Making Intelligent Systems Understandable to Humans

Jose Maria Alonso Moral
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CiTIUS Seminar Program
Santiago de Compostela, March 2, 2017

Centro Singular de Investigación en Tecnoloxías da Información

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1. Introduction

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Jose M. Alonso - Contact Details

- **Postdoc Researcher at CITIUS-USC**
  - E-mail: josemaria.alonso.moral@usc.es
  - Web: https://citius.usc.es/v/jose-maria-alonso-moral

Jose M. Alonso - Short bio

- Born in Madrid (1980)
- **M.Sc. (2003).** Technical University of Madrid (UPM)
  - Telecommunication Engineer
- **Ph.D. (2007).** FPI-UPM
  - Computer Science and Artificial Intelligence Department
  - "**Interpretable Fuzzy Systems Modeling with Cooperation between Expert and Induced Data**" (http://oa.upm.es/588/)
    - ADVOCATE2 EU Project (IST-2001-34508)
    - 18 weeks at Cemagref, Montpellier (Languedoc-Roussillon, France)
    - 32 weeks European Centre for Soft Computing, Mieres (Asturias, Spain)

Jose M. Alonso - Short bio

- **Postdoc Researcher** (Nov 2007 - Jan 2012)
  "Fundamentals of Soft Computing" Research Unit
  European Centre for Soft Computing (Spain)
  - Visiting Research Fellow (Jun 2010)
    University of Bari (Italy)
- **Postdoc Researcher** (Feb 2012 - Oct 2012)
  "Electronics" Department, University of Alcala, Madrid (Spain)
  - Visiting Research Fellow (Sep 2012)
    University of Granada (Spain)
- **Associate Researcher** (Nov 2012 - May 2016)
  "Computing with Perceptions" Research Unit
  European Centre for Soft Computing (Spain)
  - Visiting Research Fellow (Sep 2013 and Sep 2014)
    University of Granada (Spain)

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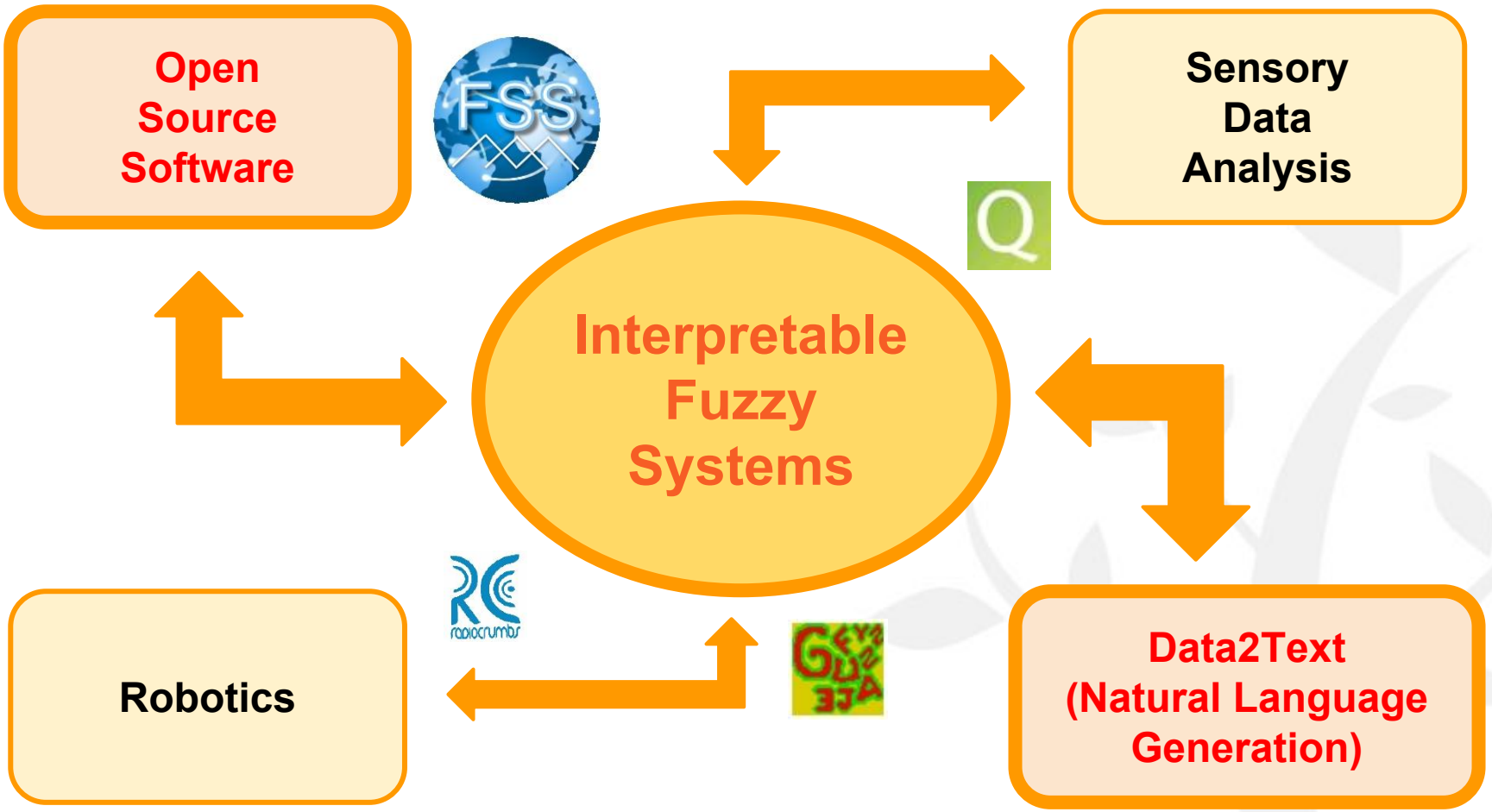
Jose M. Alonso - Current Position

- **Postdoc Researcher** CITIUS-USC (Since Jun 2016)
  - Honorary Research Fellow University of Aberdeen (Aug 2016 - Nov 2016)
- **Secretary** of the **European Society for Fuzzy Logic and Technology** (EUSFLAT)
  - **Chair of the III European Summer School on Fuzzy Logic and Applications (SFLA2017)**, supported by EUSFLAT and organized by CiTIUS-USC (to be held by July 17 - 21, 2017) https://citius.usc.es/sfla2017
- **Vice Chair** of the **IEEE Task Force** on **"Fuzzy Systems Software"**
  - Fuzzy Systems Technical Committee of the IEEE Computational Intelligence Society (IEEE-CIS) http://sci2s.ugr.es/TF-FSS
- **Associate Editor** of the **IEEE Computational Intelligence Magazine** (IEEE-CIM, Q1 in ISI-JCR)
  - Special Issue on NLG with CI https://eventos.citius.usc.es/nlgci/
- **General Chair** for the International Conference **INLG2017**
  - Supported by SIGGEN-ACL and organized by CiTIUS-USC (to be held by Sep 4 - 7, 2017) https://eventos.citius.usc.es/inlg2017/

Main Research Lines



2. Interpretable Fuzzy Modeling

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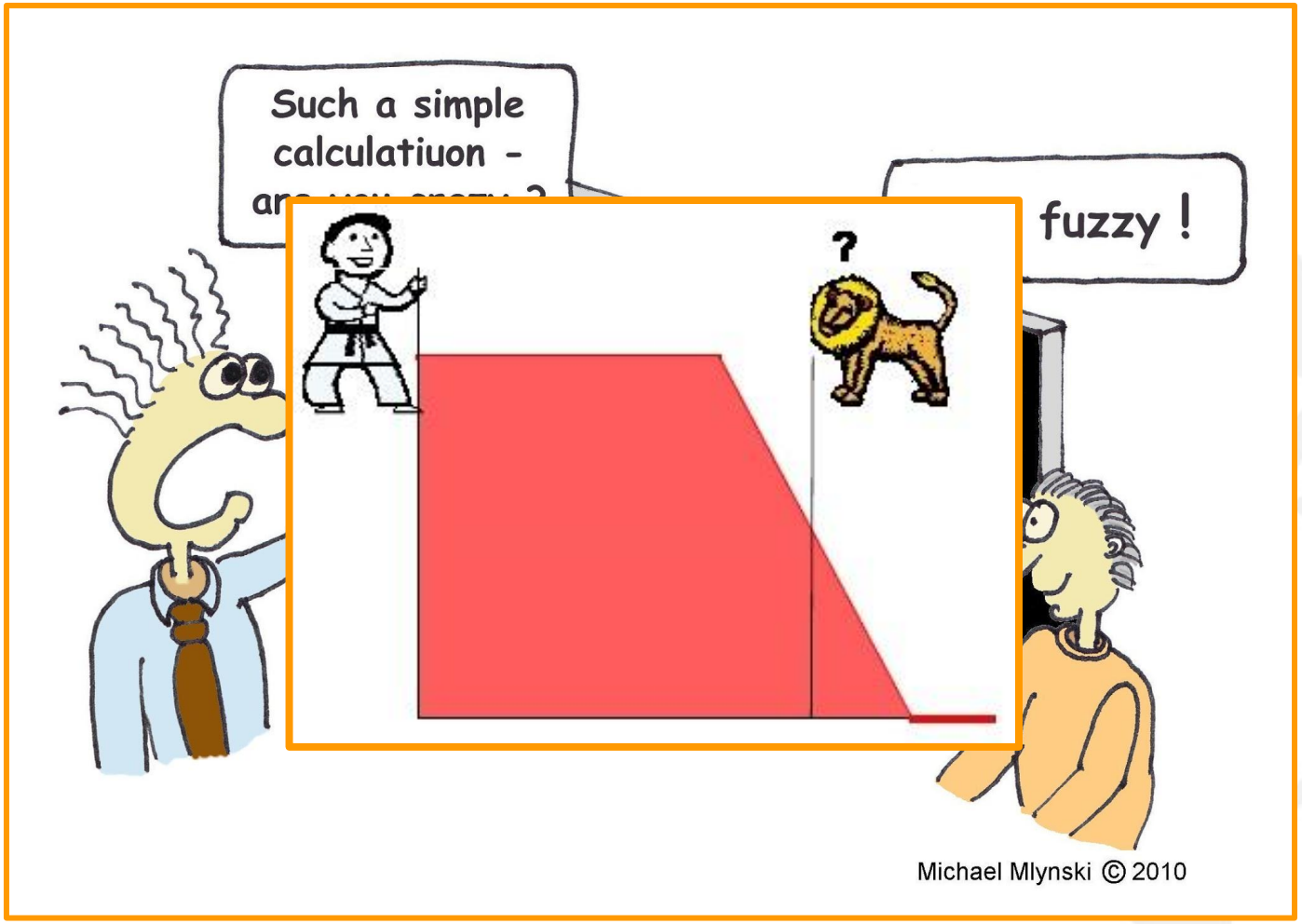

http://www.youtube.com/watch?v=J_Q5X0nTmrA
http://www.youtube.com/watch?v=2ScTwFCcXGo

- **Linguistic and Approximative Fuzzy Modeling**
  - [1965] **Fuzzy Sets**
  - [1965 − 1990] **Interpretability (I)** - LFM
    - Fuzzy Reasoning (dealing with uncertainty)
    - Simple linguistic variables and rules (high interpretability)
    - Expert knowledge (Fuzzy Control and Expert Systems)
  - [1990 − 2000] **Accuracy (A)** - AFM
    - Complex fuzzy rules with high accuracy
    - Induced knowledge (Machine Learning, Hybrid Systems)
  - [2000 − 2014] **I-A Trade-off** (LFM + AFM)
    - Simple linguistic rules with high accuracy
    - Expert + Induced knowledge, Multi-objective design
  - [2014 − 2016] Internet of Things, Big Data, Social Networks, etc.

- **Linguistic Summarization of Data** (Yager 1990)
- **Computational Theory of Perceptions** (Zadeh 2001)
  - "*From Computing with Numbers to Computing with Words*"
    "*From Manipulation of Measurements to Manipulations of Perceptions*"

INTERPRETABILITY ISSUES

Readability, Comprehensibility, Understandability, Intelligibility, Interpretability...

The purpose of building descriptions in natural language is to provide end-users with textual information which is expected to be easy to read and to understand

- **Interpretability = INTERPRET + ABILITY**
  - ABILITY = Skill or talent
  - INTERPRET = to conceive the significance of something
- **Interpreter** (Dictionary)
  - a person who translates a speech into different languages
  - a computer program which can analyze and execute high-level instructions line by line
- **Interpretable** (Dictionary)
  - capable of being understood, accounted for and trusted on

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INTERPRETABILITY ISSUES

Some Reflections

- **Interpretability is essential for effective communication**
- **How to organize a message (oral speech / text written) to become interpretable?**
  - Thinking on the expected audience's background
  - And keeping in mind:
    - **Paul Grice's Maxims** (Logic and conversation, 1975): Quality, Quantity, Relation (relevance), and Manner (brief, orderly)
    - **Occam's Razor Principle** (14th-century): Assuming two explanations are equivalent in informative terms then the simplest one is the best
    - **Inquiries into Truth and Interpretation** (Oxford 1985)
    - **Meaning Holism and Interpretability** (The Philosophical Quaterly 1991): "*... an interpreter who finds a speaker mistaken in one case might be obliged by meaning holism to find him mistaken in most cases... the possibility of massive error threatens interpretability... there can be no language that is uninterpretable…*"
    - **Minimum Description Length Principle** (Zemel, 1998)

Comprehensibility Postulate (R.S. Michalski, 1983)
*"The results of **computer induction** should be **symbolic descriptions** of given entities, **semantically and structurally similar** to those a **human expert** might produce observing the same entities"*

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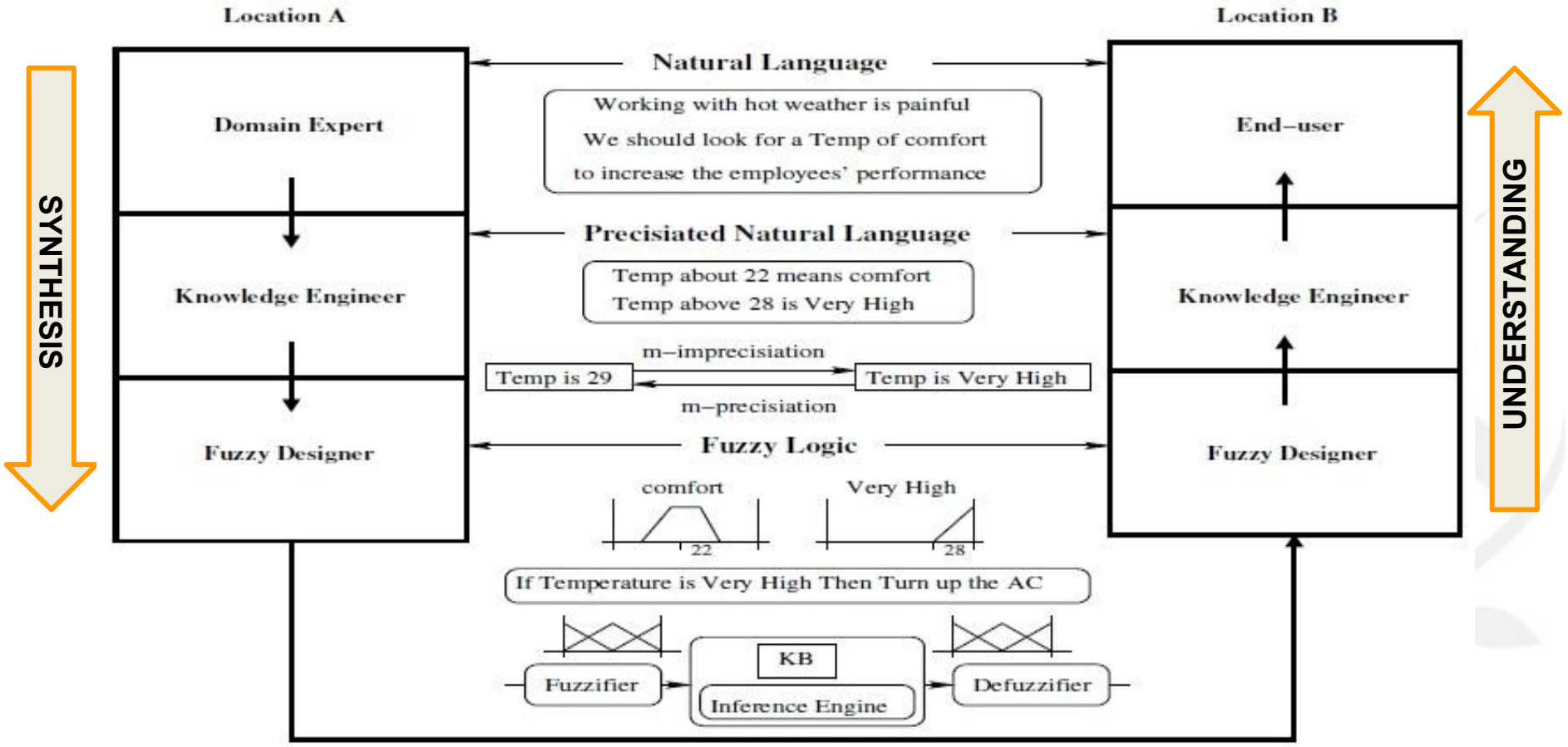
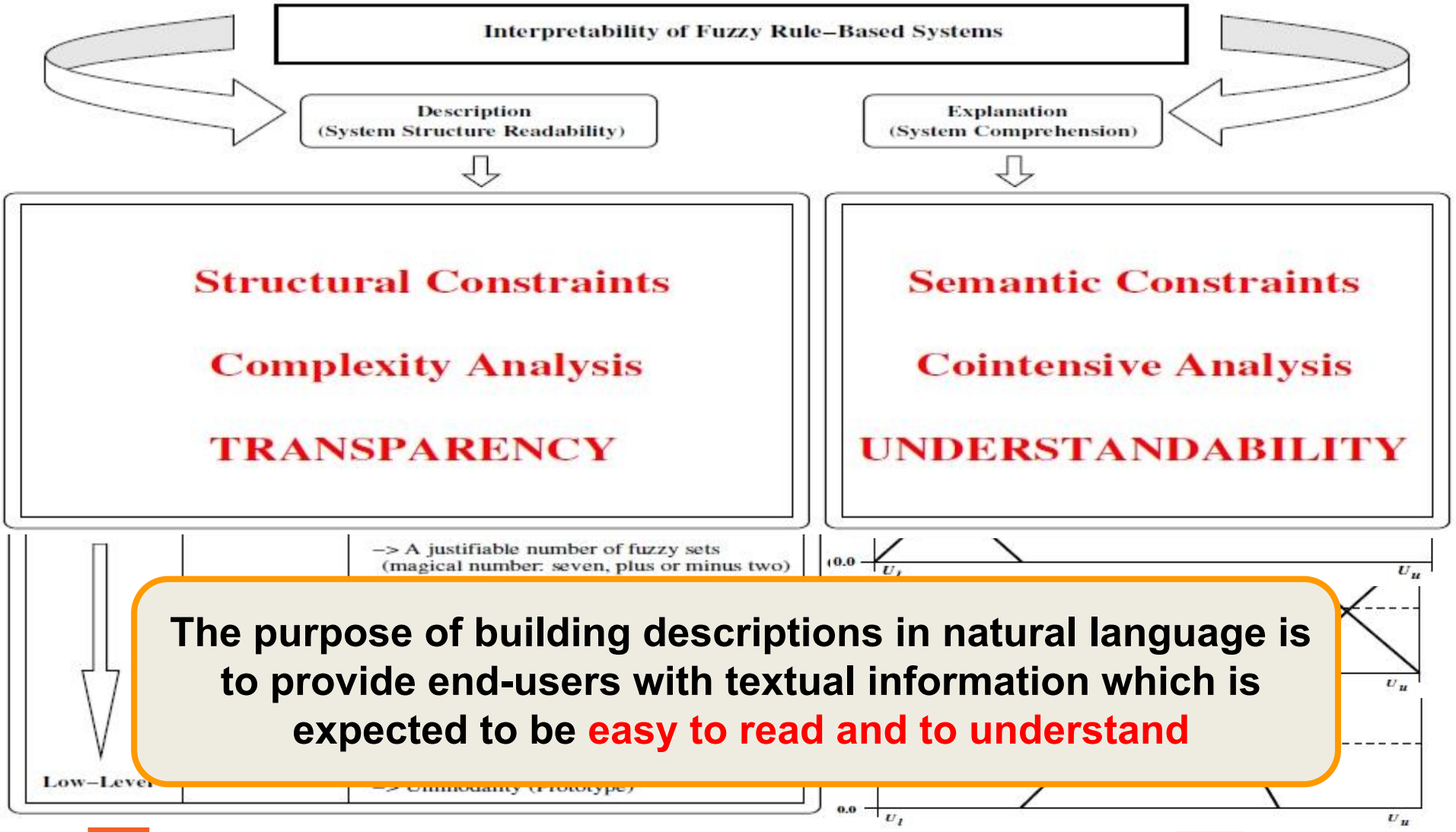
FUZZY INTERPRETABILITY ISSUES

The gap between Fuzzy Modeling and Natural Language (Uncertainty & Meaning)



FUZZY INTERPRETABILITY ISSUES

Linguistic Fuzzy Modeling - A matter of careful design



The purpose of building descriptions in natural language is to provide end-users with textual information which is expected to be easy to read and to understand

3. NLG for Data2Text

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NLG Data2Text D2T

Generating Narratives from Numeric and Symbolic Data - Applications

- **Medicine:**
  - BabyTalk: Generating English Summaries of Clinical Data (University of Aberdeen, ARRIA)
- **Transport:**
  - ROADSAFE: Generating Text for Road Maintenance Vehicle Routing (University of Aberdeen)
- **Games:**
  - The Joking Computer: An Interactive Language Playground (http://homepages.abdn.ac.uk/jokingcomputer/)
- **Biology:**
  - BeeWatch: Feedback on training about recognizing bumblebees (http://www.abdn.ac.uk/beewatch)
- **Weather Forecast:**
  - GaliWeather (https://www.youtube.com/watch?v=1wB7TfINBi4)
- **Journalism, Social Networks, Marketing, Finance, etc.**

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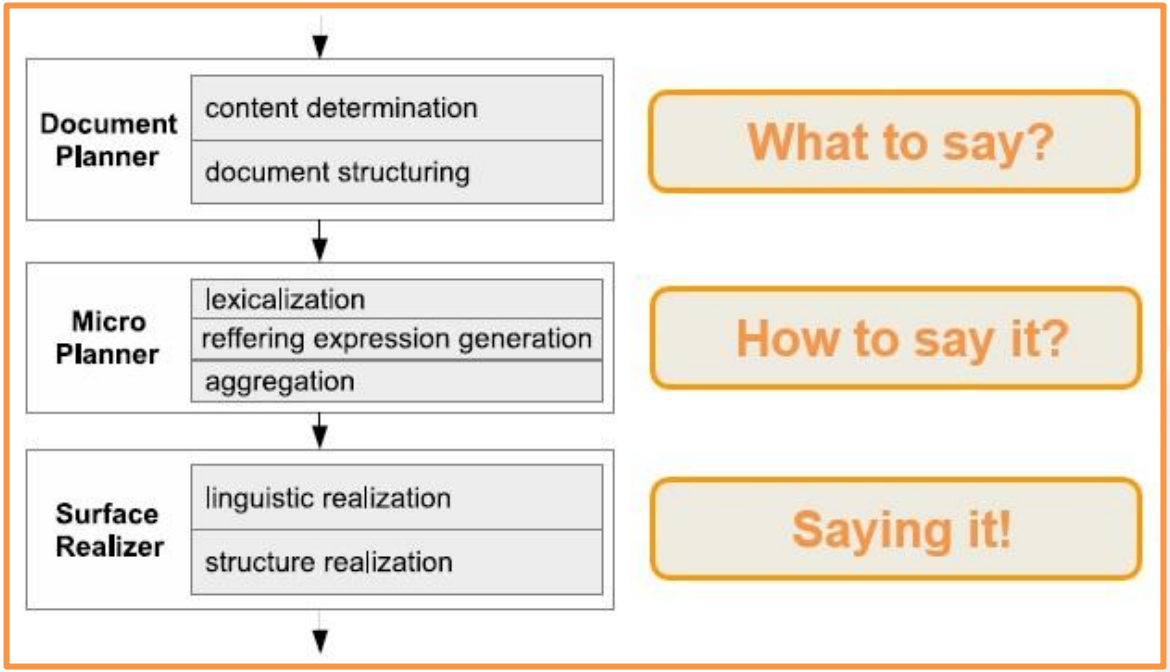
NLG Data2Text D2T

NLG/D2T Pipeline (Reiter & Dale, 2000)



https://www.arria.com/

4. IFM & NLG/D2T

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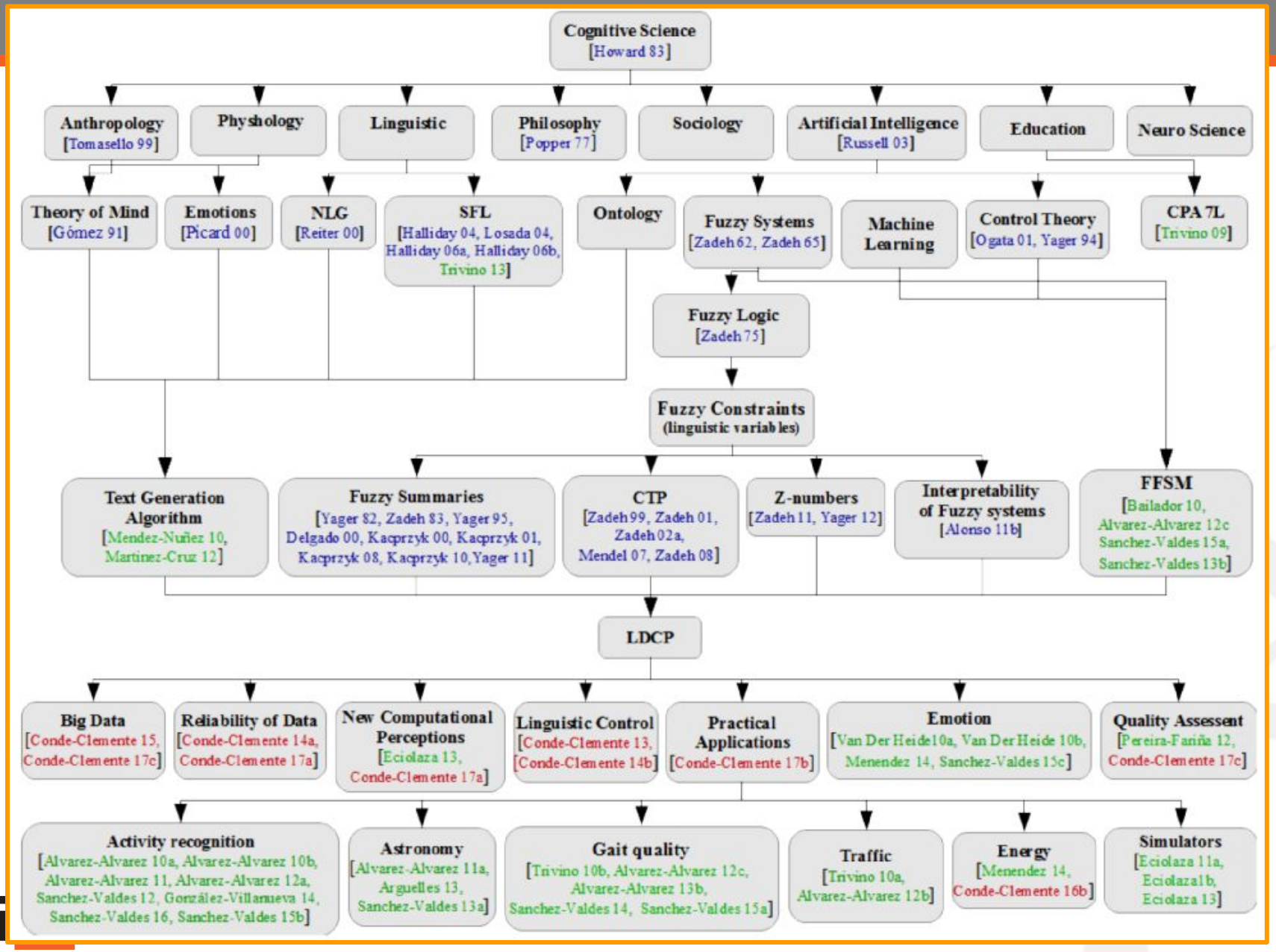
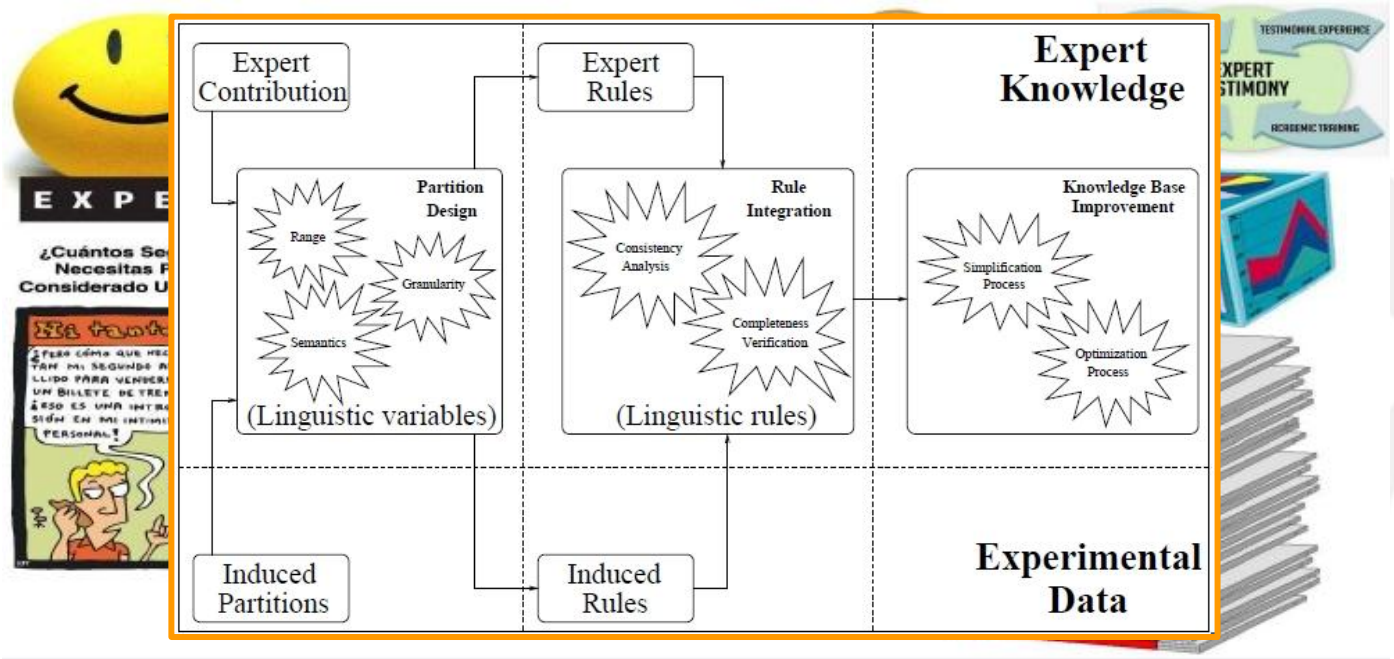
IFM & NLG/D2T - Cognitive Science



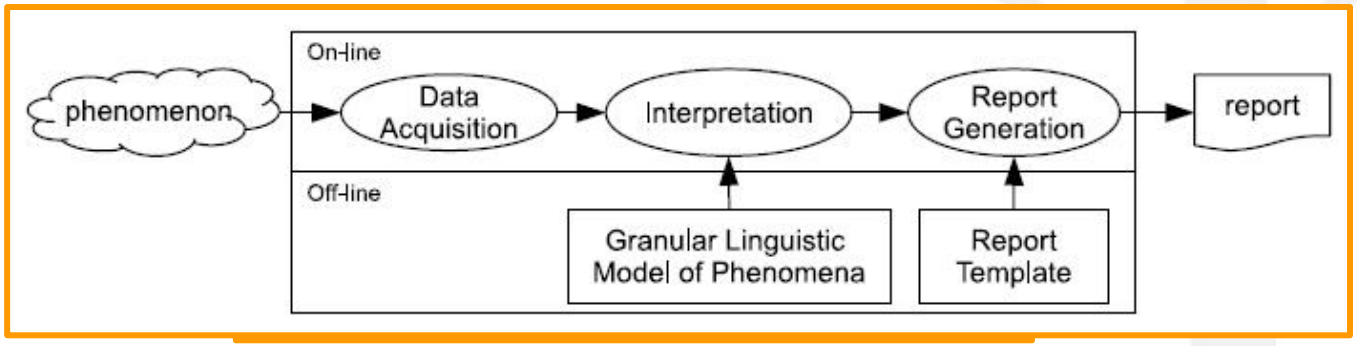
Fuzzy Data2Text: (1) Data2FRBS + (2) FRBS2Text

(Fuzzy) Linguistic Description of Data & Natural Language Generation (NLG)

- **Highly Interpretable Linguistic Knowledge (HILK)** (Alonso, 2008)



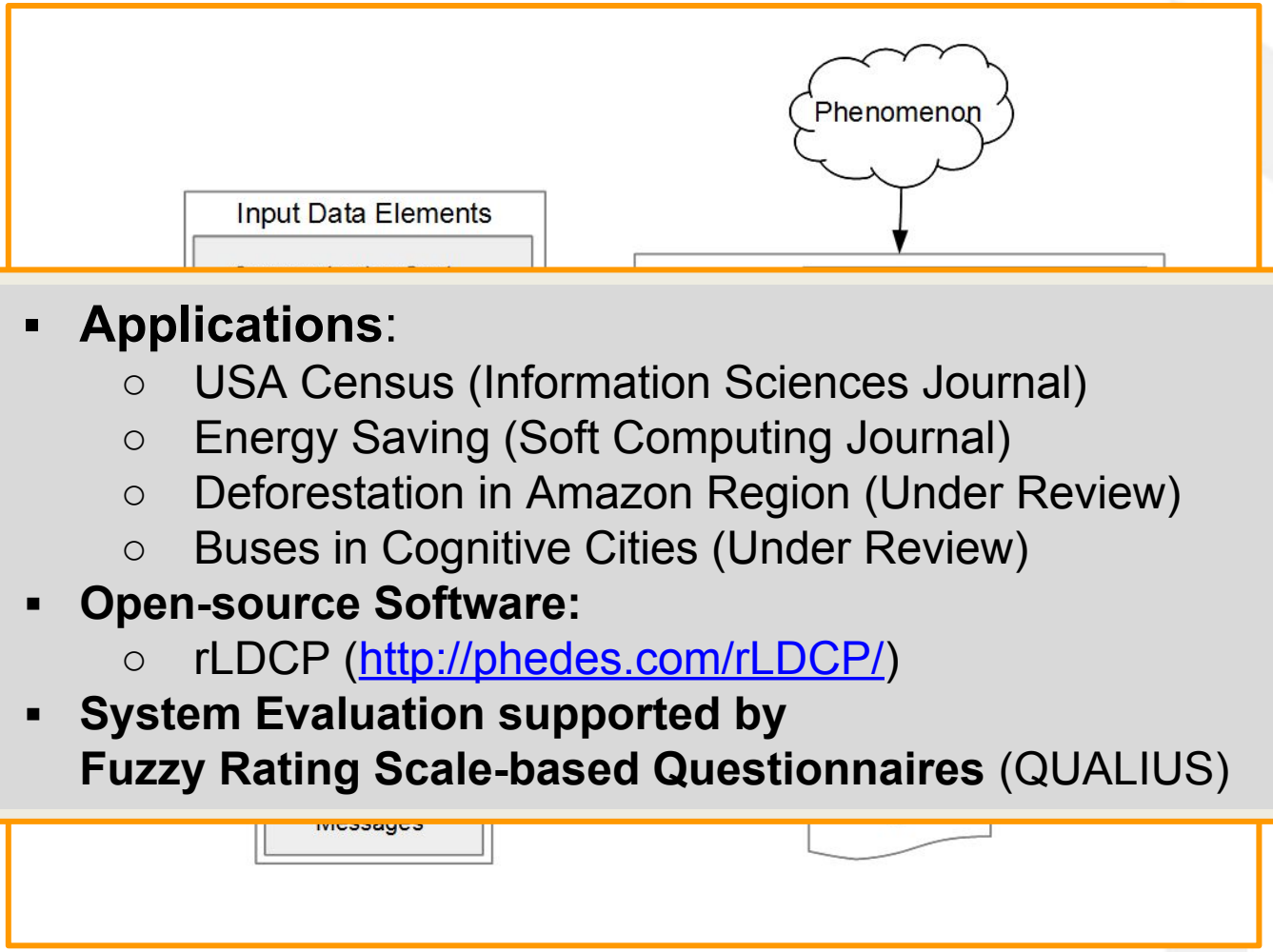
- **Linguistic Description of Complex Phenomena (LDCP)**
  (G. Trivino et al., European Centre for Soft Computing) (2007 - 2016)



Fuzzy Data2Text: (1) Data2FRBS + (2) FRBS2Text

(Fuzzy) Linguistic Description of Data & Natural Language Generation (NLG)

- **LDCP + HILK + NLG**
  (P. Conde-Clemente, PhD student at University of Oviedo, In press, 2013 - 2017)
  Advisors: G. Trivino and Jose M. Alonso



- **Applications**:
  - USA Census (Information Sciences Journal)
  - Energy Saving (Soft Computing Journal)
  - Deforestation in Amazon Region (Under Review)
  - Buses in Cognitive Cities (Under Review)
- **Open-source Software:**
  - rLDCP (http://phedes.com/rLDCP/)
- **System Evaluation supported by Fuzzy Rating Scale-based Questionnaires** (QUALIUS)

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5. Use Case

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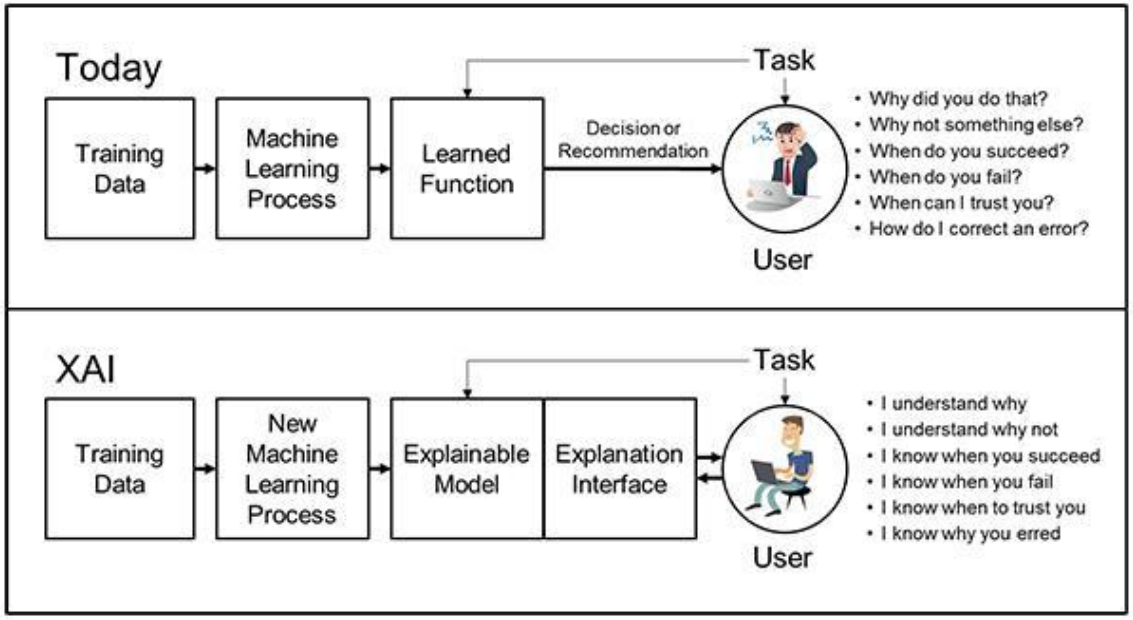
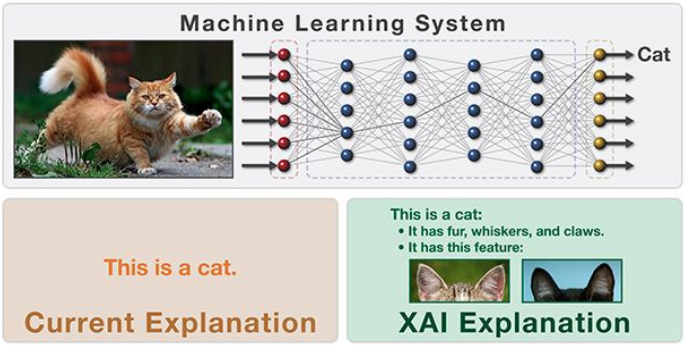
Use Case

DARPA Challenge on eXplainable Artificial Intelligence (XAI) - Mr. David Gunning





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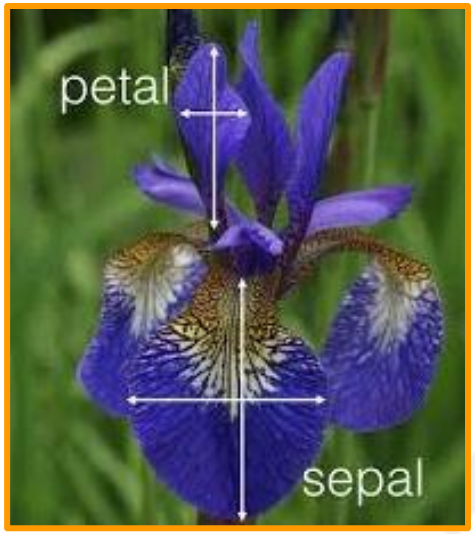
http://www.darpa.mil/program/explainable-artificial-intelligence

Illustrative Example: IFM & NLG/D2T for XAI

IRIS (R. A. Fisher, 1936)

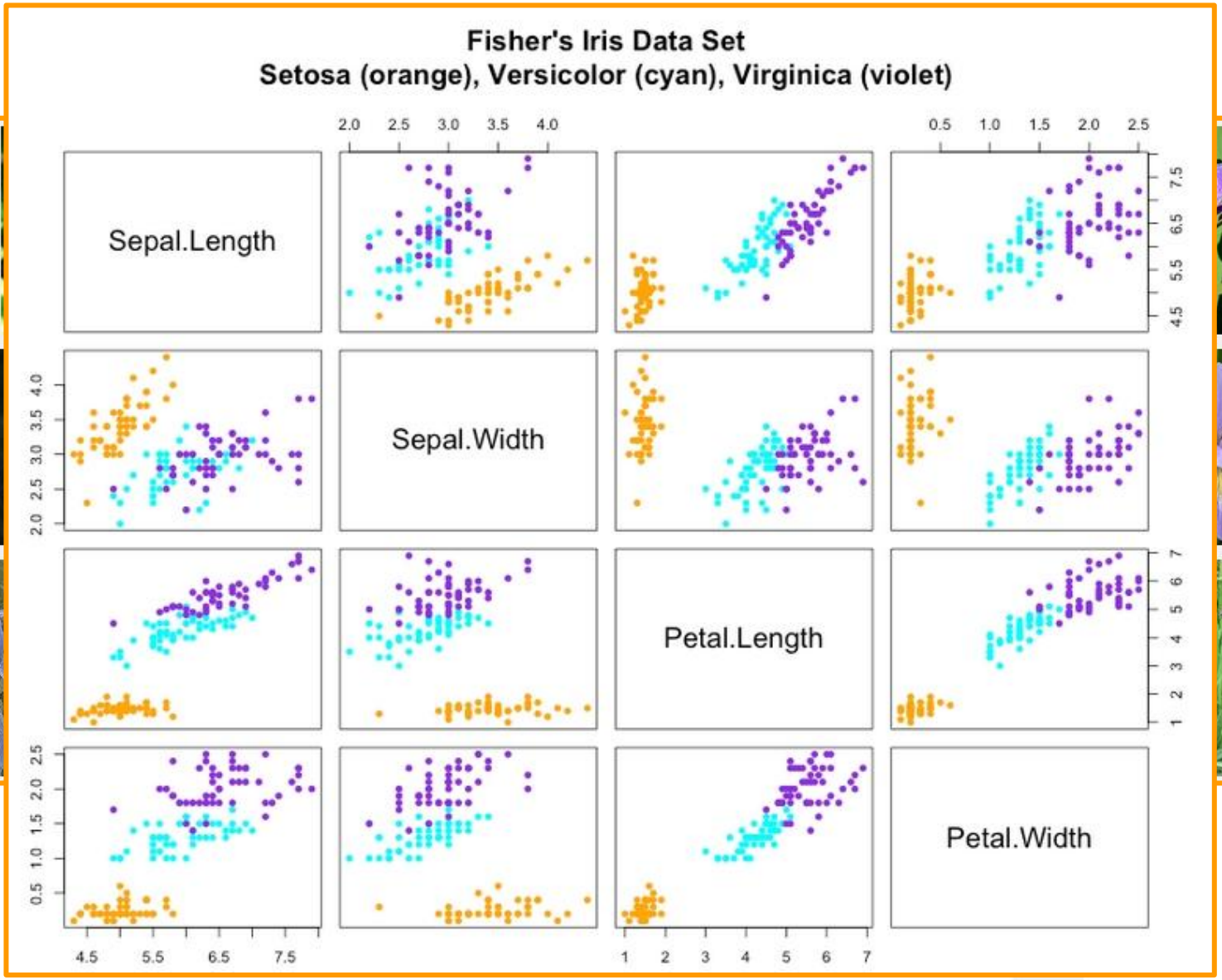
- **3 classes**
  - Iris-setosa (50 samples)
  - Iris-virginica (50 samples)
  - Iris-versicolor (50 samples)
- **4 attributes**
  - Sepal Length
  - Sepal Width
  - Petal Length
  - Petal Width

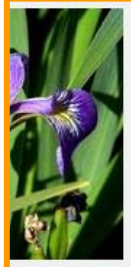


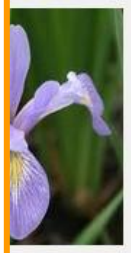
https://archive.ics.uci.edu/ml/datasets/Iris

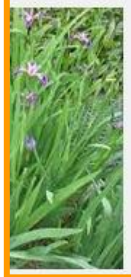
Illustrative Example: IFM & NLG/D2T for XAI

IRIS (R. A. Fisher, 1936)









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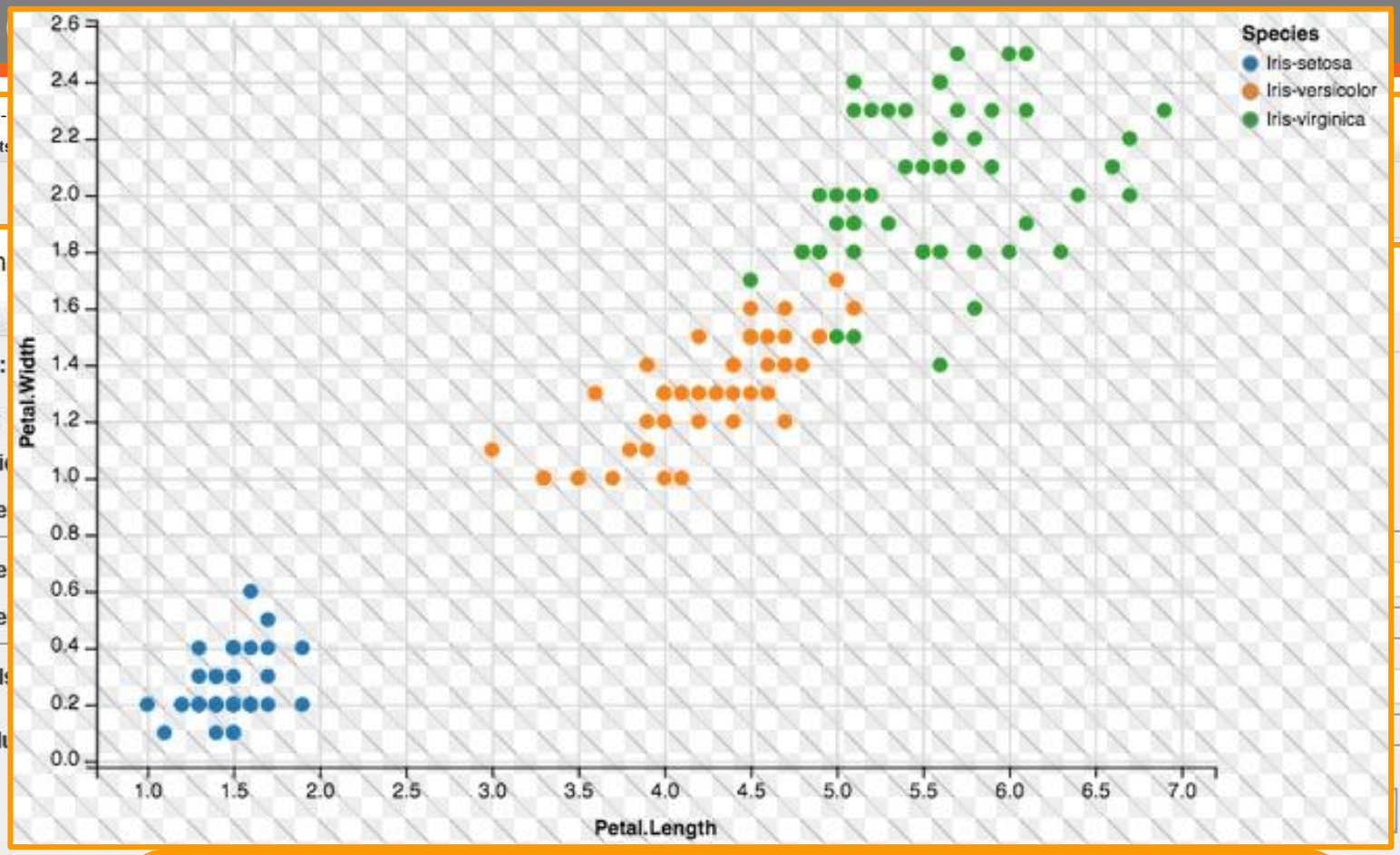
Illustrative Example: IFM & NLG/D2T for XAI

IRIS

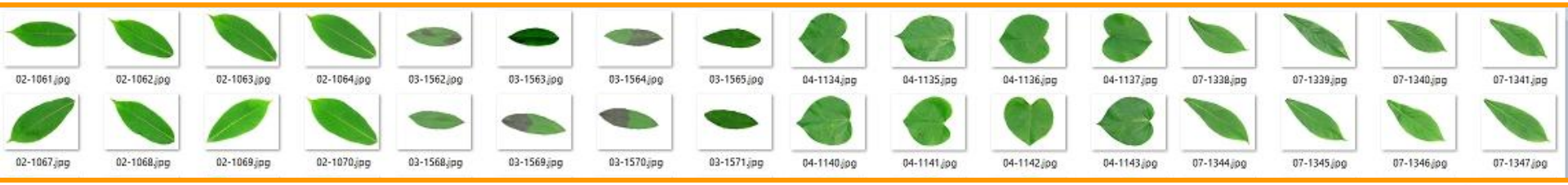


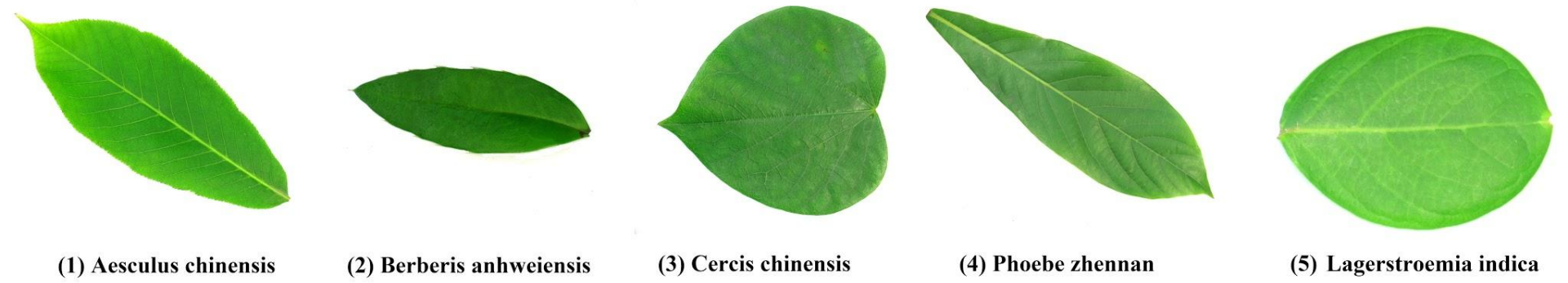
This Petal Width is something in between small and medium. It is an ambiguous case. It seems to be Iris Setosa but it may be Iris Virginica too.

A Real-world Example

Identification of Leaf Species

Leaves sampled in the campus of Nanjing University and Sun Yat-Sen arboretum, Nanking, China





(1) Aesculus chinensis (2) Berberis anhweiensis (3) Cercis chinensis (4) Phoebe zhennan (5) Lagerstroemia indica

Gang Wu et al., "A Leaf Recognition Algorithm for Plant classification Using Probabilistic Neural Network", IEEE International Symposium on Signal Processing and Information Technology, 2007
(http://flavia.sourceforge.net/)

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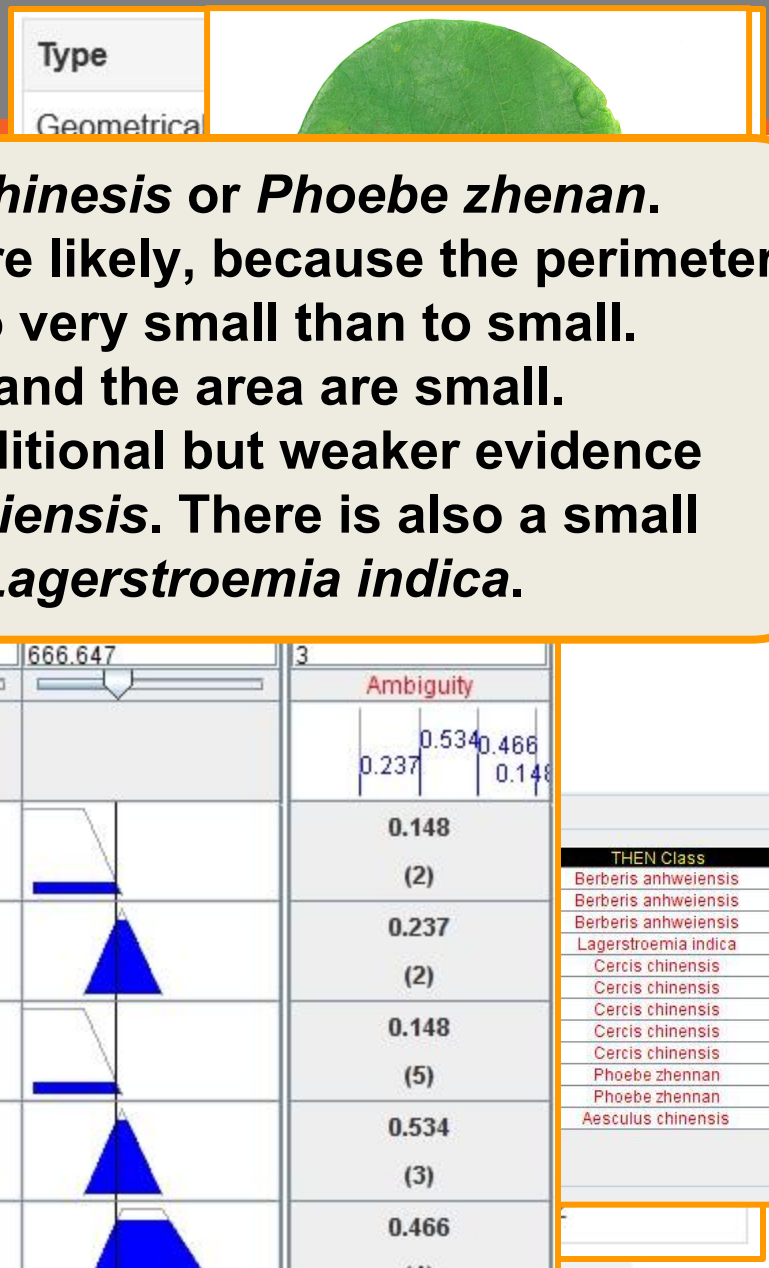
A Real-world Example

GUAJE - Identification of Leaf Species



The leaf is probably *Cercis chinesis* or *Phoebe zhenan*. On balance, Cercis is slightly more likely, because the perimeter of the leaf image is closer to very small than to small. In addition, the diameter and the area are small. On the other hand, there is additional but weaker evidence that the leaf is *Berberis anhweiensis*. There is also a small chance that the leaf is *Lagerstroemia indica*.

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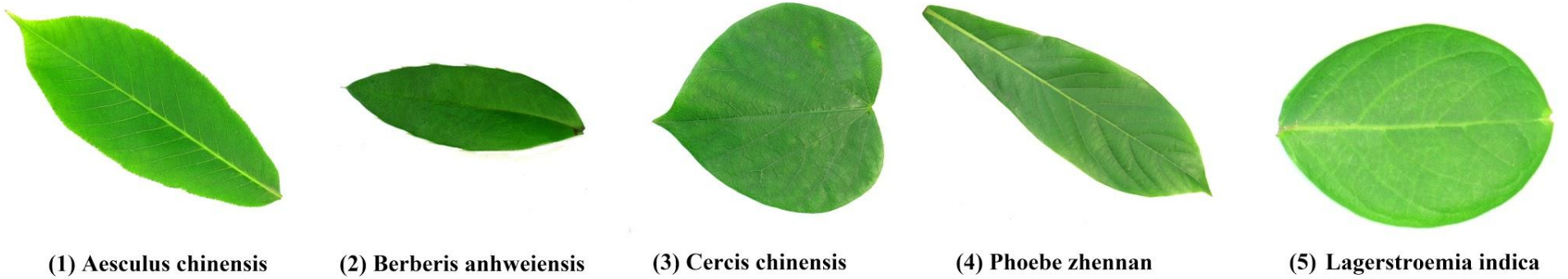
A Real-world Example

Identification of Leaf Species - **Easy for Humans but Hard for Computers ?**

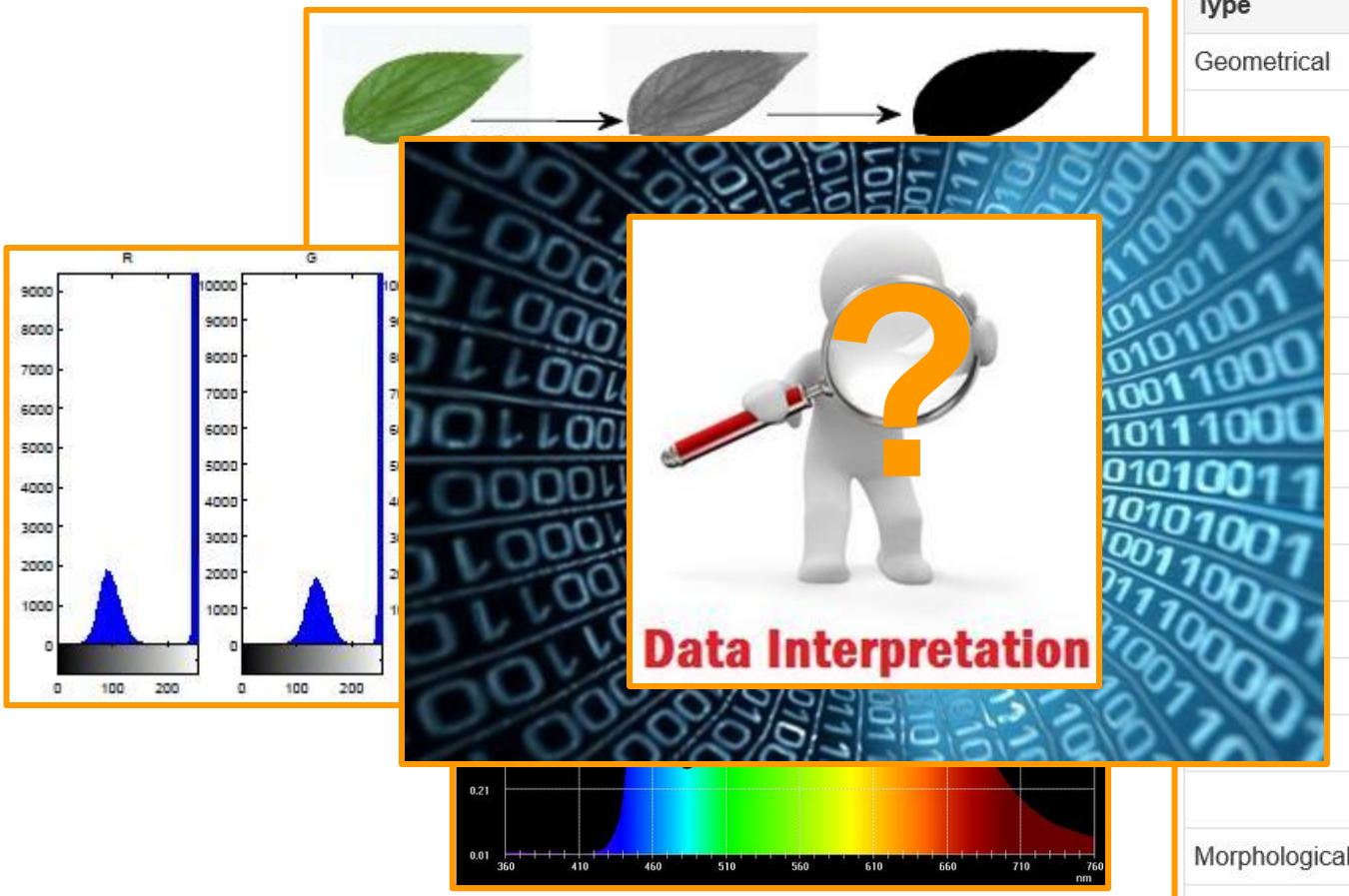
- **Sometimes, “An image is worthy a million words”**



A Real-world Example

Identification of Leaf Species - **Easy for Computers but Hard for Humans ?**

- **Sometimes, “A hundred words are worth a million data”**



Type	Variable	Description
Geometrical	A	Area
	P	Perimeter
	D	Diameter
	C	Compatibility
	Co	Compactness
	S	Solidity
	u	Median
	δ^2	
	$E_{r,\theta}$	
	$H_{r,\theta}$	Variance
	$HG_{r,\theta}$	Uniformity
	$I_{r,\theta}$	Entropy co-occurrence
	φ_1	Homogeneity
	I_1, I_2	Inertia
Morphological		Hu1
		Ami1-Ami2

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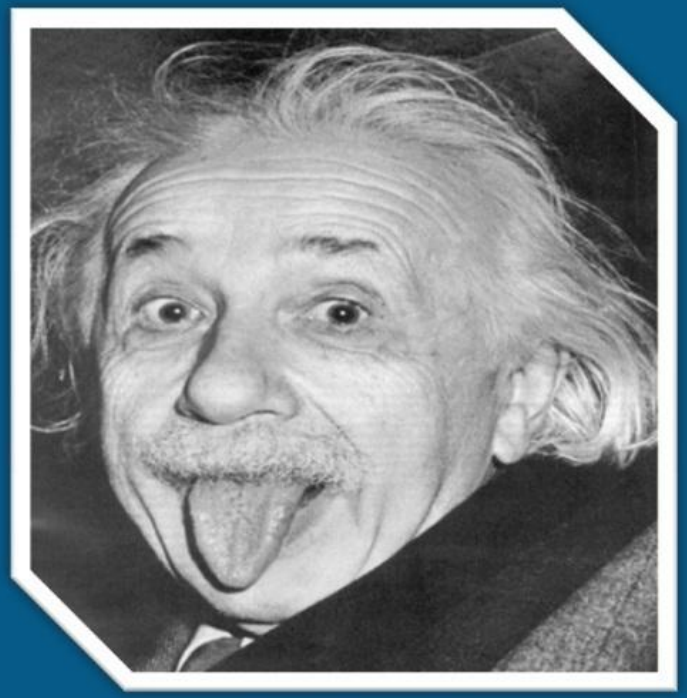
A Real-world Example

Identification of Leaf Species - Web Survey

NEXT SAMPLE

http://tec.citius.usc.es/galiweather/rulsurvey



"The important thing is not to stop questioning"

"If there is effort,
there is always accomplishment"

"Never be proud of having won an opponent. Who you won today can beat you tomorrow"

"The only victory that endures is the conquest over the own ignorance "

Jose M. Alonso


Ness Lake, Fort Augustus, Scotland
October 2016

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Useful links

- **Tutorial on Interpretable Fuzzy Systems (IFS)**
  - http://goo.gl/ufHKDx
- **Software for IFS**
  - **GUAJE:** http://sourceforge.net/projects/guajefuzzy/
  - **FINGRAMS:** https://sourceforge.net/projects/fingrams/
- **Review on Fuzzy Systems Software (FSS)**
  - http://sci2s.ugr.es/fss
- **IEEE Computational Intelligence Society (IEEE-CIS)**
  - http://cis.ieee.org/
- **IEEE-CIS Task force on FSS**
  - http://sci2s.ugr.es/TF-FSS
- **European Society on Fuzzy Logic and Applications (EUSFLAT)**
  - http://www.eusflat.org/
- **3rd EUSFLAT Summer School on Fuzzy Logic and Applications (SFLA2017):** https://citius.usc.es/SFLA2017
- **10th International Conference on Natural Language Generation (INLG 2017):** https://eventos.citius.usc.es/inlg2017/

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