TU Delft

Master Project
# Fast Dynamic Programming

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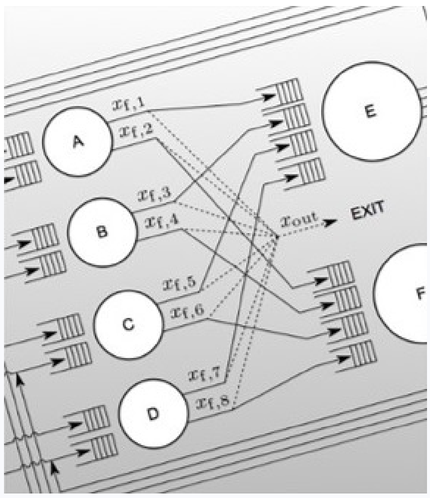
## Context




Dynamic Programming (DP) provides a powerful tool to compute optimal policies in a wide range of applications. Be it inventory management, LQ control or even stock market, the solution to the DP gives an optimal action to take. However, closed form solutions to such problems are often unavailable due the nonlinear nature of the DP operator. Therefore, numerical approaches are necessary in these cases. Inspired by Fast Fourier Transform and its effect on both scientific communities and our everyday life, this study aims at developing a method to efficiently compute solutions to DP. Analogously to how it is frequently more advantageous in signal processing to do the computations in the Fourier domain, there is a potential computational gain by changing domains to the Legendre (or convex conjugate) domain in the context of DP. Utilizing this gain would allow solving real-world problems whose optima have been far too demanding to compute.

The focus of this project is twofold. First, this computational gain needs investigation: under what conditions and how it can be applied to solve DP problems and, in general, what the limitations are of this approach. Translating the problem to the Legendre domain to make it more computationally tangible introduces phenomena that are challenging to deal with while ensuring equivalence of direct computation of DP and the alternative route (Fast DP). The second objective is to create and implement an algorithm that takes advantage of this gain and demonstrates superior performance when compared to traditional methods.

## Project tasks

This master thesis is aimed at investigating how Dynamic Programming can be computed using Legendre–Fenchel Transform. The following tasks are proposed in the thesis:

1. Investigate Fast DP in continuous and discrete state-action domains.
2. Develop and implement a numerical method for computing discrete Fast DP.
3. Study the error bounds of the numerical method.
4. Lay theoretical foundations for future work on the topic.