IT4I

Institute for Research and Applications of Fuzzy Modeling (IRAFM)

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IRAFM in brief

- Scientific workplace, organizational unit of the **University of Ostrava**, Czech Republic
- Established on September 1, 1996
- Since July 1, 2011: IRAFM is a division of the National Supercomputing Centre IT4Innovations (http://www.it4i.eu) a unique European project one of the **largest supercomputer** in Europe (2015)

IRAFM in brief

- Focus on theoretical research and development of special fuzzy modeling methods and their practical implementation

What is fuzzy modeling?

- A class of special mathematical methods enabling to process **imprecise information** *(usually formulated in natural language)*
- Design of more realistic models (**fuzzy models**) of ill defined systems – the available information is **imprecise** or **incomplete**

IRAFM in brief

- 32 researchers, out of whom: 5 prof., 4 assoc. prof., 18 PhD, 3 PhD students
- IRAFM is excellent workplace
- IRAFM contributes to the state of art of Fuzzy modeling and its methods
- Over 400 lectures given at universities and international conferences in 35 countries in Europe, America, Asia, Africa, Australia and New Zealand
- Organized several international conferences, e.g.
  IFSA'97 World Congress, Prague;
  The Logic of Soft Computing 2005, Ostrava;
  EUSFLAT 2007, Ostrava;
  ISCAMI, every year since 2009;
  Summer School on Fuzzy Logic and Technology, 2016;
  EUSFLAT 2019, Prague;

IRAFM - members

IRAFM is divided into Departments

3 Departments:

- Department of Theoretical Research
- Department of Applied Research
- Department of Software Development

Theoretical research objectives

- **Special algebras**
- **Mathematical Fuzzy Logic**
    - FLn – in narrow sense: *special formal systems of propositional, first-order and higher-order fuzzy logic*
    - Fuzzy Natural Logic: *mathematical model of special schemes of natural human reasoning by employing a mathematical model of selected parts of natural language semantics*
- **Fuzzy Transform:** original method for mathematical modeling
- **Time series analysis and forecasting**
- **Fuzzy dynamical systems**

Practical research objectives

- Original methods and implemented algorithms based on our theoretical results
- Methodology for their application an practical realization

Applications based on our methods

- **Process control**
  Linguistic control (linguistically formulated control strategy)
  Several real applications
  (Břidličná: control of 5 aluminium melting furnaces)

- **Analysis and forecasting of time series**
  - an original technology providing time series analysis. The
  technology is based on fuzzy modeling techniques and provides
  precise fitting of time series and a reliable short-term forecast

- **Managerial decision-making**
  - a universal decision-making technology providing automated
  decision-making on the basis of qualitative as well as quantitative
  information

Applications based on our methods

- **Mining associations and dependencies**
  (characterized linguistically)
  from large numerical databases

- **Image and signal processing**
  - Fusion of a sequence of damaged images into one so that the resulting image is formed of all good non-damaged parts.
  - Compression and reduction of images.
  - Search and reading of partly damaged text.
  - Automatic correction of damaged images (inpainting).
  - Automatic detection of edges in the image.
  - Search of images containing a certain known part.
    For example, if we need to find an image in the database containing known house, then our technology can find it even in the case that images are slightly damaged.

Projects

Currently 24 projects

- NPU: IT4Innovations excellence in science
- OP VaVpI: Centre of Excellence IT4Innovations - sustainability, Ministry of Education of the Czech Republic
- GAČR projects:
    - New approaches to aggregation operators
    - New approaches to financial time series modelling
    - Social adjustment of homeless children
- TAČR projects:
    - Development of software for responsive evaluation
    - Required future and applying recovery concept
- OP: Artificial Intelligence Methods for Automobile Industry;
- IRP: Complex topological structures; Data science and fuzzy modeling
- Projects ERASMUS+, COST, Comercial project Kasandra-code name (for Ministry of defense)

Publications

Over 800 scientific publications

- 7 monographs published by renowned publishing houses

- over 350 papers in scientific journals
- over 50 chapters in edited monographs
- over 400 conference papers

Other outputs

2 patents

Software packages:

- **LFL (Linguistic Fuzzy Logic):**
  - Core packages for fuzzy modeling – classes and modules for C++, Delphi, Matlab, R
  - Controller: *fuzzy control, linguistic control, decision making*
  - Forecaster: *analysis and forecasting of time series*
  - Association Miner: *mining information from data*
- **Image processing:** *fusion, compression, edge detection, filtering, reduction, reconstruction (inpainting)*

Our software modules can be included in other specialized user software systems.

IRAFM

More information

Please visit:

http://irafm.osu.cz/