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You Can Only Learn What You Already Know

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Motivation



Failed insertion.

- Simplify robot programming.
- Use high-level concepts, e.g. such as in natural language.
- Reusable skill primitives.
- Physically demonstrate tasks to the robot.
- Reason about task executions and handle errors.
- **Difficulty: integrate many types of reasoning!**
- **Let the robot learn by itself!**



Robotic (deep) learning



Learning a PICK



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Teaching by demonstration



- Kinesthetic task demonstration.
- Log data.
- Segment¹.
- Identify coordinate frames¹.
- Generate dynamic movement primitives (DMP).
- Replay the DMP trajectory.
- Generalize.

Kinesthetic demonstration.

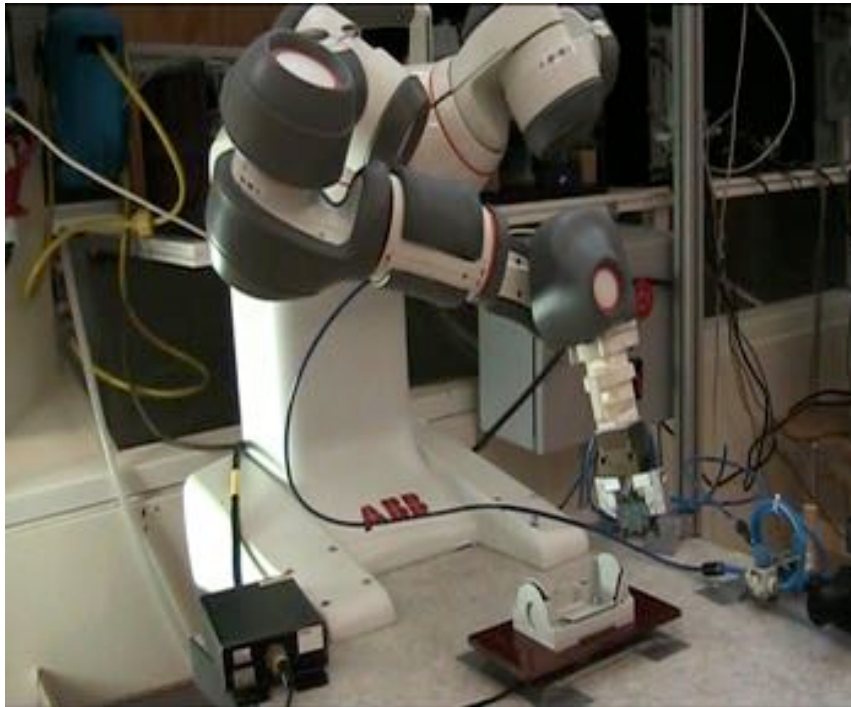
For the video, please visit <http://h2020sarafun.eu/erf-2017-tbd-for-industrialapplications/>

1. Implemented S. Niekum, S. Osentoski, G. Konidaris, S. Chitta, B. Marthi, and A. G. Barto, "Learning grounded finite-state representations from unstructured demonstrations," *The International Journal of Robotics Research*, vol. 34, no. 2, pp. 131–157, 2015



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Learning Movement and Control Parameters



Before learning



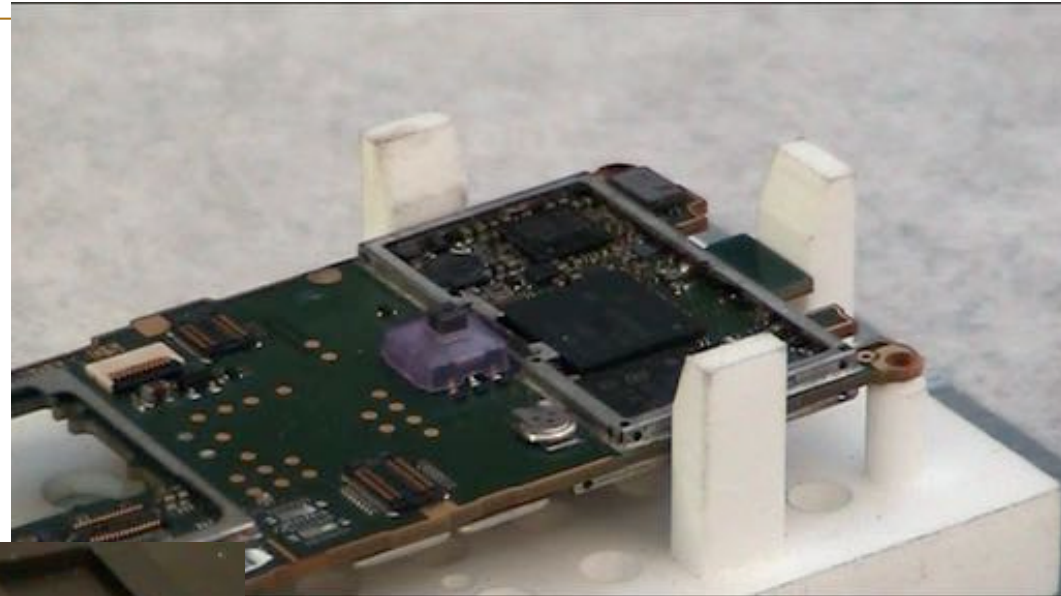
After

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Learning Parameters



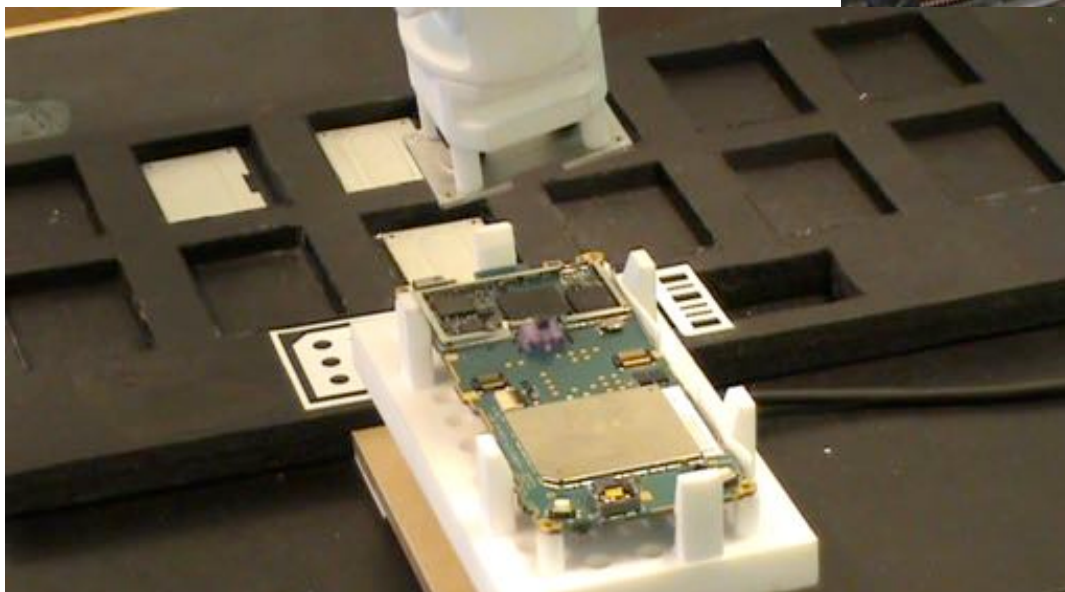
Before

After

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Robotic learning



- Impossible without a preconceived model: an expectation of the outcome;
- Takes time, lots of time;
- The robot does not really understand what is going on, i.e. what it has learnt (if at all);
- To introduce **understanding A LOT OF knowledge** is needed

- Simplifying: ***you can only learn what you already know*** (or are told)



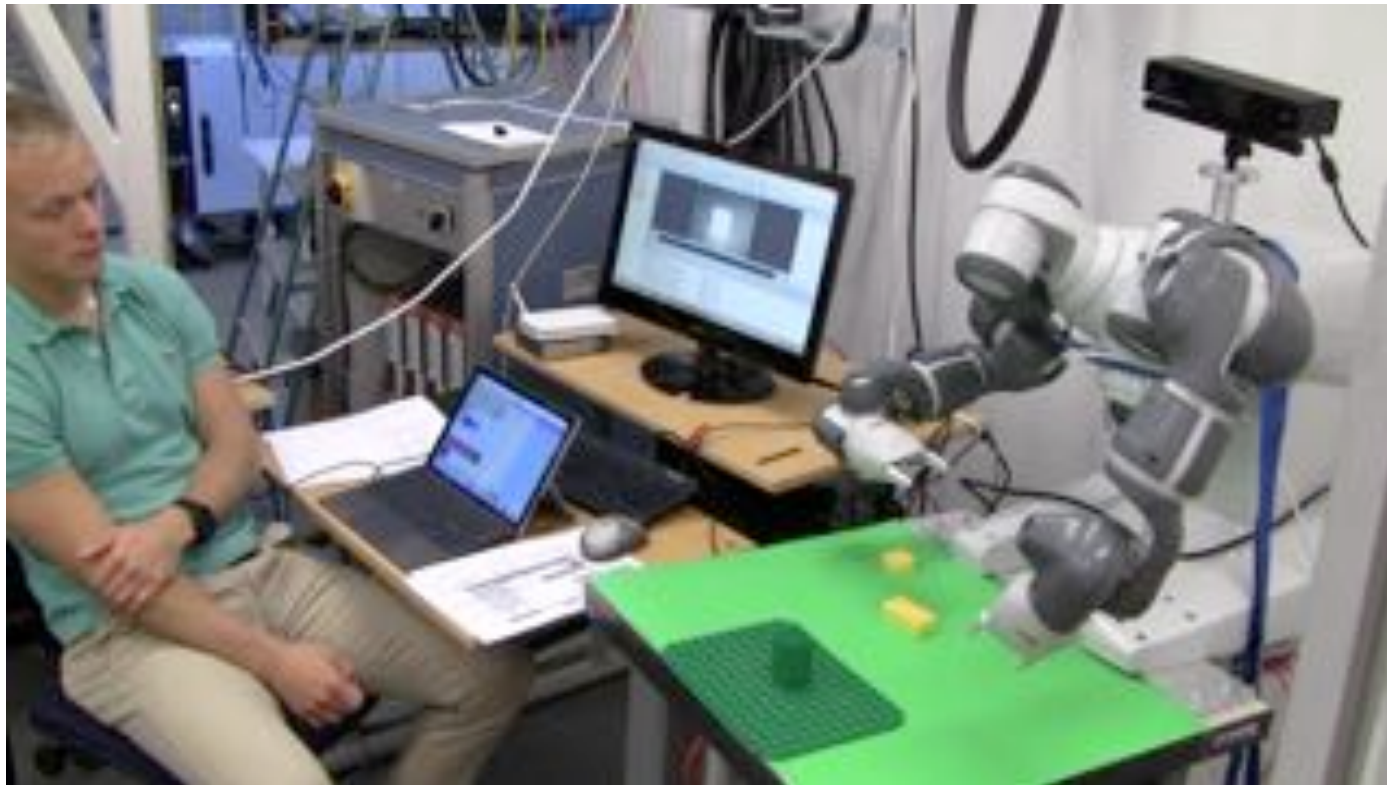
Conclusions



- Talking about generic learning for industrial applications is not serious at this moment;
- Until the robots **understand their failures**, not much can happen;
- Learning must produce **explainable, accountable** results to become useful
- Lots has been done, even more awaits to be done



Surprise, for both, is our goal



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