Investigating Automated Planning

(06/23, https://www.shoppingcentrenews.com.au/feature-stories/chadstone-to-add-850-new-parking-spaces-with-works-starting-in-2021/)

Introduction

Artificial Intelligence, with its myriad capabilities and potential, has become a cornerstone of contemporary technology. It empowers systems to replicate and, at times, surpass human intelligence in decision-making processes. This report takes a deep dive into one of the most significant components of AI - Automated Planning. This approach, rooted in AI, enables systems to make judicious decisions to attain a specific objective from a known initial state. Delving into the study of Automated Planning not only enriches our understanding of intricate AI systems but also facilitates the design and development of efficient and high-performing intelligent systems.

Automated Planning: Definition, Principles, and Concepts

Automated Planning is a specialized area within AI that emphasizes the generation of a sequence of actions that aid a system in transitioning from an initial state to a desired goal state. The core aim of automated planning is to identify the most efficient path, keeping various constraints and objectives into consideration.

The principles of Automated Planning pivot around states, actions, and goals. Here, a state signifies a particular condition or situation. An action is an operation that has the potential to modify the state. The goal is the eventual state that the system aims to reach, beginning from the initial state. Automated planning systems function by scrutinizing possible sequences of actions to pinpoint the most fitting path leading to the goal.

State Space Search and Reasoning and Planning are integral aspects of Automated Planning. The former is a method of investigating a range of possible states, initiating from an initial state, to reach a goal state. The system generates a search tree in this process, exploring various paths based on the actions available, and identifies the best path rooted in a pre-determined evaluation function.

Reasoning and Planning, conversely, refer to the cognitive process in which a system devises a plan of action grounded in its knowledge of the world, the actions at its disposal, and the intended goal. The system speculates about the effects of actions and creates a sequence of actions that culminates in the goal state.

Both State Space Search and Reasoning and Planning are critical for constructing efficient automated planning systems. They empower the system to make informed decisions by exploring the potential outcomes of actions and devising the most efficient plan of action.

The subsequent sections will further elaborate on the major methodologies in Automated Planning, demonstrate an application in a local community context—Chadstone Shopping Center, suggest a potential solution, and discuss an approach to evaluate it.

Major Approaches in Automated Planning

Automated planning techniques offer a rich tapestry of diverse strategies, each presenting their unique advantages and limitations contingent on the context of the problem. The most prominent approaches encompass classical planning, probabilistic planning, and planning under uncertainty, each embodying unique AI principles.

Classical planning is arguably the most conventional form of automated planning, utilizing the principles of state-space search and heuristic search. This method typically focuses on deterministic and fully observable environments where the present state and the effects of actions are entirely known and predictable. Such predictability streamlines the planning process but restricts its applicability to complex real-world issues that often include elements of uncertainty.

Probabilistic planning introduces the concept of uncertainty, both regarding the environment and the effects of actions, making it apt for problems involving a degree of randomness. This approach often uses the Markov Decision Process (MDP) model, which encapsulates decision-making under uncertainty and is widely used in reinforcement learning. Probabilistic planning can handle more complex scenarios than classical planning, but it necessitates higher computational resources due to the need to explore multiple potential outcomes.

Planning under uncertainty is a more advanced approach of automated planning, focusing on situations where neither the current state nor the effects of actions are entirely known. This strategy often uses the Partially Observable Markov Decision Process (POMDP) model. It is well-suited for real-world problems containing considerable uncertainty, but it carries high computational costs and complexity due to the need to consider an extensive range of possibilities.

Automated Planning in the Local Community Context:

Chadstone Shopping Center Chadstone Shopping Center, affectionately known as "Chaddy," is a bustling hub of commerce facing a critical challenge—efficient parking management for its extensive customer base. The existing parking situation often leads to customers struggling to find available spaces, resulting in frustration and potential loss of business.

Automated planning can bring a transformative change to this issue, mainly through an intelligent parking management system. This system, powered by AI, could monitor the occupancy of parking spaces and guide customers to the nearest available spots, thus minimizing the time spent in parking.

The proposed solution could be modeled using the **Planning Domain Definition Language (PDDL**), a powerful language used to encode planning problems and their corresponding solutions. For example, each parking spot in the shopping center could be represented as a state, while the actions might involve assigning or freeing a parking spot. The goal would be to ensure all customers find parking spaces in the shortest possible time.

The application of automated planning in this context embodies various AI concepts learned in the course, including state-space search (finding the nearest free parking spot) and reasoning and planning (deciding which parking spot to assign to a customer). It provides a practical demonstration of how theoretical AI principles can be employed to solve real-world problems.

Proposed Solution

The proposed solution involves developing an intelligent parking management system using Automated Planning concepts. This system would incorporate state-space search, reasoning, and planning to optimize the allocation of parking spots in real-time.

In terms of operation, the system would monitor the occupancy of each parking spot through sensors or cameras, continually updating the state of the parking lot. When a customer approaches the shopping center, the system would employ automated planning algorithms to determine the nearest available parking spot and guide the customer to it. This process is akin to state-space search, where the current state is the occupied and free parking spots, and the goal state is to find the nearest available spot for the customer.

This intelligent parking management system offers multiple benefits. Firstly, it drastically reduces the time spent by customers searching for parking, thereby enhancing their overall shopping experience and potentially increasing the time spent within the shopping center. Secondly, it encourages the efficient use of parking resources, ensuring optimal utilization of all available parking spots.

Nonetheless, several challenges need to be addressed in the implementation process. These include accurately monitoring the parking spaces, efficiently guiding customers to the designated spots, and adapting to changing parking situations, especially during peak times. The system must be robust, agile, and flexible to function effectively under these varied and dynamic conditions.

Evaluation of the Solution

The effectiveness of the intelligent parking management system can be evaluated using a series of metrics that reflect its efficiency and user satisfaction.

1. **Parking Time**: A significant reduction in the time spent by customers searching for parking spots would indicate a successful implementation. This metric could be collected by comparing the average time taken to find a parking spot before and after the system's implementation.
2. **User Satisfaction**: Customer feedback can be a valuable tool for understanding how well the system meets their expectations. This could be gauged through surveys or interviews, asking customers about their parking experience and the helpfulness of the automated planning system.
3. **Optimal Utilization**: If the system is efficient, it should lead to optimal utilization of parking spaces. The occupancy rate could be tracked to monitor how well the system is allocating spaces.
4. **Adaptability**: The system's ability to adapt to changing conditions, like a sudden influx of vehicles, can demonstrate its robustness. This could be tested by conducting stress tests and analyzing the system's performance.

Conclusion

In conclusion, automated planning holds substantial potential to address pressing challenges in local communities, like managing parking at Chadstone Shopping Centre. The proposed solution, an intelligent parking management system, harnesses the principles of state-space search and reasoning to assign parking spots efficiently, aiming to reduce customer frustration and optimize resource utilization. While some challenges must be addressed, the solution's potential benefits justify the effort. The effectiveness of the solution can be evaluated by considering parking time, user satisfaction, optimal utilization, and adaptability. The application of AI in such practical situations underscores its transformative potential and the relevance of AI studies in solving real-world problems.

References

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