Lecture 22
How to write, visualize, present
Prof. Manolis Kellis

Slides/content credit:
• Kellis Lab meetings
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• Part 2: Aiora Zabala UK cancer research
• Part 3: Tony Eng, MIT 6.UAT
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/simplify
   • Typography; composition/layout

3. Delivering impactful oral presentations
   • Importance of conveying: sharing makes work alive, point
   • Speak clearly: posture/voice/rhetoric/contact/flow/creativity
   • Planning: storyboarding, signposts, recovery
   • Convincing: rhetoric, ethos/pathos/logos, prepare/natural
   • Connect: audience first, guide, appreciate, adapt, payload
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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From: www.microsoft.com/research/people/simonpj

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

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

Idea:
A re-usable insight, useful to the reader

• 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.”

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From: www.microsoft.com/research/people/simonpj
3. Flow / Narrative

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)

From: www.microsoft.com/research/people/simonpj
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 sentence:
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

Partitioning multifactorial traits and trait combinations into their tissues and pathways of action

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

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

This partitioning of genetic loci into tissues also helped inform the shared genetic risk between pairs of co-enriched traits, by revealing the tissues that may underlie their common biological basis (Fig. 6d).

For example, the same partitioning of CAD loci showed that CAD loci in heart, muscle, and endothelial enhancers were preferentially also associated with high blood pressure and atrial fibrillation risk loci. However, CAD loci in liver and endocrine enhancers were instead associated with systolic blood pressure. Similarly CAD loci also associated with waist-to-hip ratio overlapped adipose but not liver, endocrine, or heart enhancers, and CAD loci associated with HDL cholesterol overlapped liver, 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
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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From: www.microsoft.com/research/people/simonpj
8. Get others to read your paper

- 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 mis-spelt”.)

Get your paper read by as many friendly folks as possible

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From: www.microsoft.com/research/people/simonpj
8b. Getting expert help

• 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. 

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From: www.microsoft.com/research/people/simonpj
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.
The passive voice is "respectable" but it **deadens** your paper. Avoid it at all costs.

Use the active voice

**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
<table>
<thead>
<tr>
<th><strong>No!</strong></th>
<th><strong>Yes!</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The object under study was displaced horizontally</td>
<td>The ball moved sideways</td>
</tr>
<tr>
<td>On an annual basis</td>
<td>Yearly</td>
</tr>
<tr>
<td>Endeavour to ascertain</td>
<td>Find out</td>
</tr>
<tr>
<td>It could be considered that the speed of storage reclamation left something to be desired</td>
<td>The garbage collector was really slow</td>
</tr>
</tbody>
</table>
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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
Figure 4. GWAS tissue-prioritization. **a.** Trait-tissue enrichment (center, heatmap) between reported lead single-nucleotide polymorphisms (SNPs) from 534 genome-wide association studies (rows) and accessible active enhancers across 833 epigenomes (columns) (FDR<1%). Enriched tissue groups (left) and number of enriched epigenomes (right) shown for each trait. Only 100 representative traits labeled, using a bag-of-terms approach (full list of traits in Supplementary Fig. S30). Traits colored by sample with maximal trait-tissue enrichment. **b.** Contribution of each project to the maximum GWAS trait-tissue enrichment for the 534 traits with significant enrichments. **c.** Number of traits (y-axis) with significant GWAS trait-tissue enrichments for each combination (column) of projects (rows). **d.** Increase in the cumulative number of GWAS traits (y-axis) with significant trait-tissue enrichments with increasing numbers of epigenomes (x-axis), ordered to maximize the number of novel trait annotations captured with each new epigenome. Top 25 samples labeled and colored by tissue group, with top 6 GWAS traits shown for the first 8 samples. Points colored by project. All 534 traits are captured after inclusion of 98 samples. **e.** Comparison of GWAS enrichments found (y-axis, left) and number of lead SNPs in
C

Chr16: 12.6M  12.7M  12.8M  12.9M

H1-KESC  K562  HepG2  HUVEC  HMEC  HSMC  NHEK  GM12878  NHLF

HepG2 H3K27ac

SNX29  CPPED1

Region tiled: chr16:12,707,145-12,707,529 (hg19), selected in HepG2, high dip score

Normalized MPRA reporter expression measurement for each barcode (HepG2)

432 reporter measurements (9 tile offsets x 24 barcodes x 2 replicates)

Tile #4

48 barcode measurements (24 in each replicate, see panel)

Tile #5

48 barcode measurements (24 in each replicate, see panel)

30 bp unique to #4

115 bp common between #4 and #5

30 bp unique to #5

DNA sequence and HNF4 motif

TTGTCATTTCAATGCAATGTTTGAATTTGATAATGAAAGTC  CCGACA

AGATGAAAGTC  CCGACA

HNF4 motif (known 1, rev)
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

*Images from Munzner*
Types of channel

Identity channels: categorical/qualitative attributes

- Position on common scale
- Length (1D size)
- Tilt/angle
- Area (2D size)
- Color luminance
- Color saturation
- Curvature
- Volume (3D size)

Magnitude channels: ordered/quantitative attributes

- Spatial region
- Color hue
- Shape

Images from Munzner
Types of channel (continued)

Rolandi et al. 2011
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)
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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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
<td>0.01</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>0.13</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>0.30</td>
</tr>
</tbody>
</table>
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

*Carter 2013*
Bar chart – comparison

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

*Carter 2013*
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 ≈√N and Interval width ≈ Range ÷ √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

- Upper Quartile, Q3
  - 75th percentile
  - (3rd quartile)
- Lower Quartile, Q1
  - 25th percentile
  - (1st quartile)
- Median
- Interquartile Range (IQR), 50% of the data
  - Outliers
    - Maximum Cutoff = Q3 + 1.5*IQR
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

A bean = a ‘batch’ of data
Stripchart shows individual data
Data density mirrored by the shape of the polygon

Image from Babraham Bioinformatics
**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

Babraham Bioinformatics
Scatterplot variations

Bubble scatterplot
It adds a 3\textsuperscript{rd} dimension (but only for small datasets)

From plot.ly
Scatterplot variations

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

Built using corrgram package for R
Heatmap – relationship

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

Babraham Bioinformatics
Heatmap

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

The Guardian
Chart Suggestions—a Thought-Starter

**Comparison**

What would you like to show?

**Relationship**

- Among Items
  - One Variable per Item
  - Many Categories
  - Few Categories

- Among Items
  - Two Variables per Item
  - Many Categories
  - Few Categories

**Composition**

- Over Time
  - Few Periods
  - Many Periods

- Changing Over Time
  - Few Data Points
  - Many Data Points

**Distribution**

- Single Variable
  - Few Data Points

- Two Variables
  - Scatter Chart
  - Line Chart

- Three Variables
  - Bubble Chart
  - 3D Area Chart

**Composition**

- Only Relative Differences Matter
  - Stacked 100% Column Chart
  - Stacked 100% Area Chart

- Relative and Absolute Differences Matter
  - Stacked Column Chart
  - Stacked Area Chart

- Simple Share of Total
  - Pie Chart

- Accumulation or Subtraction to Total
  - Waterfall Chart

- Components of Components
  - Stacked 100% Column Chart with Subcomponents
## Summary

<table>
<thead>
<tr>
<th>Plot</th>
<th>Aim</th>
<th>Main R function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stripchart</td>
<td>distribution</td>
<td>stripchart()</td>
</tr>
<tr>
<td>Line chart</td>
<td>relationships</td>
<td>plot(type=&quot;l&quot;)</td>
</tr>
<tr>
<td>Bar chart (stacked, norm. stacked)</td>
<td>comparison (and composition)</td>
<td>barplot()</td>
</tr>
<tr>
<td>Dotchart with CI</td>
<td>comparison</td>
<td>dotchart()</td>
</tr>
<tr>
<td>Histogram</td>
<td>distribution</td>
<td>hist()</td>
</tr>
<tr>
<td>Boxplot (violin/ bean)</td>
<td>distribution</td>
<td>boxplot(), vioplot()</td>
</tr>
<tr>
<td>Scatterplot (correlogram)</td>
<td>relationships</td>
<td>plot(x, y), corrgram package</td>
</tr>
<tr>
<td>Pie chart</td>
<td>composition</td>
<td>pie()</td>
</tr>
<tr>
<td>Heatmap</td>
<td>relationship</td>
<td>heatmap()</td>
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</tbody>
</table>
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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)
Filter, link, embed
Small multiples
Small multiples
Small multiples

McInerny & Krzywinski 2015
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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.*
Avoid aspect-ratio distortions: changing font height or size.

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

Minimise text; keep it simple
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**
Heed the numbers in your font

- Each font has different styles of numbers
- Make sure that the font you choose distinguishes them well (e.g. 1 in *Gill Sans*) and is legible at small sizes
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
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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. *Rolandi 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 equal space.
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.
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
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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?

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

Collect Raw Data

Process and Filter Data

Collect Raw Data

Clean Dataset

Exploratory analysis & visualisation

Generate Conclusion

Draft figure for illustrative visualisation (e.g. by hand)

Produce raw figure (e.g. in R, or Excel)

Edit design details (e.g. in Inkscape)

Export as a journal-ready figure

Share it with peers
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**
- **Definitions**
  - Workflows: Clarify the purpose: essential elements to depict and their relation.
  - Draft the structure of the diagram by hand and share and discuss it.
  - 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.

Check license for use.
Some useful resources

- Short papers:

- 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

- Graphic design more generally:
  - Krause. 2004. Design basics index – *very concise and to the point*
  - Samara. 2014. Design elements: a graphic design manual

- Nature Points of View blog:

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/creative
   • 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
   - Technical skills are often the emphasis, presentations skills often lack
   - Goal: clarity, persuasion, confidence, integrity, audience match

2. How to speak clearly: self-introduction video
   - 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

4. Convincing/rhetoric: effective and efficient, ethos/pathos/logos
   - All stages: Prepare (message), practice (familiar), present (natural, excited)
   - Ethos: credibility/trust (you). Pathos: emotion (them). Logos: logic (content)

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 4:0:
- 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

What they think of you will influence how they interpret your words. Their impression is influenced by many factors.
<table>
<thead>
<tr>
<th></th>
<th>Eye Contact</th>
<th>Gestures</th>
<th>Space</th>
<th>Facial</th>
<th>Body / Posture</th>
<th>Volume</th>
<th>Word Choice</th>
<th>Intonation</th>
<th>Expressiveness</th>
<th>Silence / Pacing</th>
</tr>
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<tr>
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<td>✓</td>
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<td>✓</td>
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<tr>
<td>Magic / Showmanship</td>
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<tr>
<td>Speech-reading</td>
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<tr>
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</tbody>
</table>
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Planning your talk, building a story: Storyboarding

Once upon a time...
And every day...
Until one day...
Because of that (3x)...
Until finally...
And ever since that day...
As a result...
The moral of the story is...

Where We Are Heading
Unused Variables? Remove or Callback

Context

Payload

Situation (Setup)
Conflict (Problem)
Stakes/Pain
Stakes or Resolution
Resolution (Solution)
Consequences (Delta)
Take Away (Point)

Where We’ve Been
Undeclared Variables? Setup
Typical movie storyboards

- **Action**
  - 0:00
  - World-weary cop/soldier/accented mercenary fights cable car hold explosions AC/DC AC/DC

- **Rom Com**
  - 0:00
  - Frenemies quirky bff I can explain! lonely montage he/she's right in front of you!

- **Art House**
  - 0:00
  - Philip Glass long train ride arbitrary edits yaks nudity smoking silence non-ending

- **Sci-Fi**
  - 0:00
  - Expository technobabble angry robots/aliens dystopian overlords what have we done?

- **Horror**
  - 0:00
  - Herd of weird rural people Todd? split up aeeeyaaa he won't Rob youths people die Zombie

Unusual storyboards

- **Linear**
  - Memory

- **Flash Forward**
  - Flash Back

- **Unusual**
  - Stand out? Impress? Match context? Specific goal? Someone has to leave early? Flexibility!
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 Desphande Center talk
Many storyboards are possible: Change start
Many storyboards are possible: Change order

<table>
<thead>
<tr>
<th>Problem</th>
<th>Background</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel cells are expensive and large</td>
<td>Surface area is key factor for fuel cell reaction efficiency</td>
<td>Created material with high surface area / volume ratio</td>
</tr>
</tbody>
</table>

3 |

2 |

4 |

3 |

2 |

4
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
  - Just take it in stride, rework main points, move on with what is left.
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)
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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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

“distance”
- General Public
- Family
- HS Student
- MIT students
- People in other tech disciplines
- People in your discipline
- People in your group

Relation Statement
- Narrative
- By Statement
- Intuition

Payload
- hard core technical details for how something works

Context Signposting Storyboarding
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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