CREATING TABLES AND CHARTS FOR PRESENTING DATA

BEGIN

WHAT WILL BE COVERED

Outline:

- Purpose and principles of displaying data using tables and charts
  - Reasons for using tables and charts
  - Using tables and charts in your document
  - Principles of creating good tables and charts
- Types of charts
- Making a good chart
- Further reading

NEXT

PURPOSE AND PRINCIPLES OF USING TABLES AND CHARTS

Reasons for using tables and charts:

Tables and charts are both used to summarise and communicate complicated data in a way that is 'digestable' (e.g. clear) and 'illuminating' (e.g. insightful) for the reader:

- **Tables** are used to display data that cannot be appropriately represented in the text e.g. a set of numbers or results that are much clearer to the reader if they are shown as a table
- **Charts** are used are used to display data that cannot be appropriately represented in a table or text, but is instead better represented visually in order to reveal patterns or relationships in the data that might not otherwise be 'seen' if you leave it as a table

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PURPOSE AND PRINCIPLES OF USING TABLES AND CHARTS

Using tables and charts in your document:

Often tables and charts are elements of your document that get read first, and are often key 'take home' messages for the reader

Tables and charts must be further explained in the text (e.g. what the data means, important patterns or relationships that you want to highlight)...

... However, they also need to be **'self-explanatory'** at an overview level – i.e. the table or chart should be clear 'on its own' without the reader having to read the text in-depth to understand it (imagine someone is flicking through your document and wants to get a snapshot of the key messages from your data). The surrounding text will then further explain the patterns and relationships observed in the data.

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PURPOSE AND PRINCIPLES OF USING TABLES AND CHARTS

Principles of creating good tables and charts:

1) **Efficient** display of data
   - Data supports the point you want to make in your document (i.e. no redundant data that isn't important to the study/work being presented)
   - Minimal 'ink' used to show data (no excess lines, shading or colours; no 3D features)
2) **Meaningful** display of data
   - Data used is well-suited to being presented in a table or chart
   - Data is important to the study/work being presented and offers important insights
3) **Unambiguous** display of data
   - Data clearly labelled and defined in table/chart
4) **Accurate and undistorted** display of data
   - Data presented in a way that does not mislead the reader

   (e.g. no sneaky changes in scale, even if unintentional)

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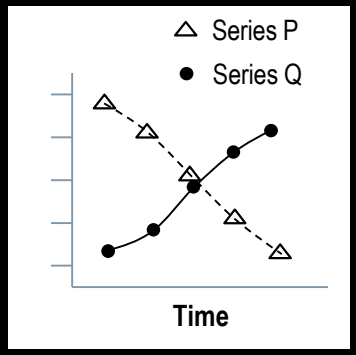
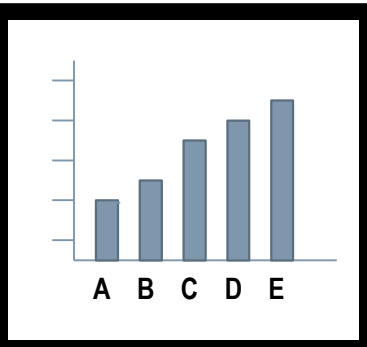
TYPES OF CHARTS

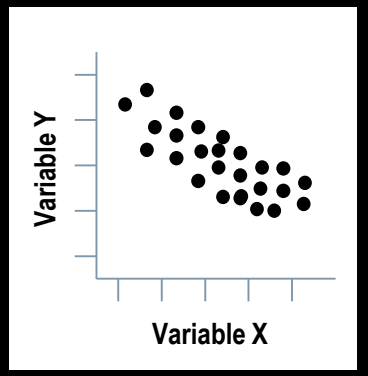
Time series



Column or bar chart

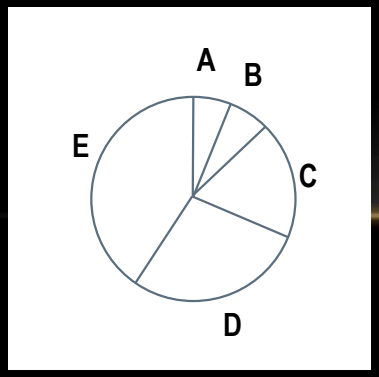


Scatter plot

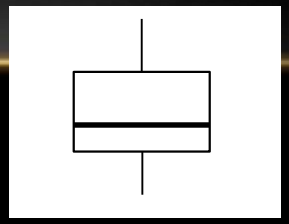


5 key types of charts

Pie chart



Box-and-whisker plot



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TYPES OF CHARTS

Column or bar charts:

These can be used when you are comparing 'categorical' variables i.e. variables that are separate 'categories' of data, such as:

- Particular types of individuals e.g.
  - Categories of survey respondents in an agricultural survey (farmers, government staff, agribusiness, scientists, ...)
  - Categories of students attending university (full-time, part-time, distance)
- Particular types of organisations e.g.
  - Universities in Australia (UQ, QUT, Griffith, UNSW, USYD, ANU, ...)
  - Notebook computer manufacturers (Apple, Dell, Toshiba, Asus, Samsung, HP)
- Particular types of products or commodities e.g.
  - Types of cars (Ford, Holden, Toyota, Nissan, ...)
  - Types of agricultural commodities (maize, wheat, rice, soybean)

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TYPES OF CHARTS

Column or bar charts:

Example 1 - International food prices for various grains from 2000-2050:

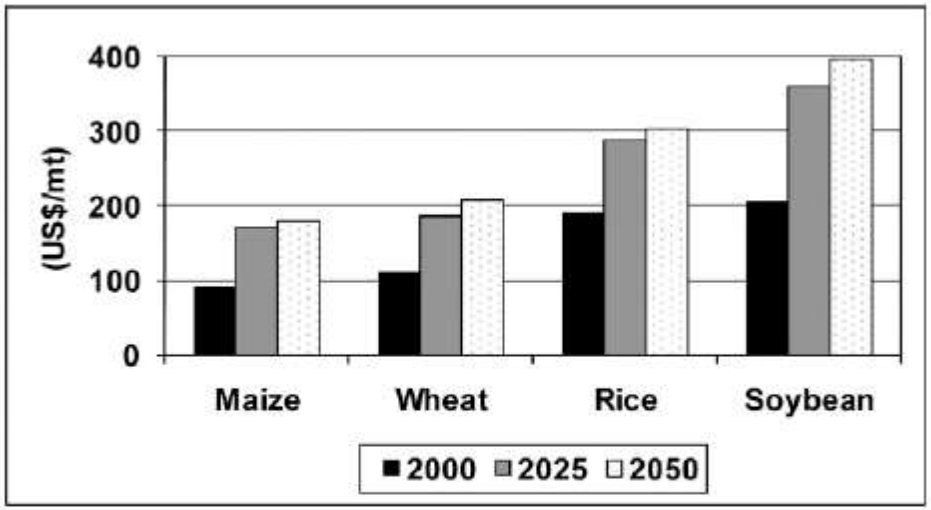

Figure 5. International food prices ($US t^{-1}) of selected grains in 2000, and projected for 2025 and 2050.

Hubert B., Rosegrant M., van Boekel M.A.J.S., Ortiz, R. (2010)
The future of food: scenarios for 2050. *Crop Science* 50: S-33-S-50.

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TYPES OF CHARTS

Column or bar charts:

Example 2 - Reasons for women working or staying at home in the US between 1978 and 1999:

Klass G. (2002) *Presenting data: tabular and graphic displays of social indicators*. Illinois State University, Available: http://lilt.ilstu.edu/gmklass/pos138/datadisplay/sections/goodcharts.htm.

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TYPES OF CHARTS

Column or bar charts:

Both of the previous examples also used time series data (i.e. data for more than one point in time) which also shows a good way of using column/bar charts to also show change over time in categorical data

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TYPES OF CHARTS

Pie charts:

These can be used in certain circumstances, but generally they should be avoided in scientific writing because the same data can be usually be displayed more clearly with column/bar charts.

- E.g., even with labels, it is often not easy to 'see' the differences between different 'pieces of the pie' as easily as it is in column/bar charts

Column/bar charts also have the advantage mentioned above that they can clearly show changes over time, whereas pie charts become very confusing if you try to put two next to each other and compare change over time

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TYPES OF CHARTS

Time series charts:

These are excellent for showing patterns of change in a variable over time

The dependant variable (i.e. the one that you are interested in looking at over time) is often a continuous variable. That is, it can be 'any value' within the range you are considering (e.g. temperature, mass, length, area, no. bacteria cells, ...) which means that you may be able to fit a line between individual points to interpolate between them later (e.g. for modelling)

For example, think about charts of:

- Change in global temperatures over time
- Change in the stock market over time

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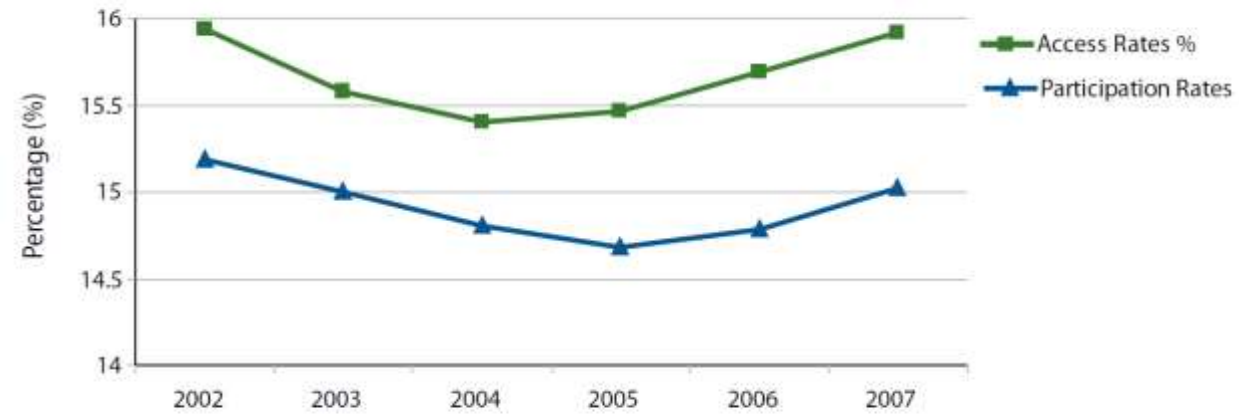
TYPES OF CHARTS

Time series charts:

Example 1 – Access and participation by people from low socioeconomic status backgrounds at Australian universities:

Figure 4: Access and Participation Rates – Low socio-economic status (all ages)



Note: 25% of the Australian population is categorised as low SES

Source: DEEWR (Selected Higher Education Statistics, various years)

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Bradley D., Noonan, P., Nugent H., Scales B. (2008) *Review of Australian Higher Education: Final Report, December 2008*. Available: http://www.innovation.gov.au/highereducation/ResourcesAndPublications/Review/Pages/ReviewOfAustralianHigherEducationReport.aspx.

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TYPES OF CHARTS

Time series charts:

Example 2 – Sea temperature anomaly over time in a major fishery in the Northeast US:

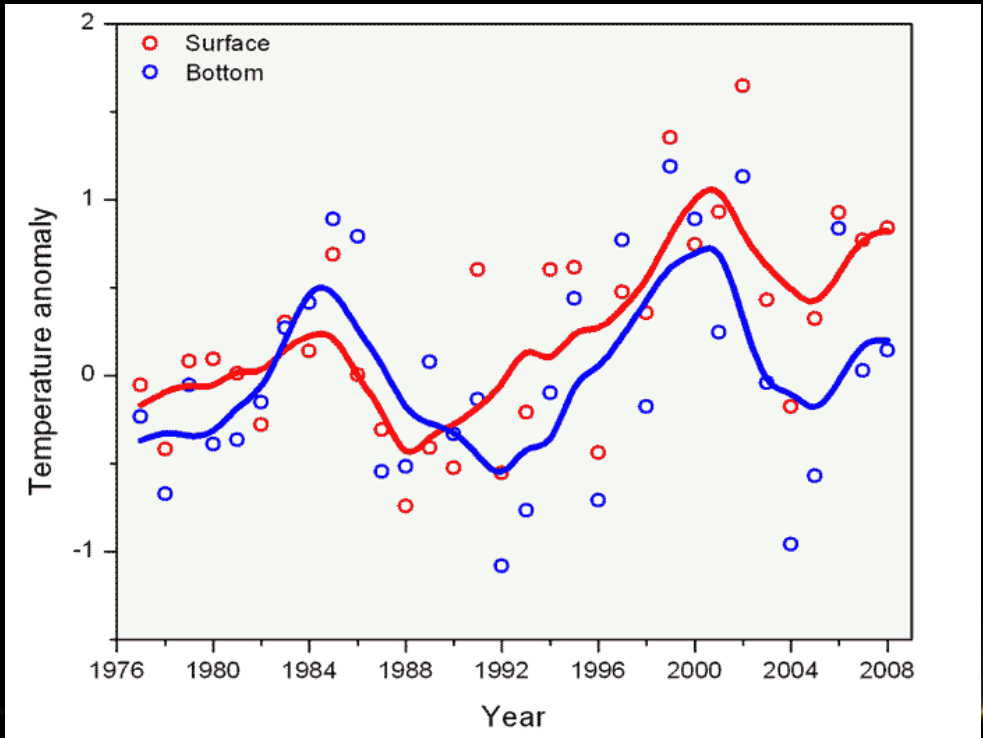

Figure 3.6 Mean surface (red) and bottom (blue) temperatures from the NEFSC survey programs. Anomalies show the mean value for 1977-1987 as 0, above the mean as positive and below the mean as negative (see Mountain [3])

Northeast Fisheries Science Center *Reference Document 09-11: Ecosystem Status Report for the Northeast U.S. Continental Shelf Large Marine Ecosystem*. NOAA, US Government. Available: http://www.nefsc.noaa.gov/publications/crd/crd0911/

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TYPES OF CHARTS

Scatter plot:

These are excellent ways of showing or exploring a potential relationship between two variables

Often the independent variable (x-axis) and dependent variable (y-axis) are both continuous variables

Each data point is determined by the value of both variables, and when you have many individual data points a trend or pattern may become apparent (or not – which can also be very useful to know!)

This can allow for identification of correlations or other types of relationships between variables, for fitting regression lines, and for subsequent modelling based on a regression line or other trend that might have been identified

For example, scatter plots could be used to explore relationships between:

- Height and weight in a population
- Socioeconomic status and education attainment
- Fertiliser application and crop yield

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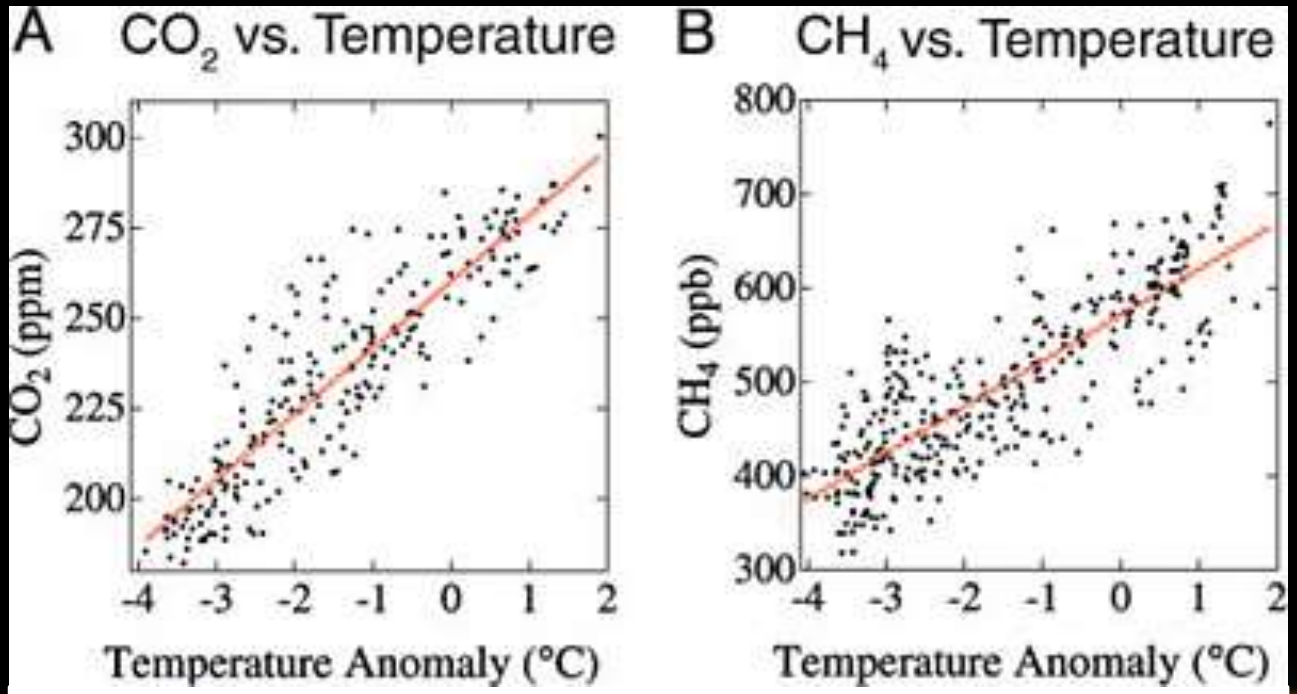
TYPES OF CHARTS

Scatter plot:

Example 1 – Relationships between amounts of carbon dioxide and methane contained in ice cores, and historical global temperature change:



Scatter plots of CO2 (A) and CH4 (B) in the Vostok ice core (21, 24) as a function of global temperature change, approximated as half of the polar temperature change.

http://www.earth.columbia.edu/news/2004/story11-11-04b.html

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TYPES OF CHARTS

Scatter plot:

Example 2 – Relationship between crop planting date and maize yields:

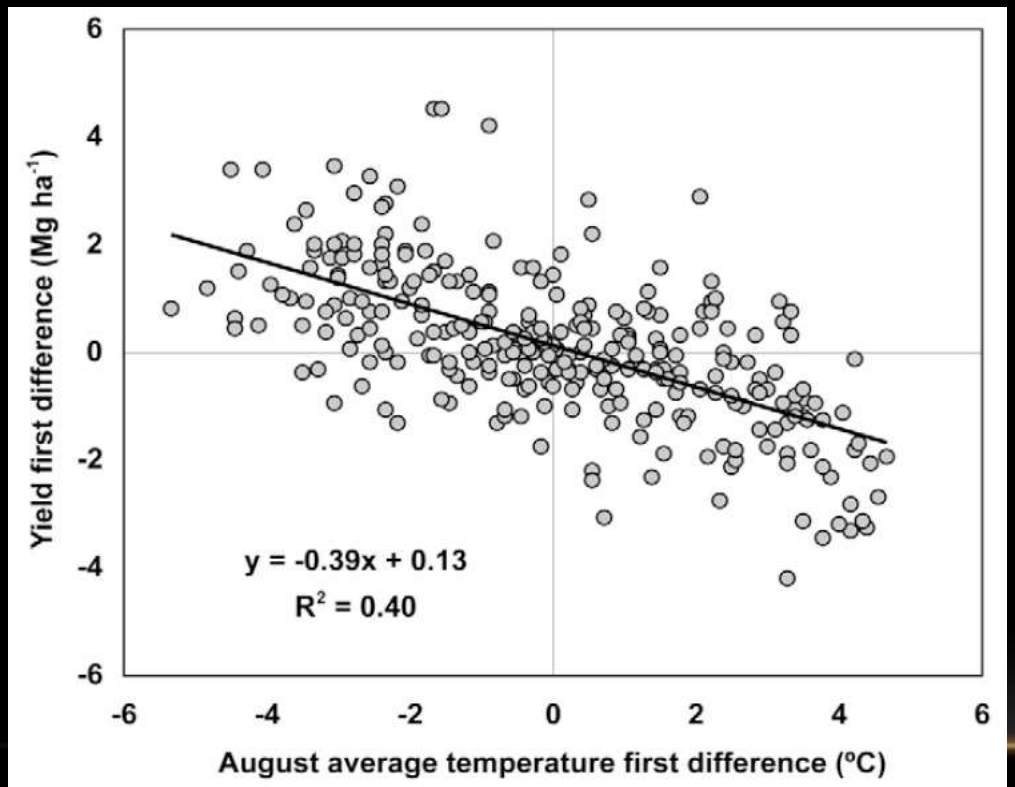

Fig. 6. Scatter plot of first differences of all annual state level August temperatures and maize yields for the 1979 to 2005 period.

Kucharik C.J. (2007) Contribution of Planting Date Trends to Increased Maize Yields in the Central United States. *Agronomy Journal* 100(2): 328-336.

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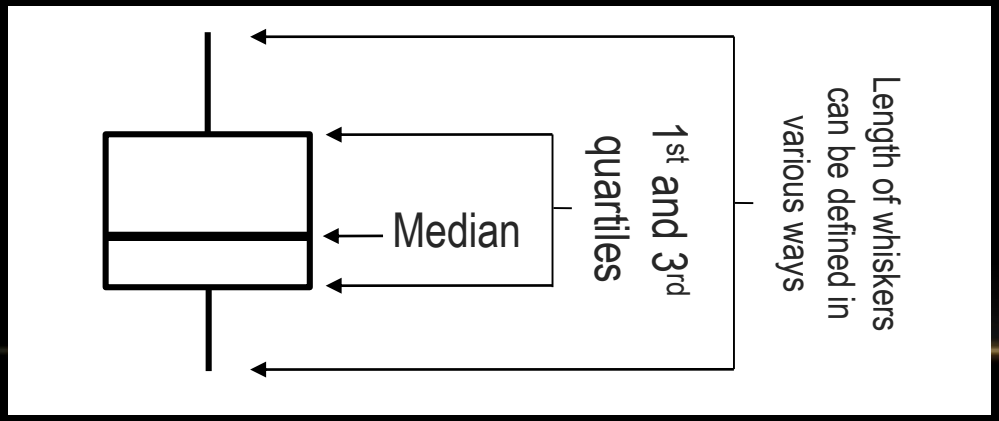
TYPES OF CHARTS

Box-and-whisker plots:

These are very useful for representing statistical data for individual datapoints or variables (e.g. distribution and skewness, median values)

On their own they are not particularly useful (as this information could easily be presented in a text or table for a single value), however the real power of this technique is when they are combined with other chart types (e.g. bar charts, time series) to show statistical information for several datapoints



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TYPES OF CHARTS

Box-and-whisker plots:

Example – Relationship between soil water content at planting and crop yield in Emerald, QLD

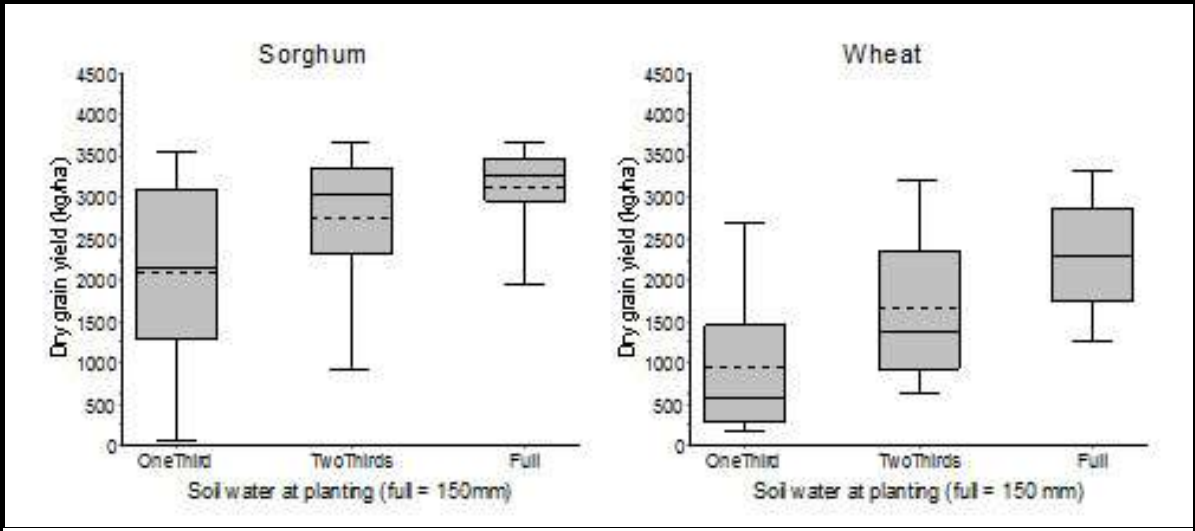

Figure 3: Effect of Starting soil water on Sorghum and Wheat yields at Emerald (Source: WhopperCropper) (Note on reading box plots in this paper - solid line is median, dotted line is average, bottom of grey box is lowest 25% of years, top of grey box is top 25% of years, bottom whisker is lowest 5 % of years, top whisker is top 5% of years)

GRDC (2010) Water use efficiency – optimizing farming systems performance and balancing fallow length and sowing decisions. Available: https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2010/09/WATER-USE-EFFICIENCY-OPTIMIZING-FARMING-SYSTEMS-PERFORMANCE-AND-BALANCING-FALLOW-LENGTH-AND-SOWING-DECISIONS

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MAKING A GOOD CHART

Components of a chart:

You can think of a chart as having 3 key components:

- **Labelling:** title, axis titles, legends identifying different data series, and any reference to the source of the data (if not your own)
- **Scales:** defining the x and y axes, with units
- **Graphical representation of data:** e.g. as columns/bars, points, time series line, cluster of data points which may be able to be fitted with a regression line, ...

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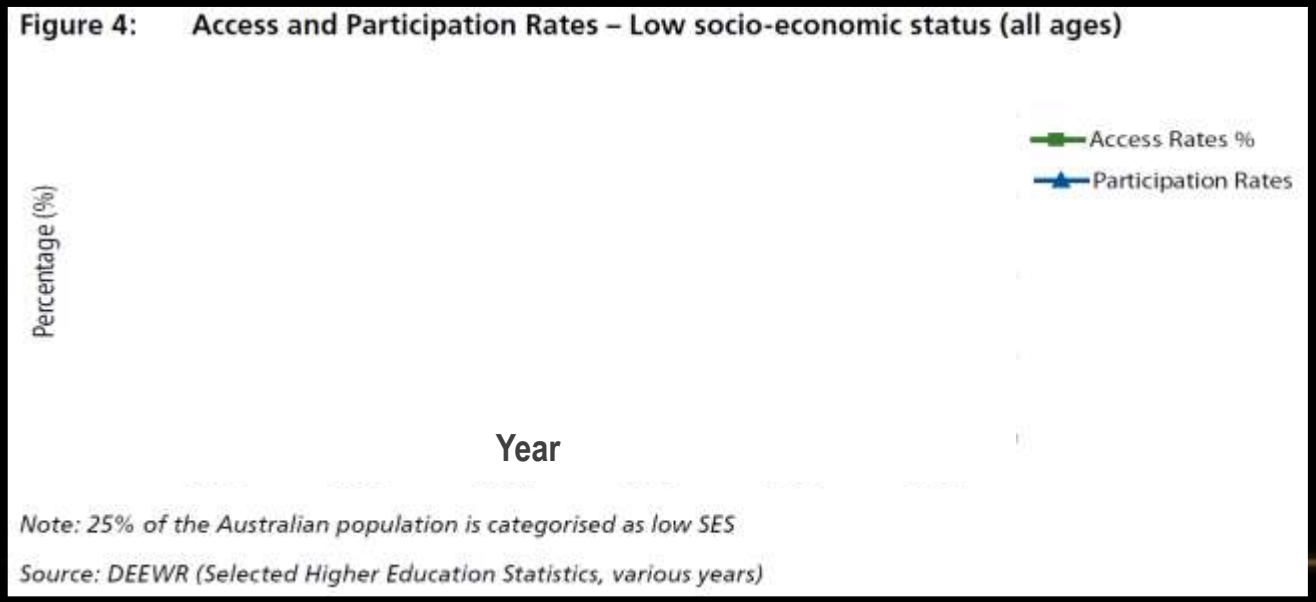
MAKING A GOOD CHART

Example – Preparing a chart showing access and participation by people from low socioeconomic status backgrounds at Australian universities:

Step 1: Labelling

- Add the title, axis titles, legends identifying different data series, and any reference to the source of the data (if not your own)



From: Bradley et al., (2008) as previously cited

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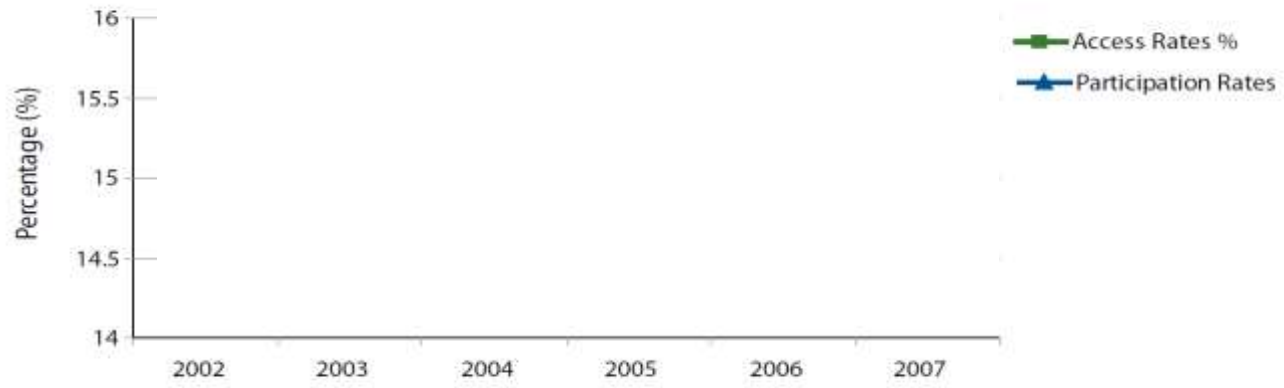
MAKING A GOOD CHART

Example – Preparing a chart showing access and participation by people from low socioeconomic status backgrounds at Australian universities:

Step 2: Scales-

- Define the x and y axes, with units

Figure 4: Access and Participation Rates – Low socio-economic status (all ages)



Note: 25% of the Australian population is categorised as low SES

Source: DEEWR (Selected Higher Education Statistics, various years)

From: Bradley et al., (2008) as previously cited

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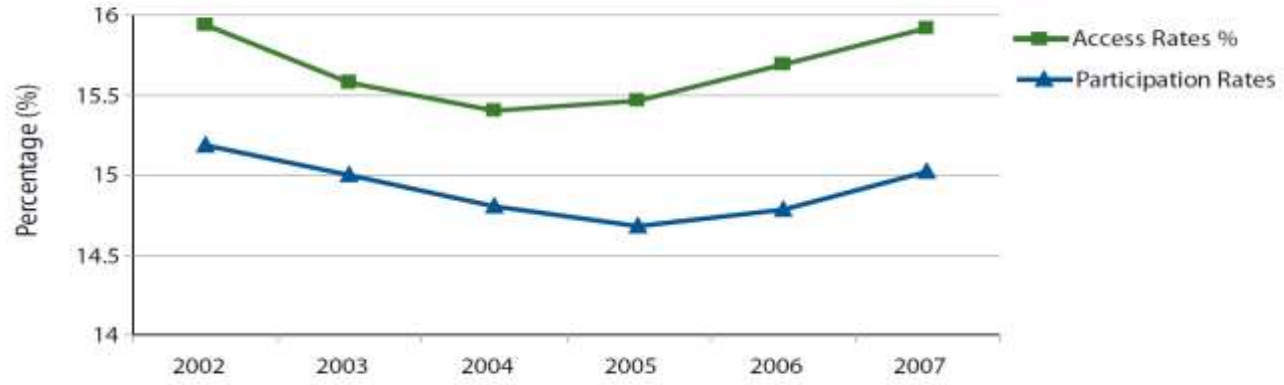
MAKING A GOOD CHART

Example – Preparing a chart showing access and participation by people from low socioeconomic status backgrounds at Australian universities:

Step 3: Data-

- Add the data represented graphically (in this case as a time series data)

Figure 4: Access and Participation Rates – Low socio-economic status (all ages)



Note: 25% of the Australian population is categorised as low SES

Source: DEEWR (Selected Higher Education Statistics, various years)

From: Bradley et al., (2008) as previously cited

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MAKING A GOOD CHART

What makes a good title?

- A clear description of the data presented in the chart, that does not pre-judge the readers interpretation of the data
  - e.g. “Variation in Y with change in X at 21^{o}C” instead of: “Y shows exponential trend with increasing X”
- The title should allow the chart to be ‘self-explanatory’ so that even if the reader does not read the text, it is clear what the chart is about

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MAKING A GOOD CHART

Axis labels:

- You (almost) always have to include axis labels
  - These need to consist of a few words that accurately describe the scale the axis represents (e.g. time, mass, volume, area, number, ...)
  - It must also contain the **units** you used! (e.g. mL, cm^2, %, seconds, kg, ...)
- The only time you don't need to use axis labels is when it is completely clear what the axis refers to e.g. if the chart is titled: "% change in Y with varying X" then it is clear that the y-axis will show %'s. However, in almost all cases you need to include proper axis labels.

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MAKING A GOOD CHART

Font size:

- Ensure that the sizes of different labels in the chart are appropriate size relative to each other i.e.

Type of label	Relative size of label
Chart title	Largest (and often bolded)
Axis labels	
Axis numbering / intervals marked	
Legend or data series labels	Smallest

- Usually it is also good practice to ensure that the chart is able to be easily seen when the reader is flicking through your document looking a page at a time i.e. the reader can easily pick up the chart title and other key details without having to stop and use a magnifying glass

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MAKING A GOOD CHART

Important notes regarding colours and other effects:

- Try to avoid using colours because these can be unclear when:
  - your chart is re-printed in poor quality or black-and-white (i.e. most of the time!),
  - you don't realise that two colours appear very similar when printed,
  - people who are colour blind may not be able to tell the difference
- Instead, use different symbols for data points, different line styles for different data series (e.g. solid line, dashed line, ...) to make you chart completely clear without colour

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MAKING A GOOD CHART

Important notes regarding colours and other effects - continued:

- Usually don't use shading in charts because this can also cause similar problems as using colour, however sometimes it is appropriate for column/bar charts and pie charts
- Overall, you want to minimise the amount of 'ink' you use to present your chart – good writing is clear and concise and doesn't waste words, and good chart-making is also clear and concise and doesn't waste 'ink'
- Almost NEVER use 3D effects in charts. These are nearly always confusing, unnecessary, and can be misleading (e.g. they skew the data because you try to show a 2D relationship between variables using a 3D visual metaphor)
- NEVER use background images or pictures or other 'chart junk' behind the data. This is guaranteed to be confusing to the reader, and does not add value to the chart (the data should speak for itself)

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FURTHER READING

Good websites:

http://lilt.ilstu.edu/gmklass/pos138/datadisplay/sections/goodcharts.htm

http://www.datavis.ca/papers/index.php#history

http://www.datavis.ca/gallery/lie-factor.php

Key texts:

Wainer, H. (1984) How to Display Data Badly. *The American Statistician* 38(2): 137-147.

Tufte, E.R. (2001) *The visual display of quantitative information (2nd Ed)*. Graphics Press, Cheshire.

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