# CS405 An Introduction to Empirical Modelling

CS405 15 CATS (7.5 ECTS) Term 1

Availability

Option - MEng Computer Science

Prerequisites

No specific requisites

Academic Aims

The purpose of this module is to introduce students to the principles, tools and potential applications of Empirical Modelling. The module offers a complementary perspective on computer science, and is oriented towards aspects of computing practice for which formal methods offer limited support. These include activities such as conceptual design, requirements cultivation and exploratory modelling that involve close human-computer co-operation and often engage many human participants concurrently. The module presumes and builds upon a mature foundational knowledge of computer science and its applications. It aims to broaden students' conception of computing through exposure to modelling principles and abstractions common to a wide range of applications drawn from education, business and engineering.

Learning Outcomes

Students will gain awareness of the fundamental and distinctive role that empirical knowledge plays in conceiving and implementing computer-based systems. They will also acquire practical skills that are relevant to the individual and team work that typically precedes the explicit specification and design of such systems.

Content

The module will run for 10 weeks and involve 30 contact hours, of which 20 will be lectures and 10 will be organised practical laboratory work. It will be organised into five sections. The course will feature laboratory work involving specified individual and team project exercises. Assessment will be by a two hour examination (50%) and the submission of an extended abstract together with supporting project work and documentation (50%).

1. Introduction and Overview (1 week)

The principles of Empirical Modelling will be introduced with reference to controversies concerning formal and pragmatic approaches to computing. Relevant topics include logicism in AI, formal vs pragmatic approaches to software development, data modelling principles, declarative and procedural programming paradigms and soft computing. Where appropriate, relevant writings from rationalist and empiricist philosophical traditions will also be briefly discussed. The tools and applications of Empirical Modelling will be introduced via practical study of an existing model (such as the Vehicle Cruise Control Simulation), and exercises that focus on its use, documentation and incremental modification. The key concepts of Empirical Modelling - observation, dependency and agency - will be related to current software products, such as computer-aided design tools (e.g. Pro-Engineer), spreadsheets, relational databases and decision support systems (Protege).

2. Observables, Dependency and Agency for Computer-based Modelling (2 weeks)

The use of definitive (definition-based) representations of state for computer-based modelling will be illustrated with reference to simple exercises in geometric design, business modelling and data visualisation. The design and use of definitive notations will be discussed and illustrated with reference to the Scout, Donald, Eddi, Arca and Sasami notations. The integration of human and computer agency will be illustrated with reference to the EDEN interpreter, and the associated 'definitive programming' paradigm.

3. Single-Agent Applications of Empirical Modelling (3 weeks)

Three areas of application for Empirical Modelling will be introduced. Each will be elaborated and illustrated with reference to specific papers and extended case studies. The relationship between Empirical Modelling and learning activity will be illustrated using OXO and heapsort models. Its relevance to business and management applications will be discussed in association with timetabling and warehouse management applications. Engineering applications will be represented by simulations of physical systems, such as a game of billiards, and a digital watch.

4. Empirical Modelling for Concurrent Systems (3 weeks)

Applications of Empirical Modelling to concurrent systems analysis and development will be described with reference to

agent-oriented analysis using the LSD notation, and visualisation and animation in the framework of the distributed EDEN interpreter and the Abstract Definitive Machine. The history of railway development will be used as an extended case study. This will be illustrated by a distributed model of a historical railway accident. Distributed Empirical Modelling will be introduced with reference to collaborative environments for design, business and education. These will be illustrated by existing distributed models for web-based concurrent geometric modelling, for timetabling and for collaborative learning.

5. Current Research Issues and Future Developments (1 week)

The module will conclude with a critical review of the current status of the Empirical Modelling project. Alternative tools for Empirical Modelling, such as the Definitive Assembler Machine, Java-based dependency maintainers, and the LSD engine will be briefly motivated and described. Suitable topics for extended abstracts and associated practical studies will be proposed. These will be drawn from previous studies that require further consolidation, and key problems for future research.

Books

The Empirical Modelling Bibliography (see **http://www.dcs.warwick.ac.uk/modelling/**)
Fred Brooks, The Mythical Man Month Re-Visited, Addison-Wesley, 1995
Cantwell-Smith, The Origin of Objects, MIT Press, 1996
Date and Darwen, Relational Database Writings (several books from 1985-1999), Addison-Wesley.
William James, Essays in Radical Empiricism, Bison Books 1996
McDermott, "A Critique of Pure Reason", Computer Intelligence 3 pp. 151-160 (1987) + subsequent responses in same journal.
Bonnie Nardi, A Small Matter of Programming, MIT Press, 1993.

Assessment: Three hour examination (50%) Documented project work (50%)

Teaching: 20 one-hour lectures plus 10 one-hour laboratory sessions

Online course material: **http://www2.warwick.ac.uk/fac/sci/dcs/research/em/teaching/cs405/**

Organisers: Meurig Beynon and **Steve Russ**