

## FINAL PROJECT

**Course:** Introduction to Artificial Intelligence

**Duration:** 06 weeks

### I. Formation

- The project is conducted in groups of 03 – 05 students.
- Student groups conduct required tasks and submit the project following instructions below.

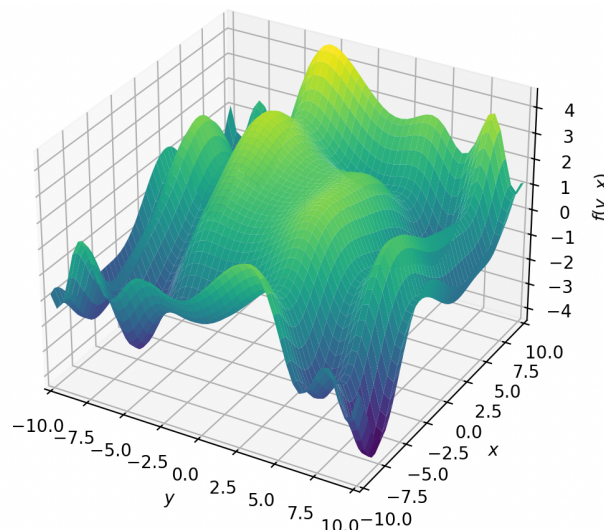
### II. Tasks

#### a) Task 1 (2.0 point(s)): Simulated Annealing Search on 3D surfaces

Given a multivariable function

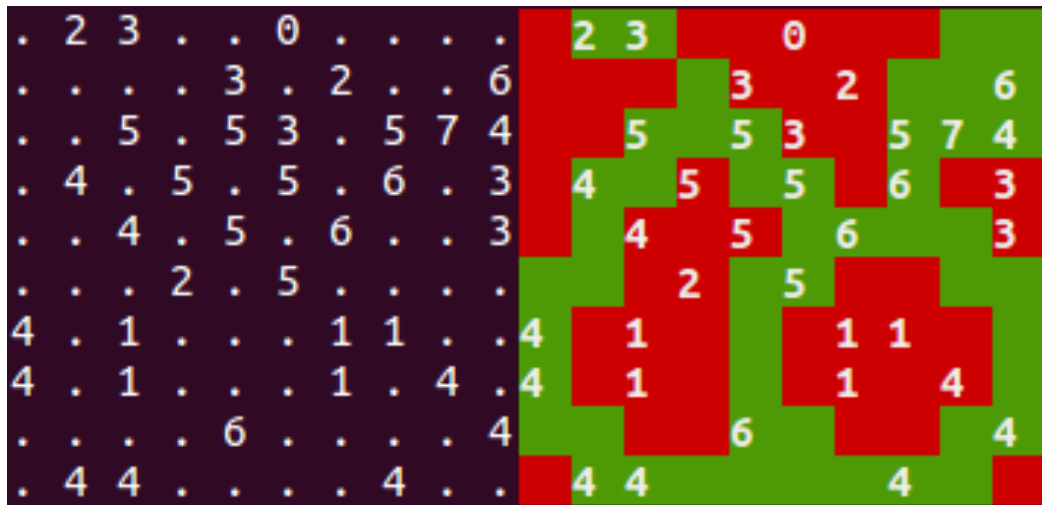
$$f(x, y) = \sin\left(\frac{x}{8}\right) + \cos\left(\frac{y}{4}\right) - \sin\left(\frac{x \cdot y}{16}\right) + \cos\left(\frac{x^2}{16}\right) + \sin\left(\frac{y^2}{8}\right)$$

- Students draw a 3D surface to illustrate the given function  $f$  using the `sympy` library, for instance,



- Then, implement the Simulated Annealing Search algorithm (SAS) to search for the location  $(x, y)$  with the  $f$ -value as large as possible.
  - Starting from  $O(0, 0)$ ,
  - Actions: for each state  $(x, y)$ , the step size is 0 or  $\pi/32$ ,

- Students propose your own *schedule()* function to compute the *temperature*  $T$  given a time step  $t$ .
  - Draw a red line connecting all visited points along the search path.
  - Students organize the program regarding to the OOP model, ensure source code is compact and reasonable.
  - Recommended editor: Visual Studio Code.
- b) Task 2 (3.0 point(s)): 9x9 Tic-Tac-Toe with Heuristic Alpha-Beta Search**
- Implement a program that allows users to play Tic-Tac-Toe against the computer on a 9 x 9 board, where whoever has 4 pieces in a row horizontally, vertically, or diagonally wins.
  - The game operates on the console screen. The player selects a square by entering its coordinates from the keyboard. Students can update the board interface by erasing and redrawing it after each turn.
  - The algorithm used for the computer is heuristic alpha-beta search.
    - *combine the original alpha-beta search algorithm and the h-minimax search,*
    - *students propose the depth limit  $L$  and the heuristic function estimating the h-minimax value, explicitly explain the rationality of the proposed heuristic function.*
  - Students organize the program regarding to the OOP model, ensure source code is compact and reasonable.
  - Recommended editor: Visual Studio Code.
- c) Task 3 (3.0 point(s)): Constraint Satisfaction Problems with Propositional Logic**
- Given a  $m \times n$  matrix, each cell consists of a non-negative integer or it is blank.
  - Each cell has 9 “adjacent” neighbors, including itself and 8 cells around.
  - The player color cells by red or green colors so that the number of green cells which are “adjacent” to a cell matches the number inside.
  - There is no constraint for blank cells.



Input data file (left) – Result (right)

- Students solve the given problem using propositional logic and the Glucose3 module of PySAT.
  - Assign a propositional symbol to each cell (true  $\rightarrow$  green, false  $\rightarrow$  red),
  - Enumerate cells to generate CNF clauses representing constraints,
  - Discover the general rule to generate clauses and eliminate redundant clauses,
  - Find a model satisfying all clauses using [Glucose3 of PySAT](#),
- Implement a function to evaluate the result matrix and illustrate it on the console screen with colors.
- Students organize the program regarding to the OOP model, ensure source code is compact and reasonable.
- Recommended editor: Google Colab.

#### d) Task 4 (1.0 point(s)): Naïve Bayesian Classifier

- Given a data set of quiz scores and course results of students in *task4\_data.csv*,
  - #: row index
  - Rank: P  $\rightarrow$  pass, F  $\rightarrow$  Fail
  - Q1, Q2, ..., Q9: quiz scores
- Scores are continuous values. Therefore, students propose an approach to discretize these values and then manually implement the Naïve Bayesian classification algorithm.

- Finally, compute the accuracy of the classifier in the given data set.
- Students organize the program regarding to the OOP model, ensure source code is compact and reasonable.
- Recommended editor: Google Colab

**e) Task 5 (1.0 point(s)): Report**

- Student groups compose the project report using [the IEEE conference proceeding template](#).
- Recommended editor: [Overleaf](#).
- Selective contents:
  - *Title*: the project title
  - *Authors*: group member's information, the lecturer is appended as the last author.
  - *Abstract*: summarize the project requirements, approaches, experimental results, and levels of completion.
  - Each following section presents a task in the project, with a meaningful and human-readable title. **Briefly** introduce the approach to tackle the problem and illustrate results with related figures/tables, etc.
  - “*Contributions*” section: individual tasks, individual completion levels (0%-100%).
  - “*Self-evaluation*” section: self-evaluate task completion and estimate scores.
  - “*Conclusion*” section: summarize the project requirements, approaches, experimental results, and levels of completion.

- References are in the IEEE format.
- Maximal length is 05 pages.

### III. Submission

- Create a folder whose name is in the format  
**final\_<Group ID>\_<Student ID>**
  - **source**: source code files

- **report.pdf:** report of the project
- Students maintain outputs of all cells in ipynb files.
- Compress the folder into a zip file and submit by the deadline.
- Every team member must submit the project individually.

#### IV. Policy

- **Student groups submitting late get 0.0 points for each member.**
- **Copying source code on the internet/other students, sharing your work with other groups, etc. cause 0.0 points for all related groups.**
- **If there exist any signs of illegal copying or sharing of the assignment, then extra interviews are conducted to verify student groups' work.**
- **AI tools are forbidden in the project.**

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