

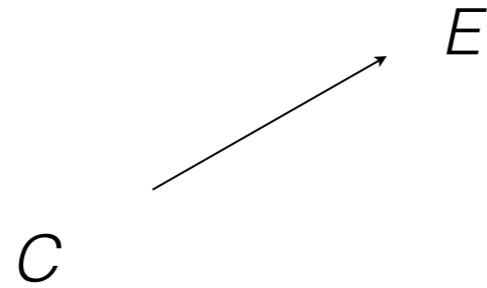
# The Direction of Causation

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# The Direction of Causation



Suppose  $C$ ,  $E$  are causally connected in the sense that either  $C$  causes  $E$  or  $E$  causes  $C$ . What makes it the case that  $C$  causes  $E$  rather than  $E$  causes  $C$ ?

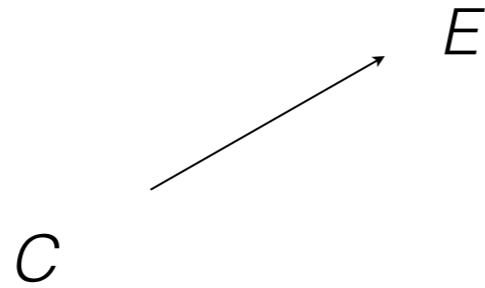
# David Lewis



Careful readers have thought they could make sense of stories of time travel... speculative physicists have given serious consideration to tachyons, advanced potentials, and cosmological models with closed timelike curves. Most or all of these phenomena would involve special exceptions to the normal asymmetry of counterfactual dependence. It will not do to declare them impossible a priori.

(p. 464) "Counterfactual Dependence and Time's Arrow," *Noûs* 13:455-76, 1979.

# Time Order

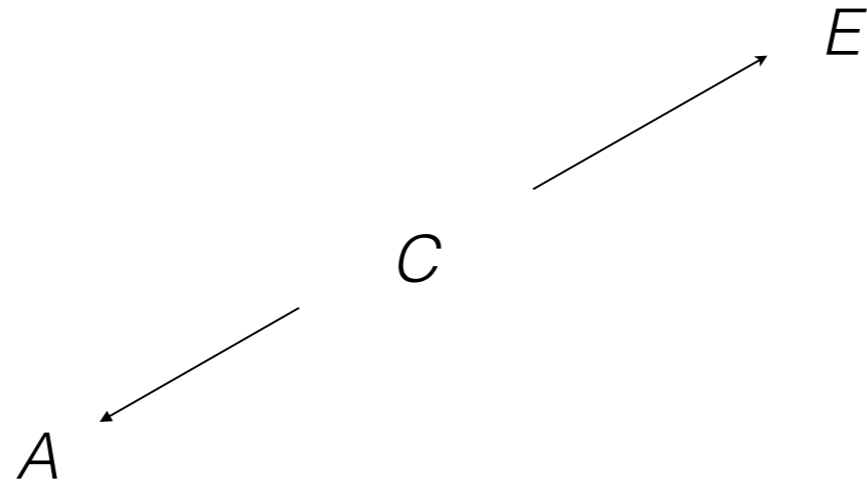


## David Hume

we may define a cause to be an object, followed by another, and where all the objects, similar to the first, are followed by objects similar to the second.

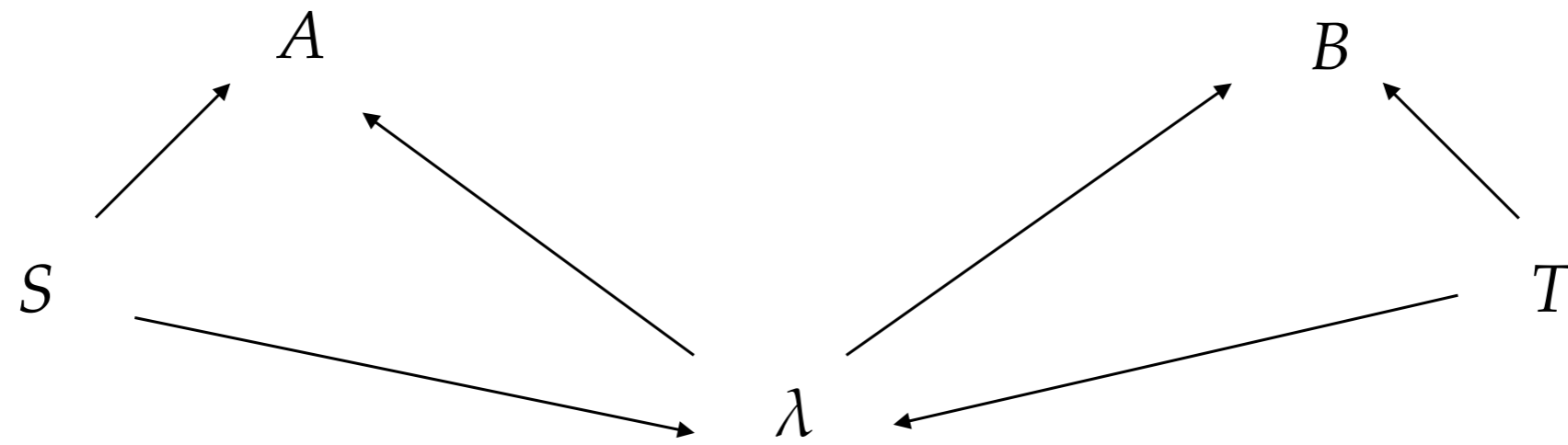
*An Enquiry Concerning Human Understanding* 1748 Ch 7.

# Advanced Potentials

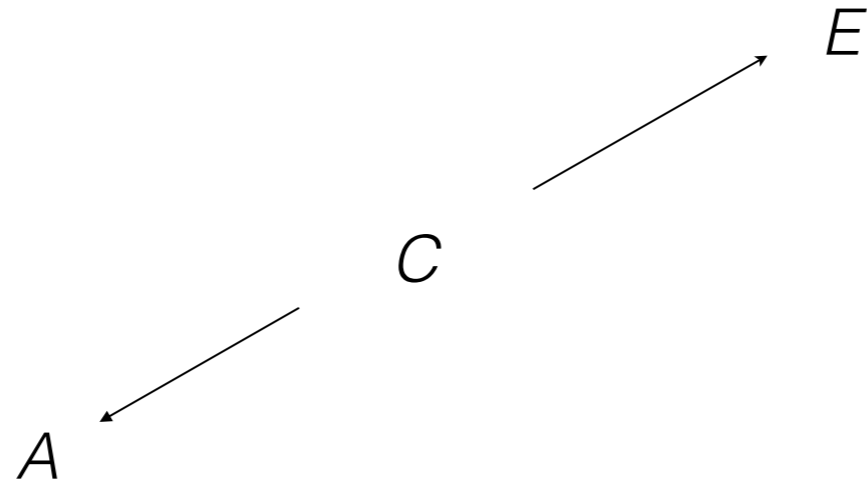


J. Wheeler and R. Feynman, 'Classical Electrodynamics in terms of Direct Interparticle Action' *Reviews of Modern Physics*, 21 (1949) pp. 425-33.

# Retrocausality in Quantum Mechanics

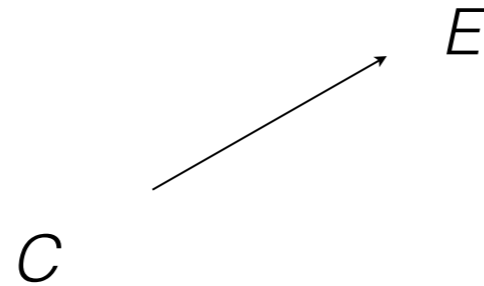


# Advanced Potentials



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# The Direction of Causation



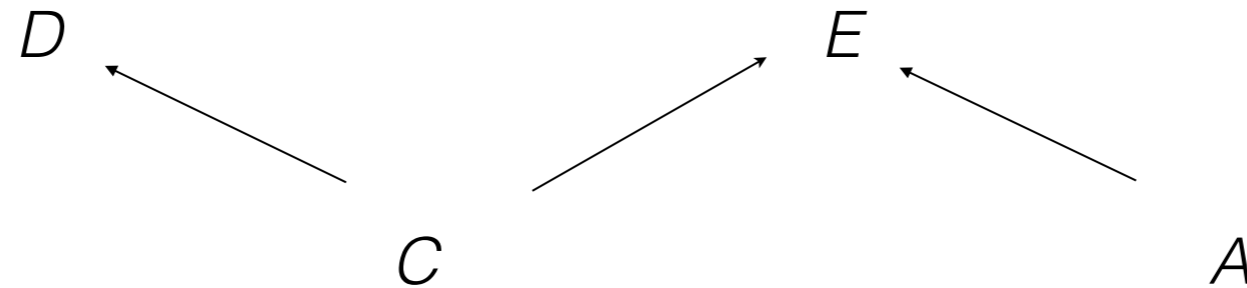
## Asymmetry of overdetermination

Determinant: a minimal set of conditions jointly sufficient, given the laws of nature, for the fact in question.

the cause exhibits an asymmetry of overdetermination in the direction of the effect



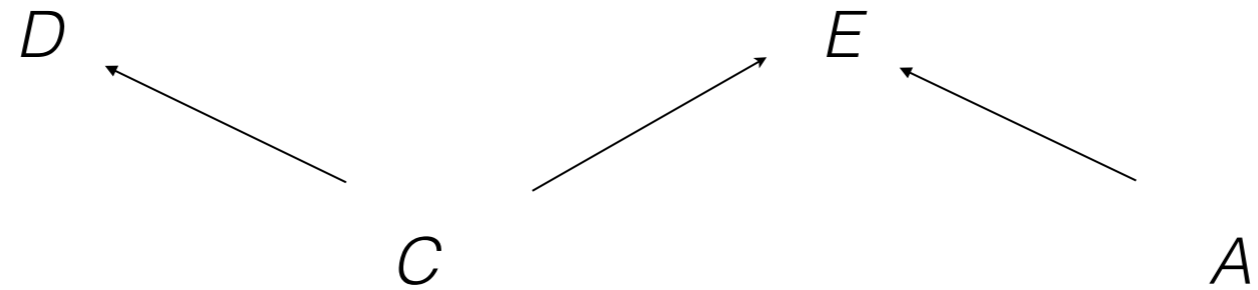
# Independence



...“causal priority consists in the causal connection among effects of a common cause and the causal independence among the causes of a given effect.” p. 55

Hausman, D. *Causal Asymmetries*. Cambridge: Cambridge University Press, 1998.

# Causal Modelling



$$A \perp\!\!\!\perp C, D \perp\!\!\!\perp E | C$$

$$A \perp\!\!\!\perp E, C \perp\!\!\!\perp E, C \perp\!\!\!\perp D, D \perp\!\!\!\perp E$$

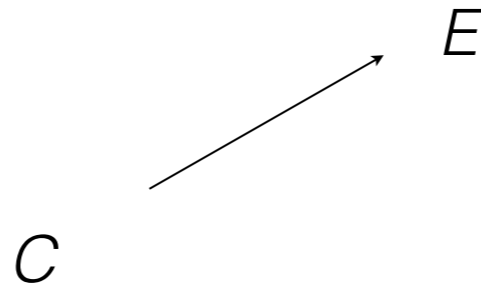
# Causal Modelling



$$A \perp C, C \perp B, A \perp B$$

$$A \perp\!\!\!\perp B|C$$

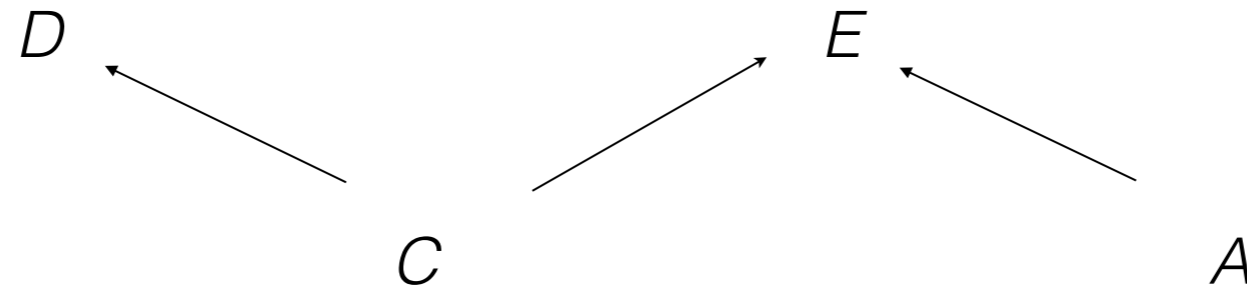
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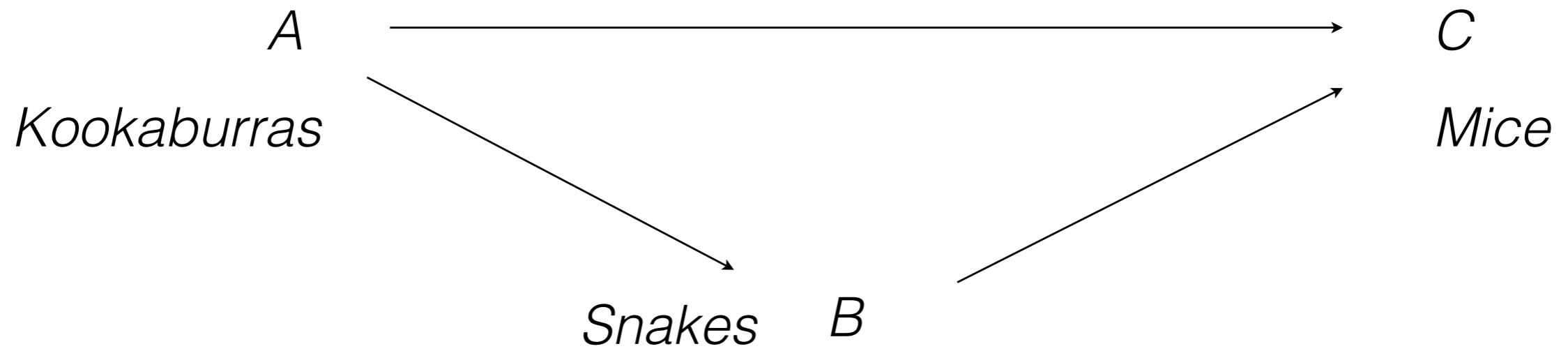
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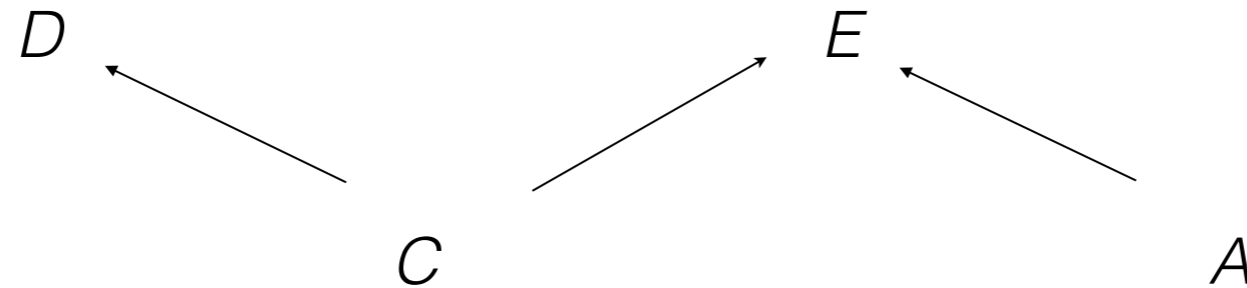
# Unfaithfulness



$$C \perp B, A \perp B$$

$$A \perp\!\!\!\perp C$$

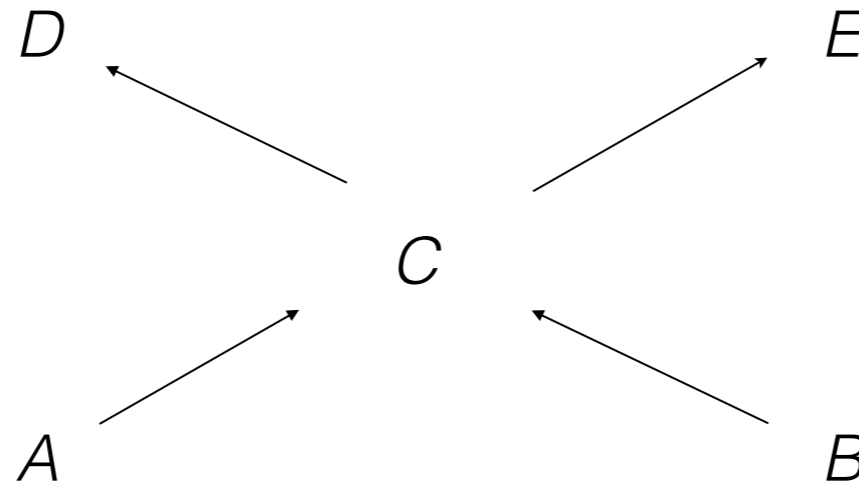
# Independence



“Tokens are causally connected if they bear that relation to one another that typically issues in probabilistic dependencies between their types.” p. 58

Hausman, D. *Causal Asymmetries*. Cambridge: Cambridge University Press, 1998.

# Independence



Lewis, D. 1972. "Psychophysical and Theoretical Identification." *Australasian Journal of Philosophy* 67: 642–63.

Menzies, P. 1996. "Probabilistic Causation and the Pre-emption Problem." *Mind* 105: 85–117.



# Interventionism

$A \longrightarrow C \longrightarrow B$

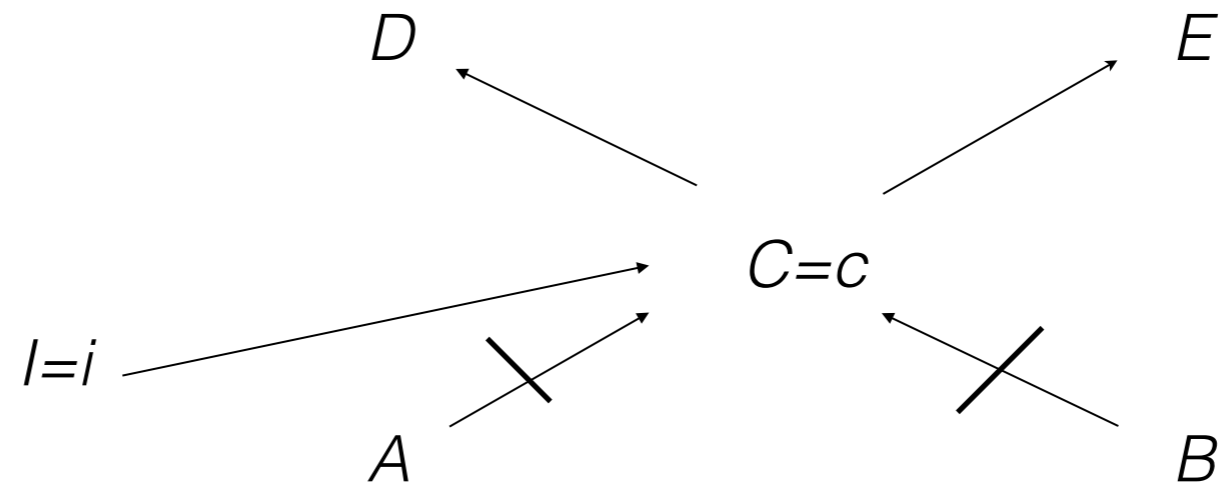
$A \longleftarrow C \longleftarrow B$

$A \longleftarrow C \longrightarrow B$

$A \perp C, C \perp B, A \perp B$

$A \perp\!\!\!\perp B|C$

# Interventionism



- $I$  causes  $C$
- Surgical intervention
- Arrow breaking
- $I$  exogenous

Woodward, J. 2003: *Making Things Happen: A Theory of Causal Explanation*. Oxford: Oxford University Press.

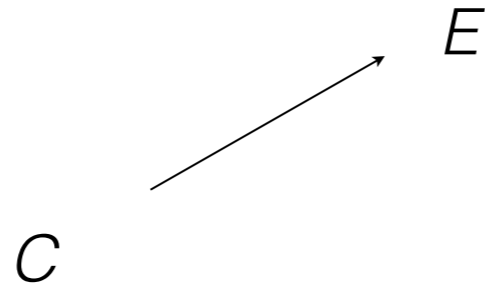
# Agency

...an event  $A$  is a cause of a distinct event  $B$  just in case bringing about the occurrence of  $A$  would be an effective means by which a free agent could bring about the occurrence of  $B$  (Menzies and Price 1993, 187).

# Primitivism

Maudlin, T. *The Metaphysics Within Physics* Oxford University Press. 2007.

# The Direction of Causation



What makes it the case that  $C$  causes  $E$  rather than  $E$  causes  $C$ ?