Arguments

Arguments

- An ARGUMENT is a collection of statements which are intended to support, provide reasons to believe, another statement.

- The supporting statements are called the Premises.

- The statement they are supposed to support is called the Conclusion.

Arguments

- A GOOD argument is one with these two features:
  - The premises provide good reasons to believe the conclusion.
  - There are good reasons to believe the premises.

Arguments

- There is a PARTIAL TEST for when the premises provide reasons to believe the conclusion.

Arguments

- The test:
  - If the argument is VALID, the premises provide reasons to believe the conclusion.
  - The argument is VALID = the truth of the premises guarantees the truth of the conclusion. If the premises are true, the conclusion MUST be true.

Examples of Valid Arguments

- If Armstrong walked on the moon, he left footprints.
- Armstrong walked on the moon.
- Therefore, Armstrong left footprints.

Examples of Valid Arguments

- If Donald Trump walked on the moon, he left footprints.
- Trump walked on the moon.
- Therefore, Trump left footprints.

Examples of Invalid Arguments

- If Armstrong walked on the moon, there are footprints on the moon.
- There are footprints on the moon.
- Therefore, Armstrong walked on the moon.

A Note on Evaluating Arguments

- IF the argument is valid, AND you think it is not a good argument, THEN you must think that one (or more) of the premises is false / unsupported.

The EPR Argument

- Is it Good?
    - Is it Valid?

The EPR Argument

- Premise 1: ``locality.'' Part (i): physical objects are ``localized in space,'' they occupy definite, spatially bounded regions. Part (ii): If objects O1 and O2 are far apart in space, then nothing that happens to O1 can directly cause anything to happen to O2. (Let us take P1 to entail that if O1 and O2 are far apart in space, then if anything that happens to O1 (indirectly) causes something to happen at O2, there is a time gap between the two events.

- Premise 2: ``the criterion of reality'' [my statement]. If there is something X that we could do that (i) would allow us to predict with certainty the outcome of a measurement of a system's value for a property Q, and if (ii) we could do X without disturbing the system, then the system has a definite value for Q ``already,'' ie even if we do not do X.

- Premise 3: the statistical algorithm that quantum mechanics supplies is correct.

The EPR Argument

- Step 1: By P3 and P1, a pair of particles could be in the “singlet spin state,” and be spatially far apart.
- Step 2: By P3 again, there is something we could do that would allow us to predict with certainty the outcome of a measurement of the right electron’s spin at 0 degrees, namely measure the left electron’s spin at 0 degrees.
- Step 3: By P1, and Step 1, we could do this without disturbing the right electron (in the short term at least).
- Step 4: By Steps 2 and 3, and P2, the right electron has a definite value for spin at 0 when the pair is in the singlet spin state.
- Step 5: If the orthodox interpretation is true, then the right electron does not have a definite value for spin at 0 when the pair is in the singlet state (true by definition of The Orthodox Interpretation).
- Therefore, the orthodox interpretation is false.

The EPR Argument

- Is it Good?
  - Is it Valid? *
    - Are there reasons to believe the premises?
    - If you think the conclusion is the argument is false, you must think that one of the premises is false.

The EPR Argument

- What is Bohr's response?

- Does he think the argument is invalid? Does he think he think it has a false premise?

Bell's Theorem

A few definitions

- A LOCAL theory is (as you expect) a theory in which there is no “direct action at a distance.”
- A HIDDEN VARIABLES THEORY (vague definition) is a theory in which there are further facts about the state of a physical system, in addition to its wavefunction, that play a role in the theory.
- A HIDDEN VARIABLES THEORY (precise definition) is a theory T with this property: according to T, every physical system has a (precise) value for every physical property.

A few definitions

- (EPR: the true theory is local; so the true theory is a (local) hidden variables theory.)

Bell's Theorem:

- No local theory can reproduce the statistical predictions of quantum mechanics.

Bell's Theorem: step 1

- Fact 1: Perfect Anti-Correlation. According to the statistical predictions of QM, if a pair of electrons is in the singlet state, and the S-G magnets are oriented the same way on both sides, then they are always deflected in opposite directions.

Bell's Theorem: step 1

- Step 1: The only kind of local theory that can make this same prediction is a DETERMINISTIC HIDDEN VARIABLES THEORY.

- A theory is deterministic = according to it, for any isolated system and any physical state it can be in at a time, the theory says there is only one possible future evolution of that system.

Bell's Theorem: step 1

- Step 1: The only kind of local theory that can make this same prediction is a DETERMINISTIC (STRONG) HIDDEN VARIABLES THEORY.

- Proof of Step 1: