direction for eco-evolutionary diversification-inspired discovery computation.

Table 1.4a: Critical risks for the research approach

Description of risk	Objective	WP	Proposed risk- mitigation measures
ESA insufficiently developed: Medium	2	WP1	Use traditional non-semantic genetic algorithms to infer data connections.
Low number of training data available: Medium	2,3	WP2	Alternative methods focusing on matrix decomposition.
Automated evolutionary-inspired expressions for causal knowledge discovery insufficiently developed: Medium	2,3	WP2	Symbolic regression methods for causal discovery accounting for evolutionary rules.
Extended EEDA in species-rich ecosystems insufficiently developed: Medium	1-4	WP3	Mean-field approximations using classical ODE systems and novel universal differential equations for scientific machine learning.
ENDI in federated networks insufficiently developed: High	1-4	WP3	Alternative neural network models based on deterministic spiking neurons.
Cooperative forecasting mixing EEDA and ENDI in federated networks insufficiently developed: High	1-4	WP3	Combine EEDA and ENDI on a smaller spatiotemporal scale.

1.4 High risk, plausibility and flexibility of the research approach

ROBHOOT represents a novel approach for discovery computation in ecosystems. The transfer of eco-evolutionary diversification-inspired principles onto fully reproducible and automated software, progressing towards a process-based discovery technology, will be a major qualitative step, defining ROBHOOT as a high-risk project, fitting into FET-Open. To achieve the ambitious goals, we will combine expertise from all the involved areas, gradually mitigating risk, following a strict line and increasing step-by-step in the complexity of the problems addressed. We will start with evolutionary biology-inspired semantic algorithms for data discovery applying them to the sustainability of the Oceans case study. This is followed by more complex eco-evolutionary diversification-inspired AI modeling to infer causality in our case study. Then, we will advance to more complex situations, where evolutionary neural diversification-inspired modeling will expand the search along many distinct forecasting schemes to discover sustainability paths. To keep the project technically feasible, and to be able to connect properties from data and causal discovery computation to discovery in federated networks, we will limit methods to three main approaches. All of the above will be done by combining data-driven simulations, theoretical work and numerical simulations with our sustainability of the Oceans case study crossing them all. The knowledge gained will allow us to present ROBHOOT as a compact science-enabled open-source technology. We will use fast computing languages to implement Agent-Based Models (ABM) along with all the theoretical development of the proposal. We will contrast the ABM with differential/difference stochastic equation methods when a large number of agents, traits, and interactions diversify in time and space. This feature represents a very desirable fallback in case of speed and convergence problems for multidimensional and nonlinear systems (Table 1.4a, Critical risks for the research approach). Our implementation activities are all complemented by numerical investigations contrasted for speed and robustness with the sustainability of the Oceans case study (Figure 2). The success of ROBHOOT would represent a breakthrough in the current discovery computation with direct application to the sustainability of ecosystems and beyond. The combination of rapid, heterogeneous database and cooperation for discovery computation based on open-source algorithms will lead to fast implementations of the demonstrators with high flexibility that will permit a rapid transit to the public.

2 Impact

2.1 Expected impact

(I) **Contribution to the foundation of a new future technology**: ROBHOOT uses the discovery of novel evolutionary diversification-inspired algorithms (EEDA and ENDI) to substantially improve