

5BUIS002W Business Analytics Coursework (2010/21)	
Module leader	Dr. Salma Chahed
Unit	Individual Coursework
Weighting:	50%
Qualifying mark	30%
Description	Forecasting and Simulation modelling
Learning Outcomes Covered in this Assignment:	The coursework rationale is to model and solve problems with appropriate forecasting and simulation techniques and analyse and discuss their solutions. It relates to learning outcomes (LO3 – LO6 and LO8).
Handed Out:	08 February 2021
Due Date	10 March 2021, 13:00
Expected deliverables	Two electronic files to be submitted via separate Turnitin links: <ul style="list-style-type: none"> • a self-containing report with complete answers including formulas, graphs, results and discussion; • a zipped folder containing evidence of your work (e.g. Excel or R files).
Method of Submission	Online via Blackboard.
Type of Feedback and Due Date:	Written feedback and marks 15 working days (3 weeks) after the submission deadline, on Wednesday 31 March 2021 All marks will remain provisional until formally agreed by an Assessment Board.

Assessment regulations

Refer to section 4 of the “How you study” guide for undergraduate students for a clarification of how you are assessed, penalties and late submissions, what constitutes plagiarism etc.

Penalty for Late Submission

If you submit your coursework late but within 24 hours or one working day of the specified deadline, 10 marks will be deducted from the final mark, as a penalty for late submission, except for work which obtains a mark in the range 40 – 49%, in which case the mark will be capped at the pass mark (40%). If you submit your coursework more than 24 hours or more than one working day after the specified deadline you will be given a mark of zero for the work in question unless a claim of Mitigating Circumstances has been submitted and accepted as valid.

It is recognised that on occasion, illness or a personal crisis can mean that you fail to submit a piece of work on time. In such cases you must inform the Campus Office in writing on a mitigating circumstances form, giving the reason for your late or non-submission. You must provide relevant documentary evidence with the form. This information will be reported to the relevant Assessment Board that will decide whether the mark of zero shall stand. For more detailed information regarding University Assessment Regulations, please refer to the following website: <http://www.westminster.ac.uk/study/current-students/resources/academic-regulations>

Coursework Description

Two parts to complete: Part A (Forecasting) and Part B (Simulation).

Your report should be self-contained including relevant results and analysis and should be produced using any appropriate application providing this can be submitted using Blackboard Assignment (details will be discussed separately). If you experience some technical problems, please log a call via Service Desk and email the module leader your report before the submission deadline. You must keep a copy of the work that you submitted.

Your work is expected to be of a professional quality. Careful selection of appropriate tables and figures, accompanied with meaningful explanations and comments, is advisable. It is never a good idea to dump the entire computer output into the main body of a report. It is your responsibility to show all the steps. Failing to do so you will be penalised. Please be concise and precise in your writing. Your work must be presentable and grammatically correct.

Remember that this is meant to be an individual coursework and that any indication that it is otherwise may result in severe penalties. In order to understand and avoid academic misconduct such as collusion and plagiarism, please visit the [academic misconduct page](#) on the student hub.

Please read all the sections carefully before you start your coursework.

Part A: Forecasting [50 Marks]

In the UK, over 100,000 babies are admitted every year to a specialist neonatal unit for care. These babies are born premature (under 37 weeks), have a low birth weight (under 2,500g) or are born at term but with medical problems (BLISS, no date). The increasing number of babies needing neonatal care is due mainly to technological and therapeutic advances. These advances have implied a decreasing neonatal mortality rate for very low birth weight infants (under 1,500g) and also a falling incidence of preterm stillbirth. In order to remedy to the changing nature of demand, the capacity of the neonatal system has to be adjusted.

Neonatal networks are made of a number of units (or hospitals) serving defined geographical areas and providing a range of levels of care, i.e. from Normal Care to Intensive Care. Normal Care consists in care given by the mother with medical and neonatal nursing advice if needed. Critical care services include intensive care (IC), high dependency (HD) care, and special care (SC). Special care, which is the least intensive, is designated for neonates that may need to be fed through a tube, be supplied with extra oxygen or treated with ultraviolet light for jaundice. High dependency care is given to neonates that may need breathing via continuous positive airway pressure or intravenous feeding and short-term intensive care. In intensive care, neonates will often be on a ventilator and need constant care to be kept alive (NHS Digital, 2020).

In Scotland, neonatal services have been facing some staffing and resources issues (BLISS, 2017). The yearly numbers of neonates per level of care from 2008 to 2019 are available in the Excel file “*Neonatal care and maternal health.xlsx*”. This data was obtained from Public Health Scotland website (<https://www.isdscotland.org/health-topics/maternity-and-births/births/>).

1. Graph the three levels of critical care time series. Discuss their features. **[7 Marks]**
2. Determine, for intensive critical care (IC), what forecast for number of neonates would be for the next year (2020) by: **[23 Marks]**
 - a. Using Naïve method;
 - b. Using 4-period moving average.
 - c. Developing an exponential smoothing model using a smoothing constant (α) that minimises the MAPE (i.e. Mean Absolute Percentage Error). Explain your approach.
 - d. Compare all three forecasting models. Conclude.
3. Based on the results of the previous questions (i.e. questions 1 and 2) and by consulting the literature on time series forecasting, explain what forecasting technique you would recommend citing any relevant references. Use the selected forecasting technique and develop an appropriate model for intensive critical care. Please note that you may select any other forecasting technique that might add any useful insight (i.e. not limited to the aforementioned techniques). **[12 Marks]**
4. Several research studies have proven that maternal health can have an impact on pregnancy and neonatal outcomes. Using the method of least squares, develop a straight-line approximation of the relationship between the number of babies born premature (under 37 weeks) and the number of mothers smoking while pregnant. For this analysis, 2018/2019 data by NHS Board of residence in Scotland is provided. Discuss your findings. **[8 Marks]**

References

NHS Digital (2020). NHS Data model and dictionary. Available from https://datadictionary.nhs.uk/attributes/neonatal_level_of_care.html [Accessed 22/01/2021].

BLISS (no date). Statistics about neonatal care. Available from <https://www.bliss.org.uk/research-campaigns/neonatal-care-statistics/statistics-about-neonatal-care> [Accessed 22/01/2021].

Bliss (2017). Bliss Scotland Baby Report 2017: An Opportunity to Deliver Improvements in Neonatal Care. Available from https://s3.eu-west-2.amazonaws.com/files.bliss.org.uk/documents/Research-and-campaigns/Campaigns/Bliss_Scotland_Baby_Report_2017.pdf?mtime=20180404115145&focal=none [Accessed 22/01/2021].

Part B: Simulation [50 Marks]

EasyB&B.com is a start-up dot-com company that provides a network for bed and breakfasts (B&Bs) and guest houses in the UK. This network makes guest reservations and provides technical support for the managers of these properties. To begin operations, one customer service representative has been hired to answer phone calls. It is estimated that on average

a call will take about 10 minutes to answer and the time between customer calls follows a discrete probability distribution:

Time between calls (min)	Probability
5	0.10
8	0.20
10	0.40
12	0.30

When the service representative is busy, the caller can wait on the line.

1. Determine appropriate intervals for the random numbers that can be used to generate the time between customer calls. **[4 Marks]**
2. Use the following random numbers: 0.53933, 0.71344, 0.83459, 0.37075, 0.00997, 0.31444, 0.48636, 0.12296, 0.09736 and 0.28647 to simulate time between customer calls of the first 10 iterations. **[5 Marks]**
3. Using your answers for question 2, Use a spreadsheet model to calculate the call arrival time for each customer, their waiting times the total time they spent in the system and the total average time spent by all ten customers (Scenario 1). **[8 Marks]**

After few weeks of operation, EasyB&B.com management thinks that demand is exceeding their estimation. Time between call arrivals follows an exponential probability distribution with mean of 9 minutes.

An extensive study of time required to answer calls with a single customer service representative let to the following probability distribution of service times:

Service time (min)	Probability
5	0.24
6	0.20
7	0.15
8	0.14
9	0.12
10	0.08
11	0.05
12	0.02

In case customer waiting times prove too long with a single service representative, the management is considering hiring a second service representative. As a guideline, they require the average waiting time to be less than 3 minutes.

4. Develop and run a spreadsheet simulation model for each of the following scenarios to calculate the call arrival time for each customer, their waiting times and the total time spent in the system for the first 100 customers. Note that no call is in the system at time $t = 0$.
 - a. Scenario 2: one customer service representative. **[8 Marks]**
 - b. Scenario 3: two customer service representatives. The service time is exactly the same for both service representatives. Assume that when a new call arrives it will

be answered by the next available service representative. When the simulation begins, the first call is answered by service representative 1. **[8 Marks]**

5. Discussion

- a. Identify and calculate any relevant statistics for each of the scenarios from question 4 (i.e. scenarios 2 and 3). Note that customer service opening hours are from 8:00 to 14:00. **[6 Marks]**
- b. Compare the two scenarios **[7 Marks]**
- c. Make any recommendations regarding the best staffing plan for and performance of EasyB&B.com. **[4 Marks]**

Deliverables

1. **A report (a PDF or WORD document)** to be submitted online via the submission link “5BUIS002W Coursework” on Blackboard. Your written report should include complete answers with formulas, graphs, results and discussion. Your report should not exceed fifteen A4 pages. Font size no less than 10pt. Margins all around should be no less than 2cm. Do not copy and paste questions in your report. Add algebraic formulas and equations to answer the questions. Excel formulas or R codes should NOT be used to justify your answers in the report.
2. **A zipped folder containing evidence of your work (e.g. Excel or R files)** to be submitted online via a separate submission link on Blackboard entitled “*Coursework Supporting Documents*”. These files will NOT be marked but will be used to check whether you have done the work. Make sure that your computer models include relevant formula and/or codes.

Coursework Marking scheme

The Coursework will be marked based on the following marking criteria:

Criteria	Mark per component	Mark provided	Comments
Part A: Forecasting	50		
Question 1: time series	7		
Graph [4 Marks]; Discussion [3 Marks]			
Question 2: smoothing methods	23		
Naïve method [2 Marks]; MA(4) [2 Marks]; exponential smoothing: parameter optimisation [4 Marks] + forecast [4 Marks]; comparison [9 Marks]; conclusion [2 Marks]			
Question 3: recommended forecasting technique	12		
Selected technique and its presentation [2 Marks]; justification [2 Marks]; reference(s) [2 Marks]; Forecasts [3 Marks]; accuracy [3 Marks]			

Question 4: method of least squares 8

Explanation / Calculation [2 Marks]; equation [2 Marks]; Discussion [4 Marks]

Part B: Simulation modelling 50

Question 1: random number intervals 4

Question 2: inter-arrival times 5

Question 3: scenario 1 8

Call arrivals [2 Marks]; Waiting times [2 Marks]; time spent in the system per caller [2 Marks]; total average time spent by all callers [1 Mark]; Explanation [1 Mark]

Question 4: scenario 2 and 3 16

Per Scenario: call arrivals [2 Marks]; waiting times [2 Marks]; time spent in the system per caller [2 Marks]; Explanation [2 Marks]

Question 5: comparison / discussion / recommendations 17

Identify key statistics [3 Marks]; calculate key statistics for each of the two scenarios [3 Marks]; Comparing the two scenarios [6 Marks]; Best scenario [1 Mark]; Recommendation [4 Marks]

Total 100