Oberseminar Abteilung Grundlagen der Künstlichen Intelligenz

Abstracts of Presentations

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Contents

1 Genetic MRF model optimization for real-time victim detection in Search and Rescue (Alexander Kleiner)

One primary goal in rescue robotics is to deploy a team of robots for coordinated victim search after a disaster. This requires robots to perform subtasks, such as victim detection, in real-time. Human detection by computationally cheap techniques, such as color thresholding, turn out to produce a large number of false-positives. Markov Random Fields (MRFs) can be utilized to combine the local evidence of multiple weak classifiers in order to improve the detection rate. However, inference in MRFs is computational expensive.

In this paper we present a novel approach for the genetic optimizing of the building process of MRF models. The genetic algorithm determines offline relevant neighborhood relations with respect to the data, which are then utilized for generating efficient MRF models from video streams during runtime.

Experimental results clearly show that compared to a Support Vector Machine (SVM) based classifier, the optimized MRF models significantly reduce the false-positive rate. Furthermore, the optimized models turned out to be up to five times faster then the non-optimized ones at nearly the same detection rate.

2 Probabilistic Roadmap Planners for Robot Motion Planning (Christian Dornhege)

Robot Motion Planning is a hard problem to solve analytically. Therefore in the last years probabilistic algorithms have shown great success in practical applications to this problem.

Extensions of these roadmap planners have also been presented for the problem of manipulation planning using a manipulation graph.

The talk gives an introduction to probabilistic roadmap planners and presents current approaches.

3 Intuitive Multimodal Interaction with Communication Robot Fritz (Dr. Maren Bennewitz)

In this talk, I present our humanoid communication robot Fritz. Our robot communicates with people in an intuitive, multimodal way. Fritz uses speech, facial expressions, eye-gaze, and gestures to interact with people. Depending on the audio-visual input, our robot shifts its attention between different persons in order to involve them into the conversation. He performs human-like arm gestures during the conversation and also uses pointing gestures generated with eyes, head, and arms to direct the attention of

its communication partners towards objects of interest. To express its emotional state, the robot generates facial expressions and adapts the speech synthesis. I will discuss experiences made during two public demonstrations of our robot and also talk about our recent work in the areas of head posture as well as pointing gesture estimation.

4 Formalizing Baddeleys Working Memory - Some Insights (Marco Ragni)

In recent years a lot of psychological research efforts have been made in analyzing human spatial reasoning. Psychologists have used implicitly many spatial cognitive models, i.e. a model of how humans conceptualize spatial information and reason about it, based on the mental model theory to model their experimental findings. But only little effort has been put into identifying from an algorithmic point of view the control mechanism in cognitive models for reasoning with spatial relations. Without having such a specification the task of testing and improving cognitive models seems to be rather difficult. Only a precise computational model defining parameters and operations make testable predictions. In this talk I present an extension of the SRM model, by embedding it into Baddeleys Working memory model. By this embedding it is possible to define the role of the central executive and show that this subsystem plays an important role in precising the role of cognitive attention.

5 Table Soccer Robot and Skill Science (Dapeng Zhang)

Skill science is a new research area studying skilful activities of human beings, such as dancing, playing sports, singing songs, and playing music instruments etc. It is nourished by approaches in artificial intelligence, cognitive science, and sport science etc. Some new ideas were inspired when the table soccer robot met skill science. In this work, the achievements in skill science are summarised, and the perspective of the table soccer robot research are discussed.

6 Accuracy of Admissible Heuristic Functions in Selected Planning Domains (Robert Mattmüller)

The efficiency of optimal planning algorithms based on heuristic search crucially depends on the accuracy of the heuristic function used to guide the search. Often, we are interested in domain-independent heuristics for planning. In assessing the limitations of domain-independent heuristic planning, it appears interesting to analyse the (in)accuracy of common domain-independent planning heuristics in the IPC benchmark domains. For a selection of these domains, we analytically investigate the accuracy of the

h+ heuristic, the hk family of heuristics, and certain (additive) pattern database heuristics, compared to the optimal heuristic h*. Whereas h+ and additive pattern database heuristics usually return cost estimates proportional to the true cost, non-additive hk and non-additive pattern-database heuristics can yield results underestimating the true cost by arbitrarily large factors.

7 How Good is Almost Perfect? (Gabi Röger)

Heuristic search using algorithms such as A* and IDA* is the prevalent method for obtaining optimal sequential solutions for classical planning tasks. Theoretical analyses of these classical search algorithms, such as the well-known results of Pohl, Gaschnig and Pearl, suggest that such heuristic search algorithms can obtain better than exponential scaling behaviour, provided that the heuristics are accurate enough.

We show that for a number of common planning benchmark domains, including ones that admit optimal solution in polynomial time, general search algorithms such as A* must necessarily explore an exponential number of search nodes even under the optimistic assumption of almost perfect heuristic estimators, whose heuristic error is bounded by a small additive constant.

The results shed some light on the comparatively bad performance of optimal heuristic search approaches in simple domains such as Gripper. They suggest that in many domains, further improvements in run-time require changes to other parts of the planning algorithm than the heuristic estimator.

8 Flexible Abstraction Heuristics for Optimal Sequential Planning (Dr. Malte Helmert)

We describe an approach to deriving consistent heuristics for automated planning, based on explicit search in abstract state spaces. The key to managing complexity is interleaving composition of abstractions over different sets of state variables with abstraction of the partial composites.

The approach is very general and can be instantiated in many different ways by following different abstraction strategies. In particular, the technique subsumes planning with pattern databases as a special case. Moreover, with suitable abstraction strategies it is possible to derive perfect heuristics in a number of classical benchmark domains, thus allowing their optimal solution in polynomial time.

To evaluate the practical usefulness of the approach, we perform empirical experiments with one particular abstraction strategy. Our results show that the approach is competitive with the state of the art.

9 2, n, ω: A tour de force into the algebraic approach to constraint satisfaction problems (Dr. Stefan Wölfl)

We will start our tour in the safe harbor of the famous theorem by Schaefer, which will supply us with a complete overview on all constraint satisfaction problems on domains with just two elements. Looking at constraint satisfaction problems on domains with finitely many elements, then, will give us the munition to treat analogous problems on infinite domains (in particular, so-called qualitative constraint satisfaction problems). However, we will have to learn more on Greek letters before we can navigate around monstrous riffs hidden in the infinite depths of the infinite sea of infinity. Fortunately, our tour is guided by excellent maps provided by Cohen, Jeavons, Chen, Bodirsky, and others. NB: This will not be a funny talk.

10 Planning for Earth Observation Satellites (Patrick Eyerich)

A low earth orbit (LEO) satellite is an artificial satellite equipped with special instruments enabling it to observe target objects on the earth's surface. The state of the art of controlling such a satellite is to build plans offline in a mission center and to upload them to the satellite for execution. However, this approach has a number of drawbacks, for example the satellite is not capable to react to unexpected changes in its environment. Therefore, it would be very useful to create plans directly on the satellite. A major restriction in doing so is the strongly limited computational power available on the satellite. We have constructed a prototype implementation of the earth oberservation domain using ff-m, an extension of the well known FF planner by external modules. First tests indicate that our implementation solves the problem while meeting the time and space bounds given on board of a satellite.

11 Automatic Abstraction Refinement for Timed Automata (Sebastian Kupferschmid)

We present a fully automatic approach for counterexample guided abstraction refinement of real-time systems modelled in a subset of timed automata. Our approach is implemented in the MobyRT tool environment, which is a CASE tool for embedded system specifications. Verification in MobyRT is done by constructing abstractions of the semantics in terms of timed automata which are fed into the model checker Uppaal. Since the abstractions are over-approximations, absence of abstract counterexamples implies a valid result for the full model. Our new approach deals with the situation in which an abstract counterexample is found by Uppaal. The generated abstract counterexample is used to construct either a concrete counterexample for the full model or to identify a slightly refined abstraction in which the found spurious counterexample cannot occur

anymore. Hence, the approach allows for a fully automatic abstraction refinement loop starting from the coarsest abstraction towards an abstraction for which a valid verification result is found. Nontrivial case studies demonstrate that this approach computes small abstractions fast without any user interaction.

12 Computing Counterexamples of Hybrid Systems by Heuristic Search/Optimization (Dr. Jan-Georg Smaus)

Joint work with Stefan Ratschan

The tool HSolver, developed by Stefan Ratschan, veryfies safety of hybrid systems by using an abstraction based on a discrete partitioning of the continuous state space. Here, safety means that a certain undesired (error) state is unreachable. If an error state is reachable in the current abstraction, this may be because the system is indeed faulty, or it may be because the abstraction is too coarse, allowing error paths that have no counterpart in the concrete. In this case, the abstraction must be refined.

In our new line of research, we want to analyse systems of which we do not know whether they are correct or not. We want to interleave the search for an abstraction fine enough to prove the system correct with the search for an actual error path in the system, so that our analysis will hopefully terminate for correct as well as incorrect systems. The main aspect of finding error paths is to find a suitable startpoint for a simulation. This problem can be understood as a heuristic search problem, and is also somewhat related to reinforcement learning.