The fundamental and the brute

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ABSTRACT: This paper distinguishes bruteness from fundamentality by developing a theory of stochastic grounding that makes room for non-fundamental bruteness. Stochastic grounding relations, which only underwrite incomplete explanations, arise when the fundamental level underdetermines derivative levels. The framework is applied to fission cases, showing how one can break symmetries and mitigate bruteness whilst avoiding arbitrariness and hypersensitivity.

1 The limits of explanation

Explanation either proceeds horizontally along the temporal dimension: causal explanations explain what is later in terms of what is earlier, in particular in terms of its causes. Or it proceeds vertically: metaphysical explanations explain what is derivative in terms of what is more fundamental, in particular in terms of its grounds. The principle of sufficient reason holds if everything can be explained, if there is a sufficient reason for everything being the way it is. By contrast, it fails if something cannot be explained, if something is such that its existence or its being a certain way has no basis in terms of which it can be explained.

Failures of explanation arise, most notably, when it comes to boundary conditions.[1] Whatever is endogenous to a system can be explained in terms of the boundary conditions of that system. The boundary conditions themselves, however, are exogenous and cannot be explained. The initial conditions, which explain subsequent events, are uncaused events that lack a causal explanation. Similarly, the fundamental facts, which explain derivative facts, are ungrounded and lack a metaphysical explanation. This, at least, is the case if one rejects infinite explanatory regresses (which violate well-foundedness), reflexive explanations whereby something can explain itself (which violate irreflexivity), mutual

[1] In addition to boundary conditions, the laws that connect causes to what they cause and grounds to what they ground might not admit of explanation. However, we can set laws aside. Either one is operating with a robust conception of laws, i.e. a non-reductionist approach that treats causation and grounding as generative and as governed by laws, in which case they stand outside the fundamentality hierarchy/causal order and are not apt for being grounded, i.e. they are autonomous (in Dasgupta's: 2016 terminology). Or, if laws merely describe patterns of causation/grounding, then they can be explained.

explanations (which violate asymmetry) and explanatory cycles (which violate acyclicity).

Something that cannot be explained along one dimension can nevertheless be explained along another dimension. Although fundamental facts do not have grounds in terms of which they can be metaphysically explained, they can be causally explained in terms of facts that obtain at prior points in time. Likewise, derivative facts that are part of the initial conditions can be metaphysically explained in terms of fundamental facts at that time, even though they cannot be causally explained in terms of prior causes. The facts that cannot be explained in either of these ways are both metaphysically and causally fundamental, both uncaused and ungrounded. These are the initial fundamental facts.

2 Incomplete explanations

On the picture that has been sketched, there are limits to what can be explained, namely the boundary conditions. Yet, the thought is that once they are in place, everything can be explained in terms of them. This raises the question whether fundamental/initial facts do suffice. The answer will be 'no' if grounding/causation can be merely probabilistic. When there are probabilistic connections between what is fundamental and what is derivative, or between what is earlier and what is later, then some things lack a sufficient reason. Some things will lack a complete explanation and will only admit of an incomplete explanation. It will be a brute fact of the matter that one event rather than another is brought about by a given cause, or that one fact rather than another is grounded in some given fundamental facts. In addition to uncaused events and ungrounded facts, there will also be brute events and brute facts.

Whilst boundary conditions admit of no explanation, brute phenomena can be explained stochastically. In the causal case, one can distinguish uncaused events from brute events. The former are the initial events that constitute the boundary conditions of a causal system. Events that are brought about through probabilistic causation, by contrast, are brute without being uncaused. Though being caused, they are nevertheless partly unexplained since they result from a chancy process. In the metaphysical case, one can distinguish ungrounded facts from brute facts. Fundamental facts are ungrounded and admit of no explanation. Probabilistically grounded facts are brute since, though being grounded, they are partly unexplained and only admit of incomplete explanations.[2]

Something that is probabilistically grounded is to some extent grounded and

[2]Stochastic explanations are widely recognised in the case of causation, yet rejected in the case of grounding: "When it comes to metaphysical ground …the very idea of a probabilistic connection makes no sense" (Rosen: 2017, p. 281). This is seen as an important disanalogy between causation and grounding. The theory of probabilistic grounding removes this disanalogy, bringing causation and grounding more closely together.

to some extent brute. Though its ground is incomplete, it does have a ground. Accordingly, it is not fundamental but derivative. What it is to be derivative is to be grounded, whether completely or incompletely. Whilst being derivative, it is nevertheless (to some extent) brute since the ground that it has is incomplete, which means that bruteness can be found at derivative levels. Something that is fundamental, by contrast, lacks a ground altogether. Fundamentalia are not even incompletely grounded. They are ungrounded and hence entirely brute. Whilst everything that is derivative has an explanation, even if only an incomplete explanation, what is fundamental does not admit of any explanation. Fundamentalia admit of maximally incomplete explanations, namely no explanations. Fundamentality is the limit of bruteness.

2.1 Stochastic grounding

Grounds are incomplete when there are grounds that favour incompatible outcomes. Γ and Δ are opposing grounds when Γ is a contributing ground for X and Δ a contributing ground for Y, where X and Y are incompatible. Given that X and Y are incompatible, whatever favours the one contravenes the other. The contributing grounds for X are contravening grounds for Y, and vice versa. When Γ and Δ are opposed, they cannot both ground that which they favour. Otherwise, an inconsistent outcome would ensue. Nor can neither of them ground. There would then not be anything preventing them, given that what prevents X from obtaining is that Y obtains, and vice versa. Hence, only one of them succeeds in grounding.

Two incompatible outcomes are compatible with Γ and Δ. X and Y are each compatible with a situation in which both Γ and Δ obtain. We either have 'X because of Γ, despite Δ' or 'Y because of Δ, despite Γ'. Which of them obtains depends on whether Γ or Δ succeeds in grounding. This is not determined by Γ and Δ. They do not necessitate what happens. They are compatible with both scenarios and hence cannot uniquely fix one outcome. Instead, it is left to chance. It is up to chance which ground wins out, thereby rendering it a brute fact whether X or Y obtains. The presence of opposing grounds, accordingly, makes grounding relations stochastic. Probabilities enter into the theory of grounding due to opposing grounds amongst which chance needs to adjudicate.[3] Rather than starting out with probabilistic resources and putting them in by hand, we start out with non-probabilistic notions and identify a place where chance has to come in.

Stochastic grounding implies a rejection of necessitation. Whilst grounds are commonly thought to necessitate: if Γ grounds X then $\Box(\Gamma \rightarrow X)$,[4] this principle is false when dealing with contravening grounds. Γ can ground X, yet

[3] Probabilities are construed as objective chances in line with propensity interpretations.

[4] Cf. "Conditional grounding" (Bader: manuscript) for an account of conditional grounding that only underwrites conditional necessitation.

can fail to necessitate X if Γ is compatible with a contravening ground Δ that can ground Y and thereby preclude X from obtaining. The contributing grounds Γ deterministically ground X only in the absence of contravening grounds. If there are no contravening factors, then Γ is a complete ground for X and the probability of it grounding X is $= 1$, i.e. nothing is left to chance.[5]

Whether Γ is a complete or an incomplete ground of X depends on whether a contravening ground Δ is present.[6] Incomplete grounds thus differ from partial grounds. Unlike merely partial grounds, which need to be supplemented by other partial grounds to arrive at a full ground, incomplete grounds do not need to be supplemented to arrive at a complete ground. Instead of supplementing Γ, one makes it into a complete ground by removing contravening grounds. Whereas a partial ground is a part of a full ground, an incomplete ground is a full ground that has opposing grounds. In the same way that Γ is a full ground when it is unopposed and completely explains X, it is likewise a full ground when it only incompletely explains X in the presence of contravening grounds. Although incomplete grounds need to be supplemented by chance in order to succeed in grounding, chance itself is not a ground. Rather than being part of the ground of X, chance is what makes it the case that Γ grounds X.

When there are opposing grounds, explanation takes the form: 'X is grounded in Γ, despite Δ'.[7] The contributing grounds Γ explain X, despite the contravening grounds Δ. Incomplete grounds underwrite incomplete explanations. Such explanations go some but not all of the way towards explaining the explanandum. Whatever is missing for a complete explanation is left to chance. The lower the probability, the more is left for chance to do. The phenomenon in question will then be more brute and the explanation less complete. A more complete and hence stronger explanation is one that leaves less to chance. The strength of an explanation can, accordingly, be understood in terms of how much it leaves to chance and hence how far it is from a complete explanation.

If two opposing grounds favour incompatible outcomes X and Y, then these outcomes will be equiprobable: $P(\Gamma \text{ grounds } X \mid \Delta) = \frac{1}{2}$ and likewise for Δ grounding Y. This is because symmetry at the level of the grounds gives rise to symmetry at the level of the probabilities. Since the probabilities are generated from the interaction of opposing grounds, equiprobability results when the op-

[5]The only necessitation principles that one can accept in the context of stochastic grounding are: if Γ grounds X then $\Box(\Gamma \rightarrow P(X) > 0)$, and: if Γ grounds X then $\Box((\Gamma \wedge \neg\Delta) \rightarrow X)$.

[6]Γ can be both a complete immediate ground and an incomplete mediate ground of X. If $X = Y \vee Z$ where Y is a stochastic ground of Z, then Y can both immediately deterministically ground X and stochastically ground Z which deterministically grounds X, thereby rendering Y a mediate stochastic ground of X. (This is analogous to how a disjunction can be both fully and partially grounded in Γ if absorption principles fail, and how Γ can be both a mediate conditional ground and an immediate unconditional ground of the same fact.)

[7]Cf. Humphreys: 1989 for a very helpful account of probabilistic explanation that has the form 'X because of ϕ, despite ψ'.

posing grounds are perfectly balanced. The probabilities decrease as the number of incompatible outcomes increases. If Z can be grounded in Λ then the probability of each of these three grounding relations $= \frac{1}{3}$. There will then be multiple contravening grounds for any given outcome, such that $P(\Gamma \text{ grounds } X \mid \Delta) > P(\Gamma \text{ grounds } X \mid \Delta, \Lambda)$.

If there are asymmetries at the level of the grounds, then asymmetric probabilities result. If some outcome has more contributing grounds than another, then the probability of that outcome is higher. The probability of X being grounded in its contributing grounds Γ_1 and Γ_2 is higher if both of them obtain than if only one of them obtains. If Γ_1 and Γ_2 have the same contravening ground Δ, then Γ_1 grounds X iff Γ_2 likewise grounds X, since there is nothing to prevent either of them from grounding X if Δ fails to ground Y. They only fail to ground X if their opposing ground succeeds in grounding Y (which is incompatible with X) and thereby prevents all contributing grounds of X from grounding X.[8]

By contrast, Γ_1 and Γ_2 are probabilistically independent if they have different contravening grounds (that are probabilistically independent from each other). Only one of them can then ground X. This can happen if X is disjunctive and the different Γ's relate to different disjuncts. For instance, if $X = Y \vee Z$, then there can be a contravening ground Δ that prevents Γ_1 from grounding Y (and thereby from grounding X) by grounding some outcome that is incompatible with Y but compatible with X so that Γ_2 can nevertheless ground Z and hence X. Both Γ_1 and X can then obtain without Γ_1 grounding X, since X is instead grounded in a different disjunct. Δ is thus not a contravening ground of X but of Γ_1 grounding X. It operates, not by grounding something that is incompatible with X, but by grounding something that is incompatible with Y, thereby preventing Γ_1 from (mediately) grounding X.

These cases show that probabilities (and bruteness) apply in the first place to grounding relations and only derivatively to the obtaining of facts. What is at issue is the probability of a grounding relation (i.e. there is a probability P that Γ grounds X), rather than a ground of a probability (i.e. Γ's grounding contribution is exhausted by raising the probability of X).[9] Consider again the disjunctive fact $X = Y \vee Z$. If Γ_1 is a stochastic ground of Y, then it is also a (mediate) stochastic ground of X, given that X is deterministically grounded in its disjuncts. The probability pool interpretation cannot make sense of Γ_1 being a stochastic ground of X in a context in which both Γ_1 and Z obtain. In that case the probability of

[8] Since X fails to be grounded in any of its contributing grounds iff some incompatible outcome Y is grounded by some opposing ground, the probability of the disjunction of the different outcomes that have contributing grounds, e.g. $X \vee Y$, is $= 1$. The probability that some contributing ground of X succeeds in grounding X is the complement of the probability that some contravening ground succeeds in grounding an incompatible outcome Y.

[9] This is analogous to the causal case if one rejects the probability pool interpretation. The main difficulty for the probability pool account results from overlapping cases (cf. Schaffer: 2000 and Hitchcock: 2004) – these arise naturally in the context of grounding.

X obtaining is 1, yet if there are contravening grounds for Γ_1 grounding Y, then the probability of Γ_1 grounding Y will be less than 1. Γ_1 is a probability-raiser of Y but not of X. Yet, transitivity implies that if Γ_1 is a stochastic ground of Y, then it is likewise a stochastic ground of X. Accordingly, stochastic grounding cannot be understood in terms of probability-raising. Instead, probabilities concern the likelihood of particular grounding relations.

2.2 Mitigating bruteness

Although everything that is fundamental is brute, the converse does not hold. Stochastic grounding makes room for non-fundamental bruteness, thereby allowing entities that occupy derivative levels, such as mereologically complex objects, to feature in brute facts. This is important for several reasons.

First, stochastic grounding mitigates bruteness. Non-fundamental brute facts admit of incomplete explanations. Something that is stochastically grounded is not entirely brute, but admits of explanation in terms of its contributing grounds. Its bruteness is, accordingly, limited. Stochastic grounding thereby reduces the extent to which things are unexplained.

Second, fundamental facts are generally independently recombinable. Brute facts would likewise be independently recombinable if fundamentality and bruteness were to coincide. Yet, in many cases there is bruteness without unrestricted recombination. Brute facts often exhibit patterns that are unintelligible in the case of fundamentalia. Non-fundamental bruteness renders such patterns intelligible. What lacks a ground is not the range of possible outcomes, but only the way in which chance adjudicates amongst the various opposing grounds and fixes one of these outcomes. Only the contrastive fact that, say, X as opposed to Y obtains lacks an explanation. Although supervenience fails, due to the underdetermination of the relevant outcomes, the range of possible outcomes does supervene. Which outcomes are possible is not brute but explained by the opposing grounds. Though it is not determined that X rather than Y obtains when Γ and Δ obtain, it is determined that one of X and Y obtains. If X and Y were fundamental rather than stochastically grounded, the supervenience of the available outcomes would not be explicable. Not only would one have to consider the obtaining of such facts to be fundamental and inexplicable, but also the patterns amongst such facts.

Third, non-fundamental bruteness allows for a unified treatment of cases involving opposed grounds and cases involving unopposed grounds. Unless X is brute yet non-fundamental, the treatment of opposed and unopposed cases becomes unduly disjunctive and obscures what these cases share in common. If X obtains in a situation in which Γ is unopposed, then X is derivative and is deterministically grounded in Γ. Now, if, rather than merely being brute, X were fundamental in the opposed case where supervenience fails, then the fundamentality status of X would switch between these cases. One would have to distinguish a fundamental variant X_f from a derivative variant X_d and consider X to be the disjunction of the two, without them being unified in terms of how they are grounded. By contrast, when considering X to be derivative and to have grounds, these cases merely differ in that the grounds are opposed in the one case but not the other.[10] Since Γ is the ground in each case, these cases share something in common. Accordingly, one ends up with a unified treatment rather than an objectionably disjunctive account.

Since the same ground that is opposed in one context (where it only grounds stochastically) can be unopposed in another context (where it grounds deterministically), this ground can incompletely explain X even when the connection is merely stochastic. Since Γ can do the explanatory/grounding work in the unopposed case where the grounding connection is deterministic, it can likewise do the work when there are opposing grounds that render the connection merely probabilistic. Although it cannot guarantee X in this context, since the grounds run out and need to be supplemented by chance, it nevertheless underwrites an incomplete explanation of X. The contributing grounds, accordingly, explain X, even when contravening grounds ensure that they do not guarantee X. The way in which Γ explains X in opposed cases is thus continuous with the way in which it explains X in unopposed cases.

Fourth, unless one countenances non-fundamental bruteness, Sider's purity constraint, which requires that fundamental facts only contain fundamental constituents (cf. Sider: 2011, sections 7.2 & 7.3), debars derivative entities, such as mereologically complex objects, from featuring in brute facts. One would then be unable to address underdetermination by invoking bruteness when dealing with derivative objects. Instead, one would have to consider such cases to involve (ontic) indeterminacy.[11] This, however, is unpalatable and can be avoided by countenancing non-fundamental bruteness.

3 Symmetry-breaking

Paradigm cases of opposing grounds are ones in which symmetry at the fundamental level is combined with asymmetry at derivative levels. In that case the fundamental level does not uniquely fix the derivative but is compatible with multiple distributions of properties at derivative levels. The resulting underdetermination implies a violation of supervenience of the derivative on the fundamental. There is a difference at the derivative level yet nothing at the fundamental level that could make a difference. Whilst the fundamental level underdetermines whether X or Y obtains, bruteness can effect the requisite symmetry-breaking to privilege

[10]This is analogous to how c can be a deterministic cause of e in one context, yet only a probabilistic cause of e in a different context in which contravening factors are present.

[11]For an account of how underdetermination, indeterminacy and bruteness interact, cf. "Coincidence and supervenience" (Bader: manuscript).

one of these candidates.

Underdetermination here results, not from a lack of grounds, but from there being multiple grounds for incompatible outcomes. It involves grounding gluts rather than grounding gaps. It is not because there is no ground that one has to posit bruteness, but because there are too many grounds amongst which only chance can adjudicate. Since chance determines which contributing ground wins out, the fact that X rather than Y obtains is a brute fact. By reconciling bruteness with non-fundamentality, the theory of stochastic grounding renders the resulting bruteness (relatively) non-objectionable.

3.1 Symmetric fission

Fission cases nicely illustrate the fruitfulness of the stochastic approach. In a symmetric fission case, each fission-product B and C has an equal claim to being identical to the person A that underwent fission. Assuming that there is only one person pre-fission (which excludes cohabitation approaches) and that there are two persons post-fission (which excludes bilocation approaches),[12] there are five possibilities:

1. $A = B \wedge A = C$
2. $A = B \wedge A \neq C$
3. $A \neq B \wedge A = C$
4. $A \neq B \wedge A \neq C$
5. $\nabla(A = B) \wedge \nabla(A = C)$

IDENTICAL TO BOTH

The suggestion that one person becomes two is incompatible with the logic of identity. The transitivity of identity rules out the possibility that both $A = B$ and $A = C$, given that $B \neq C$. Identity is a one-one, not a one-many, relation. One thing cannot be identical to two things.[13]

[12] Standard bilocation approaches consider the original person to persist as a scattered object. Non-standard approaches consider persons to be higher-order entities that allow for non-unique manifestations, such that A, B and C are different manifestations of the same higher-order entity. A non-unique manifestation relation allows for identity at the level of the higher-order entity, without identity at the level of the manifestations. A fission scenario then involves one person that has a single manifestation, namely A, prior to fission, yet two distinct manifestations, namely B and C, subsequent to fission. (Thanks to Mark Johnston for helpful discussions.)

[13] In response one might try to revise the logic of identity. Gallois: 1998, for instance, allows for occasional identities by rejecting the requirement that transitivity holds across time. This approach, however, gives rise to intra-temporal transitivity violations (cf. Bader: 2012). Alternatively, one might deny that persistence is a matter of identity. Instead of operating with a trans-temporal identity relation, stage theory accounts for temporal predication in terms of tem-

identical to only one

Options 2 and 3 respect the fact that identity is a transitive one-one relation. Yet, they are problematic on two counts.

First, symmetry considerations speak against treating B and C differently. Since B and C are symmetrically situated vis-à-vis A, nothing favours one over the other. Accordingly, treating them asymmetrically and considering only one of them to be identical to A is entirely arbitrary.

Second, the suggestion that A is identical to only one of B and C conflicts with the intrinsicness of identity, given that identity is preserved in non-branching cases that are perfect duplicates as far as A and B are concerned, but in which C does not exist (and likewise for non-branching cases in which B does not exist). A' and B' in the non-branching case are intrinsically indiscernible from A and B in the branching case and stand in the same fundamental relations to each other (though cf. section 3.2 below). The 'only x and y rule' (cf. Wiggins: 1980), which states that whether x and y are identical depends only on x and y and the relations in which they stand to each other, implies that $A = B$ in the branching case iff $A' = B'$ in the non-branching case.[14] Since they are duplicate processes, intrinsicness implies that one process preserves identity iff the other does likewise. The intuitiveness of this principle is brought out by Parfit's question: "how could a double success be a failure?" (Parfit: 1984, p. 256). If identity is preserved in the non-branching case, how can the extrinsic addition of a further (seemingly successful) branch connecting A to C imply that the branch connecting A to B fails to preserve identity?

identical to neither

If A can neither be identical to both, nor to only of them, it might seem that A is identical to neither B nor C. A goes out of existence upon undergoing fission and two new persons come into existence. This denial of identity is usually paired with the suggestion that it is survival rather than identity that matters. Although identity is not preserved, what matters is nevertheless preserved. Since survival is neither a one-one relation, nor a transitive relation, fission cases are unproblematic for survival: A is identical to neither B nor C but survives as both of them. A

poral counterpart relations (cf. Sider: 2001; Hawley: 2001). One-many counterpart relations allow A to persist as both B and C. A will be in room 1 at t' since A has a temporal counterpart, namely B, in that room at t', and A will be in room 2 at t' since A has a temporal counterpart, namely C, in that room at t'. Yet, A will not be in both rooms since A does not have a temporal counterpart that is in both rooms. To ensure that these temporal predications cannot be agglomerated, stage theorists have to insist that the counterpart relations underwriting these two predications differ, yet symmetric fission cases are precisely ones where the relation between A and B is the same as that between A and C (cf. Bader: 2016 for a critique of one-many counterpart relations).

[14] The 'only x and y rule' runs into difficulties due to maximality conditions. These can be addressed by a theory of conditional intrinsicness, cf. "Relativised intrinsicality" (Bader: manuscript).

flexible notion of survival can thus easily accommodate fission (cf. Parfit: 1984, part 3).

However, the original puzzle about identity still remains.[15] The very condition Γ that suffices for the identity $A' = B'$ in the non-branching case is also satisfied in the branching case (likewise for Δ which suffices for the identity $A'' = C''$). If these conditions are deemed to be sufficient for identity, one is saddled with the inconsistent claim that A is identical to both fission products. Accordingly, one has to reject that Γ and Δ are sufficient conditions in branching cases. This can be done by including a non-branching requirement: x at t is identical to y at t′ if (i) x and y satisfy condition Γ or Δ and (ii) this is a non-branching case.

Whilst avoiding the commitment to A being identical to both, the non-branching requirement is a non-local requirement that conflicts with intrinsicness (though cf. section 3.2 below). Identity criteria that include a non-branching clause conflict with the only x and y rule. Whether a given case is a branching case not only depends on x and y but also on z. This rejection of intrinsicality leads to objectionable non-causal counterfactual correlations between distinct objects. For instance, if B had not existed, C would not have existed either (and vice versa). Had B not existed, the non-branching clause would have been satisfied. Accordingly, A would have persisted on the C-branch and no new object C would have come into existence. B and C are thus counterfactually interdependent (cf. Garrett: 1990, section 7 & Hawley: 2005, section 5).

The verdict that A ceases to exist in the branching case is inconsistent with (i) A′ is identical to B′ in the non-branching case and (ii) identity is intrinsic. Given intrinsicness, one can adopt option 4 only if one denies that identity is preserved in non-branching cases. One can then drop the non-branching requirement and use identity criteria that are compatible with the only x and y rule. Doing so, however, leads to unpalatable implications, since it drastically restricts what kinds of changes objects can survive.

Moreover, the non-branching requirement is stipulated without adequate explanation. That the logic of identity would be violated if A were to be identical to both B and C might give us a reason for considering A to go out of existence upon fissioning. However, it does explain why it is that A ceases to exist. As Robinson notes in the case of amoebic fission, "there appears to be no guarantee that anything to be learnt about amoebae would provide natural grounds, *independent* of our desire to preserve transitivity of identity, for declaring that division spells death for amoebae" (Robinson: 1985, p. 312). In general, an object's sortal determines what changes that object can and cannot survive. Accordingly, one needs to spell out identity criteria for the objects in question that explain why fission amounts to going out of existence. Something about the nature of persons

[15] "The paradox is not dealt with by …changing the subject, ceasing to talk seriously about personal identity, and instead talking about what matters to us in survival" (Johnston: 1989, p. 377).

(or amoebas etc.) has to explain why such objects cannot survive fission.

INDETERMINATELY IDENTICAL

Option 5 preserves symmetry by appealing to indeterminacy. Neither B nor C is privileged. It is determinate that A is identical to one of them: $\Delta(A = B \veebar A = C)$. Yet, it is indeterminate to which of them it is identical.[16] Although treating B and C symmetrically, this approach nevertheless violates intrinsicness. For intrinsicness not to be violated both $A = B$ and $A = C$ would have to obtain. However, it is determinately the case that A is only identical to one of them. It is hence determinate that there is some case in which intrinsicness is violated, though in each case it is indeterminate whether that case is the one that violates intrinsicness. In short, it is determinate that intrinsicness fails, yet indeterminate on which branch it fails. In addition to violating intrinsicness, this approach involves a problematic commitment to metaphysical indeterminacy, in particular to the indeterminacy of identity.

3.2 Brute persistence

The ascription of identity in non-branching cases together with a commitment to intrinsicality leads to inconsistency in branching cases. If identity is preserved in non-branching cases, then intrinsicness implies both $A = B$ and $A = C$.[17] This, however, is incompatible with the logic of identity. Since the logic of identity is sacrosanct, we either have to reject intrinsicness or reject that identity is preserved in non-branching cases.

This unpalatable choice can be avoided by means of stochastic grounding. In non-branching cases, persistence is deterministically grounded. A' satisfies condition Γ which grounds that A' persists as B'. Similarly, A'' satisfies condition Δ which grounds that A'' persists as C''. Persistence is deterministically grounded in

[16] This approach locates indeterminacy in the world, namely in the identity relation, and is not to be confused with locating indeterminacy in the concept of a person. Cf. "When a case necessarily violates some principle relatively central to our conception of persons and their identity over time, the concepts of a person and of being the same person over time may not determinately apply in the case, so that there may be no simple fact about personal identity in that case" (Johnston: 1992, p. 603; also cf. Williamson: 1990, pp. 119-120).

[17] The bilocation approach, which denies that there are two persons post-fission and instead considers A to persist as B and C taken together, i.e. $A = \text{fu}(B, C)$, is also incompatible with standard versions of intrinsicness. One can, however, argue that persistence is conditionally intrinsic by claiming that persistence is grounded in the intrinsic features of certain processes, conditional on the processes being maximal. Proponents of bilocation consider the R-relation to be an equivalence relation. The maximal process in a fission case is thus the Y-shaped process connecting A to B and C taken together. The processes connecting A to B and A to C are, accordingly, submaximal. Although their duplicates, which connect A' to B' and A'' to C'', preserve identity, conditional intrinsicality does not imply that $A = B$ and $A = C$, since only processes satisfying the maximality condition have to agree in terms of preserving identity. (Thanks to Mark Johnston for helpful discussions.)

each case since there are no countervailing considerations. In branching cases, by contrast, A satisfies both Γ and Δ. Since their outcomes are incompatible, given that A can be identical to only one of B and C, Γ and Δ are opposing grounds. Whatever speaks in favour of $A = B$ speaks against $A = C$ and vice versa. Γ is a contributing ground of the former identity and a contravening ground of the latter, whereas Δ is a contravening ground of the former and a contributing ground of the latter. Satisfying condition Γ is thus not a sufficient condition for A persisting as B in branching cases (and likewise for Δ in the case of A and C). Instead, it is only a contributing ground that can stochastically ground $A = B$. Since we are dealing with symmetric fission cases, there is symmetry at the level of contributing/contravening grounds. The contributing grounds on each side are equally strong, which ensures equiprobable grounding connections. The probability that Γ grounds $A = B$ in the presence of the opposing ground Δ is $\frac{1}{2}$, i.e. $P(\Gamma(A) \text{ grounds } A = B \mid \Delta(A)) = \frac{1}{2}$.

Since the contravening and contributing grounds of $A = B$ and $A = C$ are anti-correlated, $P(\Gamma(A) \text{ grounds } A = B \vee \Delta(A) \text{ grounds } A = C) = 1$. A cannot be identical to both (since $A = B$ rules out $A = C$ and vice versa). It also cannot be identical to neither, since A satisfies the relevant persistence conditions. In fact, it satisfies them twice over. If A were to be identical to neither, there would be nothing to rule out either of these identities. Yet, given that A satisfies Γ it will persist as B unless it persists as something else, and likewise for persisting as C. The only thing that can rule out $A = B$ is $A = C$, and vice versa. Accordingly, A is guaranteed to be (determinately) identical either to B or to C, without it being guaranteed to which of them it is identical. Put differently, whilst it is guaranteed to be identical to one of them, it is underdetermined to which of them it is identical. Which of the two opposing grounds succeeds in grounding A's persistence, despite the presence of the other ground, is then a matter of chance.

This approach relies on distinguishing fundamentality and bruteness. Since identity is brute, but not fundamental, there can be informative criteria of identity. There is no commitment to what Zimmerman: 1998 calls 'identity mysticism'. Identity through time is not fundamental, but something that can be explained, though only incompletely explained in fission cases. In fact, it is precisely because there are persistence criteria that there are opposing grounds and that persistence is underdetermined in branching cases. Persistence involves bruteness and is only stochastically grounded because A satisfies both Γ and Δ. The persistence conditions are satisfied twice over. Since A satisfies both conditions, yet only one of them can ground persistence, it is underdetermined whether A persists as B or as C, thereby rendering it a brute fact which of them is identical to A. Yet it is only brute that, say, B rather than C is identical to A, but not that D is not identical to A, given that A does not satisfy the conditions for persisting as D. The criteria explain why B and C are the only candidates. It is brute that A persists as B rather than C, but not that it persists as one of B and C.

Since there are no sufficient but only necessary conditions for persistence in branching cases, persistence criteria, on this approach, do not encompass sufficient conditions.[18] Instead, there are contributing grounds that are sufficient in the absence of contravening grounds. Although they are sufficient in non-branching cases, in branching cases they only suffice for a probability of being identical but not for identity itself. What makes for identity need not guarantee identity. The stochastic approach thus rejects sufficient conditions in branching cases, yet accepts persistence criteria that specify contributing grounds that suffice for identity in non-branching cases.

The stochastic account avoids all the difficulties facing the other proposals:

THE LOGIC OF IDENTITY

There is no conflict with the logic of identity. The stochastic account respects that identity is a transitive one-one relation that cannot hold indeterminately. By operating with an indeterministic grounding connection, one ensures a determinate outcome and precludes indeterminacy from entering into the identity relation.

SYMMETRY CONSIDERATIONS

Suggesting that A is identical to only one of B and C seems problematic because symmetry considerations speak against privileging one of them. Nothing distinguishes the two candidates and makes one of them more eligible to be the one that is identical to A. There is nothing to privilege one over the other. Picking one of them and treating it as the successor is arbitrary and groundless.

The stochastic account respects these symmetry considerations. At the level of the probabilities, the two candidates are treated symmetrically. The probability assignments involve no arbitrariness and do not require any invidious distinctions. Yet, symmetry at the level of probabilities is combined with asymmetry at the level of the outcome. Though B and C have an equal claim, only one of them ends up being A's successor. One of B and C is privileged, without there being anything that privileges it. Since B and C are symmetrically related to A, there is nothing that makes a difference. The difference is a brute difference. Bruteness, accordingly, functions as a symmetry-breaker.

INTRINSICNESS VIOLATIONS

Traditional approaches either analyse intrinsicality in terms of duplication or accept that intrinsicality implies being shared across duplicates. The stochastic account rejects this connection between intrinsicality and duplication. It allows

[18] Although there are no sufficient conditions in branching cases but only probabilistic grounding connections, there are necessary conditions. For instance, the disjunction of all possible contributing grounds is a necessary condition. As Williamson notes, "[o]nce the claim of sufficiency is withdrawn, the cases of fission and fusion present no obstacle to the claim of necessity" (Williamson: 1990, p. 117).

intrinsic properties to differ across duplicates and thereby makes it possible for the intrinsicness of identity (which is one of the central desiderata for a theory of persistence) to be preserved in fission cases.

Stochastic grounds are not partial but incomplete grounds. Unlike a partial ground, which can be supplemented by further partial grounds to form a full ground, an incomplete ground is a full ground. It can only be supplemented by chance. Chance, however, is not a ground. If the grounding connection between Γ and F is probabilistic, x's being F is not completely explained by x's intrinsic properties. Nevertheless, when x's being F is grounded in Γ, it is wholly grounded in this way.[19] Accordingly, x's being F is fully explained in terms of Γ. All the grounds that it has (all its contributing features) are intrinsic. If x's being F is incompletely grounded in Γ, then x is F wholly in virtue of how it itself is. Consequently, it is F intrinsically, since a derivative property F is had intrinsically by x iff x's being F is wholly grounded in intrinsic properties of x (or x's parts).[20]

Since these grounds are incomplete grounds, they do not guarantee x's being F. A duplicate y of x can thus not be F. Yet, the incompleteness of the grounds does not make this property instantiation extrinsic. Bruteness does not undermine intrinsicality. After all, fundamental properties are had intrinsically and fundamentality is the limit of bruteness. Non-fundamental properties that are had brutely can likewise be had intrinsically. There is nothing besides Γ that grounds x's being F. The ground of the property instantiation resides entirely within the object. Whilst this stochastic ground does not necessitate x's being F, it is nevertheless the entire ground of x's Fness. The failure of duplication is not due to extrinsic grounds that are present in one case but not in another, i.e. x and y do not differ with regard to Fness because being F consists in being related or failing to be related to objects that are disjoint from the object instantiating Fness. Instead, the failure of duplication results from a failure of grounding.

One might object that the grounding connection is stochastic because of the existence of contravening grounds. Since such grounds appear to be extrinsic, intrinsicness seems to be undermined.[21] To avoid this problem, we need to reject the idea that the grounds of persistence consist in a relation that connects x and y. If $x = y$ is grounded in x and y standing in relation R, then the contravening grounds of $x = y$ would indeed be extrinsic. They would consist in x standing in R to some further object z. There being a distinct z to which x is R-related would then render the connection stochastic.

This needs to be rejected. Persistence criteria are not to be understood as connecting up objects existing at different times. One does not start out with x at t and y at t' and then asks under what conditions they are identical. Instead,

[19] Even though the fact that Γ obtains is an incomplete explanation of x's being F, that Γ grounds x's being F is a complete explanation of x's being F.

[20] This is a generalisation of the hyperintensional account developed in Bader: 2013.

[21] Closure will fail if the contributing grounds of F are intrinsic yet the contravening grounds that, if successful, ground not-F are extrinsic. F would be intrinsic yet its negation not-F extrinsic.

persistence criteria specify the conditions that x has to satisfy at t in order for it to persist until t′. They specify what is required for x's continued existence. We start out with one thing and ask what changes it can survive, in particular whether it will continue to exist given the influences to which it is subject. By rejecting the idea that we start out with 'two' things and ask whether they are identical, we circumvent the problem of the triviality of identity, namely that there seemingly cannot be informative criteria or grounds of identity, since identity is trivial in the sense that everything is identical to itself and to nothing else.[22] The relevant conditions thus only involve x and do not make reference to y or some distinct z. In short, we should operate with the 'only x' rule, not the 'only x and y' rule.

Once we reject the 'only x and y' rule, which considers persistence to be grounded in facts obtaining at different times together with trans-temporal relations connecting x and y, the intrinsicness of persistence is no longer to be understood in terms of duplicate R-related pairs not differing in terms of persistence. Rather than being concerned with grounding trans-temporal relations, the 'only x' rule is concerned with the grounds of immanent causation. Intrinsicness is understood in terms of the conditions that x has to satisfy at t in order for it to persist until t′. These conditions are intrinsic if duplicate inputs give rise to duplicate outputs. This combines an understanding of persistence in terms of immanent causation with an account of causation that treats it as a generative operation that has an input-output structure, rather than as a relation that connects different events that function as its relata. The intrinsicness of persistence is then simply a special case of the intrinsicality of generative operations, which amounts to the inputs being specified intrinsically. As long as the inputs are specified intrinsically, persistence is intrinsic. If the relevant generative operation operates deterministically, duplicate inputs will yield duplicate outputs. However, when operating stochastically outputs need not be duplicates but can differ.

Persistence is intrinsic if the conditions that A has to satisfy for it to continue to exist are specified in terms of A's intrinsic properties. In fission cases A satisfies both Γ and Δ, thereby underdetermining its persistence. A satisfies the persistence criteria twice over, rather than there being multiple things, namely B and C, that satisfy the identity criteria with respect to A. There are both contributing grounds for A persisting as B and for A persisting as C. Both the contributing grounds of $A = B$, namely Γ, and those of $A = C$, namely Δ, are intrinsic features of A. Accordingly, the contravening grounds are not extrinsic. Stochastic grounding thus respects the intrinsicality of identity, whilst rejecting the requirement that duplicates of non-branching cases have to preserve identity when they are part of branching cases.

[22] "Identity is utterly simple and unproblematic. Everything is identical to itself; nothing is ever identical to anything else except itself. There is never any problem about what makes something identical to itself; nothing can ever fail to be. And there is never any problem about what makes two things identical; two things never can be identical" (Lewis: 1986, pp. 192-193).

COUNTERFACTUAL CORRELATIONS

The non-branching requirement generates objectionable counterfactual correlations. If the original person A ceases to exist upon fission and two new persons B and C come into existence, then their existence is counterfactually interdependent: if B had not existed, C would not have existed either.

The stochastic account deems there to be two persons in a fission case. The original person persists on one of the branches and a new person that occupies the other branch comes into existence after the fission. If A = B, for instance, then the new person is C. The existence of the new person is then counterfactually dependent on the existence of the B-branch. If the B-branch had not existed, the new person would not have existed and A would instead have persisted on the C-branch.[23] One might object that the dependence of the existence of the new person on the existence of the other branch amounts to an objectionable form of counterfactual correlation.

The fact that if the other branch had not existed, then the new person would not have existed is not an objectionable counterfactual correlation if the two branches are connected. The problem is that the branches are not suitably causally connected. Though they have a common causal origin, since both are causally connected to A, this indirect connection does not explain the relevant correlations (cf. Garrett: 1988, p. 107). A causal explanation would require some causal influence between B and C, yet no such influence can be found.

Instead of a causal connection, we can identify a grounding connection. Importantly, A would have differed intrinsically if the other branch had not existed. Fission cases are frequently presented in a misleading way: whether fission occurs is taken to be a function of whether both operations succeed. This is incorrect. It is not subsequent events at t′ involving B and C that determine whether A underwent fission at t. Instead, whether fission occurs depends on what happens to A at t. There is something about A that makes it the case that it undergoes fission and gives rise to two branches. Since B and C are brought about by A via immanent causation, anything that prevents fission has to operate by changing A intrinsically. Accordingly, if A had not fissioned and if the B-branch had not existed, then A would have had to have differed at t.[24] In particular, A would only have satisfied condition Δ but not Γ.

That A would have differed in this way matters when it comes to whether A persists on the C-branch and hence matters when it comes to whether a new person exists on that branch. Whether the original person persists on the C-branch depends on whether there are contravening grounds Γ. If there are no contra-

[23] This does not violate the necessity of identity since the person on the C-branch in the fission case (namely the new person) is not identical to the person on the C-branch in the non-branching case (namely the original person), cf. Garrett: 1990, section 6.

[24] This counterfactual involves backtracking reasoning.

vening grounds but only the contributing grounds Δ, then these contributing grounds deterministically ground $A = C$. If $A = B$ is stochastically grounded in Γ, then it is the case that if the B-branch had not existed, then A would not have satisfied condition Γ so that Δ would have deterministically grounded $A = C$ and no new person would have come into existence on the C-branch. The difference in persistence facts is thus explained on the basis that the counterfactual supposition that the other branch does not exist implies a change with regard to the contravening grounds of $A = C$. Since Γ and Δ are opposing grounds, the two branches are suitably connected to explain the counterfactual correlations and render them non-objectionable.

Given that A would have differed intrinsically if the other branch had not existed, there cannot be perfect duplication across branching and non-branching cases: A' and B' are not perfect duplicates of A and B. Nevertheless, there is perfect duplication of all those features, namely Γ, that ground persistence in the non-branching case, so that $A = B$ iff $A' = B'$ (if grounding were to imply necessitation). The fact that A differs intrinsically between branching and non-branching scenarios implies that one can specify the non-branching clause intrinsically. Correspondingly, some CC-accounts can be specified in a way that is not objectionably extrinsic.[25] Non-branching accounts as well as these CC-accounts are problematic, not because they make identity extrinsic, in the sense of depending on the (non-)obtaining of a relation to something else, but because they consider those features that ground persistence to only be grounds in the absence of other features. Grounding becomes context-dependent, where the context consists in the other properties that the object instantiates, rather than in its external environment. Even though the stochastic account is also context-dependent, since the presence of opposing grounds determines whether a grounding connection is deterministic or merely stochastic, the fact that something is a contributing ground is an invariant matter.

NON-BRANCHING CLAUSES

The stochastic account operates with informative identity criteria and does not build in a non-branching clause. Once identity criteria are understood in terms of contributing grounds of persistence, rather than in terms of necessary and sufficient conditions, one can provide a unified treatment of branching and non-branching cases, rather than treating them in a radically disjunctive manner. Identity criteria are not restricted to non-branching cases but are applied to both cases, where these criteria are specified purely in terms of intrinsic features. The identity criteria are intrinsic and do not make any reference to competitors or

[25] This only works for some versions. Nozick considers four options. Only option 1, which understands persistence in terms of the path of closest continuation, can be stated in this way. Options 2-4, which allow for 'jumps', are extrinsic in an objectionable way (cf. Nozick: 1981, pp. 42-43).

alternative branches, in particular there is no 'closest' condition built into these criteria. The same underlying principles and mechanisms are operative in both cases. The contributing grounds for persistence are the same, independently of whether or not branching occurs.

Branching cases are special since there are contributing grounds for incompatible identities, which makes them contravening grounds for each other. The significance of branching consists in the identity criteria being satisfied twice over, which results in there being opposing grounds that ensure that persistence is grounded stochastically. The absence of branching is thus not a requirement for identity but only a requirement for persistence being deterministically grounded. From this perspective, branching is entirely unproblematic: division does not spell death for an amoeba (or a person etc.). In fact, the amoeba is guaranteed to persist, though it is not guaranteed on which branch it persists.

3.3 Cohabitation

So far we have assumed that there is one person pre-fission yet two persons post-fission. Cohabitation views reject this assumption. They claim that there are already two persons prior to fission, thereby respecting that identity is one-one and avoiding conflicts with the logic of identity.[26]

6. $A_1 = B \wedge A_2 = C$

According to 4Dist cohabitation, two overlapping worms share the person-stages prior to fission, such that there are two persons that are weakly present prior to the fission. This approach is compatible with the logic of identity and does not violate intrinsicness. Although how many persons are weakly present prior to fission is an extrinsic matter that depends on fission taking place later on, this is an unproblematic form of dependence that does not violate intrinsicness.

It has been argued that there is underdetermination because there are two objects that are partly present at t that are indiscernible at that time, yet that have different future trajectories. If objects can have different trajectories despite sharing an initial segment, then the future trajectory of an object is not fixed by the temporary facts that obtain at t (cf. McGrath: 2007). This objection is misguided. There is one temporal part that exists at t and that is a part of two different worms that are weakly present at t', one of which is in room 1 and one of which is in room 2 at t'. That there are these two worms is entailed by the facts that obtain at t together with the causal laws. There is no need to explain which worm ends up where. To be the worm that ends up in room 1 just is to be a fusion of temporal parts where the temporal part that exists at t' is in room 1.

[26] To avoid the counter-intuitive result that there were two persons prior to fission, this approach is usually combined with a revisionist semantics, whereby one does not count in terms of identity. Robinson: 1985, for instance, suggests counting by constitution rather than identity.

If one asks which of the two persons that exist prior to fission ends up in room 1 at t′ and which one in room 2, then the answer is simply that that worm which has a temporal part at t′ that is in room 1 is the one that ends up in this room.

By contrast, the 3Dist cohabitation approach claims that there are two persons that are wholly present prior to fission. In that case, it is underdetermined which of these objects ends up where. One can ask of A_1 why it ends up in room 1 at t′ whereas A_2 ends up in room 2, despite them being indiscernible at t. No answer is forthcoming. Since A_1 and A_2 are indiscernible at t, they both satisfy conditions Γ and Δ. Every condition that A_1 satisfies and that one might invoke to explain why it ends up in a given room is also satisfied by A_2. There is nothing to explain their differential trajectories.

The crucial difference is that, according to the 4Dist, there is only one temporal part at t that happens to be a part of two different worms that are both also partly present at t′ (when these worms no longer overlap but have disjoint temporal parts), yet that, according to 3Dist cohabitation, there are two wholly present objects at t that need to be connected up in a unique and non-arbitrary way to two objects that are wholly present at t′. This is why only 3Dist but not 4Dist cohabitation violates intrinsicness. For the 3Dist intrinsicness implies that A_1 is identical to both B and C (and likewise for A_2). Claiming that A_1 is identical to B whilst A_2 is identical to C amounts to a violation of intrinsicness. For the 4Dist, by contrast, intrinsicness requires that duplicate sequences of temporal parts do not differ in terms of whether they compose a person-worm. This implies that a temporal part prior to fission will be a part of two different worms. Accordingly, intrinsicness is not violated on the 4Dist approach.

The 3Dist cohabitation approach can address these underdetermination and intrinsicness concerns by adopting a stochastic approach. It will then be a brute though non-fundamental fact as to which of the pre-fission objects ends up where after the fission. Yet, in that case one might as well reject cohabitation and opt for the stochastic account, according to which there is only one original person that is identical to one of the fission-products, where it is a probabilistic matter to which of them it is identical. This approach does not give rise to troublesome temporally extrinsic dependence. 3Dist cohabitation, by contrast, implies that how many wholly present objects exist at a time depends on what happens at other times. There are two persons prior to fission only because fission will take place later on, i.e. prior to fission the two persons are only distinguished in terms of temporally extrinsic features (cf. Robinson: 1985, p. 314). This conflicts with (at least some readings of) what it is to be wholly present.

3.4 Asymmetric fission

In symmetric cases the two branches do not differ in terms of what makes for identity. Yet they differ in terms of identity if the original person persists on only one of the branches. This violates supervenience and implies underdetermination of persistence facts.

In asymmetric cases, one fission product has a greater claim to being identical to the pre-fission object than the other. Since there is asymmetry at the fundamental level, the original person can persist on only one of the branches without violating supervenience. For instance, the closest-continuer approach satisfies supervenience (though it violates supervenience on intrinsic features). Asymmetric fission products are treated differently: A is identical to whichever of B and C is the closest candidate. Alternatively, supervenience failures are avoided by non-branching approaches, which treat the asymmetric fission products the same way and claim that the original person ceases to exist. The non-branching requirement is violated by asymmetric fission cases just as much as by symmetric fission cases, such that the original person ceases to exist and two new persons come into existence in asymmetric cases.[27]

Although supervenience holds in asymmetric cases, a commitment to intrinsicness nevertheless implies underdetermination. If the connection on the weaker branch suffices for identity in an isolated non-branching scenario, intrinsicness implies that it likewise suffices in the asymmetric branching scenario. Although the grounds are stronger on one side than on the other, the stronger ones are not guaranteed to win out. Opposing grounds are not weighed up against each other. The intrinsicness considerations that imply underdetermination in symmetric cases do not disappear when there is another candidate that has a stronger claim. Since both branches satisfy the persistence criteria, there are opposing grounds: Γ^+ is a contributing ground for persistence on the stronger branch and Δ^- is a contributing ground for persistence on the weaker branch. These grounds ensure that persistence is underdetermined. Intrinsicness thus rules out both closest-continuer and non-branching approaches.

The closest-continuer account, moreover, is problematic because of concerns about hypersensitivity. Though there is a difference at the fundamental level, it is the wrong kind of difference to explain the asymmetry at the derivative level. The difference between the fission products may be so minute that it is implausible for it to make such a big difference. The difference between asymmetric and symmetric fission cases can be arbitrarily small. Yet for the closest-continuer theorist any difference between the two branches, no matter how small, can suffice for making the difference between the original person persisting on the minutely stronger branch whilst a new person comes into existence on the weaker branch, on the one hand, and the original person ceasing to exist and being replaced by two new persons, on the other. That such a minute difference can make the difference between (non-Parfitian) survival and death seems implausible.

The stochastic account gives a unified treatment of symmetric and asymmetric fission that is sensitive to the differences that occur in asymmetric fission, whilst

[27] Whilst non-branching theories consider the asymmetry to be irrelevant as regards identity, it can be significant for survival, which is a matter of degrees.

strictly adhering to intrinsicness. Unlike non-branching accounts, it does not ignore the differences between the fission products. Yet, unlike closest-continuer approaches, it does not respond to these differences in a hypersensitive way. Instead, it is sensitive to them in a continuous manner. The asymmetry makes a difference without making a radical difference. The stochastic account assigns different probabilities to the different fission products, whereby the probabilities vary continuously with differences between them. The greater claim a fission product has to being identical to the original person, the higher the probability. A minute difference between two fission products does not imply that the slightly closer one is guaranteed to be identical to the original person. Instead of being guaranteed to persist on the stronger branch, it is only more likely to do so. A minute difference in terms of closeness only makes a minute difference at the level of probability. The original person can, accordingly, persist on either branch.[28]

The difference in probabilities is explained in terms of there being more contributing grounds on the stronger than on the weaker branch. The contributing grounds in favour of persisting on the B-branch are stronger than those in favour of persisting on the C-branch if there are more contributing grounds of the former than of the latter type. This happens if the relevant identity criteria are multiply realisable and there are more conditions $\Gamma_1 \ldots \Gamma_n$ that A satisfies and that together make up Γ^+, each of which deterministically grounds persistence on the B-branch when unopposed, than there are conditions $\Delta_1 \ldots \Delta_m$ that are contributing grounds for persisting on the C-branch and that together make up Δ^-. There are then more grounds that preserve identity in isolated non-branching scenarios that favour persisting on the B-branch. Since more grounds favour persisting on the B-branch than on the C-branch, the former is more likely than the latter. In particular, the odds of persisting as B rather than as C are determined by the ratio of the number of contributing grounds, i.e. $|\Gamma^+| : |\Delta^-| = n : m$.[29]

4 Conclusion

Some things lack a sufficient reason, not because they admit of no explanation, but because they only admit of an incomplete explanation. When there are opposing grounds, the derivative is underdetermined. There are incompatible outcomes only one of which can obtain, yet which one obtains is underdetermined. Given the presence of contravening grounds, contributing grounds do not guarantee their outcomes but need to be supplemented by chance. The resulting out-

[28] There will hence be failures of supervenience: duplicate asymmetric fission cases can differ in persistence facts.

[29] If contributing grounds were to differ not only in number but also in strength, then there would be different ways of ending up with asymmetric probabilities. Such an approach, however, would build probabilities into the grounds rather than deriving probabilities from the interaction amongst opposing grounds.

come is thus only stochastically grounded. Though being brute, it is not entirely brute since it has a ground in terms of which it can be incompletely explained. Stochastic grounding mitigates bruteness and confines it to derivative levels, enabling us to deal with underdetermination both in symmetric and asymmetric cases in a way that preserves intrinsicness and avoids hypersensitivity.[30]

[30]Thanks to Fatema Amijee, Theron Pummer, Katherine Hong, Gonzalo Rodriguez-Pereyra, an anonymous referee, and the participants of my seminar on hyperintensional metaphysics at Princeton.

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