3. Evaluation

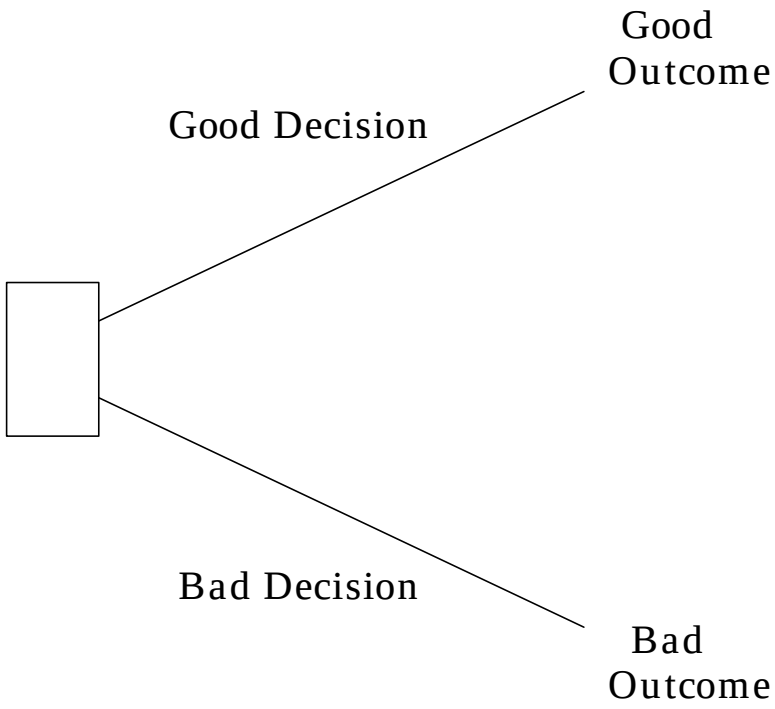
3.1 Making Difficult Decisions:

How many decisions with complete certainty have you ever made?

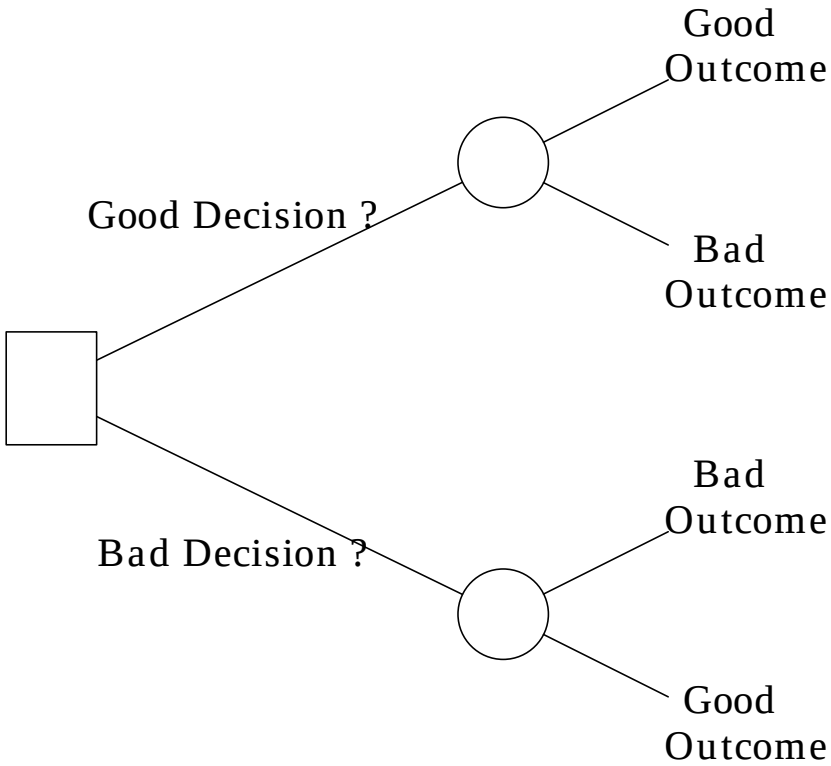
Does a good decision always guarantee a good outcome?

(Does Tiger Woods always win?)

Decisions with Certainty:



Decisions with Uncertainty:



□ implies a Decision Node

○ implies a Chance Node

A *decision*: an irrevocable allocation of resources.

Decision making under uncertainty

- Almost all decisions involve some level of uncertainty
- Some decisions are routine, others are not.
- Consequences may be large or insignificant.
- The most difficult decisions are infrequent and involve significant consequences.

3.2 A Simple Example:

You have the opportunity to win $100 if you correctly call the roll of a die as even or odd.

The opportunity is not costless — you must pay $35 for the opportunity.

You will call the die roll odd or even. There is only one chance to invest.

Would you accept this opportunity?

①

↑

Which Decision Quality principle applies?

How would you evaluate this opportunity?

Typical answers are:

- I can afford to lose $35
- I could really use $100
- I would toss a coin
- I need to ask my partner or spouse
- I don't gamble
- My internal rate of return is ...

Do you think $35 is a good deal for this opportunity?

Yes / No ?

How did you evaluate this opportunity?

Is this a good or bad decision?

If you were able to negotiate, what price would you pay for this opportunity?

We need to think logically about the decisions we make.

- Should I take this opportunity?
- What is a good decision?
- What would someone else do?
  e.g., my brother, etc.
- Can I afford to lose the $35?

①

- What do I think are my chances of a good outcome?

⑤

Decision trees help us structure decisions in a logical manner.

3.3 Using Decision Trees to Evaluate Decisions

Decision trees help us to think logically about decisions by showing the sequence between decisions and uncertainties.

Decision trees use two types of nodes:

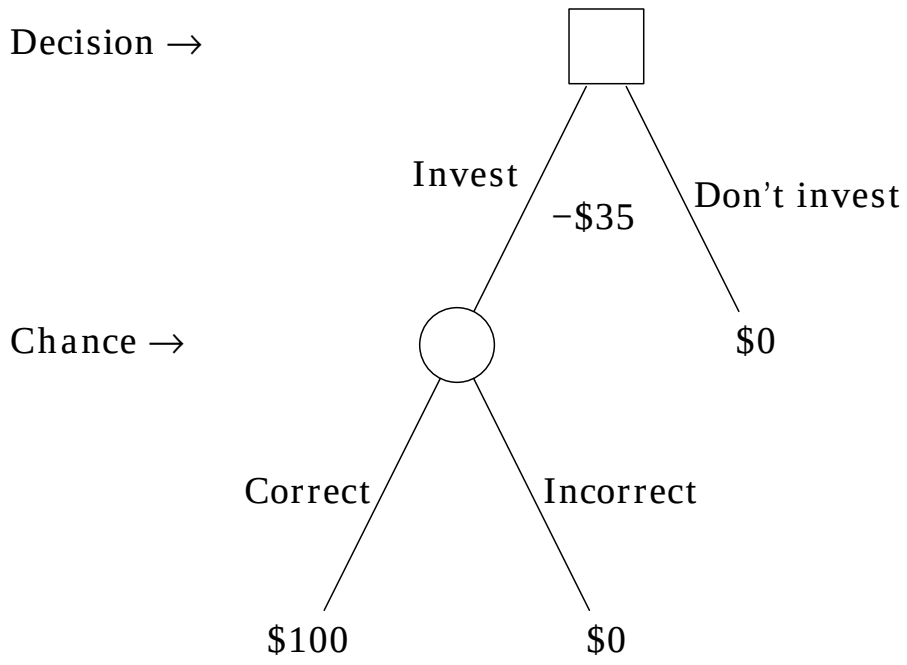
Decisions are represented by squares □ or rectangles.

Chance events (the uncertainty of which will be resolved before the payoff) are represented by circles ○.

The decision tree for this opportunity:

The decision is whether or not to invest $35 for the opportunity to receive $100 or $0 as the outcome on the call of a die roll as odd or even.

⑤



What else is needed to evaluate this opportunity?

①

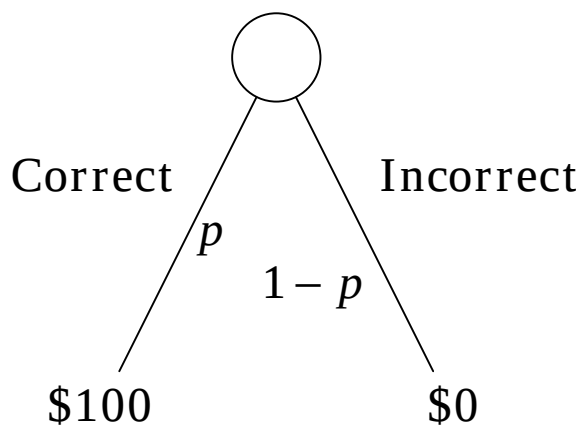
The tree is missing the probability assessments for a good and a bad outcome.

The tree does not yet incorporate the investor's judgement of the probability of success and its complement, the probability of failure or loss.

What information would help with this assessment?

③

- The number of sides on the die
- Any known bias the die might have
- Who gets to roll the die



Decision Trees

A decision tree is a flow diagram that shows the logical structure of a decision problem. It is a visual aid to lay out all the elements of a decision. It contains four elements:

- *Decision nodes*, □, which indicate all possible courses of action open to the decision maker;
- *Chance nodes*, ○, which show the intervening uncertain events and all their possible outcomes; i.e., Nature plays
- *Probabilities* for each possible outcome of a chance event; and
- *Payoffs*, which summarize the consequences of each possible combination of choice and chance.

Decision trees and Influence diagrams.

Trees structure the timing of the decisions and the revelation of the uncertainties.

Diagrams structure the influence: on decisions, on values, on uncertainties, as well as structuring the timing.

The two can be effectively identical, with good software (such as Treeage's DATA or Palisade's Precision Tree for Excel).

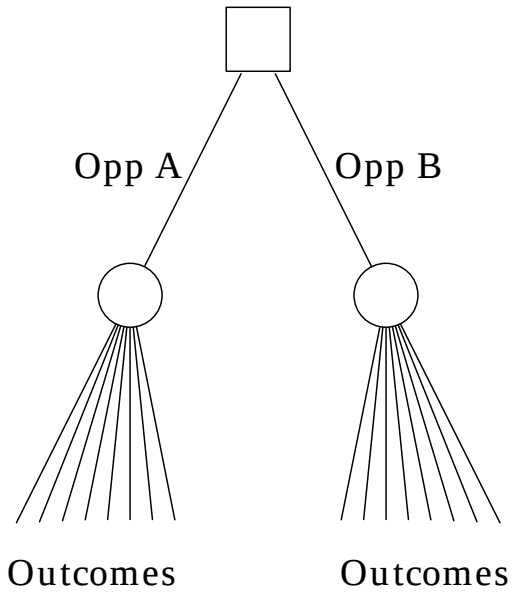
Decision analysis forces you to think carefully about:

- the true nature of the decision problem;
- the role of chance; and
- the nature of the sequential interaction of decisions and chance events.

3.4 Opportunities and Outcomes

An important distinction is that between **opportunities** and **outcomes**.

Opportunities are the sum of their possible outcomes. This is important because you can only choose your opportunities — not your outcomes.

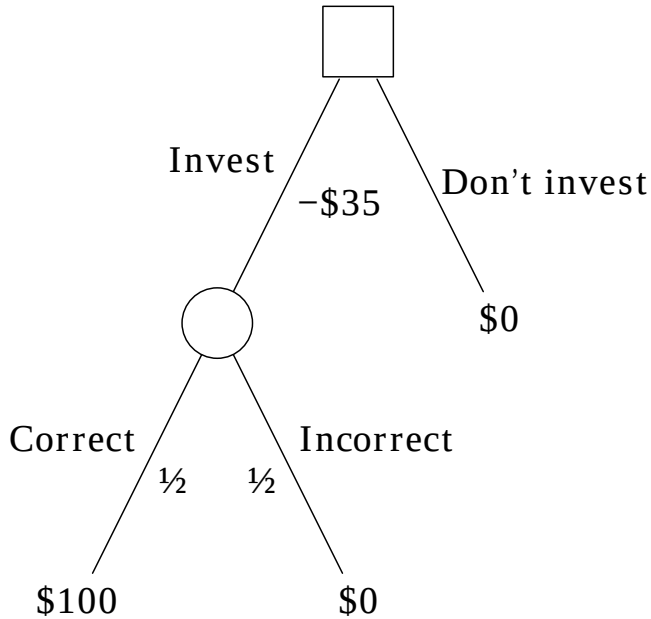


How do we evaluate the opportunity?

First, decide on the decision criterion. This can be any measure that allows the decision maker to evaluate deals in a quantitative manner.

Expected Monetary Value (EMV) provides the means to evaluate risky decisions consistently.

EMV is the probability-weighted average:



Probability		Outcome		
0.50	×	$100	=	$50
0.50	×	$0	=	$0
		EMV	=	$50
		Investment	=	−$35
		Expected Net Profit	=	$15

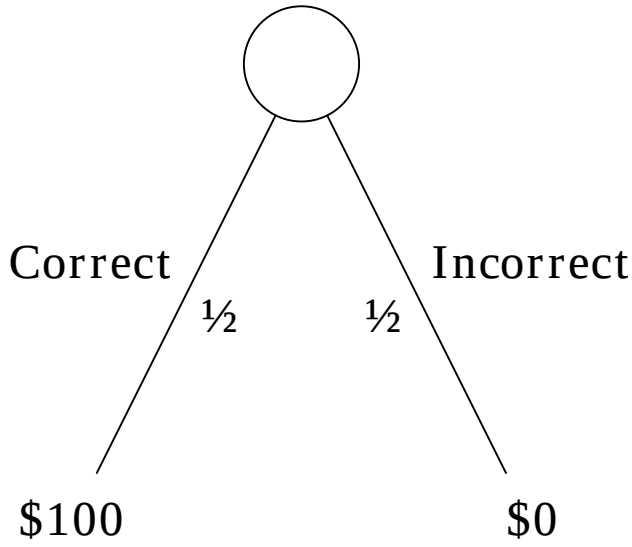
⑤

You have decided to take the opportunity.

You believe the probability of success of failure are equal, or 50/50.

You have paid the $35 investment.

Now what does the decision tree look like?



③ ④ ⑥

How has the opportunity changed?

Beware the sunk-cost fallacy.

Before deciding to pursue the investment, it is appropriate and important to include the costs to enter the deal.

But don't include what you've already paid to get into an investment: that decision has already been made and the resources allocated, usually irreversibly.

Let bygones be bygones.

Evaluate future decisions for what they are worth.

Your selling price and the value you place on the investment opportunity should not depend on sunk costs.

Accounting is not decision making.

Accounting and decision making are two different frameworks.

Accounting is concerned with making accurate assessments of things which *have already* occurred.

Decision making is concerned with making accurate assessments of things which *have not* yet occurred.

Both have their uses, but accounting is not a substitute for good decision making.

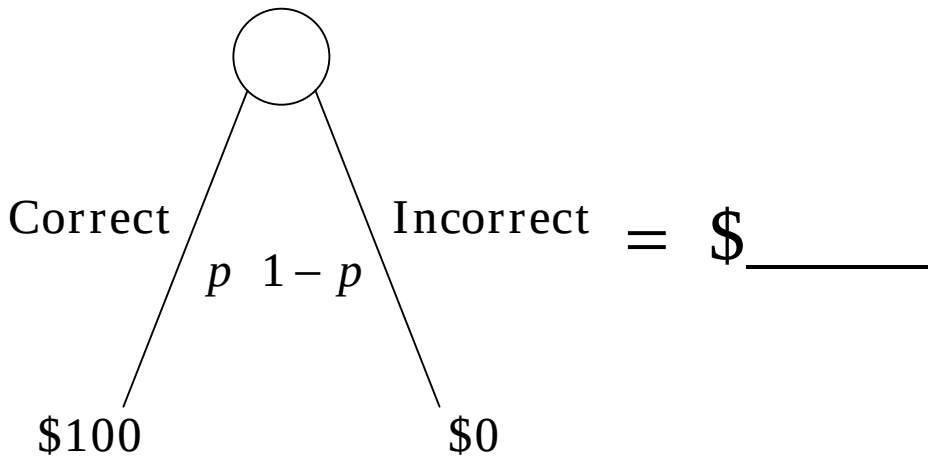
3.5 The Certain Equivalent

A better evaluation technique is the **Certain Equivalent**

The certain equivalent allows for inclusion of both *risk* and *time value* of money separately.

The certain equivalent of a deal is when the investor is indifferent between a deal with at least two opportunities and a guaranteed sum of money — also know as the investor's minimum selling price.

The Certain Equivalent of a lottery.

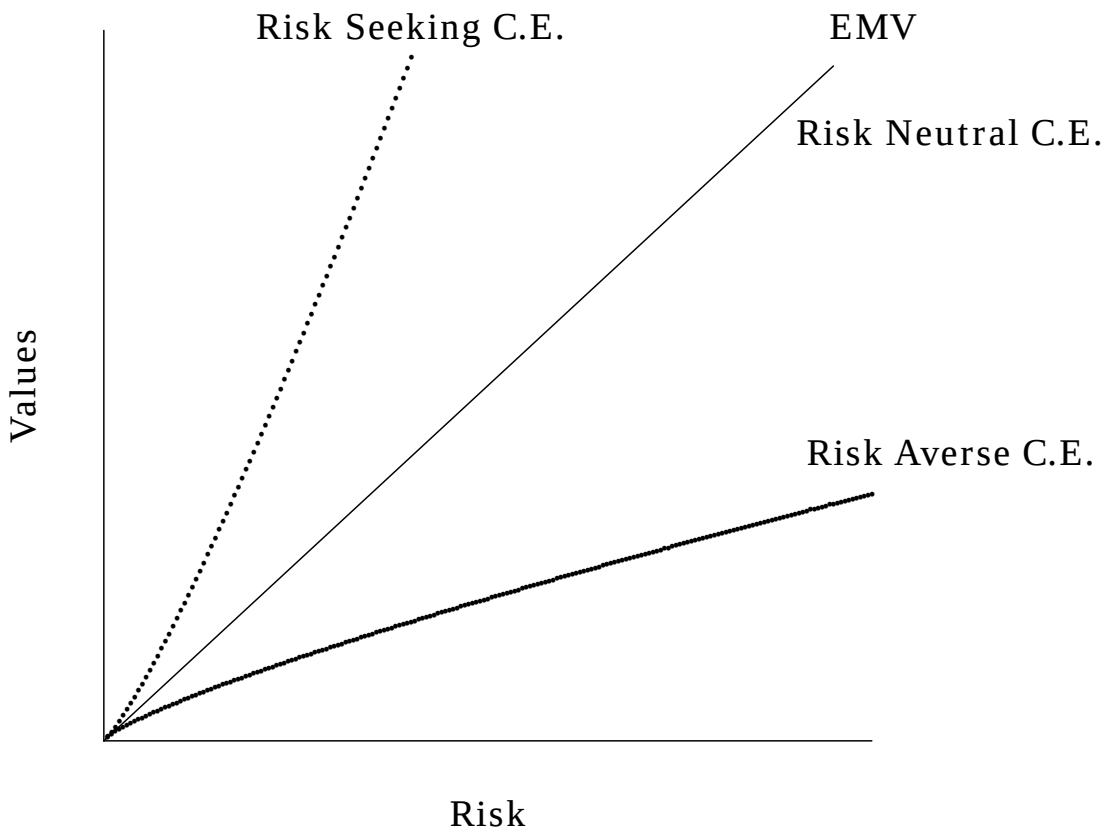


a deal or opportunity

its Certain Equivalent

3.6 What is Your Risk Attitude?

The difference between expected value (EMV) and the certain equivalent (C.E.) is your risk premium.



Risk profiles

If you would pay more than EMV for a deal, then you are *risk seeking*.

If you would pay up to the EMV for a deal, then you are *risk neutral*.

If you would not pay EMV for a deal, then you are *risk averse*.

The event is set …

The die has been rolled and the event is set.

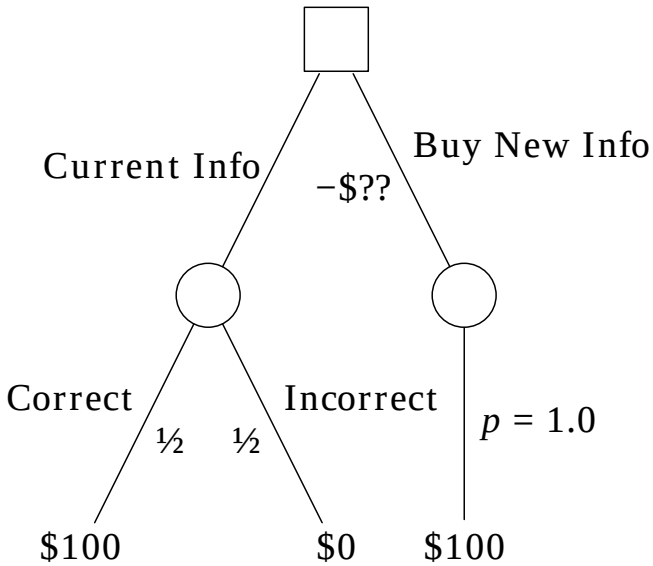
You don't know the outcome of the roll, so the outcome of the *opportunity* has not been determined.

What would it be worth to have perfect knowledge about the roll of the die?

What is the value of information?

3.7 The Value of Perfect Information

Using the concept of a clairvoyant, who knows all things past, present, and future, we can structure a new deal:



Consistency check:

Minimum selling price? _____

Value of perfect information? _____

Are these consistent?

Ask: What would I walk away with ($) in both cases?

Calculating the Value of Perfect Information:

Value of the deal with perfect information	$100
− Your minimum selling price (CE)	$____
= Value of perfect information (VPI)	$____

Calculating the Value of Perfect Information (VPI) is not difficult, but finding a clairvoyant, or *source* of perfect information, will be.

Use the VPI as a guideline for spending time, effort, and money on gathering new information before making a decision.

⑤

Sources of imperfect information:

While there are no real clairvoyants (alas), we can find new sources of information which is imperfect:

- Experiments
- Experts
- Models
- Trial runs
- Market tests
- Forecasts
- Markets for risk

We must distinguish between good decisions and good outcomes.

- *Decisions* are what we can affect.
- A good decision balances the probabilities of good and bad outcomes in accordance with our risk attitudes.
- *Outcomes* are what we get.
- A good outcome is one we like.

3.8 Summary of Evaluation

A decision is an irrevocable allocation of resources.

Probabilities, representing expert judgement, are based on experience, beliefs, knowledge, and data.

The value of a deal depends on the decision maker's risk attitude.

The maximum value of gathering more information can be determined before obtaining the actual information, in this framework.

4. Probability

4.1 What is Probability?

There are two distinct views of probability — *frequentist* and *Bayesian* (or subjective).

A frequentist views probability as an empirical set of data defined by the number of times (the frequency) that something has happened. This viewpoint works so long as we have a sufficient amount of data.

The Bayesian (or subjective) view of probability is a state of knowledge based upon one's experience, beliefs, knowledge and data. This provides a means of assessing situations where something has either never occurred or is a rare event.

Subjective Probabilities

Subjective probabilities are statements of:

how likely you believe an event will occur

What is your probability that:

1. The BHP Billiton share price will be AU $15.00 or more at the end of the year?
2. You will die in a car accident before you turn 65?
3. The AUD will be above US 70¢ by the end of 2003?
4. You can name 30 or more of the 50 state capitals of the USA?
5. You can name the English monarchs since 1066 in order?

Subjective probability: an expression of your state of knowledge, based on your beliefs, knowledge, data, and experience.

We all form subjective probabilities of events all the time (driving, playing, working, at home).

The distinction between objective and subjective probability:

Probabilities obtained from a large data set are usually considered to be *objective*.

- Cancer risk factors
- Lightening strikes
- Tossing a coin

Probabilities obtained from experts, based on their knowledge, experience, beliefs, and data, are considered *subjective*. Most decisions require subjective probabilities.

- Market acceptance of a new product.
- Probability of the Swans reaching next season's Grand Final.

Why are probabilistic statements so important?

Everyday language is imprecise and often ambiguous.

- We *might* win next season
- It *could* rain tonight

Probability is the only way to state our degree of certainty about future events correctly.

- There is an 80% chance of rain tonight [Canberra]

Example: Weather forecasts

- The *value of weather forecasts* varies from company to company and from person to person.
- depends upon the company's or person's *abilities to take actions* in response to forecasts to reduce losses or to increase profits.
- e.g., a local department store will have to decide when to phase out their summer fashion range and highlight the winter range.
- Sometimes choosing when to act is done by custom or convention, sometimes by watching rival stores.
- But it can also be decided using decision analysis.

Q: If accurate weather forecasts were available for a price, *what should the store pay for these forecasts*?

A: No more than the higher profits it could earn by taking advantage of the information.

Other Uncertainties Facing Managers

Apart from the weather, in their "games against Nature" managers are concerned about such uncertainties as:

- the future demand for a particular product
- the cost and reliability of untried technology
- the levels of future interest rates
- the levels of future exchange rates
- employees' reactions to change
- the value of Amazon.com shares at the open of trading next year.

None of these is a simple "High" versus "Low" type: you can't simply say that the future demand for a product, say, will be High or Low.

Rather than trying to identify all possible levels, you can determine thresholds, or points at which the prudent decision changes from one action to another, using *sensitivity analysis*.

Moral: There are no payoffs for spending more time and money to obtain more information than you really need.

Using probabilistic statements of uncertainty

Consider the following four sentences:

It could happen _____

It might happen _____

I think it will happen _____

I'm sure it will happen _____

On each line to the right of the sentence, write down your assessment of the likelihood of happening. Write down a *single number*, the midpoint of your range.

Take-away?

4.2 An Example of Subjective Probability.

You are shown a dictionary containing over 1,400 pages of information.

What is the probability that the first new word on page 1025 begins with the letter Q? (This experiment can be run only once.)

Write your probability here _____.

States of knowledge

Subjective (Bayesian) probabilities rely upon expert knowledge which is always changing as new information becomes available. So probabilities should also change as new information becomes available.

Helpful hints:

- Q is the seventeenth letter of the English alphabet
- Page 1025 is in the last third of the dictionary
- You have knowledge that some letters — such as the letters Z, X, and Y — begin fewer words than do others.

Does this information change your probability?

If so, what is it now _____?

Is your probability assessment correct?

5. Assessing Uncertainty

5.1 Finding the Right Experts:

An expert is like an onion.

You can peel away layers of information, with each new layer revealing more depth and breadth of information about the event.

When there is no further information, a *true* expert tells you, and does not continue commenting.

5.2 Assessing Uncertainty:

Probability provides a language to communicate, in an unambiguous manner, one's beliefs about future events.

We need the ability to elicit subjective assessments from experts.

One device for doing so is the Probability Wheel.

The “10−50−90” distribution:

When we assess an expert, we want to obtain at least three points in order to adequately describe the curve or distribution.

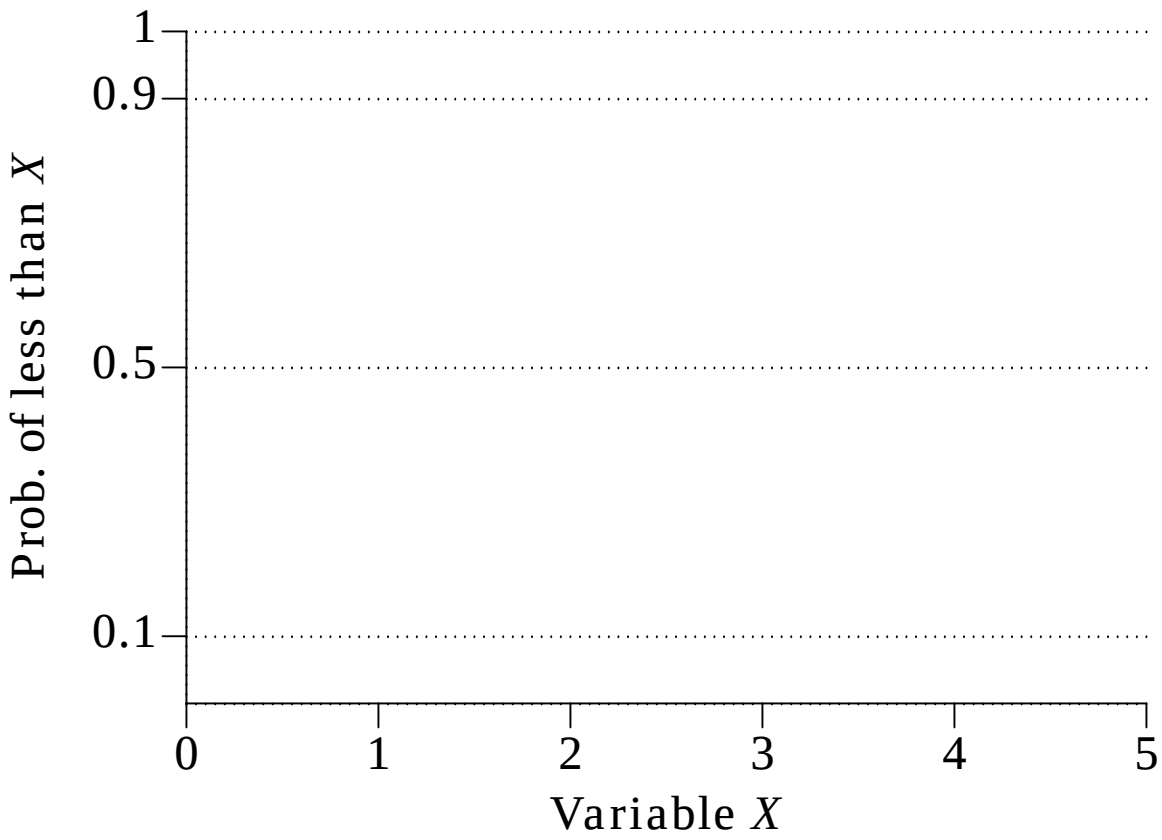
We do this by gathering a “10−50−90”.

The 10 point is a 1-in-10 chance that the assessed value could be that low or lower.

The 50 point is where the expert is indifferent: the event could equally be above or below the 50 point.

The 90 point is a 1-in-10 chance that the assessed value could be that high or higher.

Plotting the distribution.



Getting a “10−50−90” distribution:

One can assess the “10−50−90” distributions either directly or indirectly.

A direct method would be simply to ask the expert for the three values.

An indirect method is to use the probability wheel or some other method (such as coloured balls in the box).

Either way, there is a six-step process:

1. Motivate
2. Structure (definition, measure)
3. Condition (counter cognitive biases)
4. Encode (use Probability Wheel, plot, review discrepancies)
5. Verify (does the expert believe the assessment?)
6. Make discrete (for a small number of alternatives)

5.3 Summary of Probability Assessment

Probability statements are the only way to adequately describe uncertainty.

Obtaining subjective (Bayesian) probability assessments is not difficult if you follow the six-step process.

It is very important to minimise any biases before encoding probabilities.

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