

# Dialectical Contradictions as Causal Basis for Dispositions

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**Abstract.** *A disposition is an entity's trait of behaving in a certain way under determined circumstances, usually counterfactually. Thus, dispositions are critical to understanding causality, and are of central importance to scientific ontologies. However, for some applications it is necessary to represent more meticulously the underlying causal structures. We propose to model such structures as dialectical contradictions, a core concept in the philosophical discipline of dialectical materialism. Dialectical materialism analyses entities by inspecting the reciprocal interaction of its opposing tendencies. We believe that modeling the causal basis of dispositions as dialectical contradictions will allow to better differentiate, compare and explain distinct dispositions.*

## 1. Introduction

A disposition is a property of an entity which may be triggered by some circumstance, leading to the occurrence of an event or process that is called the realization of the dispositions (see, for example, [Goodman 1955] or [Prior et al. 1982]). However, the disposition existence does not depend on its actual triggering or realization - they may exist even if they are never manifested. Thus, dispositions are what enables us to affirm, for example, that a glass will break if dropped, or that a cube of ice will melt if left on the sun, even before those things happen. This kind of property is crucial in the natural sciences, where researchers aim to describe the rules that govern the behavior of their objects as scientific laws. Thus, the proper representation of dispositions is crucial for ontologies on most scientific domains.

It is of particular interest to represent the causal powers that give rise to dispositions and to their manifestations. [Prior et al. 1982] defines the *causal basis* as the causally operative sufficient condition for the manifestation of the disposition. However, currently there is no consensus in the ontology engineering community on how to better model such causal bases.

We propose a novel perspective on causal basis, the *dialectical basis*, grounded on the philosophical discipline of dialectical materialism, aimed at better explaining the underlying causal structures of dispositions and allowing distinct dispositions to be compared and differentiated. The remaining of this paper is organized as follows. Section 2 gives a brief presentation of dialectical materialism and the concept of dialectical contradiction. Section 3 discusses related work presenting distinct views on the causal basis. Section 4 presents our approach, and Section 5 gives a short conclusion.

## 2. The dialectical contradiction

Dialectical materialism is a philosophical discipline that studies “the general laws of motion and development of nature, human society and thought” [Engels 1947], and consists

in three main laws [Engels 1954]:

1. The law of transformation of quantity into quality and vice versa;
2. The law of the interpenetration of opposites;
3. The law of the negation of the negation.

The first law conveys that a change in magnitude in an attribute of an entity, i.e., a quantitative change, if taken far enough, will result in a qualitative transformation that alters fundamentally the subject of the change. On the other hand, every qualitative change that transforms its subject allows it to undergo new forms of quantitative change. For example, a certain quantitative increase in temperature in an ice cube leads to it melting down into the qualitatively distinct form of liquid water, which then may suffer quantitative increases or decreases in viscosity that are not possible for solid ice.

The second law states that in every entity, we find conflicting and opposite aspects that are inseparable from each other and that push the transformation of said entity in distinct directions. In the liquid water from the previous example, the kinetic energy of molecules is opposed to the intermolecular attraction. If the balance tends towards the energetic aspect, the water will eventually evaporate. If it falls towards the attractive aspect, the water will freeze into ice.

The literature on dialectical materialism refers to this qualitative transformation of an entity into something else as a “dialectical negation”. It is to this kind of negation that the third law refers to. If every entity has a conflict between aspects that guide its transformation, if said conflict allows the entity to suffer quantitative changes through its interaction with its environment, if the accumulation of quantitative changes leads to a qualitative transformation, that is, a dialectical negation, that gives way to new forms of quantitative changes, then after every transformation the entity enters immediately a new process of change, to be “negated” anew. This continuous process of transformation receives the name of “negation of the negation”. Thus, the ice is negated into liquid water, which in its turn may be negated into vapor or back into ice, determined by its interaction with the surroundings.

We find the unity of the three laws inside the dialectical contradiction that holds between the opposite aspects in every entity, as per the second law. The current form of the entity, that is, the expression of the contradiction, is determined by the relative intensities of those aspects. The aspect which is quantitatively stronger takes the role of dominant aspect, while the weakest takes the role of dominated aspect. The quantitative increase or decrease in the relative strength of one or both aspects may lead to an inversion of roles: the dominant aspect becomes dominated and vice versa. The new configuration determines a new form, a new expression, qualitatively different from the previous one, as dictated by the first law. Thus, “the reciprocal transformation of opposites creates a new qualitative state” [Politzer et al. 1954]. Finally, under the new form the contradiction and its aspects may be themselves transformed or replaced, allowing the entity to suffer new kinds of changes and leading to the ceaseless process of transformation described by the third law.

Thus, the dialectical contradiction provides a foundation for representing and explaining processes of change and transformation, as well as their causes. As such, it appears as a suitable framework for modeling the causal aspects surrounding dispositions and the associated realizations.

### 3. Related work

The topic of dispositions has been subject to intense philosophical controversy in the course of the past century. The core aspects of the debate have been centered on the ontological status of dispositions, on the distinctness or identity between a disposition and its causal basis and on the nature of such basis, i.e., what types of entities are responsible for the disposition's underlying causal structure. Our work aims to contribute to the later discussion, specifically in light of the positions that have been put forth within the ontology engineering community.

Following [Barton et al. 2018], we identify two main visions regarding the nature of causal bases: the *material basis* view and the *categorical basis* view.

The *material basis* of a disposition is defined by [Arp et al. 2015] as “certain features of the physical make-up of the independent continuant that is its bearer”. [Smith et al. 2015] further specify the material basis as a material entity, that is, an independent continuant, that is a part of the bearer of the disposition. This follows the view presented in the Ontology for General Medical Science (OGMS), that defines the basis of a disease - which is a disposition - as a disorder, i.e., a material entity [Goldfain et al. 2010]. In the previous example, the ice melts at a certain temperature because of its molecular structure; thus, the material base for the disposition to melt is the whole ice cube. Nevertheless, [Smith et al. 2015] recognize that in some cases the material basis is associated with a certain quality, that is, a dependent continuant that inheres in the bearer of the disposition, but unlike the disposition the quality is fully manifested for as long as it inheres in the bearer.

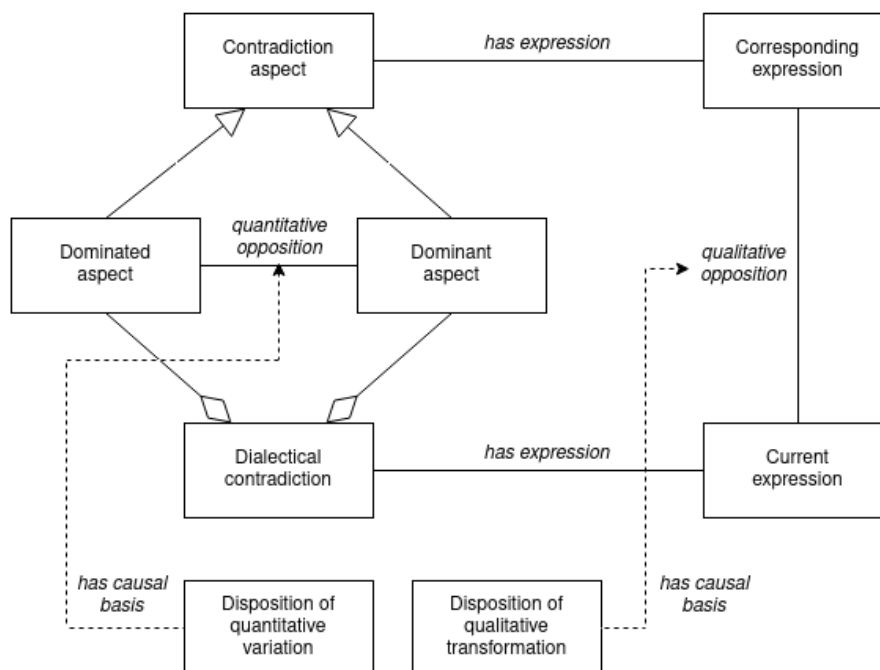
[Röhl and Jansen 2011] on the other hand argue that the idea of taking a material part of the bearer of the disposition as the disposition's basis come from conflating the bearer and the base of the disposition. Instead, they propose that the causal basis should be a quality or a sum of qualities that inhere in the bearer of the disposition. The philosophical literature refers to this kind of basis as “*categorical basis*”. [Barton et al. 2018] also endorse the categorical basis, arguing that the material basis cannot capture finely enough the causal structure relevant for a disposition. For example, the molecular structure of ice that is responsible for its disposition to melt is also responsible for its (poor) electrical conductivity - thus, a single material basis would be responsible for multiple dispositions. On the other hand, the categorical basis for the disposition to melt would be the sum of qualities of the ice cube that makes it meltable, while the basis for its conductivity would be the sum of qualities that make it conductive.

However, we consider that the categorical basis is still not enough to properly describe the causal structure of dispositions. Qualities are subject to varied degrees of abstraction. In the ongoing example, it is possible to model ice's molecular structure as a quality. In this case, the same categorical basis would be responsible for multiple dispositions - mirroring Barton's argument against material bases. Another possibility would be to model ice's melting point as a quality that is the categorical basis for its meltability and its electrical resistance as the quality that is the basis for its conductivity. However, doesn't “having a certain melting point” means precisely to have the disposition to melt under certain conditions? What explainability is added by this kind of causal basis? A rather circular one, arguably: ice melts at some temperature because it has a melting point, and it has a melting point because it melts at that temperature. Thus, while

the material basis may conflate the causal basis with the bearer of the disposition, the categorical basis allows conflating the causal basis with the disposition itself.

#### 4. Our proposal

We propose a third approach to modeling the causal basis of dispositions: the *dialectical basis*, grounded on the dialectical contradiction presented in Section 2. The dialectical basis is composed by the two conflicting aspects of the contradiction and by the distinct expressions taken by the contradiction according to which aspect holds the dominant role. Figure 1 depicts the core concepts related to the dialectical contradiction as causal basis for dispositions.



**Figure 1. Model of the dialectical basis**

In the ongoing example, the two aspects of the contradiction are the *kinetic energy of molecules* and the *intermolecular attraction*. Those aspects oppose each other quantitatively, that is, they can be numerically compared, and their relative strengths may suffer changes. This opposition is the basis for the disposition of the ice to increase or decrease in temperature: the ice warms up or cools down because in its contact with its surroundings the energetic aspect is strengthened or weakened. Further, each aspect of the contradiction has a corresponding expression. The predominance of the intermolecular attraction is expressed in the form of *solid ice*, while the kinetic energy of molecules corresponds to the expression of *liquid water*. In the ice cube, the intermolecular attraction takes the role of dominant aspect. Accordingly, the current expression of the contradiction is that of solid ice.

After a sufficient increase in the temperature of the ice, the kinetic energy aspect becomes dominant. However, the ice does not suddenly melt all at once upon reaching its melting point. Instead, for some length of time while the ice absorbs energy as latent heat,

the expression of the contradiction continues to be of solid ice even if the dominant aspect corresponds to the expression of liquid water. This qualitative opposition between the current expression and the expression corresponding to the dominant aspect is the basis for the disposition to melt: the ice melts because its content, i.e., its internal energetic state is in conflict with its expression, that is, its form as a solid. This reflects the dialectical observation that “in the process of development content precedes form, form lags behind content” [Stalin 1954].

Thus, Figure 1 presents a structure that is the basis for two distinct kinds of dispositions: dispositions of quantitative variation, based on the opposition between dominant and dominated aspect, and dispositions of qualitative transformation, based on the opposition between the current expression of the contradiction and the corresponding expression of the dominant aspect.

Of course, a single contradiction cannot account for all dispositions of an entity. The ice cube, at the same time as it is subject to an increase of temperature, is also subject to some gravitational pull and to some pressure. In representing a domain, the modeler must select those contradictions that are most important to the phenomena of interest. In the present case, the contradiction between the gravitational pull and the ice cube’s inertia is mostly irrelevant for the process of melting. If we were interested in describing the ice cube’s motion as it falls, on the other hand, it would be crucial to our model. The contradiction between the pressure and the movement of molecules inside the ice, however, does affect its melting, which then occurs at a higher or lower temperature. Therefore, our model must describe both contradictions and also their mutual interactions.

## 5. Conclusion

We have presented an alternative approach towards representing the causal basis of dispositions. Our approach, the dialectical basis, is based on the philosophical discipline of dialectical materialism, and is centered on the notion of dialectical contradiction.

We believe that the dialectical basis provides a better support for representing the causal structure underlying dispositions when compared to both material and categorical bases. It allows the explanation and differentiation of several dispositions that share a single material basis by looking at the distinct aspects that guide each of them. In the same manner, it permits finer explanatory power. Finally, the dialectical basis presents a foundation upon which to describe the relation between quantitative changes (i.e., increase or decrease in the value of some attribute) and qualitative changes (that is, changes in the fundamental nature of some entity).

Further, the dialectical basis provides a framework to describe the connections between the behavior of the entity and the behavior of its constituents, elucidating the relations between distinct scales of analysis. This is crucial to domains such as petrography, where the arrangement of microscopic grains and crystals determines the permeability of large rock units, a study that is of foremost importance to the petroleum industry.

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