Computers in Undergraduate Education

VIGRE Undergraduate Mathematics Laboratory

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http://www.princeton.edu/∼sjmiller/math/talks/talks.html
http://www.math.princeton.edu/∼mathlab/index.html
http://www.math.nyu.edu/∼millerj/

Locations and Staff

1. **Princeton University**
   Peter Sarnak and Steven Miller $2000-2001$
   Andrew Wiles and Steven Miller $2001-2002$
   Ramin Takloo-Bighash, Steven Miller and Yakov Sinai $2002-2003$

2. **Courant Institute (NYU)**
   Peter Sarnak and Steven Miller $2002-2003$

3. **Ohio State University**
   Steven Miller 2003–

Goals of UML

1. Form a research team of undergraduates, graduate students and faculty to investigate interesting conjectures (theoretically and experimentally).

2. Show undergraduates what kinds of problems mathematicians study. In the sciences / engineering, undergraduates often see state of the art projects through experimental labs; we wanted to bring a similar experience to the math majors.

Structure of Classes

1. Run as a Junior Research Seminar.

2. Professors lecture on Special Topics (and background material as needed).

3. Students then choose a problem, and individually or in small groups learn the background theory and run simulations to test conjectures.

4. At the end of the semester, the students write up the theory, their experimental findings, and present their results to the class.

Problems $(2000 - 2001)$

1. Random Matrix Theory
2. Ramanujan Graphs
3. Hardy-Littlewood Varieties
4. Prime Spacings
5. Ranks of Elliptic Curves
6. $\{n^2\alpha\}$

Problems $(2001 - 2002)$: Elliptic Curves

1. Analytic / Geometric Ranks in Families
2. Points of Low Height in Families
3. Distribution of Signs in Families
4. First Zero above Critical Point
5. Sato-Tate
6. Cryptography

Exportability Concerns

1. Good computational resources.

2. Enthusiastic faculty / graduate students.

3. Interesting, tractable problems.

4. Background lecture series.

5. Central Database to build on previous work / avoid repetition.

Summary

I think a class like this is a welcome addition to standard curriculums. It is significantly more work than a normal class for the faculty and graduate students, but it is also a fun class to teach.

This is not just a class for undergraduates, but an opportunity to form a research group of undergrads, graduate students and faculty.