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Back to Newcomb

What does the Principle of Expected Value Maximization say we should do in a Newcomb situation?

Recall that you can choose between the following two options:

$1B$	$2B$
One-Box	Two-Box

Recall, moreover, that there are two relevant states of the world:

F	E
The large box is full	The large box is empty

This means that there are four possible outcomes, depending on whether you One-Box or Two-Box and on whether the large box is full or empty.

The value of each outcome is as follows:

	Large box full (F)	**Large box empty (E)**
One-Box ($1B$)	\$1,000,000	\$0
Two-Box ($2B$)	\$1,001,000	\$1,000

When the predictor is assumed to be 99% accurate, we work with the following probabilities:

	Large box full (F)	**Large box empty (E)**
One-Box ($1B$)	99%	1%
Two-Box ($2B$)	1%	99%

As before, each cell in this matrix corresponds to a *conditional probability*. For example, the probability in the lower right corner corresponds to the probability of finding the large box empty, given that you two-box.

The expected value of one-boxing and two-boxing can then calculated as follows:

$$\begin{array}{llllllllll} EV(1B) & = & v(1B\,F) & \cdot & p(F|1B) & + & v(1B\,E) & \cdot & p(E|1B) & \\ & = & 1000000 & \cdot & 0.99 & + & 0 & \cdot & 0.01 & = & 990,000 \end{array}$$

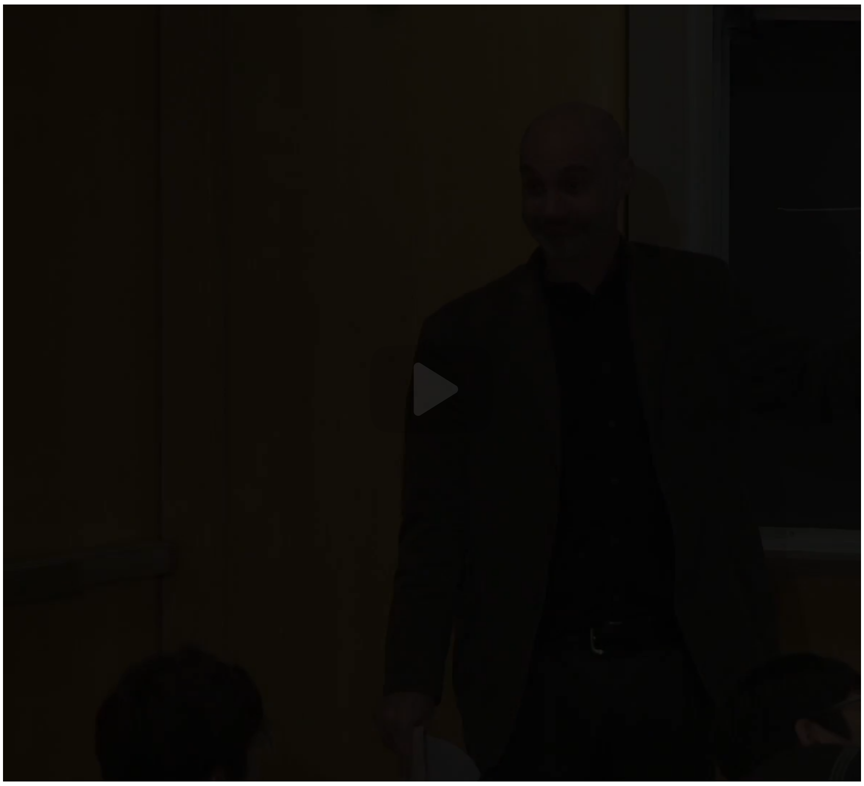
$$\begin{array}{llllllllll} EV(2B) & = & v(2B\,F) & \cdot & p(F|2B) & + & v(2B\,E) & \cdot & p(E|2B) & \\ & = & 1001000 & \cdot & 0.01 & + & 1000 & \cdot & 0.99 & = & 11,000 \end{array}$$

The expected value of one-boxing ($990,000) is much greater than the expected value of two-boxing ($11,000). So according to the Principle of Expected Utility Maximization, we should one-box.

Is that the right result?

We'll try to tackle that question in the next section.

Video Review: Calculating EV in the Newcomb Problem



That is 0.8.

And that gives us 200,100.

So on this way of thinking about decision theory,

we get the recommendation to one-box,

because that's what maximizes expected value.

So if you are right, and I think that you are right,

standard decision theory is wrong.

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Problem 1

2/2 points (ungraded)

Assume the predictor has an 80% chance of making the right prediction.

What is the expected value of one-boxing?

800000

✔ **Answer:** 800000

800000

What is the expected value of two-boxing?

201000

✔ **Answer:** 201000

201000

Explanation

When $p = 80\%$, the expected value of one-boxing is

$$1,000,000 \cdot 0.8 + 0 \cdot 0.2 = 800,000$$

the expected value of two-boxing is

$$1,001,000 \cdot 0.2 + 1,000 \cdot 0.8 = 200,200 + 800 = 201,000$$

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Answers are displayed within the problem

Problem 2

1/1 point (ungraded)

How accurate does the predictor need to be in order for the Principle of Expected Value Maximization to entail that one should one-box?

In other words: identify the smallest number x such that, as long as the predictor has an accuracy of more than x, the Principle of Expected Value Maximization entails that one should one-box.

(As usual, assume that the small box contains $1000 and that the large box contains $1M or nothing.)

0.5005

Answer: .5005

0.5005

Explanation

If p is the probability that the expert's prediction is accurate, the expected value of one-boxing is

$$1,000,000 \cdot p + 0 \cdot (1 - p)$$

and the expected value of two-boxing is

$$1,001,000 \cdot (1 - p) + 1,000 \cdot p$$

These two expected values are equal when $p = 0.5005$:

$$\begin{aligned}
1,000,000 \cdot p &= 1,001,000 \cdot (1 - p) + 1,000 \cdot p \\
1,000,000 \cdot p - 1,000 \cdot p &= 1,001,000 \cdot (1 - p) \\
999,000 \cdot p &= 1,001,000 - 1,001,000 \cdot p \\
2,000,000 \cdot p &= 1,001,000 \\
p &= \frac{1,001,000}{2,000,000} \\
p &= .5005
\end{aligned}$$

So as long as p is greater than 50.05%, the expected value of one-boxing will be greater than the expected value of two-boxing.

This means that as long as the predictor is at least 50.05% accurate, the Principle of Expected Value Maximization entails that one should be a one-boxer.

(That is pretty remarkable. Even if experts that are accurate 99% of the time exist only in science fiction, it is not hard to find a predictor that is accurate 50.05% of the time. I myself have an 80% success rate when performing this experiment on my students!)

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Problem 3

1/1 point (ungraded)

Is the following true or false?

> As long as one has a predictor who does better than chance, it is possible to find payoffs that generate a Newcomb Problem.
>
> More precisely: for any small-box value s and any positive value ϵ ($0 < \epsilon \leq 0.5$), one can find an large-box value l such that when the predictor has an accuracy of $0.5 + \epsilon$, the Principle of Expected Value Maximization entails that one should one-box in a Newcomb Scenario based on s and l.

True

Answer: True

Explanation

When the predictor is $0.5 + \epsilon$ accurate, the expected value of one-boxing is

$$l \cdot (0.5 + \epsilon) + 0 \cdot (0.5 - \epsilon)$$

and the expected value of two-boxing is

$$(l + s) \cdot (0.5 - \epsilon) + s \cdot (0.5 + \epsilon)$$

This means that the Principle of Expected Value Maximization will recommend one-boxing if and only if:

$$\begin{aligned}
(l + s) \cdot (0.5 - \epsilon) + s \cdot (0.5 + \epsilon) &< l \cdot (0.5 + \epsilon) \\
(l + s) \cdot (0.5 - \epsilon) &< (l - s) \cdot (0.5 + \epsilon) \\
l \cdot (0.5 - \epsilon) + s \cdot (0.5 - \epsilon) &< l \cdot (0.5 + \epsilon) - s \cdot (0.5 + \epsilon) \\
s \cdot (0.5 - \epsilon) + s \cdot (0.5 + \epsilon) &< l \cdot (0.5 + \epsilon) - l \cdot (0.5 - \epsilon) + \\
s \cdot (0.5 - \epsilon + 0.5 + \epsilon) &< l \cdot (0.5 + \epsilon - 0.5 + \epsilon) \\
s &< l \cdot 2\epsilon \\
\frac{s}{2\epsilon} &< l
\end{aligned}$$

This means that as long as $\epsilon > 0$, we can guarantee that the Principle of Expected Value Maximization recommends one-boxing by making l sufficiently big.
(Note that when $s = 1,000$ and $\epsilon = 0.0005$, which are the operative values in the previous exercise, the Principle Expected Value Maximization will recommend one-boxing as long as $l > 1,000,000$.)

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Problem 4

1/1 point (ungraded)

Consider a variant of the Newcomb case that works as follows:

> You can choose either the large box or the small box, but not both.
>
> If the predictor predicts that you would choose the large box, then she left the large box empty, and placed $100 in the small box.
>
> If the predictor predicted that you will choose the small box, then she left the small box empty, and placed $1000 in the large box.

According to the Principle of Expected Value Maximization, which of the two boxes should you choose? (Assume the predictor is not perfectly accurate.)

- (•) Choose the large box.
- ( ) Choose the small box.
- ( ) None of the above.

✓

Explanation

The expected value of choosing the large box is

$$(1000 \cdot (1 - p)) + (0 \cdot p) = 1000 \cdot (1 - p)$$

The expected value of choosing the small box is

$$(100 \cdot (1 - p)) + (0 \cdot p) = 100 \cdot (1 - p)$$

So the Principle of Expected Value Maximization entails that one should choose the large box (for every case except $p = 1$; in that case, both options have expected value 0, so the Principle of Expected Value Maximization doesn't entail that you ought to choose one option over the other).

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Answers are displayed within the problem

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