CORSI DI DOTTORATO in:
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UNIVERSITÀ DEGLI STUDI NICCOLÒ CUSANO –
TELEMATICA ROMA
Via Don Carlo Gnocchi, 3 – 00166 ROMA

Machine Learning

29 September 2023, Friday, 4 hours (first part) 14:00-18:00
6 October 2023, Friday, 4 hours (second part) 14:00-18:00

Via Don Carlo Gnocchi 3, Roma, 00166
Room 14, new building
The course will also be available online, the links will be circulated by email

Prof. Carlo Drago
Professore Associato di Statistica Economica presso Università degli Studi Niccolò Cusano

Abstract

Artificial intelligence, including machine learning, has become a transformative force in the tech landscape. As a result, this technology has revolutionized several engineering disciplines by introducing novel methods for problem-solving, system design, and optimization. This comprehensive summary further explores the far-reaching impact of machine learning in engineering.

Machine learning algorithms have proven invaluable for predicting the structural integrity of buildings and bridges. These algorithms analyze data from sensors embedded in structures to detect potential failures before they occur. The predictive capabilities enhance safety by enabling proactive maintenance to prevent catastrophic structural failures. In addition, this approach significantly reduces reactive maintenance and emergency repairs, resulting in a more efficient allocation of resources.

Machine learning has also greatly benefited the field of electrical and computer engineering. Machine learning algorithms have revolutionized the design and optimization of integrated circuits, power systems, and communication networks. Routing and scheduling algorithms improve the performance and reliability of networks. In addition, machine learning techniques play a critical role in the development of advanced robotics and automation systems. This enables these systems to learn from their environment and adapt their behavior accordingly, increasing their performance and utility over time.

Machine learning has played an essential role in streamlining mechanical and aerospace engineering design processes. Mechanical systems and components can be optimized using machine learning algorithms. As a result, product development cycles can be shortened by reducing prototyping and testing costs. In addition, machine learning algorithms can predict and prevent aircraft and spacecraft failure. The predictive capabilities of these vehicles contribute to aerospace safety and reliability.

Thanks to machine learning, the environmental and chemical engineering fields have also evolved significantly. Machine learning algorithms can now be used to model complex chemical reactions and environmental systems to improve processes and environmental management. For example, using machine learning models,

it is possible to develop effective remediation strategies to predict the behavior of pollutants in the environment. The importance of environmental protection in today's world makes this capability particularly necessary.

Ultimately, machine learning has become an indispensable engineering tool. Thanks to its innovative solutions to complex problems, engineering systems are more efficient, safer, and more sustainable. As a result, engineering research and practice will increasingly rely on machine learning as the field evolves. A robust and interpretable machine learning model should be developed in the future. This transformative technology can reach its full potential when these models are seamlessly integrated into the engineering design process.

It is important to note that machine learning has applications not only in traditional engineering disciplines but also in biotechnology and nanotechnology.

Several large data sets, such as genomic sequences, medical imaging, and patient records, are analyzed with machine learning in bioengineering. Algorithms can discover patterns and correlations that humans cannot, leading to new insights into disease mechanisms, personalized medicine, and health outcomes. For example, a machine learning model can predict a patient's response to treatment based on their genetic profile, allowing physicians to tailor treatment to each individual.

Nanotechnology machine learning is used to develop and optimize nanomaterials with specific properties. New materials with novel properties can be discovered using these algorithms by exploring the vast design space of possible nanomaterial configurations more efficiently than traditional methods. For example, nanoparticles for targeted drug delivery have been developed using machine learning models, resulting in more effective and less toxic treatments.

In addition, machine learning is essential in developing sustainable engineering solutions. These algorithms are more efficient and can reduce the environmental impact of renewable energy systems. For example, machine learning models can enable grid operators to better integrate wind and solar farms by predicting their output based on weather forecasts.

As a result of machine learning, engineering systems are becoming more resilient to natural disasters and climate change. Engineers can use these algorithms to design systems that withstand extreme weather events. For example, using machine learning models, power grids have been designed to be more resilient to hurricanes.

Machine learning applications in software development include automating code generation, error detection, and software testing. The algorithms can analyze large code bases and detect patterns and anomalies, leading to more reliable and efficient software development.

Engineers' use of machine learning is not just a tool but has changed how engineers approach technical problems. Our engineering processes will become more innovative and impactful as we develop more sophisticated machine-learning models. Machine learning has tremendous potential for engineering, and we are just beginning to scratch the surface.

This course introduces students to relevant contemporary Machine Learning, both supervised and unsupervised.

Carlo Drago: short c.v.

Professional Career
2008 Ph.D. in Statistics, University of Napoli Federico II.

2014-2019 Senior Researcher (RTDA) in Probability and Statistics, University Niccolò Cusano

2019-2022 Senior Researcher (RTDA) in Economic Statistics, University Niccolò Cusano

2021-2022 Expert at European Commission (Horizon Europe-HORIZON Expert Group at JRC / Joint Research Center, European Commission)

2022 Associate Professor in Economic Statistics, University Niccolò Cusano, Rome

2023 Associate at National Research Council (CNR) ISMed Institute, Naples

Main Research Areas

Machine Learning, Symbolic Data Analysis, Time Series Analysis, Network Analysis, Composite Measures using Intervals, Applications.

Publication Productivity (source: SCOPUS at 17/5/2023)
Total number of publications (since 2011): 56
Current h-index: 13
Total citations 640 by 561 documents.

Recent publications in top Internationals Journals, among others, on Energy Policy, Business Strategy and the Environment, Utility Policy, Technovation, Energy Research, and Social Science, Ecological Economics, Physica A, Quality & Quantity, Pharmacoeconomics and Cliometrica.

TEACHING ACTIVITIES

Computer Science for Engineers

Computer Science for Economists

Probability and Statistics

Economic Statistics

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