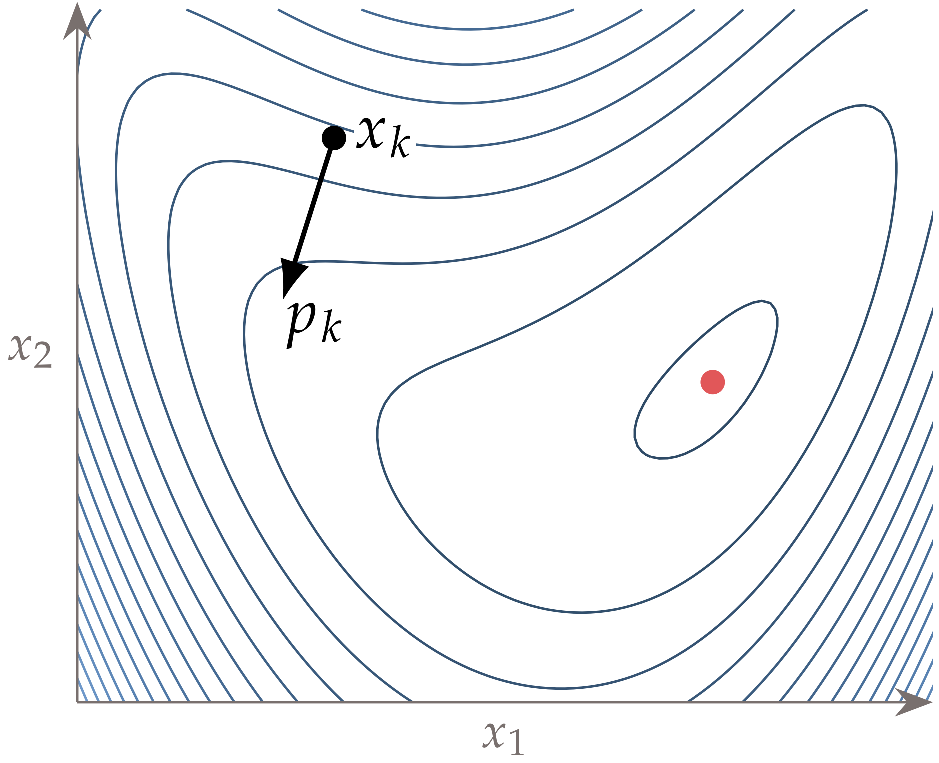
Differential Equations



ME EN 275
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Where We Are

Algebra	Calculus	Linear Algebra	Differential Equations
1D root finding	integration	systems of eqns	
	differentiation	least squares	

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1D root finding	integration	systems of eqns	
ND root finding	differentiation	least squares	
	optimization	eigenvalues	

Motivation

$$\frac{dp}{dt} = rp$$

$$\frac{dT}{dt} = -k(T - T_{room})$$

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

$$\frac{d^2\theta}{dt^2} + \frac{g}{L}\sin\theta = 0$$

First Order ODE

$$\frac{dy}{dt} = f(t, y)$$

want to solve for y

y : dependent

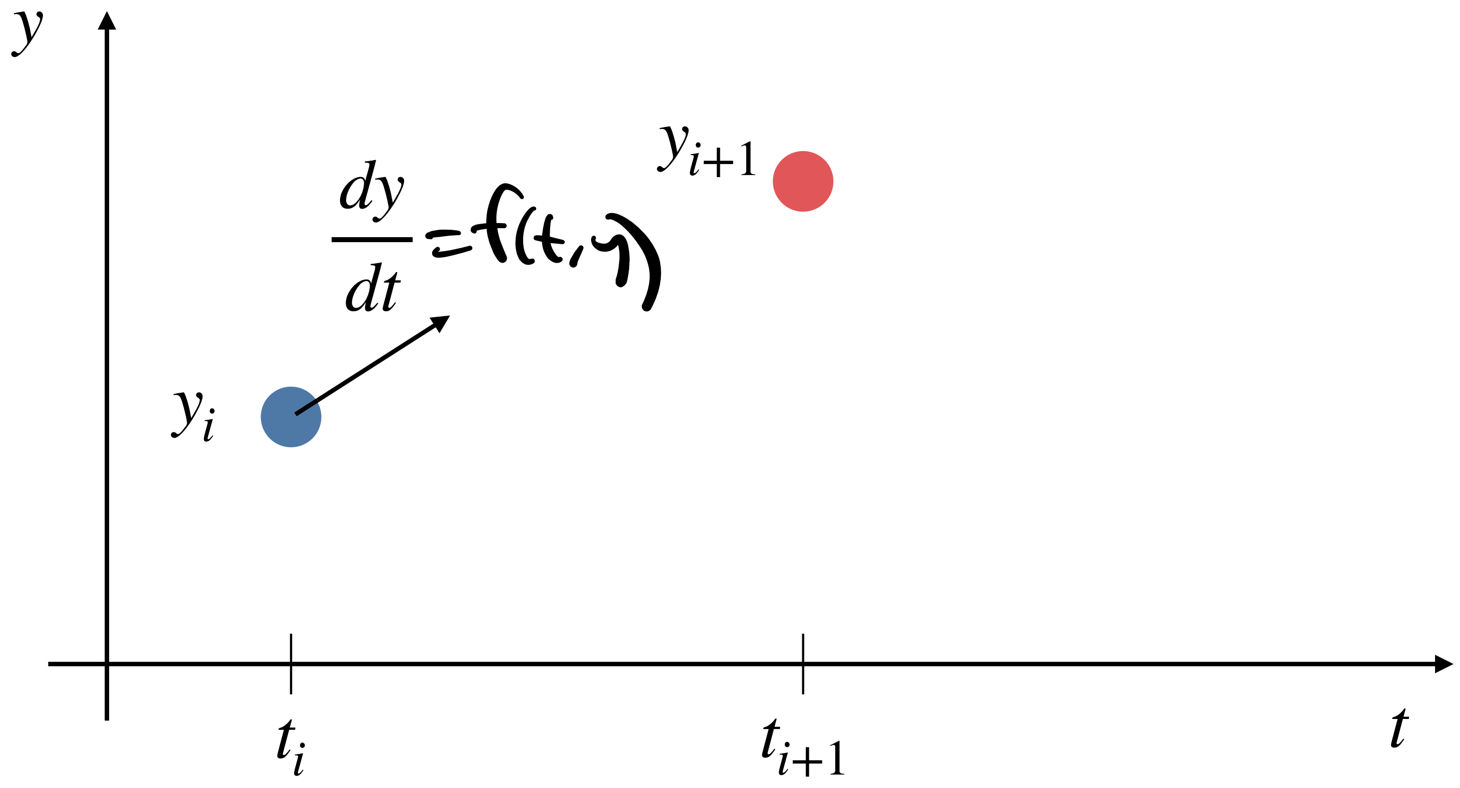
t : independent.

Initial Value Problem

$$\frac{dy}{dt} = f(t, y)$$ want $y(t)$

$$y(0) = y_0$$ ← initial condition.

How to do this numerically?



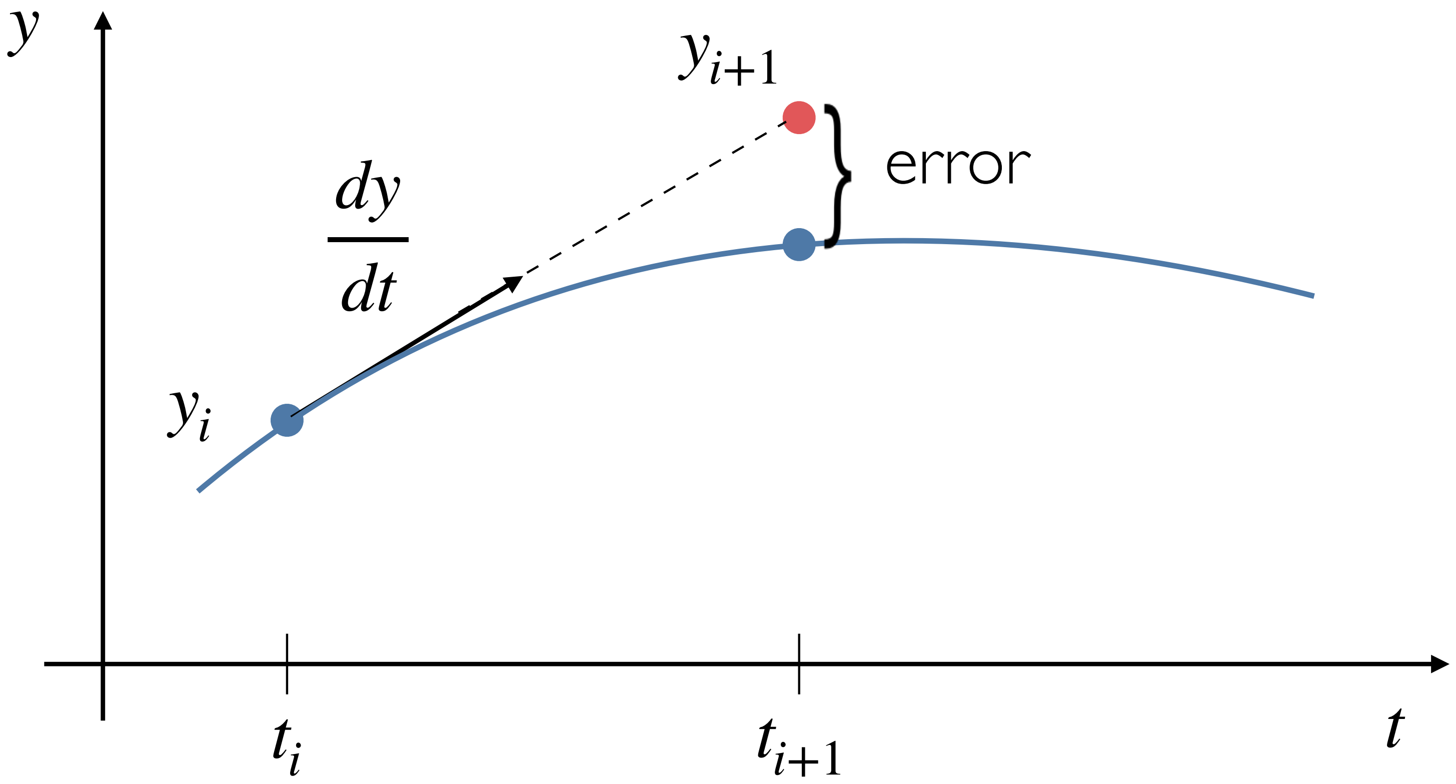
Euler's Method

$$\frac{dy}{dt} = f(t,y) \Rightarrow \frac{dy}{dt} \approx \frac{y_{i+1} - y_i}{\underbrace{t_{i+1} - t_i}_{h}}$$

$$f(t,y) = \frac{y_{i+1} - y_i}{h}$$

$$\Rightarrow \boxed{y_{i+1} = y_i + h \cdot f(t_i, y_i)}$$

Euler's Method



Write our own Euler ODE solver

euler(f, y0, t0, tf, h)

$$y_{i+1} = y_i + h \cdot f(t_i, y_i)$$

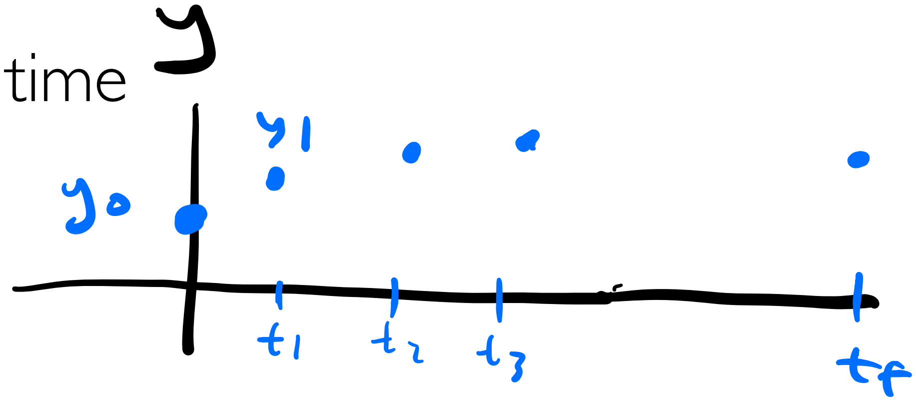
f(t, y) - returns dy/dt

y0 - starting point

t0, tf - starting and final time

h - time step

$y(t)$



$y_0 = 1$

try: odefun(t, y) = 0.1* y

$\Rightarrow \frac{dy}{dt} = 0.1y$

Stability