Physics 410: Computational Physics: Suggested Term Projects

Note that all term projects must be approved by the instructor. Term project outlines are due ***Oct 16*** *and the projects themselves are due* ***Nov 29*** *(last class day). Contact the instructor for more details concerning any of the topics listed below.*

Charges on a Sphere

Simulate the dynamics of n identically charged particles confined to move on the surface of the sphere. Incorporate dissipation so that the charges eventually come to rest in an equilibrium configuration. Determine and describe the equilibrium configuration(s) for interesting values of n.

The Game of Life

Write a simulation of the Game of Life, a two-dimensional cellular automaton.

Solitons

Solve a non-linear wave-equation which admits solitonic solutions using finite-difference techniques. Study the propagation of single solitons as well as the interaction of two or more solitons. Reference: *Solitons and Nonlinear Wave Equations*: Dodd, Eilbeck, Gibbon and Morris.

Schrodinger Equation

Write a program to solve the time-dependent Schrodinger equation in one-space dimension for an arbitrary potential V(x). Some hints for this project are available: (PS) or (PDF).

Chaos

Simulate and study the behaviour of one or more low-dimensional systems which exhibit chaos: examples include the Lorenz model or the billiard problem.

The Rings of Saturn

Write a program to study the dynamics of a large number of test particles in orbit about a massive body with one or more massive satellites. Study the impact of various satellite properties (mass, orbital radius, orbital eccentricity etc.) on the dynamics of the test particles.

Traffic Simulation using Cellular Automata

Use a cellular automata model to simulate multi-lane traffic flow.

Moon Landing

Design and implement a simulation of a rocket ship with a main booster and attitude control rockets. Implement an interactive interface to allow a user to attempt to land the rocket ship on the surface on a planet.

2D Ising Model

Write a Monte-Carlo algorithm to simulate the two-dimensional Ising model with external parameters T (temperature) and H (magnetic field). Use your algorithm to study the phase-space structure of the model. Investigate the nature of your results as a function of lattice size.

Dissipative Gas Simulation

Simulate the dynamics of a collection of hard spheres which dissipate some fraction of their kinetic energy when they collide. Work in two-dimensions and determine typical long-term behaviour of the system for a range of dissipation parameter.

Particle Physics Simulations

Reaction-Diffusion Equations

Toda Lattices

Neural Networks

Genetic Algorithms

Simulated Annealing

Pedagogical Java Applet

Design and implement an interactive Java applet which illustrates and/or "demos" some physical principle or set-up of your choosing.

Quantum Computation

Write an essay on the rapidly evolving field of quantum computation.