Learning from Constraints

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Abstract. In this talk, I propose a functional framework to understand the emergence of intelligence in agents exposed to examples and knowledge granules. The theory is based on the abstract notion of constraint, which provides a representation of knowledge granules gained from the interaction with the environment. I give a picture of the "agent body" in terms of representation theorems by extending the classic framework of kernel machines in such a way to incorporate logic formalisms, like first-order logic. This is made possible by the unification of continuous and discrete computational mechanisms in the same functional framework, so as any stimulus, like supervised examples and logic predicates, is translated into a constraint. The learning, which is based on constrained variational calculus, is either guided by a parsimonious match of the constraints or by unsupervised mechanisms expressed in terms of the minimization of the entropy.

I show some experiments with different kinds of symbolic and subsymbolic constraints, and then I give insights on the adoption of the proposed framework in computer vision. It is shown that in most interesting tasks the learning from constraints naturally leads to "deep architectures", that emerge when following the developmental principle of focusing attention on "easy constraints", at each stage. Interestingly, this suggests that stage-based learning, as discussed in developmental psychology, might not be primarily the outcome of biology, but it could be instead the consequence of optimization principles and complexity issues that hold regardless of the "body."

D. Gunopulos et al. (Eds.): ECML PKDD 2011, Part I, LNAI 6911, p. 6, 2011.