Frontiers of Computational Mathematics
Fall 2019, 3.0 credits,

Time: 周三第6,7,8节(Wednesday 13:15-15:40)
Classroom: 玉泉教11-411
Instructor: 张庆海
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Description:
This course is about cultivating essential abilities for doing research in computational mathematics. I often make an analogy that if computational mathematics were a lady, then math would be her soul, computer science would be her bone and flesh, while applications would measure her prettiness. In this class, we will focus on solving significant realworld problems via unleashing and coupling the power of math and computer science. We will also develop crucial skills in problem-solving processes and discuss useful ideas on software engineering for implementing complex algorithms.

Reference books:
Our weapons come from the following books; there will also be handouts to complement these books. You are not supposed to read all these books, as we will use at most one or two chapters from each book.

1) *A Book of Abstract Algebra* by C. C. Pinter, second edition, 1990, Dover.
2) *Introduction to Topology: Pure and Applied* by C. Adams and R. Franzosa, 2008 Pearson Education.
3) *Algebraic Topology: An Introduction* by W. S. Massey, 1990, Springer (GTM 56).
4) *Topology* by J. Munkres, second edition, 2000, Pearson.
5) *Computational Geometry: Algorithms and Applications* by M. de Berg, third edition, 2008, Springer
6) *Computational Geometry in C* by J. O'Rourke, second edition, 2000, Cambridge University Press
7) *Thinking in C++* Volume 1 & 2 by B. Eckel, (1999, 2004)
8) *Modern C++ Design* by A. Alexandrescu, 2001, Addison Wesley
9) *Quantitative Seismology* by K. Aki and P. G. Richards, 2009, University Science Books
10) *Numerical Methods of Exploration Seismology* by G. F. Margrave, M. P. Lamoureux, 2019, Cambridge University Press

Projects:
We will be working on the following problems.

I. Boolean algebra on physically meaningful regions in $\mathbb{R}^2$.
II. Boolean algebra on physically meaningful regions in $\mathbb{R}^3$.
III. Seismic inversion via real-time sampling data. (Leader: 黎颖、邵浩楠)
IV. Computer graphics for displaying and manipulating three-dimensional objects. (Leader: 杨可奥)

Project I is mandatory for all undergraduate students who take this class for credits and all first-year graduate students of mine. The math and algorithms of project I will be covered in details and you are supposed to implement the algorithms by yourself in matlab, C, or C++. No other programming languages will be accepted. For C/C++, you cannot use libraries other than the STD library and those built-in of `C++11`.
Each aforementioned student will also have to finish project II or project III or both. Project IV will be useful in both project II and project III, and hence each submission will have to utilize the fruits of project IV.
When working on these projects, you are encouraged to form a team that consists of at most three students. If you choose to form a team, the submission should be team-wise; your document must contain a clear definition of contributions of each team member, and each team member is responsible to write up her/his own work. Your score will be given both team-wise and individual-wise, according to the quality of overall submission and individual work.

Grading:
There will be no exams. If you are taking this class for credit, your final score consists of

- Project I: 30%,
- The other project: 45%,
- Presentation: 25%,

Extra credits will be given to students who choose to do project IV in addition to either II or III and those whose choose to do both project II and project III. As usual, extra credit will be given to students who find mistakes in my notes or lectures.
For exceptional quality of project answers, you will be invited to coauthor a paper with me either on project II or on project III.