ROLES AND RESPONSIBILITIES

- Simulated 1D supersonic nozzle using McCormack method for both conservative and non conservative forms of governing equations
- Conducted a grid dependence test on solution of fluid flow through nozzle
- Evaluated computation time for conservative and non conservative forms of equation for two different time steps

CODE AND RESULT SNIPPETS

the flow through that point.

A) Governing Equations:

(I) Continuity Equation:

$$\frac{\partial U_1}{\partial t'} = -\frac{\partial F_1}{\partial x'}$$

(II) Momentum Equation:

$$\frac{\partial U_2}{\partial t'} = -\frac{\partial F_2}{\partial x'} + J_2$$

(III) Energy Equation:

$$\frac{\partial U_3}{\partial t'} = -\frac{\partial F_3}{\partial x'}$$

Solution vector:U

Flux vector:F

Source term:J_2

$$U_1 = \rho' A'$$

$$U_2 = \rho' A' v'$$

$$U_3 = \rho' \left(\frac{e'}{\gamma - 1} + \frac{\gamma}{2} v'^2 \right) A'$$

$$F_1 = \rho' A' v'$$

$$F_2 = \rho' A' v' + \left(\frac{1}{\gamma} \right) p' A'$$

$$F_3 = \rho' \left(\frac{e'}{\gamma - 1} + \frac{\gamma}{2} v'^2 \right) v' A' + p' A' v'$$

$$J_2 = \frac{1}{\gamma} \cdot p' \cdot \frac{dA'}{dx'}$$

(B) Initial conditions of Profile at time, t=0:

$$x(i) \geq 0 \& x(i) \leq 0.5$$

$$\rho(i) = 1$$

$$T(i) = 1$$

$$x(i) \geq 0.5 \& x(i) \leq 1.5$$

$$\rho(i) = 1 - 0.366 \cdot (x(i) - 0.5);$$

$$T(i) = 1 - 0.167(x(i) - 0.5);$$

$$x(i) \geq 1.5 \& x(i) \leq 3.5$$

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function [v,rho,t,m,p,mach,v_t,rho_t,t_t,m_t,p_t,mach_t,k,time_execution_1] = non_conservative(n,x,d
x,c,gamma,a,nt,throat)

tic
% Inputs
        % Length of the domain
                L = 3
        % no of the grid points
                n = 31
        % x array along the length of the domain
               x =linspace(0,L,n)
        % Grid size
               dx = x(2) - x(1)
        % other parameters
               gamma = 1.4
% calculate Initial profile, which are non dimensional
     rho = 1-0.3146*x;
     t = 1- 0.2314*x;   % t =temperature
     v = (0.1 + 1.09*x).*t.^0.5;
     a = 1 + 2.2*(x-1.5).^2; % Area, a

% Time steps
     nt = 1600
% calculating the value of time step using courant criteria
for i = 1:n
    del_t(i)= c*(dx/(t(i)^0.5+v(i)));
```

```
% Inputs
        % Length of the domain
                L = 3;
        % Number of the grid points
                n = 31;
        % x array along the length of the domain
                x = linspace(0,L,n);
        % Grid spacing
                dx = x(2) - x(1);
        % Area,a
                a = 1+2.2*(x-1.5).^2;
                gamma = 1.4
        % Exact node at the throat, numbers of nodes is an odd number
                throat = ((n-1)/2)+1;

        % courant number
                c = 0.5

          % No. of time steps
          nt = 1600;
```