When 'A $\Box\!\!\rightarrow$ C' is true we say that *C counterfactually depends on A*. (Note, this is a relation between propositions!)

Causal dependence

Using the notion of counterfactual dependence, a relation between propositions, Lewis defines causal dependence, a relation between events. Let 'c' and 'e' be terms for events (e.g. 'the assassination', 'the first world war'). Let 'O' be a predicate of events, meaning 'occurs'. Let '¬' be negation. We can now define causal dependence:

> e causally depends on c iff (1) Oc $\Box\!\!\rightarrow$ Oe and (2) ¬Oc $\Box\!\!\rightarrow$ ¬Oe

If c and e are actual events, then (1) is automatically true because of the stipulation that the actual world is always the closest world to itself. Since c and e actually exist, then there is a c- and-e world which is closer to actuality than any c-and-not-e world, simply because the actual world is a c-and-e world. And in any case of causation, the cause and the effect must actually exist. Hence, clause (2) is normally taken to be the heart of the counterfactual analysis: it says that if e had not occurred, e would not have occurred. This is what it is for e to causally depend on c.

Note, there are many cases of counterfactual dependence which are not cases of causation (see Kim's paper in the Sosa & Tooley volume for some examples). Lewis himself brings out that the laws of motion in a world may counterfactually depend on the laws of gravity in that world, but the latter don't cause the former (better to say: laws of motion *supervene* on laws of gravity).

But even if we limit ourselves to events we should be careful. If you park your car on a double yellow line, then you break the law. But parking the car there doesn't cause you to break the law (it constitutes breaking the law in this instance). What we must add to exclude cases like this is to say that the events related as cause and effect must be *numerically distinct* from one another.

Causation

Causal dependence is a sufficient condition for causation. But it is not necessary. This is because causation is a *transitive* relation and causal dependence is not.

> Causal dependence among actual events implies causation. If c and e are two actual events such that e would not have occurred without c, then c is the cause of e. But I reject the converse. Causation must always be transitive; causal dependence may not be; so there can be causation without causal dependence. Let c, d, and e be three actual events such that d would not have occurred without c and e would not have occurred without d. Then c is a cause of e even if e would still have occurred (otherwise caused) without c. (Lewis 1973, 563)

A relation R is transitive when 'aRb' and 'bRc' imply 'aRc'. A relation is non-transitive when this is not the case; a relation is intransitive when 'aRb' and 'bRc' imply 'not-aRb'.

Causation is defined in terms of a *chain* of counterfactual dependence. A causal chain is defined as a sequence of actual events, c, d, e... etc., where d depends on c, e depends on d etc. Then c is a cause of e when there is a causal chain from c to e. Example:

> Suppose I shoot the president, and this brings about a revolution, which in turn brings about the president's rival ascending to power. Let's suppose that each later stage in this process causally depends on the earlier stage. Lewis would say that even though it is true that my act caused the president's rival to ascend to power, it need not thereby be true that the president's rival's ascent is causally dependent on my shooting, since it need not be true that in the closest world in which I did not shoot, he did not ascend to power (maybe the whole situation is so politically unstable that someone else would have shot if I hadn't). So we have causation between my action and the eventual outcome without causal dependence between my action and the eventual outcome.

A relation R^* that is constituted by a chain of relations R is called the *ancestral* of R (cf. Frege, *Begriffschrift*). The ancestral of a relation R is that relation which stands to R as the relation of being an ancestor stands to the relation of being a parent. The relation 'ancestor' can be roughly defined as follows: x is an ancestor of y iff x is a parent of y, or x is a parent of a parent of y, or x is a