

## **Handicapping at the Horse Races: Examining prior performance with Fuzzy Logic**

There are many reasons why people visit racetracks all around the country. For some it is a very entertaining experience. For others, however, it is all about making money. Handicapping refers to the practice of predicting the winner of a sport. At the horse racetrack, handicapping means trying to predict the order that the horses finish in. By being able to predict the finish order, one can bet money smarter. The goal of this project is to try to automatically predict the finishing order of the horses by looking at each horse's prior race statistics.

## **Nonlinear Multiple Objective Optimization Using MATLAB® and the Fuzzy Logic Toolbox**

Problems with multiple objectives and criteria are generally known as multiple criteria optimization or multiple objective optimizations. Generally, these problems have been modeled and solved in a linear fashion. However, many real-life phenomena are of a nonlinear nature, which is why we need tools for nonlinear programming capable of handling several conflicting objectives. The concepts of Fuzzy Logic and the built-in functions of MATLAB® provide an efficient way to solve these problems. This paper gives a brief overview of the problem and provides a tutorial to recreate the system in MATLAB.

## **The Fuzzy Blackjack Gambler**

This paper details an approach to determine an optimum betting strategy for Blackjack. Blackjack is one of the most popular card games in history. Millions of people around the world enjoy playing Blackjack, and there has been much effort to find a strategy that consistently increases your chances for success. In this experiment, Fuzzy controllers were implemented with rule sets based on current popular betting strategies in order to determine which, if any, give the player an advantage. Blackjack simulation software was then developed to test these different controllers for a given amount of trials. Three strategies were implemented: Risk of Ruin, Progressive Betting, and Streak Betting. A system implementing a popular high/low strategy of card counting was also utilized in conjunction with the three fuzzy controllers in an attempt to further enhance the probability of winning. Five Betting sessions of 1000 hands of Blackjack each were then simulated using each of the three controllers to determine if any of these strategies actually increased the odds of winning.

## **Fuzzy Predictor for a Moving Target**

An automated weapons targeting system aided by a fuzzy predictor was developed, and implemented. The targeting system was designed for use in a weapons system that needs to track a moving target and shoot the target down using a high-speed exploding projectile. The targeting system has a tracking unit that can accurately track the moving target and a fuzzy logic unit that predicts the position of the target in the near future. The prediction accuracy of the fuzzy logic unit was tested and tuned in a simulated virtual environment using a computer. A virtual 3-D tank, which uses the targeting system, is programmed to shoot down a virtual flying aircraft that followed predetermined routes across the three-dimensional virtual space. Two different versions of the targeting system with different fuzzy logic units, each with its own rule set, were tested and scored against a targeting system that employs only a tracking unit with no predictive capabilities. The experiments showed that the addition of the fuzzy predictors clearly enhanced the accuracy of the simulated weapons system utilized by the tank. Implementation of Fuzzy Logic Toolkit in StandardML

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## Fuzzy Bridge Traffic Estimator



The Fuzzy Bridge Traffic Estimator is a fuzzy system, with a built in linguistic interpreter, that predicts traffic conditions on a bridge located four minutes from my apartment. It uses the time of day, day of the week, and the weather as inputs. The output is translated from a fuzzy number (0-1) to a five-color display, which ranges from green to red.

## Fuzzy Control of Rotary Inverted Pendulum



This report details a simple fuzzy control scheme for balancing an inverted pendulum using 6 rules and 8 membership functions. Fuzzy control is then applied to centering the horizontal link. Discussion of control schemes and comparison with classical and state space responses is presented. Implementation is done in Matlab along with the Fuzzy Logic Toolbox.

## Fuzzy Logic Controlled Multi-Objective Differential Evolution

Evolutionary multi-objective optimization (EMOO) has gained a lot of research interests in the recent years. The beauty of EMOO is that it tends to find a set of Pareto solutions rather than any single aggregated optimal solution for a multi-objective problem. As for single-objective evolutionary algorithms, Multi-Objective Evolutionary Algorithms (MOEA) also requires offline tuning of the parameters in order to get desirable performance. Fuzzy Logic Controller (FLC) has been applied to online parameter control for single-objective evolutionary algorithms in the literature. In this paper, a fuzzy logic controller is explored to dynamically control the parameters of a particular MOEA Multi-Objective Differential Evolution (MODE). The tuning of this FLC itself is completed according to the understanding to the behaviors of the MODE. This fuzzy logic controlled multi-objective differential evolution (FLC-MODE) is applied to a suite of benchmark functions. The computed results obtained using FLC-MODE are compared with those obtained using MODE with constant parameter setting. It is shown that the FLC-MODE can obtain better results in most of the cases. However, this particular FLC cannot be omnipotent in all situations.

## SUPERVISORY FUZZY LOGIC CONTROL OF BASE ISOLATED BUILDINGS USING SMART SEMI-ACTIVE SEISMIC ISOLATION SYSTEMS

In recent years, smart damper technologies have been under development for application to base-isolated buildings. Research has shown that such dampers are capable of improving the performance of base-isolated structures, particularly when consideration is given to the disparate nature of the earthquake ground motions (near-field vs. far-field). Near-field ground motion that is of particular concern is a long period, pulse-type motion that occurs near the point of fault rupture in the fault perpendicular direction in the forward-directivity region (see Figure 1). A direct result of this pulse-type motion is large displacement and velocity demands at the isolation level. The results of this study show that supervisory fuzzy logic controllers have the potential to produce higher performance smart damping systems that are capable of reducing seismic isolation system demands beyond that of previous smart systems employing only one fuzzy controller. Isolator displacement demands are shown to be reduced by a factor of six in comparison to passive systems, with only minor penalty to floor accelerations. Furthermore, these results were obtained with only minimal tuning of the system, thus demonstrating an inherent robustness even when subjected to disparate ground motion, and therefore yielding the possibility for even higher performance with further study.

## A Evolutionary Multi-Objective Optimization Algorithm for Exploring the Pareto Frontier

In this paper an evolutionary multi-objective optimization (EMOO) algorithm is presented to solve multiobjective problems (MOPs). The algorithm uses Pareto ranking to find multiple solutions on the Pareto frontier after each generation. In every generation, each individual in the population is mutated. Then a combined population of parents and children are ranked based on the Pareto frontier they live on. Before selection occurs, every non-dominated solution is added to an archive to increase the total number of solutions found. Three real space multi-objective problems from literature are used to benchmark this algorithm.

## **Fuzzy Radar and Training**

This report discusses the application of fuzzy set and genetic algorithm on classifying real-time input data and predicting the behavior of data flow. The problem discussed here is classifying the data of artificial plane-trajectories, which produced by a simulator, and predicting the behavior of those aircrafts. A simulator is built to produce scenarios of flying. Artificial radar gathers the data from the scenarios. Because the data gathered are discrete and cannot describe continuous trajectories, fuzzy theory is applied here to help the radar classify them (i.e. which position data are produced by a certain plane) and predict where the plane would be. An evaluation of the performance of the radar is made. And the scores of that are sent to generic algorithm module, which tunes the unknown parameters of fuzzy number in the system. So, after tuning, the program would generate a set of parameters which is good for radar draws the trajectories of aircrafts which have particular characters (i.e. the speed, acceleration, limit etc.) All of models were implemented in C++. The validation and performance are discussed.

## **$H_2$ and $H_\infty$ Robust Control Design using a Genetic Algorithm as a tuning automation tool: application to a horizontal inverted pendulum.**

A Genetic Algorithm is used for tuning a  $H_2$  and  $H_\infty$  optimal controllers of a horizontal inverted pendulum. The objective is to satisfy robustness and performance as well as nominal stability. The  $H_2$  and  $H_\infty$  optimal design methodologies require an augmented version of the plant being controlled in order to achieve an optimal solution. For horizontal inverted pendulum presented this requires the addition of artificial noise in the feedback channel and a penalty in the control effort. These give as a result four tuning parameters in the design of the controllers. The GA is used to find the values of these parameters that give a better controller with respect to disturbance rejection and trajectory tracking.

## **Evolutionary Artificial Neural Networks for Medical Diagnostics**

Information systems provide an inherent instrument for knowledge discovery. The purpose of this study is to create a system architecture that will serve as a diagnostic tool for cardiovascular disease prediction extracted from medical datasets. This tool can help guide health care regarding preventive and predictive action. Classification of data to distinguish Heart Disease and non Heart Disease related information is the goal through each stage of analysis. This study compares results generated by solely Artificial Neural Networks with those generated by Evolutionary Artificial Neural Networks.

## **CBMRS: A Case-Based Movie Recommendation System**



This paper aims to describe CBMRS, as a case-based approach to movie recommendation. CBMRS provides movie recommendations based on users' preferred movie criteria such as genre, rating, theme, etc. This system has the potential to be a valuable application for movie rental stores, movie libraries etc.

Many times the renter finds him or herself wandering aimlessly about the movie rental store looking for a movie he or she would like to see. CBMRS attempts to aid this movie renter with recommendations based on his/her personal preferences. This is much more than a standard search engine. CBMRS utilizes case-based reasoning (CBR) as a means to find similar movies to its input. CBMRS provides an application of CBR methodologies as a plausible approach for recommendation systems.