Concept structures and fuzzy set theory: a proposal for concept formation and operationalization

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Abstract

Concept formation strategies can be divided in positivist or interpretivist approaches. The first relies on classification and taxonomy strategies as tools for concept formation, while the second draws on hermeneutics and uses the ideal type for the definition of concepts. I argue that both have limits concerning concept formation. The positivist approach has strong naturalist assumptions, which can be inadequate to take into account the contingency of the empirical world. By contrast, the interpretivist one is very focused on the historical specificity of concepts, which may lead to their inapplicability. A solution to these problems comes from fuzzy set theory. This holds a potential for concept formation because it has as its main strengths the possibility of configurational thinking and the use of the truth table. Concepts can be built including all the possible attributes into a table and this can have several advantages. Fuzzy set theory also contributes to the creation of partial concepts, representing configurations or sub-types. In this paper, I develop this strategy, illustrating, first, the weaknesses and the strengths of the classical approaches. Then, I discuss the ontology and logic behind fuzzy set theory and demonstrate that it can be a very useful approach to concept formation. In the end, I test applying this strategy to the concept of political participation.

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Introduction

Concept formation strategies are based, substantially, on the same contraposition present in the social sciences, namely the contrast between the positivist and the idealist approaches. We have, on the one side, the naturalist approach which relies on classification and taxonomy as tools for concept formation (Sartori, Riggs and Teune: 1975; Collier and Gerring: 2008). On the other side, we have the tradition drawing on hermeneutics which uses mainly the ideal-type for defining concepts (Weber: 1997). Both views have some limits concerning the concept formation process. While the first has strong implicit naturalist assumptions, which can be inadequate to respond to the contingency of the empirical world, the second is particularly focused on the historical specificity of concepts, which may lead to their inapplicability. Therefore, we encounter the hoary problem of complexity versus generality also in concept formation which Sartori (1970) expresses through the idea of intention and extension of a concept. The keystone to overcome this dispute would be finding a path that balances these two perspectives. In this paper I argue that a solution to this issue comes from fuzzy set theory.

What I propose here is the application of fuzzy set theory to concept formation. Since its conception (Zadeh: 1965), fuzzy set theory has been applied to several scientific fields (Kosko: 1993) and, more recently, to social sciences (Smithson: 1987; Ragin: 2000). Notwithstanding, fuzzy logic has not been applied yet to the problems of concept formation, despite several studies in psychology demonstrated that concepts never have sharp boundaries (Belohlavek et al.: 2009). The possibility of this new application gives the opportunity of looking at concepts as constructs made up of parts that are logically interconnected one with the other. This is so because fuzzy set theory has as its main strengths the possibility of configurational thinking and the use of the truth table (Ragin: 2000; 2008a) Therefore, fuzzy set theory allows combining different attributes of a concept and including them in a truth table, so to maintain complexity and, at the same time, flexibility. The truth table is a precious tool which helps in managing complexity, in creating types and in illustrating the configurations (Lazarsfeld: 1937; Becker: 1998). We can build up concepts ideally including in the truth table all the possible attributes, but we can also use configurations of attributes, which represent partially a broader concept. A concept, seen through these lenses, becomes something that has to be constructed systematically and explicitly and fuzzy set theory may be the right instrument to follow this path. Furthermore, fuzzy set theory also has a classificatory or taxonomical application, since it creates configurations that represents sub-types of a concept (Kvist: 2006). Following this strategy, concept formation becomes a dynamic process that

underlines the diversity of the different configurations and produces concepts fit to the aims and interests of the researcher.

What I argue in this paper is that we need another way of building and evaluating our concepts. A possible way to achieve this aim is to apply fuzzy set theory and logic and the ontology of vagueness to the construction of concepts and to their evaluation. I am not claiming that this is a new approach, but rather a systematization of what is present in the social sciences field on concept formation and evaluation. Fuzzy logic can be seen as an extension of classical logic. Since concepts have been always built using the latter, I argue that the application of the former can yield interesting results.

Therefore, this proposal aims to give to the researcher a guide to build concepts trying to avoid the problems that have been encountered in the literature on the topic. Here, I argue that classification procedures may be inappropriate to study the contemporary world, while we should move towards a *fuzzification* of concepts we use. Looking at cases as in-or-out instances of a concept may lead us to overlook the differences that are present among the cases we want to study.

The final objective is to present a strategy that I call "mixed", which aims to go beyond the approaches based on sufficiency and necessity of the attributes, since it uses both. Furthermore, this strategy uses fuzzy set theory and this has several advantages, especially in dealing with complexity. One of the advantages is the fact that fuzzy set theory allows establishing degree memberships. This permits modeling concept formation and operationalization to the processes that people use to categorize the objects, which are graded. Moreover, this strategy helps in making explicit the structure of the concepts by using the formal language of fuzzy set theory. Eventually, it can be a way to fill the gap between the naturalist and the interpretivist approaches to concept formation and this is due to the fact that fuzzy sets use measures which are at the same time quantitative and qualitative (Ragin: 2008a, 82).

I develop this strategy illustrating, at first, the weaknesses and the strengths of the classical approaches. Then I discuss the ontology and logic behind fuzzy sets, demonstrating that it can be a very fruitful approach to concept formation. In the last paragraph, I sketch a new concept of political participation using this approach.

Two traditions of social sciences: the consequences on concepts

Two ontologies dominated social and political research and they are simply summed up by the labels quantitative/naturalist and qualitative/interpretivist. The first generally refers to the variable-oriented approach, while the second concerns the case-oriented approach. This dichotomy comes from two methodological

traditions, the Durkheimian one and the Weberian one, which distinguished most of the social research since its dawn (Ragin and Zaret: 1983; Mahoney and Goertz: 2006).

Often, they are used to formulate hybrid approaches coping with the problems of the study of social and political phenomena. The complementarity and the mutual interdependence between these approaches prove that there is not necessarily a functional division of labor between quantitative and qualitative methods. This is why a solution for bridging the gap between the quantitative-qualitative divide seems to be needed in the literature (Tarrow: 2004).

The same contrast is applicable to concept formation approaches (Outhwaite: 1983). Social sciences never produced a unified paradigm which gathered the existing knowledge, *à la* Kuhn (1963) for instance. Thus, there are two accounts of concept formation in social sciences. The first is positivism, which can be more generally called naturalism:

> We can define naturalism as the idea that the human sciences should strive to develop predictive and causal explanations akin to those found in the natural science (Bevir and Kedar: 2008, 504).

The positivist approach to concepts stems from a critique of the metaphysics and for its depreciation of language. It sees the light in the Vienna Circle (Friedman: 1999). The main characteristics are that *(a)* scientific theories must be constructed as a series of statements that have to be seen as a system and should be formalized in a scientific language, that is a syntax; that *(b)* the use of a new formalized scientific language leads to a rejection of natural language; that *(c)* there is a distinction between the good scientific language, that is the logical one, and the bad scientific language, which is the metaphysical one. The aim is to find a neutral and a-historical language which serves as a tool for theory building and nothing else. Eventually, that *(d)* the positivist tradition aims to a reduction of natural language to neutral and scientific language which is observational and, hence, grounded on experience. In fact, "what positivism aspired to, in essence, was a harmonious fusion of the most advanced theoretical formulation in logic, mathematics and physics, and a relatively straightforward empiricism with a linguistic twist" (Outhwaite: 1983, 7). To put it simply, it was believed that it was possible to translate the natural language statements into scientific-formal language without any loss of meaning. The problem of naturalism is that it implies reification, that is the removal of meaning without a recognition of the holistic and the contingent nature of it. Essentialism, a-historicism, and linguistic instrumentalism cause decontextualization of concepts since they are seen as a tools for theory building (Bevir and Kedar: 2008).

The second position is the hermeneutics or also the anti-naturalist approach. This tradition can be seen as a reaction against positivism. The anti-naturalist view draws on the hermeneutic tradition, i.e. Dilthey, Gadamer and Weber (Martin: 2000; Mantzavinos: 2005). In fact:

> Weber developed his ideal-typical strategy of concept formation, in his famous essay on 'Objectivity', by way of an explicit critique of the naturalist tendency to require the analysis of all events into generally valid 'laws' (Bevir and Kedar: 2008, 505).

The argument of the anti-naturalists can be summarized in two points. The first is that there are differences between the concepts of natural language and those belonging to social sciences. The second regards the idea that the concepts of social sciences are closer to those used in natural language than to those used by natural sciences. Therefore, this means that the language of natural sciences is not adequate for social reality because the social world is intrinsically different from the natural world. Moreover, scientific language is built upon natural language with some modifications. This tradition opposes the view that scientific languages should be reduced and prefer a vision which privileges understanding, that is what Weber calls *Verstehen* (1947).

For this reason, the importance of interpretation is here underlined, while in positivism the attention is more focused on explanation. Although strongly rooted in social sciences, the problems of the hermeneutics approach are several. First of all, it does not provide criteria for the evaluation of interpretations. Or better, it provides some partial accounts. One is the full participation of the subject to the meaningful reality, which is the empirical world, another one is the reflexive relationship with this reality (Bourdieu: 2004). Second, this does not give the certainty that we leave aside relativism. Furthermore, social reality is simply built in terms of meanings.

The importance of an anti-naturalist approach is that it incorporates in itself the idea of the contingency of social action and, more broadly, phenomena. Social reality is constituted by features that cannot be described through the use of naturalist categories. To sum up:

> Anti-naturalists argue, in other words, that the human sciences require a historical and contingent form of explanation that distinguishes them from the natural sciences. Wittgenstein's claim that the meaning of a word cannot be elucidated in abstraction from the specific context in which that word was used points toward just such a historically contingent mode of knowledge. Indeed, this account of meaning leads Wittgenstein explicitly to conclude that no explanation is ever final

since it is always limited to a specific context (Bevir and Kedar: 2008, 506).

Following this debate on the ontologies, we need to consider that also concept formation requires a choice of ontology. A reflection upon the ontological nature of a concept allows focusing on and deciding what is important about that concept (Goertz: 2006, 27). Choosing the attributes that are important for the construction of a concept requires the formulation of a theory about that concept. We should not forget that concepts are logical constructs and, for this reason, they need a theory in order to be formed (ibid.). In other words, we need to establish how the parts interact with each other and how the concept produces causal relationships with other concepts. In particular, the theory that is behind a concept permits the understanding of the consequences of the concept's structure. The more-or-less relevance of an attribute may have effects on the secondary level dimensions of the concepts[1]. This is also relevant when we connect concepts to the context in which they are used. The structure of a concept allows formulating hypotheses and building theories about other phenomena. The way we define and build up the concept of political participation, for instance, is important to the extent it helps us to understand how this is relevant to the quality of a democracy (Diamond and Morlino: 2005). Who claims that political participation is an essential part of democratic regimes without which they cannot be defined democratic (Dahl: 1971; 1989) is building a theoretical statement that involves the attributes of the concept of political participation. If political participation is a necessary part of the democratic regimes is because of its properties and the effects it has on this type of regimes. Following this ontological approach, it is relevant to plunge into this problem and to understand the importance of ontology in connection to concepts.

Ontology and concepts

Ontology refers to the character of the world as it actually is (Varzi: 2005). The term is used in relation to the assumptions about the nature of the social and political world, in particular to the nature of causal relationships. For this reason, ontology can be meant as a theoretical construct. The importance of ontology is due to the fact that its choice has consequences on the methodological approach which follows (Hall: 2003).

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[1] For instance, Goertz (2006, 27) provides the case of copper. This type of metal has an atomic structure that "produces" its reddish color, but we would be mistaken if we based the conceptualization upon this characteristic, which is the effect of the atomic structure and not a property itself.

Since interdependence and complexity represent a problem in political and social research (Franzese and Hayds: 2008), it is necessary to begin a consideration about their role and about the relationship between a changing reality and the approaches explaining and understanding it. Complexity and interdependence have an important effect on how we build up theories and hypotheses because they undermine two relevant assumptions of the methodology of comparative research. On the one hand, complexity weakens the assumption "that the variable selected and observed with equivalent measures will tend to produce the same or similar effect(s) across the units being compared" (Schmitter: 2009, 46). On the other, interdependence mines the independence assumption that, in comparative methodology, represents an epistemological building block (King, Kehoane and Verba: 1994).

Because of these problems, Schmitter argues that we need to re-think the ontology that is used, because social and political research takes the first step from it. This ontology may be the one provided by fuzzy set theory since it allows dealing with complexity and equifinality. Ragin begins one chapter of his book, referring to what many researchers think, arguing that "[s]ocial phenomena are complex" (1987, 19). But how can we overcome this obstacle? The problem of identifying complexity is addressed with the diversity-oriented approach (Idem).

In the last paragraph we have seen that concepts can be viewed in two ways. The first is compelled to produce generalizations since it aims to solve the problems of conceptual stretching (Sartori: 1970). The second is more focused on producing concepts that are able to grasp the historical and contingent features of the phenomena under study. Therefore, it aims to go in deep and to understand the cases as complex instances and as product of historical processes and structures (Ragin and Zaret: 1983). It is, therefore, useful to find a way to overcome these two approaches in order to formulate concepts there can be applied both for studying generality and complexity. The middle path is finding a way of building concepts that helps the researcher in studying diversity (Ragin: 1987). The diversity approach tries to merge the two worlds which, on the one hand, see cases as homogeneous and, on the other, as unique. In a few words, studying phenomena endorsing a diversity approach implies a higher concern in finding the differences that are present among types of cases in order to produce middle-range generalizations. Furthermore, the diversity approach does not take the population of cases as fixed and it does not prevent the researcher to leave the boundaries open to include or exclude cases.

Comparative research is concerned to produce generalizations or an accurate understanding of some cases, but it does not try to do both things. If a middle-path is present and it is, at the same time, analytically prolific, it is also possible to understand how and why cases differentiate. Since this middle-path is available, I

propose to apply it to the construction of concepts so to introduce flexibility in their application. What it is needed is a model that can retrieve the specificity and, at the same time, the meaningfulness of social phenomena. The ability of looking for concepts that are adequate to the context allows the researcher having a flexible strategy for the concepts that are used. Moreover, the importance of a concept in a context is that its meaning is related to a system of meaning and not to categories that might be abstract.

Vagueness, concepts and fuzzy sets

Natural and daily language allows constructing propositions, which describe the cases, and producing generalizations or a complex knowledge. The problem is that natural language is often inaccurate and can produce ambiguities. Some words may be imprecise, may have different meanings or may not have a uniform use. Other words can have a limited application and this has as consequence the fact that they may not be useful for explanation. Moreover, some words can be exceptional, in the sense that they are defined in time and space.

Fuzzy logic comes from the works of Zadeh (1965; 1988). As this author states:

> More often than not, the classes of objects encountered in the real physical world do not have precisely defined criteria of membership […] The concept in question is that of a fuzzy set, that is a 'class' with a continuum of grades of membership (Zadeh: 1965, 338-339).

Fuzzy logic differs from classical logic for five properties:

- in classical logic a proposition is either true or false. Conversely, in fuzzy logic the truth values are allowed to range over a fuzzy subset of a set.
- In classical logic the predicates must be crisp "in the sense that the denotation of a predicate must be a non-fuzzy subset of the universe of discourse" (Idem). In fuzzy logic, instead, the predicates are fuzzy, which means that they do not assume the values of 0 or 1 but this range is seen as continuous.
- Classical logic permits the use of just two quantifiers, all or some, while fuzzy logic allows the use of different quantifiers, like most, many, several, much of, etc.
- Fuzzy logic can represent the meaning of both non-fuzzy and fuzzy predicate-modifiers, such as not, very, extremely, a little.
- In fuzzy logic a proposition can be qualified by truth-qualification, probability-qualification and possibility-qualification.

When a concept is described or illustrated with vague words it is almost impossible to define it clearly. The idea of the vagueness[2] is plainly described by Russell:

> Vagueness, clearly, is a matter of degree, depending upon the extent of the possible differences between different systems represented by the same representation. Accuracy, on the contrary, is an ideal limit (1923, 90).

Some words or terms are intrinsically vague because of their nature. Concepts are formed by the use of natural language, which is imprecise. The problem is that natural language is fuzzy, in the sense that it does not distinguish between clearly defined objects, but it allows thinking in terms of degrees of membership. Everybody knows what a dog is, but some dogs can be more dogs than others (Lakoff: 1973; 1987).

It is important, at this point, to underline the logic of concept formation. Sartori's approach (1970) uses the AND logical operator, while the family resemblance approach (Wittgenstein: 1958; Collier and Mahon: 1993) uses the logical operator OR. In fact, the former looks for necessary and sufficient conditions, while the latter sees the properties as sufficient or necessary parts of the concepts (Goertz: 2006, 74-5).

The idea of fuzzy concepts has to do with fuzzy set theory and the ideal-type. Fuzzy set theory is an instrument that allows the social scientist thinking of social reality differently compared to who uses classical logic. Let me take as an example the word "red":

> It is perfectly obvious, since colours form a continuum, that are shades of colour concerning which we shall be in doubt whether to call them red or not, not because we are ignorant of the meaning of the word 'red', but because it is a word to the extent of whose application is essentially doubtful (Russell: 1923, 85).

This means that, since the language used to understand and explain the empirical world is vague, the knowledge that is produced is also vague[3]. Even though certain words may seem to have a precise meaning, such as the operators

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[2] The idea that reality is vague should be seen as a third ontology that is different from the ones that have been discussed earlier. On the one hand, there is an ontology which sees the reality as given, on the other there is an ontology that sees reality as contingent.

[3] Russell warns the reader to not confuse the vagueness of the language with the vagueness of things. It should not be inferred that since words are vague, the empirical world is vague *in sè*. What he argues is that vagueness is not a property of an instance, but a characteristic of the relation between the instance and what is known. Although knowledge can be vague, this does not mean that we can say that an object is vague (1923, 84–85). It would be possible to say that vagueness is the product of the distance between what is known and the real properties of the objects. This distance may be reduced only if we make our knowledge more precise.

used is classical logic (e.g. OR, AND, NOT), the problem comes when we try to draw inferences that, obviously, presuppose the use of truth and falsity. We know that the argument "*p* AND *q*" is true when *p* is true and *q* is true and it is false when either *p*, *q* or *p* and *q* are both false. The problems with truth and falsity is that these two concepts are precise when the symbols, such as words, we use are also precise. There are logical symbols that are precise, but at the same time, we have all the non-logical symbols that are vague. Hence, if we apply the concepts of truth and falsity to the construction of an argument, it will follow that the extent to which we can determine the truth or the falsity of that argument will be more or less vague[4]. The reason for this is that it is impossible to confine those symbols into finite boundaries (ibid., 88). Nevertheless, classical logic assumes that the symbols employed are precise and this has as consequence the fact that it is inapplicable to the empirical world. The question is the inaccuracy of language since it is constructed with symbols which do not have a one-one but a one-many relation between terms and meanings.

In social sciences this problem also arises, there are plenty of instances and concepts which are not imaginable in terms of truth-or-falsity in these disciplines. The concept of democracy can be a good example. In the literature, the concept of democracy has been used both as dichotomous and as continuous (Collier and Adcock: 1999). Following the first approach, a regime is either democratic or non-democratic (Przeworski et al: 2000), while using the second, we try to assess the degree to which a case is democratic (Bollen and Jackman: 1989).

Let me assume that country X is democratic. Naturally, one could ask: "How much democratic does the country X need to be in order to gain the label democratic?" A possible answer could be: "Country X is democratic if it has the characteristics A, B, C". The problem with this type of answers is that it implicitly uses a minimum trying to assess whether the features are present or not without considering the fact that some countries may have different levels of presence of those features. Country X has the features A, B, C, but also country Y has the features A, B, C, but to a different extent. Would you say that country X and country Y are instances of the same concept? Yes, they are instances of the same concept, but they are not democratic in the same way. Lakoff makes a similar example in order to illustrate the idea of fuzzy concepts. He analyses the statement "John is tall" and then he asks: "In contemporary America, how tall do

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[4] The definition of vagueness is constructed as follows: "One system of terms related in various ways is an accurate representation of another system of terms related in various other ways if there is one–one relation of the terms of the one to the terms of the other, and likewise a one–one relation of the relations of the one to the relations of the other, such that, when two or more terms in the one system have a relation belonging to that system, the corresponding terms of the other system have the corresponding relation belonging to the other system […] *Per contra*, a representation is vague when the relation of the representing system to the represented system is not one–one, but one–many" (Russell: 1923, 89).

you have to be to be tall?" (1973, 458). The examples may be very numerous. The substance of this discussion is that we cannot apply the attribute of truth, falsity or non-sense to statements, because these statements are not entirely true, false or non-sense. Therefore, the statement "Country X is democratic" is not true or false because the concept of democracy does not have clear cut boundaries. Its boundaries are fuzzy, exactly because they are not defined. This does not mean that it is impossible to use fuzzy concepts and to measure them, but it should sound as a warning for not treating fuzzy concepts as in-or-out categories because the case may stay in the "grey area".

The dichotomy strategy is the one proposed by Sartori (1975; 1984) and that is well summed up by Taylor (1995, 23-4), saying that the classical view on concepts sees the attributes in terms of necessity and sufficiency, sees the features as binary, affirms the presence of clear boundaries and the equality of the members of the category (Cohen and Nagel: 1934). Nevertheless, following the discussion on the imprecision and the inaccuracy of language, this problem needs to be overcome. We have seen that a way to do so is assuming the precision of symbols, but this does not account for the ontology of the empirical world. Another strategy to solve the problem is accepting the vague nature of the instruments used for building scientific arguments, e.g. language and symbols, and endorsing a perspective concerned about fuzziness.

One of the most interesting characteristics of fuzzy logic is that it allows approximating answers to questions that are based onto a knowledge that is imprecise. Classical logic cannot solve the problem of approximation for two basic reasons: firstly, is it is unable to represent the meaning of proportions that are expressed in a natural language that, often, is imprecise. Secondly, in case a language can be represented symbolically, classical logic does not provide a mechanism for inference. Fuzzy set logic addresses these problems in two ways: "first, the meaning of a lexically imprecise proposition is represented as an elastic constraint on a variable; and second, the answer to a query is deduced through a propagation of elastic constraints" (Zadeh: 1988, 83).

As far as the strategy of ideal-type concept construction is concerned, it should be said that it is a common procedure among social scientists (Goertz: 2006, 83). The ideal-type is an heuristic device that helps the researcher in solving a dilemma between using general concepts, which may not be useful for understanding what is important to select, and using specific concepts, e.g. those used by the historian, that are applicable to single instances. In Weber's words:

> An ideal type is formed by the one-sided accentuation of one or more points of view and by the synthesis of a great many diffuse, discrete, more or less present and occasionally absent concrete individual phenomena, which are arranged according to those one-sidedly

emphasized viewpoints into a unified thought construct. In its conceptual purity, this mental construct cannot be found empirically anywhere in reality. It is a utopia (1997, 88).

As Ragin (1987), I think that it is necessary to unearth the concept of the ideal-type for some reasons. First of all, ideal-types allow the researcher dealing with complexity, in fact following Schmitter:

I can see no viable alternative for us comparativists than to confront the messy and noisy world in which we live and design our theories accordingly. And the place to start is by changing the basic concepts and classification systems that one needs to control for similarities and to identify differences. And the best tool for producing these building blocks is the 'ideal type' [...] comparative political analysis, if it is to remain significant, productive, and innovative in the future, has to reflect the 'real-existing' environment from which it should draw its observations and to which it should refer its findings (Schmitter: 2009, 45).

Second, they are useful to understand how an empirical case diverges from the pure case:

Theoretically pure cases serve a heuristic purpose: they assist us in learning about and/or interpreting empirical cases on the basis of theoretical knowledge. The selection of ideal-typical cases is determined by our respective research objectives (Aus: 2009, 176).

Third, and this is the aim of this paper, it can be used applied with fuzzy set theory and logic (Kvist: 1999; 2006; Goertz, 2006; Schneider and Wagemann: 2010). Applying fuzzy logic to the ideal-type it is possible to understand and to see cases as configurations of attributes that appear to a different extent. This allows studying and understanding the differences both in kind and in degree that are present among the cases (Kvist: 2006). It is also possible to apply fuzzy logic to the radial category structure of concepts (Collier and Mahon: 1993) so to establish the degree membership of the cases to this type of concepts.

The idea of boundedness (Sartori: 1970; 1975; 1984) of concepts may push the researcher towards rigidity. Instead, an ideal-typical conceptualization permits avoiding conceptual stretching because there is a constant exchange with the existing reality. There is the archetypical concept and then there are cases represented by different combinations and degrees of the attributes (Komatsu: 1992). The idea is that concepts should be constructed following the nature of reality. If reality is seen as complex and characterized by interdependence, the concepts we want or need to use to understand reality should be constructed

according to that nature, in other words to our ontology. I argue, namely, that a greater attention to ontology should be paid during the concept formation process.

The puzzle of the attributes

There is a persistent problem in social sciences, which is that concepts and theories are difficult to relate to the empirical findings and that theoretically intermediate concepts are used universally. Concepts are often a product of socio-historical configurations that, unfortunately, do not apply to the current problems under investigation. For this reason, many concepts are very difficult to be abstracted from time and space in order to render them universally applicable. A way to overcome these problems is the idea of composite concepts (Bendix: 1963). This kind of concepts has the property of being logically decomposable in a cluster of attributes that distinguishes a concept from another. As Bendix argues: "comparative sociological studies are needed to delimit the applicability of those attributes; here we are back to the space-and-time dimension of sociological concepts" (1963, 534). The role of comparison is, therefore, fundamental in dealing with concepts:

> First, comparative studies illuminate the meaning of sociological universals by exhibiting the range of 'solutions' that men have found for a given problem in different societies. Second, since many sociological concepts are composite terms, such studies provide an important check on the generalizations implicit in these terms. Third, insofar as our concepts are of limited applicability, such studies also enable us to characterize these limits and hence to specify approximately the empirical referents of contrasted social structures (ibid., 535).

Thus, the comparative approach it is not only a method to control inferences, but also a method to understand the utility and, especially, the validity of a concept. The goodness of a concept relies on its suitableness to the contexts it is applied to and on the understanding of the cases we would apply the concept to.

Only following this path we can construct our concepts coherently with the phenomena we investigate. The solution to this dilemma can be retrieving the tool of the ideal-type and re-adapt it to fuzzy set theory. We have an ideal-type of a concept which is a-historical and we reify it through fuzzy sets, going back and forth between theory and evidences.

The same thing, I argue, can be done for concepts. The idea is that concepts should be constructed following the nature of reality which surrounds us. If reality is seen as complex and characterized by interdependence, the concepts we want or

need to use in this kind of reality and that allow reading the phenomena occurring in this world should be constructed according to that nature, in other words to our ontology. I argue, namely, that a greater attention to ontology should be paid during the concept formation process. Ontology should precede concept formation.

This should be the way that a researcher focused on complexity may want to follow in order to form concepts that are suitable to the contemporary world:

> A 'complexifier' is more likely to be interested in a set of variables whose boundaries and interrelationship are intrinsically unclear. What does the explaining or is the object of explanation something 'fuzzy' that may not take on the exact same observable properties in every case. His or her concepts reference something that is similar but not identical. They may share certain properties but not all of them and when they are broken down into sub-types, the categories may be nominal and not ordinal, i.e. they may cluster according to different and not the same criteria [...] These and many more are ideal types and they are blurred, radial, and fuzzy in nature. A qualified observer knows what they are and grasps what they may have in common, but hesitates before specifying them in identical 'non-stretchable' terms (Schmitter: 2009, 55).

This can be done by using the diversity-oriented approach (Ragin: 1987) because it allows combining the different attributes of a concept and allows building a concept having a complex view on it. As it is not possible to identify an outcome by separating the conditions, similarly it is not possible to treat different attributes of a concept separately because they are interdependent. Concepts should be seen as configurations of attributes and this contrasts with the quantitative approach to concepts. It differentiates from this, which is more focused on constructing measures, because it does not see the attributes of a concepts as analytically distinct. Conversely, case-study research is more interested in studying how the parts interact with each other since concepts are seen as wholes that are made up of its parts. The way the attributes interact forms the concept itself. Thus, the attributes of a concept do not cause the concept, but it constitutes it (Goertz: 2006, 15) and the way the different attributes combine forms the concepts.

The configurational approach to concepts has the major advantage of tackling the problem of the "grey zone" (ibid., 29), namely the area in which it is not clear whether the case is a positive or negative instance of a concept, and the problem of the INUS conditions (Mackie: 1974). This perspective is very close to the "family resemblance" approach (Wittgenstein: 1958; Collier and Mahon: 1993)

and to the "prototypical" or "archetypical" approaches of the cognitive stream (Komatsu: 1992).

We will see in the following paragraph how fuzzy set theory can be applied to instances of concepts that may not work well with dichotomous categories. This is due to the fact that by using fuzzy sets we can create sub-types that are not rigid as the classes or categories are, but that are flexible and adaptable to the empirical cases. In my opinion, concepts should be seen as temporary and not as definitive. Concepts should be constructed for our context, both temporal and spatial.

Concepts can be constructed holistically and ideally. In reality a concept configures itself differently. Anyway, concepts should be constructed holistically seeing afterwards if they occur in the empirical world. This can be done by using the fuzzy logic approach, meant as a heuristic tool. If concepts are seen as configurations, it is possible to assess the degree of membership of a case to it.

The process of conceptualization is pursued by adjusting the parts that form the concept. Concept formation can be represented as a hermeneutic circle, since what changes in an aspect of the concept will affect the other parts. This should be conducted through a continuous dialogue between the concepts and the empirical data (Becker: 1998). Therefore, concept formation should be seen as holistic: it is impossible to separate the parts and treat them differently, because of the interdependence between them. This back-and-forth approach is the one suggested by Ragin (1987; 2000; 2008a) and it allows polishing the incongruence between the theory and the empirical world.

It is also desirable that the researcher does not separate the theoretical world from the empirical one, because one implies the other and vice versa. Gerring argues that "acknowledging the interdependent nature of concept formation leads us away from the static, rule-bound model of concept formation. Forming concepts in the social sciences (as elsewhere) is a dynamic process, as suggested by the ubiquitous ceteris paribus clause" (1999, 389). In my opinion, this is central to the idea that a flexible method should be used in order to form concepts. The nature, or better the ontology, of the empirical world does not allow endorsing a type of concept formation strategy that implies rules or guidelines. What I suggest is to define the ontology, which is that of the complexity of the world and its vagueness, and then to practice a method of concept formation that is coherent with this ontology (Hall: 2003).

Two logics of concept structure

A concept is made of parts (Gerring: 1999), but it should be decided how these parts relate one to the other. A concept is such because it has a certain structure. A concept should not be a list of attributes, but it is a structure that depending on

how the parts relate one to the other assumes different forms. The necessity and sufficiency structures reflect different ways of organizing the structure of the concept. The necessity structure is based, in classical logic, on the operator AND or, in set theory, on the intersection, while it is based, in fuzzy logic, on the minimum criterion. Conversely, the sufficiency structure is based, in classical logic, on the operator OR or, in set theory, on the union, while it is based, in fuzzy logic, on the maximum criterion.

As seen, a concept should be viewed as a configuration of attributes. These attributes can be considered as sets. Therefore, an empirical case belongs to the configuration of attributes to the extent to which it belongs to the different sets (attributes), which make up the concept. Thus, an object should not be seen as an instance of a given concept, but as an instance of a configuration of attributes. Let me give a clarifying example using set theory.

Recalling the classic example of the concept of "mother" (Lakoff: 1987; Collier and Mahon: 1993), there are five attributes: (1) female, (2) provides 50% of the genetic make up, (3) gives birth to the child, (4) provides nurturance, (5) married to the father. In terms of sets (Partee et al.: 1990):

$$F =_{def} \{x \mid x \text{ is a female}\} \tag{1}$$

$$G =_{def} \{x \mid x \text{ provides 50\% of the genetic make up}\} \tag{2}$$

$$B =_{def} \{x \mid x \text{ gives birth to the child}\} \tag{3}$$

$$N =_{def} \{x \mid x \text{ provides nurturance}\} \tag{4}$$

$$M =_{def} \{x \mid x \text{ is married to the father}\} \tag{5}$$

There are five sets in which a case, a person, can be in or out of it. The configuration of sets to have the "true mother" is:

$$\textit{True mother} =_{def} F \cap G \cap B \cap N \cap M \tag{6}$$

A person, to belong to the set of the true mother must have all the characteristics listed above:

$$\textit{True mother} =_{def} \{x \mid x \in F \text{ and } x \in G \text{ and } x \in B \text{ and } x \in N \text{ and } x \in M\} \tag{7}$$

As sub-type of the concept of mother is the "genetic mother":

$$\textit{Genetic mother} =_{def} F \cap G \tag{8}$$

To be a member of the set genetic mother, the person just only needs to belong to the set female and to the set provides 50% of the genetic make up:

$$F \cap G =_{def} \{x \mid x \in F \text{ and } x \in G\} \tag{9}$$

The intersection of all the sets produces the true type or the primary category of the concept, while the intersection of the set female with other sets gives us sub-types or secondary categories. It should be clear how set theory can help in expressing the idea of the configurations.

Let me give some other examples using the truth table (Becker: 1998). Following the necessary attributes structure, there is a concept Z which has four attributes or sets A, B, C, D, that are necessary in order to have the concept Z. Following the sufficient attributes approach, there is a concept Z which has four attributes A, B, C, D that are sufficient in order to have the concept Z (see table 1).

[Table 1 about here]

The necessary attributes structure leads towards concepts which are, roughly said, pure types[5]. They are made of attributes that must be present in order to have an instance of that concept. These concepts can be "adjectified" by adding further attributes (Collier and Levitsky: 1997) which give different specifications to them. The sufficiency structure allows using a concept if any of its attributes is present. In fact, as Goertz states: "[t]he family resemblance concept structure is mathematically modeled by OR or the union in set theory" (2006, 41). There is a third approach, which I call mixed, that uses both the logical operators AND and OR.

The mixed structure allows establishing what a necessary attribute is, that must be present in order to have a concept, and using other features which specify the concepts. It should be noted that the attributes are part of the primary category of a concept (Collier and Mahon: 1993) and therefore the mixed structure is, practically, the radial category structure. Conversely, if features that are not within the primary category are added to the necessary attribute, we have the concept +/- adjectives structure (Collier and Levitsky: 1997; Goertz: 2006).

Leaving aside classical logic and embracing fuzzy logic, it is possible to establish the degree membership of a case to the configuration of sets defining that concept. Let me, first, recall briefly some foundations of fuzzy set theory and algebra. A fuzzy set *A* in *X* is a set in which the elements are characterized by a membership function which associates for each point in *X* a real number in the interval between 0 and 1 (Zadeh: 1965, 339-340). This function is:

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[5] I do not say pure in the Weberian sense, but as a way to define a concept without further specifications.

$$f_a(x) = [0,1] \tag{10}$$

Using fuzzy algebra, the union of two fuzzy sets A and B which have as membership functions $f_a(x)$ and $f_b(x)$ is a fuzzy set Z which has the membership function $f_z(x)$:

$$f_z(x) = Max \ [f_a(x), f_b(x)], \ \ x \in X \tag{11}$$

Or:

$$f_z = f_a \cup f_b \tag{12}$$

The intersection of two fuzzy sets A and B which have as membership functions $f_a(x)$ and $f_b(x)$ is a fuzzy set Z which has the membership function $f_z(x)$:

$$f_z(x) = Min \ [f_a(x), f_b(x)], \ \ x \in X \tag{13}$$

Or:

$$f_z = f_a \cap f_b \tag{14}$$

Thus, the main difference between set theory and fuzzy set theory is that the latter allows establishing a degree membership of the elements in a given set, while the former does not provide this possibility.

Following this, ideal-type or prototypical concepts should be seen as configurations of properties (or fuzzy sets) that score 1 on each property (Goertz: 2006, 84). Applying fuzzy logic to concepts it is necessary, in order to have an ideal-type using the logical operator AND, that none of the attributes must score under 1. Given the fact that ideal-types do not have instances in the empirical world, we expect to find cases which just partially can be described with the ideal-typical concept.

[Table 2 about here]

The fuzzy logic approach to concepts has an important implication concerning the aggregation of the different levels of a concept. In order to aggregate the dimensions of a concept it should not be forgotten to bear in mind the internal structure of the concept itself. A concept is mostly built up through a necessary and sufficient structures. So, if the classical additive or average strategies of aggregation are used, it would not be possible to reproduce the same structure that a concept has.

The risk of not considering the structure of a concept in aggregating its dimensions is having a measure that has a low level of consistency. If the attributes of a concept are connected with a series of AND's, an additive strategy of aggregation should not be used since it does not reflect the structure of that

concept. In a few words, this is a logical, but not an additive strategy of aggregation of measures.

Using the radial category and fuzzy logic we go a step beyond the "fuzzy-set ideal-type analysis" (Kvist: 2006; 2007) not only looking at concepts as structures that have zero extension and maximum intension, but also understanding how a radial category is applicable to the set of cases that we are about to study.

An example: the concept of political participation

It is not uncommon, in a moment in which we witness growing possibilities of participating to political life, to ask whether an action can be considered political or not. Following the argument I have developed in the previous sections of this paper, I think that the issue of political action should not be seen as a matter of in-or-out, but as a problem of degree. I argue that none of the forms of political participation are clearly positive or negative cases of the concept. There are forms of political action that may be part of the so-called "grey area" and for this reason it would be more appropriate to avoid the categorization approach based on classical logic and to use an approach focused on the possibility of establishing degree membership, so to identify the uncertain cases.

Here, I follow the idea that all concepts are continuous because it is a valuable strategy to overcome the problem which appears when there are cases that are neither in-or-out of a category. In case of political participation, if a dichotomy approach is used for this concept, we would have in some categories instances that may not be the same thing, exactly because this approach does not provide the possibility of establishing the membership of a case to a set, or category. This reflection comes from the trivial question if an action is whether or not a form of political participation and, if yes, in which category of political participation we should place it. This is related to the debate which tries to assess the changes in political participation. The different forms of political participation are getting replaced by others, without jeopardizing democracy[6].

Therefore, a new conceptualization of political participation and of its forms may be helpful to understand change not only from a quantitative side, but also from a qualitative side, which allows catching what it is happening to those who participate to political life and to understand to what extent these changes in form have an impact on democracy. Furthermore, emerging forms of political participation show that they cannot be considered, for instance, conventional or

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[6] This is a very common concern among scholars of political participation. Furthermore, a different specification of political participation may be very useful for constructing types of political activists. This could be done through the definitions of forms of political participation.

non-conventional because the attributes they have make them very difficult to categorize[7].

In order to demonstrate that the structure of a concept is a fundamental issue in its formation, I surveyed a number of conceptualizations of political participation. This is done to provide an example of how much the definition of political participation can include different attributes, so that a number of actions, even the most different, can be considered forms of political action. The idea is that if we apply fuzzy set theory to the concept we can leave behind the problem of conceptual stretching and the problem of categorization thanks to a greater possibility of constructing flexible concepts. The definitions that are listed in the following lines also serve as references to capture all possible attributes that may constitute a new concept of political participation. Political participation refers to:

> (…) those activities by private citizens that are more or less directly aimed at influencing the selection of governmental personnel and/or the actions they take (Verba and Nie: 1972, 2).

> Those actions of private citizens by which they seek to influence or to support government and politics (Milbrath and Goel: 1977, 2).

> Behavior influencing or attempting to influence the distribution of public goods (Booth and Seligson: 1978, 6).

> All voluntary activities by individual citizens intended to influence either directly or indirectly political choices at various levels of the political system (Kaase and Marsh: 1979, 42).

> Action by private citizens intended to influence the actions or the composition of national or local governments (Nelson: 1979, 394).

> As individual or collective action at the national or local level that supports or opposes state structures, authorities, and/or decisions regarding allocation of public goods. Three aspects of the definition should be emphasized. First, the action can be verbal or written. Second, it can be violent or nonviolent. Third, it can be of any intensity […], I argue that neither the intentions of participants nor the outcomes of their actions are necessary attributes of political participation (Conge: 1988, 247-8).

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[7] This reflection comes from trivial questions, such as: what kind of form of political participation is joining a residents' group? Is becoming a member of a Facebook group with political aim a political action? Can we consider a political action the "virtual" attendance to a demonstration? What is hacking? What are the consequences of these actions on democracy? Do they affect legitimacy?

> Action by citizens which is aimed at influencing decisions which are, in most cases, ultimately taken by public representatives and officials (Parry et al.: 1992, 16).

> An opportunity to communicate information to government officials about their concerns and preferences and to put pressure on them to respond (Verba et al.: 1995, 37).

> Any dimensions of activity that are either designed directly to influence government agencies and the policy process, or indirectly to impact civil society, or which attempt to alter systematic patterns of social behavior (Norris: 2002, 16).

Looking at these conceptualizations, we can notice that each of them either emphasizes particular aspects of the concept or leaves room for generality, so that a lot of actions can be considered part of the set "political actions". The problem with them is that they do not clearly explicit what is the relation among the attributes they include to define political participation. What I propose is using the attributes that are present in the definitions above adding some other attributes that can render the conceptualization of political participation more complex, so to take into account some actions that may not be considered as such by those definitions.

The attributes of the conceptualization that I suggest should not be seen as dichotomies, but as sets in which the actions may be, to a certain extent or not, included. Hence, these attributes are more like specifications, rather than opposite poles of a continuum.

In defying the concept of political participation I proceed in steps: I propose two different conceptualizations in order to go from a broad idea of political participation, in which all the actions having the attributes should fit, to a more specified ones, in which different actions would fit depending on which attributes are considered part of the concept. Therefore, I define political participation:

> as an action which is characterized by the voluntariness of the action, namely the decision to take part perform the action should is taken no external obligations, by the presence of a political aim, that is an action with the scope of changing or maintaining the existing, and by the presence of an object of action, that is the object towards which the action is directed and whose decisions have an impact on the society.

Using fuzzy set theory, the membership function of political action is:

$$Political\ action_{Necessary} = f_{PA_N}(x) \tag{15}$$

$$f_{PA_N}(x) =_{def} Min\ [f_v(x), f_a(x), f_o(x)],\ x \in X \tag{16}$$

Where $f_v(x)$ is the function of the voluntary actions, $f_a(x)$ is the function of the aim of the action and $f_o(x)$ is the function of the object of the action.

As the reader can easily notice, this concept of political participation is too broad to be useful. This can be considered a first level of the definition that is necessary to have a political action, but which is not sufficient. The next step concerns the addition of a number of attributes, setting aside the three attributes that are mentioned in the previous conceptualization. This is due to the fact that these attributes are necessary, but not sufficient components of a general definition of political participation without which it is not possible to talk of a political action. Hence, political participation is:

> an action which is voluntary, has an aim and an object. These are elements without which is not possible to talk of political action. Furthermore, it is an action that can be declined through the use of a number of attributes, such as: salience, the extent to which the action has an impact; intensity, the extent to which the action requires physical energy; orientation, the extent to which the action is oriented to an aim/expression; cognition, the extent to which the action requires the use of cognitive resources; continuity, the extent to which the action is continuous over time; institutionalization, the degree of institutionalization; violence, the degree of violence that characterizes the action; agency, the extent to which the action is collective/individual; legality, the degree of legality of the action; resources, the extent to which the action requires material resources; structure, the extent to which the action is direct/mediated by other actors; level, the extent to which the action is performed on a international/national/local level; nature, the extent to which the action is supportive/oppositive.

The definition I propose has to be seen more as a strategy to combine different characteristics of a political action producing a number of combinations that in most of the cases are real action, although in some cases we could not have empirical instances[8]. It should be noted that this definition has two different levels: the first one is a necessary part of the definition that is a combination of attributes that must be present in order to have a political action, the second one is

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[8] This is the problem of "logical remainders" which also occurs in fsQCA. See Schneider and Wagemann (2006).

the level which specifies and characterizes the actions. Therefore the fuzzy membership of the first level should be such to include the political actions in the set, otherwise that given action cannot be considered political. The first level serves to define the pre-conditions to have a political action.

Therefore, the way we combine the different attributes produces a concept of political action in which the different cases are part of this set to a different degree, this depends on the membership of the same case to the sets, attributes, which make up the concept. Let me show how this definition would work using a truth table and fewer attributes (table 3).

[Table 3 about here]

For this example, I use just four of the attributes for a matter of simplicity. As already stated above, depending on how we the attributes are bound, we have different concepts of political participation and different degrees of membership of some actions to the concepts. The table is composed by three macro-columns. In the first some political actions are listed. In the secondary level macro-column there are two types of attributes. The first are called necessary since, as the definition proposed says, without them it is impossible to give to an action the adjective "political". The second are called "additional attributes" since they specify the action, giving particular declinations to it. In the third macro-column I present four structures. The AND and the OR structures are the same as shown in the previous paragraph. The other two structures highlight the importance of some attributes. The mixed structure (17) focuses more on the legality of a political action and it is close to the definition of conventional political participation, while the mixed structure (19) focuses more on the cognitive aspects that a political action needs in order to be performed. In fuzzy set theoretical terms the membership function of a "legal political action" is:

$$Political\ action_{Legal} =_{def} f_{PA_{Legal}}(x) \tag{16}$$

$$f_{PA_{Legal}}(x) =_{def} Min\ \{f_l(x), Max\ [f_c(x), f_i(x), f_r(x)]\},\ x \in X \tag{17}$$

While the membership function of a "cognitive political action" is:

$$Political\ action_{Cognitive} =_{def} f_{PA_{Cognitive}}(x) \tag{18}$$

$$f_{PA_{Cognitive}}(x) = Min\ \{f_c(x), Max\ [f_i(x), f_l(x), f_r(x)]\},\ x \in X \tag{19}$$

Where $f_l(x)$ is the function of the legal action, $f_i(x)$ is the function of the legality of the action, $f_c(x)$ is the function of cognition of the action and , $f_r(x)$ is the function of resources of the action. Before continuing the discussion, here is another point that needs to be tackled concerning the fuzzy scores that the cases,

the actions, have. The passage from crisp sets to fuzzy sets implies the definition of the scores that tell us how much a case belongs to a set, in this example to an attribute. The procedure by which the fuzzy scores are determined is called "calibration" (Ragin: 2000; 2008a; 2008b). Calibration helps in setting standards when there are qualitative phase shifts due to other conditions that are context dependent (Ragin: 2008a, 72-3). Moreover, another decision that needs to be taken is about the fuzzy scale that a researcher wants to use for assigning the scores to the cases and about the scores that define the membership of the cases to a set, namely the thresholds and the crossover points (Ragin: 2008c). For my example, I decided to use a non-continuous fuzzy scale which assumes the following six values 0, .1, .4, .6, .9, 1 to indicate, respectively, that a case is fully out, mostly but not fully out, more or less out, more or less in, mostly but not fully in, fully in (ibid.). This allows me avoiding the problem of cases that may place themselves in the "grey area".

Looking at the concept structures of the concept of political action, we see that depending on how the attributes are combined we obtain different membership scores of the action considered to the sets, namely the configuration of attributes. For instance, voting, using the sufficient attributes approach, belongs to the set of political actions with the score of 1, while using the necessary attributes approach the membership value drops to .1. Terrorism, using the OR structure, belongs to the set of political actions with the score of .9, while using the AND structure the membership score changes and it is 0. As far as the mixed structures are concerned, voting belongs to the set of legal action with a degree membership of 1[9], while it belongs to the set of cognitive actions with the degree of .4. Terrorism is fully out of the set of legal political actions, while it is more or less in the set of cognitive actions. The differences between the membership scores are due to the fact that the four concepts of political actions illustrated in table 3 underline different aspects of it.

To conclude with a few words on this point, a fuzzy definition of political participation requires the researcher to decide, first, the type of the structure of the concept, to choose, second, the fuzzy scale and, third, to assess qualitatively the membership of the action to the set. In fact:

> In a fuzzy set context, it is necessary for the investigators to decide (somehow) what objects are full members and nonmembers to anchor the scale. These objects should be included in the scaling task for subjects for two reasons. First, they provide anchors for the subjects and thus ensure that the assignments are valid. Second, a researcher's

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[9] Voting could be considered the "ideal–type" of the legal political action.

understanding may differ substantially from subjects', and the scaling task provides an opportunity to find this out! (Verkuilen: 2005, 477).

When a fuzzy set is constructed, we need to bear in mind that the universe of discourse must be clarified (Smithson and Verkuilen: 2006). The more general the definition of the universe is, the more instances may fit into it, but also the more it would be difficult to establish the membership of that instance to the set.

In the case of political participation, the attributes of the concept should be considered fuzzy sets, but the universe of discourse should not be taken as general. When I talk, for instance, of the individual/collective attribute of a political action, the attribute is not referred to any action, but to the type of instance that is the set of political actions. Thus, a strategy to avoid this problem is to specify the domain of reference of the set we are using. This helps us to render the fuzzy concepts less fuzzy because we proceed in a systematical manner, so to reduce the natural fuzziness that we encounter using concepts that cannot be clearly specified or that do not have a common meaning.

Conclusions

In this paper I have tried to formulate a strategy of concept formation. We have seen also that a discipline, such as social science, which aspires to become more and more accurate cannot study the world looking at it in black and white. What I have argued here is that when we formulate concepts, we need first of all to decide what the ontology is that is behind our thinking. For this reason, we have to take an ontological decision that concerns the aspects we repute important of a concept. After doing so, we have to define explicitly how the things we think are important for the concept that we use stay together. A concept is not only a group of attributes that bind casually, but an organic set made up by different parts that needs a structure. Furthermore, the way we structure the concepts is extremely relevant to our research. For instance, the structure of a concept has important consequences on the selection of the cases that may be part of a sample.

Another aspect that has been underlined in this paper is that fuzzy set theory should be taken as a very useful instrument to understand how to build the concept that we use in our research. This is so for several reasons. The first is that it allows distinguishing the degree membership of an object to a set. The second is that it produces a different logic with the respect of the classical one. Thanks to fuzzy set theory we can understand the extent to which an empirical instance is part of an ideal set. Fuzzy set theory permits to make choices about the structure of the concepts explicitly, avoiding that imprecision that it is often encountered in the definitions used in the social sciences. Fuzzy set theory notation helps in

making the structure of a concept explicit and helps in defining the relation between the attributes. Moreover, formalization renders clear the choices that the researcher makes. Often concepts are simply a list of attributes without a systematic reflection on how the parts of a concept tie together. As stated before, behind a concept there is a theory (Goertz: 2006) and this strategy of concept formation forces the researcher to think about the problem of the structure.

The last point, and perhaps the most important, is that the application of fuzzy set theory to concept formation can be the bridge to connect the positivist and the interpretivist traditions. As said, the positivist tradition privileges formalization and the use of a scientific language, while the interpretivist tradition is interested in the construction of ideal-types. What fuzzy set theory does is using both formalization and the ideal-type through a formalization of the ideal-type structure. Formalization is helpful to explicit and to systematize the structure of the concept and the ideal-type permits to define clearly the parts of a concept. Fuzzy set theory is the instrument that merges together elements of both traditions.

My proposal is not the solution of the problem of conceptualization but rather a tentative of systematization of the possibilities that an idea born in another field of science, i.e. information technology, can have on a distant field such as social sciences. I think that what it should be done more and more is looking at our neighbors' gardens, since it can be a fruitful experience, especially when the ideas produced for other aims apply well to ours. Coherently with what I have argued in this paper, the boundaries, like for concepts, are often obstacles because they prevent us from seeing over the fence.

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Table 1. Property space of a hypothetical concept Z using classical logic and three different concept structures.

Cases	Secondary-level				Basic-level		
	Attributes - Sets				Structures		
					AND - Intersection Classical category	OR - Union Radial category	Mixed approach
	A	B	C	D	$A*B*C*D \xrightarrow{def} Z$ $Z =_{def} A\cap B\cap C\cap D$	$A+B+C+D \xrightarrow{def} Z$ $Z =_{def} A\cup B\cup C\cup D$	$A*(B+C+D) \xrightarrow{def} Z$ $Z =_{def} A\cap(B\cup C\cup D)$
1	1	1	1	0	0	1	1
2	1	1	1	1	1	1	1
3	0	0	1	1	0	1	0
4	0	0	0	0	0	0	0
5	1	1	0	0	0	1	1
6	0	1	1	0	0	1	0
7	1	1	0	0	0	1	1
8	1	1	1	1	1	1	1

Table 2. Property space of a hypothetical concept using fuzzy-sets and three different concept structures.

Cases	Secondary-level Attributes - Sets				Basic-level Structures		
	A	B	C	D	Minimum - Intersection Ideal-type analysis $A*B*C*D\xrightarrow{def}Z$ $Z=_{def} A\cap B\cap C\cap D$	Maximum - Union Radial concept analysis $A+B+C+D\xrightarrow{def}Z$ $Z=_{def} A\cup B\cup C\cup D$	Mixed approach $A*(B+C+D)\xrightarrow{def}Z$ $Z=_{def} A\cap(B\cup C\cup D)$
1	1	.75	.75	.5	.5	1	.75
2	1	1	1	.75	.75	1	.75
3	.25	0	.75	.75	0	.75	.25
4	.5	.5	0	.5	0	.5	.5
5	.75	1	.25	.5	.25	1	.75
6	0	.75	1	0	0	1	0
7	.75	.75	.5	.5	.5	.75	.75
8	.75	1	1	.75	.75	1	.75

Table 3. The truth table for the concept of political participation.

| Actions | Secondary level | | | | | | | Basic level | | | |
| | Necessary attributes (16) | | | Additional attributes | | | | Structures | | | |
	Voluntary	Aim	Object	Cognition	Institutio-nalization	Resources	Legality	AND	OR	Mixed Legal (17)	Mixed Cognitive (19)
Voting	1	1	1	.4	1	.1	1	.1	1	1	.4
Squatting	1	1	1	.6	.1	.6	.4	.1	.6	.4	.6
Blogging	1	1	1	.9	.4	.6	.9	.4	.9	.9	.9
Terrorism	1	1	1	.6	.1	.9	0	0	.9	0	.6
Residents association	1	1	1	.6	.6	.4	.9	.4	.9	.6	.6
Campaigning	1	1	1	.6	.9	.9	.9	.6	.9	.9	.6
Political party membership	1	1	1	.6	.9	.6	1	.6	.9	.9	.6
Writing to a newspaper	1	1	1	.9	.6	.4	1	.4	.9	.9	.9
Joining a Facebook group	1	1	1	.4	.6	.1	.6	.4	.6	.6	.4

Note: The degree membership is arbitrary (this is done to provide an example).