

# Steady-state simulations of Euler equations

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# One-dimensional steady shock

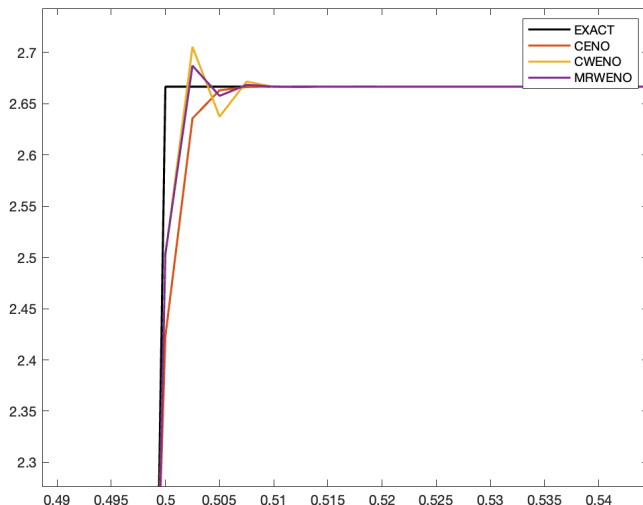


Figure 1: One-dimensional steady shock: density contours from CENO5 scheme. Final simulation time:  $t = 12$ . Resolution: 400.

# One-dimensional steady shock

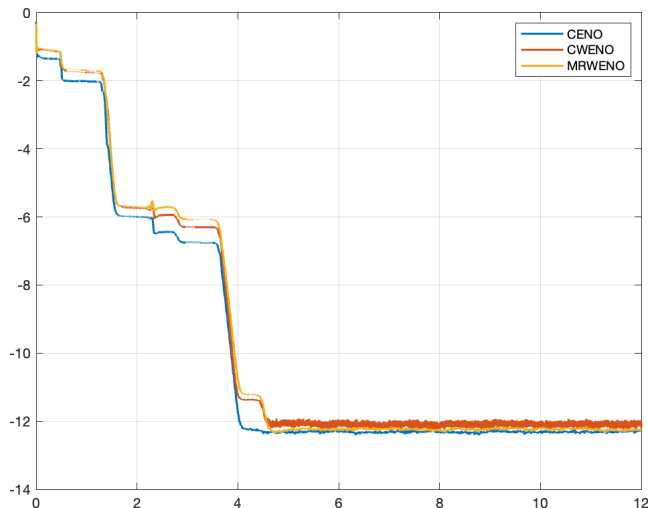
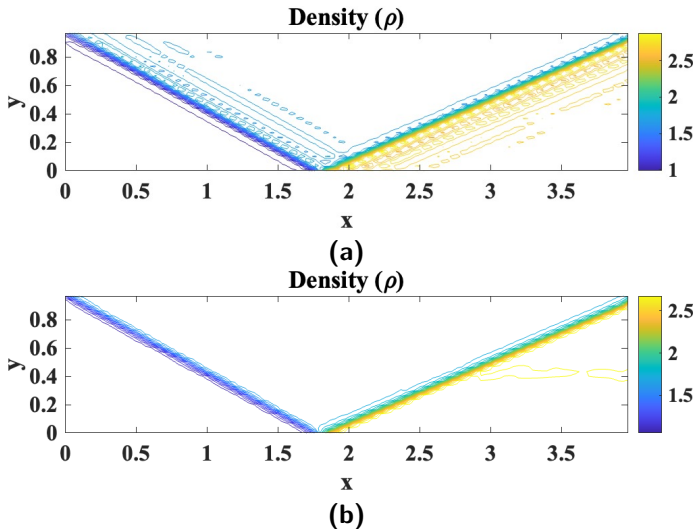


Figure 2: One-dimensional steady shock: evolution history of average residual from CENO5, CWENOZ and MRWENO scheme. Resolution: 400.

# Regular shock reflection problem



**Figure 3:** Regular shock reflection problem: density contours from (a) fifth-order linear scheme, (b) CENO5. Final simulation time:  $t = 20$ . Resolution:  $120 \times 30$ .

# Regular shock reflection problem

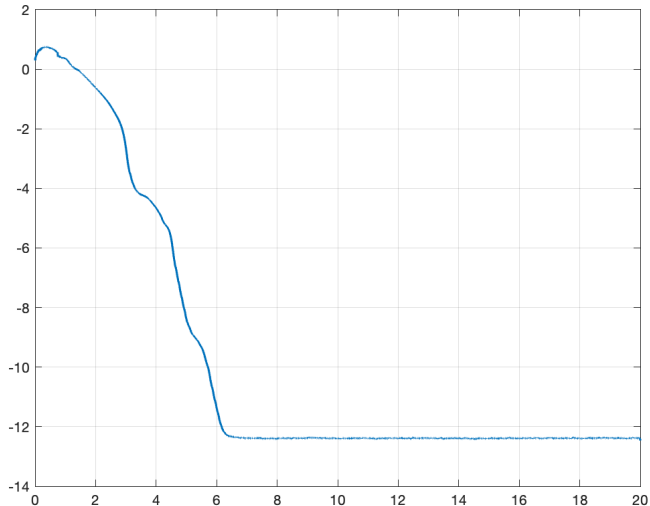
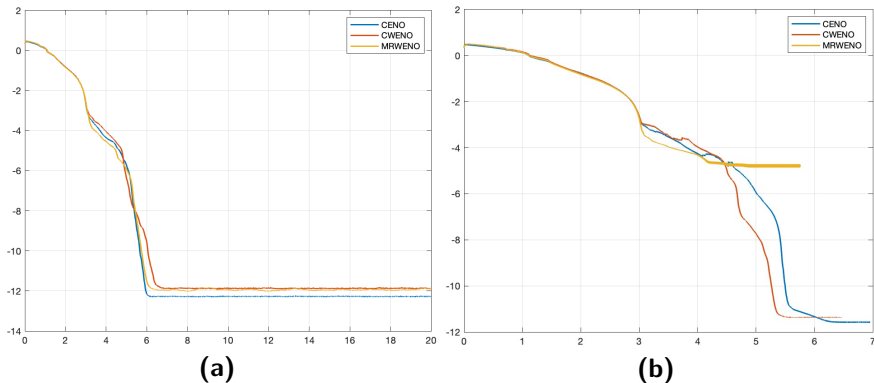


Figure 4: Regular shock reflection problem: evolution history of average residual from fifth-order linear scheme. Resolution:  $120 \times 30$ .

# Regular shock reflection problem



**Figure 5:** Regular shock reflection problem: evolution history of average residual from CENO5, CWENOZ and MRWENO scheme. Resolution: (a)  $160 \times 40$ , (b)  $640 \times 160$ .

# Heterolateral shock interaction problem

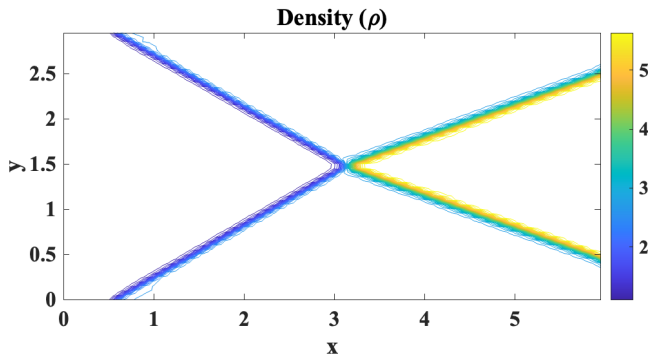
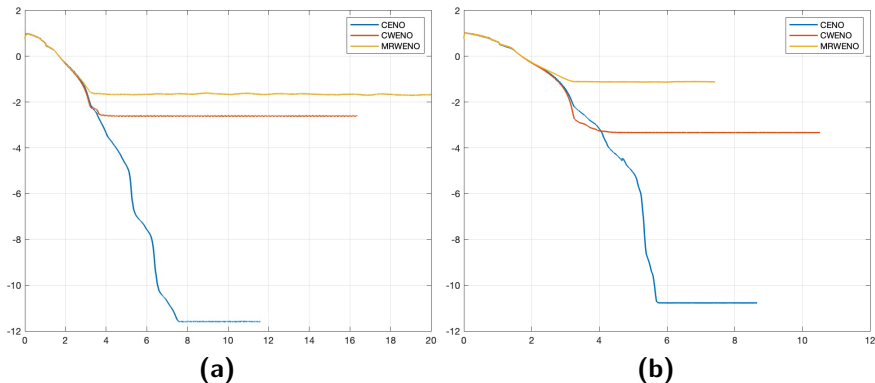


Figure 6: Heterolateral shock interaction problem: density contours from CENO5 scheme. Final simulation time:  $t = 20$ . Resolution:  $120 \times 60$ .

# Heterolateral shock interaction problem



**Figure 7:** Heterolateral shock interaction problem: evolution history of average residual from CENO5, CWENOZ and MRWENO scheme. Resolution: (a)  $240 \times 120$ , (b)  $960 \times 480$ .



# Oblique steady shock wave

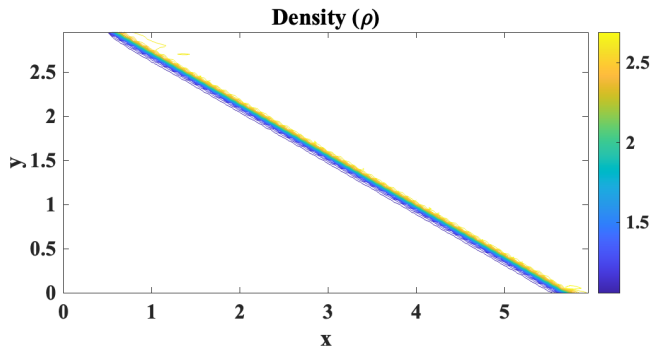
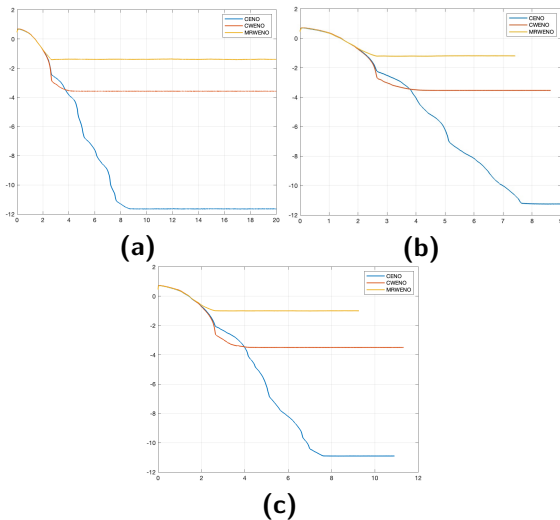


Figure 8: Oblique steady shock wave: density contours from CENO5 scheme. Final simulation time:  $t = 20$ . Resolution:  $120 \times 60$ .

# Oblique steady shock wave



**Figure 9:** Oblique steady shock wave: evolution history of average residual from CENO5, CWENOZ and MRWENO scheme. Resolution: (a)  $240 \times 120$ , (b)  $480 \times 240$ , (c)  $960 \times 480$ .

# Ipsilateral shock interaction problem

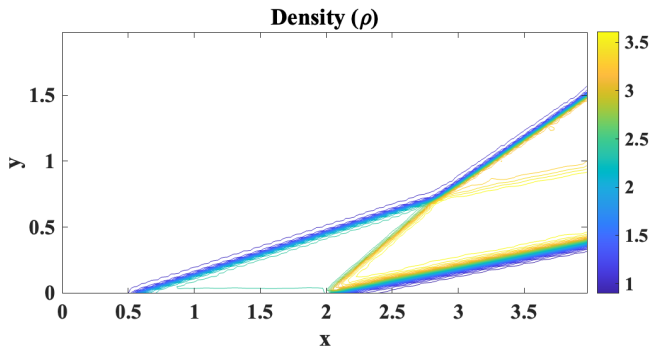
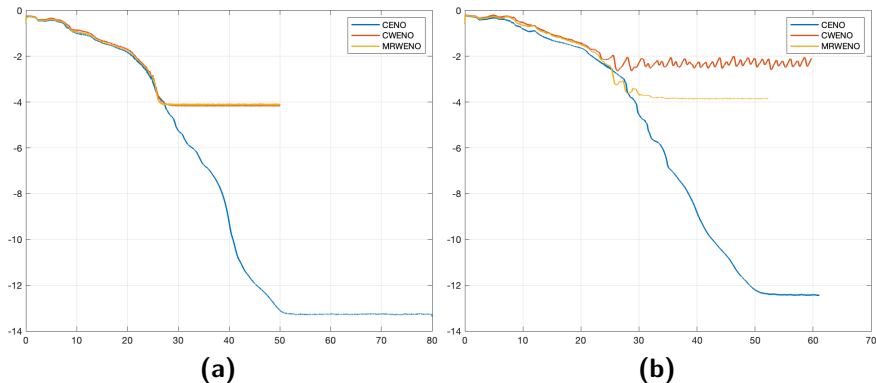


Figure 10: Ipsilateral shock interaction problem: density contours from CENO5 scheme. Final simulation time:  $t = 80$ . Resolution:  $160 \times 80$ .

# Ipsilateral shock interaction problem



**Figure 11:** Ipsilateral shock interaction problem: evolution history of average residual from CENO5, CWENOZ and MRWENO scheme. Resolution: (a)  $160 \times 80$ , (b)  $640 \times 320$ .

# Supersonic flow past a long plate

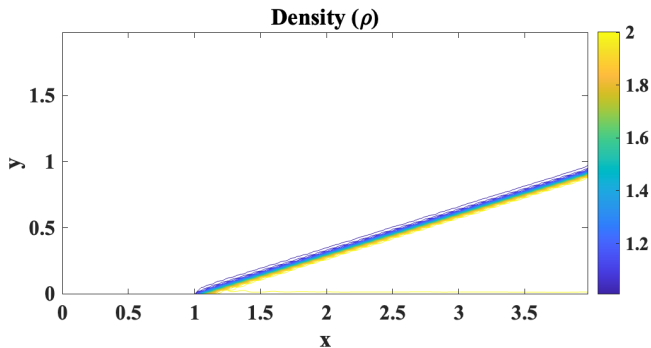
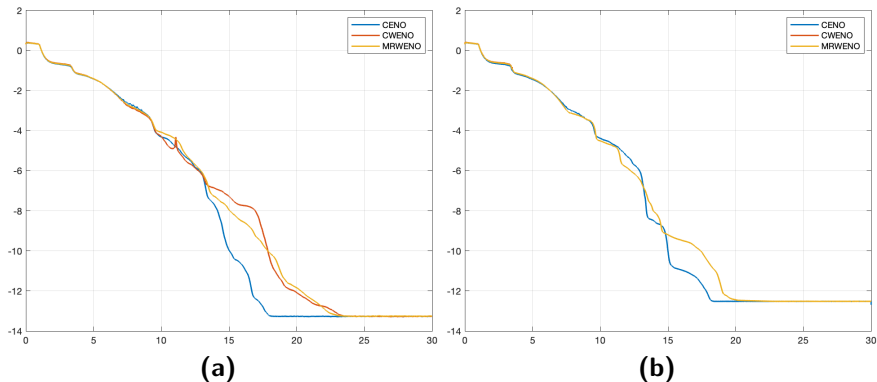


Figure 12: Supersonic flow past a long plate: density contours from CENO5 scheme. Final simulation time:  $t = 30$ . Resolution:  $160 \times 80$ .

# Supersonic flow past a long plate



**Figure 13:** Supersonic flow past a long plate: evolution history of average residual from CENO5, CWENOZ and MRWENO scheme. Resolution: (a)  $160 \times 80$ , (b)  $640 \times 320$ .

Note: The results from CWENOZ scheme at the resolution of  $640 \times 320$  blow up.

# Multiple shock reflection problem

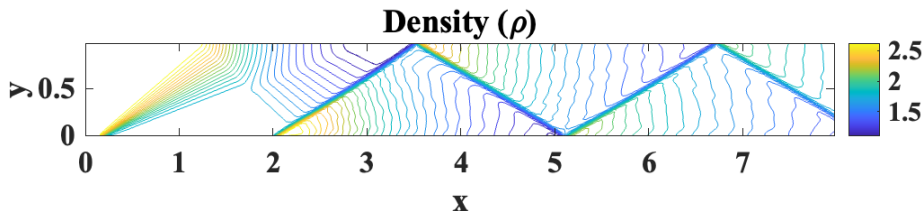
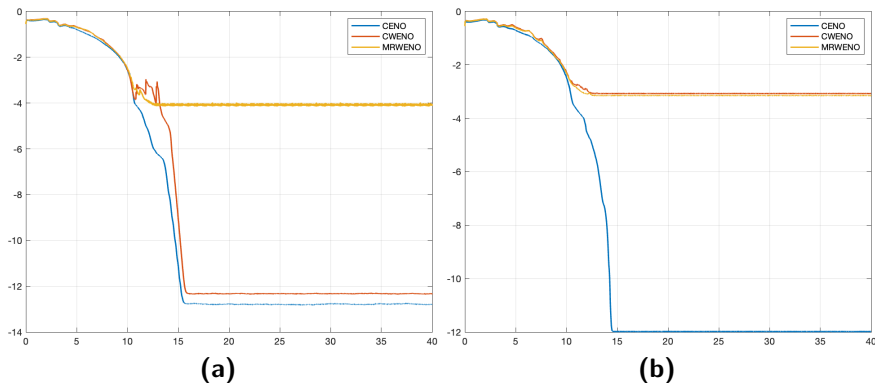


Figure 14: Multiple shock reflection problem: density contours from from CENO5 scheme. Final simulation time:  $t = 40$ . Resolution:  $320 \times 40$ .

# Multiple shock reflection problem



**Figure 15:** Multiple shock reflection problem: evolution history of average residual from CENO5, CWENOZ and MRWENO scheme. Resolution: (a)  $320 \times 40$ , (b)  $1280 \times 160$ .