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# Love and Logic

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**Abstract**

With the help of renowned logician Olivia Rodrigo, I present a paradox and a principle of classical logic.

## Introduction

Consider the following paragraph:

> And now you got me thinkin'
> Two plus two equals five
> And I'm the love of your life
> 'Cause **if rain don't pour and sun don't shine**
> **Then changing you is possible**
> No, love is never logical

It forms a verse. The singer-songwriter Olivia Rodrigo sings it in 'logical' from her album *Guts* (2023). In doing so, Rodrigo states that if certain things are true (namely, rain don't pour and sun don't shine), then – however improbable – so too is another thing (namely, changing you is possible). I shall call the bolded sentence 'Rodrigo's Statement'.

One might think that this verse is about a former relationship of Rodrigo's. *Au fait* listeners will know that it's instead inspired by a former relationship of Rodrigo's best friend.

But more than present an episode of Madison Hu's love life, the song presents a paradox of classical logic (a paradox of material implication) and a principle of classical logic (the principle of explosion).

## Getting Started

To show that Rodrigo's Statement is a paradox of material implication, I need to define one term and make two assumptions.

### *The Definition*

A material conditional *If A, then B*, according to classical logic, is true unless *A* is true and *B* is false. Here, we call *A* the antecedent; and *B* the consequent. Four scenarios exist for *If A, then B*. We can list them using a truth table, where T stands for 'True' and F stands for 'False' (see Table 1).

*Table 1. The truth table of the material conditional*

| Scenario | *A* | *B* | *If A, then B* |
|---|---|---|---|
| 1 | T | T | T |
| 2 | F | T | T |
| 3 | F | F | T |
| 4 | T | F | F |

To spell out a scenario:

> In Scenario 1, both the antecedent and consequent are true, and thus the conditional is true. This is consistent with the definition '*If A, then B* is true unless *A* is true and *B* is false'. Here it's not the case



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> that *A* is true and *B* is false. Both *A* and *B* are true. So the conditional is true.

In case, like logicians before you, you find this truth table perplexing, I'll say that it's instructive to think about the material conditional *If A, then B* as a promise. If the promise is *not* broken, then the statement is *true*. If the promise *is* broken, then the statement is *false*.

For example, suppose you make the following promise:

> *If* you buy me mangoes, *then* I'll give you money.

I shall call the conditional 'the Mango Statement'.

On Monday, you buy me mangoes and I give you money. I didn't break the promise. '*If* you buy me mangoes, *then* I'll give you money' – the Mango Statement – is true (Scenario 1).

On Tuesday, you don't buy me mangoes but, feeling generous, I still give you money. I didn't break the promise. The Mango Statement is true (Scenario 2).

On Wednesday, you don't buy me mangoes and I don't give you money. I didn't break the promise. The Mango Statement is true (Scenario 3).

Now, on Thursday, you buy me mangoes and I don't give you money. Here, I broke the promise. The Mango Statement is false (Scenario 4).

So much for the definition of 'material conditional'. Let's move to the two assumptions.

### *The Two Assumptions*

*Assumption 1*

It's not the case that 'rain don't pour'.

Rodrigo doesn't specify the location in which 'rain don't pour'. Granted, she could be talking about the McMurdo Dry Valleys in Antarctica, where winds blow away any precipitation. Or she could be talking about the Atacama Desert in Chile, reportedly the driest place on Earth.



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But it's reasonable that she's talking about her home state of California, in which it *does* rain. Or she might be talking about the world, in which in some locations – and I write this on a morning in the desert in Somaliland in which it has been drizzling – rain *does* pour.

> 'Cause if rain don't pour and sun don't shine then changing you is possible.'

We can assume it's not the case that 'rain don't pour'.

*Assumption 2*
It's not the case that 'sun don't shine'.

Rodrigo doesn't specify the location in which 'sun don't shine'. Granted, she might be talking about a polar winter. But it's reasonable she's referring to her home state, whose informal nickname is the Sunny State. And even if she were allowing for the situation in which, standing at midday in Murrieta, CA, one doesn't see the sun shining, we know that, above the clouds, the sun shines.

We can assume it's not the case that 'sun don't shine'.

So much for defining one term and making two assumptions. Let's turn to the paradox which Rodrigo's Statement presents.

## A Paradox of Material Implication

We've seen when a material conditional is true and when a material conditional is false according to classical logic (see Table 1).

Now, according to the truth table, is Rodrigo's Statement true or false?

Well, we've assumed that the antecedent is false: it's not the case that rain don't pour or sun don't shine. And the falsity of the antecedent is sufficient to make the whole conditional true. Thus 'if rain don't pour and sun don't shine[,] [t]hen changing you is possible' – Rodrigo's Statement – is true.

Indeed, it's vacuously true, just as the following conditional is:

> If London is the capital of France, then I'm a mirror ball.

I shall call it 'Vacuously True Conditional'. The antecedent is false – it's not the case that London is the capital of France. So the whole conditional is true: if London is the capital of France, then I'm a mirror ball.

But one's intuition is that Vacuously True Conditional is *false*. Just because the antecedent in Rodrigo's Statement is false, it doesn't follow that *if* rain don't pour and sun don't shine, *then* blah blah blah is true. The antecedent has no bearing on the consequent. Similarly, just because the antecedent in the Vacuously True Conditional is false, it doesn't follow that *if* London is the capital of France, *then* I'm a mirror ball is true.

And because there's a misalignment between what intuition says and what classical logic says, we say there is a paradox.

So, at the very least, Rodrigo's song presents a paradox of classical logic.

## Taking Things Further

To show that Rodrigo's Statement is, beyond a paradox of classical logic, an instance of explosion, I need to define a further term.

***The Definition***

A contradiction is a statement which cannot be true.

By 'cannot be true', I don't mean a statement such as 'Taylor Swift wrote a bad song'. Rather, I mean a statement which is not just false in *this* case but *always* false, namely a statement which is not just false in one world but is false in every world. Indeed, the quality of being a contradiction is a global property (applies to more than one world) while the quality of being false is a local property (applies to only one world).

For example, the conjunction *A and not A*, in which *A* is a statement itself, is a contradiction. It doesn't matter what statement *A* is or whether *A* is true or false. Indeed, *A* could be 'I'm



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in Somaliland' (a true statement in my case). For any consistent reading of *A*, the following will not be true:

> I'm in Somaliland and it's not the case that I'm in Somaliland.

I shall call the conjunction 'Contradiction'. I say 'consistent reading' because if we read 'I'm in Somaliland' in one case as meaning that I'm *physically* in the country and in another case as meaning that I'm *mentally* in the country, then yes Contradiction could be true. I might be at my desk in Somaliland (so physically in Somaliland) but my mind is wandering to Ethiopia (so not mentally in Somaliland).

Here, I'm interested in contradictions, namely statements which cannot be true. I'm not interested in statements which one can interpret as true. Hence my insistence on consistent readings.

So much for the definition of 'contradiction' and why I say 'consistent reading'. Let's move to the principle of explosion.

### *Explosion*

According to the principle of classical logic, the argument in Table 2 is valid.

*Table 2. The principle of classical logic*

| Line | Statement | Justification |
|---|---|---|
| 1 | *A and not A* | premise |
| 2 | *B* | by explosion |

Here *A* and *B* are statements. It's important to specify that *A* and *B* need not have anything to do with each other. In other words, *B* could be *anything*.

For example, *B* could be a sporting outcome: 'Switzerland won the 2022 UEFA European Women's Football Championship'. It doesn't matter that England actually won.

Whatever *B* is, one could prove *B* by relying on a valid rule of inference.

One proof of the argument's validity relies on disjunctive syllogism as shown in Table 3.

Now, the argument isn't *sound*. An argument is sound if and only if all its premises are true and the conclusion follows by a valid rule of inference. In the case of explosion, by definition, at least one premise is false. It's not possible for *A and not A* to be true: *A and not A* is a contradiction.

*Table 3. Disjunctive syllogism*

| Line | Statement | Justification |
|---|---|---|
| 1 | *A and not A* | premise |
| 2 | *A* | by conjunction elimination from line 1 (we've assumed *A and not A* is true; that's sufficient for us to derive that *A* is true) |
| 3 | *Not A* | by conjunction elimination from line 1 (we've assumed *A and not A* is true; that's sufficient for us to derive that *not A* is true) |
| 4 | *A or B* | by disjunction introduction from line 2 (we've derived that *A* is true; that's sufficient for us to derive that *A or B* is true) |
| 5 | *B* | by disjunctive syllogism from lines 3 and 4 (we've derived that *A or B* is true and *not A* is true; that's sufficient for us to derive that *B* is true) |

But it's still a proof: *If* the premises are true, *then* so too is the conclusion.

## Rodrigo's Statement is an Instance of Explosion

Now in her song, Rodrigo might not appear to be stating a contradiction. '[R]ain don't pour' and 'sun don't shine' – those are two statements, and the one doesn't conflict with the other.

Still, it's conceivable that Rodrigo is offering an argument whose premises she means to be contradictions. Indeed, each statement conflicts *with itself*, and thus *cannot* be true.

First, take 'rain don't pour'. This conflicts with itself inasmuch as it's in the very nature of rain to pour. Water in a cloud is not rain. Neither is water on the ground. Rain is the water pouring from the cloud, falling towards the ground. So to say 'rain don't pour' is to say 'what pours does not pour', which is a contradiction.



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Next, take 'sun don't shine'. This conflicts with itself inasmuch as it's in the very nature of [the] sun to shine. The sun is a star, and a star is an incandescent body.

> '… to say "rain don't pour" is to say "what pours does not pour", which is a contradiction …'

So to say 'sun don't shine' is to say 'what shines does not shine', which is a contradiction.

An analogous sentence to 'rain don't pour' or 'sun don't shine' would be 'an even number don't divide by two'. This conflicts with itself inasmuch as it's in the very nature of an even number to divide by two; or it's in the very nature of a number to divide by itself.

In full, Rodrigo's Argument (i.e. Rodrigo's Statement expressed as an argument) reads as in Table 4.

*Table 4. Rodrigo's Argument*

| Line | Statement | Justification |
|---|---|---|
| 1 | What pours does not pour | premise |
| 2 | What shines does not shine | premise |
| 3 | Changing you is possible | by explosion from line 1 or 2 |

If I justify line 2 by explosion 'from line 1 *or* 2', it's because Rodrigo could afford to abandon exactly one of Premise 1 and Premise 2. Both contradictions aren't necessary; one contradiction suffices for the principle of explosion. Either way, thanks to the principle and at least one of the contradictions, she can prove anything.

## Distinguishing the Two Readings of 'Logical'

This second reading – according to which Rodrigo is offering an argument whose premises are contradictions (Reading 2) – is different from the first reading – according to which Rodrigo is offering a conditional whose antecedent is false (Reading 1).

One difference lies in whether a statement is false locally or globally. In Rodrigo's Statement, the antecedent is false in this world. In Rodrigo's Argument, the premises are false in all worlds.

Another difference lies in whether one can draw a conclusion. In Reading 1, one can't draw any conclusion. We might accept that Rodrigo's Statement is true according to classical logic but we can't then claim that 'Changing you is possible'. We don't have a set of premises and a conclusion which we can derive from the set of premises. We are stuck in the hypothetical: *If* rain don't pour and sun don't shine, *then* changing you is possible.

In Reading 2, one can draw a conclusion using a valid rule of inference. We have a set of premises and a conclusion. Whenever all the premises in the set are true (in the case of Rodrigo's Argument, this will be never), the conclusion will also be true.

## Conclusion

As we've seen, in 'logical', Rodrigo presents a paradox of classical logic (a paradox of material implication): in the case of certain conditionals, there's a misalignment between what one's intuition says ('The conditional is false!') and what classical logic says ('The conditional is true!'). And Rodrigo presents a principle of classical logic (the principle of explosion): from contradiction, anything follows.

Given the principle of explosion, the existence of a contradiction has the potential to trivialize classical logic: using classical logic, one could derive all statements, even false ones. If we have just one contradiction, we can derive any statement, including 'Changing you is possible'.



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One way to avoid the existence of a contradiction leading to triviality is to adopt a *paraconsistent* logic. But that's for Rodrigo's next album.

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