EnviroInfo 2020

The 34th edition of the long standing and established international and interdisciplinary conference series on leading environmental information and communication technologies

All times are in local (Cyprus) time (CET +1 / GMT +3)

Wednesday, 23 Sep - FULL PAPERS (10 min. presentation + 5 min. Q&A)

9:00 - 9:10	Welcome message
9:10 - 9:50	Keynote Speech: Mikko Kolehmainen | Title: The next step after AI – towards Digital Twins
9:50 - 10:35	Session 1: Industrial Environments and Processes
9:50	Designing for Sustainability: Lessons Learned from Four Industrial Projects *Patricia Lago*, Roberto Verdecchia, Nelly Condori-Fernandez, Eko Rahmadian, Janina Sturm, Thijmen van Nijnanten, Rex Bosma, Christophe Debuysscher, Paulo Ricardo
10:05	Web Tool for the Identification of Industrial Symbioses within an Industrial Park Anna Luetje, *Volker Wohlgemuth*, Sinéad Leber, Jonas Scholten
10:20	Deriving Benchmarks for Construction Products Based on Environmental Product Declarations *Anna Carstens*, Tobias Brinkmann, Barbara Rapp
10:35 - 10:45	Short Break
10:45 - 11:45	Session 2: Sustainability
10:45	Circular economy in the Rostock region. A GIS and survey based approach analyzing material flows. Ferdinand Vettermann, Samer Nastah, Laurine Larsen, *Ralf Bill*
11:00	Obsolescence as a Future Key Challenge for Data Centers Fabian A. Schulze, *Hans-Knud Arndt*, Hannes Feuersenger
11:15	The eco-label Blue Angel for Software – Development and Components *Stefan Naumann*, Achim Guldner, Eva Kern
11:30	Sustainable processes on the Last Mile - Case study within the project NaCl *Uta Kühne*, Mattes Leibenath, Camille Rau, Richard Schulte, Lars Wöltjen, Kristian Schopka, Lars Krüger, Benjamin Wagner vom Berg
11:45 - 12:45	Session 3: Environmental Modelling, Monitoring and Information Systems
11:45	Algorithmic treatment of topological changes within a simulation runtime system *Jochen Wittmann*
12:00	Citizens in the Loop for Air Quality Monitoring in Thessaloniki, Greece *Theodosios Kassandros*, Andreas Gavros, Katerina Bakousi, Kostas Karatzas
12:15	WISdoM: An Information System for Water Management *Marius Wybrands*, Fabian Frohmann, Marcel Andree, Jorge Marx Gómez
12:30	Exploring Open Data portals for geospatial data discovery purposes Matthias Hinz, *Ralf Bill*
12:45 - 13:30	Lunch Break
13:30 - 14:10	Keynote Speech: Serenella Sala | Title: Environmental footprint of EU consumption: from data to knowledge and policy support
14:10 - 15:10	Session 4: Urban Environments and Systems
14:10	Developing a Configuration System for a Simulation Game in the Domain of Urban CO2 Emissions Reduction *Sarah Zurmühle*, João S.V. Gonçalves, Patrick Wäger, Andreas Gerber, Lorenz M. Hilty

| 14:25 | Estimating Spatiotemporal Distribution of Moving People in Urban Areas Using Population Statistics of Mobile |
| | *Toshihiro Osaragi* |

| 14:40 | A digital twin of the social-ecological system "urban beekeeping" |
| | *Carolin Johannsen*, Diren Senger, Thorsten Kluss |

| 14:55 | Utilizing CityGML for AR-Labeling and Occlusion in Urban Spaces |
| | Patrick Postert, *Markus Berger*, Ralf Bill |

| 15:10 - 15:20 | Short Break |

| 15:20 - 15:30 | Geo data analytics and spatial decision support: Commercial solutions and joint research opportunities of Disy Informationssysteme GmbH (Sponsor of the EnviroInfo) |

| 15:30 - 16:15 | Session 5: Physical Environments |

| 15:30 | Can animal manure be used to increase soil organic car-bon stocks as a mitigation climate change strategy? |
| | *Andreas Kamilaris*, Immaculada Funes Mesa, Robert Savé, Felicidad De Herralde, Francesc X. Prenafeta-Boldú |

| 15:45 | Digital Twins, Augmented Reality and Explorer Maps rising Attractiveness of rural Regions for outdoor Tourism |
| | *Peter Fischer-Stabel* |

| 16:00 | Identification of Tree Species in Japanese Forests based on Aerial Photography and Deep Learning |
| | Sarah Kentsch1, *Savvas Karatsiolis*, Andreas Kamilaris, Luca Tomhave, Maximo Larry Lopez Caceres |

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Thursday, 24 Sep - SHORT PAPERS (5 min. presentation + 5 min. Q&A)

9:00 - 9:40	Keynote Speech: Mario Roccaro	Title: Food in the Anthropocene - How EIT Food is contributing to the mitigation of climate changes

9:40 - 10:40	Session 6: Transport, mobility and logistics

9:40   Improving Delay Forecasts in Public Transport using Machine Learning Techniques
Henning Wobken, Alexander Dölling, Jon-Patric Ewelt, Niklas Howad, Florian Hustede, Hendrik Jordan, Abdalaziz Obead, Jari Radler, Sebastian Schnieder, Klaas von der Heide, Ole Wehrmeyer, Mathias Wille, Barbara Rapp, Jorge Marx Gómez

9:50   Decentralized Identity Management for DLT-based Cooperation Support
Thomas Osterland, Thomas Rose

10:00   Market-related opportunities and challenges for a digital platform model aiming at sustainable execution of last-mile logistics - A use case of B2C deliveries in Germany and Vietnam
Thanh Ha Mai, Carsten Dorn, Benjamin Wagner vom Berg

10:10   Visualization of greenhouse gas emissions for the means of transport airplane, car, train and coach by use of accessibility graphs.
Malte Christiansen, Jochen Wittmann

10:20   How to consolidate sustainable mobility platforms in rural areas?
Johannes Schering, *Julian Rawe*, Ali Akyol, Cedrik Theesen, Jorge Marx Gómez

10:30   Blockchain-based Electronic Record Books for Transparency to Prevent Marine Pollution
Hauke Precht, David Saive, Simon Czapski, Jorge Marx Gómez

10:40 - 10:50	Break session

10:50 - 11:50	Session 7: Environmental Information Systems

10:50   Towards Decision Tree Based Assistance Functions of a Cloud Platform for Environmental Compliance Management
Heiko Thimm

11:00   Investigation of traffic and air pollution in Thessaloniki, Greece, under ordinary and COVID-19 pandemic conditions
Evangelos Athanasakis, Theodosios Kassandros, Kostas Karatzas

11:10   Machine learning methods for approximating the temperature of exterior walls using thermal images and colour images of building facades
Klaus Schlender, Malte Riechmann, Jendrik Müller, Grit Behrens

11:20   Induction of a fuzzy decision tree for optimizing air quality data modeling
Aristotelis Karagiannis, *Kostas Karatzas*

11:30   PigFarm --Developing Decision Support for the Pork Production Industry
Thomas Rose, Julia Gruber, Kathrin Gunkelmann

11:40   Automated invasive alien species recognition: lessons learned from applying the iNaturalist 2017 computer vision model on citizen-science data
Blagoj Delipetrev, Sven Schade, Irena Mitton, Fabiano-Antonio Spinelli

11:50 - 12:50	Session 8: Sensors and Internet of Things

11:50   PM2.5 low-cost sensor performance in ambient conditions
Claudia Falzone, Anne-Claude Romain, Sylvain Guichaux, Valéry Broun, Daniel Rüffer, Guy Gérard, Fabian Lenartz

12:00   Intercomparison between IoT air quality monitoring devices for PM10 concentration estimations
Paulo Pinho, Sérgio Lopes, Marios Panourgias, Johnny Reis, Kostas Karatzas

| 12:10 | ECOSense - Collection and analysis of bicycle sensor data |
| | *Johannes Schering*, Christian Janßen, René Kessler, Viktor Dmitryev, Christian Stehno, Kyra Pelzner, Ronald Bankowsky, Roland Hentschel, Jorge Marx Gómez |

| 12:20 | Towards a robust ensemble modelling approach to improve Low-Cost Air Quality Sensors performance |
| | *Theodosios Kassandros*, Kostas Karatzas |

| 12:30 | Online energy forecasts for the Internet of Things |
| | *Danja Steinberg*, Julien Murach, Achim Guldner, Klaus-Uwe Gollmer |

| 12:40 | Analysis and modeling of low-cost air quality sensor data towards their computational improvement |
| | *Petros Zimianitis*, Kostas Karatzas |

| 12:50 - 13:30 | Lunch Break |

| 13:30 - 14:30 | Session 9: Recycling and plastics |

| 13:30 | Mechanical Recycling Considerations for Responsible Plastic Innovation |
| | *James Drayton*, Justice Wright, Minh Nguyen Vo |

| 13:40 | Engineering for a Circular Economy: Key Factors for the Design of Biodegradable Plastics and Plastic-Degrading Enzymes |
| | *Mary Rommer*, Margaret MacDonell |

| 13:50 | Database Development and Special Considerations for Storing Polymer Fate Information |
| | *Christopher Rademacher*, Marina Slijepcevic, Margaret MacDonell |

| 14:00 | Developing a preliminary data structure to assess plastics in freshwater environments |
| | *Sneha Nachimuthu*, Jennifer Cronin, Margaret MacDonell |

| 14:10 | A Database on the Health Risks of Plastics |
| | *Marina Slijepcevic*, L'Nazia Edwards, Aijalon Kilpatrick, Phuong Khanh Tran Nguyen, Margaret MacDonell |

| 14:20 - 14:30 | Closing message – Announcement of the EnviroInfo2021 conference |

9:50 - 10:35 |

Session 1: Industrial Environments and Processes

9:50 - 10:05

Designing for Sustainability: Lessons Learned from Four Industrial Projects

P. Lago[1], R. Verdecchia[1], N. Condori-Fernandez[1], E. Rahmadian[2], J. Sturm[3], T. van Nijnanten[4], R. Bosma[5], C. Debuysscher[5], P. Ricardo[5]

[1]Vrije Universiteit Amsterdam, Netherlands
[2]University of Groningen, Netherlands
[3]German Development Institute, Germany
[4]Vandebron, Netherlands
[5]European Patent Office, Netherlands

Scientific research addressing the relation between software and sustainability is slowly maturing in two focus areas, related to 'sustainable software' and 'software for sustainability'. The first is better understood and may include research foci like energy efficient software and software maintainability. It most-frequently covers 'technical' concerns. The second, 'software for sustainability', is much broader in both scope and potential impact, as it entails how software can contribute to sustainability goals in any sector or application domain. Next to the technical concerns, it may also cover economic, social, and environmental sustainability. Differently from researchers, practitioners are often not aware or well-trained in all four types of software sustainability concerns. To address this need, in previous work we have defined the Sustainability-Quality Assessment Framework (SAF) and assessed its viability via the analysis of a series of software projects. Nevertheless, it was never used by practitioners themselves, hence triggering the question: What can we learn from the use of SAF in practice? To answer this question, we report the results of practitioners applying the SAF to four industrial cases. The results show that the SAF helps practitioners in (1) creating a sustainability mindset in their practices, (2) uncovering the relevant sustainability-quality concerns for the software project at hand, and (3) reasoning about the inter-dependencies and trade-offs of such concerns as well as the related short- and long-term implications. Next to improvements for the SAF, the main lesson for us as researchers is the missing explicit link between the SAF and the (technical) architecture design.

Web Tool for the Identification of Industrial Symbioses within an Industrial Park

A. Luetje[1,2], V. Wohlgemuth[3], S. Leber[3], J. Scholten[3]

[1]Leuphana University Lueneburg, Germany
[2]HTW Berlin University of Applied Sciences, Germany
[3]HTW Berlin, Germany

Industrial Symbiosis (IS) is a systemic and collaborative business approach to optimize cycles of material and energy by connecting the supply and demand of various industries. IS provides approaches for advanced circular/cascading systems, in which the energy and material flows are prolonged for multiple utilization within industrial systems in order to increase resource productivity and efficiency. This study aims to present the conceptual IT-supported IS tool and its corresponding prototype, developed for the identification of IS opportunities in Industrial Parks (IPs). This IS tool serves as an IS facilitating platform, providing transparency among market players and proposing potential cooperation partners according to selectable criteria (e.g. geographical radius, material properties, material quality, purchase quantity, delivery period). So this IS tool builds the technology-enabled environment for the processes of first screening of IS possibilities and initiation for further complex business-driven negotiations and agreements for long-term IS business relationships. The central core of the web application is the analysis and modelling of material and energy flows, which refer to the entire industrial park as well as to individual companies. Methods of Material Flow Analysis (MFA) and Material Flow Cost Accounting (MFCA) are used to identify possible input-output- and supply-demand matchings.
The second central core of the web application is the identification of existing and potential cooperation partners for the development of IS networks. In order to achieve this, a combinatorial approach of Social Network Analysis (SNA) and a deposited geographical map are inserted, so that same suppliers and recycling/disposal companies can be detected.

Deriving Benchmarks for Construction Products Based on Environmental Product Declarations

A. Carstens[1,2], T. Brinkmann[2], B. Rapp[1]

[1]University of Oldenburg, Germany
[2]brands & values GmbH, Germany

One problem in the communication of Environmental Product Declarations (EPDs) is that there is a lack of possibilities to position a product among its peers [1]. This research gap can be addressed by determining benchmarks based on EPD results [1]. In this paper, benchmarking methods which have already been applied to results of life cycle assessments (LCAs) are analysed according to their applicability to EPDs. The methods of data envelopment analysis (DEA) and de-termination of reference values are identified as being applicable to EPDs. For comparison, these methods are applied to a case study of insulation materials. A key difference in these methods lies in the fact that reference values are calculated for individual indicators while DEA calculates efficiency for every product as a single score.

Session 2: Sustainability

10:45 - 11:00

Circular economy in the Rostock region. A GIS and survey based approach analyzing material flows.

F. Vettermann[1], S. Nastah[2], L. Larsen[3], R. Bill[2]

[1]University of Rostock, Germany
[2]Universität Rostock, Germany
[3]BN Umwelt GmbH, Germany

Within this work a method how to analyze the recycling sites in Rostock and the surrounding municipalities is presented. The approach is embedded into the pro-ject Prosper-Ro and is part of the development of a decision support system for planning purposes in the mentioned region. The recycling sites are one part of the project and in focus to tackle the challenge of transforming the linear economy to a circular economy. To make the method easy adoptable, it incorporates free available data, like Open Street Map, and governmental data, such as ALKIS, to derive a high resolution dataset for the population density as well as the potential waste. This leads to an easy adoptable approach for other municipalities. With Open Street Map and QGIS routing software QNEAT it was possible to create reachability areas for each recycling site in respect to the customer and waste po-tential. These data lead to a parameter of 250 customers per $1m^2$ of container area in the city area of Rostock which is useful for planning new sites or extending the existing ones. The derived data could be verified by the help of a survey, which shows that the customers in Rostock are mostly satisfied with their recycling sites and want to improve the transformation to an circular economy, for instance by the reuse of electrical devices.

Obsolescence as a Future Key Challenge for Data Centers

F.A. Schulze[1], H. Arndt[1], H. Feuersenger[1]

[1]Otto-von-Guericke-Universität Magdeburg, Germany

The advance of sustainable development in times of climate change, energy revolution and emerging scarcity of resources has become a new global challenge, which gives organizations the responsibility to make processes more sustainable. Obsolescence as a product aging process with complex causalities is unavoidable and, in the context of sustainability considerations, the question arises how to deal effectively with obsolescence along the entire product life cycle. Especially in the area of data center operation, a significant growth in capacity has been recorded in recent years, with organizations using cloud computing solutions to reduce space and IT equipment and to outsource them to centralized data centers, which increases the challenges for data centers in dealing with obsolescence in a sustainable manner. In cooperation with the data center Biere in Saxony-Anhalt, an as-is state regarding the management of obsolescence has been recorded. It was found that obsolescence management approaches are already being implemented in operational data centers. However, there is still potential or optimization regarding sustainable development when dealing with obsolescence, especially in procurement processes, in product life cycle management, and in cooperation with hardware vendors and service providers.

The eco-label Blue Angel for Software – Development and Components

S. Naumann[1], A. Guldner[1], E. Kern[1]

[1]Trier University of Applied Sciences, Environmental Campus Birkenfeld, Institute for Software Systems, Germany

Energy consumption induced through information technology, i.e. hardware and software, is constantly increasing. In this article we present the "Blue Angel", a label that evaluates and classifies the resource and energy efficiency of software. In particular, the process by which the label was developed is presented. We also describe the components of the Blue Angel: Energy and resource efficiency of the software product, hardware useful life and user autonomy. Finally, we give an outlook on the possibilities for expansion, since the first version of the label focuses especially on desktop software.

Sustainable processes on the Last Mile - Case study within the project NaCl

U. Kühne[1], M. Leibenath[2], C. Rau[2], R. Schulte[2], L. Wöltjen[2], K. Schopka[3], L. Krüger[4], B. Wagner vom Berg[5]

[1]Hochschule Bremerhaven, fk-wind: Institut für Windenergie, Germany

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[4]Weser Eilboten GmbH, Germany

[5]University oAS Bremerhaven, Germany

Today the proportion of customers who preferred buying online increases in many product categories. The rising proportion of online orders and the associated returns have a significant effect on the existing logistics system.

The city centers in particular are severely affected by the resulting traffic on the last mile with emissions, noise and traffic jams. In addition to these effects, the increasing pressure on performance and costs has a negative impact on the drivers employed by logistics service providers. The last mile, however, offers great potential for sustainable logistics processes. This article uses the sustainable crowd logistics project NaCl to show possible processes for last mile logistics.

Session 3: Environmental Modelling, Monitoring and Information Systems

11:45 - 12:00

Algorithmic treatment of topological changes within a simulation runtime system

J. Wittmann[1]

[1]HTW Berlin, Germany

Many applications in the field of environmental simulation are not limited to the dynamics of one-dimensional inventory variables, but additionally try to describe the spatial dimension of the investigated objects with their dynamic changes. The paper is based on a general specification level for such topological changes of geo-objects using graph replacement systems and shows how such a specification can be integrated transparently and consistently as an extension of the basic algorithm for combined, discrete-continuous models. The topological events are analyzed in their semantics and their treatment is presented as an additional, modular algorithm part. Problems caused by this kind of specification and processing are unique-ness problems when several events occur simultaneously as well as the sta-bility of the model specification in case of event cascades. Both problem areas are discussed with regard to their importance for the semantics of the model specification and the interpretation of the simulation results.

Citizens in the Loop for Air Quality Monitoring in Thessaloniki, Greece

T. Kassandros[1], A. Gavros[2], K. Bakousi[2], K. Karatzas[1]

[1]Environmental Informatics Research Group, School of Mechanical Engineering, Aristotle University of Thessaloniki, Greece

[2]Environmental Informatics Research Group, School of Mechanical Engineering, Aristotle University, Thessaloniki, Greece

Air pollution may dictate the quality of the indoor as well as outdoor atmospheric environment. Due to its complicated nature, it is important for people to be able to identify how air quality (AQ) is interwoven to their everyday life, and how it is related to specific everyday activities. On this basis, and in the frame of the citizen science project URwatair (www.urwatair.gr) that was set-up in the Greater Thessaloniki Area (GTA), a number of AQ-related activities were designed. For this purpose, we employed a number of materials (questionnaires, low-cost AQ monitoring devices, on-line collaborative electronic workspaces) as well as methods (social media, hands-on workshops, gamified collaborative data processing), in order to engage citizens in the environmental monitoring and related knowledge extraction process. We present these materials and methods in chapter 2, and we then present the obtained results in chapter 3, while we discuss our findings in chapter 4 and we draw our conclusions, accompanied by suggestions for future research in chapter 5.

WISdoM: An Information System for Water Management

M. Wybrands[1], F. Frohmann[1], M. Andree[1], J. Marx Gómez[1]

[1]Carl von Ossietzky University of Oldenburg, Germany

In the future, equal and universal access to drinking water will become more critical. In this context, collecting, processing, and analysing data is a central part of the long-term strategic decision-making process for water utilities. However, there is a lack of water management information systems that are specifically adapted to the requirements and use cases. Therefore, this work presents a prototypically implemented water management information system. The three use cases long-term water demand forecasts, groundwater data management, and precipitation data management were implemented according to the requirements of the water utility Oldenburgisch-Ostfriesicher Wasserverband. This contribution provides a first software architecture design for a water management information system and considers three specific use cases.

Exploring Open Data portals for geospatial data discovery purposes

M. Hinz[1], R. Bill[1]

[1]University of Rostock, Germany

Open Data has recently caught much attention from research, politics, and the economy as a resource that fuels innovation and growth. As more and more data becomes publicly within an ever-increasing amount of data portals, it can be hard for potential users to keep an overview and find what they are looking for. Therefore, this paper evaluates Open Data portals by their metadata to get insights about their content thematic disposition, including specific measures of interest for the geospatial domain. It includes national, regional, and local data portals from the German-speaking area of Europe. Strengths and problems of current data catalogs are shown as well as new perspectives on their content that may improve future data discovery applications.

Session 4: Urban Environments and Systems

14:10 - 14:25

Developing a Configuration System for a Simulation Game in the Domain of Urban CO2 Emissions Reduction

S. Zurmühle[1], J.S. Gonçalves[1, 2], P. Wäger[2], A. Gerber[2], L.M. Hilty[1, 2]

[1]University of Zurich, Switzerland
[2]Empa Swiss Federal Laboratories for Materials Science and Technology, Switzerland

In order to help decision-makers to find ways to reduce CO2 emissions of Swiss cities, a simulation game is being developed within the "Post-fossil cities" project. During the game, participants take on different roles in which they together explore pathways to a future, post-fossil city. An important requirement to the software system of the game was to be easily configurable in order to keep the game adaptive to different target groups of players. We describe a User Interface Management System (UIMS) that has been designed and implemented to realise the flexibility demanded from the game designers' side. The system allows game facilitators to configure the game and decide what kinds of visualisations are used during game sessions. The paper describes how the configuration system was conceptualised, implemented and integrated into the overall system architecture of the simulation game.

Estimating Spatiotemporal Distribution of Moving People in Urban Areas Using Population Statistics of Mobile

T. Osaragi[1]

[1]Tokyo Institute of Technology, Japan

This paper proposed a method for estimating the spatiotemporal distribution of static and transient populations of urban areas by using population statistics created from the location information for users of cell phones. The advantages and disadvantages of the various population statistics available were evaluated and methods were investigated for integrating the data while using their strengths to best advantage and compensating for weaknesses.

A digital twin of the social-ecological system "urban beekeeping"

C. Johannsen[1], D. Senger[2], T. Kluss[2]

[1]Uni Bremen, Germany
[2]Bremen University, Germany

We describe the system design and setup of our digital twin of the social-ecological system urban beekeeping, with the aim to support agroecological methods in urban agriculture. The physical space consists of the bee populations, their beekeepers who are part of a beekeeping community, non-beekeepers who consume honey, organisational actors shaping rules and regulations and the environment. The virtual space is a multi-agent model, where autonomous agents can take actions and make decisions in partially observed Markov processes.
To tie the physical and the virtual space, we embedded bee hives in an IoT environment and implemented an online documentation tool as a web application, where beekeepers take short notes about their work and observations. Bee hives are equipped with sensors, such as humidity, pressure and temperature sensors and a scale. Additionally, we pull data from the German weather service (Deutscher Wetter Dienst, DWD).
In our system architecture, multiple levels on data fusion are performed, beginning with raw data quality estimation and sensor failure detection. On higher levels, states of entities are estimated, such as the health of a bee colony, and assessment made whether a state is normal or to be considered an anomaly. Finally on the highest level, we deal with the desires of our agents, how actions should be chosen in order to achieve or maintain desirable and rewarding world states.

We hope to be able to refine our digital twin into a decision support tool for small-scale (bee) farmers and communal political actors that helps to reach desirable world states by predicting and simulating the effects of actions within the complex system of urban beekeeping.

Utilizing CityGML for AR-Labeling and Occlusion in Urban Spaces

P. Postert[1], M. Berger[1], R. Bill[1]

[1]University of Rostock, Germany

Cities are one of the most pertinent application spaces for current Augmented Reality systems but have proven to be technically challenging. They are abundant with information, while also requiring occlusion of that same information at different levels of depth. With more and more detailed 3D city models becoming available through the CityGML standard, we introduce an approach that can display contextual multimedia annotations on buildings in AR and properly occlude them without depending on complex computer vision analysis. Our approach also integrates directly with CityGML through an Application Domain Extension (ADE). We implement a prototype that allows for the dynamic textual labeling of urban environments on a variety of AR-capable smartphones using the Unity game engine.

Session 5: Physical Environments

15:30 - 15:45

Can animal manure be used to increase soil organic car-bon stocks as a mitigation climate change strategy?

A. Kamilaris[1], I. Funes Mesa[2], R. Savé[2], F. De Herralde[2], F. X. Prenafeta-Boldú[2]

[1]RISE LTD, Cyprus
[2]Institute of Agrifood Research and Technology, Barcelona, Spain

Soil organic carbon (SOC) plays an important role on improving soil condi-tions and soil functions. Increasing land use changes have induced an im-portant decline of SOC content at global scale. Animal manure has the char-acteristic of enriching SOC, when applied to crop fields, while, in parallel, it could constitute a natural fertilizer for the crops. In this paper, a simula-tion is performed using the area of Catalonia, Spain as a case study, to exam-ine whether animal manure can improve substantially the SOC of the Cata-lonia fields. Our results show that the policy goals of Spain cannot be achieved by using merely manure transported to the fields, but this needs to be combined with other strategies too.

Digital Twins, Augmented Reality and Explorer Maps rising Attractiveness of rural Regions for outdoor Tourism

P. Fischer-Stabel[1]

[1]University of Applied Sciences Trier, Germany

Hidden landscape features, visualized by very high resolution digital elevation models (DEM) in combination with augmented reality (AR) apps are able to rise the tourist attractiveness of hiking trails away from the known travel destinations, especially for outdoor adventure tourists. Within the work described, explorer maps as a new map format in combination with the enrichment of landscape perception using digital twins of geographic features were developed. One big challenge was the credible placement of the virtual objects in three-dimensional space. Natural markers at selected points of interest (POI) are used for the tracking of the device in the 3D room and the enrichment of the camera view with the hidden objects of the landscape (e.g. bomb craters, railway features), preprocessed before as virtual representation. This alternative view of the landscape has not only the potential to rise the attractiveness of destinations, but also to attract new target groups in hiking tourism, such as young people and technology-savvy adults.

Identification of Tree Species in Japanese Forests based on Aerial Photography and Deep Learning

S. Kentsch1[1], S. Karatsiolis[2], A. Kamilaris[3, 4], L. Tomhave[5, 6], M.L. Lopez Caceres[5]

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[2]Research Centre on Interactive Media, Smart Systems and Emerging Technologies (RISE), Nicosia, Cyprus, Cyprus

[3]RISE LTD, Cyprus

[4]Department of Computer Science, University of Twente, The Netherlands, Netherlands

[5]Faculty of Agriculture, Yamagata University, Tsuruoka, Japan, Japan

[6]Leibniz University Hannover, Germany, Germany

Natural forests are complex forest ecosystems whose lifecycles are still un-known to us, in many aspects. Maintenance of forests and their properties are of high importance, due to their significant role in aspects of biodiversi-ty, soil fertility, water supply and climatic regulation. The first step of ana-lyzing forest ecosystems is to survey them. Since most of the forests in Ja-pan are located in steep mountains, the use of aerial imagery in combination with computer vision are important modern tools for forestry research. Our study constitutes a preliminary research in this field, classifying tree spe-cies in Japanese mixed forests based on UAV (Unmanned Aerial Vehicles) and deep learning, applied in two different forests types: a site mainly com-posed of a mixture of larch (Larix kaempferi) trees and oak (Quercus mon-golica) and a coastal forest with a black pine (Pinus thunbergii) plantation having an invasion of black locust trees (Robinia pseudoacacia). Our re-sults indicate that it is possible to identify black locust trees with 62.6 % True Positives (TP) and 98.1% True Negatives (TN), while we reached lower results for larch trees (37.4% TP and 97.7% TN).

Session 6: Transport, mobility and logistics

9:40 - 9:50

Improving Delay Forecasts in Public Transport using Machine Learning Techniques

H. Wobken[1], A. Dölling[1], J. Ewelt[1], N. Howad[2], F. Hustede[1], H. Jordan[1], A. Obead[1], J. Radler[1], S. Schnieder[1], K. von der Heide[1], O. Wehrmeyer[1], M. Wille[1], B. Rapp[1], J.M. Gómez[1]

[1]Carl von Ossietzky Universität Oldenburg, Germany
[2]Universität Oldenburg, Germany

The ability to accurately predict the delays of bus routes is a good way to raise the attractiveness of public bus services. Using machine learning we tried to create a model that is capable of predicting such delays. We combined data of a German bus provider with weather and traffic data from external services to merge the data into a Data Warehouse. This creates a data set for evaluating different algorithms and implementing a forecast model. After a failed attempt to train a MLP model, we added distance to travel and delay at last stop as input values, which in return drastically increased the accuracy of the model. Furthermore, we are in the process of training a LSTM model as a new approach to predict delays.

Decentralized Identity Management for DLT-based Cooperation Support

T. Osterland[1], T. Rose[1,2]

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Distributed Ledger Technology (DLT) has been originally introduced as a means for the distribution of transaction management across different peers. In the meantime, DLT has changed into a method for collaboration support among business partners in an open network. Data stored on the distributed ledger is generally considered to be secure and trustworthy. However, the trust in the data is more a question of authenticity and origin of the data. This work in progress reports on the introduction of reliable and secure decentralized identity management applied to the use case of inland waterway transportation. This domain and in particular the handling of bulk load is dominated by paper-based transactions and suffers significantly from a lack of digitalization. Digitalization and DLT certainly enable new business collaborations such as auctions for container handling or the automation of information handling.

Market-related opportunities and challenges for a digital platform model aiming at sustainable execution of last-mile logistics - A use case of B2C deliveries in Germany and Vietnam

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This research examines the opportunities and challenges for a sustainable last-mile logistics platform from the perspective of logistics service providers in Germany and Vietnam. Improvements in economic, environmental and social dimensions could be achieved through the application of transport bundling, the electromobility, hub structure and sustainable crowd logistics approach. Research focuses on B2C-deliveries, that relate to shipments from online re-tailers to end customers. Start-up Rytle plays the central role as a platform op-erator, providing hard and software components, including a sustainable transport system. In order to find out market insights and viewpoints of com-panies regarding the proposed platform, research applied the methodology of expert interviews. Differences in market structure and customer services be-tween two markets are stated. Despite low willingness for participation of large logistics service provider, market opportunities still can be seen in Ger-many. For Vietnamese market, platform deals with some fundamental prob-lems and adjustments are indispensable.

Visualization of greenhouse gas emissions for the means of transport airplane, car, train and coach by use of accessibility graphs.

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The employees of the HTW Berlin (University of Applied Sciences) attend conferences and travel all over the world within the scope of international projects. A research group at HTW Berlin has collected travel data for 2017 to analyze the distribution of the means of transportation chosen for business trips. Their raw data form the starting point for this project, which compares and visualizes the amount of greenhouse gases emitted by air, car, coach and train.

The initial value is the greenhouse gas emissions for a flight from Berlin to Munich. The most frequently used connection for employees in 2017, this value represents the limit of greenhouse gases available to other means of transport.

The distance between Berlin and Munich is 528 km and emits 10.6 kg greenhouse gases. With the same amount, 764 km could be covered by car, 3317 km by coach and 2948 km by train. The difference is clearly visible. With the amount of greenhouse gases emitted by a flight from Berlin to Munich, the train would travel as far as Lisbon and the coach would travel deep inside Russia (e.g. Ufa).

The aim is to integrate this information into the process of planning and booking business trips in order to raise awareness of the problem of CO2-saving means of transport among those involved.

How to consolidate sustainable mobility platforms in rural areas?

J. Schering[1], J. Rawe[1], A. Akyol[1], C. Theesen[1], J. Marx Gómez[1]

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Especially in rural areas, ride-sharing as a prominent form of sustainable mobility is an accepted but not widely used solution to fill in gaps of multimodal mobility supply as many research projects have shown. In this context, the NEMo project successfully developed and implemented a comprehensive mobility platform which includes the mobile application 'Fahrkreis' that incorporates ride-sharing options. The app, which functions as mobility assistant, is led by the idea to enable and encourage citizens to become mobility providers what contributes to the improvement of the general mobility situation in the countryside. Regarding the potentials of ride-sharing in real time, the recently started project instaride aims at making ride-sharing more flexible and spontaneous. To further understand the concrete existing potential of ride-sharing solutions, the different approaches need to be thoroughly evaluated in more use cases from real life (e.g. mobility management of businesses). Nonetheless, a remaining problem is that existing approaches are locally restricted and not interconnected with other (well-working) mobility solutions. Hence, it is difficult to reach a critical mass of users and a sufficient level of acceptance. To tackle this problem we propose a holistic digital mobility marketplace. This marketplace integrates existing solutions and connects these to further expand their individual sphere of activity. Moreover, we outline the need for transition from a sole mobility solution to a community solution encouraging citizenry to participate more actively. As we know from several examples mentioned in the paper, citizens are very dedicated to act as an active part of digital community approaches if individual benefits become clear.

Blockchain-based Electronic Record Books for Transparency to Prevent Marine Pollution

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International marine pollution prevention regulation heavily relies on the usage of record books for monitoring the ship's emissions. All vessels are subject to the "International Convention for the Prevention of Marine Pollution from Ships" (MARPOL) that imposes varies duties on the vessel's record keeping. Until today, all relevant information about all activities regarding garbage, wastewater and oil is entered by hand. The digitization of these record books could help to prevent the counterfeit of data, as in nowadays court proceedings the false or falsified entries hinder the investigations. Electronic record books based on blockchain and IoT-sensors could help to improve the data quality and maintain the integrity of the stored data for more transparency. In Germany, electronic record books are subject to ISO 21745. Thus, this paper shows how a blockchain-based application could be compliant with ISO 21745 and gives an outlook for further research. Five problem areas, i.e. fraud manipulation, wrong or loss of information, manual processes, lack of knowledge about technology and lack of control are examined, to show that Blockchain and IoT is a promising approach.

Session 7: Environmental Information Systems

10:50 - 11:00

Towards Decision Tree Based Assistance Functions of a Cloud Platform for Environmental Compliance Management

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Managing compliance to environmental regulations requires that the relevance of regulations is carefully judged and that compliance enforcement measures are accurately determined by experts. Often companies are over-challenged by these tasks because of knowledge shortages, budget limitations, and organizational deficiencies. This problem is mitigated when assistance functions for these tasks are offered by the Environmental Compliance Management Information System. In this article ongoing research that targets to enhance such as an information system by corresponding assistance functions is described. Given the system's cloud provisioning architecture the assistance functions benefit from up-to-date regulatory content that is maintained by domain experts on behalf of the cloud providers. Furthermore, also the individual companies' particular compliance management context is exploited which is also stored in the platform. Context-specific decision trees are dynamically orchestrated in a two tier approach in which judgements and insights are queried from domain experts and company-level compliance managers. The article gives an overview of the general conceptual approach for the assistance functions. It also describes how context-specific assistance content for a set of different companies can be obtained through decision trees.

Investigation of traffic and air pollution in Thessaloniki, Greece, under ordinary and COVID-19 pandemic conditions

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Traffic is linked with air pollution especially in urban areas. Even though both parameters follow profiles that have been under study for some years, the details of traffic patterns and their relationship with the concentration of pollutants remains elusive. The emergence of the COVID-19 pandemic resulted in lower overall traffic and in the reduction of relevant air pollutants, yet this new type of relationship has to be quantitatively evaluated. In the present paper we aim to: a) Examine how "spot speed" data from ioT sensors, can be processed to capture traffic patterns b) Determine the relationship of these data with air pollution levels in Thessaloniki city center, under normal and pandemic conditions and c) investigate the influence of traffic data to the data driven air quality modelling in the area

Machine learning methods for approximating the temperature of exterior walls using thermal images and colour images of building facades

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Houses lose energy in the form of heat through their outer walls. The amount of heat lost depends on the structure of the wall. Modernization of older houses is expensive and should be considered carefully. In the ENVIRON project, buildings are considered. Apartments in the buildings were measured using a SmartMonitoring system. Data from the rooms of buildings before and after the refurbishment were collected and thermal images of the exterior wall were also taken to record its thermal radiation. This makes it possible, for example, to detect thermal bridges, observe heat transfer, or calculate heat losses with physical formulas. Nowadays, thermal images are often used for the evaluation and detection of thermal bridges in house walls. Besides thermal bridges, thermal areas and their heat radiation are also considered by experts. These thermal images are easy to capture, but need to be analyzed by an expert. For this reason, the focus of this work is to enable an automation of thermal image processing. This can help experts to analyze and compare buildings before and after their refurbishment with each other. A method will be developed in further project that offers a faster and simple way to calculate the thermal energy radiated by outside walls. This requires in the first step the automated removal of noise objects in the termal images, that are not part of the building, such as the sky, or those that are causing noise on the thermal image, such as windows. However, the work in progress in this paper can contribute to a faster evaluation of potential energy losses in buildings that require refurbishment and help to support the decision-making process for or against a modernization process in the future. It will also do its part to help reducing CO_2 emissions as well as benefiting the environment.

Induction of a fuzzy decision tree for optimizing air quality data modeling

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Air pollution (AP) is one of the most significant global scale problems of our time. This phenomenon has serious impacts on public health, degrades the quality of human life and contributes to the degradation of environmental quality. The development of reliable models for predicting AP episodes is nowadays feasible, due to the vast volume of available data, which can be exploited by machine learning algorithms. A common drawback of this kind of algorithms is their inability to provide a comprehensible interpretation [1] of the principles that define the operations of the system being studied. This problem can be tackled by employing fuzzy logic rather than classic logic, through the theory of fuzzy sets.

In the current paper we develop an algorithm for the induction of a fuzzy decision tree, which is then materialized using the Python programming language. The fuzzy decision tree is trained according to a dataset, which contains air quality measurements from the greater Thessaloniki area in the Macedonia region of northern Greece, and it is compared with other data-driven models, which are based on classical logic. A unique characteristic of every fuzzy model is its ability to describe the system through a set of fuzzy rules, where the conditions and the consequences are stated by expressions of the physical language [2]. The results show that the fuzzy decision tree, even in this prototype form, excels in performance its classic analogue, and by further improvements it can be compared with higher quality learning algorithms.

PigFarm --Developing Decision Support for the Pork Production Industry

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PigFarm is founded in a mathematical model for the control of production processes in the pork industry. Anchor point of our approach is a statistical model of causalities between production parameters and animal's health as determined during inspections through veterinaries at slaughterhouses. Certain diseases such as lung events can be predicted with appropriate probabilities based on knowledge about environmental conditions and other production parameters. Hence, impacts of changes in animals' living environment can be forecasted and thus control the production with respect to animal's health and raising economic and ecological efficiency. Since impacts of changes are known and their probabilities can be predicted, production processes can be optimized in re-active as well as pro-active fashion.

Automated invasive alien species recognition: lessons learned from applying the iNaturalist 2017 computer vision model on citizen-science data

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Our planet hosts many millions of plants and animals, from which many might look identical. Due to their visual similarity, an expert is needed to classify species in the natural world. In the last decade, Computer Vision (CV) has made significant advancement because of deep learning (DL) algorithms. The iNaturalist Competition is a large-scale classification competition where the goal is to improve the state of the art in automatic image classification for real-world data.

The research objective is to explore the possibility to enhance an editing tool (a mobile application) to recognize Invasive Alien Species (IAS) in Europe with CV capabilities based on the iNaturalist 2017 CV model. The European IAS dataset contains 1192 images of 59 distinct IAS gathered by 696 submitted observations. The performed analysis showed that the CV is capable of recognizing 18 IAS. The sub-dataset of these 18 IAS contains 65 quality-controlled images. The iNaturalist 2017 CV model processed these 65 images and produced results with 35.4% Top-1 and 47.7% Top-5 accuracy. The IAS recognition results are visualized and explained. The paper discusses how to include the CV in IAS Europe App, explore CV model fine-tuning strategies, discuss the current dataset limitations, and possible future cooperation with wider scientific communities. The Python research code is freely available on GitHub.

Session 8: Sensors and Internet of Things

11:50 - 12:00

PM2.5 low-cost sensor performance in ambient conditions

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The use of low-cost air quality sensors to evaluate personal exposure, complement a monitoring network or perform real-time data assimilation is spreading. Although some laboratories and project consortiums have set up their own procedures to assess the performance of such systems and although the CEN TC264 WG42 is preparing two standards on that topic, so far the only European reference remains the Guidance for the Demonstration of Equivalence of Ambient Air Monitoring Methods that holds for any kind of device, whether it costs 100 or 10 000 €.

In this experiment, where 14 mini-stations are involved along with a reference and an equivalent method, some devices based on low-cost sensors display performance similar to a higher-end instrument with respect to the demonstration of equivalence methodology. However, it is worth noticing that only two sites are investigated, that the range of measured values is relatively limited and that a rather short period of the year is covered.

A varietey of statistical tests and error metrics are applied. All these parameters are performance indicators and could be used as-is or in combination to evaluate the metrological quality of a device. However, to find an alternative to the demonstration of equivalence without adding some subjective or site-dependent thresholds seems, on the mere basis of this study, quite unlikely. The Bland-Altman plot provides an interesting visual inspection of the data set and seems promising but it will require some additional work to set the bias and L.A. values that could, hopefully, be used in all sites.

Intercomparison between IoT air quality monitoring devices for PM10 concentration estimations

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Air pollution monitoring has attracted the interest of public authorities due to the mandates of the relevant legislation, and of citizens concerned with the impact of air pollution to their quality of life. While authorities use ref-erence instruments of high sophistication and cost, people are witnessing the rise of low cost instruments that become particularly handy for every-day estimations of air pollutant concentrations, especially as Internet of Things (IoT) devices. A major question posed is how the latter behave un-der real world conditions, and how they are compared to each other in terms of their similarities and differences in capturing the main characteristics (concentration values and profiles) of the pollutants of interest. We address this question with the aid of an intercomparison exercise running in Thes-saloniki from 2018, in the frame of which we were able to test and compare three different devices belonging to three cost categories that differ an order of magnitude from each other. For doing so, we used PM10 concentration data from a period within 2019, which we analysed with the aid of linear re-lationship investigations and computational intelligence methods (chapter 2). In chapter 3 we present with the results of our intercomparison, which we discuss in chapter 4. Our results (chapter 5) suggest that in general aforementioned devices demonstrate a good linear relationship accompa-nied by similarities in their overall behaviour, as well as differences in terms of concentration levels reported and discrepancies in the patterns of their behaviour.

ECOSense - Collection and analysis of bicycle sensor data

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The bicycle is more and more perceived as an attractive mobility alternative especially in urban areas. To adjust the infrastructure to the specific demands of the increasingly growing number of cyclists appropriate data is urgently needed. So far the available cycling data base is very small and mainly focused on smartphone applications which are mainly used in leisure time by young and sportive cyclists. To tackle this problem, the ECOSense project which was funded as part of the mFUND funding guideline (German Ministry of Transport and Digital Infrastructure, BMVI) developed a sensor platform that is gathering new data about positions, speed levels, vibrations and environmental factors of bicycle traffics. Especially the vibration parameter makes the sensor platform which was developed by project partner CoSynth an innovative and unique approach for cycling measurements to learn more about the quality of cycle paths. ECOSense had a strong citizen science approach as several hundred citizens of the Oldenburg area in Lower Saxony/Germany participated actively and provided their personal cycling data to the project. Lead partner mein-dienstrad.de (baron mobility service) involved the general (cycling) public and cycling domain experts in the field of city and traffic planning, municipalities and research in the project implementation (e.g. data collection, expert workshop). The generated data base of the sensors which were applied directly to the bicycle frame was processed and analysed by the University of Oldenburg, Department of Business Informatics (Very Large Business Applications VLBA). The analysis of the completely anonymized data sets delivers new results about bicycle use in daily life and the state of the cycling infrastructure (e.g. route selection, impact of bad weather conditions on bicycle use, intensity of vibration levels). The preprocessed and validated data sets will be published at the open data portal of the BMVI, the mCLOUD.

Towards a robust ensemble modelling approach to improve Low-Cost Air Quality Sensors performance

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Systematic monitoring of air quality has been carried out on the basis of a small number of stations in large urban areas, while air quality forecasting is carried out only as a research activity (as opposed to other environmental forecasts such as weather or wave forecasting). . The KASTOM project is developing a versatile and flexible urban air quality monitoring and forecasting system by deploying an IoT-oriented network of low cost air quality sensor nodes (LCAQSN), while in parallel developing a state-of-the-art emission modelling module combined with state-of-the-art three-dimensional air quality models (WRF / CAMx). As the final KASTOM product includes detailed air quality estimates at an urban level, innovative data fusion methods as well as methods for the improvement of the performance of LCAQSN come into play. Recent studies indicate that Machine Learning (ML) may significantly improve the performance of air quality sensor nodes reducing the impact of cross-sensitivity issues as well as measurement uncertainty [1,2,3]. Aim of this study is to develop a pipeline of computational procedures (feature engineering, ML algorithms, ensemble approach, validation), which is best suited for improving the performance of the aforementioned sensor nodes for particulate matter of 10 microns or less in aerodynamic diameter (PM10), in the frame of the KASTOM project.

Online energy forecasts for the Internet of Things

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In recent years, the topic of renewable energies and sustainability has become more and more important. Renewable energies enable us to reduce the CO2 emissions produced through energy production and thus possibly reducing global warming. If we can enable people to consider the development of renewable energy production, this could help them to live more sustainably and to positively influence their ecological footprint. With the help of online platforms such as SMARD.de from the Federal Network Agency, it is possible to obtain an overview of the composition of the produced energy. With the evaluation of this information, a targeted use of low CO2 energy or energy consisting of the maximum share of renewable energy production is possible. However, the data may be cryptic for non-experts and should be prepared in such a way that it is easy to understand and access. On that account, we developed a tool to firstly display these numbers in an understandable way and to secondly use this information for further applications, regarding the Internet of Things and Thinking.

First, the current electricity data is downloaded from the internet. It is then processed and displayed on a platform. We provide the data freely accessible for everyone and show the current percentage of renewable energies and a forecast for the next 24 hours. Additionally, the CO2 emission for the same time is displayed. This data can then be accessed with the components of the already existing IoT2-workshop. This workshop links the Internet of Things (IoT) and Thinking (EDGE-AI) with a graphical programming language and thus enables people with little to no knowledge in computer science to use the possibilities of distributed systems. On this basis, users can easily realize their own projects and always use the greenest energy.

12:40 - 12:50

Analysis and modeling of low-cost air quality sensor data towards their computational improvement

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This paper contributes to the computational improvement of particulate matter measurements performed by low-cost air quality optical sensors with the use of computational intelligence algorithms. Such sensors do not produce measurements of high accuracy due to limitations in the technology they employ and also due to various environmental influences. The current research tackles this problem using machine learning algorithms to improve sensor performance. These algorithms include feedforward neural networks, random forest algorithms, and Long Short-Term Memory neural networks. The computational improvement of these systems is proven to be feasible, with the trained models being reliable in estimating PM10 concentrations. The LSTM models prove to be the best-performing ones with the feedforward models not being far off, both greatly improving the relative expanded uncertainty of the measurements.

Session 9: Recycling and plastics

13:30 - 13:40

Mechanical Recycling Considerations for Responsible Plastic Innovation

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Mechanical recycling, melting or grinding post-consumer plastics to reuse them in new products uses less energy than virgin plastic production and keeps plastics out of landfills. However, its adoption has been limited by poor understanding of the properties of recycled materials. It is thus important to quantify the effects of recycling-induced degradation in plastics. A survey of the literature identified 21 metrics describing the degree of degradation in 11 plastics, representing mechanical, chemical, and structural changes due to thermal aging during reprocessing. In conjunction with similar data quantifying the presence of low molecular weight compounds such as residual additives and the degree of mixing with other plastics, these data can be used to quickly and reliably assess the potential utility of recycled plastics in their original applications and beyond. The identified metrics may also assist in the development of new materials designed to perform better after recycling. These data can also form part of a larger database designed to describe the overall environmental impact of plastics.

13:40 - 13:50

Engineering for a Circular Economy: Key Factors for the Design of Biodegradable Plastics and Plastic-Degrading Enzymes

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Recent projections for global plastics production suggest annual production will double in roughly 20 years. Meanwhile, nearly all plastic being produced (more than 92%) is considered non-biodegradable, and roughly 20% is improperly disposed of, thus contributing to the growing accumulation of waste plastics in the environment. Biodegradation has been a topic of interest for nearly 50 years, yet scientists only discovered a plastic-degrading enzyme within the last 5 years. Needless to say, natural biodegradation of plastics at an industrial scale is still far from being realized. Data relevant to biodegradation are generally limited and scattered, and they typically reflect laboratory studies conducted under controlled conditions rather than natural conditions To help advance progress on this front, an effort is under way to identify and integrate information on the characteristics of plastics that influence their degradability, and on the characteristics of plastic-degrading enzymes that influence successful biodegradation. Both are needed to be able to identify and optimize approaches for designing both biodegradable plastics and plastic-degrading enzymes. This project involves searching the scientific literature for relevant data and outlining a database concept to begin to integrate these data, using polyethylene terephthalate (PET) as the example plastic. Factors found to affect plastic biodegradability include hydrophobicity, surface topography, crystallinity, and molecular size;; further for PET, chain fluctuation (flexibility) and water absorbency have been shown to increase susceptibility to enzymatic attack. Data elements identified from the literature are being organized into a preliminary data schema to frame the database structure. In addition, data are being extracted from key studies into spreadsheets, including specific enzyme descriptors and effective mutants, as well as the plastics they can degrade. The overall goal is to create a practical database that polymer developers can use to inform the design of more environmentally compatible, biodegradable plastics.

Database Development and Special Considerations for Storing Polymer Fate Information

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The development of plastics has historically focused on obtaining optimal mechanical properties for a product application. This has resulted in materials that are highly desirable for use, but it can come with a heavy environmental burden after that product life ends. This is because plastics that are developed to be mechanically robust in an application translate to polymers that are very slow to naturally degrade when discarded. Information relevant to the fate of polymers in the environment can be found in a diverse set of online resources that range from journal publications and agency reports to data tables. This information exists in variety of formats, and an approach to streamline the extraction of key data has been developed as part of creating the concept for a new database. The aim of this database is to serve as a practical resource that combines information about the characteristics of polymers with data on their environmental fates, together with exposure and toxicity indicators. When completed, it is envisioned that this database will inform the design of new polymers that are more biofriendly, enabling developers to consider a product's potential after-life fate at the outset. To build out the database concept, relevant online publications were readily organized into a reference management system database, with data summaries stored in an ancillary spreadsheet. To simplify writing the information from data tables to a NoSQL (document store) database, a PDF table extractor was found to be an effective tool, with implementation via a GUI that was built in Python. Next steps include extracting information from additional materials, such as from text contained in PDF documents, and directly scraping data from the Internet. The preliminary construction of this database has markedly advanced planning for a practical resource to be available for demonstration in 2022.

Developing a preliminary data structure to assess plastics in freshwater environments

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A significant fraction of all plastics ever produced remains in our lands and waters, because these products were explicitly designed to resist degradation. Decades of increasing plastic production have resulted in the global accumulation of waste plastics in multiple environmental systems. To help mitigate this problem, an integrated understanding of the environmental fate of plastics is needed, to help inform the design of replacement polymers that are more environmentally benign. Attention to waste plastics in freshwater ecosystems is relatively new, with a shift from the dominant focus on marine and coastal systems occurring within the last several years. For this reason, related information and data analysis techniques are still evolving, and overall data syntheses are still being developed. A main objective of the current literature evaluation is to identify key data elements that can underpin a practical structure for the database concept being developed. The aim is to outline a structure that can effectively incorporate the limited information from existing studies while maintaining flexibility to expand as new data become available to fill the substantial gaps in current knowledge. Findings from this literature review and synthesis, which support the development of a database that can inform the design of novel plastics, include the importance of standardizing sampling and analysis methods and data reporting. An additional insight is the value of incorporating a geospatial component into the database, to enable integration of the data for macroplastics and microplastics with topography, land use, climate regime, and other factors that influence their environmental fate over time,

A Database on the Health Risks of Plastics

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Plastics play a substantial role in the modern economy, yet the potential for long-term environment health effects is not yet well understood. As our society moves towards a more environmentally sustainable economy, the need exists for a practical database on plastic characteristics and potential health effects, to help inform both the innovators of new plastics and consumers. The sourcing, production, use, disposition, and ultimate fate of plastics after their useful life ends involves multiple chemical processes and releases. It is useful to consider the potential for exposures and adverse health effects over time, with an emphasis on the post-use fate of plastics, to help guide the design of new polymers that are more environmentally friendly. Characterizing potential exposure pathways is a key aspect of health risk analysis. When assessing plastics in the environment, the elements include: (1) the source(s) of plastics and associated pollutants; (2) the release mechanisms by which they enter the environment, (3) the environmental media that receive these materials (such as soil, water, and air), and (4) the routes by which humans and other biota can be exposed (such as ingestion, inhalation, and dermal absorption). The studies examined to develop an initial screening search for data relevant to exposures and effects have shown that individual findings cannot be broadly generalized or extrapolated to other polymers or environmental conditions. Nevertheless, the "case studies" of flame retardants, polyvinyl chloride, and related additives offer insights for the database concept. These include the consideration of qualitative descriptors to categorize the nature of the data extracted, including as they relate to the potential for extrapolation. An additional finding relates to the practical benefit of automated data extraction.