ES97K-15 Computational Intelligence in Biomedical Engineering

23/24

Department
School of Engineering
Level
Taught Postgraduate Level
Module leader
Christopher James
Credit value
15
Module duration
10 weeks
Assessment
100% coursework
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES97K-15 Computational Intelligence in Biomedical Engineering

Module web page

Module aims

To further enhance the students' skills in biomedical signal and data processing with the principles of computational intelligence as applied to biomedical engineering including cardiology, neurology, biomechanics and movement sciences.

The module will provide the student with a firm grounding in methods and tools for extracting information from biomedical signals and data.

The module will introduce the practical implementation of computational intelligence techniques applied to digitally acquired biomedical signals.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Introduction
  - o Fundamentals
  - o Basic Signal Processing Techniques
  - o The need for Computational Intelligence (CI) in BME
- Artificial Neural Networks (ANNs)
  - o Basics
  - o Architectures
  - o Optimization and Learning
  - o Popular ANN architectures and learning algorithms
- Support Vector Machines (SVM)
  - o Classifiers and Classification
  - o Support Vector Classifiers
  - o Support Vector Regression
  - o Training SVMs
- Hidden Markov Models (HMMs)
  - o The Markov Chain
  - o The Hidden State
  - o Types of HMMs
- Fuzzy Sets and Fuzzy Logic
  - o Fuzzy Sets
  - o Fuzzy Membership Functions
  - o Fuzzy Operations
  - o Applications of Fuzzy Systems
- Applications of CI to BME case studies:
  - o Cardiology – ECG feature extraction, disease diagnosis
  - o Neurophysiology – disease detection and diagnosis, EMG & neuromuscular disease
  - o Biomechanics and Gait Analysis – recognition of pathological/ageing and falls-risk, aligned to gait

Learning outcomes

By the end of the module, students should be able to:

- demonstrate a systematic knowledge of the complex physical and physiological principles that underpin the measurement of biomedical signals/ data.
- demonstrate an advanced understanding of the principles of computational intelligence.
- systematically apply computational intelligence techniques to extract relevant information from biomedical signal measurements/ data.
- critically assess the appropriateness of different computational intelligence techniques for various problems in the field.
- participate in a multidisciplinary working group for the systematic design and development of an innovative solution to a practical problem.
- evaluate the effectiveness of techniques applied to biomedical signals/ data against specific benchmarks.

Indicative reading list

1. R. Begg, D.T.H. Lai and M. Palaniswami, Computational Intelligence in Biomedical Engineering, CRC Press, 2008,ISBN-13: 978-0-8493-4080-2
2. A V Oppenheim & R W Schafer, Discrete-time Digital Signal Processing, 2009, ISBN-13: 978-0131988422 ISBN-10: 0131988425 Edition: 3rd, Prentice-Hall: Englewood Cliffs, NJ
3. M. Hagan, H.B. Demuth and M. Beale, Neural Network Design, PWS Publishing Company, ISBN-13: 0-534-94332-2
4. Selected articles from scientific journals, including:
   a. IEEE Transactions of Biomedical Engineering, ISSN: 0018-9294
   b. Medical Biological Engineering and Computing, ISSN: 1741-0444 (electronic version)

Subject specific skills

TBC

Transferable skills

TBC

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (13%)
Practical classes	4 sessions of 2 hours (5%)
Other activity	2 hours (1%)
Private study	120 hours (80%)
Total	150 hours

Private study description

Guided Independent Learning 120 hours

Other activity description

2x1 hour example/revision classes

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group A1

	Weighting	Study time
Coursework Assignment Assignment 2000 words (maximum)	50%	
Review of computational intelligence research paper Max 2000 words	50%	

Feedback on assessment

Coursework marked with detailed comments
Face-to-face feedback in practicals
Cohort level feedback on examinations

Availability

Courses

This module is Core for:

- TESA-H1CA Postgraduate Taught Diagnostics, Data and Digital Health
  - Year 1 of H1CA Diagnostics, Data and Digital Health
  - Year 1 of H1CB Diagnostics, Data and Digital Health (Medical Diagnostics)
  - Year 1 of H1CC Diagnostics, Data and Digital Health (Medical Imaging)

This module is Optional for:

- Year 4 of UESA-H116 MEng Engineering with Exchange Year
- Year 5 of UESA-H115 MEng Engineering with Intercalated Year
- Year 1 of TESA-H800 Postgraduate Taught Biomedical Engineering

This module is Option list A for:

- Year 4 of UESA-H163 MEng Biomedical Systems Engineering
- Year 4 of UESA-H114 MEng Engineering

This module is Option list B for:

- Year 4 of UESA-H163 MEng Biomedical Systems Engineering

- Year 4 of UESA-HH31 MEng Systems Engineering
- Year 4 of UESA-HH33 MEng Systems Engineering with Exchange Year
- Year 5 of UESA-HH32 MEng Systems Engineering with Intercalated Year