

6.874, 6.802, 20.390, 20.490, HST.506

Computational Systems Biology

Deep Learning in the Life Sciences

Lecture 22

How to write, visualize, present

Prof. Manolis Kellis

Slides/content credit:

- Kellis Lab meetings
- Part 1: Simon Peyton Jones, Microsoft Research
- Part 2: Aiora Zabala UK cancer research
- Part 3: Tony Eng, MIT 6.UAT



Massachusetts
Institute of
Technology

<http://mit6874.github.io>

How to write, visualize, present

1. Paper writing and organization: conveying

- Write-first, single key idea, narrative, sharing, feedback
- Readers first: intuition, examples, results-first, take-home
- Simple direct language, active voice, explain, be understood

2. Figures: displaying information visually

- Visual legends, axes:measure-vs-unit/reuse, minimize ink
- Elements: marks/channels; figure types; group/order/simpl
- Typography; composition/layout

3. Delivering impactful oral presentations

- Importance of conveying: sharing makes work alive, point
- Speak clearly: posture/voice/rhetoric/contact/flow/creativ
- Planning: storyboarding, signposts, recovery
- Convincing: rhetoric, ethos/pathos/logos, prepare/natural
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Key ideas

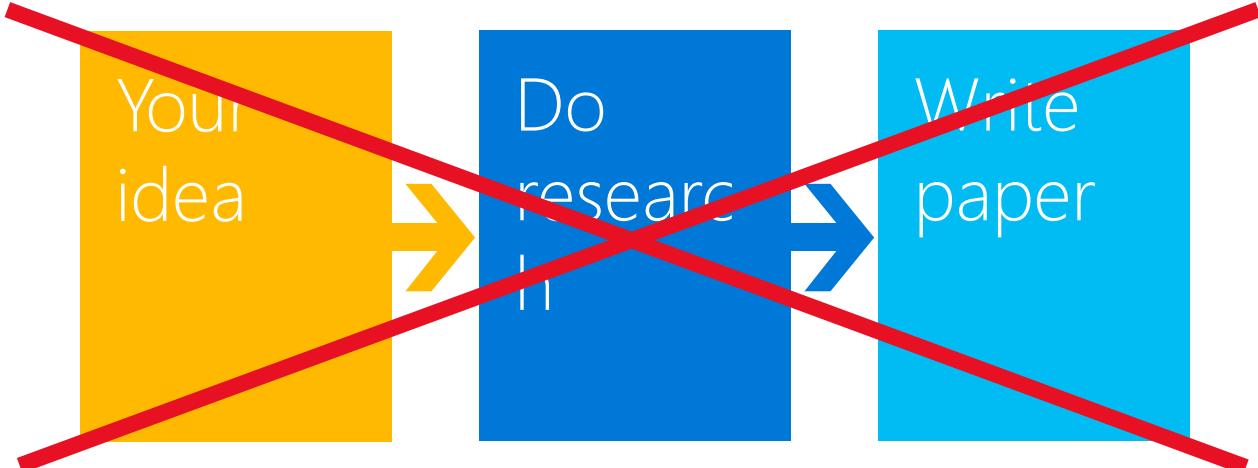
1. Don't wait: write
2. Identify your key idea
3. Tell a story
4. Focus on results/take-home
5. Nail your contributions
6. Related work: later
7. Put your readers first (examples)
8. Listen to your readers

From:

www.microsoft.com/research/people/simonpj

1. When to write:

→ early!



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Forces us to be clear, focused
Crystallises what we don't understand
Opens the way to dialogue with others: reality check, critique, and collaboration

- **Writing papers: mechanism for doing research (not just reporting research)**

2. The idea

Idea:

A re-usable insight,
useful to the reader

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- Your paper should have just one “ping”: one clear, sharp idea
- You may not know exactly what the ping is when you start writing; but you must know when you finish
- If you have lots of ideas, write lots of papers
- Many papers contain good ideas, but do not distil what they are.
- Make certain that the reader is in no doubt what the idea is. Be 100% explicit:
 - “The main idea of this paper is....”
 - “In this section we present the main contribution(s) of the paper.”

3. Flow / Narrative

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Whiteboard:

1. Problem
2. It's interesting
3. It's unsolved
4. Here is my idea
5. My idea works (details, data)
6. Here's how my idea compares to other people's approaches

Paper:

1. Title (1000 readers)
2. Abstract (4 sentences, 100 readers)
3. Introduction (1 page, 100 readers)
4. The problem (1 page, 10 readers)
5. My idea (2 pages, 10 readers)
6. The details (5 pages, 3 readers)
7. Why it's better than related work
8. Conclusions and further work (0.5 pages)

4. Focus on results/ take- home

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- Most students are taught to write with:
1. Question: *We next asked whether...*
 2. Methods: *To do this, we gathered data...*
 3. More methods: *We aligned it, analysed it...*
 4. More methods: *We plotted, found, validated*
 5. Result: *Yes, it worked* or *No, it didn't really work*
 6. Conclusion: *So we're not sure it was worth it* or *And thus, the meaning of life is ...*

Instead, start every paragraph with the last se

1. Question: *We next found that the meaning of life is to love thy neighbour and thy purpose...*
2. Methods: *To do this, we gathered data...*
3. More methods: *We aligned it, analysed it...*
4. More methods: *We plotted, found, validated*
5. Result: *Yes, it worked* or *No, it didn't really work*
6. Conclusion: [no need, move on]

Advantage: start with message, get their attention, if they care, provide all the details in the main text, and additional details in the methods & supplement

4. Focus on results/ take- home

5 **Partitioning multifactorial traits and trait combinations into their tissues and pathways of action**
6 We used the number of distinct tissue categories enriched in each trait (**Fig. 4a; Supp. Data S1**) to
7 distinguish 303 ‘unifactorial’ traits (56%) with most enriched nodes in only one tissue group (e.g. QT
8 interval in heart, educational attainment in brain, hypothyroidism in immune cells), indicating a more
9 constrained set of biological processes involved (**Fig. 6a**). Another 146 ‘multifactorial’ traits (27%) were
10 enriched on average in 5 different tissue categories indicating multiple modes of action, including:
11 Alzheimer’s disease (AD) in both immune and brain tissues^{50,51}; waist-to-hip ratio (adjusted for BMI)⁵² in
12 adipose, muscle, kidney, and digestive tissues; and healthspan in ES, T cells, adipose, and digestive
13 tissues. A subset of 92 ‘polyfactorial’ traits (17%) implicated an average of 14 tissue categories each
14 (**Fig. 6c**), including coronary artery disease (CAD)⁵³ with 19 different tissue groups, including liver,
15 heart, adipose, muscle, and endocrine samples.

16 We next used the enriched tissues of multifactorial traits to partition their associated SNPs into
17 (potentially-overlapping) sub-groups, which were enriched in distinct biological pathways, thus revealing
18 distinct processes through which multifactorial traits may act (**Fig. 6d, Supp. Fig. S29**). For example,
19 339 CAD-associated SNPs in enriched enhancers partitioned into: 212 SNPs in heart enhancers that
20 preferentially localized near artery, cardiac, and vessel morphogenesis genes; 121 SNPs in endocrine
21 enhancers, which enriched in lipid homeostasis; 122 SNPs in adipose enhancers, which enriched in
22 axon guidance/extension and focal adhesion, consistent with adipose tissue innervation processes; 169
23 SNPs in liver enhancers, which enriched in cholesterol/lipid metabolism and transport; and 112 SNPs in
24 ES-derived muscle cells, which enriched in septum morphogenesis, cardiac chamber and aorta
25 development.

26 This partitioning of genetic loci into tissues also helped inform the shared genetic risk between pairs of
27 co-enriched traits, by revealing the tissues that may underlie their common biological basis (**Fig. 6d**).
28 For example, the same partitioning of CAD loci showed that CAD loci in heart, muscle, and endothelial
29 enhancers were preferentially also associated with high blood pressure and atrial fibrillation risk loci.
30 However, CAD loci in liver and endocrine enhancers were instead associated with systolic blood
31 pressure⁵⁴. Similarly CAD loci also associated with waist-to-hip ratio^{52,54,55} overlapped adipose but not
32 liver, endocrine, or heart enhancers, and CAD loci associated with HDL cholesterol⁵⁶ overlapped liver,
33 adipose, and endocrine enhancer but not heart tissues.

7. Intuition is paramount!

- Explain it as if you were speaking to someone using a whiteboard
 - Conveying the intuition is primary, not secondary
 - Once your reader has the intuition, she can follow the details (but not vice versa)
 - Even if she skips the details, she still takes away something valuable
-
- Introduce the problem, and your idea, using EXAMPLES and only then present the general case

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7. Putting the reader first

- Do not recapitulate your personal journey of discovery. This route may be soaked with your blood, but that is not interesting to the reader.
- Instead, choose the most direct route to the idea.

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8. Get others to read your paper

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7. Put readers first (example)
8. Listen to your readers

- Experts are good
- Non-experts are also very good
- Each reader can only read your paper for the first time once! So use them carefully
- Explain carefully what you want ("I got lost here" is much more important than "Jarva is misspelt".)

Get your paper read by as many friendly folks as possible

8b. Getting expert help

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- A good plan: when you think you are done, send the draft to the competition saying “could you help me ensure that I describe your work fairly?”.
- Often they will respond with helpful critique (they are interested in the area)
- They are likely to be your referees anyway, so getting their comments or criticism up front is Jolly Good.

8c. Incorporate feedback

- Read every criticism as a positive suggestion for something you could explain more clearly
- DO NOT respond “you stupid person, I meant X”.
- INSTEAD: fix the paper so that X is apparent even to the stupidest reader.
- Thank them warmly. They have given up their time for you.

Use the active voice

The passive voice is “respectable” but it **deadens** your paper. Avoid it at all costs.

No!

It can be seen that...

34 tests were run

These properties were thought desirable

It might be thought that this would be a type error

Yes!

We can see that...

We ran 34 tests

We wanted to retain these properties

You might think this would be a type error

Use simple, direct language

No!

Yes!

The object under study was
displaced horizontally

On an annual basis

Endeavour to ascertain

It could be considered that
the speed of storage
reclamation left something
to be desired

The ball moved sideways

Yearly

Find out

The garbage collector was
really slow

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Labeling your axes

“Count”

- → Number of enhancers
- → Number of enhancers showing differential enrichment

“ $-\log_{10}$ P-value”

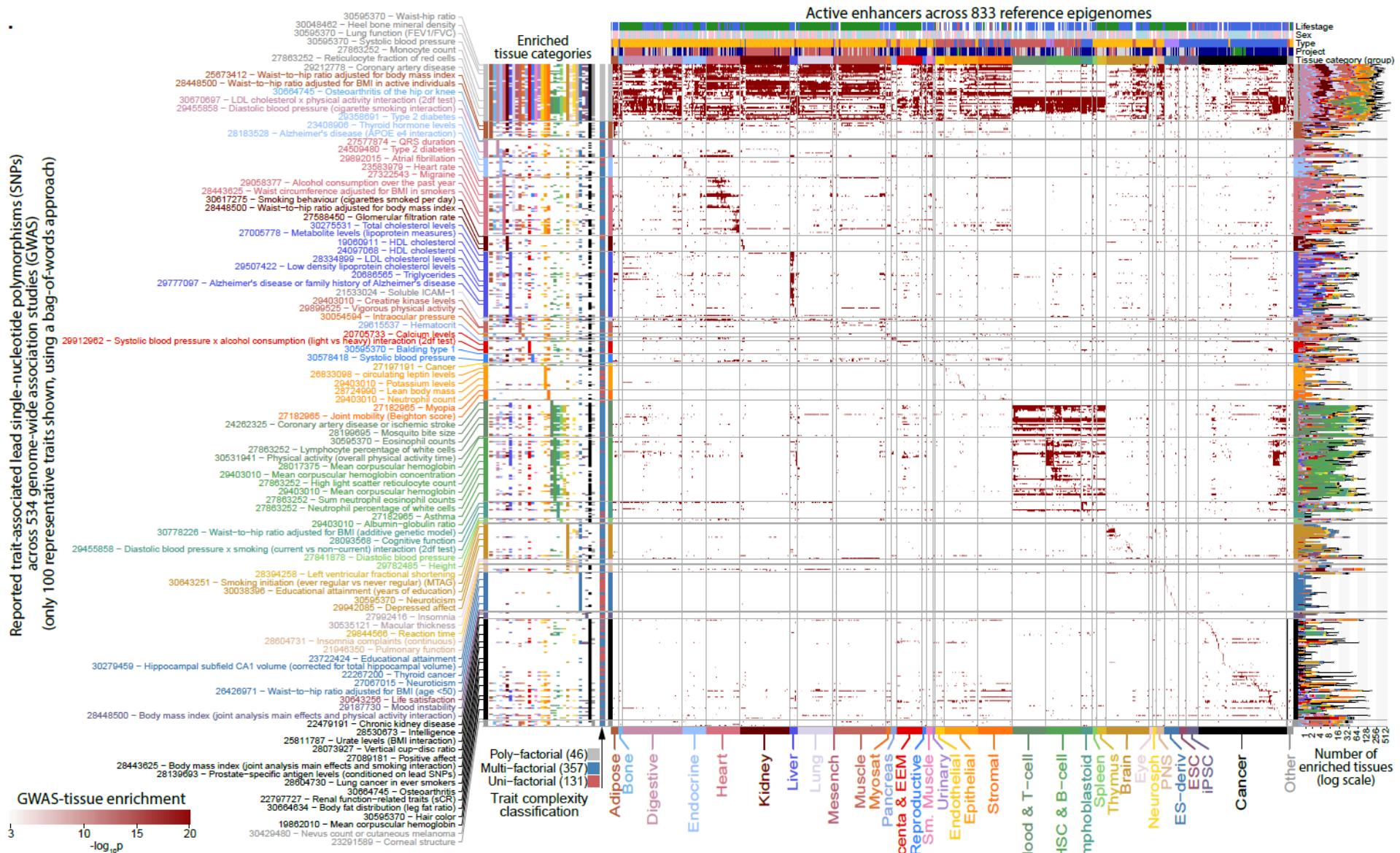
→ $-\log_{10}$ P-value (association is random)

→ T2D association

($-\log_{10}$ P-value)

Labeling your axes

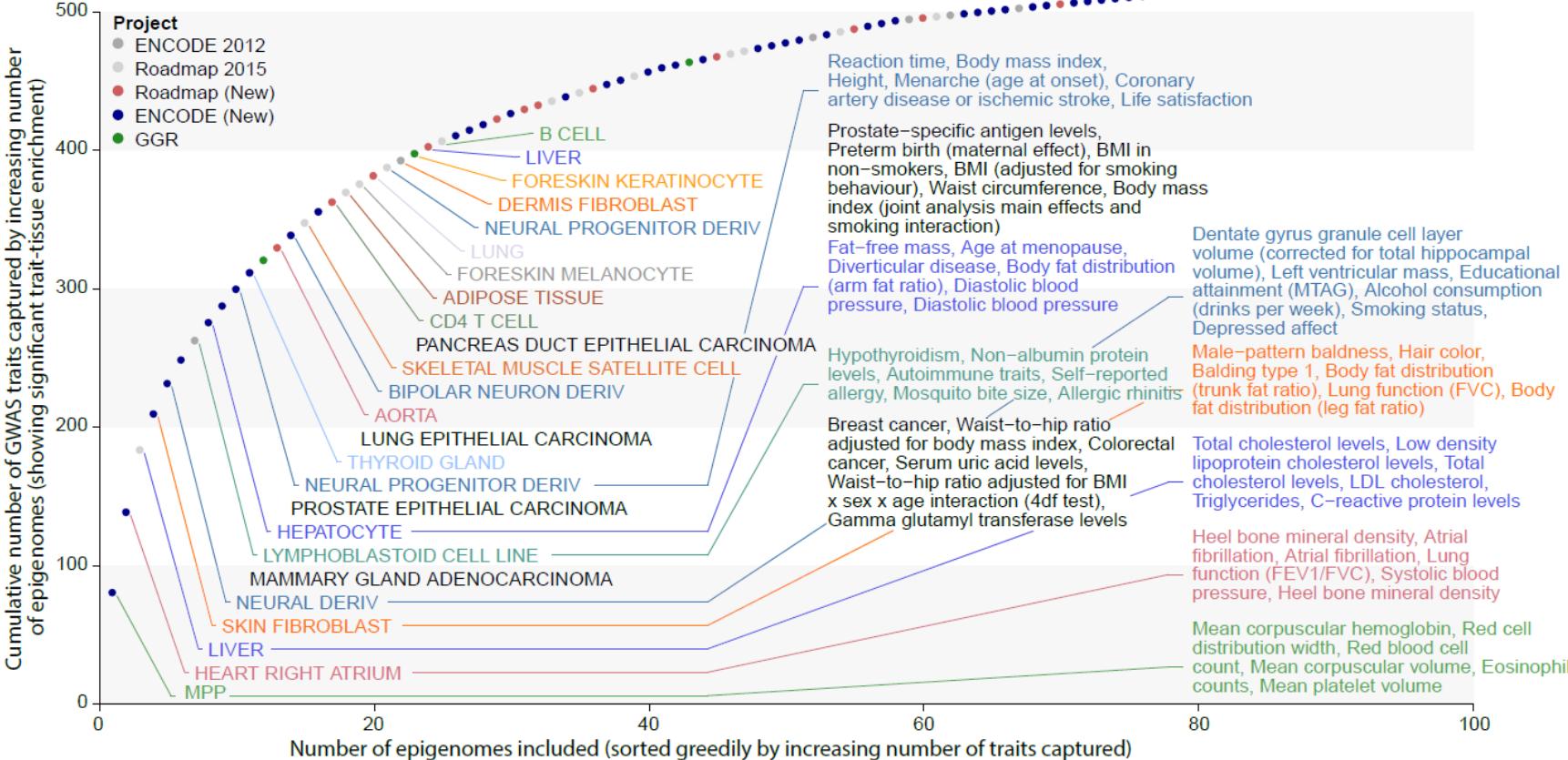
Reported trait-associated lead single-nucleotide polymorphisms (SNPs)
(only 100 representative traits shown, using a bag-of-words approach)



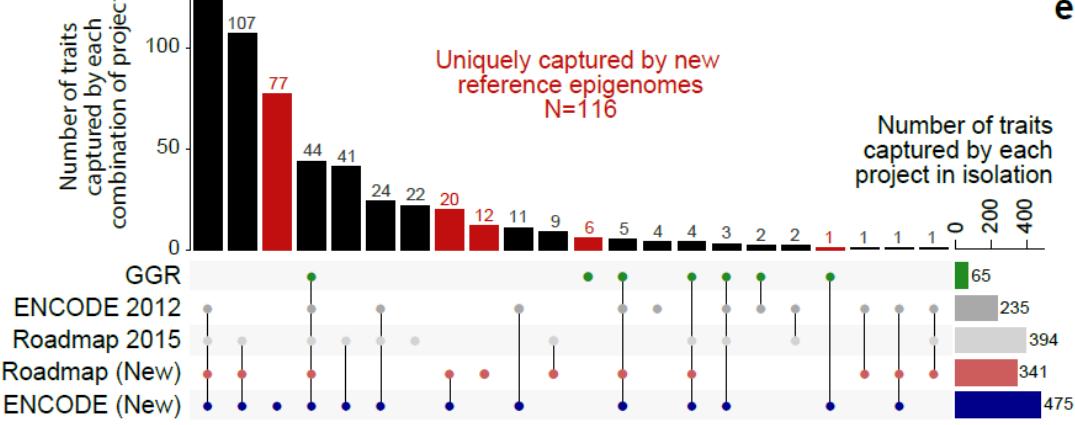
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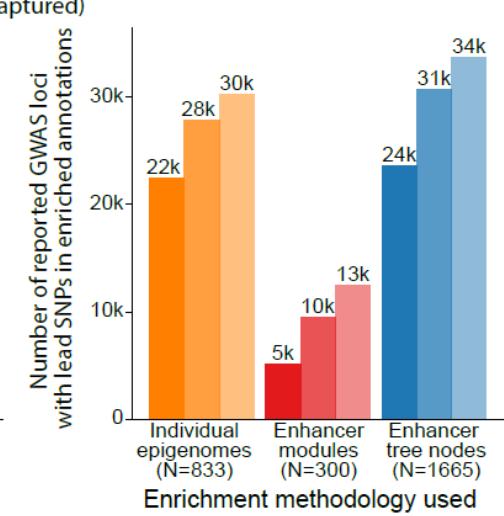
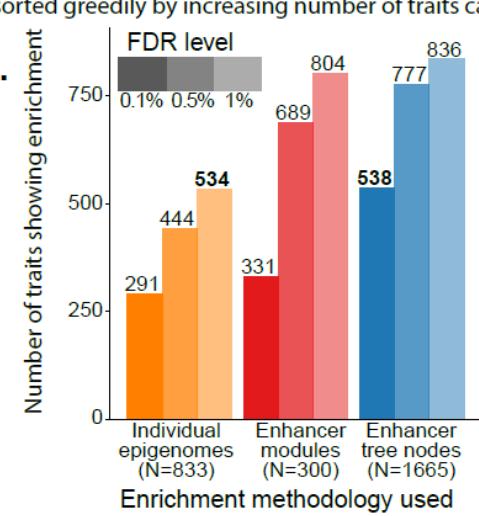
d.

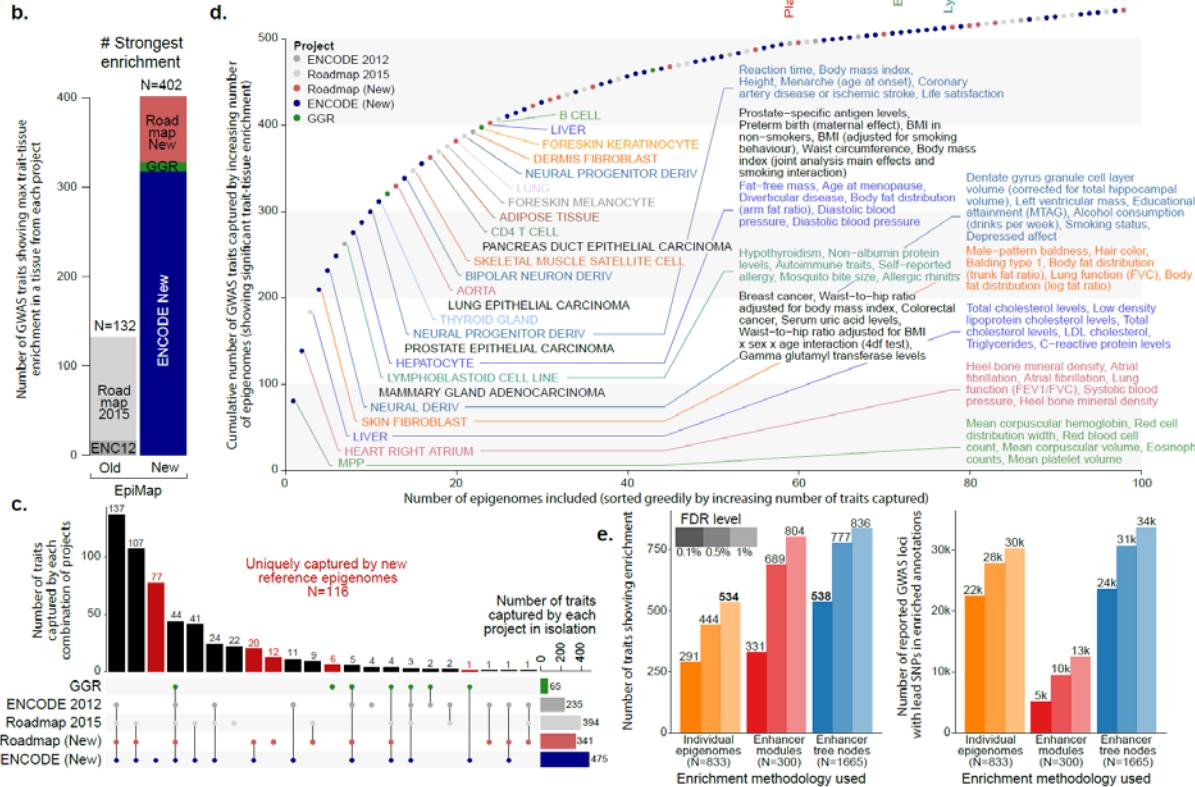


c.

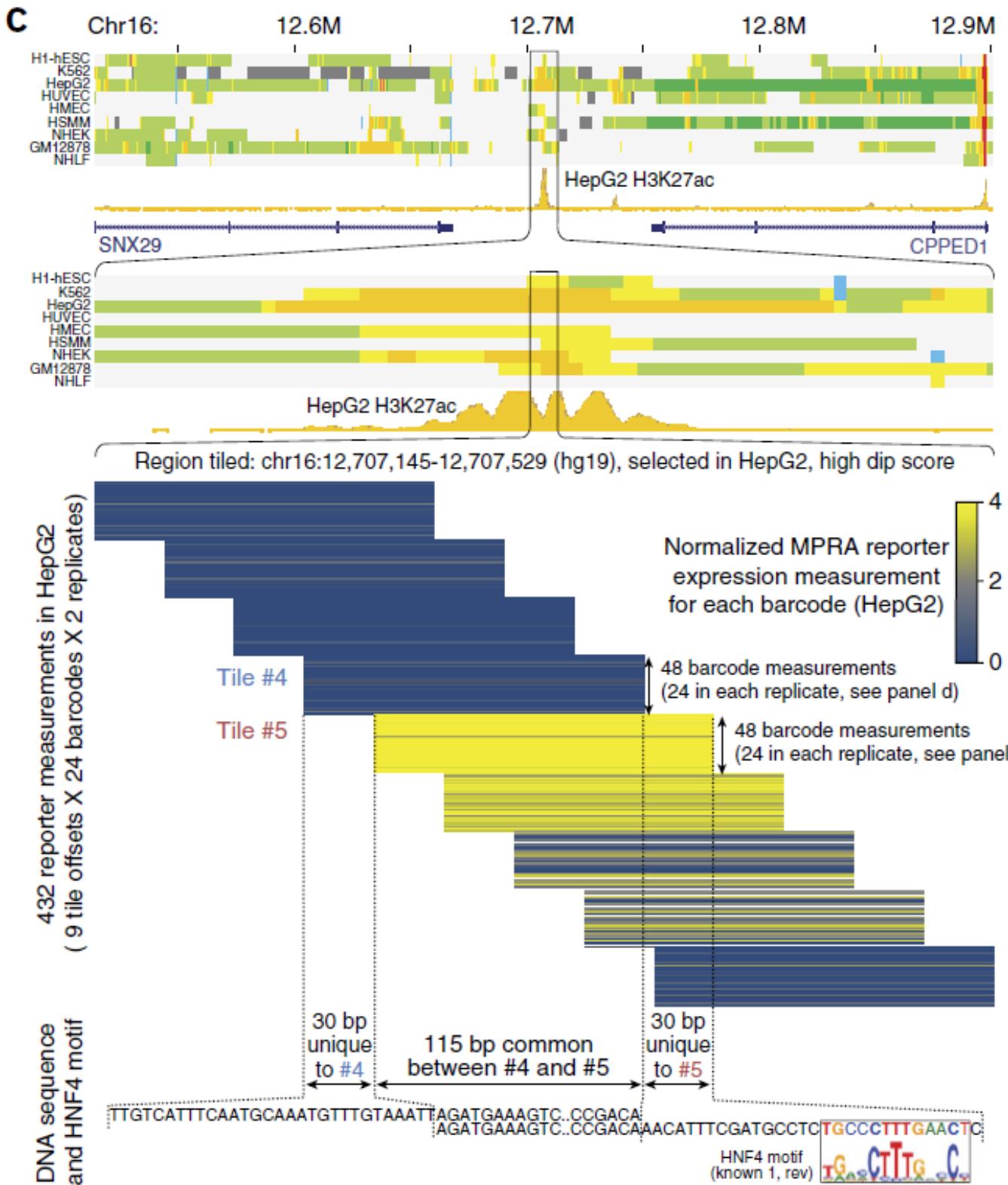


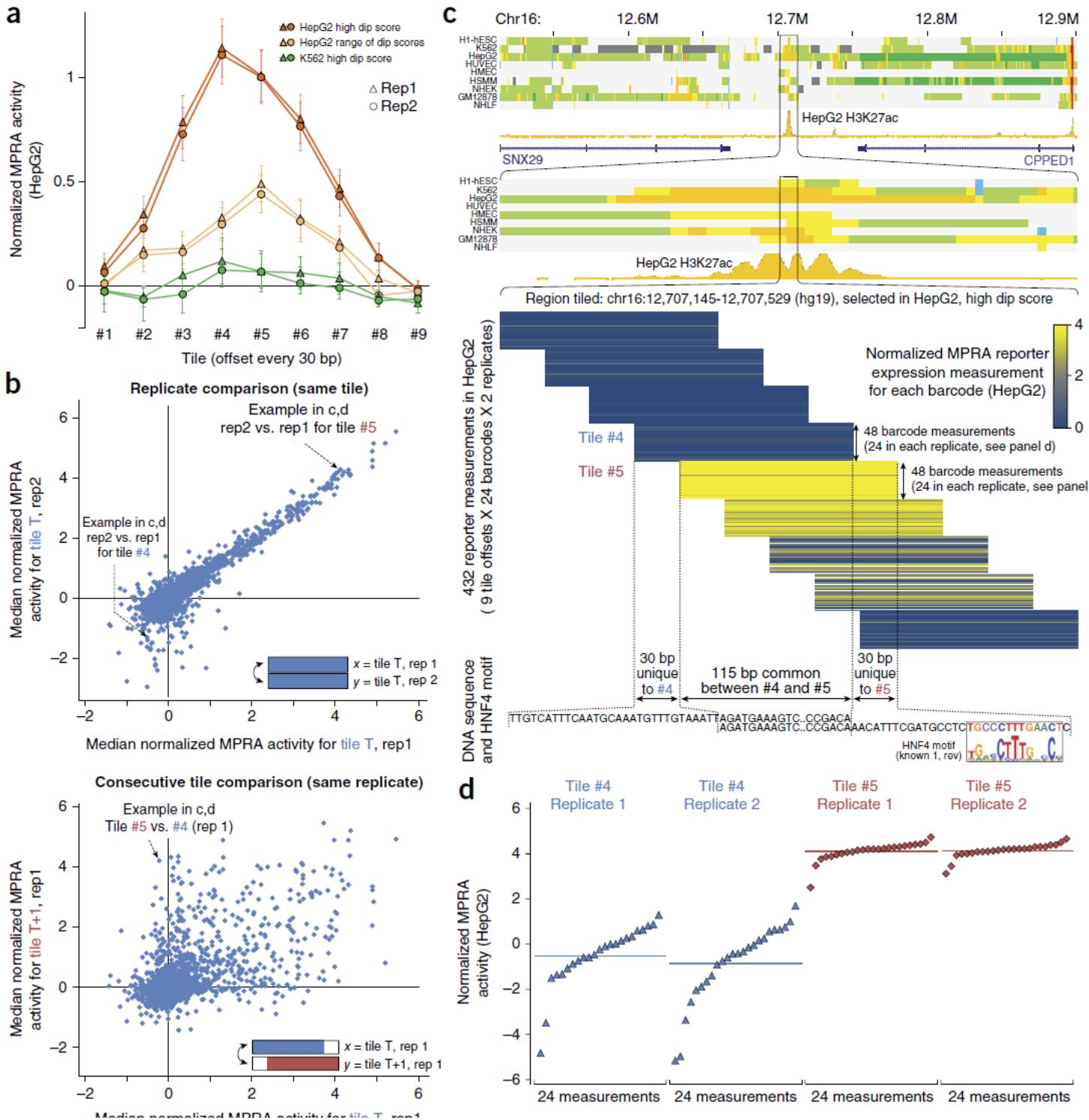
e.

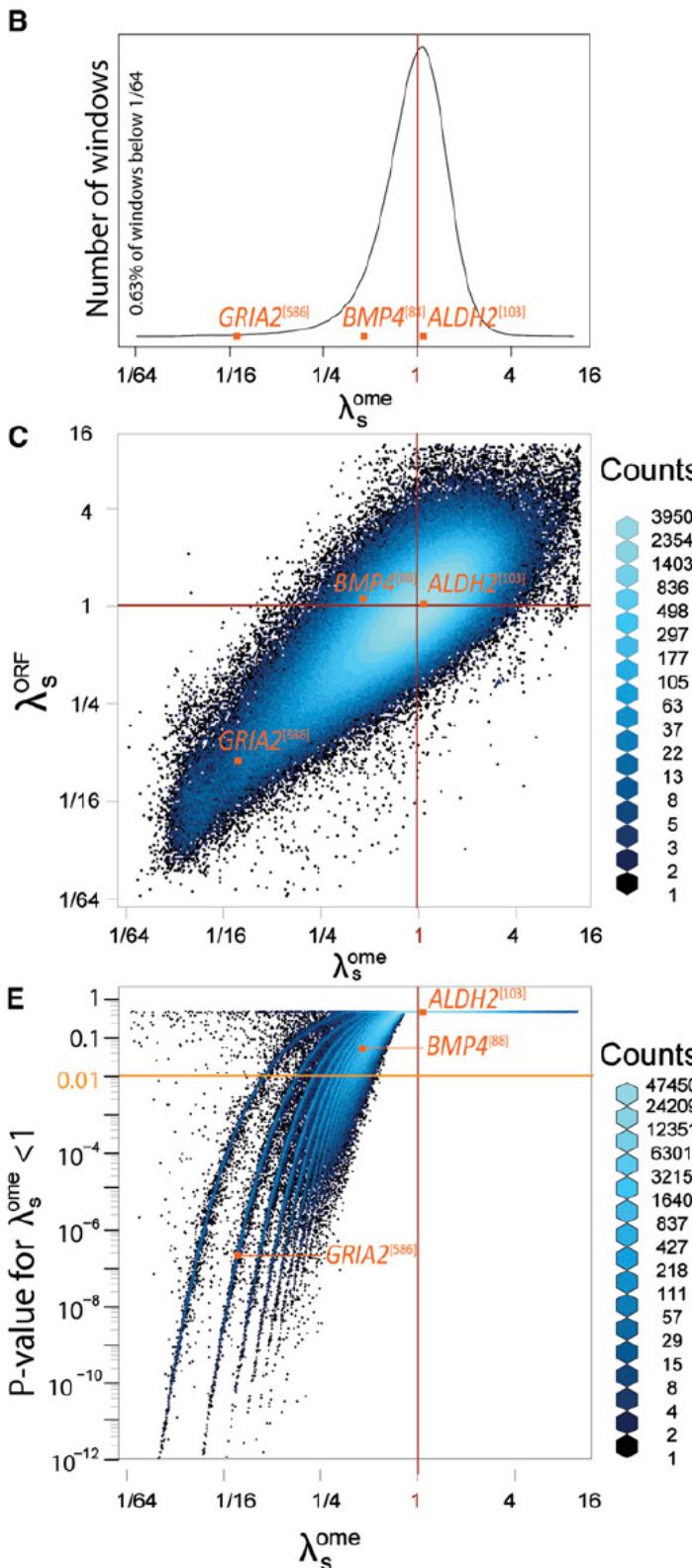
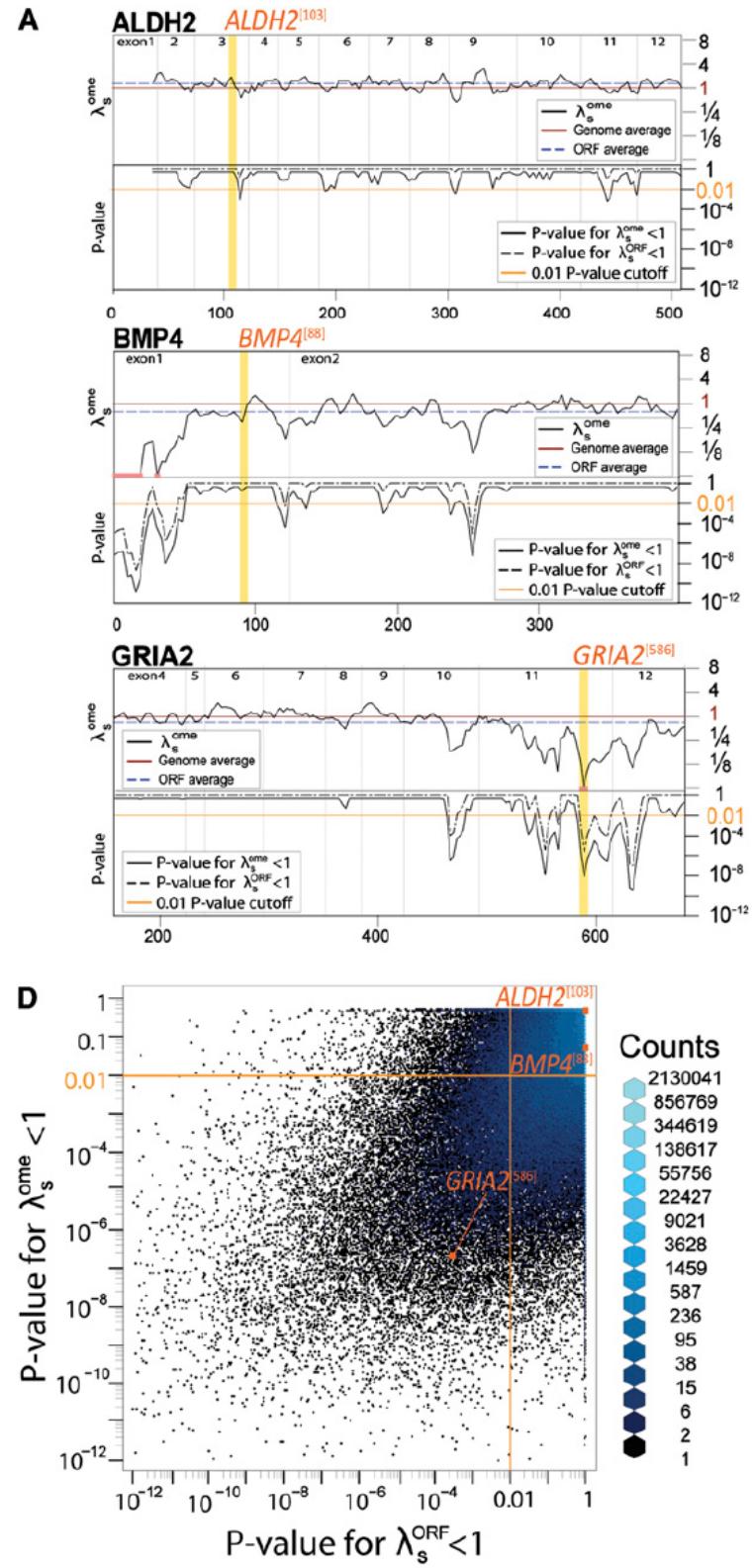




27 **Figure 4. GWAS tissue-prioritization. a.** Trait-tissue enrichment (center, heatmap) between reported lead
28 single-nucleotide polymorphisms (SNPs) from 534 genome-wide association studies (rows) and accessible active
29 enhancers across 833 epigenomes (columns) (FDR<1%). Enriched tissue groups (left) and number of enriched
30 epigenomes (right) shown for each trait. Only 100 representative traits labeled, using a bag-of-words approach
31 (full list of traits in **Supplementary Fig. S30**). Traits colored by sample with maximal trait-tissue enrichment. **b.**
32 Contribution of each project to the maximum GWAS trait-tissue enrichment for the 534 traits with significant
33 enrichments. **c.** Number of traits (y-axis) with significant GWAS trait-tissue enrichments for each combination
34 (column) of projects (rows). **d.** Increase in the cumulative number of GWAS traits (y-axis) with significant trait-
35 tissue enrichments with increasing numbers of epigenomes (x-axis), ordered to maximize the number of novel
36 trait annotations captured with each new epigenome. Top 25 samples labeled and colored by tissue group, with
37 top 6 GWAS traits shown for the first 8 samples. Points colored by project. All 534 traits are captured after
38 inclusion of 98 samples. **e.** Comparison of GWAS enrichments found (y-axis, left) and number of lead SNPs in







2. Figures: Convey information visually

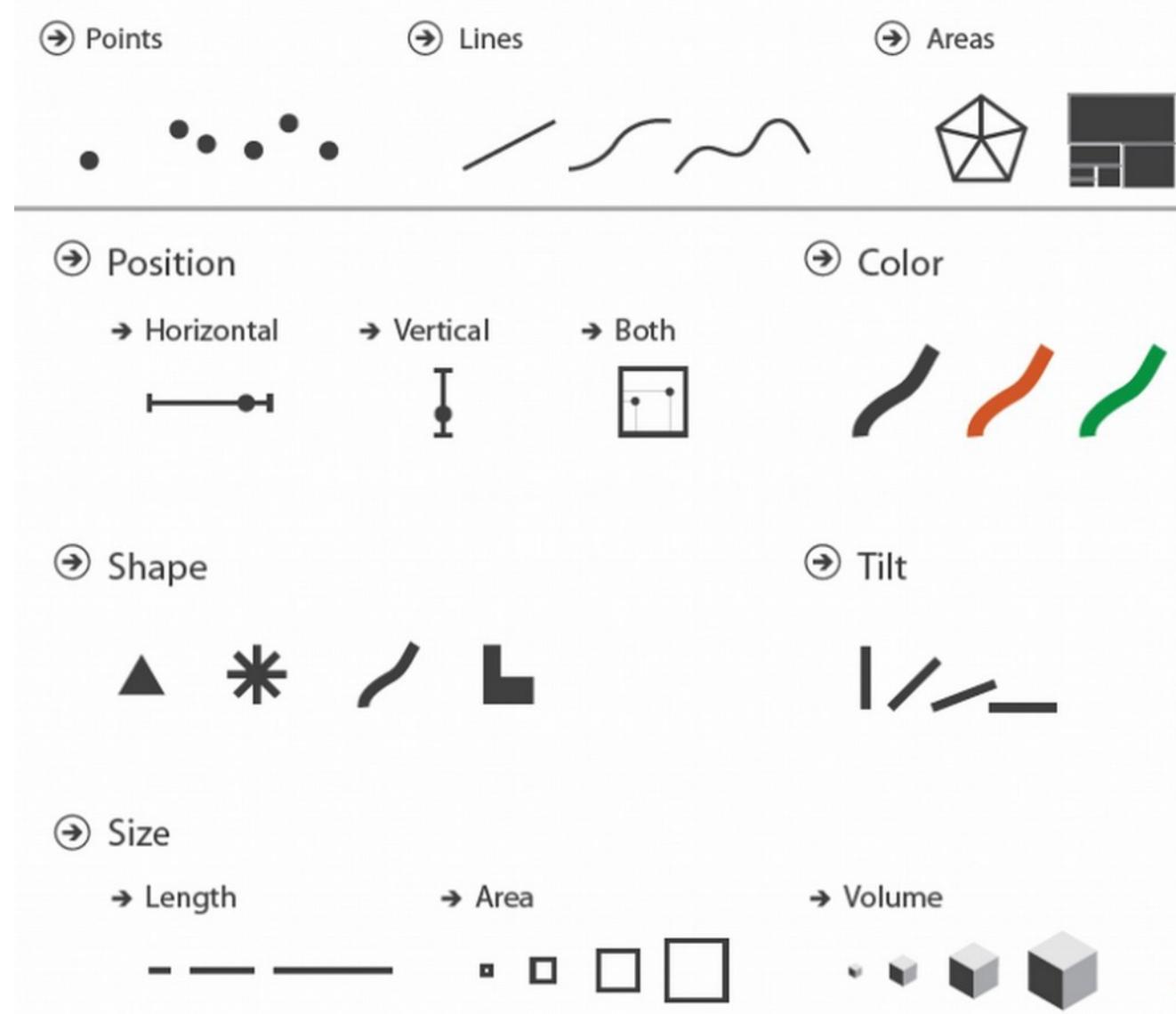
1. Key figures/legends advice
2. Elements: Marks and Channels
3. Choosing the right type of figure
4. Dealing with complexity
5. Typography
6. Composition and Layout
7. General Tips

Slides credit: Aiora Zabala
PhD Environment. VTP Graphic Design
az296, aiora.zabala@gmail.com

1. Elements: Marks and channels

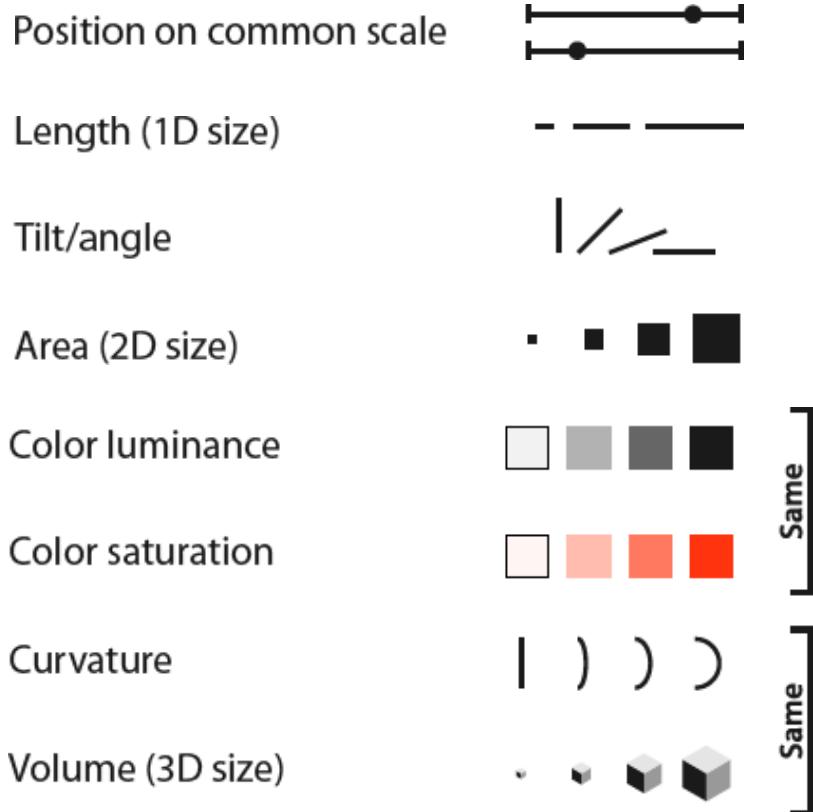
Marks (geometric primitives): used to represent data

Channels control the graphical appearance of marks: used to **encode** data, can be combined



Types of channel

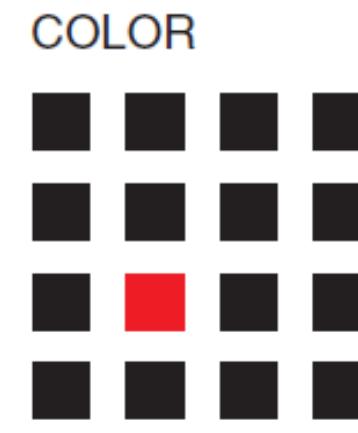
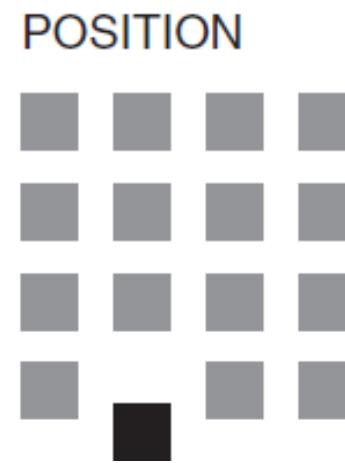
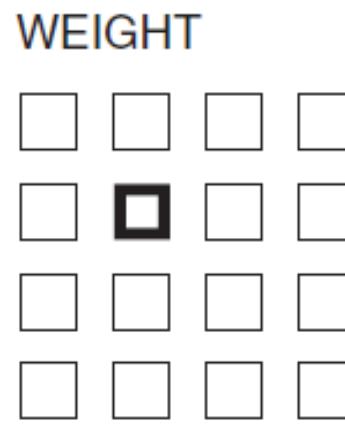
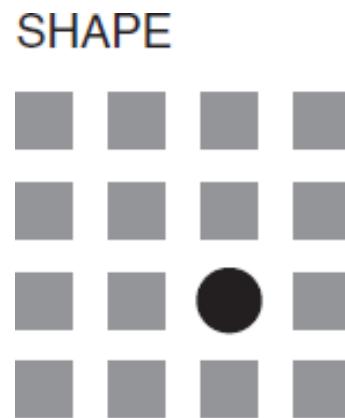
Identity channels: categorical/
qualitative attributes



Magnitude channels: ordered/
quantitative attributes



Types of channel (continued)

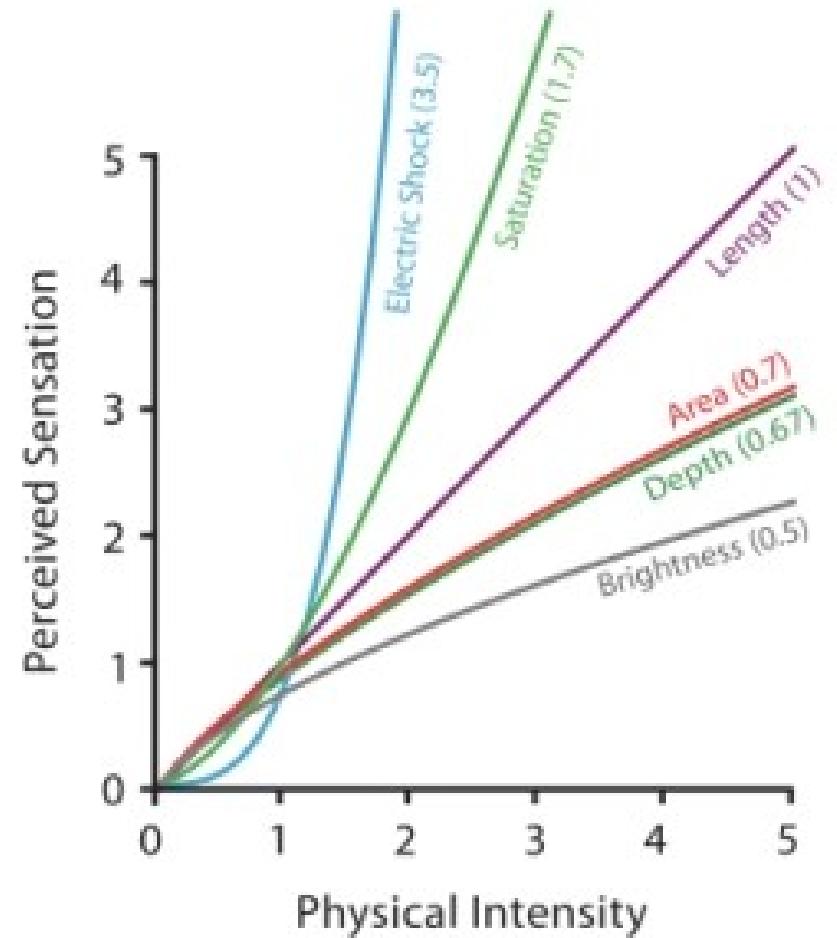


Effectiveness of each channel: Quantitation perception

The perceived magnitude
of sensory channels
follows a power law: $S =$
 I^N

Depending on the N of a
given type of sensation, its
perception is magnified (e.g.
colour saturation) or
compressed
(e.g. *brightness*)

Steven's Psychophysical Power Law: $S = I^N$



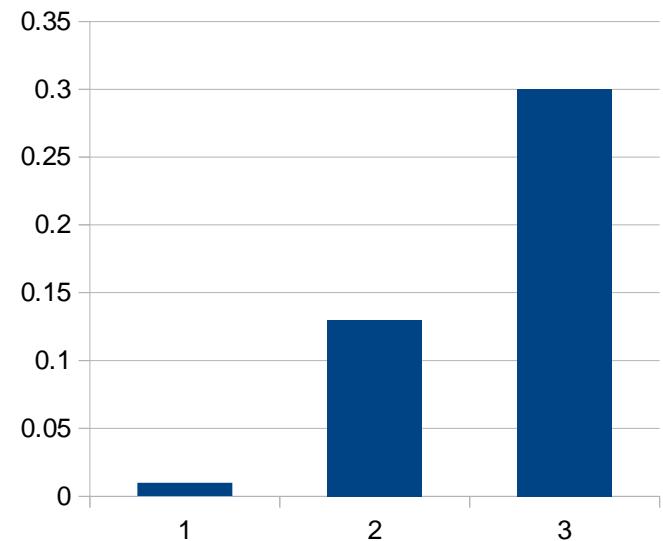
2. Figures: Convey information visually

1. Key figures/legends advice
2. Elements: Marks and Channels
3. Choosing the right type of figure
4. Dealing with complexity
5. Typography
6. Composition and Layout
7. General Tips

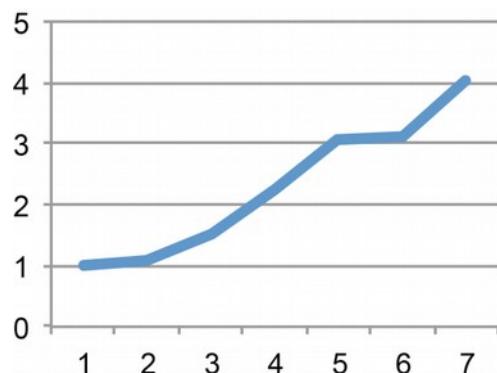
2. Choosing the type of figure

- Text, table or figure?
 - Text: one or two numbers
 - Table:
 - Exact numerical values
 - Small datasets (a figure may be best avoided if it has low data density)
 - When the data presentation requires many localised comparisons

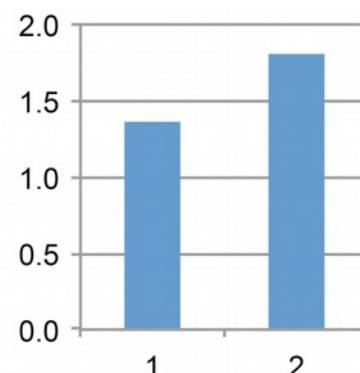
Treatment 1	0.01
Treatment 2	0.13
Treatment 3	0.30



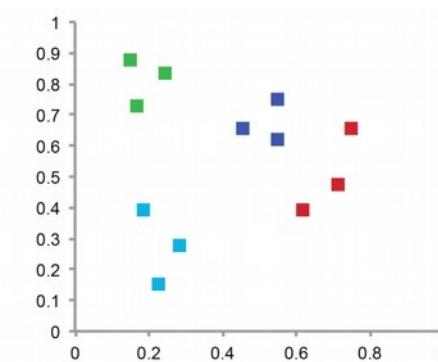
Things you can illustrate



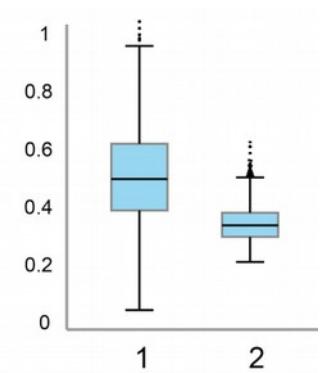
Relationship



Comparison

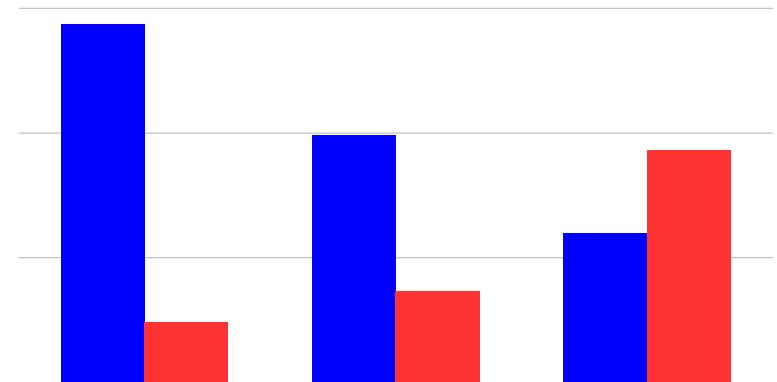
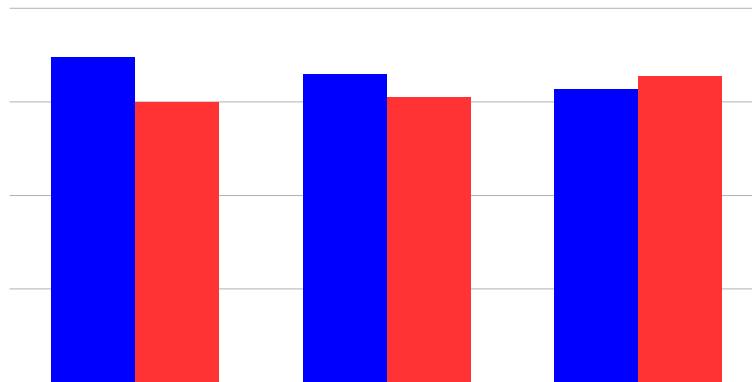
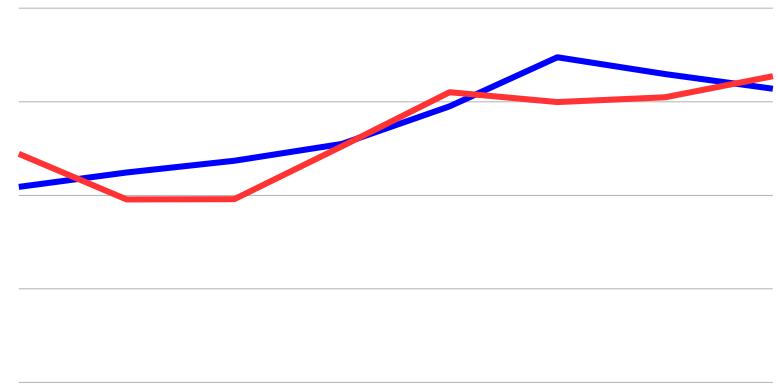
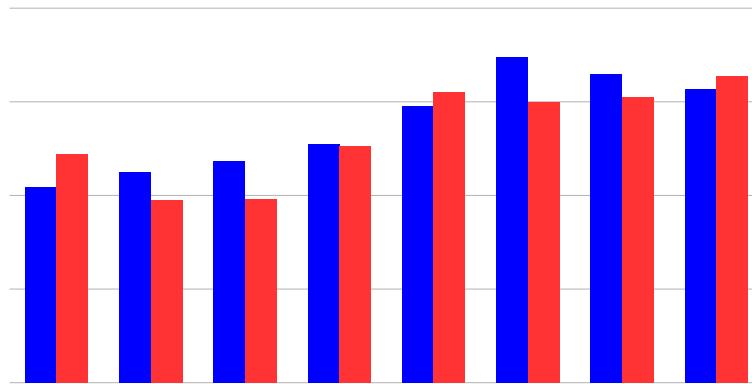


Composition

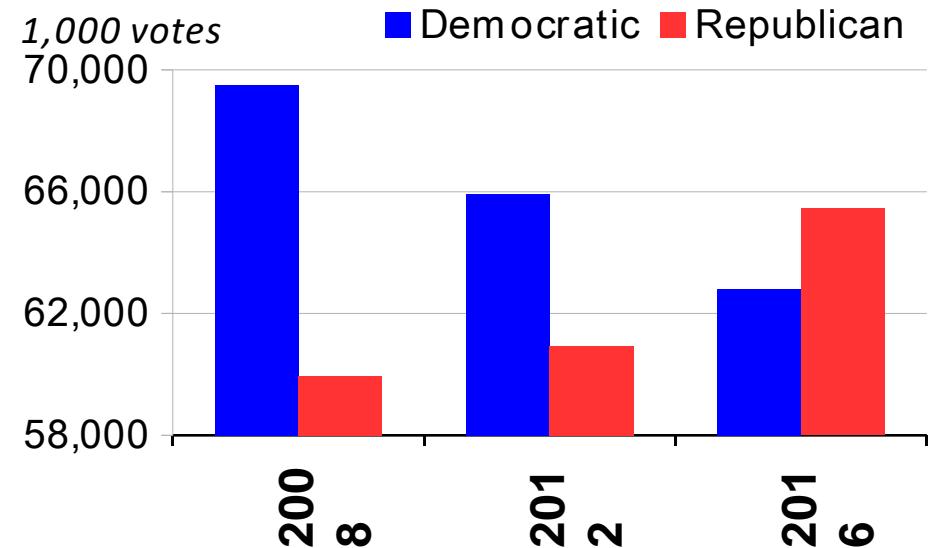
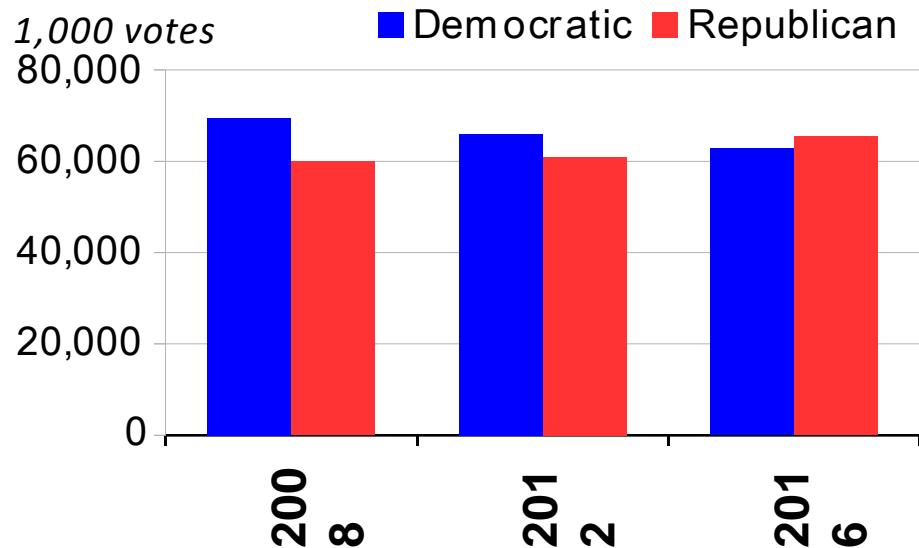
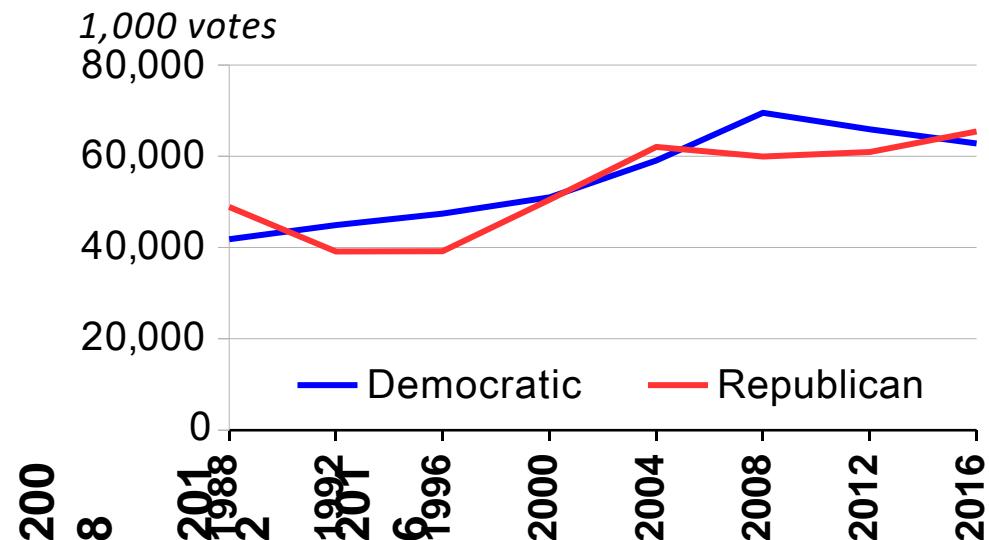
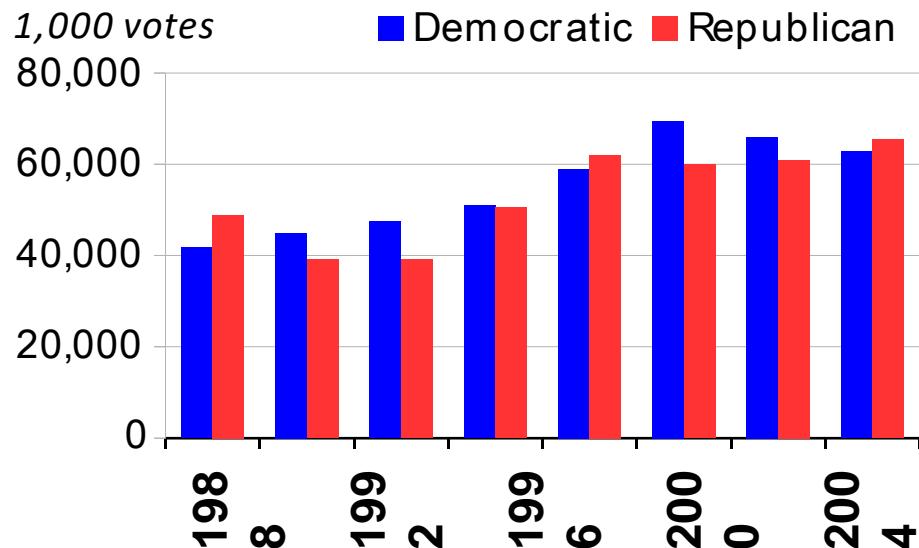


Distribution

Each figure tells a different story

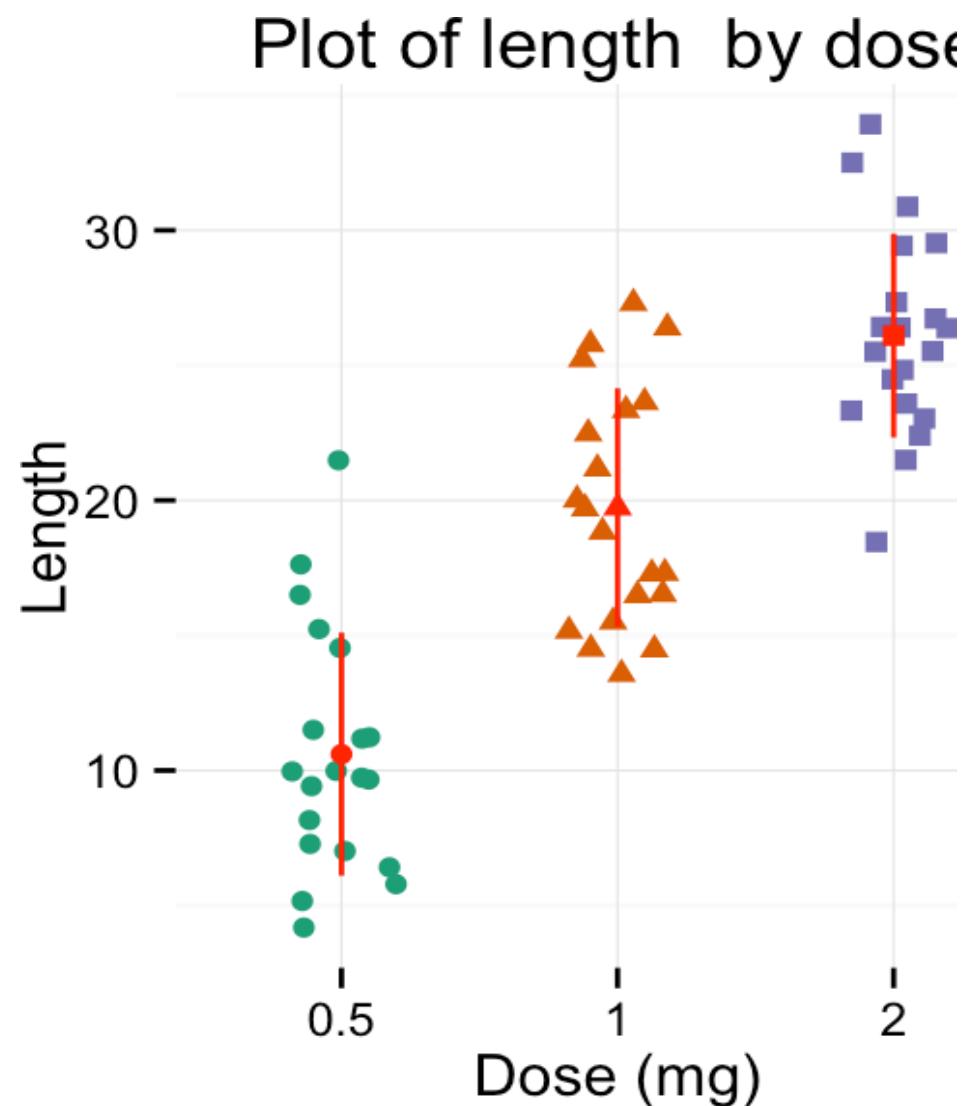


Each figure tells a story differently



Stripchart – comparison

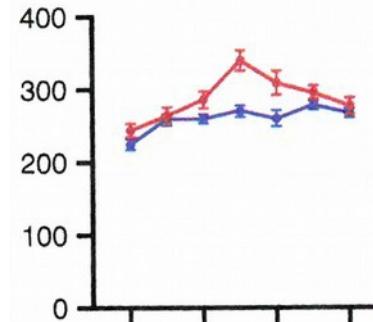
- Only one of the axis is meaningful
- To explore small datasets ($n < 100$) and compare categories
- The most basic plot (rarely in publications)



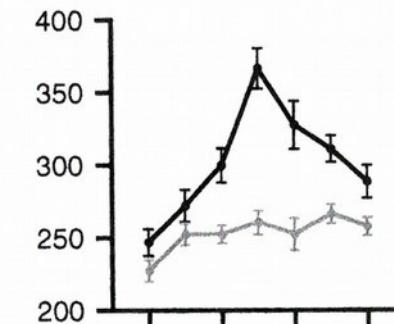
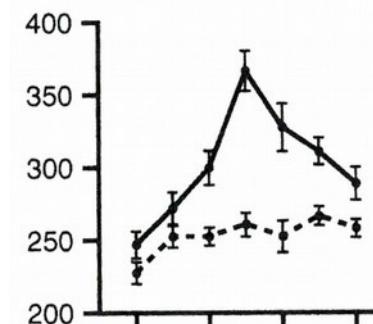
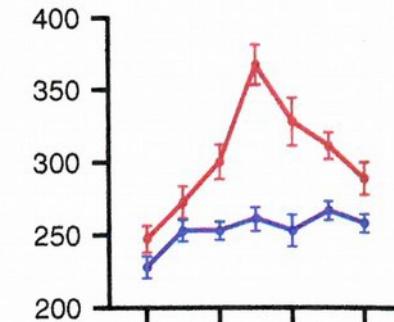
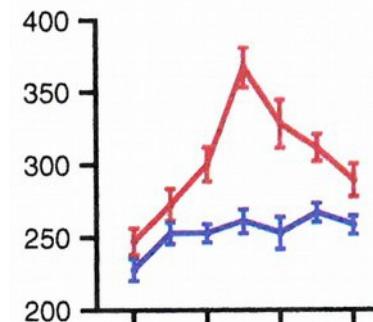
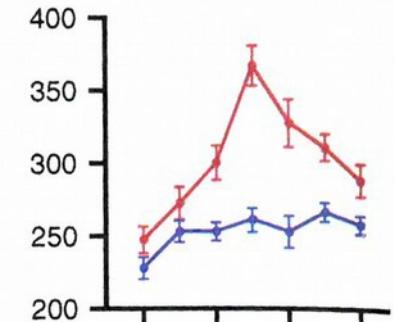
Line chart – relationships

- To show a trend of **continuous** data (usually over time)
- For matched, paired or repeated data, and for time-series
- To tell a story: how data change, rather than the discrete values of the data

Before



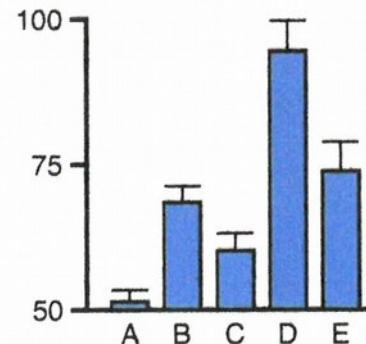
After



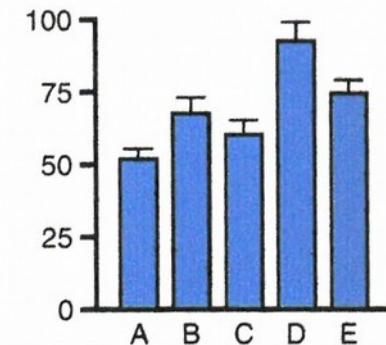
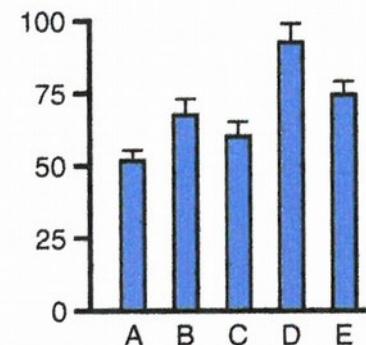
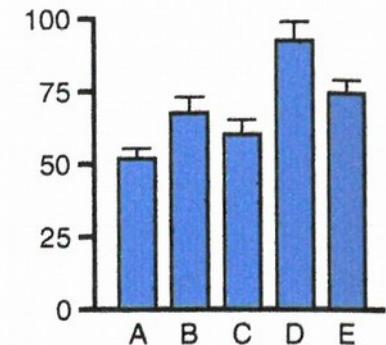
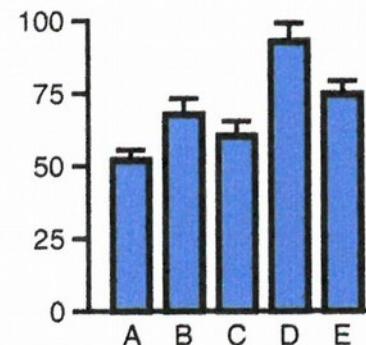
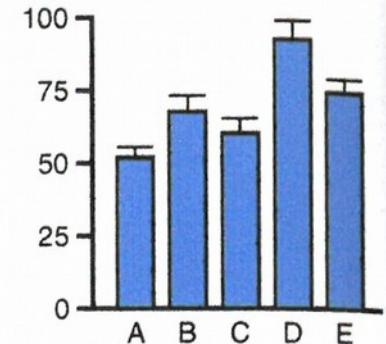
Bar chart – comparison

- To **compare** discrete quantities of **non-continuous** data
- For presenting results and emphasise differences (not so much to explore)

Before

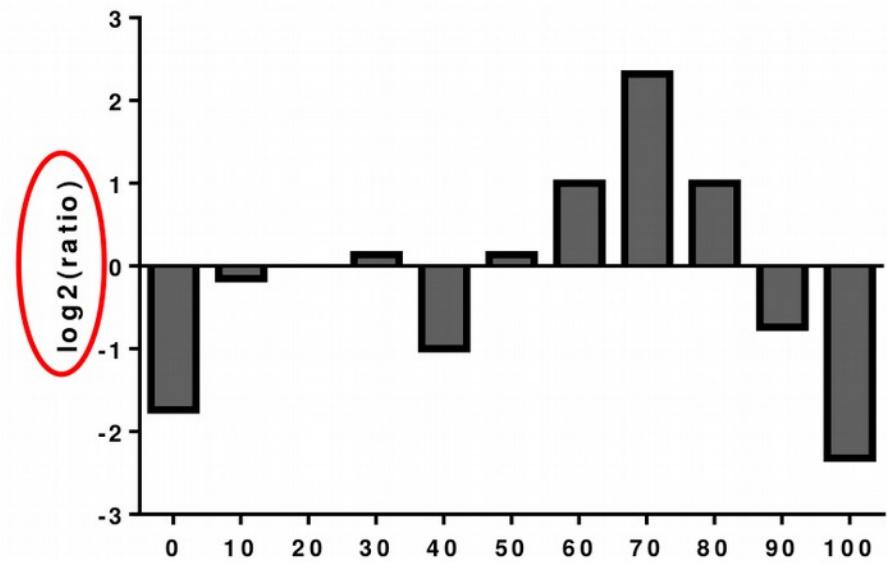
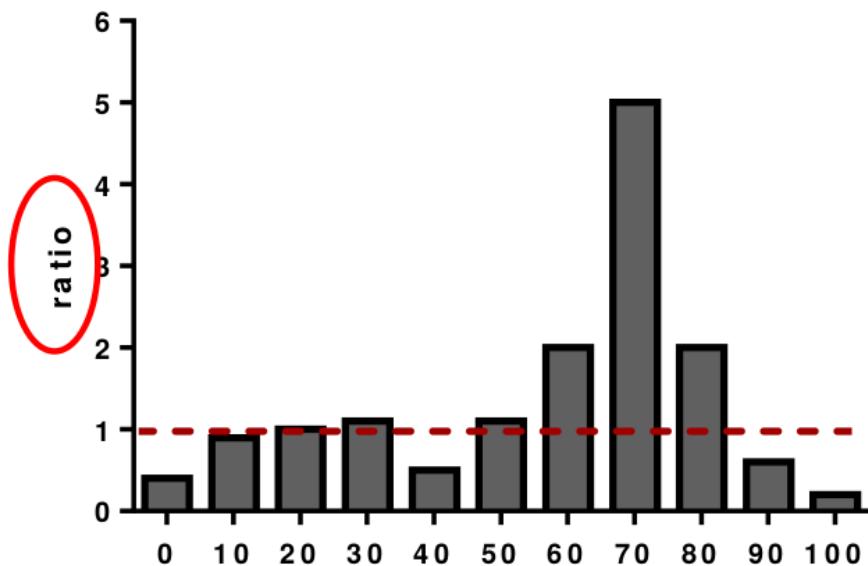


After



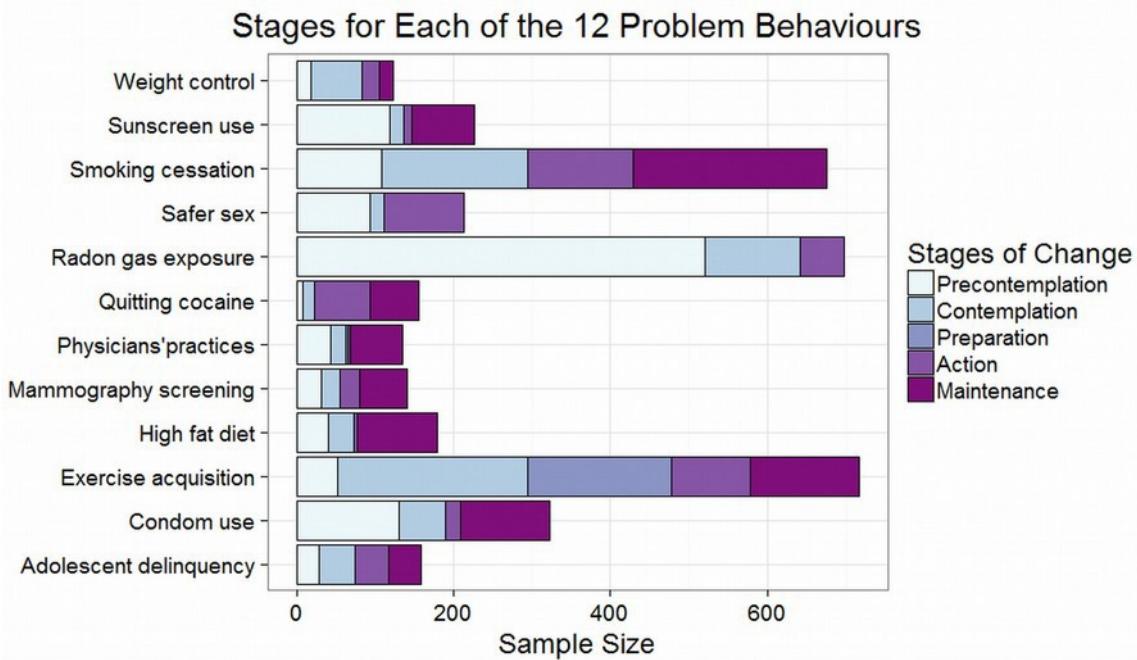
Bar chart – comparison

The choice of the x axis and of point of reference can affect how comparisons are perceived

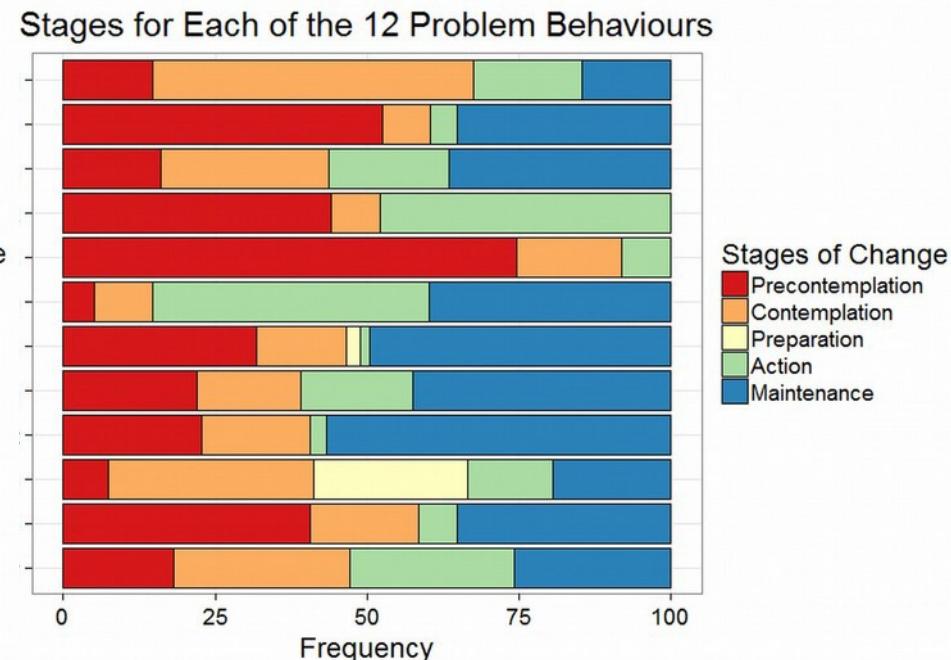


Bar chart variations

Stacked bar chart



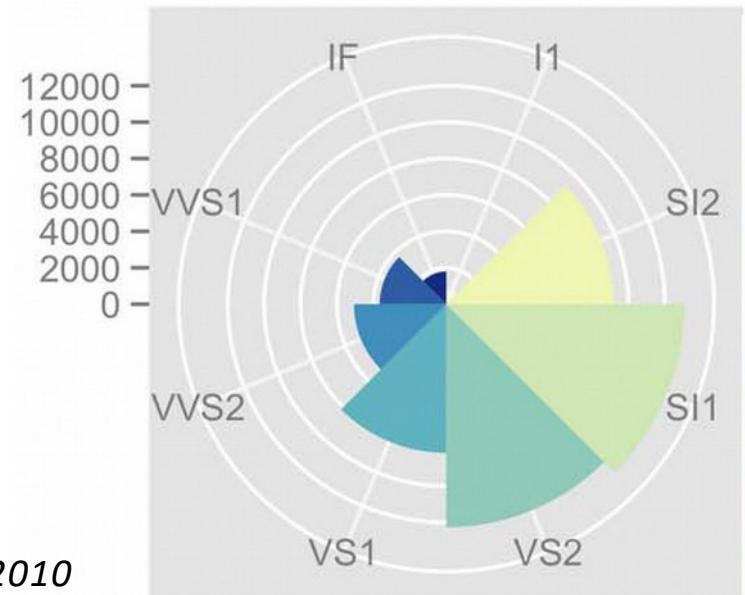
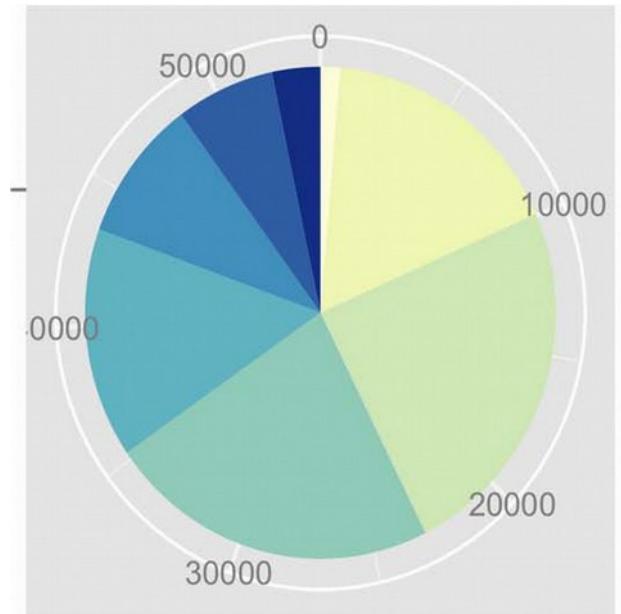
Normalised stacked bar chart



- For categorical data; heed the sample size

Pie chart – composition/ proportion

- To show relative proportions of a whole
- Not a great idea, ‘given their low data-density and failure to order numbers along a visual dimension’ (Tufte)



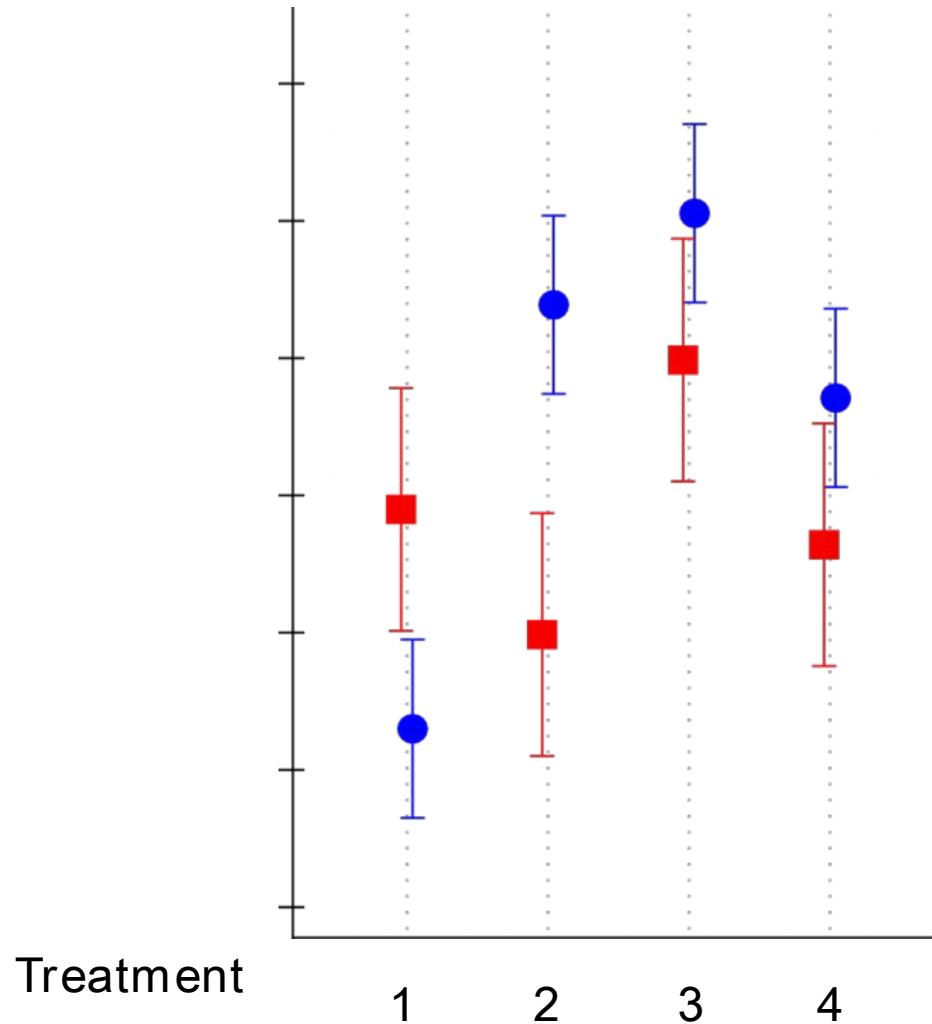
Alternative:

Polar area chart

Wickham, 2010

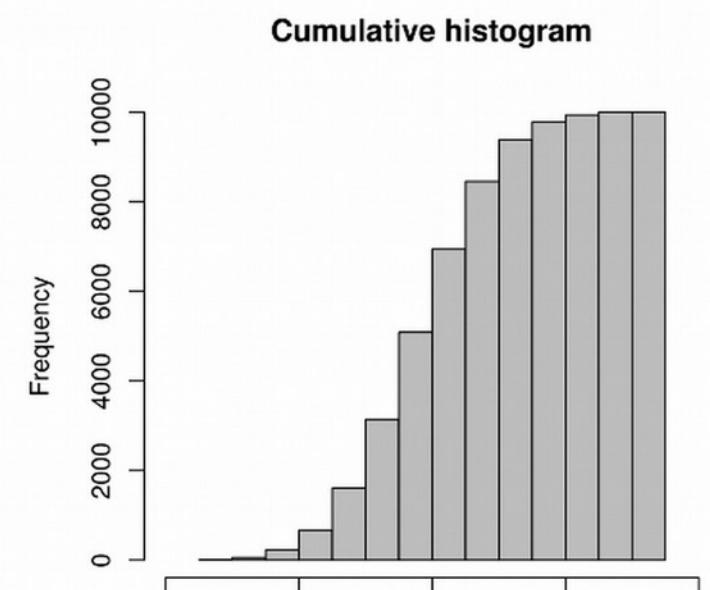
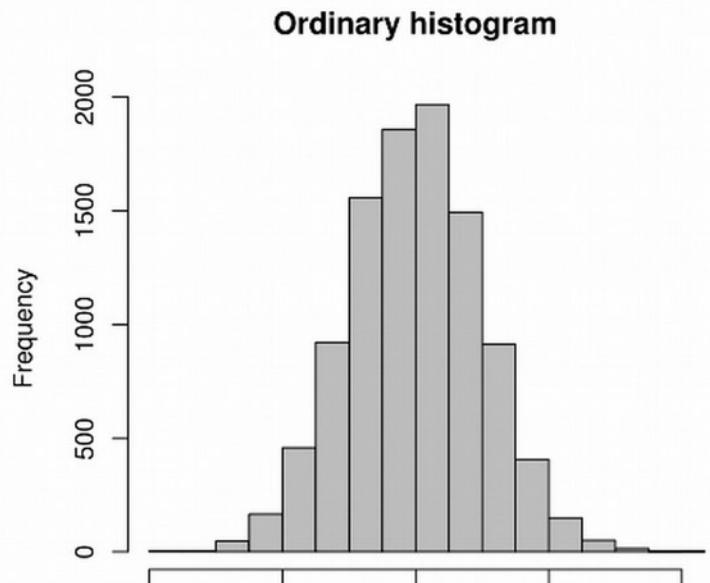
Bar chart alternative for comparisons: Dotchart with confidence intervals

- Focuses attention on the **relative values** and their measure of **variability**, rather than on the absolute values
- (absolute values are better conveyed using the heights – in a barplot)



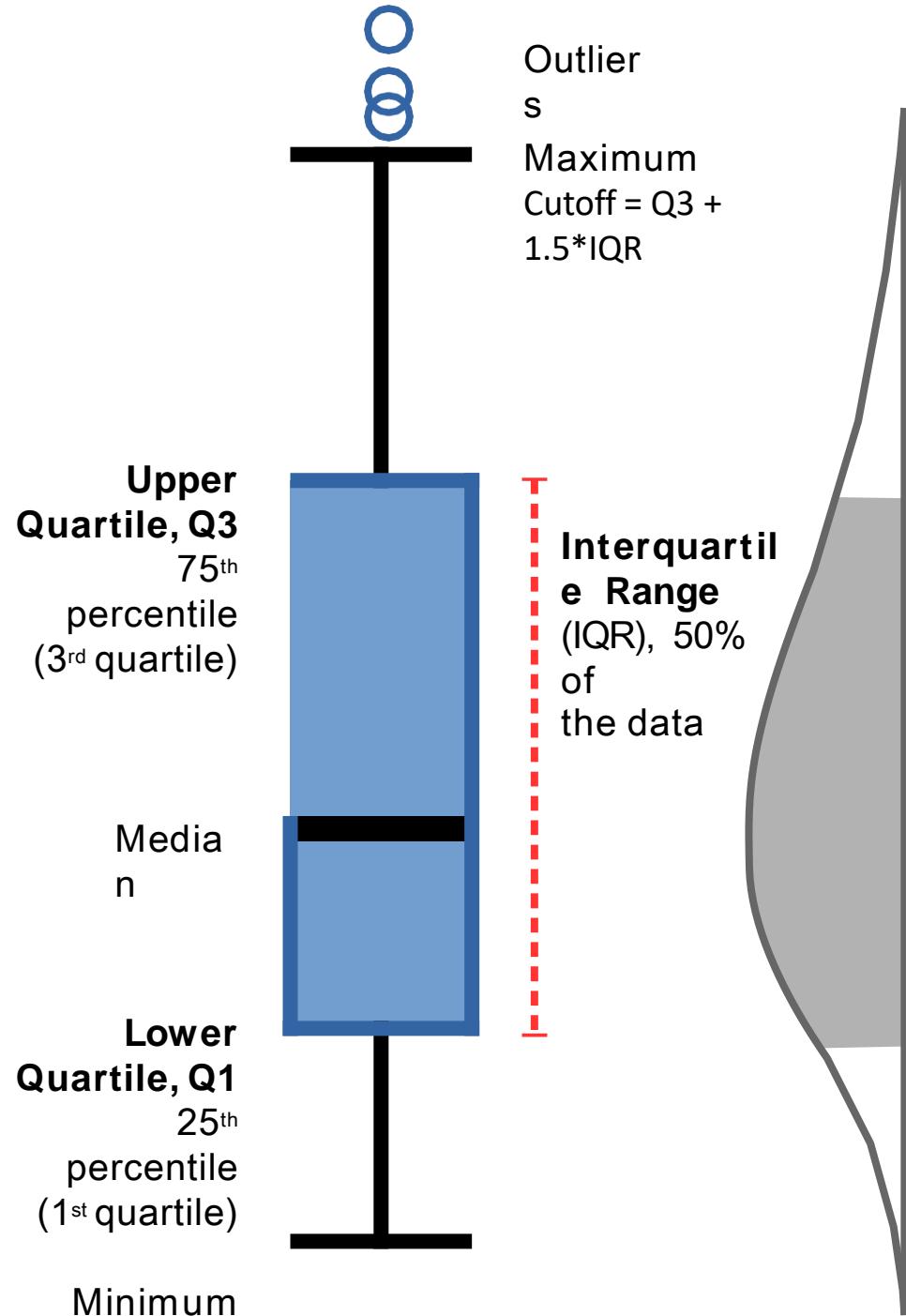
Histogram – distribution

- To show the distribution of a variable and the relative frequency of values; to explore the data
- Better on big datasets
- Estimate of the probability distribution of the variable
- The number of bins (resolution) affects the perceived shape of the distribution; the same perceptive distortion can occur when using histograms with discrete data
- Rules: Number of intervals $\approx \sqrt{N}$ and Interval width $\approx \text{Range} \div \sqrt{N}$



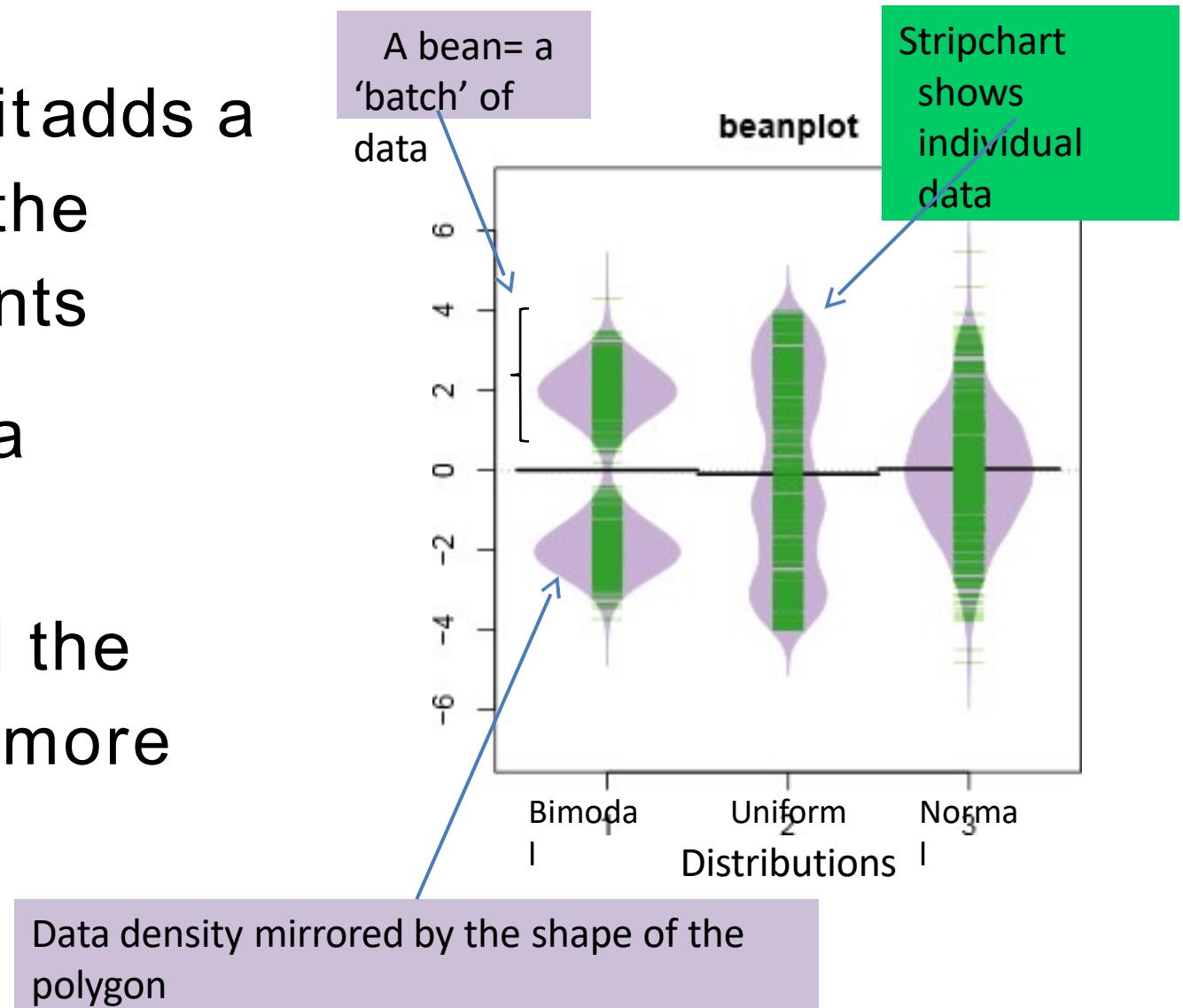
Boxplot – distribution

- Also *box-and-whisker* plot
- Shows the central value, the extremes, and the area where 50% of the values are located.
 - Usually median, minimum, maximum, lowest and highest quartiles
- Particularly useful to understand distribution of not-normal data



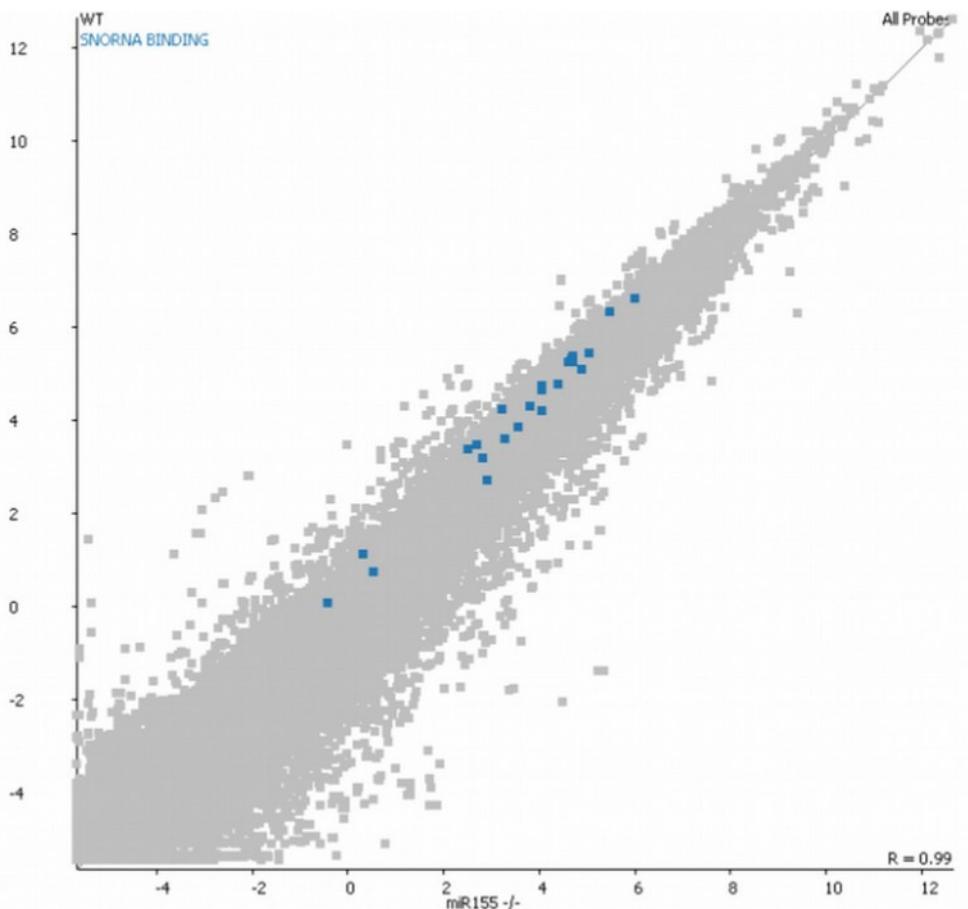
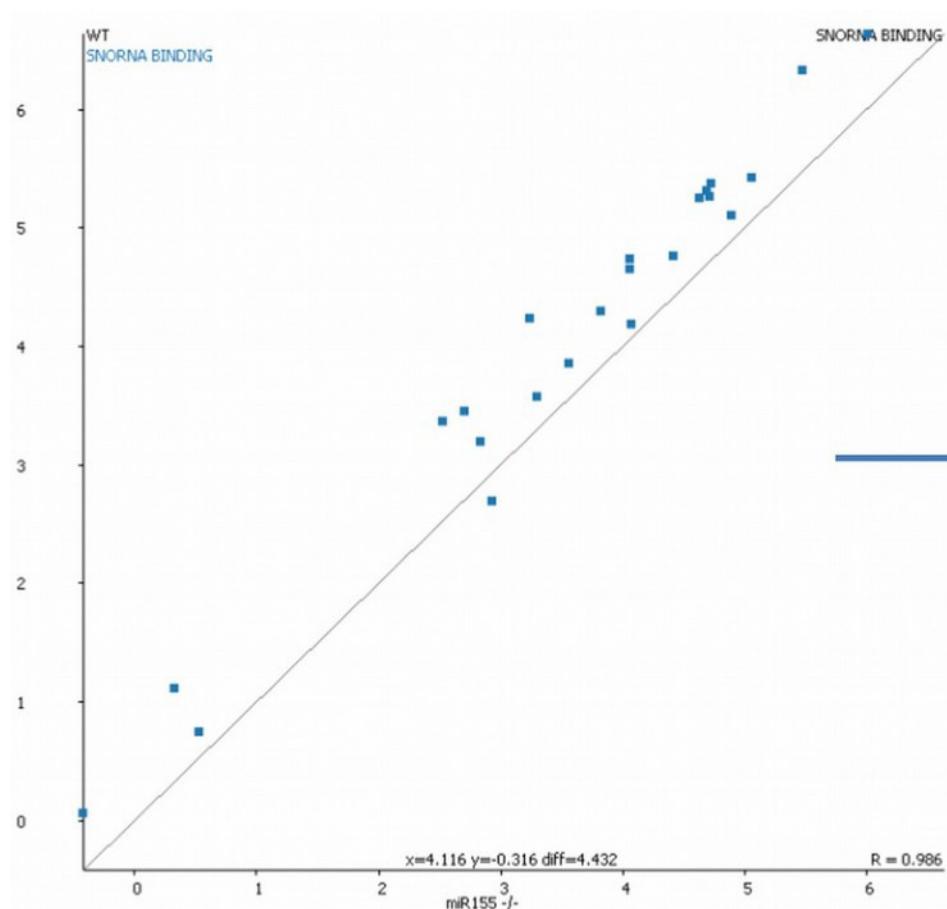
Boxplot variation: Violin/ Bean plots

- To the above, it adds a **stripchart** of the actual datapoints
- Shows the data **density**
- To understand the distribution in more detail



Scatterplot – relationships

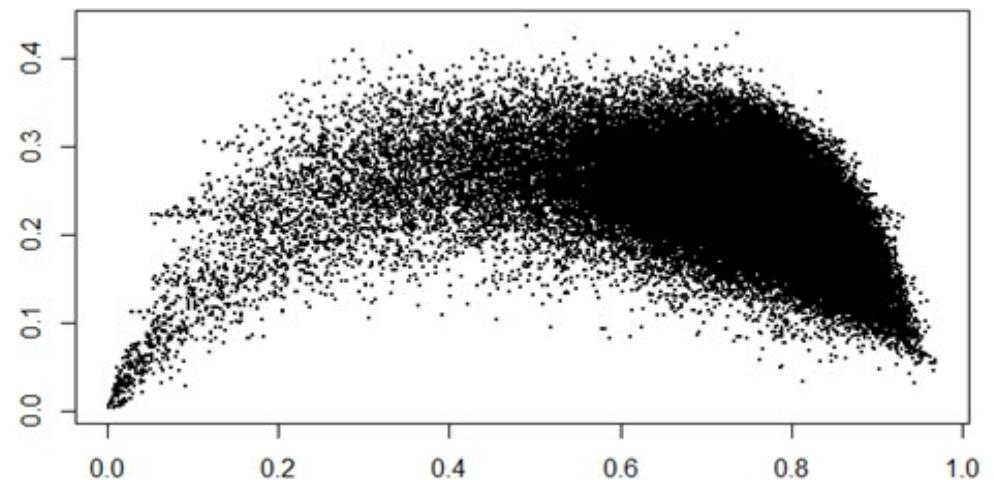
To show the relationship between two continuous variables



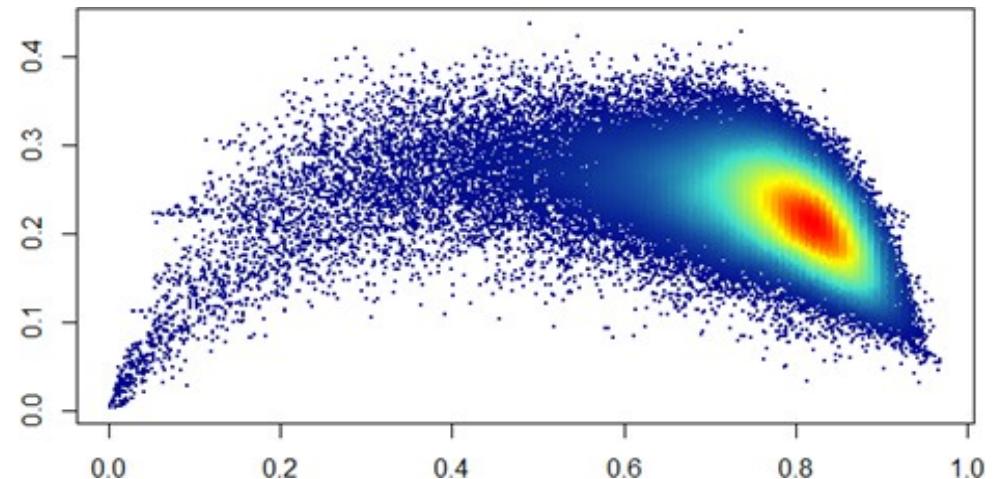
Scatterplot – relationships

For high-density data: use
colours or transparency

Problem: very big dataset



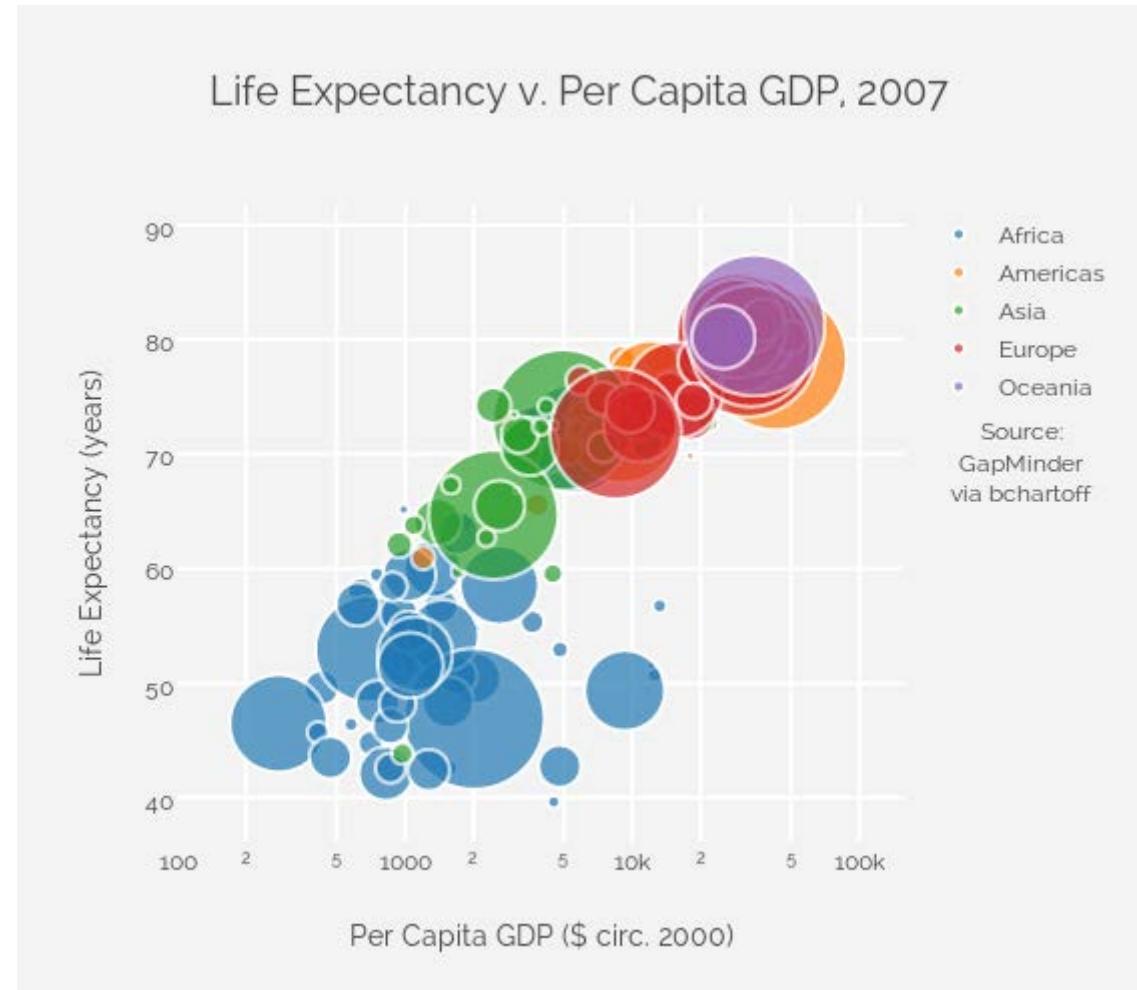
Solution: smoothed **densities**
colour representation



Scatterplot variations

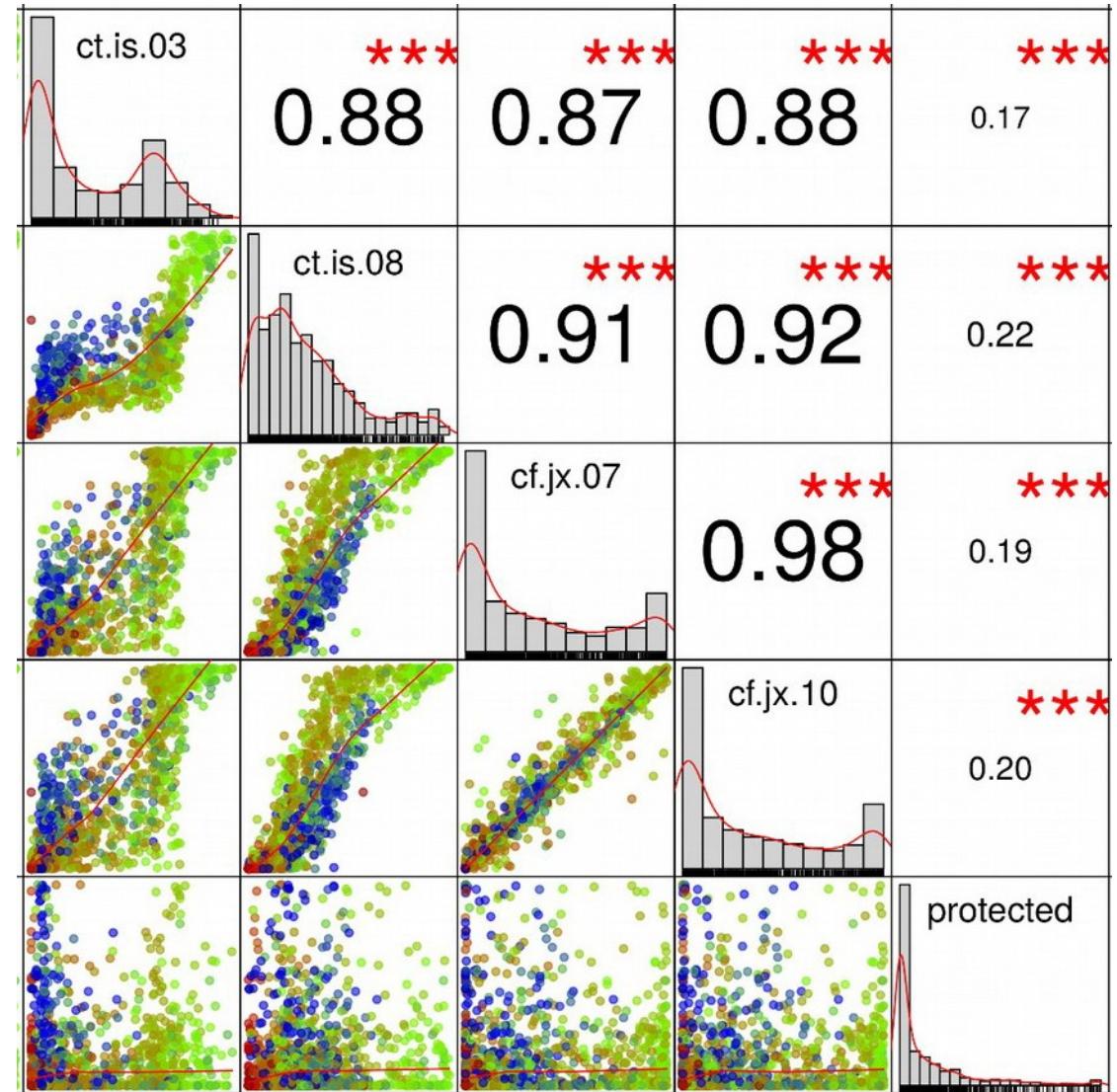
Bubble scatterplot

It adds a 3rd dimension (but only for small datasets)



Scatterplot variations

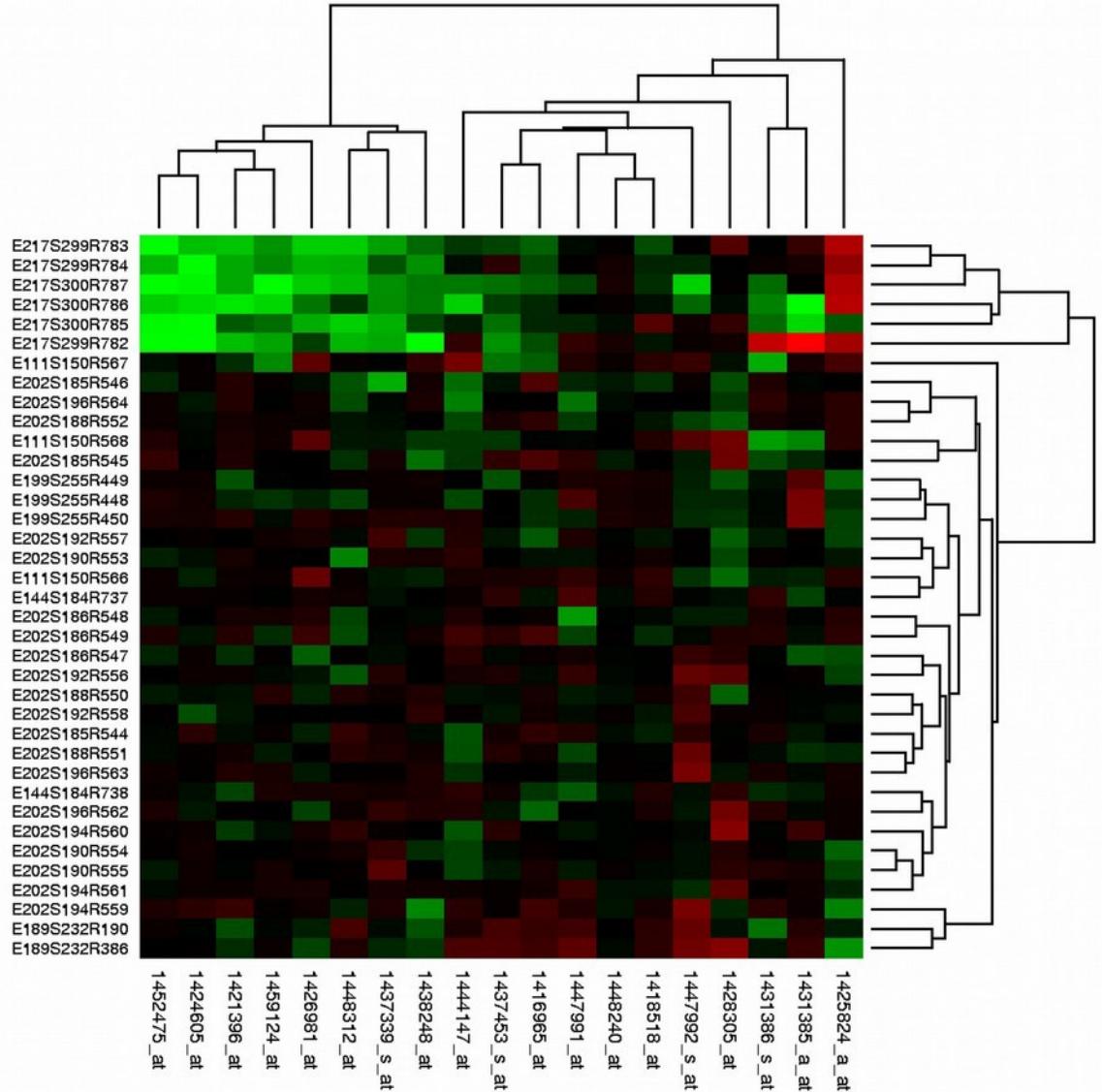
Scatterplot matrix
(correlogram)
Useful to explore
bivariate associations
in a large dataset



*Built using corrrgram package
for R*

Heatmap – relationship

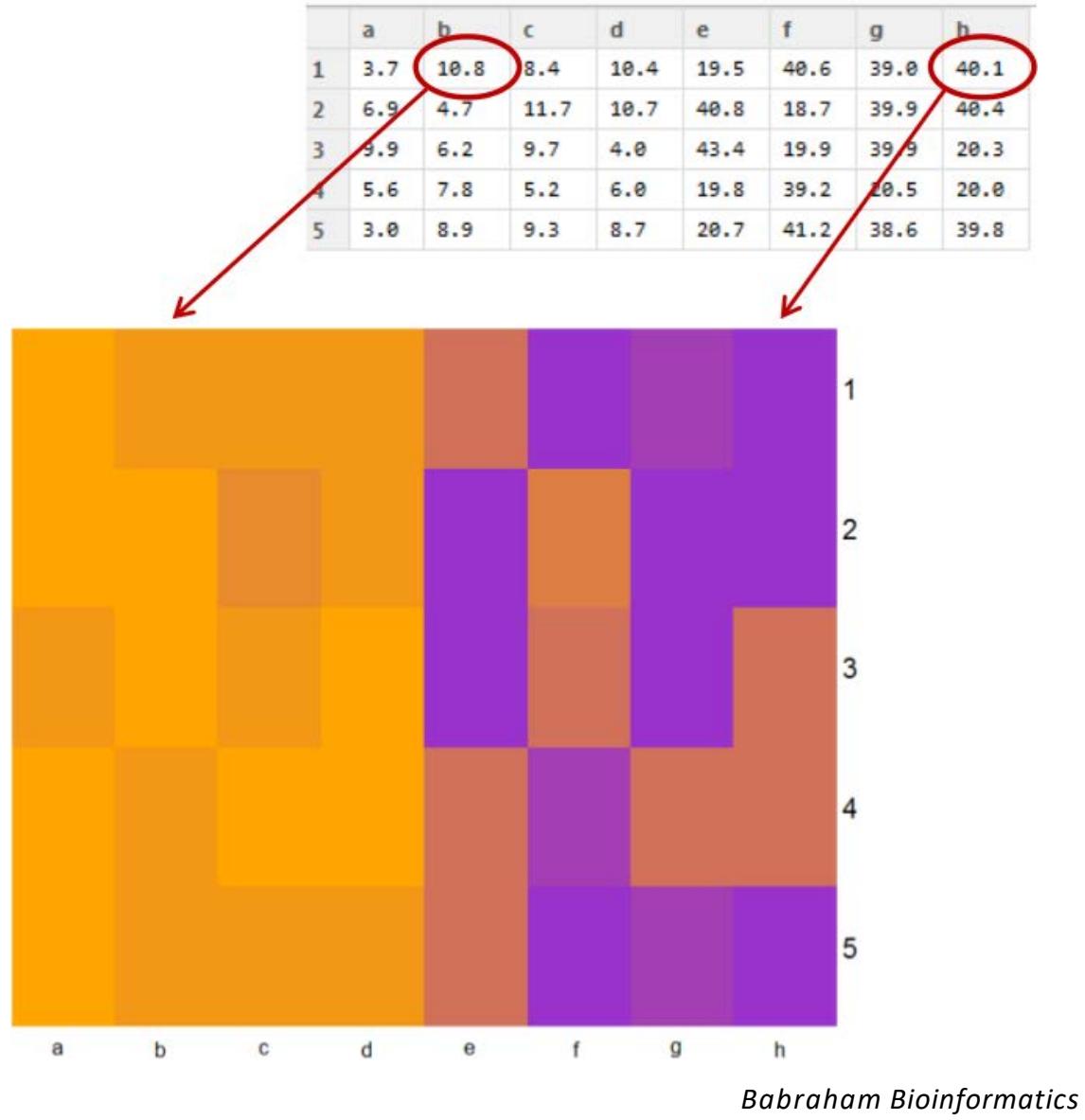
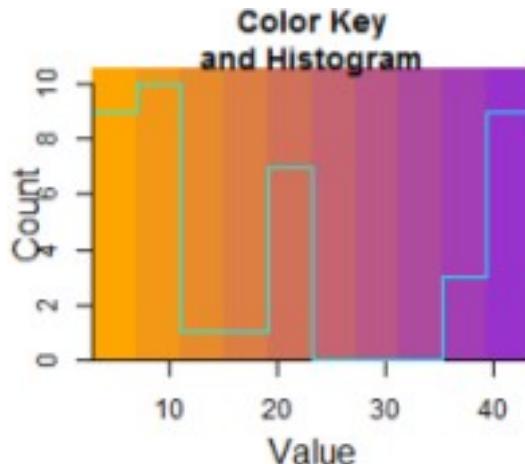
- Shows more complex relationships, e.g. many conditions
- *Steps:* normalisation, clustering
- *Representation:* colouring, filtering



Heatmap

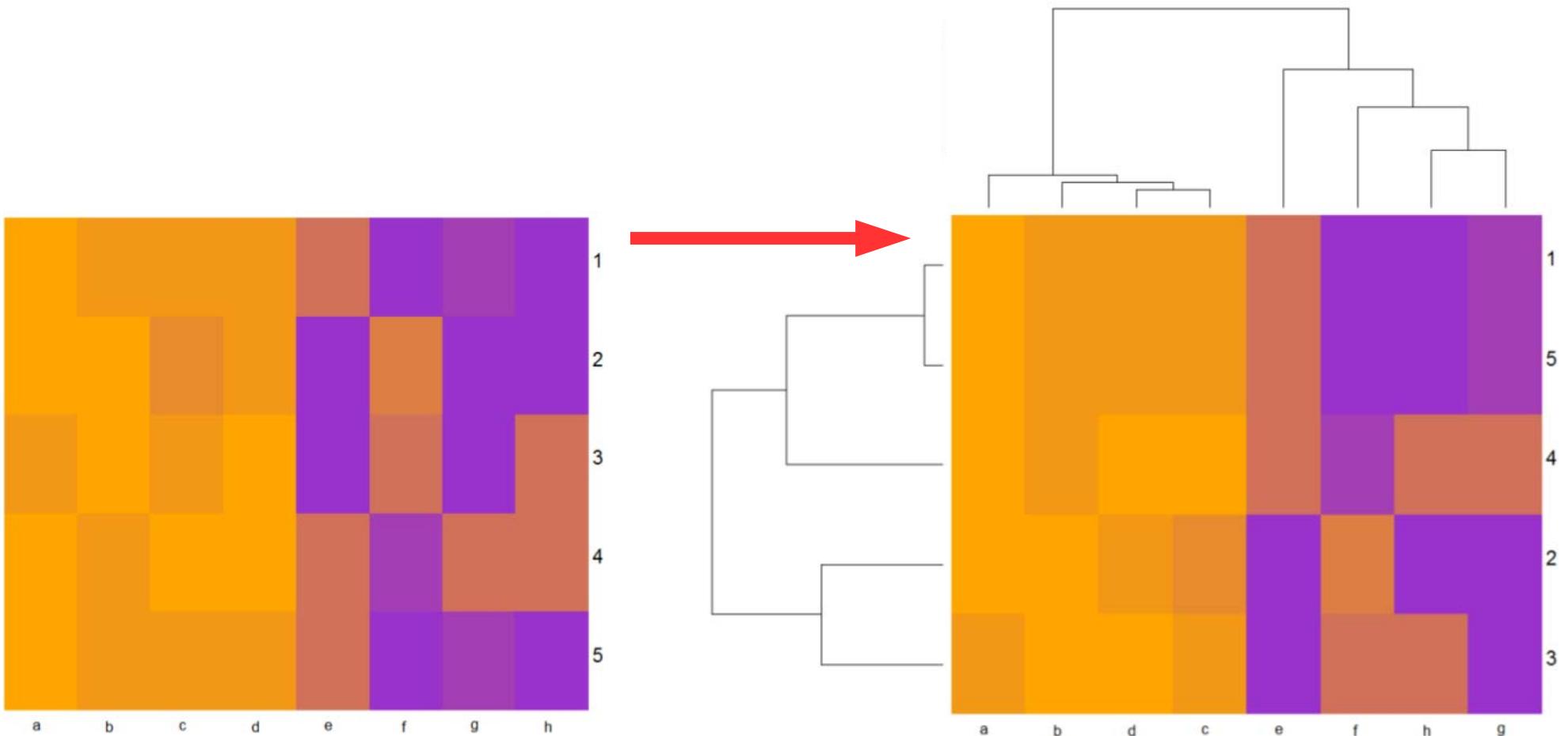
A heatmap is basically a table that has colours in place of numbers

	a	b	c	d	e	f	g	h
1	3.7	10.8	8.4	10.4	19.5	40.6	39.0	40.1
2	6.9	4.7	11.7	10.7	40.8	18.7	39.9	40.4
3	9.9	6.2	9.7	4.0	43.4	19.9	39.9	20.3
4	5.6	7.8	5.2	6.0	19.8	39.2	10.5	20.0
5	3.0	8.9	9.3	8.7	20.7	41.2	38.6	39.8



Heatmap

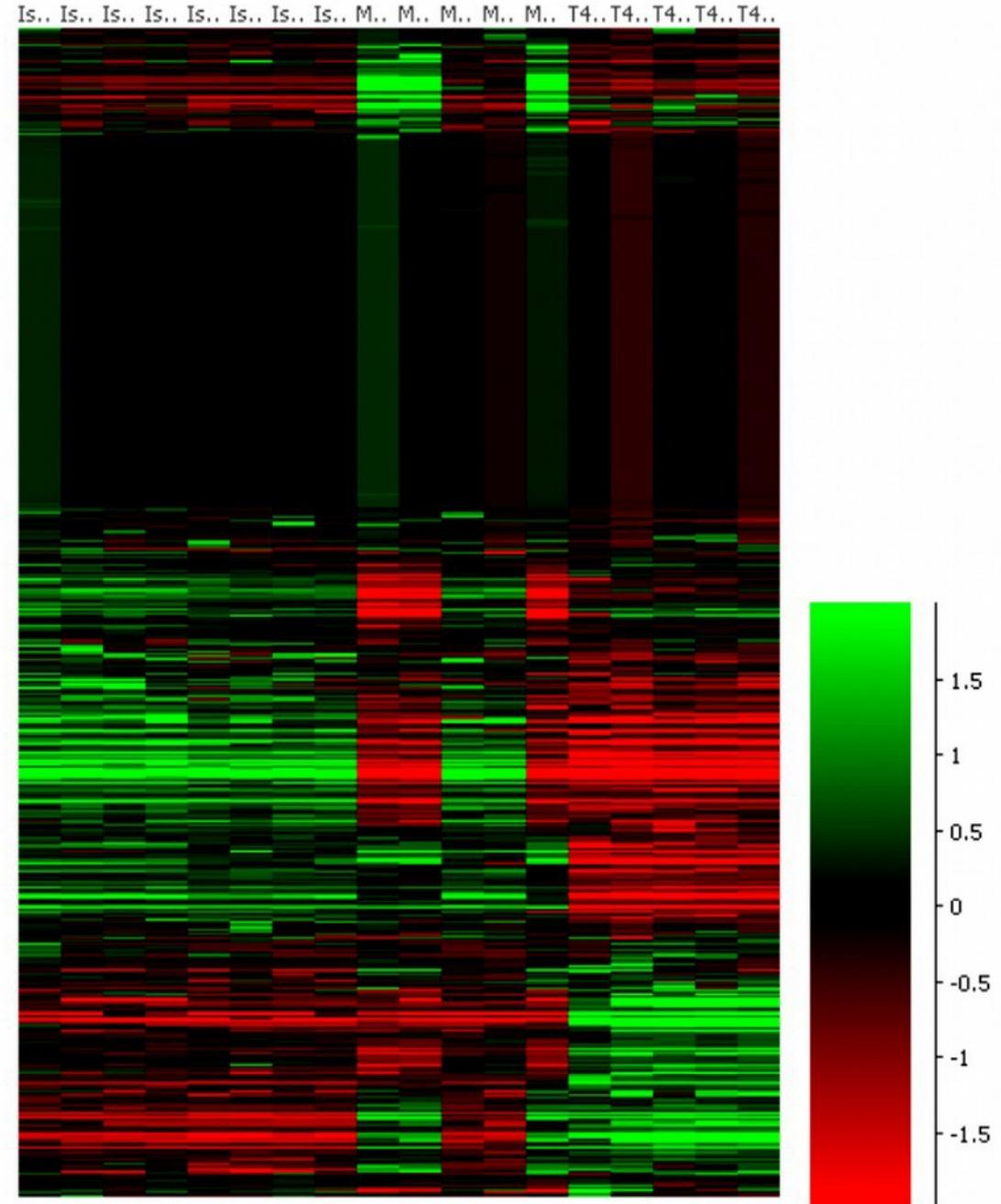
Colour scheme for grouping: **Clustering** (done usually via Euclidean distances –differences between values)



Heatmap

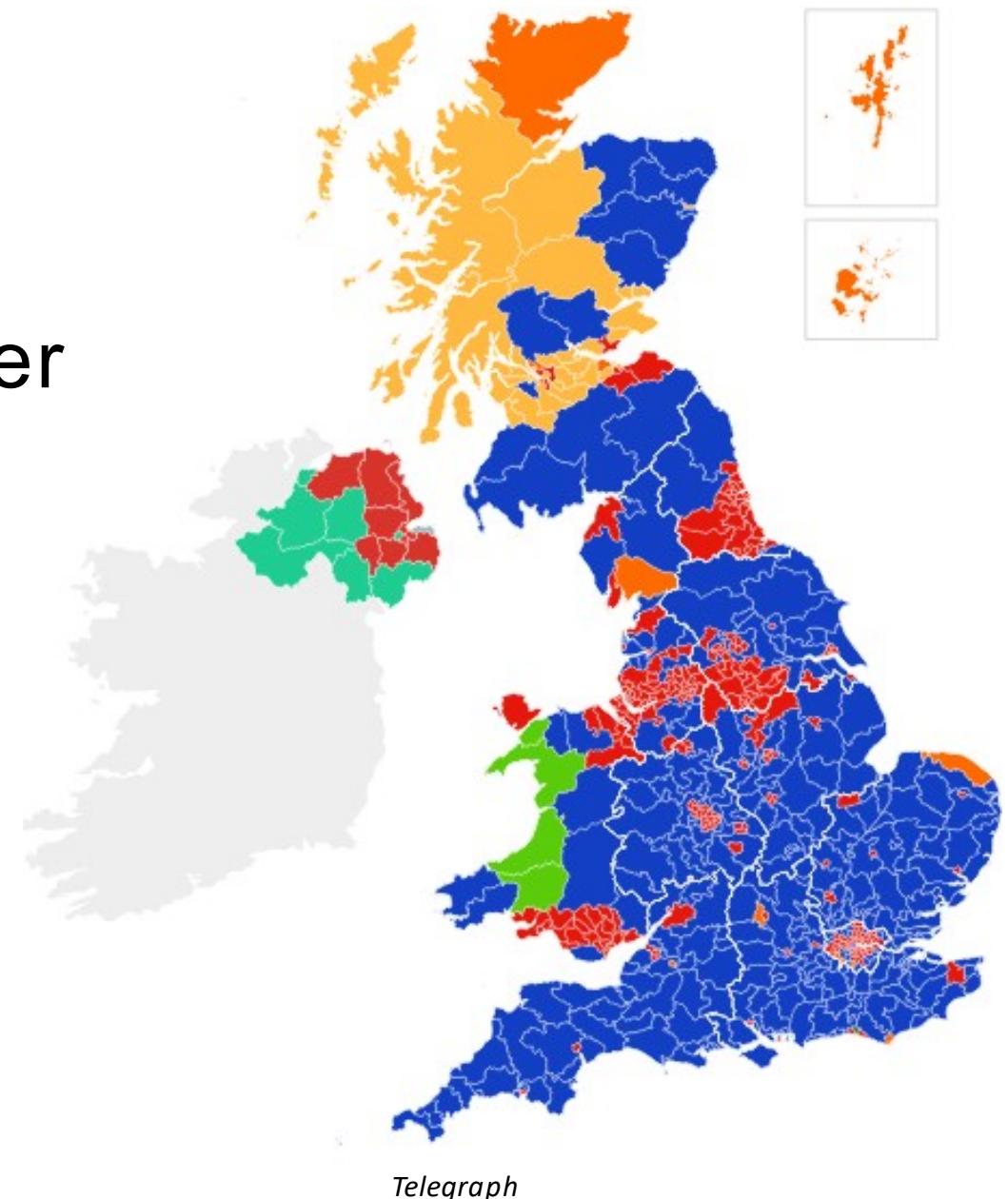
- Heatmaps are great but:
 - Careful with clustering
 - Plot data that are changing

Remove unchanging points to focus on differences



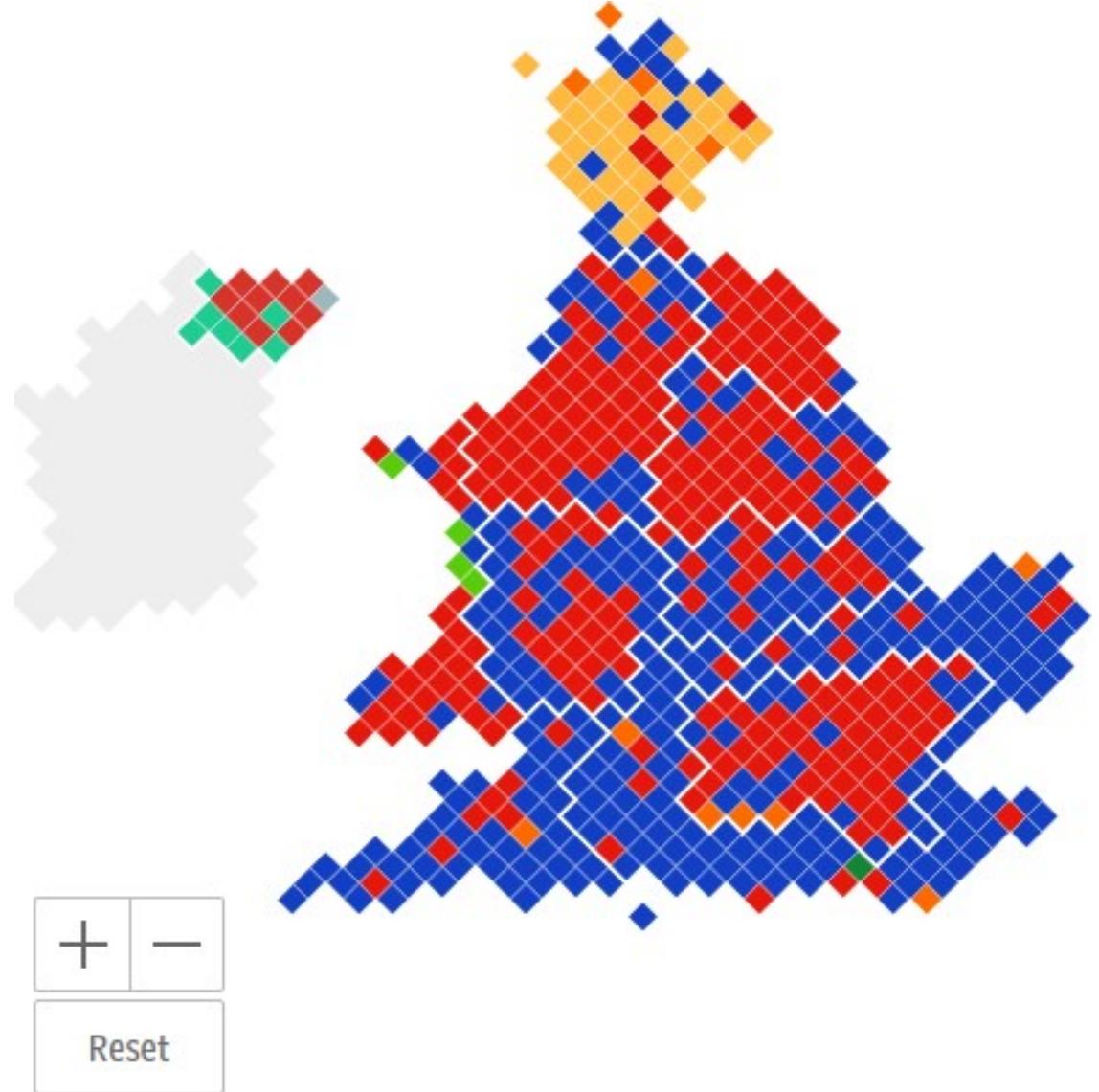
Maps (a very quick look)

Information shown over maps has great communication power



Maps (a very quick look)

But they are also
highly prone to
distortions and to
biasing perceptions



Maps (a very quick look)

What is the message you want to emphasise?

Geographical distribution?

Proportions?

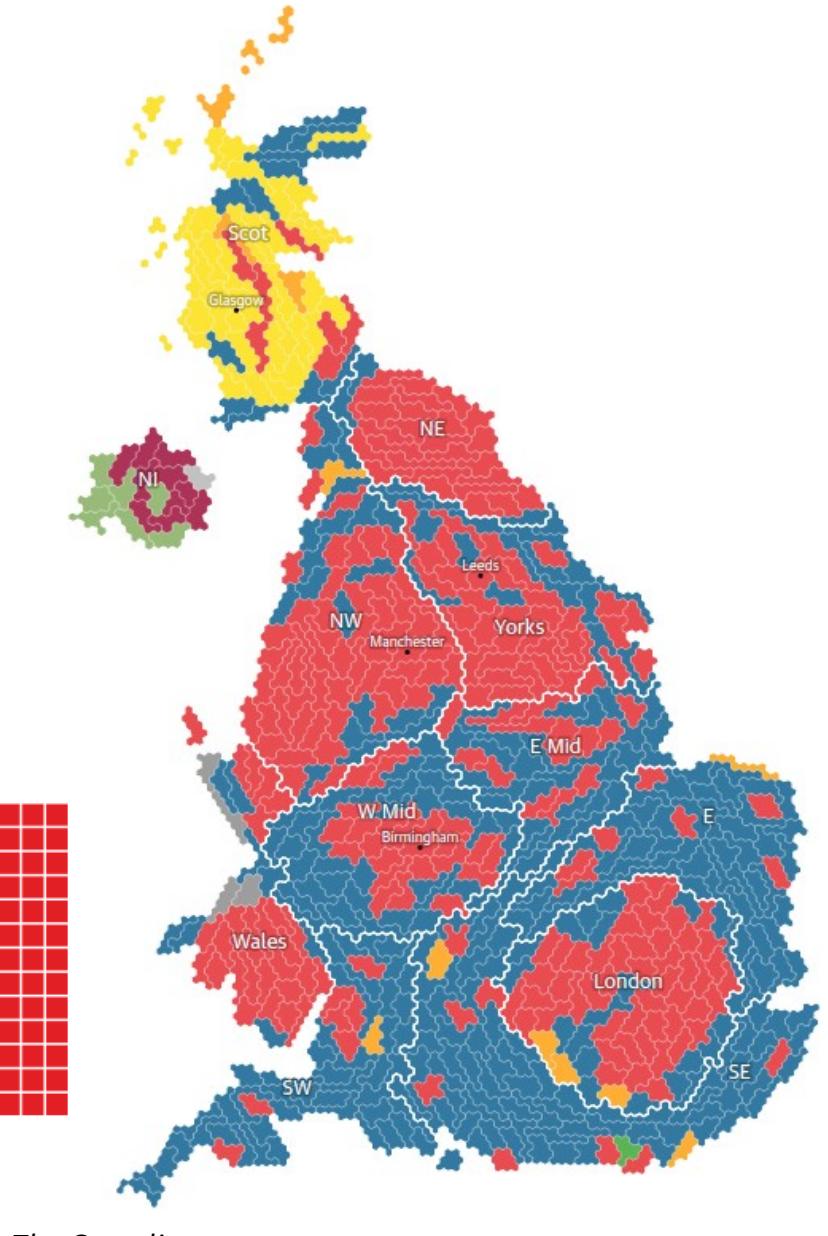
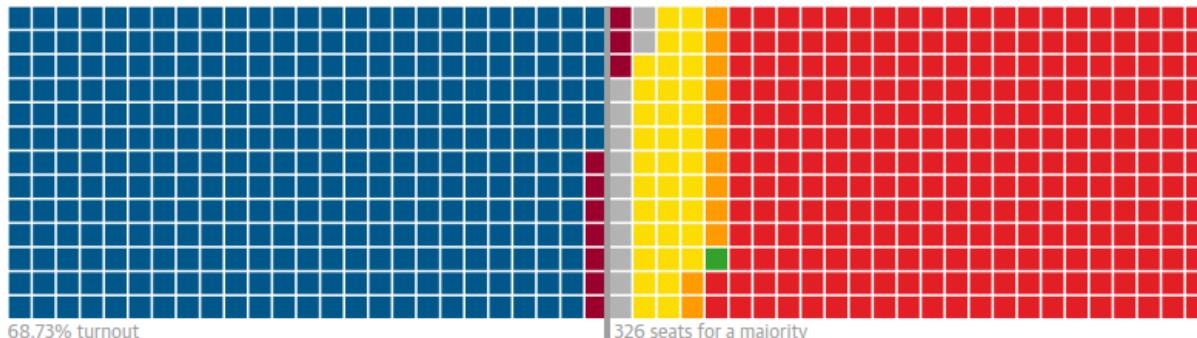
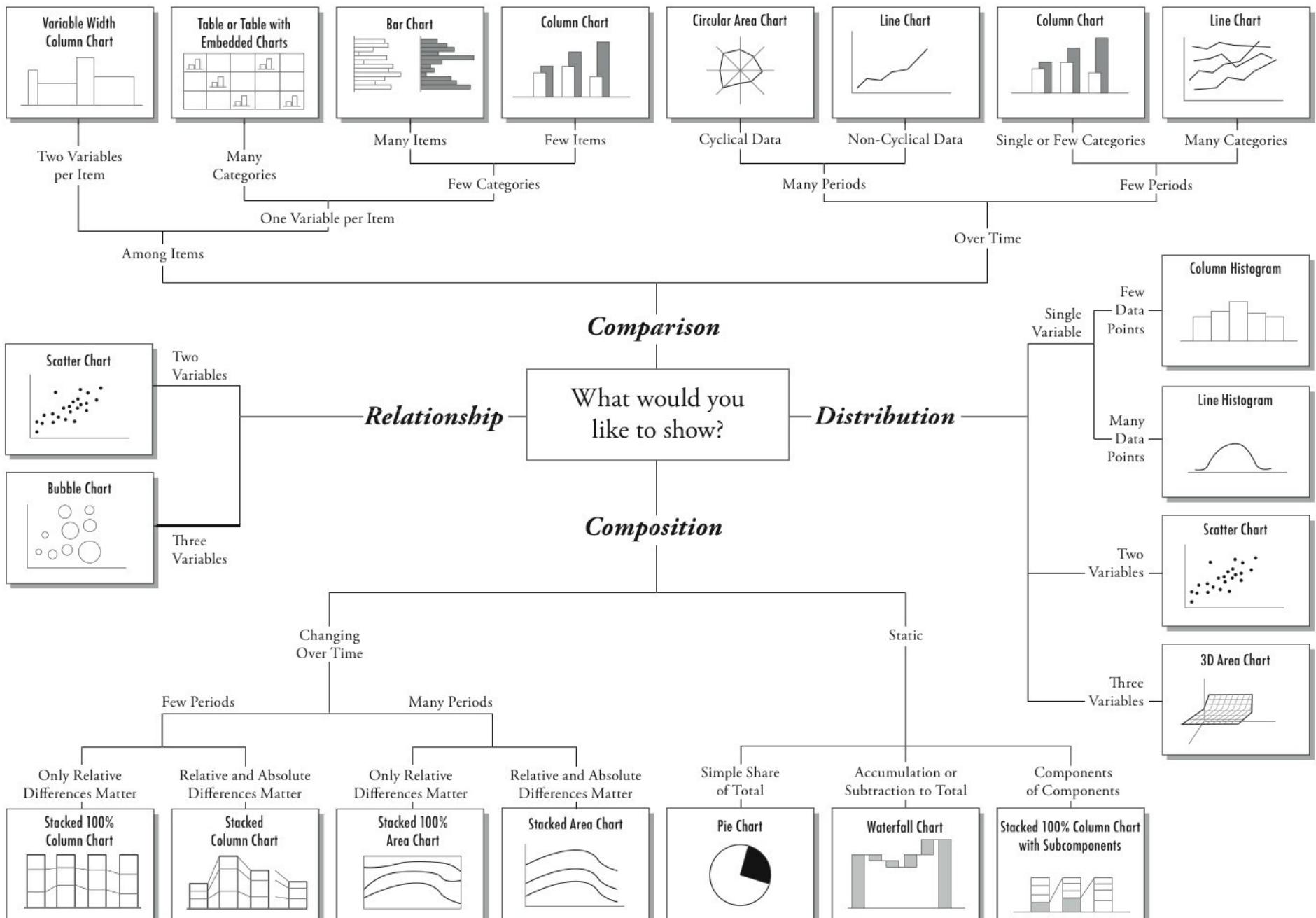


Chart Suggestions—A Thought-Starter



Summary

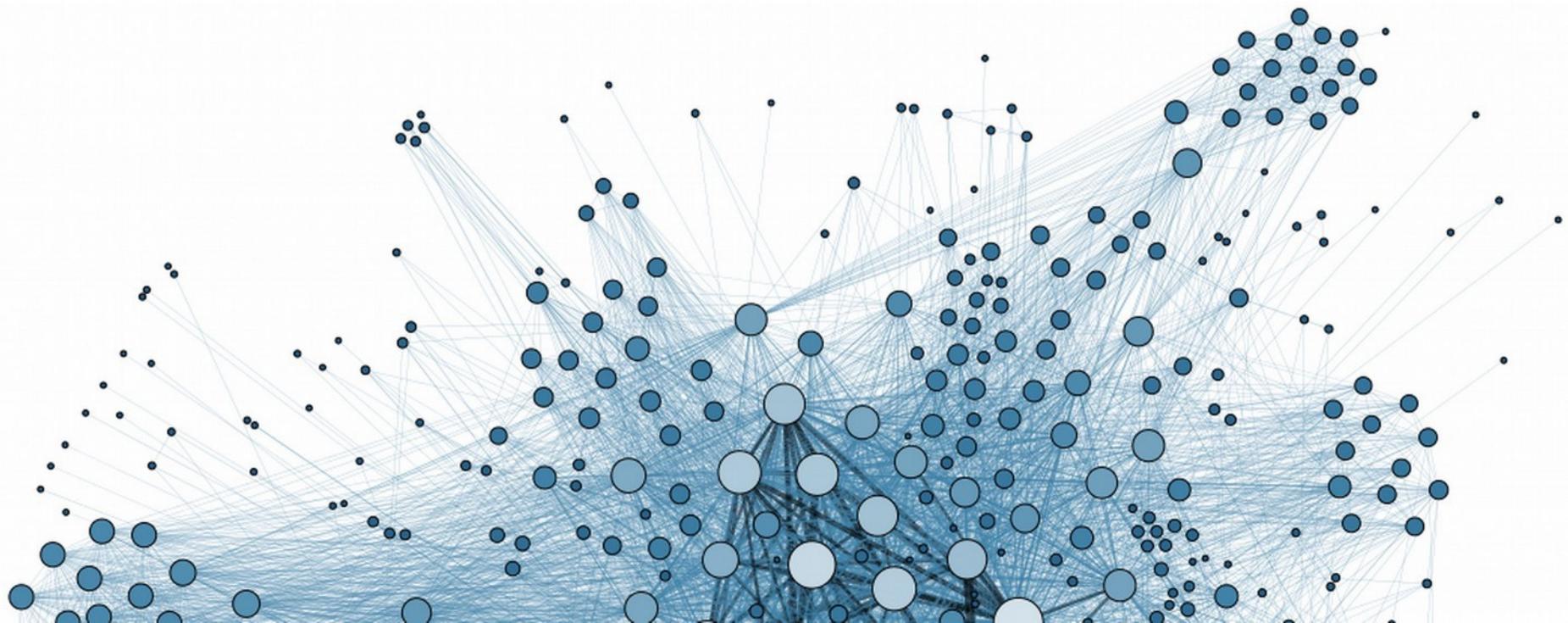
<i>Plot</i>	<i>Aim</i>	<i>Main R function</i>
Stripchart	distribution	<code>stripchart()</code>
Line chart	relationships	<code>plot(type="l")</code>
Bar chart (stacked, norm. stacked)	comparison (and composition)	<code>barplot()</code>
Dotchart with CI	comparison	<code>dotchart()</code>
Histogram	distribution	<code>hist()</code>
Boxplot (violin/ bean)	distribution	<code>boxplot()</code> , <code>vioplot()</code>
Scatterplot (correlogram)	relationships	<code>plot(x, y)</code> , corrgram package
Pie chart	composition	<code>pie()</code>
Heatmap	relationship	<code>heatmap()</code>

2. Figures: Convey information visually

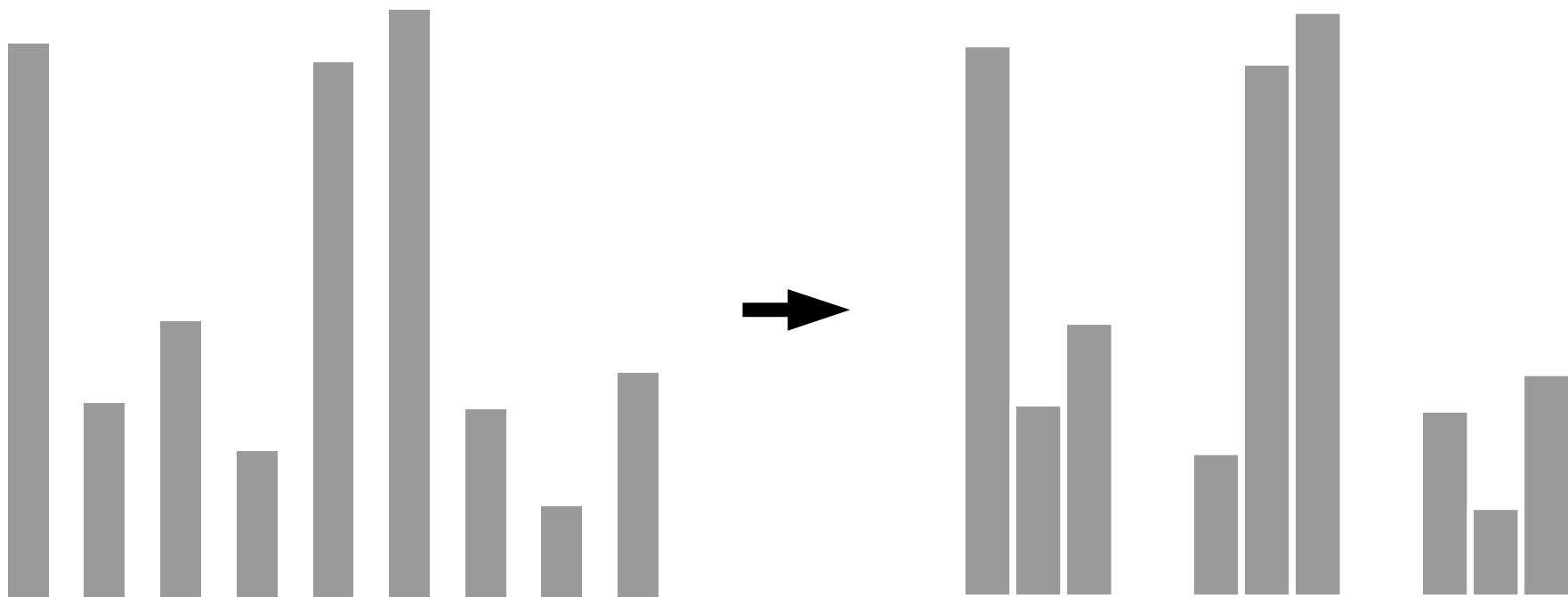
1. Key figures/legends advice
2. Elements: Marks and Channels
3. Choosing the right type of figure
4. Dealing with complexity
5. Typography
6. Composition and Layout
7. General Tips

Dealing with complexity

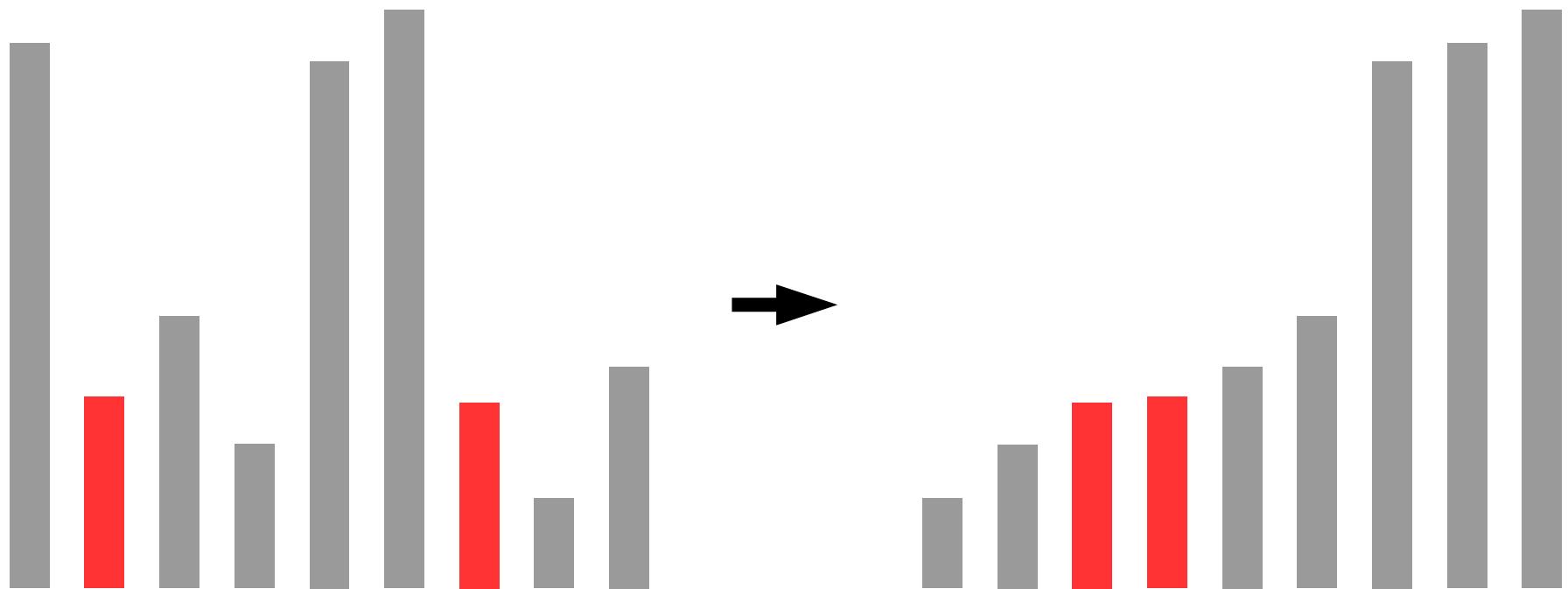
- To focus the viewer's attention onto the main point you want to convey (e.g. on specific subsets of data)
- To require less cognitive load for the viewer to understand the message

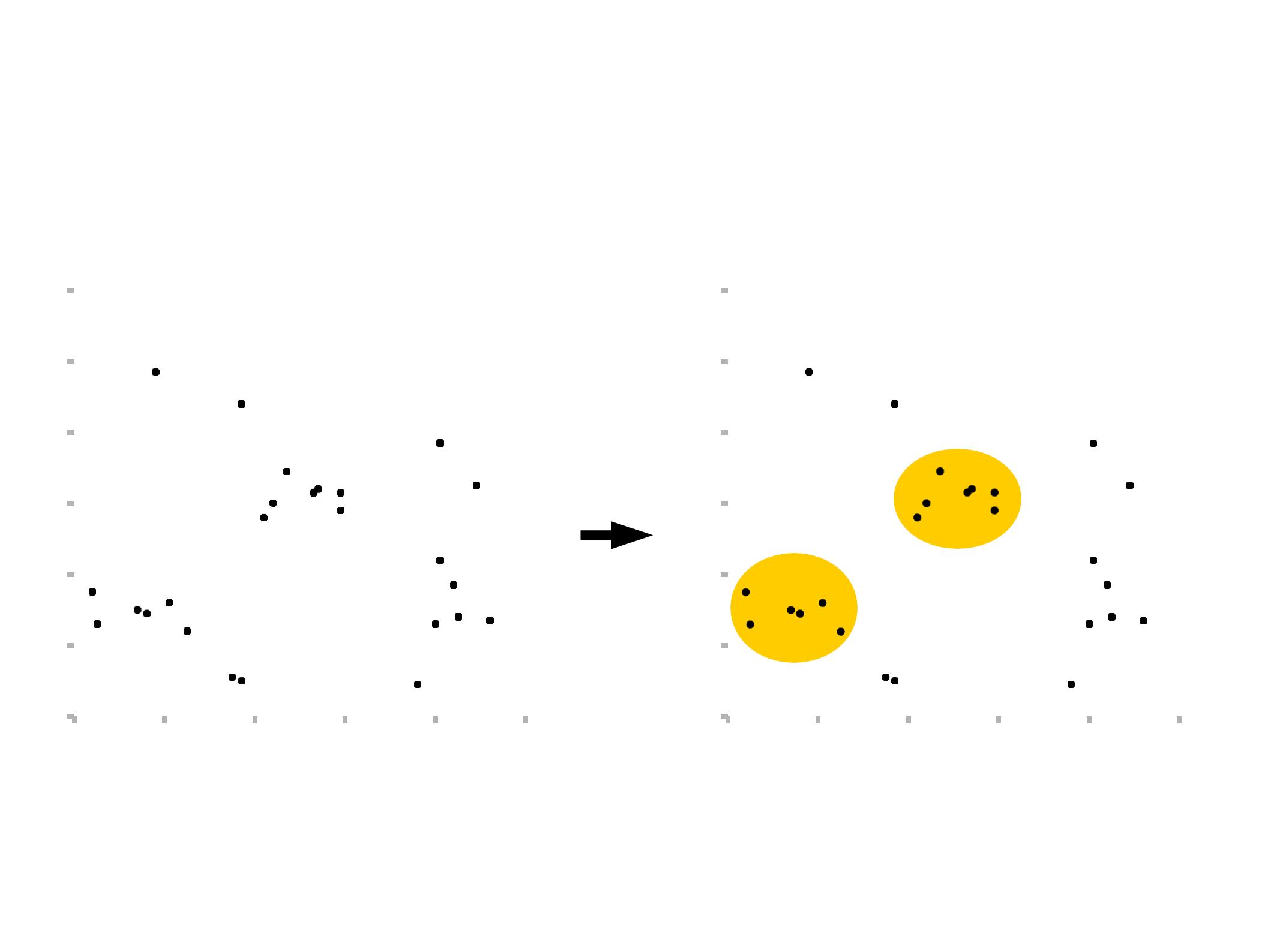


Grouping

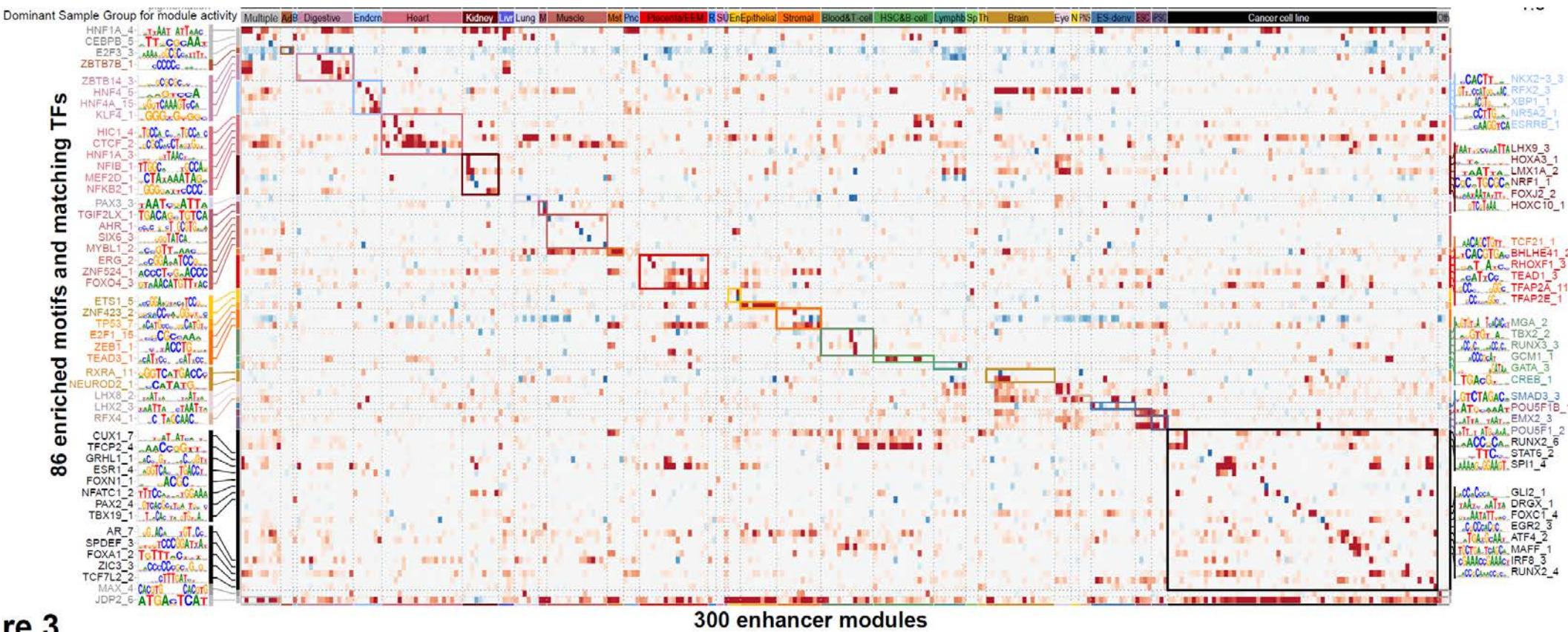


Ordering (only for categories)



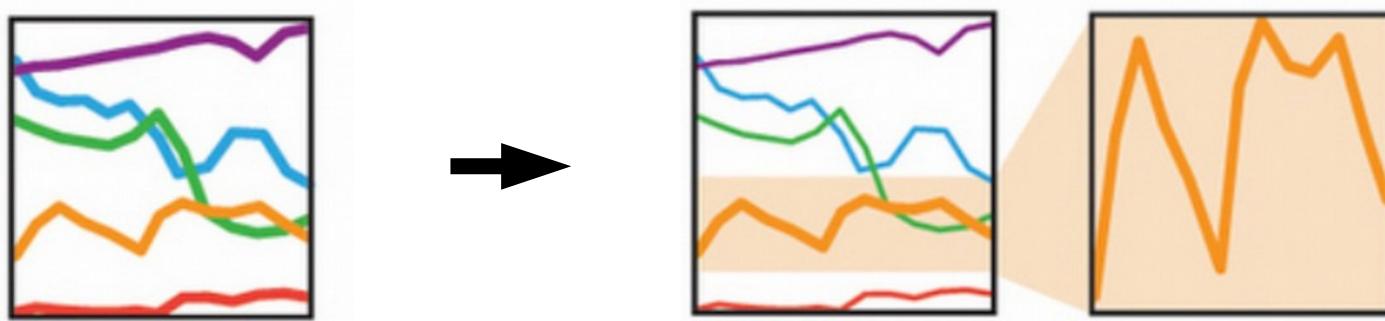


Diagonalizing (for heatmaps)

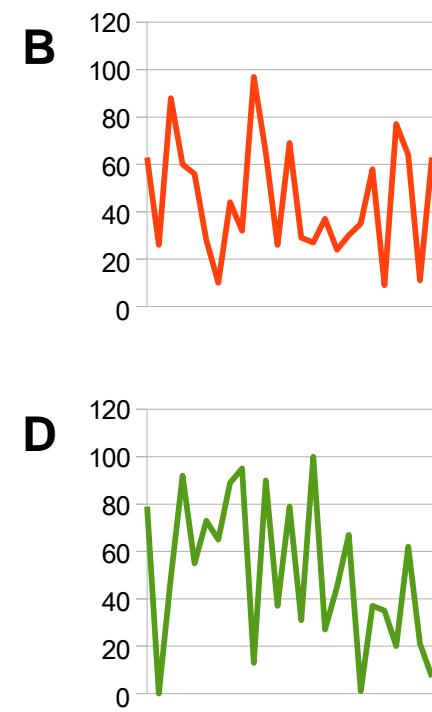
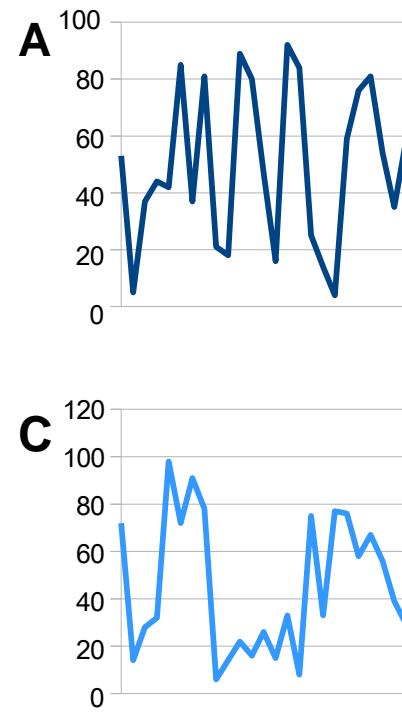
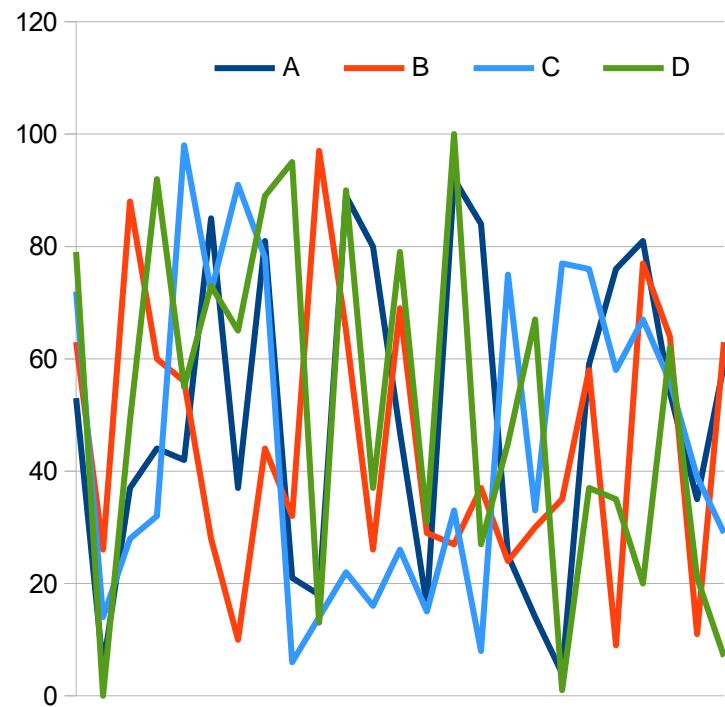


re 3

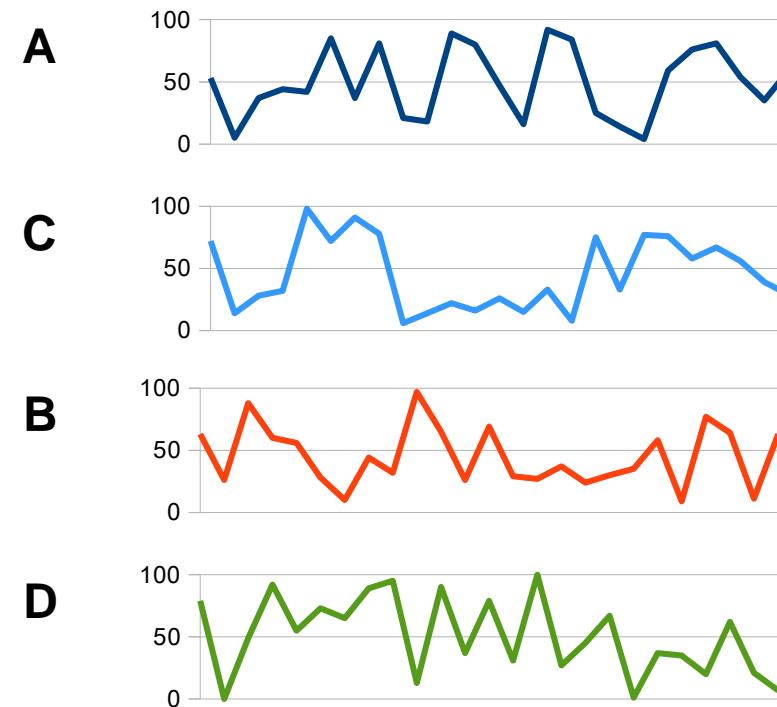
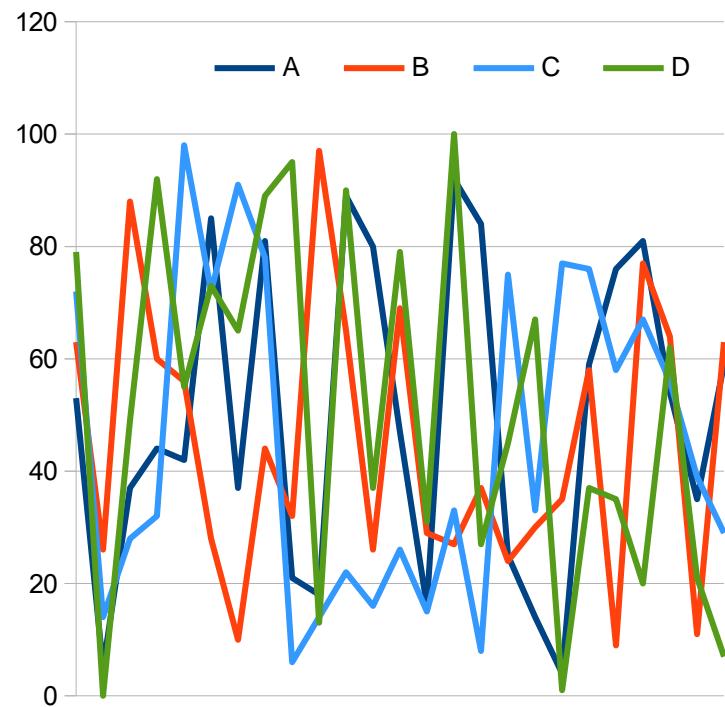
Filter, link, embed



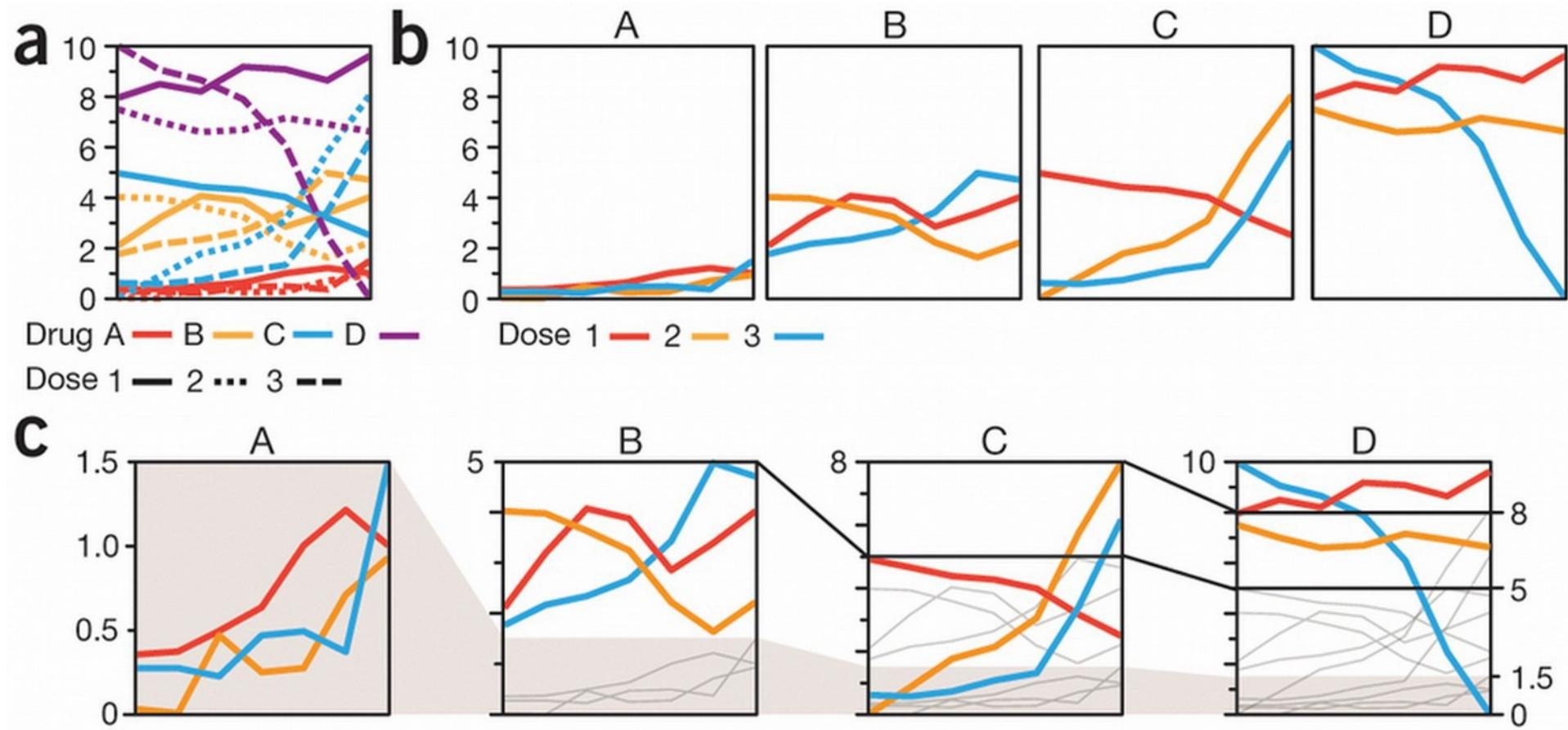
Small multiples



Small multiples



Small multiples



2. Figures: Convey information visually

1. Key figures/legends advice
2. Elements: Marks and Channels
3. Choosing the right type of figure
4. Dealing with complexity
5. Typography
6. Composition and Layout
7. General Tips

Typography (fonts)

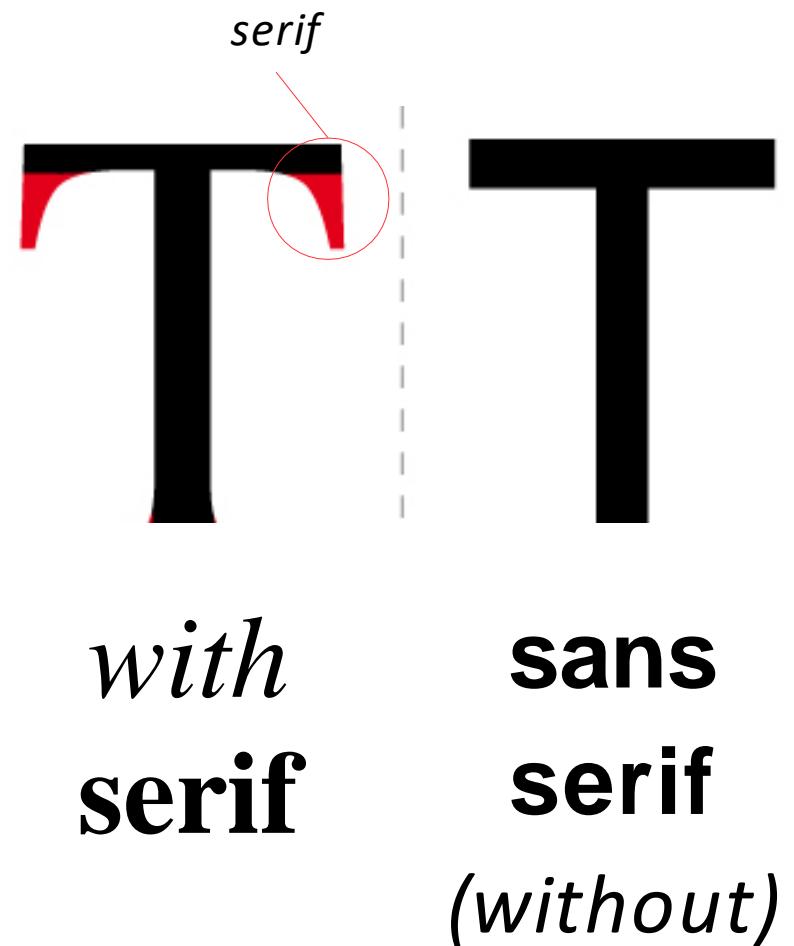
- All the elements need to be labelled
- The essential criteria for choosing fonts is **readability**:
 - **Scalability** (readable at small sizes)
 - **Contrast** with the background
- Fonts convey a personality, mood or attitude (some more than others)

Typography

- **Serif** for large blocks of text, **sans-serif** for titles, labels and annotating figures
 - Sans-serif is easier to read
- at smaller sizes

Sizing: the size of fonts is given in points, and it's the size of an imaginary block of metal that is used in printing.

- In practice, the only way to know exactly how well your font will be read is to print



Typography

- **Monospace** is good for code, or for text intended to be aligned from line to line (e.g. pseudo-tables)
 - g. m vs m; i vs i
- **Casing:**
 - UPPERCASE,
 - lowercase,
 - Sentence case,
 - Title Case.
- Check the journal guidelines
- for font types

Monospace font keeps the alignments tidy.
(this is monospace!)

Monospace font keeps the alignments tidy.
(not monospace font)

Each of the lines above has 20 characters.

Typography: Guidelines



UNIVERSITY OF
CAMBRIDGE



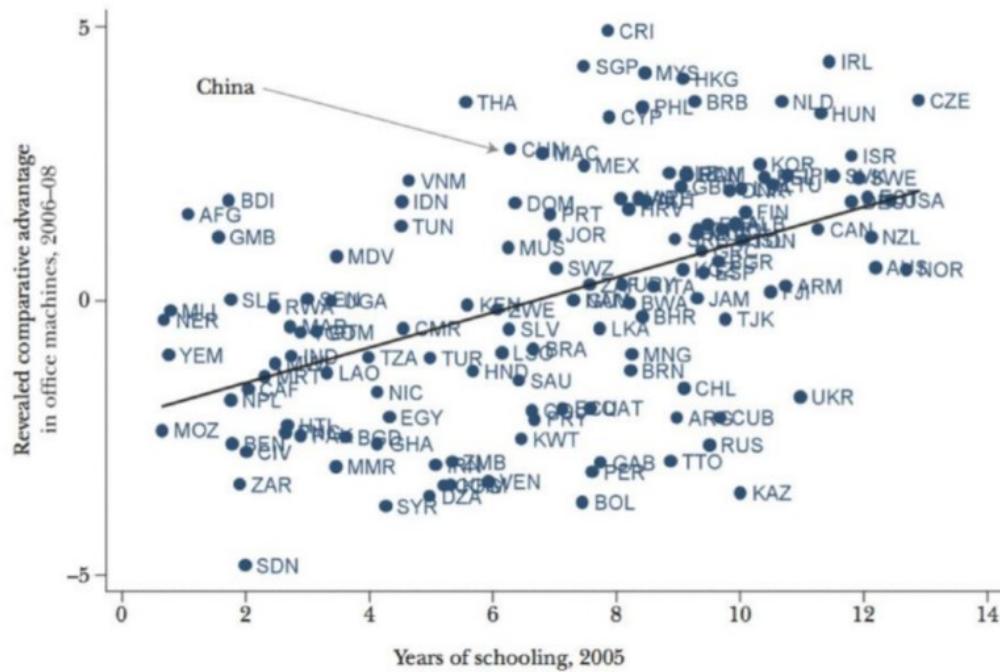
UNIVERSITY OF
CAMBRIDGE

Avoid **aspect-ratio distortions**: changing font height or size.

- The same applies to images and circular objects
- Scale axes using comparable units

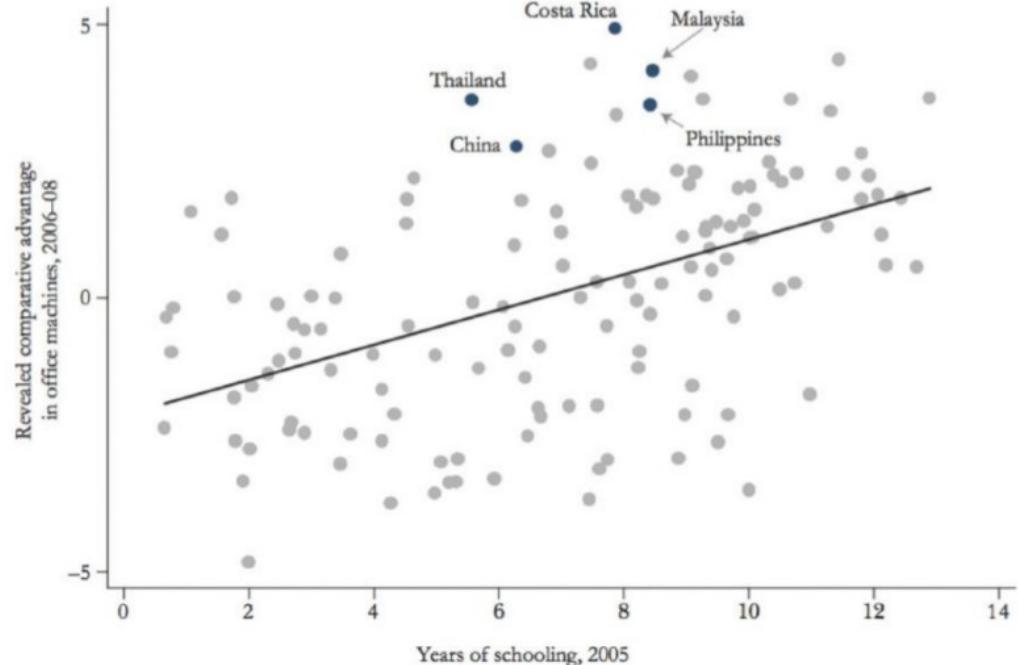
Typography: Guidelines

Education and Exports of Office Machines



Minimise text; keep it simple

Education and Exports of Office Machines



Typography: Typesetting

- Is the arrangement (spacing) of characters in words, lines or paragraphs
 - **Tracking:** space between characters
 - **Leading:** line height
 - **Paragraph alignment:** left, justified, etc.
- Important considerations where figures have many annotations, and in axis and figure titles.

Typography: Guidelines

- **Avoid colour** in text, particularly in figures (to maximise contrast)
 - **Do not tilt** text, always horizontal (or vertical)
 - Check **scalability**: text should be readable after resizing
-  Typeset in blocks of text that are **solid shapes**
-  Avoid typeset in blocks of text that are not **solid shapes**

Typography:

Heed the numbers in your font

1	l	1	1
2	2	2	2
7	7	7	7
6	6	6	6

- Each font has different styles of numbers
- Make sure that the font you choose distinguishes them well (e.g. l in *Gill Sans*) and is legible at small sizes

Typography:

Think your words carefully

- Avoid wordiness... it's a figure!
- Choose words that “precisely convey what you mean”
- Avoid contractions and spell out whenever possible

2. Figures: Convey information visually

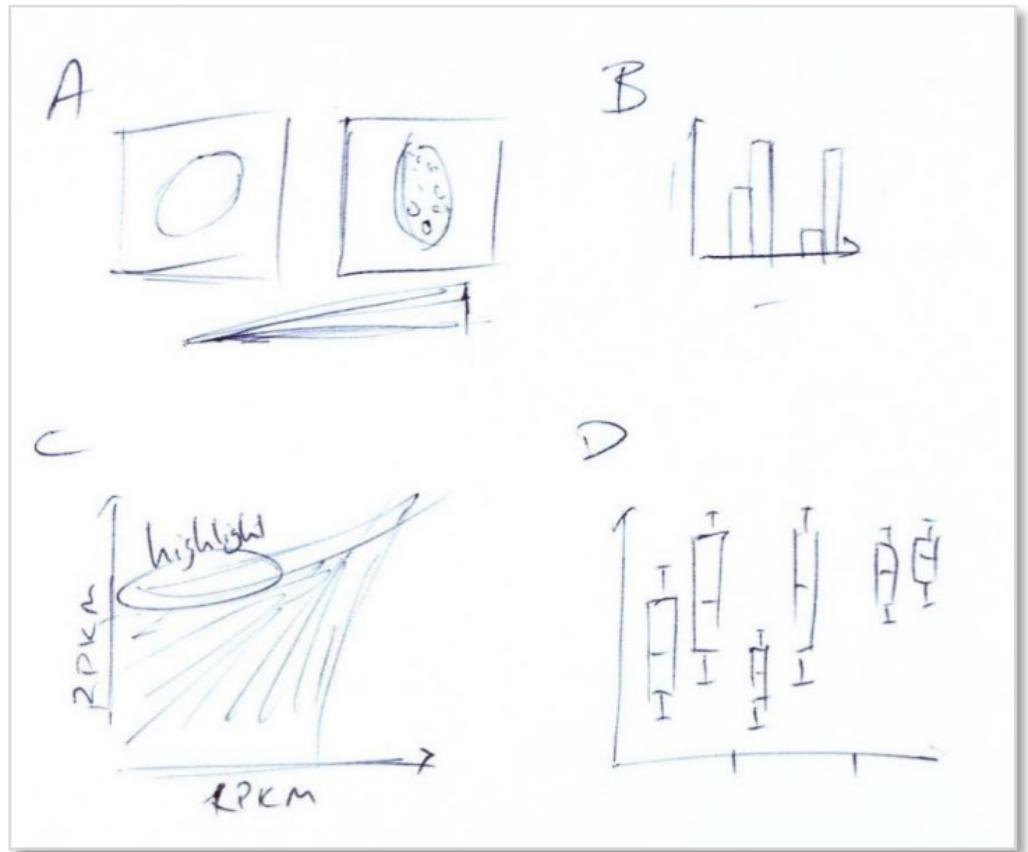
1. Key figures/legends advice
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7. General Tips

Composition and layout

- Draft
- Grid and alignments
- Balance and hierarchy

Composition and layout

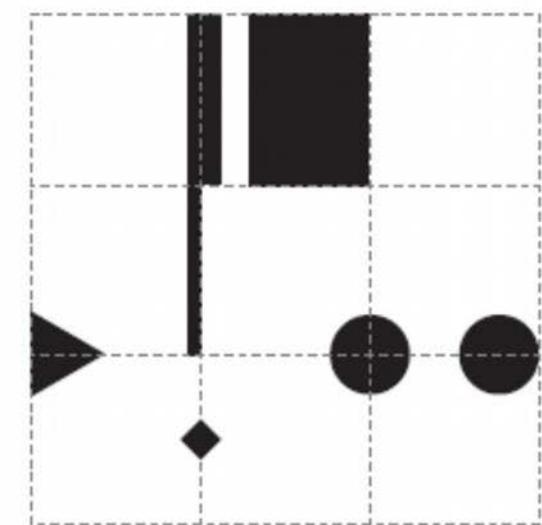
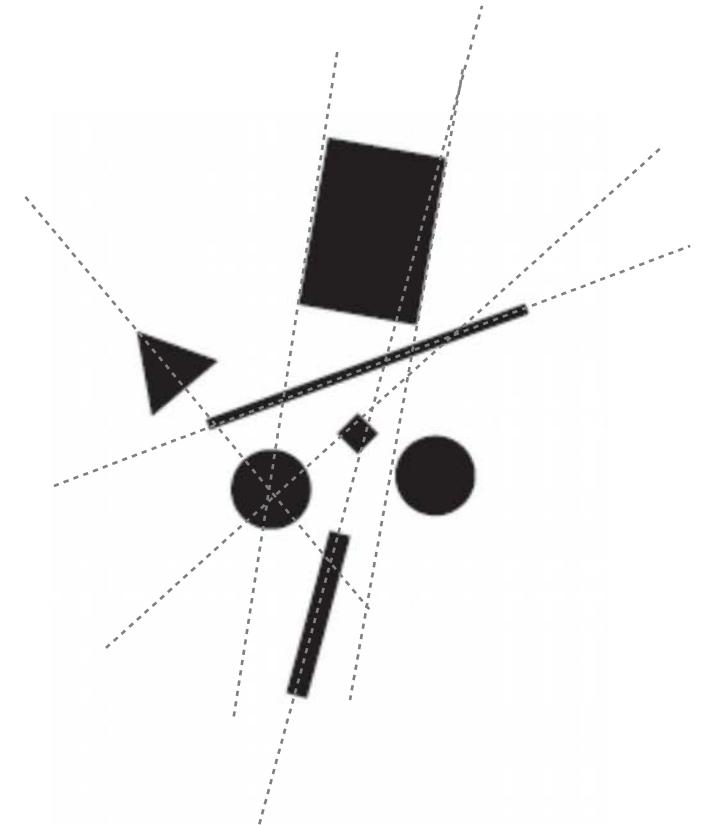
- Have an idea of what your final figure will look like
 - What message are you trying to convey?
 - How does each figure contribute to that message?
 - Identify what is essential (Supporting Information)
- Outlines can reduce time spent moving or resizing images



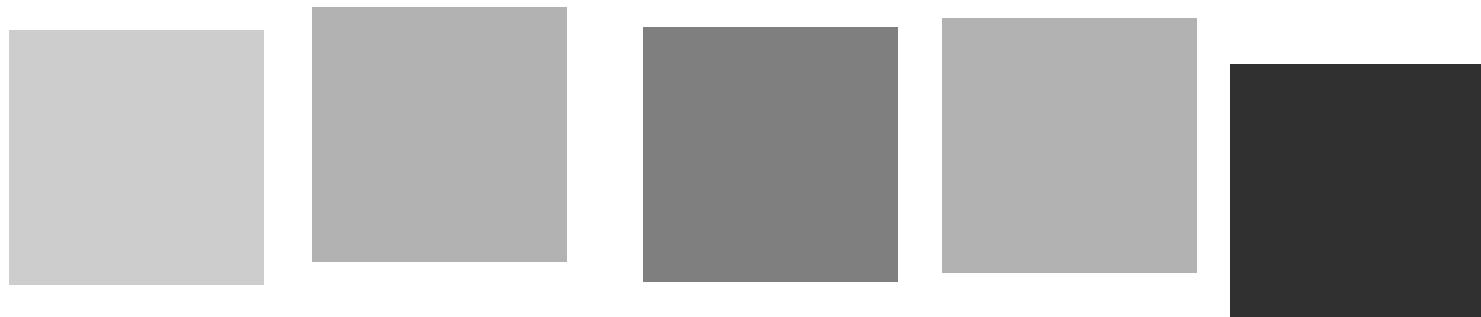
Grids

- Grids are the invisible structure behind a composition that makes it look balanced
- Every alignment (of a box, column, text line and text margin) creates a **visual line** in the grid
- Conversely, a composition where elements are aligned to a grid creates a sense of balance

Grids can help to organize the spaces around and in-between elements. *Roland et al 2011*



Alignments

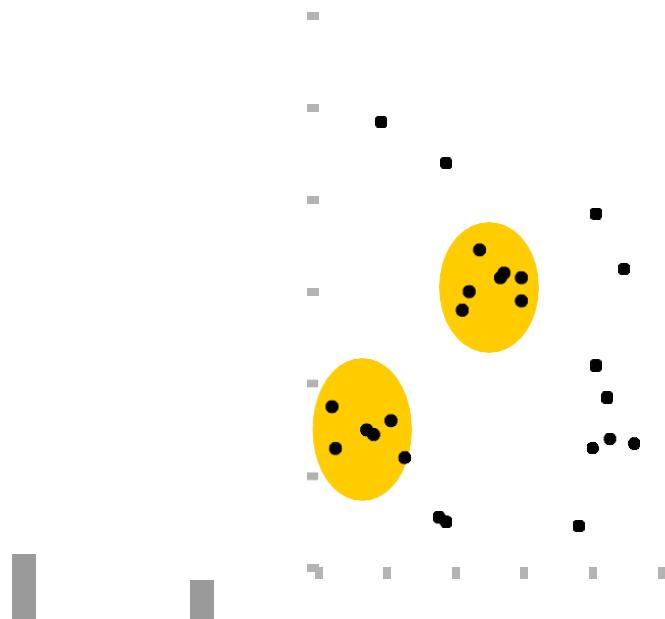


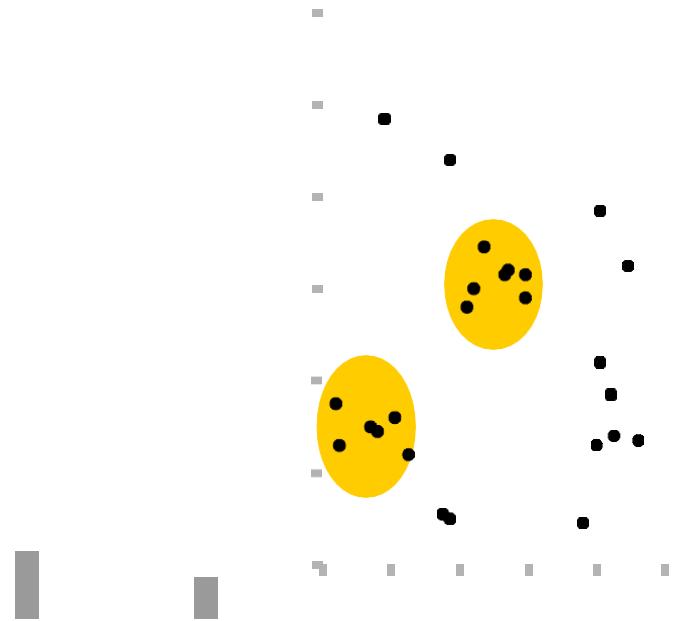
Alignments



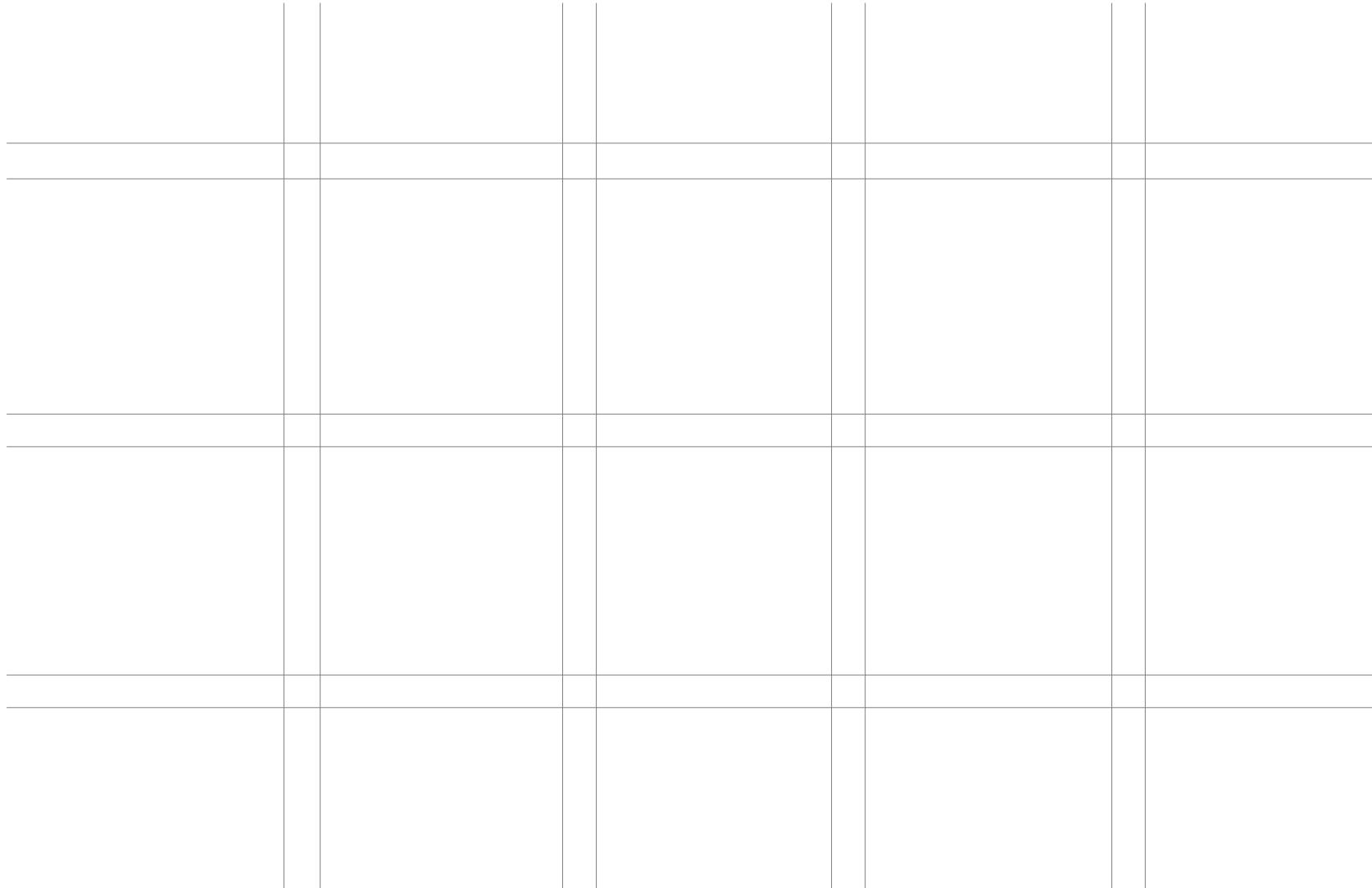
Use tools to align objects, don't do it by eye!

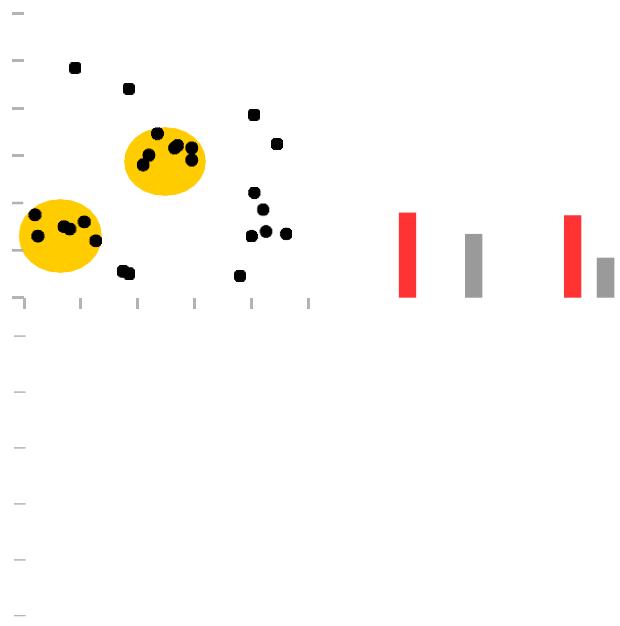
Most programmes have tools for automatic alignment and to distribute objects with equalspace.

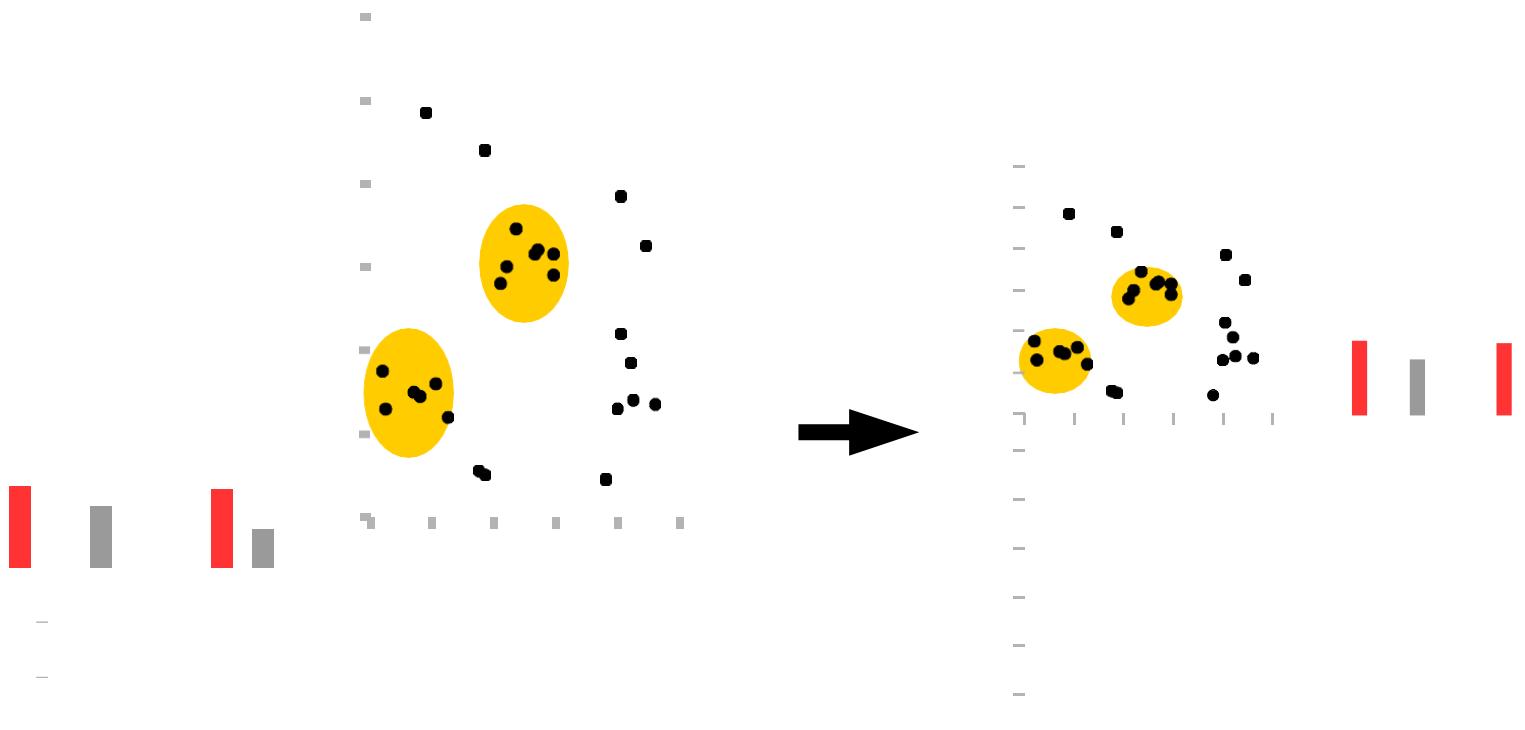


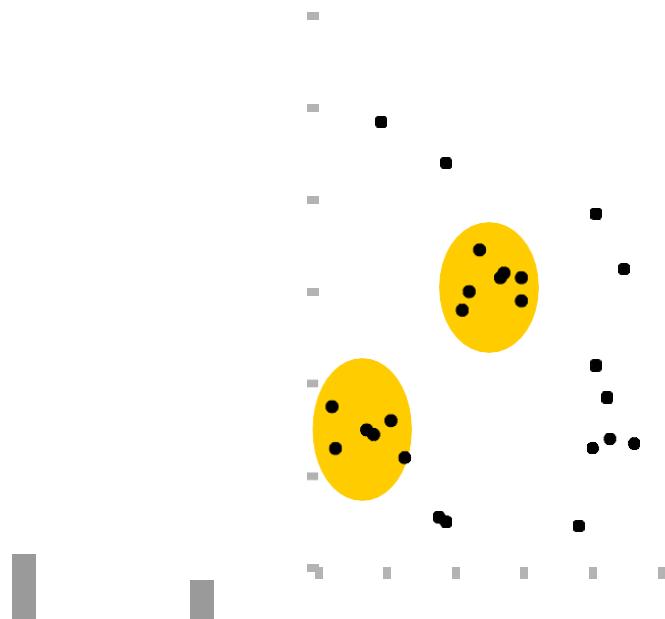


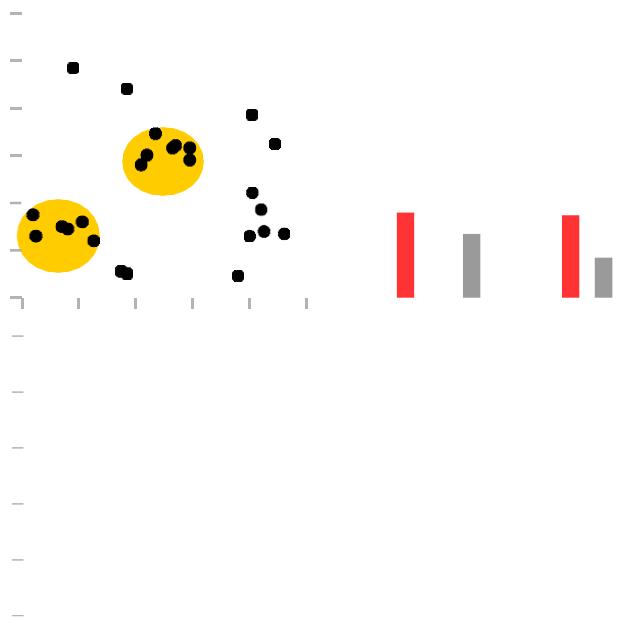
Using grids











Visual balance and hierarchy

The composition of a graphic object and the **emphasis** on each element will determine what is the **hierarchy between elements**, and how the eye will **flow** and where it will **focus**

Keep a balance between **white space**, text and figures

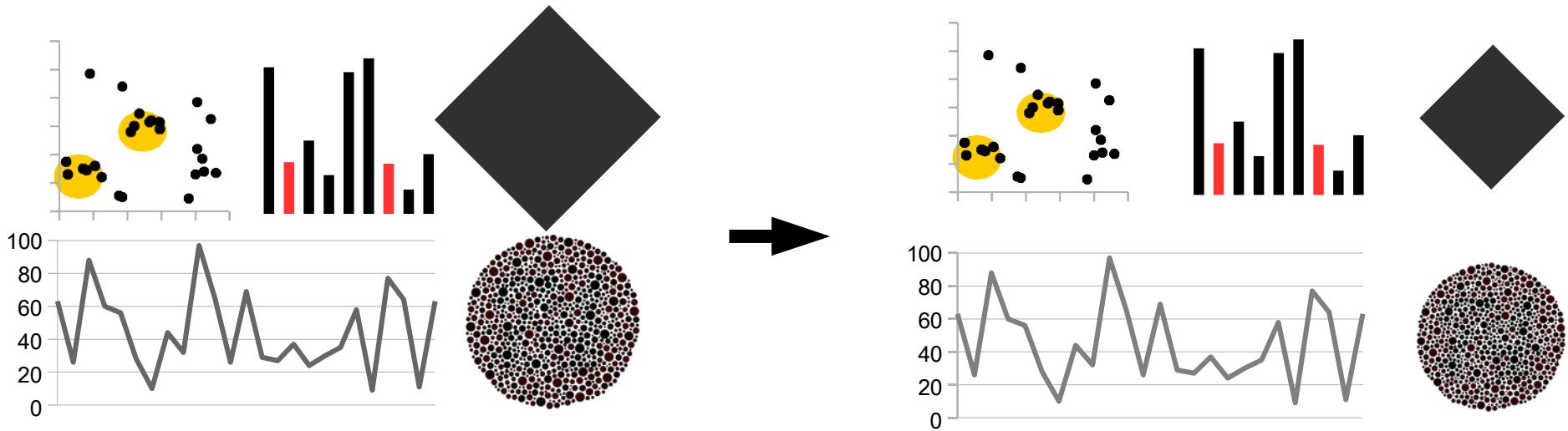
Visual weight/ emphasis:

- How much an object on the page attracts and retains the attention of your viewer
 - Depends on size, colour, position, etc.
- Should match the relevance of the information

These are some questions you can make to assess visual balance and flow: *Is there a clear (and justified) hierarchy or arrangement between elements? Can adjustments be made to make more relevant connections? Does the place feel cluttered/scattered?* (Krause, 2004)

Visual weight and balance

Visual weight: A measure of how much an object on the page attracts and retains the attention of your viewer



In the left figure, the black diamond and, to a lesser extent, the circle stand out (*is this our intention?*).

There is also little separation between the charts, which makes the figure look cluttered.

A black and white photograph of a long, straight road stretching into the distance under a cloudy sky. The road has a dashed center line and solid white lines on the sides. The horizon is flat, suggesting a coastal or plain landscape.

YOU FOCUSED ON THIS FIRST

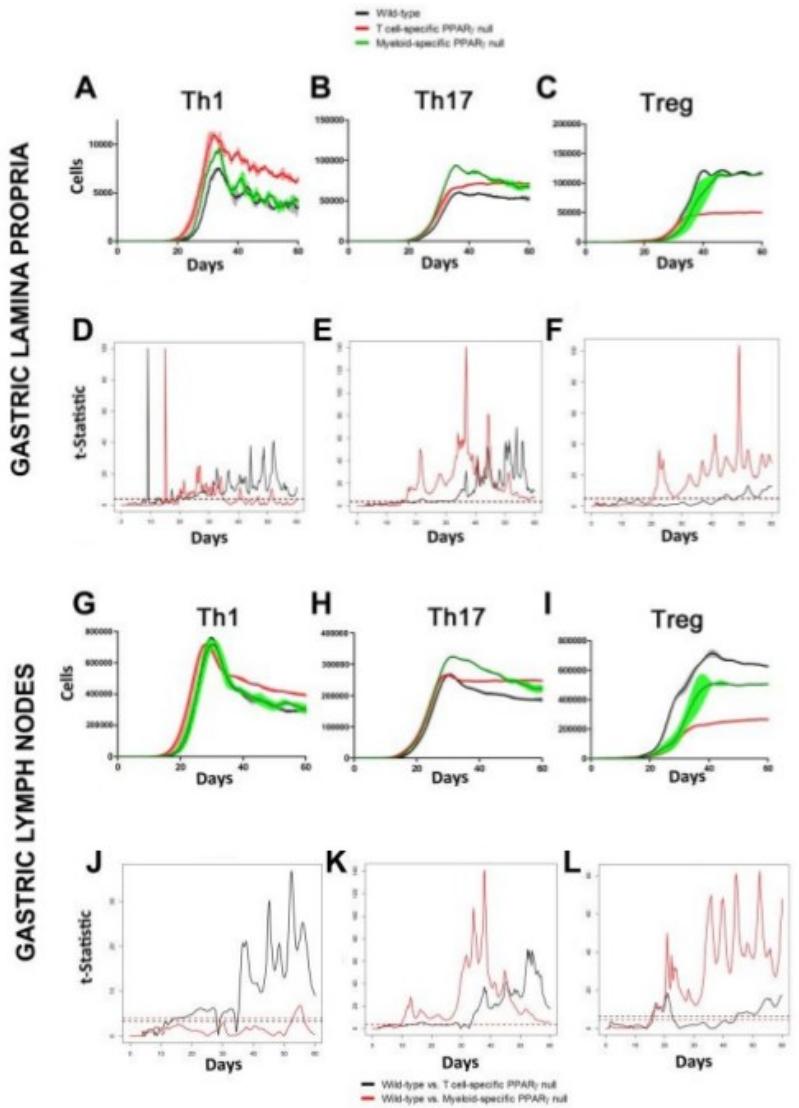
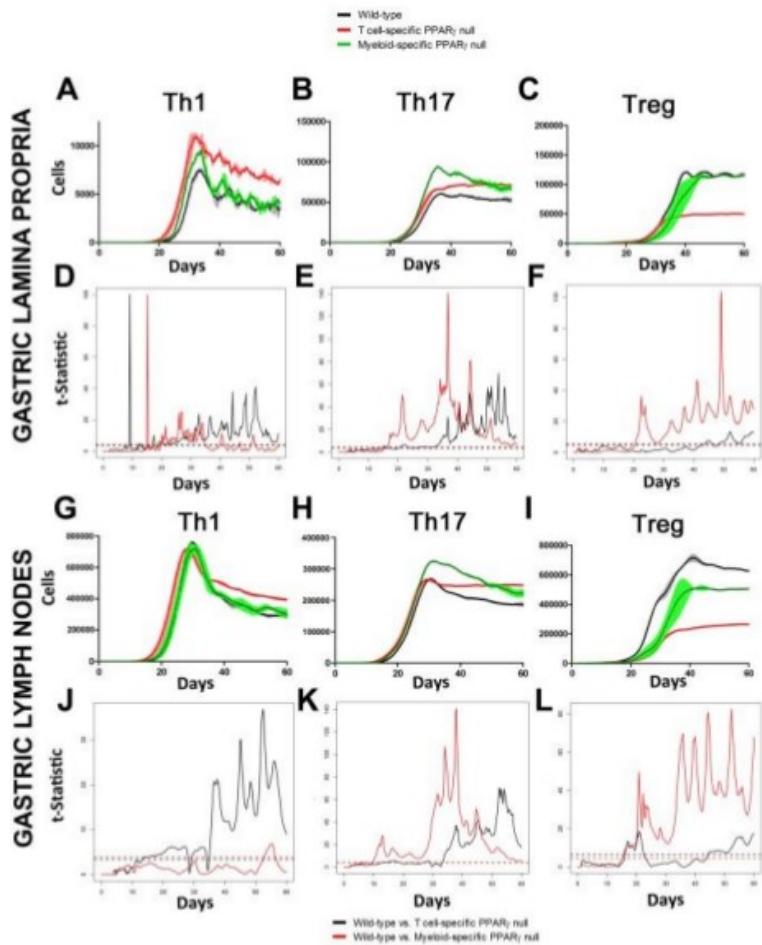
YOU FOCUSED ON THIS SECOND

Visual weight and balance

Visual weight: A measure of how much an object on the page attracts and retains the attention of your viewer

Can help to guide the viewers eye through the figure

Use of white space



2. Figures: Convey information visually

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General tips

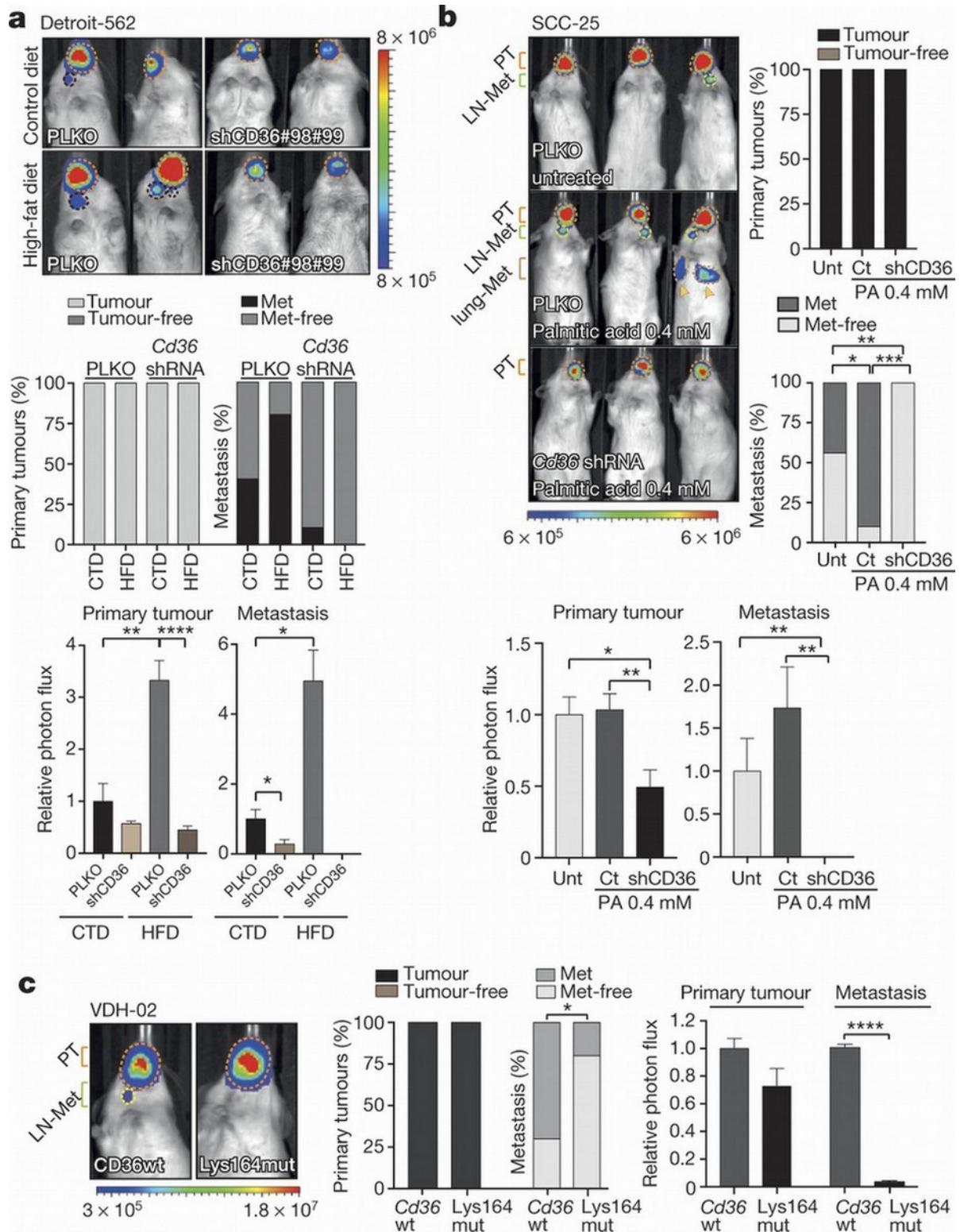
Don't-s:

- Don't distort the data
- No unnecessary figures or elements: *do we really need a figure? or a table would suffice?*
- Don't rely absolutely on colour
- No 3D: in most cases it distorts perception

Do-s:

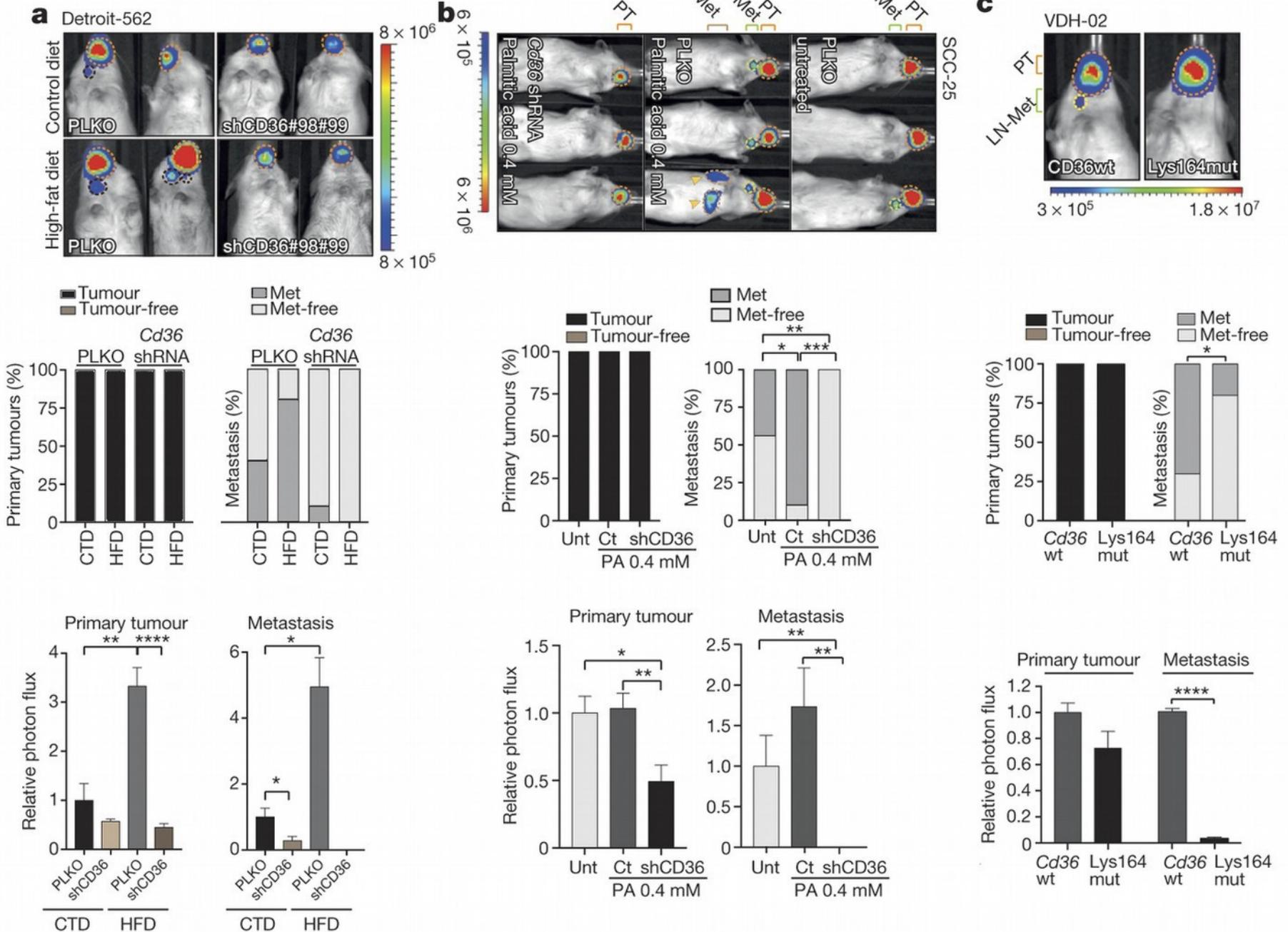
- One point per figure
- Summarise to clarify
- Have a clear purpose/ message
- Link to accompanying text and statistics

Can you find ten ways to improve this figure?

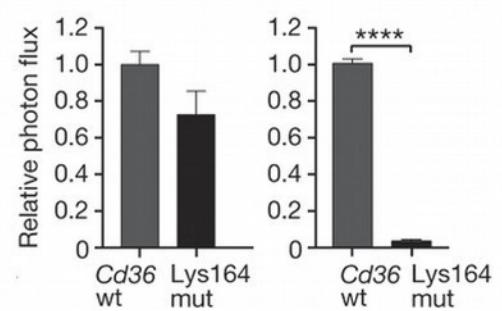
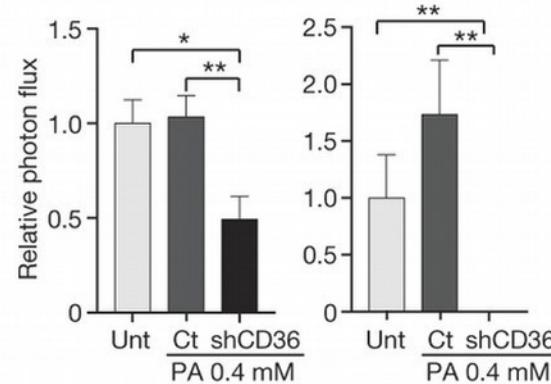
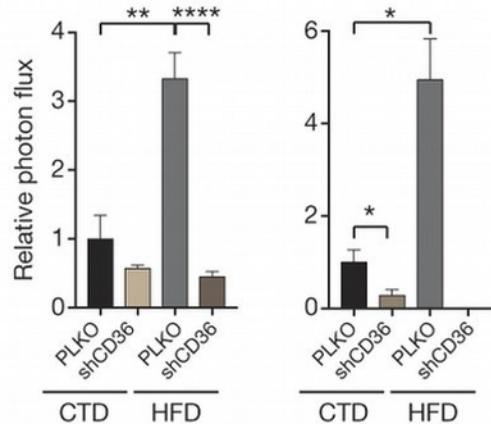
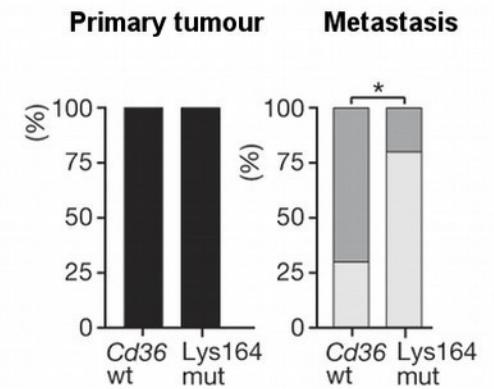
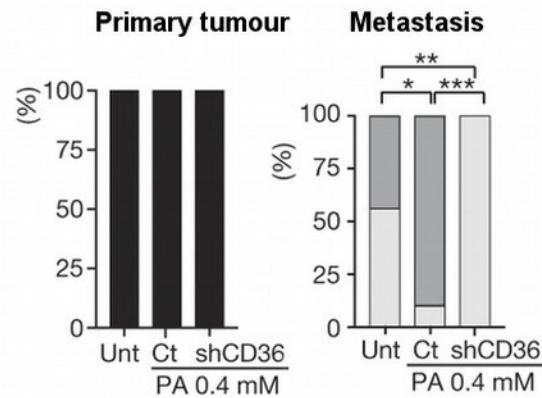
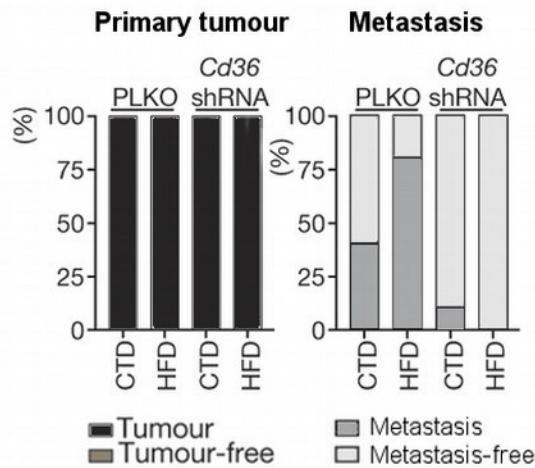
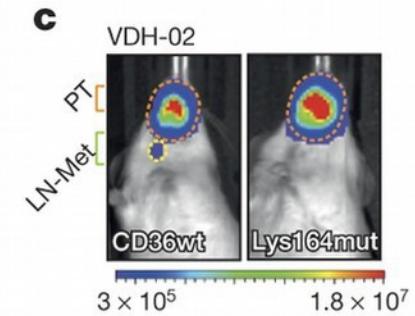
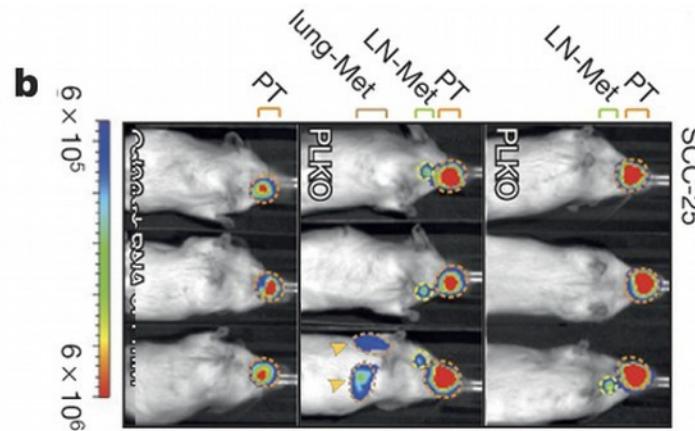
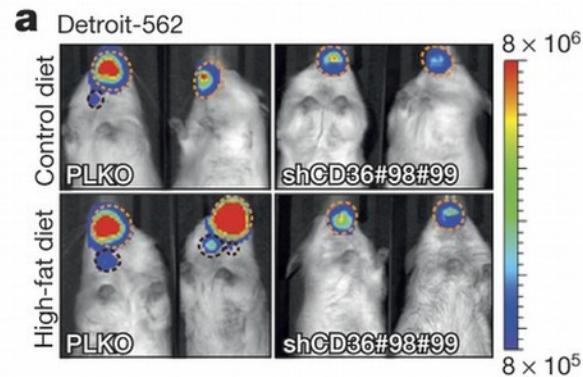


Pascual et al. Targeting metastasis-initiating cells through the fatty acid receptor CD36.
Nature. 7 December 2016

Work in progress...



Work in progress...

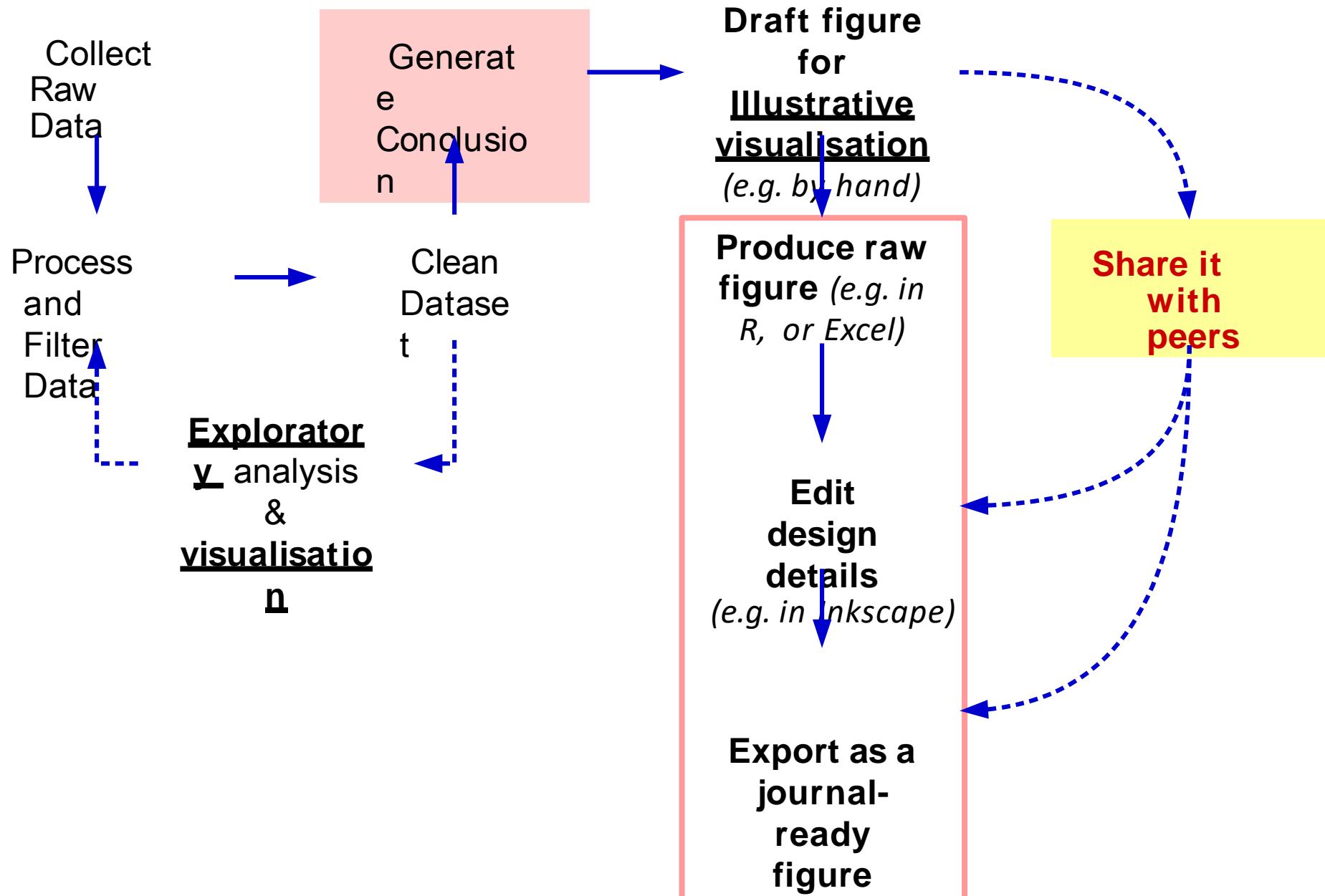


Checklist

Is your figure effective?

- The figure is **self contained**: understandable without additional information
- Every element is **labelled** or explained in the caption, including x and y units
- x and y axis: **scales** show appropriate variation of the data, or are comparable
- Readability** and **contrast** are appropriate
- Every use of **colour** has a reason
- The figure works in **grayscale** (except for very complex figures)
- If there are **groupings**, they help understand the message without manipulating
- There are no channel **inconsistencies** within the figure
- It is as **simple** as possible: i.e. no decorations, every piece that could be eliminated without losing information has been eliminated
- Has been **validated** with other people...

Data Visualisation Process



Validation

- Always try to validate plots you create
- You have seen your data too often to get an unbiased view
- Show the plot to someone not familiar with the data
 - What does this plot tell you?
 - Is this the message you wanted to convey?
 - If they pick multiple points, do they choose the most important one first?

Not covered in this session

Diagram

- Definition
- n
- Clarify the purpose: essential workflow
- w: elements to depict and their relation
- Draft the structure of the diagram by hand and share and discuss it
- Use grids and think carefully about the label choice and position
- Types: Venn diagrams (composition of datasets), flowcharts (for decision making processes), tree diagrams, timelines, networks, pathways, procedural diagrams

Remember: the key “*is not the quality of the diagram or drawing, but the clarity of the information*”

Carter p128

Photo

- Avoid unethical manipulation (deleting noise, etc.), even if it doesn't change the results
- Crop to emphasize important bits Rule of thirds
- Use good quality images (sufficient resolution and colour/ brightness settings)
- Format differences: JPEG, TIFF, GIF, PNG Resolution
- Cropping and image composition
- Image size and proportions
- In context: contrast and relation with surrounding content
- Check license for use

Some useful resources

- Short paper **Roland et al 2011.** [A Brief Guide to Designing Effective Figures for the Scientific Paper.](#)
 - **Rougier et al 2014.** [Ten Simple Rules for Better Figures.](#) *Plos Computational Biology* 10(9)
- Design for scientists/
data**Carter.** 2013. Designing science presentations – *not just for figures*,
 - *very clear*
 - **Munzner.** 2014. Visualization, analysis and design
 - *from a computer-graphics perspective*
 - **Tufte.** 2001. The visual display of quantitative information
 - *from a theory-of-design perspective*
 - *advanced information visualizations (maps, time-space, flows)*
- **Meirelles.** 2013. Design for information
- **Krause.** 2004. Design basics index – *very concise and to the point*
 - **Samara.** 2014. Design elements: a graphic design manual –
- **Nature Points of view.**
<http://blogs.nature.com/methagora/2013/07/data-visualization-points-of-view.html>

If you need additional references, help or want to collaborate: aiora.zabala@gmail.com,

2. Figures: Convey information visually

1. Key figures/legends advice
2. Elements: Marks and Channels
3. Choosing the right type of figure
4. Dealing with complexity
5. Typography
6. Composition and Layout
7. General Tips

How to write, visualize, present

1. Paper writing and organization: conveying

- Write-first, single key idea, narrative, sharing, feedback
- Readers first: intuition, examples, results-first, take-home
- Simple direct language, active voice, explain, be understood

2. Figures: displaying information visually

- Visual legends, axes:measure-vs-unit/reuse, minimize ink
- Elements: marks/channels; figure types; group/order/simpl
- Typography; composition/layout

3. Delivering impactful oral presentations

- Importance of conveying: sharing makes work alive, point
- Speak clearly: posture/voice/rhetoric/contact/flow/creativ
- Planning: storyboarding, signposts, recovery
- Convincing: rhetoric, ethos/pathos/logos, prepare/natural
- Connect: audience first, guide, appreciate, adapt, payload

Part 3: Delivering Impactful Oral Presentations

1. Importance of conveying your work

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- Posture, voice, rhetoric, eye contact, facial expression, hook, flow, creativity
- First impressions matter, influence talk perception. Practice. Use resources

3. How to plan your talk: storyboarding, signposts, recovery

- Flow: Common story arcs, logic, innovation, surprise, signposting, adaptation
- Recovery: dealing with unexpected, keep attention on talk, achieve goals

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5. Connect with your audience, achieve your goals, match them

- It's all about them, not you. Help them understand, appreciate, guide them
- Adapt your talk to the audience: jargon, detail, explanations, attire, posture

6. Take-home: delivery, recovery, credibility, goals, visibility

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Exercise – Self introduction: Film yourself & listen

- Describe (1) your background, (2) something interesting about yourself, (3) why you're taking this class, (4) what you want to do with the knowledge later, (4) what are your next career steps, (5) your longer-term plans for the future. Goal: 60-90 seconds
- Base grade of 3.3 for turning in a self-introduction video.

We will watch your video once and then will add +0.1 points for each of the following to the base grade for a max score of 10.0:

- Memorability (Overall)
- Hook (Content)
- Use of Rhetorical Devices (Content)
- Expressiveness in Voice (Delivery)
- Eye Contact (Delivery)
- Facial Expression (Delivery)
- Flow (Storyboard)
- Creativity (in any aspect)

Then, -0.1 points are deducted from the above score for:

- Poor Quality – volume, lighting
- Duration – too short or too long
- Speaker Position – not standing
- Frame – if speaker's head, torso and hands are not all visible
- Format – uncommon format / other reason causing video to not play
- Filename - failure to name file properly
- File size – resulting file too big (thus hard to download)

First impressions matter

What they think of you will influence how they interpret your words.

Their impression is influenced by many factors

- The company you work for
- Your reputation / credentials
- Reputation of those who spoke before you
- Your speech **content** (what you say)
- Your speech delivery (how you say it)
- Voice - volume/quality/tone
- Attire
- Age
- Body language
- Poise + posture
- Facial expression
- Eye contact
- Knowledge
- Confidence
- Active listening
- Company you keep
- How you treat others
- Mood/emotion
- Proximity
- Your writing style
- Deeds
- Handshake
- Punctuality
- Humor
- Physical attributes
- Hygiene
- Uniqueness

Resources to improve different aspects of delivery

	Eye Contact	Gestures	Space	Facial	Body / Posture	Volume	Word Choice	Intonation	Expressiveness	Silence / Pacing
Mime	✓	✓	✓	✓						
Cross Lingual Comm	✓		✓				✓			
Play-reading						✓		✓	✓	✓
Magic / Showmanship	✓	✓	✓	✓	✓		✓			✓
Musical Theatre	(✓)	(✓)	(✓)	✓	(✓)	✓		✓	✓	
Speech-reading	✓					✓		✓	✓	✓
Storytelling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Standup Comedy	✓	(✓)	✓	✓	✓	✓	✓	✓	✓	✓
Acting	✓	✓	✓	✓	✓	✓		✓	✓	✓

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Planning your talk, building a story: Storyboarding

Where We Are Heading	
Unused Variables? Remove or Callback	
Once upon a time...	Situation (Setup)
And every day...	
Until one day...	Conflict (Problem)
Because of that (3x)...	Stakes/Pain
Until finally...	Stakes or Resolution
And ever since that day...	Resolution (Solution)
As a result ...	Consequences (Delta)
The moral of the story is...	Take Away (Point)

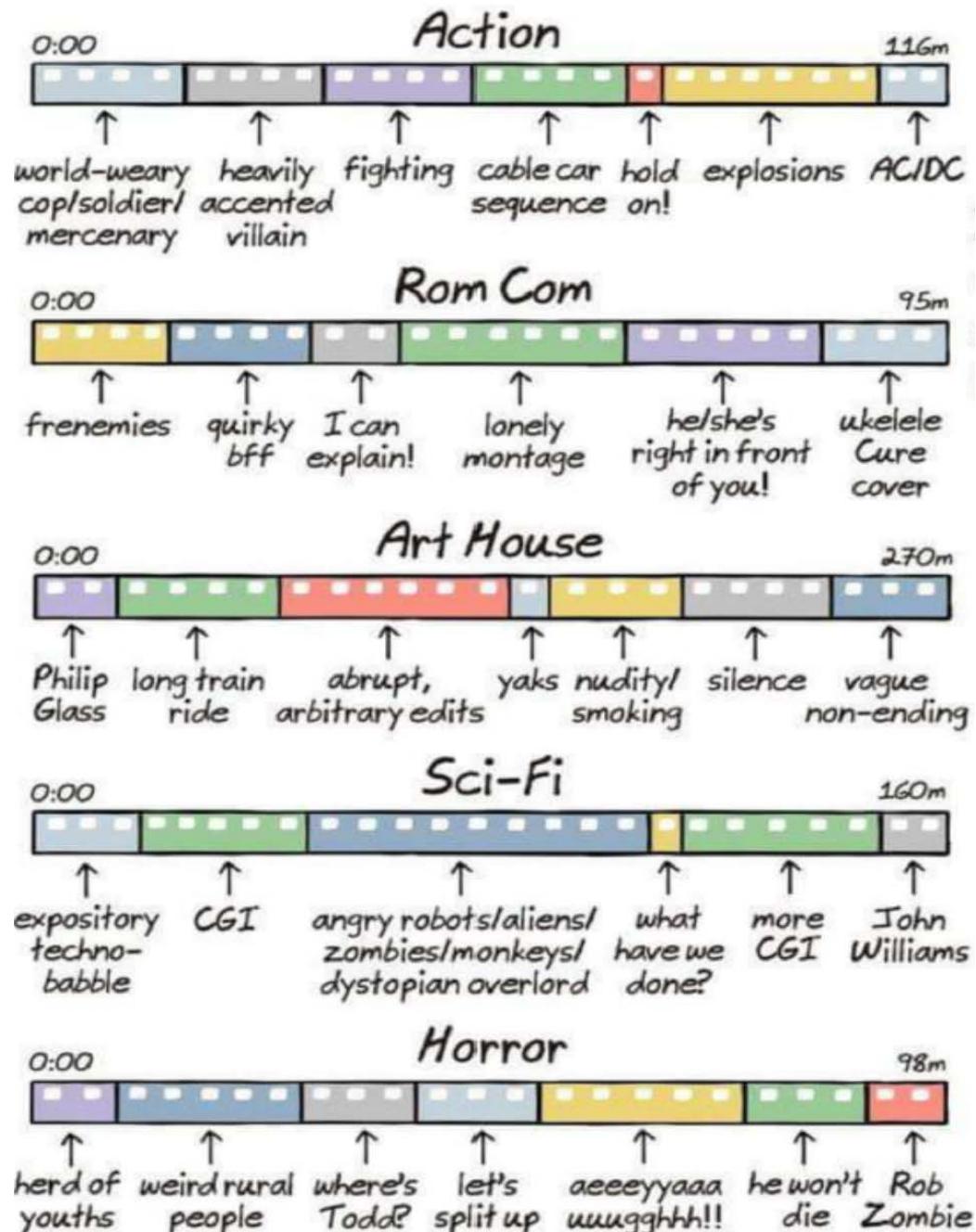
Context

Payload

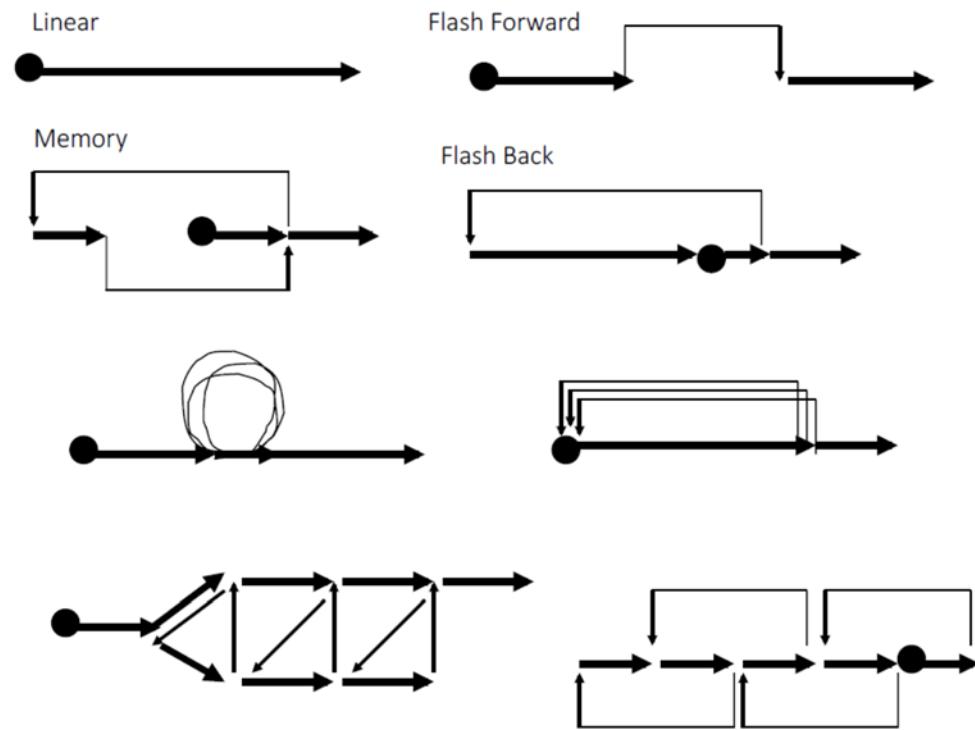
Where We've Been

Undeclared Variables? Setup

Typical movie storyboards



Unusual storyboards



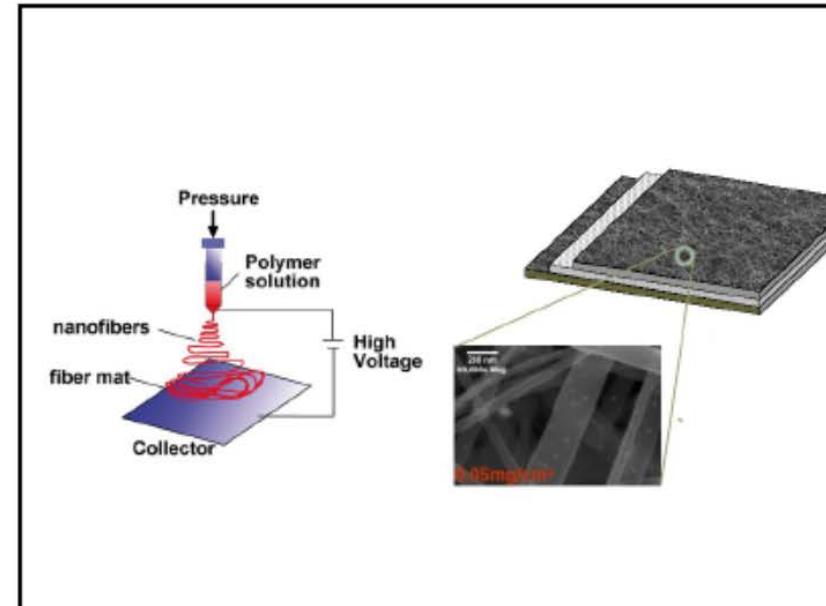
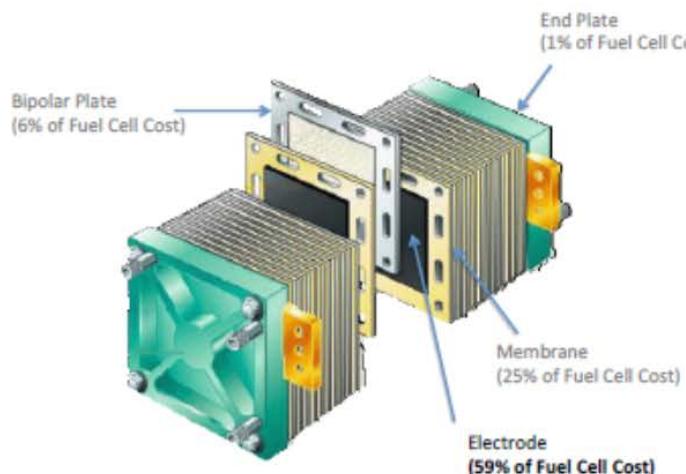
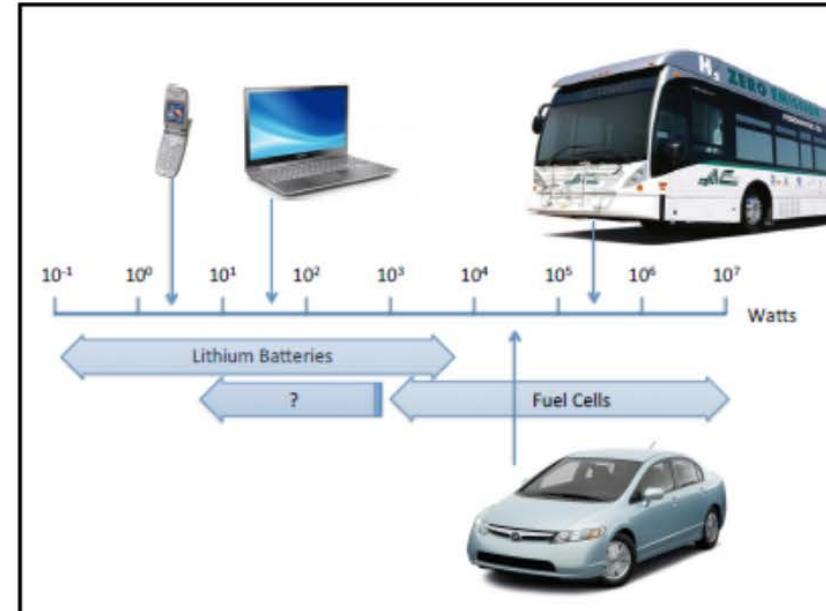
- Scientific talks have storyboards
- Many follow the same formulation
- But you can be creative about it
- Stand out? Impress? Match context? Specific goal? Someone has to leave early? Flexibility!

Example: 4-slide talk on fuel cells nanotechnology

Expanding Fuel Cell Markets using Nanotechnology

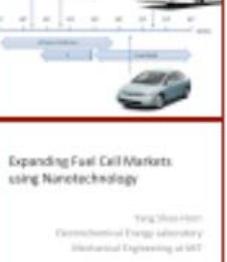
Yang Shao-Horn
Electrochemical Energy Laboratory
Mechanical Engineering at MIT

These slides are a modified version of Professor Shao-Horn's April 2002 Deshpande Center talk



Many storyboards are possible: Change start

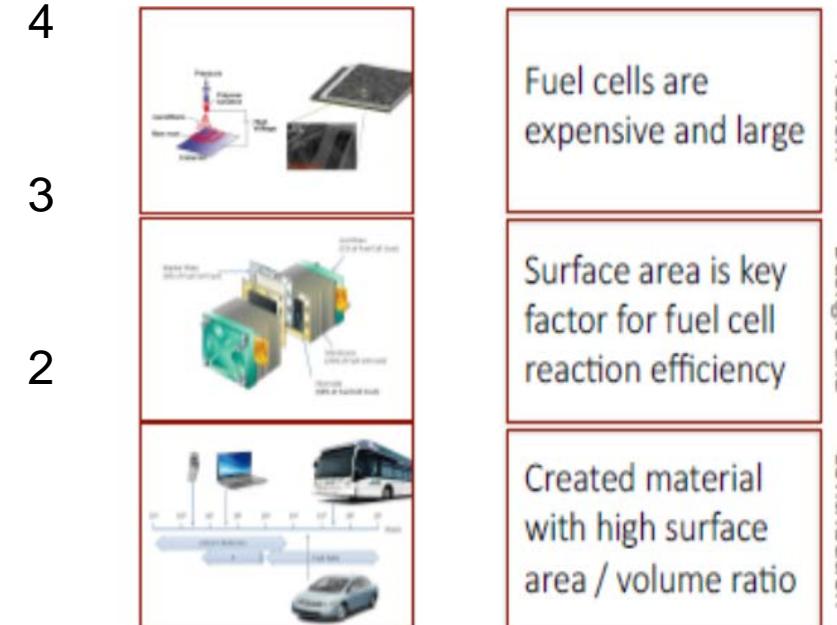
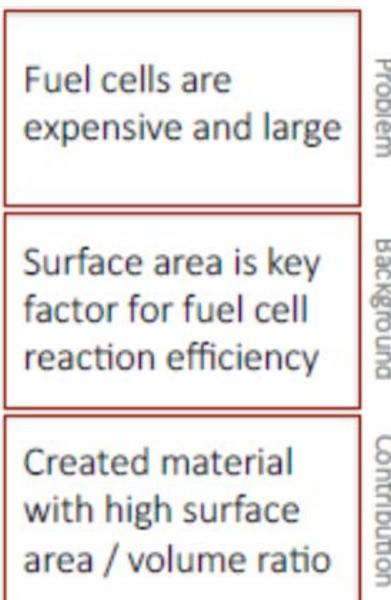
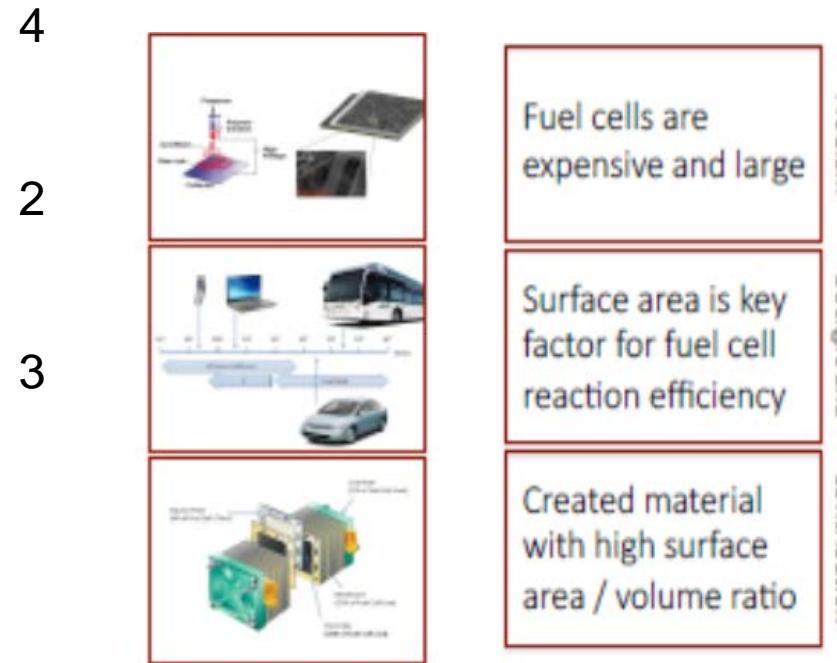
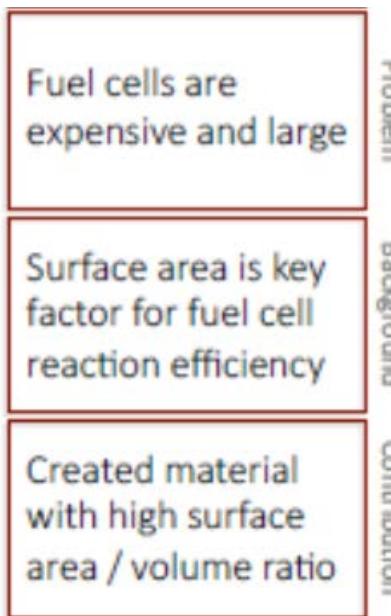
	Title	Expanding Fuel Cell Markets using Nanotechnology Yang Shao-Horn Electrochemical Energy Laboratory Mechanical Engineering at MIT
Fuel cells are expensive and large	Problem	
Surface area is key factor for fuel cell reaction efficiency	Background	
Created material with high surface area / volume ratio	Contribution	

Title		
Problem	<p>Fuel cells are expensive and large</p>	 <p>Expanding Fuel Cell Markets: using Nanotechnology</p> <p>Ying Shao-Ho Electrochemical Energy laboratory Mechanical Engineering at UST</p>
Background	<p>Surface area is key factor for fuel cell reaction efficiency</p>	
Contribution	<p>Created material with high surface area / volume ratio</p>	

	Title	
Fuel cells are expensive and large	Problem	Expanding Fuel Cell Markets using Nanotechnology Yang Shao-Horn Electrochemical Energy Laboratory Mechanical Engineering at MIT
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Background	<p>Surface area is key factor for fuel cell reaction efficiency</p>	
Contribution	<p>Created material with high surface area / volume ratio</p>	

Many storyboards are possible: Change order



Recovery: Be graceful and ready for everything

- Projector doesn't work, system malfunctions, room not set up properly
 - Ask for help, work together, be kind, make a joke
- Someone is really asking a lot of annoying questions:
 - Tell them nicely: "Great questions, and my next few slides will address them. Please ask me again at the end if I haven't fully addressed your comments".
- Someone is making a lot of noise, eating, shuffling, etc
 - Ignore first, then gently say: "I'll pause for a moment while you finish unpacking". Or just say "Please be a bit quieter, so that everyone can hear".
- Everyone is getting ready to leave lecture.
 - I only have a few moments more, please wait for a moment.
- Talk time cut short. Major VIP is leaving.
 - Rearrange slides, rework storyboard, skip sections, only give main points.
- Wrong slide deck is loaded, old talk, some slides missing
 - If minor, roll with it. If major, take moment to rearrange / preview. Always load talk on phone in Dropbox, know what's coming next. Presenter mode.
- Fonts are all off, animations not working, images not showing.
 - Make a kind joke about it, connect with the audience, they're just as surprised

Common storyboards for research talks

- Structure: Beginning Middle End
- Storyarc: Payload and Point

Common storyboards:

1. Problem - Solution
2. Technology - Application
3. Individual Trends - Merger of Trends
4. We Did It! – How We Did It
5. Past - Now (- Future)
6. What Is - What Can Be
7. Simple - Complex

Good storyboards

- Flows (logically) well
- Material is setup properly/minimally
- Takeaway highlighted in payload position
- Is an ordering you naturally recall
- Grabs interest
- Sustains interest and momentum.
- Match the audience

How to build your own storyboard

- Assemble Ideas
 - Develop Ideas
 - Flesh out an idea into multiple slides if necessary
 - Merge ideas from slides
 - Prune ideas
 - Storyboard
 - Chunk ideas together
 - Form story from start
 - Pay attention to flow
 - Anything special for intro or conclusion
 - Make slides simple & presentable
-
- Examples of Optimizing Flow
 - Fast items first in list
 - Idea on slide or as transition?
 - Reordering of points to avoid “as I said”.
 - Delta/So What:
 - What's **changed**?
 - Examples
 - What did you learn?
 - How well does it work?
 - How is system better now?
 - How is user experience improved?

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6. Take-home: delivery, recovery, credibility, goals, visibility

Being Effective and Efficient

When Preparing

- Determine message
- Create story
- Use narrative
- Work on slides
 - Only if necessary
 - Just enough on slide
 - Superposition
- Plan boardwork
- Anticipate problems
- Determine intro, concl

When Practicing

- Do not memorize!
- Impromptu speak
- Piecemeal practicing
- Re-storyboard

When Presenting

- Do not regurgitate
- Interact with slides/board
- Take an interest in your audience
- Modify jargon
- Buy the audience time
- Use verbal punctuation
- Use visual punctuation
 - Just enough gesturing
- Control audience focus

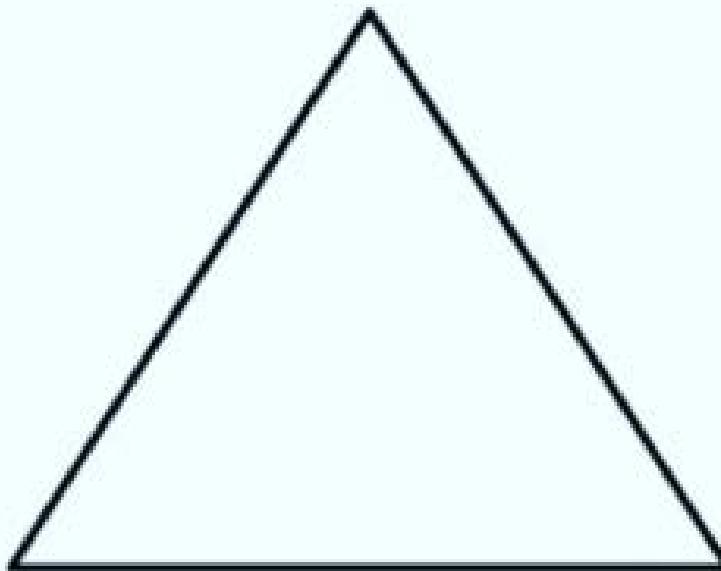
Rhetorical devices: Ethos, Pathos, Logos

LOGOS

Logic/reason/proof

Main technics:

- Structure of the speech (opening/body/conclusion)
- References to studies, statistics, case studies...
- Comparisons, analogies, and metaphors.



ETHOS

Credibility/trust

Main technics:

- Personal branding
- Confidence in delivery
- Cites credible sources

PATHOS

Emotions/Values

Main technics:

- Stories
- Inspirational quotes
- vivid language

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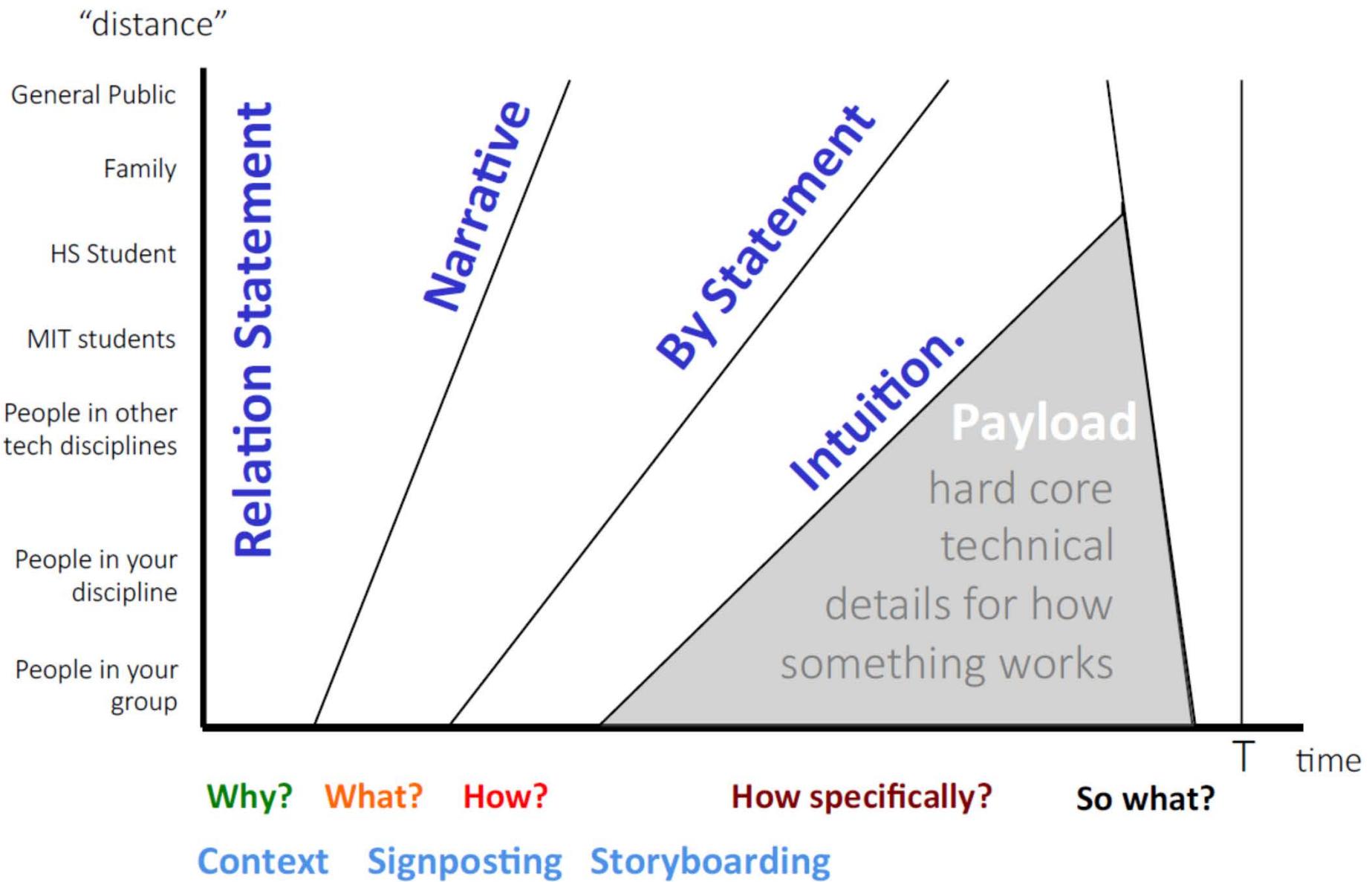
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It's all about your audience

- Help them appreciate your technical contribution
- Break any rule as long as they are helped / not bothered
- By end of intro, know overall direction of talk,
- By end of intro, understand your title,
- Cover everything on your slide
- What you say is consistent with what is on the slide
- Don't tell them anything they won't need later
- Tell them what they need to know before they need it
- Verbally/nonverbally help them parse what is important
- The more time you spend, the more important it is
- The more you repeat, the more important it is
- You tie everything together with a sense of finality
- Be memorable, be creative, be different, teach them smth

Explaining – meeting your audience halfway



Avoid mistakes in meeting your audience

too watered down
no payload
not technical
“notation” changes

no interaction
poor storyboard
poor setup
what is problem
what is solution
what is intuition
ok, so what

jargon
complex
confusing
too technical
jumps too big
misunderstandings

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Take-home messages

1. Master delivery

- Genuinely care → most interesting to watch
- Eye contact → connection
- Gesturing → illustration (visual punctuation)
- Space → comfort (visual punctuation)
- Facial Expr → enthusiasm
- Posture → confidence
- Volume → power, confidence
- Word choice → control
- Intonation → credibility
- Expressiveness → verbal punctuation
- Silence / Pacing → comfort

2. Minimize surprises

- Anticipate questions / problem areas
- Visit room beforehand
- Upload slides / bring on USB thumb drive
- Name files appropriately
- Send slides to slide coordinator
- Test slides / demo beforehand
- Arrive early
- Dynamically adjust to time / understanding

3. Build Credibility

- Built up before: get in door
- When you're in: sustain it!

4. Focus on goals

- Introduction hook
- Relation Statement
- Negotiation
- Proposals (Pitching)
- Giving Feedback
- Networking / Small Talk.

5. Gain visibility

- Not who you know, but who knows you
- Take ownership
- Ask good questions
- Be the one they go to
- Pay attention to detail
- Take credit (when appropriate)
- Take initiative
- Present your own ideas
- Give a better presentation
- Differentiate yourself.

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