

Metaphysical indeterminacy, Supervenience, and Emergence.
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Metaphysical Indeterminacy (on the view of it I like) leads to a failure of properties of composite objects to supervene on the properties of their parts. In relevantly similar cases, philosophers have used this phenomena to argue that wholes can have *emergent* properties. I argue that though in *one* sense the properties of the whole supervenes on the properties of its parts, in at least two other senses the properties of the whole do supervene on the properties of its parts, even given indeterminacy. And moreover, the putative emergent properties turn out to be *reductively definable* in terms of the properties of their parts. Those kinds of failures of supervenience to which indeterminacy leads are not, then, do not give us reason to postulate emergent properties of the whole.

Emergent properties

Some properties are possessed by *mereologically simple* things. Think of the traditional properties of point-particles: fundamental mass and charge. Philosophers have often been interested in exploring the view whereby this sort of “elite” property is the metaphysical basis for all others: where such properties are the ontological “furniture” of the world, corresponding to *perfectly natural* properties or Universals (cf. Lewis 1983, Armstrong 1978).

Sometimes properties of *non-simple* entities – mereologically compound things – are described as *emergent*. To get a genuine challenge to a metaphysics that puts simples first, one would have to argue instead for *ontic* emergence.¹ Somehow we would have to argue that properties of systems are as much part of the metaphysical basis as point-properties. for genuinely *new* properties instantiated at a relatively macroscopic level: properties that are “over and above” the properties instantiated by simples.

But this talk of “ontic emergence”, “genuinely new” properties that are “over and above” the properties of their parts, suggestive as it is, doesn’t give much guidance as to how to argue for their existence. Connecting it to the Lewis-Armstrong doctrine of perfectly natural properties/Universals helps somewhat. But there is evident attraction to a more robust *criterion* for when we have an emergent property.

Supervenience is the weapon of choice. The idea is this: if the *fundamental* nature of the world is exhausted by the distribution of point-sized properties, then fixing those properties should fix all else. It should not be possible for there to be two worlds with the

¹It’s often not clear exactly what it takes for a situation to feature an emergent property. Sometimes, it is presented as an *epistemological* characteristic: when, for actual agents, or even perhaps ideal agents, there is no way of *telling* what properties the whole system has, just given the information about what properties its ultimate microphysical parts. So construed, emergent properties are prima facie compatible with the view that all metaphysically basic properties are possessed by simples. Of course, one might make the substantive claim that epistemological and metaphysical emergence are related. Cf. the a priori physicalism of Chalmers (1996).

same distribution of fundamental point-sized properties, which yet feature qualitative differences. Supervenience, then, functions as a criterion and precisification of ontic emergence.²

The prima facie case from indeterminacy to emergence

If there is genuinely indeterminacy in the world, it is likely we will be able to construct a prima facie case for emergence. Such arguments are not unknown in the philosophical literature: the most familiar instances concern the states of entangled quantum systems. But targeting such cases directly would involve us in tendentious issues in the interpretation of quantum theory. So we will focus in the main on a toy example to examine the cogency of the general style of argument for indeterminacy (we sketch the application to the quantum case briefly at the end).

Suppose we have two honorary simples, rubber balls, one blue (ball A) and one red (ball B). Suppose each of them are (determinately) somewhere within one of the two regions 1 and 2. But suppose, in each case, it is indeterminate where exactly they are located. Imagine this to be all one can say, at the level of the properties (determinate and indeterminate) of the rubber balls taken individually.

Compatibly with this, the total facts of the situation might fall in one of two ways. It might be that, though it is indeterminate where each of the balls are, it is determinate that their fusion A+B is entirely within a single region. Or it might be that, though it is indeterminate where A and B are, A+B is spread out across both regions.

If this is right, it appears the totality of facts about the individual locations of the balls A and B fails to determine facts about the fusion A+B, and in particular, whether that fusion has the property of being entirely contained in one region. So facts about the fusion, it appears, fail to supervene on facts about the simples that compose the fusion. By the supervenience test, the location of the fusion A+B is an emergent property.

The case set out

To see exactly what is being presupposed in setting up the case, and to allow us to reason about it later, let us explore it in more detail. To this end, we use the machinery for representing ontic indeterminacy set out in Barnes (ms.) Williams (forthcoming). If it is indeterminate whether a is F, that is not a matter of a's having some third status, midway between F and non-F. Following Barnes, think of matters as follows: there are just two ways for the world to be: a being F, and a being not F. But there is no fact of the matter which obtains. And what goes for a goes for the world. If it is indeterminate whether the world is way W, or way W*, then either the world is way W or way W*: but again, it is not settled which disjunct obtains.

² One might (as Armstrong does) reserve the notion "emergent property" for a *perfectly natural* property instantiated by non-simples. To allow easy formulation of the supervenience criterion, I will allow "gruesome" constructions out of perfectly natural emergent properties to counts as emergent. I presume that if we can argue for emergent properties, we will thereby be able to argue, also, that some among them must be perfectly natural: thus arguing for the existence of emergent properties in the weaker sense suffices to argue for the existence of emergent properties in the Armstrongian sense.

Consider, then, ersatz possible worlds, describing (fully classical) ways for the world to be. The world is one of those ways: but there is no fact of the matter which one. Standardly, one would think that one could pick one among those ersatz worlds as special: as representing reality aright. But given indeterminacy, that assumption is problematic. What we can do is identify those worlds which are “ontic precisifications”: which don’t *determinately* misrepresent reality. Williams (forthcoming) calls these “actualities”. P is determinate iff all actualities agree that P; P is indeterminate if some say P and some say not P. Since all classical tautologies hold at each world, they are all determinately true. So the framework systemizes thought and talk of ontic indeterminacy: a systematization compatible with standard, classical logic.

Consider the following four worlds:

W1: the blue ball, A, is in region 1; the red ball, B, in region 2

W2: the blue ball, A, is in region 2; the red ball, B, in region 1

W3: the blue ball, A, is in region 1; the red ball, B, in region 1

W4: the blue ball, A, is in region 2; the red ball, B, in region 2.

In W1 and W2, A+B is spread out over 1+2, in the remaining worlds, A+B is contained in a single region.

The option for reality we considered can be represented by taking W1 and W2 as “precisifications of reality”: the actualities. Both these worlds agree that the balls are within the union of regions 1 or 2. They disagree over whether the blue ball is in region 1 or 2; and similarly for the red ball. On the other hand, they agree that the sum A+B is not contained in a single region. As promised, it is determinate that the balls are within the region 1+2, indeterminate which region each is in, but determinate that A+B is spread out across 1+2.

The second option we considered is represented by taking W3 and W4 as actualities. The facts are just as represented by the first reality: except that the actualities agree that A+B is contained in a single region. As promised, it is determinate the balls are within the region 1+2, indeterminate which region each is in, but in this case, determinate that A+B is in a single region.

Both these seem to be possible ways for reality to be, if metaphysical indeterminacy is possible at all. As promised, at the level of basic facts about A and B taken individually, (both determinate and indeterminate) they seem to coincide. But of course, they differ on the location of fusion A+B.

Thus the case for emergence. If this sort of ontic indeterminacy is possible, and more specifically if the two situations described are possible ways for reality to be, it seems that sometimes locational facts about wholes fails to be determined by the locational facts about their parts.

The reasoning is very general: granted indeterminacy, for almost any kind of property, we can construct a case where the instantiation of properties of that kind by wholes is not fixed by facts about the instantiation of those properties by simple parts. Thus, change our thought experiment and let A and B each have determinate locations, but let them be indeterminate in colour between blue and red. It might nevertheless be determinately the case that A+B is uniform in colour (though again, indeterminate whether that uniform colour is blue or red), or alternatively be determinately the case that A+B varies in colour (either its right half blue and the left half red, or vice versa). Such examples can be multiplied.

Disambiguation

Does this sort of situation give us reason to think that sometimes the properties of composite objects are just as “fundamental” as the properties of their parts?

First, let us examine the sense in which a “failure of supervenience” can be discerned in the case above. A family of characterizations of supervenience start out as follows: property F supervenes on properties G, H, I (etc) iff no pair of possible worlds can be duplicates with respect to properties G, H, I (etc) without also being duplicates with respect to F.

When we turn to the situation described above, what do we find? Well, the *worlds* we talked of (things like W1, W2, W3, W4) can be assumed to be *precise*, in the sense that they give specific truth values to each well formed sentence. There will be no failure of supervenience if we interpret the above principle as quantifying over these worlds: there is no prospect of finding a pair of worlds in this sense that witness the failure of the sort of supervenience principle just articulated. So in one sense (label it supervenience-1) the locational properties of mereological wholes supervene on the locational properties of their simple parts.

But of course, we are assuming that there are many more *ways for reality to be* than are represented by just these worlds taken individually. The two *possible ways for reality to be* are represented by *sets* of worlds: including not only {W1}, {W2} and so on, but also {W1, W2}, {W3, W4} (the two possible realities mentioned above). And if we treat these *sets* of worlds as the “possible worlds” in terms of which the supervenience principle is formulated, we can argue for a failure of supervenience. For, as anticipated, {W1,W2} and {W3,W4} plausibly count as duplicating the locations of simples (since they agree on all truths of the form *X is located at Y*), without duplicating the locational properties of fusions of those simples. So in this second sense (call it supervenience-2) the locational properties of wholes fail to supervene on the locational properties instantiated by simple parts.

Emergent properties?

It might seem that supervenience-2 is the most natural way to extend the traditional idea of supervenience to this new setting. After all, supervenience-1 appears to ignore the crucial, and distinctive range of ways for reality to be that are characteristic of ontic indeterminacy.

However, we are not so much interested in what notions strike one as *natural* hereabouts, but what notions can *play the theoretical role* that supervenience traditionally fills, particularly in serving as a sufficient condition for whether a certain range of properties of relatively macroscopic entities are “emergent”: properties they possess “over and above” the properties of their parts.

By arguing directly that the location of A+B is not an emergent “new” property in this case, we would have a direct argument against using supervenience-2 as a test for emergence. And I think such a case can be given. I’ll assume that if we can *reductively define* a property in terms of F, G, H, then it is paradigmatically not an emergent property. And indeed, in this case, we can explicitly say what it is, for example, for A+B to be entirely within a region: it is simply for every part of A+B to be located in that region. Notice that we mention here nothing other than the properties of its parts. What sort of reduction could be more straightforward than that? (Note, also, that this principle holds in *every* one of the worlds above: it is determinately true).

But perhaps there is an equally compelling arguments in favour of considering location to be emergent? Shouldn’t the mere fact that the locational facts about A and B individually fails to fix the locational facts about A+B, be taken to block its reducibility? The crucial question is what we count as a “locational fact about A and B individually”. In arguing for the failure of supervenience, we noted that truths of the form *X is located at Y*, where X is simple, do not fix the facts about the locations of sums. But if we cast our net wider, and look at *all* truths concerning the locations of individual particles *including logically complex ones*, then we get a different result. For in the first reality, the following will be determinately the case:

A is located in 1 and B is located in 1, or A is located in 2 and B is located in 2

The same proposition, of course, will be determinately false in the second reality. This, I contend, is a fact exclusively concerning A and B individually: their sum is never mentioned. That, I think, suffices to undermine the case from failures of supervenience-2 to emergence. (Indeed, by including such complex facts in the supervenience base, we get a new characterization of supervenience – supervenience 3 – according to which the locational properties of A+B supervene on those of A and B alone).

The moral is that we must carefully distinguish between

- (a) facts about *systems* of simples: about how fundamental properties are *distributed* across a range of objects; and
- (b) facts about *sums* of simples: about what properties are instantiated by the sum of objects

Facts about systems of simples are just logical constructions describing instantiations of properties by the simples themselves. Such distributional properties are *paradigmatically* non-emergent. And we have seen that once this is taken into account, there is no longer any case for positing, over and above this, extra fundamental properties of *sums*.

Supervenience-2 is a bad guide to the ontology of properties.

An application

If we can maintain that *what it is* for A+B to be located in a single region, is for its parts to be thus-and-so located, there should be no question of whether this locational property of A+B is something “new” and “fundamental”. Since this condition *is* met in the case just discussed, I conclude that the cases of ontic indeterminacy we have seen give no reason to postulate emergent location. All this notwithstanding failures of the locational properties of the whole to supervene on the (narrowly construed) locational properties of the parts, in a reasonably natural sense.

I hope that the toy case discussed here makes this easy to accept. But there is a more general moral. When ontic indeterminacy is in play, one must be very careful when deploying supervenience arguments for “emergent” properties. One must pay attention in particular to the worlds over which one quantifies, and the range of facts one allows into the supervenience base. One must, in short, ensure one is not illegitimately appealing to facts about supervenience-2 to try to establish the existence of emergent properties.

Consider Schaffer’s argument that quantum systems have emergent properties:

...consider the EPR system’s intrinsic correlational property of having total spin zero. This property does not supervene on the Democritean base—it is not fixed by fixing the quantum states of the two particles, and their spatiotemporal arrangement. In general, there can be differences in the intrinsic correlational properties of entangled wholes, without differences in the intrinsic physical properties of, or spatiotemporal relations between, their particles.

(Schaffer, ms. p.22)

But this *appears* to be appealing to exactly the bad kind of supervenience argument. For while *atomic* facts about the particles making up the system might not fix the intrinsic correlational property of having total spin zero, it is far less clear that facts about the *system* won’t fix the correlational properties. Even if there is no fact of the matter about what spin properties each of the particles individually has, it might be that certain disjunctive claims *appealing only to instantiations of fundamental properties by the particles* fixes the correlational property of the whole. If the property of the whole might yet be a logical construction out of properties of the parts in this way, where is the case for emergence?³

³ It may be that the particular case *having opposite spin* is just a bad choice of example for Schaffer to choose, and that other properties of systems of objects will not supervene on the distribution of natural properties over simples. (One thinks, for example, of the wavefunction describing the location of a particle on the GRW interpretation). Nothing I say here rules out these *other* supervenience arguments for the incompleteness of a supervenience base of fundamental properties of simples. To the two options that Schaffer (ms.) describes – appealing to an abundance of new perfectly natural properties; or appealing to an abundance of new perfectly natural relations between simples – I would like to add another option: appealing to a single new fundamental operator, *being determinately the case to degree d*. I have no room to spell out this option here, though it seems to me to mesh nicely with the view of indeterminacy that guides the discussion in the present paper. Thanks to Jonathan Schaffer for discussion here.

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