The relationship between milk composition associated with ketosis using Artificial Neural Networks in dairy cows

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KETOSIS – metabolic disease

Ketosis as a metabolic disease is difficult to diagnose in subclinical form. From the biological and animal welfare points of view it is worth to investigate existence of any causal relationships between different milk components and subclinical ketosis

nadis.org.uk

Diagnosis of ketosis

Diagnosis cow with clinical symptoms of ketosis–
human glucometer

Cow selection at risk of ketosis (subclinical) - based on the results of the analysis of milk composition

Method based on logistic regression selecting cows at risk of ketosis - good specificity (90%),
but lower sensitivity (60%)

Artificial Neural Network

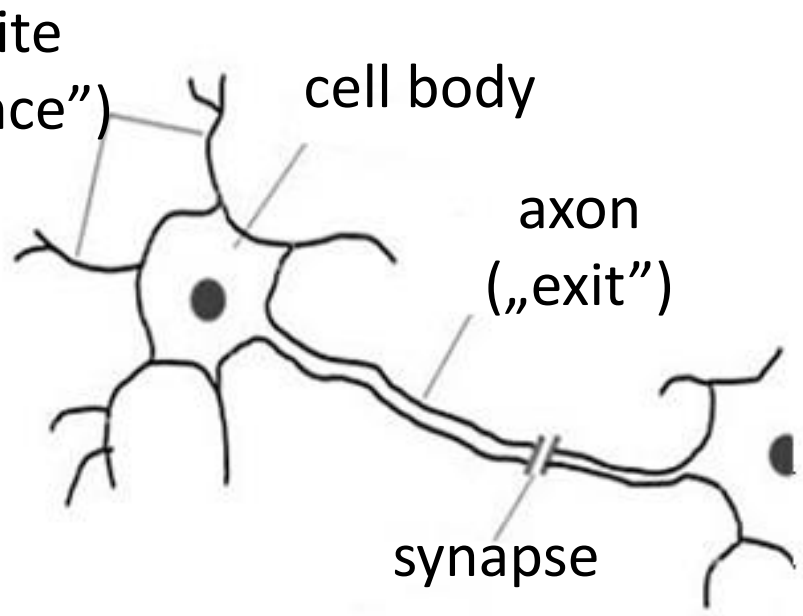
ARTIFICIAL NEURAL NETWORK

is an algorithm whose

operation is modeled on the

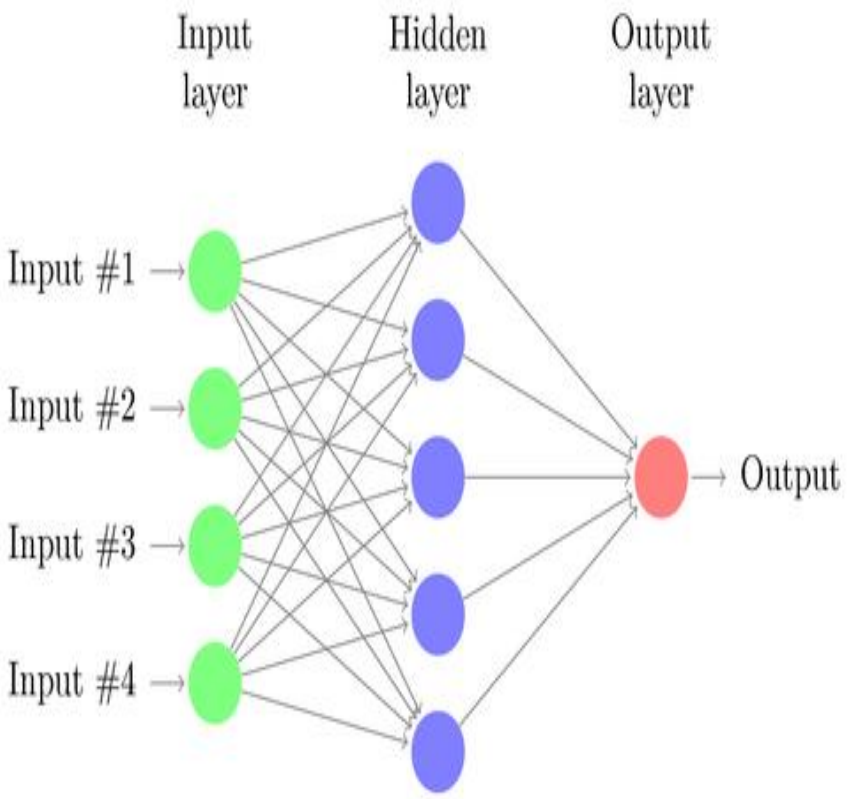
biological structure and activity

of the human brain



INPUT SIGNALS (Dendrite) → CONVERTER (Cell body) → OUTPUT SIGNALS (Axon)

Artificial Neural Network

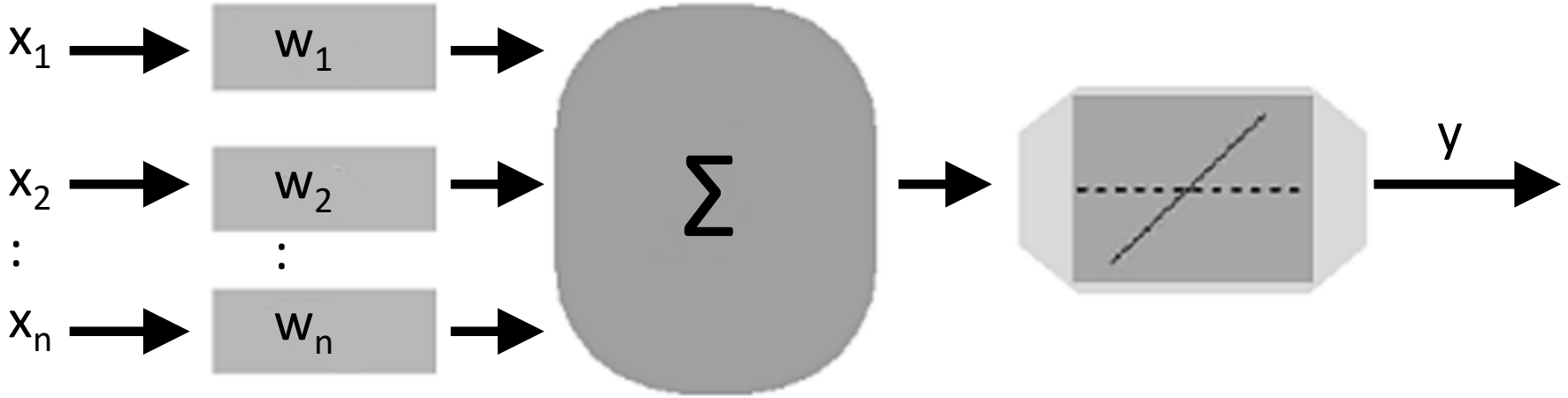


Input layer:
accepts input data and sends to all neurons of the hidden layer

Hidden layer:
it processes data and directs it to the output layer neurons

Output layer:
calculates final results, i.e. gives a solution to the problem being analyzed

Construction of artificial neural networks



The aggregation function processes input data and weights into the argument of the activation function

Activation function is a function, which is calculated according to the value of the output neuron network

Objective of the work

Define the relationship between milk composition and subclinical ketosis in dairy cows.

Artificial Neural Networks

Research data

Material-Polish Federation of Cattle Breeders and Milk Producers (PFHBiPM)

The collection contains data about 2000 cows

INPUT DATA

- MILK [kg]
- FAT (TŁ) [%]
- PROTEIN (BI) [%]
- LACTOSE (LAK) [%]
- FAT to PROTEIN (T/B)
- SOMATIC CELLS (LKS) [tys.]
- UREA (MOC) [mmol/l]
- ACETONE (ACE) [mmol/l]
- β-hydroxybutyric ACID in milk (BHB_M) [mmol/l]

OUTPUT DATA

- value 0 / 1 - healthy / unhealthy
- β-hydroxybutyric ACID [mmol/l] in blood

Research methodology

The networks was generated based on:

- different sets of input data
- different number of neurons in the hidden layer

Comparison of results obtained and selection of the optimal data set and type of network

Research methodology

The analysis used *STATISTICA*® software -

neural network - **MLP** - *multi-layer perceptron*

activation functions:

- linear
- exponential
- logistic
- hyperbolic tangent

hidden layer - 8 to 16 neurons

Traits of Yield

	$\overline{X}$	SD	CV[%]	MIN	MAX
Milk [kg]	26,89	6,38	24	5,20	47,80
Fat [%]	4,54	1,00	22	2,00	8,27
Protein [%]	3,24	0,33	10	2,33	4,58
F/P[%]	1,41	0,31	22	0,62	2,35
Lactose [%]	4,85	0,23	4,7	3,98	5,32
SCC [tys.]	561,4	1081,9	192	11,0	7252,0
Urea	197,56	70,05	35	0,00	418,00
Acetone	0,15	0,18	120	0,00	1,00
BHB_M	0,09	0,13	140	0,00	1,00

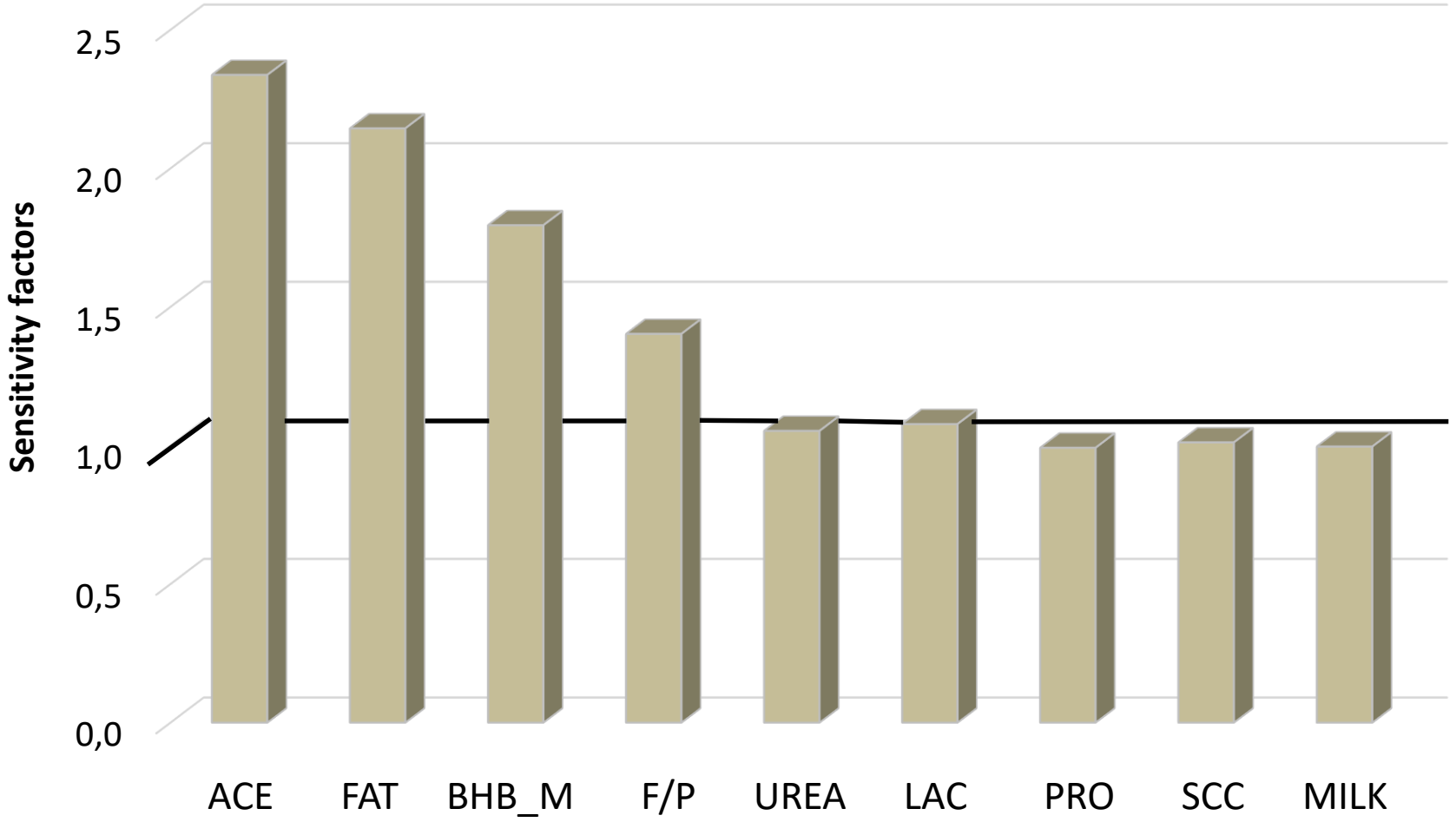
UREA, ACETONE and BHB_M in mmol/l

Examples of the characteristics of neural networks

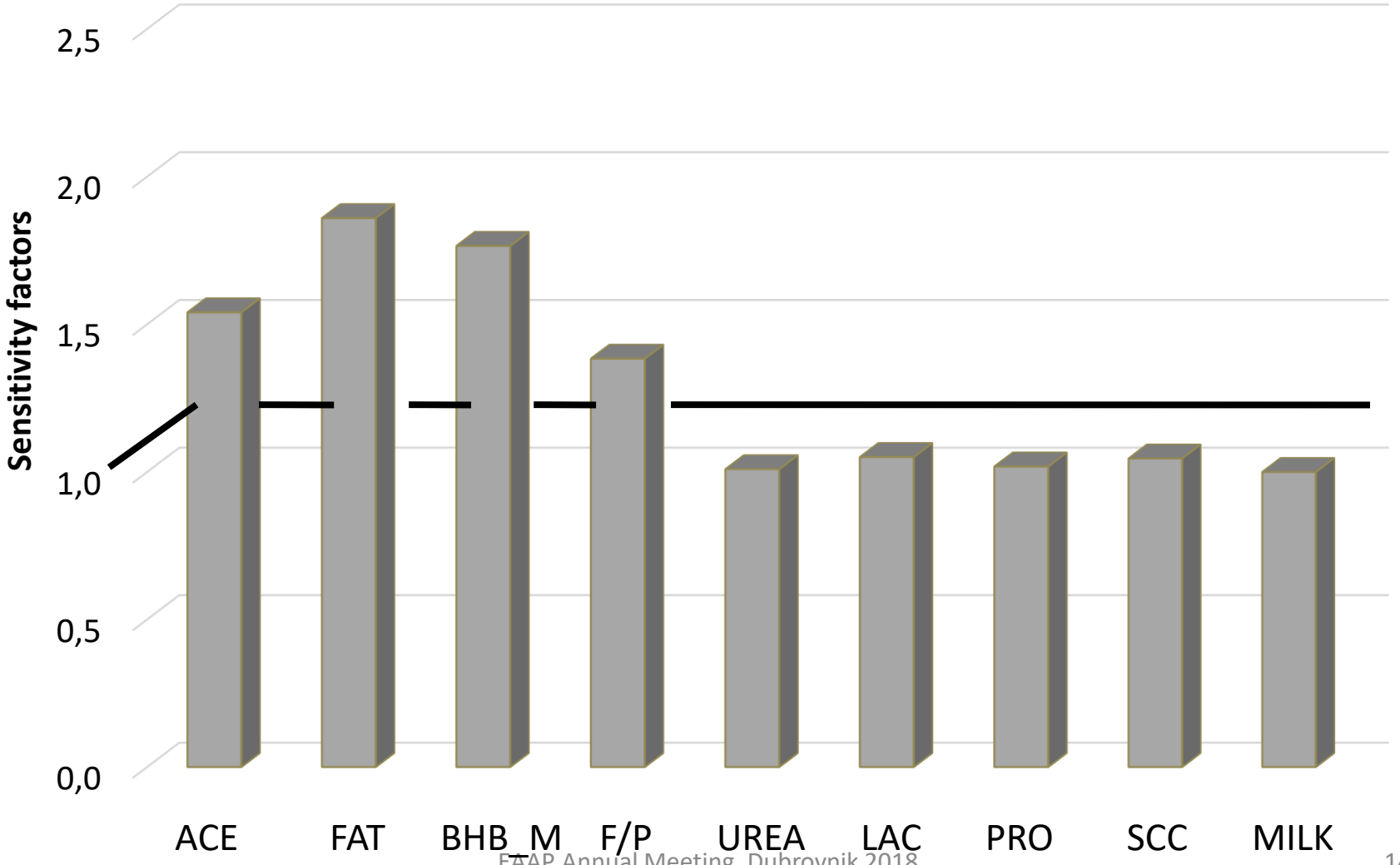
QUALITY			ERROR			Activation (hidden layer)
l	t	w	l	t	w	
0,969	0,542	0,436	0,419	0,399	0,558	Linear
0,969	0,538	0,425	0,425	0,398	0,562	Linear
0,768	0,152	0,126	6,918	0,552	0,676	Logistic
0,779	0,088	0,124	7,022	0,555	0,680	Logistic
0,070	-0,088	-0,015	7,059	0,565	0,685	Exponential
-0,298	-0,086	-0,058	7,144	0,564	0,689	Exponential
0,971	0,537	0,476	0,410	0,395	0,541	Hyperbolic tangent
0,971	0,566	0,481	0,401	0,378	0,530	Hyperbolic tangent

MLP networks with 9 input data, 8 neurons and 4 activation functions in the hidden layer

The sensitivity of neural networks with 8 hidden layers



The sensitivity of neural networks with 16 hidden layer



Continuation of research

Choosing the optimal **Multi-Layer Perceptron**;

input data - ACE; FAT; BHB_M; F/P

activation functions in the hidden layer -

linear function , hyperbolic tangent

Validation of developed networks on an independent data set and choosing the optimal network

Thank You for Your attention