SOS 2020

FINANCIAL MATHEMATICS

T PAVAN KALYAN

specialisation :

Quantitative modelling

Mid term report

INDEX:

FUNDAMENTALS OF MATLAB:

Matlab is one of the softwares and a programming language too that helps business analysts and engineers a lot. It can be used in various ways starting from a calculator to every task that a programming language does. But unlike other programming languages it's syntax is easy to get used to and it has many more in-built functions available which help engineers in solving the problems directly instead of writing down huge complicated functions.

Two online courses were completed to get acquainted with the software and its environment.one of the courses was provided by the official website of mathworks which every individual is supposed to complete upon installing the software "MATLAB". The other course was provided by coursera namely "Introduction to Programming with MATLAB" by Vanderbilt university . This was a nine week course but was completed very early as another fundamental course by mathworks had already been done.

During these courses the following book was suggested "COMPUTER PROGRAMMINGwith MATLAB" by J. MICHAEL FITZPATRICK AND ÁKOS LÉDECZI. There are three sections in the book

So far study till chapter 3 has been done. Some of the concepts in the book were too complicated to be done at that moment so they are supposed to be done later once completing the entire text.

Skills gained :

1) Matlab syntax and semantics
2) Plotting
3) accessing , combining and transforming matrices
4) Matrix arithmetic
5) Variable function arguments and outputs-robust functions
6) Logical indexing
7) Data types: character arrays, structs, cells
8) Input and output file- excel and text files
9) Linear algebra

Programming assignments:

1) Simple matlab calculation
2) Matrix indexing
3) Matrix arithmetic
4) Using functions “nargin” and “nargout”
5) Using cell arrays
6) Saddle points
7) Image blur
8) Echo generator
9) Some practice problems from matlab website

All the informations and detail given above can be found from the following websites

Matlab course : https://matlabacademy.mathworks.com/

Coursera course: https://www.coursera.org/learn/matlab

Book referred: http://cs103.net/buy

Credentials gained:

Coursera completion certificate:
https://www.coursera.org/account/accomplishments/certificate/W8TFZET2DJXE

Mathworks completion certificate:
https://matlabacademy.mathworks.com/progress/share/certificate.html?id=0cfd95b5-bfe8-4d6d-9827-24efff8abcbb

FUNDAMENTALS OF QUANTITATIVE MODELLING

1) Understanding the language of modeling

_a model is a formal description of a business process involving mathematical equations sought as a simplification of more complex business problems relying upon a set of assumptions.

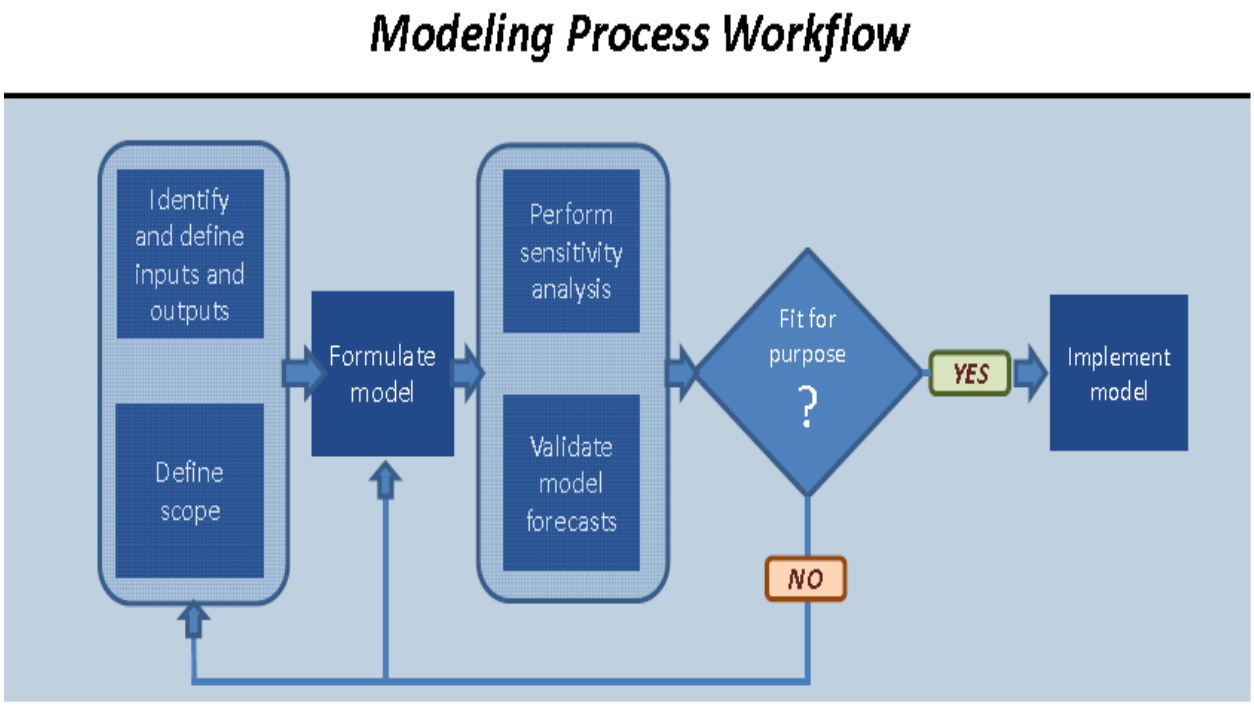
2) uses of models

Models are used in prediction, forecasting,optimisation, ranking and targeting as well as exploring whatif scenarios.

Sometimes interpretation of coefficients and sensitivity of the model to key assumptions are also very important.

Modelling makes assumptions explicit and can be used as a decision support tool. It also helps to realise gaps in current understanding of a business problem

3) key steps in modelling process:



(Source: https://www.coursera.org/learn/wharton-quantitative-modeling)

4) The modelling lexicon

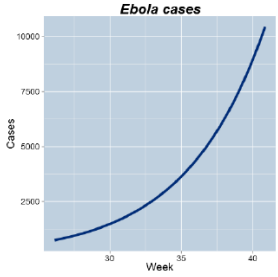
Theory driven model Derives logical consequences using a set of assumptions and relations	**Data driven model** Given a set of observations, tries to approximate the process that generated these observations
Deterministic model Given a fixed set of inputs the model always give same output	**Probabilistic model** Even with identical inputs the model output can vary from instance to instance
Discrete variable Distinct values are used in models	**Continuous variable** Smooth process with possibly infinite number of values in an interval
Static model Only deals with a single snapshot of the business process	**Dynamic model** Deals with the process itself along with the outcome of the business process.

5) Following models were dealt with during the study of fundamentals of quantitative modelling

- **The price of a diamond as a function of its weight**

  This model is the best example of a linear model.

- **The spread of an epidemic over time**



$$\text{Model: Cases} = 6.69\, e^{0.18\,\text{Weeks}}$$

(Source: https://www.coursera.org/learn/wharton-quantitative-modeling)

This model is an example of an exponential growth model. This model is also a very good example of a continuous model.

- **The relationship between demand for, and price of, a product**

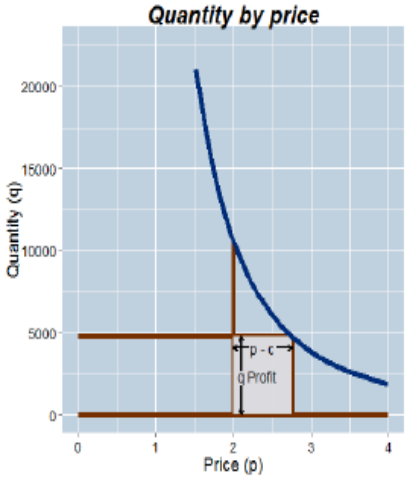
This scenario gives the best application of a model for optimisation. The objective of the optimization is to find the value of an input that maximizes/minimizes an output.

This is called demand model:

Quantity = $60{,}000\ \text{Price}^{-2.5}$

If the price of production is constant at c = 2 for each unit, then at what price is profit maximized?(this is called optimisation)

The price can be calculated using a calculus approach and the coefficient (-2.5) is called the price elasticity of demand model.



Price	Profit
1.75	-3702.509
2.0	0.000
2.5	3035.787
3.0	3849.002
3.5	3927.104
4.0	3750.000
4.5	3491.885
5.0	3219.938

Visualisation of calculus approach

Brute force approach

(Source: https://www.coursera.org/learn/wharton-quantitative-modeling)

- **The uptake of a new product in a market**

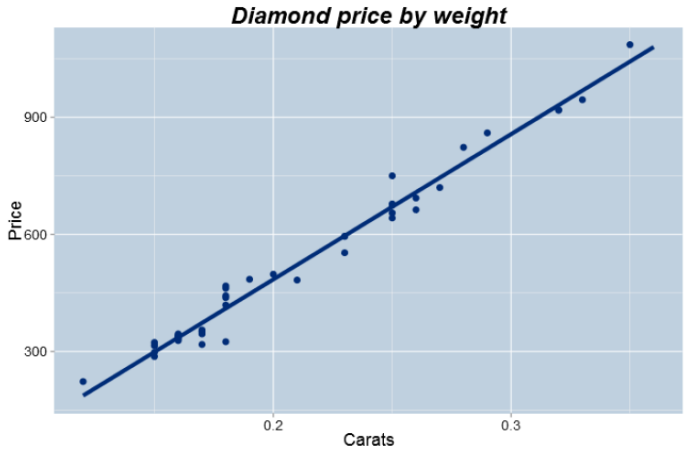
6) studying about probabilistic models:

These models include random variable and probability distributions. Probabilistic approach is required because it introduces uncertainty in outcome variables.

Following probabilistic models were studied :

- Regression model

  When a set of data is given, the process is modelled by finding out the averaged outcome variable using one or more predictor variables. If multiple predictor variables are used then it is called multiple regression. If the relationship is linear then it is called linear regression model. Example is the weight of diamonds. Most regression models are fit using least squares methods.



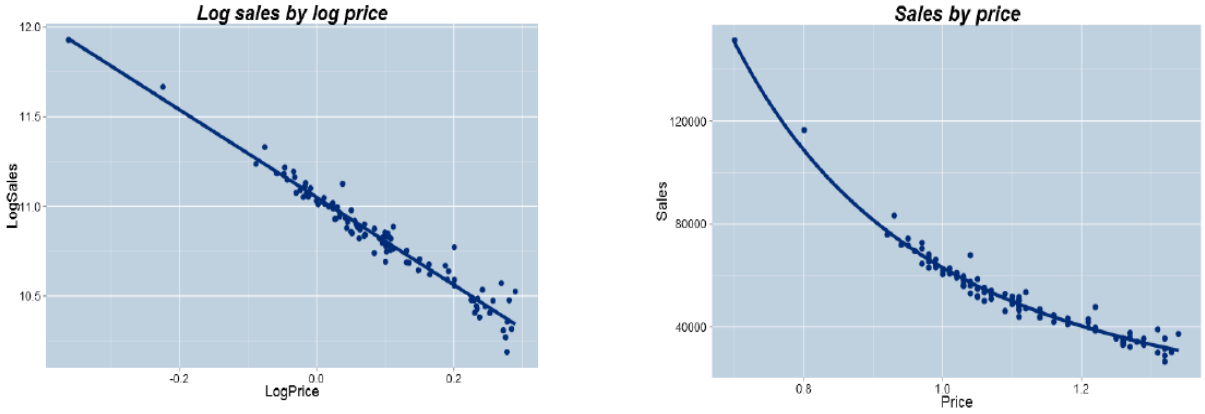
$$E(Price \mid Weight) = -260 + 3721 \times Weight$$

Diamond model-using regression

(Source: https://www.coursera.org/learn/wharton-quantitative-modeling)

Often relations are nonlinear too. So on observing the curvature transform accordingly.

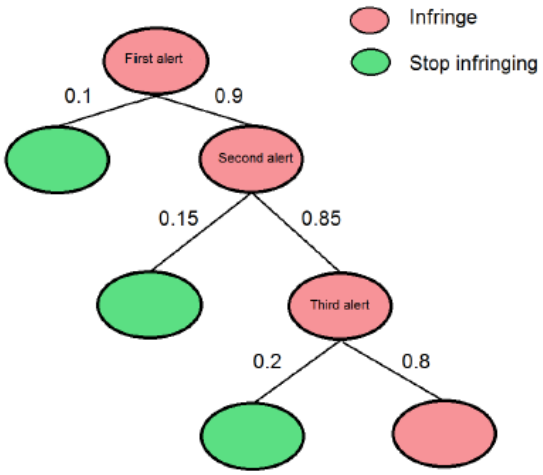
Example is the log log model.



(Source: https://www.coursera.org/learn/wharton-quantitative-modeling)

- Probability trees

  Probability trees are used to propagate probabilities through a sequence of events. Given figure is a model which shows the probability tree.



(Source: https://www.coursera.org/learn/wharton-quantitative-modeling)

- Monte carlo simulation

In the demand model introduced above if instead of a definite coefficient if a range was given then a range of outcomes was possible.i.e. A range of optimal prices. This is called monte carlo simulations

- Markov models
  These are dynamic models for discrete time state space transitions. For example modelling a process of employment status of an individual.

7) Building blocks of probability models

Random variables can be discrete or continuous. But the key summaries of any probability distribution are the mean and spread around the mean. This spread around the mean can be estimated by using the standard deviation or variance.

Types of probability distributions dealt with during the study:

1) Bernoulli distribution: it can be seen as an experiment which has only two outcomes- true or false.
2) Binomial distribution: a binomial variable is the number of successes in n independent Bernoulli trials.
3) Normal distributions: it is famously known as the bell curve. There is universality to normal distribution. I.e. most of the processes when modelled turn out to have bell shaped data. It is symmetric about it's mean.

   EMPIRICAL RULE:

   It is a rule for calculating probabilities when the underlying distribution is approximately normal.

   "There is an approximate 68% chance that an observation falls within one standard deviation from the mean . There is an approximate 95% chance that an observation falls within two standard deviations from the mean . There is an approximate 99.7% chance that an observation falls within three standard deviations from the mean"

UPDATED PLAN OF ACTION:

There is no change in the previous schedule. But the material to be studied will be extended to ensure deep understanding of quantitative modelling using excel.

Week 5: [29 april - 5 may]: Introduction to spreadsheets and models

(2 hours/day)

Week 6: [6 may - 12 may]: frameworks of financial reporting(2 hours/day)

Week 7: [12 may - 19 may]:analysing financial performances using real life

examples(2 hours/day)

Week 8: [20 may - 26 may]: Introduction to corporate finance(2 hours/day)

During this period of SOS 2 books are supposed to be completed and studied thoroughly.these books are mentioned below:

1) “Hector Guerrero-Excel Data Analysis(Modeling and Simulation)Second Edition”

   Source: https://link.springer.com/book/10.1007%2F978-3-030-01279-3

2) “Computer programming with MATLAB”

   Source: http://cs103.net/buy