Intelligent Engineering Algorithms
COE 544/744

Fall 2020
Instructor: Joe Tekli

Course Projects Description

I- Objective

Allowing students to implement, test, and manipulate software agents with intelligent features, e.g., intelligently perceiving their surrounding environment, resisting noise, capable of approximate (fuzzy) data processing, and/or simulating human behavior.

II- General Procedure:

- Each student group will work on two projects designated by the instructor, which are described in the following section.

- For each project, students are supposed to design the corresponding PEAS conceptual model of the agent in question, describing: i) the environment, ii) its sensors, iii) its actuators, and iv) the corresponding performance functions (cf. Chapter 2). Therefore, students must explain and support their choices in terms of the intelligent methods or algorithms adopted to implement the codes of the agents (when applicable).

- A short technical report, 3-5 pages long, formatted following the standard *IEEE Computer Society Transactions* template (provided on Blackboard), should be submitted to the instructor along with the software source code of each project. The technical report should follow a general scientific organization, including the following main sections:
  - Introduction: subject and objective(s) of the project
  - Background: context, prerequisites, and existing solutions
  - Proposal: underlying concepts, building blocks, design models, & implementation
  - Experimental evaluation: test protocol, test metrics, test data, & experimental results
  - Conclusion: synthesis, personal experience, and project perspectives

  Note that section titles, order, and overall presentation organization can (and should) be adapted and fine-tuned based on the nature of each project.

- A project presentation/demonstration will also be conducted per group. Presentation duration: 15 minutes (10 minutes for groups of two).

- Projects' submission and presentation deadlines:
  - Project # 1: ***Wednesday 7th of November 2020***
  - Project # 2: *End of semester* (to be specified by the instructor).

III- Project Topics

The projects proposed this semester mainly focus on supervised learning algorithms. Project topics are briefly described below, and mainly cover the design, implementation, and testing of a *human facial age recognition* agent, including: 1) a non-parametric learner, and 2) and combining multiple learners including an artificial neural network.

1. Non-Parametric Learner

The first project is to realize an intelligent human facial age classifier agent, in the form of a non-parametric learner allowing to categorize faces presented in passport photos in a two distinct age categories: such as *young* and *old*. The agent is supposed to take as input: an image of a face, and consequently output a decision: *Young* or *Old*. To simplify, facial photos can be pre-processed in order to reasonably reduce image resolution, while maintaining a certain level of precision (i.e., maintaining an identifiable face). Subsequently, images can be transformed into black and white (pixels) to simplify processing and decision-making. The image should then be processed in order to extract the features of interest in detecting the age, like: position of eyes, distance of eyes from each other, size of eyes with respect to size of face, etc. We recommend using one simple reliable feature in Project 1, based on age estimation literature.

Hint 1: Students can utilize open-source libraries to help implement their projects, such as: i) openCV for computer vision, and ii) i) Keras for machine learning among other available libraries.

Hint 2: Students need to acquire an understanding of black-and-white bitmap image coding, as well as define/utilized existing methods to identify the minimum bounding rectangle and extract the concerned feature for processing. Students also need to acquire a basic understanding of some of the main features that are useful for age recognition (students can refer to reference papers provided by the instructor, in addition to conducting their own research on the topic).

2. Hand-written Character Recognition

The second project consists in extending the first by considering: i) more than one feature, and ii) combining more than one learner in an ensemble solution, in order to help improve the effectiveness of the recognition process. The user should be able to choose the features and learners of interest before running the age recognition process. Among the additional learners to be included, the students should add at least one artificial neural network (ANN).