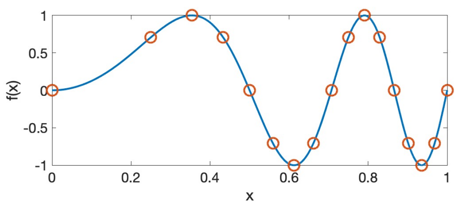
CME 108 / MATH 114: Introduction to Scientific Computing

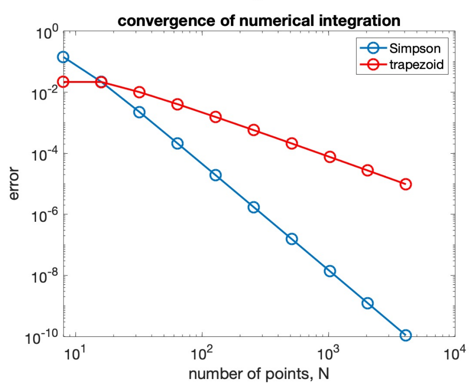
Winter 2022
TTh 1:30-3 pm
Prof. Eric Dunham

Scientific computing and the **numerical solution of mathematical problems** are fundamental to science and engineering. Tired of using software as a black box and worrying if the solution is correct? Stuck with equations you can't solve analytically? Need to analyze data? Then learn numerical methods for solving linear and nonlinear equations, optimization, regression, interpolation, numerical differentiation and integration, and solving differential equations!

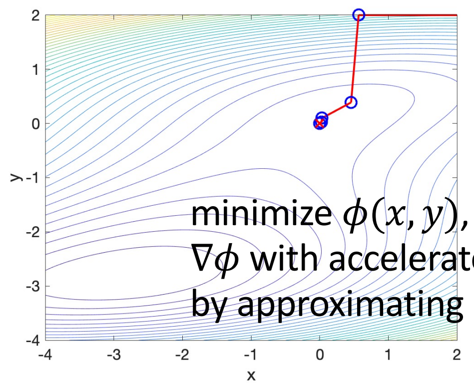
numerically approximate

$\int_0^1 \sin(4\pi x^2)\, dx$

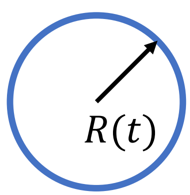




what determines accuracy? why are some methods more accurate than others? how do you know if a numerical solution is correct?



minimize $\phi(x, y)$, using gradient $\nabla\phi$ with accelerated convergence by approximating Hessian $\nabla^2\phi$



Rayleigh differential equation for oscillating bubble, solved with adaptive time stepping

$$R\ddot{R} + \frac{3}{2}\dot{R}^2 = \left(\frac{R_0}{R}\right)^{3\gamma} - 1$$

how can we estimate error for a time step Δt, and select Δt to bound error < tolerance?

which is a better approximation?

$$\frac{dy}{dx} \approx \frac{y_{i+1} - y_{i-1}}{2\Delta x} \text{ or } \frac{dy}{dx} \approx \frac{-3y_i + 4y_{i+1} - y_{i+2}}{2\Delta x}$$