COGNITIVE SYSTEMS MODEL CURRICULUM

Introduction

Cognitive systems is a fast-developing new approach to understanding intelligent systems. It draws on many different disciplines and, consequently, an ideal curriculum for teaching a course on cognitive systems - natural and/or artificial - would have to embrace a huge number of topics. This document outlines a suggested curriculum for a course on cognitive systems at undergraduate or postgraduate level. Inspired by the model curriculum in the euCognition wiki, we provide this suggestion in the knowledge that it would certainly not be feasible to cover all of the topics listed here in single year-long module. The aim, rather, is to provide a model curriculum that can be sampled (or pruned) to suit the needs or interests of a particular instructor. Doing it this way has the advantage that you know what you are leaving out.

Background

This document is the result of a Network Action funded by EUCognition. The initial conception and the subsequent undertaking of the project are the responsibility of the PI, Dr Joanna Bryson, the Project Manager Dr Dylan Evans, and the Research Officer, Dr Veronica Sunstedt.

The aim of this document is to identify essential learning outcomes for undergraduate and postgraduate education in cognitive systems as a basis for further discussion. The document is intended to assist curriculum planners, teaching staff, students and those responsible for postgraduate training. It is not intended as a blueprint for a homogenous 'international curriculum' for cognitive systems. We recognise that the content of this report is by no means the end of the story as far as learning outcomes in cognitive systems are concerned. The report is intended to be a "living" document; the ideas contained within it will evolve and develop further as it is used by universities and as third-level education in cognitive systems continues to evolve.

Outcome-based education in cognitive systems

Outcome-based education is neither a new concept nor a passing phase in educational technology and is equally applicable throughout the educational continuum from primary school to postgraduate training. Outcome-based education focuses on the end-product and defines what the learner is accountable for. It is not about telling teachers how to teach or students how to learn. Learning outcomes determine what is taught and assessed and can help to identify what is and is not essential. Having a clear idea of the desired outcomes does not necessarily have to be restrictive, since the methods of achieving the outcomes are still flexible. Using learning outcomes leads to common-sense curriculum design that specifies what students are to learn, and provides a clear and unequivocal statement of what the end-product will be like

The structure of the document

The first step in the development of this curriculum consisted in the identification of six key domains in cognitive systems. These are:

Artificial intelligence
Psychology
Neuroscience
Robotics
Philosophy
Linguistics

Each domain was then further subdivided into the appropriate learning outcomes. The task of identifying the learning outcomes was undertaken by Dr Dylan Evans in consultation with colleagues at various universities that have substantial programmes in cognitive systems.

Each domain is allocated a separate page in the document. The left hand column of each page lists the essential outcomes for that domain and the right hand column indicates what could be included in each of these when they are broken down into more detail.

The outcomes are intentionally quite broad and lacking in precise detail. The detail will be determined by each university individually according to their own interpretation of the outcome and how it should be achieved. The examples of what the outcomes might include show:

a) how they might be defined at a level of detail that allows them to be understood by students and teachers; and

b) how they might be translated into specific teaching and learning activities.

The degree of emphasis placed on each outcome and the level of detail to which it is taken will vary between universities, as will the learning and teaching methods depending on the type of curriculum and available resources. The examples provided in this document are thus not intended to be either prescriptive or comprehensive.

Inevitably there is overlap between some of the different domains with some outcomes being common to more than one domain. Any apparent duplication serves to illustrate the inextricable links and interdependence between the different elements comprising a competent and reflective expert in cognitive systems.

In conclusion the authors believe that an outcome-based approach to teaching cognitive systems at undergraduate and graduate level will allow curriculum development and reform to keep pace more effectively with changes occurring in basic research and in industry.

Feedback / your views

This is a consultative document rather than a policy statement or a set of recommendations and as such we would value feedback on its content. You can register your comments/responses either by completing the feedback form at the back of the document or by visiting the project web site at:

http://www.cs.bath.ac.uk/cogsys/

We hope that other researchers will modify this curriculum, build on it, argue over it, and develop it collaboratively into a useful shared resource. It may also provide a way of organising and indexing any teaching resources (lecture notes, slides, exam materials, etc) that lecturers in cognitive systems wish to share with their peers.

Domain 1: Artificial intelligence

Logic	Deductive and inductive logic
Algorithms	Complexity measures, sorting algorithms, search
Symbol systems	Symbol system hypothesis
Knowledge-based systems	Knowledge representation
Neural networks	Perceptrons, backpropagation, learning in neural nets
Evolutionary computing	Genetic algorithms, artificial life
Machine learning	Q-learning, classifier systems
Probabilistic reasoning	Bayesian methods, uncertainty
History of AI	Turing, von Neumann, Norbert Wiener,

Domain 2: Psychology

Learning & memory	Types of memory, neural basis of memory, theories of learning
Perception	Pyschophysics, vision, haptic perception
Decision-making	Rational choice theory, heuristics and biases, behavioural economics
Emotion and motivation	Neural mechanisms of emotion, evolution of emotions, Maslow’s hierarchy of needs
Evolutionary psychology	Massive modularity hypothesis, theory of natural selection

Domain 3: Neuroscience

Neuroatanomy	Functional localisation, neuro
Neurophysiology	Neuron doctrine, LTP, neurotransmitters,
Plasticity	Development, recovery of function, learning
Perception	Neural mechanisms of vision, sensation, audition
Motor control	Forward control,
Consciousness	Neural synchrony, sleep, blindsight
Affective neurosci	Neural mechanisms of emotion

Domain 4: Robotics

Sensing	Machine vision, sonar, microphones, signal detection theory
Actuation	Manipulation and grasping, kinematics, control theory
Locomotion	Quadrapedal and bipedal locomotion, wheeled and tracked vehicles, swimming and flying
Navigation	SLAM, biologically-inspired locomotion
Architectures	Deliberative, reactive, hybrid
Swarm robotics	Multi-robot systems, emergence
HRI	Human-robot interaction, interfaces, affective robotics

Domain 5: Philosophy

Epistemology	Theory of knowledge, philosophy of science, scientific method
Metaphysics	Realism, idealism, dualism, materialism
Rationality	Expected utility theory, decision theory, bounded rationality
Philosophy of mind	Semantics, connectionism, nativism,
Causation	Hume, problem of induction

Domain 6: Linguistics

Acquisition	Acquisition of syntax, acquisition of semantics, poverty of stimulus, nativism
Computational linguistics	Chomsky hierarchy, statistical approaches
Evolution of language	Archaeological evidence, creoles
Natural language processing	Linguistic interfaces for computers