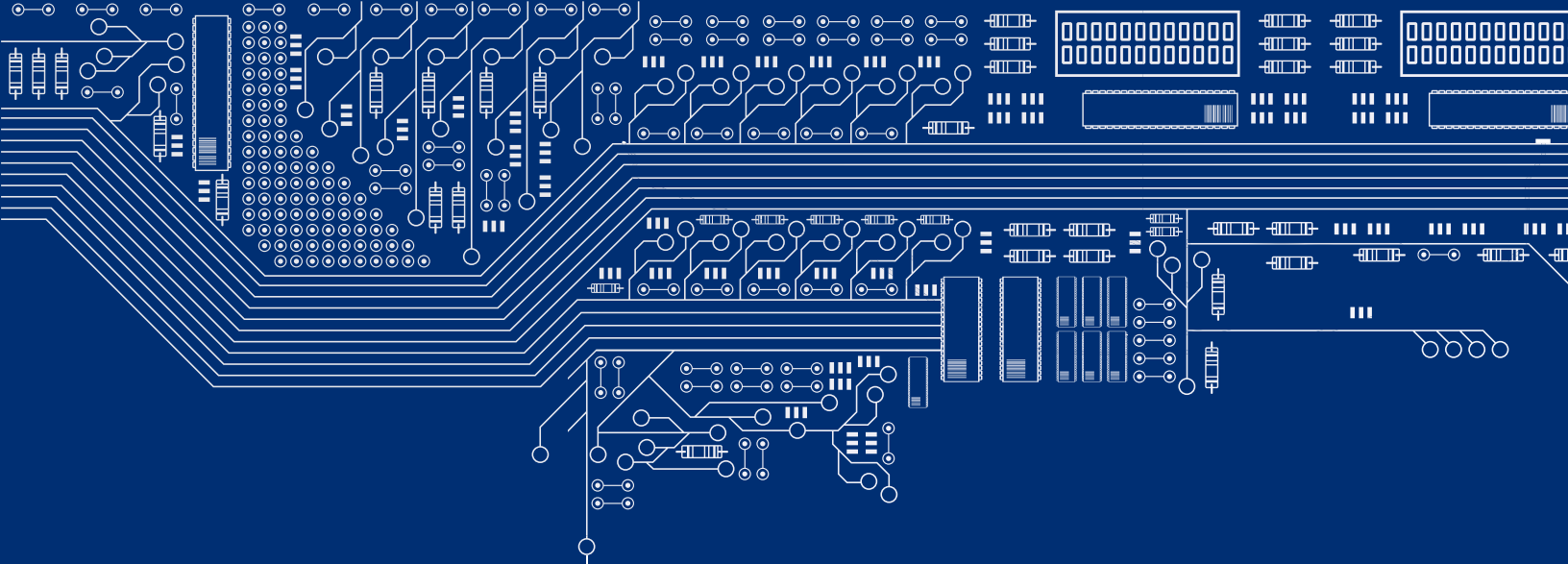

2019

UNIVERSITY OF PENNSYLVANIA

PRECISE Industry Day

Philadelphia, Pennsylvania
Friday, October 25th

https://precise-industry-day.seas.upenn.edu/2019/

WELCOME

Houssam Abbas	Oregon State University
Aiman Abdel-Malek	Thirdwayv
Ioannis Akrotirianakis	Siemens
Jose Araujo	Ericsson Research
Kiran Bharwani	Rivian
Laurent Borne	Stoneridge, Inc.
Arquimedes Canedo	Siemens Corporate Technology
Mauricio Castillo-Effen	Lockheed Martin Advanced Technology Laboratories
Jian Chang	Alibaba Group
Sanjian Chen	Alibaba Group
Rance Cleaveland	National Science Foundation & University of Maryland
Darren Cofer	Collins Aerospace
Byron Cook	Amazon Web Services
Brad Corrodi	Princeton Management Associates
Steve D'Ettore	PA Department of Community & Economic Developmen
Livio Dalloro	Siemens
Tom Damiano	Lockheed Martin Advanced Technology Labs
Jaclyn Davis	Delaware Valley Regional Planning Commission
Ken Delrossi	ExxonMobil
Biswadip Dey	Siemens Corporate Technology
Steve Drager	Air Force Research Laboratory
Michael Draugelis	Penn Medicine
Eduardo Fontes	Vanguard
Brett Garberman	Saucon
Luis Garcia	Northrop Gruman Corp.
Ross Gilson	RTI
Dagaen Golomb	Comcast
Anand Gopalan	Velodyne LiDAR, Inc.
Justin Gottschlich	Intel Labs
Vinod Grover	NVIDIA
Bill Hanson	Penn Medicine
Timothy Hu	Lockheed Martin Advanced Technology Laboratories
Rui Huang	Johnson & Johnson Corporate
Tyler Hunt	HYPR
Tim Kentley-Klay	HYPR
Andrew King	Zoox
Ross J Koppel	Univ of Penn
Balaji Krishnapuram	IBM Watson Health
Martin Kristjansen	Aalborg University, Denmark
Sanjeev Kumar	Lutron Electronics
Jean-Charles Lede	US Air Force
Steve Lemke	LG

Monika Lischke	Intel Corporation
Helen Loeb	Children Hospital of Philadelphia
James Lopez	GE
Ryan Marcus	MIT
Joel Markham	GE Research
Dave Marler	ExxonMobil
Mike Matturro	ExxonMobil
Eva McCauley	RTI
Stephen McGill	Toyota Research Institute - Risk Aware Driving Div.
William E McKeever Jr	Air Force Research Laboratory
Jonathan Mercurio	Lockheed Martin Advanced Technology Laboratories
Grant Meyer	Lockheed Martin Advanced Technology Laboratories
Chris Moye	CROSSMARK
Sandeep Neema	DARPA / U.S. Department of Defense
Hung Nguyen	Facebook, Inc.
Christopher Oster	Lutron Electronics
Achalesh Pandey	GE Global Research
Mukul Pandya	Wharton (Penn)
Rinku P. Parikh	DARPA
Luca Parolini	BMW AG
Steve Paschall	Amazon Robotics
Paul Pathikal	GGB
Paul Pazandak	RTI
Sandhya S. Pillalamarri	Insulet Corporation
Akshay Rajhans	MathWorks
Justinian Rosca	Siemens
Robie I. Samanta Roy	Lockheed Martin Advanced Technology Laboratories
Shilpa Sarode	Lutron Electronics
Jason Schlessman	Artificial Intelligence Center of Excellence at Red Hat (recently acquired by IBM)
Darren Schumacher	Stoneridge, Inc.
Lisa Kay Schweyer	Carnegie Mellon University
Shinichi Shiraishi	Toyota Research Institute - Advanced Development
Jingyong Su	Harbin Institute of Technology
Masumi Toyoshima	Denso International America
Sydney J Ulvick	Lockheed Martin Advanced Technology Laboratories
Dan Vander Valk	Lutron Electronics
Antonio Villafana	Correnty Consulting
Nurali Virani	GE Global Research
Ke Wang	Visa Research
Dan Wang	Comcast
Kim Wasson	Federated Safety, LLC
Jack Weast	Mobileye & Intel
Christina Werner	Daimler Trucks North America, LLC
Justin Wetherell	Nasdaq
Chris Woods	Siemens
Vivek Sriram Yenamandra-Guruvenkat	Siemens
Heather Yu	Futurewei
Tom Zajac	Jvion
Ding Zhao	Carnegie Mellon University
Qiming Zhao	Denso International America

AGENDA

8 - 8:30 am	Breakfast / Registration
8:30 - 8:40 am	Dean Vijay Kumar (Penn Engineering): Welcome
8:40 - 8:50 am	Insup Lee (Penn Engineering): Overview - PRECISE
8:50 - 9 am	Jim Weimer (Penn Engineering): PRECISE Outreach

SECTION 1

9 - 9:20 am	Jian Chang & Sanjian Chen (Alibaba Group): *Building an AI Engine for Time Series Data Analytics*
9:20 - 9:30 am	Rahul Mangharam (Penn Engineering): *Computer-Aided Design for Building Safe Autonomous Systems*
9:30 - 9:45 am	Jack Weast (Mobileye): *An Open, Transparent, Industry-Driven Approach to AV Safety*
9:45 - 10 am	Christina Werner (Daimler): *Automated Driving at Daimler Trucks*
10 - 10:10 am	George Pappas (Penn Engineering): *Safe Autonomy in the Wild*
10:10 - 10:25 am	Robie I. Samanta Roy (Lockheed Martin): *Autonomous Systems in the Aerospace and Defense Sector*
10:25 - 10:40 am	**Break**
10:40 - 11:40 am	PRECISE Students: 2-Minute Madness
11:45 - 1:15 pm	**Lunch / Poster Session**

KEYNOTE

1:30 - 2:30 pm	Justin Gottschlich (Intel Labs): *Machine Programming - The Future of Autonomy*
2:30 - 2:45 pm	**Break**

SECTION 2

2:45 - 2:55 pm	Linh Thi Xuan Phan (Penn Engineering): *Reliable and Secure Infrastructure for Autonomous Systems*
2:55 - 3:10 pm	Anand Gopalan (Velodyne Lidar): *Velodyne's Next Generation of Sensors & True Autonomy*

3:10 - 3:20 pm	Oleg Sokolsky (Penn Engineering): *Code Generation & Flexible Deployment for Runtime Monitoring*
3:20 - 3:35 pm	Jean-Charles Ledé (Air Force Research Laboratory): *Approach to Autonomy and AI development at the Air Force Research Lab*
3:35 - 3:45 pm	Joseph Devietti (Penn Engineering): *Feedback-Driven Processors*
3:45 - 4 pm	Vinod Grover (NVIDIA): *Improving Productivity and Performance for writing ML models*
4 - 4:10 pm	Rajeev Alur (Penn Engineering): *Syntax-Guided Synthesis*
4:10 - 4:25 pm	Byron Cook (Amazon): *Reasoning about Security of Amazon Web Services*
4:25 - 4:35 pm	Mayur Naik (Penn Engineering): *Continuous Static Analysis: Stopping the Next Security Vulnerability in its Tracks*
4:35 - 4:50 pm	**Break**

SECTION 3

4:50 - 5:10 pm	Aiman Abdel-Malek (Thirdwayv) & Sandhya S. Pillalamarri (Insulet): *Bridging the commercialization gap between Safe AI technology solutions and End-Users for Internet of Medical Things (IoMT)*
5:10 - 5:20 pm	Jim Weimer (Penn Engineering): *It works, but is it safe? - Verifying Autonomy in Healthcare and Automobiles*
5:20 - 5:35 pm	Rance Cleaveland (NSF): *Verification and Validation Issues in Machine-Learning and Control*
5:35 - 5:45 pm	Nikolai Matni (Penn Engineering): *Safe Vision Based Control*
5:45 - 6 pm	Steve Lemke (LG): *LG's Open Source Autonomous Driving Simulator*
6 - 6:15 pm	Justinian Rosca (Siemens Corp.): *Fail-Safe Architectures for Autonomous Guided Vehicles*
6:15 - 6:25 pm	Osbert Bastani (Penn Engineering): *Safety Certification and Shielding for Learning-Based Control*
6:25 - 6:40 pm	Darren Cofer (Collins Aerospace): *Ready, Fire, Aim! AI for Safety-Critical Systems*
6:40 - 6:55 pm	Mauricio Castillo-Effen (Lockheed Martin): *Trustworthy Autonomous Systems*
6:55 - 7 pm	**Closing**
7 - 8 pm	**Reception**

Machine Programming - The Future of Autonomy

PRECISE views Gottschlich as a major influencer in the field of safe autonomy, thanks to his groundbreaking work in advancing the unification of academia and industry collectively solve some of the most challenging technical issues facing the world today.

Gottschlich is a spearpoint when it comes to intelligent, safety-critical systems. His early work focused on algorithms, parallel and distributed computing, computer architecture, embedded systems, software/hardware efficiency, C/C++ systems optimization, software programability and productivity. Since then, Gottschlich's focus has shifted, and his more recent contributions are centered around intelligent, autonomous systems, with a strong emphasis on anomaly detection. His work in this area of research is considered, by many, to be the defacto standard in the industry, due to his expansive knowledge of the implementation of physical systems, and the significant impact of his innovations in the field.

Gottschlich constantly strives to leverage AI for the advancement and benefit of people and society. He represents a rare breed of researcher whose full-stack experience enables him to see problems in unique ways that elude other researchers. Leveraging this foresight, Gottschlich has become a force multiplier in the Assured Machine Learning community by coordinating with Intel to fund and actively participate in foundational and translative research focused on real-world problems plaguing AI systems. We believe their cutting-edge work will be critical to advancing the next generation of safe, intelligent systems. PRECISE is truly honored to host Dr. Justin Gottschlich as our Keynote Speaker for Industry Day 2019, and give him spotlight and recognition that he aptly deserves.

Justin Gottschlich

Inventor, Leader, and Visionary in Machine Programming

Keynote Speaker: Bio

Justin Gottschlich is a prominent figure in artificial intelligence (AI) and machine learning (ML). His research in AI focuses on deep learning, genetic algorithms, anomaly detection, ML verification, and autonomous systems. Currently, Gottschlich leads the machine programming (MP) research and vision across Intel. He also leads and co-founded the $6M Intel-NSF joint CAPA Research Center, which aims to simplify the programmability of heterogeneous computing. He has 30+ peer-reviewed publications and 30 issued patents, with ~80 patent applications pending, mostly in the space of ML and MP.

Much research and engineering must be done before autonomous systems, like autonomous vehicles (AVs), can be fully realized. Contrary to some AV experts' opinions, it is Gottschlich's belief that anomaly detection must advance significantly before we will reach level 4+ autonomy. He believes that the current state of the art is not nearly advanced enough to be used reliably and a level 3-only AV can put human lives at unnecessary risk. Sadly, this is partially why we have seen a rising number of tragic AV fatalities.

To help address this problem, in December 2018, Gottschlich et al. published a paper at NeurIPS '18, entitled "Precision and Recall for Time Series"[3] which re-defined the core mathematical foundation for the field of AD so the detection systems built using this new foundation could be more reliable, especially in the context of time series. To that end, Gottschlich's hope is that this work could be used to improve the general robustness of new AD systems and eventually save human lives. To date, this model has already been adopted by BMW, Intel, and Stanford.

In the same year, Gottschlich, along with his fellow collaborators at MIT, published "The Three Pillars of Machine Programming (MP),"[1] detailing the ground-breaking efforts that are leading to significant advancements in software development productivity by partially or fully-automating software development tasks that are currently performed manually. They lay down a blueprint of how to fully unlock the power of MP and provide a roadmap for its future evolution. Gottschlich's work in this area is significant because it is key to the strategic vision of several industry leaders (e.g., BMW, Amazon, Facebook, Microsoft). In fact, Facebook's creation of an AI-based tool to automate bug fixes in 2018[2] is an example of the "Adaptation Pillar" that Gottschlich wrote about in his paper.

Recent advancements in ML-centric computational hardware (e.g., GPUs, distributed computing, neural processors, etc.), key algorithmic discoveries and techniques, and the vast amount of learning data now available are some of the reasons why interest in MP has exploded and why Gottschlich is fascinated with this field of research.

In 2016, he co-founded the ACM Machine Learning and Programming Languages (MAPL) workshop, and subsequently has been the chair and the program chair of MAPL and TRANSACT. Previously, Gottschlich was the vice-chair of the C++ Standard Transactional Memory Working Group (SG5) during 2012 to 2014. In 2019, Gottschlich was named chairman of the MAPL steering committee.

Gottschlich has led major projects and collaboration initiatives at some of America's top corporations, startups, and research working groups. He oversees and guides several Intel-driven ML research projects at top universities such as Berkeley, Brown, MIT, Stanford, Texas A&M, and the University of Washington. He has mentored some of the smartest minds at America's top universities to solve the problem of how to effectively build software for diverse hardware architectures.

In the corporate realm, Gottschlich oversaw an industrial collaboration between Intel and BMW on anomaly detection for autonomous vehicles. Gottschlich was previously the director of engineering at Machine Zone, where he oversaw the development of the popular video games, Mobile Strike and Game of War. He is also the CEO of Nodeka, LLC, an online, multi-player software gaming company that he founded in 1999.

Between 2015 and 2018, Gottschlich has given 12+ presentations at conferences and seminars at BoostCon, BMW, IBM Research, Penn, VMWare Research, etc. He won the "Best Presentation" award at several conferences (Intel SWPC 2016, CGO 2010, and Raytheon ISaC 2009).

Gottschlich received his Ph.D. from the University of Colorado in Boulder, where he occasionally teaches a graduate-level course on neural networks. Last fall, at the University of Pennsylvania, he co-lectured a graduate-level course on anomaly detection for safe autonomy.

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[1]Justin Gottschlich, Armando Solar-Lezama, Nesime Tatbul, Michael Carbin, Martin Rinard, Regina Barzilay, Saman Amarasinghe, Joshua B. Tenenbaum, and Tim Mattson. 2018. The three pillars of machine programming. In Proceedings of the 2nd ACM SIGPLAN International Workshop on Machine Learning and Programming Languages (MAPL 2018). ACM, New York, NY, USA, 69-80. DOI: https://doi.org/10.1145/3211346.3211355

[2]Mike Wheatley, Facebook creates an AI-based tool to automate bug fixes, SiliconANGLE, 13 September 2018, https://siliconangle.com/2018/09/13/facebook-created-ai-based-tool-automate-bug-fixes/

[3]Nesime Tatbul, Tae Jun Lee, Stan Zdonik, Mejbah Alam, and Justin Gottschlich. 2018. Precision and recall for time series. In Proceedings of the 32nd International Conference on Neural Information Processing Systems (NIPS'18), Samy Bengio, Hanna M. Wallach, Hugo Larochelle, Kristen Grauman, and Nicolò Cesa-Bianchi (Eds.). Curran Associates Inc., USA, 1924-1934.

INVITED SPEAKERS

Mauricio Castillo-Effen

Lockheed Martin Advanced Technology Laboratories
"Trustworthy Autonomous Systems"

Mauricio Castillo-Effen is a Senior Researcher with the Emergent Technologies Laboratory (ETL), part of Lockheed Martin Advanced Technology Laboratories (LM ATL). He leads the Trustworthy Autonomous Systems (TAS) Focus Area, whose primary objective is to endow autonomous systems with high assurance qualities, such as: correctness, safety, security, and resiliency. His team collaborates with multiple Business Areas across the company solving challenges related to Verification and Validation, Test and Evaluation, and certification of high criticality systems. He also collaborates externally with industrial and academic researchers developing methodology and tools that capture advances in high assurance cyber physical systems, robotics, and AI, making them accessible to practitioners and engineers.

His background is in the areas of systems theory, control, and estimation applied to robotics, unmanned systems, and autonomy. His current research is centered on V&V, formal methods, and quantitative approaches to certification applied to high criticality software-intensive and AI-enabled systems. Aside from his daily job as an industrial researcher, Dr. Castillo-Effen has been an adjunct faculty member and a visiting researcher/lecturer at multiple academic institutions in the US and abroad. His work has been published in the form of patents, academic publications at conferences, journals, and books. He holds a Ph.D. from the University of South Florida, a M.Sc. from the University of San Simon/TU Delft, and a B.Sc. from the University of Applied Sciences of Hannover—all in Electrical Engineering.

ABSTRACT: Despite great advances and successful technology demonstrations in the fields of AI and robotics, when it comes to high criticality domains, many efforts seem to be contributing to a growing graveyard of autonomy technology. Because stakeholders and investors do not have the information necessary to assess risk and benefits objectively, they do not know when an autonomous system is fit for purpose. Assurance processes have helped creating air transportation systems, medical devices, and other safety critical systems with stellar records in safety and reliability. However, success may be ascribed to many factors, including conservatism and reliance on human qualities such as good judgment and "safety culture." Autonomy introduces complexity that cannot be addressed through prevailing assurance processes. At Lockheed Martin Advanced Technology Laboratories, we are working on solving for the gap between autonomy and assurance. In this talk, we will present an overview of the challenges and how they translate to specific technology gaps requiring joint efforts from academic and industrial research communities. We will also describe a vision for how assurance processes for autonomous system could look like in a not so distant future.

Rance Cleaveland

National Science Foundation and University of Maryland
"Verification and Validation Issues in Machine-Learning and Control"

Rance Cleaveland is the Director of the Computing and Communications Foundations (CCF) division within the Computing and Information Science and Engineering (CISE) directorate of the National Science Foundation. He is also a Professor of Computer Science at the University of Maryland at College Park (UMD), where his research focuses on formal methods for system verification. Prior to joining the UMD faculty in 2005, he held professorships at the State University of New York at Stony Brook and at North Carolina State University (NCSU). He is a co-founder of Reactive Systems, Inc., a company that makes model-based testing tools for embedded software, and a past recipient of National Young Investigator Awards from the National Science Foundation and the Office of Naval Research and the Alcoa Engineering Research prize from North Carolina State University. He has also won undergraduate teaching awards from UMD and NCSU. He has published over 150 papers in the areas of software and system verification and validation, formal methods, model checking, software specification formalisms, verification tools, software testing, and software architecture. Cleaveland received B.S. degrees (summa cum laude) in Mathematics and Computer Science from Duke University in 1982 and M.S. and Ph.D. degrees from Cornell University in 1985 and 1987, respectively.

ABSTRACT: System verification and validation (V&V) assume great importance in safety-critical settings, where a malfunctioning component or piece of software can lead to human injury and even death. As new technologies can also lead to safer and more robust systems, engineers are continually confronted with balancing the appeal of potentially safer technology with the possibility of unknown safety issues in incorporating it into their systems. This talk will focus on the use machine learning in the context of safety-critical feedback-control systems as an exemplar of this tension, and the implications it has for V&V. In particular, the presentation will highlight the appeal and potential pitfalls of machine learning in these systems, and suggest possible avenues, based on formal methods, for coping at design time with machine-learning-based control.

Darren Cofer

Collins Aerospace
"Ready, Fire, Aim! AI for Safety-Critical Systems"

Darren Cofer is a Fellow in the Trusted Systems group at Collins Aerospace. He earned his PhD in Electrical and Computer Engineering from The University of Texas at Austin.

His principal area of expertise is developing and applying advanced analysis methods and tools for verification and certification of high-integrity systems. His background includes work with formal methods for system and software analysis, the design of real-time embedded systems for safety-critical applications, and the development of nuclear propulsion systems in the U.S. Navy.

He has served as principal investigator on government-sponsored research programs with NASA, NSA, AFRL, and DARPA, developing and using formal methods for verification of safety and security properties. He is currently the principal investigator for Collins teams working on DARPA's Cyber Assured Systems Engineering (CASE) and Assured Autonomy programs.

Dr. Cofer served on RTCA committee SC-205 developing new certification guidance for airborne software (DO-178C) and was one of the developers of the Formal Methods Supplement (DO-333). He is a member of the RTCA Forum for Aeronautical Software, the Aerospace Control and Guidance Systems Committee (ACGSC), and a senior member of the IEEE

ABSTRACT: There has been much publicity surrounding the use of machine learning technologies in self-driving cars and the challenges this presents for guaranteeing safety. These technologies are also being investigated for use in manned and unmanned aircraft. However, machine learning algorithms and their software implementations are not amenable to verification and certification using current methods. This limits the functionality that can realistically be fielded, and essentially precludes use of these technologies in safety-critical aerospace applications. Our team is developing new technologies for analysis, testing, and architectural mitigation, with a goal of enabling autonomous systems to be safely deployed in critical environments.

INVITED SPEAKERS

Byron Cook

Amazon Web Services
"Reasoning about Security of Amazon Web Services"

Byron Cook is Professor of Computer Science at University College London (UCL) and Senior Principal Applied Scientist at Amazon Web Services. Byron's interests include computer/network security, program analysis/verification, programming languages, theorem proving, logic, hardware design, operating systems, and biological systems. Byron is the founder and leader of Amazon's Automated Reasoning Group (ARG).

ABSTRACT: This talk will discuss the development and use of formal verification within Amazon Web Services (AWS) to increase the security assurance of its cloud infrastructure and to help customers secure themselves. Topics will include cryptography, networking, policies, and virtualization. See https://aws.amazon.com/security/provable-security/ for a preview. I'll also discuss some remaining challenges that could inspire future research in the community.

Anand Gopalan, Ph.D.

Velodyne Lidar
"Next Generation of Sensors & True Autonomy"

Anand Gopalan is Velodyne LiDAR's Chief Technology Officer. In this capacity he is responsible for the advanced product development and technology development that will power Velodyne's next generation LIDAR products.

Gopalan is a seasoned technology executive with experience building and leading world-wide engineering organizations for the development of products in consumer, networking and enterprise domains. He has grown and managed organizations through deep and dynamic business model transitions and successfully delivered on a wide array of high-speed mixed signal, optical and RF products.

Gopalan comes to Velodyne from Rambus where he was the VP of Engineering responsible for all chip and IP development activities for the Memory and Interfaced Division. In that capacity he was responsible for a global engineering team spread across multiple locations in North America and India that developed a variety of IP and products for Tier 1 ASIC and OEM customers. Prior to Rambus Anand spear-headed world-wide analog/Mixed signal design at Megachips Inc.

Gopalan holds a BE degree in Electronics from Mumbai University as well as MS and PhD from the Rochester Institute of Technology in Electrical engineering and Microsystems engineering.

ABSTRACT: Gopalan will review the critical success factors Lidar technology must achieve for autonomous driving and advanced vehicle safety at highway speeds; and share insights on how their new thoroughly tested high-definition 3D Lidar provide millions more data points at highway speeds needed to enable advanced level 4 and level 5 autonomous vehicles. In this formative stage when the industry is highly focused on proving the safety case for autonomous vehicles, automakers need to focus on a perception system that provides the maximum amount of clean, measured, data points for a car to make the best judgements. There are special safety concerns for exceptional accuracy and reliability in systems when driving at highway speeds. Gopalan will address how his team is addressing these key challenges. After delving into technological performance metrics (including range, accuracy, and resolution), he will also examine reliability and scalability metrics needed to ensure automotive-grade dependability at production volumes required by automakers as well as consumers.

Vinod Grover

NVIDIA
"Improving Productivity and Performance for writing ML models"

Vinod Grover is a Director and Distinguished Engineer at NVIDIA. He has been with NVIDIA since 2007 where he led a team that developed the CUDA C++ language and compiler for programing GPUs. CUDA C++ has been a key catalyst in driving productivity, performance and innovation in many fields. Since 2017, Vinod has been focused on bringing the same productivity and performance to the problem of accelerating Deep Learning models by using important ideas from language design and compiler technology. He is currently leading a small group that is focused on problems of performance and productivity to the development of ML models. Previously Vinod held engineering, research and management positions at Sun Microsystems and Microsoft.
Vinod holds a Bachelor's degree in Physics from IIT Delhi and a Master's degree in Computer Science from Syracuse University.

ABSTRACT: Current deep learning frameworks are very powerful and expressive but hard to use productively and hard to optimize for high performance. Often it is very difficult to diagnose correctness and performance issues since these frameworks are layered on implementation artifacts like computation graphs. In this talk we present a programming model for deep learning which is based on ideas from functional programming and polyhedral compilation. Our programming model uses advanced type systems and shape inference to ease the task of writing robust and correct deep learning models. The model also enables modular construction of complex models from simpler ones and is amenable to polyhedral optimization which is a mathematical abstraction for expressing complex optimizations.

Jean-Charles Ledé

Air Force Research Laboratory
"Approach to Autonomy and AI development at the Air Force Research Lab"

Mr. Ledé joined the Air Force Research Laboratory as the Commander's Autonomy Technical Advisor in July 2018. In this role Mr Ledé oversees the entire AFRL Autonomy and AI portfolio and makes recommendation on new programs leveraging internal and external research. Mr Ledé is the senior Air Force representative in the OSD Autonomy Community of Interest, and currently serves as its chair. Prior to these positions, Mr. Ledé was a Program Manager at DARPA within the Tactical Technology Office and the Defense Sciences Office. Starting in 2013, he led multiple autonomy programs including Collaborative Operations in Denied Environment (CODE) aimed at increasing the capabilities of existing unmanned systems via heterogeneous teaming at the tactical edge, the Fast Lightweight Autonomy (FLA) program to enable autonomous navigation of small quadcopters in complex environment with no external sensing (including GPS) and no a priori knowledge, the Centralized Control of Commercial Drones (C3D) that provides a safe and effective mean of controlling multiple commercial UAS. Mr Ledé also led several classified programs focused on reducing the time and cost while improving performance of UAS, as well as several counter UAS programs. In addition, Mr Ledé developed several critical technologies to enable novel aircraft configurations including new aerodynamic effectors, new motors, and other subsystems (radios, sensor payloads, advanced fuel).

Prior to joining DARPA, Mr. Ledé was the Director for Autonomous/Unmanned Systems at Raytheon Missile Systems, where he provided a vision for innovative autonomous systems concepts and products and oversaw the development of a miniature strike weapon. Before working at Raytheon, Mr. Ledé held multiple positions with Aurora Flight Sciences Corporation, ultimately becoming Vice President for Advanced Concepts. At Aurora, he focused on rapid prototyping and the development of new unmanned air vehicle concepts.

ABSTRACT: The presentation will give a brief overview of the approach the Air Force Research Laboratory is using to operationalize Autonomy and AI and make these critical capabilities available more broadly and rapidly.

INVITED SPEAKERS

Steve Lemke

LG
"Open Source Autonomous Driving Simulator"

Steve Lemke is a principal engineer with the Advanced Automotive Platforms team at the Silicon Valley Lab of LG's America R&D Center. Steve works with several open source autonomous and automotive platform projects at LG including the LGSVL Autonomous Driving Simulator, WebOS Open Source Edition, and Automotive Grade Linux. He recently led efforts to bring together various projects from advanced user interface to 3D automotive and autonomous simulation as well as connected car cloud services to create automotive demos which were featured in the AGL Demo Showcase at CES 2018 and 2019. Prior to that he spent a decade building and supporting the web OS platform at HP and LG, and another decade before that building developer tools for the Palm OS platform.

ABSTRACT: Autonomous Vehicles are in the news every day but there is still a long road ahead for the companies working on them. Autonomous Vehicle (AV) simulation will play a huge role in the testing and certification of AV technology and is also a critical engineering tool used in the daily development and testing of AV technology. Professional but proprietary automotive simulation tools can cost $100,000 USD, and while open source simulators are also available, most have limited functionality and require a great deal of custom programming in order to integrate them with autonomous driving software.

The LGSVL Simulator (including the required 3D models, high definition maps, and photo-realistic digital environments) changes all of that. Designed and built by autonomous engineers in LG's Silicon Valley Lab, the LGSVL Simulator has built-in support for popular open source AV software stacks like Autoware and Apollo, and with ROS and ROS2 support, it can easily integrate with other proprietary driving software. In addition, it's free and because it's open source it's easy for engineers to adopt and extend it for their own needs (as many have already), rather than starting from scratch to build their own.

Justinian Rosca

Siemens Corp.
"Fail-Safe Architectures for Autonomous Guided Vehicles"

Justinian Rosca is Senior Key Expert of Siemens Corp., Corporate Technology in Princeton NJ. He holds Ph.D. and M.Sc. degrees Computer Science from the University of Rochester and a Dipl. Eng. Degree in Computer and Control Engineering from the Polytechnic University Bucharest. Dr. Rosca is also an Affiliate Researcher at Princeton University, Electrical Engineering Department and was Affiliate Professor at the University of Washington, Electrical Engineering Department, from 2008 to 2011. He obtained a certificate in executive management for innovation, from the University of Pennsylvania, Wharton School of Business.

Dr. Rosca's primary research interests span statistical signal processing, machine learning, probabilistic inference, artificial intelligence, sensing and communication, with an emphasis on embedded intelligence in autonomous systems. Dr. Rosca holds over 60 patents, 100 publications in the areas of signal processing, machine learning, communications, adaptive systems, and co-authored two books in mathematics and signal processing. His scientific contributions were transferred into a variety of products such as microphone array technologies for speech enhancement in hearing aids and mobile phones, adaptive multimedia wireless network management, connected and autonomous vehicles, and run-time edge intelligence in industry. These contributions earned him multiple Siemens business awards. He served as program chair of the 6th Independent Component Analysis and Blind Signal Separation International Conference, chair of the Neural Information and Processing Systems workshop on Sparse Representations in Signal Processing, and recently as chair of the Data Challenge 2015, 2016 and 2017 competitions of the Prognostics and Health Management Society.

Continue...

ABSTRACT: Humans are heavily involved in inspection, transport, navigation and delivery activities around the shop floor where flexibility is paramount, such as in robotic inspection or delivery of parts and tools with transportation vehicles. Currently, two main driverless transportation vehicle types are considered in the industry (at two different ends, and everything in between): automated guided vehicles (AGV) and self-driving vehicles (SDV). AGVs move over fixed paths in a highly controlled manner, utilizing predefined paths, beacons, magnetic tape, barcodes, etc. There is little decision making based on the live environment around the vehicle other than the safety stop. On the other hand, SDVs and other types of mobile robots operating in semi-structured environments with trained personnel, rely heavily on advances in Artificial Intelligence to self-drive or move in a less constrained manner, understand their environment and react in real time. They exploit rich information received from their environment by leveraging sensors (lasers, wheel encoders, infrared detectors, high resolution RGB-Depth cameras, etc.). Present mobile robots carrying parts and tools can achieve large speeds (5-10m/s) and thus project danger under the prospect that the robot hits a person. They would adapt movement speed to the level of human agility (0-2 m/s) depending on the perception of human activity and possible contact situations with a person within the robot's envelope. The need for AGVs to operate safely without human intervention while increasing the trust of human operators is a significant ongoing challenge. This talk will address fail-safe architectures for AGVs in the wider sense of the AGV acronym referring to autonomous, self-driving systems and techniques for ensuring human and material safety during autonomous operation. While safety-related parts of control systems are traditionally locked at design and implementation time, we will discuss how these could be adapted based on experience, what is a sufficiently powerful formulation to include safety during the learning process, and what new challenges it brings in adopting such approaches today.

Robie I. Samanta Roy

Lockheed Martin
"Autonomous Systems in the Aerospace and Defense Sector"

Robie I. Samanta Roy is the Vice President for Technology at Lockheed Martin Government Affairs where he is responsible for supporting corporate engagements with the US Government S&T community across the United States. From 2014-2019, Dr. Samanta Roy was the corporate Vice President for Technology Strategy and Innovation under the Chief Technology Officer where he: 1) developed and provided technical intelligence and strategy for the corporation; 2) engaged the global S&T ecosystem outside the corporation – including government labs, universities, large and small businesses, and startups; and 3) fostered cross-enterprise innovation within the corporation as well as external innovation activities.

Prior to joining Lockheed Martin, Dr. Samanta Roy was a professional staff member with the Senate Armed Services Committee from 2010 to 2014 with the portfolio of the Department of Defense's wide spectrum of science and technology-related activities including test and evaluation. He came to that position from the White House Office of Science and Technology Policy where he was the assistant director for Space and Aeronautics from 2005 to 2009 and was responsible for space and aeronautics activities ranging from human space flight to the Next Generation Air Transportation System. Dr. Samanta Roy previously served as a Strategic Analyst at the Congressional Budget Office and as a Research Staff Member in the Systems Evaluation Division of the Institute for Defense Analyses in Alexandria, Virginia.

Dr. Samanta Roy earned his Bachelor of Science, Master of Science and Ph.D. degrees in aeronautics and astronautics from MIT. He earned a master's degree in space policy from George Washington University and diplomas from the International Space University and Institut d'Etudes Politiques de Paris.

Dr. Samanta Roy is a Fellow and member of the Board of Trustees of the American Institute of Aeronautics and Astronautics and a member of the National Research Council's Aeronautics and Space Engineering Board. He also chairs the Industry Relations Committee of the International Astronautical Federation and is on the FAA's Drone Advisory Committee. Dr. Samanta Roy continues to serve in the U.S. Air Force Reserve.

ABSTRACT: Autonomous systems in the Aerospace and Defense (A&D) sector cover a broad range of missions and domains from spacecraft-asteroid rendezvous where distances from earth are such that real-time communication is not possible to helicopter search and rescue (SAR) missions in harsh and challenging weather environments where pilots need to rely on autonomy to avoid fatal controlled flight into terrain. These autonomous systems compose, select and execute courses of action with varying levels of human interaction to ultimately aid humans to accomplish complex tasks and missions. Increasingly, Artificial Intelligence/ Machine Learning (AI/ML) capabilities are being considered to address these complex missions as well as to evaluate collaboration between multiple systems. Across the spectrum of systems and missions, there

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is also a variable level of determinism to be considered. Systems can range from fully deterministic such as autopilot flight controls to highly non-deterministic such as command and control systems that learn and respond to dynamic environments and tasking.

A key challenge in the A&D sector is for both operators and the test and evaluation (T&E) and safety communities to develop "trust" in these highly complex integrated hardware/software systems [of systems]. The A&D community approaches trust at both the individual human operator/partner level and at the organizational level. Both need to be able to assume an autonomous system will operate as expected. At the organizational level, the T&E community needs the appropriate verification and validation (V&V) methodologies and tools to certify and approve the system. Likewise, the safety community needs the system to work within an existing or evolving regulatory framework. In addition, these communities are facing pressures between maintaining high levels of safety within growing markets and technology developments on the international level.

Today, the T&E and safety communities are focusing on fully deterministic systems, but are acutely aware of the need to address increasing non-determinism in the near future driven by the rapid expansion of applications of AI/ML and the supporting high performance computational (HPC) infrastructure. To increase the ability of these communities to accept and certify autonomous systems, current systems engineering approaches need to be bolstered with additional methodologies in the requirements and V&V phases. The complexity of the challenge requires context-specific integration of approaches ranging from formal methods to large scale synthetic simulation. Ultimately, as with any new technology, the regulatory community need to feel comfortable with the technologies and approval processes and it is incumbent on the developmental community to work hand in hand with them.

Jack Weast

Intel

"An Open, Transparent, Industry-Driven Approach to AV Safety"

Jack Weast is the VP Autonomous Vehicle Standards at Mobileye; he is also a Sr. Principal Engineer at Intel. In his nearly 20 year career at Intel, Jack has built a reputation as a change agent in new industries with significant technical contributions to a wide range of industry-first products and standards in complex heterogeneous high performance compute solutions in markets that are embracing high performance computing for the first time. With an End to End Systems perspective, Jack combines a unique blend of embedded product experience with a knack for elegant Software and Systems design that will accelerate the adoption of Autonomous Driving. Jack has a BS/MS in Computer Science, is an Adjunct Professor at Portland State University. He is the co-author of "UPnP: Design By Example", and is the holder of 23 patents with dozens pending.

ABSTRACT: At Intel and Mobileye, saving lives drives us. But in the world of automated driving (AD), we believe safety is not merely an impact of AD, but the bedrock on which we all build this industry. And so we proposed Responsibility-Sensitive Safety (RSS), a formal (open/non-proprietary) model to define safe driving and what rules an automated vehicle, independent of brand or policy, should abide to always keep its passengers safe.

Christina Werner

Daimler Trucks North America, LLC
"Automated Driving"

After receiving a Master's degree in Information Systems from the Dresden University of Technology in Germany, Christina Werner joined Daimler AG and took over an assignment in developing the damage brake assist for Mitsubishi Fuso in Japan. This is when Christina discovered her passion for active safety systems, which can reduce traffic accidents and save lives. After various projects in the field of driver assistance systems, she is now a manager at the Daimler Trucks Automated R&D Center in Portland, OR. Christina and her team are engineering a vehicle platform, which is perfectly suited for highly automated driving.

ABSTRACT: As a leader of our industry, Daimler Trucks has been pioneering automated trucking. We have launched the first partially automated new Freightliner Cascadia in 2019 – and next, we tackle highly automated trucks. Highly automated trucks will improve safety, boost the performance of logistics and offer a great value proposition to our customers – and thus contribute considerably to a sustainable future of transportation. In this talk the following key points will be addressed: Why does vehicle automation make sense? What are the challenges of Level 4 automated driving? How will redundant vehicle systems provide the maximum level of reliability and safety?

Aiman Abdel-Malek
Thirdwayv &
Sandhya S. Pillalamarri
Insulet Corporation

"Bridging the commercialization gap between Safe AI technology solutions and End-Users for Internet of Medical Things (IoMT)"

Dr. Aiman Abdel-Malek served as the Executive Vice President and Chief Technology Officer at Insulet Corporation (NASDAQ: PODD) since February 2018. From March 2016 to February 2018, he was Insulet's Senior Vice President, Advanced Technology and Engineering. At Insulet, Aiman's vision for a securely connected diabetes management system, controlled by users' smartphones, was realized. Under his leadership, Insulet developed, FDA cleared and market launched the "DASH" digital products platform. This product was the first secure Bluetooth connected diabetes management system platform, controlled by smartphone. DASH was also recognized as the first Insulin pump to receive DTSec Cybersecurity Certification in diabetes. Prior to joining Insulet, Aiman served as President of Frictionless Life Analytics, Inc., a business development and healthcare technology advisory company which enables the growth of start-up ventures focused on Internet of Things (IoT) platforms and solutions. From 2012 to 2015, Dr. Abdel-Malek served as Vice President of Engineering at Qualcomm Life, Inc., a mobile healthcare solutions Qualcomm company. From 1988 to 2012, he held various roles at General Electric (GE), including General Manager - Global Services Technology at GE Healthcare where he launched the first GE Healthcare predictive software services offerings. Dr. Abdel-Malek brings over 20 years of experience as a senior executive, leading healthcare business teams to develop breakthrough technology-based business solutions to many healthcare issues globally. He holds a Bachelor of Science in Systems and Biomedical Engineering from Cairo University and a Ph.D. in Biomedical Engineering from the University of Southern California. Dr. Abdel-Malek holds over 30 patents and publications and is a keynote speaker at various digital healthcare, secure IoT and mobile digital healthcare forums.

Sandhya Pillalamarri is an experienced leader in User Experience and Product Design of B2C and B2B connected devices, IoT, enterprise and SaaS technology and responsive mobile application development. Sandhya specializes in human-computer interaction and user experience research and design with over 16 years spent leading creative teams on highly visible programs within various industry verticals. She enjoys strategizing, managing and executing next-generation products through to completion by working through the iterative lifecycle of user research, ideation, design, usability analysis and implementation, to deliver product experiences that are useful, usable, and delightful. Sandhya has written for and spoken at several trade conferences, journals and other publications such as JDST, IA Summit, CHI, UXPA, ADA, HIMSS, Stanford Radiology Symposium and Web 2.0 Expo. Sandhya has experience working for several industry verticals such as medical devices, consumer devices, high-tech, education, emerging markets and consumer lifestyle and service design. Most recently, Sandhya was the Senior Director of User Experience COE at Insulet Corporation where she led a talented team of designers, researchers, prototypes, technical writers, content strategists and other UX professionals delivering ubiquitous, cross-platform value to people and caregivers living with diabetes. Prior to Insulet, she worked as the head of user experience at Dell Cloud Manager, director of user experience design at Pearson Education, director of enterprise user experience at Parametric Technology Corporation, senior design researcher at Philips Design, global usability lead at GE Healthcare, among others. Sandhya works to create new value for users by ensuring that products deliver meaningful and valuable moments, build brand equity,

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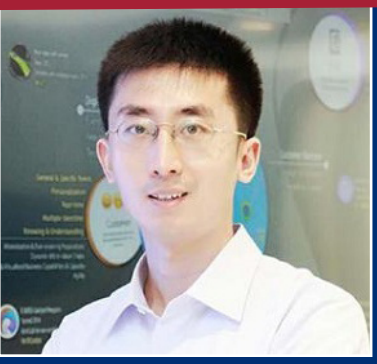
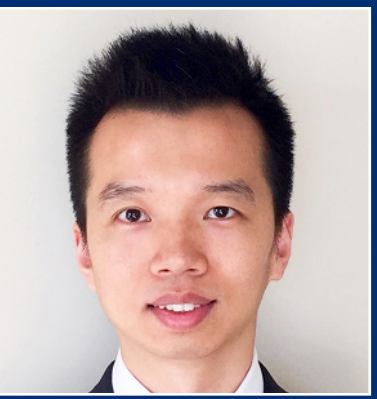
and deliver delightful interactions thereby creating social good to the marketplace. Sandhya holds a Masters in Management in General Management, Operations, and Strategy from Harvard University, a Masters in Human-Computer Interaction from Carnegie Mellon University, and a Bachelor of Science in Computer Science Engineering from Arizona State University.

ABSTRACT: Care of chronic medical conditions benefits from and is beginning to leverage rapid technological advances in consumer smartphone connectivity and cloud-centric IOT, subsequently removing friction out of patients' and providers' daily lives. The new "continuous" vs. old "episodic" care data, liberated as a result, provides rich insights through AI and machine learning. "Pervasive Data Security" and "Human Centered Design" are essential elements in the development of safe AI medical solutions (such as an artificial pancreas system) - elements that are essential components to the successful commercialization of systems that address the needs of a spectrum of care stakeholders. In this fireside chat, we will explore the "what" and the "how" for implementing these two critical and strategic elements in the development of commercially viable Safe AI Connected Medical Systems.





Jian Chang & Sanjian Chen

Alibaba Group
Joint presentation –
"Building an AI Engine for Time Series Data Analytics"

Jian Chang is a Staff Algorithm Expert at the Alibaba Group, where he is working on cutting-edge applications of AI at the intersection of high-performance databases and the IoT, focusing on unleashing the value of spatiotemporal data. As a data science expert and software system architect with expertise in machine learning and big data systems and deep domain knowledge on various vertical use cases (finance, telco, healthcare, etc.), Jian has led innovation projects and R&D activities to promote data science best practices within large organizations. He's a frequent speaker at technology conferences, such as the O'Reilly Strata and AI Conferences, NVIDIA's GPU Technology Conference, Hadoop Summit, DataWorks Summit, Amazon re:Invent, World IoT Expo, and has published and presented research papers and posters at many top-tier conferences and journals. Jian holds a PhD from the Department of Computer and Information Science at University of Pennsylvania.

Sanjian Chen is a Staff Algorithm Expert at the Alibaba Group. He is currently working on building cutting-edge cloud-based AI engines for high-performance distributed database systems that support scalable data analytics in multiple business areas. Sanjian is an expert in data-driven modeling with deep domain knowledge in several verticals. He has designed analytic solutions that drove numerous high-value business decisions for multiple Fortune 500 companies across different industries, including retail, finance, automotive, and telecommunications. He is a frequent invited speaker at top international conferences, such as the Strata Data Conference, the O'Reilly AI Conference, DataWorks Summit, the IEEE CPS Week, the IFAC ADHS Conference, and the IEEE ICHI Conference. Sanjian received a Ph.D. in Computer and Information Science from the University of Pennsylvania. He has received two IEEE Best Paper Awards (IEEE RTSS 2012 and IEEE ISORC 2018) and published over 25 papers in top conferences/journals, including 2 articles published in the Proceedings of IEEE.

ABSTRACT: Time series database is of great use for data management in IoT, retail, finance, and many other domains. Alibaba's TSDB is a time series database that provides effective and economical services to business users. So far, we were able to scale our service to thousands of physical nodes and deliver peak performance at 80 million operations per second. Our experiences in building and operating TSDB significantly impact the industry best practice of time series data management. TSDB can empower companies across various industries to better understand data trends, discover anomalies, manage risks, and boost efficiency. We believe the audience can learn valuable experiences from our story to be prepared for the zettabytes-scale IoT world in the years to come.

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Inside the Alibaba ecosystem, hundreds of petabytes of time-series data are generated each day. As the data grows rapidly, it becomes a challenge to query such data in a timely manner. TSDB is the backbone service for hosting all these data to enable high-concurrency storage and low-latency query. The AI Engine in TSDB provides intelligent advanced analysis capabilities and end-to-end business intelligence solutions.

In this talk, we will discuss the design of the AI engine built on Alibaba's TSDB service, which enables fast and complex analytics of large-scale time-series data in many business domains. We will highlight our solutions to the major technical challenges in data storage, processing, feature engineering and machine learning algorithm design. We believe both technical and business audiences will be able to learn valuable experiences and insights from our success story.

PRECISE

PENN RESEARCH IN EMBEDDED COMPUTING AND INTEGRATED SYSTEMS ENGINEERING

Rajeev Alur
Syntax-Guided Synthesis

Rajeev Alur is Zisman Family Professor of Computer and Information Science at University of Pennsylvania. He obtained his bachelor's degree in computer science from IIT Kanpur in 1987 and PhD in computer science from Stanford University in 1991. He is a Fellow of the AAAS, ACM, and IEEE, an Alfred P. Sloan Faculty Fellow, and a Simons Investigator. His awards include the inaugural CAV (Computer-Aided Verification) award, ACM/IEEE Logic in Computer Science Test-of-Time award, the inaugural Alonzo Church award, and Distinguished Alumnus Award by IIT Kanpur. Prof. Alur has served as the chair of ACM SIGBED (Special Interest Group on Embedded Systems), and the lead PI of the NSF Expeditions in Computing center ExCAPE (Expeditions in Computer Augmented Program Engineering). He is the author of the textbook Principles of Cyber-Physical Systems (MIT Press, 2015).

ABSTRACT: Emerging research shows that program synthesis and machine learning can play mutually beneficial roles to transform the way we build software. The goal of program synthesis is to allow programmers to specify the desired computation in intuitive ways without having to write traditional code. We will share our framework as a unifying formalization of the computational problem common to a wide range of synthesis problems such as program optimization, program repair to fix security vulnerabilities, and learning programs from examples.

Osbert Bastani
Safety Certification and Shielding for Learning-Based Control

Osbert Bastani received his A.B. in Mathematics from Harvard University. He earned his Ph.D. in Computer Science from Stanford University in 2017 after which he became a Postdoctoral Fellow in CSAIL at MIT. He is broadly interested in machine learning and programming languages research. Recently, Osbert has been working on developing algorithms for ensuring correctness of machine learning models. These models are increasingly used in real world systems where failures can be catastrophic, such as autonomous vehicles, medical diagnosis, and legal decision making.

ABSTRACT: As software systems increasingly incorporate machine learning components, new approaches are needed to ensure the robustness and safety of these systems. These challenges are particularly relevant for learning-based control, where machine learning is used to control safety-critical systems. In this context, our "Model Predictive Shielding" and "VIPER" algorithms ensures safety of learning-based controllers; the former does so by checking that the controller can always recover to a safe position, while the latter learns models that are far easier to verify than deep neural networks.

Joseph Devietti
Feedback-Driven Processors

Joseph Devietti is an Assistant Professor in the Department of Computer & Information Science at the University of Pennsylvania. His research focuses on making parallel computers easier to program, leveraging techniques across the computing stack, including computer architecture, compilers, runtime systems and programming languages. He was awarded an Intel Early Career Faculty Honor in 2013, and the Radhia Cousot Young Researcher Best Paper Award at SAS 2018. He earned his PhD in Computer Science & Engineering from the University of Washington in 2012.

ABSTRACT: As computer architectures become ever more complex and heterogenous, optimizing for each platform becomes increasingly difficult. Our "Feedback-Driven Processors", which uses performance counter data from live executions to discover performance bugs and automatically repair them, will allow programs to adapt to their current platform and run-time conditions without needing programmer effort.

Insup Lee
PRECISE Overview

Insup Lee is Cecilia Fitler Moore Professor of Computer and Information Science, Co-Director of Penn Health Tech since 2017, and Director of PRECISE Center since 2008 at the University of Pennsylvania. He also holds a secondary appointment in the Department of Electrical and Systems Engineering. He received his B.S. from UNC-Chapel Hill and Ph.D. from UW-Madison.

His research interests include cyber-physical systems, real-time and embedded systems, safe autonomy, runtime assurance and verification, internet of medical things, and connected health. The theme of his research activities has been to assure and improve the safety, security, and timeliness of life-critical embedded systems. His co-authored papers received the paper awards in IEEE RTSS 2003, CEAS 2011, IEEE RTAS 2012, IEEE RTSS 2012, ACM/IEEE ICCPS 2014, IEEE CPSNA 2016, IEEE ISORC 2018, and IEEE RTAS 2019. His group received the RV Test-of-Time Award, Runtime Verification 2019.

He has served on many program committees and chaired many international conferences and workshops. He has also served on various steering and advisory committees of conferences and technical societies, and the editorial boards of many scientific journals. He was Chair of IEEE Computer Society Technical Committee on Real-Time Systems (2003-2004) and an IEEE CS Distinguished Visitor Speaker (2004-2006). He is Chair of ACM SIGBED (2015-2019). He received IEEE TC-RTS Outstanding Technical Achievement and Leadership Award in 2008. He is ACM fellow and IEEE fellow.

Rahul Mangharam
Computer-Aided Design for Building Safe Autonomous Systems

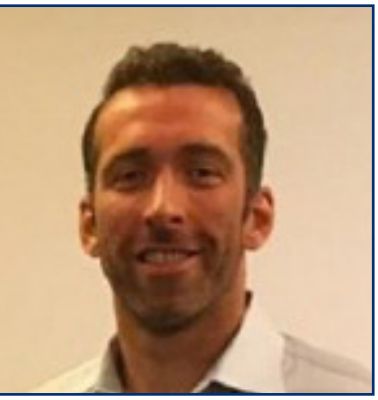
Rahul Mangharam is an Associate Professor in the Department of Electrical and Systems Engineering at the University of Pennsylvania. He is a founding member of the PRECISE Center and directs mLAB - Real-Time and Embedded Systems Lab at Penn. His interests are in cyber-physical systems which involves the tight coupling of communication, computation and control with physical systems. His current focus is on applications at the intersection of formal methods, machine learning and controls within medical devices, energy efficient buildings, automotive systems and industrial wireless control networks.

Rahul received the 2016 US Presidential Early Career Award (PECASE), the 2014 IEEE Benjamin Franklin Key Award, 2013 NSF CAREER Award, 2012 Intel Early Faculty Career Award and was selected by the National Academy of Engineering for the 2012 and 2018 US Frontiers of Engineering.

Rahul's group has won several awards: 2018 IEEE International Conference on Cyber-Physical Systems Best Paper Award, 2017 American Controls Conference Best Paper Award for Energy Systems, 2016 DoE CleanTech Prize (Regional), SRC TECHCON 2015, IPSN 2012, RTAS 2102, Intel Innovators Award 2012, World Embedded Programming Competition 2012 and 2010, Honeywell Industrial Wireless Award 2011, and Google Zeitgeist Award 2011.

Rahul received his Ph.D. in Electrical & Computer Engineering from Carnegie Mellon University where he also received his MS and BS. In 2002, he was a member of technical staff in the Ultra-Wide Band Wireless Group at Intel Labs. He was an international scholar in the Wireless Systems Group at IMEC, Belgium in 2003. He has worked on ASIC chip design at FORE Systems (1999) and Gigabit Ethernet at Apple Computer Inc. (2000). He was the Stephen J. Angelo Term Chair Assistant Professor at the University of Pennsylvania from 2008-2013. He holds a secondary appointment in the Department of Computer and Information Sciences.

ABSTRACT: Autonomous vehicles (AVs) have already driven millions of miles on public roads, but even the simplest maneuvers such as a lane change or vehicle overtake have not been certified for safety. Current methodologies for testing and verification of Advanced Driver Assistance Systems such as Adaptive Cruise Control cannot be directly applied to determine AV safety as the AV actively makes decisions using its perception, planning and control systems for both longitudinal and lateral motion. These systems increasingly use machine learning for which it is fundamentally hard to derive safety guarantees across a range of driving scenarios and environmental conditions. New approaches are needed to bound and minimize the risk of AVs to assure the public, determine liability and insurance pricing and ensure the long-term growth of the domain. Our autonomous vehicle computer-aided design (AV-CAD) toolchain will capture formal descriptions of driving scenarios in order to develop AV safety cases. The use of synthetic environments and real DoT traffic feeds will also be demonstrated to evaluate machine learning and decision control algorithms for future AVs. Be prepared to see lots of AV crashes and how AV-CAD is used for testing and verification in building safe autonomous vehicles.



Nikolai Matni
Safe vision based control

Nikolai Matni is an assistant professor in the Department of Electrical and Systems Engineering at the University of Pennsylvania, where he is also a member of the GRASP Lab, PRECISE Center, and Applied Mathematics and Computational Science graduate group. Prior to joining Penn, Nikolai was a postdoctoral scholar in EECS at UC Berkeley. He has also held a position as a postdoctoral scholar in the Computing and Mathematical Sciences at Caltech. He received his Ph.D. in Control and Dynamical Systems from Caltech in June 2016. He also holds B.A.Sc. and M.A.Sc. in Electrical Engineering from the University of British Columbia, Vancouver, Canada. His research interests broadly encompass the use of learning, optimization, and control in the design and analysis of safety-critical AI-driven cyber-physical systems. Nikolai was awarded the IEEE CDC 2013 Best Student Paper Award (first ever sole author winner) and the IEEE ACC 2017 Best Student Paper Award (as co-advisor).

ABSTRACT: From self-driving cars to personalized robotics, autonomous systems must rely on high-dimensional and complex sensing modalities such as cameras to perceive, interpret, and act up on the world. In this talk, I will share recent progress towards certifying the safety, robustness, and performance of such vision based control systems. In particular, I will argue that when the dynamics of the underlying system are known, as is often the case, vision should be used for localization, and can be modeled as a noisy position sensor characterized by a simple data-driven error profile, allowing us to leverage tools from robust control to synthesize a vision based control policy with provable safety guarantees

Mayur Naik
Continuous Static Analysis: Stopping the Next Security Vulnerability in its Tracks

Mayur Naik is an Associate Professor of Computer Science at the University of Pennsylvania. His research spans all aspects of programming systems with the goal of improving software quality and programmer productivity. His current focus is developing advanced programming systems that effectively combine the power of humans, computers, and data. He holds a Ph.D. in Computer Science from Stanford University (2008). He was a researcher at Intel Labs, Berkeley from 2008 to 2011, and a faculty of Computer Science at Georgia Tech from 2011 to 2016. He is a recipient of Georgia Tech's Lockheed-Martin Teaching Excellence Award (2015) and an NSF CAREER award (2013). He also received an ACM SIGPLAN Distinguished Paper Award at PLDI 2014 and ACM SIGSOFT Distinguished Paper Awards at FSE 2014 and ICSE 2009.

ABSTRACT: The remarkable benefits of static analysis at finding security vulnerabilities and harmful bugs early in the software development process are offset by long-standing challenges in aspects such as accuracy, scalability, and generalizability. I will describe how to address these challenges by making static analysis continuous, in three senses of the word: 1) seamlessly combining discrete and continuous modes of logical reasoning in static analysis, 2) deploying static analysis in continuous integration/deployment (CI/CD) settings, and 3) continuously improving and adapting static analysis over time with weak or no supervision.

George Pappas
Safe Autonomy in the Wild

George J. Pappas is the UPS Foundation Professor and Chair of the Department of Electrical and Systems Engineering at the University of Pennsylvania. He also holds a secondary appointment in the Departments of Computer and Information Sciences, and Mechanical Engineering and Applied Mechanics. He is member of the GRASP Lab and the PRECISE Center. He has previously served as the Deputy Dean for Research in the School of Engineering and Applied Science. His research focuses on control theory and in particular, hybrid systems, embedded systems, hierarchical and distributed control systems, with applications to unmanned aerial vehicles, distributed robotics, green buildings, and biomolecular networks. He is a Fellow of IEEE, and has received various awards such as the Antonio Ruberti Young Researcher Prize, the George S. Axelby Award, the O. Hugo Schuck Best Paper Award, the National Science Foundation PECASE, and the George H. Heilmeier Faculty Excellence Award.

ABSTRACT: Our research strives to provide safety guarantees for autonomous systems operating in unknown environments. This is accomplished by developing novel methods for semantic mapping of unknown environments (Semantic SLAM) followed by safe planning in learned environments. Our software tools leads to higher assurance autonomy which provide guarantees that integrated control loops, reasoning, and deep learning perception.

Linh Thi Xuan Phan
Reliable and secure infrastructure for autonomous systems

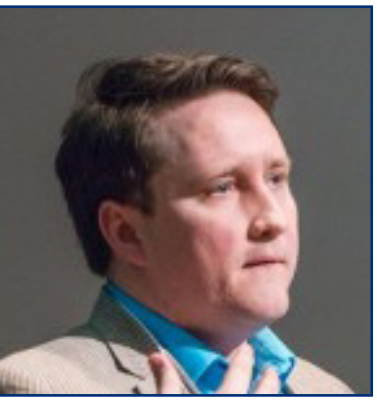
Linh Thi Xuan Phan is an Associate Professor of Computer and Information Science at the University of Pennsylvania. She works in cyber-physical systems (CPS) and distributed systems. Her research focuses on theoretical foundations and systems techniques for safety, performance, and security guarantees. Recently, she has been working on predictable, real-time cloud platforms for CPS, IoT and NFV applications, methods for detecting and defending CPS and distributed systems against DDoS and Byzantine attacks, and provenance-based diagnosis techniques for data centers. Her research has received several awards, including the NSF CAREER Award, the Dean's Graduate Excellence Award from NUS, and several best paper and outstanding paper awards at conferences such as RTAS, RTSS and EMSOFT. Phan has been serving on the Executive Committee of the IEEE Technical Committee on Real-Time Systems and on the ACM Future of Computing Academy since 2016, and is currently the Secretary-Treasurer of ACM SIGBED.

ABSTRACT: As new technologies such as AI- and ML-based control software and cloud infrastructures are being adopted, the complexity of today's cyber-physical systems (CPS) is only going to increase. This trend has introduced a new host of fundamental challenges in terms of scalability, adaptivity, safety, and security guarantees. I will give a brief overview of my recent projects that aim to address these challenges, including, e.g., predictable real-time cloud platforms for CPS, methods for detecting and defending CPS against adversarial attacks, and provenance-based diagnosis techniques for data centers.

Oleg Sokolsky
Code Generation & Flexible Deployment for Runtime Monitoring

Oleg Sokolsky received the Ph.D. degree in computer science from Stony Brook University, NY, USA. Oleg focuses his research interests on the application of formal methods to design and verify distributed real-time systems. He works on modeling and analysis of computer-based systems, particularly medical devices, which require high levels of confidence in their operation. Oleg aims to develop mathematically grounded modeling languages, algorithms, and tools to verify system models in terms of their functional correctness and timeliness. He also develops methods for implementing systems according to their models.

ABSTRACT: In modern, highly complex system, design-time verification may not guarantee correct operation of the system. Monitoring of system behavior can help detect unanticipated problems and recover from them. Our tool for generation and deployment of monitors from formally specified requirements allows users to enact flexible and efficient monitor configurations.



Jim Weimer
It works, but is it safe? - Verifying Autonomy in Healthcare and Automobiles

James Weimer is a Research Assistant Professor in the Department of Computer and Information Science at the University of Pennsylvania. He is a member of the PRECISE center at Penn, where his research interests lie at the intersection of computer science, engineering, and medicine/security. Specifically, his research focuses on the design and analysis of data-driven cyber-physical systems and the internet-of-things with application to medical devices/monitors and security. James holds a Ph.D. degree in Electrical and Computer Engineering from Carnegie Mellon University and prior to joining Penn held a Postdoctoral Researcher position at the KTH Royal Institute of Technology in Stockholm, Sweden. To train the next generation of security-aware medical device developers at the intersection of computer science, engineering, and medicine, James runs the medical device club at Penn. He is a member of the Department of Biomedical and Health Informatics at the Children's Hospital of Philadelphia. He is an associate editor for the ACM Transactions on Cyber-Physical Systems and has earned multiple best paper awards for his medical and security work applied to cyber-physical systems, including the International Conference on Cyber-Physical Systems (ICCPS) and Cyber-Physical Systems Networks and Applications (CPSNA).

ABSTRACT: James Weimer is a Research Assistant Professor in the Department of Computer and Information Science at the University of Pennsylvania. He is a member of the PRECISE center at Penn, where his research interests lie at the intersection of computer science, engineering, and medicine/security. Specifically, his research focuses on the design and analysis of data-driven cyber-physical systems and the internet-of-things with application to medical devices/monitors and security. James holds a Ph.D. degree in Electrical and Computer Engineering from Carnegie Mellon University and prior to joining Penn held a Postdoctoral Researcher position at the KTH Royal Institute of Technology in Stockholm, Sweden. To train the next generation of security-aware medical device developers at the intersection of computer science, engineering, and medicine, James runs the medical device club at Penn. He is a member of the Department of Biomedical and Health Informatics at the Children's Hospital of Philadelphia. He is an associate editor for the ACM Transactions on Cyber-Physical Systems and has earned multiple best paper awards for his medical and security work applied to cyber-physical systems, including the International Conference on Cyber-Physical Systems (ICCPS) and Cyber-Physical Systems Networks and Applications (CPSNA)

POSTERS

(1) Taylor Carpenter & Yiannis Kantaros: VisionGuard: Compression-Based Defense Against Adversarial Inputs to Perception Systems
(2) Hyonyoung Choi: Schedule Synthesis of IEEE 802.1Qbv Time-Sensitive Networks
(3) Matthew Cleaveland: Online Pattern Recognition for Time Series Data
(4) Max Demoulin: Designing Datacenters Applications in the Age of Acceleration
(5) Elizabeth Dinella: Learning Graph Transformations for Detecting and Repairing Bugs in Programs
(6) Mahyar Fazlyab: Safety Verification and Robustness Analysis of Neural Networks via Semidefinite Programming
(7) Neeraj Gandhi: Turning Lemons into Lemonade: Designing for Faults in Distributed Embedded Systems
(8) Konstantinos Gatsis: Control and Learning for the Internet of Things
(9) Robert Gifford: Multi-Resource Allocation for Multicore Real-Time Virtualization
(10) Jiani Huang: Synthesizing Reference of Object in Image
(11) Radoslav Ivanov: Verifying Safety of Autonomous Systems with Neural Network Components
(12) Kuk Jin Jang: Computer-Aided Clinical Trials: Robustness Evaluation
(13) Sooyong Jang: OpenICE-lite: Towards a Connectivity Platform for the Internet of Medical Things
(14) Kishor Jothimurugan: A Composable Specification Language for Reinforcement Learning Tasks
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PRECISE

PENN RESEARCH IN EMBEDDED COMPUTING AND INTEGRATED SYSTEMS ENGINEERING

Our research involves finding fundamental and practical solutions to problems of modeling, control, simulation, operation, formal method and the implementation of embedded/cyber physical systems. Our new Center for Safe AI's missions are to build/design intelligent, reliable, autonomous complex systems and; to develop techniques in order to establish confidence in their behavior and robustness.

PRECISE CENTER FOR SAFE AI

We are in the midst of a foundational shift. From self-driving cars and voice assistants to smart thermostats and recommendation engines, Artificial Intelligence (AI) and Machine Learning (ML) are becoming an integral part of our daily lives. The emergence of these technologies opens up countless opportunities to transform any industry and to revolutionize traditional ways of thinking, operating, and solving problems. But...

How do you know if you can trust AI?

While AI+ML-based technologies have undoubtedly enhanced our daily lives, given that they require and rely on massive amounts of historical data to work effectively, they are by no means perfect. For many of these modern uses of AI+ML, 99% reliability may be sufficient. However, for mission-critical or life-dependent applications, 99% is not good enough. What about that 1% of uncertainty? Hospitals and doctors will remember the time that an autonomous system failed and someone died. Everyone remembers when a self-driving car or airplane crashes. It may not be often, but it does happen. That 1% is magnified when it is the difference between life and death.

Addressing this 1% of uncertainty is where PRECISE's Center for Safe AI is making significant inroads. We have a team of multidisciplinary experts developing highly-scalable tools and technologies that help companies and organizations verify safety in the edge cases of autonomous systems where failure is unacceptable. **The PRECISE Center for Safe AI is focused on working with existing AI designs and systems, making them safer, and providing formal verification of their safety.** We are building run-time monitoring for anomaly detection and taking a real-time systems approach to autonomy across multiple domains (e.g., healthcare, transportation, buildings, infrastructure).

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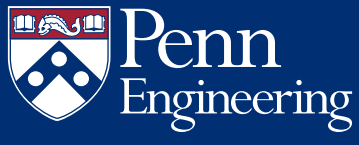
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