PAPER CODE NO.	EXAMINER : **DR RC Paton**	
COMP305	DEPARTMENT : Computer Science	Tel. No. **3781**

SUMMER 2000 EXAMINATIONS

Bachelor of Arts : Year 3
Bachelor of Engineering : Year 3
Bachelor of Science : Year 3
Bachelor of Science : Year 4

NEURAL AND EVOLUTIONARY COMPUTING

TIME ALLOWED : TWO hours and a Half

INSTRUCTIONS TO CANDIDATES

Credit will be given to the best answers to *FOUR* questions

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).

1(a) Using **two** examples in each case distinguish clearly between biologically motivated computing and computational biology. Suggest why a considerable overlap between these two fields of research is developing.

[5 marks]

1(b) The 1940s and 1950s saw a lot of the intellectual groundwork laid for the contemporary developments in biologically motivated computation. Discuss what you think were major developments during this time and say how they have influenced contemporary work.

[12 marks]

1(c) Explain in what ways Cellular Automata exhibit "life-like" behaviours and why certain researchers have developed the idea of "artificial life". [Note: reference should be made to the workings of a number of CA architectures].

[8 marks]

2(a) Sketch the shape of the curve that satisfies Equation 1 and discuss its nature and occurrence in a selection of natural examples.

$$A = 1/1+e^{-N}$$ Equation 1

[5 marks]

2(b) Give an ANN training algorithm that uses Equation 1 and explain very clearly and precisely why this equation must be differentiable for the algorithm in which it is used to work. Credit will be given for showing a thorough appreciation of the nature and workings of the algorithm.

[10 marks]

2(c) Explain why the initial weights in the ANN that uses Equation 1 should be small, randomly assigned real values.

[5 marks]

2(d) Explain why Hebbian learning is an example of associationism and account for the Hebbian learning process in the ANN training algorithm.

[5 marks]

3(a) Account for the significance of the "interpretation problem" when dealing with biological and artificial systems.

[6 marks]

3(b) Consider the following statement:

*"The differences between the functional organisation of biological neurones and the neurons found in Artificial Neural Networks are **much** greater than their similarities".*

Discuss this statement in the light of your understanding of these two types of 'device'. Credit will be given for reference to specific issues. Illustrate your answer with appropriate figures and examples and reference to particular research sources.

[13 marks]

3(c) Explain in what ways the theory of Gerald Edelman regarding Neuronal Groups does **NOT** rely on reinforcement. Illustrate your answer with appropriate references to biological and artificial systems.

[6 marks]

4(a) With reference to the general structure of a Genetic Algorithm explain what effect
(i) increasing the mutation rate
(ii) increasing crossover
could have on the likelihood that the G.A. would converge to a "good" solution.

[6 marks]

4(b) Explain what a schema is and how an understanding of schemata can help us appreciate the changes in the frequency of bit substrings within an evolving population. Illustrate your answer with an appropriate example.

[7 marks]

4(c) Discuss some of the ways biological thinking has been used to enhance the performance of standard genetic algorithms as originally developed by Holland. [Hint: your answer could reference issues related to molecular genetics, population studies and selection methods].

[12 marks]

5(a) What are the differences between Hopfield and Kohonen Networks in relation to adaptation and organisation.

[8 marks]

5(b) Neural and evolutionary computational systems can be characterised by a number of key ideas including:

(i) Emergent computation
(ii) Dynamical system

Describe how each of these ideas is displayed in a neural network and genetic algorithm.

[10 marks]

5(c) Distinguish clearly between the general doctrines of *instructivism* and *selectionism* and describe how each has been used to underpin theories of adaptation. Note: your answer should reference appropriate examples from adaptive A.I.

[7 marks]