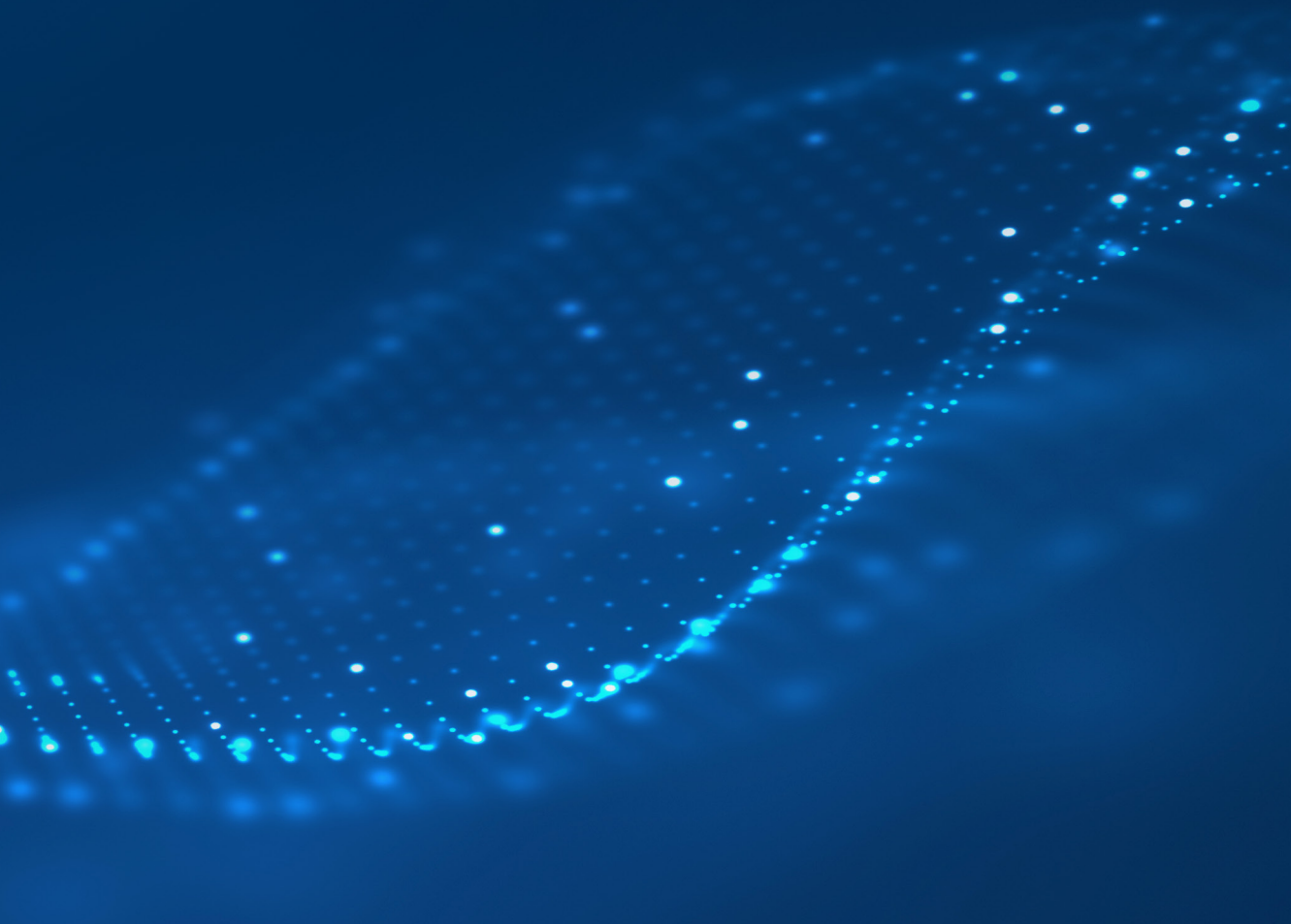
# WASP
## HIGHLIGHTS
# 2021



# Foreword

Since its inception Wallenberg AI, Autonomous Systems and Software Program (WASP) has built a unique platform for acceleration of Swedish research within AI, autonomous systems and software. With a foundation in individual PhD projects and recruited faculty at the international forefront, WASP has expanded to be a platform where top-tier scientists and Swedish industry meet, and form new ambitious constellations to address the hardest research challenges in our domains.

To carry WASP forward, several new initiatives have been instantiated in 2021. In this booklet we highlight the new multidisciplinary projects; the NEST environments and the cooperation with the DDLS (Data Driven Life Science) program.

During 2021 WASP has pronounced the will and initiated the means to push the boundaries for gender equality in the technological sciences. In this spirit WASP has launched a unique funding opportunity for female researchers in AI and have reinforced actions for diversity and inclusion throughout the program.

Based on the successful first years of the program WASP has been expanded and extended. Our new targets are to recruit 80 internationally competitive scientists and examine 600 PhD students before 2030. By doing this WASP paves the way for new applications, innovations, infrastructure and educational development that will benefit Swedish industry and society for decades to come.

**Anders Ynnerman**
WASP Program Director

**Sara Mazur**
Chair of the WASP Board

# WASP Status 2021

- Recruitment of 11 professors in autonomous systems and software completed so far
- 9 international top-level recruitments to Wallenberg Chairs in AI
- Recruitment of assistant and associate professors in AI, now counting 26 in total
- A growing Graduate School, with 364 active PhD students, where of 104 are industrial PhD students
- 43 PhD students have defended their theses
- 58 companies are engaged in WASP
- Five research arenas within different fields have been launched
- Formal collaboration with five excellent universities abroad: Nanyang Technological University, UC Berkeley, Stanford University, MIT and Aalto University

Aiming at delivering excellent research and competence in Sweden, WASP has during 2021 successfully launched several new initiatives and developed existing instruments. In this report, we have highlighted new forms of domain-spanning projects, new unique concepts for industrial cooperation and efforts to provide a world-class graduate school. Initiatives for increasing awareness of gender and inclusion as well as digital networking are also accentuated in this document.

## Vision

Excellent research and competence in artificial intelligence, autonomous systems and software for the benefit of Swedish industry.

## Mission

Build a world leading platform for academic research that interacts with leading companies in Sweden to develop knowledge and competence for the future.

## WASP in Numbers

**5.5 Billion**

**5.5 billion SEK for 15 years until 2030**

**600**

**600 Graduated PhDs**

**80**

**80 Faculty Recruitments**

# Strategic Instruments

To meet the challenges in research and competence building, WASP acts through six strategic instruments. They are designed to achieve leverage, renewal, and expansion of the program and its impact.

### Research Program

The research program within AI, autonomous systems and software is aiming for disruptive developments. The research in WASP is encompassed in all instruments and permeates every part of the program.

### Graduate School

The national graduate school in close interaction with Swedish industry has the ambition to substantially raise the level of knowledge in Sweden. The graduate school is designed to produce 600 new PhDs, at least 150 of whom will be industrial PhD students.

### Recruitment

The international recruitment program is intended to build competence, establish new research areas and to reinforce existing strengths in Sweden. The program aims to recruit both outstanding younger researchers as well as established experts. This is being achieved by offering packages that are attractive by international standards.

### Research Arenas

WASP Research Arenas is an instrument where academia and industry share infrastructures and competence to conduct joint in-depth projects and demonstrations based on the resulting advanced platforms. The arenas entail significant integration efforts at the intersection between industrial and academic interests.

### Internationalization

WASP has partnerships with selected internationally leading universities for PhD student research visits and postdoc programs. Current international partners are Nanyang Technological University, UC Berkeley, Stanford University, MIT and Aalto University. The international dimension in WASP is obvious in all instruments.

### Communication, Events and Networking

Communication, events and networking are means used to build an active WASP community and to engage with the external society. Activities to increase the awareness of WASP both nationally and internationally are important for creating successful networks and career paths for the researchers in WASP with the benefit for Swedish industry.

# WASP Highlights 2021

- New WASP Research Arenas
- 9 NEST environments awarded
- 15 collaboration projects within Data-Driven Life Science granted
- High-profile virtual events
- Formation of a Diversity and Inclusion Group
- New initiatives for PhD students
- WASP Distinguished Guest Professor program launched
- KAW funded supercomputing infrastructure for AI made available to WASP researchers

# New WASP Research Arenas

## Accelerating Activity in the Research Arenas

WASP Research Arenas aim to increase the value and relevance of research, facilitating collaboration between WASP researchers and industry partners. In 2021, two new arenas were launched. The portfolio of research arenas now embraces five different areas. Furthermore, much effort has been put in increasing the collaboration between the arenas.

### New Arenas in 2021

Two new arenas were launched in 2021: WARA Robotics and WARA Media & Language. In parallel, the already existing WARA Common broadened their function from being solely an infrastructure for computing to also engage actively in research.

#### WARA Robotics

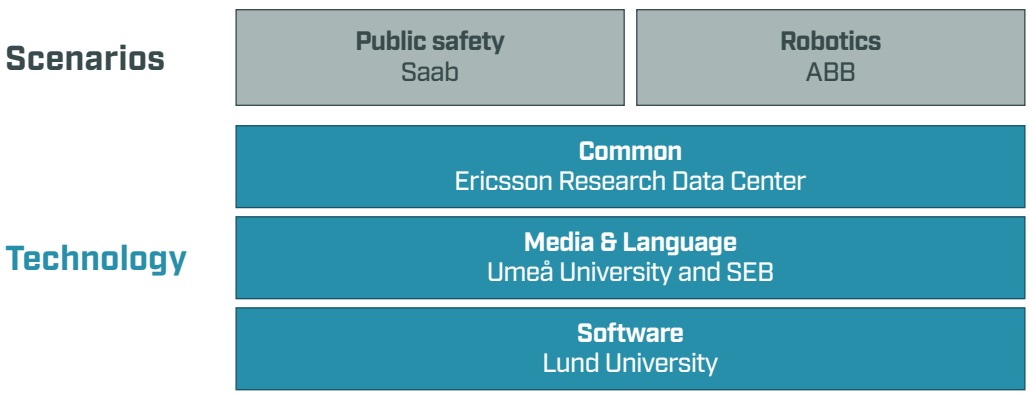
WARA Robotics is developed to be a physical and digital testbed including robots, material and other resources needed to deploy research in a multitude of aspects related to robotics for manufacturing. The setup will be designed to allow benchmarking of results.

#### WARA Media & Language

The mission of WARA Media & Language is to build a multidisciplinary ecosystem around Media AI and Natural Language Processing, connecting scientific fields and a diversity of industrial segments. It addresses research topics related to the generation and analysis of media data, and extrinsic effects of the same.

### The Two Concepts of Research Arenas

The matrix illustrates how the Scenario arenas are focusing on an industrially relevant scenario, covering one or several defined research challenges. They can include a wide range of technologies and competences. The Technology arenas take their starting point in one or several defined research challenges within a specific technology and may serve as infrastructure supporting other parts of WASP, including other arenas.



# NEST Environments

Launched with a call in early 2021, NEST is a major initiative on multidisciplinary research environments, characterized by Novelty, Excellence, Synergy and Team. The underpinning idea is to address hard, challenging research questions that require multidisciplinary efforts to be solved and that have potentially very high academic, industrial, and societal impact.

After undergoing international peer review, the following nine proposals were awarded grants for five years. In total, 180 MSEK was granted in this call.

### Learning in Networks: Structure, Dynamics, and Control

PIs: Alexandre Proutiere (KTH), Anders Rantzer (LU), Fiona Skerman (UU), Emma Tegling (LU)

> How can we learn more about the underlying structures of complex networked systems? This project aims at developing mathematical and computational tools to design algorithms able to learn underlying structures of networked systems. Two application domains are targeted: automated network management in radio communication systems, and online intermediation platforms.

### CyberSecIT: Automated and Autonomous Cybersecurity for IoT

PIs: Andrei Sabelfeld (Chalmers), Simone Fischer-Hübner (Chalmers), Vicenc Torra (UmU), Musard Balliu (KTH)

> The Internet of Things (IoT) is an emerging technology that help users manage their digital lives, ranging from cyberphysical "things" to online services and social networks. Unfortunately, the power of IoT apps can be abused by attackers. The project addresses two core challenges at the heart of IoT security: automation enabled by software, and autonomy enabled by machine learning technologies.

### DISCOWER: Distributed Control in Weightless Environments

PIs: Dimos V. Dimarogonas (KTH), Christer Fuglesang (KTH), Jana Tumova (KTH), Ivan Stenius (KTH)

> DISCOWER aims at developing safe and robust control and planning methods for operating agents in weightless environments - specifically, space and subsea settings. The goal is to develop algorithms that can be transferred across these extreme scenarios, while being capable of coordinating multi-agent teams on complex, critical tasks.

### Intelligent Cloud Robotics for Real-Time Manipulation at Scale

PIs: Florian Pokorny (KTH), Monowar Bhuyan (UmU), Erik Elmroth (UmU), Martina Maggio (LU)

> This project addresses interdisciplinary research challenges in the emerging area of cloud/edge robotics with a particular focus on the challenges of robotic manipulation

in this context. Areas of investigation include asymptotics and stability of large scale machine learning, fault tolerance, edge-cloud control and resource allocation challenges, as well as federated, continual and transfer learning for such systems.

### 3D Scene Perception, Embeddings and Neural Rendering

PIs: Fredrik Kahl (Chalmers), Cristian Smincisescu (LU), Kathlén Kohn (KTH), Mårten Björkman (KTH)

A goal of artificial intelligence is to recover representations of the three-dimensional world. In this project, new theory and algorithms will be developed that would make it possible, not only to recognize and reconstruct a semantically and geometrically meaningful representation, but also to manipulate, modify and automatically complete a three-dimensional scene model of the visual world.

### STING – Synthesis and analysis with Transducers and Invertible Neural Generators

PIs: Gustav Eje Henter (KTH), Hedvig Kjellström (KTH), Henrik Björklund (UmU), Johanna Björklund (UmU), Frank Drewes (UmU), Marco Kuhlmann (LiU)

For machines and humans to communicate on equal terms, machines need to be able to do human tasks such as interpret and express spoken language, mood, and body language. They are currently treated as different problems and studied by different researchers. STING wants to bring these areas together and create a unified framework that more accurately reflects the richness and interconnectedness of human communication.

### PerCorSo: Perceiving and Communicating Correct-by-design Socially Acceptable Autonomous Systems

PIs: Jana Tumova (KTH), Iolanda Leite (KTH), Patric Jensfelt (KTH), Joakim Gustafson (KTH)

PerCorSo aims to design autonomous behaviors of interacting robots that are both guaranteed to be safe and perceived as safe by people. It is unique in moving from conventional planning and control using simple, static human models towards synthesis of correct-by-design and socially acceptable behaviors that consider spatial and social context as well as complex empirically based human models.

### Alignment and Integration of Physical and Virtual Worlds

PIs: Jonas Unger (LiU), Amy Loutfi (ÖrU), Fredrik Lindsten (LiU), Michael Felsberg (LiU)

The integration of physical and virtual worlds has the potential to be the next disruptive step in diverse applications of AI and autonomous systems. The project aims to establish a new modeling paradigm for end-to-end learning and systematic integration of real and synthetically generated data from simulators in machine learning frameworks.

### Data-bound Computing

PIs: Mikael Johansson (KTH), Paris Carbone (KTH), Mary Sheeran (Chalmers), Per Stenström (Chalmers)

This project aims at developing the principles behind the next generation of computing systems, optimized for modern data-intensive workloads. It comprises leading experts from academia and industry and covers critical aspects of the computing stack, from computer architectures, through distributed systems, all the way to data-driven applications such as machine learning pipelines.

# WASP–DDLS Collaboration

WASP and the SciLifeLab and Wallenberg National Program on Data-Driven Life Science launched a joint call during 2021 with the aim of solving ground-breaking research questions across their different scientific disciplines. In total, 15 applications were awarded grants for two-year projects. In total, 54.5 MSEK was granted from WASP and DDLS in this call.

## List of the Granted DDLS/WASP Joint Projects 2021

Multiscale Dynamics of Biomolecules from Cryo-EM
PIs: Joakim Andén (KTH),
Erik Lindahl (SU)

Deep Learning for Protein-Protein Interactions
PIs: Arne Elofsson (SU),
Hossein Azizpour (KTH)

Data Integration via Auto-Encoders with Biological Constraints
PIs: Mika Gustafsson (LiU),
Rebecka Jörnsten (GU/Chalmers)

Self-Driving Microscope for Rare Cell State Identification and Tracking in Live Cell Imaging
PIs: Joakim Jaldén (KTH),
Emma Lundberg (KTH)

Massive Parallel in vivo Gene Editing and AI Modeling to Decipher Brain Tumor Invasion
PIs: Sven Nelander (UU),
Rebecka Jörnsten (GU/Chalmers)

Transforming Breast Cancer (TransformBC)
PIs: Kevin Smith (KTH),
Theodoros Foukakis (KI)

Visual Analytics for Enhancing Quality and trust in Genome-Wide Expression Clustering and Annotation
Mathias Uhlén (KTH),
Andreas Kerren (LiU)

Visualization and de-Identification of Biobank Data to Propel Precision Medicine Research
PIs: Martin Rosvall (UmU),
Beatrice Melin (UmU)

Novel AI Methods for Experimentally Constrained Protein Structure Prediction
PIs: Fredrik Lindsten (LiU),
Sebastian Westenhoff (UU)

A Causal Map of the Cell
PIs: Tuuli Lappalainen (KTH),
Stefan Bauer (KTH)

Understanding the Human Immune Cell Interaction Network
PIs: Petter Brodin (KI),
Dimos Dimarogonas (KTH)

Learning Pharmacometric Model Structures from Data
PIs: Mats Karlsson (UU),
Bo Bernhardsson (LU)

Data-Driven Application to Protein-Protein Interactions
PIs: Björn Wallner (LiU),
Alexey Amunts (SU)

AI-Accelerated Oligonucleotide Drug Design
PIs: Alexander Schliep (GU/Chalmers),
Pär Matsson (Sahlgrenska Academy)

HUDI-Huge Complex Diagnostic Imaging Data: Towards personalized models in the clinical workflow
PIs: Tino Ebbers (LiU),
Ingrid Hotz (LiU)

# WASP Went Virtual

Virtual events have been key to continue building the WASP community during the pandemic. WASP adapted and exceeded many expectations with regards to organizing professional online courses, summer schools, networking events, and large conferences.

## WASP4ALL—Building Excellence for the Era of AI

The WASP4ALL 2021 conference highlighted and showcased the excellence that WASP is producing in the field of AI. More than 400 participants joined to take part of talks from WASP researchers, politicians, international speakers, and industrial partners.

## The WASP Job Fair

In December, WASP arranged its second Virtual Job Fair where representatives from different industry segments engaged in discussions about their research and career opportunities in Sweden with WASP PhD students. The main topic of the event was "Life in Sweden after the PhD". It was highlighted from different perspectives through talks and a panel discussion. A recurring theme in the talks was the need to overcome the academy-industry gap, both real and perceived, to support knowledge transfer and attractive career paths.

## Diversity and Inclusion Activities

The purpose of the Diversity and Inclusion Group is to increase the gender balance and to improve diversity in WASP. The efforts from the group are focused on practical suggestions on how to promote and improve diversity and inclusion within the natural sciences. The suggestions are based on research on how processes of discrimination and privilege appear in scientific working practices at different points in the career trajectory. A digital workshop on "How to successfully recruit female researchers" was arranged in September 2021 by the WASP Diversity and Inclusion group and was aimed at researchers as well as HR and recruitment staff.

# WASP Graduate School

## New Initiatives for PhD Students

### A Unified Graduate School

A unified graduate school was launched 2021, where the two tracks (AI and autonomous systems/software) have been replaced with a joint curriculum with more flexibility and choice. The networking aspect is considered very important, and activities such as the Winter Conference, two yearly summer schools, and two yearly international trips are still parts of the graduate school. Additional activities for the WASP PhD students include study visits to companies and the possibility to apply for six months as visiting researcher abroad.

### Postdoc Program with MIT and Aalto

During 2021, targeted postdoctoral scholarships were made available in collaboration with the MIT Stephen A. Schwarzman College of Computing, focusing on core AI and machine learning, statistics and data science, as well as within the AI and Society area.

In June 2021, WASP strengthened the Nordic co-operation through a Memorandum of Understanding with Aalto University in Finland. The collaboration means that WASP doctoral students and researchers have the opportunity for exchanges and joint projects with Aalto University. First out was a postdoctoral program with a call for collaborative projects.

### Alumni Program

The WASP alumni program was introduced in 2021 with the aim to recognize and celebrate the outstanding achievements of WASP graduates. Through the Alumni of the Year award, WASP seeks to acknowledge persons that have made a contribution to the local, national and international communities.

### Collaboration with WASP-HS

To support interaction, the PhD students from both WASP and WASP-HS are invited to the WASP course “Ethical, Legal and Societal aspects on AI and Autonomous Systems”. To further strengthen collaboration, this year, the WASP Graduate School and the WASP-HS Graduate School arranged a joint social event in conjunction to their respective summer schools.

Original photo by Thor Balkhed

# Olov Andersson Alum of the Year

Olov Andersson, former WASP PhD student from Linköping University, today a WASP funded postdoc at ETH Zürich, has been awarded WASP Alum of the year 2021. This was announced at the yearly WASP Winter Conference in January 2022.

Through the Alumni of the Year award, WASP acknowledges individuals who have excelled within WASP by generating outstanding scientific impact as well as contributions to the program by engagement in the WASP community.

– Olov Andersson continues to inspire us and communicates the importance of WASP and the WASP research arenas both within WASP and to the broader international research community, says Anders Ynnerman, WASP Program Director, during the prize ceremony.

– In addition, WASP recognizes Olov's recent and outstanding achievement being a part of the winning team Cerberus in the DARPA Subterrain Challenge, a prestigious competition in Autonomous Systems. Olov is a role model for current WASP PhD students and demonstrates the ability to create unique career possibilities and memorable experiences beyond the PhD, Ynnerman continues.

Olov Andersson graduated in April 2020 with his thesis "Learning to make safe real-time decisions under uncertainty for autonomous robots", from the research lab of Prof. Patrick Doherty at Linköping University. At present, Olov is a WASP funded postdoc in the Autonomous Systems Lab (ASL) led by Prof. Roland Siegwart at ETH Zürich. The lab is a world-leading environment for research in autonomous systems.

During the Winter Conference, Olov presented his current work as a postdoctoral researcher and his visions for the future. Olov emphasized the importance of WASP for his research career:

– I would like to in particular highlight the WASP research arenas. It provides an interesting opportunity to talk to different people and companies about what their problems are, and what the solutions they need as well as possible techniques in practice.

Olov also emphasizes other networking possibilities within WASP, such as the summer schools and international exchanges.

– For me, WASP has been a great help and I am happy to be a part of the program, Olov concludes.

# WASP Recruited Faculty

WASP is dedicated to long-term strengthen the research in artificial intelligence, autonomous systems and software in Sweden. The ambition of WASP is to provide funding for at least 80 internationally competitive recruitments, ranging from promising assistant professors to outstanding senior professors. They are offered attractive recruitment packages, including relevant infrastructure and funding for doctoral students and postdocs, for the best possible starting conditions.

## WASP Recruited Faculty in 2021

**Alexandre Bartel**
Umeå University

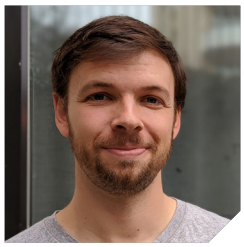
**Alp Yurtsever**
Umeå University

**Axel Ringh**
Chalmers University of Technology

**Emma Tegling**
Lund University

**Jendrik Seipp**
Linköping University

**Jens Sjölund**
Uppsala University



**Jonah Brown Cohen**
Chalmers University of Technology

**Marjan Alirezaie**
Örebro University

**Miriah Meyer**
Linköping University

**Stefan Bauer**
KTH Royal Institute of Technology

**Yvonne Stürz**
KTH Royal Institute of Technology

## WASP Distinguished Guest Professor Program

The WASP Distinguished Guest Professors program, introduced November 2021, has the ambition to strengthen and complement research within WASP, both by contributing to existing research environments and by establishing new research groups in strategic areas. The two annual guest professorships should be at the highest international scientific level and the first successful candidates are expected to start during the second half of 2022.

# WASP Dissertations During 2021

The WASP Graduate School provides unique opportunities for PhD students who are dedicated to achieve international research excellence with industrial relevance.

In 2021, 26 students defended their doctoral thesis.

**Shahbaz Abdul Khader**
KTH Royal Institute of Technology/ABB

**Maximilian Algehed**
Chalmers University of Technology

**Pavel Anistratov**
Linköping University

**Kristoffer Bergman**
Linköping University/Saab

**Per Boström Rost**
Linköping University/Saab

**Mladen Čičić**
KTH Royal Institute of Technology

**Abdelrahman Eldesokey**
Linköping University

**Marcus Greiff**
Lund University

**Fredrik Hagebring**
Chalmers University of Technology

**Carl-Johan Hoel**
Chalmers University of Technology/Volvo

**Gustav Häger**
Linköping University

**David Issa Mattos**
Chalmers University of Technology

**Takuya Iwaki**
KTH Royal Institute of Technology

**Thomasz Kosinski**
Chalmers University of Technology

**Mårten Lager**
Lund University/Saab

**Martin Lindvall**
Linköping University/Sectra

**Piergiuseppe Mallozzi**
Chalmers University of Technology

**Chanh Nguyen Le Tan**
Umeå University

**Linnea Persson**
KTH Royal Institute of Technoloy

**Arian Ranjbar**
Chalmers University of Technology

**Amir Roozbeh**
KTH Royal Institute of Technology

**Vidit Saxena**
KTH Royal Institute of Technology/Ericsson

**Per Skarin**
Lund University

**Lars Svensson**
KTH Royal Institute of Technology

**Alfred Åkesson**
Lund University

**Max Åstrand**
KTH Royal Institute of Technology/ABB

The Wallenberg AI, Autonomous Systems and Software Program (WASP) is a major national initiative for strategically motivated basic research, education and faculty recruitment in artificial intelligence, autonomous systems and software development. WASP was initiated in 2015 and its mandate extends to 2030. WASP is mainly funded by the Knut and Alice Wallenberg foundation.

Knut och Alice Wallenbergs Stiftelse

CHALMERS

KTH VETENSKAP OCH KONST

LINKÖPINGS UNIVERSITET

LUNDS UNIVERSITET

UMEÅ UNIVERSITET

WASP | WALLENBERG AI, AUTONOMOUS SYSTEMS AND SOFTWARE PROGRAM

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