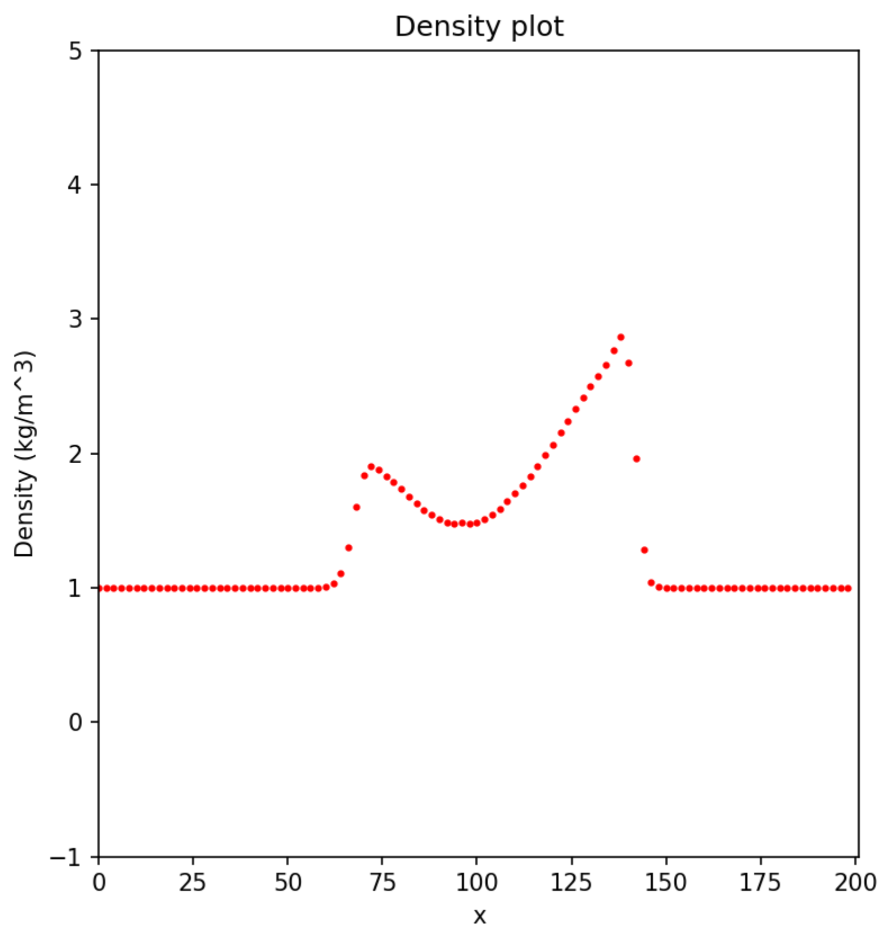
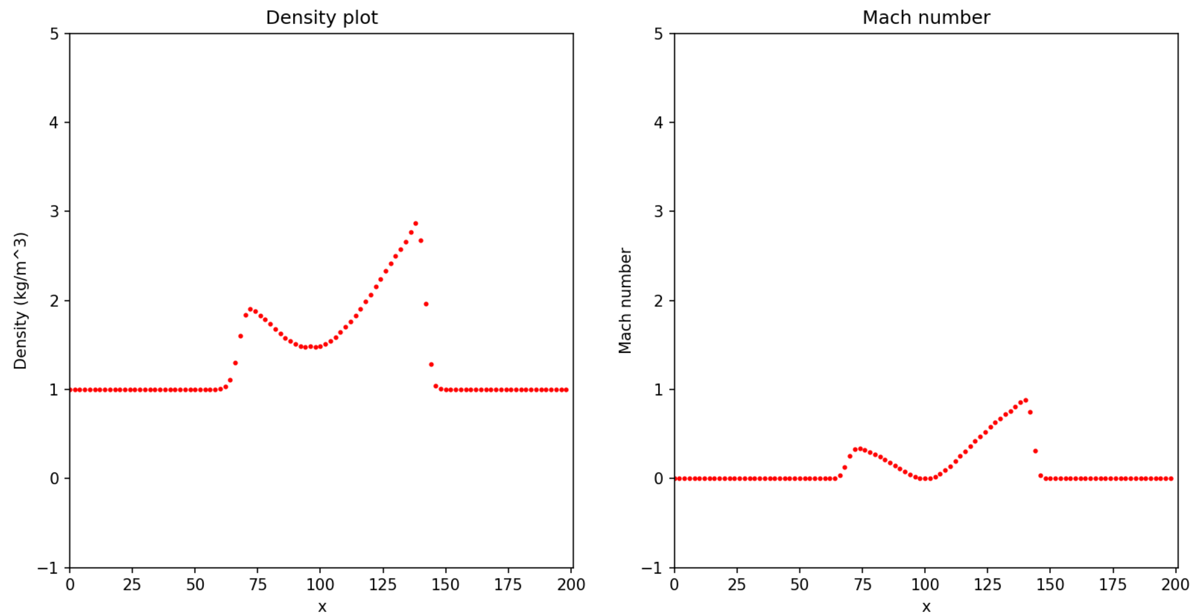
1) For ratio of densities pre- and post-shock, we can see that the density ρ_2 behind the shock is much larger than the density $\rho_1 = 1$ in the unperturbed state. The ratio seems to depend on the starting amplitude of the perturbation, but it eventually stabilizes before reaching the boundary on the right. Theoretically, for an adiabatic index of 5/3, we expect the ratio to be:

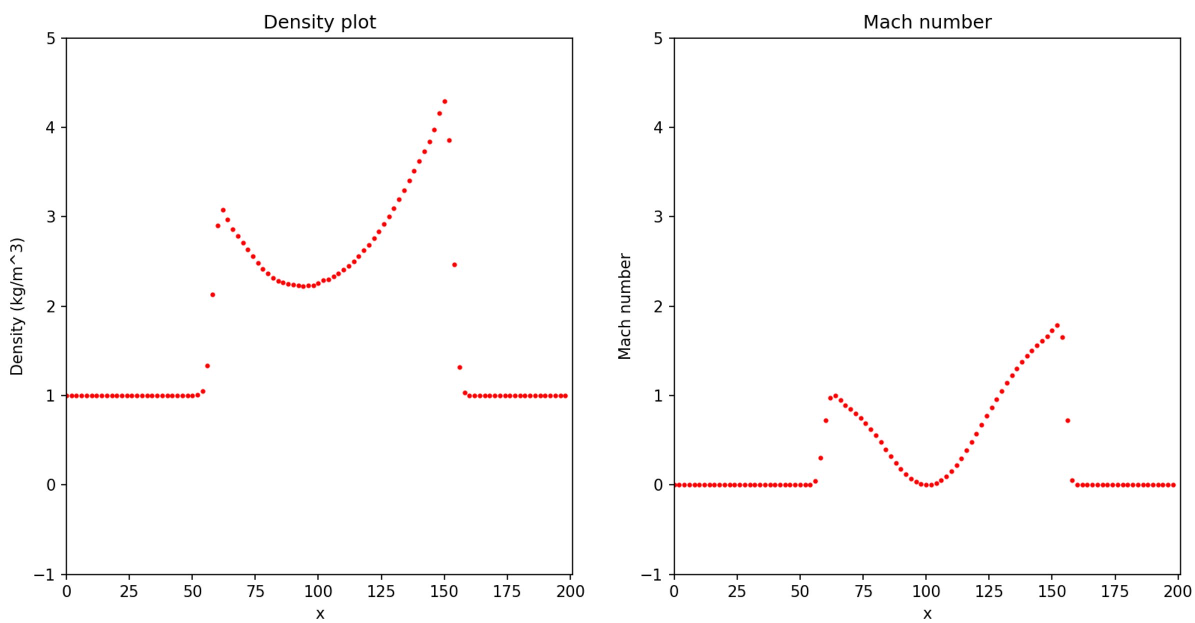
$$\frac{\rho_1}{\rho_2} = \frac{\gamma - 1}{\gamma + 1} = \frac{1}{4}$$

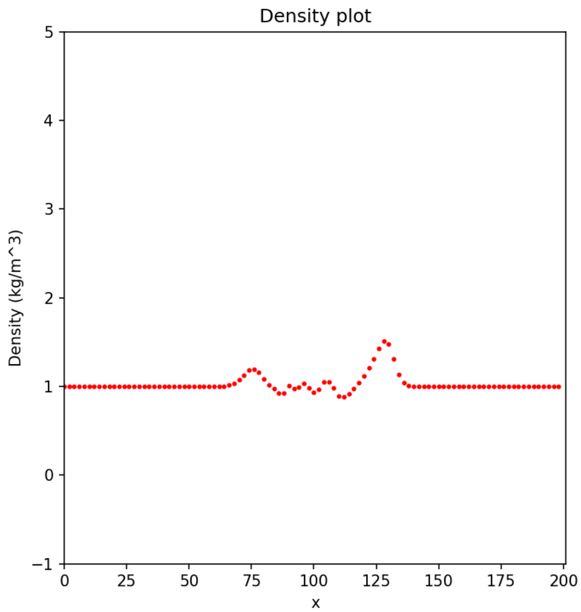
The parameters for the amplitude and spread σ are 4 and Ngrid/10 respectively, for Ngrid = 100. From the plot, $\rho_2 = 3$ just behind the shock and $\rho_1 = 1$. This gives a ratio of 1/3 which is not exactly what we expect. A larger amplitude for a larger shock may give 1/4 but we would need a longer x-axis and more points to see the shock travel.

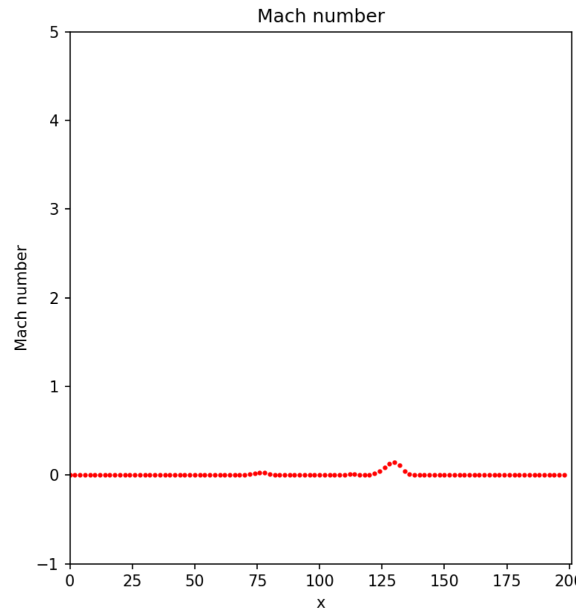


2) The width of the shock is approximately 10 points given the same parameters as before. We know that the width of the shock is inversely proportional to the Mach number. For the perturbation we have, the Mach number of the shock travelling to the right is approximately 1 as shown on the first set of plots. However, if we input a larger perturbation by increasing the amplitude to 10, the width of the shock decreases to approximately 5 points and the Mach number increases to approximately 2. This is shown in the second set of plots. In the last set of plots, the amplitude is kept at 4 and the spread σ is reduced to Ngrid/100. This gives a smaller perturbation and a smaller shock. The width is increases to a little above 10 points while the Mach number is reduced to nearly zero. We don't really have a shock in the last plot.






Density plot
Density (kg/m^3)
x
5
4
3
2
1
0
−1
0
25
50
75
100
125
150
175
200


Mach number
Mach number
x
5
4
3
2
1
0
−1
0
25
50
75
100
125
150
175
200