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GEOL 305.01: Computation and Computers in Geology

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Computation and Computers in Geology - Geology 395

Professor: Steve Sheriff

Grading: Mandatory pass/fail based on problem sets and attendance
Homework due one week after assignment

The venue for this course is Science Complex 11, a joint Geology-Physics teaching room equipped with a computer for each student. Currently we have facilities for fourteen students.

This course is under continual development, there will be regular changes to this page - I'll try to remember to announce important changes in class. The content of the page will be lecture/discussion notes, examples, references and problem sets. So far the most convenient and expedient way to distribute the information seems to be to provide the material in Adobe's .PDF format. Thus these exercises and notes are provided as .PDF files and you need Adobe's free Acrobat Reader installed in your browser to view them.

If your browser is not currently set up to read and print such files, download Acrobat Reader from Adobe's web page, close your browser (preferably version 4.0 or greater of MS Internet Explorer or Netscape), install the reader, restart your browser, click on one of my links pointing to a set of notes or problems, and Acrobat Reader should pop up with the .PDF file.

For background information and additional problems:

* A Guide to Microsoft Excel for Scientists and Engineers, B.V. Liengme, John Wiley and Sons, 1997, 207 p.
* Introduction to Linear Algebra in Geology, J. Ferguson, Chapman & Hall, 1994, 203 p.
* Numerical Analysis for the Geological Sciences, J.R. Carr, Prentice Hall, 1995, 592 p.
* Linear Algebra, Geodesy, and GPS, G. Strang & K. Borre, Wellesley-Cambridge Press, 1997, 694 p.
* Statistics and Data Analysis in Geology, 2nd edition, J.C. Davis, 1986, John Wiley and Sons, 646 p.
* Introduction to Geological Data Analysis, A. Swan & M. Sandilands, Blackwell Science, 1995, 446 p.

Introductory material: course structure

* Take a look at the course description to see where we might go this semester.
* If you want to know a little about the overall setup of a networked computer system, including some definitions and explanations, check out Alden Wright's page for his CS 487 course. And, if you want some upper-level information on scientific computing, take a look at Don Morton's web page for his Scientific Computing course.
* The University of Geneva maintains an excellent list of geology resources on the web. The Geology Department at the University of Oklahoma has a good write up on bits, bytes, programming and computer hardware.

Spreadsheets: graphing functions and manipulating data

During this portion of the course we will investigate some Excel capabilities that are handy for solving various types of problems in the Geosciences. Of course we will not be able to do everything, my objective is to get you familar with spreadsheet programming and its utility. You can find many spreadsheet examples on the web. The Geology Department at Vanderbilt University has a particularly comphrehensive set of Exercise one covers relative versus absolute addresses and graphing equations.
* Exercise two introduces Excel's array functions for transposing, multiplying and inverting matrices.
* Exercise three uses the array functions for solving simultaneous equations and fitting lines to linear data.
* Exercise four demonstrates Excel's LINEST() function for least squares.
* Exercise five requires importing ASCII data, sorting, MEDIAN(), and AVERAGE.
* **Auxiliary exercises**

  * Erosion and landscape evolution

SURFER(C): USGS DEMs, Volumes, Index Maps, Gridding and Contouring

SURFER[(C)], from Golden Software, Inc., is a gridding, contouring and 3D surface plotting program well suited for many geologic applications. We will use SURFER for importing and displaying USGS digital elevation models (DEMS), calculating the volumes of topographic features, creating index maps, and contouring various spatial data. Golden Software has some great examples of figures, distributed throughout their site, created with **SURFER, GRAPHER**, and **MapViewer**.

- Exercise 1: Downloading, importing and manipulating 3-arc second USGS DEMs; calculating the volume of Lake Missoula.
- Exercise 2: Acquiring and displaying Montana's 30-meter DEMs and the USGS's 30-meter DEMs.
- Exercise 3: Acquiring DLGs and combining them with 30-meter DEMs to produce index maps.
- Exercise 4: Gridding and contouring random data: problems and pitfalls.
- Summary Exercise: SURFER and Excel, putting it all together.
- **Auxiliary information and exercises**

  - Creating SURFER grids with Excel; includes an example from landscape evolution.

GRAPHER[(C)]: 2D plotting

GRAPHER[(C)], from Golden Software, Inc., is a very flexible graphing package that gives you much more control over your graphs than does Excel. Besides allowing a larger variety of graphs, **GRAPHER** handles larger data sets, interfaces well with **SURFER** if you want to extract and plot profiles, and includes built-in smoothing and statistical functions. Given your experience with **SURFER,GRAPHER** should seem somewhat familiar.

- Exercise 1: Extracting a profile from a **SURFER** grid and plotting it with **GRAPHER**.

MATHCAD[(C)]: Calculation, Curve Fitting, Nonlinear Regression, and Fourier Analysis.

Mathcad combines the live document interface of a spreadsheet with the WYSIWYG interface of a word processor while allowing you to solve just about any math problem you can think of. You can place equations, text, and graphics anywhere in the Mathcad worksheet. This makes it easy keep track of the most complex calculations and represent your results in two or three dimensional plots.

- Exercise 1: Introduction to Mathcad, its use as a calculator and for evaluating and graphing functions.
- Exercise 2: The inverse approach, curve fitting by nonlinear regression.
- Exercise 3: More nonlinear regression and using Mathcad to analyze and visualize 3D data.
- Exercise 4: Using a difference equation to model conductive cooling of a dike; Mathcad's animation.

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