MIDTERM REVIEW for CS 423/523
You will complete short answer questions (T/F, multiple choice, fill in the blank, or single phrase answers) and short problems.

These are the kinds of topics that will be covered (this is not an exhaustive list)

1. Be able to define terms such as
    1. Logistic map
    2. Effective complexity
    3. Shannon information
    4. Sensitive dependence on initial conditions
    5. Evolution by Natural Selection
    6. Natural Terms from Evolution & basic genetics: Central Dogma, Transcription & translation
2. Genetic Algorithms basic operators & terms: e.g., cross over, mutation, elitism, tournament & roulette selection
3. Cellular Automata
   a. Wolfram notation (e.g. specify rule 110) & definitions of his 4 classes
   b. Calculate the number of rules required to specify a GA with a given alphabet and neighborhood size
4. Understand why majority classification difficult for a CA and how the solution evolved by the GA in Mitchell works.
5. Understand how Langton's Lambda parameter, Wolfram's CA classification and the parameter, R, in the logistic map relate to chaotic dynamics.
6. Be able to compare and contrast two definitions of complexity.
7. Understand what Fiegenbaum's constant measures
8. Be able to write the equation for the logistic map. Give a parameter value that causes chaotic population growth. Given two different initial conditions, show that that the populations diverge after *n* time steps given one parameter value, and that they don't diverge given another parameter value.
9. Be able to answer a question such as: given an initial input of 000111000110101, what state is the CA in after 3 time steps, given transition rule 30?
10. Be able to explain how information is represented and communicated in GAs, CAs & ant colonies and how these systems balance exploration and exploitation.
11. Be able to draw a Koch curve and calculate its fractal dimension.

Example ACO question

Given the following ACO equations describing the probability ($p^k_{ij}$) that ant $k$ will transition from node $i$ to node $j$ where $j$ is in the allowed set of nodes for ant $k$

$$p^k_{i,j} = \frac{\tau^{\alpha}_{i,j}\eta^{\beta}_{i,j}}{\sum_{k \in allowed_k} \tau^{\alpha}_{i,k}\eta^{\beta}_{i,k}}$$ and $$\eta_{i,j} = \frac{1}{d_{i,j}}$$

where $d_{i,j}$ is the distance from node $i$ to node $j$

and $\tau_{i,j}$ is the pheromone on edge $i,j$ and

$\tau_{i,j}(t+1) = (1-\rho) \cdot \tau_{i,j}(t)$ where $\rho$ is the pheromone evaporation rate.

which of the following is most likely to cause premature convergence

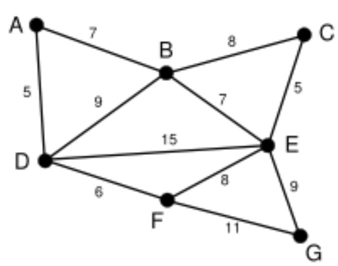
A) $\alpha = 1, \beta = 5, \rho = 0.5$

B) $\alpha = 5, \beta = 1, \rho = 0.1$

C) $\alpha = 1, \beta = 1, \rho = 0.1$

D) $\alpha = 5, \beta = 5, \rho = 0.5$

Given the graph below, and parameters $\alpha = 1, \beta = 2$ and an ant agent at node A that has not visited any other nodes




The weights show the distance between nodes. The pheromone value on the edge between A and B is 0.5 and from A to D is 0.4.

To which node is the ant most likely to go next? ____________

Is there any chance that the ant will go to any other node instead? __________

Example CA question

Fill in the rule table for Wolframs Cellular Automata Rule 30.

| Current STATE | Center Cell transition |
|---|---|
| 000 | |
| 001 | |
| 010 | |
| 011 | |
| 100 | |
| 101 | |
| 110 | |
| 111 | |

Hint: Remember that the transition state for 000 is the least significant bit (0 or 1) and the transition state for 111 is the most significant bit (0 or 128).

Given Wolfram's Rule 30, and a 1 D CA with initial condition 0 0 0 1 1 (implemented as a torus) show the state of the CA for the next 3 time steps:

| | | | | |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 |
| | | | | |
| | | | | |
| | | | | |

Example questions on readings (also see 2012 Midterm)

Answer TRUE or FALSE for the following statements:

Gell-Mann defines Effective Complexity as equivalent to Shannon Entropy.

Marshall et al (2009) in *On optimal decision-making in brains and social insects* argue that the decision making powers of ant colonies are identical to the decision making powers of human brains.

In Mitchell 1991, a bit string after 90 generations of evolution is more likely to have lambda = ½ than a bit string after 2 generations of evolution.

Brook's approach to robotics (called the subsumption architecture) differed from traditional AI because it reduced the number of sequential steps between sensing and action.

Triani et al, (Evolving Aggregation Behaviors in a Swarm of Robots, 2003), describes using GAs to evolve aggregations of s-bots. Static aggregations have higher fitness values, but only form small aggregations (approximately 5), while dynamic aggregations that move in space can form in larger numbers of s-bots.