Causality Discussion

CS 851 Forensic Software Engineering
University of Virginia

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by
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AHD 1. The producer of an effect, result, or consequence. The one, such as a person, an event, or a condition, that is responsible for an action or a result.
C causes E?

\[ C \text{ causes } E \equiv \]

\[ C \text{ produces } E \equiv \]

\[ C \text{ brings forth } E \equiv \]

\[ C \text{ yields } E \]

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OED: cause, n.

b. as philosophically defined

1656 tr. Hobbes’ *Elem. Philos*. ii. ix. (1839) 121 A cause simply, or an entire cause, is the aggregate of all the accidents both of the agents how many soever they be, and of the patient, put together; which when they are all supposed to be present, it cannot be understood but that the effect is produced at the same instant.  

c1790 REID *Wks*. I. 76/1 We have no ground to ascribe efficiency to natural causes, or even necessary connection with the effect. But we still call them causes, including nothing under the name but priority and constant conjunction.  

1846 MILL *Logic* (1856) iii. v. §5 We may define+the cause of a phenomenon, to be the antecedent or the concurrence of antecedents, on which it is invariably and unconditionally consequent.  

1870 JEVONS *Elem. Logic* xxviii. 239 By the Cause of an event we mean the circumstances which must have preceded in order that the event should happen.
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c1790 Reid Wks. I. 76/1 We have no ground to ascribe efficiency to natural causes, or even necessary connection with the effect. But we still call them causes, including nothing under the name but priority and constant conjunction. Ibid. 77/1 In the strict philosophical sense, I take a cause to be that which has the relation to the effect which I have to my voluntary and deliberate actions. 

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Thus C causes E if ...

1. C precedes E in time
   and

2. C is necessary for E (without C, no E)
   and

3. C is sufficient for E (with C, definitely E)
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Why-Because Analysis Notations

A □→ B

((A □→ B) ∧ A) → B

A =>> B
WBA Inference Rule

\[ A \land B \]

\[ \neg A \implies \neg B \]

\[ A = \implies B \]

Causal Sufficiency Condition

\[ A_1, ..., A_n \text{ form a sufficient set of causal factors for } B \text{ if and only if} \]

\[ \neg B \implies \neg (A_1 \land A_2 \land ... \land A_n) \]

That is, it is impossible for B not to have happened if \( A_1, ..., A_n \) happened
Warsaw Overrun

On 14 September 1993, a Lufthansa Airbus A320 landed at Warsaw in a thunderstorm.

None of the braking systems worked at all for about 9 seconds; wheel brakes only started working after 13 seconds.

Aircraft ran off the end of the runway, hit an earth bank, and caught on fire.

One pilot was killed on impact.

One passenger who was unconscious and unnoticed in the evacuation suffocated.
Warsaw Overrun

3.1
AC hits earth bank

3.1.2
earth bank in overrun path

3.1.2.1
built by airport authority for radio equipment

http://www.rvs.uni-bielefeld.de/publications/Reports/WarsawWB.html

Problems with Counterfactual Reasoning
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1. It is counterintuitive.

2. Necessity often isn’t necessary.

3. Sufficiency often isn’t sufficient.

Necessity / Sufficiency

C1
C2
C3
C4

C2 is necessary but insufficient
C1 and C2 is sufficient but unnecessary
C2 and C3 is sufficient but unnecessary

No necessary ‘causes’
C1 and C2 is sufficient but unnecessary
C3 and C4 is sufficient but unnecessary
Necessity / Sufficiency

- C2 is necessary but insufficient
- C1 and C2 is sufficient but unnecessary
- C2 and C3 is sufficient but unnecessary

- C3 and C4 is sufficient but unnecessary

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Johnson’s Suggestion

- Root Causes: necessary and sufficient
- Contributory Factors: necessary but not sufficient
- Contextual Factors: neither necessary nor sufficient, but needed in reports to set context
The Key Question is ...

When do you stop?
When do you stop?

The answer depends primarily on the purpose of the investigation.

More Questions for Discussion

- How does Leveson define ‘cause’ in her ISSC02 paper?
- Is consistency in determining causes of mishaps something to be desired?
- Does using the word ‘cause’ (and its modified variants) help or hurt in preventing future mishaps?
- Others?
NASA Langley and the University of Virginia are co-hosting the 2003 Workshop on Investigating and Reporting Incidents and Accidents
- September 16-19, 2003
- Radisson Fort Magruder Hotel, Williamsburg, Virginia

See the web site for the call for papers: