parameters through scalar quantities, thus it is reasonable to think that in the future fuzzy logic will be employed more in clinical diagnosis.

Keywords
Probabilistic logic • Fuzzy logic • Clinical diagnosis • Diabetes • Renal failure • Liver disease

Abstract
In this study I have compared classic and fuzzy logic and their usefulness in clinical diagnosis. The theory of probability is often considered a device to protect the classical two-valued logic from the evidence of its inadequacy to understand and show the complexity of world [1]. This can be true, but it is not possible to discard the theory of probability. I will argue that the problems and the application fields of the theory of probability are very different from those of fuzzy logic. After the introduction on the theoretical bases of fuzzy approach to logic, I have reported some diagnostic argumentations employing fuzzy logic. The state of normality and the state of disease often fight their battle on scalar quantities of biological values and it is not hard to establish a correspondence between the biological values and the percent values of fuzzy logic. Accordingly, I have suggested some applications of fuzzy logic in clinical diagnosis and in particular I have utilised a fuzzy curve to recognise subjects with diabetes mellitus, renal failure and liver disease. The comparison between classic and fuzzy logic findings seems to indicate that fuzzy logic is more adequate to study the development of biological events. In fact, fuzzy logic is useful when we have a lot of pieces of information and when we dispose to scalar quantities. In conclusion, increasingly the development of technology offers new instruments to measure pathological

Introduction
Some ideas presented in this work were born while reading a book on the relations between the theory of probability and fuzzy logic by Bart Kosko [1]. Other remarks came from the necessary inclusion of the debate in the history of the problem of truth. Kosko makes a point that fuzzy logic is better than the logic of probability for solving some problems, or that probability does not actually exist [1]. The theory of probability, in principle, looks for rules to predict future events on the basis of their frequency in the past or on the basis of their mathematical frequency. Conversely, fuzzy logic, being a multi-valued logic, considers an infinite range of values between the truth and the false and approves the contradiction. The field of clinical diagnosis is optimal for understanding the distance between these two kinds of logic. Let us consider the following assertions:

A. The patient P is affected by $D_1$
B. The patient P is probably affected by $D_1$
C. The patient P is in a certain measure affected by $D_1$

These three assertions, in an exact logical sense, could be considered three strictly comparable but different conclusions of three different kinds of argumentation: conclusion A belongs to an argumentation of classical two-valued logic, conclusion B belongs to an argumentation of probabilistic logic and conclusion C belongs to an argumentation of fuzzy logic. On the other hand A, B and C could appear very similar to common sense and could involve the same consequences. To physi-
Comparison between classical logic and probabilistic logic in clinical diagnosis

I will propose a comparison between some argumentations of classical logic and the analogous ones suggested in probabilistic logic. The usual argumentations employed by doctors to obtain a nosographic diagnosis follow the classical rules of inference: modus ponens, modus tollens, hypothetical syllogism, disjunctive syllogism.

1. The argumentations following the *modus ponens* are those which show this form:

   If P shows the symptoms S₁, S₂, S₃ then P is affected by D₁
   P shows the symptoms S₁, S₂, S₃

   
   P is affected by D₁

   (The assertions over the line are the premises, the assertion under the line is the conclusion, the line means “then”). Obviously it is possible to make some negative forms:

   If P does not show the symptoms S₁, S₂, S₃ then P is not affected by D₁
   P does not show the symptoms S₁, S₂, S₃

   P is not affected by D₁

   If P shows the symptoms S₁, S₂, S₃ then P is not affected by D₂
   P shows the symptoms S₁, S₂, S₃

   P is not affected by D₂

2. The argumentations following the *modus tollens* are those which show this form:

   If P is affected by D₁ then P should show the symptoms S₁, S₂, S₃
   P does not show the symptoms S₁, S₂, S₃

   P is not affected by D₁

Also in this case, as in the case of *modus ponens*, it is possible to make some negative forms or enlarge the premises or the conclusion or both.

3. The argumentations following the *hypothetical syllogism* are those which show this form:

   If P shows the symptoms S₁, S₂, S₃ then P has the syndrome SC₁
   If P has the syndrome SC₁ then P is affected by D₁ when other diseases suggested by SC₁ are excluded

   If P shows the symptoms S₁, S₂, S₃ then P is affected by D₁
   when other diseases suggested by SC₁ are excluded

   P is affected by D₁ or P is affected by D₂
   P is affected by D₁

   This form of argumentation is the one, very usual in medicine, of differential diagnosis. Also in this case, as in the former, it is possible to make some negative forms or enlarge the premises or the conclusion or both.

   The logic of classic rules of inference presents many ways to transfer the truth in the argumentation; I believe they are powerful examples of our natural thinking. However the development of the theory of probability has doubtless improved our power to reason. The most important reason for this is that probabilistic logic does not search the truth in the facts, but its goal is to calculate the possible occurrence of a future event on the basis of the experience of the past or on the basis of mathematical data. This kind of logic projects the regularity of past phenomena on the development of the future. At variance with classical logic, probabilistic logic works with uncertainty. Considering probability, it is necessary to distinguish at least two kinds of probabilities: a ‘mathematical’ probability and an ‘indeterminate’ probability. The former is the exactly computable probability of card games, raffles or dices; the latter is the application of a probabilistic thinking without certain mathematical data. To show some examples of indeterminate probability, I can discuss the equations studied to estimate the probable number of planets with alien forms of life in our galaxy or in the universe, the probable economic growth in the next 20 years in Europe or the weather in the next 365 days in Paris. These examples deal with approximate data, averages or principles of computa-