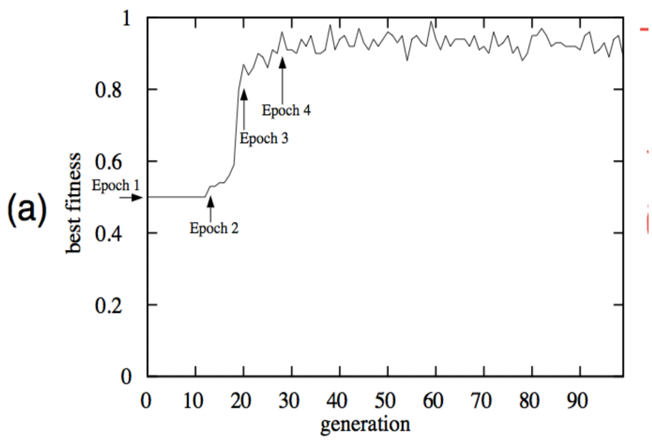
MIDTERM REVIEW for CS 423/523
Sprint 2018

You will complete short problems and short answer questions (T/F, multiple choice, fill in the blank, or answers that require one or a few phrases).

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 entropy
    4. Sensitive dependence on initial conditions
    5. Evolution by Natural Selection
    6. Terms from Evolution & basic genetics: Central Dogma, Transcription & translation
    7. Transfer Entropy
    8. Kolmogorov complexity
    9. Mutational robustness
    10. Phenotype
    11. Genotype
    12. Antigenic map
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.



Refer to the figure above from Mitchell (1991).

a. The best strategy from Epoch 1 is likely to have approximately what lambda value (what fraction of 0's)?

b. In which epoch is the most fit rule likely to have a very short transient period when it successfully classifies an IC of the CA?

The uniform distribution of the % of 1s in the initial configuration (IC) of the CA slows the GA

a. in early generations because it makes cross-over ineffective at getting to Epoch 2
b. in late generations because many evaluations are wasted on easy initial conditions
c. in all generations
d. in no generations

9b. Why do fitness values sometimes decrease during Epoch 4?

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

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.

In the Usher McClelland model of decision making in the primate brain, an optimal tradeoff between ________________ and _______________ occurs when the _______________ equals the _______________.

The Central Dogma states that DNA is transcribed into RNA which is translated into proteins which are largely responsible for an organism's phenotype. T or F?

T or F? Andreas Wagner argues that in mutationally robust systems, mutations often do not result in new phenotypes, and therefore, mutational robustness reduces genetic variation.

Example Short answer questions

1. Suppose two individuals with very different genotypes (i.e. a high hamming distance between them), have similar phenotype and high fitness. How does mutational robustness make it possible for both individuals to exist in the same population? Answer in 2 – 3 sentences. (10 points)

2. Mitchell lists 4 ways that information is communicated and processed in complex adaptive systems. List three of them and explain what they mean in 1 – 2 sentences each.

Understand the main points of each paper we've read

1. Walker, S. Evolutionary Transitions and Top-Down Causation, 2012
2. Does evolutionary theory need a rethink?, 2014
3. Gell-Mann, M. What is Complexity?,
4. Kolmogorov Complexity – A Primer, 2012
5. Forrest, S. Genetic Algorithms: Principles of Natural Selection Applied to Computation, 1993
6. Software Mutual Robustness
7. The role of robustness in phenotypic adaptation and innovation,
8. Mitchell, M. Evolving Cellular Automata to Perform Computations: Mechanisms and Impediments, 1994
9. Peled, B. Computing by nowhere increasing complexity, 2017
10. Marshall, J. On Optimal Decision-Making in Brains and Social Insect Colonies, 2009
11. Hecker, J. Beyond pheromones: evolving error-tolerant, flexible, and scalable ant-inspired robot swarms, 2015
12. Smith, D. Mapping the Antigenic and Genetic Evolution of Influenza Virus, 2004