Ph.D. in Information Technology: Theses Defenses

January 26th, 2018

DEIB Seminar Room "Alessandra Alario" (building 21) - 9.30 am

First Ph.D. presentation and discussion:

Mehrnoosh ASKARPOUR – XXX Cycle

"SAFER-HRC: a Methodology for Safety Assessment through Formal Verification in Human-Robot Collaboration"

Advisor: Prof. **Dino Mandrioli**

Abstract:

Human-Robot Collaboration (HRC) is increasingly prominent in industry and daily life. However, it raises new challenges to guarantee system safety due to the presence of human operators. Close proximity and frequent physical contacts between operators and robots, and intrinsic non-determinism in operators' behavior make it difficult for safety assessors to cope with the dynamism of collaborative applications. Yet, formal verification techniques can help in this regard through the exhaustive state-space exploration of system models.

This thesis proposes to use formal verification techniques for analyzing risks in HRC, through a methodology called SAFER-HRC, which is compatible with well-known robotic standards and relies on temporal logic based models to describe the different possible ways in which tasks can be carried out, and on exploration of the corresponding state-space to detect and modify the hazardous situations at early stages of system design.

Angela GERONAZZO – XXX Cycle

"Smart Buildings: A Methodological Approach to Data Design, Analysis and Exploitation"

Advisor: Prof. **Cristiana Bolchini**

Abstract:

During the last decades, improving energy efficiency in buildings has risen as an important societal issue and research area, motivated by a pressing quest to design, develop and implement effective and affordable energy demand reduction strategies. The ultimate goal is to optimize the trade-off between energy

consumption and the occupants' comfort, aiming at reducing the high-energy demand and carbon footprint without compromising the occupants' quality of life. In this perspective, current research trends focus on ICT to enhance energy efficiency in buildings and communities. Buildings and occupants are the two key elements of the stated problem, to be opportunely monitored, dynamically controlled and made aware in order to pursue the desired optimization goal. In this context, ICT empowers the adoption of Energy Management Systems (EMSs), equipped with sensors and actuators, supports the collection and storage of real-time information and contributes to the definition of an integrated infrastructure useful to extract from the available heterogeneous, multi-facet data the information needed to provide an overarching picture of the building ecosystem thus empowering dynamic operation strategies. Nonetheless, it introduces the need to master the data collected data and to effectively exploit it.

In this scenario, the main contribution of the thesis is the introduction of the Building Monitoring and Exploitation (BuildME) methodological framework to drive the design of building monitoring and data exploitation processes. The framework identifies the relevant aspects to be investigated toward an effective design of monitoring campaigns and an efficient exploitation processes of the harvested data. The methodology outlines for each of these aspects a set of alternatives by clarifying their impact on the collected data and thus on the exploitation process results.

Third Ph.D. presentation and discussion:

Giovanni QUATTROCCHI – XXX Cycle

“Fast and Fine-Grained Elastic Resource Provisioning for Modern Software Systems”

Advisor: Prof. **Luciano Baresi**

Abstract:

One of the key challenges of modern software systems is how to provision and optimize resources to meet a varying demand. To avoid resource saturation and unresponsiveness, user dissatisfaction and unnecessary costs, the provisioning of resources must be elastic: this means that a system is capable of automatically adapting to changes that could affect the quality of service perceived by the users. State of the art solutions focus on the control of software systems deployed in the cloud by changing the number of allocated virtual machines. These approaches mainly use heavyweight techniques such as optimization problems or delegate to the system administrators part of the adaptation process (i.e., rule-based approaches). Moreover virtual machines are relatively slow to be provisioned (around six minutes on average) and only available in fixed configurations limiting how fast and precise the adaptation could be.

This thesis aims to study, analyze and evaluate novel solutions that enable the creation of lightweight, autonomous, fine-grained and fast elastic resource provisioning. Its main contribution is the technique used to plan and enact the adaptation actions. It mixes containers, a lightweight virtualization technology that enables the fast and fine-grained elasticity, and control theory that provides a lightweight theoretical foundation for controlling systems. Containers can be provisioned in seconds and re-configured in milliseconds, and control theory enables the computation of next allocations in constant amount of time. This methodology was successfully applied to two real-world scenarios: web and big-data applications.

PhD Committee:

Prof. **Luciano Baresi**, DEIB

Prof. **Davide Brugali**, Università di Bergamo

Prof. **Tania Cerquitelli**, Politecnico di Torino

DEIB Conference Room "Emilio Gatti" (building 20) - 3.30 pm

Alessio PAGANI – XXX Cycle

Algorithms and Methods for the Design and Development of Intelligent, Context Aware and Sustainable Mobility Services

Advisor: Prof. **Francesco Bruschi**

Abstract:

The interest towards the applications of ICT in public and private urban transport has grown significantly over the last few years. In the field of transit design and planning, however, travel agencies don't exploit the inherent potential of the increasing volume of data being generated by user devices and applications, and work mostly in open loop when planning services. In the field of user interfaces with transportation, on the other hand, continuous, highly context-aware, real time interaction can still be found only in a very limited number of cases, mostly in private transportation. One of the main issues in actually developing data-driven, closed loop planning tools and assistive, portable, continuously interacting applications is getting to know the transports system state (equations of motion of the means, position of the users). In the majority of cities the most temporally accurate data currently available is yet only the estimated departure time of the next train or bus at the stops. Both these informational dimensions are being

thoroughly revolutionized, in their perspectives and actual possibilities, by the flood of available coming from transport operation and applications. There is a relevant and potentially disruptive consequence of this perspective, when taken to the extreme: if adequate relevant information is available to transport agencies in real-time, it will be possible for them to dynamically adjust service parameters, and immediately assess their effects, in order to dynamically improve service quality in a closed-loop fashion. This would open up the possibility, among the others, to exploit self-adjusting behaviors that perform small variations (experiments) on transit schedule parameters, seeking to optimize some service metrics (e.g., mean travel time) at the lowest cost possible, in real-time.

A general framework able to provide all the information required to develop multimodal, real-time, continuous and context-aware applications is proposed. From a transit agency perspective, it could be possible to evaluate metrics valuable to duly assess service quality, such as origin-destination matrices annotated with mean travel time, number of connections taken, mean waiting times at connections, number of passengers that traveled between two points in a given time interval.

PhD Committee:

Prof. **Francesco Bruschi**, DEIB

Prof. **Davide Giglio**, Università di Genova

Prof. **Mirco Musolesi**, University College London