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MODEL OF DIAGNOSTICS INFORMATION SYSTEM PANCREAS CANCER

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Abstract

The article analyzes the development of a medical decision support system based on fuzzy logic. In an era of increased healthcare demands and complex analytical situations, the role of information technology is indispensable. The ambiguous behavior of cancer in the early stages can lead to late detection and sometimes to erroneous treatment. The proposed method is intended to help doctors make optimal decisions. The use of fuzzy logic techniques in oncology can increase efficiency in diagnosing and predicting cancer.

Keywords: *Oncological diseases, Pancreatic cancer, Decision support system*

Introduction

A huge problem today is the increase in the number of cancer patients, and all sciences, not just oncology, must fight it. Pancreatic cancer, unlike other oncological diseases, behaves more aggressively and has a very high mortality rate. The pancreas is an abdominal organ that plays a significant role in the digestive and endocrine systems. Pancreatic cancer occurs as a result of a mutation of the body's own cells, which multiply randomly and spread to other organs. The development of the disease is based on damage to the DNA structure and disruption of tissue growth regulation. The reason for this behavior of cells remains a mystery. However, its development is most often associated with some possible prerequisites for its appearance, such as: age; use of hormonal drugs; diabetes; chronic pancreatitis; poor

nutrition, history of cancer; exposure to radiation; excess weight; smoking; alcohol abuse. In the early stages, the disease is difficult to identify, as it does not produce any obvious symptoms. They can be confused with pancreatitis, inflammatory processes and other various diseases that have similar patterns of symptoms. Discomfort occurs at later stages and this complicates treatment (Cherenkov V. G., 2010). Symptoms of an uncertain nature become a major problem on the way to making an accurate diagnosis and can lead to incorrect treatment. Late detection is one of the main reasons for high mortality. There are various methods for diagnosing pancreatic cancer, such as laboratory tests, tumor markers, magnetic resonance imaging, computed tomography, ultrasound, endoscopic scanning, biopsy, and so on. Saving a human life depends on timely diagnosis. To elimi-

nate medical errors and help doctors make decisions, it is extremely important to create advanced self-learning information and analytical systems based on expert knowledge, patient data, laboratory test results, diagnostic methods, treatment, rehabilitation, and so on. These include a decision support system based on fuzzy logic, which uses intelligent analysis and data processing technologies that effectively influence the processes of diagnosis, disease development prediction, treatment plan and rehabilitation program. The system evaluates and provides accurate results by providing a set of methods designed to improve patient diagnosis. At present, there is no longer any doubt that the use of fuzzy logic models in various areas of human activity allows for a complete transition to a higher quality level of solving the assigned task (Litvin A. A., Litvin V. A., 2018). Fuzzy logic is a suitable and applicable basis for developing decision support systems in medicine. It is especially necessary in oncology, to detect cancer in the early stages, because the incidence rate is growing, but survival is not increasing. The purpose of creating and developing fuzzy approaches is to adapt mathematical models to real life, the ability to organically combine the potential of computational methods with the characteristics of human thinking (Aliyev R. A., Aliyev R. R., 2001).

Main goal. Diagnostics plays a decisive role in the treatment of cancer pathologies. To grow, tumors use substances necessary for the human body and release toxic compounds, thereby causing changes in the composition of the blood. Therefore, it can be argued that blood test results are an important tool for making a preliminary diagnosis of cancer (Congress 2021). In connection with the above, the material for the research work was taken from the blood test results, since deviations from the norm can be signs of pancreatic cancer in the early stages. The work involved seven input variables (Leukocytes, ESR, Hemoglobin, C 19–9, CA 242, CEA, Glucose) and one output variable.

– Leukocytes, or white blood cells, perform a protective function in the body. They cleanse the blood of dead cells and fight viruses and infections. Most often, leukocytes decrease in the following cases: viral diseases

that disrupt the functioning of the red bone marrow; long-term infections, as a result of which their consumption exceeds the production of new ones; autoimmune diseases, and malnutrition;

– ESR – erythrocyte sedimentation rate. Deviation of the indicators from the norm indicates an inflammatory process and general intoxication of the body, and also exceeding this indicator indicates the breakdown of tissues in the body and, as a consequence, the presence of a malignant neoplasm;

– Hemoglobin is a chemical compound of protein and iron that carries oxygen from the respiratory system to the tissues. A sharp decrease in hemoglobin, as well as a sharp increase, can occur with various oncological diseases;

– C 19–9 and CA-242 are tumor markers used in the diagnosis of pancreatic cancer. High levels of C 19–9 CA-242 are found mainly in patients with tumors and metastases;

– CEA is a cancer embryonic antigen that is used as a tissue marker for cancer. Reasons for an increase: malignant neoplasms, metastases, relapse of the oncological process, pancreatitis, autoimmune diseases, and reasons for a decrease: surgical removal of a malignant tumor and remission of a benign tumor;

– Glucose is an indicator of carbohydrate metabolism, the sugar content in the blood. Increased – diabetes, endocrine disorders, pancreatitis, pancreatic tumor, chronic liver and kidney damage. Decreased – liver and pancreas damage, hypothyroidism, stomach or adrenal cancer, drug poisoning, alcohol intoxication (Lugovskaya S. A., Pochtar M. E., 2018).

Based on expert consultations and medical literature, a database has been compiled consisting of 211 rules that determine the degrees of risk (high, medium and low) based on the assessment of the input variables mentioned above. The output variable takes values from 1 to 3 (Healthy, Non-oncology, Below, respectively). The mechanism for finding the output variable is developed in the MATLAB application, as a tool for fuzzy logic.

x_1 – Leukocytes; x_2 – ESR; x_3 – Hemoglobin; x_4 – C 19–9; x_5 CA-242; x_6 – CEA; x_7 – Glucose.

If x_1 = “Norm” and x_2 = “Norm” and x_3 = “Norm” and x_4 = “Norm” and x_5 =

= “Norm” and x_6 = “Norm” and x_7 = “Norm”,
then y = “Healthy”;

If x_1 = “Norm” and x_2 = “Above normal” and x_3 = “Below normal” and x_4 =
= “Norm” and x_5 = “Norm” and x_6 = “Norm” and
 x_7 = “Above normal”, then y = “Non-oncology”;

If x_1 = “Above normal” and x_2 = “Above
normal” and x_3 = “Norm” and x_4 = Above
normal” and x_5 = “Above normal” and x_6 =
= “Norm” and x_7 = “Below normal”, then y =
= “Oncology”;

Table 1. Test values

Leuko- cytes	ESR	Hemoglobin	C 19–9	CA-242	CEA	Glucose	Risk
6	9	142	0	1	0	102	1
5	11	155	4	2	5	367	2
7	58	140	89	37	16	103	3

Conclusion

The use of the proposed technology helps
to systematize and solve many problems that
can prevent medical errors in the future. To
make reliable decisions in many complex
problems and under conditions of uncertain-

ty, an excellent tool in the field of intelligent
systems is the use of fuzzy logic. Fuzzy log-
ic was created by Zadeh in 1965. It has not
lost its relevance to this day and continues to
benefit the entire world.

Problem statement with using MATLAB application.

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Type='sugeno'
Version=2.0
NumInputs=7
NumOutputs=1
NumRules=28
AndMethod='prod'
OrMethod='probor'
ImpMethod='min'
AggMethod='max'
DefuzzMethod='wtaver'
```

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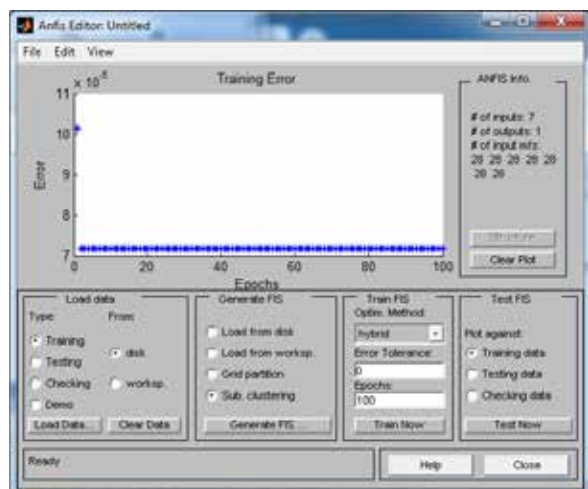
NumMFs=28

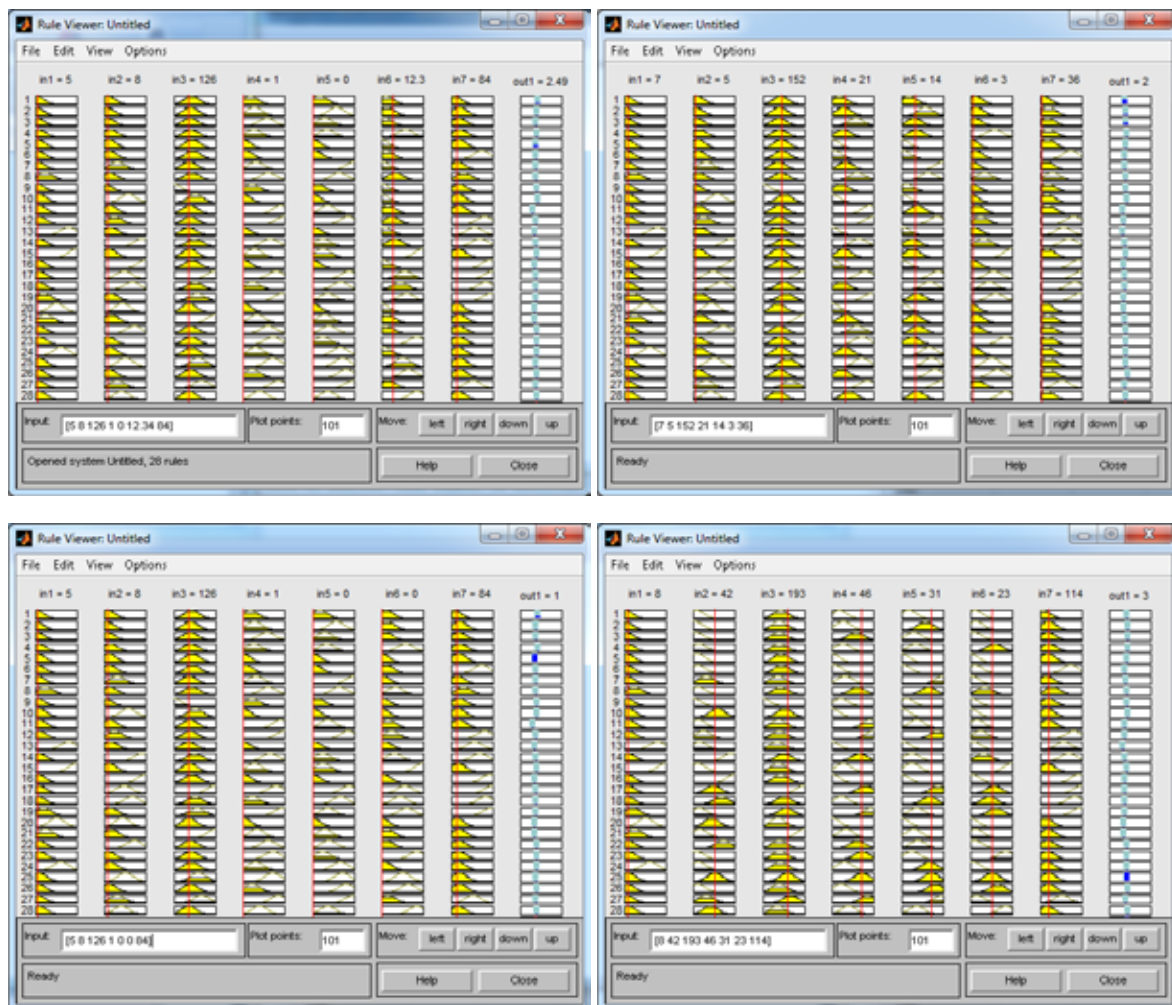
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MF7='in7mf7': 'gaussmf', [82.3779375579068 87.9999973505523]
MF8='in7mf8': 'gaussmf', [82.3779468735902 158.999999003701]
MF9='in7mf9': 'gaussmf', [82.3779500839988 110.000003389708]
MF10='in7mf10': 'gaussmf', [82.3779452947135 97.0000041911469]
MF11='in7mf11': 'gaussmf', [82.3779378597246 105.000000966963]
MF12='in7mf12': 'gaussmf', [82.3781801589073 398.999848538774]
MF13='in7mf13': 'gaussmf', [82.3779917024653 285.999977553512]
MF14='in7mf14': 'gaussmf', [82.377899449348 345.000016306329]
MF15='in7mf15': 'gaussmf', [82.3779400081906 99.9999999999845]
MF16='in7mf16': 'gaussmf', [82.3779396016493 452.000000325067]
MF17='in7mf17': 'gaussmf', [82.3779437382521 486.999999097207]
MF18='in7mf18': 'gaussmf', [82.3779386699641 1.000000901985]
MF19='in7mf19': 'gaussmf', [82.3779373054853 465.000002997372]
MF20='in7mf20': 'gaussmf', [82.3780397189137 79.0000607318225]
MF21='in7mf21': 'gaussmf', [82.377939250243 108.99999984321]
MF22='in7mf22': 'gaussmf', [82.3781408551459 103.000068496496]
MF23='in7mf23': 'gaussmf', [82.3779397980624 102.000000228715]
MF24='in7mf24': 'gaussmf', [82.3779401086157 94.0000004931807]
MF25='in7mf25': 'gaussmf', [82.3779356283345 114.000000147445]
MF26='in7mf26': 'gaussmf', [82.3779196170231 112.999980771133]
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MF27='in7mf27': 'gaussmf', [82.3784916658578 267.000361833462]
MF28='in7mf28': 'gaussmf', [82.3779409527934 96.0000015023281]

[Output1]
Name='out1'
Range=[1 3]
NumMFs=28
MF1='out1mf1': 'linear', [0.158846382660904 0.0587524383286939
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0.010253761724145 0.0140654173728168 0.00464357845222863]
MF2='out1mf2': 'linear', [0.0561834562854644-0.0153538376101239
0.00351808780979215-0.0140714419182644 0.0663210539572894
0.0875780159085567 0.00614975520482215 0.00188076681864329]
MF3='out1mf3': 'linear', [0.0771575118801949 0.00602401730324073
0.00573641943181894 0.0612813618447968 0.0205588224957719-
0.00696519655375428-0.00119084360816463 0.00510760016191922]
MF4='out1mf4': 'linear', [-0.025549563984591-0.00856225774008171
0.010575242130827 0.0242685569659812 0.0277813718744204-
0.0822692984282304 0.0264873429395337 0.0011574345174786]
MF5='out1mf5': 'linear', [0.00695797394114312-0.127189981062661-0.00204236276384948
0.0293665535841354 0.120492276604518 0.106687603509042
0.0159323790945404 0.01108662376174]
MF6='out1mf6': 'linear', [-0.000416324454824522-0.00151757080354308
0.00361230326976529-0.00133084838485524 0.000203045717135199
0.00141352351047578 0.00391956578751069 4.12688331443791e-005]
MF7='out1mf7': 'linear', [-0.00419845760335789 0.0226446647083472
0.00256968656337916-0.0107546464199351 0.0500800564999357-
0.0014217766944071 0.00182917280404271 0.00013449845027435]
MF8='out1mf8': 'linear', [0.0116583687024116-0.0126741278595615
0.00512502020543052 0.0202400892028078 0.0344207887479192
0.0185838174334332 0.000453005093695126 0.000564346728511731]
MF9='out1mf9': 'linear', [-0.0127816846574794-0.0209673073280881
0.00969213601412203 0.0129725886787988-0.00551790752328125
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MF10='out1mf10': 'linear', [0.00359898906580869-0.0485411108960952
0.0207346430307942 0.011980358698493 0.0403400019994528
0.00980035383201311 0.00792287700255176 0.000845836281415888]
MF11='out1mf11': 'linear', [-0.0283134574554906 0.00332062683414345-
0.0214546139618103 0.0931928969603685 0.0141216627902833
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MF12='out1mf12': 'linear', [0.000101166093010777 0.000403507680235701
0.00109928818396514 0.00101735137783403 0.000668690221527047
4.71696511125267e-005 0.00683352697063924 1.28815709764724e-005]
MF13='out1mf13': 'linear', [-0.000114367356941918-0.000758903843047438-0.0119427989199992-
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MF14='out1mf14': 'linear', [0.000136549603645853 0.00142100694334504
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MF15='out1mf15': 'linear', [0.00641451006328544 0.000811959297538643
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0.0035726198812947 0.00811953704924713 8.11958546806982e-005]
MF16='out1mf16': 'linear', [5.12886474046489e-005 0.000676538585548326
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1.7162599349221e-005 0.00387430673238141 8.55504908837456e-006]
MF17='out1mf17': 'linear', [6.24850939918067e-005 0.000352068233390456
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MF18='out1mf18': 'linear', [8.75680326374059e-005 0.000807171530695437
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MF19='out1mf19': 'linear', [0.000221113022605768 0.000106454301108803
0.00111589245942067 0.000600296087796417 3.28973817280287e-005
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MF20='out1mf20': 'linear', [0.0066840433251709 0.0610534050657449
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0.0107024610472769-0.0236470423788051 0.000276965249035705]
MF21='out1mf21': 'linear', [0.00901465034762551-0.000999453279116807
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0.000717224989598662-0.0269962670071518-0.000241701267939011]
MF22='out1mf22': 'linear', [0.00055474984387186 0.0086069407791468
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0.000399332238451362 0.00964852106772644 9.80641012661468e-005]
MF23='out1mf23': 'linear', [0.000797425700368113 0.00096186270877293
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0.00425215003845595 0.00810863388541316 9.63589561592896e-005]
MF24='out1mf24': 'linear', [0.0140310455236635-0.0012777709194829
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MF25='out1mf25': 'linear', [0.00114292289269646 0.00679771003613147
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0.00281520882315064-0.0027342223715192 9.00247202419326e-005]
MF26='out1mf26': 'linear', [5.01342475587267e-005 0.000261215854896123
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MF27='out1mf27': 'linear', [7.88255983582174e-006 0.00137121849601779
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0.000498257054942344 0.00676079022483021 2.43537423742934e-005]
MF28='out1mf28': 'linear', [0.00149221357802887 0.0126900386297353
0.0146145949980682 0.00789759690870224 0.00261798008022367
0.0093755718578698 0.00177123959808159 0.000179511639465914]





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