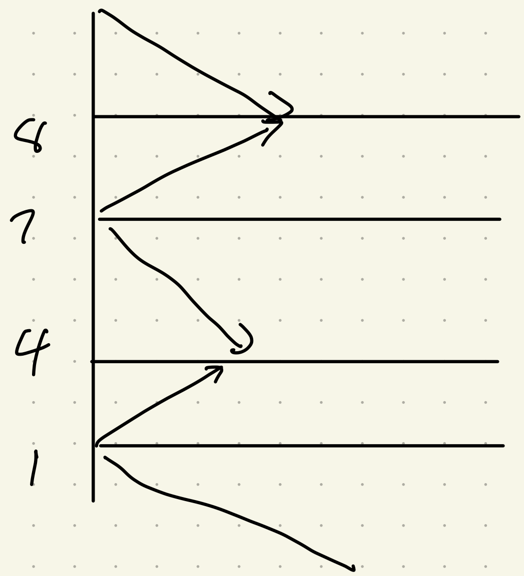
① $x = 1, 4, 7, 8$

Stable : $x = 4, 8$



② equilibrium $= (1,1,1)$

$$\begin{bmatrix} \frac{df_1}{dx} & \frac{df_1}{dy} & \frac{df_3}{dz} \\ \frac{df_2}{dx} & \frac{df_2}{dy} & \frac{df_2}{dz} \\ \frac{df_3}{dx} & \frac{df_3}{dy} & \frac{df_3}{dz} \end{bmatrix} \quad \begin{bmatrix} \frac{-3}{1+y+z} & \frac{3x}{(1+y+z)^2} & \frac{3x}{(1+y+z)^2} \\ \frac{3y}{(x+1+z)^2} & \frac{-3}{1+x+z} & \frac{3y}{(1+x+z)^2} \\ \frac{3z}{(1+x+y)^2} & \frac{3z}{(1+x+y)^2} & \frac{-3}{1+x+y} \end{bmatrix}$$

$$\begin{bmatrix} -1 & 1/3 & 1/3 \\ 1/3 & -1 & 1/3 \\ 1/3 & 1/3 & -1 \end{bmatrix} \quad \lambda = -1/3, -4/3, -4/3$$

③ equilibrium $= (-1,-1,-1)$

$$\begin{bmatrix} \frac{-1}{1+y+z} & \frac{x}{(1+y+z)^2} & \frac{x}{(1+y+z)^2} \\ \frac{y}{(1+x+z)^2} & \frac{-1}{1+x+z} & \frac{y}{(1+x+z)^2} \\ \frac{z}{(1+x+y)^2} & \frac{z}{(1+x+y)^2} & \frac{-1}{(1+x+y)} \end{bmatrix} \Rightarrow \begin{bmatrix} 1 & -1 & -1 \\ -1 & 1 & -1 \\ -1 & -1 & 1 \end{bmatrix}$$

$\lambda = 3, 0, 0$

④ $N\left(\frac{a_1 \cdot C}{1+C} - 1\right) = \frac{dN}{dt}$

$\frac{dC}{dt} = \frac{-C}{1+C} N - C + a_2$

ⓐ $a_1 = 2$

ⓐ$_2 = 5$

$-\frac{C}{1+C} N - C + 5$

Solve for $\frac{dN}{dt}=0$ $\quad \frac{dC}{dt}=0$

$\frac{2C}{1+C}=1 \quad C=1$ inner

$N=0 \quad \frac{-C}{1+C}(0)-C+5=0$

$C=5$

$C=1$

$\frac{-1}{1+1}(N)-1+5=0$

$N=8 \quad (8,1)$

$$J=\begin{bmatrix} \frac{2C}{1+C}-1 & \frac{2N}{(1+C)^2} \\ \frac{-C}{1+C} & \frac{-N}{(1+C)^2}-1 \end{bmatrix}$$

@ $(0,5)$

$$\begin{bmatrix} 2/3 & 0 \\ -5/6 & -1 \end{bmatrix}$$

$\lambda = 2/3, -1$

unstable

@ $(8,1)$

$$\begin{bmatrix} 0 & 4 \\ -1/2 & 3 \end{bmatrix}$$

$\lambda = -1, -2$

stable