12 The Fuzzy Complexity of Language

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Abstract. Fuzziness is understood here as one of the properties of complex systems. An epistemological reading of fuzzy set theory reveals that the general principles of classical logic become exceptional under fuzzy logic, and a reading of language as a fuzzy phenomenon uncovers new characteristics of the complexity of language systems. Using this approach, the current paper identifies strategies of intentional and unintentional language manipulation adopted to eliminate or at least to reduce this fuzziness. These strategies are explained in terms of indefiniteness, categorization, dichotomization and conceptualization, offering paradoxical examples and examining questions such as the indefiniteness of definitions and the resources used to reach supposedly crisp definitions. Nouns and adverbs are shown to be elements indicative of fuzziness, as elements of *imprecise precision*. The paper concludes with a consideration of the growth of fuzziness in the context of globalization and the emergence and development of hypertext.

1 Fuzziness as a Property of Complex Systems

Theories and research on complex systems in a range of scientific fields have brought to light various irreducible, endogenous properties that constitute the qualitative aspects of such systems, such as their *chaoticity* and *fractality*. In my view, *fuzziness* is another of these aspects.

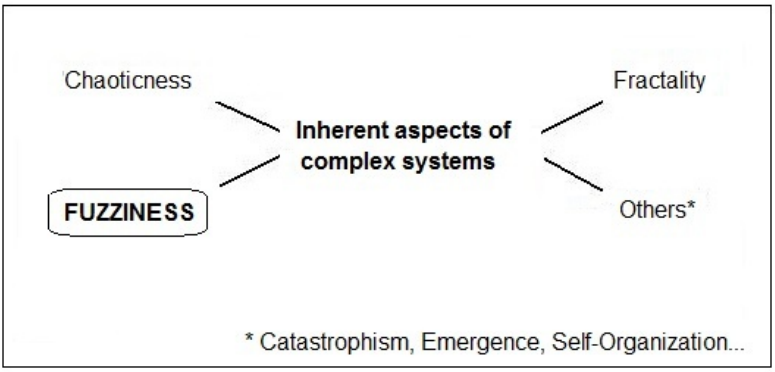

Fig. 12.1 Chief properties of a system with strong complexity.

When these properties are taken as an integrated whole, they offer a new vision of complexity, which we could call *strong complexity*, and capture its epistemological sense as a knowledge paradigm that goes beyond the dominant understanding prevailing in Western thought since classical or post-archaic Greece. Strong complexity supersedes the ancient but still reigning paradigm of simplicity (Munné 2004 and 2005).

This epistemological focus on complexity builds on systems theory and first- and second-order cybernetics and it leads us to see non-linearity at the core of complexity, because non-linearity is the common denominator of the theories involved. Non-linearity in this context must be taken not only as mathematical but also in its epistemological sense as a disproportional relationship between cause and effect. Viewed in this light, complexity is an entirely qualitative concept, which depends more on interactions and feedbacks among a system's elements than on the number of elements. This distinguishes complexity from complication, which is a quantitative concept.

Currently, the most fruitful of the theories feeding into the complexity paradigm is chaos theory, the most surprising is fractal theory, the most disputed is catastrophe theory, and the most subversive is fuzzy set theory. This subversiveness makes fuzzy set theory extremely troublesome for scientific thought and may well explain why it is the most neglected, when not entirely ignored, by nearly all chaos and fractal theorists. It is precisely on fuzziness that this paper intends to focus its investigation into aspects of thought and language.

Lofti A. Zadeh, an Iranian by background and an electrical engineer by training, proposed a theory of logic based on fuzzy sets in the nineteen-sixties while he was a professor at the University of California, Berkeley. Initially, Zadeh was thinking of technological applications, but soon the theory gained ground in other fields as well, including language.

Leaving aside other forerunners, the fundamental characteristic of this logic (close to Eastern thought) is that, unlike Aristotelian or Boolean logic (although Aristotle did envisage the possibility of such a logic), it is not bivalent, but rather polyvalent. The starting point appears to be straightforward: the relation of an element belonging to a given set. In classical logic, the relation is of belonging or not belonging and that is sufficient, while in fuzzy logic it concerns a question of degree.

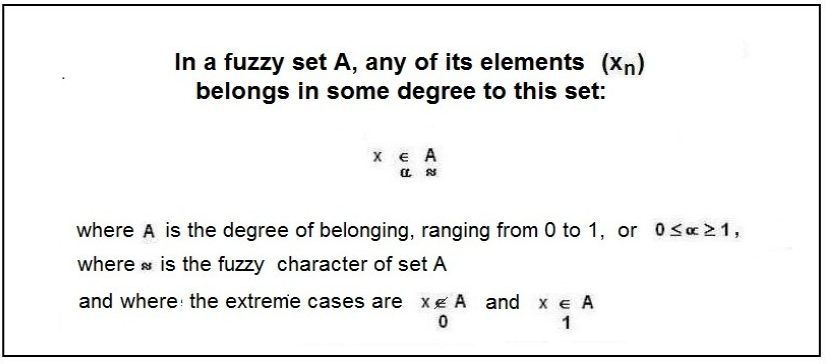

Fig. 12.2 The fuzzy relation is a relation of belonging "and" not belonging (not "or").

Frequently, fuzzy logic is viewed as a type of multivalent logic. Epistemologically, however, this view is not sustainable. The nature of fuzzy logic differs nearly as greatly from multivalent logic as it does from classical logic. In mathematical and programming terms, binary logic only works with "0 and 1", while multivalent logic can have intermediate values, for instance, 0, 0.25, 0.50, 0.75 and 1.00. By contrast, fuzzy logic moves "*between* 0 and 1", where the *possible* values are infinite.

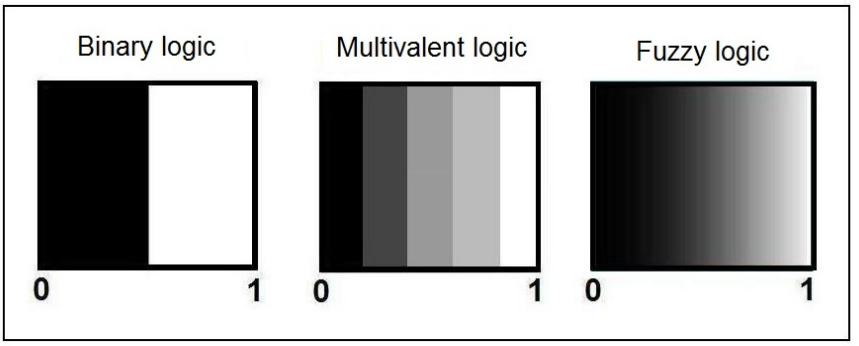

Fig 12.3 Visual difference in values according to three fundamental types of logic.

This difference is striking when observed in black and white. In the first box, the two colours are pure. By the third box, however, they are reduced to the linear limits touching the sides, while the shades of grey in the second box correspond only to specific vertical lines in the third box. Bivalent logic could be called a logic of dichotomy and multivalent logic a logic of discontinuity, while fuzzy logic is a logic of continuity.

2 Inverting the Laws of Aristotelian Logic

As a result, choosing fuzzy logic to study the complexity of language goes a long way toward overturning the ancient and undisputed laws of Aristotelian logic that have fed Western thought. Comparing these Aristotelian laws with their fuzzy equivalents, we find that: 1) the law of identity, by which A is A, becomes A can be A *and* not-A at the same time; 2) the law of contradiction, A or not-A, expressing bivalence, becomes A *and* not-A; and 3) the law of the excluded middle, A and not-A and no other possibility, becomes the law of the included middle, i.e., between A and not-A, other possibilities exist.

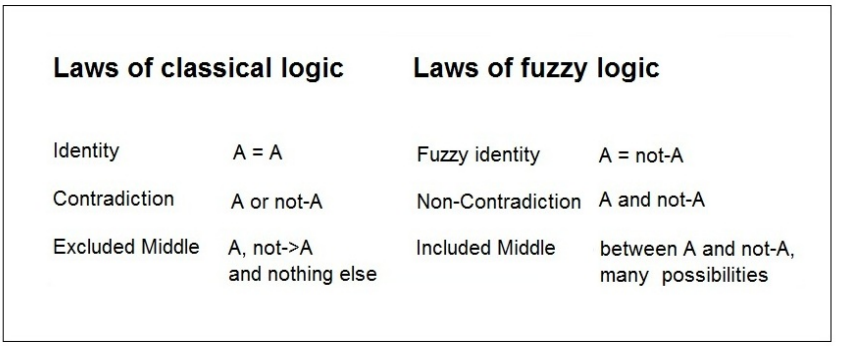

Fig. 12.4 Fuzzy logic inverts the principles of classical logic, which become exceptional or singular rather than general.

Does this dispense with the three Aristotelian laws? No, but it does mean that they hold *only* in the extreme or boundary cases, when the criteria of belonging are total and absolutely clear. The classical laws become exceptional or singular, while the fuzzy laws become general. This shift subverts the established logic and the thought based on it.

3 Language as a Fuzzy System

By the mid-1960s, Zadeh began to see the issue of fuzzy sets as a language problem as well. In an interview, he put it like this: a basic characteristic of the human brain, held more or less in common with other information-processing systems, is its limited ability to manage classes with a large number of elements, and when this ability is exceeded, the boundaries of sub-classes become fuzzy. For this reason, natural languages, which are of a higher level than programming languages, are fuzzy, while programming languages are not. Developing these ideas through the nineteen-seventies, Zadeh (1978) designed a formal language called PRUF (Possibilistic Relational Universal Fuzzy), which permitted fuzzy meanings, but his interest was limited to artificial intelligence. In my view, Zadeh's perspective has been superseded today by the notion of fuzziness as one of the properties of complexity and, in the case of language, as a property of language systems.

Fuzziness is a chief feature of daily language. In fact, fuzziness may even be its *conditio sine quan non.* Thanks to fuzziness, we understand each other without any problem when we utter, for example, a routine greeting like "Hi, how are you? I'm good, how about you?" or when we say "let's sleep in a little" without adding another word. Words, as William James said, have a fringe of indeterminacy that makes communication possible without an attention to detail that would become otherwise intolerable (Stebbing 1950).

Fuzziness is potential. We use language in the degree of fuzziness necessary and sufficient to each case in order to understand or influence another person. It is

a tool that we use carefully, often without realizing it, drawing on analogy and metaphor, symbol and , double meanings, misunderstanding and implication, tone and expression. Fuzziness makes it possible to interpret and apply the explicit and implicit rules of social life efficiently. Consider an example from daily life: at the *express* check-out lanes in supermarkets, a sign informs customers that the lanes are for "up to 10 items" (or a similar amount). The check-out assistant can treat the rule with a literal inflexibility or with a fuzzy richness. In this case, the check-out assistant must decide whether or not 10 products are *always* 10 products, whether two units of the same product count as one or two items, whether a 2x1 offer counts as one or two items, whether or not a customer with 11 or 12 items may proceed when the other check-out lanes have queues or no customer or only one customer is waiting in the express lane, and so forth.

If we view a language as fuzzy, how many words does it have? From the perspective adopted here, it is not only difficult, but impossible to respond (just as it is impossible to respond to the famous question posed by Mandelbrot, the father of fractals: "How long is the coast of Britain?"). This is because any response obscures the fuzziness of the language system. The data given by dictionaries stretch and shrunk like the folds of an accordion. The number of entries and senses vary widely by dictionary and edition.

However, by way of response, suppose we accept the words contained in a given dictionary. Then, let me propose an imaginary game in line with the thought experiments much loved by our early quantum physicists. Let us call it "the dictionary game". Now, supposing that we do not know the meaning of the words, let us select a word randomly from the dictionary and immediately look up its definition within the dictionary itself. "Surprisingly", we see that this definition has more words, so we decide to look up the meanings of each one in order to understand the original definition. However, it turns out that looking up the meaning of these words leads us to yet more new words, for which we need to look up their meanings. And this sequence goes on indefinitely. Under the uncertain assumption that the dictionary gave the meaning of all the words it contained, at the limit (in mathematical terms) we would have gone round "all" of the words, completing an immense vicious circle. Is it possible that we can only understand what the words mean by leaving them behind, by stepping beyond them? I will return to this topic, because at this point Gödel's theorem casts a long shadow…

If each word is defined by other words, we have a self-defining set. This calls to mind the well-known drawing by Escher of two hands sketching one another, feeding into one another. In our case, Escher's hands are the words that signify what the words themselves mean. And this leads to a few reflections:

1) If I am not mistaken, what we have in the "dictionary game" is a dual system, at once linguistic and meta-linguistic, and both systems provide mutual feedback, self-regulation and self-organization. As in a game of ping-pong, two players hit a ball back and forth. Turning from the game back to reality and offering a generalization, we can deduce that a language system tends toward mutual feedback, self-regulation and self-organization. This is paradoxical, because it occurs despite the effect of *disruptive* elements extraneous to the system

(dubbed "noise" by Heinz von Foerster, who introduced the second cybernetics, and by the biophysicist Henri Atlan). These *disruptive* elements, which both restrict and strengthen these processes, include experience and thought.

2) Although the dictionary game is a closed system, the language system is open, because the meanings also flow from usage, tone, expression and the like.

3) Lastly, the language system is a Gödelian system in the sense that it is incomplete. The subject who looks up a word in the dictionary finds more and more words, until sooner or later the subject again finds the original word, running into an inevitable and insurmountable paralogism. The dictionary game winds up becoming an exchange of words, but an exchange of words across two levels of meaning in the system: the level of the word being defined and the level of the other words used to define it, which then give us more words to define, and so on. This returns us to our original observation: the system, because it is self-defining, can only *complete* its meanings taking external elements from within the same system, demonstrating that it is not self-sufficient or rather that it is incomplete.

These characteristics point to an indefiniteness or fuzziness of language, leading us to one of two responses: 1) adopting an *as if* attitude (in the sense of Hans Vaihinger's *as if* philosophy), that is, accepting the fiction that this is clear enough; or 2) resorting consciously or unconsciously to strategies of logic and thought that enable us to manipulate language in order to reduce the fuzzy complexity of the world around us. Of these strategies, I would distinguish three as basic: delimitation, categorization and dichotomization.

4 Delimitation: Reducing the Fuzziness

An example of a fuzzy set appears in the figure below:

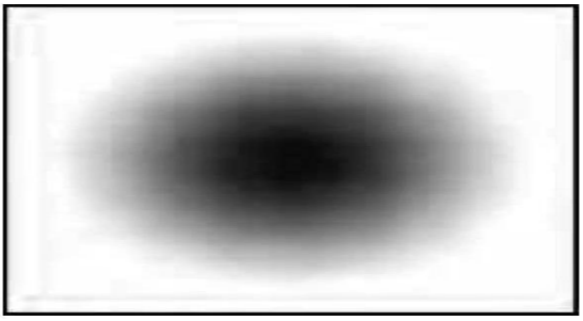

Fig. 12.5 A fuzzy set also has limits, but they are not crisp.

We can observe that the fuzziness in the figure has limits, but not crisp ones. Limits? Yes, there are limits in the sense that we eventually reach what is not included in the set. Here, the limit is an area that becomes gradually blurrier and occupies nearly the entire set, with the exception of the central point (in Euclidean

geometry, a point has no dimension, we should recall), and the central point is where the intensity is at least theoretically maximum or pure. It is interesting to observe that this figure produces an intriguing optical effect, which is intelligible from the perspective of fuzzy complexity. If you stare at it, you will see that the focus gradually dissolves and the limits press inward, *as if* the lack of precise limits forced us to reject the figure.

This does not occur in crisp sets, where the limits are clear-cut. We can test this by reproducing the figure as a crisp set, taking the core or relatively dark area and reducing the set to a dichotomous whole. It occurs even when expanding the limits, while preserving the crispness.

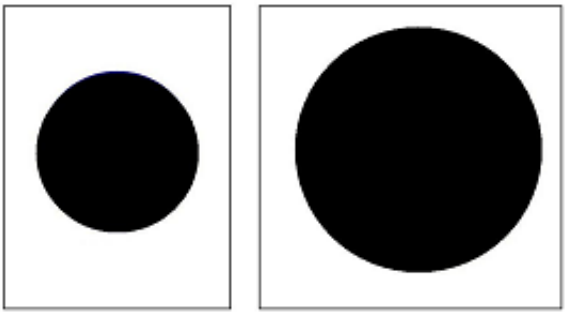

Fig. 12.6 The "breathing" effect is lost in a crisp set created by putting any arbitrary limit on a fuzzy set.

Fuzzy sets contain a paradox. The question of where they begin and where they end has no answer. The best way to grasp this phenomenon is in the chromatic spectrum, which is a natural paradigm of fuzziness. The rainbow, which is in effect the same thing, contains colours that gradually shift towards the right and left until, imperceptibly, black becomes red, red becomes yellow, yellow turns to green, then blue, then finally black again. If we ask ourselves where each colour begins and ends, we find no answer. We can only point to the area where one colour changes into another and say, "Around there". While crisp colours do exist in a rainbow, they exist only in the singularity of the line (which is one-dimensional!) running through the centre of each band. There *are* different colours, but they fade and vanish.

The aim here is not to claim that fuzziness abolishes limits. To the contrary, fuzziness gives limits a leading role in thought and language. Nor is the claim that crisp definition vanishes, but rather that it becomes a singularity, an extreme case, an exception. What is normal, however, is fuzziness.

Now I think we can understand the price that we pay when we establish rigid limits. We gain in clarity, but lose all the fuzziness that is precisely where the vast richness of the phenomenon is found. To lose fuzziness is to create discontinuity and generate "missing information". This expression, which was introduced by the physicist Joseph Ford, is one of the most interesting concepts in the epistemology

of complexity. It captures the *lost* information that paradoxically led the meteorologist Edward Lorenz to discover the phenomenon of chaos.

Returning to the notion of fuzziness, fuzzy, imprecise, vague, inexact areas are considered uncomfortable or bothersome not only because they complicate things, but also because they are seen as undesirable, unnecessary. However, if we eliminate all fuzziness from the chromatic spectrum and reduce it to small boxes of crisp colours, moving from fuzziness to multivalence, the amount of missing information is enormous. It is necessary to note that if we do not want to lose so much information, the solution is not to make more areas that we might call pure or crisp. The cost would be to complicate the question without effectively resolving the problem of fuzziness. Rather, the solution is simpler than that: assume fuzziness.

Before progressing to the next point, it may be useful to provide an example of the question of limits in the case of a company, comparing a crisp conception with a fuzzy one.

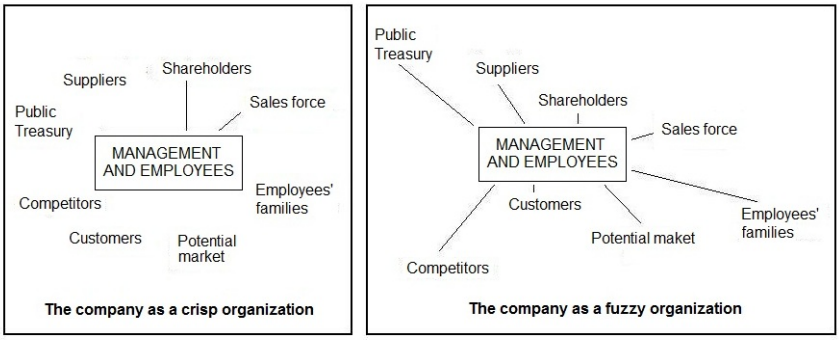

Fig. 12.7 The company as a crisp or fuzzy organization.

In the crisp conception, the company is limited to the management and employees and, at a stretch, to the shareholders and sales force. In the fuzzy conception, all of the elements *are* the company and their greater or lesser proximity to the centre shows their degree of belonging as a function of the degree of the organization's dependence on them. Moreover, in order not to reduce the complexity, each element is itself fuzzy. For instance, if we take the employees, a new employee is not the same as an employee who is on the verge of retirement.

5 Categorization: A Resource for Definition

Categorization is a way of defining sets of things so that they can be compared and classified according to their differences and similarities. It creates divisions based on belonging and non-belonging.

Classification as an empirical scientific activity was institutionalized by the Swedish naturalist Carl von Linné (known as Linnaeus), who created the first modern taxonomy, based on various hierarchical levels, especially the levels of genus and species. From his contribution, we can draw three lessons of an epistemological nature.

The first lesson is summarized in his motto *"Nomina si nescis, perit et cognitio rerum"* (*Metamorphosis plantarum* 1755), or in other words, "If you know not the names of things, the knowledge of things themselves perishes".

The second lesson comes from his magnum opus *Sistema Naturae* (1735, continually revised and reprinted until 1770), in which he classified the plant and animal kingdoms and even the genus *homo* or human beings, which he differentiated into *homo aeuropeus*, *homo asiaticus*, *homo americanus*, and *homo afer* (for *africanus*). However, finding that some human beings did not share the traits typical of these four classes, Linnaeus added the class *homo ferus*, and then because he encountered further cases that were so strange he did not know what to do with them, he created a final miscellaneous category that he dubbed *homo monstruosus* (Bitlloch 1996). The lesson is that from that moment onwards there "existed" human beings classified as *monstruosus*. This clearly points to the fact that no activity of classification and categorization is ideologically neutral. Rather, such an activity invites us to fall into the trap of taking epistemology for ontology.

Fig. 12.8 From *homo monstruosus* to "black sheep".

The third lesson can be deduced from the second. Already in the time of Linnaeus, it was said that *Deus creavit: Linnaeus disposuit* (God created, Linnaeus organized). Certainly Linnaeus organized our understanding of nature, but this act of organizing was just as much as act of recreating. Simply put, to classify is to create reality, because established types can become models for constructing reality and this constructed reality can eventually take hold and flourish.

Many years ago, within the context of cognitive psychology, Eleanor Rosch (1973) made a claim for "natural" categories in her theory of prototypes (Rosch and Lloyd 1978). In the standard version, she took a prototype to be the best

representative or ideal example most frequently associated with a category (it was therefore a criterion based on statistical use). This made it possible to take account of graded proximity to the prototype, which acted as a cognitive reference point. In response to criticisms, Rosch offered a new version, which according to Kleiber (1990) breaks with the earlier version and is less accepted. In it, the prototype is no longer the sole foundation and origin of a category, but rather a shared property (prototypicality), which brings to mind the Wittgensteinian category "family resemblance".

From my perspective, both versions are consistent with fuzzy set theory and the need to grasp, directly or indirectly, a more or less singular core that can support the categorical fuzziness, that is, a focus from which knowledge can expand or blur, and in the opposite direction, grow more concentrated until a core is reached. (It is fanciful and tempting to be carried away even farther and look for common ground with Moscovici's theory of social representations, Jung's archetypes or Eliade's transhistorical paradigms).

Nonetheless, what is crucial in fuzzy knowledge is not the core but the indefinite edges. We recall that the core is the exception and the edges are what make it possible. The very possibility of categorization reveals that the fuzzy set has a core that marks its identity, i.e., the singularity in the fuzziness. The figure below features a dark focus, which in this case shows a significant non-symmetrical or non-concentric expansion, but one which is biased toward one side.

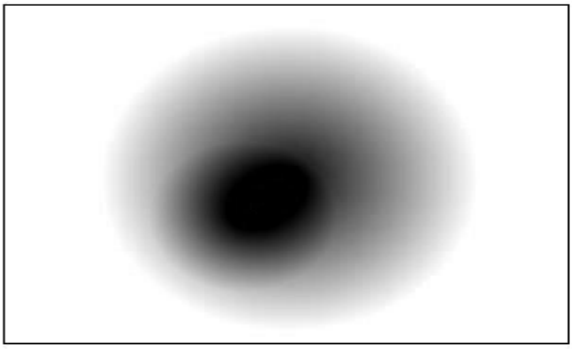

Fig. 12.9 An identifying singularity may not centralize the fuzziness.

6 Dichotomization: Glossing over the Fuzziness

The easiest way to gloss over the fuzziness of concepts is to establish their limits and categories so crisply that they achieve what magicians or conjurers call a "misdirection effect", distracting attention from something else. How does this happen? Through a reduction to two categories or, in other words, by establishing a dichotomy. The limits are closed and no third possibility is admitted. A polarized question can only be understood from one of two poles. The fuzziness disappears "magically".

The tendency to make dichotomies is reflected in a joke that used to do the rounds in Northern Ireland in the midst of the clashes between Irish Republican Catholics and Unionist Protestants. It goes like this: a foreigner arrives in Belfast, the capital, and he does not want to get drawn into the conflict. So he has an answer ready for anyone who asks him, "Are you a Catholic or a Protestant?" When the first person poses the question, he quickly answers, "Me? I'm a Jew!" But the person just as quickly replies: "So you're a Jew, huh? … But are you a Catholic Jew or a Protestant Jew?" We might just as easily recall that other joke of the unfortunate Catalan cartoonistPerich. Seated at the bar next to Perich, a customer turns and asks him, "So, are you with the right or the left?" "I'm a member of the Socialist Party (PSOE)!" Perich replies. But his questioner (raising doubts about how left-wing the PSOE is), goes on, "Okay. But, like I said, are you with the right or the left?"

Beyond their show of wit, these occurrences confirm the resistance to giving up dichotomies, because dichotomies simplify knowledge to the utmost. Science and religion agree on this issue: both are enamoured of the dichotomy "truth *vs*. error". Clearly, the greatest amount of missing information arises from this dual categorization, because it creates an empty space between two poles where the presumably insignificant information is left abandoned, discarded.

Can we say that to think in dichotomies is doing "half thinking"? No, because every dichotomy ends in a monopoly: it leads to total, if not totalitarian, thought. Only by considering each pole as an extreme limit of thought can we destroy the dichotomy and see what is or what might be between its poles. Only in this way can we be aware that dichotomies are an extreme way of thinking.

Dichotomy generates contradiction: the choice of a pole negates the other pole. The concepts "happy" and "unhappy", understood *tout court,* imply that one who is happy is not unhappy and vice versa, which (apart from the *definitio per negatio)* gives rise to the folly that one can only be completely happy or completely unhappy and that being partially happy or unhappy has no meaning. Only in the fuzzy conception of happiness/unhappiness does the question become one of degree. The problem with dichotomous thinking and disjunctive logic is that they contain the trap "this is true because that is false" and vice versa. Dichotomization sets three varieties of trap.

Plato's Socratic dialogues are clearly manipulated pseudo-conversations between a very sage Sage (Socrates), who is in possession of the Truth and has an ability to lead people where it suits him, and a very ignorant Ignorant man, made so if not already. It is a situation with no room for half-measures. The concept in question must be clarified without the poor victim becoming aware that his leg is being pulled with respect to a notion that is fuzzy. If he did catch on to the trick, he would smash a guitar over Socrates' conceited head.

Another trap of dichotomies appears in Shakespeare, where he makes Hamlet fall for it. Once the Dane poses his situation in terms of "to be or not to be", his doubt becomes unsolvable and pathological. What we might call "the Hamlet syndrome" is to a question with no way out, as in Greek tragedy. Hamlet's soliloquy presupposes that nothing else exists between being and not being. Hamlet's only solution would be to acknowledge the fuzzy complexity of the

situation and dispense with the bravado, that is, *between* being and not being is precisely where the possibilities of fuzziness lie. Of course, if Shakespeare had admitted half-measures, Hamlet would no longer be Hamlet … and Shakespeare would certainly not be Shakespeare.

Another trap of dichotomies lies behind the character created by Stevenson in *The Strange Case of Dr Jekyll and Mr Hyde* (1886), the terrifying tale of a doctor who chances upon a strange potion that enables him to separate two aspects of himself and turn them into two people. The Uruguayan writer and poet Mario Benedetti has characterized the tale's protagonist as the archetype of the morally and physically split man. Adopting a fuzzy reading of human beings, however, we might situate the success of the tale less in its splitting potion and much more in its fiction of a polarized good and evil, two absolutes, in which the good is Good and the evil is Evil.

7 Words as Fuzzy Concepts

The question we must ask ourselves is whether there have been or could be any concepts without a single dose of fuzziness. Because if we want to send a scientist or professional *cul-de-sac*, we need only ask for a definition of one of the fundamental concepts in his or her branch of knowledge (in short, the underpinning concepts). Ask the mathematician what the unit or number one is. Ask the geometrician what a point is or the physician what energy or force is. Query the meteorologist about the concept of temperature, the biologist about life or the doctor about health. Ask the psychologist to define "intelligence" or the economist to define "money". And so on and so forth. Every one of these concepts will cause deep and endless debate. This will also occur with concepts – perhaps not fundamental but certainly key ones – in the scientific fields, particularly in the human sciences. For instance, take "cognition", "emotion", "intelligence", "disease", "madness", "person", "mind", "influence", "group", "social class", "social control", "public opinion", "social institution", "unemployed", "delinquent", "drug addict", etc.

Moreover, the same thing occurs with everyday concepts. Considering adults, for example, the concept of "young" could be applied to anyone between 20 and 30 years of age. The concept "tall" could be applied to anyone measuring over 1.85 metres. Of course, it is always possible to say that a person who is 19 or 29 years of age is almost "young" or still "young", while somebody who stands 1.84 m is nearly "tall". It is tempting to reach the conclusion that only concepts considered in terms of their fuzziness keep their naturalness and all the richness of their content. Let us look at some instructive cases.

What is a gene? The concept of a gene, which is currently in the news because of issues such as transgenic foods, animal cloning and the manipulation of the human genome, has been widely discussed in prestigious scientific publications. In 2002, the French journal *Monde Scientifique* posed this complicated question to 18 experts whose responses registered strong disagreements. Some of these responses deserve to be mentioned here:

A biophysicist gave 12 responses and went on to criticize all of them.

Two molecular biologists could not agree with each other and one of them confessed not to know.

A geneticist avoided responding and chose only to recall that 11 different concepts had already been proposed in the nineteen-seventies.

A virologist gave three different responses and concluded by saying that it was a matter of intuition (?).

A biotechnologist sidestepped the question, offering only an unexpected but realistic observation: any response affects the patent wars (!).

Nor is that the end of the matter. In 2010, *Scientific American* dedicated a special issue to the same question. However, in not one of its articles, which examined various aspects of genes, was the question that appeared in bold letters on the cover ever answered: What is a gene?

The conclusion is amusing: the people working with genes do not know what they are working with. Unsurprisingly, when the first of the journals mentioned above, *Monde scientifique,* had asked what a gene was earlier, in 1996, Jean-Jacques Perrier, an in-house science journalist, headed his article with that famous line of Groucho Marx: "A child of five could understand this. Send someone to fetch a child of five!"

Why is it not possible to respond "dogmatically" to the question of what a gene is? The answer probably lies in the fact that genetic or biological reality is a vast fuzzy complexity and the semantic field of the word *gene* corresponds to a set of meanings open to a concept that has, to put it in other words, a "variable geometry".

However, what is interesting and revealing is that, in spite of the fuzziness of the concept, genetic biology not only keeps advancing, but is now enjoying the most spectacular successes of its short history, successes that were unthinkable only a few years ago. Fuzziness appears to be no impediment to understanding nor does it frustrate research. Rather, it seems to encourage the advance of knowledge.

Take another example: what is a"book"? In the nineteen-eighties and nineties, the social psychology establishment was rocked by a headlong assault from a sector of critical social psychology. Kenneth Gergen (1991) argued that it was through the different uses of language that we went about constructing social reality. One of the examples offered in support of this thesis was the concept of "book". Certainly, Gergen explained, the basic purpose of a book is for reading, but it can also feed a fire, act as a hammer, provide toilet paper, serve as a paperweight and so on. This led Gergen to denounce the modernist tradition, which, in his view, stifled all these alternatives without stopping to consider that if a book were *really* a book, we would not be able to do anything with it except reading.

However, if Gergen had put on "fuzziness glasses", he would have seen that the explanation that could account for the multiple meaningful uses of a thing can be found in the fuzziness of the signifier. Mark Twain is credited with the anecdote about a woman who asks him how many books he has in his home. To this, Twain gives a droll reply: "The more books the better, because books are indispensable. Look, if a piece of furniture wobbles, I need a book to put under its leg. The walls

of my office have cracks and I use stacks of books to hide them. If I weren't tall, I would need to put one or two books on the seat of my chair to be able to eat or work at the table. And when my dog makes me angry, I throw a book at its head …". Twain was able to give this response not because the concept of book has different linguistic uses, according to Gergen's thesis (although, of course, it does have), but because of its possible factual uses as an everyday object, which turn the concept into a fuzzy set rich with meanings, without leaving aside a core meaning given by its primary, original use. It is not necessary to invoke linguistic construction to understand that a book is not just for reading and nothing else.

Let me add a third example that is polemical because it affects our individual and social identity. Who am I? According to the model that I have proposed based on the perspective of complexity (Munné 1997 and 2000), a person is a self-referential system that has four "facets": self-esteem, self-concept, self-realization and self-image. These "facets" correspond to the affective, cognitive, volitional and interactive aspects of any individual. Graphically, we can picture these aspects in the "diamond-shaped" model below.

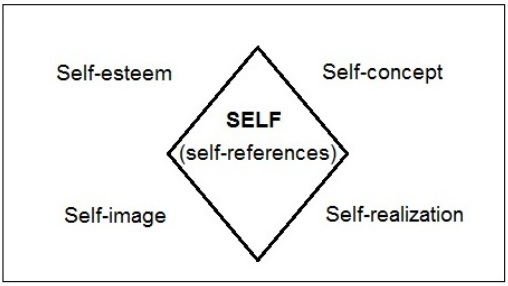

Fig. 12.10 The four facets of the self.

These aspects blend together, becoming fuzzy in the answers to the TST or Twenty Statements Test, the well-known personality test of Kuhn and MacPartland. The subject is asked twenty times to respond freely to the question, "Who am I?" and must give a new response each time. For example, the subject replies: I am Albert, bold, a good father, an executive, a swimmer, jealous, a smoker, diabetic, a lover of jazz, and so on. According to the paradigm of complexity, the subject gradually sorts through the fuzziness of who he or she is (Codina 1998 and 2005), while "jumping" from one facet to another facet of his or her *self*.

Interestingly, the same questions may later give rise to more or less different responses, because the context has changed (e.g., Albert is older, has a new job, or his marital status has changed) and the self-perception of the subject has also changed … without ceasing to be who he or she is. In other words, the fuzziness of the human being leads him or her to say, in opposition to the principle of contradiction, that I am *and* I am not the same as I was yesterday or will be tomorrow.

This statement is a paradox that is difficult for the traditional mindset to digest. It is related to self-resemblance, a characteristic of the fractal property of our complex system that would lead us away from the subject at hand. This paradox also gives rise to the question of where a person begins and ends, a question with no answer, certainly no crisp answer, just as the colours of a rainbow or the length of the coast of Britain has no crisp answer. Nor does it have a physical, psychological or social answer. Obviously, acceptance of this point also meets with stiff resistance.

8 Words and Definitions

If we return to the dictionary game, we see that it has a trick: the words are both defined and defining. And this is possible thanks to the system of concepts that acts as an intermediary, facilitating fuzzy references.

The Catalan dictionary *Diccionari de la Llengua Catalana, de l'Institut d'Estudis Catalans (DIEC)* gives the first meaning of the word "define" as "to make the limits (of a thing)", while the Spanish dictionary *Diccionario de la Lengua de la Real Academia Española (DRAE),* exercises an ingenuous decisiveness in saying that "define" is "to fix with clarity, exactitude and precision the meaning of a work or the nature of a person or thing". The DIEC seems more sensible or more prudent that the DRAE, depending on how you look at it and certainly without knowing it, much like Molière's *Monsieur Jourdain*, because the DIEC does not exclude, at least not explicitly, the possibility of fuzzy limits in a definition. By contrast, the DRAE shows a total allergy to fuzziness in a definition that is at once naïve and ostentatious. Because speaking of a clear, exact, precise definition makes no sense. Such a definition would have to be total, absolute, perfect, and none of these attributes is possible. Demonstrating greater intuition and experience, lawyers cite the *Digest* of Justinian (Lib. V, Tit. XVII, law 202), which says,*"Omnis definitio in iure civile periculosa est; parum est enim, ut non subverti possit",* or in other words "Every definition in civil law is perilous; but a little may reverse it". And this notion does not hold only for civil law…

To define is not to define. Let me explain: if by defining, we understand delimiting a concept as crisply as possible, then the greatest amount of missing information is generated. In other words: thanks to what we do not say, to what we keep quiet or do not define, we can say, speak and define. In this respect, language lies in the very heart of what we say and do not say. It is speaking and not speaking. Inevitably, every definition is a lack of definition.

Not acknowledging the fuzziness of concepts creates "as a problem" the endless multiplicity of definitions that emerge not only from differences in criteria and perspectives, but also especially from the fuzziness of their limits. Take this example from social psychology, a focus of mine for several decades: the crisp definition of what a human group is gives rise to debate over dozens of definitions,

leading many to think that it is not worth the effort to pose another definition, because it would simply make matters worse, more entangled. Certainly, it would complicate matters. Seen from the perspective of complexity, however, definitional pluralism reflects fuzziness and, as a result, enriches the concept.

Bearing that in mind, it would be a hasty conclusion to deduce that fuzziness hampers the crispness of definition. What it does do is that it reduces the definition to a core and makes it possible to arrive at definitions by convention, negotiated definitions, implicitly or not, around this core as a function of interests, needs, ideas, beliefs, desires, commitments, etc. To avoid fuzziness in definitions, criteria are reached and established expressly or tacitly and these criteria can always be renegotiated. In 1791, the metre was defined in Paris as one ten-millionth of the distance from the equator to the north pole, that is, one ten-millionth of the length of the Earth's meridian along a quadrant through Paris. By 1983, after its ultimate renegotiation, the definition of the metre became the distance travelled by light in a vacuum during a time interval of $^{1}/_{299,792,458}$ of a second. The question "what is a metre, *really*?" can have many answers; what it does not have is *only one* answer.

Consider another example of definition by convention, which reproduced the category problem of *homo monstruosus* in another sense and in a different branch of science. In the seventeenth century, the Sun and the Moon were ruled out as planets when planets were classified as all those heavenly bodies that revolved around the Sun in more or less (fuzziness!) circular orbits. With the discovery of Neptune, significantly smaller bodies were excluded and a new category was created: asteroids. Then, in 2006, the question was raised whether Pluto was a planet or an asteroid. Provisionally, Pluto was reclassified in a new category: "dwarf planet". However, the current definition of planet requires three conditions: 1) the object has sufficient mass to pull it into a roughly (fuzziness!) spherical shape; 2) it revolves around the Sun on an orbit resembling (fuzziness!) a circle; and 3) it has cleared the neighbourhood around it of other celestial bodies (how many? to what distance?: more fuzziness!). In the case of Pluto, the third condition is not met, because Pluto's orbit passes through the Kuiper Belt, which contains more than 70,000 bodies with a diameter of less than 100 kms. So it could not even qualify as a dwarf planet! The International Astronomical Union has left any decision in abeyance, because a hidden question lurks in the background, apparently foreign to science, like the patents war in the case of the gene. As it happened, the change in classification had unsuspected "collateral effects": the astronomers and general public of the United States mounted pressure against the change, because it meant eliminating *their* planet, that is, the unique discovery of an American, specifically made by Tombaugh in 1930 (Weiss 2010).

Definitions by convention make dictionaries possible. The fuzziness of the different meanings of terms reveals the internal debates of Spanish Academicians. In late 2008, the Royal Spanish Academy of the Language was at work on a new definition and meanings for the word "culture". Some of the details of the debates

or negotiations were leaked. The psychiatrist Castilla del Pino wanted the definition to say explicitly that culture was the "set of behaviours that characterize a group, for example, drinking culture, drug culture, Hollywood culture or Andalusian culture" and recalled that the sociologist Georg Simmel had written about "women's culture". Francisco Rico that this was good, but wanted to add the case of "corporate culture". By contrast, Luís Goytisolo thought it would be more appropriate to add "wine culture" and rejected the inclusion of "drug culture" and "drinking culture" (referring to the Spanish idea of the *botellón*). Pérez Reverté came down in favour of gathering the noble meanings and the more vulgar uses, such as "drug culture" and "culture of violence". And not to keep going on, Alvaro Pombo interjected that more than one concept dealt with a semantic field. In addition, the reported discussion made mention of a "transcultural" dimension, after making comparisons with the authoritative dictionaries of other countries, such the Oxford Dictionary, the Larousse, the Zingarelli and the Great Russian Encyclopaedia Dictionary (Ruíz Matilla and Constenla 2008.)

The artificiality of consensus cannot eliminate the natural fuzziness of words. But are there no crisp definitions at all? Yes, by means of the reductionist strategy of operational definitions, constructed with the *ad hoc* manipulation of fuzziness, to take a specific case. As I said at the start of this paper, when I noted what was understood by complexity and fuzziness here. Operationally defined concepts are delimited *hic et nunc,* even though they continue potentially to be fuzzy or indefinite. Any of us in another context could give an operational definition that is more or less different for the same concept or word. The fiction of saying how many ill people or poor people there are in a country at any given time admits different versions and all of these versions respond to the complex reality.

Earlier, I noted that fuzzy set theory is the most subversive of the theories of complexity. Can this statement be better understood if we take into account that the fuzziness of concepts has a particularly strong effect on concepts that we might call "sensitive" in the areas of social and culture life, such as politics, law, and morality? In these areas, convention makes little sense and has little to do with the matter. It is relatively easy to reach agreement on the metre as a unit of length, but what sense would there be in negotiating what "Democracy", "Homeland" or "God" means? These are concepts that, when treated "as if" they were crisp, lose all of their interest and certainly their meaning.

9 Indicators of Fuzziness

Despite definition, categorization and dichotomization, are there indicators of the degree of fuzziness in language? That is, just as definitions try to indicate crispness, are there (grammatical) elements that indicate and maintain imprecision?

Language renders the fuzzy shape of everyday life. Colloquial language is fuzzy because, unlike scientific and technical languages, it does not typically require a great number of elements of exactness. Fuzziness has its linguistic rendering in the use of concepts, in the form of nouns, verbs, adjectives and other grammatical elements. For example, we say: "bring it to me *right now*"; "I'll finish *in an hour*"; "come to my office *at once*", and so on.

Adverbs seem to constitute a separate world. They were already an object of attention for Zadeh (1971), when he observed that natural languages have linguistic variables given by elements capable of modifying or transforming one fuzzy set into another, such as adverbs that indicate one mode at the same time that they indicate the possibility of another mode and, therefore, open up a field of semantic possibilities that can be represented by an applicability curve or a possibility distribution curve in reference to the imprecision or fuzziness of a given expression or concept.

In my view, adverbs and adverbial locutions play a more basic role in language fuzziness. The most interesting aspect of adverbial function is that, in general, an adverb specifies a circumstance, modulating the conceptual limits of the word that it accompanies. This is a paradoxical function, because it specifies without restricting the fuzzy area of the semantic field. In a sense, it produces an "imprecise precision" in response to a wide array of circumstances of: place, time, manner, quantity or degree, comparison, exception, number, similarity, equality, affirmation, negation, doubt, union, division, addition, exclusion, order and so on. Particularly in colloquial speech, the wish to specify what is imprecise can lead to the construction of genuinely fuzzy adverbial chains, such as: *hurry over here right now already* and *the house is not far over there on the right*.

Taken literally, some adverbs can be highly "precisor". Examples include: *only, not at all, always, by no means, merely, exclusively* and, especially, *exactly*. Also, the adverbs *yes* and *no*, when they conceal no doubt, can come to have only a potential fuzziness. In principle, they are absolute limits, such as the terrifying *no* that brings down the curtain on the final scene of *Le malentendu* by Albert Camus. Even so, this last example contains a latent fuzziness, according to the playwright's own explanation of the scene. Camus writes: "The character of the old servant does not necessarily symbolize destiny. When the survivor of the drama (Marta) cries out to God, he is the one who responds to her. But *perhaps* this is another misunderstanding. If he says *no* to the woman asking for his help, it is because he does not, in fact, have the intention of helping her and because *amid a certain amount* of suffering or injustice nobody can do anything for anybody and sorrow is solitary." (The italics are the author's.) Ambiguity? Without doubt, but with the support of fuzziness.

One way to study the fuzziness of adverbs might be to observe the effects of deleting them, adding them, changing them, moving them and so on; in other words, manipulating the fuzziness and observing the effects (on interpretation, behaviour or interaction) in the recipient.

Some adverbs of quantity (*more, less; enough, a lot, a little, none*) are "precisors" adverbs that have been used since the nineteen-thirties to give ratings in well-known psychometric scales of attitudes and opinions like the Likert scale. These rating scales may seem to apply multivalent logic, but the fuzziness comes in with the quantitative value of each response variable, because is not discrete, but rather fuzzy. The scales that are most completely fuzzy are based on a continuum, such as when the subject is asked to rate generic political thinking anywhere on a right-centre-left axis. If we moved to the right or the left of where the respondent has marked their rating and asked, "Would you go this far?", we would be putting the respondent in the diffuse problem of marking the limits conventionally.

We can relate fuzziness to the missing information not only of words, but also of fuzzy phrases and clauses, and it is particularly interesting to bear fuzziness in mind in discourse analysis. Lasaga Millet (2005) has put forward a method for analysing texts that respects and emphasizes the fuzziness inherent in language and in the communication process, incorporating the principles of fuzzy logic to the grounded theory methodology of Strauss and Corbin by means of the QSR Nvivo software program.

10 Expanding Fuzziness: Hypertext

A highly suggestive aspect of the fuzziness of language in today's setting of globalization is *hypertext*, which is a new addition to the classic *text* and *context*. Hypertext is a kind of text that has a potential context that globalizes the indefiniteness. With new technologies, the fuzziness has grown to new dimensions and become hypercomplex.

The relational dimension of fuzziness was addressed, albeit occasionally, by Michel Foucault (1969), who wrote that the margins of a book are never clear or rigorously cut, beyond the title, the first lines and the final period, beyond the book's internal structure and the form that makes it an independent object; it exists within a system of references to other texts, to other phrases, a node in a network. Today, inevitably, this reference to context extends to hypertext in the Internet.

The original idea for what we now call hypertext was conceived by Vannevar Busch in response to a concern over information management. In 1945, Busch published an article significantly entitled *As We May Think*, in which he proposed a new system (called Memex) to store and classify information not sequentially, as it was done then, but by association, because "that is how the human mind works". Twenty years later, the computational scientist Theodor Holm Nelson gave the name *hypertext* to a "body of written or pictorial material interconnected in a complex way that cannot be represented conveniently on paper", insisting on Busch's idea that traditional writing is sequential, while the structures of ideas are not (Lamarca Lapuente 2009).

As a system, hypertext is a non-linear organization of textual information (Tolhurst 1995), in which any text is *potentially* related to any other. That is what differentiates it from other systems of information organization.

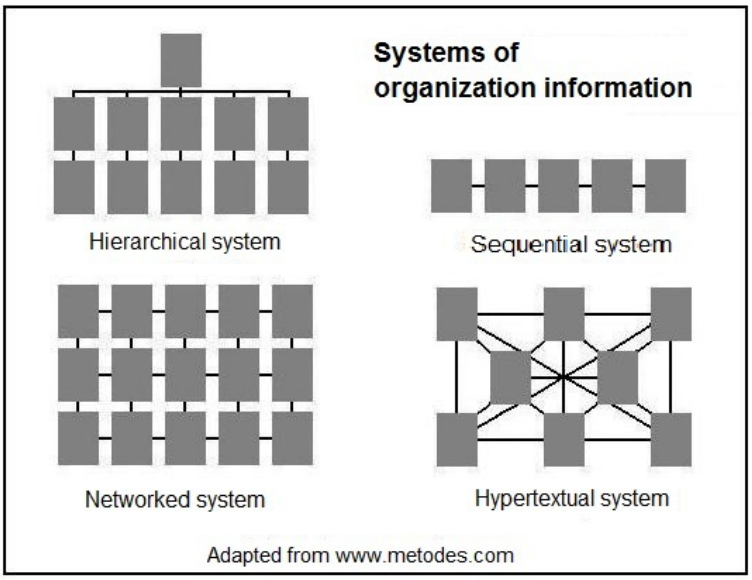

Fig. 12.11 Hypertext is a complex system of organizing information while keeping its fuzziness.

Connections between texts occur through links and tags that are not simple cross-references, as in traditional bibliographical referencing. The links and tags lead to other texts that are extensions of the original text, which turn out to be again extensions of the text. In this way, they form part of an illusive, indefinite web, with a high degree of fuzziness; a web in which the missing information is constant, changing and always very rich. The complexity of hypertext is emergent and self-organizing. It allows a text to be handled in multiple possible contexts, wandering off the beaten track as Heidegger does in his *Holzwege*, following a non-linear path that might lead us to unexpected, ever-different places. The hypercomplexity of hypertext goes beyond fuzziness, demanding attention to the different properties of complex systems, such as their "chaoticity" and "fractality".

Oddly enough, we began by talking about the dictionary game and now, in the end, the enormous potential field of hypertext once again evokes the game in reference to the Internet. What role does fuzziness play here? Might it increase the complexity and complication of the chaosystem? It appears not. At least in terms of search results obtained with Wordnet, a large-scale lexical database with sets of synonyms (synsets) that take the structure of a network of semantic associations. With more than 150,000 words (nouns, adjectives, verbs and adverbs) and their

possible relations, Wordnet was designed to capture how we acquire and organize knowledge.

Sigman and Cecchi (2002) analysed the organization of Wordnet (taking a base of 66,000 words) and found that any two randomly selected words would give rise to word chains (e.g. between *lion* and *stripes* appears the word *tiger*), as well as triangles and other local associations. The whole network turned out to be "a small world (Milgram 1967), because the average distance was 7 degrees (or steps) of separation and there was a large number of triangles; further, it was a scale-free network because the most interconnected words were the words with the most general content. The most interesting aspect is that deleting the polysemous words did not make Wordnet more efficient, an outcome that the absence of redundancies might lead us to expect, but instead raised the average distance to 11 degrees and the triangles dwindled 300 times. This means that polysemous words give an extraordinary coherence to Wordnet, enabling navigation (degrees of separation in the interrelations) and local association (triangles). Thus, paradoxically, the ambiguity introduced by polysemy does not produce inefficiency, but rather makes Wordnet much more fluid. Subsequent studies on other networks, such as *Thesaurus*, confirm these observations (Solé 2009).

As Pajares Tosca (2004) has written, the hypertext paradigm in the end not only reconfigures the literary paradigm in all its aspects, theoretical, creative and educational, but also, hypertext links have a political, ideological and theoretical dimension. We think they can be, and in fact they are, ways to direct or redirect a path forward often without anyone taking notice!

11 Returning to Where We Began

At the very beginning, I noted that the analysis of complexity is an analysis of its aspects, including fuzziness. We have seen a number of questions arising from a treatment of language systems as fuzzy systems. Delving more deeply into this aspect, however, requires that we do not uncouple it from the other properties of complex systems. For example, what missing information signifies is not only a question of fuzziness, but also has profound connections with "chaoticity" and "fractality", emergence, self-organization and so on.

That question, however, remains for another occasion. In the meantime, I invite the reader to reflect on the question that I posed in another article (2007): "Should the explanation of human behaviour (which, in this case, is language behaviour) be the simplest possible or the most complex?" I think that this current exploration of the fuzziness of language is a step in the direction of the latter choice.

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