

In this project, we built GA(Genetic Algorithm) algorithm. To coordinate clothes using artificial intelligence according to color and type of clothes. I believe this project has a future in the recommendation system

### 1. Solution representation

First, we stored each type of clothing in a sperate CSV Files. Then, we took a random sample from each file and stored it in a dataframe.

So initially we have 5 dataframes each with a random sample (1 row) from a clothing type.

Then we merged the 5 dataframes into 1 big dataframe called the chromosome, where each row in the chromosome represents a gene and that gene is a type of clothing.

### 2. Fitness function

In the fitness function, we created new columns for the weights, initially filled with zeros and added them to the generated chromosome then we started comparing the values of the chromosome vs. the user's preferences.

**i.e:** In each iteration we check if the chromosome color is the same as the user's color value, if true, we fill the column of color weights in the  $x$ th row index with 1.0 else we will fill it with 0.0.

The same goes for the other two (Dress Code Value & Budget).

After that we sum the values of each weights column then divide it by 5 (the length of chromosome) then multiply it by the importance of factors ( $w_i$ ), where ( $w_1 = 0.2$ ,  $w_2 = 0.4$ ,  $w_3 = 0.4$ ) for (ColorWeight, DressCodeWeight, PriceWeight) respectively.

At the end we sum all the values together which results in the final fitness function value that ranges from 0 to 1.

### 3. Genetic Operators

- Selection by roulette wheel selection

- 1- Calculating the total fitness value of the population.
- 2- Generating a random number between 0 and the total fitness value of the population
- 3- We apply the selection by comparing the random number with the fitness value of the first chromosome in the population. If it's larger we select it as a parent otherwise we sum its' fitness with the next chromosome's fitness, then we repeat the step until we get a parent.

- Crossover

We generated two parents by roulette wheel selection, then we generated a random cross point index that ranges between 0 and the length of the chromosome.

Then we generated two new chromosomes (children) by slicing and paring the parents at the random cross point index.

- Mutation

We generated a random index that ranges between 0 and the length of the chromosome. That index indicates the position of the rows that'll be replaced. it's similar to the crossover but instead of replacing segments we replace one gene (1 row) in each child.

- Replacement

In the replacement step we replace each generated parent from the selection using roulette wheel selection, by the new child that resulted in the crossover/mutation.

The replacement happens in the generated population and each time we do a replacement we are generating a new generation.

#### 4. Analysis of your results

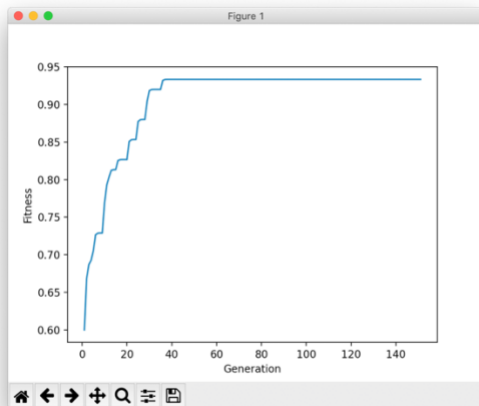
### When Population Size is 10

*\*Termination Condition is 150 for all*

#### Large Values

Cross Over Rate = 0.99

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	short skirt	bright	casual	400.0	0.0	1.0	1.0
2	sneakers	bright	casual	300.0	0.0	1.0	1.0
3	necklace	dark	business	150.0	1.0	0.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

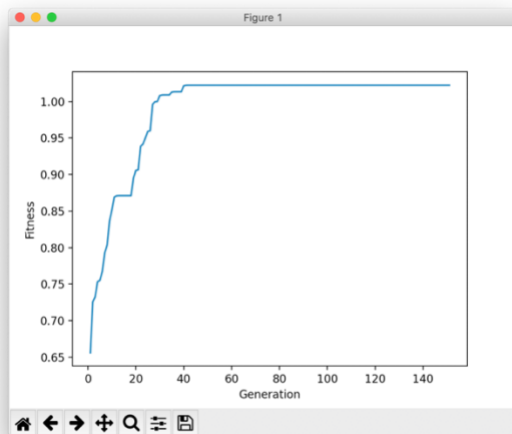
0.8400000000000001

The Total Price of the Outfit is:

1350.0

Cross Over Rate = 0.99

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	t-shirt	dark	casual	0.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	flat	bright	casual	0.0	0.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

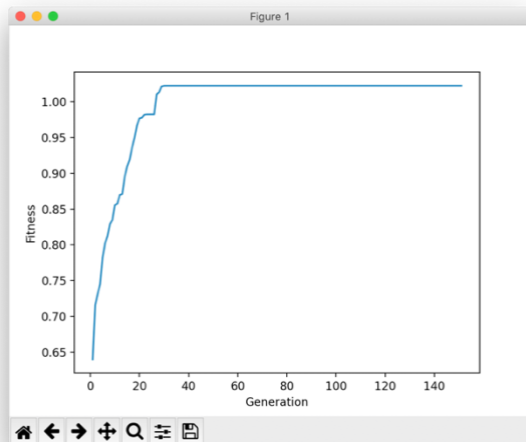
0.92

The Total Price of the Outfit is:

450.0

Cross Over Rate = 0.99

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	bow tie	dark	business	100.0	1.0	0.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.92

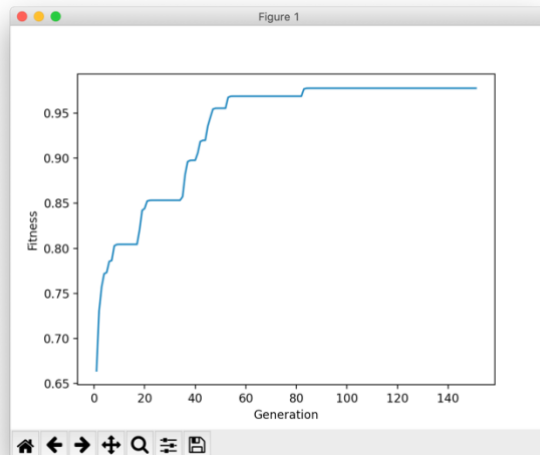
The Total Price of the Outfit is:

1160.0

## Medium Values

Cross Over Rate = 0.55

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	short skirt	bright	casual	400.0	0.0	1.0	1.0
2	sneakers	bright	casual	300.0	0.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

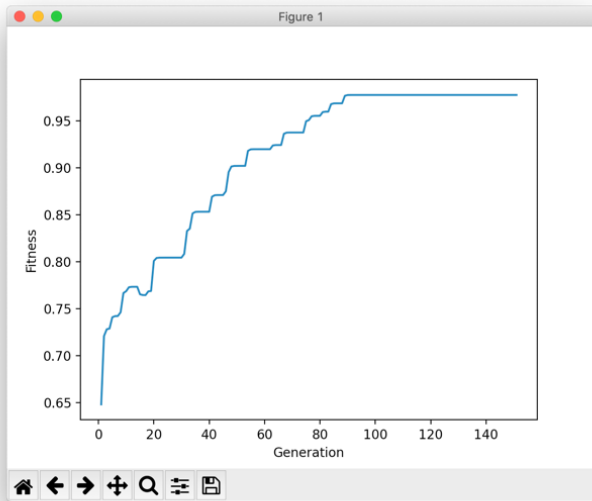
0.8800000000000001

The Total Price of the Outfit is:

1200.0

Cross Over Rate = 0.55

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	cardigan	bright	casual	300.0	0.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	flat	bright	casual	0.0	0.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

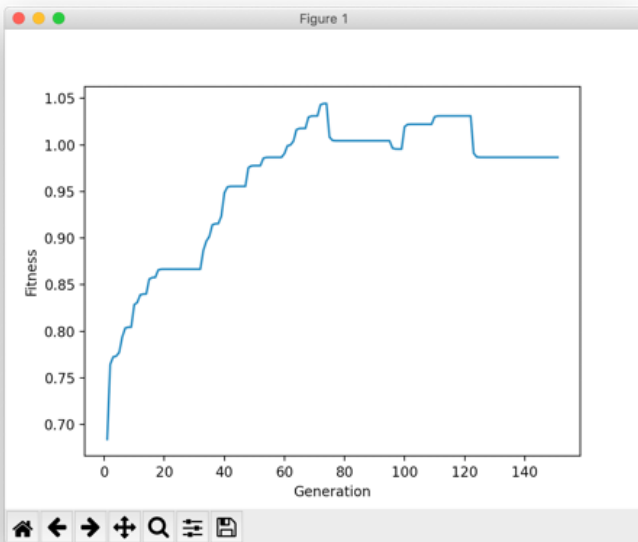
0.8800000000000001

The Total Price of the Outfit is:

1000.0

Cross Over Rate = 0.55

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	legging	dark	casual	100.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	cross bag	dark	business	0.0	1.0	0.0	1.0

The Fitness Value for the Best Outfit is:

0.9600000000000001

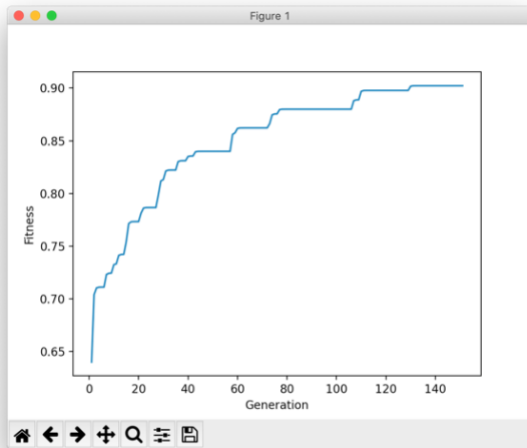
The Total Price of the Outfit is:

670.0

## Small Values

Cross Over Rate = 0.20

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	cardigan	bright	casual	300.0	0.0	1.0	1.0
1	legging	dark	casual	100.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	cross bag	dark	business	0.0	1.0	0.0	1.0

The Fitness Value for the Best Outfit is:

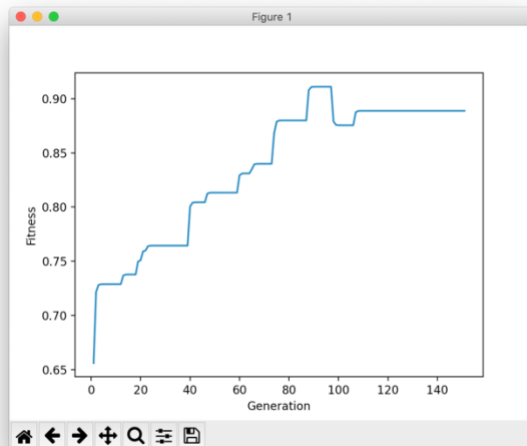
0.8400000000000001

The Total Price of the Outfit is:

900.0

Cross Over Rate = 0.20

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	knee length pant	bright	casual	220.0	0.0	1.0	1.0
2	sandals	dark	evening	120.0	1.0	0.0	1.0
3	necklace	dark	business	150.0	1.0	0.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

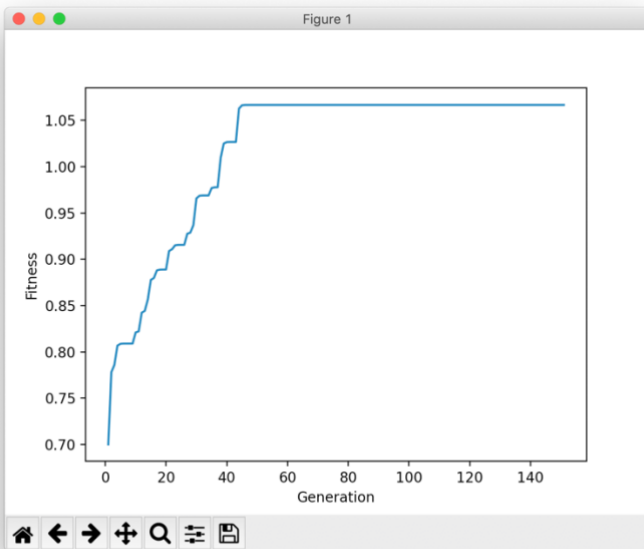
0.8

The Total Price of the Outfit is:

900.0

Cross Over Rate = 0.20

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	legging	dark	casual	100.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.9600000000000001

The Total Price of the Outfit is:

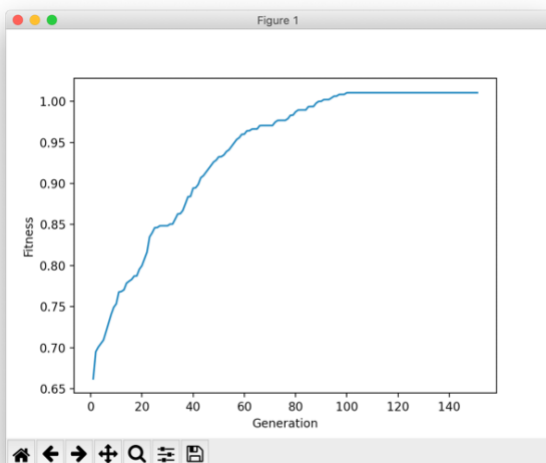
1010.0

## When Population Size is 20

### Large Values

Cross Over Rate = 0.99

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	bodysuit	dark	casual	150.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

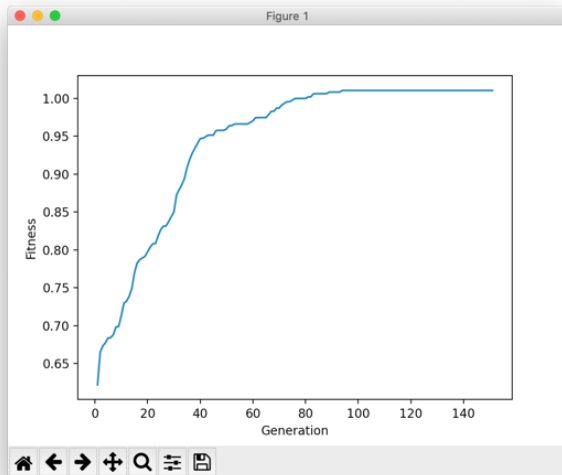
0.9600000000000001

The Total Price of the Outfit is:

1350.0

Cross Over Rate = 0.99

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	legging	dark	casual	100.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

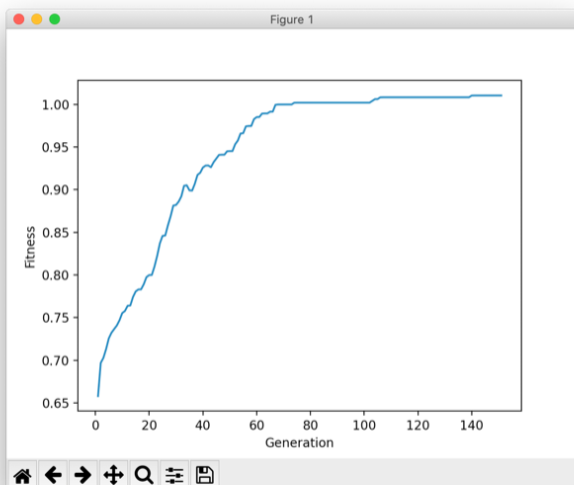
0.9600000000000001

The Total Price of the Outfit is:

880.0

Cross Over Rate = 0.99

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	legging	dark	casual	100.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.9600000000000001

The Total Price of the Outfit is:

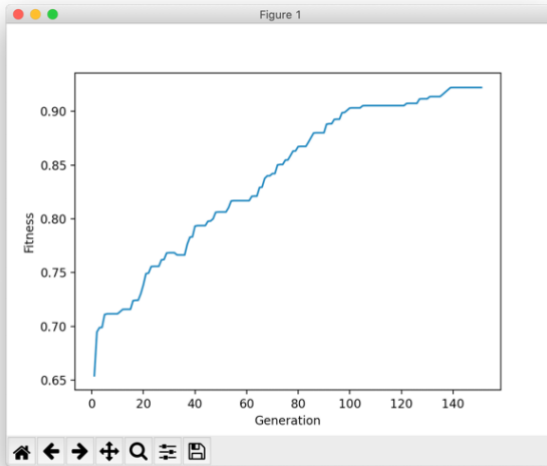
1260.0



## Medium Values

Cross Over Rate = 0.55

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	clutch	dark	evening	500.0	1.0	0.0	1.0

The Fitness Value for the Best Outfit is:

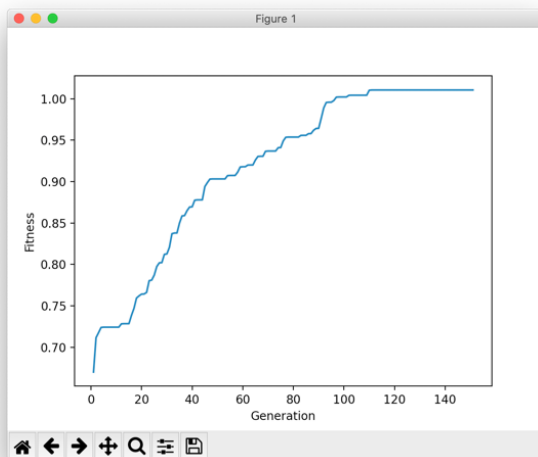
0.8800000000000001

The Total Price of the Outfit is:

970.0

Cross Over Rate = 0.55

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

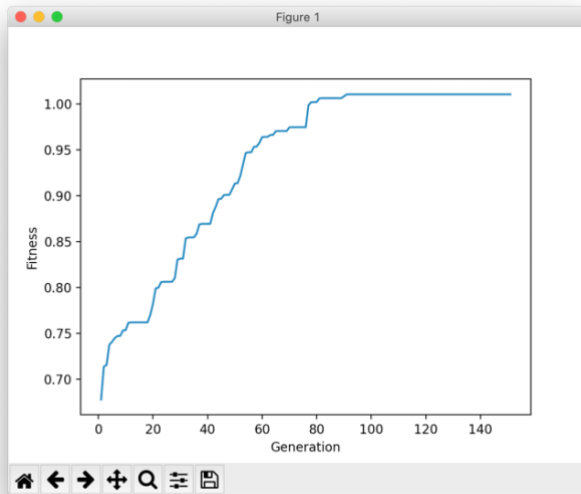
0.9600000000000001

The Total Price of the Outfit is:

680.0

Cross Over Rate = 0.55

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.9600000000000001

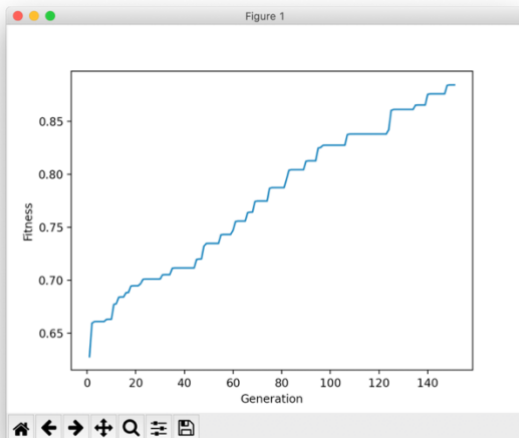
The Total Price of the Outfit is:

680.0

## Small Values

Cross Over Rate = 0.20

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	bodysuit	dark	casual	150.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	necklace	dark	evening	150.0	1.0	0.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

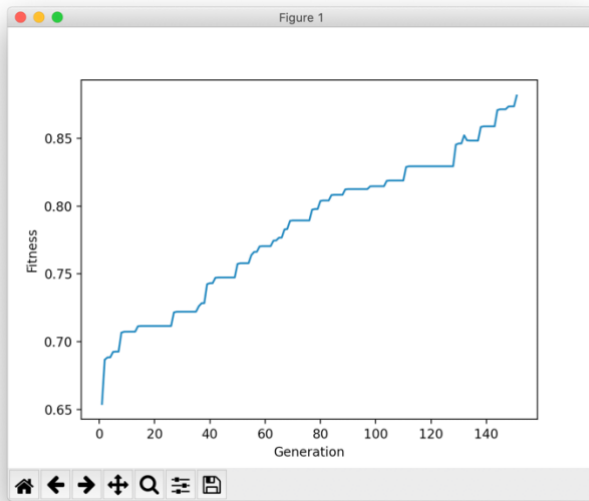
0.92

The Total Price of the Outfit is:

1250.0

Cross Over Rate = 0.20

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	tank	bright	casual	70.0	0.0	1.0	1.0
1	ankle length pant	dark	business	0.0	1.0	0.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

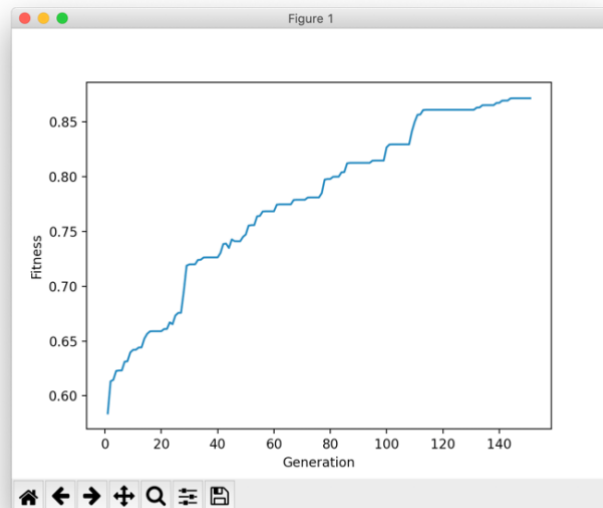
0.8800000000000001

The Total Price of the Outfit is:

490.0

Cross Over Rate = 0.20

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	midi skirt	dark	business	0.0	1.0	0.0	1.0
2	sneakers	bright	casual	300.0	0.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.8400000000000001

The Total Price of the Outfit is:

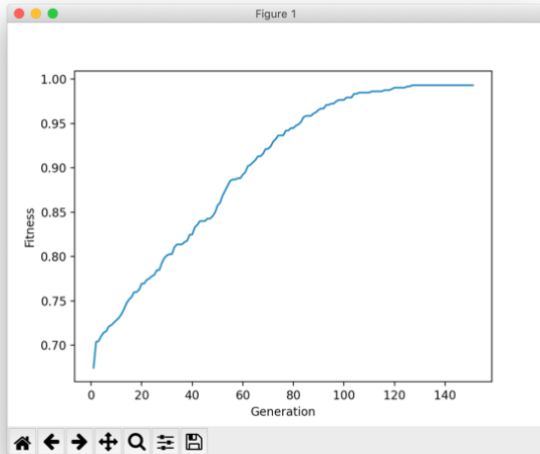
800.0

## When Population Size is 30

### Large Values

Cross Over Rate = 0.99

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

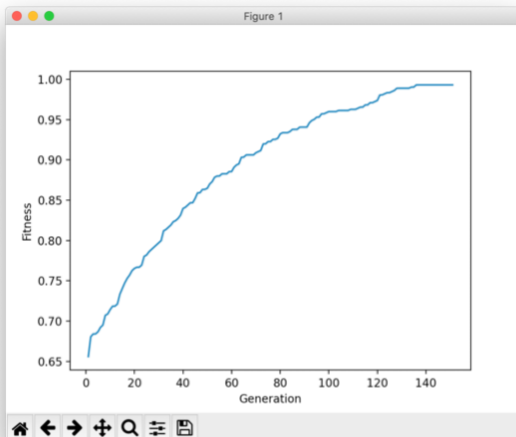
0.9600000000000001

The Total Price of the Outfit is:

1020.0

Cross Over Rate = 0.99

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

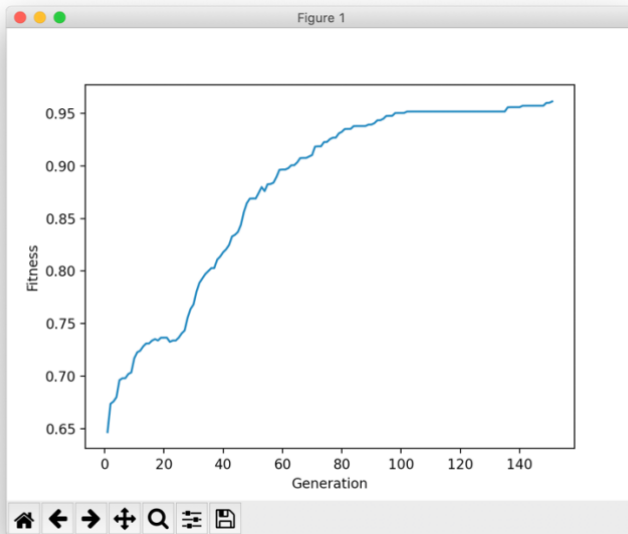
0.9600000000000001

The Total Price of the Outfit is:

1020.0

Cross Over Rate = 0.99

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.9600000000000001

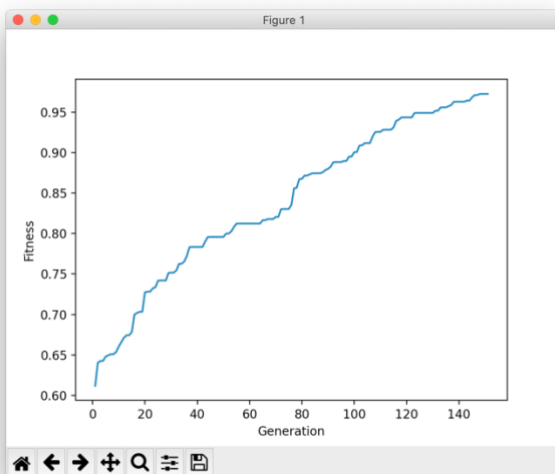
The Total Price of the Outfit is:

1310.0

## Medium Values

Cross Over Rate = 0.55

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	t-shirt	dark	casual	0.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

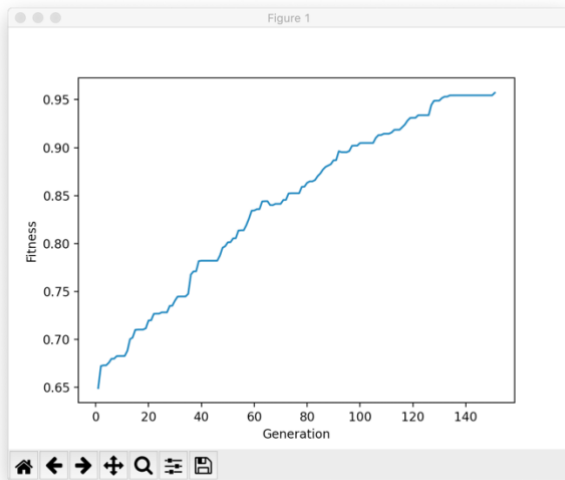
0.9600000000000001

The Total Price of the Outfit is:

820.0

Cross Over Rate = 0.55

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	legging	dark	casual	100.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

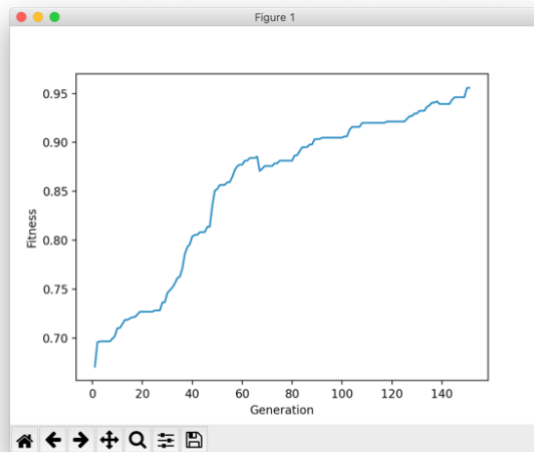
0.9600000000000001

The Total Price of the Outfit is:

970.0

Cross Over Rate = 0.55

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	t-shirt	dark	casual	0.0	1.0	1.0	1.0
1	legging	dark	casual	100.0	1.0	1.0	1.0
2	boots	dark	casual	500.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.9600000000000001

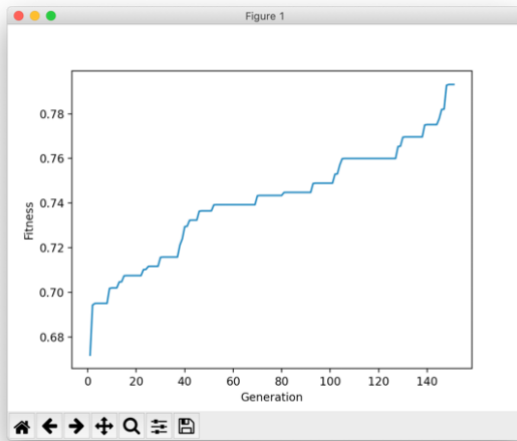
The Total Price of the Outfit is:

900.0

## Small Values

Cross Over Rate = 0.20

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	t-shirt	dark	casual	0.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

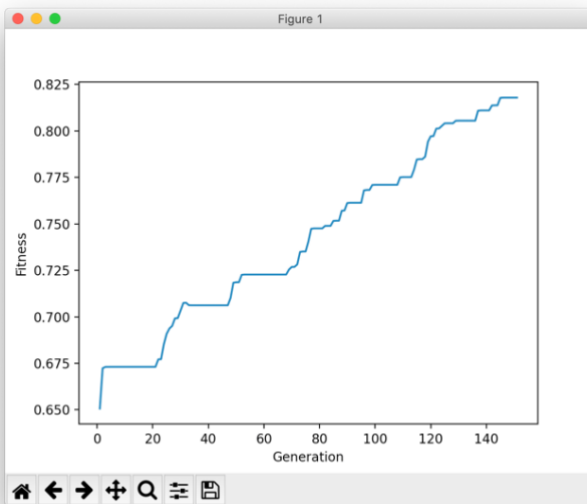
0.9600000000000001

The Total Price of the Outfit is:

570.0

Cross Over Rate = 0.20

Mutation rate = 0.10



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	flat	bright	casual	0.0	0.0	1.0	1.0
3	choker	bright	casual	0.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

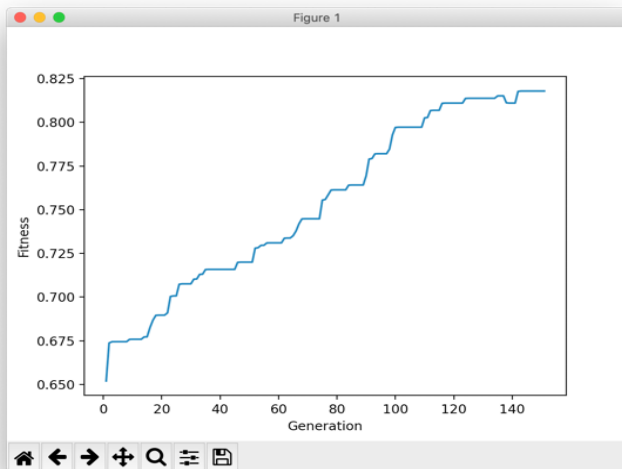
0.92

The Total Price of the Outfit is:

560.0

Cross Over Rate = 0.20

Mutation rate = 0.30



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sleeveless	dark	casual	110.0	1.0	1.0	1.0
1	sweatpants	bright	casual	100.0	0.0	1.0	1.0
2	sandals	dark	evening	120.0	1.0	0.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.8400000000000001

The Total Price of the Outfit is:

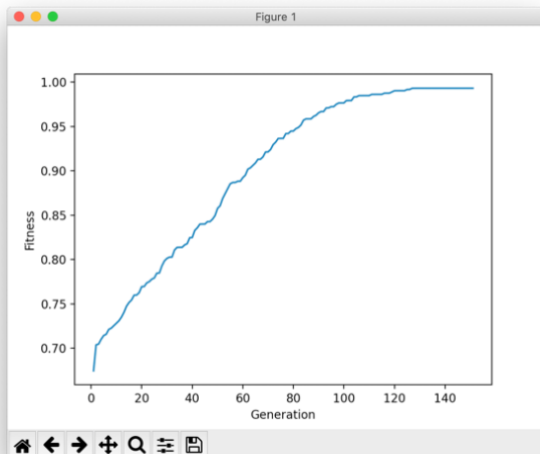
880.0

When the population is 30 and the cross over rate is 0.99 and mutation rate is 0.01 it will generate the best fitness as seen below

Population Size is 30

Cross Over Rate = 0.99

Mutation rate = 0.01



The Best Outfit is:

	Piece	Color	Dress_Code	Price	1	2	3
0	sweater	dark	casual	200.0	1.0	1.0	1.0
1	jeans	dark	casual	150.0	1.0	1.0	1.0
2	sandals	dark	casual	120.0	1.0	1.0	1.0
3	scarf	bright	casual	250.0	0.0	1.0	1.0
4	belt bag	dark	casual	300.0	1.0	1.0	1.0

The Fitness Value for the Best Outfit is:

0.9600000000000001

The Total Price of the Outfit is:

1020.0