Clear Thinking in an Uncertain World: Human Reasoning and its Foundations

Lecture 11

Eric Pacuit

Department of Philosophy
University of Maryland, College Park
pacuit.org
epacuit@umd.edu

November 11, 2013

Framing Matters

UMD plays Ohio State next year. Suppose that (miraculously) UMD wins the game. There are two headlines that could run in the Diamondback:

1. “The Terps Won!”
2. “The Buckeyes Lost!”

Framing Matters

UMD plays Ohio State next year. Suppose that (miraculously) UMD wins the game. There are two headlines that could run in the Diamondback:

1. "The Terps Won!"
2. "The Buckeyes Lost!"

Do the two headlines have the same *meaning*?

Framing Matters

UMD plays Ohio State next year. Suppose that (miraculously) UMD wins the game. There are two headlines that could run in the Diamondback:

1. "The Terps Won!"
2. "The Buckeyes Lost!"

Do the two headlines have the same *meaning*?

"The fact that logically equivalent statements evoke different reactions makes it impossible for Humans to be as reliably rational as Econs." (pg. 363)

Framing Matters

UMD plays Ohio State next year. Suppose that (miraculously) UMD wins the game. There are two headlines that could run in the Diamondback:

1. "The Terps Won!"
2. "The Buckeyes Lost!"

Do the two headlines have the same *meaning*?

"The fact that logically equivalent statements evoke different reactions makes it impossible for Humans to be as reliably rational as Econs." (pg. 363)

Rationality is associated with both the capacity to order outcomes *and* to choose from the *top* of the order.

Maximizing

A. Sen. *Maximization and the Act of Choice*. Econometrica, Vol. 65, No. 4, 1997, 745 - 779.

"The formulation of maximizing behavior in economics has often paralleled the modeling of maximization in physics an related disciplines.

Maximizing

A. Sen. *Maximization and the Act of Choice*. Econometrica, Vol. 65, No. 4, 1997, 745 - 779.

“The formulation of maximizing behavior in economics has often paralleled the modeling of maximization in physics an related disciplines. But maximizing *behavior* differs from nonvolitional *maximization* because of the fundamental relevance of the choice act, which has to be placed in a central position in analyzing maximizing behavior.

Maximizing

A. Sen. *Maximization and the Act of Choice*. Econometrica, Vol. 65, No. 4, 1997, 745 - 779.

"The formulation of maximizing behavior in economics has often paralleled the modeling of maximization in physics an related disciplines. But maximizing *behavior* differs from nonvolitional *maximization* because of the fundamental relevance of the choice act, which has to be placed in a central position in analyzing maximizing behavior. A person's preferences over *comprehensive* outcomes (including the choice process) have to be distinguished form the conditional preferences over *culmination* outcomes *given* the act of choice." (pg. 745)

You arrive at a garden party and can readily identify the most comfortable chair. You would be delighted if an imperious host were to assign you that chair. However, if the matter is left to your own choice, you may refuse to rush to it.

You arrive at a garden party and can readily identify the most comfortable chair. You would be delighted if an imperious host were to assign you that chair. However, if the matter is left to your own choice, you may refuse to rush to it. You select a “less preferred” chair.

You arrive at a garden party and can readily identify the most comfortable chair. You would be delighted if an imperious host were to assign you that chair. However, if the matter is left to your own choice, you may refuse to rush to it. You select a “less preferred” chair. Are you still a maximizer?

You arrive at a garden party and can readily identify the most comfortable chair. You would be delighted if an imperious host were to assign you that chair. However, if the matter is left to your own choice, you may refuse to rush to it. You select a "less preferred" chair. Are you still a maximizer? Quite possibly you are, since your preference ranking for choice behavior may well be defined over "comprehensive outcomes", including choice processes (in particular, who does the choosing) as well as the outcomes at culmination (the distribution of chairs).

You arrive at a garden party and can readily identify the most comfortable chair. You would be delighted if an imperious host were to assign you that chair. However, if the matter is left to your own choice, you may refuse to rush to it. You select a “less preferred” chair. Are you still a maximizer? Quite possibly you are, since your preference ranking for choice behavior may well be defined over “comprehensive outcomes”, including choice processes (in particular, who does the choosing) as well as the outcomes at culmination (the distribution of chairs).

To take another example, you may prefer mangoes to apples, but refuse to pick the last mango from a fruit basket, and yet be very pleased if someone else were to “force” that last mango on you. ” (Sen, pg. 747)

Environmental Uncertainty

In many circumstances the individual doesn't get to choose outcomes directly, but rather chooses and instrument that affects what outcome actually occurs.

Environmental Uncertainty

In many circumstances the individual doesn't get to choose outcomes directly, but rather chooses and instrument that affects what outcome actually occurs.

Choice under

- *certainty*: highly confident about the relationship between actions and outcomes
- *risk*: clear sense of possibilities and their likelihoods
- *uncertainty*: the relationship between actions and outcomes is so imprecise that it is not possible to assign likelihoods

Expected Utility

Expected Money/Value/Utility: Given an agent's beliefs and desires, the **expected utility** of an **action** leading to a set of outcomes *Out* is:

$$\sum_{o \in Out} [\text{how likely the act will lead to } o] \times [\text{how much the agent desires } o]$$

Expected Utility

Expected Money/Value/Utility: Given an agent's beliefs and desires, the **expected utility** of an **action** leading to a set of outcomes *Out* is:

$$\sum_{o \in Out} [\text{how likely the act will lead to } o] \times [\text{how much the agent desires } o]$$

1. principle of maximizing expected *monetary value*
2. principle of maximizing expected *utility*

A Choice

Options	1/2	1/2
L_1	$1M$	$1M$
L_2	$3M$	$0M$

A Choice

Options	1/2	1/2
L_1	$1M$	$1M$
L_2	$3M$	$0M$

$$EVM(L_1) = 1/2 \cdot 1 + 1/2 \cdot 1 = 1$$
$$EVM(L_2) = 1/2 \cdot 3 + 1/2 \cdot 0 = 1.5$$

A Choice

Options	1/2	1/2
L_1	$1M$	$1M$
L_2	$3M$	$0M$

$EVM(L_1) = 1/2 \cdot 1 + 1/2 \cdot 1 = 1$
$EVM(L_2) = 1/2 \cdot 3 + 1/2 \cdot 0 = 1.5$

What numbers should we use in place of monetary value?

A Choice

Options	1/2	1/2
L_1	$1M$	$1M$
L_2	$3M$	$0M$

$EVM(L_1) = 1/2 \cdot 1 + 1/2 \cdot 1 = 1$
$EVM(L_2) = 1/2 \cdot 3 + 1/2 \cdot 0 = 1.5$

What numbers should we use in place of monetary value? (moral) value? personal utility?

Allais Paradox

	Options	Red (1)	White (89)	Blue (10)
S_1	A	$1M$	$1M$	$1M$
	B	0	$1M$	$5M$
S_2	C	$1M$	0	$1M$
	D	0	0	$5M$

Allais Paradox

	Options	Red (1)	White (89)	Blue (10)
S_1	A	$1M$	$1M$	$1M$
	B	0	$1M$	$5M$
S_2	C	$1M$	0	$1M$
	D	0	0	$5M$

same prize configurations and the same chance of winning the prizes implies one will have the same preferences.

Allais Paradox

	Options	Red (1)	White (89)	Blue (10)
S_1	A	$1M$	$1M$	$1M$
	B	0	$1M$	$5M$
S_2	C	$1M$	0	$1M$
	D	0	0	$5M$

same prize configurations and the same chance of winning the prizes implies one will have the same preferences.

In S_1, many people would choose A over B ($A \succeq B$).

Allais Paradox

	Options	Red (1)	White (89)	Blue (10)
S_1	A	$1M$	$1M$	$1M$
	B	0	$1M$	$5M$
S_2	C	$1M$	0	$1M$
	D	0	0	$5M$

same prize configurations and the same chance of winning the prizes implies one will have the same preferences.

In S_1, many people would choose A over B ($A \succeq B$). *But, according to the axioms, this cannot be because of the white ball.*

Allais Paradox

	Options	Red (1)	White (89)	Blue (10)
S_1	A	$1M$	$1M$	$1M$
	B	0	$1M$	$5M$
S_2	C	$1M$	0	$1M$
	D	0	0	$5M$

same prize configurations and the same chance of winning the prizes implies one will have the same preferences.

In S_1, many people would choose A over B ($A \succeq B$). *But, according to the axioms, this cannot be because of the white ball*. So, your preferences in S_2 should be C over D ($C \succeq D$),

Allais Paradox

	Options	Red (1)	White (89)	Blue (10)
S_1	A	$1M$	$1M$	$1M$
	B	0	$1M$	$5M$
S_2	C	$1M$	0	$1M$
	D	0	0	$5M$

same prize configurations and the same chance of winning the prizes implies one will have the same preferences.

In S_1, many people would choose A over B ($A \succeq B$). *But, according to the axioms, this cannot be because of the white ball*. So, your preferences in S_2 should be C over D ($C \succeq D$), but many people prefer D over C.

Allais Paradox

We should not conclude either

Allais Paradox

We should not conclude either

(a) The axioms of cardinal utility fail to adequately capture our understanding of rational choice, or

Allais Paradox

We should not conclude either

(a) The axioms of cardinal utility fail to adequately capture our understanding of rational choice, or

(b) those who choose A in S_1 and D is L_2 are irrational.

Allais Paradox

We should not conclude either

(a) The axioms of cardinal utility fail to adequately capture our understanding of rational choice, or

(b) those who choose A in S_1 and D is L_2 are irrational.

Rather, people's utility functions (*their rankings over outcomes*) are often far more complicated than the monetary bets would indicate....

D. Kahneman and A. Tversky. *Prospect Theory: An Analysis of Decision under Risk*. Econometrica, Vol. 47, No. 2., pgs. . 263 - 292, 1979.

N. Barberis. *Thirty Years of Prospect Theory in Economics: A Review and Assessment*. Journal of Economic Perspectives, 27:1, pgs. 171 - 196, 2013.

Prospect Theory

Consider a gamble

$$(x_{-m}; p_{-m}; x_{-m+1}; p_{-m+1}; \ldots; x_0; p_0; \ldots; x_{n-1}, p_{n-1}; x_n, p_n)$$

where $x_i < x_j$ for $i < j$ and $x_0 = 0$

Expected Utility

$$\sum_{i=-m}^{n} p_i U(W + x_i)$$

where W is current wealth and $U(\cdot)$ is an increasing and concave utility function.

Prospect Theory

Consider a gamble

$$(x_{-m}; p_{-m}; x_{-m+1}; p_{-m+1}; \ldots; x_0; p_0; \ldots; x_{n-1}, p_{n-1}; x_n, p_n)$$

where $x_i < x_j$ for $i < j$ and $x_0 = 0$

Cumulative Prospect Theory

$$\sum_{i=-m}^{n} \pi_i v(x_i)$$

where $v(\cdot)$ is the "value function" is an increasing function with $v(0) = 0$ and π_i are "decision weights".

reference dependence: people derive utility from *gains and loses*, measured relative to some reference point, rather than from absolute levels of wealth.

reference dependence: people derive utility from *gains and loses*, measured relative to some reference point, rather than from absolute levels of wealth.

loss aversion: people are much more sensitive to losses—even small losses—than to gains of the same magnitude. Many people turn down a gamble $(-\$100 : \frac{1}{2}, \$110 : \frac{1}{2})$, but this is very hard to explain in classical utility theory (Rabin, 2000) *diminishing sensitivity*: people tend to be risk adverse over moderate probability gains (they typically prefer a certain gain of \$500 to a 50 precent chance of \$1,000) and *risk seeking* over losses (they prefer a 50 precent chance of loosing \$1000 to loosing \$500 for sure) *diminishing sensitivity*: people tend to be risk adverse over moderate probability gains (they typically prefer a certain gain of \$500 to a 50 precent chance of \$1,000) and *risk seeking* over losses (they prefer a 50 precent chance of loosing \$1000 to loosing \$500 for sure)

probability weighting: people tend to overweight the tails of a probability distribution (they tend to overweight extremely unlikely outcomes).

A Choice

Options	1/2	1/2
L_1	$1M$	$1M$
L_2	$2M$	$0M$

A Choice

Options	1/2	1/2
L_1	$1M$	$1M$
L_2	$2M$	$0M$

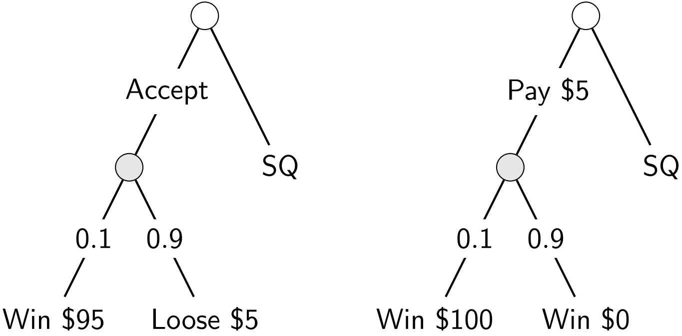
$$EVM(L_1) = 1/2 \cdot 1 + 1/2 \cdot 1 = 1$$
$$EVM(L_2) = 1/2 \cdot 3 + 1/2 \cdot 0 = 1$$

Would you accept a gamble that offers a 10% chance to win $95 and a 90% chance to loose $5?

Would you pay $5 to participate in a lottery that offers a 10% chance to win $100 and a 90% chance to win nothing?

Would you accept a gamble that offers a 10% chance to win $95 and a 90% chance to loose $5?

Would you pay $5 to participate in a lottery that offers a 10% chance to win $100 and a 90% chance to win nothing?



"A bad outcome is much more acceptable if it is framed as the cost of a lottery ticket that did not win than if it is imply described as losing a gamble. We should not be surprised: *losses* evokes stronger negative feelings than *costs*. " (pg. 364).

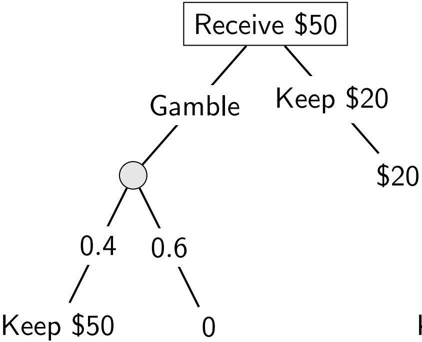
Suppose you are given $50.

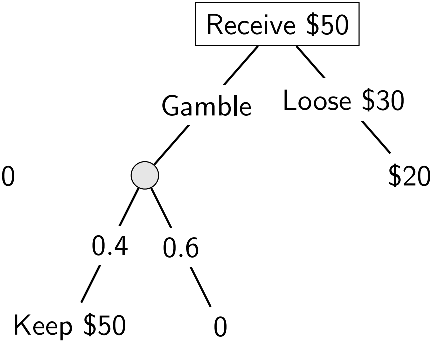
Situation 1: Choose one of the following:

1. You keep $20.
2. There is a 40% chance that you keep $50, otherwise you keep nothing.

Situation 2: Choose one of the following:

1. You loose $30.
2. There is a 40% chance that you keep $50, otherwise you keep nothing.


Receive $50
Gamble
Keep $20
$20
0.4
0.6
Keep $50
0


Receive $50
Gamble
Loose $30
$20
0.4
0.6
Keep $50
0

Logicophilia, a virulent virus, threatens 600 students at the University of Maryland

[Adapted from Tversky and Kahneman (1981)]

Logicophilia, a virulent virus, threatens 600 students at the University of Maryland

1. You must choose between two prevention programs, resulting in:
   - A: 200 participants will be saved for sure.
   - B: 33 % chance of saving all of them, otherwise no one will be saved.

[Adapted from Tversky and Kahneman (1981)]

Logicophilia, a virulent virus, threatens 600 students at the University of Maryland

1. You must choose between two prevention programs, resulting in:
   - A: 200 participants will be saved for sure.
   - B: 33 % chance of saving all of them, otherwise no one will be saved.

   72 % of the participants choose A over B.

[Adapted from Tversky and Kahneman (1981)]

Logicophilia, a virulent virus, threatens 600 students at the University of Maryland

2. You must choose between two prevention programs, resulting in:
   - A': 400 will not be saved, for sure.
   - B': 33 % chance of saving all of them, otherwise no one will be saved.

[Adapted from Tversky and Kahneman (1981)]

Logicophilia, a virulent virus, threatens 600 students at the University of Maryland

2. You must choose between two prevention programs, resulting in:
   - A': 400 will not be saved, for sure.
   - B': 33 % chance of saving all of them, otherwise no one will be saved.

   78 % of the participants choose B' over A'.

[Adapted from Tversky and Kahneman (1981)]

Logicophilia, a virulent virus, threatens 600 students at the University of Maryland

1. You must choose between two prevention programs, resulting in:
   - A: 200 participants will be saved for sure.
   - B: 33 % chance of saving all of them, otherwise no one will be saved.

   72 % of the participants choose A over B.
2. You must choose between two prevention programs, resulting in:
   - A': 400 will not be saved, for sure.
   - B': 33 % chance of saving all of them, otherwise no one will be saved.

   78 % of the participants choose B' over A'.

[Adapted from Tversky and Kahneman (1981)]

The Experiment:	
A: 0 + 200 for sure.	**B:** (33% 600) + (66% 0).
⇒ 72 % of the participants choose A over B.	
A': 600 - 400 for sure.	**B':** (33% 600) + (66% 0).
⇒ 78 % of the participants choose B' over A'.	

- Standard decision theory is extensional
  - Choosing A and $A \leftrightarrow B$ implies Choosing B.

The Experiment:	
A: 0 + 200 for sure.	**B:** (33% 600) + (66% 0).
$\Rightarrow$ 72 % of the participants choose A over B.	
A': 600 - 400 for sure.	**B':** (33% 600) + (66% 0).
$\Rightarrow$ 78 % of the participants choose B' over A'.	

- Standard decision theory is extensional
  - Choosing A and $A \leftrightarrow B$ implies Choosing B.

  Also true of many formalisms of beliefs:
  - "Believing" A and $\vdash A \leftrightarrow B$ implies "Believing" B.

“The different choices in the two frames fit prospect theory, in which choices between gambles and sure things are resolved differently, depending on whether the outcomes are good or bad. Decision makers tend to prefer the sure thing over the gamble (they are risk avers) when the outcomes are good. They tend to reject the sure thing and accept the gamble (the are risk seeking) when both outcomes are negative. ” (Kahneman, pg. 368)

Schelling's Example

Suppose your tax depends on your income and how many kids you have.

- The "child deduction" might be at, say 1000 per child:

$$Tax(i, k) = Base(i) - [k \cdot 1000]$$

- Or it might depend on the taxpayers income

$$Tax(i, k) = Base(i) - [k \cdot Deduction(i)]$$

Q1: Should the child deduction be larger for the rich than for the poor?

Schelling's Example

Instead of taking the "standard" household to be childless, we could lower the base tax for everyone (e.g., by 3000), and add a surcharge for households with less than 3 kids (e.g., 1000/2000/3000).

We could also let the surcharge depend on income.

$$Tax(i, k) = LowerBase(i) + [(3 - k) \cdot Surcharge(i)]$$

Q2: Should the childless poor pay as large a surcharge as the childless rich?

Schelling's Example

Q1: Should the child exemption be larger for the rich than for the poor?

Q2: Should the childless poor pay as large a surcharge as the childless rich?

if you answered No to both, then you are not endorsing a coherent policy

as Kahneman puts the point...
"The difference between the tax owed by a childless family and by a family with two children can be described as a reduction or as an increase. If you want the poor to receive at least the same benefit as the rich for having children, then you must want the poor to pay at least the same penalty as the rich for being childless. "

Another Framing Effect

A woman has bought two \$80 tickets to the theater. When she arrives at the theater, she opens her wallet and discovers that the tickets are missing. Will she buy two more tickets to see the play?

A woman goes to the theater, intending to buy two tickets that cost \$80 each. She arrives at the theater, opens her wallet, and discovers to her dismay that the \$160 with which she was going to make the purchase is missing. She could use her credit card. Will she buy the tickets?

Another Framing Effect

A woman has bought two \$80 tickets to the theater. When she arrives at the theater, she opens her wallet and discovers that the tickets are missing. Will she buy two more tickets to see the play?

A woman goes to the theater, intending to buy two tickets that cost \$80 each. She arrives at the theater, opens her wallet, and discovers to her dismay that the \$160 with which she was going to make the purchase is missing. She could use her credit card. Will she buy the tickets?

"Most believe that that woman in the first story will go home without seeing the show if she has lost the tickets, and most believe that she will charge tickets for the show if she has lost money...The different frames evoke different mental accounts, and the significance of the loss depends on the account to which it is posted. " (pg. 371)

...And One More

Adam and Beth drive equal distances in a year.

Adam switches from a 12-mpg to 14-mpg car.
Beth switches from a 30-mpg to 40-mpg car.

Who will save more gas?

...And One More

Adam and Beth drive equal distances in a year.

Adam switches from a 12-mpg to 14-mpg car.
Beth switches from a 30-mpg to 40-mpg car.

Who will save more gas?

Adam:	$\frac{10{,}000}{12} = 833$	$\frac{10{,}000}{14} = 714$	saving of 119 gallons
Beth:	$\frac{10{,}000}{30} = 333$	$\frac{10{,}000}{40} = 250$	saving of 83 gallons

"The message about the nature of framing is stark: framing should not be viewed as an intervention that masks or distorts an underlying preference. At least in this instance...there is no underlying preference that is masked or distorted by the frame. Our preferences are about framed problems, and our moral intuitions are about descriptions, not substance."