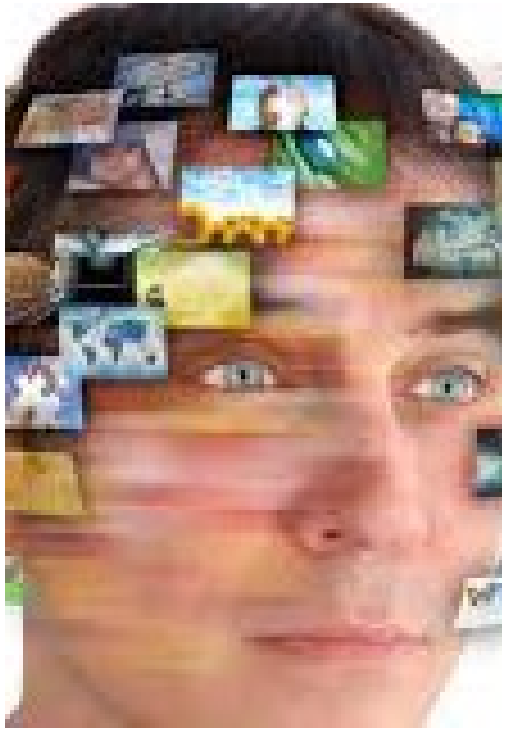
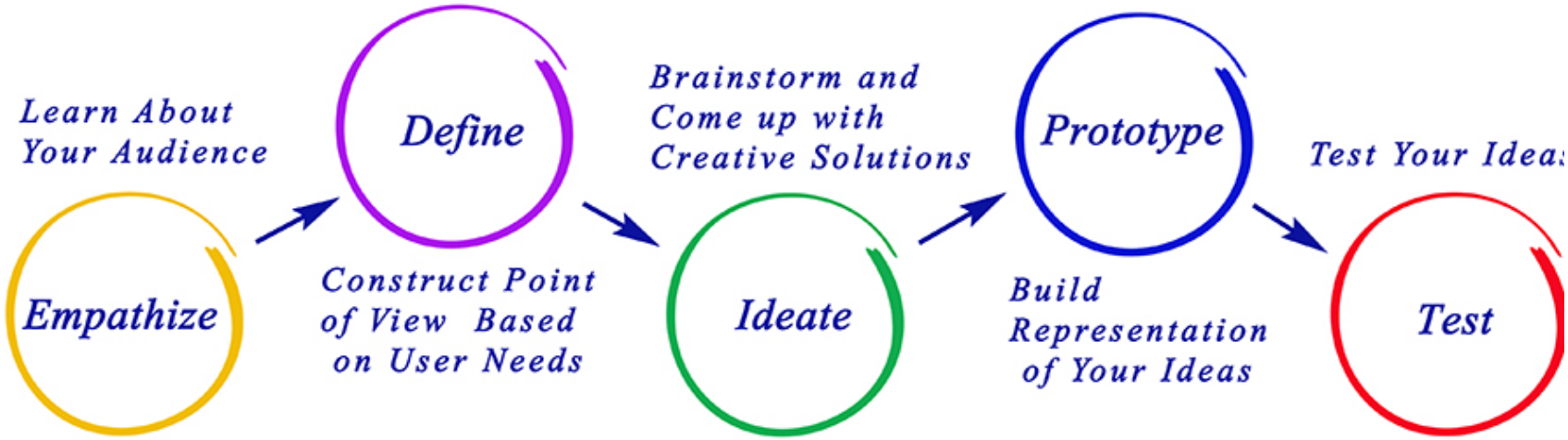
HCI: LECTURE 9 OVERVIEW

- DESIGN THINKING 4: PROTOTYPE (Information Architecture / Design)
  - Information Visualisation
    - Perception: Representation
    - Interpretation: Interaction, Analysis
    - Understanding



Design Thinking Process



INFORMATION ARCHITECTURE

"An information architect is the individual who organizes the patterns inherent in data, making the complex clear."

- (Richard Wurman, *Information Anxiety* 1976)

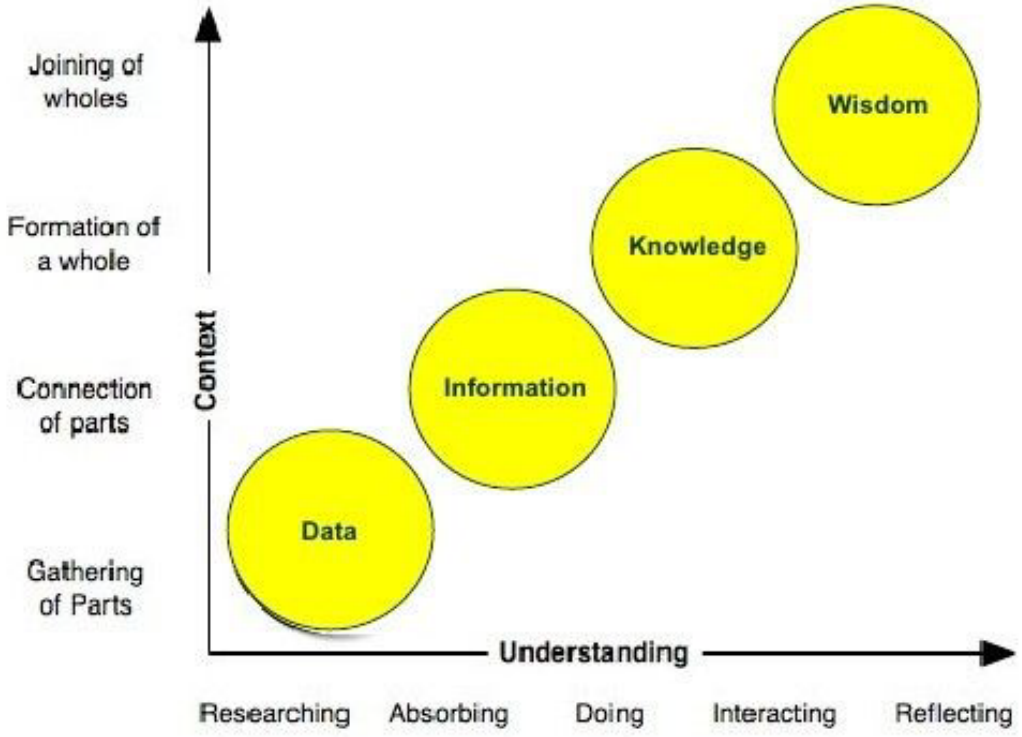
- Information Architects:
  - Label (ontology)
  - Organise (taxonomy) and
  - Present (choreography) content
- According to user goals to minimize cognitive load

INFORMATION DESIGN

- Information Visualisation: Representing data in a way that is easy to ***understand*** and to ***manipulate***, helping us make ***sense*** of information and make it ***useful*** in our lives
- Understand user goals to make effective design decisions
- Help people understand the world better
- Add value by translating raw data into relevant, useful information
- Data – Information – Knowledge – Wisdom: Gathering – Connecting – Formation - Joining

Imperial College
London

The Continuum of Understanding



understanding is a continuum (Cleveland, 1982):

USER GOALS

- Understanding users and user goals essential to move from data to information on the continuum of understanding
- Different users with different goals and emotions: alleviates information anxiety
- "*Information anxiety is the black hole between data and knowledge, and it happens when information doesn't tell us what we want or need to know.*"
  Richard Saul Wurman
- Example of Diabetes patients: patient's perspective vs. healthcare professional perspective: what they need to know

INFORMATION VISUALISATION: THREE STAGES OF UNDERSTANDING

1

Perceiving: What does it show? Where is big, medium, small? How do things compare?

Design Choices

2

Interpreting: What does it mean? What is good and bad? Is it meaningful or insignificant? Unusual or expected?

Viewer Capacity

3

Understanding: What does it mean to me? What are the main messages? What have I learnt? Any actions to take?

Depends on Viewer

Data Visualisation: A Handbook, Kirk, 2016

1. PERCEIVING: REPRESENTATION

REPRESENTATION

- How information can and should be encoded and displayed
- "*Design cannot rescue failed content*" Edward R. Tufte
- What is salient? What to attend to?
- **Representation:** Design decisions about what information to encode: only a portion of the information space can be visible in the representation space at any given time
- Representation connects the human mind to the information space (mental model to data model)

INFORMATION REPRESENTATION

Guidelines for good visual information representation (Tufte): (value over beauty / decoration)

1. Graphical Excellence: "the greatest number of ideas, in the shortest time, using the least amount of ink, in the smallest space" – in short, **usability**
2. Visual Integrity: neither distort the data nor create a false impression
3. Maximizing the Data-Ink Ratio: all superfluous elements should be removed (borders, 3D etc.)
4. Aesthetic Elegance: simplicity of design (Minard's representation of Napoloeon's march)

INFORMATION READABILITY

Nielsen Usability Research (1997): How people read online

- People look around, interlaced browsing: **don't read**
- Effective Writing Strategy: improve comprehension
  - Concise text: improved by 58%
  - Scannable Layout: improved by 47%
  - Objective language: improved by 27%
  - Combined version: improved by 124%
- Use structure: headings, subheadings & pages
- Information bearing words in links: improves scanning
- Eye catching text elements: bulleted lists, capitals

INFORMATION REPRESENTATION

- Visual Tools for representing complex data:
  - Tables
  - Brackets and Tree diagrams
  - Blueprints, diagrams, schematics: 2-D micro representations of 3-D macro systems
  - Flow charts, Organisation charts
  - Notational systems: chess, music, maths
  - Maps: 2-D figures to represent complex multi-dimensional data

CHARTS

Define the shape, size and layout choices for all components:

- **Size**: small multiples, readable labels
- **Scales**: most meaningful range of values for data?
- **Orientation**: which way is best?
- **Value sorting**: most meaningful? LATCH acronym

INFORMATION DESIGN: "5 HAT RACKS"

How Do Things Compare?

Location: Mapping locations to explore connections

Alphabetic: Organising information following standard alphabetic order

Temporal: Showing trends and activities over time

Categorical: Comparing categories and distributions of quantitative values

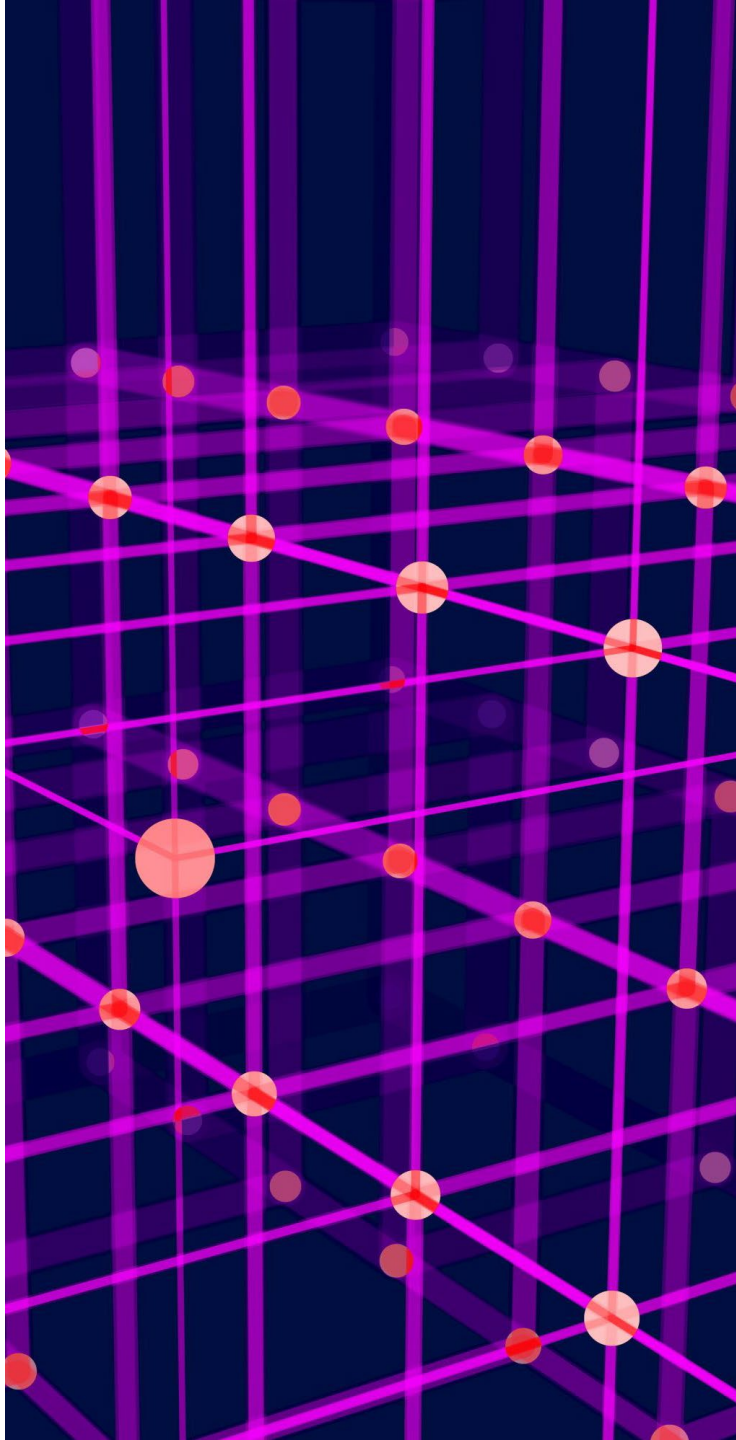
Hierarchical: Charting part-to-whole relationships and hierarchies

LATCH: Saul Wurman (1989)

HOW TO REPRESENT? HOW & WHAT TO ENCODE?

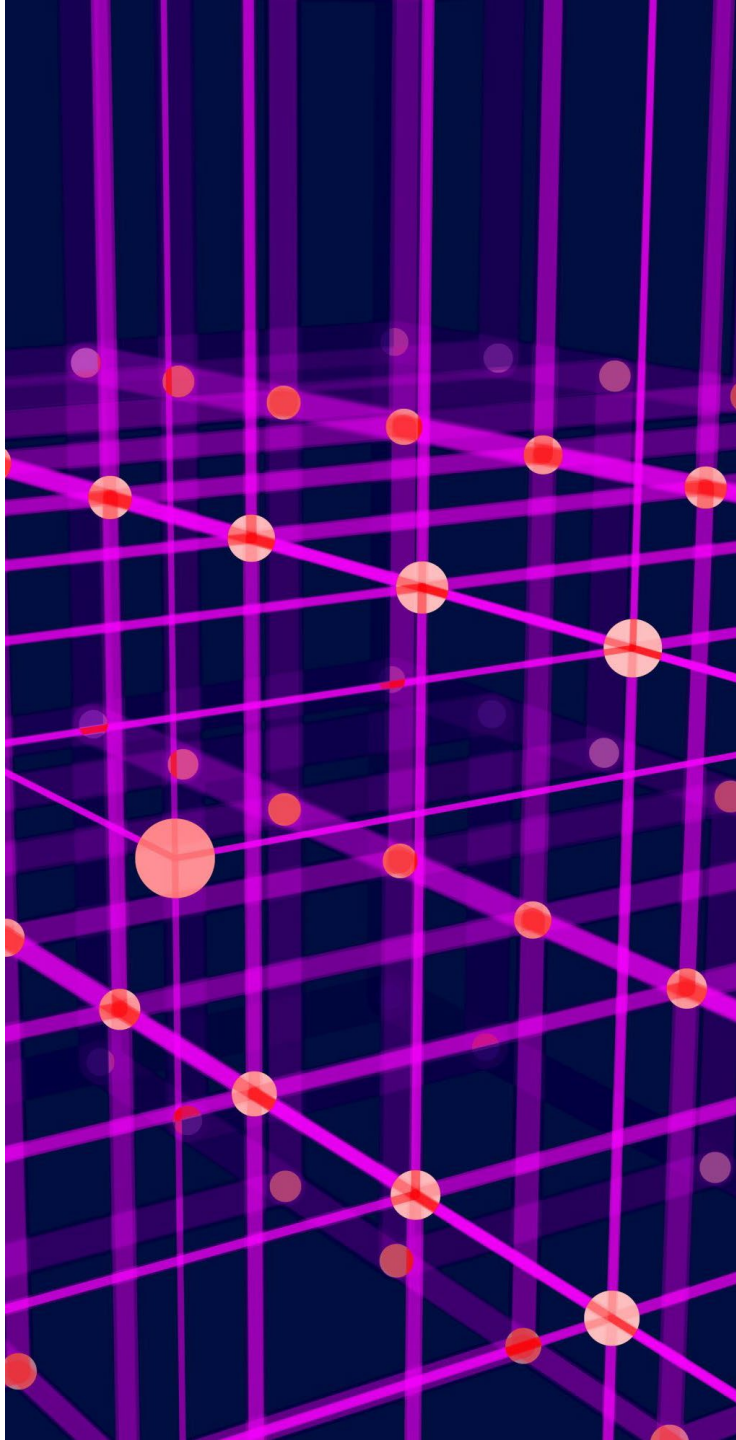
ENCODING

- Three visual mapping elements (Card, Mackinlay and Shneiderman, 1999):
  - The **Spatial Substrate**: 2/3/multi dimensional spaces; data type (quantitative, ordinal, categorical)
  - The **Graphical Elements**: Visual elements that will appear in the spatial substrate: points, lines, surfaces, volumes
  - The **Graphical Properties**: apply to the graphical elements to make them more or less noticeable: size, orientation, colour, texture and shape

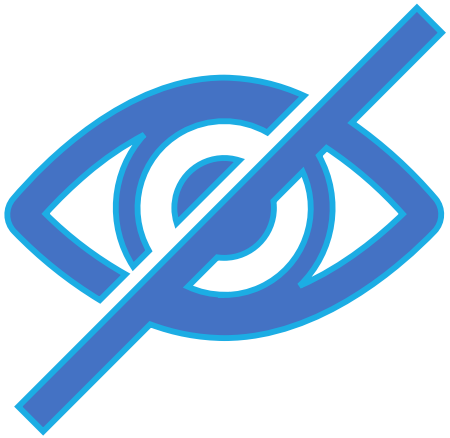


ENCODING

- Encoding comprises two different properties
  - **Marks** (elements) - visible features like dots, lines, areas
  - **Attributes** (properties) - appearance of marks, e.g. colour, size, position
- Objective of Visual Encoding is to find the right blend between marks and attributes that best captures the angle you want to portray
- Marks & Attributes are called Visual Variables

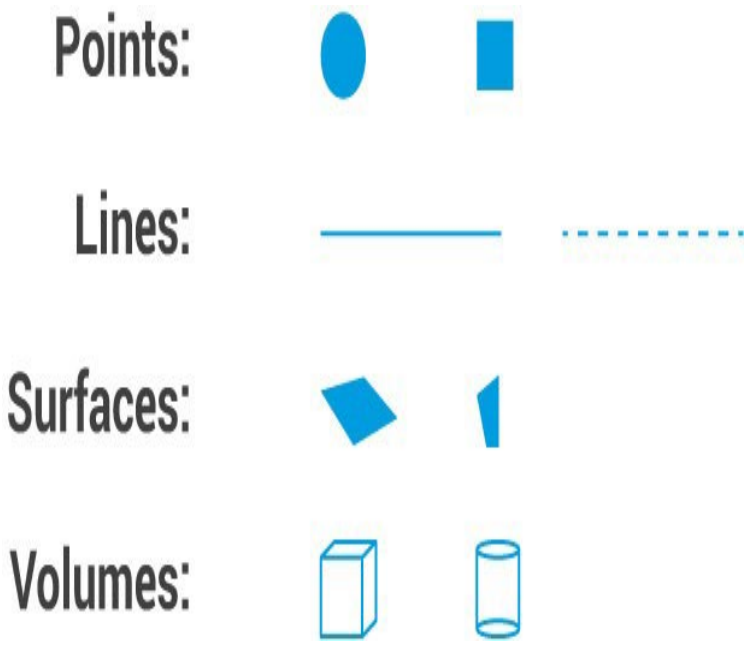


ENCODING



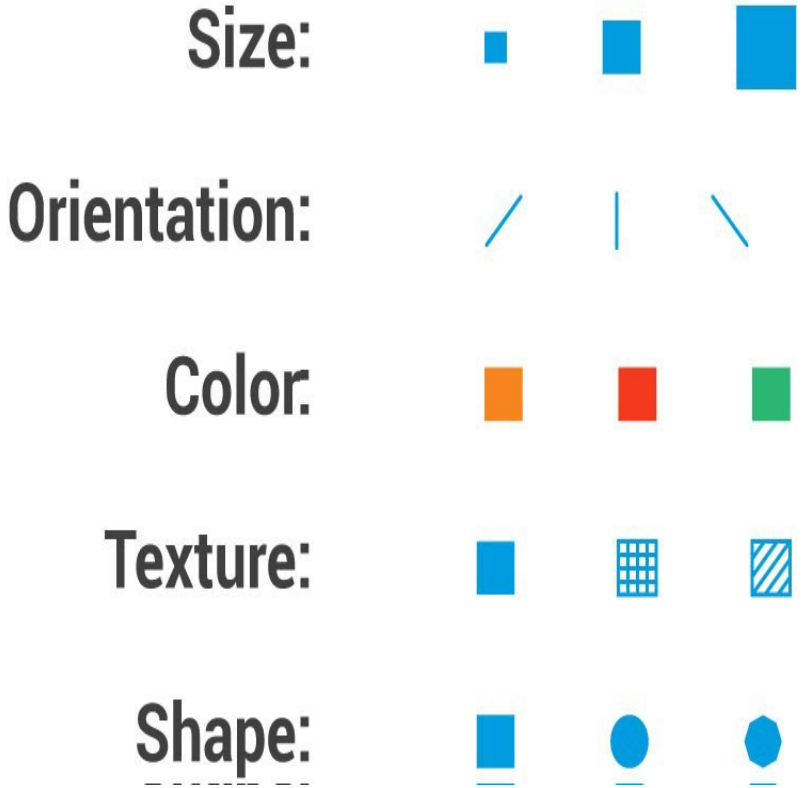
- Visualisers encode, giving visual properties to data values (graphics)
- Visually differentiate elements from other elements during design process
- Originally designed by Jaques Bertin (Semiologie Graphique, 1967) and intended for cartography
- "**Visual Variables** are a specified set of symbols that can be applied to data in order to translate information"
- 12 Visual variables: arranged in specific order they convey information (location, size, shape, orientation, colour: hue, value, saturation; texture, arrangement, crispness, resolution and transparency)

Information Encoding



Graphical Elements

Information Encoding

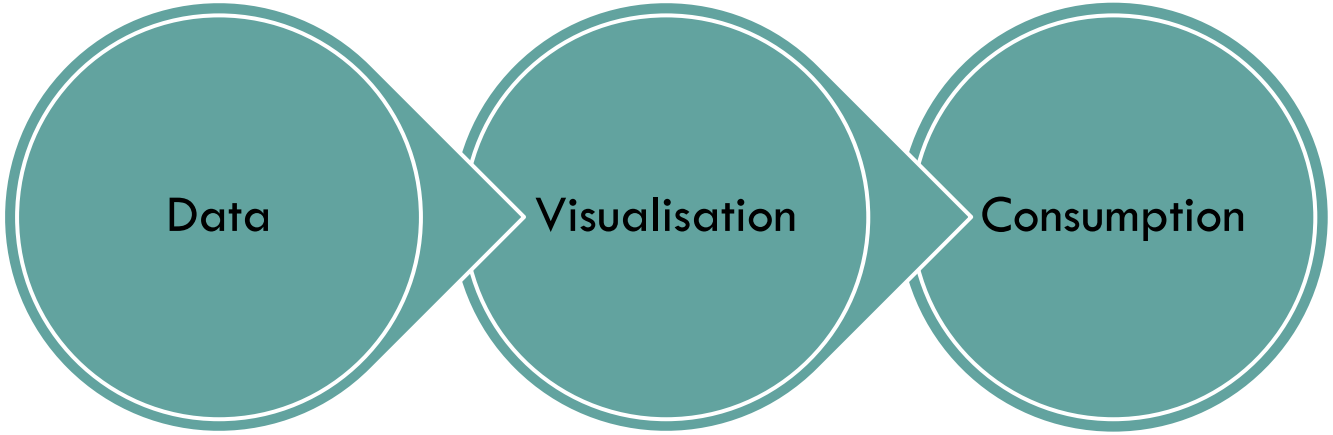


Graphical Properties

2. INTERPRETING: INTERACTING, ANALYSING

INFORMATION VISUALISATION: INTERACTIVITY

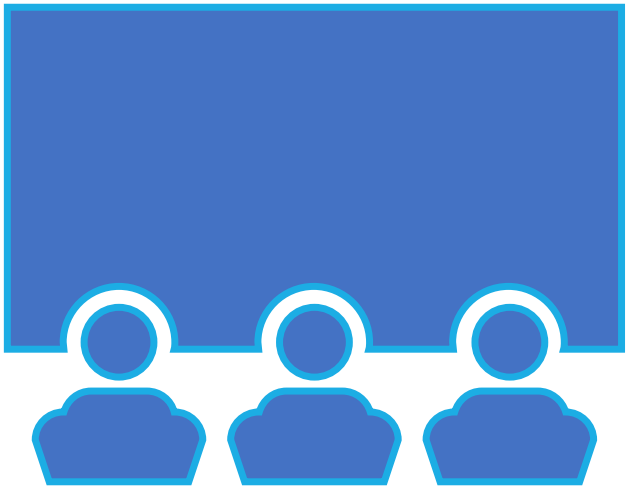
- Expands the physical limits of what you can show in a given space (e.g. large ranges of data)
- Increases the quantity and broadens the variety of angles of analysis to serve different curiosities
- Facilitates manipulations of the data displayed to handle varied interrogations
- Increases the overall control and potential customisation of the experience
- Extends scope for exploring different techniques for engaging users

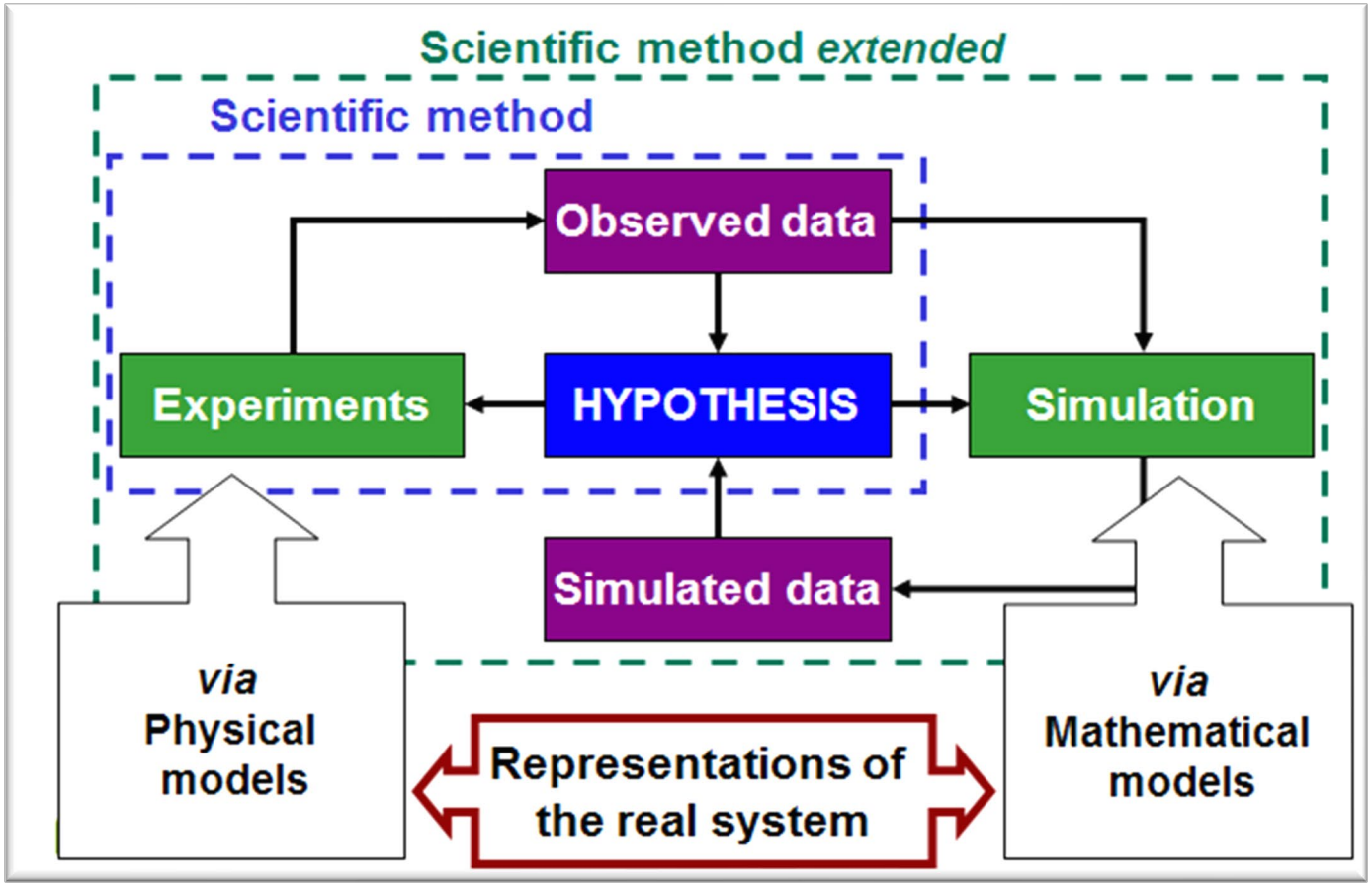


PASSIVE VISUALISATION

INFORMATION EXHIBITION

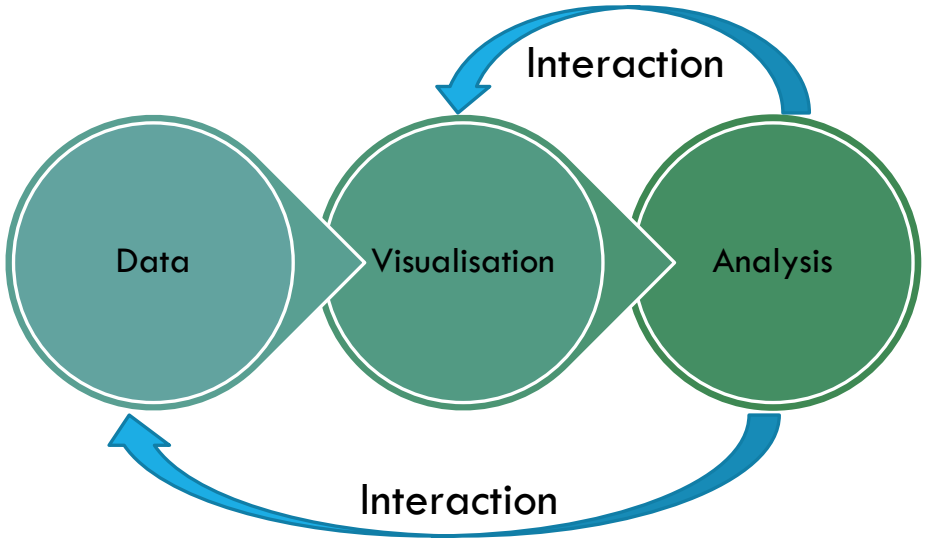
- Viewers interpret data themselves: relies on their knowledge of the subject-matter
- Visual displays of data similar to an exhibition of artwork
- Useful for specific audiences (e.g. boardroom meetings)
- Usually quite narrow focus
  May be part of a bigger display (dashboards, newspaper article)





INFORMATION VISUALISATION: STATIC

INTERACTIVE VISUALISATION



INFORMATION VISUALISATION: INTERACTIVITY

- Interaction Types:
  - Interaction for **data** adjustments: Affecting what data is displayed
  - Interaction for **presentation** adjustments: Affecting how the data is displayed

INFORMATION VISUALISATION: INTERACTIVITY

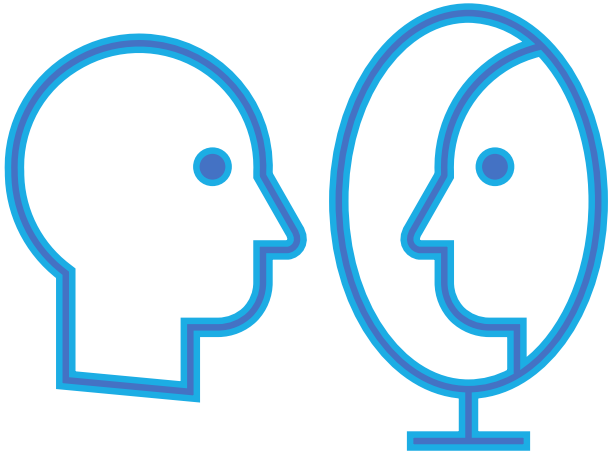
Data Adjustments:

- **Framing** allows users to modify the criteria by which data is displayed
- **Navigation** allows users to expand or explore greater levels of detail in the displayed data
- **Animation** especially useful for temporal data
- **Sequence:** predefined series of angles to build a story
- **Contribution:** incorporation of user input

INFORMATION VISUALISATION: INTERACTIVITY

Presentation Adjustments:

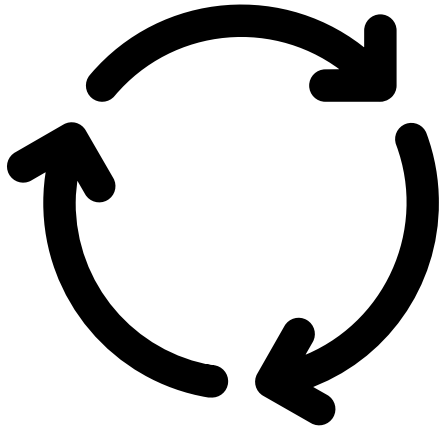
- **Focus:** what data is visually emphasised and, sometimes, how it is emphasised
- **Annotation** adding extra details through pop-ups / tooltips (e.g. chart annotations: labels, legends, captions)
- **Orientation** providing indications of screen location (eg cursor points)



INFORMATION VISUALISATION: INTERACTIVITY

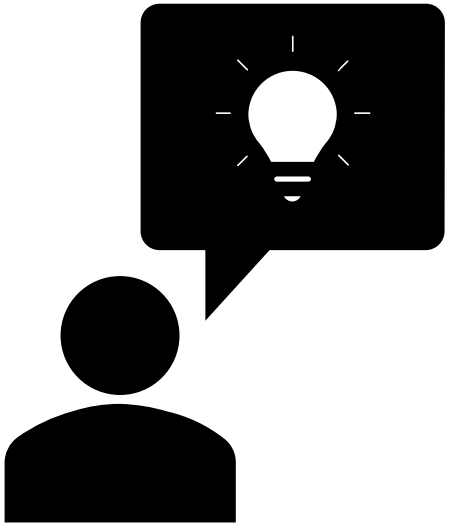
Different interactive features:

- **Events** - input interaction (such as a click)
- **Controls** - applied to a control (maybe a button) or element on your display
- **Functions** - the resulting operation that is performed (e.g. filter the data)

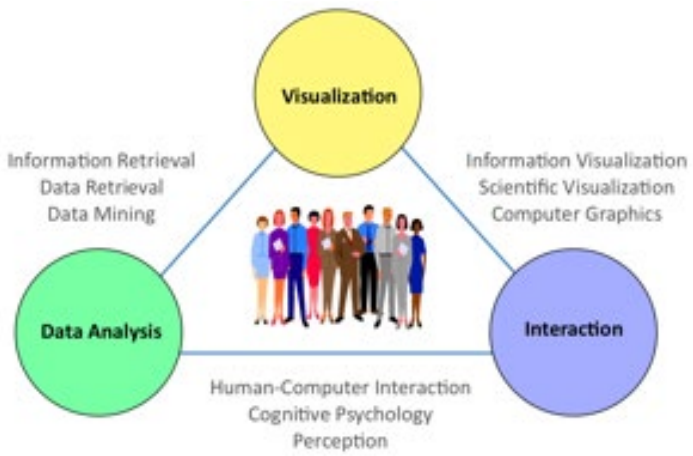


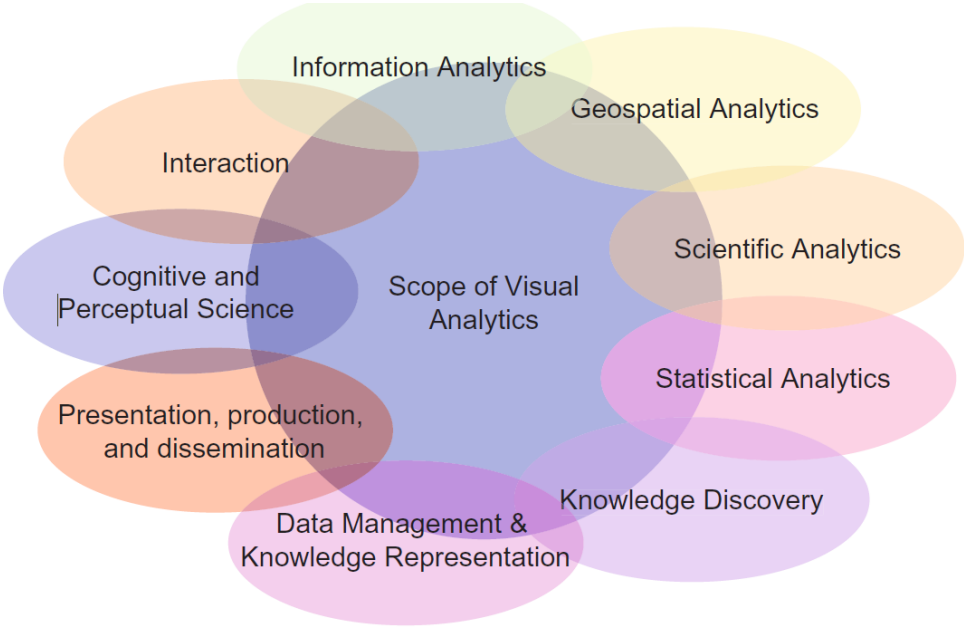
VISUAL ANALYTICS

- "Combines automated analysis techniques with interactive visualisations for effective understanding, reasoning, and decision making on the basis of very large and complex data sets" (Keim et al, 2008)
- "Visual analytics combines automatic and visual analysis methods with **human interactive** exploration." (Keim et al, 2008)



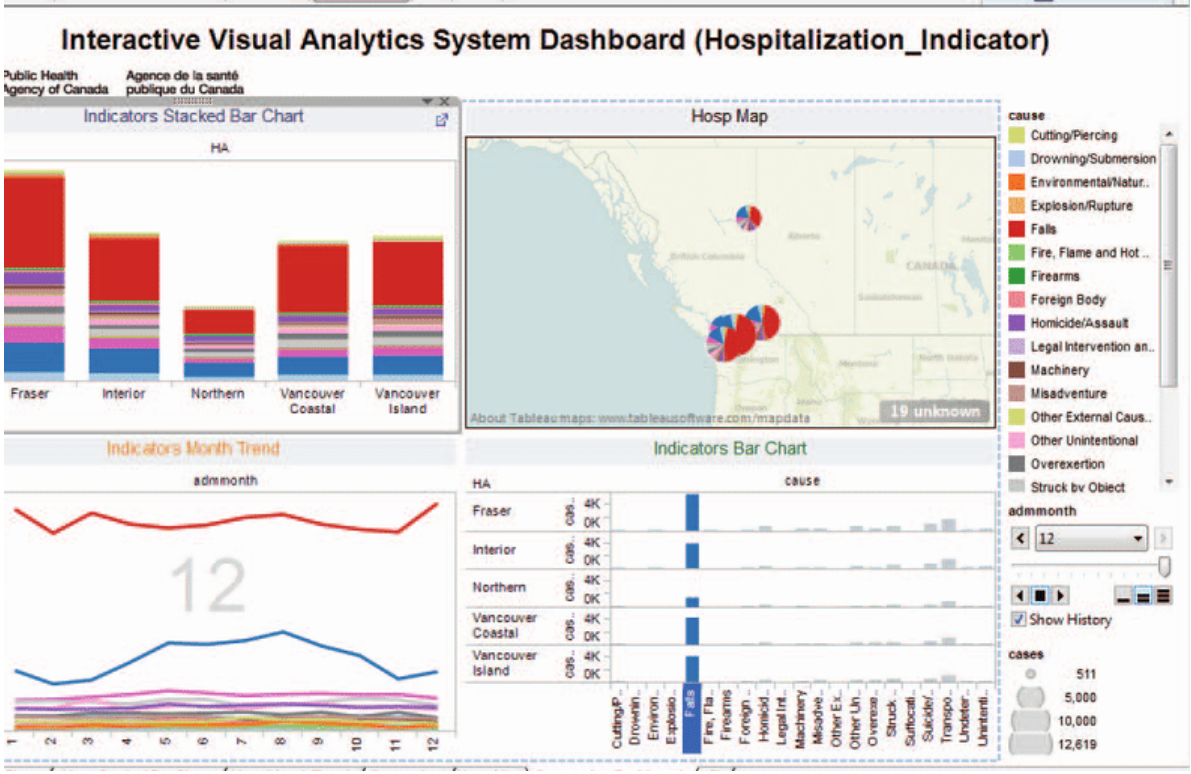
Visual Analytics

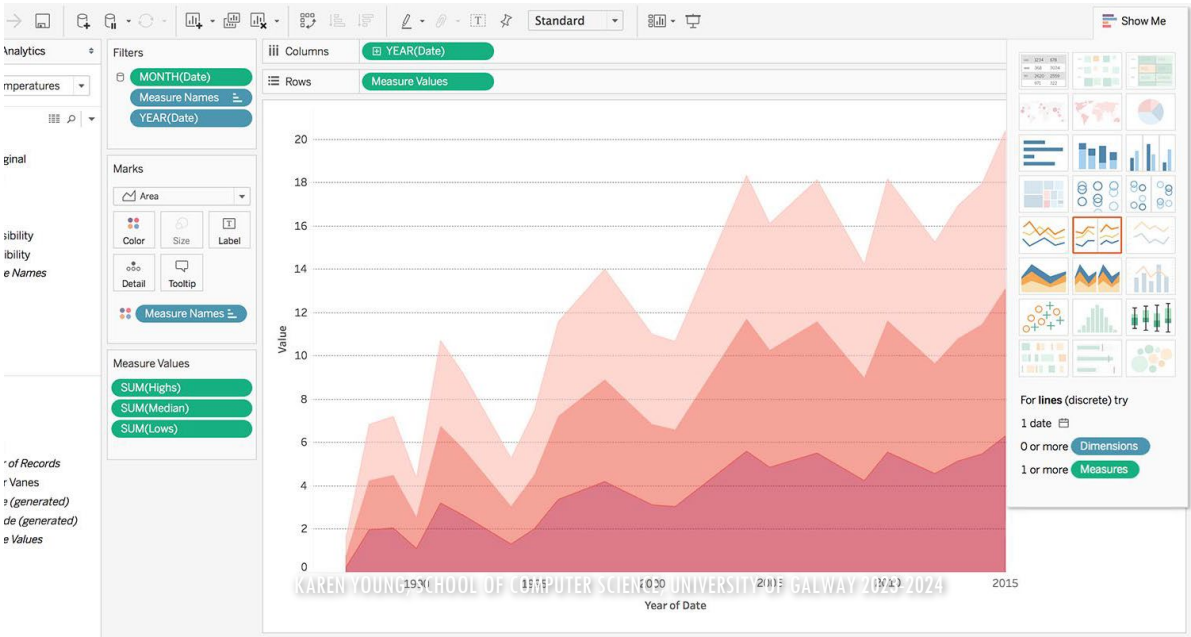




https://visual-analytics.eu/faq/

VISUAL ANALYTICS: WHAT TO SHOW?





Dashboard Examples

3. UNDERSTANDING: SENSEMAKING, STORYTELLING

UNDERSTANDING?

Figure it Out: Getting from information to understanding (Anderson & Fast):

- Foraging: Locating resources that will lead to understanding
- Tuning: Adjusting resources to align with desired understanding
- Externalizing: Moving resources out of the head and into the world
- Constructing: Forming new knowledge structures in the world

FORAGING

Foraging happens anytime we need information from the world, in any form, to accomplish a task:

- Searching: To look for, or locate the position of, resources in the world
- Probing: To acquire more detailed information from the world
- Animating: To initiate, and optionally, control motion in a resource
- Collecting: To gather resources for future use

TUNING

Tuning happens whenever you adapt a resource to your own needs

- Cloning: To create an identical copy of a resource
- Collecting: To gather resources for future use
- Cutting: To remove unwanted resources
- Filtering: To expose, conceal, or transform parts of a resource that have certain characteristic

EXTERNALISING

The point of externalizing, as an interaction, is to add information to the world:

- Annotating: To add useful markings and meta-information to a resource
- Linking: To establish relationships between resources
- Generating: To create new information structures in the world

CONSTRUCTING KNOWLEDGE

Constructing is how we assemble new shapes, using the information at hand to fashion meaningful structure

- Chunking: To group independent yet related resources into a unified structure
- Composing: To create a new resource by assembling other resources into a meaningful structure
- Fragmenting:To dismantle a resource into its component parts
- Rearranging: To alter the position of a resource or the elements within
- Repicturing: To convert a resource from one form, or shape, into another.

HOW TO SUPPORT SENSEMAKING?

"Algorithmic thinking uses artificial intelligence to break things down so they can be analyzed. Sensemaking—using "human intelligence to develop a sensitivity toward meaningful differences—what matters to other people as well as ourselves," connects things and puts them in context."

(Madjsberg, 2017)

HOW TO SUPPORT SENSEMAKING?

- Sensemaking activities: not pre-defined, goals formed during ongoing discourse between the user and the information
- Interaction: Dynamic, Engagement
- Interaction design decisions influence goal formation, task performance and ultimate performance

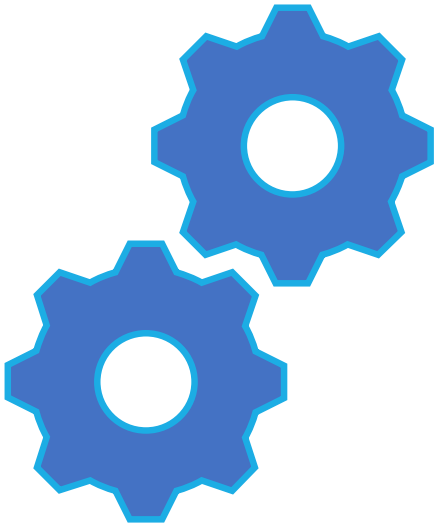
INFORMATION VISUALIZATION TOOLS

KAREN YOUNG, SCHOOL OF COMPUTER SCIENCE, UNIVERSITY OF GALWAY 2023-2024

PROGRAMMING LANGUAGES

- Advantages: Complete control, usually free
- Disadvantages: Learning Curve

- Examples:
  - D3.js
  - R
  - Python Processing

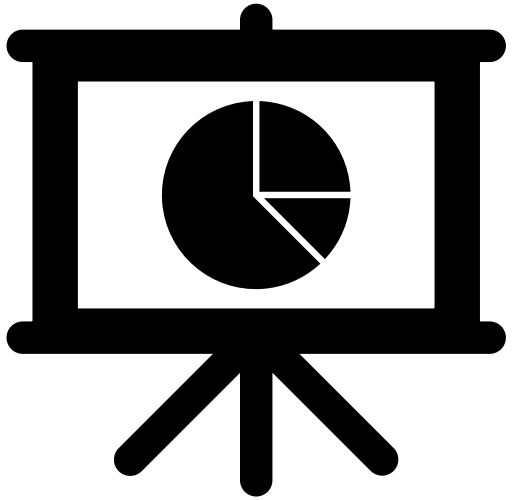


D3.JS

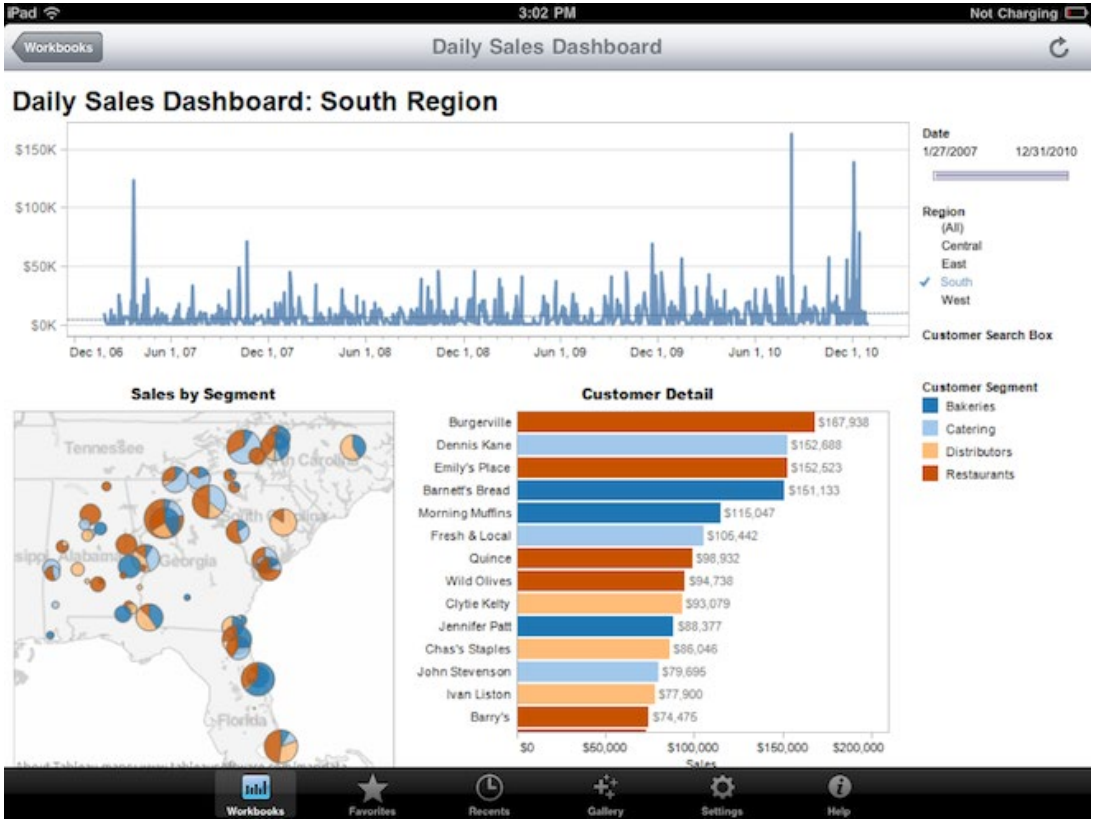

Box Plots
Bubble Chart
Bullet Charts
Calendar View
Non-contiguous Cartogram
Chord Diagram
Dendrogram
Force-Directed Graph
Circle Packing
Population Pyramid
2000
Stacked Bars
Streamgraph

SOFTWARE PACKAGES

- Advantages: Easy to use, predetermined charts
- Disadvantages: Less control, potentially expensive (though a number offer free basic versions or academic licenses)
- Examples:
  - Tableau
  - Microsoft BI
  - Qlik
  - PlotLy



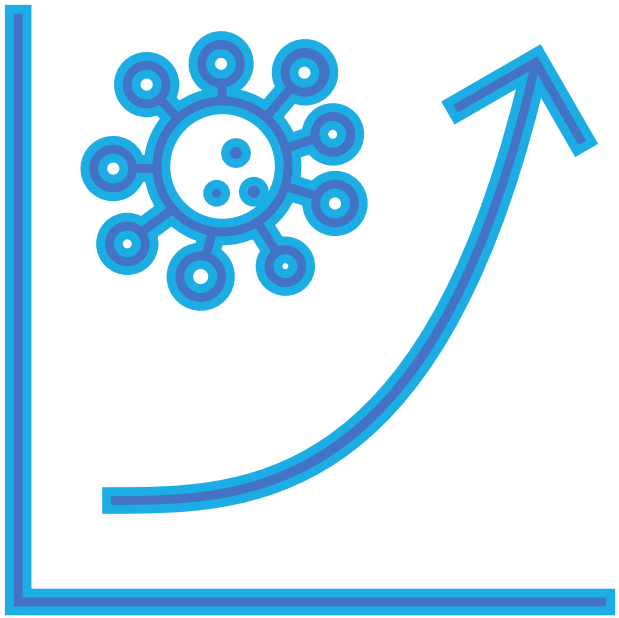
TABLEAU


iPad
3:02 PM
Not Charging
Workbooks
Daily Sales Dashboard
Daily Sales Dashboard: South Region
$150K
$100K
$50K
$0K
Dec 1, 06
Jun 1, 07
Dec 1, 07
Jun 1, 08
Dec 1, 08
Jun 1, 09
Dec 1, 09
Jun 1, 10
Dec 1, 10
Date
1/27/2007
12/31/2010
Region
(All)
Central
East
South
West
Customer Search Box
Sales by Segment
Tennessee
Georgia
Florida
Customer Detail
Burgerville $167,938
Dennis Kane $152,688
Emily's Place $152,523
Barnett's Bread $151,133
Morning Muffins $115,047
Fresh & Local $106,442
Quince $98,932
Wild Olives $94,738
Clytie Kelty $93,079
Jennifer Patt $88,377
Chas's Staples $86,046
John Stevenson $79,695
Ivan Liston $77,900
Barry's $74,475
$0
$50,000
$100,000
$150,000
$200,000
Sales
Customer Segment
Bakeries
Catering
Distributors
Restaurants
Workbooks
Favorites
Recents
Gallery
Settings
Help

INFORMATION VISUALISATION: PROCESS

Information Visualisation Process:
("Introduction to Information Visualization" Riccardo Mazza)

1. Define the **problem**
2. Define the **data** to be represented: quantitative, ordinal (intrinsic order), categorical
3. Define the **dimensions** required to represent the data: dependent variables against independent variables:
    - Univariate: single dependent variable
    - Bivariate: two dependent variables
    - Trivariate: three dependent variables
    - Multivariate: more than three dependent variables



INFORMATION VISUALISATION

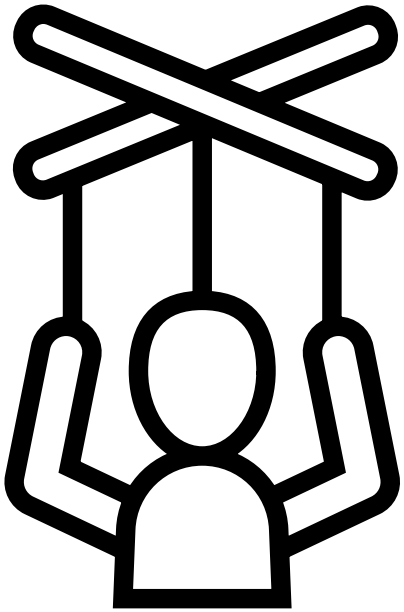
4. Define the structures of the data: how datasets relate to each other: linear, temporal, spatial, hierarchical, networked

5. Define the interaction required from the visualization:

Static models: "as is", e.g. maps in a Road Atlas

Transformable models: user can transform/modify data

Manipulable models: user has control over the generation of views, zooming in/out, rotating etc.



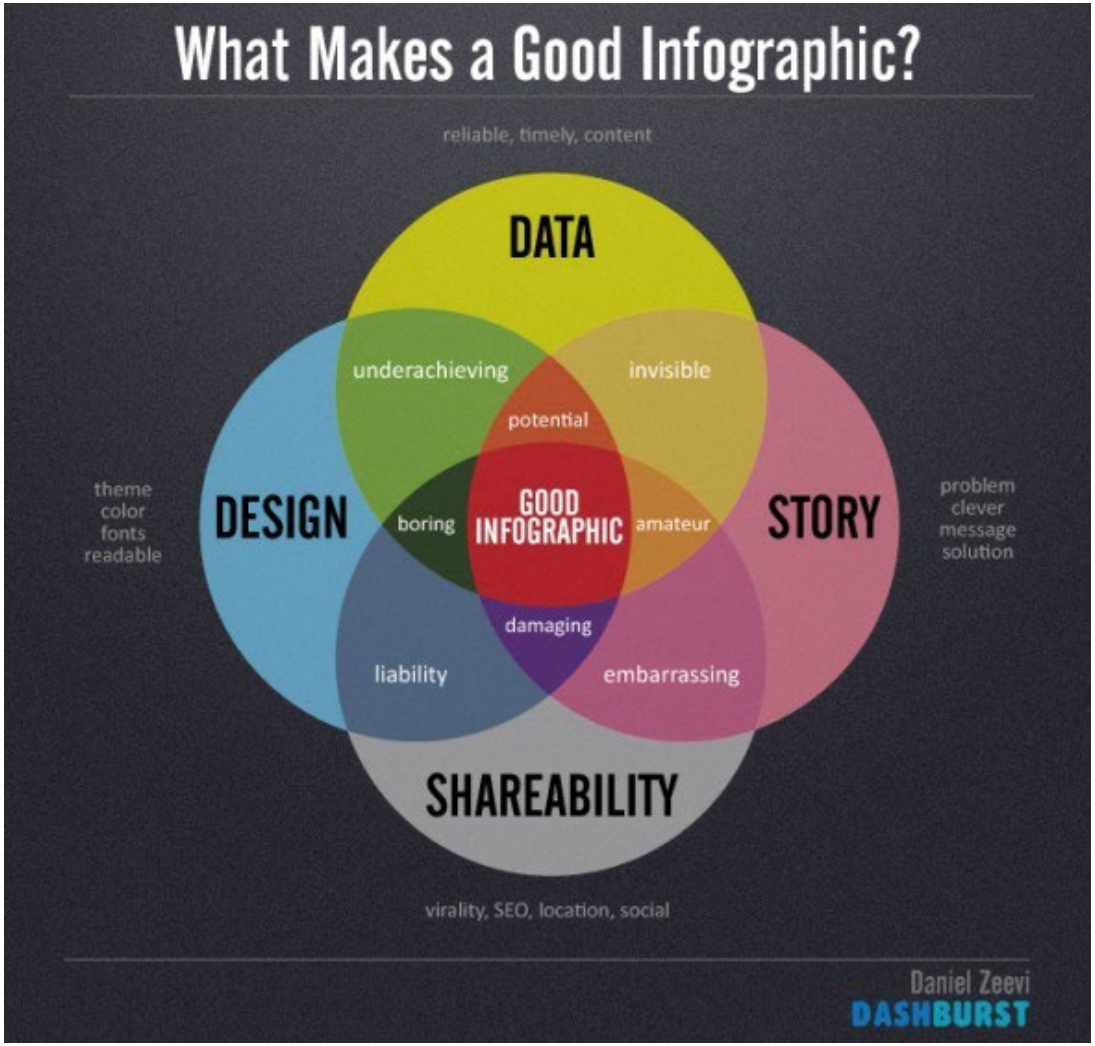
INFORMATION VISUALISATION

Good Visualisation is always about **compromise**

Good Visualisation is always about **good decisions**: you need to be familiar with all your options (things you could do) and aware of the things that will influence your choices (things you will do)

Examples? Elections; Covid-19?

INFORMATION VISUALISATION



HCI: LECTURE 9 REVIEW

- DESIGN THINKING 4: PROTOTYPE (Information Design)
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- LECTURE 10: Evaluation