2014 Wits Honours Projects
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1. Advising with Goal Inference

An important component of both natural and artificial intelligence is learning. It is well known that learning is greatly facilitated by the process of teaching. Teaching is often achieved by a teacher agent providing advice to a learner agent. In a structured teaching setting, the goal of the learner is known to the teacher (for example, to learn to solve a particular problem). This project aims to examine the unstructured case, where the teacher does not know the goal of the learner.

In a recent paper, we addressed this problem by providing advice to the learner based on the current state of the learner. In this project, we instead want to try and infer the goal of the learner, and provide advice based on the task the learner is most likely attempting.

This project would involve implementing such a system in a simulated domain, where a teacher should offline learn (or be given) different tasks and their solutions, and then online a second learner agent should be observed, its goal inferred, and the appropriate advice provided to it.

B. Rosman, S. Ramamoorthy. Giving Advice to Agents with Hidden Goals. In Proc. International Conference on Robotics and Automation (ICRA), 2014.

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2. Content Adaptation in Games

Personalisation is becoming a major theme in both hardware and software. In order to achieve optimal performance with a complex program or interface, it should be able to automatically adapt itself to the use styles of each individual user.

We hypothesise that this same concept could be applied to content adaptation in computer games, which could provide new content to the player based on their skill level. Inferring the skill level or even preferences of the user would allow for personalised content to be generated. One could provide content which is always challenging for a particular player, or alternatively easy enough that they do not become frustrated. Similarly, content could be generated which emphasises aspects of the game the player seems to enjoy most.

As an example, consider the popular smart-phone "running games" (such as Temple Run), which may change the speeds and overall difficulty based on the inferred skill of the user, or else the scenery or random bonuses based on inferred user preferences.

This project would involve setting up a simple game simulator, learning different skill levels, preferences or play styles, inferring these online, and consequently adapting the content. Evaluation could be quantitative in terms of user performance and qualitative in terms of user enjoyment.

See this paper for a study on how different interface affect user performance

B. Rosman, S. Ramamoorthy, M.M.H. Mahmud, P. Kohli. On user behaviour adaptation under interface change. In Proc. International Conference on Intelligent User Interfaces (IUI), 2014,

and this paper for preliminary work in this direction
S. Ramamoorthy, M.M.H. Mahmud, B. Rosman, P. Kohli. Latent-variable MDP models for adapting the interaction environment of diverse users. Technical Report, University of Edinburgh, 2013.
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3. Scene Abstraction from Kinect Data

In recent years, the field of image recognition has seen significant advances. There are many successful approaches to identifying particular objects in images, such as cars, people and buildings. This is useful for a number of applications, such as searching for images with related content.

In a behavioural context, we are interested in similar approaches to autonomously uncovering the structure of scenes. This would be very useful for transferring behaviours between different environments with similar topologies, in cases such as robot manipulation. Examples of this include being able to identify supports in a scene (which should not be disturbed), or handles (for lifting objects).

This project will require devising an algorithm based on, or in a similar spirit to, the one in the attached paper, for inferring the spatial relationships from a set of objects placed in front of a Kinect sensor. We are aiming at an approach which would provide a complete relational description of a scene, rather than identifying the objects themselves, so as to gain a higher level understanding of the scene.

As a simple example, a robot could be presented with a physical scene, which it should be able to redescribe as:
(object A) on (object B)
(object C) on (object B)
(object A) next to (object C) ...

Rosman, Benjamin, and Subramanian Ramamoorthy. "Learning spatial relationships between objects." The International Journal of Robotics Research 30.11 (2011): 1328-1342.
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4. Action Priors on a Mobile Robot

Action priors are situation-based distributions over the action set of an agent which indicate the preference of the agent to taking certain actions under different conditions, and these correspond to a simple model of "common sense" knowledge. In a recent paper, we showed how these can be learnt empirically, and provide significant speed ups in learning to solve new tasks in the same domain, by biasing exploration. The benefits are particularly important when the agent has a large action set, as they effectively prune the local action space of the agent, and so simplify search.

This project will involve implementing these ideas in a physical situation, by building a mobile robot with some basic sensors. The goal of this robot is to be able to learn to solve a number of different navigation tasks, such that learning is accelerated by experiencing more tasks. The robot should be trained in a set of mazes where it can easily recognise some features, such as the colour of the walls around it, while learning navigation policies around the mazes. From this first set of behaviours, it should then be able to learn action priors using the approach described in the attached paper, which allow it to accelerate learning in future tasks. This performance should be compared to learning to navigate in the same domain with different priors.

We want a real robot to be able to acquire common sense concepts such as avoiding obstacles, moving towards regions of interest, avoiding dead ends, etc.

Rosman, Benjamin, and Subramanian Ramamoorthy. "What good are actions? Accelerating learning using learned action priors." Development and Learning and Epigenetic Robotics (ICDL), 2012 IEEE International Conference on. IEEE, 2012.
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