UNINOVA
Instituto de Desenvolvimento de Novas Tecnologias

CA3
Computational Intelligence Research Group

Our Space Activities

2016 onwards

GAVIDAV– GAIA Added-value Data Visualisation (ESA-ESAC)

Technologies: Big data Visualization tools, graphical interfaces

Consortium: Fork.Research, Uninova, FFCUL

Description: Development of generic visualisation Added-Value Visualization Interfaces (AVIs) such as scatter plots, histograms, dendograms, density maps, etc

AVERT – AVoidance algorithms Extended development and Realistic Testing (ESA-ESTEC)

Technologies: Fuzzy logic, multi-criteria, FPGAs

Consortium: SpinWorks, Uninova, IRIDA, RUAG

Description: Hardware implementation of two HDA algorithms (H2DAS and IPSIS) using Field-Programmable Gate Arrays (FPGAs) alongside the landing processing system

ESASOC - Evolution of Solar Activity over a Solar Cycle (FCT bi-lateral agreement with Slovakia)

Technologies: image processing, evolutionary algorithms

Consortium: Univ. Coimbra, Uninova, Hurbanov Solar observatory

Description: Investigationin of the evolution of solar features over a solar cycle. Development of a software tool for automated identification and tracking of the Solar features.

Key Technologies

Fuzzy Logic

Fuzzy logic is a powerful problem-solving methodology with a myriad of applications in embedded control and information processing. Fuzzy provides a remarkably simple way to draw definite conclusions from vague, ambiguous or imprecise information. In a sense, fuzzy logic resembles human decision making with its ability to work from approximate data and find precise solutions. Unlike classical logic (**Boolean Logic**) which requires a deep understanding of a system, exact equations, and precise numeric values, **Fuzzy Logic** allows modelling of complex systems using a higher level of abstraction originated from our knowledge and experience. Fuzzy Logic allows expressing this knowledge with subjective concepts such as "very hot", "bright red", and a "long time" which are mapped into numeric ranges.

Knowledge Discovery/Data Mining

Knowledge Discovery and Data Mining (KDD) is an interdisciplinary area focusing upon methodologies for extracting, by computer, useful, new and previously unknown knowledge, from large amounts of data and/or from various sources. The ongoing rapid growth of online data due to the Internet and the widespread use of databases have created an immense need for KDD methodologies. The challenge of extracting knowledge from data draws upon research in statistics, databases, pattern recognition, machine learning, clustering, data visualization, optimization, and high-performance computing, to deliver advanced intelligence and web discovery solutions.

Knowledge Based Systems

Knowledge Based Systems (KBS) are able to execute knowledge intensive tasks (e.g.: diagnosis, assessment, planning). Usually the referred tasks are intended to automate human activities by applying previously extracted expert knowledge. Deriving a KBS involves two parallel processes:

Knowledge Engineering	**Software Engineering & Development**
Allows a structured, methodical and modular formalisation of expert knowledge, enhancing organizational knowledge management.	Is concerned with the design and implementation of the system, that provides solutions inferred by the application of knowledge model to data.

Intelligent Decision Support Systems

Intelligent decision support systems (I-DSS) aim at developing effective intelligent systems for problem solving and decision making. These systems can deal with complex, imprecise and ill-structured situations, i.e. contexts for which discovery and learning can positively impact the outcome of the problem solving process. Intelligent decision support systems (I-DSS) are dynamic in the sense that we want to develop and implement more effective and productive support systems, both for individual users as well as for groups of users. In general, the need for I-DSS derives from: (i) the growing need for relevant and effective decision support to deal with a dynamic, uncertain and increasingly complex management environment, (ii) the need to build context-tailored, not general purpose systems; (iii) standard support technology is becoming obsolete as a way to improve decision quality and work productivity.

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Past Space Projects: 2010- 2015

VA-4D – Visual Analysis of 4-Dimensional Fields, Processes & Dynamics (ESA- Harwell)

Technologies: Visual Analytics, Software Engineering

Consortium: UNINOVA (PT), King´s College (UK), NcomVa (SE)

Description: Design a conceptual model for an intelligent Visual Analysis tool for large datasets of 4-Dimensional fields. Analysis/validation for 5 scenarios from distinct domains.

IVELA - Interactive Visualisation Environment for Large Archives (ESA- ESTEC)

Technologies: Data mining algorithms, visualization techniques

Consortium: FORK, , FFCUL

Description: Develop technologies to tackle two main challenges: how to interactively visualize a large amount of data and how to perform complex selections in 3D environments.

FUSION - Sensor Data Fusion for Hazard Mapping and Piloting (ESA- ESTEC)

Technologies: Multi-criteria decision making models, fuzzy logic, specialized aggregation operators

Consortium: Spin.Works (PT), UNINOVA (PT)

Description: Comparison of algorithm solutions for terrain sensors fusion with hazard avoidance, applied to planetary landing.

ILUV – Intelligent Landing of Unmanned aerial Vehicles (IPN- ESA tech transfer)

Technologies: Fuzzy Logic, Decision support systems, data fusion

Consortium: UNINOVA (PT), Spin.Works

Description: Feasibility study for transfer of technology for IPSIS (Intelligent safe landing algorithm) into Unmanned Aerial Vehicles (UAV's) for providing services for governmental entities (e.g. civil protection, cartography) and other civil markets.

LULAB– Lunar Lander Phase B1 (ESA- ESTEC)

Technologies: Multi-criteria + fuzzy logic + synergetic operators

Consortium: Astrium GmbH (D), DLR (D), Jena-optronik (D), Deimos (P), Kayser (D), UNINOVA (sub-contractor of Deimos)

Description: Customization of the IPSIS algorithm (piloting with hazard avoidance) for the Lunar Lander mission design .

IPSIS – Inteligent Planetary Site Selection (ESA-ESTEC)

Technologies: Fuzzy Logic, Decision support systems, Non-exhaustive optimization

Consortium: EADS-Astrium Space (F), UNINOVA (PT)

Description: Intelligent Dynamic and adaptable multi-criteria decision model for planetary landing of Spacecraft. A site selection model is developed using fuzzy logic and metaheuristic algorithms.

GEAF – EO Ground Segment Elements Automation Feasibility(ESA-ESTEC)

Technologies: Fuzzy Logic, Rule-Based Systems

Consortium: Deimos Eng., Uninova,

Description: prototype for reducing human intervention in the data processing of Payload Data Ground Segment (PDGS) missions and optimizing the quality of the processed data and performance of the instruments.

E-CEO – E-Collaboration for Earth Observation (ESA-ESRIN)

Technologies: Multi-criteria decision making models, fuzzy logic, specialized aggregation operators

Consortium: Terradue (UK), UNINOVA (PT), S[&]T, Pixalytics Ltd. (UK), Irea (F)

Description: Development of a collaborative platform for data challenge open contests to improve the adoption and outreach of new applications and methods to processes EO data.

GaiaII – Portuguese Participation on DPAC (FCT, Portugal)

Technologies: Big data visual analytics

Consortium: FCUL, Uninova, GAUC,

Description: Definition of 4D visualization tools for GAIA telemetry and continuation of software development for Bias estimation algorithms on GAIA mission.

KD-LADS– Knowledge Discovery tool for LArge Data Sets analysis (ESA-ESTEC)

Technologies: Knowledge-Discovery/Data mining; intelligent HMI

Consortium: UNINOVA (PT), FFCUL (PT), Geneva observatory (CH)

Description: The objective of this activity is to develop a general Knowledge Discovery (KD) tool for handling Large Data Sets, to support scientific exploratory data analysis, during and after any mission.

MODI – Fuzzy Monitoring and Diagnosis for Mars Driller (ESA-ESTEC)

Technologies: Fuzzy Logic, Rule-Based Systems

Consortium: Uninova, Deimos Eng., Galileo Avionica

Description: Prototype for intelligent monitoring of the drill device for the ExoMars Rover also capable of recognizing Mars terrain hardness.

NOMDIS – New Operators for Monitoring and Diagnostic of Intelligent Systems (ESA-ESOC)

Technologies: Fuzzy Rule-based Systems, Choquet Integral

Consortium: Uninova, Trento Univ., Vega

Description: Integration of the Choquet integral as a new aggregation method in fuzzy inference systems. Case study: Rosetta.

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Past Space Projects: 2000- 2010

SEISOP – Space Environment Information System Operational (ESOC -ESA)

Technologies: Knowledge-based Systems

Consortium: DEIMOs space, Deimos eng, INTA, VEGA, HOLOS, UNINOVA

Description: Operational Space Weather Data Center to be located at ESOC and ESAC

SEIS – Space Environment Information System (ESA-ESOC)

Technologies: Data warehouses

Consortium: Uninova, Deimos Eng.

Description: Integration of Space Weather information, S/C orbital positions and Telemetry data. The system includes a monitoring module, a reporting analysis tool and a meta-data repository.

SESS – Space Environment Support System for Telecom / Navigation Missions (ESA-ESTEC)

Technologies: Data Warehouses / Knowledge Discovery

Consortium: Deimos, Uninova, INTA

Description: Prototype to supply information on space environment and its effects on the spacecraft for Telecom and Navigation Mission operators, project teams, development engineers and scientists.

IMPACTED – Intelligent Mathematical Processing for Autonomous and Consistent Trajectory Elaboration & Decision (Contract EADS-Astrium)

Technologies: Fuzzy Logic Multi-Criteria Decision Making

Consortium: Uninova

Description: Development of an autonomous, dynamic and adaptable multi-criteria model to choose the best candidate landing site for a planetery spacecraft.

SIMORG – Swarm Intelligence Modelling Of Root Growth (ESA- ESTEC)

Technologies: Evolutionary algorithms, multi-agent systems

Consortium: UNINOVA (PT), FFCT (PT)

Description: Develop a root growth simulator modeled from a swarm intelligence algorithm. The viability of applying evolved algorithms on Collective Robotics for Scouting tasks is explored.

CERTAIN – CryoSat Event Reporting Tool for Analysis and Investigation (ESA-ESOC)

Technologies: Knowledge Based Systems, Web-based Reporting

Consortium: Holos, Uninova

Description: Development of a flexible reporting tool to provide the CryoSat /GOCE Flight Control Teams with status summary reports for the mission, describing events, performance and the S/C status during non-manned periods.

Fuzzy Logic For Mission Control Purposes (ESA-ESOC)

Tecnologies: Fuzzy Logic, Neural Networks

Consortium: GTD, Uninova

Description: Demonstration of the advantages/limitations of soft-computing techniques (Fuzzy Logic, Neural Networks and Genetic Algorithms) in mission control operations.

Gaia – Portuguese Participation on DPAC (FCT, Portugal)

Technologies: Knowledge discovery, softwae engineering

Consortium: Uninova, FCUL, CAUP, GAUC,

Description: DPAC (Data Processing Consortium of GAIA mission) objective is to prepare the data analysis mechanisms for telemetry from Gaia.

CESADS – Centralised ESTRACK Status and Diagnostic System (ESA-ESOC)

Technologies: Knowledge Based Systems

Consortium: GTD, Uninova

Description: Monitoring and diagnostic of health status of components involved in linking a satellite and the control centre (space link).

ASSD – Aspects Specification for Space Domain (ESA-ESTEC)

Technologies: Aspect-Oriented Software Engineering

Consortium: Uninova, Univ. Nova Lisboa, Deimos Eng., EADS TS

Description: Assessment of benefits of using Aspect-Oriented methodologies in software early requirements phase. Case study: SEIS, SESS.

COSIS – Coimbra Observatory: Solar Information System (FCT, Portugal)

Technologies: Databases, Image / Feature Recognition

Consortium: Coimbra Observatory, Uninova

Description: Development of a web-based software tool for image feature recognition of sunspots (K1).

EO-KES - Earth Observation Knowledge Enabled Services (ESA-ESRIN)

Tecnologies: Knowledge Based Systems/Ontologies

Consortium: GTD, Uninova

Description: Information system with an ontology to provide EO Knowledge Enabled Services through powerful, customized, and adaptive search capabilities.

Aurora Program: Knowledge Engineering Roadmap (ESA-ESTEC)

Technologies: Fuzzy Logic, Data Mining/Knowledge Discovery, Knowledge Based Sytems, Multi-Agent Systems

Consortium: Uninova, GTD

Description: Road map from now up to 2030 on knowledge enabled technologies.

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