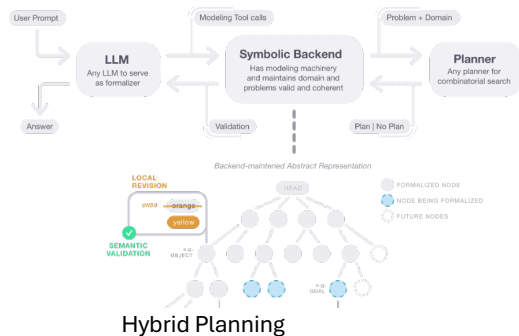


Some of the most exciting developments in modern Artificial Intelligence go beyond simply building ever larger neural networks. An important line of research asks how learning-based, probabilistic, and symbolic methods can be combined. Neural models excel at learning complex patterns from data; probabilistic models provide a principled representation of uncertainty; symbolic methods can represent structured knowledge and support reliable reasoning and planning. Hybrid AI aims at bringing these complementary strengths together in integrated models and inference procedures. Probabilistic programming, neurosymbolic AI, and hybrid inference therefore form a rapidly developing research area at the intersection of Machine Learning, Knowledge Representation, and Automated Reasoning.

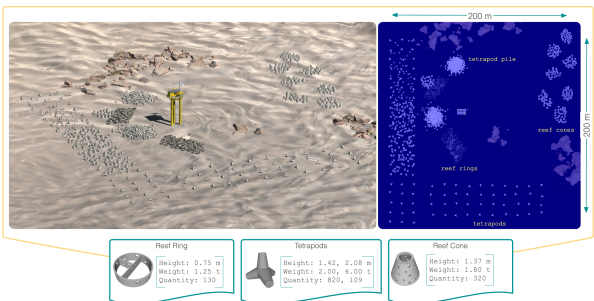
Possible seminar topics include:

- **Neurosymbolic approaches to Bayesian filtering:** How can neural perception and symbolic representations be integrated with HMMs, Dynamic Bayesian Networks, or other methods for state estimation in dynamical systems?
- **LLMs and symbolic planning:** How can a Large Language Model incrementally formalize a planning task expressed in natural language, while a symbolic planner performs the combinatorial search and verifies the resulting solution?
- **Probabilistic programming and variational inference:** How can complex generative models be expressed in systems such as Pyro and combined with automated approximate inference? One application is semi-supervised annotation of single-cell data using scANVI.
- **Hybrid data-driven and model-based perception:** How can deep-learning approaches be combined with geometric or physical prior knowledge, for example to bridge the simulation-to-real gap in underwater 3D perception?

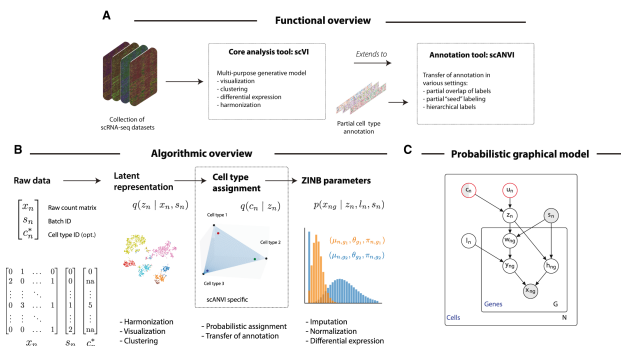
The seminar is aimed at Master's students who want to analyze, compare, and critically discuss current research. A central question throughout the seminar is when combining different representations and inference paradigms provides a genuine advantage over purely data-driven or purely symbolic approaches.



Hybrid Planning



Hybrid Sonar Data Analysis (Nienhagen Reef)



Hybrid Cell Analysis (DOI: 10.15252/msb.20209620)