European Centre for Soft Computing

Solving real-world problems

From computing with numbers to computing with words
From coal mining to intelligent data mining
Human- œntric approaches

Jose María Alonso
jose.alonso@softcomputing.es
http://www.softcomputing.es

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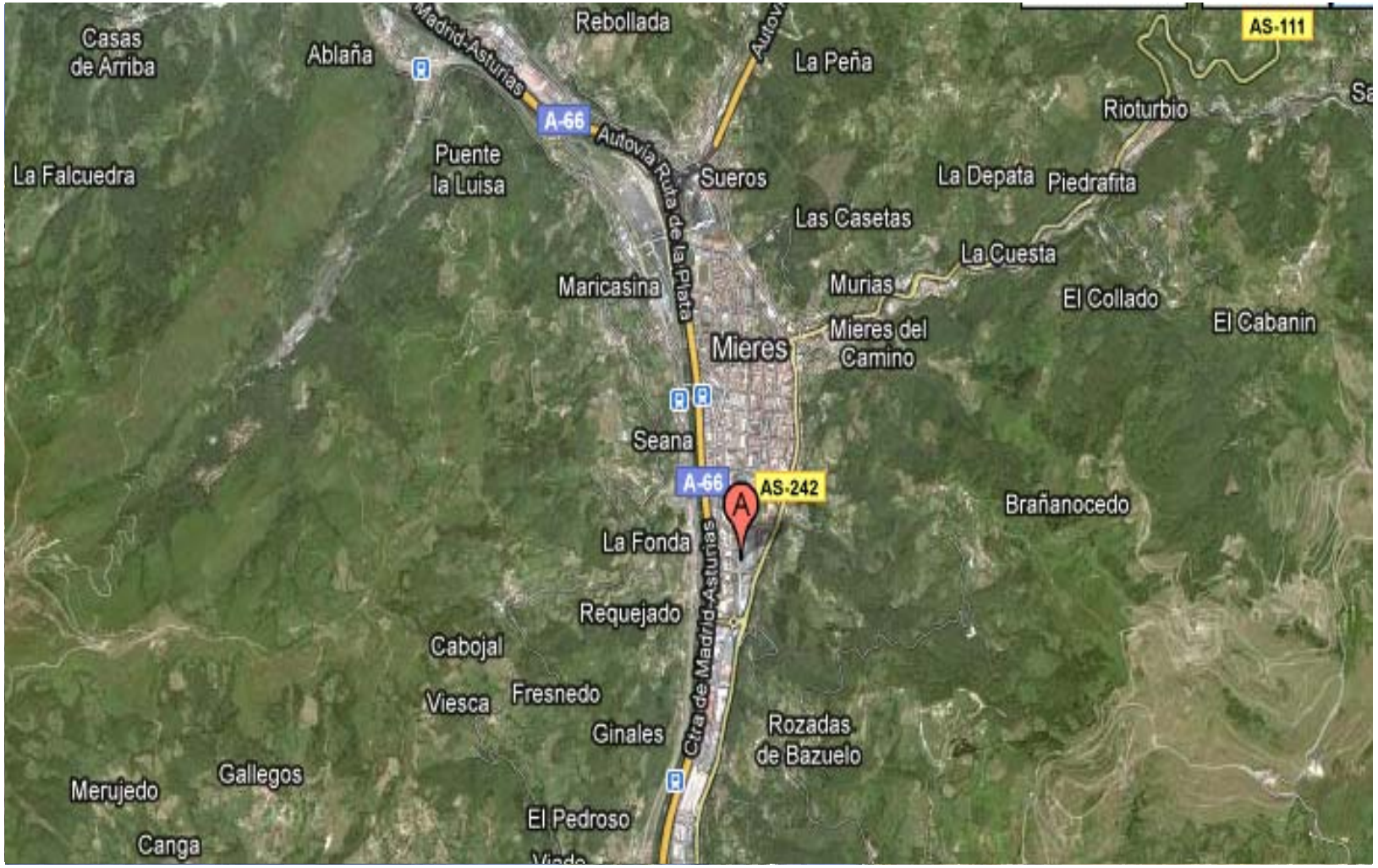

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Private R&D Center

Sponsors

From real coal mining to intelligent data mining based on Soft Computing

Gobierno del Principado de Asturias

Ministerio de Industria, Turismo y Comercio

Reestructuracion mineria reactivacion comarcas

European Centre for Soft Computing

Activity (research and industry)

Basic and applied research

- Contribute to scientific advancement
- Organizing workshops and conferences
  - ESTYLF 2008
  - SCHSS 2009
  - GEFS 2010
  - SMPS 2010
- Teaching activities
  - Seminar programs
  - International Summer Courses (2007, 2008, 2009)
  - Master Course on Soft Computing and Intelligent Data Mining (2009-2010)

Technology transfer

- Improve business competitiveness
- Technology forum:
  - Automotive industry, Food industry, Renewable Energy, Digital TV, Logistics

Dissemination

- Improving the technological image of the region
- Approaching science to society
  - Talks at high schools
- One international Prize each year (M. Dorigo, P. Bonissone, W. Pedrycz)
  - IV Cajastur Mamdani prize for Soft Computing

European Centre for Soft Computing

Staff

25 researchers (11 non-spanish)

15 people in management, administration and technical support positions

4 students from UniOvi

+ Affiliated researchers, Master students, and Visitors

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Staff

RESEARCH

Principal Researchers

- Óscar Cordón
- Enric Trillas
- Gracián Triviño
- Christian Borgelt
- Claudio Moraga
- Enrique Ruspini

Asssistants and Postdocs (Young Researchers)

- Sergio Damas
- Gil González
- Sergio Guadarrama
- José Alonso
- Luka Eciolaza
- Arnaud Quirin
- Wolfgang Trutschnig
- Marc Segond
- Prakash Shelokar

Visitors

- Jose Santamaría
- Michio Sugeno
- Rudolf Seising

Predocs

- Itziar García-Honrado
- Ana Belén Ramos
- Óscar Ibáñez
- Alberto Álvarez
- Sheila Méndez
- David Pérez
- Albert van der Heide
- Krzysztof Trawinski
- Raiko Schulz
- Sebastian Kaiser

UniOvi grants

- Carmen Campomanes
- Adrian Álvarez
- Luis de Arquer
- Antonio Palacio

Direction

- Luis Magdalena
- Raul del Coso
- Manuel Rodriguez

Management & admin

- Noelia Bueno
- Cristina Diago
- José Ramón González
- Carmen Peña
- Laura Roces
- María Jesús Santano
- Álvaro Villagrá
- Carmen Zarco

ICT

- Borja Gómez
- Marcos Montoro
- Daniel Álvarez
- Daniel Sánchez
- Pablo Suárez
- David Rivera

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Research Units

Intelligent Data Analysis and Graphical Models

- Christian Borgelt (Germany)

Applications of Fuzzy Logic and Evolutionary Algorithms

- Óscar Cordón (Spain)

Cognitive computing: computing with perceptions

- Gracián Trivino (Spain)

Collaborative Soft Intelligent Systems

- Enrique Ruspini (Argentina, USA)

Fundamentals of Soft Computing

- Claudio Moraga (Chile)
- Enric Trillas (Spain)

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Scientific Committee

Chair: Lotfi Zadeh (USA)

Vice-chair: Enric Trillas (ECSC)

Secretary: María Ángeles Gil (Spain)

Members:

- Piero Bonissone (USA)
- Christer Carlsson (Finland)
- Janusz Kacprzyk (Poland)
- Rudolf Kruse (Germany)
- Xin Jao (UK)
- Javier Montero (Spain)
- Henri Prade (France)

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R&D Projects

18 ongoing research projects (european, national and regional) and contracts

7 Basic & applied research projects

14 Projects with companies

- 3 CENIT projects and 3 Strategic projects

4 European projects

- BISON project
- COST Action
- Marie Curie Initial Training Network (MIBISOC)
- Marie Curie Fellowship for experienced researchers

MARIE CURIE ACTIONS

SEVENTH FRAMEWORK PROGRAMME

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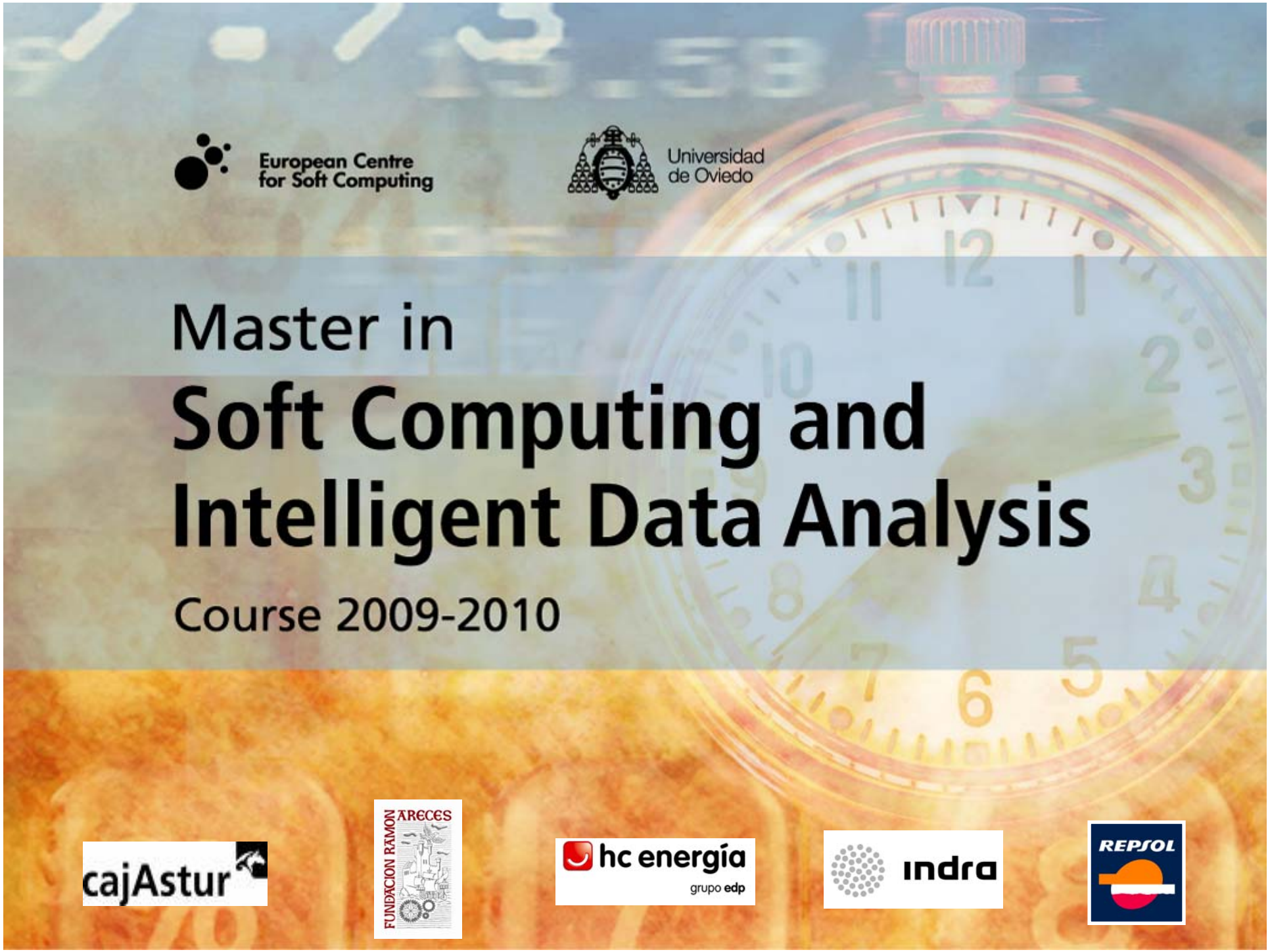
European Centre
for Soft Computing
Universidad
de Oviedo
Master in
Soft Computing and
Intelligent Data Analysis
Course 2009-2010
cajAstur
FUNDACION RAMON ARECES
hc energía
grupo edp
indra
REPSOL

Main features

- **Academic Period:** September 13, 2010 to July 31, 2011
- **Language:** English
- **Class Schedule:** From 15:30 until 20:00, Monday through Friday
- **Application Period**
  - First pre-registration period: April 26th to May 15th
  - Second pre-registration period: **May 16th to July 10th**
- **Course Fee:** 2.300€ aprox
- **Scholarship:** The Master offers scholarships that cover registration fee, travel and living expenses. Scholarships will be awarded on the basis of academic excellence

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What is Soft Computing?

Everytime you tell an outsider you work in Soft Computing or you apply Soft Computing techniques, the first question will be:

- **What is Soft Computing?**

There is neither a single nor the best answer

We apologize for SC as a tool for solving real problems, so we need to explain SC to non scientific people

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Revisiting several definitions

Soft computing has been defined from different points of view

- Properties
- Comparison (As opposite to …)
- Purpose
- Components

“What is Soft Computing? Revisiting possible answers”

Luis Magdalena

Plenary lecture at FLINS’08

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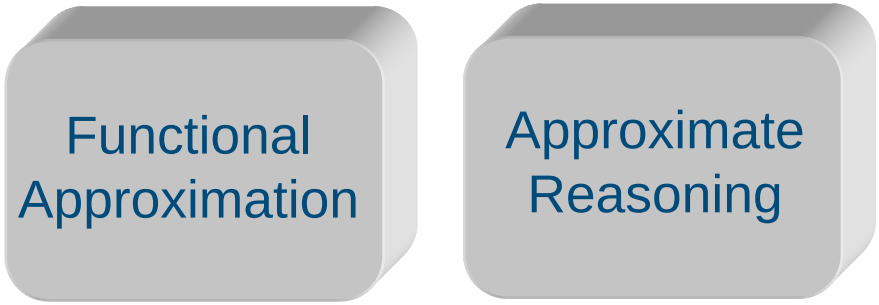
Soft Computing by properties

Every computing process that purposely includes imprecision into the calculation on one or more levels and allows this imprecision either to change (decrease) the granularity of the problem, or to "soften" the goal of optimization at some stage, is defined as to belonging to the field of soft computing

X. Li, D. Ruan, and A.J. van der Wal

Discussion on soft computing at FLINS'96

Int. Journal of Intelligent Systems, Vol. 13, (2–3), pp. 287–300 (1998)



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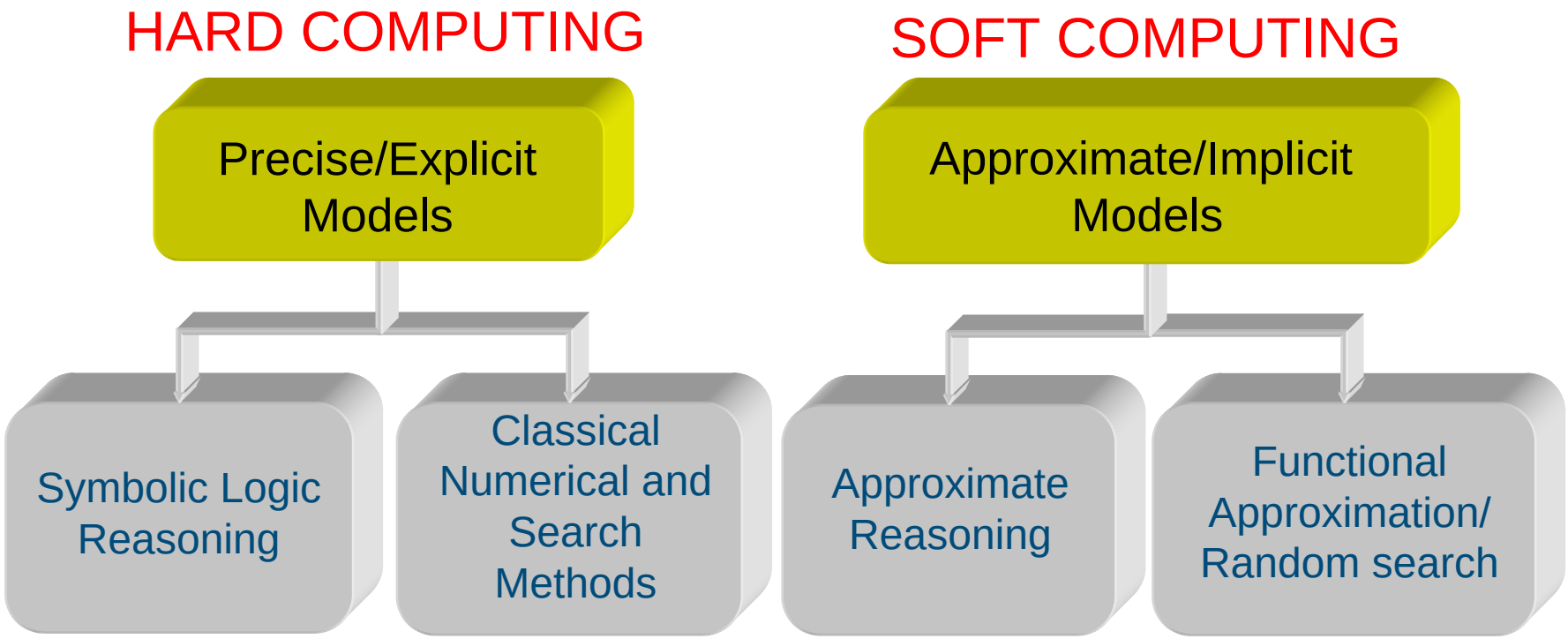
Soft computing as opposite to ...



Piero P. Bonissone
Soft Computing: the convergence of emerging computing technologies
Soft Computing, Vol 1 (1), pp 6-18 (1997)

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Soft computing as opposite to ...

Actually, the distinguishing feature of soft computing is straightforward. Hard computing uses an explicit model of the process under consideration while Soft computing does not do this. Instead, as an indispensable preliminary step, it infers an implicit model from the problem specification and the available data.

Stephen W. Kercel
Guest Editorial, Special Issue: Industrial Applications of Soft Computing
IEEE Trans. on Systems, Man and Cybernetics-Part C, Vol. 36 (4), pp 450-452 (2006)

Soft computing by purpose

The guiding principle of soft computing is:

Exploit the tolerance for imprecision, uncertainty, partial truth, and approximation to achieve tractability, robustness, low solution cost and better rapport with reality.

L.A. Zadeh
Soft computing and fuzzy logic
IEEE Software, Vol 11 (6), pp 48–56 (1994)

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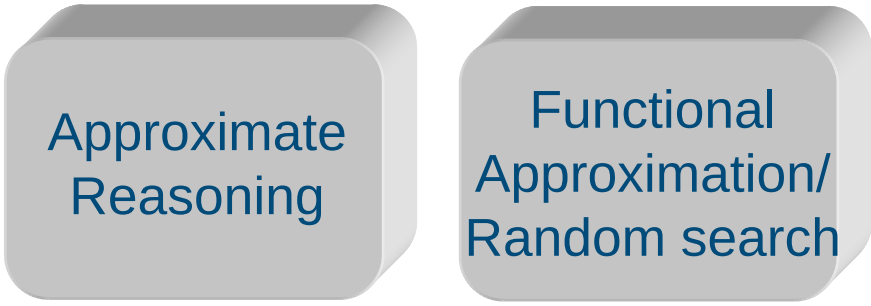
Soft computing by components

... soft computing is a partnership of distinct methods ...

The principal constituents of soft computing are fuzzy logic, neurocomputing, and probabilistic reasoning, with the latter subsuming genetic algorithms, belief networks, chaotic systems, and parts of learning theory.

L.A. Zadeh
Soft computing and fuzzy logic
IEEE Software, Vol 11 (6), pp 48–56 (1994)



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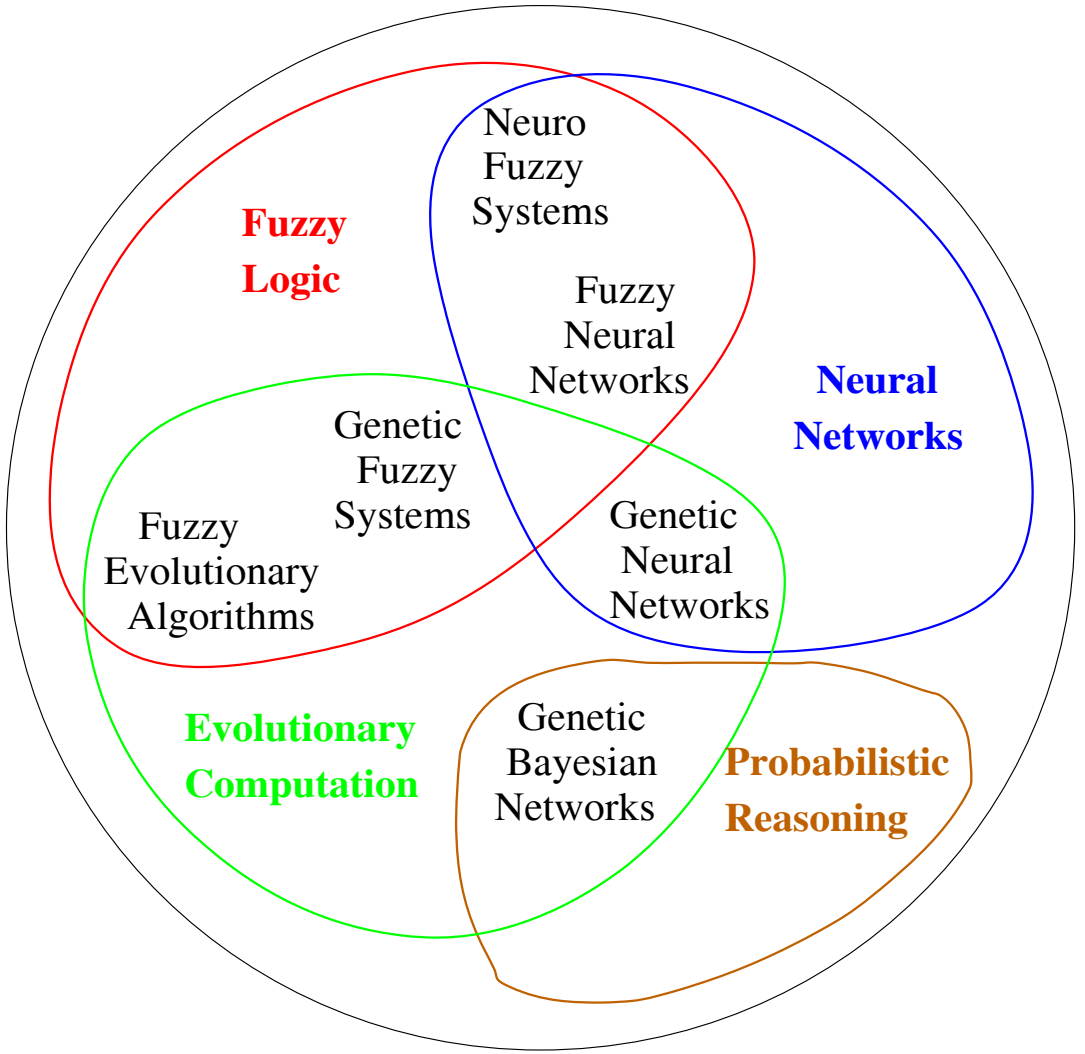
Soft Computing in practice

Solving real-world problems

- Approximate reasoning
  - Expert Knowledge
  - Intelligent Data Analysis
  - Automatic Learning
  - Decision Making
  - Handling Uncertainty



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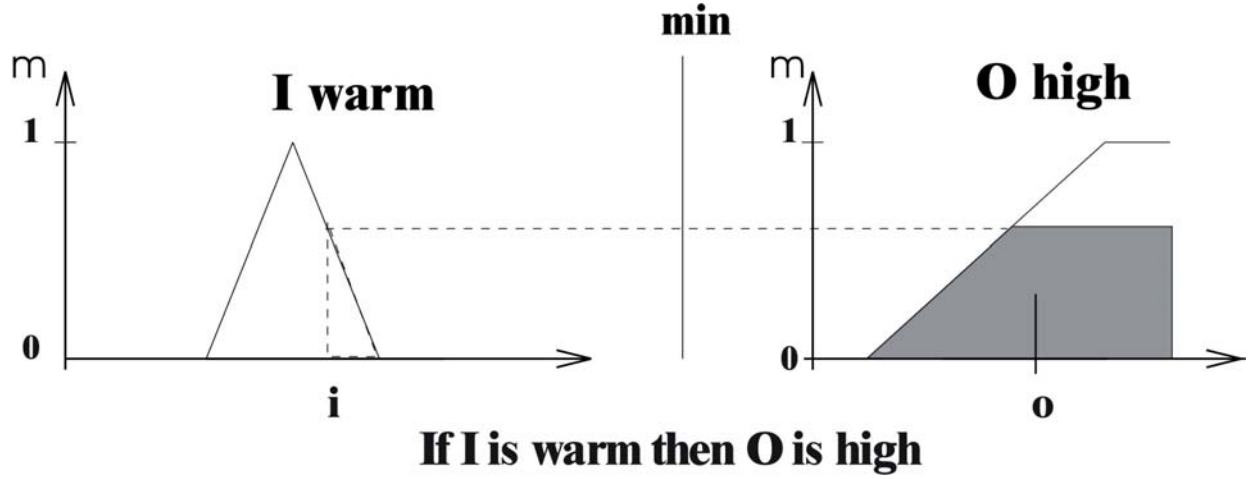
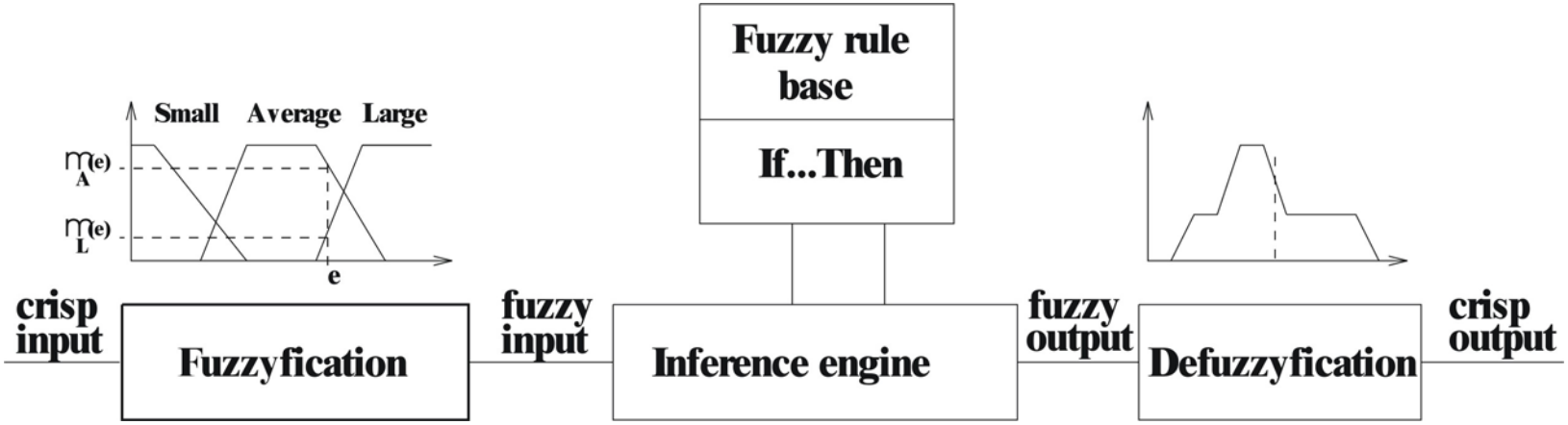
Soft Computing techniques





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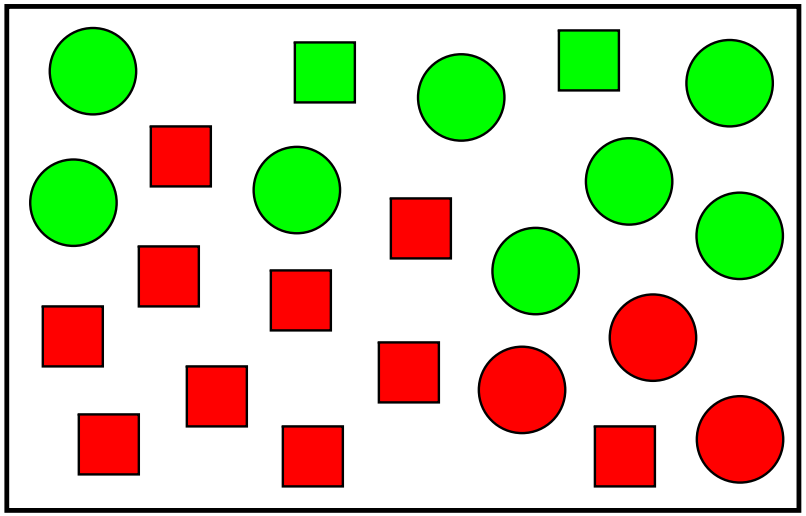

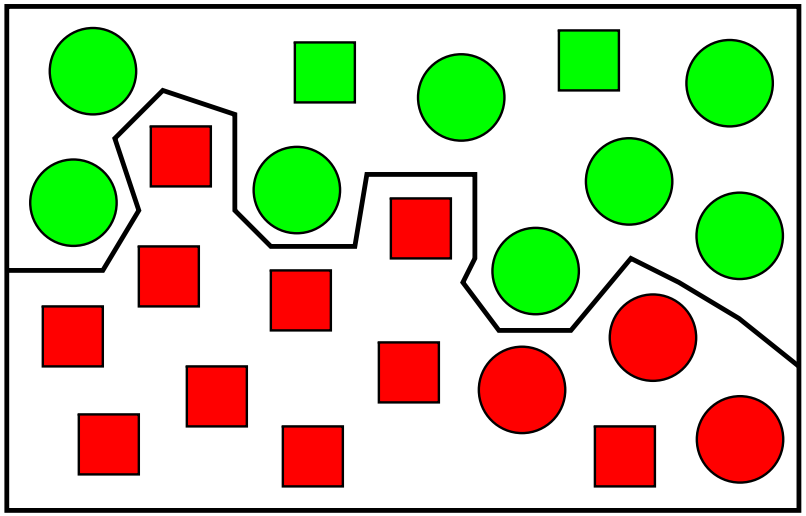

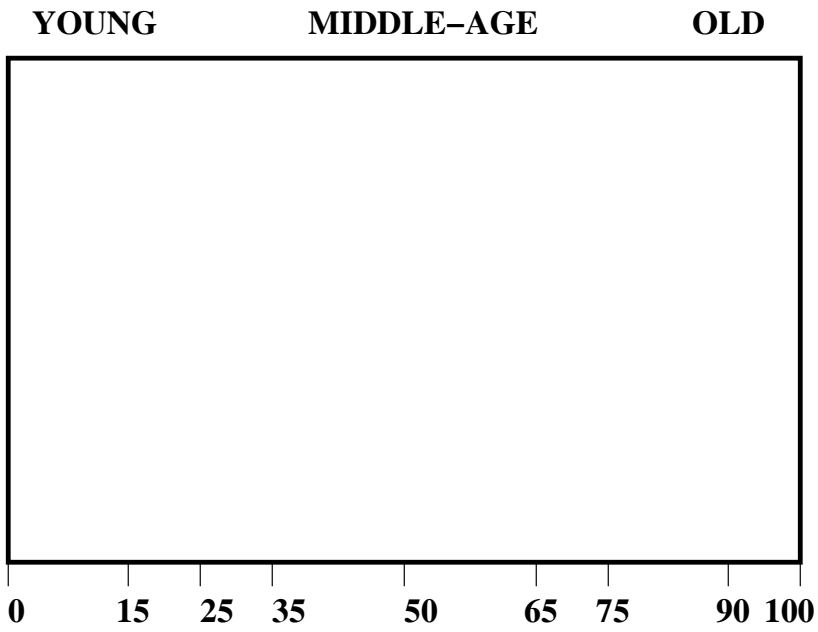
YOUNG
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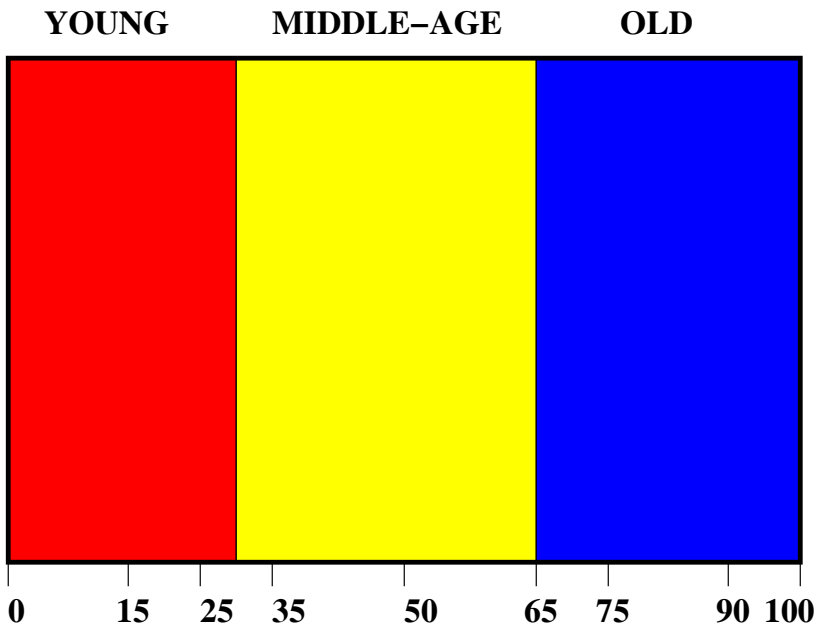
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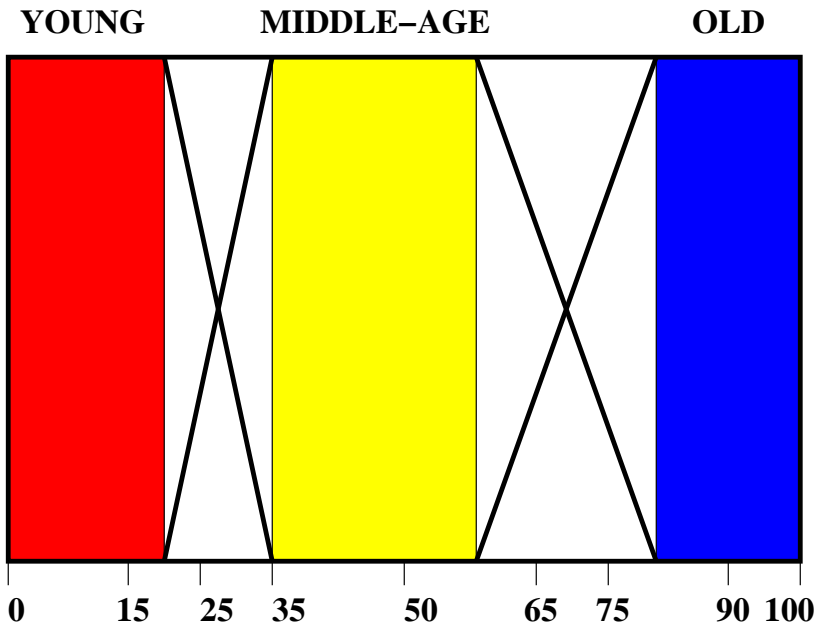
YOUNG
MIDDLE–AGE
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100

Fuzzy Inference Systems (FIS)

The most commonly used fuzzy inference technique is the so-called Mamdani method (1975): Min-Max

- Fuzzification of inputs
- Rule evaluation (conjunction / implication): Minimum
- Aggregation of rule outputs: Maximum
- Defuzzification

Fuzzy Inference Systems (FIS)

A simple example: two-input one-output problem that includes three rules

NOTE: this example is taken from “Artificial Intelligence. A guide to Intelligent Systems” (Michael Negnevitsky, Addison Wesley)

Rule: 1

IF *x* is *A*3
OR *y* is *B*1
THEN *z* is *C*1

Rule: 2

IF *x* is *A*2
AND *y* is *B*2
THEN *z* is *C*2

Rule: 3

IF *x* is *A*1
THEN *z* is *C*3

Rule: 1

IF *project_funding* is *adequate*
OR *project_staffing* is *small*
THEN *risk* is *low*

Rule: 2

IF *project_funding* is *marginal*
AND *project_staffing* is *large*
THEN *risk* is *normal*

Rule: 3

IF *project_funding* is *inadequate*
THEN *risk* is *high*

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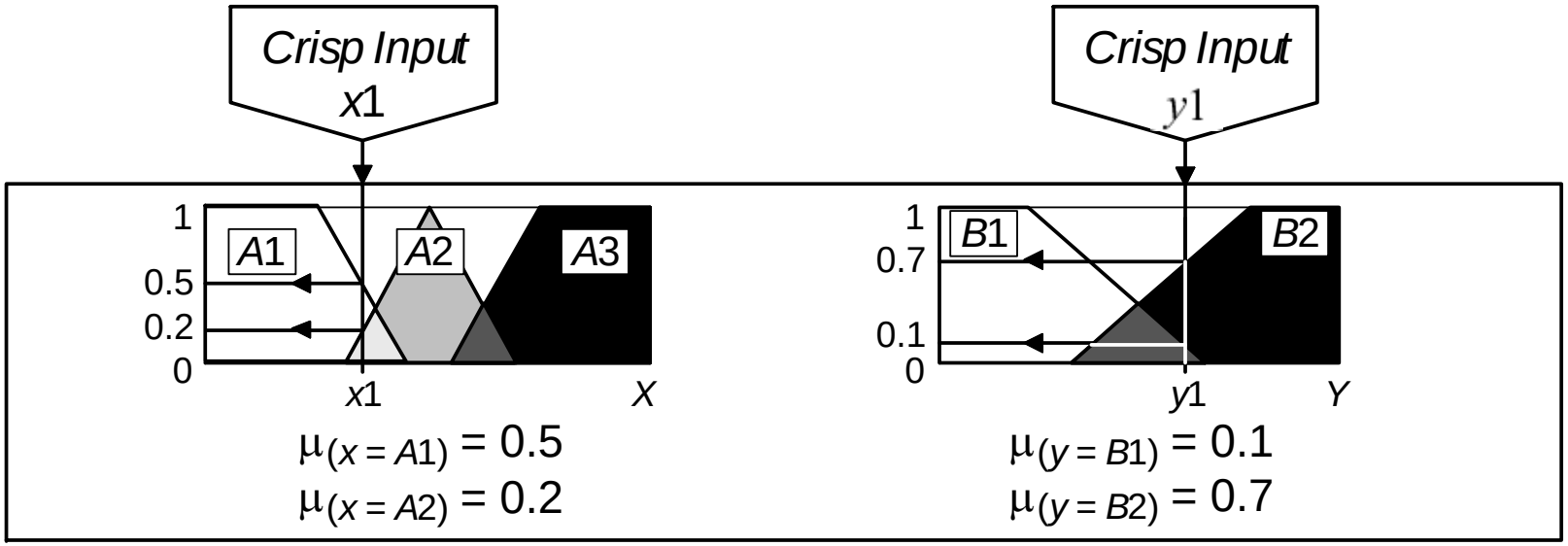
FIS: Fuzzification



NOTE: this example is taken from "Artificial Intelligence. A guide to Intelligent Systems" (Michael Negnevitsky, Addison Wesley)

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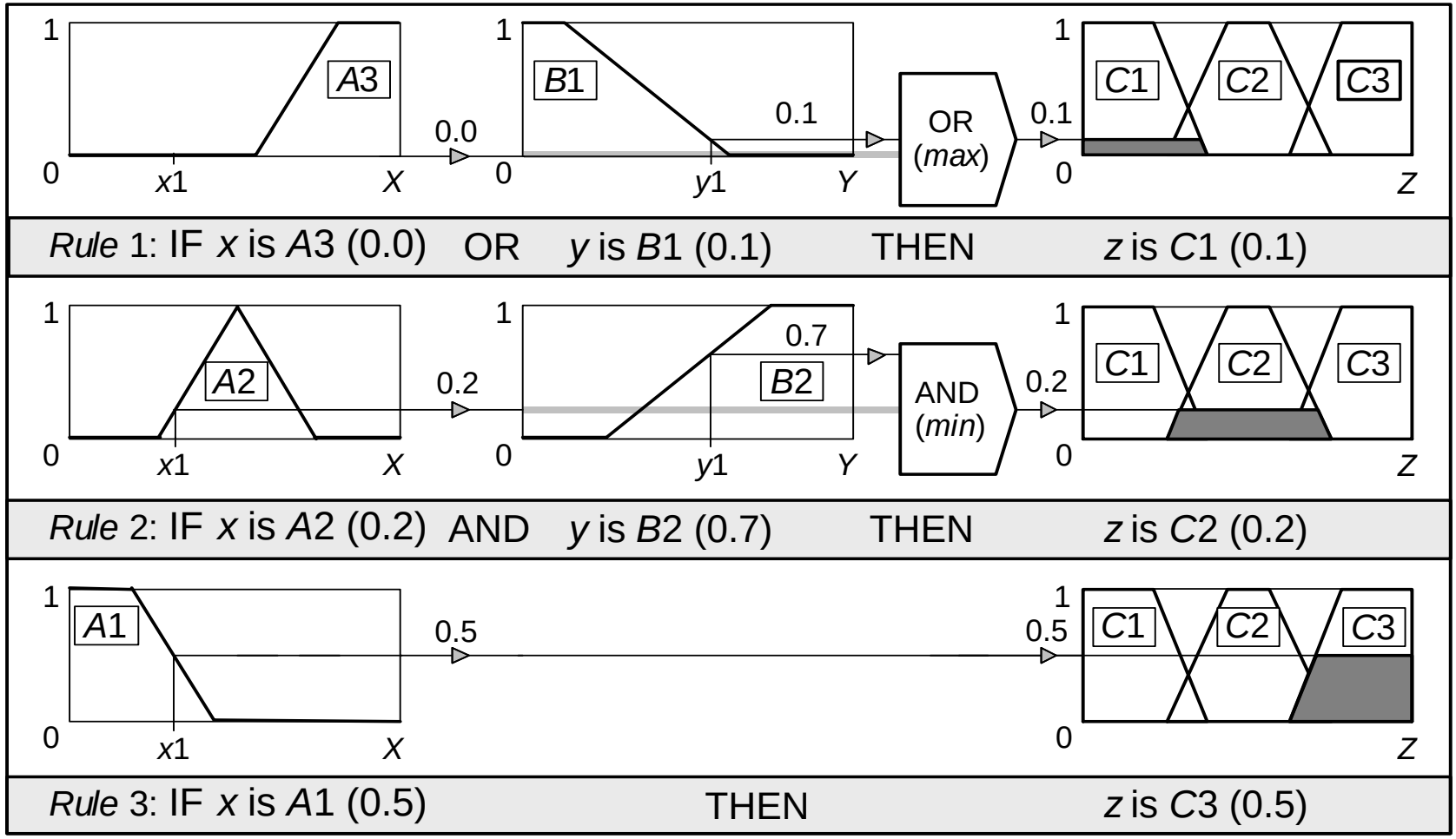
FIS: Rule evaluation



NOTE: this example is taken from "Artificial Intelligence. A guide to Intelligent Systems" (Michael Negnevitsky, Addison Wesley)

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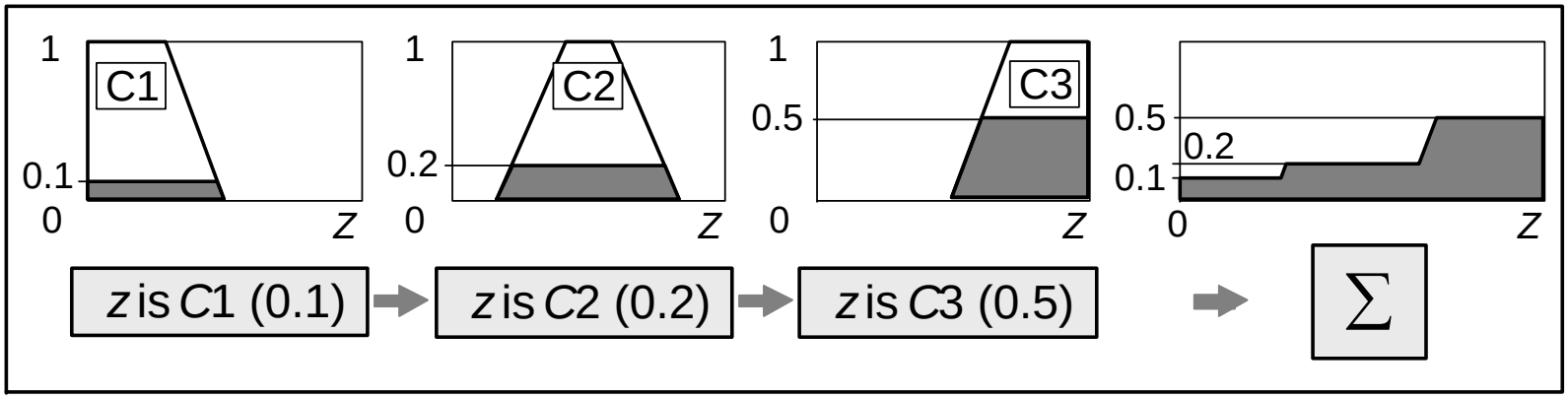
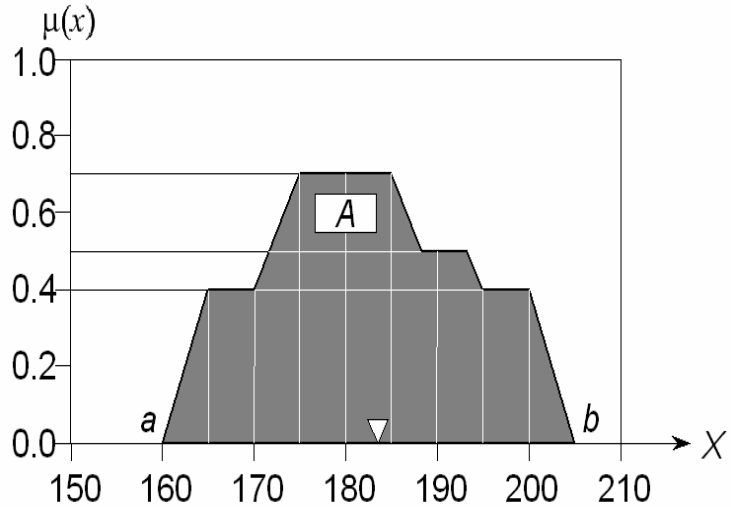
FIS: Aggregation



NOTE: this example is taken from "Artificial Intelligence. A guide to Intelligent Systems" (Michael Negnevitsky, Addison Wesley)

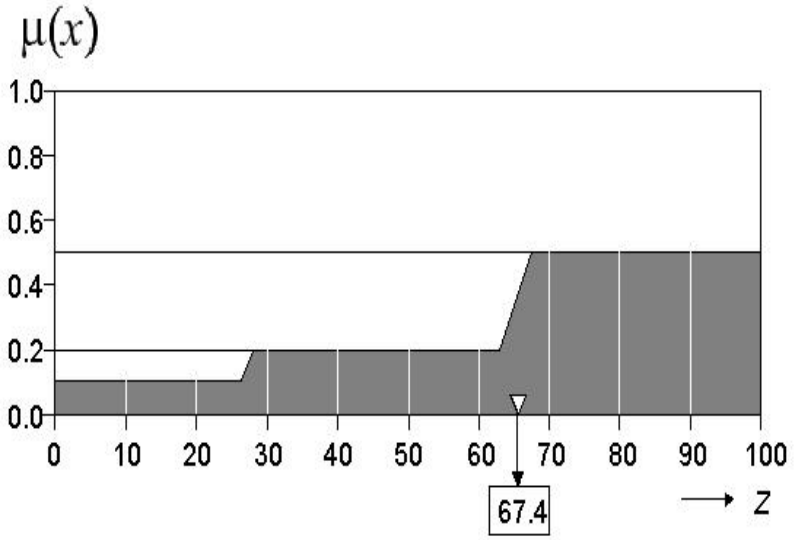
FIS: Defuzzification

Centroid



Center of Gravity (COG)

$$COG = \frac{(0+10+20)\times 0.1+(30+40+50+60)\times 0.2+(70+80+90+100)\times 0.5}{0.1+0.1+0.1+0.2+0.2+0.2+0.2+0.5+0.5+0.5+0.5} = 67.4$$



NOTE: this example is taken from "Artificial Intelligence. A guide to Intelligent Systems" (Michael Negnevitsky, Addison Wesley)

Solving real-world problems

Three illustrative examples

- **WIFIROBOTS**
  - **A team of robots is in charge of extending a wireless network**
- **SARBIA**
  - **Advanced irrigation system based on Soft Computing techniques**
- **LILA-CATA**
  - **Assessing the quality of asturian cheeses**

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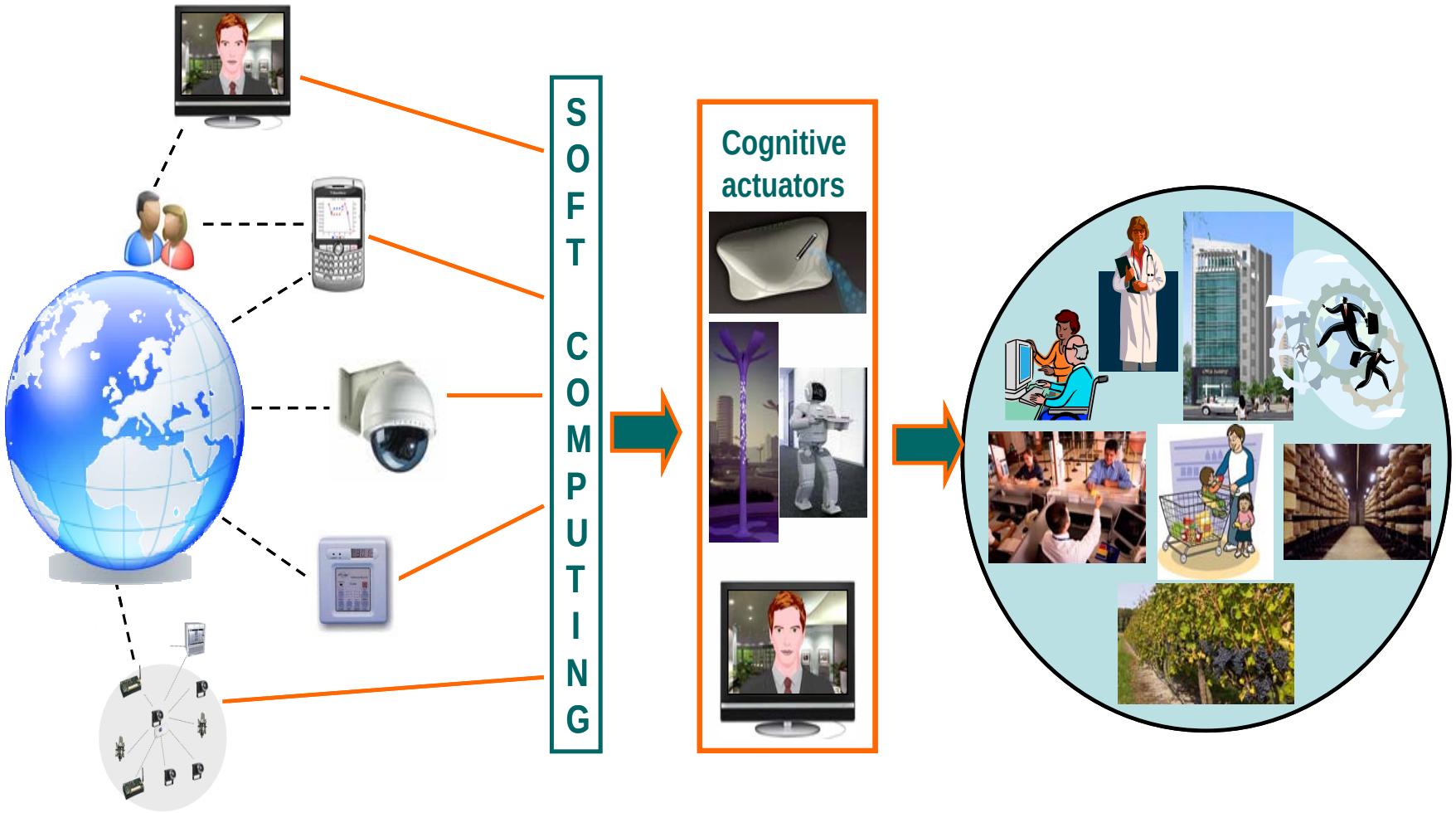
Ambient Intelligence



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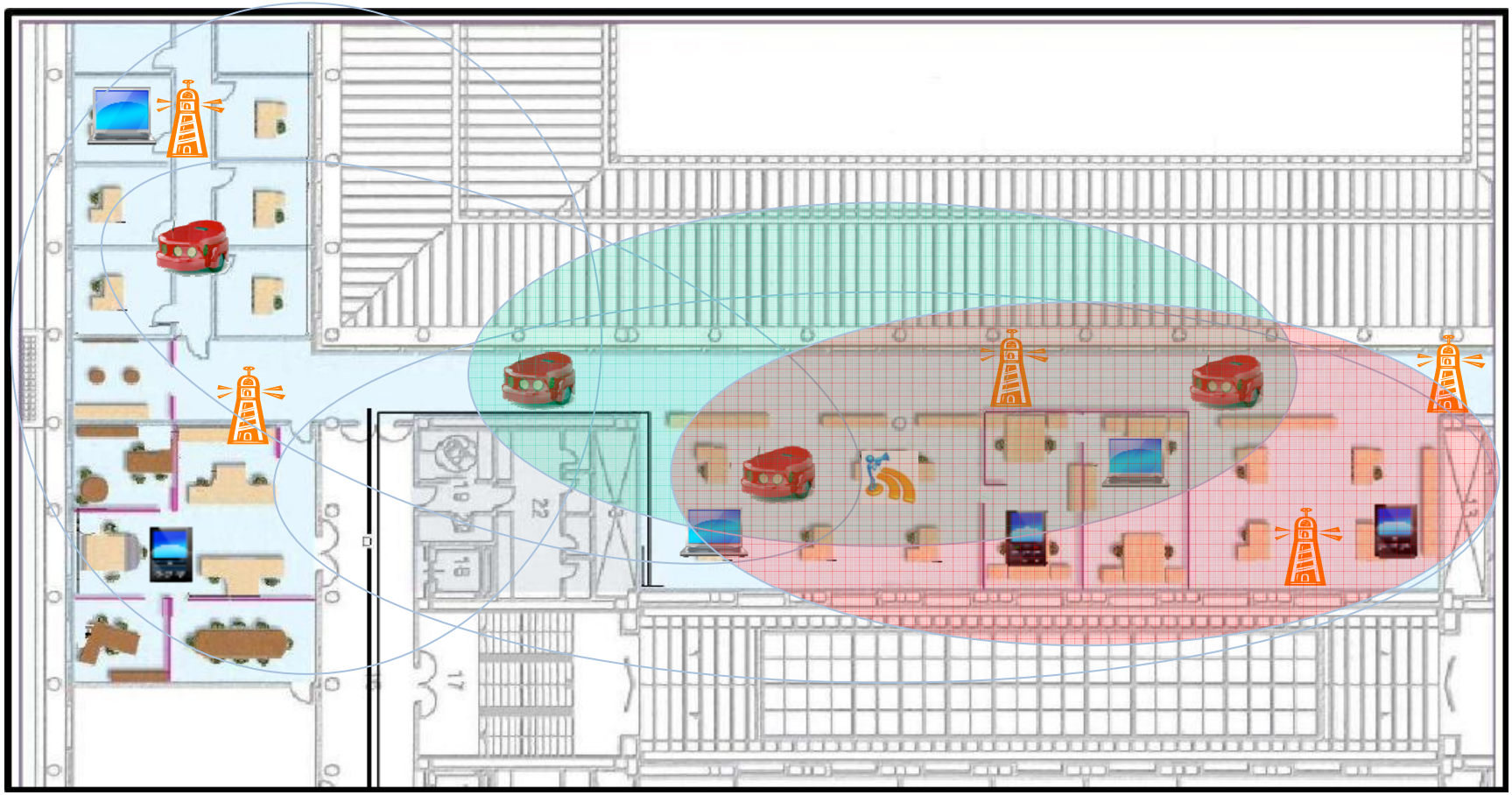
Ambient Intelligence

- **1999**: The IST Advisory Group of the UE introduces the term ***Ambient Intelligence* (AmI)** as part of the preparations for the FP6
- **2000:** The first document describing future applications for AmI

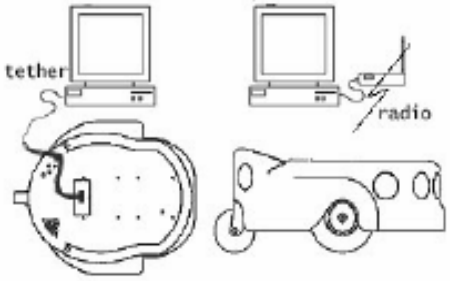
  (absolutely wrong prediction)
  - ***Scenarios for Ambient Intelligence in 2010***
    (http://cordis.europa.eu/fp7/ict/istag/home_en.html)
    - Road Warrior
    - Dimitrios and the Digital-Me
    - Carmen – traffic, sustainability, and commerce
    - Annette and Solomon in the ambient for social learning
  - Basics
    - **Ubiquitous computing**
    - **Pervasive computing**
    - **Context awareness**
    - **Profiling practices**
    - **Human-centric computer interaction**

Dynamic extension of a WiFi network



WIFIROBOTS

AMIGOBOTS (MobileRobots Inc.)



Team AmigoBot™

- Weight: 3.6kg / Carga: 1kg
- Batery: 3h
- 8 ultrasounds (12cm / 5m)
- 44 MHz Renesas SH2-7144
- RS-232, WiFi, Ethernet

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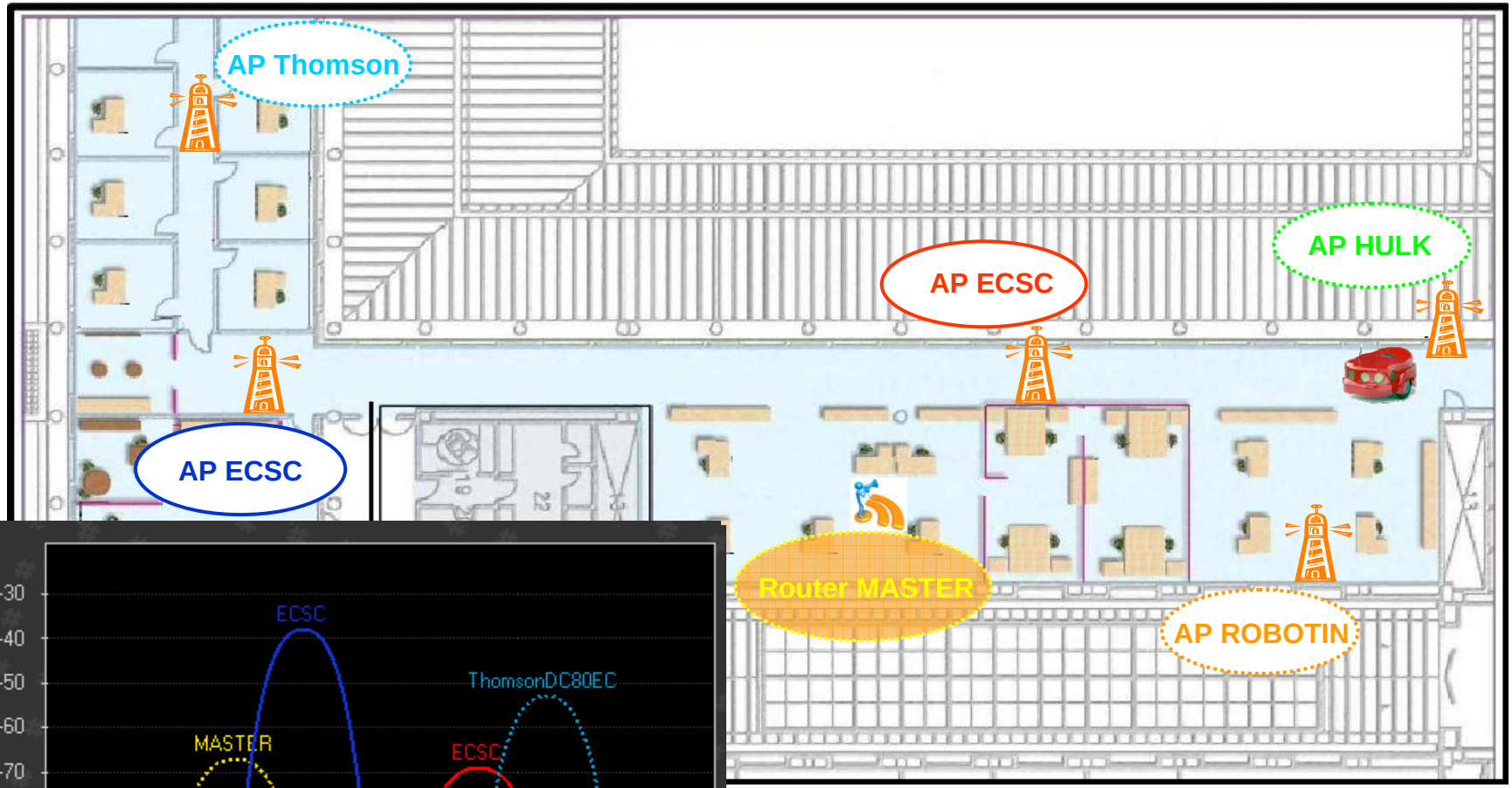
WIFIROBOTS



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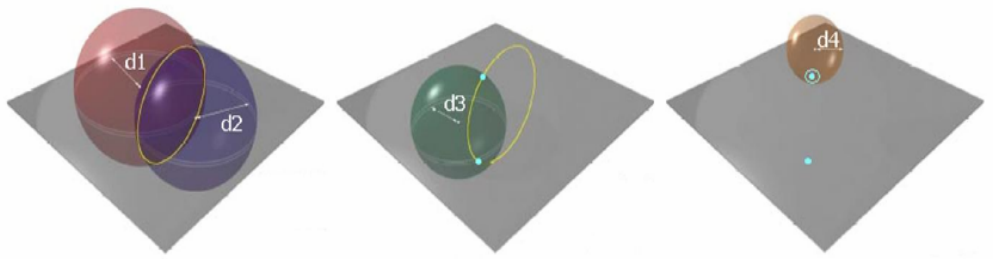
Soft Computing

- The WiFi signal is extremely noisy (multi-path effect)
  - Handling uncertainty by means of Fuzzy Logic
  - Indoor localization system based on Fuzzy Logic
- Enhancing navigation
  - Fuzzy Finite State Machines, Aggregation Operators, etc
  - Fusion of sesors: WiFi + ultrasounds + odometry
- Collaborative tasks
  - Fuzzy Logic + Multi-objective Evolutionary Algorithms
  - SLAM (Self-localization and mapping)
    - Combining partial observations of the whole environment
  - Real-time robot deployment
    - Communication, planning, routing, etc.

WiFi localization by means of Triangulation

- Signal strength strongly depends on distance and obstacles
- WiFi frequency (2.4GHz): water resonancy (human interference)
- WiFi channel is very noisy
  - Reflection + Refraction + Diffraction => Multipath effect

$$\underbrace{RSL_{AP_u}}_{\text{Received Signal Level}} = TSL_{AP_u} + G_{TX} + G_{RX} + 20log(\lambda) - 20log(4\pi) - \underbrace{10 \cdot n_W \cdot log(d_u)}_{\text{Distance dependant}} - X_a, \forall u \in U$$



PROPAGATION MODEL

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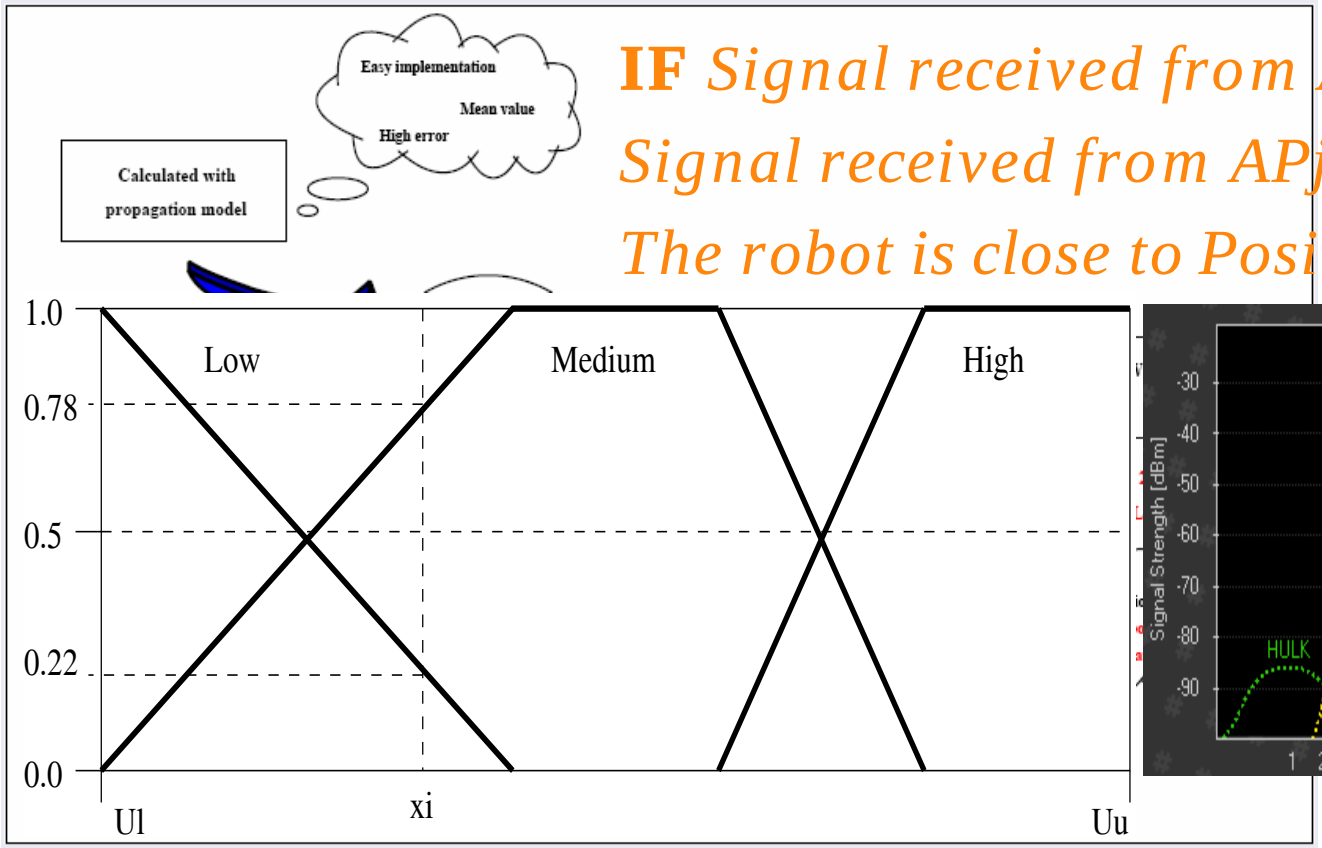
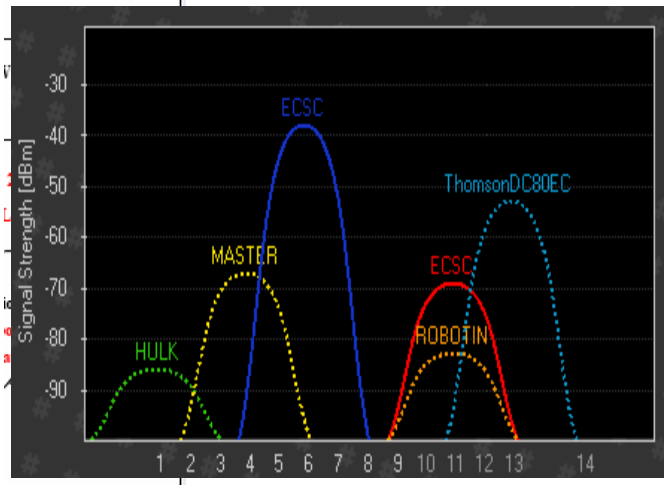
WiFi localization by means of Fuzzy Rule-based Systems



IF *Signal received from APi is High* **AND** *Signal received from APj is Low* **THEN** *The robot is close to Position k*



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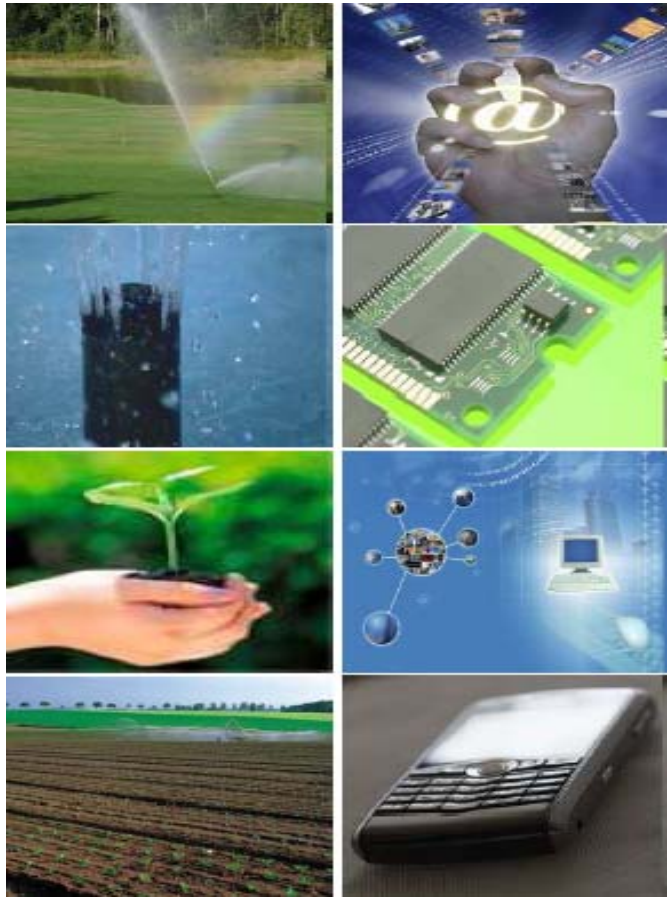
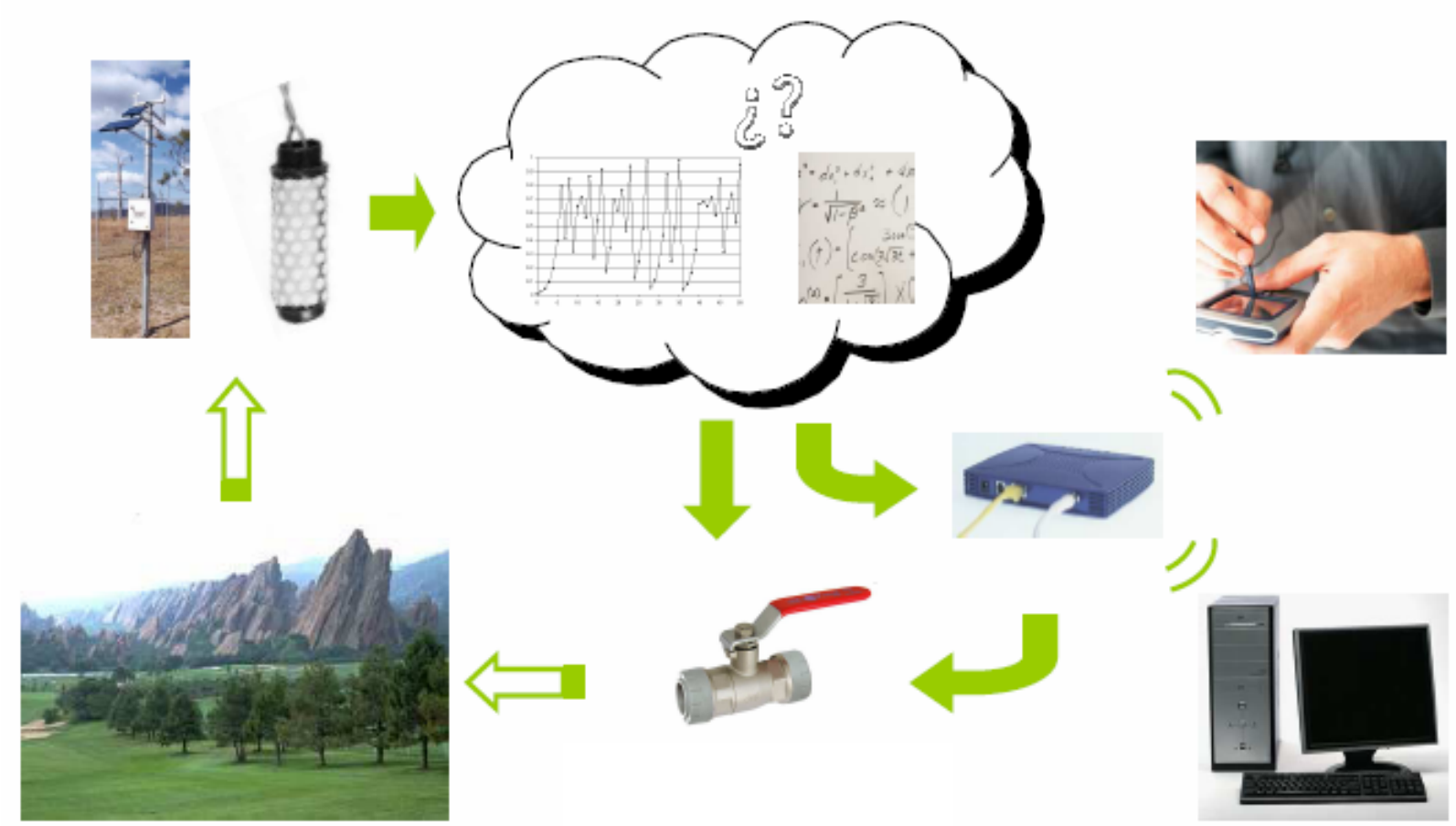
Requirements

- Efficiency / Security
- Remote control
- Automatic data acquisition
- Data analysis
- Fusion of heterogeneous information
- Learning capabilities
- Autonomous decision making
- High interaction with humans
- Adding expert knowledge
- Explaining decisions in a comprehensible way
- Incorpotating feedback information
- Close Loop: sensors + reasoning + actuators



SARBIA



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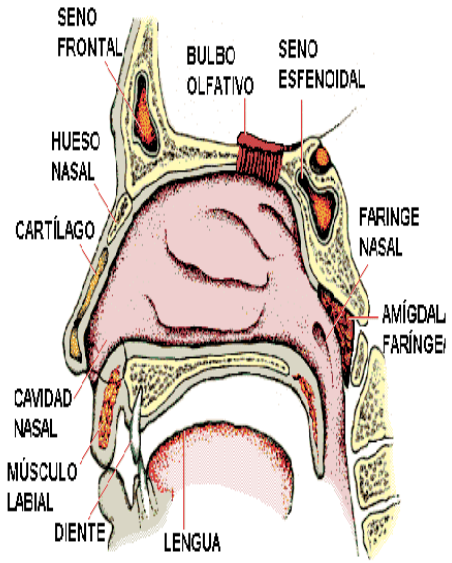
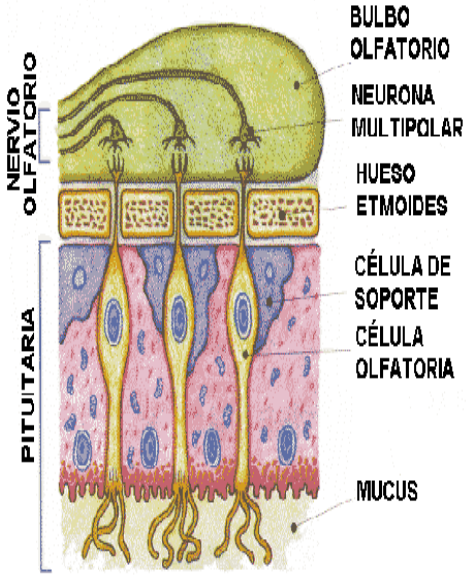
Cheese ripening process (cure)

Quality evaluation

- Physico-quimical analysis (It can be eaten - Healthy)
- Sensor analysis (It can be sold as certified)





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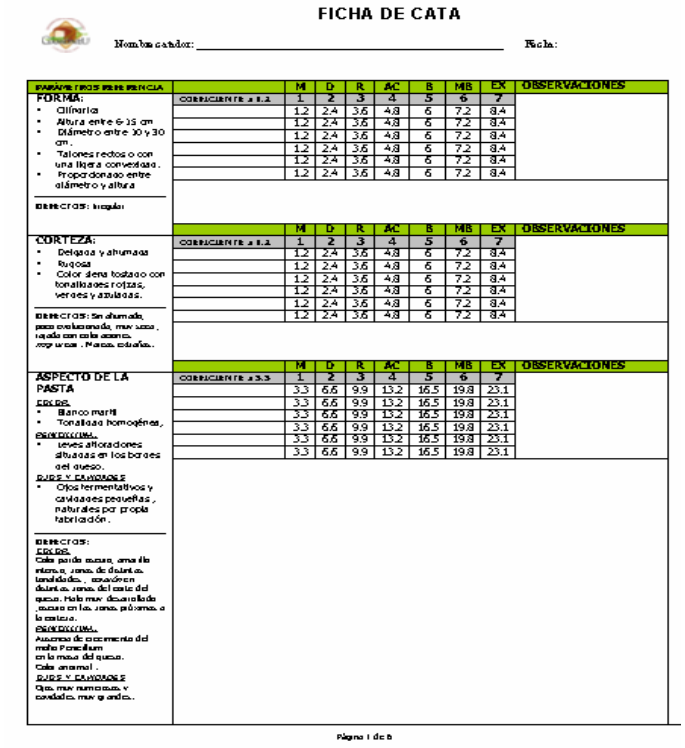
LILA-CATA

Assessing the quality of asturian cheeses by means of combining statistics and Soft Computing



FICHA DE CATA

Nombre catador: _____ Fecha:

PARÁMETROS DE REFERENCIA		M	D	R	AC	B	MB	EX	OBSERVACIONES
FORMA:	COEFICIENTE x 1.2	1	2	3	4	5	6	7	
• Cilíndrica • Altura entre 6-15 cm • Diámetro entre 20 y 30 cm. • Talones rectos o con una ligera convexidad. • Proporcionado entre diámetro y altura		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
INCORRECTAS: Irregular									
		M	D	R	AC	B	MB	EX	OBSERVACIONES
CORTEZA:	COEFICIENTE x 1.2	1	2	3	4	5	6	7	
• Delgada y aterciopelada • Rugosa • Color desde tostado con tonalidades rojizas, verdes y azuladas.		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
		1.2	2.4	3.6	4.8	6	7.2	8.4	
INCORRECTAS: Sin aterciopelada, poco aterciopelada, muy lisa, rugosa con arrugas excesivas. Manchas extrañas.									
		M	D	R	AC	B	MB	EX	OBSERVACIONES
ASPECTO DE LA PASTA	COEFICIENTE x 3.3	1	2	3	4	5	6	7	
COLOR: • Blanco marfil • Tonalidades homogéneas.		3.3	6.6	9.9	13.2	16.5	19.8	23.1	
		3.3	6.6	9.9	13.2	16.5	19.8	23.1	
		3.3	6.6	9.9	13.2	16.5	19.8	23.1	
		3.3	6.6	9.9	13.2	16.5	19.8	23.1	
		3.3	6.6	9.9	13.2	16.5	19.8	23.1	
		3.3	6.6	9.9	13.2	16.5	19.8	23.1	
PROTEOLISIS: • Leves aflocaciones situadas en los bordes del queso.									
OJOS Y CAVIDADES • Ojos fermentativos y cavidades pequeñas, naturales por propia fabricación.									
INCORRECTAS: COLOR: Color pardo oscuro, amarillo intenso, zonas de distintas tonalidades, excesivo en distintas zonas del corte del queso. Halo muy desarrollado, oscuro en las zonas próximas a la corteza. PROTEOLISIS: Abundante crecimiento del moho Penicillium en la masa del queso. Color anormal. OJOS Y CAVIDADES Ojos muy numerosos y cavidades muy grandes.									

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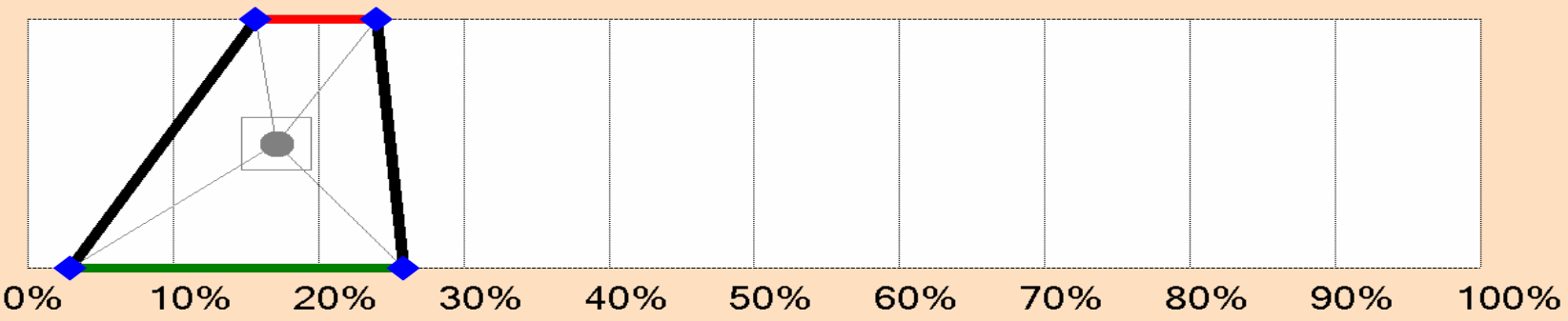
LILA-CATA

Catador: Muestra: 36 Pregunta: 1/8

FORMA

- Cilíndrica.
- Caras sensiblemente planas.
- Altura entre 6 y 15 cm.
- Diámetro de 10 a 30 cm.
- Peso: 0,5-7 Kg.
- Proporcionado diámetro-altura.
- Talones rectos o ligeramente convexos.



Siguiente

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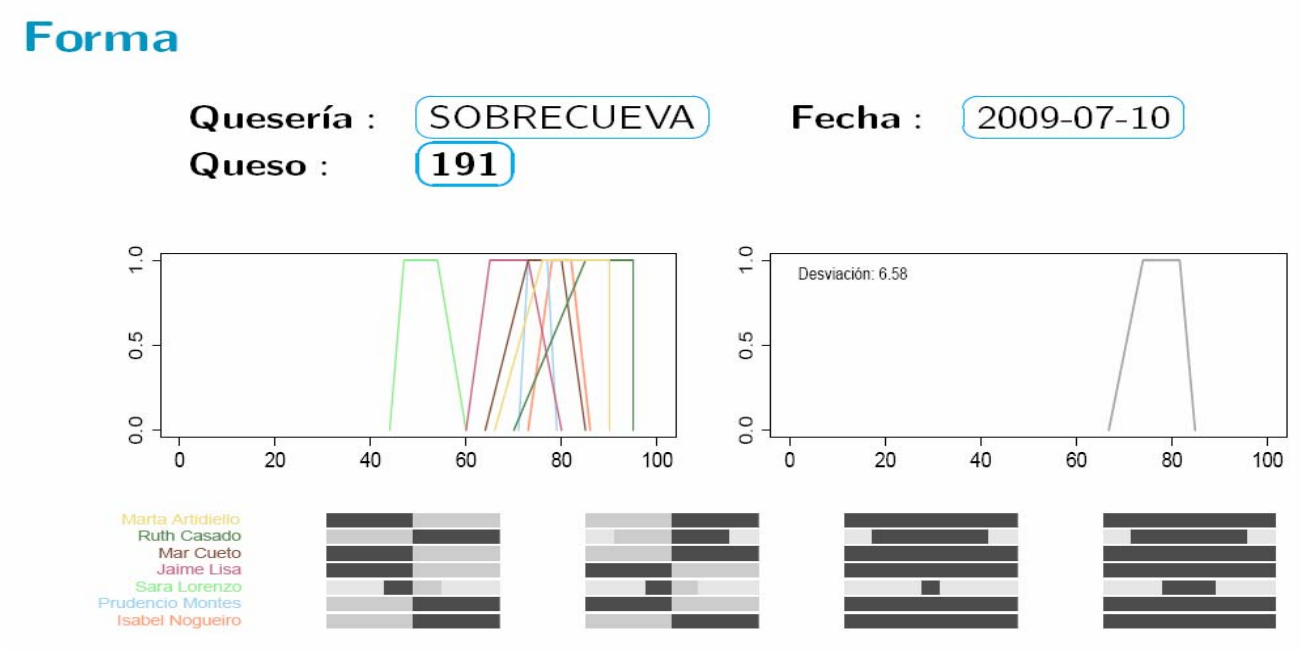
LILA-CATA

Assessing the quality of asturian chesses by means of combining statistics and Soft Computing



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Conclusions

- Soft Computing represents a computational approach to solve problems under circumstances of uncertainty and/or imprecision, either inherent or “added”
- Uncertainty or imprecision is not a target, it is a fact or a mean
- Core techniques are Fuzzy Logic, Neural Networks, Evolutionary Computation and Probabilistic Reasoning
- Other components are granular computing, bio-inspired search and optimization, or computing with words
- Hybridization is one of the central aspects of the field
- Is particularly focused on real-world problems, working on the basis of approximate and implicit models achieving good (but not optimal) solutions
- Apparently there are some differences in between Soft Computing and Computational Intelligence (not very significant in practice)
  - CI - Biologically and linguistically motivated computational paradigms
  - SC - Computing processes that purposely include imprecision (decreasing) the granularity or "softening" the goal

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What is CI?

Computational intelligence (CI) is a recently emerging area of fundamental and applied research exploiting a number of advanced information processing technologies. The main components of CI encompass neural networks, fuzzy set technology and evolutionary computation.

Witold Pedrycz

Computational Intelligence: An Introduction

CRC Press, 1998

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What is CI?

The Field of Interest of the Society shall be the theory, design, application, and development of biologically and linguistically motivated computational paradigms emphasizing neural networks, connectionist systems, genetic algorithms, evolutionary programming, fuzzy systems, and hybrid intelligent systems in which these paradigms are contained.

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