Brain Inspired Cognitive Systems 2004
29 August - 1 September 2004,
University of Stirling, Scotland, UK

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Brain Inspired Cognitive Systems 2004

29 August - 1 September 2004,
University of Stirling,
Scotland, UK

Book of Abstracts

Tutorials:

Sunday 29 August 2004, Cottrell Building,
University of Stirling.

Conference Sessions:

Monday 30 August – Wednesday 1 September 2004,
Cottrell Building , University of Stirling

Organised by:

University of Stirling, Stirling, Scotland, UK

Imperial College of Science & Technology, London, United Kingdom

ICSC Interdisciplinary Research,
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And additional thanks to:
Margaret Ferguson, Grace McArthur, Aprill Smith

Abstracts of Tutorials

Sunday August 29 2004, 15:00-16:00, LTB3

Models of Consciousness: The world scene.

Prof Igor Aleksander, Department of Electrical and Electronic Engineering, Imperial College, London

An increasing number of laboratories around the world are trying to design a machine which could be said to be conscious. Their efforts are not only revealing how to build more competent machines, they are also illuminating how consciousness arises in living beings. The key historical event was a closed conference organised by Christof Koch of CalTech and David Chalmers Arizona University in 2001. A mixture of 20 philosophers neurologists and computer scientists meeting at the Cold Spring Harbour Laboratories in the US determined almost unanimously that approaching consciousness from the perspective of computational modelling would not only introduce novel mechanisms, but would clarify many philosophical puzzles about consciousness. I review what has happened since then, drawing attention to salient work both in the US and Europe. This is proceeding over a spectrum ranging from the 'functional' to the 'material'. The functional is sited in the artificial intelligence tradition being concerned with behaviour that one would say might require consciousness, while the material is neurologically based and asks what possible mechanisms could give rise to consciousness. I amplify work in my own laboratory which is at the material end of the spectrum and breaks down into five major lines of enquiry[1]: How could a mechanism:

1. sense an out-there world with itself in it?
2. imagine either experienced or fictional worlds?
3. attend to important events in the world an in its imagination?
4. plan its future actions?
5. evaluate emotionally the nature of its plans?

I shall briefly show that these new modelling approaches throw light on

1. Chalmers' 'hard' problem;
2. what it is to be unconscious;
3. animal consciousness;
4. 'illusion' theories of consciousness.

The conclusion will draw attention to areas that need serious attention from computationally minded researchers.

[1] I. Aleksander and B. Dunmall : Axioms and tests for the presence of consciousness in agents: Jour. Of Conc. Studies, June 2003, 15 pp.

Sunday August 29, 16:00-1700, LTB3

Implementing neural models in silicon

Prof Leslie S. Smith, Dept. of Computing Science and Mathematics, University of Stirling Stirling FK9 4LA, Scotland

Neural models are used in both computational neuroscience and in pattern recognition. The aim of the first is understanding of real neural systems, and of the second is gaining better, possibly brain-like performance for systems being built. In both cases, the highly parallel nature of the neural system contrasts with the sequential nature of computer systems, resulting in slow and complex simulation software. More direct implementation in hardware (whether digital or analogue) holds out the promise of faster emulation both because hardware implementation is inherently faster than software, and because the operation is much more parallel. There are costs to this: modifying the system (for example to test out variants of the system) is much harder when a full application specific integrated circuit has been built. Fast emulation can permit direct incorporation of a neural model into a system, permitting realtime input and output. Appropriate selection of implementation technology can help to make interfacing the system to external devices simpler. We review the technologies involved, and discuss some example systems.

Abstracts of Papers

Biologically Inspired Systems

Monday, August 30, 10:10am-10:30am
Paper BIS1.1

TEMPORAL PROCESSING IN THE AUDITORY SYSTEM.

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Abstract
In spite of the fact that the auditory system is the best available acoustic signal processor, so far computational modelling in neuroacoustics has concentrated on the auditory periphery. The first auditory stage, the cochlea, may be considered as filter bank performing a kind of frequency analysis. However, this is only the first step of complex hierarchical processing which finally, at the level of the cortex, leads to perception and recognition of sound signals. On the basis of our neurophysiological investigations, a spiking neural network has been simulated which implements temporal processing in the central auditory system. Essential elements of the first level of this network are coding of amplitude modulations by oscillatory neurons in the ventral cochlear nucleus (VCN) and by integrating neurons in the dorsal nucleus cochlearis (DCN). At the second level undelayed responses from the VCN and delayed responses from the integrated response in the DCN coincide on neurons in the inferior colliculus (IC). Finally, synchronized inhibition originating in the nucleus of the lateral lemniscus (VNLL) provides additional timing and low pass filtering. In the auditory system the result of temporal analysis is represented along a neuronal axis orthogonal to the well-known tonotopic axis. Corresponding evidence comes from different methods of mapping auditory midbrain and cortex in various animal, including man.

Monday, August 30, 10:30am-10:50am
Paper BIS1.2

ONSETS: AN ELEMENT OF ECOLOGICAL SOUND INTERPRETATION

Leslie S. Smith and Dagmar S. Fraser
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Abstract
We justify the usage of onsets in sound processing by appealing to an ecological view of auditory processing. The biological basis for onset processing is briefly discussed, and we describe our biologically motivated approach for a spike-based system for onset detection. This is based on a auditory-nerve like representation (with multiple spike trains per filter-bank band) followed by a leaky integrate-and-fire neuron with depressing synapses. Onsets are detected with essentially zero latency relative to the filter-bank. We show how this can be used to find the starts of certain phonemes in the TIMIT database, and how, by a small variation in the parameters, it can be used to detect amplitude modulation.

Monday, August 30, 11:10am-11:30am
Paper BIS1.3

BIOLOGICALLY INSPIRED BINAURAL ANALOGUE SIGNAL PROCESSING

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Abstract
The glaring performance gap between people and artificial systems when interpreting multiple sound sources has lead several researchers to investigate the advantages that may arise if artificial systems reproduce the behaviour of biological systems more closely. In particular the importance of binaural information, including interaural intensity and time differences, in biological systems has stimulated research into artificial systems that determine interaural time differences (ITDs) as part of procedures to improve the signal to noise ratio of a desirable auditory input. Determining ITDs can be a complex process in the presence of multiple sound sources if they are determined by correlating the two input signals. However, these problems can be avoided if sound onsets are used to determine ITDs. This paper describes the initial work of the development of an analogue VLSI system to determine ITDs. The most important result to emerge from this work is that ITDs will be more accurately determined from the initial response of the filter to any signal. This suggests that by limiting the impact of unavoidable variations between individual filters the use of onsets to determine ITDs will result in a significantly higher level of attenuation of unwanted signals.

Monday, August 30, 11:30am-11:50am
Paper BIS1.4

HYBROTS: HYBRIDS OF LIVING NEURONS AND ROBOTS FOR STUDYING NEURAL COMPUTATION

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Thomas B. DeMarse, Department of Biomedical Engineering, University of Florida, Gainesville, FL 32611 USA
Douglas J. Bakkum, Mark C. Booth, John R. Brumfield, Zenas Chao, Radhika Madhavan, Peter A. Passaro, Komal Rambani, Alexander C. Shkolnik, and R. Blythe Towal, Georgia Institute of Technology, Department of Biomedical Engineering 0535, Atlanta, GA 30332 USA
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Abstract
We are developing new tools to study the computational properties of living neuronal networks. We are especially interested in the collective, emergent properties at the mesoscopic scale (Freeman 2000) of thousands of brain cells working together to learn, process information, and to control behavior. We grow dissociated monolayer mammalian cortical cultures on multi-electrode arrays. We created the electronics and software necessary for a real-time feedback loop that allows the neurons to trigger their own stimulation. A key part of this loop is a system for re-embodying the in vitro network. We use the neural activity to control either simulated animals (animats) or robots. By using networks of a few thousand neurons and glia, we have tremendous access to the cells, not feasible in vivo. This allows physical and pharmacological manipulation, and continuous imaging at the millisecond and micron scales, to determine the cell- and network-level morphological correlates of learning and memory. We also model the cultured network in software; This helps direct our experiments, which then improves the model. By combining small networks of real brain cells, computer simulations, and robotics into new hybrid neural microsystems (which we call Hybrots), we hope to determine which neural properties are essential for the kinds of collective dynamics that might be used in artificially intelligent systems.

Monday, August 30, 11:50am-12:10pm
Paper BIS1.5

FAMILIARITY GATED LEARNING FOR INFERENTIAL USE OF EPISODIC MEMORIES IN NOVEL SITUATIONS - A ROBOT SIMULATION

Emilia I. Barakova
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Abstract
This paper presents a computational model for encoding and inferential reuse of memories, based on novelty and familiarity principle. The method is strongly inspired by the state of the art understanding of the hippocampal functioning and especially its role in novelty detection and episodic memory formation in relation to spatial context. A navigation task is used to provide an experimental setup for behavioral testing with a rat-like agent. The model is build on three presumptions. First that episodic memory formation has behavioral, as well as sensory and perceptual correlates; second, hippocampal involvement in the novelty/familiarity detection and episodic memory formation, experimentally supported by neurobiological experiments; and third, that a straightforward parallel exists between internal hip-pocampal and an abstract spatial representations. Some simulation results are shown to support the reasoning and reveal the methods applicability for practically oriented behavioral simulation.

Monday, August 30, 12:10pm-12:30pm
Paper BIS1.6

EXECUTIVE ATTENTION AND ACTION SELECTION IN A NEURALLY CONTROLLED SIMULATED ROBOT

Jason Garforth1, Sue McHale2 and Anthony Meehan1
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Abstract
In this paper, we describe an integrated model for neural control of both routine and nonroutine action selection. Functionally, the model is based upon an architecture originally proposed by Norman & Shallice (Norman and Shallice, 1986; Shallice 1988). This model includes a Contention Scheduler (CS) and a Supervisory Attentional System (SAS). The CS mechanism is based upon the CS architecture described by Presott, Redgrave and Gurney (1999). Little is known of the neural architecture of the prefrontal cortex (PFC) that might realise the SAS. Accordingly, we have developed a partial implementation in which the architecture is guided by an analysis of the functionality required by Shallice's SAS. The resulting model is used to control the behaviour of a simulated robot. This paper extends earlier work on normal executive control (Garforth, McHale, Meehan, 2003), describing lesion studies to explore the correspondence between the behaviour of the robot and behaviours seen in humans suffering lesions of the PFC. In doing so, we are able to assess the legitimacy of the SAS model as hypothesised and as implemented.

Monday, August 30, 12:30pm-12:50pm
Paper BIS1.7

A CASE STUDY OF DEVELOPMENTAL ROBOTICS IN UNDERSTANDING "OBJECT PERMANENCE"

Yi Chen and JuyangWeng_
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Abstract
In this paper, a biologically inspired computational model is proposed and implemented on a robot to study one of the most fundamental and controversial issues in cognitive science – "Object Permanence." Because of the world-knowledge free design and the developmental learning ability of this model, we are able to analyze the robot's behavior based on its perceptual development through different experiences. Our experimental result shows

consistency with prior researches on human infants, which not only sheds light on the highly controversial issue of object permanence, but also demonstrates how biologically inspired developmental models can potentially develop intelligent machines and verify computational modeling that has been established in cognitive science.

Monday, August 30, 13:45pm-14:10pm
Paper BIS2.1

DESIGN AND BASIC BLOCKS OF A NEUROMORPHIC VLSI ANALOGUE VISION SYSTEM

Jordi Cosp, Jordi Madrenas, Oscar Lucas, Eduard Alarcón, Eva Vidal, Gerard Villar
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Abstract:
In this paper we present a complete neuromorphic image processing system and we report the development of an integrated CMOS low-power circuit to test the feasibility of its different stages. The image system consists of different parallel-processing stages: phototransduction, non-linear filtering, oscillatory segmentation network and post-processing to extract fundamental characteristics. The circuit presented emulates parts of the behaviour of biological neural networks as found in the retina and the visual cortex of living beings, adopting the neuromorphic approach that takes advantage of analogue VLSI electronics. The final objective is to develop a small and low-power system embedded in a single focal-plane integrated circuit to be used in portable applications. Each stage is briefly described. Simulations and experimental results of some basic blocks are also reported.

Monday, August 30, 13:45pm-14:10pm
Paper BIS2.2

A NEUROMORPHIC SELECTIVE ATTENTION ARCHITECTURE WITH DYNAMIC SYNAPSES AND INTEGRATE-AND-FIRE NEURONS

Chiara Bartolozzi
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Abstract
Selective attention is a process widely used by biological sensory systems to overcome the problem of limited parallel processing capacity: salient subregions of the input stimuli are serially processed, while non–salient regions are suppressed. We present an analog Very Large Scale Integration implementation of a building block for a multi–chip neuromorphic hardware model of selective attention. We describe the chip's architecture underlining the similarity between the circuits and biological neurons and synapses. We plan to present experimental results that explore the dynamics of the system varying its bias settings corresponding to physiological properties of neurons and synapses.

Monday, August 30, 14:35pm-15:00pm
Paper BIS2.3

ANALOG TWO-DIMENSIONAL NETWORK FOR MOTION DETECTION BASED ON LOWER ANIMAL VISION

Kimihiro Nishio, Hiroo Yonezu and Yuzo Furukawa
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Abstract
A two-dimensional network for motion detection constructed with simple analog circuits was proposed and designed based on the lower animal vision. In the frog visual system, output signals which correspond to the two-

dimensional motion direction and velocity are generated by performing simple information processing at the tectum and thalamus. The measured results of the test chip fabricated with 1.2µm CMOS process showed that basic circuits utilized in the network can operate correctly. The results with the simulation program with integrated circuit emphasis (SPICE) showed that the network can generate currents which are proportional to the motion direction and the velocity of the object.

Monday, August 30, 15:00pm-15:20pm
Paper BIS2.4

AN ORIENTATION SELECTIVE MULTI-CHIP AVLSI SYSTEM FOR PARALLEL IMAGE PROCESSING

Kazuhiro Shiminomura & Tetsuya Yagi
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Abstract
We describe a multi-chip aVLSI system which emulates the orientation selective response of the simple cell in the primary visual cortex. The system consists of two analog chips: a silicon retina and an orientation selection chip which mimics the parallel and hierarchical architecture of the visual system in the brain. First, the image filtered by the Laplacian-Gaussian-like receptive field of the silicon retina then it is transferred to the orientation selection chip. The communication between the two chips is carried out using analog signals to represent pixel values. The orientation selection chip selectively aggregates multiple pixels of the silicon retina, mimicking the feed forward model proposed by Hubel and Wiesel. The present system exhibits the orientation selectivity with even and odd-type response. The spatial properties of analog responses from the orientation selection chip where verified for different receptive field sizes under indoor illumination. Multiple orientations and types of the images can be obtained within a single frame period. The multi-chip aVLSI architecture used in the present study is considered to be applicable in the implementation of higher order controls in the primary visual cortex, such as the complex cell.

Monday, August 30, 15:20pm-15:45pm
Paper BIS2.5

BIOLOGICALLY MOTIVATED OSCILLATORY NETWORK MODEL FOR DYNAMICAL IMAGE SEGMENTATION

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Abstract
We continue to develop the 2D oscillatory network model with self-organised dynamical coupling and synchronization -based performance for image segmentation tasks. The model has been extracted via proper reduction form 3D oscillatory network, previously designed by the authors as oscillatory model of the brain visual cortex (VC). Known neurobiological data on VC structure and functioning were reflected in design of 3D network architecture and single oscillator dynamics, and the idea of dynamical binding was attracted in construction of network connectivity rule. Under supplemented coupling adaptation method the 2D network is capable to provide accurate segmentation of the gray-level brightness images and to perform some texture segmentation tasks. Besides, the network demonstrates capabilities of smooth contour integration. New advanced version of internal oscillator dynamics and network connectivity rule have been designed and introduced into the 2D model at current study. The modified network characteristics encompass promising possibilities of more efficient network performance, providing higher accuracy of brightness image segmentation.

Tuesday, August 31, 10:00am-10:20am
Paper BIS3.1

A CONNECTIONIST APPROACH FOR VISUAL PERCEPTION OF MOTION

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Abstract
Modeling visual perception of motion by connectionist networks offers various areas of research for the development of real-time models of dynamic perception-action. In this paper we present the bases of a bio-inspired connectionist approach that is part of our development of neural networks applied to autonomous robotics. Our model of visual perception of motion is based on a causal adaptation of spatiotemporal Gabor filters. We use our causal spatiotemporal filters within a modular and strongly localized architecture that performs a shunting inhibition mechanism. This model has been evaluated on artificial as well as natural image sequences.

Tuesday, August 31, 10:20am-10:40am
Paper BIS3.2

OPTIC FLOW STATISTICS AND INTRINSIC DIMENSIONALITY

Sinan Kalkan (1) , Dirk Calow (2), Michael Felsberg(3), FlorentinWoergoetter(1), Markus Lappe (2) , and Norbert Kruger (4)
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Abstract
Different kinds of visual substructures (such as homogeneous, edge-like and junction-like patches) can be distinguished by the intrinsic dimensionality of the local signals. The concept of intrinsic dimensionality has been mostly exercised using discrete formulations. A recent work [KF03,FK03] introduced a continuous definition and showed that the inherent structure of the intrinsic dimensionality has essentially the form of a triangle. The current study work analyzes the distribution of signals according to the continuous interpretation of intrinsic dimensionality and the relation to orientation and optic flow features of image patches. Among other things, we give a quantitative interpretation of the distribution of signals according to their intrinsic dimensionality that reveals specific patterns associated to established sub-structures in computer vision. Furthermore, we link quantitative and qualitative properties of the distribution of optic-flow error estimates to these patterns.

Tuesday, August 31, 10:40am-11:00am
Paper BIS3.3

NEURALLY INSPIRED OBJECT TRACKING SYSTEM

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Abstract
Object tracking is useful in applications like computer-aided medical diagnosis, video editing, visual surveillance etc. Commonly used approaches usually involve the use of filter (e.g. Kalman filter) to predict the location of the object in next image frame. Such approaches actually borrow ideas from signal theory and are limited to applications where dynamic model is known. In this paper, a flexible and reliable estimation algorithm using wavelet network (or wavenet) is proposed to build an object tracking system. This system simulates the perception of motion that occurs in primates. Neural-based filters will be used for color, shape and motion analysis. Experimental results show that object can be tracked accurately without fixing any dynamic model compare with commonly used Kalman filter.

Tuesday, August 31, 13:45pm-14:05pm
Paper BIS4.1

VISION COINCIDENCE DETECTION WITH STDP ADAPTATION FOR OBJECT RECOGNITION AND DEPTH ANALYSIS

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Abstract
A cognitive vision neuronal network based on leaky integrate-and-fire (LIF) neurons is proposed for object recognition and depth analysis. In this network every LIF neuron is able to capture the edge flowing through it and record the temporal information. If the neuron issues a spike, the temporal information will be encoded by the time constant of the spike potential and transferred to its successor neuron through synapses. The successor neuron, on reception of the spike, will check whether that edge arrives at its sensor. In the case that both events synchronise the successor neuron will fire to confirm the correct edge propagation. Meanwhile, in the process the spike-timing-dependent plasticity (STDP) is employed to achieve the suitable synapse efficacies to reject spurious edge propagation. On recognition of the effective CMOS realisation of LIF neuron, our model aims to be a biologically inspired neuromorphic system amenable to aVLSI implementation.

Tuesday, August 31, 14:04pm-14:25pm
Paper BIS4.2

A NOVEL PERSPECTIVE INTO THE NEURONAL ENCODING ALONG THE RETINAL PATHWAY EMPLOYING TIME/FREQUENCY TRANSFORMATION: PART I — FOR OBJECT

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Abstract
This paper presents an innovative approach to investigate the information encoding taking place in the visual pathway, particularly the retinal pathway. Gabor time-frequency (TF) transformation is applied to the spatio-temporal spike trains from the layers of the retinal pathway, corresponding to input object stimuli varying in shape, orientation & distance. These spike trains are generated by employing simulation tools. Using the TF transformation, a methodology is evolved to analyze information encoding in terms of dominant harmonic variations. Statistical analysis of these variations and extrapolation reveal that the dominant harmonic variations can be encoded as multinomial (multivariate polynomial) functions. For the set of input stimuli considered, a bivariate polynomial encoding is observed with the order of the polynomial and its coefficients encoding the variations in amplitude of dominant harmonics. Analysis of encoding is carried out for both 'within the layers', like horizontal only and 'across the layers', the entire retinal pathway. The simulation results presented enunciate the findings. In the companion paper part II, neuronal encoding for chromatic information is analyzed on similar lines. After analyzing the neuronal color encoding process in part II, a generalized encoding scheme applicable to object shapes as well as color is proposed.

Tuesday, August 31, 14:25pm-14:45pm
Paper BIS4.3

A NOVEL PERSPECTIVE INTO THE NEURONAL ENCODING ALONG THE RETINAL PATHWAY EMPLOYING TIME/FREQUENCY TRANSFORMATION: PART II — FOR COLOR

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Abstract
This paper analyses how color information gets encoded along the retinal pathway in the time-frequency domain (TFD). A multinomial (multivariate polynomial) encoding for chromatic information is established based on the spatiotemporal spike trains corresponding to input stimuli varying in hue & saturation. Simulation tools are used to generate the spike trains from the retinal layers. The Gabor time-frequency transformation presented in the companion paper part I [1] is employed here for analyzing the dominant harmonic variations corresponding to the color stimuli. For the set of color input stimuli considered, a bivariate polynomial encoding is observed with the order of the bivariate polynomial and its coefficients encoding the variations in amplitude of the dominant harmonics. Analysis is pursued along the similar lines presented in part I. The simulation results pertaining to encoding for color variations are presented. This paper suggests a new mathematical formulation called the generalized "stochastic multinomial" encoding, for the retinal pathway in general.

Wednesday, September 1, 11:20am-11:40am
Paper BIS5.1

BIOLOGICALLY PLAUSIBLE MODEL OF GROWING NEURITES

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Abstract
To better understand how a real neuron works, knowledge of neuronal growth is required. During growth, a neuron changes many of its topological characteristics over time, forming complex dendritic trees and long, branched axons. Many internal and external factors affect the growth of these neurites. We present a model of dendritic growth as determined by the construction of its internal cytoskeleton.
Results indicate that changes in particular parameters can lead to different characteristic tree topologies, as seen in real neurons.

Wednesday, September 1, 11:40am-12:00pm
Paper BIS5.2

UNILATERAL COUPLING BETWEEN TWO MFHN ELECTRONIC NEURONS

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Abstract
A nonlinear electrical circuit is proposed as a basic cell for modeling FitzHugh-Nagumo neurons with a modified excitability. Depending on initial conditions and parameters experiments show various dynamics including stability with excitation, bistability and oscillations. Moreover, we present an electrical circuit which will be used to realize a unidirectional coupling between two cells, mimicking chemical synaptic coupling. Finally, we characterize the frequency-doubling and the chaotic dynamics depending on the coupling strength in a master-slave configuration. In all experiments, we stress the influence of the coupling strength on the control of the slave neuron.

Wednesday, September 1, 12:00pm-12:20pm
Paper BIS5.3

EFFECTS OF NMDA AND NON-NMDA RECEPTORS ANTAGONISTS ON THE BEHAVIOR OF CULTURED CORTICAL NETWORKS

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Sergio Martinoia , NBT, Neuroengineering and BionanoTechnologies Group, DIBE, University of Genoa, Via Opera Pia 11A, 16145 – Genoa, Italy martinoia@dibe.unige.it

Abstract
Nowadays several research groups in neuroscience are interested in understanding the basic mechanisms of information processing within the Central Nervous System. Thanks to the application of silicon technology in the field of cellular biology, non-conventional electrophysiological techniques allow to screen the activity of brain tissue or nervous cell cultures in spontaneous and stimulus-evoked conditions. Activity patterns in cultured networks of cortical neurons from rat embryos (E18) were investigated at different Days In Vitro (DIV), by using a multisite recording technique based on planar Micro Electrode Arrays (MEAs). Transitions in neuronal dynamics of cortical networks were induced administering antagonists of NMDA and non-NMDA receptors. Neurochemical effects on synaptic transmission were evaluated analyzing the whole network activity by means of ad-hoc developed algorithms. A decrease in excitatory synaptic transmission corresponded to a decrease in both spiking and bursting activity with a loss of network synchronization. This experimental study constitutes a potential approach to quantify how structural modifications in a neuronal network can induce changes in the computational properties of the network itself.

Wednesday, September 1, 12:20pm-12:40pm
Paper BIS5.4

METHODS FOR SIMULATING HIGH-CONDUCTANCE STATES IN NEURAL MICROCIRCUITS

Eilif Mueller, Karlheinz Meier, Johannes Schemmel
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http://www.kip.uni-heidelberg.de/vision

Abstract
A network simulation paradigm was developed to be consistent with observations of the high conductance state of layer IV cortical neurons in an awake brain *in-vivo*. Two classes of integrate-and-fire based neurons, pyramidal (with adaptation) and inhibitory, were modeled. Synapses were conductance based. The high conductance state was induced by synaptic bombardment with 1000 excitatory and 250 inhibitory Poisson process with firing rates (e,i) respectively. The rates (e,i) were chosen so that the respective neuron models, (pyramidal, inhibitory), reproduce these rates under this bombardment. Network synapses were then enabled, replacing a fraction of the Poisson process input. A 9x9x9 lattice of neurons with a cortical layer IV inspired network topology was simulated at 1/200th real-time. Coherent network bursting emerged at 5-7 Hz. The dependence of the burst period on the time constant of adaptation was demonstrated to be linear with a slope consistent with unity. The simulation uses event based communication and a scalable Linux cluster implementation is foreseen.

Wednesday, September 1, 12:40pm-13:00pm
Paper BIS5.5

CONTROLLING THE CORTEX STATE TRANSITIONS BY ALTERING THE OSCILLATION ENERGY

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(b) Centro de Investigaciones en Optica, Apartado Postal 1-948, 37150 Leon, Guanajuato, Mexico

Abstract
The method of controlling dynamical systems based on alteration of the oscillation energy is applied to multistable systems, attractors of which are qualitatively similar to their counterparts in the cortex. The attraction basins of "basal" and "epileptic" states are associated with their own energy levels. Changing the system energy causes switching from the pathological attractor to the physiological one. The approach utilizes simple feedback depending solely on the output signal and, hence, is especially useful when the system parameters are inaccessible or are costly to adjust, which is characteristic of biological systems. The technique requires neither knowledge of the system equations nor computation of the control signal, and, hence, can be useful for control as well as identification of unknown systems.

Wednesday, September 1, 13:45pm-14:05pm
Paper BIS6.1

SUPERVISED TRAINING OF SPIKING NEURAL NETWORKS WITH WEIGHT LIMITATION CONSTRAINTS

Q Wu, T. M McGinnity, LP Maguire, B Glackin, A Belatreche
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Abstract
There has been much evidence to show that single precise spikes, transfer information among biological neurons. Based on this encoding scheme various spiking neural networks have been proposed to solve computational problems. One such algorithm, a spike time error-backpropagation algorithm for temporally encoded networks of spiking neurons, has been successfully applied to the problem of complex non-liner data classification. There are however, certain features of the algorithm that can be further improved. In this paper, synaptic weight limitation is introduced into the algorithm and a novel solution for the problem raised by non-firing neurons is presented. In addition a square cosine encoder is applied to the input neurons and thus the number of input neurons can be reduced. The improved algorithm becomes more reliable, robust, efficient and reduces the implementation costs. The classical XOR-problem, a function approximation experiment and the Iris benchmark data have been applied to validate the improved algorithm. The experimental results reported show that the modified algorithm produces comparable accuracy in classification with the original approach utilising a smaller spiking neural network.

Wednesday, September 1, 14:05pm-14:25pm
Paper BIS6.2

EXTENDING NEUROMORPHIC ENGINEERING BEYOND ELECTRONICS

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Abstract
One of the advantages of the neuromorphic approach is energy efficiency, which comes from the exploitation of the intrinsic physics of electronic devices. Taking the intrinsic efficiency of physics as a guiding principle, we can extend it beyond electronics to other technologies including optical, mechanical, and chemical. In this paper we

consider the role that some of these other technologies may has to play in this area, describe some of the work that has already been done, and suggest some advantages of pursuing what we call a physical computational approach to AI.

Wednesday, September 1, 14:25pm-14:45pm
Paper BIS6.3

SILICON-BASED NEUROMORPHIC OLFACTORY PATHWAY IMPLEMENTATION

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Thomas J. Koickal(b), Carlo Fulvi-Mari(a), James A. Covington(c), Forest S. Tan(c), Julian W. Gardner(c), Alister Hamilton(b)
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Abstract
This paper describes our efforts to implement the world's first silicon olfactory system in aVLSI/MEMs. To achieve this requires integration of a biologically constrained neuronal model, chemical micro-sensor technology and aVLSI spiking neuromorphic circuits. Here we describe our progress towards this goal, by presenting an olfactory bulb model, a reduced 70 element broadly-tuned chemosensor array (25 different chemsensor tunings), and details of their silicon implementation. Current results shown here demonstrate that the olfactory bulb model that has been implemented is capable of pattern classification, that the odour delivery, uptake and sensor circuitry, as well as the fundamental units of the neuromorphic model (spike-driven synapse and spiking soma) are all functional. Work will continue towards completing a fully-integrated scalable implementation of the olfactory system.

Wednesday, September 1, 14:45pm-15:05pm
Paper BIS6.4

OPTIMISING THE CONNECTIVITY COEFFICIENTS IN THE SOMATOSENSORY PATHWAY USING GENETIC ALGORITHMS

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Abstract
The interacting questions of consciousness, awareness and depth of anaesthesia are challenging and timely. A neuronal network of the somatosensory pathway relating to administration of narcotic/hypnotic drugs for surgical anaesthesia has been developed. It employs spatially distributed and lumped-parameter modelling, and is a derivative of other established neuronal models. It comprises 22 ODE (Ordinary Differential Equations) and has many connectivity parameters which require careful selection. The initial model used connectivity coefficients proportional to the average number of synaptic contacts between the relevant cortical cellular components based on histological examination. While giving reasonable correspondence to experimental data from rats, the manual adjustment of these crudely estimated coefficients was both tedious and not entirely satisfactory. In this paper, the connectivity terms have been optimised using global GA (Genetic Algorithm) tuning. The GA is seeded with the previously established synaptic weighted estimates. It is shown that very good agreement with physiological data has been achieved in an automated fashion. The resultant connectivity coefficients can now be investigated for probing likely areas of uncertainty for further detailed anatomical studies.

Wednesday, September 1, 15:05pm-15:30pm
Paper BIS6.5

NEW ALGORITHMS FOR BLIND SEPARATION WHEN SOURCES HAVE SPATIAL VARIANCE DEPENDENCIES

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Abstract
Blind separation problem is discussed, when sources are not independent, but have spatial variance dependencies. Hyvarinen and Hurri (2003) proposed an algorithm which requires no assumption on distributions of sources and no parametric model of dependencies between components. In order to obtain semiparametric algorithms which give a consistent estimator regardless of the source densities and the dependency structure, we study estimating functions for this model by the statistical approach of Amari and Cardoso (1997). Unlike the ICA model, the maximum likelihood estimation is not a semiparametric method in this case. Therefore, we consider a class of estimating functions which contain the quasi maximum likelihood estimation of the ICA model and the nonstationary ICA algorithm by Pham and Cardoso (2000). By modifying the score function, we got an estimating function close to it and proposed semiparametric algorithms based on it. Our algorithms were compared to other BSS methods with several artificial examples and speech signals.

Wednesday, September 1, 15:50pm-16:10pm
Paper BIS7.1

CREATION OF A CUSTOM BASIS FOR DETECTION OF A NEURAL PHYSIOLOGICAL EVENT IN EEG

Philip M. Zeman, University of Victoria Assistive Technology Team, Unive rsity of Victoria, BC, CANADA
Nigel Livingston, University of Victoria Assistive Technology Team, University of Victoria, BC, CANADA
W. H. Hook, Department of Forest Biology, University of Victoria, BC, CANADA
Peter F. Driessen, Department of Engineering, University of Victoria, BC, CANADA

Abstract
This paper describes some of the basic principles and motivations underlying our brain-computer interface design. Our intent is to abstractly describe multi-rate filtering and orthogonal subspace decomposition appropriate for processing electroencephalographic data and identify some of the constraints imposed on the interface when considering a user with amyotrophic lateral sclerosis . Using an additive Gaussian noise model, orthogonal filter bank decomposition using a custom basis vector is demonstrated as an effective means for identification of events in an electroencephalogram.

Wednesday, September 1, 16:10pm-16:30pm
Paper BIS7.2

INTERFERENCE NETWORKS - A PHYSICAL, STRUCTURAL AND BEHAVIOURAL APPROACH TO NERVE SYSTEM

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Abstract
Physical wave properties in nervous system offer new methodologies by contrast to artificial neural networks, especially to pattern handling networks. All information inherent a nerve impulse is only the time point the first derivative crosses zero. To change physical distances, delays or arrangement in space means for net models, to vary the most significant value, to destroy the information. It is somewhat surprising, that mathematics, medicine and neurocomputation years ago began simultaneous but different to use and to interpret the physical term 'projection'. In opposite to non- mirroring, mathematical vector- or matrix 'projections' (X => Y) a *physical projection mirrors* the image between source and screen in general. Neurophysiology speaks of 'projective' trajectories and maps. Known nerve maps, independent if they are feature-specific, anatomically or abstract seem to have mirroring properties. There are lots of works about brain maps and *non-mirroring projections in neurocomputation.* Not realizing, that this is a dangerous, wave-interferential, physical category, the term

projective is miss-used. In neuro-physiology we find maps, that mirror the representations between source and sink, between generator and detector field, so the well known 'Homunculus'. By analogy between neuro-physiology and physical meaning, physical wave properties in nervous system must be supposed.

Wednesday, September 1, 16:30pm-16:50pm
Paper BIS7.3

BIOLOGICAL ASYMMETRIC AND PARALLEL - SYMMETRIC NEURAL NETWORKS WITH NONLINEAR FUNCTIONS

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Abstract
In the biological visual neural networks, one of prominent features, is nonlinear functions, which play important roles in the visual systems. The visual information is inputted first to the retinal neural networks, then is transmitted and finally is processed in the visual cortex and middle temporal area of the primate brain. In these networks, it is reported that some nonlinear functions will process the visual information effectively. However, it is not clarified that what kinds of nonlinear functions will process what kinds of works in the visual processing. The order of the nonlinear functions is not yet clarified to show the mechanism of the visual information functions. In this paper, we discuss the nonlinear functions in the visual systems to clarify the structural and functional properties of the networks.

Wednesday, September 1, 16:50pm-17:10pm
Paper BIS7.4

PARTITIONED PARALLEL PROCESSING APPROACH FOR PREDICTING MULTI-MILLION NEURON INTERCONNECTIVITY IN THE BRAIN : INVOLVING SOMA-AXON-DENDRITES-SYNAPSE

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Abstract
This paper presents a simulation model based on partitioned parallel processing approach to predict Multi-Million Neuron Interconnections in the various brain regions involving soma, axon, dendrites and synapse. This is an attempt to develop a methodology for predicting such massive neural inter-connectivity to analyze the spatio-temporal information processing and synaptic based learning in its lowest level. The paper presents the importance of such massive prediction and opens up avenues for developing fault simulation techniques for modeling various brain diseases and disorders. The prediction of multi-million neuron interconnectivity involves awesome computations. To tackle this massive computational complexity a partitioned parallel approach employing the randomized algorithm namely the simulated annealing is evolved. The computational complexity is derived and is shown to be in hundreds of petaflop years. Heuristics are presented to drastically reduce this complexity. However, the high computational complexity necessitates the evolution of a novel supersupercomputer. This paper strongly suggests the need for evolving a DNA based computing paradigm for brain modeling in its total reality.

Tuesday, August 31
Poster BIS8.1 (poster P4)

NEURAL MULTILAYER STRUCTURE FOR MOTION PATTERN SEGMENTANTION

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Abstract
Bio-inspired energy models compute motion following the guidelines suggested by the neurophysiological studies of V1 and MT areas of monkeys and human behaviour that use neural populations to extract the local motion structure through local competition of MT like cells. In this paper we present a neural structure that works as dynamic filter on the top of this MT layer for image segmentation and can take advantage of the neural population coding in the cortical processing areas. The test bed application addressed in this work is an automatic watch up system for overtaking situations seen from the rear view mirror. The ego-motion of the host car induces a global motion pattern whereas an overtaking vehicle produces a motion pattern highly contrasted with this global ego-motion field. We described how a simple neural processing scheme can take full advantage of this motion structure for segmenting overtaking cars in this scenario.

Tuesday, August 31
Poster BIS8.2 (poster P5)

ON REFRACTORINESS OF CHAOTIC NEURONS IN INCREMENTAL LEARNING

Toshinori Deguchi, Gifu National College of Technology, Gifu, 501–0495, Japan
Naohiro Ishii, Aichi Institute of Technology, Aichi, 470–0392, Japan

Abstract
This paper develops the incremental learning by using chaotic neurons, which is called "on-demand learning" at its developing time. The incremental learning unites the learning process and the recall process in the associative memories. This learning method uses the features of the chaotic neurons which were first developed by Prof. Aihara. The features include the spatio-temporal sum of the inputs and the refractoriness in the chaotic neurons. Because of the temporal sum of the inputs, the network learns from inputs with noises. But, it is not obvious that all the features are needed to the incremental learning. In this paper, the computer simulations investigate how the refractoriness takes an important part in the incremental learning. The results of the simulations, show that the refractoriness is an essential factor, but that strong refractoriness causes failures to learn patterns.

Tuesday, August 31
Poster BIS8.3 (poster P6)

GROUPING OVER STEREO FOR VISUAL CUES DISAMBIGUATION

Nicolas Pugeault(1), Florentin Woergoetter(1) and Norbert Krueger(2)
1 Psychology, University of Stirling, Scotland
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Abstract
In stereo–vision, the goal is to reconstruct the three–dimensional structure of the scene observed from two camera inputs. The core problems are the matching of features into both camera frames, and the interpretation of image features in terms of the 3D scene. In this paper, we use a rating scheme of the potential correspondences, based on the multi–modal intrinsic similarity of the features. We propose here to join approach of stereo feature matching and feature grouping processes, into one intertwined spatial and stereo integrated process. We show here that those two apparently separated processes are based on the same assumptions. This joint approach allow to improve reliability and performance of both processes, and to solve some of their inherent ambiguities

Tuesday, August 31
Poster BIS8.4 (poster P7)

MODELLING STDP: SEQUENCE LEARNING AND RECALL

Matthew Hartley, Neill Taylor, John Taylor
Department of Mathematics, King's College London, The Strand, London, WC2R 2LS

Abstract
Long term synaptic plasticity underlies many important learning processes in the brain. Recent physiological data have shown that the precise relative timing of pre- and post-synaptic neuron firings at a synapse determine both

the direction of modification (potentiation or depression), and the magnitude of this modification. We model this form of plasticity using a model based on calcium dynamics and show that, in addition to reproducing experimental data for both paired and triplet spike paradigms, the model allows a reciprocally connected network of hippocampal pyramidal neurons to store and recall short term temporal sequences.

Tuesday, August 31
Poster BIS8.5 (poster P8)

HOW YOUR BRAIN KNOWS WHERE YOUR HAND IS

Milana Mileusnic, University of Southern California, Los Angeles, CA 90089. mileusni@usc.edu
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Abstract

Proprioceptors provide the central nervous system (CNS) with the feedback information required to compute body posture and to regulate muscle activation accurately during ongoing movement. A large amount of proprioceptive information arrives at the CNS from diverse receptors distributed among muscles, tendons and joints, raising the question of how such information is encoded, combined and used. We here consider and contrast the two most important proprioceptors, muscle spindles and Golgi tendon organs, from the perspectives of psychophysics, neurophysiology and mathematical modeling. The muscle spindle is a particularly complex transducer of both muscle length and velocity whose properties appear to be dynamically optimized via its fusimotor innervation; its sensorimotor role and signal encoding are starting to be wellunderstood through mathematical modeling but decoding in the CNS appears to be a very difficult computational problem. The Golgi tendon organ is a much simpler transducer whose ensemble properties may provide a linear indication of muscle force; paradoxically, its role in proprioception and sensorimotor regulation remains enigmatic.

Tuesday, August 31
Poster BIS8.6 (poster P9)

DEVELOPMENT OF RETINOTOPY AND OCULAR DOMINANCE BY SOFT TOPOLOGY-PRESERVING MAPS AND ELASTIC NETS: DERIVING ONE CLASS OF THE MODELS FROM ANOTHER

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Abstract

The batch version of soft topology-preserving map producing retinotopy and ocular dominance in visual cortex is proven to be reduced to the elastic net. This verifies numerous results of numerical simulations described in the literature demonstrating similarities of neural patterns produced by lateral and elastic synaptic interactions.

Neural Computation

Monday, August 30, 10:10am-10:35am
Paper NC1.1

A HYBRID LEARNING ALGORITHM

Jihane BOULAHIA SMIRANI and Fériel MOURIA BEJI (Member IEEE)
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Abstract
The integration of symbolic prior knowledge and neural networks in so-called Knowledge and neural networks is becoming increasingly popular for solving difficult real-world problems[1]. Hybrid intelligent systems that combine and artificial neural network systems typically have four phases involving domain knowledge representation, mapping into connectionist network, network training, and rule extraction respectively. In order to obtain a concise set of symbolic rules, redundant and irrelevant units and connections of a trained neural network are usually removed by a network pruning algorithm before rule are extracted Typical pruning algorithms require retraining the network, which incurs additional cost. In this paper, we introduce a new rule extraction technique without network retraining. Our technique is a universal and comprehensive approach that extracts all embedded knowledge in a trained artificial neural network and represents it in a rule base format. Experimental results show that the size and the predictive accuracy of the rule generated are comparable to those extracted by another method, which prunes and retrains the network.

Monday, August 30, 10:35am-11:00am
Paper NC1.2

CLUSTERING HUMAN ASSOCIATION

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Abstract
We combined a novel associations strength ranking algorithm and an unsupervised Self Organizing Maps technique to cluster free associations. We tested the algorithm on 171 seed terms and showed a very good clustering performance. The algorithm suggests a linkage between the two biggest known databases - the human mind and the Internet.

Monday, August 30, 11:20am-11:45am
Paper NC1.3

STOCHASTIC COMPLEXITY OF REINFORCEMENT LEARNING

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Abstract
Using the asymptotic equipartition property which holds on empirical sequences we elucidate the explicit performance of exploration, and the fact that the return maximization is characterized by two factors, the stochastic complexity and a quantity depending on the parameters of environment. We also examine the sensitivity of stochastic complexity, which is useful in appropriately tuning the parameters of the action selection strategy, and show the lower bound of the convergence speed of the divergence between the empirical

sequence and the best empirical sequence which produces a maximal return. **Nomenclature** reinforcement learning, Markov decision process, typical sequence, asymptotic equipartition property, stochastic complexity.

Monday, August 30, 11:45am-12:45pm
Paper NC1.4

OSCILLATORY DYNAMIC LINK MATCHER: A BIO-INSPIRED NEURAL NETWORK FOR PATTERN RECOGNITION

Ramin Pichevar and Jean Rouat
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Abstract
In this paper we show that an unsupervised two-layered oscillatory neural network with intralayer connections, and a learning rule based on stimulus difference can behave as a Dynamic Link Matching Machine for invariant pattern recognition. We show that this architecture is robust to affine transformations. We call this architecture Oscillatory Dynamic Link Matching (ODLM).

Monday, August 30, 14:10pm-14:35pm
Paper NC2.1

SUPERVISED INFORMATION-THEORETIC COMPETITIVE LEARNING BY COST-SENSITIVE INFORMATION MAXIMIZATION

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Abstract
In this paper, we propose a new supervised learning method whereby information is controlled by the associated cost in an intermediate layer, and in an output layer, errors between targets and outputs are minimized. In the intermediate layer, competition is realized by maximizing mutual information between input patterns and competitive units with Gaussian functions. The process of information maximization is controlled by changing a cost associated with information. Thus, we can flexibly control the process of information maximization and to obtain internal representations appropriate to given problems. The new method is considered to be a hybrid model similar to the counter-propagation model, in which a competitive layer is combined with an output layer. In addition, this is considered to be a new approach to radial-basis function networks in which the center of classes can be determined by using information maximization. We applied our method to an artificial data problem, the prediction of long-term interest rates and yen rates. In all cases, experimental results showed that the cost can flexibly change internal representations, and the cost-sensitive method gave better performance than did the conventional methods.

Monday, August 30, 14:35pm-15:00pm
Paper NC2.2

EFFECTS OF SOFT MARGINS ON LEARNING CURVES OF SUPPORT VECTOR MACHINES

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Abstract
The generalization properties of support vector machines (SVMs) are examined. From a geometrical point of view, the estimated parameter of an SVM is the one nearest the origin in the convex hull formed with given examples. Since introducing soft margins is equivalent to reducing the convex hull of the examples, an SVM with soft margins has a different learning curve from the original. In this paper we derive the asymptotic average generalization error of SVMs with soft margins in simple cases and quantitatively show that soft margins increase the generalization error.

Monday, August 30, 15:00pm-15:25pm
Paper NC2.3

A NEURO-FUZZY ARCHITECTURE FOR IMPROVING THE PERFORMANCE OF A CLASSICAL CONTROLLER

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Abstract
In this paper a control strategy based on a neuro-fuzzy systems have been devised. Two control system have been considered in order to test the method. Satisfactory results have been obtained in both cases.

Monday, August 30, 15:25pm-15:50pm
Paper NC2.4

A NEW NON-LINEAR MULTI-VARIABLE MULTIPLE-CONTROLLER INCORPORATING A NEURAL NETWORK LEARNING SUB-MODEL

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Abstract
A new non-linear multi-variable multiple-controller incorporating a neural network learning sub-model is proposed. The unknown multivariable non-linear plant is represented by an equivalent stochastic model consisting of a linear timevarying sub-model plus a non-linear neural-network based learning sub-model. The proposed multiple controller methodology provides the designer with a choice of using either a conventional Proportional-Integral-Derivative (PID) self-tuning controller, a PID based pole-placement controller, or a newly proposed PID based pole-zero placement controller through simple switching. The novel PID based pole-zero placement controller employs an adaptive mechanism, which ensures that the closed loop poles and zeros are located at their pre-specified positions. The switching decision between the different non-linear fixed structure controllers can be done either manually or by using Stochastic Learning Automata. Simulation results using a non-linear Multiple

Input Multiple Output (MIMO) plant model demonstrate the effectiveness of the proposed multiple controller, with respect to tracking setpoint changes. The aim is to achieve a desired speed of response, whilst penalizing excessive control action, for application to non-minimum phase and unstable systems.

Tuesday, August 31, 13:45pm-14:10pm
Paper NC4.1

A BINARY NEURAL DECISION TABLE CLASSIFIER

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Abstract
In this paper, we introduce a neural network –based decision table algorithm. We focus on the implementation details of the decision table algorithm when it is constructed using the neural network. Decision tables are simple supervised classifiers which, Kohavi demonstrated, can outperform state-of-the-art classifiers such as C4.5. We couple this power with the efficiency and flexibility of a binary associative-memory neural network. We demonstrate how the binary associative-memory neural network can form the decision table index to map between attribute values and data records. We also show how two attribute selection algorithms, which may be used to pre-select the attributes for the decision table, can easily be implemented within the binary associative-memory neural framework. The first attribute selector uses mutual information between attributes and classes to select the attributes that classify best. The second attribute selector uses a probabilistic approach to evaluate randomly selected attribute subsets.

Tuesday, August 31, 14:10pm-14:35pm
Paper NC4.2

MIXED-SIGNAL NEURON-SYNAPSE IMPLEMENTATION FOR LARGE SCALE NEURAL NETWORK

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Abstract
This paper describes a new mixed-signal VLSI implementation of neural networks for low power and asynchronous operation. The linearised transconductance produces the synaptic function of multiplication, weight programming, and summation of synaptic currents for the neuron. The synapse circuit is designed with 8 transistors, by compensating the non-linearity of MOSFET resistance in the triode region. The flexible configuration of synapse accommodates either the pulse-based implementation or any analogue synapse with multiplication or summation. The operation speed of individual synapse is up to 300 Mega operations with the power consumption of less than 33μW, from the chip design using 0.18μm(3.3V) CMOS process. The accuracy is extendable in modular structure, though the current design is based on 8-bit accuracy. The overall power consumption can be less in practice, as individual synapse only demands the power when there is an active signal. The advantages of proposed VLSI implementation are the large scale implementation with low power consumption and its adaptable features to various requirements from different paradigm of neural network architecture, depending on the demand of asynchronous architecture, pulse/spike-based architecture, or the accuracy requirements.

Tuesday, August 31, 14:35pm-15:00pm
Paper NC4.3

A PLATFORM FOR PARALLEL OPERATION OF VLSI NEURAL NETWORKS

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Abstract
This paper presents a platform for the parallel operation of VLSI neural networks allowing to seamlessly map neural network topologies on distributed resources. The scalable approach provides fast isochronous communication channels transporting the neuron signals between single network modules. The network modules are printed circuit boards hosting a programmable logic with an embedded microprocessor core, memory, and a VLSI neural network ASIC. Currently, the modules are equipped with a mixed-signal neural network ASIC. For its McCulloch-Pitts type neurons a biologically inspired higher-level model of perception is adopted and demonstrated.

Wednesday, September 1, 11:20am-11:45am
Paper NC5.1

CLASSIFICATION OF RECORDED CLASSICAL MUSIC: A METHODOLOGY AND A COMPARATIVE STUDY

R. Malheiro, R. P. Paiva, A. J. Mendes, T. Mendes, A. Cardoso,
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Abstract
As a result of recent technological innovations, there has been a tremendous growth in the Electronic Music Distribution industry. Consequently, tasks such as automatic music genre classification address new and exciting research challenges. Automatic music genre recognition involves issues like feature extraction and development of classifiers using the obtained features. We use the number of zero crossings, loudness, spectral centroid, bandwidth and uniformity for feature extraction. These features are statistically manipulated, making a total of 40 features. Regarding the task of genre modeling, we follow three approaches: the *K*-Nearest Neighbors (KNN) classifier, Gaussian Mixture Models (GMM) and feedforward neural networks (FFNN). A taxonomy of sub-genres of classical music is used. We consider three classification problems: in the first one, we aim at discriminating between music for flute, piano and violin; in the second problem, we distinguish choral music from opera; finally, in the third one, we seek to discriminate between all five genres. The best results were obtained using FFNNs: 85% classification accuracy in the three-class problem, 90% in the two-class problem and 76% in the five-class problem. These results are encouraging and show that the presented methodology may be a good starting point for addressing more challenging tasks.

Wednesday, September 1, 11:45am-12:10pm
Paper NC5.2

SYMMETRY AXIS EXTRACTION BY A NEURAL NETWORK

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Abstract
This paper proposes a neural network model that extracts axes of symmetry from visual patterns. The input patterns can be line drawings, plane figures or gray-scaled natural images taken by CCD cameras. The model is a hierarchical multi-layered network, which consists of a contrast-extracting layer, edge extracting layers (simple and complex types), and layers extracting symmetry axes. Its architecture resembles that of the lower stages of the neocognitron. The model extracts oriented edges from the input image first, and then tries to extract axes of symmetry. To reduce the computational cost, the model checks conditions of symmetry, not directly from the oriented edges, but from a blurred version of them. The use of blurred signals endows the network with a large tolerance to deformation of input patterns, too. It is important to get blurred signals, not directly from the input image, but from the oriented edges. If the input image is directly blurred, most of the important features in the image will be lost. Since the model uses oriented edges, however, most of the important features can still remain even after the blurring operations, by which information of edge locations becomes ambiguous.

Wednesday, September 1, 12:10pm-12:35pm
Paper NC5.3

A NOVEL WAVELET BASED TECHNIQUE FOR DETECTION AND DE-NOISING OF OCULAR ARTIFACT IN NORMAL AND EPILEPTIC ELECTROENCEPHALOGRAM

S.Venkata Ramanan B.Tech, 3rd year, ECE, IIT Guwahati svraman@iitg.ernet.in
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Abstract
The Electroencephalogram (EEG) is a biological signal that represents the electrical activity of the brain. Typical EEG instrumentation settings used are low pass filtering at 75Hz and paper recording at 100V/cm and 30mm/s for 10-20 minutes over 8-16 simultaneous channels. A commonly encountered problem in clinical practice during EEG recording is the 'blanking' of the EEG signal due to blinking of the user's eyes. Eye-blinks and movements of the eyeballs produce electrical signals that are collectively known as Ocular Artifacts and these are 10-100 times stronger than the EEG Signal which is being recorded. The effective filtering of these ocular artifacts is extremely difficult owing to the fact that their frequency spread (1Hz - 50Hz) is observed to be overlapping with that of the EEG. Another major drawback of the existing frequency based de-noising techniques is that they require continuous recording of the Electrooculargram (EOG) signals as well. Recently, Stationary Wavelet Transform (SWT) of the corrupted EEG signal has been used to de-noise it. This paper presents a novel and simple technique for the detection and subsequent de-noising of these ocular artifacts using Haar wavelets of high orders. A comprehensive error analysis has been carried out, both in the time domain based artifact detection as well as the frequency domain based SWT de-noising of EEG. This procedure is also highly artifact selective and so we have applied it to detect and de-noise Epileptic EEG signals.

Wednesday, September 1, 12:35pm-13:00pm
Paper NC5.4

APPLICATION OF ARTIFICIAL NEURAL NETWORK IN PREDICTION OF RAVELING SEVERITY

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Abstract
The most unacceptable structural damage of porous asphalt top layers is the loss of stones leading to raveling. Therefore it is important to predict when the porous asphalt top layer will achieve a critical level of raveling so as to allocate funds for necessary maintenance. SHRP-NL database including eight provinces of the Netherlands was used as the data resource. Artificial Neural Network (ANN) was employed to predict severity of raveling having input parameters related to historical raveling and climate, construction and traffic factors. An ANN is able to forecast raveling low with a high correlation factor (R2=0.986), raveling moderate with (R2=0.926) and raveling high with (R2=0.976). Besides another ANN provided sensitivity analysis indicating the relative contribution of factors related to climate (58%), traffic factor (14%), thickness (6%), roughness (12%) and age (10%) for raveling low and high but for raveling moderate climate (46%), traffic factor (15%), thickness (15%), roughness (13%) and age (11%) are the results. Color Contours illustrated that heavy traffic, low thickness and high roughness cause raveling on old asphalt especially in cold rainy days. ANN proved to be a powerful technique to predict and analyze raveling opening great opportunities for development of ANN models for other detriments.

Tuesday, August 31
Poster NC6.1 (poster P10)

NEW HYBRID SUB-BAND SPEECH ENHANCEMENT SYSTEMS INCORPORATING NEURAL NETWORKS AND POST-WEINER FILTERING

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Abstract
In this paper, two new hybrid sub-band systems are proposed which aim to combine neural network sub-band processing with post-Wiener filtering for adaptive speech-enhancement processing of noisy signals. The proposed hybrid architectures comprise an early auditory-processing modelling inspired Multi-Microphone Sub-band Adaptive (MMSBA) system incorporating neural-network based non-linear sub-band filters, integrated with post-Wiener filtering (WF) in order to further reduce the residual incoherent noise components resulting from the application of conventional non-linear MMSBA processing (without WF). A human cochlear model resulting in a nonlinear distribution of the sub-band filters (as in humans) is also employed in the developed schemes. Preliminary comparative results achieved in simulation experiments using anechoic speech corrupted with real automobile noise show that the proposed structures are capable of significantly outperforming the conventional non-linear MMSBA and wide-band noise cancellation schemes.

Poster NC6.2 (poster P11)

APPLICATION OF EAR-BRAIN ANALOGY FOR SOUND SPECTRAL RESPONSE CHARACTERISATION IN NON-DESTRUCTIVE MATERIAL EVALUATION

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Abstract
The ability of the human's ear-brain system in recognising distinctive sound patterns has been used to develop a non-destructive testing system that is able to evaluate the strength class of material. The work involves the development of the most appropriate and effective configuration of devices and software to observe the response of specimens of wood composites to externally induced excitation of sound in form of white noise. This system predicts the strength class, and eventually the elastic and strength properties, of the specimens nondestructively. The unique sound spectral response of each group of specimens is captured by a microphone, filter and amplifier system that mimics the human 'ear'. The 'brain' is made up of a computer with an adaptive neuro -fuzzy analysis capability. The net amplitude readings of the spectral response changes according to the species and the frequency levels but generally higher density specimens absorb more sound energy resulting in lower readings. Virtual specimens were generated using Weibull distribution to enhance the training and validation, and it was found to be appropriate for the biological materialbeing evaluated. Fuzzy inference model of sound response of the wood composites has successfully been used to classify them according to their density ranking.

Poster NC6.3 (Poster P12)

ANALYSIS OF UNSUPERVISED CLUSTERING BY CROSSING MINIMIZATION

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Abstract

In [3] it was demonstrated for the first time that crossing minimization of bipartite graphs can be used to perform unsupervised clustering. In this paper, we present a detailed analysis of the bipartite graph model used to perform unsupervised clustering. We also discuss the effect of data discretization, followed by simulation results which demonstrate the noise immunity of the proposed technique. Finally we use the proposed technique to discover useful hidden patterns in real agriculture data.

Poster NC6.4 (Poster P13)

A NEW BICLUSTERING TECHNIQUE BASED ON CROSSING MINIMIZATION

Ahsan Abdullah
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Abstract
Clustering only the records in a database (or data matrix) gives a global view of the data. For detailed or a local view, biclustering is required i.e. clustering the records and the attributes simultaneously. In this paper, a new graph theoretic, crossing minimization based biclustering technique is proposed. The performance of the proposed technique is compared with a recently reported classical biclustering technique of Cheng & Church [4] demonstrating notably better results. A white noise model is also used to demonstrate the robustness of the proposed technique.

Cognitive Neuroscience

Monday, August 30, 10:10am-10:35am
Paper CNS1.1

SYNCHRONISATION-BASED COMPUTATIONAL MODEL OF ATTENTION-GUIDED OBJECT SELECTION AND NOVELTY DETECTION

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Yakov Kazanovich, Institute of Mathematical Problems in Biology, Russian Academy of Sciences
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Abstract
We develop a new biologically inspired oscillatory model that combines consecutive selection of objects and discrimination between new and familiar objects. The model
works with visual information and fulfils the following operations: (1) separation of different objects according to their spatial connectivity; (2) consecutive selection of objects located in the visual field into the attention focus; (3) extraction of features, (4) representation of objects in the working memory; and (5) novelty detection of objects. The functioning of the model is based on two main principles: the synchronization of oscillators via phase-locking and resonant increase of the amplitudes of oscillators if they work in-phase with other oscillators. The results of computer simulations of the model are illustrated for visual stimuli representing printed words.

Monday, August 30, 10:35am-11:00am
Paper CNS1.2

MODELLING THE INTERACTION OF ATTENTION AND EMOTION

J. G. Taylor, N. Fragopanagos
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Strand, London WC2R 2LS, UK

Abstract
We review a recently developed engineering control approach to attention. The control system is extended to include biasing by emotional valence, with qualitative analysis given of a range of emotion paradigms. Application of the model is made to a recent paradigm underlining the need for attention in emotional influences. The paper ends with conclusion and discussion of further work.

Monday, August 30, 11:20am-11:55am
Paper CNS1.3

THE RECOMMENDATION ARCHITECTURE MODEL FOR HUMAN COGNITION

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Abstract
A model for human cognitive processing is described. The advantages of the model are that it is able to learn complex combinations of capabilities with limited information recording and processing resources; it can bootstrap its memory and cognitive capabilities from experience with very limited, genetically plausible a priori guidance; and modules in the model resemble physiological structures in the brain. In the model, all information recorded or activated in the cortex is perceptually, cognitively and behaviourally ambiguous. Cognitively complex processing occurs within populations of ambiguous information, and only achieves unambiguous meanings in subcortical structures. The model can account for a wide range of cognitive phenomena with a limited range of information recording and access mechanisms, as illustrated by a detailed discussion of working memory phenomena. However, the need to limit resources means that modules in the model are defined as collections of similar system operations and do not correspond with cognitive features or categories. Descriptions of cognitive phenomena are therefore more complex than "user manual" type models, but "user manual" type models are not

capable of providing an understanding of these phenomena in terms of physiology. An electronic implementation of the model confirms its viability.

Monday, August 30, 13:45pm-14:10pm
Paper CNS2.1

EMBODIED CONSTRUCTION GRAMMAR APPROACH TO COMPOSITIONALITY AND CONCEPTUAL REPRESENTATION

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Abstract
The objective of this paper is to bring us a little bit closer to a general Neuro -Cognitive Theory of Cognition in Language and Thought that can account for the mechanics of language understanding, studied by the models of AI or connectionism, and the biology, explained by neurology and psychobiology. Embodied Construction Grammar (Bergen et al. 2001) provides a formalism to show conceptual representation. Traditionally compositionality is considered a key feature of structured representational systems, be the case of the so called linguistic system. A system of representations is considered compositional because the semantic values of complex representations are determined by the semantic values of their parts. It is the aim of this paper to further the exchange of views on compositionality across disciplines and to explore the implications and condition of compositionality as a property of representational systems in the study of language, mind and brain.

Monday, August 30, 14:10pm-14:35pm
Paper CNS2.2

THE LEARNING OF INSERTIONS BY THE CEREBELLUM

NR Taylor, M Hartley, JG Taylor
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Abstract
A computational model of the cerebellum is developed to learn how to guide the learning of insertions in syntax or motor responses by means of a teacher (assumed in the hippocampus). A short simulation is shown, in which LTP/LTD is used for synapses from the granule cells onto the Purkinje cells, attaining suitable effectiveness.

Monday, August 30, 14:35pm-15:00pm
Paper CNS2.3

TOWARDS A BIOLOGICALLY-INSPIRED REPRESENTATION OF HUMAN AFFECT

YingLiang Ma, Psychology Department, University of Glasgow, Glasgow, G12 8QB, UK
HelenaPaterson, Psychology Department, University of Glasgow, Glasgow, G12 8QB, UK
Alexander Dolia, School of Electronics and Computer Science, University of Southampton, SO17 1BJ, UK
Sung-Bae Cho, Department of Computer Science, Yonsei University, Seoul 120-749, South Korea
Ales Ude, ATR Computational Neuroscience Laboratories, Kyoto 619-0288, Japan
Frank Pollick, Psychology Department, University of Glasgow, Glasgow, G12 8QB, UK

Abstract
We propose a method to reveal the features used by humans in the classification of human movement and apply it to the case of classifying arm movements as angry or happy. The method begins with psychophysical experiments investigating the human classification of point-light movements. Then by comparing the results from these perception experiments with the results of principal component decomposition, we can find a particular feature component that has the highest correlation with human perception. In order to verify the component, we reconstruct movements by using either the first two PCA components alone as well as those two components and

the feature that correlates highly with human perception. Finally, we used a Parzen window to test the recognition effectiveness of these reconstructed movements.

Monday, August 30, 15:00pm-15:30pm
Paper CNS2.4

NEURO-FRACTAL COMPOSITION OF MEANING: TOWARD A COLLAGE THEOREM FOR LANGUAGE

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Washington & Lee University, Lexington, VA 24450, USA

Abstract
This paper presents languages and images as sharing the fundamental property of self-similarity. The self-similarity of images, especially those of objects in the natural world (leaves, clouds, galaxies), has been described by mathematicians like Mandelbrot, and has been used as the basis for fractal image compression algorithms by Barnsley and others. Self-similarity in language appears in the guise of stories within stories, or sentences within sentences (”I know what I know”), and has been represented in the form of recursive grammar rules by Chomsky and his followers. Having observed this common property of language and images, we present a formal mathematical model for putting together words and phrases, based on the iterated function system (IFS) method used in fractal image compression. Building (literally) on vector-space representations of word meaning from contemporary cognitive science research, we show how the meaning of phrases and sentences can likewise be represented as points in a vector space of arbitrary dimension. As in fractal image compression, the key is to find a set of (linear or non-linear) transforms that map the vector space into itself in a useful way. We conclude by describing some advantages of such continuous-valued representations of meaning, and potential implications.

Tuesday, August 31, 13:45pm-14:10pm
Paper CNS4.1

A COMPUTATIONAL FRAMEWORK FOR IMPLEMENTING BAARS’ GLOBAL WORKSPACE THEORY OF CONSCIOUSNESS

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Abstract
We consider Baars’ "Global Workspace" theory of consciousness and discuss its possible representation within a model of intelligent agents. We first review a particular agent implementation that is given by an abstract machine, and then identify the extensions that are required in order to accommodate the main aspects of consciousness. According to Baars’ theory, this amounts to unconscious process coalitions that result in the creation of contexts. These extensions can be formulated within a reified virtual machine encompassing a representation of the original machine as well as an additional introspective component. This computational framework is illustrating throughout using a simple working example.

Tuesday, August 31, 14:10pm-14:35pm
Paper CNS4.2

STEREOSCOPIC DEPTH - A BIOLOGICAL INSPIRED JUDGMENT

Hugo Gravato Marques, IEETA – Institute of Electronic Engineering of University of Aveiro, Campus Universitário de Santiago, 3800-193 Aveiro, Portugal.
Eugénio Oliveira, Faculty of Engineering of University of Oporto, Rua Dr. Roberto Frias, s/n 4200-465 Porto, Portugal.

Abstract
The present paper aims to contribute to the research on depth perception using a biologically inspired model of stereoscopic vision. Stereogram images show that human beings are able to perceive depth just from the differences between the images coming from the retinas of both eyes. The research that was made aspires to find

support for the idea that the way stereogram images are perceived by human beings is just a consequence of the way they see on real world environments; that is, to show that the information received by the brain over generations is sufficient to make us interpret stereogram images as having differences on depth.

Tuesday, August 31, 14:35pm-15:00pm
Paper CNS4.3

CONTEXT BASED MESSAGE SELECTION STRATEGIES IN A BIOLOGICALLY INSPIRED AMBIENT INTELLIGENCE SYSTEM

S. Piva,
D.I.B.E. - University of Genova via Opera Pia 11, 16145 Genova, Italy
L. Marchesotti(1), C. Bonamico(2), C.S. Regazzoni(1)
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(2)C.N.I.T. Genova Research Unit via Opera Pia 11, 16145 Genova, Italy

Abstract
The presented work is concerned with the wide research field of the Ambient Intelligence systems. These systems, also called Smart Spaces (SS), are designed to provide users with augmented services that do not need intensive and invasive interaction efforts. To obtain this, SS main functionalities are *sensing, analyzing, deciding, acting / communicating.* In the scope of this wide research field, this paper particularly deals with the analysis task through the study of a theoretical biologically inspired brain model and with the deciding and communicating tasks through the description of a rule engine based message customization system. Virtual Characters (*avatars*) displayed on the user's device represent the final front-end of the system. This choice is due to the high expressive capabilities guaranteed by this kind of communication means, able to enrich the message content with prosody, facial expressions, gestures and to make the communication more effective. Through examples and architecture diagrams, our solution for the problem of the context awareness-based parameterisation of the system reaction is explained.

Wednesday, September 1, 11:20am-11:45am
Paper CNS5.1

INTER-TRIAL PHASE SYNCHRONISATION IN THE ERP DELTA BAND ACCOUNTS FOR DIFFERENCES IN ODDBALL P300

Thang Nam Hoang, Wael El-Deredy, Paulo J. G. Lisboa and Francis Mcglone*
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*Centre for Cognitive Neuroscience, University of Wales, Bangor LL57 2DG, UK
Correspondent: Thang Nam Hoang Tel: 44-(0)-151-231-2188, Email: hoangnamthang@yahoo.co.jp

Abstract
In a visual oddball reward conditioning task, we demonstrate that changes in the distinctive late positive event related brain potential (P300) can be attributed to differences in phase synchronisation in the delta band of the electroencephalogram, detectable by single trial analysis, where responses to rewarding stimuli exhibit consistent inter-trial phase synchronisation. Consequently, the mean latency of the P300 peak, estimated from the single trials, is significantly different from the latency of the averaged signal, and the distribution of the latencies affects the amplitude of the average. Our result strengthens the suggestion that P300 results from phase oscillation of ongoing EEG and emphasize the importance single trial analysis for investigating brain dynamic.

Tuesday, August 31, 11:45am-12:10pm
Paper CNS5.2

DIPOLE SOURCE LOCALISATION USING INDEPENDENT COMPONENT ANALYSIS: SINGLE TRIAL LOCALISATION OF LASER EVOKED PAIN

Thang Nam Hoang(1), Wael El-Deredy(1), Deborah E. Bentley(2), Anthony K.P. Jones(2), Paulo J. Lisboa(1) and Francis Mcglone(3)
(1) School of Computing and Mathematical Sciences, Liverpool John Moores University, Byrom Street, Liverpool L3 3AF, UK
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Correspondent: Thang Nam Hoang Tel: 44-(0)-151-231-2188, Email: hoangnamthang@yahoo.co.jp

Abstract
The accuracy of the inverse solution that finds the spatial location of the generating sources from averaged scalp-recorded event related potentials (ERPs) relies on assumptions about the ERP signals and the sources. We provide evidence that using independent component analysis (ICA) as a signal
decomposition filter prior to applying the inverse solution reveals sources that cannot be detected by conventional source localisation methods.

Wednesday, September 1, 12:10pm-12:35pm
Paper CNS5.3

EYE MOVEMENT PREDICTIONS ENHANCED BY SACCADE DETECTION

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University of Lueubeck, Ratzeburger Allee 160, 23538 Luebeck, Germany

Abstract
We present a model for predicting eye movements of an observer viewing dynamic scenes. Supervised-learning techniques are used to tune the model for a particular observer. The approach builds on earlier work [3], adding a saccade detector that is used to switch between two different algorithms for saccade and inter-saccade prediction, respectively. This separation yields a significant improvement in prediction quality. The predictor for saccade targets operates on a list of salient locations. These are obtained by evaluating the intrinsic dimension of the image using the structure tensor. Prediction of eye movements between two saccades uses a model that operates on a limited history of locations attended in the past. Both models learn by minimizing the quadratic prediction error using gradient descent. Our work is motivated by applications that involve gaze-contingent interactive displays on which information is displayed as a function of gaze direction. The approach therefore differs from standard approaches in two ways: (i) we deal with dynamic scenes, and (ii) we provide means for adapting the model to a particular observer.

Wednesday, September 1
Paper CNS6.1 (poster P1)

A MATHEMATICAL FRAMEWORK FOR THE GLOBAL BRAIN

JG Taylor
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Abstract
We develop a mathematical framework of continuum neural field theory as the beginning point for an analysis of the global brain. Arguments for and against this approach are developed. Applications to cortical dynamics and learning in somato-sensory cortex, visual cortex and motor control are briefly reviewed. Extensions to a broader range of brain systems, including attention and emotions, are outlined. Open problems are listed to conclude the paper.

Paper CNS6.3 (poster P3)

DEMONSTRATING VOLITION AND AFFECTIVE DECISION MAKING IN BRAIN-INSPIRED NEURAL MODELS

Rabinder Lee, Imperial College, Exhibition Road, South Kensington, London SW7 2AZ

Abstract
This paper presents an experiment concerning affective decision making in artificial neural networks (ANNs). The type of neuron used is the virtual G-RAM neuron, which was developed by Aleksander (1990) and implemented on a multimodule neuro-computational software system called Neural Representation Modeller (NRM), created by Aleksander and Dunmall (2000). I have built two neural configurations, each dealing with contrived and worldly scenarios. Each has a set of rules and facts which are pre-learned, and during execution the

entity has to decide on an appropriate course of action to take, depending on the situation unfolding in the world. The entity also takes into account its current 'emotional' state. I am working on making the decisions largely non-deterministic and random, to create a true freedom of choice. However, as the entity learns about its world, it will develop preferences and habits, and these will introduce a bias in the decision making process. The neural configurations presented in this paper are novel.

Machine Consciousness Debate Abstracts

MECHANICAL BODIES; MYTHICAL MINDS: Dr. Mark Bishop, Dept. Computing, Goldsmiths College, New Cross, London, UK

Abstract
A cursory examination of the history of Artificial Intelligence, AI, serves to highlight many strong claims from its researchers, especially in relation to the populist form of computationalism that holds, 'any suitably programmed computer will instantiate genuine conscious mental states purely in virtue of it carrying out a specific series of computations'. The argument to be presented in this paper is a simple development of ideas first presented in Hilary Putnam's 1988 monograph, "Representation & Reality", which, if correct, has important implications for Cognitive Science both with respect to the prospects of developing a computationally instantiated consciousness and in general for any computational, (purely-functional), explanation of mind. In the paper, instead of seeking to ground Putnam's claim that, "everything implements every Finite State Automata, (FSA)", I will simply seek to establish the weaker result that, "everything implements the specific FSA [Q], when executing program (p) on a particular input set (x)". Then, equating Q (p, x) to an AI program with putative genuine phenomenal (conscious) states, I will show that conceding the computational thesis for Q, (crediting it with genuine mental states and consciousness), opens the door to a vicious form of panpsychism whereby all open systems, (e.g. grass, rocks and toadstools), have conscious experience and disembodied minds, ('ubiquitous pixies'), are found dancing everywhere...

THE AXIOMATIC APPROACH TO MACHINE CONSCIOUSNESS: Prof Igor Aleksander, Professor of Neural Systems Engineering, Imperial College, London

Abstract
For me it makes sense to break my own feeling of being conscious into five basic introspective components or 'axioms':

- Feeling as a 'self' in an out-there world
- Imagining being in real of imaginary out-there worlds
- Attending to out-there worlds according to current needs
- Planning what to do next using imaginative knowledge
- Evaluating plans through emotions

These can be shown to map into computationally achievable structures and together provide 'explanations' of consciousness as well as novel machinery for artificial systems. Some of the major benefits of this approach can be listed

- A bridging of the explanatory gap in Chalmers' formulation of the 'hard problem'
- An explanation of change and inattention blindness
- A model of will
- A comment on dreaming.
- A comment on animal consciousness

The final parable, however is: it's not being conscious that distinguishes between the human, the slug and the machine, it is the content of the states of the machine consciousness models. But having such computational models Is a distinct step forward in the science of consciousness.

CONSCIOUSNESS NEEDS CAREFUL CRAFTING: Prof John G Taylor, Dept of Mathematics, King's College London, UK

Abstract
The necessary and sufficient conditions are still unknown for consciousness to emerge from the activity of the human brain. It is therefore expected to be even more difficult to construct a machine that can be guaranteed to be conscious. That does not however mean that machine consciousness is impossible. I will describe a program of work that attempts to attack machine consciousness by a) analysing how any machine can be tested for its conscious powers (the extended Turing test) b) developing a set of criteria on the structure of the machine so that it have the possibility of real-time experience c) detect that the machine possess an attention control structure indicating it is filtering out all but what might be in its consciousness. The need for such criteria is made stronger by the new generation of nano-chips being created over the next few years.

Abstracts for Workshop on Information coding in early sensory stages

13:45-14:15. **THE ROLE OF THE RETINAL BIPOLAR CELLS IN THE SEQUENTIAL PROCESSING OF THE VISUAL INFORMATION.**
Varela Rodríguez, C.

Abstract
Since Cajal's works were published the retina has been considered a model of the Central Nervous System (CNS) in reason of two facts. The first one is that the retina is the only part of the CNS accessible to a simple clinical exploration as the fond of the eye, and it is also very easy to obtain to perform experimental manipulations. The second reason is that it has a very well organised nature, so it has been quite easy to find some of the circuits that underlay the processing of the visual information. The understanding of the retinal information processing can help to improve the electronic-computational devices inspired in the CNS.
The retina transforms the energy, the luminous to electrical and this to chemical. So, the visual information travels across the CNS and allows the animal to perceive the visible world. However, the retina is much more than a transductor of the light to electrical energy. Nowadays, it is classical the explanation of the "Parallel Processing" of the information performed by the retina (for review see Boycott and Wässle, 1999; Wässle and Boycott, 1991; Kolb, 1994). The retina performs a sequential as well as a parallel processing of the information. In this workshop we propose a little review to have a look to the first steps in the processing of the visual information. We will centre our explanation and examples in the scotopic or nocturnal pathway.

14:15-14:45. **SPATIO-TEMPORAL INFORMATION CODING IN THE CUNEATE NUCLEUS.**
Navarro J., Canedo A. and Sánchez E.

Abstract
The dorsal column nuclei, cuneatus and gracilis, receive somesthetic information impinging on projection cells and local inhibitory interneurons. The presence of these interneurons allows spatio-temporal progressive coding of information that can be modelled (Sánchez et al., 2004) using their known synaptic connections with projection cells (Mariño et al., 1999; Aguilar et al., 2002, 2003). Here we explore the dependency of the processing time required to complete the progressive coding with regard to cutaneous stimuli varying in size and contrast.

14:45-15:15. **CORTICAL REPRESENTATION LEARNING REGULATED BY ACETHYLCOLINE.**
Junichiro Hirayama (1), Junichiro Yoshimoto(2) and Shin Ishii(2)
(1) Nara Institute of Science and Technology 8916-5 Takayama, Ikoma, Mara 630-0192, Japan
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Abstract
A brain needs to detect an environmental change and to quickly learn internal representations necessary in a new environment. This article presents a theoretical model of cortical representational learning that can adapt to dynamic environments, incorporating the results of previous studies on the functional role of acetylcholine (ACh). We adopt the probabilistic principal component analysis (PPCA) as a functional model of cortical representational learning, and present an on-line learning method for PPCA according to Bayesian inference. Our approach is examined in two types of simulations with synthesized and realistic datasets, in which our model is able to re-learn new representation bases after environmental changes. Our model implies the possibility that the higher-level recognition regulates the cortical ACh release in the lower-level, and that the ACh level alters the learning dynamics of a local representation unit in order to continuously acquire appropriate representations in a dynamic environment.

15:15-15:.45. **SIMULATION OF A PROPOSED BINDING MODEL**
Coward A**.**

Abstract
A model for cortex information processing is described which depends upon a combination of population, rate and temporal coding for action potential spikes. In this model, binding of information derived from one visual attention object occurs because attention causes a slight (~ 1 millisecond) shift in each spike in the sensory inputs derived from the object towards the nearest peak to the spike in a 40 Hz modulation frequency. This frequency modulation results in preferential processing of the information derived from the attention object. Simulations of populations of leaky integrator neurons with both excitatory and inhibitory connectivity demonstrate that this preferential processing occurs with physiologically reasonable synaptic integration times, and allows object categorization on time scales consistent with human cognitive processing.