Error of linear regression on demagnetizaion plots.

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Multi-component analyses of progressive demagnetization plots are now common routine in paleomagnetic studies. The direction of each component is found using linear regression. An algorism calculating the least square direction of the component formulated by Kirschvink (1980) is widely used, and known as PCA (Primary Component Analysis) method. He gave a measure of the precision as MAD (Maximum Angular Dispersion), but did not formulate the error.

The statistical model Kirschvink (1980) assumed is a set of linearly aligned points with isotropic error of a 3-dimensional normal distributon. The line that PCA gives is that of least sum of square errors. Generality is not lost using a coordinate of the X-axis aligned to the true direction. Assuming the dispersion of the error of each point is small, the mean square of the angle between fitted lines and X-axis (da^2) is derived as

$da^2 = MAD^2/(N-2)$

The 2-d normal distribution with this dispersion gives a confidence limit of significance level P as

d_P = sqrt(-ln(1-P)) $*$da (1.73 $*$da when P=95%)

This relationship is reproduced well by numerical simulation.