MATH1309 – Practice Problems 1

By hand

1) Given the matrices $\mathbf{A}=\begin{bmatrix}-1 & 3\\ 4 & 2\end{bmatrix}, \mathbf{B}=\begin{bmatrix}4 & -3\\ 1 & -2\\ -2 & 0\end{bmatrix}$ and $\mathbf{C}=\begin{bmatrix}5\\ -4\\ 2\end{bmatrix}$

Perform the indicated multiplications

a) 5A
b) BA
c) A'B'
d) C'B
e) AB

SOLUTIONS

a) $5\mathrm{A}=\begin{bmatrix}-5 & 15\\ 20 & 10\end{bmatrix}$

b) $\mathrm{BA}=\begin{bmatrix}-16 & 6\\ -9 & -1\\ 2 & -6\end{bmatrix}$

c) $\mathrm{A'B'}=\begin{bmatrix}-16 & -9 & 2\\ 6 & -1 & -6\end{bmatrix}$

d) $\mathrm{C'B}=\begin{bmatrix}12 & -7\end{bmatrix}$

e) AB is not defined

2) Let $\mathbf{A}=\begin{bmatrix}9 & -2\\ -2 & 6\end{bmatrix}$

a) Find the eigenvalues and the eigenvectors of A

SOLUTIONS

Find the eigenvalues first

$$\left|\mathbf{A}-\lambda\mathbf{I}\right|=\mathbf{0}$$

$$\left|\begin{bmatrix}\mathbf{9} & \mathbf{-2}\\ \mathbf{-2} & \mathbf{6}\end{bmatrix}-\begin{bmatrix}\lambda & \mathbf{0}\\ \mathbf{0} & \lambda\end{bmatrix}\right|=\mathbf{0}$$

$$\left|\begin{bmatrix}\mathbf{9}-\lambda & \mathbf{-2}\\ \mathbf{-2} & \mathbf{6}-\lambda\end{bmatrix}\right|=\mathbf{0}$$

$$(9-\lambda)(6-\lambda)-(-2)(-2)=0$$

$$\lambda^2-15\lambda+50=0$$

$$\lambda_1=10$$

$$\lambda_2=5$$

Then solve for the eigenvector $\mathbf{Ax}=\lambda\mathbf{x}$

Using

$\lambda_1=10$

$$\left|\begin{bmatrix}\mathbf{9} & \mathbf{-2}\\ \mathbf{-2} & \mathbf{6}\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}\right|=10\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

$$9x_1+-2x_2=10x_1$$

$$-2x_1+6x_2=10x_2$$

$$x_1=-2x_2$$

$\lambda_1=5$

$$\left|\begin{bmatrix}\mathbf{9} & \mathbf{-2}\\ \mathbf{-2} & \mathbf{6}\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}\right|=5\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

$$9x_1+-2x_2=5x_1$$

$$-2x_1+6x_2=5x_2$$

$$2x_1=x_2$$

Normalising to length of 1

$$e=\mathbf{x}/\sqrt{\mathbf{x'x}}$$

$$e_1=\begin{bmatrix}2/\sqrt{5}\\ -1/\sqrt{5}\end{bmatrix}$$

$$e=\mathbf{x}/\sqrt{\mathbf{x'x}}$$

$$e_2=\begin{bmatrix}1/\sqrt{5}\\ 2/\sqrt{5}\end{bmatrix}$$

Using Software

You can attempt these problems with R, however it would also be a good idea to know how to work with data in SAS as the second half of the course will only have SAS based examples.

Working with SAS coding

There are two main coding statements in SAS. Either a data step to create or manipulate data, or a procedure step. We need to work with both steps to work with multivariate data. Complete the following steps using either SAS Studio, or SAS Enterprise Guide.

If you want to use SAS Studio, you can also enrol for the course which will give you access to the class files that I will place in the SAS folder for you. See the instructions on Canvas here:

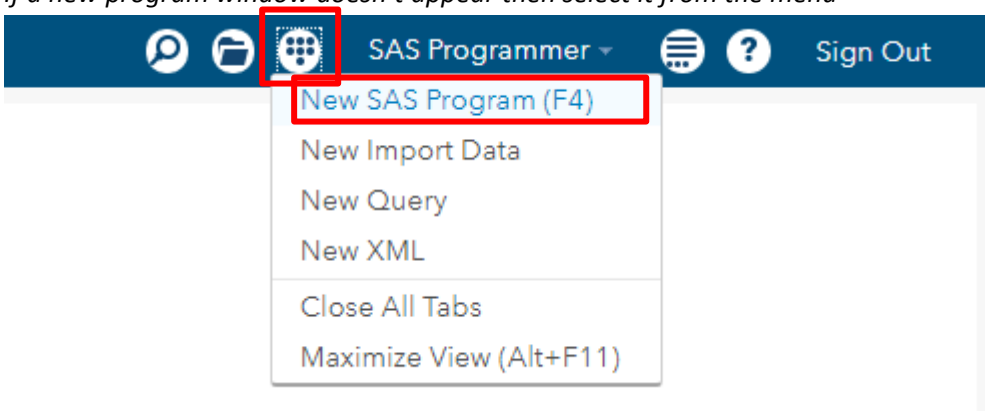
https://rmit.instructure.com/courses/17206/pages/getting-started-with-sas?module_item_id=1159388

If you need any help, check the videos on Canvas or ask the tutors for help during class.

1) Open SAS and start a new program.

Follow the enrolment steps from the link above, and then access:
https://odamid.oda.sas.com/SASStudio/

If a new program window doesn't appear then select it from the menu



2) Create a new data step to type in the data from the following table:

Age	Gender	Height	Weight
18	M	158	68
18	F	150	58
19	F	145	58
21	M	165	85

Copy or type in the information into the program window inside a data step, make sure to use spaces between columns.

```
1 data example1;
2 input age gender$ height weight;
3 datalines;
4 18 M 158 68
5 18 F 150 58
6 19 F 145 58
7 21 M 165 85
8 ;
9 run;
```

Now that you have a data file, you can run procedures with the data.

3) Calculate the descriptive statistics for each of the variables using PROC MEANS

```
proc means data=example1;
run;
```

4) Find the correlation matrix using PROC CORR

```
proc corr data=example1;
run;
```

5) Find the covariance matrix using PROC CORR

```
proc corr data=example1 cov;
run;
```

SOLUTIONS

```
data example1;
input age gender$ height weight;
datalines;
18 M 158 68
18 F 150 58
19 F 145 58
21 M 165 85
;
run;

proc means data=example1;
run;

proc corr data=example1;
run;

proc corr data=example1 cov;
run;
```

Question 2

Read in the data file Example2.csv which has five variables id, x1, x2, x3 and x4. This time, rather than typing the data in, we can read directly from the file in the class folder by adding the infile line into the data step.

Infile "path/filename.extension";

6) Calculate the descriptive statistics for each of the variables using PROC MEANS

7) Find the correlation matrix using PROC CORR

8) Find the covariance matrix using PROC CORR

9) Visualise the correlation in a scatterplot matrix using PROC SGSCATTER

SOLUTIONS

```
data example2;
infile "/courses/dc373215ba27fe300/MATH1309/Example_2.csv" delimiter=",";
input id x1 x2 x3 x4;
run;

proc means data=example2;
var x1 x2 x3 x4;
run;

proc corr data=example2;
var x1 x2 x3 x4;
run;

proc corr data=example2 cov;
var x1 x2 x3 x4;
run;

proc sgscatter data=example2;
matrix x1 x2 x3 x4;
run;
```