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ERCIM NEWS

Special theme:

The Climate Action

Mathematics, Informatics and Socio-Economics Accelerating the Sustainability

Editorial Information

ERCIM News is the magazine of ERCIM. Published quarterly, it reports on joint actions of the ERCIM partners, and aims to reflect the contribution made by ERCIM to the European Community in Information Technology and Applied Mathematics. Through short articles and news items, it provides a forum for the exchange of information between the institutes and also with the wider scientific community. This issue has a circulation of about 6,000 printed copies and is also available online.

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JOINT ERCIM ACTIONS

SPECIAL THEME

The special theme "The Climate Action" has been coordinated by Sobah Abbas Petersen (NTNU) and Phoebe Koundouri (Athens University of Economics and Business and Athena RC)

Introduction to the special theme

RESEARCH AND INNOVATION

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Foreword from the President

I always find it inspiring to talk to people from the ERCIM member organisations. These are highly skilled people with solid experience who both create advanced theoretical knowledge and come up with practical and immediate ways to address challenges. Right now, the coronavirus pandemic is on all our minds. We all need to adapt and do our best to help. As ERCIM members we can share knowledge and solutions and we can use ERCIM as a channel for this.

I realise that it can be hard to look beyond the immediate issues, but nevertheless I want to share my thoughts on the future of ERCIM. To my mind, the ERCIM member organisations contribute an absolutely essential piece in the jigsaw puzzle of innovation. The ERCIM organisations have managed to create a space where wild ideas can blossom without the restraints of thinking about back compatibility or competitor advantages, a space that also succeeds in hosting endeavours where precision and restraint are key to deliver reliable service or advice. The fact that we are both creative and trustworthy means that we get access to the real unmasked details of problems and real data, which in turn attracts extreme talent to work at ERCIM organisations. Real data and real experts! Of course we rock!

How do we maintain this and help it to grow? This is ERCIM's challenge. Perhaps we can find solutions to help mobility for talent between the ERCIM members; perhaps cross border start-up support or a place for entrepreneurs to cultivate ideas when they are between ventures; perhaps continuous learning for professionals; perhaps data repositories. I look forward to brainstorming these ideas with the ERCIM community.

I am honoured to have been elected President of ERCIM AISBL for the next term of office and I am looking forward to serving this exciting organisation.

Björn Levin

The General Assembly of the ERCIM AISBL, held on 31 October 2019 in Rome, in conjunction with ERCIM's 30th anniversary celebration, unanimously elected Björn Levin, Business Manager of RISE-SICS in Sweden as its new President for a period of two years as of January 2020. Björn succeeds Jos Baeten from CWI who served as President of ERCIM since January 2018. The assembly also elected the board for a new term of office. From left: Gabriel David, INESCTEC/University of Porto, Secretary General; Fabio Martinelli, IIT-CNR, Dimitris Plexousakis, FORTH-ICS, Science Task Group chair, Christos Koulamas, ISI, Treasurer, Monica Divitini, NTNU, Human Capital Task Group chair; Jos Baeten, CWI, former President; Claude Kircher, Inria, former chair of the Human Capital Task Group; Björn Levin, RISE, President; Han La Poutre, CWI, Strategy Task Group chair, Jerzy Tiuryn, University of Warsaw, former Secretary General.

ERCIM Membership

ERCIM membership is open to research institutions (including universities). By joining ERCIM, your research institution or university can participate in ERCIM's activities and contribute to the ERCIM members' common objectives playing a leading role in Information and Communication Technology in Europe.

About ERCIM

ERCIM – the European Research Consortium for Informatics and Mathematics – aims to foster collaborative work within the European research community and to increase cooperation with European industry. Founded in 1989, ERCIM currently includes 17 leading research establishments. ERCIM is able to undertake consultancy, development and educational projects on any subject related to its field of activity.

ERCIM members are centres of excellence across Europe. ERCIM is internationally recognized as a major representative organization in its field. ERCIM provides access to all major Information Communication Technology research groups in Europe and has established an extensive program in the fields of science, strategy, human capital and outreach. ERCIM publishes ERCIM News, a quarterly high quality magazine and delivers annually the Cor Baayen Award to outstanding young researchers in computer science or applied mathematics. ERCIM also hosts the European branch of the World Wide Web Consortium (W3C).

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Introduction to the Special Theme

The Climate Action:

Mathematics, Informatics and Socio-Economics Accelerating the Sustainability

by Sobah Abbas Petersen (Norwegian University of Science and Technology) and Phoebe Koundouri (Athens University of Economics and Business and Athena RC)

The 2018 IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [L1], idicates clearly that climate change is an existential threat. Anthropogenic emissions continue to cause further long-term changes in the climate system, such as sea level rise, increased frequency in extreme weather conditions and biodiversity and ecosystems services loss, are evident around the world. These significantly increase the risks for catastrophic events and loss of food security for the world's growing population. According to the IPCC's report, we have 10 years to limit climate change catastrophe and keep global warming to a maximum of 1.5C, beyond which even half a degree will significantly worsen the risks of drought, floods, extreme heat and poverty for hundreds of millions of people.

The UN Sustainable Development Goals (SDGs) [L2] have become the world's framework for sustainable development and for countries and individual organizations to take action to address the growing need to reduce global warning and the undesired climate changes. Efforts are made to bring clarity on how to implement these SDGs and how countries could make the necessary changes and track progress towards these 17 goals. In the last few years, there has been an increased awareness among the research community on implementing these goals and supporting countries, organizations and industry reduce their contributions to global warming and the emission of greenhouse gases. Importantly, the 2019 United Nations Sustainable Solutions Network (UN SDSN) report on the "Six Transformations to achieve the Sustainable Development Goals" [L3] lays out integrated framework for implementing the SDGs and the Paris Agreement on Climate Change. The six UN SDSN transformations provide an integrated and holistic framework for action that reduces the complexity, yet encompasses the 17 SDGs, their 169 Targets and the Paris Agreement. They provide a new approach to shift from incremental to transformational change; to identify synergies using sustainable development pathways; formulate actionable roadmaps; and a focus on inter-relationships to uncover multiple benefits and synergies. They focus on: (1) education, gender and inequality, (2) health wellbeing and demography, (3) energy decarbonization and sustainable industry, (4) sustainable food, land, eater and oceans, sustainable cities and communities and (6) digital revolution for sustsainable development. The six SGD transformations are underpinned by the principles of leaving no one behind and circularity and decoupling.

Just before 2020, the European Green Deal (EGD) [L4] was announced by the president of the European Commission. The EGD is the European response to the climate crisis. It is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy. The explicit aim of the EGD is climate neutrality (no net emissions of greenhouse gases) by 2050, while economic growth is decoupled from resource use. It also aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, this transition must be just and inclusive. As part of the Green Deal,

the Commission will refocus the European Semester process of macroeconomic coordination to integrate the United Nations' sustainable development goals, to put sustainability and the well-being of citizens at the centre of economic policy, and the sustainable development goals at the heart of the EU's policymaking and action. Figure 1 illustrates the various elements of the Green Deal.

The response of governments to the climate crisis thus far has not been sufficient and the world is not on track to meet the objective of the SDGs, the Paris Climate Agreement and the European Green Deal. The IPCC report explicitly refers to the need for "rapid far-reaching and unprecedent changes in all aspects of society". Incremental changes will not be enough. What is needed now is a fundamental transformation of research, innovation, financial, economic, and social systems that will trigger exponential change in decarbonization rates and strengthen climate resilience. We need big thinking and big changes. We need systems innovation and science has a big role to play! The world needs to catalyse systemic change for climate action through innovation (technological and social[1]) by connecting the supply of innovation with demand-side actors, problem owners and those with a high ambition for change. Europe is currently leading the efforts in the sustainability transition and hopes to become an illustrating case study of the possibility achieving economic growth and socio-economic prosperity, while transitioning to a sustainable, circular, climate resilient economy and society.

The current global crisis caused by the pandemic of COVID-19 has clearly proven the ability of governments to take dramatic measures to mitigate an existential threat, as well as people's ability, at least in the short run, to adapt to new restricted lifestyles imposed by these measures. Importantly, there is serious scientific speculation that COVID-19 might be connected to the climate crisis and the related loss in biodiversity. Indeed, the measures that can help solve the health crisis can make the economic crisis worse and vice versa.

Figure 1: The European Green Deal (Source: European Commission).

What is the way forward and the effect on the potential implementation of the EGD? We can use the science -as we are using science currently for designing measures to restrain the diffusion of CONVID-19- to design economies that will mitigate the threats of climate change, biodiversity loss, and pandemics. The economic measures and fiscal packages (mainly financed by public debt) that are being designed to sustain and restart the European (and global) economy, should embrace EU taxonomy for sustainable investments (2019) and direct finance to those who are sustainable or have the potential to become sustainable, but also those who are willing to commit and be monitored henceforth, to learning how to become sustainable [1].

Researchers have focused on developing energy efficient industrial process and material that has less emissions and innovative and efficient use of existing material and solutions. The role of models and simulations are explored in many disciplines to make predictions and determine sustainable transitions and the optimal solutions in many situations. This special issue focuses on the use of Climate Informatics and Mathematics in supporting the development of models, tools and solutions for sustainable transitions and transition pathways to support climate action. The research featured in this special issue covers a broad range of applications ranging from electrical vehicles and smart grids, smart water distribution to methods and frameworks for describing an overview of the different technologies and ICT solutions (e.g. models). Research activities in the following themes have been included:

- Green spaces in urban areas and forests
- Smart energy management
- Models for marine, coastal areas and climate change
- Big Data analysis
- Methods and approaches for sustainable solutions.

Green spaces in urban areas and forests

An important aspect of a healthy lifestyle and a good urban design is the availability of green spaces for the urban population. Laan and Piersma explored the availability of urban green spaces for the inhabitants in the Municipality of Amsterdam, by taking into account the population density and green spaces within the area and by using Open Data (p. 8). These models also provide an insight to urban planners and the municipality to make decisions about incorporating facilities such as restrooms and play areas in the green spaces. Ponsard's and Nihoul's contribution focuses on understanding the diverse roles of a forest for different stakeholders; thus highlighting the need for supporting multiple stakeholders, goals and objectives of forests and not restricting forests to a single use or group of people (p.9).

[1] *Social innovations are new social practices that aim to meet social needs in a better way than the existing solutions, resulting from - for example - working conditions, education, community development or health. These ideas are created with the goal of extending and strengthening civil society.*

Smart Energy Management

As the no. of electrical vehicles increases, the load on the energy grids increase too. One of the challenges currently faced by smart grid operators is balancing the load on the smart grids. Bons, van den Hoed and Piersma describe a pilot study conducted in Amsterdam, where flexible charging options were introduced on a proportion of the city's electrical charging stations. A time-dependent restriction on the amount of electricity that could be consumed by an electrical vehicle was implemented (p.10). The data from the charging stations and from the owners of the electrical vehicles showed that flexible charging patterns could be implemented without negatively impacting the vehicle owners. As many cities progress towards energy transitions in the transport sector. Another article that describes smart energy management is the microgrid energy management system developed for a residential bottom-up community. Kaisers, Klein and Klauer describe the technologies developed for two neighbourhoods that have a combination of renewable energy sources and locally generated energy and a microgrid, where power is shared and jointly controlled by all the houses in the neighbourhood (p.12).

Models for marine, coastal areas and climate change

The oceans and the ecosystems around them are one of the areas that are most affected by climate change. Thus, understanding them and making predictions of the complex processes and phenomena related to them is an important research area. Several modelling methods and approaches have been included in this special issue. Vidard describes models for ocean coastal areas and discuss different approaches for reducing the uncertainty of these models (p.14). Modelling of the seabed and marine life is equally important to understand the evolution of marine ecosystems. Crommelin, Edeling and Jansson describe their research in applying superparameterization, a computational approach to multi-scale modelling and simulation of atmosphere and ocean, and its advantages over other modelling methods (p.15). Pavoni, Corsini and Cignoni descibe an application, TagLab, that uses underwater photogrammetry and Machine Learning to analyse images and data for semantic segmentation and annotations of coral reef maps (p.17).

Reducing greenhouse gas emissions, effective waste management and circular and bio economy are of utmost importance in taking climate action and a sustainable future. Tsachidou, Hissler and Delfosse describe their investigation of the contribution of biogas residues to climate change mitigation through carbon sequestration in agricultural soils (p.19).

Big Data analysis

Many of the models and solutions that are currently developed rely on numerus data sources and contribute to the vast amount of data that are around us. Data is analysed and leveraged to generate value from them in several ways. Dalamagas, Kokossis and Gentimis describe an application to harnesses the power of big data to bridge the circular economy with the data economy, by analysing large amounts of diverse data to determine where they may be industrial symbiosis and the potential for achieving a circular or a bio economy (p.20). In addition to data analysis, Artificial Intelligence and Machine Learning applications, numerous smart sensor technologies and ICT tools are used to monitor, assess and manage many applications. Tzagkarakis, Anastasiadou and Eliades describe an application that uses Internet of Things (IoT) and data analysis to monitor and manage, in real-time, their water distribution system to minimise loss of water through leakages (p.22). Indeed, analysis of existing data such as climate indexes, can provide valuable insights as to how a particular area has changed. Karavoulias and Argiriou analysed various climate indexes for Greece to better understand the climate changes and their potential impact on humans and the environment (p.23).

One of the challenges that organisations and municipalities face are the management of their own data, and to have an overview of other data sources that could be of relevance to their analyses and models; e.g. Open Data from municipalities. Bokolo, Petersen and Helfert propose an Enterprise Architecture Framework for modelling Sustainable solutions, where several organisations collaborate and a variety of data from diverse sources may be used (p.25).

Methods and approaches for sustainable solutions

Of course, with the increase in new technologies, models and solutions, the social acceptance of these is an important part of a successful implementation of them and their contributions to affecting climate change. Indeed, many solutions that are developed today affect future generations and therefore should reflect the future. Tangari, Occhipinti and Briguglio propose a model to draw attention to the concerns and expectations of people who live today to consider the concerns of future generations (p.26). It is equally important that decisions made by municipalities, designers and planners are well-informed and align with the wishes and needs of the citizens. To achieve this, we often see innovative participatory approaches and practices. One such approach, the Living Labs methodology was used by Ponsard's and Nihoul's, to obtain an insight on how the citizens' used their forests (p.9).

In conclusion, this special issue provides a glimpse of the diverse research activities that focus on mobilizing the research-innovation and innovation commercialization ecosystem, towards producing solutions for the much needed sustainability transition that aims to a sustainable interaction between the society the economy and the natural environment.

Links:

[L1] https://www.ipcc.ch/sr15/
[L2] https://kwz.me/h4Y
[L3] https://kwz.me/h4B
[L4] https://kwz.me/h4b

Reference:

[1] P. Koundouri: "Never waste a good crisis: For a Sustainable Recovery from CONVID-19, UN Sustainable Development Solutions Network, online, 2020. https://kwz.me/h4r

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Urban Vitality: Re-Evaluating the Availability of Urban Parks

by Corine Laan (Amsterdam University of Applied Sciences) and Nanda Piersma (Amsterdam University of Applied Sciences and CWI)

Parks are necessary for sustainable urban vitality. We studied the optimal availability of parks by combining open data sets with polygons and classification frameworks from urban planning literature. Both distance and population density should be considered as measures of availability when planning urban parks.

Urban green spaces may have a historic origin or be planned in cities for purposes such as maintaining biodiversity, recreation, health, climate control, amelioration of air pollution and fire protection. Parks and their facilities may be owned and maintained either by municipalities or private parties. Studies show a positive relationship between the availability of parks and the health and the wellbeing of residents.

The evaluation of urban green space has been studied from different perspectives, including city planning, user appreciation, availability and accessibility, and its function in the urban context. Many case studies from these perspectives have given city planners and municipalities tools to manage urban green spaces in their cities.

The classification and evaluation of urban green spaces has commonly accepted indicators such as availability and accessibility [R1]. Availability is defined here as a quantification of green spaces (in size and distance) without consideration of public availability or proximity to residential locations (WHO2016). Accessibility is defined as a quantification of green space availability to general or specified public groups in relation to distance, expressed in service radius, or neighbourhood green index.

With the availability of more and new data sources on green urban areas, the classification framework for urban green spaces can be further developed and detailed. Global data also enables the framework to be generalised and standardised to overcome case-specific city characteristics.

In our research, we include the park size and population density within the catchment area of the parks as an indicator of availability of urban parks. The case study of Amsterdam shows that including park size and population density provides a radically different availability score of parks.

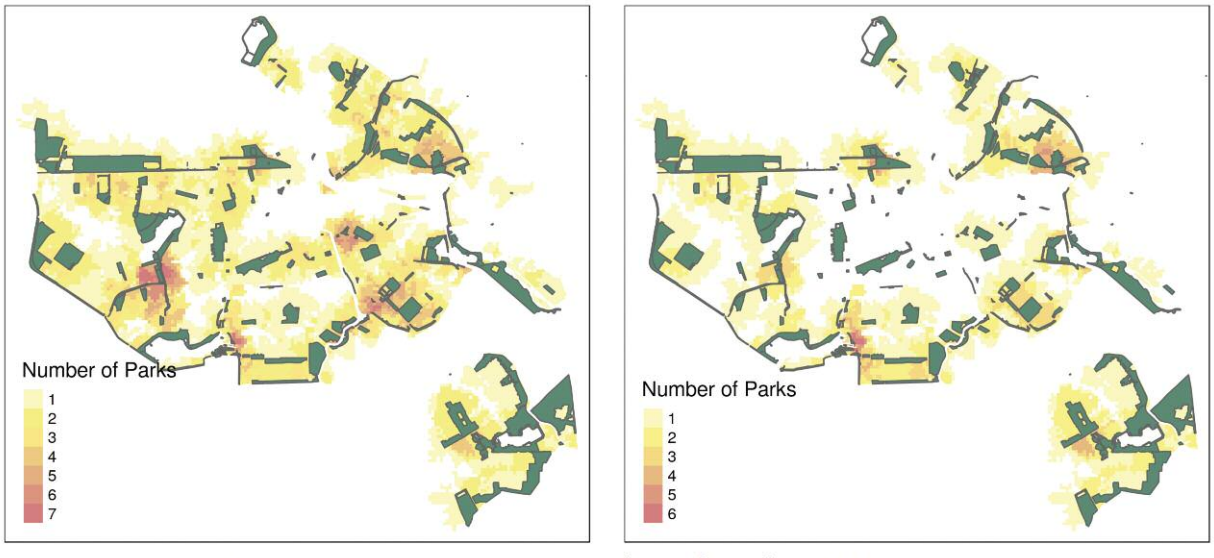
The indicators are modelled in an interactive dashboard for the Amsterdam case.

The Amsterdam case

We use open data, provided by the Municipality of Amsterdam, and consider urban parks that are open to the public and maintained by the municipality. The parks are denoted by polygons in line with another data set from the Copernicus urban atlas data for Europe [L1]. The polygons are plotted on a 100 x 100 m grid of the city of Amsterdam. The population size for each grid cell is available from Central Bureau of Statistics, the Netherlands [L2]. A total of 21.81 km^2 green space exists within the city borders of Amsterdam, representing 9.93% of Amsterdam's total area.

The model

Amsterdam is famous for its canals in the inner city and waterways in all neighbourhoods, features that need to be considered when calculating travel-



a. Population density 0.5

b. Population density 0.05

Figure 1: Locations in Amsterdam near a park. The left shows the number of parks within 750m with 2m^2 space per person and the right with 20m^2 per person. This shows that the inner city has some parks in the immediate surroundings whereas suburbs have multiple parks in close range. However, the parks near the inner city are very busy since they are also used by residents of the suburbs.

ling distances. The distance to a park is therefore measured by calculating the actual walking distance from the centre of a grid cell to the nearest edge of the polygon of the park, using OpenStreetMaps.

The catchment area is defined as all grid cells within P metres walking distance of a park polygon, with P having values of 900, 750 or 500m.

The population density of a park is measured by the total population of the catchment area of a park, divided by the size of the park (population/m^2). A second parameter Q is used as a threshold of desired population density, with values of 0.05, 0.5 and 1.

We show the catchment area of each park in Amsterdam within P metres walking distance and with park density below Q. With a value Q > 5 (maximum population density), the park density parameter is inactive, since all parks are taken into account.

Results

Figure 1 shows the catchment areas for P = 750 and Q = 0.05 and Q = 0.5. The catchment area of parks consists of 64% of the grid cells. If we include population density, this number decreases to 59% with a density of 0.5 and to 45% for a density of 0.05. As a percentage of the population of Amsterdam the catchment area of parks is 83%, but only 69% of the people are within 750 meters of a quieter park (density 0.05).

This research is part of the joined Urban Analytics program of the CWI and AUAS. Current work is incorporating the parks' facilities, such as restrooms, catering, picnic areas and sports facilities. The accessibility to parks in relation to the available facilities is relevant. It gives a better insight into accessibility of parcs taken into account the population density of a park and park users' intention for visiting parks. New research will also include a comparison with other European cities.

Links:

[L1] https://kwz.me/hSR

[L2] https://kwz.me/hSU

Reference:

[1] Gupta, Kshama and Kumar, Pramod and Pathan, S. K. and Sharma, K. P., 2012, Urban Neighborhood Green Index - A measure of green spaces in urban areas, Landscape and Urban Planning, Vol 105, nr 3, 325-335, https://kwz.me/h4S

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A Living Lab Approach for Sustainable Forest Management

by Christophe Ponsard and Bérengère Nihoul (CETIC)

Humans and forests share a longstanding common history, largely driven, from the human side, by economics. The consequence is ever-increasing degradation, despite progress in forest science and public awareness. We took a "living lab" approach to support the evolution of the Greater Luxembourg forest. The aim was to restore a more sustainable balance across various forest functions, in part by adopting a multiple-use management approach.

Forests are a key resource for humanity, but in many areas they are under increasing stress and degradation through deforestation, over-exploitation, and abandonment. These problems have existed for a long time [1], but they are still worsening, exacerbated by climate change-related events, such as increased frequency of fires and storms and the spread of pathogens.

The recent increase in public concern about the environment is a catalyst to rethink our relationship with the forest, using a cross-disciplinary approach involving not only professionals but also citizens, state organisations and research institutions. Co-innovative methods and digital tools for such user-centred creative processes have recently been developed, e.g., coworking, incubators, creative hubs, fab labs and living labs. The living lab is characterised by an open-innovation ecosystem, generally focused on a specific domain; in our case forestry. It integrates concurrent research and innovation processes within a public-private-partnership. It also provides an experiential environment where selected users are immersed to design and experience their own future [2].

Our living lab is anchored in the Greater Luxembourg forest, covering 2,375,000 ha across four countries (Luxembourg, Belgium, France and Germany). A large portion (over 40%) of this forest is privately owned and poorly maintained, thus returning to a wild state with positive (biodiversity) and negative impacts (spread of illness, fire risk). Biodiversity is also affected by monocultures of non-endemic species like spruce which dominate parts of the forest. To tackle these challenges, the living lab has explored all the dimensions of sustainability, i.e., environmental, social and economic, with various stakeholders and through two complementary projects: Agreta (focusing on tourism) [L1] and RegioWoodII (focusing on forest monitoring and management) [L2]. Key scenarios and activities illustrating those dimensions are depicted in Figure 1.

A key point is to avoid restricting an area to single use relating to the goal of a specific stakeholder, but to keep it

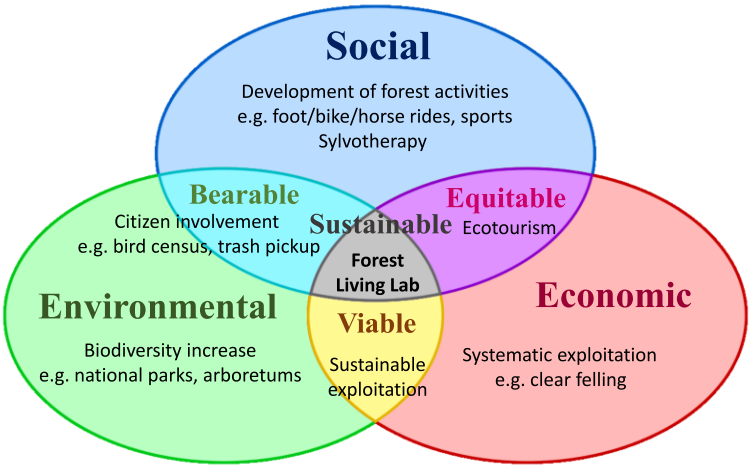

Figure 1: Different means for a sustainable forest.

open to multi-objective/use/purposes, e.g., wood production, water quality, wildlife, recreation, aesthetics and clean air [L3]. Such a multi-use approach is not new but was deployed through a living lab based on the combined methodological experience of two Walloon research centres respectively specialised in information technology and forestry. The strengths and differentiators of our approach are:

- Workshopping activities to bring together people of different backgrounds and identify mutually enriching usage scenarios.
- Multi-objective identification and reasoning using different techniques such as system thinking. This approach can help to pinpoint synergies and barriers, or positive and negative feedback loops, relating to different stakeholders' goals.
- Rapid technical feedback about existing tooling and related constraints, key issues and success factors (e.g., monitoring tools, tracking tools, information channels).
- Easy set-up of experiments involving different types of participant in specific or mixed scenarios.

As an example, participative workshops and online tools supporting collaborative decision making can help to work out how the combined monitoring and recreative functions of the forest might work together. From a technical perspective, useful information is provided by a variety of GIS tools such as WalOnMap [L4]. This helps us assess the potential for a given area to evolve towards more integrated and multiuse management by combining biodiversity, remarkable features (e.g., landscapes, rocks, waterways) and the path/road infrastructure. This approach is proving quite successful and is being applied by CETIC to other ecosystems, such as mobility management to organise ride sharing [3].

Links:

[L1] https://kwz.me/hSW
[L2] http://www.regiowood2.info/en
[L3] https://kwz.me/hSX
[L4] https://kwz.me/hSZ

References:

[1] O. Ciancio, S. Nocentini: "The forest and man: The evolution of forestry thought from modern humanism to the culture of complexity", Acad. Ital. Science Forestali, 1997.
[2] A. Kusiak: "Innovation: The Living Laboratory Perspective", CAD & Applications, vol. 4, n°6, 2007.
[3] C. Ponsard: "Building sustainable software for sustainable systems: case study of a shared pick-up and delivery service", GREENS@ICSE 2018.

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Can Smart Charging Balance the Urban Energy Grid?

by Pieter Bons, Robert van den Hoed (Amsterdam University of Applied Sciences) and Nanda Piersma (Amsterdam University of Applied Sciences and CWI)

Smart charging protocols for electric vehicles can help avoid overload and instability in the electrical distribution network and can increase the proportion of locally generated solar energy used for charging. Our results show that the impact of smart charging depends heavily on the technical charging characteristics of the target vehicle.

Electric mobility is developing at a rapid pace, led by a few European countries, including Norway and the Netherlands. The electrification of transport constitutes a considerable additional load for the electricity grid. Electric mobility is estimated to increase the total demand for electricity by 15 to 20%. Given that charging profile of electric vehicles (EVs) tends to overlap with household consumption profiles, the power consumption peaks are likely to significantly increase as a result of EV charging, and limits to grid capacity may be reached [1].

Since May 2019, an experiment known as "Flexpower" has been underway in Amsterdam, with the aim of investigating the technical feasibility and measuring the impact of load shifting on public charging stations under real-world conditions. The project is a collaboration between the Municipality of Amsterdam together with the Amsterdam University of Applied Sciences, charging point operator Vattenfall, grid operator Liander, and knowledge centre ElaadNL.

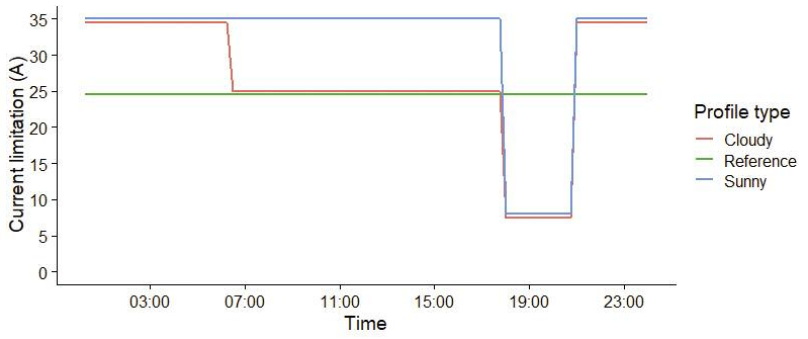

Figure 1: The time-dependent current profile deployed on the selected Flexpower charging stations under sunny and cloudy conditions compared to the current limit on a regular public charging station in Amsterdam.

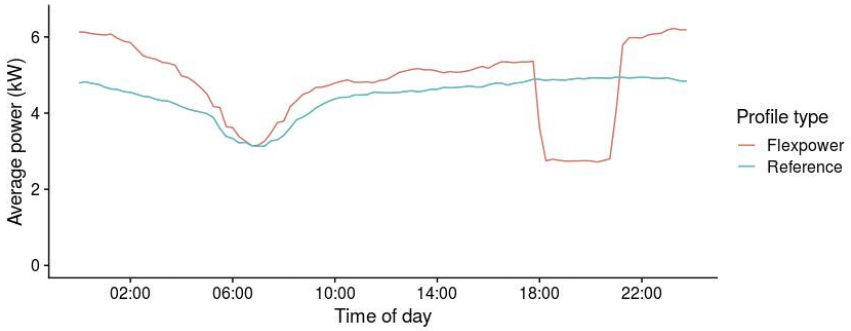

Figure 2: Charging power averaged over all active sessions as a function of the time of day,. The resolution of the graph is 15 minutes, which is limited by the resolution of the data.

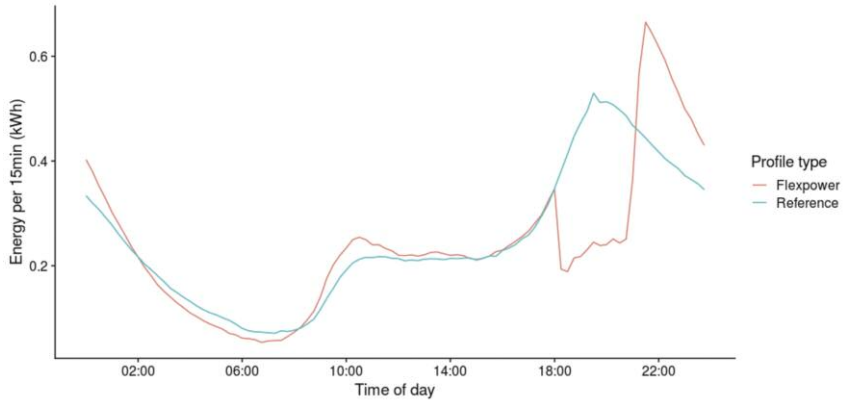

Figure 3: Average energy volume per charging socket per 15-minute interval. During each 15-minute interval of the day, a share of charging stations is distributing energy while the remaining stations are idle. The value plotted in this figure is the total amount of energy charged during this 15-minute interval divided by the total number of stations and averaged over the duration of the experiment.

Out of the 2,100 public charging stations in the city, 450 were selected to deploy a time-dependent current limit, with a higher limit during sunny conditions and greater restrictions during cloudy conditions and household peak-use times (Figure 1). During this pilot, data was collected from about 40,000 users, responsible for approximately 450,000 unique charging transactions. The data contained information on the start time, end time, amount of energy, charge point, payment ID as well as smart meter information at 15-minute intervals. The dataset contains transactions of battery electric vehicles (BEVs; all-electric vehicle) as well as plug-in hybrid electric vehicles (PHEVs; cars with dual fuel systems) since these share the same public charging infrastructure. The type of EV is not known in the data, but a classification is inferred based on the charging behavior over multiple sessions of a payment ID.

During the operational pilot, multiple key performance indicators (KPIs) were monitored to evaluate the effects of the smart charging profiles. These KPIs represent the interest of the different stakeholders involved in EV charging:

1. Effective charging power (kW) as a function of time of day,
2. Average amount of charged energy (kWh) per charging socket as a function of time of day,
3. Number of positively/negatively affected sessions in terms of amount of charged energy per transaction.

Results

Figure 2 shows the average power of all active sessions over the course of the day. The charging power on Flexpower stations is higher during the daytime and lower during peak times, which is exactly the intended effect for grid balancing in relation to household energy usage and availability of solar energy.

However, the charging volumes shown in Figure 3 (amount of charged energy) show no significant increase during the daytime, and a delayed peak in charging volume just after the evening peak. This shows that during the day the energy demand does not increase along with the higher power. Vehicles can charge faster but will finish the session earlier with the same net amount of charged energy. Without extra incentives to increase daytime demand, the current time-dependent profile does not result in more solar energy being utilised by EVs. The fact that there is a rebound peak directly after limitations are lifted proves that

the Flexpower infrastructure can deliver higher energy volumes if there is outstanding demand.

An important finding of this study is that a determining factor of the effects of a flexible charging profile are the charging characteristics of the EV itself. There are many different EV models on the market with different charging characteristics. The number of phases that a vehicle uses to charge can differ (there are 1-phase, 2-phase and 3-phase models) as well as the maximum current at which the vehicle can charge (16A, 25A and 32A). Full electric cars tend to have larger batteries that require higher charging powers (3-phase charging at up to 32A), PHEVs generally use 1-phase charging at 16A. The effects of a flexible current limit depend heavily on the type of EV that is charging.

In total, 5% of all transactions on Flexpower stations received a lower average power than on reference stations, which represents a negative impact on EV users. It should be noted, however, that PHEVs dominated these negatively affected sessions. As such, although there will be a slight reduction in zero-emissions kilometres driven by these users, it is unlikely that they will be impacted by range anxiety.

In total, 4% of the sessions were positively affected, owing largely to vehicles that were technically able to profit from higher current during off-peak hours. This category of vehicles is dominated by full electric vehicles, which are more dependent on a full charge. For this category, the Flexpower profile provides a significant improvement.

The results of this experiment show that smart profiles on charging stations can suppress charging volumes during a designated time window without large implications for EV drivers. The possibility of increasing charging volumes during the day is limited by the level of demand and technical limitations of most EVs currently on the market. More advanced battery electric vehicles are increasing in popularity in the major European markets for EVs, so the percentage of positively affected users is likely to increase rapidly in the near future.

Link:
[L1] https://kwz.me/h4C

Reference:
[1] García-Villalobos, Javier, et al.: "Plug-in electric vehicles in electric distribution networks: A review of smart charging approaches", Renewable and Sustainable Energy Reviews 38 (2014): 717-731.

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Grid-friendly Sustainable Local Energy Communities

by Michael Kaisers (CWI), Matthias Klein and Alexander Klauer (Fraunhofer ITWM)

New software and algorithms are being developed to help communities become less dependent on the electricity grid and less of a burden on it. This decoupling is an important step towards improving sustainability without compromising on affordability, comfort and efficiency of the overall system. Experience from pilot projects provides key insights into the management of the challenges that arise.

The transition towards (fluctuating) renewable electricity generation requires increased flexibility to use energy when available, either by shifting time of use or by storing energy. This capacity to be flexible is referred to as demand response. Such demand response is possible given decreasing storage prices, flexible thermal loads, electric vehicle charging schedules etc., but it requires intelligent coordination. The project "Demand response for grid-friendly quasi-autarkic energy cooperatives (Grid-Friends)" [L1] has developed and evaluated solutions that aim to achieve cost efficiency and maximum autarky by shared exploitation of storage and other flexible energy resources within communities.

The coordination challenge has been addressed with both fundamental and applied research, published in scientific conferences and journals. The research output can be roughly divided into three main directions. First, automated negotiation based on user preference models enables decentralised coordination of flexibilities within energy communities [1]. Second, fundamental research on reinforcement learning highlights how individual agents can learn to optimise their strategy in order to best respond within a collective of autonomous decision makers with potentially mixed interests, using methods such as opponent modelling [2]. Finally, future scenarios have been investigated that allow for the between-community exchange of flexibilities on regional energy markets [3]. Overall, the project resulted in 26 peer reviewed publications, and consortium members contributed to the discussions and policy briefs of several working groups within the knowledge community of the funding programme (ERA-Net Smart Grids Plus).

Practical challenges have been addressed with new software components and algorithms, added to the myPowerGrid internet platform [L2] and the local Amperix® energy management system, providing synergetic new capabilities across three interconnected sectors (electricity, eHeat and eMobility). Offered services include load-based dynamic power control of photovoltaic (PV) systems, curtailment event reduction by active scheduling of

Figure 1: Grid-Friends pilot site Schoonschip, Amsterdam Noord. © Isabel Nabuurs Fotografie.

heat pumps, electric vehicles (EV), and battery storage, increasing consumption of locally generated energy between several controllable loads, generators, and storages based on forecasts, EV charging strategies based on EV state of charge (several car manufacturers are supported), and peak shaving, both physically per phase, and based on 15-minute intervals for customers paying for power usage in addition to energy usage.

The developed technology has been advertised at multiple trade fairs and within industry interest groups. Furthermore, a Fraunhofer spin-off Wendeware AG [L3] was founded on 14 March 2019 to commercialise the developed technology.

The myPowerGrid platform and the Amperix Energy Management System (EMS) have been deployed as a microgrid energy management system at the residential bottom-up community Schoonschip [L4], advised by the system integrator company Spectral. This pilot with 30 floating houses, each with a PV system, heat pump, and battery storage, demonstrates both a cutting-edge technical microgrid where power is shared and all the houses jointly controlled, accounted for and optimised behind a single 150 kVA grid connection, as well as a unique civic engagement to jointly invest in this infrastructure. Agreements have been put in place for the operation beyond the project's duration. Schoonschip's residents have overcome numerous challenges in managing and coordinating their community-driven project, which is a sign of their determination and dedication to sustainability.

The second pilot is a residential neighbourhood with a comprehensive metre infrastructure for water, electricity and heat, managed by evohaus IRQ GmbH, which developed an EMS that calculates an instant electricity price. The higher the component of renewable generation at a given moment, the lower the energy price, visualised by a traffic light system in a web-frontend and with three coloured LEDs inside the house/flat of the consumer. This system fosters consumer acceptance, since the impact of active participation is immediately visible. Once teething problems of smart hardware are eliminated and the legal framework is adjusted to further encourage consumption of locally produced renewable energy, the pilot project has good replication potential for a sustainable power supply in the future.

Links:

[L1] http://www.grid-friends.com/
[L2] https://www.mypowergrid.de/
[L3] https://www.wendeware.com/
[L4] https://schoonschipamsterdam.org/

References:

[1] S. Chakraborty, T. Baarslag and M. Kaisers "Automated Peer-to-peer Negotiation for Energy Contract Settlements in Residential Cooperatives", Applied Energy, 2019.

[2] P. Hernandez-Leal, et al.: "A Survey of Learning in Multiagent Environments: Dealing with Non-Stationarity", arXiv preprint arXiv:1707.09183, 2017.

[3] F. Lezama, et al.: "Local Energy Markets: Paving the Path Towards Fully Transactive Energy Systems", IEEE Transactions on Power Systems, pages 1–8, 2018.

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Coastal Ocean Modelling: Uncertainty Representation and Forecast

by Arthur Vidard (Inria)

Ocean model developers from Inria teams, together with external partners from Shom, Brgm and Ifremer, are coming together to develop and improve ocean modelling capabilities from regional to nearshore.

The ocean plays a major role in global climate change; first, by acting as a moderator by absorbing around 30% of the excess anthropogenic carbon dioxide and more than 90% of the resulting additional energy. Second, this in turn dramatically affects ecosystems (through effects such as ocean acidification and temperature rises) and can create or aggravate severe weather conditions (e.g., hurricanes and coastal floods). This is particularly true for coastal areas directly threatened by such events and by sea level rises, and where about 60% of the world's population lives.

Many human activities and associated problems, such as food production, trade, public safety and pollution, are directly linked to the ocean. Understanding and predicting complex phenomena at various scales (regional, coastal, littoral) is therefore of utmost importance. For models of these phenomena to function as analysis tools for policy makers, they also need to provide a measure of their associated uncertainties.

In this context, the SURF project [L1] aims to develop several solutions for ocean coastal modelling with significantly different approaches, both in terms of system of equations and discretization schemes. Purely from a modelling point of view there exist three main approaches: a fully depth-averaged PDE stand point in which all small scale effects are modelled; multi-layer approximations also based on some form of averaging/projection; full/direct discretization of primitive PDEs (full non-linear potential, Euler, or RANS) with another method.

Inria teams are contributing to a variety of such models. In particular, members of SURF are involved in: Croco, a community primitive equation model on structured grid; Uhaina, a Green-Naghdi-based unstructured near-shore wave model; Freshkiss3d, a finite volume code for the simulation of the 3D hydrostatic and incompressible Navier-Stokes equations; and SW2D, a finite volume, unstructured mesh shallow water. Different models work better in particular situations, depending on the geographic location and physical regime, and models need to be chosen accordingly.

Figure 1: Target application: multiscale simulation around Gâvres Presque-isle. Different models will be valid on these different domains (courtesy BRGM).

By definition, models only partially represent reality and there are many sources of uncertainty. The common thread of SURF is the estimation, propagation, reduction and representation of uncertainties in coastal ocean modelling. It is possible to artificially distinguish two types uncertainties: epistemic uncertainties that are coming from approximations, unknown parameters or lack of physical knowledge, and random uncertainties coming from inherent variability of the system or external sources of uncertainties. Typically, the latter can be unresolved physical processes due to discretization (sub-grid scale processes) or uncertainties about external forcing, for instance. The former category can be related to crucial poorly known numerical or physical parameters of the model. We are addressing both types of uncertainty, either by estimating or reducing them. Additionally, satellite measurements are reaching a spatial resolution that is potentially finer than those of the current oceanic computational simulation capabilities. Even though they only measure part of the system (one quantity, at the surface only), this is a great opportunity to qualify our coupling of models and quantify and reduce uncertainties.

Within this framework, three research axes are being developed:

Model coupling

A simple way to combine different models is a pure statistical combination of part of their output. The difficulty here lies in the fact that the different model, despite being linked through mathematical properties, may not represent the same part of the reality. The other possibility is to mathematically couple the equation systems on respective areas of validity (different boxes in

figure 1, [1]), but going beyond domain decomposition, with possibly moving boundaries and ensuring conservative properties wherever it proves feasible. The main outcome is to devise an optimal strategy for further developments for coastal ocean modelling at Inria, from regional to nearshore.

Uncertainty reduction and numerical schemes

Ocean models are built on a combination of numerical schemes and choices of physical terms. The variety of available models in SURF makes it possible to understand the relative strengths and weaknesses of these combinations, and this could enable more appropriate choices to be designed. Moreover, some specific issues like how to best discretize vertically or how to properly deal with moving boundaries are still open questions [2].

Uncertainty propagation

A numerical forecast is most useful if associated to a measure of its uncertainties. This is commonly achieved using an ensemble of forecasts representing the range of possible future states. The key is to well represent this range. Inria recently developed a way to represent uncertainties associated to unresolved processes (processes that live at smaller scales than the discretization grid) through stochastic modelling. It is more consistent with the approximation actually made but requires the stochastic process at an early stage of the equations' derivation [3]. Within SURF, we first develop and validate this approach for our hierarchy of models and second use the same approach to describe the uncertainties associated to ocean atmosphere coupling processes.

With the multitude of scientific questions it raises, SURF is an ambitious research project that requires the mobilisation of varied skills and thus involves complementary Inria teams. Airsea (in Grenoble) will contribute its expertise on oceanic modelling and the coupling of models at very different spatial and temporal scales. Cardamom (in Bordeaux) will complete the numerical methods and the associated uncertainties for the models. Ange in Paris and Lemon in Sophia will be asked to model coastal flows in shallow waters, or on the coupling between ocean and river models. Fluminance (in Rennes) will develop statistical image processing techniques to supply the sub-mesh models. Finally, Defi in Saclay and Mingus in Rennes will contribute theoretical skills on the quantification of uncertainties and partial differential equations, respectively.

During the four years of the project, the Inria teams will also collaborate with experts from the Bureau of Geological and Mining Research (BRGM), the Hydrographic Service of the Navy (SHOM) and IFREMER on both coastal security issues and the development and validation of the models.

Link:

[L1] https://project.inria.fr/surf/

References:

[1] M. Tayachi, et al.: "Design and analysis of a Schwarz coupling method for a dimensionally heterogeneous problem", Int. Journal for Numerical Methods in Fluids, Wiley, 2014, 75 (6).

[2] T. Song, et al.: "The shifted boundary method for hyperbolic systems: Embedded domain computations of linear waves and shallow water flows", Journal of Computational Physics, 369, 2018

[3] V. Resseguier, E. Mémin, B. Chapron: "Geophysical flows under location uncertainty", Part I, II & III, Geophysical and Astrophysical Fluid Dynamics, 111 (3), pp.149-176, 2017.

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Tackling the Multiscale Challenge of Climate Modelling

by Daan Crommelin (CWI; Korteweg-de Vries Institute for Mathematics, University of Amsterdam), Wouter Edeling (CWI) and Fredrik Jansson (CWI)

The atmosphere and oceans are key components of the climate system, each involving a wide range of space and time scales. Resolving all relevant scales in numerical simulations with atmosphere/ocean models is computationally not feasible. At CWI, we are tackling this longstanding multiscale challenge by developing new algorithms, including data-based and stochastic methods, to represent small, unresolved scales.

Simulating the climate system on a computer presents a formidable challenge. A major difficulty is the multiscale nature of the key components of the climate system - the atmosphere and oceans. They possess physical and dynamic processes that occur across a range of spatial and temporal scales. Some aspects of the global atmospheric circulation operate at the planetary scale, in the order of 10^4 km, yet it is also significantly affected by atmospheric convection and cloud formation, processes taking place at scales of order 10-100 m. Similarly disparate scales play a role in oceanic circulation.

Resolving all these scales at once in numerical simulation is computationally unfeasible. Therefore, global models employ simplified representations, or "parameterizations" of the effect that the unresolved processes have on the resolved-scale processes. Formulating such parameterizations is difficult, and the limitations of common, existing methods of doing so are well-known. The uncertainties and errors of parameterizations are a major source of uncertainty in climate change

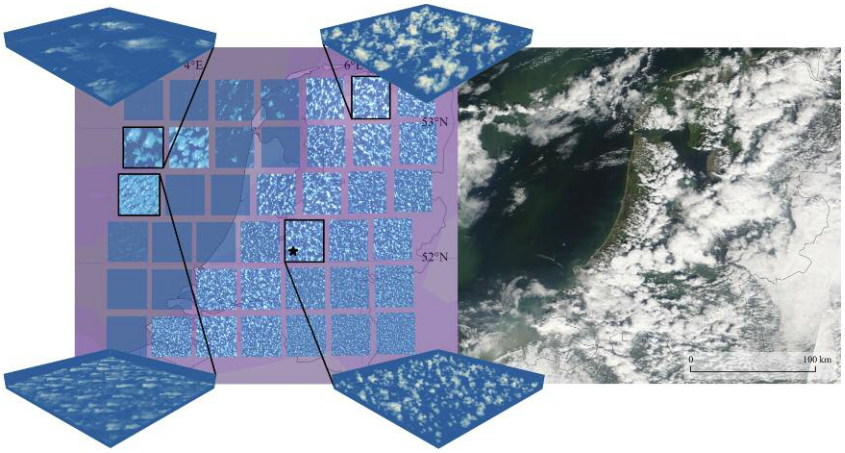

Figure 1: Superparameterized weather simulation over the Netherlands, compared to a satellite image from Terra/MODIS. Each blue tile represents one local, cloud-resolving model, connected to a global model (shown as the purple background). From ref. [1].

simulations (e.g., through uncertainties in the cloud-climate feedback); see also [1] for more background information and references.

New methods and approaches for parameterization are vital. In the Scientific Computing group at CWI, we are working on this topic along two related research lines. One is focused on superparameterization, a computational approach to multiscale modelling and simulation of atmosphere and ocean, in which high-resolution local models (i.e., which cover a small area) are nested in the model columns (vertically stacked numerical discretization boxes) of a coarse-resolution global model that covers the entire earth. Importantly, it concerns a two-way nesting, in which the global model state drives the local models while the local models also feed back onto the global model. It effectively replaces traditional parameterizations based on physical insights and intuition by a computational model based on first principles.

Superparameterization is computationally very expensive, as in principle it would involve high-resolution local models that collectively cover the entire earth (one local model nested within each global model column). The set-up is very well suited for massive parallelization, because the local models do not directly interact with each other; only with the global model. Notwithstanding, it is still much too expensive run roughly 10^5 local models in parallel, each with a horizontal domain of, say, 25 km x 25 km and grid resolution of 50 m so that they can resolve atmospheric convection and cloud formation explicitly. To reduce computational costs, previous superparameterization studies have reduced either the grid resolution or the domain size of the local models. In a joint project between CWI, the Netherlands eScience Center and Delft University of Technology, we have taken a different approach and developed a method in which the local models are only nested in a selected geographical region [1]. The selection is flexible and made by the user, based on factors such as research interest and available computational resources. Outside the selected region, traditional parameterizations are used.

Comparing results from simulations with and without superparameterization, clear differences were observed in the height and vertical extent of the cloud layers. Using superparameterization resulted in higher clouds, in good agreement with ground-based LIDAR observations. Figure 1 (reproduced from [1]) shows a snapshot of the modelled cloud fields over the Netherlands next to a satellite image.

In another research line at CWI, we are developing methods to train a data-based parametrization scheme using data from high-resolution models, such as the local models used in superparameterization, or from observations. By inferring or training parameterizations from such data one can circumvent ad-hoc physical assumptions for formulating parameterizations while also avoiding running high-resolution models for the entire duration of climate simulations (although clearly, a certain amount of computational effort is needed to generate the training data, unless these can be obtained from observations).

Our focus is on data-based methods for stochastic parameterization. The feedback from unresolved scales is intrinsically uncertain (e.g., because of chaotic dynamics) and this uncertainty can be represented with stochastic methods for parameterization [2,3]. In [2], we explored several methods to parameterize unresolved scales with stochastic models trained from data. The methods were tested on a multiscale test model (the Kac-Zwanzig heat bath model) that has its origins outside the climate domain yet forms a suitable test bed. One approach, making use of data resampling (or bootstrapping) for parameterization, was shown to be particularly effective.

Building on the results from [2], we use the resampling approach for parameterizing subgrid scales in a simple ocean model in [3], with positive results. The data-driven parameterization approach can be viewed as a methodology for surrogate modelling, as the parameterization is meant to replace (i.e., serve as a surrogate of) the expensive high-resolution model that generated the data. Stochastic (as opposed to deterministic) methods for surrogate modelling have not been explored much to date; our resampling approach is such a stochastic surrogate modelling method. We are currently making this approach part of the software toolkit VECMAtk, under development in the EU H2020 project VECMA (Verified Exascale Computing for Multiscale Applications). Furthermore, we are strengthening our methods by using machine learning methods to build stochastic surrogates with wider capacity.

This research was supported by the Netherlands eScience Center, by the Dutch Research Council (NWO) through the Vidi project “Stochastic models for unresolved scales in geo-

physical flows" and by the European Union Horizon 2020 Research and Innovation Programme under grant agreement #800925 (VECMA project). Furthermore, we acknowledge the use of ECMWF's computing and archive facilities.

Links:
https://kwz.me/hSQ
https://www.vecma.eu/

References:
[1] F. Jansson et al.: "Regional super-parameterization in a global circulation model using Large Eddy Simulations", JAMES, Vol. 11 (2019), 2958-2979.
[2] N. Verheul, D. Crommelin: "Data-driven stochastic representations of unresolved features in multiscale models", Comm. Math. Sci, Vol. 14 (2016), 1213 – 1236.
[3] W. Edeling, D. Crommelin: "Towards data-driven dynamics surrogate models for ocean flow", in: Proc. of PASC 2019, ACM.

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A State of the Art Technology in Large Scale Underwater Monitoring

by Gaia Pavoni, Massimiliano Corsini and Paolo Cignoni (ISTI-CNR)

In recent decades, benthic populations have been subjected to recurrent episodes of mass mortality. These events have been blamed in part on declining water quality and elevated water temperatures (see Figure 1) correlated to global climate change. Ecosystems are enhanced by the presence of species with three-dimensional growth. The study of the growth, resilience, and recovery capability of those species provides valuable information on the conservation status of entire habitats. We discuss here a state-of-the art solution to speed up the monitoring of benthic population through the automatic or assisted analysis of underwater visual data.

Ecological monitoring provides essential information to analyse and understand the current condition and persisting trends of marine habitats, to quantify the impacts of bounded and extensive events, and to assess the resilience of animal and plant species.

The underwater world is a hostile working environment for humans, with researchers' activities being limited in time and space. Large-scale exploration requires underwater vehicles. The use of autonomous data-driven robotics for acquiring underwater image data is making large-scale underwater imaging increasingly popular. Nevertheless, video and image sequences are a trustworthy source of knowledge doomed to remain partially unexploited. A recent study [1] reported that just 1-2% of the millions of underwater images acquired each year on coral reefs by the National Oceanic and Atmosphere Administration (NOAA) are later analysed by experts. Automated solutions could help overcome this bottleneck.

Underwater photogrammetry represents a useful technology for obtaining reliable measurements and monitoring benthic populations at different spatial scales. Detecting temporal variations in both biotic and abiotic space holders is a challenging task, demanding a high degree of accuracy and fine-scale resolution. The detailed optical spatial-temporal analysis involves the acquisition of a massive stream of data. Evaluating changes in the benthos at a scale reflective of the growth and dissolution rates of its constituents requires a pixel-wise classification. This task, called semantic segmentation, is highly labor-intensive when conducted manually. Current manual workflows generate highly accurate and precise segmentation for fine-scale colony mapping but they demand about one hour per square metre.

The automatic extraction of information can contribute enormously to environmental monitoring efforts and, more generally, to our understanding of climate change. This operation can be performed automatically by using Convolutional Neural Networks (CNNs). Nevertheless, the automatic semantic segmentation of benthic communities remains a challenging task owing to the complexity and high intra-specific morphological variability of benthic organisms, as well as by the numerous artefacts related to the underwater image formation process.

In our work, we propose to carry out the classification and the outlining of species from seabed ortho-mosaics. From a machine learning perspective, ortho-mosaics displays a reduced variance of distinctive class features, simplifying the task of automatic classification.

While fully automated semantic segmentation can significantly reduce the amount of processing time, current state-of-the-art solutions still lack the accuracy provided by human experts. Besides, the automation of such specific processes requires specific tools to prepare the data and provide control over the results. So, we propose a human-in-the-loop approach in which a skilled operator and supervised learning neural networks cooperate through a user-friendly interface to achieve the required degree of accuracy. This can be seen as an interactive segmentation cycle for the automatic analysis of benthic communities: intelligent tools assist users in the labelling of large-scale training datasets. Exploiting these data, CNNs are trained to classify coral species, and predictions inferred in new areas. In the evaluation of predictions, the human operator intervenes again to correct both ML-based and human annotation errors. This maximises accuracy when it comes to extracting demo-

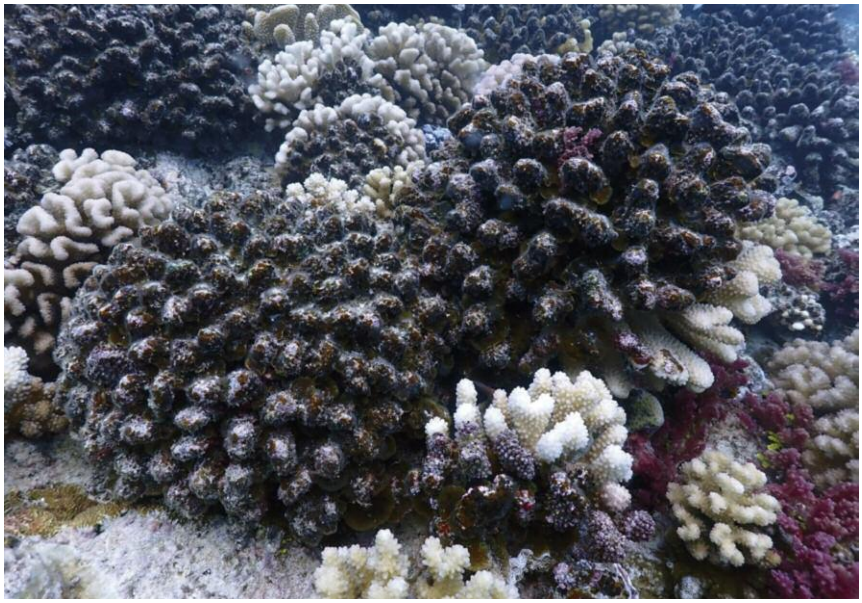

Figure 1: Spring-2019 Coral Bleaching event in Moorea Dead (Pocillopora) colonies have been covered by algae. Source: Berkeley Institute of Data Science [L3].

graphic statistics and creating new datasets to train more performing networks. For this goal, we have developed a custom software tool: TagLab (see Figure 2).

TagLab is an AI-powered configurable annotation tool designed to speed up human labelling of large maps. TagLab dramatically reduces the dataset's preparation time and brings the accuracy of CNN's segmentation up to a domain expert level. Following the human-computer interaction paradigm, this software integrates a hybrid approach based on multiple degrees of automation. Assisted labelling is supported by CNN-based networks specially trained for agnostic (relative only to object partition) or semantic (also related to species) segmentation of corals. An intuitive graphical user interface (GUI) speeds up the human editing of uncertain predictions, increasing the overall accuracy. More precisely, TagLab integrates:

- Fully-automatic per-pixel classifiers based on the fine-tuning of the semantic segmentation network Deeplab V3+ [3];
- A semi-automatic interactive per-pixel classifier to perform the agnostic segmentation following the extreme clicking approach of Deep Extreme Cut [2].
- A Refinement algorithm to quickly adjust the labelling of colonies contours.
- Manual annotation tools to edit the per-pixel predictions. This allows makes it possible to reach a level of accuracy not achievable through standard machine learning methods alone.

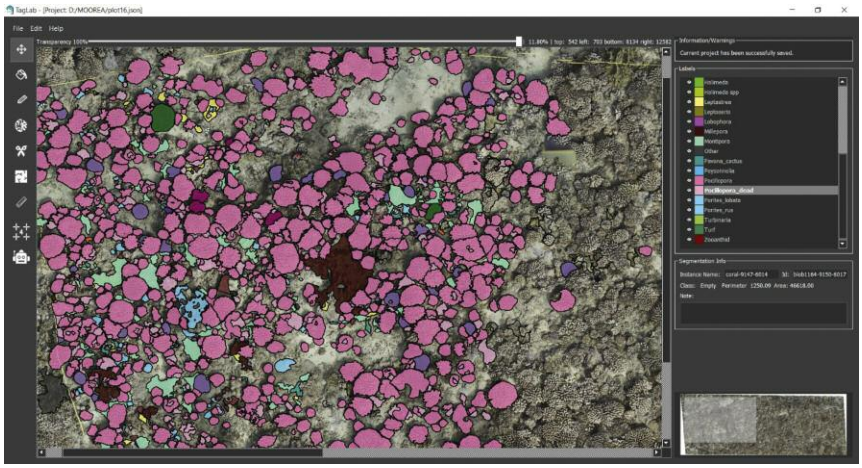

Figure 2: TagLab – an interactive semi-automatic tool for semantic segmentation and annotations of coral reef otho-mosaics.

At the end of the process, TagLab outputs annotated maps, statistics, as well as new training datasets. Besides, multiple projects can be managed for the multi-temporal comparison of labels. Resuming, Taglab provides dataset preparation, data analysis, and validations of predictions, in an integrated way. Different, separated, software applications usually perform most of these processing steps.

TagLab has been successfully adopted by important long term monitoring programs: the 100 Island Challenge [L2] headed by the Scripps Institution of Oceanography (UC, SAN DIEGO) and the Moorea Island Digital Ecosystem Avatar headed by ETH Zurich and the Marine Science Institute (UC Santa Barbara) [L3].

Links:

[L1] https://kwz.me/h4n
[L2] http://100islandchallenge.org/
[L3] https://kwz.me/h4N

References:

[1] O. Beijbom, et al.: "Improving Automated Annotation of Benthic Survey Images Using Wide-band Fluorescence". Scientific Reports, 201.
[2] K. K. Maninis, et al.: "Deep Extreme Cut: From Extreme Points to Object Segmentation", Computer Vision and Pattern Recognition (CVPR), 2018.
[3] L. Chen ,et al.: "Encoder-Decoder with Atrous Separable Convolution for Semantic Image", European Conference on Computer Vision, (ECCV), 2018.

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Biogas Residues in the Battle for Terrestrial Carbon Sequestration

by Bella Tsachidou, Christophe Hissler (Luxembourg Institute of Science and Technology) and Philippe Delfosse (University of Luxembourg)

A team from the Environmental Research and Innovation Department of the Luxembourg Institute of Science and Technology (LIST) is investigating the contribution of biogas residues (BRs) to climate change mitigation through carbon sequestration in agricultural soils.

Climate change is one of the most complex global problems faced by humanity. There are two main approaches to mitigate climate change: (i) to reduce the sources of greenhouse gases (GHGs) and (ii) to sequester GHGs; i.e., to enhance the pools that have the capacity to accumulate and store them. Anthropogenic activities, such as land use, excessive fertilisation and fossil fuel overuse, have altered the cycling and storage of carbon, leading to the depletion of terrestrial reservoirs over time. Therefore, carbon sequestration and its long-term storage in terrestrial ecosystems, including agricultural soils, is considered the most effective measure to reduce GHGs in the atmosphere [1] while improving soil quality and productivity.

The input of organic matter (OM) to agricultural soils has been a means of improving soil fertility and agronomic productivity since the dawn of civilisation, and the application of manure, agricultural residues and other organic waste on fields is still a common practice. Despite this, a large proportion of organic waste is still landfilled or at best composted. A more effective use of organic waste in agriculture, at a lower environmental cost and with multiple societal benefits, can be achieved via the process of anaerobic digestion. Biogas residues are the by-product of organic waste treated through anaerobic digestion, and their application on agricultural land has the potential to impel the agricultural sector towards sustainability and a circular economy. In addition to their demonstrated fertilising properties, biogas residues also have the potential to promote terrestrial carbon sequestration due to their high content of stable organic matter. Therefore, using biogas residues as biofertilizers could help combat climate change, both by offsetting greenhouse gas emissions inherent to the landfilling, composting or storage of organic wastes, and by increasing the size of soil carbon sinks.

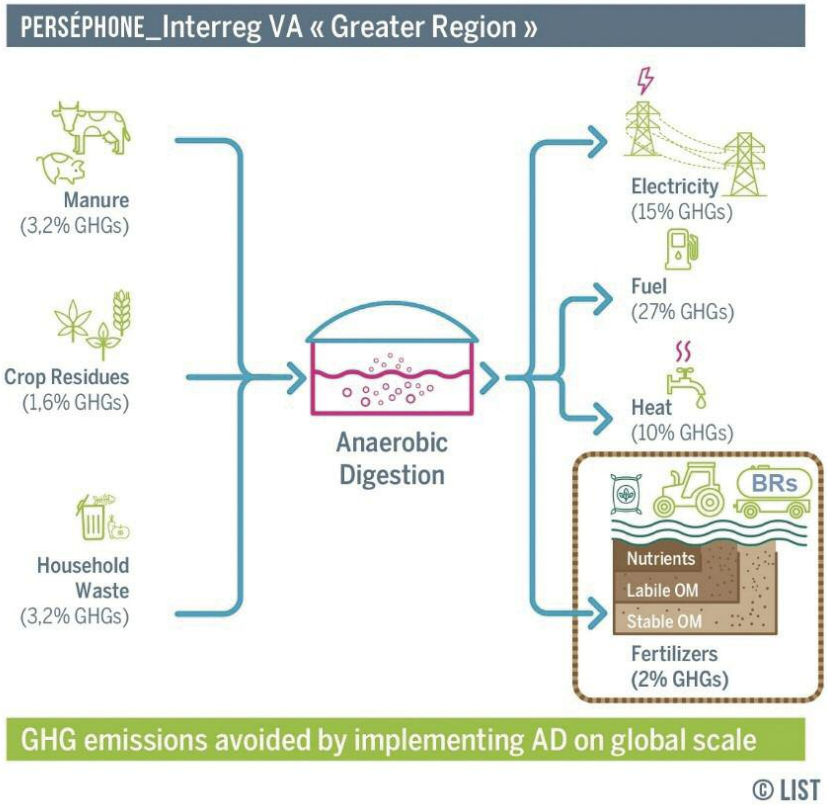

Figure 1: Implementation of anaerobic digestion on a global scale to mitigate climate change by reducing greenhouse gas emissions and enhancing storage of stable organic carbon in agricultural soils.

A novel field study within the framework of the PERSEPHONE project has been implemented at LIST to investigate the dual property of biogas residues as a valuable source of nutrients for plants and soil organisms, and as a wherewithal to boost carbon sequestration and storage in agricultural ecosystems. More specifically, as organic carbon sequestration potential is greater in grasslands than in arable land [2], we have conducted in situ experiments on permanent grasslands in the Greater Region aiming to understand the stability of biogas residues and, at the same time, assess the impact of different nitrogen sources on the decomposition capacity of the soils. Before biogas residues can replace chemical fertilisers on a large scale, it is essential to understand organic matter decomposition and stabilisation. Since biogas residues are rich in stable organic carbon, post-anaerobic digestion – particularly the use of their solid fraction – could constitute an integral component of this land-based solution to climate change.

To maximise the environmental benefits of biogas residues and to determine application strategies, we need to be able to estimate their decomposition rates and nutrient release. Furthermore, given the wide range of biotic and abiotic modulators involved in decomposition studies with an unpredictable impact on soil carbon storage and release, the generation of decomposi-

tion data could increase the predictive power of climate models and consequently facilitate climate-smart agriculture. Finally, it is important to demonstrate the potential of biogas residues to sequester stable organic carbon in agricultural soils not only for the sake of climate change mitigation, but also for agricultural productivity.

Implementing anaerobic digestion on a global scale and using biogas residues on agricultural land can fulfil several desiderata sought in sustainable agriculture and climate change mitigation strategies, including: organic waste management, offsetting greenhouse gas emissions, carbon sequestration, reduction of fossil fuel use, moderation of manufacture and application of synthetic fertilisers, soil health enhancement, and rural revenue (Figure 1). This approach can substantially benefit both ecosystem services and the economy by improving human health, food security and environmental remediation on a European and global level.

This study is being conducted in collaboration with the PERSEPHONE project partners within the framework of the Transfrontier Program for European Territorial Cooperation, and is co-financed by the European Union - European Regional Development Fund 2014-2020 INTERREG VA "Greater Region" and the Ministère de l'Environnement, du Climat et du Développement durable (MECDD) of Luxembourg.

References:

[1] I. P. Hartley, B. K. Singh: "Impact of Global Changes on Soil C Storage—Possible Mechanisms and Modeling Approaches," in Soil Carbon Storage, B. K. Singh, Ed. Elsevier, 2018, 245–279.

[2] R. Lal, W. Negassa, K. Lorenz: "Carbon sequestration in soil," Current Opinion in Environmental Sustainability, 2015.

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Circular Intelligence: Digital Services to Facilitate Industrial Symbiosis

by Theodore Dalamagas, Antonis Kokossis and Thanasis Gentimis (SymbioLabs)

SymbioLabs is working on the innovative concept of circular intelligence. Circular intelligence involves the application of business intelligence and big data technologies to drive profitable business actions in the circular economy. We provide digital solutions to collect and analyse data related to industrial facilities, waste production and supply chain economics, and detect geographic areas and industrial sectors to establish collaborative partnerships (networks of industrial symbiosis) to exchange materials, waste and energy for economic, environmental and social benefit.

The circular economy is an economic model that aims to retain the highest value and utility of products, components and materials at all time, based on sharing, reusing, repairing and recycling practices. It is an essential element to develop a sustainable, low carbon, resource-efficient and competitive economy in the face of increasing pressure for production and consumption, but with respect to the environment and the finite nature of natural resources. The circular economy mimimizes waste and encourages waste valorisation to extract secondary raw materials that can replace virgin materials in production processes. Circularity is an essential part of a wider transformation of industry towards climate-neutrality and long-term competitiveness. It can deliver substantial material savings throughout value chains and production processes, generate extra value and unlock economic opportunities. EC's Circular Economy Action Plan [L1] is one the main blocks of the recently published European Green Deal, Europe's new agenda for sustainable growth.

Digital technologies hold great potential for advancing the circular economy. SymbioLabs is working on the innovative concept of circular intelligence. Circular intelligence involves the application of business intelligence (BI) and big data technologies to drive profitable business actions in the circular economy. It is a suite of software and services to transform data into actionable intelligence and knowledge, supporting the creation of data value chains for the circular economy in several sectors: smart waste management and valorisation, energy efficiency, industrial symbiosis facilitation, and logistics optimisation for raw materials, waste and by-products.

Enabling the shift of heavy industry and production towards the circular economy presents a challenge. Industrial symbiosis (IS) [1] has been recognised as a key driving force to address this challenge and realise the circular economy. IS is an innovative approach to establish industrial collaborative partnerships (networks), exchanging materials and energy for economic, environmental and social benefit. In IS industrial networks, waste or by-products of one industry become the raw materials for another, allowing materials to be used in a more sustainable way.

Developing IS networks is a knowledge-intensive practice, where information is necessary to discover the potential of symbiotic connections between industrial material and energy flows. Therefore, the efficiency of digital solutions to support the facilitation of IS depends heavily on collecting, analysing and integrating highly diverse quantitative and qualitative data related to industrial material and energy flows.

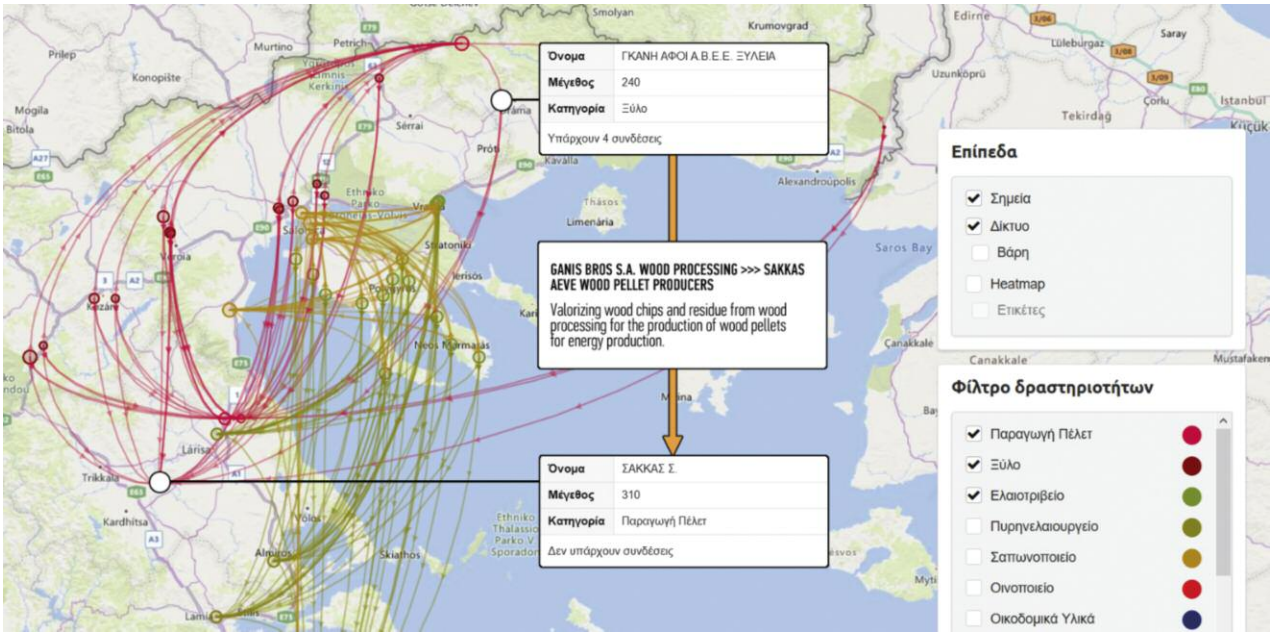

Figure 1: Detecting potential symbiotic links in North and Central Greece.

In SymbioLabs [L2], we use a data-driven approach for the facilitation of IS. We are developing a digital platform to collect and analyse datasets relating to industrial facilities, regional waste production and supply chain economics with the aim to detect and visualise geographic areas and industrial sectors with high IS potential. Key datasets collected and imported in the platform are: (i) location and activity data of industrial facilities (e.g., location, magnitude, industrial NACE codes), (ii) input/output flow data of industrial facilities (e.g., based on life cycle inventory (LCI) data), (iii) waste production data (e.g., national statistical data), and (iv) data describing possible material/fuel substitutions (e.g., curated list of wastes that can replace raw materials in input flows).

By processing and analysing these datasets, we are able to detect potential symbiotic connections, i.e., potential exchanges of waste and raw materials among industrial facilities in a geographical region. Each symbiotic connection is weighted based on the distance between the industrial facilities (transport cost), the facility magnitude and the savings from the suggested exchange. Results are visualised on a map, indicating potential symbiotic conections and "hot spots" of IS regional synergies among industries.

We have already used our platform to detect potential symbiotic connections in various regions in Northern and Central Greece. Figure 1 shows the potential symbiotic links we detected (presented as arrows) among industrial facilities that produce pellet (in Greek: Παραγωγή Πέλετ), process wood (in Greek: Ξύλο) as well as olive oil mills (in Greek: Ελαιοτριβείο). These symbiotic links are detected based on the analysis of data relating to each industrial facility (e.g., waste production, production capacity, distance from other facilities). For example, wood processing facilities have a symbiotic potential with wood pellet production facilities, based on the fact that wood residue can be used for the production of wood pellets. In this sense, the wood processing company GANIS BROS SA (in Greek: ΓΚΑΝΗ ΑΦΟΙ ΑΒΕΕ ΞΥΛΕΙΑ), located in the city of Drama, has four detected symbiotic connections, one of which is with SAKKAS AEVE (in Greek: ΣΑΚΚΑΣ Σ), a pellet producing company in Central Greece.

About SymbioLabs

We build innovative digital solutions to support industries and policy makers in their transition to the circular economy model. We develop and provide digital tools and services for data analytics on material/resource data collections, decision support for waste valorisation, support a nd maintenance of industrial symbiosis networks, waste and by-product supply chain optimisation, and environmental footprint reduction.

Founded in 2019, we are a spinoff company of ATHENA Research Center [L3] with leading expertise in big data analytics, knowledge engineering and machine learning.

Links:

[L1] https://kwz.me/h4e
[L2] https://www.symbiolabs.gr/
[L3] http://www.athenarc.gr/

Reference:

[1] Cooperation fostering industrial symbiosis: Market potential, good practice and policy actions, EU Publications, 2018.

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Smart Water Distribution Networks to Reduce Water Loss

by George Tzagkarakis (FORTH-ICS), Maria N. Anastasiadou and Demetrios G. Eliades (KIOS, University of Cyprus)

"Lost water" in drinking water distribution systems is the water that enters the distribution network but never reaches the consumer, owing either to leakages or because it is not metered by the water utilities. SmartWater2020 is a research project that is working to develop a smart platform for real-time condition monitoring and autonomous pressure control in urban distribution networks, with the goal of reducing telemetry costs and water losses.

Drinking water supplies face pressing issues, particularly in island regions, where climate change, water scarcity, pollution and the high cost of desalination are putting pressure on water distribution organisations. At the same time, 15-25% of the drinking water produced is lost via invisible leakages, which represent a main contributor to non-revenue water. From an economic perspective, the cost of lost water worldwide, due to leakages, metering errors and non-billed consumption, is about US$15 billion annually. In developing countries, more than 45 million m3 of treated water is lost due to leakages each day. The challenge for water utility companies is to save resources, thus improving water sustainability. Innovative monitoring and control technologies to reduce water loss can help achieve this.

The SmartWater2020 project [L1], funded by the INTERREG V-A "Greece-Cyprus 2014-2020" Cooperation Programme, focuses on developing smart technologies to support water utilities in the islands of Crete (Greece) and Cyprus. The goal is to significantly reduce water losses by improving condition monitoring and control of their water distribution networks. The project's activities span four major axes: (i) installing innovative technologies, including pressure and quality sensors, autonomous smart meters and pressure reduction valve controllers, in households and water supply networks; (ii) optimal deployment of the communication infrastructure (IoT, LoRaWAN) by accounting for the hardware's specifications, the terrain's characteristics, and the buildings' position and height; (iii) modelling water distribution networks based on the EPANET platform for generating artificial data and simulating "what-if" scenarios; and (iv) developing smart algorithms for telemetry cost reduction, early warning of leakage events and water quality issues, automatic pressure control, and data visualisation.

Commercial sensing, metering and telecommunications hardware is utilised, according to the specific needs of the involved water utilities. A software tool has been designed in-house (FORTH-ICS), which employs the sensors' specifications along with the geography and urban layout of the monitored area, and calculates the optimal locations for deploying the sensing and communication infrastructure to guarantee full and robust coverage of the monitored area (ref. Fig. 1). Furthermore, it is critical for water utilities to be capable of simulating "what-if" scenarios, in order to predict the effects of specific actions undertaken by the network operators, or to examine the influence of abnormal events. To this end, a software tool is provided by KIOS-University of Cyprus, based on EPANET, for modelling hydraulic and quality dynamics of a water distribution system (ref. Fig. 2). In addition, the Leakage Diagnosis Benchmark (LeakDB) [L2], developed by the team of KIOS-University of Cyprus, is a free tool for generating realistic leakage datasets from different water distribution networks under varying conditions.

At the core of the SmartWater2020 platform (ref. Fig. 2) is the high-level data analysis and visualization engine developed jointly by FORTH-ICS and KIOS-University of Cyprus. First, motivated by the need to reduce telemetry costs for the water utilities, an efficient data compression method has been developed based on the theory of compressive sensing (CS) [1]. CS enables simultaneous data acquisition and lightweight compression, thus reducing transmission costs by putting the computational burden to the side of the control room, where increased computational resources are available. Having received the recorded data in the control room, the SmartWater2020 platform supports a set of high-level analysis

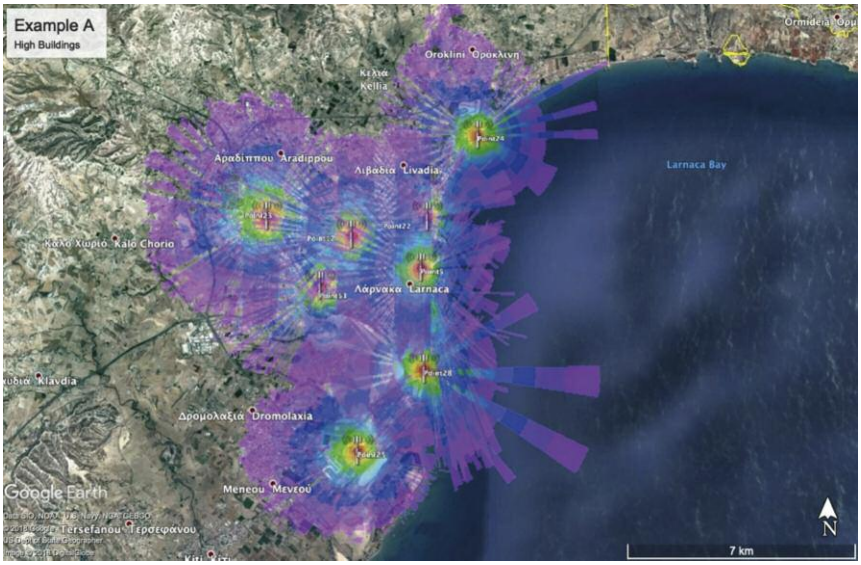

Figure 1: Optimal antennas' deployment in the city of Larnaca based on the LoRaWAN technology.

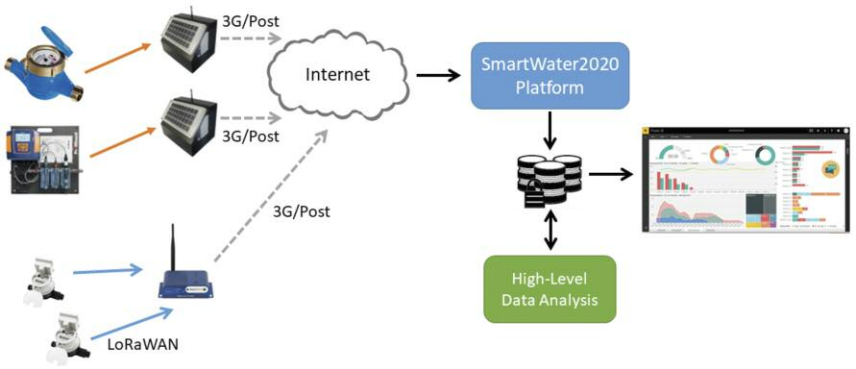

Figure 2: The SmartWater2020 platform architecture.

functionalities. These include: (a) recovery of missing values due to sensors or network malfunction; (b) real-time correlation monitoring of the received data streams to reveal hidden interdependencies among the sensors; (c) early warning for abnormal events by combining the recorded data with hydraulic models [2], along with advanced algorithms for the uncertainty-aware localization of leakages; (d) estimation of water quality conditions in areas which are not monitored by sensors (in the case of unobserved contamination events, the platform supports the utilization of an Active Contamination Detection scheme [3], which facilitates the detection and isolation of the contamination propagation path and its possible source through valve control); and (e) reduction of background leakages through pressure control, by jointly solving an optimization and control problem for deciding the most appropriate valve settings in order to reduce the overall and worst-case pressures within the metered areas. Finally, the recorded data, along with the high-level analysis outcomes are visualized in a versatile, yet user-friendly, interface designed in-house in close collaboration with the participating water utilities in order to fit perfectly their needs.

Links:
[L1] https://www.smartwater2020.eu
[L2] https://kwz.me/h4T

References:
[1] G. Tzagkarakis, J. P. Nolan, and P. Tsakalides: "Compressive sensing using symmetric alpha-stable distributions for robust sparse signal reconstruction," IEEE Trans. on Signal Process., 67(3), pp. 808-820, 2019.
[2] S. G. Vrachimis, D. G. Eliades and M. M. Polycarpou: "Leak detection in water distribution systems using hydraulic interval state estimation," in Proc. IEEE CCTA, 2018.
[3] S. G. Vrachimis, et al.:"Active contamination detection in water-distribution systems," J. Water Resources Planning & Management, 146(4), 2020.

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Analysis of Extreme Climatic Indexes over Greece for the Period 1979 - 2019

by Athanasios Karavoulias and Athanassios A. Argiriou

A study analysing World Meteorological Organization (WMO) extreme climatic indexes in Greece for the period 1979-2019 to better understand the impact and the significance of extreme phenomena on the environment and humans.

Climatic extremes can have major impacts on ecosystems and urban areas. Extremes in temperature have significant effects on agriculture, forestry, industry and tourism, and can lead to huge financial loses and most importantly to loss of human life. For this reason, it is crucial to better understand these phenomena and their trends so that we can design mitigation measures and avoid future disasters. This study focuses on the trends of extreme climatic indices, and their impact on humans, in Greece over the last 40 years.

Fifteen climate indexes were examined, associated with minimum and maximum daily temperature and daily precipitation. The three indices that have greatest impact in urban areas are: the TX95, which is the annual percentage of days when the maximum temperature is above the 95th percentile; the TXX which is the monthly maximum of daily maximum temperatures; and the SU, which represents the "summer days" , or annual number of days when the maximum temperature exceeds 25º C. The indices were calculated using hourly air temperature at 2 m height for the period 1979 to 2019. The data were sourced from the ERA 5 reanalysis database [L1]. The results are presented in contour maps depicting the average value of each index during seven sub-periods and then we calculated their trends for the three largest Greek cities, namely Athens, Thessaloniki and Patras.

TX95

The TX95 index shows a clear increase over time, as shown in Figure 1, especially in the continental region, with spikes over major urban areas like Athens. This indicates that warm days are becoming common and phenomena

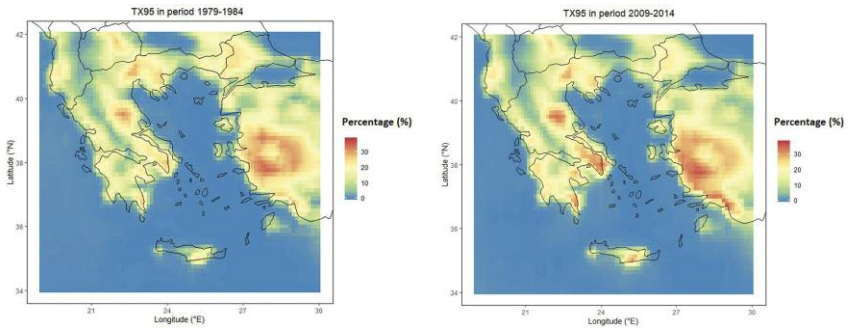

Figure 1: The average value of the TX95 index in Greece for the periods 1979-1984 and 2009-2014 with an obvious increase in later years and big cities demonstrating a rise in the number of days when the temperature exceeds the 95th threshold.

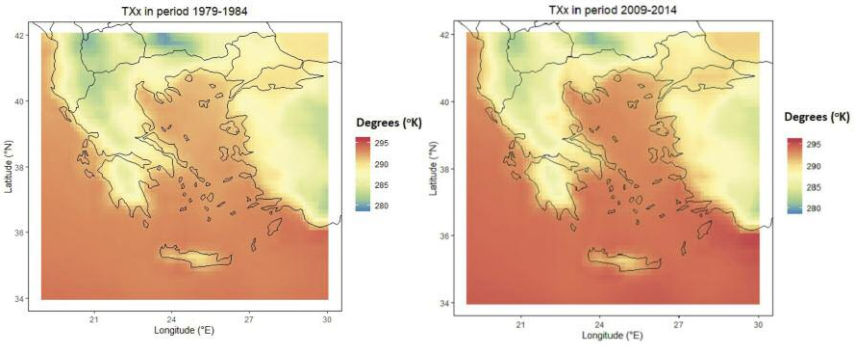

Figure 2: The average value of the TXX index during the periods 1979-1984 and 2009-2014. A slight increase can be observed over the years with coastal areas suffering the most.

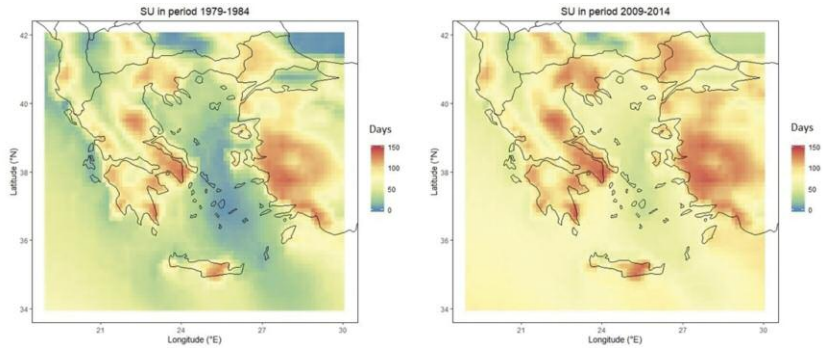

Figure 3: The average annual number of "summer days" in Greece for the periods 1979-1984 and 2009-2014. Peaks over the major cities are getting more intense and there is a dramatic increase in coastal areas.

like heatwaves are more likely to occur [3]. The trend of the TX95 index is positive in the three cities.

TXX

The TXX shows a slow constant rise over the years with coastal and highly dense urban areas like Athens and Thessaloniki having the highest values (Figure 2). The increase of the TXX index indicates that there is a trend towards higher maximum temperatures that results in an increased energy demand [2]. This is further supported by the trend of the TXX index in each city, which is positive for all of them with the highest occurring in Thessaloniki.

SU

The SU index counts the annual number of days when the maximum temperature is above 25º C, a phenomenon that has increased dramatically over time (Figure 3). Every part of Greece now experiences more hot days when compared to the past, with the highest number of them occurring over large urban areas. Additionally, when we examine the trend of the SU index in both Athens and Thessaloniki we see a high positive value, results that agree with the findings of the contour maps.

Urban areas usually experience higher temperatures compared to their rural surroundings; a phenomenon described as urban heat island (UHI), caused by human activities [2]. UHI further amplifies the trend of the climate extreme indices, resulting in higher values in urban areas.

The above results indicate that Greece has a trend towards a warmer more tropical climate. The extreme indices we studied show a positive trend in every city, suggesting that there is a tendency towards a warmer environment. Furthermore, it is almost certain that there is a correlation behind this shift towards a warmer climate with human activities, something that is supported by the fact that when studying the contour maps of indices like SU and TX95 show much higher values and peaks over large cities when compared to surrounding areas.

In conclusion, there is no doubt that the climate in Greece is suffering a dramatic change with temperatures reaching even higher values and extreme phenomena getting more frequent and more severe. For this reason, it is crucial to monitor climate change constantly and seriously in order to prevent any more calamities and losses.

Link:

[L1] https://www.ecmwf.int/

References:

[1] A. Mamara, et al.: "High Resolution Air Temperature Climatology for Greece for the Period 1971–2000", 2016.

[2] S. Magli, C. Lodi, L. Lombroso: "Analysis of the urban heat island effects on building energy consumption", 2015.

[3] S. Feron, R. R. Cordero, A. Damiani: "Observations and Projections of Heat Waves in South America", 2019.

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Fostering Smart Cities based on an Enterprise Architecture Approach

by Bokolo Anthony Jnr. (NTNU), Sobah Abbas Petersen (NTNU) and Markus Helfert (Maynooth University)

The concept of smart cities means using data and information communication technology (ICT) to manage a city's resources to create a sustainable environment, benefit the economy and improve quality of life. Unfortunately, the rapid population increase in urban areas has reduced the quality of life for many city-dwellers. Therefore, in the Positive Energy Exchange (+CityxChange) project [L1], we have adopted an enterprise architecture framework to support sustainable smart cities.

The +CityxChange project [L1] is designing an Enterprise Architecture Framework (EAF) to provide data-centric integrated and interconnected smart services. The goal of this collaboration between several organisations is to develop "positive energy blocks"—or areas that can collectively produce more energy than they consume.

The research aims to develop an overall ICT architecture and service-based ecosystem to ensure that service providers of the +CityxChange project can develop, deploy and test their services through integrated and interconnected approaches [1]. For the purpose of this research, a city can be seen as a big enterprise with different departments [2]. With its ability to model the complexities of the real world in a practical way and to help users plan, design, document, and communicate IT and business-oriented issues, the Enterprise Architecture (EA) method has become a popular domain for business and IT system management. The decision support that it offers [3] makes EA an ideal approach for sustainable smart cities, and it is being increasingly used in smart city projects. This approach allows functional components to be shared and reused and infrastructure and technologies to be standardised. EA can enhance the quality and performance of city processes and improve productivity across a city by integrating and unifying data linkages.

The +CityxChange EAF employs a distributed approach that uses loose coupling and stronger integration where necessary in line with EA methodologies in developing an ICT ecosystem that will give partners a better overview of +CityxChange project for integration and thus allows ongoing gap analyses of the state of smart city development. We have adopted a layered EA, where the higher layers address business related concepts and the lower layers address the technical components. The heart of the EAF is centred around a data layer called the +CityxChange DataxChange, to capture the data-centric smart city scenarios. The main benefits of this EAF, compared with other developed EAs, are its capabilities of:

- Capturing the variety of data and data sources that are available for creating value-added services, by data creators, owners and third parties.
- Bringing together the citizens', municipalities', and the business view in the higher layers.
- Describing the collaborative business endeavours that are relevant for creating value-added services.
- Showing the data, its origin and the full context (e.g., owner, format, Application Programming Interfaces (APIs), etc.), how they may be accessed and by whom they may be used to provide value to the citizens.

This includes the overall architecture concepts and diagrams as seen in Figure 1.

Figure 1 depicts the developed EAF for the +CityxChange project. A description of the EAF as shown in Figure 1 includes the architecture layers, stakeholder perspective, and data perspective.

Architecture layers

The horizontal layers of the CityxChange EA are:

- Context layer describes the needs of the citizens and the drivers for the services, which may also be the key performance indicators (KPIs) of the +CityxChange project.
- Service layer describes the value-added services that are offered to users and customers, that bring together a number of service providers, data and applications.
- Business layer describes the different actors and processes that are involved in providing the service. Here the actors would typically be organisational units that need to collaborate to provide the service, referred to as a virtual enterprise.
- Application and data processing layers describe the different applications that support smart city services.
- +CityxChange DataxChange layer describes the data that is available that could be used by various entities to provide smart city services.
- Technologies layer describes the different technologies that support the data exchange and the higher layers of the EAF.
- Physical infrastructures layer identifies the sources that provide the data,

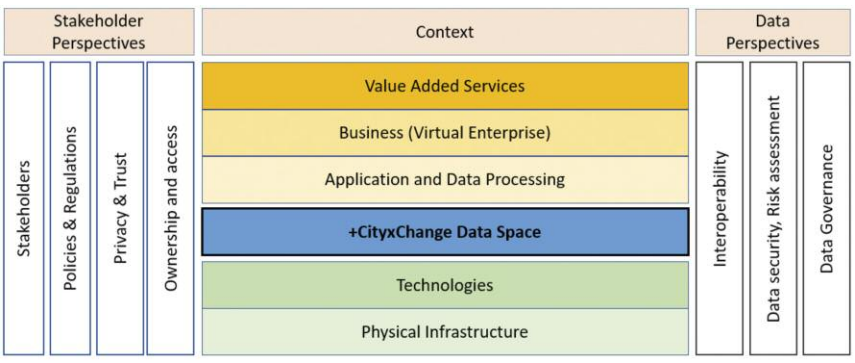

Figure 1: Proposed EAF for the +CityxChange project.

such as IoT devices, mobile phones and social media.

Stakeholder perspective

The stakeholder perspective, as seen in Figure 1, comprises stakeholders that describe the various entities (citizens, service providers, and consumers) involved in the city-wide EA space. Policies and regulations which specifies regulations that are relevant for meeting the objectives of smart city services. Privacy and trust which describe the relevant principles that need to be followed to respect and protect the privacy of individual people and organisations in supporting a network of trust among the various stakeholders, such as EU GDPR regulations. Lastly, ownership and access, which describe the relationships between the stakeholders and the entities that will be represented in city services.

Data perspective

The data perspectives comprise interoperability, which addresses how entities, through all the layers in the EA, could be brought together in a cohesive way to provide value-added services. Data security and risk assessment ensure that the data is handled in a secure and reliable manner. Data governance ensures proper data management processes and data quality and encompasses people, organisations and processes.

In future we plan to apply the proposed EAF to improve smart city services, such as electric mobility as a service and sustainable energy trading in the cities of Trondheim [L2] and Limerick [L3]. Other institutes involved in this project include Maynooth University, Innovation Value Institute (Ireland) and Lero, the Irish Software Research Centre, Ireland.

The project is funded by the European Union's Horizon 2020 research and innovation programme, Grant Agreement No. 824260. It comprises two follower cities Trondheim, Norway and Limerick, Ireland, and is led by Norwegian University of Science and Technology (Norway). The consortium comprises five follower cities (Sestao +Alba Iulia +Pisek +Võru +Smolyan) and a total of 32 project partners.

Links:

[L1] https://cityxchange.eu/
[L2] https://www.trondheim.kommune.no/
[L3] https://www.limerick.ie/council

References:

[1] Ahlers, et al.: "A Smart City ecosystem enabling open innovation", I4CS, 2019.
[2] Petersen, et al.: "Value-added services, virtual enterprises and data spaces inspired Enterprise architecture for smart cities", PROVE, 2019.
[3] Anthony, et al.: "Big data-oriented energy prosumption service in smart community districts: a multi-case study perspective", Energy Inform, 2019.

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Close-The-Loop Model: Social Acceptance of Technology for Sustainability

by Emanuela Tangari, Carmela Occhipinti and Luigi Briguglio (CyberEthics Lab.)

The CyberEthics Lab. is developing a model to assess the social acceptance of disruptive technologies, and specifically 5G, with the goal of enabling and accelerating innovation and sustainability.

Sustainability, and our concomitant responsibility to future generations, is increasingly becoming a social priority—particularly in developed countries. The UN [1] anticipates that the world's population will reach 8.5 billion by 2030, with the number of people living within cities rising to 5 billion. In Europe, cities account for 75% of the population, consuming 80% of the EU's energy. In such a scenario, 5G technology promises to (i) overcome the limits of current infrastructures, designed decades ago for a smaller number of urban dwellers; (ii) spread the connectivity pervasively; (iii) enable capacities, due to reduced latency and enhanced efficiency and bandwidth, for efficiently enacting activities in different domains (e.g. industry, ports, mobility) never considered in the past; and (iv) fostering innovation and sustainability of new and smarter cities for the next decades.

The day-to-day behaviour of humans helps shape society, creating new visions and hopes for the future but simultaneously contributing to mounting economic, environmental, social and security challenges. There is a growing need for innovative technological solutions to help society achieve a sustainable future. In our hyper-technologized societies, as people's hopes and concerns increase, the need for immediate solutions increases too. Clearly, "we can't solve problems by using the same kind of thinking we used when we created them". But the "new kind of thinking", manifesting as disruptive technology that significantly alters the way that citizens, industries or businesses operate, requires social acceptance. We need a novel way of aligning the thus-far divergent concepts of sustainability, social acceptability and technological innovation. Our approach seeks to combine these three concepts.

In the 1980s, public policy began to enshrine sustainability as a goal in its own right, encompassing ecological reflection and our moral obligation to future generations. Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. Social acceptance (with respect to technology), on the other hand, is concerned with the present (e.g. UTAUT [2]). Finally, technological

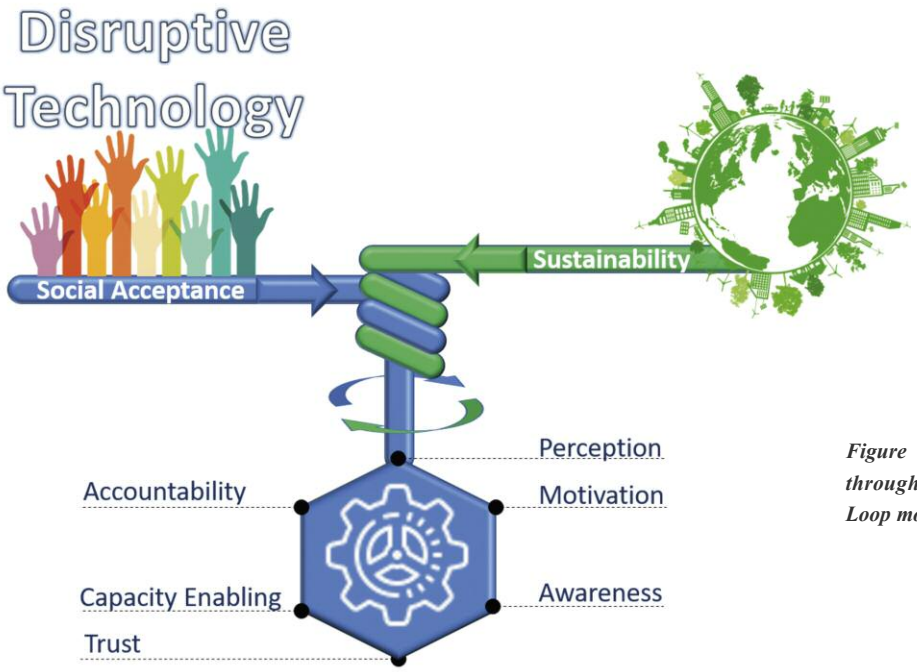

Figure 1: "Twists of time" throughout the Close-the-Loop model.

innovation moves on a seemingly inexorable timeline, continuously evolving. We are therefore faced with three different timelines: that of future human generations; the present, with our current needs and the demand for immediate solutions; and spanning and encompassing both of these, the "flat" timescale of technological innovation.

Our approach has the theoretical objective of extending social acceptance for concepts beyond the immediate needs of the present and, at the same time, bringing concern for future generations into the current psyche. We use a hexagonal diagram to assess the social acceptability of disruption technologies. From a figurative point of view (see Figure 1), the goal is to make a twist of time on itself, giving back to the flat sense of technological time the ethical and moral reflexivity of human timing, where the concerns and expectations of people who live today approach the concerns of future generations [3].

Our concept, known as the Close-the-Loop model, aims to observe, understand and evaluate how social acceptance drives the market of 5G technology. It forms part of the European research project "5G-SOLUTIONS" [L1]. This model includes the six fundamental dimensions over which social acceptability (i.e. perception, motivation, trust, awareness, capacity enabling and accountability) are measured and assessed. The method of evaluating technological acceptability is innovative due to its stepwise nature, which is as follows:

1. perception works on a subject's conscious and subconscious mental patterns;
2. motivation illustrates the moral basis according to which subjects align their preferences;
3. trust represents the level of reciprocity of individual and social expectations;
4. awareness shows the ability for individuals to choose and judge using universal values;
5. capacity for action pinpoints to what extent a technology enables people to all of the above;
6. accountability refers to the degree to which a society and its institutions are able to introduce policies that favour such complex models of acceptance.

This model, including dimensions that are considered in different classical theories of the societal acceptance (i.e. social acceptance, market acceptance and ethical acceptability), is able to (i) "close-the-loop" between the main critical concerns for citizens, justice and policy-makers, and consequently (ii) better track societal feedback. This allows to define and evaluate ethics-driven approaches (based on a better understanding of the technology and willingness to use it) aiming at reducing the barriers of diffidence and mystification against 5G technology, and fostering its wider and faster deployment.

This model and approach are agnostic with respect to a specific technology and application domain and could be applied to a wider set of contexts and case studies.

This document is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 856691.

Links:

[L1] https://www.5gsolutionsproject.eu/
[L2] https://www.cyberethicslab.com

References:

[1] United Nations, "World Population Prospect 2019: Highlights" (2019) https://kwz.me/h4m
[2] Venkatesh, et al.: "User Acceptance of Information Technology: Toward a Unified View", (2003) In MIS Quarterly. 27 (3): 425–478. JSTOR 30036540. https://www.jstor.org/stable/30036540
[3] A. Carnevale: "Tecno-vulnerabili. Per un'etica della sostenibilità tecnologica", (2017) Orthotes Ed., ISBN 978-8893141130

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European Research and Innovation

Cultural and Heritage Site Defect Detection via 3D Saliency Map Extraction

by Christos Anagnostopoulos, Aris S. Lalos, George Pavlidis, Christos Koulamas, Athanasios Kalogeras (ISI, Athena R.C), Ana Garcia Lopez (University of Granada) and Giacomo Di Benedetto (Enginlife-Engineering)

The WARMEST project is developing an intelligent decision support system that will result in a low impact tool to suggest improvements in maintenance and risk management procedures in cultural and heritage sites (CHSs).

The decision support system developed by the WARMEST project [L1] will utilise existing data over multiple sources to anticipate future scenarios and indicate actions in order to avoid major risks in maintenance and probable risks related to climate change. The generated maintenance scenarios will have to be both technologically and economically feasible; a significantly difficult task owing to the large variety of loads (different types of sites), strict regulations to consider and the need for continuous operation throughout the year.

The preservation and promotion of culture contributes to Sustainable Development Goals (SDGs), as well as being a worthwhile goal in itself, according to UNESCO [1]. The relationship between heritage and sustainable development is described explicitly in two SDGs. More specifically, in SDG 11, entitled "Make cities and human settlements inclusive, safe, resilient and sustainable", target 11.4 focuses on strengthening efforts to protect and maintain cultural and heritage sites. In SDG 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all", target 8.9 refers to the need for creating policies that will support sustainable tourism through carefully devised maintenance and operational plans. In other words, a set of actions must be carefully prepared that will ensure the viable preservation of the CHS while allowing its touristic exploitation.

In this context, WARMEST will try to satisfy these targets by: (i) collecting updated and detailed data about CHSs; (ii) producing accurate and cost-effective maintenance plans to face current heritage conservation needs and foreseen scenarios; (iii) defining safe and effective visitor routes for sites; (iv) making decisions about excavation campaigns in relation to expected maintenance plans; and (v) supporting new companies or technologies in monitoring and maintaining CHSs. The project plans to use 3D models to document and digitalise parts of the CHSs that take part in the project, identify the current state of the artifacts by analysing heterogeneous data sources like 3D meshes, dense point clouds, and IR photos, evaluate the temporal evolution of the artifacts by studying archive material and weather data information, correlate the identified damage with external factors like weather conditions or accidents, evaluate the success of maintenance actions that have been

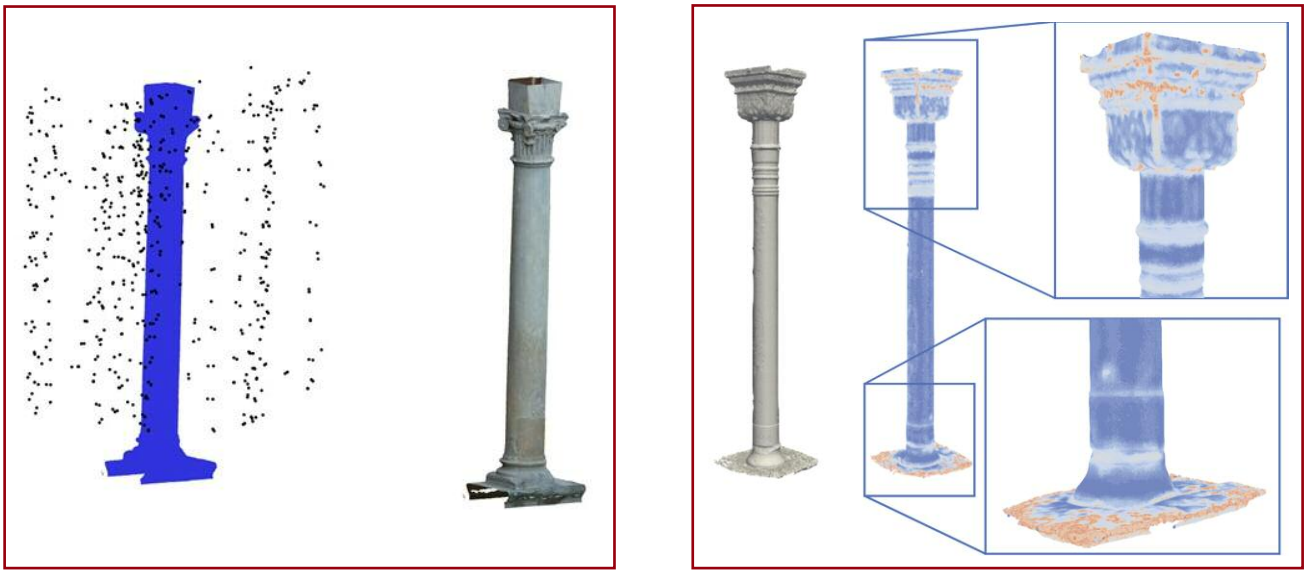

Figure 1: Camera positions and 3D reconstructed object (left), saliency map extraction (right).

undertaken and finally deliver a decision support system to deliver cost-effective maintenance plans.

To this end, we propose a novel CHS defect detection methodology by extracting saliency mapping from 3D models. The first step is to collect a big dataset that can provide valuable information. One of the CHS participating in the project is the Patronato de Alhambra, an UNESCO Heritage Site palace and fortress complex located in Granada, Spain. Its most famous courtyard is the Court of Lions, which includes a low gallery supported on 124 white marble columns. We used photogrammetry technologies to construct 3D models of the columns. More than three hundred photos per column were taken at different angles and heights. Photos were taken manually and no UAV was used, in accordance with safety regulations. A low ISO in conjunction with an aperture of around f/11 were selected to reduce image noise and optimise sharpness and depth of field. The photoshoots were conducted just before opening at around 7 a.m., to ensure optimal lighting conditions and avoid crowds. The 3D reconstruction was performed using a structure from motion combined with Multiview stereo (SfM-MVS) technique. SfM-MVS systems are affordable, can be automated and used by non-specialists and produce high quality 3D data. This system is increasingly used in demanding cultural digitisation applications, surpassing laser scanning and structured light approaches. Figure 1 shows a sample of the camera locations and the final 3D object.

The 3D reconstructed model is then processed using a data-driven approach that focuses on the extraction of the 3D saliency mapping. Training data were generated from meshes and a given saliency mapping, which was previously generated by traditional methods [2]. After the training process, the generated output can be used to automatically extract saliency mapping for any other new 3D model. We start by separating the whole mesh into n (i.e., equal to the number of centroids) overlapped and equal-sized patches. We then follow two different steps for the estimation of the spectral and geometrical saliency. The final result is a combination of these two values. Once the saliency mapping has been estimated, we use it as input to train the convolutional neural network (CNN) (see Figure 1(b)). This concludes the procedure and gives us the appropriate input data to detect defects on the columns using machine learning techniques.

WARMEST is a H2020 Marie Curie Research and Innovation Staff Mobility Project (H2020- Marie Skłodowska-Curie Actions-RISE-2017). The project is carried out by an international and multi sectorial consortium comprising more than 30 researchers. In close cooperation with the consortium, three heritage sites are involved in the research: Patronato de la Alhambra y Generalife (Granada, Spain), Marzamemi Underwater Museum (Sicily, Italy) and Opera Santa Croce (Florence, Italy).

Link:

[L1] https://warmestproject.eu/

References:

[1] UNESCO, 2003. Convention for the Safeguarding of the Intangible Cultural Heritage. World Heritage Committee, https://ich.unesco.org/en/convention .

[2] G. Arvanitis, A.S. Lalos, K. Moustakas: “Saliency mappingfor processing 3d meshes in industrial modeling applications,” in 2019 IEEE 17th Int. Conf. on Industrial Informatics (INDIN), July 2019.

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Various Approaches to Statistical Calibration of Ensemble Weather Forecasts

by Sándor Baran and Annette Möller (Faculty of Informatics, University of Debrecen and Institute of Mathematics, Technical University of Clausthal)

Statistical calibration of ensemble weather forecasts is a rapidly developing research area of statistics as well as atmospheric and water sciences. We are developing and implementing multivariate approaches explicitly accounting for dependencies between weather observation locations and/or between weather variables, including temperature, precipitation and pressure.

Capturing and modelling uncertainty is essential in any forecasting problem, and, in weather or hydrological predictions, can have enormous economic benefits. The early 1990s saw an important shift in the practise of weather forecasting, from deterministic forecasts obtained using numerical weather prediction (NWP) models in the direction of probabilistic forecasting. The crucial step was the introduction of ensemble prediction systems (EPSs), which came into operational use in 1992, both at the European Centre for Medium-Range Weather Forecasts (ECMWF) and the U.S. National Meteorological Center.

An NWP model essentially consists of a large and complex set of partial differential equations describing the processes that take place in the planet's atmosphere. An EPS provides not only a single forecast but a range of several forecasts, which are usually generated by running the NWP model multiple times, each time based on another set of assumed initial values obtained by random perturbation of an initial guess derived from the actually available information about the state of the atmosphere.

In recent decades, the ensemble method has become widely used globally, its appeal lying in its ability to easily provide statistical summary measures that explicitly reflect the forecast uncertainty. However, the raw outputs of the EPS often exhibit systematic forecast errors (bias) or cannot properly capture the forecast uncertainty (calibration), thus calling for some form of post-processing. Simple approaches to bias correction or calibration have a long history, and in the first years of the twenty-first century several more sophisticated methods appeared, including statistical models providing full predictive probability distributions of the weather variables at hand. This means that one is not only able to provide a forecast of tomorrow's temperature in Berlin, but also to forecast the probability that tomorrow's temperature in Berlin will be between 20 and 25 oC with say 80% confidence. Starting with the fundamental works of Tilmann Gneiting and Adrian Raftery that introduced Bayesian model averaging and ensemble model output statistics for ensemble calibration [1], statistical post-processing of ensemble forecasts became a hot topic both in statistics and atmospheric sciences, resulting in a multitude of probabilistic models for different weather quantities, new methods and algorithms for training these models on real weather data and novel approaches to forecast verification [2].

The Hungarian-German research project "Statistical post-processing of ensemble forecasts for various weather quantities", jointly financed by the Hungarian National Research, Development and Innovation Office and the Deutsche Forschungsgemeinschaft, aims to develop and test multivariate post-processing methods that model correlations between different weather variables, and/or incorporate correlations in space, e.g., between observation stations. Further goals are the development of user-friendly software packages for statistical calibration of ensemble weather forecasts,

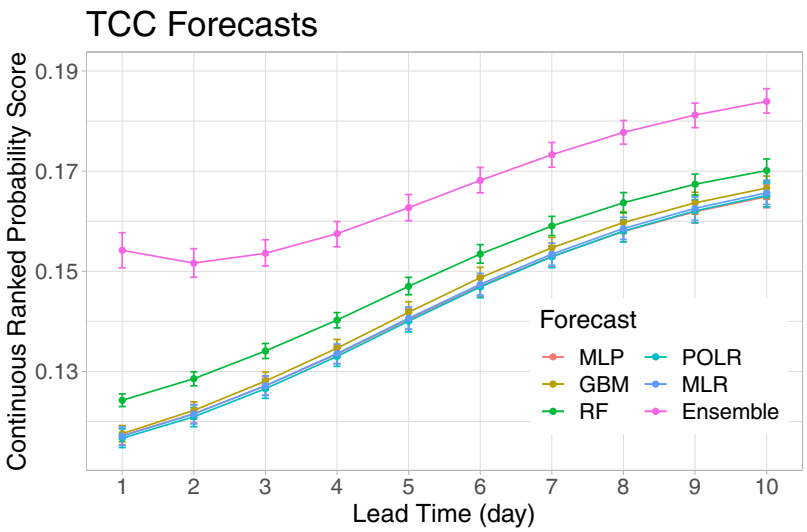

Figure 1: Mean continuous ranked probability score (CRPS) values of the various post-processing approaches and the raw forecasts for different lead times. The CRPS measures the goodness of fit of the predictive distribution to the corresponding observation, the smaller the better.

investigation of approaches that take advantage of local features in the neighbourhood of an observation station, and finally, to create an efficient scientific network.

Most members of the small research group have connections with Tilmann Gneiting's research group at the Heidelberg Institute for Theoretical Studies. The members have a long history of collaboration and include mathematicians and statisticians from Heidelberg University, Karlsruhe Institute of Technology, Technical University of Clausthal, University of Debrecen, University of Hildesheim, and a meteorologist from MeteoSwiss Agency.

Since its inception in April 2018, the project has investigated various angles, including:

- An approach to calibrate hydrological ensemble forecasts, such as water levels of rivers. The challenge when dealing with this type of data is that water level measurements exhibit natural bounds from below and above and are non-Gaussian, so appropriate data transformation schemes are required. The proposed model was applied to predict water levels for the river Rhine at Kaub gauge with great success.
- An approach that accounts for the interdependency between weather variables over time. The temperature today is not independent of the temperature yesterday or other recently observed temperatures. Thus, the forecast errors on different days are not independent from one another. This time dependence was utilised to improve the ensemble forecasts, which worked particularly well for higher lead times when considering temperature forecasts.
- An investigation of the applicability of machine learning approaches to statistical post-processing of ensemble forecasts of total cloud cover (TCC), a variable describing what fraction of the sky is covered by clouds, measured on a nine-point scale: 0, 1/8, 2/8, 3/8, 4/8, 5/8, 6/8, 7/8, 1. Using the ECMWF global TCC ensemble forecasts for the period 2002–2014 and considering different lead times, the predictive performance of multilayer perceptron (MLP) neural networks, gradient boosting machines (GBM) and random forest (RF) algorithms was compared with the forecast skill of the state-of-the-art multiclass- and proportional odds logistic regression (MLR and POLR) approaches and the raw ensemble (see Figure 1). To obtain more specific insight, a detailed simulation study was conducted to compare properties and performance of different multivariate post-processing methods (ensemble copula coupling, dual ensemble copula coupling, Schaake shuffle and the Gaussian copula approach, see ([2]) for different situations (e.g., weather variables). The main message gained from the simulation study was that a misspecification in the multivariate dependence structure in the post-processing model leads to a notable deterioration in forecast performance.

Finally, the researchers of our group also complemented existing post-processing software packages [L1] with the necessary algorithms to deal with different types of weather variables.

Links:
[L1] https://kwz.me/hSM

References:
[1] T. Gneiting, A. E. Raftery: "Weather forecasting with ensemble methods", Science 310 (2005), 248–249.
[2] S. Vannitsem, D. S. Wilks, J. W. Messner, (eds.): "Statistical Postprocessing of Ensemble Forecasts", Elsevier, Amsterdam, 2018.

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Enabling the European Business Knowledge Graph for Innovative Data-Driven Products and Services

by Dumitru Roman and Ahmet Soylu (SINTEF)

Corporate information, ranging from basic company information such as company name(s) and incorporation date to complex balance sheets and personal data about directors and shareholders, are the foundation that many data value chains depend upon in various sectors. However, collecting and aggregating information about a business entity from relevant public and private sources and especially across borders and languages is a tedious and very expensive task rendering many potential business models non-feasible.

The euBusinessGraph project [L1], funded by European Union's Horizon 2020 programme, set the foundations for a business knowledge graph of companies, and delivered a set of innovative data-driven business products and services dealing with company information.

Governments and other public bodies are increasingly publishing open data about firmographics and contextual databases, which reference companies. For example, the UK, Norway, France, and Denmark openly publish records about companies, while other countries have various degrees of openness for their company registries. Examples of contextual databases include the EU TED (Tenders Electronic Daily) public procurement notices and gazette notices.

Unfortunately, firmographics datasets are not yet fully harmonised and interoperable because data differs widely in semantics from one source to another and data formats vary, ranging from UK's five star Linked Data to poorly accessible and poorly documented datasets. Furthermore, contextual databases are not linked to the national company registries and they still use different company identifier systems or, in some cases, no identifiers at all. Private businesses also produce valuable company-related data, which is seldom linked to the public sources mentioned above. For example, media publishers often reference businesses and legal entities by name (hence ambiguously) even within their digital publications. This occurs because there is no widespread mark-up schema to annotate a digital reference to a company and no standardised way of accessing its information once it's unambiguously identified. As a result, it is extremely expensive, time consuming, and error prone to find, interpret and reconcile these data from private sector sources.

One of the immediate consequences is that the business information sector is not very cost-efficient in itself, which is reflected in a lack of transparency and efficiency of the markets [1]. Nevertheless, the most relevant consequence in this context is that these inefficiencies severely harm digital

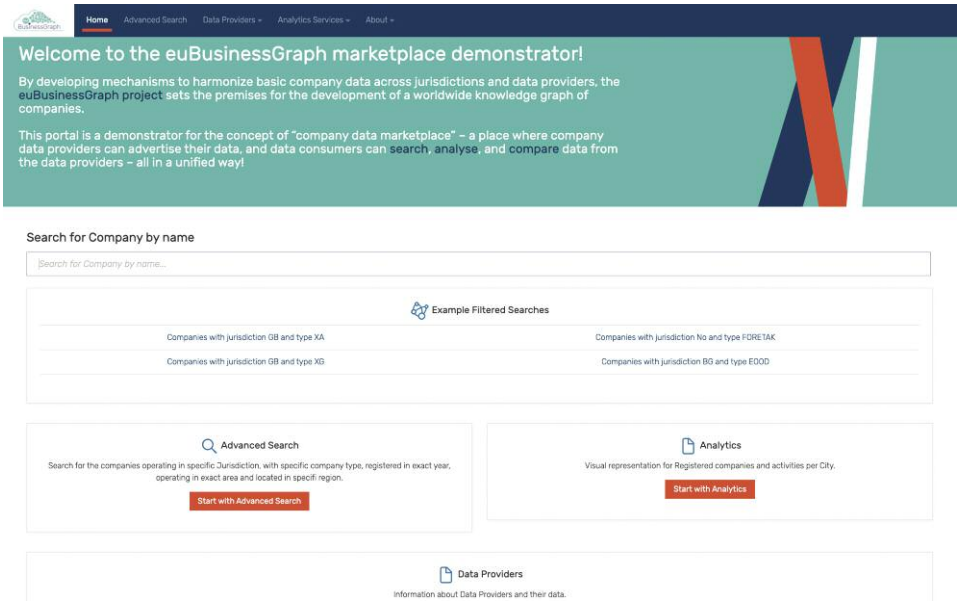

Figure 1: Homepage of the euBusinessGraph data marketplace prototype.

innovation across sectors, which is often introduced by small and agile actors (e.g., start-ups, civil society organisations) who lack the capacity to invest time and resources.

The euBusinessGraph project used ontologies as a key mechanism for aggregating, linking, provisioning and analysing company-related data in order to create a "business knowledge graph" – a highly interconnected graph of company-related information. A prototype data marketplace was created on top of the provisioned knowledge graph for enabling the creation of data-driven products and services. It exemplifies the democratisation of the company information market, currently dominated by a few large international players creating a market barrier for smaller company data providers. The marketplace exemplified how such smaller players can join a common ecosystem to promote their data offerings, and for data consumers to have a central point where they could easily compare company data offerings.

An ontology – the euBusinessGraph ontology [L2] – was developed by following common techniques recommended by well-established ontology development methods. The main sources used in its development were existing ontologies and vocabularies, such as the W3C Organisation ontology, and company data from four data providers. The data providers include: (i) OpenCorporates with core company data on over 145 million entities, obtained from more than 120 company registers around the world; (ii) SpazioDati with basic firmographics about more than 11 million business entities in the UK and Italy and information about 13 million directors and managers; (iii) Brønnøysund Register Centre (Brønnøysundregistrene) with a database that contains information on all legal entities in Norway such as commercial enterprises and governmental agencies, and; (iv) Ontotext with data from the Bulgarian Trade Register for commercial and non-profit organisations. The data made available by the data providers originally came from both official (e.g., national and regional company registers) and unofficial sources (e.g., the corporate web, business-centric news aggregators and social networks).

A data provisioning infrastructure was developed to onboard data from various data providers [2]. Using this infrastructure, data source files from data providers were processed and mapped to the euBusinessGraph ontology. The data provisioning infrastructure includes a set of data ingestion services and data preparation tools that can be used to simplify data cleaning and transformation from the various sources. The services include tools for data transformation, enrichment, interlinking, and metadata generation processes in order to publish the business knowledge graph data as Linked Data. DataGraft [3] was used to clean, transform, enrich and convert tabular data to Linked Data. Currently, more than 1.4 billion Linked Data triples available in the business knowledge graph. A data marketplace prototype [L3], depicted in Figure 1, was implemented on top of the knowledge graph and includes functionality for full-text advanced search and detailed faceted search for exploration of the company knowledge graph. Furthermore, the marketplace offers analytics services such as data aggregation and visualisation (e.g., company activities per city), search for company news articles, and search for company events.

The project partners are SINTEF AS (Norway, coordinator), OpenCorporates (UK), Cerved (Italy), SpazioDati (Italy), Evry AS (Norway), Deutsche Welle (Germany), Ontotext (Bulgaria), Brønnøysund Register Centre (Norway), Jozef Stefan Institute (Slovenia), and University of Milano-Bicocca (Italy).

Links:

[L1] https://www.eubusinessgraph.eu
[L2] https://github.com/euBusinessGraph/eubg-data
[L3] http://marketplace.businessgraph.io

References:

[1] Janssen et al.: "Driving public sector innovation using big and open linked data (BOLD)", Information Systems Frontiers 19(2) 2017.
[2] Maurino et al.: "Modelling and Linking Company Data in the euBusinessGraph Platform", in Proc. of DSMM@SIGMOD 2019.
[3] Roman, et al.: "DataGraft: One-stop-shop for open data management", Semantic Web 9(4) 2018.

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ALerT – Learning about Privacy at the Time of Data Sharing Everywhere

by Patrick Jost (NTNU), Gisela Böhm (University of Bergen), Monica Divitini (NTNU) and Ingvar Tjostheim (Norwegian Computing Center)

Data is being collected everywhere, and people are often unaware of what information they share, with whom and what it is used for. Games have the potential to increase people's awareness about privacy and, at the same time, help researchers to better understand decision-making processes around data sharing. This is the challenge addressed by ALerT, a multi-disciplinary project aiming at developing serious games and research tools for privacy awareness.

ALerT aims to develop serious games to promote privacy awareness. For citizens, the games are used for practising and learning. For researchers, the games are a tool for studying how to evoke users' awareness and for understanding choices involving the use of personal data.

In order to address the complexity of the problem, the games do not aim at providing simulations of specific situations. Rather, the objective is to let players explore different scenarios, creating awareness of the risks and tradeoffs connected with the use of personal data. This will be done in serious games by promoting understanding and reflection. The ALerT approach recognises the importance of reflection in the form of, for example, debriefing sessions after the game or reflection triggers in the game. Reflective learning theories will be used to inform the design of the ALerT games. In addition, the project will explore different game dynamics to promote learning and engagement, including individual and collaborative game dynamics. ALerT will also investigate different modalities of interaction, including traditional desktop games, but also mobile games and hybrid board games to promote richer learning experiences.

Figure 1: Modular game framework "Conquest of Shareadise".

The games aim to trigger System 2 modes of thinking, i.e., helping players to move from an automatic reaction when sharing data to consciously reflecting on the current problem, and deliberately anticipating potential future effects of their behaviour. The design of the games will be based on the dual-process model proposed in [1], providing cues on the consequences of sharing private information as well as provoking moral evaluation of the conduct of mobile apps, internet and software companies.

The first game has been developed using chatbot technology. The game is intended to help students to learn about the privacy challenges that are connected to data sharing in the context of smart cities [2]. Initial evaluation of the game showed that the learning benefits perceived by students are higher for older students (15-18 years old) and for students who report less time spent playing video games.

We are currently developing a modular game framework called Conquest of Shareadise (Figure 1, left) that can be used by researchers to explore unobtrusive strategies of assessing and improving privacy choices following psychological theories [3]. The framework is designed to mediate a variety of privacy-related scenarios to citizens/players while presenting an engaging and enjoyable experience. Conquest of Shareadise is developed to run on web browsers as well as mobile devices for reaching a broad audience. First privacy challenges created with the quest-oriented game frame demonstrated the potential for investigating privacy decisions while maintaining an engaging game flow. Significant differences between experienced lecturers and high school students could be observed when reflecting about sharing private data and spreading potential fake news. Students showed low awareness when sharing false information which underlines the importance of data sharing education. An accompanying workshop is under development for the co-creation of modular game scenarios with participating students and researchers (Figure 1, right). The toolset will provide scientists and educators with a research-oriented approach for ideating balanced game experiences while integrating evaluation and reflection concepts.

While the project is national, it keeps a European perspective on privacy behaviour and personal data sharing. The workshop concept and tools will be refined with gameplay and creation sessions at several European universities involving researchers and students from multiple disciplines including Game Design, Human Factors Computing and Psychology.

Link:
http://alert.nr.no/

References:

[1] G. Böhm, H.-R. Pfister: "The perceiver's social role and a risk's causal structure as determinants of environmental risk evaluation," J. Risk Res., vol. 20, no. 6, pp. 732–759, 2017.

[2] E. Berger et al.: "PrivaCity - A Chatbot Game to Raise Privacy Awareness Among Teenagers", in LNCS 11913, Springer, 2019, 293–304

[3] A. Acquisti: "Nudging privacy: The behavioral economics of personal information", IEEE Security and Privacy, 7(6):82–85, 2009.

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Roadmaps for AI Integration in the Rail Sector - RAILS

by Francesco Flammini (Mälardalen University and Linnaeus University, Sweden), Valeria Vittorini (CINI and University of Naples Federico II, Italy) and Zhiyuan Lin (University of Leeds, UK)

The European RAILS research project is investigating the potential applications of artificial intelligence (AI) within the rail sector, and helping define roadmaps for future research in next generation signalling systems, operational intelligence, and network management.

The overall objective of the Roadmaps for AI integration in the raiL Sector (RAILS) research project is to investigate the potential of artificial intelligence (AI) in the rail sector, and contribute to the definition of roadmaps for future research in next generation signalling systems, operational intelligence, and network management. RAILS will address the training of doctoral students to support the research capacity in AI within the rail sector across Europe by involving research institutions with a combined background in both computer science and transportation systems, in four countries: Italy, United Kingdom, the Netherlands, and Sweden.

RAILS will produce knowledge, ground-breaking research and experimental proof-of-concepts for the adoption of AI in rail automation, predictive maintenance and defect detection, traffic planning, and capacity optimisation. As such, RAILS will effectively contribute to the design and implementation of smarter railways. To this end, RAILS will combine AI paradigms like machine learning with the Internet of Things (IoT) in order to leverage on the big amount of data generated by smart sensors and applications. The research activities will be conducted in continuity with ongoing research in railways, in particular within the Shift2Rail innovation program, and will be based on in-depth analysis of AI applications in transport and other relevant sectors in order to perform a transferability study of available results to railways.

The methodological and technological concepts developed in RAILS are expected to stimulate further innovation in railways, providing new research directions to improve reliability, maintainability, safety, security, and performance. With respect to safety, emerging threats (e.g., adversarial attacks) and certification issues will be addressed when adopting AI in autonomous and cooperative driving (e.g. virtual coupling), based on the concepts of explainable AI (XAI) and trustworthy AI.

With respect to cyber-physical threat detection, innovative approaches will be developed based on AI models like Artificial Neural Networks (ANN) and Bayesian Networks together with multi-sensor data fusion and artificial vision. Resilience and optimisation techniques based on genetic algorithms and self-healing will be addressed to face failures and service disruptions, as well as to increase efficiency and line capacity.

Furthermore, transport management problems, such as timetabling and real-time traffic rescheduling, are notoriously difficult, and commonly referred as to NP-hard problems. This means that solving such problems exactly in large-scale while in practical time limit is often intractable. For these problems, alternative approaches are often needed. For example, heuristic algorithms and evolutionary approaches have been developed for providing near-optimal solutions to transport problems. Recently, machine learning has been applied to solve NP-hard scheduling problems, giving a promising direction as an alternative to heuristics.

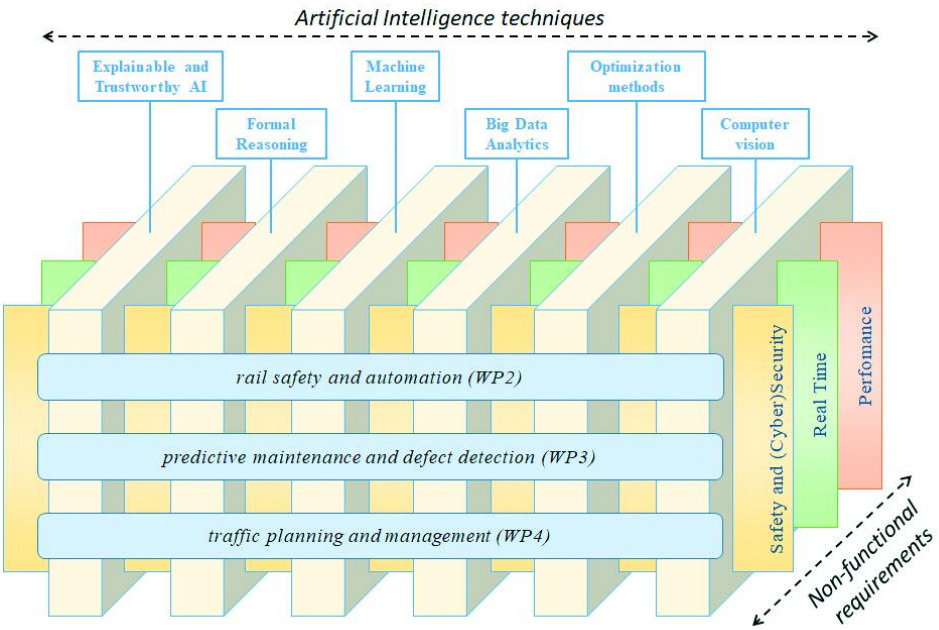

Figure 1: The RAILS project will study current AI techniques and their applications in order to improve railway performance, safety, reliability, and security.

Therefore, we are interested in alternative AI algorithms in finding good (near-optimal) solutions in practical time for transport problems.

All these techniques will pave the way to the development of the new Railway 4.0.

The project is structured into six work packages (WPs):
- WP1 provides the reference taxonomy and state of the art of AI in railways and related sectors.
- WP2 addresses AI for railway safety and automation.
- WP3 explores AI applications in predictive maintenance and defect detection.
- WP4 is about AI for traffic planning and management.
- WP5 manages dissemination activities as well as definition of future roadmaps.
- WP6 deals with project management.

An overview of the project is provided in Figure 1.

The organisations participating to the project are: Consorzio Interuniversitario Nazionale per l'Informatica (CINI), Italy – project coordinator; Delft University of Technology, the Netherlands; University of Leeds, United Kingdom, and Linnaeus University, Sweden. The project is also supported by an industrial Advisory Board currently including Hitachi Rail STS (IT), Dutch State Railways (NL), The MathWorks (IT), First Rail (UK), Aitek (IT), Comesvil (IT), NextTechnologies (HU), and SYENMAINT (IT).

The project is funded by the European Union's Horizon 2020 research and innovation programme (Shift2Rail Joint Undertaking, Open Call S2R-OC-IPX-01-2019) under grant agreement No. 881782. It runs for three years, from 1 December 2019 to 30 November 2022.

Links:
[L1] https://cordis.europa.eu/project/id/881782
[L2] https://rails-project.eu

References:
[1] D. Burroughs: "The future of intelligence is artificial", International Railway Journal, September 2019, https://kwz.me/h4E
[2] G. Ho, "Artificial intelligence in rail: "Hype or reality?", Global Railway Review, May 2019, https://kwz.me/h4K
[3] D. Tokody, F. Flammini: "The intelligent railway system theory: The European railway research perspective and the development of the European digital railway strategy", International Transportation, Issue 1, 2017.

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A Formal Methods Demonstrator for Railways

by Franco Mazzanti and Davide Basile (ISTI-CNR)

The 4SECURail project – funded by the European Union Horizon 2020 Shift2Rail Joint Undertaking – has two overall objectives: to design a Computer Security Incident Response Team (CSIRT) for joint EU-Rail cybersecurity, and the setup of a Formal Methods Demonstrator for the evaluation, in terms of cost, benefits and required learning curve, of the impact of the use of Formal Methods for the rigorous specification of the components of a railway signalling infrastructure.

While it is recognized that the adoption by the railways infrastructure managers of a rigorous specification methodology based on formal methods would definitely improve the dependability of the subsystems - that still have to guarantee the safety and availability of the overall infrastructure even when they are likely to be developed by the different suppliers - a detailed analysis of the costs, benefits, and of the required learning curve, of such adoption of formal methods is still missing.

As part of the first Work Stream of the project, researchers from the Formal Methods and Tools group of ISTI-CNR will shed more light on this issue with the design of a Formal Methods Demonstrator to evaluate the potential impact of the use of Formal Methods within a system specification process that could be adopted by railway infrastructure managers. The ISTI-CNR demonstrator design efforts will be complemented in the project by SIRTI for the selection and specification of signaling subsystem to be used as case study, and by FIT Consulting for development of the Cost/Benefits analysis.

The second Work Stream of the project, led by Hit Rail B.V. with the collaboration of UIC (International Union of Railways) and Tree Technology, will deliver a collaboration platform for a European Railway Computer Security Incident Response Team (CSIRT), designed to coordinate the Cyber Security response actions of the separate railway security teams.

The 4SECURail project which has started in December 1st 2019 and it is expected to end in November 30th 2021, is coordinated by engineering consulting firm Ardanuy Ingeniería, S.A.

Links:
[L1] https://cordis.europa.eu/project/id/881775
[L2] http://www.4securail.eu

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Cyber-Ranges as a Mean of Security Culture Establishment

by George Hatzivasilis (FORTH), Kostas Fysarakis (Sphynx) and Sotiris Ioannidis (FORTH)

Modern educational tools and computer technologies are now getting adapted in the cyber-ranges field. Simulation, emulation, as well as serious gaming provide an enhanced training experience under realistic conditions and accurate operational environments. The THREAT-ARREST Horizon-2020 project is developing a model-driven platform for professional cyber-security training and the raising of awareness for individuals and organizations.

Nowadays, more-and-more cyber-security training is emerging as an essential process for the lifelong personnel education in organizations, especially for those which operate critical infrastructures [1], [2]. Gartner estimates that the global cyber-security awareness and training market will worth around $1.5 billion by 2021. This is due to security breaches on popular and widely-used services that become publicly known and raise the people's security awareness [L1], [L2].

This study combines pedagogical practices and cyber-security modelling in an attempt to support dynamically adaptive training procedures [3]. The training programme is tailored to the trainee's needs and technical capabilities, promoting the continuous monitoring and adaptation to his/hers performance. As the trainee accomplishes the basic evaluation tasks, the assessment starts involving more advanced features that demand higher level of understanding. The overall method is integrated in a modern cyber-ranges platform and three pilot applications on training programmes for smart energy, shipping, and healthcare employees are developed.

The THREAT-ARREST approach [L3] is composed of 4 main phases (see Figure 1): i) analysis, ii) programme establishment, iii) training and user feedback, and iv) post-training monitoring and security evaluation.

At first, we analyze the customer organization system and establish the knowledge base for the training programme. The goal is to estimate the current security status and specify the weak points (e.g. system or behavioral vulnerabilities). The platform's Assurance tool installs monitoring modules in the pilot system that capture its technical aspects (like the type and version of the running software of the installed hardware components) and check if it operates in a secure manner. Then, it searches to widely-known security repositories (i.e. CVE) and automatically discovers the active vulnerabilities of the system (e.g. if a server uses MSQL 5.5.35, then it is vulnerable to buffer overflow attacks based on the CVE-2014-0001). The vulnerabilities set is evaluated in a semi-automated fashion by the experts, who identify the most significant of them for the examined organization. Experts also interview the organizations personnel and record the followed operational procedures (e.g. password-update policy, anti-virus updates, etc.). The training programme is developed afterwards based on the overall outcomes of the initial analysis.

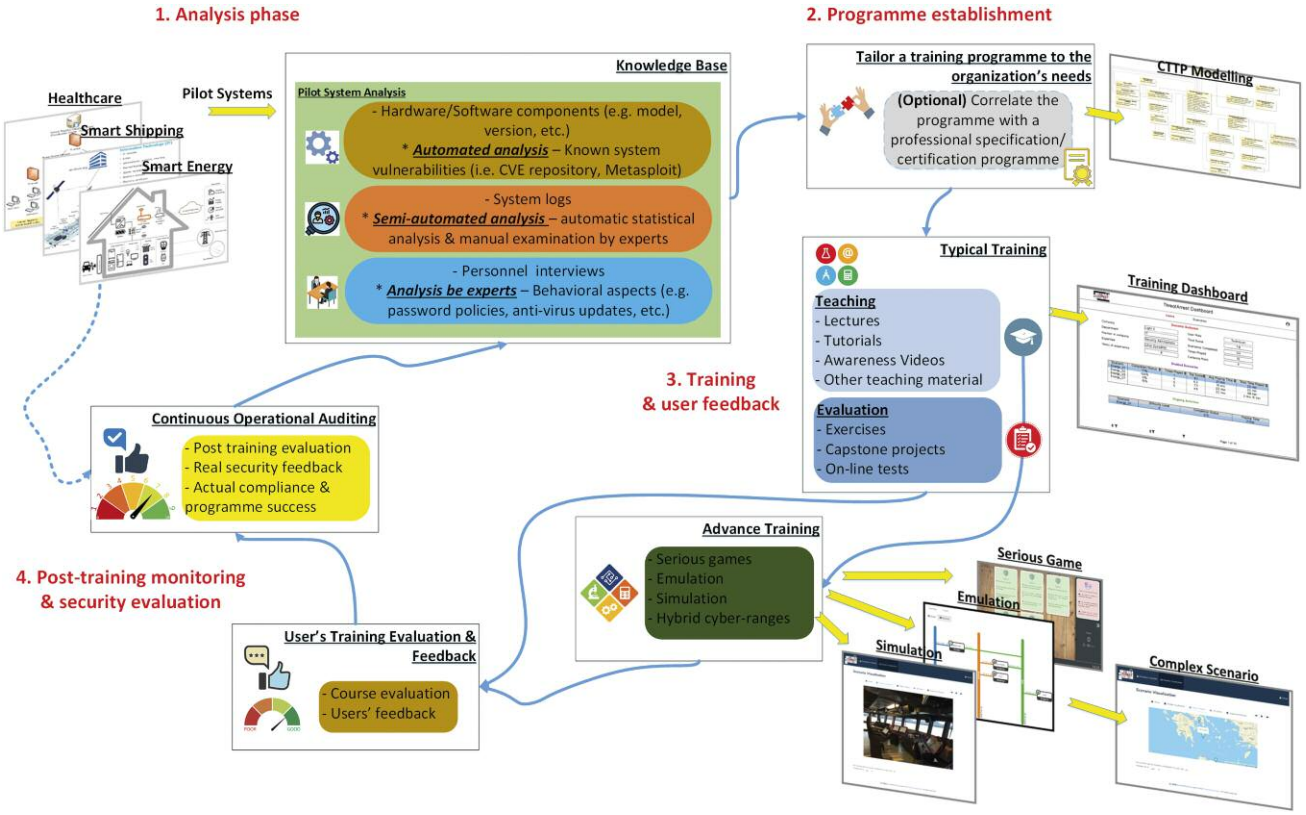

Figure 1: The THREAT-ARREST lifecycle.

Also, during this phase, the experts collect real-operational log or other data files from the examined system. This knowledge is further processed in order to enhance the advance training procedures of the THREAT-ARREST platform. At first, we perform statistical analysis on the original data in order to disclose the statistical patterns of each file. This is performed either through manual examination by experts or via an automatic statistical analysis module. The goal is to produce synthetic events (i.e. a series with legitimate and/or phishing emails) or other data (i.e. a database's content with dummy but realistic entries) via our Data Fabrication tool that will be later used in order to provide advance training under realistic conditions.

Then, based on these results we tailor a Cyber Threat and Training Preparation (CTTP) programme to the organization's special needs, which could also be combined and cover the training for a professional certification programme (e.g. Certified Information Security Manager (CISM) by ISACA or Certified Information Systems Security Professional (CISSP) by ISC2), in order to increase the THREAT-ARREST's efficiency. Afterwards, we collect the related teaching material for the typical training (e.g. lectures, tutorials, awareness videos, etc.) and model the advance training scenarios based on emulation, simulation, and serious gaming.

Once the trainee has completed the basic training for a learning unit, the accompanied CTTP models are activated in the Dashboard and the trainee can now proceed with the advanced training. The CTTP models describe a virtual system and how to instantiate it via the Emulation, Simulation, and Gamification tools.

These virtual labs and digital twins, which could resemble the organization's actual system and followed procedures, offer hands-on experience to the trainees/personnel. Thus, they can test and evaluate new policies and technologies, break-down the system, restore the default state and start over again, without affecting the real system. The trainees start the programme, consume the teaching material and are evaluated against the desired learning goals.

After the completion of the training, the platform displays the results for each trainee and the programme as a whole. This process indicates the scores of the trained personnel and their achievements regarding the educational procedures. Finally, the trainees can also complete questionnaires and provide feedback to the THREAT-ARREST operator, e.g. for the platform modules, the programme, etc., in order to update and improve our system. All these form ordinary features of training platforms.

However, the successful completion of a programme does not always reflect to the improvement of the pilot organization's security in a straightforward manner [1]. The security level can be increased only if the trainees apply what they have learnt in the actual system. The evaluation of this phase is one of the THREAT-ARREST's novelties in contrast to other competitive solutions [2].

Thus, our platform continues to audit the pilot system for a determined period after the training phases. The deployed controls from the initial phase continuously assure the organizations security-sensitive components. The goal is to capture if the trainees really applied what they were toughed.

For example, in the analysis phases we discover that the trainees do not update their email passwords in a regular basis, i.e. by examining the log-file of the mailing server. Thus, we tailor a programme to include the learning topic of password management. When the programme is finished, we inspect the servers log and check if the password-update entries have been increased or not.

The confirmation that the personnel adheres with the learned features, and thus the system's security is really improved, constitutes the actual evaluation that the programme was successful. Feedback is gathered from this phase in order to improve the THREAT-ARREST's operation for future training iterations and new programmes.

Links:

[L1] https://kwz.me/h4H
[L2] https://www.concordia-h2020.eu/
[L3] https://www.threat-arrest.eu/

References:

[1] Urias et al.: "Cyber Range Infrastructure Limitations and Needs of Tomorrow: A Position Paper," ICCST, IEEE, 2018.
[2] Schwab et al.: "Cybersecurity Experimentation at Program Scale: Guidelines and Principles for Future Testbeds," EuroS&PW, IEEE, 2019.
[3] Sultatos et al.: "The THREAT-ARREST Cyber-Security Training Platform," ESORICS – MSTEC workshop, Springer, 2019.

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Worried about Data Privacy in Big Data? Don't Be!

by Sabrina Kirrane, and adapted for ERCIM News by Jessica Michel

The SPECIAL project (Scalable Policy-aware Linked Data Architecture For Privacy, Transparency and Compliance) addresses the contradiction between Big Data innovation and data protection compliance requirements by proposing a technical solution that makes the achievement of both of these goals realistic. SPECIAL allows citizens and organisations to share more data, while guaranteeing compliance with the General Data Protection Regulation (GDPR), thus enabling both trust and the creation of valuable new insights from shared data.

The value of the EU data economy was more than €285 billion in 2015, and is expected to rise to €739 billion by 2020 [L1]. The expectation is that the mining of Big Data will bring significant advances for business, science and society at large, however there are concerns with respect to privacy and data protection. In order to address this challenge, the European Commission-funded research and innovation action, SPECIAL, has enabled the trustful usage and sharing of personal data even across company borders. It does so by providing an "automated means using technical specifications" to support consent and transparency requirements that are specified in the European General Data Protection Regulation (GDPR).

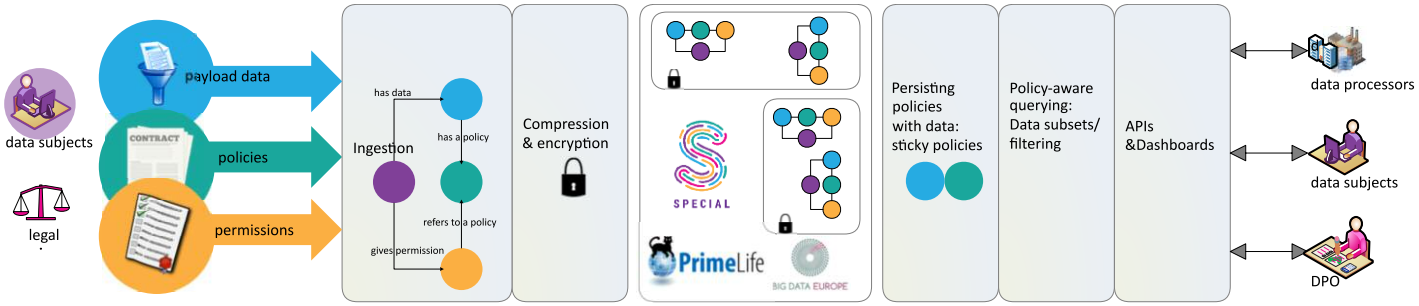
The SPECIAL project [L2] has aimed to address the contradiction between Big Data innovation and privacy-aware data protection by proposing a technical solution that makes both of these goals realistic. To this end it has developed technology that: (i) supports the acquisition of user consent at collection time and the recording of both data and metadata (consent, policies, event data, context) according to legislative and user-specified policies; (ii) caters for privacy-aware, secure workflows that include usage/access control, transparency and compliance verification; (iii) demonstrates robustness in terms of performance, scalability and security all of which are necessary to support privacy preserving innovation in Big Data environments; and (iv) provides a dashboard with feedback and control features that make privacy in Big Data comprehensible and manageable for data subjects, controllers, and processors. SPECIAL thus allows citizens and organisations to share more data, while guaranteeing data protection compliance, enabling both trust and the creation of valuable new insights from shared data.

Early on in the project, the use cases (developed from Telecoms and Financial Services industries) underwent a thorough legal and technical analysis. Both the uses cases and the insights gained from the analysis were used to develop the SPECIAL usage policy language and supporting vocabularies. Which, subsequently lead to the development of a log vocabulary that can be used to record data processing and sharing events, and the compliance checking algorithm that can be used for both ex-post and ex-ante compliance checking. Consequently, the legal partners worked closely with the technological development partners in order to provide a solutions based on the principles of privacy by design and privacy by default.

The resulting policy language and vocabularies formed the basis of initial discussions around standardisation. Towards this end, SPECIAL launched a W3C Data Privacy Vocabularies and Controls Community Group (DPVCG) on May 25th 2018 (the day the GDPR came into effect). The objective of the DPVCG is to provide a platform for engagement with the wider community, to gather additional uses cases and to develop standard vocabularies that can be used for personal data processing consent, transparency and GDPR compliance [L2].

The SPECIAL architecture is presented in the figure provided. It has led to significant advances in the state of the art in the following concrete areas:

- From a policy perspective, SPECIAL builds upon sophisticated policy frameworks and existing standardisation efforts and adapts them so as to reach the right balance between the expressiveness and scalability of the usage control policy language.
- From a transparency perspective, SPECIAL enables data transactions (i.e. who shared what data with whom and



The SPECIAL Architecture. SPECIAL uses the Big Data Europe Integrator Platform of the EU-funded project Big Data Europe. BDE focuses on cross-community big data management and building innovative products or services with semantically interoperable, large-scale data assets. The Integrator Platform enables deployment of common big data technologies with minimal effort and forms the basis of the SPECIAL platform. It does not impose any restrictions on the data processing components with respect to the data being processed, how it is processed and how it is being disseminated. Within SPECIAL, this platform has been extended and adapted to create a system compliant with the European data protection framework, which encompasses, e.g., the protection of personal data by effective access control policies.

under what usage conditions) to be stored in a manner that prevents tampering and repudiation from any of the involved peers (i.e. those owning, disclosing, and acquiring data, respectively), and to ensure that all recorded transactions have actually taken place.
- SPECIAL extends the Big Data Europe (BDE) platform, an open source and multi-purpose data management environment, with transparency and compliance checking capabilities.
- The SPECIAL dashboard is a generic visualisation platform that is able to show users the information that data controllers and processor know about them, and the relevant metadata (policies, event data, context) attached to this data. While, the consent and control interfaces enable users to effectively manage permissions in an understandable manner.

Vienna University of Economics and Business is the technical coordinator of the SPECIAL project. The consortium partners are the World Wide Web Consortium (W3C), the Unabhängiges Landeszentrum für Datenschutz, the Centro Regionale Information Communication Technology, the Technische Universität Berlin, TenForce, PROXIMUS/ Belgacom, Deutsche Telekom AG and Thomson Reuters/Refinitiv. The project is coordinated by the ERCIM Office. SPECIAL is formally closing at this time, with the European Commission congratulating the project on delivering exceptional results with significant impact.

If you would like to know more about the SPECIAL Approach toward GDPR consent, transparency and automated compliance checking, you can view a video that resulted from a webinar held on March 29th 2019 via the Big Data Value Association platform and is now available on YouTube [L4].

Links:
[L1] https://kwz.me/h4g
[L2] https://www.specialprivacy.eu/
[L3] https://www.specialprivacy.eu/related-projects/dpvcg-w3c
[L4] https://www.youtube.com/watch?v=RKwINcaBXlE

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MOSAICrOWN - Data Protection in the Data Market Scenario

by Pierangela Samarati, (Università degli Studi di Milano)

MOSAICrOWN - Multi-Owner data Sharing for Analytics and Integration respecting Confidentiality and OWNer control - is a Horizon 2020 project that aims at enabling data sharing and collaborative analytics in multi-owner scenarios in a privacy-preserving way, ensuring proper protection of private, sensitive, and confidential information. MOSAICrOWN will provide effective and deployable solutions allowing data owners to maintain control on the data sharing process, enabling selective and sanitized disclosure providing for efficient and scalable privacy-aware collaborative computations.

The application of data analysis techniques over large data collections provides great benefits, to the personal, business, research, and social domains. The availability of large data collections recording actions and choices of individuals and organizations can lead to great improvement in the understanding of how the world operates. The continuous evolution of ICT is enabling the realization of such vision at a fast pace, supporting the realization of architectures enabling collaborative data sharing and analytics. Clear obstacles towards the realization of such potential and vision are security and privacy concerns. Indeed, the loss of control over data and potential compromise of their confidentiality can have a strong detrimental impact on the realization of an open framework for enabling the sharing of data from multiple independent data owners.

The goal of providing effective data protection in multi-owner scenarios entails several challenges. MOSAICrOWN tackles such challenges with a gradual approach, addressing first policy specification and data governance, and then developing enabling technologies providing data wrapping and data sanitization techniques for enforcing data protection.

Policy specifications – Data governance framework

MOSAICrOWN provides a data governance framework for managing data and for specifying policies in multi-owner collaborative scenarios. MOSAICrOWN first identifies all relevant requirements and protection needs. The step from requirements to specifications, understandable for data owners, requires capturing the different concepts that need to be expressed providing a metadata model for referencing data. As data owners need to regulate the use, sharing and processing of their data, MOSAICrOWN is designing a formal model and a declarative policy language that also non-specialists can use for specifying different protection regulations. The model is based on solid foundations to understand the effect of policy specifications and to reason on actual protection guarantees. The language supports restrictions on the whole data processing life-cycle and is compatible with existing technology, so that it can be deployed in real systems. As data collections of different

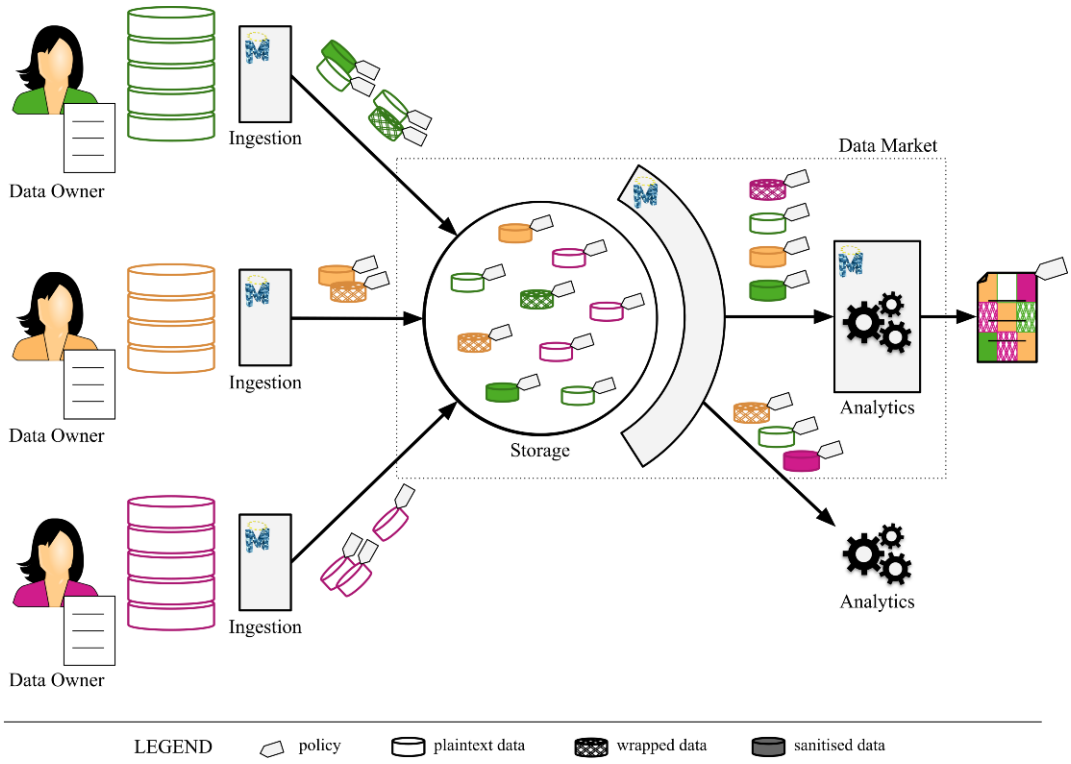

Figure 1: The MOSAICrOWN protected data and data market scenario.

owners may also need to be combined or processed together to conduct analysis, MOSAICrOWN is also investigating solutions for policy management.

Data wrapping

MOSAICrOWN is defining techniques to wrap data with a protection layer, guaranteeing access functionality while preserving protection. Data wrapping techniques need to support different kinds of functionality, as they need to be used in all phases of the data-life cycle: in data ingestion by data owners, to move self-protected data to the market while enabling fine-grained data retrieval; in data storage by the data market provider, before releasing data to external third parties for enabling their elaboration while satisfying the protection policies; and in data analytics by the data market provider, to combine different data sources and produce a result that satisfies the policies of all the data owners. The design of data wrapping techniques is complicated by the need of ensuring efficiency and scalability of computations over wrapped data. MOSAICrOWN also considers economic incentives, which can be given to data owners for the use of data, and economic benefits that can derive from the use of less expensive Cloud Infrastructures.

Data sanitization

MOSAICrOWN is designing efficient and scalable enforcing techniques that work on whole data collections to provide an obfuscated or aggregated version of the data, robust against possible re-identification, linkage, and correlation attacks. The distributed and multi-owner nature of the considered scenario makes the design of such techniques a difficult task, which requires the consideration of several challenges. First, sanitization techniques must protect data while preserving their utility for the expected computations. Second, sanitization must be applied in respect of the policy associated with such a data collection, regulating the required level of privacy and utility. Third, analysis and computations can involve data collections under the control of different data owners and possibly subject to usage and sharing restrictions. To address such challenges, MOSAICrOWN is designing sanitization techniques selectively operating at different granularity level and techniques for supporting computations over sanitized data.

The result of MOSAICrOWN will be a set of modular tools providing for an enriched data market scenario and protection to data across the whole life-cycle.

MOSAICrOWN is coordinated by Università degli Studi di Milano. ERCIM EEIG is a partner of the project. The consortium also includes Dell EMC Information Systems International, Mastercard, SAP SE, and Università degli Studi di Bergamo.

Link:
https://mosaicrown.eu/

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ERCIM "Alain Bensoussan" Fellowship Programme

The ERCIM PhD Fellowship Programme has been established as one of the premier activities of ERCIM. The programme is open to young researchers from all over the world. It focuses on a broad range of fields in Computer Science and Applied Mathematics.

The fellowship scheme also helps young scientists to improve their knowledge of European research structures and networks and to gain more insight into the working conditions of leading European research institutions.

The fellowships are of 12 months duration (with a possible extension), spent in one of the ERCIM member institutes. Fellows can apply for second year in a different institute.

Why to apply for an ERCIM Fellowship?

The Fellowship Programme enables bright young scientists from all over the world to work on a challenging problem as fellows of leading European research centers. In addition, an ERCIM fellowship helps widen and intensify the network of personal relations and understanding among scientists.

The programme offers the opportunity to ERCIM fellows:

- to work with internationally recognized experts;
- to improve their knowledge about European research structures and networks;
- to become familiarized with working conditions in leading European research centres;
- to promote cross-fertilization and cooperation, through the fellowships, between research groups working in similar areas in different laboratories.

Conditions

Candidates must:

- have obtained a PhD degree during the last eight years (prior to the year of the application deadline) or be in the last year of the thesis work with an outstanding academic record;
- be fluent in English;
- have completed their PhD before starting the grant.

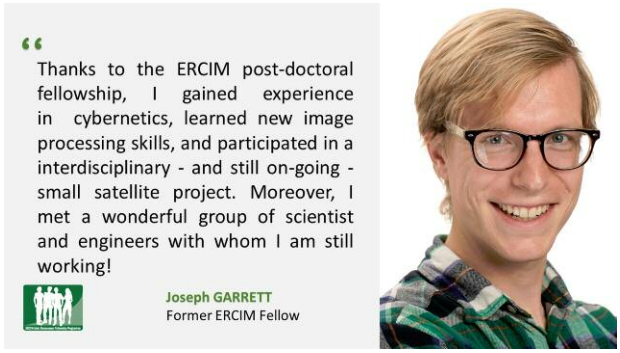
The fellows are appointed either by a stipend (an agreement for a research training programme) or a working contract. The type of contract and the monthly allowance/salary depends on the hosting institute.

Application deadlines

Deadlines for applications are currently 30 April and 30 September each year.

Since its inception in 1991, over 500 fellows have passed through the programme. In 2019, 53 young scientists commenced an ERCIM PhD fellowship and 79 fellows have been hosted during the year. Since 2005, the Fellowship Programme is named in honour of Alain Bensoussan, former president of Inria, one of the three ERCIM founding institutes.

http://fellowship.ercim.eu



SCHLOSS DAGSTUHL
Leibniz-Zentrum für Informatik

Call for Proposals

Dagstuhl Seminars and Perspectives Workshops

Schloss Dagstuhl – Leibniz-Zentrum für Informatik is accepting proposals for scientific seminars/workshops in all areas of computer science, in particular also in connection with other fields.

If accepted the event will be hosted in the seclusion of Dagstuhl's well known, own, dedicated facilities in Wadern on the western fringe of Germany. Moreover, the Dagstuhl office will assume most of the organisational/ administrative work, and the Dagstuhl scientific staff will support the organizers in preparing, running, and documenting the event. Thanks to subsidies the costs are very low for participants.

Dagstuhl events are typically proposed by a group of three to four outstanding researchers of different affiliations. This organizer team should represent a range of research communities and reflect Dagstuhl's international orientation. More information, in particular, details about event form and setup as well as the proposal form and the proposing process can be found on

https://www.dagstuhl.de/dsproposal

Schloss Dagstuhl – Leibniz-Zentrum für Informatik is funded by the German federal and state government. It pursues a mission of furthering world class research in computer science by facilitating communication and interaction between researchers.

Important Dates

- Proposal submission: July 1 to July 15, 2020
- Notification: October 2020
- Seminar dates: Between May 2021 and August 2022 (tentative).

Please note, there will be no submission deadline on November 1, 2020.

DMS Accelerator Opens its Second Call to Promote Data-Centric Startups and SMEs

DMS Accelerator aims at overcoming the barriers of data-centrics SMEs and start-ups in Europe in data skills, entrepreneurial opportunities, legal issues and standardisation. To that end, all startups seeking a new boost in the European market are encouraged to apply to this new DMS Accelerator open call.

To help improve their skills, the 50 selected startups, spanning all European Union countries, are entitled to benefit from a series of free services taught by the member organizations of the DMS Accelerator. These services are split into five different categories: investment, acceleration, legal training, standardization and data skills. Services are delivered through diverse channels: webinars (investment, content, data protection), mentoring and coaching sessions with specialists, mobility programs, matchmaking with investors, and promotion at events such as The Next Web, South Summit, Smart City Solutions, Pixel Camps, etc.

A video showcasing all services provided to startups during the 1st call is available at https://youtu.be/nk3VC8L1E40

In order to apply to this 2nd call, the data-specialized startups should be part of the European Union. The application is done via a form available to from March 16 to May 31: https://index.co/program/data-market-services-2020

DMS Accelerator is a consortium comprised of several organizations (such as ERCIM/W3C) that aim to help SMEs and startups specialized in data to overcome existing barriers in markets. This project is funded by the European Union Research and Innovation Program Horizon 2020.

https://www.datamarketservices.eu/

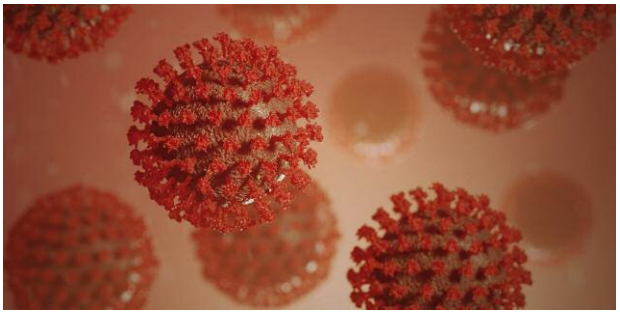
FMICS 2020

FMICS 2020, the 25th International Conference on Formal Methods for Industrial Critical Systems will be held in Austria on 2-3 September 2020.

FMICS is the yearly conference organised by the homonymous ERCIM Working Group. The conference series provides a forum for researchers who are interested in the development and application of formal methods in industry. FMICS 2020 is part of the QONFEST umbrella conference comprising also CONCUR, FORMATS, and QEST, along with workshops and tutorials, from August 31 to September 5, 2020.
https://fmics20.ait.ac.at/

Pan-European Privacy-Preserving Proximity Tracing

ERCIM members Inria and Fraunhofer (Fraunhofer AISEC, Fraunhofer HHI and Fraunhofer IIS) are participating in the Pan-European Privacy-Preserving Proximity Tracing (PEPP-PT) initiative, launched by European scientists to create mobile apps useful in tracking the spread of COVID-19. PEPP-PT will focus on the development of applications that can trace contact and potential COVID-19 spreads across populations, not just now, but also potentially in the future. PEPP-PT will provide standards, technology, and services to countries and developers. PEPP-PT says they embrace a fully privacy-preserving approach and build on well-tested, fully implemented proximity measurement and scalable backend service. Researchers and institutions are invited to join. PEPP-PT is establishing a partner management team to help partners to get going quickly.
https://www.pepp-pt.org/

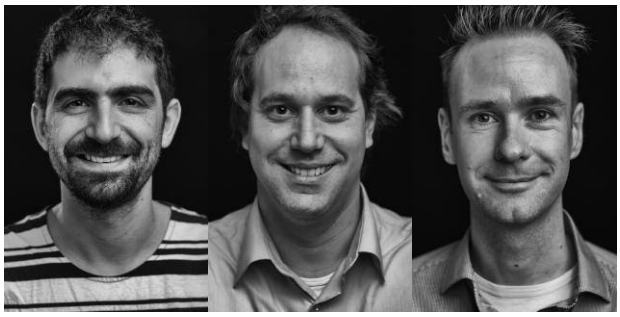


Artificial Intelligence by CWI and Amsterdam UMC Proposes the Best Radiation Treatment Plans in Clinical Practice for the First Time

CWI researchers, together with the department of radiation oncology of Amsterdam UMC, have developed software based on Artificial Intelligence (AI) that quickly proposes multiple radiation treatment plans for each patient. The software functions as a type of 'route planner' for the doctor: it presents multiple plans based on the data of the patient that represent trade-offs between giving sufficient radiation dose to the tumor with as little damage possible to the surrounding organs. This not only helps the doctors to make plans faster, it will also improve plan quality. Amsterdam UMC has treated the first patient with a plan proposed by the new AI on March 17, 2020. The innovative technique will be used for the treatment of prostate cancer with internal radiation.

The development of the new software was made possible by a close research collaboration between CWI's Life Sciences and Health group, the department radiation oncology of Amsterdam UMC-location AMC, and Elekta, a company that delivers radiation equipment and software to hospitals.
https://kwz.me/h4y

Three Awards for CWI Researchers



From left: Daniel Dadush, Pablo Cesar and Marc Stevens. Photos: CWI

Daniel Dadush received Van Dantzig Prize

Researcher Daniel Dadush from CWI has been awarded the Van Dantzig Prize, together with Marloes Maathuis from ETH Zurich. This prize is considered the highest Dutch award in statistics and operations research and is awarded once every five years. Dadush and Maathuis were given recognition for the award on 12 March, at the annual meeting of the VVSOR, the Netherlands Society for Statistics and Operations Research, which took place in Utrecht.
https://kwz.me/h4t

Pablo Cesar awarded Dutch prize for ICT research 2020

The 2020 Dutch Prize for ICT Research is to be awarded to Pablo Cesar. The group leader of the Distributive and Interactive Systems (DIS) group at Centrum Wiskunde & Informatica (CWI) and associate professor at Delft University of Technology is given the prize for his research on modelling and controlling complex collections of media objects (including real-time media and sensor data that are distributed in time and space). The prize comes with € 50.000, that can be freely spent by the winner to support their own research.
https://kwz.me/h4d

Levchin prize for Marc Stevens

For their groundbreaking work on the security of collision resistant hash functions, researchers Marc Stevens (CWI) and Xiaoyun Wang (Tsinghua University, China) were awarded one of the two 2020 Levchin Prizes for real-world cryptography. The other prize recipient is Ralph Merkle, known as one of the inventors of public key cryptography and cryptographic hashing. The winners received the award at the Real World Cryptography Conference in New York on 8 January. The prize, comprising a trophy and 10.000 dollar, was established by Max Levchin, CEO of the fintech company Affirm and co-founder and former CTO of PayPal.
https://kwz.me/h4c

ERCIM
European Research Consortium for Informatics and Mathematics

ERCIM – the European Research Consortium for Informatics and Mathematics is an organisation dedicated to the advancement of European research and development in information technology and applied mathematics. Its member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry.

ERCIM is the European Host of the World Wide Web Consortium.

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Figure 1: