Math 581d: Computer Programming for Pure Mathematicians (Syllabus)

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Class: Monday, Wednesday, Friday at 12:30PM in Sieg Hall 229.

Webpage: `http://wiki.wstein.org/edu/2010/581d`

Evaluation:

- 60% homework (assigned each Wednesday, due the following Wednesday)
- 40% final project (about 10 pages – see below for topic)
- No exams

Office Hours: Mondays 2:30–4:30 in Padelford C423 (my office). I will also frequently go to lunch at 1:30 PM nearby with students.

References: I'm not aware of any course like this or textbook specifically on this topic. However, I've listed many software packages and relevant articles on the course website. In particular, there are good books on Python, C/C++, and documentation about Sage, Cython, etc.

Course Goals:

1. Learn about a **range of software** that is useful for pure mathematics research.
2. Learn the **basic ideas (both in theory and practice) behind a selection of algorithms** that are important to computation in pure math, such as: Strassen matrix multiplication, Dixon p-adic lifting, LLL lattice basis reduction, Buchberger (and F4?) for computing Groebner basis, Karatsuba (and FFT) for multiplying stuff, polynomial factorization (univariate, multivariate, over various rings), Hermite normal form algorithms, Wiedemann's algorithm, etc.
3. Learn how computation has played a role in the **development of some area of pure mathematics**, via a project. Some ideas:

- How were computers used in the classification of finite simple groups?
- Choose a subject area in the mathematical part of `http://arxiv.org`, and look at the most recent N papers posted. How many specifically state that the authors used computer programs in some way? Which software did they use, and how?
- How did computers and computation play a role in the development over many years of Fermat's Last Theorem? The Birch and Swinnerton-Dyer Conjecture? The Riemann Hypothesis? Sphere packing results (Kepler's conjecture)? Graph coloring?