**Title:** Nature-Inspired Computation with Julia

**Mentor:** Dr. Steffen Heber

**Name:** Wenting Zheng

**Semester:** 2019 Spring

**Course:** CSC499 as Other Restricted Elective 1(3 credits)

**Prerequisites:** CSC116: Intro to Programming, CSC216: Programming Concepts, CSC226: Discrete Mathematics

**Description:** In this project we will investigate how search, classification, and optimization algorithms can be derived from natural models, and how to implement and evaluate such algorithms using the recently developed high-performance programming language Julia (<http://julialang.org/>). This project focuses on major nature-inspired algorithmic approaches: evolutionary computing (for example genetic algorithms, evolution strategies, genetic programming, differential evolution, etc.), and social computing (for example particle swarm algorithms, ant colony optimization, artificial bee optimization). We will form teams of 2-3 students. Each team will focus on one nature-inspired approach, implement the approach in julia, and assess its performance for solving the traveling salesman problem. In addition, each team will generate an artistic visualization that builds on their project. All results will be documented. Below is a list of tasks, milestones, and deliverables.

**Tasks:**

1. Get familiar with the Julia programming language and programming environment and learn how to use Jupyter notebooks.

**Deliverable** 1: each team compiles a jupyter notebook that introduces the julia language. The notebook should also include installation instructions for julia, jupyter notebook, and additional educational resources.

1. Learn about the selected algorithm and the TSP.

**Deliverable** 2: each team prepares a short presentation that introduces their algorithm.

1. Each team identifies suitable (python/matlab) implementations as starting point for their algorithm.

**Deliverable** 3: each team will describe their planned julia implementation, identify TSP resources (solved instances, generators, libraries), and sketch their performance assessment experiments.

**Milestone 1 (background & planning phase)**: complete and submit deliverables 1-3

1. Implement the selected algorithm (and a simple, greedy competitor) in julia.

**Deliverable** 4: each team will create a jupyter notebook that documents their implementation

**Milestone 2 (implementation)**: complete and submit deliverable 4. It’s expected to have a basic working program at this point, and to refine and optimize implementation until the end of the semester.

1. Refine program, explore, tune, and document the effects of algorithm parameters; evaluate the performance of the tuned algorithm and compare it to the results of other teams

**Deliverable** 5: each team will create a jupyter notebook that documents their results

1. 6) Develop an artistic visualization out of your project (check out TSP art as inspiration).

**Deliverable** 6: each team will create a jupyter notebook that documents their artwork

**Deliverable** 7: each student has to submit a Research Summary (see web page)

**Milestone 3 (evaluation, application, and reflection)**: complete and submit deliverables 5 and 6, submit research summary.

**Timeline:**

* **Phase 1:** Task 1-3 completed, deliverables 1-3 submitted.

Milestone 1: Background knowledge acquired, planning completed. Due date: February 15.

* **Phase 2**: Task 4 completed, deliverable 4 submitted.

Milestone 2: working implementation of algorithm completed. Due date: March 29.

* **Phase 3**: Task 5-6 completed, deliverables 5-6 submitted.

MILESTONE3: evaluation & application performed, research summary submitted. Due date: April 26.

**Grading:** we will use pass/fail grading. To pass, all milestones must be cleared. A milestone is cleared if the corresponding deliverables have been submitted/executed and a total score of at least 60% is reached.

Milestone 1: deliverable 1 (30%), deliverables 2 (40%), deliverable 3 (30%)

Milestone 2: deliverable 4 (100%)

Milestone 3: deliverable 5 (100%), deliverable 6 (30% bonus), deliverable 7 (mandatory)