ARTIFICIAL INTELLIGENCE

DM 630/Fondazione ISI - Mathematical modeling and control - theoretical approaches to forecast and contain epidemic processes

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] FONDAZIONE DI PARTEC.PER L'INNOVAZ.E LO SVIL.IMPRENDITORIALE [P.iva/CF:02247870500] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	The project aims at leveraging mechanistic and data-driven techniques to model the spreading of epidemics in populations. The developed models will be used to produce epidemic forecasts and to design model-based control strategies to contain epidemics, entailing different pharmaceutical and non-pharmaceutical options (e.g. vaccination, quarantine, travel bans, etc.). Methodological tools encompass nonlinear systems and controls, game-theoretical approaches, stochastic systems and data-driven approaches. Progetto finanziato dal PNRR a valere sul DM 630/2024 - CUP: E14D24002330004
Objectives	The PhD activity aims to develop and integrate mathematical modeling and control-theoretical approaches to forecast and contain epidemic processes. The research focuses on constructing advanced differential equation models, agent-based simulations, and stochastic processes to accurately simulate the dynamics of infectious disease spread. The integration of real-time data analytics with these models will enhance their predictive accuracy and responsiveness through the application of advanced AI techniques, providing robust tools for public health decision-making. The balance between AI- and data-driven approaches and mechanistic ones will enhance interpretability and explainability of the modeling and control system. By incorporating control theory, the project seeks to design optimal intervention strategies, including vaccination, quarantine, and social distancing, to minimize the impact of epidemics. This multidisciplinary approach will contribute

	significantly to the theoretical foundation and practical application of epidemic control, offering novel insights and methodologies for managing public health crises effectively. The expected outcomes include improved predictive models, optimized control strategies, and a comprehensive framework for epidemic containment, ultimately aiding in the development of proactive and adaptive public health policies. The research is consistent with the needs of the Country, as specified in the PNRR objectives “M6C1” and “M6C2”.

Skills and competencies for the development of the activity	- System and control theory, especially in nonlinear systems - Stochastic systems - AI and data-driven approaches for data analysis - Coding skills in contemporary programming languages (e.g. C++, Python, Matlab)