ELECTRONIC TONGUE

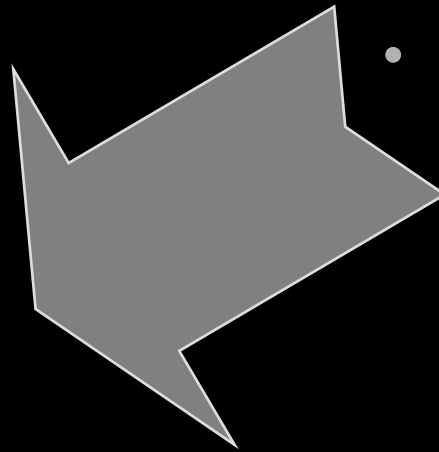*Patrycja Ciosek*

CHEMICAL SENSORS

Advantages:

- Selective
- Real-time measurement
- On-line measurement

Disadvantages:

- No sensors for some analytes
- Sometimes not sufficient selectivity

SENSOR ARRAY

Identification and classification of a sample

CSRG

Electronic tongue

A SYSTEM FOR AUTOMATIC ANALYSIS AND CLASSIFICATION (RECOGNITION) OF LIQUID SAMPLES

AN ARRAY OF CHEMICAL SENSORS

PATTERN RECOGNITION SYSTEM

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Applications

⇗Foodstuff industry

⇗Medicine

⇗Safety

⇗Environment monitoring

⇗Quality control

⇗Chemical industry

⇗Legal protection of inventions

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Commercial Systems

↗ Alpha MOS, France

↗ Anritsu Corp., Japan

↗ .....

cost :

20 000 – 100 000 $

Electronic tongue developed at WUT

Sensor array → **Ion-selective electrodes (ISEs)**
- Selective
- Partially selective

Data analysis
- ↗ Extraction of information from multidimensional measurement data

→
- PCA
- ANN
- SIMCA (Soft Independent Modeling of Class Analogy)
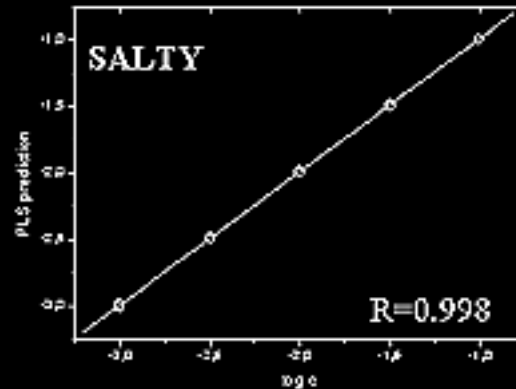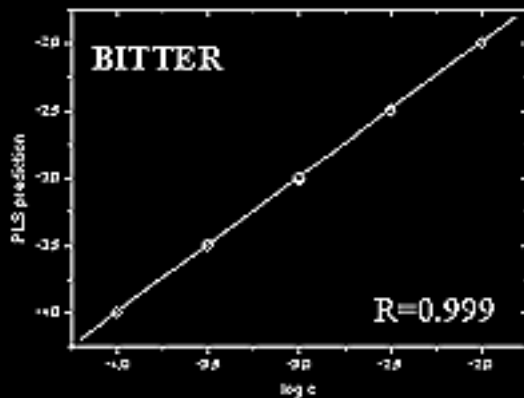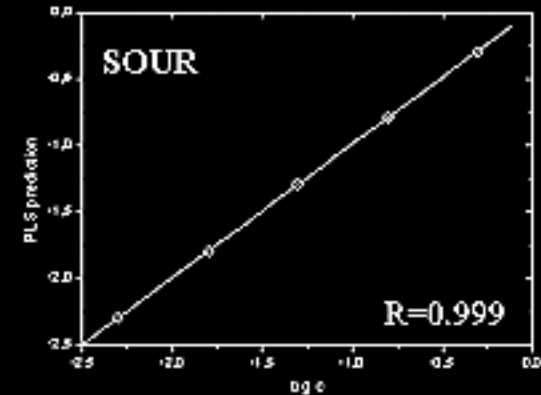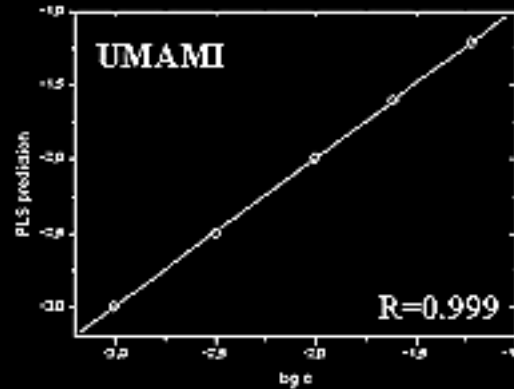- PLS (Partial Least Squares)
- More...

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Sensors

Electrode type	Ionophore
Ca^{2+}	2 wt.% ETH 1001
NH_4^+	2 wt.% nonactine
Na^+/ K^+	5.15 wt.% ionophore X 0.2 wt.% valinomycin
Cl^-	1 wt.% TPPClMn
HCO_3^-	1 wt.% ETH 6010
„cation-selective"	-
$F^-/ H_2PO_4^-$	1.5 wt.% ionophore $H_2PO_4^-$, 0.05 wt.% ionophore F^-
„anion-selective"	-

Partial selectivity

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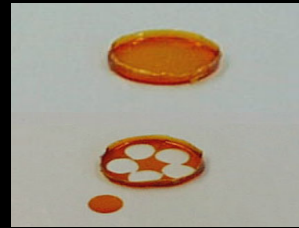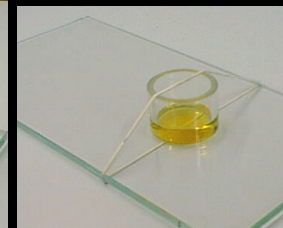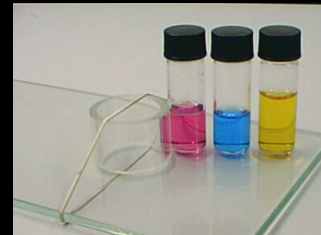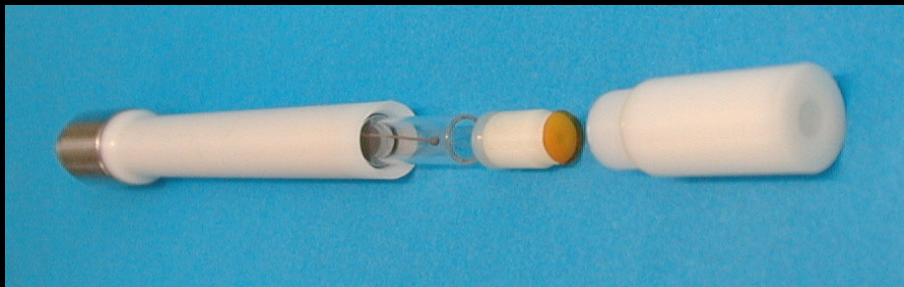
Taste recognition
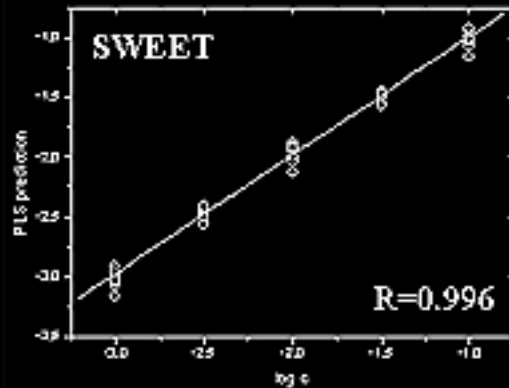
Taste	Concentration range	
	$\log c_{min}$	$\log c_{max}$
SWEET (glucose)	-3.0	-1.0
UMAMI (sodium glutamate)	-3.0	-1.2
SOUR (citric acid)	-2.3	-0.3
BITTER (quinine)	-4.0	-2.0
SALTY (sodium chloride)	-3.0	-1.0

Real samples

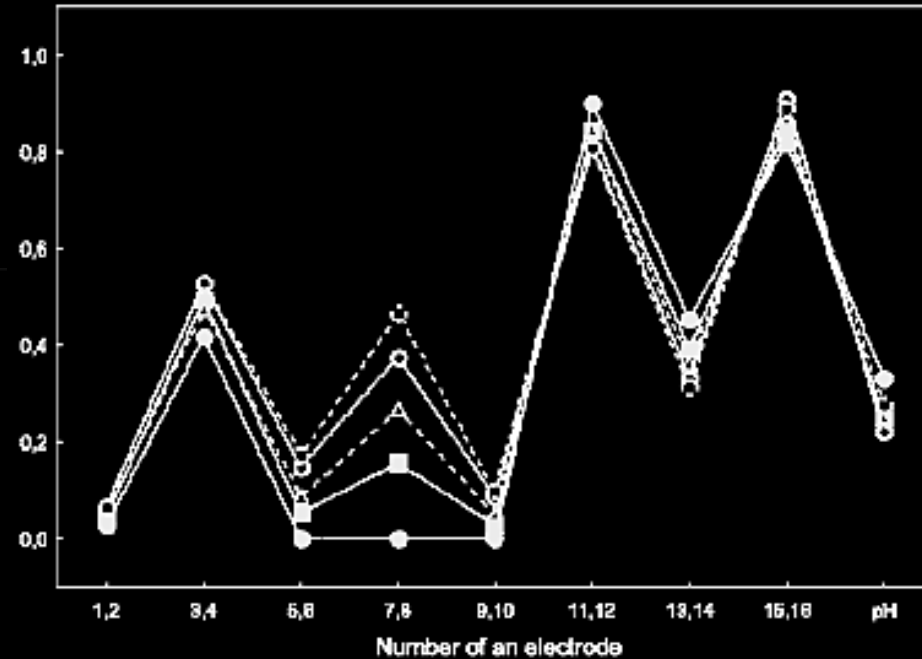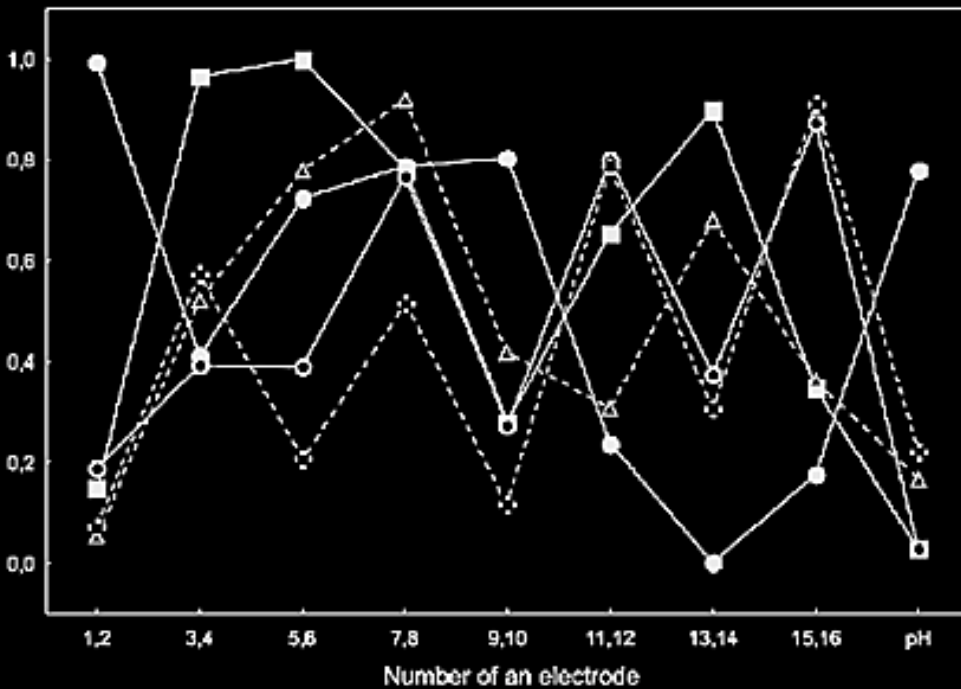## ORANGE JUICE

- Cappy
- Fortuna
- Clippo
- Tarczyn
- Hortex

MILK

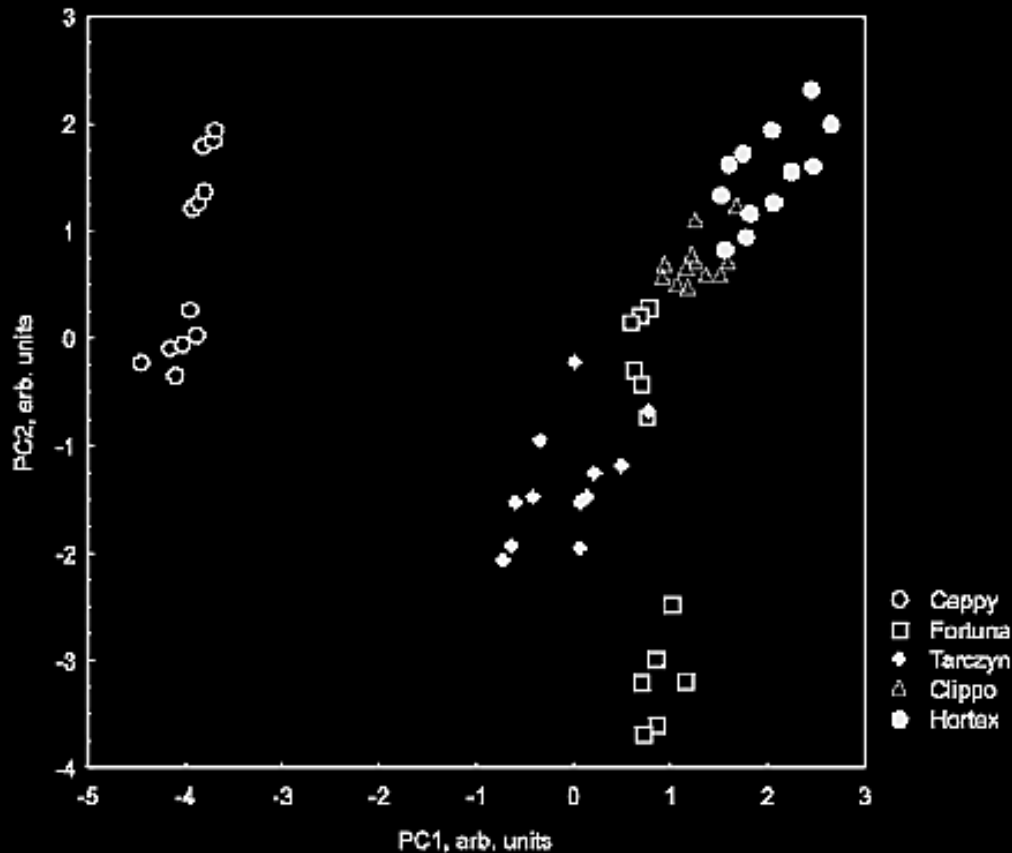- Łaciate
- Sielska Dolina
- Łowicz
- Bakoma
- Białe

**5 producers
3 manufacture lots
for each product**

TONIC

- Schwepps
- Helena
- Kinley

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Juice brand recognition

All brands

One brand

(Hortex)

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Juice measurements – PCA & ANN

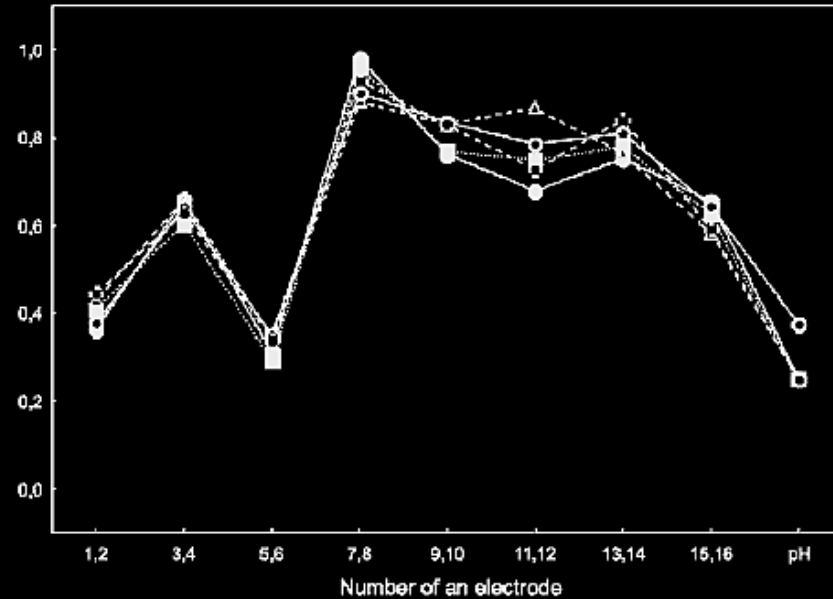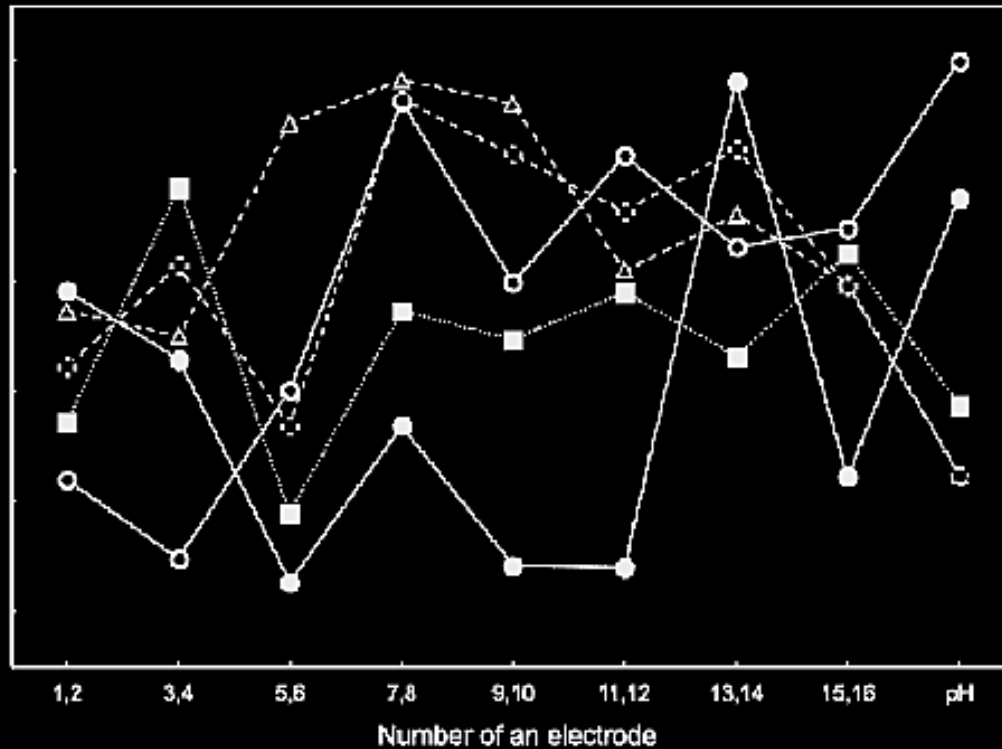↗ **Mean squared error of neural net processing** $3.09 * 10^{-4}$
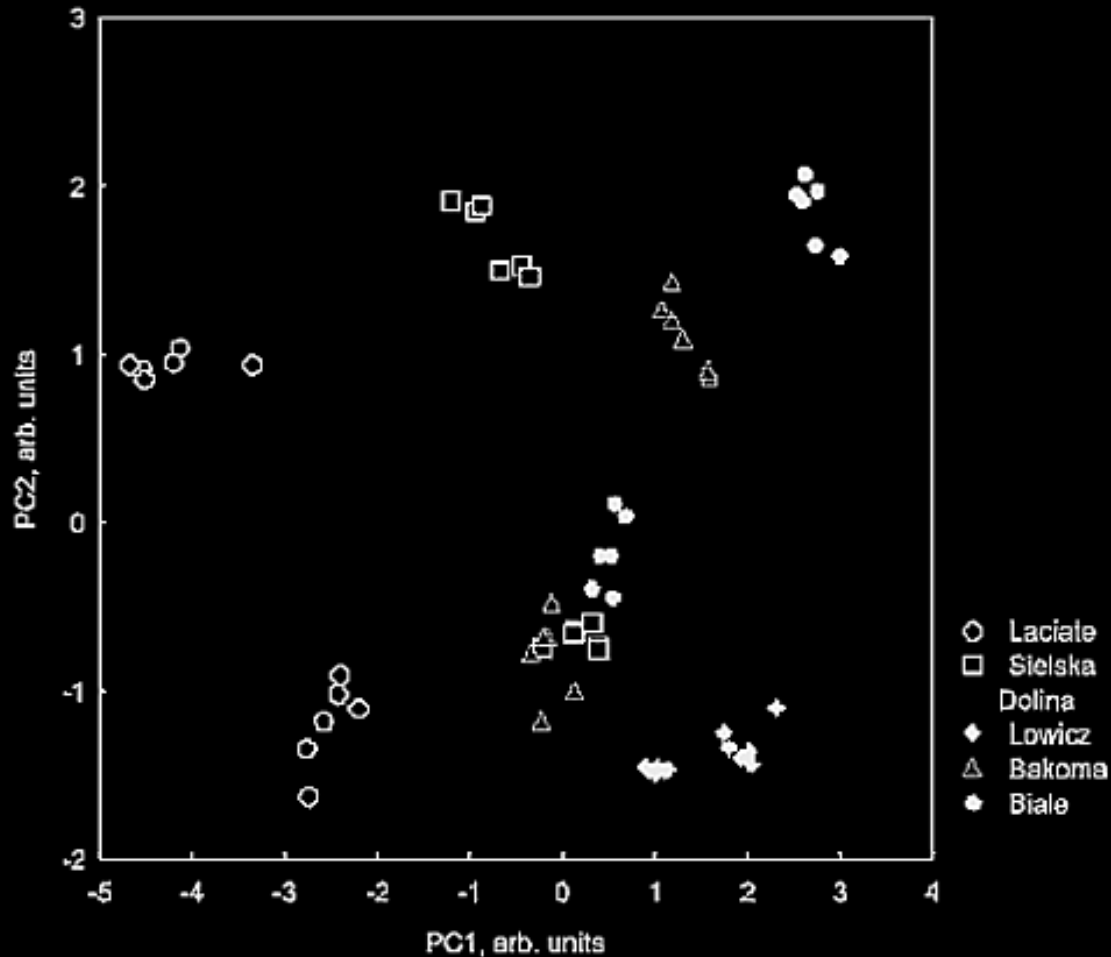
↗ **% of correct classifications** 92.0

Milk brand recognition

All brands

One brand

(Białe)

Milk measurements – PCA & ANN
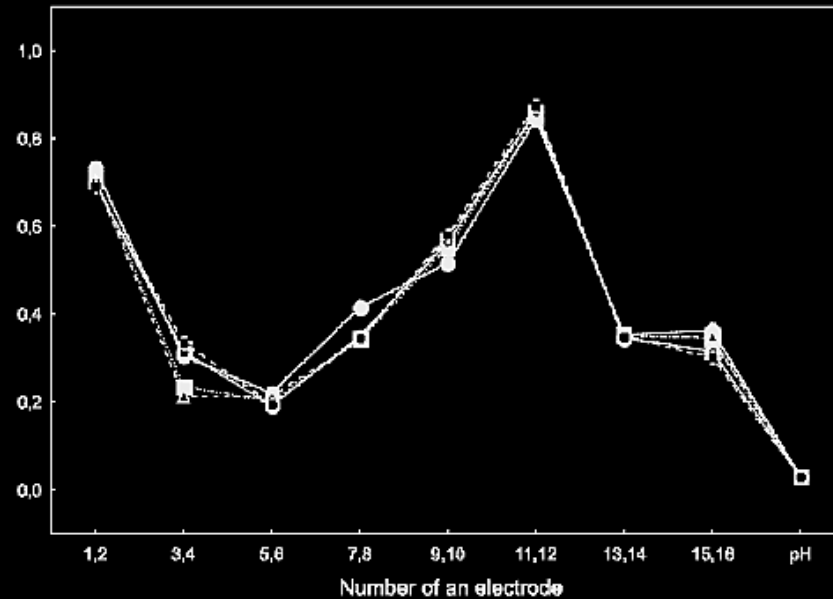

↗ **Mean squared error of neural net processing** 1.70 * 10⁻³
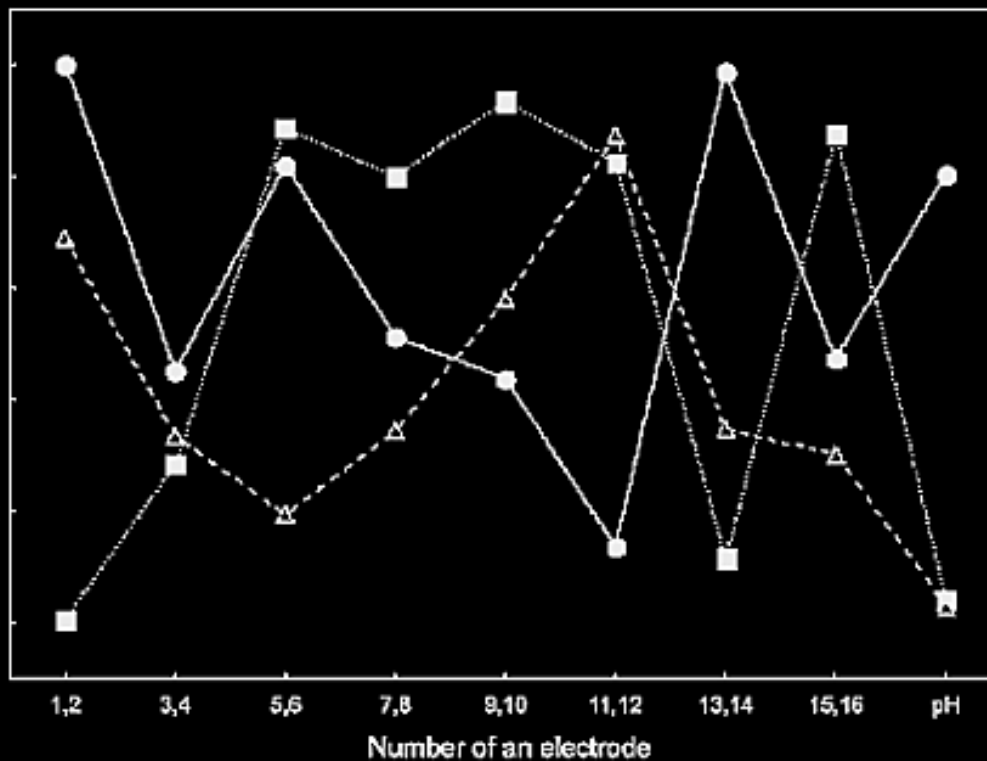
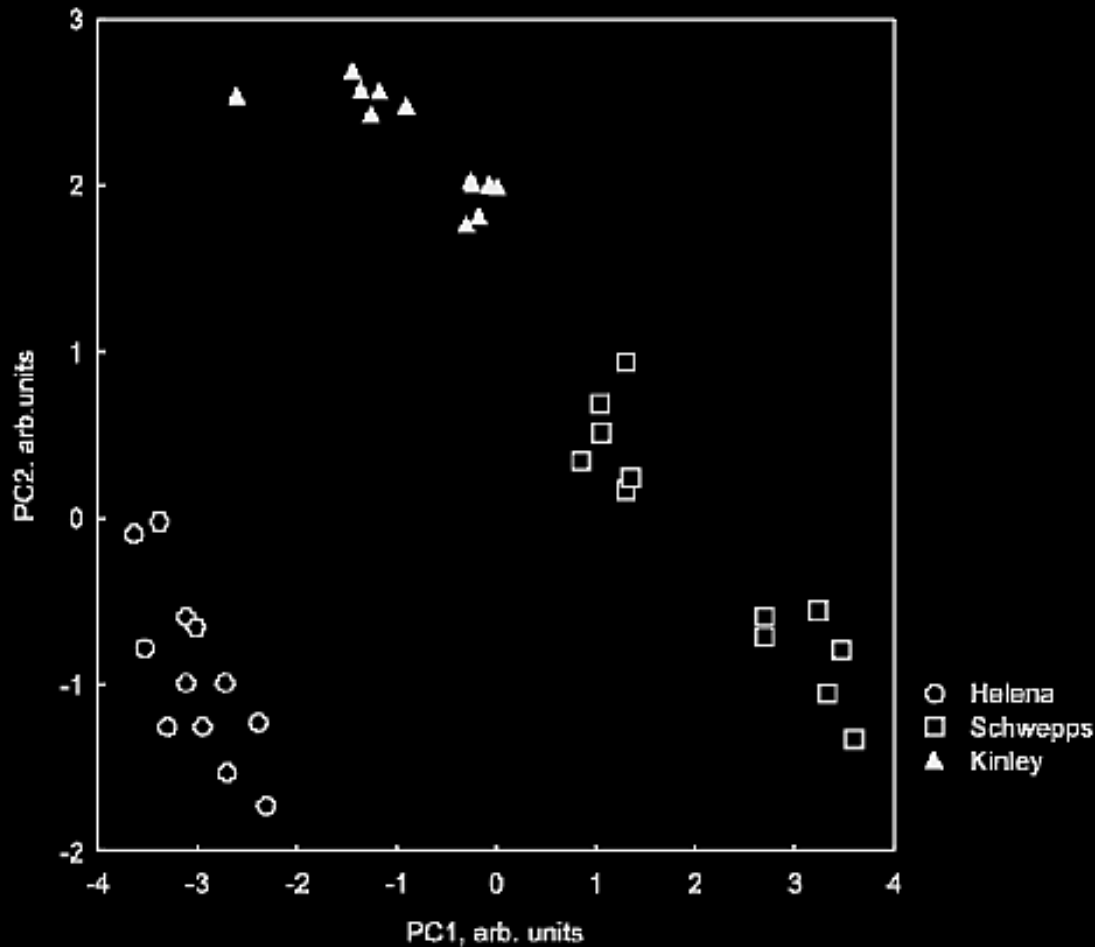↗ **% of correct classifications** 93.3

Tonic brand recognition

All brands

One brand

(Kinley)

Tonic measurements – PCA & ANN

↗ **Mean squared error of neural net processing** 6.76 * 10^{-5}

↗ **% of correct classifications** 100.0
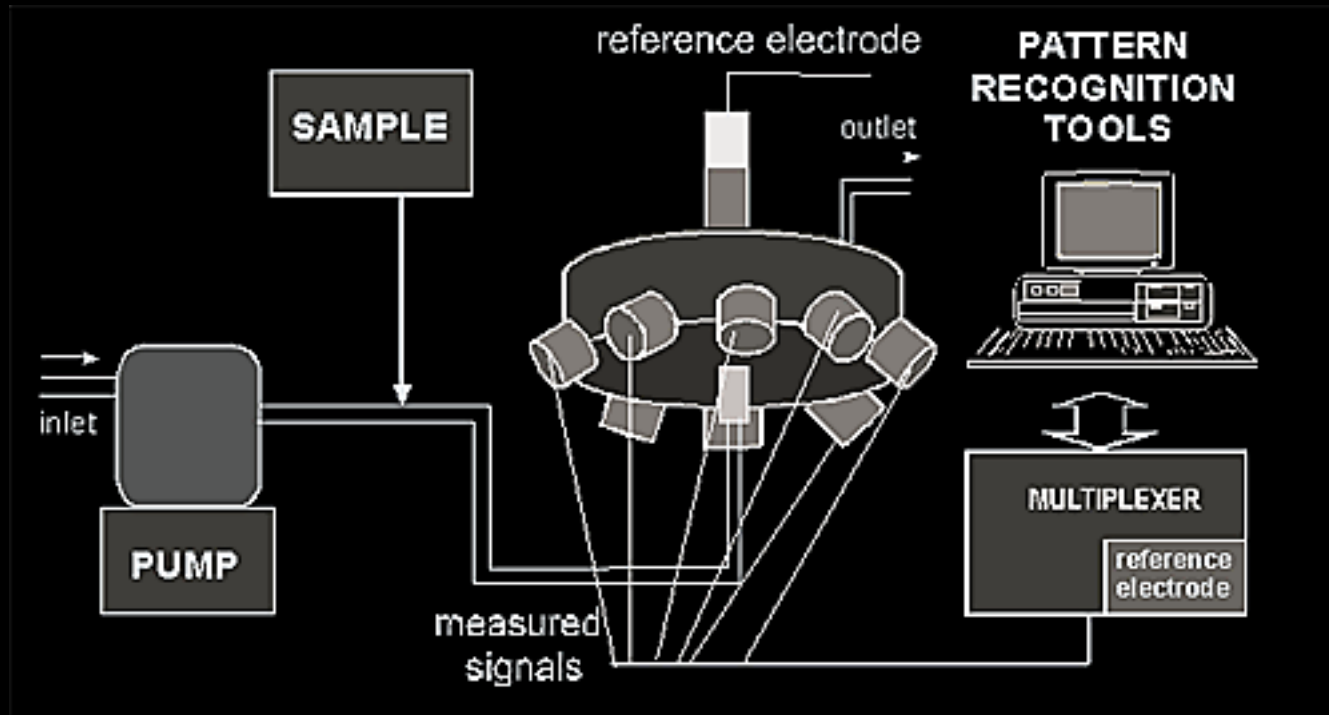
Miniaturized flow-through electronic tongue

✓ Shorter response time
✓ More simple to calibrate
✓ Can be miniaturized

FLOW

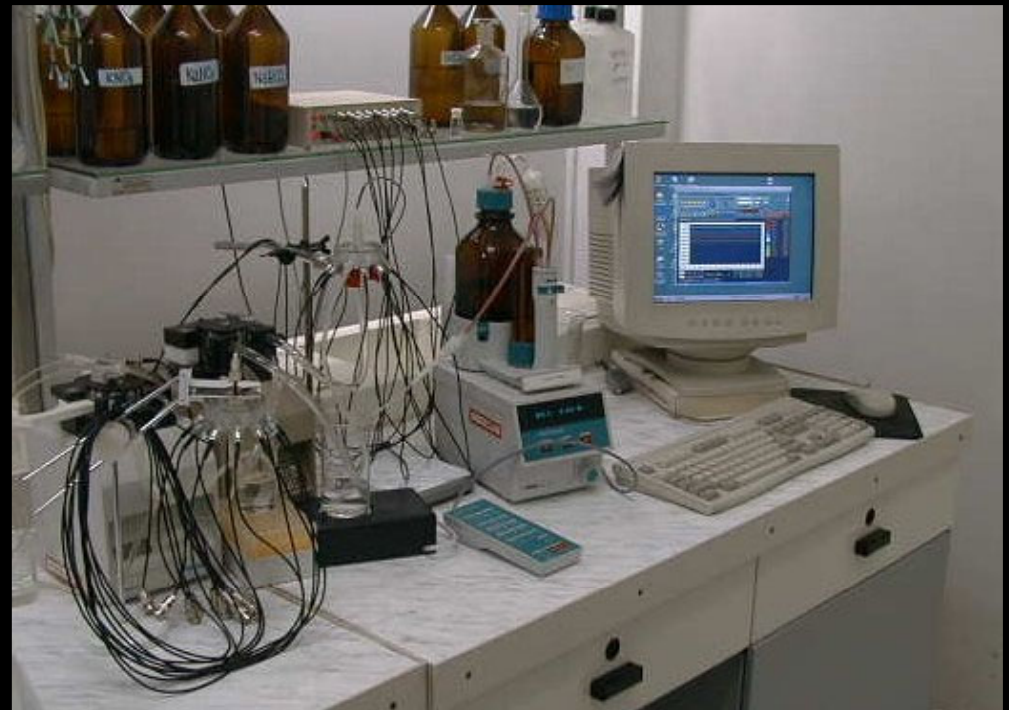**MINIATURIZATION**

✓ Less chemicals, waste, costs

✓ Less sample volume

✓ Shorter time of analysis

✓ Compatibility with miniaturized systems

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Miniaturized flow-through electronic tongue

Miniaturized flow-through electronic tongue

Flow-through cell

Reference electrode

implants

outlet

inlet

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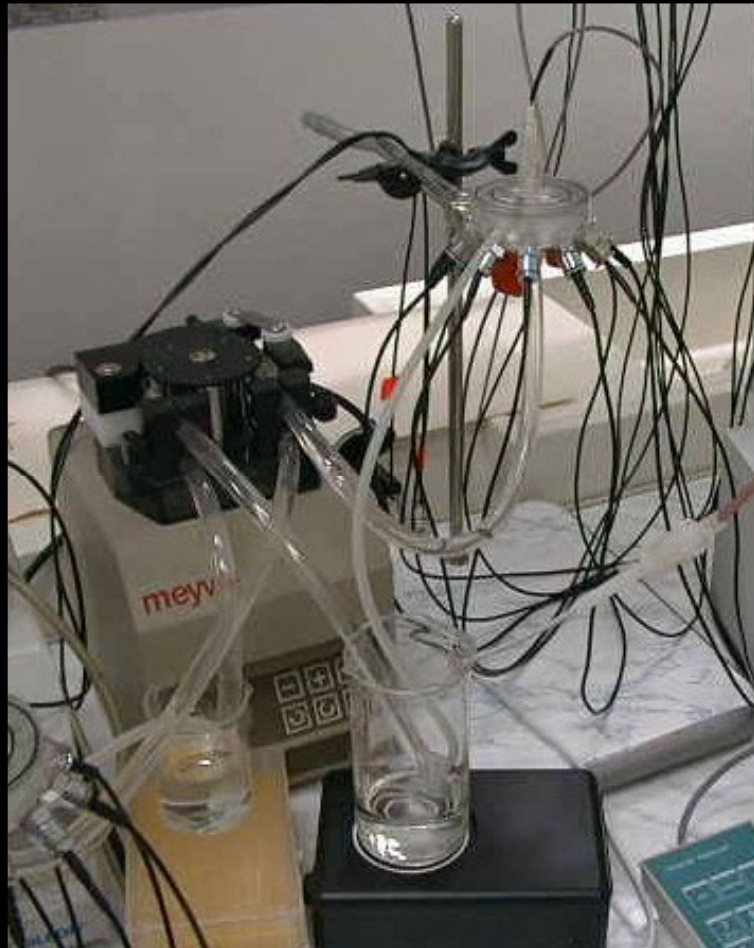
Solid-state electrodes
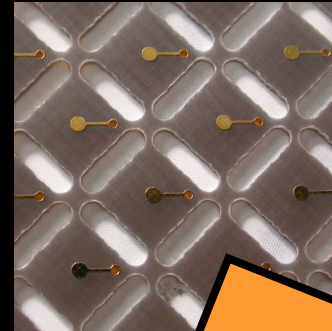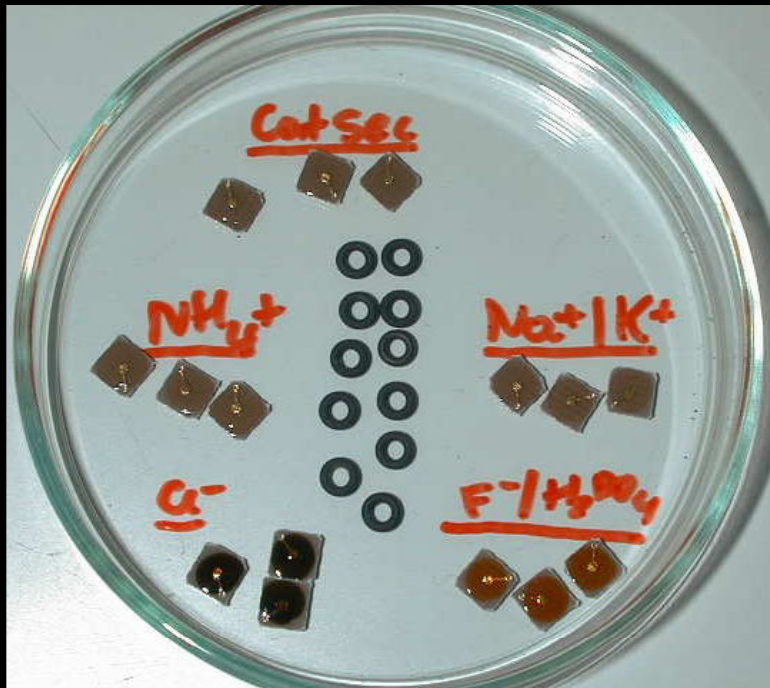
Beverages recognition
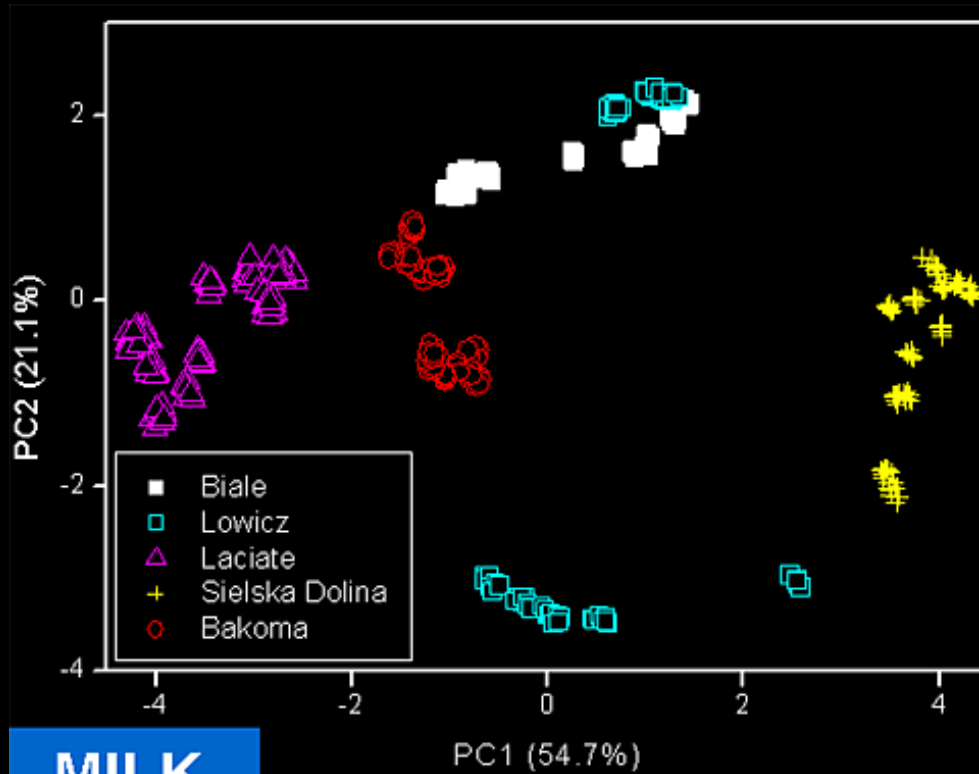
	% of correct classifications
Orange juice	86,7
Milk	96,7
Beer	86,3

Summary

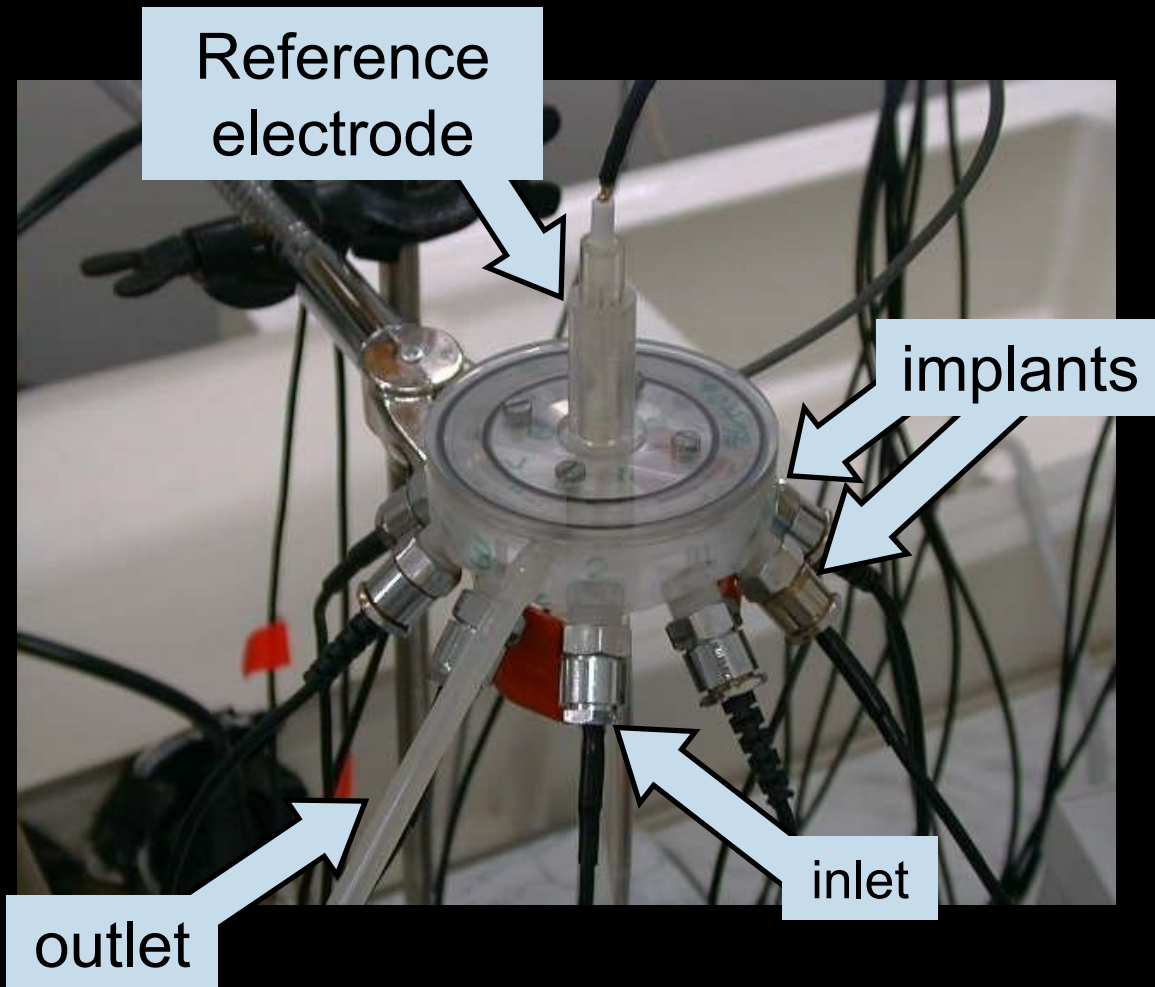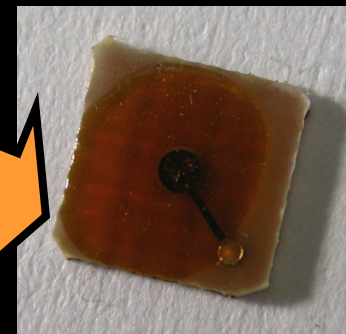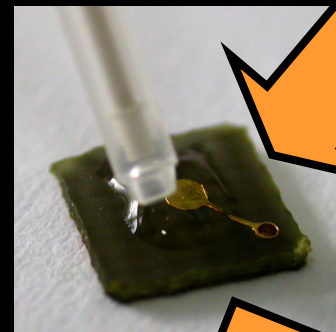↗ Novel method in chemical analysis – sensors+data analysis

↗ the **real working conditions** of the system must be evaluated in a proper way (samples of the same brand of beverage but with different manufacture dates, originating from different manufacture lots). It is often overlooked in practice!

↗ **E-Tongue developed at WUT** – fusion of ion-selective and cross-sensitive sensors in the array allows to discriminate various beverages with very high degree of accuracy (90 - 100%)

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References

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8. Krantz-Ruckler C., Stenberg M., Winquist F., Lundstrom I., Electronic tongues for environmental monitoring based on sensor arrays and pattern recognition: a review, Analytica Chimica Acta, 426 (2001), 217
9. Winquist F., Holmin S., Krantz-Ruckler C., Wide P., Lundstrom I., A hybrid electronic tongue, Analytica Chimica Acta, 406 (2000), 147