Paper Review 7

Summary:

In the given paper titled “A Survey of Dynamic Programming Computational Procedures” the author is trying to present novel computational strategies used for dynamic programming. To solve an optimization problem, Dynamic programming is one of the most powerful approaches that one can use. Before the publication of the given research paper, dynamic programming was not as good as it is today. Their space and time complexity was higher than expected. Which is why people did not use it that much as the computation capability of that time was not that good. Here, in this paper, the author at first claimed that dynamic programming was used mainly to formulate the deterministic variational control problem. The system can have a state specific to each stage. For varying stages and states, the author defined some performance benchmark along with cost and control function. Then he presented a solution to this problem that uses the dynamic programming approach. To minimize the cost function for each states existing in each stage, he proposed a function that is recursive. This proposal was based on Bellman’s principle of optimality. According to the author, this solution gives us an optimal control for all states. Then the author talked about how this solution can be implemented using the existing algorithm. One such algorithm is called the standard algorithm. The author drew a figure (figure 1) to show us the inner workings of the algorithm for the one-dimensional problem. The algorithm works like this: at first, all the states and stages are quantized. In the second step, the minimum cost is determined using interpolation and comparison for every step. Accroding to him, this approach gives us the minimum cost every time we use it. He also claimed that the answer would always be unique. Despite having a very high computational requirement, in this algorithm, we can get an optimal control with true feedback as this approach calculates the optimal control for each of the possible states with the corresponding stages. This algorithm also requires offline storage and high-speed storage locations also known as HSM. Then, the author tried to solve the same problem for stochastic approaches. In this solution, he added only one more function to the previous solution. He did it to use it for random forcing vector with a PDF that we already know. Then, the author proposed a novel computational way that can lower the HSMR or computational time for dynamic programming. Often times, this solution can achieve both. Using different techniques this novel ways can give us solutions that have complete feedback control. Although these techniques can reduce memory usage, computing time does not change that much. We can achieve the optimal control by a single initial state using other novel approaches. The author claimed that in these approaches, based on the information and constraints that are available, a nominal trajectory is selected. According to him, we can achieve better space and time complexity using these approaches. Then the author then proposed some solutions where we can have infinite stages. Real life applications of dynamic programming were discussed by the author in the last part of the given research paper. Here, he proposed some new approaches that he himself invented.

Strengths:

1- One of the main contributions of this paper is the introduction of novel ways to lower the space and time complexity of dynamic programming. This was backed up by real-world applications done by the author himself.

2- As the author defined the problem in a cogent manner, he also proposed the solution. Then he presented algorithms that exist which can implement his solutions. Then he presented his novel approach that can use the algorithms to implement the solution he proposed. As this was done in clear and predictive gradual steps, the research paper was very easy to understand. His illustration of some algorithms also helps the readers in this cause.

3- Control engineers would be more prone to using dynamic programming as a part of their computational approach because of the novel approaches presented in this paper. That should lead to better space and time complexity by the system overall.

Weakness:

1- One of his most efficient approach named “Closed form” has limitations as it needs a very specific case to be applied. This approach was proposed to implement the iterative function for dynamic programming problems. Another one of his novel approach named “polynomial approximation” has limitations as well. According to him, it can only be applied for “well-behaved” problems. This term “well-behaved” has not been explained by him. This is such a vague term to use in a research paper.

2- All of the novel ways to solve the dynamic programming problems presented in this paper requires a very specific state to be applied. Which is why none of these ways are general solutions to this problem. If one is to analyze the approaches closely, it can be evident that these approaches are actually edited versions of the standard algorithm.

3- One of his proposed methods that uses finding a nominal trajectory might not work if the trajectory is far from optimal one. Which is a big weakness to the proposed method.

Future Works:

Engineers from different areas can start to use dynamic programming as their computational tool. Which can help them solve different problems that exist in their domain. The author did predict that control engineers would be more willing to use dynamic programming because of the solutions that he presented in this paper. As this paper only provides solutions that are applicable in specific cases, future researchers can start working on finding a general solution to the problems of dynamic programming.