

**2025.**

### **Representing reality in Artificial Intelligence**

This is a rather extraordinary group, consisting of only a single active member. All other participants associated with this topic are former group members now working elsewhere, as well as students engaging with the subject as part of their university studies.

The goal of this group is to understand the logic of how reality can be represented. While this endeavor is independent of artificial intelligence (AI) as a discipline, any effective AI system must necessarily rely on elements of such representations. Reality representation has several distinct aspects, some of which are outlined below.

- **Direct and indirect representation (System 1 vs. System 2):** The most direct form of representation arises when a model is trained to predict the next element of a time series. Although this approach is simple and highly scalable, it comes with significant drawbacks. It offers little control over the generated elements, provides limited generalization, and tends to lose any global overview when dealing with long or complex inputs.
- **General and actual reality:** Contemporary AI systems—even large-scale projects such as large language models—encode general aspects of reality in an extremely detailed manner, often through hundreds of billions of parameters. In contrast, the representation of actual, local reality is only weakly incorporated, typically through a relatively small number of tokens. As a consequence, the ability to relate a concrete input (such as a text) to its surrounding, real-world context is largely absent rather than preserved.
- **Causality and laws:** Real-world situations are influenced by a multitude of factors that may affect an observed signal. Retaining all such factors is not only computationally inefficient but also leads to a significant loss in effectiveness. The relevance of parameters must therefore be estimated, and one principled way to do so is through causal analysis between a signal and its assumed causes. Only once an effect has been shown to be informative should it be incorporated into a model, for example as part of a classifier or a governing law.

We have published 5 papers in these topics:

1. [Representation and Abstraction](#), where we studied the mathematical model of abstraction, generalization and extension.
2. [Unified causality analysis based on the degrees of freedom](#), where we studied a new method for revealing causal relations in different systems
3. [Unified causality analysis based on the degrees of freedom](#), where we studied the relation of the functional renormalization group of physics and the artificial intelligence
4. [Lightweight ECG signal classification via linear law-based feature extraction](#), where we have demonstrated in an actual application the use of laws

5. [Adaptive law-based feature representation for time series classification](#), where we have further developed the law transformation method of ours to be able to solve adaptive tasks as well