December 2002

VAGUENESS IN LANGUAGE AND INFORMATION SYSTEMS

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Abstract

This paper looks at various models of vagueness, a phenomenon of language, which leads to ambiguity. Three approaches to defining the vagueness problem are presented: the epistemic, the ontic, and the semantic. Each of these approaches is discussed along with the strengths and weaknesses of each approach. The relevance of the topic to information system research and implementation is undertaken.

Introduction

This paper is about vagueness. Vagueness is a phenomenon of language such that predicates and other word types do not provide clear cut definitions for the concepts they express. Vagueness is a problem for information system (IS) development as, either vagueness exists in the world or is exists as part of our cognitive perception of the world. Either way, as humans become more and more reliant on systems to assist and perform tasks, the ability or inability of these systems to deal with the problems of vagueness will impact systems' abilities to adequately support human use. Vagueness, then, is particularly relevant to information representation, knowledge-based, and artificial intelligence applications.

A commonly used predicate to illustrate the vagueness problem is the predicate "tall." There are objects to which the predicate unproblematically applies and objects to which it problematically applies. To illustrate a continuum is set up consisting of three components. The first is the extension ---- those individual instances which unquestioningly belong to the set of things denoted by the predicate. Michael Jordan would be a clear cut example of an individual who is tall and who falls into the extension of tall people. The second component is the antiextension --- the set of things that definitely do not fulfill the predicate. Danny Devito, for example, is definitely not a member of the things that are tall. The third component of the continuum is the penumbra. The penumbra consists of things that are borderline cases of the predicate. For instance, a man standing 5'10" may or may not be an example of a tall person.

We could create such a continuum by starting with a man 7' tall, then placing beside him a man who is 0.01" shorter and so on, until we get to a man who is 4'. With this physical continuum before us, it would be easy to pick out the men who are definitely members of the extension and also the men who are the members of the antiextension. It would be difficult to say where the penumbra, those who are neither tall nor not tall begins and ends. This inability to find the point of distinction between the extension and the antiextension is the problem characterized as vagueness.

It should be noted that fuzzy logic is an approach to solve the problem of vagueness. The importance of studying vagueness, then, emerges as a way to find alternative approaches to solving vague problems in a computational environment.

The format of this paper is as follows. Section two will present approaches to vagueness. This will include three models of vagueness, the epistemic, the ontic, the semantic, and an example of the semantic approach, a multivalued logic. Section three will provide a discussion of the various approaches to vagueness. Finally, section four will provide a conclusion discussing the importance of vagueness to information systems (IS).

Background

Three approaches to vagueness are presented in this paper --- the epistemic, ontic, and the semantic approach.

The Epistemic View

Perhaps the most non-intuitive approach to vagueness is the epistemic view. This view holds that vagueness does not exist and that vagueness is a result of our ignorance which prevents us from knowing where the sharp boundaries that separate the extension from the antiextension lie.

Williamson, 1994 writes that though the epistemic view does not seem likely, the way that we use language makes it more palatable. For example, "... we do not seem to use 'tall' as if one hundredth of an inch could make difference to its applicability. More generally, we do not seem to use vague predicates as if they are sharply bounded." Keefe and Smith, 1999. Per Keefe and Smith, if we were to abandon the epistemic view, then we would have to abandon the close connection between meaning and use.

Epistemic views of vagueness are also concerned with the relationship between knowledge and belief. For to know something is to have a correct belief about that something. Keefe and Smith use the case of "borderline Tek" who is on just one side of the sharp boundary between tall and not tall. If we believe that Tek is tall and Tek is on the tall side of the continuum (he is in the extension), then our belief and our knowledge are correct. If it happens that Tek is not part of the extension, but part of the antiextension (or the penumbra) then our belief and our knowledge about Tek is incorrect. The epistemic view of vagueness provides a way to account for a world where vagueness can be avoided as a problem. However, this is not the way that the world appears to be and objections to the epistemic view point this out.

The Ontic View

The ontic view is concerned with identity claims and their resulting truths. In order to explore the ontic view of vagueness the work of Parsons and Woodruff, 1999 is used. This work examines "a view that admits there is indeterminacy in the world, but denies that this extends to identity." Woodruff and Parsons, 1999, p. 336. Identity statements are statements of the type "a = b." Indeterminacy in the world leads to a lack of truth-value in the identity statements. Indeterminacy (vagueness) leads to a lack of truth-value. Since truth-value of a predicate is frequently held to be its meaning, the lack of a truth-value is an important development. Vagueness can be viewed a producing propositions which lack truth values because the predicate they contain lack truth values and so have no meaning. Consider the following (Parsons and Woodruff, p. 336):

> "Suppose that n denotes any of $o_{1,...,}o_n$ but that there is no fact of the matter which of the o_i's are denoted. Then Pn is true if all of the o_i's are definitely P, false if all of them are definitely not P, and otherwise lacking in truth-value. The view under examination holds that identity sentences can have only the latter because of lack of truth value, though predications can have either."

This means that any o_i, which falls into the penumbra, will lack truth-value. This is one of the problems, which the ontic view cannot solve.

The Semantic View

The semantic view is a little easier to explicate. The semantic view says that vagueness is in our language and that when we learn to use language in cases where a vague predicate resides, we learn to use the predicate with clear-cut cases. So, when learning the predicates "bald," Uncle John, an individual who has not a hair on his head, will be pointed out. Contrariwise, when we see Uncle Bob, a man with a full head of hair, we learn that Uncle Bob is not bald. For the penumbral cases we learn to say things like George Castanza (of Seinfeld fame) is "kind of" bald, or "sort of" bald. Multivalued logics are an example of the semantic view. In the following section, we discuss Körner's three valued logic.

Körner's Three-Valued Logic

Some attempts to handle vagueness have used multivalued logics. The multivalued logic presented here is the three valued logic developed by Körner. The motivation behind developing the three valued logic centers on the belief that if two values fail to account for vague predicates, than a multivalued logic can take care of the cases where bivalence fails. Other multivalued logics include Peirce's, and Hallden's. Körner develops a "logic on inexact concepts," Williamson, p. 108, which is intended to account for borderline cases of vagueness. If something violates the law of excluded middle (p v ~p) then another value may provide an account for its truth value. Körner uses the value *neutral* to account for these cases. Körner's logic tables are shown below:

p	*~p*
T	F
N	N
F	T

p	*q*	*p* V *q*	*p&q*	*p* → *q*	*p* ↔ *q*
T	T	T	T	T	T
T	N	T	N	N	N
T	F	T	F	F	F
N	T	T	N	T	N
N	N	N	N	N	N
N	F	N	F	N	N
F	T	T	F	T	F
F	N	N	F	T	N
F	F	F	F	T	T

They can be read as follows. Körner allows a candidate truth-value to be either true, false, or neutral (N). The tables retain the classical logical relations when *p* and *q* are T or F. The presence of N in the input requires that a function be performed in order to determine what truth-value will be the outcome. All possible values are used to replace the N. If all of the possible values are T, then the outcome of the truth function will be T. If all of the possible values are F, then the outcome of the truth function will be F. If some of the values are T and some of the values of F, then the outcome of the truth function will be N. Take for example the input of "F" and "N" for *p* V *q*. *p* will take the value F, *q* will take the value N. *q* will be substituted with both T and F, since its value is N. This will lead to two different truth-values. The output value assigned to *p* and *q* when the truth function is "OR" and the input values are F and N will be N.

Körner's logic runs into trouble when other truth functions are evaluated. For example modus ponens fails. If $p \rightarrow q$, *p* is our paradigm, then when *p* and *q* are assigned the designated values such that $p = T$ and $q = N$, the resulting value is invalid. Although the three-valued logic takes care of some problems of vagueness, it does so that cost of losing some of the robustness of classical logic. Other multivalued logics can also be shown to lack support for some aspect of classical logic.

Discussion

So far, three approaches to vagueness have been discussed, the epistemic, the ontic, and the semantic. Each of these views has strengths and weaknesses.

The epistemic view, surprisingly, is a robust approach, which continually and successfully survives attempts at criticism. Black, 1937 suggests that the sharp edges of distinction needed to eliminate vagueness can be resolved empirically. Groups of people could look at the various continua and determine, as a group, where the cut off points are. This information could then be incorporated into the natural language.

The ontic view, the belief that vagueness exists in the world, makes sense intuitively, but does not offer much help when trying to produce a solution to vagueness in a bivalent computational environment.

The semantic view, represented in this paper by Körner's three valued logic, also appears to offer an immediate solution of vagueness. But, as we saw, the three valued logic does not support classical logic and so does not solve the problem of vagueness.

Conclusion

Vagueness is a persistent problem and characteristic of language. Once one discovers that the phenomenon exists, it can be seen everywhere.

Vagueness has particular importance to information systems, especially systems that seek to solve real world language, vision, and spatial applications in the two-valued logic of computation. Another approach to solving vagueness, fuzzy logic also has logical weaknesses so it does not provide a complete solution to the vagueness problem. However, awareness of the problem can lead to its consideration when solving the above-mentioned types of problems and can eventually lead to more robust system design, implementation, and use.

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