IT426: ARTIFICIAL INTELLIGENCE SYSTEMS
INFORMATION TECHNOLOGY DEPARTMENT

PROGRAMMING ASSIGNMENT

ASSIGNED: OCT 4TH 2020
DUE: NOV 8TH 2020 @ 12:00 PM

# Best Meal Synthesis using GA Optimization

RULES:

1. You are allowed to work on this assignment in a group approved in the shared excel sheet.
2. You are NOT allowed to copy online published solutions.
3. Some questions are supposed to encourage you to read more on the topics taught in class.

You are going out on the weekend to have a meal in international cuisine restaurant. You went to your favorite international restaurant and found the menu in the table below. Your goal is to optimize your meal based on type of food, number of calories and the price. Each meal consists of items from each of the following category (starters, main-course, dessert, hot beverage, cold beverage) given your dietary preference (see note below), budget and calories intake.

You decide to implement a GA algorithm to find the best combination of items for each course. The code should work as follows; the user enters an item type (options include regular, vegetarian and vegan), calories = [CAL 0 – CAL ∞], and budget= [SAR 0.0 – SAR∞]. Your GA will then run to find the best items from each category that maximize your fitness function and output the items.

Your fitness function includes three parameters; item type, calories, and budget. The item type and budget are equally important, and the calories is half important. Your fitness function can be designed as *weighted sum* and importance of factors can be encoded as weights $w_i$ in the fitness function, where $\Sigma\, w_i = 1$. Please note that your fitness function value must be in the range [0,1].

Dietary preference notes:

1. Vegan individuals can choose only vegan items.
2. Vegetarian individuals can choose vegan or vegetarian items.
3. People with no dietary preferences can choose vegan, vegetarian and/or regular items.

Restaurant Menu:

| CATEGORY | ITEM | CALORIES | TYPE | PRICE |
|---|---|---|---|---|
| STARTER | Dynamite shrimp | 770 | Vegetarian | 74.00 SR |
| | Halloumi fries | 530 | Vegetarian | 48.00 SR |
| | Baked eggplant | 270 | Vegan | 36.00 SR |
| | Fish cake | 480 | Vegetarian | 60.00 SR |
| | Lentil soup | 290 | Vegan | 26.00 SR |
| | Chicken soup | 280 | Regular | 32.00 SR |
| | Lamb samosa | 650 | Regular | 52.00 SR |
| | Kale salad | 280 | Vegan | 38.00 SR |
| | Quinoa salad | 320 | Vegan | 36.00 SR |
| | Burrata salad | 360 | Vegetarian | 65.00 SR |
| | Shredded beef salad | 520 | Regular | 52.00 SR |
| | Hummus and bread | 620 | Vegan | 28.00 SR |
| MAIN COURSE | Margarita Pizza | 740 | Vegetarian | 35.00 SR |
| | Veggie Pizzas | 850 | Vegan | 45.00 SR |
| | Pepperoni Pizza | 1100 | Regular | 40.00 SR |
| | Fish & Chips | 2000 | Regular | 100.00 SR |
| | Fried Shrimp | 2050 | Regular | 103.00 SR |
| | Grilled Salmon | 1130 | Regular | 124.00 SR |
| | Classic Burger | 1360 | Regular | 84.00 SR |
| | Mushroom Burger | 1490 | Regular | 76.00 SR |
| | Veggie Burger | 1140 | Vegan, | 35.00 SR |
| | Grilled Chicken Sandwich | 1200 | Regular | 84.00 SR |
| | Chicken Parmesan Sandwich | 2050 | Regular | 87.00 SR |
| | Tomato Basil Pasta | 1460 | Vegan | 59.00 SR |
| | Fettuccini Alfredo | 1990 | Vegetarian | 65.00 SR |
| | Spaghetti with Meatballs | 1650 | Regular | 85.00 SR |
| | Four Cheese Pasta | 1240 | Vegetarian | 65.00 SR |
| | Grilled Rib Eye Steak | 1300 | Regular | 130.00 SR |
| | Vegetable Biryani | 1240 | Vegetarian | 47.00 SR |
| | Biryani Rice | 1350 | Vegan | 25.00 SR |
| DESSERT | Chocolate Fondant | 587 | Vegetarian | 45.00 SR |
| | Date Pudding | 322 | Vegetarian | 38.00 SR |
| | Coconut Crunch | 896 | Vegetarian | 46.00 SR |
| | Mango & Passion Fruit Crémeux | 498 | Vegetarian | 34.00 SR |
| | Carrot Cake | 290 | Vegetarian | 26.00 SR |
| | Salted Caramel & Pecan Pie | 880 | Vegetarian | 32.00 SR |
| | Almond Delight | 509 | Vegan | 42.00 SR |
| | Coconut and almond vanilla tart | 320 | Vegan | 45.00 SR |
| | Cashew Apple pie | 920 | Vegan | 40.00 SR |
| | Vegan coconut ice cream | 520 | Vegan | 25.00 SR |
| | Assorted fruits platter | 238 | Vegan | 22.00 SR |
| | Vegan chocolate cake | 829 | Vegan | 28.00 SR |
| | Chocolate Brownie | 580 | Vegetarian | 57.00 SR |
| | Millefeuille | 296 | Vegetarian | 52.00 SR |
| | Classic Cheesecake | 798 | Vegetarian | 64.00 SR |
| | Almond pistachio croissant | 533 | Vegan | 52.00 SR |
| | Signature Apricot almond tart | 334 | Vegan | 68.00 SR |
| | Almond Pistachio Pie | 940 | Vegan | 56.00 SR |
| HOT DRINK | Americano | 15 | Vegan | 18.00 SR |
| | Espresso | 9 | Vegan | 13.0 SR |
| | Cappuccino | 120 | Vegetarian | 19.0 SR |
| | Cafe Latte | 190 | Vegetarian | 19.0 SR |
| | Macchiato | 250 | Vegetarian | 20.0 SR |
| | Black tea | 0 | Vegan | 15.00 SR |

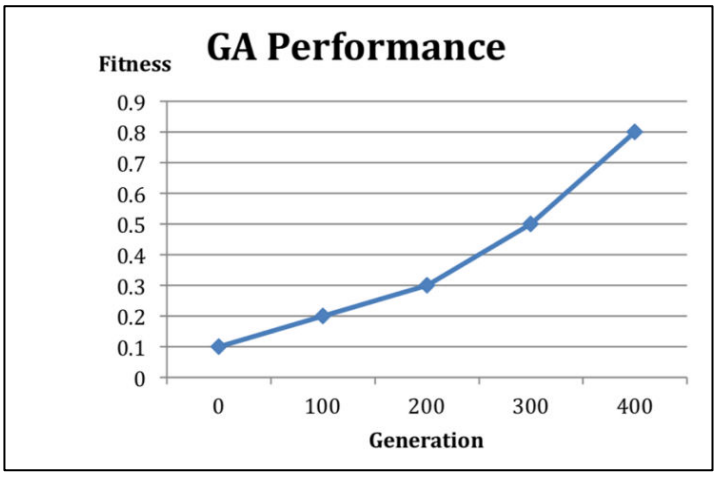
| | | | | |
|---|---|---|---|---|
| | Green tea | 0 | Vegan | 15.00 SR |
| | Hot Chocolate | 350 | Vegetarian | 21.00 SR |
| COLD DRINK | Pepsi | 120 | Vegan | 10.0 SR |
| | Diet Pepsi | 0 | Vegan | 10.0 SR |
| | 7up | 120 | Vegan | 10.0 SR |
| | Mirinda | 90 | Vegan | 10.0 SR |
| | Orange Juice | 130 | Vegan | 16.0 SR |
| | Strawberry milkshake | 210 | Vegetarian | 20.0 SR |
| | Tropical Juice | 340 | Vegan | 25.0 SR |
| | Ice Latte | 160 | Vegetarian | 18.0 SR |
| | Large Water | 0 | Vegan | 10.0 SR |
| | Small Water | 0 | Vegan | 10.0 SR |
| | Raspberry Mojito | 129.4 | Vegan | 28.0 SR |
| | Blueberry Mojito | 136 | Vegan | 30.0 SR |

**Deliverables:**

1. Python Code.
2. Report
3. Termination condition.
4. Result:

Graph of GA performance containing the generation vs fitness function as shown in the figure below for each combination of parameter setting in the table (Total of $3^3$ combinations). containing explanation of your choice of:

1. Solution representation.
2. Fitness function.
3. Genetic operators:
   i. Crossover.
   ii. Mutation.
   iii. Selection by roulette wheel selection (See below).
   iv. Replacement.
4. Analysis of your results




**Experimental Settings:**

1. Runs: Run your GA 20 times and report the average fitness.
2. Initialize your first generation randomly in the search range.

| GA Parameter | Value | Number of combinations to try |
|---|---|---|
| **Population size** | variable (multiples of 10) | 3 |
| **Selection method** | Roulette wheel selection | - |
| **Crossover type** | Random one point | - |
| **Crossover rate, c** | Variable 0<c<1, the higher the better | 3 |
| **Mutation rate, m** | Variable 0<m<1<br>The lower the better | 3 |
| **Termination Condition** | 1. Try different conditions and choose the best. For example, terminate when the error value is less than $10^{-8}$, or after 20000 generations. (The error value is the difference between the objective function value and the optimal solution) | - |

**Helpful links:**

**GA Explanation:**

http://www.cs.ucc.ie/~dgb/courses/tai/notes/handout12.pdf
https://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol1/hmw/article1.html
https://www.slideshare.net/pbpimpale/genetic-algorithms-200688

**Roulette wheel Selection:**

https://en.wikipedia.org/wiki/Fitness_proportionate_selection
http://www.edc.ncl.ac.uk/highlight/rhjanuary2007g02.php
https://www.youtube.com/watch?v=9JzFcGdpT8E