Project Year
2004

Project Team
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Project Title
Java Virtual Physics Laboratory

Audience
Students studying statistical mechanics at the undergraduate and graduate levels

Pedagogical Issue
Several abstract topics in physics are difficult both to teach and to learn. One is statistical mechanics, which deals with such large numbers of particles that it is not possible to directly calculate the effects of each particle. Instead, statistical mechanics relies on abstract statistical averaging techniques, which can be challenging for students to understand.

Solution
The team proposes to develop a series of interactive JAVA simulations that will be incorporated into the undergraduate and graduate classes on statistical mechanics. Each simulation will include a narrative explaining the concepts represented. Students will be able to control the simulations, which will help them to visualize, learn, and internalize difficult statistical mechanics concepts.

Technologies Used
JAVA

Project Abstract
Our classroom experience shows that the teaching and understanding of statistical mechanics is improved by incorporating into the curriculum interactive simulations which the student can control. The simulation can serve as an illustration to a theoretical course, filling the void of a lab curriculum. For example, an introductory lecture in last year's *Statistical Mechanics* class included a computer simulation of a magnet. The students observed a phase transition, spontaneous breaking of a symmetry, and the development of scale invariance at a critical point. This single simulation illustrated the three main concepts of the course. An informal poll, conducted at the end of the semester, showed that the students had found the demo very helpful. We plan to expand on this experience by creating a series of computer simulations that will be used in both the undergraduate and graduate classes on statistical mechanics. The simulations will be written specifically for incorporation into homework sets, and will be accompanied by write-ups explaining the simulations and containing assigned problems. In each homework set, the student will learn a theoretical concept, observe a simulated physical phenomenon,

measure relevant physical quantities, and use a theoretical model to explain the results. To ensure cross-platform capability without compromising application speed, we plan to use Java applet technology in developing our software. A student will need nothing more than a computer with a modern browser and an Internet connection to run a simulation. By solving homework problems and running a related simulation, the student will see how abstract theoretical concepts can be combined to describe a real physical phenomenon. The Tech Fellow on this project, Jeffrey Wasserman, is also the current Teaching Assistant in the undergraduate *Statistical Mechanics* class and has a good feel for areas that present difficulty to the students. At the end of the course, the students will be asked to provide feedback.

The Virtual Physics Lab resource is available to the public and is highlighted on Martindale's Online Physics Calculator site (http://www.martindalecenter.com/Calculators3A_2_S-QZ.html).

A link to the Virtual Physics Lab site is available here:
http://www.pha.jhu.edu/~javalab/