Today’s lecture

- history of spreadsheet applications
- basic use of spreadsheets
  - absolute vs relative references
  - functions:
    - basic functions (SUM, MIN, MAX, AVG)
    - IF function
    - logical tests and operators

VisiCalc

The first spreadsheet program was called VisiCalc, short for Visible Calculator
Developed by Dan Bricklin and Bob Frankston, released in 1979.
Very popular.

About me...

Dr Matthew Egbert
Computational Scientist
I use computer simulations to investigate questions like:
How did life originate?
How can we build robots that are as adaptive as living creatures?

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Hard of Hearing
I am more-or-less deaf in my left ear, so I can’t always tell where sounds are coming from. If you have a question, raise your hand so I can find you :)
VisiCalc

VisiCalc had a number of features that are commonly found in spreadsheet programs today:

- Organising calculations in rows and columns
- Automatic updating of calculations
- Formulas

Microsoft Excel

Commonly used spreadsheet program, part of Microsoft Office

Appearance of cells

You can change the appearance of cells:

- Alter size
- Add borders
- Add shading
- Alter font
- Alter font (eg. currency, decimal points, date values)

Entering data

Enter data into:

- The cell
- The formula bar (after selecting a cell)

You can enter:

- Text
- Numbers
- Images
- Formulas; must begin with ‘=’

  e.g.: ”=2+3” \( \rightarrow \) displayed as 5

When you enter a value, any formulas which use the current cell are recalculated
Filling cells

Allows you to automatically copy a value or formula from one cell in any direction.

Steps:
- Select a cell
- Click and drag the small box in the bottom right hand corner in any direction.
- Release mouse when you’ve selected the cells to fill.

Alternatively you can CTL-C / CTL-P to copy a cell and paste.

DEMO

Formulas

The power of spreadsheets lies in the use of formulas.

Instead of writing explicitly what you want to put inside of a cell, you can tell the spreadsheet what calculation you want the cell to show the answer to.

You could put in

= 4 + 3 + 0 …

But then what if you made a mistake in your initial count and you correct it? It is better to have the spreadsheet do these calculations for you.

Cell references

In some formulas, you’ll need to refer to other cells. There are two kinds of cell references.

Relative references (eg. C3)
The cell reference moves along with the formula.

Absolute reference (eg. $C$3)
The ‘$’ locks the column and/or row in the reference, meaning it stays the same if the formula moves.

Relative references

When the formula moves down by one row, the cell references move down by one row.

Game of Thrones Spreadsheet

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Season</td>
<td>Episode</td>
<td># of Deaths</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Total # of deaths in Season 1</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

Total hours

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hours worked</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Monday</td>
<td>Tuesday</td>
<td>Total hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Paul</td>
<td>5</td>
<td>8</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Steve</td>
<td>9</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Michael</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Pay rate: $15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Absolute references

Since the reference to ‘Pay Rate’ is not fixed, we get incorrect results

- Using ‘$’ to lock the row in place fixes the problem
- We can also lock the column with ‘$’ but it doesn’t make a difference in this case

Example

What formula would you use in cell E8 to calculate the money made from ticket sales? Your formula must be able to be filled up and down

ANSWER:  

=\text{C8}$B$3  
or  

=\text{C8}$B$3

Example

Ticket Sales

<table>
<thead>
<tr>
<th>Event</th>
<th>Tickets Available</th>
<th>Tickets Sold</th>
<th>Remaining Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycling</td>
<td>4000</td>
<td>2000</td>
<td>2000 $20,000.00</td>
</tr>
<tr>
<td>Weightlifting</td>
<td>2000</td>
<td>750</td>
<td>1250 $7,500.00</td>
</tr>
<tr>
<td>Triathlon</td>
<td>1000</td>
<td>100</td>
<td>900 $1,000.00</td>
</tr>
<tr>
<td>Football</td>
<td>3000</td>
<td>3000</td>
<td>0 $30,000.00</td>
</tr>
<tr>
<td>Badminton</td>
<td>5000</td>
<td>4500</td>
<td>500 $45,000.00</td>
</tr>
</tbody>
</table>
Rows and Columns, Absolute or Relative?

Note that the column reference and row-reference can each be absolute or relative?

- $A$1: both absolute
- A1: both relative
- $A1$: column absolute, row relative
- A$1$: column relative, row absolute

Referring to ranges

It is possible to refer to a range of cells using the following notation.

**Example:**

$C10:C20$  
A selection of 10 cells, all in column C, between rows 10 and 20 (inclusive).

**Quiz:**

A1:C4  
A selection of 12 cells. Rows 1-4 (inclusive) of columns A-C (inclusive).

Does everyone know what I mean by inclusive?

Functions

Functions allow you to process data in your spreadsheet.

Formulas → Insert Function lets you search for functions and learn about their syntax.

**Basic Functions**

- **SUM, MAX, MIN, AVERAGE**
- **Similar syntax:** `[function name](values)`
  - SUM(range), eg. SUM(B3:B10)
  - SUM(cell, cell ...), eg. SUM(B3, B4, B5)
  - SUM(number, number ...), eg. SUM(5, 7, 8)
- Functions can be included in formulas
  - =B6 + SUM(A1:A100)
Game of Formulas

We now have all we need to improve our Game of Thrones spreadsheet.

Q: What is the formula that we put in cell C13?

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Season</td>
<td>Episodes</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Total # of deaths in Season 1:</td>
<td></td>
</tr>
</tbody>
</table>

IF function

Inserts a value in a cell based on the outcome of a logical test (ie. true/false).

Syntax

=IF(logical_test, value_if_true, value_if_false)

Logical tests (comparison operators)

A condition which evaluates to TRUE or FALSE.
Also known as a "Boolean expression"

Comparison operators:

=  
eg. "10 = 15" is

> or <  
eg. "5 > 10" is

>= or <=  
eg. "5 >= 5" is

George Boole, 19th c. Mathematician
https://en.wikipedia.org/wiki/Gorge_Boole

Logical tests (Boolean functions)

Boolean functions, AND, OR and NOT are used to combine or modify comparisons.

AND(a, b)  
both a and b must be true
eg. "=AND(3 = 4, 2 = 2)" is

OR(a, b)  
either a or b can be true
eg. "=OR(3 = 4, 2 = 2)" is

NOT(a)  
inverts the outcome of a
eg. "=NOT(2 = 3)" is
IF function

Syntax
=IF(logical_test, value_if_true, value_if_false)

In cell B3 is the formula:
=IF(A3>$B$1, "Bigger", "Smaller")

This would place 'Bigger' in B3, if number in A3 is bigger than number in B1...

But it isn't!
...so it puts 'Smaller' instead.

Exercise

Write formulas that can be filled down:

E2: formula to calculate the package’s volume (volume = length * width * height)

F2: if the package is less than 5000cm³, then write “Yes” in cell, otherwise write “No”

B7: formula (that can be filled right) for calculating the average

● package length
● width
● height

Answers

Formula in E2: =B2*C2*D2

Formula in F2: =IF(E2<$C$9, “Yes”, “No”)

Formula in B7: =AVERAGE(B2:B6)

Summary

VisiCalc was the first spreadsheet program and ‘killer app’

Microsoft Excel is centred on a spreadsheet made up of columns and rows

Cell references can be relative and absolute

Formulas allow us to compute values in cells.

Functions allow us to process data and see an output

● Functions: SUM, MAX, MIN, AVERAGE, IF

Some functions use logical tests (a.k.a. Boolean expressions) which involve comparison operators (<,=,<= etc.) and Boolean functions (AND,OR,NOT).