HERIOT WATT UNIVERSITY

SCHOOL OF MATHEMATICAL AND COMPUTER SCIENCES

Computer Science

F21BC

BIOLOGICALLY INSPIRED COMPUTATION

Semester 1 2018/19

December 2018

Duration: Two Hours

ANSWER THREE QUESTIONS

Q1

This question is concerned with activation functions, which are crucial hyperparameters of artificial neural networks.

(a) What is the main role of including these elements in the network? (4)

(b) Give **four** examples of activation functions. (2)

(c) From the four examples of activation functions you gave in part (b), can you mention which ones are used in classification and regression? (2)

(d) Can you explain two different issues that you might face when using some of the activation functions you gave in part (b)? (8)

(e) Define what is meant by a "sparse neural network" and explain whether or not it is beneficial to use sparse activation functions. (4)

Q2

One of the most recent uses of deep learning techniques is in processing video streams to work in problems like human motion or human-object interaction.

(a) Can you explain why a single convolutional neural network cannot deal with this kind of problem? (3)

(b) Can you propose two different deep neural network models seen in class to deal with this kind of data and briefly explain what are the main elements of these architectures? (8)

(c) What is the common element that make their use suitable for this particular problem? (3)

(d) Draw a schematic representation of one of the topologies/models you proposed in your answer to part (b). In the drawing, you only need to represent the general idea of the architecture, highlighting the most important elements and how they are connected. (6)

Q3

(a) Using pseudocode, describe the general structure and features of an evolutionary algorithm. (5)

(b) What are the advantages and disadvantages of using an evolutionary algorithm to train a neural network, rather than using a more conventional method such as back-propagation? (3)

(c) Describe the role of representation within genetic programming. Your answer should mention evolvability and expressiveness. (3)

(d) What are the main differences between particle swarm optimisation (PSO) and a genetic algorithm? (2)

(e) Describe the meaning of the following terms with respect to particle velocity updates in PSO: inertia, cognitive component, social component, informants. (4)

(f) In principle, genetic programming can be done with any kind of optimiser. Do you think that PSO would be a good choice of optimiser for this? If so, then why? If not, then why not? (3)

Q4

(a) In what ways does a multiobjective evolutionary algorithm (MOEA) differ from a standard evolutionary algorithm? (2)

(b) Describe the meaning of dominance, non-dominated solutions, and Pareto optimal fronts in the context of MOEAs. (3)

(c) Describe the Non-Dominated Sorting Genetic Algorithm II (NSGA-II). Your description should broadly explain how the algorithm works, and highlight the role of ranks and sparsity values. You may use text and/or pseudocode in your answer. (6)

(d) Genetic programming (GP) is the use of evolutionary algorithms to optimise computer programs. Briefly outline the differences between these four types of genetic programming in terms of how they represent programs: Koza GP, Cartesian GP, linear GP, grammatical evolution. (4)

(e) Evolutionary algorithms can be used to evolve cellular automata (CA) rules, and this can be considered to be another kind of GP. Why would it be useful to do this rather than design the CA rules by hand? (2)

(f) It is also possible to use an MOEA to implement genetic programming. Why might this be a useful thing to do? (3)

END OF PAPER