GBL rev i 4/19

Department of Electrical and Computer Engineering

**CSCE686 Advanced Algorithm Design**

Spring Quarter 2019

**Complex Optimization Algorithm Design Project**

**Introduction to Project Problem Selection**

The intent of this individual project is to incorporate the major educational aspects of search algorithm development for combinatoric complex optimization problem solutions (NP-Complete, PSpace, …) . These discrete optimization projects can be an aspect of the student’s research or selected from the list provided (*note that each student should have a unique project*).

**General Educational Objectives:**

**1.** Develop an *ability to design and evaluate algorithms* for solving complex NPC or more complex scientific and engineering optimization problems using explicitly the design techniques presented in class. This includes explicit problem domain specifications and selection and integration of appropriate search algorithm templates from the deterministic and stochastic spectrum. This should result in software engineered code that is effective and efficient and well documented. And, thus, should make testing less complex and maintenance less expensive.

**2.** Develop an ability to define appropriate experimental design in order to characterize computational performance (*effectiveness and efficiency*) for solving such optimization problems.

**3**. Be able to represent computational results in a professional well written journal/conference format with *qualitative* conclusions supported by *quantitative* data.

**Project Development: *(Define your project problem!)***

1. **Problem Selection:** (English → symbols → math/logic). “with constraints”  
   Select and discuss a specific real-world discrete optimization problem. It should **incorporate at least TWO independent NP-Complete problem models (multi-objective).** Aggregate objectives into one evaluation function (additive, …). Another project selections include **a dynamic NPC problem with a nonlinear model or with extensive constraints or a PSPACE-Complete Problem**. What does the search landscape look like? Di and Do

**Thoughts on possible CSCE686 Discrete Optimization Projects: (my interests)**

1. **Self-organized Autonomous Multi- Agents in Computer Network**

***- Define/optimize agent behavior given attacks using***

***POMDP (Partially Observable Markov Decision Process Models)***

* ***Optimal multi-agent network attack classification using reputation***

1. **UAV (aircraft, robots, satellites) “optimizing self-organizing rules/process” in dynamic environment – behavior optimization**

* ***Recon/loitering scheduling, max coverage, min risk***
* ***Routing and task/weapon assignment, min response time***
* ***Combat, engagement, attack (rule-based & bio-inspired)***

1. **The Vehicle Routing Problem (3D) with constraints**

* ***Optimal Movement of Swarms of Autonomous Unmanned Aerial Vehicles in dynamic environment***

1. **Optimal Intrusion detection (ID) and network anomaly detection (AD)**

* ***ID and AD Pattern Recognition (feature selection using Heuristic search) optimization with multi-agents***

1. **Real Time Strategy Games using Computer Generated Forces (AI Opponent)**

* ***Tactical Planning for Optimal Real-time Games***

1. **Game Theory Modeling for Cyber Warfare   
   - *Optimize probabilistic strategy selection over Nash equilibrium.***
2. **Machine learning for optimal learning of information collection and processing**
3. **Cyber Security Agents  
   *- Distributed Constraint Optimization (risk, surveillance, cost)  
   - Drone Placement and Surveillance Coverage***

***Submit your initial PD model proposal by April 30th (English, symbols, and math/logic formulation) – discuss with professor as appropriate. Algorithm design, implementation, testing and reporting dates are to be indicated later.***