CSE6339 3.0 Introduction to Computational Linguistics
Tuesdays, Thursdays 14:30-16:00 – South Ross 101
Fall Semester, 2011

A NOTE ON REPRESENTING ADJECTIVES AND ADVERBS

Representing English adjectives and adverbs using a logically perspicuous notation (extended semantic networks, Schubert. 1974) and their accommodation within a state-based paradigm (Cercone, 1975) is discussed. Where appropriate, explicit comparisons are made with related approaches such as those of Schank (1972.1970), Montague (1972), Bartsch and Venneraann (1972), Zadeh (1972), and Reichenbach (1947).

1. Introduction

The state-based representation, vide Cercone (1975), has been developed for use in a computer program concerned with the comprehension and manipulation of factual knowledge where such knowledge is communicated to the computer program via natural language. The representation is not based on "primitives", yet permits efficient use of semantic preferences; it is capable of accommodating unlimited amounts of information about complex concepts without loss of efficiency in the use of those concepts (Cercone, 1975, Ch 4). Modifiers, of course, complicate this endeavour.

The following discussion addresses the task of incorporating modifiers into the state-based representation. It will certainly not exhaust the myriad problems of representing all English adverbs and adjectives. Nevertheless, theoretical (the use of functors) and methodological (the visual suggestiveness of extended semantic networks) advantages accrue from the approach outlined below.

2. Adjectives and Relative Terms

Bartsch and Vennemann (1972) outline a unified treatment of relative adjectives and comparatives extending Montague's (1972; treatment within the intensionai logic framework. Their notion of a reference set (a set of objects whose members are used for comparison with some given object relative to some measurable attribute of the objects) may, however, be inadequate. For example, while it is possible to define a more or less adequate "reference set" to account for a phrase like "a large apple", it is not immediately apparent what is reference set if one were to ask a child to draw a large circle on a sheet of paper. This raises the additional question of how to infer the reference set from context.

The use of functors (Creswell, 1973) avoids some difficulties predetermined reference sets entail. For example, the “typical value" functor applied to a concept with some measure attribute returns a value, e.g. the typical value of size for mar). Note that this is not the same as the typical man’s size, which cannot be readily determined since it is difficult to ascertain exactly what constitutes a typical man. A “typical value" functor is shown in Fig. 1. We abbreviate the typical value functor in a manner analogous to predicate collapsing in the abbreviated semantic net notation (Schubert, 1974).

We treat descriptive adjectives as conjoined predications in most cases. The sentence "Judy ate a circular spice cake" is diagrammed in Fig. 2 (abbreviated notation). Spice in this sentence is treated as a kind of cake like a chocolate cake.

Most adjectives appear to be comparative in nature regardless of their morphology. For example, tall, slow, hard, and so on are relative adjectives based on some measurable attribute of the object of attention. The sentence "John is bigger than Bill" is diagrammed in Fig. 3. The explanatory paraphrase of Fig. J is "John s size is greater than Bill's size". Often the comparative is implicit in the utterance. For example, in the sentence "John is a big man", "big" serves as a comparative. The meaning of "John is a big man" is diagrammed as Fig. 4. The associated paraphrase is as follows: "John is a man and the size of John is greater than a typical value of size for a man". Note the use of the " typical value" functor in Fig. 4.

Finally, Fig. 5 illustrates a non-directly predicative, non-directly comparative use of a relative adjective. The sentence "Big John drinks the whiskey" is paraphrased in the diagram as "John drinks the whiskey and John's size is greater than the typical value of size for something and John is an instance of that something". In Fig. 5, the node immediately to the left of John represents John's size (size is used as a functor in the proposition containing John and size). In general the treatment of relative adjectives based on measurable attributes can be summarized as follows: The value of the "attribute" of "x" exceeds the value of the attribute" which is typical for that concept (of which x is an instance).

Ordinary discourse admits constructions such an:

John is the perfect man.	[1]
Mary is the worst conceivable baker.	[2]
Mike is the ideal fat man.	[3]
In order to form a more perfect union...	[4]

Modifiers such as perfect, worst conceivable, and ideal are problematic to represent because of the way they operate on what they modify. For example, we might formulate [1] in logical terms as:

(P){[(x)[man(x)&P(x) = >y-approves[P(x)]]]r>p(John)}

Here y is the speaker. The formulation reads "John has all properties such that y would approve of any man's having them". We can then easily formulate an expression for "someone is not a perfect man" by utilizing the expression above with the existential quantifier added (Ez)~ and replacing P(John) with P(z). Clearly, the method of handling comparative adjectives such as big does not work here.

At this time I make no definite proposals for handling adjectives such as perfect, best conceivable, and so on, at any adequately detailed level of analysis. However one might render the sentence "Mike is the perfect fat man" as shown in Fig. 6. Note that the predicate "fat man" is formed using lambda abstraction, vide Cercone (1975) Ch 3 & 4. The predicate " fat man" is then operated on by the "perfect" functor. In the case of descriptive adjectives (cf. the implicit comparative " fat" In the " fat man" example above) the best one could do (in absence of context) is to treat them as conjoined predications outside the scope of the functor operating.

3. Adverbials

The purpose of this section is to suggest plausible methods for handling adverbials within the state-based framework and to reformulate a version of Fig. 8 consistent with the use of functors above, see Cercone and Schubert (1974).

There appear to be two major approaches to the treatment of adverbial modifiers. One approach, expressed in Montague (1972), Bartsch and Vennemann (1972), and Zadeh (1972) is to regard comparative adjectives and adverbs as operators, which transform predicates. Reichenbach s (1947) approach, seemingly accepted by Schank (1972) and Anderson and Bower (1973), is to regard adverbial modifiers as second-order predicates that impose constraints on a specific relation, thereby restricting the class of specific relations of which it may be a member. Bartsch and Vennemann's approach seems promising but will be seen to have serious defects.

Schank (1972) diagrams adverbs as action modifiers without further analysis. Apparently he has not concerned himself with the meanings of genuine manner adverbials as yet (but see Schank, 1974, for a discussion of adverbs such as vengefully). In the case of many adverbs (and many adjectives) this neglect is probably justified, since most of the meaning content derives from perceptual processes. For example, in the sentence "Mary walked gracefully" it is difficult to paraphrase "gracefully" in more elementary terms. Essentially we know gracefulness when we see it. Thus perceptual understanding needs to be supplemented only by a few additional facts for language comprehension purposes such as the fact that graceful motion is generally pleasing, is more or less the opposite of awkward motion, is smooth and well-coordinated, and the like. Other adverbial modifiers, however clearly require systematic analysis; 'quickly' is a good example. This term appears to say something about the speed of an action or activity, comparing it to some standard. An adequate meaning representation for "quickly" should spell this out precisely.

Bartsch and Vennemann suggest that adverbial modifiers operate on verb meanings in the same manner that adjectival modifiers operate on noun meanings, i.e., they have semantic representations with functions such that f is applied to term x to map x onto a new term f (x). One problem in this approach is illustrated by the following example.

John owns a large car. [5]
John is running quickly. [6]

Whereas large in [5] has as a reference set the set of cars, and John's car is large in relation to the "average" for that set. "running quickly" cannot be analyzed so easily. if the analogy were perfect then the reference set operated on by "quickly" would be the set of "runnings" (whatever that means); but clearly this set of runnings must be further restricted to the set of runnings John is capable of performing. Thus "quickly" appears to operate not on "running" alone, but on "John running" . As further examples consider [7] and [8].

The cheetah is running quickly. [7]
The ant is running quickly. [8]

Clearly "quickly" here operates on "running ant" and "running cheetah" respectively. Hence the nature of the "runner" can narrow the reference set to which we apply a measure function. In [6] "quickly" modifies running with respect to John's runnings, or, if we don't know John, at least to human runnings (assuming that John is human).

In [7] and [8] the measure function is applied to the runnings of cheetahs and ants respectively. Unfortunately factors other than the identity or category of the runner can also affect the meaning of "quickly" , as shown by [9] through [13].

John is running quickly on his hands and knees.	[9]
John is running quickly on the moon.	[10]
John is running quickly in Chile.	[11]
The cheetah is running quickly in the dense forest.	[12]
The cheetah is running quickly on the plain.	[13]

The effect of locale on the meaning of "quickly" is seen in the contrast between [10] and [11] and between [12] and [13].

Consequently it appears that the context, which determines the meaning of an adverbial modifier, cannot be circumscribed once and for all. Adverbials must e allowed to interact with any specific and general knowledge available about the participants of (and setting of) an action. Zadeh's (1972) treatment of adverbial "hedges" lacks generality since he specifies (weighted) components of each fuzzy term on which a hedge may operate once and for all prior to using a particular "hedge". Thus we diagram [7] without the adverb, as Fig. 7; (a) and (b) are based on alternative (but equivalent) representations of definite descriptions. In [12] consistent with Bartsch and Vennemann's general approach, but takes into account the above considerations. In Fig. 8 the relationship is made explicit between the speed of t h e cheetah's running and the typical value of speed for something that is running, a cheetah, and in dense forests.

Note that the set of cheetahs running in dense forests, required for comparison, may well be empty (if not replace "dense forest" with "deep snow"). The "reference set" therefore, if it exists at all, is not of this world but of some imaginary world which is our conception of how hard cheetahs would find the going if they were to run through forests (or snow). In our formulation, we have applied the typical value functor to the lambda abstracted predicate

lx [cheetah(x) & running(x) & in-dense-forests(x)]

The typical value functor does not presume the existence of a reference set. [7] can have two readings:

$x {"y [cheetah(y) & ?(y) Û x=y] & running(x)}	[a]
$x {running(x) & cheetah(x) & ?(x) & {"y [cheetah(y) & ?(y) Þ x=y]}	[b]

[a] and [b] are based on alternative (but equivalent) representations of definite descriptions. The reading of [12] then is an attempt to represent the adverbial construction in keeping with Bartsch & Vennemann's general approach but taking into account the considerations we have been discussing. We show the explicit relationship between the speed of the cheetah's running as compared to a typical value of speed for something that is running, a cheetah, and in dense forests.

In the approach of Zadeh (1972) to the treatment of adverbial hedges he specifies (weighted) components of each fuzzy term on which a hedge may operate once and for all. Because he needs to specify these (weighted) components prior to using a particular hedge, his approach lacks generality. In our semantic network, we would represent "The sun is shining brightly on the beach" without the adverb as diagrammed in Figure 3-6, in keeping with Bartsch & Vennemann's general approach but taking into account the above considerations. In the representation we show the explicit relationship between the speed of the sun's shining as compared to the typical value of brightness for something that is shining on a beach and is a sun.

It is well to note that the set of suns shining brightly on beaches required for comparison, may well be empty (if not, replace "beach" with "ocean floor"). The reference set therefore, if it exists at all, is not of

this world but of some imaginary world which is our conception of how hard suns would find the going if they were to shine brightly on beaches (or ocean floors). In our formulation we have applied the typical value functor to the lambda-abstracted predicate “shining brightly on the beach”.

References

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FIGURES

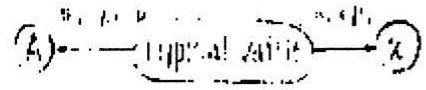


Fig 1 A typical value functor

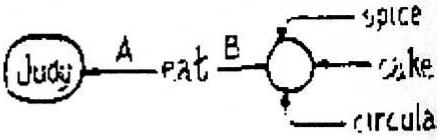


Fig 2 "Judy ate a circular spice cake."

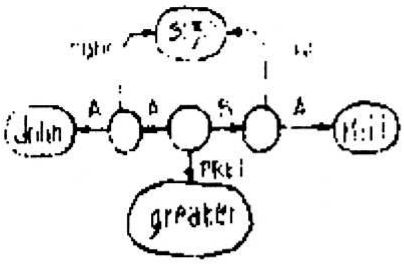


Fig 3 "John is bigger than Bill"

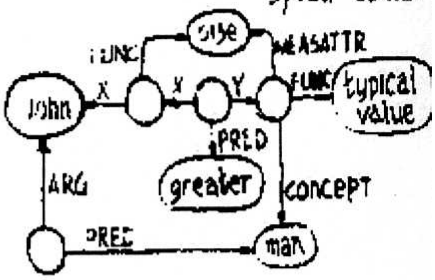


Fig 4 "John is a big man."

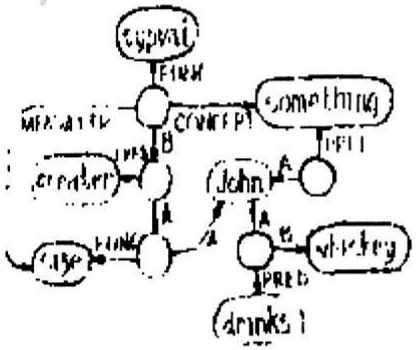


Fig 5. "Big John drinks the whiskey"

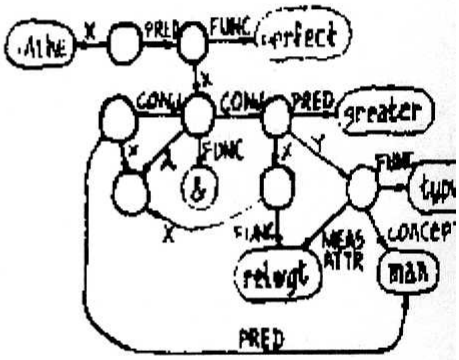


Fig.6 "Mike is a perfect fat man."

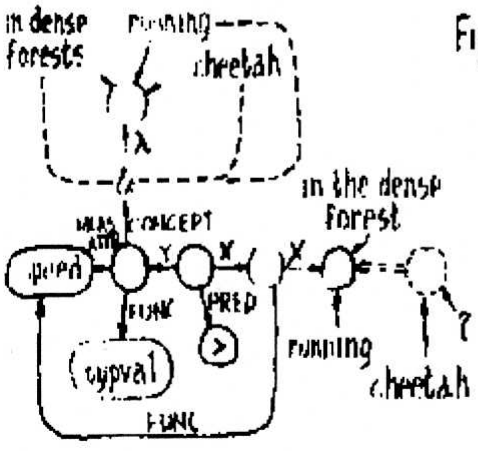
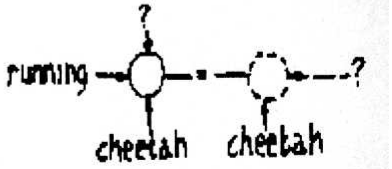


Fig 8 "The cheetah is running quickly in the dense forest."

(a) $\exists x \{\forall y [\text{cheetah}(y) \& ?(y) \Leftrightarrow x = y] \& \text{running}(x)\}$



(b) $\exists x \{\text{running}(x) \& \text{cheetah}(x) \& \forall y [\text{cheetah}(y) \& ?(y) \Rightarrow x = y]\}$

Fig 7. "The cheetah is running."