HW 4:

The idea in this homework is to do the calculations “geometrically” – using dot and cross products directly, not their expansions into algebraic equations.

Both questions can also be done analytically in spherical trigonometry, but the derivation is much longer and getting the program debugged is much harder.

Thinking about it geometrically and in Cartesian coordinates also simplifies many other calculations such as drawing a great circle between 2 points.

You should not be using lats and longs after you have converted to Cartesian coordinates, just (x,y,z).

Look at the example m file “dot\_cross\_ex.m” below (it shows how to vectorize the dot and cross products beyond what Matlab already does).

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1) Write a function to find the distance (delta) in degrees between two points on a **spherical** earth specified by their lat, lon in degrees.

The function should be vectorized (giving it a 2xN matrix of N points and a 2x1 vector it should find the delta between each column of the matrix and the vector [this simulates calculating the deltas between an earthquake and each of N seismic stations], and if given two matrices of the same size it should calculate the delta between each pair of vectors. N results in either case).

Have the function check the inputs for valid data (correct input types, numbers within appropriate ranges, correct sizes, etc.) If the input data is bad, print an error message identifying the error (this tells you there is a problem) and return NaN (this tells the calling program there is a problem).

In addition – **test** your program by giving it input data for which you know the answer. You can test it using the Matlab mapping toolbox functions distance and azimuth (enter “help distance” and “help azimuth” to get the documentation on how these functions work). Test your function for some points such as from your home city to Memphis, several US cities to Memphis, etc.

To do the calculation, do not use the spherical trigonometry Haversine formula or multiply the dot and cross products out into their algebraic forms.

Don’t use the algebraic formulas in the excerpt from Stein and Wysession.

Convert the lat, lon into Cartesian coordinates (x,y,z) and then use the dot and cross products.

You can use the Matlab dot product or multiply things out if Matlab is not properly vectorized (using vector/matrix math, not the expansion of the vector math).

See Stein and Wysession p462-466 for the math – specifically the geometry.

2) Write a function to find the azimuth between two points on a spherical earth specified by their lat, lon in degrees.

The second and third paragraphs above still hold.

Again, do the problem in Cartesian coordinates. See Stein and Wysession p462-466 for the math - geometry.

This is a bit more involved than finding delta as there are a number of steps involving dot and cross products.

Again, use Matlab dot and cross functions or matrix multiplication as appropriate.

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Save this as an “m-file”. Watch out for problems with the quotes.

%make some vectors - you can check the answers by hand

a=reshape([1:6],2,3);

b=fliplr(a);

%what do these calls do?

dot(a,b)

cross(a,b)

c=[1 2]';

%what do these do? (they are commented out because they don't work)

%dot(c,b)

%cross(c,b)

%here is where "multiplying it out as matrix/vector math" can solve the

%above, note you have to arrange the vectors/matrices so they multiply

%together correctly

c'\*b

%or you can do it by making the vector c into a matrix of the correct size

dot(repmat(c,1,size(b,2)),b)

%unfortunately for the cross product you are stuck with the repmat method

cross(repmat(c,1,size(b,2)),b)