Traffic and Autonomy Conference
June 21-23 2023, Maiori, Italy

Organizing committee
Maya Briani (Istituto per le Applicazioni del Calcolo-CNR), Barbara De Filippo (Istituto per le Applicazioni del Calcolo-CNR), Maria Teresa Chiri (Queen's University), Xiaoqian Gong (Arizona State University), Jonathan Lee (UC Berkeley), Rosanna Manzo (University of Salerno), Sean McQuade (Rutgers–Camden)

Scientific Committee Alexandre Bayen (UC Berkeley), Ciro D'Apice (University of Salerno), Maria Laura Delle Monache(UC Berkeley), Benedetto Piccoli (Rugers–Camden), Jonathan Sprinkle(Vanderbilt University), Dan Work (Vanderbilt University)

Venue
Conference: Reginna Palace Hotel, Maiori
Social dinner: Torre Normanna a Maiori, Maiori

Program

Wednesay

Morning
9:00-9:30 Welcoming remarks
9:30-10:30 **Plenary** Alex Bayen *(UC Berkeley)*
10:30-11:00 Coffee Break
11:00-11:40 Jonathan Sprinkle *(Vanderbilt)*
11:40-12:20 Sharon Di *(Columbia)*
12:20-13:00 Raphael Stern *(U. of Minnesota)*

- Lunch -

Afternoon
14:30-14:50 Nathan Lichtle' *(UC Berkeley)*
14:50-15:10 Matt Bunting *(U. of Arizona)*
15:10-15:50 Amaury Hayat *(Ecole des Ponts)*
15:50- 16:10 Derek Gloudemans *(Vanderbilt)*
16:10- 16:30 Sean McQuade *(Rutgers-Camden)*

Thursday

Morning
9:20-10:00 Shengquan Xiang *(Beijing)*
10:00-10:30 Coffee Break
10:30-11:30 **Plenary** Miroslav Krstic *(UC San Diego)*
11:30-12:10 Raffaele Cerulli *(UnisSalerno)*
12:10-12:50 Rinaldo Colombo *(UniBrescia)*
12:50-13:30 Massimiliano Rosini *(Lund)*

- Lunch -

Afternoon
14:00-15:00 **Plenary** Bruno Siciliano *(UniNa Federico II)*
15:00-17:00 Afternoon activity

Friday

Morning
9:00-10:00 **Plenary** Paola Goatin *(INRIA Sophia Antipolis)*
10:00-10:30 Coffee Break
10:30-11:10 Maria Laura Delle Monache *(UC Berkeley)*
11:10-11:50 Barbara De Filippo *(IAC-CNR)*
11:50-12:30 Mostafa Ameli *(Université Gustave Eiffel & UC Berkeley)*

- Lunch -

Afternoon
14:00- 14:20 Nish Hossein Matin Sinat *(UC Berkeley)*
14:20- 15:00 Benjamin Seibold *(Temple)*

Titles and Astracts

Alex Bayen

The MegaVanderTest

This lecture will present the story of the MegaVanderTest, a test involving 103 connected and automated vehicles, which ran the week of Nov. 18, 2022 on I-24 in Nashville, TN. The MegaVanderTest is to our knowledge the test which achieved the largest concentration of connected and automated vehicles collaboratively controlling traffic on a single stretch of freeway in the history of connected and automated vehicles. The lecture will explain the objectives of CIRCLES, the consortium which conducted the MegaVanderTest.

The talk will first cover the architecture built and deployed by the CIRCLES team. It will present some of the algorithms populating the planning layer of the system, mostly based on optimal control and imitation learning of Kernel-based expert controllers. It will also present some of the algorithms populating the local control regulation layer, based on deep-reinforcement learning, model-based control and MPC. Finally it will present the way the algorithms had to run in the field, due to the fact that most modern ACC architectures do not allow third party access to some of the sensing equipment other than through inference by proxy of control, and due to the fact that prescribing acceleration is problematic on many vehicles.

It will finally show some preliminary results, on the way to our quest: leveraging 1% to 2% of the total flow of vehicles to improve the fuel economy of every car on that freeway on that day (not just ours), by up to 10%.

Paola Goatin

Traffic flow models for new mobility paradigms

Modern technologies have the potential to dramatically change the mobility paradigms in the next future. Indeed, they allow for extended data collection and Vehicle-to-Vehicle or Vehicle-to-Infrastructure communication, possibly providing new tools to control and optimize traffic flows. In this setting, mathematical models play an important role, allowing the design and evaluation of new management approaches. In this talk, I will present applications to road traffic regulation by means of Connected Automated Vehicles or dynamic routing. All results are based on the development of specific macroscopic models accounting for the interacting dynamics of the different classes of users. Numerical experiments show that controlling a

small fraction of users is in general sufficient to consistently improve the global system performance.

Miroslav Krstic

PDE Backstepping Control for Stop-and-Go Stabilization

While the CIRCLES demonstration reduces the necessity of formulating stop-and-go suppression as a ramp metering-actuated boundary control problem for the underlying ARZ PDE model, it remains relevant to have the capability to solve this and related traffic flow stabilization problems in such a highly "actuation-deprived" scenario. I will review the design of PDE backstepping controllers for the stabilization of stop-and-go flows in the direction upstream of a metered ramp - the architecture that represents the benchmark of difficulty for stabilization. Extensions will be given to stabilization of ARZ-like PDE models of multi-lane freeways and of freeways with multiple classes of vehicles and drivers (e.g., cars and trucks, young and old, human-driven and self-driven, etc). The possibility of traffic flow PDE stabilization in the nonlinear, large-signal regime, such as with severe stop-and-go oscillations, will be discussed. The candidate approaches are (1) gain scheduling based on linear PDE backstepping and (2) feedback-linearizing nonlinear backstepping with Volterra series operators with respect to the freeway's spatial variable.

Bruno Siciliano

Robotics, AI 5G — The Future is Now!

Robotics research has advanced in the last two decades through an intensive collaboration with other disciplines and research communities. Multidisciplinary approaches are more successful in addressing the combined issues of cognition (perception, awareness and mental models), and physical attributes (safety, dependability and dexterity) in the world of robotics. Previously separated from humans behind a fence, the new advanced robots (or cobots) are sharing our workspace and collaborating with us. Increasingly sophisticated built-in sensors enable them to see and feel the presence of humans and avoid accidental contact. The perception of robotics technology is improving, as we experience more ways it can positively affect our lives. In particular, the social and medical benefits of robots are starting to get more attention. In this scenario, the terms artificial intelligence (AI) and robotics are liberally used, and frequently interchanged today. However, the physical nature of a robotic system distinguishes it from the pure abstraction of

AI. We are experiencing a transition from Information and Communication Technology (ICT) to InterAction Technology (IAT). The fifth generation of wireless technology (5G) will pave the way for a new generation of robots, some free to roam controlled via wireless rather than wired communication links while exploiting the vast computing and data storage resources of the cloud. Armed with these capabilities, robots can be controlled dynamically in real time and be connected to people and machines locally and globally. In the near future, 5G will fully enable applications with minimal latency such as "factory of the future", "remote surgical training" and many others that were previously beyond the capabilities of both cellular and robotics technologies.

Mostafa Ameli - *Agent-based Dynamic Traffic Simulation and Calibration: I-24 CIRCLES Test Case*

Raffaele Cerulli - *Shortest paths with exclusive-disjunction arc pairs conflicts*

Rinaldo M. Colombo - *Inverse Design for Hamilton-Jacobi Equation Conservation Laws*

Barbara De Filippo - *Atmospheric Pollutants and vehicular traffic: a mathematical approach*

Matt Bunting TBA

Maria Laura Delle Monache - *Modeling and control for large scale traffic networks*

Sharon Di - TBA

Derek Gloudenmans - *I24 Motion: A Computer Vision system for large-scale vehicle trajectory extraction*

Amaury Hayat - *From control theory to AI and regulation of traffic flow*

Hossein Nick Zinat Matin - *Conservation Law in the Presence of Bottleneck and Discontinuous Flux: A Riemann Problem and Wave Interactions*

Sean McQuade - *Experimental set up guided by data*

Massimiliano Rosini - *From microscopic to macroscopic traffic models*

Benjamin Seibold - *How transferable is energy-centered traffic control?*

Jonathan Sprinkle - TBA

Raphael Stern - *Adaptive ramp metering control for mixed-autonomy traffic flow*

Shengquan Xiang - *MicroAccel and feedback stabilization of traffic*