Denominazione corso di dottorato: INFORMATION AND COMMUNICATION TECHNOLOGY FOR HEALTH

1. Informazioni generali

Corso di Dottorato

Il corso è:	Rinnovo
Denominazione del corso	INFORMATION AND COMMUNICATION TECHNOLOGY FOR HEALTH
Cambio Titolatura?	NO
Nuova denominazione del corso	INFORMATION AND COMMUNICATION TECHNOLOGY FOR HEALTH
Ciclo	39
Data presunta di inizio del corso	01/11/2023
Durata prevista	3 ANNI
Dipartimento/Struttura scientifica proponente	Ingegneria Elettrica e delle Tecnologie dell'Informazione
Numero massimo di posti per il quale si richiede l'accreditamento ai sensi dell'art 5 comma 2, DM 226/2021	30
Dottorato che ha ricevuto accreditamento a livello internazionale (Joint Doctoral Program):	NO
Il corso fa parte di una Scuola?	NO
Presenza di eventuali curricula?	NO
Link alla pagina web di ateneo del corso di dottorato	http://icth.dieti.unina.it

Descrizione del progetto formativo e obiettivi del corso

n.	Denominazione dell'insegnamento	Numero di ore totali sull'intero ciclo	Distribuzione durante il ciclo di dottorato (anni in cui l'insegnamento è attivo)	Descrizione del corso	Eventuale curriculum di riferimento	Per i dottorati nazionali: percorso formativo di elevata qualificazione	Verifica finale	Note
1.	Immunology: from basic	15	primo anno	Content Lecture I - The immune			SI	Docenti di riferimento: Alberico Angela, Veronica De Rosa, Francesco Verde

Attività didattica programmata/prevista

Insegnamenti previsti (distinti da quelli impartiti in insegnamenti relativi ai corsi di studio di primo e secondo livello)

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	principles to mathematical modeling			system: the innate and adaptive response. T cell activation. T cell differentiation, clonal expansion and maturation. Lecture II - T lymphocyte fate and plasticity. Impact on activation, differentiation and regulation of the immune response. Relationships with autoimmunity. Lecture III - Role of mathematical models in immunology. Molecular-level, cellular-scale, and tissue-scale immune dynamics. Lecture IV - Models based on ordinary differential equations (ODEs) in immunology. Lecture V - Models based on partial differential equations (PDEs) in immunology. Lecture VI - Models based on information theory in immunology. Cell signalling and uncertainty into kinetics of T cell receptor (TCR) binding.				Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
2.	Research and application of technological innovation in clinical practice	10	primo anno	Rationale: Clinical research plays a crucial role in the application of technological innovations in clinical practice, ensuring the effectiveness, safety, and efficiency of new diagnostic and therapeutic approaches. Objectives: This course aims to provide a foundation for understanding clinical research and the methods for applying technological innovation in clinical practice, preparing students to play an active role in promoting health and transforming healthcare services. Lecture I- Introduction to clinical research: fundamental principles and methodologies for designing and conducting clinical studies to evaluate the effectiveness, safety, and efficiency of technological innovations. LectureII -Ethical and regulatory aspects in the application of technological innovation in clinical practice. Lecture III-Critical evaluation of the impact of technological innovations on the quality of care and clinical outcomes. Lecture IV -Patient engagement and communication in the application of technological innovations in clinical practice. Lecture V - The role of interdisciplinary collaboration among healthcare professionals, researchers, and technology experts in promoting optimal integration of technological innovation in clinical practice.			SI	Docente di riferimento: Anna Franzone Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
3.	Statistical data analysis for science and engineering research	12	primo anno secondo anno	The course provides an overview of the experimental design and data analysis and is intended for PhD students in science and engineering disciplines who need to use statistical methods and data analysis as part of their research.			SI	Docenti di riferimento: Roberto Pitrantuono. Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules

				More specifically, the course introduces the main elements required to plan robust experiments according to the Design of Experiment (DoE) methodology and the basic statistics required to properly analyse the resulting data depending on the experimental settings. The course will also treat data analysis under unplanned experiments with observational data. Common errors in experimental planning and misuse of statistics will be highlighted throughout the course. The course will show the application of what explained on exemplifying science and engineering research problems, possibly depending on the need of the participants. There will be a final assessment. The course foresees six two-hours lectures split in three weeks, two days per week.				
4.	Data Science for Patients Records Analysis	10	primo anno	The course provides an overview of data science methods and tools, from data preparation to data modeling and validation, and it is intended for PhD students in science and engineering disciplines who need to use machine learning and data analysis as part of their research. The course focuses on the application of the analyzed methods for the analysis of patient records, in the context of a real case study.			SI	Docenti di riferimento: Marcello Cinque, Marcella Bravaccio, Maria Pia Riccio Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
5.	Design and Implementation of Extended Reality Software Systems	20	primo anno secondo anno	With the term Extended Reality, we refer to the use of devices such as displays, cameras, and sensors for overlaying digital information to the real world. The application of extended reality technology is opening up new opportunities in ICT industry. The goal of this module is to introduce the Extended Reality Software Systems to the researchers working in ICT context and smart Health domain and to present software engineering solutions appositely crafted for specifying the requirements, designing, implementing, and evaluating the quality of such software systems. At the same time, the module will show the new research trends in the field of Extended Reality Software Systems and its novel applications. To earn the credits, at the end of the course students are requested to provide a good quality presentation about the potential application of Extended Reality in the context of their research field. Alternatively, students can also present a project (or running demo) of an Extended Reality Software System prototype they develop. Student's presentations will take place in the last lesson. Details about the presentation format will be given during the course. The schedule of the presentations will be defined during the course.			SI	Docenti di riferimento: Domenico Amamlfitano, Anna Rita Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
6.	Interaction control in surgical and rehabilitation robotics	14	secondo anno	Lecture I - Introduction: Introduction on surgical and rehabilitation robotics. Lecture II - Rationale: Impedance Control and			SI	Docente di riferimento: Fanny Ficuciello. Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules

				Force Control. Lecture III Idea: Variable Impedance Control. Lecture IV - Applications: Shared Control Lecture V - Scope: Series Elastic Actuators Lecture VI - Conclusions: Prof. Nicola Vitiello will illustrate Wearable robotics solutions and exoscheleton. Lecture VII - Dott Marco Molinari will illustrate his research in Neuro-rehabilitation from a clinical point of view.					
7.	Matlab Foundamentals	10	primo anno	The course is intended to prepare student for the "MATLAB Certificate Associate". To this aim, students will be guided on the concepts and aspects of the MATLAB language and environment. Each lesson is 2H long and will both feature theoretical and practical aspects. Since the core of the course will be MATLAB Fundamentals, students are required to create the Unina - MATLAB account and to bring a laptop. It is mandatory to register by using the following link.			SI	Docenti di riferimento: Stefano Marrone, Agostino De Marco. Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
8.	Data uncertainty	15	primo anno	Lecture I - Theoretical and practical foundations of experimental data acquisition processes: concept of measurement and measurement; measurand, reference and their comparison; unit of measure; metrological traceability and calibration; errors, systematic and random effects, corrections. Lecture II - Definition of uncertainty associated with experimental data from measurements. Meaning and sources of measurement uncertainty and its main contributions. Lecture III - Models for the evaluation of measurement uncertainty: the JCGM 100:2008 standard - Evaluation of measurement data — Guide to the expression of uncertainty in measurement. Evaluation of the Type A standard uncertainty. Evaluation of the Type B standard uncertainty. Determination of the compound standard uncertainty: LPU - law of propagation of uncertainty; Monte Carlo method. Lecture IV - Models for the evaluation of measurement uncertainty: Bayesian approach. Subjective probability and objective description of the world. Bayes theorem. Bayesian inference and maximum likelihood. Evaluation of uncertainty with Bayesian approach. Practical applications to Gaussian distributions. Lecture V -Experimental tests aimed at evaluating the uncertainty associated with measurements performed with basic electronic instrumentation present in a typical laboratory (voltmeters, calibrators, generators), with the aim of verifying, given a certain			SI	Docente di riferimento: Leopoldo Angrisani Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules

				action to be taken, the differences between the decisions taken on the basis of standardized practice and those instead to be taken following the Bayesian approach.				
9.	Social Robotics	16	primo anno	In this module, students will learn the key aspects of designing and developing robots' behaviours that are accepted and familiar to people. Particular attention will be given to robotics applications and scenarios where robots are expected to have close interactions with people and support therapists and caregivers. Students will be provided with an overview of the multidisciplinary aspects to consider in order to design a human-robot interaction (HRI) by discussing and learning aspects and techniques from different relevant fields, such as robotics, computer science, engineering, psychology, and artificial intelligence (AI). Students will learn how to design and conduct a HRI study, and how to choose subjective and objective measures to evaluate the interaction with the robot, and people's perception of the robot's behaviours and their effect on users. Students will also be exposed to different robots, such as Pepper and Furhat, that are used in human-centred scenarios, such as assistive robots in private homes, care facilities and hospitals, robotic companions in home environments, and robots in rehabilitation centers.			SI	Docenti di riferimento: Silvia Rossi, Alessandra Rossi. Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
10.	Digital Health and Simulation approaches for the Analysis and Reengineering of Healthcare Systems	10	secondo anno	Lecture I - Towards digital healthcare systems: Introduction to the use of simulation as a digital tool to improve healthcare systems. Comparison among different modelling strategies (data-driven and physics-driven models). Description of objectives, impact, current and future challenges. Discussion of relevant case studies from the literature. Lecture II - Practical tools to model and analyse healthcare systems: Methods and tools (statistical and visual) to analyse healthcare systems. Introduction to management and digital approaches and tools for the modelling and analysis of care processes and services, and for the design of novel in-silico healthcare systems. Lecture III - Practical applications to design digital healthcare models: Creating digital models of healthcare systems: practical applications. Use of discrete event simulation and data analysis for healthcare process modelling. Development of simulation models of healthcare processes. Lecture IV - Artificial data to assess and improve healthcare systems: Generation of artificial data and analysis of healthcare scenarios: practical application. Use of simulation tools and data analysis to generate artificial data and compare different healthcare scenarios to improve care processes and services.			SI	Docente di riferimento: Alfonso Maria Ponsiglione Aggiornamenti su contenuti e tempi del corso sul sito

				Lecture V - Conclusions: Discussion of case studies developed by the students. Final remarks and future directions.				
11.	Modeling of Physiological Control Systems	15	secondo anno	Lecture I - Introduction: Course introduction; modeling of mechanical, fluidic, thermal and chemical systems, by using the electrical analogy. Definition of generalized compliance and inertance. Lecture II - Rationale: The mechanical-fluidic model of the pulmonary system; chemical regulation of ventilation; model of the regulation of the blood flow in the circulatory system; mechanism of the glucose regulation. Lecture III - Idea: Comparison between the open- and closed-loop behaviour of the physiological models developed in lesson II, through the analysis of the impulsive and step responses. Lecture IV - Applications: Implementation in MATLAB/SIMULINK of the models developed in lesson II. It will be shown how the in-silico analysis can predict the occurrence of pathological events. Lecture VI - Conclusions (200-300 car.): Discussion of some case studies developed by the students.			SI	Docenti di riferimento: Francesco Amato, Maria Romano. Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
12.	Combining GAIT Analysis and Artificial Intelligence for Health Monitoring	10	secondo anno terzo anno	Lecture I - Course introduction; the history of motion analysis; Footprint and Bulky systems. Lecture II - Wearables systems; Spatial, temporal, kinematic, kinetic, and other parameters. Lecture III - Protocols; Neurology, Orthopaedics, and Rehabilitation purposes. Lecture IV - Verticalization on Parkinson's Disease; How to deal with gait analysis data (statistics and machine learning applications). Lecture V - Presentations of the project work from the students; final considerations.			SI	Docente di riferimento: Carlo Ricciardi. Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules
13.	Using Deep Learning properly	12	secondo anno terzo anno	Designing and implementing a Deep Learning system is not an easy task. The process requires several choices regarding model design, data engineering, parameter modification and testing. This process is easily subject to errors that are not easily identifiable and, in some cases, may lead to underestimating or overestimating the performance of the proposed solution. This course aims to provide a general pipeline for designing and validating a machine learning system, avoiding the most common errors that can easily be made. To this end, it will be shown how to implement the experimental evaluation of simple classification tasks, highlighting their			SI	Docente di riferimento: Andrea Apicella Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules

			peculiarities and points to pay attention to. The practical part of the course is based on PyTorch, one of the best-known packages for neural networks. An introductory view of it is given. Lecture I (2h) - Introduction - Reminders of supervised ML - NumPy Fundamentals Lecture II (2h) - PyTorch Fundamentals Lecture III (2h) - Automatic Gradient Computation - Common mistakes in Automatic Gradient Computation Lecture IV (2h) - Building a neural network - Common mistakes in building a PyTorch neural network - Gradient Descent Lecture V (2h) - Hyperparameters estimation - Model validation strategies - Training a PyTorch Neural Network Lecture VI (2h) - Data Leakage in Machine Learning - The randomness incidence - The importance of ablation studies - Clever Hans in ML and the importance of eXplainable Artificial Intelligence (XAI)				
14.	Ultra High Field Magnetic Resonance Imaging	12	terzo anno	Lecture I - Introduction and basic principles: Physical basis of the Magnetic Resonance Phenomenon. The Bloch equation and the Larmor frequency. Effect of static field B0 and RF field B1 on the magnetization of the hydrogen nucleus. The relaxation phenomenon. The spin-spin and the spin-lattice relaxations. Reciprocity. Lecture II - MRI signal and image formation: Signal to noise ratio in MRI. Intrinsic SNR and ultimate intrinsic SNR. Gradient fields and their use for localization. Definition and comprehension of the k-space for image creation purposes. Electromagnetic description in canonical and actual problems. Numerical and analytical approaches. Advantages and limitations of the presented methodologies. Lecture III - MRI in clinical applications: dedicated to clinical applications of MRI with reference to the multiparametric characterization of normal and abnormal structures using different acquisition sequences. Conventional as well as "advanced" applications will be covered Lecture IV - Ultra High field MRI: Why Ultra High field MRI. Challenges in Ultra high field MRI. Field inhomogeneity and patient safety. Solutions to control the field distribution in the scanner.			SI	Docente di riferimento: Giuseppe Ruiello Aggiornamenti su contenuti e tempi del corso sul sito https://icth.dieti.unina.it/index.php/en/didactics/ad-hoc-modules

				Lecture V - High permittivity materials in MRI: Introduction of high permittivity materials (HPM) in MRI. Experimental evidences and actual knowledge on the underlying phenomena. Discussion, concluding remarks and learning assessment. Lecture VI - Exposure limits in MRI and Conclusions: Scientific principles. International Guidelines. Italian law. Occupational limits.				
15.	Metrology and Machine Learning for Brain Computer Interfaces	14	secondo anno terzo anno	Lecture I - Wearable EEG-based instrumentation for Brain-Computer Interfaces (History, taxonomy, architectures, Design of daily-life Brain Computer Interfaces, Characterization of low-cost EEG instrumentation, Cybersecurity and privacy issues) Lecture II - Fundamentals of metrology for BCI (Metrological characteristics, Experimental design, Statistical testing) Lecture III - Signal acquisition for BCI (Sampling and errors, Hardware for Analog Digital Converters, truncation error) Lecture IV - Introduction to Machine Learning (Traditional machine learning approaches, Artificial Neural Networks (ANN), Fully connected neural network, Convolutional neural networks, Validation methods) Lecture V - Uncertainty management in passive BCI measurement (Uncertainty sources: the role of the model uncertainty and the intrinsic, uncertainty of the measurands, Experimental reproducibility issues: stimuli standardization and sensitivity) Lecture VI - Active BCI instrumentation (fundamentals of neurophysiology in active BCI, hardware and software for acquisition and neurofeedback, processing approach).			SI	Docente di riferimento: Pasquale Arpaia Aggiornamenti su contenuti e tempi del corso sul sito
16.	Modern science and legal discipline of Artificial Intelligence	22	primo anno secondo anno	Lecture I - This lesson will explore Galileo's intuition that the natural world can be understood through mathematical language and geometric figures. It will discuss how this intuition led to the development of modern science and how it differs from previous understandings of the natural world. Lecture II - This lesson will focus on the hypothetical-deductive method, which is a way of testing scientific hypotheses by deriving predictions from them and then testing those predictions against empirical data. Lecture III - This lesson will examine the limitations and uncertainties of scientific knowledge and how philosophy can help overcome these aporias. It will also discuss the different ways in which science and			SI	Docente di riferimento: Lucio Franzese Aggiornamenti su contenuti e tempi del corso sul sito

				philosophy approach questions of truth and certainty.				
				Lecture IV - This lesson will argue that science cannot claim to grasp the truth, but rather only to provide models that are useful for predicting and explaining phenomena. It will explore the relationship between power and knowledge and how scientific knowledge can be used for both good and bad purposes.				
				Lecture V - This lesson will discuss the relationship between law, science, and philosophy. It will explore how different legal theories have attempted to define the nature of law and how they have been influenced by scientific and philosophical thinking.				
				Lecture VI - This lesson will focus on the complexity of contemporary law, particularly in the context of economic and technical globalization. It will examine the challenges of regulating new forms of economic activity.				
				Lecture VII - This lesson will discuss the challenges of regulating the digital world, particularly in the context of emerging forms of global economic activity.				
				Lecture VIII - This lesson will argue that law is a social phenomenon that arises from the values and norms of a particular society.				
				Lecture IX - This lesson will focus on the European AI Regulation and its implications for the regulation of AI.				

Riepilogo automatico insegnamenti previsti nell'iter formativo

Totale ore medie annue: 72.33 *(valore ottenuto dalla somma del Numero di ore totali sull'intero ciclo di tutti gli insegnamenti diviso la durata del corso)*

Numero insegnamenti: 16

Di cui è prevista verifica finale: 16