AXES/1

SC_EN_04

IMT SCUOLA ALTI STUDI LUCCA

RESEARCHERS

Giorgio Gnecco

LAB

Analysis of Complex Economic Systems

Research activity

The research activity is based on advanced optimization and machine learning techniques, and belongs to the field of operational research, i.e., that branch of applied mathematics in which complex problems or systems are analyzed through suitable mathematical tools to guide the decision-making process. Given the cross-disciplinary nature of the applications of operations research, collaborations with researchers with different backgrounds (for example: economists, engineers, mathematicians, doctors), are frequent, with projects in various areas. Some current and past lines of research are listed below.

Optimization (determination of optimal parameters of mathematical models of complex systems)

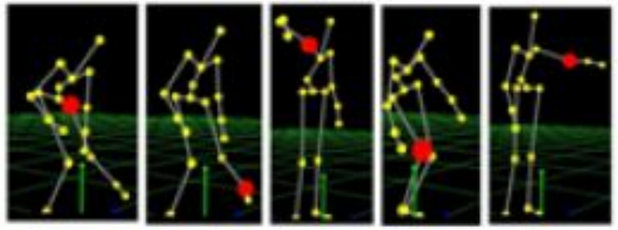
· In the economic field: determination of optimal parameters in insurance contracts and pension systems; optimal drug pricing; optimal choices of production and consumption.

· In the industrial field: call access control and congestion control in telecommunications networks; optimization of physical properties of complex materials for the design of mechanical filters.

Game theory (analysis of the interaction between agents with or in the absence of cooperation): in the economic field, solution of mathematical models related to pollution and deforestation through the theory of non-cooperative dynamic games; study of centrality measures of nodes of network for the analysis of road transport networks through the theory of cooperative games.

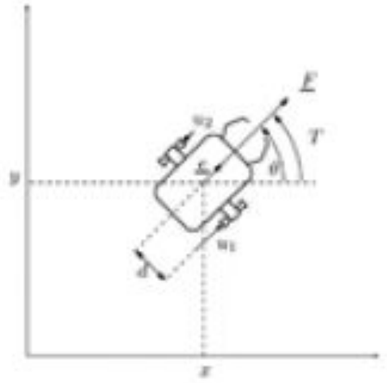
Machine learning (automatic learning from data) for environmental, medical, economic, biomechanical applications: classification of natural hazards; medical image classification and segmentation; study of soft skills and input/output analysis; analysis of human movement data collected with motion capture techniques.

Images



example of application of machine learning techniques to the analysis of movement

example of a public transport network



example of control of a spatial robot

Technologies and services

Implementation (mainly through the MATLAB software) of the optimization and machine learning algorithms resulting from the own research activity

Applications and collaborations

Considering the growing availability of datasets from companies and organizations, machine learning is becoming a knowledge-extraction tool that will be applied across many sectors to understand their hidden potential, detect patterns hidden in the data, and make possible both the personalization of the services and the control, also in real time, of environments and objects. In the context of the strategies for problem formulation and solving based on Machine Learning, also optimization plays a relevant role, sharing many of the approaches expressed above.

The research activities have applications in the automatic analysis and optimization of industrial processes and complex systems. The following are some possible examples:

· Application of machine learning techniques to various phases of industrial processes (e.g., quality control, fault detection).

· Applications of operations research to the analysis of transport and telecommunications networks (for example: routing problems, study of centrality measures of nodes on a graph, traffic congestion analysis).

· Applications of optimization to logistics (for example: warehouse management, scheduling, distribution).

By the way of example, techniques that can be used for such applications include:
unsupervised learning; supervised learning; semi-supervised learning; online learning; deep learning; optimal control; reinforcement learning; cooperative game theory; non-cooperative game theory; linear optimization; non-linear optimization; combinatorial optimization.

For more information

Ufficio di Trasferimento Tecnologico della Scuola IMT Alti Studi di Lucca

Address: Piazza San Ponziano 6 - 55100 Lucca, LU
Web site: https://www.imtlucca.it/
E-mail: projects@imtlucca.it

For more information

Ufficio Regionale di Trasferimento Tecnologico

Address: Via Luigi Carlo Farini, 8 - 50121 Firenze, FI
E-mail: urtt.@regione.toscana.it

IMT SCUOLA ALTI STUDI LUCCA

REGIONE TOSCANA

urtt Ufficio Regionale di Trasferimento Tecnologico