Minimization of Functions

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The Case

- The distance between earth and Mercury can be defined as:
- t in days, distances in Gm

$$Xm = -11.9084 + 57.9117\cos\left(\frac{2\pi t}{87.97}\right)$$

$$Ym = 56.6741\sin\left(\frac{2\pi t}{87.97}\right)$$

$$Xe = -2.4987 + 149.6041\cos\left(\frac{2\pi t}{365.25}\right)$$

$$Ye = 149.5832\sin\left(\frac{2\pi t}{365.25}\right)$$

$$d = \sqrt{(Xe - Xm)^2 + (Ye - Ym)^2}$$

Problem Statement

- Find the minimum and maximum distances between earth and mars over the first 1000 days

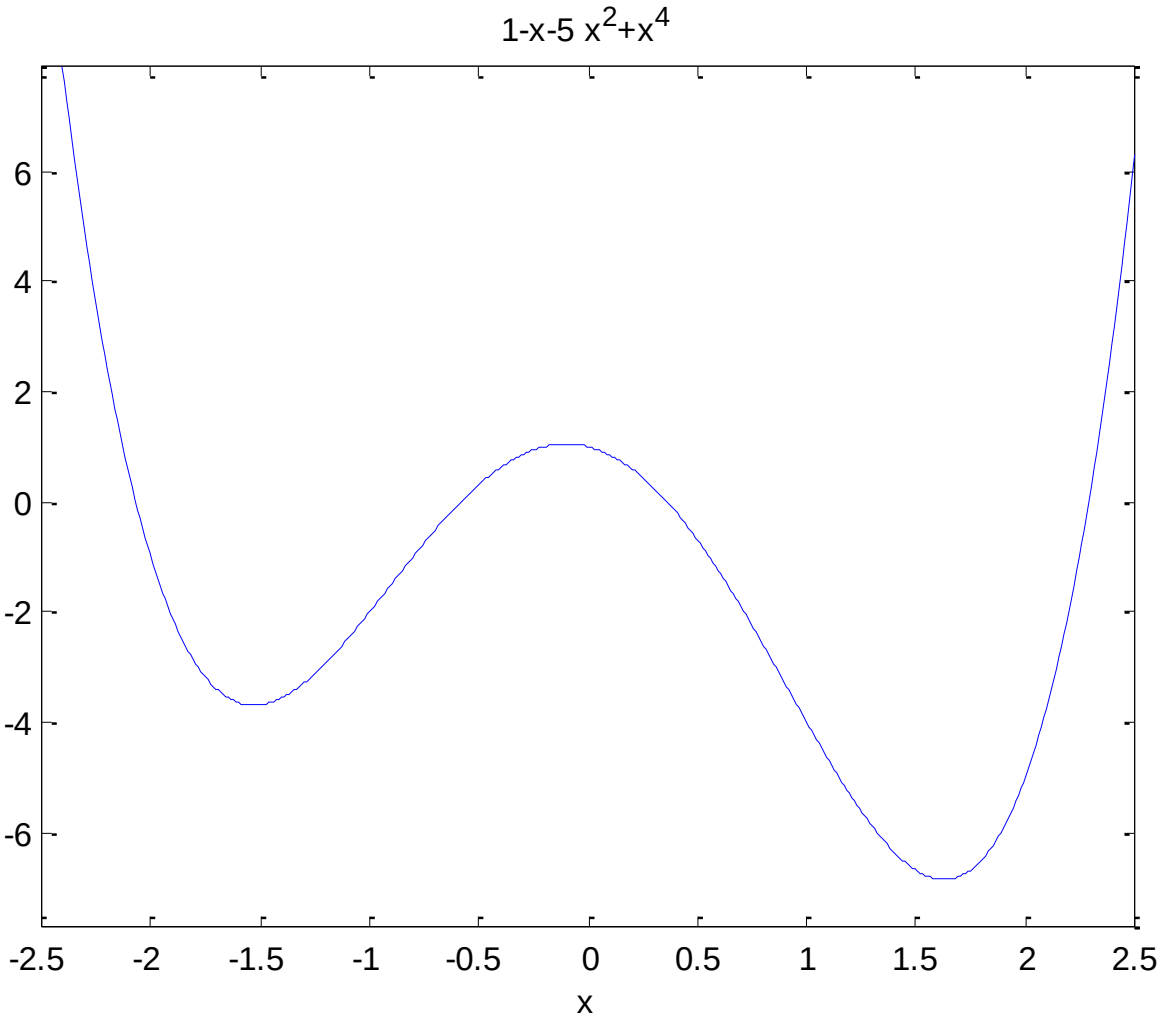
Example

- Suppose we want to minimize:

  $$f(x)=1-x-5x^2+x^4$$

- First plot it, then use tools to find minimum

Plot of function



Minimizing Functions in Matlab

- **fminbnd(FUN,x1,x2)** - single variable, bounded, nonlinear function minimization
- Looks for minimum on the interval $x_1<x<x_2$

Minimizing Functions in Matlab

- Use the FMINBND function

- **[x,fmin]=fminbnd('f',-2.5,2.5)**
- **[x,fmin]=fminbnd('f',-2.5,0)**

- **function fun=f(x)**
- **fun=1-x-5*x.^2+x.^4;**

Notes

- To maximize a function, just minimize the negative of that function
- Use GLOBAL variables to get constants into functions or include parameters as function argument
- In latter case, syntax becomes:
- **fminbnd(@(x) f(x,c),-2.5,2.5)**

Practice

- Find the maximum of **$f(x)=1-x-5x^2+x^4$** on the interval $-1<x<1$
- Use **fminbnd**

Practice

- Plot earth/Mercury distance from 0 to 1000 days
- Find min and max distance over this period
- Note: formulas for xm, xe, ym, and ye are typed out in planets.m file on web site.
- Use these to calculate **d** and then find minimum of **d** over 1,000 days

Notes

- **fminbnd** does minimization in one variable
- If you need to minimize a function of several variables, use **fminsearch**
- If you need to do constrained optimization, you need the optimization toolbox (or use the Solver in Excel)

Questions