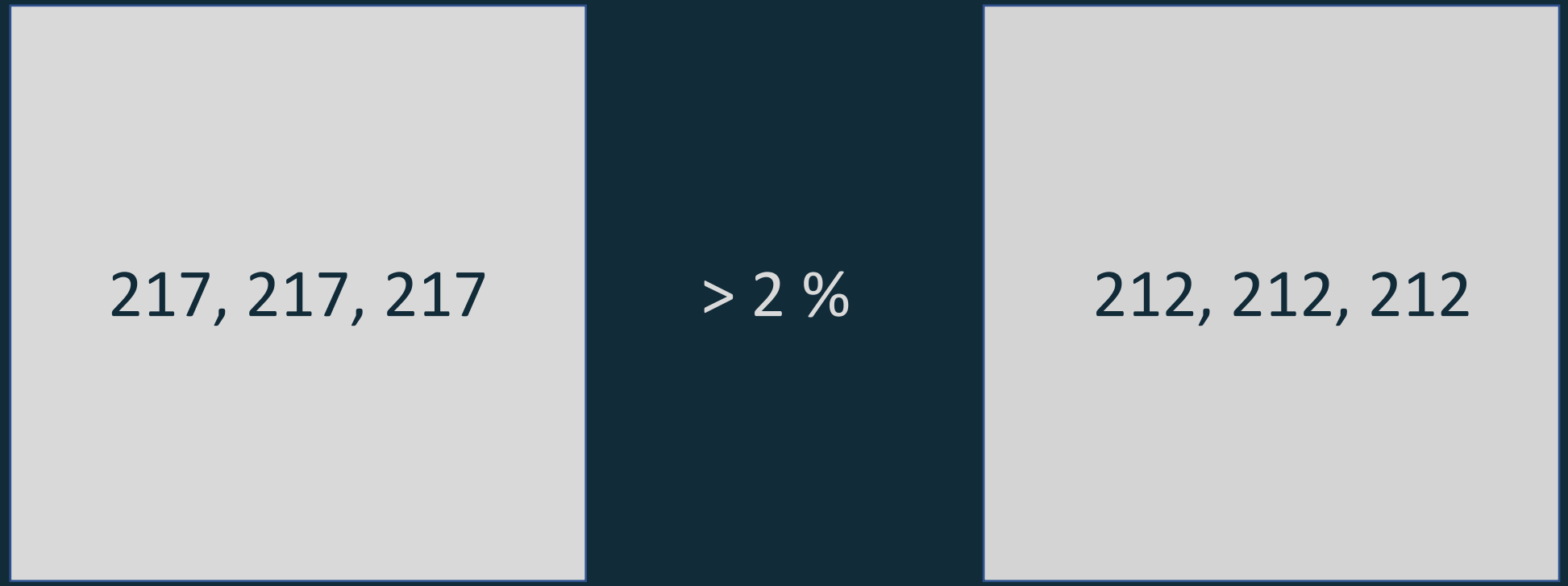
- Mackinlay's list: based on his experiments with computer graphics, trying to automate and formalize the creation of charts
- The Vega visual language/grammar is built on Mackinlay's work

Which square is lighter?

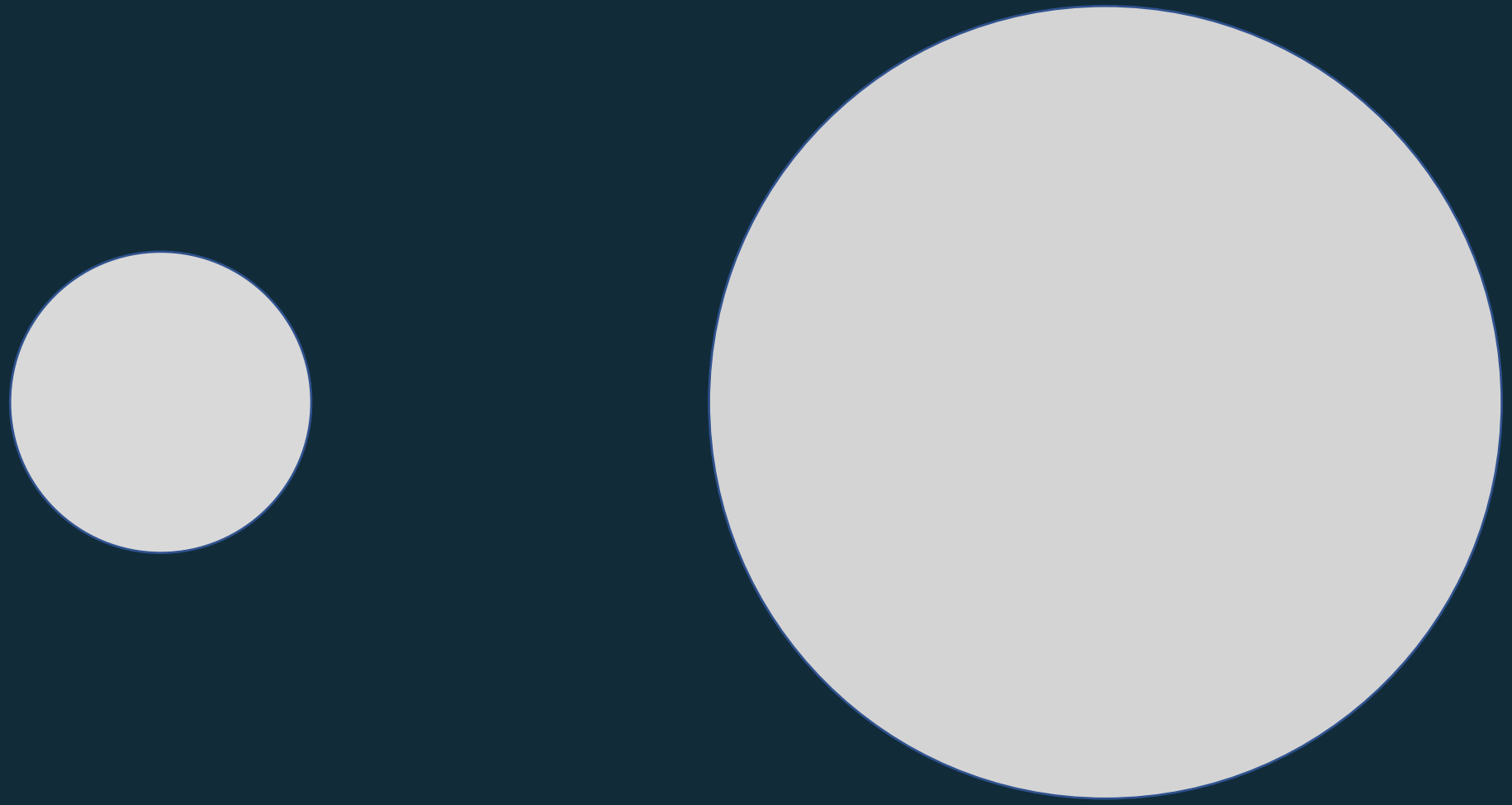




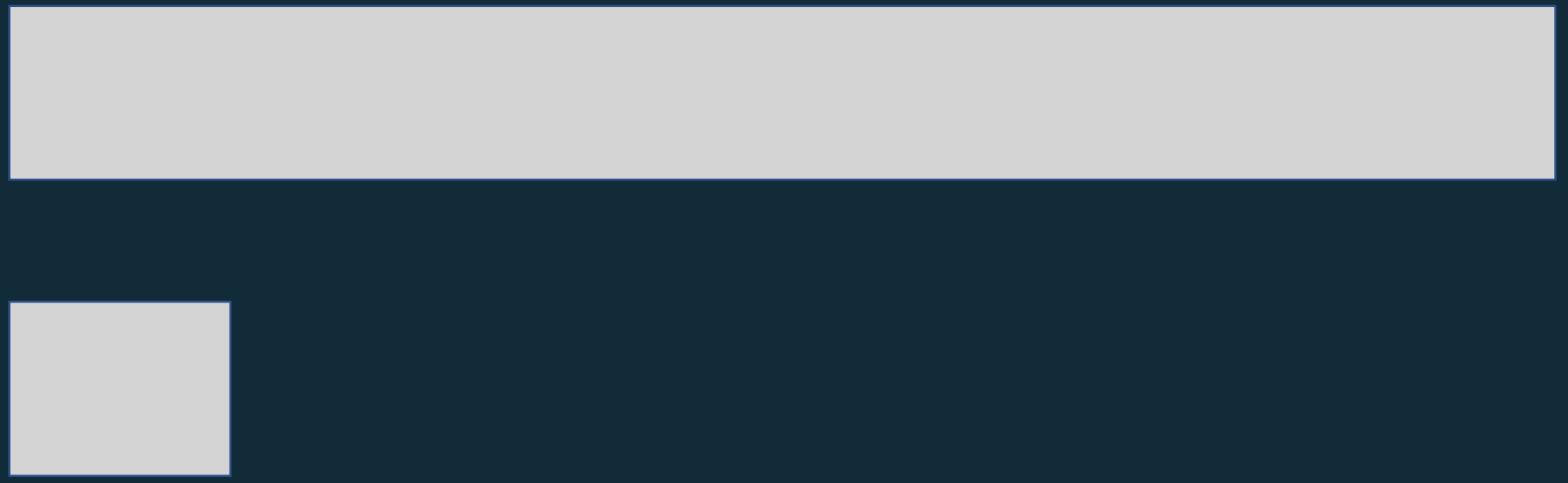
Which square is lighter?



How many times is the right circle larger?



How many times is the top bar longer?



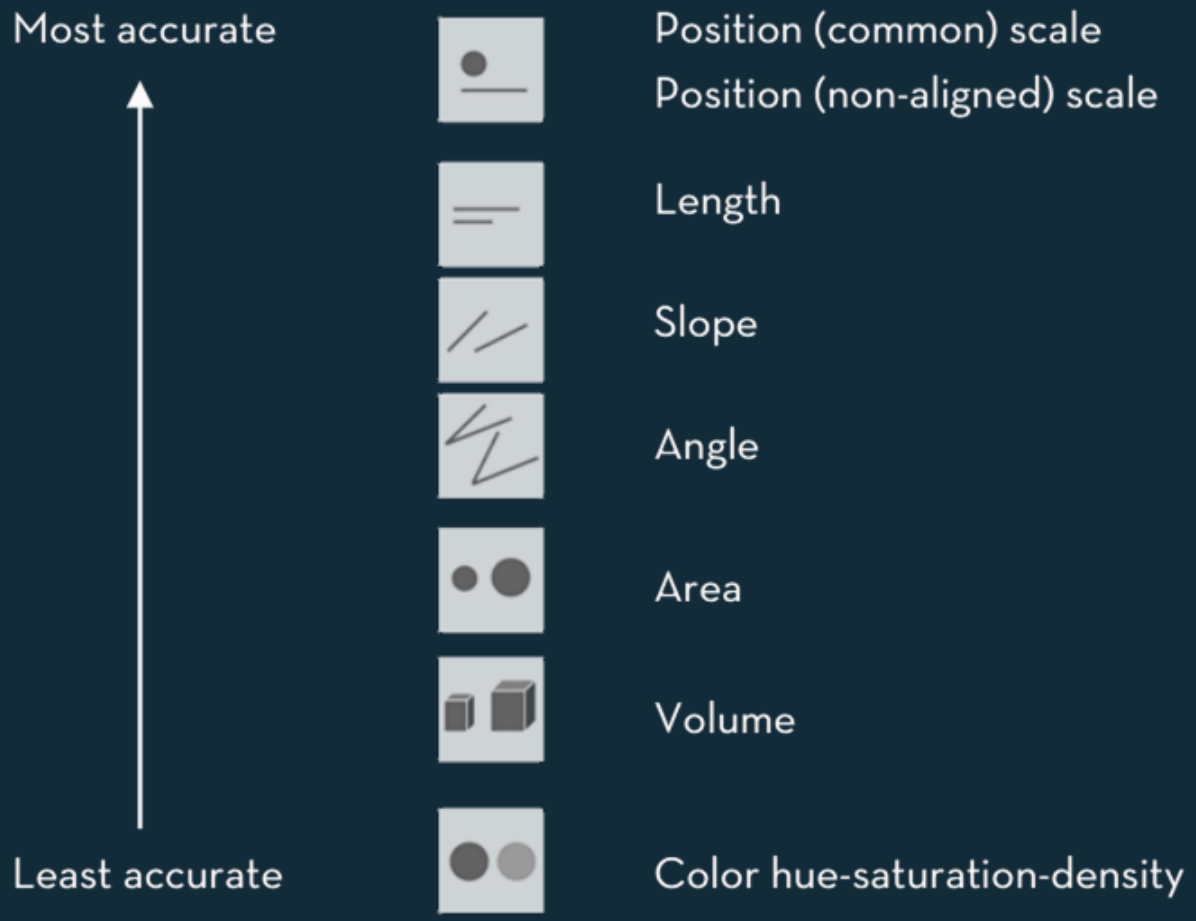
Stevens' power law.

sensation = intensity^{exponent}

Our senses are not linear!

Stanley Smith Stevens, Harvard, 1957

Stevens' power law.



Stanley Smith Stevens, Harvard, 1957

Stevens' list:

based on psychological experiments with human senses

Visual language is a sign system.

- When designing visual information use correct encodings
- data → information correct data model
- information → knowledge correct visual representation
  - Bertin's semiology of graphics
  - Mackinlay design criteria
  - Stevens' power law

Data visualization zoo.

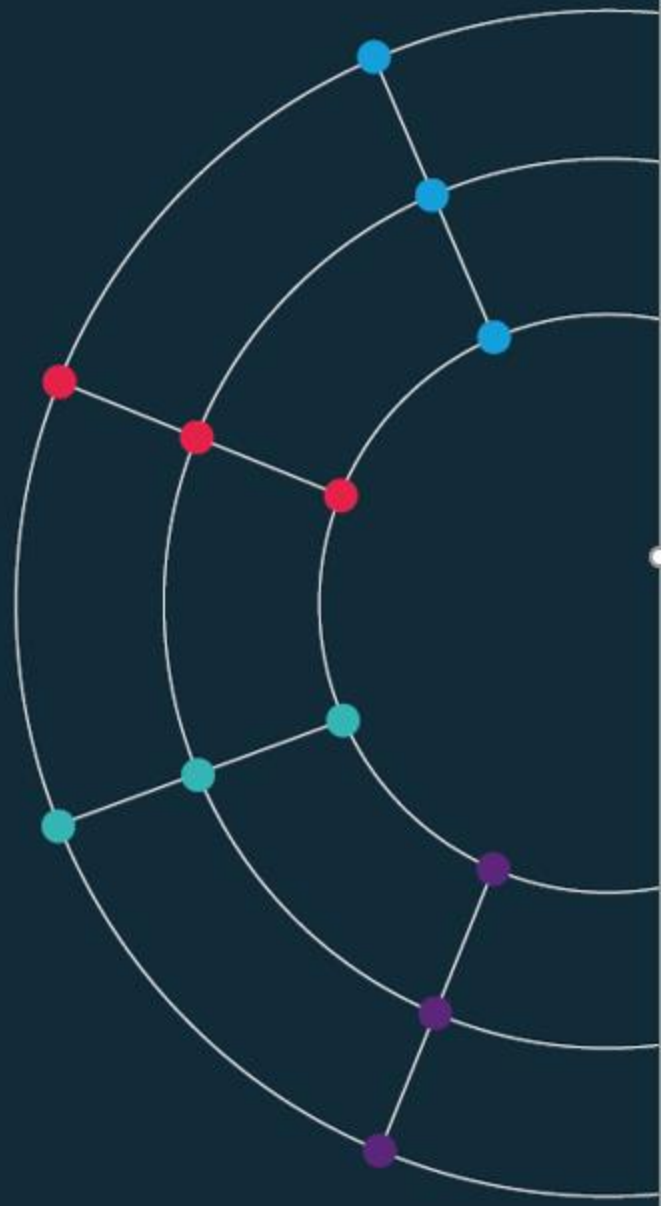
- The actual “A Tour through the Visualisation Zoo”
- **Economics Observatory** **Visualisation Guidelines**
- Financial Times Visual Vocabulary
- Vega Edition of the Visual Vocabulary
- The D3 Graph Gallery
- Andy Kirks's The Chartmaker Directory

Heer, Bostock, Ogievetsky, *A Tour through the Visualization Zoo*, ACM, 2010

Session 4.

Advanced visualisations

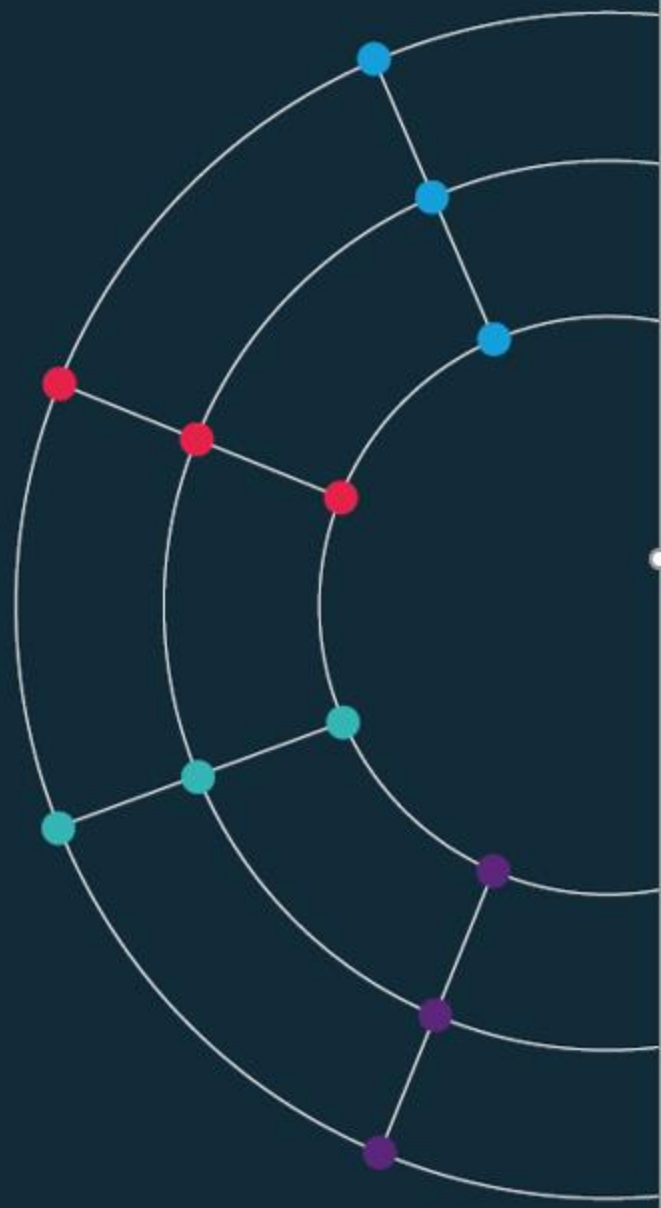
Adding multi-dimensional charts



Session 4.

Advanced visualisations

https://github.com/EconomicsObservatory/courses/blob/main/README.md



Code-along.

In this fourth practical session, we will use Vega-Lite, VS Code and GitHub to explore and embed a multi-dimensional chart into your website using one (or more) of the following:

- Beginner: “example_advanced1.json”
- Intermediate:
  - “example_advanced2.json”
  - “example_advanced3.json” (map)
- Advanced: “more_example_charts”