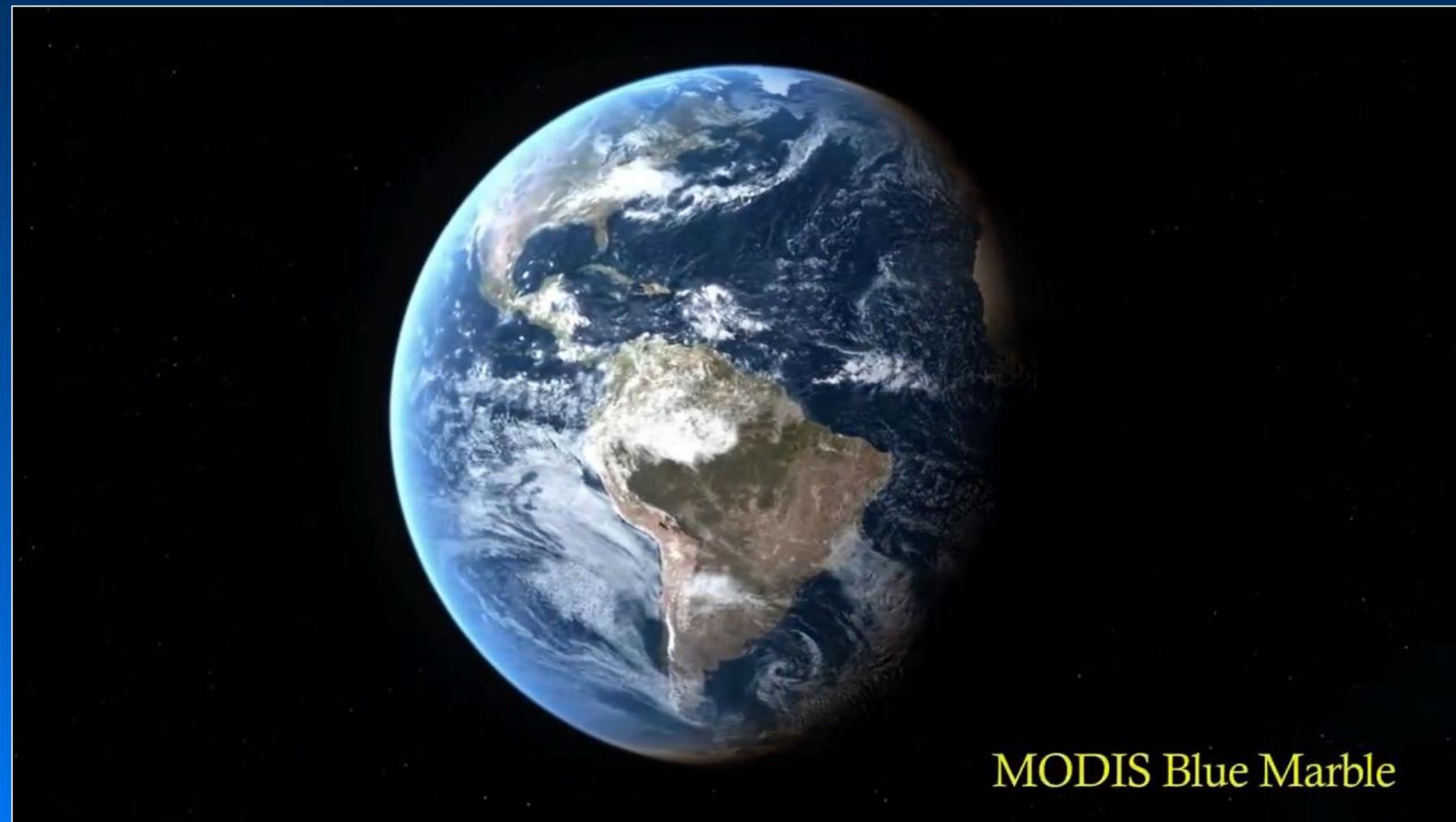NJU Course
Data Analysis & Statistics in the Earth Sciences

Prof. Norman MacLeod

School of Earth Sciences & Engineering, Nanjing University

MODIS Blue Marble

Data Analysis & Statistics in the Earth Sciences

Traditional Way Earth Scientists Learn Data Analysis & Statistics

Trial & Error (Mostly Error)

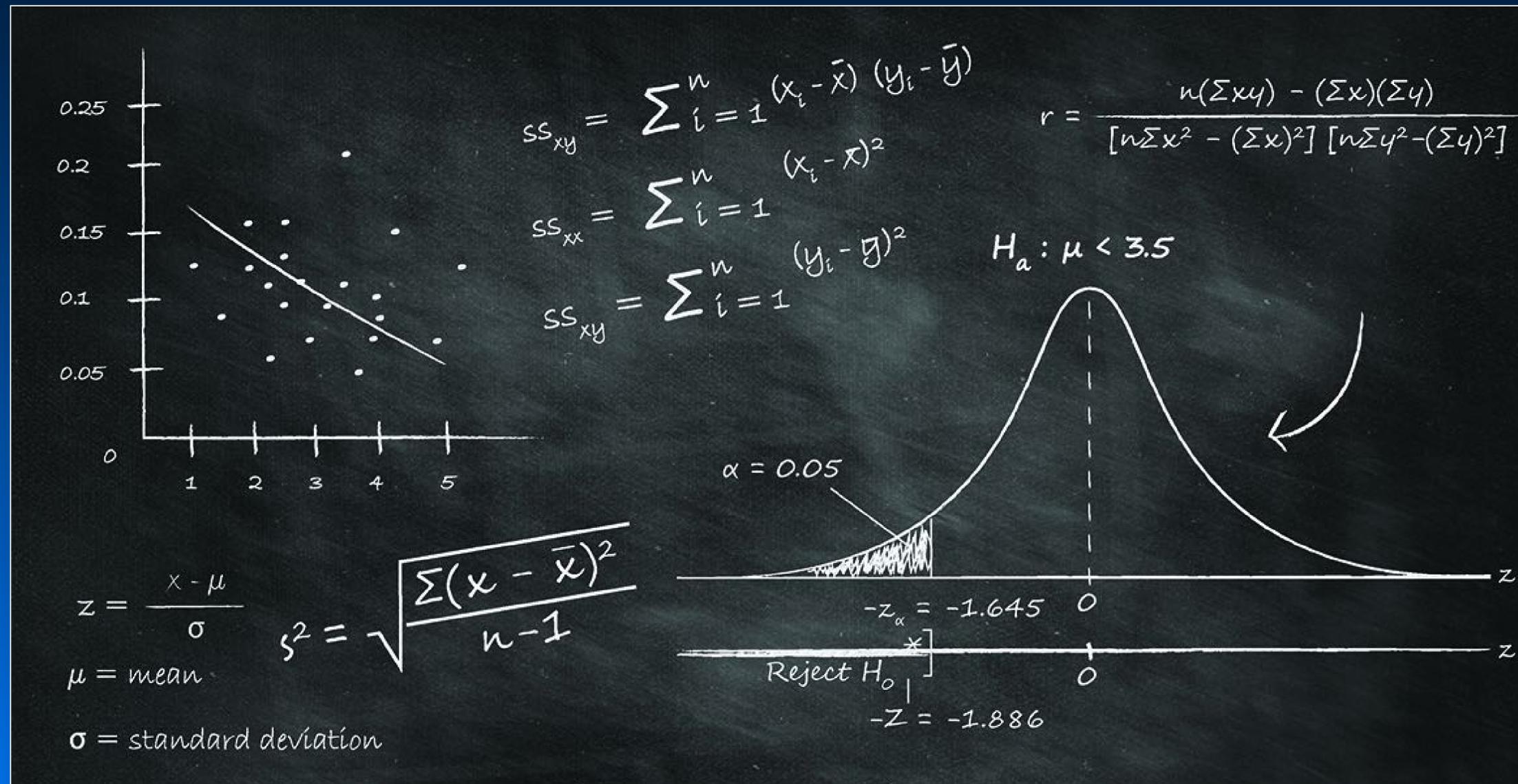# Data Analysis & Statistics in the Earth Sciences

The core problem is that Earth Science is such a large and diverse field.

Earth scientists need to analyze many different types of data, some of which are quite unusual.

Data Analysis & Statistics in the Earth Sciences

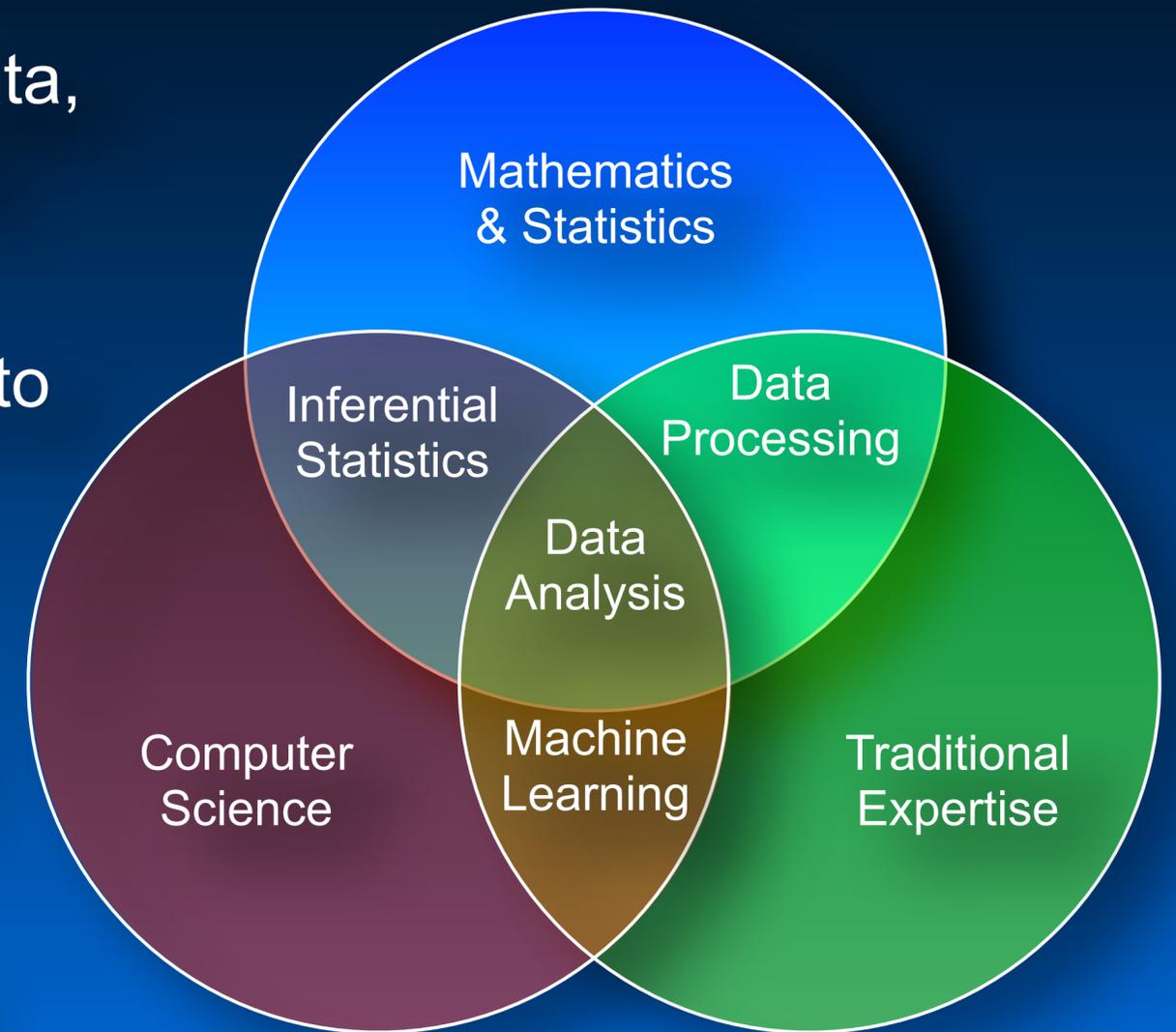University math & statistics courses tend to be oriented to business and industrial applications …

… not data analysis and/or scientific research.

Data Analysis & Statistics in the Earth Sciences

Course Objectives

- Provide a systematic introduction to the types of data, data-analysis procedures and statistical tests used routinely in earth-science research.

- Demonstrate the power of a quantitative approach to earth-science research problems.

- Allow students to gain skill and confidence in applying these methods to earth-science data using both standard and advanced data-analysis software packages.

- Encourage students to consider using these (and other) quantitative and graphical data analysis and statistical methods in their current, and future, educational & professional careers.


Mathematics & Statistics

Inferential Statistics

Data Processing

Data Analysis

Computer Science

Machine Learning

Traditional Expertise

Data Analysis & Statistics in the Earth Sciences

Course Schedule

Weeks	Date	Lecture Topics	Date	Labs
1	Mar 5	Intro + Statistical Concepts	Mar 3	
2	Mar 12	Statistical Concepts + Data Visualization	Mar 10	Basic Statistical Testing
3	Mar 19	Univariate & Bivariate Statistical Methods	Mar 17	
4	Mar 26	Multivariate Data Analysis	Mar 24	Multivariate Data Analysis
5	Apr 2	Dimensionality Reduction	Mar 31	
6	Apr 9	Morphometrics I	Apr 7	Landmark Morphometrics
7	Apr 16	Morphometrics II	Apr 14	
8	Apr 23	Mid-Term Exam	Apr 21	Outline Morphometrics
9	Apr 30	Estimating Diversity	Apr 28	
10	May 7	Analysis of Directional Data	May 5	Directional Data Analysis
11	May 14	Analysis of Spatial Data	May 12	
12	May 21	Inferring the Order of Stratigraphic Events I	May 19	Graphic Correlation
13	May 28	Inferring the Order of Stratigraphic Events II	May 26	
14	Jun 4	Time Series Analysis	Jun 2	RASC & UA Analysis
15	Jun 11	Phylogenetic Analysis I	Jun 9	
16	Jun 18	Phylogenetic Analysis II	Jun 16	Phylogenetic Analysis
Finals	TBA	Final Exam		

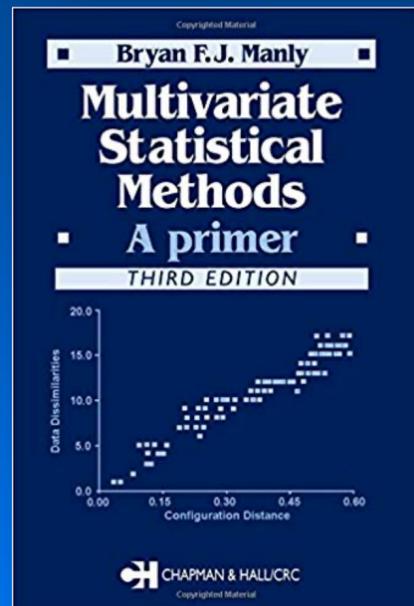# Data Analysis & Statistics in the Earth Sciences

Text References
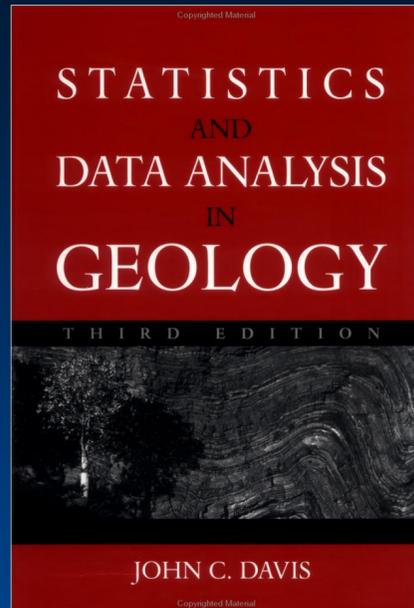
Davis John C. 2002. Statistics and data analysis in geology (3rd edition). New York: John Wiley and Sons, 638 p.
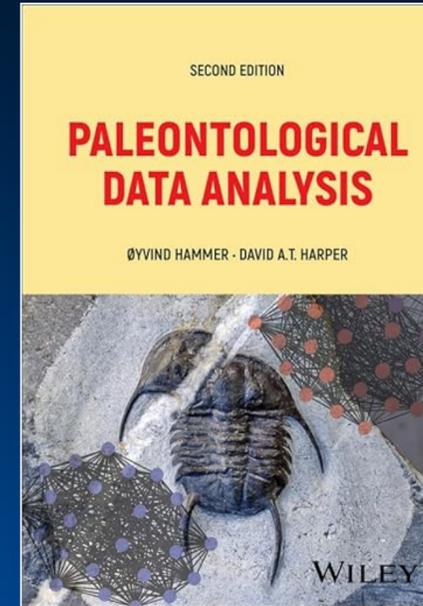
Hammer, Øyvind and Harper, David. 2024, Paleontological data analysis (2nd Edition). Oxford, UK, Blackwell Publishing, 376 p.
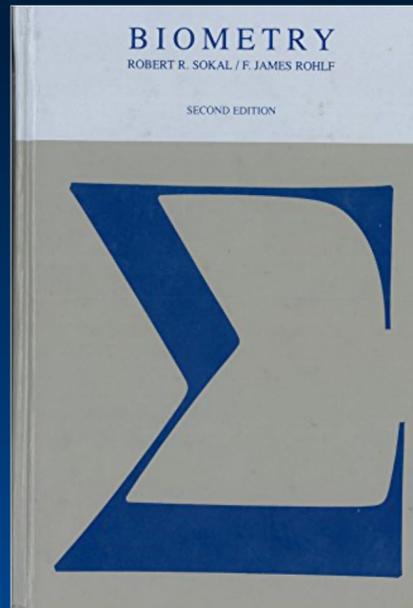
Manly, Brian F. J. 2004. Multivariate statistical methods: a primer (3rd edition). Boca Raton, Florida, Chapman Hall/ CRC, 224 p.
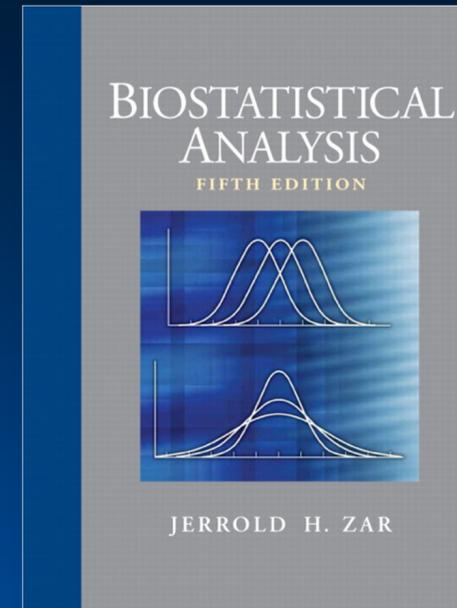
MacLeod, N. 2004 – 2013. PalaeoMaths 101, Palaeontological Association Newsletter, vols 55–83. https://paleonet.org/page-6/

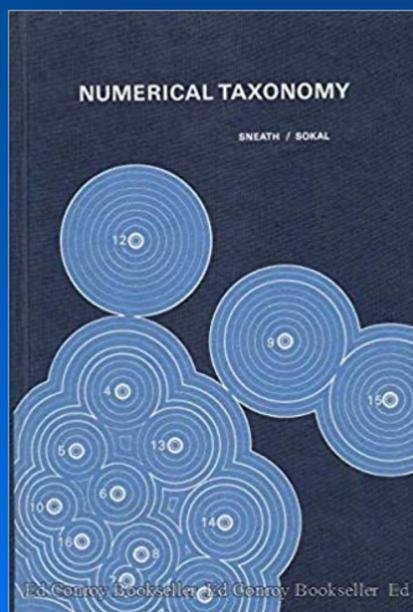# Data Analysis & Statistics in the Earth Sciences

Text References (Supplementary)

Sokal, Robert R. and Rohlf, F. James. 2012. Biometry (4th edition). New York, W. H. Freeman and Company, 937 p.

Zar, J.H., 2018, Biostatistical analysis, (5th edition). Upper Saddle River, New Jersey, Prentice Hall, 960 p.

Sneath, Peter H. A. and Sokal, Robert R. 1973. Numerical taxonomy: the principles and practice of numerical classification. San Francisco, W. H. Freeman, 573 p.
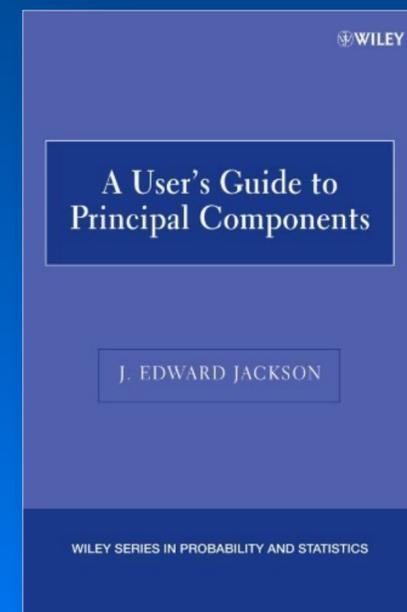
Jackson, J. Edward, 1991, A user's guide to principal components. New York, John Wiley & Sons, 592 p.

Data Analysis & Statistics in the Earth Sciences

Paleontological Statistics (*PAST*) Software

- Public domain software: https://www.nhm.uio.no/english research/infrastructure/past/ index.html

- Available for Microsoft Windows & Apple operating systems;

- Extensive range of numerical & statistical procedures;

- User's manual available (Hammer, Ø. 2024. *PAleontological STatistics Version 5.0, privately published, Olso, Norway, 314 p.*);

- In places good integration of numerical and graphical procedures.
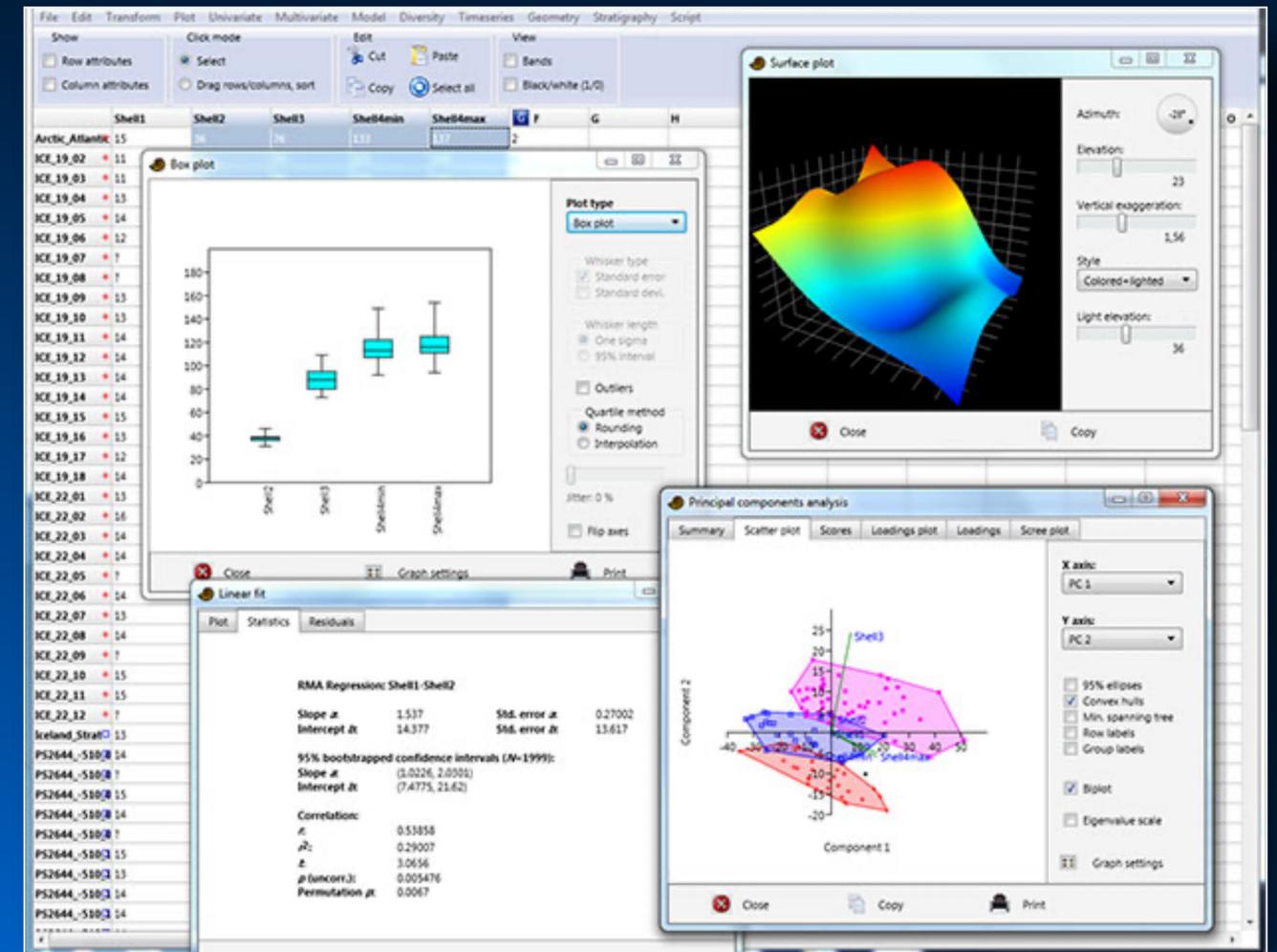
Data Analysis & Statistics in the Earth Sciences

Wolfram *Mathematica*™ Software

- Commercial mathematics software:

  - Available for Microsoft Windows & Apple operating systems;

  - Extensive range of numerical & statistical procedures;

  - Extensive array of graphics and data visualization tools;

  - World-class and customizable machine learning procedures;

  - Extensive online support built into software;

  - The most extensive library of data analysis and statistics algorithms available anywhere with extensive document-ation and a easy-to-learn & use command language.
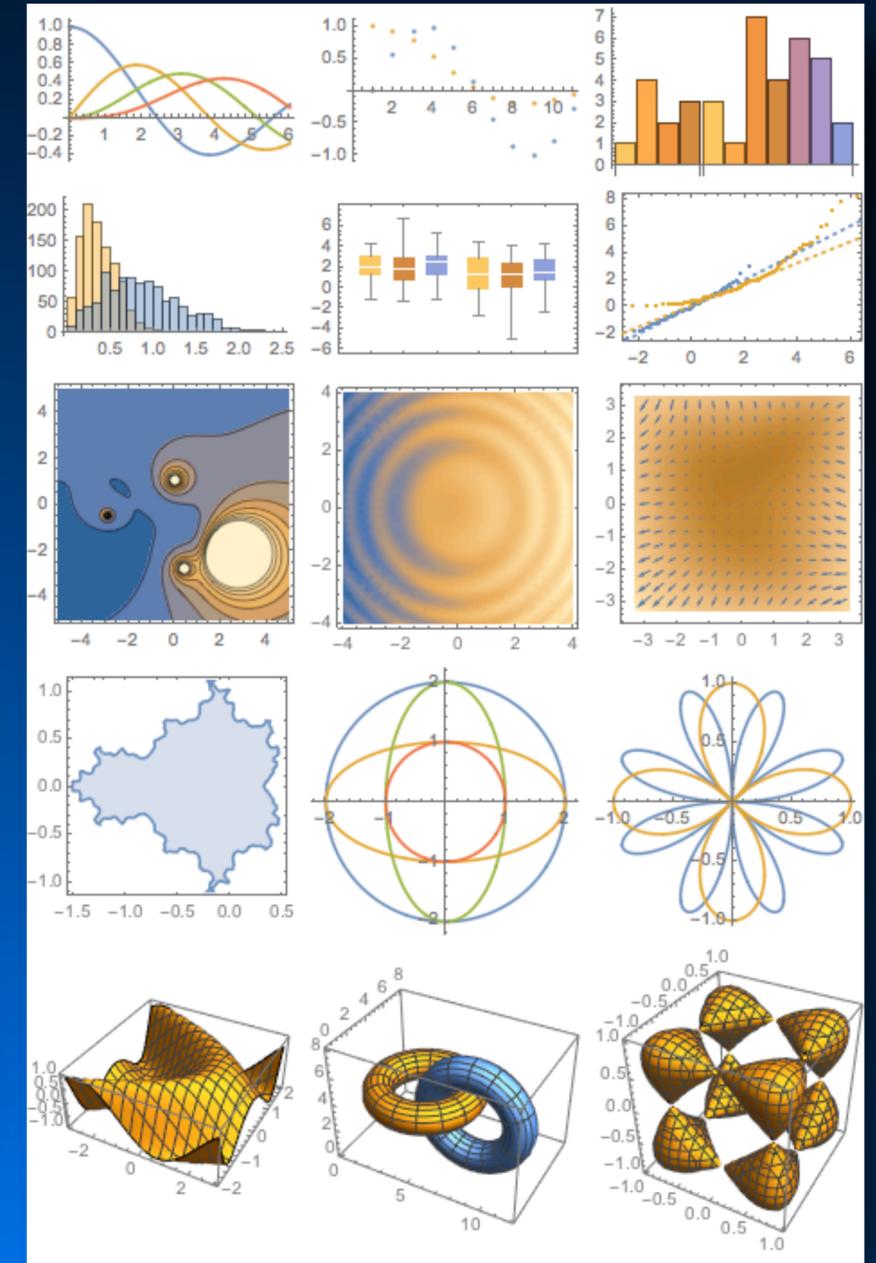
Data Analysis & Statistics in the Earth Sciences

Evaluation

- 🟠 Mid-term Examination (30%)

- 🟠 Final Examination (30%)

- 🟠 Lab Practical Reports (30%)

- 🟠 Class Attendance & Participation (10%)

Data Analysis & Statistics in the Earth Sciences

Course Schedule

- Class meetings

  - Lecture: Thursdays, 10:10 AM - 12:00 noon
  - Lab practical: Tuesdays, 10:10 AM - 12:00 noon, every other (even count) week.

- Lectures to consist of:

  - Live lectures in NJU classroom (仙 I-215)
  - Videos
  - Class discussions

- Course WeChat room at ⟶

- Prof. MacLeod's Office Hours

  - Monday's from 10:00 AM - 12:00 Noon or by appointment (also accessible via course WeChat group, e-mail, and/or office phone)

Prof. Norman MacLeod

- Office: A464, Zhu Gongshan Building

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Data Analysis & Statistics in the Earth Sciences

Course Support Personnel

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(Facilitator)

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Data Analysis & Statistics in the Earth Sciences

Course Web Site

https://paleo-bio.com/

Data Analysis & Statistics in the Earth Sciences

Course Web Site

https://paleo-bio.com/data-analysis-statistics-in-the-earth-sciences/

NJU Course

Data Analysis & Statistics in the Earth Sciences

Prof. Norman MacLeod

School of Earth Sciences & Engineering, Nanjing University