Proceedings

AI4Health

Lecture Series 2021

27 January 2021 – 24 November 2021

University Luxembourg, Campus Belval

Belval-Université, December 2021

Vladimir Despotovic
Jorge Goncalves
Jun Pang
Venkata Satagopam
Thomas Sauter
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Foreword

The second part of the lecture series took place this year from 27 January to 24 November. Like last year, and due to the Covid 19 pandemic, all lectures could only take place virtually. While last year we highlighted the research field between health and AI exclusively through invited lectures, this year the programme was expanded with numerous other events.

The first focus was on the current pandemic. A total of 16 colleagues accepted our invitation to present their project, which were funded under the FNR funding scheme launched by the National Research Fund (FNR). This was very well received, especially as colleagues from different directions were able to meet, to present, and to discuss results from different perspectives. Overall, we were thus able to attract an audience from different disciplines such as medicine, computer science, social sciences, humanities and history. Many thanks for this!

We would also like to thank the organisers (and colleagues) from the Luxembourg Centre for Systems Medicine (LCSB) of the "Rudi Balling GoodBye Lecture Series" for allowing us to include this programme in our programme. Thus, a second focus was placed on five more exciting lectures, which enabled a lively exchange beyond our research landscape. Here, too, we would like to express our warmest thanks!

The third focus was a direct continuation of last year's lectures, where six invited experts from six different countries reported on current research.

In addition, we would like to take this opportunity to thank in particular the Department of Computer Science, the AI Lab (ILIAS) of the Faculty of Science, Technology and Medicine (FSTM), the Department of Life Sciences and Medicine of the Faculty of Science, Technology and Medicine (FSTM) and the Luxembourg Centre for Systems Biomedicine (LCSB). Our thanks also go to the FNR: through the projects funded by the FNR, all audience members were able to benefit from exciting research and multidisciplinary exchange.

We hope that we have been able to provide the audience with some interesting presentations on the topic of AI and health and thus stimulate further and future research in this area. We are aware that multidisciplinary research requires and demands joint efforts. We hope that the AI4Health lecture series has made a great contribution to this.

See you next year!

Vladimir Despotovic
Jorge Goncalves
Jun Pang
Venkata Satagopam
Thomas Sauter
Christoph Schommer

Programme

Part 1 – Invited Research Talks

27 January, 14 April, 05 May, 14 July, 17 + 24 November

27 January 2021, 16h00
Prof Dr **Juan Rafael Orozco-Arroyave**

University Antioquia, Columbia + Erlangen-Nürnberg

An overview of ML methods to model symptoms in movement disorders (Parkinson's disease): from classical ML to DL

14 April 2021, 16h00
Dr. **Mauro Dragoni**

Fondazione Bruno Kessler, Trento, Italy

Achieving Explainable AI through Semantic Technologies: Challenges and Future Directions in Digital Health

05 May 2021, 16h00
Dr.-Ing. **Aureli Soria-Frisch**

Director, Neuroscience BU, Starlab Barcelona

Machine Learning for Brain Health and Understanding at Starlab Neuroscience

14 July 2021, 16h00
Dr **Sergio Martinez-Cuestra**

AstraZeneca R&D and the University of Cambridge, UK

Developing new genomics technologies to map DNA epigenetic modifications and damage in humans, parasites and cancer

17 November 2021, 1600
Dr. habil. **Jürgen Landes**

Ludwig-Maximilians-Universität München

Causal Inference in Medicine in the Real World

24 November 2021, 16h00
Prof. Dr. med. **Jochen Klucken**

LCSB, UL

Integration of AI into the life of patients and healthcare providers: how does it work and what does it change?

27 January 2021, 16h00

Prof Dr **Rafael Orozco-Arroyave,** University of Antioquia + Adjunct researcher at the Pattern Recognition Lab, University of Erlangen

An overview of ML methods to model symptoms in movement disorders (the case of Parkinson's disease): from classical ML to DL

Abstract: There exist different movement disorders with different origin. Parkinson's disease (PD) is one of those disorders and appears due to the progressive death of dopaminergic neurons in the substantia nigra of the mid-brain. Diagnosis and monitoring of PD patients is still highly subjective, time consuming and expensive. Existing medical scales used to evaluate the neurological state of PD patients cover many different aspects, including activities of daily living, motor aspects, speech and depression. This makes the task of automatically reproducing experts' evaluation very difficult because several bio-signals and modeling methods are required to produce clinically acceptable/practical results. This talk tries to show part of the way that has been traveled since about ten years considering different bio-signals (e.g., speech, gait, and handwriting) and methods of Machine Learning and the relatively new topics of Deep Learning (DL) with the aim to find suitable models for PD diagnosis and monitoring. Results with classical feature extraction and classification methods will be presented and also experiments with CNN and LSTM architectures will be discussed.

Bio: Juan Rafael Orozco-Arroyave was born in Medellín, Colombia in 1981. He is an Electronics Engineer from the University of Antioquia (2004). From 2004 to 2009 he was working for a telco company in Medellín, Colombia. In 2011 he finished the MSc. degree in Telecommunications from the Universidad de Antioquia. In 2015 he finished the PhD in Computer Science in a double degree program between the University of Erlangen (Germany) and the University of Antioquia (Colombia). Currently Juan Rafael Orozco-Arroyave is an Associate Professor at the University of Antioquia and adjunct researcher at the Pattern Recognition Lab at the University of Erlangen.

14 April 2021, 16h00

Prof Dr **Sergio Martinez-Cuestra,** AstraZeneca R&D and the University of Cambridge

Developing new genomics technologies to map DNA epigenetic modifications and damage in humans, parasites and cancer

Abstract: DNA is much more than ACGT. I will give a broad overview of the experimental and computational technologies and challenges used to map and understand epigenetic modifications, damage and structures in DNA. We are just beginning to understand how changes to the chemistry of DNA play a key role in the development of diseases (e.g. cancer), life cycle control and development of eukaryotic diseases. Using recent projects from my own collaborative research with talented chemists and biologists I will introduce the state of the art in the areas of DNA epigenetics from a computational perspective.

Bio: Sergio is starting a research group in bioinformatics exploring fundamental mechanisms of protein degradation and DNA epigenetics at the interface between industry and academia. He builds from his early training in laboratory chemistry and biochemistry, through a PhD and postdoc appointments in bioinformatics and cheminformatics developing projects in collaboration with wet-lab colleagues sharing his time between the AstraZeneca headquarters and the University of Cambridge. Outside research, Sergio teaches bioinformatics at university, contributes as an editor of the emerging journal Frontiers in Bioinformatics and supports the growth of the European life science data infrastructure ELIXIR. Beyond science, he has a passion for team sports, languages and culture/gastronomy.

05 May 2021, 16h00

Dr. **Mauro Dragoni,** Fondazione Bruno Kessler, Trento, Italy

Achieving Explainable AI Through Semantic Technologies: Challenges and Future Directions in Digital Health

Abstract: The interest in Explainable Artificial Intelligence (XAI) research area has dramatically grown during the last few years. The main reason is the need of having systems that beyond being effective are also able to describe how a certain outcome has been reached and to present it in a comprehensive manner with respect to the target users. The Digital Health domain is a pioneering scenario where XAI strategies have been designed and implemented. In this talk, I would go through the milestones of this paradigm and I will discuss the role of semantic technologies. Then, I will present how such strategies have been applied to the Digital Health domain, and which are the challenges that have to be tackled in the near future.

Bio: Mauro Dragoni is a research scientist at Fondazione Bruno Kessler within the Process and Data Intelligence (PDI) Research Unit. He received his Ph.D. in Computer Science from the University of Milan in 2010. His main research topics concern knowledge management, information retrieval, and machine learning with a focus on the design and development of real-world prototypes for enabling the access of both industries and people to research. Since 2015, he has been involved in activities dedicated to bring AI solutions within the Digital Health area. He has been involved in a number of national and international research projects and he co-authored more than 100 scientific publications in international journals, conferences, and workshops. Beyond AI, he is a motorsport (real and simulated) passionate and a certified personal trainer from the Italian National Olympic Committee.

14 July 2021, 16h00

Dr. **Aureli Sonia-Frisch,** Director, Neuroscience BU, Starlab Barcelona

Machine Learning for Brain Health and Understanding at Starlab Neuroscience

Abstract: The convergent development of different technologies is bringing the understanding of the brain, both on healthy and pathological condition, further than ever before. The confluence of Wearables, Neurotechnologies, Augmented and Virtual Reality, Serious Gaming, Data Science, Machine Learning and Artificial Intelligence are a game changer in the way we study brain functionality, make use of it for interacting with the environment, and treat mental and neurological disease. The talk will deal with the combination of Neurotechnologies, Machine Learning and Artificial Intelligence in different Digital Brain Health applications developed at Starlab Neuroscience. Digital markers of brain function will lead in the near future to improved diagnostic, drug discovery, risk analysis, and interactivity. We will show developed methodologies for: stratified performance evaluation of classifiers in operational conditions for Parkinsons' risk assessment, differential diagnosis in ADHD based on Reservoir Computing, and new treatment outcome prediction in Coma patients. I will go over the technical challenges we faced to develop these applications, but also over some insights that influence the applicability of pure academic data science in the real world.

Bio: Dr.-Ing. Aureli Soria-Frisch received the MSc from the Polytechnic University of Catalonia–UPC (1995), and the PhD from the Technical University Berlin. Between 1996 and 2005 he worked at the Fraunhofer IPK (Berlin), as research scientist and project leader. After 3 years as Visiting Professor at the Universitat Pompeu Fabra, he joined Starlab in 2008. He is the Director of the Neuroscience Business Unit since beginning 2017. His research interest is focused on the fields: computational intelligence for data analysis, and machine learning for electrophysiological signal analysis. He has authored 20 journal papers, seven book chapters, and over 60 conference papers. He has been Project Manager of the FP7 HIVE project, where the Starstim early prototype for transcranial electrical stimulation was developed, Project

Coordinator of the H2020 FET Open LUMINOUS project on the clinical study of consciousness, and PI of the 2 MJFF grants for the development of Machine Learning PD biomarkers.

17 November 2021, 16h00

Dr. habil. **Jürgen Landes**, Ludwig-Maximilians Universität München

Causal Inference in Medicine in the real world

Abstract: In an ideal world, we draw causal inferences based on well-controlled randomised experiments carried out by independent and impartial experts. In reality, we cannot infer whether drugs cause adverse reactions from such data. Randomised clinical trials are too short and study too few patients to observe rare (and possibly severe) adverse reactions. These trials are often carried out by employees of a multi-billion dollar industry incentivised to sell their products. In this talk, I will i) present a Bayesian framework, E-Synthesis, which > facilitates causal inference from (possibly biased) real world evidence and ii) discuss its applicability in the real world.

Bio: After obtaining a PhD in mathematical (probabilistic) logic and two brief postdocs I turned to philosophy in 2012. I have since been interested in evidence and confirmation of (causal) hypotheses. In particular, I'm much interested in how to assess the causal hypothesis that a drug causes an adverse reaction based on real world evidence. I also work on Maximum Entropy inference (finite and infinite domains) and Bayesian epistemology of science.

24 November 2021, 16h00

Prof. Dr. med. **Joachim Klucken**, University Luxembourg

Integration of AI into the life of patients and healtcare providers: how does it work and what does it change?

Abstract: Wearable sensors and smartphone apps are increasingly providing information - usually referred to as "data" - from the real world environment of patients home. Data-driven medicine has generated a profound area of research aiming to provide better diagnostic and therapeutic applications. The anticipated effects for patients as well as the market for new digital healthcare services seems endless. Using the example of wearable sensors on gait analysis in Parkinson's disease the presentation will show how to translate data-driven research into data-driven medicine. The technical, medical and societal aspects of the different development phases of data-driven medicine will be presented, as well as the difference between AI-driven innovations and AI-driven medical applications. The goal is to better understand how to bring smart algorithms and real-world data driven innovations into healthcare applications that in the end are beneficiary for patients, healthcare provider and society.

Bio: Digital medicine is a new field Medicine that aims to understand how patient-centered technology can be used in everyday medical practice, and which evidence assessment is needed to not only understand the medical benefits of healthcare technologies, but also their patient- and social acceptance and economical efficacy. Here, the major goal lies in clinical studies for healthcare technologies providing evidence for their medical, social, ethical and legal benefit as well as economic efficiency ultimately generating a concept of "clinical validation of healthcare technologies and services". Prof. Klucken earned his MD in Laboratory Medicine and specialized in Neurology. He finished his habilitation thesis in 2009 in translational neuroscience in Parkinson's disease including work at the Massachusetts Institute for Neurodegenerative Diseases, Harvard Medical School, Boston, USA on neurodegenerative processes in Parkinson's disease. In 2004 he also started translational research projects in the field of medical technology (m/eHealth) applying sensor-based motion detection in movement disorders. Jointly with engineers and data-scientists, he developed novel gait-specific instrumented movement analysis concepts for Parkinson's disease, multiple sclerosis, osteoarthritis, sarcopenia, oncology and healthy well-being of the elderly. From 2008 until 2021 he was a senior physician and PI at the Movement Disorder Unit (Department of Molecular Neurology, University Hospital Erlangen, Germany) and developed sensor-based gait analysis for patients with movement disorders. From 2018-2021 he also lead a group at Fraunhofer IIS, Erlangen, Germany with the focus on developing digital health pathways that enable technology integration into healthcare workflows. In 2019 he also established a contract research organization (Medical Valley Digital Health Application Center - dmac) supporting personalized healthcare technologies in order to get access to the German healthcare market. Within the scientific community he initiated and leads the task-force "Telehealth Services" of the Germany Parkinson Society (DPG), he is a founding member of the task-force "technology" of the international movement disorder society (MDS), and he is the chairman of the advisory board "e-health, telematics methods) of the Professional Association of German Neurologists (BDN). On political and societal level including patient-support groups he promotes the use of mobile healthcare technologies and innovations for comprehensive digital healthcare services, clinical studies and care. In addition, he participates in spin-offs/start-ups in the field of sensor-based movement analysis, and is advising several pharmaceutical companies and healthcare insurances/services on the topic of wearable derived objective outcomes.

Part 2 – FNR Covid-19 Funding Schemes – Selected Project Presentations by UL colleagues

21 April – 02 June 2021

FNR's Funding Scheme

Over the past year, the global COVID-19 pandemic has drastically changed our society and affected humanity on an individual, economic and social level. All countries have been affected by this crisis and are beginning to join forces to combat the spread of this disease and minimise its devastating impact.

Research is particularly well placed to help respond to this crisis. Expertise in a wide range of different fields combined with the scientific method will allow us to understand the spread and mechanisms of the disease, as well as the short-, medium- and long-term impact on society and the economy, and on a wide range of other sectors affected by COVID-19. Luxembourg scientists have the experience and capacity to contribute to these global efforts and the FNR would like to support researchers to make a difference both in Luxembourg and globally.

This specific FNR tool to combat COVID-19 is based on a 'fast track' approach that allows support for research projects that require an immediate start, e.g. in terms of data collection or other work during the current crisis.

The projects are expected to have a direct impact on the management of the crisis in the coming months, e.g. in the field of public health or pandemic surveillance. In doing so, the projects are expected to lead to new, tangible knowledge about the current state of the crisis and/or provide actionable crisis management measures in the short term

Source: fnr.lu

21 April 2021, 16h00

- Dr. Eugenio Peluso (LISER): *Family Response And Well-being Effects Of Covid-19*
- Prof. Dr. **Isabelle Astrid Albert** (UL): *Correlates Of Resilience In The Context Of Social Isolation In Seniors (CRISIS)*
- *Prof Dr.* **Frédéric Clavert** *(C2DH): Ordinary life in extrarodinary times. The #covid19fr project.*

28 April 2021, 16h00

- Prof. Dr. **Stefan Krebs** (UL): *History In The Making: #Covidmemory (COMEM)*
- Prof. Dr. **Robin Samuel** (UL): *Young People And Covid-19 – Social, Economic, And Health Consequences Of Infection Prevention And Control Measures For Young People In Luxembourg (YAC)*
- *Dr.* ***Jorge Augusto Meira*** *(UL): Pocket Rehab: Mhealth-based Rehabilitation Program For Patients With Cardiovascular Disease As Prevention And Treatment Strategy For Covid-19 Victims: An International Collaborative Multicentre Research Trial*

12 May 2021, 16h00

- Dr. **Muhannad Ismael** (LIST): *Covid-19 Detection By Cough And Voice Analysis*.
- **Ninghan Chen** (UL): *Information Diffusion In Twitter During The Covid-19 Pandemic: The Case Of The Greater Region (PandemicGR).*
- Dr. **Joshgun Sirajzade** (UL): *DeepHouse - Deep Mining With The Covid-19 Data Warehouse*

19 May 202, 16h00

- Dr. **Francesco Sarracino**, STATEC: *Preferences Expressed Through Twitter*
- Dr. **Aymeric Fouquie**, UL: *Phylodynamic Real-time Monitoring Of Sars-cov-2 Genomes In Luxembourg (Co-PhyloDyn) and UCoVis*
- **Lisa Veiber**, UL: *REBRON : Rescue - From Health Recovery To Economic Revival*

02 June 2021, 16h00

- Dr. **Andreas Husch**, UL: *AI Based Diagnosis Of Covid-19 From Ct/X-ray Imaging (AICovIX+)*
- Dr. **Anupam Sengupta**, UL: *Virus-surface Interactions In Dynamic Environments (V-SIDE)*
- Dr. **Ulrich Leopold**, LIST: Towards An Integrated Geospatial Pandemic Response System.
- Dr. **Sascha Jung**: *Leveraging Systems Biology To Target Hyperinflammation In Critically-ill Covid-19 Patients*

Abstracts

21 April 2021, 16h00

Dr. Eugenio Peluso (LISER)

Family Response And Well-being Effects Of Covid-19

Abstract: Lockdowns and the economic crisis induced by Covid-19 are imposing unprecedented constraints on families in terms of freedom of choice, consumption opportunities, time use, and social interactions. The "Farewell-to-C19" project focuses on the role of the family as a place that can both buffer and amplify the shockwave. For example, a spouse that already had a higher earnings before the crisis will (in most cases) continue to work more, and absorb less of the increase in the unpaid workload due to childcare, likely amplifying gender-specific sharing rules and inequalities within the household – a factor that has been shown to affect the well-being of its members (Peluso and Trannoy 2007, Couprie et al. 2010). However, compared to singles, the family plays a natural inequality-reducing role due to the insurance possibilities offered by multiple income sources or consumption and time sharing. Looking across households, people most likely to be working from home were already better off, and children of already better-off households suffer less in terms of loss of human capital during the lockdown and are less exposed to material deprivation. To investigate how these interlaced effects will impact Luxemburgish households, the Farewell-to-C19 project will be developed by a team of researchers belonging to the Living Conditions, Labor Market and Urban Development and Mobility Departments of LISER, in collaboration with the University of Glasgow and the AMSE Marseille. This project is organized in three work packages (WP): The first WP compares different types of households to identify how individual preferences can be affected by family ties in the circumstances induced by the Covid-19 crisis. The second WP analyses several effects of the Covid-19 crisis on children conditions. The third WP focuses on preferences towards redistribution, their development within the family, and their transmission to children.

21 April 2021, 16h20

Prof. Dr. Isabelle Astrid Albert (UL)

Correlates Of Resilience In The Context Of Social Isolation In Seniors (CRISIS)

Abstract: In the current COVID-19 crisis, older adults are at particular risk for severe health outcomes and increased mortality. Whereas it is of prime importance to raise public awareness regarding the special risk of older people, and reduced in-person contact is

essential to protect vulnerable groups, we have to take into account what effects these measures have on subjective well-being, mental health and further development of older persons. The present research project will tackle the question of how current measures and their communication to the public are experienced by the target group (60+) and will focus on the psychological and behavioral correlates and outcomes. In particular, the following questions will be addressed: 1) How are claims of being a risk group and COVID 19 related ageing stereotypes incorporated in views of self and others and how are they related to psychological and behavioral consequences, e.g. regarding the experience of self-efficacy and agency? 2) How is subjective risk experienced and how do older people commit to protective measures and guidelines, also depending on their self-views? 3) How can the risk for social isolation and loneliness be reduced? This includes the availability of appropriate information and communication channels? 4) What are resilience factors that protect older adults from negative mental health outcomes and help to maintain subjective well-being? Results will inform policies related to controlling the virus and information strategies to ensure compliance with the measures, especially (but not only) in the at-risk population of older adults. Furthermore, the project will contribute knowledge to reduce negative side effects of the preventive measures for older adults' long-term autonomy, health, and well-being.

21 April 2021, 16h40

Prof Dr. Frédéric Clavert (C2DH)

Ordinary life in extrarodinary times. The #covid19fr project.

Abstract: The research project # covid19fr aims to understand the interactions between digital social networks - more particularly Twitter - and the collective memory in formation of the confinement of French-speaking countries during the COVID-19 epidemic.

28 April 2021, 16h00

Prof. Dr. Stefan Krebs (UL)

History In The Making: #Covidmemory (COMEM)

Abstract: The COVID-19 pandemic is a global crisis, but its local impact on Luxembourg will be determined in part by how people memorialise its effects in the moment, and how they will remember it later. Luxembourg declared a state of emergency on 18 March which dramatically reshaped public and private life. Schools, businesses and shops are closed. Students stay home and learn online. New rules govern home workers and cross-border commuters. With no end yet in sight, it is already clear that we are experiencing an extraordinary moment in the collective memory of Luxembourg. With the online platform #covidmemory, the Luxembourg Centre for Contemporary and Digital History (C2DH) at the University of Luxembourg will offer people living or working in Luxembourg the opportunity to share their personal experiences with one another and to archive them for future generations. Contributors can post their photos, videos or stories on an open web-based platform from their personal computers or mobile devices. A team of reviewers and curators will oversee the website in the coming weeks and months. The #covidmemory project is inspired by the "Rapid Response Collecting" approach that has been used in public history and museum circles as a way to collect the stories, material culture, digital creations and ephemera of historical events as Hurricane Katrina, 9/11 and the 2015 terrorist attacks in France.

28 April 2021, 16h20

Prof. Dr. Robin Samuel (UL)

Young People And Covid-19 – Social, Economic, And Health Consequences Of Infection Prevention And Control Measures For Young People In Luxembourg (YAC)

Abstract: Whereas young people have a low risk for severe illness due to COVID-19, they are an important link in the transmission chain and they might find it particularly hard to accept and comply with governmental guidelines and measures to prevent and control the disease. Some of the measures may further interfere disproportionally with their development and result in short- and long-term consequences for education, professional careers, economic situation, psychosocial development, and mental health. Our project will generate the knowledge required to address the current and post-pandemic challenges of the COVID-19 crisis, by (1) focusing on how young people residing in Luxembourg comply with and accept the governmental measures to prevent and control infection with COVID-19 and (2) by identifying the economic, psycho-social, and health consequences of these measures during and after the COVID-19 pandemic in relation to a pre-pandemic baseline we were able to collect in 2019. Inequalities between and within socio-demographic and socio-economic groups in relation to (1) and (2) are of particular interest. To evaluate the situation during and after the pandemic, two intermediate waves (2020 and 2021) are added to the 2019 and 2023/24 waves of the Youth Survey Luxembourg. The Youth Survey Luxembourg is a representative large-scale survey among 16- to 29-year-old residents in Luxembourg, covering all relevant areas outlined above (e.g., education and employment, social situation, health, etc.). COVID-19-specific modules, for example on compliance with measures, will be included to provide vital information for the control of the COVID-19 pandemic. Statistical comparisons of recent data with pre-pandemic baselines will enable a broad and thorough assessment of the short-term, mid-term, and long-term impacts of the COVID-19 crisis on the lives of young people. Results will be made available to the public and the research community on a rolling

basis. Furthermore, the evidence generated will inform policy-making in Luxembourg and contribute to address various key research priorities identified by the WHO.

28 April 2021, 16h40

Dr. Jorge Augusto Meira (UL)

Pocket Rehab: Mhealth-based Rehabilitation Program For Patients With Cardiovascular Disease As Prevention And. Treatment Strategy For Covid-19 Victims: An International Collaborative Multicentre Research Trial

Abstract: According to the World Health Organization (WHO) , Cardiovascular Diseases (CVDs) are responsible for approximately 17 million deaths per year, being the cause number 1 of deaths worldwide and considered the major public health problem. In Europe, CDVs account for 45 % of all deaths . In the context of the COVID-19 pandemic, the CDVs figure in the list of groups of elevated risks . Among the reasons, it is known that the pathophysiological mechanism of the coronavirus SARS-CoV-2 uses the angiotensin converting enzyme 2 (ACE2) as a functional receptor, a surface molecule that is localised on the endothelial cells of arteries and veins, increasing the risk of contamination and the mortality rate CVD population. In countries such as Brazil, according to the epidemiological bulletin of COE-COVID19 of the Ministry of Health, among the 1124 deaths recorded until 11 April 2020, in those under the age of 60, 82.5% had illness associated CVDs. In order to mitigate the risks for these patients, multi professional cardiopulmonary and metabolic rehabilitation program has been presented as an essential therapeutic and preventive strategy, with a positive impact on cardiorespiratory capacity and quality of life, adherence to clinical treatment, impacting on the reduction of cardiovascular disease risk factors and hospital admissions. Traditional cardiac rehabilitation (CR) is usually performed in a single outpatient center and involves a structured exercise program (usually 3 sessions per week for 36 total sessions) supervised by trained physicians, nurses, and exercise therapists. As an alternative method, home-based CR involves prescribed exercises that can be carried out in a variety of settings and can be delivered "mostly or entirely outside of the traditional CR setting". Recently, the popularization of technologies such as internet and mobile phones have enabled Mobile health (mHealth) tools. MHealth can be defined as the use of mobile and wireless technologies to support the achievement of health objectives, such as surveillance, diagnosis, and management of chronic diseases [4]. The use of mHealth interventions has the potential to support successful management of chronic conditions and health behavior by: (1) improving patient self-monitoring and management, (2) building social networks for patients, (3) informing health care professionals of patients' health status, (4) providing indirect feedback interactions, (5) tailoring care and education to patient needs, and (6) improving communication among health care professionals. Considering the current and undefined social distance scenario period, and to prevent and treat of CVD population during Covid-19 pandemic, we propose a cardiopulmonary and metabolic rehabilitation program based on mobile technology (mHealth). This program can counteract the new dysfunctions occasioned by this virus and avoid the demand for services face-to-face, dropping contamination and mortality.

12 May 2021, 16h00

Dr. Muhannad Ismael (LIST)

Covid-19 Detection By Cough And Voice Analysis

Abstract: Emergency services receive a large number of calls during an epidemic. Some calls are from people who are critical cases and require a rapid intervention. However, we have identified that the volume of calls and complexity of remote diagnosis may lead to delays or failure in diagnosis. We will develop a classification system for health status based on the voice and cough patterns of the caller. Respiratory conditions, such as dry cough, sore throat, excessively breathy voice and dyspnea, caused by Covid-19, can make patients' voices distinctive, creating identifiable voice signatures, that may be discovered using the proposed system. CDCVA project will provide a way for health professionals to improve remote diagnosis while also minimising contact between medical staff and patients.

12 May 2021, 16h20

Ninghan Chen (UL)

Information Diffusion In Twitter During The Covid-19 Pandemic: The Case Of The Greater Region (PandemicGR)

Abstract: The PandemicGR project will address of the challenge of understanding and analysing the information diffusion mechanism in online social media during the COVID-19 pandemic, based on a newly collected and properly anonymised Twitter dataset concentrating on Luxembourg and the greater region. In this project, we aim to (1) achieve in-depth analysis of user engagement and communication patterns during this public health crisis, (2) build a machine learning model to simulate and predict COVID-19 information cascades, and (3) develop an effective classifier to detect misinformation in order to improve information trustworthiness in online social media. The results from the PandemicGR project will have both immediate and medium-term impact for crisis management for bother Luxembourg and the greater region.

12 May 2021, 16h40

Dr. **Joshgun Sirajzade** (UL)

DeepHouse - Deep Mining With The Covid-19 Data Warehouse

Abstract: In a time where COVID-19 is attracting worldwide attention, the data quantity and variety is increasing dramatically. The result are data lakes, where (raw) data appears in different formats and quality. In the case of COVID-19, the Johns Hopkins University Center for Systems Science and Engineering (JSU-CCSE) has compiled a number of various data sources including data from the World Health Organization and others, where the published data itself is largely time-series data that covers worldwide mortality rates, infected and recovered cases of the Covid-19 disease for more than 200 countries. The Open Research Dataset Challenge (CORD-19) is a resource of almost 60000 scholarly articles, where more than 75% of these are full text articles. These are only two examples of publicly available data that aims to provide a comprehensible analysis of the entire disease development. The decisive problem here, however, is that the heterogeneity, diversity, and (partially) unstructuredness of data makes a deep analysis more difficult rather than easier. In this view, DEEPHOUSE has two central goals: first, we consolidate the available text data and time series data in a Covid-19 data warehouse, e.g., along multidimensional axes (time, place, and topic) by applying appropriate data integration techniques. Second, we build a web-based platform being extendable, which demonstrates the successful discovery of time-related sequences or time series, for example by visualization or tracking of topics over time. Since data underpins the warehouse, the methodology of DEEPHOUSE is transferable to other diseases.

19 May 2021, 16h00

Dr. Francesco Sarracino, STATEC

Preferences Expressed Through Twitter

Abstract: Preferences, attitudes, and well-being affect people's economic decisions and their effective adherence to policies. Arguably, the COVID-19 pandemics changed these factors, but we do not know the direction of the changes nor how permanent they are. Today more than ever, decision makers need timely information on these factors to effectively introduce policies to exit from the crisis, promote economic recovery, and support social cohesion. This project addresses this urgent need by informing about how people's preferences, attitudes, and well-being changed during the COVID-19 crisis, and whether such changes are permanent or transitory. We use sentiment analysis on data sourced from Twitter to provide real-time tracking of the social change triggered by the pandemics. In this way we aim to provide timely information and to avoid delays typical of conventional large scale surveys. We will track the changes of life satisfaction, mental stress, trust in others and in institutions, loneliness, uncertainty about the future, populism, and attitudes towards globalization. The project will produce a time-series database for each of these aspects in Luxembourg and 5 European countries severely affected by the crisis (Italy, France, Germany, Spain, and United Kingdom). The data will go from December 2019 to December 2020. We believe that timely data releases produced by our project will be a useful tool to inform economic and social policies, and an important contribution to public and scientific debate at European level.

19 May 2921, 16h20

Dr. Aymeric Fouquie, UL

Phylodynamic Real-time Monitoring Of Sars-cov-2 Genomes In Luxembourg (Co-PhyloDyn) and UCoVis

Abstract: The current COVID-19 pandemic caused by the SARS-CoV-2 virus is an extreme challenge to mankind's health affecting currently more than 1.7 million people world-wide. Current approaches to manage this challenge rely on reliable testing as well as the development of vaccination which both depend on the stability of specific sequences of the viral genome. Sequencing of viral genomes from patient samples provides deep insights on pathogen dynamics in terms of phylogeny and evolution allowing for spreading analysis and adaptation of molecular diagnostic and prevention strategies. Hence, the real-time monitoring and automated dynamic analysis of phylogenomic data derived from virus genome sequencing together with available geographical and clinical data in an accessible and portable manner is key to support decisions in research, diagnostics and physiology, which strongly impacts individuals and societies within and outside Luxembourg and is also important as a health monitoring resource for possible similar future events. In the frame of the planned COVID+ study, the Co-PhyloDyn project will lay the foundation of the retrospective in-depth genomic characterization of COVID-19 positive cases over the COVID-19 pandemic in Luxembourg and its neighbouring countries by implementing an efficient fully automated and reproducible infrastructure for the phylodynamic analysis of COVID-10 in Luxembourg. The close collaboration between the Luxembourg Centre of Systems Biomedicine (LCSB) at the University of Luxembourg and the Department of Microbiology at the Laboratoire National de Santé (LNS) will bring together the needed expertise in genomics, bioinformatics, sequencing and virology to tackle the needed in-time phylogenetic analysis of COVID-19 in Luxembourg.

19 May 2021, 16h40

Lisa Veiber, UL

REBORN : Rescue - From Health Recovery To Economic Revival

Abstract: REBORN is a data science project that focuses on the challenge of ensuring sustainable economic recovery in the face of COVID-19. The project team will apply advanced Machine Learning, business ecosystem modelling (i.e., expert knowledge) and simulation techniques to yield recommendations of economic actions given different scenarios in which the lockdown is relaxed, partially or totally lifted. By interacting with other teams of the Luxembourg Task Force, this project targets high impact for the various sectors of the Luxembourg economy, by providing appropriate data-driven recommendations for political

decision-makers. We expect that REBORN could answer important questions such as: What are the industrial sectors to help in priority? What are the sectors that should be restarted first? What are the possible changes in consumer habits and the impact of neighboring country decisions on commuters?, etc. Ultimately, REBORN contributes towards reflections on initiatives to limit the spread of the future economic crisis due to COVID-19 as well as avoid worsening future waves of coronaviruses.

02 June 2021, 16h00

Dr. Andreas Husch, UL

AI Based Diagnosis Of Covid-19 From Ct/X-ray Imaging (AICovIX+)

Abstract: The gold standard for Covid-19 diagnosis is RT-PCR for SARS-CoV-2 from the upper airways. This method suffers from decreased accuracy in more severe disease stages affecting the lower airways. False negative PCR tests in severe cases impose a massive risk to the health system, promoting intra-hospital disease spread in the actual pandemic situation. Reports from China indicate false negative PCR from upper airway samples in severe Covid-19 pneumonia in more than 50% of the cases. Therefore, complementary tests for the detection of these dangerous cases are urgently needed. The value of chest CT and/or X-ray has been demonstrated as complementary diagnostics. Luxembourg has already reacted to these needs, and is urgently acquiring four additional CT scanners only for lung CTs. Based on our experience in deep learning for medical imaging our project aims to rapidly provide AI tools to speed-up diagnosis of high-risk cases from medical imaging. Our short-term objective is a an AI tool for fast and accurate discrimination between Covid-19, other pneumonia, or healthy. This information can be key for early treatment as well as for the safety of health workers, hospitals and other patients. A basic version of an AI tool is already in training and aims to be applied as soon as possible during the current pandemic. Additionally, long term research and preparation to future scenarios is planned and will be integrated with diagnostic approaches using other biomarkers for disease staging by aligning with other groups in Luxembourg.

02 June 2021, 16h20

Dr. Anupam Sengupta, UL

Virus-surface Interactions In Dynamic Environments (V-SIDE)

Abstract: Since the recent outbreak of the COVID-19 pandemic, a growing body of scientific literature has reported on the pre-infection viability and stability of the SARS-CoV-2 virus, qualitatively indicating the role of physical surfaces in transmission of the virus. The nature of the surfaces (e.g., paper, plastics, glass, or metals) and their properties (smooth v/s rough), are believed to play a critical role in determining the viability during the pre-infection phase. Virus-surface interactions are inherently physical in nature wherein dynamics of the environmental parameters (variations in temperature or humidity over time) could underpin the viral viability. Here, using non-pathogenic mutant of SARS-CoV-2 virus as our model organism, we will uncover key physical parameters that underpin viability of SARS-CoV-2 species on a range of commonly used surfaces. Enzyme-linked immunosorbent assay (ELISA) for S proteins, the material forming 'spikes' of the coronavirus will be used to test the surface-specific viability, and complemented by flow virometry and high resolution visualization of the chosen material surfaces (using AFM, SEM and fluorescence imaging), providing quantitative estimation of viral viability. Crucially, time series analysis of viability and concomitant changes in the chemical signature of the material surfaces (FTIR method), will give us unprecedented insights into the mechanistic underpinnings of surface-specific viability of coronavirus, under steady state and dynamic changes in temperature and humidity parameters. The data obtained from this three-pronged approach will be used to biophysically model the system, with a long-term goal of incorporating machine learning methods to identify surface-specific viabilities of virus species. In summary, by revealing the fundamental biophysics of virus-surface interactions, V-SIDE will be in a robust position to develop an integrative mechanistic framework for SARS-Cov-2 viability on various material surfaces. V-SIDE benefits from an active follow up strategy, wherein the overarching goal will be to develop generic recipes for tailoring anti-viral surfaces in a scalable and facile manner, equipping us ultimately to better tackle the recurring incidence of novel viral pandemics.

02 June 2021, 16h40

Dr. Ulrich Leopold, LIST

Towards An Integrated Geospatial Pandemic Response System.

Abstract: The recent COVID-19 pandemic has shown that rapid information integration is of high importance to control the spatial and temporal spread of unknown deadly diseases across different scales, from local sources of origin to the entire globe. Risk and probability maps can provide a good picture of the spatial and temporal distribution of COVID-19 across local, regional, national and continental areas and can help to control spreads, not overwhelming health emergency infrastructures and allowing for controlled return to our daily lives. First results of the CON-VINCE study shows that only 2 % of the population has been in contact with the virus. Due to low, daily infection rates, the Luxembourgish Government is reopening schools, parts of the economy and societal life. But a second infection wave is likely to occur. Therefore, further testing and surveys are currently implemented through the COVID-19 TaskForce, building on interdisciplinary probabilistic scenarios and the Weizmann COVID-19 pilot study for self reporting of COVID-19 cases to get a better idea about the spatio-temporal distribution across the country. This is of high importance to allow controlled reopenings and a good functioning of logistics chains. The TIGER project will strongly contribute to the COVID-19 TaskForce's WPs 06, 07 and 13 with a replicable, reproducible and scalable probabilistic approach, implemented into an interoperable geospatial web platform

which can be reused by, linked to or integrated into current and future initiatives on infectuous disease spread and control. We propose an interoperable geospatial disease response system, built upon the existing iGuess® software technology platform developed at LIST to: 1) integrate existing high resolution geospatial information on infrastructure, population vulnerability, self reporting, publicly released and TaskForce COVID-19 data; 2) provide tools to analyse and forecast spatio-temporal disease patterns and to optimise spatial sampling to get a better picture on spatial coverage of infected cases and disease spread; 3) provide easy access to tools and generated information for experts and decision makers through secure interoperable web services. We suggest to use geostatistical spatio-temporal methods, such as space-time point-to-area (aggregation) and area-to-point (disaggregation) simulation and Log-Gaussian Cox based simulations to analyse and estimate current and near future status of the pandemic situations. We will use established OGC web service standards which enable the integration of distributed geospatial data from geoportals, OpenStreetMap, social media etc. with COVID-19 observation data, and provide an automated spatio-temporal mapping and prediction system to retrieve optimal information for crisis response support for public health across the entire country. The TIGER project has strong impacts and innovation potential due to its integrated approach combining distributed data, methods and tools to provide spatio-temporal evidence for multiple experts, researchers and stakeholders, to take improved decision for lock-down measures and a controlled reopening of societal life. The platform will provide easy secured access to different experts and researchers within the TaskForce and thus can provide integrated views across different WPs and expert teams. Results can be easily shared through interoperable web services to the different expert teams and the government in forms of maps, tables, graphs and summary statistics at different aggregation levels. Such a replicable, reproducible and scalable response system will help to react more rapid in future outbreaks of infectious diseases and can provide better coordination with neighbouring countries as if well established data standards for sharing are used and further adapted to pandemic outbreaks.

02 June 2021, 17h00

Dr. Sascha Jung, UL

Leveraging Systems Biology To Target Hyperinflammation In Critically-ill Covid-19 Patients

Abstract: The emergence of COVID-19 pandemic implies new challenges for the Health Systems worldwide. A small percentage of the patients require hospitalisation and specialised attention in Intensive Care Units (ICUs). Furthermore, accumulating evidence suggests that a subgroup of patients with severe COVID-19 might have a cytokine storm syndrome. Therefore, the main goal of the proposal is to elucidate the potential role of cytokine storm in COVID-19 disease severity, and to propose novel strategies for counteracting this hyperinflammatory response. In this context, we propose to develop a single-cell based systems biology approach that infers and compares functional cell-cell communication networks of immune cells between patients with mild and severe symptoms to characterize the cytokine storm and, in particular, to identify functionally relevant intercellular positive feedback loops maintaining this hyperinflammatory condition. Indeed, feedback loops have been shown to support the inflammatory response in other infectious diseases. Therefore, we propose that these loops are responsible for maintaining and amplifying the cytokine storm during the COVID-19 infection. As a plausible therapeutic strategy to modulate hyperinflammation, we propose to target these feedback loops by simulating the effect of perturbing receptor-ligand interactions as well as intracellular signaling molecules participating in them. In this regard, an automatic search in databases of clinically approved drugs would identify candidates for specifically disrupting or modulating the functioning of these loops. To carry out this study we will perform a single cell RNA sequencing of blood cells from 16 COVID-19 patients, half of which only showing mild symptoms whereas the others present with severe symptoms needing ICU treatment.

Part 3 – Joint Event 'Rudi Balling Goodbye Lecture Series'

16 September – 14 October 2021

After 12 years of being the Director of the LCSB, Prof. Rudi Balling is retiring. For this very special occasion, LCSB is organising a Goodbye lecture series to honour him. This lecture series brings together internationally renowned scientists from different disciplines who will share their perspectives on the major challenges of the future scientific research and interdisciplinary approaches to solve them.

16 September 2021, 16h00 Prof. Dr. Rudi Balling, Director of the Luxembourg Centre for Systems Biomedicine (LCSB), Luxembourg.

Wicked Problems: mission impossible or next frontier?

23 September 2021, 16h00 Prof Dr. David Leigh, Sir Samuel Hall Chair of Chemistry, Department of Chemistry, University of Manchester, UK.

Making the tiniest machines

30 September 2021, 16h00 Prof. Dr. Ortwin Renn, Scientific Director at the Institute for Advanced Sustainability Studies (IASS), Potsdam, Germany.

Behavioral adaptations to the COVID-19 crisis: What is here to stay?

07 October 2021, 16h00 Dr. Sara-Jane Dunn, Google DeepMind, London, UK.

Biological Computation in Stem Cells

14 October 2021, 16h30 Prof. Dr. Edith Heard, Director General of the European Molecular Biology Laboratory (EMBL), Heidelberg, Germany.

Launching a new era of biology to understand 'life in context'

Abstracts

16 September 2021, 16h00

Prof. Dr. Rudi Balling, Director of the Luxembourg Centre for Systems Biomedicine (LCSB), Luxembourg

Wicked Problems: mission impossible or next frontier?

Abstract: Today's problems cannot be solved any more by a single person, organisation or discipline. Therefore, interdisciplinary cooperation and systems approaches have been widely adopted to cope with the complexity and uncertainty of our world. Big data and artificial intelligence penetrate almost every single aspect of our lives. However, we now realise the limitations of such a data driven toolbox. There are problems that seem to defy a solution. These are sometimes called "wicked problems", that apparently have many possible, but no real solution. Each wicked problem is unique and involves social or cultural issues, touching upon a diversity of individual or societal values. As a result, a much deeper understanding of the stakeholders involved is necessary. I will give an overview and discuss some of the challenges related to wicked problems.

23 September 2021, 16h00

Prof. Dr. David Leigh, Sir Samuel Hall Chair of Chemistry, Department of Chemistry, University of Manchester, UK

Making the tiniest machines

Abstract: Perhaps the best way to appreciate the technological potential of controlled molecular-level motion is to recognise that molecular machines lie at the heart of every biological process. Nature has not repeatedly chosen this solution for achieving complex task performance without good reason. In stark contrast to biology, none of mankind's myriad of present day technologies exploit controlled molecular-level motion in any way at all: every catalyst, every material, every pharmaceutical, all function through their static or equilibrium dynamic properties. When we learn how to build artificial structures that can exploit molecular level motion, and interface their effects directly with other molecules and the outside world, it will potentially impact on every aspect of functional molecule and materials design. An improved understanding of physics and biology will surely follow.

30 September 2021, 16h00

Prof. Dr. Ortwin Renn, Scientific Director at the Institute for Advanced Sustainability Studies (IASS), Potsdam, Germany.

Behavioral adaptations to the COVID-19 crisis: What is here to stay?

Abstract: The rise of populism and corresponding political resonance in Europe and the USA is precarious because it is threatening democracy and science. Many political decision-making processes are based on evidence and expert knowledge. This is particularly true for systemic risks such as the recent COVD-19 pandemic. However, many political and social actors discredit well-grounded knowledge as "fake news" or conspiracy theory; they bring alternative facts and truth into play. The public is often confused and lacks orientation. The paper will stress the importance of robust knowledge stemming from science, expertise and practical experience.

07 October 2021, 16h00

Dr. Sara-Jane Dunn, Google DeepMind, London, UK

Biological Computation in Stem Cells

Abstract: Experimental biology has proven our ability to induce cell identity via differentiation or reprogramming, offering huge promise for medicine and the study of development. Yet despite this wealth of research, an explanation of how cell state conversions arise remains fragmentary. Ideally, we would like to understand the complex, dynamic interplay of genetic components that manifests as cell fate conversions. To address this gap, computational analyses can be combined with mathematical modelling to interrogate experimental data and generate testable hypotheses on how a program of genetic interactions governs cell identity. In this talk, I will demonstrate how interdisciplinary approaches have revealed the biological program governing fate decisions in stem cells, and indeed, could be used in other domains to expose the regulatory programs that drive cellular decision-making more broadly.

14 October 2021, 16h30

Prof. Dr. Edith Heard, Director General of the European Molecular Biology Laboratory (EMBL), Heidelberg, Germany.

Launching a new era of biology to understand 'life in context'

Abstract: Most molecular research has entailed the study of organisms in the laboratory. However, life does not happen in isolation - organisms including humans interact with each

other, are challenged by pathogens and respond to changing physiochemical parameters. Now, technologies are being developed to collect measurements of all ecosystem components at unprecedented volumes. Advances in compute and AI enable the rigorous analysis and creative integration of these data. With the world also facing an urgent need to understand and revolutionise human and planetary health, a new era of molecular biology encompassing life in its varying natural contexts is needed. As part of EMBL's next scientific Programme, Molecules to Ecosystems 2022-2026, scientists plan to implement and deliver large-scale collaborative projects, promote joint standards and open science, and inform and impact international research and policymaking.