Using New Information to Update the Probabilities

- The **prior probabilities** of the possible states of nature often are quite subjective in nature. They may only be rough estimates.
  - However, a complete removal of uncertainly, although desirable:
    - is not possible in the real-world;
    - can not be done in a reasonable time frame;
    - cannot be done at a reasonable cost.
- It is frequently possible to do additional testing or surveying (at some expense) to improve these estimates.
- The improved estimates obtained from sample information are called **posterior probabilities**.

Credibility Matrix

- Consider J possible states of nature ($\theta_1, \theta_2, \dots, \theta_J$) and we know the prior probabilities of the states of nature θ_j, $P(\theta_j)$.

- Imagine that we have access to additional information (a survey or experience) that gives K possible results ($R_1, R_2, \dots R_k$). The credibility of this information can be calculated and hence we know the probability of a certain result given the state of nature that has occurred.

- These probabilities are organized in a table called Credibility Matrix.

Credibility Matrix	States of nature			
Results	θ_1	θ_2	...	θ_J
R_1	$P(R_1 \mid \theta_1)$	$P(R_1 \mid \theta_2)$	...	$P(R_1 \mid \theta_J)$
R_2	$P(R_2 \mid \theta_1)$	$P(R_2 \mid \theta_2)$	...	$P(R_2 \mid \theta_J)$
...	...	...	...	...
R_k	$P(R_k \mid \theta_1)$	$P(R_K \mid \theta_2)$	...	$P(R_K \mid \theta_J)$
$\sum_k P(R_k \mid \theta_j)$	1	1	...	1

Posterior probability

- However, we intend to calculate the probability of a particular state of nature θ_j, given the result R_k of a certain experience, i.e.

$P(\theta_j | R_k)$ – posterior probability

- In the credibility matrix we have $P(R_k | \theta_j)$
- The Bayes Theorem enables to obtain the desired probabilities: $$\boxed{P(\theta_j | R_k) = \frac{P(\theta_j, R_k)}{P(R_k)} = \frac{P(R_k | \theta_j) \times P(\theta_j)}{\sum_j (P(R_k | \theta_j) \times P(\theta_j))}}$$
- The states of nature are mutually exclusive: $1 = P(\theta_1 \vee \theta_2 \vee \cdots \vee \theta_J) = P(\theta_1) + P(\theta_2) + \ldots + P(\theta_J)$
- So, to calculate $P(R_k)$,

$$P(R_k) = P(R_k, (\theta_1 \vee \theta_2 \vee \cdots \vee \theta_J)) = P((R_k, \theta_1) \vee (R_k, \theta_2) \vee \ldots (R_k, \theta_J)) =$$
$$= P(R_k, \theta_1) + P(R_k, \theta_2) + \ldots + P(R_k, \theta_J) =$$
$$= P(R_k | \theta_1) \times P(\theta_1) + \cdots + P(R_k | \theta_J) \times P(\theta_J)$$

An example

Suppose that you regularly visit www.weather.com and hence you can build a credibility matrix to assess the quality of the provided forecasts:

Credibility matrix	**States of nature**	
Results	θ_1	θ_2
R_1	$P(R_1 \mid \theta_1)$	$P(R_1 \mid \theta_2)$
R_2	$P(R_2 \mid \theta_1)$	$P(R_2 \mid \theta_2)$
$P(\theta_j)$	**0.1**	**0.9**

Credibility matrix	**States of nature**	
Results	**It rains**	**It does not rain**
Rain forecast	0,7	0,4
No rain forecast	0,3	0,6
	Σp=1	**Σp=1**

We know the prior probabilities for each state of nature, $P(\theta_j)$.

We also know the probability of each result (forecast) given the state of nature that has occurred (credibility matrix), or $P(R_k \mid \theta_j)$.

<u>We want to calculate</u>:

The probability of a particular state of nature (it rains or it does not rain), given the forecast provided by www.weather.com, or:

Posterior probabilities: $P(\theta_j \mid R_k)$

Posterior probabilities

Credibility matrix

Results	States of nature Θ_1 (It rains)	Θ_2 (It does not rain)
R_1 (Rain forecast)	0,7	0,4
R_2 (No rain forecast)	0,3	0,6
$P(\Theta_j)$	0.1	0.9

Bayes Theorem:

$$P(\theta_j \mid R_k) = \frac{P(\theta_j, R_k)}{P(R_k)} = \frac{P(R_k \mid \theta_j) \times P(\theta_j)}{\sum_j (P(R_k \mid \theta_j) \times P(\theta_j))}$$

P(Rains|Rain forecast) = $P(\theta_1 \mid R_1) = \frac{P(R_1 \mid \theta_1) \times P(\theta_1)}{P(R_1 \mid \theta_1) \times P(\theta_1) + P(R_1 \mid \theta_2) \times P(\theta_2)} = \frac{0.7 \times 0.1}{0.7 \times 0.1 + 0.4 \times 0.9} = \frac{0.07}{0.43} = 0.162$

P(No Rain|Rain forecast) = $P(\theta_2 \mid R_1) = \frac{P(R_1 \mid \theta_2) \times P(\theta_2)}{P(R_1 \mid \theta_1) \times P(\theta_1) + P(R_1 \mid \theta_2) \times P(\theta_2)} = \frac{0.4 \times 0.9}{0.7 \times 0.1 + 0.4 \times 0.9} = \frac{0.36}{0.43} = 0.837$

P(Rains|No rain forecast) = $P(\theta_1 \mid R_2) = \frac{P(R_2 \mid \theta_1) \times P(\theta_1)}{P(R_2 \mid \theta_1) \times P(\theta_1) + P(R_2 \mid \theta_2) \times P(\theta_2)} = \frac{0.3 \times 0.1}{0.3 \times 0.1 + 0.6 \times 0.9} = \frac{0.03}{0.57} = 0.052$

P(No Rain|No Rain forecast)= $P(\theta_2 \mid R_2) = \frac{P(R_2 \mid \theta_2) \times P(\theta_2)}{P(R_2 \mid \theta_1) \times P(\theta_1) + P(R_2 \mid \theta_2) \times P(\theta_2)} = \frac{0.6 \times 0.9}{0.3 \times 0.1 + 0.6 \times 0.9} = \frac{0.54}{0.57} = 0.947$

Posterior probabilities

Now that we know the posterior probabilities (improved estimates for the states of nature), we update the expected value of our decision taking into account the sample infomation:

For each decision alternative, multiply each payoff by the corresponding posterior probability and sum these products. Choose the alternative with maximum expected value.

Posterior probabilities

Resultados	States of nature: It rains	States of nature: It does not rain
Rain forecast	0.162	0.837
No rain forecast	0.052	0.947

Decision with sample information

Alternatives	States of nature: It rains	States of nature: It does not rain	E.V.
Umbrella	15	10	**10.8**
No umbrella	0	18	**17.0**

EV(umbrella) = 15x0.162+10x0.837=10.8

EV(no umbrella)= 0x0.052+18x0.947=17.0

Maximum expected value of the decision <u>with</u> sample information

The EV of the sample information (EVSI) = EV with sample information – EV without sample information.

In our example VESI = 17.0 – 16.2 = 0.8

Efficiency of sample information

Decision with risk

Alternatives	States of nature: It rains	It does not rain	E.V.
Umbrella	15	10	10.5
No umbrella	0	18	16.2
Prior probabilities	p=0.1	p=0.9	

Decision with perfect information

Alternatives	States of nature: It rains	It does not rain	E.V.
max(a_i,θ_j)	15	18	17.7
Prior probabilities	p=0.1	p=0.9	

Decision with sample information

Alternatives	States of nature: It rains	It does not rain	E.V.
Umbrella	15	10	10.8
No umbrella	0	18	17.0

$$\text{Eficciency} = \frac{\text{expected value of sample infomation}}{\text{expected value of perfect infomation}}$$

$$= \frac{EVSI}{EVPI} = \frac{17.0 - 16.2}{17.7 - 16.2} = \frac{0.8}{1.5} = 53\%$$

Low efficiency values may suggest thar the decision maker should look for new information sources.

High efficiency values indicate that the sample information is almost equivalent to perfect information and, probably, using new information sources will not add significant value.

Sequential decisions-Decision trees

Decision Trees are often used to structure complex decision processes, eventually sequential, and to identify the strategy (sequence of actions) that maximizes the expected value.

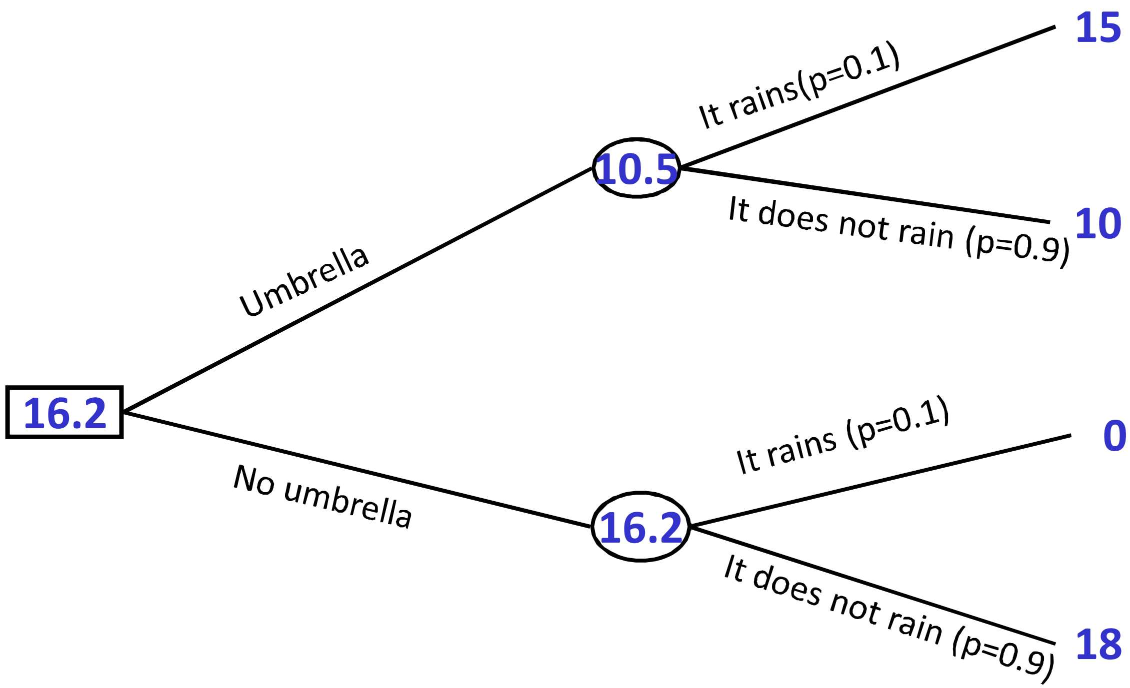
Decision trees include:

- Decision events: controlled by decisors
- Random events: determined by external factors (not controlled)

A decision tree consists of nodes and branches.

- A decision node, represented by a *square*, indicates a decision to be made. The branches represent the possible decisions.
- An event node, represented by a *circle*, indicates a random event. The branches represent the possible outcomes of the random event.

Decision trees

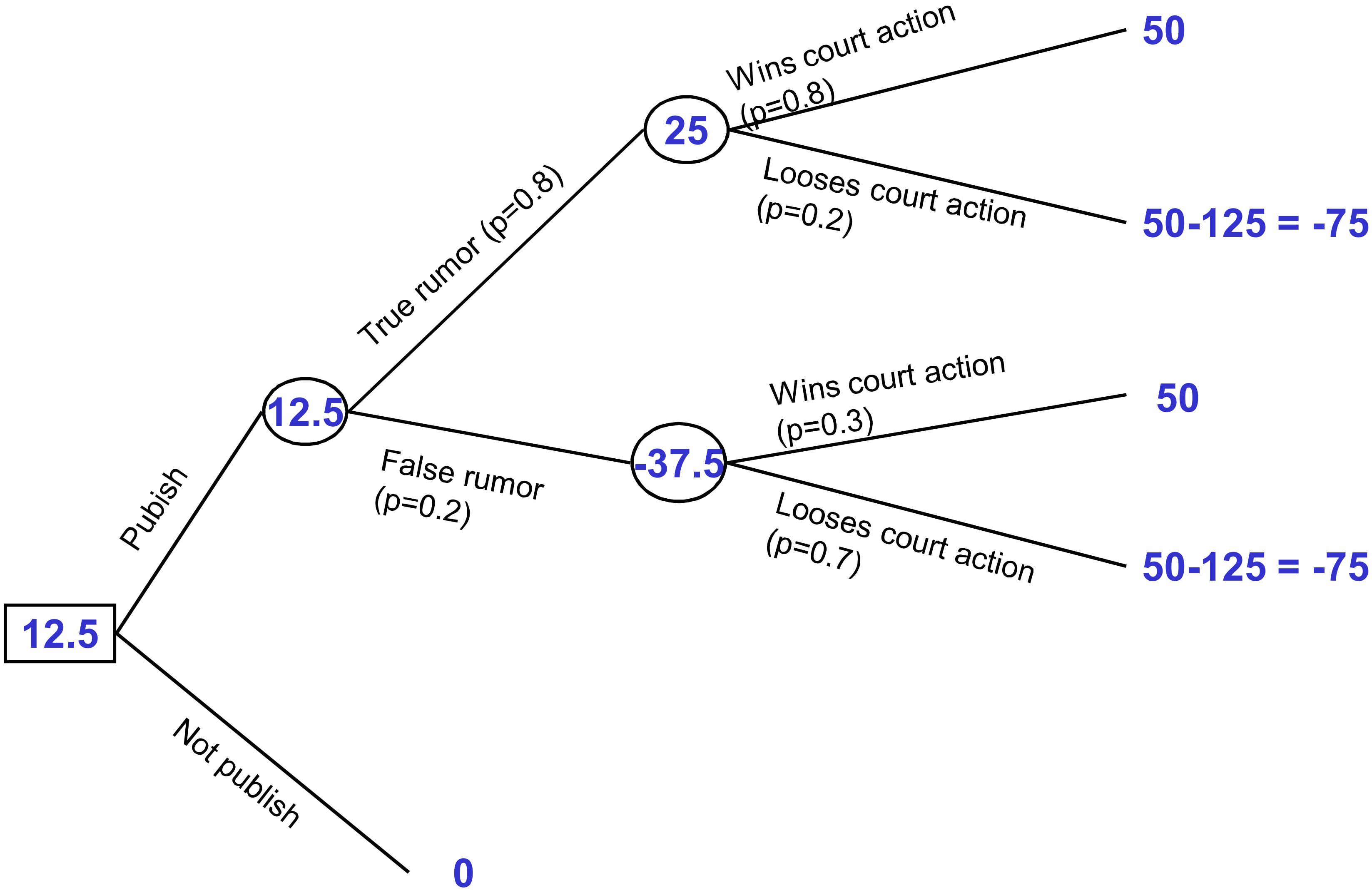


The decision that maximizes the expected utility is not bringing the umbrella, with an expected value of 16.2

Exercise - A tabloid newspaper (a)

- A tabloid newspaper is specialized in publishing embarrassing details of the private lives of eminent citizens. The editors are aware of a scandalous rumor about a prominent politician and they are considering to publish this rumor.
- They are going to decide whether or not to publish on the basis of their expected net income. They know that if they publish the rumor they will certainly be taken to court by the politician.
- If the rumor is true, they have a 0.8 chance of winning the court action which, as a consequence, means their legal fees cost them nothing (since they have to be paid by the politician). However, if they loose, they will incur costs of €125.000 (including any compensation they will have to pay the politician).
- If the rumor is false, they have a 0.3 chance of winning the court action but, if they loose they will incur, again, in costs of €125.000.
- They also believe that regardless of whether they win or lose the court action, and regardless of whether the rumor is true or false, if they publish the rumor, they will make €50.000 profit from sales of the magazine.
- They also estimate that there is a 0.8 chance that the rumor is true and a 0.2 chance that it is false.

Build a decision tree for this problem and find the decision that maximizes the expected value of profit.



The decision that maximizes the expected value of profit is to publish the rumor, EV= €12 500

Exercise- A tabloid newspaper (b)

Suppose they can hire an infallible private investigator (PI) to discover, before they decide whether or not to publish, if the rumor is true or false. What is the maximum amount that they should be willing to pay the (PI)? (i.e., what is the expected value of perfect information?)

Profit (thousand euros)	True rumor (p = 0.8)	False rumor (p = 0.2)
Publish	€ 25	€ -37.5
Not publish	€ 0	€ 0
Maximum profit	**€ 25**	**€ 0**

The expected value with perfect information is 25 * 0.8 + 0 * 0.2 = 20000.
The PI information has increased the expected profit from €12500 to €20000.
Hence, the expected value of perfect information is the difference between the expected profit with perfect information and the expected profit with risk.

VEIP = € 20 000 – € 12 500 = € 7 500

This is the maximum value the newspaper is willing to pay the infallible PI.

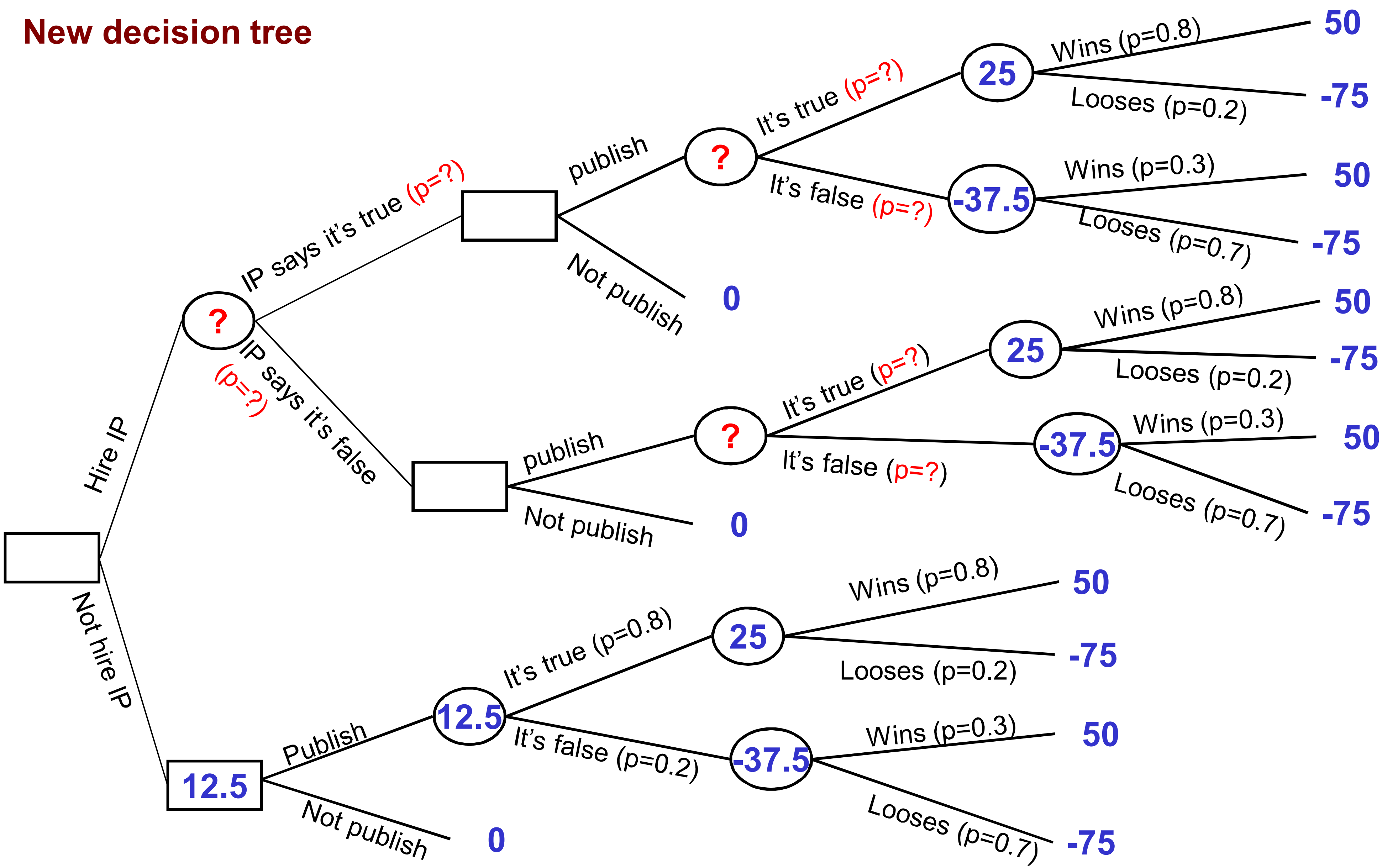
Exercise- A tabloid newspaper (c)

- Suppose the PI is not infallible and sometimes he does make mistakes. From his record you know that when a rumor is actually true there is a 0.8 chance that the PI will say it is true and a 0.2 chance he will tell you it is false.
- When the rumor is actually false, there is a 0.7 chance that he will tell you this and a 0.3 chance he will tell you it is true.
- What is the maximum amount you should be prepared to pay the PI? (i.e., what is the expected value of sample information?).

PI credibility matrix

Results r_k	States of nature	
	True rumor (V) P(V)=0.8	False rumor (F) P(F)=0.2
PI says the rumor is true (IPV)	P(IPV/V) = 0.8	P(IPV/F) = 0.3
PI says the rumor is false (IPF)	P(IPF/V) = 0.2	P(IPF/F) = 0.7

New decision tree



IP credibility matrix

Results r_k	States of nature: True rumor (V) P(V)=0.8	False rumor (F) P(F)=0.2
IP says it's true (IPV)	P(IPV/V) = 0.8	P(IPV/F) = 0.3
IP says it's false (IPF)	P(IPF/V) = 0.2	P(IPF/F) = 0.7

P(IPV) = P(IPV ∧ (V ∨ F) = P(IPV ∧ V) + P(IPV ∧ F) = P(IPV/V) * P(V) + P(IPV/F)*P(F)
= 0.8 * 0.8 + 0.3 * 0.2 = 0.7

P(IPF) = 0.3

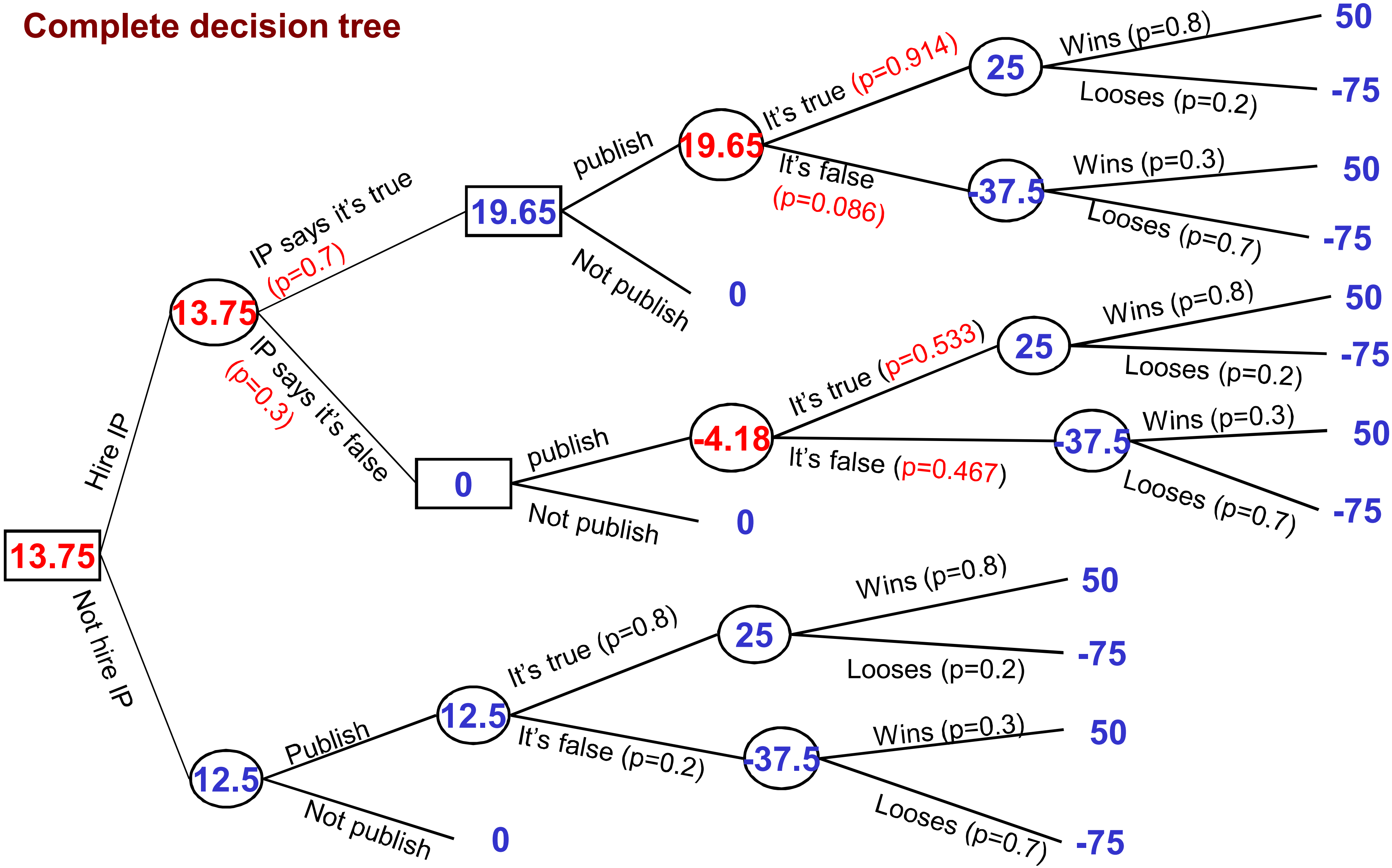
$$P(V/IPV) = \frac{P(V \wedge IPV)}{P(IPV)} = \frac{P(IPV/V) \times P(V)}{P(IPV)} = \frac{0.8 \times 0.8}{0.7} = 0.914$$

$$P(F/IPV) = 1 - 0.914 = 0.086$$

$$P(V/IPF) = \frac{P(V \wedge IPF)}{P(IPF)} = \frac{P(IPF/V) \times P(V)}{P(IPF)} = \frac{0.2 \times 0.8}{0.3} = 0.533$$

$$P(F/IPF) = 1 - 0.533 = 0.467$$

Complete decision tree



The maximum amount the editors should be prepared to pay the IP is the expected value of sample information:

EVSI = €13 750 – €12 500 = €1250

The efficiency of sample information is:

$$\text{Efficiency} = \frac{\text{Expected value of sample information}}{\text{Expected value of perfect information}} = \frac{1250}{7500} = 0.16$$

Using Utilities to better reflect the values of payoffs

- In the Maximum Expected Value decision rule we have assumed that the expected payoff expressed in *monetary terms* is the appropriate measure.
- In many situations, this is inappropriate.
- Suppose an individual is offered the following choice:
  - Accept a 50-50 chance of winning € 100,000.
  - Receive € 40,000 with certainty.
- Many would pick € 40,000, even though the expected payoff on the 50-50 chance of winning € 100,000 is € 50,000. This is because of **risk aversion**.
- A Utility Function for money is a way of transforming monetary values to an appropriate scale that reflects a decision maker's preferences (e.g., aversion to risk).

Utility Functions

- When a *utility function for money* is incorporated into a decision analysis approach, it must be constructed to fit the current preferences and values of the decision maker.

- **Fundamental Property:** Under the assumptions of utility theory, the decision maker's *utility function for money* has the property that the decision maker is *indifferent* between two alternatives if the two alternatives have the *same expected utility*.

- When the decision maker's utility function for money is used, *maximum expected value decision rule* replaces monetary payoffs by the corresponding utilities.
- The optimal decision (or series of decisions) is the one that *maximizes the expected utility*.

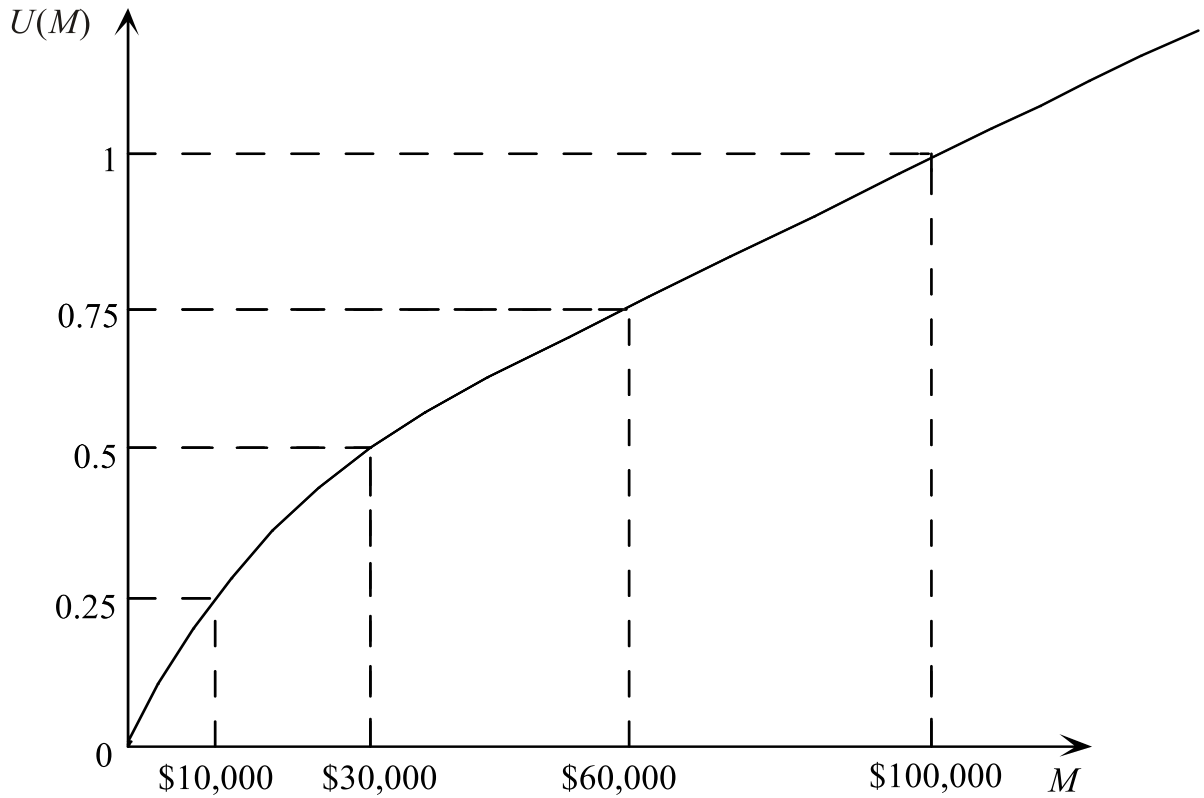
Illustration of Fundamental Property

- By the fundamental property, a decision maker with the utility function below-right will be indifferent between *each* of the three pairs of alternatives below-left.

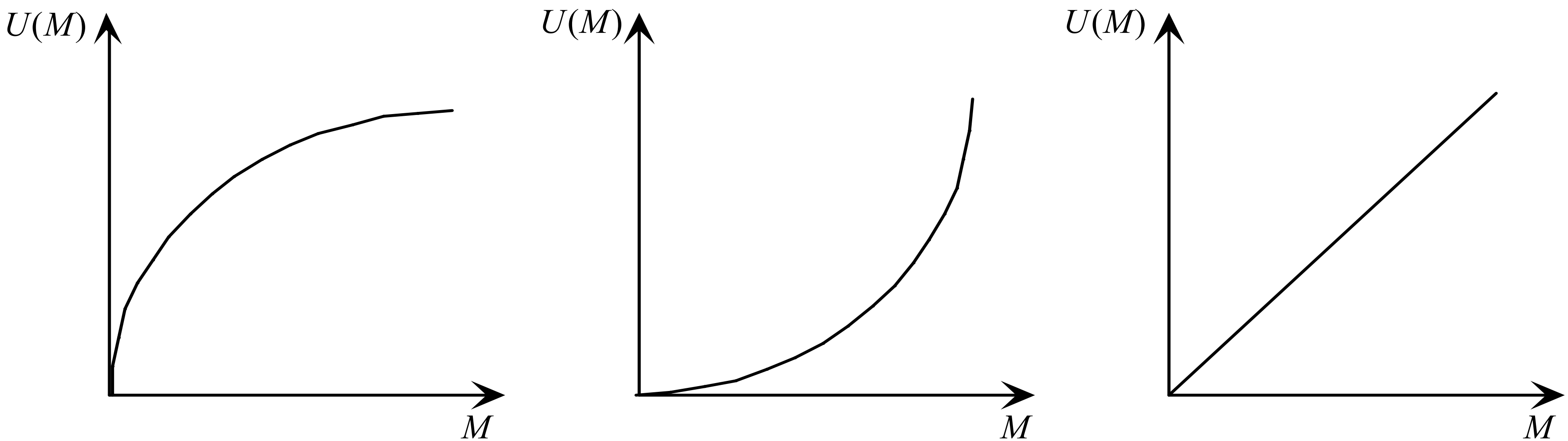
- 25% chance of € 100,000
  or € 10,000 for sure
- Both have E(Utility) = 0.25.

- 50% chance of € 100,000
  or € 30,000 for sure
- Both have E(Utility) = 0.5.

- 75% chance of € 100,000
  or € 60,000 for sure
- Both have E(Utility) = 0.75.



Shape of Utility Functions



(*a*) Risk averse (*b*) Risk seeker (*c*) Risk neutral

The Lottery Procedure

1. We are given three possible monetary payoffs: M_1, M_2, M_3 ($M_1 < M_2 < M_3$).
   The utility is known for two of them, and we wish to find the utility for the third.
2. The decision maker is offered the following two alternatives:

   a) Obtain a payoff of M_3 with probability p.
      Obtain a payoff of M_1 with probability $(1–p)$.
   b) Definitely obtain a payoff of M_2.

3. What value of p makes you *indifferent* between the two alternatives?
4. Using this value of p, write the *fundamental property equation*,
   E(utility for *a*) = E(utility for *b*)
   so
   $p\, U(M_3) + (1–p)\, U(M_1) = U(M_2)$.
5. Solve this equation for the unknown utility.

Procedure for Constructing a Utility Function

1. List all the possible monetary payoffs for the problem, including 0.
2. Set $U(0) = 0$ and then arbitrarily choose a utility value for one other payoff.
3. Choose three of the payoffs where the utility is known for two of them.
4. Apply the lottery procedure to find the utility for the third payoff.
5. Repeat steps 3 and 4 for as many other payoffs with unknown utilities as desired.
6. Plot the utilities found on a graph of the utility $U(M)$ versus the payoff M. Draw a smooth curve through these points to obtain the utility function.

Generating the Utility Function for João

- The possible monetary payoffs in a given investment are:

  –130, –100, 0, 60, 90, 670, and 700 (all in €).

- Set $U(0) = 0$.
- Arbitrarily set $U(-130) = -150$.

Finding $U(700)$

- The known utilities are $U(-130) = -150$ and $U(0) = 0$.
  The unknown utility is $U(700)$.
- Consider the following two alternatives:
  a) Obtain a payoff of 700 with probability p.
     Obtain a payoff of –130 with probability $(1-p)$.
  b) Definitely obtain a payoff of 0.
- What value of p makes you indifferent between these two alternatives?
  João chooses $p = 0.2$.
- By the fundamental property of utility functions, the expected utilities of the two alternatives must be equal, so

$$pU(700) + (1-p)U(-130) = U(0)$$
$$0.2U(700) + 0.8(-150) = 0$$
$$0.2U(700) - 120 = 0$$
$$0.2U(700) = 120$$
$$U(700) = 600$$

Finding $U(-100)$

- The known utilities are $U(-130) = -150$ and $U(0) = 0$.
  The unknown utility is $U(-100)$.
- Consider the following two alternatives:
  a) Obtain a payoff of 0 with probability p.
     Obtain a payoff of –130 with probability $(1-p)$.
  b) Definitely obtain a payoff of –100.
- What value of p makes you indifferent between these two alternatives?
  João chooses $p = 0.3$.
- By the fundamental property of utility functions, the expected utilities of the two alternatives must be equal, so

$$pU(0) + (1-p)U(-130) = U(-100)$$
$$0.3(0) + 0.7(-150) = U(-100)$$
$$U(-100) = -105$$

Finding $U(90)$

- The known utilities are $U(700) = 600$ and $U(0) = 0$.
  The unknown utility is $U(90)$.
- Consider the following two alternatives:
  a) Obtain a payoff of 700 with probability p.
     Obtain a payoff of 0 with probability $(1-p)$.
  b) Definitely obtain a payoff of 90.

- What value of p makes you indifferent between these two alternatives?
  João chooses $p = 0.15$.

- By the fundamental property of utility functions, the expected utilities of the two alternatives must be equal, so

$$pU(700) + (1-p)U(0) = U(90)$$
$$0.15(600) + 0.85(0) = U(90)$$
$$U(90) = 90$$

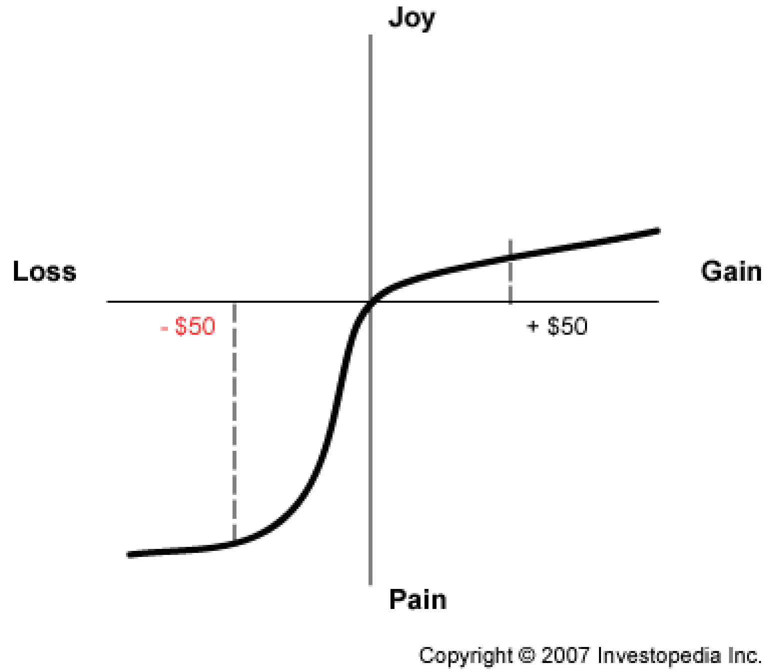
Prospect Theory

Kahneman and Tversky

We overvalue loss. We tend to overweight risk when faced with possible loss of a perceived gain. That is, when we are afraid of losing what we have gained, we are prone to type 1 errors (believing a risk is greater than it really is).

We also undervalue risk when faced with certain loss. We are willing to risk losing more in small hopes of recouping losses. That is, when faced with certain loss, we are prone to type 2 errors (believing a risk to be less than it really is).

The distorted perception of risk probability has been quantified experimentally by Kahneman and Tyversky.



Fourfold Patter for Risk Aversion or Risk Seeking

	Significant Gains	**Significant Losses**
High Probability	**Risk Averse** (under-weigh potential benefit) Fear of dissapointment Take unfavorable settlement Refuse preventative care Science Denialism?	**Risk Seeking** (under-weigh potential harm) Desperate to recoup loss Reject favorable settlement Continue gambling Seek risky pseudoscience
Low Probability	**Risk Seeking** (over-weigh potential benefit) Hope for large gain Reject favorable settlement Start gambling Supplements, acupuncture, Chiropractic?	**Risk Averse** (over-weigh potential harm) Fear of large loss Take unfavorable settlement Buy insurance Unwarranted diagnostic testing

Loss Aversion and the Endowment Effect

Two behavioral economics principles

1. The endowment effect

   "Ownership creates satisfaction"

2. Loss aversion

   "People are more motivated by avoiding a loss than acquiring a similar gain"

• Kahneman and Tversky's "Prospect Theory" describes how people evaluate gains and losses; it includes concepts such as status quo bias, loss aversion, and the endowment effect

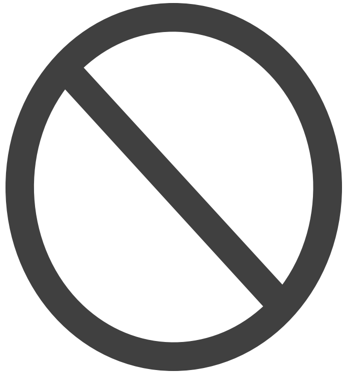
The endowment effect

- People value a thing more once it becomes theirs
- Ownership increases utility
- Term originated by Richard Thaler (U. of Chicago)

Thaler, R. (University of Chicago), 1980, Toward a positive theory of consumer choice. *Journal of Economic Behavior and Organization*, March, 39-60.

Students in every other seat were given university mugs. Then reported how much they would be willing to sell the mug for.

Students who did not get a mug reported the price they would be willing to pay to get one.



What happened?

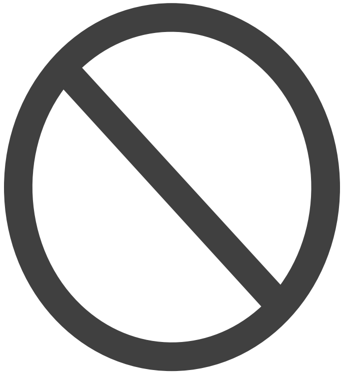
a) The students with mugs priced them higher.
b) The students with no mugs priced them higher.
c) Both sets of students priced them about the same

Students with the mugs were willing to sell them, on average, for

$4.50

Students with no mugs were willing to buy them, on average, for

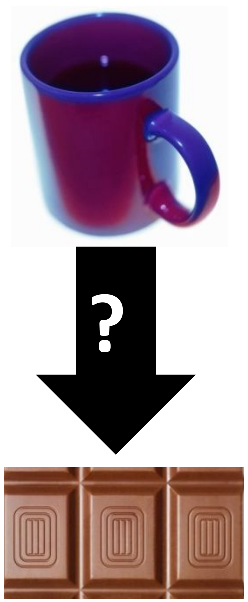
$2.25



•Kahneman, D. (UC Berkley), Knetsch, J. (Simon Fraser U), Thaler, R. (Cornell), 1990, Experimental tests of the endowment effect and the Coase theorem. *Journal of Political Economy, 98*(6), 1325-1348.

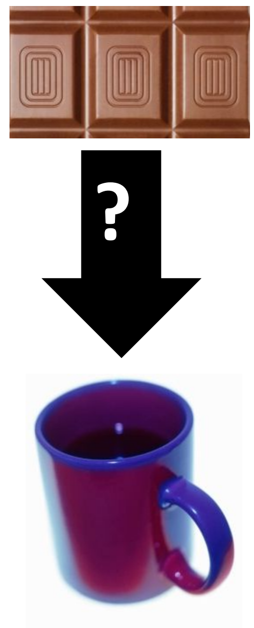
Class A

At the beginning, students given a coffee mug. At the end, given option to trade for a bar of Swiss chocolate.



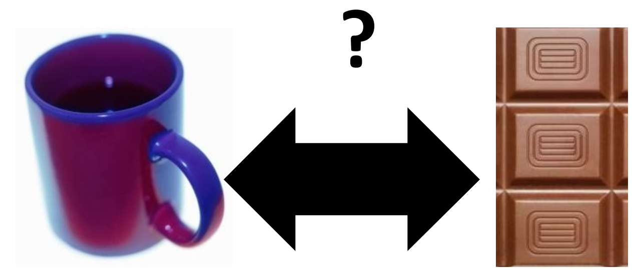
Class B

Students given a chocolate bar. At the end, given option to trade for a coffee mug.



Class C

At the beginning, offered a choice between a chocolate bar or coffee mug.

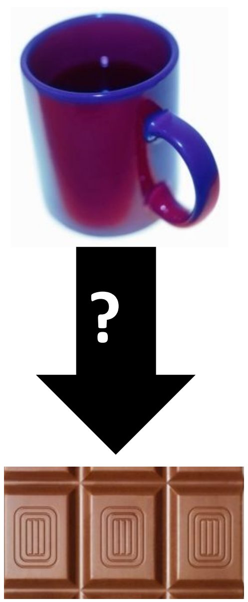


Which class was most likely to choose the coffee mug?

Class A

89%

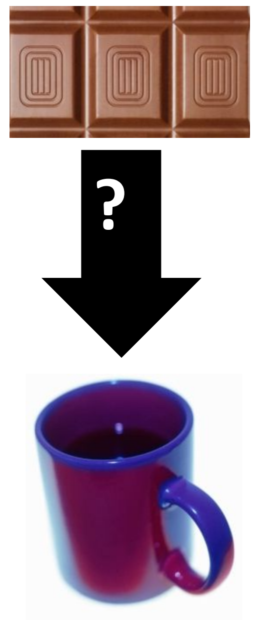
chose coffee mug



Class B

10%

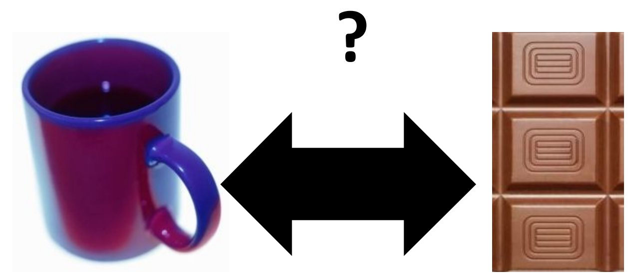
chose coffee mug



Class C

59%

chose coffee mug



33 chimpanzees given frozen-juice popsicle or tube of peanut butter (both familiar items) and then an opportunity to trade.

When initially given peanut butter

89%

Chose peanut butter

When initially given popsicle

42%

Chose peanut butter

Students in a non-credit photography class at Harvard picked two photos to develop and then chose one to keep.

Group 1

"pick your favorite, … you won't be able to change your mind."

Group 2

"If you change your mind within four days, you can swap it. I'll call at the end to double-check."

Gilbert, D. (Harvard) & Ebert, J. (MIT), 2002, Decisions and revisions: The affective forecasting of changeable outcomes. *Journal of Personality and Social Psychology, 82*, 503-514

Both before and two days after their choice, participants asked how much they liked their photograph from 1 (*not at all)* to 9 *(very much)*

<u>Group 1</u>

"pick your favorite, … you won't be able to change your mind."

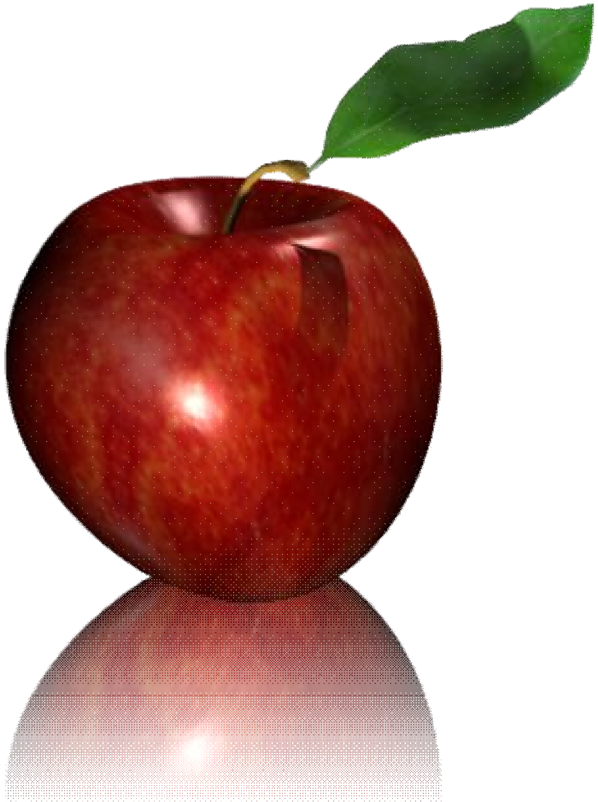
+1.3

<u>Group 2</u>

"If you change your mind within four days, you can swap it. I'll call at the end to double-check."

-1.8

Gilbert, D. (Harvard) & Ebert, J. (MIT), 2002, Decisions and revisions: The affective forecasting of changeable outcomes. *Journal of Personality and Social Psychology, 82*, 503-514



"The ratio of fructose to cellulose is an objective and unchanging property of apples, of course, but the experience of sweetness is a subjective property that increases when *an apple becomes my apple*"

Loss aversion and endowment effect

Once I own something, not having it becomes more painful, because it is a loss.

If I don't yet own it, then acquiring it is less important, because it is a gain.

People are more motivated to avoid a loss than to acquire a similar gain.

Loss aversion and framing

If the same choice is framed as a loss, rather than as a gain, different decisions will be made.

Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people.

Choose a program to address the problem.

A: 200 people will be saved

B: 1/3 chance that 600 people will be saved. 2/3 chance that no people will be saved.

Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people.

Choose a program to address the problem.

- 72% A: 200 people will be saved
- 28% B: 1/3 chance that 600 people will be saved. 2/3 chance that no people will be saved.

Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people.

Choose a program to address the problem.

A: 400 people will die.

B: 1/3 chance that nobody will die. 2/3 chance that 600 people will die.

Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people.

Choose a program to address the problem.

22% A: 400 people will die.

78% B: 1/3 chance that nobody will die. 2/3 chance that 600 people will die.

Only the framing changed

600 people expected to die…

1/3 chance that nobody will die. 2/3 chance that 600 people will die.

=

600 people expected to die…

1/3 chance that 600 people will be saved. 2/3 chance that no people will be saved.

78% ≠ **28%**

We will take great risks to avoid a loss.

Reframing the same option as a loss changes the choices.

Using prospect theory to pursue your goals

1. Make it a habit (status quo bias)

Goal pursuit becomes the status quo

"Creating a good habit requires much conscious effort, but once the groove has been produced the acts which make up a habitual pattern are not consciously willed."

2. Own it (endowment effect)

Ownership creates satisfaction (endowment effect). By completely identifying yourself with a future goal, you become more attached to it

3. Fear its loss (loss aversion)

By "owning" a future goal, immediate temptations which put that future at risk can be framed as a potential loss.

Which of these concepts of utility is more useful?

Two persons get their monthly report from a broker:

A is told that her wealth went from 4M to 3M

B is told that her wealth went from 1M to 1.1M

“Who of the two individuals has more reason to be satisfied with her financial situation?”

“Who is happier today?”

- This example highlights the contrasting interpretations of utility in theories that define outcomes as states or as changes.
- In Bernoulli’s analysis only the first of the two questions is relevant, and only long term consequences matter.
- Prospect theory, in contrast, is concerned with short-term outcomes, and the value function presumably reflects an anticipation of the valence and intensity of the emotions that will be experienced at moments of transition from one state to another.