NE 155, Midterm 2 Review S21

Here are the topics we've covered and that are fair game for the exam.

The exam will be takehome (24 hours) and open book – you may use your notes, google, etc.
You may use a calculator, wolfram alpha, or python/matlab.
You **must** submit all of your work, including wolfram alpha solves (screenshot it) or python, etc.
I will not ask questions requiring coding; the project is for that.

More deterministic methods

- Matrices and properties
  - how to compute a determinant; properties of determinants
  - matrix norms
  - eigenvalues, eigenvectors, and spectral radius
- Direct solutions of linear systems ($\mathbf{A}\vec{x} = \vec{b}$)
  - diagonal, lower-tri and upper-tri systems
  - LU decomposition
  - tridiagonal systems
- Iterative solutions of linear systems
  - General form of the fixed point iterative method
  - Richardson / Source interation
  - Jacobi
  - Gauss Seidel
  - SOR
  - convergence
  - preconditioning
- Finite difference derivation; application to the 1-D, fixed source diffusion equation

- Finite volume method (1-D and 2-D)
  - Derivation
  - Application to the diffusion equation
  - Vacuum and reflecting boundary conditions
  - Simplification to homogeneous, uniform mesh
- Methods for solving the system of equations we created
  - Directly with Thomas Algorithm
  - Iteratively with Jacobi, GS, or SOR
- Eigenvalue form of the DE
  - form of the equation; applying finite difference
  - applying finite volume method, including BCs
- Solving the Eigenvalue equations
  - determining convergence of k and ϕ
  - calculating k
  - Power Iteration

MC: Math with Random Numbers

You can use random numbers to do math in two primary ways:

- sample physical distributions to reproduce physics needed to solve problems
- conduct numerical integration to solve problems

You would choose to do Monte Carlo when

- analytical integration is impossible
- deterministic methods are too slow, require approximations that don't work, you can't get the solution, etc.

MC algorithm

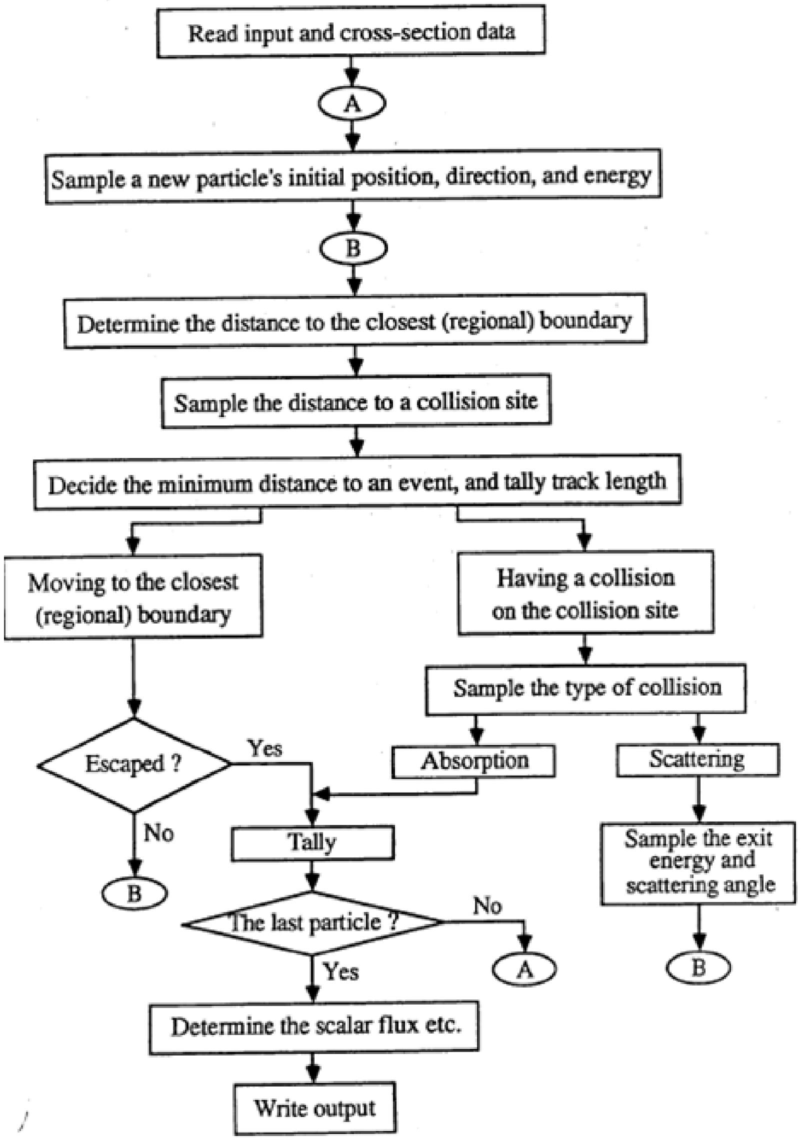

Figure 1: Monte Carlo neutral particle transport algorithm

Figure 1 shows the algorithm that is basically what happens in MC. We learned the items needed to do all of these steps.

Statistics

Monte Carlo solution statistics are based on the Central Limit Theorem, which is applicable when samples are taken from the same distribution (identical) and they are independent of one another.

In this case we can assert formulas for the sample mean, error, and variance and relate those to the true mean, error, and variance.

We have the ability to measure precision and criteria for determining how precise an answer must be for it to be acceptable.

PDFs, CDFs

We learned how to define PDFs and CDFs for continuous and discrete variables; including how to normalize them.

Sampling

We learned how to sample different kinds of CDFs. An example of direct inversion is determining the distance to the next interaction (we also did this as a function of mean free path only):

If we're in a multi-region problem, we figure out if we intersect a boundary and if so move the particle to that boundary and determine how much farther it goes into the next material before having a collision.

After finding the location of the collision and the isotope collided with, we need to determine what type of collision occurs.