Basics of Spreadsheets

- Motivation: A sample engineering problem
- Why Use a Spreadsheet?
- Problem Solving
- Basics of a Spreadsheet
- Graphing Data
- Organising Data
- Useful functions and Features
- Pivot tables
- And more…
A sample engineering problem - 1

• Research project at UNSW and NICTA

• Ultimate goal: To improve road traffic management by adjusting red/green light cycles at traffic junctions according to the actual number of vehicles present

• Need a method to automatically count the number of vehicles at a junction

• Research question: How well can a video camera do this job?
A sample engineering problem - 2

- Issue: A trailing vehicle may be occluded resulting in wrong vehicle counts

Actual picture from a camera on Anzac Parade

- Research question: Can we solve this question by, say, adjusting the mounting height of the camera?
A sample engineering problem - 3

- Step 1: Model the problem

- Step 2: Derive a formula for the chance that a vehicle is occluded

\[
\int_{h_{\text{min}}}^{h_{\text{max}}} p_h(h) \int_{\ell_{\text{min}}}^{\ell_{\text{max}}} p_\ell(\ell) \int_0^{(L+\ell)/H-h} p_g(g)\,dg\,d\ell\,dh
\]
A sample engineering problem - 4

- Step 3: Need to find this chance of occlusion for different camera mounting heights and different traffic speeds
  - Formula is complex and need to repeat the calculations
  - Repeatedly punching the calculator is boring and error prone
  - Computers and programs such as Excel are here to rescue

Do you know? During the second world war:

*Computers were people using desk calculators when Los Alamos began.*

A sample engineering problem - 5

- Step 4: Computer program to do the calculations

On-Axis Occlusion

![Graph showing the probability of occlusion versus distance from sensor at different sensor heights for average speeds of 5km/h and 20km/h.](image)
Why computers?

- Performing calculations repeatedly
- Large amount of data
- Visualise the data, e.g. graphs
- etc

- Computers and programming are not only for engineers
  - Finance: Pricing options and other financial products
  - Biology: Which gene(s) is responsible for which cancer
  - Pharmacology: Which drug(s) for which disease
  - etc.
Why Use a Spreadsheet?

Many things that can be done with a pencil, a pad of paper, and a calculator can be done much faster, far more accurately and conveniently using a spreadsheet.

The biggest advantage of using spreadsheet is that every time a user makes changes, the spreadsheet automatically recalculates all the other related values.

Nowadays, spreadsheets also allow easy creation of charts and offer useful statistical and mathematical functions.

The best known commercial spreadsheet application is Microsoft’s Excel®, but there are also free, open-source applications with similar functionality and even compatibility, notably OpenOffice.org™’s Calc, and Gnumeric from the long-running GNU project.

In this course we use Excel because of its popularity, its widespread availability, and its broad range of features.
Problem Solving

• Preparing to Solve a Problem

  – What is the overall purpose of the problem (define)?
  – What information is known (input)?
  – What information must be determined (output)?
  – What fundamental principles apply to the problem?
  – What will be the overall solution strategy?
  – How can we check correctness our solution?
  – How can we test our solution(s)?
Problem Solving with Excel

• Excel allows you to **easily solve** many of the problems that arise during problem analysis phase.

• Excel provides features that allow you to:
  – Import, export, store, process and sort data
  – Display data **graphically**
  – Analyse data **statistically**
  – Solve **optimisation** problems
  – Find **relationships** between data sets (fit algebraic equations through data sets)
  – **Solve** single and simultaneous algebraic **equations**
  – *etc, etc*
A spreadsheet is divided into rows and columns*

In Excel, rows are labelled as integers starting from 1; column labels are from A to Z, AA to AZ, BA to BZ, etc..

The intersection of a row and column forms a cell. Each cell has a unique cell reference. For example, the cell at the intersection of column C and row 5 is called C5

* 1 million+ rows and 16000+ columns in Excel 2007/2010
Every cell in a spreadsheet contains either a constant or a formula.

A constant is an entry that the spreadsheet does not change, for example, test marks, student name or a date.

A formula is a combination of numeric constants, cell references, arithmetic operators, and/or functions that returns the result of a calculation. Formulas are prefixed by an equals sign (=).
A *function* is a predefined computational task

For example, the function **AVERAGE(C3:C7)**, in cell C9, calculates the average of all the cells in the range from C3 to C7.

Excel provides many useful functions for statistical, mathematical and other tasks.
Copy and Paste Commands

The **copy** command duplicates the contents of a cell, or range of cells.

The **paste** command copies the contents to the destination cell, or range of cells. However, a formula is not copied exactly, but is adjusted as it is copied, depending on the destination cell.

For example, if the formula in cell C9 is copied to D9, it is adjusted so that the cells referenced in the new formula are in the same relative position as those in the original formula.

### Original Formula

AVERAGE(C3:C7)

### Copied Formula

AVERAGE(D3:D7)

Same principle applies to:
- inserting rows, cols
- deleting rows, cols
- filling down or right
Absolute vs Relative Reference

In a formula, if the cell reference has $ signs in front of the row and column designation, it is considered an **absolute reference** and the cell reference remains **unchanged** throughout all copy/paste operations. E.g. $B$13

A **relative reference**, on the other hand, adjusts during copy operations and is specified without $ signs. E.g. B4

A **mixed reference** uses a single $ sign to make the column or the row absolute, leaving the other as relative. For example F$6 or $F6
Formatting Cells

The appearance of a cell can be changed by altering fonts, borders, colour patterns and number formatting, including indents.

Note that changing the format of a number affects the way the number is displayed but does not change its value.

Some of the number formats available in Excel are:

- **General format**
  a number is displayed the way it was originally entered
  for example, 247 or 247.58 or 2257.42E+10

- **Number format**
  125.345 or 10,200.45 or 10200.45 or 135.50 or 1.355e+2 etc
  (default alignment is right-justified, can use right-indent too)

- **Date format**
  May 2, 2011 or 2/5/2011 or 2-May-11, etc

- **Percentage format**
  23% or 23.56% or 9%

- **Text format**
  numeric values are displayed as ASCII text strings, left-justified
Basics of Excel

- Read **Topic-1** in the textbook.
- The topic describes the basic concepts/terminology of Excel that you need to know in order to use Excel effectively.
- Even if you know some of these concepts/terminology, you are still encouraged to quickly read through Topic-1.
- Key knowledge and skills:
  - The Ribbon, menus, workbook and worksheet structure
  - The active cell
  - Formulas and addressing
  - Selecting cell ranges, copy/paste
  - Filling down (and right) using menu or fill handle
  - Named cells
Graphing Data

The graphical representation of data can be an attractive, easy-to-understand way to convey information.

Any good spreadsheet application will let you create charts from the spreadsheet data, with just a few simple keystrokes or mouse clicks.
Graphing Data

You can draw lots of different types of charts with Excel

For example, pie chart, bar chart, line chart, 3D bar chart, 3D pie chart, etc.

A user can also modify different parameters of the chart and add additional text and graphics.
Graphing Data

• Excel offers several different types of graphs that are commonly used in engineering.

• For example:
  – Line Graphs
  – Bar Graphs
  – Pie Charts
  – X-Y graphs (Scatter Charts)
  – Semi-Log Graphs
  – Log-Log Graphs

• You can find more information on all of these from Microsoft Excel Help, and also from online tutorials on Excel (available on the class web page)
Beware Chartjunk

• Like much of Microsoft’s recent developments, Excel 2010’s charts by default are overloaded with too many fancy features that can obscure data relationships rather than reveal them.

• This kind of useless embellishment is called **chartjunk**, a term coined by Edward Tufte (*Envisioning Information*, 1990).

Example:


Excel column chart defaults

What the user wanted
Organising Data - Sorting

- Data values can be sorted in ascending or descending order, using numeric or text comparisons as appropriate.

In the following example, a student listing is sorted based on names. The example also uses different cell formatting to enhance the appearance and readability of data.
Organising Data - Filtering

**Filtering** in Excel:

- Filtering is a quick and easy way to find and work with a subset of data in a list. A filtered list displays only the rows that meet the criteria you specify for a column.  
  *(from MS Excel Help)*

Two commands for filtering lists:

- **AutoFilter**, which includes filter by selection, for simple criteria
- **Advanced Filter**, for more complex criteria
Organising Data - Filtering

Filtering, continued:

- Filtering does not rearrange a list. Filtering temporarily hides rows you do not want displayed.

- .... Live Demonstration .......

- You can find more information on all of these from Microsoft Excel Help, and also from online tutorials on Excel (available on the class web page)
Organising Data - Pivot Tables

• A **PivotTable** is an interactive table that can be used to quickly summarise large amounts of data.

• You can rotate its rows and columns to see **different summaries** of the source data, filter the data by displaying different pages, or display the details for areas of interest.

• Live Demonstration ........

• Read **Topic-7** in the textbook.
Useful Functions and Features

• Excel provides many **predefined functions** and **features** that could prove very useful in solving many real life problems.

• Excel offers a wide range of Mathematical functions. For example:
  
  – Elementary Math[s] Functions
  – Trigonometry functions
  – Convert function to convert units
  – Advanced Math Functions
  – Financial functions
  – *etc, etc*

• Read **Topic-2** in the textbook.

• You can find more information on all of these from **Microsoft Excel Help**, and also from **online tutorials** on Excel (available on the class web page)

• …… Live demonstration ……
Useful Functions and Features

Common Functions:

- **SUM**: Example: SUM(C2:C8) equals 94
- **AVERAGE**: Example: AVERAGE(C2:C8) equals 13.428571
- **COUNT**: Counts the number of cells that contain numbers
  - Example: COUNT(B2:B8) equals 4
- **COUNTA**: Counts the number of cells that are not empty
  - Example: COUNTA(B2:B8) equals 6
Useful Functions and Features

- **COUNTIF**: Counts the number of cells within a range that meet the given criteria
  - Example: `COUNTIF(C2:C8, "<10") equals 2`

- **SUMIF**: Adds the cells specified by a given criteria.
  - Example: `SUMIF(B2:B8,"Absent", C2:C8) equals 29`
Useful Functions and Features

Conditional Functions:

• **IF**: Returns one value if a condition you specify evaluates to TRUE and another value if it evaluates to FALSE.

  \[ \text{IF}(\text{logical\_test}, \ \text{value\_if\_true}, \ \text{value\_if\_false}) \]

  - Examples:

    \[ \text{IF}(\text{C5}<50, "FL", "PS") \]
    \[ \text{IF}(\text{C5}<50, "FL", \text{IF}(\text{C5}\geq85, "HD", "Between PS and DN")) \]

• Read **Topic-2 (page 74)** in the textbook.
Useful Functions and Features

Conditional Functions:

- **AND**: Returns TRUE if all its arguments are TRUE; returns FALSE if one or more arguments is FALSE. Example:

  \[
  \text{IF(AND(B2>75, C2>15), "Very Good", "Not Good!")}
  \]

- **OR**: Returns TRUE if any argument is TRUE; returns FALSE if all arguments are FALSE. Example:

  \[
  \text{IF(OR(B2>75, C2>15), "Good", "Not Good!")}
  \]

- **NOT**: Reverses the value of its argument, a logical expression. Example:

  \[
  \text{IF(NOT(C5<50), "PS", "FL")}
  \]
Conditional Formatting in Excel:

- We can highlight cells that meet specific conditions.
  - Conditional Formatting using Cell Values
  - Conditional Formatting using a Formula

- .... Live Demonstration .......

- Consult online Excel Tutorials (available on the class web page) for more information.
Useful Functions and Features

Converting Units

• Often we need to convert values from one system units to another.

• Excel offers a very useful function called **CONVERT**, that could be used to carry out **simple and complex** unit conversions.

• For example:
  
  – CONVERT(525, “mi”, “m”)
  
  – CONVERT(B45, “g”, “lbf”) 
  
  – CONVERT(A10, “gal”, “l”)
  
  – CONVERT(34, “C”, “F”)
  
  – Etc .. Etc …

• Read **Topic-2 (page 57)** in the textbook.
Useful Functions and Features

Text Functions

• Excel offers a wide range of functions to handle text. For example:
  – CONCATENATE(text1, text2), can also use the & operator
  – EXACT(text1, text2), returns TRUE if both strings are same
  – FIND(text_to_find, text_to_search, start_pos) or SEARCH for a case-insensitive equivalent
  – TRIM(text), removes spaces from text
  – UPPER(text), converts text to uppercase
  – LEFT(text, n), returns the left most n chars
  – etc, etc

• See Topic-2 (page 53) in the textbook.

• If you have any problems, please ask your tutor or the lecturer to help you understand these functions/features.