PhD in Computer and Control Engineering

Research Title: A computational biology approach to the diagnosis and characterization of genetic-related diseases

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Supervisor

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Possible involved institutions:
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Context of the research activity

The recent availability of huge amounts of biological data is radically changing the diagnostic and therapeutic approach to many diseases, especially those whose etiology includes a genetic component. Systems biology is a research approach that takes advantage of multidisciplinary expertise (mathematics, physics, engineering, and chemistry, medicine) to support Life Science researchers in the interpretation and use of data gathered from biological samples of patients. In the context of Systems biology, Computational biology consists in the application of Computer Science to model, simulate, and study the biological world.
In this proposal, we want to design algorithms and tools to support several steps in the diagnosis and characterization diseases characterized by a strong, although not fully understood genetic substrate: from several types of cancer, to pervasive development disorders and neurodegenerative and psychiatric diseases. Improved machine learning techniques are required to extract knowledge from the raw biological data. Modeling formalisms and languages, as well as simulators, have to be defined and implemented to allow a deeper investigation of biological systems.

**Objectives**

1) One of the main problems to face when dealing with genetic-related diseases is the correct identification and classification of all the possible variants of the disease. This is crucial, as allows the clinicians to optimize the pharmacologic and/or rehabilitation therapy for each single patient (personalized medicine). This can help enhancing the therapy efficacy, while reducing their side effects. This topic requires machine-learning techniques suited for the specific features of biological data. As an example, a possible outcome of this research could be to understand if the different variants of a cancer are correlated with a given therapy efficacy for a specific patient.

2) Another difficulty in Life Science research is the lack of a formalisms that allows to build a model to be simulated. In this PhD, the candidate will be required to define, formalize, or refine modeling techniques for biological systems, in order to enable their simulation. This research is particularly important, for example, in the identification of new drug targets, as well as in drug repositioning.

3) A third objective regards the definition of reliable and useful protocols to gather neurophysiological data from patients affected by neurological disorders. This will require building or using sensor arrays, as well as developing tools to correctly transform the sensor data into usable information.

4) A more detailed planning of the activities will be defined at the time of the research, since the best methodology is often dictated by the available biological data. This type of research requires a close collaboration and interaction with Life Science researchers. The reinforcement of scientific multidisciplinary collaborations is the fourth objective of this research.
| Skills and competencies for the development of the activity | The candidate- besides skills in machine learning, big data analysis and artificial intelligence - should be characterized by a strong motivation to pursue this research topic. He/she should be interested in a multidisciplinary approach to the research, and ready to work in team with biologists, clinicians and genetists, with the objective of providing a concrete help in improving the quality of life of patients. |