Statistical physics 2009: topics

February 5, 2010

1 Understanding

- Random variable
- Expectation/Variance
- Discrete/continuous distribution
- probability/cumulative density function (CDF/PDF)
- Probability distributions
  - Uniform distribution
  - Bernoulli distribution
  - Binomial distribution
  - Poisson distribution
  - Normal distribution
- Central limit theorem
- Law of large numbers
- Petri-nets & Stochastic petri-nets
- Boltzman distribution
- Markov chains
  - absorbing state
  - ergodic chain
  - regular chain
  - Chapman-Kolmogorov
- Stochastic view on the diffusion (1d, random-walk)
- Stochastic Process

  - reaction rate approach (RRE)
  - chemical master equation (CME)
  - stochastic simulation algorithm (SSA)
  - when to use RRE/CME/SSA
- Gillespie algorithm
- Tau leaping algorithm
- Petri-nets&Stochastic Petri-nets

2 Skills

- solve simple probabilistic exercises (like on lists)
- translate a list of reactions into Petrinet (like we did in Lecture 4)
- explain the process of diffusion in the context of stochastic random walk (Lecture 9)
- create a matrix for simple Markov chain (similar as on the Lecture 10)
- calculate a probability distribution after n steps for simple Markov chain (similar as on the Lecture 10)
- make a simple probabilistic/distribution R code (in front of R, and with the help of 'help')
- explain how to create hazard functions for every reaction in Gillespie algorithm (Lecture 12)
- present Gillespie algorithm (Lecture 12)
- know how to translate the kinetic constants from RRE to stochastic constants for SSA (Lecture 14)
- describe how to analyze the results of SSA (compare it with RRE)

3 Formulas

- Binomial coefficient, Factorial
- Conditional probability
- Mean, Variance, Standard Deviation
- Probability distributions (PDF/CDF, Mean, Variance)
  - Uniform distribution

  - Bernoulli distribution
  - Binomial distribution
  - Poisson distribution
  - Normal distribution
- Boltzmann distribution in the context of physics
- Master equation
- Generating functions (expressing mean, variance)
- Chapman-Kolmogorov equation