Abstract: Analysis of axial orientation data (undirected lines, as opposed to vectors) in $\mathbb{R}^3$ continues to be a difficult topic in statistical theory and practice.

Probability models almost invariably use the unit sphere as the domain. The curved topology leads to obstacles and intractabilities, but if we ignore it (a flat earth paradigm?) we insert systematic errors into statistical estimates.

The most basic of sample estimates (mean, variance, confidence regions) generally do not exist in simple forms and must be obtained by applying iterative numerical techniques to surface integrals and/or infinite series. There is no benchmark software.

There are some interesting connections to other branches of mathematics, such as differential equations and algebraic topology, and occasionally these provide insights and alternative methods.

The presentation will include:

1. a brief taxonomy of directional statistics,

2. probability models for axial data in $\mathbb{R}^3$,

3. methods of parametric and nonparametric estimation,

4. case studies and meta-analysis, and

5. ideas for statistical practice and further research.

Time permitting, my motivating problem from geomechanics will be shown: estimating a stress tensor from passive seismic measurement.