

Causation in AI&Law

Jos Lehmann
Joost Breuker
Bob Brouwer

University of Amsterdam
Faculty of Law
{jos, breuker}@lri.jur.uva.nl
brouwer@jur.uva.nl

Abstract

Reasoning about causation in fact is an essential element of attributing legal responsibility. Therefore, the automation of the attribution of legal responsibility requires a modelling effort aimed at the following: a thorough understanding of the relation between the legal concepts of responsibility and of causation in fact; a thorough understanding of the relation between causation in fact and the common sense concept of causation; and, finally, the specification of an ontology of the concepts that are minimally required for (automatic) common sense reasoning about causation.

This article offers a worked out example of the indicated analysis. Such example consists of: a definition of the legal concept of responsibility (in terms of liability and accountability); a definition of the legal concept of causation in fact (in terms of the initiation of physical processes by an agent and of the provision of reasons and/or opportunities to other agents); a definition of an AI-like ontology of the common sense (causal) concepts that are minimally needed for reasoning about the legal concept of causation in fact (in particular, the concepts of category, dimension, object, process and event).

1 Introduction

This article presents the most relevant results of an AI&Law-like research project [Lehmann, 2003], which was conceived and envisioned, as part of the Functional Ontology of Law (FOLaw, in the following) [Valente, 1995], between 1991 and 1997 at the (then) Department of Computer Science and Law of the University of Amsterdam. Between 1998 and 2003 the project was (partly) realized and finished at the (recently renamed) Department of Computational Jurisprudence of the same university. The central topic of the reported investigation is the *representation of causation for automatic legal reasoning*. In the attempt at expanding FOLaw's modules for Causal and Responsibility knowledge, the main purpose of this study is the definition of an analytical

model of the concepts (and the conceptual relations) used in legal reasoning when assessing causation in a case. Such a model could then be used as a basis for automatic legal reasoning.

The paper is structured as follows. In the rest of this introduction we provide a first intuitive treatment of causal issues in legal settings: we provide arguments in favor of considering causation in fact as a relevant problem both for Legal Theory and for Artificial Intelligence and Law. Section 2 concentrates on the legal (theoretical) concept of responsibility and on the notion of ground for the attribution of legal responsibility. One of such grounds is causation in fact. Section 3 concentrates on the legal theoretical notion of causation in fact. Three main legal theoretical approaches to causation in fact are presented: causal maximalism, causal minimalism and Hart and Honoré's approach. This last approach is chosen as our legal theoretical point of reference on matters of causation in fact. Section 4 presents a preliminary analysis of the ontological elements that are implicit in Hart and Honoré's proposal. Their definition refers to four ontologically distinct causal relations: physical, agent, interpersonal and negative causation. Section 5 concentrates on the case of physical causation and provides an overview of the main problems that should be considered when defining the relation of physical causation. Section 6 presents part of the ontology developed for representing physical and agent causation. We concentrate on the concepts that are minimally needed in order to represent physical causation. Finally, Section 7 draws some conclusions.

1.1 Legal knowledge about causation: preliminary remarks

Trying to come to grips with the representation of legal knowledge about causation and responsibility poses two main types of problems: problems of recognition and scientific problems.

1.1.1 Causation in fact as a problem for (automatic) legal reasoning

In the first place, one has to fight one's way through widespread skepticism. A significant part of the AI and Law community has strong doubts on whether causation is a problem at all for legal reasoning. These doubts may be traced back to the classical distinction between causation in fact, on the one hand, and legal causation, on the other hand. Causation in fact is the problem of understanding what actually happened (i.e. what caused what) in a case. Such factual interpretation is something legal experts usually take for granted and mostly see as unproblematically achieved by common sense. On the contrary, they see legal causation as problematic and, therefore, interesting. Legal causation is the set of criteria that should be applied either when a clear common sense factual interpretation of the case is missing or when, despite having a clear causal interpretation of the case, legal policy considerations should be applied (e.g. foreseeability) and this results in adopting a causal interpretation that is different from the factual causal one. Typical examples of cases where a legal causal interpretation must be used, because a factual interpretation is *missing*, are so called cases of overdetermination. For instance, two shooters hit the same one person at the same time and each shot is such that it may have caused her death. Who caused her

death? From a *causal factual* point of view, further investigation is needed in order to establish which of the shooters actually caused the person's death. And even such an investigation may have no more means than common sense has for reconstructing the actual chain of events. Therefore, from a *legal causal* perspective it is solomonicly¹ assumed that *both* shooters caused the death of the person. On the other hand, typical examples of cases where a legal causal interpretation substitutes a *clear* factual interpretation are cases where foreseeability or risk play a role. For instance, a truck-driver transporting toxic substances has an accident and the toxic substances are spilled on the road. Subsequently, the toxic substances drain through the soil into a groundwater reservoir, thereby polluting the water and creating great damage to a nearby village's water supply. Despite the clear factual connection between the truck-driver's conduct and the polluting of the water, from a legal causal perspective one may argue that the truck-driver did not cause the polluting, because he had no means of foreseeing that there was a groundwater reservoir right at the place where the accident took place.

In other words, in the legal analysis of such difficult cases as those illustrated above, questions of factual causation are simply left unanswered or their answers are set aside. This has resulted in a skepticism of a more general nature concerning the very necessity of treating causation in fact as a legal theoretical problem. "Don't worry - say the skeptics - be happy! Because causation in fact is only a minor detail. Legal reasoning has all it needs in order to determine (and attribute) legal responsibility *without* going into the details of what caused what."

An intuitive refutation of this position, may be summarized in the phrase *dubitant ergo est* - they doubt, therefore it exists. Such phrase is the conclusion of the following counterargument. The problem of consistently and completely defining the relation of causation between two events or states of affairs is one of the hardest among the scientific and philosophical questions of all times. Every theory of the world (e.g., Physics, Chemistry or Philosophy) and any organized corpus of knowledge about the world (e.g., the Law, Medicine or History) suffers from internal paradoxes which are provably due to some lack of understanding of causal relations². The causal plague is so diffused and general that each scientific field has developed its own particular rules of the thumb for dealing with causal issues. As a matter of fact, specific causal rules have so far proven to be much more reliable than general inferential schemes. The latter should in principle guarantee more uniformity in distinguishing causal from non causal relations; but the former actually provide a tighter correspondence between general causal intuitions and each fields peculiar way of describing basic facts, of assessing their truth and of handling exceptions. This sort of "causal scientific secessionism" has generated a lot of technical views on causation which are hardly comparable to each other. Nonetheless, as the word cause and its synonyms keep being used for communication within and across different fields, secessionism has also produced a general desire for unity in the form of "federalism". Every sufficiently theoretical study of causation almost invariably makes two statements:

1. The word "cause" refers to a cluster of variegated and sometimes even conflicting

¹With justice, like Solomon would have done.

²In this article, for a philosophical causal paradox see Example 1: counterfactuals generate pretty absurd interpretations; for a legal case, which is particularly tough even though not paradoxical, see Example 2.

concepts, rather than just one clear-cut notion.

2. The unity of such diverse conceptual family is guaranteed by common sense, i.e. by something that everybody has (i.e., common) but that nobody can rationally describe (i.e., sense).

The law makes no exception, neither for its sometimes provincial tendency to secessionism nor for its desire to fully take part to the causal federation. Going through the legal-theoretical debate on the problem of causation makes very clear how deep the dichotomy is between different groups of legal theoreticians. Some, the secessionists, sincerely think that legal practice and reasoning has hardly any problems with causation in fact. In their eyes, in most cases the law has to do with attributing legal responsibility; in other words, legal reasoning deals only with so called questions of policy. On the other hand, the federalists try to convince their fellow scholars of the following: if it is true that legal practice has felt the need to let juries or judges solve difficult questions of fact arising in legal cases, then it is also true that legal reasoning has problems with causation in fact as much as any other type of reasoning has. Therefore, the pragmatic solution (e.g., letting juries decide questions of fact) should not be considered as a miraculous way out of the problems of causal reasoning. Juries do not shield the court room from the causal federation. On the contrary, they work as the channel of communication between the legal apparatus and social common sense, in any given moment of time. The function of juries is twofold: they represent in the court room general social knowledge (at least in the form doubts, if not as certainties) about questions of fact and they provide a reasonable solution for the specific case they are called to judge. In short, juries at least doubt; therefore, the problem, that they are called to doubt about, exists. *Dubitant ergo est.*

These tight relations between the factual-causal interpretation of a case and the attribution of responsibility are well exemplified by the following story, from [Pearl, 2000].

Example 1 (The Desert Traveler) A desert traveler T has two enemies. Enemy 1 poisons T's canteen and Enemy 2, unaware of Enemy 1's action, shoots and empties the canteen. A week later, T is found dead and the two enemies confess to action and intention.

If a jury were asked to attribute the legal responsibility for T's death, it would probably have to consider the following additional information, which is left implicit in Example 1:

1. T never drank from the canteen.
2. T was found dehydrated.

Based on such information, the jury would very probably come to an unanimous decision and indicate Enemy 2 as the responsible person for T's death. If asked why, the jury may answer: because Enemy 2 caused T's death. If asked in what sense Enemy 2 caused what he caused, the jury would probably say that Enemy 2's action is a *counterfactual condition* of T's death, which makes it a cause. In other words, had Enemy 2 not shot the canteen, T would still be among us. But this is not true - it should be

replied. Had Enemy 2 not shot the poisoned canteen, T would have drunk from it and he would not be among us anyway. Therefore, Enemy 2's action is not a counterfactual condition of T's death. Is it still its cause? - the jury should be asked. Again its answer would probably be unanimous and indicate Enemy 2's action as the cause of T's death in the sense that he is the most *proximate cause* of T's death. If asked to give a definition of such proximity, the jurors would probably give a temporal definition of such proximity: Enemy 2's action is the latest cause of T's death. But, then again, it could be replied that from a strictly physical point of view the heat of the Sun was definitely a temporally more proximate cause than Enemy 2's action.

This "cat and mouse game" with the jury could go on for a long time. This is due to the fact that Example 1 is no real-life case. It is just a tricky and underspecified combination of circumstances devised by some smart philosopher on some lazy day, with the explicit purpose of fooling imaginary juries. The example, though, does show at least one thing: a "short circuit" in our causal understanding of a series of events has major consequences on our capacity to attribute (legal) responsibility.

More arguments in favor of recognizing causation in fact as a major question for AI and Law can be found in [Aqvist and Mullock, 1989] and in [Prakken and Renooij, 2001]. Both these studies show how automatic legal reasoning would greatly profit from a causal upgrade. We will make no further use of these two references because their approaches are somewhat orthogonal to our own. Both those (couples of) authors describe legal causation under an inferential perspective. They propose the adoption of complex game-theoretical or logical machinery for tackling the problem, whereas we take a chiefly ontological stance on the problem.

In conclusion, it seems convenient, if not essential, to develop AI and Law-like theories of causal relations. This would make automatic legal reasoning both more efficient (i.e. speeding up the software performance) and more effective (i.e. refining the software understanding of the world and enhancing its reasoning power about cases and/or legislations).

1.1.2 Scientific problems

Provided that the problems of legal reasoning about causation in fact are relevant problems, what kind of scientific problems *are* they? What kind of questions do they raise? Rather difficult questions, must be said. We provide here a first schematic overview of the main groups of such questions, as follows.

Group 1: Legal responsibility First of all, the question must be answered what is meant by legal responsibility. What is the role of this concept in legal reasoning? And what is its relation with other similar legal concepts such as liability and accountability?

Group 2: Legal responsibility and causation in fact Secondly, the relation between causation in fact and legal responsibility must be clarified. Is causation in fact part of the definition of legal responsibility? Or is it a separate concept which somehow interacts with the concept of responsibility?

Group 3: Causation in fact Thirdly, questions arise concerning the relations between

the legal and the common-sensical notion of causation in fact. Is the former a specialization, or an expansion or a “recombination” of the defining elements of the latter?

Group 4: Causation Fourthly, after answering the questions on the legal notion of causation in fact, the realm of Legal Theory must be abandoned for the open territory of Philosophy. A definition of common-sense causation is needed. And this in turn raises a lot of philosophical questions. Can we distinguish between different types of causation (e.g., physical vs agent causation)? How? Is causation a logical (and deterministic) relation? Or is it a probabilistic (and indeterministic one)? Or is it yet another type of relation? What does causation relate: what are its relata? Is causation (and its types) the *only* causal relation? Or are there ontologically different causal relations?

Group 5: Representation of causation Finally, representing causation in a machine-friendly way raises yet another group of questions. In particular the problem arises of how to represent causation in a parsimonious way, i.e. in a way that is computationally not too demanding.

In this article section 2 treats questions pertaining to Group 1 and 2; section 3 treats questions pertaining to Group 3; sections 4, 5, 6 treat questions pertaining to Group 4 and 5.

1.1.3 Causation in fact, evidence and the burden of proof

Before getting started with treating the questions above, a caveat is needed here. Our treatment makes abstraction of problems of evidence and of the burden of proof. As partly explained in [Hart and Honore, 1985] (p. 406-428), those two problems influence the role of legal causal reasoning only by regulating the acquisition of information by the court. This means that in principle, as well as in most real cases, evidence and the burden of proof affect legal causal reasoning solely from a procedural point of view. They do not inherently change the kind of information that is considered by a court when assessing causal relations in a case. At most, problems of evidence or burden of proof may affect the *amount* or the *order* of the information provided to a court for making a decision. Despite the fact that incomplete or poorly ordered information may lead a court to make unjust decisions, this does not affect the *type* of information that a court requires in order to make a decision, be it just or unjust.

In other words, throughout our treatment of causal issues in legal settings we will rely on a complex assumption by which it is assumed that whoever between the parties has the burden of proof:

1. *Sufficient evidence is provided that each considered fact or event actually took place.* We therefore assume, for instance, that in Example 1 there is sufficient evidence that it was Enemy 2 who pulled the trigger.
2. *Sufficient evidence is provided that no relevant facts have been omitted.* We assume, for instance, that Enemy 2 was not forced by someone to fire.

In conclusion, given 1 and 2 we may overlook problems concerning evidence and the burden of proof. We focus here only on the type of information required by a court. After this due clarification, we may now consider some of the main legal theoretical models of responsibility and causation.

2 Legal Theory on responsibility

The present section elaborates on the legal (theoretical) concept of responsibility and on the notion of ground for the attribution of legal responsibility.

2.1 The air rifle example

The theoretical literature about causal relations is riddled with an exceptional variety of disparate examples. In this section we too adopt a parametric example, which helps us in the illustration of various theories that are relevant to our purposes. We use here a case taken from the legal theoretical literature. Due to the many complications that characterize it, this example illustrates both the pervasiveness of causal relations in our concrete experience and the elusiveness of such relations when trying to conceptualize them.

Example 2 (The air rifle) In breach of a statute forbidding the sale to an infant under the age of 16 of dangerous weapons, the defendant sold an air rifle and ammunition to a boy of 13. The boy's mother told the boy to return the weapon to the defendant and get a refund: on the defendant's refusal to take the rifle back, the boy's mother took it from the boy and hid it. Six months later the boy found it and allowed a playmate to use it, who shot and accidentally wounded the plaintiff, destroying the sight of one eye. (Henningsen v. Markovitz (1928) 132 Misc. 547, 230 NYS 313)

The dramatic development of the events described in Example 2 raises a general question of responsibility. This is due to the fact that the final event described in the example is a harmful one. It is mostly - even though not exclusively - about undesirable events that people seriously ask themselves: "Who made this happen? Who is to blame?". Most people would agree that there is *at least* a question of *moral* responsibility connected to the described chain of events. The attribution of moral responsibility, though, may greatly vary from individual to individual. Someone might see the mother as morally responsible of the plaintiff's lost eye; someone else might have reasons for pointing his finger against the seller (the defendant); someone else might consider morally responsible the manufacturer of the air rifle or the engineers who designed it. There even might be someone who blames the victim himself, seeing in his blindness a sort of payoff decided by a metaphysical entity (e.g. God) based on mysterious (but necessary) criteria of (divine) justice.

Now, if the attribution of responsibility (for the plaintiff's lost eye) is not simply of a moral nature, but of legal one, then the great variation of judgement indicated above may turn into a *very* serious practical problem. A problem that requires detailed (and preventive) analyses concerning the *explicit* criteria that should be used by a judge

when blaming someone for the harm inflicted on someone else.

The reasons why moral judgement can tolerate more variety than legal judgement may be spelled out in the following five points:

1. Great variation of judgement on moral responsibility is a rather common phenomenon, because everybody *has* his personal opinion on moral matters.
2. In (modern) pluralistic societies the situation described in 1 is cherished and protected. It is not only acknowledged as a *fact* that everybody *has* his personal opinions on moral matters, but it is also defended as a right: everybody is free to have and to express his opinions on moral matters.
3. In order to limit the negative side-effects of the situation described in 2, modern societies have adopted ways for limiting the practical effects that moral judgement has on the person who is morally blamed. In particular, the moralist has no right whatsoever to exert any form of violence or coercion on the person who is blamed. This principle, which counterbalances the principle of moral pluralism, regulates interpersonal relationships. For instance, until the 80s the Italian legislation contained special provisions for a person who committed so called honor killing: the murder of the partner motivated by his/her adultery. When in 1981 the penal relevance of a person's honor was abrogated, this was seen as a significant step forward in Italian (legislative) culture. It was something of a revolution the idea that honor is no mitigating factor if a man kills his wife, even if he morally may have the right to blame her for her infidelity.
4. In pluralistic societies the right to (directly) effect the person who is blamed is left to other (non moral) types of judgement. It is a prerogative of those who attribute *legal* responsibility to focus on the behavior of a person and to punish and/or correct the person for such behavior.
5. Therefore, great variations in judgement become a serious problem for the type of judgement indicated in 4. Legal judgement has a generalized value, in the sense that the person that expresses such judgements usually does it from a position of authority, speaking in the name of a larger group of individuals and applying their laws. This requires that the attribution of legal responsibility is as *consistent* as possible over *as many cases* as possible. This requirement is not (so explicitly) present in the case of moral responsibility.

Now, it is precisely the longing for consistency indicated in 5 that raises the tough problems concerning the criteria of legal responsibility attribution, problems that are further illustrated in the next subsection. A closer and more systematic look is given at various aspects of Example 2 that are relevant to the attribution of legal responsibility. Legal Theory provides different and alternative types of criteria for legal responsibility attribution. Such a variety shows that moving from the widely varying views on moral responsibility attribution to a more structured and consistent legal view requires a very complex analytical process.

2.2 Legal responsibility

Most legal-theoretical debates about the notion of responsibility revolve around the problem of how much space common-sense has in the determination and the attribution of legal responsibility. A case presents two main types of elements, which may play a role in attributing responsibility.

1. On the one hand, there are *factual elements*, which contain information for establishing the chain of causation and which, therefore, make it possible to attribute the responsibility of the harm to the person(s) who caused it.
2. On the other hand, there are the *legal elements* of the case, which contain information for identifying the person(s) who may be held responsible for the harm, based on so called considerations of legal policy.

Now, as observed in [Hart and Honore, 1985] (p. xlviii), most legal theoretical treatments of legal responsibility are not neutral with respect to the roles that either causation or legal policy play in the attribution of responsibility. This situation makes the overall debate on responsibility very difficult, due to the lack of a common ground for comparing different approaches.

In order to overcome such lack of a neutral ground of confrontation, Hart and Honoré propose to see legal responsibility as described by three main elements. These form together a general framework for treating issues of responsibility, without requiring any strong commitment about the role of causation or of legal policy. The three elements indicated by Hart and Honoré are: a definition of the legal concept of responsibility, the legal grounds for the attribution of legal responsibility and, finally, the types of cases that arise from combining different grounds. In the following two subsections, we illustrate these three elements in more detail.

2.2.1 The legal concept of responsibility

Hart and Honoré [Hart and Honore, 1985] (p. xliii) reduce the notion of legal responsibility to the legal status of someone who is subject to a legal punishment or a sanction.

Definition 1 (Legal responsibility) *Legal responsibility is the liability of a person to be punished, forced to compensate, or otherwise subjected to a sanction by the law.*

The definition above does not give any indications regarding what a person must have done in order to be held legally responsible. Hart and Honoré limit the concept of legal responsibility to the purely legal aspects of this notion and they reduce legal responsibility to the legal status that a person acquires (i.e. the liability to certain disagreeable consequences). Analytically speaking, this definition might sound ill-founded because it is given in terms of (legal) consequences. One would rather expect a proper definition to spell out the legal, non legal, necessary and/or sufficient conditions that a person must fulfill in order to be considered responsible (e.g. if you commit a murder, then you are legally responsible for the death of the victim). Hart and Honoré's approach is not that odd, though, when seen in the context of legal-theoretical debates. This is true for three reasons.

1. First of all, by binding the notion of legal responsibility to the notion of *liability* Hart and Honoré mark a clear distinction between legal responsibility and any other form of responsibility, in particular moral responsibility. This is due to the very meaning of liability. The liability of a person may be seen as the person's relation with a (judicial) authority. Such authority has the power to make decisions that directly affect the person and her future.
2. Secondly, defining legal responsibility in terms of liability entails the presence of a second legal requirement: the *accountability* of the person. In order to be liable, a person must be accountable, which depends on whether the person satisfies the criteria of accountability fixed in the law. These criteria usually refer to the physical and psychological capacity of a natural person to have control on her actions and/or to stand trial. Typical examples of such criteria are age or mental sanity.
3. Thirdly and lastly, limiting the definition of the legal concept of responsibility to liability has another legal-theoretical merit. It shields the definition of legal responsibility from the (legal-theoretical) debates about the existence of necessary and/or sufficient conditions for legal responsibility. Hart and Honoré propose instead to see such so-called conditions as *grounds*, which are used in *attributing* legal responsibility rather than as defining conditions of legal responsibility itself.

In the next subsection we further illustrate the notion of ground. Before doing this, though, we spend here some more words on the notions of liability and accountability, which completes our treatment of Definition 1.

As explained above, the definition binds the legal concept of responsibility to the chiefly legal notion of liability and, consequently, to the notion of accountability. Now, both the legal literature and the legal practice do not provide unambiguous distinctions between the exact meaning of the terms responsibility, liability and accountability. These are often even used as synonyms, which is due to the fact that, intuitively speaking, the three terms indicate the same one concept, which could be metaphorically described as the “visibility” of a person to the legal system. In other words, the terms responsibility, liability and accountability may be taken as indicating four different degrees of the legal visibility of a person, as follows:

1. A person is *ultrahighly visible* to the legal system (i.e., *actually legally responsible*) when a judicial authority decides that she shall be punished (punishment is here meant in its broader sense).
2. A person is *highly visible* to the legal system (i.e., *potentially legally responsible*) when she is subject to the power of a judicial authority which may make a legal decision that might result in some form of punishment.
3. A person is *lowly visible* to the legal system (i.e. *liable*) when she is subject to the power of a judicial authority.

4. Finally, a person is *ultralowly visible* to the legal system (i.e. *accountable*) when she fulfills the necessary criteria, which are established by law and which any person must fulfill in order to be subject to punishment or sanctions.

Given the four visibility degrees introduced above we may say that, in intuitive terms, Hart and Honoré define the attribution of responsibility as the increase of visibility of a person for the legal system. It should further be noted that a consequence of points 2 and 3 above is that there is a difference in visibility between a person that is possibly subject to a legal decision of, say, contract resolution (for which a person is only liable) and a person that is possibly subject to a legal decision of, say, conviction (for which the person's liability turns into potential legal responsibility). The difference is the following. The resolution of a contract simply restores (or at least tries to restore) the situation holding between the parties before the conclusion of the contract. In other words, the parties are (possibly) subject to a legal decision that changes their future to the extent that such change is needed in order to restore their past. On the contrary, in the case of sanction or punishment, such as conviction, the parties are (possibly) subject to a legal decision that changes their future to a much more considerable extent, in the sense that the judgement should make it unlikely for them to cause harm (ever) again. In other words, the harsher the consequences of the judgement the more you want the person you are judging to be visible.

Given the analysis presented above, we may conclude that, in any given case, the person who is found legally responsible of the wrongdoing acquires the legal status of being liable to be punished, forced to compensate or otherwise be sanctioned. A legal prerequisite of such liability is accountability. In order to be liable to be punished, a person must satisfy the legally defined criteria of possession of certain physical and mental capacities.

Having clarified the legal nature of responsibility, we illustrate the grounds that are usually used by courts in attributing legal responsibility and the typology of cases generated by combining such grounds.

2.2.2 Grounds for responsibility attribution and types of cases

According to Hart and Honoré: "There are many grounds on which responsibility may be imposed, and others may be invented in the future." (p.xliv). In other words, the grounds for responsibility attribution do not have the status of logical or strictly rational conditions. They rather are widely accepted requirements, which generally grow out of tradition and that are progressively codified by legislators in the Law. The difference between a logical condition and a requirement may be understood in terms of the (Kantian) difference between analytic statements (logical conditions) and synthetic statements (requirement). As explained above, such requirements should therefore be left outside the definition of legal responsibility. They may instead be spelled out in a separate definition, like the following one.

Definition 2 (Grounds for legal responsibility attribution) *Grounds for the attribution of legal responsibility to a person for a given harm are:*

1. *The conduct of the person.*

2. *The causal connection between the conduct of the person and the given harm.*
3. *The fault legally implied by the conduct of the person.*

Definition 2 revolves around the notion of conduct. This is not further defined by Hart and Honoré, but it can be quite safely taken as indicating the intentional or unintentional behavior of a person throughout the events under analysis. Furthermore, the definition considers both factual and legal elements as grounds for the attribution of responsibility. This is in accordance with Hart and Honoré's intention of giving equal consideration to causation and legal policy in their framework definition of legal responsibility. In Example 2 an instance of conduct is the combination of the seller's sale of the rifle and his later refusal to accept it back; an instance of fault is the seller's breach of the mentioned statute; finally, an instance of a causal connection is the relation between the shooting and the blinding of the victim.

By combining the grounds mentioned above, a wide variety of actual cases may be described. There are five main types of cases:

Type 1: Conduct, Causation, Fault In this case type (which exactly corresponds to Example 2) the court allocates responsibility based on the causal chain that started from the seller's faulty conduct and led to the harm. In other words, the court has to decide whether the unlawful behavior is causally related to the harm.

Type 2: Conduct, Causation Suppose that in Example 2 the seller's conduct, despite resulting in a violation, is not faulty, because it is proven that the boy who bought the rifle showed a faked identity card and the shop keeper had no reasons to assume that this card was faked. The seller could still be responsible for the plaintiff's blinding based on strict liability *and* on the causal connection between his conduct and the harm. In other words, in this case the court may allocate responsibility to the seller, based on the causal connection between his conduct and the harm and on his strict liability as a seller of dangerous implements. Furthermore, the strict liability of the seller could be used as an argument against him even if his non faulty conduct did *not* result in a violation. The seller could be considered responsible for the harm caused to the plaintiff, simply based on his causal involvement in the case.

Type 3: Conduct, Fault Suppose that in Example 2, no harm takes place (i.e., there is no causation involved at all). In this case a court could only allocate responsibility to the seller for his faulty conduct, i.e. his breach of the statute. This, by the way, actually happened: before the case presented in Example 2, the seller was actually convicted by a criminal court for his breach of statute.

Type 4: Conduct Imagine a combination of types 2 and 3, where no harm takes place and the seller is not to blame because it is proven that the boy who bought the rifle did it by showing a faked identity card and the shop keeper had no reasons to assume that this card was faked. In this case a court could still allocate responsibility to the seller for his conduct, simply based on his strict liability as a seller of dangerous implements.

Type 5: No Conduct, No Causation, No Fault This last type of case cannot be exemplified by directly considering the seller, because he has a role in the case. Clear examples of persons that could be found legally responsible for the harm, despite having no role in the case (vicarious liability), are the parents of the boy who shot (the playmate), given that there was no omission/negligence on their part.

Now, according to Hart and Honoré's analysis two types of cases require the assessment of causal relations as a ground for attributing legal responsibility (the first and the second type above). Therefore, if cases were evenly distributed over their types, we would have to conclude that at least two cases out of five require a thorough and coherent analysis of causal relations when a court decides on the related questions of responsibility. We believe, though, that the amount of cases, for which causal reasoning is required, goes well beyond two fifths of the total cases. This is true for the following reasons:

1. *It is very improbable that the distribution of cases over their types is even.* Most cases discussed in court deal with *actual* undesirable events, which were brought about by someone's (possibly faulty) conduct.
2. Even when considering cases of the third and fourth types, where no actual harm has happened, *courts may have to make (quite extensive) use of hypothetical causal reasoning.* The (ontological) basis of such hypothetical causal reasoning are exactly the same as the basis of reasoning about actual causes.
3. For what concerns the fifth type of cases indicated by Hart and Honoré, it is quite evident that *the responsibility of a parent to pay for the damages caused by the children, can only be attributed once it is clearly established that the children actually caused the damages.* Which again imposes to the court to assess the *causal* grounds on which the decision is taken.

The situation described above imposes the formulation of clear criteria for handling problems of causation when dealing with questions of responsibility. Legal theory has indeed dedicated a lot of attention to define such criteria. Three main (families of) approaches may be individuated in this stream of legal theoretical research: causal maximalism, causal minimalism and Hart and Honoré's approach. The following section illustrates each of these approaches in some detail.

3 Legal Theory on causation in fact

This section concentrates on the legal theoretical notion of causation in fact. Three main legal theoretical approaches to causation in fact are presented: causal maximalism, causal minimalism and Hart and Honoré's approach. The last approach is then chosen as our legal theoretical point of reference on matters of causation in fact. We invite the reader to mentally try out the presented approaches on Example 2 every time this is not already done by us (for reasons of conciseness).

3.1 Causal maximalism

The most traditional view on problems of legal causation allows to trace legal responsibility through causal relations solely: the person who caused the harm is responsible for it. The causal maximalist recognizes only clause 2 of Definition 2 as valid ground of responsibility attribution. This approach does not allow the use of any other consideration, besides purely causal ones. Therefore, Hart and Honoré call this view causal maximalism, because it simply equates legal responsibility with causation. Causal maximalism is much stronger than the position we expressed at the end of section 2. There we stressed that the causal relation is the central (or paradigmatic) criterion for responsibility attribution. Causal maximalism goes well beyond this and sees the causal relation as the *only* admissible criterion of legal responsibility attribution. This, of course, leaves the causal maximalist with the open problem of establishing clear criteria for individuating causal relations in legal settings. In the following we provide a description of two examples of criteria proposed by causal maximalists as adequate means for the individuation of causal relations.

Causal proximity The most general criterion provided by causal maximalists is a combination of common sense and of the principle of so called causal *proximity* to the harm. In other words, the agent that by common sense may be considered as the most proximate cause of the harm is *the* cause of the harm and should, therefore, be held responsible for it.

Consider Example 2. There is small doubt that the shooting of the rifle by the playmate is the most proximate cause of the harm (the blinding of the plaintiff). But the playmate is a person of young age (i.e., not accountable), which means that either his parents are to be held responsible (vicarious liability) or that the next proximate cause must be individuated. A pure causal maximalist, of course, would choose the second option. The next proximate cause is the boy who found the rifle and gave it to his playmate. Again a person of young age. Therefore, the next proximate cause must be found. To do this, though, we have to make a jump of six months backward in time, when the seller sold the rifle to the boy and the mother confiscated and hid it. Now, time wise the most proximate cause to the harm is the mother, who (ineffectively) hid the rifle from her child. It is rather counterintuitive, though, to admit that hiding something from someone causes that something to be found and used. Such causal assessment becomes even more counterintuitive, when the mother's conduct is contrasted with the seller's, who actually gave the rifle to the boy in the first place. So it seems that, materially speaking, once the two children are ruled out, the most proximate cause of the harm is the seller, rather than the mother, even though her conduct temporally followed his.

Such rather arbitrary conclusion shows, though, that the criterion of causal proximity very easily breaks down, because the more one goes back in time (which often is required in case analysis) the more conditions may be considered as candidate proximate causes.

Beale's criteria There have been a few attempts at further specifying the notion of

causal proximity. A further specification would save the overall maximalist approach, by standardizing the use of the notion of proximate cause. A first example of systematic attempts at standardization are Beale's rules. These rules reformulate the notion of proximity in terms of mechanical forces, by providing a sort of Newtonian universal view on legal causation. For instance, one formula that summarizes Beale's view on causal proximity states that: "Where defendant's active force has come to a rest in a position of apparent safety, the court will follow it no longer; if some new force later combines with this condition to create harm, the result is remote from defendant's act." [Beale, 1920]. This may also be seen as a reformulation of the classical theory of the so called *novus actus interveniens*, a new intervention, which breaks the chain of causation and, therefore, the line of responsibility. By applying Beale's principle to Example 2, the judge decided that: "Defendant's wrongdoing continued to be potentially active, so long and whenever the infant purchaser obtained access to the dangerous implement, constituting in itself a force which defendant had set in motion." Now, this judgement might be right and just. But its phrasing is far from being that intuitive mixture of common sense and causal proximity that causal maximalists proposed in the first place. Beale's mechanistic approach seems to complicate things, rather than simplifying them. The notion of force is not rich enough, especially when used for describing the causal influence of human actions. In particular, the psychological aspects of human actions cannot be properly captured by a purely deterministic description in terms of forces.

Epstein's criteria In the late 70s a further attempt was made at rescuing causal maximalism from (intellectual) bankruptcy. In [Epstein, 1979] Epstein, just as any other good causal maximalist, takes the legal notion of cause to be that embedded in ordinary language. He admits, though, that some more structure is needed for consistent use of this notion. Epstein proposes such a structure, in particular for application to tort law. The author is inspired, on the one hand, by Beale's notion of force and, on the other hand, by Hart and Honoré's analysis, which was firstly presented in the 1959 edition of [Hart and Honore, 1985]. By merging these two results Epstein proposes that: "The plaintiff must show that the manner of causing harm falls within one of four 'paradigms'. These are: the use of force; fright; the exercise of compulsion; and the creation of a dangerous situation." [Hart and Honore, 1985] (p.lxxiv).

Despite the added notions related to agenthood (fright, compulsion, etc.), Epstein's criteria, just as Beale's, are too restrictive. As a matter of fact, it can hardly be said that ordinary language confines 'causing' to causing by one of those four modes. Furthermore, there is a problem of ranking between the four paradigms, in case of multiple actions. And last, but not least, all the ambiguities of a case might still be there, when it comes to apply the same one paradigm to the conducts of two persons.

Finally, there is an ultimate criticism to causal maximalism and its extensions. A criticism that, in a way, rules out the very possibility of making the notion of proximity more explicit and structured. As Hart and Honoré put it: "Rules for determining proximate cause very often contain explicit or implicit reference to principles of legal pol-

icy.” [Hart and Honore, 1985] (p.97). It must be said that the two English scholars do not fully agree with such harsh criticism. They nonetheless present it because it bears some truth, which justifies the rising of a second legal theoretical movement, known as causal minimalism, that opposed causal maximalism and finally took its place in the hearts and minds of many legal theoreticians and practitioners.

3.2 Causal minimalism

In the 30s a new wave of legal theoreticians, lead by Leon Green [Green, 1930], opposed the very possibility of distinguishing between questions of fact and questions of policy. They claimed that almost every issue in a legal case may be reduced to a question of legal policy. The causal minimalist recognizes only clause 3 of Definition 2 as a valid ground for responsibility attribution. These should therefore receive most of the attention, because once the questions of policy of the case are solved, the remaining questions of fact may be tackled by (standard forms of) counterfactual reasoning.

This approach has - so to speak - a nice refreshing flavor if compared to causal maximalism. It cuts loose from all the complications connected to the maximalist’s search for what is causally proximate to (or remote from) the harm. Apparently, the combination of a thorough legal analysis and a counterfactual test is much more practical than (pure) causal analysis. This is due to two intertwined reasons. On the one hand, such combination allows to clarify *by purely legal means* the relative positions of the persons involved in the case. This very fact, on the other hand, allows to *separately* assess the causal influence of each person’s conduct by applying *purely logical means* of analysis (i.e. counterfactuals).

In the following we give an overview of the most salient among the tests proposed by the minimalists.

***Sine qua non* test** The first and most traditional counterfactual test formulated for application to legal analysis is the *sine qua non* test. The most distinctive point of this test is that it checks for necessary conditions. In other words, according to this logical test all conditions that are recognized as necessary for the harm should be considered as causes of the harm. On its turn, the notion of necessity that supports this view is usually reduced to Mill’s philosophical conception of cause. According to Mill the cause of an event (or, rather, of an event of a certain type) is the sum total of all the conditions which are together sufficient to produce it, in the sense of being invariably and unconditionally followed by it [Mill, 1886]. Each of these jointly sufficient conditions is necessary to the effect. Now, this notion of causation has been subject to fierce criticism from countless legal theoretical sides. The main argument against it is that the logical criterion of necessity is unpractical (or even worse: philosophical!) for the purpose of assessing causal relations, because it does not provide any clear way of distinguishing the actual cause of an event from its necessary conditions. The typical example of the fundamental ambiguity characterizing the *sine qua non* test is the example of a fire produced by striking a match. Both the striking of a match and the presence of oxygen are necessary conditions of the fire. Why, then, does the striking of the match usually counts as the actual cause of the fire? This question

may be answered in terms of normal circumstances (the presence of oxygen) as opposed to abnormal, incidental ones (the striking of the match). Or - again - the question might be answered by reference to the notion of the causal context of an event (which is characterized by the presence of oxygen) as opposed to its cause (the striking of the match). Whatever the chosen answer might be, the very need to provide such an answer shows that the *sine qua non* test fails somewhere, and usually where it is most needed.

But-for test The so called but-for test helps focusing the inquirer on the sufficient rather than on the necessary elements of the causal relation. The question that must be asked is, again, a counterfactual one, ranging on the conducts of the persons involved in the case. This test, though, is phrased in a slightly different way than *sine qua non* counterfactuals: “Would the harm have taken place *but for* the conduct of this person?”. A negative answer is equivalent to the assessment of a causal relation.

Now, the but-for test is entailed by the *sine qua non* test and, therefore, logically indistinguishable from it. Cognitively speaking, though, there is some difference. The but-for test tries to put the emphasis on the *singularity* of the sufficient (causal) condition of an event as opposed to the *multiplicity* of its necessary (causal) conditions. It conveys the urgency for the inquirer to make a definite choice (“Would the fire have started *but for* the striking of the match?”). This makes such test more appealing for the modern legal expert who is eager to use clear, general, logical tools, rather than vague, specific, material analysis.

Probability tests There is a group of tests which detects causation by testing the increased probability of the harm given the conduct of a certain person. These probabilistic approaches retain a counterfactual flavor, even though this is not always patent. In a purely probabilistic approach, an event causes another event if the occurrence of the first event is followed with high probability by the occurrence of the second event. This is very similar to the counterfactual statement that, if the first event had not occurred, the second would not have either. This similarity with counterfactual approaches makes probabilistic ones an interesting option for the causal minimalist, because they apparently possess all the legally needed properties of consistency, simplicity and fairness sought by legal experts. The first proposal in favor of using the notion of objective probability in legal contexts dates back to the end of the XIX century and is due to Von Kries [Kries, 1888]. He formulated the notion of adequate cause (Definition 3) as a probabilistic refinement and a repair of the *sine qua non* test, which at the time was already seen as too shallow.

Definition 3 (Adequate cause) *An event is the adequate cause of a harm, if and only if:*

1. *It is the sine qua non of the harm.*
2. *It increases the objective probability of the harm by a significant amount.*

The distinctive feature of the notion of adequate cause is the notion of *objective* probability. This is a relation between events, which is independent of our knowledge. The classical example of objective probability is the one sixth probability of any given face of a cubic die to turn up. This probability is independent of our knowledge: it is just observed after a sufficient number of throws.

Adequacy theories suffer from the same instability suffered by any other causal theory. This is due to the fact that, despite the objectivity derived by analyzing frequencies on a large amount of cases, it is extremely difficult - so to speak - to run the way back, i.e. to derive conclusions about a particular case starting from statistical data. As a matter of fact, it may often be argued that statistical data fail to describe an aspect of the particular case under scrutiny that *ought to* be considered. For instance, even imagining to have significant statistical data about the correlation between illegally sold air rifles and damages caused to third parties, it is very improbable that such data could - so to speak - make justice of the six months time span between the fault and the harm, time span that uniquely characterizes Example 2 and that *ought to* be considered in the causal analysis of the case.

Foreseeability and risk Two other notions that have a probabilistic flavor may play an important role in the causal assessment of a case: the notions of foreseeability and risk. According to foreseeability theories, which are mostly adopted by common law jurisdictions, the defendant is liable for harm of which his conduct was a *sine qua non* condition only if the *type* of harm was objectively foreseeable. Moreover, foreseeability is not regarded as a test of causation but as a requirement additional to it.

The other probabilistic notion that is used in common law systems is risk. Hart and Honoré see it as a generalization of foreseeability [Hart and Honore, 1985] (p. 255). If defendant's conduct is a *sine qua non* condition of harm, he is responsible if the harm falls within the risks to which his conduct has exposed others.

Scope of the rule and equity There exist other two adjunctive criteria, that are not causal, but that are proposed by the minimalists as complementary to counterfactuals or probabilities in attributing legal responsibility. These are the scope of the rule violated and equity.

On the one hand, minimalistic tests should be applied only if it is already clear that the considered harm is within the scope of the rule violated by the person whose conduct is under scrutiny. On the other hand, the minimalist seeks an imposition of liability that is equitable as between parties (for instance, based on defendant's poverty and/or on plaintiff's wealth).

3.3 Hart and Honoré's solution

The last approach to the problem of legal causation that is relevant to the purpose of our research is Hart and Honoré's approach. In their book [Hart and Honore, 1985] the

two English authors argue against causal maximalism as well as against causal minimalism and they propose an alternative view, which is a synthesis of those two opposed approaches.

The arguments of the two scholars against the existing doctrines of legal-theoretical causation are somehow intertwined. We have already mentioned some of these arguments. We briefly summarize them here. On the one hand, Hart and Honoré see the notion of causal proximity as too vague for supporting a coherent form of legal analysis. Therefore, the definition of a clearer concept of causation is needed. This should not become, though, an attempt at defining a set of rigid “rules for the determination of proximate cause”, because most of these rules for handling questions of fact (e.g. Beale’s) implicitly encode legal principles, i.e. answers to questions of policy. On the other hand, Hart and Honoré advocate that the correct usage of technical concepts such as foreseeability, risk and scope of the rule is highly dependent on (the application of) a plausible notion of causation; and this notion, they say, is mostly hidden by causal minimalists in the *sine qua non* test (i.e., counterfactual reasoning), which is often proposed as the necessary inferential counterpart of the technical notions mentioned above.

In order to ease the tension between the common sense perception of the world and the (technical) legal view on it, Hart and Honoré propose a whole new approach to the problem. The main methodological novelty of their study is the idea of importing analytical philosophy into the discussion on legal causal reasoning (p. xxxiii), chapters I and II). The theoretical starting point of their analysis (p. xxxv) is the observation that the lack of agreement between causal maximalism and causal minimalism is due to a misunderstanding on whether it should be clause 2 or clause 3 of Definition 2 that prevails in the assignment of legal responsibility. While causal maximalism points everything on causation (clause 2), causal minimalism considers almost exclusively fault (clause 3). Neither of this two approaches, though, yields sufficiently convincing results because they both fail to provide an explicit account of the elements of a case that a judicial authority should consider when assessing causation. Causal maximalism makes this mistake as a consequence of its excessively optimistic reliance on common sense and its capacity to find the right elements of causation every time this is needed. Causal minimalism makes this same mistake as a result of its excessively pessimistic view of common sense, as not being sufficiently logical.

According to Hart and Honoré the way out of this theoretical impasse may be found through an analytical approach. They propose to move from the classical common sense, logical or mathematical approaches to an analytical approach, which attempts at defining what it *concretely* means in legal settings for an agent to cause an event. There is some non logical knowledge of the world that must be taken into consideration when assessing causal relations. Hence, in order to find out what is such non logical generalization, the legal language of causation must be studied by means of ordinary language analysis, which, at the time when Hart and Honoré wrote, was a major development in the Anglo-Saxon philosophical landscape (development which is usually attributed to the “second” Wittgenstein or Austin, in legal theoretical circles and their analytical approach to language). Such study should refrain from both temptations of explaining everything (as in causal maximalism) and of leaving everything unexplained (as in causal minimalism).

The result of Hart and Honoré's search may be spelled out in the following definition.

Definition 4 (Common sense legal causation) *Agent A causes an event e, that might involve agent B, if either of the following holds:*

1. *A starts some physical process that leads to e;*
2. *A provides reasons or draws attention to reasons which influence the conduct of B, who causes e;*
3. *A provides B with opportunities to cause e.*
4. *All the important negative variants of clauses 1, 2, 3³*

Now, an analysis of Example 2 according to Definition 4 yields a result that is not very different from those obtained by applying any maximalist or minimalist causal criteria. Either the mother or the seller are at the beginning of the causal chain. Contrary to most causal tests that we have seen so far, though, Definition 4 provides more clarity. It explicitly distinguishes the various types of causal links that connect each of the involved agents to the harm. Rather than reducing every relevant causal relation to one type (e.g. proximate cause or *sine qua non*), Definition 4 distinguishes the various types of causal roles played by the persons involved in the case. For instance, the playmate (the boy who shot) has clearly started a physical process that leads to the harm (clause 1). The boy who owns the rifle has either provided opportunities to the playmate for shooting. The mother of the rifle's owner has failed to provide her child with reasons for not using the rifle and this has led him to play a causal role in the harm. Finally, the seller - if he has played any causal role in the harm at all - has provided an opportunity for the harm to come about.

Hart and Honoré's approach tries to do exactly this: to make explicit what both the maximalist and the minimalist leave implicit. The simplicity of the tests built around proximity or counterfactuals hides a lot of complex assumptions. These, though, are implicitly employed by the legal expert in order to make sense of those tests. Hart and Honoré notice that such freedom of application jeopardizes the consistency of the tests, especially when employed over large corpora of cases. Therefore Definition 4 is proposed as a way of minimizing variations of outcome in legal causal analysis, by explicitly standardizing the implicit meaning of causal proximity or of counterfactual dependence.

Hart and Honoré's effort at making things explicit is comparable under many respects to our own. For this reason in our treatment we adopt Definition 4 as our legal theoretical point of reference. In order to make it computationally tractable for an *automatic* interpreter, Definition 4 should be reconfigured. Such process of reconfiguration consists of three steps:

1. We first have to "open up" Definition 4, in order to have a better understanding of its internal elements and of their functioning.

³An example of such negative variants is: A *does not* provide reasons or *does not* draw attention to reasons which might influence the conduct of B, who causes e.

2. Then, based on such understanding, we have to decide what parts of Definition 4 may be reduced to one another (or simply given up) without losing too much of the overall original expressivity of the definition.
3. Finally, we may concentrate on reassembling the parts of Definition 4. In such final step, our focus is on gaining as much tractability as possible.

We proceed as follows. The next section is dedicated to a preliminary analysis of Hart and Honoré's definition (opening up). Definition 4 distinguishes four different cases of causation. In section 5, the case of physical causation is discussed from a philosophical perspective. Finally, in section 6 we will profit of this discussion and propose our own model of physical causation (reassembling).

4 Preliminary analysis

From an ontological viewpoint Definition 4 is redundant. Being constructed for the purpose of capturing a wide variety of cases of causation, the definition ranges over many of the levels of complexity characterizing our world. For instance, on the one hand, the concept of process is used for indicating some physical connection between an agent and a certain event; on the other hand, the concept of providing reasons is employed for indicating some psychological connection between two agents. From the definition it is not clear, though, what is the relation between a process and the providing of reasons. One might legitimately argue that providing reasons may be seen as a complex physical process that connects an agent to a (mental) event, which occurs within the (brain of) another agent (thus reducing clause 2 to clause 1). Another example of redundancy in Definition 4 is the use of concepts such as 'starting', 'process' or 'event'. These concepts too might be defined in terms of one another.

Given the ontological ambiguities which characterize Definition 4, we want here to strive for some more clarity. In particular, we want to isolate all the terms that in the definition are particularly significant from a causal perspective and group them according to the level of complexity to which they pertain (e.g., the physical level, the psychological level, etc.). Each of these levels comprises an ontologically distinct type of causation. In particular, Definition 4 refers to the following four main types of causation: physical causation, agent causation, interpersonal causation, negative causation.

Physical causation The case of physical causation is described by the final part of clause 1 of Definition 4, where the definition mentions **a physical process that leads to an event**. This is the intuitively most simple case of causation, in the sense that it is frequently quite simple to agree about cases of physical causation. For instance, in Example 2 it is rather obvious for anyone that the relation between the shooting of the gun and the wounding of the plaintiff is (physically speaking) a causal one. This is mainly due to the direct physical connection between the bullet and the victim's eye.

Agent causation Agent causation is described by the initial part of clause 1 of Definition 4, where the definition mentions **an agent starting a physical process**. The agreement around cases of agent causation is not reached as easily as in

cases of physical causation. This is due to the problem of detecting the beliefs, desires and intentions of the agent that starts the physical process. Usually a non intentional action does not fully qualify the agent that performs it as an agential cause, despite him being a physical cause. In Example 2, for instance, the boy who shoots clearly is a physical cause of the harm, simply because he pulled the trigger. His psychological state while pulling the trigger, though, can make a lot of difference on his status as the agential cause of the harm. Did he know what he was doing (i.e. pulling a trigger)? Did he intend or at least desire the consequent harm?

Answers to this type of questions, even though not always positive ones, must be given (or assumed) in order to individuate agent causation in Example 2. Given the case description we provided, it is quite immediate to assume that the boy is an agential cause of the harm. But what if it is shown that the boy inadvertently pulled the trigger while falling on the ground, after being pushed by the plaintiff himself? Or, again, what if it is shown that the boy acted under hypnosis or narcosis? In these cases the boy would not acquire the status of agential cause, despite holding a clear *physical* role in starting the harmful process.

Interpersonal causation Things become even more complex when considering the role that interpersonal relations play in the chain of causation. One might be tempted to consider interpersonal causation just as a subcase of agent causation, where the psychological state of an agent exerts a causal influence on another agent. Things are not that simple, though. The causal influence that an agent may exercise on someone else may be physical in nature or psychological or a combination of the two. In an attempt at simplifying things, Definition 4 casts the intricate interpersonal causal relations in two separate clauses. Clause 2 refers to the psychological aspects of interpersonal causal relations as **an agent giving another agent reasons or drawing another agent's attention to reasons** for causing something. Clause 3 refers to the physical aspects of causally relevant interactions as **an agent providing another agent with opportunities** for causing something. In other words, both reasons and opportunities act upon the psychological attitude of the agent that (physically) causes the harm. But, while reasons psychologically influence the attitude of an agent, opportunities physically sustain his attitude. This seems to be the main difference between the two cases of interpersonal causation individuated by Definition 4.

Negative causation The most elusive case of causation is negative causation. Definition 4 refers to negative causation in clause 4 as **all the important negative variants of the preceding clauses**. Two intertwined problems are at stake here: an ontological problem and an epistemological problem. The ontological problem goes as follows. On the one hand, it is ontologically very difficult, almost paradoxical, to accept the general idea that something that does not exist can cause anything. This is quite evident in cases of physical causation: it does not make much sense, for instance, to say that the orbit of the Earth around the Sun is determined by Jupiter because this planet is *not* enough near to our planet to significantly divert its orbit. In other words, the principle applied to this astronomical example is that the *absence* of Jupiter can not determine the orbit of the

Earth more than the absence of any other thing could. By applying this same principle to Example 1, one must say that the physical cause of the death of the traveler is not dehydration (i.e. the *absence* of water from the traveler's body) but the (increasing) presence of heat. Physically speaking it is heating that causes the death of the desert traveler. Therefore, ontologically speaking, in order to see dehydration - rather than heating - as a cause, one must compare the *actual* situation with an *ideal* or *optimal* condition of the traveler's body. This type of comparison usually has some sense in cases of agent or interpersonal causation, where it is common to compare actual conducts with expected standards of behavior, because it is assumed that agents are free to determine their conduct - while physical objects are not. Therefore, negative causation is ontologically admissible in cases of agent and of interpersonal causation. Not all these types of cases admit negative versions, though. It is not simply a question of putting a negation before the positive formulation of one of the clauses. The choice of the admissible cases of negative agent or interpersonal causation poses interesting and (very) tough epistemological problems, which fall outside the scope of this article.

In the next section we concentrate on the case of physical causation and provide an overview of the main problems that should be considered when defining the relation of physical causation.

5 Philosophy on physical causation

Physical causation is nowadays considered as the most general and comprehensive causal relation of all. Most of contemporary (western) culture works under the assumption that causal relations should be reduced to their (basic) physical aspects in order to be fully understood. For a simple and exhaustive historical overview of the development of the concept of causation, the reader is referred to the second chapter of [Hulswit, 1998]. For a more easily accessible reference, the chapters about the Scientific Revolution of any handbook of Philosophy will do. A fairly entertaining one is, for instance, [Russell, 1984].

In this section we rather offer an overview of the main philosophical problems and approaches to physical causation. This provides us with the necessary context for the definition of our own approach in the following section. Moreover, from now on we only consider the very last part of Example 2, i.e. the physical relations between the being pulled of the trigger (A), the being shot of the bullet (B) and the being hit of the plaintiff (C).

5.1 Formal properties of the causal relation

To begin with, there are some formal properties of the causal relation which are a problem for any approach to causation. These are the classical logical relations of transitivity, symmetry and reflexivity. In particular one might ask:

1. Is causation a *transitive* relation? In other words, if A causes B and B causes C, does A cause C?
2. Is causation a *symmetric* relation? In other words, if A causes B, does B cause A?
3. Is causation a *reflexive* relation? Can A cause itself?

In our definition of physical causation (definition 15), we encapsulate the most widely accepted view that sees physical causation as a transitive, asymmetric and non reflexive relation.

5.2 Main approaches to the causal relation

There are a number of philosophical approaches to the problem of defining the right criteria for physical causation: logical, probabilistic, singularistic and functionalistic approaches, as follows.

Logical criteria The most traditional definition of causal relations is in terms of logical conditions. Logical reductionism is definitely a form of causal minimalism. According to logical reductionism, the sentence **A causes B** can be thought as equivalent to one of the following logical statements:

1. A is a necessary condition of B, which may be formally represented as a material implication from B to A: $B \rightarrow A$.
2. A is a sufficient condition of B, which is formally represented as a material implication from A to B: $A \rightarrow B$.
3. A is a necessary and sufficient condition of B, which is formally represented as a double implication between A and B: $A \leftrightarrow B$.
4. A is an INUS condition of B. The acronym INUS means: *insufficient* but *non redundant* part of an *unnecessary* but *sufficient* condition. The logical form of an INUS condition is the following complex double implication: $(A \wedge X) \vee Y \leftrightarrow B$, where A is the cause, X is the causal context of the cause, Y is a series of alternative sets of causes and of causal contexts and B is the effect.
5. A is a counterfactual condition of B. The last set of logical criteria for causal relations are counterfactual criteria. A definition of causation in terms of counterfactuals was already present in Hume's analysis and it has more recently been reformulated by philosophical logicians such as Lewis [Lewis, 1973]. A counterfactual, which is formally represented by a modified implication symbol (e.g., $A \square \rightarrow B$), is a speculation on the past, in the same sense as a *sine qua non* condition.

Probabilistic criteria A second group of criteria that have been proposed for modeling and detecting causal relations are probabilistic criteria. In legal theoretical terms, these criteria may also be considered as minimalistic ones. The mathematical notion of probability is based on another mathematical notion: the notion

of frequency. Something (B) that in past experiences has often presented itself in correlation with something else (A), has a higher probability of presenting itself in the future, every time A does. Now, as advocated by empiricists, frequency and probability analysis may be applied to the detection of causal relations. By means of various probabilistic techniques based on frequency tables, it is possible to determine whether something (A, the candidate cause) does or does not raise the probability of something else (B, the candidate effect). Formally, the probabilistic relation that underlies a causal relation is expressed by the following inequality: $p(B|A) > p(B|\neg A)$, which means that the conditional probability of B given A is higher than the conditional probability of B given not A.

Singularistic criteria There is a third group of criteria proposed in the philosophical literature on physical causation, which are known as singularistic criteria. These may definitely be associated with maximalist approaches to legal causation. In very general terms, one may think of singularistic criteria as the *conceptual* counterpart of *logical* approaches based on counterfactuals. In other words, approaches based on the notion of change and logical approaches based on counterfactual dependencies may both be called singularistic. This is due to the fact that they both pivot on the principle that causation should not be defined in terms of any general principle or general causal law. As far as counterfactuals are concerned, such singularistic view leads to the definition of the truth conditions for causal statements in terms of counterfactual dependencies and in terms of a similarity relation between the actual world and the possible worlds accessible from it. The singularistic view on causation leads to the adoption of the rather neutral notion of change as the only parameter for detecting causation. In addition to change, spatio-temporal criteria usually play an important role too in accounts based on change. Thus, a singularist would for instance say that the cause of a particular change B is such particular change A as alone occurred in the immediate environment of B immediately before.

Functionalist criteria Functionalism is the last philosophical approach to causation that we want to mention here. This view on causation, which is definitely a minimalistic one, may be seen as the theoretical retreat of Philosophy under the practical advances of Science. To some extent, functionalism may be seen as the continuation of singularism by other means⁴. The main difference from singularism is that functionalism seeks sharper tools than the notions of change or of counterfactual dependence for detecting causation. The various functionalist views proposed so far ([Russell, 1912], [Russell, 1948], [Salmon, 1984], [Dowe, 1995]) try to reduce the notion of causation to physical notions such as energy or momentum⁵ transfer between processes, in accordance to contemporary Physics. For instance a functionalist would consider a relation between A and B as causal, if the actual physical intersection between A and B involves exchange of a conserved quantity (e.g. energy).

⁴And it is exactly the choice of the means that makes functionalism a minimalistic approach, as opposed to the maximalist spirit of singularism.

⁵The momentum of an object is its propensity to continue moving, because of its mass and speed.

The approach that is most suitable to our purposes is a combination of singularism and functionalism, because these two approaches are the most explicit ones in defining the *physical* elements of physical causation. In section 6 we explain how singularism and functionalism converge on our own view.

5.3 The ontological status of the causal relata

In addition to the questions concerning what a causal relation is and how can it be best described, there is the question regarding the ontological nature of the relata of a causal relation. There are three main options here: objects, states of affairs or events. The causal relata usually adopted in the (singularistic) literature on causation are events, because these bring about change. Moreover, it is easier to include objects and states of affairs in the definition of events, rather than the other way around; and events undoubtedly have a tighter conceptual relation with time, which in turn is deeply related to the notion of change. One of the main consequences of adopting events, is that all other ways of expressing the causal relation (i.e. as a connection between objects and/or states of affairs) must be considered only as linguistic tricks, i.e. shortcuts taken by the layman in order to avoid long, albeit proper, explanations in terms of events.

6 The Proposed Ontology

This section presents some parts of the developed ontology, namely those parts that contain the concepts that are minimally needed for defining the relation of physical causation. For conciseness we do not spend much time on matters of representation. Our ontology was implemented in Protégé-2000, a fairly liberal knowledge representation tool, based on the classical is-a relation. The figures, shown in the following, reproduce part of our is-a hierarchy. It should be noticed that such figures were automatically generated by Ontoviz, the graphic tool of Protégé-2000. For this reason they may sometimes be visually confusing, in the sense that they do not always mirror the order of presentation of our ontology in this article. We, therefore, have to ask for some patience from the reader, for the purpose of being conducted to a correct reading of the figures.

6.1 Top level

We present here the contents of the four top boxes shown in figure 1: noesis, category, dimension and entity. We illustrate both the intended meaning of such terms and we briefly introduce the subsumed concepts that are relevant to the present exposition.

6.1.1 Noesis

The first ontological choice, to which we commit ourselves, is avoiding to make a truly ontological choice. After years of struggling with the notion of causal relation (and those related to it, e.g. matter, object, process, energy, work, power, etc.) two main general properties of causal relations appeared quite clear:

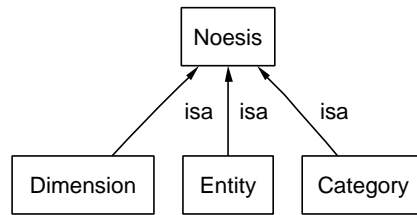


Figure 1: Top level

1. *Causal relations are neither purely ontological nor purely epistemological. They are something in between. A child, for instance, learns that fire is harmful by touching it and experiencing the painful sensations that it causes. This hard ontological fact is at the basis of the (subsequent) epistemological generalization that brings the adult to be aware of the harm caused by hot things in general. Similarly to the causal awareness of individuals, the causal awareness of humanity is developmental. We have mainly learnt about causal relations by a process of trial and error.*
2. *Therefore, the representation of causal knowledge cannot be limited to the ontological elements of causal relations (i.e. the entities). It must be extended to the epistemological elements (i.e. the categories) and to the phenomenological relations between them (i.e. the dimensions). This extension might seem as a non parsimonious scientific practice, and it probably is. But it gives us some room to explain what in causal reasoning pertains to us as observing entities and what pertains to the world as observed entity. Furthermore, by not limiting ourselves to ontology we provide a clear way of distinguishing semantically similar terms (e.g., matter, a category; mass, a dimension; object, an entity) within the same AI-like ontology.*

Given 1. and 2. we define the top class of our ontology as follows.

Definition 5 (Noesis) *Noesis is the psychological counterpart of experience (i.e. perception, learning and reasoning).*

The notion of noesis has a rather long philosophical tradition, which dates back to Greek Philosophy. A number of words stemming from the root *nous-* (e.g. *noein*, thinking, *nous*, mind, *noumenon*, the object of thought) were used to indicate whatever was related to thought as a psychological activity. In the XX century, the notions of noesis and noemata were employed by the phenomenologists (e.g. Husserl) to indicate, respectively, the process and the result of perceptual and intellectual activity.

As far as we are concerned, we adopt here the notion of noesis in its broadest cognitive sense. We consider all the experiences of an individual human being to be physical phenomena. On the one hand, perceptual experiences (e.g. perceiving the color red) are the result of the interaction between the physical world (i.e. light) and an individual's

sensory system (e.g. his optic nerve and other parts of his brain). On the other hand, intellectual experiences (e.g. thinking about the notion of color) occur in the brain, i.e. they too are physical phenomena. Besides their physical nature, though, both perceptual and intellectual experiences generally seem to have a psychological counterpart, i.e. a part of which the individual is aware (i.e. the color red, in the example of perceptual experiences, and the notion of color, in the example of intellectual experiences). Any such psychological counterpart of an experience is noesis.

6.1.2 Category

A category is that part of noesis, which cannot be (philosophically) reduced to any other parts. It must therefore be assumed as a basic intellectual element⁶, which structures our perceptual experience of the world and our reasoning about the world. We define it as follows.

Definition 6 (Category) *Category is knowledge-related (i.e. epistemological) noesis.*

Categories form the intellectual *background* of our noetic experience of the world (i.e. of our perception, learning and reasoning about the world). Even though categories play a crucial role in noesis, we are hardly aware of them in our experience. When perceiving, learning or reasoning we are not fully aware of the categories that are supporting our effort. For instance, when reasoning about (i.e. having an intellectual experience of) or perceiving (i.e. having a physical experience of) an entity (e.g. an object), a number of categories (e.g. matter and quantity) make our experience possible, even though they are not immediately present to our mind and/or to our sensory system.

Categories are, therefore, here understood as in (Kantian) Epistemology: as the basic notions on which our (intellectual and perceptual) experience builds up⁷. Categories are different from sets, classes and instances. They are different from sets because they are not collections of (prototypical) individuals. Categories are different from classes because they have no properties describing them. Finally, categories are different from (prototypical) individuals because they are universal not particular.

We consider it to be important for an AI-like ontology to contain a description of the categories on which it is based. Even though categories do not play a direct role in reasoning about and/or perceiving entities, they may play two other important roles in an ontology:

1. On the one hand, as support to reasoning about knowledge at a general level.
2. On the other hand, as purely descriptive notions that clarify the intuitive meaning of the terms that are used in reasoning about entities (which we call the dimensions, see below).

⁶The expression ‘assuming a notion as *basic* intellectual element’ is used here as a synonym of ‘postulating a notion’. In other words, categories must be postulated.

⁷We want to avoid to use here the expression *a priori* in order to describe the status of categories. As a matter of fact, under a noetical perspective nothing is *a priori* and one may see categories as the result of evolution, both of individuals and of species.

Our intent is to use categories in the sense indicated at point 2 above. We therefore present a number of terms that indicate the basic epistemological structure assumed in our ontology. As shown in figure 2 we distinguish between two main groups of categories: the categories of existence and the categories of experience. The opposition

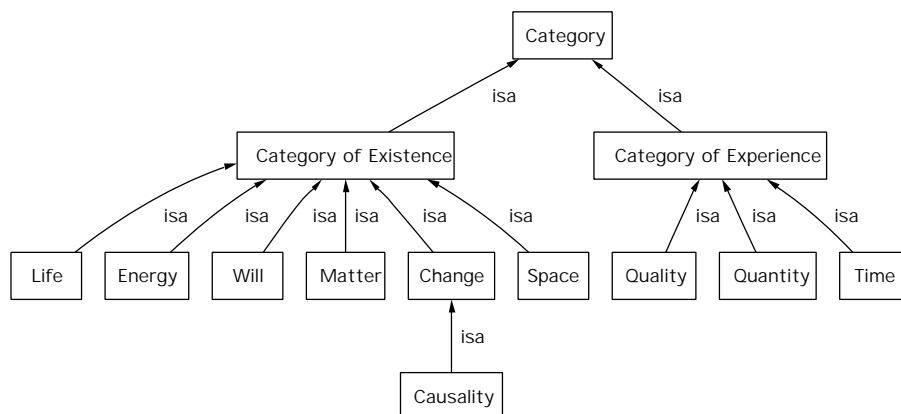


Figure 2: Category

between these two types of categories is the epistemological equivalent of the opposition, within noesis, between entity (or Ontology) and category (or Epistemology). In other words, just like in noesis, where we distinguish existence (the entity) from knowledge (the category), in category we distinguish between the knowledge of what exists (category of existence) from the knowledge of the modes of knowledge (category of experience). These second categories describe how we know what exists (or, rather, how we know the categories of existence). Categories of existence encompass notions such as space, matter, energy, change (and others, shown in figure 2, which we do not treat in this article, though); whereas category of experience encompass notions such as quantity, quality and time. An important subcategory of change is causality. There has been a lot of philosophical discussion concerning both the ontological and the epistemological status of causal relations. In accordance with [Hulswit, 1998] we provide here the first half of the solution proposed by us. We adopt the term ‘causality’ to indicate *the epistemological counterpart of an ontological dependence*. We see here causality as the epistemological counterpart of an ontological dependence between categories of existence. In other words, from an epistemological point of view causality is an ontological constraint between the categories of existence. Such constraint fixes the possibility of existence of one category relative to another. For instance, we propose here to adopt the following ontological dependence between categories of existence as standard notion of common sense causality: energy, matter and space. In other words there is no ontological dependence between energy, matter and space. This statement can be better appreciated by considering the dependence between all the categories shown in figure 2, as follows: will cannot exist without life, life cannot exist without

energy, matter and space. In other words there is an ontological dependence between will and life, on the one hand, and energy, matter and space, on the other hand.

6.1.3 Dimension

From the (theoretical) background consisting of the categories the dimensions emerge, which we define as follows.

Definition 7 (Dimension) *Dimension is experience-related (i.e. phenomenological) noesis. A dimension relates two categories.*

The standard example of a dimension is mass. By experience, all physical objects have a mass, which is the quantity of matter they comprise. We never have, though, a concrete experience of either matter or quantity as such. Therefore, we must assume their existence as categories, rather than as entities, and employ them in the definition of the notion of mass. In other words, the concrete notion of mass relates the epistemological to the ontological part of our noetic experience. We experience objects (ontology) as having mass (phenomenology), which relates two categories: matter and quantity (epistemology).

In the definitions of dimensions, we associate categories to one another with the expression ‘experienced by means of’. This is to underline the fact that the definition of dimensions in terms of categories is not an ontological but a phenomenological definition. We therefore say, for instance, that mass is matter *experienced by means of* quantity (rather than mass *is* a quantity of matter), where the experience of matter by means of quantity is a purely *intellectual* one, as both matter and quantity are categories, not entities.

Furthermore, it should be noticed that we use the expression ‘experienced by means of’ also in the definition of entities in terms of dimensions. In this case, the expression ‘experienced by means of’ refers to the *perceptual* (rather than the intellectual) experience of an entity (e.g. an object) through a dimension (e.g. mass).

Among others, the following dimensions have been defined: volume (i.e., space experienced by means of quantity), form (i.e. space experienced by means of quality), location (i.e., space experienced by means of time); mass (i.e., matter experienced by means of quantity), material (i.e., matter experienced by means of quality), state (i.e., matter experienced by means of time); work (i.e., energy experienced by means of quantity), energy-form (i.e., energy experienced by means of quality), power (i.e., energy experienced by means of time). Some of such dimensions are shown in figure 3, as descriptors of a class (for instance, dimension ‘mass’ is a descriptor of class ‘object’ and usually takes numeric values).

6.1.4 Entity

The notion of entity indicates something that exists separately from other things and has a clear identity. Entities are the subject of study of ontology. We define entity as follows.

Definition 8 (Entity) *Entity is existence-related (i.e. ontological) noesis.*

In Example 2 examples of (different types of) entities are: the event of the trigger being pulled; the boy who pulls the trigger (both his body and his mind); the process of being pulled; the trigger; the causal connection between the event of the trigger being pulled and the event of the plaintiff being hit.

6.2 Causal entities

By means of the dimensions we define here some of the entities needed for the definition of causal relations. We proceed as follows: we firstly introduce the definition of physical entity, object and process; we then define the notions of occurrence and event. The dimensions that stem from the categories of physical existence (i.e. space, matter, energy, change) provide us with the necessary terminology for defining physical entities. We define physical entity as follows.

Definition 9 (Physical entity) *Physical entity is an entity experienced by means of one or more of the following dimensions: volume, form, location, mass, material, state, work, energy-form, power, direction, transition, period, sensitivity, instinct, age.*

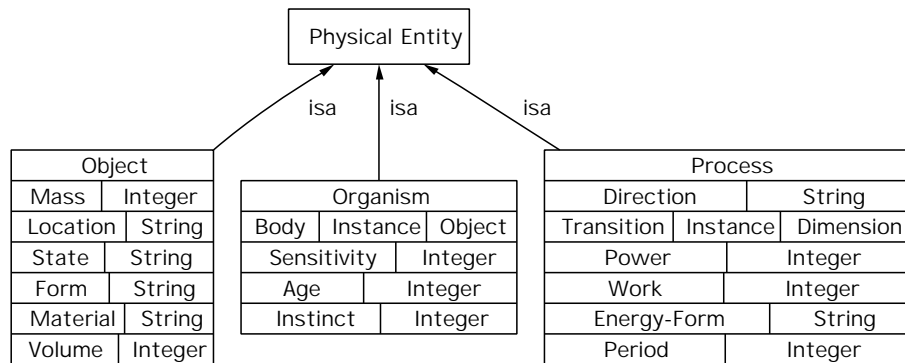


Figure 3: Physical Entity

As show in figure 3, there are three main physical entities: objects, organisms (which we do not treat here) and processes. They are defined as follows.

Definition 10 (Object) *Object is a physical entity which is experienced by means of all of the following dimensions: volume, form, location, mass, material, state.*

In Example 2 an example of object is the trigger.

Definition 11 (Process) *Process is a physical entity experienced by means of all of the following dimensions: work, energy-form, power, direction, transition, period.*

In Example 2 an example of process is being pulled. A second type of entity, non physical but relational, must be introduced here in order to subsequently generate the notion of event.

Definition 12 (Occurrence) *Occurrence is a reified relation between objects, processes, thoughts and/or occurrences.*

An event is a reified relation between a process, an object an action and an agent. We define an event as follows.

Definition 13 (Event) *Event is an occurrence of a process (the occurrence) involving an object (the subject), where the process is possibly initiated by an action (the act) of an agent (the actor).*

In Example 2 an example of event is the trigger being pulled. Finally, the notion of causation may be defined as follows.

Definition 14 (Causation) *Causation is an occurrence of two events, the cause and the effect.*

Physical causation is a type of causation and there are a number of conditions that must be met by any two considered events in order for physical causation to hold.

Definition 15 (Physical causation) *Physical causation is causation between an event E_1 , which is an occurrence of a physical process P_1 (the occurrence of) involving an object O_1 (the subject), and event E_2 , which is an occurrence of a physical process P_2 (the occurrence of) involving an object O_2 (the subject). A relation of physical causation holds between E_1 , the cause, and E_2 , the effect, if the following conditions are met:*

1. O_1 and O_2 are not the same object, according to the adopted identity criterion for objects.
Comment: the subjects must be truly distinguished objects.
2. P_1 and P_2 are not the same process, according to the adopted identity criterion for processes.
Comment: an event cannot cause itself. By this clause we adopt the view that causation is an irreflexive relation.
3. P_1 's period precedes P_2 's period.
Comment: the cause temporally precedes the effect. Even for processes that are temporally distributed (i.e. continuous) the causing process starts before the caused one. By this clause we adopt the view that causation is a temporally asymmetric relation.
4. P_1 's energy-form is the same as P_2 's energy-form or E_2 is reducible to events $E_{2,1} \dots E_{2,n}$ such that:
 - (a) $E_{2,1} \dots E_{2,n}$ are occurrences of processes $P_{2,1} \dots P_{2,n}$, which all have the same energy form of P_1 .
 - (b) $E_{2,1} \dots E_{2,n}$ have as their subjects objects $O_{2,1} \dots O_{2,n}$, which are the grains of O_2 , according to the adopted structural constraints.

In the interaction between two objects energy is transferred or transformed. In this latter case, the transformation of energy should be reducible to a transfer of energy between the cause and the events occurring to the grains of the object of the effect.

5. *P_1 's direction is the same as P_2 's direction or P_1 's power is greater or equal to P_2 's power or P_1 's work is greater or equal to P_2 's work.*

Comment: this clause accounts for the fact that usually changes of one sign cause changes of the same sign (i.e. an increase can usually only be caused by an increase and a decrease by a decrease). If this condition cannot be tested (which might be the case when lack of information makes it impossible to establish the directions of either P_1 or P_2) or if it is not satisfied, one may want to use the principle of the dispersion of energy in order to distinguish the cause from the effect.

6. *The category of existence of P_2 's transition can not exist without the category of existence of P_1 's transition, according to the adopted causality constraint.*

Comment: changes in O_1 's dimensions can only affect those dimensions of O_2 that are ontologically dependent on the dimensions changed in O_1 , according to the adopted causality.

It should be added that we take physical causation to be a *transitive* relation. In Example 2 an example of physical causation is the relation between the event of the trigger being pulled and the event of the plaintiff being hit.

7 Conclusion

Reasoning about causation in fact is an essential element of attributing legal responsibility. Therefore, the automation of the attribution of legal responsibility requires a modelling effort aimed at the following: a thorough understanding of the relation between the legal concepts of responsibility and of causation in fact; a thorough understanding of the relation between causation in fact and the common sense concept of causation; and, finally, the specification of an ontology of the concepts that are minimally required for (automatic) common sense reasoning about causation.

In this article we offered a worked out example of the indicated analysis. Such example consists of: a definition of the legal concept of responsibility (in terms of liability and accountability); a definition of the legal concept of causation in fact (in terms of the initiation of physical processes by an agent and of the provision of reasons and/or opportunities to other agents); a definition of an AI-like ontology of the common sense (causal) concepts that are minimally needed for reasoning about the legal concept of causation in fact (in particular, the concepts of category, dimension, object, process and event). As, of reasons of conciseness, we could only present the modelling of physical causation, the interested reader should refer to [Lehmann, 2003] for the complete model, which includes also the definition of agent causation.

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