

08 Data Visualisation - human vision

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Today

Choosing Charts Recap

Human visual processing

Perception

Attention

Sometimes a “chart” is not even needed!

In our recent technology workshop
42% identified as female
and 57%* as male.
*1% declined to answer

Gender balance of workshop participants
12th July 2019

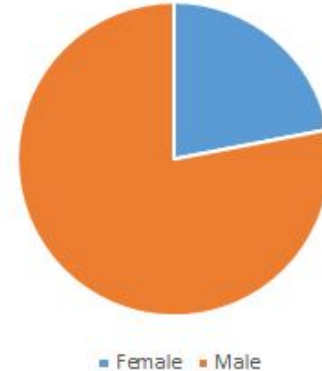


Chart types

Categorical: comparing categories and distributions of quantitative values

Hierarchical: Charting part-to-whole relationships and hierarchies

Relational: Graphing relationships to explore correlations and connections

Temporal: Showing trends and activities over time

Spatial: Mapping spatial patterns through overlays and distortions

CHRTS - the classic examples ([full list](#))

Categorical - Bar chart

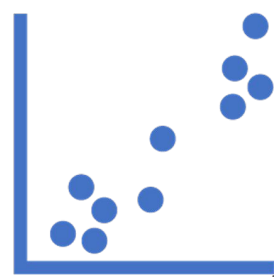
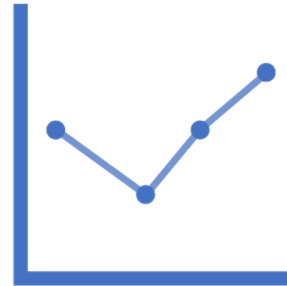
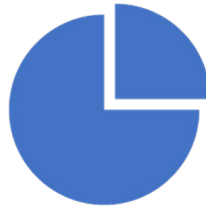
Hierarchical - Pie chart

Relational - Scatterplot

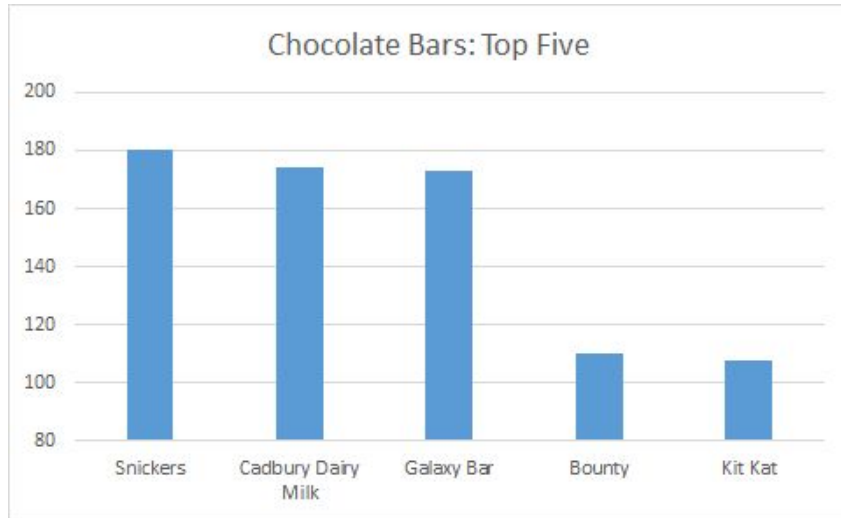
Temporal - Line chart

Spatial - Maps

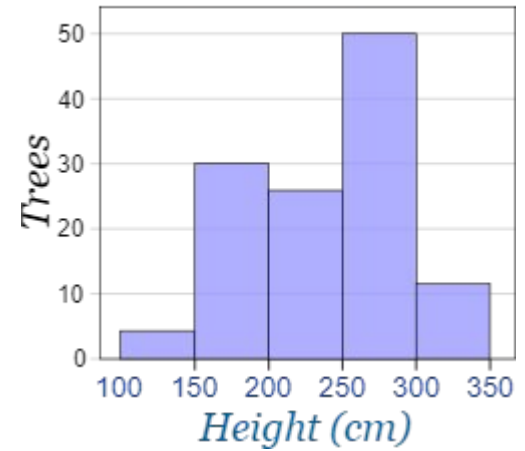
“There’s a strand of the data viz world that argues everything could be a bar chart. That’s possibly true but also possibly a world without joy.” Amanda Cox, Editor, The Upshot



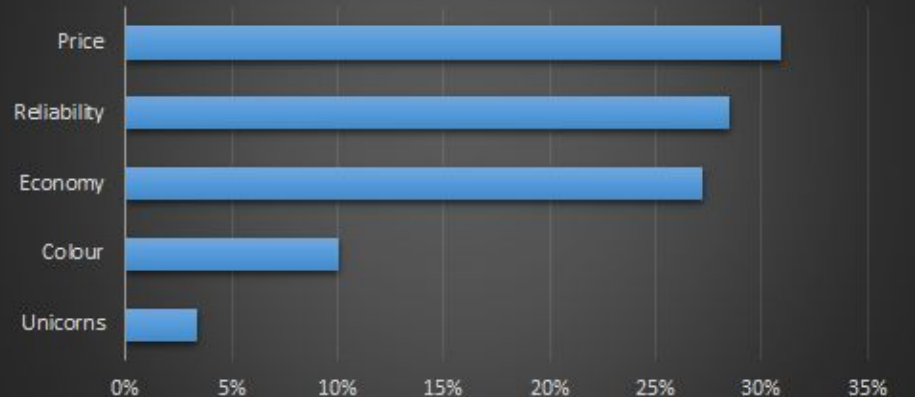
Bar chart or Histogram?



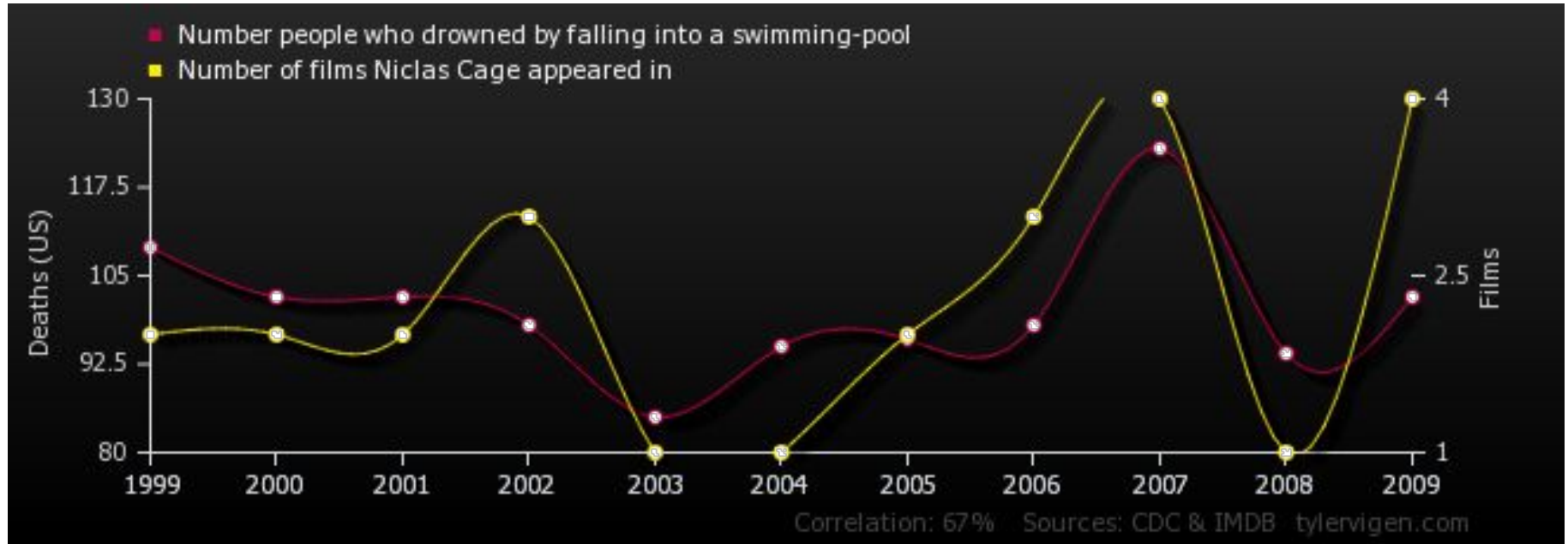
Tree Heights



Reasons for purchasing a particular car



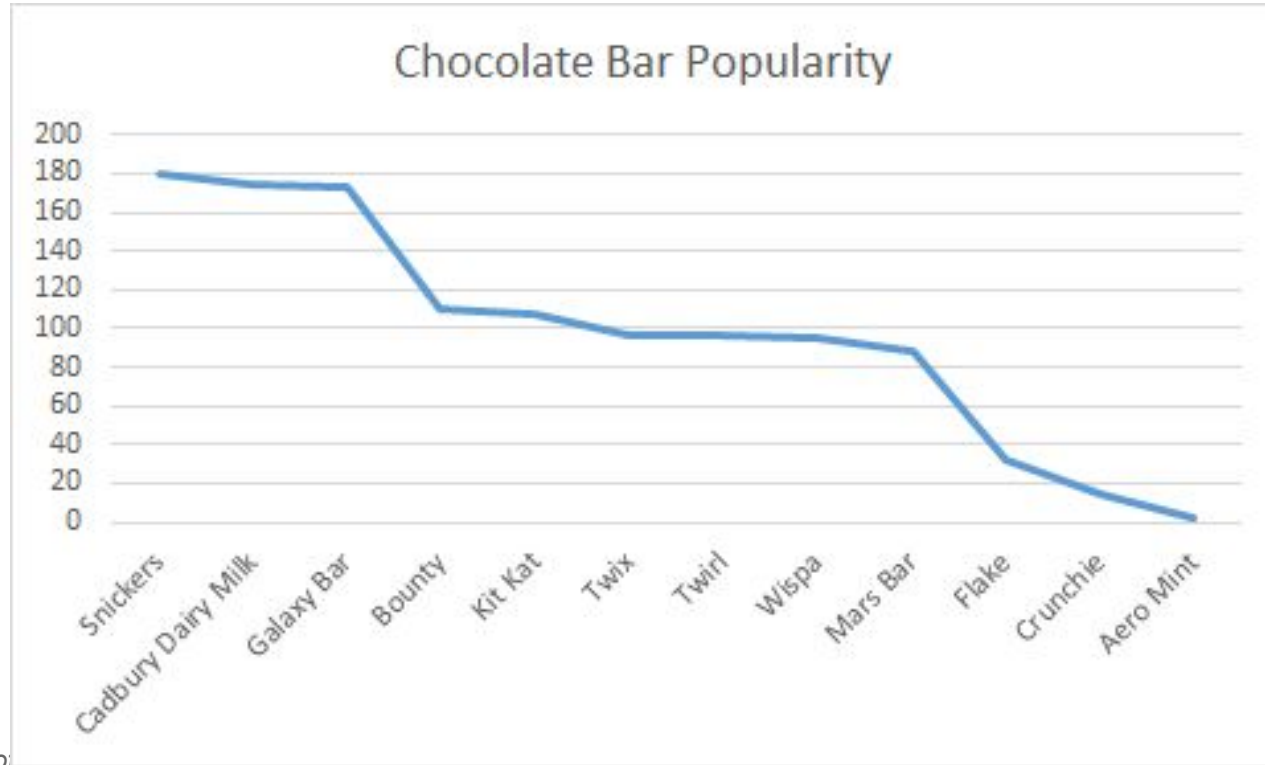
Beware of spurious correlations!



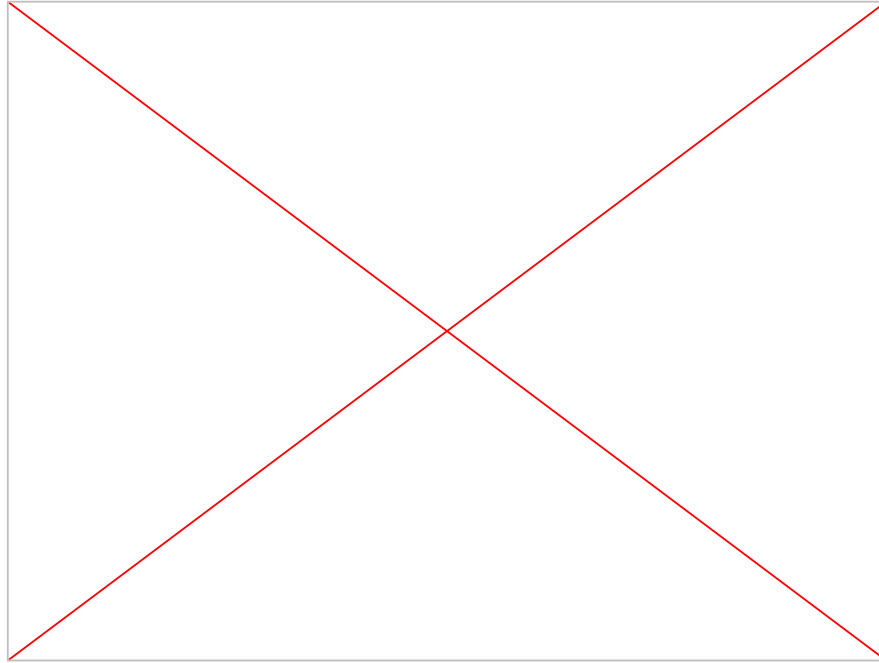
<https://tylervigen.com/old-version.html>

Temporal - Line charts

Be careful that the attribute on the x-axis is connected!



Another risk of spatial maps ...



<https://www.fastcompany.com/90572489/u-s-election-maps-are-wildly-misleading-so-this-designer-fixed-them>

Tools for Visualisation?



Excel/Google sheets

Photoshop/GIMP

Powerpoint

Tableau

PowerBI

Qlikview

R - ggplot

Pandas .plot()

Python - matplotlib, seaborn,
bokeh

Plot.ly

D3.js & other javascript libraries

[Overview of Python Visualisation Libraries \(with example notebooks\)](#)

Tools to create visualisations

- Programming languages
 - Document discussing Python Libraries on Loop
- Dedicated tools (many!)
 - Tableau - <https://www.tableau.com/academic/students>
- Web-based, interactive options like D3.js and other Javascript libraries

Visualisation Assignment -- feedback and questions

Remember only 1 graph! 😭

If your dataset is from kaggle it might already be simplified and clean so you won't have the opportunity to show your data integration and processing skills 😞

Especially if you use Tableau or PowerBI (or similar) make sure you think about the design choices (graph type, colour, layout, labels, etc) so you can explain to me why they are good ones.

Assignment due **November 29th** via upload to loop (report, document with link to video (google drive or DCU youtube), code/config files).

Today

~~Choosing Charts~~

Human visual processing

Perception

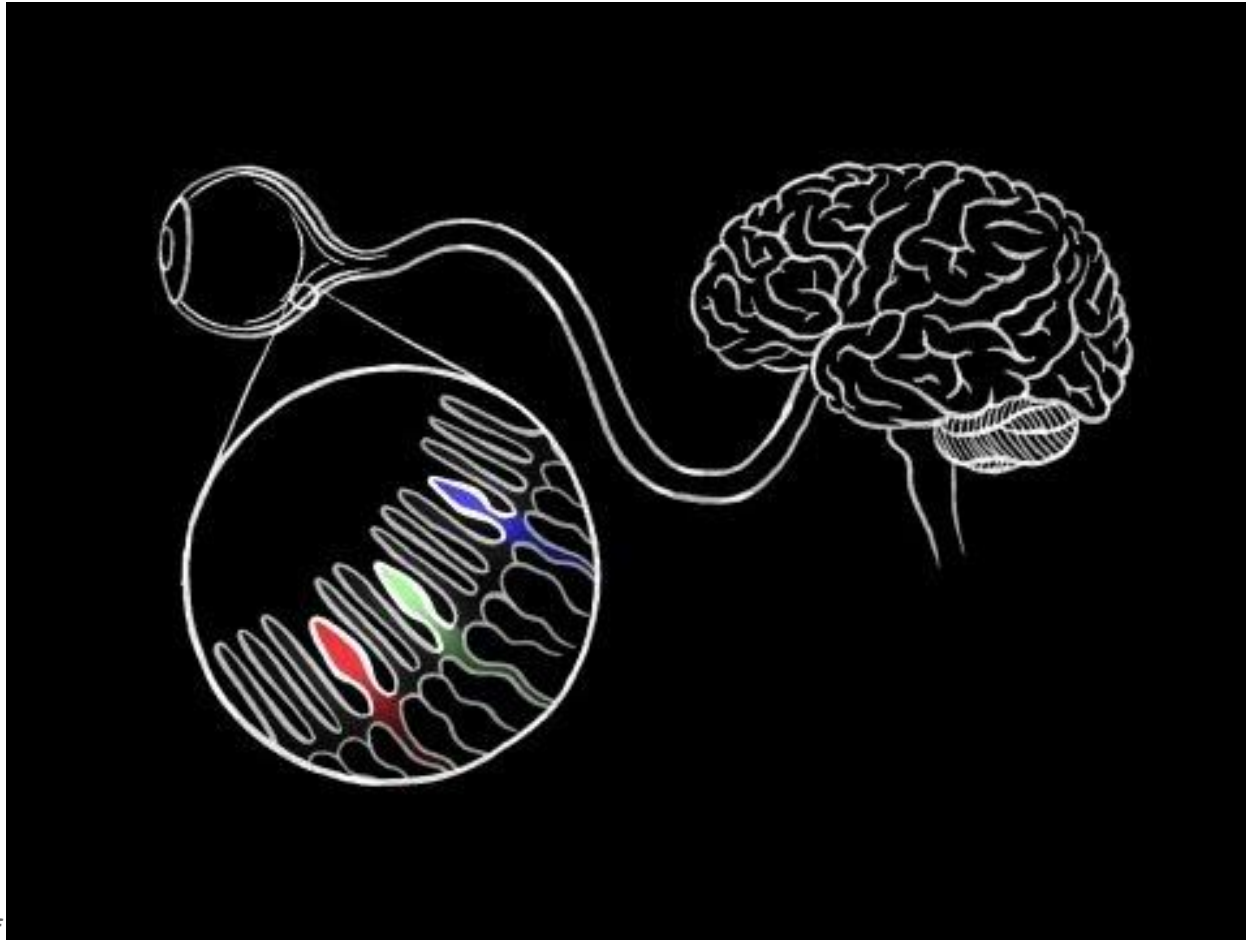
Attention

Graphic Communication: Stages of Understanding

- Sensing → your brain seeing colours and shapes
- Perceiving → what does it show? big, small, bright, red,
- Interpreting → what does it mean? increasing, smaller, good, bad
- Comprehending → what does it mean **to me**? relevance, consequences



How we see colour - https://www.youtube.com/watch?v=l8_fZPHasdo



How we see

Light enters through Lens to focus on Retina

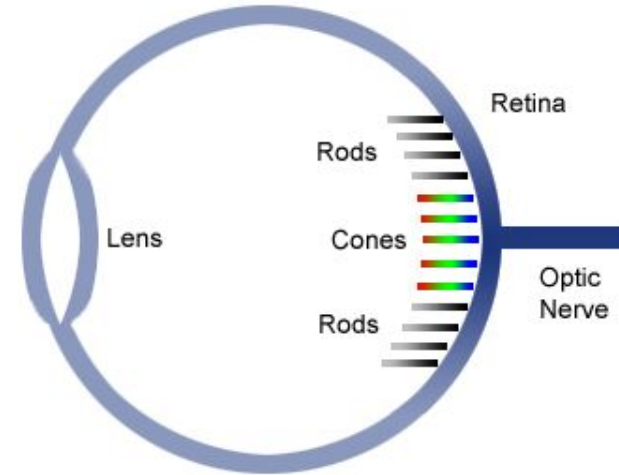
(Lens actually inverts the image!)

Triggers nerve impulses

Rods = low light; B&W; peripheral, movement

Cones = colour; 3 types: RGB

Processed in visual cortex (back of brain)



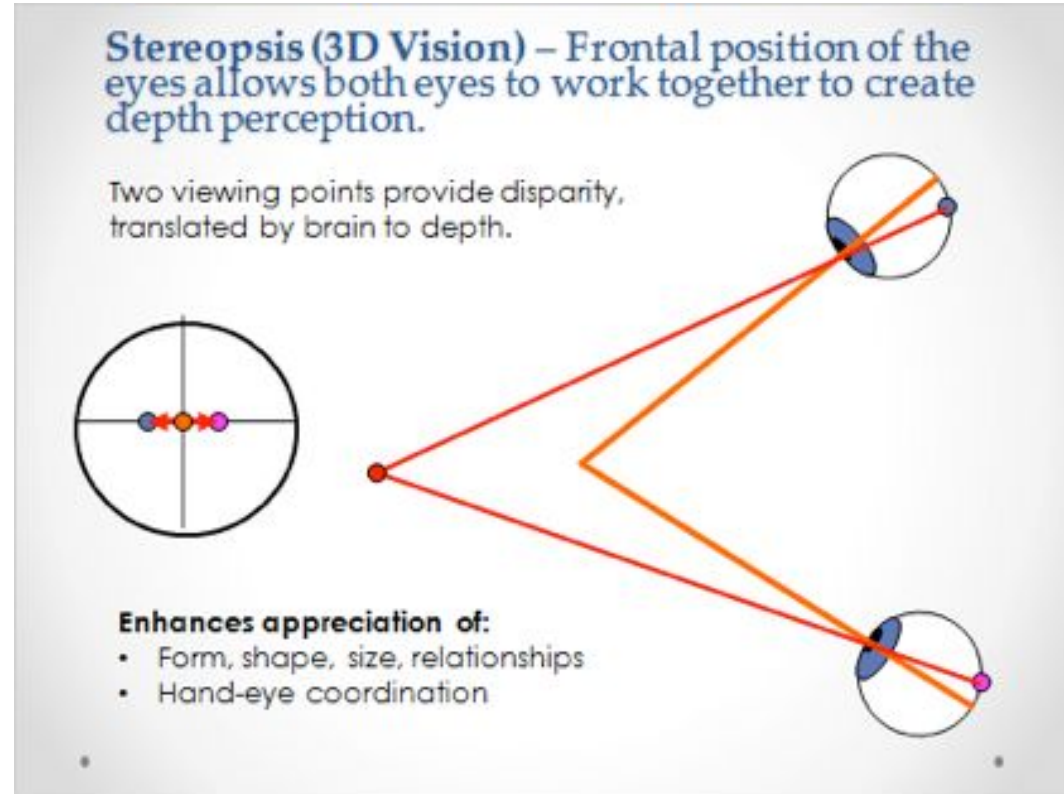
How we see

Binocular vision

Depth perception due to two different images (L & R)

Useful for hand-eye coordination

Other important cues for depth ...





Depth Cues - Binocular Vision

Most important cue is **Binocular Disparity** (or the binocular parallax)

Images sensed by our two eyes are slightly different and this difference is used to determine depth

Exploiting this gives 3D movies - 1 eye sees the red while the other sees the blue due to lens filters. Or use polarised lens for the same effect.

Also **Convergence** - the difference in direction of our eyes when looking at closer objects (slightly pointing inwards)

<http://sciencelearn.org.nz/Contexts/Light-and-Sight/Sci-Media/Video/How-we-see-3D>

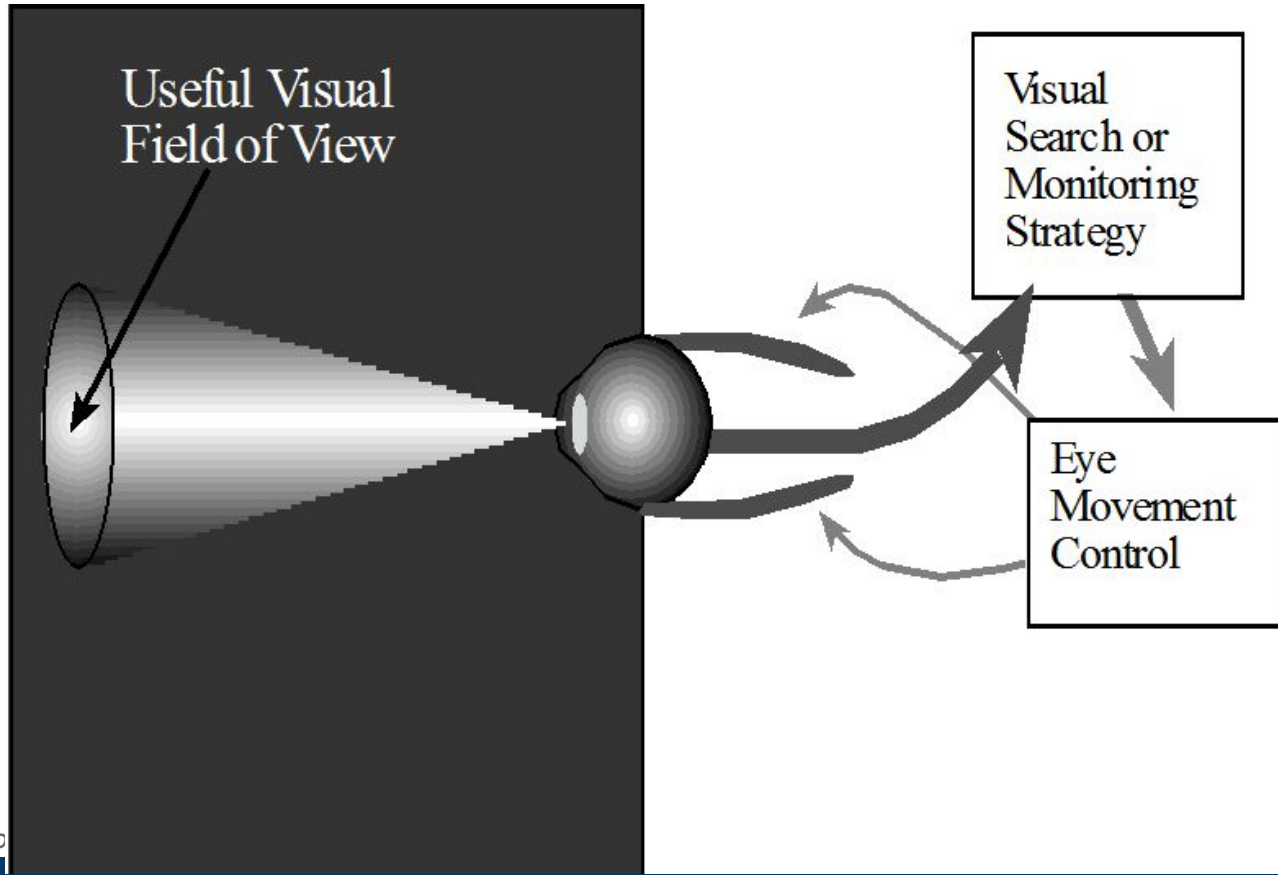
Depth Cues - Monocular

Can still perceive depth with one eye

- **Occlusion** – the blocking of more distant objects by closer objects (overlapping)
- **Relative size** – when viewing an object of known size (e.g., people) the brain compares the sensed size to the known size to estimate the distance of the object
- **Aerial haze** (texture) – object on the far horizon (e.g., mountains) look hazy due to particles in the air
- **Accommodation** – tension of the muscle that changes the focal length of the lens of the eye (weak cue)
- **Motion parallax** – similar to binocular parallax, by moving the head slightly the differences in the sensed images (even from 1 eye) can be used to judge depth.

<http://www.eruptingmind.com/depth-perception-cues-other-forms-of-perception/>


Attention - Searchlight model



Attention - Searchlight properties

- Searchlight Size varies with
 - Data density
 - Stress level (distraction, motivation)
- Attention operators work within searchlight beam
- Attention = Tunable Filter
- Eye movements 3/sec – series of saccades*
- **Popout** effects (general attention)
- Segmentation effects (dividing up the visual field)
 - Guide Attention

*a rapid movement of the eye between fixation points

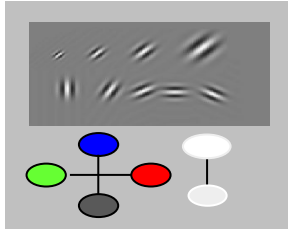


How many passes does the team in white make?

Parallel Processes

Feature extraction:

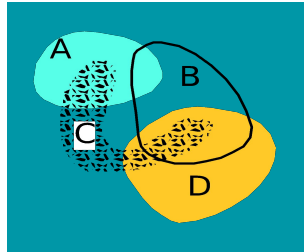
- Orientation
- Texture
- Colour
- Motion



Detection: Edges, Regions, 2D shape

Transitory state

Bottom-up, data driven



Serial Processes

Object recognition: visual attention & memory important.

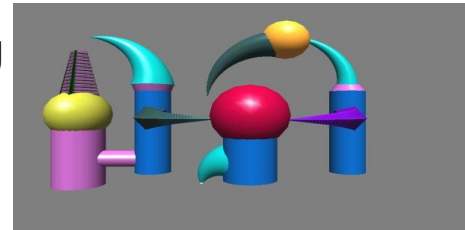
Uses both short-term memory and long-term memory

Short-term memory (chunking):

$$7 \pm 2 = 5 \text{ to } 9 \text{ Objects}$$

More emphasis on symbols

Top-down processing



Pre-attentive processing

Some visual properties detected very rapidly

< 200-250ms

When designing visualisations these features/properties are:

immediately perceived

can mislead the viewer

How many '2's?

035219248730515
708029135238051
337920714842415
119665329034538

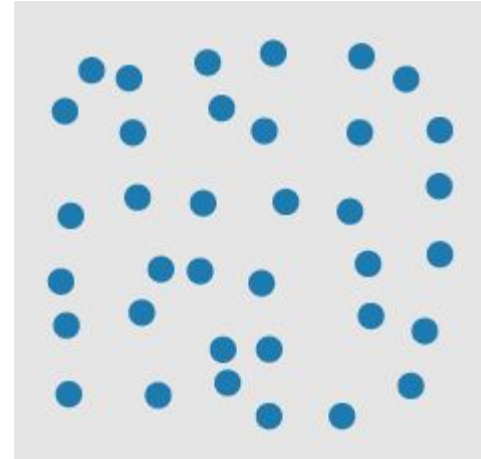
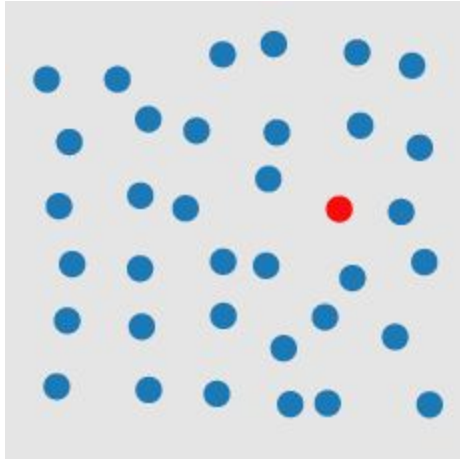
How many '8's?

035219248730515
708029135238051
337920714842415
119665329034538

Pre-attentive processing - Colour

Target (red circle)

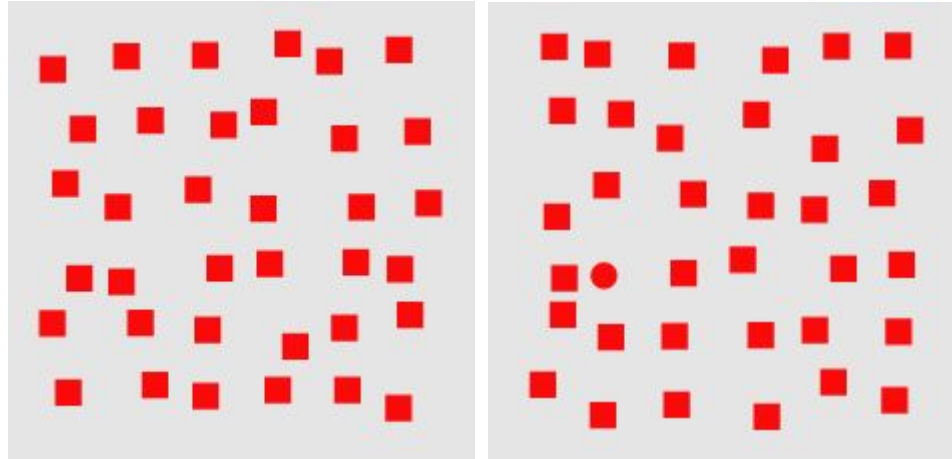
Distractors (blue circles)



Pre-attentive processing - Shape

Target (red circle)

Distractors (red squares)

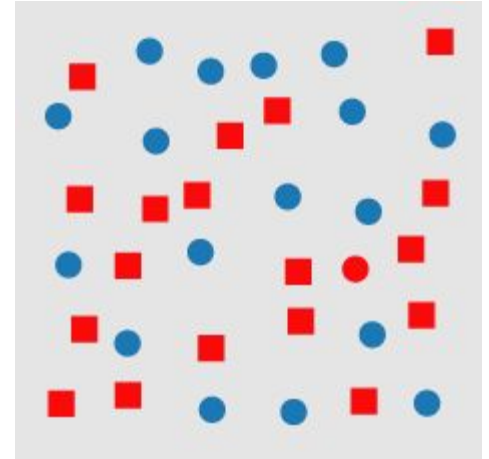
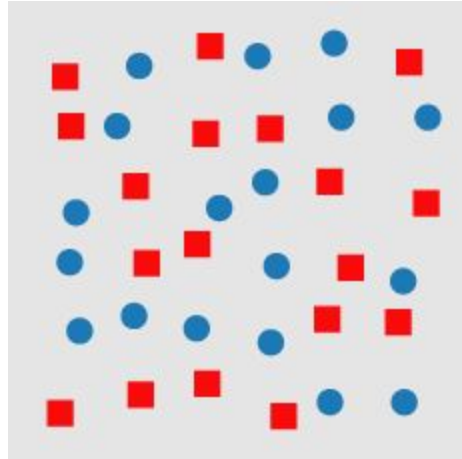


Pre-attentive processing - Conjunction Target

Cannot be detected
pre-attentively!

Target (red circle)

Distractors (blue circles & red
squares)



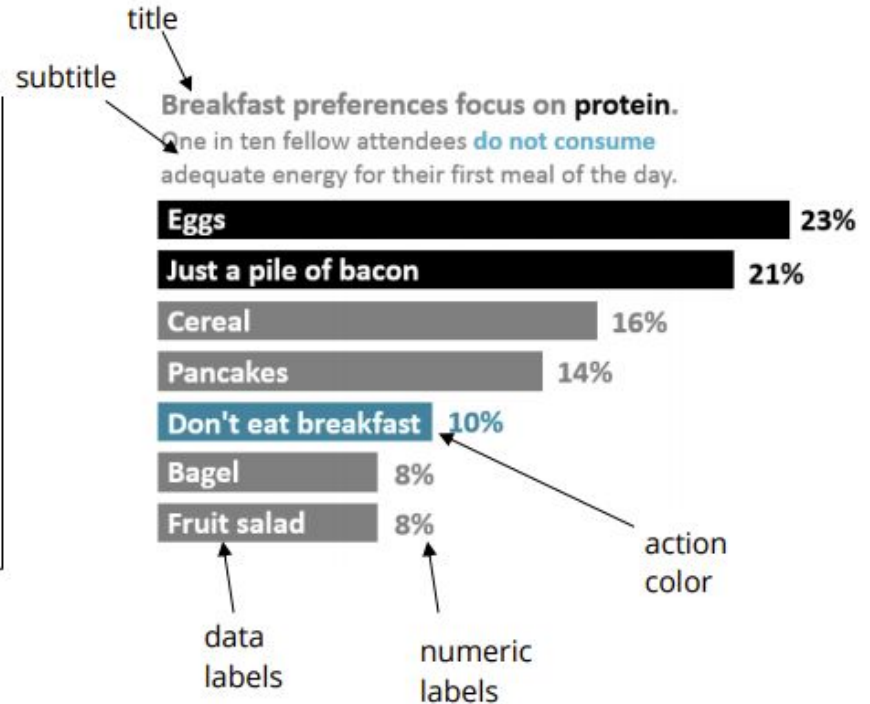
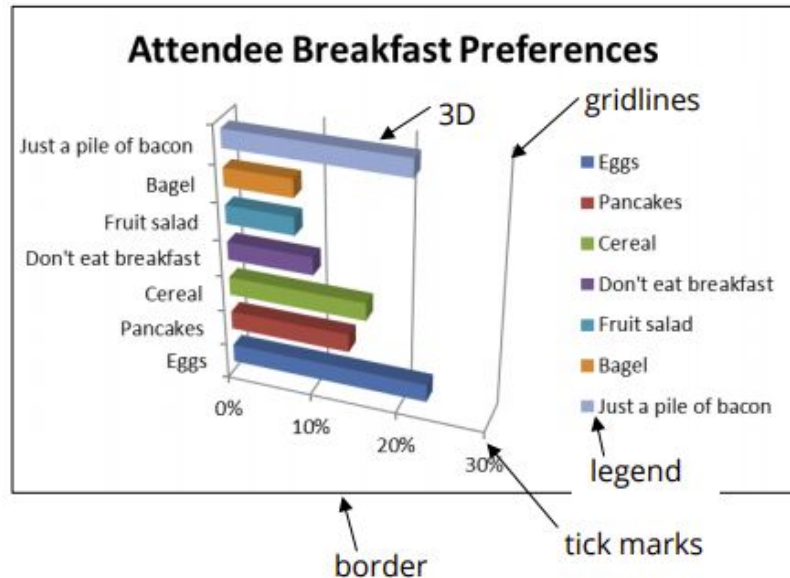
Use Pre-attentive Processing

Target must stand out in simple dimension

- Color
- Simple Shape = orientation, size
- Motion
- Depth



Using pre-attentive features



<http://stephanieevergreen.com/updated-data-visualization-checklist/>

2016 Berlin Marathon

<https://interaktiv.morgenpost.de/berlin-marathon-2016/>

References

How we see:

<http://sciencelearn.org.nz/Contexts/Light-and-Sight/Sci-Media/Video/How-the-eye-works>

In-depth Perception: <http://www.csc.ncsu.edu/faculty/healey/PP/index.html>

Pre-attentive processing: https://infovis-wiki.net/wiki/Preattentive_processing

Depth cues:

http://www.hitl.washington.edu/projects/knowledge_base/virtual-worlds/EVE/III.A.1.c.DepthCues.html

Today's Labs

Finish the Python Visualisation Libraries activity and the “[Notebook: Create a graph using Python](#)”

Revision quiz on deconstructing a graph on loop

Complete the replicate a graph exercise and upload your result to loop

Work on your visualisation assignment

Activate your [Tableau student license](#) (if interested)