Final Reiview

Topic 5

- Use a transition rate matrix to describe a continuous-time discrete-space Markov Chain (CTDS-MC)
    - Describe the properties of the transition rate matrix
    - Derive transition probabilities from a transition rate matrix
- Propose a justify a CTDS-MC for a biological process
    - Describe 2 different models of molecular evolution.
    - Describe a phylogenetic tree and the derivation of the tree likelihood under JC69
- Analyze a CTDS-MC and use these analyses to draw biological conclusions using:
    - Simulate a CTDS MC
    - Derive and analyze the stationary distribution of a CTDS-MC

    - Derive and analyze the Master equations of a CTDS-MC

    - Derive and analyze an Ensemble Moment Approximation of a CTDS-MC

    - Use branching processes to analyze a CTDS stochastic process

- Define **reversibility** of a CTDS-MC, assess whether a given CTDS is reversible, and give an example of a biological process that is modelled as reversible and why.

Topic 6:

- Describe what is an "object" in object oriented programming and why this programming paradigm is useful in ecology and evolution

- Describe the pros and cons of individual (agent) based simulation.

- The three main features of an IBM are: (1) agent behaviour, (2) agent-agent interactions, and (3) the environment. Explain how each of these could be modelled.

- Analysis of agent-based simulations:
  - Hypothesis design and experimental controls (Null model)
  - Plotting and statistical tests
  - Testing and validating individual based simulations
- Propose and justify an agent-based model for a biological phenomena

- Use an agent-based model to simulate a biological process
- Define a Cellular Automaton

- Propose and justify a Cellular Automaton for a biological phenomena

- Use a Cellular Automaton to simulate a biological process

Topic 7

- Define the objective functions for likelihood, and Bayesian inference. Describe the measures of confidence in each paradigm. What are the pros and cons of each paradigm?

- Describe the data, $\mathcal{D}$, and the model, Θ, for a given biological inference problem.

- Define a likelihood in terms of probability and describe why the likelihood is not a probability.

- Name the terms in Bayes' theorem and describe their role in this inference paradigm.

6. Describe the Metropolis-Hastings algorithm for simulating posteriors