

Behavioural models

Cognitive biases

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Judgement under uncertainty

- Humans are not necessarily very good at estimating under uncertainty.
- We tend to have cognitive biases that lead us astray from the true probabilities and outcomes.
- In the coming slides we will look at a few of the models that attempt to explain some discrepancies between what the true quantities are, and what humans tend to estimate.

ANCHORING

Anchoring

- Attaching or “anchoring” our thoughts onto reference points that may have no logical relevance to the decision at hand.
- The share price of a stock XYZ drops 50%. Anchoring occurs when we believe the stock to be undervalued and cheap – we anchor our judgement on the price of the stock in the past (the true cause of the drop may be due to massive drop in sales etc.).
- Estimating the percentage of countries in Africa that belong to the United Nations: Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. Science (New Series), 185, 1124-1131.

Anchoring

- Estimating the percentage of countries in Africa that belong to the United Nations: Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science (New Series)*, 185, 1124-1131.
 - In the subject's presence, a wheel was spun that had values 0 to 100. The wheel was spun, and the subject was first asked whether the percentage was higher or lower. Then the subject was asked to adjust the estimate by moving the value higher or lower.
 - Different groups were given different initial numbers on the wheel.
 - The median estimate of those who received a 10 on the wheel was 25, and for those who received 65 the median estimate was 45.

Anchoring

- Initial assumptions or even random values may have a detrimental effect on both the estimate of probability and on consequence.
- Be careful during a risk analysis that you are not anchoring, consult a “devil’s-advocate” to wipe out some traditional benchmarks.

CONFIRMATION AND HINDSIGHT BIAS

Confirmation bias

- People tend to look for information that confirms their preconceived opinion.
- They ignore or find rationalisations to why other opinions are wrong.
- If you believe that there is a low chance of somebody breaking into your building and stealing a workstation, then you look for evidence that this is the case:
 - Look at the locks, the key-codes, the elevation of the building, etc.
 - However, you disregard the fact that a person who works for you could take the computer.
- Consult a contrarian!

Hindsight bias

- After the fact, e.g. after a stock crash, many people say that the signs were obvious and it should have been evident that the crash was imminent.
- Assuming that it is easy to detect that something is wrong while it is happening blinds you from future events.
- Assuming during the risk analysis that: *we will know this before it happens, so no need to prepare* – will place you in a very vulnerable position.

GAMBLER'S FALLACY

Gambler's fallacy

- Some people lack an understanding of basic probabilities.
- If I flip a coin 20 times and each time the coin turns up heads, then what is the probability that the next flip will be tails?
 - Some people like to believe that this probability is close to 99.99%, however it is still 50% (given a fair coin).
 - Each flip is an independent event, thus one flip does not affect the next.
- Roulette tables often show the result of the last 20 spins, as a courtesy. It was shown that people tend to flock to tables where the past 20 spins have been predominantly one colour, expecting the next spin to be a different colour.

Gambler's fallacy

- From a risk analysis perspective it is important to understand where probability estimates are coming from.
 - Do you believe that past events affect future events?
 - Will the same event reoccur?
- Base your decisions on fundamental understanding of the problem.

HERDING

Herding

- People tend to exhibit herd behaviour, copying the actions of others in a large group, regardless if the actions are rational or not.
- However, individually most people would not take these actions.
 - Reason 1: social pressure, want to fit in and be accepted.
 - Reason 2: rationalising the action by assuming that a large group cannot be wrong.

Herding

- Herding can result in devastating consequences:
 - Dotcom bubble
 - Financial crash –sub-prime mortgages
- Avoid herding behaviour by:
 - Not using “everybody is doing it” as a reason to do something.
 - Figure out what actions make sense in your case, and work out the consequences of making the wrong actions – i.e. don’t let the herd do your job.

OVERCONFIDENCE & OVERREACTION

Overconfidence & Overreaction

- Being confident is important – being overconfident is detrimental.
 - Confidence is important, being realistic about what you can achieve and knowing your limitation.
 - Overconfidence implies that you are ignoring some of your weaknesses and not looking at the world realistically.
- When an overconfident person makes a mistake they tend to find external reasons for the mistake – learning nothing.
- When a confident person makes a mistake they figure out what went wrong, and try to improve - learning a lot.

Overreaction

- People tend to put more weight on events that just happened:
 - Seeing a car crash on the road that you take to work everyday makes you drive slower on the road the next couple of weeks – even though you haven't seen a crash on this road the past 20 years.
- While it is certainly important to respond to new threats, we sometimes give too much attention to recent events.
- Threats that have existed for years are still very common: SQL injections, stack overflows, etc.

PROSPECT THEORY

Prospect theory

- We are used to risk = probability * consequence ($r = pc$)
- Assume that I change c from 1000 to 2000, what is the change in risk?
 - $\Delta r = 2000p - 1000p = 1000p$
- What if I changed it from 2000 to 3000?
 - $\Delta r = 3000p - 2000p = 1000p$
- It's linear – but does it have to be?

Prospect theory

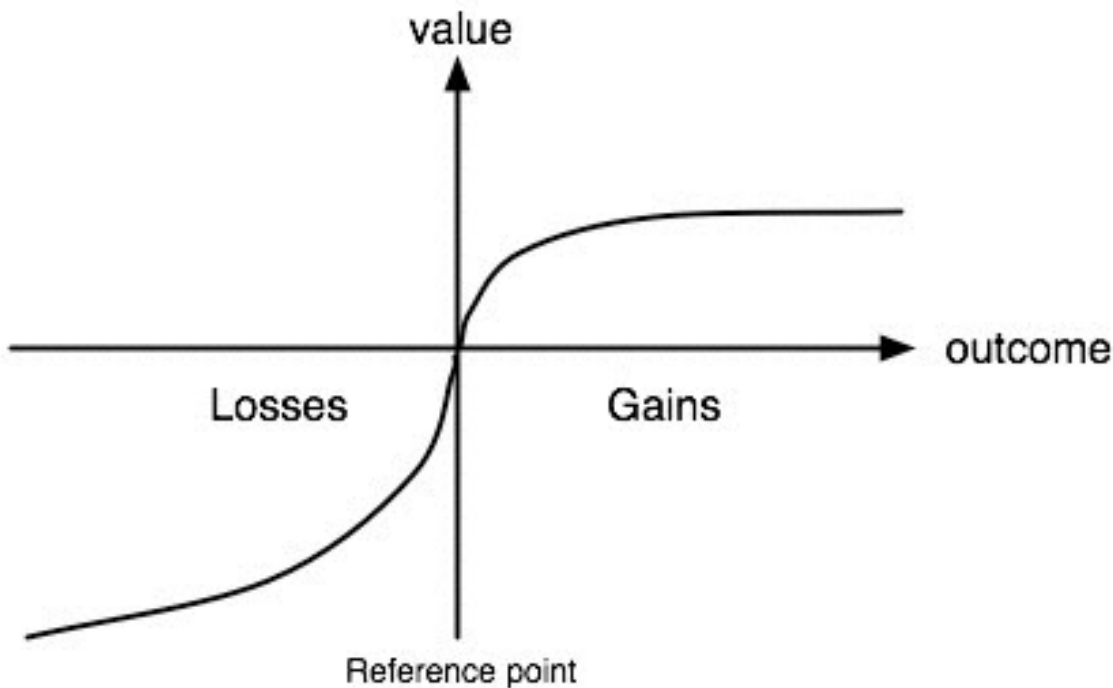
- Kahneman and Tversky suggest that this is not how people think about changes to consequence and probability.
- Instead $r = \pi(p)v(c)$
- p and c are transformed via the functions π and v before being multiplied.
- (Note - Prospect theory was developed to deal with utility, i.e. the value of decisions, not risks, but the equations are the same).

Prospect theory

- If I have \$0 and find \$50 on the ground, and then I drop the \$50, then prospect theory suggests that people do not react in a zero sum emotional way, but rather actually feel disappointed.
- Person A has \$1000 and person B has \$10, if A and B both find \$50 then A feels less joy than B.
- If person B has \$0 and loses \$1000 then B is disappointed, but if B already owed \$1 000 000 then the added loss of \$1000 would not add very much to B's disappointment.

Prospect theory

- This leads to a *utility curve* that is not a straight line, but is asymmetrical.



$$v(\$50) = 20$$

$$v(-\$50) = -40$$

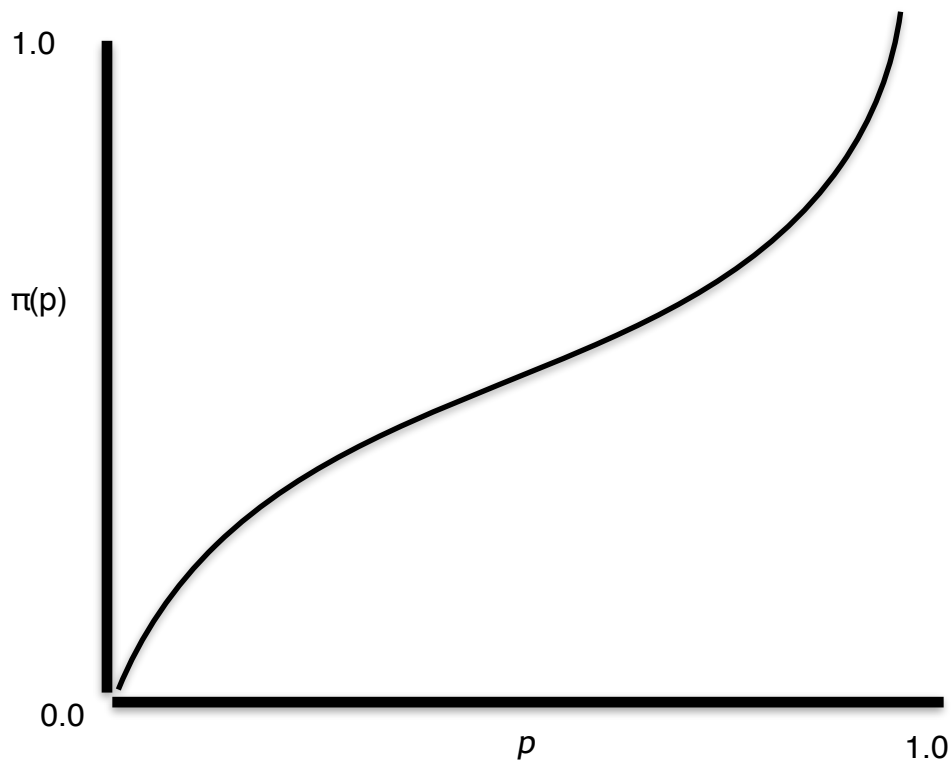
$$v(\$50) + v(-\$50) = -20$$

Prospect theory

- The challenge is trying to separate what others are telling you that the consequence is for a certain event, and what you are responsible for protecting:
 - If 10 human health records are leaked, then the consequence is high.
 - If 10 000 human health records have already leaked, then the added consequence of another 10 is insignificant.
- Well, maybe for the customer, but are you protecting the health records or the customers utility?

Prospect theory

- What about $\pi(p)$?
 - Turns out that people do not completely understand small and large probabilities.



Prospect theory

- Other phenomena are also consequential:
 - If I offer you \$1000 with 99% probability or \$500 with 100%, which will you take?
 - If I offer you \$1000 with 50% probability or \$500 with 51%, which will you take?
 - How do you value 1% of probability mass?
- Probability of dying in an airplane crash is 1 in 19.8 million (flying with a top rated airline).
 - But not if you ask me! - I will say that it's closer to 1 in 4.
 - Complete distortion of probabilities are not uncommon.

Behavioural models - Summary

- Be careful when estimating probability and consequence
- Be mindful of the common mistakes that we make, and the biases that we may be under.
- Consult people that do not agree with you.
- **Do your job!** - Don't rely on benchmarks or "common knowledge", instead find out the reasons for something happening and estimate probabilities with a better understanding of the system.
- Keep in mind that consequences are in most cases not linear, and remind yourself what you are trying to protect.



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