Knowledge discovery in eco-evolutionary diversification-inspired federated networks (ROBHOOT)

1 Excellence

1.1 Radical vision of a science-enabled technology

Ecosystems' collapse around the globe is calling for technologies to discover novel ways of sustainable exploitation. Knowledge-based societies place great expectations on data-driven intelligent machines to face global sustainability challenges. In this regard, rapid and real-time discovery computation is currently a major issue revolving around data-driven intelligent machines and knowledge-based societies. Diversification of biological systems offers an unexplored avenue for inspiration of new computational approaches. However, diversifying ecosystems are not used for discovery computation yet, despite the rapid changes of traits and interactions observed in experimental and theoretical systems [1, 2]. Biological systems are characterized by feedbacks between the ecology and evolution of interacting traits, the eco-evolutionary feedbacks, to produce novel traits with new functionalities. This results in new computational properties, like new cooperation and competition strategies and information processing capabilities. Conventional Artificial Intelligence (AI) is rapidly moving towards explainable and discovery pattern inference [3] but often avoids evolutionary diversification for exploring new computing capabilities [4]. The same situation occurs for artificial neural networks that also make limited use of novel computing capabilities as a consequence of new interactions and traits [5]. **The goal of this project is to implement eco-evolutionary diversification-inspired solutions to perform discovery computation based on rapidly evolving traits and interactions**. The exploitation of evolving connections and traits will allow us to create novel discovery computation solutions for natural ecosystems facing sustainability challenges like overexploitation of the Oceans, where harvesting renewable resources are in the point of diminishing returns for many species [6].

Why should we go deeper into diversifying networks for discovery computation? With connections and traits represented in a spatially distributed network, as found in natural ecosystems, diversification is an avenue to harvest renewable resources. This allows considering not only evolutionary processes changing traits and agents but the formation of new entities to decipher new scenarios for sustainability. This also allows representing real-time solutions for ever-changing renewable resources, which is a key problem in many digital and natural ecosystems. To show the capabilities of the ROBHOOT approach, we will address full reproducibility, automation, visualization, and reporting (Figure 1). **The main impact of ROBHOOT is to provide a new technology to improve ecosystem sustainability relevant to community-rich digital and natural ecosystems.** To support this notion, we will perform eco-evolutionary diversification-inspired simulations along the whole life cycle of the project. The central goals of ROBHOOT are:

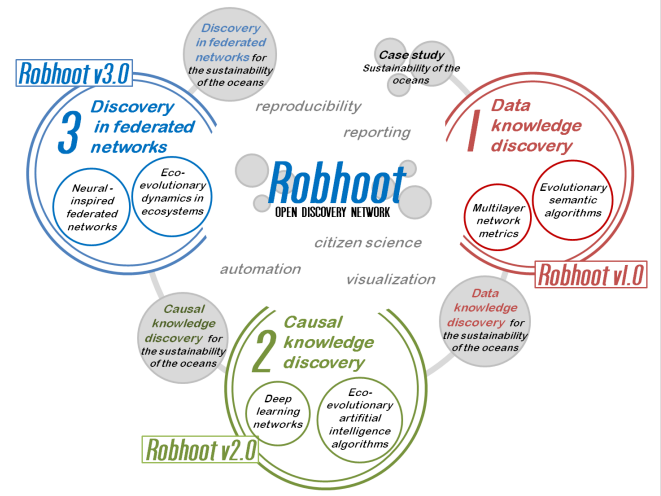

Figure 1: **Discovery in evolutionary diversification-inspired federated networks**. ROBHOOT target knowledge discovery when heterogeneous groups of species, humans and technologies share resources for a sustainable knowledge-based society: It introduces three science-enabled technologies: Evolutionary biology-inspired semantic algorithms for ROBHOOT v1.0 (ESA, data knowledge discovery, red), eco-evolutionary diversification-inspired AI models for ROBHOOT v2.0 (EEDA, causal knowledge discovery, green), and evolutionary neural diversification-inspired federated networks for ROBHOOT v3.0 (ENDI, discovery in federated networks, blue). ROBHOOT uses the sustainability of the Oceans case study in federated networks as an open-source technology with full reproducibility, automation, visualization and reporting for an open citizen science.

(G1) To extend existing theories of eco-evolutionary diversification and AI-inspired solutions to decipher the factors driving discovery computation in federated networks. This will allow us to identify novel solutions for ecosystem sustainability.

(G2) To investigate how spatiotemporal evolutionary diversification and AI-inspired networks mimic the empirical patterns of natural and socio-technological ecosystems when heterogeneous human groups and species coexist.