Title
Measuring the hedonimeter

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Measuring the hedonimeter

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Abstract We revisit classical Utilitarianism by connecting and generalizing two ideas. The first is that there is a representation theorem possible for hedonic value (pleasure) similar to, but also importantly different from, the one provided by von Neumann and Morgenstern to measure decision utility. The idea is to use objective time, in place of objective chance, to measure hedonic value. This representation for hedonic value delivers a stronger kind of scale than von Neumann–Morgenstern utility, a ratio scale rather than merely an interval scale. The second idea is that measurement on a ratio scale allows the meaningful aggregation of utilities over a group. This is aggregation by product rather than sum. Aggregation by product is known to have interesting Prioritarian consequences. Aggregation becomes complicated when the two approaches are mixed, when hedonic value is mixed with uncertainly. It becomes problematic when pain as well as pleasure is taken into account.

Keywords Hedonimeter · Measurement · Utilitarianism · Meaningfulness · Prioritarian · Pleasure · Pain

"Now suppose happiness to consist in doing or choosing the greater, and in not doing or in avoiding the less, what would be the saving principle of human life? Would not the art of measuring be the saving principle; or would the power of appearance? Is not the latter that deceiving art which makes us wander

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up and down and take the things at one time of which we repent at another, both in our actions and in our choice of things great and small?"
- Socrates in Protagoras.

1 Introduction

There has been a resurgence of interest in measuring experienced utility—hedonic value—that was of primary interest to classical Utilitarians. Hedonic utility is distinct from the concept of utility as disposition to choose that was developed by decision theorists and economists. Classical Utilitarians were well aware that there was a problem of measurement of hedonic value. Consider the following from an anonymous (1871) review of Jevons (1871):

> We can tell that one pleasure is greater than another; but that does not help us. To apply the mathematical methods, pleasure must be in some way capable of numerical expression; we must be able to say, for example, that the pleasure of eating a beefsteak is to the pleasure of drinking a glass of beer as five to four. The words convey no particular meaning to us; and Mr. Jevons, instead of helping us, seems to shirk the question. We must remind him that, in order to fit a subject for mathematical inquiry, it is not sufficient to represent some of the quantities concerned by letters.
> Anonymous review of Jevons. In Saturday Review, Nov. 11, 1871 (quoted by Edgeworth 1881, in *Mathematical Psychics.*)

We revisit classical Utilitarianism by connecting and generalizing two ideas. The first is that there is a representation theorem possible for hedonic value similar to, but also importantly different from, the one provided by von Neumann and Morgenstern to measure decision-based utility. The idea is to use objective duration, in place of objective chance, to measure hedonic value. This line of thought is developed in Kahnemann et al. (1997) "Back to Bentham". Their representation for hedonic value delivers a stronger kind of scale than von Neumann–Morgenstern utility, because in their representation there is a natural zero point, whereas in von Neumann–Morgenstern the choice of zero point is arbitrary. In technical terms, hedonic utility is measured on a ratio scale. Decision-based utility is measured on a weaker interval scale.

The second idea is that measurement on a ratio scale allows a kind of meaningful aggregation of utilities over a group. For aggregation to be meaningful[1] it must give results that are invariant over arbitrary choices of parameters of the measurement scales for individuals comprising the group. The natural zero of the hedonic value scale makes a kind of utilitarian aggregation of pleasures meaningful that is not meaningful on an interval scale. This is aggregation by product rather than sum. Aggregation by sum is still not meaningful, so this is not quite classical Utilitarianism, but it is closely related. Aggregation of pleasures (of positive

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[1] On Meaningfulness, see Krantz et al. (1971) and Narens (1985).

hedonic values) has Prioritarian consequences, and has been independently proposed for this reason. Adler (2011) contains an extensive discussion.

When all individuals have negative hedonic values (net pain) meaningful aggregation is still possible, but Priotarianism is lost (and indeed reversed.) When some individuals have positive hedonic values and others negative all sensible aggregation seems impossible. Restricting ourselves to the positive case, aggregation of pleasures becomes complicated when hedonic value is mixed with uncertainly. Meaningful aggregation is still possible. But can be done in two different ways, and they are not equivalent.

The representation of hedonic value saves some parts of classical Utilitarianism as meaningful, but not others. It should be of interest to proponents of Utilitarianism, as well as opponents to see what survives as meaningful and what is meaningless. For instance Parfit's "lives barely worth living" assumes a non-arbitrary zero point. Nozick's (1974) "Utility Monster" assumes a non-arbitrary unit. The latter assumption is meaningless on the kind of hedonic utility developed here. Both are meaningless on von Neumann–Morgenstern utility measurement. We will return to these questions.

2 Bentham, Edgeworth and Jevons on hedonic value of episodes

...let us begin with saying: Pleasure is comprised under two dimensions, Intensity and Duration ...(Bentham in Halévy (1901, 1995) v. 1, Appendix II, p. 302.)

The primary bearers of utility for an individual are *episodes*.[2] They are characterized by the times they begin and end, their intensity and duration of pleasure. Duration is the interval of time between their beginning and end. Intensity need not be constant, it is some function over time. Leaving pain to the side for the moment, the utility of an episode is gotten by "summing up" the constituent pleasure intensities. The utility of an episode is the integral of pleasure intensity with respect to time, evaluated from the beginning to the end of the episode.[3]

We immediately notice a property of this scheme that may seem counterintuitive; order does not matter: *If episode 2 comes from episode 1 by permuting two sub-episodes of positive duration, then it is a matter of indifference between episode 1 and episode 2.*This may appear to fly in the face of the commonplace that order of experiences makes a difference in judged overall pleasure. The Benthamite would reply that this confuses order of the experiences that engender pleasure with the order of pleasure intensity. You may like appetizer before entree before main before dessert better than permutations of courses, but this just shows that permutations of courses do more than permute subintervals of pleasure intensity: They change the intensities of pleasure within those sub-intervals.

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[2] Here we follow the terminology of Kahnemann et al. (1997) "Back to Bentham."

[3] Bentham does not have the notion of the integral, but the idea is clear in chapter II of Jevons' *Theory of Political Economy*, in Edgeworth's (1879) Mind article and in Edgeworth's appendix III, on the Hedonimeter, to *Mathematical Psychics,*

The second of Bentham's "sovereign masters" is pain. Pains are compared just as pleasures are.

> If of two pains a man would as lief escape one as the other, such two pains must be reputed equal. ...(Bentham in Halévy v. 1, Appendix II, p. 302.)

In a purely painful episode, the total pain would be the integral of pain intensity over time.

We may have episodes that combine both pleasure and pain. How are they to be treated? First we have to ask what kinds of combinations are possible. We may have episodes that are pleasurable for a stretch of time and painful for a stretch. Can we have also episodes that are both pleasurable to some extent and painful to some extent at the same time? How do pleasure and pain interact in determining the utility of an episode? Is it possible that someone might prefer a pleasure with a small amount of pain to the pure pleasure?

Bentham insists that the interaction of pleasure and pain is purely additive. Thus,

> If of two sensations, a pain and a pleasure, a man would as lief enjoy the pleasure and suffer the pain, as not enjoy the first and not suffer the latter, such pleasure and pain must be reputed equal ...(Bentham in Halévy v. 1, Appendix II, p. 302)

and

> Sum up all the values of all the pleasures on the one side, and those of all the pains on the other. The balance, if it be on the side of pleasure, will give the good tendency of the act upon the whole, with respect to the interests of that individual person; if on the side of pain, the bad tendency of it upon the whole.[4]

That is to say that pleasure and pain are put on the same scale, with pleasure intensities being positive values and pain intensities being negative values. The hedonic value of an episode is the integral of this hedonic value function over time, and may itself be positive, negative or zero. There is a representation theorem for just this conception of hedonic value.

3 Representation of hedonic value

We discuss this in two stages. In the first we choose some fixed time period and draw out the parallel with the von Neumann–Morgenstern representation of decision-based utilities. Then we proceed to episodes of variable duration. To start, recall von Neumann–Morgenstern[5]. There is a set of prospects. A subject is assumed to have preferences over chance distributions over prospects. (These are sometimes

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[4] Bentham (1789, 2017), *An Introduction to the Principles of Morals and Legislation Chapter IV: "Value of a Lot of Pleasure or Pain, How to be Measured"*, section V. The setting here is different. Bentham is thinking here of just noticeable differences. But the principle is clear.

[5] von Neumann and Morgenstern (1947).

called "lotteries" to provide a vivid image of the objective chances, but no actual lottery procedure is implied.) Under the assumption that preferences are a total ordering of these "lotteries" that satisfies independence and continuity conditions,[6] it is shown that a utility exists such that preference over lotteries goes by their expected utilities. The expected utilities for two lotteries are equal just in case the subject is indifferent between them. The expected utility of one is higher than another just in case the subject prefers it to the other. The utilities are unique up to arbitrary choice of zero and unit. That is to say that if we add or subtract a constant to all utilities we get the same preferences, and if we multiply all utilities by a positive constant, we get the same preferences. *The position of the zero point, and the size of a unit on the scale do not derive any empirical meaning from the preference ordering.* In the terminology of measurement theory, this is said to be an interval scale.

Compare hedonic episodes over a fixed time period, one hour or one day or one year. Hedonic intensities are analogous to prospects. Episodes are analogous to lotteries over prospects. An episode with with 2/3 of the time at intensity A and 1/3 of the time at intensity B is like a lottery with chance 2/3 of getting A and chance 1/3 of getting B. With some not inconsiderable idealization of the psychology, the von-Neumann Morgenstern representation [or rather a modern generalization, see Kreps (1988 Ch 5).] can be applied.[7] There is an integral representation of hedonic value of episodes. But at this point, we have only an interval scale. Choice of zero and unit are still arbitrary.

Now consider the extension to measurements of hedonic values of intervals of arbitrary duration. Two non-overlapping episodes can be concatenated to make a composite episode. Order does not matter. Measurement at some fixed intensity proceeds just like measurement of length. Hedonic value of episodes adds. There is an integral representation of hedonic value of episodes along these lines in Kahnemann et al. (1997). Notice that no matter what the intensities, the null episode of zero duration must have zero hedonic value. We now have a natural non-arbitrary zero point for hedonic value of episodes. This gives a natural zero for intensities, the intensity such that a positive duration of it is an episode of the same hedonic value as the null episode. Hedonic values are now measured on a scale with arbitrary unit, but a meaningful zero. This zero can be taken as marking the Utilitarians' divide between pleasure and pain.

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[6] Together with a few other technical conditions.

[7] We are indebted to a referee for pointing out that continuity, completeness of the order, and the Archimedean property are all psychologically questionable. These idealizations are far from Bentham, who talked of counting particles of pleasure, but closer to Edgeworth, who wanted to apply the integral calculus.

4 Aggregation of pleasures

Consider a stretch of time, where the members of a group of finite size remain constant. Assume that the net hedonic value of the episode for each member of the group is positive. How can utility of the group be meaningfully quantified? Bentham thought that we should take the sum of the hedonic values of the individuals. On the foregoing account it cannot be as a sum, because individual utilities are only measured up to an arbitrary unit. Multiply Peter's units one constant and Paul's by another, and provided their interests conflict, you may reverse the pair's group preferences. Bear in mind that on the account of measurement given in the last section, the units do not correspond to anything in reality. The sum is not meaningful. But the foregoing account, unlike that of von Neumann–Morgenstern, has a distinguished zero, and measures each individual's utilities on a ratio scale. Choice of unit is arbitrary, but choice of zero is not. This has the property that it preserves the numerical ordering of the aggregates of individual episodes no matter which representation from individuals' ratio scales are used. Suppose the product of net pleasures of Peter and Paul rate episode A over episode B. This is equivalent to the ratio of the product for A over the product for B being positive. Multiply Peter's utilities by one positive constant c, and Paul's by another, d and we see that the scale changes cancel out.[8] The product is meaningful.

For example, suppose that Peter has utility 5 for A and 4 for B, and Paul has utility 2 for A and 3 for B. Peter prefers A; Paul prefers B. The group, going by product, prefers B (4×3) to A (5×2), so the group preference goes with Paul. Now we change Peter's scale by multiplication by 100. Peter now values A at 500 and B at 400. The group, going by product, has the same preferences, preferring B $(100 \times 4 \times 3)$ to A $(100 \times 5 \times 2)$. The scale change cancels out.[9]

Aggregation by product is not only meaningful, but it has properties of independent interest. It has been suggested by Adler (2011)[10] and others for its Prioritarian flavor, as is evident in the following examples: Suppose that a windfall has been found and the feasible social options under consideration all give each member of the group positive utility. Then we can use the product to aggregate. For instance, new trees appear in the garden of Eden, and there is new fruit to distribute. Adam and Eve can enjoy them over the time period in question. Distribution (A) gives Adam utility 1 on one version of his ratio scale, and Eve 20 on one version of hers, while distribution (B) gives Adam 5 and Eve 5. We resist the urge to look at the sum which is meaningless; we look at the product. Then (B), with a product of 25 is socially preferable to (A) with a product of 10. If we multiply Adam's utilities by one positive constant and Eve's by another, (B) is still preferable to (A). We must note that by choosing the constants, we could make (A) look more egalitarian than (B) because "egalitarian" doesn't mean anything in this framework. Suppose

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[8] See Aczél and Roberts (1989), for discussion of uniqueness of product representations.

[9] Observe that if we had used the sum, rather than the product, the scale change would have changed the group preference to favor Peter, 502 to 403. The sum is not meaningful; the product is.

[10] Adler uses the von Neumann–Morgenstern representation, and postulates a zero on ethical grounds. His account is thus quite different in both motivation and character from that examined here.

that we multiply Adam's utiles by 20, and leave Eve's alone. Then, in this representation, (A) looks egalitarian, but Adam does so well in (B) that the aggregate good favors (B).

If we know that Adam's utilitiy (on some version of his ratio scale) is a function of the quantity of some real or monetary good possessed, and likewise for Eve, then we can do more. Consider the case of dividing $100 between Adam and Eve, with the proviso that each must get at least $1. On some choice of units for their ratio scales, Adam's utility function is $\varphi_a(\$x) = x$ and Eve's is $\varphi_e(\$x) = \sqrt{x}$. In this case, if the utilitarian sum were meaningful, the only utilitarian sum solution (the distribution that maximizes the sum of their utilities) would be $99 to Adam and $1 to Eve. The utilitarian product solution is $\frac{2}{3}$$100 to Adam and $\frac{1}{3}$$100 to Eve.

We have a way of measuring hedonic value that, so far, allows meaningful aggregation in an interesting way. But we have not yet considered pain.

5 Aggregation of pain

Suppose a disaster is at hand and the members of the group will undergo episodes that give each member net pain. To evaluate these scenarios we need to aggregate negative hedonic values. Obviously we cannot simply take the product, with the sign of the aggregate flipping back and forth as each additional member is factored in. But meaningful aggregation is still possible. We take the negative of the product of the absolute values of the pains. Thus, if Adam and Eve have hedonic values − 2 and − 3, the aggregate is − 6. Pain can also be aggregated in a perfectly meaningful way.

But we must notice that the Prioritarian flavor of product aggregation that has been remarked on in the aggregation of pleasures is now reversed. Adam and Eve face two alternative scenarios which affect how they will share the pain. Scenario (A) gives Adam utility − 1 on one version of his ratio scale, and Eve − 20 on one version of hers, while distribution (B) gives Adam − 5 and Eve − 5. We again resist the urge to look at the sum which is meaningless. We aggregate as above. Then (A), with aggregate pain of − 10 is socially preferable to (B) with aggregate pain of − 25.

Those who have advocated product aggregation on Prioritarian grounds without taking pains into account have food for thought.

6 Aggregation of mixed pleasure and pain

Suppose that we wish to aggregate hedonic values for episodes in which some members of the group have net pleasure and others have net pain. We can meaningfully aggregate the pleasures and the pains separately, as shown in the foregoing. There is an aggregate group pleasure and an aggregate group pain. But how are they to be combined to get a group hedonic value?

We cannot simply subtract the group pain from the group pleasure to get group hedonic value. This is not meaningful. Multiplying individual's hedonic values by arbitrary positive constants could then reverse group hedonic ordering. On our way of measuring individual pleasures and pains, this conception of group hedonic value is quite without meaning.

It is evident that the quotient, the value of group pleasure over the absolute value to group pain, will not do either. A tiny amount of group pain would blow up the quotient, giving the result that a state where someone would be slightly unhappy would be better than one the same except that that person was slightly happy. But since pain is measured on a ratio scale, there is no meaningful distinction between aggregate pain less that one and aggregate pain greater than one. And what about zero pain?

We could try absolute value of group pleasure over one plus absolute value of group pain. This would at least have the property that zero pain gives a group hedonic value equal to total pleasure. But this is not meaningful. Suppose that in scenario A, Eve gets pleasure of magnitude 2 and Adam pain of magnitude 1 and in scenario B Eve gets pleasure of magnitude 1 and Adam is has neither pleasure nor pain. Adam is at 0. Then Eve prefers A and Adam prefers B, and the proposed aggregation rule counts them as, on balance, equal. But if we multiply Adam's units by 10 the aggregation rule favors B and if we multiply them by .1, it favors A.

At this point we see no sensible meaningful way to combine group pleasure and pain. In what follows we will confine the discussion to positive hedonic values.

7 Parfit's counterexamples

The foregoing discussion deals with a fixed population. If the alternative scenarios being evaluated involve different populations, then things are different. In that context Parfit raised a difficulty for Utilitarianism thus:

> For any possible population of at least ten billion people, all with a very high quality of life, there must be some much larger imaginable population whose existence, if other things are equal, would be better even though its members have lives that are barely worth living. Parfit (1984) p. 388[11]

Parfit's "lives barely worth living" presumably assumes a non-arbitrary zero, dividing lives that are worth living from those that are not. According to von Neumann–Morgenstern utility there is no such zero; all the lives in question could just as well be represented as having negative values; Parfit's argument is meaningless. For this reason, modern decision theorists do not think much of Parfit's argument.

But here we do have a non-arbitrary zero point, and all the values assumed in the argument are positive. We have a way of meaningfully aggregating positive hedonic

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[11] See also Parfit (1991, 2004).

values. So one might wonder well whether we have not made some version of Parfit's argument, taking lives as hedonic episodes, meaningful.

The answer is negative. A different kind of comparison is being made, and we must be careful with meaningfulness in the context where we are adding or subtracting members of the group. Adding a life with utility 2 doubles the product; adding a life with utility .5 cuts it in half. But utility of 1 is not meaningful when utilities are measured on a ratio scale. It is not meaningful to ask whether adding a life with positive utility increases or decreases the aggregate.

He has another argument, in the same framework, against those who would compare populations using the arithmetic average. A population with a few extremely happy people has an average utility higher than one which, in addition, has many people who are almost, but not quite, as happy.

> Suppose that Adam and Eve lived these wonderful lives. On the Average Principle it would be worse if, *not instead but in addition*, the billion billion other people lived. [Note: Specified earlier as having a quality of life almost as high.] This would be worse because it would lower the average quality of life. Parfit (1984) p. 420.

On our measurement of pleasures for a fixed population the artithmetic average is not meaningful, but the geometric mean[12] is. Consider Perfit's second argument using the geometric mean. On one representation, Adam has utility 101. We could add Eve who, on one representation, would have utility 100. This would decrease the geometric mean so, by Parfit's second argument, it would argue for leaving Adam alone. But Eve's utilities could just as well be rescaled to 1000, which would increase the geometric mean. Or to 101, which would leave it unchanged. Likewise for all those other people. In our measurement setting, both of Parfit's arguments fail to be meaningful. It is not the size of a particular product or geometric mean that is meaningful, but their comparison for the *same* population.

An anonymous reader made the interesting suggestion that a version of Parfit's first argument applies at the individual level. A long life with very small intensity of pleasure throughout would have greater hedonic value as an episode than a short life with high intensity of pleasure. This certainly follows from the integral representation. We do not think that Bentham would disagree. In fact, one of his arguments for the contemplative pleasures was that they could be sustained over a long time.

8 Chance

In his (1822) *Codification Proposal*, and elsewhere, Bentham called attention to the role of chance in evaluating prospects for future episodes. This is where Bentham comes in contact with von Neumann and Morgenstern. We consider only the most

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[12] The arithmetic mean of n values is gotten by adding them together and dividing them by n. The geometric mean is gotten by multiplying them together and taking the nth root

tractable case of positive hedonic values. There are still complications, but not insuperable difficultioes.

Suppose that a Utilitarian's choices do not determine a forthcoming episode, but rather a gamble over possible episodes. How should she value such gambles? Bentham says to take the expectation. This is not uncontroversial, but we pursue Bentham's suggestion here. Suppose an individual's utilities are extended to probability distributions over possible episodes in this way.

A social planner may also face choices of gambles over episodes. How should the utilitarian planner value such gambles? Two possible approaches present themselves:

(1) First, aggregate utilities of episodes by product; second planner takes expectations to get utilities of lotteries.
(2) First, individuals take expectations to get utilities of lotteries; second planner aggregates utilities of lotteries by product.

These two approaches do not give the same result.

We illustrate with a simple example:

- Adam has Utilities 1, 3, 5 for prospects A, B, C respectively.
- Eve has Utilities 5, 3, 1 from prospects A, B, C respectively.
- There is also a lottery $< \frac{1}{2}A, \frac{1}{2}C >$, giving A or C, each with probability $\frac{1}{2}$.

(1) first aggregates prospects by product, giving 5, 9, 5 to A, B, C. Then extends to lotteries by expectation, giving:

$$\begin{array}{cccc} A & B & C & \left\langle \frac{1}{2}A, \frac{1}{2}C \right\rangle \\ 5 & 9 & 5 & 5 \end{array}$$

(2) first has each individual extend to lotteries by expectation:

$$\begin{array}{ccccc} & A & B & C & \left\langle \frac{1}{2}A, \frac{1}{2}C \right\rangle \\ Adam & 1 & 3 & 5 & 3 \\ Eve & 5 & 3 & 1 & 3 \end{array}$$

Then aggregates by product:

$$\begin{array}{cccc} A & B & C & \left\langle \frac{1}{2}A, \frac{1}{2}C \right\rangle \\ 5 & 9 & 5 & 9 \end{array}$$

With each of the alternatives we lose a property of the social planner's utilitarian evaluation of gambles that we might wish to retain:

- With alternative (2), the social planner is incoherent. Both A and C have social utility 5, but a 50%/50% gamble between them has utility 9 by the product rule. This violates the von Neumann–Morgenstern independence axiom.[13]
- With alternative (1), the social planner flouts consensus. Each individual is indifferent between preferring B to the lottery $<1/2A, 1/2C>$. But the social planner strictly prefers B to the lottery. This violates a weak form of the Pareto principle.

Given the preceding, there are two, mutually exclusive, versions of Product Utilitarianism. The choice between alternatives (1) and (2) is a choice between group rationality and respect for group consensus. An advocate of alternative (2) might argue that coherence is not all that important. A proponent of alternative (1) might maintain that the *prima facie* plausibility of the Pareto Principle does not hold up under examination. In somewhat different contexts, both sorts of arguments have generated an extensive literature.

Suppose one is not willing to give up either coherence or Pareto. And suppose one follows Bentham in extending utility to gambles by taking the expectation. Then a famous theorem of Harsanyi (1955) shows that one must be some version of a Sum Utilitarian. One then would have to wrestle with the meaningfulness problem that product utilitarianism (at least partially) solves.

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[13] Most of those who have questioned the independence axiom would not welcome a deviation in this direction. The social planner here is not risk-averse but risk seeking.

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