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ERCIM NEWS

Special theme:

PANDEMIC Modelling & Simulation

Also in this issue

Research and Society:

Meeting the Challenges of COVID-19

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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April 2021: Brain-Inspired Computing

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JOINT ERCIM ACTIONS

RESEARCH AND SOCIETY

This section “Facing the Challenges of COVID-19” was coordinated by Peter Kunz (ERCIM Office) and Annette Kik (CWI).

SPECIAL THEME

The special theme “Pandemic Modelling and Simulation” has been coordinated by the guest editors Salvatore Rinzivillo (ISTI-CNR), Joakim Sundnes (SIMULA) and Karin Rainer (AGES)

RESEARCH AND INNOVATION

ANNOUNCEMENTS

Stefano Cresci Wins the 2020 ERCIM Cor Baayen Young Researcher Award

Stefano Cresci has been selected from among 13 excellent short-listed nominees as the winner of the 2020 ERCIM Cor Baayen Award. Stefano, from CNR, Italy, has received the award in recognition of the outstanding scientific quality of his research and the impact on science and society that he has already achieved as a young researcher.

Stefano Cresci is currently employed at the Institute of Informatics and Telematics at the National Italian Research Council (IIT-CNR). He obtained his PhD with honours in 2018 from University of Pisa, Italy, publishing a thesis titled "Harnessing the Social Sensing revolution: Challenges and Opportunities". His timely and societally relevant research focuses on the study of online social networks, with the twofold goal of evaluating their potential to improve society, and their pitfalls. As part of his research, he studied how to collect, filter, and analyse real-time online data streams to improve situational awareness in the aftermath of natural and human-made disasters, for example earthquakes, riots or terrorist attacks. Stefano has also been investigating the challenges related to the use of online social network data, pioneering studies on online deception and on the manipulation of online information. Since 2013, he has been studying problems such as the automatic detection of automated and malicious online accounts – for example, the detection of social bots and trolls, and the spread of false and misleading information, like fake news detection.

His research is highly interdisciplinary, lying at the conjunction of systems and information security, AI and data science, web and social media. In his research he adopts and develops web crawling and scraping techniques, big data analytics, as well as novel data science and AI techniques, making several widely-acclaimed contributions to these areas of research.

He has published over 50 papers, including publications in highly prestigious journals and conferences in the fields of web analytics and security. These contributions have amassed more than 1,500 citations on Google Scholar, with a high h-index (which measures the impact of a particular scientist).

Stefano is an active and recognised member of the research community. During and after his PhD, he was invited to visit renowned international institutions such as the Hamad Bin Khalifa University in Doha (Qatar) and the Nokia Bell Labs in Paris (France), where he spent several months researching solutions to threats to information credibility. Stefano regularly organises and chairs workshops and special issues at important conferences and journals. He has also held a number of presentations and keynotes at international venues. He holds editorial roles for several journals, and reviews for major conferences and journals in his scientific fields, including Nature Communications. Over the years, he has been involved in many national and European research projects.

In acknowledgment of his notable scientific contributions and the impact of his research, Stefano has already received several prizes. His PhD thesis was awarded the 2018 PhD thesis Award by the Italian Section of the IEEE Computer Society. In 2018 he received a SAGE Ocean Concept Grant in recognition of his contributions to social and political scientists as well as to data journalists. In 2019 Stefano received the IEEE Next-Generation Data Scientist Award in Washington, DC – awarded for exceptional early-career achievements in data science. Recently, he was selected by senior ACM members as one of the most promising young researchers in computer science and was invited to participate in the 8th Heidelberg Laureate Forum, meeting the recipients of the most prestigious awards in computer science and mathematics.

In addition to the scientific value of Stefano´s research, it is important to underline its societal impact. The Italian State Police, Europol, and the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) are using some of his algorithms and tools. The Italian National Institute of

COR BAAYEN YOUNG RESEARCHER AWARD

The Cor Baayen Young Researcher Award is awarded each year to a promising young researcher in computer science or applied mathematics. The award carries a prize of € 5000.

Nominees must have carried out their work in one of the 'ERCIM countries': Austria, Cyprus, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, Norway, Poland, Portugal, Sweden and The Netherlands. Nominations have to be made by a staff member of an ERCIM member institute.The selection of the Cor Baayen Young Researcher Award winner is the responsibility of the ERCIM Human Capital Task Group.

The Cor Baayen Young Researcher Award is named after Cor Baayen, the first president of ERCIM. Cor Baayen played an important role in its foundation. Cor Baayen was scientific director of the Centrum voor Wiskunde en Informatica (CWI) in the Netherlands, from 1980 to 1994.

For more information including the presentation of all the award winners since 1995 is available at:

https://www.ercim.eu/human-capital/cor-baayen-award

Geophysics and Volcanology uses the social media emergency management tools developed by Stefano.

His research has also attracted the attention of non-profit organisations and NGOs, such as the United Nations via their Global Pulse initiative, and First Draft – a renowned non-profit organisation devoted to the fight of mis/disinformation.

ERCIM Cor Baayen Award 2020

Winner:
Stefano Cresci (IIT-CNR), nominated by Maurizio Tesconi (IIT-CNR)

Honorary mention
- Jasmijn Baaijens (Harvard Medical School-DBMI), nominated by Leen Stougie (CWI)
- Kelwin Fernandes (NILG.AI), nominated by Jaime Cardoso (INESC)
- Xixi Lu (Utrecht University), nominated by Lynda Hardman (CWI)
- Paulo Martins (Samsung R&D Institute UK), nominated by Leonel Sousa (INESC)
- Hana Vrzakova (Kuopio University Hospital and University of Eastern Finland), nominated by Tuomo Tuikka (VTT)

Finalists
- Michalis Agathocleous (AC Goldman Solutions & Services), nominated by Chris Christodoulou (University of Cyprus)
- Marcella Bonazzoli (Inria) , nominated by Laura Grigori (Inria)
- Michael Fasoulakis (FORTH-ICS), nominated by Dimitris Plexousakis (FORTH)
- Adam Karczmarz (University of Warsaw), nominated by Piotr Sankowski (University of Warsaw)
- Michalis Mountantonakis (FORTH-ICS), nominated by Yannis Tzitzikas (FORTH)
- Hussein Rappel (Alan Turing Institute/Cambridge University), nominated by Stéphane BORDAS (University of Luxembourg and Cardiff University)
- Michał Włodarczyk (Eindhoven University of Technology), nominated by Marek Cygan (University of Warsaw)

Evaluation Committee
The Evaluation Committee was composed of Monica Divitini (NTNU - chair of the ERCIM Human Capital Task Group); Thierry Priol (Inria); Fabrizio Sebastiani (CNR ISTI); Jerzy Tiuryn (UWAW); Edgar Weippl (University of Vienna). The evaluation was conducted with the support from the ERCIM members' representatives. The decision was unanimous.

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 ERCIM fellowship helped me to acquire technical skills for my projects and obtain the required accreditation for a professorship in Albania. It is a rewarding process which has strengthened my career with a strong international network, exposure and skills development. This fellowship is one of the best programs available for any scholar seeking to advance his or her research career.

Ogerta ELEZAJ
Former ERCIM Fellow

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.

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;
- submit the following required documents: cv, list of publications, two scientific papers in English, contact details of two referees.

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 2020, 22 young scientists commenced an fellowship and 77 fellows have been hosted during the year. Since 2005, the programme is named in honour of Alain Bensoussan, former president of Inria, one of the three ERCIM founding institutes.

http://fellowship.ercim.eu

MEETING THE CHALLENGES OF COVID-19

During the COVID-19 pandemic, which is still impacting us, many research institutes have asked their employees to work from home. This presents challenges that need to be resolved. We asked ERCIM members how they have adapted to the pandemic and how the institutes and researchers have altered methodologies and processes. How do they stay in contact with colleagues? How are they introducing new colleagues, especially those from overseas, to the research organisations? How are institutes helping people who are working from home over longer periods? Which platforms do they use to communicate with their team? What is good practice for team building in these times? All institutes are facing these questions. In this section, contributions from CNR, CWI and W3C describe these particular challenges and how the institutes have responded to them.

This section was coordinated by Peter Kunz (ERCIM Office) and Annette Kik (CWI)

Smart Working at CNR-ISTI in the COVID-19 Era

by Roberto Scopigno and Daniela Giorgi (ISTI-CNR)

The CNR Institute for Information Science and Technologies describes its experience in adapting to smart working, which has dramatically changed the institute's modus operandi for most of the year 2020.

When the Coronavirus epidemic led to the abrupt closing of all its offices in March, CNR introduced the Covid-19 smart working regime. This was the most significant experiment on smart working ever done at CNR. Indeed, CNR had never accepted that much research activity could be done anywhere and at any time.

In spring, we operated under a remote-work-only regime. Then, after alternating between home and office working for a few months, in November we were back at home. Though what we have experienced has not been real smart working, but rather a forced situation in which we had no or limited choice about where (and how) to work, this experience has provided much food for thought: could the solutions we devised to run research groups remotely be continued after the emergency has ended? Can smart working be successful in complex research organisations such as CNR?

The past months have tested both our organisation and our resilience. Embarking on a well-planned smart working project would require months, if not years, to redesign policies, technologies, and behaviour. Instead, at the beginning of March, we were mostly unprepared: we had to implement a new organisation of work in just a few days. But we were fast to react. We were eager to keep Italy up and running. This included continuing to run existing projects as well as starting new activities designed in response to the epidemic.

Of course, there have been practical issues in moving our offices to our homes. The administrative staff used paper archives and desktop rather than portable computers. Often, home Internet connections were insufficient to serve the needs of entire families. Luckily, it was easy to solve the technical issues by bringing some of the office equipment home or buying new devices.

The major problems were organisational. With family homes of a small size, several people had to work in kitchens or living rooms, with many sources of distractions. Spring school closure forced many colleagues to divide themselves between their professional roles and activities as tutor/ technician/babysitter for children. An experience that either destroys or fortifies you forever is taking part in an international project meeting while dealing with interruptions from impatient kids.

The other side of the coin was that, since we all were in the same boat, we felt a sense of common fate, which created new bonds. We began to know each other's homes, as the backgrounds of virtual meetings showed kitchen furniture or toy shelves. We laughed when a colleague had to leave the virtual conference to let a yowling cat out of the room, and others laughed at us when we had embarrassing conversations with our families without muting our mikes. As weeks passed, we learned how to keep virtual meetings light, while still productive.

We found that virtual meetings can save time and money. We experimented with many different virtual platforms and bought professional accounts when needed. The (impossible) quest for the ideal platform has not been solved yet, but we are getting there.

Our annual meeting, which we call ISTI-Day, turned virtual as well. While in the past we had a full-day conference, this year we distributed the event across three weeks, one afternoon per week, to maximise attendance. The program featured both plenary talks for researchers to share their latest advances, and poster sessions for young researchers and PhD students. Keeping young researchers motivated and involved has always been a priority for us. This year we felt the need even more, as young people are likely to suffer from isolation from their lab environments.

Admittedly, we missed social contact and social life. But there is more to smart working than the reduction of social interaction. CNR-ISTI is organised in 12 large research groups, and much informal discussion and exchange of new ideas happen during coffee or lunch breaks. We missed these chances, which often turned into productive brainstorming. Despite many jokes circulating about Shakespeare writing plays and Newton discovering fundamental laws while being isolated during pandemics, we were well aware that social distancing could affect motivation, creativity, and productivity. We conducted an informal survey among ISTI lab heads to investigate if researchers were mostly working on established projects or if brand new ideas emerged during the epidemic period. The replies indicated a perceived decrease in our capacity to innovate during the stringent spring lockdown.

Our lab heads had to look for different ways to maintain relations with and among the lab members, as well as upholding the sense of belonging to the group – from formal teams on yet another platform to informal digital chats or virtual happy hours through video conferencing tools. Dealing with the sense of isolation has been very important: it is essential that the reduced visibility of smart workers does not result in missed opportunities.

A downside was a perception of reduced delineation between work and non-work time, with the risk of lower quality down-time. As the epidemic emergency period is now getting longer, learning how to switch-off is growing in importance.

Finally, to evaluate our countermeasures to the emergency situation, we will have to analyse our research production in the coming months. This analysis will need to take into account gender issues, to check whether the need to balance family care with research had a different impact on women than men, and to help us proceed towards full gender equality.

Overall, we look at the experience from a glass-half-full perspective. Without a doubt, we see smart working as an opportunity for the future, not as an ordeal to endure.

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Home Office - A Curse or a Blessing?

by Manuela Kos (AIT Austrian Institute of Technology)

Together through distance, but virtually. The unexpected disruption called COVID-19 came upon Europe at a rapid pace. Companies and their employees had to adjust to the situation in the best possible way and to embrace new routines. We explain how this was achieved by the AIT Austrian Institute of Technology.

In March of this year we were really thrown in the deep end. One day, employees were going into work as usual; the next, everyone was discouraged from attending the office unless absolutely necessary, e.g. to sustain a minimum presence of administration staff on site, or work in labs. At this time COVID-19 was still unknown territory for society.

The restrictions on social and work gatherings didn't only affected our institute: they had more far-reaching consequences than initially anticipated. Trade, cultural and leisure facilities and schools were affected, and some families faced the challenge of working from home. The situation was further intensified by home schooling, home cooking, home cleaning, home playing, etc. This was particularly challenging for families with several children, necessitating an

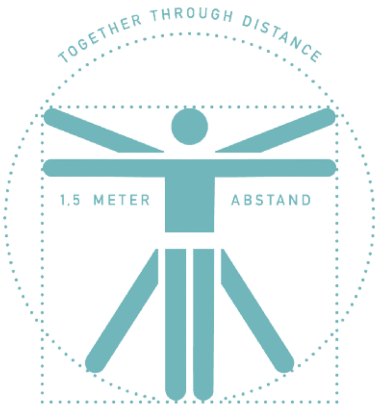

Figure 1: Keeping 1.5m distance is required also in the office.

unprecedented level of multitasking. At the AIT, and especially at the Center for Digital Safety & Security, we were well-equipped to embrace this challenge. Over 95% of our employees have laptops and were able to continue their work without interruption. Special consideration was given to employees with childcare obligations, who were supported through various models, both by colleagues and the company. After a short "acclimatisation phase" to this new situation we managed to do this well, in my view. Several factors contributed to the success of this process:

- Stay connected: The informal "coffee chats" from the office kitchen were held virtually. Lots of informal exchange occurs in this kind of setting: The final status of a project is discussed; quick updates about deliverables are passed on; and briefings for the next meeting are discussed. Of course we also used these meetings for informal social conversation.
- Come with us: New colleagues, who had already had the challenge of changing jobs in this particularly volatile time, were virtually taken along. We endeavoured to hold the meetings with a camera so that new colleagues had not only the voice but also a visual impression of their colleagues. We also held mixed meetings when circumstances allowed: one part of the group physical and the other part virtual. Tours of our institute have also helped to familiarise new colleagues with the new environment. "Pop-up telcos" were also established, replacing the idea of visiting our own office and encouraging informal exchange.
- Multi-channel presence: Various media offer different services. The pandemic forced us to break out of our established routine and enter new territory. This has created a variety of new opportunities. I would say that many of us now know and use more than just one conference tool. In this respect, too, we have learned and changed very quickly. Zoom, Go to Meeting, Webex and Skype for Business are now part of everyday life and will continue to accompany us into the future. Microsoft Teams have proven to be particularly useful. By creating teams and subgroups, information can be exchanged quickly and very easily. This also plays a major role in the social aspect, since almost no physical exchange was possible.
- Stay relaxed, practice acceptance: A key factor for me was not to lose my nerves. All over the globe you could see funny pictures of crashed video calls, and this is something we experienced too. The motto has to be: "Stay cool. Do what you can and try to be as good as possible in the situation". Cooking lunch during a telco or sitting in front

of the computer in the evening for a concentrated period of work helped a lot. But good coordination and a schedule were also necessary. In web conferences, it was sometimes funny to hear children talking or crying in the background, dogs barking, or interruptions from telephones or door-bells ringing.

Currently in our second lockdown, we are almost old-hands at working from home. However, it is still critical to note the full scope of perspectives and experiences: colleagues who live alone have particular challenges to deal with. The problem here is not that there are too many people in the home office, but too few. The danger of isolation is real; but we at AIT have made preparations for this situation, addressing it through special programs and a virtual offer of a meeting or a consultation hour. AIT's sports club offered online Live-Stream Team Events, Outdoor and Live-Stream Workouts. In the office, face masks were available for free, and the slogan displayed everywhere was "Together through Distance" (see Figure 1). In Austria the "standard measure" of social distancing was the "Baby-Elephant", about 1.5 m, because just before the COVID-19 outbreak a baby elephant was born in the Schönbrunn Zoo in Vienna, a very popular event.

Formal department meetings, European project reviews and other activities (e. g. standardisation meetings, workshops and training) took place virtually. Additional effort was necessary to develop videos instead of live demonstrators or exhibition booths. We have found this form of online interaction to be effective when listening and taking part in a more passive way, but not so good for real personal networking, brief small-group meetings aside the main meetings as done normally during coffee breaks, and intensive discussions. Further, the very efficient information exchanges that can take seconds during regular work hours across an office desk, may instead take days, requiring email exchanges or return phone calls. The increased number of telcos or web conferences, often scheduled simultaneously, present another challenge. The attitude that "it is only a web meeting" has raised the expectation that shorter weekly meetings between project partners/clients can replace the meetings that are traditionally held over several days two to three times per year. and could take place very (and too) often and at any time If a web conference includes partners from East Asia to California, even the selection of an appropriate time slot is a challenge.

Curse or blessing? A little of both would be the answer here. On the one hand, this situation gives us the opportunity to build up and maintain social contacts virtually – of course with some compromises. Also, flexibility must be provided and accepted by both employers and employees. Compassion and empathy are vital too. In my opinion, a home office is a nice option, but should not be a permanent situation.

Links:
[L1] https://www.ait.ac.at/en/
[L2] COVID Pop-Up Hub, https://kwz.me/h2w

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Special Video Pages for the W3C Member Meetings

by Bert Bos (W3C/ERCIM)

In 2020 the global pandemic accelerated a global trend towards virtualisation, making the Web even more critical to society. W3C converted its physical meetings and workshops to virtual ones, tapping into the capabilities of the Web it has been leading for over 25 years.

We replaced the usual presentations with recorded videos that participants could view in their own time before the meeting. For the two W3C member meetings (May and October 2020) and a workshop in September, the W3C team created special web pages to make watching talks as convenient as possible. To make the videos easier to follow, and accessible, we added transcripts and subtitles in four languages (English, Korean, Japanese and Simplified Chinese).

We leveraged our own technologies, such as HTML, WebVTT and CSS. At the core are the HTML elements <video>, <track> and <audio>.

The whole process took six weeks from creating the agenda and inviting the speakers to publishing the video pages.

The video pages

A combination of server-side and client-side code combined the videos, slides, transcripts and subtitles into web pages, one page per presentation, with navigation links between them (see Figure 1).

The pages allow different ways to watch the talks: by reading the slides and the video transcript; by playing the video in a corner of the screen while reading the slides and the transcript; or by watching a synchronised slide show and video side by side ("kiosk mode"). The video can display captions or subtitles. When watching the slide show, the captions or subtitles are under the slides.

Captions and subtitles

To make the captions and subtitles, we hired the services of a specialised company. That gave us captions with good timing, although the text needed some editing. Many speakers were not native speakers of English and several talks were technical in nature, which is probably why some words were not correctly transcribed and some punctuation was wrong. The English captions needed a little editing; the translations needed more.

The transcripts were generated from the captions, with minimal editing, most notably to mark the places where the speaker moved to the next slide.

Video hosting

We did not host the videos ourselves, but got help from WebCastor, who offered their StreamFizz platform.

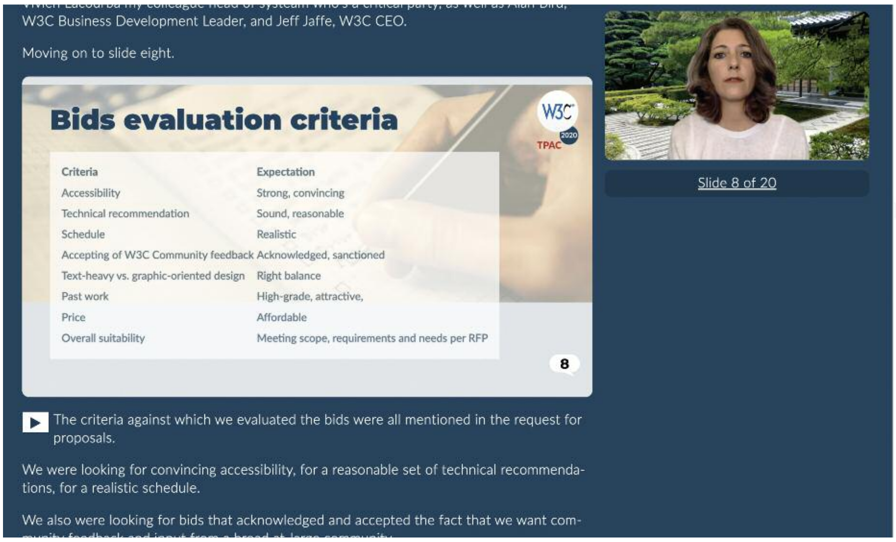

Figure 1: Screenshot of a medium-size browser window with the slides and the transcript on the left and a small video on the right.

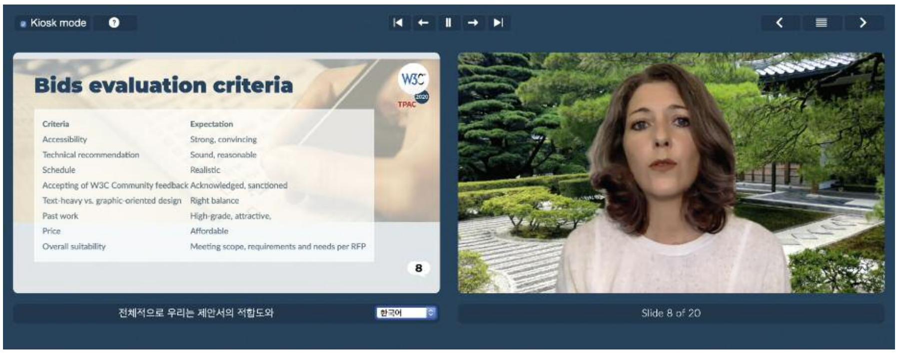

Figure 2: Screenshot of a maximised browser window, showing 'kiosk mode': one slide on the left, the video on the right and subtitles (here in Korean) under the slides.

Using a video hosting service has advantages and disadvantages. The platform automatically provided lower-resolution versions of each video and switched between them depending on bandwidth; it made backups; and offered good network connection. On the other hand, it limited the accuracy with which captions, slides and video could be synchronised and it required the captions to be loaded twice: once to display them in the video and once to display them under the slides, because the video player could not export them.

Accessibility and the default user interface

A page that is built by a program from various pieces made by different people, and which on top of that contains scripts that modify the contents in response to user actions, has a high risk of not being very usable.

There appeared to be a difference of opinion between people relying on the visuals and those relying on assistive technology, with respect to one aspect of the pages:

Everybody liked the "kiosk mode", but people seeing the pages for the first time had trouble realising that it existed and then had trouble finding the button to activate it. We tried different wordings for the button, but then, on the advice of the "visual" people, just made kiosk mode the default. There was still a button, but it served now to exit from kiosk mode.

However, that led to complaints, because people relying on assistive technology now found themselves on a page that appeared to be incomplete, with only one slide and no transcript. They had trouble understanding that the button would reveal the other slides and the transcript.

So, in the end, we went back to the transcript mode as the default, with a button to enter kiosk mode. We also added a help page with a longer explanation of the button. And we made it so that, if people navigated to the next talk while in kiosk mode, that next talk would start in kiosk mode.

Continuous system improvements

As detailed in a blog article [L1] on the W3C site, we improved the system after the first meeting. We allowed PDF slides in addition to the Showr and b6+ slide frameworks. The kiosk mode now only shows the current slide, the video, buttons to navigate the slides, buttons to jump to the next/previous talk and a button to exit kiosk mode. It omits the usual header, footer and menus of other web pages, and it has no scroll bar anymore. Finally, in version 1, the slides and video were scaled down on small screens, but not scaled up on (very) big ones. They are now always as large as possible. That allows watching them on a TV screen while sitting at a distance.

Link:

[L1] https://www.w3.org/blog/2020/09/making-video-pages-for-the-w3c-ac-meeting/

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From We@CWI to CWI@home

by Angelique Schilder (CWI)

During the coronavirus pandemic, CWI was one of the many research institutes that asked their employees to work from home, which presented challenges for everyone. The Dutch Research Council (NWO) conducted a survey to find out about researchers' experiences of working from home. Based on the results of the survey, CWI developed recommendations to ease the pressure of working at home.

Since March 2020, most CWI employees have been working from home due to the COVID-19 outbreak. In June the rules were relaxed a bit, but since 14 October 2020 we have been in partial lockdown again and since mid-December in total lockdown. Working from home has once again become the norm. For CWI this means a decrease in the number of employees working in our building. At the time of writing this article (early December 2020), about 15% to 25% of employees are present at CWI each business day. Each group leader and department manager decides on a daily basis which staff members will be on site, with a maximum per group.

The second partial lockdown undoubtedly feels like a burden for many. Just as restrictions were starting to ease in the summer, and we could meet a little more often again, we were thrown back into working from home. The big challenge for both management and employees is: how do we stay connected with our colleagues so that we stay motivated and maintain the quality of our work?

In June, a survey was conducted by the Dutch Research Council (NWO) at all institutes to investigate how working from home is experienced during the COVID-19 crisis. We have used the results to develop further recommendations to help home-based employees maintain their wellbeing and optimise their home facilities and communication.

Well-being

Approximately 20% of our scientific staff scored lower than a six on a scale of one to ten when it comes to job satisfaction when working from home. Finding a work-life balance was also reported to be difficult for more than a quarter of scientists. In addition, over a quarter of respondents said they feel less fit and missed contact with colleagues. To a large extent, the scientific staff experienced more work pressure than the support staff. The PhD students (OIOs), and especially new students from abroad, are seen as being particularly vulnerable: they have come to a new country and a new work environment but are unable to attend it in person. When asked, it appeared that all teams meet online several times a week, both for business and personal contact.

When it comes to promoting the wellbeing of employees when working from home, we offer the following recommendations:

- Supervision meetings between PhD students and their supervisors may take place at CWI.
- A buddy system has been set up in which a new employee is linked with a colleague within the group. This is especially important for new expat employees to help them familiarise themselves with Amsterdam and the organisation
- We will offer more online, such as time management, mindfulness and personal development courses
- We are establishing a more intensive course for scientific staff on the subject of mental strength, with topics including motivation, stress management, concentration and self-confidence. This will be offered in 2021
- Extra coaching and supervision will be made available
- The activity committee for PhD students and postdocs regularly organises online events, such as pub quizzes, chess competitions and movie nights, where everyone is welcome
- We encourage employees to make the time to go for walks. This could also be done with colleagues.

Facilities

The employees are largely very satisfied with the facilities that have been available to them during the COVID-19 restrictions. Recently everyone has received their own Zoom account. People can borrow office utilities, such as the monitor, mouse, keyboard and office chair, from CWI, to use at home. Within CWI, various extra communication channels are used, such as Slack, Zoom, WhatsApp, and Matrix / Riot. To facilitate internal processes, we are investigating other online improvements for remote whiteboard facilities and digital document signing. A number of meeting rooms within CWI has already been set up for hybrid working: meeting conducted partly live and partly online will be the way of the future.

Communication

At the start of the lockdown period in April, we made immediate efforts to increase our internal communication. The CWI@home corona newsletter is published every fortnight and includes all current affairs. This includes, for example, a section in which an employee tells about his or her own home office, with a photo. Personnel magazine We@CWI also features pictures of employees during COVID-19 times. Every three weeks there is an online update meeting where the director gives the floor to employees who have achieved a result such as a prize, award or a project, new employees are introduced and other current issues are explained. And on special occasions, employees are surprised at home with a small present; December is a fun month for that ☺.

Hopefully our measures can contribute to a more comfortable working-from-home experience and better employee wellbeing for the coming period. We see that everyone is really doing their utmost best, but we are deeply aware that this remains a difficult time. Let's continue to take good care of each other.

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Panel Discussion on Mobile Contact Tracing Apps at IEEE MDM 2020: A Summary

by Demetrios Zeinalipour-Yazti (University of Cyprus) and Christophe Claramunt (Naval Academy Research Institute)

The outbreak of the COVID-19 global pandemic has called for practical information and communication technologies to contribute to the worldwide effort to track and curb the spread of the virus. To this end, a series of mobile contact tracing applications (MCTA) have been developed to help identify people who may have been in contact with a person infected with COVID-19 and to rapidly deliver information to these individuals. We gathered together prominent scientists to discuss the major and open topics surrounding MCTA [1] in an online panel discussion at the 21st IEEE International Conference on Mobile Data Management [L1], held between 30 June and 3 July 2020, Versailles, France.

The aim of the panel discussion on mobile contact tracing apps (MCTAs) was to convey to the audience an advanced understanding of the unique characteristics, socio-technical challenges and opportunities in the sphere of contact tracing mobile apps. The panel comprised eminent industrial, governmental and academic experts: Prof. Vania Bogorny, Federal University of Santa Catarina, Brazil; Dr. Yannick Léo, Emerton Data, France; Prof. Stan Matwin, Dalhousie University, Canada; Mr. Thierry Roussel, Alstom SA, France; Prof. Moustafa Youssef, Alexandria University, Egypt. Together they brought a wealth of experience to the discussion, giving decisive answers to challenging technical, socio-economic and ethical questions that were open to public debate amongst a large international audience of several hundreds of academics and postgraduate students. The discussion revolved around a series of key issues that mobile contact tracing applications have faced during the COVID-19 pandemic, pinpointed the key technical challenges and opportunities, and suggested how we might address them.

On the topic of privacy and ethics, there was a clear consensus about the importance of relying on a trusted entity, supported by the broader scientific community, to direct the development of the MCTAs. To be confident in the way the data is stored and used, and to ensure that the most balanced centralised/decentralised implementation architecture is used, this task should not be left to smartphone operating systems such as Apple and Google.

Further, in the absence of a strong political strategy and widespread public acceptance, MCTA will be useless. Indeed, robust political engagement and continuous pedagogy across the media are needed to secure adherence by a large proportion of the population (the current penetration rate is between 5 and 20% in western countries, which is far from sufficient). This kind of strategic approach is essential if MCTAs are to succeed, and will lead to better coordination of development and implementation initiatives at the international level and better coordination from the World Health Organization. Legal issues are an important part of the picture as recently demonstrated in Australia where the Privacy Act 1988 was amended to ensure privacy protection for users of the national MCTA [2].

The inherent antonymy between privacy and MCTA means it is vital to develop specific protocols to guarantee data destruction in the long term (i.e., Sunset clause guarantee) and to clearly define how MCTA tracing data should be used and by whom. In the midst of a pandemic, timing matters: tracing data must be made available to the right people at the right time, as well as aggregated for epidemiologic studies and shared across regions. While these protocols should be coordinated across different implementations and mobile phone technologies, data security and integrity issues should also be carefully considered. Location-based data are another key issue to secure MCTAs. So far, indirect tracking technologies have been widely used, but GPS does not work everywhere and it is unlikely to be sufficiently precise or ubiquitous. There is a need for additional tracing sensors in indoor environments (BLE, Wi-Fi, RFID, etc.), fine resolution real-time data and easy-to-use interfaces.

Beyond government initiatives, applications such as live dashboards have been emerging from crowdsourcing initiatives that rely on volunteers. These apps, which are based on public trust and confidence, also deserve attention (e.g., COVID-19 Hong Kong Map [L2]).

The pandemic is leading to a change of paradigm, from individual to collective, as demonstrated by the success of many Asian countries in the combat against the COVID-19 pandemic. MCTAs form just part of the bigger picture; social distancing and compliance with health recommendations should be followed until a treatment and/or vaccine is available and distributed globally. The knowledge we acquire from this experience is likely to be invaluable in the future as human environmental exploitation and interaction contributes to further pandemics.

Links:

[L1] http://mdmconferences.org/mdm2020/panel.html
[L2] https://covid19.vote4.hk/en

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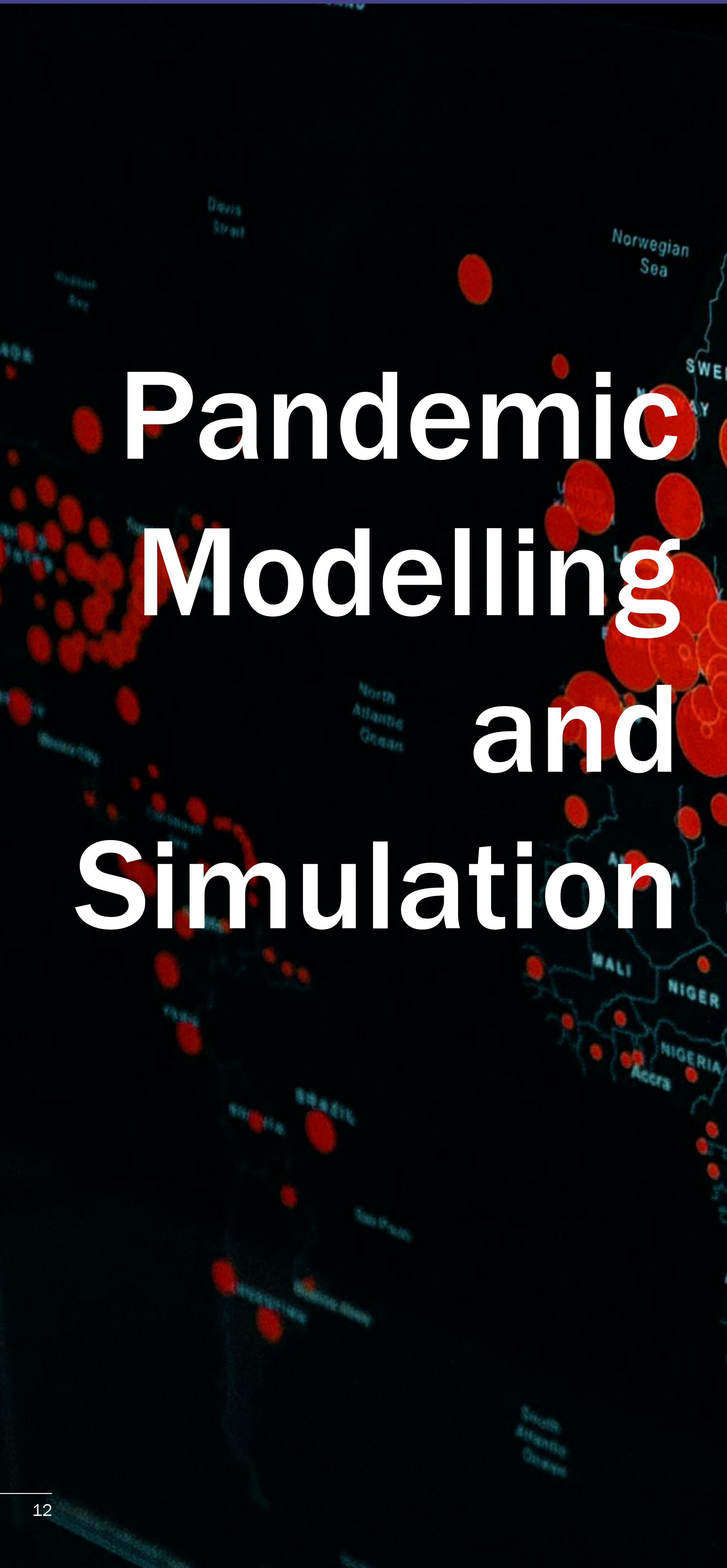
Pandemic Modelling and Simulation



Introduction to the Special Theme

by Salvatore Rinzivillo (ISTI-CNR), Joakim Sundnes (SIMULA) and Karin Rainer (AGES)

The epidemic emergency created by the rapid spread of SARS-Cov-2 drew attention to the methods and models that allow us to understand, predict and control the diffusion of infectious diseases. A thorough knowledge of the diffusion dynamics of viruses can help us conduct effective tracking of the transmission chain, precisely identify and assess restrictive measures, and promptly counteract local outbreaks. Mathematical models and simulation systems based on these models provide a means of obtaining such an understanding and enable evaluation and comparison of multiple mitigation approaches.

The ongoing pandemic has fostered cross-collaboration among multiple disciplines, including mathematics, physics, epidemiology, medicine and computer science, as well as social science, ethics, and law. The wide availability of data collected through multiple Big Data sources, and the advances in the field of data science and artificial intelligence (AI), have facilitated the development of data-driven, holistic epidemiology as a tool to analyse the disease dynamics and the assessment of the associated risks. In this special issue, we review recent advances in model-based and data-driven epidemiology that can help us understand and predict the ongoing global pandemic.

Situational monitoring for decision support

One of the main countermeasures to reduce the diffusion of the SARS-Cov-2 is the enforcing of social distancing, both with personal protections and movement restrictions. To balance the need for segregation with the general needs of society and the continuation of normal activities, contact tracing methodologies have been proposed, with the objective of quickly identifying the potential risk of contagion after the identification of an infected person. This kind of tracing can be implemented at different levels of granularity.

At the individual level, we can exploit mobile devices to reconstruct the social contacts of each person, by means of dedicated apps capable of estimating reciprocal distance on the basis of communication signals (Kondylakis et al, p.17; Faye p. 23). An app installed on the individual device may also be exploited to enforce communication with the healthcare system, providing direct dialogue with healthcare professionals, doctors, or assistance in the self-assessment of symptoms (Petrellis, p.14). The effectiveness of these solutions strongly depends on the penetration of their adoption within the population. The promotion of their usage should comprise a balanced evaluation of the challenges and opportunities for these apps, identifying trusted entities, supported by the scientific community, to develop dependable and secure applications. Moreover, a campaign to inform the population should be promoted, as well as guarantee the protection and oblivion of the data when it is no longer needed.

At the population level, communication infrastructures can provide country-wide indicators of population mobility, which is a vital input to predictive models of pandemic spread. Mobile phone data can be aggregated to develop indicators such as stay-at-home or mobility indices, providing a timely pulse of the situation and a measure of the effectiveness of the implemented solutions (Gaal et al, p.16). Also, earth observation images may offer a view to monitoring the effectiveness of the lockdown measures, by estimating the movement of vehicles from times of images (Duro et al, p.27).

The data that is actively collected by dedicated personnel should be certified by ensuring internal constraints and soundness (Carvalho, p.21).

The data collected with these approaches and others during the course of the pandemic help to reconstruct and model the dynamics of the diffusion and to compare with well-known spreading models (Kuruoglu and Li, p.25). Such data-driven analysis makes it possible to reason about the external impact of the pandemic on society since it goes beyond the healthcare sphere and has a profound impact on economics (Lo Duca and Marchetti, p.19) and other dimensions of our society (Ponsard and Nihoul, p.20).

Simulation systems and forecast

Simulation systems provide an estimate of the evolution of the epidemic in different scenarios, evaluating the impact of policy implementation and actions, like enforcing restrictions or introducing sanitary improvements, e.g., new treatments or vaccines.

The simulation systems may model the single individual and their social structure (Rossetti et al, p.29) evaluating different diffusion models and parameters. The system may also incorporate external layers, like mobility infrastructure, economic processes (Emrich and Popper, p.32), geography, and spatial structures (Zimeras, p.36).

The simulation systems suffer from high computational complexity to model the decision and actions of each synthetic agent. The impact of specific actions and phenomena, such as the airborne dispersion of droplets (Henry, et al, p.35), can be modelled as a specific parameter.

Alternative methods exploit a simulation process based on compartments, i.e. potential states of sub-populations. These approaches simulate the aggregate behaviour of a group of people to derive indicators for relevant indices (e.g., number of IBUs, replication number Rt) (Szederkényi et al., p.38). In the article by Edeling (p.33) verification techniques are applied to estimate the validity of the provided indicators.

Many of these models are well known in the literature and may potentially be enhanced by injecting observations collected from the data and models learned by machine learning algorithms (Veiber et al, p.40). Recent approaches (Coro, p.30) also take into account the influence of climate on the local diffusion of the virus.

This issue of ERCIM News focuses on research surrounding the current epidemic emergency: all the contributions address different actions to understand and counteract the spread of the virus. On one hand, the current COVID-19 epidemic has brought to the fore a wide field of research activities that have been developed in Europe over recent decades. An existing network of research institutes was able to pull together and collaborate to provide efficient tools to fight this emergency.

On the other hand, new research challenges have emerged: we highlight here two main topics “situational monitoring for decision support” and “simulation systems and forecast”. There is a clear and strong focus to embed evidence collected from the data into a repertoire of modelling theories that now require strong support from the patterns emerging from data collections, in particular for those diffusion dynamics that have not been clearly understood. A viral agent like SARS-Cov-2, that exploits social interactions among individuals to spread in the population, calls for more efficient simulation engines, that should be capable of managing the computational complexity of thousands or millions of synthetic agents, to explore potential scenarios derivable from policy actions.

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Exploiting a Symptom Tracking Platform for Social Distancing

by Nikos Petrellis (University of the Peloponnese)

Coronario is a multi-purpose platform that supports symptom tracking, social distancing and tracing, and experimentation with the reactions of the COVID-19 virus. Coronario users can be patients, medical practitioners and researchers. A major aim of the platform is to facilitate early detection and tracing of infected individuals as well as their behaviour based on localization and sensor indications.

Remote tracking of COVID-19 symptoms is essential to control the spread of the virus. Recent research indicates that symptoms such as coughing can reveal a COVID-19 infection with a greater than 97% success rate [L1]. Medical practitioners in primary healthcare units have to remotely assess the condition of people who are potentially infected by COVID-19, based on vague descriptions of symptoms. Missing or exaggerated information, rush and congestion, rapidly changing medical protocols and the subjective opinion of a doctor can lead to an inaccurate initial diagnosis. Reliable molecular tests (polymerase chain reaction-PCR) and immunoassays are used to confirm a COVID-19 infection. Less expensive, but also less reliable, rapid tests have recently been employed to keep up with the large numbers of people that need regular monitoring. Rapid tests are also useful for screening travellers and sampling asymptomatic people. These tests lead to a good statistical assessment of the pandemic, but symptom tracking and social distancing are still valuable weapons. Distinguishing the symptoms of COVID-19 from other infections is particularly useful in seasons other than summer, when colds and the flu are also common.

The Coronario platform was developed at the University of Peloponnese, Patras, Greece. Its primary goal was to reduce the traffic to the call centres of primary healthcare units during the first outbreak of COVID-19. Several approaches were proposed that involved smart phone apps or web pages that advise users about how to treat their symptoms [1]. In addition to symptom tracking, Coronario was equipped with additional functionality to support social distancing [2][3] and research, with the incorporation of advanced signal processing techniques and geolocation. The accuracy of the diagnosis is further improved through the use of data from external medical and environmental sensors (temperature, SPO2, blood pressure, glucose meter, galvanic skin sensors (GSS), etc). Some of these sensors (body position and respiratory sensors, GSS, etc) can also provide indications about the habits of the users. For example, body position can be used to estimate how long the user stays in bed or in conjunction with the respiratory sensor it can reveal how much exercise he gets.

COVID-19 diagnosis rules change regularly, and this was especially pronounced during the first outbreak, due to the unknown nature of this virus. For example, difficulty is smelling or tasting was added later as a typical COVID-19 symptom. Thus, dynamic medical protocol adaptation was one of the major features that the Coronario platform had to support. The medical protocols are used in Coronario to determine the alert rules, the sampling strategy of the various sensors and the list of questions that the user needs to answer. The alert rules are defined as conditions with associated actions. If the sensor indications and the information given by the user make a condition true, an alert action takes place. Sensor sampling strategy is a schedule of the medical tests the user should undertake using the available sensors listed in the previous paragraph. The dynamic adoption of new medical protocols makes Coronario useful in a range of circumstances. One target group includes people who are suspected to have COVID-19 but have not yet been tested. It is also useful for monitoring the condition of recovered patients once they have returned home from hospital. People who are more likely to be vulnerable to COVID-19, such as those with kidney failure or cancer. These patients can also benefit from the platform by using this tool before they visit their hemodialysis or oncology centre,

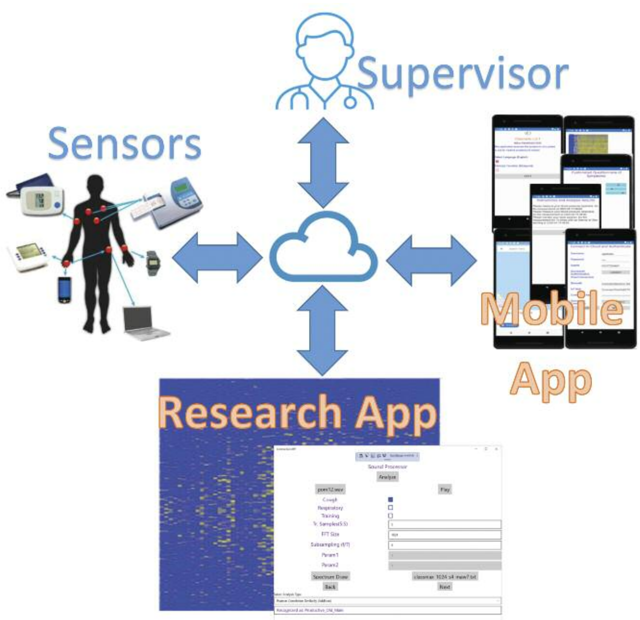

Figure 1: The Coronario platform consists of: (a) a mobile app to acquire patient input, geolocation, cough/respiratory sounds, and to allow communication between supervisor and patient, (b) medical and environmental sensor infrastructure, (c) cloud storage, (d) a supervisor app, and (e) a research app for experimentation.

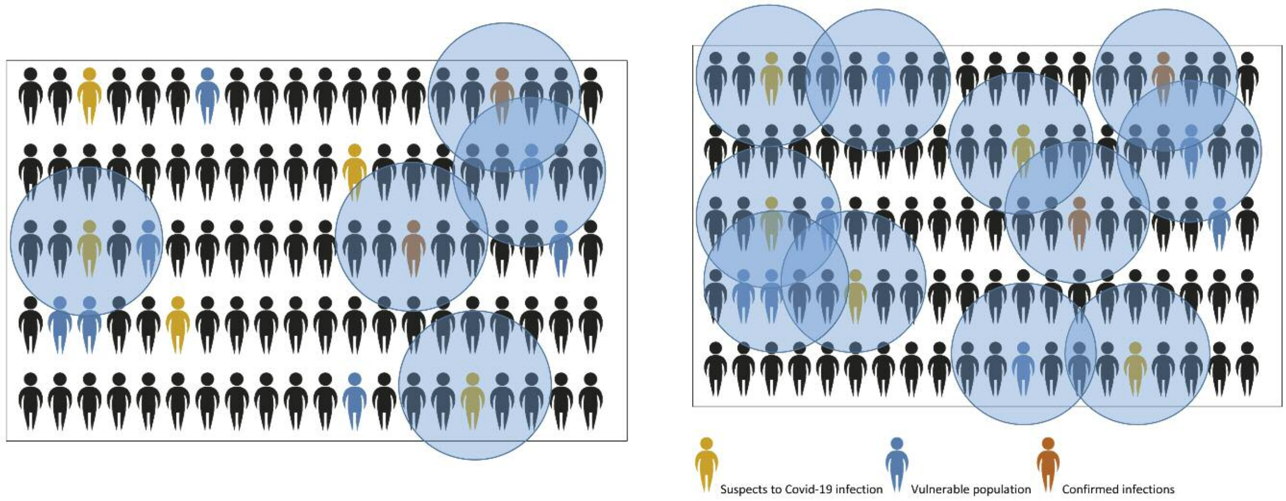

Figure 2: Coronario allows more individuals and groups to be monitored. Suspects with severe symptoms and an indicative sample of asymptomatic individuals are currently being tested: (a, left) Vulnerable people and all suspects, even with milder symptoms, are added to the population that is systematically monitored using Coronario; (b, right) Being able to identify more infected people leads to more efficient tracing and social distancing policies.

respectively, in order to make sure that they won't spread COVID19 once their symptoms indicate that they may have been infected.

The data gathered by the smart phone app and the sensor infrastructure can be stored in the cloud. The authorised supervising doctor accesses this information, approves a diagnosis and suggests actions through a desktop application. The doctor is also responsible for determining the appropriate medical protocol. In addition to the aforementioned Coronario components (user mobile app, sensor infrastructure, cloud, supervisor app), the platform is also equipped with an application for researchers, as shown in Figure 1. In this version of the Coronario platform, the sound of a cough or respiration can be analyzed and classified using an extensible set of pattern matching algorithms.

Social distancing and tracing is also supported by the smart phone's GPS (Global Positioning System), which determines the user's location. A web page with up-to-date information is accessed and the history of COVID-19 cases for the region is retrieved. The user is informed about the number of registered incidents in the local area. A detailed report about the evolution of COVID-19 incidents over recent days and their regional dispersion can encourage the user to maintain social distancing. Furthermore, preserving the GPS records of the user's phone for, say, 14 days, can enable contact tracing if the user is diagnosed with COVID-19.

Figure 2 shows how Coronario can assist in tracing COVID-19. Currently, some of the symptomatic (suspects) and asymptomatic patients will undergo a PCR test (Figure 2a). Many of the symptomatic patients will not recognise their symptoms as COVID-19 and will not perform a molecular test. Members of the vulnerable population will not do a COVID-19 test unless they have a reason to do so, such as developing symptoms or moving to a new medical centre. Coronario is expected to be used primarily by symptomatic individuals, urging them to proceed to a PCR test if necessary. Vulnerable people with weak immune systems can also be monitored systematically. The coverage of the infected people, and consequently the appropriate tracing, can be more efficient using a platform like Coronario.

The app adheres to the General Data Protection Regulation (GDPR) guidelines: all users are authenticated and data are encrypted and exchanged anonymously. Most of the data processing is performed locally in the user's mobile application or by the medical sensor controller. Only the necessary information is uploaded to the cloud and is deleted as soon as it has been accessed by the authorised supervisor. The data used for scientific research (e.g., cough sounds) are anonymous, and used only after user consent.

The next step is to test and improve the platform in a hospital environment. Even if a vaccine or treatment for COVID-19 is developed, Coronario will still be useful for tracking any similar viruses.

Link:
[L1] https://kwz.me/h26

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Population Movement Monitoring Based on Mobile Phone Usage Data to Support Pandemic Decision Making

by Peter Gaal, Miklos Szocska, Tamas Joo and Tamas Palicz (Semmelweis University, Budapest)

The analysis of routinely generated Big Data is increasingly seen as an inexpensive method to support evidence-based policymaking and implementation. Analysing routine data generated as a result of the use of mobile phones has long been recognised as a potential method to monitor population movement. This would provide invaluable information on the impact of social distancing measures that were implemented at an unprecedented scale during the COVID-19 pandemic [1]. While population movement monitoring on the basis of mobile phone use seems an obvious choice to support the management of the outbreak, several technical questions need addressing: in particular, the challenge of collating data from different mobile network providers. There are also data protection concerns, such as the need to comply fully with General Data Protection Regulation of the European Union (GDPR), which limits the feasibility of using the data in this way.

In a paper entitled “Putting (Big) Data in Action: Saving Lives with Countrywide Population Movement Monitoring Using Mobile Devices during the COVID-19 Crisis” [2], which has already been published as a preprint at MedRxiv and is under consideration for publication at Scientific Reports, we introduce a methodology, to assess the effectiveness of social distancing measures on the basis of routine call detail records, anonymised and aggregated at settlement level. While the use of mobile phone call detail records (CDR) to track population movement has been reported from several countries during the COVID-19 pandemic, to our knowledge, no detailed discussion of the methodology developed in the frame of these projects has been published to date.

In our study, based on datasets provided by all three main domestic telecommunication companies in Hungary, we provide a detailed introduction and analysis of our method, with which we have been able to overcome all the main feasibility limitations, and show that the CDR-based method is an effective and inexpensive tool to monitor population movement with good accuracy and resolution. In particular, GDPR compatibility has been ensured, not just by the anonymity of individual users’ data, but the aggregation of data on the level of settlements for a 24-hour period. In constructing the mobility and stay-at-home (resting) indices, the key methodological solutions have been: (i) Distinguishing between mobile devices showing an activity in a single location and those showing an activity in a pair of different Hungarian cities, (ii) the decision to compare the data with an appropriate reference period of activity before the outbreak, looking at the relative, rather than the absolute number, of location-changing or resting devices, and (iii) the integration of the datasets from three different mobile network providers.

The analysis of CDR data is not the only way that mobile phones can be used to monitor population movement. The smartphone-based method, which can

Figure 1: An example of the graphical presentation of changes in the Mobility (blue) and Stay-at-home (green) indices before and during the first wave of the COVID-19 epidemic.

also use GPS data to locate mobile phones, is more accurate for determining the geographical location of individual mobile phone users, but only as long as the user has a smartphone, the GPS sensor of the phone is turned on and the user has agreed to share the data. In our paper, we compared the two methods and concluded that the CDR-based solution is superior for monitoring mass population movement, while the latter is better for tracking individuals, for instance in contact tracing and during quarantine, so these are complementary, rather than competitive, tools in supporting the management of epidemics.

Given that the developed methodology integrated CDR data from three major European telecommunication companies, that the algorithms automatically process these huge routine databases into information easily interpreted by high level decision-makers, and that the process is standardised and fast enough to make it relevant for swift decision making, we are convinced that it can be easily adapted by other countries. We believe this methodology is an effective and inexpensive tool to support decision-makers in combating the epidemic; minimising loss of lives and damage to the economy. It should therefore be made available worldwide for any country interested in using it in their management of the pandemic. We are happy to share further technical details with governments interested in adapting our approach in their respective countries, but also across countries at the supranational level.

The methodology being further developed in cooperation with the Artificial Intelligence Hungarian National Laboratory [L1] to expand its use in pandemic management: in particular to better understand the patterns of human interactions in the spread of the disease, to identify super-spreading events, and to evaluate the cost-effectiveness of interventions to prevent them.

The described research has received support from the Hungarian National Research, Development and Innovation Office, and the Research Excellence Programme of the Ministry for Innovation and Technology in Hungary through the Digital Biomarker thematic program of the Semmelweis University.

Link:
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Staying Safe in COVID-19

by Haridimos Kondylakis, Dimitrios G. Katehakis and Angelina Kouroubali (FORTH-ICS)

We protect the community. We protect ourselves. We decongest the health system. We stay safe in COVID-19. One of the many responses to the global call against the world pandemic of COVID-19 resulted in "Safe in COVID-19", an electronic platform developed by the Institute of Computer Science of the Foundation for Research and Technology – Hellas (FORTH-ICS), which is intended for tracing suspect, probable and confirmed incidence cases.

The ongoing coronavirus pandemic is affecting the lives of millions of people, while changing society by establishing new norms for social life, business and travel. The digital health domain has responded rapidly to the challenges presented by the coronavirus disease 2019 (COVID-19) pandemic, delivering multiple health apps [1] designed for training, information sharing, risk assessment, self-management of symptoms, contact tracing, home-monitoring and decision making [L1].

In response to calls from the international community [L2], the Centre for eHealth Applications and Services of FORTH-ICS developed "Safe in COVID-19" [2][3], a set of digital tools unified under a single platform focusing on artificial intelligence (AI), semantics and data management. The platform, which is based on pre-existing work on personal health record systems and integrated care solutions, is designed to support personal health management and public health.

"Safe in COVID-19" has been designed to support the needs of public authorities, health professionals and individuals. It allows public authorities to gain a better overview of the distribution of suspect, probable and confirmed COVID-19 cases through real-time statistics. The platform provides citizens with self-assessment tests to help them keep track of their health, and access to reliable personalised information and instructions with the ability to have direct contact with healthcare professionals. Healthcare professionals can gain access to digital tools to facilitate the management of COVID-19 cases and communication with patients, tailoring medical advice on patient reported status. Citizens and their families can use "Safe in COVID-19" to record their vital signs and keep track of any symptoms that might be related to COVID-19, as part of the contact tracing process.

"Safe in COVID-19" consists of three applications for different user groups: public health authorities (web app), healthcare professionals (web app), and

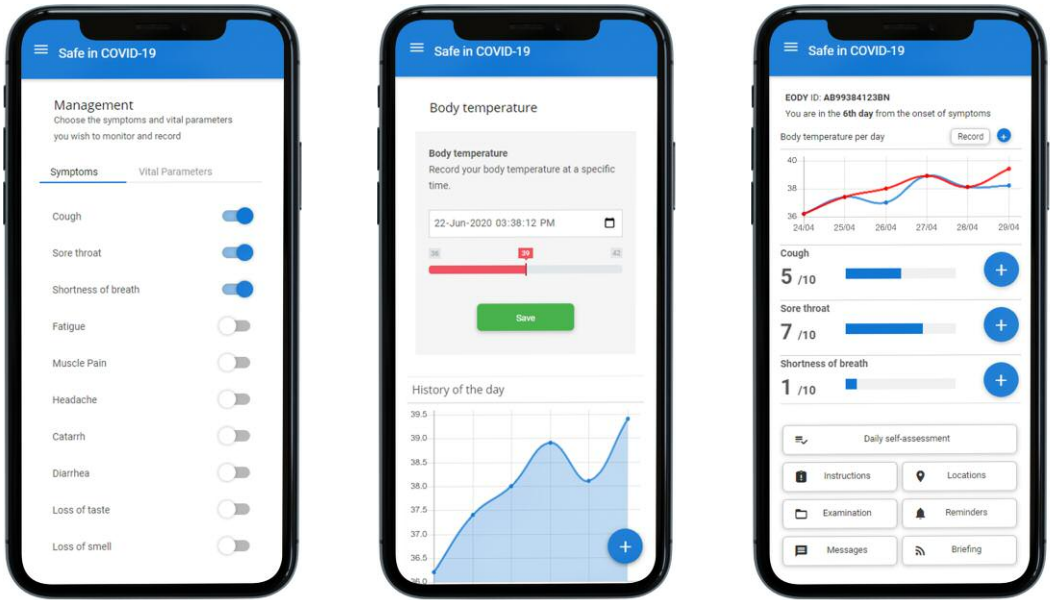

Figure 1: The mobile app |FORTH-ICS developed for Citizens staying "Safe in COVID-19" (in Android/iOS).

citizens (mobile app) [L3]. The web app for public health authorities aims to give a complete picture of the spread of the disease at a national level and the measures taken by healthcare services. It provides real-time detailed data about suspected, probable and confirmed cases; information that is useful for the surveillance of COVID-19 case distribution. The web app for healthcare providers supports online communication with registered patients to provide personalised information and coaching, and instant access to patient-reported symptoms related to COVID-19 in case of confirmed cases or symptoms that might be related to COVID-19 for probable or suspect cases. This app also supports the recording of COVID-19 laboratory test results. The mobile application for citizens supports the ability to keep daily records of health status and communicate synchronously or asynchronously with healthcare professionals in order to receive personalised instructions for health management.

Initially, the patient registers on the platform and provides self-assessment information based on a questionnaire for underlying diseases related to COVID-19 (chronic lung disease, severe heart disease, immunosuppression, diabetes, renal failure, liver failure and morbid obesity). The patient receives daily prompts to record any symptoms that might be related to COVID-19 and further self-assessment information using a visual analogue scale (VAS). These include cough, sore throat, shortness of breath or difficulty of breathing, fatigue, muscle pain, headache, runny nose or nasal congestion, diarrhoea, and loss of taste or smell. The patient can record vital parameters related to COVID-19 (body temperature, oxygen saturation SPO2, breathing rate, systolic and diastolic blood pressure and heart rate). Reminders for monitoring symptoms and vital parameters based on medical history and symptomatology help patients to stay safe at home. The app also facilitates patient access to laboratory test results.

All data are stored in a data lake, semantically uplifted and annotated using standard health ontologies. In addition, fast healthcare interoperability resources (FHIR) have been used to represent the medical data related to COVID-19. Based on the collected data, AI algorithms and epidemiological models can make predictions about how the virus is spreading in each geographic region, combining regional, country and health-system data. Instead of raw data, AI services are able to work directly on semantically uplifted data, exploiting the semantic correlation in the available data.

We anticipate that "Safe in COVID-19" will help public health authorities by easing the pressure on healthcare units, providing real-time information about the evolution of suspected, candidate and confirmed cases, providing online monitoring of the spread of the virus, and helping with decision-making regarding measures such as ordering a test or an onsite visit. Benefits for citizens include systematic recording of symptoms, self-assessment, access to personalised information, and instructions and reminders based on overall health status. Benefits to healthcare professionals include support in managing patients, reduced time in direct contact with patients, more efficient case management, and improved working conditions.

Links:
[L1] https://covid19.forthehealth.gr/
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Impact of COVID-19 Outbreak on Italian Tourism During the First Quarter of 2020

by Angelica Lo Duca and Andrea Marchetti (IIT-CNR)

Within the Institute of Informatics and Telematics in Pisa (Italy), a novel working group was born, called Human-Centered Technologies (HCT). One of the main objectives of HCT involves the definition of decision support systems, which help stakeholders and people in general to understand the Italian society, economy and health. Within this context, we have implemented a strategy to assess the impact of the COVID-19 outbreak on the Italian tourism industry in terms of tourism income and reduction in the number of tourist arrivals.

Breaking events, such as terrorism attacks and or political instabilities, tend to influence the trend of the tourism industry, by reducing the tourism demand. The timing of this paper, November 2020, a new pandemic, called COVID-19, is still ongoing, causing more than 1 million cases in Italy. The COVID-19 outbreak was identified for the first time in China on 2019, 31st December, and then spread all over the world [1].

In order to reduce the spread of the virus, many governments launched different restriction laws, including people mobility reduction. This paper quantifies the impact of the Italian COVID-19 outbreak on the tourism industry for the months of February and March 2020. In particular, the impact of the COVID-19 outbreak is calculated in terms of two metrics: the number of tourist arrivals, which is the number of visitors reaching Italy, and the tourism income, which is calculated as the product between the tourist spending and the number of tourist arrivals. The tourist spending is the sum of expenses carried out by visitors to purchase goods and services used for and during the vacation, or in travel and in the tourist stay. Usually, the average tourist spending can be considered constant for the considered period of time. The tourist spending is extracted from “Tavole Dati Turismo”, released by Banca d’Italia [L1], and from “Spese per viaggi in alloggi a pagamento” released by Istat [L2].

This paper analyses the time series regarding the number of tourist arrivals to accommodation establishments in Italy. Data have been extracted from the European Statistics: Annual Data on Tourism Industries [L3]. An analysis of the trend of the time series revealed a breaking point in March 2020, due to the restriction laws imposed by the Italian governments to cope with the COVID-19 pandemic. Therefore, it is possible to break down the time series into three parts: before (January 2012-February 2020), during (March 2020/April 2020-May 2020) and after the first lockdown (starting from May 2020).

Data before the lockdown (historical data) can be represented through a model, which is then used to predict the behavior of the time series if the COVID-19 outbreak had not occurred, during and after the first lockdown (March 2020-May 2020). Historical data are compared with data during and after the first lockdown (actual data), in order to calculate the gap between the predicted number of tourist arrivals (without the effects of the COVID-19 outbreak) and the actual number of tourist arrivals (with the effects of the COVID-19 outbreak). The obtained gap is then used to calculate the reduction in tourism income due to the COVID-19 outbreak.

We propose two strategies to model historical data. The first strategy exploits a statistical model called SARIMA [2], and the second strategy exploits mathematical concepts to build a sinusoidal model [3].

A recovery model from the crisis is also proposed, based on a linear regression model. Three scenarios are defined, considering three possible recovery periods: best-case, with a recovery period of 6 months after the fist lockdown, base-scenario with a recovery period of 24 months, and worst-scenario with a recovery period of 40 months.

Statistical Model

The time series before the lockdown (historical time series) can be modeled through a SARIMA model, in order to

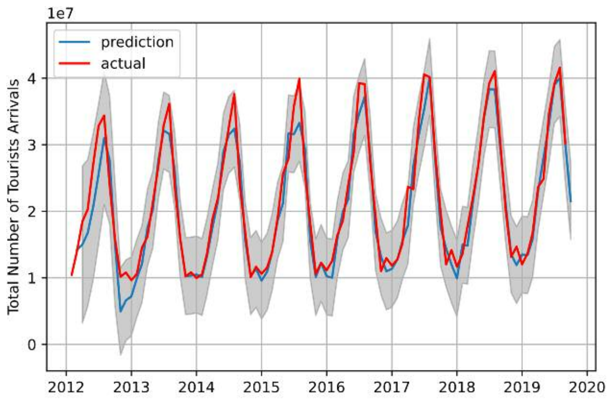

Figure 1: A comparison between the SARIMA model and actual data.

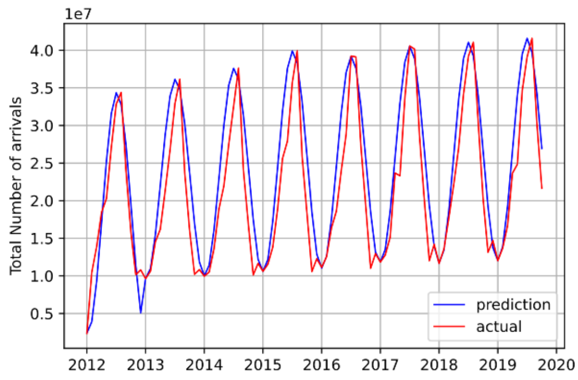

Figure 2: A comparison between the sinusoidal model and actual data.

predict which would have been the trendline of the number of tourist arrivals, if the COVID-19 outbreak had not occurred (Fig. 1). In order to build the SARIMA models, the Autocorrelation (ACF) and Partial Autocorrelation (PACF) plots can be used, as well as the number of transformations needed to make the time series stationary, through a Dickey-Fuller test.

Mathematical Model

The time series before the lockdown can be modelled also through a sinusoid with a variable amplitude (Fig. 2), where maximum peaks correspond to the high seasons (August) and minimum peaks to the low seasons (December). Two linear regression models are used to calculate lines crossing maximum and minimum peaks, respectively.

Discussion

The sinusoidal model shows that for the months of February and March 2020, the reduction in terms of tourism income due to the COVID-19 outbreak should be of 1,713,632,577 € for February and 7,168,022,367 € for March.

The statistical model has been used to calculate the reduction in tourism income, considering the three recovery scenarios. In the worst-case scenario (6 months) the reduction in tourism income would be $ 137,727,300,190, in the base case (24 months) it would be $ 91,811,091,246, in the best case (40 months) it would be $ 45,078,563,960.

Links:

[L1] https://kwz.me/h2x

[L2] http://dati.istat.it/

[L3] https://kwz.me/h2z

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Fairness Analysis of Pandemic Management using a Sustainability Pattern Library

by Christophe Ponsard and Bérengère Nihoul (CETIC)

The design sustainable systems requires to explore and combine multiple facets relating to the dimensions of society, economics and the environment. To analyse COVID-19 pandemic management strategies from a fairness perspective, we used a sustainability modelling framework together with a pattern library focusing on fairness. This helps with the analysis of strategic decision making and provides guidance for a successful adoption of measures.

Inherent in the concept of sustainability is the idea of "fairness" in terms of resource allocation among actors involved in a system. To achieve a balanced design it is necessary to set some constraints on the way systems are designed. A "balanced design" does not imply pure formal equality, which in practice is unachievable, but rather a global equilibrium based on core values such as solidarity. In our work, we are trying to determine how different aspects of fairness can be identified and managed in complex systems composed of different kinds of users, stakeholders and software that needs to deal with related rules.

Reasoning on such systems requires that, in addition to the above dimensions, we need to capture key organisational concepts, such as goals/barriers, values, activities, regulations, and indicators. These can be organised in multi-perspective sustainability models [1]. Specific model patterns can be identified to enable the reuse of proven designs with their context and some guidelines [2]. From the literature and our experience in designing healthcare and shared transport systems, we identified fairness patterns such as rule adoption and acceptance, distributive justice[L1], violation anticipation and transparency [3].

The COVID-19 pandemic provided a rich case study to experiment and enrich our approach and pattern library. Figure 1 depicts a sustainability analysis of pandemic management focusing on the social dimension. Values are depicted using ovals and their barriers using explosion labels. For example, the herd immunity strategy is discarded because too risky. The longer-term vaccine strategy is not detailed to focus on shorter-term protection actions. Different patterns were applied during the analysis and are tagged using grey balloons:

- a distributive justice pattern is used for protecting vulnerable community members;
- an acceptance pattern is also identified to implement the assumption that all people will adopt safe behaviours to protect the vulnerable as called for by authorities [L2];
- an anticipation pattern is used to make sure care will stay available. It results in a balance between monitoring (using indicators such as Re) and lockdown level that can ensure the contamination curve is flattened;
- rule acceptance and transparency patterns are also useful to ensure that people adhere to confinement rules.

So far, our framework has proved very interesting for analysing and reasoning on complex systems such as COVID-19 management, especially when scaling it up to other dimensions so that it covers environmental (e.g. waste due to overpacking, the use of disposable masks)

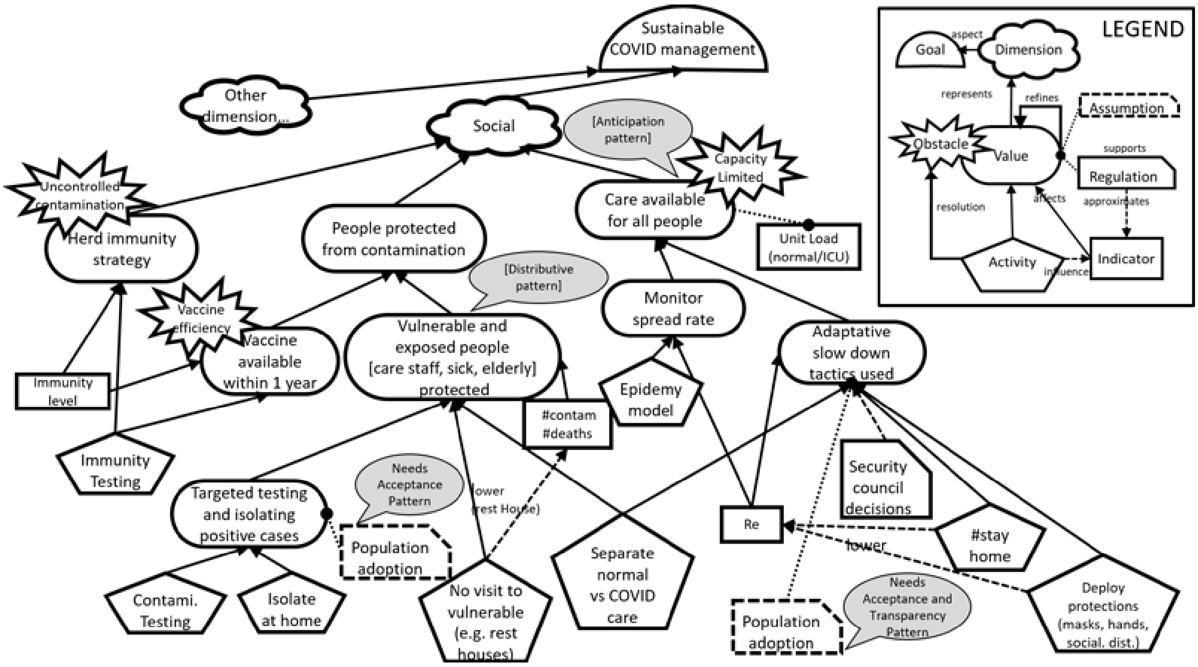

Figure 1: Sustainability analysis of pandemic management focusing on the social dimension.

and economic issues (e.g. temporary unemployment benefits). In our future work, we plan to adapt the KAOS/Objectiver goal-oriented requirements engineering tools to support our notations and capture our patterns through the existing library mechanism [L3].

Links:

[L1] https://kwz.me/h2J
[L2] http://bit.do/covid-call-for-fairness
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A Tabular Data Analysis Solution to Help Improve the Quality of Data Relating to the COVID-19 Pandemic

by Paulo Carvalho (CGIE – Centre de gestion informatique de l’éducation - Luxembourg), Patrik Hitzelberger (LIST – Luxembourg Institute of Science and Technology – Luxembourg)

Tabular structures (e.g. Excel, CSV) are often used to represent and store information. Unfortunately, user error can result in the valuable and diverse data stored in such structures being lost or overwritten. This can lead to major problems, depending on how and why the data is intended to be re-used. We propose a visual solution to help users analyse and detect problems in tabular data.

The year 2020 has been difficult worldwide. Many sectors globally – from education and health through to national economies – have been feeling the impacts of the COVID-19 pandemic. Countries are collecting daily data to measure the number of infected people, the affected regions, and other information. This information is precious: it can help us understand the phenomenon and maybe to predict its evolution.

The challenge of understanding and exploiting this data is real. The data has huge potential to help governments to minimise the effects of the pandemic. However, all its value can disappear if we lack efficient systems to assure its quality and to permit its reusability.

Data of this type is often stored in a tabular file: a way to organise information using rows and columns. The data is stored in cells – a cell being the intersection of a row with a column. Each cell may contain a value of a certain type and often, all the cells present in a column are or should be of the same type. Having a tool to detect disparities in data types in a column may be useful.

We have been developing a visual solution to help users detect problems in their tabular data. The first step in our approach is to help the user understand the type of data (e.g. numeric, date, string) that is present in a given cell. To do this, each cell of the tabular file is checked. From this analysis, a tabular matrix, the same size of the source file, is build. Each cell of this new tabular matrix has a data type code that depends on its related cell value in the source file (Figure 1).

Now that the data type matrix exists, three more steps are applied. These steps are necessary because the efficiency of visual solutions increases along the area to be analysed decreases [1]:

1. Group de rows of the matrix that share the same structure (i.e. rows with the same data type in the same position). The result's name is "PiledRowsMatrix" (Figure 2 - Step 1).
2. Group the columns of the "PiledRowsMatrix" that share the same structure (i.e. columns with the same data type in the same position). The result's name is "PiledColumnsMatrix" (Figure 2 - Step 2).
3. From both the "PiledRowsMatrix" and the "PiledColumnsMatrix", build the "PiledMatrix". This matrix is a reduced structure of the data types contained in the analysed tabular file. This can be an important tool to detect potential error – e.g. a cell containing the code for a string value when the user is expecting to view the code type for a numeric one (Figure 2 - Step 3).

What is the point of the PiledMatrix? From a tabular structure of 12 cells comprising three columns and four rows (a data type matrix), a tabular structure with the same information with only one column and two rows (two cells) was obtained (Figure 3).

The user needs to be able to view the PiledMatrix in order to understand and analyse the data in an effective way. Colours are essential in the field of visualisation [2]. Each PiledMatrix cell is set to a colour, based on its data type, to efficiently distinguish and identify values. A coloured cells matrix is shown

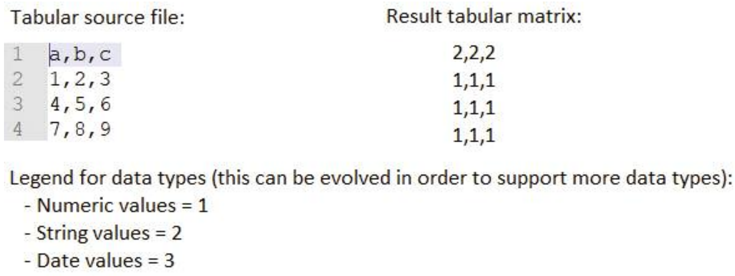

Figure 1: From analysed tabular source file to tabular data type matrix.

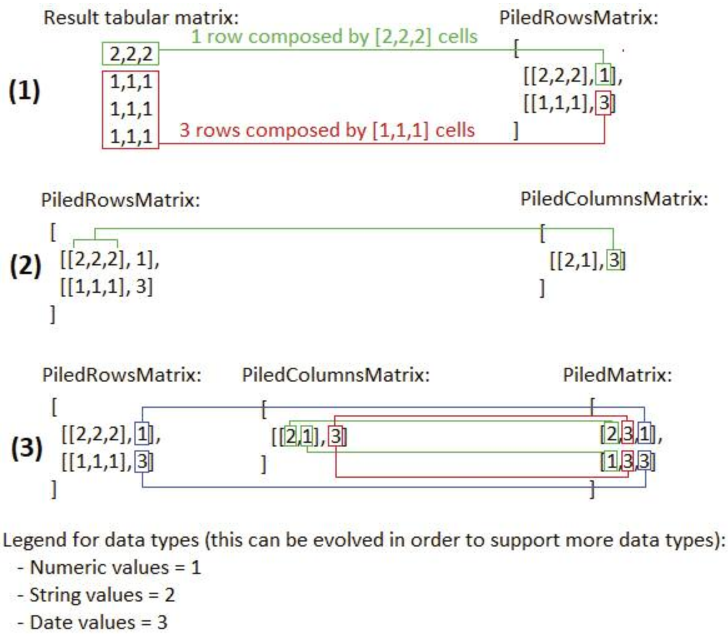

Figure 2: Flow from the data type structure to the "PiledRows" structure.

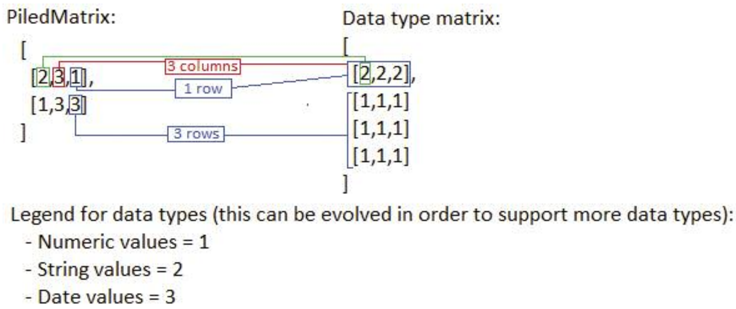

Figure 3: From the PiledMatrix we can obtain the original structure.

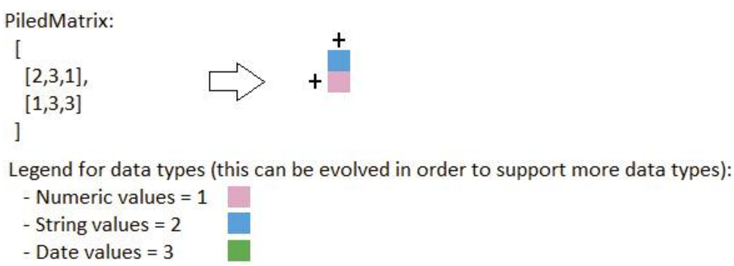

Figure 4: PiledMatrix – The result matrix: Grouping the PiledRowsMatrix with the PiledColumnsMatrix.

instead of a matrix with numbers (Figure 4).

The "plus" is used to expand grouped rows/columns to see the values of each cell. When a row or column is expanded, a "minus" signal appears, to reverse the operation.

Conclusion

This work, which started in 2014, encompasses two major fields: data analysis and data quality/data cleansing. This paper presents the first part of the solution to understand and reuse tabular data, which we do not have many information about its structure and quality. In this time of COVID-19, governments manage huge volumes of data each day, and data quality check tools are vital. The example described here involves a short tabular file with only a few rows and columns, but the potential of such solution is bigger when applied to large files. The gain of space to analyse could be enormous – and this could lead to more effective data analysis. This approach also has a drawback: it works if the data source has a regular structure, i.e., a structure with many rows and/or columns with the same data type in the same index; however, it will not work with irregular structures.

Beyond what we've outlined here, we are also working on providing other operations: correct errors, complete missing values and delete rows/columns manipulating the PiledMatrix.

The large amount of information about the pandemic that is being amassed is valuable: it can be used to better understand and manage the disease (and others into the future). This is only possible, however, if the data files are managed correctly – ensuring that high quality and reusable data are available to be analysed using techniques such as machine learning, algorithms and simulation scenarios. This is where our solution can make a difference.

I would like to express my deep gratitude for the help in this work to Patrik Hitzelberger and Prof. Gilles Venturini.

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Fusing Wireless Network Data to Analyse Indoor Social Distancing

by Sébastien Faye (Luxembourg Institute of Science and Technology – LIST), Tai-yu Ma (Luxembourg Institute of Socio-Economic Research – LISER), Pascal Lhoas (LIST) and Djamel Khadraoui (LIST)

The COVID-19 pandemic has given rise to many digital tools to help monitor and interrupt infection chains. Among them, contact tracing apps are a reliable means of preventing the virus from spreading further, but they suffer from a low adoption rate. This article introduces complementary approaches based on data fusion from wireless networks such as Bluetooth or Wi-Fi, which will be tested in Luxembourg in 2021 in the mobility sector and have the potential to facilitate the monitoring of social interactions in indoor environments.

Contact tracing apps rely on communication technologies to quickly identify and interrupt infection chains. Geolocation approaches have been considered for this purpose, but the most promising solutions now rely on Bluetooth and signal strength measurements, which are more respectful of user privacy. However, while these solutions may be effective at tracing an infected person's contacts, they suffer from significant issues:

- *Difficulty in adopting a mobile app:* To be fully effective, these solutions must be massively adopted by the population. Convincing the end-user to install them is not an easy task, and there are still issues about data protection compliance and moving across borders.
- *Indoor misinterpretations:* Even the most advanced solutions are based solely on Bluetooth and do not consider the constraints of the user's environment, which can lead to misinterpretation and false signals, particularly in buildings where walls are not an absolute barrier to wireless technologies.
- *Lack of dedicated tools to monitor social distancing in workplaces:* The risk of infection is higher in these environments due to frequent contact between people. However, existing solutions usually involve bulky, limited-range and privacy-invasive cameras, which are not entirely suitable for protecting professional activities and ensuring social distancing rules.
- *Lack of relevant indicators/tools to assess the risk of infection:* Most contact tracing approaches using wireless network data focus solely on calculating the proximity between two users. However, it is also possible to assess the potential risk of infection by looking at more detailed interaction patterns. This would provide human analysts and "disease detectives" with tools to proactively monitor the evolution of the virus.

To address these problems, we need novel methodologies and tools to monitor and assess the risk of infection in closed environments and to help manage exit strategies accordingly. We have developed an approach that continuously monitors pervasive information from people's devices to develop meaningful social interaction indicators. Several layers of information can be exploited, but the easiest to use and illustrate relies on network discovery: the process by which devices of a net-

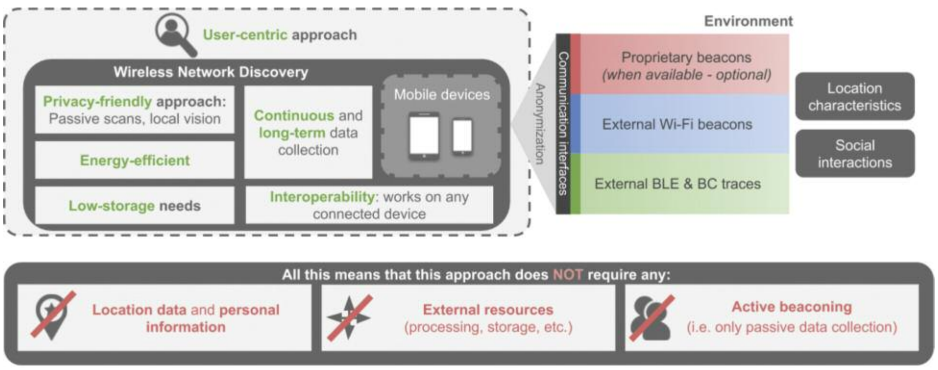

Figure 1: Overview of the network discovery approach.

work announce their presence to each other. This is usually done through dedicated messages that contain contextual information. Table 1 illustrates the information contained in Wi-Fi and Bluetooth traces, which are two of the most commonly used types of short-range networks. It has been shown that Wi-Fi traces can be analysed to discover places of interest or movements inside buildings without explicit location information. Bluetooth traces have already been used to reconstruct the path of a vehicle and for people-counting applications.

As illustrated in Figure 1, collecting and analysing network discovery data passively (i.e., listening only) and in real time has the potential to lead to new, privacy-friendly indicators that can be estimated using graph theory and new artificial intelligence models [1, 2]. With this approach, it would be possible to generate in real time a dynamic interaction graph, which allows the intensity of interactions between individuals to be quantified. The evolution of the graph can be analysed over time without the need to install a mobile app.

LIST has established expertise in this research area, having worked on both indoor geolocation and user profiling models through projects such as the H2020 project MODALES, which aims to investigate how driving behaviour correlates with vehicle emissions [L1]. Even though this project's field of application is far removed from epidemiological management, MODALES has technological building blocks that can greatly benefit a new generation of user-centric tools for measuring social distancing indicators. One proposed solution is a mobile app to estimate in real time the behaviour of a driver and identify his/her environment, which includes the density of vehicles and the type of road on which a user is driving, and which have a direct impact on particle emissions. Network traces can be collected passively and in real time to dynamically estimate the users' context and thus them in their choices. The expected accuracy is, of course, less precise than the accuracy that could be provided by cameras or LiDARs, but has the advantage of involving low storage and energy consumption while being more respectful of user privacy.

Technology			Data	Details	Example
Wi-Fi	Bluetooth	Bluetooth LE	MAC address	Can be used to identify a device	AA:BB:CC:DD:EE:FF
Wi-Fi	Bluetooth	Bluetooth LE	RSS indicator	Received Signal Strength	-80 dBm
Wi-Fi	Bluetooth	Bluetooth LE	Device or access point name	Assigned device name (if defined)	iPhone_XXX
Wi-Fi			Access point properties	May vary according to the access points and standards	Security type, frequency, location-specific information
	Bluetooth		Class identifier	Type of device	20040 (hands-free kit)
		Bluetooth LE	Manufacturer information	Manufacturer of the discovered device	4C 00 (Apple)

Table 1: Overview of the data available through network discovery, via Wi-Fi and Bluetooth, which is currently composed of two versions: Bluetooth classic (BC), offering a pairing mechanism between two devices, and Bluetooth Low Energy (BLE), which no requires it.

This model has the potential to be fully replicable to COVID-19 by deploying dedicated sensors in buildings or confined spaces (even buses). The sensors would passively collect network information to help understand user interactions in the area and to estimate their number and proximity in real time. Multi-network data fusion would reduce estimation errors related to the indoor environment and the discovery mechanism would not require users to install a mobile app. The social distancing indicators resulting from this approach could lead to an infection risk model, which would allow potential risk in space and time to be quantified and predicted relying on social network analysis and computer simulations of stochastic infection process. LISER has established expertise in the modelling and simulation of individual mobility patterns and behaviours [L2] and has recently developed an epidemionomic model of the COVID-19 crisis in Luxembourg [3]. All these elements could lead in the medium term to the development of solutions, such as online dashboards, to provide useful risk indicators, inform companies' employees and prevent potential infection. This decision support system, which could also integrate simulation and optimisation elements, could enable the company manager to take rapid and relevant health measures.

Links:
[L1] https://modales-project.eu
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Modelling Time-Varying Epidemiological Parameters for COVID-19

by Ercan Engin Kuruoglu (ISTI-CNR) and Yang Li (Tsinghua-Berkeley Shenzhen Institute)

Daily estimates of parameters relating to epidemics can help public health experts to track the changes in the epidemic's dynamics and the effectiveness of public health policy changes.

It's approaching one year since COVID-19 first emerged: a year that is rich with stories of success and failure, contributed to by various factors. The heterogeneous temporal and spatial characteristics of data relating to the epidemic reflect various factors including government health policies, cultural differences between societies, public responses to epidemic control policies, and possibly mutations that affect the transmissibility of the virus. Temporal heterogeneity is particularly notable owing to the rather drastic changes in public policy over the time – such as lockdowns and reopening period during the summer. The delay in the response of the epidemic curve to public policy changes also reflects the response of society or how strictly the policies are enforced. Research groups around the world have modelled the spread of virus using classical compartmental models such as SIR and SEIR. Most of these works unfortunately assume fixed parameters for the epidemic models. The fixed parameter models fall short of describing the non-smooth curves demonstrated by epidemic's spread in almost every country.

The epidemic's parameters can give public health authorities important information regarding the changes in the transmissibility of the virus and the effect of changes in control policies. In particular, the parameters obtained from each city's local data can point to problems associated with implementing policies, such as the local lockdowns in regions in Italy. Fixed parameter models do not provide the temporal information needed to help public health officials to adjust or fine-tune policies. It is therefore vital to develop methods that can track epidemic's parameters daily.

This challenge was addressed by researchers from ISTI-CNR, China, and Data Science and Information Technology Center of Tsinghua-Berkeley Shenzhen Institute, China. We adopted a state-space formulation that relates temporal observations to hidden parameters of the epidemic. A statistical modelling approach was used, which aims to estimate the probability distributions of hidden variables, rather than just point estimates. This formulation also makes it possible to handle non-Gaussian distributions and nonlinear dynamics in data. Although the classical solution for this problem is provided by Kalman filtering, it necessarily makes the assumption of linearity of the system and Gaussianity of state and observation noise.

We have utilised the Unscented Kalman Filter for the solution of the state-space model which both deals with non-Gaussianity and nonlinearity, and offers computational simplicity. Despite its name, the Unscented Kalman Filter (UKF) has a different computing approach to the Kalman filter. It follows a sampling approach and avoids matrix calculations. The method is also faster

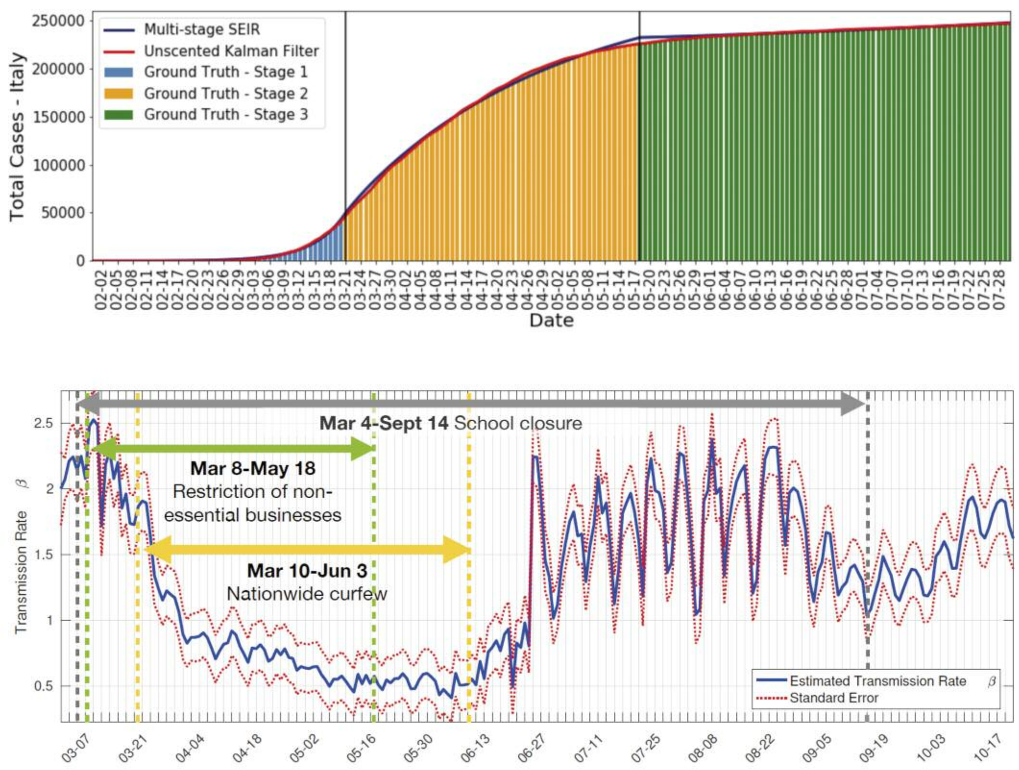

Figure 1:
a) Daily epidemic statistics for Italy and the fit to it by UKF (top);
b) The corresponding daily transmissibility index for Italy calculated by UKF (bottom).

when compared to other sampling-based approaches, such as sequential Monte Carlo.

We have applied this method, which provides daily estimates of transmissibility rate and error bounds, to daily epidemic data from the USA, UK, Italy and Turkey. It has demonstrated precise fits to the actual data: the methods were even capable of capturing daily changes in data from Italy during the summer period, showing the patterns of holiday-making during weekends. The method can also be used to make short-term predictions for the coming days. Figure 1a shows the daily statistics for Italy and the fit to it by UKF. In Figure 1b, we provide the corresponding daily transmissibility index for Italy calculated by UKF. This shows the drastic effect that occurred within a week of lockdown after 10 March 2020 and the rise of infected cases again within one week of normalisation (the removal of travel restrictions) on 3 June 2020.

As we continue this project, we will analyse the data from different regions of Italy and new factors will be introduced to the model first to take care of the period for immunity and also in anticipation of the arrival of a vaccine. We will also include the availability of healthcare resources as a parameter in our model and will simulate extreme case scenarios in which the health system has been stretched beyond capacity.

The software we have developed is available to public health officials upon request. We welcome experts on epidemics and health officials to contact us to collaborate.

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A Common Information Space for Pandemic Management

by Mario Drobics, Alexander Preinerstorfer and Andrés Carrasco (AIT Austrian Institute of Technology)

Managing a global pandemic requires constant analysis of the current situation and corresponding responses. An open message bus can help organisations achieve a common operational picture across system boundaries, thus ensuring efficiency and effectiveness of their efforts.

In recent decades, many isolated information technology solutions have been developed within the field of crisis management (CM), which very specifically describe, interpret and present information for each organisation. The challenge is to share information about observations, resources and approaches between organisations such as first responders and local crisis management units.

Especially in complex situations like the ongoing COVID-19 pandemic, information from many different sources, like first responders, hospitals, laboratories and national crisis management centres, is needed to assess the current situation, develop strategies and coordinate their efforts [1].

Requirements

There is a clear need for a cross-organisational information exchange. Recent collaborative projects involving various stakeholders have identified some key requirements to achieve this:
- A decentralised platform for sharing information with one or multiple C2 systems, negating the need for a central data storage
- Lightweight standardised interfaces to reduce implementation efforts
- Logging of all activities in the system to fulfil documentation requirements
- The ability to join the platform later and receive previously sent objects on demand
- A resilient and secure design to ensure operation even in the case of (partial) failure.

Design of the Public Safety Hub

Based on these requirements, AIT has developed a communication backbone called Public Safety Hub (PSH) [L1]. The special technological architecture of the PSH enables secure and flexible data exchange between most diverse organisations without creating numerous dependencies and single points of failures. The data is exchanged in the form of protocol-agnostic messages through a lightweight REST interface, allowing the simple integration of systems without predefined protocols. Messages can be delivered to a specific recipient or through broadcast channels. These broadcast channels can be open or organised using a topological hierarchy of addresses, enabling a tailored information exchange for any organisational structure.

The PSH utilises an elastic federated design to ensure the resilience and division of responsibilities required by the CM and other public safety domains (see Figure 1). Each organisation has its own structure, workflow, and responsibility. Through the flexible design of the PSH, each federated instance can be fitted to the specific needs of an organisation. Moreover, its elastic design allows the PSH to scale to the size of the organisation, which increases performance and reliability. Federated instances of the PSH are independent and isolated. However, they can be interconnected in a mesh of federated instances, enabling information exchange on any organisational or pan-organisational structures, while keeping the internal information exchange isolated.

In order to gather a common operational picture, messages in the CM domain are often exchanged based on the EMSI (Emergency Management Shared Information) data model, as defined in the ISO Technical Report 22351. EMSI enables the peer-to-peer exchange of information on the same hierarchical level, as well as across the command structure. A simple PSH client can use an extension of the EMSI data model based on XML. To ensure the validity of the transmitted messages, all messages are

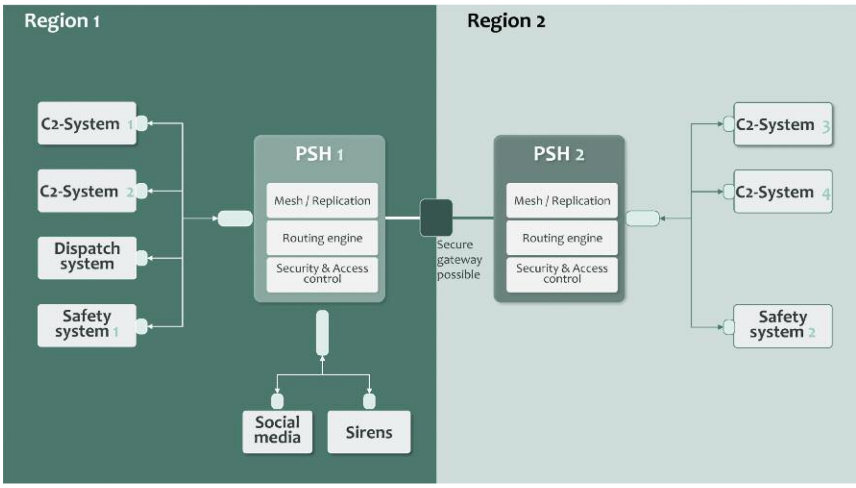

Figure 1: Federated architecture of the Public Safety Hub enabling resilient and flexible information exchange in the CM domain.

checked regarding their syntactical conformity and semantical correctness. The latter is done by referring to a pre-defined EMSI data dictionary, which can be easily expanded. These messages can then be exchanged with any C2 system using the standardised PSH interface, overcoming the need to implement specific interfaces for each different C2 system. This enables end-users to focus on the information exchange rather than on the integration of different systems and organisations.

Evaluation
The initial evaluation of the public safety hub was carried out as part of a larger crisis management exercise in October 2018 in Murau (Austria). In this evaluation, four different civil and military C2 Systems where connected using the PSH. Technical and usability evaluations where carried out. The evaluation showed a high level of satisfaction from stakeholders regarding efficiency, simplicity and robustness of the solution.

Outlook
The modular and open design allows the PSH to bundle separate competencies and ensure a highly secure and efficient cooperation of different organisations in crisis situations like the current pandemic. Fully automated data exchange between the information systems is thus ensured. This can reduce the effort needed to enter data, increase consistency of information across stakeholders, and reduce time to obtain a situational picture. Thus, decisions can be based on broader and more accurate sets of data, ensuring efficiency and effectiveness in fighting the current pandemic and other crises.

Future research will focus on automated process support and semantic mapping between different protocols and domains.

Link:
[L1] http://www.public-safety-hub.com/

Reference:
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Observing Moving Vehicles as a Signature of Human Activity During a Pandemic

by Refiz Duro, Alexandra-Ioana Bojor and Georg Neubauer (AIT Austrian Institute of Technology GmbH)

The measures to tackle the COVID-19 pandemic have introduced a new way of living: human activities and behaviour have had to change. Lockdowns, closed businesses and social distancing have placed governments and their decision-making processes under scrutiny. Significant amounts of timely and precise data are critical in decision-making processes. Our contribution comes from a high vantage point – collecting and analysing Earth observation satellite imagery to detect moving vehicles as a direct sign of human activity. Can it be done?

In the current challenging times of the global pandemic, governments are attempting to counter the spread of COVID-19 using different approaches – some more effective than others. Most of these measures are based on insights gained from analysing data, from sources such as hospitals and COVID-19 test stations, about the number of individuals tested, infected and hospitalised. To help to contain the spread of the virus, important information can be acquired by analysing mobile phone tracking data (as in Italy), video surveillance data using cameras mounted on drones, or data collected using thermal cameras (as in Taiwan). These are just a few examples of information sources that can assist with decision making in the current situation. However, each has its own particular limitations pertaining to issues such as coverage (both spatial and temporal), ethics and data privacy.

In this respect, remote sensing and imaging – Earth observation (EO) – shows huge potential to help shed new light on the changes introduced by the pandemic. EO imagery features specific characteristics only available through

Figure 1: Left: Panchromatic WorldView-2 image of a city with traffic activity. Centre: After the roads have been extracted, PCA produces an output image in which neighbouring dark and bright polygons are visible, an indication of moving vehicles. Right: WorldView-3 image of a rural area showing the detection of a moving vehicle on a dirt road using the same methodology.

satellite technologies; the main characteristic being the spatial coverage ranging from a few km² to 100 km² per image, thus allowing for quick, spatially wide-ranging data collection. Both low to medium spatial resolution (> 2 m) to very high spatial resolution data (0.3 m for optical imagery) are available from commercial and non-commercial EO missions. Furthermore, the availability of imaging sensors covering specific bands of the electromagnetic spectrum allow the constituent information within an image to be separated and the information to be interpreted as required. EO has been used increasingly in crisis situations in recent years due largely to improvements in the availability, timeliness and quantity of today's satellite images. Similarly, EO data images have been used during the pandemic as a reliable basis and complementary source to help monitor the effectiveness of lockdown measures, social distancing and similar pandemic-related human activities.

The pandemic has affected traffic volumes in cities: in some cases traffic was reduced to half or even one third of its usual volume [L1]. EO imagery bypasses the limitations of spatial coverage encountered in other monitoring sensing devices and can observe traffic conditions for entire cities and road networks. The detection and counting of vehicles (e.g., trucks, cars) in sub-meter spatial resolution satellite imagery has been widely studied using standard machine learning methods [1, 2] but we have limited ability to acquire information on their kinematic properties, such as speed and direction of movement. To extract precise information on these variables, we need to know a vehicle's location at two different points in time. This is not straightforward with satellite images, owing largely to the inherent temporal resolution of the data: the revisit time for all polar-orbiting satellites is not a matter of seconds, but of days. A direct comparison of images from two observations separated by many hours or even days is not useful for calculating the speed of a vehicle, which requires satellite observations that are taken (sub-) seconds apart.

The MiTrAs project, funded by the Austrian Security Research Programme, took on the challenge of acquiring the kinematic properties of vehicles from EO imagery. In principle, we bypassed the limitations by exploiting the imaging instruments' setup design used on WorldView EO missions, where the detectors' positions on the imaging device allow for short time lags between imaging in different spectral bands. For instance, WorldView-3 has eight multispectral detectors and thus eight images with time lags of up to 0.4 seconds, providing enough time to detect a vehicle on the ground moving at speeds of over roughly 20 km/h.

After extracting the data from the EO images using standard procedures, we applied a proven method: the standard principal component analysis (PCA) combined with thresholding [3]. PCA effectively reduces the number of a variables of a dataset while preserving as much information as possible. Applied on the WorldView 8 band images, a moving object (i.e., a vehicle) generates a pair: a bright and a dark spot (see Figure 1). This is the signature that provides enough information to extract the position of the vehicle, its speed, and its direction of movement.

We performed the analysis using WorldView-2 and -3 images collected from several locations. By annotating the data, we could establish a confusion matrix, resulting in a detection accuracy of 85%. Vehicle movement is an indirect measure of human activity when put in the context of the situation, place and time, thus comparisons of observations from before and during the pandemic can provide valuable insights for decision-makers.

The main challenges with the method are related to detecting darker vehicles against a dark background (e.g., underlying road/asphalt), spatial resolution when two vehicles are only a few metres apart, thus not being able to discern individual vehicles and false detections due to other reflective objects producing similar bright/dark features. There is clearly potential for the improvement of the method and even for it to be combined with suitable machine learning approaches. Given the spatial coverage provided by the EO images, including very high spatial resolution, the method can be applied not only for monitoring human (or vehicle) activities during the pandemics, but also for purposes such as pollution source and traffic flow monitoring. This will be especially attractive when the planned satellite constellations (i.e., WorldView-Legion; [L2]) with up to 15 revisits per day establish the basis for near real-time monitoring.

Links:
[L1] https://kwz.me/h2G
[L2] https://kwz.me/h2I

References:

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NDlib: A Python Library to Model and Analyze Diffusion Processes over Complex Networks

by Giulio Rossetti (ISTI-CNR), Letizia Milli (University of Pisa) and Salvatore Rinzivillo (ISTI-CNR)

Analysing the dynamics of and on networks is currently a hot topic in social network analysis. To support students, teachers, developers and researchers in this work, we have developed a novel framework, namely NDlib, an environment designed to describe diffusion simulations. NDlib is designed to be a multi-level ecosystem that can be fruitfully used by different user segments.

The analysis of diffusive phenomena unfolding on top of complex networks is a task attracting growing interest from multiple fields of research. Diffusive phenomena include things like epidemics, gossip and innovations, all of which can be considered “contents” that spread among individuals interacting in a social group. Several mathematical models have been designed to study and analyse spreading phenomena, to capture and anticipate real-world patterns.

A few analytical platforms, which typically focus on a narrow set of classic models, have tried to offer out-of-the-box solutions to analysts and researchers. However, such tools are often characterised by complex interfaces that mean they are not user-friendly for non-technical audiences. The background heterogeneity of the specialists interested in analysing diffusive phenomena (ranging from students to social scientists and researchers) underlines the need for a more general framework that can abstract technicality, to scale, to big data sources and to allow flexible model selection and definition. Currently, only a few of these projects are still active (the main ones being nepidemix [1], for Python, and EpiModel [2], for R). The major issues raised by such tools are:

- steep learning curves: existing models are designed by technicians for technicians. They rarely offer abstract/visual interfaces that make them usable by non-programmers;
- a reduced number of implemented models: all existing tools implement classic models (SI/SIR/SIS) almost exclusively, completely ignoring recent ones;
- novel model design complexity: custom model design is not always supported, or it requires a deep understanding of tool internals;
- narrow use cases: all available tools are designed to support quantitative research. They are not easily adaptable as training material or as analytical tools due to the very specific audience they are designed for and the underlying programming proficiency they require.

To address such issues, we designed an analytical ecosystem that will allow the widest possible audience to create and perform diffusion-related experiments. At the core of our project stands NDlib

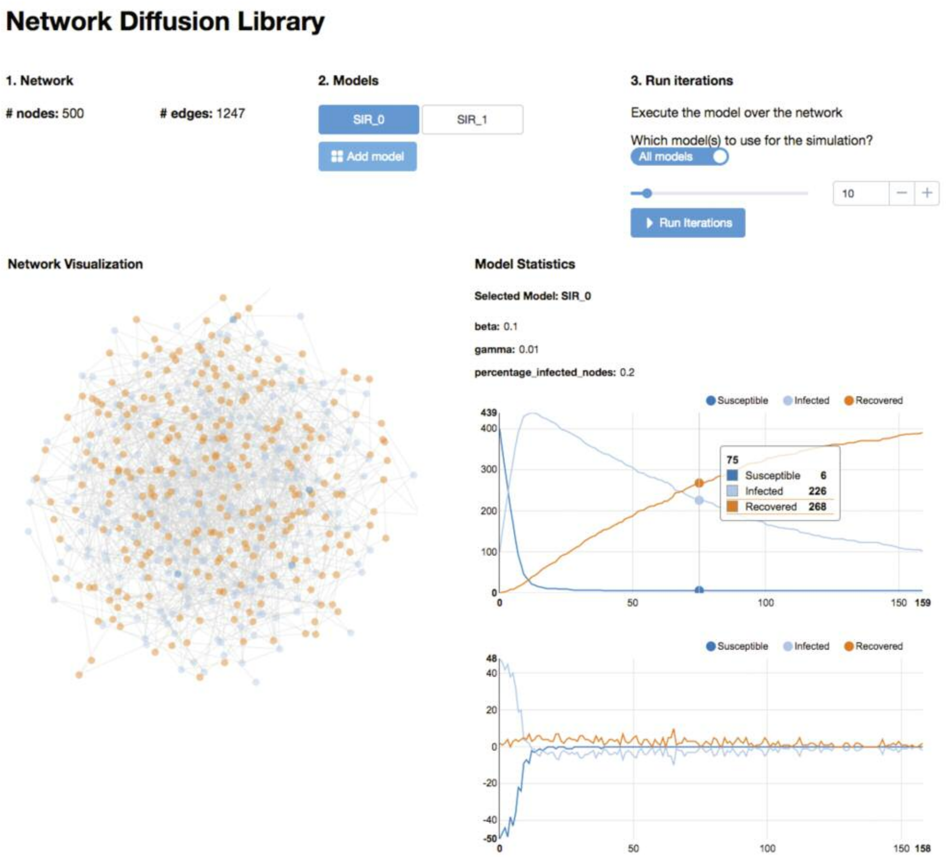

Figure 1: Web platform. The appearance of the NDlib visualisation framework during a simulation.

(Network Diffusion Library [3]), a python package we designed to model diffusive phenomena.

NDlib represents a multi-level solution to simulate the spread of epidemics. We organised the library in three incremental modules: the NDlib core library (written in Python), a remote RESTful experiment server accessible through API calls and, finally, a web-oriented visual interface.

At the core of our tool, is NDlib, a Python package built upon the network facilities offered by NetworkX and iGraph. NDlib models diffusive phenomena as discrete-time agent-based processes. It implements several epidemics and opinion dynamics models (around 20) and allows its users to design novel ones. To allow the user to easily analyse simulation evolution, NDlib also exposes a set of visual facilities. The initial set of infected nodes has a relevant impact on how a diffusive process unfolds. For this reason, with a single line of code, NDlib allows execution to occur several times in parallel: the simulation of the same model over a given network topology while varying the initial infection status. All the diffusion models implemented in NDlib extend the same template, which makes it easy to extend the NDlib library.

As with classical analytical tools, the simulation facilities offered by NDlib are specifically designed for users who want to run experiments on their local machine. However, in some scenarios—e.g., due to limited computational resources or to other needs arising—it may be convenient to separate the machine on which the definition of the experiment is made from the one that actually executes the simulation. To satisfy such needs, we developed a RESTful service, NDlib-REST, that builds upon NDlib with an experiment server, queryable through API calls.

Finally, upon the NDlib-REST service is a visualisation platform. NDlib-Viz ([L1], Figure 1) aims to allow non-technicians to design, configure and run epidemic simulations, thus removing the barriers introduced by the usual requirements of programming language knowledge. Indeed, apart from the usual research-oriented audience, we developed NDlib-Viz to support students and facilitate teachers to introduce epidemic models: in order to better support the educational nature of the proposed platform and collect user feedback, we currently employ NDlib-Viz in a Social Analysis course of the Computer Science Master Degree at the University of Pisa, Italy. The platform itself is a web application: it can be executed on a local as well as on a remote Ndlib-REST installation.

The proposed library aims to provide a reasonable trade-off between ease of use and efficiency. NDlib is released as free software under a BSD-2-Clause license and the NDlib project is hosted on GitHub ([L2]), documented on ReadTheDocs ([L3]) and shipped through Pypi ([L4]). For advertising purposes, we released a promo video hosted on YouTube ([L5]).

Finally, NDlib is also indexed in the SoBigData catalogue ([L6]). SoBigData is an EU H2020 project that promotes the integration of already existing software infrastructures.

Links:
[L1] https://goo.gl/tYi48o
[L2] https://kwz.me/h2M, https://kwz.me/h2Q
[L3] http://ndlib.readthedocs.io/
[L4] https://pypi.python.org/pypi/ndlib/
[L5] https://youtu.be/tYHNOuKJwbE
[L6] http://www.sobigdata.eu

References:
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Predicting the Spread of COVID-19 through Marine Ecological Niche Models

by Gianpaolo Coro (ISTI-CNR)

Researchers from ISTI-CNR (Italy) used marine models, designed to monitor species habitats and invasions, to identify the countries with the highest risk of COVID-19 spread due to climatic and human factors. The model correctly identified most locations where large outbreaks were recorded, independent of population density and dynamics, and is a valuable source of information for smaller-scale population models.

The correlation between the reduction of the spread of COVID-19 and season change was foreseen at the beginning of the 2020 pandemic and has been observed during the Northern Hemisphere summer. The models that forecast this correlation ranged from dynamic systems (that constantly monitor the infection's spatio-temporal spread) and general models that aim to identify global similarities between areas strongly affected by the virus. However, while dynamic systems are still struggling to produce new recommendations to reduce the spread of infection, general models are informing scientists and decision-makers about large-scale trends and ideal conditions for infection. These models can match patterns at a large temporal and spatial resolution and can provide information about the general conditions that support the virus's persistence, independently of social dynamics. Patterns

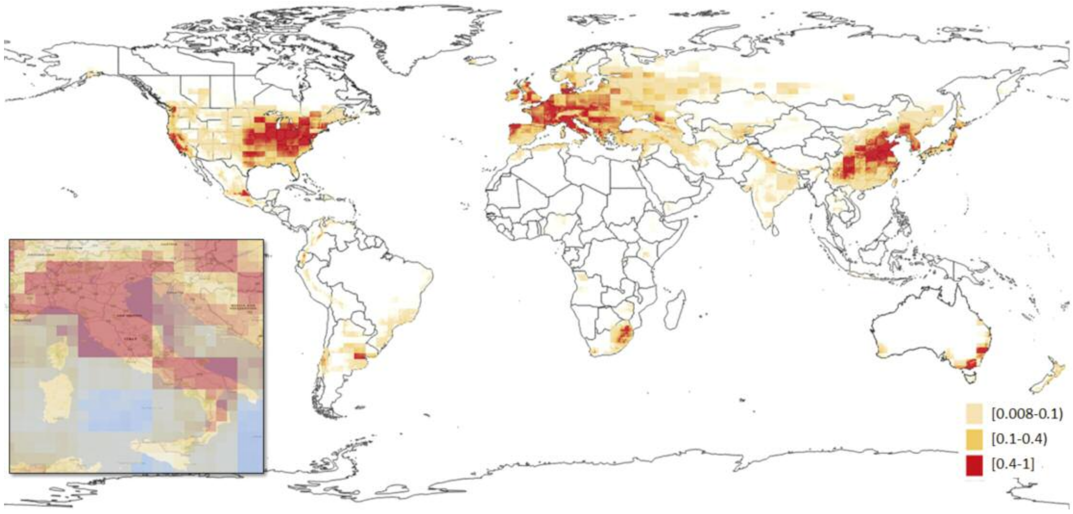

Figure 1: Global-scale probability distribution of the COVID-19 infection rate produced by Coro's (2020) model, with Italy magnified at the lower-left hand side (situation of March 2020).

related to temperature variation have been evident in some parts of the world, and have been used (and sometimes abused) by political authorities to modify regulations.

Among the general models used to explore correlations, ecological niche models (ENMs) have been extensively and effectively used to predict the spread of viruses, including SARS-CoV-2. Generally, an ENM estimates the presence of a particular species in a geographical area by correlating species-specific occurrence records in its native habitat with environmental parameters. The species' niche is the space within a hypervolume of numerical vectors – corresponding to environmental parameter ranges – that is correlated with the species' presence and that fosters the species' persistence in an area. Once a model has estimated the species' ecological niche, it can then project it across a new geographical area to identify other locations that provide ideal conditions for the species.

While COVID-19 is capable of persisting in a range of environments, some populated regions experience lower infection rates than others. Studies using ENMs have pinpointed very interesting similarities between global regions with the highest infection rates. One of these used a Maximum Entropy-based Ecological Niche Model [1] to estimate the COVID-19 infection rate (disease spreading speed) globally at a half-degree spatial resolution. The model identified geographical areas that favour higher infection rates due to their particular geophysical (surface air temperature, precipitation and elevation) and anthropogenic characteristics (CO2 and population density). Relying solely on data from Italian provinces that reported high infection rates in March 2020, the model was then used to predict global regions that were likely to experience high infection rates. Surprisingly, the model highlighted strong similarities between the climatic and anthropogenic characteristics of locations where disease outbreaks have really occurred, e.g. the Hubei province in China, the Western United States, and Europe, and correctly foresaw a high risk of fast disease increment in 77% of the countries that have then reported significant outbreaks. This experiment has highlighted that certain parameter combinations, such as a temperature range of 11 to 12 °C, moderate humidity, and a high level of air pollution, are strongly correlated with a high infection rate. Once above a low threshold, this correlation is also independent of population density. The model also indicates that in some regions (e.g. Brazil, Ecuador and Peru), the high infection rate cannot be explained in terms of the identified environmental factors, with population dynamics possibly being more important than climatic conditions. Overall, this kind of ENM can inform fine-grained dynamic models about which areas have the conditions to be a catalyst of the infection.

One interesting aspect of the ENM [1] is that the model comes from the marine science domain, where it had been used to predict the spread of invasive species [2] and the potential distribution of rare species [3]. The model was directly re-used to predict COVID-19 infection rates because it was based on findable, accessible, interoperable, and reusable (FAIR) data and on an Open Science-oriented methodology that standardised the input, output, and the processing, and thus enhanced the reusability of the model.

The challenge now is to introduce these models into larger decision support systems to increase their prediction accuracy and resolution, and to estimate the risk for individuals to end up in intensive care, based on background data about their environmental and health conditions.

Link:
[L1] Suitability Map of COVID-19 Virus Spread – Experimental Data and Results https://kwz.me/h2g

References:
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How an Agent-Based Population Model Became a Key-Element of the Austrian Effort Against COVID-19

by Štefan Emrich and Niki Popper (dwh GmbH, TU Wien, DEXHELPP)

COVID-19 brought unprecedented publicity for modelling and simulation. But a broad audience was left with very little information about what modern simulation models have to take into account and how valuable they have become as decision-support-tool. And how versatile: by far not limited to health-care.

When information about COVID-19 became available in early 2020, the questions were not if but when the first case would be recorded in Austria – and how best to prepare the healthcare system. The Generic Population Concept (GEPOC) became one of the key tools to answer this question.

The GEPOC is one of the major accomplishments of the research project "Decision Support for Health Policy and Planning" (DEXHELPP). This project was a collaboration between nine partners, amongst them dwh GmbH, the university TU Wien and SBA Research, who provided solutions for secure data processes [L1]. The GEPOC [1], which has been in development since 2014, is a reusable population model that can evolve into a versatile simulation framework to support policymakers in decision-making around population-related research questions.

The research team chose an agent-based (AB) approach for this platform, which makes it possible to model each of the country's almost 9 million citizens individually. It allows flexible integration of "personal" characteristics and features, such as sex, age, workplace, level of education, preferences (e.g. commute to work by car or public transport) and requirements (e.g. medication, childcare). This framework can virtually imitate the behaviour and contacts of each citizen. For COVID-19 this was just what was needed: a tool that simulate the influence of individual behaviour on the epidemic spread – and hence help evaluate the effect of measures on the number of reported cases.

Data from the Austrian Bureau of Statistics (Statistik Austria) was used in the model to precisely depict Austria's demographic structure, including predictions of international and national migration and population development. One problem was that available data for residence is only precise to the municipality. Consequently, we did not have an accurate picture of population density, which is strongly influenced by topography and settlement and is highly relevant for many issues, including epidemic spread. To overcome this we included information from the Global Human Settlement Project in the model, and distributed the agents accordingly. Each agent is assigned a residence coordinate, which mitigates problems due to changes of administrative regions over time (changes, splits or mergers of regions). This also allows for different aggregation levels (e.g. lattice grids of a given granularity or aggregation on different levels, such as levels of settlement, district or province).

The social and contact behaviour, especially daily routines (going to workplaces, schools, etc.) was based on the POLYMOD study, a large survey on social contact behaviour that is relevant to many aspects of human interactions (from demand for transportation to the spread of infectious diseases), and information from Statistik Austria on variables such as workplace and school sizes.

GEPOC was designed to cope with extremely different time scales, ranging from a few days or weeks (e.g. short time resource planning) to years or decades (e.g. observing the impact of demographic changes on the healthcare landscape).

This poses yet another challenge: AB-models need a time-update strategy that correctly coordinates and processes all events and interactions. Usually either a time-continuous or a time-discrete concept is used, but neither is optimally suited for a generic population model. Consequently, we developed a new logic combining both strategies.

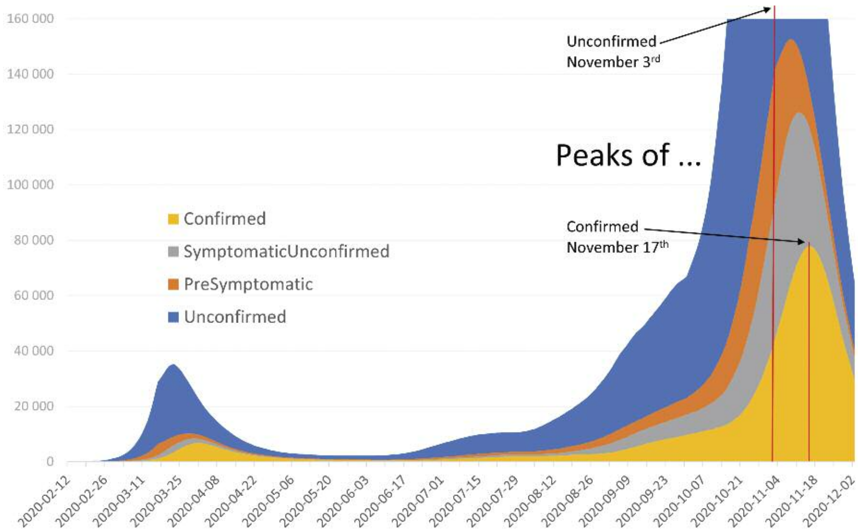

Figure 1: Daily testing of suspected COVID-19 cases yields only very limited information about the dynamic of the epidemic. But via calibration of the model it becomes possible to analyse the epidemic dynamics in detail. Our forecast on 1 November predicted the peak of confirmed cases (yellow) to take place on 17 November, and the peak of the much larger population of unconfirmed cases (blue) to take place almost two weeks earlier on 3 November. At this time the number of pre-symptomatic (orange) or still unconfirmed cases (grey), is still building up. Understanding these dynamics between subpopulations is important for timely reactions and appropriate countermeasures.

The great power and versatility of GEPOC lie in its extensions: the ability to add various modules and layers to the model. For example, having the precise geographic and demographic location of the population, incorporating information about railroads, stations and timetables, as well as information about schools and workplaces, allows us to determine where rail services are needed. Information about locations, specialisation and opening hours of doctors, and available healthcare services show which areas are undersupplied and where different infrastructure might be needed in ten years due to demographic changes.

Modules that simulate diseases can also be incorporated. There are containing rules describing the disease, such as predisposing factors (e.g. sex, age, predisposition, underlying health conditions or medication), patient pathways and the epidemiology of the disease. Of course, disease modules can be coupled with infrastructure layers, e.g. to assess the impact of epidemics on the healthcare system or areas where resources will become critical. Due to the modularity of the tool, it is possible to add more than one disease module to simulate and study the reciprocal effects of concurrent diseases.

It is always challenging for decision-makers to formulate an adequate response to diseases – especially epidemics. Possible actions are added through "policy modules" where implementations of interventions such as immunisation, medication, contact-reduction policies, contact tracing, closures of organisations such as schools and workplaces and quarantine are described.

This framework has been proven and tested in several research projects with such diverse applications as: (i) evaluating Austrian vaccination rates for measles and polio (for the Austrian Ministry of Health's report to the WHO [L2]); (ii) modelling re-hospitalisation rates of psychiatric patients (in DEXHELPP, funded by CEPHOS-Link FP7) and (iii) optimising locomotive scheduling (for ÖBB Rail Cargo Group Austria).

When it became evident that COVID-19 was going to be a global problem, the flexible nature of GEPOC meant that our research team could adapt an existing module for influenza (the mechanics of which seemed acceptably similar to COVID-19) for this new disease [L3].

Naturally, in the early stages of the pandemic, comprehensive knowledge about the disease was not available. Nevertheless, the simulations gave highly accurate predictions, which quickly improved with increasing knowledge. The model proved useful for tasks such as: evaluating testing and tracing strategies; determining the effectiveness of different measures (e.g. how much contact reduction is necessary to bend the curve?); and calculating numbers of undetected [2] and pre-symptomatic cases (Figure 1). The research team thus became part of the advisory board for the Austrian Ministry of Health, and the Viennese and the Lower Austrian associations of hospitals commissioned dwh GmbH to simulate weekly short-term forecasts of required ICU capacities.

With the second lockdown just proclaimed by the Austrian government, the next steps will be to evaluate policies to maintain infection at a low level afterwards and to study the concurrent effect of COVID-19 and the influenza season.

Links:
[L1] http://dexhelpp.at/
[L2] https://kwz.me/h2U
[L3] https://kwz.me/h2V

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The Case for Uncertainty in COVID19 Predictions

by Wouter Edeling (CWI) and Daan Crommelin (CWI and University of Amsterdam)

We argue that COVID19 epidemiological model simulations are subject to uncertainty, which should be made explicit when these models are used to inform government policy.

Computational models are increasingly used in decision- and policy-making at various levels of society. Well-known examples include models used to make climate projections, weather forecasting models, and more recently epidemiological models. The latter are used to model the time evolution of epidemics and the effect of interventions, e.g. social distancing or home quarantine. These models have assisted governments in their response to the COVID-19 epidemic.

When performing a physical experiment, it is common practice to provide not only the measured values themselves, but also an estimate of the uncertainty in the measurement, via error bars. This is not yet standard practice, however, when presenting predictions made by computational models. We argue that due to the increased importance of computational models for decision-making, a similar practice should be adopted. A model output without some type of uncertainty measure can lead to an incorrect interpretation of the results. This is especially relevant if there are hard thresholds that should not be exceeded. In the case of epidemiological models, for instance, such a hard threshold could be the maximum number of hospital ICU beds that are available for COVID-19 patients. A single, deterministic model prediction can give a value on the safe side of that threshold, but models nearly always have some degree of uncertainty so that there might well be a (significant) non-zero probability that the model is indeed able to cross the threshold if only the uncertainty was taken into account.

Assessing the uncertainty in computational models falls under the domain of uncertainty quantification (UQ). A common breakdown of uncertainty is that of parametric and model-form uncertainty. The latter is related to structural assumptions made in the derivation of the model form. In the case of epidemiological models one can think of missing intervention measures, e.g. a model in which contact tracing is not implemented. Parametric uncertainty deals with uncertainty in the input parameters. Models can have a large number of parameters, and in many cases their values are estimated from available data. These estimates are not perfect, and so some uncertainty remains in the inputs, which will get transferred to the predictions made by model. If the model is nonlinear, it is quite possible that the computational model actually magnifies the uncertainty from the input to the output.

Within the EU-funded Verified Exascale Computations for Multiscale Applications project (VECMA) [L1], we are developing a UQ toolkit for expensive computational models that must be executed on supercomputers. In a recent study we used the VECMA toolkit to assess the parametric uncertainty of the CovidSim model developed at Imperial College London [1], by treating its parameters as random variables rather than deterministic inputs. CovidSim has a large number of parameters, which complicates the propagation of uncertainty from the inputs to the outputs due to the “curse of dimensionality”. This essentially means that the computational cost rises exponentially with the number of parameters that are included in the UQ study. We first identified a subset of 60 parameters that were interesting, which we further narrowed down to 19 after an iterative sensitivity study. As a 19 dimensional space is still a rather large, we used a well-known adaptive uncertainty propagation technique [3]. Such techniques bank on the existence of a lower “effective dimension”, where only a subset of all parameters has a significant impact on the output of the model. Our study [2] found that CovidSim is quite sensitive to variations in the input parameters. This work was commissioned by the Royal Society’s RAMP (Rapid Assistance for Modelling the Pandemic) team, and is a collaboration between CWI, UCL, Brunel University, University of Amsterdam and PSNC in Poland. Relative perturbations in the input parameters can be amplified to the output by roughly 300%, when the variation around the mean is measured in terms of standard deviations. Figure 1 shows the output distribution of the predicted cumulative death count, for one of the intervention scenarios we considered. It also depicts the actual death count data as recorded in the UK, and a single deterministic baseline prediction made with default parameter settings. Furthermore, in a UQ study like this, sensitivity estimates can be obtained from the results in a post-processing step. In this case we found that only 3 of the 19 considered inputs were responsible for roughly 50% of the observed output variance.

Note that none of this is an argument against modelling. CovidSim provided valuable insight to the UK government at the beginning of the pandemic, e.g. about the need to layer multiple intervention strategies [1]. Instead, it is an argument for the widespread adoption of including error bars on computational results, especially in the case where models are (partly) guiding high-impact decision-making. In [L2] and [L3] it is suggested to investigate ensemble methods for this purpose, drawing on the experience from the weather and climate modelling community.

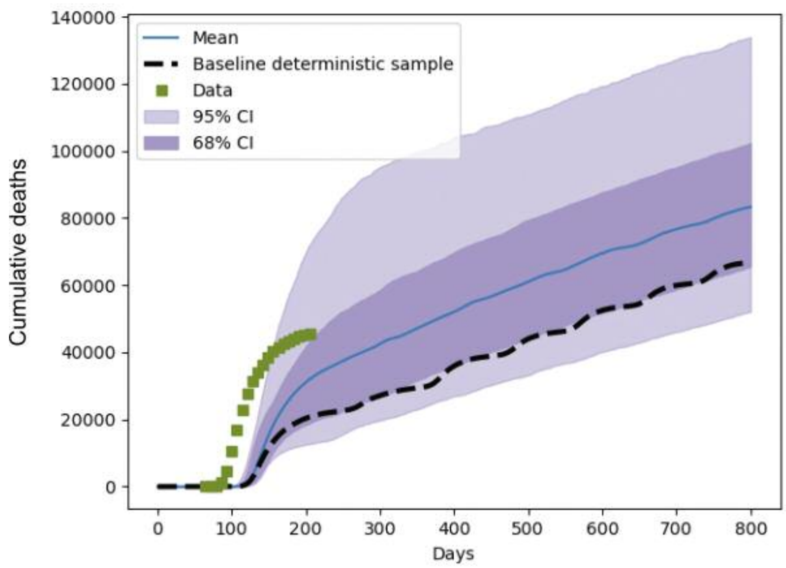

Figure 1: The distribution of the predicted cumulative death count in the UK, when the 19 input parameters were varied within 20% of their baseline values. Blue is the mean prediction, and the purple shaded areas indicate 68 and 95% confidence intervals. Day 0 is January 1st 2020 and the green squares indicate recorded UK death count data. The striped line is a deterministic prediction using default input values, which clearly shows that a single model prediction paints an incomplete picture.

Links:
[L1] https://www.vecma.eu/
[L2] https://kwz.me/h2A
[L3] https://kwz.me/h2D

References:

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Social Distancing: The Sensitivity of Numerical Simulations

by Christophe Henry, Kerlyns Martinez-Rodriguez, Mireille Bossy (Université Côte d'Azur, Inria, CNRS, Cemef), Hervé Guillard (Université Côte D'Azur, Inria, CNRS, LJAD), Nicolas Rutard and Angelo Murrone (DMPE, ONERA)

Researchers from Inria and the French Aerospace Lab ONERA are collaborating on a joint project. The goal is to assess the variability in the advice for social distancing precautions that can be drawn from numerical simulations of airborne dispersion. This variability depends on a number of factors, including: physical variables (e.g. droplet size, ejection velocity), modelling methods used (e.g. turbulence model) and numerical aspects (mesh). We use sensitivity analysis tools to quantify and order the role these factors play in influencing the numerical results.

Airborne transmission of respiratory diseases involves a number of disciplines such as virology, or fluid mechanics. The outbreak of COVID-19 has triggered a number of numerical studies to better understand the fate and transport of respiratory droplets in the air. This research aims at developing a methodology to evaluate the variability in numerical simulations of airborne dispersion that can provide astimations of social distancing precautions. For that purpose, we rely on standard techniques available in computational fluid dynamics (CFD) software to run numerical simulations of airborne dispersion. We then used variance-based methods [2], such as the "Sobol indices" or "variance-based sensitivity indices", to analyse the variability of a number of parameters that were demonstrated to affect droplet dispersion.

For illustrative purposes, this paper details the results from the simple scenario of droplet emission in quiescent air. In this scenario, two observables are considered: the number of particles remaining above a given height after a period of time (here 1.5 m after 20 s) and the mean distance from the source after a given time period (here 20 s).

We performed numerical simulations with the Lagrangian tracking module of Code_Saturne CFD software [L1]. Prior to injection, the fluid was at rest and at a temperature of 25 °C. Droplets were injected into a box with dimensions of 4 x 3 x 2 m. Droplets are injected in the domain at a given location, with a height representative of an average adult's height (here 1 x 2 x 1.7 m) and approximating the shape of a mouth (an ellipsoid with a width of 0.03 m and height of 0.015 m). In accordance with previous studies [1,2], we assumed droplets to be expelled from the mouth within a fixed cone, i.e. with a vertical injection angle in the range of 15 to 40° and with a horizontal injection angle in the range of –5 to 5°. Droplets were all injected with the same size and velocity. Simulations were run for a physical time of 20 s (with a time step of 0.01 s). To complete the simulation set-up, five additional input parameters were used as uncertainty sources modelled with the help of standard random distributions. A simulation is realised with a random trial of the input parameters according to the following distributions:

- The droplet diameter (uniform distribution between 1 and 10 µm);
- The number of injected droplets (uniform distribution between 700 and 1,300);
- The cough velocity (Gaussian distribution, mean of 10 m/s and variance of 2 m/s);
- The cough duration (Gaussian distribution, mean of 75 ms and variance of 6 ms);
- The head angle in relation to the vertical direction (uniform distribution from –15 to 50°).

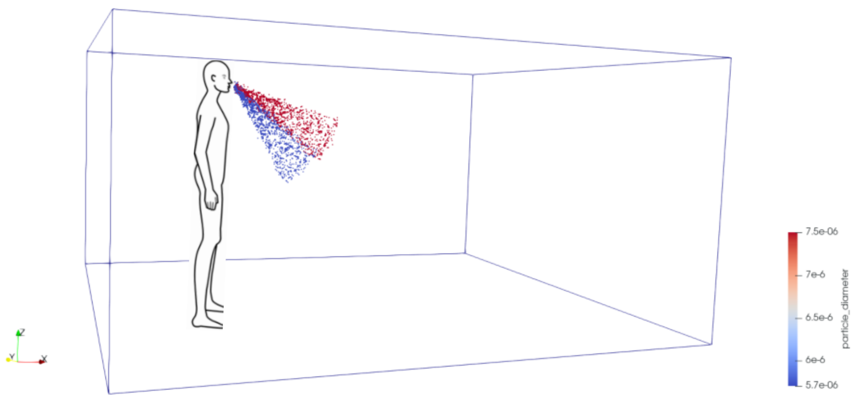

Figure 1:. 3D plot of droplet dispersion generated from two simulations:
997 droplets of 7.6 µm injected during a time of 705 ms and at a velocity of 12.4 m/s (red dots);
997 droplets of 5.7 µm injected during a time of 743 ms and at a velocity of 11.4 m/s (blue dots).
Note: the person's drawing was added for visualisation purposes only.

Observable	Number of droplets	Droplet diameter	Cough velocity	Cough duration	Head angle
N_p (z>1.5 m)	0,252435	-0,0593705	0,0942603	-0,0427005	0,434486
<Xp-X0>	0,0838429	0,084791	0,346216	0,123051	0,765763

Table 1: First-order Sobol indices obtained from 6,000 simulations, with a column for each uncertainty source and two lines corresponding to the two observables (number of droplets remaining above a height of 1.5 m and the mean distance from the point source along the x-direction).

Results

Figure 1 shows a typical set of results from our simulations: the droplets are dispersed in the flow at rest. Once injected in the simulation, these droplets undergo only Brownian motion and settling due to gravity. Due to their size and the fact that no evaporation is accounted for, gravity is the predominant force, which leads to their sedimentation on the ground within a finite time.

Using OpenTurns scientific library and API [2, L2], 6.000 simulations were performed with various values of the five uncertainty sources (i.e. droplet diameter, number of droplets, head angle, cough velocity and cough duration). The results obtained with the first order Sobol index are summarised in Table 1.

As expected, it appears that the number of droplets remaining above a certain height (here 1.5 m) varies mostly with the angle at which the head is tilted. The second parameter that affects the results is actually the number of droplets emitted during coughing, while the injection velocity is only the third most influential parameter (with a much lower importance).

Yet, if the observable of interest is taken to be the mean distance travelled by droplets along the horizontal direction, then the analysis changes. The results are again mostly affected by the angle at which the head is tilted, but the second input affecting the results is the velocity of injection of the droplets. The cough duration, the number of particles and the diameter of particles are less influential on the result.

This study illustrates the application of sensitivity analysis techniques to investigate the variability of numerical simulations of airborne dispersion. The first results show the robustness of such techniques as well as their limitations. In particular, in the simple case considered, the head angle during the cough is the key parameter driving the particles towards the ground. However, these results are expected to change significantly if another observable is used. Moreover, this study shows that, as prerequisite of the sensitivity analysis, a clear definition of an observable is needed.

Simulations in more complex cases are still underway due to the high numerical costs and size of data generated by such numerical experiments. In the near future, our analysis will move towards more realistic descriptions, including models for droplet evaporation/condensation as well as new models related to viral and biological properties (lifetime, contagiousness, etc.) that appear to be key in designing more efficient public health recommendations [1].

Links:

[L1] https://www.code-saturne.org/
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Using Markovian Models to Simulate Disease Spread

by Stelios Zimeras (University of the Aegean)

In disease spread processes where hidden information dramatically affects the quality of the data, modelling of the spatial patterns is a challenging task. In this situation, models based on spatial structure are important for the investigation of neighbourhood structure between regions where spatial connectivity is defined. We have developed spatial techniques to investigate homogeneity.

Spatial patterns can be explained by modelling the interaction between homogeneous regions or inhomogeneous regions [3]. Spatial models can be defined as specific models where estimation techniques can be applied in regions (in a rectangular or non-rectangular manner) using advanced statistical techniques. These models can be analysed based on Markov random fields where the local neighbouring structure is under investigation. The main concept in spatial analysis is to define the smallest possible areas for the estimation of patterns. This is because regions are composed of a mosaic of textures. Stochastic models and statistical methods have been successfully applied in image analysis. For any statistical analysis that uses such methods, it is vital to choose an appropriate model as the prior and to accurately estimate the prior model parameters.

These local characteristics are defined in terms of the conditional distribution of the random variables at each site, given the values at other sites. This specification is called a Markov random field (MRF). The definition of the MRF came originally from statistical physics, though these processes form a family of Markov processes in which a time index is replaced by a space vector. At this stage, a Markov random field model must be introduced [2]. Markov random fields are defined based on the conditional distributions of the neighbours. As a result, a conditional probability of the pixels, given the neighbours, is introduced with general form given by the Gibbs distribution (e.g. Ising and Potts models) or by auto-models. Models for disease spread are given based on whether the disease succeeds or fails to appear in the region. For this reason, a logistic model could be used with white patches representing success and black representing failure. Due to the 2D definition of the region and the conditionality of the pixel values, these

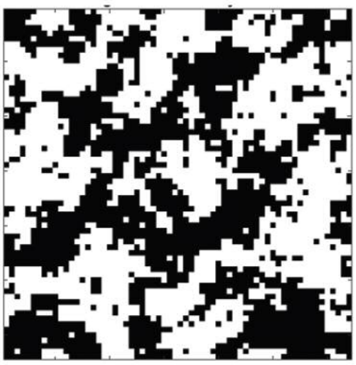

Figure 1: Auto-logistic model of disease spread. The white pixels show where the disease has appeared and black is the background.

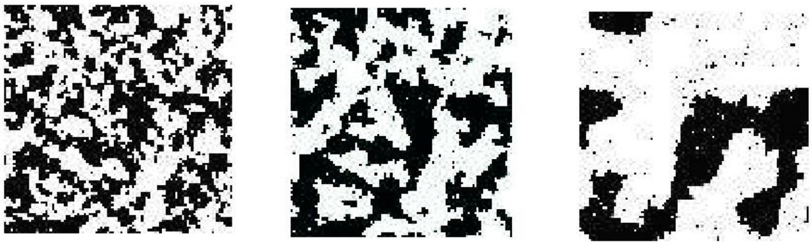

Figure 2: An auto-logistic model of disease of disease spread. The images show realizations from Ising model: 3 iterations, 25 iterations, and 100 iterations from the Ising model.

models are defined as auto-models (Figure 1).

A homogeneous auto-logistic model (Ising model), assuming uniform temperature, is shown in Figure 2. Texture analysis focuses on extraction information based on sufficient features to characterise real texture images. By representing a complex real texture via statistical methods or parameters, texture analysis becomes an important tool to explain specific phenomena.

Uncertainty can present a major problem when analysing incomplete data, especially in spatial modelling at different spatial and temporal scales. Uncertainty analysis, in this context, is the process of assessing uncertainty in modelling or scaling to identify its major sources, quantify their degree and relative importance, examine their effects on model output under different scenarios, and determine prediction accuracy. Inherent in the modelling process is the introduction of statistical errors (especially in spatial modelling where homogeneity of the neighbours is one of the measures to justify differences between regions). Incomplete datasets, spatial differences and statistical modelling all contribute to the complexity of analysing uncertainties in regions.

Although the issues with uncertainty analysis can be considered to be analogous to standard statistical problems, in practice, uncertainty analysis in this context is often more complex, necessitating the use of specific models. The choice of the model is a choice that leads to structural uncertainty. Model uncertainty has two basic components: model structure and model parameters [4]. Model structure uncertainty is caused by the modelling processes of simplification and formulation. Model simplification, which is essential to modelling, involves identifying the most important relationships and variables [2]. Considering the auto-logistic model (binary model), in situations where different times or different periods are introduced, an auto-binomial model must be performed. This model includes additional information, with the success or the failure of the diseases: the patterns disease frequency, which vary by region (illustrated with different shades) (Figure 3).

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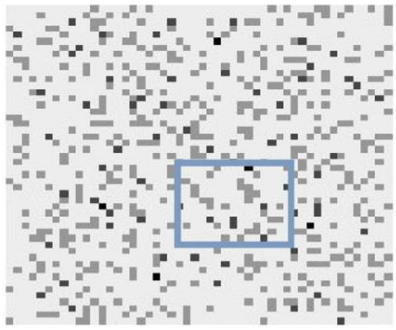

Figure 3: Patterns of disease spread: the darker shades indicate the regional pattern combining various Ising realisations. The rectangular frame indicates the uncertain region.

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Control Theoretic Approach for COVID-19 Management

by Gábor Szederkényi (Pázmány Péter Catholic University), Tamás Péni (SZTAKI) and Gergely Röst (University of Szeged)

A control theoretic approach can efficiently support the systematic design of strategies to suppress or mitigate the effects of the COVID-19 pandemic.

The COVID-19 pandemic is one of the biggest challenges the world is currently facing. Until a vaccine and effective treatment are available, carefully planned measures are needed in every country to control the spread of the disease. Choosing the right management policy is a sensitive task that requires several potentially contradicting objectives to be considered. The most important limiting constraint is the capacity of the healthcare system, which can easily be overwhelmed if the spread of the disease is not controlled. It is clear that the transmission of the virus can be efficiently slowed down by appropriate restrictions (social distancing, lockdown), but these measures have negative social and economic impacts that we can't afford to overlook. At the moment, governments are continuously evaluating their control measures, trying to find a balance between public health concerns and the costs of social distancing measures. This paper shows that control theory provides an appropriate framework for the support of decision-making through the systematic design of optimal management strategies.

A mathematical model of the epidemic spread

The computation of the control policy requires a mathematical model describing the relationship between important time-dependent quantities and capable of predicting the future behaviour of the epidemic. The most common approach is to use compartmental models [1] for this purpose. In this modelling framework the total population is divided into groups (compartments) such that each compartment collects individuals of the same infection status. One possible grouping is obtained by introducing the following compartments [2]: Susceptible (S) collects individuals who can be infected ; Latent (L) contains those who have already contracted the disease, but do not show symptoms and are not infectious yet. Individuals who have just recently been infected and need a few more days to develop symptoms are collected in class Pre-symptomatic (P). Depending on whether or not an infected individual develops symptoms he/she belongs to the compartment Symptomatic infected (I) or Asymptomatic infected (A). Three additional groups are defined for the Hospitalised (H), Recovered (R) and Deceased (D) individuals. The transition diagram representing the interconnections between the compartments is depicted in Figure 1. The transmission rates are given in the labels of the arrows. The model depends on several parameters (α, β, ρ, etc.) which can be determined and continuously updated by following the current literature and analysing the data registered worldwide on the active COVID-19 cases (e.g., L1).

defining constraints and optimality criteria for the predicted future behaviour of the system. Possible examples for the former are (physical) bounds on the inputs and/or on the state variables and minimal control costs or operation time for the latter. Therefore, a complex control problem can be expressed in the form of constrained optimisation [2]. In the compartmental model introduced above the control input is the scaling factor of coefficient β determining infection probability. By applying restrictions of varying stringency index (from mandatory mask wearing through closing of different institutions and limiting public gatherings to total lockdown) this factor can be varied between well-defined limits. Assuming that the number of hospitalised and deceased individuals can be reliably documented,

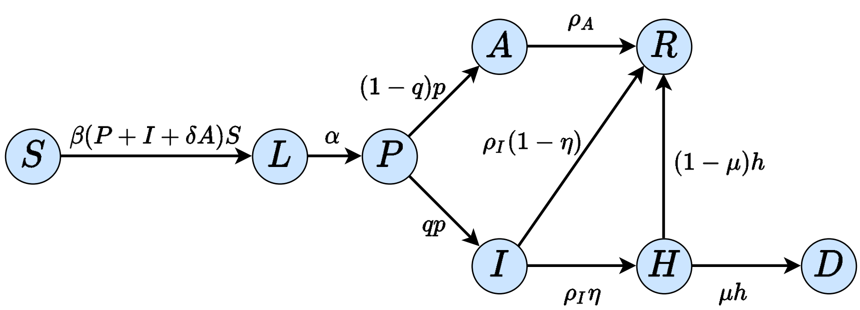

Figure 1: Transition diagram of the compartmental model describing the transmission dynamics of COVID-19.

Formulating COVID management as a control design task

In a control theory framework, dynamical systems are considered as operators mapping from an input signal (function) space to an output space. We distinguish between manipulable inputs which can be set (often between certain limits) by the user and disturbance inputs from the environment that cannot be directly influenced. The outputs are either directly measured quantities or they are computed from measurements. The inner variables representing the actual status of the model are the states. The control goals can be prescribed by

these two quantities are chosen for outputs. The main goals of epidemic management, such as protecting the healthcare system and applying less stringent interventions to avoid social and economic crisis, can be formalised by defining a strict upper limit for the number of hospitalised individuals (e.g., $H \leq H_{max}$) and adding the control cost to the optimality criteria.

State estimation

In order to use the model to predict the future behaviour of the epidemic, information is needed about the non-measured compartments. The state variables

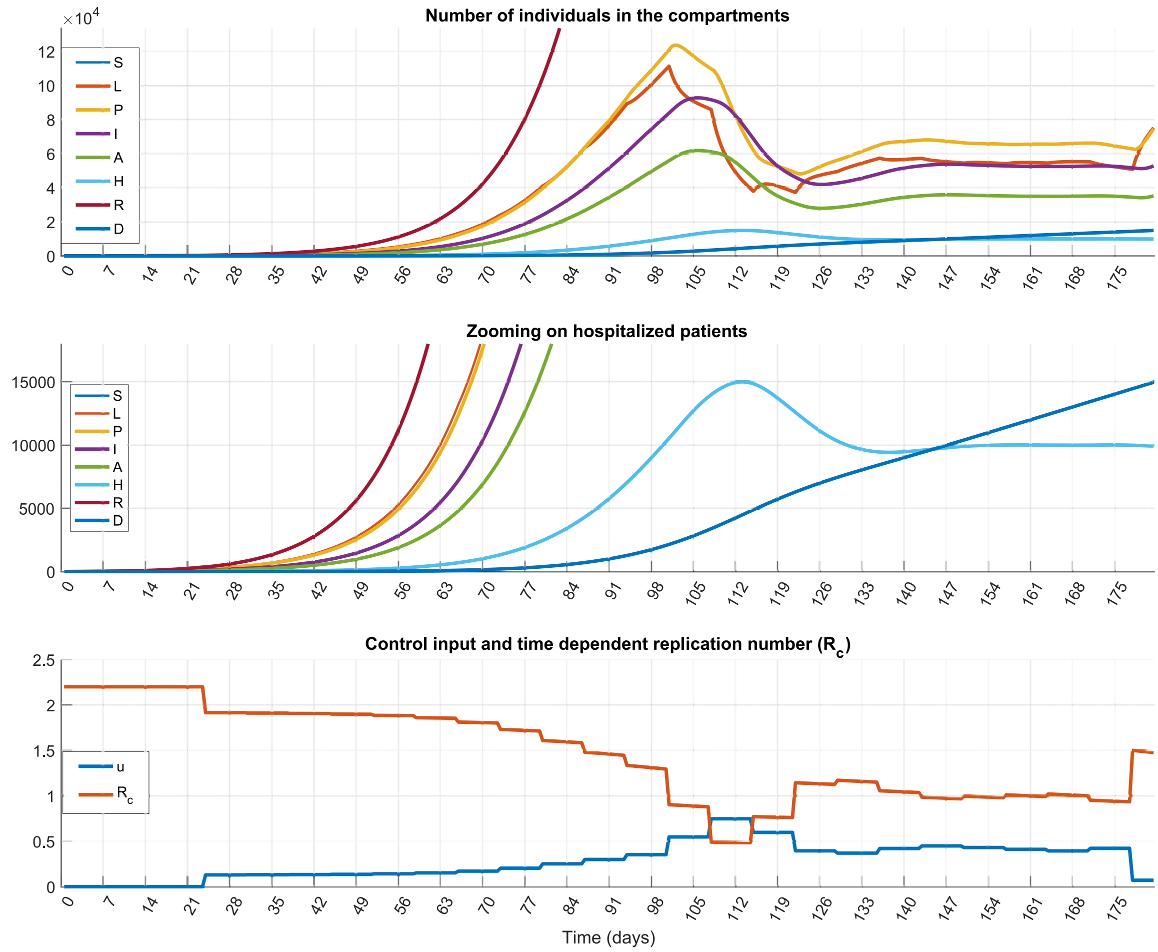

Figure 2: Simulation results obtained by a predictive controller computed by constrained optimisation. The goal is to mitigate the effect of the epidemic and protect the functionality of the healthcare system by taking less stringent measures. The limitation of the healthcare system is modelled by specifying two upper bounds $H^{(1)}_{max}$ and $H^{(2)}_{max}$ with $H^{(1)}_{max} < H^{(2)}_{max}$ for the number of hospitalised patients (H). The primary goal is to keep H under $H^{(1)}_{max}$. If this is not possible, this limit can be exceeded, but only up to $H^{(2)}_{max}$ and only for a given time period. The control input can vary between “no-interventio”‘ and “total lockdown”‘. It can be seen that the required control goal can be achieved by applying strict measures at the very beginning of the epidemic and systematically easing the restrictions thereafter. Together with the control input, the bottom figure depicts the time dependent replication number (R_c) as well.

corresponding to these have to be estimated from the past measurements and the applied control actions using the nonlinear compartmental model.

Illustrative results

Figure 2 presents a simulation result obtained by performing the control design concept above for the Hungarian situation. In this specific scenario, we assumed that the capacity of the healthcare system (H_{max}) can be temporarily exceeded if needed, but only for a short time and by only a specific amount. This scenario models the actual, real situation, when there is an extra, but limited and possibly costly reserve in the healthcare system that can be activated if necessary.

This research was partially supported by the Artificial Intelligence Hungarian National Laboratory, https://milab.hu/

Links:

[L1] COVID-NET: A weekly summary of US COVID-19 Hospitalization Data: https://kwz.me/h2X

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A Hybrid Predictive Model for Mitigating Health and Economic Factors during a Pandemic

by Lisa Veiber, Salah Ghamizi (University of Luxembourg) and Jean-Sébastien Sottet (LIST)

Many statistical and machine learning (ML) models have been developed to provide forecasts for the COVID-19 crisis. Acquiring qualitative data with a rather short timeframe is a challenge for anyone who wants to build a ML algorithm to support forecasts about the pandemic. We propose a hybrid approach that takes into consideration factors from human knowledge in order to reinforce or correct data-driven ML predictions.

At the peak of the COVID-19 crisis, governments took drastic measures to stop the pandemic, forcing the population into a total lockdown, which brought the economy to a standstill. While social distancing has disrupted social life, the economic impact of this outbreak has been severe and unprecedented. During the resurgence in COVID-19 positive cases, countries are too economically impacted to reinstate a strict lockdown as they did for the first wave and are instead investigating different actions to limit the pandemic without crushing the economy.

Our research is thus driven by the need to provide decision-makers in Luxembourg with an appropriate tool to identify which measures help control the spread of the virus with minimal economic impacts. In contrast to current approaches, which take a rather holistic view of the crisis, we have been focussing on the impact on particular sectors; specifically, the impact of the COVID-19 on the hospitality sector.

We have developed a machine learning (ML) driven approach, intended to function as an instrumental backup to the economic recovery strategy and ensure granular mitigation of the pandemic's effects. Our approach is complemented by human-centric modelling of the impacted ecosystem, including social, economic and health aspects. This model-based approach aims to correct the potential lack of data; fine-tuning the ML results and providing better user control. Ultimately, we aim to deliver a decision-making tool that helps find the right balance between health protection and economic recovery.

The machine learning approach

The proposed ML approach embeds state-of-the-art simulation and prediction techniques to provide predictions about economics and health, based on scarce data.

We use Bayesian likelihood [1] to estimate the Reproductive Number Rt (a measure of how fast the disease is spreading), then we implement a Deep Neural Network classifier that uses mobility data as [2] to predict the Rt of each economic sector. These processes are shown by the red indices 1 and 2 in Figure 1. We only relied on the cases per sector where we had enough data for Bayesian estimation. Other sectors were estimated using a generic country-wide Rt. The Neural Network uses smoothed samples of 30 days with a total of 76 features.

Once the Rt is predicted using our ML classifier, it is injected in a SEIR-HCD compartmental model to predict the cases (see Figure 1, index 3: prediction process and SEIR-HCD using a set of ordinary differential equations), deaths,

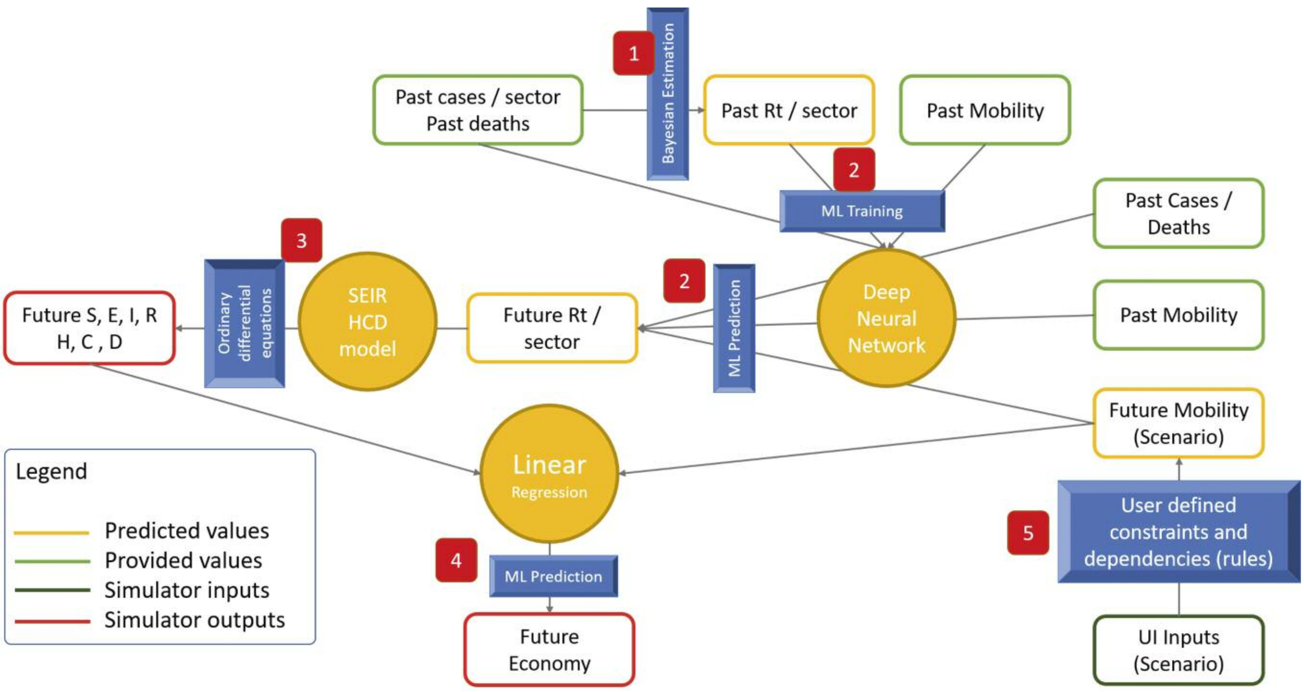

Figure 1: Overall process and in/outputs of our simulation tool.

individuals who are hospitalised and number of people who are critically ill for each economic sector. Once these elements are known, economic metrics can be computed.

For the economic modelling, only a few data points were available for the target output, which meant that only shallow ML techniques could be used without risk of overfitting. After training and validation, a linear regression was used to link the simulated epidemiological output and the different measures parameters to the economic impact. This is shown in Figure 1, red index 4.

Human factors and the decision-making process

We designed a user-centred tool to help decision-makers: inputs of the simulation are mapped on real polices that authorities in Luxembourg and throughout Europe can use to mitigate the impacts of COVID-19. We believe that collecting human knowledge about contextual information, which is not always reflected in the training data, is necessary to make models more precise. Thus, we have enhanced our original ML with human-design models (e.g., rules). These models affect the input measure and potentially the learning, or correct and/or mitigate the result of the learned model. This is represented in Figure 1, red index 5, where we build mitigation rules for ML and user input. These rules will map the user input measures into the ML inputs.

We identified some possible measures to be used as input, such as: the closure of borders to neighbouring countries (Belgium, France and Germany); the restriction of economic activity; school restrictions; and restrictions on public and private gatherings. Having data on the actual number of cases and deaths, we were able to infer the reproduction rate Rt of the pandemic and build a model to link this Rt to actual measures like border closures and school restrictions. Our model showed a R^2=82% on a random split for Luxembourg.

We have also designed a model for different economic dependencies between the sectors. For instance, essential sectors such as energy production cannot be completely shut down since many industries, and more importantly hospitals, depend on them.

We also tuned the output of the ML approach by proposing a contamination factor between the sectors. It then corrects the output of the Rt for the defined sector using a mitigation factor. We will be able to fully validate and potentially retrieve those inter-sector contamination factors when we have access to more data, which unfortunately was not available at the time that we developed this model.

A decision-making tool

Our decision-making tool, embedding human-designed models and ML, represent a major leap in simulation engines, which, in the near future, will help decision-makers to compare the impact of different policies on health and the economy. As it uses simulation and ML prediction as a tool for decision-making, it still requires fine-tuning to correctly calibrate government policy (e.g., closures of non-essential shops) on our prediction tool inputs: the impacts of some measures on the pandemic have not been scientifically evaluated as data is lacking or not trustworthy. As the pandemic evolves, further study is required to examine the correlation of measures with reality and economic sector specificity, as well as to make this model interoperable with other models developed during the crisis.

Link:
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Call for Papers and Workshop Proposals

SAFECOMP 2021

York, UK, 7-10 September 2021

Safecomp 2021 will take place in York, UK, from 7-10 September 2021. After SAFECOMP 2020 was successfully organized as on-line event, we hope that this year we can meet physically, but it will take place anyway like 2020. The conference covers development, assessment, operation, and maintenance of safety-related and safety-critical computer systems. A special theme is this year "Safe human-robotic and autonomous system (RAS) interaction", but other papers are welcome too for the other sessions. Deadline for abstracts is 1 February 2021 (recommended, not mandatory), for papers 15 February 2021.

Call for Papers: https://kwz.me/h3N

Call for Workshop-Proposals

Tuesday 7 September will be a day of tutorials and workshops. Proposals are welcome. Workshops can be half-day or full-day. If a reviewing process is implemented, the papers will be published in the SAFECOMP 2021 Workshop Proceedings by Springer LNCS. Please send a short description of your proposed workshop to workshop chair Erwin Schoitsch (erwin.schoitsch@ait.ac.at), with title, scope/rational, topics, format/length, audience to be addressed, PC, contacts. Deadline: January 25, 2021.

DECSoS Workshop

The ERCIM-DES WG is again organizing the DECSoS Workshop "Dependable Smart Embedded and Cyber-Physical Systems and Systems-of-Systems", which will take place on 7 September 2021. This workshop is aiming at reports on "work in progress", aiming at fruitful discussions and experience exchange. Reports on European or national research projects as well as industrial experience reports are welcome. All papers will be reviewed by at least three reviewers. The workshop proceedings will be provided as a complementary book to the SAFECOMP Proceedings. Deadline for submitting workshop papers is 30 April 2021. Submission will be via EasyChair (to be announced).

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A Multidimensional Method for Capturing Spatial Data

by Christian Kollmitzer (AIT Austrian Institute of Technology GmbH), Melanie Schranz (Lakeside Labs GmbH) and Manuel Warum (AIT Austrian Institute of Technology GmbH)

Current methods for collecting spatial information from, e.g. crime scenes, historical excavation sites or construction sites, sometimes have significant limitations. Our approach is based on a modular, adaptable system that can be equipped with multiple sensors, an intuitive presentation and processing of collected, heterogeneous data. The generated model can be stored in a structured manner and supplemented with additional information such as place and time, whereby a continuous signature procedure is used.

Current technologies, in particular developments in the field of photo and sensor technology, make it possible to obtain a wide range of heterogeneous data. These can be used to obtain a detailed image of spatial conditions. Due to the multitude of heterogeneous data sources and the increased quality of the measurements, however, the complexity of the data model also increases. Therefore, appropriate preparation, processing and representation of the data obtained are a prerequisite for efficient usage. Our method offers a multidimensional approach, which considers the current and upcoming development of sensor technologies, combines them, and prepares them as multidimensional models for visualisation. The robust design and the simple and intuitive handling of multiple sensors minimise the probability of errors during data acquisition. The resulting high-quality models form the base for further processing of the data, the representation using different techniques as well as archiving. By using appropriate procedures, the data and models are also digitally signed to prove their authenticity. We are pursuing these goals with the patent pending Vestigator method (A50147/2020).

The ever-improving methods for recording and evaluating spatial data with a high degree of detail are applicable to many applications – for example, the digital reconstruction of crime scenes, historical buildings and excavation sites, or for the documentation of the progress at construction sites. Accordingly, there is a multitude of individual products, procedures, and approaches that work independently from each other.

In most cases it is common to use 360-degree cameras to depict an environment. This creates individual high-resolution photographs that allow the preservation of details that are particularly relevant to an application. Depending on the application, further data is obtained from additional sources and analyses. In the context of forensics, these would include fingerprints or biochemical laboratory reports of previously unidentified substances. This results in a collection of facts about the site, but the potential to combine the data into a holistic model is very restricted.

A number of problems arise from the current procedures. On the one hand, the components used cannot be adapted to current developments, which means that they cannot keep pace with the state of the art. Furthermore, they are expensive to purchase and operate, and therefore in many cases are not available in sufficient quantities. In addition, some widely

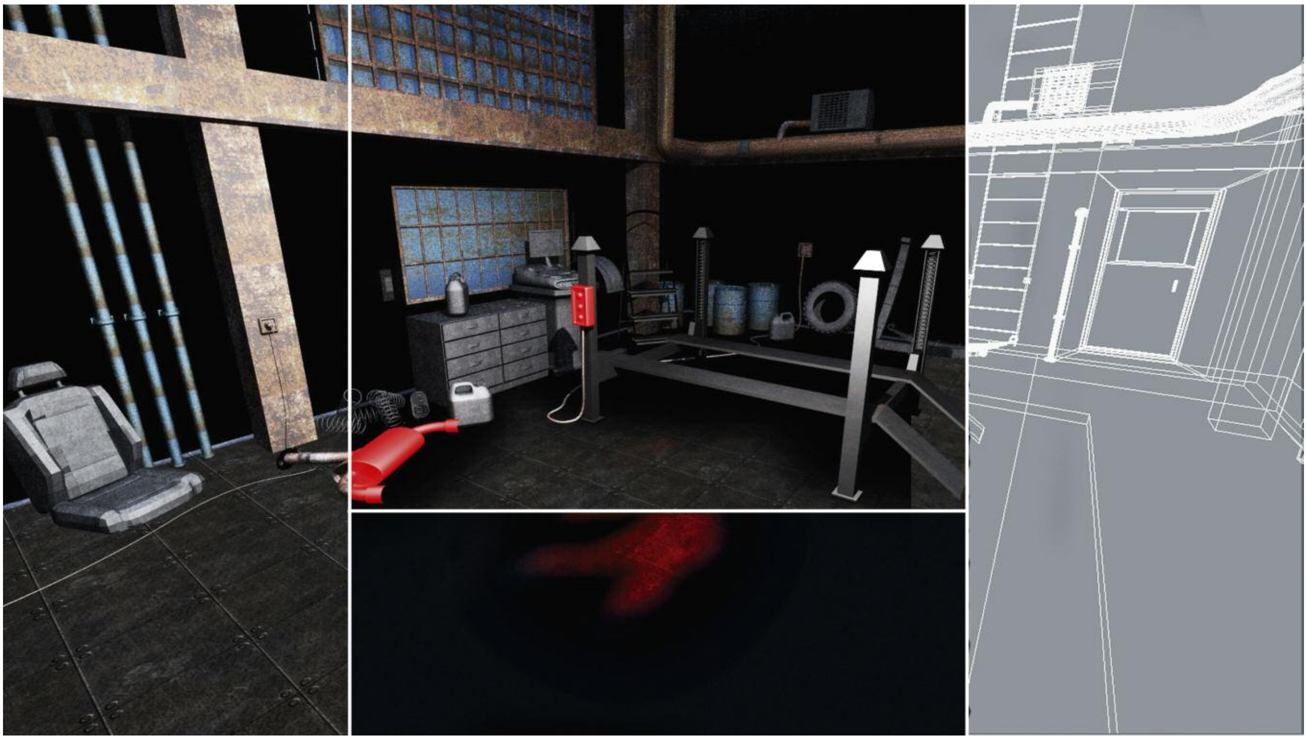

Figure 1: Vestigator-different layers of spatial data from four different sensors.

used methods to map a 360-degree environment are very time consuming: the creation of the photographs and the subsequent image processing (for example with stitching algorithms) can take a long time, as they are sensitive to errors. Incorrectly recorded images (i.e. insufficient quality, poor lighting conditions, etc.) must usually be reacquired completely. Additionally, collected information such as detailed images or analysis reports are loosely combined into a collection of facts. However, the complete processing of the different data cannot be completely guaranteed due to their diversity and quantity. In many cases, it is this comprehensive mapping that is crucial.

In addition, it must be ensured that the authenticity of the collected data is verified to prevent any subsequent manipulation of the data. This is relevant, for instance, if the collected data must be updated or reassessed after a longer period of time, for example in connection with a new commencement of legal proceedings.

Solution approach

Our solution approach is based on a modular, adaptable system that can be equipped with current and future sensors. The data is efficiently recorded by the simultaneous use of several heterogeneous sensors, stored in a structured manner and supplemented with additional information such as place and time. The data of a single measurement or several measurements can then be transferred into a holistic model. This model can subsequently be extended by further information, whereby a continuous signature procedure is used at any time to prove which additions have been made to the model.

Apart from the developments in the field of photo and sensor technology, new advances in the areas of data analysis and artificial intelligence are continuously emerging. To account for progress in these areas, the data is prepared accordingly. This makes it possible, among other things, to interpret individual measurements or entire models, to identify common features or noticeable divergences. Current techniques such as augmented reality (AR) or virtual reality (VR) also allow individual models to be presented in such high quality that both qualified experts and members of a jury can work with them in a meaningful way.

Vestigator model

The creation of a model begins with the definition of the task. Depending on the definition, the type of measurement and the corresponding sensors are selected. In addition to measurements with a tripod, the use of self-propelled systems or drones is also possible, for example in environments that are difficult to access, dangerous for humans or contaminated.

The measurement is performed using a carrier device on which the individual sensors are mounted. The sensors are mounted in such a way that the measuring beam would pass in a backward extension through the centre of rotation of the carrier device. The carrier device is then brought to a measuring point. In order to carry out a measurement, the carrier device performs a full, stepwise 360 degrees rotation depending on the sensors used. During this rotation process, the sensors acquire measurement data. Afterwards, further measurements can be carried out at different points of origin, or at the same measuring point in a different perspective by changing the height or by tilting the carrier device. The data obtained from the measurement is digitally signed immediately while it is saved.

From the data obtained, a model is created, which includes the different sensor measurements. This model consists of several layers (at least one per sensor), whereby the layers are evaluated individually or combined. Figure 1 shows different layers with data from four different sensors clockwise from the left: thermo scan, picture, LiDAR and UV scan. This model can be extended at any time to include additional external data independent of the individual measurements such as the time at which the measurements commenced, people in charge, climate conditions etc. After that, the model is signed like individual measurements.

Additional information relevant to the model can be obtained even after the original measurement took place, for example in the form of laboratory reports, legal assessments or research reports. These can be incorporated into the model by adding an additional layer.

This layer can be based on the optical image and the additional information can be integrated into the model using anchor points. For example, data about a person found in a database containing fingerprints can be added to the fingerprints found at a site so the information about the person concerned can be subsequently incorporated into the model. After each addition to the model, a further digital signature is added.

The representation of the data can be carried out in different ways. The layer model enables the use of VR technology to virtually move through the environment. The use as AR model or a representation as 2D model, especially to display individual details, is possible. The model itself can be enhanced with further elements for representation. For example, additional objects such as mannequins can be inserted, the target state can be compared to the measured actual state or reconstructions of damaged items can be made. The models can be sent to experts for assessment, and their reports can be included in the model. This database can be supplemented by new insights over the years. Apart from the conservation of the scene, this approach is open to current and future methods from the field of machine learning, for example in pattern recognition or the reconstruction of sequences.

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Digital Seafaring: Digitising, Curating and Exploring Archival Sources of Maritime History

by Martin Doerr (ICS-FORTH), Pavlos Fafalios (ICS-FORTH) and Apostolos Delis (IMS-FORTH)

The European project SeaLiT has developed a set of innovative tools for supporting maritime historians in digitising, curating and exploring archival sources of maritime history. The tools are the result of the interdisciplinary work between maritime historians of the Institute of Mediterranean Studies of FORTH and researchers and data engineers of the Centre for Cultural Informatics of the Institute of Computer Science of FORTH.

A vast area of research in historical science concerns the analysis of historical archival sources, in order to describe, examine and question a sequence of past events, and investigate patterns of causes and effects. This kind of research requires a data management approach that can support historians in all activities involved in their research processes, from digitising the (usually hand-written) archival sources, to curating the transcribed data and performing quantitative analysis and exploration. However, current practice nearly exclusively uses spreadsheets or simple relational databases to organise the data and perform quantitative analysis. This practice causes problems like the high dependency of the transcribed data on the initial research hypothesis, usually useless for other research, the lack of representation of the details from which the registered relations are inferred, and the difficulty to revisit the original sources of transcribed facts for verification, corrections or improvements.

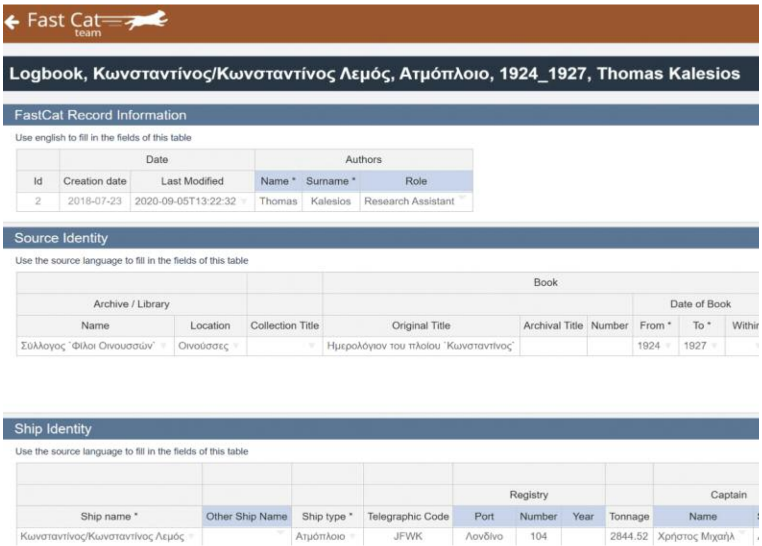

Figure 1: An example of a record in FAST CAT.

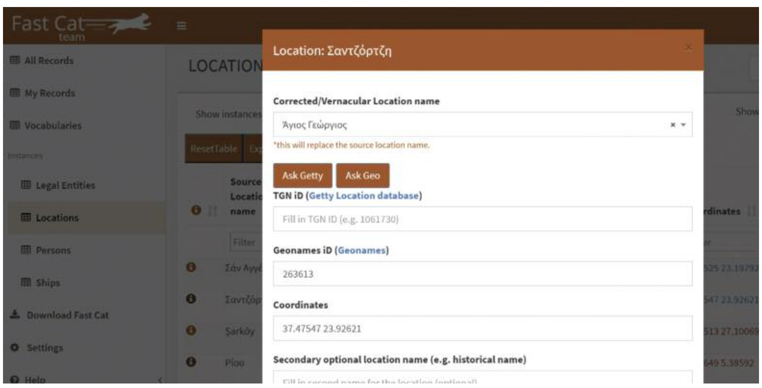

Figure 2: Data curation in FAST CAT TEAM.

SeaLiT [L1] is a European (ERC) project of maritime history in this context, that explores the transition from sail to steam navigation and its effects on seafaring populations in the Mediterranean and the Black Sea between the 1850s and the 1920s. Historians in this project are investigating a range of areas, including the maritime labour market, the evolving relations among ship-owners, captain, crew and local societies, and the development of new business strategies, trade routes and navigation patterns, during the transitional period from sail to steam. The archival sources that are studied range from handwritten ship logbooks, crew lists, payrolls and student registers, to civil registers, business records, account books and consulate reports, gathered from different authorities and written in different languages, including Spanish, Italian, French, Russian and Greek.

The information management challenge faced by SeaLiT is the ability to faithfully catalogue these unique historical sources and then use them as a primary source for research, while integrating this data into a common form from which historical analysis and questions can be carried out efficiently.

To this end, we have developed FAST CAT [L2], a collaborative system for assistive data transcription and curation in digital humanities and similar forms of empirical research. In FAST CAT, data from different information sources can be transcribed as “records” belonging to specific “templates”, where a template represents the structure of a single data source. A record organises the data and the metadata in tabular form (similar to spreadsheets), offering functionalities like nesting tables and selection of terms from vocabularies (Figure 1). The cells in a table can accept values of different types, in particular entity (the value is the name or attribute of an entity, e.g., of a person or location), vocabulary term (the value is a term from a controlled vocabulary), literal (the value is a literal, e.g., a free text, number, or date), or nested table (the value is another table).

The curation of the transcribed data can be performed through FAST CAT TEAM, a special environment of FAST CAT that allows the collaborative management of entities and vocabularies (Figure 2). This involves activities like i) applying corrections in entity names or attributes, ii) adding missing entity information or enriching with additional data (e.g., adding coordinates in the locations for enabling map visualisations), iii) dealing with the varying entity identity assumptions through instance matching, and iv) maintaining vocabularies of terms for certain types of transcribed data and enabling the creation of term hierarchies.

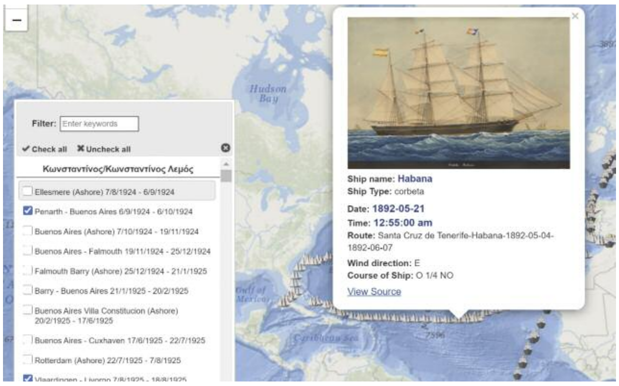

Figure 3: The Ship Voyages map application.

FAST CAT is innovative in its ability to support features like nested tabular structures for data entry, embedded instance matching and vocabulary maintenance processes, as well as provenance-aware data curation that does not spoil the data as transcribed from the original sources. In addition, it is configurable, which means that it can be easily used for digitising and curating other data sources, beyond the area of maritime history. These are important features that, to our knowledge, are not currently supported by existing solutions.

The transcribed and curated data can be then exploited by external applications, like the Ship Voyages map application [L3]. Ship Voyages visualises, on an interactive map, the curated data of a set of transcribed ship logbooks of the nineteenth and twentieth centuries (Figure 3). Up to now, the data of fourteen ships are visualised: nine Greek and five Spanish. The user can inspect the routes of particular ships, get more information about a selected ship location, such as location date and time, weather conditions, ship course, and related events (like change of ship course), or visit the corresponding FAST CAT record for getting additional context information as transcribed from the original sources.

Currently, we are studying additional methods on how to explore and visualise the transcribed and curated data, focusing on how to support historians in expressing complex information needs through intuitive and user-friendly interfaces.

This work has received funding from the European Union's Horizon 2020 research and innovation programme under the European Research Council (ERC) grant agreement No 714437.

Collaborators: Georgios Samaritakis, Kostas Petrakis, Korina Doerr, Athina Kritsotaki (ICS-FORTH)

Links:
[L1] http://www.sealitproject.eu/
[L1] https://www.ics.forth.gr/isl/fast-cat
[L3] http://www.sealitproject.eu/digital-seafaring

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Airborne Reconnaissance in the Field of Natural Hazard Management and Public Safety

by Alexander Preinerstorfer, Philip Taupe (AIT Austrian Institute of Technology GmbH) and Christoph Hochwarter (IFES Institut für empirische Sozialforschung GmbH)

Airborne information gathering can benefit crisis and disaster management by allowing authorities to quickly obtain an overall operational picture and gain in-depth insights into specific aspects of the situation. Developments in the field of unmanned aerial vehicles (UAVs) and the associated sensor technology are opening up a wide range of application areas, helping authorities and organisations tasked with security to reduce the operational risks. These areas of application are being investigated in the AREAS research project.

Austria's hazard landscape is characterised by natural hazards. A large part (75% of the total area) of Austria is covered by the Alps, and consequently the threat of natural hazards is higher than in most other European countries, with several such events occurring each year. Because of this, 58% of the national territory is declared as intensive zones of protection against alpine natural hazards. Furthermore, about 17% of the country's landmass is extensively threatened by torrents, avalanches and erosion. Austria has clearly defined protection goals when it comes to managing natural hazards, including the protection of human life and health, protection of the environment and protection of settlement areas. These protection goals are highlighted in the research project "AREAS: Aerial search & Rescue support and supErvision of inAccessible terrainS" [L1] that focuses on airborne support.

Methods

The multidisciplinary consortium involved in the AREAS research project is investigating unmanned airborne reconnaissance, which can significantly reduce the risks for emergency services when exploring unknown terrain. The project is bringing together modern technologies such as UAVs and sensor technology in a combined research design to provide resource-efficient support for users in public safety and natural hazard management applications ("end-users") and to provide valuable information about the current situation. The AREAS use cases were derived using an interdisciplinary approach starting with a requirements phase. In this phase, the end-user's needs were thoroughly examined in workshops from which we developed project goals that relate to the operational realities of the end-users.

Based on the scenarios and use cases that we established in the workshops, the detailed functional and technical requirements for the system architecture to be developed were defined, taking into account the existing legal framework in national aviation and data protection. This technology has a range of potential applications, but for our use cases we gave special priority to torrent monitoring (early detection of sedi-

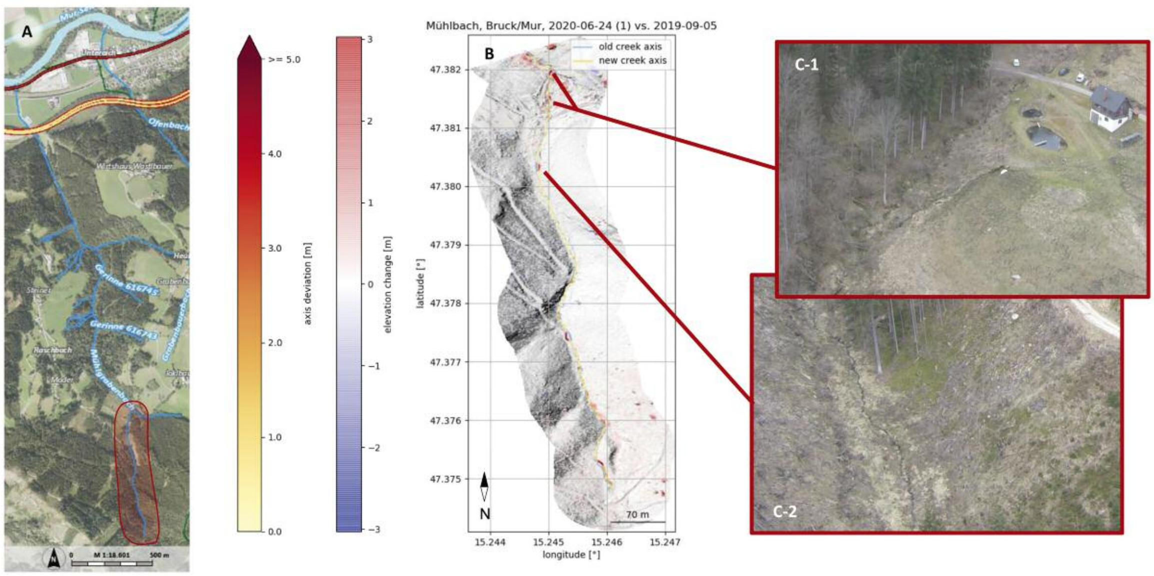

Figure 1: Analysis of torrent monitoring: (A) Geographical region of Mühl(graben)bach Bruck/Mur, red highlighted area marks the flyover area. (B) Hillshade overview map of potentially critical areas. Overlay blue-red: Change of the elevation profile against reference recording. Light blue line: torrent course of the reference recording. Light yellow-red line: torrent course of the current recording; deviation from the reference image highlighted in colour. (C-1, C-2) In-flight images of potentially critical areas for visual verification.

mentation, degree of filling of bed load barriers, material deposits) and search for missing persons.

Results and Discussion

(i) Population survey: We conducted sociological research to investigate the potential fears, hopes and subjective feelings of the Austrian population regarding an official government UAV deployment and to make such a deployment as socially acceptable as possible. For this purpose, an Austria-wide, representative telephone and online survey of 1,280 individuals was carried out in 2019; two focus groups were held; and finally acceptance-promoting recommendations were developed.

The results of the survey showed that people's opinion about the use of UAVs varies strongly depending on the area of application and the user. For example, a minority of respondents (23%) supported the use of UAVs for leisure purposes (e.g. as toys), while commercial or professional applications rated somewhat better (67%). The negative public perception of UAVs was confirmed by an association test conducted as part of the survey, using the terms "drone", "flying drone" and "unmanned aerial vehicle". The test showed that for many people these terms carry negative connotations associated with surveillance or harassment – a finding in accordance with the results of the focus groups.

However, when asked about UAV usage by public authorities in civil protection and disaster relief, 88% of respondents expressed support. The majority of respondents approved of the use of UAVs for official applications such as to search for missing persons in nature (92%) and in acute disaster situations in inhabited (90%) and uninhabited areas (87%). For routine checks of protective infrastructure in unpopulated areas or torrents that are not urgent, the approval rate was still 82%–83%. For UAV use in official contexts, the lowest rate of approval was given to UAV use for police-related searches in villages and towns (66%).

These results support the findings of other studies and research projects that the general population's attitude towards the use of UAVs varies considerably depending on the context and the field of application [1, 2].

(ii) Data analysis of torrent monitoring: The monitoring of alpine torrents contributes significantly to the prevention of high-risk natural events like mudflows. Currently, federal authorities carry out regular inspections on foot. We developed a more efficient solution utilising a UAV equipped with a multi-target laser scanner to obtain detailed 3D point clouds of the torrent's vicinity even in the presence of dense vegetation. Data was collected on three dates over two years. An automatic data analysis pipeline evaluates and compares the current against historic inspections and highlights potentially critical areas, i.e. unfavourable changes of the terrain and/or torrent flow path. Together with regular in-flight camera images (Figure 1) and readily available 3D data, this system enables experts to efficiently assess large and impassable areas.

The AREAS results contribute to the protection of infrastructure assets and the population and can provide decision-makers with essential support in their respective areas of responsibility.

The project AREAS is funded by the Austrian security research programme KIRAS of the Federal Ministry of Agriculture, Regions and Tourism (BMLRT).

Link:
[L1] https://areas-project.at/

References:
[1] P. Boucher: "You Wouldn't have Your Granny Using Them: Drawing Boundaries Between Acceptable and Unacceptable Application of Civil Drones", Science and engineering ethics, Vol. 22, 5, p.1391-1418, 2016.
[2] Verband unbemannte Luftfahrt, Was denken die Deutschen über unbemannte Luftfahrt. Ergebnisse einer repräsentativen Umfrage. Chart Report. [Online] https://kwz.me/h2F [Accessed: 02.09.2019], 2017.

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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: April 1 to April 15, 2021
- Notification: July 2021
- Seminar dates: In 2022/2023 (final dates will be announced later).

CNR-Inria Team Wins Gold Medals at the RERS 2020 Parallel CTL Challenge

Franco Mazzanti (FMT lab, ISTI-CNR, Pisa, Italy), Frédéric Lang and Wendelin Serwe (CONVECS, Inria-Grenoble, France), after their successful participation in last year's RERS 2019 Challenge, again won three gold medals at the "Parallel CTL" track of RERS 2020 [L1]. The RERS (Rigorous Examination of Reactive Systems) challenge is an international software verification competition held every year since 2011. RERS 2020 is the 10th edition of the challenge. Gold medals are awarded based on the number of problems solved, and the joint CNR-Inria team solved 79 of the proposed 90 problems which were structured in three groups of increasing difficulty. Also this year, the result was obtained by the exploitation of advanced compositional verification techniques, some of which have been presented at the 3rd World Congress on Formal Methods (FM 2019) [1] and implemented in the CADP toolbox developed at CONVECS [L2].

Links:
[L1] http://rers-challenge.org/2020/
[L2] https://cadp.inria.fr/

Reference:
[1] F. Lang, R. Mateescu, F. Mazzanti: "Compositional Verification of Concurrent Systems by Combining Bisimulations", in Formal Methods: The Next 30 Years, Proc. of FM 2019, Porto, Portugal, LNCS, Springer, 196-213. https://doi.org/10.1007/978-3-030-30942-8_13

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W3Cx

One Million Enrollments in W3Cx

W3C's training activities have reached a significant milestone: one million enrollments in their MOOCs (Massive Open Online Courses) dedicated to front-end Web development! This achievement is particularly significant as W3C's catalogue is composed of six courses only of all entry levels, beginner, intermediate and expert:
- HTML5 and CSS Fundamentals
- HTML5 Coding Essentials and Best Practices
- HTML5 Apps and Games
- CSS Basics
- JavaScript Introduction
- Introduction to Web Accessibility.

A W3C Front-End Web Developer program delivers certificates of HTML5, CSS and JavaScript that people can showcase on their LinkedIn profile and/or their resume.

During the pandemic in 2020, interest in online education and demand in programming skills has increased. 30 years after its inception, the Web remains the key and most ubiquitous digital platform that enables communications, commerce, education, etc. the world over.

W3C accomplishes its mission by developing Web standards and ensuring their broadest adoption. Training people to learn Web technologies directly from W3C is a key enabler of that goal. This is why W3Cx with edX was created in 2015, with the first HTML5 course launched. It was an instant success with nearly 90.000 students from all over the world.

The W3Cx MOOCs let the learners practice, create and innovate while-building fun projects. With the advent of machine learning, smart things and more, there is an unexplored world of future Web applications and usages to create and play with.

https://w3cx.org/

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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The GATEKEEPER project, in which ERCIM is a partner, has launched a first Open Call offering an opportunity for research institutes, SMEs, Midcaps and industry with competencies in the Big Data and AI domains to apply for projects. The available budget is 600.000€ for ten projects with a duration of one year.

The GATEKEEPER 1st Open Call is now open!

GATEKEEPER is offering the opportunity to third parties to contribute to the development and sustainability of the project, working in a European environment and getting financial support.

The GATEKEEPER project is an EU-funded initiative under the Horizon 2020 Framework Programme. Its main objective is to create a GATEKEEPER that connects healthcare providers, businesses, entrepreneurs, elderly citizens and the communities they live in. This connection between stakeholders will promote an open, trust-based arena for matching ideas, technologies, user needs and processes, aimed at ensuring healthier independent lives for older adults.

- **Aim:** actively engage new technological members in the GATEKEEPER Ecosystem, supplying new Artificial Intelligence (AI) and Big Data applications, tools or components which will be incorporated into the Gatekeeper portfolio and offered to pilots and platform designers and developers.
- **Target:** start-ups, SMEs, Midcaps, industries and research technology organisations
- **Budget:** 600,000€, with a maximum of 10 projects funded
- **Deadline:** 29/01/2021
- **Project duration:** 12 months

For more information:

https://www.gatekeeper-project.eu/open-call