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- well-posed? (math + biological)
  - sol'ns exist and are unique
  - biologically 'impossible' dynamics don't happen (solutions are non-negative and ? bounded ?)
- attractors (equilibria)
- local / global? stability (Lyap functions)
  - Jacobian, linearization, e.g.
- bifurcation structure (when does stab of attractors change?)

* PHASE PLANE.

plot eq, nullclines, flow field, trajectories

$S(t)$

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grad = g_x, g_y, g_z

$$g_x(x(t), y(t), z(t), \cancel{t})$$

dep on t — nonautonomous

FORCED

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tools for phase plane analysis:

XPPAUT

phaseR

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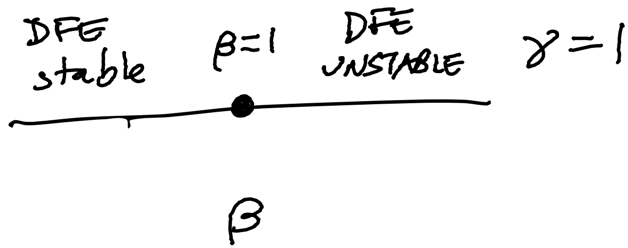
BIFURCATION analysis

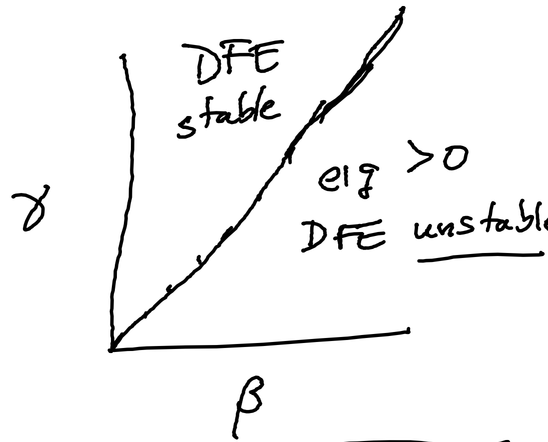
changes in stability

bifurcation parameter

eigenvalue = $\beta - \gamma$

DFE changes stab when $\beta = \gamma$





$R_0 = \boxed{\dfrac{\beta}{\gamma}}$ intrinsic (basic) reproductive number

units of R_0? UNITLESS . : $\boxed{\dfrac{1}{\gamma} \text{ infectious period}}$

$\dfrac{dI}{dt} = \beta S I - \gamma I$

$=$

$\gamma \sim [t^{-1}]$

$\beta \sim [\cancel{S}^{-1} t^{-1}]$

$t \sim$

newinf $= \beta S I \sim \beta I$

$I(0) = 1$: $\underline{\beta}$

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$\gamma = 1 \text{ week}^{-1}$

$\frac{1}{\gamma} = 1 \text{ week}$

$\beta = 3 \text{ week}^{-1}$

$\frac{\beta}{\gamma} = 3$

EXPECTED number of new cases from 1 infected case in an <u>otherwise</u> susceptible pop (near the DFE)

$\boxed{R_0 > 1 \text{ DFE unstable}}$

$R_0 < 1$ DFE stable

rate of change per disease generation

$R_0 \gtrless 1$

$r = \underline{\beta - \gamma}$ rate of change <u>per time</u>

$\frac{\log(2)}{r}$

$r \lesseqgtr 0$?