ERC Advanced Grant 2017
Research proposal [Part B1]

White-Box Self-Programming Mechanisms

WhiSeMech

Cover page:

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- Proposal duration: **60 months**

We are witnessing an increasing availability of **mechanisms** that offer some form of programmability. These include software, manufacturing devices, smart objects and smart spaces, intelligent robots, business process management systems, and many others. All these mechanisms are being currently revolutionized by means of advances in Machine Learning (ML). In particular central sensing capabilities (vision, language undestanding) and actuation capabilities (robot-arm movement, camera twisting) are envisioned to be handled by next generation ML-components. However, irrespective of the technological nature of the components, the connections between them are still organized, monitored, and coordinated through standard programming.

WhiSeMech aims at developing the **science** and the **tools** for a new generation of mechanisms to emerge: machanisms that are able to **program themselves** without human intervention, and automatically tailor their behavior so as to achieve desired goals, maintain themselves within safe boundaries in a changing environment, and keep following rules, regulations and conventions that evolve over time.

Unlike ML approaches which are typically black-box, WhiSeMech intends to exploite **Knowledge Representation** (KR) for realizing self-programming mechanisms that are **white-box**: specifications and automatically synthesized programs must be human comprehensible. In other words, possibly on top of suitably characterized black-box ML-components, the behavior enacted by WhiSeMech self-programming mechanisms intends to be fully **explainable in human terms by design**.

Scientifically, WhiSeMech aims at **repurposing KR** so as to bring about, together with current ML advancements, a **new AI framework** that merges key ideas from **traditional KR** on how to represent the domain of interest, the system, and their properties in a high-level human comprehensible fashion, with ideas from **Data-aware Processes** in *Databases* on how to build data-aware dynamic behaviors, and from **Verification and Synthesis** in *Formal Methods* which provide mathematically elegant foundations for synthesis. For effectiveness WhiSeMech will focus on synthesis agains computationally well-behaved temporal specification formalisms recently proposed in KR and will exploit recent advancements in **Automated Planning** in AI to gain algorithmic insights to the synthesis process.

WhiSeMech grounds its scientific results upon diverse real **application contexts**, including manufacturing systems (Industry 4.0), smart spaces (IoT) and business process management (BPM).