UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"On Cyber-Physical Social Systems (CPSSs): Challenges and new research directions"

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Short Abstract: Cyber-Physical Systems (CPSs) are related to the integration of computing and communication capabilities into physical systems. Currently there are an important domain for research and innovation, including robotics; smart homes, buildings, and mobility solutions; medical implants; drones, and numerous others. CPSs are also the medium through which next-generation Artificial Intelligence and Machine Learning applications will be deployed, and are a growing source of big data.

An example of CPSs is the smart city model, which is growing around the prototype of an urban (physical) environment with a new generation of innovative services for transportation, energy distribution, healthcare, environmental monitoring, business, emergency response, and social activities developed in its digital twins. Smart cities are also an example of how CPSs must include people, which can't be neglected in the loop of producing, collecting and consuming data, information and services.

Enabling the technology for such a setting requires a viewpoint of Smart Cities as system of cyber-physical and social systems (CPSSs) which are the result of the integration of several technologies to provide seamless services to end users. Such technologies enable the collection, storage, and processing of massive amount of data sensed from the environment and/or produced by citizens themselves, while promoting social interactions.

The vision of a smart city as a CPSS corresponds to a closed–loop system with data collection, processing, decision making and control and optimization actions. Otherwise, the result could be critical, sometimes harmful: as in the case of a "smart parking" app that informs drivers about some available parking spaces; the result is that multiple drivers would converge to the few spaces, thus creating additional traffic congestion. There is a need for novel approaches in order to cope with CPSSs and with the increasing requests of citizens about reliable, secure and affordable services.

IoT technologies and mobile technologies are the foundation of cyber–physical systems: nowadays, they are applied in smart cities extensively. Smart cities as a system of integrated sensors, actuators, infrastructures and people in a whole call for novel integrated and holistic approaches considering both the component resources and their inter–relationships.

Course Contents in brief:

- Introduction to Cyber-Physical Social Systems: taxonomies and examples: a survey about definitions of CPSS, the main challenges will be provided.
- The management of services provided by CPS to people: Approaches and tools for managing SLAs of digital services in complex CPS ecosystems
- Architectures of CPSSs: From IoT to cloud computing through fog and edge computing with people in the loop: last advances
- The security management of CPSSs: Physical, cyber aspects and their mutual dependencies

Total # of hours of lecture: 16 hours

References:

[1] IEEE Cloud Computing > Volume: 3 Issue: 6 (Dec 2016): Massimo Villari ; Maria Fazio ; Schahram Dustdar; Omer Rana ; Rajiv Ranjan, " A New Paradigm for Edge/Cloud Integration"

[2] ACM Transactions on Internet Technology (TOIT) 18 (1), 5, A Longo, M Zappatore, M Bochicchio, SB Navathe, "Crowd-sourced data collection for urban monitoring via mobile sensors"

[3] IEEE Trans. Comput. Social Syst., vol. 5, no. 3, pp. 829-840, Sep. 2018.J. J. Zhang et al., "Cyber-physical-social systems: The state of the art and perspectives"

[4] Proceedings of the 31st Annual ACM Symposium on Applied Computing, 321-326, RA Falbo,et alii. "An ontology pattern language for service modeling"

[5] Journal of Parallel and Distributed Computing, Volume 127, 2019, Pages 118-133, Antonella Longo, Marco Zappatore, Shamkant B. Navathe, "The unified chart of mobility services: Towards a systemic approach to analyze service quality in smart mobility ecosystem"

CV of the Teacher

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Short bio: Dr. Antonella Longo is an Assistant Professor at University of Salento where she teaches data management at the Engineering School and Big Data for decision support at the business school. Currently her main research interests deal with models and tools for the integration of heterogeneous data sources coming from the crowd and from IoT devices in urban computing and Urban pollution specifically. She is also vice director of the Interdisciplinary Research Center on the Security and Resilience of Critical Infrastructures (CRISR).

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule: potential dates: 2 sequential dates in the week from Jan 21st - Jan 24th

Day1 – 9-13: Introduction to Cyber-Physical Social Systems; 14-18: The management of services provided by CPS to people

Day2 – 9-13: Architectures of CPSSs; 14-18: The security management of CPSSs