**Vagueness, Semantic Representation and Verification**

This paper claims that the vagueness inherent in gradable adjectives is a reflection of an independently-motivated, underlying measurement mechanism, called the *analog magnitude system* (AMS). The AMS is a language external system that can be called on to help verify sentences. Differences between positive forms of gradable adjectives like *tall* (1) and their comparative forms (2), in terms of vagueness, is a consequence of what the AMS is measuring: for positives it measures and compares objects, and for comparatives it measures and compares abstract units (degrees). This distinction is caused by the morpho-syntactic differences between positives and comparatives.

(1) John is tall ∅/for a jockey/compared to Bill.

(2) John is taller than Bill.

Positives differ empirically from comparatives in at least three ways.[1,2] First, comparatives allow measure phrases to describe the difference between the two objects compared, but not positives. (3-4).

(3) John is **three inches** taller than Bill.

(4) *John is **three inches** tall for a jockey/compared to Bill.

Second, only comparatives allow crisp judgments (5-6). Comparatives can be used to describe even minute differences, but small differences are not enough to warrant application of the positive.

(5) Context: a 100 page novel and a 99 page novel

    a. This novel is longer than that one.
    b. #This novel is long compared to that one.

(6) Context: a boy is 5’ 1/8”, while everyone else in his family is exactly 5’ tall

    a. This boy is taller than everyone else in his family
    b. #This boy is tall for a member of his family.

Third, positive adjectives *even when they are accompanied by an explicit standard* create compelling Sorites premises (7)-(10)[7], but comparative adjectives (14) resist them.

(7) √Anyone who is 1mm shorter than someone who is <u>tall</u> is also <u>tall</u>.

(8) √Anyone who is 1mm shorter than someone who is <u>tall for a jockey</u> is also <u>tall for a jockey</u>.

(9) √Anyone who is 1mm shorter than someone who is <u>tall compared to Bill</u> is <u>tall compared to Bill</u>.

(10)#Anyone who is one nanometer shorter than someone who is <u>taller than Bill</u> is also <u>taller than Bill</u>.

These differences are unexpected if the semantic representations of both positives and comparatives should be written in terms of *degrees*, or precise points on a measurements scale, as in (11-12).

(11) ||John is tall|| =1 iff ∃d [john is d-tall and **d > c**] *c = salient standard height*

(12) ||John is taller than Bill|| =1 iff ∃d∃d’ [john is d-tall & Bill is d’-tall & **d > d’**]

This is true even in cases where the standard is expressed via a *for-PP* or a *compared-to* phrase. A degree analysis would posit a precise degree to represent the standard expressed in those phrases. So, a positive adjectival construction can be a comparison, but not of two exact degrees.

Models of AMS’s accurately describe the abilities of many species (including humans, human babies, bees, rats, and monkeys) to mentally represent number, quantity, or magnitude without counting.[3,4,5] An analog magnitude is an inherently noisy mental representation that obeys Weber’s law: their imprecision linearly increases with their magnitude.[6] The higher the number, the fuzzier it gets, and the harder it is to discriminate it from other high (and fuzzy) numbers that are close to it. For instance, even when we are prevented from counting, we are still very good at discriminating quantities of 2 and 3; but we get much worse when forced to discriminate 8 from 9, 22 from 26, or 360 from 380, etc. The same applies to discriminating magnitudes such as luminosity, weight, heat, etc.[6] Analog magnitudes can be accurately represented as Gaussian, and as such, a mathematics has been devised so that they can be compared via addition and subtraction algorithms, the result of which can indicate the higher or lower of two magnitudes (with an error dependent on Weber’s Law).

The AMS can help describe the differences between positives and comparatives. Let’s assume that the AMS measures and compares the entities in a positive adjectival construction under verification. First, measure phrases cannot describe the distance between two analog magnitudes because these analog magnitudes do not exist on a scale, nor can their differences be measured consistently. Second, because analog magnitudes can be difficult to discriminate, we cannot make crisp judgments. This predicts that crispness is a function of discriminability, which appears to be true. A 1’ difference is enough for a crisp judgment when comparing 5’ and 6’ but not 200’ and 201’.

(13) Context: John = 6’, Bill = 5’; John’s office building = 200’ Bill’s building = 201’.

c. John is tall compared to Bill.

d. #?John's office building is tall compared to Bill's office building.

Third, positive adjectives are vague because Gaussian values do not have boundaries in the sense that degrees do (or degree intervals, which have precise boundaries). Hence, the vagueness that is apparent in positive adjectival constructions is a product of the verification device that measures magnitudes.

It has been argued that even comparative adjectives are vague, though in a different way than positives.[8,9,2] This vagueness appears to be dependent on measurement granularity. Russell famously pointed out that perhaps all of natural language was vague and used a measure phrase as an example: what counts as one foot?[10] The answer depends on our own interests and abilities in the contexts that we use measure phrases. We could measure very precisely, and exclude measurements that are too big or small, or we could measure less precisely and include those very same measurements. The unit itself (for instance, *one foot*) is vague. Let's call this *observational tolerance*. Hence, even though there are clear differences in (7-10), we can arrange a context in which the granularity of measurements creates borderline cases and a tendency to accept Sorites sentences. Suppose John wants to wear Bill's suit. Pete is taller than Bill, and can't fit into Bill's suit.

(14) Anyone who is only 1/8" shorter than some who is taller than Bill is still taller than Bill.

For (14), when the context becomes one in which we are worried about wearing suits, then small differences are tolerated, provided they aren't too big to make a difference for suit-wearing. 1/8" isn't going to make a difference: if Pete couldn't wear the suit, neither could John. It is the granularity of our measurements, i.e., measurements consistent with our needs and worries, that drive this type of vagueness (or, 'natural precisifications' in [11].) We can provide an explanation for this if we again invoke AMS for use in verification. The difference is that in comparatives, AMS measures a unit of measurement, not an entity, as it does with positives. Recursive application of this measurement smooths out error and fuzziness, and we get the properties that are apparent in comparatives.

Something about the semantic representation of each construction forces the AMS to either measure and compare entities or units of measurement. The difference between the two is a matter of whether or not there is measurement unit in the semantic (or conceptual) representation or not.

(15) Degree comparison: entities must be mapped onto degrees and their degrees compared

(16) Individual comparison: entities must be compared directly, without intermediary degrees

Then, the AMS simply does what comes natural to it: it measures units (or, degrees) for comparatives and individuals for positives. Degree comparison vs. individual comparison must therefore be a function of the degree morphology *–er/more* and its syntax.

There is (at least) one exception to the generalization that positives are comparisons between individuals: [12] points out that *full* is different from *tall* in that included in the conceptual meaning of *full* is a maximum measurement. A container can be *completely full* but one can't be **completely tall*. This maximum, [14] argues, is responsible for adjectives such as *full* behaving like comparatives – with precision and (at most) observational tolerance. Assuming that this is true, we can say that the AMS does not measure an entity's *fullness*, even in the positive form, because *full* conceptually provides a unit, namely the container. The container that is being compared is itself a unit. This is why a glass, pool, or lake can be *a quarter full, half full,* etc. The AMS is not intimately wired into the semantic module such that it responds to specific requests for it to measure particular things. Rather, it simply measures the things that if finds to be measurable, i.e., entities or units.

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