

University of Waterloo / University of Bordeaux
Workshop on Artificial Intelligence and Health Science
April 8 – 10, 2019

Final report

Prepared by:

Peter van Beek
Professor, Cheriton School of Computer Science
Co-Director, Waterloo Artificial Intelligence Institute
University of Waterloo

Paul Fieguth
Professor, Department of Systems Design Engineering
University of Waterloo

Terrence McMahon
University Professor, Department of Chemistry
University of Waterloo

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Overview

The partnership between the University of Waterloo and the University of Bordeaux began in 2009 – 2010 with a program to facilitate graduate students in nanotechnology visiting the University of Bordeaux. The relationship was strengthened in 2014 – 2015 with significant financial commitments by the Vice President Academic and the Dean of Science at Waterloo for collaborative research projects at the University of Bordeaux. The result was a flourishing partnership with significant research collaborations in topics with a strong impact on society, including projects in energy, aging, and water resource management.

Most recently, the University of Bordeaux received a substantial financial award (~25 M€/yr) to promote research collaborations and a significant amount (~250,000 €/yr) of this was proposed to be devoted to support research projects in collaboration with the University of Waterloo. In turn, the University of Waterloo Office of Research has made a request for a substantial sum (\$300,000/yr) for collaboration with the University of Bordeaux. Subsequently, it was decided that the two institutions would give precedence to research in Artificial Intelligence focused on area of Public Health and Health Sciences. The Waterloo – Bordeaux Workshop on Artificial Intelligence and Health Science April 8 – 10, 2019 was thus organized to foster collaborations between researchers at the two institutions. Fourteen faculty members from seven different departments and five different faculties at the University of Waterloo attended and presented their research, and sixteen faculty members from diverse departments and research laboratories at the University of Bordeaux attended and presented their research.

Next Steps

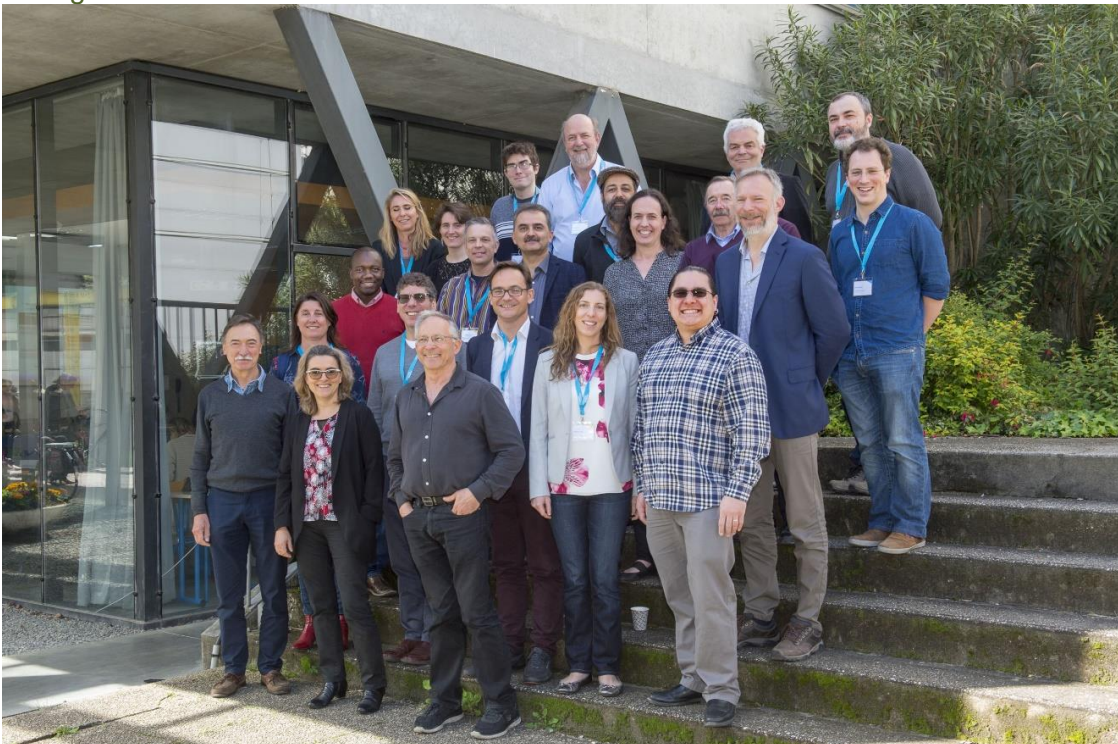
The following ideas were proposed for fostering future collaborations during a brainstorming session held as the last session of the conference.

- Exchange of PhD students, especially using the MITACS program to help with funding.
- Establish a Summer School program, alternating between the two universities.
- Establish a data hub for sharing health related data.
- Collaborative networks or clusters (June 10, Bordeaux President will be here), perhaps joint institute (Water, Material Science, AI)
- Introduce University of Bordeaux students to the UW entrepreneurship model and initiatives, as it is thought it would be of great interest to their graduate students.
- Funding is available, and there will be a call for proposals (most likely the formal announcement will occur before the University of Bordeaux president comes for a visit?).
- Several possible collaborations were established between UW participants and University of Bordeaux participants.

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University of Bordeaux “Artificial Intelligence & Health Science” Workshop attendees
8-10 April 2019

Frédéric Alexandre: Director of Research Inria, head of the Mnemosyne team. Mnemosyne is a team in computer science embedded in a biological and clinical environment in the Bordeaux NeuroCampus. We design models of the brain circuitry and of its pathologies, with a special emphasis on decision making and executive functions. Our domains of application range from the study of neurological diseases with bio-inspired models to industrial applications and robotic implementations with simplified models adapted to machine learning and artificial intelligence.

<http://www.labri.fr/perso/falexand/>

frederic.alexandre@inria.fr

Jenny Benois-Pineau: Full professor, chair of video analysis and indexing group at LABRI. The group Video Analysis and Indexing at LABRI develops AI methods for recognition of visual content. Three open problems of Computer vision, such as object recognition, action recognition and fusion of heterogeneous data in recognition tasks are addressed with applications in Healthcare and well-being. We deploy classical architectures such as CNNs and LSTM. In object recognition problem we are interested in the design of methods to recognize objects that a person intends to grasp. The application of this research conducted in the framework of the project supported by CNRS with INCIA and INRIA Flowers is assistance to amputees wearing neuro-prostheses. An attention - guided content selection in ego-centered video is performed to recognize natural life objects in difficult scenarios of everyday life of the subjects. Ego-centered videos are characterized by strong camera motion, lightening changes, the subjects attention measured by eye-trackers is variable and the data are very noisy. Hence we deploy specific strategies for object proposal selection and multiple instance learning approach combined with a ResNet. Action recognition problem is related to the indexing of sport video content capturing students during training sessions of table tennis. Here we resort to 3D CNNs on spatio-temporal segments and propose a new architecture. This project is supported by New Aquitania Region and implies participation of Sport Faculty of Bordeaux University and University of La Rochelle. Fusion of heterogeneous data is related to the target prevention of risks of everyday life of fragile persons. Data collection here is a task per se. Together with BPH and SME InfLexSys we have designed a wearable prototype for continuous data collection and elaborated scenarios of recording which will allow feeding siamese Deep NNs to detect potential risk situation in real-time. This research is conducted in the framework of the project Birds supported by National Association of Technological Research (ANRT). Finally, one of the intensively research subjects in AI is the attention propagation and attentional Deep NNs. Here we try to understand if the so-called inducted attention in CNNs is of top-down or bottom - up nature, comparing it with subjective human attention models when propagated through different layers of CNNs. LaBRI <http://www.labri.fr/projet/AIV/jennybenoispineauen.php>

jenny.benois-pineau@u-bordeaux.fr

Cécile Delcourt: Director of research at Inserm, leader of team LEHA (lifelong exposures, health and aging) at BPH. My primary area of interest is epidemiology of aging, with particular focus on eye and brain aging. My research includes the identification of circulating biomarkers

for age-related diseases, in particular through "omics" technologies (metabolomics, lipidomics, proteomics...) and their combination in molecular signatures. I also develop multidimensional prediction models, which could be used for early detection of high-risk individuals and intervention in these individuals. Such a model is currently being implemented in a website, for the detection of individuals at high risk for age-related macular degeneration (AMD).

Website: <https://www.bordeaux-population-health.center/en/teams/lifelong-exposures-health-and-aging-leha/>
cecile.delcourt@u-bordeaux.fr

Gayo Diallo: Associate Professor in Computer Sciences. Research interests include logic-based healthcare related knowledge representation and reasoning, semantic information retrieval, heterogeneous data integration.

Web site <https://www.bordeaux-population-health.center/profile/gayo-diallo/>
gayo.diallo@u-bordeaux.fr

Boris Hejblum: Associate Professor in Biostatistics at the University of Bordeaux, member of the Inria/Inserm BPH SISTM team. My main research focuses on statistical learning methods for longitudinal high-dimensional biomedical data, with applications in genomics and single-cell analysis for vaccinology, as well as in individual phenotype predictions from electronic health records.

Website: <https://borishejblum.science>
boris.hejblum@u-bordeaux.fr

Vincent Lepetit: Full Professor at the LaBRI. Research interests include Computer Vision, Deep Learning, 3D Scene Understanding, Transfer Learning, Real-Time Computer Vision – LaBRI <https://www.labri.fr/perso/vlepetit/>
vincent.lepetit@u-bordeaux.fr

Pierre-Yves Oudeyer : Research director at Inria, heading the Flowers team at Inria Bordeaux Sud-Ouest (see PhD students). I was previously a permanent researcher in Sony Computer Science Laboratory for 8 years (1999-2007). I have been studying lifelong autonomous learning, and the self-organization of behavioural, cognitive and cultural structures, at the frontiers of artificial intelligence, machine learning, cognitive sciences and educational technologies. In particular, I study mechanisms of exploration in autonomous learning, with a special focus on mechanisms enabling agents to set their own goals, and how this can self-organize curriculum learning. This includes mechanisms of intrinsically motivated learning (also called curiosity-driven active learning), autonomous unsupervised exploration, imitation and social learning, multimodal statistical inference, embodiment and maturation and self-organization.

[Research interests] <http://www.pyoudeyer.com/>
pierre-yves.oudeyer@inria.fr

Mélanie Prague: Inria researcher in the BPH SISTM team. My research focuses on the development of statistical methods for treatment and prevention of infectious diseases. I draw motivation for the methods from example in immunology such as HIV or Ebola. The methods we

develop are generic in the sense that they can be applied to other fields than medicine and various medical concerns such

melanie.prague@u-bordeaux.fr

Cécile Proust-Lima: Inserm researcher in the BPH Biostatistics team. My research focuses on the development of statistical methods to analyze the complex multivariate longitudinal data collected in epidemiological studies of chronic diseases. The final goal can be either to describe the disease progression, understand its etiology or provide individualized dynamic predictions. My main applications are in neurodegenerative diseases (e.g., Alzheimer's disease) and cancers.

Website: <http://cvscience.aviesan.fr/cv/2055/cecile-proust-lima>; <https://www.bordeaux-population-health.center/en/teams/biostatistics/>

cecile.proust-lima@u-bordeaux.fr

Cecilia Samieri: Tenure Track researcher at INSERM, epidemiologist with a focus on brain aging (dementia and Alzheimer's disease, cognitive aging and healthy aging more generally) and a specific interest on environmental risk factors and the food exposome. My general research aim is to understand how the food exposome determines the risk of dementia and cognitive aging over the life-course, with the optimal goal to design optimal prevention strategies and inform public health policies on risk management for dementia prevention. One of my research axes utilizes IA approaches to explore optimal target populations and agents (alone or in combination) for personalized prevention.

<http://cvscience.aviesan.fr/cv/1707/cecilia-samieri>.

<https://www.bordeaux-population-health.center/profile/cecilia-samieri/>

cecilia.samieri@u-bordeaux.fr

Olivier Saut: Senior Researcher at CNRS, team leader INRIA Research Team Monc (Modeling in Oncology, <http://team.inria.fr/monc>).

Research interest : I am interested in developing novel approaches combining mathematical modeling and AI to build new tools to help clinicians diagnose and evaluate the progression or the efficacy of treatments of cancer. My main source of insight on the disease comes from medical images which requires additional research on image processing to feed the models with data. The model are personalized for each patient through data assimilation techniques.

Keywords: PDE mechanistic modeling, scientific computing, data assimilation, statistical learning, radiomics, deep learning.

Website: <http://osaut.monc.fr>

olivier.saut@inria.fr

Hélène Sauzéron: Professor of psychology and cognitive science at the University of Bordeaux. I work in two labs: the former is related to the area of health research (Handicap, Activity, Cognition & Health – team of Bordeaux Population Health Lab, Inserm-University of Bordeaux) and the latter is related to area of computer science (Flowers Team of Inria Center of Bordeaux). My primary research interests regard cognitive aging (including developmental trajectories from child to older person) and cognitive disorders associated to brain-damage

conditions. In 2008, I began my research on applied cognition with virtual reality-based devices. In 2012, I joined the Inria center of Bordeaux for developing multidisciplinary researches around assistive technologies for aging in place (HomeAssist Projects), for school Inclusion of children with cognitive disabilities (School+ projects) and for personalized education (Kidlearn projet, Kidbreath project, Curiosity project/ Flowers team). Website : <https://flowers.inria.fr/team/helene.sauzeon@u-bordeaux.fr>

Laurent Simon: Professor in Computer Science at the engineering school Bordeaux INP and at the LaBRI. His main research interest is around propositional logic and the design of efficient algorithms for solving real world problems represented under this formalism (typically Constraints and SAT). He is also working on the more general frameworks Knowledge Representation and Compilation. LaBRI <http://www.labri.fr/perso/lsimon/lSimon@labri.fr>

Rodolphe Thiébaud: Professor, team leader (SISTM: Statistics in Systems and Translational medicine, Inria/Inserm BPH), deputy director of BPH. Primary research interest is in dynamical modelling and statistical learning of high dimensional data with applications mainly in immunology/vaccinology and personalized medicine. Website: <https://www.bordeaux-population-health.center/en/teams/statistics-in-systems-biology-and-translational-medicine-sistm/> as cancer. During my PhD, I specialized in mechanistic modeling based on Ordinary Differential Equations (ODE) then during my postdoctoral positions we proposed methods to inference a treatment or intervention effect based on causality theory using semi-parametric statistics. In both experiences, once the statistical problem has been modeled, we focus on optimization, to say the treatment delivery and personalization based on control theory and the design or analysis of intervention trials using network sciences. Website: <http://people.bordeaux.inria.fr/melanie.prague/rodolphe.thiebaut@u-bordeaux.fr>

Frantz Thiessard: MD and Associate Prof in Health Informatics. Research interests include designing ICT based pharmacovigilance approaches, in particular drugs misuse and interactions as well as public health indicators identification from Electronic Health Records. frantz.thiessard@u-bordeaux.fr

Christophe Tzourio: Professor of epidemiology, director of the Bordeaux Population Health (BPH) research center, University of Bordeaux. I'm a neurologist by training and my research interests focus on brain ageing on population-based cohorts including MRI and genetic studies, as well as mental health in students and its impact on brain structures. Projects under development include the use of smartphone and other numeric tools to capture repeated data over time and assess their prognostic value on depression. Website : <http://cvscience.aviesan.fr/cv/20/christophe-tzourio/christophe.tzourio@u-bordeaux.fr>

University of Waterloo “Artificial Intelligence & Health Science” Workshop attendees
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1. **Shai Ben-David**: Professor, School of Computer Science. My research interests span a wide spectrum of topics in the foundations of computer science and its applications, with a particular emphasis on statistical and computational machine learning. The common thread throughout my research is aiming to provide mathematical formulation and understanding of real world problems. In particular, I have been looking at popular machine learning and data mining paradigms that seem to lack clear theoretical justification.
2. **Jennifer Boger**: Assistant Professor, Systems Design Engineering. My research focuses on intelligent technologies for enhancing the safety, health, wellbeing, and independence of older adults and people with disabilities. My research employs transdisciplinary collaboration to advance theory and create operational technologies that reflect the needs, abilities, and contexts of the people using them. A central theme is ambient zero-effort technologies – technologies that blend into people’s environments and operate with little or no perceived effort. Jennifer is also the Schlegel Chair in Technology for Independent Living at the Research Institute for Aging. Lab website: www.itwil.ca
3. **Christian Boudreau**: Research Associate Professor, Department of Statistics and Actuarial Science. Research interests include survival analysis, event history analysis, survey sampling, and longitudinal data. Analytical inference from longitudinal data collected through complex survey designs involving stratification and clustering. Also strong research interests in biostatistical methods applied to bone marrow transplant data.
4. **Yuri Boykov**: Professor, School of Computer Science. His research is concentrated in the area of computer vision and biomedical image analysis with focus on modeling and optimization for structured segmentation, restoration, registration, stereo, motion, model fitting, recognition, photo-video editing and other data analysis problems.
5. **Helen Chen**: Professor of Practice, Associate Director, Professional Practice Centre for Health Systems. Primary research interests are Health data quality and analytics, Health information system integration and interoperability, Healthcare decision support, Medical imaging informatics, Patient radiation protection, mobile health technology and home monitoring service.
6. **Joel Dubin**: Associate Professor Department of Statistics & Actuarial Science, and School of Public Health & Health Systems; Lead of the Health Data Science Lab (HDSL). Primary research interest is in the area of methodological development in longitudinal data analysis, including for multivariate longitudinal data, where more than one outcome, (e.g., systolic and diastolic blood pressure, or two distinct measures of smoking behaviour) are each followed for individuals over time. An additional research interest involves predictive modeling, including utilizing person similarity.

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7. [Paul Fieguth](#): Professor, Department of Systems Design Engineering. Main areas of research lie in multiscale statistical modelling and remote sensing. Machine learning and interpretability in public health (with collaborators in AHS, looking at questions of the interpretability for kidney transplant / intensive care datasets, and questions of how interpretability could even be measured / assessed).
 8. [Ali Ghodsi](#): Professor, Department of Statistics and Actuarial Science. My research interests lie at the interface of statistics and computer science. They span a variety of areas in computational statistics particularly in the areas of machine learning and probabilistic modelling. I study theoretical frameworks and develops new machine-learning algorithms for analyzing large-scale data sets, with applications in data mining, pattern recognition, robotics, computer vision, sequential decision making, and bioinformatics.
 9. [John Hirdes](#): Professor, School of Public Health and Health Systems. Primary areas of interest include geriatric assessment, mental health, health care and service delivery, case mix systems, quality measurement, health information management, and quantitative research methods. He is senior Canadian Fellow and Board Member of interRAI, an international consortium of researchers from over 35 countries and Chairs interRAI's International Network of Excellence in Mental Health and the interRAI Network of Canada.
 10. [Sharon Kirkpatrick](#): Associate Professor, School of Public Health and Health Systems. The main research focus is on improving and disseminating strategies for appropriately collecting, analyzing, and interpreting dietary data. Additional interests include food policy, the environmental sustainability of current eating patterns, food environments, and food access among marginalized populations. The utility of systems thinking and methods to better understand the array of factors that influence major nutrition challenges and the effectiveness of interventions to address these challenges are under investigation as well.
 11. [Laura Middleton](#): Associate Professor, Kinesiology. My primary research interests are the identification of strategies to improve cognition across the life course and to prevent and manage dementia in late life. I use integrate approaches from several disciplines including epidemiology, person-oriented medicine, clinical research (neuroscience, exercise physiology). In collaborative research, I am also interested in the use of machine learning and AI to understand physical activity and cognitive engagement among people living with or at risk for dementia, as well as the use of advanced statistical methodology to understand, interpret, and inform patient-oriented research and care.
 12. [Plinio Morita](#): Assistant Professor, School of Public Health and Health Systems. In a nutshell, my research interests are in the areas of population-level surveillance using IoT data, mHealth and wearable technology design, ubiquitous sensors for smart homes, usage data and health data analytics, precision medicine, and technology for aging. All technologies that will help us live longer independent lives.

13. [Terry McMahon](#): University Professor, Chemistry. My research program is directed toward the investigation of structure, energetic and reaction dynamics of gaseous ions. Most recently, the majority of his work has focussed on cluster ions. To carry out this research, I use High Pressure Mass Spectrometry (HPMS) and Fourier Transform Ion Cyclotron Resonance (FTICR) spectrometers.

14. [Michael Wallace](#): Assistant Professor, Department of Statistics & Actuarial Science. Primary research interest is in causal inference, with a specific focus on dynamic treatment regimes and personalized medicine. Dynamic treatment regimes are sequences of decision rules that take subject-level data (such as age, health status, or prior treatment) as input and recommend actions (such as which drug to take) as output. Working with longitudinal datasets, my work focuses on deriving methodologies that help identify the sequence of treatment decisions that yields the best expected outcome.



UNIVERSITY OF
WATERLOO

Workshop

Artificial intelligence and health sciences

08 > 10.04.2019

université
de **BORDEAUX**

Program

Day 1: April 8th, 2019

Talence campus - LaBRI amphitheater

◆ **08:45**
Welcome coffee

◆ **09:00**
Welcome
S. Debette, Vice-president for external relations, University of Bordeaux

University of Bordeaux (UBx) - University of Waterloo (UW) partnership
L. Servant, Vice-president for international networks, UBx
T. McMahon, Professor, coordinator for UW-UBx collaborations, UW

◆ **09:10**
Artificial Intelligence (AI): general context in France, local dynamics in Bordeaux
B. Le Blanc, Policy officer, General directorate for research and innovation, Ministry of higher education, research and innovation, France

AI: University of Bordeaux's policy
H. Jacquet, Vice-president for strategy and development, UBx

AI: general context in Canada, local dynamics in Waterloo (Ontario)
P. Fieguth, Professor, Department of systems design engineering, UW

Programs that support French - Canadian collaborations in AI
V. Debord-Lazaro, Director of the international office, UBx

Introduction to the workshop topics
R. Thiebaut, Professor, leader of the Inria/Inserm Bordeaux Population Health (BPH) Statistics in Systems & Translational Medicine (SISTM) team, Deputy director of BPH, UBx

◆ **10:00**
Scientific session 1: Core artificial intelligence

Developmental autonomous learning: AI, cognitive sciences and educational technologies
P.-Y. Oudeyer, Director of research, Inria, UBx

Call for a fundamental paradigm change in the way clustering is being applied and analyzed
S. Ben-David, Professor, School of computer science, UW

◆ **11:00**
Coffee break and group photo

◆ 11:30

Setting the basis of a bio-inspired reinforcement learning

F. Alexandre, Director of research, Inria, leader of the Mnemosyne team, UBx

Knowledge compilation

L. Simon, Professor in computer science, Bordeaux INP Engineering School & LaBRI, UBx

◆ 12:30

Lunch

◆ 13:30

Scientific session 2: Medical informatics & big data

Dealing with heterogeneous data and their secondary use for public health

G. Diallo, Associate professor in computer science, UBx

F. Thiessard, MD, Associate professor in health informatics, UBx

Unlocking, integrating and leveraging health data through the Canadian personalized healthcare innovation network

H. Chen, Professor of practice, Associate director, Professional practice center for health systems, UW

Automatic analysis of aortic aneurysm and modeling

F. Bernard, Research engineer, team member of the Memphis project (Inria)

Public health applications of large health care databases of vulnerable populations

J. Hirdes, Professor, School of public health and health systems, UW

◆ 15:30

Coffee break

◆ 16:00

Scientific session 3: Biostatistics - personalized medicine

Personalized medicine: easy estimation via dynamic treatment regimes

M. Wallace, Assistant professor, Department of statistics and actuarial science, UW

Personalized medicine using a dynamical model

M. Prague, Inria researcher - BPH SISTM team, UBx

Some prediction problems in the ICU, with a bridge to problems in public health

J. Dubin, Associate professor, Department of statistics and actuarial science, School of public health and health systems, UW

Early evaluation of some therapies against cancer using modeling and AI

O. Saut, Senior researcher, CNRS, leader Inria research team Monc, UBx

18:00

End of day



Day 2: April 9th, 2019

Carreire campus – Bordeaux School of Public Health (ISPED) – Louis amphitheater

◆ **08:45**
Welcome coffee

◆ **09:00**
Presentation of research and teaching activities in public health at UBx
C. Tzourio, Professor of epidemiology, Director of the Bordeaux population health research center, UBx
G. Chêne, director of the Bordeaux school of public health, UBx

◆ **09:30**
Scientific session 4: Biostatistics – part 2

Machine learning for automatic cell populations classification
B. Hejblum, Associate professor in biostatistics, Member of the Inria/Inserm BPH SISTM team, UBx

Variable selection for clustered survival data
C. Boudreau, Research associate professor, Department of statistics and actuarial science, UW

Individual dynamic prediction of clinical endpoints using repeated marker data: how joint models can contribute
C. Proust Lima, Inserm researcher (BPH Biostatistics team), UBx

◆ **11:00**
Coffee break

◆ **11:30**
Machine learning for neoantigens sequencing and immunotherapy
A. Ghodsi, Professor, Department of statistics and actuarial science, UW

Accelerating development and personalizing therapy: the example of IL7
R. Thiébaud, Professor, leader of the Inria/Inserm Bordeaux Population Health (BPH) SISTM team, Deputy director of BPH, UBx

◆ **12:30**
Lunch



◆ 13:30

Scientific session 5: Public health - part 1

Elucidating the complexity of population-level dietary patterns - can AI help?

S. Kirkpatrick, Associate professor, School of public health and health systems, UW

Machine learning for the prediction of age-related macular degeneration

C. Delcourt, Director of research at Inserm, leader of the BPH LEHA (Lifelong Exposures, Health and Aging) team, UBx

Opportunities and challenges in prevention and management of dementia

L. Middleton, Associate professor, kinesiology, UW

Nutritional exposome in brain aging

C. Samieri, tenure track researcher, Inserm, Epidemiologist, UBx

◆ 15:30

Coffee break

◆ 16:00

Scientific session 6: Public health - part 2

Intelligent technologies for supporting graceful aging

J. Boger, Assistant professor, systems design engineering, UW

Digital technologies for everyday cognition of older adults or individuals with cognitive impairments

H. Sauzeon, Professor of psychology and cognitive science, UBx

High speed, real-time public health surveillance using IoT technology

P. Morita, Assistant professor, School of public health and health systems, UW

E-cohort for studying student health

C. Tzourio, Professor of epidemiology, Director of the Bordeaux Population Health (BPH) research center, UBx

◆ 18:00

End of day



Day 3: April 10th, 2019

Talence campus - LaBRI amphitheater

◆ 08:45
Welcome coffee

◆ 09:00
**Scientific session 8: Computer science / machine learning,
algorithm and health / medicine**

Image segmentation without full supervision

Y. Boykov, Professor, School of computer science, UW

AI for health application with visual and heterogeneous data

*J. Benois-Pineau, Full professor, chair of video analysis and indexing
group, LaBRI, UBx*

Interpretability and robustness in machine learning

P. Fieguth, Professor, Department of systems design engineering, UW

3D scene understanding from monocular images

V. Lepetit, Full professor, LaBRI, UBx

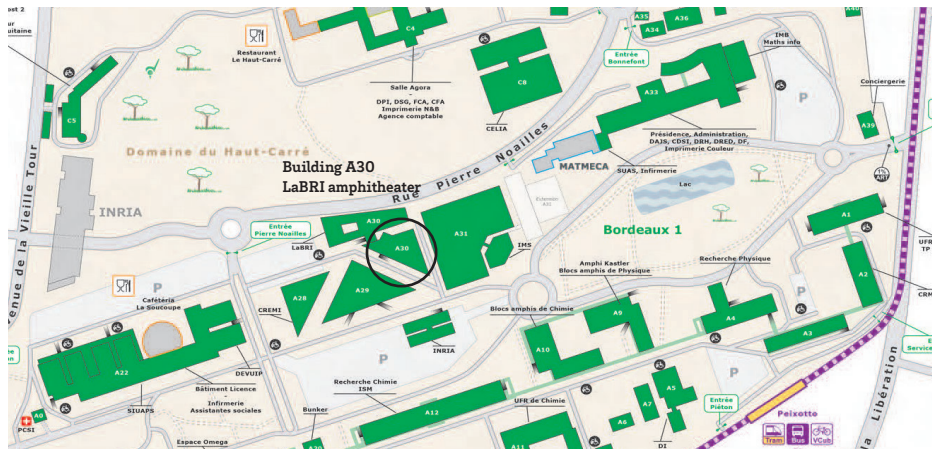
◆ 11:00
Coffee break

◆ 11:30
Next steps
*C. Tzourio, Professor of epidemiology, Director of the Bordeaux population health
(BPH) research center, UBx*
P. Fieguth, Professor, Department of systems design engineering, UW

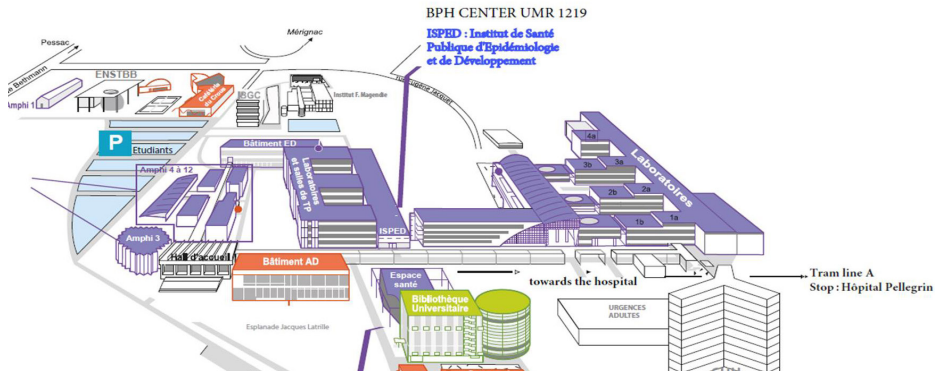
◆ 12:30
Lunch and workshop conclusion



Talence campus - LaBRI amphitheater



Carreire campus - Bordeaux School of Public Health (ISPED) - Louis amphitheater



University of Bordeaux
351 cours de la Libération, 33405 Talence Cedex, France
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International Office
April 2019

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