# Knowledge discovery in eco-evolutionary biology-inspired federated networks ROBHOOT

## 1 Excellence

### 1.1 Radical vision of a science-enabled technology

Rapid, real time, data heterogeneity- and cooperation-based, discovery computation is currently a major issue revolving around data-driven intelligent machines and knowledge inspired societies. Several of these properties are found in evolving networks being these changes occurring in dynamic connectivity patterns and/or traits in neurons, and populations in natural ecosystems. However, evolving networks are not used for discovery computing yet, despite rapid trait evolution has been observed in experimental and theoretical systems [15, 17]. For example, evolving networks are characterized by feedbacks between the ecology and evolution of interacting traits, the eco-evolutionary feedbacks, to produce novel trait changes with new functional properties in ecosystems. This results in new computational properties, like novel interaction types (i.e., cooperation, competition, antagonism, etc), morphologies and/or evolving learning capabilities among agents to add discovery computing properties to the network. Conventional Artificial Intelligence (AI) computation is rapidly evolving towards explainable and discovery pattern inference [22] but often avoids evolutionary changes for exploring new computing capabilities [27]. The same situation occurs for artificial neural networks that also make only limited used of novel computing capabilities as a consequence of evolutionary changes in interactions and traits [29]. However, the rapid novel properties of evolving connections and traits, the diversifying power of biological systems, that make evolutionary-biology inspired networks highly plastic and resilient, have not yet been exploited in discovery computation. **The goal of this project is to implement eco-evolutionary-biology inspired solutions to make discovery computation a cooperative game of rapidly evolving traits and interactions**. The exploitation of evolving connections and traits will allow us to create novel types of discovery computation solutions for natural ecosystems facing sustainability challenges like overexploitation of the Seas, where harvesting renewable resources are in the point of diminishing returns for many species, communities and ecosystems (refs +++).

Why should we go deeper into evolving and diversifying information processing systems for discovery computation? With connections and traits (i.e., nodes and links in networks) represented in a spatially distributed network, as found in natural ecosystems, it is possible to untangle mapping of many spatiotemporal inputs onto many output functions considering learning among the interacting and heterogeneous traits and agents to decipher new solutions for harvesting renewable resources. This allows representing real-time solutions for spatiotemporal ecosystems with renewable resources, which is a key problem in many digital and natural ecosystems.

To show the capabilities of the ROBHOOT approach, we will complement the novel implementations of evolutionary biology-AI discovery computation with full cycle reproducibility, automation and visualization to trigger its properties at large-scale (Figure 1). **The main impact of ROBHOOT is that we provide novel discovery computation solutions to substantially improve ecosystem sustainability especially relevant for community-rich digital and natural ecosystems**. To support this notion, we will perform eco-evolutionary biology-AI network inspired simulations of multiple data-heterogeneity based networks. The central goals of $\mathcal{ROBHOOT}$ are:

1. To extend existing theories of eco-evolutionary biology-AI inspired in networks to obtain understanding of the factors and their interactions underlying discovery computation in cooperative federated networks. This will allow us to identify novel paths of reliable solutions for ecosystem sustainability.
2. To investigate how spatiotemporal evolutionary biology-AI-inspired networks can mimic the empirical patterns of natural and socio-technological ecosystems when large and heterogeneous exploiting groups and species coexist.
3. To develop fast, reproducible and automated discovery eco-evolutionary biology-inspired computation prototypes for real-time information processing tasks.