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# A BRIEF EXEGESIS OF SOME BASIC TERMS USED IN THE THEORY OF FUZZY SYSTEMS

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**Abstract:** This article performs a brief exegesis of some basic terms of the theory of fuzzy systems. Terms, such as 'vagueness', 'information', 'knowledge' and 'truth' are considered

**Keywords:** Concept analysis

## 1. INTRODUCTION

The *Third Joint IFSA-EC And EURO-WG Workshop on Fuzzy Sets* stated its aim to be the pursuit of a unified theory of fuzzy systems. One basic presupposition of a unified theory is a common language in the scientific community. The common language, in turn, presupposes a thorough concept formation, at least in the context of the basic terms. As regards the theory of fuzzy systems, the meanings of certain essential terms, however, have been widely confused. Examples of these are 'vagueness', 'uncertainty' and 'probability'. On the general level, the main purpose of scientific concept formation is theoretical fruitfulness. This aim comprises ([2]),[3]): (i) Simplicity with respect to the structure and applicability of a system. (ii) Clarity which includes unambiguity and exactness. (iii) Generality of the logical forms of scientific expressions. (iv) Truth of scientific expressions.

In practice, definitions (cf. [2]) play an essential role in scientific concept formation. Psychological aspects usually presuppose that definitions should describe the meanings of new terms, replace long expressions by shorter ones, and resolve the meanings of complex terms on the basis of their constituents. From the methodological point of view it is usually presupposed that definitions should be clear, applicable, theoretically fruitful, and powerful with respect to systematization (cf. above). Bearing in mind the foregoing conditions, this article will perform a compact exegesis of certain basic terms used in the theory of fuzzy systems.

## 2. VAGUENESS AND UNCERTAINTY

*Non-exactness* comprises *generality, ambiguity,* and *vagueness* ([5]):(i) An expression is general if it refers to several objects (e.g. 'cat'). (ii) Ambiguous expressions have more than one meaning (e.g. 'probability', cf. below). (iii) Vagueness may be *ontological, epistemological,* or *linguistic* in nature. The ontological approach considers whether vague objects actually exist (e.g. the spectrum). In epistemological inquiry vagueness is related to person's mental processes and it is assumed to be caused by people's inability to conceptualize certain entities as being precise in nature (e.g., a house in the fog). Linguistic vagueness, in turn, comprises *syntactic, pragmatic* and *semantic* approaches. An expression is syntactically vague if its scope is unknown (e.g. 'Do you choose coffee or tea and biscuits?'). The pragmatic approach considers vagueness in the light of peoples' opinions (e.g. unamity of peoples' opinions in the case of the expression 'A person aged 30 is young'). Semantic vagueness (especially if we are examining terms) comprises *extensional* and *intensional* approach. Semantic extensional vagueness, which is usually the object of research, means that extensions of terms (i.e. sets of objects) include borderline cases (e.g. the set of young persons). A term is intensionally vague if its extension might include borderline cases (e.g. 'young person' is intensionally, but not extensionally, vague in a world where all the people are less than 15 years old).

'Uncertainty' and 'vagueness' have often been confused in the literature. However, the distinction is clear: *Uncertainty* is an epistemological object of research, and in this case the factors concerning a given phenomenon are not sufficiently known, or the output of a given process is unknown in advance. For example, in the case of the statements (i) 'John is probably 30 years old', (ii) 'John is young' and (iii) 'John is probably young', (i) is related to unceratainty, (ii) to vagueness and (iii) to both uncertainty and vagueness.

Uncertainty has usually been examined by applying the theory of *probability*. 'Probability' has various nuances of meaning, these comprising the *etymological, classical, mathemathical, epistemic* and *physical* approaches ([3], [4]): (i) 'Probability' is etymologically derived from the Greek terms 'pistin', 'pithanos', 'doxa' etc. These terms were translated into Latin as 'opinio', 'probabilis' and 'verisimilis'. Hence, in this respect 'probability' has English counterparts such as 'verisimilitude', 'truthlikeness' and 'truth appearance' (cf. e.g. 'Wahrscheinlichkeit' in German). From the historical point of view, 'probability' has thus related to either uncertainty or truthlikeness, or to both of them. The modern theory of *truthlikeness*, in turn, pivots on the notion *degree of truth,* this concept also playing an essential role in the theory of fuzzy systems. Hence, a tenuous connection between vagueness and uncertainty/probability may be found on the linguistic level. (ii) The *classical* approach mainly stems from mathematical theories of gambling, and it examines problems such as the ratio of successful events to all possible events. (iii) The *mathematical theory* of probability may be regarded as a formal calculus, and in this case 'probability' is an abstract primitive term with no particular meaning. (iv) *Epistemic* approaches (e.g. *subjective* interpretations) regard probability as a degree of belief, and hence this term is dependent upon our knowledge and ignorance. For example, on the basis of my feelings I may state thet I will probably be healthy tomorrow. (v) *Physical* approaches (e.g. *frequency* interpretation) presuppose that probabilities are dependent upon physical properties assigned to occurrences. For example, on the basis of the statistical facts we may state that the probability of a person aged 40 still being alive after 30 years is 0.4. (vi) *Possibility*, as used in the theory of fussy systems, is related both to various approches to probability, and to *modelity*.

## 3. INFORMATION, KNOWLEDGE AND TRUTH

In the context of computerised fussy systems, such as applications of Artificial Intelligence, the terms 'datum', 'information', 'knowledge' and 'truth' have sometimes been problematic. In the philosophy of science *datum* (i.e. 'given') is regarded as an information bearer, and thus it does not have any meaning or truth value. In this sense 'datum' is synonymous with 'sign'. As regards computers, they actually perform *automatic data processing*, and the inputs to and outputs from the computer may thus be meaningless or false.

*Information* ('informationem' in Latin, 'which has been formed') may be recorded, processed and transferred using data as information bearers. It may be *physicalistic* or *linguistic* in nature ([4]): (i) The physicalistic approach considers, *inter alia,* organisation, complicacy and complexity of material systems (cf. the notion of *entropy* in physics). (ii) the linguistic *syntactic* approach primarily deals with the measurement of the amount of information. For example, the appropriate *encoding of messages* and *noise reduction* are essential objects of this branch of research (cf. *Shannon's entropy*). The linguistic *semantic* approach concentrates on the information content of messaes. Notions, such as *surprise value, unexpectedness, surface information* and *depth information*, are typical in this context. The linguistic *pragmatic* approach examines the significance or meaning of information with respect to human culture or a human being. In a wide sense, this type of information is closely related to modern *semiotics*. In practice, it is often problematic to draw a clear distinction between semantic and pragmatic information. types of information may also be considered in the light of probabilistic mesures of information content, or from the ontological point of view.

'Art' ('tekhne' in Greek, 'ars' in Latin, 'Kunst' in German) may be regarded as a preliminary stage or *knowledge* (cf. below). In a wide sense, it is related to the expressive and instrumental behaviour of human beings (e.g. toys, instruments, tools, the fine arts, and the achievements of instrumental aims). Art usually presupposes *tacit knowledge*, and this is non-linguistic in nature (e.g., the process of an infant learning English). The practice of art, on the other hand, which is known as *technology* ('tekhne' and 'logic' in Greek), is mainly linguistic in nature, and at first it comprised colections of skills, common sense procedures etc., but then it provided a basis for the applied sciences.

'Knowledge' ('episteme' in Greek) is traditionally regarded as justified true belief, this definition, however, raises certain problems in the praxis of science. In this sense, knowledge may be singular, general, statistical, modal, conditional, explanatory, isntrumental, or assessing in nature. If we adopt this standpoint, knowledge is clearly linguistic in nature, and it comprises assertions with semantic information content on actual world (e.g. 'The sun is yellow'). Knowledge in this sense is known as *propositional knowledge*. In the applications of the theory of fuzzy systems, such as fuzzy expert systems, instrumental knowledge probably plays the most essential role because the specifications of computerised collections of *technical norms*, i.e., computerised collections of *know how*, belong to this category. If 'technology' is described as above, it is closely related to know how.

Epistemological terms are widely used in Artificial Intelligence because its principal aim is to construct intelligent computerized systems such as expert systems. 'Knowledge base', 'knowledge engineer' and 'knowledge acquisition' are typical terms in this branch of research. In this context we have to bear in mind that 'knowledge' is distinct from 'wisdom' because the latter concept includes, *inter alia, worldy wisdom* (heuristics, ethical aspects etc.). Hence, is it posible to achieve the level of human experts using computerized systems?

The notion of *truth* is also essential in the theory of fuzzy systems. In the philosophy of science a distinction is usually drawn between *definitions* of thruth and *criteria* of truth ([1]). The former describes the meaning of this term, and the latter provides the criteria for recognizing truth. For example, on the one hand, we may define that the sentence 'The sun is yellow' is true if and only if the sun is yellow, and, on the other hand, we may establish that "Praxis is the criteria for recognizing truth!". Hence, these aspects belong to semantics and epistemology, respectively. One basic idea of the syntactic and semantic approach to information is that information is dependent upon neither the truth nor probability ([4]). Thus, these types of information may not be regarded as knowledge in the sense stated above. For example, tautologies are regarded as being both true and probable, but uninformative. Hence, if a researcher is aiming at informative assertions, he is "gambling with truth" because then the risk of obtaining false results becomes higher. In order to attain informative truths, at least to some extent, the theory of truthlikeness may be applied (cf. [4]).

In the bivalent logics vague expressions and informative true statements have raised several problems, In order to solve these problems, various methods based on notions, such as *partial truth* or *approximate truth*, have been suggested in the literature. In addition, the concept of *probability* has been supported although this view is usually fallacious. The notion *degree of truth* stems from the idea that an expression may be almost true, approximately true etc. In the theory of truthlikeness, which is a bivalent approach, metrics is applied to this concept. In the theory of fuzzy systems the degrees of truth have been used applying multivalent assumptions, but most approaches seem unintelligble from the logico-psychological point of view (cf. [5], [6]). Hence, a fussified version of metric truth, which attempts to solve the problems related to both the theory of truthlikeness and prevaling fuzzy systems, is suggested in [6] and [7].

## 4. SUMMARY

The foregoing considerations show that certain essential terms of the theory of fuzzy systems may have various meanings, this phenomenon raising problems in communication between researches. Hence, in order to attain both a unified theory for fuzzy systems and theoretical fruitfulnes, a thorough exegesis of these terms is required in the theory of fuzzy systems.

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