Title: Toy Models for Retrocausality

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Abstract:

Toy Models for Retrocausality

Huw Price

Centre for Time

University of Sydney


EEN VERGETEN GENIE

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— Hugo Martin Tetrode (1895–1931)

REVIEWS OF MODERN PHYSICS VOLUME 17, NUMBERS 2 AND 3 APRIL-JULY, 1945

Interaction with the Absorber as the Mechanism of Radiation†*

JOHN ARCHIBALD WHEELER** AND RICHARD PHILLIPS FEYNMAN***
Palmer Physical Laboratory, Princeton University, Princeton, New Jersey

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— Neils Bohr (1934)

J. Phys. A: Math., Nucl. Gen., Vol. 7, No. 15, 1974. Printed in Great Britain.

A proposed experiment on absorber theory

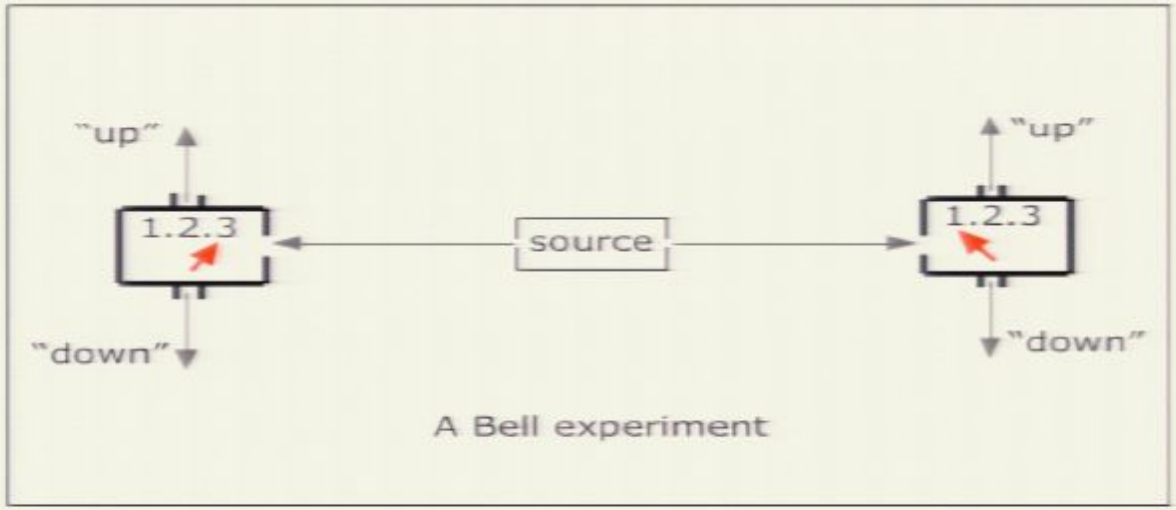
M L Heron and D T Pegg

Physics Department, James Cook University, Townsville, 4811, Australia

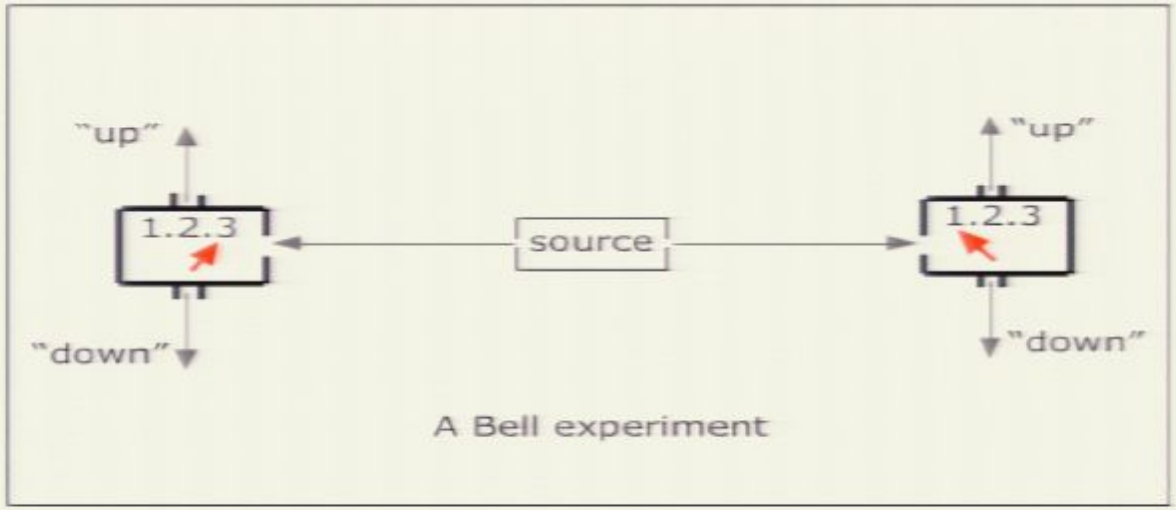
Received 1 October 1973, in final form 20 May 1974

Abstract. As distinct from conventional electrodynamics in which the advanced potential solution of Maxwell's equations is rejected on causal grounds, absorber theory allows the possibility of a mixture of advanced and retarded radiation, dependent on cosmological boundary conditions.

In a recent experiment Partridge attempted to detect advanced effects by introducing a local absorber, but it was maintained by Pegg that, because a static absorber was used, only a null result was possible. In this paper we give the theory and a brief outline of an experiment which uses a time-asymmetric chopper absorber to alter the boundary conditions and thus the ratio of the advanced to retarded components in the mixture, provided this is non-zero initially, leading to possibly detectable effects.



A Bell experiment



A Bell experiment

"[T]he observed perfect quantum correlations seem to demand something like the 'genetic' hypothesis. For me, it is so reasonable to assume that the photons in those experiments carry with them programs . . . telling them how to behave. This is so rational that I think that when Einstein saw that, and the others refused to see it, he was the rational man. The other people, although history has justified them, were burying their heads in the sand. I feel that Einstein's intellectual superiority over Bohr, in this instance, was enormous; a vast gulf between the man who saw clearly what was needed, and the obscurantist. So for me, it is a pity that Einstein's idea doesn't work. The reasonable thing just doesn't work."

— John Bell (1928-1990)

"In 1947 I proposed an explanation that was not to the liking of [my thesis advisor,] Louis de Broglie. I said to him, it is well known that all phenomena of fundamental physics are symmetrical between past and future, at the elementary level: this is certainly a basic phenomenon.

And between two distant events [in an EPR experiment] there is no direct link, but there is a direct link with the past . Therefore, I am fully entitled to suggest that the influence . . . spreads via a zigzag first to the past and then into the future."

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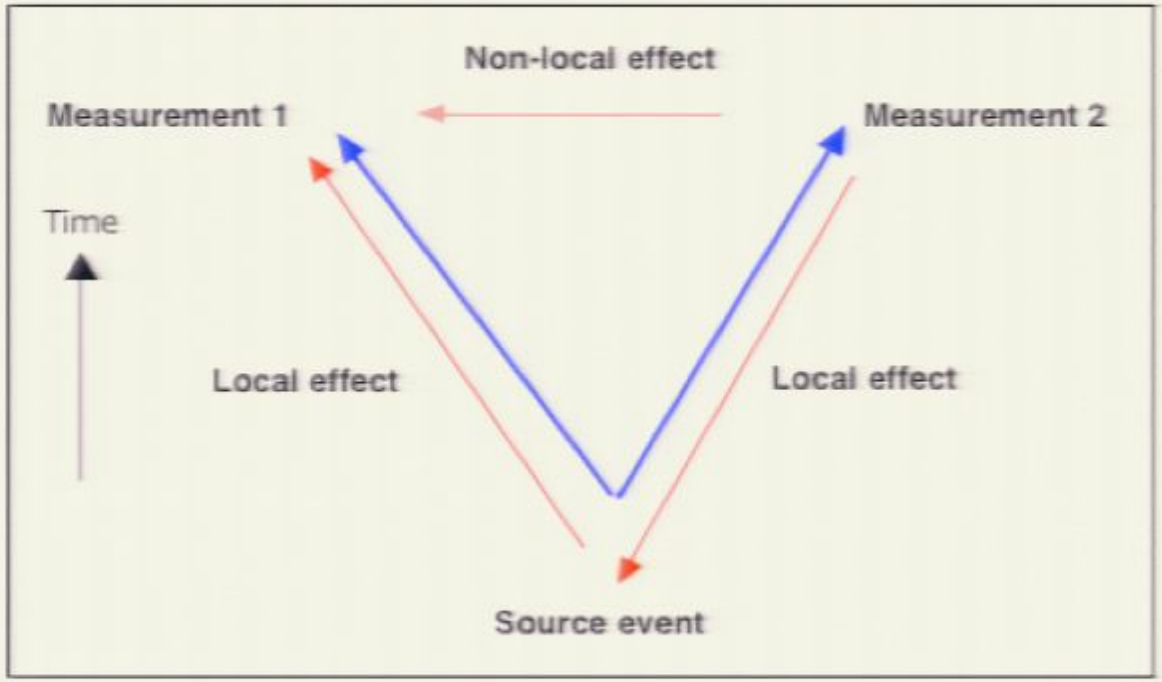
Costa de Beauregard's zig-zag 'retrocausality'.



Costa de Beauregard's zig-zag 'retrocausality'.

The first retrocausalist?

Grete Henry-Hermann

1901-1984

Philosopher, Physicist and Mathematician before her time?

The first retrocausalist?

"The idea of using backward causation to explain the non-locality of the Einstein Podolsky Rosen paradox has been around since the year the EPR paper was published. The idea that future events have a causal effect on past events was introduced by Grete Hermann in 1935 and further explored by Costa de Beauregard in 1953 and later, but has been commonly ignored by almost everyone including books devoted to the EPR paradox."

— W. Wharton [quant-ph/9810060].

>In those years (1933-36) in which Einstein,
>but also Popper, were thinking about
>measurements of correlated observables,
>and related uncertainties, and predictions and
>retrodictions, and 'non-separability' of quantum
>entangled systems, and Grete Hermann developed
>her "relative state" interpretation of QM (now
>known as MWI) and - it seems so, according to Max
>Jammer - also the first "retrocausation" solution
>of EPR effect (decades ahead of Huw Price, O. Costa
>de Beauregard, Pegg, Hoyle, etc.), W. Pauli
>and C.G. Jung were corresponding about telepathy,
>as well as 'psychic' entanglements, 'non-separability'
>of systems, and 'retrocausations'.

Taking sides on retrocausality

- Yes: Huw Price, Ken Wharton, Cramer, Sutherland, Price, Miller

Taking sides on retrocausality

- **Yes:** Hermann, Costa de Beauregard, Cramer, Sutherland, Pegg, Schulman, Price, Miller ...
- No/Don't know: [illegible]

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- **No/Don't know:** Most people. A recent example:

> "To be scrupulous, there are perhaps four other ways [i.e., other than nonlocality] that the correlations in [an EPR-Bohm] experiment could be explained away ..."

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> — Howard Wiseman (2005)

1. Taking the future seriously
2. The Helsinki model
   - Motivation
   - The 'dynamics'
   - Adding 'preparation' and 'observation'
3. Revealing the retrocausality
4. Where next?

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- Simple 'intuition pumps' for clarifying and motivating unfamiliar ideas – [illegible]

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The Helsinki model

1. Two kinds of primitive nodes ('interactions')

'Pair production'

'Pair annihilation'

The Helsinki model

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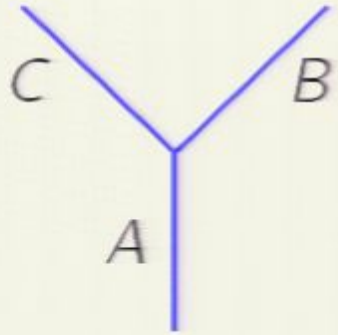

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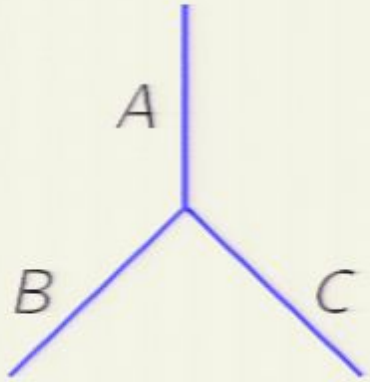

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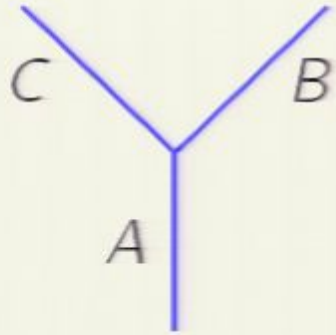

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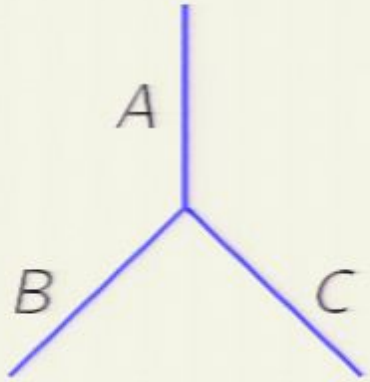

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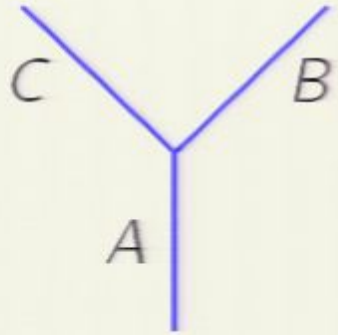
1. Two kinds of primitive nodes ('interactions').
2. Three kinds of edges ('particles').
3. Each node must be strictly inhomogeneous (i.e., all edges different) or strictly homogeneous (all edges the same).
4. Pair production and pair annihilation events alternate.



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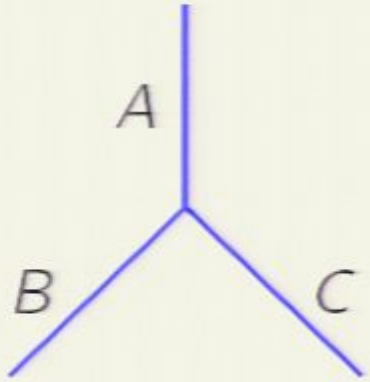

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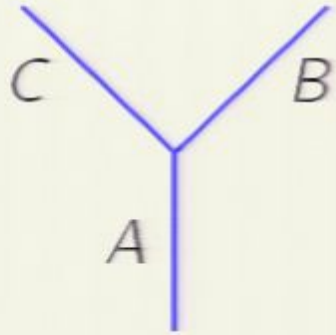
5. Successive homogeneous vertices must have opposite [illegible].



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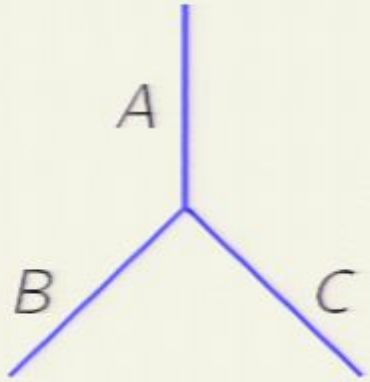

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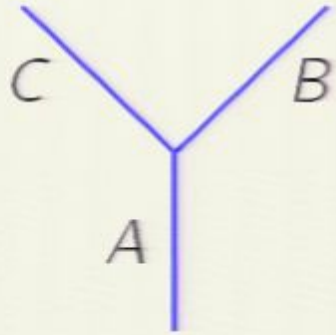

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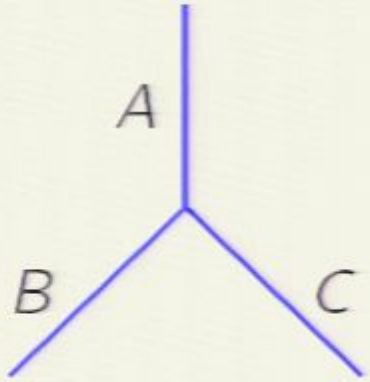

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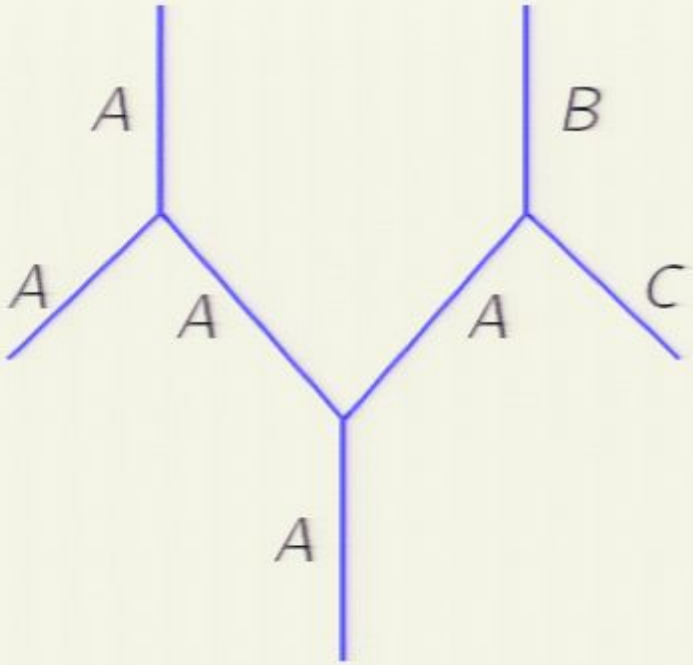
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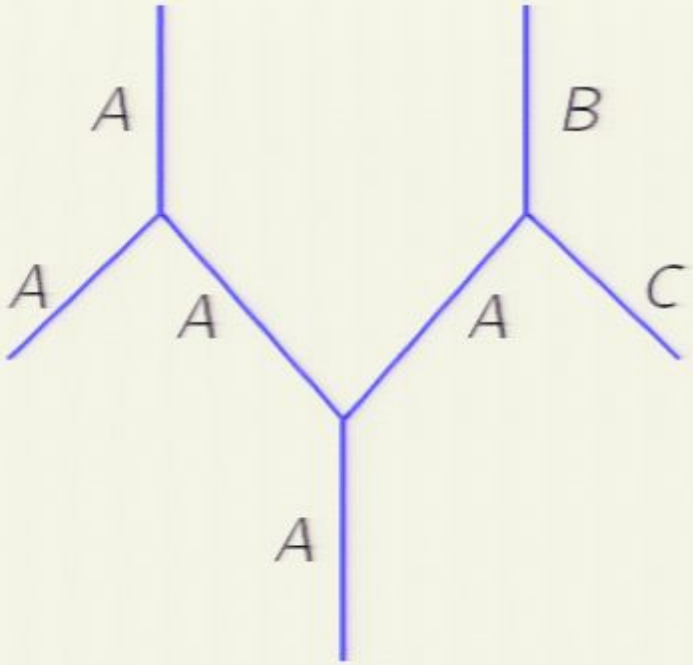
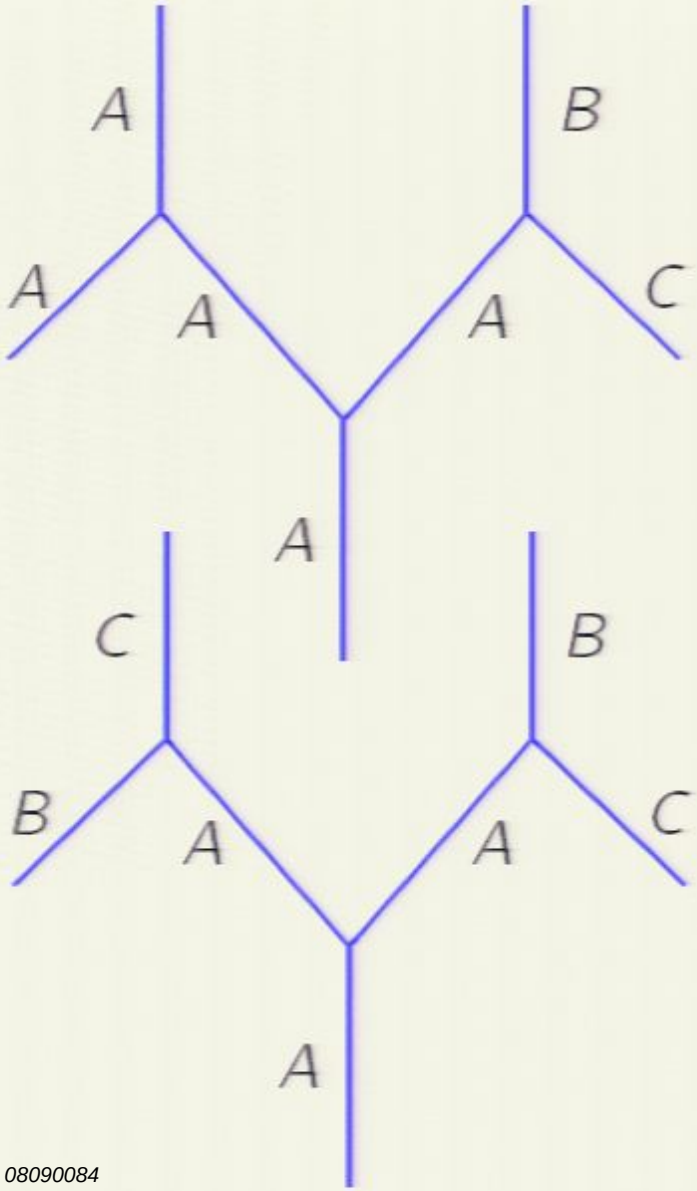


Prohibited!

- Repeated homogeneous nodes.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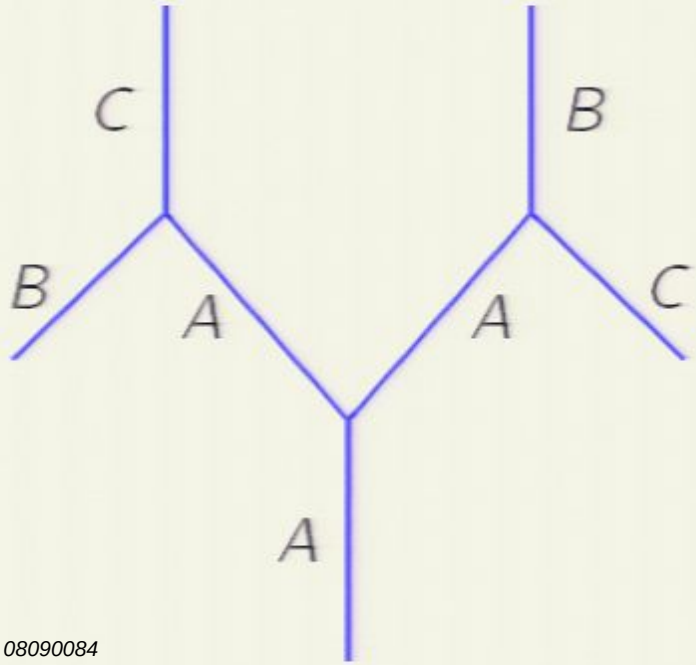
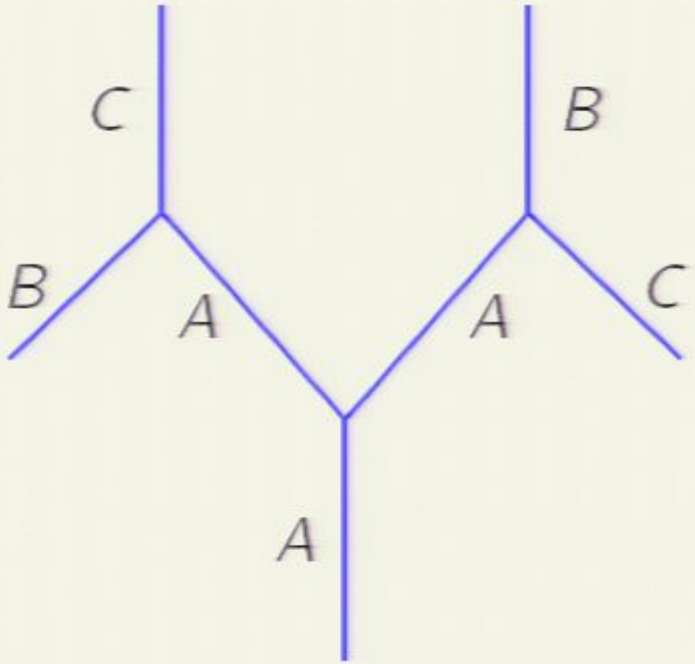


Allowed

- No repeated homogeneous nodes.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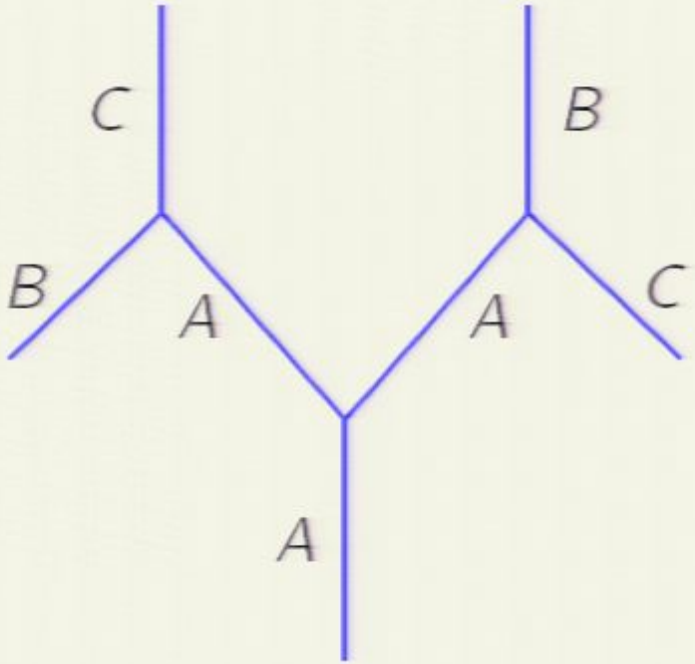

'Preparation' & 'measurement'

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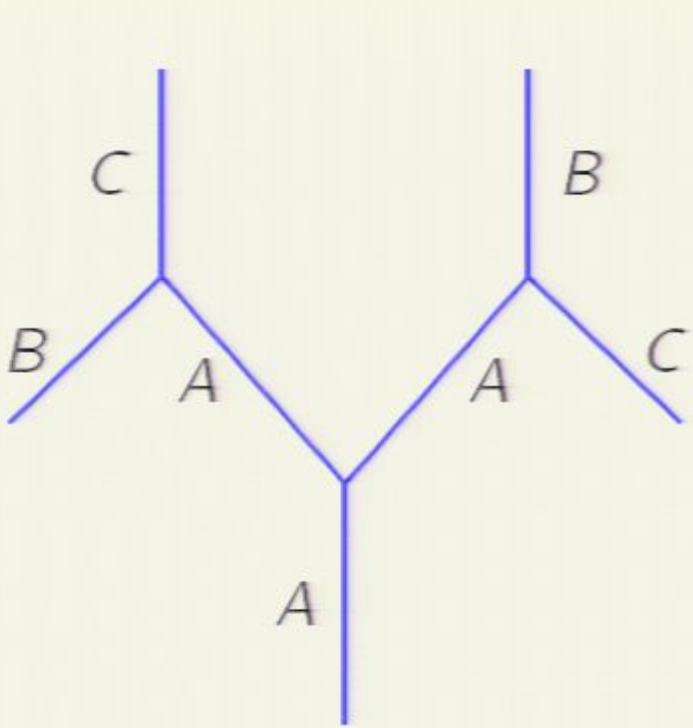
- . . . or time-symmetric if we treat up-down as a temporal axis.



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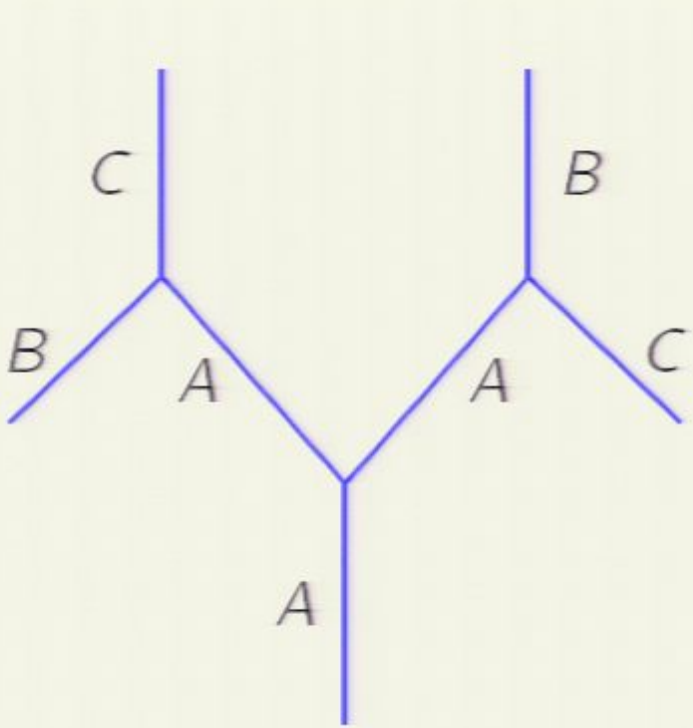

'Future'

'Past'

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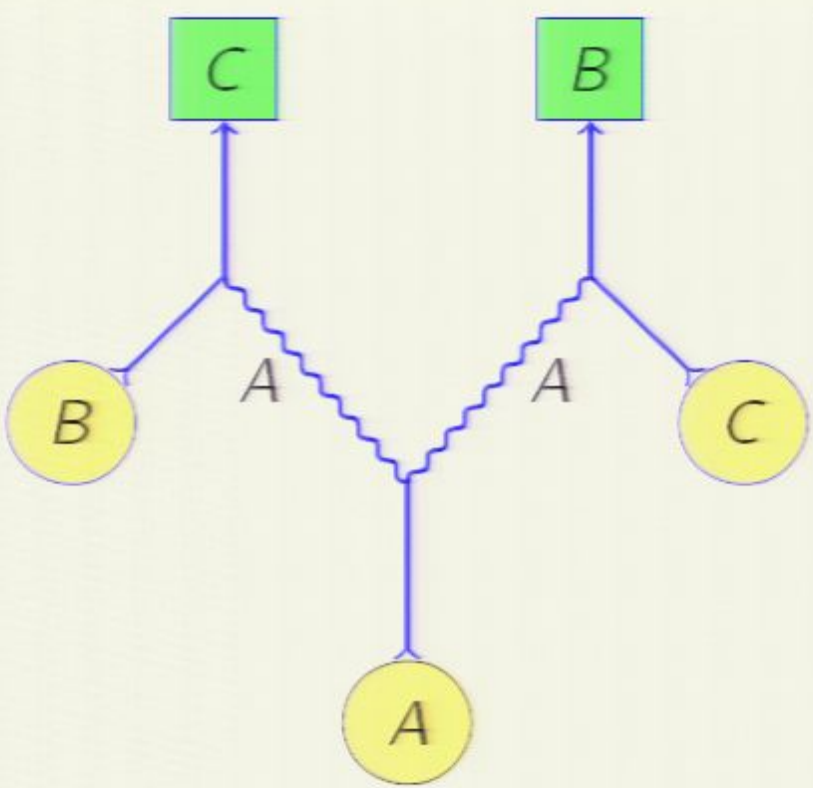

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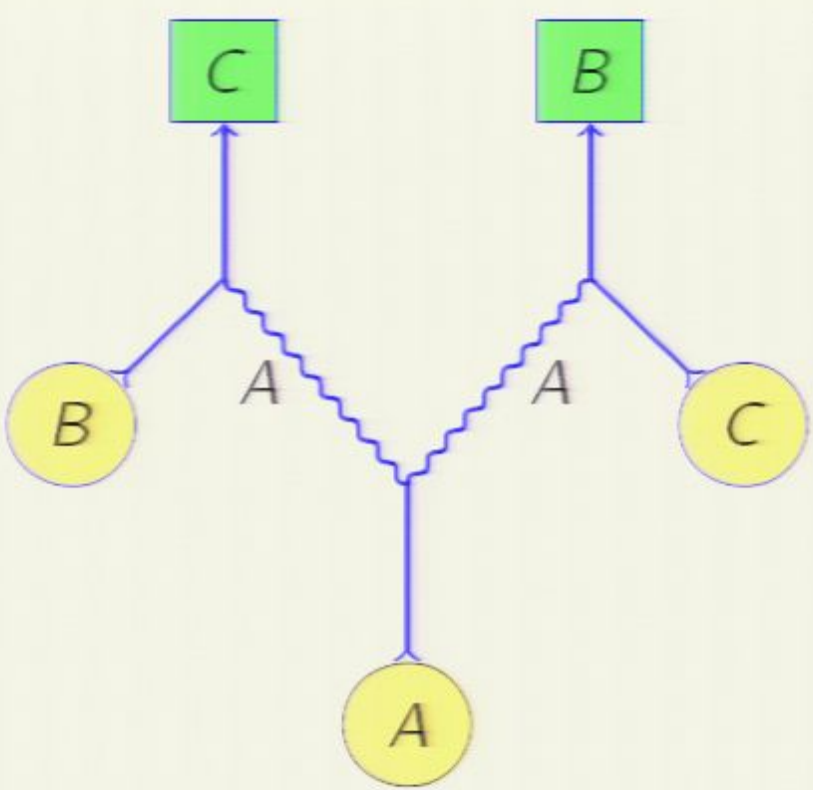

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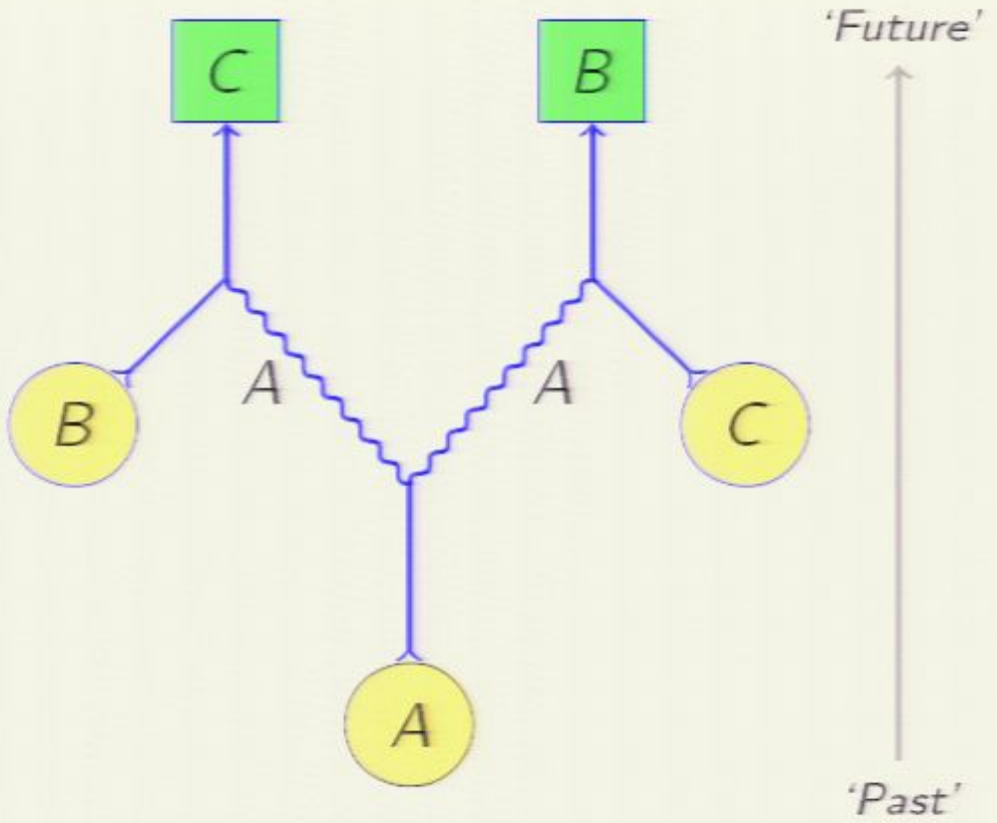
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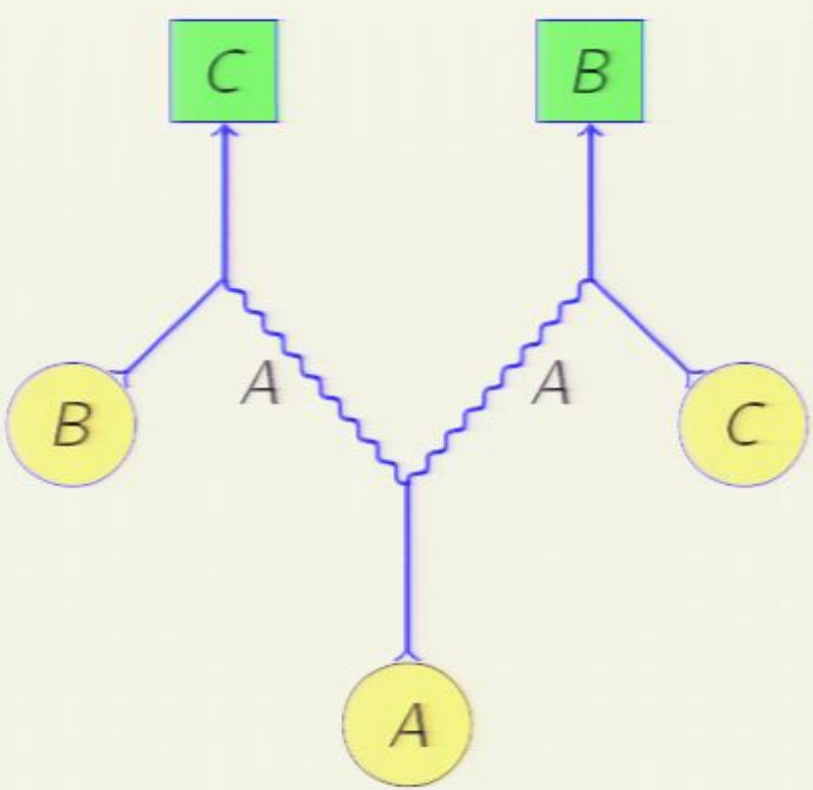

Notes

1. The direction of causation is 'put in by hand', by our stipulation of what we can control.
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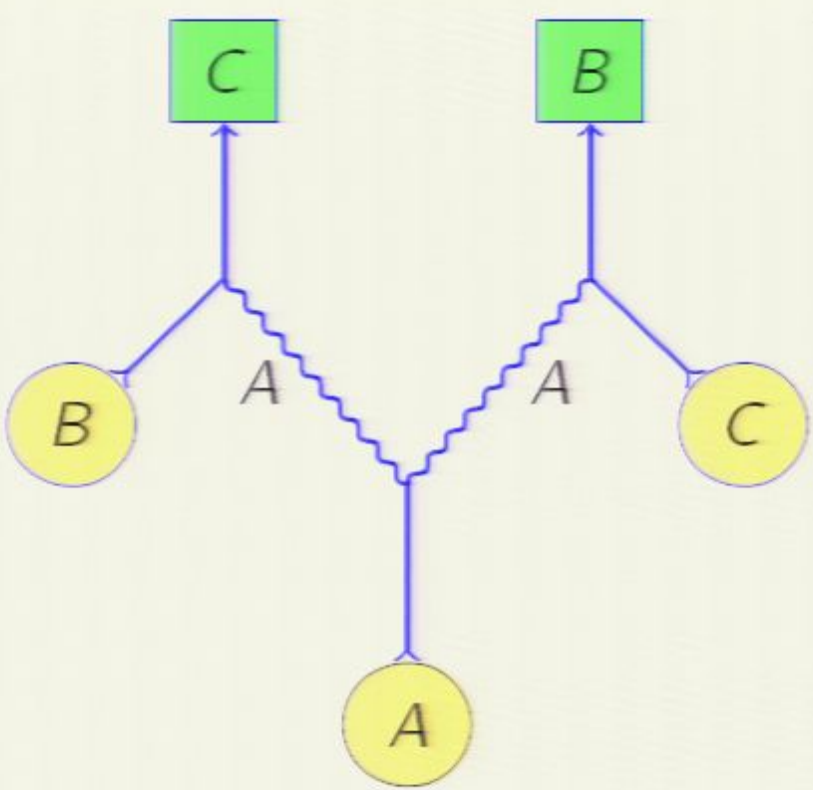

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Next tasks

1. Explaining what retrocausality amounts to (when the direction of causation is only put in by hand).
2. Showing that the Helsinki model requires retrocausality.

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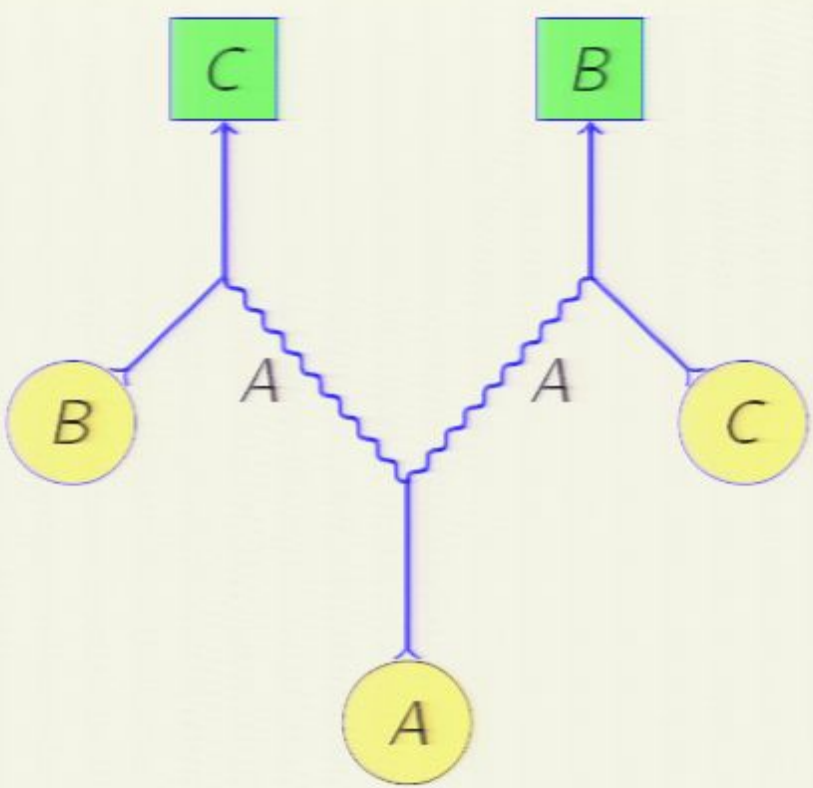
2. The Helsinki model
3. Revealing the retrocausality
   - Reverse causation v. retrocausation
   - Admissible cases
   - The state table
   - Retrocausality revealed
4. Where next?



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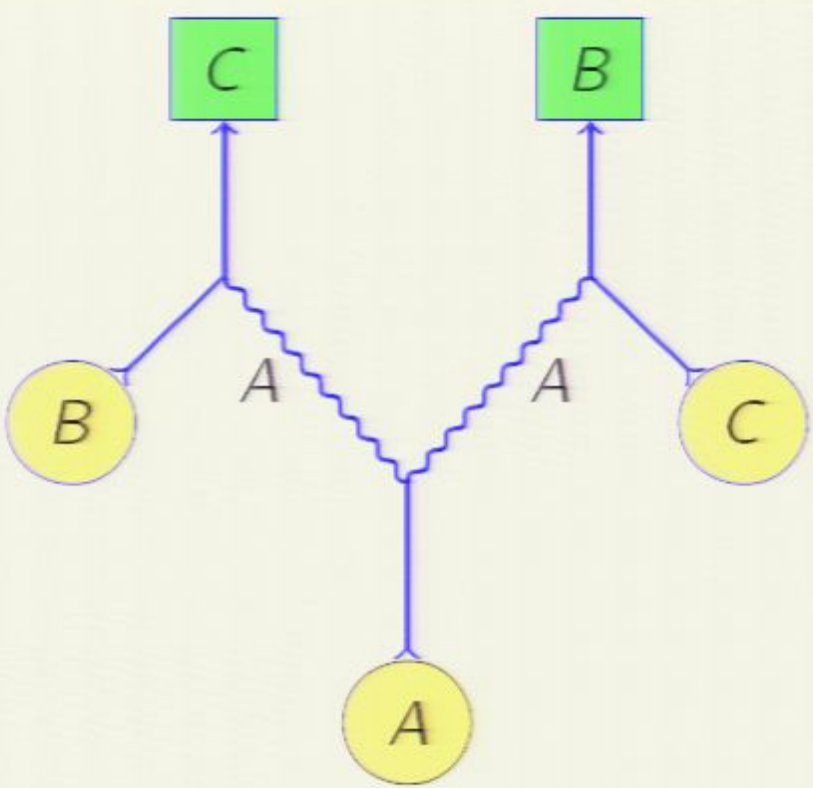

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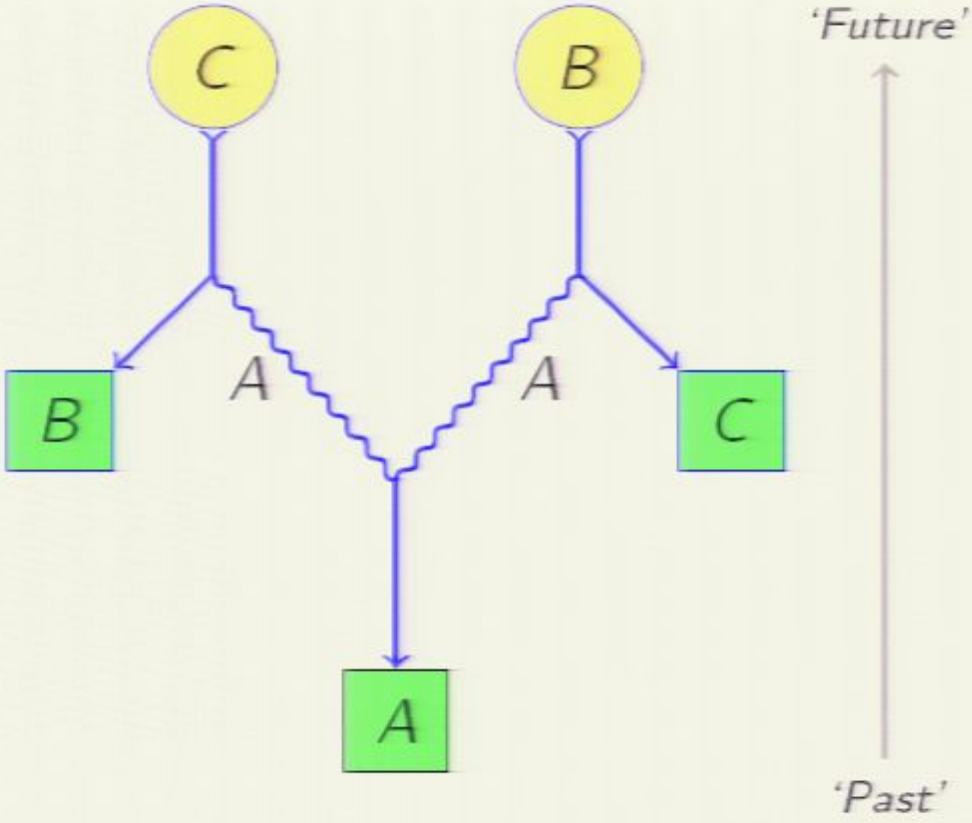

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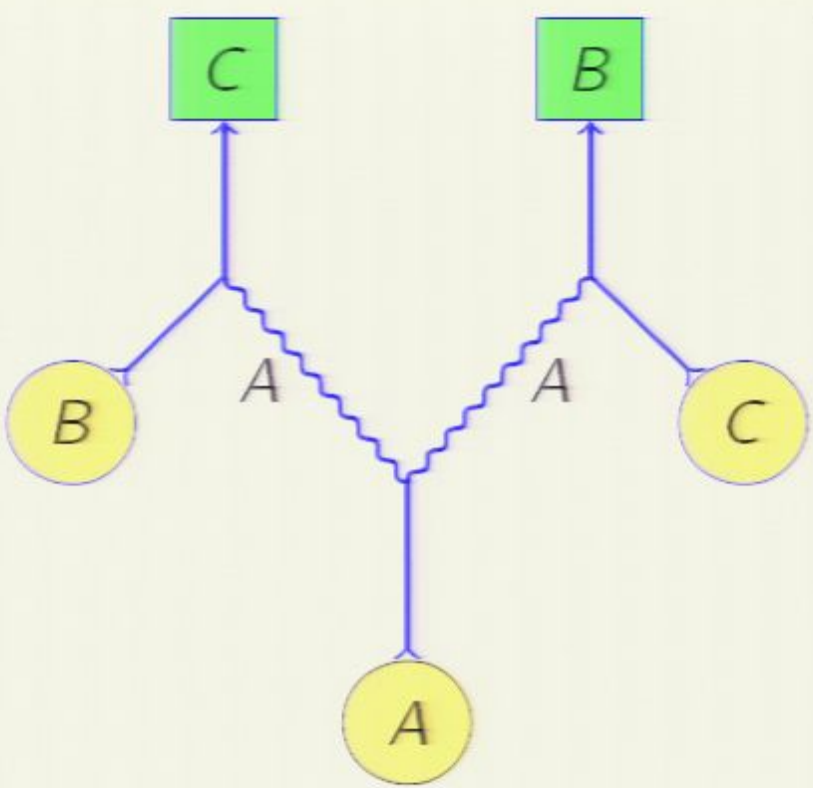

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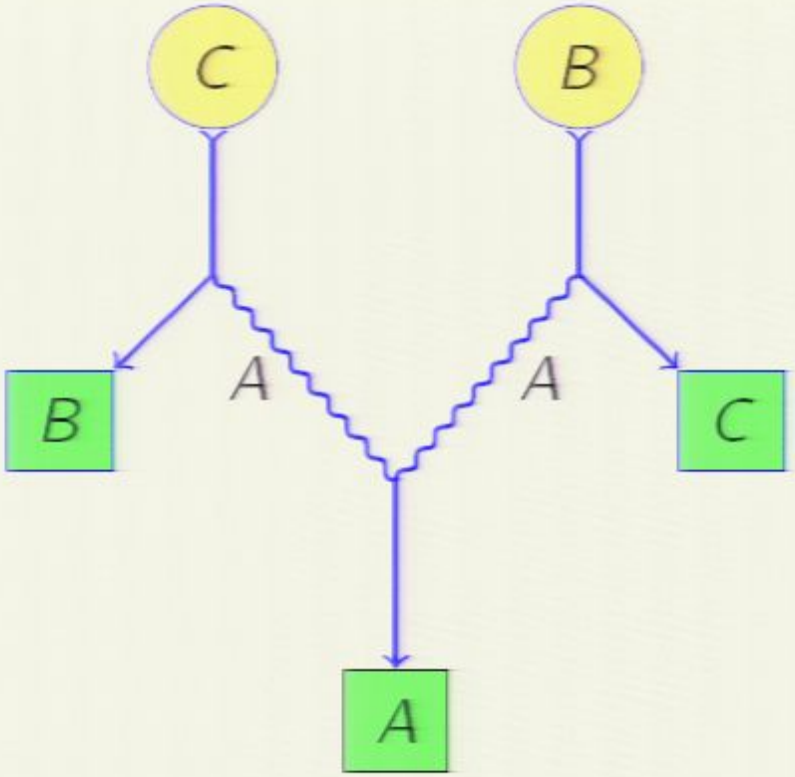

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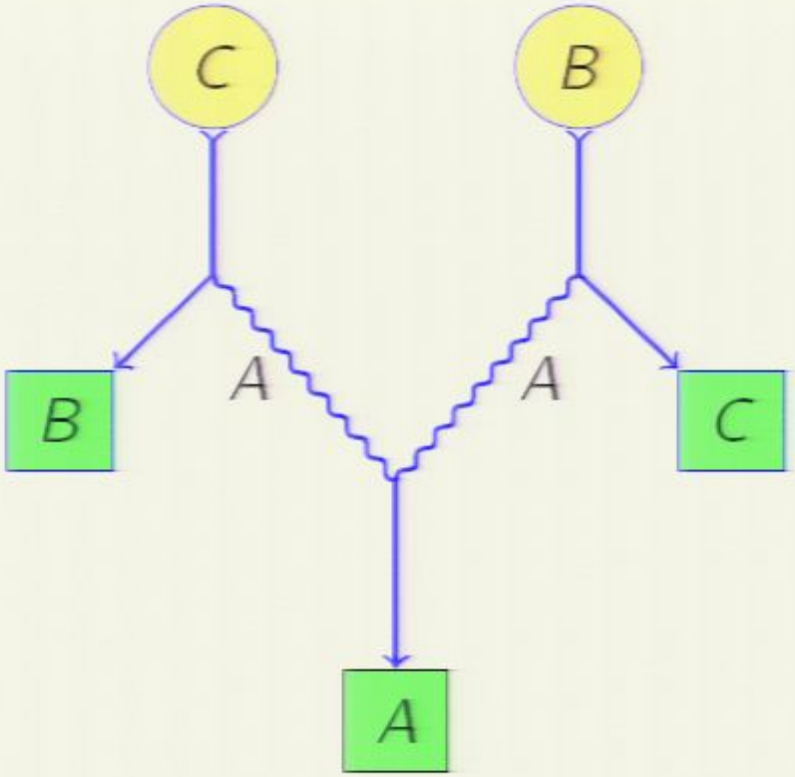

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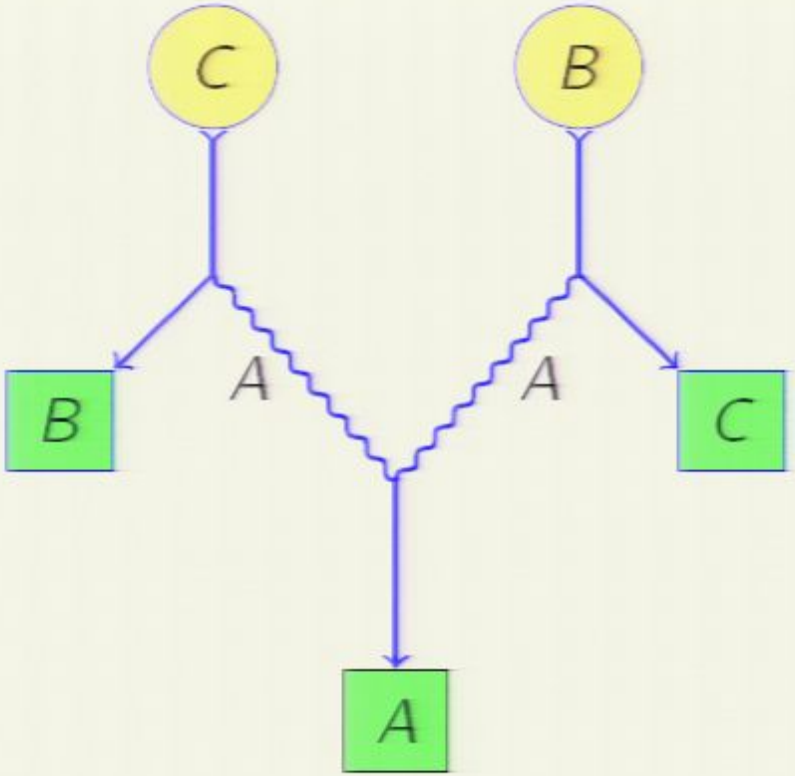

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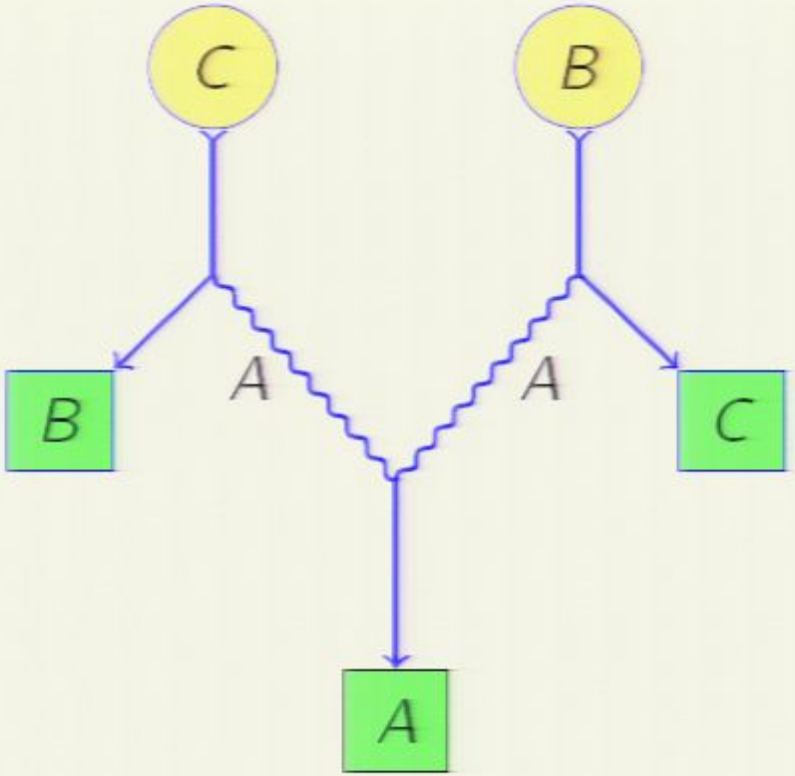

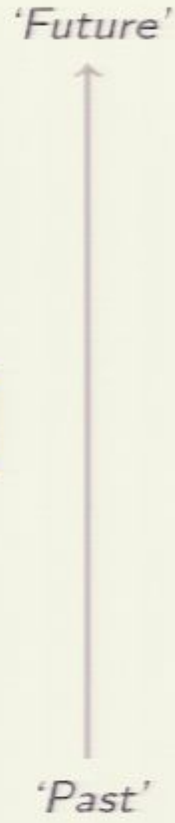

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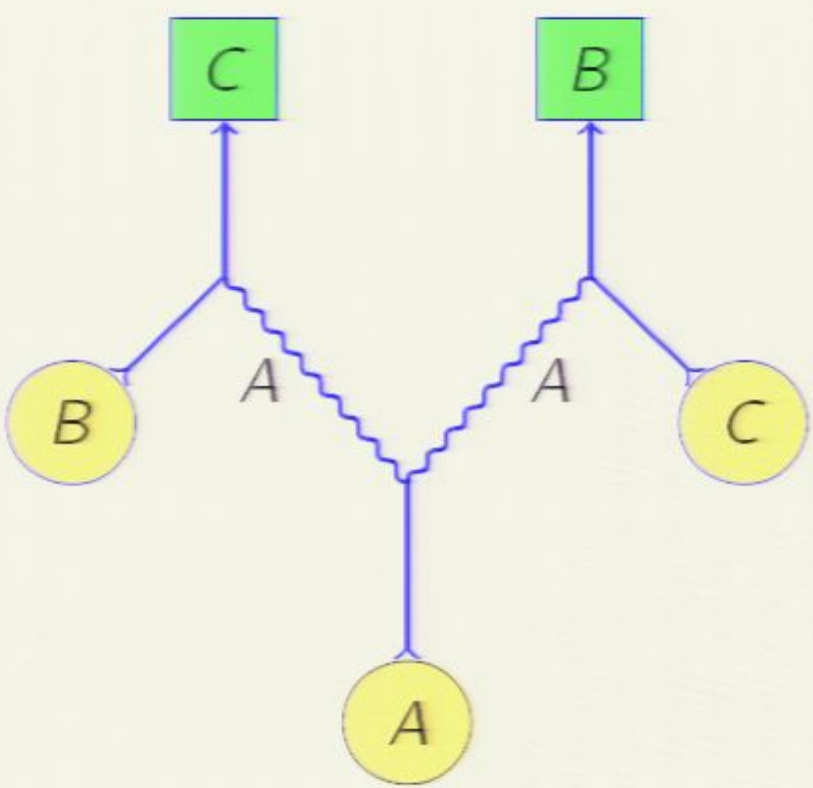

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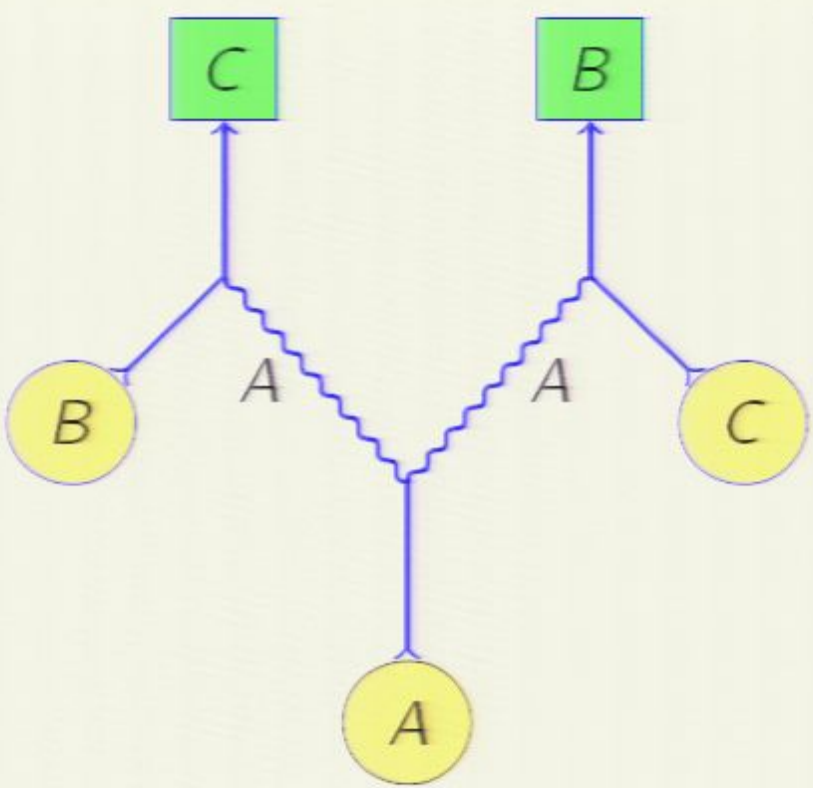

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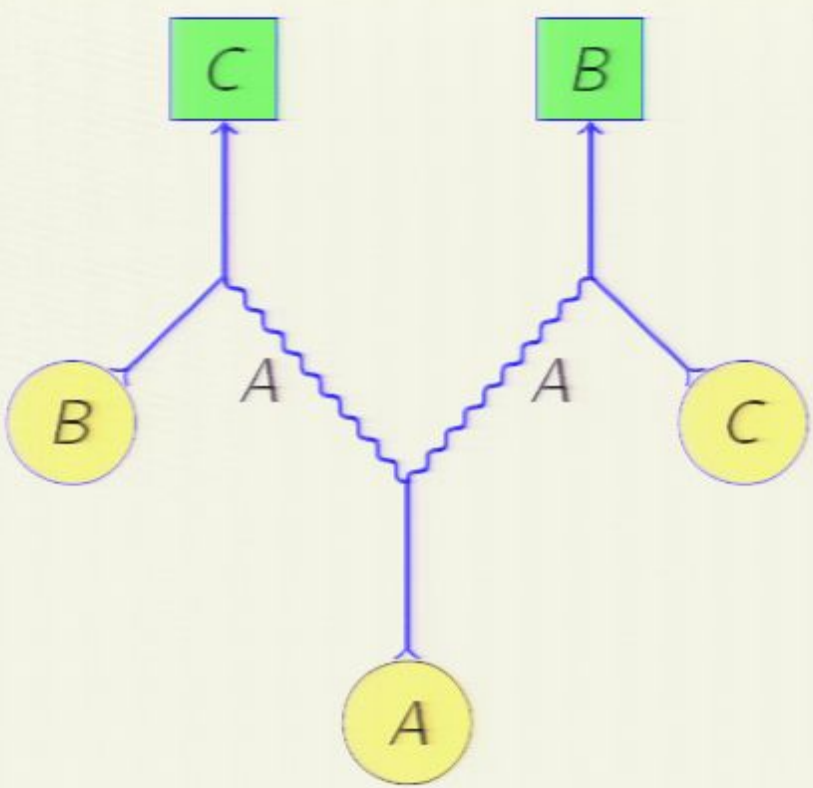

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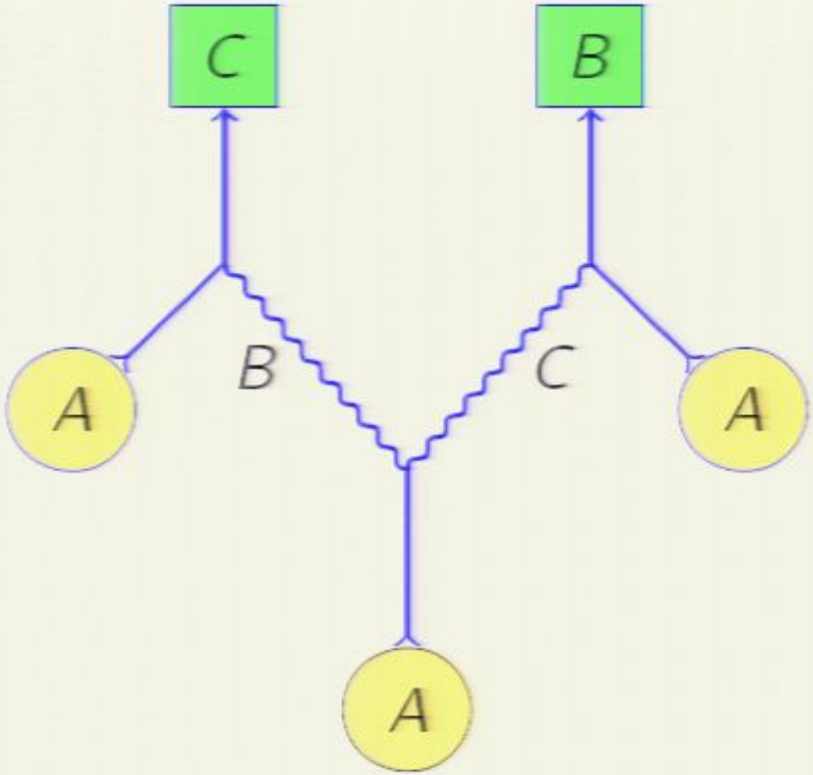
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B
A
B
C
A
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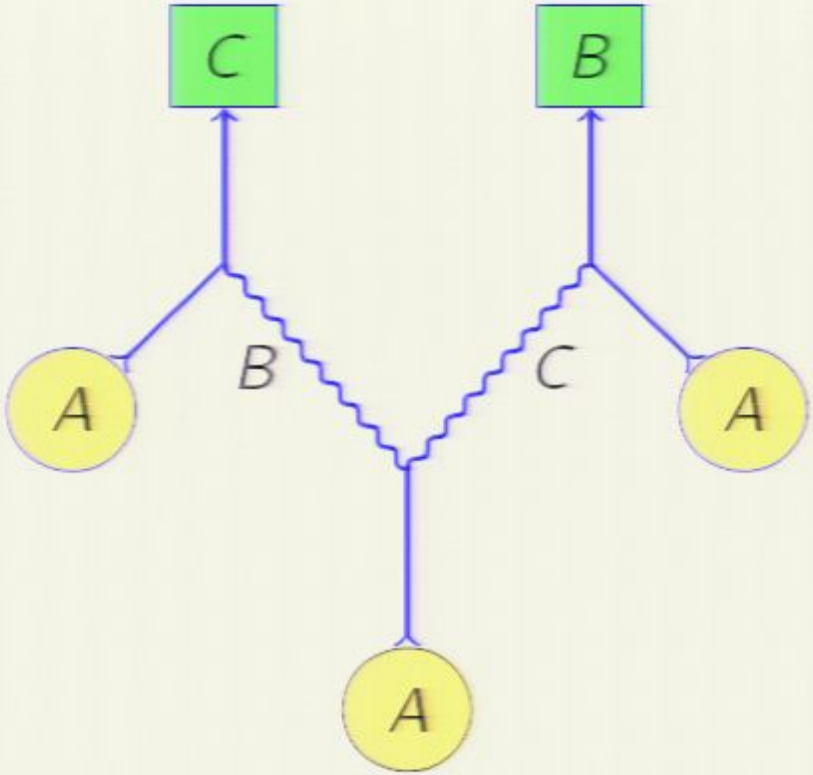

Setting: AAA_1

Hidden state: $\langle BC \rangle$

Summary

- We have (up to symmetry) just **four** possible choices of measurement settings, and **three** possible hidden states.
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	$\langle AA \rangle$	$\langle BC \rangle$	$\langle CB \rangle$
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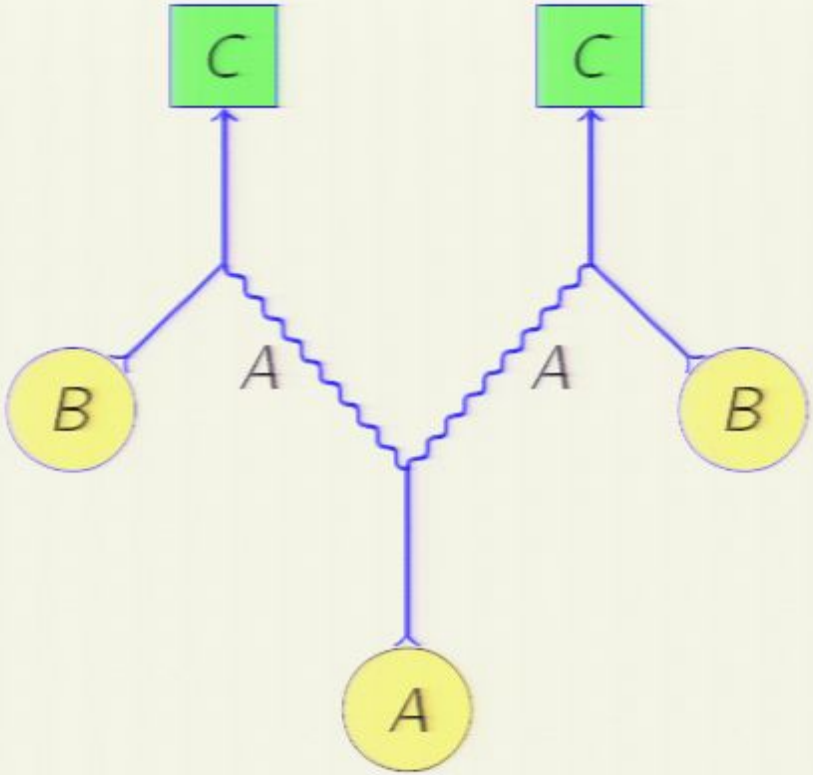

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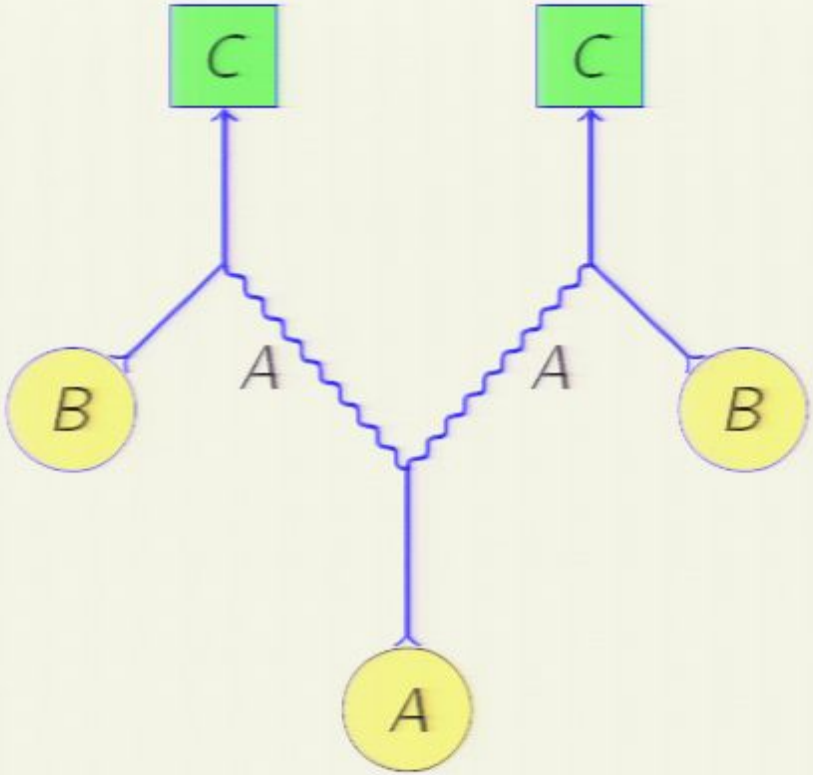

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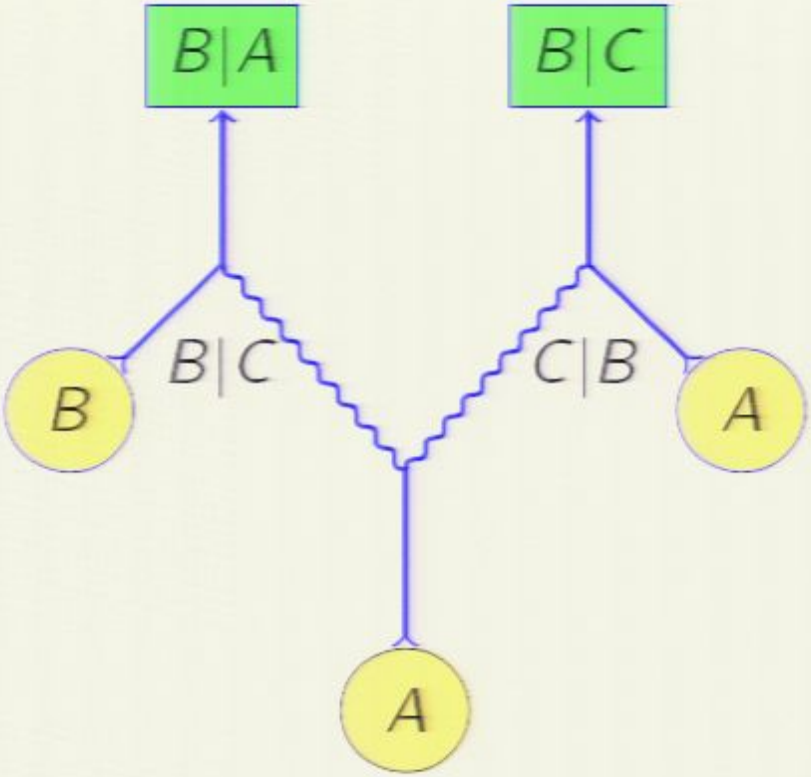

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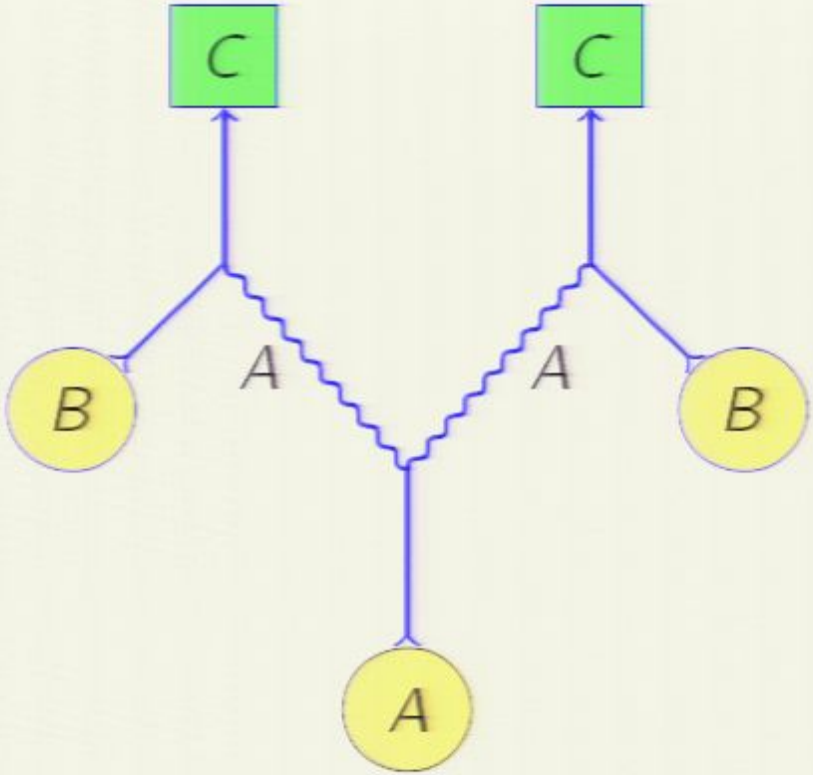

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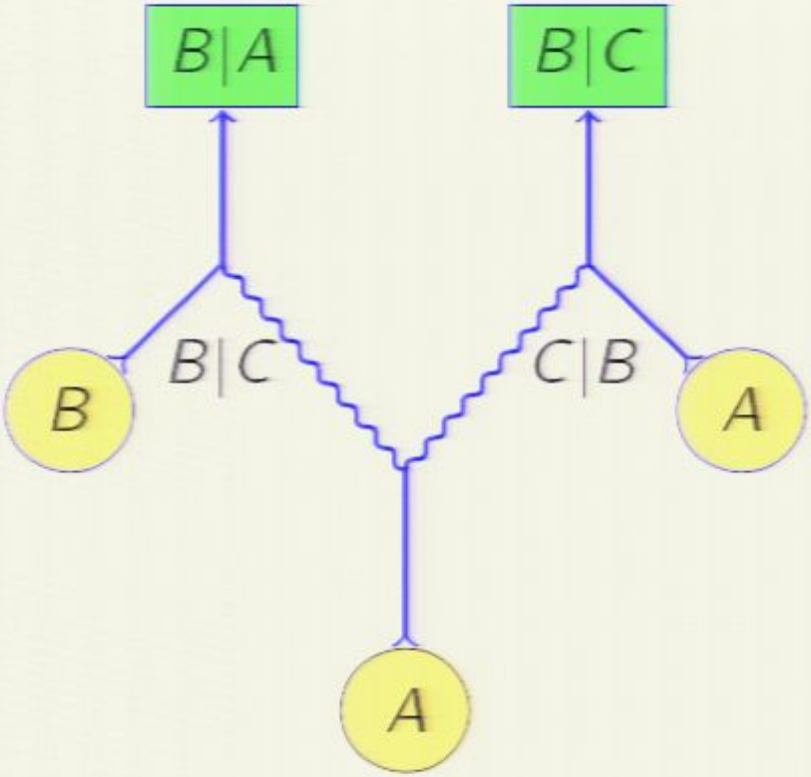

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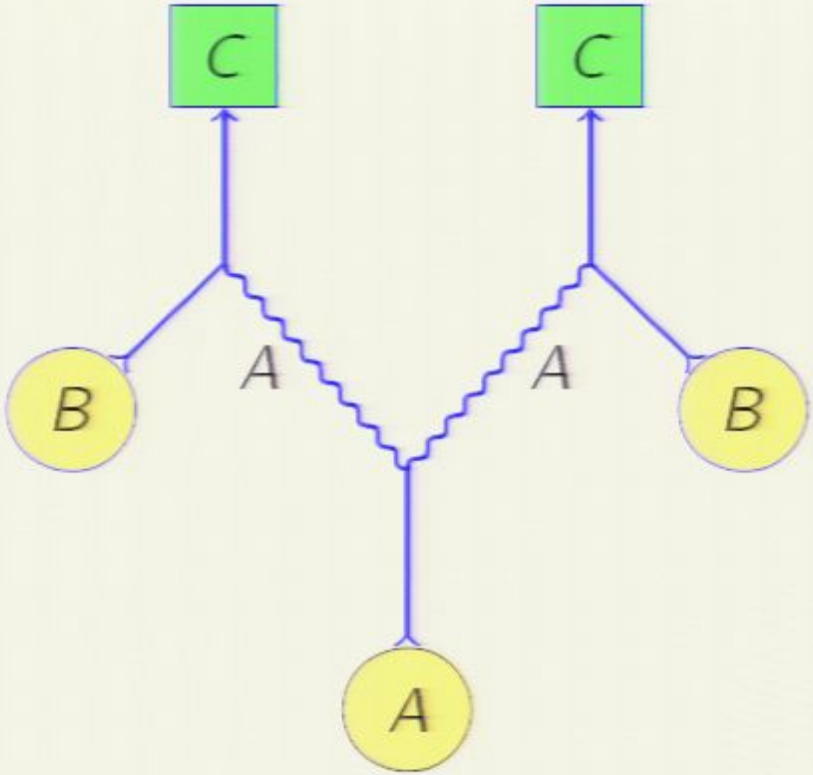

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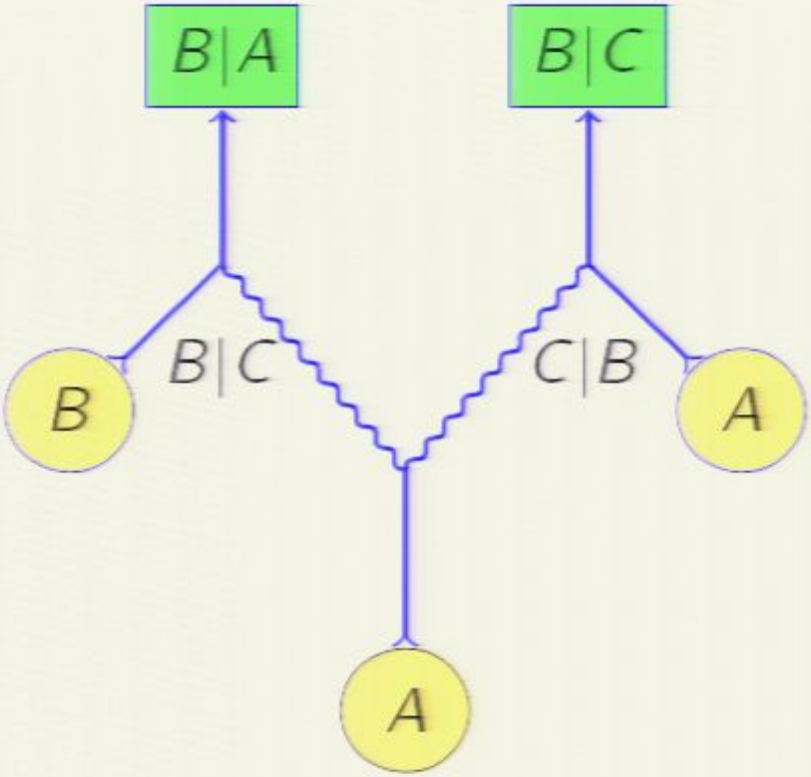

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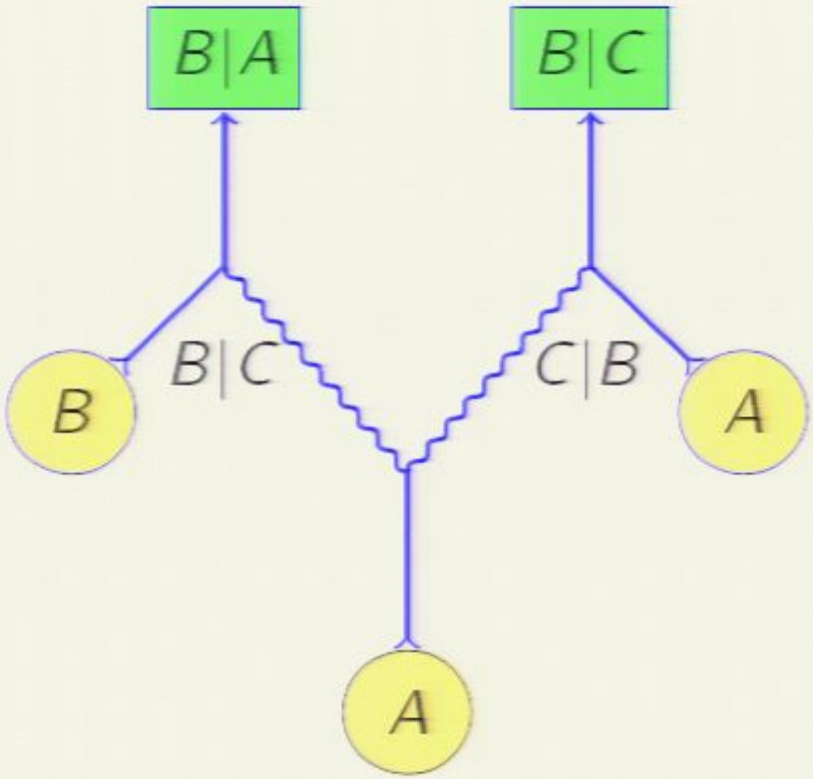

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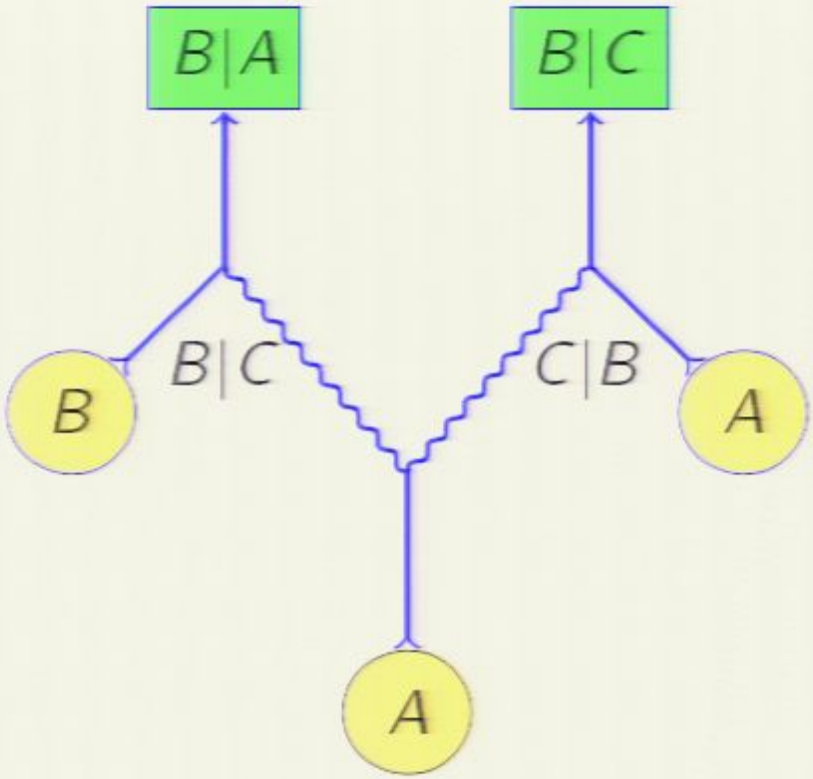

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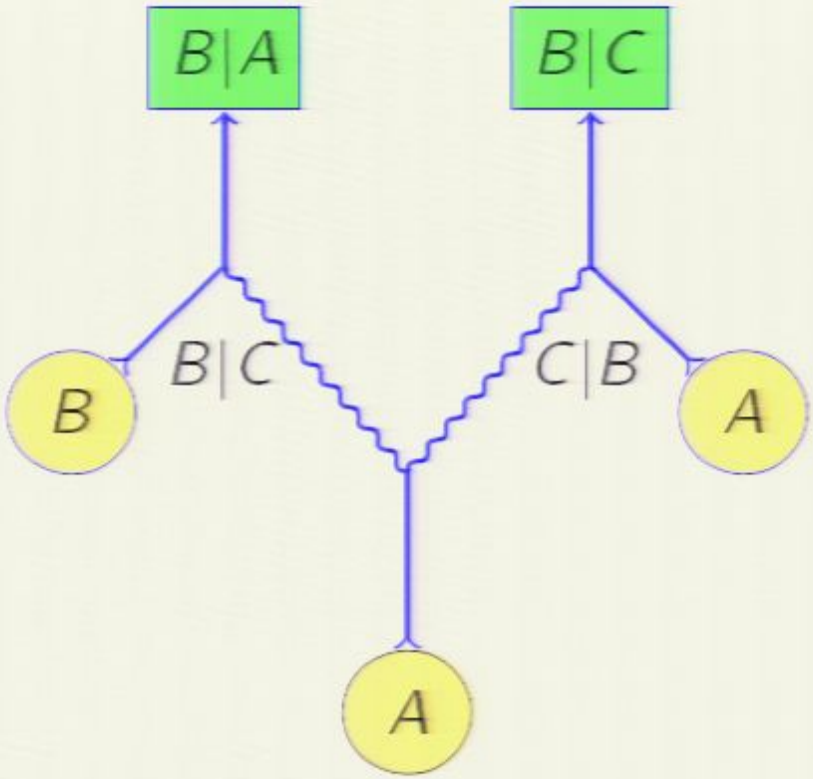

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3. Revealing the retrocausality
4. Where next?
   - Consistency?
   - Causal loops?
   - Improving the model
   - The End

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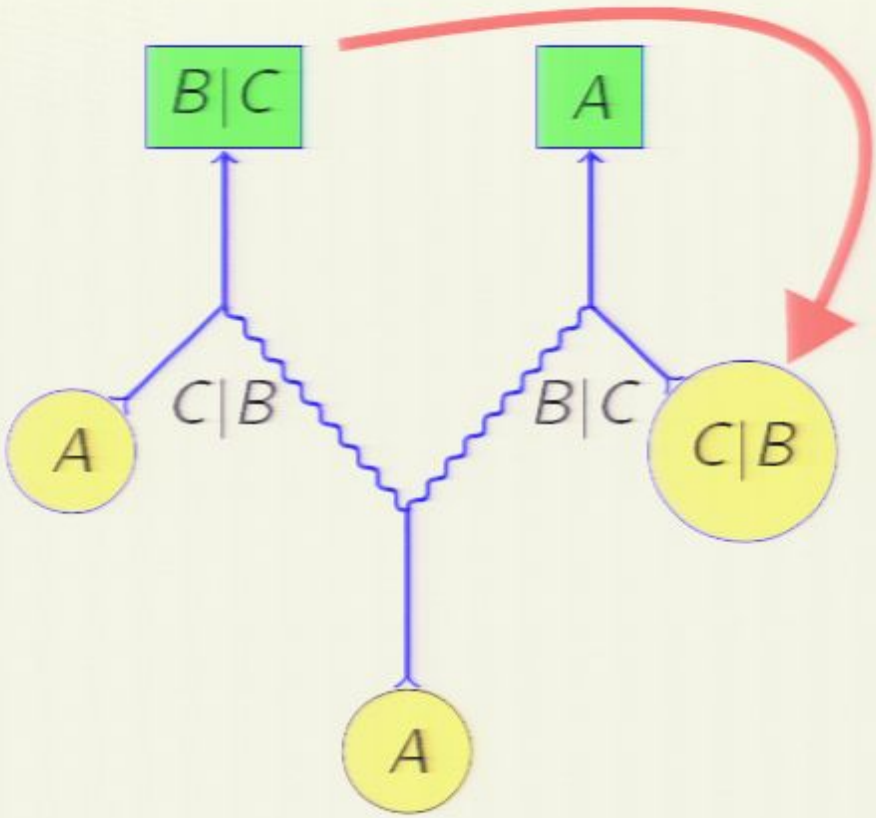

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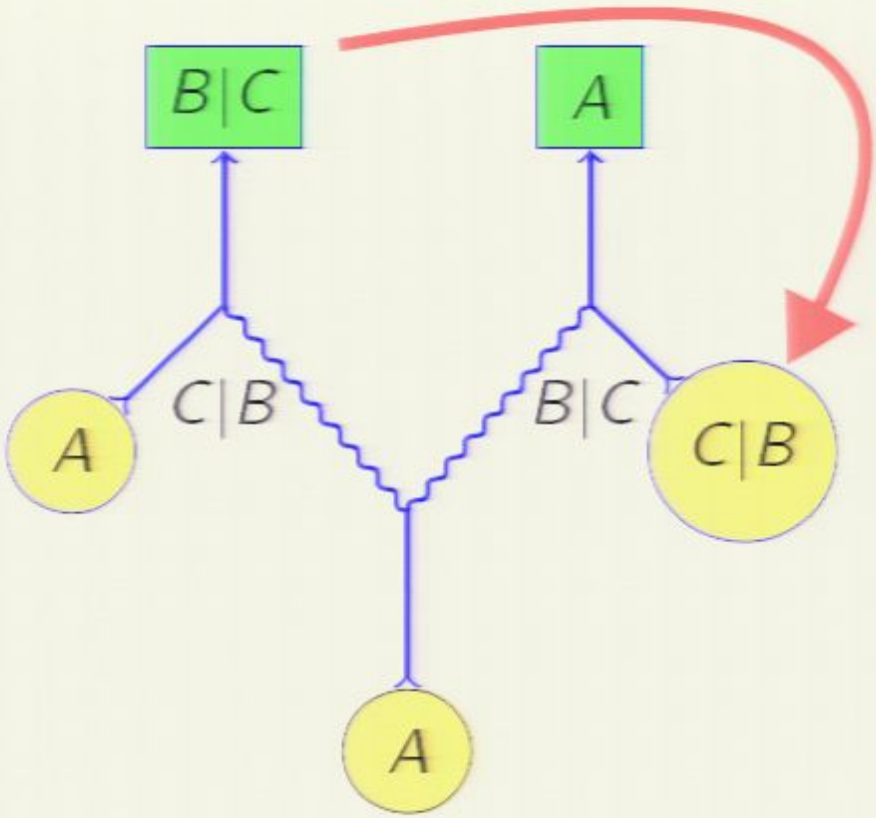

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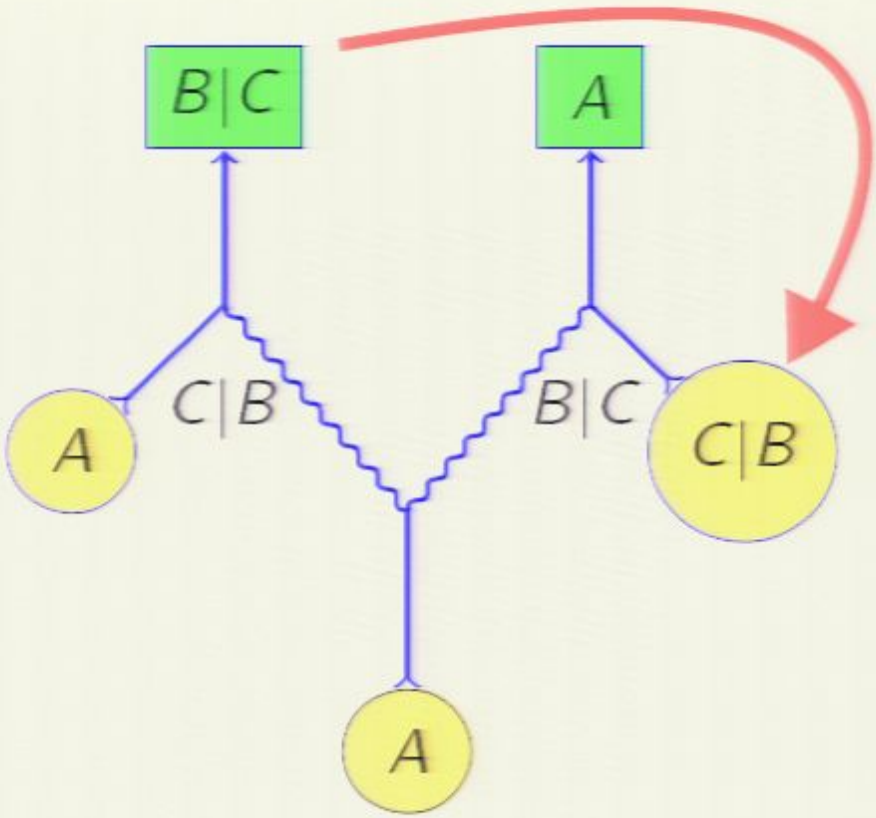

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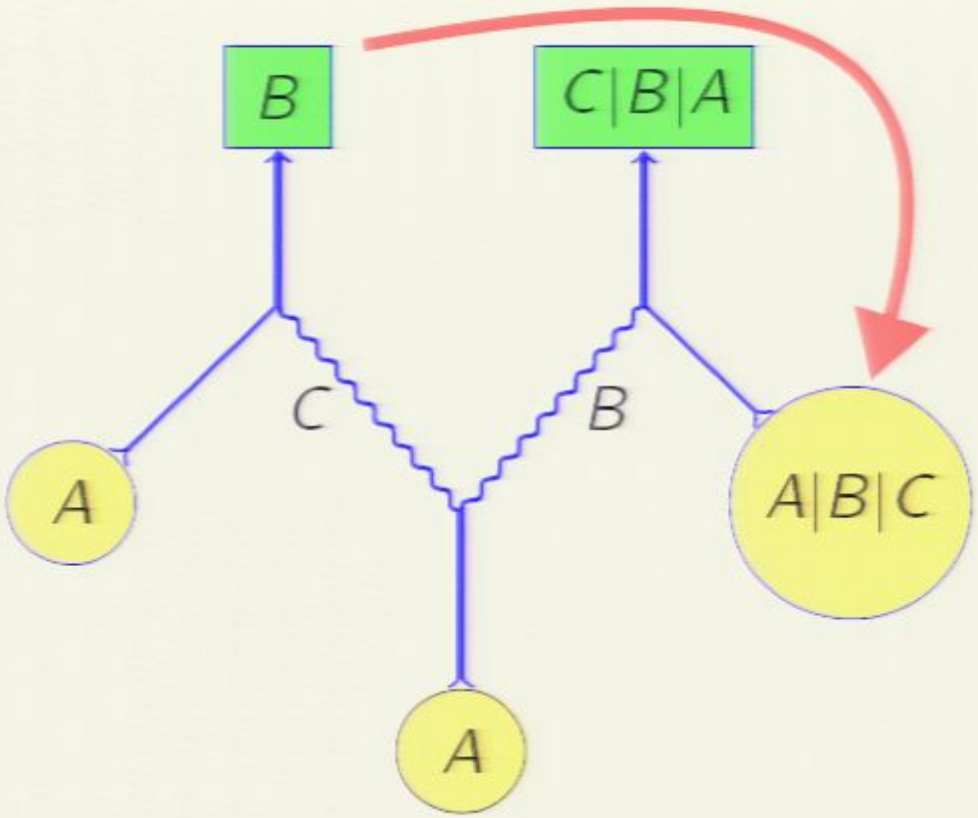

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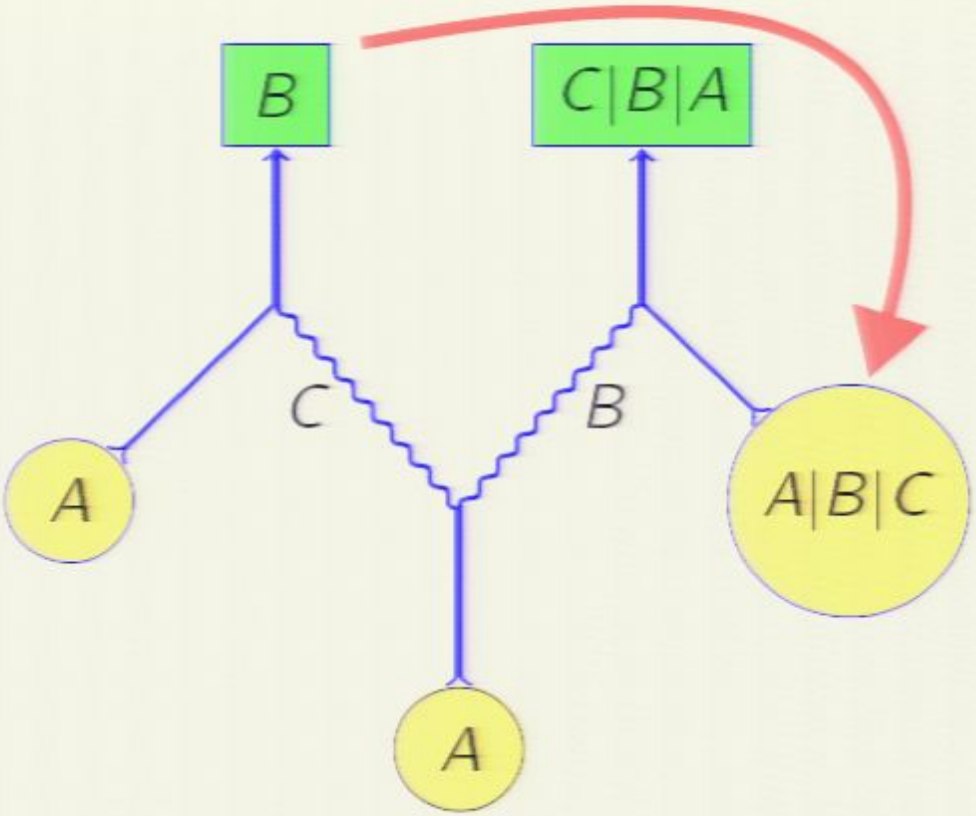

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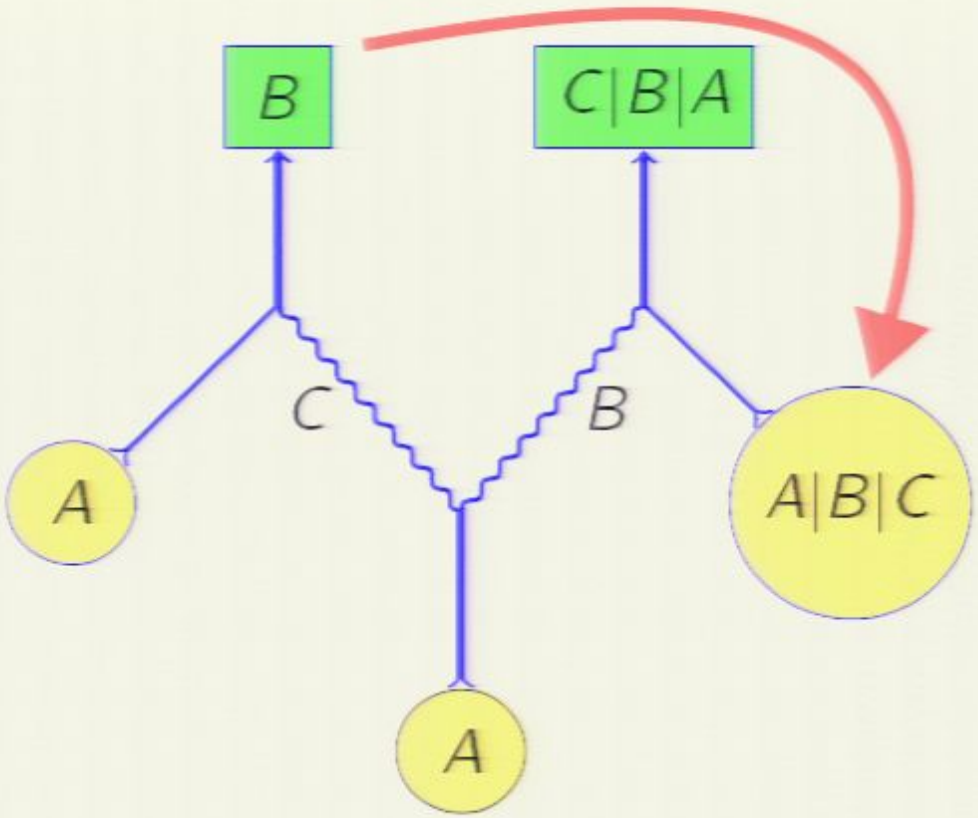

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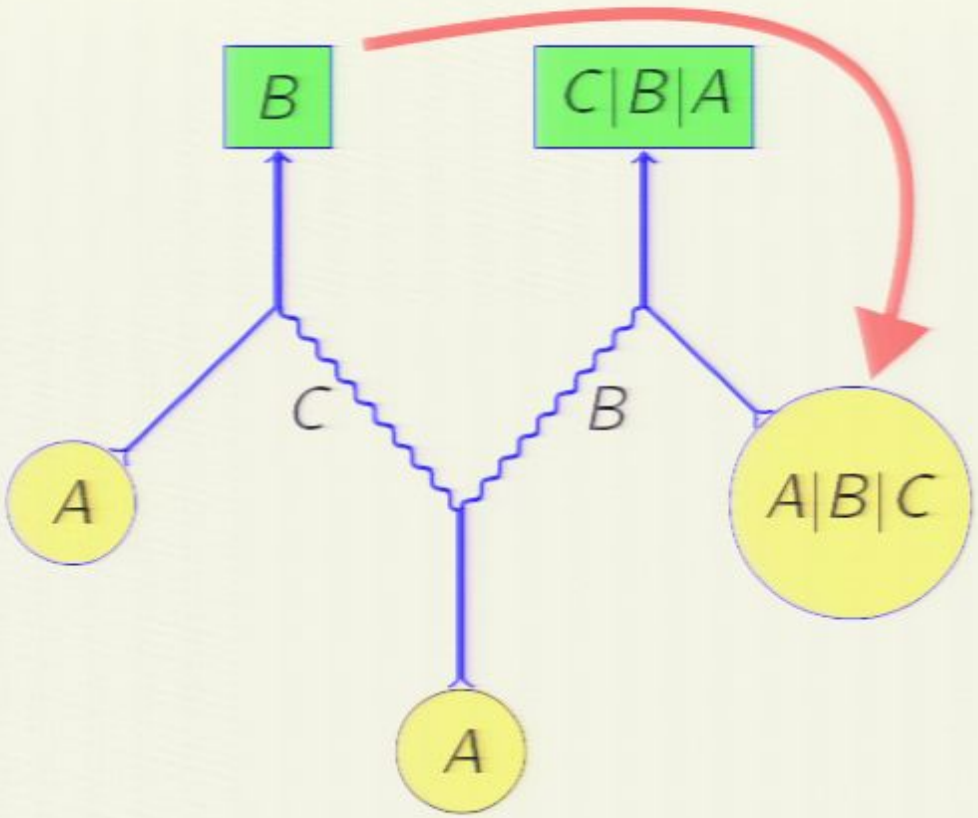

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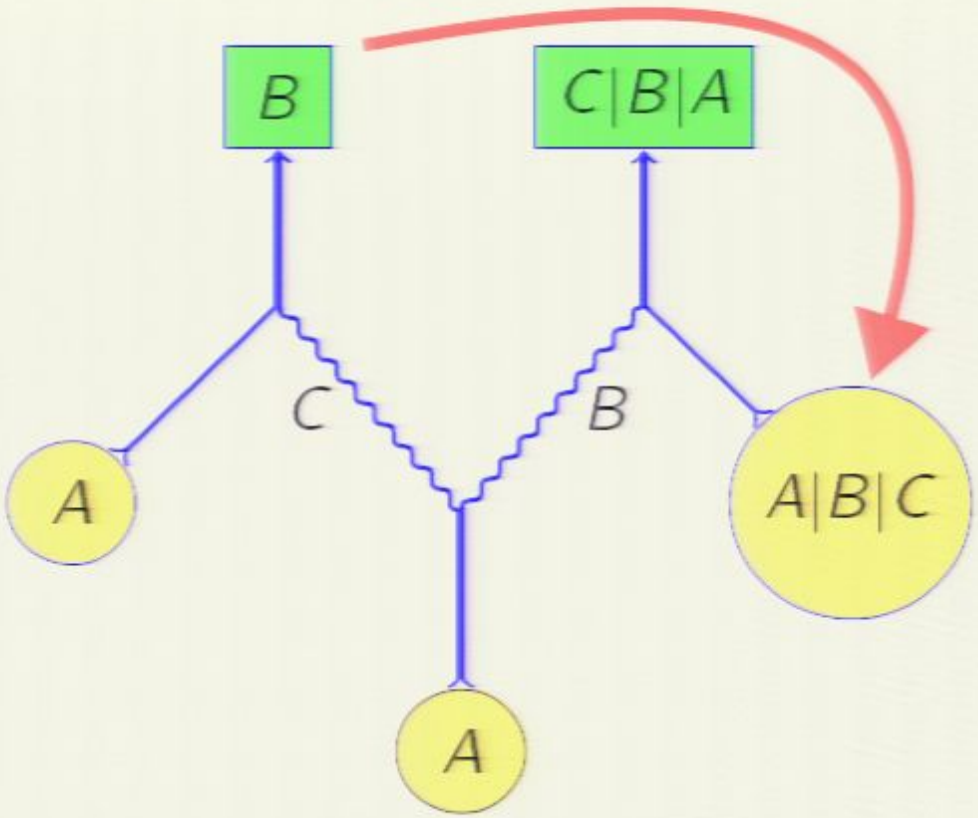

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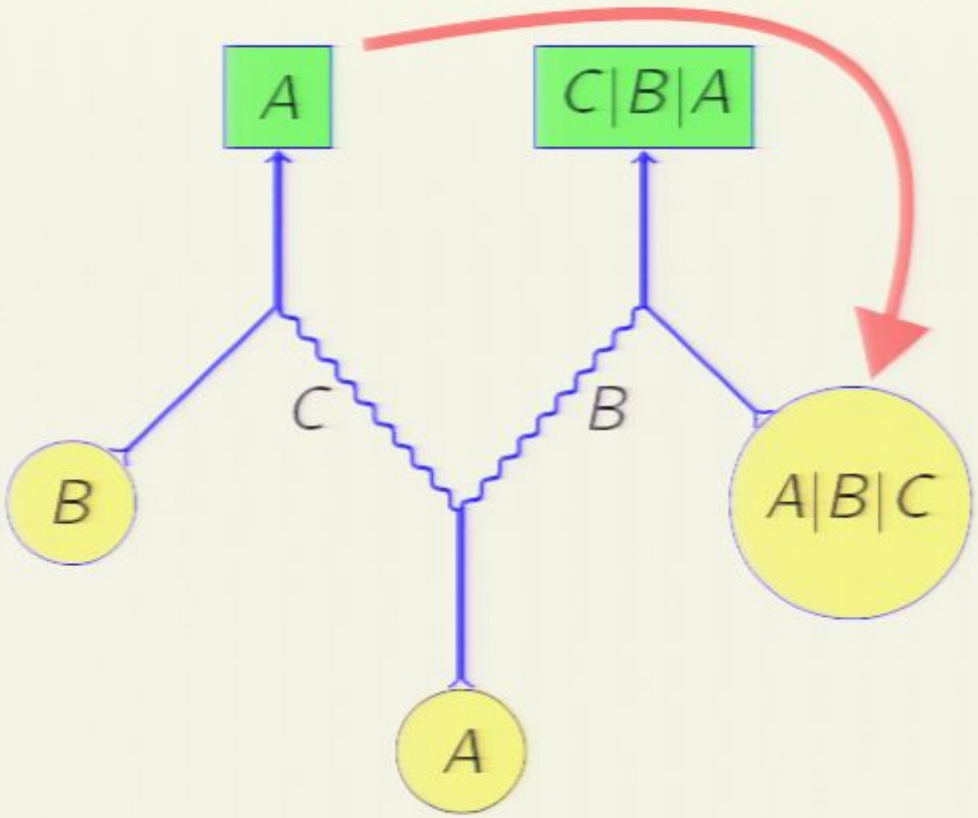

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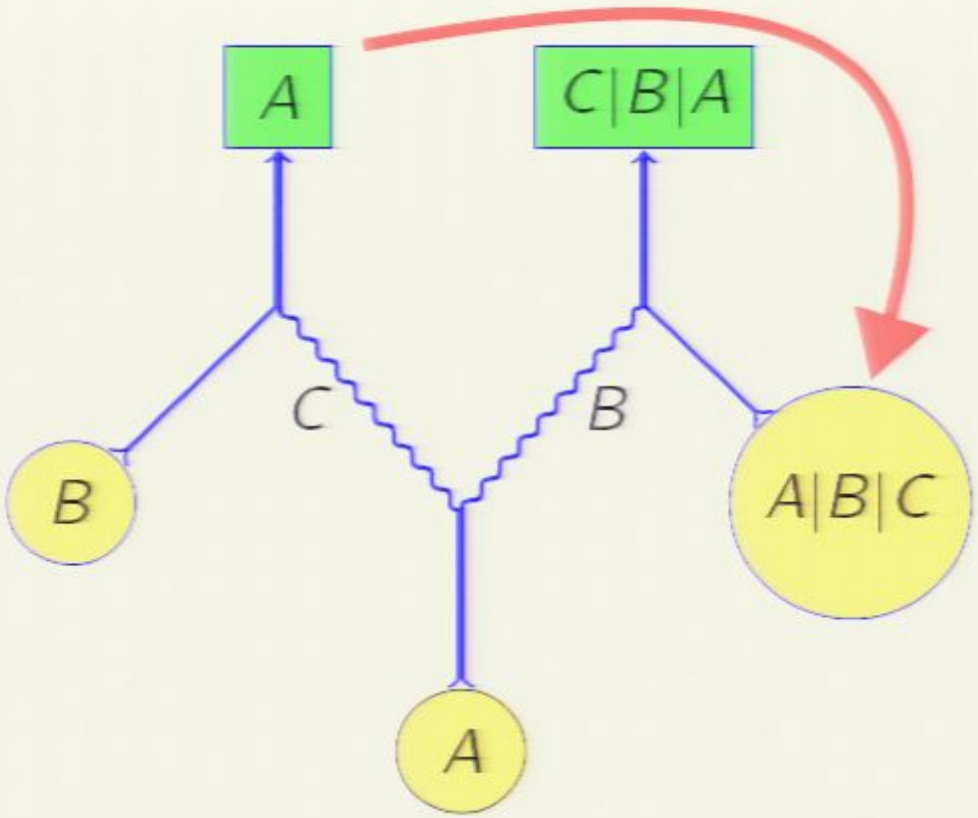

Causal loops

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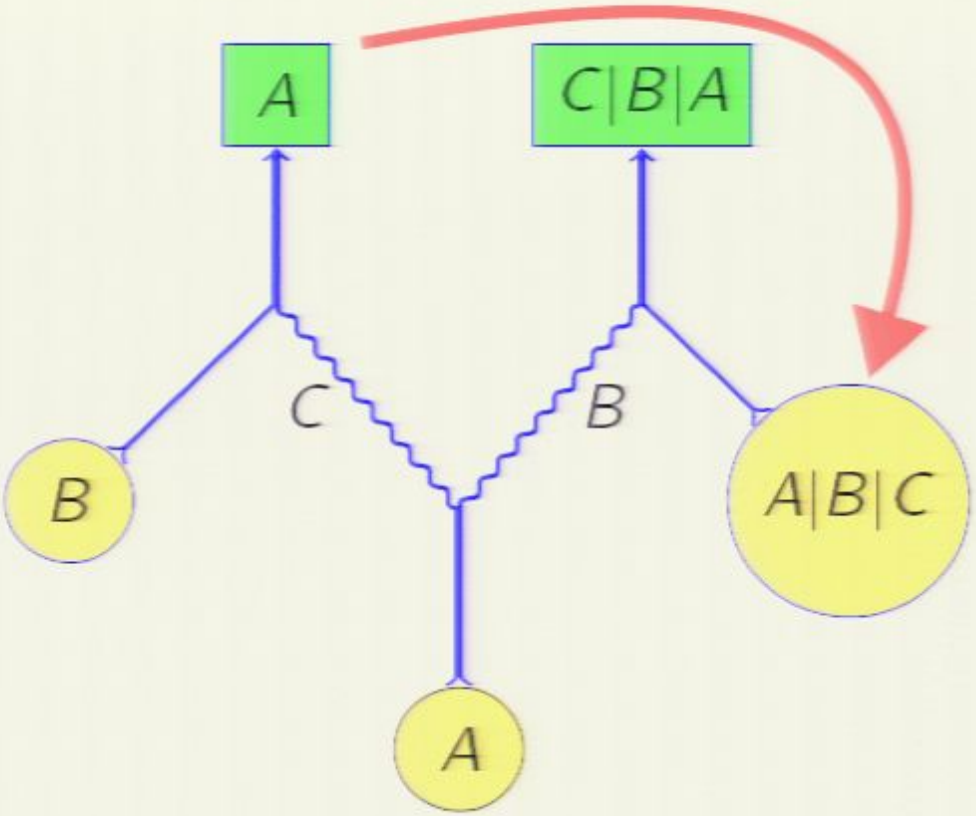

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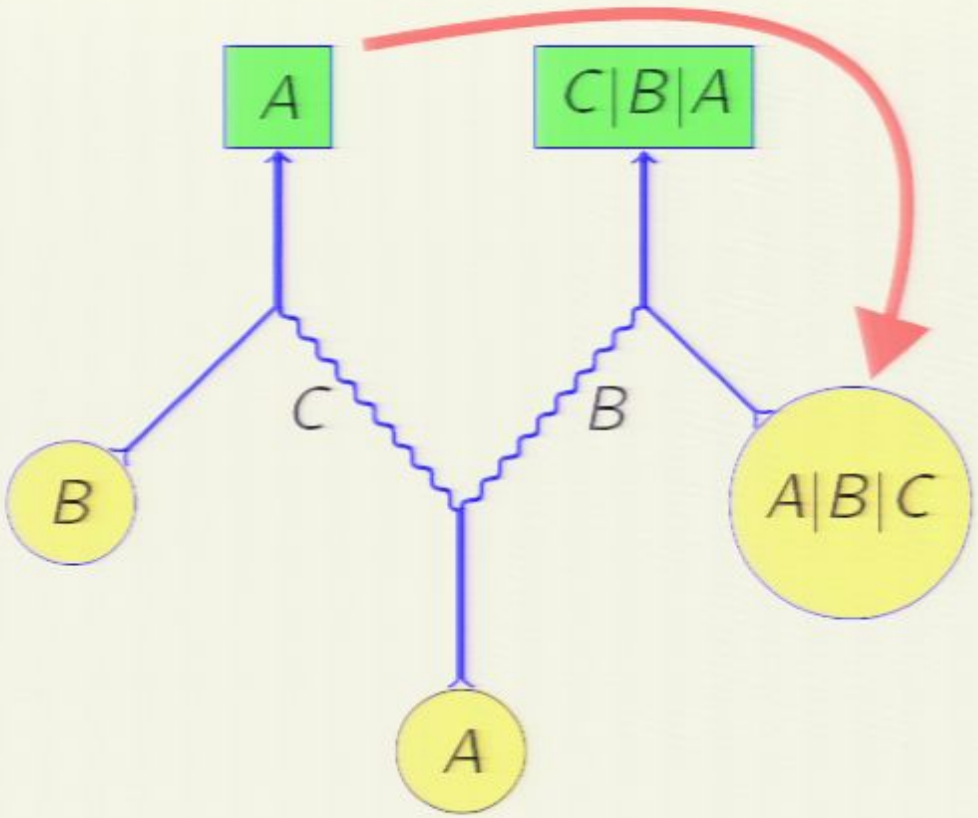

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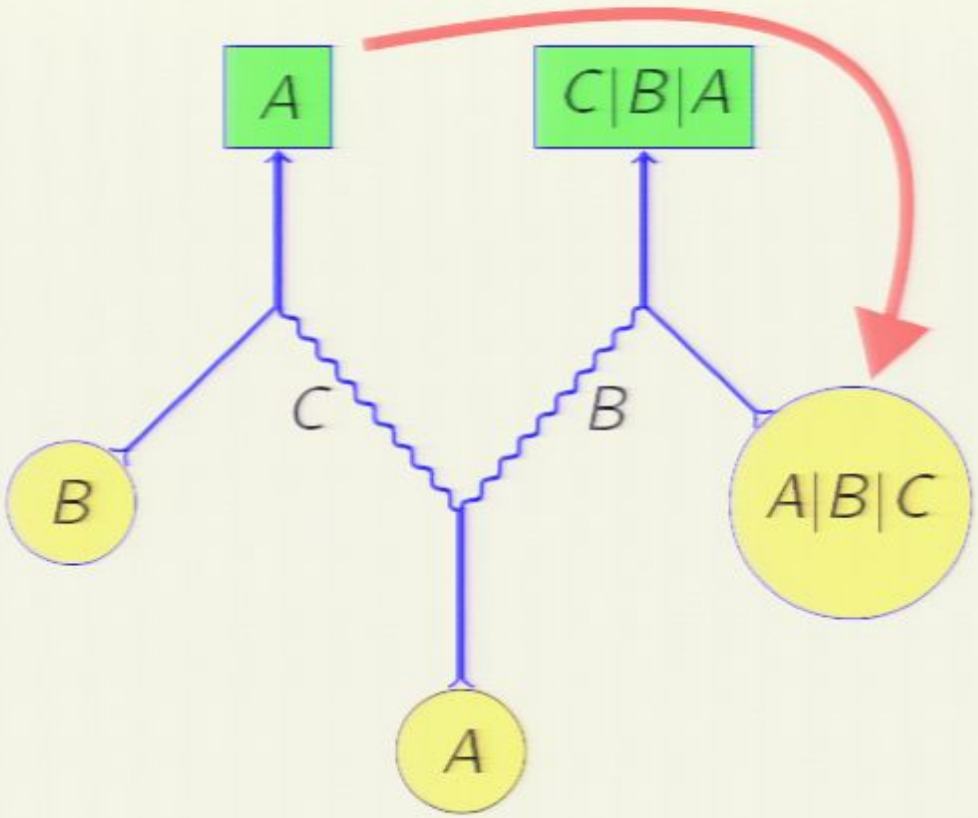

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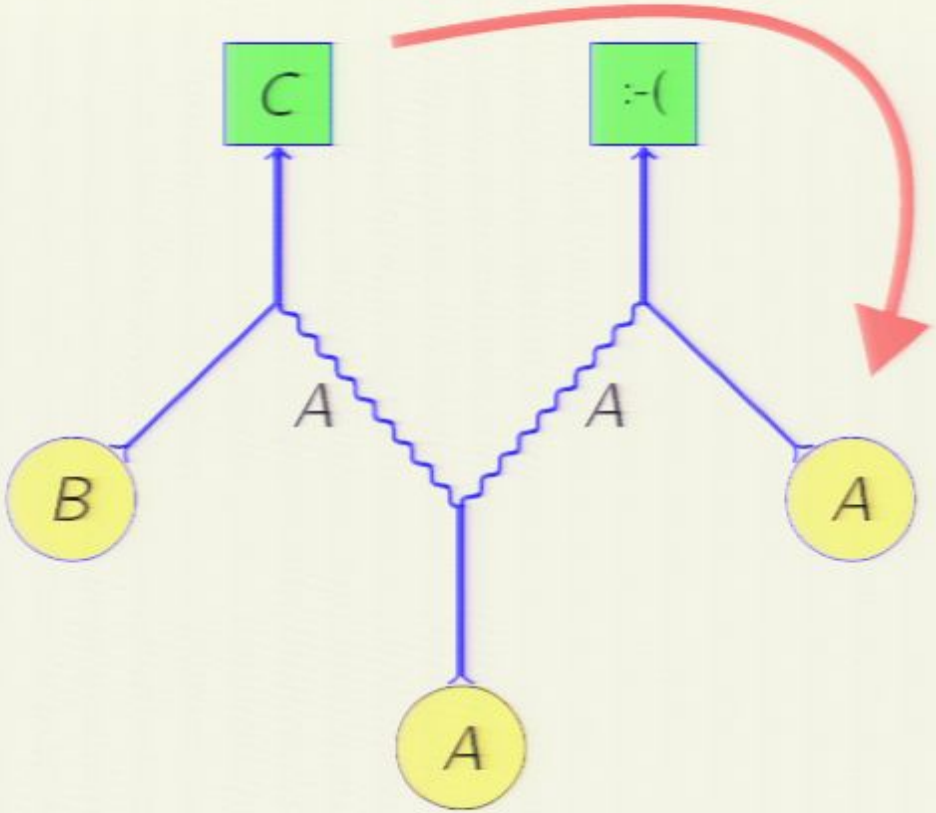

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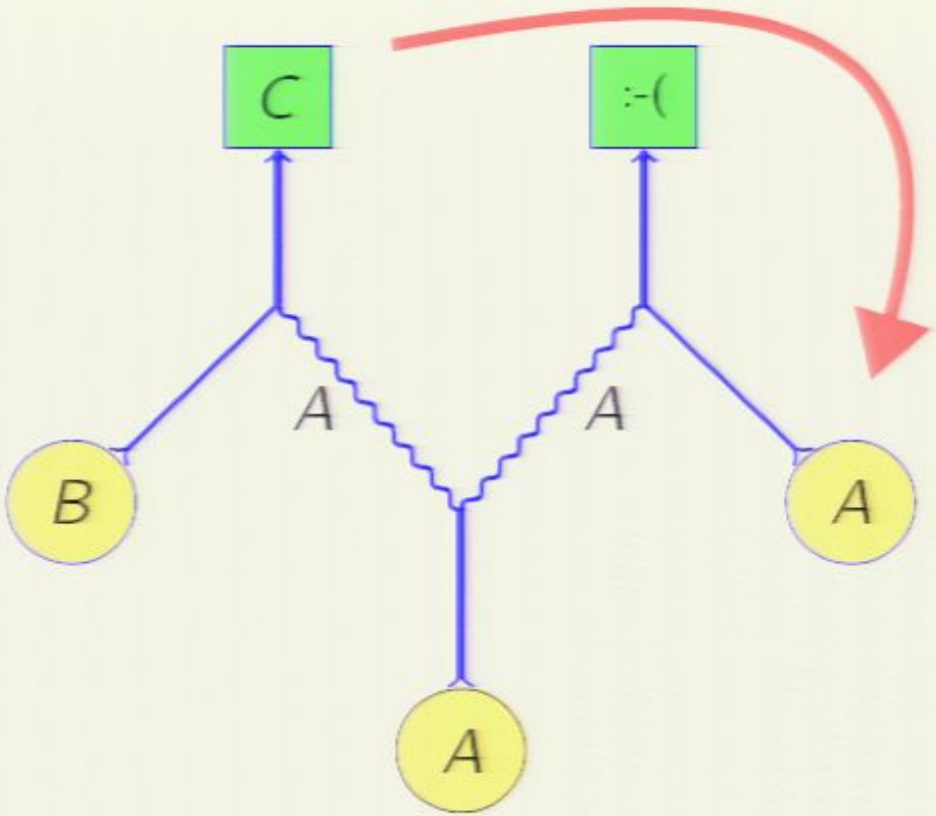

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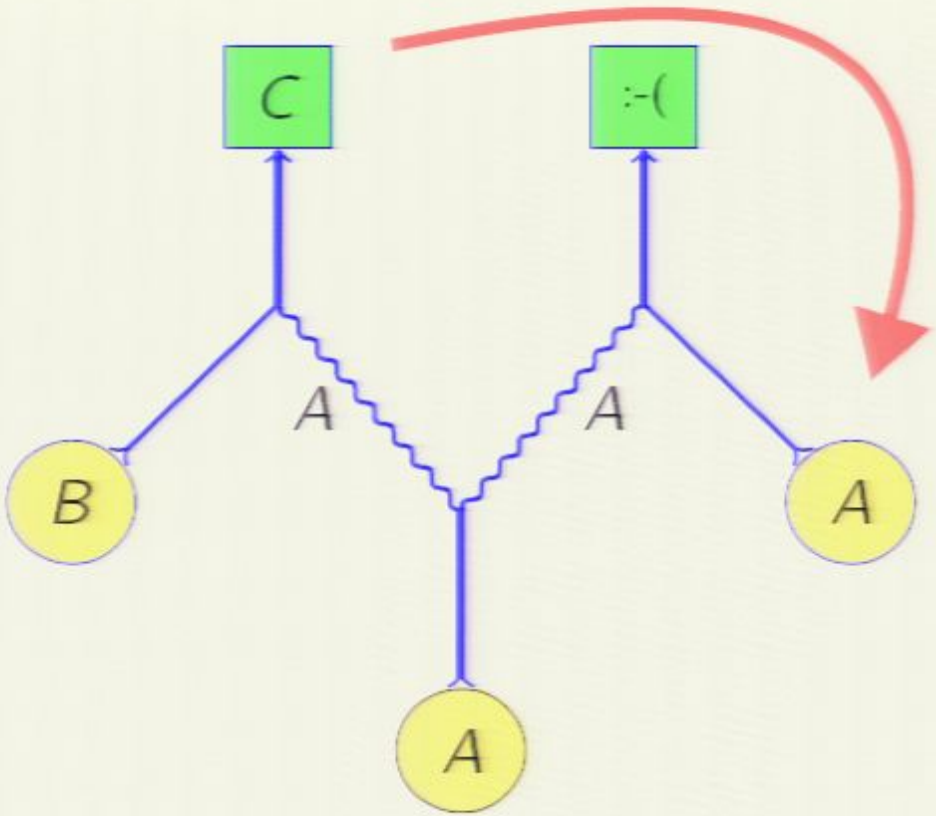
- Here's a case in which this kind of constraint does exclude a hidden state – $\langle AA \rangle$ – which would otherwise be permitted.
- So the Helsinki model is rich enough to show how this kind of causal loop can impose new constraints, without leading to inconsistency.



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The End


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