Additional material for the lecture Numerical Methods for Hyperbolic and Parabolic Conservation Laws

Andreas Meister

University of Kassel, AG Analysis and Applied Mathematics

Finite Volume Scheme in one space dimension

Example 3.4

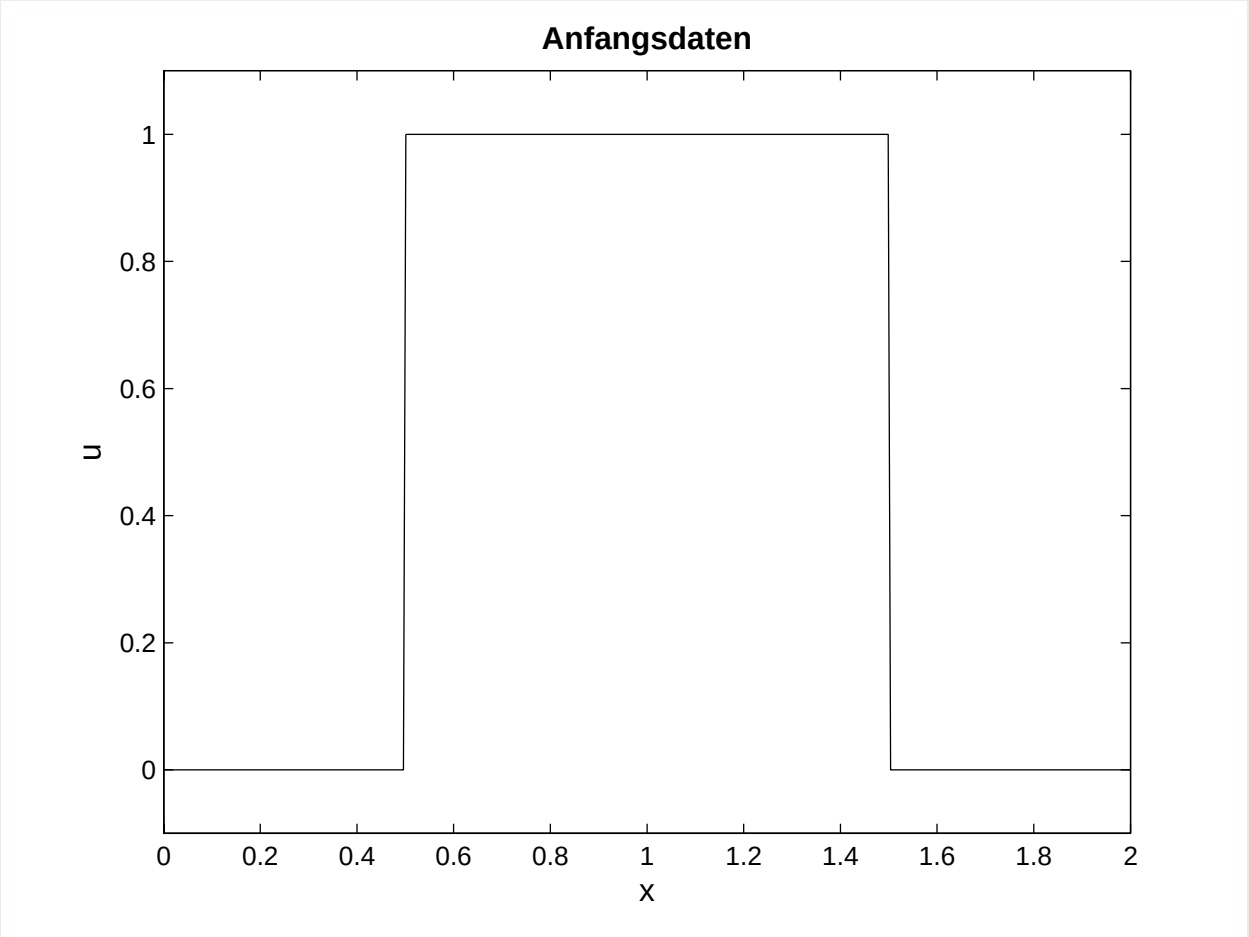


Figure: Initial distribution

Finite Volume Scheme in one space dimension

Example 3.4

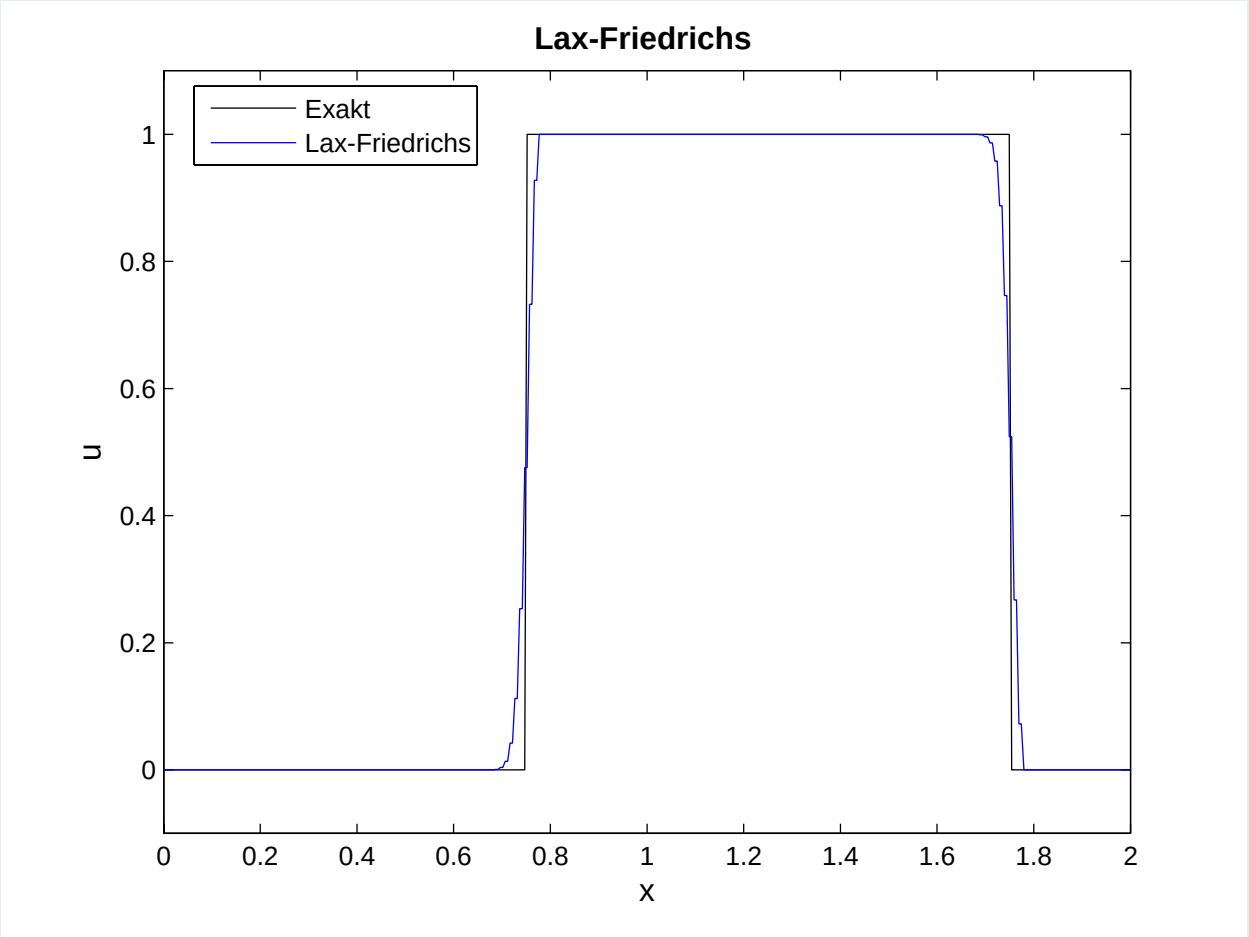


Figure: Approximate solution of the Lax-Friedrichs-scheme at $t = 0.5$.

Finite Volume Scheme in one space dimension

Example 3.4

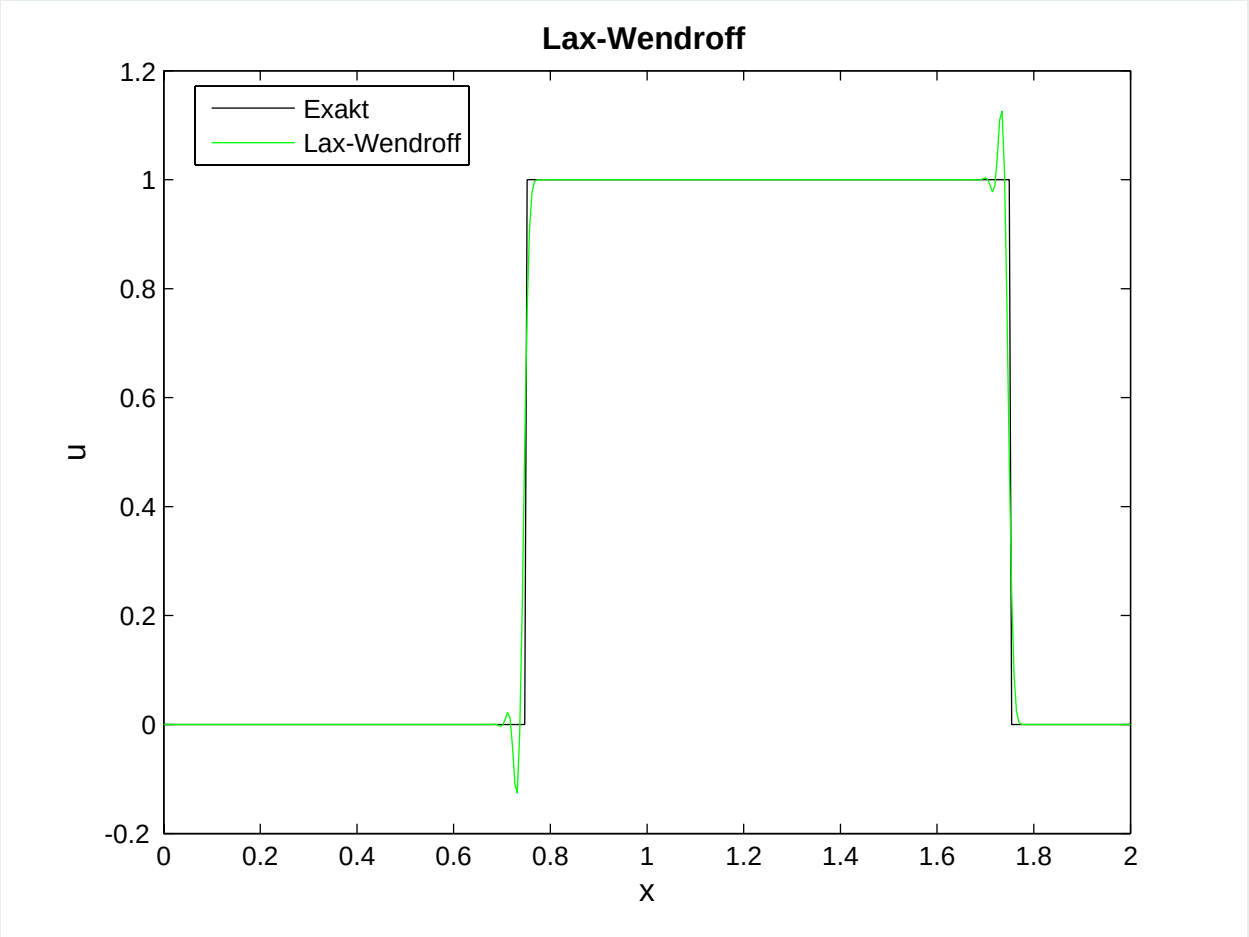


Figure: Approximate solution of the Lax-Wendroff-scheme at $t = 0.5$.

Example 3.4

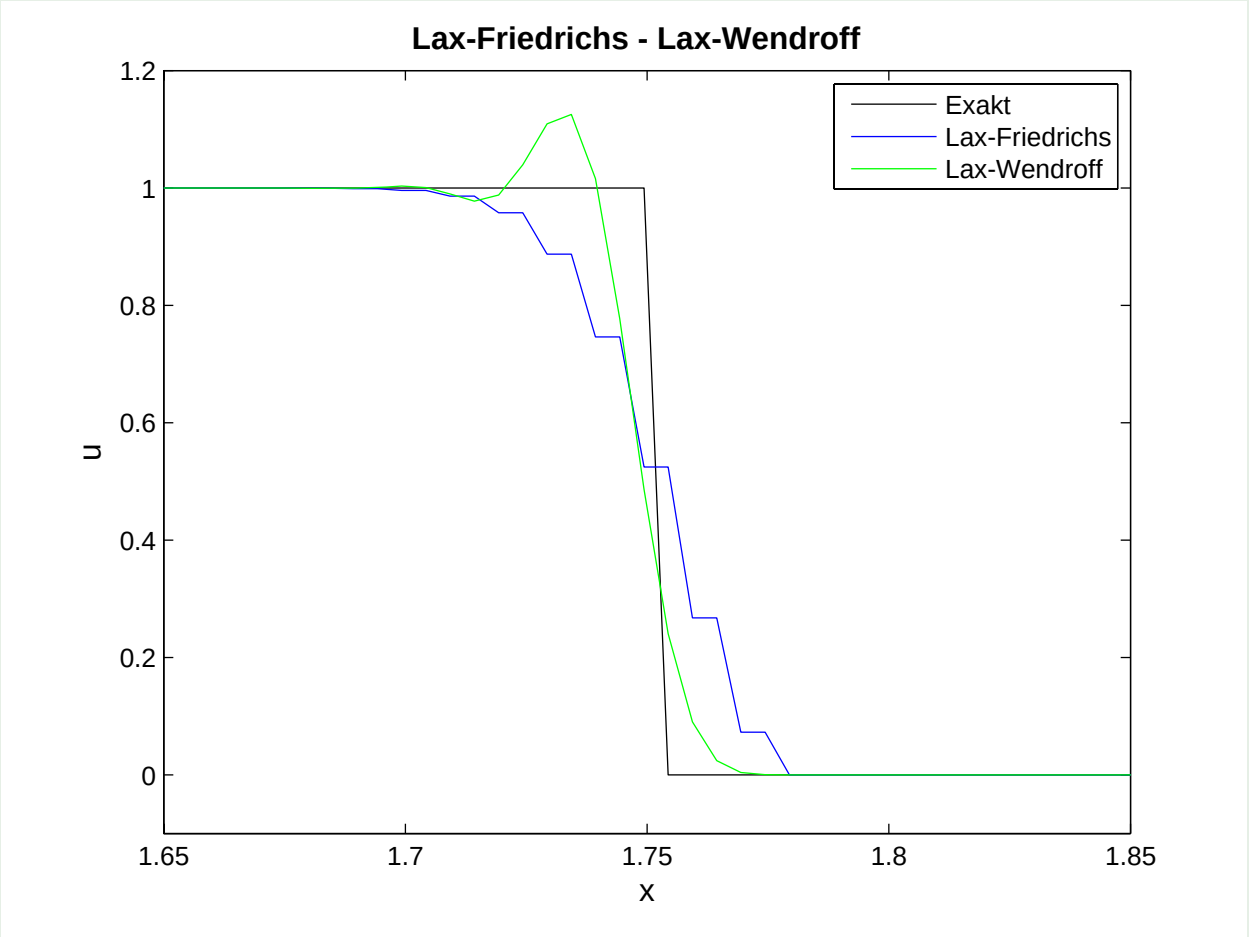


Figure: Comparison between Lax-Friedrichs and Lax-Wendroff

Example 3.4

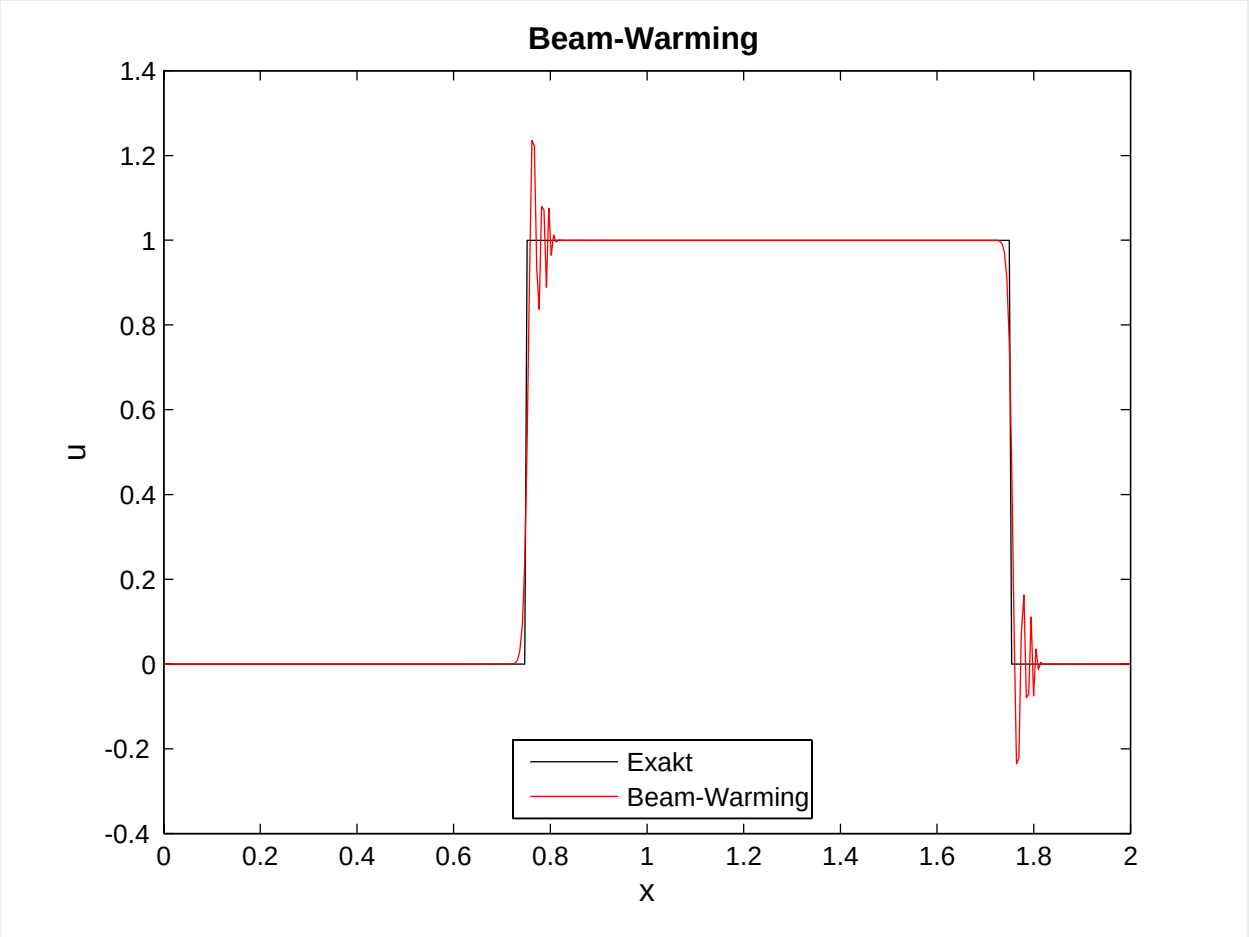


Figure: Approximate solution of the Beam-Warming-scheme at $t = 0.5$.

Finite Volume Scheme in one space dimension

Example 3.4

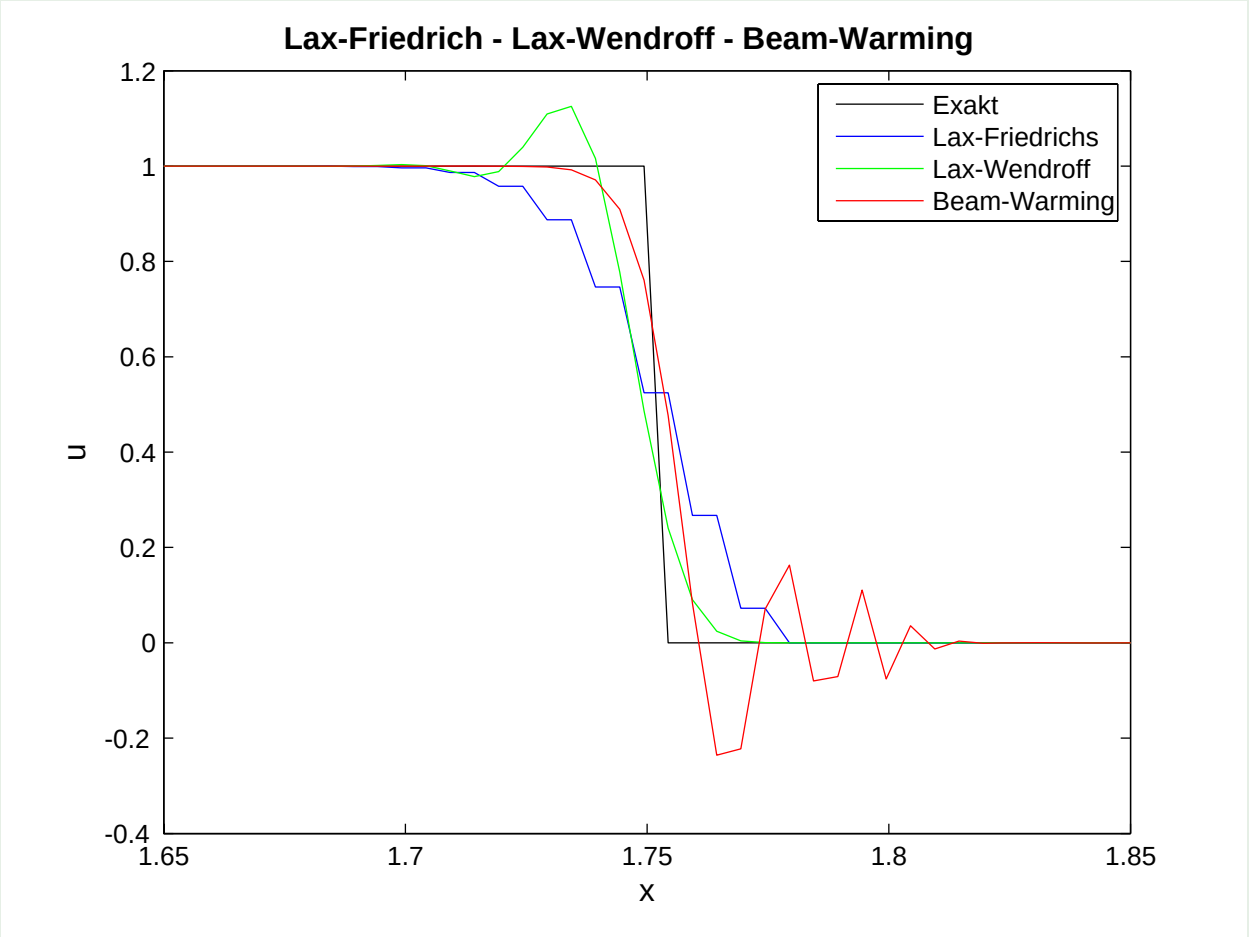
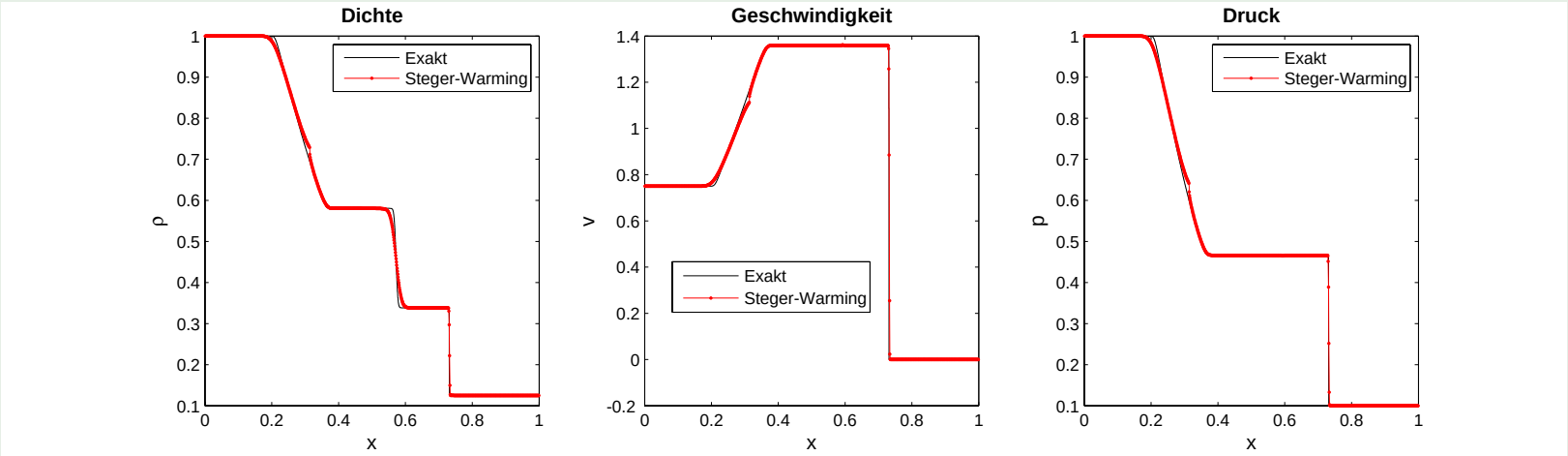


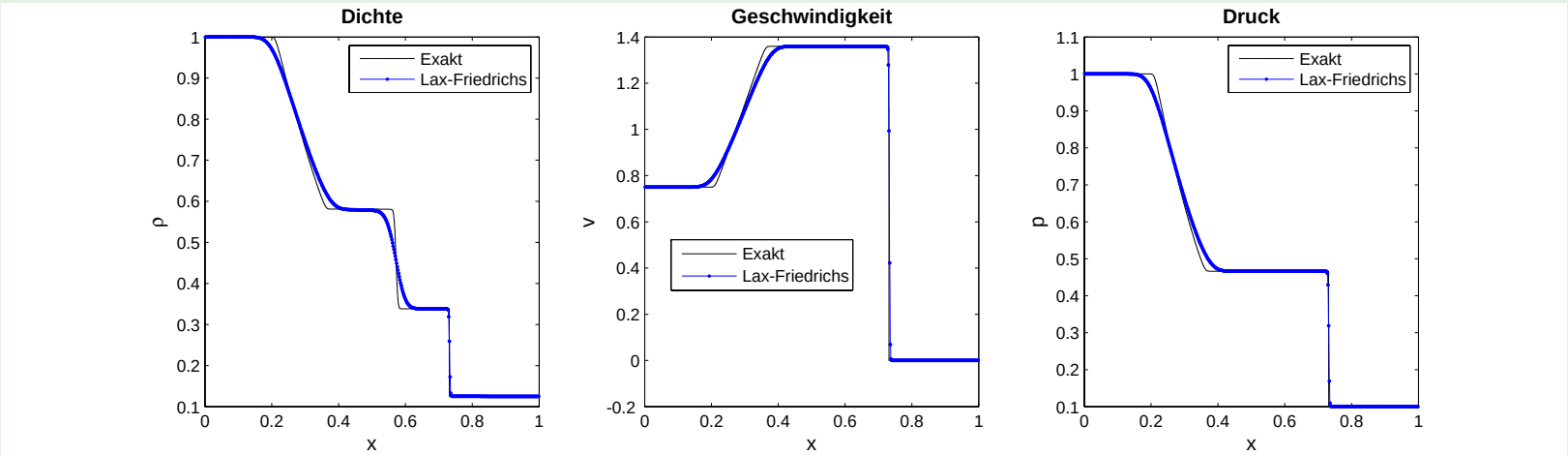
Figure: Vergleich Lax-Friedrichs, Lax-Wendroff, Beam-Warming

Finite Volume Scheme in one space dimension

Example 3.9: Results Steger-Warming



Example 3.9: Results Lax-Friedrichs



Example 3.9: Shock

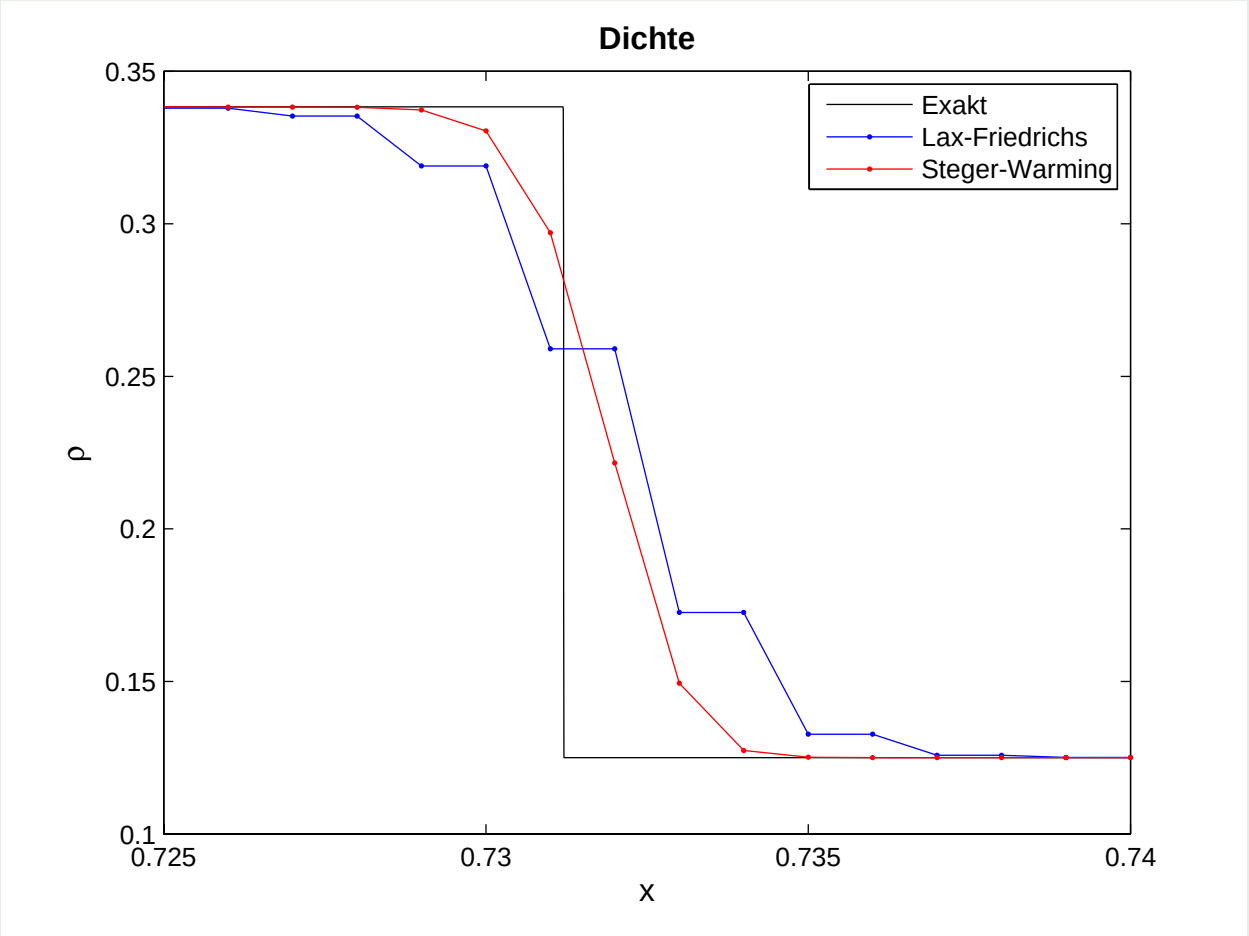


Figure: Comparison between Lax-Friedrichs and Steger-Warming

Example 3.9: Contact discontinuity

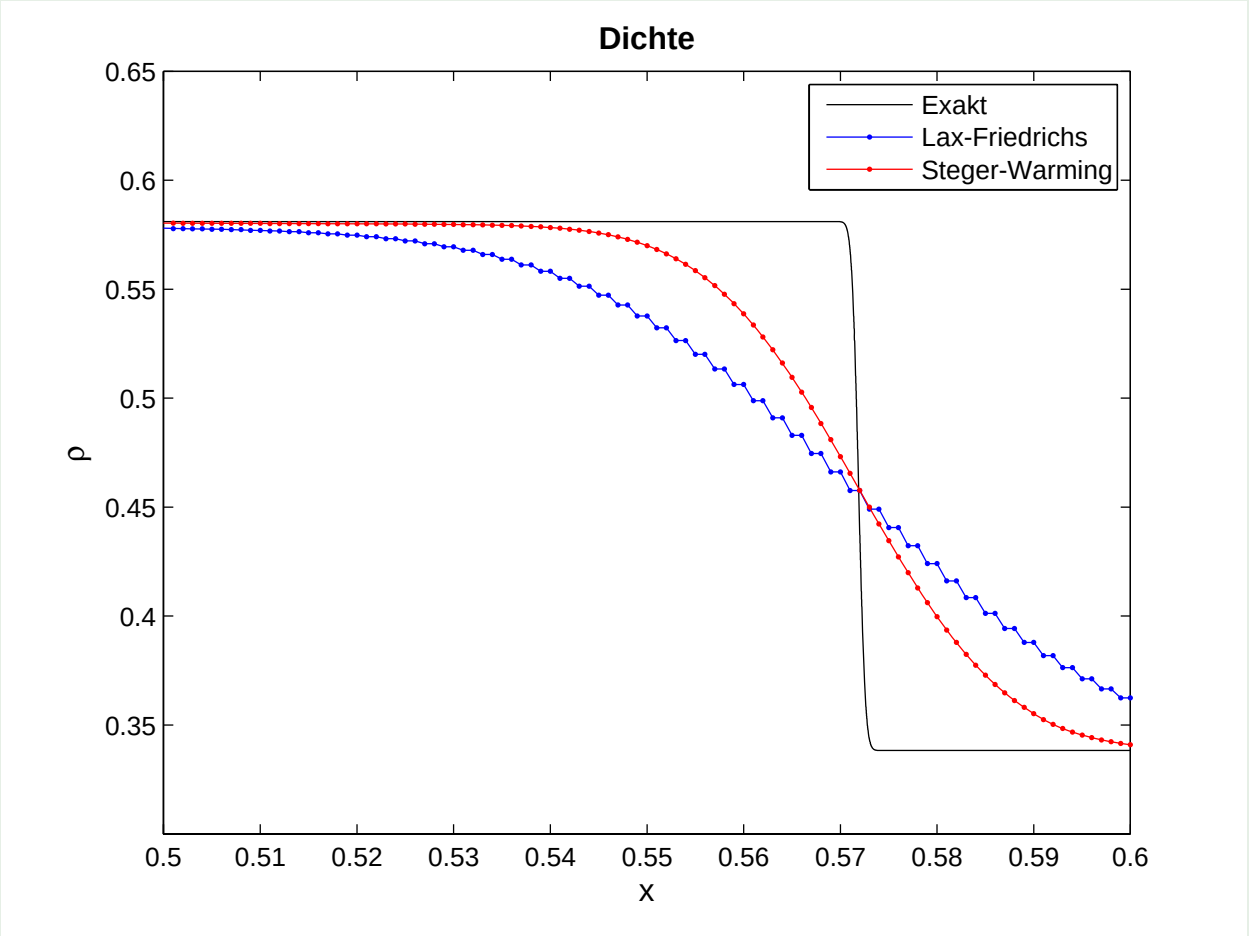


Figure: Comparison between Lax-Friedrichs and Steger-Warming

Example 3.9: Expansion fan

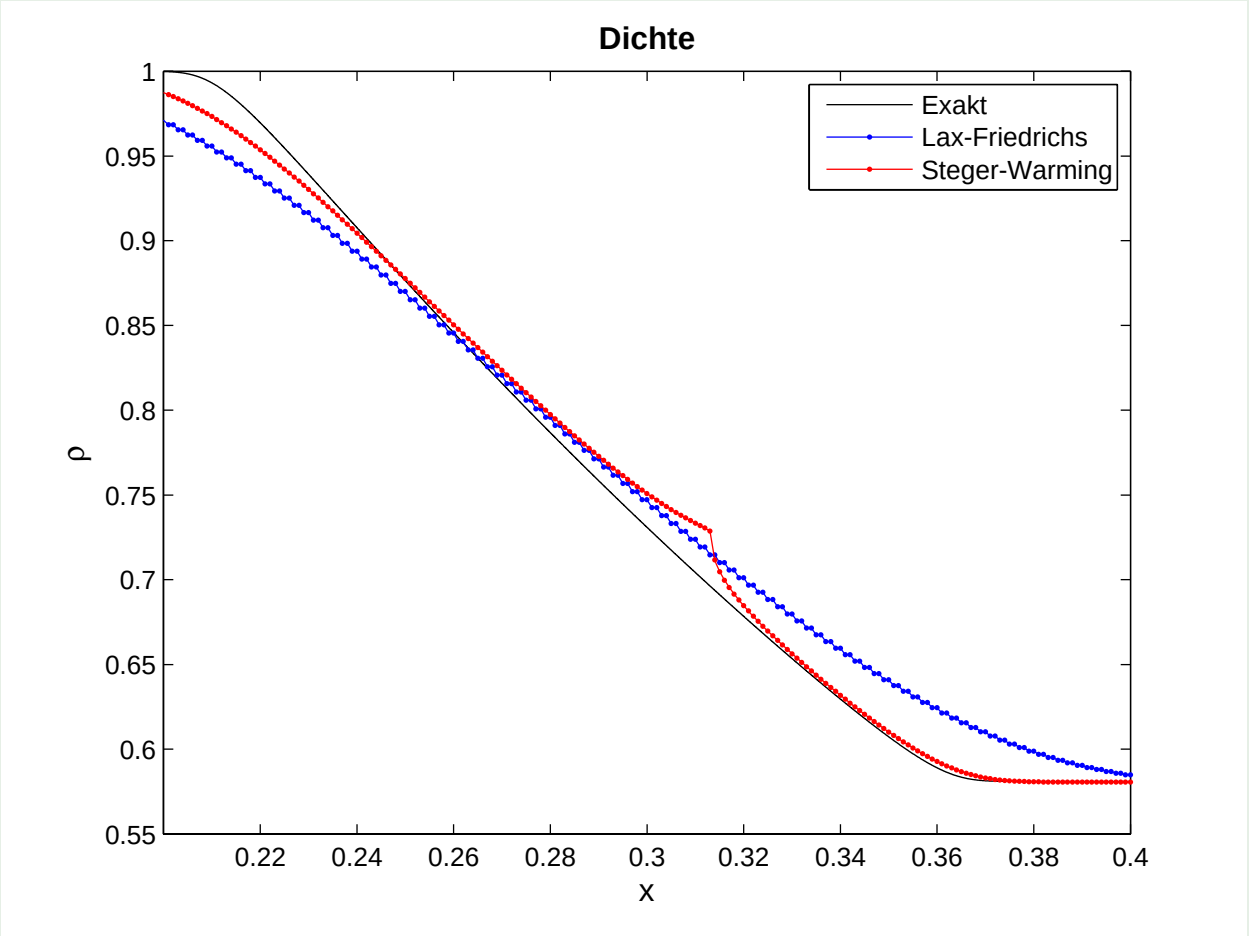


Figure: Comparison between Lax-Friedrichs and Steger-Warming

Distribution of the mass flux w.r.t. the Mach number

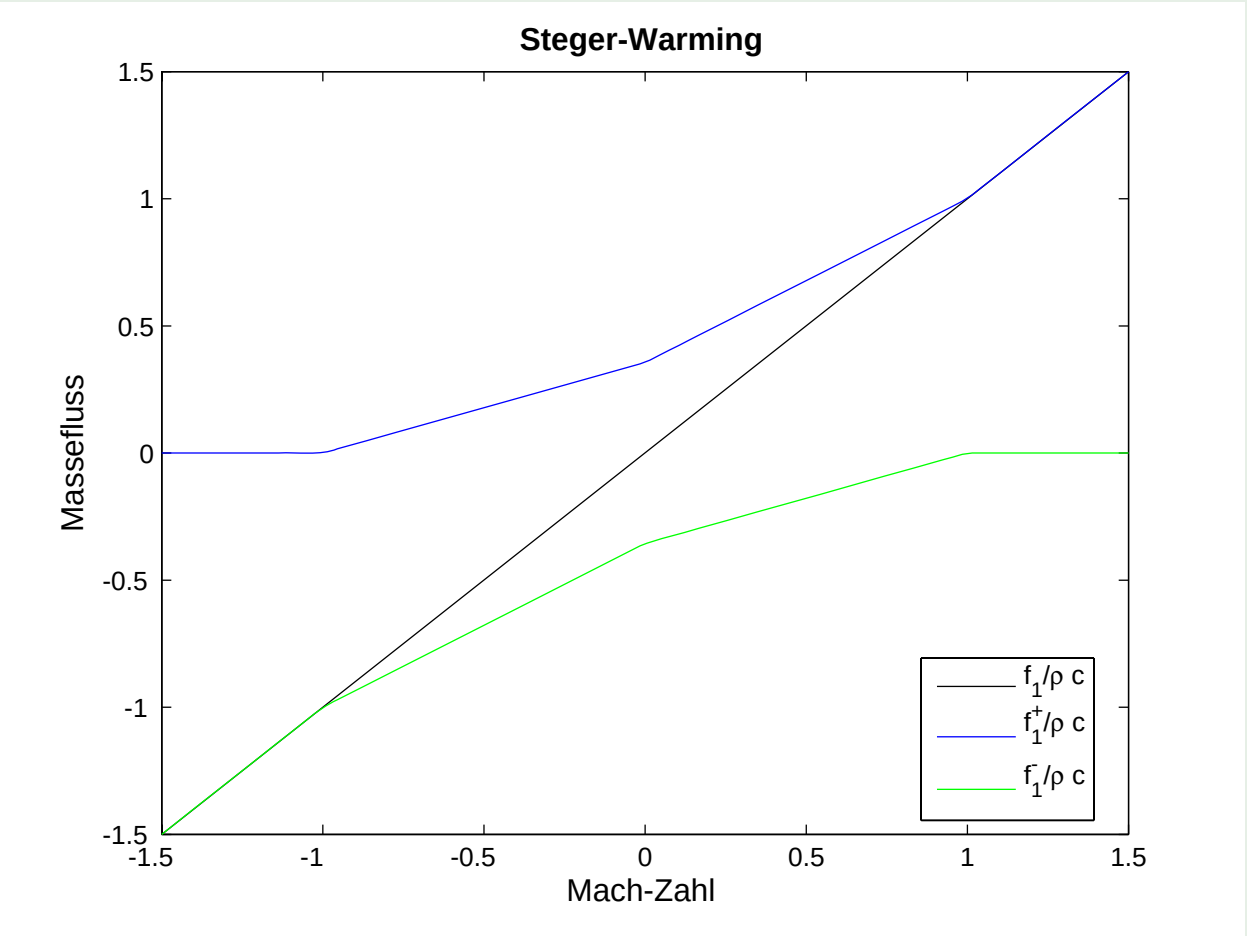


Figure: Steger-Warming

Distribution of the momentum flux w.r.t. the Mach number

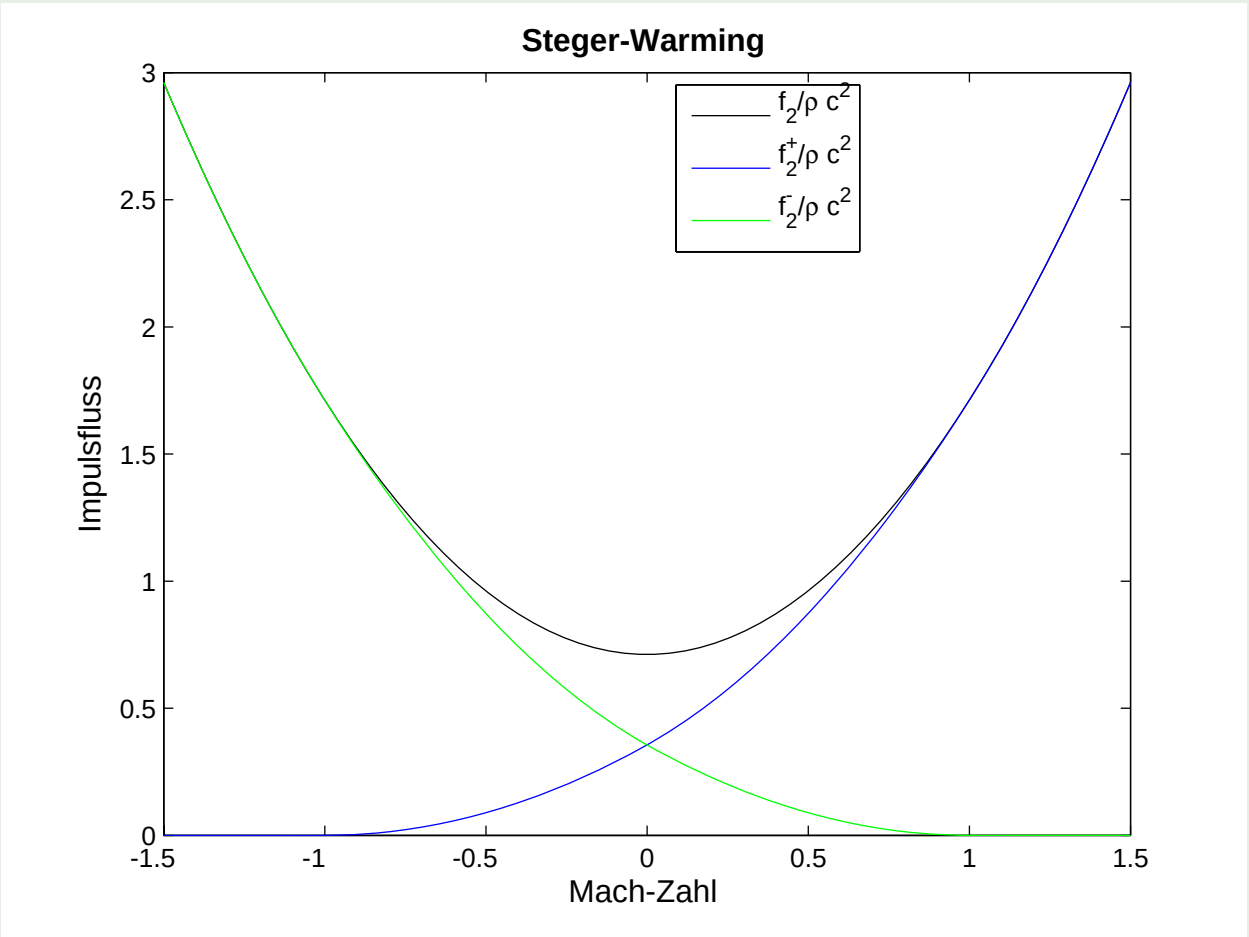


Figure: Steger-Warming

Distribution of the energy flux w.r.t. the Mach number

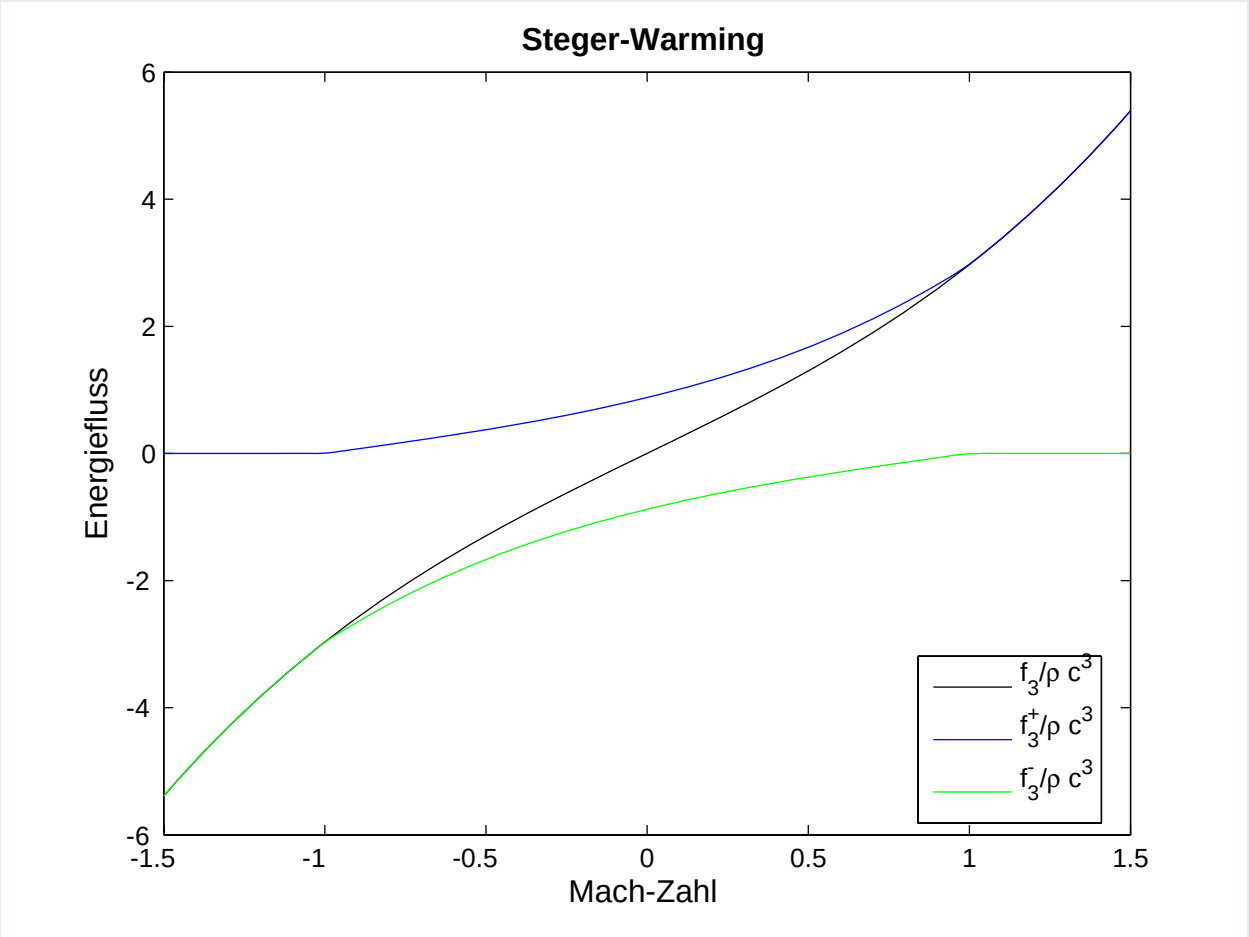


Figure: Steger-Warming

Distribution of the mass flux w.r.t. the Mach number

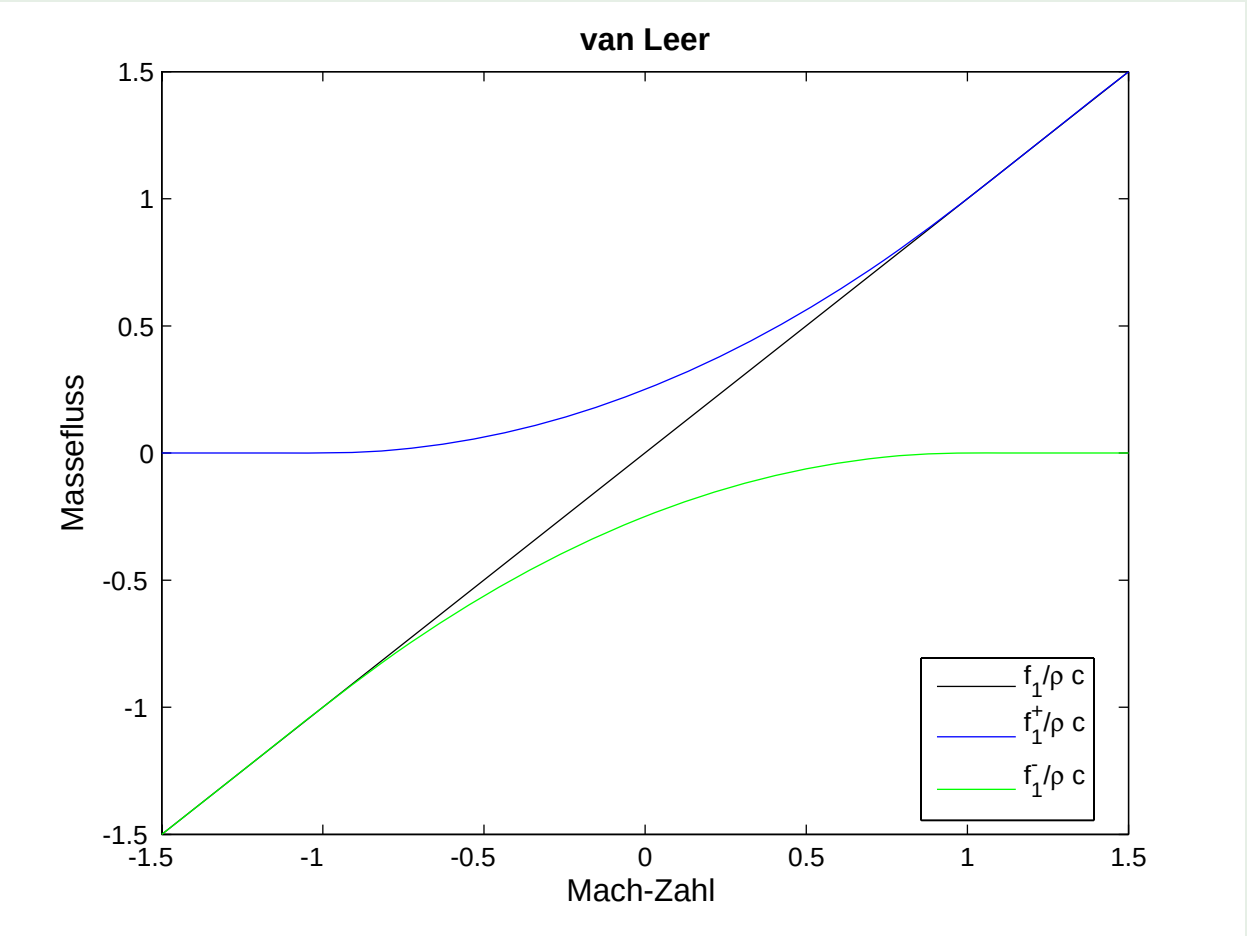


Figure: Van Leer

Distribution of the momentum flux w.r.t. the Mach number

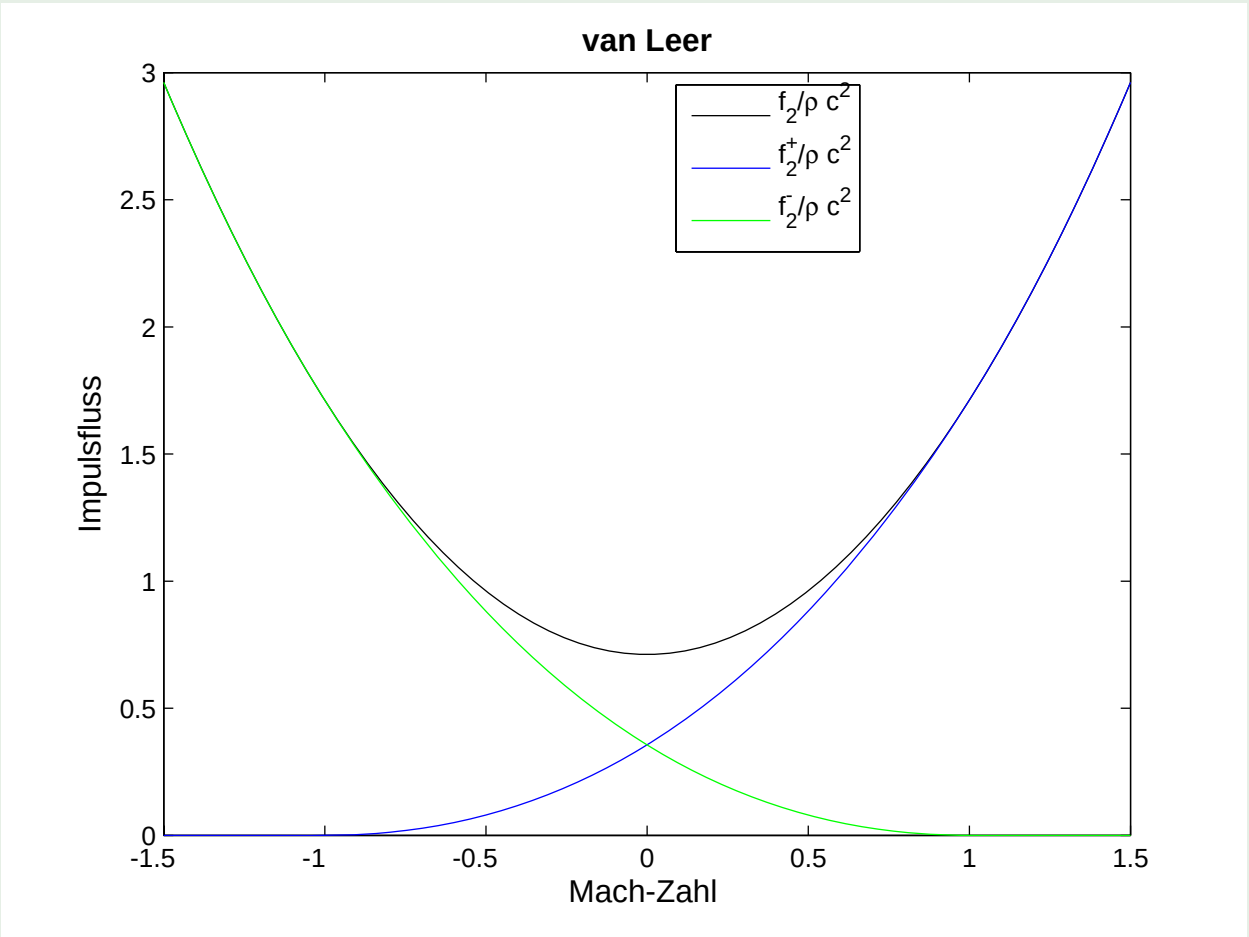


Figure: Van Leer

Distribution of the energy flux w.r.t. the Mach number

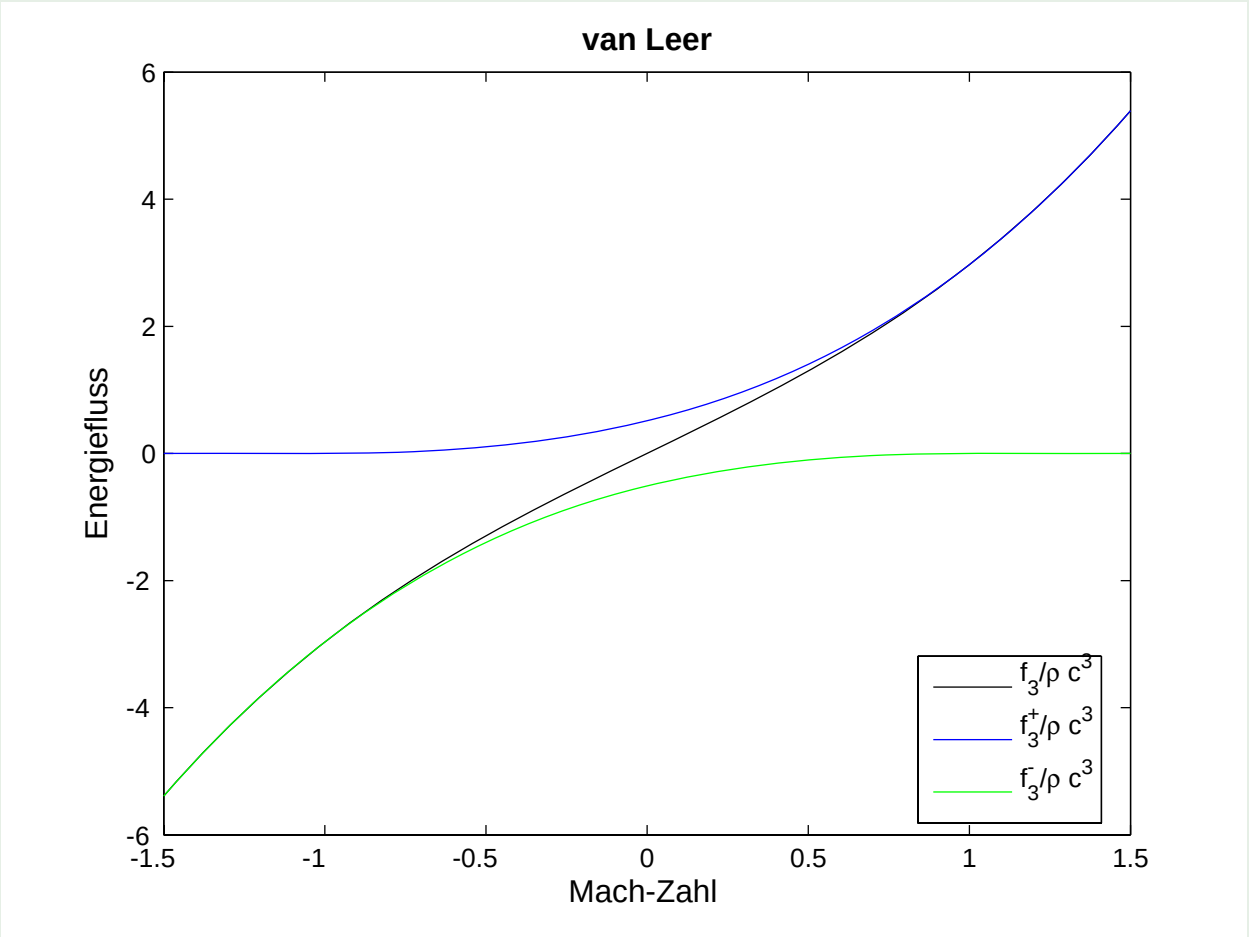
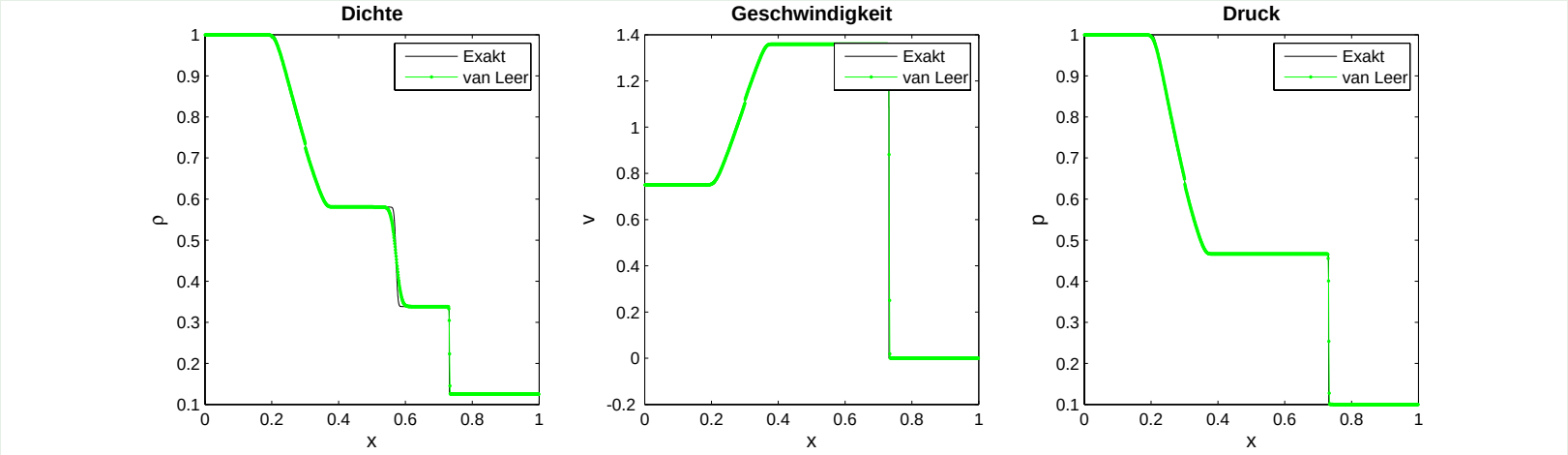


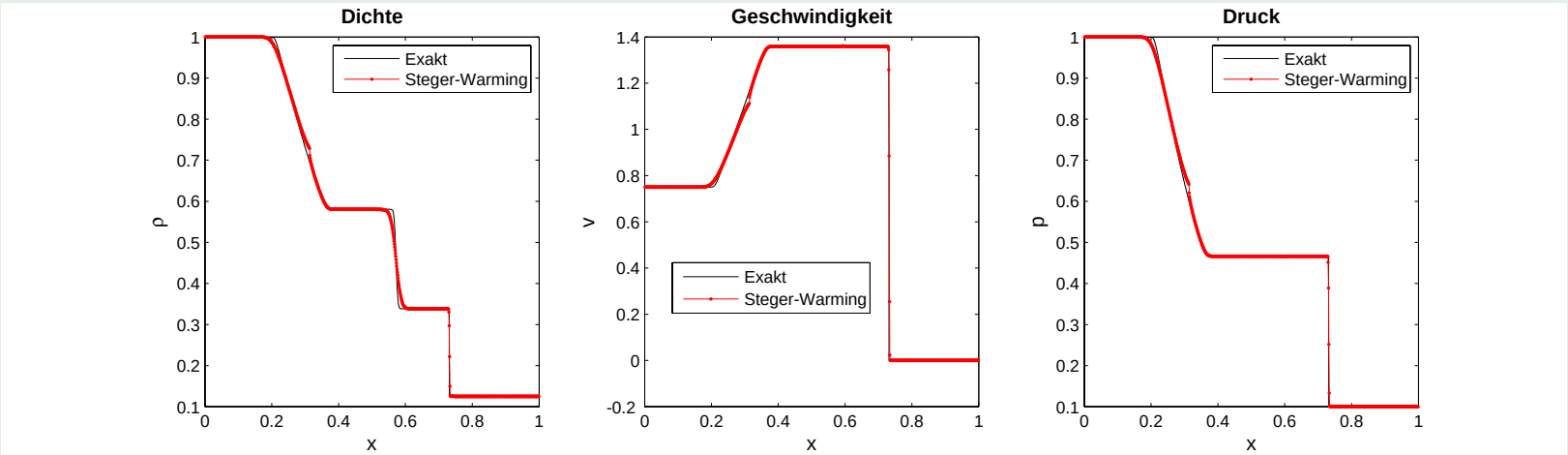
Figure: Van Leer

Finite Volume Scheme in one space dimension

Example 3.10: Results van Leer



Example 3.10: Results Steger-Warming



Finite Volume Scheme in one space dimension

Example 3.10: Shock

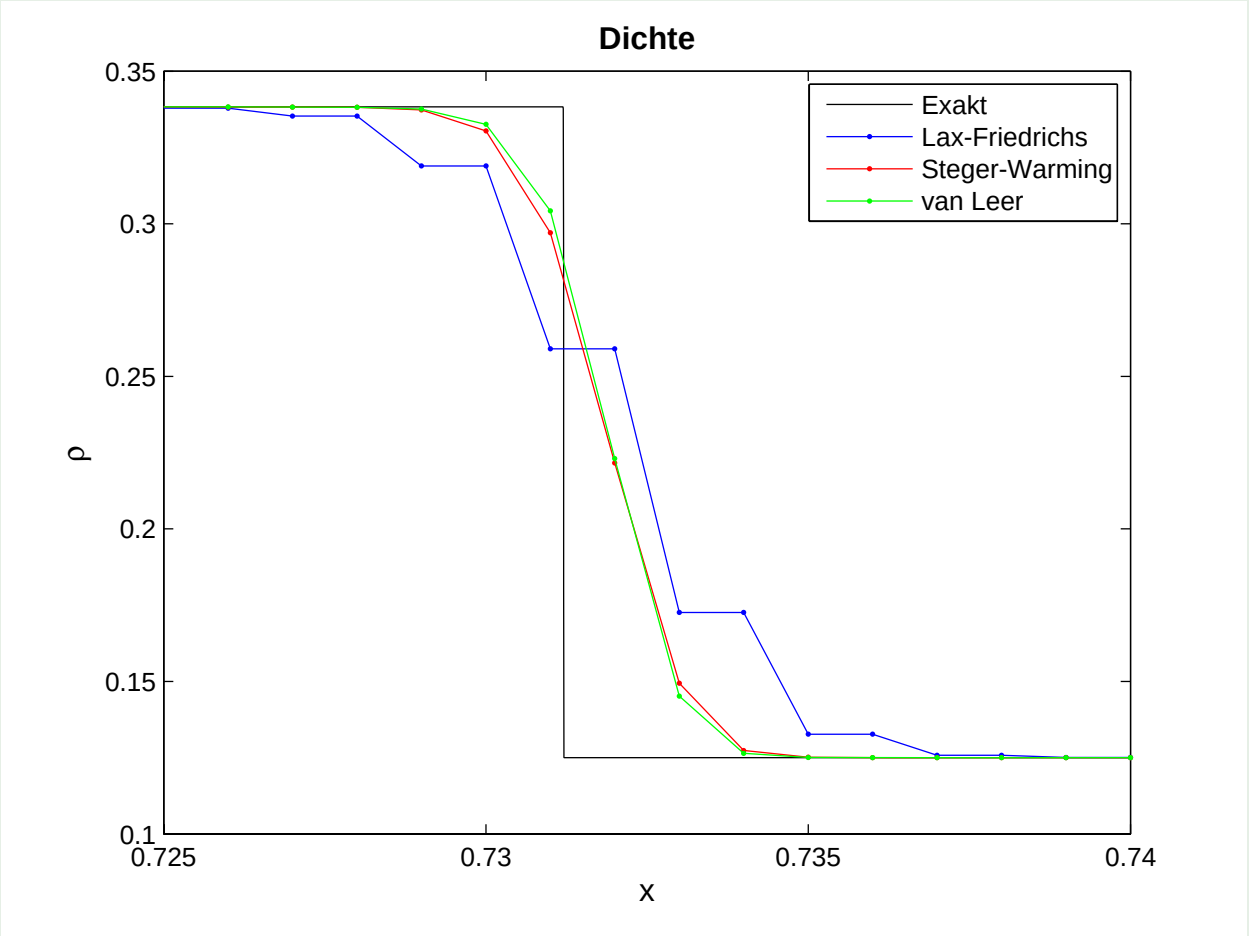


Figure: Comparison between Lax-Friedrichs, Steger-Warming and van Leer

Example 3.10: Contact discontinuity

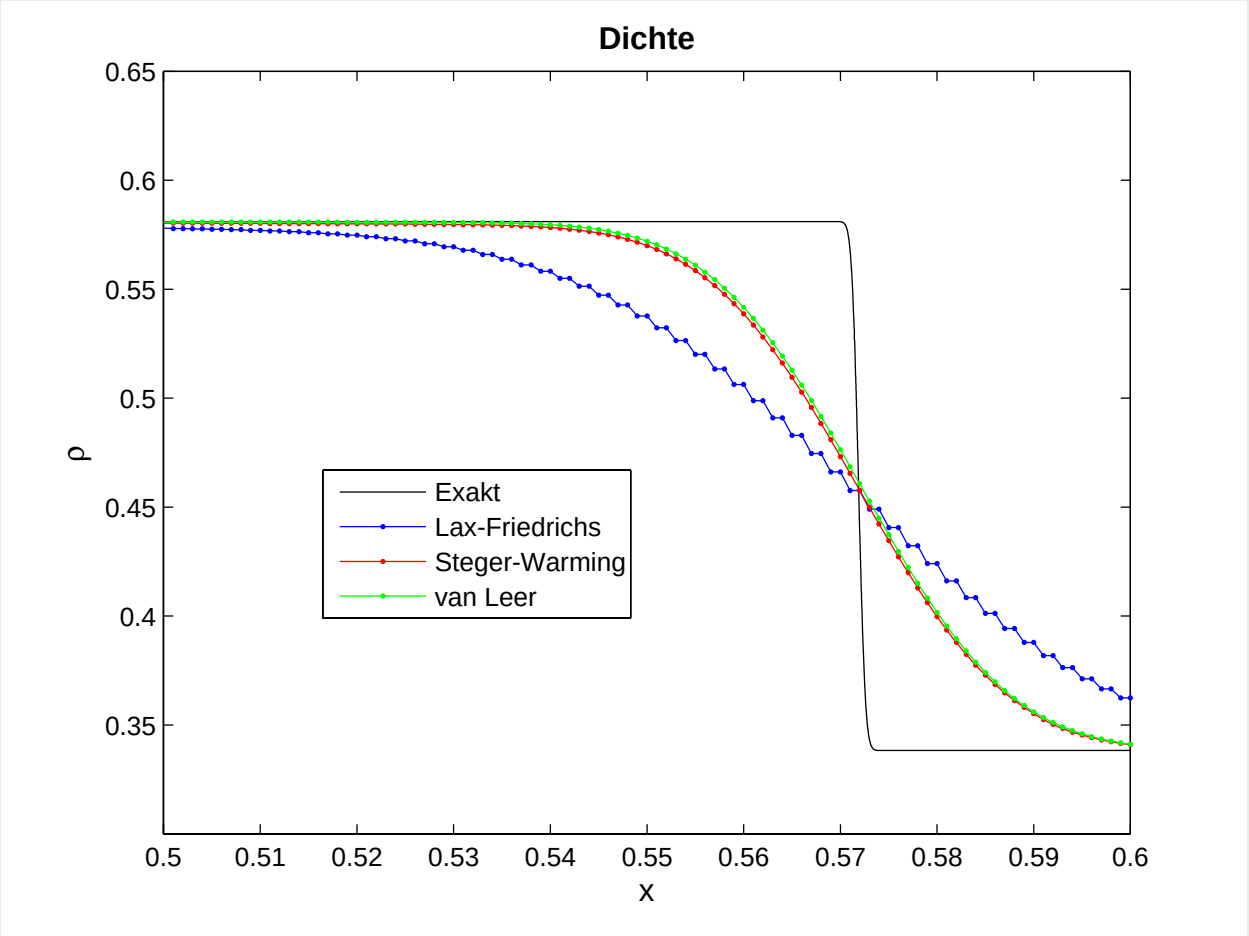


Figure: Comparison between Lax-Friedrichs, Steger-Warming and van Leer

Example 3.10: Expansion fan

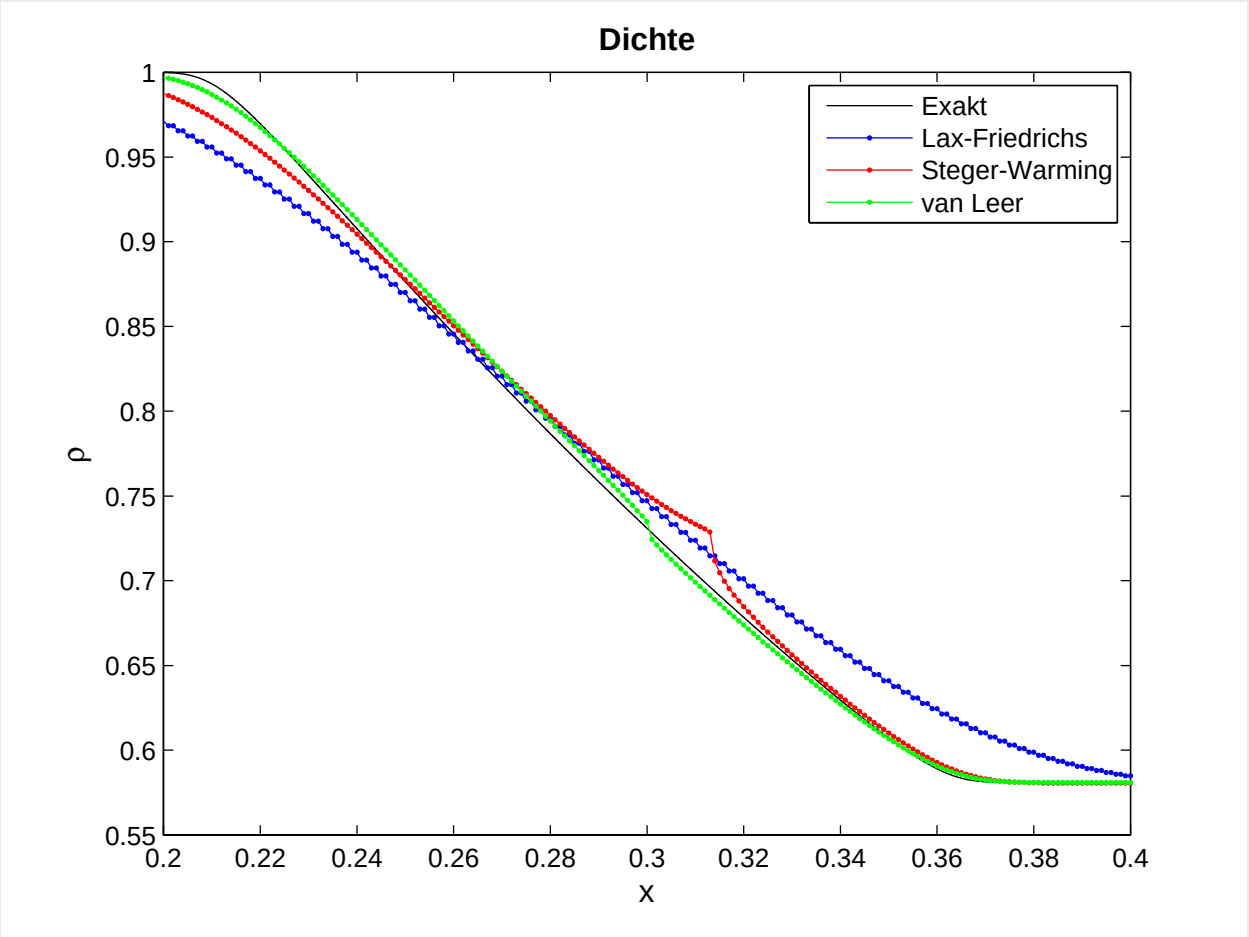
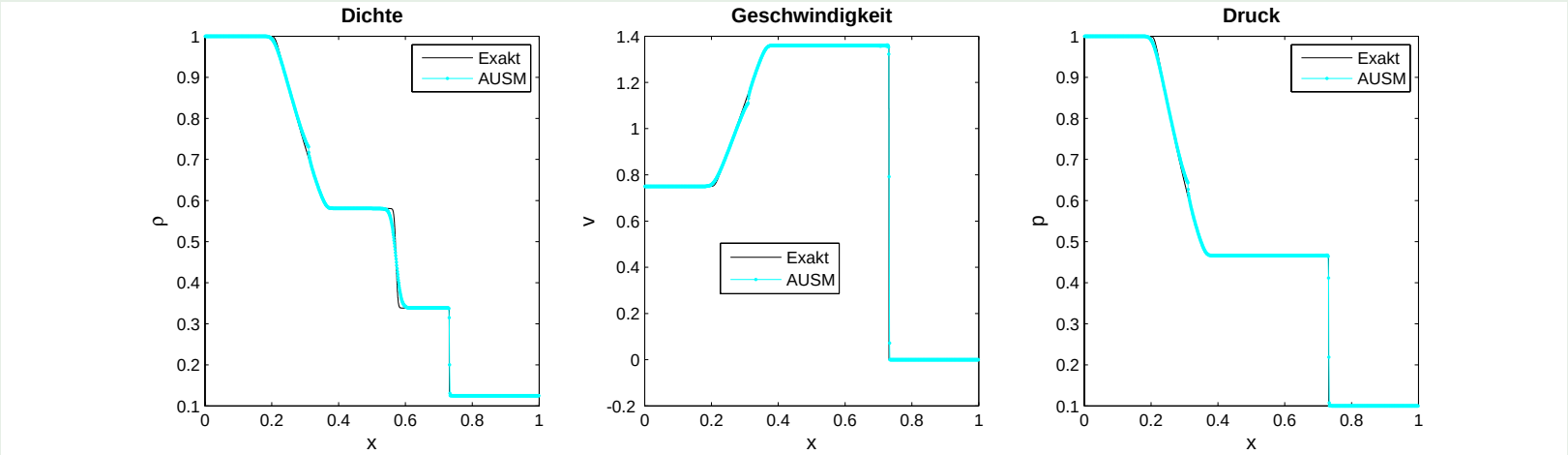
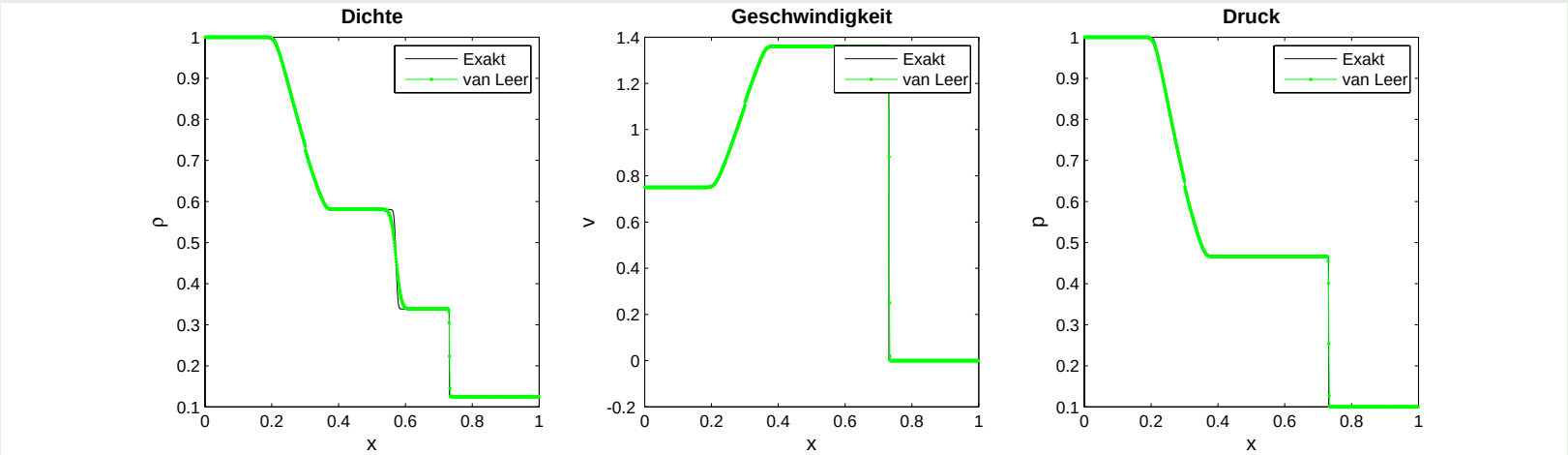


Figure: Comparison between Lax-Friedrichs, Steger-Warming and van Leer

Example 3.12: Results AUSM



Example 3.12: Results van Leer



Example 3.12: Shock

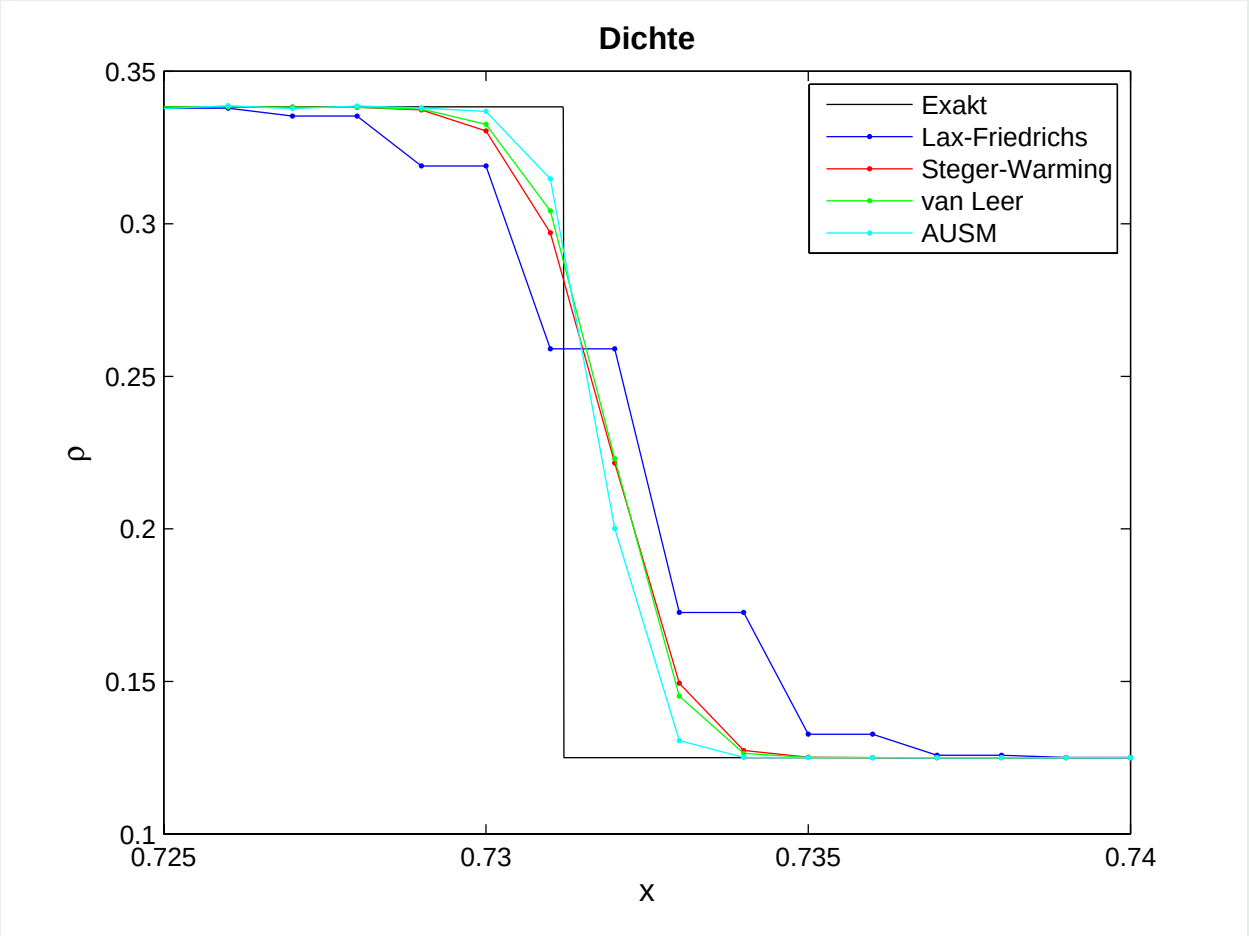


Figure: Comparison between Lax-Friedrichs, Steger-Warming, van Leer and AUSM

Example 3.12: Contact discontinuity

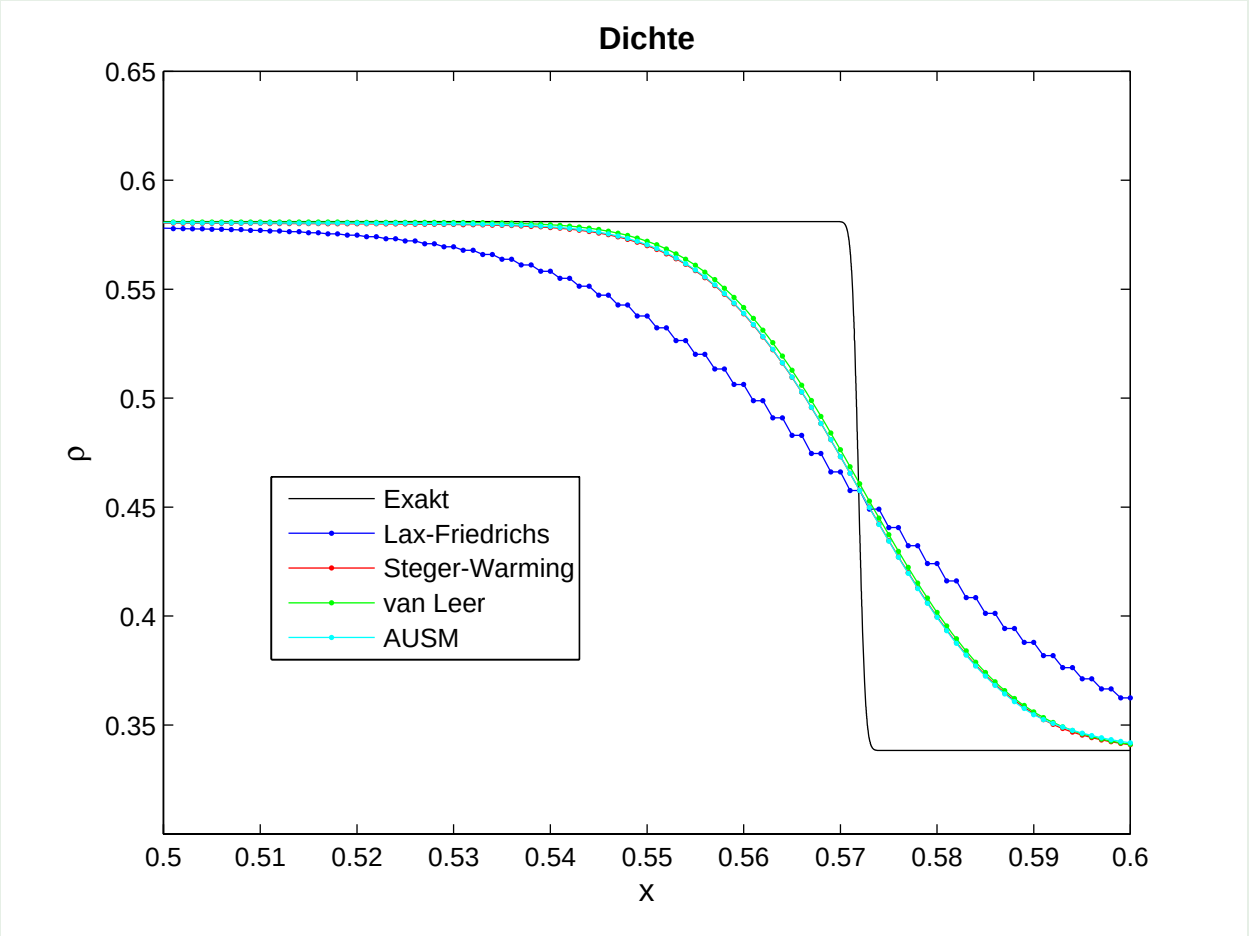


Figure: Comparison between Lax-Friedrichs, Steger-Warming, van Leer and AUSM

Example 3.12: Expansion fan

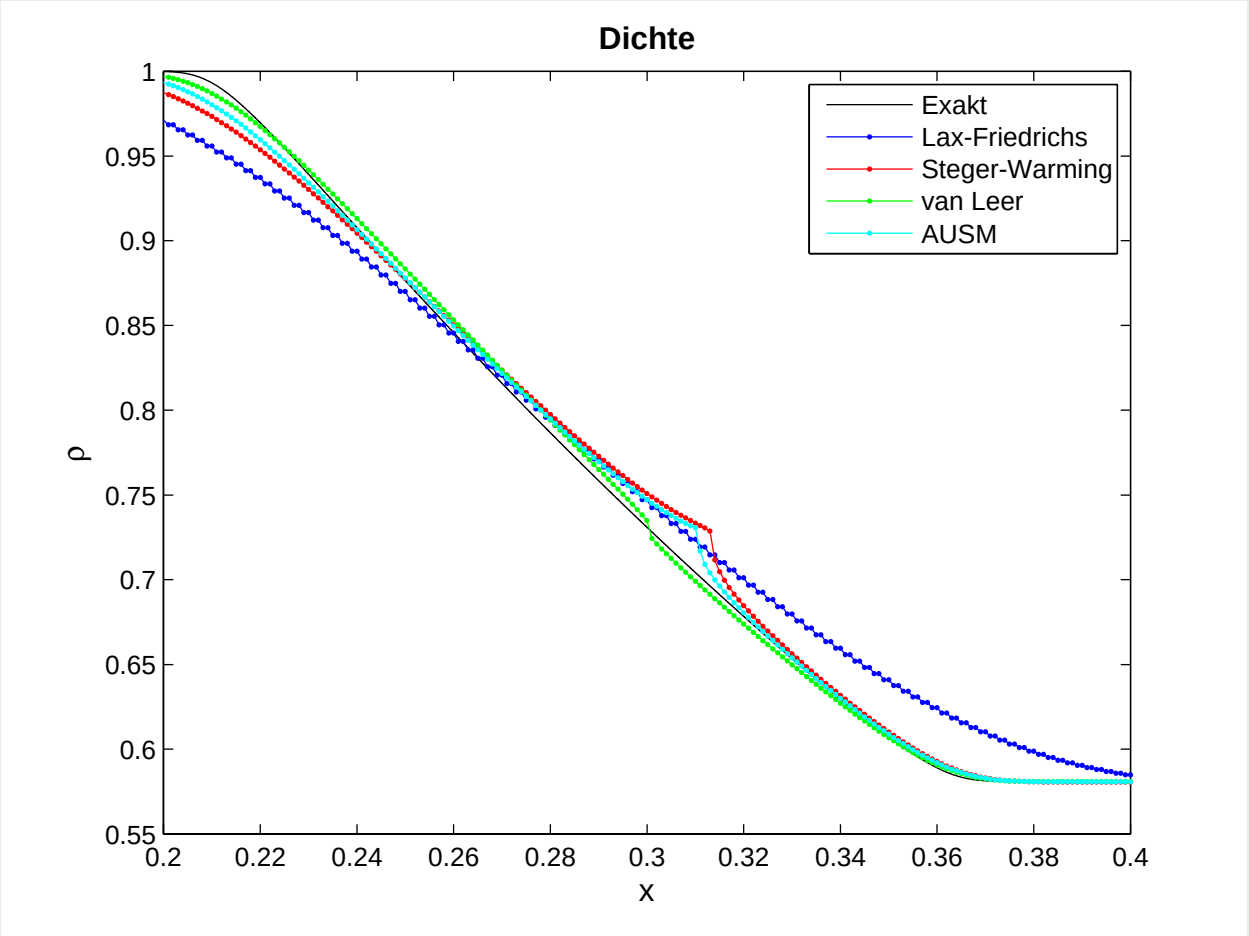


Figure: Comparison between Lax-Friedrichs, Steger-Warming, van Leer and AUSM

Example 3.13: Stationary Contact discontinuity

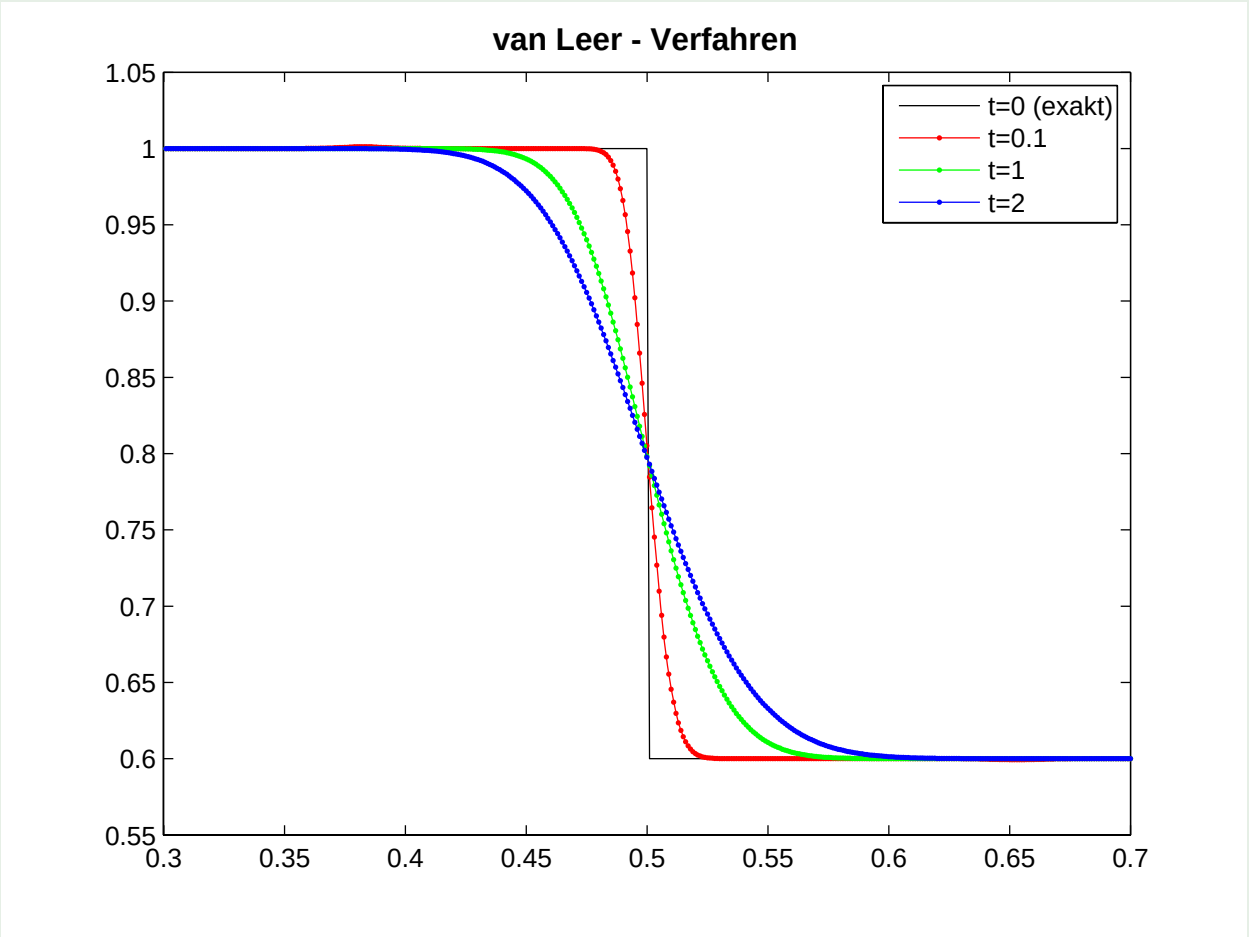


Figure: Comparison between exact solution and the results of van Leer

Example 3.13: Stationary Contact discontinuity

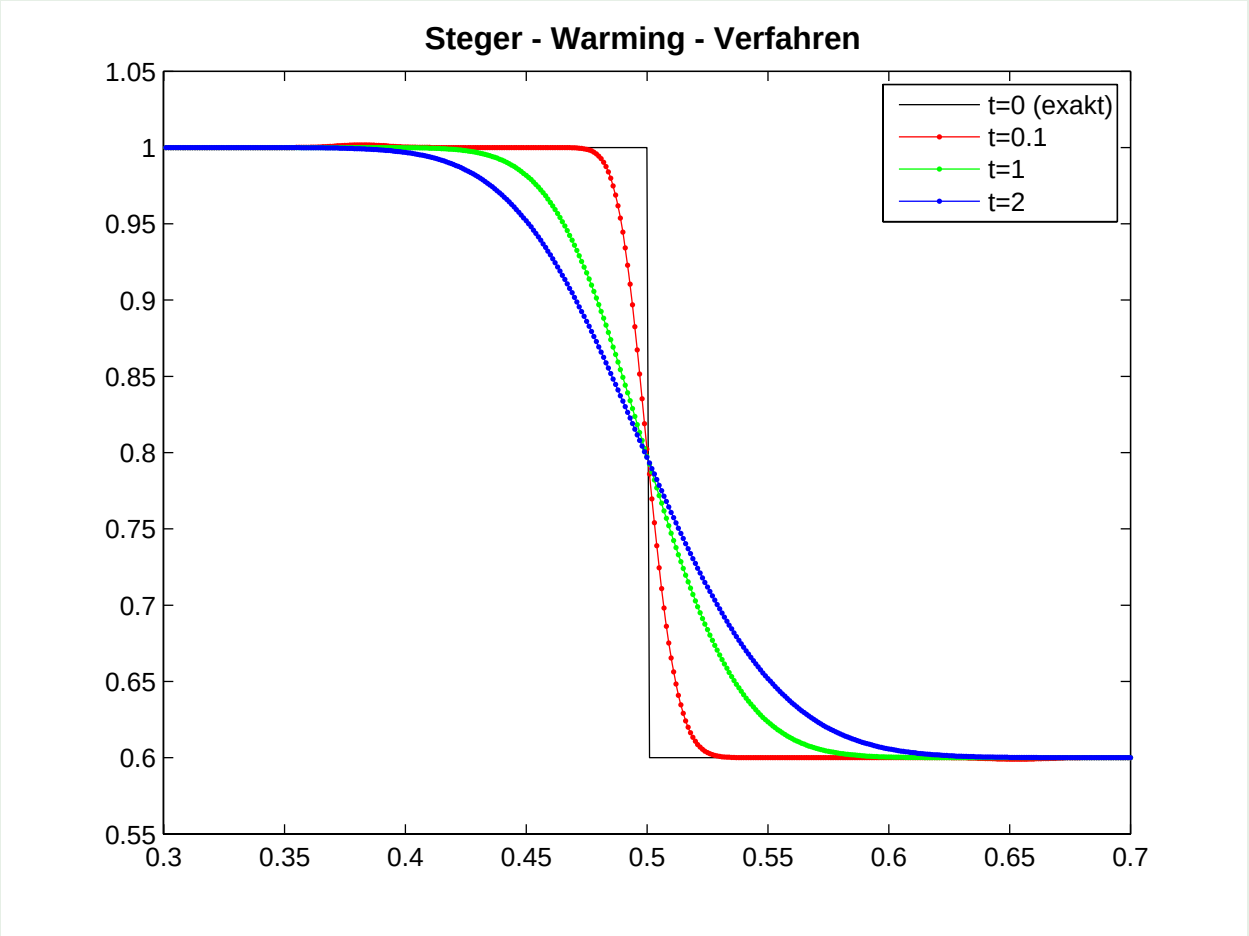


Figure: Comparison between exact solution and the results of Steger-Warming

Example 3.13: Stationary Contact discontinuity

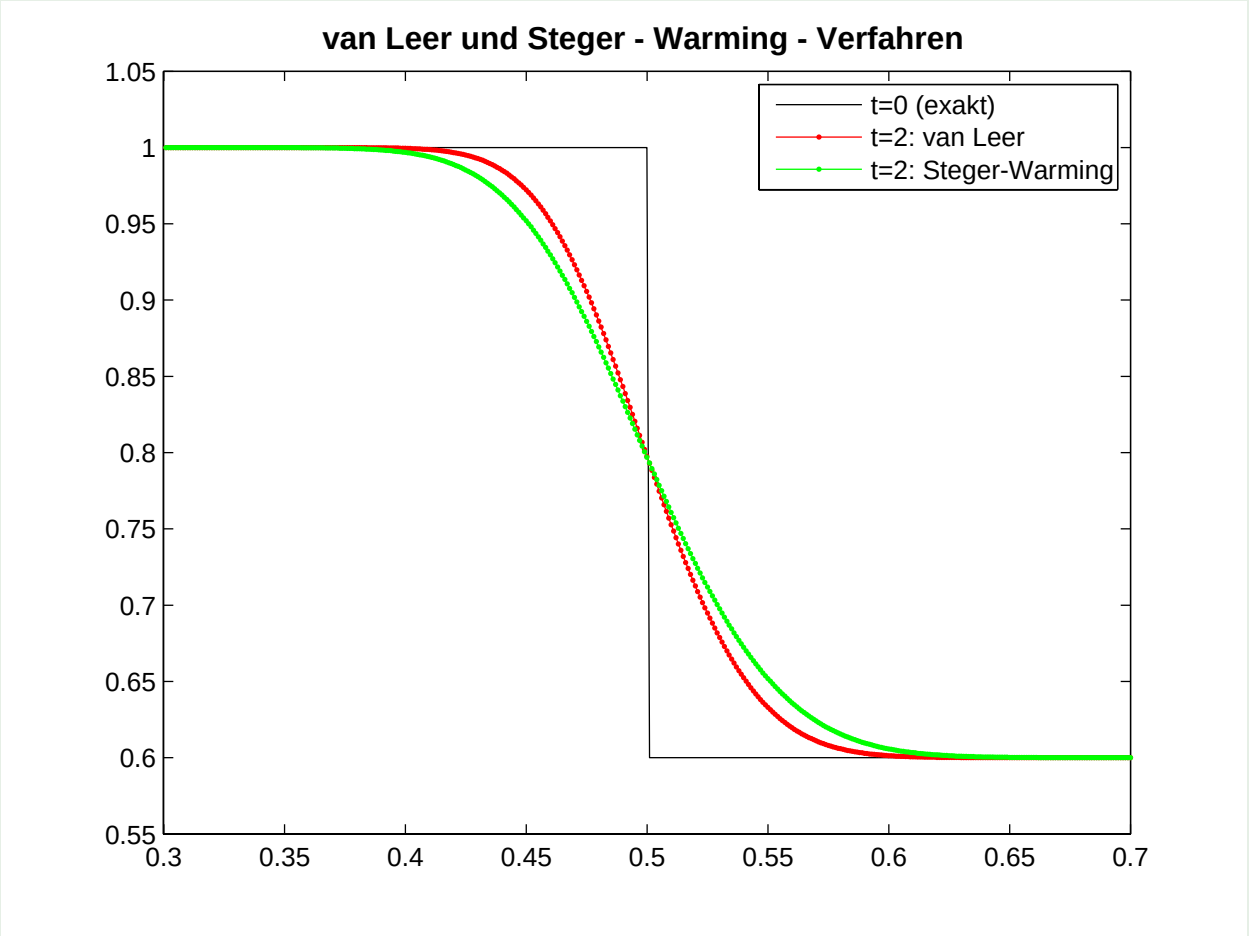


Figure: Comparison between the exact solution and the results of van Leer as well as Steger-Warming

Example 3.13: Stationary Contact discontinuity

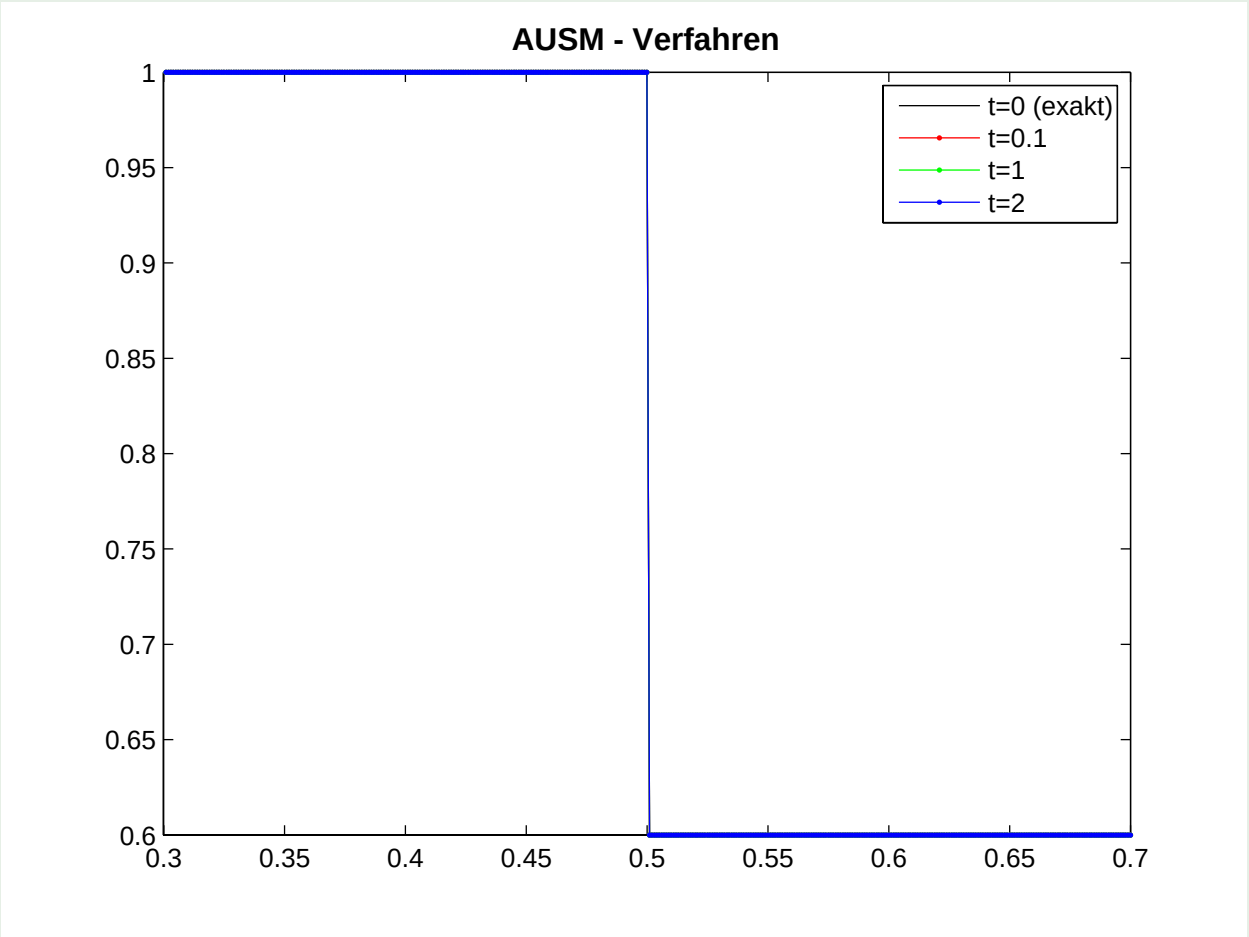


Figure: Comparison between exact solution and the results of AUSM

Example ?.??: Linear Advection Equation

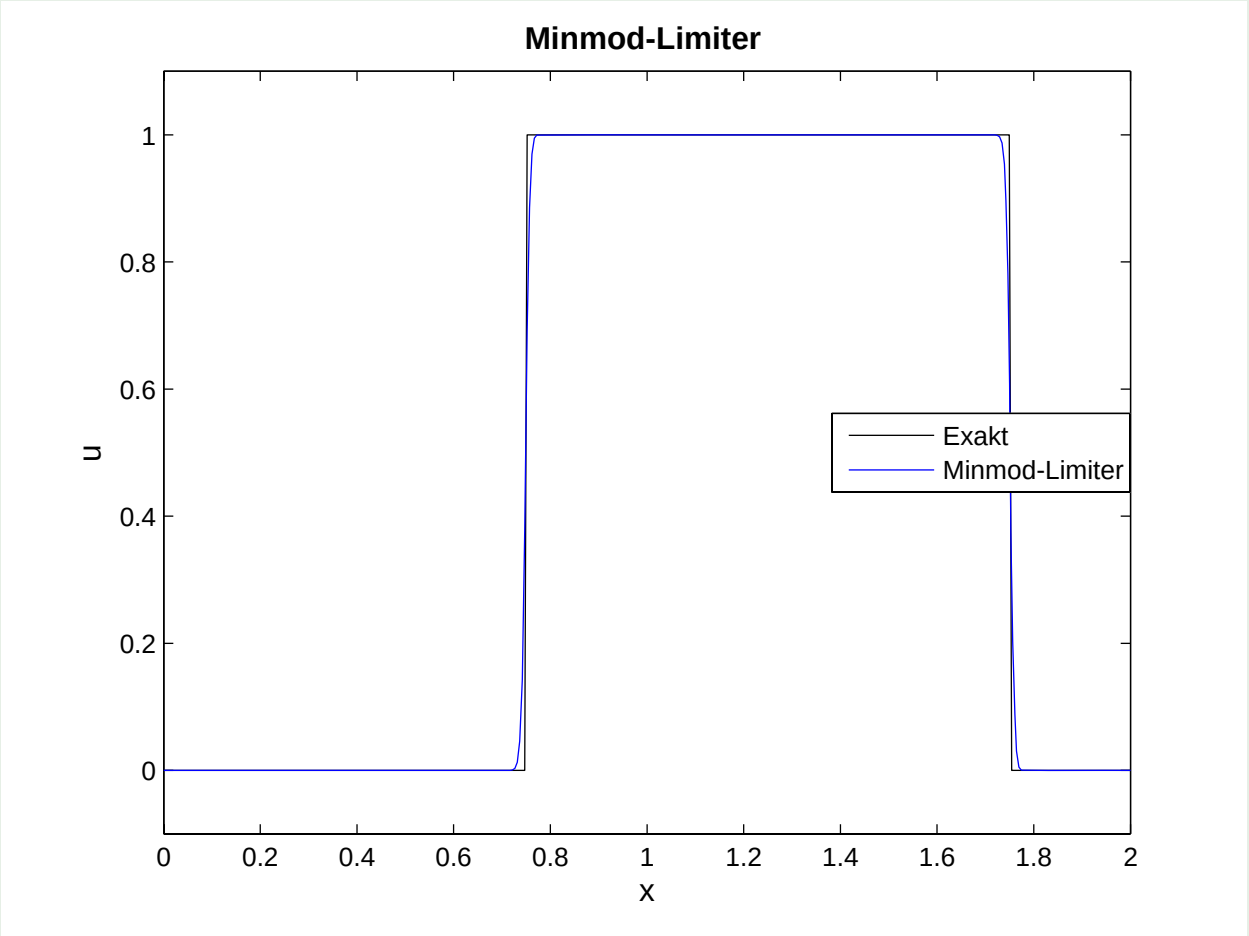


Figure: Minmod-Limiter

Example ?.??: Linear Advection Equation

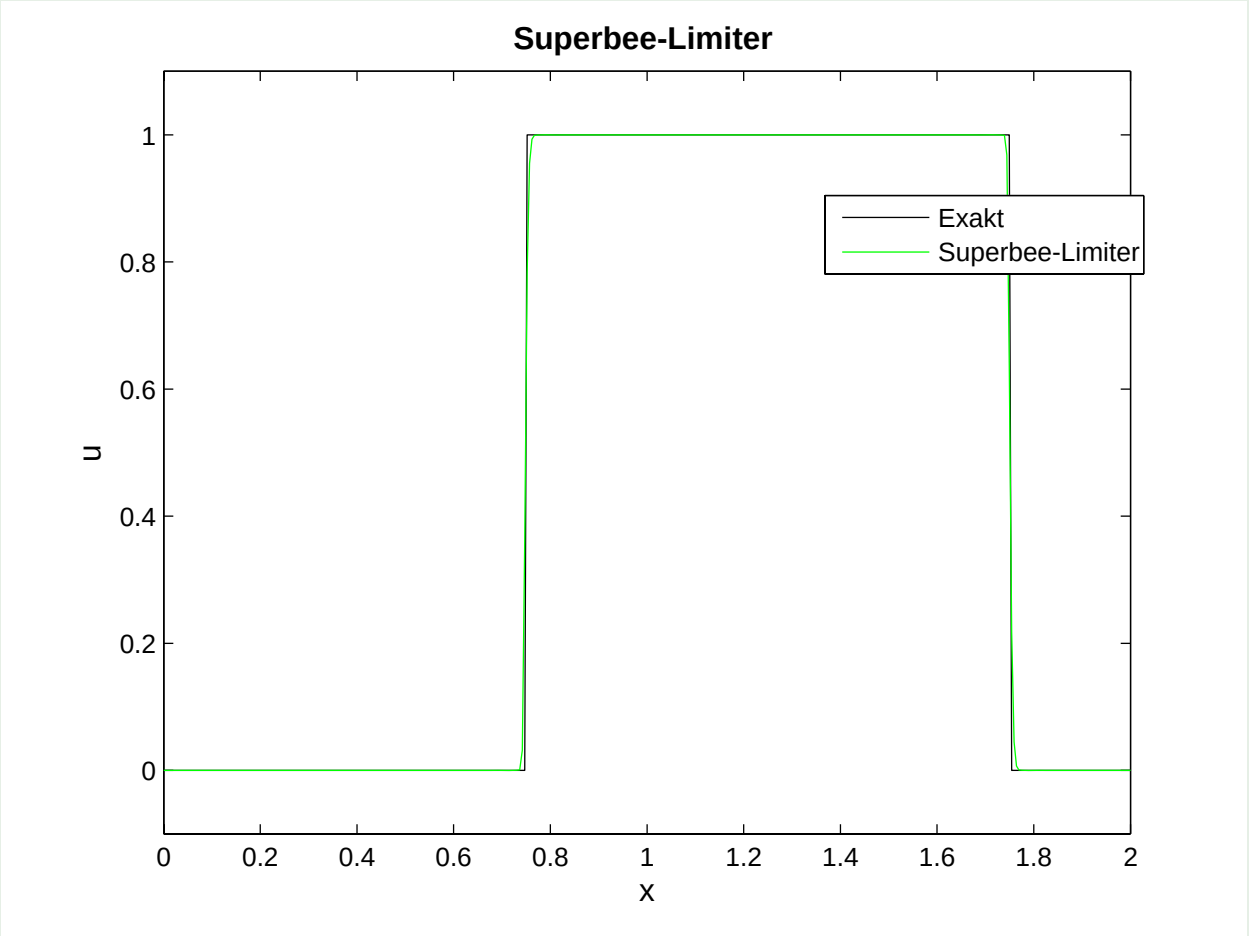


Figure: Superbee-Limiter

Example ?.??: Linear Advection Equation

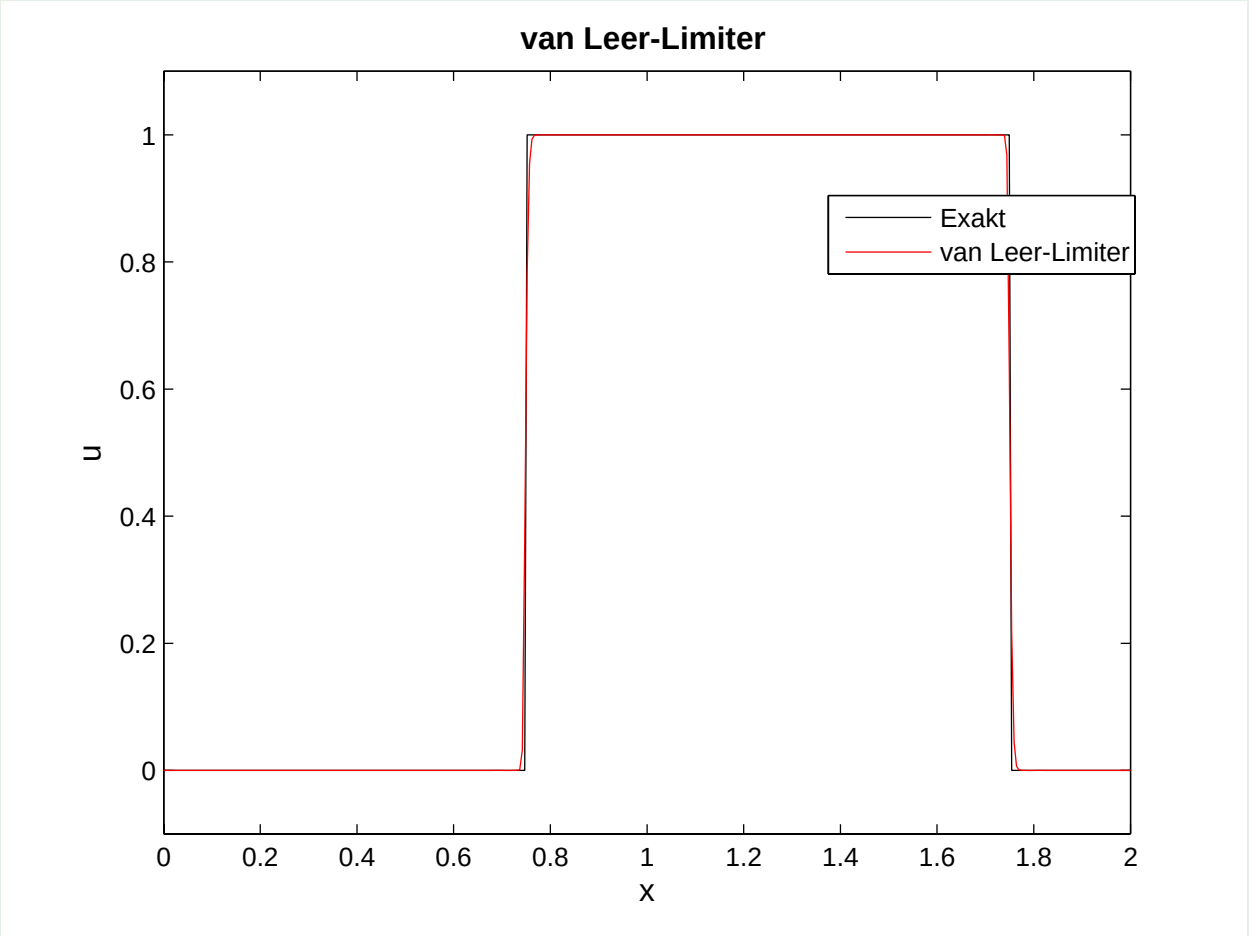


Figure: Van Leer Limiter

Example ?.??: Linear Advection Equation

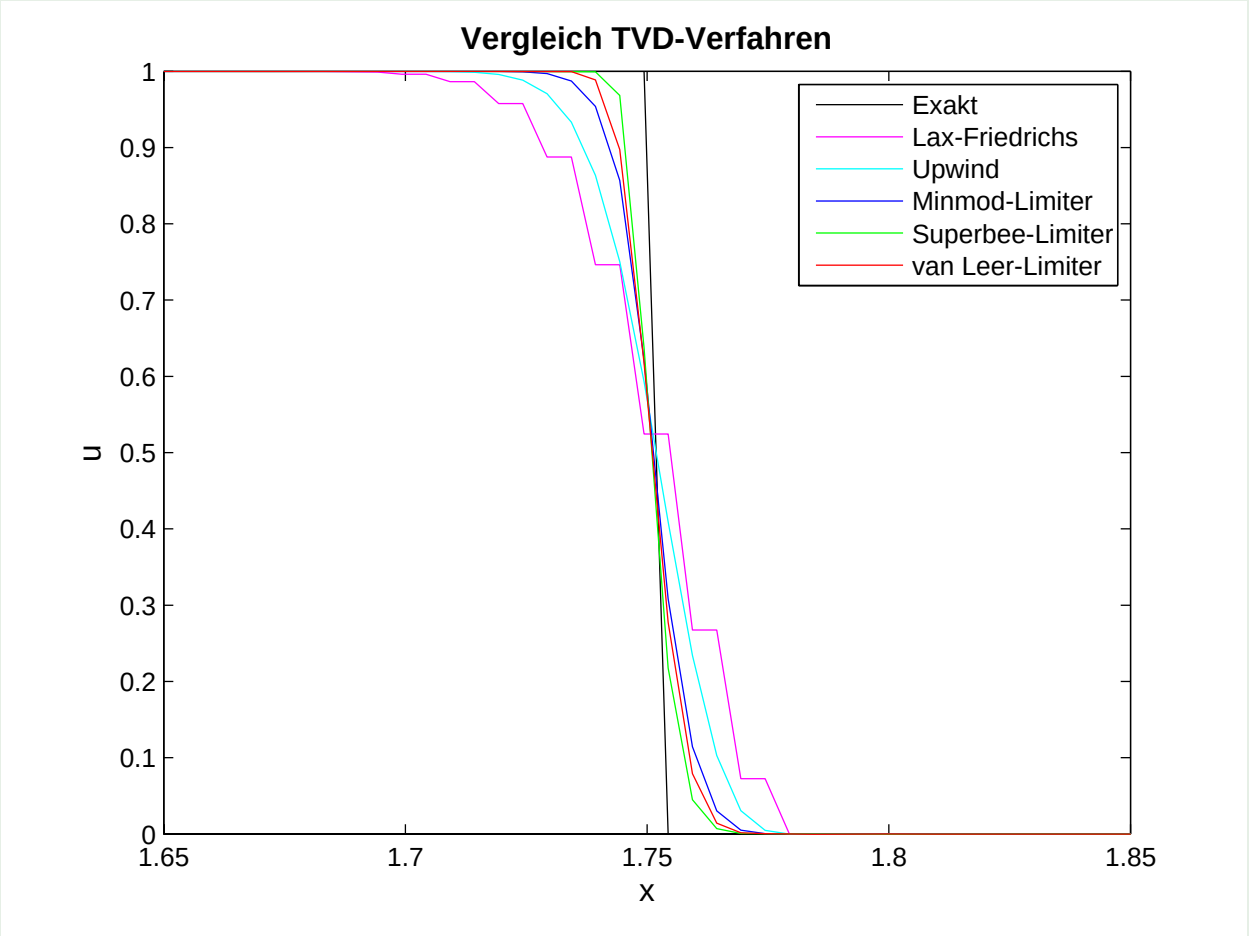
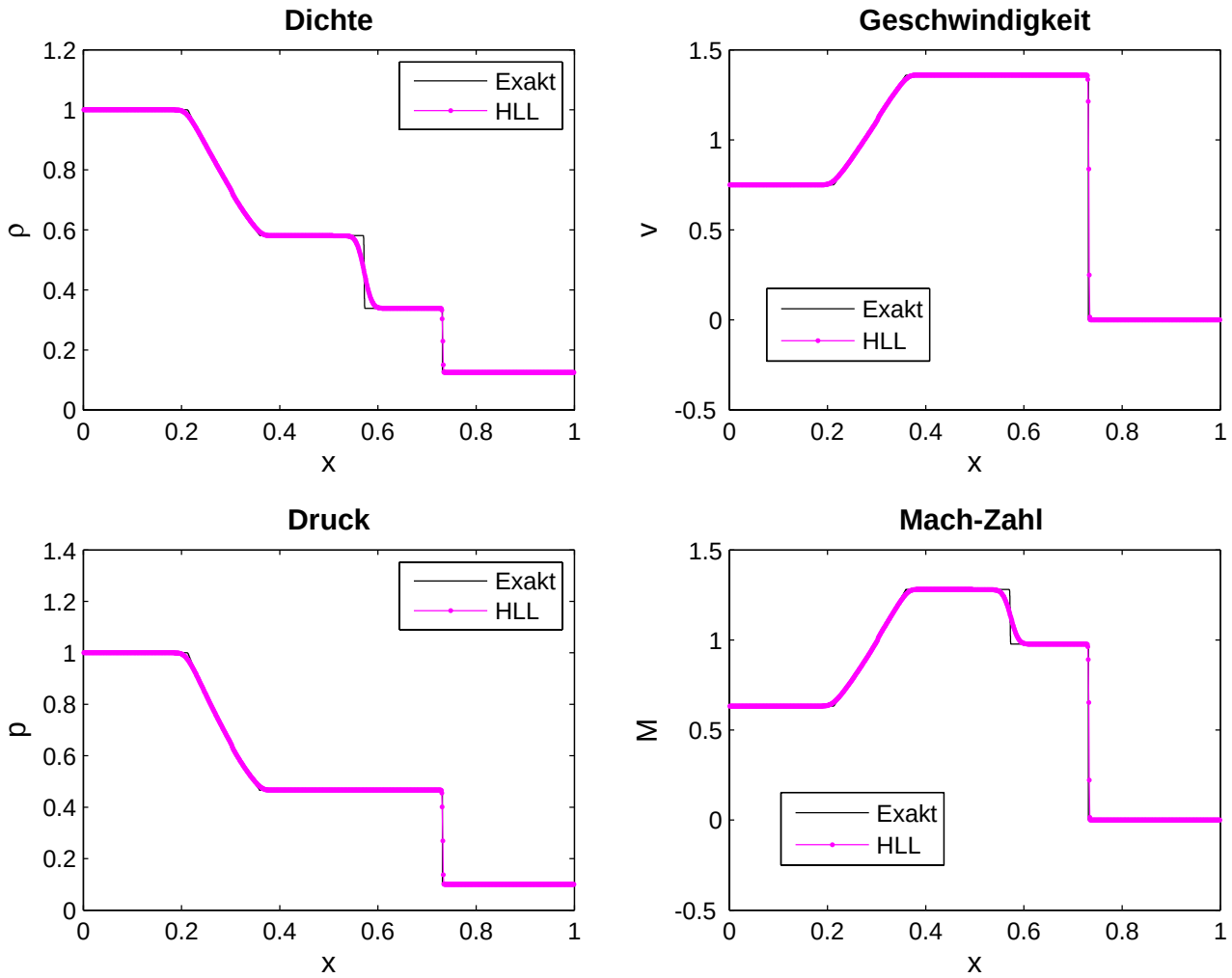


Figure: Comparison between different limiters

Finite Volume Scheme in one space dimension

Example 3.15: Results HLL



Finite Volume Scheme in one space dimension

Example 3.15: Shock

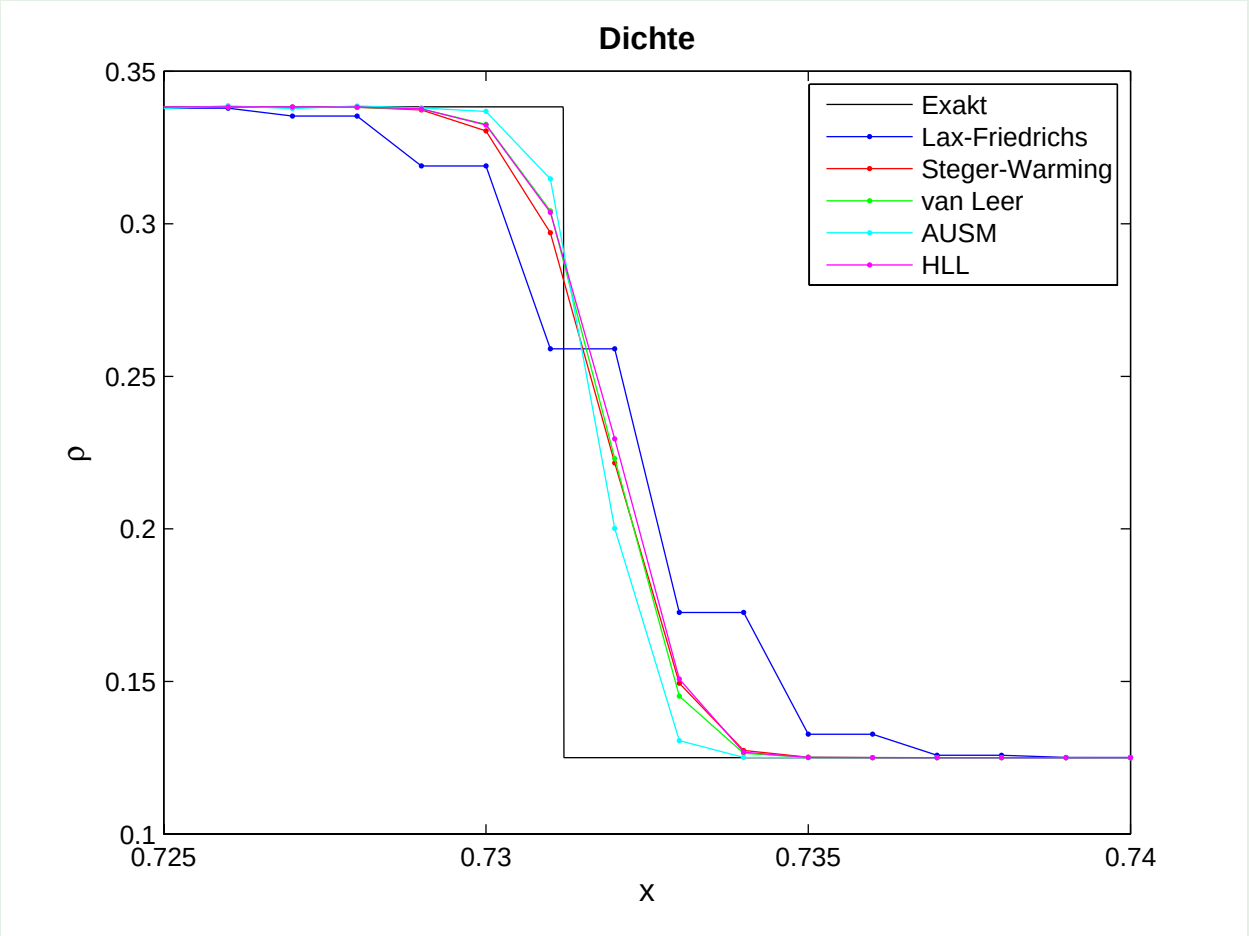


Figure: Comparison between different schemes

Example 3.15: Contact discontinuity

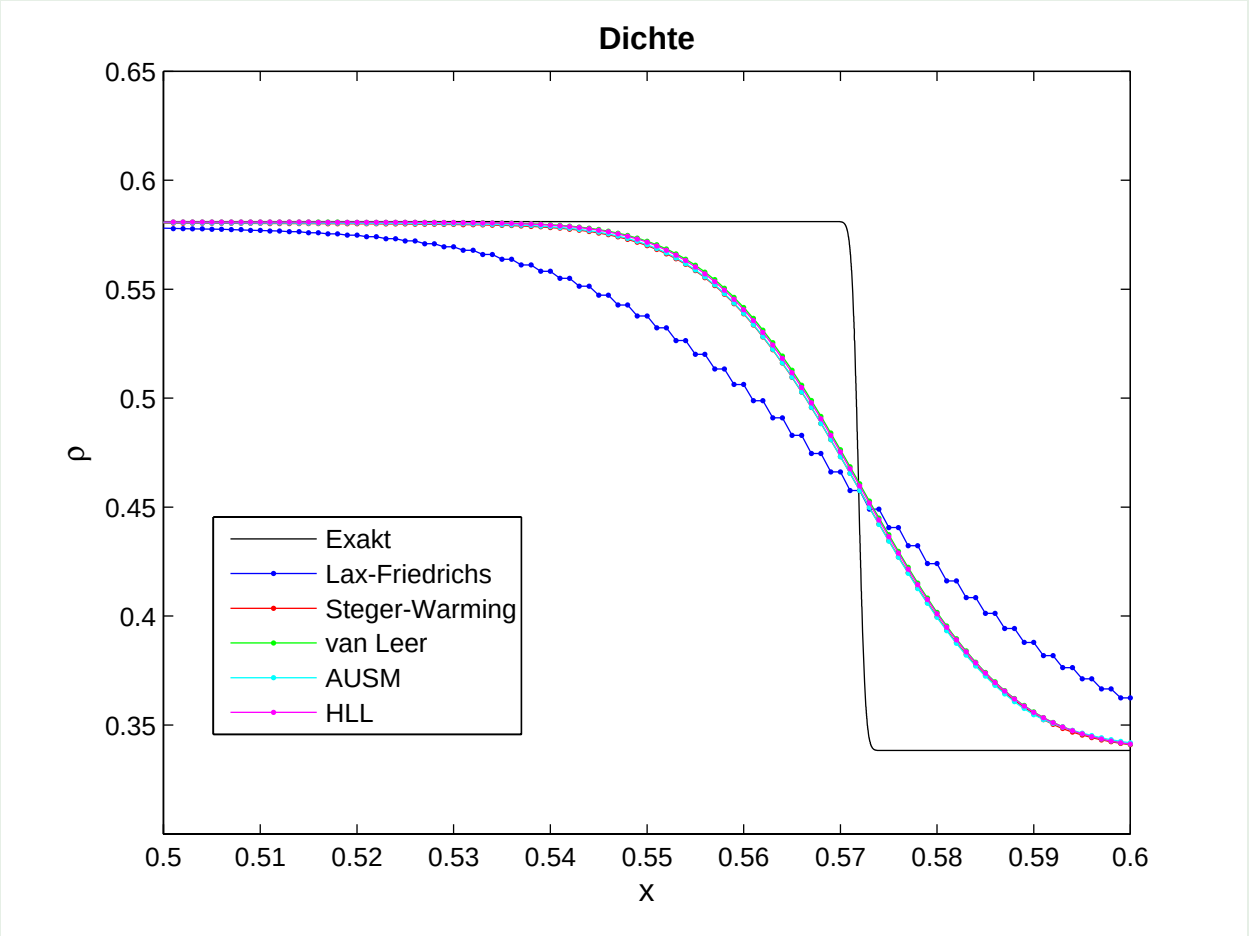


Figure: Comparison between different schemes

Example 3.15: Expansion fan

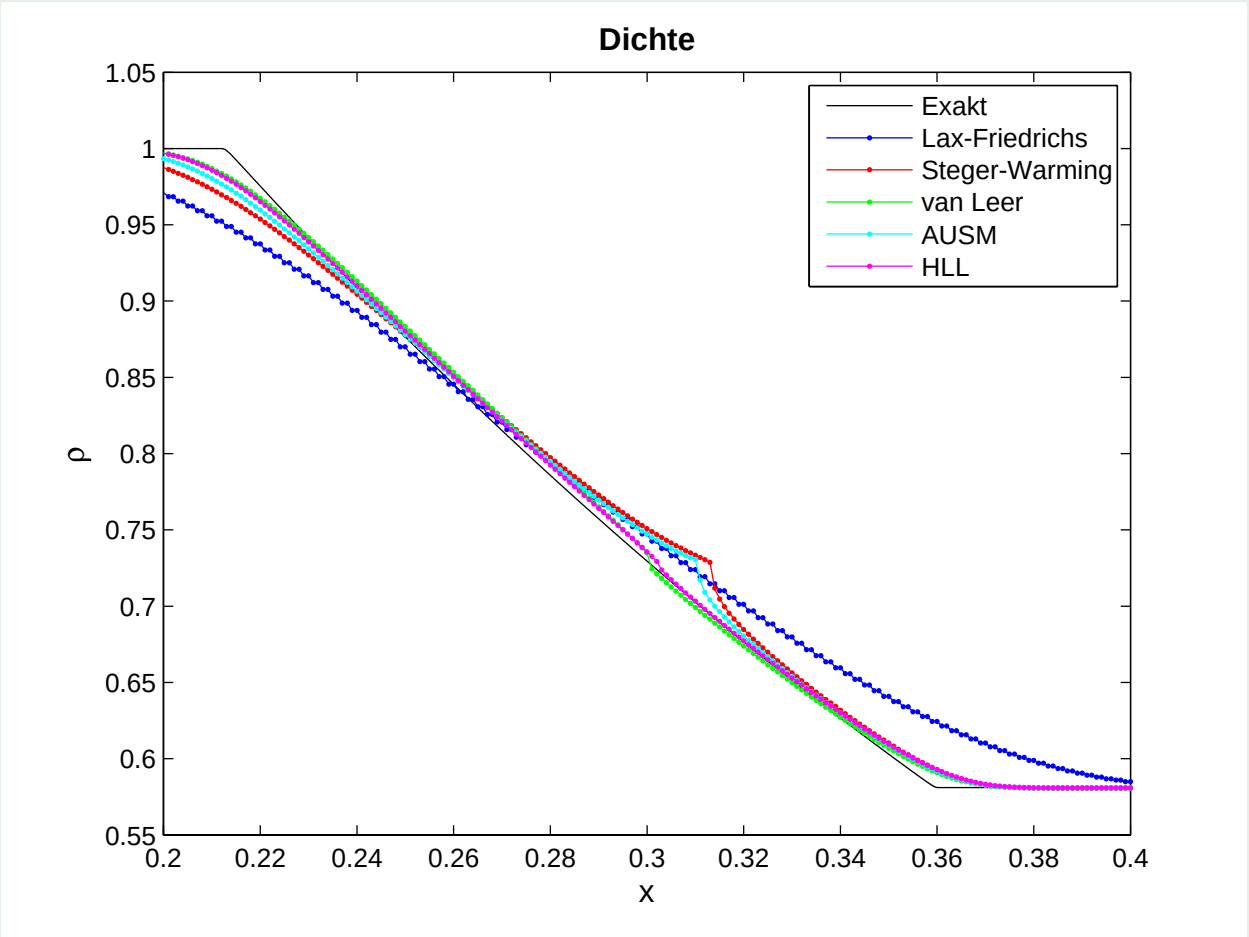
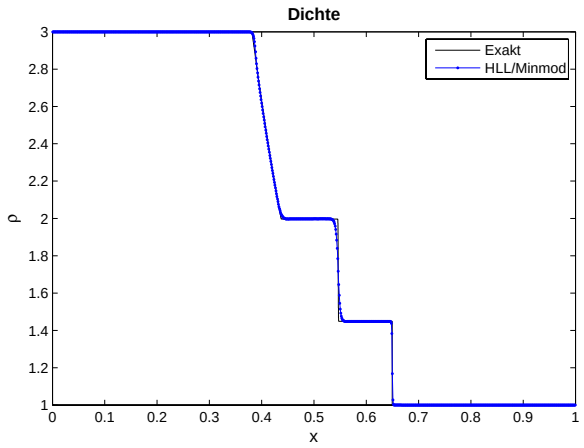
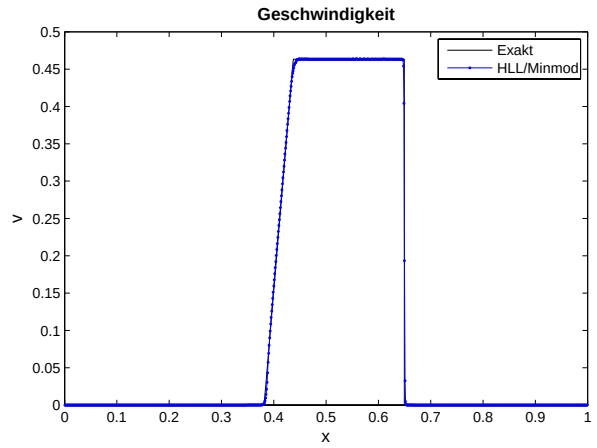
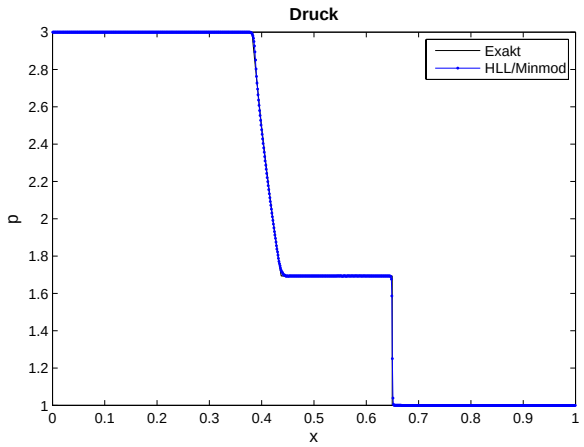


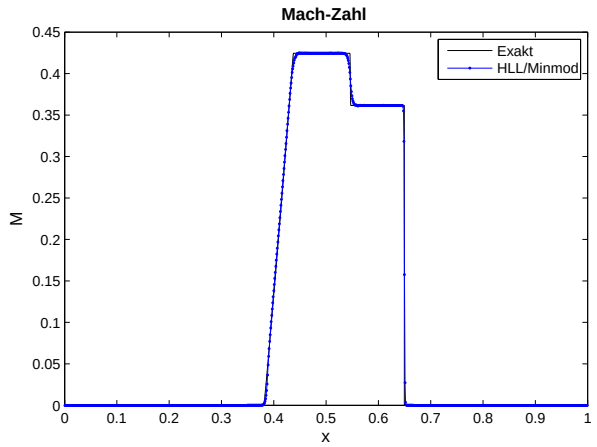
Figure: Comparison between different schemes

Example 3.18: Results HLL with limiter minmod









Example 3.18: Shock

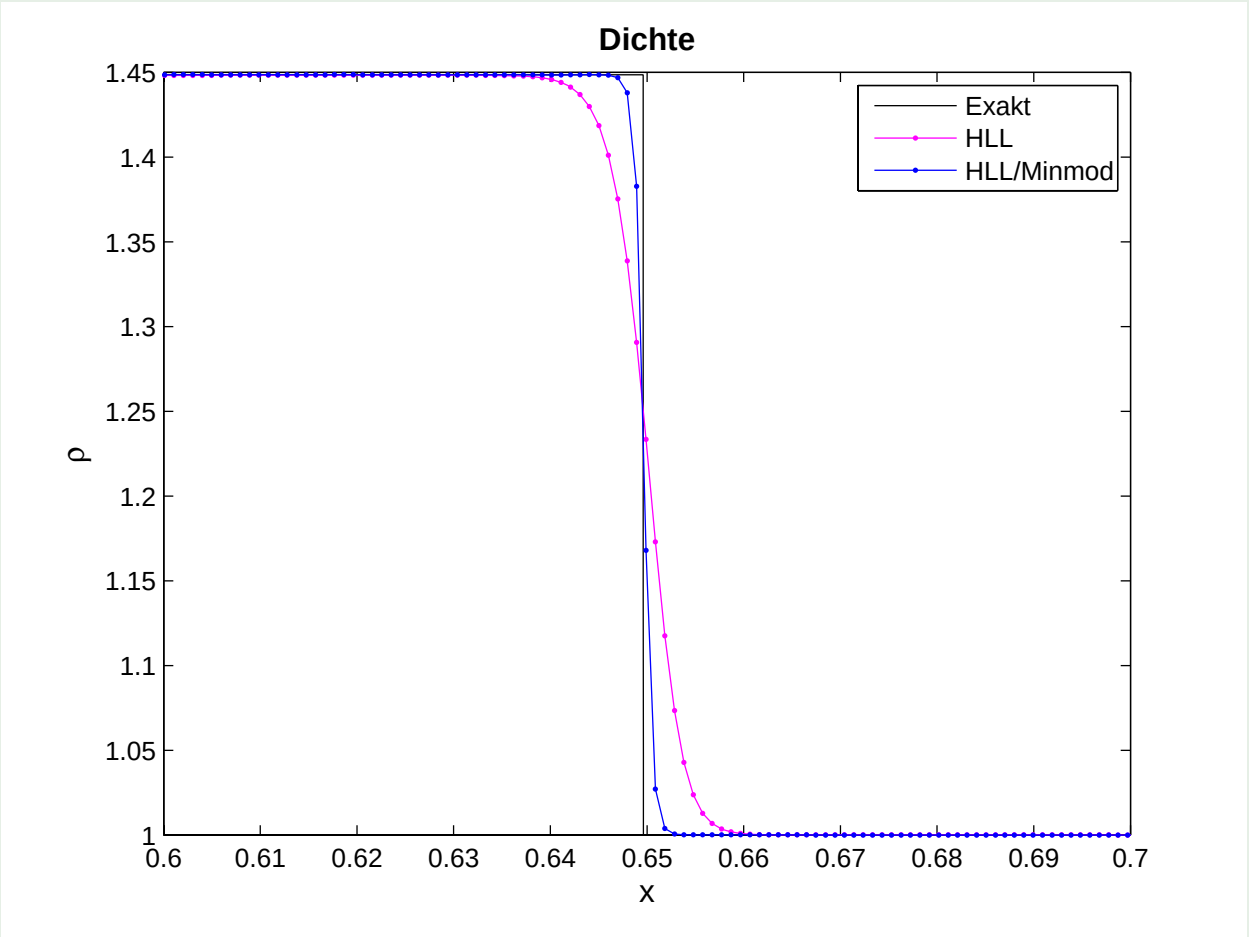


Figure: HLL with limiter minmod

Example 3.18: Contact discontinuity

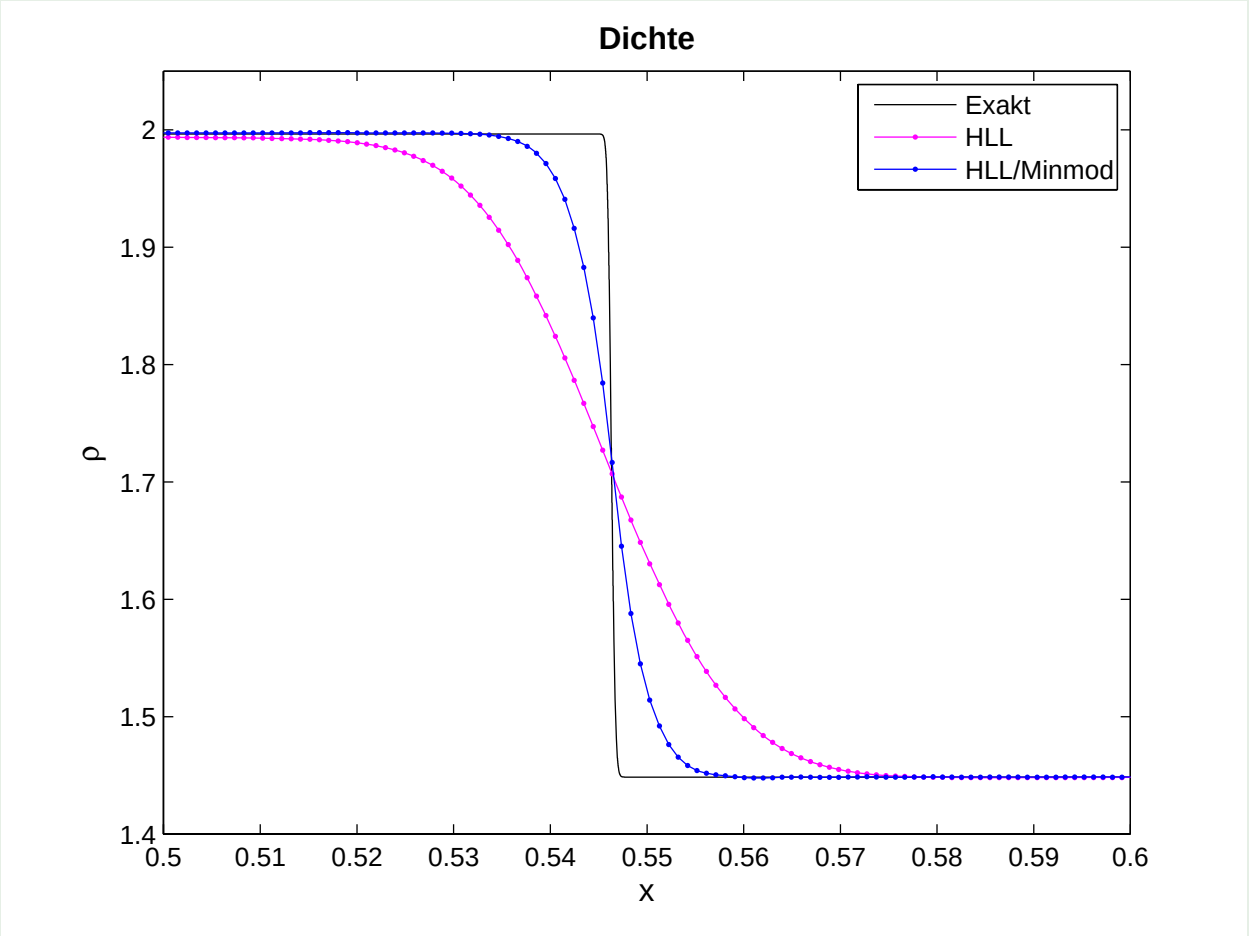


Figure: HLL with limiter minmod

Example 3.18: Expansion fan

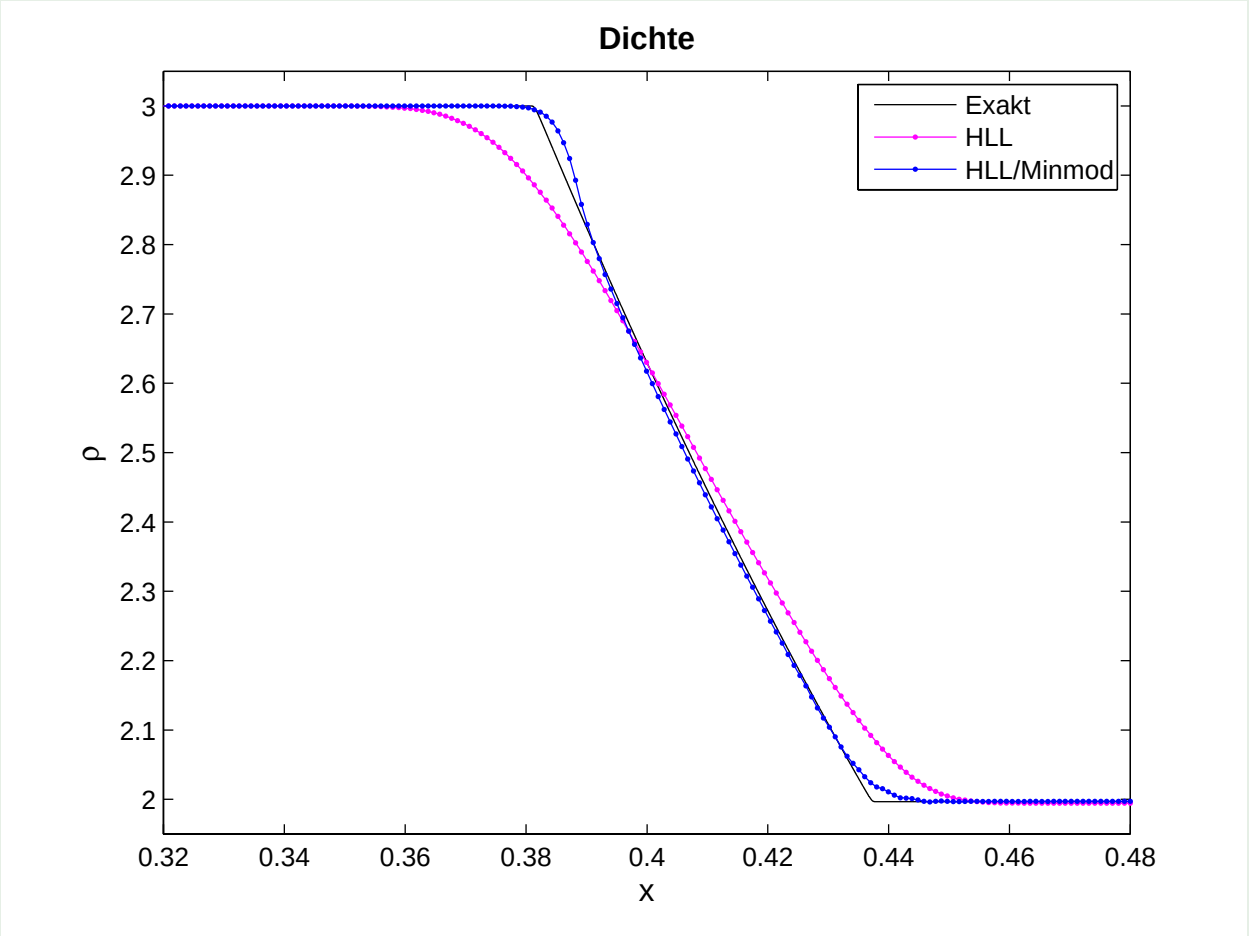
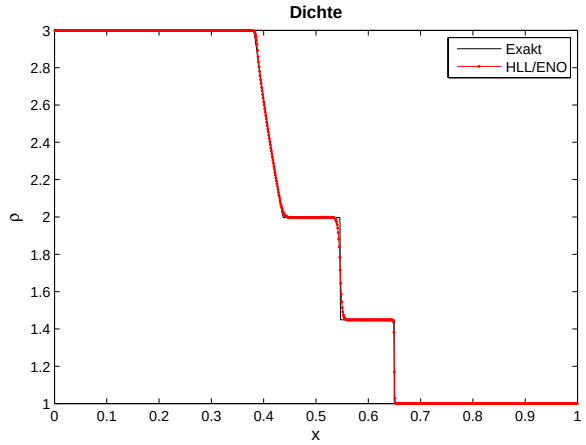
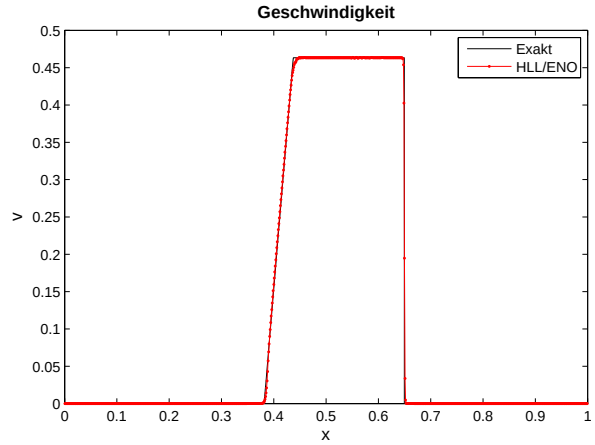
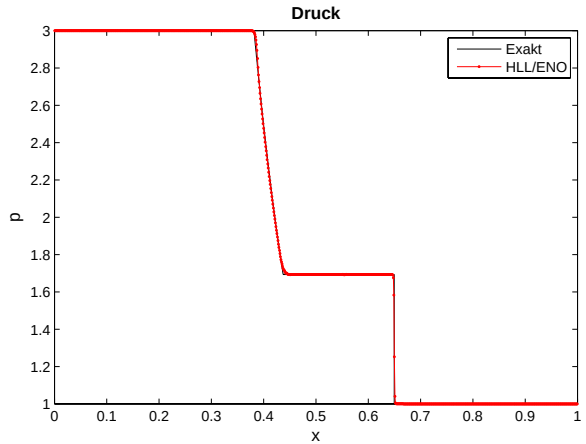


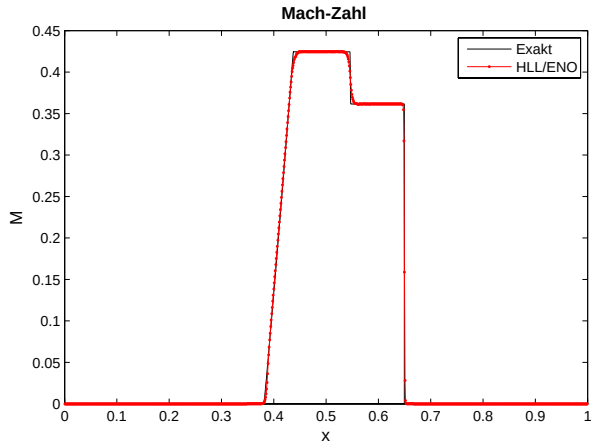
Figure: HLL with limiter minmod

Example 3.19: Results HLL with ENO-reconstruction

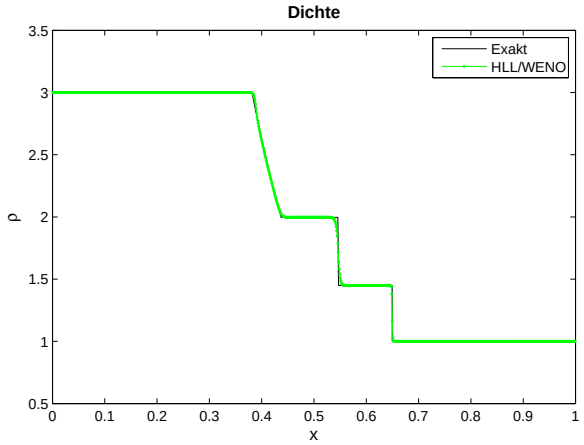


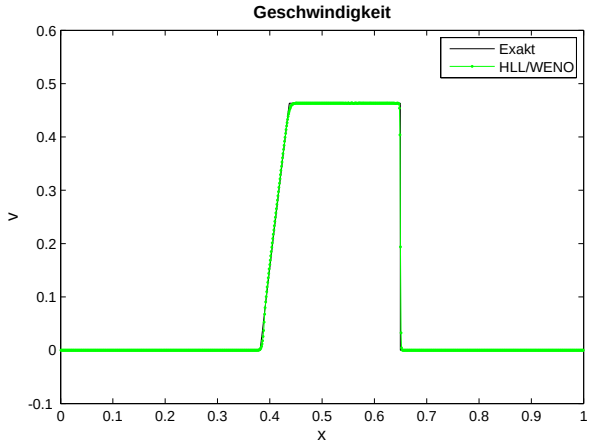


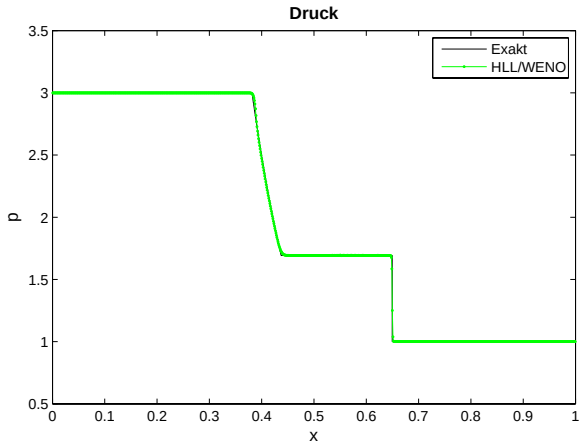


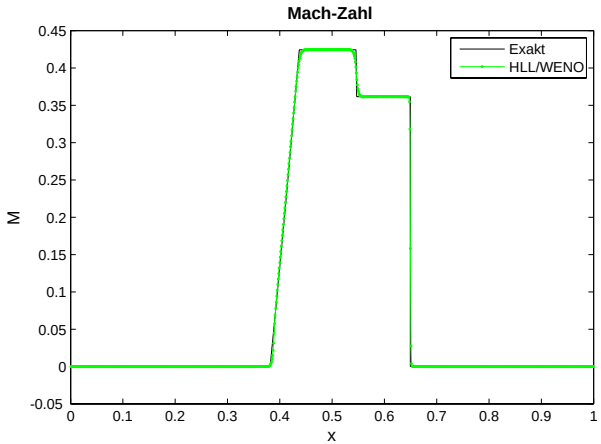


Example 3.19: Results HLL with ENO-reconstruction









Finite Volume Scheme in one space dimension

Example 3.19: Shock

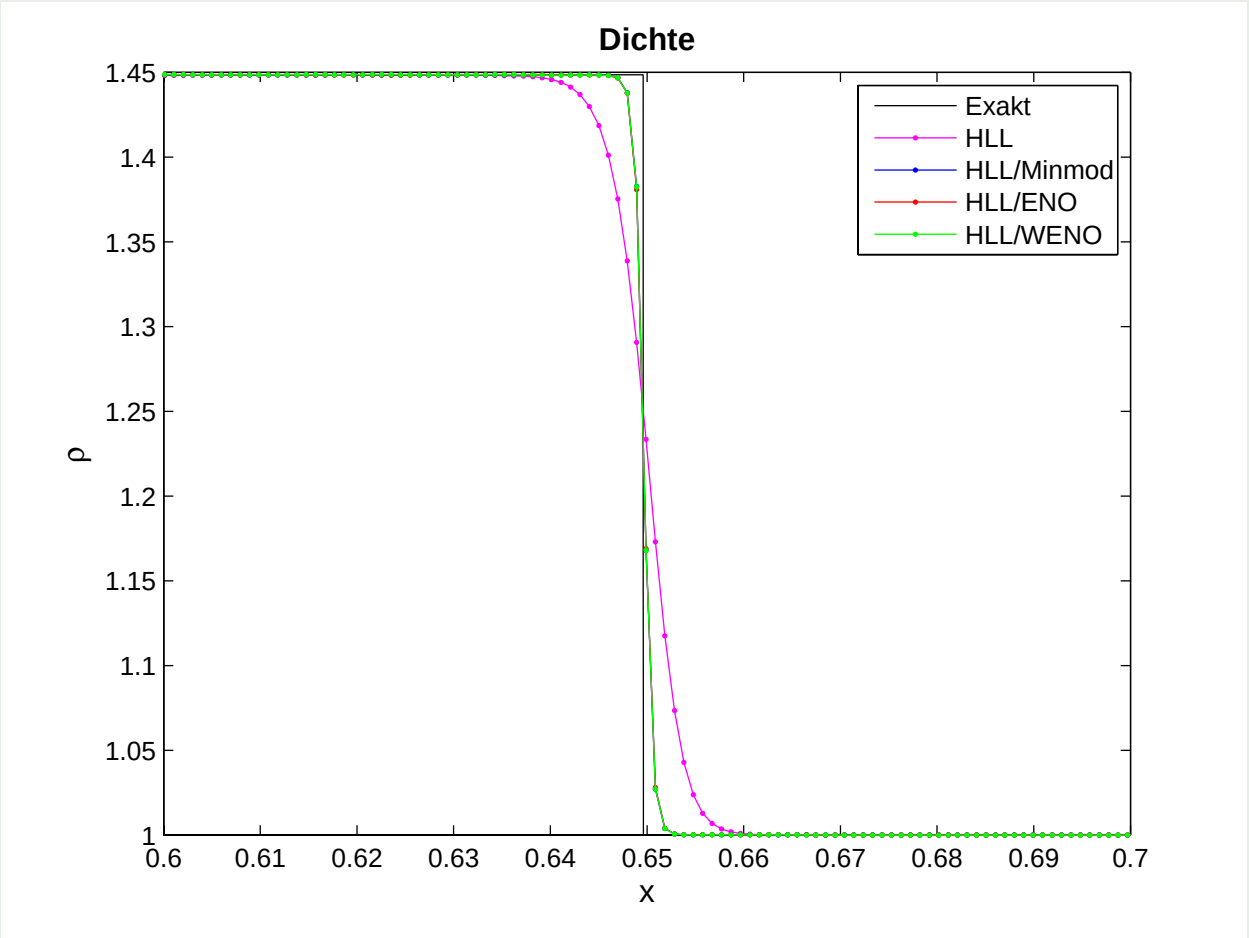


Figure: HLL with different reconstructions

Example 3.19: Contact discontinuity

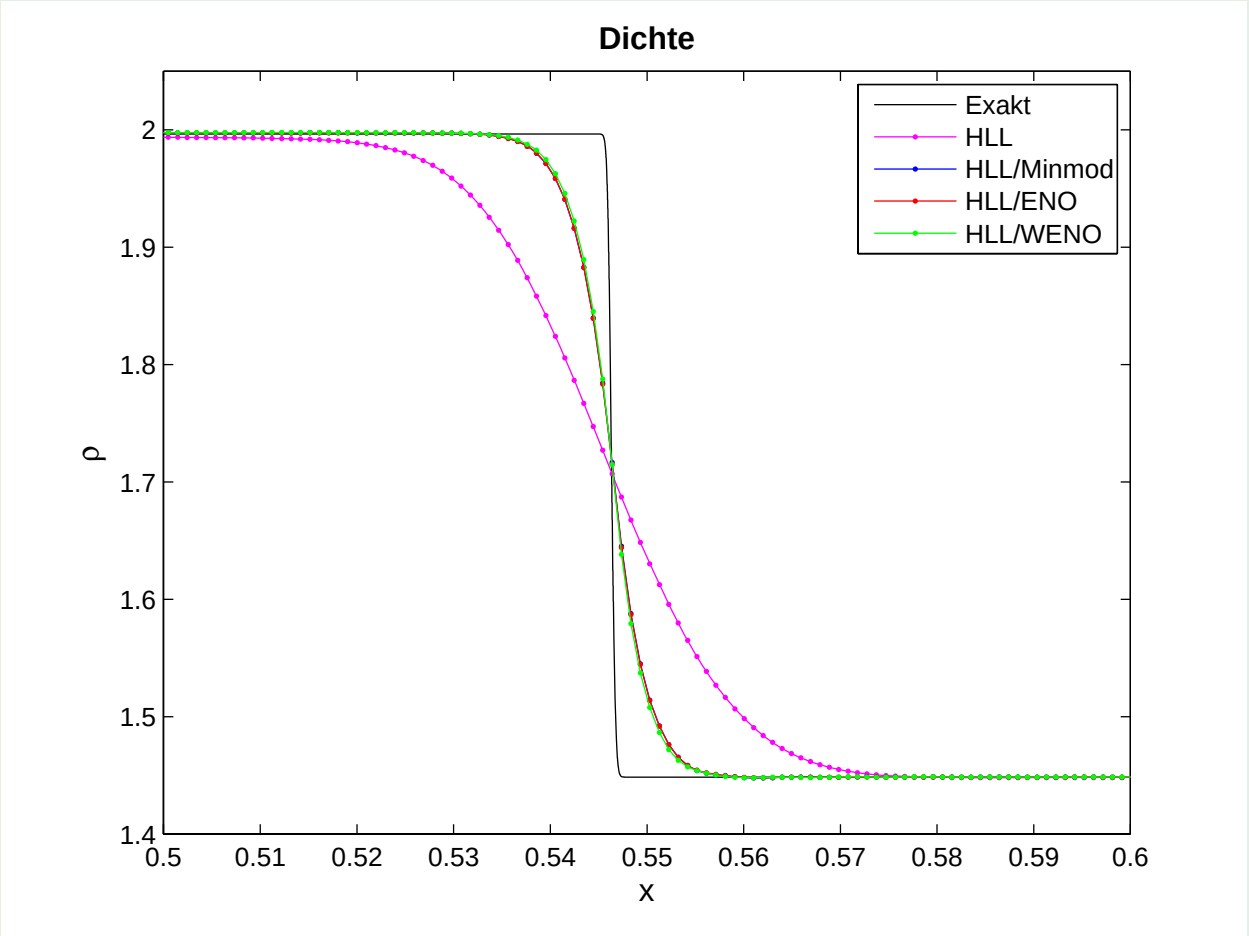


Figure: HLL with different reconstructions

Example 3.19: Expansion fan

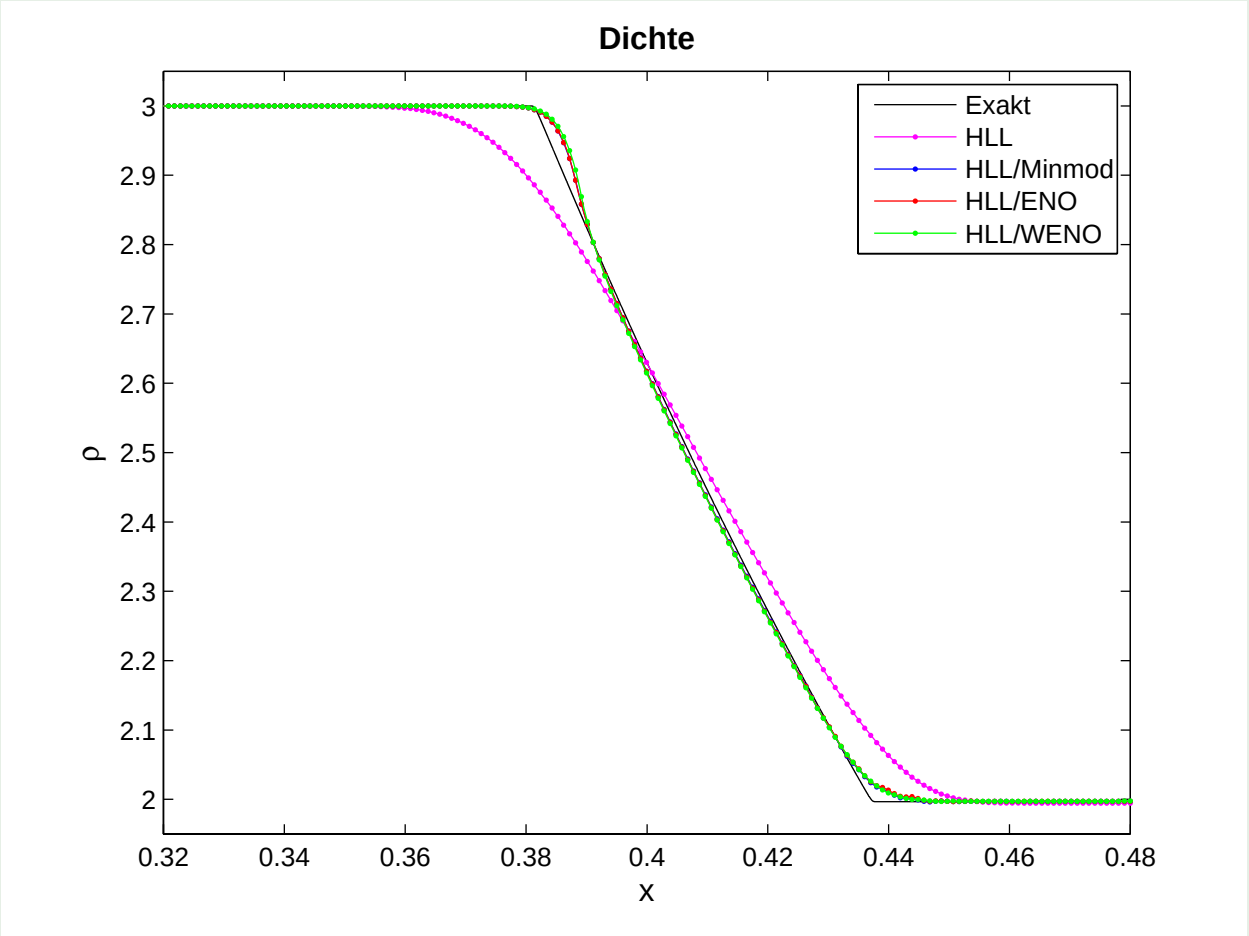


Figure: HLL with different reconstructions