The Shape of Absolute Coincidences. Salmon's Interactive Fork Model as Shape of Coincidental Processes.

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Abstract. According to a particular view, chance events are not uncaused but they are simply the result of intersecting causal lines. More precisely, the intersections between different processes that belong to independent causal chains are the origin of accidental events, called *absolute coincidences*.
This paper provides a new account devoted to showing the strong relation between absolute coincidences and Salmon's interactive fork criterion, in an attempt to endorse the idea that coincidences can be shaped in terms of a causal model.

Keywords. Absolute coincidences, causal, interactive forks, shape

Introduction

As for the word "chance", the word "coincidence" is used to indicate many different things. The present study, however, considers only a particular type of coincidences, namely what is known as *absolute coincidences*.

According to Jacques Monod, absolute coincidences are the result of intersections between different processes that belong to totally independent *causal* chains[1]:

> Mais dans d'autres situations, la notion de hasard prend une signification essentielle et non plus simplement opérationnelle. C'est le cas, par exemple, de ce que l'on peut appeler les "coïncidences absolues", c'est-à-dire celles qui résultent de l'intersection de deux chaînes causales totalement indépendantes l'une de l'autre.[2]

I will call that type of coincidences "*causal* absolute coincidences".

The first part of the present work provides a precise definition of *causal* absolute coincidences. The second one presents the strong relation between *causal* absolute coincidences and Salmon's common cause model. As we will see, *causal* absolute coincidences are events that can be divided into intersecting causal components, and

[1] In *Metaphysics*, Aristotle already maintains the fact the existence of *per accidence* causes is a sign of the existence of *per se* causes. In commenting on Aristotle's *Metaphysics*, Saint Thomas also says that if we treat accidental beings as things produced by *per se* causes, many things may be by accident, such us the meeting of independent causal lines. Although very important for the philosophical historiography, I leave out from this discussion the Aristotelian-Thomistic notion of chance. For an extended enquiry see [1].
[2] [2], p. 128.

that intersection gives origin to consequences. Equally, Salmon's interactive forks are characterized by two, or more, intersecting processes and two, or more, ensuing processes. It seems that *causal* absolute coincidences can be represented by an *x*-shape, as with Salmon's interactive forks.

The core idea of this paper is that representing and reasoning with the shape of coincidental phenomena is essential to understand those phenomena.

The fact that the DNA molecule has the shape of a double helix is crucial to understand how it functions. The same is true of coincidences: the fact that coincidences have a particular shape is crucial to understand how they work.

1. *Causal* Absolute Coincidences: a Definition

As we have already seen, *causal* absolute coincidences are not uncaused, but they are simply the effect of the intersection of independent causal processes.

We can explain the independence between different processes, *A* and *B*, that belong to independent causal chains in the following terms:

1) *A* and *B* are independent if they are statistically independent, so that:

$$P(A/\neg B) = P(A/B) = P(A) \tag{1}$$

and

$$P(B/\neg A) = P(B/A) = P(B) \tag{2}$$

2) The statistical independence between *A* and *B* is not due to a common cause in their past[3].

To clarify this point let us consider Monod's example as it is represented in Figure 1. Doctor Dupont is going to visit a patient for the first time. In the meanwhile, Mr Dubois is fixing a roof in the same area. When doctor Dupont comes across Dubois' work site, Dubois' hammer falls inadvertently down and the trajectory of the hammer intersects the trajectory of doctor Dupont, who dies[4].

In Figure 1:

$$P(A/\neg B) = P(A/B) = P(A) \tag{1}$$

and

$$P(B/\neg A) = P(B/A) = P(B) \tag{2}$$

[3] I want to avoid the case in which an event *X* is a screening-off common cause of the two processes *A* and *B*. In that case, according to Reichenbach's screening-off condition, given *X*, *A* and *B* are independent of each other. For a more extended discussion on Reichenbach's screening-off condition see [3].
[4] [2], p. 128.

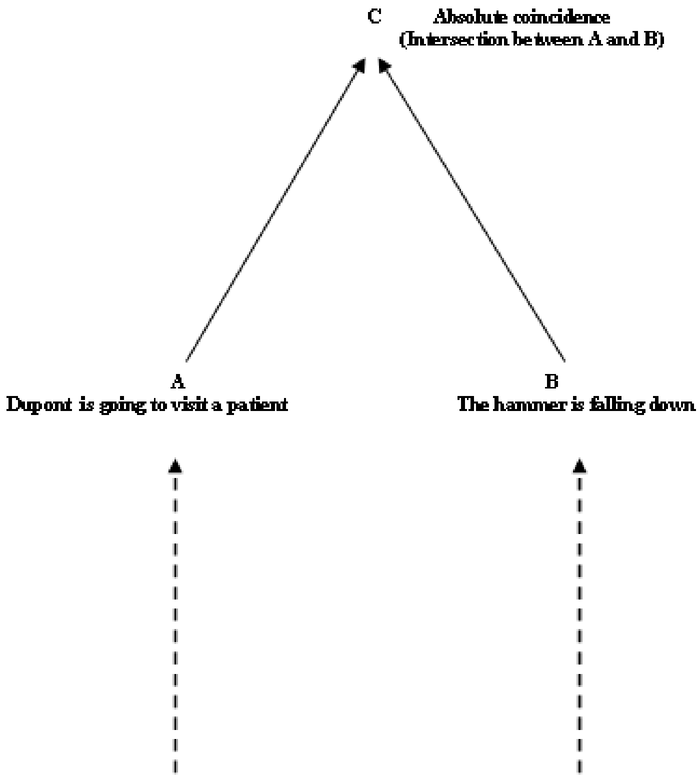

Figure 1. Monod's example of absolute coincidences

That is, the fact that doctor Dupont goes to visit his patient is statistically independent of the fact that the hammer falls down, and the fact that the hammer falls down is statistically independent of the fact that doctor Dupont goes to visit his patient.

The two dotted lines in Figure 1 represent the two independent causal histories of *A* and *B*.

To sum up, *causal* absolute coincidences are events that can be divided into components independently produced by some causal factor and those components join together.

Let us consider another example. Suppose I am watching a TV programme on Boris Pasternak. In the meanwhile my best friend, without knowing what I am doing and without knowing anything about that TV programme, is reading doctor Zhivago.

We would say that it is a coincidence that at the same time (but in different places) my friend and I are doing something that concerns Boris Pasternak.

However, since there is no physical direct *interaction* between the two coincidental processes, someone may conclude from this example that something is a coincidence only in the eye of the beholder.

Hence, we need a more precise definition of what a *causal* absolute coincidence is:

We speak of a causal absolute coincidence *whenever there is an intersection, which is also a physical interaction, of two or more statistically independent causal processes in exactly the same space and at exactly the same time*.

A good example could be Monod's one: in that case the two independent causal processes intersect, and physically interact, in exactly the same space and at exactly the same time. No one may conclude that the intersection is a coincidence only in the eye of the beholder[5].

Moreover, in such cases the intersection gives origin to some consequence, as it is illustrated in Figure 2.

2. The Connection Between Salmon's Interactive Fork Criterion and *Causal* Absolute Coincidences

Causal absolute coincidences are events that can be divided into components which intersect (and also interact) in certain spaces and at certain times and, as we have already seen, that intersection gives origin to consequences.

This section is devoted to showing the strong relation between *causal* absolute coincidences and Salmon's common cause model. More precisely, after an overview of Salmon's model, I will show that coincidences can be entirely described in terms of interactive forks[6].

2.1 Salmon's Interactive Fork Model

As Salmon says:

> [...] Consider a simple example. Two pools balls, the cue ball and the 8-ball, lie upon a pool table. A relative novice attempts a shot that is intended to put the 8-ball into one of the far corner pockets, but given the positions of the balls, if the 8-ball falls into one corner pocket, the cue ball is almost certain to go into the other far corner pocket, resulting in a ``scratch''. Let A stand for the 8-ball dropping into the one corner pocket, let B stand for the cue ball dropping into the other corner pocket, and let C stand for the collision between the cue ball and the 8-ball that occurs when the player executes the shot. We may reasonably assume that the probability of the 8-ball going into the pocket is also about 1/2 if the player tries the shot, and the probability of the cue ball going into the pocket is also about 1/2. It is immediately evident that A, B, and C do not constitute a conjunctive fork, for C does not screen off A and B from one another. Given that the shot is attempted, the probability that the cue ball will fall into the pocket (approximately 1/2) is not equal to the probability that the cue ball will go into the pocket, given that the shot has been attempted and that the 8-ball has dropped into the other far corner pocket (approximately 1).[7]

[5] One may say that coincidences are also unexpected events, so that one could ask whether a non-unexpected intersection, between processes that belong to independent causal chains, is still a coincidence. I find this point very interesting, but I will leave it out of this discussion.

[6] Although a very similar work can be done using Bayesian networks, I will leave that discussion for another paper.

[7] [4], pp. 168-169.

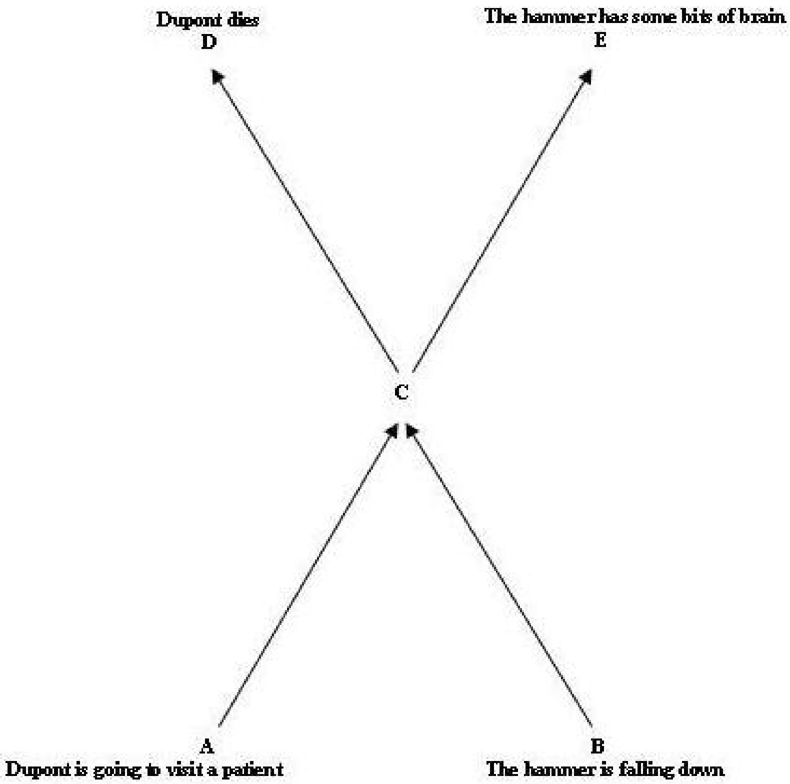

Figure 2. Consequences of coincidences

Salmon's interactive forks are considered as spatio-temporal intersections between two processes. The space-time diagram of the interactive forks has the shape of an *x*, as illustrated in Figure 3.

In Figure 3, P_1 and P_2 are two processes which intersect in C. E_1 and E_2 are the two emerging processes from the intersection.

The intersection produces an interaction and the interaction, according to Reichenbach's mark criterion[8], has the capacity to produce changes in the properties of the two separate processes that come from the intersection.

In order to characterize Salmon's forks we need the following condition:

$$P(E_1 \wedge E_2/C) > P(E_1/C) \times P(E_2/C) \quad (3)$$

The intersection in C makes the two effects statistically dependent on each other. The interactive forks are considered as spatio-temporal intersections that in general violate Reichenbach's screening-off condition[9].

[8] For a more extended discussion on Reichenbach's mark criterion see [3].
[9] For a more extended discussion on Reichenbach's screening-off condition see [3].

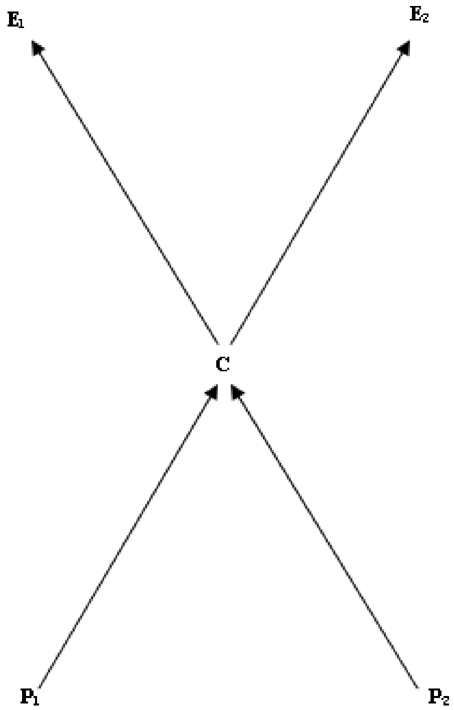

Figure 3. Salmon's interactive fork

However, the screening-off condition may represent a limit case for interactive forks. There seems to be a kind of screening-off that is valid for some macroscopic interactive forks[10] and it can be represented by the following condition:

$$P(E_1 \wedge E_2/C) = P(E_1/C) \times P(E_2/C) = 1 \qquad (4)$$

which violates the relation (3). Salmon calls this sort of forks "perfect forks".
According to Salmon, we can say:

> The main point to be made concerning perfect forks is that when the probabilities take on the limiting values, it is impossible to tell from the statistical relationships alone whether the fork should be considered interactive or conjunctive. [11]

Which is, then, the most important difference between conjunctive[12] and interactive forks?

The answer is: the shape of the fork, as we can read from the following quotation:

[10] [4], pp. 177-178.
[11] [4], p. 178.
[12] For a detailed discussion on conjunctive forks see [3].

> […] For it seems essential to have two processes going in and two processes coming out in order to explain the idea of mutual modification. [13]

In recognizing interactive forks, the shape of the phenomena is more relevant then statistical relationships.

Moreover, according to the conjunctive fork model, the common cause can produce one of its effects without producing the other one, and vice versa. According to the interactive fork model, the common cause (the intersection) *cannot* produce one of its effects without producing the other one, and vice versa.

Furthermore, as a result of the physical interaction, in the case of interactive forks, the two emerging processes have something (a mark) of each other and this is not true for the case of conjunctive forks.

2.2 The Coincidences *x*-Shape *and Interactive Forks*

Interactive forks are characterized by two, or more, intersecting (and interacting) processes and two, or more, ensuing processes. Equally, absolute coincidences are events that can be divided into components which intersect (and interact) in certain spaces and at certain times and that intersection gives origin to consequences. It seems that *causal* absolute coincidences can be represented by an *x*-shape, like interactive forks. I will call this *x*-shape *coincidences* x-*shape*, and I will try to investigate its relation with *x*-shapes which characterize interactive forks.

2.2.1 The First Part of the Coincidences *x*-Shape *and Interactive Forks*

In Salmon we find some instances in which the two intersecting processes, P_1 and P_2, are statistically independent of each other, as in our definition of *causal* absolute coincidences. We can quote the following example:

> In every day life, when we talk about cause-effect relations, we think typically (though not necessarily invariably) of situations in which one event (which we call the cause) is linked to another event (which we call the effect) by means of a causal process. Each of the two events in this relation is an interaction between two (or more) intersecting processes. We say for example, that the window was broken by boys playing baseball. In this situation there is a collision of a bat with the ball (an interactive fork), the motion of the ball through space (a causal process), and a collision of the ball with the window (an interactive fork).[14]

According to this example, the ball travelling towards the window and the window are two intersecting processes; the collision between them represents the intersection. In this case, the two intersecting processes belong to independent causal chains, since the fact that the window is there is statistically independent of the fact that the ball travels towards the window, and vice versa.

Salmon does not care about the distinction between intersecting processes that belong to independent causal chains and intersecting processes that belong to non-independent causal chains. This is not a relevant point for a good definition of interactive forks.

Interactive forks are not a sufficient requirement to say that an interaction happens by coincidence, since a fork can always be found in which the interacting processes do

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[13] [4], p. 182.
[14] [4], p. 178.

not belong to independent causal chains[15]. However, cases of intersecting processes that belong to independent causal chains are not ruled out by Salmon's account, and Salmon's model can be used to describe such cases.

The first part of the *coincidences* x-*shape* can be described with Salmon's model.

2.2.2 The Second Part of the Coincidences *x*-Shape *and Interactive Forks*

Let us consider again Monod's example, as it is represented in Figure 2. In that case we may reasonably assume that the probability of doctor Dupont dying *D* is of 1/2 if there is a collision between the hammer and doctor Dupont's head *C*, and that the probability of the hammer having some bits of brain *E* is also of about 1/2. In this case, it is evident that *D* and *E*, given *C*, are statistically dependent on each other:

$$P(D \wedge E/C) > P(D/C) \times P(E/C) \qquad (5)$$

Given that the hammer collides with doctor Dupont's head, the probability that the hammer will have some bits of brain (approximately 1/2) is not equal to the probability that the hammer will have bits of brain, given that the hammer has collided with doctor Dupont's head and doctor Dupont has died [$P(E/C \wedge D) \approx 1$]. That is:

$$P(E/C \wedge D) > P(E/C) \qquad (6)$$

Moreover, given the collision between the hammer and doctor Dupont's head, the probability that doctor Dupont will die (approximately 1/2) is not equal to the probability that the doctor will die, given that the hammer has collided with doctor Dupont's head and the hammer has some bits of brain [$P(D/C \wedge E) \approx 1$]. That is:

$$P(D/C \wedge E) > P(D/C) \qquad (7)$$

The intersection in *C* makes the two effects, *D* and *E*, statistically dependent, like in Salmon's example of the two billiard balls.

However, as we have already seen, the condition of screening-off represents a limit case for interactive forks. There seems to be a kind of screening-off which is valid for some macroscopic interactive forks. That limit case is represented by the following condition:

$$P(E_1 \wedge E_2/C) = P(E_1/C) \times P(E_2/C) = 1 \qquad (4)$$

Consider the two billiard balls example once more. Suppose that our novice returns to attempt another shot from time to time. Since practice helps improve one's skills to perfection, the novice becomes so good that he can invariably make the cue ball and the 8-ball collide (*C*) in the manner that the 8-ball drops into one of the far corner pockets (E_1) and the cue ball goes into the other far corner pocket (E_2). We may reasonably assume that the probability of the 8-ball going into the pocket is about 1 if the player tries the shot, and the probability of the cue ball going into the pocket is also

[15] The aim of this paper is to show that interactive forks are a *necessary* condition for coincidental phenomena.

about 1. It is immediately evident that *C does* screen E_1 and E_2 off from one another. Up until the moment when our player has perfected his technique, the results of his shots exemplified interactive forks, and it would be absurd to claim that when he achieves perfection, the collision of the two balls no longer constitutes a causal interaction, but it must now be considered as a conjunctive fork. It is an arithmetical accident that, when perfection occurs, the equation (4) is fulfilled while the inequality (3) must be violated.

Let us go back to Monod's example once again. We may reasonably assume that the probability of doctor Dupont dying (*D*) is of about 1, if there is a collision between the hammer and doctor Dupont's head (*C*), and that the probability of the hammer having some bits of brain (*E*) is also of about 1. In this case, it is evident that *C* screens *D* and *E* off from one another:

$$P(D \wedge E/C) = P(D/C) \times P(E/C) = 1 \tag{8}$$

However, it would be absurd to claim that the collision between the hammer and doctor Dupont's head no longer constitutes a causal interaction, but must now be considered as a conjunctive fork. According to this last example, the common cause (*C*) cannot produce one of its effect without producing also the other one, and vice versa. Moreover, the two emerging processes (*D* and *E*) have something of each other. It is an arithmetical accident that, when perfection occurs, the equation (4) is fulfilled while the inequality (3) is violated.

According to what I said in this section, even the last part of the *coincidences* x-*shape* can be described using Salmon's interactive fork model.

3. Conclusion

To conclude, the primary reasons for saying that interactive forks can describe *causal* absolute coincidences are:

1. Interactive forks are characterized by two, or more, intersecting (and interacting) processes and two, or more, ensuing processes. Equally, absolute coincidences are events that can be divided into components which intersect (and interact) in a given space and at a given time, and that intersection gives origin to consequences. *Causal* absolute coincidences can be represented by an *x*-shape, as with interactive forks.

2. Cases of intersecting processes that belong to independent causal chains are not ruled out by Salmon's account and Salmon's model can be used to describe such cases. The first part of the *coincidences* x-*shape* can be described by Salmon's criterion.

3. Salmon's interactive fork model can be easily used to describe the last part of the coincidences *x*-shape.

Finally, we can conclude not only there is a connection between *causal* absolute coincidences and the Principle of Causality, according to which whatever begins to exist has a cause, but also the possibility to describe them in terms of some causal model.

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