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Master Thesis Proposal – Math/ESE/MST/SSE

Efficient Numerical Integration of Squared Residual Functions for Integration Error Estimation

To increase the accuracy of the simulation in optimal control problems we want to use adaptive integration methods that change the discretization grid based on estimates of the integration error. A particular type of estimate for this error computes the integral of a squared residual function. Exploring a new quadrature method with this type of integrand, instead of approximating the squared residual function with a polynomial we want approximate just the residual function with a polynomial. Preliminary results show a better approximation accuracy.

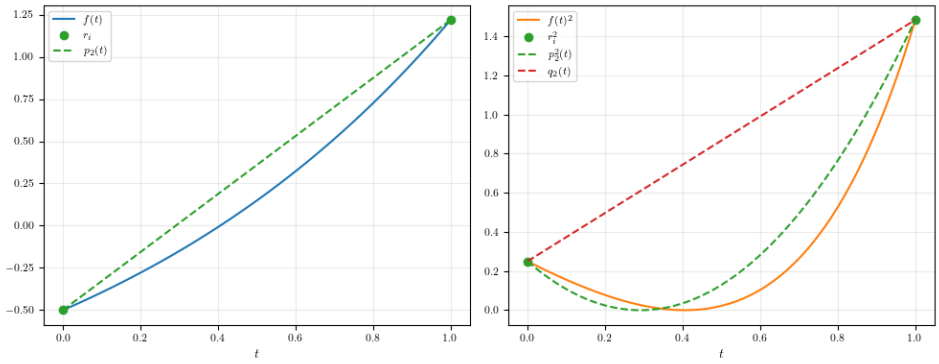

Figure 1: (left) The polynomial $\mathrm{p}_2(\mathrm{t})$ approximates the function $\mathrm{f}(\mathrm{t})$ from two evaluations, (right) The squared polynomial $\mathrm{p}_2^2(\mathrm{t})$ is a better approximation for $\mathrm{f}^2(\mathrm{t})$ than $\mathrm{q}_2(\mathrm{t})$, we would thus expect that the corresponding quadrature method for integration is also more accurate

Master topic: We want to explore the mathematical details of the proposed quadrature method and show how it can be used for the efficient estimation of the integration error in optimal control problems.

Your skills: Prior knowledge numerics, optimization, simulation and control is advisable. We will most likely be using a combination of Python along with the CasADi symbolic framework, so experience with these tools is recommended.

Supervisors and contacts: Prof. Dr. Moritz Diehl, Jakob Harzer

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