

# From Deep Perceptual Learning to Deep Reasoning: A compositional perspective

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With the explosion of data, evolution of 5G networks towards 2020-2030 will be mostly based on machine learning techniques. They provide the first era of intelligent networks which we call learning networks. The second era of 6G Intelligent network for the period 2030-2040 are networks which are able to think. This requires new advanced mathematical tools which go beyond the perceptual framework of deep neural networks. Starting with compositional learning, we will present the essence of compositionality, the theory of categories, and how they define fragments of logics. Today global learning only contains semantics and is unable to generalize. In the future, we will have to introduce a syntax (naturally coming from composition). From the fragments of logics, we will have to complete it in order to have a full logic which will allow the machines to generalize. Doing that makes us combine the topology of perception and the logic of reasoning. This categorical completion, which side effect makes real the strong connection between perception and reasoning is the Grothendieck topos. We will finish our presentation by introducing this difficult notion and give some insights on the computations that can be done within a Grothendieck topos in order to design reasoning neural networks.