TUTORIAL SUMMARIES

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TUTORIAL 1

Agent based Classifier Design and Applications

Pattern recognition and classification are activities that humans perform everyday without much conscious effort. Humans receive patterns via sensing organs, whereby the patterns acquired are processed by the brain to form useful information. Subsequently, a decision for the action to be taken with respect to the patterns received is made. However, recognizing and classifying patterns is a non-trivial task for computerized systems. To tackle pattern recognition and classification problems, it is necessary for a computerized system to have techniques and algorithms that are able to process and recognize patterns from data and/or information supplied to the system. Owing to the cross-fertilization nature, pattern recognition and classification researches normally require knowledge from many disciplines, which include engineering, computer science, physics, mathematics, and cognitive science.

In this tutorial, the design of a Multi-Agent Classifier System (MACS), which is developed based on the Multi-Agent System (MAS) methodology, will be presented. The MACS comprises an ensemble of computational-intelligence-based classifier agents. A novel Trust-Negotiation-Communication (TNC) method is employed as the reasoning model for the MACS. In TNC, communication is concerned with the interaction among agents in order for them to understand each other. Negotiation, on the other hand, is concerned with how agent teams are formed. The core part of the TNC model is trust, whereby the main concern is how an agent handles trust and interacts with other agents. As such, effective algorithms to measure and quantify trust, which is of prime importance to determine the success or failure of the TNC model, will be described.

To assess the practical applicability of the MACS, two real-world problems, i.e., fault detection and diagnosis with sensor data collected from a power generation plant and medical prognosis and diagnosis with patient data collected from hospitals will be demonstrated. The effectiveness and implications of the MACS in undertaking these real industrial and medical pattern classification tasks will be analyzed and discussed.

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TUTORIAL 2

Kinematics, Dynamics and Optimal Trajectory Planning of Industrial Manipulators

Trajectory planning is one of the fundamental issues in the design and development of manipulators. A time-trajectory may be generated in joint space or Cartesian space. In joint space trajectories, trajectories are specified for each independent joint. The actual Cartesian position of the end-effector is only known at the initial and goal position. On the other hand, Cartesian trajectories are easy to specify and tip motion of the manipulator is completely specified. Joint motion is obtained via the velocity Jacobian. Since trajectories are not generated in joint space, care must be taken that the trajectories do not pass, or close to, singularities. Trajectories are chosen to fairly smooth to allow reasonable time for the manipulator to accelerate and to decelerate. The trajectories in both joint and Cartesian space schemes can be chosen in a number of ways.

The trajectory is normally determined to satisfy a certain criterion optimally. Optimal performance means different things to different people such as minimum time, minimum kinetic energy, and obstacle avoidance. Optimization is normally performed in the presence of constraints. In addition to the dynamic system equations acting as constraints, there may be bounds on the inputs as well as constraints on some of the states. The constraints are of two types: The system constraints imposed by the manipulator itself and task constraints given by the task. The problem is how to calculate feasible trajectories from a given path with simultaneous utilization of the maximal capabilities of the manipulator.

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TUTORIAL 3

Intelligent Multi-Agent Systems (i-MARS)

Summary to be announced

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TUTORIAL 4

Cochlear Mechanics

This tutorial will describe the structure of the sensory organ in the inner ear and how waves propagate within it that allows us to discriminate different frequencies and different levels of sound.

A simple but powerful discrete model of the mechanics of the cochlea will be described, in which the fluid coupling along the length of the cochlear interacts with the dynamic behaviour of the cochlear partition. This model has recently been formulated in state space form, which allows the stability to be assessed of the array of feedback loops that amplify the waves that propagate within the cochlea. This formulation also allows time domain simulations to be performed of the nonlinear behaviour of the cochlea, particularly the behaviour of various types of otoacoustic emission.

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TUTORIAL 5

Introduction to Data Mining and its Application to Mechanical Engineering

Data Mining (DM) is the process of knowledge discovery or retrieval of hidden information from datasets. DM is becoming an essential instrument for researchers. It comprises of many techniques used for knowledge discovery. DM can process and analyze engineering data, medical data, business data, etc. In a recent study, DM was listed among the 12 IT skills that employers can't say no to.

This tutorial gives an introduction to DM. It also explains briefly how some of the major DM algorithms work. It gives a hands-on experience on the use of WEKA. At the end of the tutorial, participants will be able to understand DM better, and will be able to select the appropriate approach to a particular problem.

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TUTORIAL 6

Shape Design Algorithms in Thermo Fluid Engineering Problems

The needs of the society to carry out tasks are the design problems for engineers. Design problems can be defined in all engineering disciplines and the mechanical engineering is not an exception. Among the mechanical design problems, thermo-fluid design problems are directly related to the very basic and urgent needs of the human kind. Thermo-fluid design problems, in turn, have many sub-categories. This lecture is about the thermo-fluid shape design problems.

Consider a duct facilitating the flow of a fluid. How can we design the shape of the duct such that the pressure loss is minimized? In an external flow context, how a wing section should be designed to achieve a prescribed surface pressure distribution? Turning to thermal problems, how the boundary of a heat conductor needs to be shaped such that both the prescribed heat flux and a target temperature distribution at the boundary are satisfied? These are important practical questions that engineers are expected to answer and that are discussed in this lecture.

The traditional try and error experimental design approach is both expensive and time consuming. Employing the mathematical models in an iterative procedure guided by an experienced engineer is also neither practical nor desirable. Design algorithms offer efficient solution methods to the shape design problems. Important inputs to a shape design problem are an initial guess for the shape and a user-specified design objective.

Since the thermo-fluid phenomena are in general too complex to be modeled with analytical mathematical expressions, numerical solution of the design problems is often necessary. Hence, the mathematical models have to be discretized. This is where the Computational Fluid Dynamics (CFD) comes into the play, often called the flow solver or analyzer. Also, any numerical solution needs a discrete solution domain. Therefore, grid generation is also an important ingredient in the mix. When the thermo-fluid field is calculated for the most recent available shape, a procedure is needed to change or update the current shape and to get closer to the design objective. A design algorithm, here called a shape updater, takes care of this last part of one design iteration. Therefore, a grid generator, a flow solver and a shape updater are the required tools in each design cycle. These are here called the three design tools.

In this lecture, three general shape design algorithms are introduced and used to solve a number of thermo-fluid shape design problems. In the first category, which includes the classical optimization methods as well as the recently developed adjoint equation-based methods and genetic algorithms, the mathematical expressions for the design tools are decoupled and solved in a sequence of operations. In the second category, which offers a fully coupled formulation, the mathematical expressions for all of the design tools are solved simultaneously. Finally, a semi-coupled formulation is also introduced which offers a partial coupling between the design tools. This third category is particularly attractive when unstructured grid generators are employed.

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TUTORIAL 7

Thermal Management in Electrical Systems

The course starts with an emphasis on the necessity of the thermal management in electronic systems. Fundamentals of the heat transfer are briefly covered to appreciate the methods used in thermal management and their implications. It is followed by introduction of New Method of determining the thermal resistance of electronic packages. Next Microchannel heat sinks are dealt especially with two-phase flow with a view to reduce thermal resistance. It is followed by heat generation and transport in micro and submicro scale in electronic packages. A fast local transient solution methodology is introduced to demonstrate a quick solution at a given location. Method of using the tools of artificial intelligence like ANN and GA to optimize the shapes of the fins used in heatsinks is demonstrated. Finally the strategies for thermal management in portable products like cellular phone are illustrated.

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TUTORIAL 8

Reverse Engineering

Reverse Engineering is the development of technical data necessary to support manufacturing products which is critical for smooth and continuous operation of any manufacturing facility. Manufacturing companies are looking to Reverse Engineering as a potential tool for reducing product development cycle and resolving issues concerning the need to create a 3D digital file for an object where such a data did not exist before. Development of accurate technical data is the essence of reverse engineering. Reverse engineering begins with the pre screening of components such as automotive parts, styling studies on automobiles, 3D metrology of large components such aircraft wings, gear box castings, intricate parts such as dental braces, implants, prosthetic devices, electronic devices, pattern making.

In many situations designers give a shape to their ideas by using clay, wood or foam rubber, but a CAD model is required to enable the manufacturing of the parts. As products become more organic shape, designing in CAD may be challenging or impossible. The CAD model may not be acceptably close to the sculptured model. Reverse engineering provides a solution to this problem because the physical model is the source of information for the CAD model. The pre-screened technical information can be in the form of detailed drawings, failure data, etc. The steps followed in reverse engineering are i) data enhancement , ii) data verification, and iii) data development

These steps would help to create a duplicate component as an exact one for one to match.

This involves software issues such as 3D data capture, handling point clouds, 3D image processing, data export and import aspects.

The workshop is intended to cover practical aspects of reverse engineering.

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TUTORIAL 9

Tools and Methods for Integrated Scheduling Problems

Scheduling problems involve several types of activities that solicit different resources in a production system. These resources have to be optimally utilized in order to maximize throughput among other objectives. The setting where different types of resources with different characteristics are solicited result in what we may call the integrated scheduling problem in which activities calling for the different types of resources need to be scheduled in a simultaneous fashion. Resources include machines, material handling devices, buffers, route segments and intersections on a shop floor, labor, tools, pallets, fixtures and energy among other resources. Material handling resources are especially important because they represent a considerable investment. This is the case for robot arms and AGV's for example. Different approaches have been contributed to deal with this complex problem. Scheduling problems involving one type of resources are NP-Hard. Integrating more resources makes the problem more difficult to tackle and developing models and solution methodologies becomes an important research avenue. The objective of this tutorial is to give an overview of integrated scheduling problems that arise in different production settings and to present the different types of constraining resources. All these resources result in costs that the system assumes. The different cost components need to be understood because they guide the choice of optimization objectives. We also provide an overview of the formulations of the integrated scheduling problem. Several methodologies are used to solve these problems. These include approaches based on mathematical programming, heuristics, constraint programming and expert systems among other artificial intelligence approaches.

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TUTORIAL 10

Fuzzy Systems Approach To Human Factors, Analysis And Reliability

Human factors are one of the most important in developing software and designing products. But in nature human factors are vague and uncertain to measure. Then it is proper to employ fuzzy system methods and fuzzy data analysis methods to analyze them. Here we are explaining two topics: the analysis of accidents in a factory, the management of reliability of a system and the forecasting bug numbers in software. In these experiences, we employed various methods of fuzzy systems and fuzzy data analysis. such methods will be explained and the effect and influence of the methods will be depicts.