Ph.D. in Information Technology: Thesis Defenses

February 13th, 2020

Room Beta – 10.00 am

Federico BIANCHI – XXXII Cycle

"A randomized model structure selector for complex dynamical systems"

Advisor: Prof. **Luigi Piroddi**

Abstract:

This thesis addresses the problem of choosing suitable model structures for dynamical systems when the data-driven model learning is pursued with parametric methods. The model structure selection (MSS) problem is known to be challenging due to its combinatorial nature which requires in principle to exhaustively search for the model terms to be included into the model within a space that might be large. Accordingly, many strategies have been proposed with the aim of exploring in a smart way the model structure space, ranging from greedy incremental policies, regularization based techniques, evolutionary methods, and probabilistic approaches. This thesis extends a recent randomized approach based on a probabilistic reformulation of the MSS problem for nonlinear systems, to the case of distributed data, switched nonlinear systems, and also to the estimation of the process covariance matrix in Kalman filter applications.

Simone GELMINI – XXXII Cycle

"Accident prevention, detection, and early response: Using machine learning and data analysis to improve driver and pedestrian safety"

Advisor: Prof. **Sergio Savaresi**

Abstract:

The benefits of personal mobility are unquestionable. However, with its high number of fatalities every year, road traffic accidents are still one of the top causes of death worldwide. Despite enormous efforts by the scientific community and industry to make vehicles safer, traditional technological development has proved unable to cope with this issue entirely. Studies show that human factors, rather than vehicle performance, are contributing to the numerous vehicle fatalities. More than ever, drivers are distracted by external factors and electronic devices, reducing their capability to counteract unexpected situations and increasing the likelihood of a crash. Furthermore, emergency calls are often delayed when nobody witnesses the accident, increasing the risk of serious injury or fatality if the injured person(s) are incapable of calling for help. Inspired by standard medical practices, this thesis presents a set of methods that aim to reduce the number of accidents,

both for motorists and pedestrians, and mitigate their consequences. First, we discuss an algorithm that promotes safe driving practices by enabling driver awareness, focusing on the driver's average driving behavior. In this context, we investigate how to account for the use of smartphones while driving, which is a known dangerous habit. Then, in the unfortunate occurrence of a crash, we propose a method for automatically detecting it, grading its severity, and calling for rescue in case the person is injured or needs immediate assistance. Following the same approach, we present a similar strategy for pedestrians, in which we detect when the subject loses consciousness, becoming incapable of calling for rescue. Additionally, for some specific anomaly events, we provide a methodology that deploys an airbag cushion placed inside a garment, aiming to mitigate the injuries severity. Thanks to the increasing availability of smart devices, we have chosen to leverage machine learning and data analysis techniques to tackle the aforementioned challenges. Special attention has been devoted to designing a flexible, methodical sounding algorithmic structure. The proposed framework has also been designed considering the limited resources of telematics e-Boxes, smart devices already used by a large number of drivers due to widespread use and promotion by automotive insurance companies.

Gabriele POZZATO – XXXII Cycle

“Advances in propulsion systems modeling, optimization, and control”

Advisor: Prof. **Sergio Savaresi**

Abstract:

The quest for improved fuel economy, lower vehicular emissions, and energy efficiency have led automotive companies to devote resources, in terms of both money and time, for the development of new powertrain solutions for the next generation of vehicles. Against this background, the main focus of the doctoral research is the modeling, optimization, and control of propulsion systems. Different powertrain architectures, namely internal combustion engine vehicles, electric vehicles, and hybrid electric vehicles, are considered. With the goal of improving their energy efficiency, attention is focused on problems specific to the architectures mentioned above, that is: knock control for internal combustion engine vehicles – to optimize the air/fuel mixture ignition –, battery aging control for electric vehicles – to maximize the battery lifetime –, and the development of energy management strategies for hybrid electric vehicles – to determine the optimal power split between the available movers –. Eventually, the research activities have led to the development of new tools and methods, interesting for the pursue of efficient and optimized mobility solutions.

PhD Committee:
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Prof. **Antonio Sciarretta**, IFAC