Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2024

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Department Name: Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB)

Research topic: data-driven decision-making

MSCA-PF Research Area Panels:
  ☐ ECO_Economic Sciences
  √ ENG_Information Science and Engineering
  ☐ ENV_Environmental and Geosciences
  ☐ LIF_Life Sciences
  ☐ MAT_Mathematics
  ☐ PHY_Physics
  ☐ SOC_Social Sciences and Humanities
  ☐ CHE_Chemistry

Brief description of the Department and Research Group (including URL if applicable):

The research project will be hosted by the Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB), a distinguished institution dedicated to advancing research, education, and technology transfer in various domains, including computer science, electrical engineering, electronics, bioengineering, telecommunications, and systems and control. With more than 300 faculty members and 400 PhD students spanning diverse fields, DEIB stands as one of the largest departments of Information Technology in Europe, fostering a dynamic and vibrant environment conducive to interdisciplinary collaboration and cutting-edge research.

The project will be under the supervision of Prof. Simone Garatti, who pioneered the Scenario Approach as a comprehensive framework for data-driven decision making. Prof. Garatti's groundbreaking contributions have earned him international recognition, solidifying his position as a leading authority in this field.

TITLE of the project: Trustworthy data-driven decision-making via the scenario approach

Brief project description: The increasing complexity of problems faced by scientists and engineers has somehow questioned the effectiveness of traditional approaches to decision-making under uncertainty. In these conventional paradigms, decisions are crafted based on models that attempt to describe the mechanisms driving uncertainty generation. However, as the problems tackled by modern science and engineering become ever more intricate, these models often fall short and are unable of a suitable representation of the factors at play. Consequently, the assumption of comprehensive knowledge becomes unrealistic, leading to potential misjudgments and flawed decisions.

In response to these challenges, a new paradigm has emerged: data-driven decision-making. In this approach, first-hand information contained in data is directly used as the primary source of knowledge upon which decisions are based. This shift has sparked a revolution in problem-solving, unlocking achievements previously deemed unattainable and propelling us into a dynamic and vibrant era of discovery and innovation.

Yet, amidst this progress, a significant concern arises: the rapid development of algorithmic solutions has outpaced our theoretical understanding, leading often to purely heuristic methods, and this gap threatens to jeopardize the effectiveness and the dependability of our decision-making processes. This issue is particularly worrisome as society increasingly embraces automated decision-making systems, where the reliability of data-driven solutions is paramount for ensuring safety and efficacy.

Addressing this challenge requires the development of certified methodologies that can attest to the reliability of data-driven solutions. However, this task is full of difficulties: to be truly effective, certification must be conducted in an agnostic manner, acknowledging our inherent ignorance of the underlying mechanisms generating uncertainty; moreover, in many cases data are a scarce resource, since collecting them is time-consuming and expensive, and new methods capable of maximizing their utility without wasting the available information are essential.

In this respect, the Scenario Approach has proven to be a genuinely new and versatile framework for dependable data-driven decision-making where the informational content of the data is fully exploited without introducing conservatism. In particular, the Scenario Approach is underpinned by an unprecedented generalization theory that enables risk certifications starting from the data used for design, and its development has unveiled fundamental mechanisms for learning from observations.

Despite its considerable promise, the journey toward fully realizing the potential of the scenario approach is far from over. While significant progress has been made, there remains a vast landscape of uncharted territory to explore, and the aim of the present project is to begin this exploration. Removing certain standing assumptions that significantly limit applicability, improving methodologies substantially, and enhancing computational aspects are just a few of the challenges that lie ahead to evolve the Scenario Approach into a full-fledged paradigm. This research project is not merely about utilizing existing tools, but rather about embarking on a quest to discover; the impact and importance of this long-term research cannot be overstated, as it lays the groundwork for the technologies of the future.