NE 155
Introduction to Numerical Simulations in Radiation Transport
Lecture 33: Probability and Statics

R. N. Slaybaugh

April 13, 2015

Outline / Learning Objectives

1. Probability Density Functions
2. Standard Statistical Quantities
3. Accuracy vs. Precision
4. Central Limit Theorem
5. Relative Error

1. Understand the derivation of basic statistical quantities
2. Be able to explain the difference between accuracy and precision
3. Understand how to interpret and apply confidence intervals
4. Understand derivation and use of relative error

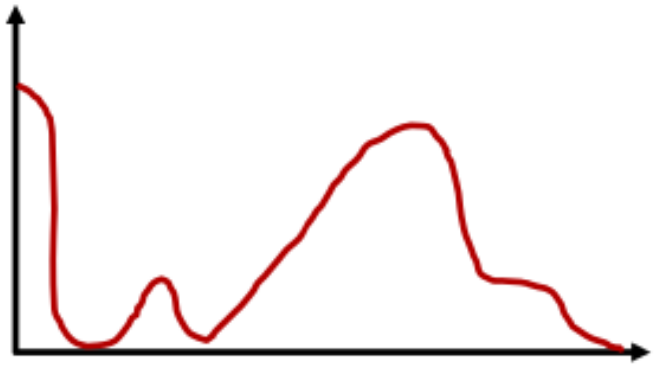
Notes derived from Jasmina Vujic and Paul Wilson

Fundamental Concept

- Many individual particle histories are simulated
- Each physical event is determined by randomly sampling a probability distribution
- Each history can contribute to the physical measurement of interest
  - x_i = contribution of history i
  - Different ways to calculate score
    - Does particle cross surface?
    - How much time does particle spend in particular region?

Fundamental Concept

- Set of individual contributions, x_i, forms a *probability distribution*



- We are interested in the mean value of that contribution, $\overline{x_i}$, and its variance, $S_{\overline{x}}^2$

Two Encounters with Probability Distributions

- Probability distributions for the outcome of each physical event
- We use **Random Sampling** techniques to evaluate these at each occurrence
- Underlying probability distribution for each physical measurement of interest
- We estimate the statistical moments of these distributions to get our physical answers

To the Board

Probability & Statistics Summary

- Rich variety of statistical analysis is possible.
- The difference between accuracy and precision is important
- Accuracy is not always known and can be difficult to improve
- Precision can be improved by more histories in a measurement, but not always more histories in a problem