$+$ $\times$

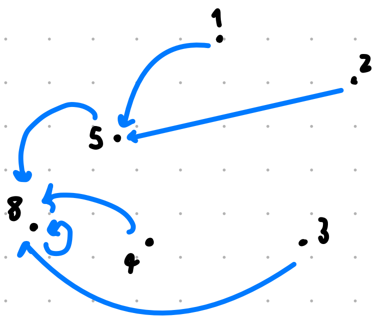
$-$ $\div$

$P \propto R^{\alpha} \quad t \propto r^{-\beta}$

$E \propto r^{\alpha-\beta}$

$P = \frac{E}{T} \qquad E = PT = R^{\alpha} R^{-\beta} = R^{\alpha-\beta}$

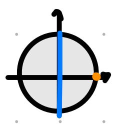
$x_{n+1} = f(x_n) \qquad x \in \{1,2,3,4,5\}$



$x=1 \quad f(x=1)=5$
$x=2 \quad f(x=2)=5$
$x=3 \quad f(x=3)=8$
$x=4 \quad f(x=4)=8$
$x=8 \quad f(x=8)=8$

- FIXED POINT: $\{8\}$
- CYCLE: $\{8\}$
- TRANSIENT STATE: $\{1,2,3,4,5\}$
- RECURRENT STATE: $\{8\}$
- CONNECTED COMPO: $\{1,2,3,4,5,8\}$

$y'(t) = -\sin\left(\frac{\pi y(t)}{3}\right)$



FIND FIXED POINT

$0 = -\sin(0) = 0$:)

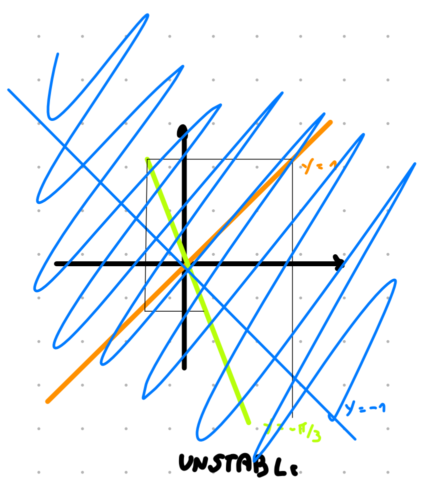
LINEARIZE

$\dot{y}(t) = -\frac{\pi}{3}\left(\cos\left(\frac{\pi y}{3}\right)\right)$

SUBSTITUTE

$\dot{y}(0) = -\frac{\pi}{3}(\cos(0)) = -\pi/3$

STABLE



-1.1

$y = -5x$

UNSTABLE SPYRAL

2

$f(x) = rx(1-x)$ FIND FIXED POINT $x = f(x)$

$x = rx(1-x)$

$x = rx(1-x)$;

$x = rx - rx^2 \longrightarrow x^2r - rx + x = 0$

$x^2 r + x(1-R) = 0$

$Rx^2 - x(1-R) = 0$
$Rx^2 + x(R-1) = 0$

$(R-1)^2 - 4(R)(0)$

$Rx^2 - x(1-R) = 0$

$(-(1-R))^2 - 4(R)(0)$

$(-(1+R^2-2R)) - 0$

$-R^2 + 2R - 1$

$(R-1)^2 - 4(R)(0)$

$\frac{-(R-1) \pm \sqrt{(R-1)^2}}{2R}$

$\frac{1-R \pm \sqrt{(R-1)^2}}{2R} = 0$

$\frac{(1-R \pm (R-1)}{2R}$

$\frac{(1-R) \pm (R-1)}{2R} = 0$

$\frac{1-R}{R} = 0 \Rightarrow R = 1$

FIND FIXED POINT

$$X = Rx(1-x)$$

$$x = Rx - Rx^2$$

$$Rx^2 + x - Rx = 0$$

$$Rx^2 + x(1-R) = 0 \longrightarrow Rx^2 - x(R-1)$$

$$\Delta: (1-R)^2 - 4(R)(0) = (1-R)^2$$

$$R: \frac{-(1-R) \pm \sqrt{(1-R)^2}}{2R}$$

$$x_{1,2} = \frac{(R-1) \pm (1-R)}{2R}$$

$$(+): \frac{(R-1)+(1-R)}{2R} = \boxed{0}$$

$$(-): \frac{(R-1)-(1-R)}{2R} = \frac{R-1-1+R}{2R} = \frac{2R-2}{2R} = \frac{R-1}{R} = \boxed{1-\frac{1}{R}} = \frac{R-1}{R}$$

LINEARIZE

$$f(x) = Rx(1-x)$$

$$f'(x) = R(1-x) - Rx = R - Rx - Rx = \boxed{-2Rx + R}$$

SUBSTITUTE

$\bullet\ f'(0) = \boxed{R} \longrightarrow$ To STABLE $f'(0) < 1 \Rightarrow \boxed{R < 1}$

$0 < R < 1$

R_1

$\bullet\ f'\left(1-\frac{1}{R}\right) = -2\cancel{R}\left(\frac{R-1}{\cancel{R}}\right) + R = -2R + 2 + R \Rightarrow \boxed{2-R}$

To BE STABLE $f'\left(1-\frac{1}{R}\right) < 1$

$2 - R < 1;\ \boxed{R > 1}$

$1 < R < 4$

R_1