Las Matemáticas de la Materia Viva

Workshop en la frontera entre las Matemáticas y las Ciencias de la Vida

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Learning to Behave

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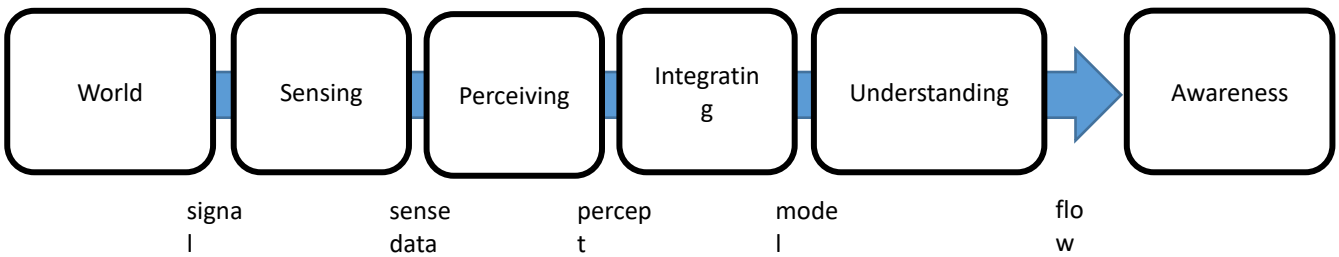
Summary

In this presentation I addressed the question of how biology connects to control systems technology. Control systems engineering has a single purpose: force systems behave in a specific way to fulfill some goals. In terms of behavior generation, life is paramount, esp. animals, and has produced entities capable of reaching goals against all odds: knowledgeable humans. In particular, I dealt with the highest forms of biological mechanisms for behavior generation -minds and knowledge- and focused on how adaptive and learning controllers are able to change their very own laws to match the challenges that an environment may impose. Dealing with change and disturbance is the core matter of control systems. This continuous change and the accompanying necessary adaptation of the agent happen at many timescales -in biology and in technology- because they are based on internal changes that affect different structures. I then addressed the core matter of my research activity: intelligent control, or how knowledge-based, agent-environment coupling can offer maximal opportunities for behavior generation, adaptation and learning. To close the talk I described my current research inside the recently approved Horizon Europe CoreSense project: how to endow autonomous systems -robots- with the capability of understanding that we humans do have. Understanding by the very agent of the agent/environment relation is a critical capability for adaptive animals and dependable artifacts; it is a much sought technology for engineering safer, trustable machines. In this project we seek a formal, mathematical model of understanding. Finally, I ended with some take home messages: Feedback, learning, prediction can leverage knowledge in the form of better agent-environment structured models (systems math). Mechanistic models are deep, use-neutral, knowledge structures (in opposition to ad-hoc, black, box, function-specific modules). The machine can know what the builder knows (physics, bio, engineering) and use it to make sense and perform run-time adaptation. This is what high-end, intelligent, educated animals do. Use more math. It is the language of the cosmos, life and cognition.



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