A system of differential equations is a set of differential equations relating two or more unknown functions.

Ex.

\[
\begin{align*}
x' &= y + 1 & \text{first order linear} \\
y' &= x + y & \text{2x2 system}
\end{align*}
\]

Ex.

\[
\begin{align*}
z' &= x' + xy & \text{first order nonlinear} \\
y' &= xz & \text{3x3 system,} \\
x' &= x + y + z
\end{align*}
\]

We can frequently translate an system into n-th order equations via elimination.

Ex.

\[
\begin{align*}
x' &= y \\
y' &= -x
\end{align*} \rightarrow \begin{align*}
x'' &= (y)' &= -x \\
\rightarrow x'' + x &= 0 \\
\rightarrow x &= Acos t + B sin t \\
y &= -Asin t + B cos t.
\end{align*}
\]

Interpretation: \((x(t), y(t))\) is a trajectory that comes from the level set of \(z = x^2 + y^2\) \((\frac{dz}{dt} = 0)\).

Can visualize with a phase portrait.