Statistics and Simple Plots

Outline
- Announcements:
  - Homework II: due Wed. by 5, by e-mail
- Cookie Challenge
- Statistics
- Simple plots
- Tutorial 4

Homework II
- myfft.m
  - Inputs:
    - x, t (a signal)
  - Outputs:
    - a, b, (Fourier coefficients)
    - f (Frequencies)
- FourierMat.m
  - Inputs:
    - a, b, f (Fourier coefficients & frequencies)
    - t (a vector of times)
  - Outputs:
    - x (signal at times in t)
**Homework Policy**

- You may discuss problems sets with others in the class
- BUT--write-up should be done alone

**Cookie Challenge**

**Statistics**

- Descriptive
  - summarize properties of data
- Comparative
  - compare data sets
  - test hypotheses
Descriptive Stats

• Most common descriptive stats are in "datafun" toolbox
  - mean, median, min/max, std
  - vectorized, operate on columns
  - Ex: x & y are column vectors with data
    • m=mean([x,y])
    • m(1)=mean of x, m(2)=mean of y
    • Can force mean to work on rows:
      • m=mean([x,y],2);%mean along 2nd dimension

Descriptive Stats

• The descriptive stats functions don’t like nans
  - mean([nan;x]) returns NaN
• The statistics toolbox has nanmean, nanmin, nanstd, etc. that ignore nans
  - Simple to write your own versions

Basic Comparative Stats

• Curve fitting with polyfit
  - coefs=polyfit(x,y,n):%fits n-th order polynomial to data
    • [x.^n, x.^n-1,...,x,1]*coefs = y
  - Correlation coefficient (r) with corrcoef
    • r=corrcoef([x,y]);
    • r=[ r(x,x), r(x,y); r(y,x), r(y,y)]
    • will also return probability
“Advanced” Comparative Stats

- Statistics toolbox has functions for
  - statistical distributions
  - parameter estimation
  - statistical tests
- A useful function:
  - regress-like polyfit, but get stats (p, R2)
    - Fits any linear model (anything you can write as a matrix-vector product)
    - \( b = \text{regress}(y,X) \) finds \( b \) s.t.
      - \( X^t b = y \)

Fitting Polynomials with \( \backslash \)

- \( x, y \) are (column) vectors of observations
  - \( X=[x.^3 \ x.^2 \ x.^1 \ x.^0]; \ %\text{matrix} \)
  - If we know \( b \):
    - \( y=x^t b \)
  - Instead, we know \( y \):
    - \( b=X\backslash y \)
  - Matrix division--Matlab computes the inverse of the matrix
  - \( \backslash \) is very smart--can deal with a variety of matrices
    in a very intelligent manner.

Summary of Matlab Stats

- Matlab has basic stats built-in
- Can expand with the stats toolbox
- Most statistical tests are easy to program
  - Can program Matlab to deal with your data!
  - look for vector-products!
Simple plots

- Plot 1D functions (2D data) with plot
  - plot(x,y) plots (x,y) with a blue line
  - plot(y) is plot([1:length(y)],y)
  - plot(x,[y1,y2,y3]) plots (x,yX) each in a different color

Customizing plot

- plot(x,y,'r') is a red line
- plot(x,y,'o') plots circles rather than lines
- plot(x,y,'yp') plots yellow pentagrams
- Type help plot to get more options

Specialized 1D graphics

- bar--bar chart
- pie--pie chart
- polar--polar coordinates
- semilogy, semilogx, loglog--plotting with log-scales
2D basics

- Assume data \( Z \) is on a regular grid defined by \( X \) and \( Y \)
- `pcolor`, `imagesc`, `contour` plot in 2D
- `surf`, `mesh` plot in 3D (perspective)

2D basics

- 2D graphics use colors to represent data
- Color of \( z \) is defined by a colormap and `caxis`
- several built-in colormaps--help `graph3d`
- Used in Lecture 01

Generic graphics functions

- `xlabel`, `ylabel`, `title` label your plots
- `hold on`--allows multiple plots on same axes
- `clf` clears the figure window
- `axis([xmin,xmax,ymin,ymax])` controls axis limits
Multiple plots

- subplot(m,n,j) creates the jth plot in an m-by-n matrix of plots

<table>
<thead>
<tr>
<th>m=row</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>3</td>
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</tr>
</tbody>
</table>

n=col

Axes & Figures

- Matlab plots into figures
  - figure(n) makes n the current figure or creates a figure numbered n
- Figures contain axes
  - If no axes exist in current figure, then any graphics call will create one
  - Can explicitly create with subplot or axes

Printing figures

- print will send gcf to printer (or use GUI)
- print -depsc fname.eps will save graphics in EPS format
- print -djpeg fname.jpg will save into JPG format
Summary of Matlab Graphics

- Matlab has most standard plots built in
- Also has advanced tools for visualization of high dimensional data
  - colors, light, isosurfaces, slices
- The best thing about Matlab graphics are that they can be programmed
  - put graphics statements in functions for display or debugging
- Take CIS 402!

Tutorial 4: Temp. on NW Atlantic Shelf

- Data consist of yearly mean temperatures between 150-250m depth from 4 locations on NW Atlantic Shelf:
- Are the temp’s independent?
- Practice working with data, simple stats and graphics