

Student Name: _____ Student ID # _____

UOSA Statement of Academic Integrity

On my honor I affirm that I have neither given nor received inappropriate aid in the completion of this exercise.

Signature: _____ Date: _____

Notes Regarding this Examination

Open Book(s) You may consult any printed textbooks in your immediate possession during the course of this examination.

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No Electronic Devices Permitted You may not use any electronic devices during the course of this examination, including but not limited to calculators, computers, and cellular phones. All electronic devices in the student's possession must be turned off and placed out of sight (for example, in the student's own pocket or backpack) for the duration of the examination.

Violations Copying another's work, or possession of electronic computing or communication devices in the testing area, is cheating and grounds for penalties in accordance with school policies.

Question 1: Fundamentals of Artificial Neural Networks (10 points)

A. What is the function of the bias θ in a feedforward neural network with a single hidden layer used for classification problems?

B. What advantage is there to using augmented vectors rather than bias values in such a network?

Question 2: Fundamentals of Evolutionary Computation (10 points)

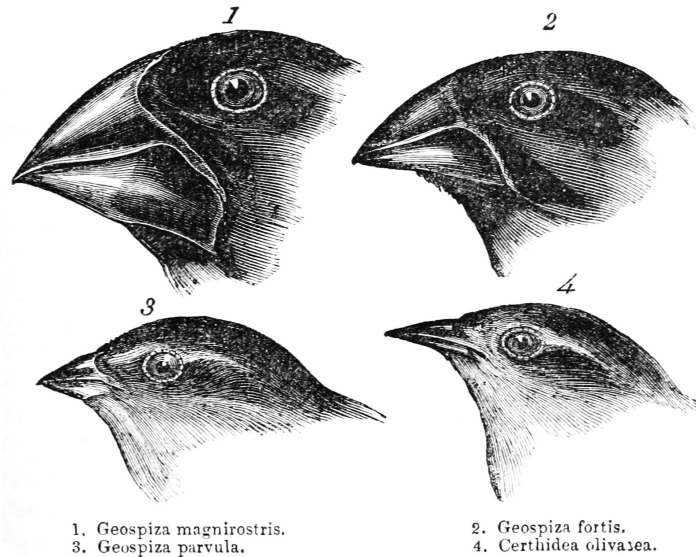
Describe two methods for doing selection where the likelihood of an individual being selected is proportional to that individual's fitness.

A. Method one.

B. Method two.

Question 3: Problem Solving with Artificial Neural Networks (30 points)

Prof. S. wants to use an artificial neural network (ANN) to automatically determine the species of Galápagos finches (birds of the subfamily Geospizinae) in images using the following measurements: Beak length, beak height, eye diameter, head length, and body length. Given the location where the pictures were taken, the possible species are: 1. Large Ground Finch *Geospiza magnirostris*, 2. Medium Ground Finch *Geospiza fortis*, 3. Small Tree Finch *Camarhynchus* (formerly *Geospiza*) *parvulus*, and 4. Green Warbler-Finch *Certhidea olivacea*. He has a database of a few hundred labeled images of individuals of these species on which to train his ANN.



Provide your input on the following design aspects for this ANN. That is, give choices for these design aspects and **justify** your choices.

A. How many input units should the ANN have?

B. How many output units should the ANN have?

C. Should the ANN use hidden units or not?

D. Should the ANN use feedforward connections, recurrent connections, both, or neither?

E. What activation function(s) should the neurons use?

F. What learning mechanism(s) should the ANN use?

Question 4: Problem Solving with Evolutionary Computation (30 points)

Prof. T. wants to use a genetic algorithm (GA) on a problem with a fitness landscape that she knows to have many local optima, numerous plateaus, and a global optimum that is only slightly better than several of the local optima. Each fitness evaluation is expensive but gives an accurate measure of fitness for the evaluated individual.

Provide your input on the following design aspects of a GA system for this problem. That is, give choices for these design aspects and **justify** your choices.

A. Should the population size be large or small?

B. Which would be a preferable selection method, roulette-wheel selection or tournament selection?

C. Should the crossover rate be low or high?

D. Should the mutation rate be low or high?

E. Should the selection pressure be low or high?

F. Should elitism be used?

Question 5: Evolutionary Artificial Neural Networks (20 points)

Consider the “competing convention” problem in evolutionary artificial neural networks (EANNs).

A. Is this problem likely to occur in EANNs in which weights are evolved but topologies are not? (Assume that topologies are determined by the EANN user before the weights are evolved.) **Explain** your answer.

B. Is this problem likely to occur in EANNs in which topologies are evolved but weights are not? (Assume that weights are learned via backpropagation of error after the topologies are evolved.) **Explain** your answer.

C. Is this problem likely to occur in EANNs in which topologies and weights are evolved at the same time by evolving neuron populations and combining neurons using “blueprints” that are also evolved as with *symbiotic, adaptive neuro-evolution* (SANE)?

D. Is this problem likely to occur in EANNs in which topologies and weights are evolved at the same time by evolving multiple distinct neuron subpopulations and forming networks by selecting one neuron from each subpopulation as with *enforced subpopulations* (ESP)?