Business Analytics 1st edition Abdey Solutions Manual

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Business Analytics:
Applied Modelling and Prediction

Solutions to end-of-chapter exercises

Chapter 1:

Decision-making under uncertainty

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Chapter 1
Decision-making under uncertainty

1.1 Exercises

1.1.1 Test your understanding

1. What is meant by 'uncertainty'?

   Solution:

   Uncertainty refers to a lack of knowledge, information or predictability about a particular situation, event or outcome. It signifies a state of doubt or ambiguity where the future or the true nature of something is uncertain. Uncertainty can arise from various factors, such as incomplete data, conflicting evidence, complexity, or the presence of unpredictable variables. It often poses challenges in decision-making, planning, and risk assessment as it hampers our ability to accurately foresee or quantify potential outcomes. Managing uncertainty involves acknowledging its presence, assessing probabilities, considering alternative scenarios, and adopting flexible approaches to adapt to changing circumstances.

2. What is the difference between 'dependent' and 'independent' variables?

   Solution:

   A dependent variable is the variable being measured or observed in an experiment or study. It is the outcome or result in which we are interested in understanding, explaining or predicting. Examples of dependent variables in business analytics include:

   - behavioural responses, such as customer awareness, brand perception, knowledge, intention to purchase and preference.
   - performance metrics, such as sales revenues, production costs, profits, market share, cash-flow and share price.

   Independent variables are those that impact the dependent variable – think of it in terms of 'cause and effect'. Examples of independent variables in business analytics include:

   - marketing mix variables, such as product, price, placement and promotion (the 4 Ps), which are controllable, i.e. are under the control of the decision-maker.
   - situational factors, such as demand, competition, economic climate, political climate, exchange rates, supply chain, regulations and technology, which are uncontrollable, i.e. are not under the control of the decision-maker.

   The relationship between the dependent and independent variables is often explored through statistical analysis to determine whether changes in the independent variable cause changes in the dependent variable. This helps establish cause-and-effect relationships and provides insights into the phenomenon under investigation. Understanding the distinction between dependent and

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independent variables is fundamental for designing experiments, conducting research, and drawing meaningful conclusions from data.

3. Identify examples of real-world dependent variables for any business problem of your choice.

Solution:

Consider a hotel. Management may be interested in the following dependent variables.

- Customer satisfaction score – this could be measured using surveys or feedback forms where customers rate their overall satisfaction with the hotel, its services, staff, amenities, cleanliness, etc. The satisfaction score can be a numerical rating or a categorical measure (for example, ranging from 'very satisfied' to ' very dissatisfied').
- Revenue per customer – this variable represents the average amount of money a customer spends during their stay. Higher revenue per customer can indicate customer satisfaction, as satisfied guests are more likely to use additional services, such as room upgrades, spa treatments, or dining options.
- Customer retention rate – this metric indicates the percentage of customers who continue to stay at the hotel over a specific period of time. It reflects customer satisfaction and loyalty, as satisfied customers are more likely to return in the future!

4. For each dependent variable identified in Question 3, what are the likely independent variables? Briefly justify your choice.

Solution:

Customer satisfaction score would likely depend on the following:

- Service quality.
- Price/value for money.
- Food and beverage quality.
- Room cleanliness.
- Location.
- Facilities.

Revenue per customer would likely depend on the following:

- Room type booked.
- Length of stay.
- Season of the booking (peak vs. off-peak).
- Ancillary services used.
- In-room dining.
- Purpose of visit (business vs. leisure).

Customer retention rate would likely depend on the following:

- Service quality (note also for customer satisfaction score!).
- Price/value for money (note also for customer satisfaction score!).
- Loyalty programs (accrue points for free nights, perhaps).

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- Special packages (think conferences, weddings etc.).
- Brand image.
- Partnership with other hotel brands.

Note the above are not necessarily collectively exhaustive lists!

5. What is meant by the 'four Ps'?

Solution:

The 'four Ps' are known as the marketing mix variables:

- Product – what the business is selling (which could be a tangible good, or intangible service).
- Price – what price to sell at and whether to offer a discount.
- Placement – the provision of customer access and convenience.
- Promotion – the choice of marketing communications.

6. Explain the DIKW pyramid.

Solution:

The pyramid models the conversion of (i) data, into (ii) information, from which we gain (iii) knowledge, leading to our enlightenment with (iv) wisdom. The pyramid illustrates these as hierarchical relationships.

7. What is a model?

Solution:

A model is a deliberate simplification of reality.

A good model retains the most important features of reality and ignores less important details. Immediately we see that we face a trade-off. The benefit of a model is that we simplify the complex real world. The cost of a model is that by simplifying reality we engineer a departure from reality. Broadly speaking, we would be happy if the benefit exceeded the cost, i.e. if the simplicity made it easier for us to understand and analyse the real world while incurring only a minimal departure from reality.

8. For a city other than London with a metro system, look at the official map of the network. Critique the map, noting any possible improvements you would recommend are made.

Solution:

Possible improvements may relate to:

- geographic accuracy
- clarity of presentation
- ease of navigation.

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9. A friend of yours is a contestant on the Monty Hall game show. Your friend tells you 'No matter what, I will not switch door'. Would you support your friend's decision (to maintain your friendship!) or would you advise otherwise?

Solution:

At the risk of jeopardising your friendship, you should (politely) point out that probabilistically it is optimal to switch door. Of course, you need to balance this with the possibility that the original door chosen is the correct door, in which case you may never be forgiven if your friend followed your advice!

10. Suppose the producers of the Monty Hall show changed the format of the game. Instead of there being three doors, there are now $n > 3$ doors. The contestant chooses a door. Monty (who continues to know where the car is) opens $n - 2$ doors, leaving the contestant's original door and one other door unopened.

(a) In terms of 'to switch, or not to switch?' what would you recommend is the optimal strategy and why?

(b) Do you support the producers in increasing the number of doors to $n > 3$? Justify your view.

Solution:

(a) With $n > 3$ doors, the probability that the correct door is chosen at the start by the contestant is $1/n$. Hence the probability that the correct door is one of the other $n - 1$ doors is $(n - 1)/n$, and clearly:

$$\frac{1}{n} < \frac{n-1}{n}.$$

Once Monty opens $n - 2$ doors (excluding the contestant's original choice, of course), the probability of winning by switching is $(n - 1)/n$ since this amount of probability is 'inherited' by the one door Monty chooses not to open. Decision-making under uncertainty requires us to 'play to the probabilities', hence it is optimal to switch.

Chapter 4 solves the Monty Hall problem more formally using Bayes' theorem.

(b) If contestants are savvy enough to understand the probabilistic argument for switching door each time, then we would expect all such contestants to switch. This would mean that (in percentage terms) the win rate of contestants (and hence the loss rate of the show's producers) in the long run would be:

$$\frac{n-1}{n} \times 100\%.$$

As n increases, this worsens the situation for the show's producers (more prizes are won, which costs money!) so increasing the number of doors would seem to be a bad idea. Also, television shows are meant to be for entertainment, so with $n = 3$ doors this maximises the extent of unpredictability about whether the contestant would win, which in turn would likely be optimal for audience viewing figures. Suspense is more exciting!

1.1.2 Case study corner

For a company or industry of your choice, formulate a possible quantitative business problem which could be analysed. In particular, think about the following.

- What is the specific business question to be addressed?

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- What are the business objectives of the analysis?
- What are the dependent and independent variables?
- Are there any challenges in collecting relevant data to analyse the problem?
- Are there any uncertainties involved with the business problem? If so, what are they?

Solution:

Formulating a problem suitable for quantitative analysis begins with posing a question. Suppose the company's question is: 'What price should we set for our new product?'

While we may have previously relied on gut instinct decisions, we now aim to approach this question using a more quantitative approach. To answer it, we must identify the factors which may influence the pricing decision. The challenge lies in the lack of knowledge regarding consumers' willingness to pay. However, we would likely have data on manufacturing costs and marketing expenses for our product (or at least reasonable estimates).

Market research could be conducted to examine the current market landscape and the pricing strategies adopted by competitors for similar products. Such research encompasses various approaches, each with its own set of assumptions and uncertainties. By analysing this market research, we could estimate what consumers might be willing to pay for a similar product and develop a pricing structure accordingly.

However, there are additional uncertainties that need to be considered. For instance:

- Will there still be demand for our product when it is launched?
- Will consumers have the financial means to purchase it at that time? (If there was a recession, consumers may reduce their discretionary spending.)
- Even if we price our product lower than our competitor(s), will consumers remain loyal to their familiar brand and refrain from purchasing our product?

To address these uncertainties, we could conduct surveys to collect data on brand loyalty, make predictions regarding consumers' future willingness to pay, and assume that demand for our product will be strong at launch. By gathering relevant data related to these uncertainties and incorporating logical assumptions, we can create data-driven models to predict the outcomes of our proposed pricing structures.

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