



Government  
Actuary's  
Department

# Data visualisation

as a powerful means of communication

IFoA Data Visualisation Working Party  
Yorkshire Actuarial Society

Aidan Smith, Government Actuary's Department

18 September 2019



# Agenda

- What is data visualisation?
- Data visualisation working party
  - Who are we?
  - Our vision
- Examples of data visualisation from our blog
  - <https://dataviz-wp.blogspot.com>
- Getting involved
- Discussion



# Data visualisation

What is data visualisation?



# What is data visualisation?

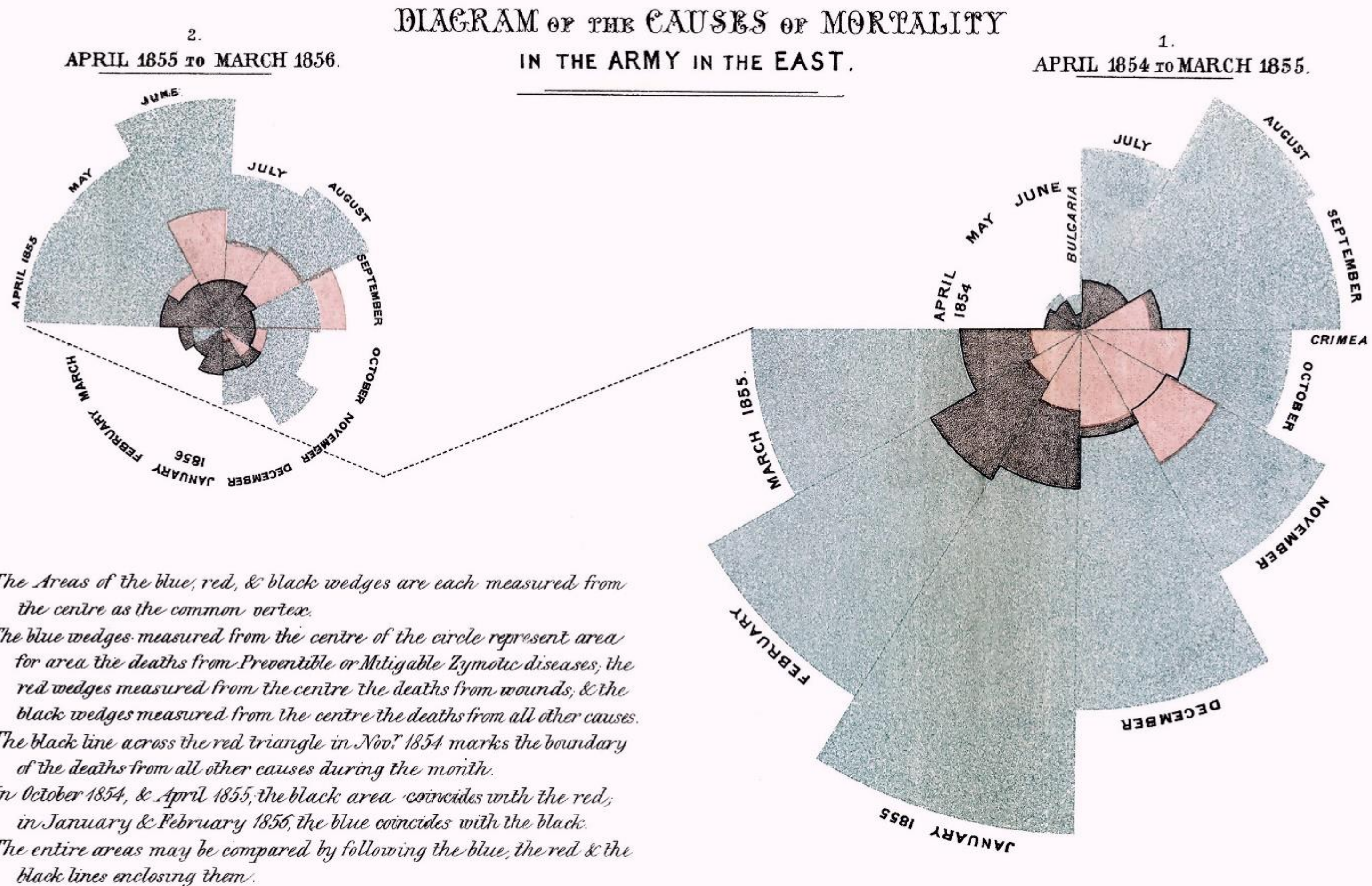
- “The main goal of data visualisation is to **communicate information clearly and effectively through graphical means**” (Friedman)
- “Important stories live in our data and data visualisation is **a powerful means to discover and understand these stories, and then to present them to others**” (Few)
- “Data visualisation **gives you answers to questions you didn’t know you had**” (Shneiderman)





# Florence Nightingale (1855)

(Coxcomb chart - source: <https://commons.wikimedia.org/>)

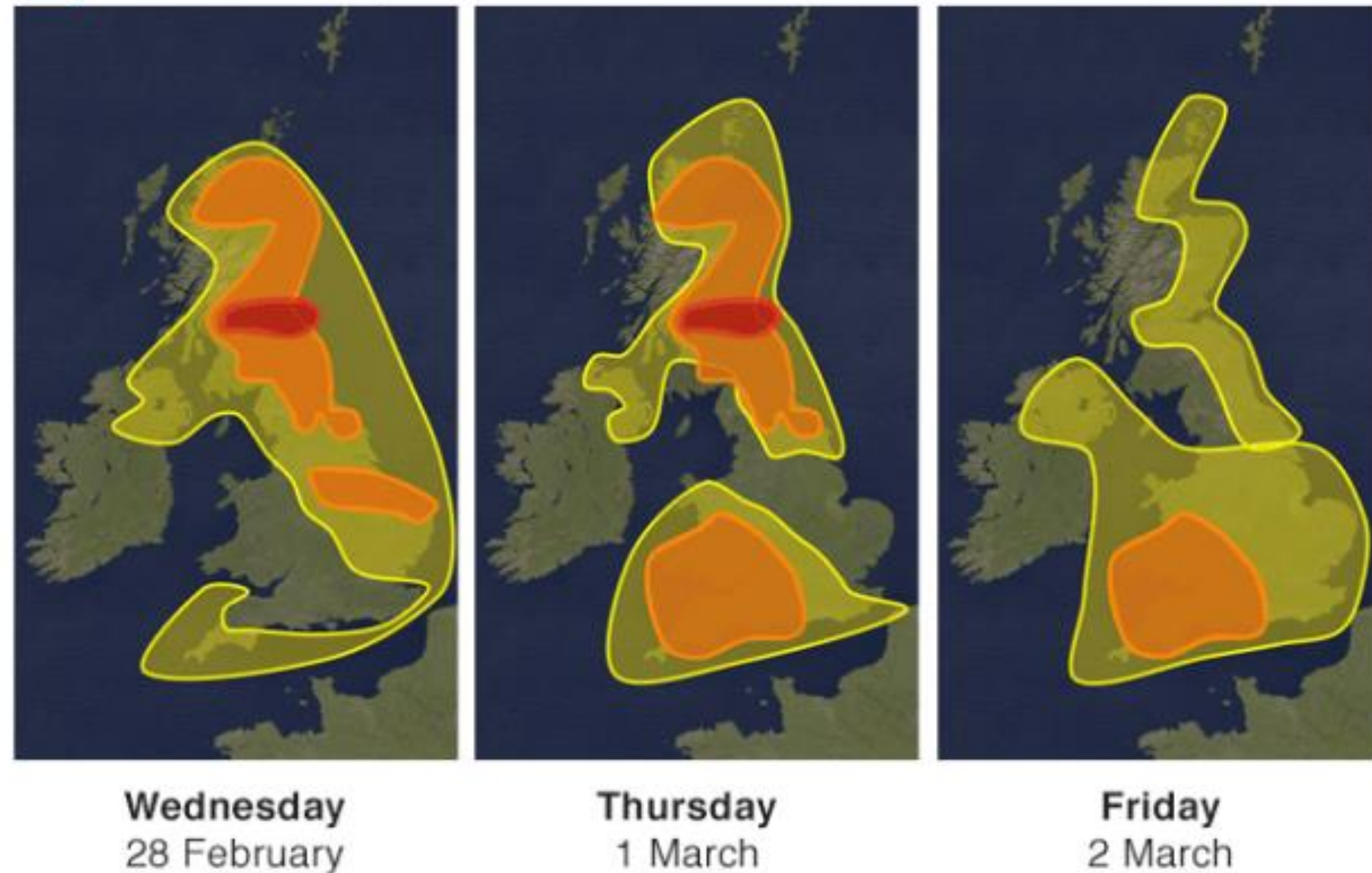




# “Beast from the East” – BBC (2018)

## Snow warnings for the UK

Severe weather possible    Potential risk to life and property  
Risk to life likely



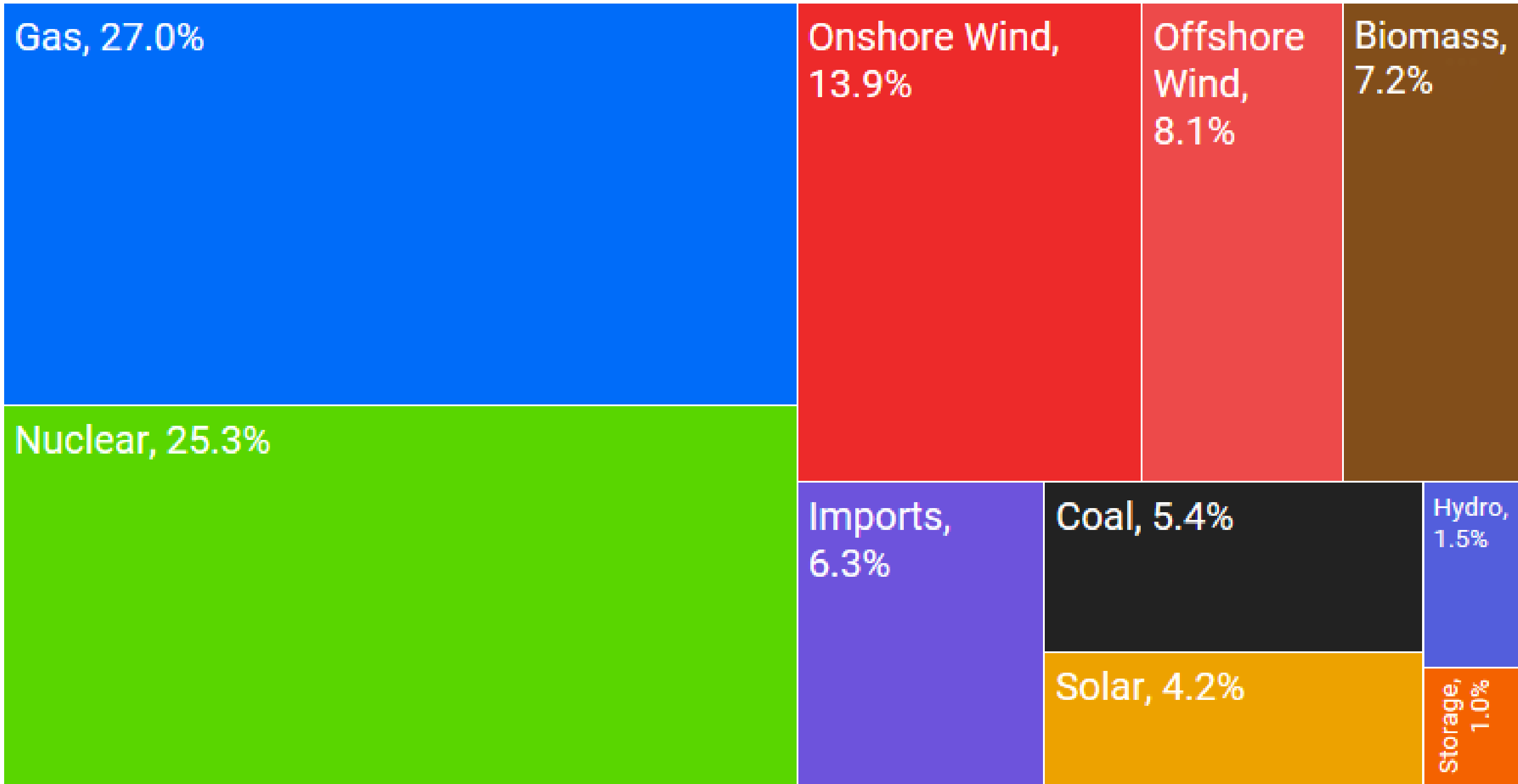
Source: Met Office

BBC

# UK electricity generation (2018)

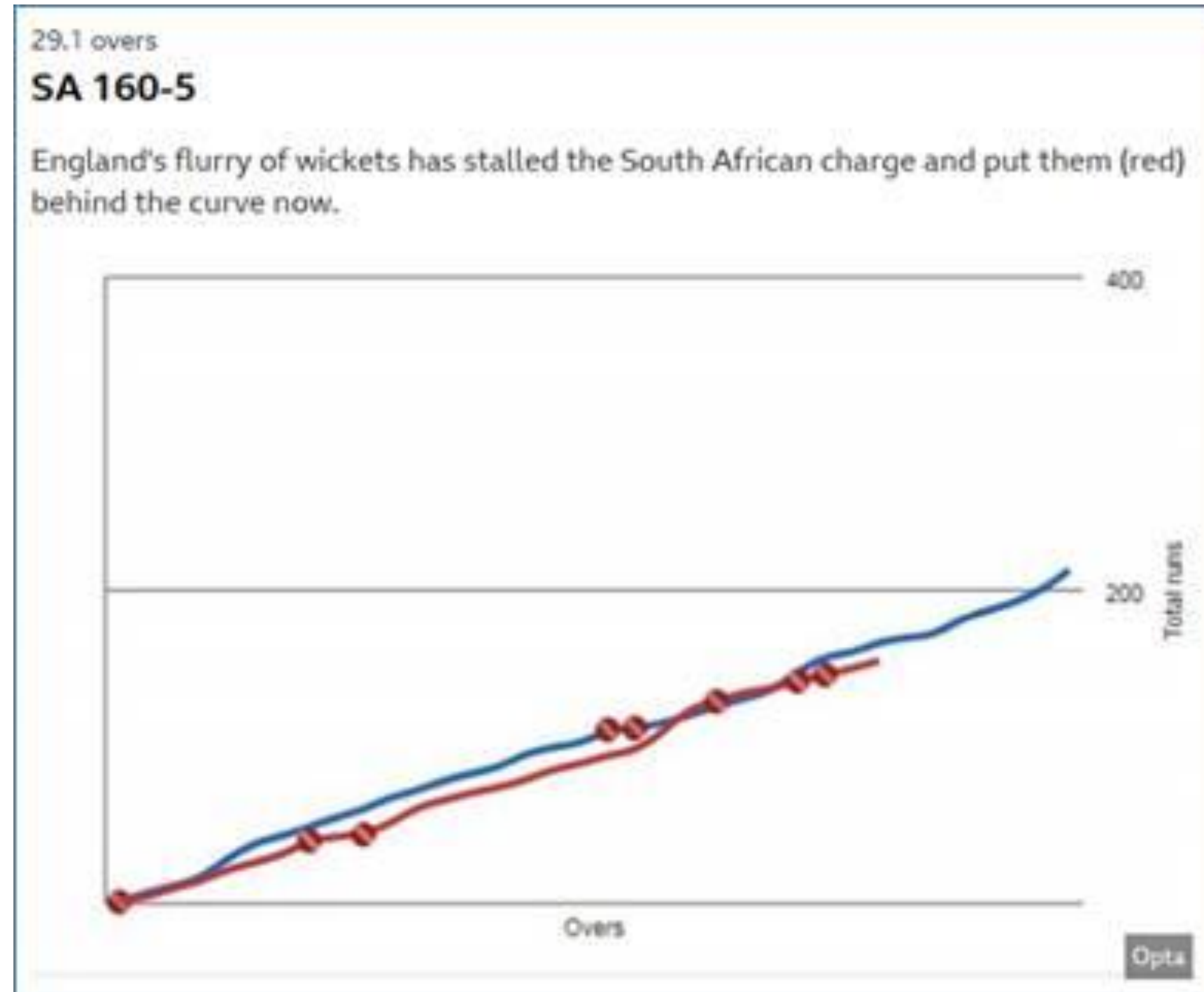
Source: <https://www.mygridgb.co.uk/last-48-hours>

GB electricity generation over 48 hours from Sat 15 September 2018 to Mon 17 September 2018



# Cricket World Cup run worms (2019)

Source: BBC website / Opta





# Data visualisation

## IFoA data visualisation working party



# Who are we?

- Rob Black (Chair) Standard Life
  - Aidan Smith Government Actuary's Department
  - Anees Aslam BUPA
  - Florian Gomez Partner Re
  - Julian Ellacott Just Group
  - Lloyd Richards Crowe (crowe.com)
  - Martin Cairns Aviva
  - Paul Teggin Bank of England/PRA
  - Will Mirams EY
- 
- <https://www.actuaries.org.uk/practice-areas/risk-management/risk-management-research-working-parties/data-visualisation>



# Our vision

We have in mind a picture of an actuary at their desk with some data and asking themselves how best to summarise and present it.

Our vision is that, through the work of the working party, the actuary should have:

- A modern library of different visualisation techniques
- An understanding of which visualisations work well for different purposes (eg, data investigation vs reporting to management)
- Domain-specific examples of helpful practice (eg, pensions, investment, life or general insurance)
- An understanding of how to produce the visualisations, including tools and techniques (not just Excel)
- An understanding of the principles of developing and improving data visualisations
- Awareness of caveats that should be associated with data visualisations

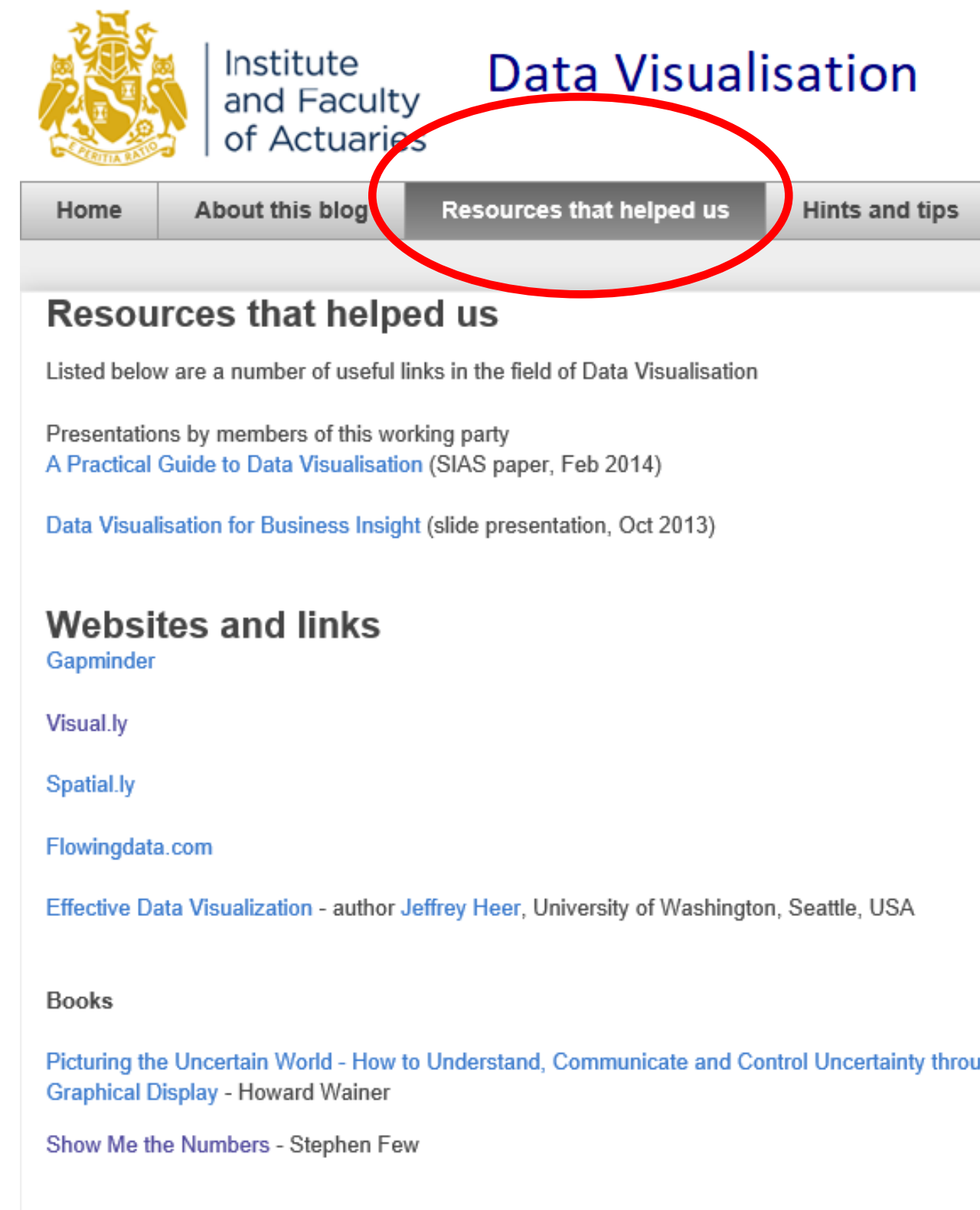




# Background to the working party

- Builds on SIAS paper, “*A Practical Guide to Data Visualisation*” (Ellacott and Teggin, 2014)
- Further examples in “*Data Visualisation for Business Insight*” (Ellacott and Teggin, 2013)

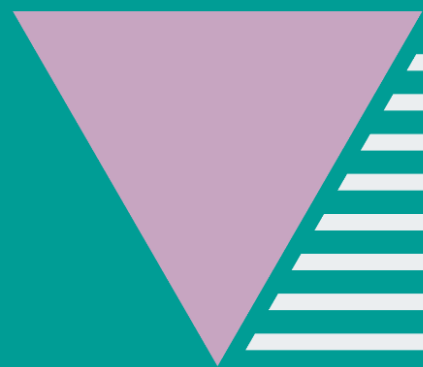
Both available on the *Resources that helped us* page of our blog



# Data visualisation

## Examples of data visualisation from our blog

[dataviz-wp.blogspot.com](http://dataviz-wp.blogspot.com)



# General approach

For each data visualisation example:

- Problem statement
- Suggested approach
- Rationale and commentary
- Applicability and alternatives
- Implementation
- Resources
- + Comments from others

Plus helpful resources, hints & tips, etc.



Institute  
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Data Visualisation

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Wednesday, 25 July 2018

## Display a Matrix of Correlation Assumptions

### 1. Problem Statement

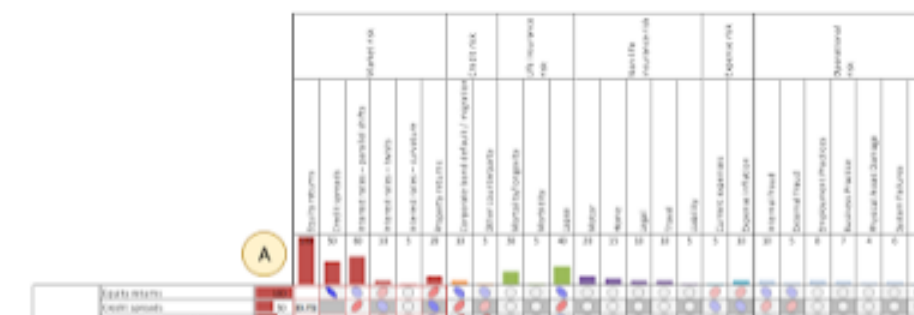
Correlation matrices are often large, complex and visually off-putting. The objectives of the visualisation are to:

- Present a correlation matrix in a way which is straightforward to engage with
- Make it easy to locate the material assumptions
- Make it easy to identify possible inconsistencies between correlation assumptions

### 2. Suggested Approach

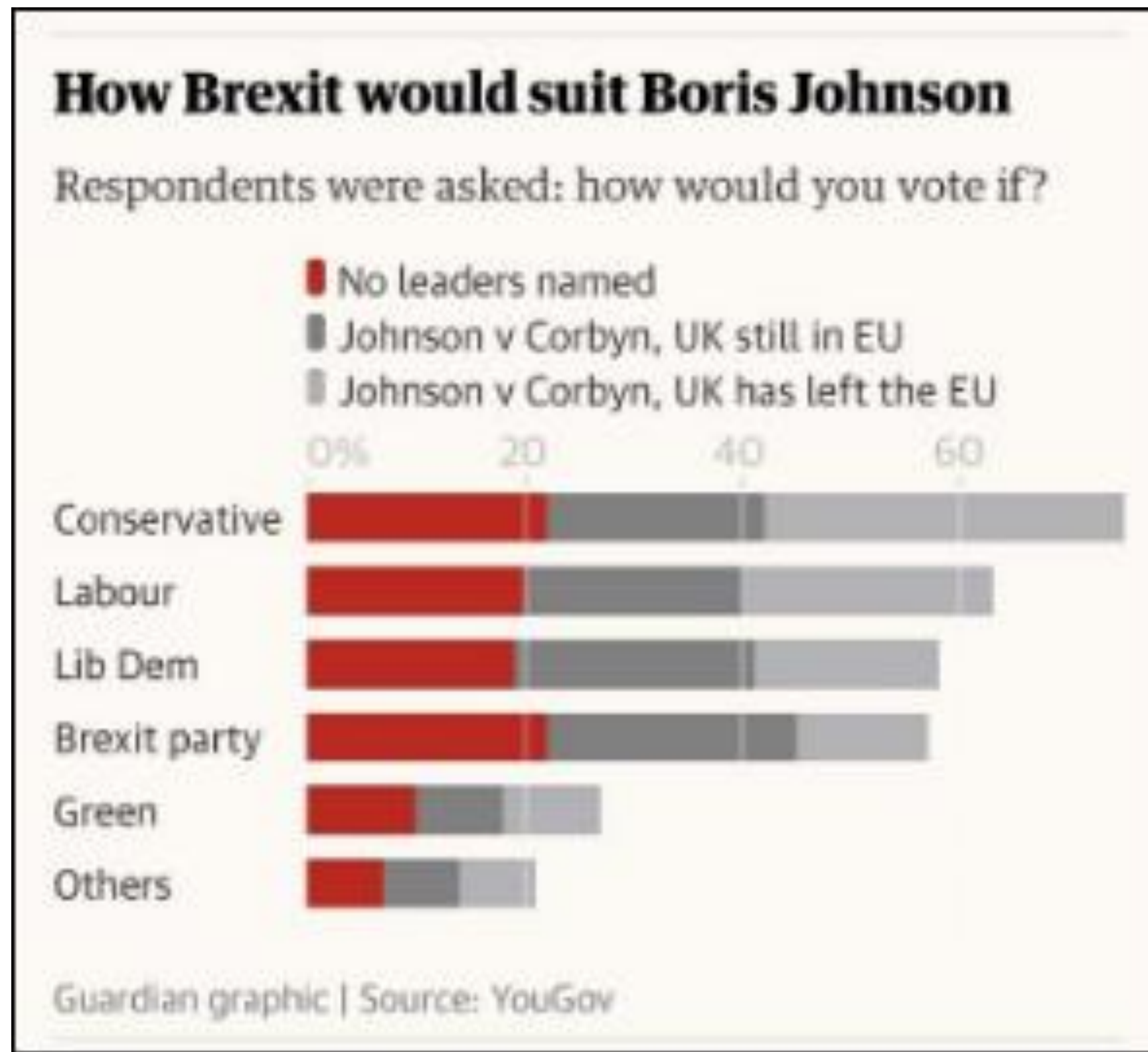
We suggest a hybrid of the following techniques – see example below:

- A. Bar charts to illustrate the materiality of individual risks, measured by undiversified capital requirements. Colour is used to collate risks into categories.
- B. Shading of alternate rows and columns to lead the eye to the row and column headings, and borders around correlations within each category that align to the bar charts.
- C. A table of values to show the correlation assumptions – this can be triangular because the matrix is symmetric, and the values of 1.0 on the diagonal are omitted. The typography is designed to emphasise visual differences between zero, positive and negative values.
- D. Ellipses to visualise the sign and magnitude of each correlation, in the space created by restricting the numerical assumptions to a triangle. These help with seeing patterns.



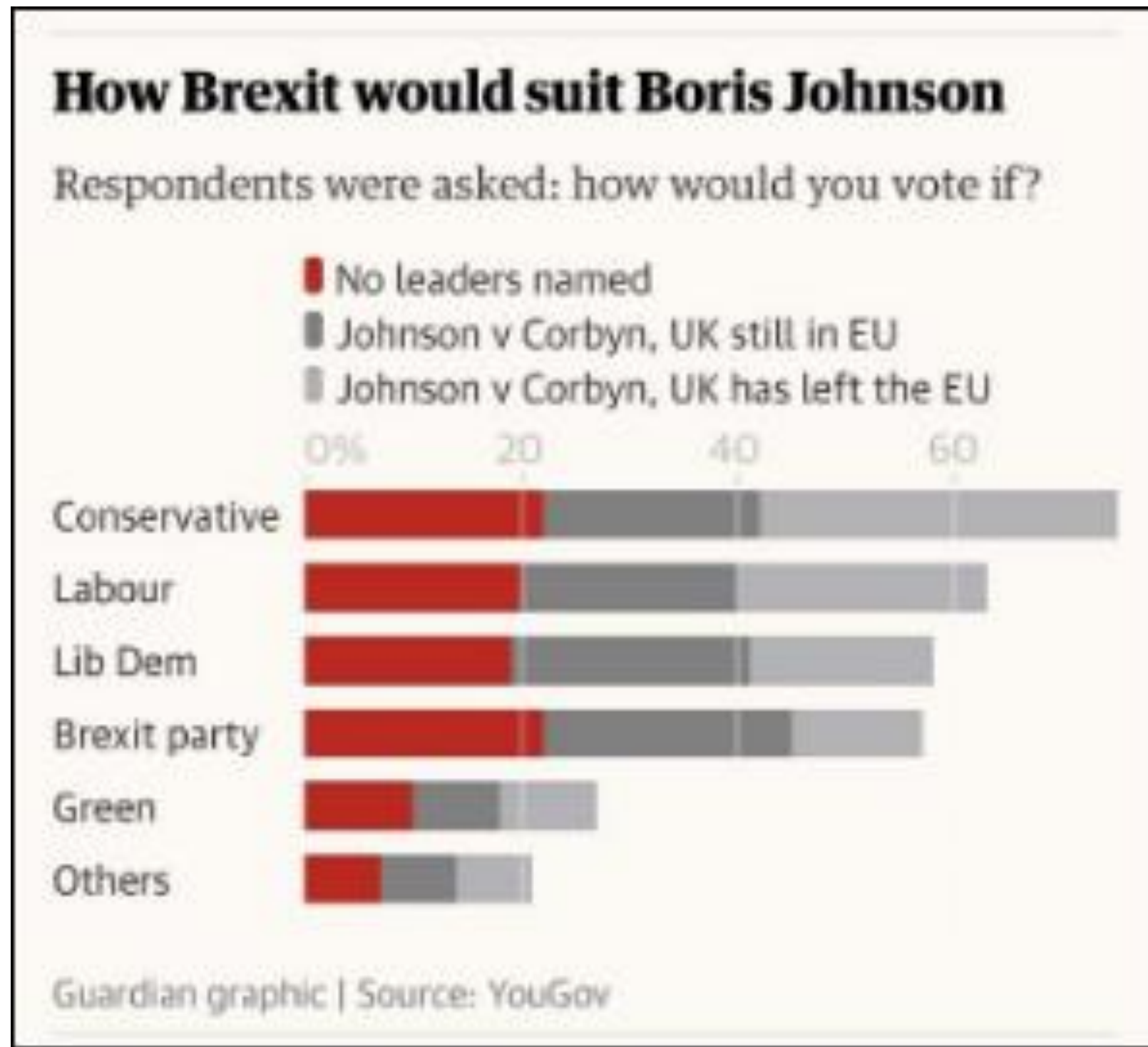


# Graphic in a news article (July 2019)



<https://www.theguardian.com/commentisfree/2019/jul/04/post-brexit-election-boris-johnson-polls-jeremy-corbyn>

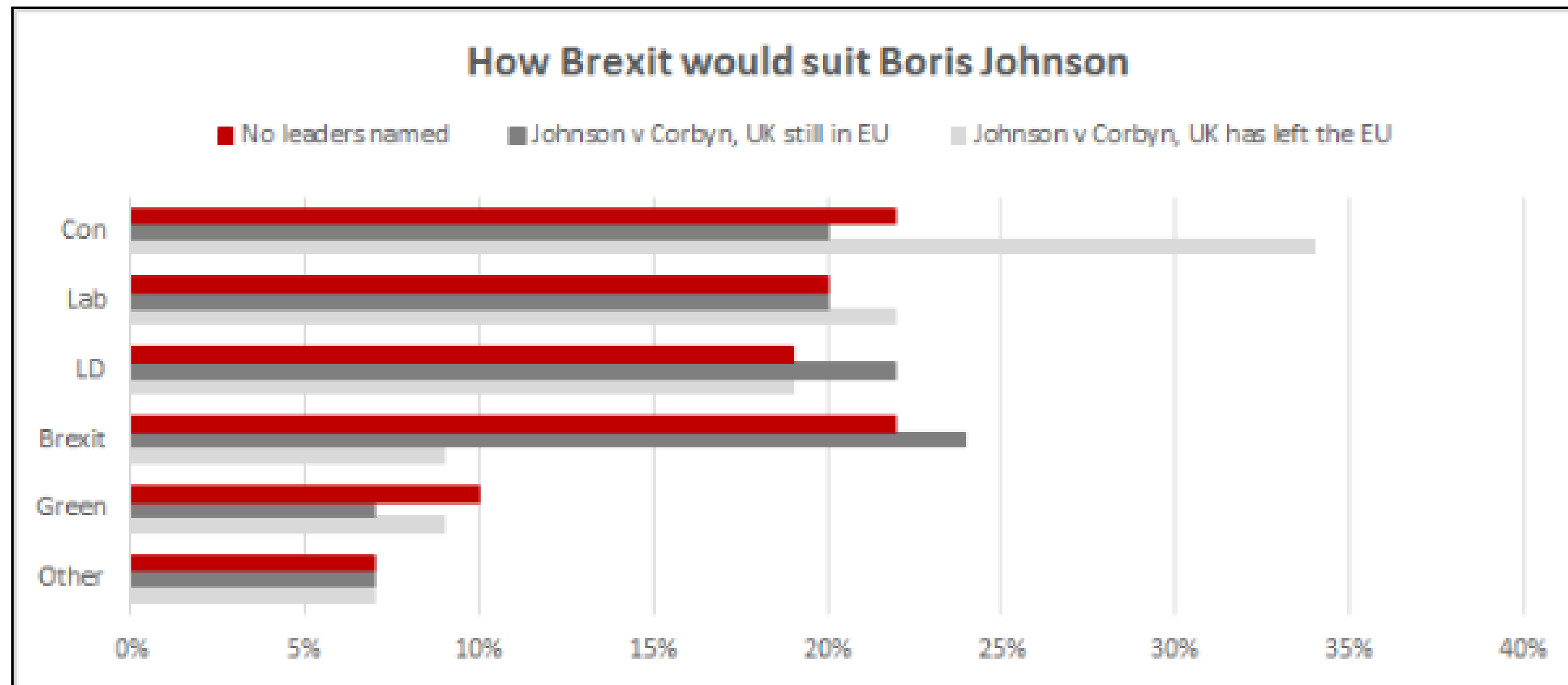
# Graphic in a news article (July 2019)



- ✓ Good use of title and subtitle (gives key message upfront)
- ✓ Bar chart rather than columns
- ✓ Good placement of the legend
- ✗ The sums of the bars are meaningless
- ✗ The colour scheme is unhelpful

<https://www.theguardian.com/commentisfree/2019/jul/04/post-brexit-election-boris-johnson-polls-jeremy-corbyn>

# Iteration 1 – unstack the bars

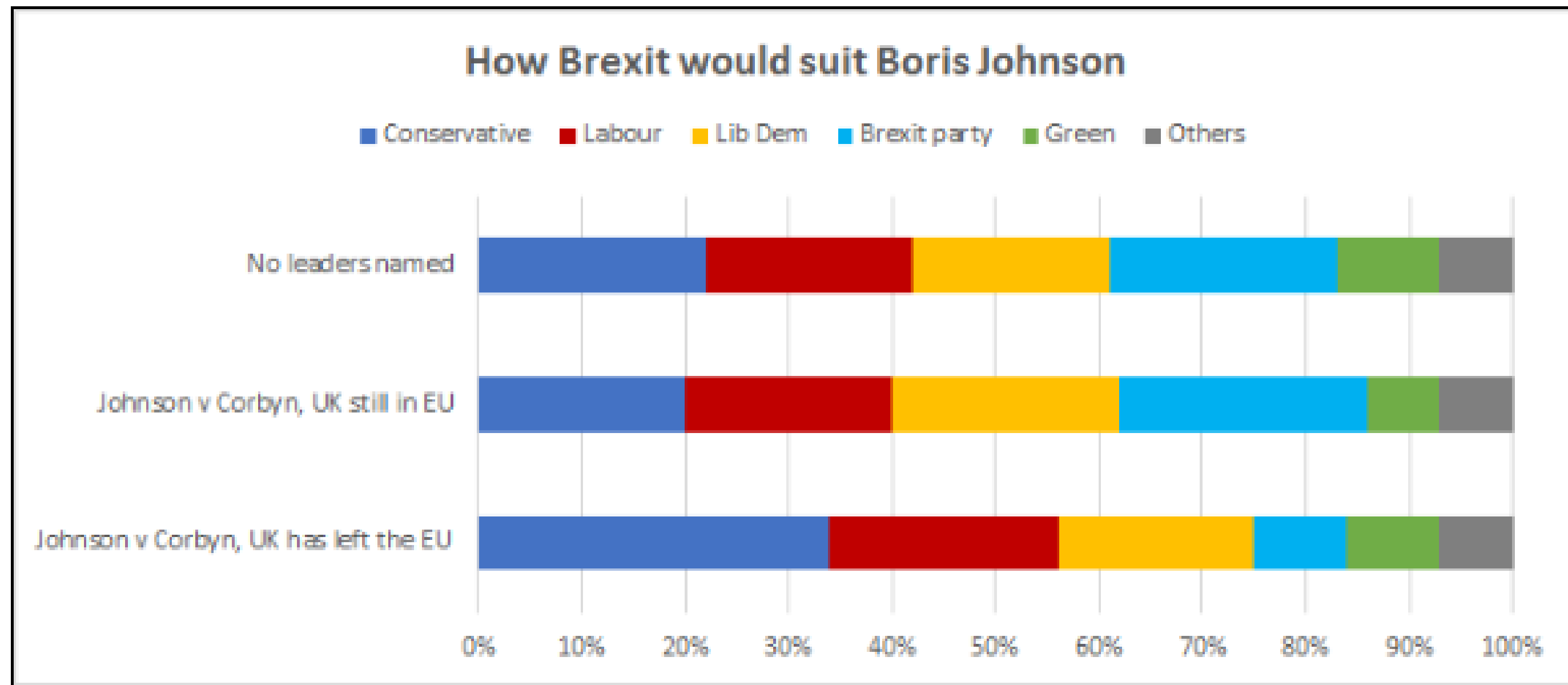


- ✓ Can now see the results of three different polls
- ✗ Too many bars (and colour scheme is still unhelpful)





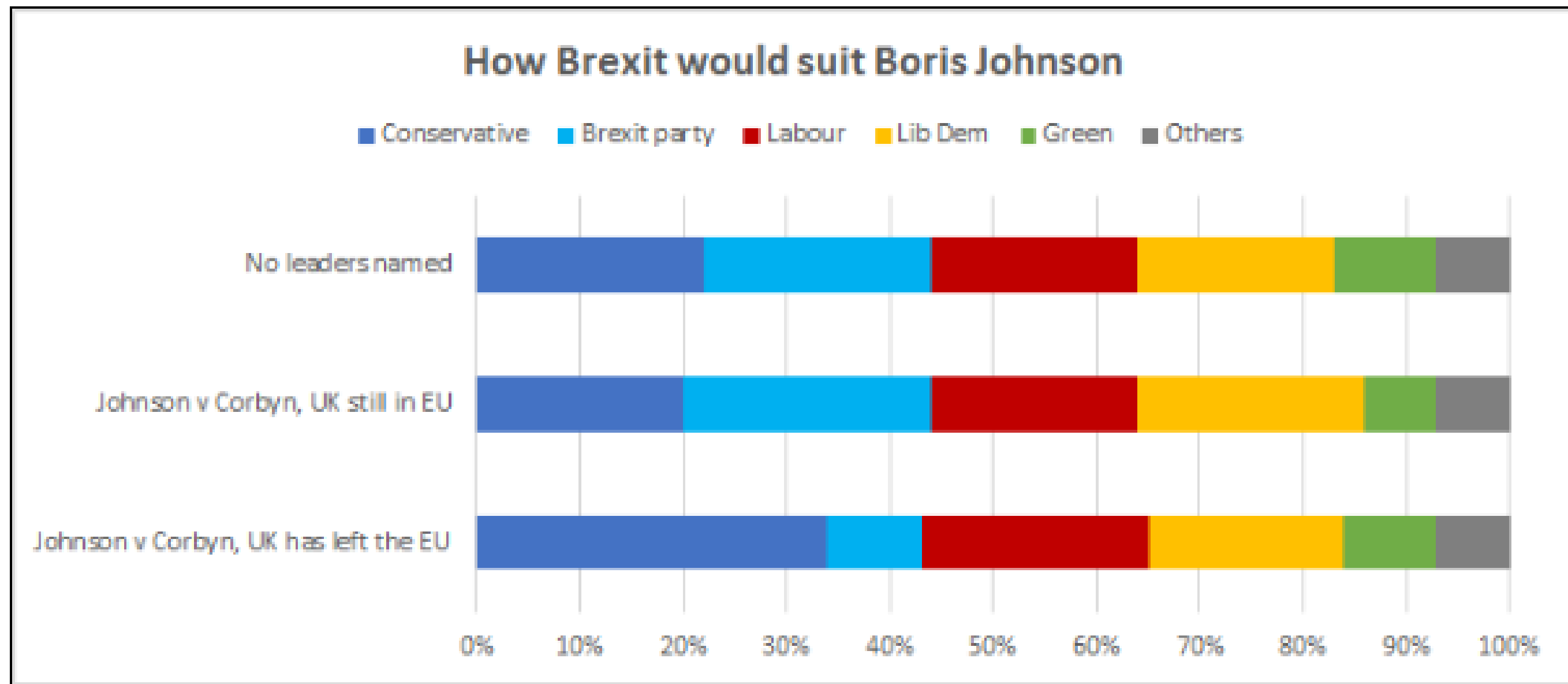
# Iteration 2 – flip rows/columns & recolour



- ✓ More intuitive colours; each poll adds to 100%; clearer message
- ✗ Can we provide greater insight?



# Iteration 3 – reorder the parties



- ✓ Can see interaction between Conservative and Brexit Party votes
- ✗ Danger of reader implying causation when not proven?

# Principles of data visualisation (July 2019)

## Step 1 - Context

- Who is your audience? What message or story are you conveying? What data do you need to tell that story?

**(a) Does the information within the visualisation answer the question posed by your audience?**





# Principles of data visualisation (July 2019)

## Step 2 – Choose your chart carefully

- What is the best chart for your audience and story?

**(b) Have you chosen the right type of visualisation?** There is nothing wrong with a simple bar chart.



# Principles of data visualisation (July 2019)

## Step 3 – Test it out and experiment

- Can you improve the visualisation? Reduce clutter to make it easier for your audience to understand the story. Does it help to add any emphasis of boxed text to tell the story? Seek feedback from your audience.

- (c) Can your audience understand and interpret the visualisation quickly?**
- (d) Will the user ask a subsequent question after viewing your visualisation?**
- (e) Would your visualisation benefit from any form of data grouping?**
- (f) Does the visualisation make due consideration to all your users?**
- (g) Is the style and design of your visualisation sufficiently future-proof or may it change next time?**



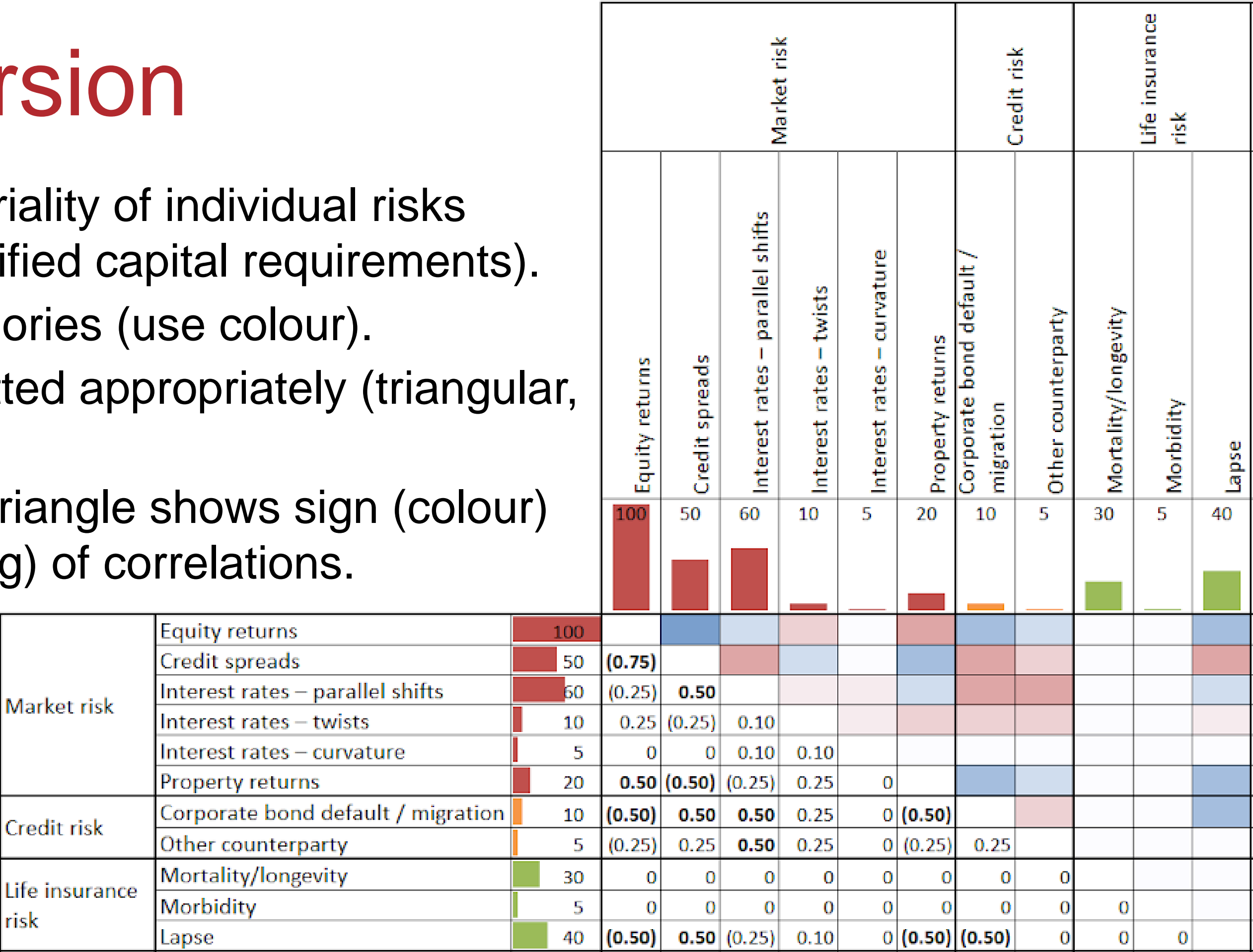
# Correlation matrix (July 2018)

✗ Correlation matrices are often large, complex and visually off-putting

		Market risk						Credit risk		Life insurance risk		
		Equity returns	Credit spreads	Interest rates – parallel shifts	Interest rates – twists	Interest rates – curvature	Property returns	Corporate bond default / migration	Other counterparty	Mortality/longevity	Morbidity	Lapse
Market risk	Equity returns	1.00	-0.75	-0.25	0.25	0.00	0.50	-0.50	-0.25	0.00	0.00	-0.50
	Credit spreads	-0.75	1.00	0.50	-0.25	0.00	-0.50	0.50	0.25	0.00	0.00	0.50
	Interest rates – parallel shifts	-0.25	0.50	1.00	0.10	0.10	-0.25	0.50	0.50	0.00	0.00	-0.25
	Interest rates – twists	0.25	-0.25	0.10	1.00	0.10	0.25	0.25	0.25	0.00	0.00	0.10
	Interest rates – curvature	0.00	0.00	0.10	0.10	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	Property returns	0.50	-0.50	-0.25	0.25	0.00	1.00	-0.50	-0.25	0.00	0.00	-0.50
Credit risk	Corporate bond default / migration	-0.50	0.50	0.50	0.25	0.00	-0.50	1.00	0.25	0.00	0.00	-0.50
	Other counterparty	-0.25	0.25	0.50	0.25	0.00	-0.25	0.25	1.00	0.00	0.00	0.00
Life insurance risk	Mortality/longevity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
	Morbidity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
	Lapse	-0.50	0.50	-0.25	0.10	0.00	-0.50	-0.50	0.00	0.00	0.00	1.00

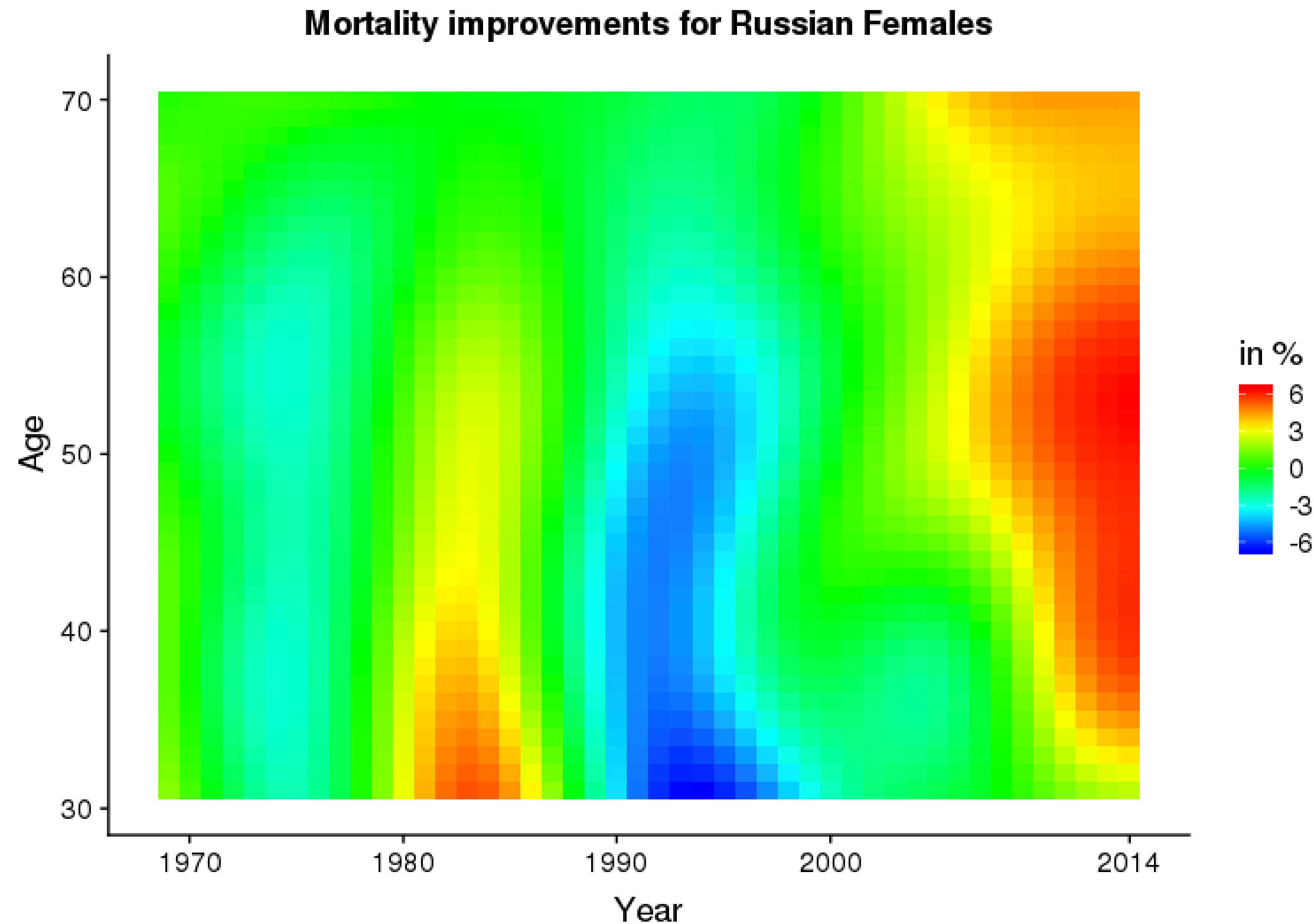
# Improved version

- **Bar charts** show materiality of individual risks (measured by undiversified capital requirements).
- **Collate** risks into categories (use colour).
- **Table of values** formatted appropriately (triangular, to remove duplication).
- **Heat map** in opposite triangle shows sign (colour) and magnitude (shading) of correlations.

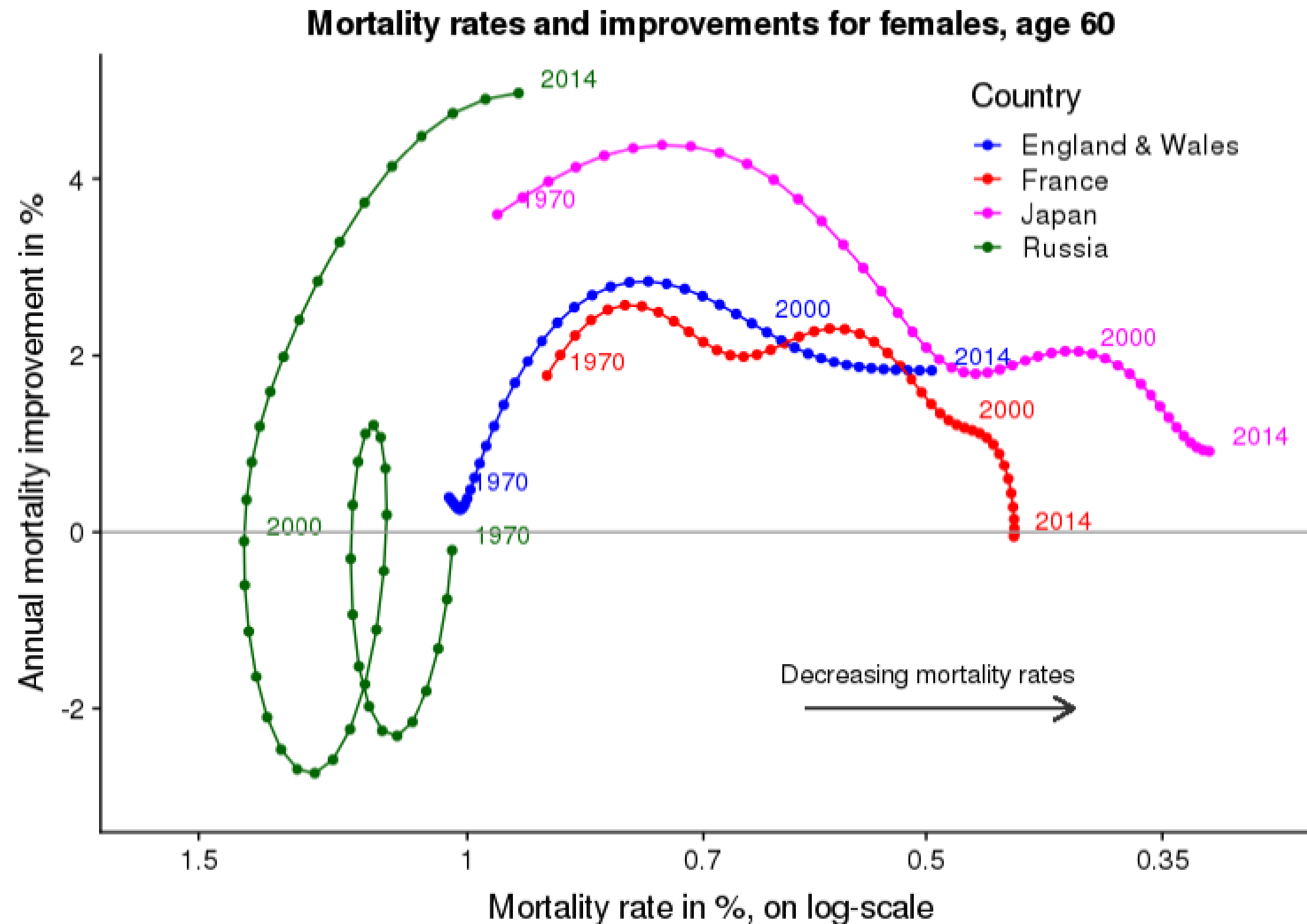




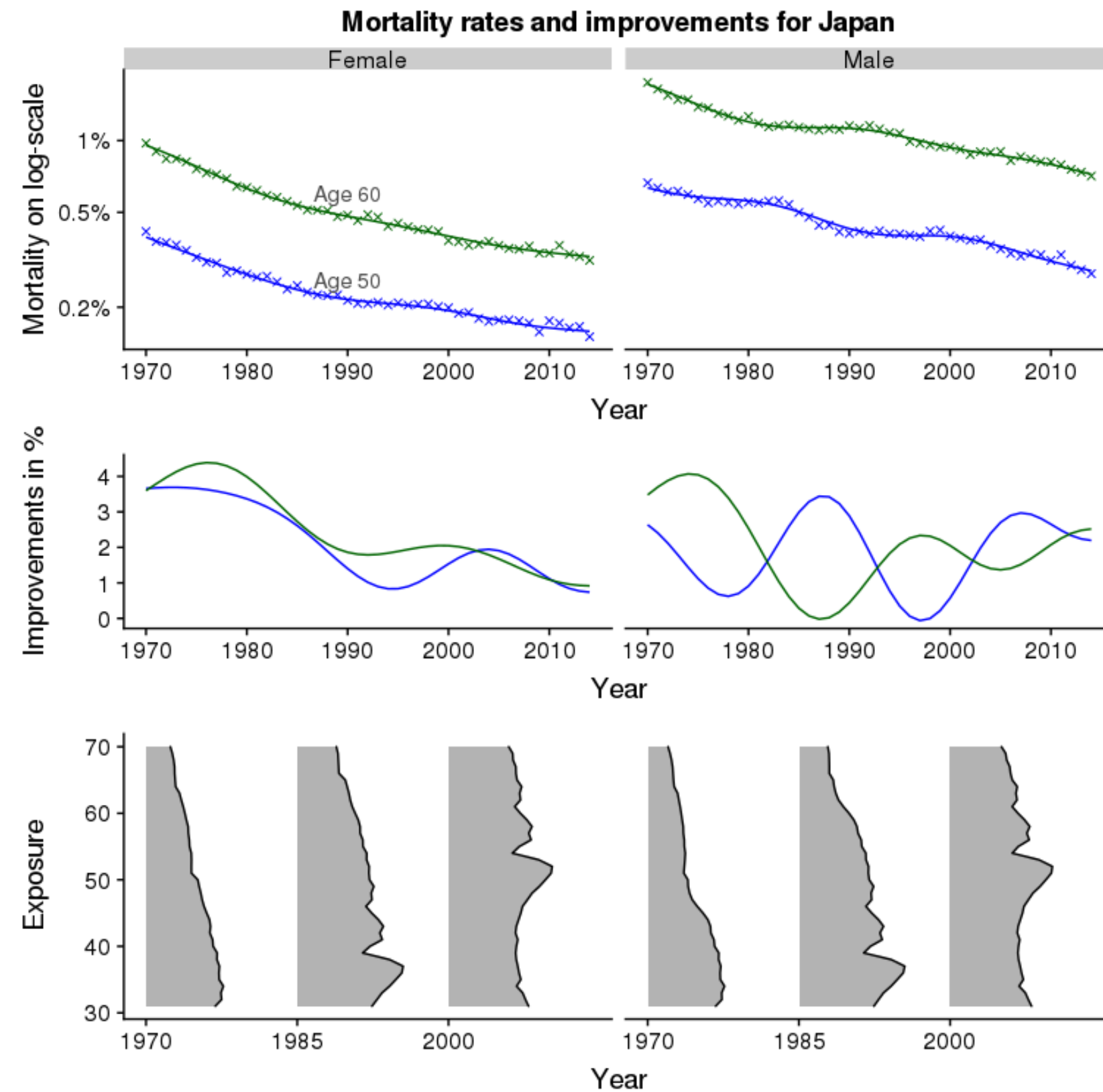
# Mortality improvements (November 2018)



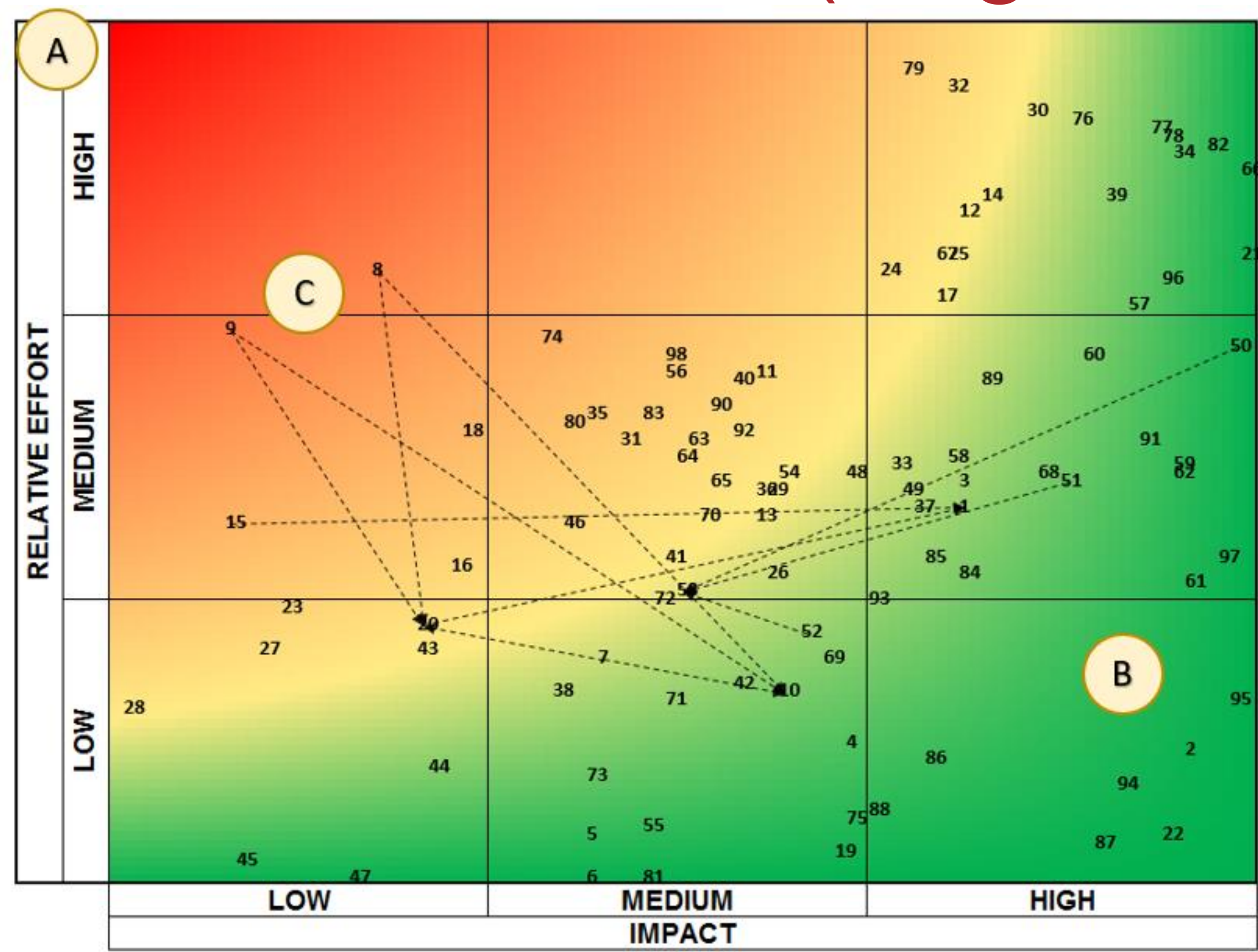
# Mortality improvements (November 2018)



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# Client recommendations (August 2018)




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# Waterfall chart in Excel (April 2019)



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Monday, 22 April 2019

## Create a Waterfall Chart in Excel

### 1. Problem Statement

Waterfall charts are an extremely useful tool in an actuarial context, for example to visualise an analysis of change in insurance reserves over a year. In Excel 2013 and earlier, there is no inbuilt way to create a waterfall chart. This exists in Excel 2016, however the inbuilt graphing options currently lack much of the functionality that is desirable in a waterfall chart.

In this post we show how to achieve the same waterfall functionality that exists in Excel 2016, but using a stacked column chart and Excel's regular charting functionality. This should allow waterfall charts to be created in all versions of Excel, and also allows for some additional functionality over that offered in Excel 2016's in-built waterfall chart.

### 2. Suggested Approach

We show how a waterfall chart can be built as a clustered bar or column chart, which allows for additional functionality in the graphing (such as more flexibility over colouring, detailed analysis of largest changes, more control over end points) with only a little added complexity.

Firstly, some data manipulation is required. The table below shows the data for a typical analysis of change needed to use Excel 2016's inbuilt waterfall chart, and the additional columns needed to create this as a stacked column chart.

To use Excel 2016 Waterfall		To use stacked column approach (any version of Excel)				
Factor	Amount	Blank Space	Col Up	Col Down	Col label	
Opening Reserves	100		100	0		20
Longevity Assumption	10	100	10	0		20
Interest Rate Assumptio	-20	90	0	20		20
Expenses Assumption	10	90	10	0		20
Equity Return Assumptio	30	100	30	0		20
Disability Assumption	5	130	5	0		20
New Business	50	135	50	0		20
Mortality Assumption	-30	155	0	30		20
One-Off Adjustment	-10	145	0	10		20
Insurance	-10	135	0	10		20

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► Jul 2019 (2)


► Jun 2019 (1)


▼ Apr 2019 (1)


[Create a Waterfall Chart in Excel](#)


► 2018 (5)


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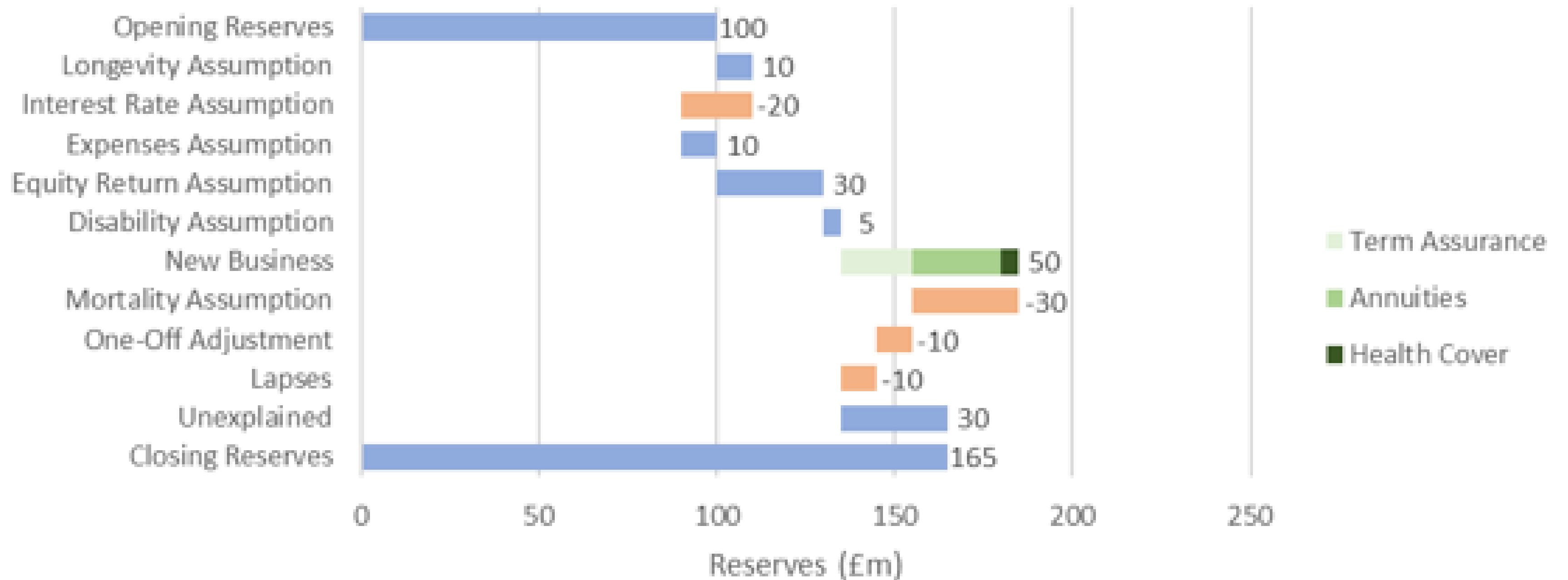
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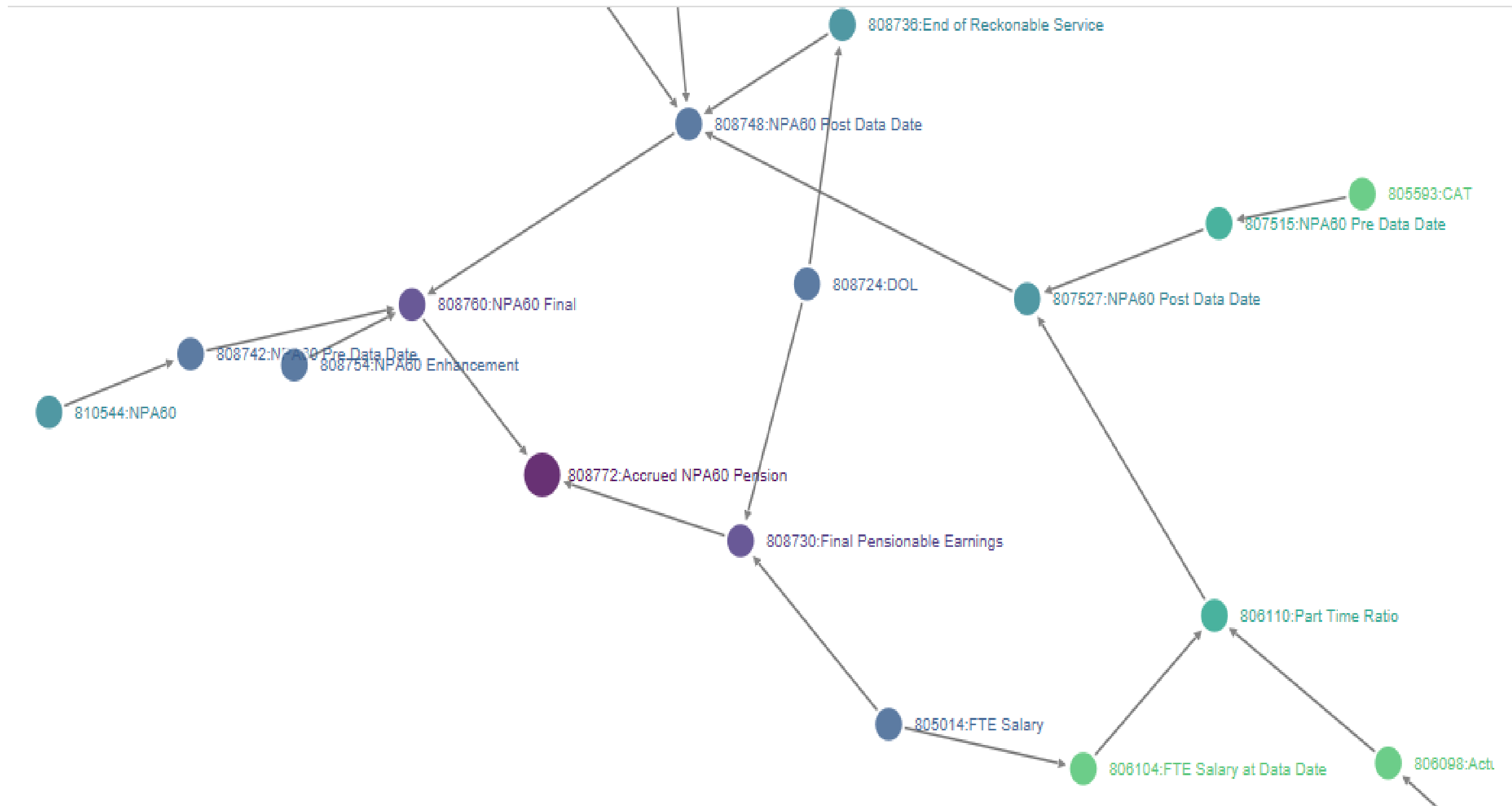
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# Waterfall chart in Excel (April 2019)

Stacked Bar Waterfall - reversed



# Model dependencies (due shortly)



# Data visualisation

## Getting involved



# Getting involved

- Please visit our blog – <https://dataviz-wp.blogspot.com>
- Please talk to your colleagues about data visualisation and our blog
- Registered users can submit visualisations (blog posts) of your own
  - Or, if you have ideas for blog posts you would like to write (or read), please get in touch with one of us ([aidan.smith@gad.gov.uk](mailto:aidan.smith@gad.gov.uk))
- Anyone can add comments via the blog





# Data visualisation

## Discussion



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