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Dutch Book Arguments

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Philosophers looking to support a position about how certain we ought to be of some belief, given our other beliefs, sometimes take advantage of *Dutch book arguments*. These arguments show that alternative positions lead to accepting a series of bets, each of which seems acceptable on its own, but which, together, are guaranteed to lose money (a *Dutch book*) and thus are unacceptable.[1]

Here we'll see how Dutch books generate important philosophical arguments and consider two examples of such arguments.

1. Understanding Dutch Books

Let's better understand Dutch books.

Imagine that you have a button that destroys a dollar in your wallet whenever you push it. Would you push it?[2] Of course not – doing so is against your self-interest and is irrational!

The situation is the same if we replace buttons with bets: taking a bet or a series of bets you know is *guaranteed* to lose you money is as irrational as pushing the money-loss button. Dutch books reveal a kind of inconsistency in a position since someone who is willing to accept each bet in the book on its own wouldn't accept all of the bets bundled together for a guaranteed loss. For example:

	Costs	Payout
Bet 1	$0.50	$1 if it rains today
Bet 2	$0.60	$1 if it doesn't rain today

If I accept Bets 1 and 2 together, then I have paid $1.10; however, I will make exactly $1 because either it's going to rain today or not. Since it's impossible for both bets to pay out, I'm guaranteed to lose $0.10 if I accept both bets, accepting both bets is irrational, and Bets 1 and 2 together constitute a Dutch book.

2. Dutch Book Arguments

Philosophers have deployed *Dutch book arguments* to reveal the irrationality of specific positions by showing that they would require us to accept a Dutch book.

These arguments concern what *credences*, or degrees of belief represented by numbers between 0 and 1,[3] it's rational for a person to assign to a claim under certain conditions, like learning new relevant information or having certain other credences.[4]

One of the reasons Dutch book arguments are useful when discussing credences is because of the connection between credences and betting behavior: if your credence in a claim can be represented by the fraction X/Y, then you should treat as fair (and thus accept) any bet that costs X dollars and pays out Y dollars if the claim is true.[5]

3. Dutch Books and Probabilism

The position that our credences ought to obey the rules of probability is called *probabilism*, and one argument for it relies on the fact that having credences that violate the rules of probability opens us up to a Dutch book.

For example, the rules of probability tell us that the probability of some event happening and the probability of it not happening should add up to 1. So our credence in, for example, "It will rain today" and our credence in "It will not rain today" should, together, add up to 1 if we're probabilists.

If we're not probabilists, then we might assign a credence of 0.5 to the claim "It will rain today" and a probability of 0.6 to the claim "It will not rain today". But doing so opens us up to the Dutch book just discussed:

	Costs	Payout
Bet 1	$0.50	$1 if it rains today
Bet 2	$0.60	$1 if it doesn't rain today

We're guaranteed to pay $1.10 for these bets and gain $1, resulting in a loss of $0.10.[6]

The same reasoning can be used to show that any set of credences that doesn't respect the rules of probability[7] (for instance, a credence in a certainty like "either it's raining or it isn't" that isn't 1) is "Dutch-bookable", and so we have good reason to think that violating probabilism is irrational.[8]

4. Dutch Books and Sleeping Beauty

Dutch book arguments may be helpful for those looking to resolve the Sleeping Beauty problem too.[9]

The Sleeping Beauty problem asks how Beauty's credence in the claim "the coin landed heads" should change in the following situation: on Sunday night, Beauty is put to sleep. Then, the experimenters flip a fair coin. If the coin lands *heads*, Beauty is awakened on Monday, then is put back to sleep until the experiment ends. If the coin lands *tails*, Beauty is awakened on both Monday and Tuesday; however, after her Monday waking, Beauty is given a drug that makes her forget her Monday waking when she wakes up on Tuesday. When Beauty wakes up, she wonders what credence she ought to have in the claim "the coin landed heads". The two most popular positions in the literature are that she should have credence 1/2 (so say *halfers*) and that she should have credence 1/3 (so say *thirders*).

Christopher Hitchcock has shown that halfers are susceptible to a Dutch book argument.[10] Since no Dutch book can be constructed against the thirder, it seems like the thirder's position is correct.

Consider the following two bets:

	Costs	Payout
Bet 1	$15	$30 if tails
Bet 2	$10	$20 if heads

Bet 1 costs $15 and pays out $30 if the coin landed on tails, and Bet 2 costs $10 and pays out $20 if the coin landed on heads. The halfer should think each of these bets is fair. If Beauty is offered Bet 1 before she goes to sleep and Bet 2 each time she wakes up, then a halfer Beauty will be Dutch-booked: if the coin lands heads, then she'll take Bets 1 and 2 once each, meaning that she'll win a net $10 from Bet 2 and lose a net $15 from Bet 1 for a total loss of $5. If the coin lands tails, then she'll take Bet 1 once and Bet 2 twice, meaning that she'll win a net $15 from Bet 1 and lose a net $20 from buying Bet 2 twice for, again, a loss of $5. So regardless of the coin flip result, a halfer Beauty loses $5. Thus, it seems we have a good reason to believe that Beauty ought to be a thirder thanks to this Dutch book argument.[11]

5. Conclusion

Dutch book arguments do have their critics;[12] however, as the Dutch book arguments in favor of probabilism and the thirder solution to the Sleeping Beauty problem show, they are an important tool for philosophers, especially those interested in formal epistemology and rational choice theory.

Notes

[1] The origin of the term "Dutch book" is something of a mystery. It's found in a number of texts foundational to formal epistemology (see, for instance, Ramsey's reference to "books" in his "Truth and Probability"). Wakker (2011) has presented the most exhaustive attempt to track down the origin of the term that I've seen, yet even his attempt remains inconclusive: the term may be taken from horse racing or Dutch auctions, or it may be simply one in a number of expressions in English that refer to the Dutch negatively. It may even refer to a gangster with the nickname "Dutch" and so have nothing to do with the Dutch nationality at all.

[2] We exclude here cases where someone is compelling you to push the button (perhaps someone puts a gun to your head) or provides some external incentive greater than the penalty you face from pushing the button (perhaps I offer to pay you two dollars to push the button) as these cases break the analogy between the button and Dutch book arguments.

[3] If we're certain that a particular sentence is true, then we assign it a credence of 1, and if we're certain that a particular sentence is false, then we assign it a credence of 0.

[4] Though I will focus on Dutch book arguments for probabilism and the thirder solution to the Sleeping Beauty problem, Dutch book arguments have a range of applicability far beyond the two cases I've chosen. Dutch book arguments have also been presented in favor of a range of principles that impose constraints on what credences are acceptable, including conditionalization, Jeffrey conditionalization, the principle of reflection, and the principle of countable additivity. As a full explanation of even the principles supported by these Dutch book arguments (let alone the arguments themselves) would take us far beyond

our 1,000 words, I refer the interested reader to Briggs (2015) and the references therein.

[5] This connection only holds under certain conditions: see Bradley and Leitgeb (2006) and Briggs (2010) for more on the connection between credences and betting behavior.

[6] To walk through things a bit more slowly: because the non-probabilist assigns credence 0.5 to "it will rain today", they see Bet 1 as fair ($0.50/$1=.5). Because they assign credence 0.6 to "it will not rain today", they see Bet 2 as fair ($0.60/$1=.6). However, if you accept Bets 1 and 2 together, then you have paid $0.50+$0.60=$1.10 for both bets, and either Bet 1 will pay out or Bet 2 will pay out (but not both). Hence, you're guaranteed to pay $1.10 and gain $1, so you are guaranteed to lose $0.10.

[7] See the article "The Probability Calculus" by Thomas Metcalf for more information on the rules of probability referenced here.

[8] This style of this Dutch book argument is an example of a *synchronic* Dutch book argument – it tells us something about what rational consistency constraints should apply to our credences *at a particular point in time*. Next, we'll turn to a *diachronic* Dutch book argument which concerns how consistent our credences need to be with credences at earlier or later times.

[9] See my entry on The Sleeping Beauty Problem for more about this philosophical puzzle.

[10] Given some reasonable assumptions about how Dutch book arguments should work in this strange scenario, at least; see Hitchcock (2004) for the full presentation of this argument.

[11] Neither of the arguments sketched in this article is without its critics, but let's highlight one criticism here in particular. As Briggs (2010) has pointed out, what bets we accept depends not just on our credences but on our understanding of the utility offered by each bet. Briggs has shown that both the halfer and the thirder are "Dutch-bookable" depending on which of the two central theories of utility (causal or evidential decision theory – see Gibbard and Harper (1981)) one adopts. And so Dutch book arguments against the halfer require a substantial commitment to a theory of assessing utility. Another notable objection to Hitchcock's thirder argument appears in Draper and Pust (2008). See also Arntzenius (2002).

[12] While there are many concerns about Dutch book arguments that have been raised in the literature, I'll mention just one here. Hayek (2008) asks us why we should think that being open to a Dutch book argument makes us practically irrational if we're never going to take the kinds of bets that play such a central role in Dutch book arguments. In other words, if I just decide to follow the rule "never take any bets", I can have whatever credences I want and still never lose money should I find myself offered bets in a Dutch-book-style situation or be open to charges of inconsistent behavior. What this objection gets at is that those who propose Dutch book arguments need to say more to convince us that there really is something irrational about being open to taking a Dutch book – the kind of motivation I began this article with isn't enough.

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For Further Reading

Vineberg, Susan, "Dutch Book Arguments," *The Stanford Encyclopedia of Philosophy* (Spring 2016 Edition), Edward N. Zalta (ed.).

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