IEEE SMC 2009 Tutorials (in alphabetic order by presenter's surname)

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(1) Title: **"Multimedia Security Systems"**
Presenters: **Sos Agaian and Dr. Philip Chen**
Duration of Tutorial: Full day

Abstract

The issue of multimedia data security is becoming increasingly vital as civilization moves closer and closer toward the information age. Creation, editing, distribution, and storage of digital multimedia data, such as images, audio, video, and text, have become the major tasks of today's computerized systems (cell phones, PDAs, etc.) along with the continuous availability of Internet, and will continue to be the major driving strength to the system research and communications in the future. Current advances, in the digital multimedia processing community, have introduced a wide range of security aspects on the topics of confidential data transmission and storage, user identification, and authentication.
This course will present an overview of the theory and the integrated applications in the secure communication and information systems. The three main objectives of this course are: To gain knowledge of the multimedia data system representations; to ensure security and the integrity of the vital multimedia data through the concepts of cryptographic and digital data hiding (steganographic, watermarking) techniques; to utilize these concepts in the real time applications.

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(2) Title: **"Brain-Machine Interfaces"**
Presenters: **Jose M. Carmena and Jose del R. Millan**
Duration of Tutorial: One-half day

Abstract

In this tutorial we will introduce the exciting new field of brain-machine interfaces (BMI) and survey the main invasive and non-invasive techniques employed and their applications. BMI is a young interdisciplinary field that has grown tremendously during the last decade. BMI is about transforming thought into action, or conversely, sensation into perception. This novel paradigm contends that a user can perceive sensory information and enact voluntary motor actions through a direct interface between the brain and a prosthetic device in virtually the same way that we see, hear, walk or grab an object with our own natural limbs. Proficient control of the prosthetic device relies on the volitional modulation of neural ensemble activity, achieved through training with any combination of visual, tactile, or auditory feedback. BMI has enormous potential as therapeutic technology that will improve the quality of life for the neurologically impaired.
Research in BMIs has flourished in the last decade with impressive demonstrations of nonhuman primates and humans controlling robots or cursors in real-time through single

unit, multiunit and field potential signals collected from the brain. These demonstrations can be divided largely into two categories: either continuous control of end-point kinematics, or discrete control of more abstract information such as intended targets, intended actions, and the onset of movements. In the first part of the tutorial, Dr. Carmena will cover cortical approaches to BMI with a focus on bidirectional techniques for decoding motor output and encoding sensory input. The techniques to be discussed include chronic microelectrode arrays in animal subjects as well as electrocorticography (ECoG) in human subjects. In the second part of the tutorial, Dr. Millan will cover non-invasive approaches to BMI with a focus on brain-controlled robots and neuroprosthetics. These approaches are based on electroencephalogram (EEG) signals. As illustrated by some working prototypes such a wheelchair, the success of these approaches rely on the use of asynchronous protocols for the analysis of EEG, machine learning techniques, and shared control for blending the human user's intelligence with the intelligent behavior of a semi-autonomous robotics device.

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(3) Title: **"Challenges in Network Virtualization"**
Presenter: **Omar Cherkaoui**
Duration of Tutorial: One-half day

Abstract
This tutorial provides an overview to the discipline of Network Virtualization (NV). Previously, Network Virtualization has consisted in deploying network services (VLAN, VPN, etc) and today it has evolved in the deployment of multiple distinct networks over the same physical infrastructure. Each network instance requires a level of isolation from the other instances. This isolation uses some old OS concepts of virtualization like: Hypervisor (VMM) and Containers. Furthermore, those concepts use an independent layer for the control and sharing of resources like network links, CPU, memory, interfaces, etc. Virtualization has emerged as an active research area. Many large research projects (GENI, 4ward, Federica, Clean Slate, Horizon, JGN2 Japan) have been launched during the last two years. Those initiatives mainly try to develop the next generation network based on the network virtualization concept. Network virtualization will require resolving many research issues and challenges. We need to know where to push this virtualization: on which network/equipment and at which layer (L3/L2/L1)? We also need to determine the right trade - off between isolation, performance and flexibility of migration. It means that we need to decide where to push virtualization: at the data plane, control plane or management plane. Another approach is to determine if virtualization needs to be established at the hardware level, OS level or service level. New Infrastructure virtualization architectures need to be developed. Resource allocation algorithms will have to be adapted to the network virtual instances. This virtualization also adds a new level of configuration complexity that requires resolution. We will review the way the main architectures proposed by the different projects like GENI, VINI, Find, Clean slate, Horizon, etc. handle those virtual slices and instances. We will expose different migration strategies in order to offer resiliency and reliability in this new virtualized environment.

(4) Title: **“Simulation-Based Engineering of Complex Systems”**
Presenter: **John R. Clymer**
Duration of Tutorial: Full Day

Abstract

A description of a new, proven way for engineering complex, adaptive systems is presented, consisting of a method, a graphical system description language, a computer-aided design tool, and several illustrative examples. Study of a large number of complex systems during the last 40 years by Dr Clymer and others, including computer, transportation, manufacturing, business, and military systems, has shown that complex systems are best characterized as a set of interacting, concurrent processes. This discovery inspired the development of Context Sensitive Systems (CSS) theory, based on mathematical linguistics and automata theory, as a way of thinking about complex systems using interacting concurrent processes. During the 1968-1971 time-frame, Dr. Clymer developed a graphical modeling language, Operational Evaluation Modeling (OpEM), to express CSS models of both existing and conceptual systems. During the same time period, an alternative approach, Petri nets, was developed independently of OpEM. Subsequently, after 20 years of using procedure oriented simulation programs to design and evaluate complex systems, a graphical, object-oriented, discrete event simulation library, OpEMCSS, was developed that works with ExtendSim (Imagine That Inc.) to enable rapid development of CSS models and simulations in the OpEM language.

Since an OpEMCSS simulation is an abstract description of a complex system, understanding how the simulation works assists the systems engineer in understanding how the complex system works, allowing the system design to be optimized to meet stakeholder requirements. In this tutorial, it is shown that CSS theory, OpEM modeling language, and OpEMCSS library can be applied to understand Complex Adaptive Systems (CAS) and to perform Model-Based Systems Engineering.

Model-Based Systems Engineering (MBSE) mitigates system development problems (resulting from “stove-piped systems” design methods) that are caused by the failure to optimize the interoperability and synergisms among all component algorithms and methods at the overall system level. Further, the interactions of the system with its external systems and the dynamic demands of the operational environment on the system must be included in a MBSE system level model and evaluated for tradeoffs.

An OpEMCSS system level model provides the structure and ontology (top level formalisms) needed to connect detailed component models for MBSE. The MBSE approach presented in this tutorial is: (1) apply the OpEM top-down systems design methodology, (2) perform system concept and top level design tradeoffs to optimize stakeholder requirements using OpEMCSS, (3) produce a systems design specification that includes component interface and qualification system requirements using a design capture database tool, (4) develop component detailed models of alternative component algorithms and methods using the OpEMCSS special blocks, (5) perform virtual systems integration and system Verification & Validation (V&V) using the system level OpEMCSS simulation, and (6) determine impact of requirements changes and conduct detailed design trades using the system level OpEMCSS simulation.

The OpEMCSS graphical simulation library works with the popular commercial software

tool, ExtendSim (www.ImagineThatInc.com), which was chosen for two major reasons. First of all, ExtendSim is relatively inexpensive for people to buy and use. Further, the ExtendSim DEMO program is available free from Imagine That Inc.
The OpEMCSS icon-blocks automatically provide more than 95% of all simulation code that in the past had to be programmed by hand. In context-sensitive systems, these programming details are very complex and would otherwise require extensive programming skill and effort to accomplish. ExtendSim, with the OpEMCSS library, gives systems practitioners the ability to experiment with complex, context-sensitive interactions and quickly build a model. Time is not wasted dealing with complex programming details and writing extensive code, but rather the emphasis is on complex systems design, analysis, and evaluation for MBSE.
ExtendSim +OpEMCSS can be used in any field that is concerned with entities that perform a set of tasks that lead to satisfaction of a measurable goal that may or may not be explicitly known or stated. Such fields include project management, systems engineering, software engineering, industrial engineering, business organizations, societal systems and sociology, biological and ecological systems, economic systems, and others. Thus, this tutorial is designed for a broad spectrum of people who wish to gain an understanding of complex systems and MBSE. It will be shown that, although complex systems have behaviors that are often difficult to understand, the underlying ExtendSim +OpEMCSS modeling building blocks comprising a complex system model are simple and easy to understand.

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(5) Title: **“Requirements Engineering for Complex Systems”**
Presenter: **Dr. Armin Eberlein**
Duration of Tutorial: Half-day

Abstract
This tutorial addresses the early life cycle of system development and its effect on later stages of the life cycle. Assuming that the primary measure of project success is the extent to which the system meets the users’ needs, the determination of these needs is critical. A flawlessly working system that does not meet the users’ needs is considered a failed project. How much requirements engineering is needed? Should we use traditional approaches or agile approaches? This tutorial aims at demystifying the challenges related to requirements. It shows the importance of getting just enough requirements to have a sufficient understanding of the system in order to start its development. The requirements engineering process will be introduced together with the activities involved, such as requirements elicitation, analysis, documentation, validation and management. The tutorial will focus on techniques that can be used to improve each one of these stages. The techniques include stakeholder identification and profiling, interviewing, traceability techniques, reviews, requirements testing, requirements management, requirements change, tools, prototyping, etc. Emphasis will also be placed on how to handle nonfunctional quality requirements. The tutorial points out situations in which the various requirements engineering techniques are most applicable. Using all the techniques all the time and going for more-and-more complex approaches is just as detrimental to project success as ignoring

requirements engineering completely. The aim is to find the most efficient set of requirements engineering techniques for the project at hand. With the help of an industrial case study, the tutorial will show how a customized development process that contained just-enough requirements engineering was used to maximize the benefits. The success of this project is shown by comparing it with another, similar project that did not use a proper requirements engineering process.

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(6) Title_6a: **"New Trends in Safety Engineering"**
Presenter: **Dr. Hossam A. Gabbar**
Duration of Tutorial: Half-Day
Abstract
Accidents are still occurring in industrial systems, which cause harm to human, facility, and the environment. Manufacturing and production organizations are seeking better ways to ensure safety. This tutorial explores advanced methods and best practices in safety engineering, which includes safety system design, process safety management, safety life cycle, fault simulation, qualitative and quantitative fault diagnosis techniques, risk assessment and management, safety verification, safety knowledge management and decision support, and computational methods for safety systems. Participants will have hands on practice using international standards of IEC-61508, ISA-S84, ISA-S88, ISA-S95, and other related safety standards that will be explained using selected processes from oil & gas, energy systems, production and manufacturing systems. Participants will acquire essential knowledge and hands on experience about risk calculation, treatment, management, and their applications on the design and verification of recovery, startup/shutdown, and disaster operating procedures. They will acquire knowledge about accident / incident analysis and management using knowledgebase systems and computational intelligence techniques.

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(6) Title_6b: **"Risk-Based Design & Evaluation of Green Hybrid Energy Supply Chains"**
Presenter: **Dr. Hossam A. Gabbar**
Duration of Tutorial: Half- Day
Abstract
All nations are seeking cleaner and cheaper energy systems to cover their local and regional energy needs using combined hybrid energy technologies. This tutorial will enable energy practitioners and professionals to learn engineering design methods and best practices to model and evaluate difference energy supply chain scenarios using all possible renewable energy sources, such as sun, wind, nuclear, geothermal, water, and biomass. Participants will learn modeling and simulation techniques, risk-based design, and process control and operation synthesis of energy supply chain with the considerations of safety, health, and environmental management. Attendees will acquire essential knowledge on

qualitative and quantitative process optimization to achieve best energy supply chain scenarios in view of local renewable sources, energy demand, and conversion technologies. Case studies will be analyzed to identify possible energy supply chain scenarios and their implementation using smart grid controllers.

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(7) Title: **"Frequency-time discrete transforms and their applications in image processing"**
Presenter: **Artyom Grigoryan**
Duration of Tutorial: Half-Day
Abstract
The goal of this tutorial is to present the theory of splitting of fast 2-D Fourier transforms in time-frequency domain and their applications in image processing, namely in multiresolution, image filtration, image reconstruction from their projections, image enhancement and encryption. We focus on a novel approach for efficient calculation of 2-D unitary transforms, which relates to the construction of decomposition, namely the universal transition to the short unitary transforms with minimum computational complexity. The core of this course is the tensor representation and its modification, the paired representation of the 2-D images with respect to the Fourier transform.
The paired transformation provides frequency and time representation of 2-D images, but it is not a wavelet transform. The basic functions of the paired transforms are defined by linear integrals (sums) along specific parallel directions in the spatial domain. Therefore it is possible to decompose the image by its direction images and define a multiresolution map which can be used for image processing and enhancement. Many examples and MATLAB-based programs illustrating the proposed concepts of the tensor and paired forms of image representation and their implementations in image enhancement and image reconstruction are demonstrated as well. We also introduce novel concepts of the mixed and parameterized elliptic Fourier transforms which can be used in signal and image processing, including image cryptography. This course introduces the reader new concepts and methods in Fourier analysis in advanced digital image processing. It will help readers to use new forms of representation and their effective applications in 2-D image processing, as well as in multidimensional image processing in the frequency-and-time domain.

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(8) Title_8a: **"Model a Discourse and Transform it to Your User Interface"**
Presenter: **Hermann Kaindl**
Duration of Tutorial: Half-Day
Abstract
Every interactive system needs a user interface, today possibly even several ones adapted for different devices (PCs, PDAs, mobile phones). Developing a user interface is difficult and takes a lot of effort, since it normally requires design and implementation. This is also

expensive, and even more so for several user interfaces for different devices. This tutorial shows how human computer interaction can be based on discourse modeling, even without employing speech or natural language. Our discourse models are derived from results of Human Communication theories, Cognitive Science and Sociology. Such discourse models can specify an interaction design. This tutorial also demonstrates how such an interaction design can be used for model driven generation of user interfaces and linking them to the application logic and the domain of discourse.

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(8) Title_8b: **"Combining Requirements and Interaction Design through Usage Scenarios"**
Presenter: **Hermann Kaindl**
Duration of Tutorial: Half Day
Abstract
When the requirements and the interaction design of a system are separated, they will most likely not fit together, and the resulting system will be less than optimal. Even if all the real needs are covered in the requirements and also implemented, errors may be induced by human computer interaction through a bad interaction design and its resulting user interface. Such a system may even not be used at all. Alternatively, a great user interface of a system with features that are not required will not be very useful as well. Therefore, we argue for combined requirements engineering and interaction design, primarily based on usage scenarios. However, scenario-based approaches vary especially with regard to their use, e.g., employing abstract use cases or integrating scenarios with functions and goals in a systematic design process. So, the key issue to be addressed is how to combine different approaches, e.g., in scenario-based development, so that the interaction design as well as the development of the user interface and of the software internally result in an overall useful and useable system. In particular, scenarios are very helpful for purposes of usability as well.

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(9) Title: **"Soft Computing For Biometrics Applications: A Comprehensive Overview"**
Presenter: **Dr. Marian S. Stachowicz**
Duration of Tutorial: Half- day
Abstract
The goal of soft computing is to create systems, which can handle imprecision, uncertainty, and partial information while preserving robustness, tractability, and low solution cost. The ideal model for such a system is the human brain. Three of the principal components of soft computing are fuzzy systems, neural computing, and genetic algorithms. Different combinations of these principals can be used in a complementary fashion to produce powerful systems for modeling, diagnosis, and control. Various biometric technologies are available for identifying or verifying an individual by measuring fingerprint, hand geometry, face, signature, voice, or combination of these traits. Because a biometric feature

cannot be captured in precisely the same way twice, biometric matching is never exact. The matching is always a fuzzy comparison. This characteristic makes soft computing an ideal approach for solving different biometric problems. This user-friendly tutorial is a valuable resource to introduce professionals from many disciplines to the broad applicability of Soft Computing to several areas of human affairs.

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(10) Title: **"New Global Optimization Techniques Based on Computational Intelligence"**
Presenter: **Dr. Mark Wachowiak**
Duration of Tutorial: Half-day
Abstract
Global optimization techniques from computational intelligence, such as particle swarm and ant colony methods, have become increasingly important in systems science and engineering, and in human-machine systems. For example, complex systems are often modeled as large systems of equations, in which model parameters are determined to correspond with experimental data. Global optimization is used to find these parameters. Furthermore, many important problems from systems science rely on simulation-based or multi-objective optimization, wherein the cost function itself is formed from the results of large simulation experiments. Although derivative-based methods are generally agreed to be preferred strategies, in simulation-based optimization, closed-form derivatives of the objective function are generally not available, and are not easily computed. As a result, new optimization paradigms must be considered to solve these problems. The purpose of this tutorial is to introduce the motivations for these new optimization strategies – in particular, swarm intelligence, quantum particle swarm, ant colony optimization, new concepts in evolutionary computation, and hybrid deterministic-stochastic paradigms – their fundamental theoretical principles, implementation issues, and recent novel applications. The adaptation of these innovative techniques to new multi- and many-core computers, which are becoming increasingly popular and inexpensive, will also be addressed. Visualization-guided and interactive optimization will also be demonstrated.

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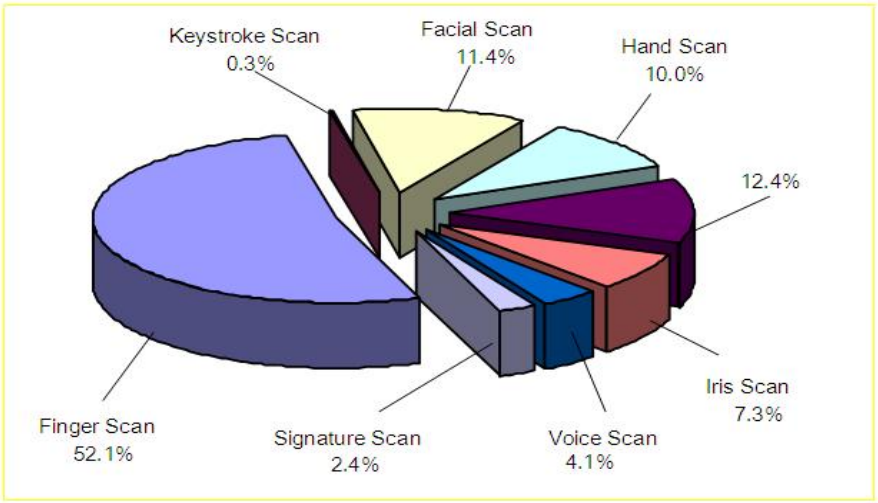
(11) Title: **"Intelligent Pattern Recognition and Applications on Biometrics in Interactive Learning Environment"**
Presenter: **Dr. Patrick Wang**
Duration of Tutorial: Half-day
Abstract
This talk deals with some fundamental aspects of biometrics and its applications. It basically includes the following: Overview of Biometric Technology and Applications, Importance of Security: A Scenario of Terrorists Attack, What are Biometric Technologies? Biometrics: Analysis vs Synthesis, Analysis: Interactive Pattern Recognition

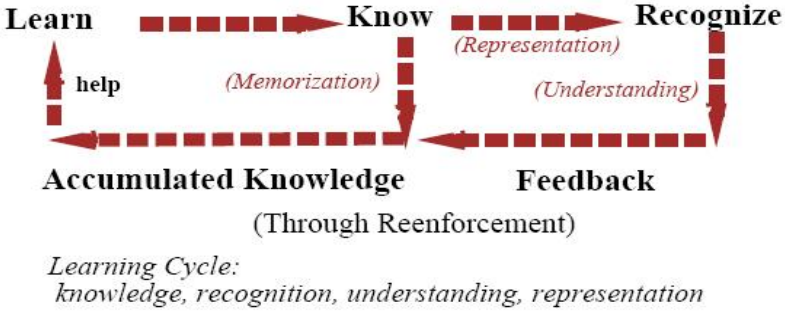
Concept, Importance of Measurement and Ambiguity, How it works: Fingerprint Extraction and Matching, Iris, and Facial Analysis, Authentication Applications, Thermal Imaging: Emotion Recognition. Synthesis in biometrics, Modeling and Simulation, and more Examples and Applications of Biomedical Imaging in Interactive Fuzzy Learning Environment. Finally, some future research directions are discussed.

What are Biometrics?

Biometrics are automated methods of recognizing a person based on the acquired physiological or behavioral characteristics



Percentage of usage (Source: International biometric group)



Learning Cycle:
knowledge, recognition, understanding, representation

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(12) Title:e:: **"Role Base Collaboration"**
Presenter: **Dr. Haibin Zhu**
Duration of Tutorial: Half- day

Abstract

This tutorial aims at promoting the research and application of role-based collaboration and attracting more researchers and practitioners' interests. RBC is a computational thinking methodology. It is an emerging technology that mainly uses roles as underlying mechanisms to facilitate abstraction, classification, separation of concern, dynamics, and interactions. It will find wide applications in different fields, such as, organizations, management systems, systems engineering, and industrial engineering. It is generally

relevant to many research and engineering fields including Software engineering, Computer Security, Collaborative Intelligent Systems and Social Psychology (Fig. 1). The goal of special RBC to improve collaboration among people based on computers. CSCW (Computer-Supported Collaborative Work) systems are computer-based tools that support collaborative activities and should meet the requirements of normal collaboration. They should not only support virtual face-to-face collaborative environment but also improve face-to-face collaboration by providing more mechanisms to overcome the drawbacks of face-to-face collaboration. The extended goal of general RBC is to improve collaborations among objects including humans, systems, and system components. Roles can be used to improve the collaboration methodologies, upgrade the management efficiencies, keep the consistencies of systems, and regulate the behaviors of system components and systems. In this tutorial, we hope to clarify the terminology of role-based collaboration and answer the following questions: What do we mean by roles in collaboration? What is role-based collaboration (RBC)? Why do we need RBC? How can we support RBC? What are the emerged and potential applications of RBC? What are the emerged and potential benefits? What are the challenges and difficulties?

At first the current situation of CSCW research and the applications of role concepts are reviewed, and the reasons of proposing role-based collaboration is explained. Then, a synthetic view of roles in collaboration is proposed. Based on the role concept, the general process of role-based collaboration is demonstrated. To support role-based collaboration efficiently, the architecture of role based collaborative systems and the system model E-CARGO are described. To demonstrate the application of RBC, two case studies of RBC applications are presented: role-based multi-agent systems and role-based software development. To show that RBC is significant and practical, the role transfer problem is explained, an initial solution is presented and a copyrighted software is demonstrated. At last, potential applications of RBC and challenges that need further research are predicted.

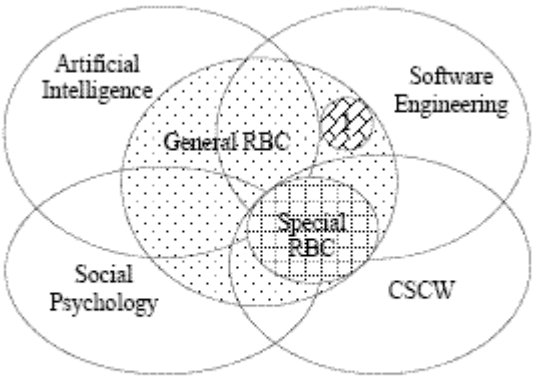

Fig. 1 RBC and other relevant Area

(13) Title: **"Neurodynamic Optimization: Mathematical Models and Selected Applications"**
Presenter: **Dr. Jun Wang**
Duration of Tutorial: Half-day

Abstract

Optimization problems arise in a wide variety of scientific and engineering applications. It is computationally challenging when optimization procedures have to be performed in real time to optimize the performance of dynamical systems. For such applications, classical optimization techniques may not be competent due to the problem dimensionality and stringent requirement on computational time. One very promising approach to dynamic optimization is to apply artificial neural networks. Because of the inherent nature of parallel and distributed information processing in neural networks, the convergence rate of the solution process is not decreasing as the size of the problem increases. Neural networks can be implemented physically in designated hardware such as ASICs where optimization is carried out in a truly parallel and distributed manner. This feature is particularly desirable for dynamic optimization in decentralized decision-making situations. In this talk, we will present the historic review and the state of the art of neurodynamic optimization models and selected applications. Specifically, starting from the motivation of neurodynamic optimization, we will review various recurrent neural network models for optimization. Theoretical results about the stability and optimality of the neurodynamic optimization models will be given along with illustrative examples and simulation results. It will be shown that many computational problems can be readily solved by using the neurodynamic optimization models including k winner-take-all, linear assignment, shortest-path routing, data sorting, robot motion planning, robotic grasping force optimization, model predictive control, etc..