Corresponding abstract for presentation "Learning Action Rules in Surgery" by P. Fiorini and D. Meli "Cognitive Robotic Surgery" workshop - IROS 2020

This presentation focuses on the Autonomous Robotic Surgery (ARS) project, funded by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 742671). The project aims at introducing autonomy in the surgical robotic scenario, to improve the quality of interventions and mainly the outcome for the patients. The presentation is held by Paolo Fiorini, full professor at the Department of Computer Science, University of Verona, Italy, and Daniele Meli, PhD student at the same institution.

After a general introduction to the project and its research challenges, the presentation summarizes the recent results related to autonomous task planning and learning of task knowledge. First, a framework for the autonomous execution of surgical task is presented, employing answer set programming (ASP, a logic programming paradigm) to encode expert surgeons' knowledge in terms of rules and constraints. ASP addresses a number of issues not completely solved by state-of-the-art approaches to autonomous robotic surgery, including explainable plan generation for monitoring and reliability, real-time knowledge retrieval and plan refinement as new evidence is acquired from sensors, and guarantee of constraint-safe plan generation thanks to the logic formalism. The framework is validated on the benchmark surgical training task of ring transfer, exhibiting real-time performances even in unconventional scenarios.

The second part of the presentation shows the advances in inductive logic programming (ILP) as applied to the problem of learning new surgical ASP knowledge, using the state-of-the-art tool ILASP by Mark Law. Given some background ASP knowledge and a very limited set of example executions, ILASP tries to learn logical rules which guarantee the satisfaction of examples. Moreover, negative examples can be shown to the learner for constraint inference. ILASP is tested for learning pre-conditions to actions in the ring transfer scenarios. The tool is able to learn in very short time the minimal set of rules to represent full task knowledge, using only four incomplete examples of execution. Current research is investigating the unsupervised automatic generation of examples from surgical datasets and the problem of learning effects of action with temporal delay.

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