

4-1-2008

Fuzzy and research paradigms relationship: a mutual contribution

Devood Salmani

Mohsen Akbari

Follow this and additional works at: <https://scholars.fhsu.edu/alj>



Part of the [Educational Leadership Commons](#), [Higher Education Commons](#), and the [Teacher Education and Professional Development Commons](#)

Recommended Citation

Salmani, Devood and Akbari, Mohsen (2008) "Fuzzy and research paradigms relationship: a mutual contribution," *Academic Leadership: The Online Journal*: Vol. 6: Iss. 2, Article 7.

DOI: 10.58809/WXAY9272

Available at: <https://scholars.fhsu.edu/alj/vol6/iss2/7>

This Article is brought to you for free and open access by the Peer-Reviewed Journals at FHSU Scholars Repository. It has been accepted for inclusion in *Academic Leadership: The Online Journal* by an authorized editor of FHSU Scholars Repository. For more information, please contact ScholarsRepository@fhsu.edu.

Academic Leadership Journal

Introduction:

Fuzzy sets were introduced by Zadeh in 1965 to represent manipulate data and information possessing non-statistical uncertainties. It was specifically designed to mathematically represent uncertainty and vagueness and to provide formalized tools for dealing with the imprecision intrinsic to many problems. However, the story of fuzzy logic started much earlier. Fuzzy system is an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy.

Research paradigms are rooted in philosophy paradigm, determine the direction of researches; how the researches reach to the reality, how they answer the questions of the seeking mind ... four main research paradigms distinguished so far are: Positivism, Constructivism, Critical theory and Post structuralism. These paradigms create not only the mind set of the researcher (what the reality is and how it can be accessed), but also help him/her use the research methodologies, research methods, and apply the research findings.

Here in this research we are to investigate how the different research paradigms can help fuzzy to grow and in the other hand how fuzzy can be used in a research paradigms.

After reviewing the background of fuzzy and its definition, we provide a useful background about the research paradigms, then in conclusion we will show how research paradigms and fuzzy are related mutually.

Literature review:

Fuzzy system is an alternative to traditional notions of set membership and logic that has its origins in ancient Greek philosophy. The precision of mathematics owes its success in large part to the efforts of Aristotle and the philosophers who preceded him. In their efforts to devise a concise theory of logic, and later mathematics, the so-called "Laws of Thought" were posited (S. Korner 1967). One of these, the "Law of the Excluded Middle," states that every proposition must either be true or false. Even when Parmenides proposed the first version of this law (around 400 B.C.) there were strong and immediate objections: for example, Heraclitus proposed that things could be simultaneously True and not True. It was Plato who laid the foundation for what would become fuzzy logic, indicating that there was a third region (beyond True and False) where these opposites "tumbled about." Other, more modern philosophers echoed his sentiments, notably Hegel, Marx, and Engels. But it was Lukasiewicz who first proposed a systematic alternative to the bi-valued logic of Aristotle (C. Lejewski, "Jan Lukasiewicz 1967). Even in the present time some Greeks are still outstanding examples for fussiness and fuzziness, (note the connection to logic got lost somewhere during the last 2 millenniums (A. Reigber 1999)).

Fuzzy sets were introduced by Zadeh in 1965 to represent manipulate data and information possessing non-statistical uncertainties. It was specifically designed to mathematically represent uncertainty and vagueness and to provide formalized tools for dealing with the imprecision intrinsic to

many problems. However, the story of fuzzy logic started much earlier.

To devise a concise theory of logic, and later mathematics, Aristotle posited the so-called “laws of Thought”. One of these, the “Law of the Excluded Middle,” states that every proposition must either be True (T) or False (F). Even when Parmenides proposed the first version of this law (around 400 Before Christ) there were strong and immediate objections: for example, Heraclitus proposed that things could be simultaneously True and not True.

It was Plato who laid the foundation for what would become fuzzy logic, indicating that there was a third region (beyond T and F) where these opposites “tumbled about.” A systematic alternative to the bi-valued logic of Aristotle was first proposed by Łukasiewicz around 1920, when he described a three-valued logic, along with the mathematics to accompany it. The third value he proposed can best be translated as the term “possible,” and he assigned it a numeric value between T and F. Eventually, he proposed an entire notation and axiomatic system from which he hoped to derive modern mathematics. Later, he explored four-valued logics, five-valued logics, and then declared that in principle there was nothing to prevent the derivation of an infinite-valued logic. Łukasiewicz felt that three- and infinite-valued logics were the most intriguing, but he ultimately settled on a four-valued logic because it seemed to be the most easily adaptable to Aristotelian logic.

It should be noted that Knuth also proposed a three-valued logic similar to Łukasiewicz’s, from which he speculated that mathematics would become even more elegant than in traditional bi-valued logic. The notion of an infinite-valued logic was introduced in Zadeh’s seminal work “Fuzzy Sets” where he described the mathematics of fuzzy set theory, and by extension fuzzy logic. This theory proposed making the membership function (or the values F and T) operate over the range of real numbers $[0, 1]$. New operations for the calculus of logic were proposed, and showed to be in principle at least a generalization of classic logic.

Fuzzy logic provides an inference morphology that enables approximate human reasoning capabilities to be applied to knowledge-based systems. The theory of fuzzy logic provides a mathematical strength to capture the uncertainties associated with human cognitive processes, such as thinking and reasoning.

The conventional approaches to knowledge representation lack the means for representing the meaning of fuzzy concepts. As a consequence, the approaches based on first order logic and classical probability theory do not provide an appropriate conceptual framework for dealing with the representation of commonsense knowledge, since such knowledge is by its nature both lexically imprecise and non-categorical.

The development of fuzzy logic was motivated in large measure by the need for a conceptual framework which can address the issue of uncertainty and lexical imprecision.

Some of the essential characteristics of fuzzy logic relate to the following (Zadeh, 1992):

In fuzzy logic, exact reasoning is viewed as a limiting case of approximate reasoning.

In fuzzy logic, everything is a matter of degree.

In fuzzy logic, knowledge is interpreted a collection of elastic or, equivalently, fuzzy constraint on a

collection of variables.

Inference is viewed as a process of propagation of elastic constraints.

Any logical system can be fuzzified.

There are two main characteristics of fuzzy systems that give them better performance for specific applications.

Fuzzy systems are suitable for uncertain or approximate reasoning, especially for the system with a mathematical model that is difficult to derive.

Fuzzy logic allows decision making with estimated values under incomplete or uncertain information.

Research paradigms:

Since the late 1960s, the word paradigm has referred to a thought pattern in any scientific discipline or other epistemological context. Philosopher of science Thomas Kuhn gave this word its contemporary meaning when he adopted it to refer to the set of practices that define a scientific discipline during a particular period of time.

A research paradigm is a dynamical system of scientific works, including their perceived values by peer scientists, and Governed by intrinsic intellectual values and associated citation endurance and decay. Identifying an emerging research paradigm and monitoring changes in an existing paradigm have been a challenging task due to the scale and complexity involved (Kuhn 1996).

We can distinguish following research paradigms with their specifications as following:

Research paradigms	Ontology	Epistemology	Methodology	Common Research method
Empirical analytical positivism	Reality is out there	Knowledge can be objective	Experts formulate research questions then test them empirically	Experiments, controlled surveys
Imperativisim /constructivism	Reality is not out there, it is conditional upon human experience	Knowledge is not objective and constructed	Identification of varied interpretations of reality and attempt to recognize the pattern	Ethnographic, Case study, phenomenology ...

Critical theory	Reality is not out there, it is material , never fully understood	Knowledge is not objective, values and power play pivotal role.	Research seeks to understand the effect of power, then empower people to...	Particularly action research ...
Post structuralism	Multiple representation of reality	Events are understood in theme of powerful and subordinated discourses	Research seeks to expose how dominant interests preserve social inequalities	Discourse analysis

Positivism

What could be described as the traditional scientific approach to research has its underpinnings in positivist philosophy. From the literature it is clear that positivism can be defined in various ways. Smith (1998) provides a useful insight into positivist thinking within social sciences with this description:

‘Positivist approaches to the social sciences . . . assume things can be studied as hard facts and the relationship between these facts can be established as scientific laws. For positivists, such laws have the status of truth and social objects can be studied in much the same way as natural objects’. The general elements of positivist philosophy have a number of implications for social research based on this approach. These implications, adapted from Bond (1989), Easterby-Smith et al (1997), and Hughes (1994) are:

- Methodological: all research should be quantitative, and that only research which is quantitative can be the basis for valid generalizations and laws
- Value-freedom: the choice of what to study, and how to study it, should be determined by objective criteria rather than by human beliefs and interests
- Causality: the aim should be to identify causal explanations and fundamental laws that explain human behavior
- Operationalization: concepts need to be operationalised in a way that enables facts to be measured quantitatively
- Independence: the role of the researcher is independent of the subject under examination
- Reductionism: problems are better understood if they are reduced to the simplest possible elements.

Post-positivism

Following the recognition by scholars such as Jacob Bronowski (1956) and Karl Popper (1959) that

within the world of modern science the elementary justifications of positivism were no longer entirely defensible, a new philosophy emerged, that of post-positivism. Post-positivism provides an alternative to the traditions and foundations of positivism for conducting disciplined inquiry. For the post-positivist researcher reality is not a rigid thing, instead it is a creation of those individuals involved in the research. Reality does not exist within a vacuum, its composition is influenced by its context, and many constructions of reality are therefore possible (Hughes 1994). Proctor (1998) suggests that among the various factors that influence reality construction, culture, gender, and cultural beliefs are the most significant.

In summary, post-positivist approaches assume that reality is multiple, subjective, and mentally constructed by individuals. The use of flexible and multiple methods is desirable as a way of studying a small sample in depth over time that can establish warranted assertibility as opposed to absolute truth. The researcher interacts with those being researched, and findings are the outcome of this interactive process with a focus on meaning and understanding the situation or phenomenon under examination.

Constructivism:

Constructivism is a perspective in philosophy that views all of our knowledge as “constructed”, under the assumption that it does not necessarily reflect any external “transcendent” realities; it is contingent on convention, human perception, and social experience.

The common thread between all forms of constructivism is that they do not focus on an ontological reality, but instead on the constructed reality

One version of social constructivism contends that categories of knowledge and reality are actively created by social relationships and interactions. These interactions also alter the way in which scientific episteme is organized.

Cultural constructivism asserts that knowledge and reality are the products of their cultural context, meaning that two independent cultures will likely form different observational methodologies. For instance, Western cultures generally rely on objects for scientific descriptions; by contrast, Native American culture relies on events for descriptions. These are two distinct ways of constructing reality based on external artifacts. In the constructivist perspective, knowledge is constructed by the individual through his interactions with his environment.

Critical Theory:

Critical theory is social theory oriented toward critiquing and changing society as a whole, in contrast to traditional theory oriented only to understanding or explaining it. Horkheimer wanted to distinguish critical theory as a radical, emancipatory form of Marxian theory, critiquing both the model of science put forward by logical positivism and what he and his colleagues saw as the covert positivism and authoritarianism of orthodox Marxism and communism.

Critical theory derives from Kant’s (18th-Century) and Marx’s (19th Century) use of the term “critique”, as in Kant’s Critique of Pure Reason and Marx’s concept that his work *Das Kapital* (Capital) forms a “critique of political economy”. For Kant’s transcendental idealism, “critique” means examining and establishing the limits of the validity of a faculty, type, or body of knowledge, especially through

accounting for the limitations imposed by the fundamental, irreducible concepts in use in that knowledge system (Blackwell 1995)

Post – Structuralism:

Post-structuralism refers to the intellectual developments in continental philosophy and critical theory which were outcomes of twentieth-century French philosophy. The prefix “post” refers to the fact that many contributors such as Jacques Derrida, Michel Foucault, and Julia Kristeva were very critical of structuralism. In direct contrast to structuralism’s claims of culturally independent meaning, post-structuralists typically view culture as inseparable from meaning.

Post-structuralism is difficult to define or summarize. There are two main reasons for this. First, it rejects definitions that claim to have discovered absolute ‘truths’ or facts about the world. Second, very few people have willingly accepted the label ‘post-structuralist’; rather, they have been labeled as such by others. Therefore no one has felt compelled to construct a ‘manifesto’ of post-structuralism.

Post-structural practices generally operate on some basic assumptions:

Post-structuralists hold that the concept of “self” as a singular and coherent entity is a fictional construct. Instead, an individual comprises conflicting tensions and knowledge claims (e.g. gender, class, profession, etc.). Therefore, to properly study a text a reader must understand how the work is related to his own personal concept of self. This self-perception plays a critical role in one’s interpretation of meaning.

The meaning the author intended is secondary to the meaning that the reader perceives. Post-structuralism rejects the idea of a literary text having a single purpose, a single meaning or one singular existence. Instead, every individual reader creates a new and individual purpose, meaning, and existence for a given text.

A post-structuralist critic must be able to utilize a variety of perspectives to create a multifaceted interpretation of a text, even if these interpretations conflict with one another. It is particularly important to analyze how the meanings of a text shift in relation to certain variables, usually involving the identity of the reader. (H. Paul 2006)

Discussion:

According to Kuhn, the advance of science is made through scientific revolutions that dramatically change the scientific world view, or a scientific paradigm. Science can be characterized into an endlessly iterating process from normal science to crisis, revolution, and the re-establishment of new normal science under a new paradigm. Classic examples of scientific revolutions include the Copernican revolution and the Einstein’s relativity theory in modern physics. At a smaller scale, scientific revolutions take place all the time, from major breakthrough and discoveries to relatively minor ones². It is therefore of fundamental significance for scientists, science policy makers, and the general publication to be able to identify the most significant changes in science.

Introduction of fuzzy in 1965 by Lotfi A Zadeh with its roots in Greek philosophy has changed the direction and attention of many researchers toward itself and has challenged many scientists; like what Kuhn calls the signals of a paradigm that must have attention of many researchers and scientists

around a problem and should answer the questions around its main subject, fuzzy has created this context. But as far this paper is not after investigating if fuzzy is a paradigm or not, we will leave this subject for further research.

But for our main purpose to see how fuzzy contribute to the research paradigms and how research paradigms can help fuzzy to grow, looking at the following table can be helpful:

Research paradigms	Ontology	Epistemology	Methodology	Common Research method	fuz
Empirical analytical positivism	Reality is out there	Knowledge can be objective	Experts formulate research questions then test them empirically	Experiments, controlled surveys	No fuz
Imperativism /constructivism	Reality is not out there, it is conditional upon human experience	Knowledge is not objective and constructed	Identification of varied interpretations of reality and attempt to recognize the pattern	Ethnographic, Case study, phenomenology ...	Fu as phi an
Critical theory	Reality is not out there, it is material , never fully understood	Knowledge is not objective, values and power play pivotal role.	Research seeks to understand the effect of power, then empower people to...	Particularly action research ...	Mc col
Post structuralism	Multiple representation of reality	Events are understood in theme of powerful and subordinated discourses	Research seeks to expose how dominant interests preserve social inequalities	Discourse analysis	Th col as mu rep of l

In positivism research paradigm, fuzzy is not applicable, not in designing the research, not in proposing research questions and hypotheses, or even just as a tool as many other tools used for data analysis. In this paradigm since the reality is out there and can be observed by all people in a same way, therefore, fuzzy and fuzzification is senseless. In this paradigm, neither fuzzy help neither the research paradigm

nor the research paradigm helps fuzzy to get the meaning, to boost and grow.

Since human experience is the basis for finding out the reality, in imprativism research paradigm, fuzzy gets the meaning; fuzzy logic provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information; the fuzzy logic model is empirically-based, relying on an operator's experience rather than their technical understanding of the system. The basis of fuzzy logic starts with this research paradigm, here the research paradigm give the meaning to the fuzzy and fuzzy can be used in both research design and as a tool to analyze data.

With shifting toward critical theory and post structuralism research paradigms, they represent different views on what the reality is and how to acquire it. Therefore this they have a big impact on what the fuzzy can be. From fuzzy logic point of view the reality is dependant to the human experience, but in the critical theory and post structuralism research paradigms, we don't have the same reality with the same person, as he or she changes the environment the reality changes, as he or she changes the time, the reality changes, in fact we have many representations of the reality, we don't have the same reality in the same time with the same person.

Resources:

1. A. Reigber (1999); My life with Kostas, unpublished report, Neverending Story Press
2. Blackwell (1995); A survey of and introduction to the current state of critical social theory is Craig Calhoun's Critical Social Theory: Culture, History, and the Challenge of Difference.
3. Bond S (1993); Experimental research nursing: necessary but not sufficient, Kitson A (Ed) Nursing. Art and Science. London, Chapman and Hall.
4. Bronowski J (1956); The Common Sense of Science. London, Pelican.
5. Lejewski, "Jan Lukasiewicz, (1967); "Encyclopedia of Philosophy, Vol. 5, MacMillan, NY
6. Easterby-Smith M et al (1997); Management Research: an Introduction. London, Sage.
7. Harrison, Paul; (2006); Post-structuralist Theories; pp122-135 in Aitken, S. and Valentine, G. (eds); Approaches to Human Geography; Sage, London
8. Hughes J (1994); The Philosophy of Social Research. Essex, Longman.
9. Kuhn, Thomas S. (1996); The Structure of Scientific Revolutions, 3rd Ed. Chicago and London: Univ. of Chicago Press, 1996
10. L.A.Zadeh (1965), Fuzzy Sets, Information and Control, 8.
11. Paul Watzlawick (1984). Invented Reality: How Do We Know What We Believe We Know? (Contributions to constructivism), W W Norton & Co Inc; 1st edition
12. Popper K (1959) The Logic of Scientific Discovery. London, Hutchinson.
13. Proctor S (1998); Linking philosophy and method in the research process: the case for realism.

Nurse Researcher. 5, 4, 73-90.

14. S. Korner (1967); Laws of thought, Encyclopedia of Philosophy, Vol. 4, MacMillan, NY

15. Smith MJ (1998); Social Science in Question. London, Sage.

VN:R_U [1.9.11_1134]