

Description of Three-Point Problem by Simultaneous Linear Equations
as an example of Quantitative Methods for upper level undergraduates

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Students are introduced to the use of linear algebra in an intuitive and accessible way, through classroom activity and homework set. The familiar three-point problem is cast in terms of three dimensional analytic geometry, fostering understanding of mathematical models for simple geometric forms. The suitability of a planar representation of geological features such as sedimentary horizons or fault surfaces is discussed in class. Preparatory to developing a useful algorithm, a system of equations is developed, put into matrix form (which most have seen before, but never applied), and solved for slopes and intercept. Finally, the slopes are resolved into geologically familiar strike and dip form.

Typically, the exercise is handed out in class and the examples are worked with the students, who are then given the assignment of repeating the examples and devising their own automated code to solve a problem set. The present development is in terms of MatLab, but can be done well with a modern spreadsheet. Four advantages to teaching this material in MatLab are 1) the students can develop a portable code that they may use later (including an exam question), 2) the methodology extends readily to overdetermined parameter estimation (see part C of exam question), serving as an intuitive introduction to least-squares fitting, 3) MatLab graphics can be introduced to display plane attitudes, and 4) MatLab is readily available in many research environments.

This geometrical introduction to linear algebra is based on an introduction to analytic geometry (see handout) and serves as basis for other linear algebra applications such as factor analysis (see second exam question). It also forms the basis for subsequent discussion of polynomial fitting and the appropriateness of functions for various geologic situations (polynomial orders, collocation, alternate functions, etc.). More advanced topics such as eigenvectors and condition numbers have been undertaken with particularly adroit classes, exploiting the sense of degree of determination for various drill patterns (three drillholes in a straight line is poor experiment design!) and the sources and significances of observational error.