Student Name: _____ Student ID # _____

OU Academic Integrity Pledge

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.

Open Notes You may consult any printed notes in your immediate possession during the course of this examination.

Electronic Device Use You may use computers or other electronic devices during the course of this examination solely for the purpose of reading existing documents, such as PDFs of papers covered during the course. Electronic devices may not be used for any other purpose, including but not limited to sending and receiving messages to and from others; retrieving information from search engines, databases, intelligent agents, or similar electronic help systems; or composing new documents.

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)

Consider a standard, feed-forward artificial neural network (FFANN) with several input nodes, a hidden layer of computational elements, and an output layer of computational elements. This FFANN is to be used for classification problems.

A. *Explain* the key advantage of having the hidden layer of computational elements (as opposed to having the input nodes connect directly to the output layer of computational elements).

B. *Explain* the key advantage of having multiple computational elements in the hidden layer (as opposed to having just one computational element in the hidden layer).

C. *Explain* the key advantage of having multiple output elements (as opposed to having a single output element).

Question 2: Fundamentals of Evolutionary Computation (10 points)

A. *Explain* the role of tournament size in evolutionary computation systems that use tournament selection.

B. *Explain* the role of mutation rate in evolutionary computation systems that use mutation.

C. *Explain* how tournament size and mutation rate interact with each other in evolutionary computation systems that use both.

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

Kaz wants to estimate the ship traffic near a port. He suspects that the usage varies hourly, daily, monthly, and seasonally, as well as increases when the economy picks up (as measured by orders for durable goods) and decreases when bad weather approaches. He has historical time-series data for ship traffic and weather near that port for the past several years as well as economic data by country for that same period of time. The ship traffic and weather data are sampled each hour during this period of time but the economic data is sampled only each month. Kaz decides to use an artificial neural network (ANN) to calculate his estimates for him.

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 feed-forward 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)

Tiffany wants to use evolutionary computation (EC) to assign cargo to ships for transportation. She has one database that contains records of all of the cargo to be shipped, including the size, weight, origin port, destination port, origin date, and required unload date for each cargo item. She has another database that contains records of all the ships available, including their capacity in terms of both size and weight and the amount of fuel each uses as a function of its laden weight. This database also indicates which ships sail which routes on which days and the base cost to operate each ship. Finally, she has a database that tells her fuel costs. Naturally, the total cargo assigned to a ship cannot exceed either its size or weight capacity. Tiffany's primary goal is to ensure that all of the cargo gets from its origin to its destination, leaving and arriving on the correct days. Her secondary goal is to minimize the total cost to ship all of this cargo.

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

A. How should the chromosome be encoded?

B. What should the fitness function be?

C. Should crossover be used? If so, how should it be implemented?

D. Should mutation be used? If so, how should it be implemented?

Question 5: Evolutionary Artificial Neural Networks (20 points)

Consider the task of evolving the parameters of a weight adjustment rule for an artificial neural network (ANN) that should carry out supervised learning.

A. **Explain** whether you would expect the ANN weight adjustment rule evolved to be more or less likely to be a general purpose learning rule if it were evolved while evaluating its fitness on a small set of tasks (rather than on a large set of tasks).

B. **Explain** whether you would expect the ANN weight adjustment rule evolved to be more or less likely to be a general purpose learning rule if the initial weights of the ANN were also evolved (rather than only evolving the parameters of the weight adjustment rule).

C. **Explain** whether your answer would differ for Part A if the ANN should carry out reinforcement learning rather than supervised learning.

D. **Explain** whether your answer would differ for Part B if the ANN should carry out reinforcement learning rather than supervised learning.