

MASTER

Multiple ASpects Trajectory
management and analysis

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Editorial

Welcome to the 8th issue of the MASTER newsletter!

MASTER entered its final year as the project will finish on December 31, 2023. The activities are many as we fully restarted after the pandemic.

In this issue we are hosting the project EMERALDS (Extreme-scale Urban Mobility Data Analytics as a Service) presented by our partner Yannis Theodoridis from University of Piraeus.

We also report about our secondments: UVSQ seconded one staff member to PUC during December 2022, CNR seconded 5 staff members to the Federal University of Santa Catarina in the period March / April 2023 working on the future challenges of the multiple aspects trajectories with the UFSC staff.

A group of two UVSQ researchers visited our partner at Thira municipality discussing the next trends in the tourism of the island and possible analysis that can help.

We also report on our past and next events with details on our Mid Term meeting held at our Versailles partners Prof. Zeitouni in February 2023 and the Big Mobility Data Analysis (BMDA) workshop organised by our partner Alessandra Raffaeta with other colleagues.

We also highlight the last MASTER event to be held in conjunction with the SIGSPATIAL conference in Hamburg next November 2023 called EMODE "1st ACM SIGSPATIAL International Workshop on Methods for Enriched Mobility Data:

Emerging issues and Ethical perspectives".

We hope you will enjoy reading our exciting news.

You can download this and previous issues of the newsletter from the MASTER web site:

<http://www.master-project-h2020.eu>

Chiara Renso, MASTER Project Coordinator

EMERALDS: Extreme-scale Urban Mobility Data Analytics as a Service

Prof. Yannis Theodoridis, EMERALDS scientific & technical manager, University of Piraeus, Greece | ythead@unipi.gr

In a rapidly urbanised and connected world, data is driving decision-making in cities across Europe. A plethora of sensors and computing devices covering the edge/fog/cloud compute continuum are deployed, connected, and monitored. New mobility services are reshaping the urban mobility landscape leading to a radical expansion of data. To address this need, the EMERALDS project brings together experts in IT, Urban Data Science, Data Engineering, Urban Mobility, stakeholders from public authorities,

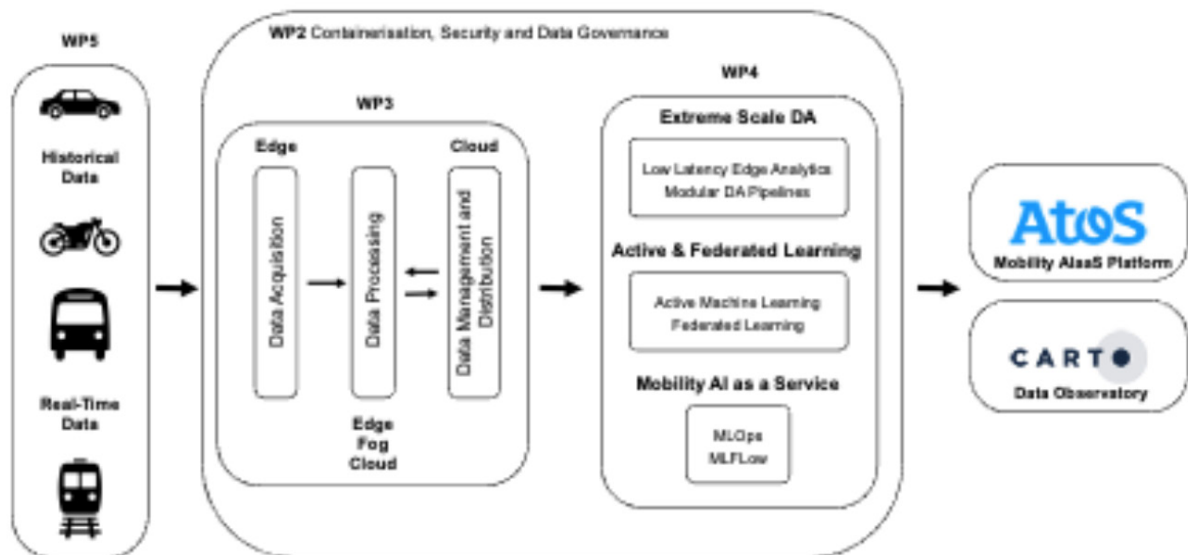
mobility data and as a result, improve urban mobility decision making.

The Mobility AlaaS toolset will demonstrate advanced capabilities in analyzing (and learning from) large amounts and varieties of urban mobility data whilst considering privacy aspects. As opposed to off-the-shelf solutions, EMERALDS will actually create tailor-made data acquisition services which go beyond the simple collection of extreme mobility data and is able to distribute computa-

analytics tools and services.

Three use cases have been designed to assess the validity of EMERALDS technical results:

Risk-assessment, prediction and forecasting during events: Crowdedness in cities is becoming an increasing problem, resulting in major issues for residents, visitors, companies, and subsequently authorities, emergency services, etc.



EMERALDS Reference Architecture

and SMEs activated in Mobility Planning and Operations, a total of 20 organisations from 10 European countries; its overall objective is to design and develop an urban data-oriented Mobility AI as a Service (AlaaS) toolset to exploit the untapped potential of extreme urban

mobility data and as a result, improve urban mobility decision making. **The Mobility AlaaS toolset** will demonstrate advanced capabilities in analyzing (and learning from) large amounts and varieties of urban mobility data whilst considering privacy aspects. As opposed to off-the-shelf solutions, EMERALDS will actually create tailor-made data acquisition services which go beyond the simple collection of extreme mobility data and is able to distribute computa-

Event organizers, municipalities, emergency services, and other stakeholders, express the need for decision support to be able to anticipate – either on the short-run (real-time interventions) or on the longer-run (planning) undesirable situations. Partners Argaleo and TU Delft

are working closely with the municipality of The Hague to design a risk assessment, prediction and forecasting system to support decision-making. In particular, EMERALDS will address how to make optimal use of them to provide reliable decision support for planning and operational management under stressful conditions. The use case will design a decision support system for municipalities to address several scientific and technical challenges using dedicated AI techniques.

underperformance and self-tuning, and providing AI-driven, context-dependent multi-modal network predictions.

Trip characteristics inference and traffic flow data analytics: Data analytics for urban mobility planning is necessary to develop efficient resource management and infrastructure in cities and peri-urban areas. Riga (Latvia) deals with an increased number of commuters from the outskirts and neighbouring municipalities to the city, as people have relocated to areas with lower population density.

human movement activity in the urban domain, among others. Since MASTER has already produced a plethora of related scientific results, EMERALDS technical partners plan to validate MASTER methods and tools in their use cases and exploit on the concept of multiple aspect trajectories. Indicative fields include methods and techniques in semantic enrichment (e.g., weather integration) and trajectory pattern mining (hot spot and hot path analysis, anomaly detection, clustering, etc.).



The 3 use cases

Multi-modal integrated traffic management: Multi-modal traffic management is an important tool to promote modal shift to more sustainable mobility options, prioritizing active modes and public transport, reducing mobility spatial footprint, etc. Even if many sources of data are at cities' disposal, their processing, analysis, and use (e.g., for context dependent prediction) is hindered by the lack of applicable methods and extreme data processing tools. The use case, coordinated by partners ARANE and TU Delft, focuses on enabling extreme data-driven methods for predictions and predictive optimization, and the required network analysis to determine decongestion opportunities, considering multi-modal traffic operations in the city of Utrecht. The use case aims to provide innovations in reducing the need for dedicated (and expensive) data collection methods, self-identifying

ty. This outflow has a direct impact on the transportation system and creates the need for AI-driven decision-making tools for mobility planning. To optimize the transport network and its efficiency, adapt to changes and forecast future demand, real time data analytics of travel behaviour is essential. The use case, coordinated by partner Grupa93, will develop a traffic data analysis toolset to analyse and forecast passenger travel behaviour and optimize the public transport network.

EMERALDS (grant agreement no. 101093051) is a Research & Innovation Action project, funded by the EU Horizon Program (from January 1st, 2023, to December 31st, 2025). For more info: <https://emeralds-horizon.eu/>.



EMERALDS
Extreme-scale Urban Mobility
Data Analytics as a Service

The relation to MASTER project is evident since both projects perform research over the data produced by the

NEXT EVENT

EMODE23

**1ST ACM SIGSPATIAL INTERNATIONAL WORKSHOP ON METHODS FOR ENRICHED MOBILITY DATA:
EMERGING ISSUES AND ETHICAL PERSPECTIVES 2023**

NOVEMBER 13 2023

HAMBURG, GERMANY

<http://www.master-project-h2020.eu/emode23/>

We are planning our last event: the **Final MASTER workshop**. The consortium agreed to have it as a workshop join to the SIGSPATIAL conference, the one of the reference events for the spatial and spatio-temporal research.

We proposed the workshop EMODE23: 1st ACM SIGSPATIAL International Workshop on Methods for Enriched Mobility Data: Emerging issues and Ethical perspectives 2023. The workshop is planned to be held as half day on November 13, 2023 in Hamburg, Germany in conjunction with the SIGSPATIAL conference (<https://sigspatial2023.sigspatial.org/>). The workshop is seeking submissions in a wide range of topics all around the current and future challenges of enriched mobility data. Thus, the topics of interest include, among others, AI and NLP methods for mobility data management and analysis, Federated and cloud solutions, but also ethical issues like fairness, trustworthiness, explainability, sustainability.

The deadline for submission is September 1st, 2023 and we accept long, short and demo papers. We also plan to nominate a best paper award.







EMODE23

**1st ACM SIGSPATIAL International Workshop on Methods for Enriched Mobility Data:
Emerging issues and Ethical perspectives 2023 (EMODE23)**

November 13, 2023

Hamburg, Germany

-  Submission deadline: **September 1, 2023**
-  Authors notification: September 29, 2023
-  Camera-ready due: October 13, 2023
-  Workshop day: November 13, 2023

Joint with **ACM SIGSPATIAL 2023**, *International Conference on Advances in Geographic Information Systems*

Secondments

Experiences and results



Chiara Renso and Chiara Pugliese (CNR) at UFSC, Florianopolis, Brasil

During the last few months in MASTER we had secondments to Pontifical Catholic University of Rio de Janeiro from UVSQ, Federal University of Santa Catarina from CNR staff and Thira municipality from UVSQ.

Karine Zeitouni from UVSQ completed her secondment to PUC during December 2022.

Specifically, Prof. Zeitouni, with Prof. Casanova from PUC, explored the use of natural language to query semantic trajectories. Natural language processing (NLP) techniques are becoming a powerful tool for retrieving and mining not only textual documents but also various types of data. Using NLP tools could be an alternative to more formal semantic data representation (such as RDF) and query language (such as SPARQL). In this approach, rather than expressing the query in SPARQL and retrieving RDF triples as a result, both the query and the result are sentences. The internal data representation remains a structured knowledge graph. Therefore, the question is “how to use natural language to query a knowledge graph and return an enhanced response in natural language?”

Beatrice Rapisarda, Chiara Renso, Chiara Pugliese, Maddalena Amendola and Guido Rocchietti, all from CNR, have been seconded to Federal University of Santa Catarina (UFSC) in Florianopolis.

Their secondments focussed on the future challenges of multiple aspects trajectories and relative discussion with the UFSC staff about new ideas to follow. Specifically, Chiara Renso focussed on new applications for multiple aspects trajectories with Prof. Jonata Carvalho who will shortly visit CNR to continue the collaboration. Beatrice Rapisarda discussed with the UFSC staff to understand which datasets and methods could be added to the MASTER catalogue. Chiara Pugliese found many similarities of her work on semantic enriching trajectories with the PhD student Vanessa Machado and started collaboration in the topic of summarizing semantic trajectories with her and prof. Ronaldo Mello. Vanessa is also spending a period at CNR in Pisa to strengthen the collaboration. Maddalena Amendola investigated how her PhD topic can be adapted to a mobility task with UFSC professors and students. Her research area deals with social systems (the Expert Finding task is a current application). The idea is to ap-

ply the model to a location-based social network (e.g. Flickr). This can be a very promising future challenge for multiple aspects trajectories. Guido Rocchietti also discussed a future challenge that is exploiting Social Search methods and Conversational Systems for trajectories enrichment. Two ways to apply NLP approaches and datasets to further enrich the trajectories have been devised: using Knowledge Bases (KB) for Common-sense and Concepts such as ConceptNet and WordNet to better specify the type of nodes in a trajectory and also to validate possible neighbourhoods. Another idea could be using NLP text generation approaches to automatically create descriptions for the trajectories.

Saloua Bouabba and Zaineb Chelly Dagdia from UVSQ completed their secondments to Thira in the month of May. Saloua focussed on gaining a comprehensive understanding of analyzing mobility data using deep learning techniques and experience with state-of-the-art technologies and tools related to mobility data analysis.

Exchange knowledge and perspectives on open research and technological challenges with other MASTER members that attended the DSM summer school by attending a panel on Emerging issues on mobility data science, especially on privacy, as everyone agreed, to be the hot topic of mobility data.

Zaineb discussed several future research perspectives such as (i) Developing personalized travel recommendations: One potential research direction is to develop machine learning algorithms that can analyse tourists’ trajectory data to provide personalized travel recommendations. (ii) Improving tourism infrastructure planning: use machine learning to analyse tourists’ trajectory data to better understand traffic patterns, popular destinations, and other factors that can inform tourism infrastructure planning



PAST EVENT

BMDA (BIG MOBILITY DATA ANALYTICS) WORKSHOP @ EDBT/ICDT 2023

**MARCH 2023
IOANNINA, GREECE**

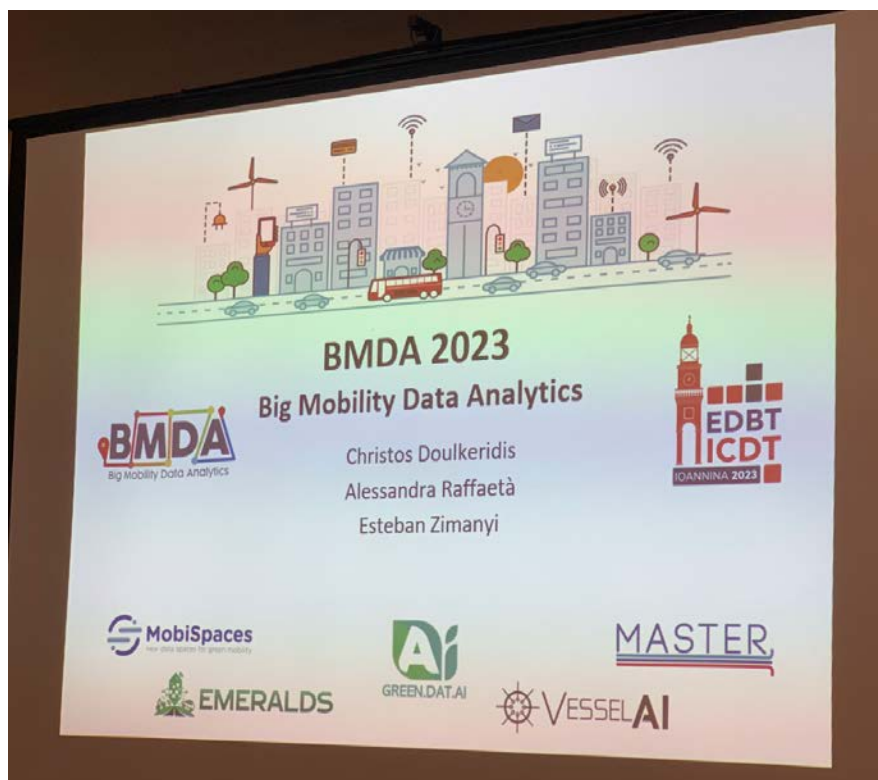
Alessandra Raffaeta' (University Ca' Foscari Venice)

On March 28, 2023 the 5th edition of the Big Mobility Data Analytics (BMDA) workshop took place in Ioannina, Greece organized by Christos Doukeridis from University of Piraeus, Greece, Alessandra Raffaeta' from Ca' Foscari University of Venice, Italy, and Esteban Zimanyi from Université Libre de Bruxelles, Belgium. The workshop has been partially supported by the EU Horizon projects and organizations: MASTER (Multiple Aspects Trajectory Management and Analysis, (2018-22), MobiSpaces (New Data Spaces for Green Mobility, 2022-25), Green.Dat.AI (Energy-efficient AI-ready Data Spaces, 2023-25), EMERALDS (Extreme-scale Urban Mobility Data Analytics as a Service, 2023-25), VesselAI (Enabling Maritime Digitalization by Extreme-scale Analytics, AI and Digital Twins, 2021-23),

The BMDA workshop series started in 2018 associated with the EDBT/ICDT Conference, with the idea of exploring the theme: "From spatial to spatio-temporal and, then, to mobility data. So, what's next? It is the rise of mobility-aware integrated Big Data analytics." The workshop aims at bringing together experts in the field from academia, industry and research labs to discuss the lessons they have learnt over the years, to demonstrate what they have achieved so far, and to plan for the future of mobility. In its 5th edition, the BMDA workshop has fostered the exchange of new ideas on multidisciplinary real-world problems, discussed innovative solutions and identified emerging opportunities for further research in the area of big mobility data analytics, such as deep learning on mobility data, visual analytics and scalable distributed techniques for trajectory clustering. The workshop achieved the goal of bringing researchers and stakeholders in big mobility data closer together, including experts from crucial areas such as urban and maritime transport.

After 3 years of online EDBT/ICDT events, this was a great occasion to meet again in person. The conference operated in a hybrid mode, with approximately 20 participants attending the sessions on-site while others joined remotely. The program consisted in 9 papers selected from a pool of 11 submissions. The authors of these papers represented nine different countries, i.e., Italy, Brazil, Canada, Austria, Greece, Ireland, United Kingdom, Belgium and France. There was one invited talk by Gennady Andrienko and Natalia Andrienko from Fraunhofer IAIS, Germany, presenting the work titled "Patterns of collective movement behavior ... in football".

Based on the reviews and on the discussion at the conference, 6 papers have been selected to create a strong extended version to be submitted to a Special Issue for the Geoinformatica journal.



PAST EVENT

MID TERM MEETING IN VERSAILLES

FEBRUARY 24TH 2023
VERSAILLES, FRANCE

On February 24th we held the third internal meeting of MASTER hosted by Karine Zeitouni of UVSQ in Versailles. During the meeting we have discussed the current project issues, deadlines of deliverables and secondment plans. A special session dedicated to the presentation of scientific project results achieved by Early Stage Researchers (ESR).

Chiara Pugliese (CNR)

Semantic-aware building and representation of multiple-aspect trajectories

Giulia Rovinelli (UNIVE)

Analyses of the fishing effort and of the underwater noise for a sustainable exploitation of the northern Adriatic Sea

Antonis Makris (HUA) (online)

TraClets: A trajectory representation and classification library

Saloua Bouabba (UVSQ)

Privacy-Preserving Synthetic Trajectory Generation - A federated Time GAN Approach

Mohammad Abboud (UVSQ)

Enriching fixed stations air pollution monitoring with opportunistic mobile monitoring





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