Ex: Suppose

$$\frac{dy}{dx} = (x+y)^2 =$$

This equation is a bit of a problem. Is nonli

$$u = x+y$$

$$\frac{du}{dx} = 1 + \frac{dy}{dx} \Rightarrow \frac{dy}{dx} = \frac{du}{dx} - 1$$

$$\Rightarrow \frac{du}{dx} = u^2 + 1$$

$$\Rightarrow \frac{1}{u^2+1}\, du = dx$$

$$\Rightarrow \arctan(u) = x + C$$

$$\Rightarrow u = \tan(x+C)$$

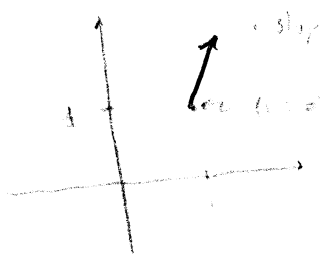
$$\Rightarrow x + y = \tan(x+C)$$

$$\Rightarrow y = \tan(x+C) - x$$

What if we want to know (qualitatively) how the function is changing?

Ex: $\frac{dy}{dx} = (x+y)^2$

$x = 1,\ y = 1$



slope 4

at $(1,1)$ $\frac{dy}{dx} = (1+1)^2 = 4$

Along with constant solutions we can get trajectories

$\frac{dy}{dx} = 0$ at

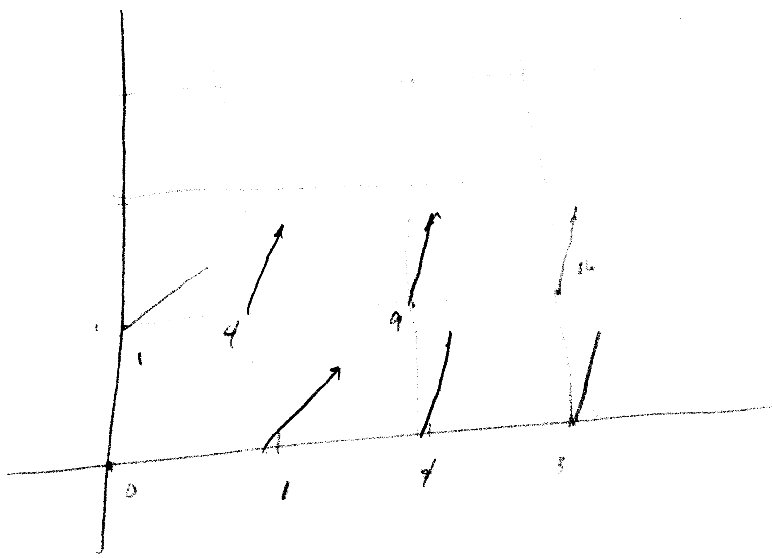
There is the only pt

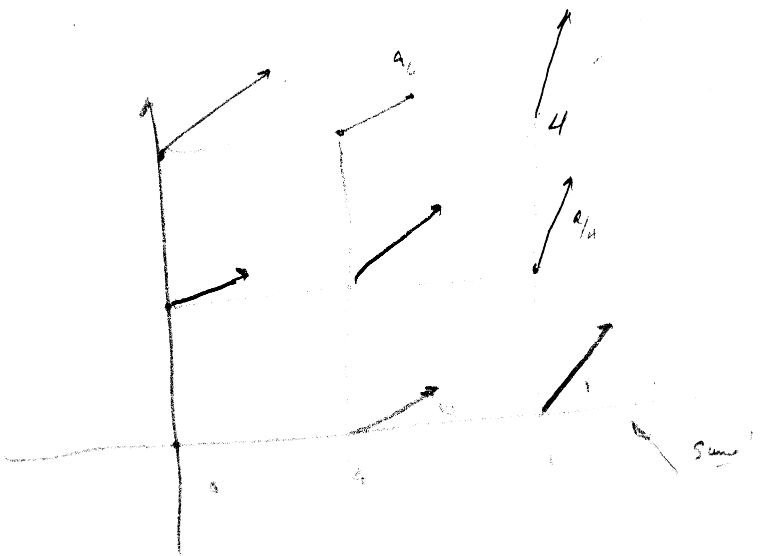
What happens if we perturb off (0,0)?

$x=0,\ y\neq 0 \Rightarrow \frac{dy}{dx} = y^2 \Rightarrow -\frac{1}{y} = x+c \Rightarrow y = -\frac{1}{x+c} = -\frac{1}{c}$

$x\neq 0,\ y=0 \Rightarrow \frac{dy}{dx} = x^2 \Rightarrow y = \frac{1}{3}x^3$

So, let's put a grid out for some of this





Show some results from book

Look at constant solutions

1. Malthusian Model

2 Logistic Model

3. Sustainability model