Cairo University

Faculty of Computers and Artificial Intelligence

DS313/DS351

Computational Intelligence

Manufacturing

Genetic Algorithm

Names	IDs
Mawada Ebrahim Ali	20210415
Rahama Khaled AbdEl-khaleq	20210130
Salma Ashraf Mohammed	20220529
Fatma Abd El-monem Mohmmed	20210285

Deliverid to:

Assoc. Prof. Ayman Ghoneim – Assoc. Prof. Sally Kassem

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-Introduction :

Computational Intelligence *(CI)*:

AI with thinking rationally is known as "Traditional AI".
Traditional AI is strongly oriented to symbolic representations and manipulations (reasoning) in a top-down manner. That is, the structure of a given problem (environment, domain context) is analyzed beforehand and the construction of an intelligent system is based upon this structure.
One form of AI with acting rationally is known as "Computational Intelligence”.

Genetic Algorithm *(CI)*:

Genetic algorithm (GA) is the most used and known algorithm in EC.
GA is a search technique used in computing to find true or approximate solutions to optimization and search problems.
(GA)s are categorized as global search heuristics.
(GA)s are a particular class of evolutionary algorithms that use techniques.
inspired by evolutionary biology such as inheritance, mutation, selection, and crossover (also called recombination).

Fuzzy Logic *(CI)*:

Fuzzy logic is a set of rules that can be used to reach logical conclusions from fuzzy sets of data. Since data mining is often applied to imprecise measurements, fuzzy logic is a useful way of determining relevant relationships from this kind of data.

-manufacturing Problem:

A manufacturer has production facilities for assembling two different types of television sets. These facilities can be used to assemble both black and white and colored sets. At the present time the firm is producing only one model of each type of set. The black and white set contributes Rs. 150 towards profit while a colored set contributes Rs. 450 towards profit. The number of colored television sets manufactured every day cannot exceed 50 as the number of colored picture tubes available every day is 50. Each black and white set requires 6 man-hours of chassis assembly time, whereas each colored set requires 18-man hours. The daily available man hours for the chassis assembly line are 1800. A black and white set must spend one man hour on. the set assembly line whereas a colored set must spend 1.6-man hours on the set assembly line. The daily available man hours on this line are 240. A black and white television set requires 0.5-man hours of testing-and final inspection whereas a colored set requires 2-man hours. The total available man hours per day for testing and inspection is 162.

Objective: Maximize the daily profit from producing television sets.

-Formulation:

Decision Variables:

Let $x1$ be the number of black and white television sets produced per day,

$x2$ be the number of colored television sets produced per day.

Constraints:

1. **The number of colored television sets manufactured daily cannot exceed 50:**

   C1 -> $x2 \leq 50$

2. **Chassis assembly time constraint: C2 -> $6x1+18x2 \leq 1800$**
3. **Set assembly time constraint: C3 -> $x1+1.6x2 \leq 240$**

Objective function:

Maximize Z=150x1+450x2Maximize Z=150x1+450x2

Subject to:

$x2 \leq 50$

$6x1+18x2 \leq 1800$

$x1+1.6x2 \leq 240$

$0.5x1+2x2 \leq 162$

$x1, x2 \geq 0$

Solving by genetic Algorithm:

1-Initialization:

-Initialize a population of individuals, where each individual represents a potential solution to the problem. In this problem, each individual could be represented as a tuple or list of two values, indicating the quantities of black and white sets ($x1$) and colored sets ($x2$).

2-Fitness Evaluation:

Evaluate the fitness of each individual in the population based on the objective function., the fitness represents the profit obtained from producing the given quantities of black and white and colored television sets.

3-Selection:

Select individuals from the population to serve as parents for the next generation. Common selection methods include tournament selection or roulette wheel selection.

4-Crossover:

Create offspring by combining genetic material from selected parents. In this problem, we can use arithmetic crossover to create new solutions.

5-Mutation:

Introduce random changes to the offspring to maintain genetic diversity in the population. In this problem, we can apply Gaussian mutation to mutate the individuals.

6-Elitism:

Select the best individuals from the current population to survive to the next generation. This ensures that the best solutions found so far are not lost.

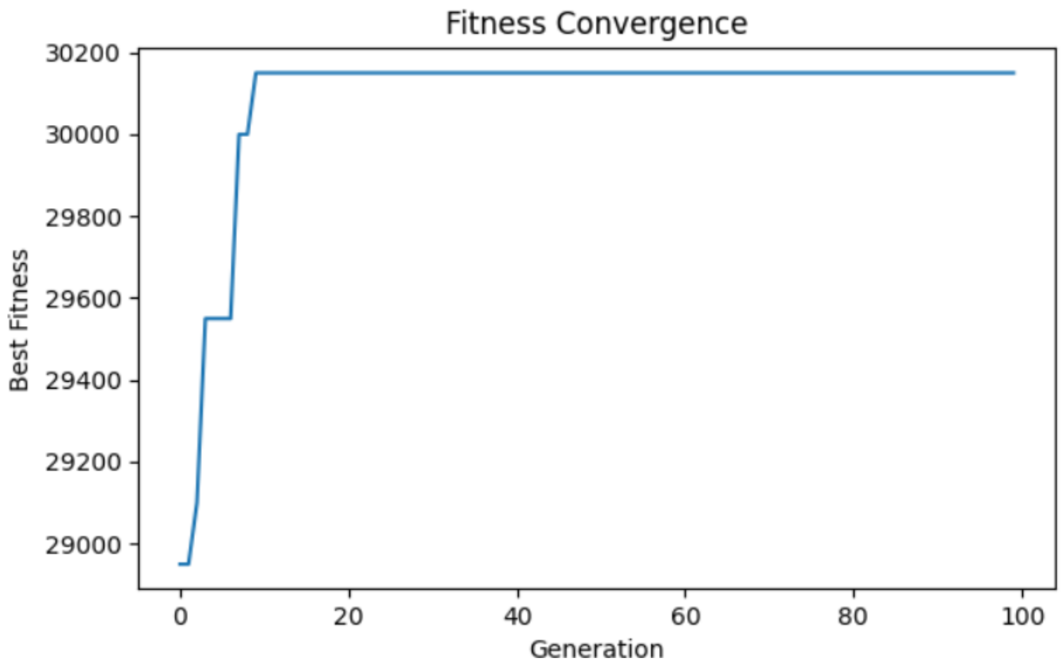
7-Termination:

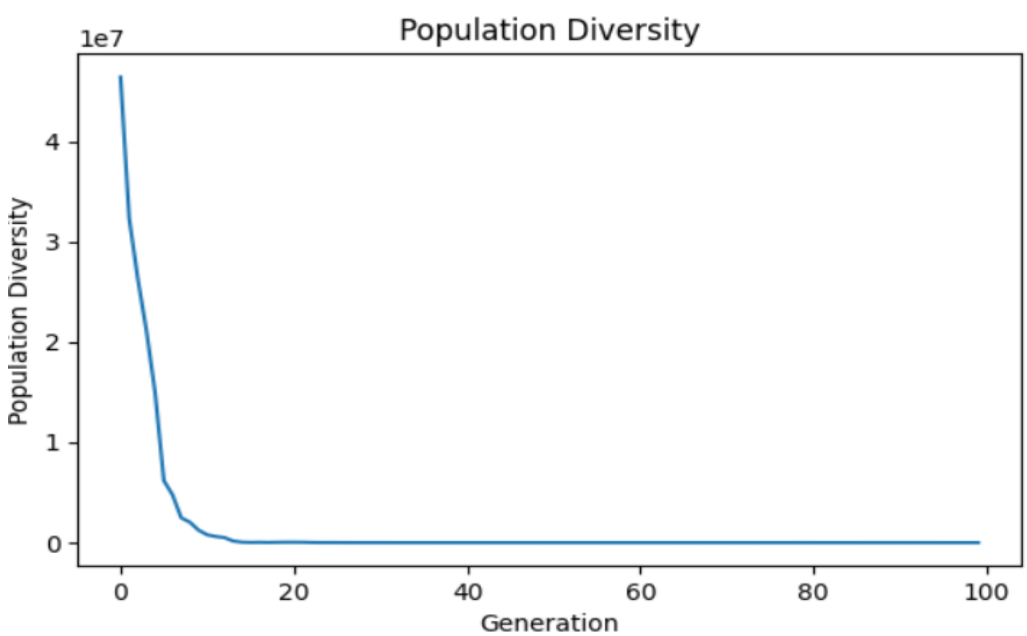
Repeat the selection, crossover, mutation, and elitism steps for a fixed number of generations or until a termination criterion is met (e.g., reaching a maximum number of generations, convergence).

-Analysis& Results:

Best solution: [51, 50]

Fitness: 30150





-Fuzzing:

Report of fuzzy code:

We chose to focus on assembly hours and production line hours because these are two critical operations in the production process.

Assembly requires a certain number of hours, which depends on the number of workers and their daily working hours.

By using fuzzification, we can distribute assembly hours more flexibly. Similarly, the production line has a capacity that should not be exceeded,

and fuzzification can help improve the flow of products through this line.

This report explains a fuzzy logic implementation using the scikit-fuzzy library.

The code models and analyzes the Chassis Assembly Hours using fuzzy logic concepts and Monte Carlo simulation.

1_install the scikit-fuzzy library and import necessary libraries such as numpy for numerical operations and matplotlib for plotting.

2_Defining the Universe of Discourse:the range of possible valuesfor Chassis Assembly Hours, spanning from 0 to 2100.

3_Defining the Fuzzy Variable and Membership Functions : The fuzzy variable assembly_hours_fuzzy is created to represent Chassis Assembly Hours. Three trapezoidal membership functions are defined for this variable:

Low: Ranges from 0 to 1000 with a peak between 600 and 1000.

Medium: Ranges from 800 to 1600 with a peak between 1000 and 1400.

High: Ranges from 1400 to 2000 with a peak between 1600 and 2000.

4_Visualizing Membership Functions: This code visualizes the membership functions defined using matplotlib.

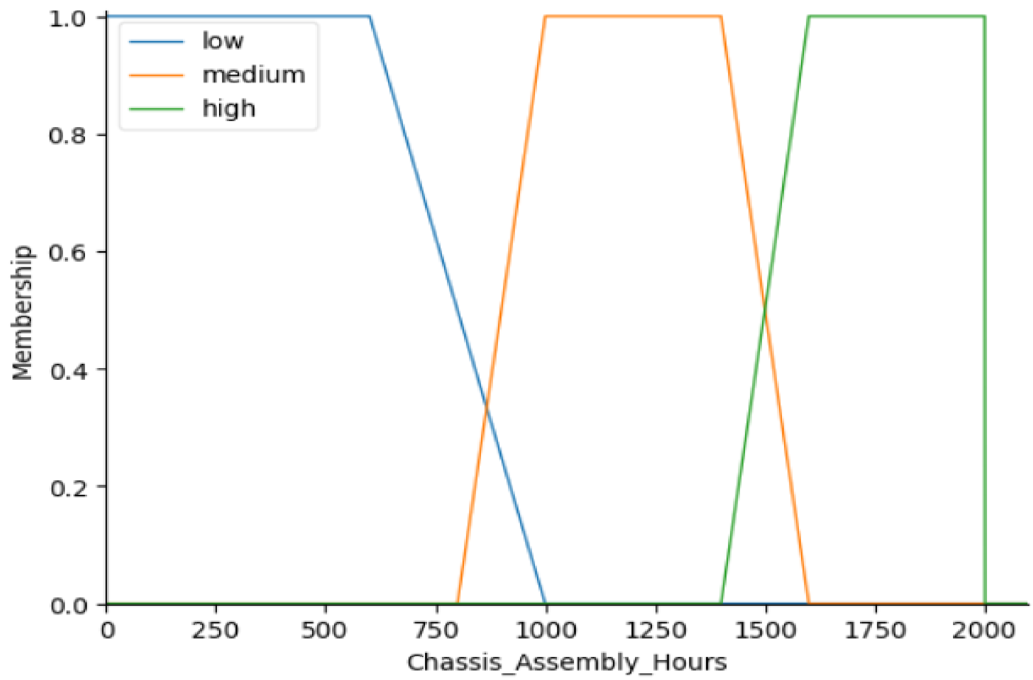
5_Fuzzification of Crisp Demand : This section calculates the degree of membership (fuzzification) for the crisp demand value of 1750 in the low, medium, and high fuzzy sets. The results are printed to show how the crisp value relates to each fuzzy set.

6_Monte Carlo Simulation for Defuzzification : This loop performs a Monte Carlo simulation to generate defuzzified demand values. It randomly selects values within the range of 0 to 1800 and checks their membership degree in the high fuzzy set. If a randomly generated alpha value is less than or equal to the membership degree, the value is accepted and added to the list of defuzzified demands.

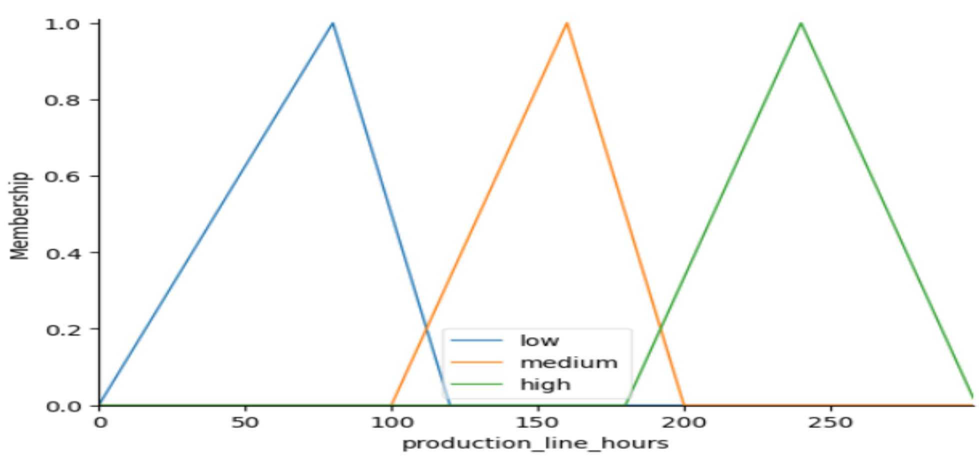
7_Calculating the Average Defuzzified Demand : calculates and prints the average defuzzified demand based on the Monte Carlo simulations performed.

the same steps used in production line hours but with triangula membership function.

Graph of membership function for ***`assembly hours fuzzy`***



Graph of membership function for production line hours fuzzy



-Conclusion:

The manufacturing problem presented involves optimizing the production of black and white and colored television sets to maximize profit while adhering to various constraints such as resource availability and market demand. The problem was formulated as a linear programming problem, where decision variables represent the quantities of each type of television set produced, and the objective is to maximize profit subject to constraints on resources and market demand.

To solve the manufacturing problem, a genetic algorithm (GA) approach was employed. The GA was implemented with key steps including initialization, fitness evaluation, selection, crossover, mutation, and elitism. Through multiple generations of evolution, the GA iteratively improved the population of potential solutions, eventually converging to the best solution that maximizes profit while satisfying the constraints.

Following the analysis and optimization using the GA, the problem can be further explored using fuzzy logic. Fuzzy logic provides a framework for dealing with uncertainty and imprecision in decision-making, which is often present in real-world manufacturing scenarios. By incorporating fuzzy logic into the problem formulation, it becomes possible to model vague concepts such as "high" and "low" production quantities or "strong" and "weak" adherence to constraints.

Notebook of code:

https://colab.research.google.com/drive/1SpDND7fEjRPz25-MZ5ua1hGAQNENQ3E9?usp=sharing#scrollTo=Nn8C9RNPuJ9b

-Reference:

https://www.spiceworks.com/tech/it-strategy/articles/linear-programming/#_001

https://www.geeksforgeeks.org/genetic-algorithms/

https://drive.google.com/drive/folders/19fozLPhp27cCSj1i2NFuXUUPdGewjpzi

https://drive.google.com/drive/folders/1RjUTek3VBAHF7HodLEd1tdkBa0rYuC7l

https://classroom.google.com/u/0/c/NjYyNjY5OTg0NDIx\