Computational methods in optimization

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Thanks to Nick Henderson for many slides.

Course objectives

To understand optimization

To be able to optimize a function

Course outline

Background

Software

Least Squares

Matrix calculus

Unconstrained Optimization

Non-linear equations

Newton methods

Line search

Trust region

Quasi-newton

minimize $f(x)$

Constrained Optimization

Linear programming

Quadratic programming

Large-scale

$$\begin{aligned} &\text{minimize} \quad f(x) \\ &\text{subject to} \quad l \le \begin{bmatrix} x \\ Ax \\ c(x) \end{bmatrix} \le u \end{aligned}$$

Modern Topics

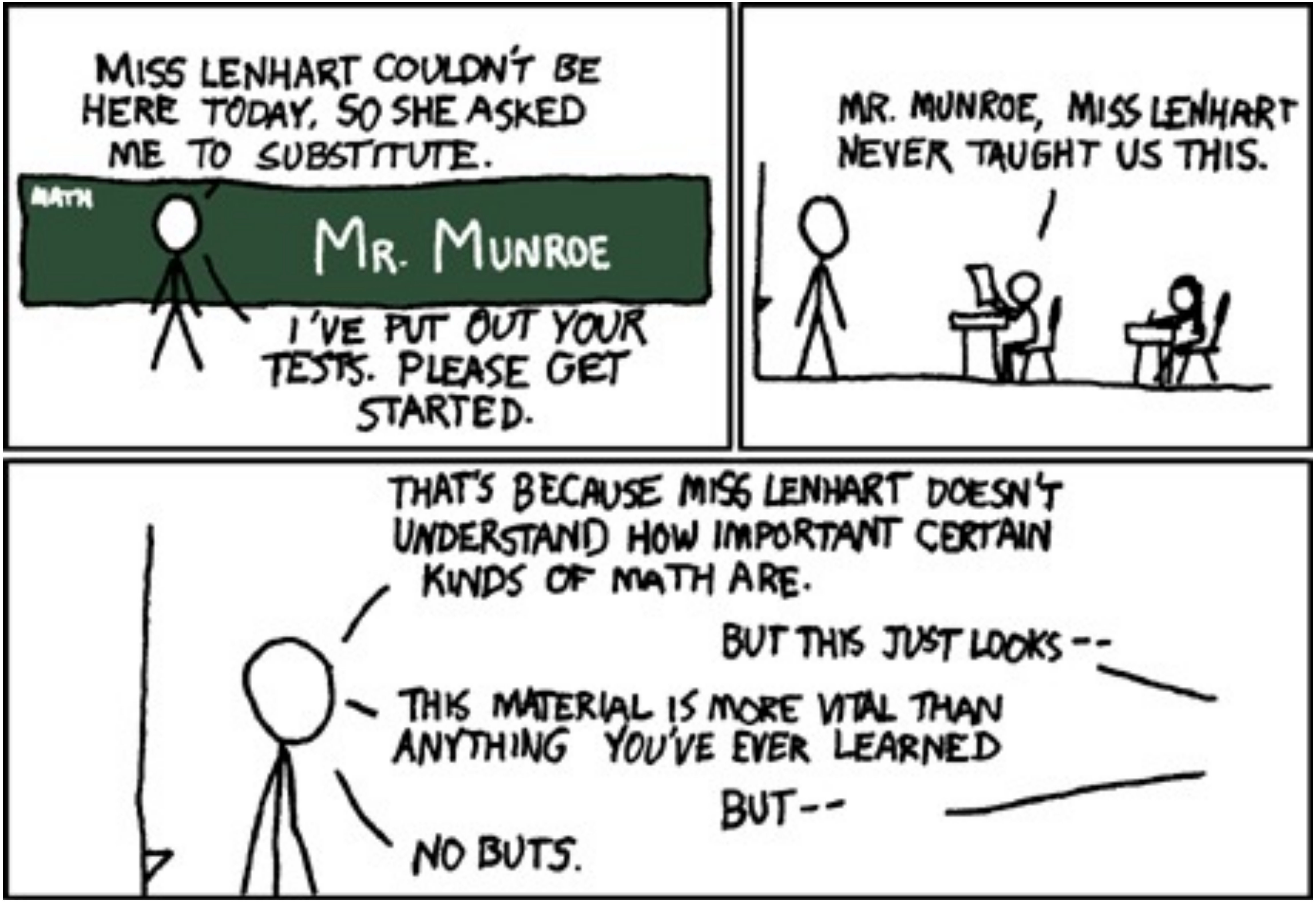
Convex

Integer

Stochastic

Questions about topics?

Your first quiz



Source: http://xkcd.com/135/

2. You are at the center of a 20m equilateral triangle with a raptor at each corner. The top raptor has a wounded leg and is limited to a top speed of 10 m/s.

The raptors will run toward you. At what angle should you run to maximize the time you stay alive?

Raptors move at 25 m/s

You move at 6 m/s

But who cares?

The new model

choose — direction to run — $\mathbf{v}_p[j]$ for $j = \{1, \ldots, N\}$

to minimize — "likelihood" of being eaten

$$\sum_{j=1}^{N} \sum_{i=1}^{3} \frac{1}{\|\mathbf{p}[j] - \mathbf{r}_i[j]\|^2} dt$$

subject to

raptor motion

$$\mathbf{r}_i[j+1] = \mathbf{r}_i[j] + h v_i \frac{\mathbf{p}[j] - \mathbf{r}_i[j]}{\|\mathbf{p}[j] - \mathbf{r}_i[j]\|}$$

human motion

$$\mathbf{p}[j+1] = \mathbf{p}[j] + h \mathbf{v}_p[j]$$

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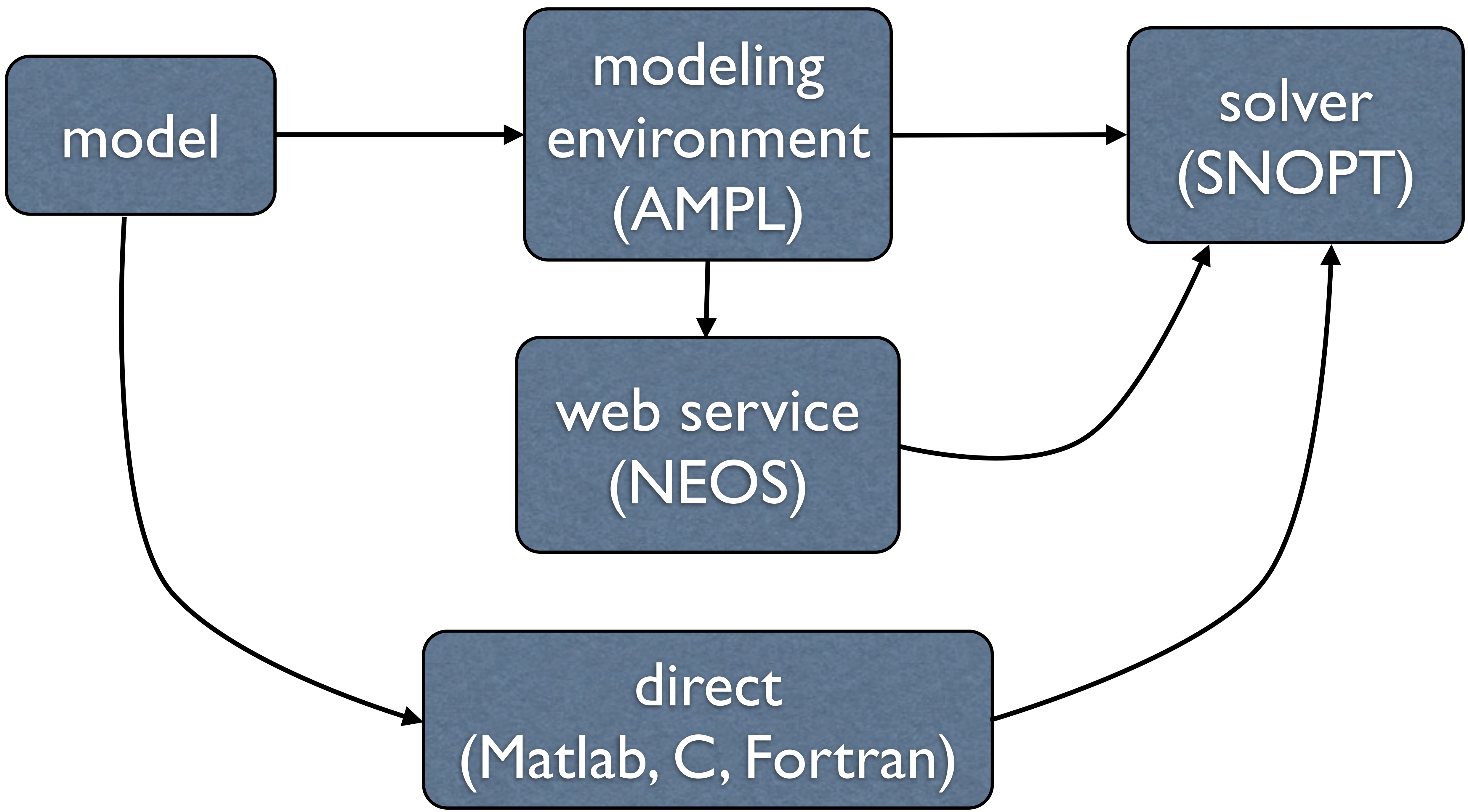
How it's done



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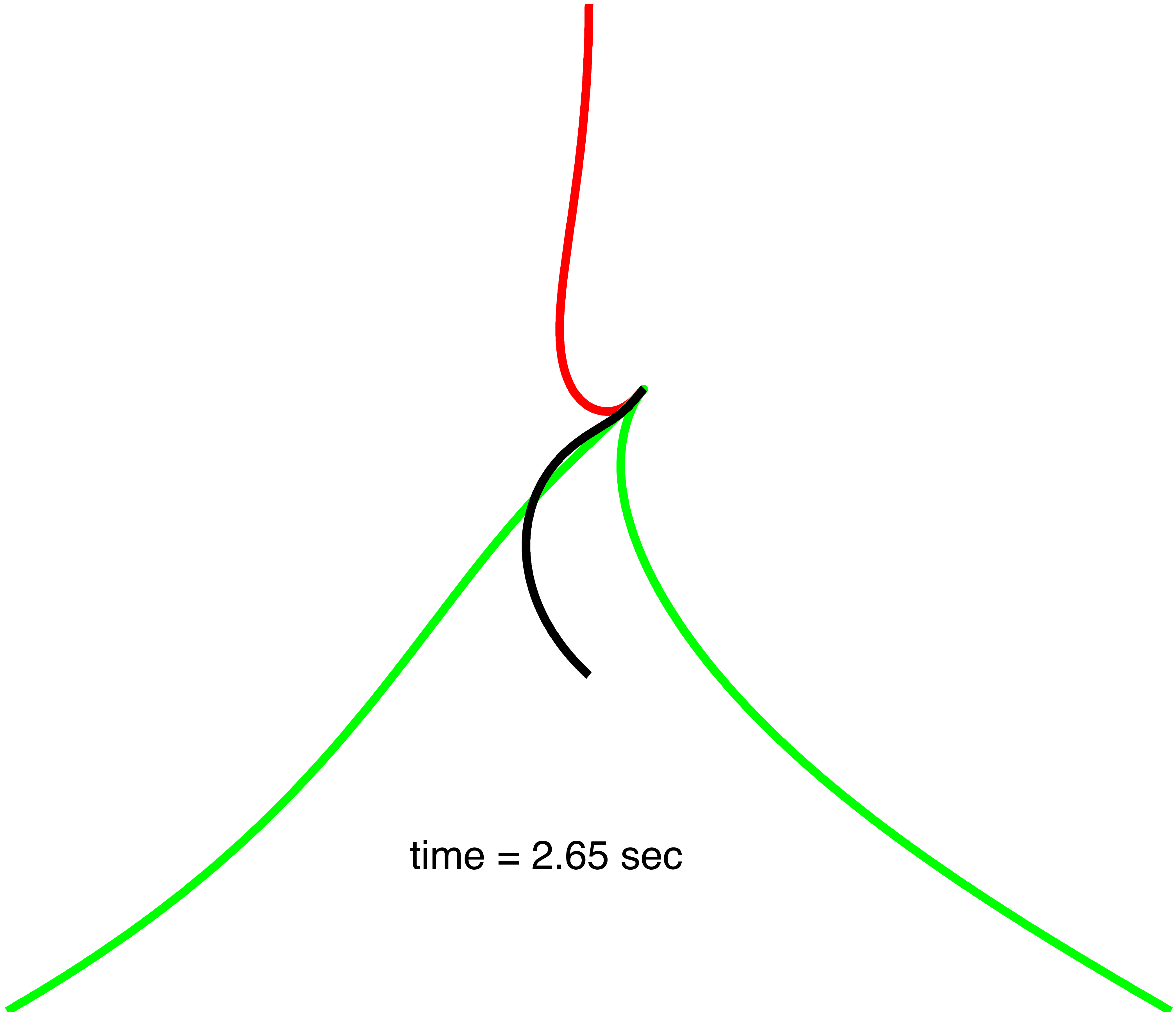
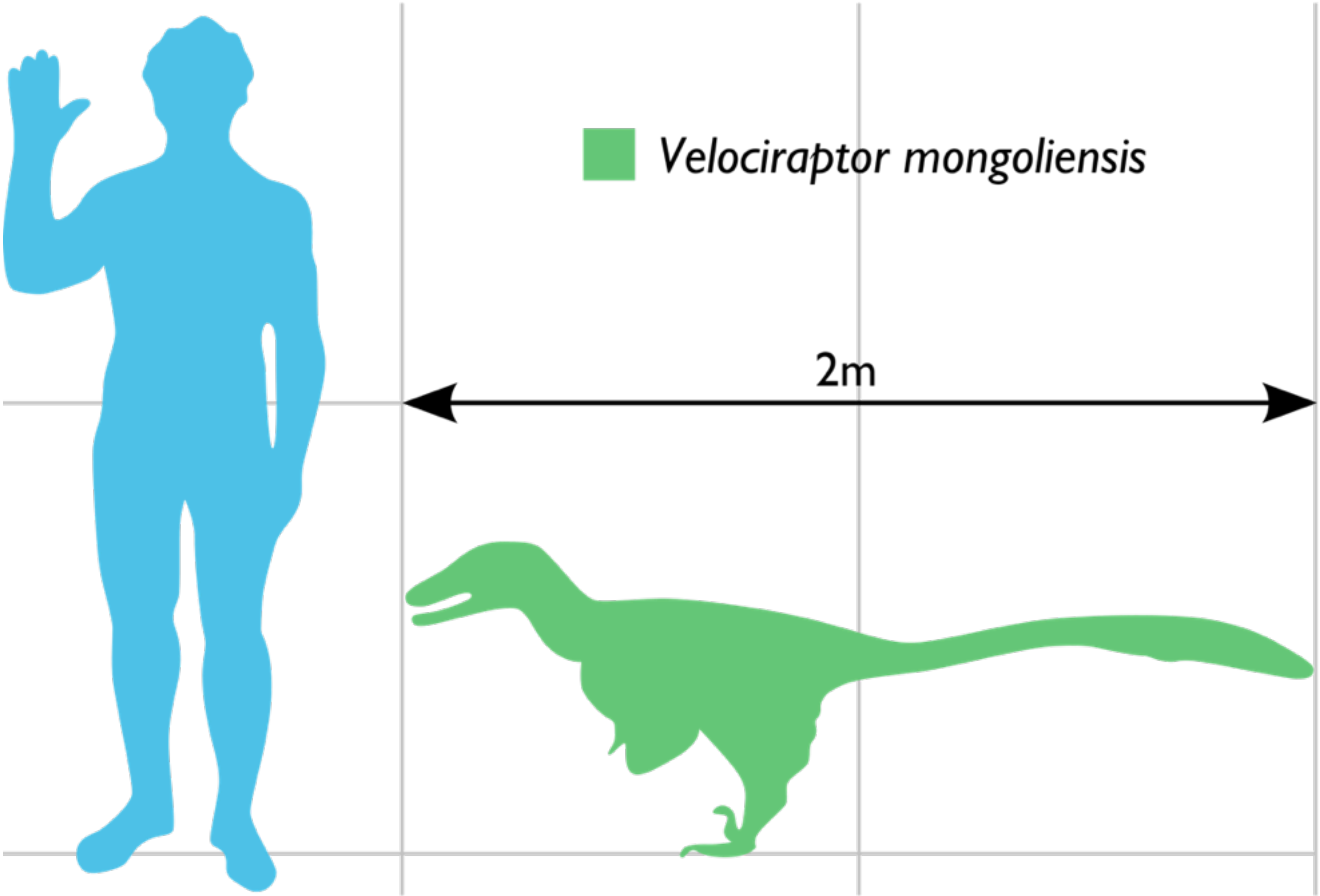
Solve!

time = 0.01 sec

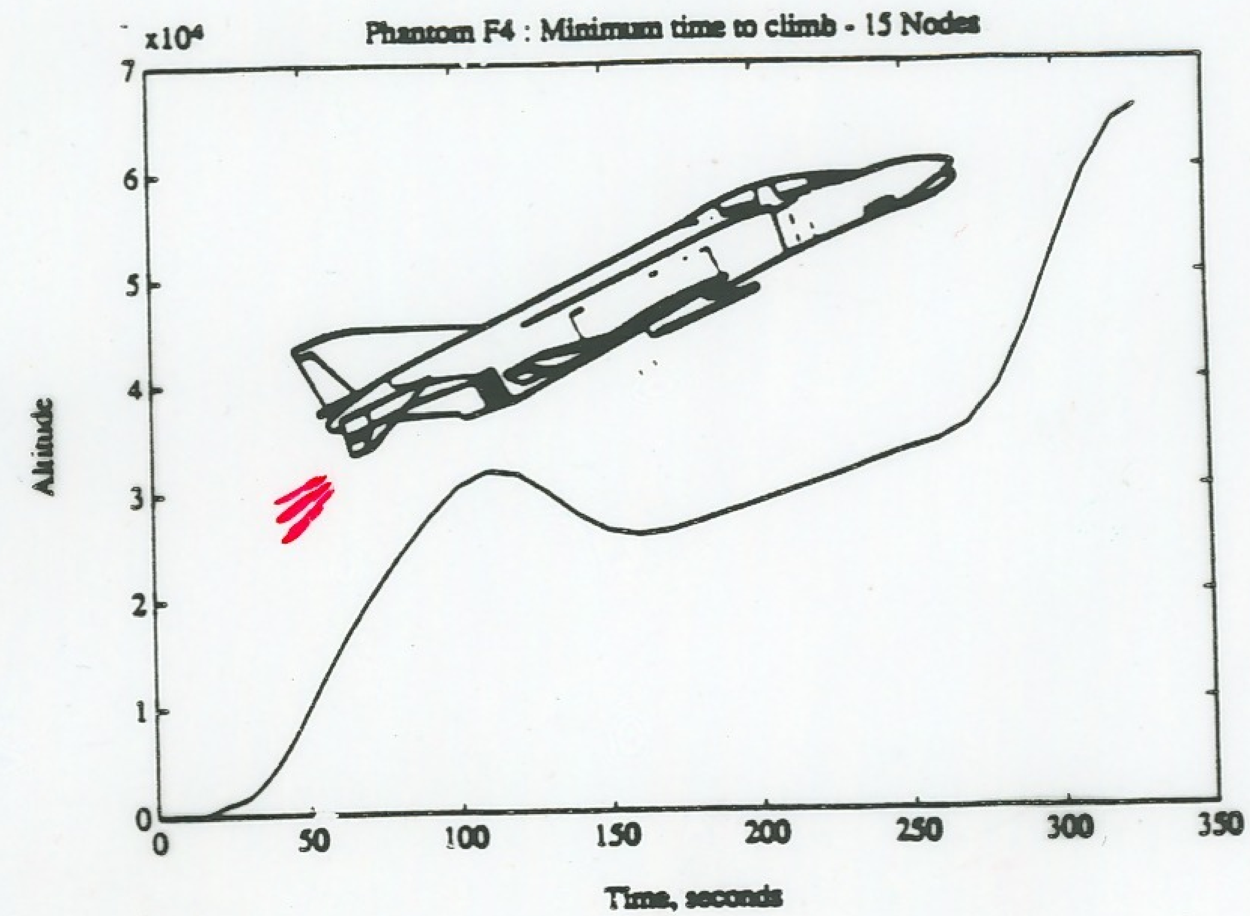

time = 2.65 sec



Source: http://en.wikipedia.org/wiki/Velociraptor

Aerospace Applications
of NPSOL and SNOPT

OTIS #1



What are your applications?