- Introduction

- Decision making under certainty
  - Preference relations
  - Revealed preference

- Decision making under uncertainty
  - Acts, states and outcomes
  - Dominance
  - MaxiMin
  - LexiMin

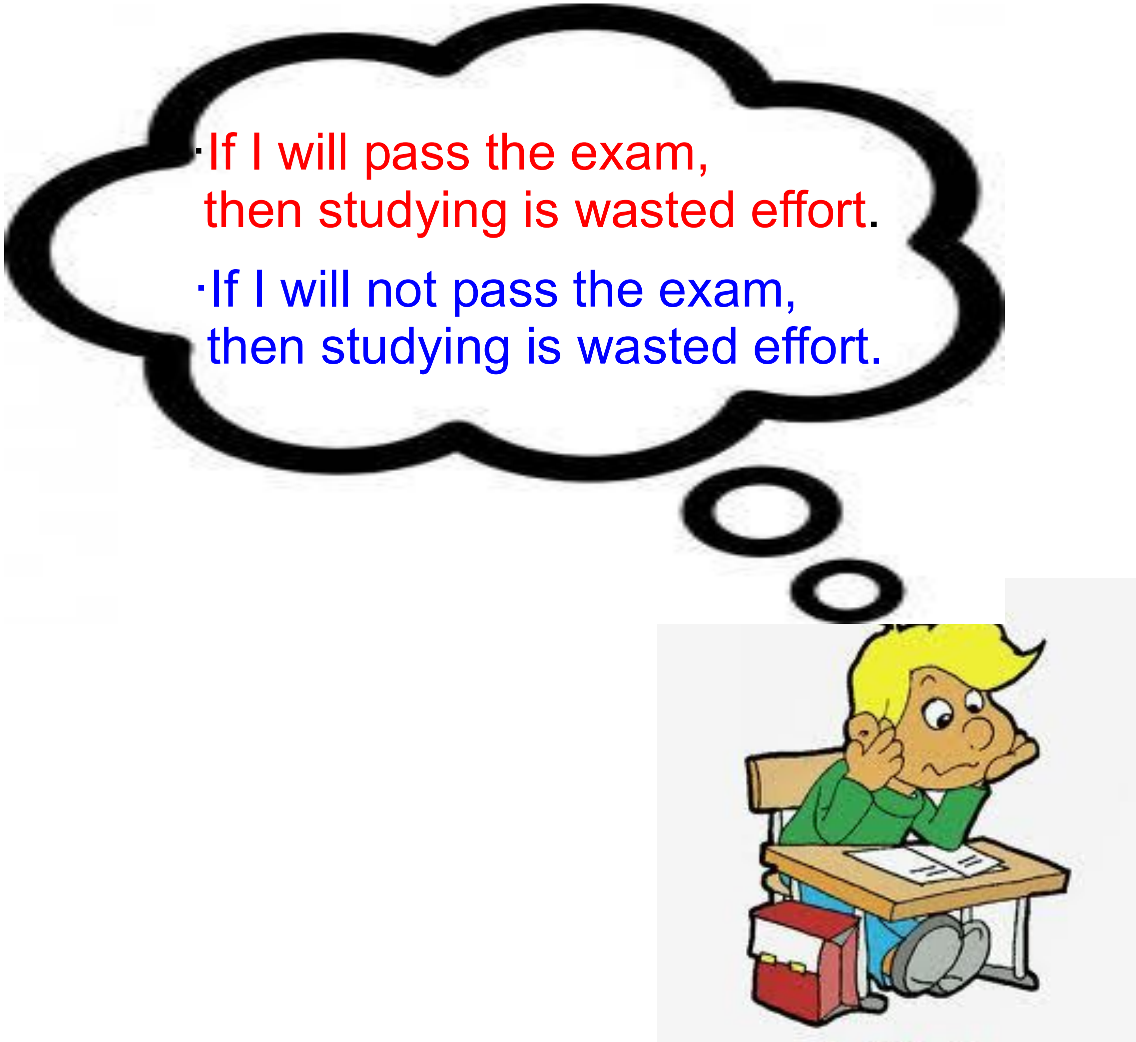
- Money lotteries and attitudes to risk

RATIONAL DECISION MAKING

The psychologist Keith Stanovich defines rationality as the

capacity to make decisions that help you achieve your objectives

1. How to think about choices



Since, whatever will happen, studying is wasted effort,
it is better for me **not** to study.

possible states

possible choices	Pass	Not pass
Study	second best 2	worst 0
Not study	best 3	third best 1

utilities

	Pass	Not pass
Study	2	
not study		1

possible states

possible choices or acts		Exam is long and difficult	Exam short and easy
	Study	B	A
	Not study	F	C

If you only care about the grade

Study <u>strictly dominates</u> Not Study

2. What does ‘Rationality’ mean?

Harold Egbert Camping, president of Family Radio 1958-2011, predicted that the Rapture (the taking up into heaven of God’s elect people) would take place on May 21, 2011 at 6pm.

Some followers of Camping gave up their jobs, sold their homes and spent large sums promoting Camping’s claims.

Did these people act irrationally?

Bob smokes two packets of cigarettes a day. When asked if he would still smoke if he knew that he was going to get lung cancer from smoking, he says "No". When asked if he is worried about getting lung cancer, he says that he is not and explains that his grandfather was a heavy smoker all his life and died at the age of 98. He also explains that he read an article stating that smoking causes lung cancer only if one has a genetic predisposition to it.

state → act ↓	0% s_1 : genetically predisposed	100% s_2 : no genetic predisposition
smoke	get cancer enjoy smoking 2	no cancer enjoy smoking 4
not smoke	no cancer no enjoyment 3	no cancer no enjoyment 3

3. Framing

I will give you $200:  

and then you will have to choose one of:

OPTION A : I give you an additional $100: 

75% of people chose option A

GAINS RISK AVERSE

HEADS: I give you an additional $200

OPTION B : I toss a coin

TAILS: I give you no additional money

I will give you \$400: 

and then you will have to choose one of:

OPTION 1 : **You give me back \$100**:

LOSSES RISK LOVING

HEADS: You keep the \$400

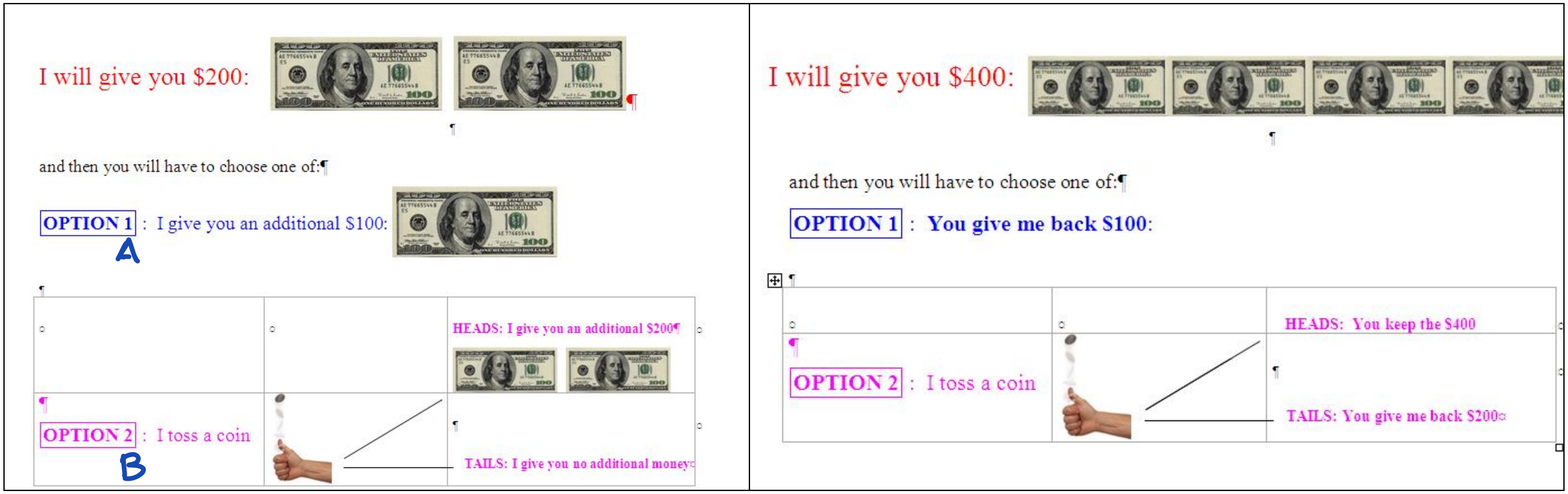
OPTION 2 : I toss a coin 

TAILS: You give me back \$200

75% people

chose Option 2

Put the first and third problems side by side:



In both cases:

Option 1 = you end up with \$300

Option 2 = you face the uncertain prospect (lottery)

$$\left(\begin{array}{c|c} \text{You end up with \$400} & \text{You end up with \$200} \\ \text{Probability } \frac{1}{2} & \text{Probability } \frac{1}{2} \end{array}\right)$$

Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 60,000 people. Two alternative programs to combat the disease have been proposed.

most doctors chose A

- If **Program A** is adopted, 20,000 people will be saved.
- If **Program B** is adopted, there is a $\frac{1}{3}$ probability that **all** 60,000 people will be **saved** and a $\frac{2}{3}$ probability that **none** of the 60,000 will be **saved**.

Ø

Which of the two programs would you favor?

Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 60,000 people. Two alternative programs to combat the disease have been proposed.

- If **Program C** is adopted, 40,000 people will **die**.

$\varnothing$

- If **Program D** is adopted, there is a $\frac{1}{3}$ probability that **none** of the 60,000 will **die** and a $\frac{2}{3}$ probability that **all** of the 60,000 people will **die**.

Put the second and fourth problems side by side:

Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 60,000 people. Two alternative programs to combat the disease have been proposed. • If **Program A** is adopted, 20,000 people will be saved. • If **Program B** is adopted, there is a $\frac{1}{3}$ probability that **all** 60,000 people will be **saved** and a $\frac{2}{3}$ probability that **none** of the 60,000 will be **saved**.	Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 60,000 people. Two alternative programs to combat the disease have been proposed. • If **Program C** is adopted, 40,000 people will **die**. • If **Program D** is adopted, there is a $\frac{1}{3}$ probability that **none** of the 60,000 will **die** and a $\frac{2}{3}$ probability that **all** of the 60,000 people will **die**.

The two problems are the same. In both cases,

if Program A/C is adopted, 20,000 people are saved and 40,000 die;

Program B/D corresponds to the following lottery $\left(\begin{array}{c:c} \text{all 60,000 are saved} & \text{nobody is saved} \\ = \text{nobody dies} & = \text{all 60,000 die} \\ \text{Probability } \frac{1}{3} & \text{Probability } \frac{2}{3} \end{array}\right)$.

4. How to process information

- In the US, **1% of women of age 40 have breast cancer**.
- If a woman **has** breast cancer, the probability that she tests **positive** on a screening mammogram is **90%**.
- If she **does not have** breast cancer, the probability that she tests **negative** on a screening mammogram is **90%**.

That is, mammograms have a **90% accuracy**.

Susan is a 40-year old woman who tested **positive** *on a mammogram.*

What are the chances that she actually has breast cancer?

Correct answer is : about 8%

You are at the CVS store in West Covell Blvd about to buy a watch that costs $14. You bump into a friend who says that the same watch costs only $7 at Target. Are you willing to drive 15 minutes across town to get the better deal?

You are about to buy a washing machine that costs $420. A friend tells you that a different store, which is a 15-minute drive from here, sells the same washing machine for $413. Are you willing to drive 15 minutes across town to get the better deal?

Recommended viewing:

1. Dan Ariely, Are we in control of our own decisions?, on Ted.com:

http://www.ted.com/talks/view/lang/en//id/548

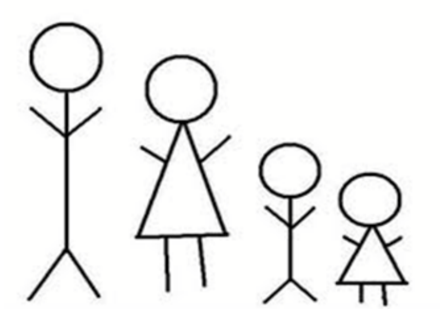
2. Dan Gilbert, Why we make bad decisions, on Ted.com:

http://www.ted.com/talks/lang/en/dan_gilbert_researches_happiness.html

Decisions under certainty

act		outcome
a_1	$\longrightarrow$	z_1
a_2	$\longrightarrow$	z_2
$\vdots$	$\dots$	
a_n	$\longrightarrow$	z_n

A binary relation R on a set Z is a set of ordered pairs (x,y) with both x and y elements of Z.



Alex Beth Carl Dana

Z = {A, B, C, D}

R is the "taller than" relation: (x,y) means that x is taller than y

$R = \{ (A,B), (A,C), (A,D), (B,C), (B,D), (C,D) \}$

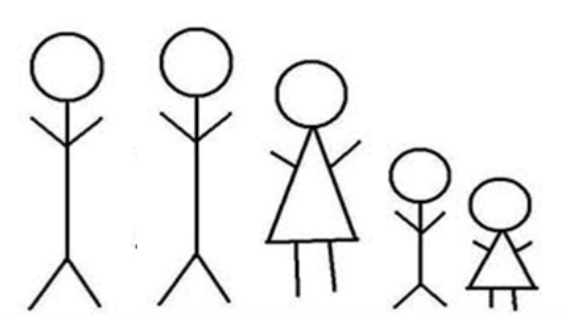
Tallest A

B

C

least tall D

A binary relation R on a set Z is a set of ordered pairs (x,y) with both x and y elements of Z.



E **Alex Beth Carl Dana**

Z = {A, B, C, D}

R is the "~~taller than~~" at least as tall as relation: (x,y) means that x is taller than y

$R = \{ (A,A), (A,E), (A,B), (A,C), (A,D), (E,A), (E,B), (E,C), (E,D) \ldots \}$

outcomes

z_1, z_2, z_3, z_4

best z_2

(1) z_1, z_3 indifferent between z_1 and z_3

worst z_4

(2) utility function:

z_1	z_2	z_3	z_4
5	9	5	2

(3) binary relation (x, y) : x is at least as good as y

since (z_1, z_2) is not in R then z2 is better than z1

$R = \{ \cancel{(z_2, z_2)}, (z_2, z_1), (z_2, z_3), (z_2, z_4),$
$\boxed{(z_1, z_3)}, (z_1, z_4), \cancel{(z_1, z_1)},$
$\boxed{(z_3, z_1)}, (z_3, z_4), \cancel{(z_3, z_3)},$
$\cancel{(z_4, z_4)} \}$

z_1 is just as good as z_3

(4) $x \succ y$ x is better than y

$x \sim y$ x is just as good as y

$$z_2 \succ z_1 \sim z_3 \succ z_4$$