risky business
dopamine and rewards

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We face risk everyday.

- Which class to take?
- Who to date?
- What’s my major?
- What to do this summer?
We rarely know *in advance* and with certainty what the **outcome** of our decision will be.

- Which class to take?
- Who to date?
- What’s my major?
- What to do this summer?

We are forced to make tradeoffs between the pros and cons of the potential outcomes and their probability of happening.
The *many* definitions of *risk*

Lay person associates *risk* with hazards and lack of familiarity.
The *many* definitions of *risk*

Business person associates *risk* as a challenge to overcome.
The *many* definitions of risk

Medical clinicians associate *risk* as exposure to loss or harm.
The *many* definitions of risk

Decision economists associate *risk* as increasing with variance in the probability distribution.
Regardless of whether a potential loss is involved.

Decision economists associate risk as increasing with variance in the probability distribution.
Heads: $100

Tails: $0

Which is considered more risky?
Decisions under risk

Decision maker knows with precision the probability distribution of possible outcomes.

Decisions under uncertainty

Decision maker must assess the probabilities of potential outcomes that are vague.
prospect theory

Models what people actually choose versus what they should choose

Reference dependence

Decision

Probability weighting
reference dependence

1. What does it mean?
2. Why is it important?
3. How does it influence D-M?
SHAPES HOW WE THINK!

Reference dependence
Probability weighting

bias
decisions
Law of Diminishing Marginal Utility

Traditional economics

$m = \#\text{ of apples}$
The perceived value of, or satisfaction gained from, a good to a consumer declines with each additional unit acquired or consumed.

... if consumption continues, sickness (disutility) will result.

http://www.businessdictionary.com/definition/law-of-diminishing-marginal-utility.html
Law holds only under the following conditions:

1. Homogeneous Units
2. No Change in Tastes
3. Continuity
4. Suitable Size Units
5. Constant Prices
6. Indivisible Goods
7. Rational Consumers
8. Ordinary Goods
9. Marginal Utility of Money not Constant
(1) **Homogeneous Units**

All units of the commodity should be of the same weight and quality.
(2) **No Change in Tastes**

There should be no change in the tastes, habits, customs, fashions and income of the consumer.

A change in any one of them will increase rather than diminish utility.
(3) **Continuity**

- There should be continuity in the consumption of the commodity.
- Units of the commodity should be consumed in succession at one particular time.
(4) **Suitable Size Units**

- Units of the commodity should be of a suitable size.
- Giving tiny apples to a hungry person would increase the utility of the subsequent apple!
(5) **Constant Prices**

Prices of the different units and of the substitutes of the commodity should remain the same.

http://www.economicsdiscussion.net
(6) Indivisible Goods

The commodity should not be indivisible.
(8) Ordinary Goods

- Goods should be of an ordinary type.

- If they are commodities, like diamonds and jewels, or hobby goods like stamps, coins or paintings, the law does not apply.

http://www.economicsdiscussion.net
Marginal utility of money changes as a person acquires more and more money.
Which one feels subjectively greater?
The “value” of an additional $1,000 increment is influenced both the intrinsic value of the extra $1,000 and by how many $1,000’s of dollars the decision-maker has.

1. The graph shows the value of any given number of $1,000. Note, that as the total number of $1,000 dollars possessed increases, the value of an additional $1,000 diminishes.

2. Thus if a person possesses no money at all, a $1000 is of tremendous value. If a person possesses tens of thousands of dollars, then the value to them, of an additional $1,000 would be low.
We don’t process information in absolute terms.
Pascal and gambling logic
Early decision theory & utility maximization

Understanding the logic of gambling decisions

Blaise Pascal, Mathematician
https://en.wikipedia.org/
Lottery ticket costs $45. It has a 50% chance of winning $200

Expected value = the probability of winning X the amount to be won

\[
EV = 0.5 \times 200 = 100
\]

$45 < \$100$

Caplin, Andrew and Paul W. Glimcher (2014)
Consider a **poor** person...
I’ll give you $7,000 for the ticket.
Daniel Bernoulli: one should maximize expected utility. He makes a distinction between: expected value and expected utility.

Caplin, Andrew and Paul W. Glimcher (2014)
Prospect Theory

people *evaluate potential changes* in relative wealth, not absolute wealth
A reverse sunk cost effect in risky decision making: Sometimes we have too much invested to gamble

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Abstract

The sunk cost effect refers to the empirical finding that people tend to let their decisions be influenced by costs made at an earlier time in such a way that they are more risk seeking than they would be had they not made these costs. This finding seems to be in conflict with economic theory which implies that only incremental costs and benefits should affect decisions. The effect is often explained in terms of prospect theory of (Kahneman, D., Tversky, A., 1979. Prospect theory: An analysis of decision under risk. Econometrica 47, 263–291), suggesting that sunk costs may induce a ‘loss frame,’ consequently causing risk seeking behavior. We argue that sunk costs may also result in risk aversion. In the present study we investigated the effect of time and effort investments (Behavioral Sunk Costs) on risky decision making in gain and loss situations. The results showed that, in agreement with prospect theory, participants were more risk averse in gain situations than in loss situations. Moreover, incurring Behavioral Sunk Costs appeared to increase risk aversive choices, i.e., a reverse sunk cost effect.
Your bonus: let’s flip a coin

Great job!

$100,000 salary

??

$110,000

??

$90,000
Which would you choose?
Compare that with $10,000

Casino promotion $10,000

?? $10,000

?? $0
Prospect Theory says that people evaluate potential changes in RELATIVE wealth, not in absolute wealth states.

This is the most central idea in behavioral economics.

It will exert its influence in many key decisions.

When faced with a risky decision we think less about our bank account and more about whether we will be better or worse off afterward.
"The Truth about Relativity"

https://www.youtube.com/watch?v=_ERQEVdliinc
Everyday example of reference points
Is the left center circle larger?

Is the top yellow line longer?
Are these lines straight or crooked?
How do you represent something with sufficient range to accommodate big numbers and sufficient precision to resolve differences between small numbers?
Humans can see over a light intensity range of several million to one.
Surface luminance levels

- Sunlight: \(10^5\) candelas/meter\(^2\) (cd/m\(^2\))
  - Approx. \(10^{22}\) photons/m\(^2\)/sec
  - 3%-90% of photons are reflected as luminance
  - 3% for black surfaces, 90% for white surfaces
  - Only some of the reflected photons enter the pupil of eye
- Indoor lighting, CRTs: \(10^2\) cd/m\(^2\)
- Moonlight: \(10^{-1}\) cd/m\(^2\)
- Starlight: \(10^{-3}\) cd/m\(^2\)
- The eye can adjust to changes in light level by a factor of 100,000,000!
- Yet firing rates only typically range from 0-400Hz.

Mechanisms of light/dark adaptation

1. Pupil size
2. Switchover between rods and cones
3. Bleaching/regeneration of photopigment
4. Feedback from horizontal cells to control the responsiveness of photoreceptors

At night, tiny changes in absolute brightness change the neurons firing rate.

During the day, in bright light, the reference point increases and greater changes in absolute brightness are required to alter the firing rate of a neuron.