Outline

- Announcements:
  - Homework IV due Wed. 10/8 by 5, by e-mail
    - Extra week for projects
    - Absolutely no exceptions!
    - Answers will be posted on web
    - I will be available during office hours & by appt.
  - Homework III: answers on web
- Homework III
- AdvDiff1D example
- What you know
- What I haven't told you, & where to find out more
- Course Evaluations

Homework

- Solution to 6 was harder than I thought
  - x=[1 2 3 3 3]
  - d=diff(x)-->[1 1 0 0]
  - d=diff(d)-->[0 -1 0]
  - find(d~=0)-->[1 3]!
- Need to do the diff and scan for n-1 0's.
  - I=[]
  - for j=1:length(d)-n+2
    - if(sum(d(j+(0:n-2)))
      - I=[I,j];
    - end
  - end

Numerical Solution

- This is a matrix problem
  - $A*C^{t+dt}=f(C^t)$
- Each grid point will have a row in matrix A
  - A(j,:)=[0 …0, -□, (1+2*□), -□, 0 … 0]
- All rows are the same except for first and last
  - We need to specify what happens at end points
  - Boundary conditions are a big problem
  - We'll use periodic BC's
    - C(0)=C(1), so first and last rows are:

$$\begin{bmatrix} (1+2\sigma) & -\sigma & \dots & -\sigma \end{bmatrix}$$
$$\begin{bmatrix} -\sigma & \dots & (1+2\sigma) & -\sigma \end{bmatrix}$$

Numerical Solution

- Algorithm:
  - build A
  - for j=1:n
    - build RHS=$f(C^t)$
    - C^{t+dt}=A\RHS ----- very time consuming!
  - end

Numerical Solution

- Same A used in each iteration
- Factor once:
  - build A
  - [L,U]=lu(A);%chol would be better..
  - for j=1:n
    - build RHS=$f(C^t)$
    - y=L\RHS; ---forward substitution
    - C^{t+dt}=U\y; ---back substitution
  - end

Sparse Matrices

- A is sparse
  - the only non-zero elements are immediately above, below, and on the diagonal
  - corners for periodic BC's
- Matlab has special sparse matrices
  - much less memory (don't need space for 0's)
  - faster to process
  - A=sparse(I,J,S) forms A s.t. A(I(j),J(j))=S(j)

AdvDiff1D.m

- Uses slightly more complicated procedure for advection known as "Lax-Wendroff" method
- Must specify
  - Initial concentration C0
  - parameters (u, k)
  - size of domain L
  - length of time T,
  - dx, dt
- Returns x, t, and C(x,t)

What Do You Know?

	Data →	Program →	Output
Currents	SSH	Geostropic eq.	U,V,plot
Weather	T,V,M	Finite diff.	T,V,M in future
Bioinfomatics	ATCGCGTA…	Search for genes	Location of genes
Electronics	Signal	FFT	Plot of spectrum

- You know enough Matlab to solve any of these problems

What Do You Know?

- You know how to
  - get ASCII and binary data into Matlab
  - data are stored in arrays (vectors, matrices, ND-arrays)
  - Manipulate data with array operations
    - find, relational and logical operators
  - get data out of Matlab

What Do You Know?

- You know that Matlab has built in functions for
  - statistics
  - graphics
  - solving ODE's
  - optimization
  - linear algebra

What I Haven't Told You

- Matlab has lots of functions, and you'll never know them all
  - learn about functions through
    - help, helpwin, or help browser (through GUI)
    - www.mathworks.com

What I Haven't Told You

- Other important packages
  - splines (turn anything into a smooth function)
  - signals (beyond FFT)
  - finance (follow the money)
  - mapping (explore your world)
  - Simulink (GUI for creating dynamical systems)

What Do You Know?

- You know how to extend Matlab's capabilities through functions
  - function [outputs]=fname(inputs);
- And that Matlab is a procedural programming language
  - Iterations with for & while loops
  - Conditionals with if-elseif-else-end
  - error(estring)
- And that Matlab functions can be polymorphic
  - nargin, varargin, etc.

What Do You Know?

- Matlab is more than just arrays of doubles
  - structs--similar to C-structs or Java objects
  - cell-arrays-- arrays of anything

What Do You Know?

- Matlab can do graphics
  - plot--plots of 1D functions
  - bar--bar plots
  - surf, pcolor--plots of 2D functions with color
- Matlab's graphics can be programmed
  - Build functions for specialized graphics

What I Haven't Told You

- There are lots of graphics functions
  - patch, imagesc, plot3, fill, isosurface
- Graphics have lots of properties to play with
  - color, light, markers, text, size, position
- Matlab has a system for working with graphics
  - handle graphics
- Shameless plug for CIS 402!

Other Scientific Computing Courses

- CS421--Introduces basic concepts and issues in scientific computing and numerical analysis
- CS621, CS622, CS624--Advanced scientific computing and numerical analysis (Matrices, Optimization, ODE/PDE's)
- Math and Applied Math offer courses on linear algebra, ODE/PDE's
- Domain-specific courses in your department

Evaluations

- Please give me as much data as you can
  - specific lecture/topics you liked & those you didn't
  - other topics to cover?
  - were tutorials useful?
- Thanks!