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Data Visualisation for Business Insight

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Topics

- What is data visualisation and why is it useful?
- Principles and practices of data visualisation
  - Illustrated throughout by case studies
- Focus is very practical
  - "Rules and tools" for actuarial staff to help improve day to day communication of information
  - Not intended to imply that some of these methods aren't already in use
  - Not about "MI/BI" data analytics systems / processes
- Commentary, additional material and references are all contained in an accompanying paper, available from www.sias.org.uk.

What is data visualisation?

- *The main goal of data visualization is to **communicate information clearly and effectively** through graphical means.* (Friedman [1])
- *Important stories live in our data and data visualization is a powerful means to **discover and understand these stories**, and then to present them to others.* (Few [2])
- *Visualization gives you **answers to questions you didn't know you had**.* (Shneiderman [3])

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Why is data visualisation useful for actuaries?

Boards struggle to understand internal model outputs
Poor communication of the outputs from Solvency II internal models means the results are at risk of being ignored or misunderstood by the boards of insurance companies, according to LCP.

"What are these numbers telling me? And the font is too small – my eyesight isn't what it used to be."
Unnamed UK Chief Actuary

AVOID PRINTING IN SOLID FULL COLOUR
Sign above printer in most offices in the UK

"Why is there so little graphical communication of internal model results and how much healthy challenge is missing as a result?"
InsuranceERM article

Information [should be] presented in a clear and comprehensible manner
TAS R

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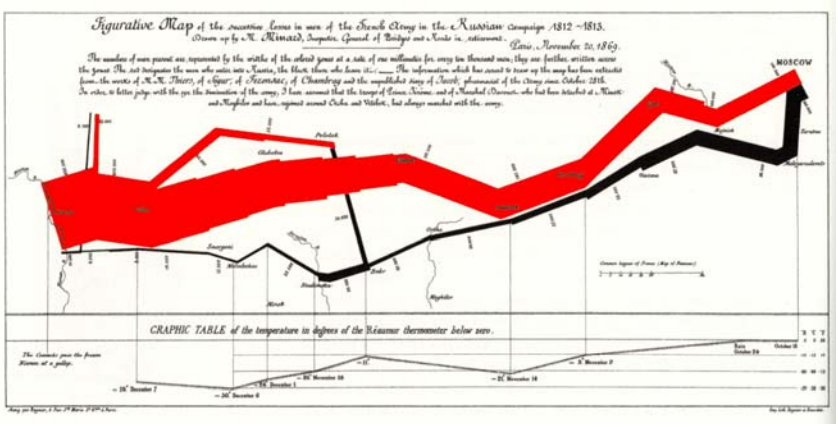
Napoleon's 1812 March to Moscow



- Produced in 1869 (!) by Charles Minard
- Red is towards Moscow, black is retreat, width represents size of army
- Temperatures during the retreat are shown at the bottom
- "*It may be the best statistical graphic ever drawn*" (Tufte [6])

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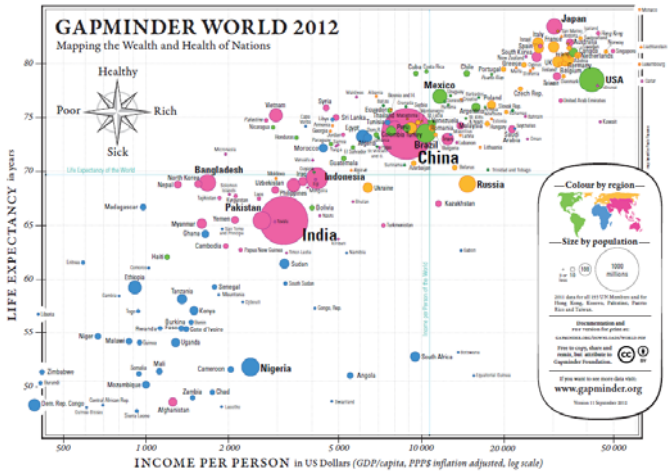
Encoding 4 variables in 2-D



- Size and colour used to encode 2 more variables
- Axes use log-scales to bring out the roughly linear relationship between life expectancy and transformed income per person

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Encoding 4 variables in 2-D

Gapminder
http://www.gapminder.org/world-offline/

Life expectancy vs wealth
over the last 200 years

- Interactive version showing global changes over 200 years
- Application contains a wealth of other data
- Live web site at www.gapminder.org/world

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Key principles of data visualisation

Data visualisation techniques are not magical, they can be **studied** and **learned**

The key to good visualisations is **good communication**

Trial and error will almost always lead to improvements.

A **top-down structured process** to data visualisation, starting with the **needs of its users**, is likely to be more successful than diving straight in.

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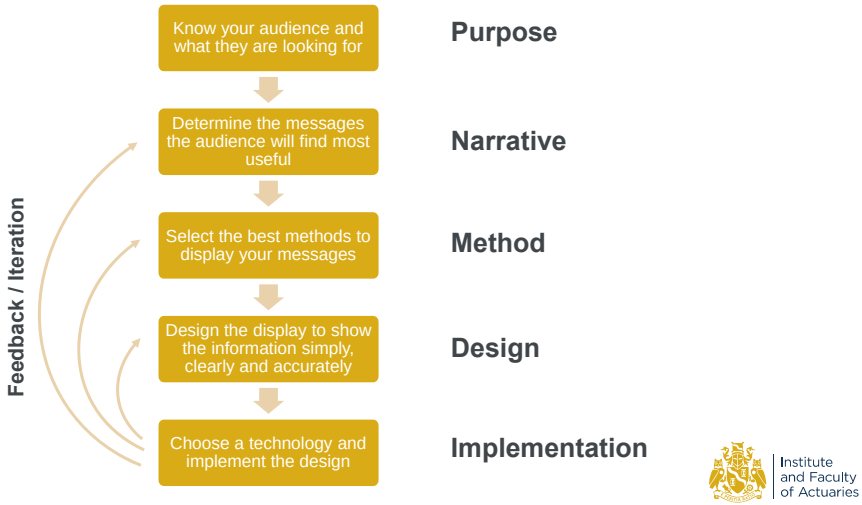
Data Visualisation Process

Process Diagram



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Narrative

- The narrative is the "overall message" of a visualisation, in business rather than technical terms
- Even where the objective of an actuarial report is very narrow (e.g. a statutory valuation) it is important to place it in a business context
  - TAS R A.1.2: "*sufficient information is included to enable users to understand the implications of the contents of the reports*"
- Many actuarial techniques can be seen as narratives:

How and why have the numbers changed?	Analysis of Change Analysis of Surplus
How do we know these numbers are reasonable / internally consistent?	Reconciliation Reasonableness testing Sensitivity analysis
How do the numbers break down into component parts?	Capital waterfalls P&L attribution

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Purpose of a data visualisation

What is the data?

- Precision
- Clarity
- Simplicity

What does the data mean?

- Context
- Patterns
- Trends

What else can I discover?

- Relationships
- Connections
- Associations

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Case Study 1: Governance Approval of a Correlation Matrix

Thought leadership
Progress
Community
Sessional Meetings
Education
Working parties
Volunteering
Research
Shaping the future
Networking
Professional support
Enterprise and risk
Learned society
Opportunity
International profile
Journals

Correlation Matrix: Initial Process

Know your audience and what they are looking for	**Technical Committee**
Determine the messages the audience will find most useful	**Governance approval**
Select the best methods to display your messages	**Table of values**
Design the display to show the information simply, clearly and accurately	**Whatever it looks like in Excel**
Choose a technology and implement the design	**Copy from Excel**

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Correlation Matrix: Attempt 1

		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	Motor	Home	Legal	Travel	Liability	Current expenses	Expense inflation	Internal fraud	External fraud	Employment Practices	Business Practice	Physical Asset Damage	System Failures	Execution Management
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	0.00	0.00	0.00	0.00	0.00	0.25	-0.25	-0.25	-0.25	0.00	0.00	0.00	0.00
	Credit spreads	-0.75	1.00	0.50	-0.25	0.00	-0.50	0.50	0.25	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	-0.25	0.25	0.25	0.25	0.00	0.00	0.00	0.00
	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00
	Other counterparty	-0.25	0.25	0.50	0.25	0.00	-0.25	0.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00
Non-life insurance risk	Motor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Home	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.00	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Legal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	1.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Travel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Liability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.25	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Expense risk	Current expenses	0.25	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	1.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	Expense inflation	0.25	-0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.25	1.00	0.25	0.25	0.25	0.25	0.25	0.25
Operational risk	Internal fraud	-0.25	0.25	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	1.00	0.50	0.50	0.50	0.50	0.50
	External fraud	-0.25	0.25	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.50	1.00	0.50	0.25	0.50	0.50
	Employment Practices	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.50	0.50	1.00	0.50	0.50	0.25
	Business Practice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.50	0.25	0.50	1.00	0.50	0.50
	Physical Asset Damage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.50	0.50	0.50	0.50	1.00	0.50
	System Failures	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.50	0.25	0.50	0.50	0.50	1.00
	Execution Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.50	0.50	0.25	0.50	0.50	0.50

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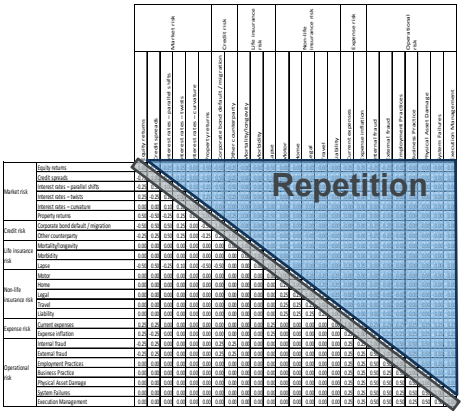
Commentary on Attempt 1

- Precise – important since approval being sought
- Symmetry ⇨ repetition
- Mismatch between what's important to the audience and what stands out visually
  - Size and sign of values are important to audience
  - But very hard to pick out
  - Leading diagonal looks important, but conveys no information (values are always 1)
- "Wall of numbers" - hard to see patterns and relationships
- No sense of financial significance



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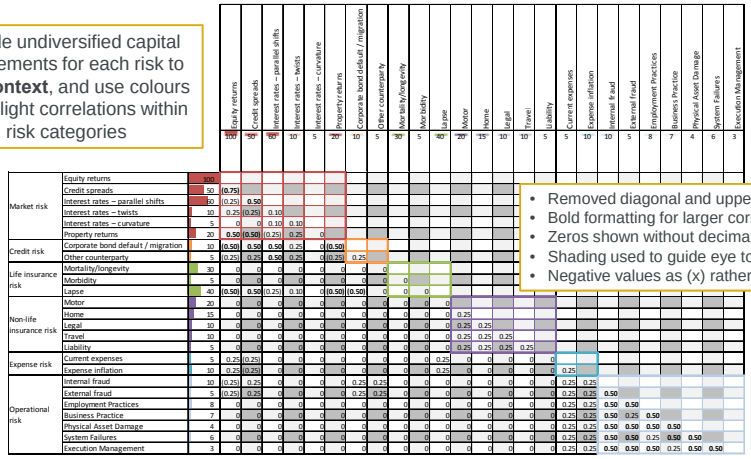
Correlation Matrix: Attempt 2

Include undiversified capital requirements for each risk to give **context**, and use colours to highlight correlations within risk categories



- Removed diagonal and upper triangle
- Bold formatting for larger correlations
- Zeros shown without decimal places
- Shading used to guide eye to headings
- Negative values as (x) rather than –x

Improving the **design** has started to help with seeing **patterns**

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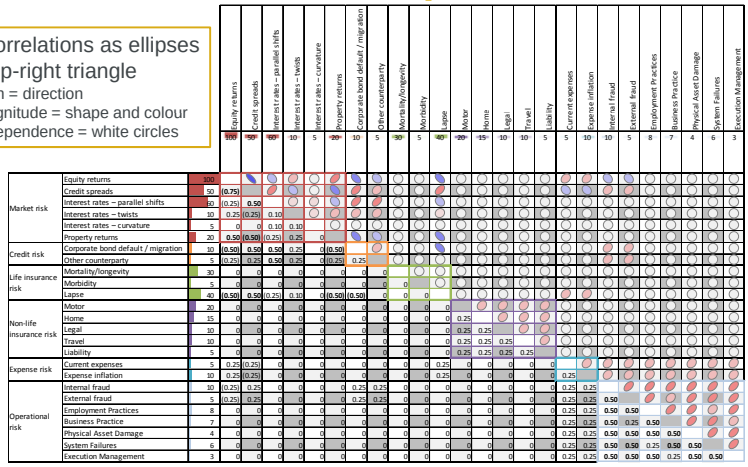
Correlation Matrix: Attempt 3

Show correlations as ellipses in the top-right triangle
- Sign = direction
- Magnitude = shape and colour
- Independence = white circles



Can see more **patterns** - easier to **explain** and **explore** the correlations

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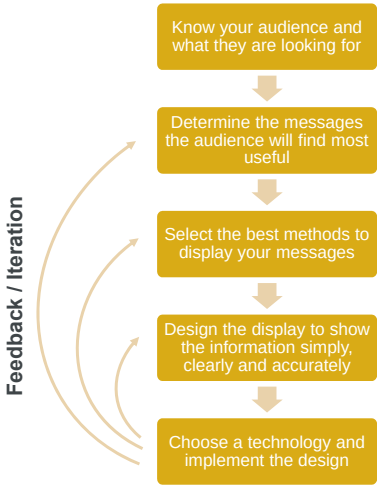
Correlation Matrix: Updated Process



Technical Committee

Governance review, challenge and approval

Hybrid matrix of values and ellipses

Choose appropriate colour scheme

Excel data bars, sparklines, VBA

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Case Study 1: Lessons Learned

- Methodology
  - Tables are important in actuarial work, to set out numerical values out precisely
  - However, tables are at the Exhibit end of the spectrum, if we want to make it easy for users to Explain or Explore the data, pictures are likely to be useful
  - The paper covers the methodologies for tables and charts in more detail
- Design
  - Changing the design of a table can both improve the presentation and suggest improvements to methodology
    - In the case study, creating the white space in the upper triangle prompted the question “what can we do with this?”
    - In order to use the space, we had to develop the methodology further
- Implementation
  - We had to use advanced Excel features (data bars, sparklines, VBA)

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Implementation

- Excel is the obvious tool, familiar to and used by most actuarial staff
- More recent versions (2010, 2013) have more visualisation features:
  - Lots of chart types – but avoid spurious 3-d charts
  - Sparklines (small charts embedded in cells – example later)
- Since Excel is so familiar, it's easy to allow visualisations to be constrained by what it can and can't support, but there are options:
  - http://peltiertech.com/Excel/Charts/ChartIndex.html is an excellent resource for producing additional types of chart in Excel itself
  - VBA can be used to embellish tables and charts (e.g. the ellipses)
  - The statistical package R has powerful charting capabilities – but steep learning curve
  - Bespoke packages (see accompanying paper)

Try not to let your visualisation ideas be constrained by technology – there will often be a way to do it

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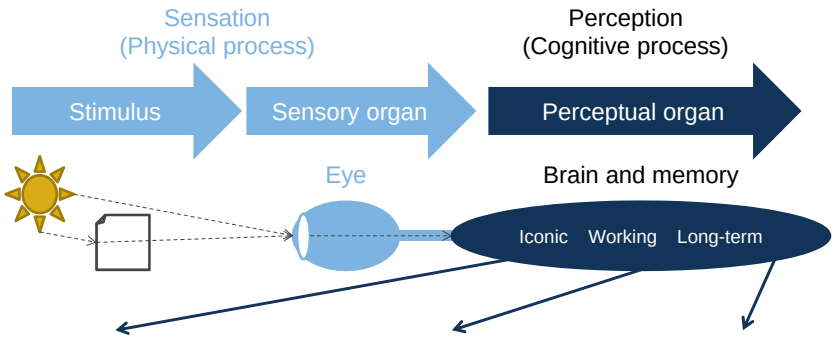
Design and Method

Design: Perception and Cognition



Iconic memory

Very short-term (<1 s)

Colour and location

Where things stand out

Working memory

Few seconds only

At most 3-4 items

⇨Viewers will need to go back to a legend with 6 entries

Long-term memory

Stored for later use

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Avoid Pie Charts

The only good pie chart?

- It is difficult to perceive the relative size of areas correctly
- Much easier to see relative sizes using lengths
- Almost always preferable to use a bar/column or line chart
  - Show absolute as well as relative values

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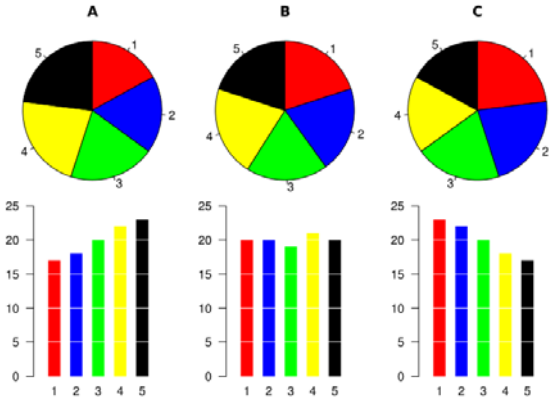
Avoid Pie Charts



- It is difficult to perceive the relative size of areas correctly
- Much easier to see relative sizes using lengths
- Almost always preferable to use a bar/column or line chart
  - Show absolute as well as relative values

Source: http://commons.wikimedia.org/wiki/File:Piecharts.svg
where author information can be found.
Licensed under the Creative Commons Attribution 1.0 Generic licence.

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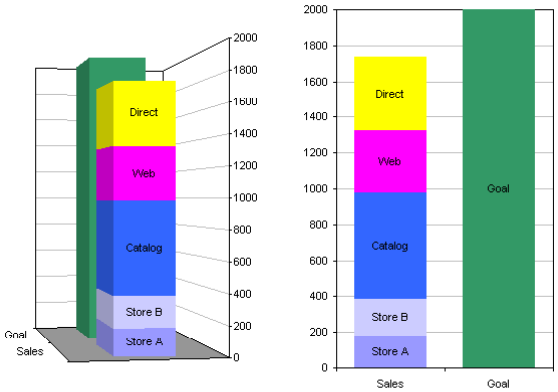
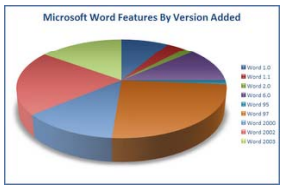
Avoid Gratuitous 3-D





Especially avoid 3-D pie charts with badly-chosen colours!

Source: http://peltiertech.com/WordPress/the-perils-of-being-in-3d/

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Design: Overarching Principles

- Remove everything that isn't necessary
- Identify what is data and what isn't
- Make the data prominent and clear
- Make the non-data as unobtrusive as is sensible
  - Non-data are things like axes and grid-lines, which can sometimes be too "busy" – if so, remove or use light grey
- Highlight the information that's most important to your narrative (and vice versa)
- Keep colours and fonts under control
  - 2 or 3 colours will create a sense of unity
  - Different shades and sizes are allowed (within reason)
  - More will distract from the data

Just as a good editor of prose ruthlessly prunes out unnecessary words, so a designer of statistical graphics should prune out ink that fails to present fresh data-information.

Graphical elegance is often found in simplicity of design and complexity of data.

Graphical excellence consists of complex ideas communicated with clarity, precision and efficiency.

(All from Tufte [6])

In summary: "maximise the data/ink ratio, within reason"

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Case Study 2: Presentation of Stochastic Model Results

Stochastic model output is ideally suited to visualisation techniques – lots of high-dimensional data

Case study is based on a hypothetical annuity writer backing liabilities purely with corporate bonds

Thought leadership Progress Community Sessional Meetings Education Working parties Volunteering Research Shaping the future Networking Professional support Enterprise and risk Learned society Opportunity International profile Journals

Stochastic Results: Initial Process

Know your audience and what they are looking for	**Various, from reviewer through to Chief Actuary**
Determine the messages the audience will find most useful	**Governance review, challenge and approval**
Select the best methods to display your messages	**Probability Density Function, scenario results table**
Design the display to show the information simply, clearly and accurately	**Use default formatting**
Choose a technology and implement the design	**Excel**

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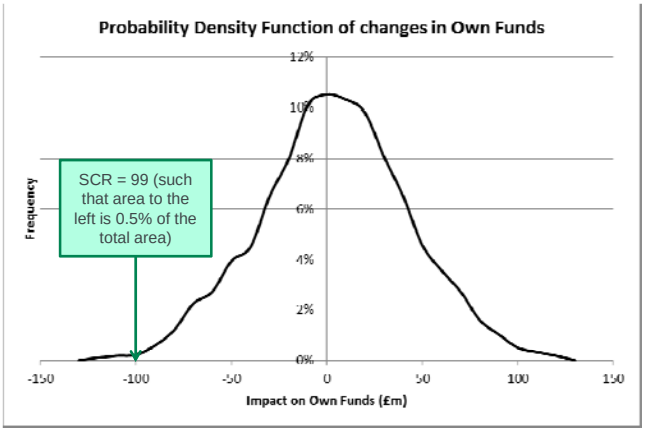
Probability Distribution Forecast: Attempt 1



- "Traditional" view
- Probability is represented by area under the curve
- Not straightforward to read off percentiles, or see whether the median is close to 0
- Y-axis is not especially meaningful

Good for: showing overall degree of symmetry/skew, comparisons of shape of different distributions

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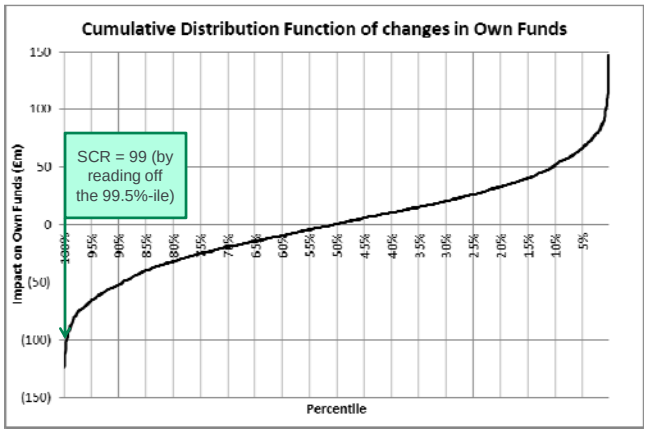
Probability Distribution Forecast: Attempt 2



- Percentiles represented along the X-axis
- Straightforward to read off percentiles (except in the extremes?), and to see the median impact on own funds
- Gridlines are extra "ink", but facilitate reading off percentiles and impacts

Good for: reading off percentiles across the body of the distribution, showing the contribution of different risks to the total (see later slides)

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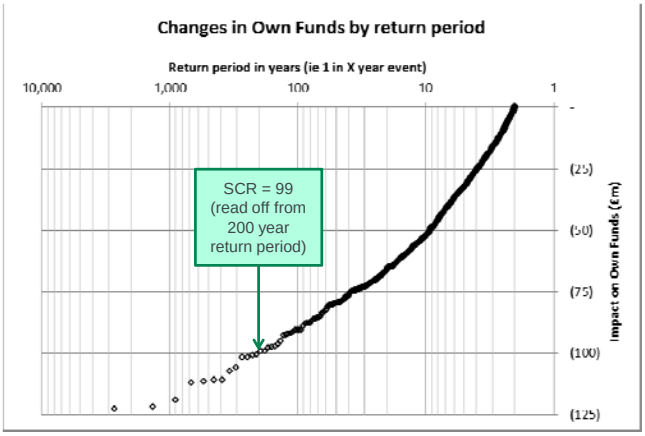
Probability Distribution Forecast: Attempt 3



- Percentiles have been converted to "1 in X year" values, and shown on a log scale
- More straightforward to read off values, especially in the tail (where we are most interested)
- "Stretching" of the tail highlights sparseness of extreme simulations, not evident in the previous graphs

Good for: reading off percentiles in the downside tail, showing the granularity of the underlying results

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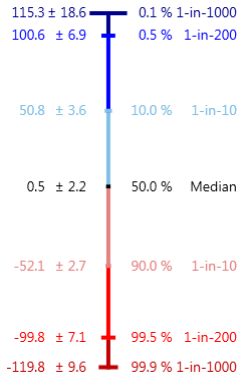
Probability Distribution Forecast: Attempt 4



- "PDF summary plot" – related to box-and-whiskers/ candlestick plots, but with enhancements
- A summary of the PDF may be more useful than showing the whole distribution – this example focuses on 7 key points across the risk spectrum
- On the left-hand side we show the impact at each distribution point, along with an assessment of simulation error
- We can tell quite a lot about the distribution just from these 7 points, so we haven't lost too much by summarising:
  - Distribution is fairly close to symmetrical
  - 1-in-200 events have roughly twice the impact of 1-in-10, like the Normal distribution
  - 1-in-1000 events not much larger than 1-in-200

Good for: minimising data/ink ratio, showing another dimension (eg simulation error), comparing distributions side by side

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Scenario Level Results: Attempt 1

Drilling down into the scenario level results:

Percentile	Scenario	All risks change in OF (£m)	Interest rate risk change in OF (£m)	Credit risk change in OF (£m)	Longevity risk change in OF (£m)	Operational risk change in OF (£m)	Implied non-linearity/non-separability (£m)
100.0%	89	-123.74	-0.10	-81.26	-42.23	-0.24	0.10
100.0%	2336	-122.47	3.33	-92.75	-29.48	-0.29	-3.28
99.9%	238	-121.60	-23.18	-73.54	-47.37	-0.05	22.55
99.9%	1540	-119.01	-3.11	-78.76	-40.12	0.00	2.97
99.9%	1105	-111.91	-0.10	-89.79	-21.94	-0.17	0.09
99.8%	2258	-111.39	-5.18	-78.71	-31.75	-0.32	4.56
99.8%	2716	-111.00	2.46	-63.67	-47.55	-0.06	-2.19
99.7%	389	-110.81	-2.98	-82.69	-27.16	-0.59	2.61
99.7%	510	-107.30	-3.41	-90.41	-16.25	-0.12	2.89
99.7%	235	-105.98	0.07	-86.58	-18.98	-0.43	-0.06
99.6%	557	-101.64	3.21	-60.59	-41.42	-0.26	-2.58
99.6%	440	-101.57	5.12	-86.57	-15.70	-0.29	-4.13
99.6%	1365	-100.99	2.38	-71.90	-29.39	-0.18	-1.90
99.6%	2285	-100.58	-2.82	-70.24	-29.07	-0.66	2.20
99.5%	689	-99.19	-1.86	-73.04	-25.65	-0.08	1.44
99.4%	1202	-99.18	-5.21	-100.09	2.19	-0.08	4.00
99.4%	2761	-97.72	2.18	-59.24	-38.97	-0.01	-1.68
99.4%	2274	-97.50	4.76	-50.22	-48.22	-0.13	-3.68
99.3%	640	-97.27	2.28	-52.02	23.52	-70.70	-0.35
99.3%	541	-96.54	4.53	-75.73	-21.77	-0.10	-3.47
99.3%	2879	-94.96	-0.25	-95.03	0.81	-0.68	0.19
99.2%	373	-92.90	1.84	-82.36	-10.86	-0.18	-1.34
99.2%	1948	-92.60	3.91	-79.71	-13.85	-0.09	-2.86
99.2%	1038	-92.23	2.49	-74.69	-18.08	-0.15	-1.80
99.1%	2752	-91.98	-1.16	-70.20	-21.29	-0.16	0.83
99.1%	1083	-91.33	-2.88	-51.47	-39.00	0.00	2.03
99.0%	2355	-90.69	-2.16	-61.66	-27.93	-0.45	1.51
99.0%	1100	-90.63	3.57	-36.60	-54.82	-0.24	-2.54
99.0%	1750	-90.50	-2.94	-66.98	-22.55	-0.08	2.05

- Overly focussed on precise values
- Wasted "ink", eg gridlines, repetitious headings
- Difficult to spot patterns

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Scenario Level Results: Attempt 2

Euler allocation by risk		(99)		1	(75)	(21)	(4)	(0)
		Changes in Own Funds arising from variations in... (£m)						
Percentile	Scenario	All risks	Interest rate risk	Credit risk	Longevity risk	Operational risk	Implied non-linearity & non-separability	
100.0%	89	(124)	(0)	(81)	(42)	(0)	0	
100.0%	2336	(122)	3	(93)	(29)	(0)	(3)	
99.9%	238	(122)	(23)	(74)	(47)	(0)	23	
99.9%	1540	(119)	(3)	(79)	(40)	(0)	3	
99.9%	1105	(112)	(0)	(90)	(22)	(0)	0	
99.8%	2258	(111)	(5)	(79)	(32)	(0)	5	
99.8%	2716	(111)	2	(64)	(48)	(0)	(2)	
99.7%	389	(111)	(3)	(83)	(27)	(1)	3	
99.7%	510	(107)	(3)	(90)	(16)	(0)	3	
99.7%	235	(106)	0	(87)	(19)	(0)	(0)	
99.6%	557	(102)	3	(61)	(41)	(0)	(3)	
99.6%	440	(102)	5	(87)	(16)	(0)	(4)	
99.6%	1365	(101)	2	(72)	(29)	(0)	(2)	
99.6%	2285	(101)	(3)	(70)	(29)	(1)	2	
99.5%	689	(99)	(2)	(73)	(26)	(0)	1	
99.4%	1202	(99)	(5)	(100)	2	(0)	4	
99.4%	2761	(98)	2	(59)	(39)	(0)	(2)	
99.4%	2274	(97)	5	(50)	(48)	(0)	(4)	
99.3%	640	(97)	2	(52)	24	(71)	(0)	
99.3%	541	(97)	5	(76)	(22)	(0)	(3)	
99.3%	2879	(95)	(0)	(95)	1	(1)	0	
99.2%	373	(93)	2	(82)	(11)	(0)	(1)	
99.2%	1948	(93)	4	(80)	(14)	(0)	(3)	
99.2%	1038	(92)	2	(75)	(18)	(0)	(2)	
99.1%	2752	(92)	(1)	(70)	(21)	(0)	1	
99.1%	1083	(91)	(3)	(51)	(39)	(0)	2	
99.0%	2355	(91)	(2)	(62)	(28)	(0)	2	
99.0%	1100	(91)	4	(37)	(55)	(0)	(3)	
99.0%	1750	(91)	(3)	(67)	(23)	(0)	2	

- Excessive precision removed
- Excel "sparklines" added to bring out patterns
- Data/ink ratio improved
- Enables insight into risk profile

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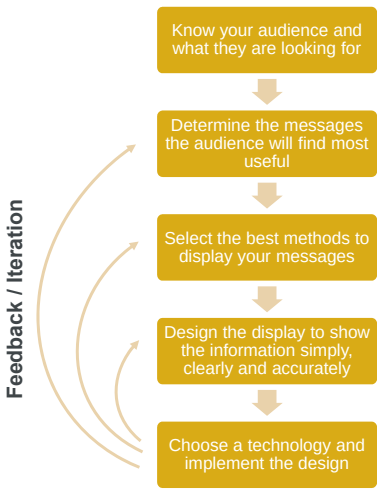
Stochastic Case Study: Updated Process



Various, from reviewer through to Chief Actuary

Governance review, challenge and approval

Cumulative Distribution Function, add sparklines to table of scenario results

Use appropriate colours and other formatting

Excel (≥2010), PowerPoint

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Case Study 2: Lessons Learned

- Process
  - Trial-and-error is very useful (probably necessary) in improving visualisations
  - Use what you know about the business (e.g. risk profile, investment strategy) to determine whether the visualisation is working or not
    - Also, asking whether you can see things you already know puts you in a frame of mind where you might well notice other aspects not yet thought about
- Methodology
  - Changing the 'units of measurement' (density ⇨ distribution) or the scale (linear ⇨ log) can help bring out the important features
- Design
  - Using colour consistently (e.g. for the different risks) creates a sense of unity across different visualisations

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Qualitative Visualisations

- Focus has been on **quantitative** visualisations
- However **qualitative** visualisations are also useful
  - Diagrams of model structure and data flow (e.g. www.slateforexcel.com)
  - Process diagrams and Gantt charts
  - Cognitive maps - see paper on complex systems by Neil Cantle and co-authors
  - Word clouds to get an overall sense of a (long and conceivably tedious) text

Word Cloud of the June 2013 IFRS Exposure draft on insurance contracts

Produced using www.wordle.net

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Non-Linear Presentation and Motion Charts

- PowerPoint presentations are very **linear**
  - Fixed sequence of slides
  - Hard to get a sense of the relationship between the detail and the big picture
- Prezi (http://prezi.com) is a new(ish) tool for **non-linear** presentation
  - Zoom into and out of different levels of detail
  - Move around key concepts using non-linear **paths**
  - Cross between a slide show and a whiteboard
- Similarly, motion charts are a method of adding extra dimensionality and interest into visualisations:
  - "Poor man's" version can be undertaken in PowerPoint using sequential slides like a flickbook.
  - Google has an online tool (Google Motion Chart) to create simple motion charts, along the lines of the earlier, more sophisticated, Gapminder example.

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Summary of principles

- Conceptual
  - Good visualisations aren't especially difficult to develop and produce
  - The techniques for producing them can be studied and learned
    - Just like the communications exam!
  - It is possible to follow a well-defined process to maximise the effectiveness of your visualisations
    - Much of the content of the case studies resulted from following the process on slide 10
- Practical
  - Trial and error - don't be afraid to try new things, present alternative ways of showing the same information, ask colleagues to critically evaluate your visualisations, and take forward the most popular
  - "**Maximise the data/ink ratio, within reason**" is the simplest principle to remember and apply – it will help drive all sorts of improvements
  - There are lots of resources out there to help
  - A technically imperfect chart that stimulates discussion and insight is better than a perfect one which is ignored

The SIAS paper discusses these principles in more depth

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References (1): Books and articles

1. Friedman, Vitaly (2008) Data Visualization and Infographics
   In: *Graphics*, Monday Inspiration, January 14th, 2008.
2. Few, Stephen (2013): Data Visualization for Human Perception.
   In: Soegaard, Mads and Dam, Rikke Friis (eds.) *The Encyclopedia of Human-Computer Interaction, 2nd Ed* Aarhus, Denmark: The Interaction Design Foundation.
3. Shneiderman, Ben (quoted in Kirk, Andy (2012): Data Visualization: a successful design process)
4. Few, Stephen (quoted in Kirk, Andy (2012): Data Visualization: a successful design process)
5. Few, Stephen (2012): Show Me The Numbers
6. Tufte, Edward (2001): The Visual Display of Quantitative Information
7. Cairo, Alberto (2013): The Functional Art: An introduction to information graphics and visualization

Just a flavour – more in the SIAS paper

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References (2): Websites

- http://www.visualisingdata.com/index.php/resources/ (Lots of onward links)
- http://visual.ly/
- http://www.visual-literacy.org/periodic_table/periodic_table.html
- http://datawrapper.de/
- http://spatialanalysis.co.uk/
- http://flowingdata.com/
- http://www.informationisbeautiful.net/ (Accompanying book is useful for idea generation)
- http://www.economist.com/blogs/graphicdetail
- http://www.guardian.co.uk/technology/data-visualisation
- http://peltiertech.com/Excel/Charts/ChartIndex.html (Guidance/tutorials for Excel charts)
- http://www.statmethods.net/ (Guidance/tutorials for producing charts in R)

Links were valid at the time of writing, but may not remain so indefinitely.

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Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

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Appendix 1: Audience Case Study

Equity Market Trends: Initial Process

Know your audience and what they are looking for	**General background to a set of financial results**
Determine the messages the audience will find most useful	**Understand how equities have performed during the period**
Select the best methods to display your messages	**Line chart**
Design the display to show the information simply, clearly and accurately	**Show index values; use default formatting**
Choose a technology and implement the design	**Excel**

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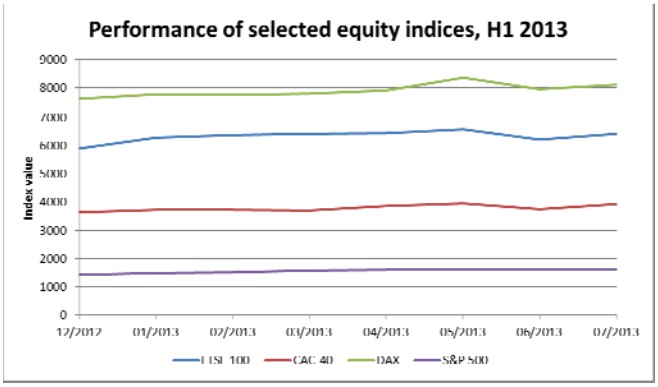
Equity Market Trends: Attempt 1



Strengths?
Weaknesses?
Suggestions for improvement?

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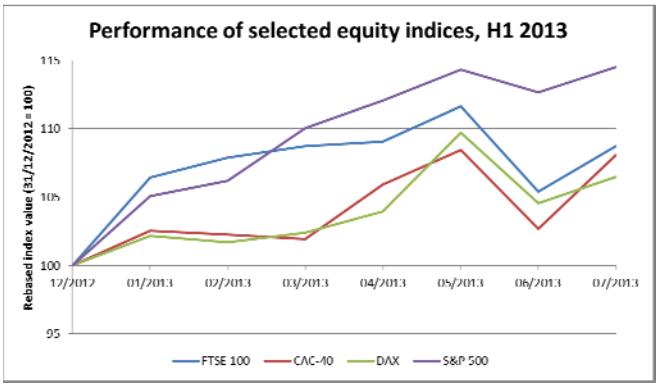
Equity Market Trends: Attempt 2



Strengths?
Weaknesses?
Suggestions for improvement?

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