Review of developments in the field of planning and searching in AI

An analysis by Kris Roosen as requested by Udacity for the 3rd project in the AIND program.

Reasoning as search and heuristic functions

To achieve a goal state, many of the early days' algorithms made use of the same basic algorithm that received the name "reasoning as search". The idea is that of finding a path out of a maze by trying several steps and backtracking when you get stuck.

The main difficulty for these kind of problems is the "combinatorial explosion". The size of the state spaces increases so fast that it would become astronomical within a very limited amount of steps. A lot of effort was done to decrease the state space by using certain rules of thumb. These rules eliminated those paths that were less likely to lead to a goal state. In his book, Pólya first used the term 'heuristic' to describe these rules [1]. Nowadays, heuristic functions are commonly found in various searching and planning algorithms.

Autonomous robots

In 1951 the scientist Grey Walter invented the first autonomous robot called Tortoise [2]. This was an electro-mechanical robot that was created to follow the strongest source of light. With a rotating photo-cell, it detected the angle with the strongest light intensity and then drove in that angle. When an obstacle was hit, the pressure on the outside shell created an electrical connection that caused the robot to move at random until it got unstuck. This can be considered to be a searching algorithm, although it is a purely electro-mechanical one.

To progress further in the field of autonomous robots, better programs were needed. Building upon the 'reasoning as search' algorithm and by making use of heuristic functions, a new invention was created. In 1959 an attempt was made to create a program that could handle multiple tasks by making use of a general version of this search algorithm. It was given the name "General Problem Solver" and was meant to be able to solve all sorts of searching problems from proving theorems to moving in a maze.

Modern commercial robots

Many years later, in 2002, one of the first commercially available intelligent robots was brought on the market. It came in the form of a autonomous vacuum cleaner with the name Roomba® [3]. Thanks to the now available processors, sensors and optimized searching algorithms, including SLAM, the robot is able to navigate an unknown area and remember it. SLAM is short for Simultaneous Localization And Mapping and it does just that; creating a map of an unknown environment and navigating it at the same time. SLAM was first being researched in 1986 [4]. Further research and improvements has led to it being a key set of algorithms for autonomous robots, such as the Roomba® or the autonomous car STANLEY by Sebastian Thrun's team that has won the DARPA Grand Challenge in the 2000s.

[1]   http://www-history.mcs.st-andrews.ac.uk/Extras/Polya_How_to_solve_it.html

[2]   http://www.rutherfordjournal.org/article020101.html

[3]   http://www.irobot.com/About-iRobot/Company-Information/History.aspx

[4]   Smith, R.C.; Cheeseman, P. (1986). "On the Representation and Estimation of Spatial Uncertainty" (PDF). *The International Journal of Robotics Research*. **5** (4): 56–68. doi:10.1177/027836498600500404