

Statistics and Numerical Methods, Tsinghua University

Introduction

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清華大學

Tsinghua University

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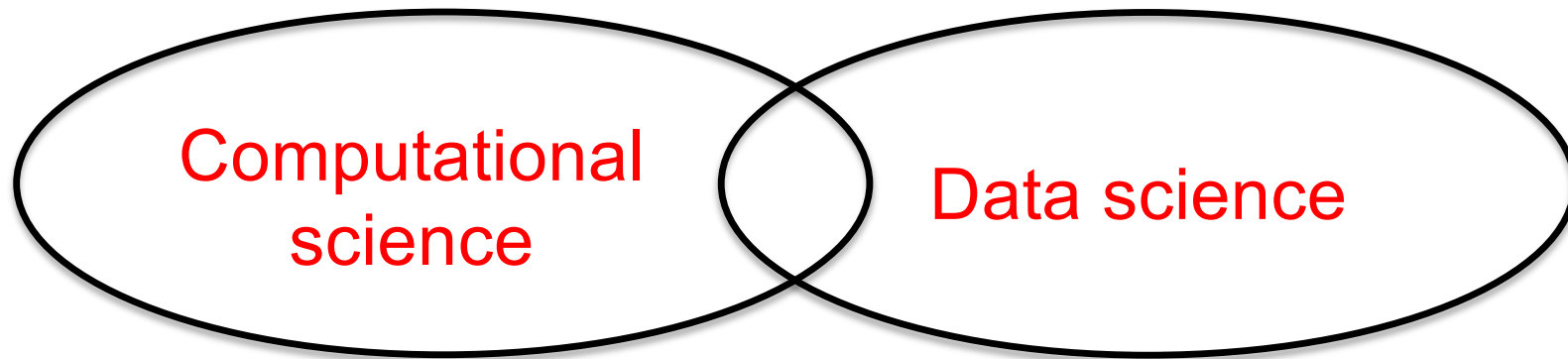
Supercomputing in China



National supercomputing centers in Tianjin, Guangzhou, Wuxi, Chengdu, Ji'nan, Changsha, Zhengzhou, Kunshan, etc.

No longer join the Top500 list. Fastest machines use domestically produced CPUs, and would have ranked the top. (Need users!)

Scope



Main components:

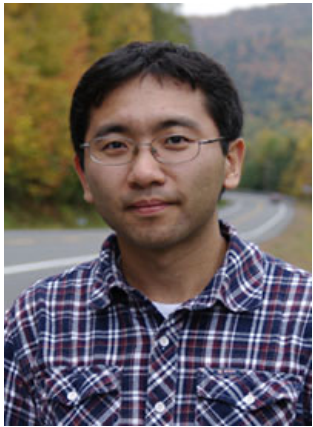
- **Algorithm**: methods for (efficiently) solving equations and/or analyzing data.
We focus on algorithms, emphasizing the basic ideas behind, but less on math details.
- **Software**: computer implementation of the algorithms.
We only briefly discuss implementation. You will implement some algorithms, as well as using matured software.

Course objectives

- This course provides an overview to statistics and computational methods primarily for astronomers/astrophysicists.
- We hope to get you familiarize with the fundamental tools and methods, mostly numerical, in preparation for your future research in astronomy.
- We place more emphasis on basic principles and ideas (with less mathematical rigor), and real-world applications (mostly drawn from astronomy).

By the end of the course, you should be able to identify appropriate algorithms and software, and potentially design your own customized algorithms, for problems of interest in your research.

Instructors



Xuening Bai (白雪宁)

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Dandan Xu (许丹丹)

Associate professor, Department of Astronomy

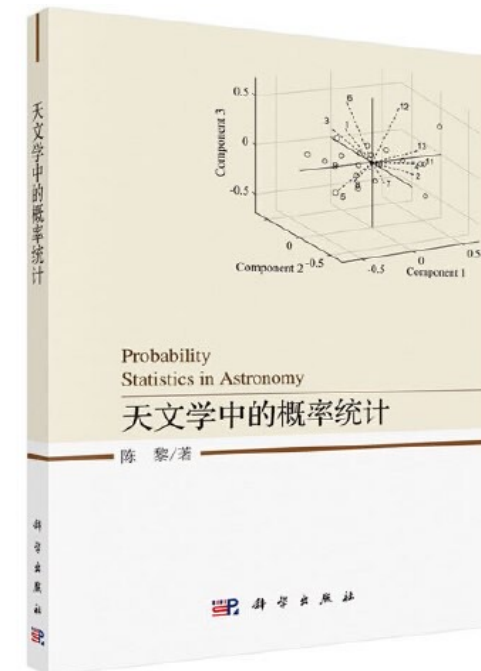
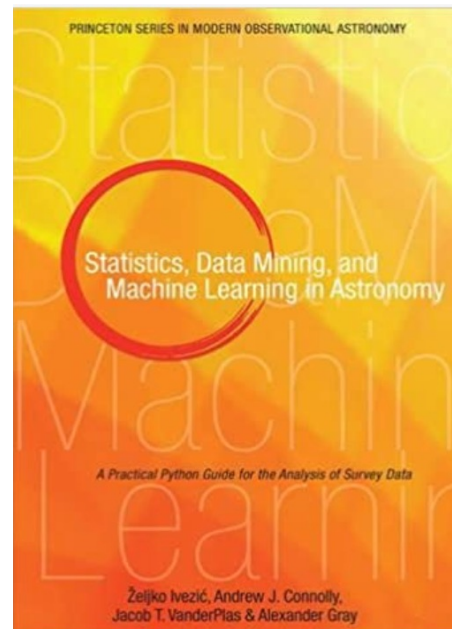
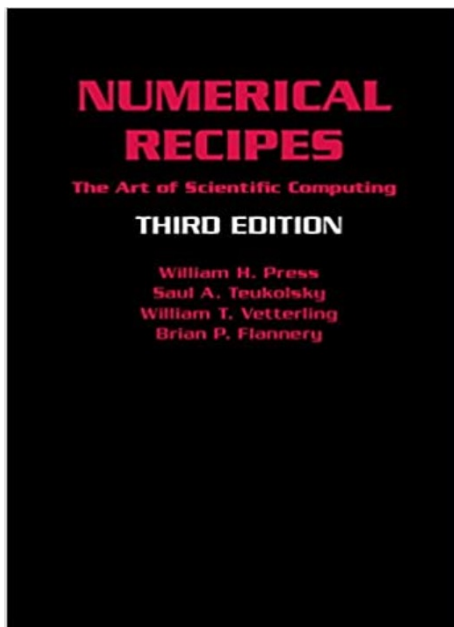
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Office hour: Tuesdays 1:30-3pm, by email appointment

Textbooks and references

The course material is developed from a variety of sources. There is **no required textbook**, but several books below are recommended for further reading, and some others will be mentioned in specific lectures.



See syllabus for more details.

Problem sets

There will be **six problem sets** assigned throughout the semester. They will be posted after the lecture, and are **due two weeks later**.

You should **submit the homework through the web learning platform**. Please pack them using **.zip format**, with the following **naming convention**:

2024310000_ZhangSan_HW2.zip

Grade with comments will be returned in 2 weeks.

A penalty of 10% lower grade per day will be incurred for late submission, except for special reasons.

*Some problems can be challenging: **don't start at the last moment!***

Discussion/consultation with your peers are permitted, but the answers submitted must be the results of your own efforts.

Grading and exams

The final grade will be broken down into contributions from [problem sets \(65%\)](#), and a [final take-home exam \(35%\)](#).

Unless otherwise noted, we plan to distribute the final exam after the final lecture, and it will be due one week later (on Dec. 31st).

Grading will be based on the accuracy of the solution, the inclusion of intermediate steps, and communication of how the solution was found. When there is substantial coding, you are also required to [attach your source code](#) (make sure they are well organized with comments).

Course schedule

| Dates | Content | Lecturer | Comments |
|--------|--|-----------|--------------|
| 9/10 | Introduction; basic scientific computing | XB | |
| 9/17 | No lecture | | |
| 9/24 | Interpolation/differentiation/integration | XB | |
| 9/29 | Numerical linear algebra I | XB | HW1 |
| 10/8 | Numerical linear algebra II, Nonlinear systems | Zhuo Chen | |
| 10/15 | Optimization methods | XB | HW1 due; HW2 |
| 10/22 | Ordinary differential equations | XB | |
| 10/29 | Partial differential equations | XB | HW2 due; HW3 |
| 11/5 | Probability and statistical distributions | XB | |
| 11/12 | Classical statistical inference | XB | HW3 due; HW4 |
| 11/19 | Bayesian statistical inference | DX | |
| 11/23* | Monte Carlo method and Stochastic processes | DX | HW4 due; HW5 |
| 12/3 | Model Regression | DX | |
| 12/10 | Fourier analysis and Application | DX | HW5 due; HW6 |
| 12/17 | Data Structure and Classification | DX | |
| 12/24 | Applications | TBD | HW6 due |

Dandan traveling;
Time/location TBD.

Course materials are dense, but you should find them very useful!