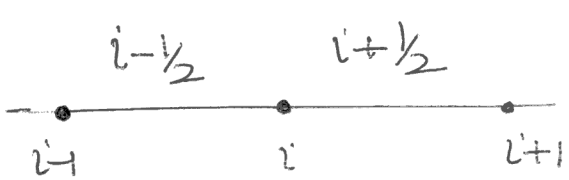
Linear System



1st

$$\underline{U}_i^{n+1} = \underline{U}_i^n - \frac{\Delta t}{\Delta x}\left[\sum_{\substack{p \\ \lambda_p>0}} \Delta \underline{f}^{+,n}_{i-1/2,p} + \sum_{\substack{p \\ \lambda_p<0}} \Delta \underline{f}^{+,n}_{i+1/2,p}\right]$$

$$\Delta \underline{f}^{+,n}_{i-1/2,p} = \lambda_p \Delta \underline{U}^n_{i-1/2,p}$$

$$= \lambda_p \alpha^n_{i-1/2,p} \underline{\gamma}_p$$

$$\Delta \underline{U}^n_{i-1/2} = \begin{bmatrix} 1 & 1 & & 1 \\ \gamma_1 & \gamma_2 & \cdots & \gamma_m \\ 1 & 1 & & 1 \end{bmatrix} \underline{\alpha}^n_{i-1/2} = \sum_{p=1}^{m} \alpha^n_{i-1/2,p} \gamma_p$$

2nd

$$\underline{U}_i^{n+1} = \underline{U}_i^n - \frac{\Delta t}{\Delta x}\left[\sum_{p=1}^{m}\left[\frac{(1+\nu_p)}{2}\Delta \underline{f}^{+,n}_{i-1/2,p} + \frac{(1-\nu_p)}{2}\Delta \underline{f}^{+,n}_{i+1/2,p}\right]\right]$$

$$\nu_p = \lambda_p \frac{\Delta t}{\Delta x}$$