DECISION THEORY

in PRACTICE

BIASES

Judgment and Decision

Biases – I

Framing Effects

Problems 1.1, 1.4

A 65-year old relative of yours suffers from a serious disease. It makes her life miserable, but does not pose an immediate risk to her life. She can go through an operation that, if successful, will cure her. However, the operation is risky. (A: 30% of the patients undergoing it die. B: 70% of the patients undergoing it survive.) Would you recommend that she undergoes it?

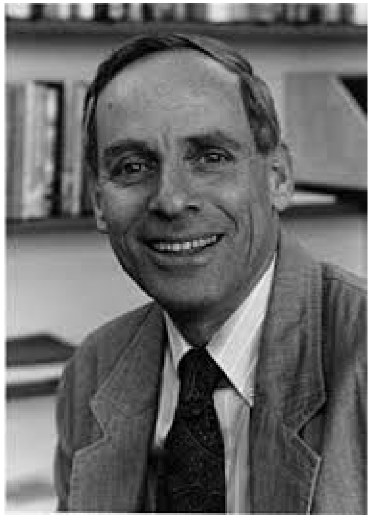
Framing Effects

Daniel Kahneman

(b. 1934)

Amos Tversky

(1937-1996)



The Bigger Project

Daniel Kahneman and Amos Tversky more or less showed that no assumption of rationality holds.

Tversky: “Show me the axiom and I’ll design the experiment that refutes it”

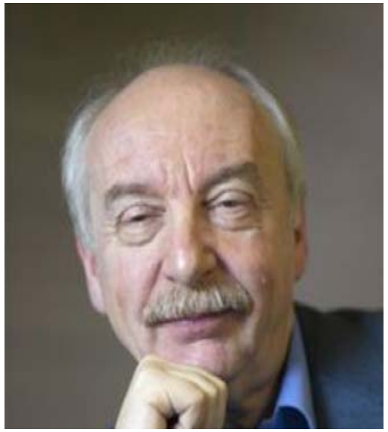
(Many of the examples we discuss here are theirs)

Questions about K-T's Project

- How robust are the findings?
  - Gigerenzer's Critique

- How relevant are they to economics?

… We will discuss these throughout the course



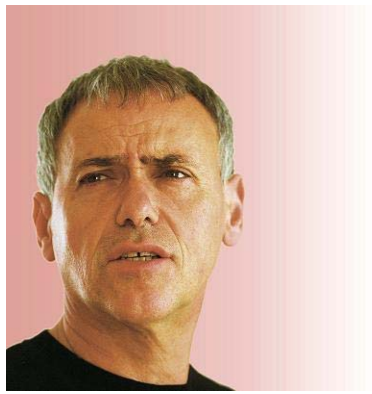
Gerd Gigerenzer (b. 1947)

Back to Framing Effects

- Additional examples:
  - Cash discount
  - Tax deductions
- What can be done about them?
  - The role of formal models

Framing Effects

- That representations do not matter is not even a formal assumption
- Implicitly assumed away in economic theory
  - (It is not even an explicit assumption, apart from a few exceptions such as Rubinstein)



Ariel Rubinstein (b. 1951)

Problems 1.2, 1.5

A: You are given $\$1,000$ for sure. Which of the following two options would you prefer?

a. to get additional $\$500$ for sure;

b. to get another $\$1,000$ with probability 50%, and otherwise – nothing more (and be left with the first $\$1,000$).

B: You are given $\$2,000$ for sure. Which of the following two options would you prefer?

a. to lose $\$500$ for sure;

b. to lose $\$1,000$ with probability 50%, and otherwise – to lose nothing.

Problem 1.2, 1.5

the choice is between:

a. $\$1,500$ for sure;

b. $\$1,000$ with probability 50%,

and $\$2,000$ with probability 50%.

Framing

Loss Aversion,

Status Quo Bias,

Endowment Effect

Gain-Loss Asymmetry

- Loss aversion
- Relative to a reference point
- Risk aversion in the domain of gains, but loss aversion in the domain of losses

Is it rational to fear losses?

Three scenarios:

- The politician
- The spouse
- The self

The same mode of behavior may be rational in some domains but not in others

Endowment Effect

What's the worth of a coffee mug?

- How much would you pay to buy it?
- What gift would be equivalent?
- How much would you demand to sell it?

Should all three be the same?

Standard economic analysis

Suppose that you have m dollars and 0 mugs

- How much would you pay to buy it?

$$(m - p, 1) \sim (m, 0)$$

- What gift would be equivalent?

$$(m + q, 0) \sim (m, 1)$$

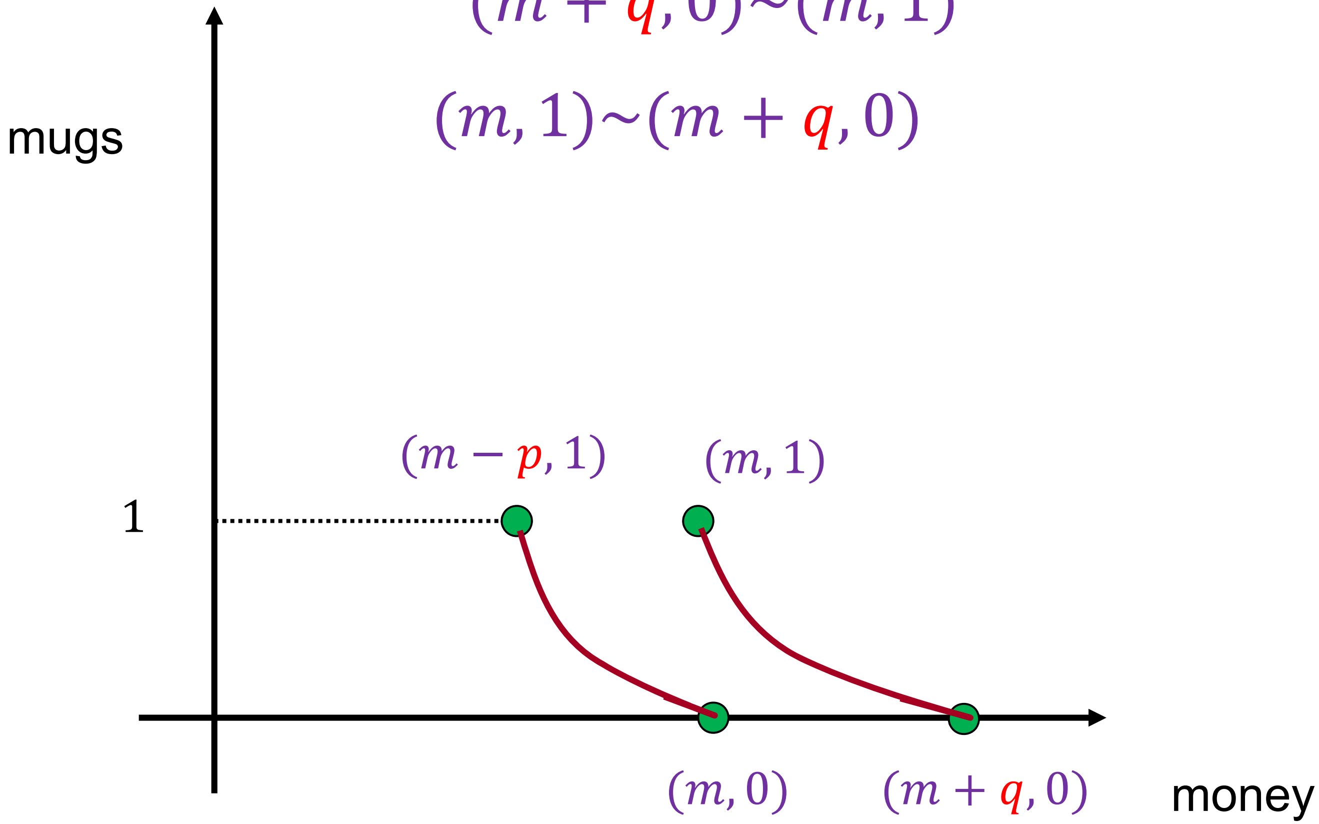
- How much would you demand to sell it?

$$(m, 1) \sim (m + q, 0)$$

Standard economic analysis

$$(m+q,0)\sim(m,1)$$

$$(m,1)\sim(m+q,0)$$



Standard analysis – conclusion

In short, of the three questions,

- How much would you pay to buy it?
- What gift would be equivalent?
- How much would you demand to sell it?

– (only) the last two should be the same

Results of mug experiment

- How much would you pay to buy it?

  $2.87

- What gift would be equivalent?

  $3.12

- How much would you demand to sell it?

  $7.12

The Endowment Effect

- We tend to value what we have more than what we still don't have

- A special case of "status quo bias"

- Related to the "disposition effect"

Reference

Toward a positive theory of consumer choice

Richard H. Thaler

Journal of Economic Behavior and Organization Vol. 1 (1980) pp. 39-60.

Abstract

The economic theory of the consumer is a combination of positive and normative theories. Since it is based on a rational maximizing model it describes how consumers should choose, but it is alleged to also describe how they do choose. This paper argues that in certain well-defined situations many consumers act in a manner that is inconsistent with economic theory. In these situations economic theory will make systematic errors in predicting behavior. Kahneman and Tversky's prospect theory is proposed as the basis for an alternative descriptive theory. Topics discussed are: underweighting of opportunity costs, failure to ignore sunk costs, search behavior, choosing not to choose and regret, and precommitment and self-control.

Reference

Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias

Daniel Kahneman, Jack L. Knetsch, Richard H. Thaler

Journal of Economic Perspectives Vol. 5 No. 1 (Winter 1991) pp. 193-206

Abstract

A wine-loving economist we know purchased some nice Bordeaux wines years ago at low prices. The wines have greatly appreciated in value, so that a bottle that cost only $10 when purchased would now fetch $200 at auction. This economist now drinks some of this wine occasionally, but would neither be willing to sell the wine at the auction price nor buy an additional bottle at that price. Thaler (1980) called this pattern—the fact that people often demand much more to give up an object than they would be willing to pay to acquire it—the endowment effect. The example also illustrates what Samuelson and Zeckhauser (1988) call a status quo bias, a preference for the current state that biases the economist against both buying and selling his wine. These anomalies are a manifestation of an asymmetry of value that Kahneman and Tversky (1984) call loss aversion—the disutility of giving up an object is greater that the utility associated with acquiring it. This column documents the evidence supporting endowment effects and status quo biases, and discusses their relation to loss aversion.

Recent Survey

Explanations of the endowment effect: an integrative view

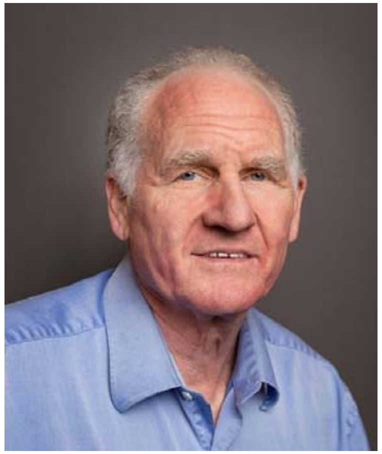
Carey K. Morewedge, Colleen E. Giblin

Trends in Cognitive Science Vol. 19 No. 6 (June 2015) pp. 339-348

Abstract

The endowment effect is the tendency for people who own a good to value it more than people who do not. Its economic impact is consequential. It creates market inefficiencies and irregularities in valuation such as differences between buyers and sellers, reluctance to trade, and mere ownership effects. Traditionally, the endowment effect has been attributed to loss aversion causing sellers of a good to value it more than buyers. New theories and findings – some inconsistent with loss aversion – suggest evolutionary, strategic, and more basic cognitive origins. In an integrative review, we propose that all three major instantiations of the endowment effect are attributable to exogenously and endogenously induced cognitive frames that bias which information is accessible during valuation.

The Status Quo Bias



William Samuelson (b. 1952)

Richard Zeckhauser (b. 1940)

“individuals disproportionately stick with the status quo”

Reference

Status quo bias in decision making

William Samuelson, Richard Zeckhauser

Journal of Risk and Uncertainty Vol. 1 (1988) pp. 7-59

Abstract

Most real decisions, unlike those of economics texts, have a status quo alternative—that is, doing nothing or maintaining one's current or previous decision. A series of decision-making experiments shows that individuals disproportionately stick with the status quo. Data on the selections of health plans and retirement programs by faculty members reveal that the status quo bias is substantial in important real decisions. Economics, psychology, and decision theory provide possible explanations for this bias. Applications are discussed ranging from marketing techniques, to industrial organization, to the advance of science.

The Disposition Effect

People tend to hold on to stocks that lost in value and to sell stocks that gained

Hersh Shefrin (b. 1948)

Meir Statman

Is it rational

… to value

a house
your grandfather's pen
your car
equity

…more just because it's yours?

Rationalization of Endowment Effect

- Information: there is less uncertainty about products we know
  - Someone else's used car
- Stabilization of choice
- Transaction costs
  - Getting used to a new computer system

Problem 1.3, 1.6

- 1.3: You go to a movie. It was supposed to be good, but it turns out to be boring. Would you leave in the middle and do something else instead?

- 1.6: Your friend had a ticket to a movie. She couldn't make it, and gave you the ticket "instead of just throwing it away". The movie was supposed to be good, but it turns out to be boring. Would you leave in the middle and do something else instead?

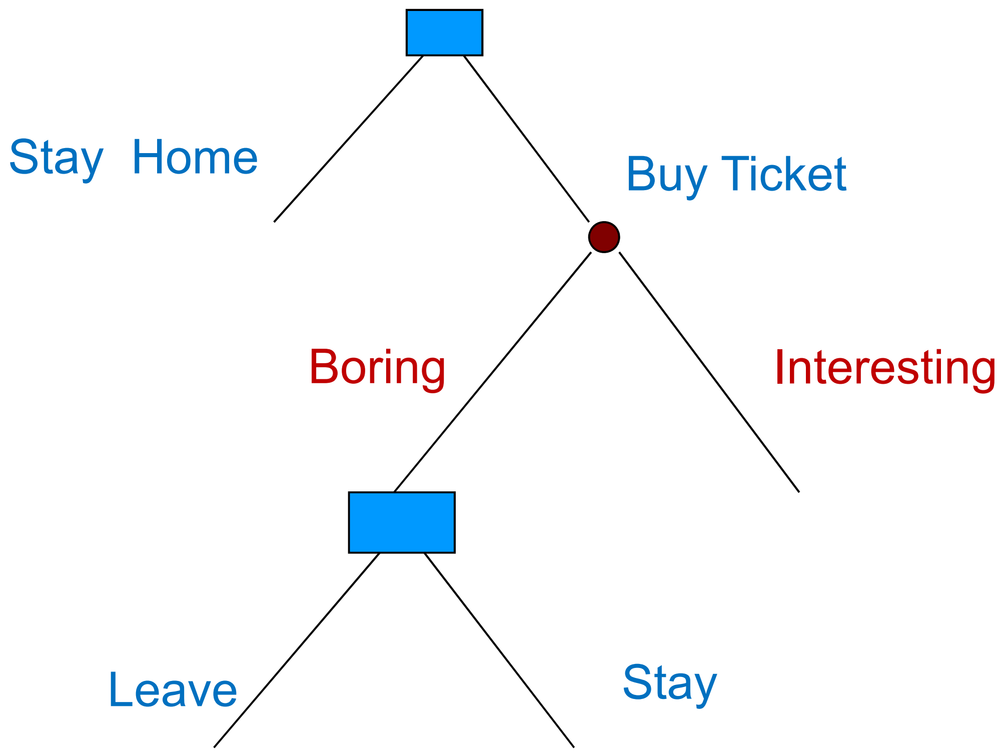
Sunk Cost

- Cost that is "sunk" should be ignored
- Often, it's not
- Additional examples:
  - Switching to another line (or another lane) when yours is evidently very slow
  - Eating more than you really want just because you already paid for the food

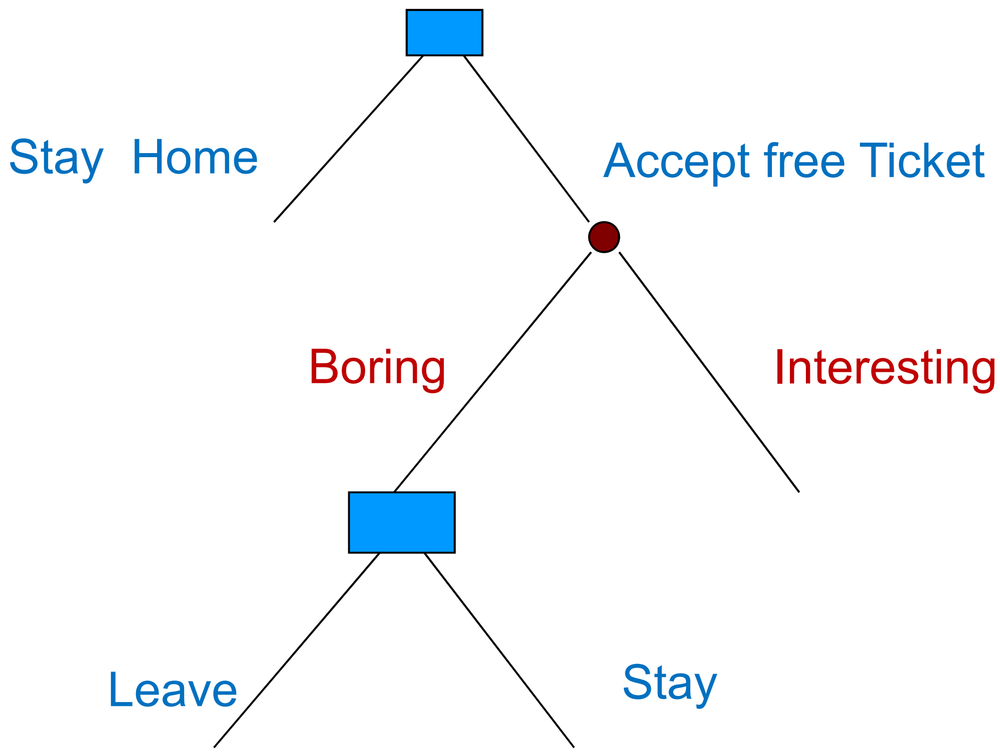
Is the Sunk Cost Effect rational?

- Well, it makes us feel bad to admit a mistake
- And it makes us look bad in the eyes of others
- But if we don’t like it, what can be done to avoid the sunk cost effect?

Decision Tree – Problem 1.3



Decision Tree – Problem 1.6



Consequentialism

- Only the consequences matter
- The decision at a node in the tree depends only on the subtree that starts there
- Not on how we got there and which other subtrees we could have been at
- Helps ignore sunk costs if we so wish

What’s in a consequence?

- Does consequentialism mean we’ll be ungrateful to our old teachers?
- Not necessarily: history can be part of the “consequence”
- If we push it too far, consequentialism would be vacuous. The formal model helps us decide how much of the history we wish to put into the notion of “a consequence”

Menu Effects

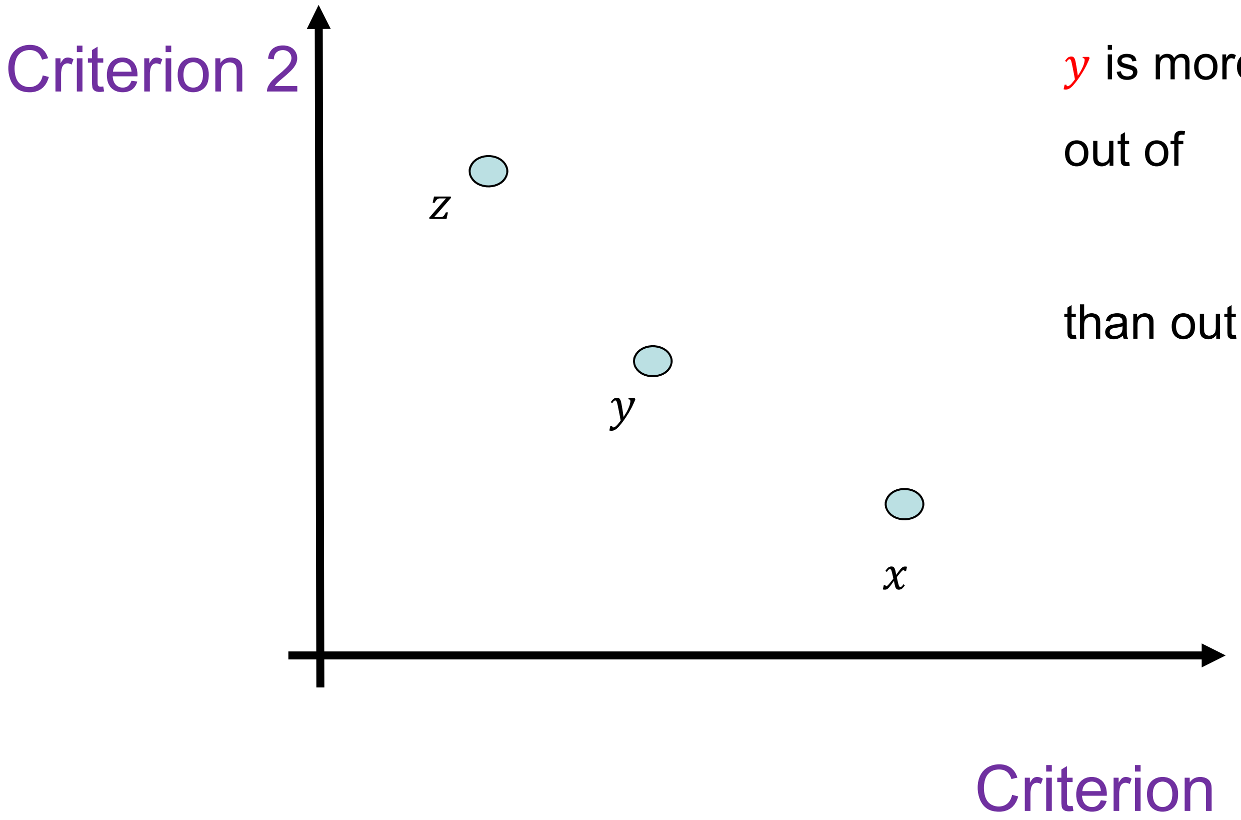
President Trump

From Jan 4th NY Times:

WASHINGTON — In the chaotic days leading to the death of Maj. Gen. Qassim Suleimani, Iran's most powerful commander, top American military officials put the option of killing him — which they viewed as the most extreme response to recent Iranian-led violence in Iraq — on the menu they presented to President Trump.

They didn't think he would take it. In the wars waged since the Sept. 11, 2001, attacks, Pentagon officials have often offered improbable options to presidents to make other possibilities appear more palatable.

The Compromise Effect



y is more likely to be chosen

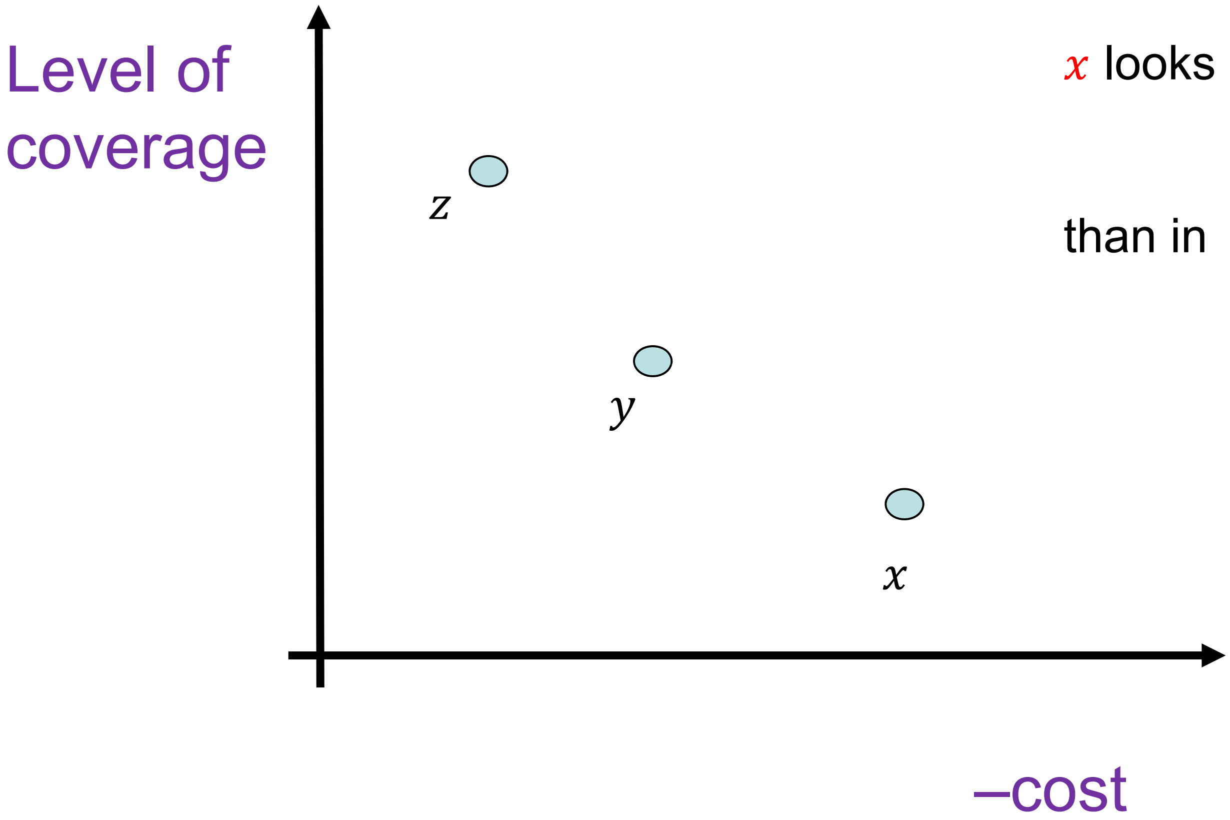
out of

$\{x, y, z\}$

than out of

$\{x, y\}$

Example: Choice of health plan



x looks more extreme in

$\{x, y, z\}$

than in

$\{x, y\}$

Is the Compromise Effect rational?

- Could be a way to save cognitive resources
- Requires some implicit theory about who put options on the menu and why
- But taking these into account is actually implied by rationality

Was Trump rational?

- One story: sure; the consultants were trying to trick him via the compromise effect but he wouldn't budge

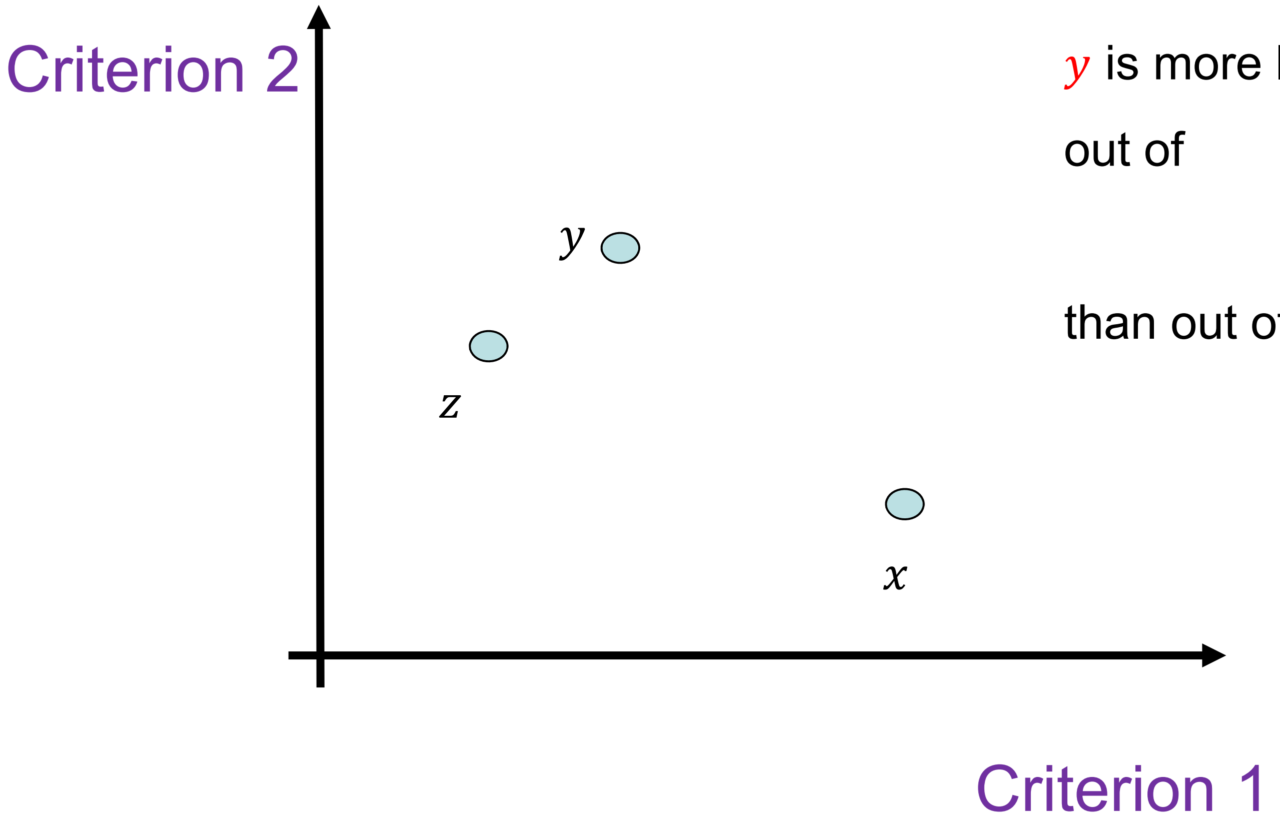
- Another story: no; he failed to understand that the consultants were giving him more information by the selection of the menu

The IIA

(Independence of Irrelevant Alternatives)

- If x appears to be preferred to y in the context of one menu, this shouldn’t be reversed in another
  - (“appears to be preferred” – observed to be chosen where the other is also available)
- Violated when the Compromise Effect is in action

The Decoy Effect



y is more likely to be chosen

out of

$\{x, y, z\}$

than out of

$\{x, y\}$

Other violations of the IIA

- Order the second-least-expensive wine on the menu
- If the costs are $x > y > z$

select

x out of $\{x, y\}$

but

y out of $\{x, y, z\}$

Is that rational?

- Two types of rationalizations:
  - Subtle information effects
  - Psychological payoffs
- Behavioral economics contributed in
  - Awareness to some subtleties
  - Psychological determinants of the utility
- In any event, if we look at bare data, the IIA might be violated

Other Menu Effects

- Changing the default
- The 401K example
- Organ donation

Reference

The power of suggestion: Inertia in 401(K) participation and savings behavior

Brigitte C. Madrian, Dennis Shea

Quarterly Journal of Economics Vol. 116 No. 4 (Nov. 2011) pp. 1149-1187

Abstract

This paper analyzes the impact of automatic enrollment on 401(k) savings behavior. We have two key findings. First, 401(k) participation is significantly higher under automatic enrollment. Second, a substantial fraction of 401(k) participants hired under automatic enrollment retain both the default contribution rate and fund allocation even though few employees hired before automatic enrollment picked this particular outcome. This "default" behavior appears to result from participant inertia and from employee perceptions of the default as investment advice. These findings have implications for the design of 401(k) savings plans as well as for any type of Social Security reform that includes personal accounts over which individuals have control. They also shed light more generally on the importance of both economic and noneconomic (behavioral) factors in the determination of individual savings behavior.

Is the Default Effect rational?

Well:

- The default tells me something about the options
- I might also not want to be among the few who selected differently from most

Again, two types of rationalizations:

- Subtle information effects
- Psychological payoffs

Main Biases

- Framing effect
- Endowment/ disposition/ status quo
- Sunk cost
- Menu effects (framing?)

Main Lessons

- Formal models are important to help us understand our decisions

- They often do not give one “right” answer

- But they let us see what affects a decision, and ignore the biases we don’t like.

Exercises Chapter 1 – Problem 1

Jim and Joe are students who live on small scholarships. They go to an all-you-can-eat restaurant and pay $8.95 for the meal. Joe is unexpectedly told that, being the 100th customer of the day, he gets his money back (and gets to eat at no charge). Other things being equal, do you think that Joe will consume the same amount of food as will Jim?

Exercises Chapter 1 – Problem 2

Magazines often offer their new customers subscription over an initial period at a very low cost. Provide at least two reasons for which this may be a smart way to attract customers.

Exercises Chapter 1 – Problem 3

In most countries, a driver who wishes to join an organ donation program has to make an explicit choice to do so. There is a proposal to make every driver an organ donor unless they opt out. Do you think that this proposal might have an effect on the number of organ donors? If so, which psychological effect might be responsible for this?

Judgment and Decision

Biases – II

Problem 2.1, 2.9

Linda is 31 years old… etc.

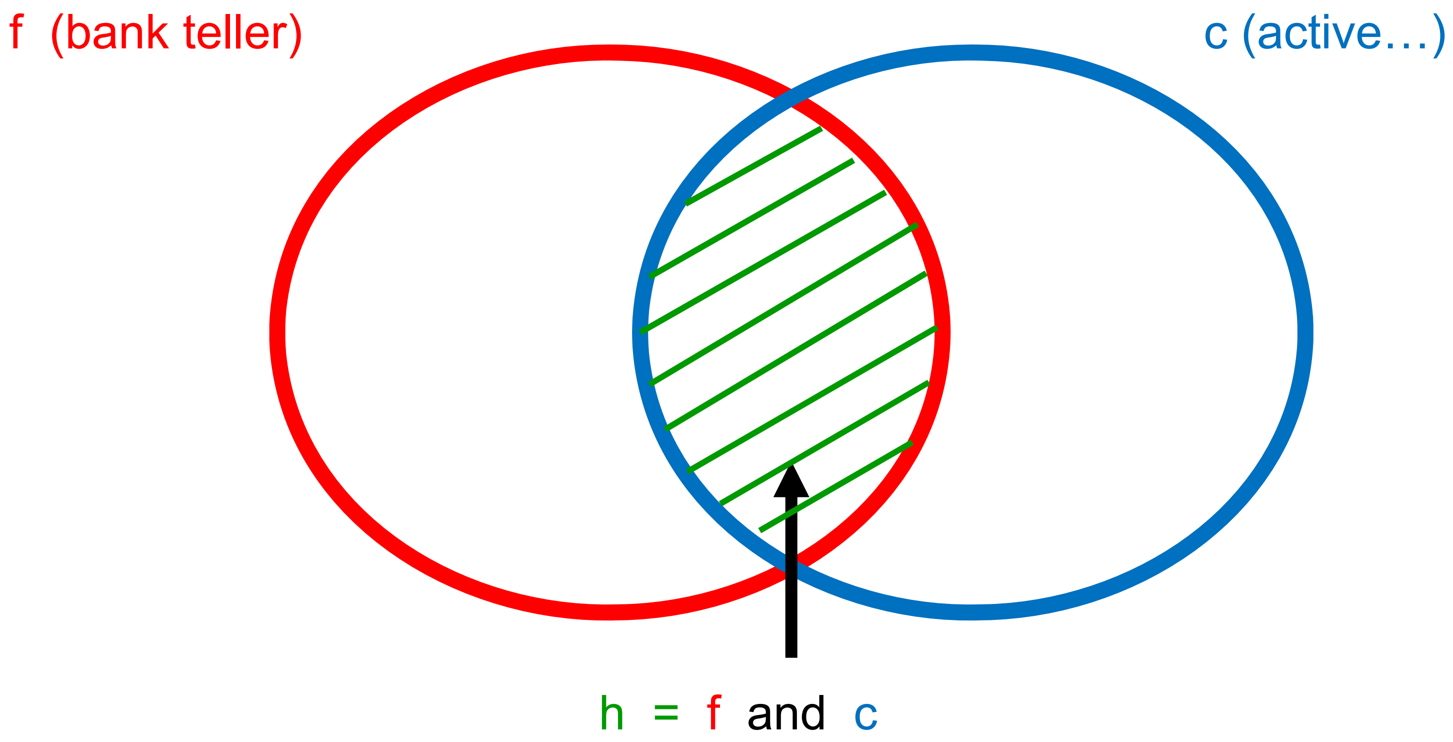
Did you rank

f. Linda is a bank teller

below

h. Linda is a bank teller who is active in a feminist movement ?

The Conjunction Fallacy



A conjunction can't be more likely than any of the conjuncts!

What’s behind the conjunction fallacy?

Many explanations:

– “a bank teller” – “a bank teller who is not active”?

– Ranking propositions is not a very natural task

In particular, it may be the case that people implicitly switch to the question

“Is this really the same Linda?”

rather than

“Is this proposition true?”

Is this person telling the truth?

As with a witness in court, more details, provided they’re coherent, increase credibility.

How come?

The more the witness tells us, the less likely is the conjunction of her statements

But we’re not asking

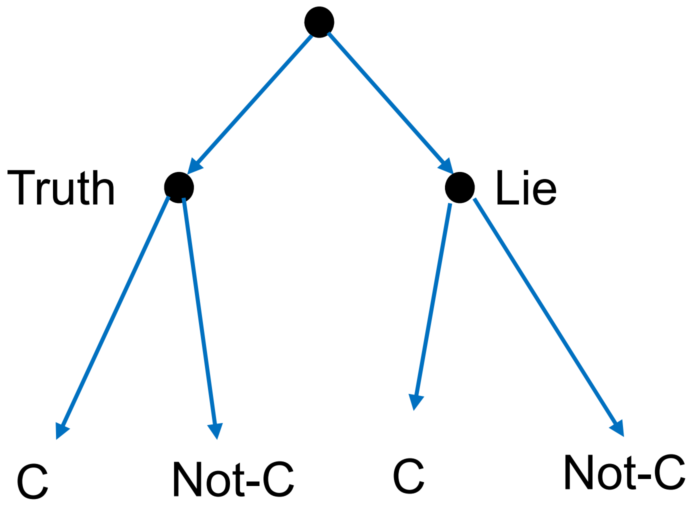
“How likely is this conjunction of propositions?”

but

“Is this witness telling us the truth?”

Is the witness telling the truth?

Bayesian inference



C – consistent testimony

What's behind the conjunction fallacy?

Kahneman and Tversky:

- There is a Representativeness Heuristic at work, and it can be misleading
- Being a bank teller doesn't seem representative of Linda
- A bank teller who's active in a feminist movement – more like the Linda we know

What’s a “Heuristic” ?

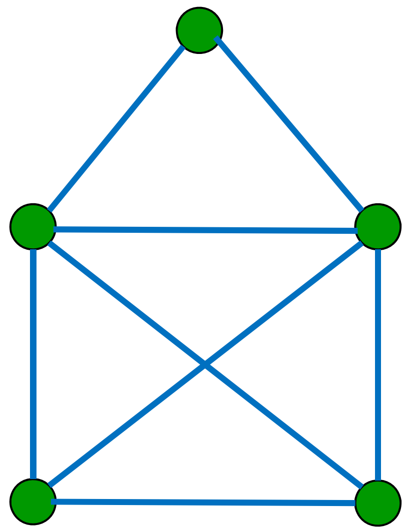
A method that helps us deal with a complex problem, suggesting a solution that typically makes sense but isn’t guaranteed to be optimal

The term is used both in CS (computer science)/ OR(operation research) and in psychology

Allow me a medium-length digression…

Example of an algorithm

Problem: Can you draw a path that goes through each edge exactly once?



That was an Euler path

A (connected, undirected) graph has an Euler path if and only if, when we count the number of edges that go through each node (the node's "degree"), we find either all even numbers, or all even but two (that are odd).

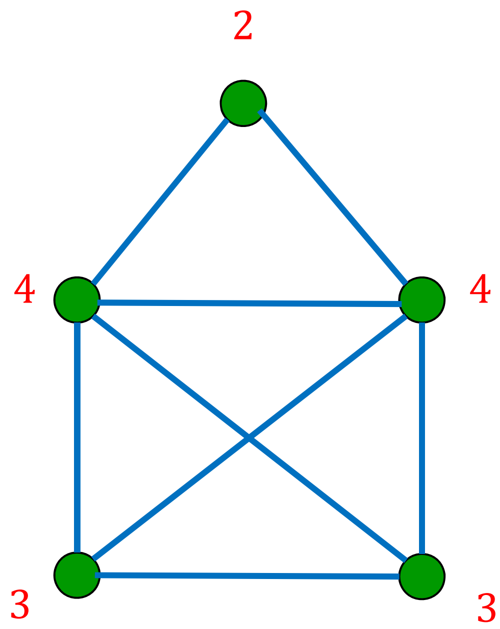
Leonhard Euler (1707-1783)

(What about "all but one"?)

The “degrees” in the example

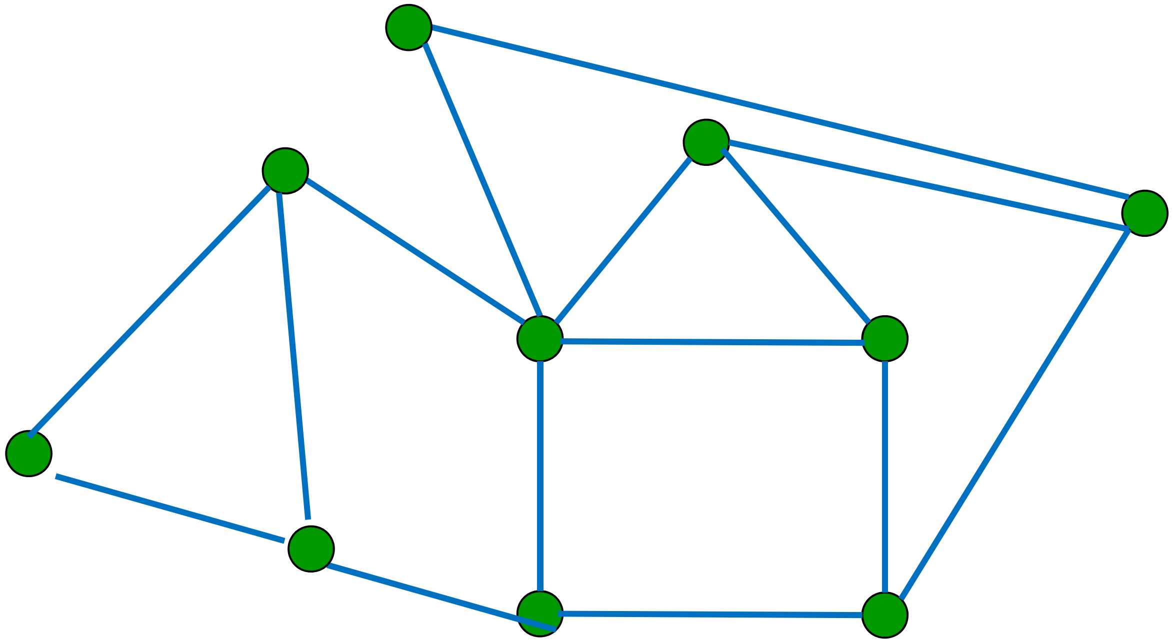
The counting shows that an Euler path exists here

(and the counting will also give us a hint as to where to start):



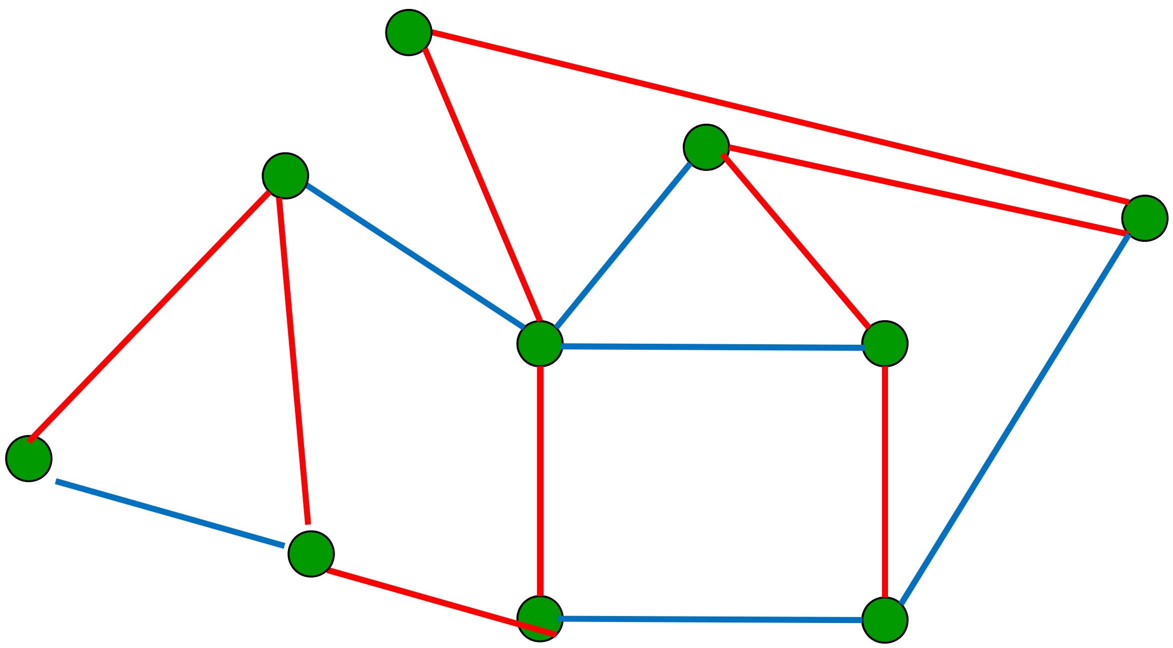
And how about…

Problem: Can you draw a path that goes through each node exactly once (a Hamiltonian path) ?



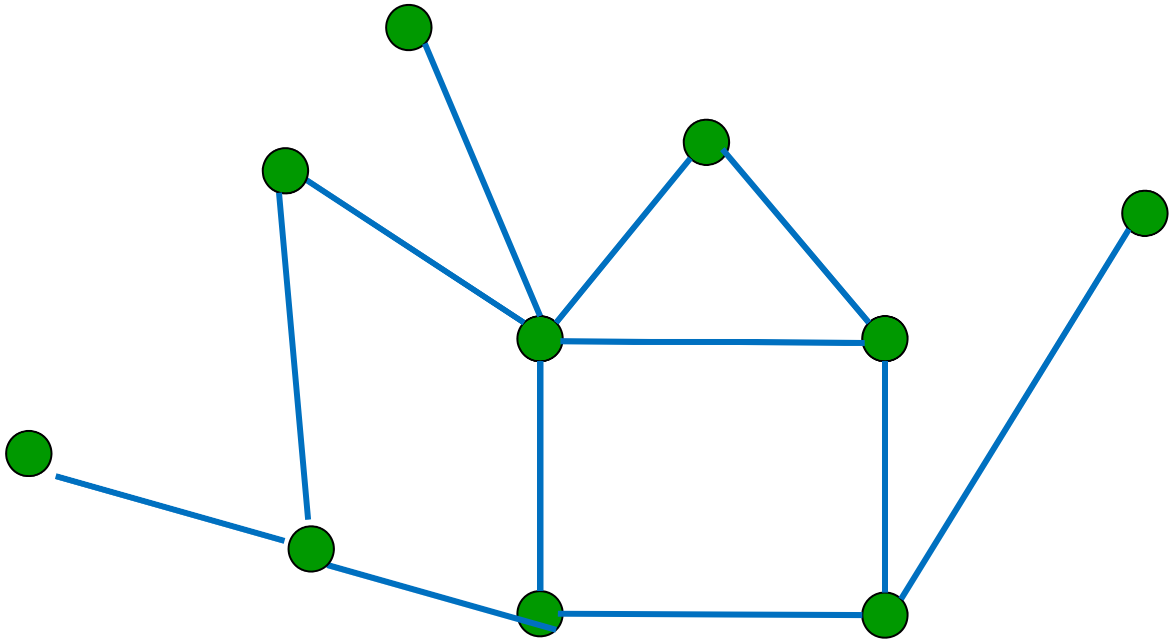
For instance

A Hamiltonian path exists in this example:



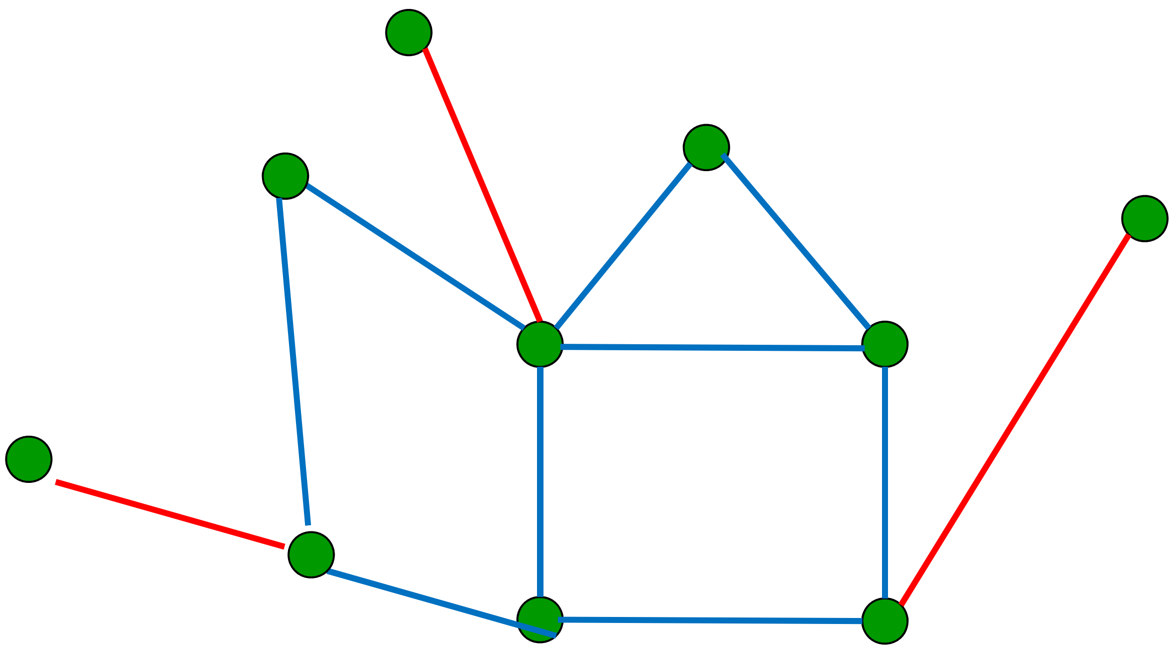
But

A Hamiltonian path doesn’t exists in :



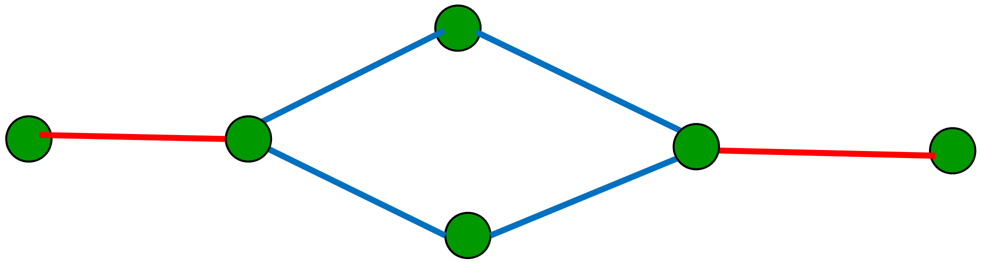
Because…

This graph has too many (3) nodes of degree 1:



Can we just count nodes of degree 1?

No:



This graph has only two such nodes, yet no Hamiltonian path

Instead of being so clever

Let's just try all possibilities

If a Hamiltonian path exists, it is simply a permutation (ordering) of the nodes such that any two consecutive nodes are connected by an edge

Let's try them all!

Brute Force

"Try all possible permutations" –

Easier said than done…

The number of atoms in the universe is estimated to be in the range

$10^{78} - 10^{82}$

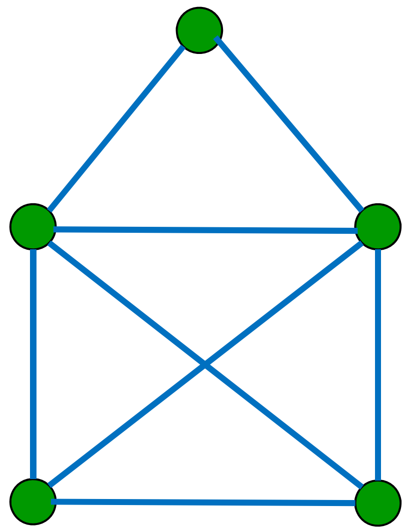
So even parallel computing is hopeless

n	$n!$
1	1
2	2
3	6
4	24
10	3,628,800
30	$2.65 * 10^{32}$
60	$8.32 * 10^{81}$

Wait, but…

With an Euler path, we could also try all permutations of the edges – in our example $8! = 40{,}320$ – but we found something much smarter!

(OK, Euler did.)



What is “much smarter”?

Polynomial complexity of an algorithm – solves the problem for n data points, at the worst case, in a number of steps that is no more than a polynomial in n

$$n\,, n^2, n^5, \dots$$

Exponential complexity of an algorithm – might take a number of steps that grows exponentially in n

$$2^n, n!, \dots$$

Polynomial Problems

A problem is polynomial if there exists at least one algorithm that can solve it in polynomial time complexity

Maybe the Hamiltonian Path problem is polynomial?

Maybe. We don't know.

Classes of (yes/no) problems

P (Polynomial) – A solution can be found in polynomial time

NP (Nondeterministic Polynomial) – A suggested solution can be verified in polynomial time

"Does there exists a Hamiltonian path?" is in NP

(A bit like the distinction between recall and recognition in psychology)

NP-Completeness

There is a problem about which the following is true:

IF you could solve it in polynomial time, THEN you can solve any problem in NP in polynomial time

(This isn't the definition of NP-Completeness)

Results from 1971, 1973

Stephen Cook (b. 1939)

Leonid Levin (b. 1948)

Many problems are NP-Complete

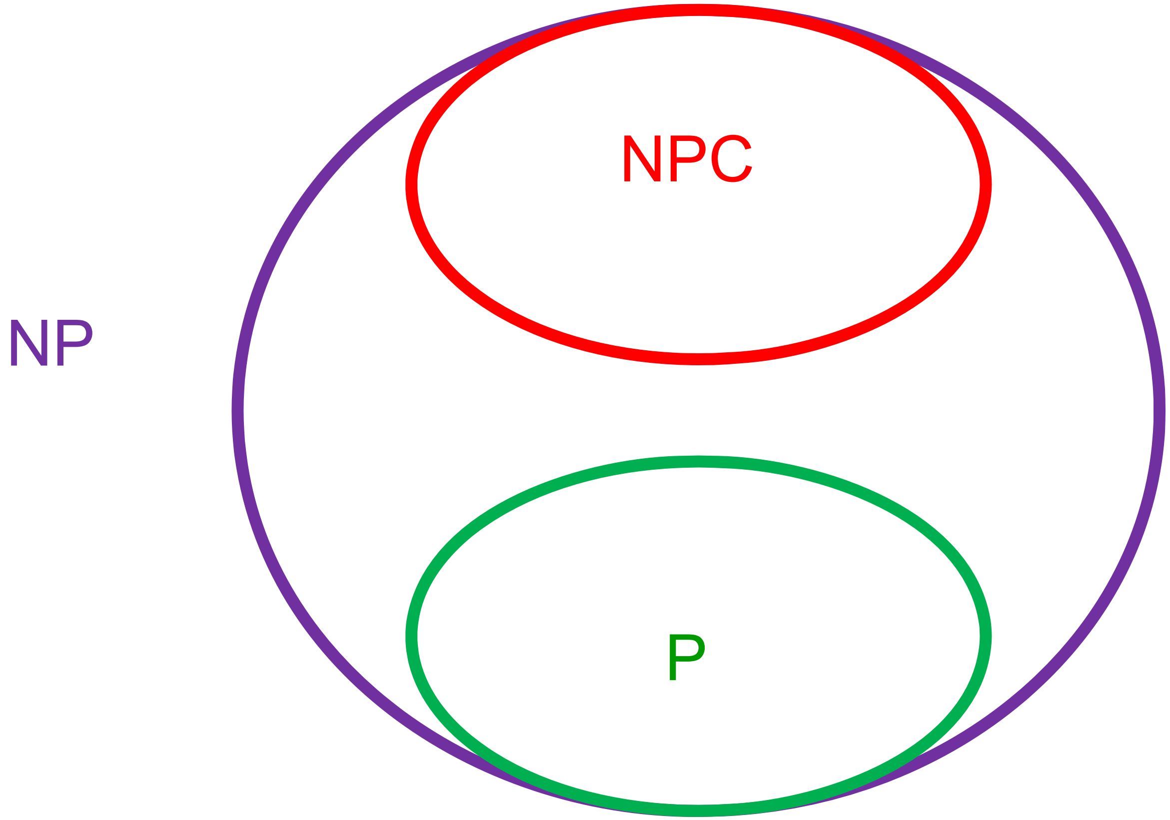
1972 Karp showed that 21 problems are NP-Complete

1979 Garey and Johnson publish a book with many more

You can find a catalog at https://www.nada.kth.se/~viggo/problemlist/compendium.html

Richard Karp (b. 1935)

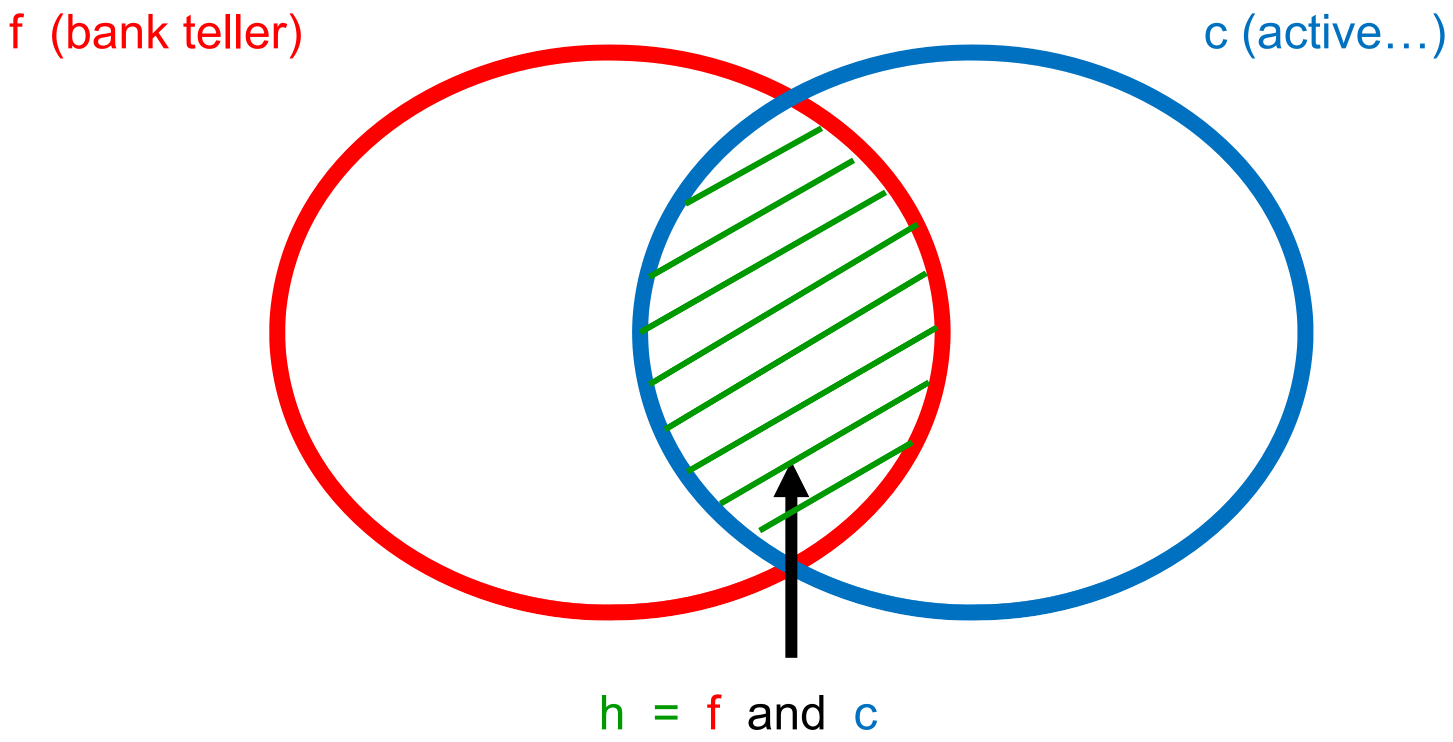
P = NP ?



Why am I telling you all this?

- Computer scientists also use heuristics
- Some problems that economic theory assumes people solve are NP-Complete
- And that brings about questions about “rationality”
- For now: if the best computer scientists sometimes can only offer heuristics, it makes sense that so does the human brain

Back to Linda



One way to be immune to the Conjunction Fallacy is to use

subjective probabilities

Subjective Probabilities

- Formal models immune against framing effects
- Subjective probabilities – against the Conjunction Fallacy and related mistakes
- In both cases, the model won't provide the answer
- But it will help you avoid certain patterns that you may consider mistakes

(Truth is, other models can also immune against the Conjunction Fallacy)

Problems 2.2, 2.10

A: In four pages of a novel (about 2,000 words) in English, do you expect to find more than ten words that have the form _ _ _ _ _ *n* _ (seven-letter words that have the letter *n* in the sixth position)?

B: In four pages of a novel (about 2,000 words) in English, do you expect to find more than ten words that have the form _ _ _ _ *ing* (seven-letter words that end with *ing*)?

Availability Heuristic

In the absence of a “scientific” database, we use our memory

Typically, a great idea

Sometimes, results in a biased sample

Problems 2.3, 2.11

A: What is the probability that, in the next 2 years, there will be a cure for AIDS?

B: What is the probability that, in the next 2 years, there will be a new genetic discovery in the study of apes, and a cure for AIDS?

Availability heuristic

Problems 2.4, 2.12

A: What is the probability that, during the next year, your car would be a "total loss" due to an accident?

B: What is the probability that, during the next year, your car would be a "total loss" due to:

a. an accident in which the other driver is drunk?
b. an accident for which you are responsible?
c. an accident occurring while your car is parked on the street?
d. an accident occurring while your car is parked in a garage?
e. one of the above?

Availability heuristic

Reference

The Unpacking Effect in evaluative judgments: when the whole is less than the sum of its parts

Nicholas Epley, Leaf Van Boven

Journal of Experimental Social Psychology, Vol. 39 (2003), pp. 263-269

Abstract

Any category or event can be described in more or less detail. Although these different descriptions can reflect the same event objectively, they may not reflect the same event subjectively. Research on Support Theory led us to predict that more detailed descriptions would produce more extreme evaluations of categories or events than less detailed descriptions. Four experiments demonstrated this unpacking effect when people were presented with (Experiments 1 and 4), generated (Experiment 2), or were primed with (Experiment 3) more rather than less detailed descriptions of events. This effect was diminished when the details were less personally relevant (Experiment 4). We discuss several psychological mechanisms, moderators, and extensions of the unpacking effect.

Problems 2.5, 2.13

Which of the following causes more deaths each year:

a. Digestive diseases
b. Motor vehicle accidents?

In the original KT study

(In the US 1981-1984)

Which of the following causes more deaths each year:

a. Stomach cancer
b. Motor vehicle accidents (MVA)?

The also collected data on media stories. For every story on stomach cancer death there were 147 on MVA death

Problems 2.6, 2.14

A newly hired engineer for a computer firm in Melbourne has four years of experience and good all-around qualifications.

Do you think that her annual salary is above or below [A: $65,000; B: $135,000] ? ______

What is your estimate?

Anchoring Heuristic

- In the absence of solid data, any number can be used as an "anchor"
- Is it rational?
- In K-T's original formulation, someone "who knows little" said something
- But there's still some information in that
- I only asked you what you thought about a given value
- And yet, there's some information in that, too

Anchoring Heuristic

Can be used strategically

Should an employee be promoted / retained / fired ?

By talking about one option first you can affect the outcome

Especially if most people don’t really have an opinion

Mental Accounting

Problems 2.7, 2.15

- A: You have a ticket to a concert, which cost you $50. When you arrive at the concert hall, you find out that you lost the ticket. Would you buy another one (assuming you have enough money in your wallet)?

- B: You are going to a concert. Tickets cost $50. When you arrive at the concert hall, you find out that you lost a $50 bill. Would you still buy the ticket (assuming you have enough money in your wallet)?

Mental Accounting

- Different expenses come from “different” accounts
- People and households run “accounts” in their heads as if they were large organizations with budgets

Richard Thaler (b. 1945)

Mental Accounting Examples

- Your spouse buys you the gift you didn't afford
  - Have you ever bought yourself a B-day present?
- You spend more on special occasions
  - Vacations

    OK, this may be due to "producing" the perfect vacation
  - Moving
- Spending money on a car's accessories

Reference

Mental Accounting and Consumer Choice

Richard Thaler

Marketing Science, Vol. 4 No. 3 (1985), pp. 199-214

Abstract

A new model of consumer behavior is developed using a hybrid of cognitive psychology and microeconomics. The development of the model starts with the mental coding of combinations of gains and losses using the prospect theory value function. Then the evaluation of purchases is modeled using the new concept of "transaction utility". The household budgeting process is also incorporated to complete the characterization of mental accounting. Several implications to marketing, particularly in the area of pricing, are developed.

Is Mental Accounting rational?

- The consumer problem is complex
- There are many choices

https://www.ted.com/talks/barry_schwartz_the_paradox_of_choice

- In fact, if there are indivisible goods, the consumer problem can be NP-Complete

("can"??? – well, it depends on the modeling)

Other rationalizations

- Helps cope with self-control problems

  How will I guarantee that I don’t buy myself the sweater “only this time” every week?

- Uses external events as memory aids

  How many times this month have I bought the more expensive wine?

Dynamic Inconsistency

Problems 2.8, 2.16

A: Which of the following two options do you prefer?

- Receiving $10 today
- Receiving $12 a week from today

B: Which of the following two options do you prefer?

- Receiving $10 50 weeks from today
- Receiving $12 51 weeks from today

The classical model

$$U(c_0, c_1, c_2, \dots)$$
$$= u(c_0) + \delta u(c_1) + \delta^2 u(c_2) + \dots$$

$0 < \delta < 1$ – a discount factor

Paul A. Samuelson (1915-2009)

Three assumptions

$$U(c_0, c_1, c_2, \dots) = u(c_0) + \delta u(c_1) + \delta^2 u(c_2) + \ \dots$$

We could have:

$$U(c_0, c_1, c_2, \dots) = u_0(c_0) + u_1(c_1) + u_2(c_2) + \cdots$$

$$= a_0 u(c_0) + a_1 u(c_1) + a_2 u(c_2) + \cdots$$

$$= u(c_0) + \delta u(c_1) + \delta^2 u(c_2) + \ \dots$$

First assumption: additivity

$$U(c_0, c_1, c_2, \dots) = u_0(c_0) + u_1(c_1) + u_2(c_2) + \cdots$$

Do you prefer to stay at

$\ast\ast\ast$ hotels in year 1

$\ast\ast\ast\ast$ hotels in year 2

$\ast\ast\ast\ast\ast$ hotels in year 3

Or the other way around?

Does utility in a given period depend on consumption in past ones?

Second assumption: “same” utility

$$U(c_0, c_1, c_2, \dots) = u_0(c_0) + u_1(c_1) + u_2(c_2) + \cdots$$

$$= a_0 u(c_0) + a_1 u(c_1) + a_2 u(c_2) + \cdots$$

With positive coefficients

$$a_0, a_1, a_2, \dots > 0$$

Will my preference between ski vacations and concerts remain unchanged throughout my lifetime?

Third assumption: Dynamic Consistency

$$a_0 u(c_0) + a_1 u(c_1) + a_2 u(c_2) + \cdots$$

$$= u(c_0) + \delta u(c_1) + \delta^2 u(c_2) + \ \ldots$$

The preference questions

$\$10$ today or $\$12$ a week from today

$$U(10,0,0,0,\dots)\ ?\ U(0,12,0,0,\dots)$$

$\$10$ 50 weeks from today or $\$12$ 51 weeks from today

$$U(0,0,\dots,0,10,0,0,0,\dots)\ ?\ U(0,0,\dots 0,0,12,0,0,\dots)$$

The difficulty

The classical model

$$U(c_0, c_1, c_2\ \dots) = u(c_0) + \delta u(c_1) + \delta^2 u(c_2) + \ \dots$$

with a discount factor $0 < \delta < 1$

Can't explain

$$U(10,0,0,0,\dots) > U(0,12,0,0,\dots)$$

As well as

$$U(0,0,\dots,0,10,0,0,0,\dots) < U(0,0,\dots 0,0,12,0,0,\dots)$$

In more detail

Assume $u(0) = 0$

$$U(10,0,0,0,\dots) > U(0,12,0,0,\dots)$$

means

$$u(10) > \delta u(12)$$

But

$$U(0,0,\dots,0,10,0,0,0,\dots) < U(0,0,\dots 0,0,12,0,0,\dots)$$

is equivalent to

$$\delta^{50} u(10) < \delta^{51} u(12)$$

Dynamic Consistency

- What we plan today to do tomorrow is indeed what we will choose to do tomorrow
- Violated in this example
- Other violations:
  - Tomorrow I'll start studying for the exam
  - Next week I'll quit smoking
  - Next year I'll start saving for retirement

By contrast

The classical model

$$U(c_0, c_1, c_2, \dots)$$

$$= u(c_0) + \delta u(c_1) + \delta^2 u(c_2) + \ \dots$$

More or less follows from dynamic consistency

Tjalling C. Koopmans (1910-1985)

Dynamic Inconsistency or Impatience?

The marshmallow experiment

https://www.youtube.com/watch?v=Yo4WF3cSd9Q

https://www.youtube.com/watch?v=QX_oy9614HQ

It might be hard to tell whether the impatient kids are (also?) dynamically inconsistent

Hyperbolic Discounting

In

$$U(c_0, c_1, c_2, \ldots) = a_0 u(c_0) + a_1 u(c_1) + a_2 u(c_2)$$

replace

$$a_t = \delta^t$$

by

$$a_t = \frac{1}{1 + kt}$$

The β – δ Model

Instead of

$$U(c_0, c_1, c_2, \ldots) = a_0 u(c_0) + a_1 u(c_1) + a_2 u(c_2)$$

Give the first period an extra (relative) weight:

David Laibson
(b. 1966)

$$U(c_0, c_1, c_2 \ \ldots) = u(c_0) + \beta[\delta u(c_1) + \delta^2 u(c_2) + \ \ldots]$$

with a discount factor $0 < \beta, \delta < 1$

Reference

Golden Eggs and Hyperbolic Discounting

David Laibson

The Quarterly Journal of Economics, Vol. 112 No. 2 (May 1997), pp. 443-478

Abstract

Hyperbolic discount functions induce dynamically inconsistent preferences, implying a motive for consumers to constrain their own future choices. This paper analyzes the decisions of a hyperbolic consumer who has access to an imperfect commitment technology: an illiquid asset whose sale must be initiated one period before the sale proceeds are received. The model predicts that consumption tracks income, and the model explains why consumers have asset-specific marginal propensities to consume. The model suggests that financial innovation may have caused the ongoing decline in U. S. savings rates, since financial innovation increases liquidity, eliminating commitment opportunities. Finally, the model implies that financial market innovation may reduce welfare by providing “too much” liquidity.

Critique of the β – δ Model

Present-bias, quasi-hyperbolic discounting, and fixed costs

Jess Benhabib, Alberto Bisin, Andrew Schotter

Games and Economic Behavior, Vol. 69 No. 2 (July 2010), pp. 205-223

Abstract

In this paper we elicit preferences for money–time pairs via experimental techniques. We estimate a general specification of discounting that nests exponential and hyperbolic discounting, as well as various forms of *present bias*, including quasi-hyperbolic discounting.

We find that discount rates are high and decline with both delay and amount, as most of the previous literature. We also find clear evidence for present bias. When identifying the form of the present bias, little evidence for quasi-hyperbolic discounting is found. The data strongly favor instead a specification with a small present bias in the form of a fixed cost, of the order of $4 on average across subjects. With such a fixed cost the curvature of discounting is imprecisely estimated and both exponential and hyperbolic discounting cannot be rejected for several subjects.

Attitudes to dynamic inconsistency

Ted O'Donoghue

Matthew Rabin (b, 1963)

Donoghue and Rabin suggested to distinguish between naïve and sophisticated decision makers

Reference

Doing it now or later?

Ted O'Donoghue, Matthew Rabin

American Economic Review, Vol. 89 No. 1 (1999), pp. 103-124

Abstract

The authors examine self-control problems--modeled as time-inconsistent, present-biased preferences--in a model where a person must do an activity exactly once. They emphasize two distinctions: do activities involve immediate costs or immediate rewards, and are people sophisticated or naive about future self-control problems? Naive people procrastinate immediate-cost activities and preproperate--do too soon--immediate-reward activities. Sophistication mitigates procrastination but exacerbates preproperation. Moreover, with immediate costs, a small present bias can severely harm only naive people, whereas with immediate rewards it can severely harm only sophisticated people. Lessons for savings, addiction, and elsewhere are discussed.

Main Biases

- Availability
- Representativeness
- Anchoring

- Mental Accounting
- Dynamic Inconsistency

A catalogue of pitfalls

- Framing effects
- Loss aversion and gain/loss asymmetry
- Endowment effect
- Compromise and decoy effects
- Sunk cost
- Availability
- Representativeness
- Anchoring
- Mental accounting
- Dynamic Inconsistency

Summary

- Many of the classical economic assumptions are violated
- Some violations are more rational than others
- Formal models may help us decide which modes of behavior we would like to change

Exercises Chapter 2 – Problem 1

Some people are afraid of flights. They are often surprised to learn that many more people lose their lives in motor vehicle accidents (on the ground) than in flights. Why are their evaluations of these numbers inaccurate? And does it follow that flying is less dangerous than driving?

Exercises Chapter 2 – Problem 2

Credit card companies used to offer students loans at enticing rates. Presumably, this was an example of voluntary trade among adults, which should be allowed in a free market. Provide a reason for which such offers may be restricted by law.

Exercises Chapter 2 – Problem 3

Mary noticed that, when she gets an unexpected bonus from her employer, she allows herself to buy goods she didn't plan to buy, and often ends up spending an amount of money larger than her bonus. What psychological effect is related to this phenomenon, and what goes wrong in her decision making?

CONSUMING STATISTICAL DATA

Conditional Probabilities

Problem 3.1

A newly developed test for a rare disease has the following features: if you do not suffer from the disease, the probability that you test positive ("false positive") is 5%. However, if you do have the disease, the probability that the test fails to show ("false negative") is 10%.

You took the test, and, unfortunately, you tested positive.

The probability that you have the disease is:

The missing piece

The a-priori probability of the disease,

$$P\,(D)\ =\ p$$

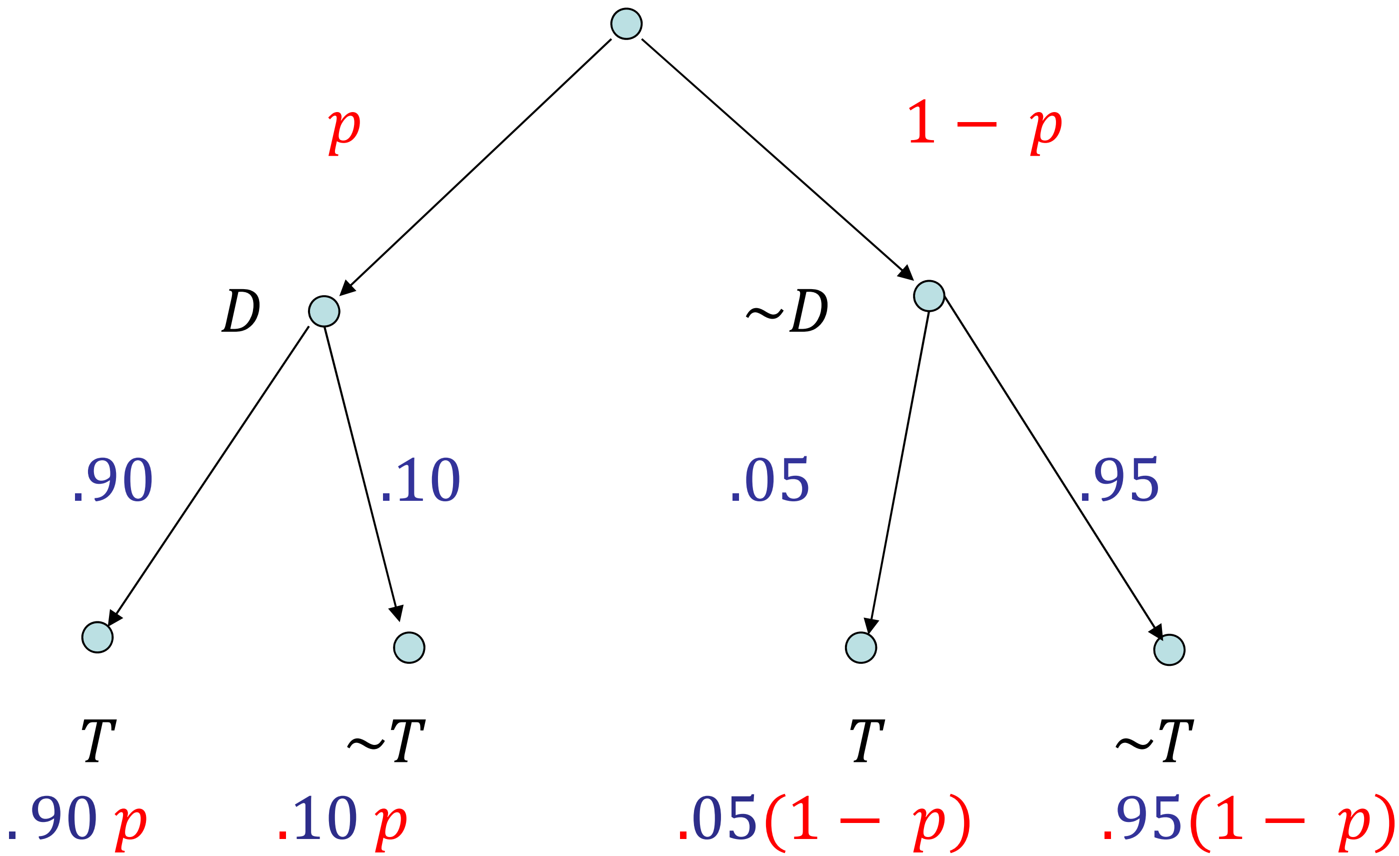
Intuitively, assume that $p = 0$ vs. $p = 1$

Maybe the disease is known to be extinct ($p = 0$)

The accuracy of the test is unchanged, there are still false positives

Maybe I'm anyway diagnosed ($p = 1$)

Conditional probabilities



The calculation

$$P(D|T) = \frac{\mathrm{P}(D \cap T)}{\mathrm{P}(T)}$$

$$= \frac{.90p}{.90p + .05(1-p)}$$

with $p = P(D)$

… can indeed be anywhere between 0 and 1 !

For example…

If, say, $P(D) = .01$,

$$P(D|T) = \frac{.90p}{.90p + .05(1-p)}$$

$$= \frac{.01 * .90}{.01 * .90 + .99 * .05} = 15.3\%$$

So

$$P(D|T) > P(D)$$

but

$$P(D|T) < 50\%$$

That is,

$$P(D \mid T) > P(D)$$

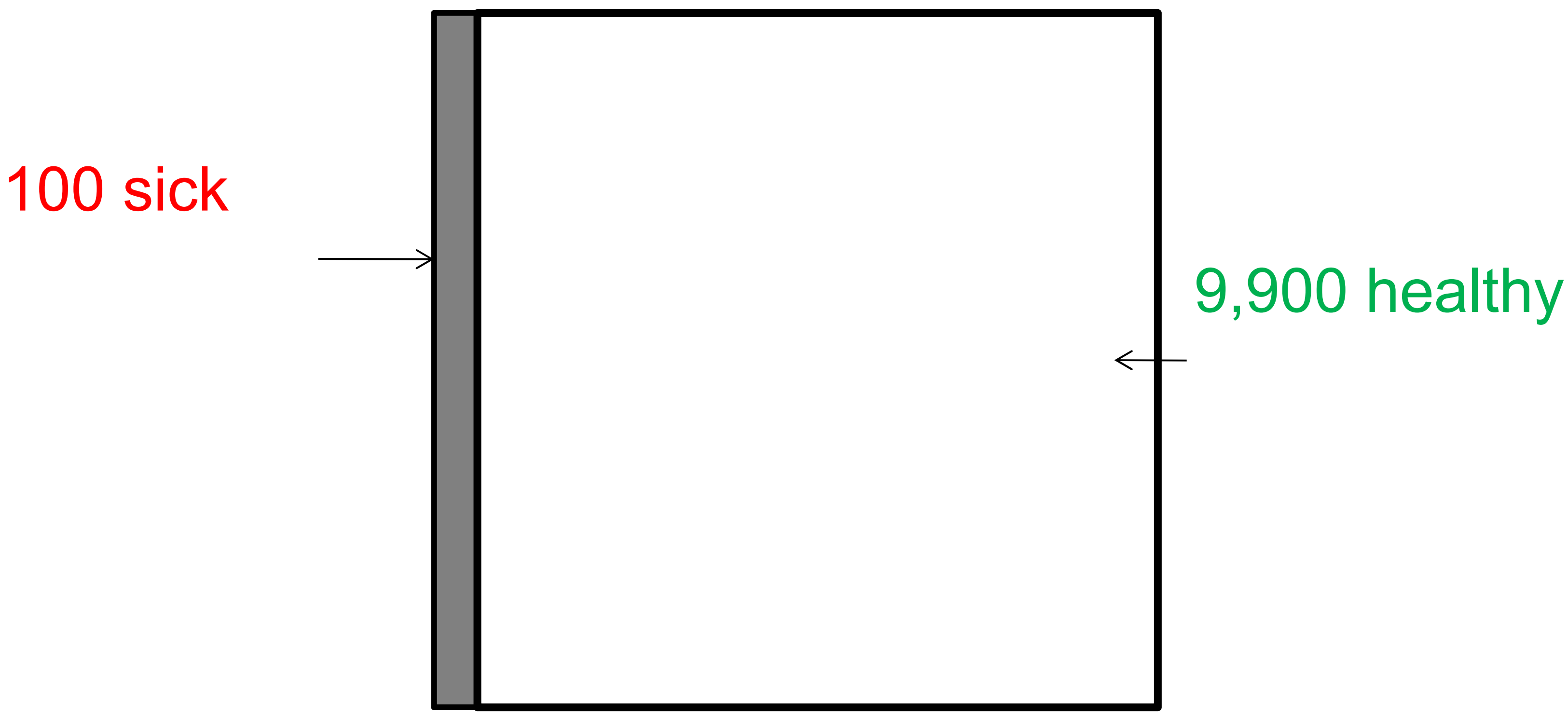
means that testing positive isn't good news

but

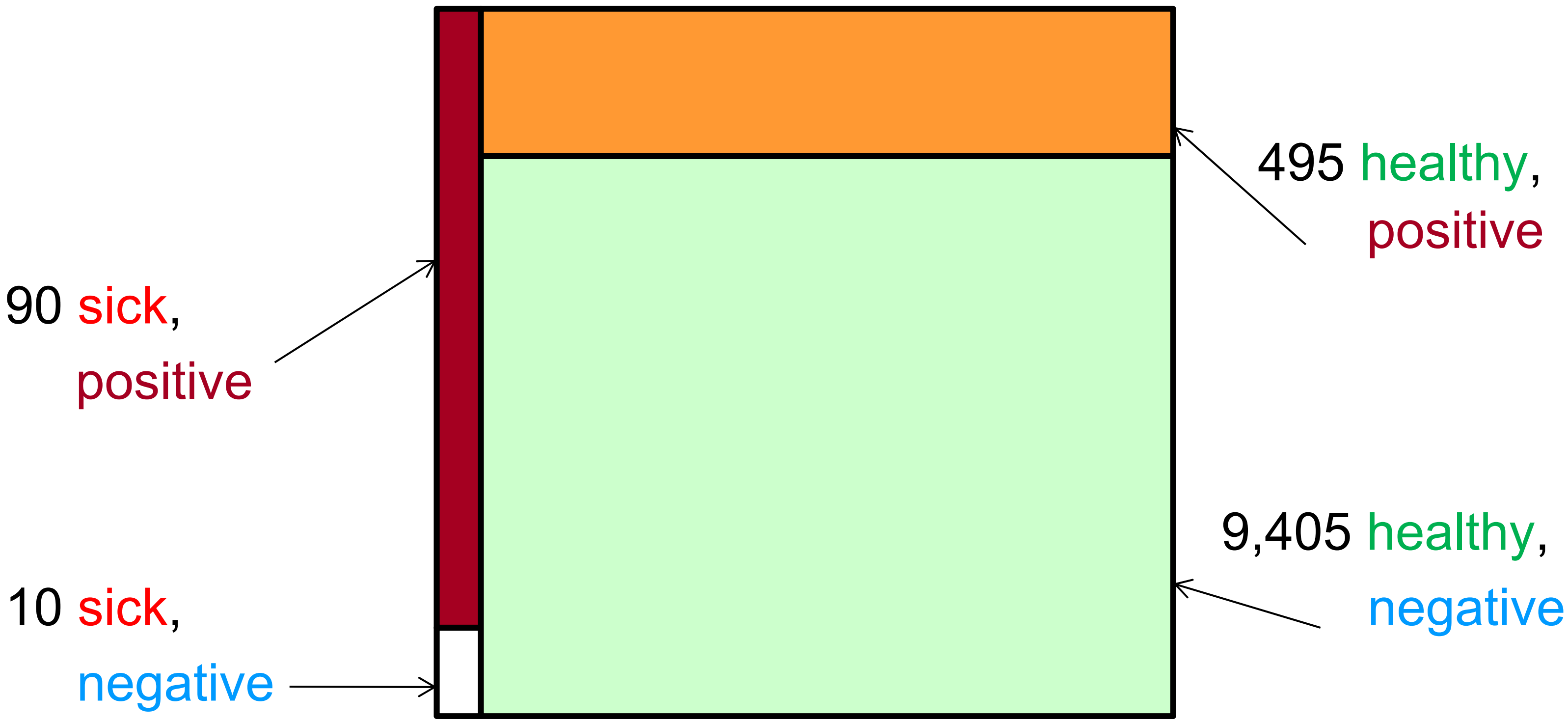
$$P(D \mid T) < 50\%$$

says it's not the end of the world either

The frequency story



The frequency story cont.



Ignoring Base Probabilities

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

$$P(B|A) = \frac{P(A \cap B)}{P(\mathrm{A})}$$

So

$$P(B|A)P(A) = P(A \cap B) = P(A|B)P(B)$$

and

$$P(B|A) = \frac{P(B)}{P(A)}P(A|B)$$

Ignoring Base Probabilities

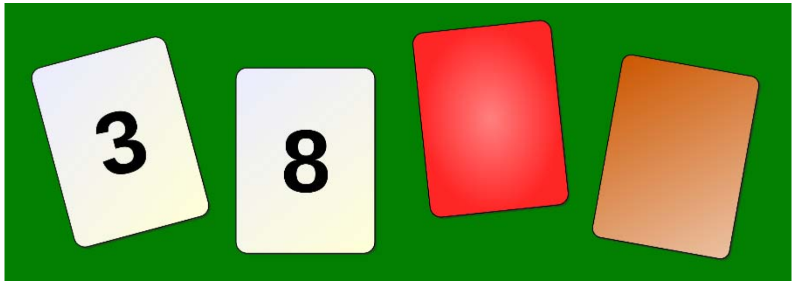
$$P(B|A) = \frac{P(B)}{P(\mathrm{A})} P(A|B)$$

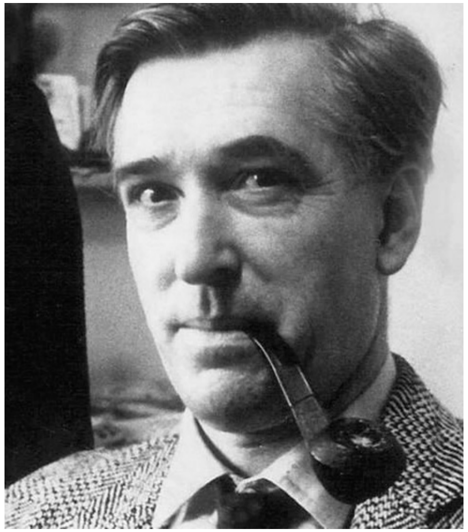
In general,

$$P(B|A) \neq P(A|B)$$

The deterministic analog

Wason selection task





Peter C. Wason (1924-2003)

Reasoning
Peter C. Wason (1966)
In Foss, B. M. (ed.). *New horizons in psychology* **1**
Harmondsworth: Penguin (1966)

Reference

Reasoning about a rule

Peter C. Wason

The Quarterly Journal of Experimental Psychology, Vol. 20 No. 3 (1968), pp. 273-281

Abstract

Two experiments were carried out to investigate the difficulty of making the contra-positive inference from conditional sentences of the form, “if P then Q.” This inference, that not-P follows from not-Q, requires the transformation of the information presented in the conditional sentence. It is suggested that the difficulty is due to a mental set for expecting a relation of truth, correspondence, or match to hold between sentences and states of affairs. The elicitation of the inference was not facilitated by attempting to induce two kinds of therapy designed to break this set. It is argued that the subjects did not give evidence of having acquired the characteristics of Piaget's “formal operational thought.”

Though…

The effect of experience on performance in Wason’s selection task

James R. Cox, Richard A. Griggs

Memory and Cognition, Vol. 10 No. 5 (1982), pp. 496-502

Abstract

The Wason selection task is a hypothetico-deductive reasoning problem employing the logical rule of implication. Recent studies have indicated that performance on this task may be related to subjects' experience with the task content. Five versions of the task that differed in the manner in which they were related to the subjects' experience with a familiar implication relationship were examined. The correct solution rate varied as a function of both the subjects' extraexperimental and intraexperimental experience. A memory-cuing/reasoning-by-analogy explanation is proposed to account for the direct relationship between performance and the degree ofsimilarity to subjects' experience.

Why do we get confused?

It is true that

$$P(A \mid B) > P(A \mid \sim B)$$

is equivalent to

$$P(B \mid A) > P(B \mid \sim A)$$

Correlation is symmetric; but, generally,

$$P(B \mid A) \neq P(A \mid B)$$

Social prejudice

It is possible that:

Most top squash players are Pakistani

but

Most Pakistanis are not top squash players

(Pick your favorite prejudice…)

Problem 3.2

You are going to play the roulette. You first sit there and observe, and you notice that the last five times it came up "Black." Would you bet on "Red" or on "Black"?

The Gambler’s Fallacy

- If you believe that the roulette is fair, there is independence
- By definition, you can learn nothing from the past about the future
- Kahneman and Tversky: The law of large numbers doesn’t say that errors get corrected, they are simply diluted

The Law of Large Numbers (LLN)

Roughly, the average converges

to the expectation

Giving meaning to "expectation"

Jacob (James or Jacques) Bernoulli (1654 – 1705)

The LLN more formally

Let X_i be I.I.D. (Independently and Identically Distributed) and consider their average (obviously, also a random variable) :

$$\bar{X}_n = \frac{1}{n} \sum_{i=1}^{n} X_i$$

Then, with probability 1,

$$\bar{X}_n \rightarrow \mu = E(X_i)$$

when

$$n \rightarrow \infty$$

($\mu = E(X_i)$ is the expectation of each variable, hence also of the average)

LLN's assumptions

- If the variables are not independent, the theorem doesn't hold
  - Insuring houses in California against earthquakes
- If the variables are not identically distributed, the theorem doesn't hold (what would it say, exactly?)
  - Insurance for different levels of risk (and the Lemons problem)
- And if n is small, the theorem doesn't say much

Errors are "diluted"

Suppose we observe 1000 blacks

The prediction for the next $1{,}000{,}000$ will still be around

$$500{,}000\ ;\ 500{,}000$$

Resulting in

$$501{,}000\ ;\ 500{,}000$$

But

- It's very unlikely to get six Black's in a row…
- Indeed, the probability of $BBBBBB$ is $\left(\frac{1}{2}\right)^6 = \frac{1}{64}$
- But so is the probability of $BBBBBR$ – also $\left(\frac{1}{2}\right)^6 = \frac{1}{64}$

  As well as the probability of $BRBBRB$, $RBBRBR$…

Why do we get confused?

One possibility:

Confounding conditional and unconditional probabilities

- Thinking of $P(A)$ instead of $P(A|B)$
- The probability of two bombs on the plane is very low (ε^2) but it doesn't mean that it will help you to bring one yourself

Another effect

We use memory to assess likelihood

And then $BBBBBB$ is very special, in “a class of its own”

with low probability $\left(\frac{1}{2}\right)^6 = \frac{1}{64} = 1.5\%$

While $BRBRRB$, $RBBRBR$ may be lumped together

For example, the probability of 3 R out of 6 is

$$\binom{6}{3}\left(\frac{1}{2}\right)^6 = \frac{20}{64} = 31.25\%$$

Yet, to be honest

If the state lottery were to come up with $1,2,3,4,5,6$ (out of $1, \ldots, 47$) I'd be very surprised

(That's why I don't play the lottery)

I'd react differently to $1,2,3,4,5,6$ than to, say,

$$3,8,12,14,25,36$$

The Bulgarian State Lottery

- From a BBC news website (Sep 2009)

Bulgarian lottery repeat probed

The Bulgarian authorities have ordered an investigation after the same six numbers were drawn in two consecutive rounds of the national lottery.

The numbers - 4, 15, 23, 24, 35 and 42 - were chosen by a machine live on television on 6 and 10 September.

An official of the Bulgarian lottery said manipulation was impossible.

A mathematician said the chance of the same six numbers coming up twice in a row was one in four million. But he said coincidences did happen.

Why?

- Is it “rational to be surprised” by 1,2,3,4,5,6 ?
- Well, maybe. If there is an alternative theory to “pure randomness”
- If we’re rational, we should probably always entertain some doubt about the data we were provided

Maybe the roulette is not fair?

- Indeed, we will have to conclude this after, say, $1{,}000{,}000$ Black's.

- But then we will expect Black, not Red

… It's hard to explain a preference for Red

Wait a minute…

- If the random variables are independent of each other, how do we learn?
- If we take a sample of, say, 100 X_i's, do we know more about X_{101}?
- If so – what happened to independence?
- If not – why are we taking the sample?

Two approaches to statistics

- Classical Statistics
  - There is no probability over unknown parameters
  - Probabilities are only over random variables given the unknown parameters
- Bayesian Statistics
  - There is probability over any unknown
  - If not objective – then subjective

Subjective Probabilities

Pascal, one of the founders of probability theory (if not *the* founder)

for games of chance ("risk")

suggested subjective probabilities and expected utility maximization in his "Wager"

Blaise Pascal (1623-1662)

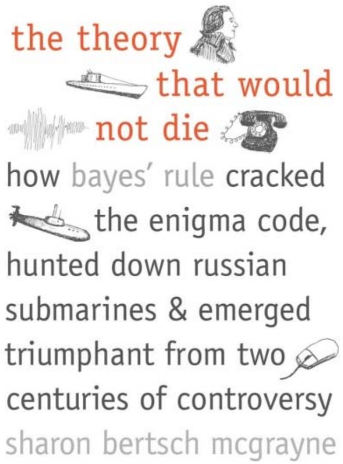
And then came Bayes

Bayesian updating is called after…

Rev. Thomas Bayes (1702-1761)

"Bayesian" – committed to having a subjective prior probability over any unknown

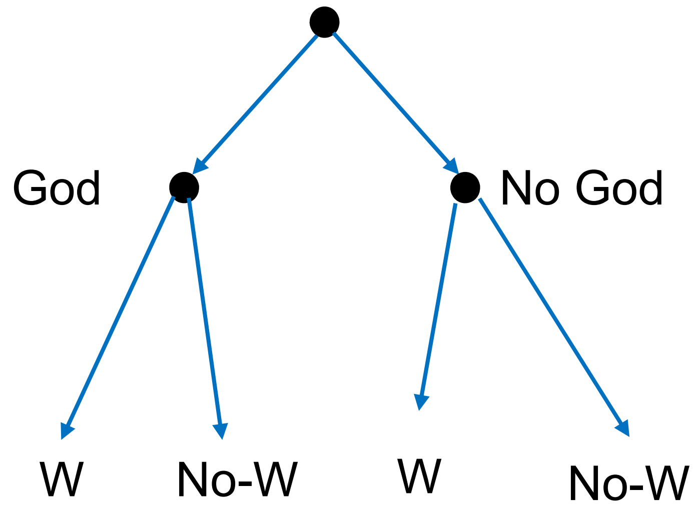
Relying on



Sharon B. McGrayne (b. 1942)

The existence of God

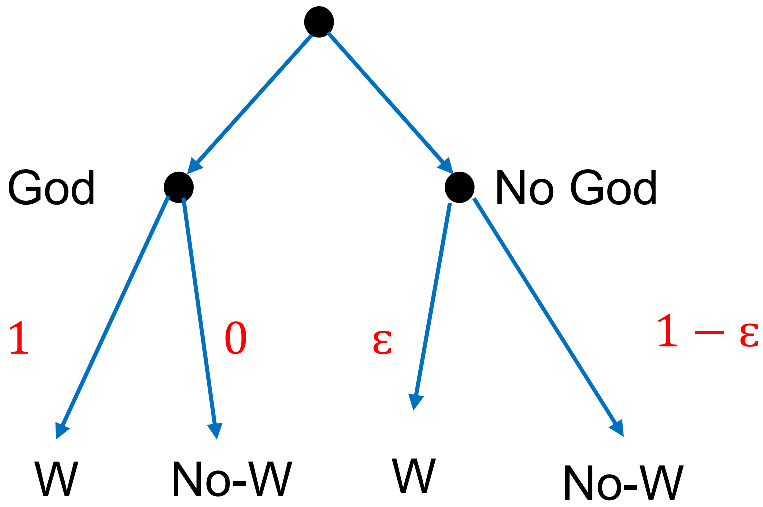
As described in McGrayne (2011), Bayes wanted to prove it:



The conditional probabilities

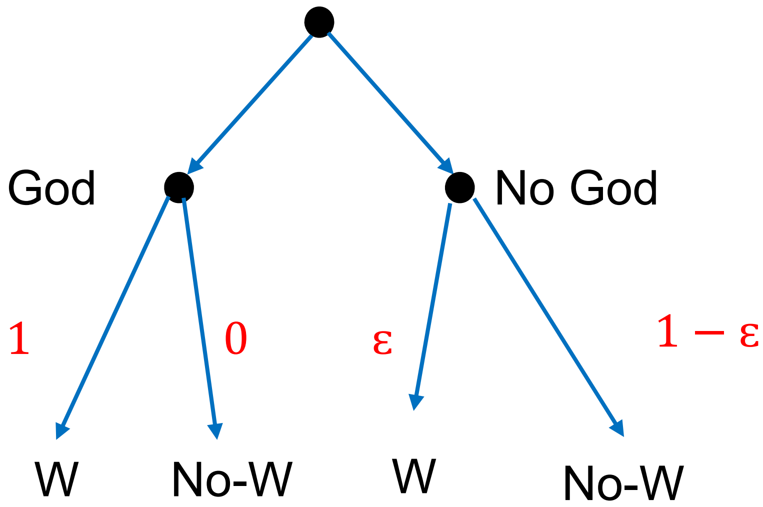
If God exists, we'll surely find the World as we know it

If not…

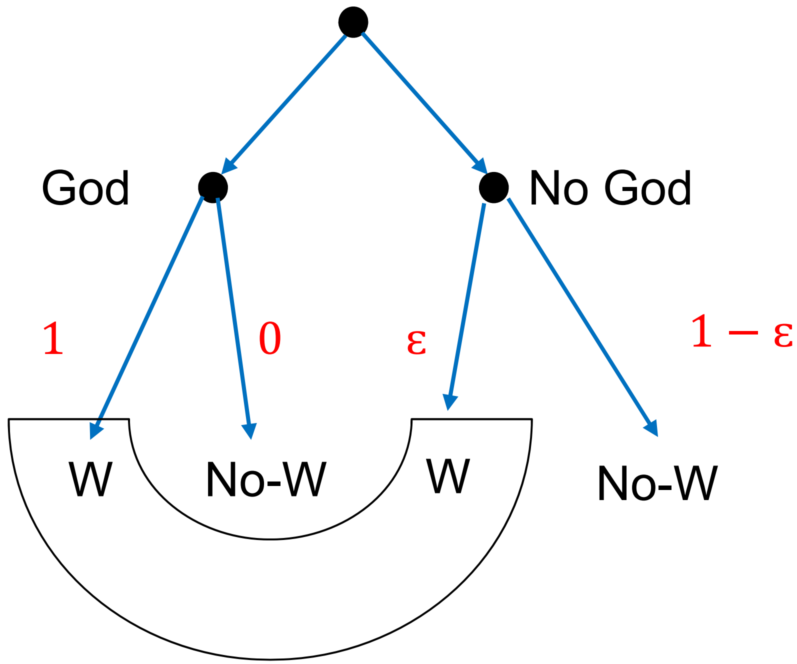


But we want the other direction…

$$P(\text{God}|\text{World}) \neq P(\text{World}|\text{God})$$



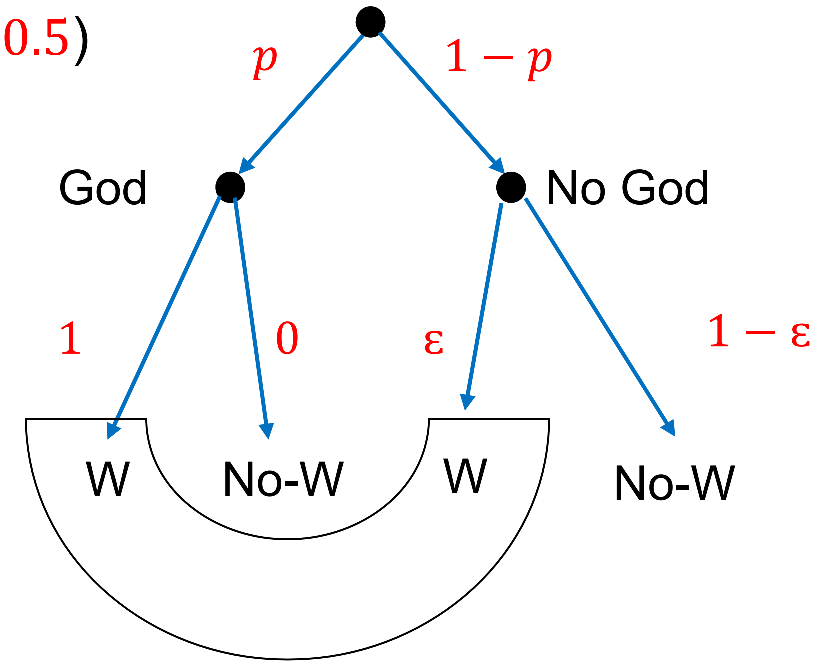
We need to collect probabilities



And we need a prior!

And then the argument can be completed

(Bayes used $p = 0.5$)



Time passed by

- The Bayesian approach is inherently subjective
- Which might be a reason it wasn't discussed much in the 19th century
- But in the 20th…
  - Bruno de Finetti (1931, 1937)
  - Bayesian Statistics
  - Big fights in the 1930-40s
  - More convergence today

Bayesian Statistics

- Tries to quantify subjective hunches, intuition

- Uses only probability

Bruno de Finetti (1906-1985)

Classical Statistics

- Trying to be objective
- Uses confidence intervals, hypotheses tests
- "Confidence", "significance" – not "probability"

Ronald A Fisher (1890-1962)

Back to our question

- If the random variables are independent from each other, how do we learn?
- If you're Classical statistician, you learn outside of the probability model
- If you're Bayesian, you don't have independence indeed
- You have only exchangeability (de Finetti)

Is the roulette fair?

- A Classical statistician will assume independence *given* the parameter of the roulette wheel, and will learn from observations about this parameter outside the probability model
- A Bayesian statistician will assume only conditional independence (*given* the parameter of the roulette wheel), and will learn about the parameter by Bayes’s updating

Biased Samples

Problem 3.3

A study of students’ grades in the US showed that immigrants had, on average, a higher grade point average than did US-born students. The conclusion was that Americans are not very smart, or at least do not work very hard, as compared to other nationalities.

Biased Samples

- The point: immigrants are not necessarily representative of the home population

- The Literary Digest 1936 fiasco
  - They predicted Alf Landon would beat Franklin Delanor Roosevelt 57% to 43%
  - As it turned out, Roosevelt won 62% to 37%

More Biased Samples

Everyday examples:

- Students who participate in class
- Citizens who exercise the right to vote

The Corona Virus

From the NY Times, February 13, 2020, an interview with Prof. Nicholls:

"… that just as with SARS there's probably much stricter guidelines in mainland China for a case to be considered positive. So the 20,000 cases in China is probably only the severe cases; the folks that actually went to the hospital and got tested. The Chinese healthcare system is very overwhelmed with all the tests going through. So my thinking is this is actually not as severe a disease as is being suggested. The fatality rate is probably only 0.8%-1%. There's a vast underreporting of cases in China.

Problem 3.4

In order to estimate the average number of children in a family, a researcher sampled children in a school, and asked them how many siblings they had. The answer, plus one, was averaged over all children in the sample to provide the desired estimate.

Inherently Biased Samples

Here the very sampling procedure introduces a bias.

A family of 8 children has 8 times higher chance of being sampled than a family of 1.

$$\frac{8 * 8 + 1 * 1}{9} = 7.22 > 4.5 = \frac{8 + 1}{9}$$

But

It is true that most children have many siblings

Whether a sample is biased or not depends on your question

How many poor families are there?

How many children grow in poverty?

Problem 3.5

A contractor of small renovation projects submits bids and competes for contracts. He noticed that he tends to lose money on the projects he runs. He started wondering how he can be so systematically wrong in his estimates.

The Winner's Curse

- Firms that won auctions tended to lose money
- Even if the estimate is unbiased ex-ante, it is not unbiased ex-post, given that one has won the auction.
- If you won the auction, it is more likely that this was one of your over-estimates rather than one of your under-estimates.

The Winner's Curse – an Example

Real worth of an oil field – an unknown μ

Two firms ask experts for estimates

Each one provides an unbiased random variable X_i

$(i = 1,2)$

The estimators are unbiased: $E(X_i) = \mu$

Say, X_i can be $\mu - 5$, μ, $\mu - 5$ with equal probabilities

The Example – cont.

Joint distribution (probabilities)

X_1 \ X_2	$\mu-5$	μ	$\mu+5$	
$\mu-5$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{3}$
μ	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{3}$
$\mu+5$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{3}$
	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	1

The Example – cont.

Probability of Firm 1 winning the contract

X_1 \ X_2	$\mu - 5$	μ	$\mu + 5$	
$\mu - 5$	$\frac{1}{18}$	0	0	$\frac{1}{18}$
μ	$\frac{1}{9}$	$\frac{1}{18}$	0	$\frac{3}{18}$
$\mu + 5$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{18}$	$\frac{5}{18}$
	$\frac{5}{18}$	$\frac{3}{18}$	$\frac{1}{18}$	$\frac{1}{2}$

The Example – cont.

Firm 1's payoff

X_1 \ X_2	$\mu - 5$	μ	$\mu + 5$
$\mu - 5$	$+5$	0	0
μ	0	0	0
$\mu + 5$	-5	-5	-5

The Example – cont.

Expected profit for Firm 1

X_2 / X_1	$\mu - 5$	μ	$\mu + 5$	
$\mu - 5$	$\frac{1}{18}$	0	0	$\frac{1}{18} * (+5)$
μ	$\frac{1}{9}$	$\frac{1}{18}$	0	$\frac{3}{18} * (0)$
$\mu + 5$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{18}$	$\frac{5}{18} * (-5)$
				$-\frac{20}{18}$

The Winner's Curse – main point

- The auction introduces a bias
- Given the fact that you won, you're more likely to be on the higher side
- Just imagine there were 10 firms

Regression to the Mean

Problem 3.6

Ann: “Do you like your dish?”

Barbara: “Well, it isn’t bad. Maybe not as good as last time, but…”

This restaurant

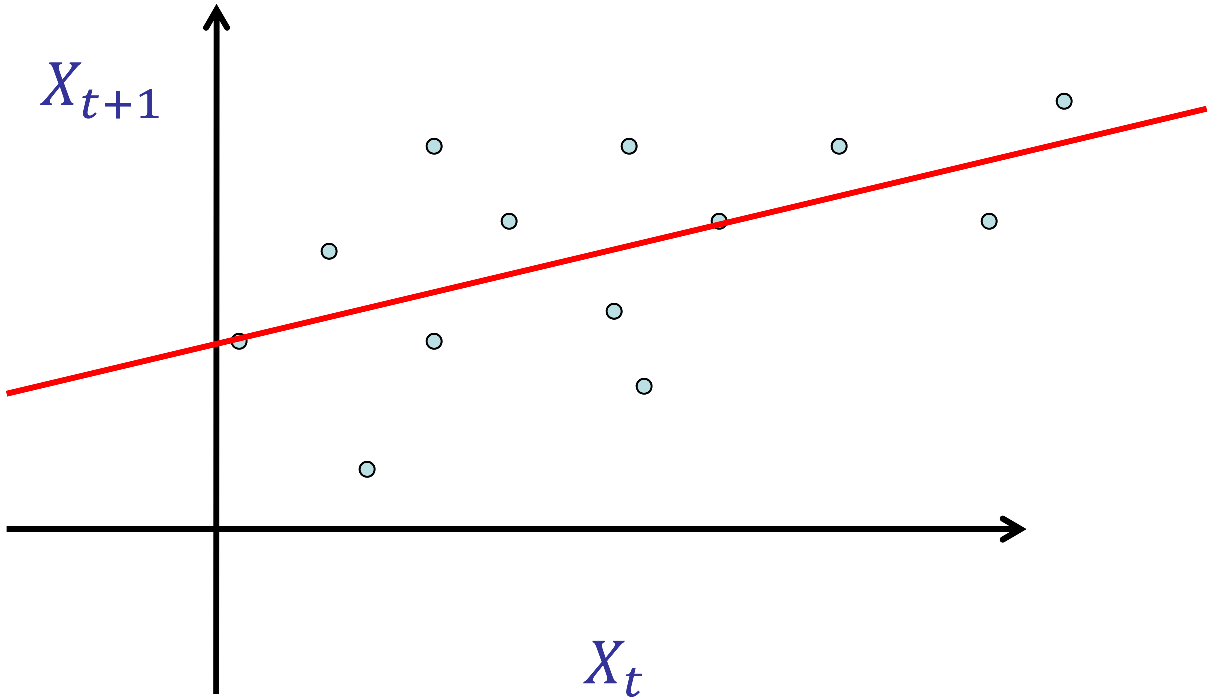
… isn’t as good as we recall it. Why?

- Maybe they don’t make an effort any longer
- Maybe we developed expectations

But also…

Regression to the Mean

Regressing $X_{t+1} = X_t + \varepsilon_t$



Why is called linear “regression”?

The method of least squares was invented by Legendre (1805) and Gauss (1809)

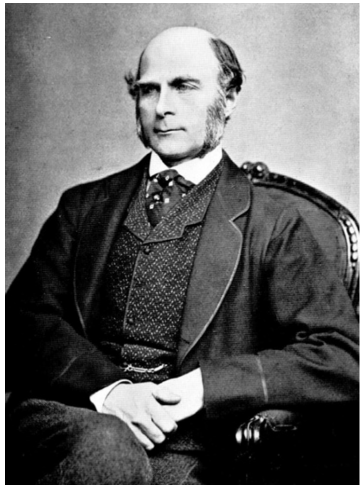
Carl Friedrich Gauss (1777-1855)

Adrien-Marie Legendre (1752-1833)

But “regression” is due to

Galton regressed the height of descendants on the height of parents

(Around the mid-1880s)



Francis Galton (1822-1911)

Regression to the Mean – main points

- We should expect an increasing line

- We should expect a slope < 1

- It need not follow a temporal or causal direction

… and in everyday life

- Students selected by grades
- Your friend’s must-see movie
- The broker with the best performance over the past 5 years
- The best mayor

…

Causality

Problem 3.7

Studies show a high correlation between years of education and annual income. Thus, argued your teacher, it’s good for you to study: the more you do, the more money you will make in the future.

Correlation and Causality

Possible reasons for correlation between X and Y:

- X is a cause of Y
- Y is a cause of X
- Z is a common cause of both X and Y
- Coincidence (should be taken care of by statistical significance)

Problem 3.8

In a recent study, it was found that people who did not smoke at all had more visits to their doctors than people who smoked a little bit. One researcher claimed, "Apparently, smoking is just like consuming red wine – too much of it is dangerous, but a little bit is actually good for your health!"

Correlation and Causality – cont.

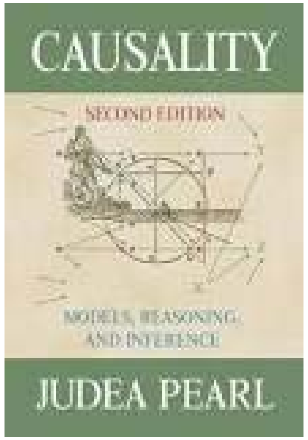
Other examples:

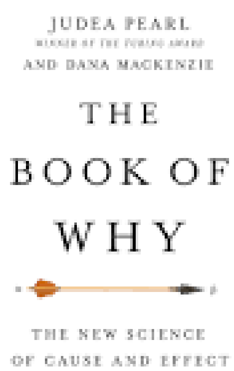
- Do hospitals make you sick?
- Will a larger hand improve the child's handwriting?

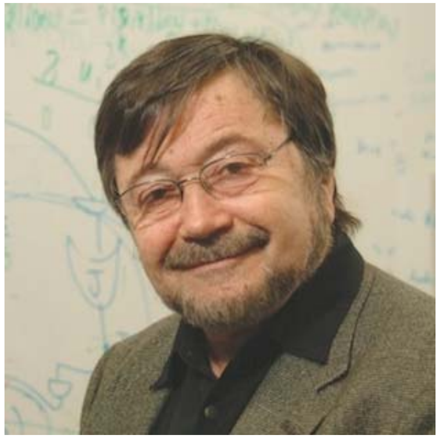
How to establish causality?

Major debates, as well as advancements

(Causality, 2000, The Book of Why, 2018)





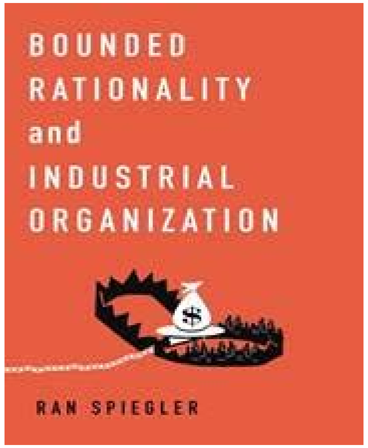


Judea Pearl (b. 1936)

Misperception of causality

Behavioral implications of causal misperceptions

Part of a larger project of IO implications of bounded rationality



Ran Spiegler (b. 1972)

Hypotheses Testing

Problem 3.9

Daniel: “Fine, it’s your decision. But I tell you, the effects that were found were insignificant.”

Charles: “Insignificant? They were significant at the 5% level!”

Statistical Significance

- Means that the null hypothesis can be rejected, knowing that, if it were true, the probability of being rejected is quite low
- Does not imply that the null hypothesis is wrong
- Does not even imply that the probability of the null hypothesis is low

The mindset of hypotheses testing

- We wish to prove a claim

- We state as the null hypothesis, H_0, its negation

- By rejection the negation, we will “prove” the claim

The mindset of hypotheses testing – cont.

- A test is a rule, saying when to say “reject” based on the sample
- Type I error: rejecting H_0 when it is, in fact, true
- Type II error: failing to reject H_0 when it is, in fact, false

The mindset of hypotheses testing – cont.

	H_0	H_1
Not reject	✓	Type II error
Reject	Type I error	✓

The mindset of hypotheses testing – cont.

- What is the probability of type I error?
  - Zero if the null hypothesis is false
  - Typically unknown if it is true
  - Overall, never known
- So what is the significance level, α ?
  - The maximal probability possible (over all values consistent with the null hypothesis)

The mindset of hypotheses testing – cont.

- We never state the probability of the null hypothesis being true

- Neither before nor after taking the sample

- This would depend on subjective judgment that we try to avoid

The mindset of hypotheses testing – Analogy

A court case

H_0 : The defendant is innocent

H_1 : The defendant is guilty

Asymmetry between the two

We give H_0 the benefit of the doubt

Acquittal does not mean a proof of innocence

The court case analogy

	H_0: innocent	H_1 : guilty
Not convict		Type II error
Convict	Type I error	

Problem 3.10

Mary: "I don't get it. It's either or: if you're so sure it's OK, why isn't it approved? If it's not yet approved, it's probably not yet OK."

Consistency?

Would you join an experimental study of a drug that hasn’t been approved yet?

In cases you’re sure you would, why not just approve it?

Classical and Bayesian Statistics

- Bayesian:
  - Quantify everything probabilistically
  - Take a prior, observe data, update to a posterior
  - Can treat an unknown parameter, μ, and the sample, X, on equal ground
  - A priori beliefs about the unknown parameter are updated by Bayes rule

Classical and Bayesian Statistics – cont.

- Classical:
  - Probability exists only given the unknown parameter
  - There are no probabilistic beliefs about it
  - μ is a fixed number, though unknown
  - X is a random variable (known after the sample is taken)
  - Uses "confidence" and "significance", which are not "probability"

Classical and Bayesian Statistics – cont.

- Why isn't "confidence" probability?
- Assume that $X \sim N\,(\mu, 1)$

$$Prob\,(\,|X - \mu| \leq 2\,) = 95\%$$

- Suppose

$$X = 4$$

- What is

$$Prob\,(\,2 \leq \mu \leq 6\,) = ?$$

Classical and Bayesian Statistics – cont.

- The question is ill-defined, because μ is not a random variable. Never has been, never will be
- The statement

$$Prob\ (|X - \mu| \leq 2) = 95\%$$

is a probability statement about X, not about μ

Classical and Bayesian Statistics – cont.

- If Y is the outcome of a roll of a die,

$$Prob\,(Y = 4) = \frac{1}{6}$$

- But we can't plug the value of Y into this, whether $Y = 4$ or not.
- Classical is complicated. Why use it?

A Bayesian approach to the court case

H_0 : The defendant is innocent

H_1 : The defendant is guilty

There is a prior probability on each (adding up to 1)

Evidence is gathered

The prior is updated to a posterior

Suppose the judge/jury is the defendant's mom

Suppose they're not…

Different Methods for Different Goals

	Classical	Bayesian
Goal	To be objective	To express also subjective biases and intuition
For	Making statements in a society	Making the best decision for oneself
Analogous to	Rules of evidence	Self-help tool
To be used when you try	To make a point	To make a decision

Which is why we need both

- It's perfectly consistent to acquit a defendant, but not to want to ever see him again
- Or to join an experimental drug testing sample without approving it
- To use your intuition in looking for conjectures, but avoid it when proving them
- To do empirical research by Classical statistics, while assuming that agents are Bayesian

Having said that

- Neither technique is perfect for its stated goal
- Classical statistics never achieves perfect objectivity
  - Objectivity is a direction, not a place
- Bayesian statistics may not be perfect in capturing our intuition
  - More on that later…

Main Mistakes

- Conditional probabilities
  - Confounding $P(A|B)$ with $P(B|A)$
  - Confounding $P(A|B)$ with $P(A)$
- Biased samples
- Regression to the mean
- Correlation and causation
- Over-interpretation of hypotheses tests

Main Lessons

- Probability models can help us think clearly about uncertainty

- This is true even when probabilities are not "objectively known"

Exercises Chapter 3 – Problem 1

A home owner who has a mortgage and who is not going to default may miss a payment on a particular month with probability 2.8%. (One who defaults obviously misses the payment for sure). If Mr A missed a payment, what is the probability that he is going to default?

- 2.8%
- 2.8%/[2.8%+1]
- 1/[2.8%+1]
- Cannot be determined.
- Can be determined, but differs from (a)-(c).

Exercises Chapter 3 – Problem 2

A leading newspaper followed up on the inflation rate predictions by several economists. It has selected the five with the best record, and asked them to predict the inflation in the current year. At the end of the year, it appeared that they were not so successful. The journalist concluded that we must be living in a very tumultuous period, where even top experts cannot make good predictions. This conclusion is

- Erroneous, and it reflects the journalist's anchoring bias.
- Reasonable, because the journalist can't tell the inflation rate either.
- Erroneous, as this might be a case of regression to the mean.
- Quite likely, though the journalist may still be exposed to an availability bias.

Exercises Chapter 3 – Problem 3

"Most journalists I met were superficial. Next time I see someone superficial, I'm going to ask them if they are journalists." Which statement would you endorse?

- It's not enough to know that most journalists are superficial – maybe most people are superficial anyway. One has to look at the comparison between superficial people among journalists and among non-journalists.
- Even if most journalists are superficial, it doesn't mean that most superficial people are journalists.
- Assuming that there are many more superficial people in the population that there are journalists, the percentage of superficial among the journalists must be larger than the percentage of journalists among the superficial.
- All of the above.
- None of the above.

Exercises Chapter 3 – Problem 4

Suppose that fashion models tend to be stupid more than the rest of the population. In this case

- We can conclude that the fashion industry tends to hire stupid people for modeling.
- We can conclude that the life of a model tend to dull the mind.
- We can conclude that the fashion industry chooses its models according to some criteria that correlate negatively with intelligence.
- All of the above (All are warranted conclusions).
- None of the above.

Exercises Chapter 3 – Problem 5

- Your friend has a car repair shop, specializing in transmission systems. You told him that you consider buying a car of make A, which is not very popular. His reaction was, “Don’t get near them – I fix their transmission all the time. In fact, they’re 90% of my business!” What can you say based on your friend’s experience?
  - That, if you buy a car of make A, you’ll have 90% probability of transmission problems.
  - That, if you buy a car of make A, you’ll be more likely to have transmission problems than not.
  - That, if you buy a car of make A, you’ll be more likely to have transmission problems than if you buy a car made by another make.
  - All of the above.
  - None of the above.

Exercises Chapter 3 – Problem 6

A certain genetic disease is recessive, which implies that a child might have it only if both parents are carriers of the disease. The probability of each person being a carrier is 2%. One of two prospective parents took a test and was found to be a carrier. Before the second took the test, the doctor said, “Oh, don’t worry: I have seen people who were carriers of the disease in my life, but I’ve never seen two parents being carriers!” Do you support the doctor’s view?

Exercises Chapter 3 – Problem 7

We wish to estimate the expectation μ of a random variable X. We ask two statisticians, one classical and the other Bayesian, to do the job. The difference between them will be that

- The Bayesian one will have a guess about μ even before taking the sample.
- The Bayesian one will not take a sample at all.
- The classical one will generate a confidence interval, but she will not truly think that it contains the parameter μ.
- The classical one will prefer counter-intuitive answers.
- All of the above.

Exercises Chapter 3 – Problem 8

The difference between confidence intervals and hypotheses tests is that

- The confidence level is a probability only a priori, before taking the sample, whereas significance is a probability also after the sample has been taken.
- Significance looks at the difference between values of the unknown parameters, and not just at the probabilities of type I and type II errors.
- Confidence intervals are general-purpose estimation technique, whereas each hypothesis test is tailored to a particular statement.
- All of the above.
- None of the above.

DECISION UNDER RISK

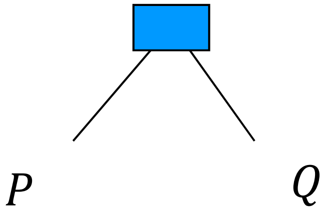
Expected Utility Theory

Problems 4.1 and 4.6

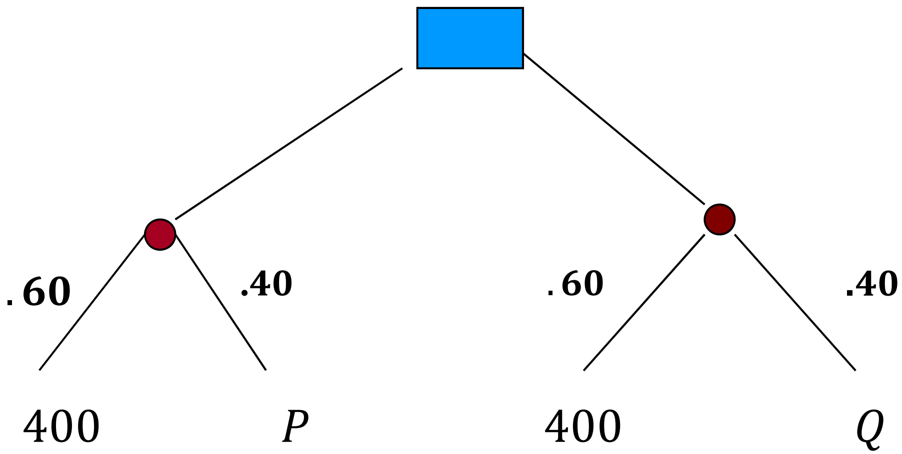
Problem 4.1

$P = (.5, 0\ ;\ .5, 1000)$

$Q = (1{,}500)$

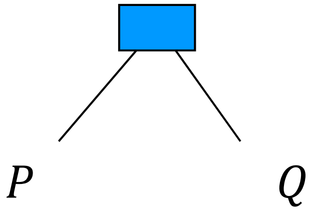


Problem 4.6



Problems 4.2 and 4.7

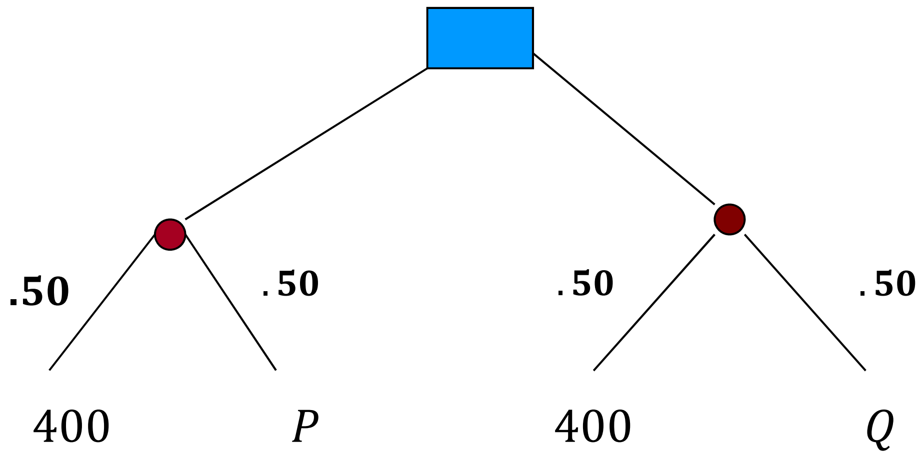
Problem 4.2



$$P = (.2, 0\ ;\ .8, 1000)$$

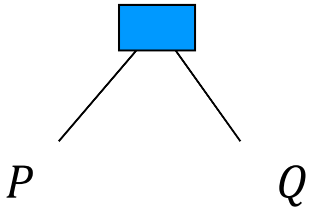
$$Q = (1{,}500)$$

Problem 4.7



Problems 4.3 and 4.8

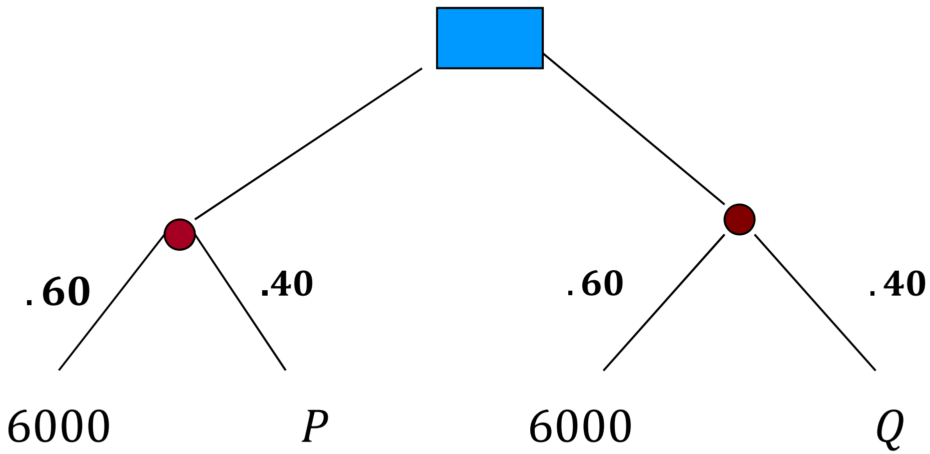
Problem 4.3



$$P = (.5, 2000\,;\ .5, 4000)$$

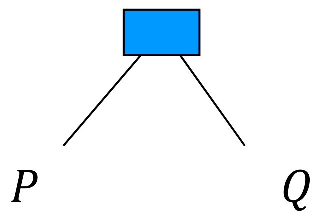
$$Q = (.5, 1000\,;\ .5, 5000)$$

Problem 4.8



Problems 4.4 and 4.9

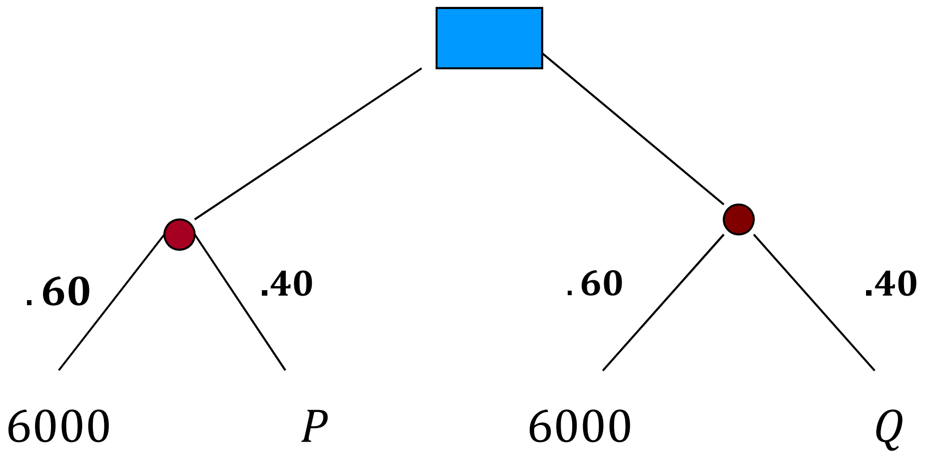
Problem 4.4



$P = (.5, 2000\ ;\ .5, 4000)$

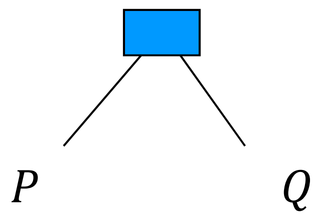
$Q = (.4, 1000\ ;\ .6, 5000)$

Problem 4.9

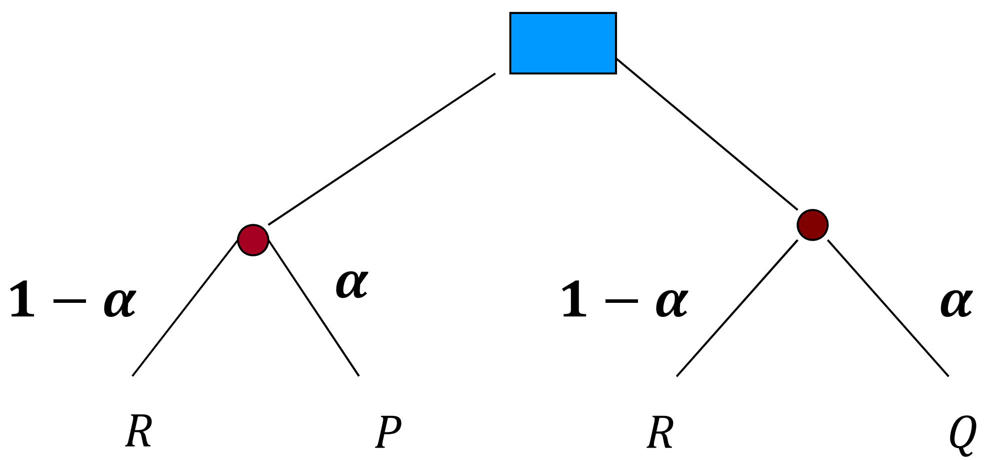


The Independence Axiom

The choice

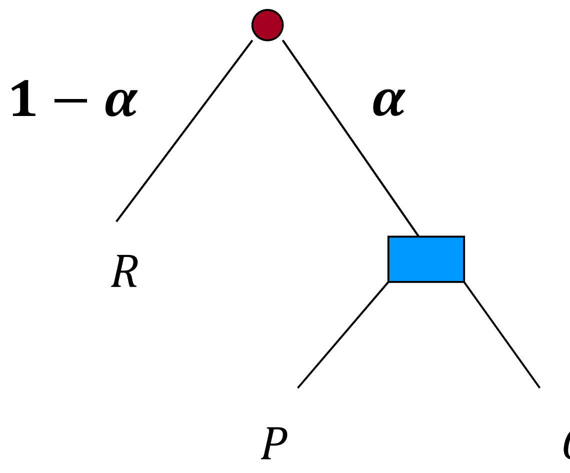


would/should be the same as

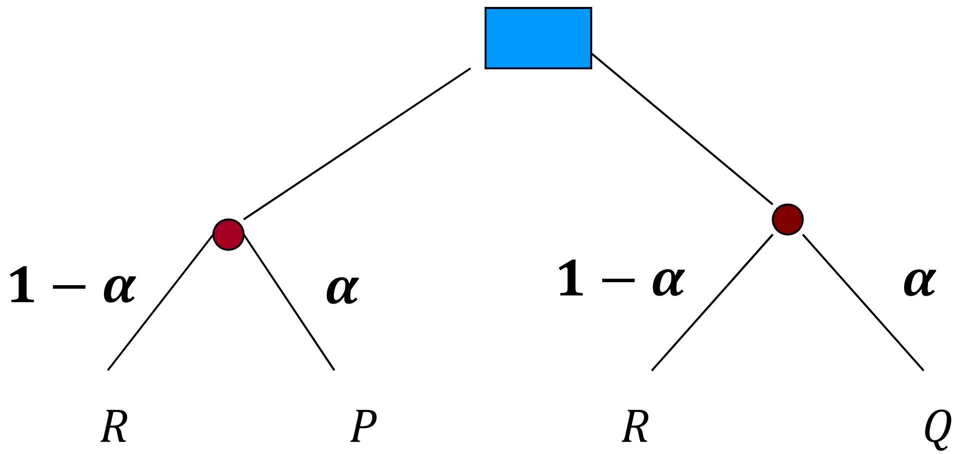


Assumption 1: Rational planning

Compare your plan for choice in



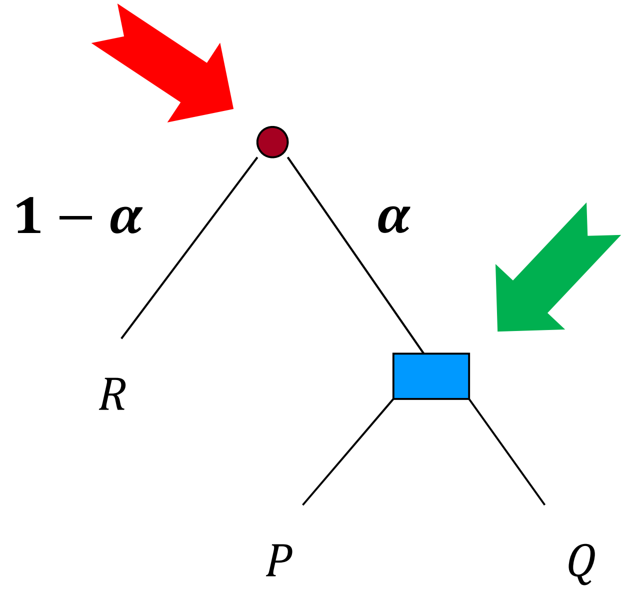
and your actual choice in



Assumption 2: Dynamic Consistency

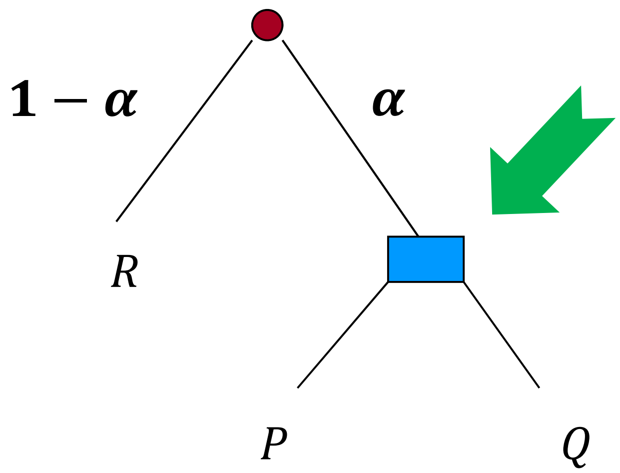
Your plan for choice in

will indeed be followed

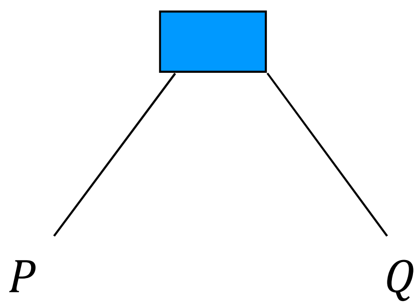


Assumption 3: Consequentialism

Your choice if and when you get to it in



will be the same as your choice in



Thus, Independence might not hold if

- We can’t plan rationally
  - Cognitive limitations: can one plan one’s reaction to an event such as Sep 11, 2001?
- We may not follow our plans
  - Emotional reactions: how would I respond to temptation? How would I deal with anger?
- We feel that the lotteries in the subtree aren’t the same as they would have been in a separate tree
  - History has an effect

The Independence Axiom as a formula

The preference between two lotteries P and Q is the same as between

$$(\alpha, P; (1-\alpha), R)$$

and

$$(\alpha, Q; (1-\alpha), R)$$

von-Neumann Morgenstern's Theorem

A preference order $\succcurlyeq$ over lotteries (with known probabilities) satisfies:

– Weak order (complete and transitive)

– Continuity

– Independence

IF AND ONLY IF

It can be represented by the maximization of the expectation of a "utility" function

Expected Utility

A lottery

$$(p_1, x_1;\ \dots\ ; p_n, x_n)$$

is evaluated by the expectation of the utility:

$$p_1 * u(x_1) + \cdots + p_n * u(x_n)$$

Early origins: Pascal's "Wager"

	God is	God is not
Become a believer	∞	0
Forget about it		0

The basic argument: what have you got to lose?

What we call today "a (weakly) dominant strategy"

What Pascal didn't say

	God is	God is not
Become a believer	∞	0
Forget about it	$-\infty$	0

While some use burning in hell to scare you into faith, Pascal believed in positive marketing

Beyond dominance

	God is	God is not
Become a believer	∞	0
Forget about it		c

… But even if there is some $c > 0$ that you have to give up on by becoming a believer, it's finite.

Hence it's better to become a believer

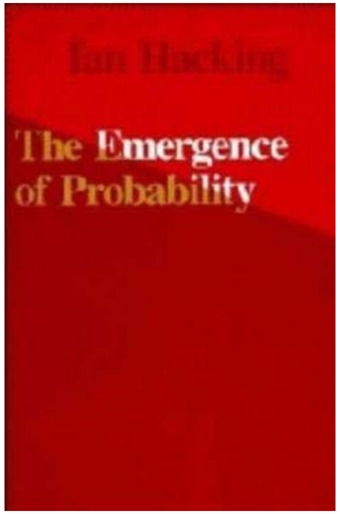
Pascal's Wager – Ideas

A few ideas in decision theory (Hacking, 1975)

- The decision matrix
- Dominance
- Subjective probability
- Expected utility
- Absence of probability

Not to mention humanism… (Connor, 2006)

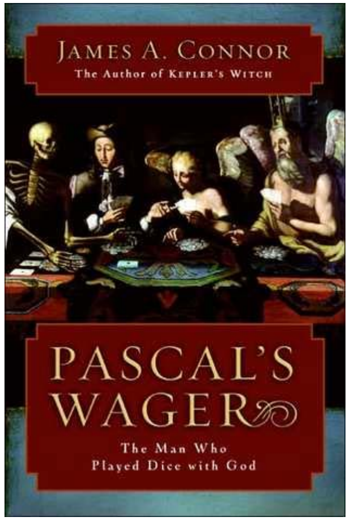
The emergence of probability



Ian Hacking (b. 1936)

Pascal's Wager:

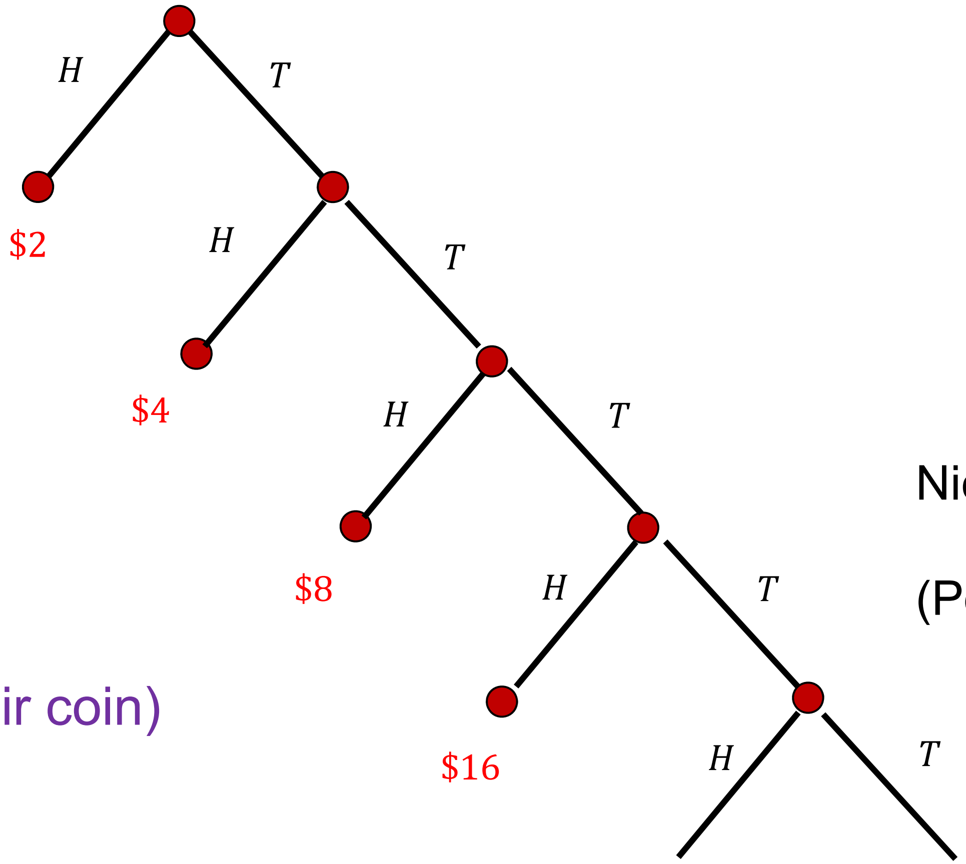
The man who played dice with God



James A. O'Connor

Next, a puzzle

How much would you pay to play:



(Fair coin)

Nicolaus Bernoulli (1687-1759)

(Posed the question in 1713)

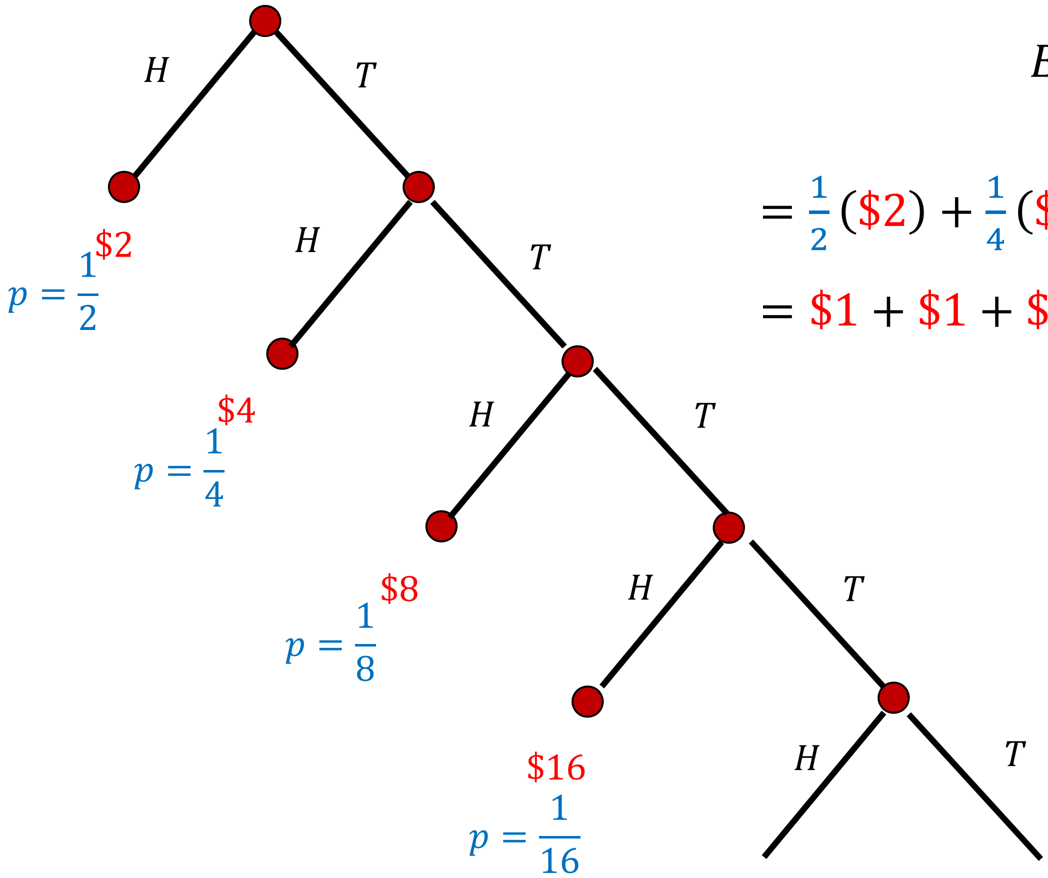
N. Bernoulli’s Game

- You only stand to gain
  - … at least $\$2$

- You know that a Tail will show up with probability 1
  - If something can happen with probability $\geq \varepsilon > 0$ every period, it eventually will

- True, we ignore time discounting

Expected Profit in N. Bernoulli's Game



$$EX = \sum p_i x_i$$

$$= \frac{1}{2}(\$2) + \frac{1}{4}(\$4) + \frac{1}{8}(\$8) + \frac{1}{16}(\$16) + \ldots$$

$$= \$1 + \$1 + \$1 + \$1 + \ldots$$

$$= \$\infty$$

“St. Petersburg Paradox”

- People aren’t willing to pay any amount to play the game – despite the infinite expected value
- Daniel Bernoulli (1738): that’s because they don’t maximize expected value, but expected utility

Daniel Bernoulli (1700-1782)

Daniel Bernoulli's resolution

Instead of

$$EX = \sum p_i x_i = \frac{1}{2}(\$2) + \frac{1}{4}(\$4) + \frac{1}{8}(\$8) + \frac{1}{16}(\$16) + \cdots$$

Consider

$$Eu(X) = \sum p_i\, u(x_i) = \frac{1}{2}u(\$2) + \frac{1}{4}u(\$4) + \frac{1}{8}u(\$8) + \frac{1}{16}u(\$16) + \cdots$$

Daniel Bernoulli's intuition

The utility function is such that the marginal utility of money is inversely proportional to the amount of money we have

$$u'(x) = \frac{1}{x}$$

or (up to constants)

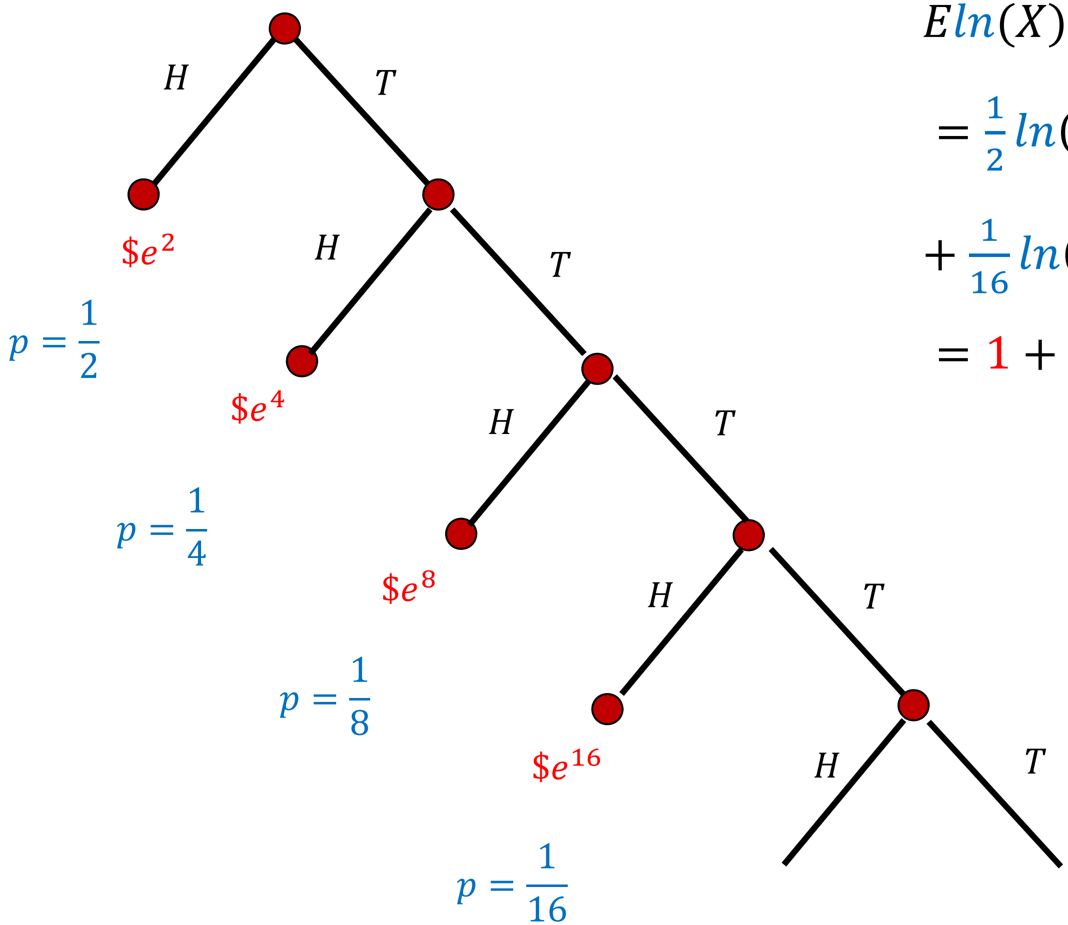
$$u(x) = ln(x)$$

and then

$$Eu(X) = \sum p_i \, ln(x_i)$$

$$= \frac{1}{2} ln(\$2) + \frac{1}{4} ln(\$4) + \frac{1}{8} ln(\$8) + \frac{1}{16} ln(\$16) + \cdots < \infty$$

We could tease (D.) Bernoulli



$$E\,ln(X) = \sum p_i\, ln(x_i)$$

$$= \frac{1}{2} ln(\$e^2) + \frac{1}{4} ln(\$e^4) + \frac{1}{8} ln(\$e^8)$$

$$+ \frac{1}{16} ln(\$e^{16}) + \ldots$$

$$= 1 + 1 + 1 + 1 + \ldots$$

$$= \infty$$

In fact

- The paradox can be resurrected whenever the utility function is unbounded
- And it makes sense that the utility from money be bounded: at some point you will have bought the entire planet

Moreover, there is no paradox

- Even if my utility is unbounded, would I trust you to give me unbounded amounts of money?
- And why should I look at expected value to begin with?
- But let’s not be petty. This is amazing.

Expected Utility Theory

Not much has happened in the next 200 years…

Until (the 1947, second addition of) "Games and Economic Behavior", the book in which von Neumann and Morgenstern more or less inaugurated game theory

John von Neumann (1903-1957)

Oskar Morgenstern (1902-1977)

von-Neumann Morgenstern's Theorem

When faced with choices between lotteries (with known probabilities) a decision maker satisfies

– Weak order
– Continuity
– Independence

IF AND ONLY IF

We can think of the decision maker as an EU maximizer

(Along the lines of the "as if" paradigm)

Let's understand the other axioms a bit better

Weak Order

– Preferences are complete:

For any two lotteries, P, Q there is preference

$$P \succcurlyeq Q\text{, or } Q \succcurlyeq P$$

or perhaps both (indifference)

– Preferences are transitive:

For any three lotteries, P, Q, R,

$$\text{if } P \succcurlyeq Q\text{, and } Q \succcurlyeq R\text{, then } P \succcurlyeq R$$

Continuity

– For any three lotteries, P, Q, R,

if $P \succ Q \succ R$

then there are

$\alpha < 1$ and $\beta > 0$

such that

$$(\alpha , P ; (1 - \alpha) , R) \succ Q \succ (\beta , P ; (1 - \beta) , R)$$

Notice: continuity is in probabilities

(Not in outcomes, which may not even be numerical)

A counterexample to Continuity?

Suppose that

$$P - \$1 \qquad Q - \$0 \qquad R - Death$$

$$P \succ Q \succ R$$

Is there $\alpha < 1$ such that

$$(\alpha, P; (1-\alpha), R) \succ Q \quad ?$$

Will you risk your life for a dollar?

Will you cross the street to get a free newspaper?

Is Continuity Reasonable?

Well, in terms of actual behavior – maybe so

(we do seem to take risks)

Perhaps more reasonable when dealing with less extreme outcomes

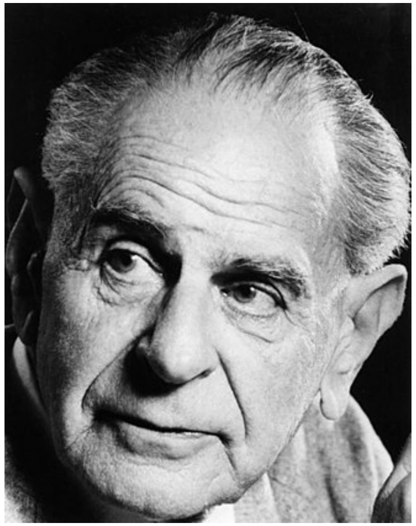
In any event, continuity is a matter of mathematical convenience

Continuity is irrefutable

No finite database could refute continuity

We can only test it in mind experiments

Popper would not allow us to use it



Karl Popper (1902-1994)

Back to vNM's Theorem

Very little is assumed, beyond Independence: we needed

Weak order

Continuity

Independence

to conclude that

behavior can be represented

by expected utility maximization

Implications of the Theorem

- Descriptively: It is perhaps reasonable that maximization of expected utility is a good model of people's behavior
  - Even if this isn't a description of a mental process they go through

- Normatively: Maybe we would like to maximize expected utility
  - Even if we don't do it anyway

“How unique” is the utility?

In consumer theory – any monotone transformation

$$v(x) = f\big(u(x)\big)$$

(for an increasing f) represents the same preferences

“utility is only ordinal”

Here – only affine transformations are allowed (but all of these) :

$$v(x) = au(x) + b$$

($a > 0$) – “utility is cardinal”

Why is the utility cardinal?

Why can't we have

$$v(x) = f\big(u(x)\big)$$

for a non-affine f?

- Because u doesn't only rank outcomes x
- It also ranks lotteries over x's via the expectation formula
- Non-linear transformations f would mess things up

But affine transformations are OK?

Yes. An affine transformation

$$v(x) = au(x) + b$$

commutes with expectation:

$$E[v(x)] = E[au(x) + b\ ]$$

$$= aE[u(x)] + b$$

… and maximizing Ev (when $a > 0$) is the same as

maximizing Eu

What does it mean?

Compare with temperature

$$v(x) = au(x) + b$$

This is the type of transformation between Celsius, Fahrenheit, and Kalvin

It doesn't mean much to say that the temperature is 5^o – on which scale?

The temperature analogy

So it is meaningless to say that the temperature is 5^o

Not even that it is positive

(It can be positive in Fahrenheit but not in Celsius)

(Does snow melt when it's 5^o ? – Depends…)

But it is meaningful to compare differences

"Tomorrow will be warmer than today by more than today is warmer than yesterday"

Similarly…

$$v(x) = au(x) + b$$

We don't attach any meaning to the numbers $u(x)$

Not even to their signs

But we can talk about differences: the comparison

$$u(x) - u(y) > u(y) - u(z)$$

will be meaningful

Cardinality – respect for differences

If

$$u(x) - u(y) > u(y) - u(z)$$

then for any

$$v(x) = au(x) + b$$

($a > 0$)

we also have

$$v(x) - v(y) > v(y) - v(z)$$

Because lotteries compare differences

If

$$u(x) - u(y) > u(y) - u(z)$$

then

$$\frac{1}{2}u(x) + \frac{1}{2}u(z) > u(y)$$

That is, the 50%-50% lottery between x and z is preferred to y

And this is an observation that v also has to describe

In other words

If both Eu and Ev represent preferences over lotteries, then the following are equivalent:

$$u(x) - u(y) > u(y) - u(z)$$

$$\frac{1}{2}u(x) + \frac{1}{2}u(z) > u(y)$$

the 50%-50% lottery between x and z is preferred to y

$$\frac{1}{2}v(x) + \frac{1}{2}v(z) > v(y)$$

$$v(x) - v(y) > v(y) - v(z)$$

And that would hold not only for $\left(\frac{1}{2}; \frac{1}{2}\right)$ weights

The Independence Axiom – meaning

- It basically says that preferences are linear in probabilities – and that's what we'd expect…

$$p_1 * u(x_1) + \cdots + p_n * u(x_n)$$

- Not (necessarily) in outcomes
- The theory works also if the outcomes are not numerical at all (so that "linearity" isn't even defined)

Consider three outcomes

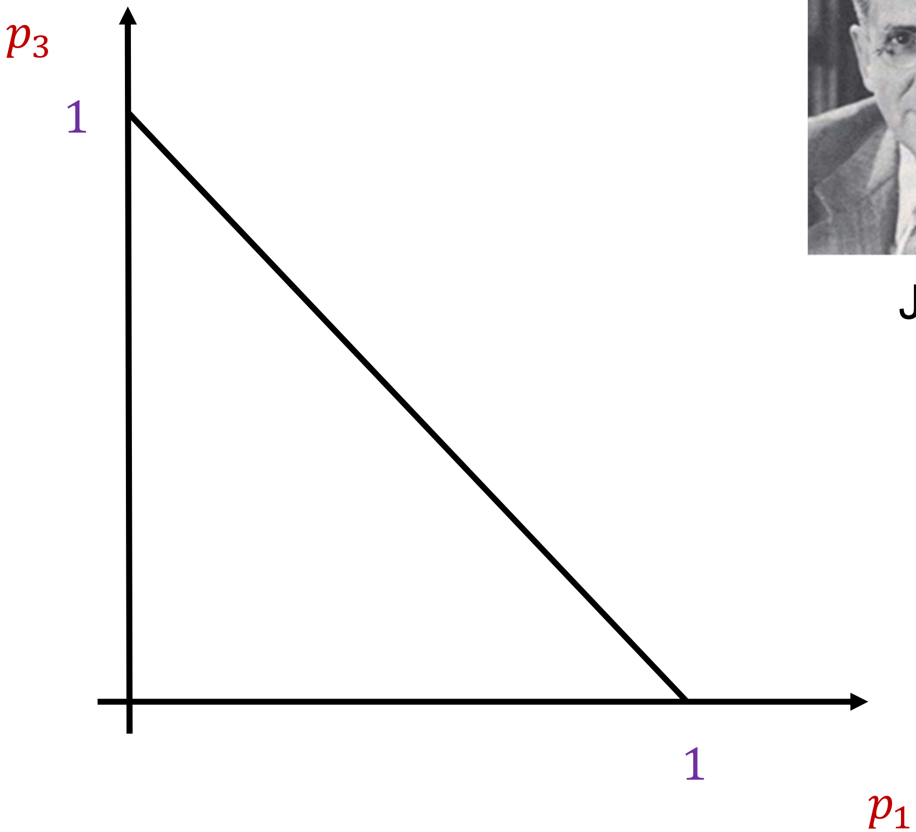
- Suppose that $x_1 \succ x_2 \succ x_3$
  - Where $\succ$ means strict preference
- Fix the three outcomes. A lottery

$$(p_1, x_1; p_2, x_2; p_3, x_3)$$

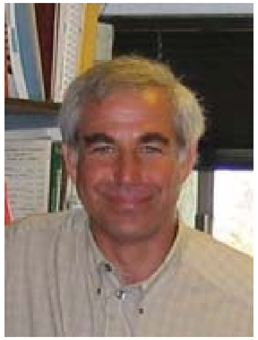
can be represented graphically by two numbers, p_1, p_3

where we recall that $p_2 = 1 - p_1 - p_3$

The Marschak-Machina Triangle

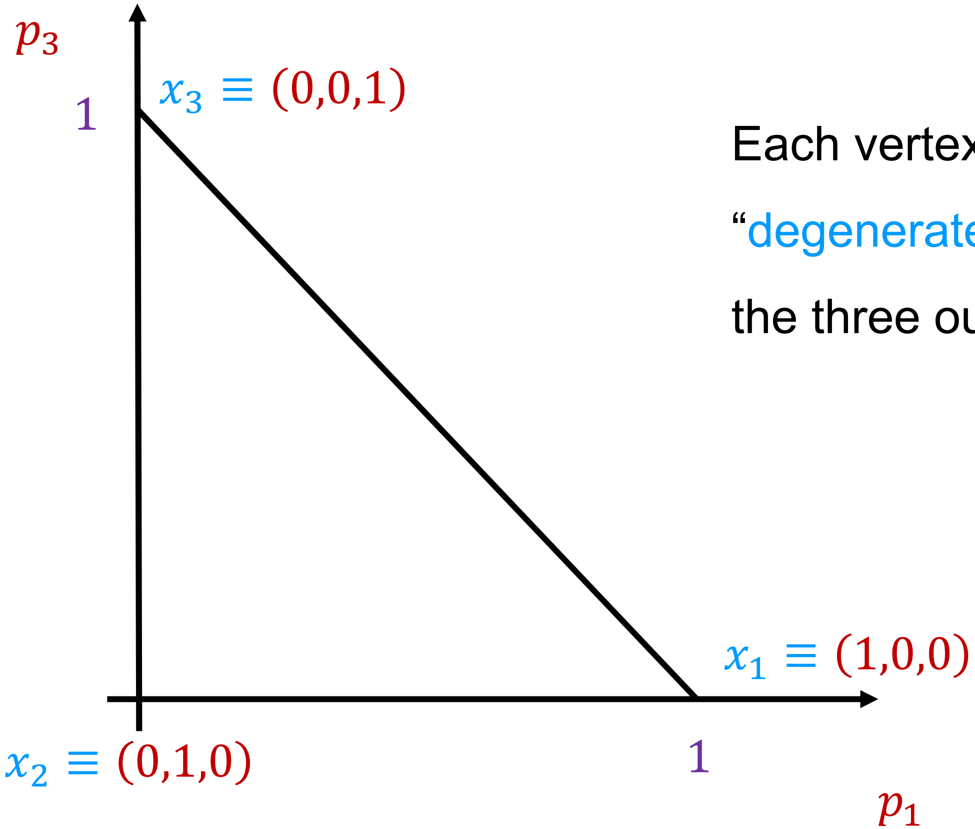


Jacob Marschak (1898-1977)



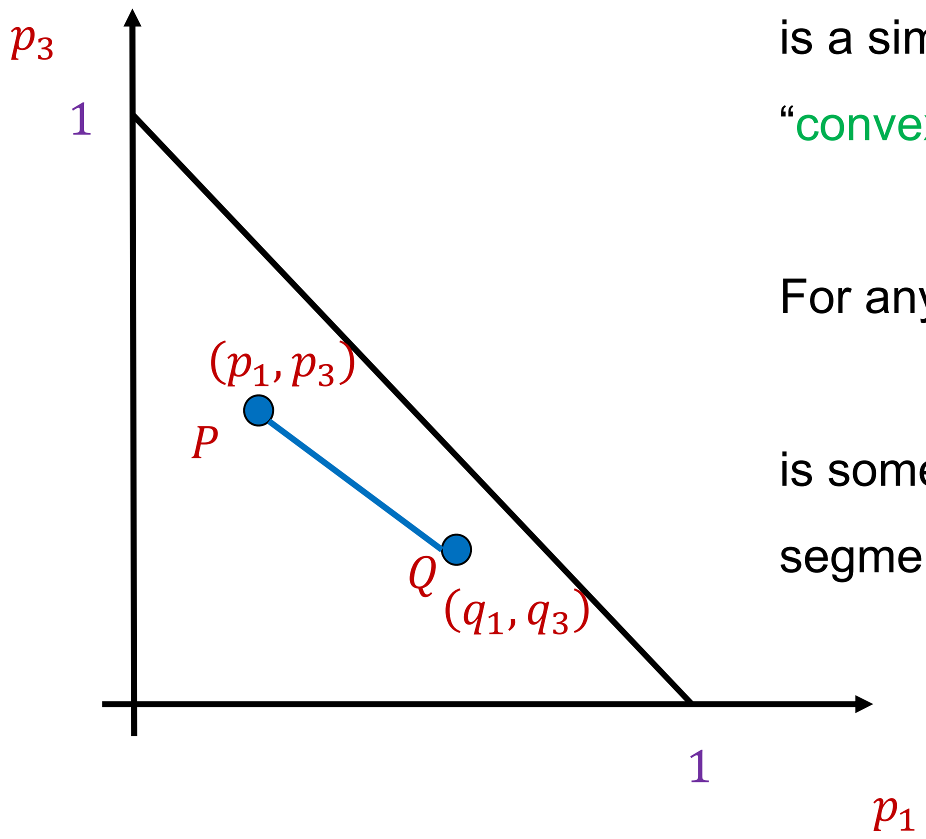
Mark J. Machina (b. 1954)

The Marschak-Machina Triangle



Each vertex corresponds to a "degenerate" lottery, yielding one of the three outcomes with certainty

The "Mixture" operation



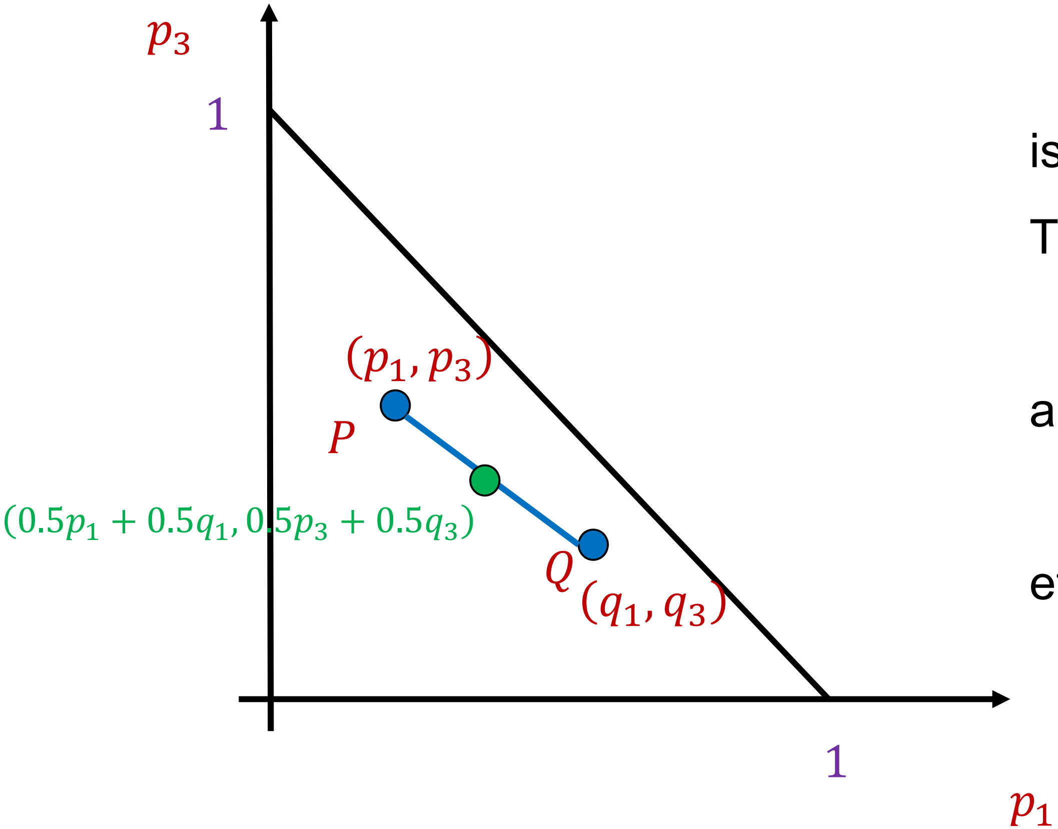
is a simple weighted average (or "convex combination")

For any P , Q

$$(\alpha , P ; (1 - \alpha) , Q)$$

is somewhere on the straight line segment between P and Q

For example



For $\alpha = 0.5$

$$(0.5 , P ; 0.5 , Q)$$

is the midpoint between P and Q

The probability to get x_1 is

$$0.5p_1 + 0.5q_1$$

and the probability to get x_3 is

$$0.5p_3 + 0.5q_3$$

etc. (for x_2)

First implication of the Independence Axiom

Indifference curves are linear:

If

$$P \sim Q$$

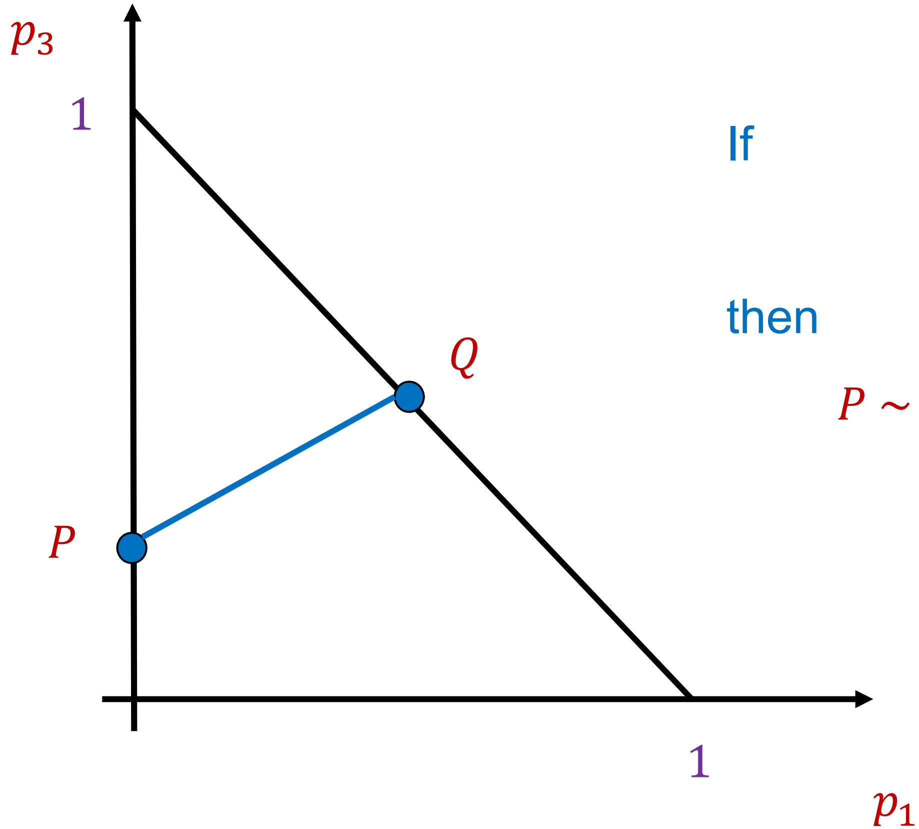
then

$$(\alpha, P; (1-\alpha), Q) \sim (\alpha, Q; (1-\alpha), Q) = Q$$

so that

$$P \sim (\alpha, P; (1-\alpha), Q) \sim Q$$

Linear indifference curves



If

$$P \sim Q$$

then

$$P \sim (\ \alpha\ , P\ ;\ (1 - \ \alpha)\ , Q\ ) \sim Q$$

Second implication of the Independence Axiom

Indifference curves are parallel to each other:

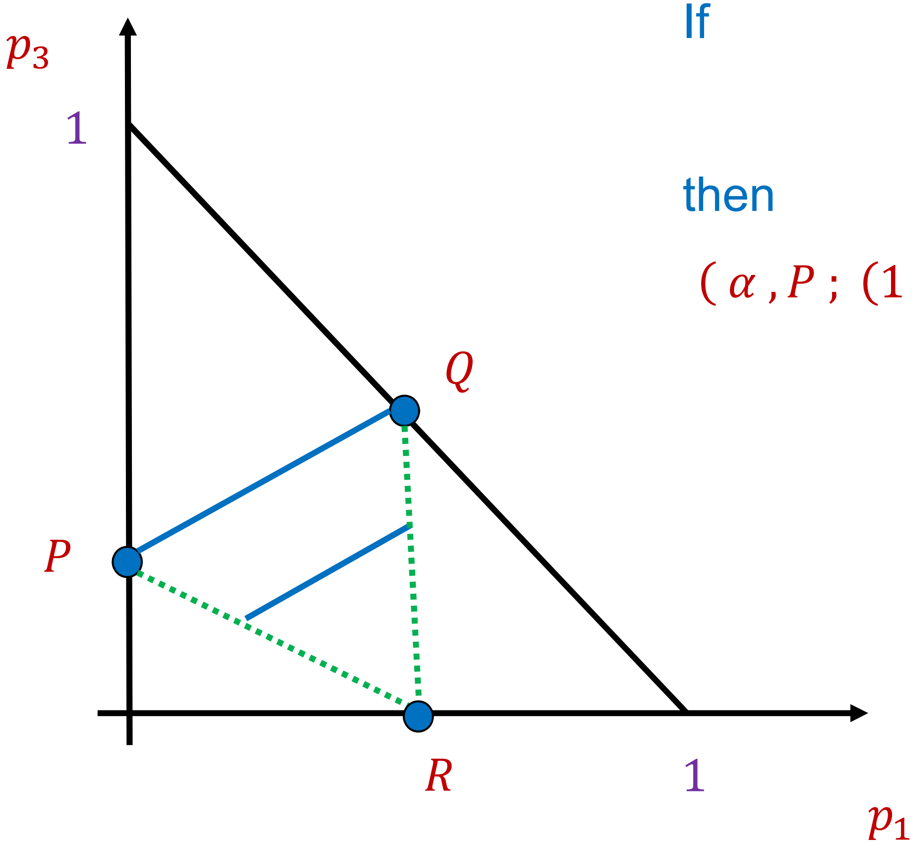
If

$$P \sim Q$$

then

$$(\alpha, P; (1-\alpha), R) \sim (\alpha, Q; (1-\alpha), R)$$

Indifference curves are parallel



If

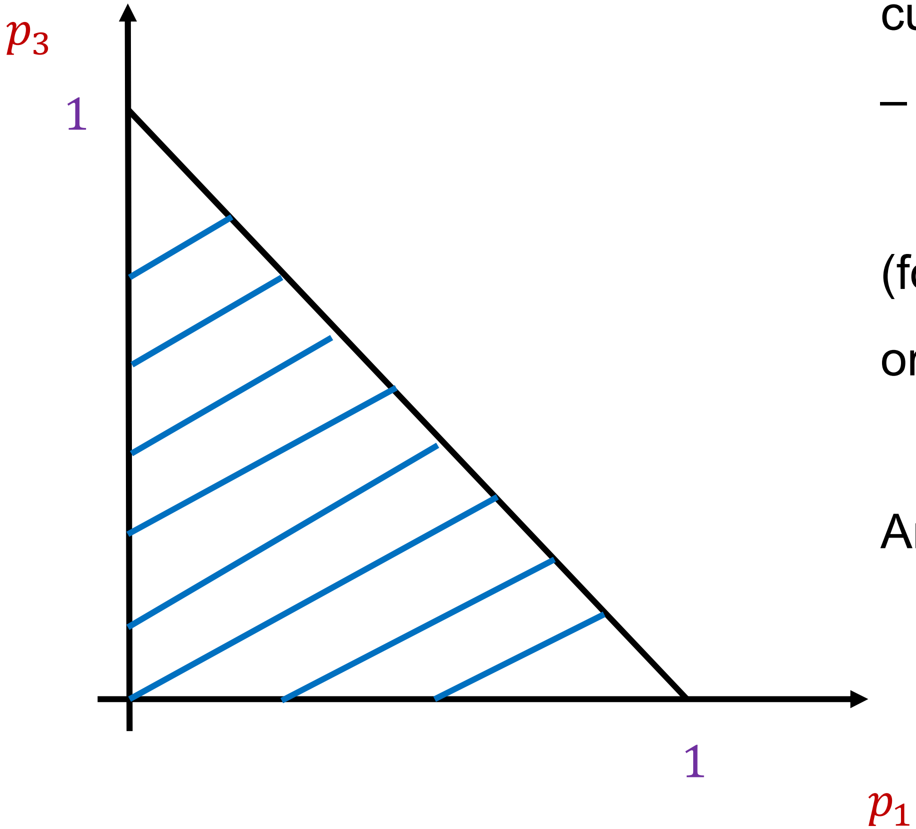
$$P \sim Q$$

then

$$(\ \alpha\ , P\ ;\ (1-\alpha)\ , R\ ) \sim (\ \alpha\ , Q\ ;\ (1-\alpha)\ , R\ )$$

(Thales's Theorem)

The Independence Axiom implies



Linear and parallel indifference curves

– all have the form

$$a_1 p_1 + a_3 p_3 = c$$

(for various c)

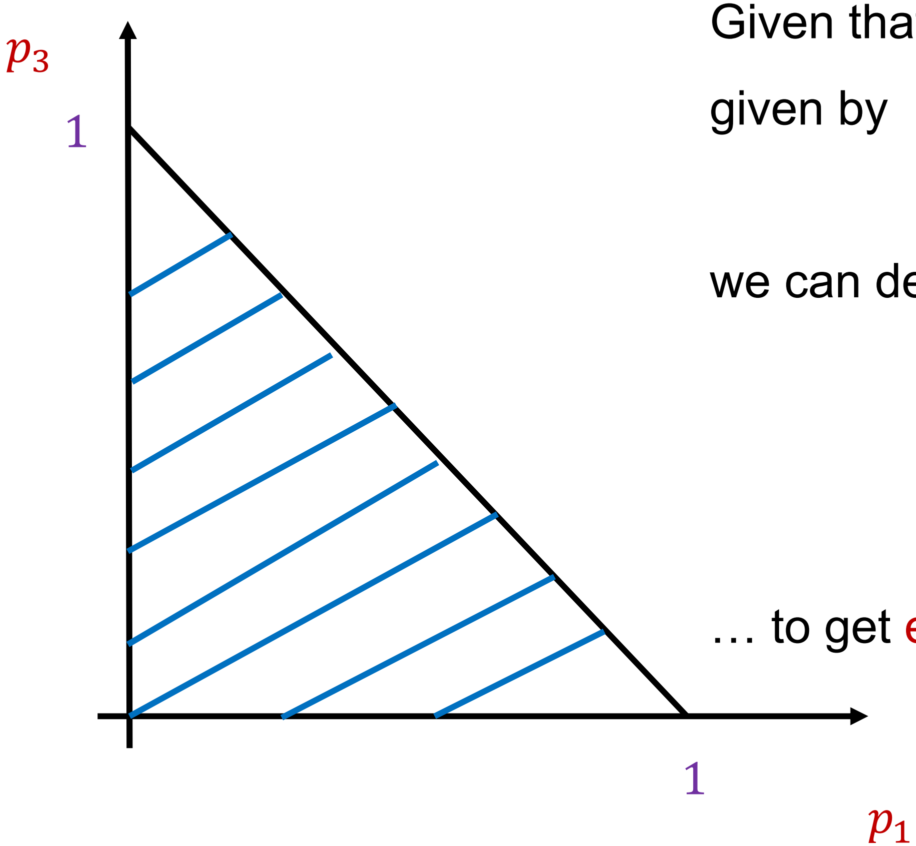
or

$$a_1 p_1 - c = -a_3 p_3$$

And we can assume

$$a_1 > 0 > a_3$$

The Independence Axiom implies



Given that the indifference curves are given by

$$a_1 p_1 + a_3 p_3 = c$$

we can define

$$u(x_1) = a_1$$

$$u(x_2) = 0$$

$$u(x_3) = a_3$$

… to get expected utility!

Calibration of Utility

- If we believe that a decision maker is an EU maximizer, we can calibrate her utility function by asking, for which p is

$$(\,1, \$500\,)$$

equivalent to

$$(\,(1-p)\,, \$0\;;\;p, \$1{,}000\,)$$

Calibration of utility – cont.

If, for instance,

$$u(\ \$0\ ) = 0$$

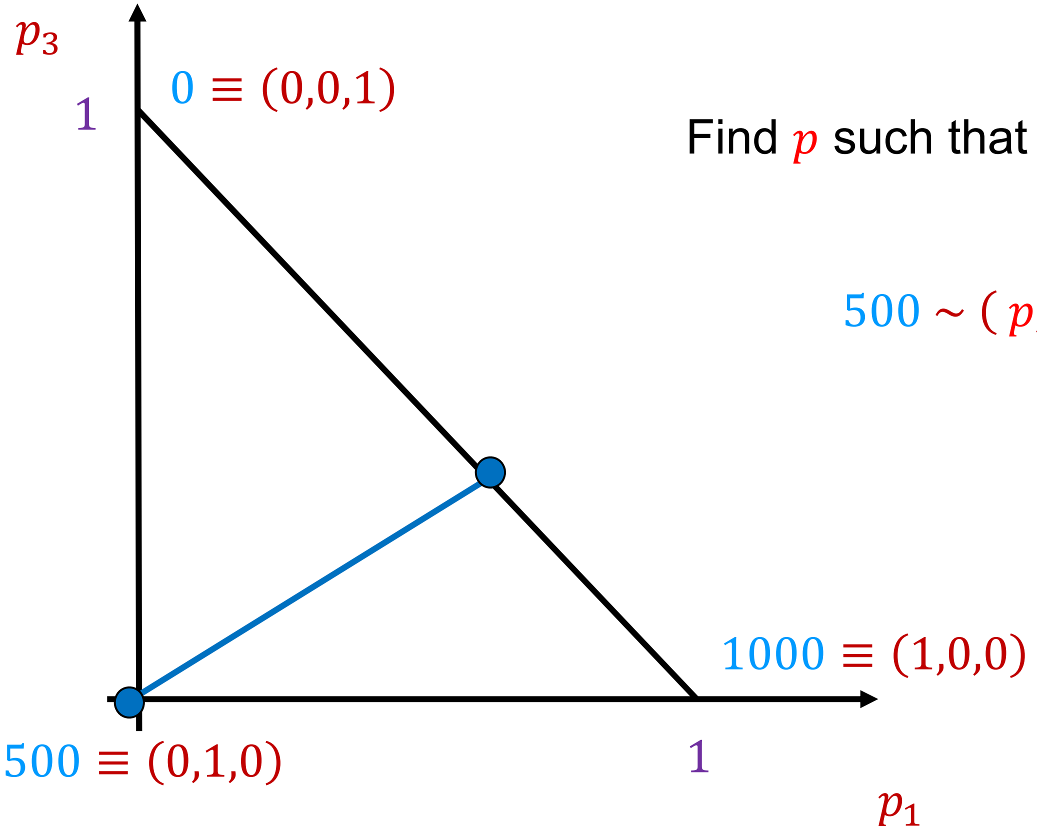
$$u(\ \$1{,}000\ ) = 1$$

Then

$$u(\ \$500\ ) = p$$

(And we can set two values of u as we wish – provided we respect monotonicity; the other values will be uniquely defined by preferences)

Calibration of utility in the Marschak-Machina Triangle



Find p such that

$$500 \sim (p, 1000\,;\ (1-p), 0)$$

Problem 4.1

- Do you prefer $\$500$ for sure or

$$(.50, \$0 \, ; \, .50, \$1{,}000 \,) \text{ ?}$$

- Preferring $\$500$ for sure indicates risk aversion

- Defined as preferring $E(X)$ to X for every random variable X

Gambles

Let W be a given level of wealth

A bet is offered:

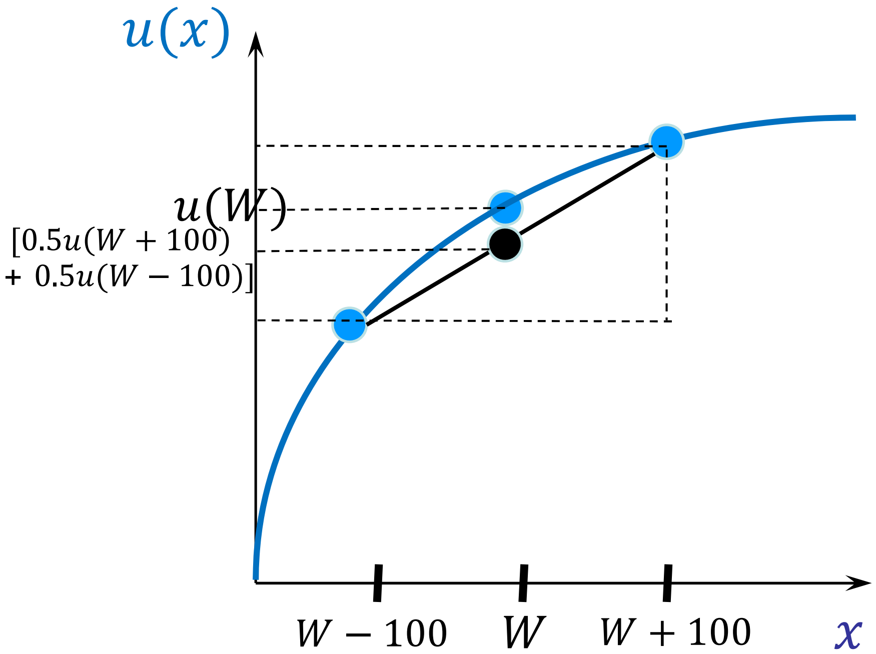
$$X = \begin{cases} +100 & .5 \\ -100 & .5 \end{cases}$$

It is a fair bet if

$$E(X) = 0 \qquad \text{or} \qquad E(W + X) = W$$

Expected value maximization implies indifference

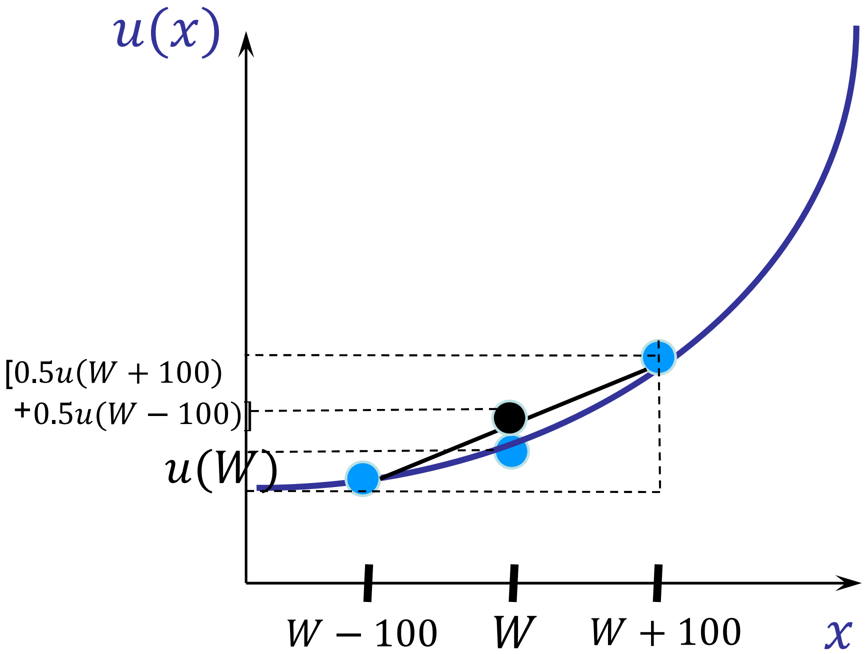
But…



If u is concave then

$$E\,u(W+X) \ \leq u(W)$$

And, conversely for convex utility



If u is convex then

$$E\,u(W+X) \geq u(W)$$

Risk Aversion

… is defined as:

For every fair bet $X \quad (E(X) = 0)$

and for every wealth level W

W is at least as desirable as $W + X$

Risk loving: just the opposite

Under EU maximization

Risk aversion $\Leftrightarrow u$ concave

Risk loving $\Leftrightarrow u$ convex

(Both can be defined in a strict sense as well)

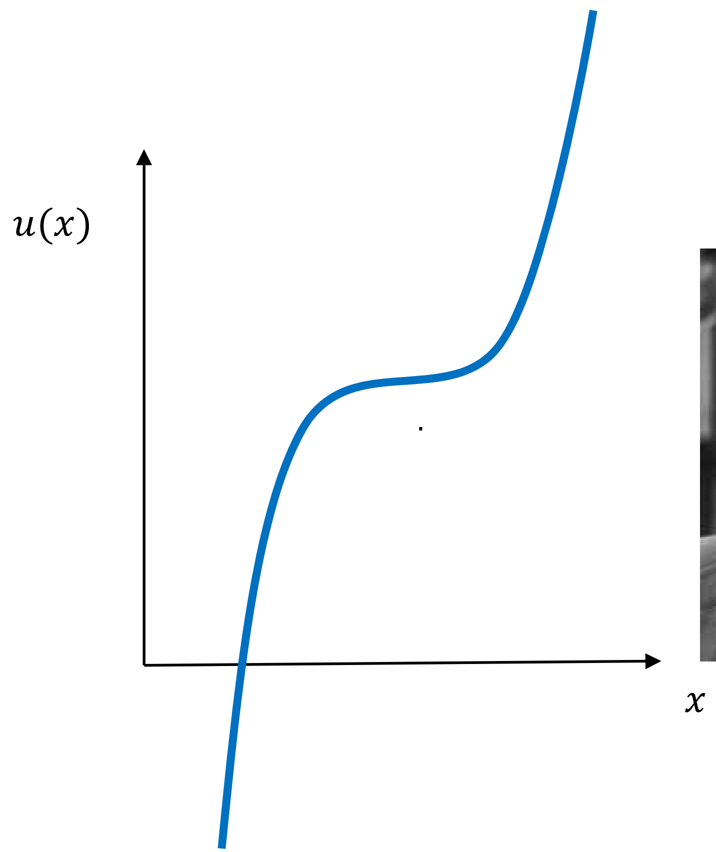
Difficulties and

Alternative Theories

EU maximization can explain

- Insurance (concave u)
- State lotteries (convex u)
- But… what about both occurring simultaneously?

An attempt to explain both

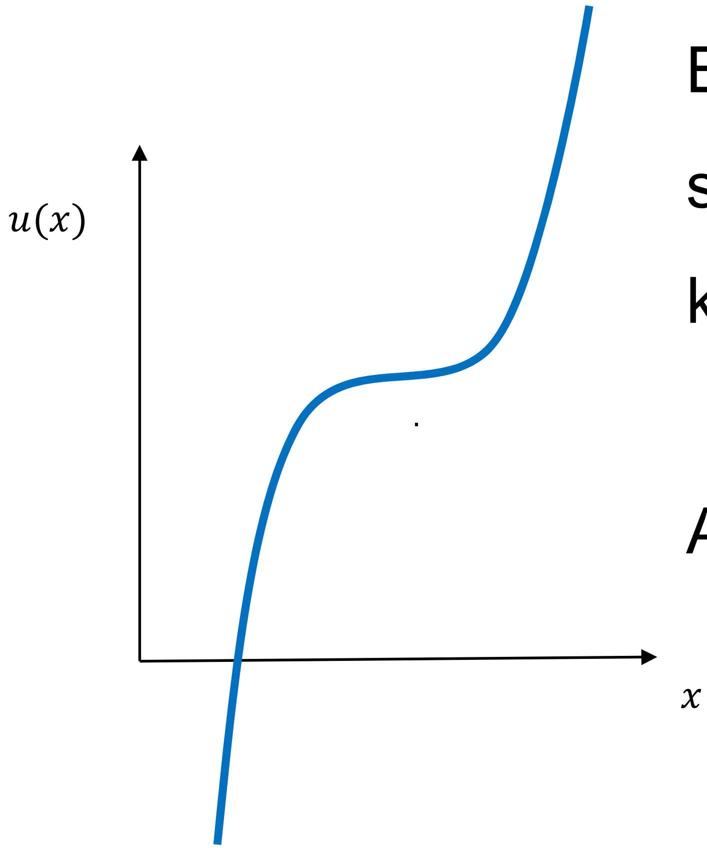


Maybe u starts out concave and turns to be convex?

Milton Friedman
(1912-2006)

Leonard Jimmie Savage
(1917-1971)

Well…

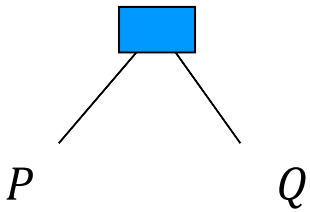


But then if one gets rich one should stop buying insurance and keep buying lottery tickets

And that's not what we observe

Problems 4.5 and 4.10

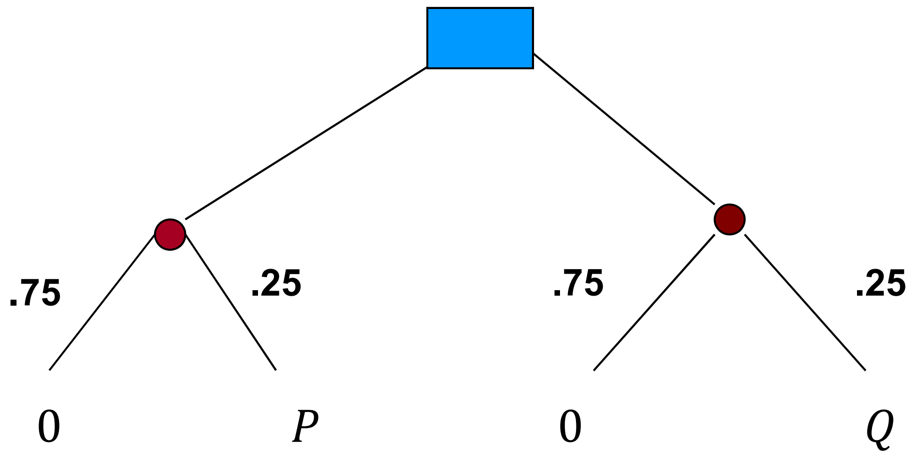
Problem 4.5



$$P = (.2, 0\ ;\ .8, 4000)$$

$$Q = (1, 3000)$$

Problem 4.10



Ample evidence that

- The independence axiom fails in examples such as 4.5 and 4.10.

- A version of Allais's paradox

Allais's Paradox

Which do you prefer?

Prob	Outcome
1.00	$1M$

vs.

Prob	Outcome
0.01	$0
0.89	$1M$
0.10	$5M$

Maurice Allais (1911-2010)

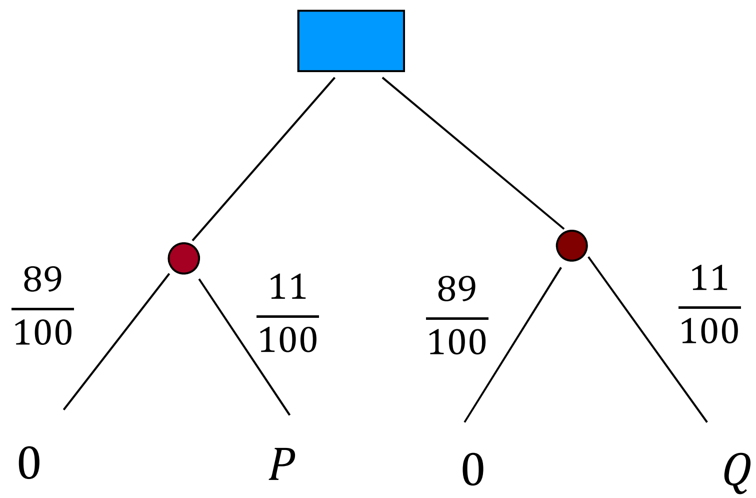
And

Prob	Outcome
0.89	$0
0.11	$1M$

vs.

Prob	Outcome
0.90	$0
0.10	$5M$

Allais's Paradox in decision trees



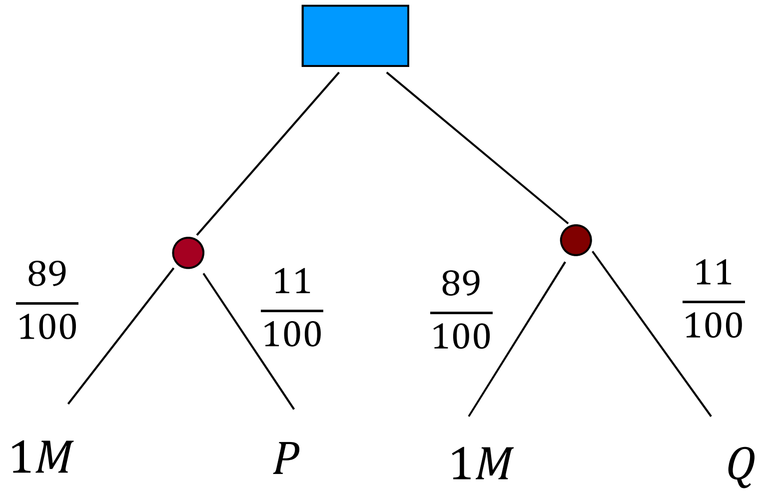
$(.90\,,\ 0\ ;\ .10\,,\ 5M)$ $(.89\,,\ 0\,;\ .11\,,1M)$

$$P = (\frac{1}{11}, 0\,; \frac{10}{11}, 5M)$$

$$Q = (1, 1M)$$

First choice

Allais's Paradox in trees – cont.



$$P = (\frac{1}{11}, 0\,; \frac{10}{11}, 5M)$$

$$Q = (1, 1M)$$

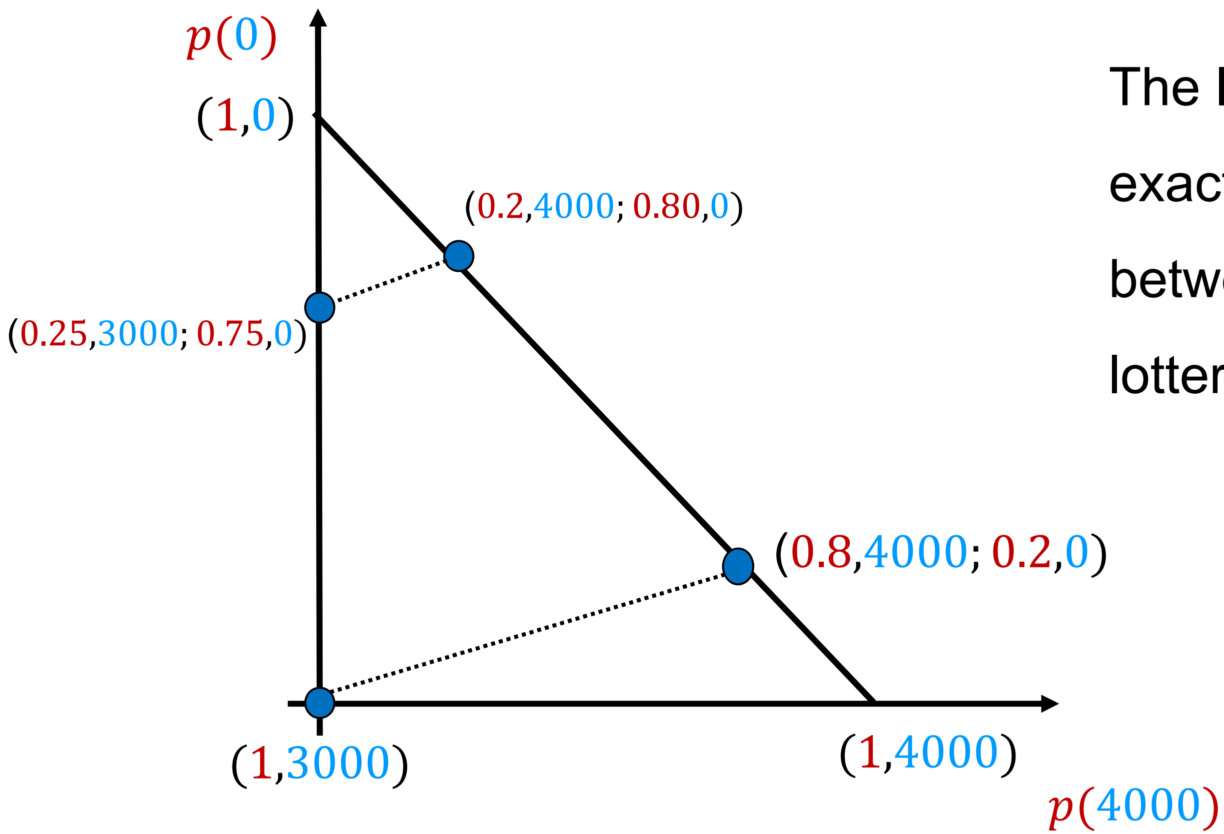
Second choice

$(.01\,, 0\,; 0.89\,, 1M\,;\ .10\,, 5M)$ $\qquad$ $(1, 1M)$

The Certainty Effect

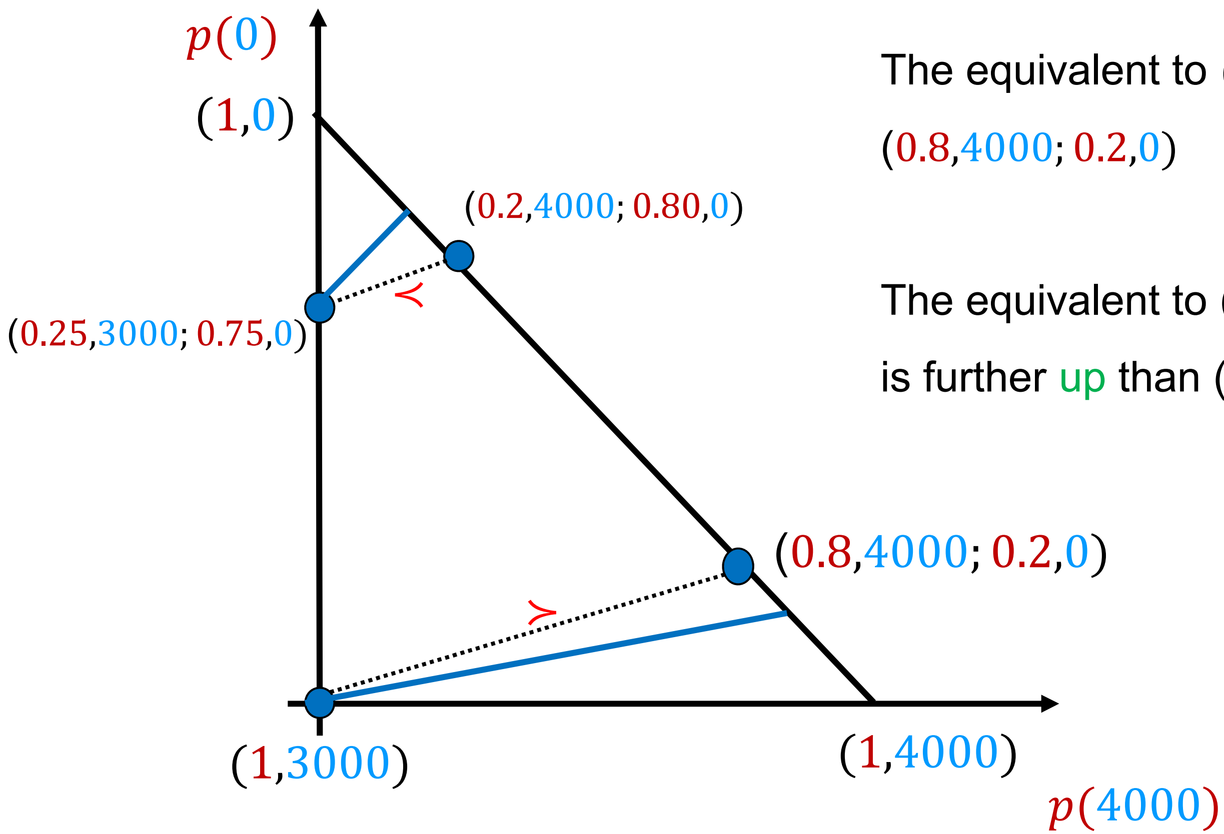
- Kahneman and Tversky wanted to “clean” Allais’s example so that it contains only two-outcome lotteries
  - And then violations of the axiom are hardly due to confusion
- Choices 4.5 and 4.10 are their example of the Certainty Effect
- The point: psychologically, 100% is more than just four times 25%

The Certainty Effect in the Triangle



The lotteries in 4.10 are exactly 25% of the "way" between $(1,0)$ and the lotteries in 4.5

Indifference curves “fanning out”



Preferences as $\succ$ mean that

The equivalent to $(1,3000)$ is further down than $(0.8,4000;\ 0.2,0)$

The equivalent to $(0.25,3000;\ 0.75,0)$ is further up than $(0.2,4000;\ 0.8,0)$

Another example

- Do you prefer

  $\$1,000,000$ with probability 0.8

  or

  $\$2,000,000$ with probability 0.4 ?

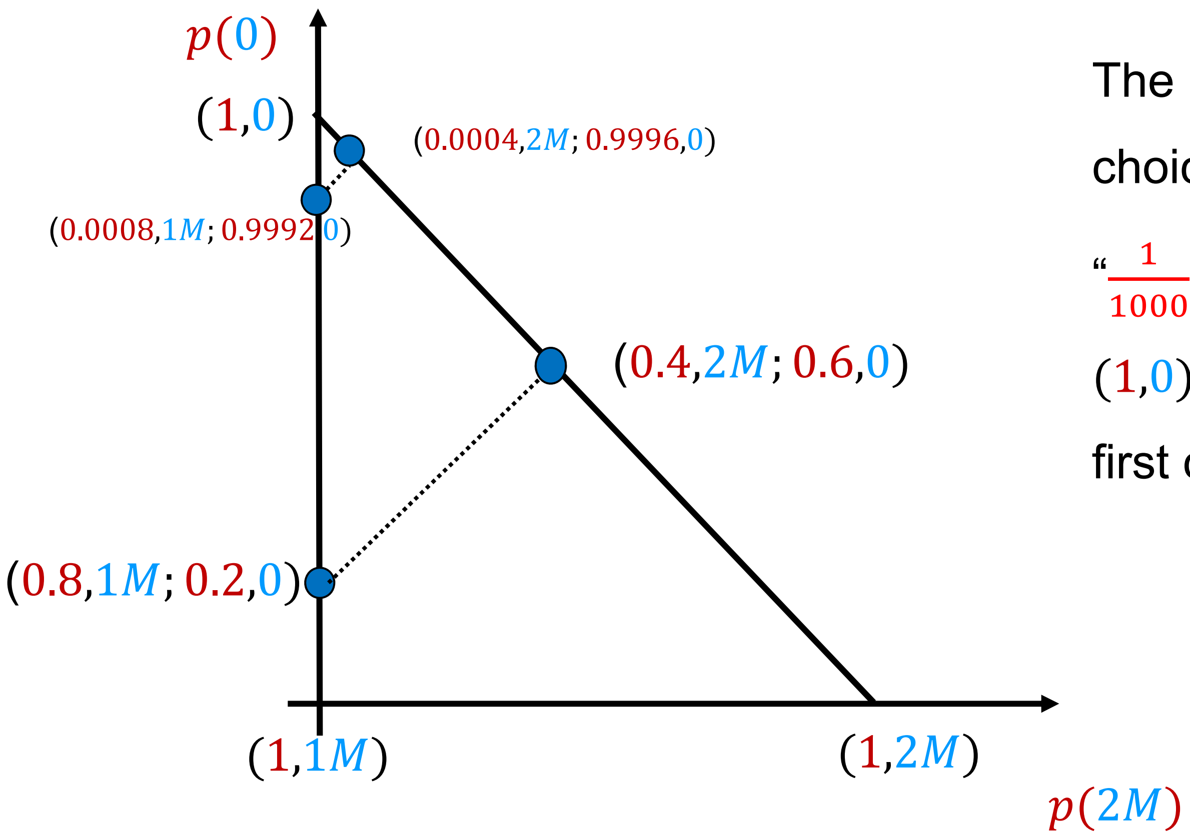
- How about

  $\$1,000,000$ with probability 0.0008

  or

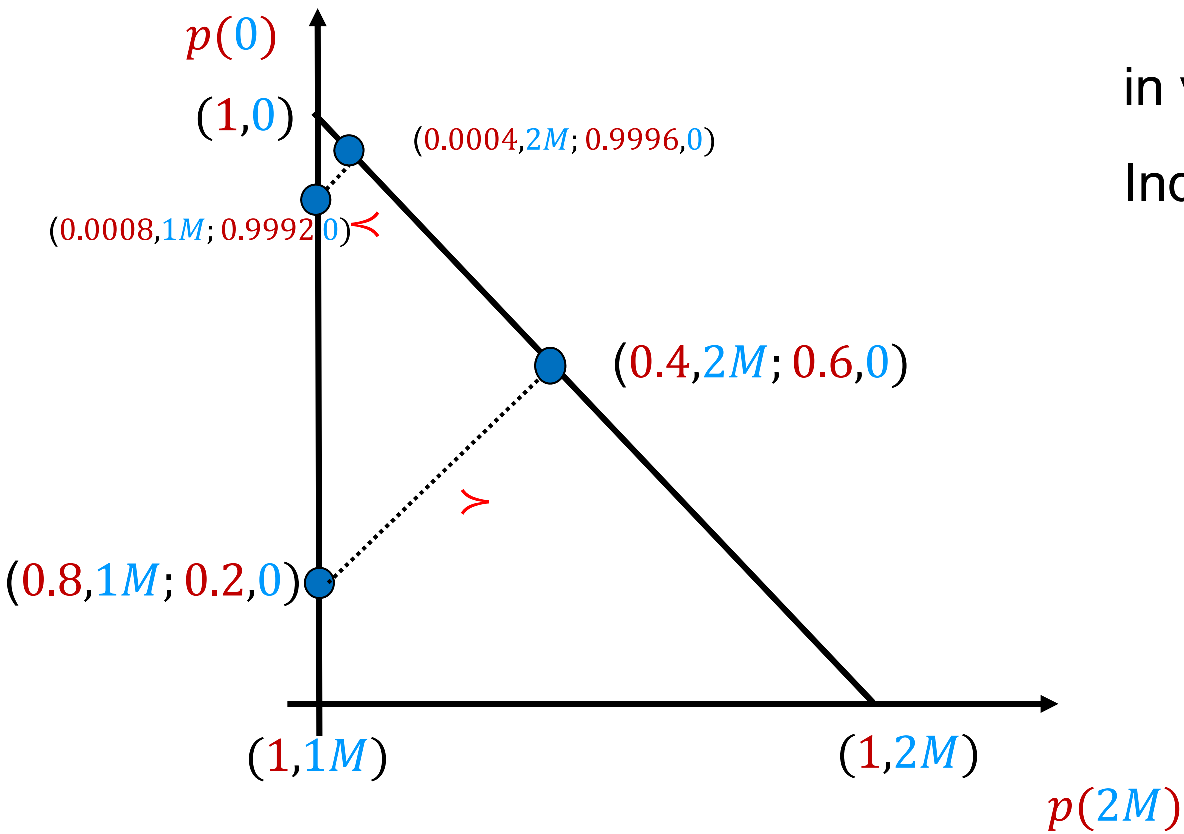
  $\$2,000,000$ with probability 0.0004 ?

Again, a Common Ratio



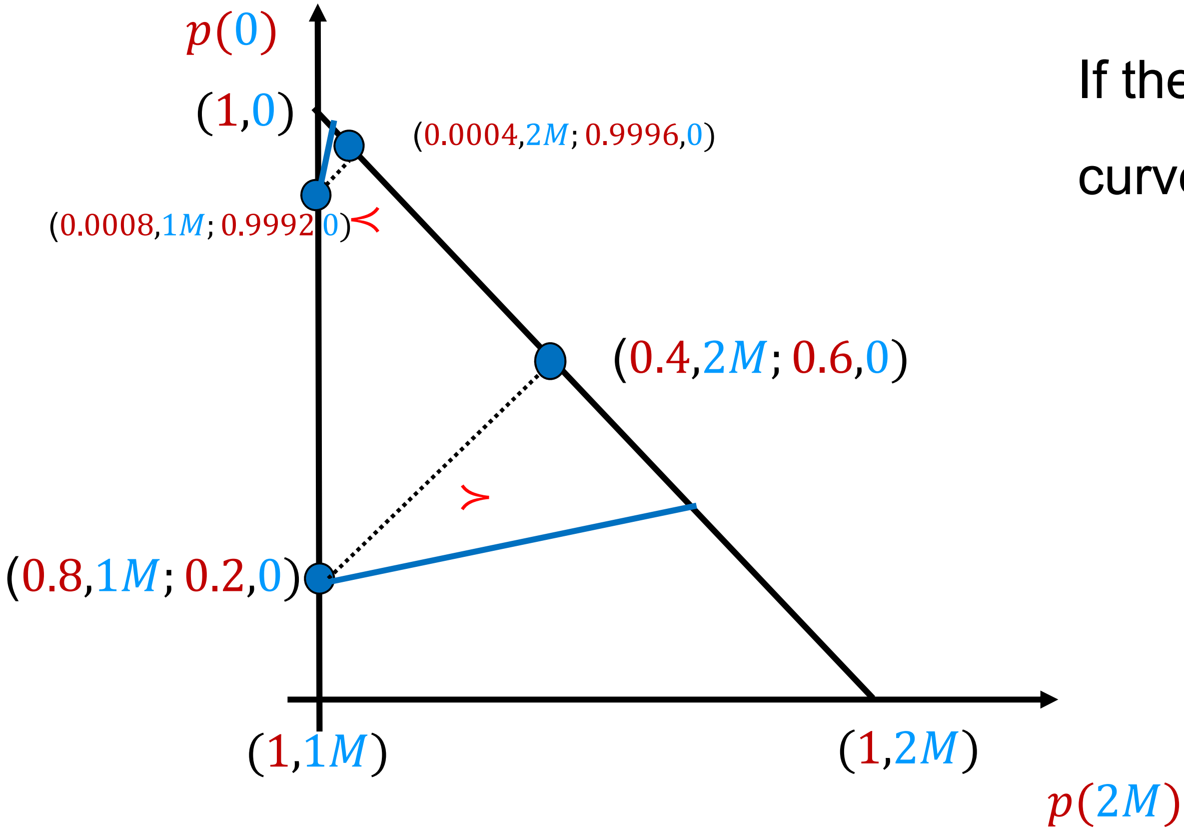
The lotteries in the second choice problem are exactly "$\frac{1}{1000}$ of the way" between $(1,0)$ and the lotteries in the first choice problem

And, again, we often observe



in violation of the Independence Axiom

Which can be explained



If the indifference curves "fan out"

A confession

$$10^{-9} = 10^{-12}$$

- I know that the first is $1{,}000$ larger than the second
- But when it comes to probabilities, I can't tell the difference
- Can you imagine making a different decision when the stated probability is 10^{-9} vs. 10^{-12} ?

Excuses – Irrationality

$$10^{-9} = 10^{-12}$$

- Well, evolution has not prepared us to deal with these
- So we can't really realize how small small numbers can be
- Notice that it's much easier to tell the difference between the amounts

  $$\$1{,}000{,}000 \quad \text{and} \quad \$2{,}000{,}000$$

  than between the probabilities

  $$0.0008 \quad \text{and} \quad 0.0004$$

Rational excuses

$$10^{-9} = 10^{-12}$$

- What's the probability that whoever gave me these numbers actually knew what they were talking about?
- Shouldn't I have a healthy doubt about the reliability of these numbers?
- A similar point to some rationalizations of the compromise effect, the default effect…

Prospect Theory

In any event, Kahneman and Tversky suggested an alternative theory for decision under risk

Two main components:

- People exhibit gain-loss asymmetry
- People "distort" probabilities

Gain-Loss Asymmetry

- Positive-negative asymmetry in psychology
- A “reference point” relative to which outcomes are defined
- “Prospects” as opposed to “lotteries”
  - Same mathematical entities
  - Only the monetary values are interpreted as changes (relative to the reference point)

Zero on the utility scale

In the classical theory, we can "shift" the utility

$$v(x) = u(x) + b$$

For any b without affecting anything. For

utility maximization

expected utility maximization

discounted (expected) utility maximization…

the "zero" has no particular meaning

By contrast

Psychology suggests that there might be a "special point" on the utility/payoff scale:

Helson's adaptation level

Simon's aspiration level

Kahneman-Tversky's reference point

Adaptation Level Theory

- A theory of perception
  - The brain responds mostly to changes
  - It adapts to a certain level of the stimulus
  - The adaptation level determines what needs to be attended to

Harry Helson (1898-1977)

- Warning: we do not adapt to anything and everything

Satisficing

- A theory of decision making
  - Managers don’t optimize, they satisfice
  - They put out fires
  - An aspiration level is the level of performance below which there’s a problem
- Suggested (and coined the term) “Bounded Rationality”

Herbert A. Simon (1916-2001)

What determines the reference point?

Botond Kőszegi (b. 1973)

Matthew Rabin (b. 1963)

Kőszegi and Rabin: the economic environment

Reference

A model of reference-dependent preferences

Botond Kőszegi, Matthew Rabin

The Quarterly Journal of Economics, Vol. 121, No. 4 (Nov. 2006), pp. 1133-1165

Abstract

We develop a model of reference-dependent preferences and loss aversion where “gain-loss utility” is derived from standard “consumption utility” and the reference point is determined endogenously by the economic environment. We assume that a person's reference point is her rational expectations held in the recent past about outcomes, which are determined in a *personal equilibrium* by the requirement that they must be consistent with optimal behavior given expectations. In deterministic environments, choices maximize consumption utility, but gain-loss utility influences behavior when there is uncertainty. Applying the model to consumer behavior, we show that willingness to pay for a good is increasing in the expected probability of purchase and in the expected prices conditional on purchase. In within-day labor-supply decisions, a worker is less likely to continue work if income earned thus far is unexpectedly high, but more likely to show up as well as continue work if expected income is high.

Probability Distortion

- Small probabilities are translated into larger "decision weights"
- As in the examples of State lotteries and insurance
- Indeed…

Small probabilities

People have a hard time understanding small probabilities

Imagine that every week a State lottery allows you to guess 6 numbers out of 47

The number of such choices is $\binom{47}{6} = 10{,}737{,}573$

And the chance of winning (not necessarily alone) in a given week is

$$\frac{1}{10{,}737{,}573} = 0.000{,}000{,}0931$$

How long should you wait to obtain a probability of winning of 1% ?

Calculation

What is n such that

$$(1 - 0.000{,}000{,}0931)^{n} = 0.99$$

$$n \log\ (1 - 0.000{,}000{,}0931) = \log(0.99)$$

$$n = \frac{\log\ (0.99)}{\log(0.999{,}999{,}9069)} = 107{,}916$$

Or, in years

$$\frac{107{,}916}{52} = 2{,}075$$

(And a linear approximation isn't so bad in this case, yielding

$2{,}065$ years)

Psychologists have noticed that

Roughly as soon as economists started to get excited about EU theory

von Neumann and Morgenstern (1944,1947)

Friedman and Savage (1948)

… there were findings that “psychological probability” isn’t “mathematical probability”

Preston and Baratta (1948)

Edwards (1955)

Reference

An experimental study of the auction-value of an uncertain outcome

Malcolm G. Preston, Philip Baratta

American Journal of Psychology, Vol. 61, No. 2 (April, 1948), pp. 183-193

(No abstract. An "Baratta" is the correct spelling)

Reference

The prediction of decisions among bets

Ward Edwards

Journal of Experimental Psychology, 50(3) (1955)., 201-214.

https://doi.org/10.1037/h0041692

Abstract

A very simple mathematical model was developed for predicting choices among bets. This model, based on the concepts of subjective value or utility of money and subjective probability, asserts that Ss choose the bet with the maximum subjectively expected utility. An experiment was designed to test this model… . The model predicted substantially better than chance." The efficiency of other models is discussed and "it is concluded that the subjectively expected utility maximization model is adequate to account for the results of this experiment, and that subjective probabilities are much more important than utilities in determining choices among bets such as those used in this experiment.

Decision weights

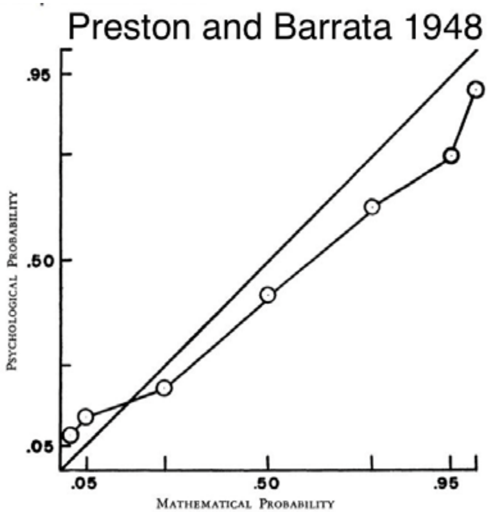


Fig. 1. Functional Relationship Between Psychological and Mathematical Probability

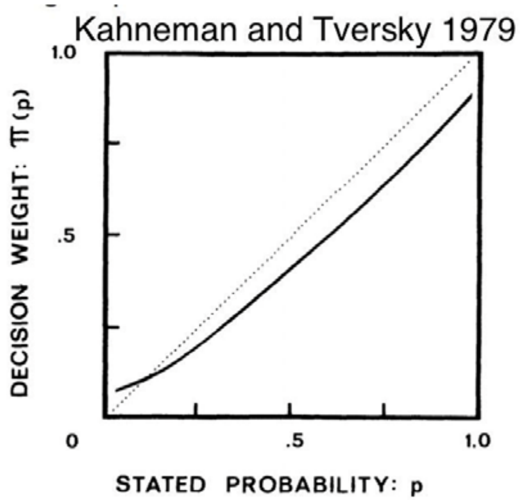


FIGURE 4.—A hypothetical weighting function.

How do we use decision weights?

One idea: just as D. Bernoulli suggested to switch from

(expected value) :

$$p_1 * x_1 + \cdots + p_n * x_n$$

to (expected utility)

$$p_1 * u(x_1) + \cdots + p_n * u(x_n)$$

We can now have

$$f(p_1) * u(x_1) + \cdots + f(p_n) * u(x_n)$$

A problem

Maximizing

$$f(p_1) * u(x_1) + \cdots + f(p_n) * u(x_n)$$

doesn't satisfy basic monotonicity properties unless f is linear

(Increasing some x_i's may result in a small overall sum, unless one uses "editing")

This seemed excessive to many an economist

A suggested solution

Use f not for the probability to obtain an outcome, but for the probability to obtain an outcome or more

Rank Dependent Utility

Quiggin (1982), Chew (1983), Yaari (1987) (without reference points) and

Cumulative Prospect Theory

Tversky and Kahneman (1992) (with reference points)

Main Points

- There are good reasons to maximize the expectation of a utility function
- In fact, most of us probably do so most of the time
- Hence expected utility is considered to be the main tool to understand others' behavior, as well as to make decisions for ourselves

Main Points – Cont.

- But there are also persistent violations:
  - Distortion of small probabilities
  - Gain/loss asymmetry
- And Prospect Theory captures these
- It’s important to recognize these phenomena around us
- And to decide whether we like to behave so ourselves

Exercises Chapter 4 – Problem 1

Assume that you are indifferent between getting $\$700$ and getting $\$1000$ with probability 80% (and otherwise nothing). Assume also that you are indifferent between getting $\$300$ and getting $\$700$ (not $\$1000$ this time!) with probability 60% (and otherwise nothing).

Consider lottery A, which gives you $\$1000$ with probability 2/3 (and otherwise nothing), and lottery B, which gives you a $50\% - 50\%$ bet between $\$300$ and $\$700$. If you follow von-Neumann-Morgenstern's theory, you should:

- Prefer A to B
- Prefer B to A
- Be indifferent between A and B
- One cannot tell based on the data.

Exercises Chapter 4 – Problem 2

Mary likes the von Neumann Morgenstern's axioms and she would like to make decisions in accordance with these axioms. By careful introspection, she has decided that she would be indifferent between

$400 for sure and a 50% of obtaining $1,000 (otherwise – nothing);

and also between

$600 for sure and a 80% of obtaining $1,000 (otherwise – nothing).

Mary is offered a bet among ($0, $400, $600, $1,000) with equal chances (25% each) for a cost of $400. Should she prefer the bet or should she prefer to keep her $400?

Exercises Chapter 4 – Problem 3

A state lottery sells tickets for a cost of $1 each. The ticket has a probability of 1/(2,400,000) of winning $1,000,000, and otherwise – nothing.

- What is the expected profit of the state from each ticket sold?
- In the hope of increasing profits, the state considers to increase the award to $2,000,000 and to reduce the probability of winning to 1/(4,800,000). A statistician said that it's not worth the trouble, because the expected profit remains precisely the same. What do you think?

Exercises Chapter 4 – Problem 4

It is often argued that the value function in Kahneman and Tversky's Prospect Theory is convex in the domain of losses, that is, that individuals behave in a risk loving way when it comes to losses. How can this be reconciled with the fact that people buy insurance (where premia exceed expected losses)?

DECISION UNDER

UNCERTAINTY

Uncertainty

- As mentioned above, Pascal (1670) already used (subjective) probabilities to discuss the problem of becoming a believer
- Bayes (1763) used subjective probabilities to convince us that God exists
- Can we always quantify uncertainty probabilistically?

Answer 1: No, we cannot

Knight distinguished between these two types of uncertainty

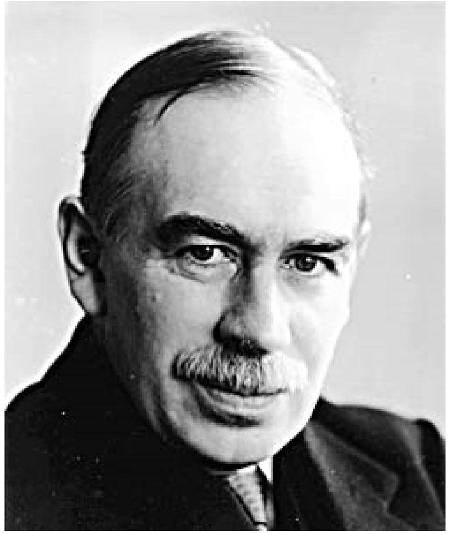
"Knightian uncertainty" – cannot be quantified

Argued that entrepreneurs are more tolerant of that type uncertainty

Frank Knight (1885-1972)

And this was also Keynes's view

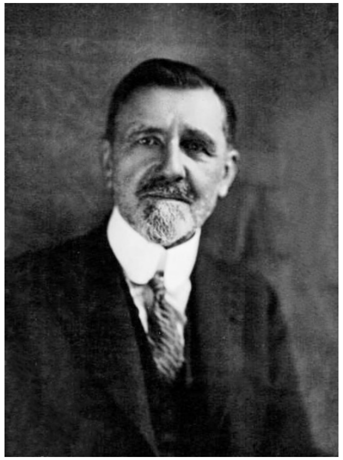
"...About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know."



John Maynard Keynes (1883-1946)

On the other hand…

There were others…



Émile Borel (1871-1956)

Bruno de Finetti (1906-1985)

Frank P. Ramsey (1903-1930)

Subjective probabilities and choice

- Borel, Ramsey, de Finetti: subjective probability should be measured by betting behavior

  "Put your money where your mouth is"

- Coherent betting behavior $\Rightarrow$ maximization of expectation
- Define probabilities by behavior

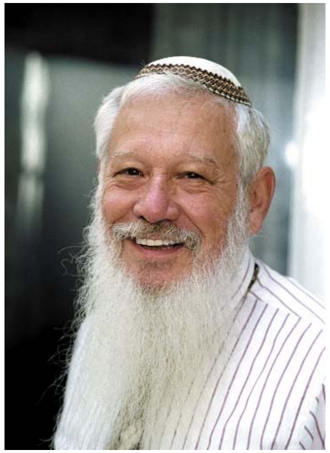
Savage’s Result

Leonard J. Savage
(1917-1971)

- An amazing theorem that shows
- Coherent decisions $\Rightarrow$ expected utility maximization with respect to a subjective probability
- Both the probability and the utility are derived from preferences
- It convinced the entire field. Make it “fields”.

Anscombe and Aumann

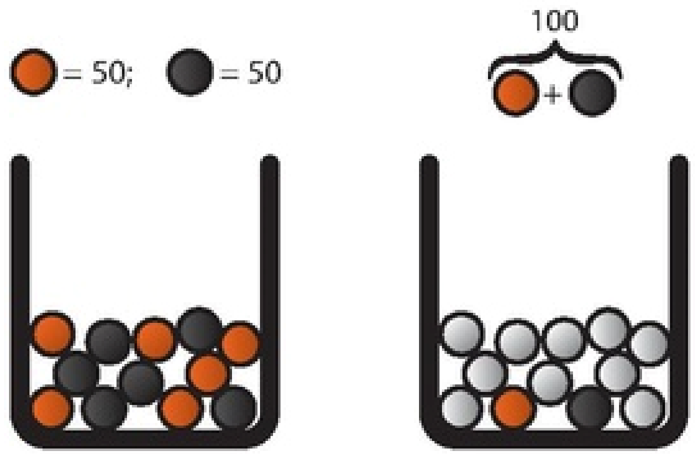
Francis J. Anscombe (1918-2001)



Robert J. Aumann (b. 1930)

A conceptually similar result deriving subjective from objective probabilities

Ellsberg's Paradox(es)



Daniel Ellsberg
(b. 1931)

Would you prefer to bet on the known or unknown?

Ellsberg's Paradox

- If you're not indifferent, you're probably not Bayesian
- A Bayesian would have to have probabilities that add up to 1
- In case of symmetry, 50%-50%
- There no distinction between 50%-50% that result from statistics and 50%-50% that come with a shrug of shoulders
- Keynes (1921) gave a similar example

The descriptive problem

People often do not behave as if there had subjective probabilities

- Investment in financial markets
- Fear of epidemics, financial crises, terrorist attacks…

The normative problem

- It is not obvious that it is rational to behave as if there were probabilities
- What's the probability that all Arbodytes are Cyclophines?
  - (I made up these words)
  - 50%-50% ? How about the converse? How about the two being disjoint? How about meta-Arbodytes?

The normative problem

- The main point: the Bayesian approach doesn't have the language to say "I don't have any idea"
- "I don't know" is countered by "How much do you not know? 0.75? 0.74?"

Why aren't we convinced by Savage?

- Well, it depends to a large extent on the state space
- When it is theoretically constructed, the axioms are less compelling
- Even the two-urn example required construction
- In real-life examples we may never even observe a state

Other Models

- The are models than can capture "ambiguity aversion"
- For example: maxmin expected utility
- But there are many others
  - Pioneering work: Choquet Expected Utility by David Schmeidler

David Schmeidler
(b. 1939)

EMOTIONS and

STRATEGIC REASONING

The Ultimatum Game

There is a sum of $\$100$ to share between Players I and II

Player I offers a way to divide the sum (say, integer values)

Player II can say Yes or No

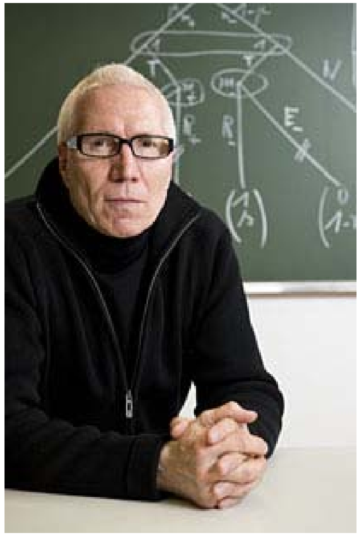
Yes – they get the amounts offered

No – they both get nothing

What will happen?

What does the theory say?

The Ultimatum Game



Werner Güth (b. 1944)

Bernd Schwarze (b. 1944)

Güth, Schmittberger, Schwarze (1982)

Reference

An experimental analysis of ultimatum bargaining

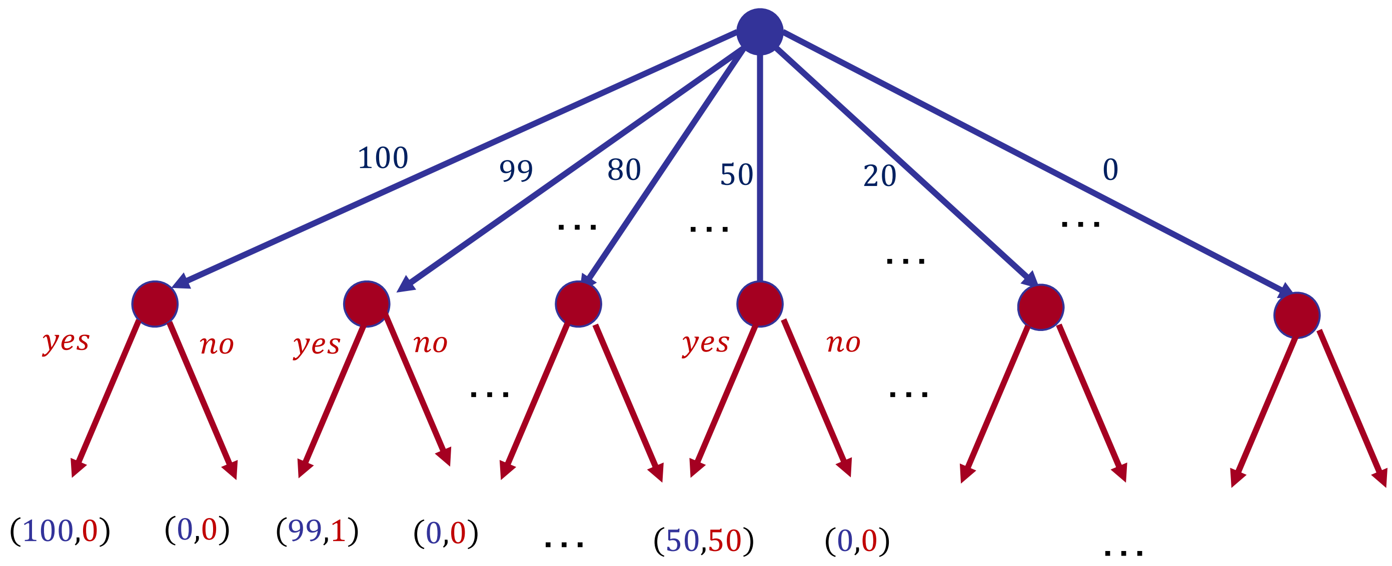
Werner Güth, Rolf Schmittberger, Bernd Schwarze

Journal of Economic Behavior and Organization, Vol. 3, No. 4 (Dec., 1982), pp. 367-388

Abstract

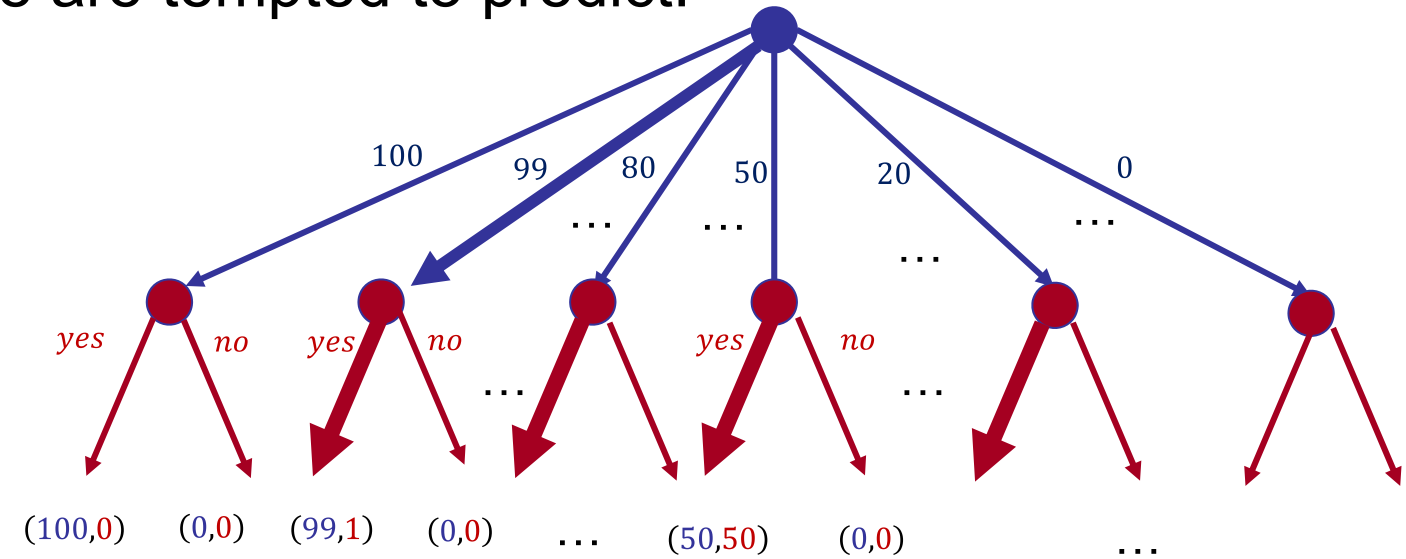
There are many experimental studies of bargaining behavior, but suprisingly enough nearly no attempt has been made to investigate the so-called ultimatum bargaining behavior experimentally. The special property of ultimatum bargaining games is that on every stage of the bargaining process only one player has to decide and that before the last stage the set of outcomes is already restricted to only two results. To make the ultimatum aspect obvious we concentrated on situations with two players and two stages. In the ‘easy games’ a given amount *c* has to be distributed among the two players, whereas in the ‘complicated games’ the players have to allocate a bundle of black and white chips with different values for both players. We performed two main experiments for easy games as well as for complicated games. By a special experiment it was investigated how the demands of subjects as player 1 are related to their acceptance decisions as player 2.

What does the theory say?



Well,

We are tempted to predict:



The “Backward Induction” solution

Backward Induction

In a finite game of perfect information we can go down to the leaves and work our way backwards to find the players' choices

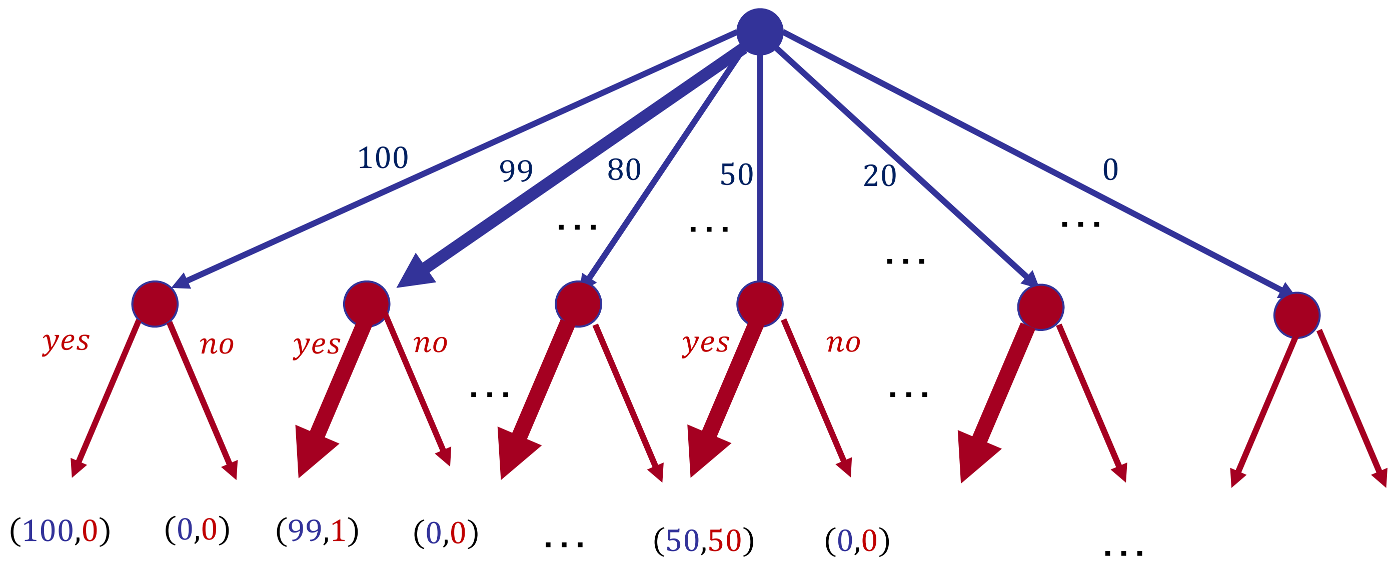
Ernest Zermelo (1871-1953)

Backward Induction Assumptions

- Rationality
- Common knowledge (or common belief) in rationality
- To be precise, as many levels of belief as there are steps in the game

So in this case

The backward induction seems to be



– But this assumes that the monetary sums are the "utilities"

Important

- In a game as simple as the Ultimatum Game, it is impossible to test basic decision/game theoretic assumptions (such as transitivity)

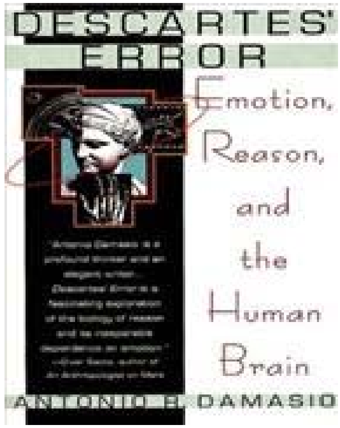
- We can only test them coupled with the assumption that only material payoffs matter

Emotional payoffs

- Player II might be angry/insulted at a low offer
- Player II as well as Player I might care for fairness
- Player I might be altruistic
- etc.

- A way to tell some explanations apart: the Dictator Game

Is it rational to respond to emotions?



Antonio Damasio (b. 1944)

In "Descartes' Error" (1994) argued that it is wrong to think of emotions and rationality as divorced; rather, rationality relies on emotions

How could we think otherwise?

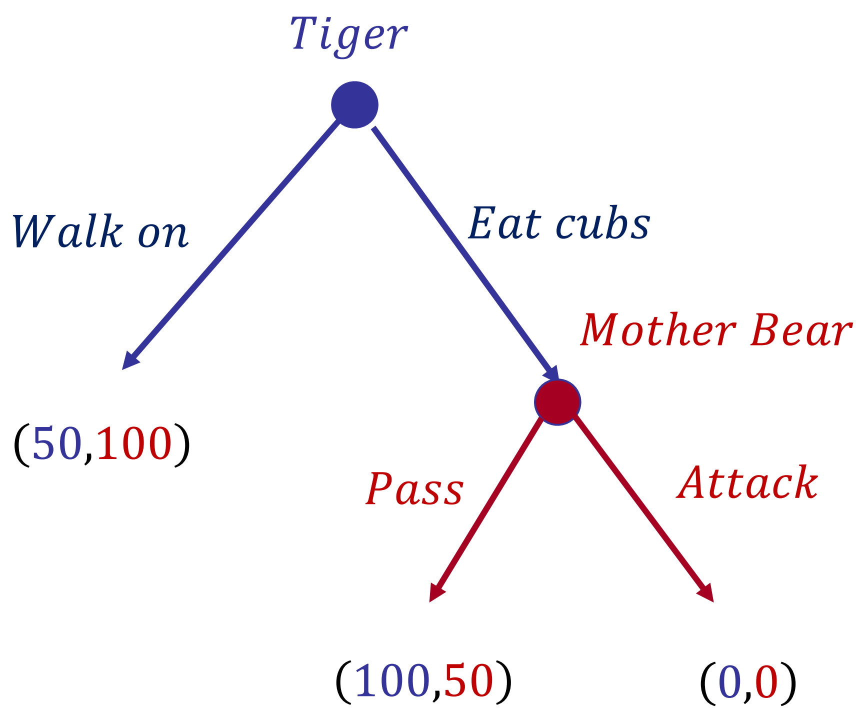
- Surely, there are cases where emotional reactions are excessive, “take over”
  - I may shoot someone and regret it for the rest of my life
- But pure reason cannot tell me what to do if I don’t have an affective/hedonic reaction to it
- How would I “know” I should maximize u ?

Evolutionary Psychology

- Love of our children
- Caring for others (partners, siblings…)
- What about negative emotions?
- Who needs anger? Vindictiveness?

A toy model of anger

Material* payoffs

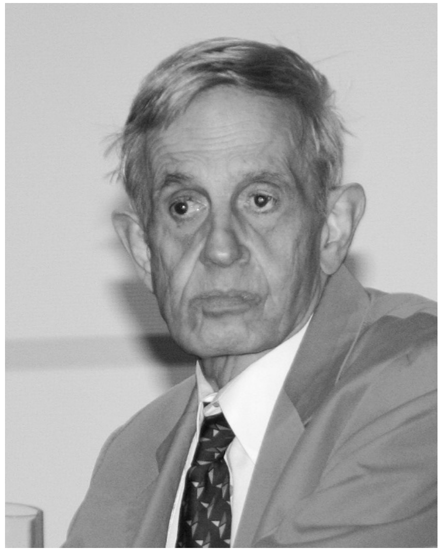


* Assuming maternal love but no vengeance

Nash equilibrium

A selection of a strategy for each player such that each is a best response to the others

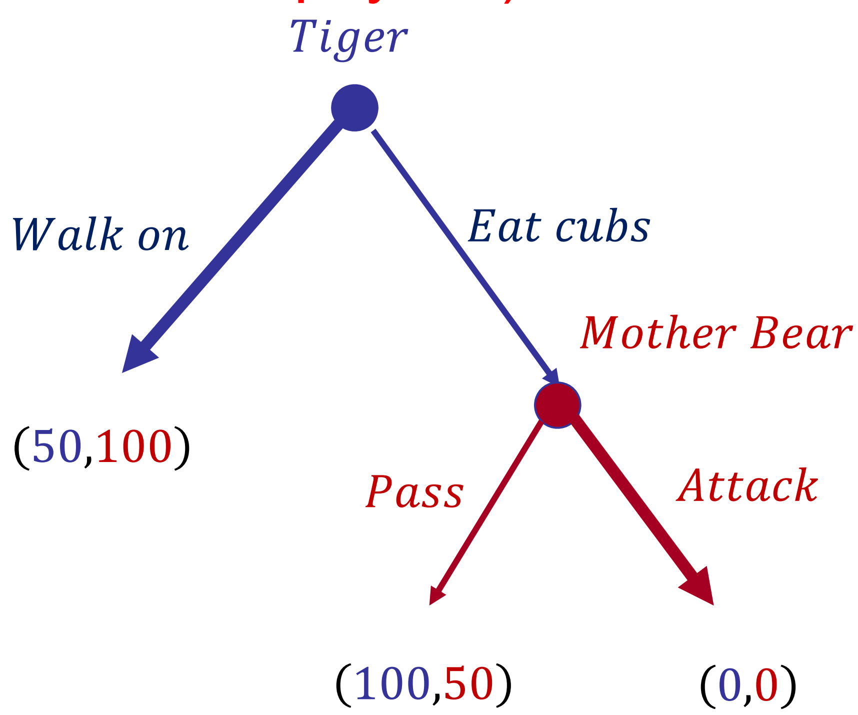
A deep theorem about existence in mixed strategies



John F. Nash (1928-2015)

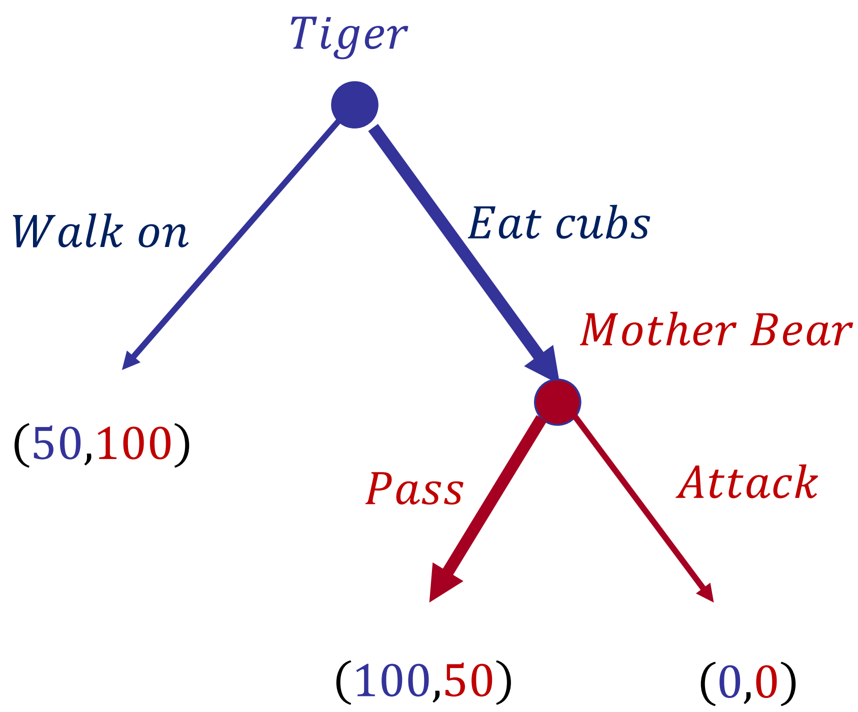
Nash equilibrium I

(in this game with material payoffs)



Nash equilibrium II

(in this game with material payoffs)



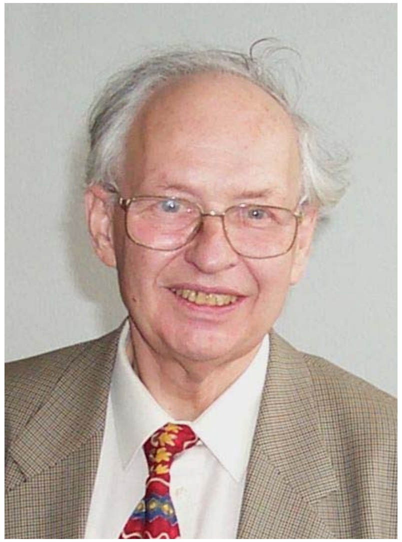
The game in the strategic form

		Mother Bear	
		Pass	*Attack*
Tiger	*Eat cubs*	100 , 50	0 , 0
	Walk on	50 , 100	50 , 100

Both shaded entries are Nash equilibria

Subgame Perfect equilibrium

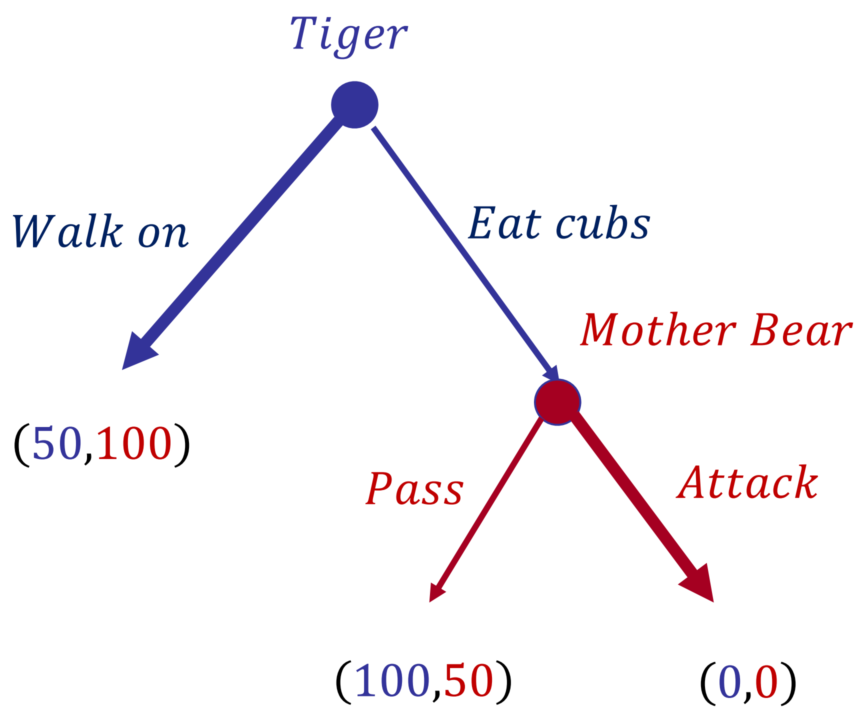
A Nash equilibrium that is still an equilibrium when we look at its restriction to any subgame



Reinhard Selten (1930-2016)

The idea: cross out threats that are not credible

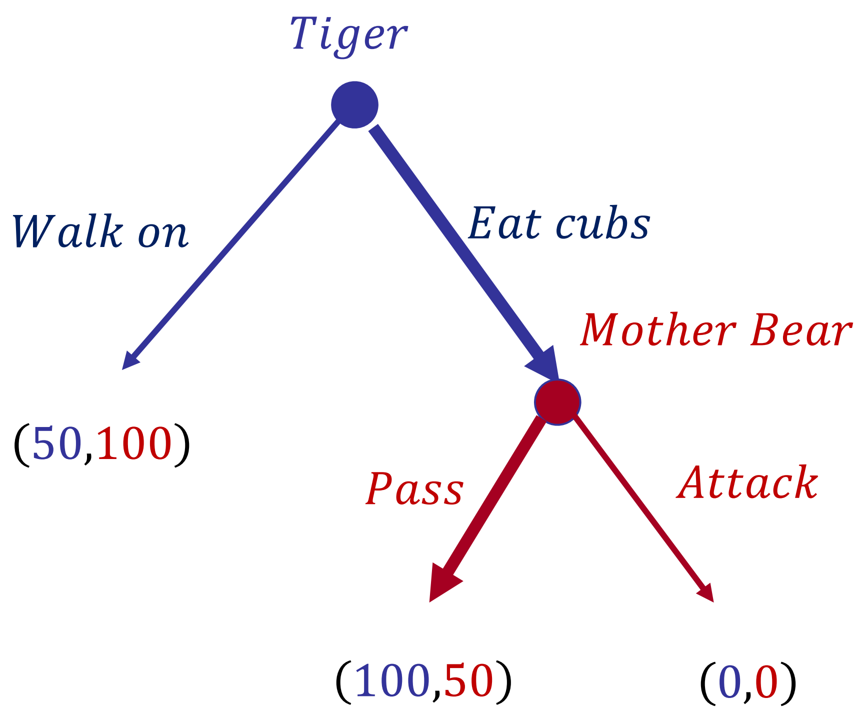
Equilibrium I isn’t subgame perfect



Mother Bear’s choice isn’t optimal in the subgame

It is a non-credible threat

Equilibrium II is subgame perfect



As would be the Backward Induction solution in general

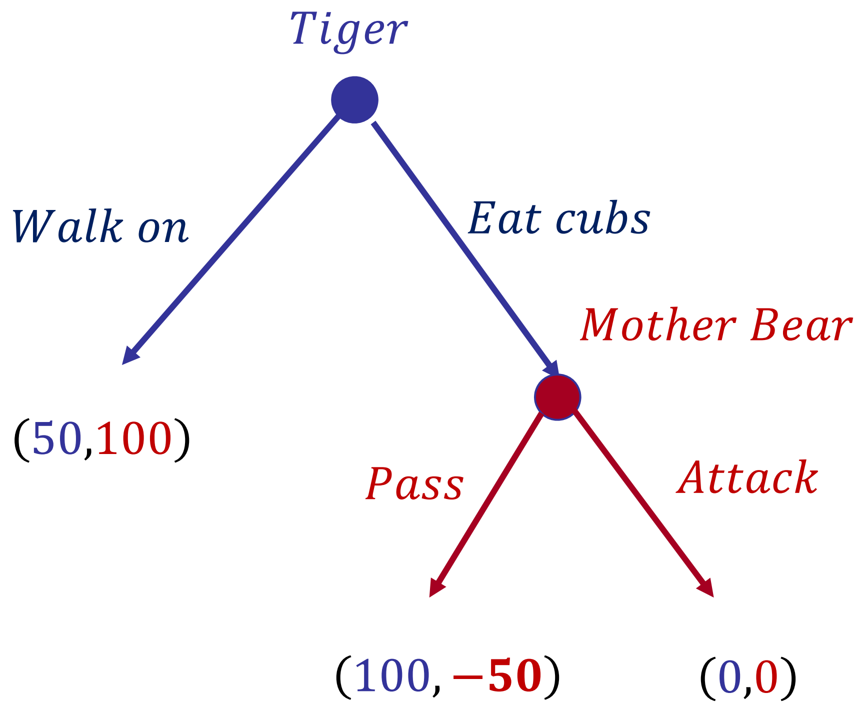
And we can expect evolutionary processes to lead to this one

Perfectness in the strategic form

		Mother Bear	
		Pass	*Attack*
Tiger	*Eat cubs*	100 , 50	0 , 0
	Walk on	50 , 100	50 , 100

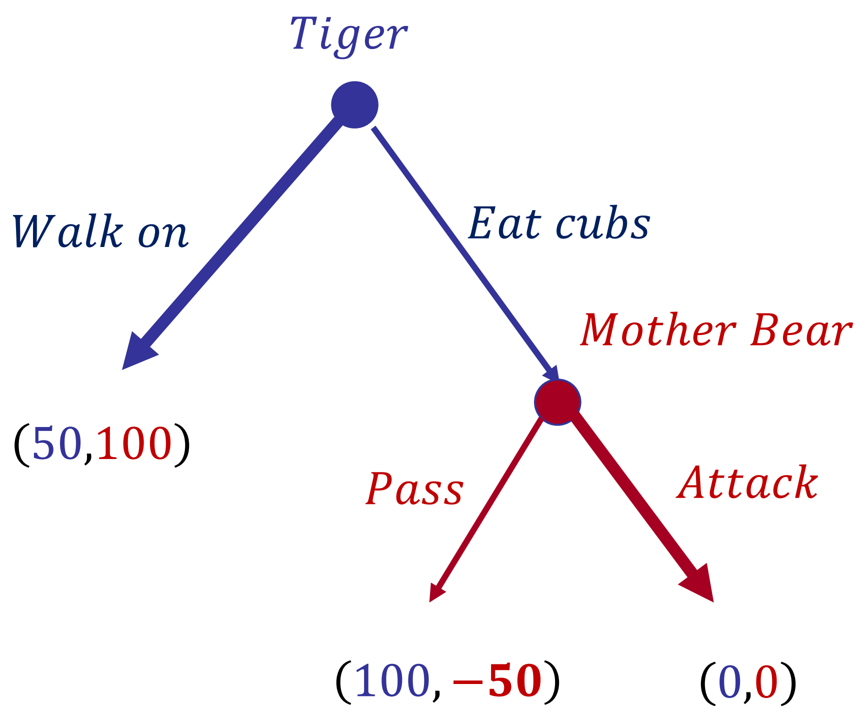
Only the first is trembling-hand perfect

Let’s build vengeance into the payoffs



Recall that the payoffs are supposed to describe behavior

Equilibria in the "emotional" game



Only one equilibrium (in pure strategies), which is also Subgame Perfect

Similarly in the strategic form

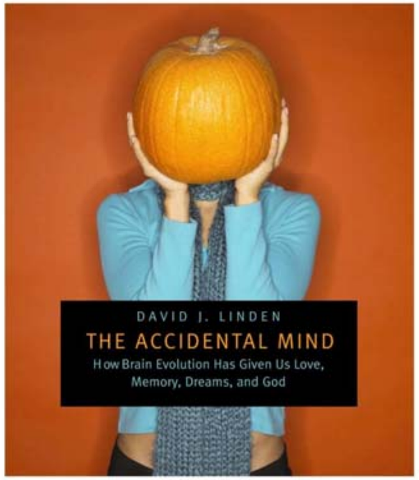
		Mother Bear	
		Pass	*Attack*
Tiger	*Eat cubs*	$100, \mathbf{-50}$	$0, 0$
	Walk on	$50, 100$	$50, 100$

The unique pure strategy equilibrium is trembling-hand perfect

The evolutionary role of emotions

- Not only love for children or partners
- Anger, vengeance can be useful, too
  - Repeated game strategies often use a “punishment phase”
- How about envy?
  - If someone else has more, maybe I missed something?
  - … and our reproduction technology has competition built into it

Can we explain falling in love?



The Accidental Mind (2007)

David Linden (b. 1961)

One common explanation: signaling of future commitment

Which might be helpful to get a mate

Back to the Ultimatum Game

- Having said all that, emotional payoffs should not be overstated
- In the Ultimatum Game, if the payoffs were in millions of dollars rather than dollars, acceptance of low offers would likely to be higher
- As well as when Player II has to wait before responding

The Ultimatum Game with Delay

Let me sleep on it: Delay reduces rejection rates in ultimatum games

Grimm, V and Mengel, F (2011) Economics Letters, 111: pp. 113-115

Abstract

Delaying acceptance decisions in the Ultimatum Game drastically increases acceptance of low offers. While in treatments without delay less than 20% of low offers are accepted, 60-80% are accepted as we delay the acceptance decision by around 10. min.

Well Being

Problem 5.1

Mary’s direct boss just quit, and you’re looking for someone for the job. You don’t think that Mary is perfect for it. By contrast, Jane seems a great fit. But it may be awkward to promote Jane and make Mary her subordinate. A colleague suggested that you go ahead and do this, but give both of them a nice raise to solve the problem.

Money and Well-Being

Money isn't everything

- Low correlation between income and well-being
- The relative income hypothesis (Duesenberry, 1949)
- Higher correlation within a cohort than across time (Easterlin, 1974)
- Relative to an aspiration level

Other Determinants of Well-Being

- Love, friendship
- Social status
- Self fulfillment
  - So how should we measure “success”?

Subjective Well Being

- We already mentioned Helson and Adaptation Level Theory
- Some of his disciples applied it to well-being
- Brickman and Coates (1971): the hedonic treadmill
- Brickman, P., Coates, D., & Janoff-Bulman, R. (1978). Lottery winners and accident victims: Is happiness relative? *Journal of Personality and Social Psychology, 36*(8), 917–927. https://doi.org/10.1037/0022-3514.36.8.917
- https://www.ted.com/talks/dan_gilbert_asks_why_are_we_happy/footnotes?referrer=playlist-324

Reference

Lottery winners and accident victims: Is happiness relative?

Philip Brickman, Dan Coates, Ronnie Janoff-Bulman

Journal of Personality and Social Psychology, Vol. 36 No. 8 (1978), pp. 917-927

Abstract

Adaptation level theory suggests that both contrast and habituation will operate to prevent the winning of a fortune from elevating happiness as much as might be expected. Contrast with the peak experience of winning should lessen the impact of ordinary pleasures, while habituation should eventually reduce the value of new pleasures made possible by winning. Study 1 compared a sample of 22 major lottery winners with 22 controls and also with a group of 29 paralyzed accident victims who had been previously interviewed. As predicted, lottery winners were not happier than controls and took significantly less pleasure from a series of mundane events. Study 2, using 86 Ss who lived close to past lottery winners, indicated that these effects were not due to preexisting differences between people who buy or do not buy lottery tickets or between interviews that made or did not make the lottery salient. Paraplegics also demonstrated a contrast effect, not by enhancing minor pleasures but by idealizing their past, which did not help their present happiness.

Subjective Well Being – Methodology

- Strack, Martin, and Schwarz (1988) showed that the order of questions can change correlation of factual ones with assessment of well-being

- Schwarz and Clore (1983) showed that people could “deduct” the effect of weather in responding to well-being questions, provided they were induced to notice it

Reference

Priming and communication: Social determinants of information use in judgments of life satisfaction

Fritz Strack, Leonard L. Martin, Norbert Schwartz

European Journal of Social Psychology, Vol. 18 No. 5 (1988), pp. 429-442

Abstract

Two experiments examined the effects of answering a question about a specific component of life satisfaction on respondents' assessment of their overall satisfaction with life. The results suggest that the use of primed information in forming subsequent judgments is determined by Grice's conversational norms. In general, answering the specific question increases the accessibility of information relevant to that question. However, the effect that this has on the general judgment depends on the way in which the two questions are presented. When the two questions are merely placed in sequence without a conversational context, the answer to the subsequent general question is based in part on the primed specific information. As a result, the answer to the general question becomes similar to that for the specific question (i.e. assimilation). However, this does not occur when the two questions are placed in a communication context…

Reference

Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states

Norbert Schwartz, Gerald Clore

Journal of Personality and Social Psychology, Vol. 45 No. 3 (Sep. 1983), pp. 513-523

Abstract

Investigated, in 2 experiments, whether judgments of happiness and satisfaction with one's life are influenced by mood at the time of judgment. In Exp I, moods were induced by asking 61 undergraduates for vivid descriptions of a recent happy or sad event in their lives. In Exp II, moods were induced by interviewing 84 participants on sunny or rainy days. In both experiments, Ss reported more happiness and satisfaction with their life as a whole when in a good mood than when in a bad mood. However, the negative impact of bad moods was eliminated when Ss were induced to attribute their present feelings to transient external sources irrelevant to the evaluation of their lives; but Ss who were in a good mood were not affected by misattribution manipulations. The data suggest that (a) people use their momentary affective states in making judgments of how happy and satisfied they are with their lives in general and (b) people in unpleasant affective states are more likely to search for and use information to explain their state than are people in pleasant affective states.

More on method

- And will the lottery winners be willing to swap?
- What about having children?

The Day Reconstruction Method

Kahneman and colleagues: memories of experiences are not to be trusted

We need something more objective

Ask people what they did and how long, ask others how much fun it is

Reference

A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method

Daniel Kahneman, Alan B. Krueger, David A. Schkade, Norbert Schwarz, Arthur A. Stone

Science, Vol. 306 No. 5702 (Dec. 2004), pp. 1776-1780

Abstract

The Day Reconstruction Method (DRM) assesses how people spend their time and how they experience the various activities and settings of their lives, combining features of time-budget measurement and experience sampling. Participants systematically reconstruct their activities and experiences of the preceding day with procedures designed to reduce recall biases. The DRM's utility is shown by documenting close correspondences between the DRM reports of 909 employed women and established results from experience sampling. An analysis of the hedonic treadmill shows the DRM's potential for well-being research.

Problem

Robert is on a ski vacation with his wife, while John is at home. He can't even dream of a ski vacation with the two children, to say nothing of the expense. In fact, John would be quite happy just to have a good night sleep.

Do you think that Robert is happier than John?

What's Happiness?

- Both subjective well being and day reconstruction would suggest that Robert is happier
- And yet…
- What's happiness for you?
- How should we measure happiness for social policies?