FOSE1025 — Scientific Computing

Week 8 Lecture 1: Transforming Data

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Abstract

This lecture will focus on the stage of transforming data for data science projects. The first part will focus on various ways to manipulate times and dates in Excel and MATLAB. We will then look at two fundamental ways to represent tables of data: the long format, and the wide format. Finally, we will introduce Excel's pivot tables, which are powerful tools for data transformation and summarisation.

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Contents

Reading

- These notes

1 Dates

This section really belongs to "cleaning data" but we're adding it to this lecture because of time costraints . . . there was enough covered last week already!

Processing Dates

- Dates come in many formats, we need to make sure they are in the format we need.
  - dd/mm/yyyy (Australia)
  - dd.mm.yyyy (Germany)
  - mm/dd/yyyy (USA)
  - yyyy/mm/dd (Japan)
  - . . .
- If input manually, check if there are errors!
  - 24 Maye 2020

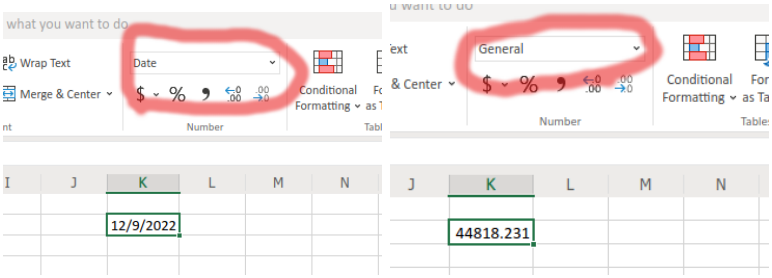
1.1 Dates in Excel

Excel Dates Are Not Text or Numbers

Excel does not represent dates and times as text or numbers.They are called "serial numbers" and they represent the number of days since a specific date: 1st January 1900.

Demonstration 1
Type 12/9/22 in an Excel cell and observe the format (see screenshot). Change the cell format to "Number". You will see that the cell now display the number 44904.00

Demonstration 2
Type the number 44818.231 in an Excel cell and change the format to "Short Date". You will see the date 9/14/2022 Change the format now to "Time." You will see the time 5:32:38 AM.



The second demonstration shows that the serial number contains the information of both the date and the time:

- The integer part of the number indicates the number of days since 1st January 1900. In our example, the date 9/14/2022 is the day that happens 44818 days after 1/01/1900.
- The fractional part of the number indicates the time as the fraction of day. Can you figure out how to convert 0.231 to the time 5:32:38 AM?

Useful Excel Functions to Manipulate Dates
Creating Dates and Times

DATE(year,month,day): Create a date from numbers.

TIME(hours,minutes,seconds): Create a time from numbers.

DATE(year,month,day) + TIME(hours,minutes, seconds): Create a date with time.

Useful Excel Functions to Manipulate Dates
Formatting Dates to Text

TEXT(serial_number,pattern)
Represent a date as text using a specific pattern. For example, if cell A1 has the formula =DATE(2020,12,23) + TIME(21,35,12):

TEXT(A1, "dd/mm/yy") returns the value "23/12/20".

TEXT(A1, "dd/mm/yyyy hh:mm") returns the value "23/12/2020 21:35".

TEXT(A1, "dd mmm yyyy hh:mm:ss") returns the value "23 Dec 2020 21:35:12" (notice the three "m"?).

TEXT(A1, "dd mmmm yyyy hh:mm AM/PM") returns the value "23 December 2020 09:35 pm".

Example 1: Dates in Different Formats

Ch-03.xlsx from *https://www.linkedin.com/learning/excel-2016-cleaning-up-your-data*

1. What formula would you type in cell B2?
2. What formula would you type in cell D2?

	A	B	C	D
1	**Month Year**	=DATE(Year, Month, Day)	**Year Month**	=DATE(Year, Month, Day)
2	10 2016		2016 10	
3	4 2016		2016 4	
4	5 2016		2016 5	
5	9 2015		2015 9	
6	10 2016		2016 10	
7	6 2016		2016 6	
8	4 2015		2015 4	
9	5 2016		2016 5	
10	1 2016		2016 1	
11	12 2015		2015 12	
12	12 2015		2015 10	
13	11 2015		2015 11	
14	8 2016		2016 8	
15	11 2016		2016 11	
16	8 2015		2015 8	

Exercise: Mixed date formats in one column

Create a blank Excel worksheet, import this CSV file, and normalise the dates so that they appear as in the screenshot.

dates.csv

```
Date,Name,Email,Consultation Times,Zoom
12/01/2020,Diego Molla-Aliod,diego.molla-aliod@mq.edu.au,,
12 May 2020,Gaurav Gupta,gaurav.gupta@mq.edu.au,,
15 Apil 2020,Urvashi Khanna,urvashi.khanna@mq.edu.au,Wed 12-1,https://macquarie.zoom.us/j/4
2020-11-23,Munazza Zaib,munazza-zaib@mq.edu.au,Wed 11-12,https://macquarie.zoom.us/j/267542
```

	A	B	C	D	E	F	G	H
1	Date	Name	Email	Consultati	Zoom			
2	Tuesday, December 1, 2020	Diego Mol	diego.molla-aliod@mq.edu.au					
3	Tuesday, May 12, 2020	Gaurav Gu	gaurav.gupta@mq.edu.au					
4	Wednesday, April 15, 2020	Urvashi Kh	urvashi.kh	Wed 12-1	https://macquarie.zoom.us/j/472568461			
5	Monday, November 23, 2020	Munazza Z	munazza-z	Wed 11-1	https://macquarie.zoom.us/j/267542550			

You should have no problems to normalise the dates. Excel did a good job to guess the date from the input CSV but the resulting worksheet is trying to display them using the original date format. The only problem was with cell A4, which has a typo. You can do this:

1. Select the A column and set the format to "Long Date".
2. Edit cell A4 to correct the typo. After correcting the typo, Excel will correctly convert the cell to the date in the correct format.

Arithmetic with Dates in Excel

- To add 4 hours 25 minutes to a date: =A2+TIME(4,25,0)
- To find the difference (in days) between two dates: =DATEDIF(A2,B2,"d")
- To find the difference (in months) between two dates: =DATEDIF(A2,B2,"m")
- To find the difference (in years) between two dates: =DATEDIF(A2,B2,"y")

- =B2−A2 can also be used to compute the time difference in days and fraction of the day. *Make sure that the result is formatted as a time.*

In the above examples, we presume that the time shown in cell A2 is before the time shown in B2. Otherwise, the function DATEDIF will generate an error.

1.2 Dates in MATLAB

Understanding Dates in MATLAB
https://au.mathworks.com/help/matlab/date-and-time-operations.html

- As with Excel, MATLAB has a specific data format for date-time.
- MATLAB's datetime allows one to create a date-time. It accepts several formats, including:
  - year, month, day
  - year, month, day, hour, minute, second

```
hello_date = datetime(2020, 7, 3, 18, 30, 23)
hello_date = datetime(2020, 7, 3)
```

MATLAB does not try to guess the meaning of each number. *They must be placed in the correct order.* Compare these:

```
date1 = datetime(2020, 7, 3)
date2 = datetime(2020, 3, 7)
date3 = datetime(3, 7, 2020)
```

In the above examples, MATLAB will take the first number as the year, the second as the month, and the third as the day (so the third line will generate a completely unexpected date).

From Text to Dates and Back

- Sometimes we want to convert a string containing a date (and or time) into MATLAB's date-time, or vice-versa.
- MATLAB's datetime can convert from text (and other types) to date.

```
t = datetime('21/09/2020')
```

This example converts the string '21/09/2020' into a MATLAB date.

- MATLAB's string converts from date (and other types) to text.

```
w_table.StringDate = string(w_table.Date,
                            'MM/dd/yyyy')
```

This example converts all dates from the Date column of table with name w_table into strings. The result is then stored in column with name StringDate of the same table w_table. The format 'MM/dd/yyyy' is used for the conversion to string.

Text Date Formats in MATLAB
https://au.mathworks.com/help/matlab/ref/datetime.html#buhzxmk-1-Format

- As with Excel, MATLAB allows to read and write dates using different formats.
- MATLAB formats are slightly different from Excel's formats.
- These formats can also be used when importing from CSV files.

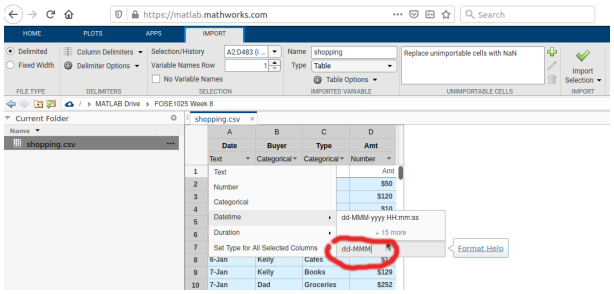
Examples of Formats

Format	Example
dd-MMM-yyyy HH:mm:ss	01-Mar-2000 15:45:17
MM/dd/yyyy	03/01/2000
MM dd yy	03 01 00

MATLAB appears to have different variants of time format specifications. Other MATLAB functions may use different specifications. For example, the function "datestr" converts dates to strings using a different pattern (*https://au.mathworks.com/help/matlab/ref/datestr.html*) If in doubt, read the MATLAB documentation.

Example: Importing shopping.csv

- The file shopping.csv represents dates using the day and month only, using a specific format of the form "1-Jan", "2-Jan", etc.
- In MATLAB, specify the datetime format "dd-MMM" in the "Date" column when you use the data import wizard.



2 Long and Wide Formats

2.1 Long and Wide Formats

Tables as 2D Data

- Remember that tables represent 2-dimensional information.
  - Rows indicate different records.
  - Columns indicate different types of data in the record.
- We can, for example, represent the work address (street, city, postcode, etc) of a group of people.

(file WorkAddresses.xlsx)

First Name	Last Name	Address	City	State	Post	Phone
Deane	Haag	9 Hamilton B	Sydney South	NSW	1235	02-9718-2944
Edelmira	Pedregon	50638 North	Bandy Creek	WA	6450	08-8484-3223
Andrew	Keks	51 Bridge Av	Carwarp	VIC	3494	03-5251-3153
Miesha	Decelles	457 St Sebas	Eltham	VIC	3095	03-5185-6258
Javier	Osmer	6 Ackerman	Doncaster Ea	VIC	3109	03-8369-6924
Kizzy	Stangle	8 W Lake St	Welbungin	WA	6477	08-1937-3980
Sharan	Wodicka	8454 6 17 M	Shenton Park	WA	6008	08-4712-2157
Novella	Fritch	5 Ellestad Dr	Girraween	NSW	2145	02-2612-1455
German	Dones	9 N Nevada A	Woronora	NSW	2232	02-2393-3289
Robt	Blanck	790 E Wisco	Woodbury	TAS	7120	03-6517-9318
Rossana	Biler	60481 N Clar	Lee Point	NT	810	08-9855-2125

Tables as 3D, 4D . . . ?

- How would you keep information about the work *and the home address*?
- What if one person has 15 different properties, how do you store the information for all people?
- A solution: Add one column that indicates the type of address.
- (Databases can encode this information more efficiently using relational tables but this is not the topic of this unit.)

	A	B	C	D	E	F	G	H
	First Name	Last Name	Addres Type	Address	City	State	Post	Phone
1	Deane	Haag	Work	9 Hamilton B	Sydney South	NSW	1235	02-9718-2944
2	Edelmira	Pedregon	Work	50638 North	Bandy Creek	WA	6450	08-8484-3223
3	Andrew	Keks	Work	51 Bridge Av	Carwarp	VIC	3494	03-5251-3153
4	Miesha	Decelles	Work	457 St Sebas	Eltham	VIC	3095	03-5185-6258
5	Javier	Osmer	Work	6 Ackerman	Doncaster Ea	VIC	3109	03-8369-6924
6	Kizzy	Stangle	Work	8 W Lake St	Welbungin	WA	6477	08-1937-3980
7	Sharan	Wodicka	Work	8454 6 17 M	Shenton Park	WA	6008	08-4712-2157
8	Novella	Fritch	Work	5 Ellestad Dr	Girraween	NSW	2145	02-2612-1455
9	German	Dones	Work	9 N Nevada A	Woronora	NSW	2232	02-2393-3289
10	Robt	Blanck	Work	790 E Wisco	Woodbury	TAS	7120	03-6517-9318
11	Rossana	Biler	Work	60481 N Clar	Lee Point	NT	810	08-9855-2125
12	Deane	Haag	Home	302 N 10th S	Oakleigh Sou	VIC	3167	03-9085-5714
13	Edelmira	Pedregon	Home	79346 Firest	Gununa	QLD	4871	07-1217-9907
14	Andrew	Keks	Home	37564 Grace	Salamander	NSW	2317	02-9187-4769
15	Miesha	Decelles	Home	470 W Irving	Bundaberg N	QLD	4670	07-3963-4469
16	Javier	Osmer	Home	6 Jefferson S	Middleton	SA	5213	08-5236-2143
17	Kizzy	Stangle	Home	1758 Park Pl	Eaglemont	VIC	3084	03-6144-7318
18	Sharan	Wodicka	Home	7659 Market	Premer	NSW	2381	02-7239-9923
19	Novella	Fritch	Home	9583 0 Webs	Trott Park	SA	5158	08-8343-3550
20	German	Dones	Home	26 Old Willia	Boynewood	QLD	4626	07-1698-9047
21	Robt	Blanck	Home	343 E Main S	Maraylya	NSW	2765	02-2208-2711
22	Rossana	Biler	Home	8 Cabot Rd	Wayville	SA	5034	08-5221-9700
23								

Long and Wide Formats

- The tables that we are used to see are in the *wide format*.
  - Each column indicates a specific data: name, address, location, temperature, etc.
- For complex data we may want to use a *long format*.
  - One column indicates the type of data.
  - Another column (or columns) indicate the value.

(file weather_data.csv)

	A	B	C	D	E	F
1		data	date	param	siteid	
2	1	0	1/1/03	Precipitatior	ACRE	
3	2	0	2/1/03	Precipitatior	AlbertLea	
4	3	11.3199997	3/1/03	Precipitatior	Ames	
5	4	0	4/1/03	Precipitatior	Antigo	
6	5	3.03999996	5/1/03	Precipitatior	Appleton	
7	6	0.49000001	6/1/03	Precipitatior	Arlington	
8	7	0	7/1/03	Precipitatior	Bean&Beet	
9	8	0	8/1/03	Precipitatior	Brookings	
10	9	0	9/1/03	Precipitatior	Brownstown	
11	10	0	10/1/03	Precipitatior	Columbia	
12	11	0	11/1/03	Precipitatior	Crookston	
13	12	0	12/1/03	Precipitatior	Dekalb	
14	13	0	13/1/03	Precipitatior	DixonSprings	

Processing Tables in Long Format
The lecturer will demonstrate how to use filters and pivot tables to process tables in long format. File: shopping.csv

- Many tables are expressed in long format for some columns.
- Excel does not have a specific tool to process these tables.
- You have seen how you can use filters to focus on specific values.
- You have also seen how you can use conditional functions to calculate values of one column based on the values of another column.
  - e.g. =SUMIFS(D:D,G:G,"Fuel") sums all values in column D such that the cell in row D has the value "Fuel").
- You can also use *pivot tables*.
- We will see pivot tables more in detail next week, but here we see how to use them to process tables in long format.

2.2 Introducing Pivot Tables

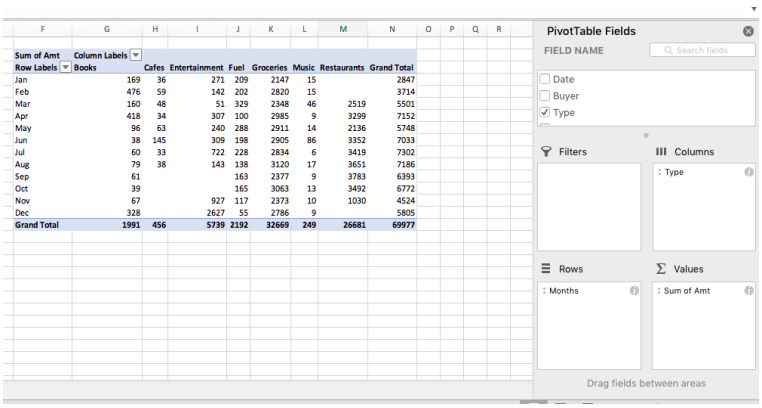
This section really belongs to next week's data summarisation. We will see more of this, and data analysis, next week.

Pivot Tables: A Motivational Example
(data from *https://www.linkedin.com/learning/excel-pivottables-for-beginners*)

- Find the total shopping in each category "Fuel", etc, of file shopping.csv.
- Find the total shopping of each month.
- What shopping per month and per category??
- Pivot tables can help you generate data for all of above and more.

	Date	Buyer	Type	Amt
1	1-Jan	Mom	Fuel	$50
2	2-Jan	Mom	Groceries	$120
3	3-Jan	Dad	Cafes	$10
4	4-Jan	Dad	Fuel	$40
5	4-Jan	Kelly	Groceries	$129
6	5-Jan	Mom	Cafes	$12
7	6-Jan	Kelly	Cafes	$14
8	7-Jan	Kelly	Books	$129
9	7-Jan	Dad	Groceries	$252
10	9-Jan	Kelly	Fuel	$44
11	10-Jan	Dad	Groceries	$39
12	12-Jan	Mom	Books	$20
13	13-Jan	Dad	Groceries	$132
14	14-Jan	Dad	Groceries	$79
15	16-Jan	Kelly	Groceries	$172
16	16-Jan	Dad	Music	$8
17	18-Jan	Kelly	Fuel	$30

A Simple Pivot Table



Anatomy of a Pivot Table

Filters

- What column to use to filter values.
- Only for columns with categorical data.

Rows

- What column to use in the rows of the pivot table.
- Only for columns with categorical data.

Columns

- What column to use in the columns of the pivot table.
- Only for columns with categorical data.

Values

- What value we want to aggregate.
- Only for columns with numerical data.

Pivot Tables to Convert from Long to Wide

Exercise 1 (weather_data.csv)
What is the average precipitation in Antigo?

- Using AVERAGEIFS
- Using a pivot table

Exercise 2 (weather_data.csv)
What is the March-2013 average precipitation in Antigo?

- Using AVERAGEIFS
- Using a pivot table

	A	B	C	D	E	F
1		data	date	param	siteid	
2	1	0	1/1/03	Precipitatior	ACRE	
3	2	0	2/1/03	Precipitatior	AlbertLea	
4	3	11.3199997	3/1/03	Precipitatior	Ames	
5	4	0	4/1/03	Precipitatior	Antigo	
6	5	3.03999996	5/1/03	Precipitatior	Appleton	
7	6	0.49000001	6/1/03	Precipitatior	Arlington	
8	7	0	7/1/03	Precipitatior	Bean&Beet	
9	8	0	8/1/03	Precipitatior	Brookings	
10	9	0	9/1/03	Precipitatior	Brownstown	
11	10	0	10/1/03	Precipitatior	Columbia	
12	11	0	11/1/03	Precipitatior	Crookston	
13	12	0	12/1/03	Precipitatior	Dekalb	
14	13	0	13/1/03	Precipitatior	DixonSprings	

Take-home Messages

- Both Excel and MATLAB have a specific data type that is used to represent Dates and times.
- Pay attention when importing files that use unconventional date and time expressions. Both Excel and MATLAB may guess the format wrong.
- Both Excel and MATLAB offer functions that can be used to create dates and convert dates to strings.
- Understand the power of Excel's pivot tables.

What's Next

- Week 9 lecture: Summarising, Visualising and Analysing Data.
- Week 9: in-class quiz during your scheduled SGTA 1 (Friday 6-9pm for external students).
  - You can also find a practice quiz in iLearn. Complete it at your leisure.