### WALLENBERG AI, AUTONOMOUS SYSTEMS AND SOFTWARE PROGRAM

# WASP 2021 Kick-Off Danica Kragic















# **WASP AI-MLX Scientific focus**

- Representation learning and grounding
- Sequential decision-making and reinforcement learning
- Learning from small data sets, GANs and incremental/active learning
- Multi-task and transfer learning

• 'Established' 2018 – to be updated given transformers, contrastive I, explainability, ③



# Main activities so far

- Two calls for collaborative projects
- Two calls for industrial PhD students
- 8 Assistant Professors and 2 Associate Professors
- 5 Chairs in Al
- 4 Guest Professors in Al



## **1<sup>st</sup> gen collaborative projects**

Project name	Universities
Statistical and Adversarial Learning in Continuous System Control	LU, KTH
Reinforcement Learning in Continuous Spaces with Interactively Acquired Knowledge-based Models	LU, ÖU
How to Inject Geometry into Deep Learning - Theoretical Foundation and New Computational Methods	Chalmers, LiU
Probabilistic models and deep learning - bridging the gap	UU, Chalmers
Robot learning of symbol grounding in multiple contexts through dialog	KTH, ÖU
Under-Supervised Representation Learning	KTH, Chalmers
Beyond supervised learning for semantic analysis of visual data	KTH, LiU
Exploration and uncertainty in generative networks for supervised learning and reinforcement learning	KTH, Chalmers
Deep Probabilistic Neural Networks for Survival Analysis	UU, KTH
Data-driven foundations for robust deformable object manipulation	Chalmers, KTH



### **2**<sup>nd</sup> gen collaborative projects

No of PhD students	Project type	Title	PI1	PI2	Ind. Pl
2	PI+PI	Efficient Data Representation and Machine Learning over Next Generation Networks	Ashkan Panahi, Chalmers	Carlo Fischione, KTH	
2	PI+PI	Learning and Leveraging Rich Priors for Factorization Problems	Carl Olsson, LU	Christopher Zach, Chalmers	
3	PI+PI+Ind	Machine Learning for Causal Inference from Observational Data with Applications in Healthcare	Fredrik Johansson, Chalmers	Dave Zachariah, UU	Claudia Cabrera, Astra Zeneca
	PI+PI+Ind	Interpreting and Grounding Pre-trained Representations for Natural Language Processing	Richard Johansson, Chalmers	Marco Kuhlmann, LiU	Staffan Truvé, Recorded Future



# Wallenberg Chairs in Al

A major initiative to build up AI in Sweden



#### Virginia Dignum, Wallenberg Chair in AI at UmU

Professor in artificial intelligence with focus on social and ethical AI at Umeå University from September 2018. Previously Virginia was Associate Professor at the Faculty of Technology, Policy and Management, Delft University of Technology.



#### Vicenc Torra, Wallenberg Chair in AI at UmU

Vicenc Torra is currently a professor at the Hamilton Institute at Maynooth University (Ireland). Data privacy, machine learning, and approximate reasoning.



#### Aristides Gionis, Wallenberg Chair in AI at KTH Before coming to Aalto Aristides was a senior research scientist in Yahoo! Research, and previously an Academy of Finland

postdoctoral scientist in the University of Helsinki. Has ERC grant.



#### Frank Dignum, Wallenberg Chair in AI at UmU

Professor in AI with a focus on socially aware AI at Umeå University from February 2019. Previously Frank was associate professor at Utrecht University and professor at Czech University of Technology in Prague. He is also a honorary principal research fellow at the University of Melbourne.



#### **Ross King, Wallenberg Chair in AI at CTH** Professor in AI at Chalmers. He is currently Professor of Machine Intelligence at the University of Manchester. His main research interests are in the interface between computer science and biology/chemistry.



# **WASP- AI MLX recruitments**



Christopher Zach Research at Chalmers University of Technology



**Fredrik D. Johansson Assistant professor** at Chalmers University of Technology



Oscar Martinez Mozos Assistant Professor at University of Örebro



Simon Olsson Assistant Professor at Chalmers University of Technology



Amir Aminifar Assistant Professor at Lund University



Gustav Eje Henter Assistant Professor at KTH



Luigi Nardi Assistant Professor in Machine Learning at Lund University



Monowar Bhuyan Assistant Professor at Umeå University



Johannes Stork Assistant Professor at University of Örebro



Jendrik Seipp Assistant Professor at Linköping University



# Wallenberg Guest professors in Al

Wallenberg Guest professors is a new initiative. The requirements are presence at least 20 % over 5 years and that the guest professor is main advisor of at least two PhD students in Sweden. The aim is to build a new research group so there are also means to hire an assistant professor.



Professor Hector Geffner Wallenberg Guest Professor in AI at LiU Hector Geffner is an ICREA Research Professor at the Universitat Pompeu Fabra (UPF) in Barcelona, Spain. His research interests are in computational models of reasoning, action, and learning.



### Professor Diego Calvanese

Wallenberg Guest Professor in AI at UmU Diego Calvanese is a full professor at the Research Centre for Knowledge and Data, University of Bozen-Bolzano, Italy. His research interests include formalisms for knowledge representation and reasoning, ontologybased data access and integration, description logics, Semantic Web, and data-aware process management.



**Professor Dr. Luc De Raedt Wallenberg Guest Professor in AI at ÖrU** Luc De Raedt is full professor at KU Leuven, and head of the DTAI lab. Work on learning and reasoning, often using logic and probability.



Professor Michalis Vazirgiannis Wallenberg Guest Professor in AI at KTH Dr. Vazirgiannis is a Distinguished Professor at LIX, Ecole Polytechnique in France and leads the Data Science and Mining (SaSciM) group. Machine learning and combinatorial methods for Graph analysis.



# Probabilistic models and deep learning – bridging the gap

#### **Probabilistic Models**

- Uncertainty quantification
- Hierarchical models
- Structure exploitation from probabilistic priors

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#### **Deep Learning**

- Learning from unstructured data
- Highly flexible and powerful models, with state-of-the-art performance for many applications

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**This project:** We will develop new **models** and new **learning algorithms** for applications where latent variables are naturally charachterized using, e.g., probabilistic graphical models, but data come from a domain where deep learning has been successful (e.g., images)

- PhD students: Amanda Olmin (LiU) and Jakob Lindqvist (Chalmers)
- **PIs:** Fredrik Lindsten (LiU) and Lennart Svensson (Chalmers)



# How to Inject Geometry into Deep Learning -Theoretical Foundation and New Computational Methods

• Objectives: Widen the scope of Deep Learning methods to incorporate geometry, in particular, with respect to geometric invariance, geometric priors and geometric consistency.

• Participants:

- Pavlo Menlyk, New PhD student, Linköping University
- Georg Bökman, New PhD student, Chalmers
- Michael Felsberg, Professor, Linköping University
- Fredrik Kahl, Professor, Chalmers



### **Statistical and Adversarial Learning in Continuous System Control**

Johan Grönkvist, Yassir Jedra, Alexandre Proutiere, Anders Rantzer

### **1. CDC 2019 Tutorial on Self-Tuning and Reinforcement Learning**

Nikolai Matni, University of Pennsylvania Alexandre Proutiere, KTH Anders Rantzer, Lund University Stephen Tu, Google Brain

Highest possible visibility at the main annual control conference.

### **2. Fastest Identification of Linear Systems**

How much data do we need to identify a system with given levels of accuracy and certainty?

To get an  $\epsilon$ -accurate estimate with probability  $1 - \delta$ , we need *t* samples with:

$$\lambda_{\min}\left(\sum_{k=0}^{t-1} \left[ (t-k)A^k (A^k)^\top \right] \right) \ge \frac{1}{\varepsilon^2} \left( \log(1/\delta) + d \right)$$

and the Ordinary-Least-Squares estimator achieves this fundamental limit.



CDC 2019

Control Systems

Societ

58th IEEE Conference on Decision and Control

Nice, France. December 11-13, 2019

This solves a long-standing open problem, and establishes a result conjectured by **Simchowitz-Mania-Tu-Jordan-Recht** 2018 **Papers:** "Sample complexity lower bound for system identification", "Finite-time analysis of linear system identification", Jedra-Proutiere, IEEE CDC 2019, 2020.

### Deep probabilistic neural networks for survival analysis

- Objective: Explore and develop new methods and models to learn representations for probabilistic deep neural networks. In particular this involves the connection to probabilistic programming.
- PIs: Thomas Schön (UU), David Broman (KTH) and Lawrence Murray (Uber AI).
- PhD students: Daniel Gedon (from Delft, The Netherlands) and Gizem Caylak (from Bilkent, Turkey)
- Medical collaborators (Providing relevant medical problem settings and data within our application within cardiology): Johan Sundström (UU) and Antonio Rebeiro (Universidade Federal de Minas Gerais, Brazil)
- **Time-line:** Started roughly 1 year ago. The more applied start-up projects are now coming to a close and we are now also starting up more fundamental methods-oriented research.







