UNIVERSITAT POLITÈCNICA DE VALÈNCIA

VRAIN

Technological Offering

GENERALITAT VALENCIANA

IVACE+i INSTITUTO VALENCIANO DE COMPETITIVIDAD E INNOVACIÓN

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INDEX

Presentation portfolio VRAIN of the UPV

What you are holding in hour hands is a service portfolio of artificial intelligence tools. It is a pleasure for the **Valencian Research Institute for Artificial Intelligence (VRAIN)** at the Valencia Polytechnic University (UPV) to present this guide for business and organizations.

We have compiled here a catalogue of our patents, corresponding to our over 24 software development undertakings and 35 services. Their goal is to make artificial intelligence accessible an ethical, explainable and unbiased, for the benefit of society. We have in mind not only businesses and organizations, but also individuals, within and beyond our territory, the Valencian Community.

This is a tool to find all the services of UPV VRAIN. Our institute makes part of the **Scientific Unit for Technology Development and dissemination of knowledge to Businesses (UCIE)**, devoted to transfer artificial intelligence innovations to the industrial network. This has been funded by the **Valencian Institute for Competitiveness and Innovation (IVACE+I) of the Generalitat Valenciana government and the European Union.**

Its intention is to close the gap to bridge the gap between businesses and technology, and especially between companies and artificial intelligence. We want to show how all these services are already within their reach, regardless or being small businesses, medium-sized companies or large corporations.

There are two aspects of AI that we need to address. On the one hand, the use we humans make of AI. And on the other hand, the implication of current innovators, professionals and researchers in AI, to follow the path of ethics, reliability and elimination of biases as pointed out by the EU AI Law.

With AI, businesses, society and professionals are moving down the path of undreamed-of benefits. Truth is that whilst AI will not replace people, companies and professionals, the people who do not use it will be replaced by the people who implement it.

Vicente Botti

Director of the Valencian University Institute for Research in Artificial Intelligence (VRAIN) of the UPV

The VRAIN team is made up of over 178 researchers from eight research groups:

- Automata, Formal Languages and its Applications (ALFA)
- Language Engineering and Pattern Recognition (ELiRF)
- Extensions of Logic Programming (ELP)
- Software Production Methods (PROS)
- Machine Learning and Language Processing (MLLP)
- Information Technology and Artificial Intelligence (GTI-IA)
- Multi-paradigm Software Technology (MiST)
- Interactive Tehnologies Lab (VertexLit)

VRAIN is part of **TAILOR** (Trustworthy AI Integrating Learning, Optimisation and Reasoning), **CLAIRE** (Confederation of Laboratories for Artificial Intelligence Research in Europe), **EFFRA** (European Factories of the Future Research Association), **ellis** (European Laboratory for Learning and Intelligent Systems), **RENIC** (National Network for Cybersecurity Research Excellence), **BDV** (Big Data Value Association), **CLAIS** (Consortium on the Landscape of AI Safety), **AIOTI** (Alliance For IoT and Edge Computing Innovation), **EOSC pilot** (The European Open Science Cloud for Research Pilot Project), **NESSI** and **Inndromeda** (Innovating Technology Alliance of the Valencian Community).

WHAT IS VRAIN?

The **Valencian Research Artificial Intelligence** Institute is a research organisation of the UPV (Universitat Politècnica de València: Valencia Polytechnic University) composed of eight research groups with more than 30 years' experience in several lines of research in artificial intelligence.

The process to create VRAIN started in 2019, as a combination of six research groups. In 2020, it merged with the PROS Research Centre in Software Production Methods and in 2021 it was eventually established as a University Research Institute following the approval of the Generalitat Valenciana, Valencian government.

It has more than **178 researchers** in nine research areas. These nine areas that centre its research allow for the institute's developments to be applicable to a large number of strategic industries such as health, mobility, earth sciences, smart cities, education, social networking, agriculture, manufacture, privacy/security, autonomous robots, services and energy, as well as environmental sustainability, among others..

These activities have received funding from over **135 projects** through competitive funding, mainly from the European Union, but also from the Spanish National Research Plan, the Valencian Research Plan and Technology Transfer Projects.

30
years

178
researchers

135
projects

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

VRAIN

PATENTS AND SOFTWARE

COMMUNICATION AREA

Natural language processing

SOFTWARE

TransLectures Platform-UPV (TLP) for automatic multilingual transcription and subtitling of training videos

A software platform with a web interface and an advanced API to integrate automatic and assisted transcription, translation and speech synthesis technologies in audiovisual repositories. It enables multilingual video and audio subtitling, subtitle and text translation and speech synthesis to cover the entire contents of an online course platform or an over-the-top content platform. It can be used online via https://ttp.mllp.upv.es.

Subtitles are extracted within the time frame of the video and can be viewed and edited using the TLP Subtitle Editor, an advanced media player for post-editing multilingual subtitles.

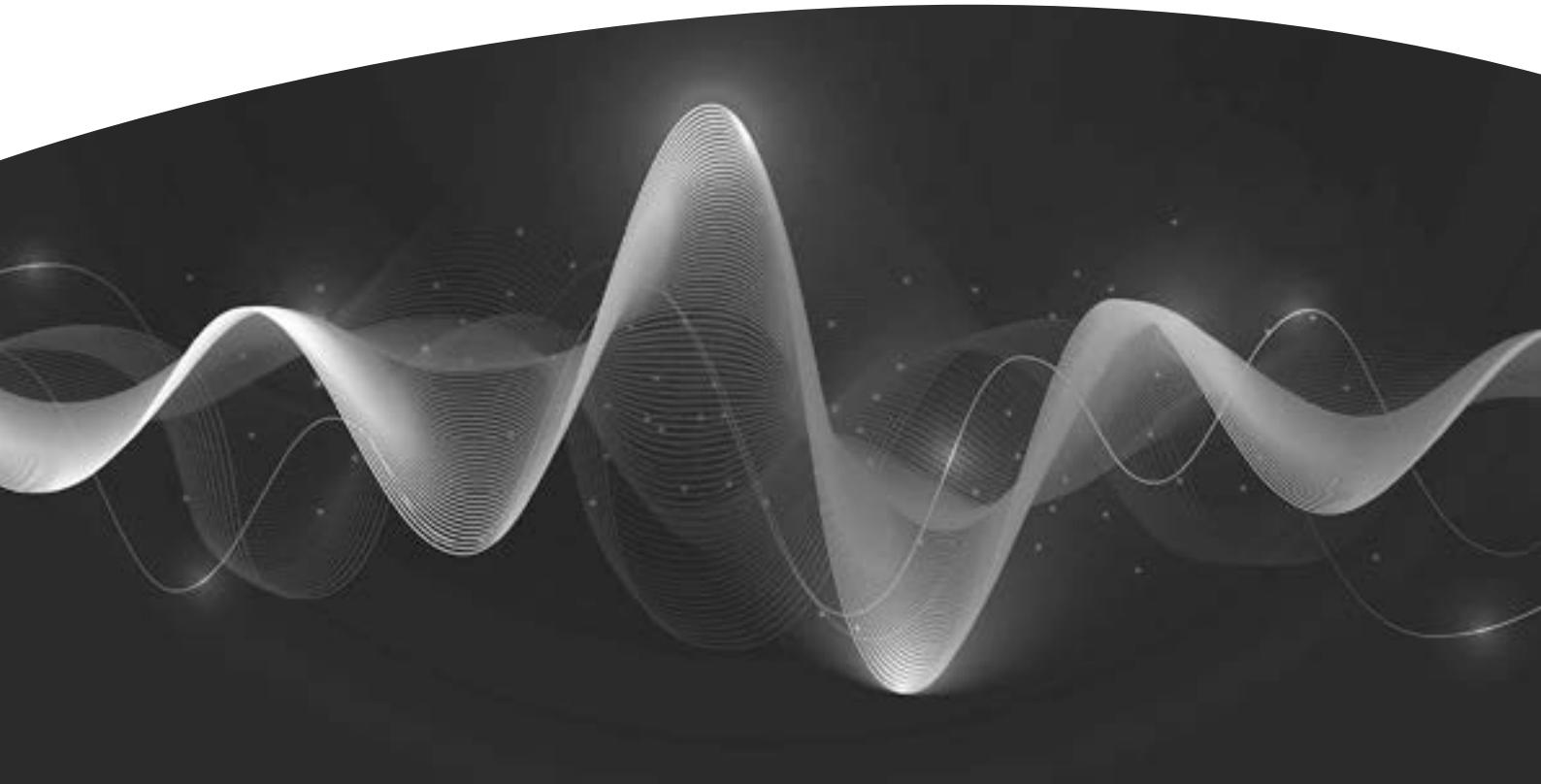
Alfons Juan Císcar, **ajuan@dsic.upv.es**

SOFTWARE

TT-Streaming: RPC API for transcription, translation and dubbing of live audio broadcasts

Unlike the previous software, which is not designed for the processing of audiovisual content broadcast live nor in contexts that may require an immediate response (personal assistants, chatbots or voice control systems), TT-Streaming responds to the growing interest and need to apply speech transcription, text translation, and speech synthesis systems in real time or in contexts that require a quick response. This SaaS (Software as a Service) system uses an API based on the standard RPC (Remote Procedure Call) protocol. It integrates speech recognition (ASR), machine translation (MT), and speech synthesis (TTS) systems of the Machine Learning and Language Processing (MLLP) group of VRAIN at UPV. These systems are at the cutting edge of technology equal in quality, and (in some languages such as Catalan or Slovenian) even surpass it, major technology provider systems such as Google and Microsoft software.

Joan Albert Silvestre Cerdá, **jsilvestre@dsic.upv.es**



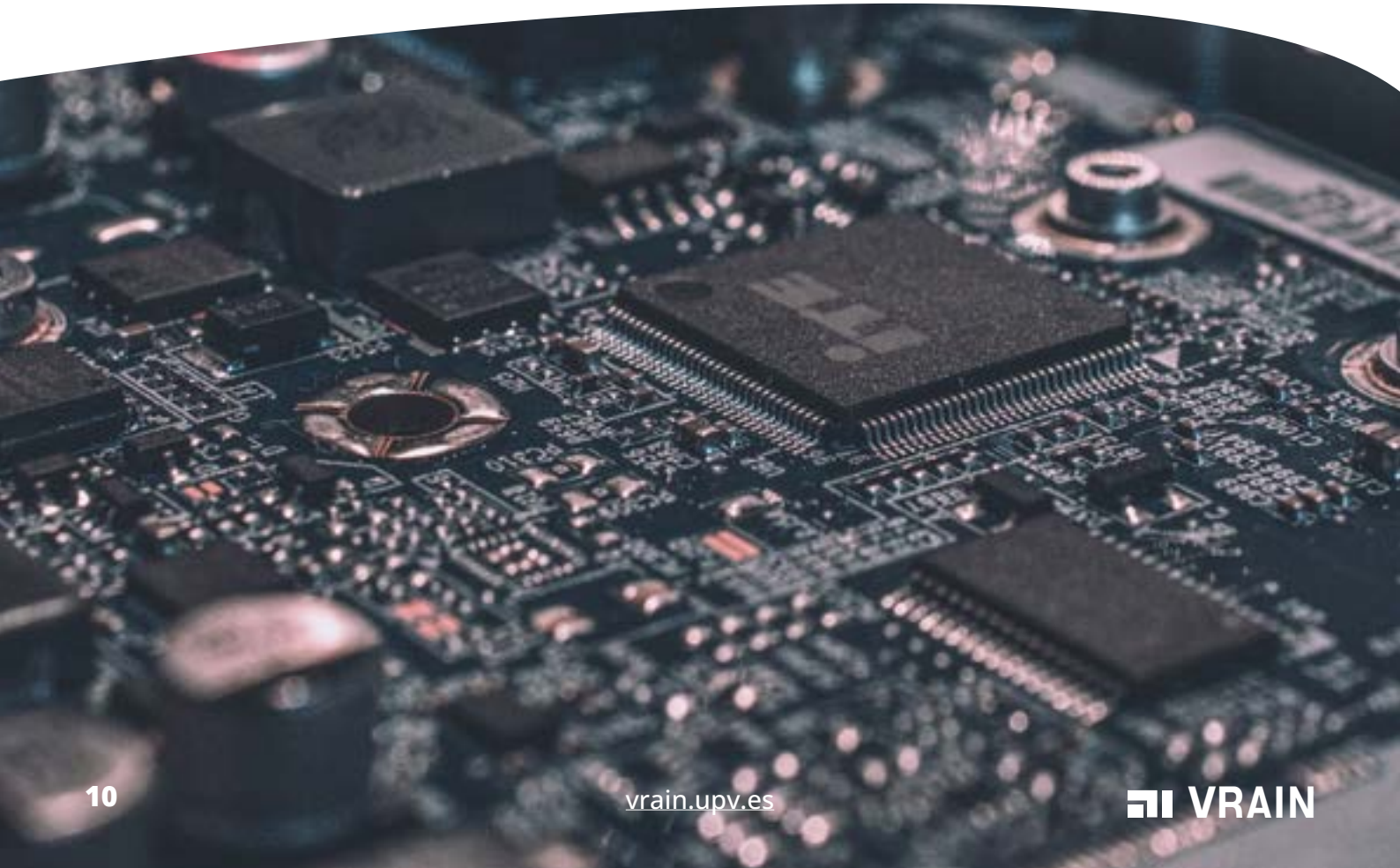
SOFTWARE

Neural network-based models for speech synthesis (lang.: en, es, ca)

These are speech synthesis models (text-to-speech) for English (en), Spanish (es) and Catalan/Valencian (ca) languages, based on deep neural network technology.

They enable applications such as automatic video and audio dubbing, audio description, audio book creation, web accessibility or virtual assistants and chatbots. These models have performed at the highest level in international competitions.

Alfons Juan Císcar, **ajuan@dsic.upv.es**



SOFTWARE

Neural network-based models for machine translation systems

(en > {fr,sl,es,de,it}; {fr,sl,es,de,it,nl} > en; fr <> de; es <> pt). Models for machine translation between the following languages:

- English (EN)
- French (FR)
- Slovenian (SL)
- Spanish (ES)
- German (DE)
- Italian (IT)
- Dutch (NL)

One model is included for each of the following language pairs:

EN>FR, EN>SL, EN>ES, EN>DE, EN>IT, FR>EN, SL>EN, ES>EN, DE>EN, IT>EN, NL>EN, FR>DE, DE>FR, ES>PT AND PT>ES

They produce automatic translation of documents and subtitles in real time or delayed. They are based on deep neural networks with massive data from different sources that allow for high-precision results in diverse domains, as well as they are able to be adapted to specific domains in order to increase accuracy. These models have performed at the highest level in international competitions.

Jorge Civera Saiz, **jcivera@dsic.upv.es**

These software records are aimed at organizations and professionals who need to incorporate transcription/subtitling (speech-to-text conversion), translation (text-to-text conversion) or speech synthesis (text-to-speech conversion) processes, in real time (streaming) or delayed, to their workflows. These include the media (TV, radio and web, live and recorded), city council and parliaments sessions for live and recorded broadcasting, university monitoring for classes and conferences in real time and to be recorded, creators of streaming or recorded content, audiovisual companies specialized in providing support for meetings and conferences, as well as accessibility companies.

SOFTWARE

SPA-Sentences: Training and evaluation of handwriting recognition systems in Spanish

This corpus of Spanish handwritten sentences is used for training and assessment of Spanish handwriting recognition systems. It has a total of 13,691 sentences with about 100,000 word instances and a vocabulary of 3,288 words.

This fact allows an efficient training of the recognition systems, as the corpus files include the scanned images of forms and information from their online segmentation and a manually supervised transcription of such. This software contributes to the automation to transfer hard copies to digital support.

This software is intended for any individual or company that deals with handwriting recognition topics and who would like to refine their models.

María José Castro Bleda, **mcastro@dsic.upv.es**

SOFTWARE

EN-IRONIC: Irony detection

EN-IRONIC is a software system to detect irony in X (formerly Twitter) in English. Determining whether a tweet is ironic or not is important to understand its meaning and has proven useful for individuals, entities or brands.

The main feature of this approach is how it uses deep learning models specifically trained with English tweets. Specifically, it is based on the contextualization of embeddings using the Transformers architecture. This software has been awarded the second position in the SemEval2018 competition.

To use EN-IRONIC, a Docker container is provided that allows it to be run on Linux, Windows and MacOS operating systems. The system is accessible through a web app that is independent of the operating system thanks to the REST API provided.

Lluis Felip Hurtado Oliver, **lhurtado@dsic.upv.es**

SOFTWARE

ES-IRONIC: Irony detection

ES-IRONIC is a software system for irony detection in X (formerly Twitter) in Spanish. Determining whether a tweet is ironic or not is important to understand its meaning and has proven useful for individuals, entities or brands. The main feature of our approach is how it uses specifically trained deep learning models and it deals with tweets in Spanish.

Specifically, it is based on the contextualization of embeddings using the Transformers architecture. This software has been awarded the first position in the IroSVA-2019 competition. To use ES-IRONIC, a Docker container is provided that allows it to be run on Linux, Windows and MacOS operating systems.

The system is accessible through a web app that is independent of the operating system thanks to the REST API provided.

Lluis Felip Hurtado Oliver, **lhurtado@dsic.upv.es**

SOFTWARE

SENTAT: Analysis of sentiments in Spanish tweets

X (formerly Twitter) has become an excellent tool to express feelings and opinions about companies, institutions, products, services or politics.

SENTAT is a social network opinion analysis software, its main feature being the use of deep learning models specifically trained for X (Twitter), both in Spanish and English.

These models have obtained very good results in the analysis of opinions in many variants of Spanish in Spain and Latin America. For its use, a Docker container is provided that allows it to be run on Linux, Windows and MacOS operating systems.

Lluis Felip Hurtado Oliver, **lhurtado@dsic.upv.es**

Natural language and audio processing

SOFTWARE

Models based on neural networks for speech recognition systems (CA, SL, EN, ES, DE, PT, IT, NL, FR)

These are automatic speech recognition models for Catalan/Valencian (ca), Slovenian (sl), English (en), Spanish (es), German (de), Portuguese (pt), Italian (it), Dutch (nl) and French (fr). For each of such languages, an acoustic model and a language model are included. They deal with the problem of automatic and assisted subtitling/transcription of video or audio, in real time or delayed.

They are based on deep neural networks with massive data from different sources that allow for high-precision results in diverse domains, as well as they are able to be adapted to specific domains in order to increase accuracy. These are state-of-the-art models similar to those used by large technology companies, with top-level results in international competitions.

José Alberto Sanchis Navarro, **josanna@dsic.upv.es**

SOFTWARE

TTT: Transcription and translation tools for video-talks

TTT software enables automatic and assisted transcription/subtitling and translation of video and audio, in real time and delayed, with high accuracy. This software is based on deep neural networks and can be adapted to the topic of each video, hence increasing accuracy beyond what systems aimed at general speech offer. The use of this software reduces the time and effort required for transcription, subtitling and translation of audiovisual and textual content.

Alfons Juan Ciscar, **ajuan@dsic.upv.es**

These two software records are aimed at organizations and professionals who need to incorporate transcription/subtitling (speech-to-text conversion), translation (text-to-text conversion) or speech synthesis (text-to-speech conversion) processes, in real time (streaming) or delayed, to their workflows. These include the media (TV, radio and web, live and recorded), city council and parliaments sessions for live and recorded broadcasting, university monitoring for classes and conferences in real time and to be recorded, creators of streaming or recorded content, audiovisual companies specialized in providing support for meetings and conferences, as well as accessibility companies.

VRAIN

INTEGRATION AND INTERACTION AREA

Multi-agent systems

PATENT

Anonymous voting

VRAIN has patented an electronic voting system capable of guaranteeing the anonymity of the vote despite potential malicious behaviour of any partner implied in the process. In this way, it can guarantee the desirable properties of similar systems and provide security, regardless of the computational capacity of potential attackers.

This VRAIN system features a scheme that does not require encryption of votes to ensure privacy. Once a user casts a vote, it is divided a set of information shares, each of them unable to reveal any data by themselves, where, only the possesion of all of the shares allows the recovery of the direction of the vote. This system allows the user to generate a vote in an independent manner and guarantees the integrity of the vote, offering the possibility to verify and audit the tally of the election without compromising the voters. The design of this scheme offers post-quantum security.

VRAIN is seeking to collaborate with a company that may be interested in licensing this patent

Its target audience is public and private administration bodies with the capacity to promote elections and voting of any scope and size: from companies with shareholders to public government.

Damián López, **dlopez@dsic.upv.es**

PATENT

Anonymous access

VRAIN holds the patent to a security protocol for controlling access to online resources or services that allows to cloak the user's identity at the time of access. The system is backed by sound theorems, mathematical properties that provide security even in a post-quantum scenario. This new protocol allows for limited interaction between the parties involved, minimal user interaction, low computational cost and does not require the storage of user-related information for access control.

The system developed by VRAIN considers a step previous to the user authentication that generates a trusted credential to identify the user. Credentials cannot be replicated even if different malicious parties colluded for this purpose. Once this credential is obtained, it is verified by the access control agents and they authorize entry into the system. No party nor coalition of them can gather enough information to link this credential with the user's identity.

VRAIN is seeking to collaborate with a company that may be interested in licensing this patent for development.

This venture would target technology companies that manage sensitive or confidential data in order to maintain the anonymity of such data at all times. Also, anonymous access control to information repositories. And, additionally, companies that manage sensitive data: insurance companies, public and private healthcare bodies or financial institutions.

Damián López, **dlopez@dsic.upv.es**

SOFTWARE

SPADE- Phyton intelligent agent development environment

This open multi-agent system platform is written in Python and is based on instant messaging (XMPP tool). It has proven useful to develop intelligent agents that can communicate with both other agents and humans. The SPADE platform provides an infrastructure that was missing in Python, the most widely used programming language for intelligent systems. Additionally, it also provides a modern, asynchronous programming interface that optimizes IM-based applications.

Target audiences include development businesses that may need a framework for multi-agent systems, as well as generic businesses that want VRAIN to build an application based on multi-agent systems.

Javier Palanca, **jpalanca@dsic.upv.es**

SOFTWARE

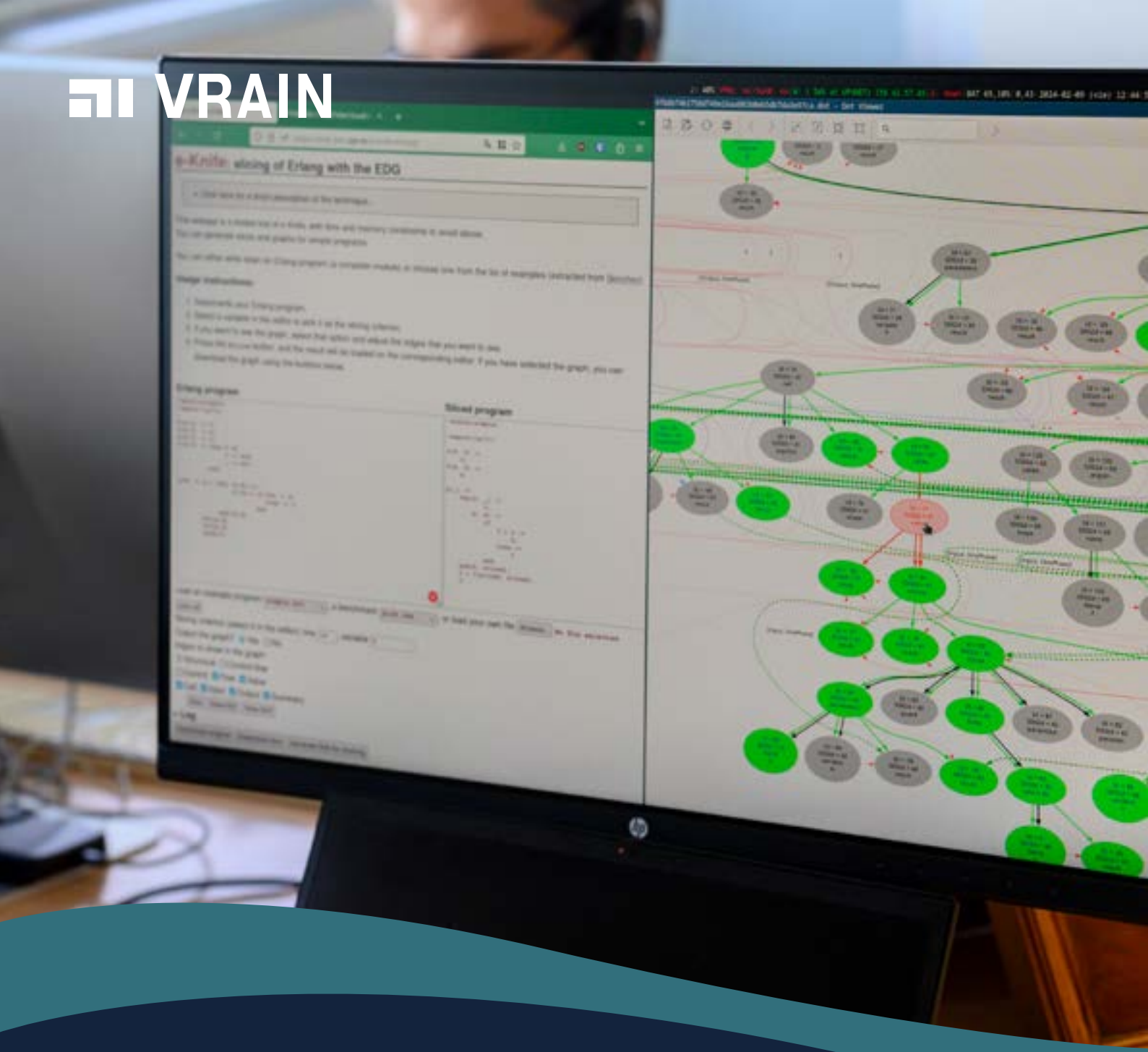
PlantIllo, plant disease detection device

It is a low-cost smart device designed for plant disease identification using a Raspberry Pi Zero and a built-in camera. A built-in deep learning model allows the device to classify and present information through an LCD display. Its versatility makes it easy to install is on drones, robots and agricultural equipment, as well as it offers an efficient way to visualize disease hotspots. Its purpose is to optimize costs by preventing the unnecessary application of chemicals. Preliminary results highlight the viability of EDGE systems for classification and detection of plant diseases without a need for Internet connection. This reduces the costs associated with image transmission and analysis and grants farmers the ability to perform a pre-analysis on possible diseases.

It is aimed at agricultural and agribusiness companies, as well as drone and agricultural robot manufacturers, agricultural technology and research companies or agricultural service providers.

Vicente Julián, **vjulian@upv.es**

VRAIN



PLANNING AREA

Optimization

SOFTWARE

PREDICARE

This tool can calculate the risk of a hospitalized patient from an AI model trained with information from inpatient data and labelled by an expert nursing team. It avoids having to obtain information on multiple factors from the assessment scales as commonly used in different hospital services, so that with very few factors, assessed by the nursing staff, the patient's overall risk can be determined. Currently no nursing scale with these characteristics that assesses this type of aggregate risk exists. The information provided by this tool is very useful both for improving the quality and effectiveness of nursing care and for hospital management itself, since it allows for an adequate allocation of resources according to the severity of the patient.

It is aimed at public and private hospitals and healthcare businesses such as nursing homes for the elderly or long-term care facilities.

Vicente Botti, **vbotti@dsic.upv.es**

SOFTWARE

TESTAR

Is an open source tool with a BSD-3 clause license (https://github.com/TESTARtool/TESTAR_dev). This software testing tool connects to a desktop, web or mobile application and automatically interacts with GUI elements. It performs click, type and swipe actions, while debugging the application, avoiding flaws such as crashes, exception messages or overlapping GUI elements. The main purpose of this type of testing is to evaluate how robust an application is.

In the last 3-4 years, TESTAR has reached a TRL-6 level as a research tool for software testing. In various collaborations with industrial partners (ING, ProRail, CapGemini, I.D.B., I.D.B. Telematica B.V., E-Dynamics, SoftTeam, KuveytTürk or ProDevelop) the tool has attracted positive attention thanks to its ability to debug and to explore app issues that other software testing approaches do not test. TESTAR is aimed at companies that create ICT systems.

Tanja Vos, **tanvopol@dsic.upv.es**

Planning and scheduling

SOFTWARE

R-16265-2012-GREAT Process Modeller: Global Reengineering Environment with Automatic Transformations

This is a platform for business process modelling and to create requirement specifications for I.T. systems focused on quality software production in record time and its subsequent maintenance and evolution. Time reduction is achieved by employing model transformation technologies that automate part of the system design. It also adds an integral perspective as it covers the entire software development process, from analysis phase to final coding. Therefore, this platform provides an environment for modelling and specification of requirements and agile development of software applications through automatic transformations.

It is a platform aimed at general software development companies.

Óscar Pastor, **opastor@dsic.upv.es**

SOFTWARE

UTool

It is a tool for the analysis of big data collected from social networks. This tool can be applied to fields such as urban planning and management, marketing, public opinion analysis and scientific or social research. The tool kit offered by UTool provides utilities to analyse social network data based on three essential axes: spatial localization –through visualization of tweet distribution on a raw map, gravitational potential maps (static or dynamic), heat maps and distance matrices; social interaction –through visualization of pagerank and communities in graphs that measure relevant metrics from social analytics; textual emotional charge –through sentiment analysis allowing for detection of positive, neutral and negative messages, as well as tag clouds with the most frequent words linked to positive and negative emotions.

UTool is meant for a broad spectrum of companies that require or need to analyse data produced in a social network, not limited to a specific sector.

Further information; https://www.youtube.com/watch?v=1DzSpqZRUR0

Vicente Botti, **vbotti@dsic.upv.es**

SOFTWARE

SimFleet: Software for the simulation and evaluation of mobility models

It is a simulation tool that allows users to develop and test new mobility management models or policies in urban and interurban environments, as well as to analyse new coordination strategies and vehicle fleet regulation mechanisms to improve efficiency in the distribution of people or goods. Until now, these types of tools were oriented to general purpose applications and their use in the design and evaluation of resource allocation was complex. This tool is flexible enough to support several types of deliveries, carriers, logistics and other mobility requirements. It also includes different scenarios with new delivery models, collaborations or carsharing solutions. It is built as a multi-agent system running on the SPADE platform, where different agents interact among them in a regulated environment. It has been coded in Phyton, so it can be easily extensible and run on any operating system.

SimFleet is particularly useful for companies focused on logistics and transportation, especially those managing vehicle fleets. Delivery companies, taxi or carsharing services, and organizations involved in the distribution and shipping of goods could benefit from its simulation and analysis features. In addition, it may be of service to companies interested in route optimization and fleet management strategies, for public transportation companies and for public authorities such as municipalities. These organizations can use it to optimize routes, improve operational efficiency and analyse urban mobility strategies.

Vicente Julián, **vjulian@upv.es**

VRAIN

REASONING AREA

Presentation of knowledge

SOFTWARE

GTIbot cognitive assistant for the assistance of people with cognitive or physical disabilities

GTIbot is a physical cognitive assistant shaped as a companion robot, developed by VRAIN (Valencian Research Institute for Artificial Intelligence). It is designed to monitor biological signals in elderly people or people with specific disabilities, which to determine their state of health and mood by means of an integrated camera. In addition, it can recommend exercise work and monitor activities with a follow-up by caregivers. It includes environmental sensors to measure humidity, temperature, CO2 and volatile organic compounds. GTIbot can also communicate with portable devices for ECG analysis, which is useful in monitoring cardiac issues.

GTIbot is designed primarily for its use in the health and wellness industries, especially in settings that require caring for elderly and people with disabilities. It would be suitable for nursing homes, healthcare facilities and hospitals looking for innovative tools for patient monitoring and care. In addition, it can be useful for researchers in the field of healthcare and assistive technology.

Vicente Julián, **vjulian@upv.es**

SOFTWARE

G-MAC

Information system based on conceptual models for an effective and efficient management of data associated with retina-macula pathology. This system provides the ophthalmologist with a great help to make more precise decisions in treating this disease and, in addition, it entails lower pharmaceutical expenses.

Previously, patient information was scattered in various files and documents in different formats, which made it difficult to manage. Currently, G-MAC is available to the Ophthalmology Services of the Valencia Government Department of Health (Conselleria de Sanitat de la Generalitat Valenciana) to improve the processing of data associated with these patients in a simple, organized and secure way, avoiding high costs. It can be run in any browser from any platform. This system makes it possible to offer a better quality of care together with improved management of the costly drugs that such diseases require, as used in the said Ophthalmology Services.

Additionally, epidemiological studies (by gender, allowing for this variable to be researched properly) can be carried out with the aim of improving diagnosis, care, optimization of consultations, waiting times, treatment indications, cost-benefit improvement as well as a more personalized follow-up.

Juan Carlos Casamayor, **jcarlos@dsic.upv.es**

SOFTWARE

DIAGEN: Software platform for genetic diagnosis assistance

One of the issues that genetic laboratories face when diagnosing is a slow pace and propensity to errors due to the diversity of databases, to be consulted manually. The ProS group of the UPV VRAIN institute is working on a software platform prototype capable of analysing genomic sequences by using a database that matches diseases with genes and mutations, through the creation of a novel conceptual scheme of the human genome. This software unifies all available information in a single repository to reduce the existing sources in the field of genetics and molecular biology and thus speeding up the search process.

This software is aimed at genetic diagnose companies in the field of precision medicine.

Óscar Pastor, **opastor@dsic.upv.es**

SOFTWARE

Calysap. Development of an intelligent information system for data management to be adapted to the criteria of quality, safety and efficiency required for patient-oriented precision nuclear medicine

The system focuses on the application of conceptual modelling techniques and Explainable Artificial Intelligence (EIA) technology for the development, maintenance and integration of an information system that allows for the management of nuclear medicine services and radio frequency units of the Valencian region and other national and international services.

This development is aimed at clinical software development companies in the healthcare field.

Óscar Pastor, **opastor@dsic.upv.es**

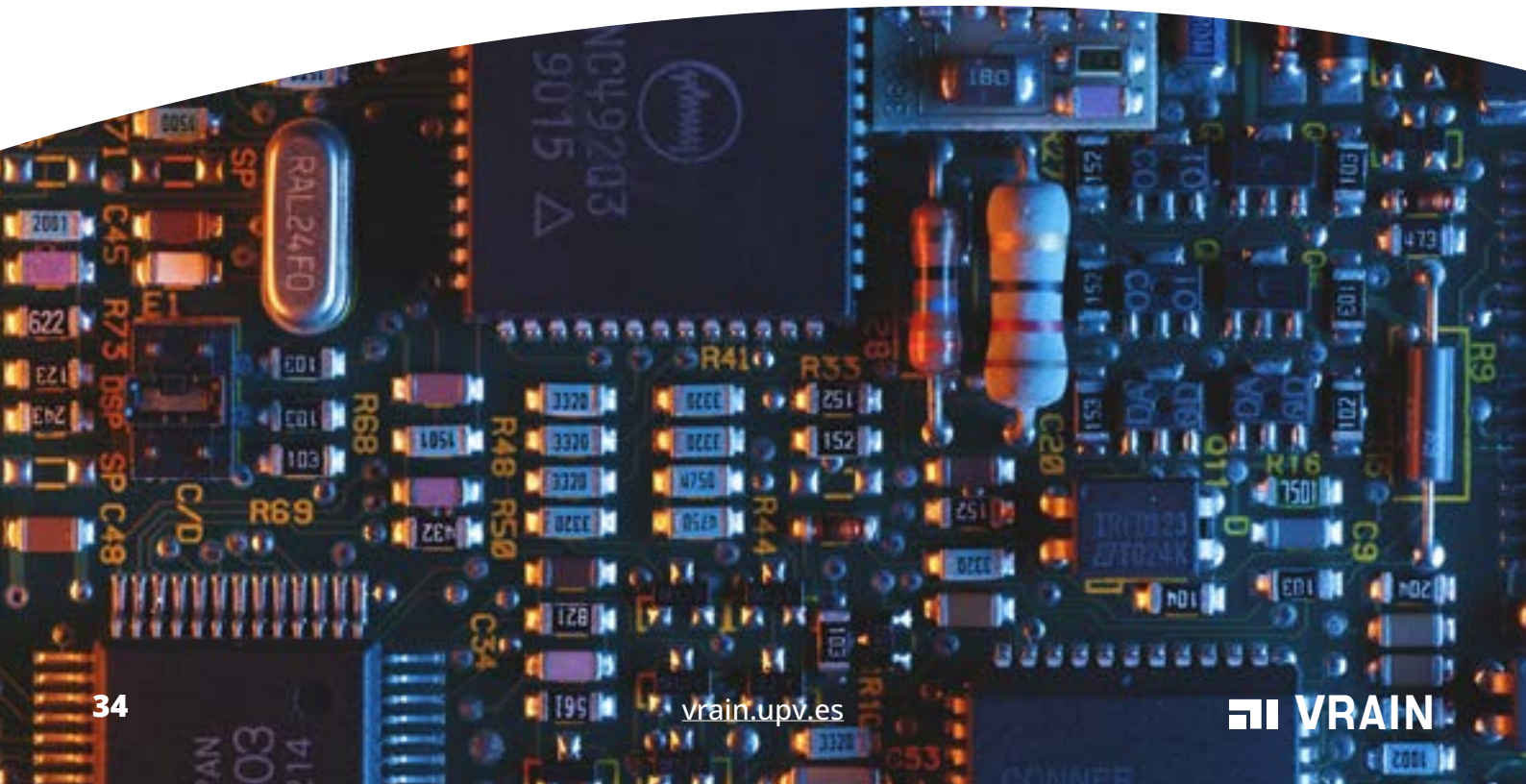
SOFTWARE

MATE: Model-based automation engine

Currently one of the main challenges of ubiquitous computing systems is to automate their provided services in a coordinated way, taking into account behavioural patterns and the context in which they are implemented. MATE is a software infrastructure that enables the automation and evolution of context-adaptive behaviour patterns. It continuously monitors the context and environment of the system to decide on pattern execution. Among other benefits, patterns to be automated may be defined through high-level abstraction models without needing to implement any type of coding, they may be autonomously executed in a context-adaptive way at runtime without the intervention of developers, or they can evolve at runtime without stopping the system. In addition, its evolution is carried out in a controlled manner and ensures that no model is left in an unconscious state. It also allows interfaces for users to make their patterns evolve according to their needs.

This software infrastructure is aimed at companies that implement the internet of things or self-adaptive systems in scenarios such as smart buildings, smart cities, smart health, automated production processes or autonomous vehicles.

Pedro José Valderas, **pvalderas@dsic.upv.es**



SOFTWARE

Moskitt4ME; CAME (Computer Aided Method Engineering) environment for the agile construction of Software Production Methods (SPM) tailored for every company

At present, there are general methods that allow for software development, but they are difficult to adapt to particular circumstances of each development project, such as the size of the company, available resources or planning changes, so that companies end up developing custom methods for their specific needs. Some approaches for the construction of SPM and CAME tools are not widely accepted in the industry due to their complexity and lack of flexibility.

The main advantage of CAME Moskitt4ME is how it speeds up the construction of SPM, adapted to the particularities of each company or project, and how it allows for easy and fast design of MPS and to obtain the corresponding supporting CASE tools. It also allows reusing parts of other predefined methods and linking method parts with already built assets.

Moskitt4ME is aimed at large software development companies.

Vicente Pelechano, **pele@dsic.upv.es**

SOFTWARE

AKABAT is a tool to facilitate the work of researchers and documentation centres

In a context with an overwhelming amount of available information, it offers an analysis of research topics, allowing users to identify patterns, trends and emerging areas of interest quickly and efficiently. It combines artificial intelligence and data mining techniques to automatically group and categorize thousands of scientific articles, and exposes the topics of a research area and their trends.

AKABAT performs an exhaustive analysis to identify the most important and prominent areas by taking as input one or several csv files containing scientific article titles, keywords and years of publication. All this information is stored in a database specially designed for the application.

Thus, it may generate useful diagrams and statistical graphs, and can be used as reinforcement in the portrayal of the state of the art and systematic literature reviews. This tool is aimed at researchers and documentation centres, as it allows to speed up and deepen their work.

Francisco Enguix, **fraenan@upv.es**

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

VRAIN

SERVICES

VRAIN

COMMUNICATION AREA

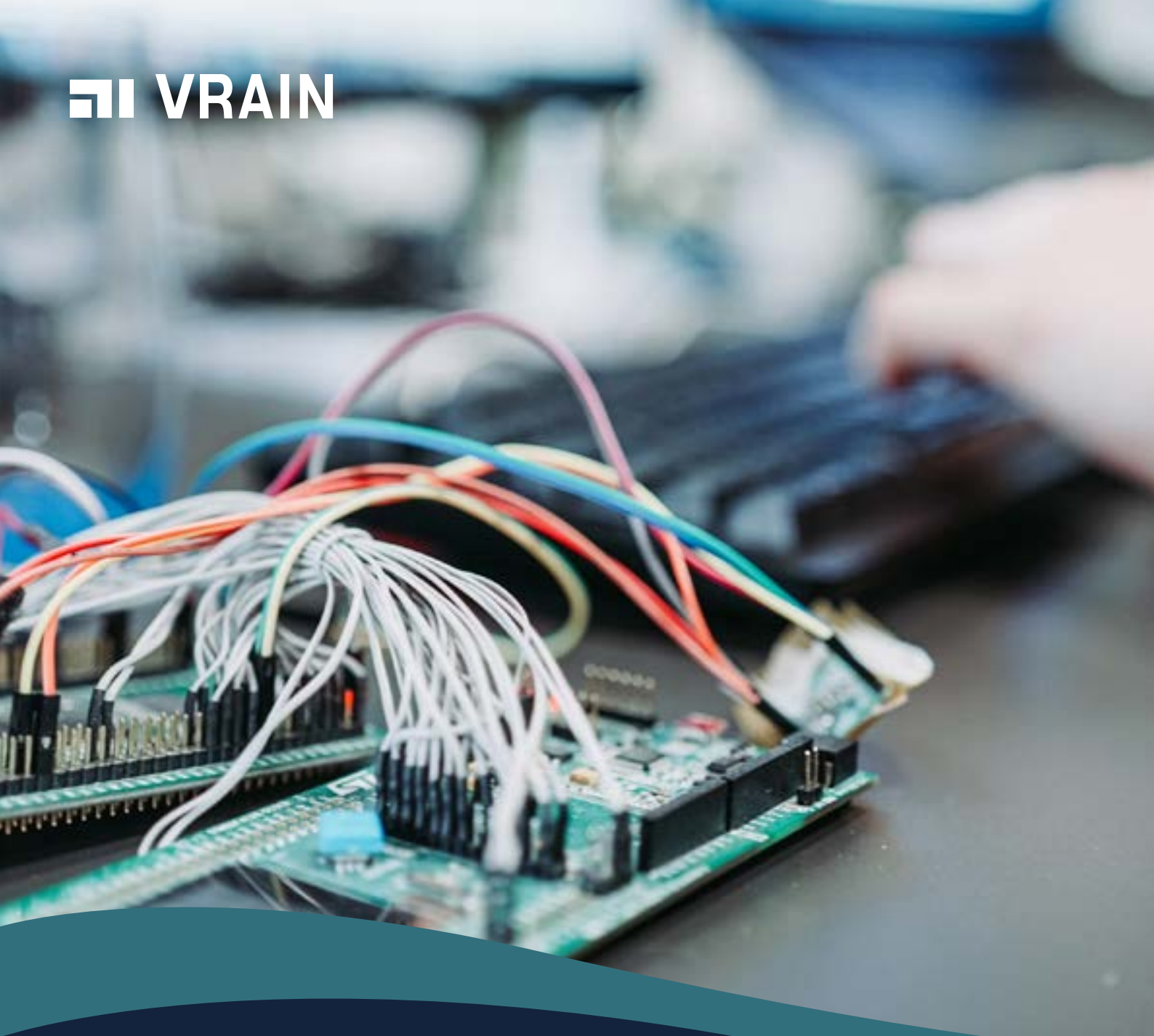
SERVICES

Text simplification

This service provides simplified versions of texts such as court rulings, official documents or informative texts. It is used to convey information to people with reading difficulties. It is aimed at public administrations and special education schools.

Lluis Felip Hurtado, **lhurtado@dsic.upv.es**

VRAIN



INTEGRATION AND INTERACTION AREA

SERVICES

Smart cities

We offer innovative solutions for smart cities using data provided by authorities such as municipalities. We develop services based on artificial intelligence and other technologies to improve key aspects like mobility, waste management, geolocation and air quality. These services are designed for public authorities and companies dedicated to urban development and to the improvement of life quality in urban environments.

Vicente Botti, **vbotti@dsic.upv.es**

Intelligent agents / multi-agent systems, agreement technologies

This field focuses on developing systems where multiple computational entities, the so-called agents, work together to solve a problem.

Each agent has autonomy to achieve its own objectives and also cooperation and coordination skills to work with the rest of agents towards a common objective. Within this field, the UPV VRAIN is specialized in areas such as: cognitive agents, agents that simulate aspects of human cognition; agreement technologies, techniques to enable coordination, collaboration and negotiation between different agents; as well as ethical and responsible agents, capable to represent and reason about the principles that guide complex decisions.

The techniques of this area can be applied to domains such as distributed systems, robotics or the simulation of complex systems.

Vicente Botti, **vbotti@dsic.upv.es**

VRAIN

PERCEPTION AREA

SERVICES

Deep learning and visual artificial intelligence

This area focuses on the development of methods that enable image analysis using deep neural networks including convolutional neural networks (CNN), recurrent neural networks (RNN) and visual transformers (ViT).

Its applications include object recognition, semantic segmentation, division of images into semantically meaningful regions, image classification, anomaly detection and image generation (GAN). These neural networks, whilst being very powerful, face the issue of interpretability. Therefore, we are also working on methods that allow these "black boxes" to explain their behaviour.

In this context, the work developed includes vehicle classification, object detection, visual detection of graphical anomalies, satellite image segmentation, programming of an autonomous video-guided robot and medical image segmentation. We also offer training focused on Deep Learning and its practical applications.

Carlos Monserrat, **cmonserr@dsic.upv.es**

SERVICES

Multimodal interaction, VR/AR/XR, metaverse

Multimodal interaction involves the use of multiple communication channels between the user and the machine, such as voice, gestures and touch. It is enhanced in the fields of virtual reality (VR), augmented reality (AR) and extended reality (XR), where digital environments merge with the physical world to create immersive experiences. The metaverse, a virtual expansion of the real world, allows a range of applications from entertainment to education or professional collaboration. The application of generative artificial intelligence in this area unlocks a way to more natural and adaptive interactions and facilitates the creation of personalized content and experiences. This set of technologies not only redefines digital experiences, but also opens up endless possibilities for applications in different industries.

Jordi Linares, **jlinares@dsic.upv.es**

VRAIN

PLANNING AREA

SERVICES

Sequence processing, pattern and structure search

We use our own machine learning techniques to design and implement classifying and prediction systems to act on textual and structural information. We found our approach on the design of formal language models. We focus especially on genomic information that allows us to address the design of gene locators, functional and/or structural motifs in proteins, and any other pattern of interest in the domain of omics information. This service is aimed at companies in the bio sector: pharmaceutical, health, phytosanitary and bioinformatics.

José María Sempere, **jsempere@dsic.upv.es**

Social network monitoring

This is a content analysis service, for the detection of social network message polarity, opinions, topics or narratives, as well as to detect hate speech or harassment.

It is aimed at businesses seeking to analyse the impact and value of their products in social networks, as well as political organizations or public authorities.

Lluis Felip Hurtado, **lhurtado@dsic.upv.es**

SERVICES

Robustness of AI models

To ensure that ML and AI models can maintain a robust and consistent performance, even when faced with unstable conditions, noise in the data or perturbations in the environment, it is necessary to assess them under different operating conditions.

VRAIN researchers have extensive experience in analysing model robustness –the ability of models to generalise appropriately for different datasets and to handle unexpected situations effectively. At VRAIN we have developed specific methodologies for the evaluation of model robustness by measuring the impact that data complexity and noise level have on the models.

María José Ramírez, **mramirez@dsic.upv.es**

SERVICES

Software verification and testing

Good software quality requires techniques to analyse software behaviour and detect possible issues and their solutions. However, such tools entail a high cost due to the complexity of today's software systems.

At UPV VRAIN we use techniques that allow us to reduce such cost, time and memory, like abstract interpretation or like symbolic or partial representations which benefit of a design to guarantee reliability. Therefore, by using these reduction/compaction techniques, UPV VRAIN is able to mitigate the cost issue (time and memory) of tools that analyse and test the behaviour of software systems.

This service can be applied to optimise verification tools, debugging tools, static analysis of programmes and software testing. Its benefits lie in a faster execution of tools, as well as more competitive software analysis and verification applications in terms of response time and reliability. In addition to supporting improved verification techniques, concurrent systems in particular show extra complexity to ensure good behaviour due to interleaving of threads. At UPV VRAIN we can assist in modelling the critical aspects of concurrent systems in order to make use of existing verification tools that may be specific to these systems. We also advise on the use of automatic test case generation tools.

Alicia Villanueva, **villanue@dsic.upv.es**

SERVICES

Code debugging tools

From the VRAIN institute of the UPV we have developed a range of advanced code debugging techniques, with emphasis on automatic and/or low-input assisted tools. We mainly consider techniques based on slicing and reversible debugging.

While the former allows to narrow down the lines of code where errors may be found, the latter is used to explore executions step by step, both forwards and backwards. Debugging tools are the ideal complement to testing and validation techniques, as they assist in locating the source of errors detected. In this way, it is possible to shorten the time required to detect, locate and, especially, correct software errors, a crucial task in any software development environment.

Germán Francisco Vidal, **gvidal@dsic.upv.es**

SERVICES

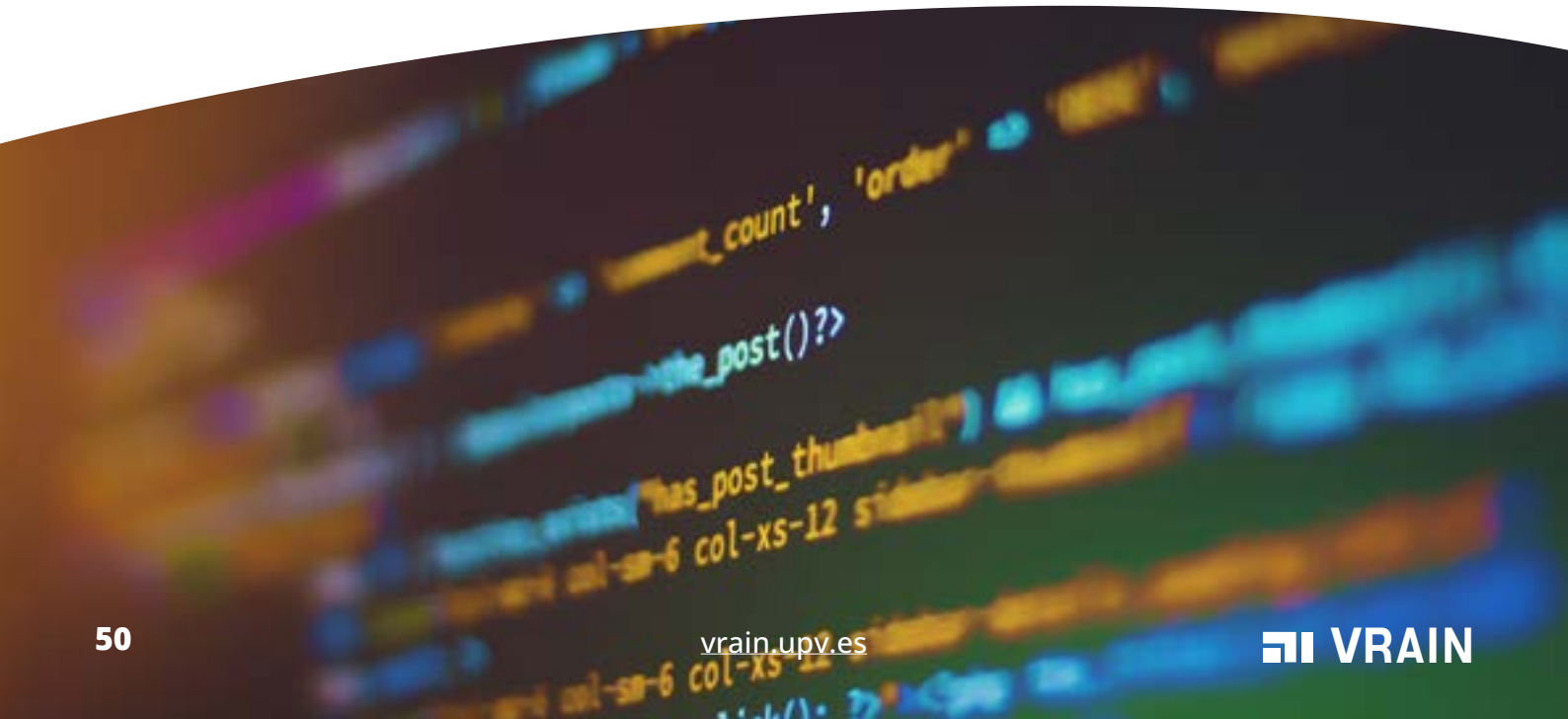
Automatic planning

Automatic planning is used to calculate a plan or a sequence of actions to be applied to one state of a problem in order to reach another state within specific conditions. A planner requires three inputs:

For instance, in the case of a manufacturing problem, one could indicate the number of warehouses, their location, their contents or what machines are available for the manufacture of goods. - A description of the actions that can be taken. For the above example, one could define actions to put away or remove raw materials from a warehouse. For each action, the conditions to be fulfilled for execution and the expected effects must be indicated.

In order to manufacture 100 units of a certain product. We have planners that allow modelling problems that require a high level of expressivity, which include control parameters in the actions. Thus, the planner can decide certain numerical values for each action, e. g., the power or speed for the machine to work or the amount of material to be used.

Vicente Botti, **vbotti@dsic.upv.es**



SERVICES

Conceptual modelling programming - CMP

Development of information systems for organizational management and methodological consulting for organizations seeking to improve their software production processes or that undertake projects externalising implementation, as well as complex domain modelling and consulting for new technology adoption for model-driven development and automatic code generation. These methods have proven a high performance in industrial environments, the delivery of quality products within project schedules and budgets, and the ability to solve large and complex problems. This service is open to all types of businesses that may need to manage or exploit information of any kind.

Óscar Pastor, **opastor@dsic.upv.es**

Business process design, abstraction and automation

Business process design with model-driven methodologies. Methodological advice for processes to be modelled in line with organizational goals and structures, in order to ensure an efficient and scalable implementation of information services. Our business process design method takes into account the organizational scenario for process re-design, and it automatically proposes collaboration between business processes to achieve business goals. Business process modelling is focused on communication between system participants, and it offers traceability and automation for the generation of support information services.

Óscar Pastor, **opastor@dsic.upv.es**

SERVICES

Automatic software testing

TESTAR is a software test automation tool that uses accessibility APIs to connect and test systems through graphical user interface (GUI). TESTAR's flexible architecture allows for the extension of its capabilities to connect and test desktop, web and mobile systems, as well as cutting-edge systems such as Extended Reality (XR) video games.

A high degree of automation that allows changing the testing paradigm by using AI-enabled intelligent agents to enhance automatic system exploration as well as fault detection is a distinctive feature of TESTAR. TESTAR has been used in countless industry collaborations which prove the how this approach is a fit complement to traditional testing.

Tanja Vos, **tanvopol@upv.edu.es**

VRAIN

REASONING AREA

SERVICES

Membrane computing

We design customized solutions to solve complex problems in different application areas. Our solutions are based on membrane computing, which allows the implementation of parallel and distributed information processing. Our approach can be applied in any field supporting efficient algorithmic resolution for complex problems in process engineering, health, energy or logistics, among others.

This service is aimed at all kinds of businesses.

José María Sempere, **jsempere@dsic.upv.es**

SERVICES

Digital twins, bioprocesses, biosequences

We design digital simulators oriented to life sciences. Our simulators operate at the biochemical, biocellular and biological levels on a large scale. These simulators integrate all relevant biological information for the modelling of processes and entities applied in biomedicine and systems biology. We optimize our simulators for a possible use in high performance platforms, with distributed and parallel information. It is meant for businesses in the bio- sector: pharmaceutical, bioinformatics, biomedical or phytosanitary, among others.

José María Sempere, **jsempere@dsic.upv.es**

SERVICES

Design of cryptographic protocols: access control and electronic voting

Cryptography offers tools to guarantee confidentiality, authenticity, information integrity, secure registry of deeds or decisions and availability of services. Although there is a wide range of protocols that can be adapted to a plethora of situations, all of them may be modified to suit the particular needs of a business or institution.

We have patented protocols for anonymous access control or remote electronic voting. Hence, we offer protocol adaptation to the requirements of companies with particular needs or, if necessary, design of specific protocols to meet their needs and guarantee the desirable properties mentioned above.

Damián López, **dlopez@dsic.upv.es**

SERVICES

Named entity detection, automatic summarization and text classification

This service includes the analysis of texts to automatically detect named entities, such as companies, or names of people or places, in order to extract related information. Automatic summarization tasks can be applied to any type of text, whether journalistic, administrative, cultural or educational. For instance, a newspaper article about economics, sports or culture, or a text addressed to a city council would be classified according to the corresponding service. Then, these products are useful for documentation services, journalistic companies, public authorities and information analysis businesses.

Lluis Felip Hurtado, **lhurtado@dsic.upv.es**

SERVICES

AI Evaluation

In recent decades, the volume of information that is computerized in the databases of most organizations and businesses has grown dramatically. Its analysis provides businesses with a great deal of knowledge that helps them in decision making. However, the dispersion of this data in different formats and large volumes is a challenge that can be overcome with data mining techniques and tools. With the evaluation of AI, UPV VRAIN generates predictive and descriptive data mining models, the evaluation of cost-based data mining models and the adaptation/ contextualization of models for their application. Among its benefits are the optimization in the use of data mining models and the inclusion of costs in model assessment.

José Hernández Orallo, **jorallo@upv.es**

SERVICES

Computational argumentation and argument mining

Computational argumentation is an interdisciplinary research field that emerged in the early 1990s as a paradigm for knowledge representation and reasoning. It is currently applied to various AI domains, such as decision making, multi-agent systems and natural language processing, as well as in specific areas of application, such as automatic analysis of debates and opinion pieces, disinformation detection and analysis, automatic negotiation, healthcare and legal reasoning. Argumentation also plays an important role in the design and development of interactive technologies capable of maintaining or changing human thinking and behaviour using persuasive techniques.

Given its close relationship with natural language processing, with the rise of AI-based generative language models, this area is facing multiple challenges. Computational argumentation provides an avenue to critically examine both the training data and the outputs of these models, and it helps to identify, explain and correct gender biases, which is crucial for the development of fair and responsible AI technologies.

UPV VRAIN is working on the development of argumentative technologies from different perspectives: application in recommendation systems and decision support within educational and health contexts, application in virtual societies of humans and agents (where agents act as virtual assistants for humans), use in social networks, ability to persuade users and effect change in thinking and behaviour through argumentation techniques, as well as text analysis and detection of underlying patterns and lines of reasoning, identifying misinformation and biases.

Vicente Botti, **vbotti@dsic.upv.es**

SERVICES

Digital twins (DT)

In AI-driven digital twin applications, AI plays a major role in each layer and provides capabilities for:

-Advanced pre- and post-processing, hybrid simulation, data augmentation and fusion, as well and mining and discovery in the data layer;

-Hybrid physics-based AI modelling, data assimilation, downscaling and downstream model integration, among others, for the model layer.

-Recommendation, reasoning and scenario generation under uncertainty, digital assistance and visualization, among others for the decision support layer.

The power of the DT-IA pair lies in the way different AI support approaches can be combined to implement the DT layers. Without a fixed rule on how this integration should be done, developers can combine the approaches that best suit particular needs to solve the problem at hand (at the particular DT layer) and connect them in order to compose a set of AI-enabled modules for a given configuration.

In addition, AI approaches, such as multi-agent systems, can endow DTs with social capabilities, such as interaction and collaboration, to boost computational capabilities beyond the single physical or social entity or phenomenon that the DT represents. This allows for the interconnection of different DTs within an organization.

Vicente Botti, **vbotti@dsic.upv.es**

SERVICES

Affective computing

Affective computing studies the simulation and improvement of the interaction between computer systems and humans through the interpretation and use of human emotions. It includes the study of emotional processes such as the generation and recognition of emotions or empathy. Among its applications we find the development of personal assistants that help in emotional regulation or in monitoring and emotional support for elderly people.

Vicente Botti, **vbotti@dsic.upv.es**

Optimization and prescriptive analytics

These services are aimed at companies seeking to improve their decision making, operational efficiency and optimization of resources and human capital. Using advanced and intelligent optimization techniques, we develop customized solutions for a variety of common problems in many industries such as production planning, work scheduling, fleet management, service location, schedule and shift planning, training management, resource allocation, routing, logistics, e-mail recommendation planning, work time minimization, team building or cost reduction, among others. These solutions are ideal for companies in various industries seeking to optimize their processes and make strategic decisions based on data.

Juan M. Alberola, **jalberola@dsic.upv.es**

SERVICES

Customer segmentation

We help companies better understand their customers and improve their marketing strategies through advanced segmentation techniques. Using artificial intelligence, we analyse internal and external data to categorise customers into homogeneous groups and to enable businesses to run more effective and personalized marketing campaigns. This is a especially useful service for businesses of all sizes and industries seeking to maximize the return on their marketing strategies and to improve customer loyalty.

Juan M. Alberola, **jalberola@dsic.upv.es**

SERVICES

Urban and interurban mobility

AI research applied to urban and interurban mobility seeks to improve transportation systems by optimizing the distribution of resources, such as vehicles and stations, to efficiently meet transportation needs.

This approach takes into account crucial aspects such as environmental sustainability, user experience and the economic viability of the transport operator, as well as it proposes solutions that balance these often conflicting interests. With the use of artificial intelligence techniques, such as agent-based modelling, modifications to transportation infrastructures and its operations can be experimented with prior to actual implementation, thus ensuring practical solutions tailored to the specific needs of urban and rural areas. This integrated approach enables the creation of more adaptive, efficient and environmentally friendly transportation systems, improves the mobility of people within urban environments significantly and connects interurban areas effectively.

Our urban and interurban mobility service is aimed primarily at a wide range of businesses and public authorities interested in optimizing transportation systems. These include transport operators running bus, tramway and underground services, looking to improve operational efficiency and user experience. Logistics and freight forwarding businesses focused on route optimization, efficient distribution of goods, as well as reduction of costs and environmental impact can also benefit from it, as they may developers of technological solutions for intelligent mobility and municipal and regional authorities responsible for transportation planning and regulation.

Vicente Botti, **vbotti@dsic.upv.es**

SERVICES

Recommendation systems

At VRAIN we work with recommendation system, a tool that extracts a set of criteria and ratings on user data to make predictions on item recommendations that may be useful or valuable to users or businesses.

This type of systems can be applied, for example, to online shopping services, in which user preferences are extracted from purchase history or from user interaction with the service itself (e. g.: Amazon, Netflix, or Spotify). They can also be used to improve processes within a business, for example, to recommend candidates for a certain position in the HR department.

Vicente Botti, **vbotti@dsic.upv.es**

Serious games

Serious games represent a revolution in the use of video game technology and extend its reach beyond entertainment to address educational, therapeutic and training objectives. They are powerful tools in education, rehabilitation, training, and cognitive stimulation, so they even provide special support for people with different needs. Gamification in work environments, another side of serious games, transforms everyday productive processes into more attractive and efficient experiences. By integrating these elements, serious games not only enrich the learning and working experience, but also open up new avenues for skill development and innovation.

Jordi Linares, **jlinares@dsic.upv.es**

SERVICES

Explainable Artificial Intelligence (EAI) systems for data analysis and management

The amount of data being generated in different domains and complex environments requires the use of AI techniques to make data analysis easier. AI algorithms, some based on black box models, are now being used. However, the results are not 100% accurate and these techniques do not allow practitioners to check the reasons behind the results obtained in order to improve them. Therefore, at VRAIN we propose an Explainable AI that allows the user to identify the decisions that motivate its results in an understandable way to allow the system to evolve according to the user's needs. This service has numerous applications such as information management, analysis and interpretation of big data, selection and consolidation of different data sources or repositories, or the understanding of biological mechanisms that give rise to diseases. It provides benefits such as improved identification and processing of the data and cost reduction in the study and analysis of the genomic domain.

Óscar Pastor, **opastor@dsic.upv.es**

SERVICES

Internet of things in production and manufacturing environments, modernization of infrastructures and integration of processes and physical objects with production systems:

Integration of industrial IoT infrastructures

We have developed solutions that facilitate the integration of production systems with physical devices for efficient real-time communication between both environments.

Process modelling and evaluation

We use advanced process modelling techniques to define, assess and optimise operations in production environments, and thus anticipate potential problems in order to accelerate the development cycle.

Development of business support applications

Creation of customized applications that support specific business processes and incorporate physical elements and modelling techniques adapted to the particular needs of each domain such as logistics, production or resource control.

Autonomous computing and self-adaptation

Implementation of autonomic computing capabilities in the developed services and software elements that allow real-time self-adaptation to changing production scenarios. This includes optimisation, healing, protection and automatic configuration.

Real-time optimization

Integration of algorithms and methodology that allows for continuous real-time optimization of production support processes that contribute to operational efficiency and decision making based on updated data.

Intermediary elimination with IoT

Design of solutions that automate the flow of information between physical objects and information systems to eliminate unnecessary intermediaries and enable the emergence of new business models.

Efficient management of physical resources

Development of applications to make the management and control of physical resources and provide detailed information on location, traceability and status in real time easier.

Technological abstraction

Focus on developing solutions at a higher level of abstraction to avoid dealing with the peculiarities of underlying technologies and ensure system acceptance by users.

The development of this type of business support applications involving physical elements can take place in any domain, as modelling techniques have been defined to be adapted to the particular needs of each domain. Some activities would include advanced manufacturing, smart logistics, quality management, waste control and sustainability, intelligent transportation, energy resource management, automation and industrial robotics, production customization and Industry 4.0.

Its benefits are enhancing operational efficiency, reducing waste and improving traceability, speeding up of development and continuous optimization, creating new business models and eliminating intermediaries, managing physical resources efficiently, reducing maintenance and management tasks, decision making based on updated data and adaptation to various industrial sectors.

Joan Fons, **jjfons@dsic.upv.es**

SERVICES

Organizational modelling

Analysis and modelling of key organizational definitions for the development of software systems. This method of organizational analysis and modelling allows us to represent strategic definitions to guide the development and evolution of software systems and the business processes they support.

Our approach allows us to define the ideal configuration of units within the organization that may require and/or develop software systems in order to ease business process and system design in line with the goals of the organization and its units.

Óscar Pastor, **opastor@dsic.upv.es**

VRAIN

CYBERSECURITY AREA

SERVICES

Cybersecurity in software systems

We develop tools for the analysis and verification of safety and security properties in mobile code (e.g. Java or Python), in cryptographic communication protocols (e.g. based on elliptic curves or post-quantum cryptography) or in generic software systems (e.g. poor management of shared resources).

In this regard, UPV VRAIN has developed advanced techniques to reduce the search space for solutions that have been integrated into different applications developed in research centres around the world.

Santiago Escobar, **sescobar@upv.es**

Application of cybersecurity techniques to AI

There are currently a multitude of cyber-physical systems such as cars, aeroplanes or aerial vehicles, with the capacity to make vital decisions. In this sense, it is essential that reliability and protection be established at very early stages of the system, such as design itself. The benefit provided by UPV VRAIN is the application of cybersecurity techniques to AI-based systems.

Santiago Escobar, **sescobar@upv.es**

SERVICES

AI applied to cybersecurity

Cyber attacks have increased significantly in recent years, both to businesses and to organizations. UPV VRAIN is working on the use of artificial intelligence techniques and generation of visual traffic reports in network computers. In this way, the network administrator can easily and quickly initiate the entire server protection protocol in the event of a possible attack. These systems are based on the use of neural networks and case-based reasoning to process information, agent technologies for distributed system management, and real-time technologies to ensure a response within a delimited maximum time. The fact is that limiting deliberative processes within the intrusion detection system is a very positive development, as it allows security staff to know the maximum time interval for response.

Vicente Botti, **vbotti@dsic.upv.es**

VRAIN

SEARCH AREA

SERVICES

Data mining and analysis

UPV VRAIN offers a series of consulting services focused on helping small and medium-sized businesses to take advantage of these disruptive technologies. We specialise in the development of predictive and descriptive models based on the analysis of large volumes of data for informed decision making. We also help automate business processes by implementing LM algorithms. We have experience in the application of language models. We maintain strong ties with academia, so our solutions are based on the latest trends and advances in AI and LM research. In addition, we offer customized workshops and training sessions to help teams in companies and organizations understand and adopt these technologies.

César Ferri, **cferri@dsic.upv.es**

SERVICES

Development of software tools for the management and analysis of genomic information

Biologists currently have an increasing amount of genetic information available but no quality software tools to process this information in a productive manner. To this end, the PROS research group of UPV VRAIN, together with biologists, has created conceptual models that capture genetic concepts accurately.

This service allows the development of bioinformatics applications, the integration of heterogeneous information from genomic databases or pattern detection for genomic analysis. It can increase productivity in Human Genome research and reduce the cost of implementation of information systems in the field of bioinformatics. This improves the quality of bioinformatics tools and cost reduction in Genome research. This service is aimed at medical and clinical professionals, hospitals, geneticists and laboratories.

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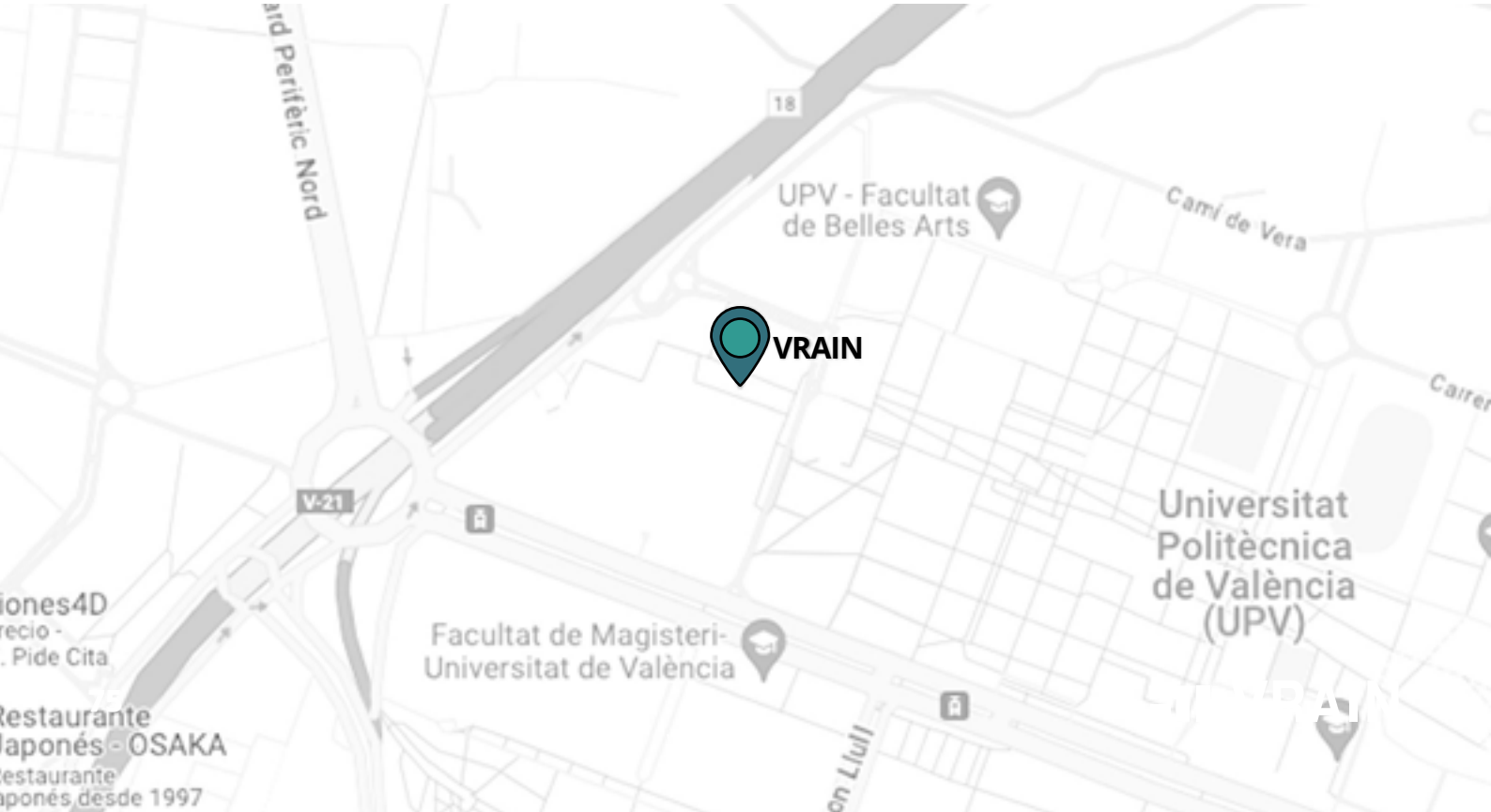

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GENERALITAT VALENCIANA

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