# Adaptive Grid Control for Singular BVPs

We describe a mesh selection strategy for the numerical solution of boundary value problems for singular ordinary differential equations. We prove that under realistic assumptions our mesh selection strategy serves to approximately equidistribute the global error of the collocation solution, thus enabling to satisfy prescribed tolerances efficiently.

This mesh adaptation procedure has been implemented in our new `Matlab` code `colimp`, a successor of `sbvp`. `colimp` is based on polynomial collocation, equipped with an a posteriori estimate for the global error of the numerical solution, and the mesh adaptation procedure. Moreover, in the present version of the code a pathfollowing strategy based on pseudo-arclength parametrization applied for the computation of solution branches with turning points of parameter-dependent equations in implicit form,

$$\begin{aligned} &f(y'(t), y(t)/t^{\alpha}, t, \lambda), \quad t \in (0,1], \quad \alpha \geq 1 \\ &g(y(0), y(1)) = 0, \end{aligned}$$

is available. We show that the pathfollowing procedure is well-defined under realistic assumptions, and a numerical solution is possible with a stable, high-order discretization method.

Finally, we demonstrate the performance of our code by solving a number of problems relevant in applications. These include the computation of density profiles in a non-homogeneous fluid, complex Ginzburg-Landau equation, and problems from the shell buckling.