Let's talk about solutions:

<u>Example</u> $y'' - 4y = 0$

Here are some solutions

$y_1(x) = e^{2x}$: indeed $(e^{2x})'' = 2(e^{2x})' = 4e^{2x}$

so $(e^{2x})'' - 4(e^{2x}) = 0$

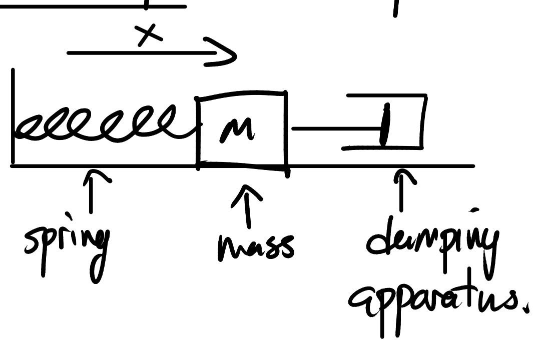
Also $y_2(x) = e^{-2x}$: indeed $(e^{-2x})'' = -2(e^{-2x})' = (-2)^2 e^{-2x}$

so $(e^{-2x})'' - 4(e^{-2x}) = 0.$

There are even other solutions, such as $\sinh(2x)$, $\cosh(2x)$, and more.

We want to understand the "space" or "set" of all possible solutions, this is our goal.

<u>Physical example</u>: Damped oscillation



Spring force $= -kx$

damping force $= -cv$

Newton's 2^{nd}: $ma = -kx - cv$

$$ma + cv + kx = 0$$

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = 0$$

This is second order linear (and homogeneous)!