UNIVERSITY OF LONDON

Probability and Statistics: To p, or not to p?

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1.2 Decision making under uncertainty

To study, or not to study? To invest, or not to invest? To marry, or not to marry?

These, among others, are **decisions** many of us face during our lives. Of course, decisions have to be taken in the present, with **uncertain future outcomes**.

In the workplace, for example, making decisions is the most important job of any executive. However, it is also the toughest and riskiest job. Bad decisions can damage a business, a reputation and a career, sometimes irreparably. Good decisions can result in promotion, a strong reputation and making money!

Today we are living in the **age of technology**, with two important implications for everyone.

1. Technology has made it possible to **collect vast amounts of data** – the era of **'big data'**.

2. Technology has given many more people the power and responsibility to **analyse data** and **make decisions** on the basis of quantitative analysis.

A large amount of data already exists, and it will only increase further in the future. Many companies, rightly, are seeing **data-driven decision-making** as a source of competitive advantage. By using quantitative methods to uncover and extract the information in the data and then acting on this information – guided by quantitative analysis – they are able to gain advantages which their more qualitatively-oriented competitors are not able to gain.

Today, demand for people with quantitative skills far exceeds supply, creating a **'skills deficit'**. With demand set to increase further, and supply failing to keep pace with demand, then Economics 101 will tell you that the price increases whenever demand exceeds supply. Of course, the 'price' being referred to here is that of an employee, i.e. the salary which quantitative staff can command (already high) is set to rise even further.

Decision-making is a process when one is faced with a problem or decision having more than one possible outcome.

The possible results from the decision are a function of both **internal variables** (which we can control) and **external variables** (which we cannot control), each of which cannot be expressed with certainty. Hence the outcome cannot be known in advance with certainty.

When evaluating all decision-making, we start with structuring the problem.

Example

'What price should we charge for our new product?'

Determine the set of possible alternatives, for example:

- £1.00
- £2.00
- £3.00
- £4.00.

Determine the possible criteria which could be used to evaluate the alternatives:

- qualitative analysis
- quantitative analysis.

An example of a **qualitative analysis**:

- 'Well, last time we brought a new product to the market, we priced it at £2 and we sold out on the first day. This time let's price it higher.'

This is all very well, but how much 'higher'? How would we justify a specific increase of £x?

An example of a **quantitative analysis**:

- 'What do we know about current market demand?'
- 'What do we know about competitive market factors?'
- 'Where will we manufacture the new product and how much will it cost to bring it to the market?'
- 'How will we advertise and how much will the advertising cost?'
- ...

Note this is not an exhaustive list, but clearly market demand, competition, production costs and advertising expenditure (among other factors) are likely to be **relevant** to the price-setting problem.

For all decisions, we need to **determine the influencing factors** which could either be internal or external, such as:

- demand and competitive supply

- availability of labour and materials

- . . .

which are then used to derive **expected results** or *consequences*. Of course, determining *which* are the influencing factors, and their corresponding weights of influence, is not necessarily easy, but a thoughtful consideration of these is important due to their cumulative effect on the outcome.

In a *qualitative* analysis, once we have determined a preliminary list of the factors which we think will affect the possible outcomes of the decision:

- the management team 'qualitatively' evaluates how each factor could affect the decision

- this discussion leads to an assessment by the decision-maker

- the decision is made followed by implementation, if necessary.

For example, in a qualitative analysis we might describe the potential options in a **decision tree** (covered in week 6) in which we can include the concept of probable outcomes. We could make this assessment using the (qualitative) qualifiers of:

- 'optimistic'

- 'conservative'

- 'pessimistic'.

However, a qualitative approach inevitably is **susceptible to judgement and hence biases** on the part of the decision-makers. 'Gut instinct' *can* lead to good outcomes, but in the long run is far from optimal.

In a *quantitative* analysis, once we have determined a preliminary list of the factors which we think will affect the possible outcomes of the decision, we need to ask the following questions.

- What do we know?

- What data can we 'mine' which will help us understand the factors and the effect each will have on the possible outcomes?

In a quantitative analysis, the evaluation becomes a process of **using mathematics and statistical techniques**. These are used to find predictive relationships between the factors, the potential outcomes of the problem we are **seeking to understand** and the decision we are seeking to make.

Our objective becomes to define mathematically the relationships which might exist. Next, we evaluate the significance of the predictive value of the relationships found. An assessment of the relationships which our analysis defines leads us to be able to quantitatively express the expected results or consequences of the decision we are making.