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What research methods I currently use and which ones I consider using in the future

Introduction

I work within the field of robotics, in particular robot learning, learning from demonstration and human-robot interaction. Robot learning is basically machine learning applied in the robot context, while learning from demonstration and human-robot interaction deals mostly with fast, intuitive mediation of a certain task from a robot operator to a robot, e.g., by showing the task. I work at the Department of Automatic Control, and some of the staff from my institution, including myself, work closely with staff from Computer Science. We form a team where we share lab environment, robots and projects. The projects form very important criteria of what direction our work should take. Usually, the core of a project consists of a description of work, where the goals of the project, their dependencies and their deadlines, are listed. It is in most cases quite clear from the description of work what to achieve, but not detailed how to achieve it.

Current work flow

Here follows an overview of the work flow. Each step will be described in more detail in the following paragraphs. First, we work towards a main functionality, that is outlined in a description of work of a project and believed to be useful and beyond state-of-the-art. We identify sub-problems on the way. In case these can be solved with today's knowledge, we try to implement such solutions. Otherwise, we try to come up with a new one. If we come up with a promising solution, we evaluate it, and if it still seems promising, we use it in our setup. When that sub-problem is solved, it allows us to move further towards the main functionality.

While working towards a main functionality, we are forced to think about what sub-problems there are, and what their causes are. For a certain sub-problem, we have to develop testable solutions, and at least an implicit hypothesis of how it should work with our solution. If we come up with something that we think would work well, we try to do some initial, informal tests, in order to see if the solution seems promising or if it has problems that were not thought of. These tests could be either simulations or trials on a robot. If the solution seems promising, we proceed by implementing the solution, and then test it more thoroughly.

The testing of the solution can take many different forms. One common form is to apply the solution in different scenarios where it should be used, and see whether it works as desired or not. In this context, the test results are just binary. Sometimes, it is also necessary to do the testing with similar, earlier methods, for comparison. Even though the scenarios are varied, many tests are usually done on each setup, in order to evaluate how robust/reliable the methods are. Subsequently, we draw a conclusion about the functionality of our proposed

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solution, based on the testing.

If the solution contains a model, e.g., of some part of the robot, this model could be tested separately. This is different from the case where we just want to see whether something works or not. Usually, it is tested by means of standard system identification methods. Test data are gathered. Subsequently, the test output data are compared with the output data of the model based on the test input data. Typically, some statistical method is used to determine whether the model is accurate enough. For example, we might conclude that the model can predict output data with a certain accuracy, and compare that to the accuracy required by the application.

If the solution is evaluated with successful results, it is used as part of the main functionality. When it is integrated, the work continues with the next identified sub-problem.

Because our field if so applied, our methodology differs significantly from how the scientific method is usually described. It is very common to form a new algorithm or model, and then evaluate it ourselves. Since we evaluate our own work, in that sense, negative results are very rarely published in this field. Instead, if something does not seem to work, we would try to understand why, and come up with a better solution or algorithm. Further, we rarely formulate hypotheses, and formal motivations of why certain evaluation methods were used are also uncommon. On the other hand, formal problem formulations are quite common, followed by a suggested solution, an evaluation, and an answer to the problem formulation. Usually, the chosen evaluation methods make sense, and do not have to be motivated formally. There might, however, be some details that are motivated in a few sentences. For example, it might be stated that a certain experimental parameter was chosen to resemble some common real world scenario.

Possible future methods

In the future, I would be very interested in involving more human-robot interaction in the experiments. Currently, we test most of our algorithms with ourselves acting as robot operators. This has the drawback that we know in detail how the algorithm should work, which an ordinary robot operator would not. Hence, the results do not generalize as well to real world scenarios as they would if external test persons helped to evaluated the functionality. This would also imply more traditional scientific methods. It would be more natural to formulate hypothesis in the experiments, for instance. However, human studies also mean much more administration, ethics considerations, etc.

Conclusion

To conclude, my research is very applied, and therefore the methods differ from the traditional scientific method. We usually aim to solve practical problems, and therefore, the main parts of the research is to come up with solutions, and then evaluate these.