Impact Objectives

- Increase the safety, efficiency and economy of operations concerning moving entities in the air-traffic management and maritime domains
- Develop novel methods for real-time detection and prediction of trajectories and important events related to moving entities

Big Data heralds new era for time-critical mobility forecasting and situation awareness

__Professor George Vouros__, from the __Department of Digital Systems, University of Piraeus__, is leading __datAcron__, a collaborative research and innovation project that is introducing novel methods to operations at sea and air, for large numbers of vessels operating in large geographical areas

Firstly, can you share what your own research interests and ambitions are?

My research interests include data science topics (semantic data integration and link discovery, ontologies, big knowledge graphs) and multi-agent systems. Regarding data integration and ontologies, one of the objectives of my work is to develop semi-automatic methods for the semantic enrichment of data from varying sources, the semantic integration of data from disparate and heterogeneous data sources, and, more specifically, the development of multi-dimentional data interlinking methods for Big Data sources, also combining data-in-motion (streaming data) and data-at-rest (archival data). These are core topics of research in the current project I am coordinating. One of the main objectives of datAcron (Big Data Analytics for Time Critical Mobility Forecasting) project is to advance the state of the art in data integration and data interlinking in Big Data sources, while also semantically enriching data in computationally effective ways to support advanced analytics at varying levels of detail and with strict latency (real-time) requirements.

What is the vision behind the datAcron project?

Our vision is to advance the management and integrated exploitation of voluminous and heterogeneous data-at-rest and data-in-motion sources, which will in turn significantly advance the capacities of systems to promote safety and effectiveness of critical operations for large numbers of moving entities in large geographical areas.

How do you propose to achieve this aim?

DatAcron aims to develop novel methods for real-time detection and prediction of trajectories as well as detection and prediction of important events related to moving entities. There are several key objectives of the project towards this target. These include advanced visual analytics methods, over multiple heterogeneous, voluminous, fluctuating, and noisy data streams from moving entities, the real-time processing of multiple data streams, the provision of integrated views of streaming data with archival data expressing entities' characteristics, geographical information, patterns of mobility in specific areas, regulations, planned routes, etc., and the provision of advanced solutions for managing spatio-temporal data.

Can you explain what the important issues are in this research?

These issues include the big characteristics of data from disparate and heterogeneous sources. This, together with the requirements for real-time detection and forecasting accuracy of moving entities' trajectories, and the real-time recognition and prediction of important events concerning these entities, implies challenges in advanced methods for processing, managing and integrating data. This line of research in datAcron is also in coordination with developments of advanced methods for managing large knowledge graphs, including their storage, partitioning and querying. The ambition is to provide a generic infrastructure to manage data to support analysis tasks for mobility tracking and forecasting in real time. The project validates and evaluates its technological developments in real-life scenarios to improve maritime and aviation operations for a large number of entities in large geographical areas. As a University of Piraeus Research Centre group leader, head of the Artificial Intelligence Lab and member of the Data Science Lab, I must say that, beyond data management and integration, we aim to significantly advance the state of the art in trajectories detection and long-term forecasting of trajectories.

Adding significant value to real-time tracking and forecasting mobility

Managing and analysing huge amounts of streaming and archival data regarding the mobility of ships and aircraft in real time is vital to operational efficiency, but poses many challenges. The collaborative research effort ***datAcron*** *is addressing these in new and innovative ways*

The maritime and aviation sector has a huge impact on the global economy and our everyday lives. The ability to effectively track ship and plane mobility in real time increases safety and improves operational efficiency. Over recent years there has been increased investment in R&D for information-oriented infrastructures and systems that address many aspects of data management and data analytics regarding the movement of these types of vessels. The combined exploitation of data sources that offer archival and live streaming data is considered a necessity. Furthermore, due to the limitations of current surveillance resources to monitor and predict the world's shipping and air operations channels, new tools that help analysts and domain-specific operators identify and predict important activities are extremely valuable.

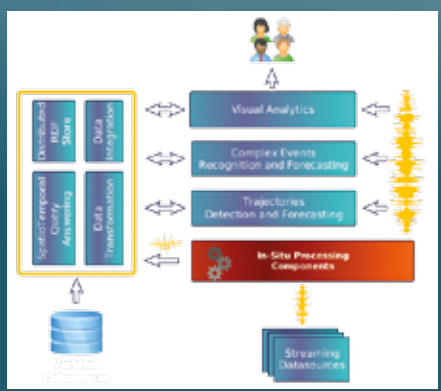
BIG DATA & BIG CHALLENGES

There are various types of data available that, properly combined and integrated, can provide useful knowledge, but combining this information creates computational challenges. A three-year collaborative EU Horizon 2020 project which started in early 2016 has been designed to address these challenges to support analytics for mobility detection and forecasting. datAcron (Big Data Analytics for Time Critical Mobility Forecasting) aims to develop novel methods to detect threats and abnormal activity among very large numbers of moving maritime and air vessels in large geographic areas.

Professor George Vouros of the Department of Digital Systems in the University of Piraeus Research Centre is spearheading a consortium of academic and industry partners. One of the key driving forces behind datAcron is the European Big Data Vision, together with the requirements of the aviation and maritime sectors and the related domain scenarios that provide the common ground for validating and evaluating datAcron technologies and methods.

Vouros explains that the need for novel tools to process vessel motion data, which are scalable, is highly critical for security, safety, predictability, efficiency of operations and cost-effectiveness: 'For instance, in the maritime domain, about 12,000 ships daily are tracked in EU waters and about 200.000.000 positional messages are recorded every month in EU waters from 700 coastal stations.' Only if properly combined and integrated with other data acquired from other data or information sources, can they provide useful information and knowledge for achieving maritime situational awareness. datAcron encompasses several maritime risk and environmental issues such as environmental destruction and degradation but also maritime accidents, Illegal, Unreported and Unregulated (IUU) fishing and trafficking problems.

Additionally, the highly complex air traffic management socio-technical system is based on an airspace management paradigm that leads to demand imbalances that cannot be dynamically adjusted. This entails higher workloads for air traffic controllers, which ultimately determines the maximum air traffic management system capacity. High fidelity aircraft trajectory prediction capabilities aim to satisfy societal and market needs (with focus on improved, weather-independent arrival punctuality), protect environment and energy supply, and ensure safety and security of operations in air.



The integrated datAcron prototype overall architecture

DEVELOPING, TESTING AND DELIVERING NEW TOOLS

The overall aim of the research is to develop innovative approaches to detecting and predicting in real time trajectories and important events that are related to marine and air operations. As Vouros explains, this involves applying 'advanced analytics methods to multiple heterogeneous, voluminous, fluctuating, and noisy data streams from moving entities, and correlating them with archived data expressing, amongst other things, entities' characteristics, geographical information, mobility patterns, regulations and intentional data (e.g. planned routes), in a timely manner'.

The project has been split up into eight key Work Packages (WPs) covering all of the necessary inputs and outputs. WP1 aims at scalable data management and data integration solutions, together with integrating research components resulting from WPs 2–4 into a coherent Big Data

architecture satisfying the requirements of both use case domains. WP2 – Mobility Pattern Detection and Forecast – involves delivering the datAcron trajectory detection and prediction modules, together with advanced mobility analytics tasks. WP3 – Complex Event Recognition and Forecasting – delves into the wealth and depth of data that is available, towards recognising and predicting events concerning the mobility of moving entities. WP4 – Visual Analytics – involves the development of interactive scalable methods and tools to analyse the data visually. WPs 5 and 6 – Prototype Validation Evaluation in Use Cases – are tasked with evaluating the different components and the datAcron integrated prototype based on domain-specific scenarios 'which will validate and demonstrate the applicability of the whole project development,' says Vouros. WPs 7 and 8 focus on Dissemination and Exploitation and Project Management and Coordination activities, respectively.

COLLABORATIVE EFFORT

datAcron brings together partners from six countries, including an SME whose business is related to Big Data for the maritime domain, two research partners closely related to Big Data for the air transport domain, three research organisations closely related to the maritime domain, one university and two research centres. The consortium combines scientific and technical expertise that addresses different components of the Big Data value chain: cross-sources archival and streaming data management and semantic data integration, advanced data analytics and long-term forecasting of trajectories and events, visual analytics, and data providers with domain-specific expertise targeting Big Data. All this expertise is highly valuable for the project, says Vouros: 'Together this consortium has deep scientific, technical and industry knowledge and understanding of the requirements of the relevant stakeholders in both industry and research settings.'

> *'datAcron addresses contextualisation of data seamlessly through its data management, data integration and interlinking tasks to support and further advance mobility analytics'*

ADDING VALUE TO THE AIR AND MARINE SECTOR

The volume of vessels movements is expected to continue increasing in the near future and may also include the added complication of unmanned platforms – both in the air and at sea. This will result in even more data being generated that will require advanced data analytics to resolve. 'Considering the paradigm shift towards trajectory-based operations for many businesses regarding moving objects, analysis methods and data that revolve around the notion of trajectory are needed,' observes Vouros. 'Exploitation of this data for analysis purposes is a core issue for datAcron.' With the mid-point of the project now reached, the team are excited about both the progress they make while progressing to the second half and the significant benefits datAcron promises to deliver to the Big Data value chain, the marine and air sectors.

Project Insights

FUNDING

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 687591

CONSORTIUM

University of Piraeus Research Center • Boeing Research & Technology Europe S.L.U • Centro de Referencia Investigacion Desarrollo & Innovacion ATM, A.I.E • Ecole Navale Groupement Interet Public • Fraunhofer Gesellschaft Zur Foerderung Der Angewantden Forschung E.V • IMIS Global Limited • National Center for Scientific Research "Demokritos" • NATO Science and Technology Organisation • Centre for Maritime Research and Experimentation

CONTACT

George Vouros
Project Coordinator

T: + 30 210 414 2552
E: georgev@unipi.gr
W: http://datacron-project.eu/

PROJECT COORDINATOR BIO

Professor George Vouros holds a BSc in Mathematics and a PhD in Artificial Intelligence from the University of Athens, Greece. Currently, he is a Professor in the Department of Digital Systems, University of Piraeus. Vouros works mainly in the areas of knowledge management, knowledge representation and reasoning (focusing on semantic representation and ontologies), multi-agent systems organisations and their adaptation, architectures of collaborative agents, collaboration and coordination in multi-agent systems, and collaborative reinforcement learning in complex systems. He has published numerous articles on these topics and has participated in numerous national and international research and innovation projects as a researcher, scientific manager and principal investigator.

datAcron

CRIDA

Fraunhofer IAIS

S&T CMRE

UNIVERSITY OF PIRAEUS RESEARCH CENTER

BOEING

This project is funded by the European Union