

(1 October 2008, 10.00 - 12.00, LRC2)

NOTE:

*You **do not** hand in your solutions for marking, but you are welcome to discuss them with me at my office hours if you wish. Also, the solutions will be given at the course website on Wednesday, 8 October.*

1.1 Getting Started

YOUR NEW DIRECTORY - TIME_SERIES

Log on and choose **>The Standard Student Service<**

then

choose **Time Series** environment.



To create your new **Course Directory** (folder) do the following:

Double click on the shortcut to your space



In the **Dialog Window** choose

File → New ▶ Folder

An icon  will appear in the Window. Delete its initial name "New Folder" and give the new name "TIME_SERIES". Close the Dialog Window (click on  in the right top corner of this Window).

Please, save all your files and results, which you get during this course in the directory TIME_SERIES.

To start MINITAB follow the path:

Public >> ▶  11-Maths and Stats ▶  Minitab ▶ Minitab 15

Familiarize yourself with all the icons shown in the toolbar, particularly with the Project Manager icon. You will be asked to put the results of your calculations and the graphs in a report which you can easily write using the Report Pad in the Project Manager or copy and paste the Report Pad document to Word for Windows and then edit it further.

You may get the information about MINITAB Environment by choosing

Help > Help > Getting Started > Introduction to Minitab

Familiarize yourself with the menu functions shown in the toolbar (File, Edit, Data, Calc, Stat, Graph, Editor, Tools, Window, Help). You will need quite a few of them in your work with MINITAB.

1.2 Open Worksheet

When you start Minitab, you begin with a new, empty project. You can add data to your project in many ways, but the most common way is to open a worksheet. Note that you are only copying the data from the worksheet to the project; any changes that you make to the data added to your project will not affect the original file. In this session, you will start your work on time series analysis with the data file **OlympicGold.mtw**. Go to

File > Open Worksheet...

- Browse the directories to find the subdirectory *STU on 'Qmwcc2\Maths\Users\Tsetutor' (F:)*
- Click on **OlympicGold.mtw** and click Open.

This worksheet contains three variables, labeled High_Jump, Discus_Throw, Long_Jump, representing the gold medal results of these three events obtained during the Modern Olympic Games. The year have been coded: to obtain the actual year add 1900 to the values in the column Year.

1.3 Time series plot

To plot a time series go to

Stat > Time Series > Time Series Plot ...

In the dialog window:

- select 'Simple' plot,
- select the three variables to graph,
- under the Time/Scale... option select Index

- under Multiple Graphs select In separate panels on the same graph to view all of them at one time on your screen,
- use labels to give the plot your unique title.

Look at the plots carefully and make comments on them in the Report Pad. Your comments should be brief and should indicate the features of the data the plots reveal (see Lecture Notes, page 9).

Writing Minitab Project Report

You may create a report of your work using the ReportPad folder in the Project Manager.

- From the Graphs directory in the Project Manager copy the pictures into your report (right-clicking on the graph's name will show a set of options, one of them is Append to Report). Make the graphs small, so that two graphs are in one line (saving paper).
- If there are important results in the Session window you should also append them to the report.
- Write down your comments on the results.
- To save the Report in your directory TIME_SERIES as an *.rtf file choose

File > Save Report As

You can also edit the Session Window Output if necessary.

By default, the Session window is **read-only**, so that you cannot accidentally delete results. To be able to edit text you have to make the Session window editable:

- Press [Ctrl]+[M] to make the Session window active.
- Pull down the Editor menu.
 - If there is no check mark next to Output Editable, then select it to enable Session window editing.
 - If there is already a check mark next to Output Editable, then Session window editing is already enabled. Press [Esc] to close the menu.

1.4 Trend Analysis

1.4.1 Regression model fit

To do the trend analysis go to **Stat > Time Series > Trend Analysis...**

1. In the dialog box chose **high_jump** as a Variable and choose a Model type, also graph Residuals versus order.
2. Find out in Help what is the meaning of MAPE, MAD, MSD.

3. Repeat the trend analysis for other model types. Compare the values of MAPE, MAD, MSD and choose the best trend model. Add the model, relevant graphs and your comments on the choice of model to the Report.
4. Repeat points 1-3 for the two other variables.
5. Save the Report Pad.
6. Save the worksheet. To do this go to **File > Save Current Worksheet As...** Save it as a MINITAB worksheet.

Open a new worksheet with the **ChangeInTemp.mtw** data.

- Graph the time series plot. What features of the series does the plot indicate?
- Perform a trend analysis. Are the residuals trend-free?
- Include graphs, important results and your comments in a new Report.
- Save the report and the worksheet in your directory.

1.4.2 Moving Average (ma)

Equally weighted moving average

- For the ChangeInTemp data calculate a symmetric moving average of length 5. To do this go to
 - **Stat > Time Series > Moving Average...**
 - Center the moving averages.
 - Store the moving average in the worksheet.
 - Plot smoothed values versus actual values.
- Subtract the moving average values from the original data (**Calc > Calculator...**) and examine the residuals (estimates of random noise).
- Repeat this procedure for other lengths of the moving average and compare the results.
- Write down your conclusions (supported by appropriate graphs) in the Report Pad.
- Save the Report Pad in your directory.

SAVE your Report and your worksheet and exit MINITAB.

1.5 Theoretical Questions

Question 1

Assume that $X_t = m_t + Y_t$, where m_t is a third order polynomial trend and Y_t denotes a random noise. Show that the 5-point moving average

$$\frac{1}{35}(-3, 12, 17)$$

follows the trend without distortion. Does it also follow a second order polynomial trend without distortion? Explain.

Question 2

Calculate a moving average $\{a_j\}$ as a set of successive terms in the expansion

$$\left(\frac{1}{2} + \frac{1}{2}\right)^{2q}, \quad \text{where } q = 2 \text{ and } q = 3.$$

(Recall the expansion of $(a+b)^n$ and apply it)

Question 3

Calculate the convolution of the following two filters

$$\{a_j\} = (a_{-2}, a_{-1}, a_0, a_1) \quad \text{and} \quad \{b_k\} = (b_0, b_1, b_2).$$

Apply the result to calculate the convolution of

$$\{a_j\} = \left(\frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right) \quad \text{and} \quad \{b_k\} = \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right).$$

Write down the resulting form of the new series Z_t as a combination of the elements of the series X_t .

Question 4

For a time series X_t calculate $\nabla^3 X_t$ and show that $\nabla^3 X_t$ is a convolution of three filters of the form $(-1, 1)$.