FUZZY PREDIAGNOSTIKA VE FÁZI KONSTRUKCE MODELŮ KOMPLIKOVANÝCH MATEMATICKÝCH MODELŮ

FUZZY PREDIAGNOSTICS IN THE PHASE OF COMPLICATED MATHEMATIC MODELS CONSTRUCTION

Jaroslav Švasta, Petra Nevřivová

Abstrakt:

Typ, konzistence, konečnost a obvyklé matematické problémy a jejich transformované modely jsou obvykle definovány pomocí omezujících podmínek, proměnných a srovnávacích funkcí. Prediagnostika je nezávislá na nelineární, stochastické, dynamické, kombinatorické nebo simulační povaze problému. Principem řešení takových úloh je obecně definovat prostor přípustných řešení bez ohledu na typ, konzistentnost nebo konečnost úloh. Hlavním cílem je najít různé extrémy jedné nebo *m* srovnávacích funkcí. Analytické řešení se různí podle charakteru těchto extrémů a povahy transformovaných problémů. Příspěvek se zabývá přístupy k fázi prediagnostiky v konstrukci modelu problému.

Abstract:

The idea from its type, consistency, finality or usual mathematic problems and their transformed models are usually defined through their conditions, variables and comparative functions structure. The prediagnostics is independent from non-linearity, stochastic, dynamic, combinatorial or simulation character of problem. The principle of these problems is generally the task to define the default space of possible solutions aside from its type, consistency, finality or countability. The main goal in these problems is to find various types of extremes of one or *m* comparative functions. Analytis solution varieties originate from these extremes and attributes of the transformed problems. The contribution denotes to another access to prediagnostics phase of the construction of model problems.

Klíčová slova:

Matematické problémy, funkce, extrém, model, struktura podmínek a proměnných, prediagnostika, fuzzy.

Key words:

Mathematic problems, function, extreme, model, structure of conditions and variables, prediagnostics, fuzzy

Introduction

Using the method of operation research in the decision process is developed more than 40 years in our country. The real knowledge base was created over the mathematic programming tasks, graphs theory, stochastic modelling, simulation etc. From the deterministic mathematic tasks to hybrid model system was put the base not only of the common theory of the system and model analysis but also of the practical implementation in

the concrete decision processes. The biological oriented production process belongs to specific part of the solved problems. The production effect of the biological process is based on the production genetic potential of the concrete biological material in opposite to the technical technologies. The realization of this process proceeds within qualitative and quantitative different phases in various length of their duration (Fig.1). The dynamic intersection of the factors set reacts to the process in these phases. The proportion of the sets is liable to the various random changes.

As a result of the stochastic character of the development is the high level of the variability output especially qualitative parameters of the production.

Formulation of the problem

Let's have the concrete biological process that whose output is the product designated for fast successive treatment. The delay of the successive phase could have the negative impact to the quality of the product and it's next usage.

An example of this product (P) is the fresh milk. The decision process and it's next usage is based on the structure of qualitative parameters, which are following:

- F1 – temperature
- F2 – pH
- F3 – capacity of the milk fat
- F4 – acidophilic complex
- F5 – number of the somatic cell and others

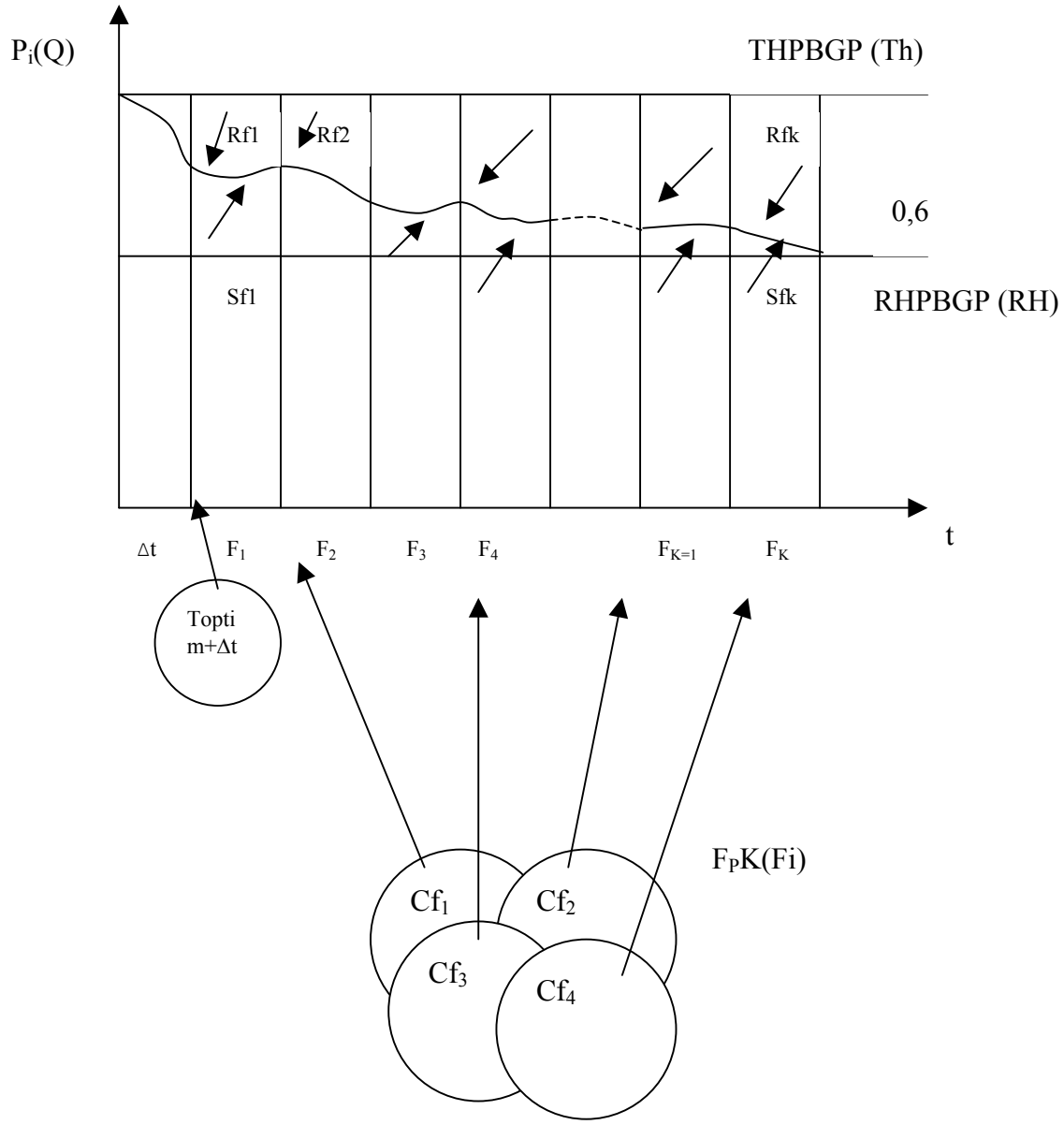
The general structure of the parameters above is set on the base of the laboratory analysis. This analysis represents of course the time delay. The high-density milking houses, where rises the production of the "mixed" milk from the individual dairy cows, are endanger by the Mastitis illness (this is stochastic factor). The milk from the dairy cow with mastitis contains multiple higher numbers of the somatic cells. The number of the somatic cells rises as the exponential function in the common temperature. On the base of the 200 000 examples in the various breeding we can document, that one dairy cow with mastitis could devalue the milk of circa 50 healthy ones. This is expressed as the decrease of the price and limitation of the possibilities of the next process (the production of the cheese, yogurt etc.)(Doc. Švasta). The economic aspects of this stochastic effect are evident.

The possible solution of this task could be the emphasis to the prediagnostics in the production process. The possibilities of the prediagnostics, where the object of the investigation has the typical "fuzzy" principles – that is diffuseness, indeterminateness, great variability of the quantitative parameters, are based on the following logic of the solution:

- Prediagnostic component in analysis does not have function of the object of the exact laboratory solution.
- The conclusions are only orientation, fuzzy with indeterminate limits.
- It allows very fast preliminary conclusion.
- By the help of the one parameter quantify the base informative flow, that is necessary for the decision, replaces the intersection of the several sets of parameters.

The basic principles of the „ Fuzzy logic“ in the stochastic biotope processes

Fig.1.:



Where:

- THPBGP (Th) is the theoretical level of the production of biogenetic potential of the biological material.
- F_1-F_k (F_i) are the several development phases of the biological process with the demands to the Cf_PK (intersection of the sets of factors of the production conditions). The limits of the sets and their intersection are fuzzy.
- RHPGBP (RH) is the production effect.
- P_iQ are probability quantifications of the realization of the production potential. Comment: This probability is realized on a standard conditions on O,55-0,7 of potential level.
- Δt Toptim is the time delay of initiation of the production process.
- Rf (i) are the retardation factors. These factors are mostly stochastic.
- Sf (i) are the stimulation factors and they are optional within the decision process.

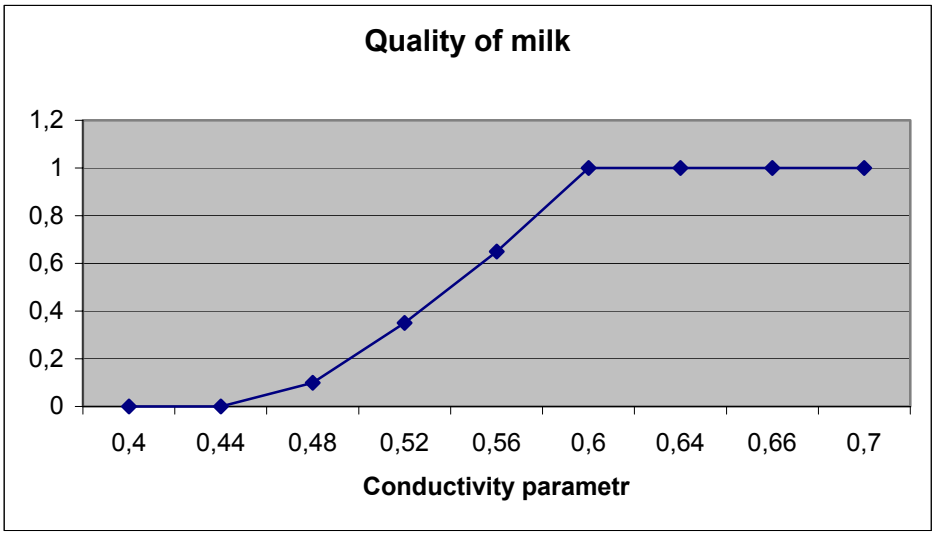
The biological processes are situated almost in the Fuzzy Decision Space (FDS)(Fig.1).

The construction of the model analysis not only of the partial production process but productions verticals is based on the function:
RH = f (Th, CpF (i), Z), where Z is the set of the stochastic influences.
To summarize above consideration, which are rather philosophical, we can say following:

- Biological processes are usually fuzzy, diffuse, and indeterminate, with the great variability of the quantitative parameters.
- We cannot determine the consistent limit of the behaviour of the factors.
- We cannot easily classify the combination of the parameters according to membership to the borders 1 – 0.
- The conversion between 1 – 0 concerns " Membership rate".

The problem of fuzzy logic and fuzzy quantification of sets, we could derive from Hamming's indeterminateness rate.

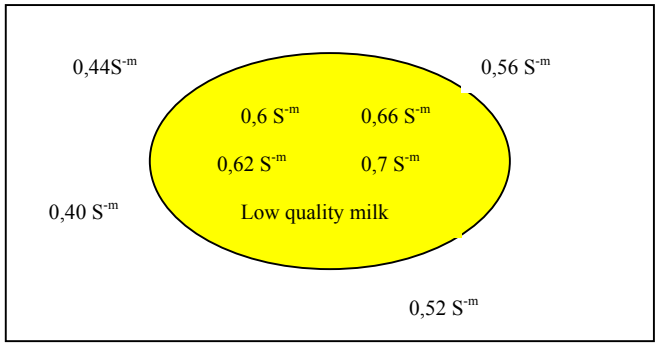
The scheme of this problem:
A – "Discrete definition" – JM (Duality of the milk)
μ JM (0,400 S^{-m}) = 0
μ JM (0,440 S^{-m}) = 0
μ JM (0,480 S^{-m}) = 0,1
μ JM (0,520 S^{-m}) = 0,35
μ JM (0,560 S^{-m}) = 0,35
μ JM (0,600 S^{-m}) = 0,65
μ JM (0,640 S^{-m}) = 1
μ JM (0,660 S^{-m}) = 1
μ JM (0,700 S^{-m}) = 1
B – Analogical definition



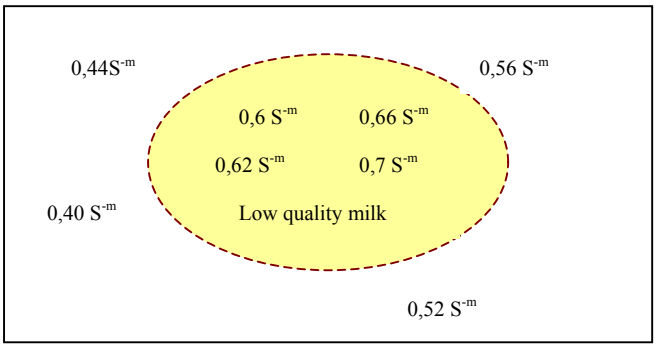
High quality milk – 0,40 – 0,44 S^{-m}
Uncertain quality of milk – 0,44 – 0,6 S^{-m}
Low quality milk – 0,6 S^{-m} and more

Graphic scheme of the model tasks

A) The decision space of the prediagnostics based on the Boole's set theory Fig.2.:



B) The decision space of the prediagnostics based on the Fuzzy set theory Fig.3.:



At the end of 80th years most of the producers of the milking equipments installed into the system flow conductometers, which were linked with dividing stopcocks. The parameters for quality milk admittance into cooling device were set for the conductometers, while the milk, that does not meet the parameter S^{-m} was separated into specialized device. The relevant program was based on Boolean logic and operated with 0/1 as follow:

A 0 0 1 1
B 0 1 0 1
A ˅B 0 0 0 1

Using the conductometers (for example MAT-4) is possible to arrange the decision on the base of the Fuzzy logic operating with (0,1) as follow:

AND: $\mu A \wedge B = \min \{\mu A; \mu B\}$
OR: $\mu A + \mu B = \{\mu A; \mu B\}$
NOT: $\mu -A = 1 - \mu A$

It allows creating the degree of "suspicious" samples, which are situated between exact expected quality and inferiority. The detailed description does not meet the frame of this paper. The problem of the fuzzy logic will be the object of the further possible research in the field of the meat and flour. Some of the preliminary solutions show that in the cases described above the uncertain approach of the concept and their quantificational parameters enable to get over some problems with the border's points of the classical sets. It seems that the way of the fuzzy sets and fuzzy logic in the field of the biological systems is open and perspective in environment and hybrid model system.

Literature

1. Získal J., Švasta J., Brožová H., Systémová analýza a modelování II., ČZU, Praha 1999.
2. Navara M., Základy fuzzy množin, ČVUT, Praha 2002.
3. Novák V., Fuzzy množiny a jejich aplikace, Mat. seminář SNTL, Praha 1990.
4. Gottwald, S., Fuzzy Sets and Fuzzy Logic., Friedr. Viewegh&Sohn, Braunswieg, Teknea, SA, Toulouse, 1993.
5. Klir G.J., Yuan, B., Fuzzy Sets and Fuzzy Logic. Theory and Applications, Prentice-Hall, 1995.

Contact:

Doc. Ing. Jaroslav Švasta, CSc., Ing. Petra Nevřivová
Department of operational and Systems Analysis
Faculty of Economics and Management, Czech University of Agriculture Prague
Kamýcká 129, 165 21, Praha 6 – Suchdol, Czech Republic
svasta@pef.czu.cz, nevrivova@pef.czu.cz