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 in the absence of technologies to discover novel ways of sustainable exploitation of complex ecosystems. In this regard, rapid, real time, heterogeneous- and cooperation-based, discovery computation is currently a major issue revolving around data-driven intelligent machines and knowledge inspired societies facing global sustainability challenges. However, diversifying networks are not used for discovery computation yet, despite rapid changes in trait and interaction have been observed in experimental and theoretical systems [15, 17]. 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 interactions (i.e., cooperation, competition, antagonism, etc), and information processing and learning capabilities. Conventional Artificial Intelligence (AI) computation is rapidly moving towards explainable and discovery pattern inference [21] but often avoids evolutionary diversification for exploring new computing capabilities [26]. The same situation occurs for artificial neural networks that also make limited use of novel computing capabilities as a consequence of the emergence of new interactions and traits [28]. **The goal of this project is to implement eco-evolutionary-diversification inspired solutions to make 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 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 diversifying information processing for discovery computation? With connections and traits 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. This allows considering not only evolutionary processes changing traits and agents but the diversification of new entities to decipher new solutions for harvesting renewable resources. 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 complement novel implementations of evolutionary diversification-AI discovery computation with full reproducibility, automation, visualization and reporting to trigger its citizen science and scalability properties at large-scale (Figure 1). **The main impact of ROBHOOT is to provide novel open-source software for reproducible discovery computation solutions to substantially improve ecosystem sustainability relevant for community-rich digital and natural ecosystems**. To support this notion, we will perform eco-evolutionary diversification and AI inspired simulations accounting for heterogeneity in data-sources. The central goals of ROBHOOT are:

1. 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 paths of reliable solutions for ecosystem sustainability.
2. To investigate how spatiotemporal evolutionary diversification and AI inspired networks can mimic the empirical patterns of natural and socio-technological ecosystems when large and heterogeneous exploiting human groups and species coexist.
3. To develop fast, reproducible and automated eco-evolutionary biology-inspired discovery computation prototypes for real-time information processing tasks.
4. To arrive at powerful discovery computation principles for forecasting in federated networks when diversification in interactions and traits occur in a large and heterogeneous pool of species, technologies and human groups.

1.2 Science-to-technology breakthrough that addresses this vision