



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 4 - Telecommunications

**PNRR 117 Research Field: COMMUNICATION AND SENSING TECHNIQUES ASSISTED BY
MACHINE LEARNING**

Monthly net income of PhDscholarship (max 36 months)

€ 1400.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

In the recent past years, learning techniques have been successfully applied in the upper layers of telecommunication systems, in particular for the purpose of quality-of-service estimation and resource allocation in networks.

A new research trend is to process channel state information by learning methods in order to add sensing capabilities to classical wireless communication systems. Sensing will enable to estimate features such as range, velocity, and motion of objects in an area of interest, i.e. the coverage area, to allow applications such as presence detection, no matter if objects are in visibility or behind walls. Moreover, fundamental limits of joint communication and sensing for indoor scenarios need to be investigated: learning techniques can play a key role in determining such limits, both as an optimization tool and as a part of practical encoding/decoding schemes.

Typically, information theory provides fundamental limits in the large code blocklength regime, while it is not mature enough to find optimal modulation schemes in the finite blocklength regime. In such cases, we expect that applying learning techniques can give new insights into the signal set design.



	<p>From a hardware implementation standpoint, learning techniques could be used to design algorithms that account for energy efficiency.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>In the first phase of the doctoral studies, we plan to use learning techniques to enhance already deployed communication systems with sensing capabilities. In the second phase of the doctoral studies, optimal strategies that combine communication and sensing will be investigated through the lens of information theory, to get insights into the fundamental limits on the design of practical systems. We will finally aim to improve the system design with learning-aided techniques.</p>
<p>Educational objectives</p>	<p>The goal of this PhD is to let the student improve his/her hard and soft skills in the context of academic and industrial research.</p> <p>On one hand, the student will learn mathematical methods borrowed from both information theory and learning theory, and how to interpret the results of the research with a critical eye. Moreover, the student will learn how to program embedded systems with internet connectivity.</p> <p>On the other hand, the student will acquire soft skills like technical writing and scientific dissemination through participation to international conferences and doctoral courses. Especially during the visit period in the company, the student will have the opportunity to work in team.</p> <p>Finally, the student will learn to act as a bridge between academia and industry.</p>
<p>Job opportunities</p>	<p>Learning techniques find broad application in many fields of engineering. Specifically, companies in the field of electronics and telecommunications are investigating machine learning based solutions for the design of their products, with emphasis on sensing, pattern recognition, and internet connectivity.</p> <p>We are aware of several companies in the Milan area that</p>



	<p>are working and investigating on these subjects.</p> <p>Moreover, we expect that learning methods will play a fundamental role in the design of the sixth generation of mobile and other emerging connectivity technologies.</p>
Composition of the research group	0 Full Professors 2 Associated Professors 2 Assistant Professors 7 PhD Students
Name of the research directors	Prof. Luca Barletta

Contacts	
Email: luca.barletta@polimi.it; Phone: +390223998927.	

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	STMicroelectronics
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Department of Electrical and Computer Engineering, University of Illinois Chicago
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.</p> <p>TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student.</p> <p>There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the</p>



regulations.

COMPUTER AVAILABILITY: individual use.

DESK AVAILABILITY: individual use.