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ARTICLE

Weak Superiority, Imprecise Equality and the Repugnant Conclusion

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Abstract

Derek Parfit defends *the Imprecise Lexical View* as a way to avoid *the Repugnant Conclusion*. Allowing for 'imprecise equality', Parfit argues, makes it possible to avoid some well-known problems for *the Lexical View*. It is demonstrated that *the Lexical View* (without imprecise equality) has stronger implications than envisaged by Parfit; moreover, his assumption of *Non-diminishing Marginal Value* makes *the Lexical View* collapse into a much stronger view, which lets the two appear incompatible. Introducing imprecise equality does not address the latter problem. But it does makes it possible for *the Imprecise Lexical View* to soften the discontinuities it would otherwise face, at the cost of blurring the difference between options.

However, if *Non-diminishing Marginal Value* is rejected, the remaining complications for the resulting most plausible version of *the Imprecise Lexical View*, including a confrontation with Arrhenius' *Non-Elitism Condition*, may be within a range where the view largely remains defensible.

1. Introduction

Parfit defends *the Lexical View* as a way to avoid *the Repugnant Conclusion*.[1] This view involves requiring a case of *weak superiority* to be true of the general betterness relation. Parfit acknowledges the objection to weak superiority, that it forces us to accept an implausible discontinuity in value between qualitatively very similar objects. But, he argues, this objection depends on an assumption of 'evaluative precision'. Once we give up this assumption and allow for 'imprecise equality', the objection does not apply.

The present article is concerned with evaluation of this strategy. In section 2, I introduce Parfit's arguments. In sections 3–4, I develop a formal framework, which I then use in sections 5–6 to study the properties of the weak superiority relation under conditions not allowing for and allowing for imprecise equality, respectively. I use the results from these sections to evaluate Parfit's arguments in sections 7–8. Then, in section 9, I confront the most plausible version of *the Imprecise Lexical View* with Arrhenius' *Sixth Impossibility Theorem*. Section 10 summarizes the results.

[1]Derek Parfit, 'Can We Avoid the Repugnant Conclusion', *Theoria* 82 (2016), pp. 100–27; Derek Parfit, 'Material from Towards Theory X', unpublished manuscript (Oxford, 2016), pp. 1–36.

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2. Introduction to Parfit

This section will introduce Parfit's arguments and thereby point out where the formal analysis will set in. Parfit's main ambition in population ethics is to avoid

> *The Repugnant Conclusion*: Compared with the existence of many people who all have some very high quality of life, there is some much larger number of people whose existence would be better, even though these people would all have lives that were barely worth living.[2]

To this end, Parfit proposes

> *The Lexical View*: If many people exist who all have some high quality of life, that would be better than if there existed *any* number of people whose lives, though worth living, would be, in certain ways, much less good.[3]

The Lexical View represents an instance of the kind of relation whose properties will be studied in the next sections. As for domain, Parfit in his arguments considers a sequence of possible types of lives ***a***, ***b***, ***c***, …, ***z*** where each life is better than its successor, but any two neighboring lives are qualitatively very similar.

Parfit calls his sequence a 'continuum'; however, he merely means that the difference in value between neighboring lives is 'small'. But it matters whether the sequence is discrete, or it is truly continuous (dense). It will be a task to reframe the arguments in a framework that allows for denseness.

As I understand the proposal, a sufficiently large population of people with high, but not necessarily *very* high, quality of life may be lexically better than any number of people with much less good lives, but lives still worth living, that is, better than *barely* worth living. When the loss of quality of life reaches a certain size, it can no longer be compensated by quantity.

One possibility regarding *the Repugnant Conclusion*[4] would be to appeal to what Parfit calls

> *Diminishing Value Views*: Though it would always be in itself better if there existed any extra person whose life would be worth living, the goodness of there being more such people would steadily diminish, and would have some upper limit.[5]

But he rejects this kind of view. Instead, he appeals to

> *The Simple View*: Anyone's existence is in itself good if this person's life is worth living. Such goodness has non-diminishing value, so if there were

[2]Parfit, 'Can We Avoid', p. 110.

[3]Parfit, 'Can We Avoid', p. 115. There is another statement at page 112, but it must contain an error; it says 'non-existence' instead of 'existence'. Moreover, on p. 112, Parfit calls it *the Imprecise Lexical View*. But imprecision only enters through further assumptions, see below.

[4]See the discussion in G. Arrhenius and W. Rabinowicz, 'Millian Superiorities', *Utilitas* 17 (2) (2005), pp. 127–46; G. Arrhenius and W. Rabinowicz, 'Value Superiority', *The Oxford Handbook of Value Theory*, ed. I. Hirose and J. Olson (Oxford 2015), pp. 225–48 and K. K. Jensen, 'Millian Superiorities and the Repugnant Conclusion', *Utilitas* 20 (3) (2008), pp. 279–300.

[5]Parfit, 'Can We Avoid', p. 112.

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> more such people, the combined goodness of their existence would have no upper limit.[6]

Clearly, Parfit must mean 'non-diminishing *marginal* value'. However, the concept of 'non-diminishing marginal value' alludes to numerical representation of value, the possibility of which Parfit otherwise denies. Thus, it will be a challenge to give it a meaning without assuming such numerical representation.

Parfit defends *the Lexical View* in at least two different ways. The first consists in meeting a serious objection to lexical views in general, namely that if in a sequence of objects of decreasing value, the first is lexically better than the last, the range of intermediate things must involve at least one sharp discontinuity between neighboring objects, and this is implausible. Parfit's strategy is to meet this objection by giving up an underlying assumption of evaluative precision; and the relevant arguments are mainly to be found in an unpublished manuscript.[7]

Clearly, if *the Lexical View* is true, *the Repugnant Conclusion* is false. The second type of defense consists in addressing seemingly plausible premises that would force us to accept *the Repugnant Conclusion* and thereby make *the Lexical View* untenable. In this regard, Parfit is particularly concerned with so-called *Continuum Arguments*. A *Continuum Argument* is based on a premise of the following form:

> [C]ompared with the existence of many people who would all have lives that were equally worth living, there are some much larger numbers of people whose existence would be better, though these people would all have lives that would be *slightly* less worth living.[8]

Recursive application of this premise combined with transitivity leads to *the Repugnant Conclusion*, Parfit claims. Also, in the case of *the Continuum Argument*, Parfit sees the remedy in giving up an underlying assumption of evaluative precision.

By *evaluative precision*, Parfit appears to imply that value differences can always be measured on a real-valued cardinal scale. He makes at least two independent claims as to why this is not the case. The first claim is that equality cannot always be precise: 'when neither of two things is better than the other, we may need to know whether *this* relation is precise'. It need not be, and Parfit adopts a definition of imprecise equality from John Broome.[9] The second claim is that, because Parfit assumes *Non-diminishing Marginal Value*, he seems to commit himself to the possibility that the value of populations has no upper limit. If lexical superiority is supposed to dominate such populations, Parfit is forced to reject *the Archimedean Property*.[10] These claims will be explained in the formal section.

Corresponding to the two types of defense outlined above, two relevant lines of thought can be identified in the literature. One is roughly concerned with the question that if we have a sequence of objects of decreasing value, what are the implications of

[6]Parfit, 'Can We Avoid', p. 112.
[7]Parfit, 'Material', pp. 2–3.
[8]Parfit, 'Can We Avoid', pp. 116–17.
[9]Parfit, 'Can We Avoid', pp. 113–16; Parfit, 'Material', p. 3, note 3. John Broome, *Weighing Lives* (Oxford 2006) pp. 21–22.
[10]Parfit, 'Can We Avoid', pp. 116–16.

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claiming that the first is lexically better than the last?[11] With one minor exception to be mentioned below, the implications of introducing imprecise equality have not yet been examined in this context.

The other line of thought is the literature on *Continuum Arguments*. As initiated by Larry Temkin and Stuart Rachels (under the name of 'spectrum arguments'), these arguments were understood as a challenge for the transitivity of the betterness relation. However, Parfit understands them rather as arguments for repugnant-like conclusions that refute lexical views. From this perspective, the question becomes: what are necessary and sufficient conditions for blocking the premises of a *Continuum Argument* in order to allow for a case of lexical betterness? In this case, there is an answer in the literature involving imprecise inequality, but it is confined to the case of a discrete sequence.[12]

Although the two strategies and the two lines of thought are distinct, they have important overlaps and it is beneficial to address them together.

3. The framework

I shall adapt the framework, which was developed by Arrhenius and Rabinowicz, and later used by Jensen,[13] but which in the present context needs a minor revision. The abstract framework allows me to present results in a general form which is independent of any specific interpretation.

Consider a set of objects $\boldsymbol{L}$ weakly ordered by a binary relation Q.[14] Two objects are of the same *type*, if they are qualitatively identical with respect to Q; in that case, they belong to the same equivalence class. Call the set of types or equivalence classes $\boldsymbol{P}$ and let $\boldsymbol{Q}$ be the *simple order* on $\boldsymbol{P}$ induced by Q, which is a complete, transitive and antisymmetric relation.[15] If two objects are equally good, a weak order allows that they may be different objects; but in a simple order they must be identical (the same object). I shall be concerned with this domain $\boldsymbol{P}$ of types in this article (indicated by the use of bold), even though I shall often write 'object' for simplicity. But all definitions could also apply directly to the members of the set $\boldsymbol{L}$.

All the literature mentioned merely considers *discrete finite sequences of objects of decreasing* (*or increasing*) *value*. However, the more general case of continuous sequences of objects shall not be excluded from the outset. 'Continuity' shall be cashed out in terms of the sequence in question being an *order-dense subset* of the set of atomic objects $\boldsymbol{P}$:

> *Definition* 1: A subset $\boldsymbol{S}$ of a set of atomic object types $\boldsymbol{P}$ simply ordered by a binary relation $\boldsymbol{Q}$ is *order-dense* in $\boldsymbol{P}$, if and only if, for all $\boldsymbol{x}$ and $\boldsymbol{y}$ in $\boldsymbol{P}$ such that $\boldsymbol{xQy}$, there exists $\boldsymbol{z}$ in $\boldsymbol{S}$, such that $\boldsymbol{xQz}$ and $\boldsymbol{zQy}$.

[11]This line of thought is found in Arrhenius and Rabinowicz, 'Millian Superiorities' and Jensen, 'Millian Superiorities'.

[12]T. Handfield and W. Rabinowicz, 'Incommensurability and Vagueness in Spectrum Arguments: Options for Saving Transitivity of Betterness', *Philosophical Studies* 175 (2018), pp. 2373–87. W. Rabinowicz, 'Can Parfit's Appeal to Incommensurabilities Block the Continuum Argument for the Repugnant Conclusion?', manuscript (2018) applies their result directly to Parfit's attempt to refute *Continuum Arguments* for the Repugnant Conclusion. See Handfield and Rabinowicz, 'Incommensurability' for references to Temkin and Rachels.

[13]Arrhenius and Rabinowicz, 'Millian Superiorities' and Jensen, 'Millian Superiorities'.

[14]A binary relation R is a *weak order*, if and only if, R is transitive and complete. R is transitive, if and only if, for all $\boldsymbol{x}, \boldsymbol{y}, \boldsymbol{z}$: if $\boldsymbol{xRy}$ and $\boldsymbol{yRz}$, then $\boldsymbol{xRz}$. R is complete, if and only if, for all $\boldsymbol{x}, \boldsymbol{y}$: either $\boldsymbol{xRy}$ or $\boldsymbol{yRx}$.

[15]A relation R is antisymmetric, if and only if, for all $\boldsymbol{x}, \boldsymbol{y}$: if $\boldsymbol{xRy}$ and $\boldsymbol{yRx}$, then $\boldsymbol{x}$ and $\boldsymbol{y}$ are identical.

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The definition implies for all types in $\boldsymbol{P}$ that, if $\boldsymbol{xQy}$, then there is always a type $\boldsymbol{z}$ in the subset $\boldsymbol{S}$, which lies between $\boldsymbol{x}$ and $\boldsymbol{y}$ in terms of $\boldsymbol{Q}$.

Definition 2: A subset $\boldsymbol{S}$ of a set of atomic object types $\boldsymbol{P}$ simply ordered by a binary relation $\boldsymbol{Q}$ is discrete, if and only if, it is not order-dense in $\boldsymbol{P}$.

On the set $\boldsymbol{P}$ is defined a concatenation operation, designated with '∘', by which two types can be conjoined into a new object, which also belongs to $\boldsymbol{P}$. Call such new objects in $\boldsymbol{P}$ formed by concatenation *compound* objects, and call the subset of the original atomic types $\boldsymbol{P_A}$. The concatenation procedure forms a whole (new object) out of the original types. But this could just mean that the objects are put side by side and considered together. Thus, a population will be defined as an object concatenated out of the lives of its individual members.

Concatenation is assumed to be associative; and $\boldsymbol{P}$ is assumed to be closed under concatenation.[16] *Self-concatenation* is to concatenate an object $\boldsymbol{x}$ with an object of the same type as itself any number of times m, which object is designated $m\boldsymbol{x}$.

Handfield and Rabinowicz use a comparable framework,[17] which however is limited to what I call self-concatenation only. In fact, they do not define any concatenation procedure; instead they talk about quantities of objects, assuming that, for any object, 'any quantity is possible'. However, the set of quantities they sketch has its members indexed by natural numbers, and their examples only use natural numbers, so in practice their framework is comparable with self-concatenation as I define it.

Between pairs of types in the set $\boldsymbol{P}$, I assume the existence of the following asymmetric[18] and transitive relation, '– is better than –'. The betterness relation evaluates types according to their overall betterness. On the set of atomic objects $\boldsymbol{P_A}$, I assume the betterness relation to be induced by $\boldsymbol{Q}$: for all types $\boldsymbol{x}$ and $\boldsymbol{y}$, $\boldsymbol{x}$ is at least as good as $\boldsymbol{y}$ (see *Definition* 5 below), if and only if $\boldsymbol{xQy}$.

In this article, I shall only be concerned with cases where all members of $\boldsymbol{P}$ are positively valuable, and in particular, I shall assume that *concatenation is value-increasing*, i.e. for all $\boldsymbol{x}$ and $\boldsymbol{y}$, $\boldsymbol{x}\circ\boldsymbol{y}$ is better than $\boldsymbol{x}$. But the framework could allow for negatively valuable objects.

On the domain corresponding to $\boldsymbol{P}$, Arrhenius and Rabinowicz defined a complete and transitive weak betterness relation, '– is at least as good as –'; and Jensen followed them.[19] My choice here of '– is better than –' as primitive constitutes the revision of their framework. The two approaches can easily be transformed into each other. However, for the purpose of introducing *evaluative imprecision*, the present framework is intuitively easier to grasp, and it is more in line with Parfit's presentation.

We need to distinguish between:

[16]A binary operation ∘ is associative, if and only if, for all $\boldsymbol{x}$ and $\boldsymbol{y}$, $\boldsymbol{x}\circ\boldsymbol{y}$ is equivalent with $\boldsymbol{y}\circ\boldsymbol{x}$; i.e. the order of objects does not matter for the concatenation operation. A set is closed on an operation, if and only if, any object formed by performing the operation on two members of the set is also a member of that set. Thus, concatenating lives always result in a population.

[17]Handfield and Rabinowicz, 'Incommensurability' and Rabinowicz, 'Can Parfit's Appeal'. The fact that they use a worseness relation rather than a betterness relation is insignificant from a formal point of view.

[18]A relation R is asymmetric, if and only if, for all $\boldsymbol{x}$, $\boldsymbol{y}$: if $\boldsymbol{xRy}$, then not $\boldsymbol{yRx}$.

[19]Arrhenius and Rabinowicz, 'Millian Superiorities' and Jensen, 'Millian Superiorities'.

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Definition 3: ***x*** *is precisely equally as good as* ***y***, if and only if ***x*** is not better than ***y*** and ***y*** is not better than ***x***, and for any third object ***z***, ***z*** is better than ***x***, if and only if ***z*** is better than ***y***, and ***x*** is better than ***z***, if and only if ***y*** is better than ***z***.

Definition 4: ***x*** *is imprecisely equally as good as* ***y***, if and only if, ***x*** is not better than ***y*** and ***y*** is not better than ***x***, and there exists a third object ***z***, such that ***z*** is better than ***x***, and ***z*** is not better than ***y***, or ***x*** is better than ***z***, and ***y*** is not better than ***z***.[20]

The latter part of *Definition* 3 ensures that '– is precisely equally as good as –' is an equivalence relation (reflexive, symmetric and transitive),[21] whereas the latter part of *Definition* 4 indicates that '– is imprecise equally as good as –' is not, because it is not necessarily transitive.[22] If imprecise equality is allowed, value differences cannot be measured precisely on a real-valued scale, because no real-valued numerical representation of betterness will then be possible, be it cardinal or ordinal.[23]

Hence, one aspect of *evaluative precision* can be cashed out by:

Condition 1: For all ***x*** and ***y***, exactly one of the following holds: ***x*** is better than ***y***, ***y*** is better than ***x***, ***x*** is precisely equally as good as ***y***.

Note that since *Q* is assumed to be a weak order, it follows that *Condition* 1 must hold for the betterness relation on the set of atomic objects $\boldsymbol{P_A}$.

Allowing for *evaluative imprecision* involves that *Condition* 1 is rejected and replaced by:

Condition 2: For all ***x*** and ***y*** in ***P*** but not in $\boldsymbol{P_A}$, exactly one of the following holds: ***x*** is better than ***y***, ***y*** is better than ***x***, ***x*** and ***y*** are precisely equally good, ***x*** and ***y*** are imprecisely equally good.

Let me add the following definition, which holds under both *Condition* 1 and *Condition* 2:

Definition 5: ***x*** is at least as good as ***y***, if and only if ***x*** is better than ***y*** or ***x*** is precisely equally as good as ***y***.

Definition 5 ensures that weak betterness is transitive.[24] I shall be concerned with the properties of *lexical* betterness:[25]

[20]I find the account of Parfit's notion of imprecise equality in R. Chang, 'Parity, Imprecise Comparability and the Repugnant Conclusion', *Theoria* 82 (2016), pp. 182–214, at 200, somewhat misleading. See Appendix 1.

[21]A binary relation *R* is reflexive, if for all ***x***: ***xRx***. *R* is symmetric, if for all ***x*** and ***y***: if ***xRy***, then ***yRx***.

[22]See P. C. Fishburn, *Utility Theory for Decision Making* (New York, 1970), p. 15.

[23]A real-valued representation of a relation '– is better than –' means that, for all ***x*** and ***y***, there are real numbers, such that if ***x*** is better than ***y***, then the number assigned to ***x*** is larger than the number assigned to ***y***. If the representation is ordinal, only the order of the numbers has significance. The minimal requirement for a cardinal representation is that ratios between differences (intervals) are unique. This allows for a measure of value differences.

[24]In the framework, which takes weak betterness as the primitive notion, the analogue of *Condition* 1 is the assumption that weak betterness is *complete*; if weak betterness as primitive is not complete, it is not necessarily transitive.

[25]The term 'lexically better' is Parfit's. I shall use it in the present article rather than 'weakly superior', which was used in both *Utilitas* articles (see note 11). I believe James Griffin, *Well-Being: Its Meaning, Measurement and Moral Importance* (Oxford, 1986), p. 85, was the first to introduce the weaker version,

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Definition 6: An object $\boldsymbol{x}$ is *lexically better* than [or *weakly superior* to] an object $\boldsymbol{y}$, if and only if, for some positive integer m and all positive integers n, $m\boldsymbol{x}$ is better than $n\boldsymbol{y}$.

Definition 7: An object $\boldsymbol{x}$ is *strictly lexically better* than [or *superior* to] an object $\boldsymbol{y}$, if and only if, for all positive integers n, $\boldsymbol{x}$ is better than $n\boldsymbol{y}$.

4. Non-diminishing marginal value

The literature has showed that it makes a lot of difference for lexical betterness whether for the inferior object $\boldsymbol{y}$, when it is concatenated to itself any number of times n, the marginal contribution diminishes and eventually converges to zero, such that there will be an upper limit for the value of the object $n\boldsymbol{y}$, or self-concatenation of $\boldsymbol{y}$ has constant marginal value and thus never reaches an upper limit.[26]

However, the concepts of 'diminishing' and 'non-diminishing marginal value' allude to numerical representation of value on a cardinal scale, of which the possibility cannot be assumed under the condition of evaluative imprecision. So how can these terms be given a meaning without assuming such numerical representation?

I shall ignore the possibility that self-concatenation of an object could have increasing marginal value and simply assume that it has either constant marginal value or diminishing marginal value. I suggest 'constant marginal value' can be captured by the concept of a *standard sequence*.

A standard sequence defines value contributions having non-zero, equal spacing in some intended numerical representation.[27] Thus, the existence of standard sequences must be a necessary condition for constant marginal value, even if a numerical representation, for other reasons, happens to be impossible.

Definition 8: A sequence $\boldsymbol{x}$, $2\boldsymbol{x}$, $3\boldsymbol{x}$, … constitutes a *standard sequence* based on the atomic object $\boldsymbol{x}$, if and only if there exists some other object $\boldsymbol{s}$ (the standard), such that for all integers $n \geq 0$, $(n{+}1)\boldsymbol{x}$ is precisely equally as good as $n\boldsymbol{x}\circ\boldsymbol{s}$:

$\boldsymbol{x}$ and $\boldsymbol{s}$ are precisely equally good
$\boldsymbol{2x}$ and $\boldsymbol{x}\circ\boldsymbol{s}$ are precisely equally good
$\boldsymbol{3x}$ and $\boldsymbol{2x}\circ\boldsymbol{s}$ are precisely equally good
…

A standard sequence can be either finite or infinite.

The problem is that it does not seem possible to construct a standard sequence based on an atomic object in the domain described above. If $\boldsymbol{s}$ and $\boldsymbol{x}$ are precisely equally good, they belong to the same type. If that is the case, both $\boldsymbol{s}$ and $\boldsymbol{x}$ may diminish in marginal value as they each are concatenated with a sequence $n\boldsymbol{x}$ of the same type. The standard should not be susceptible to diminishing marginal value, so it needs to be of a different type.

which he called 'discontinuity'; he distinguished it from the stronger version, which he called 'trumping'. Presumably, the weaker version is thought to be less implausible than the stronger version. Parfit simply adopts the weaker version without any further explanation.

[26]Arrhenius and Rabinowicz, 'Millian Superiorities' and Jensen, 'Millian Superiorities'.

[27]D. H. Krantz, R. D. Luce, P. Suppes and A. Tversky, *Foundations of Measurement. Volume 1: Additive and Polynomial Representations* (San Diego and London, 1971), pp. 4, 25.

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Therefore, consider:

> *Condition* 3: *Non-diminishing Marginal Value for a sequence* $\boldsymbol{x}$, $2\boldsymbol{x}$, $3\boldsymbol{x}$, … *based on the atomic object* $\boldsymbol{x}$: For all atomic objects $\boldsymbol{y}$ of a type different from $\boldsymbol{x}$, if $\boldsymbol{x}$ is better than $\boldsymbol{y}$, then, for all $n \geq 1$, $\boldsymbol{x} \circ n\boldsymbol{x}$ is better than $\boldsymbol{y} \circ n\boldsymbol{x}$.

and

> *Condition* 4: *Non-increasing Marginal Value for the sequence* $\boldsymbol{x}$, $2\boldsymbol{x}$, $3\boldsymbol{x}$, … *based on the atomic object* $\boldsymbol{x}$: For all atomic objects $\boldsymbol{y}$ of a type different from $\boldsymbol{x}$, if $\boldsymbol{y}$ is better than $\boldsymbol{x}$, then, for all $n \geq 1$, $\boldsymbol{y} \circ n\boldsymbol{x}$ is better than $\boldsymbol{x} \circ n\boldsymbol{x}$.

These conditions make it possible to define a standard sequence in a domain where *Definition* 8 does not apply, i.e. where there is no atomic object $\boldsymbol{s}$ which is both (1) of a type different from the atomic object $\boldsymbol{x}$ and (2) precisely equally as good as $\boldsymbol{x}$:

> *Definition* 9: The sequence $\boldsymbol{x}$, $2\boldsymbol{x}$, $3\boldsymbol{x}$, … based on the atomic object $\boldsymbol{x}$ is a *standard sequence*, if it fulfills *Condition* 3 and *Condition* 4.

I shall later make use of the following condition:

> *Condition* 5: *Non-diminishing Marginal Value for the sequence* $t\boldsymbol{x}$, $2(t\boldsymbol{x})$, $3(t\boldsymbol{x})$, … *based on the compound object* $t\boldsymbol{x}$: For all atomic objects $\boldsymbol{y}$ of a type different from $\boldsymbol{x}$, if $t\boldsymbol{x}$ is better than $\boldsymbol{y}$, then, for all $n \geq 1$, $t\boldsymbol{x} \circ n\boldsymbol{x}$ is better than $\boldsymbol{y} \circ n\boldsymbol{x}$.

However, note:

> *Observation* 1: Given that self-concatenation is value increasing, *Condition* 5 is implied by *Condition* 3.
> *Proof*: See Appendix 2.

In the literature, the possibility of diminishing marginal value (with an upper bound) is contrasted with the following independence condition:[28]

> *Condition* 6: *Strong Independence*: For all atomic or compound objects $\boldsymbol{x}$, $\boldsymbol{y}$ and $\boldsymbol{z}$, if $\boldsymbol{x}$ is at least as good as $\boldsymbol{y}$, then $\boldsymbol{x} \circ \boldsymbol{z}$ is at least as good as $\boldsymbol{y} \circ \boldsymbol{z}$.

This condition is a principal necessary condition for value additivity; it applies to all triples of objects and is thus much stronger than *Condition* 3, which is merely concerned with self-concatenation. But note that *Condition* 5 is implied by it. Another independence condition is:

> *Condition* 7: *Weak Independence*: For all atomic objects $\boldsymbol{x}$ and $\boldsymbol{y}$ and all atomic or compound objects $\boldsymbol{z}$, if $\boldsymbol{x}$ is at least as good as $\boldsymbol{y}$, then $\boldsymbol{x} \circ \boldsymbol{z}$ is at least as good as $\boldsymbol{y} \circ \boldsymbol{z}$.

Conditions 3 and 4 are implied by *Weak Independence*.

[28] Arrhenius and Rabinowicz, 'Millian Superiorities' and Jensen, 'Millian Superiorities'.

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Definition 8 and *Definition* 9 both allow that a standard sequence has no upper limit. But lexical betterness implies that some standard sequence has an upper limit. Consider:

> *Definition* 10: A standard sequence $\boldsymbol{x}$, $2\boldsymbol{x}$, $3\boldsymbol{x}$, …, $n\boldsymbol{x}$ based on the atomic object $\boldsymbol{x}$ is *strictly bounded* if there exists an object $\boldsymbol{y}$ (atomic or compound) of another type, such that for all n, $\boldsymbol{y}$ is better than $n\boldsymbol{x}$.

Consider next:

> *Condition* 8: *Archimedean Property*: Every strictly bounded standard sequence is finite.

This condition is necessary for representing betterness with a real-valued cardinal scale since such a scale would have to satisfy *the Archimedean Property* of real numbers: for any positive number x, however small, and any number y, however large, there is some integer n, such that ny is at least as great as x.[29]

Under *Condition* 3, lexical betterness violates *the Archimedean Property*. '$\boldsymbol{x}$ is lexical better than $\boldsymbol{y}$' implies that no number of $\boldsymbol{y}$s can bridge the value of some number of $\boldsymbol{x}$s; but if self-concatenation of any type fulfills *Non-diminishing Marginal Value* and *the Archimedean Property*, any upper bound should be reachable in a finite number of self-concatenations. Therefore, under these conditions, *Condition* 8 needs to be rejected and this provides another reason for the impossibility of a real-valued cardinal scale.[30]

I shall now present some results that follow under *Condition* 1. These results pose various problems for *the Lexical View*. Later, I shall evaluate the extent to which these problems can be met by rejecting the evaluative precision involved in *Condition* 1 by replacing it with *Condition* 2.

5. Results under precision

Consider first the negation of lexical betterness. If $\boldsymbol{x}$ is *not* lexically better than $\boldsymbol{y}$ then, for all m, there is some n, such that $m\boldsymbol{x}$ is not better than $n\boldsymbol{y}$. Under *Condition* 1, this means that for all m, there is some n, such that $n\boldsymbol{y}$ is as least as good as $m\boldsymbol{x}$; this means further (given that self-concatenation is value increasing) that for all m, there is some $n' = n + 1$, such that $n'\boldsymbol{y}$ is better than $m\boldsymbol{x}$.

> *Definition* 11: $\boldsymbol{x}$ is *exchangeable with* $\boldsymbol{y}$ if, for all m, there is some n, such that $n\boldsymbol{y}$ is better than $m\boldsymbol{x}$.

Thus, since under *Condition* 1, *exchangeability* and *lexical betterness* are negations of each other, the following holds:

> *Observation* 2: Under *Condition* 1, for all $\boldsymbol{x}$ and $\boldsymbol{y}$, either $\boldsymbol{x}$ is lexically better than $\boldsymbol{y}$, or $\boldsymbol{x}$ is exchangeable with $\boldsymbol{y}$.

One problem that has been raised for lexical betterness is that if, for some sequence $\boldsymbol{b}$, …, $\boldsymbol{q}$, $\boldsymbol{b}$ is lexically better than $\boldsymbol{q}$, then one member of the sequence must be

[29]Krantz et al., *Foundations*, p. 25.

[30]Note that this does not exclude numerical representation as such, only representation by a cardinal, real-valued scale. Under *Condition* 1, if the domain is a countable set, betterness could be represented by an *ordinal* real-valued scale (Krantz et al., *Foundations*, p. 39 (Theorem 2.1)).

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lexically better than its successor, and this seems to be an implausible discontinuity in value.

Arrhenius and Rabinowicz proved:

> *Observation* 3: Suppose that *at-least-as-good-as* is a complete and transitive relation on the domain. Then, in any finite sequence of objects in which the first element is lexically better than the last element, there exists at least one element that is lexically better than its immediate successor.[31]

However, it is possible to obtain a considerably more general result:

> *Observation* 4: Consider a (possibly order-dense) set of objects $\boldsymbol{b}$, …, $\boldsymbol{q}$ of decreasing value, where $\boldsymbol{b}$ is lexically better than $\boldsymbol{q}$. Assume that '– is better than –' is transitive and that *Condition* 1 holds. Let $\boldsymbol{x}$ belong to the set $\{\boldsymbol{x} \mid \boldsymbol{b}$ is better than $\boldsymbol{x}$ and $\boldsymbol{x}$ is better than $\boldsymbol{q}\}$. For any $\boldsymbol{x}$: Assume that $\boldsymbol{b}$ is not lexically better than $\boldsymbol{x}$, i.e. is exchangeable with $\boldsymbol{x}$. Then $\boldsymbol{x}$ is lexically better than $\boldsymbol{q}$.
> *Proof*: See Appendix 2.
> *Corollary to Observation* 4: For any $\boldsymbol{x}$: Assume that $\boldsymbol{x}$ is not lexically better than $\boldsymbol{q}$, i.e., is exchangeable with $\boldsymbol{q}$. Then $\boldsymbol{b}$ is lexically better than $\boldsymbol{x}$.
> The corollary follows by *Modus Tollens*.

This demonstrates that a case of lexical betterness has much stronger implications than those indicated by *Observation* 3. Consider first the case, where $\boldsymbol{b}$ is exchangeable with all $\boldsymbol{x}$. Then not only $\boldsymbol{b}$ but all $\boldsymbol{q}$'s predecessors in the sequence after **b** are lexically better than $\boldsymbol{q}$. Alternatively, if all $\boldsymbol{x}$ are exchangeable with $\boldsymbol{q}$, then $\boldsymbol{b}$ is lexically better than all its successors down to and including $\boldsymbol{q}$.

If the sequence is discrete, *Observation* 4 makes the claim that one element will be lexically better than its immediate successor more precise, namely that either will $\boldsymbol{q}$'s nearest predecessor be lexically better than $\boldsymbol{q}$, or $\boldsymbol{b}$ will be lexically better than its immediate successor.

If the sequence is an order-dense subset of $\boldsymbol{P}_{\boldsymbol{A}}$, then there will be a discontinuity in value between an object arbitrarily close to $\boldsymbol{q}$ and $\boldsymbol{q}$ itself, or between $\boldsymbol{b}$ and an object arbitrarily close to $\boldsymbol{b}$. These sharp discontinuities between qualitatively close objects appear implausible.

Another problem that has been raised for lexical betterness is a so-called *Continuum Argument.*[32] This argument is believed to rule out lexical betterness. Consider

> *Premise* (A) In the discrete sequence $\boldsymbol{a}$, …, $\boldsymbol{z}$, each object is exchangeable with its successor.

The following holds:

> *Observation* 5: If, for some discrete sequence $\boldsymbol{a}$, …, $\boldsymbol{z}$, *Premise* (A) holds, and transitivity holds for betterness, then $\boldsymbol{a}$ is exchangeable with $\boldsymbol{z}$.
> *Proof*: See Appendix 2.

[31]Arrhenius and Rabinowicz, 'Millian Superiorities', pp. 136–37. This is their *Observation* 3, based on a transitive and complete weak betterness relation and stated with Parfit's term 'lexically better'.

[32]I follow the presentation of this argument in Handfield and Rabinowicz, 'Incommensurability', pp. 2377–78. They present the corollary in note 6. See also Gustaf Arrhenius, 'Population Ethics and Different-Number-Based Imprecision', *Theoria* 82 (2016), pp 166–81, at 171–74.

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Corollary to Observation 5: If betterness is transitive, then exchangeability is transitive.
Proof: Follows directly from the proof of *Observation* 5.[33]

We know from *Observation* 4 that if the conclusion of *the Continuum Argument* is false, such that $\boldsymbol{a}$ is lexically better than $\boldsymbol{z}$, then either object $\boldsymbol{y}$ immediately preceding $\boldsymbol{z}$ must be lexically better than $\boldsymbol{z}$; or $\boldsymbol{a}$ must be lexically better than its immediate successor $\boldsymbol{b}$. In other words, in order to block *the Continuum Argument*, one case of lexical betterness between neighbors (at either end of the sequence) is necessary.

Suppose, on the other hand, that some object in the sequence, say $\boldsymbol{p}$, is not exchangeable with its successor, $\boldsymbol{q}$. Then *the Continuum Argument* is blocked at this point. Although $\boldsymbol{a}$ may be exchangeable with $\boldsymbol{p}$, $\boldsymbol{a}$ is not necessarily exchangeable with $\boldsymbol{q}$, which means that $\boldsymbol{a}$ may be lexically better than $\boldsymbol{q}$. Hence, *the Continuum Argument* is blocked precisely at the point where an object for the first time in the sequence is not exchangeable with its successor. Of course, if lexical betterness between neighboring objects is implausible anyway, this way to block *the Continuum Argument* seems dubious.

However, *the Continuum Argument* only works if the sequence $\boldsymbol{a}, \ldots, \boldsymbol{z}$ is both finite and discrete. If the sequence $\boldsymbol{a}, \ldots, \boldsymbol{z}$ is an order-dense subset of $\boldsymbol{P_A}$, then the conclusion of *the Continuum Argument* does *not* follow. Consider the following restatement of *Premise* (A) to allow for an order-dense subset of $\boldsymbol{P_A}$:[34]

Premise (B): For all $\boldsymbol{x}$ in the set $\{\boldsymbol{x} \mid \boldsymbol{x}$ is better than $\boldsymbol{z}\}$, there is some $\boldsymbol{y}$, such that $\boldsymbol{x}$ is both better than and exchangeable with $\boldsymbol{y}$.

In this case, we might never reach all the way down to $\boldsymbol{z}$. The fact that, starting from $\boldsymbol{a}$, we can keep on finding some $\boldsymbol{x}$ which is progressively worse, and which can be exchanged with some $\boldsymbol{y}$ that is still worse than this $\boldsymbol{x}$, such that, by transitivity, each new $\boldsymbol{y}$ can be exchanged for $\boldsymbol{a}$, is compatible with $\boldsymbol{a}$ being lexically better than $\boldsymbol{z}$, and more generally, with some $\boldsymbol{b}$ in the set being lexically better than some $\boldsymbol{q}$ in the set (worse than $\boldsymbol{b}$); repeated application of *Premise* (B) and transitivity might only get us arbitrarily close to $\boldsymbol{q}$ but never actually make us reach it.
Premise (A) is only plausible if the members of the discrete sequence are sufficiently close. But there is no principled way to demonstrate, for any actual sequence, that the members are close. And given denseness, there is even no such thing as neighboring objects; between any two objects in the sequence, there will be infinitely many objects.

However, even if *Premise* (B) is compatible with the $\boldsymbol{b}$ being lexically better than $\boldsymbol{q}$, this blocking of *the Continuum Argument* does involve a serious discontinuity in value, as we saw above.

Finally, I need to present another observation under *Condition* 1, or rather, merely the weaker assumption that *Condition* 1 applies for cases of lexical betterness:

[33]It is also easy to show that, given that betterness is transitive, lexical betterness is also transitive.

[34]I owe the statement of this premise, and the point that it is insufficient to support the conclusion, to John Broome, 'Lessons from Economics', manuscript (2018), pp. 18, at 13–14, and personal communication. Broome has been complaining for many years that *Continuum Arguments* only are valid given the strong assumption about a discrete domain.

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> *Condition α*: if $\boldsymbol{x}$ is lexically better than $\boldsymbol{y}$, then *Condition* 1 applies for all $m\boldsymbol{x}$ and $n\boldsymbol{y}$, i.e., for all m and n: either $m\boldsymbol{x}$ is better than $n\boldsymbol{y}$, or $n\boldsymbol{y}$ is better than $m\boldsymbol{x}$, or $m\boldsymbol{x}$ and $n\boldsymbol{y}$ are precisely equally good.

Neither *Observation* 3 nor *Observation* 4 assumes *Non-diminishing Marginal Value*. But it does make a difference to assume *Non-diminishing Marginal Value*:[35]

> *Observation* 6: Assume $\boldsymbol{x}$ is better than $\boldsymbol{y}$. *Condition* 3 and *Condition* 5 (*Non-diminishing Marginal Value*) and *Condition α* implies that, if $\boldsymbol{x}$ is lexically better than $\boldsymbol{y}$, then $\boldsymbol{x}$ is also strictly lexically better than $\boldsymbol{y}$, i.e., if for some m and all n, $m\boldsymbol{x}$ is better than $n\boldsymbol{y}$, then $\boldsymbol{x}$ is better than $n\boldsymbol{y}$.
> *Proof*: See Appendix 2.

This means that, given *Non-diminishing Marginal Value*, lexical betterness collapses into strict lexical betterness, that is, if no $n\boldsymbol{y}$ can be at least as good as $m\boldsymbol{x}$, no $n\boldsymbol{y}$ can even be at least as good as $\boldsymbol{x}$.

When objects come in natural units, e.g., lives, it is clear what a drop from some number m to 1 involves. But what about objects that do not come in natural units? Handfield and Rabinowicz,[36] for instance, deal with types of harms, which do not seem to come in natural units. However, a type of harm seems to be determined by its intensity; and these harms are assumed to be quantifiable by their duration. If they are, these harms in fact satisfy the condition of *Non-diminishing Marginal Value*. Take a unit of time as small as you want. *Observation* 6 implies that if some duration of one type of harm is better than any duration of another, then even a duration of the first type of harm as short as the smallest unit of time is better than any duration of the other type.

In all cases, if lexical betterness involves an implausible discontinuity in value in the first place, this becomes a much more implausible discontinuity in value if we assume *Non-diminishing marginal Value*.

What does *Constant Marginal Value* imply for *the Continuum Argument*? *Premise* (B) allows for cases of lexical betterness with an upper limit. But suppose we accept *Conditions* 4 and 5 together with *the Archimedean Property* (*Condition* 8). Consider an infinite standard sequence $\boldsymbol{q}$, $2\boldsymbol{q}$, $3\boldsymbol{q}$, …, $n\boldsymbol{q}$ according to *Definition* 9, where n is any integer, and let $\boldsymbol{b}$ be an object which is better than $\boldsymbol{q}$. If $\boldsymbol{b}$ were lexically better than $\boldsymbol{q}$, then the standard sequence $\boldsymbol{q}$, $2\boldsymbol{q}$, $3\boldsymbol{q}$, …, $n\boldsymbol{q}$ would be strictly bounded; but since it is infinite, $\boldsymbol{b}$ being lexically better than $\boldsymbol{q}$ would violate *the Archimedean Property*. Hence, *the Archimedean Property* excludes any case of lexical betterness under *Constant Marginal Value*. This follows directly from the assumptions and does not depend on any *Continuum Argument*.

Suppose next that we accept *Constant Marginal Value* (*Conditions* 3 and 5) but reject the *Archimedean Property* (*Condition* 8). This will allow for cases of lexical betterness, since a strictly bounded standard sequence does not have to be finite. However, because *Observation* 6 also holds under these assumptions, any instance of lexical betterness will involve a much stronger discontinuity in value than need be the case without *Constant Marginal Value*.

[35]This is a refinement of *Observation* 1 in Jensen, 'Millian Superiorities'.
[36]Handfield and Rabinowicz, 'Incommensurability'.

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6. Imprecise equality

I shall now examine how allowing for imprecise equality, i.e., exchanging *Condition* 1 with *Condition* 2, affects the results of the previous section. Under *Condition* 2, lexical betterness and exchangeability are not simply negations of each other; negating one leads to a weaker version of the other.

Definition 12: An object $\boldsymbol{x}$ is *minimally exchangeable with* (not lexically better than) an object $\boldsymbol{y}$, if and only if, for all m, there is n, such that $m\boldsymbol{x}$ is not better than $n\boldsymbol{y}$.

Definition 13: An object $\boldsymbol{x}$ is *minimally lexically better than*[37] (not exchangeable with) an object $\boldsymbol{y}$, if and only if there is m, such that for all n, $n\boldsymbol{y}$ is not better than $m\boldsymbol{x}$.

Minimal exchangeability is thus implied by exchangeability (*Definition* 10) but not vice versa; and minimal lexical betterness is implied by lexical betterness (*Definition* 5), but not vice versa. Let me add a definition of a weaker version of strict lexical betterness (*Definition* 6), which is implied by it, but not vice versa:

Definition 14: An object $\boldsymbol{x}$ is *strictly minimally lexically better* than an object $\boldsymbol{y}$, if and only if, for all positive integers n, $n\boldsymbol{y}$ is not better than $\boldsymbol{x}$.

Handfield and Rabinowicz introduce the concept of *radical imprecise equality*:[38]

Definition 15: An object $\boldsymbol{x}$ is *radically imprecisely equal* to an object $\boldsymbol{y}$, if and only if there is m', such that for all $m \geq m'$, there is n_m, such that for all $n \geq n_m$, $m\boldsymbol{x}$ is imprecisely equal to $n\boldsymbol{y}$.

It is easy to show

Observation 7: Given that concatenation is value increasing, $\boldsymbol{x}$ is both minimally lexically better than and minimally exchangeable with $\boldsymbol{y}$ is equivalent with $\boldsymbol{x}$ is radically imprecisely equal to $\boldsymbol{y}$.
Proof: See Appendix 2.

As explained by Handfield and Rabinowicz,[39] radical imprecise equality is quite different from the behavior of imprecise equality in the small-improvement type of cases described by Chang.[40] The point of these examples is that, in cases where none of the objects is better than other, *small* improvements on either side may not change that; hence imprecise rather than precise equality is true. But it seems implicit in these examples that *large* improvements on either side would make one object better than

[37]I adopt this name from Arrhenius and Rabinowicz, 'Millian Superiorities', p. 137. They define this relation that allows for a not necessarily complete weak betterness relation and call it *minimal superiority*.

[38]I adopt this definition from Handfield and Rabinowicz, 'Incommensurability', p. 2380. They call it 'radical incommensurability', whereas Rabinowicz, 'Can Parfit's Appeal' calls it 'strictly persistent incommensurability'.

[39]Handfield and Rabinowicz, 'Incommensurability', pp. 2379–80.

[40]R. Chang, 'The Possibility of Parity', *Ethics* 112 (2002), pp. 659–88.

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the other. However, the imprecise equality between objects involved in radical imprecise equality is persistent despite improvements on either side, however large.

Handfield and Rabinowicz prove the following result, which, given *Observation* 7, follows immediately from *Definitions* 11 and 12:[41]

> *Observation* 8: For all ***x*** and ***y***, one of the following holds: ***x*** is lexically better than ***y***, ***x*** is exchangeable with ***y***, ***x*** is radically imprecisely equal to ***y*** (i.e., ***x*** is both minimally lexically better than and minimally exchangeable with ***y***).

It follows that someone who wants to deny that some object ***x*** is exchangeable with another object ***y***, without confirming that ***x*** is lexically better than ***y*** (or vice versa), by way of appealing to imprecise equality, is committed to claim that these objects are radically imprecisely equal. This is a stronger claim than may have been envisaged.

Now consider what radical imprecise equality may imply for *Observation* 4 above. The crucial point was step (4) in the proof. Now, under *Condition* 2, there is the possibility that if, for all *m*, there is some *n*, such that *n**x*** is not better than *m**b***, this could imply that *n**x*** could be imprecisely equally as good as *m**b***. This fact is used in the proof of *Observation* 9:

> *Observation* 9: Consider a (possibly order-dense) set of objects ***b***, …, ***q*** of decreasing value, where ***b*** is lexically better than ***q***. Assume that '– is better than –' is transitive and that *Condition* 2 holds. Let ***x*** belong to the set {***x*** | ***b*** is better than ***x*** and ***x*** is better than ***q***}.
>
> (9.1) For any ***x***: Assume that ***b*** is not lexically better than ***x***. Then ***x*** is minimally lexically better than ***q***.
> (9.2) For any ***x***: Assume that ***x*** is not lexically better than ***q***. Then ***b*** is minimally lexically better than ***x***.
>
> *Proof*: See Appendix 2
> *Corollary 1 to Observation* 9.1 *and* 9.2: Assume that ***x*** is minimally lexically better than but not lexically better than ***q***. Then ***x*** is minimally exchangeable with ***q***. Assume that ***x*** is minimally exchangeable with but not exchangeable with ***q***. Then ***x*** is minimally lexically better than ***q***.
> *Proof*: Follows from *Observation* 8.
> *Corollary 2 to Observation* 9.1: For any ***x***: Assume that ***x*** is not minimally lexically better than (i.e., exchangeable with) ***q***. Then ***b*** is lexically better than ***x***.
> *Corollary 2 to Observation* 9.2: For any ***x***: Assume that ***b*** is not minimally lexically better than (i.e., exchangeable with) ***x***. Then ***x*** is lexically better than ***q***.
> *Proof*: These corollaries follow by *Modus Tollens*.

Observation 9 applies under *Condition* 1 as well as *Condition* 2. In the former case, '– is not lexically better than –' means '– is exchangeable with –', and *Observation* 9 simply reduces to *Observation* 4, as is also clear from the two *Corollaries* 2. In the latter case, '– is not lexically better than –' may mean '– is minimally exchangeable, but not exchangeable with –', implying radical imprecise equality.

[41] Handfield and Rabinowicz, 'Incommensurability', pp. 2386–87.

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What are the implications of introducing radical imprecise equality in a sequence of objects of decreasing value? It might be worth spelling out the possibility of a full zone of radical imprecise equality between some endpoints $\boldsymbol{b}$ and $\boldsymbol{q}$:

Corollary 3 to Observation 9.1: Assume that all $\boldsymbol{x}$ are radically imprecisely equal to $\boldsymbol{q}$. Then $\boldsymbol{b}$ is radically imprecisely equal to all $\boldsymbol{x}$.

Corollary 3 to Observation 9.2: Assume that $\boldsymbol{b}$ is radically imprecisely equal to all $\boldsymbol{x}$. Then all $\boldsymbol{x}$ are radically imprecisely equal to $\boldsymbol{q}$.

Next, suppose that, after a zone $\{\boldsymbol{x} \mid \boldsymbol{b} < \boldsymbol{x} \leq \boldsymbol{m}\}$ where $\boldsymbol{b}$ is exchangeable with $\boldsymbol{x}$, there is another zone $\{\boldsymbol{x} \mid \boldsymbol{m} < \boldsymbol{x} < \boldsymbol{q}\}$, such that $\boldsymbol{b}$ is not exchangeable with $\boldsymbol{x}$, but radically imprecisely equal to $\boldsymbol{x}$. Then it follows that all $\boldsymbol{x}$ in the zone are radically imprecisely equal to $\boldsymbol{q}$. Since $\boldsymbol{b}$ is exchangeable with $\boldsymbol{m}$, it also follows that $\boldsymbol{m}$ is lexically better than $\boldsymbol{q}$. But then we can apply *Corollary* 3 with $\boldsymbol{m}$ as first object instead of $\boldsymbol{b}$ with the result that $\boldsymbol{m}$ is radically imprecisely equal to all members $\boldsymbol{x}$ of the zone, and all members $\boldsymbol{x}$ of the zone are radically imprecisely equal to $\boldsymbol{q}$.

Alternatively, we might have a zone $\{\boldsymbol{x} \mid \boldsymbol{b} < \boldsymbol{x} < \boldsymbol{m}\}$, where $\boldsymbol{b}$ is lexically better than $\boldsymbol{m}$, $\boldsymbol{m}$ and all its successors are lexically better than $\boldsymbol{q}$, $\boldsymbol{b}$ is radically imprecisely equal to all $\boldsymbol{x}$ in the zone, and all $\boldsymbol{x}$ in the zone are radically imprecisely equal to $\boldsymbol{m}$.

What has been obtained as compared with *Observation* 4? Instead of the single borderline of lexical betterness, a zone of radical imprecise equality has been inserted. At the borderlines at either end of this zone, radical imprecise equality appears, and the size of the zone determines the minimal interval across which lexical betterness holds.

This can all be said to soften the sharp borderline of lexical betterness, but the question is how much. One aspect is the size of the zone of radical imprecise equality. The smaller it is, the less the discontinuity appears to be softened. But even if it is large, the fact that the objects at either end of the zone are radically imprecisely equal to all members of the zone in between seems to dissolve the difference in value between the members of the zone. This seems to indicate that the discontinuity in value because the first end point is lexically better than the second to a large extent remains independent of the size of the zone between them.

Another aspect is the situation at either borderline of the zone – between two pairs of neighboring objects in the case of a finite, discrete sequence, or between two pairs of arbitrarily close objects in the case of a dense sequence. Here, the single case of lexical betterness under *Condition* 1 is transformed into two cases of minimal lexical betterness, each of which still represents some discontinuity of value as compared with exchangeability.

All in all, even if some softening has been obtained, it can be questioned how much it amounts to. However, I believe further evaluation depends on analysis of the actual interpretation of the domain.

Observation 9 also confirms, and makes more precise, a point made by Handfield and Rabinowicz, that in order to block *the Continuum Argument* by the help of imprecise equality between some pair(s) of neighboring objects, one case of radical imprecise inequality between a pair of neighbors in the (finite, discrete) sequence is incompatible with $\boldsymbol{a}$ being lexically better than $\boldsymbol{z}$ – at least two cases are needed.[42]

[42]Handfield and Rabinowicz, 'Incommensurability', pp. 2381–82. The point was first made in Handfield, 'Rational Choice and the Transitivity of Betterness', *Philosophy and Phenomenological Research* 89 (2014),

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From *Observation* 9, we learn that if $\boldsymbol{b}$ is lexically better than $\boldsymbol{q}$, then there needs to be a zone of radical imprecise equality consisting of at least one object somewhere in between. Could we not just claim that, say, $\boldsymbol{p}$ is imprecisely equal to it successor $\boldsymbol{q}$? No, because it follows from *Observation* 9 that if $\boldsymbol{b}$ is exchangeable with $\boldsymbol{p}$, then $\boldsymbol{p}$ is lexically better than $\boldsymbol{q}$. Contrary, if $\boldsymbol{b}$ is radically imprecisely equal to $\boldsymbol{p}$, then $\boldsymbol{p}$'s predecessor $\boldsymbol{o}$ must be imprecisely equal to $\boldsymbol{p}$, because if it were not, $\boldsymbol{o}$ would be exchangeable with $\boldsymbol{p}$, and then since $\boldsymbol{b}$ (by assumption) is exchangeable with $\boldsymbol{o}$, by transitivity it would also be exchangeable with $\boldsymbol{p}$. Hence, two cases of radical imprecise equality must exist, one at either border of the zone consisting of $\boldsymbol{p}$.

Finally, I shall prove an analogue of *Observation* 6 for minimal lexical betterness:

> *Observation* 11: Assume $\boldsymbol{x}$ is better than $\boldsymbol{y}$. *Condition* 3 and *Condition* 5 (*Non-diminishing Marginal Value*) implies that, if $\boldsymbol{x}$ is minimally lexically better than $\boldsymbol{y}$, then $\boldsymbol{x}$ is also strictly minimally lexically better than $\boldsymbol{y}$, i.e., if for some m and all n, $n\boldsymbol{y}$ is not better than $m\boldsymbol{x}$, then $n\boldsymbol{y}$ is not better than $\boldsymbol{x}$.
> *Proof*: See Appendix 2

What I said above concerning *Observation* 6 about units applies here as well.

Consider a (possibly order-dense) set of objects $\boldsymbol{b}$, …, $\boldsymbol{q}$ of decreasing value, where $\boldsymbol{b}$ is lexically better than $\boldsymbol{q}$, and assume that both *Condition* 2 and *Non-diminishing Marginal Value* holds. *Observation* 6 implied that $\boldsymbol{b}$ is strictly lexically better than $\boldsymbol{q}$, and that fact will persist in spite of *Condition* 2 and in spite of *Observation* 11, as long as imprecise equality cannot hold between any $m\boldsymbol{b}$ and $n\boldsymbol{q}$, that is, as long as *Condition* α holds.

But *Observation* 11 does imply that any instance of $\boldsymbol{x}$ being radically imprecisely equal to $\boldsymbol{y}$ will imply that $\boldsymbol{x}$ is strictly minimally lexically better than $\boldsymbol{y}$, meaning that for all $m \geq 1$ and all but very small n, $m\boldsymbol{x}$ is imprecisely equal to $n\boldsymbol{y}$. Thus, the difference in value between members of the zone of radical imprecise equality as compared with either endpoint of a case of lexical betterness will be further erased; and at either end of the zone, strict minimal lexical betterness will be true representing a more serious discontinuity in value.

7. Implications for Parfit's lexical view of the results under precision

Here are a few remarks on the relevant interpretation of the formal framework. In his arguments, Parfit considers a sequence of possible types of lives $\boldsymbol{a}$, …, $\boldsymbol{z}$ where each life is better than its successor, but any two neighboring lives are qualitatively very similar. Thus, we have as the domain $\boldsymbol{L}$ the set of possible lives. Each life is characterized by a certain quality of life (level of welfare), and the set of lives are weakly ordered by their quality of life (the relation Q). Two lives are of the same type if and only if they have the same quality of life. Hence, the domain becomes the set of types $\boldsymbol{P_A}$, the set of lives with varying qualities.

A population is simply a compound formed by concatenation of lives of various types or – at the limit – just one life. Since Parfit's examples always assume that a

pp. 584–604, at 599, note 18. Rabinowicz quotes it in 'Can Parfit's Appeal', pp. 6–7. Strictly speaking, they prove something slightly different, namely that in a cyclical sequence of objects, where each object is exchangeable with its successor, but the first is better than the last, one case of radical imprecise equality is not sufficient. But it can be proved, see *Observation* 10 in Appendix 2.

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population consists of some number of people all with the same quality of life, a population simply becomes a type of life, concatenated with itself some number of times.

Parfit acknowledges that, under *Condition* 1, if ***b*** is lexically better than ***q***, then there is at least one life within this sequence which is lexically better than its successor, but he claims that it only follows if we assume evaluative precision. He could merely point out that *Observation* 3 assumes completeness and thus relies on *precision* in terms of a relation of precise equality. Instead, he sets up his own argument for the conclusion that, under *Condition* 1, ***p*** is lexically better than ***q*** and shows how this argument can be met by denying the assumption of *precision*, that is, by denying *Condition* 1.[43]

However, Parfit's argument has more implications than he himself exploits, since it can be used to prove *Observation* 4, which demonstrates that one instance of lexical betterness, such as ***b*** being lexically better than ***q***, draws with it many more instances of lexical betterness than merely ***p*** being lexically better than ***q***. Parfit's argument can further be used to prove *Observation* 9, which similarly demonstrates far more details about the consequences of introducing imprecise equality than he himself draws out.

Concerning *the Continuum Argument*, Parfit also seems to acknowledge that, under *Condition* 1, rejection of *Premise* (A) at one step is implausible, because it would involve an instance of lexical betterness between neighboring lives in a discrete sequence. However, he does not consider the possibility of denseness at all, which would make *the Continuum Argument* futile, but still leave a discontinuity at the limit.

And importantly, he appears to be unaware of the implications of assuming *Non-Diminishing Marginal Value* spelled out in *Observation* 6.[44]

8. Implications for Parfit's lexical view of giving up precision

The greatest challenge for Parfit's proposal comes from *Observation* 6. The condition of *Non-diminishing Marginal Value*, which Parfit confirms, implies that lexical betterness collapses into the much stronger strict lexical betterness. This would imply that even one life of the superior quality of life is better than any number of lives of the inferior quality of life. I believe Parfit would consider it a *reductio* of lexical betterness, if it collapses to strict lexical betterness. This means that *Observation* 6 can be understood as an impossibility theorem, which makes the condition of *Non-diminishing Marginal Value* (*Conditions* 3 and 5) incompatible with *the Lexical View*.

Parfit does not address this problem. Neither is it addressed through the introduction of imprecise equality. Admittedly, the proof of *Observation* 6 makes use of *Condition* α, which is incompatible with *Condition* 2 in cases of lexical betterness. But *the Imprecise Lexical View* involves by definition at least one case of lexical betterness, which could not be true, if radical imprecise equality could hold between the lives in question. *Non-diminishing Marginal Value* further amplifies the problems relating to the introduction of imprecise equality, as *Observation 11* demonstrates.

This raises the question of whether the *Non-diminishing Marginal Value* condition should be abandoned, if *the Imprecise Lexical View* is otherwise defensible. I myself share Parfit's intuition that *Non-diminishing Marginal Value* is a very plausible requirement in population ethics. But given the theoretical benefits of giving it up, should *the Imprecise Lexical View* without it end up being a viable view, it might be worth revisiting.

[43]Parfit, 'Material', pp. 9–12.

[44]Or maybe not. After having stumbled over Jensen, 'Millian Superiorities', he approached me for comments to his work, maybe because he sensed a problem here.

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Interestingly, Parfit does not make use of *Non-diminishing Marginal Value* in his arguments about imprecision. Thus, the following discussion of the consequences of introducing (radical) imprecise equality does not assume *Non-diminishing Marginal Value*. Consider the implications for the *Imprecise Lexical View* of *Observation* 9 for a sequence of lives of descending quality of life (dense or discrete) ***b***, …, ***q***. *Observation* 9 implies that there may be an interval, say from ***m*** to ***q***, where ***m*** is lexically better than ***q***, and a zone in between, all the members of which will be radically imprecisely equal to both ***m*** and ***q***.

One problem is that within the zone, differences between options tend to get blurred. In comparison with populations based on ***m*** or ***q***, for any sufficiently large population size based on lives in the open interval in between ***m*** and ***q***, there is no difference in value in choosing one population over another. There is a dilemma visible here. If the distance between ***m*** and ***q*** is short, this would appear to result in an implausible discontinuity between them after all. If the distance between ***m*** and ***q*** is long, it appears implausible that it should make almost no difference which option in between we choose. However, compared with a reasonable balance between these two horns, no zone of imprecise equality or even no case of lexical betterness might be even more implausible.

The next thing to consider is discontinuity between close objects. At each border of the zone of radical imprecise equality, there will be an instance of radical imprecise equality between close objects. In the following I mean 'close' to cover both the case of discreteness (in which case the objects are neighbors) and the case of denseness (in which case 'close' means 'arbitrarily close'). Is not radical imprecise equality between close objects still an implausible discontinuity?

I grant that lexical betterness between close objects is implausible and, consequently, that minimal exchangeability is more plausible.[45] But why is it that a very small loss of quality of life could not be outweighed by some much larger gain in quantity, that is, why is minimal lexical betterness plausible? What is special about the differences between close objects at the borders of the zone, where minimal lexical betterness is true, as compared with any other pair of close objects outside the zone where it apparently is not true?

To point at the mere possibility of imprecise equality does not provide a justification, since we need to know why it holds exactly here. However, in the context of *the Continuum Argument*, Parfit actually considers minimal lexical betterness between *any* neighboring lives plausible, as he conjoins minimal exchangeability with minimal lexical betterness for *all* neighboring pairs, at least if they are sufficiently close:[46]

> *Compared with the existence of some number of people, it would not always be worse if instead there existed many more people who would have a slightly lower quality of life. But we should deny that such truths would be precise. We should then claim that no slight loss in quality of life would either be outweighed by, or outweigh, any such gain in quantity.*

But *why* could these truths (about exchangeability) not be precise? Moreover, the problem with the proposal is that it has odd consequences. Suppose ***b*** is radically imprecisely equal

[45]Parfit, 'Material', p. 9 considers lexical betterness between qualitatively very similar objects almost a *reductio* on lexical betterness.

[46]Parfit, 'Can We Avoid', p. 120.

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to ***c***, ***c*** is radically imprecisely equal to ***d***, and so on further down to ***m***, but that ***b*** is lexically better than ***d***, and ***c*** is lexically better than ***e***, and so on down to ***m*** (in case the sequence is dense, allow a difference between close objects and less close objects). Then it follows from *Observation* 9 that ***c*** is radically imprecisely equal to ***q***, ***d*** is lexically better than ***q***, ***e*** is radically imprecise equal to ***q***, and so on, which appears very difficult to justify.

In my view, a better justification of the two necessary instances of minimal lexical betterness between close objects assumes that the overall case of lexical betterness (e.g., ***m*** is lexically better than ***q***) has an independent, non-arbitrary justification. But then it is necessary to accept that thereby a border is established in the sequence, from where *no* loss of quality of life below the value of some number of ***m***s can ever be outweighed, regardless of quantity; this border is most plausibly followed by a zone of radical imprecise equality, which necessarily involves another instance of minimal lexical betterness between close objects at the lower end.

Thus, I suggest that the most plausible version of *the Imprecise Lexical View* is one that establishes a lower bound ***m*** for the exchange of quality with quantity. Below ***m***, there is a zone, such that ***m*** and all lives better than ***m*** are radically imprecisely equal to all members of the zone, but lexically better than the life at the lower end of the zone ***q***, and all lives worse than ***q***; and all members of the zone are radically imprecisely equal to ***q***, and all lives worse than ***q***. Call this version of *the Imprecise Lexical View* (without *Non-diminishing Marginal Value*) the *Lower Bound for Exchangeability View*.

The zone of radical imprecise equality will reduce the arbitrariness of picking out a sharp limit, but it seems unavoidable that the zone will have sharp borderlines, of which it may be difficult to justify the non-arbitrariness. In the last resort, it is a matter of judging which theory of population is the least implausible in comparison.

9. Violation of Arrhenius' non-elitism condition?

There is reason to consider another question. If *the Lower Bound for Exchangeability View* is to have any future in population ethics, it must not only be able to avoid *the Repugnant Conclusion* but do so without implying other counterintuitive conclusions. In effect, the hardest challenge in this regard comes from *the Sixth Impossibility Theorem*.[47]

It is well known that lexical views violate a condition of *Inequality Aversion*:[48] For any triplet of lives ***x***, ***y***, ***z*** of descending value, there is a positive integer n, such that for all numbers $m > n$, if we have $n\boldsymbol{x}$, $m\boldsymbol{z}$ and $(m+n)\boldsymbol{y}$, then $(m+n)\boldsymbol{y}$ is at least as good as $n\boldsymbol{x} \circ m\boldsymbol{z}$. The increase from ***z*** to ***y*** and the obtained equality can compensate for the loss from ***x*** to ***y***. But this is denied by *the Lower Bound for Exchangeability View*, if ***x*** is lexically better or at least minimally lexically better than ***y***. I demonstrate in Appendix 3 how *the Lower Bound for Exchangeability View* violates the more sophisticated *Condition β*, which is implied by *the Non-Elitism Condition* of *the Sixth Impossibility Theorem*.[49]

[47]Gustaf Arrhenius, 'The Impossibility of a Satisfactory Population Ethics', *Descriptive and Normative Approaches to Human Behavior, Advanced Series on Mathematical Psychology*, ed. H. Colonius and E. N. Dzhafarov (Singapore, 2011), pp. 1–26.

[48]Gustaf Arrhenius, 'Population Ethics' at p. 174, note 18; cf. Gustaf Arrhenius, *Future Generations: A Challenge for Moral Theory* (Uppsala, 2000), ch. 6.

[49]Arrhenius, 'The Impossibility', p. 10.

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However, *the Non-Elitism Condition*,[50] even though it implies *Condition β*, cannot itself be rejected for the same reasons, according to Arrhenius.[51] It is not entirely obvious that *the Lower Bound for Exchangeability View* violates *the Non-Elitism Condition*, but for logical reasons, it must. I demonstrate how in Appendix 3.

Roughly, *the Non-Elitism Condition* claims that, in a discrete domain, a small decrease of quality of life in one life from $\boldsymbol{a}$ to $\boldsymbol{b}$ can always be compensated by a larger increase from $\boldsymbol{z}$ to $\boldsymbol{b}$ for a sufficiently high number of lives. This condition brings out a further dimension of discontinuity of lexical betterness. Assume *Condition* 1 and suppose that $\boldsymbol{a}$ is lexically better than its successor $\boldsymbol{b}$. This sets an upper bound $m\boldsymbol{a}$ for any number of $\boldsymbol{b}$s. But for $(m\text{-}1)\boldsymbol{a}$, there is some number n such that $n\boldsymbol{b}$ is better than $(m\text{-}1)\boldsymbol{a}$. If $\boldsymbol{z}$ is exchangeable with $\boldsymbol{b}$, then by transitivity, there is a number n' such that $n'\boldsymbol{z}$ is better than $(m\text{-}1)\boldsymbol{a}$. In that case, the value decrease from $m\boldsymbol{a}$ to $(m\text{-}1)\boldsymbol{a}\circ\boldsymbol{b}$ is so large, because we get below the limit of $m\boldsymbol{a}$, that it cannot be compensated. The fact that $\boldsymbol{a}$ could be radically imprecisely equal to $\boldsymbol{b}$ is not of any help here. See Appendix 3 for details.

Arrhenius' theorem presupposes a discrete (sub)set of $\boldsymbol{P_A}$. If there is an order dense subset of the set of lives $\boldsymbol{P_A}$, then we can also form a discrete fine-grained subset $\boldsymbol{P_{A1}}$; and if some condition is intuitively plausible of an order dense subset of $\boldsymbol{P_A}$, it is also plausible of a discrete subset of $\boldsymbol{P_{A1}}$, Arrhenius says.[52] But as we saw with *Premise* (A) of *the Continuum Argument*, an argument often starts from what seem intuitively plausible conditions of a discrete subset of $\boldsymbol{P_{A1}}$, which may not be true on an order dense subset of $\boldsymbol{P_A}$. The assumption that there exists a discrete domain, which fulfills certain conditions, is certainly not innocent if denseness is true.[53] The space does not allow an investigation of how Arrhenius' theorem is dependent on the assumption of discreteness, but I believe there is room for some suspicion, not least when it comes to lexical views.

Setting this point aside and accepting discreteness, the question is to what extent *the Lower Bound for Exchangeability View* can be considered independently plausible. The violation of *Condition β* involves a disregard for the value of equality among (some of the) lexically dominated lives. This is an unavoidable feature of any *Lexical View*. Surely, there are strong intuitions about the value of equality. But there might also be strong intuitions about lexical betterness, particularly, I suggest, about a lower bound for exchangeability. The question is, then, which intuition is more credible. Given that *the Lower Bound for Exchangeability View* may represent a way to avoid *the Repugnant Conclusion*, the overall weighing may be in its favor.[54]

Consider next the following claim:

> *Roughly, the intuition which the Non-Elitism Condition tries to capture is that there is at least some very small decrease in the welfare of one of the best off lives which can be compensated for by an increase in welfare for at least some number of worst off people.*[55]

[50]Arrhenius, 'The Impossibility', p. 8.
[51]Arrhenius, '*Future Generations*', ch. 6.3.
[52]Arrhenius, 'The Impossibility', at p. 6; cf. Arrhenius *Future Generations*, at pp. 154–55.
[53]Rabinowicz, 'Can Parfit's Appeal' struggles with this problem.
[54]See Jensen, 'Millian Superiorities', pp. 297–98.
[55]Arrhenius, *Future Generations*, p. 98.

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The question is to what extent this intuition relies on an assumption that the comparison in all cases is independent of who else lives. Since *the Lower Bound for Exchangeability View* rejects *Non-diminishing Marginal Value*, it also rejects *Weak Independence* (*Condition* 7). But this raises the possibility that a comparison could be influenced by who else lives, which is at stake when *the Lower Bound for Exchangeability View* violates *the Non-Elitism Condition*. And again, the overall weighing could be in favor of *the Lower Bound for Exchangeability View*.

10. Summary of results

A formal framework has been developed to study the properties of lexical betterness, in general as well as regards Parfit's *Imprecise Lexical View* in particular. In contrast to comparable frameworks from the literature, (1) the present framework allows not only for a domain of a discrete finite sequence, but also a dense one; and (2) a condition of *Non-diminishing Marginal Value* is formulated without assuming numerical representation by a real-valued cardinal scale of value.

Under conditions that do not allow for imprecise equality (i.e. conditions of full comparability), a result which goes beyond existing literature is proved: If in some sequence of objects (dense or discrete) the first is lexically better than the last (and assuming some regularity), then either all members of the sequence (except the last) are lexically better than the last, or the first is lexically better than all its successors including the last. Moreover, it was proved that the condition of *Non-diminishing Marginal Value* implies that lexical betterness collapses into strict lexical betterness. In passing, it was observed (1) that *the Continuum Argument* only holds for a discrete sequence, but not for a dense one; and (2) that *Non-diminishing Marginal Value* excludes any case of lexical betterness, unless *the Archimedean Property* is rejected.

The analysis of conditions allowing for imprecise equality builds on Handfield and Rabinowicz's notion of radical imprecise equality, which is shown to be equivalent to the conjunction of the negation of lexical betterness and the negation of exchangeability, and on their result that for all objects $\boldsymbol{x}$ and $\boldsymbol{y}$, either $\boldsymbol{x}$ is lexically better than $\boldsymbol{y}$, or $\boldsymbol{x}$ is exchangeable with $\boldsymbol{y}$, or $\boldsymbol{x}$ is radically imprecisely equal to $\boldsymbol{y}$ (i.e. $\boldsymbol{x}$ is both minimally lexically better than and minimally exchangeable with $\boldsymbol{y}$).

Allowing for imprecise equality, the following general result is obtained: In some sequence of objects (dense or discrete) where the first is lexically better than the last, there may be a zone of radical imprecise equality before the last object or after the first, or possibly a zone occupying all of the space between the first and the last object, such that the object before the zone is lexically better than the last. This also confirms, and makes more precise, a point made by Handfield and Rabinowicz, namely that, in order to block *the Continuum Argument* by the help of imprecise equality between some pair(s) of neighboring objects, at least two cases are needed, namely one at either end of the zone.

Moreover, it is shown that *Non-diminishing Marginal Value* implies that minimal lexical betterness collapses into strict minimal lexical betterness.

Applied on Parfit's *Imprecise Lexical View*, it is argued that the most defensible version is what I call *the Lower Bound for Exchangeability View*, which still does involve some implausible discontinuities. Also, it violates Arrhenius' *Non-Elitism Condition*. However, the logical space for alternatives in the area is quite limited, so in the end

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the Lower Bound for Exchangeability View might turn out to be the least implausible option.[56]

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0953820819000517.

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