Ph.D. in Information Technology
Thesis Defense

March 4th, 2026
at 8:45 am
"Alpha" Room – building 24

Abednego Wamuhindo Kambale – XXXVIII Cycle

Partitioning and Managing Artificial Intelligence in Computing Continua for Smart EyeWear

Supervisor: Prof. Danilo Ardagna
Co-Advisor: Prof. Federica Filippini, Prof. Hamta Sedghani

Abstract:

Smart Eye-Wear (SEW) devices represent a transformative paradigm in wearable computing, which enables real-time AI-powered applications such as object detection, scene understanding, and augmented reality experiences across diverse domains including healthcare, navigation, education, entertainment, and industrial assistance. These devices utilize Deep Neural Networks, which necessitate substantial computational resources to provide advanced functionalities that augment human capabilities and transform our interaction with our surroundings. However, SEW are resource-constrained devices, which possess limited computational power, memory capacity, and battery life. This creates fundamental challenges for executing complex AI applications while maintaining satisfactory user experience. The mismatch between AI computational demands and SEW resource availability requires intelligent task offloading strategies that can help distribute processing across heterogeneous computing environments, which comprise local devices, edge servers, and cloud infrastructure in a Computing Continuum paradigm. The effective management of AI execution in such resource-constrained, distributed environments poses significant optimization challenges. AI applications requires real-time guarantee while at the same time minimizing energy consumption and communication costs, often requiring dynamic adaptation to changing network conditions and varying computational loads. Furthermore, many critical applications demand accuracy guarantees, which creates complex multi-objective optimization problems where traditional approaches prove inadequate. The dynamic nature of SEW environments, which is characterized by mobility, variable connectivity, and heterogeneous resource availability, imposes adaptive runtime management strategies. This dissertation addresses these challenges by investigating reinforcement learning approaches for intelligent resource management in SEW-centric AI execution. The research proposes mathematical formulations for identified problems which comprise multiple competing objectives and proposes reinforcement learning algorithms, progressing from foundational tabular methods to advanced hierarchical multi-agent systems. The work establishes frameworks that balance energy efficiency, execution performance, communication costs, and application accuracy across distributed computing environments. This dissertation considers AI applications based on a single component or those based on a pipeline, federated learning scenarios, and extensions to serverless computing environments. The proposed approaches demonstrate significant improvements over existing methods through extensive experimental validation in both simulated and real-world prototype environments based on Microsoft HoloLens 2. The research establishes reinforcement learning as a fundamental technology that enables efficient AI execution in SEW resource-constrained environments, and provides theoretical foundations and practical frameworks for next-generation AI-enhanced wearable technologies.

PhD Committee

Prof. **Manuel Roveri, Politecnico di Milano**

Prof. **Gabriele Russo Russo, Università degli Studi di Roma Tor Vergata**

Prof. **Riccardo Lancellotti, Università degli Studi di Modena e Reggio Emilia**