

CSE 443
OBJECT ORIENTED ANALYSIS AND DESIGN

HOMEWORK 02

REPORT

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1. Part 1

In that part, I create *AbstractGA* abstract class which interfaces the three versions of genetic algorithm concrete classes: *Version1*, *Version2* and *Version3*. *AbstractGA* class has its template method called *geneticAlgorithm()*. This method calls *selection()*, *crossover()*, *mutation()* and *computeFitness()* until *populationConverge()* method returns false. In *geneticAlgorithm()* method first of all *computeFitness()* method calls and first fit values of $f(x1, x2)$ sets. *populationConverge()* method gets the average of population's fitness values and checks if it is less than 126 or not. Finding that constant 126 value we calculated the most value of $f(x1, x2)$.

Then *selection()* method calls in that loop. That *selection()* method is implemented by three version of genetic algorithm which is 'Roulette Wheel Selection' or 'Rank Selection' or 'Tournament Selection'.

In *Version1* class, Roulette Wheel Selection is implemented as representing fitness values as a birthday cake parts. Then creating parents randomly in that cake.

In *Version2* class, Rank Selection is implemented as sorting fitness values. Then creating parents randomly which gets higher weighted random based.

In *Version3* class, Tournament Selection is implemented as selecting 3 random racer parents. Then selecting parents the fittest between them.

Each fitness, x1 and x2 values are keeping by *Individual* concrete class and *Population* concrete class keeps array of *Individual* objects.

AbstractGA abstract class keeps *Population*, *Individual* parents and *Individual* child. In *AbstractGA* abstract class has *mutation()* method and it's mutating x1 or x2 of child randomly. Then adding the child into population's first place after shifting population.

In *crossover()* method each version implements their own crossover methods. In *Version1*, creating a child and setting its x1 and x2 values as average of parents x1 and x2 values. In *Version3*, creating child and setting its x1 and x2 values as *Version1* for cross point 1 assumed as like that. In *Version2*, creating its child and setting its x1 and x2 values as summing parents x1 and x2 values and multiplying by 0.55 which crosspoint 2 assumed as like 0.55.

- **Class Diagram For Part 1**

- Output Results For Part 1

Roulette Wheel Selection

```

Main x
/usr/lib/jvm/java-12-oracle/bin/java -javaagent:/opt/idea/li
02/Homework_02/out/production/Homework_02:/home/omer/Downlo
Roulette Wheel Selection Genetic Algorithm

x1 : [ 0.24 ] x2 : [ 0.67 ] Fitness : 12.60
x1 : [ 0.47 ] x2 : [ 0.88 ] Fitness : 19.34
x1 : [ 1.00 ] x2 : [ 0.04 ] Fitness : -1.73
x1 : [ 0.00 ] x2 : [ 0.61 ] Fitness : 8.98
x1 : [ 0.62 ] x2 : [ 0.95 ] Fitness : 22.95
x1 : [ 0.89 ] x2 : [ 0.96 ] Fitness : 26.51
x1 : [ 0.87 ] x2 : [ 0.18 ] Fitness : 3.39
x1 : [ 0.70 ] x2 : [ 0.94 ] Fitness : 23.73
x1 : [ 0.83 ] x2 : [ 0.03 ] Fitness : -1.08
x1 : [ 0.94 ] x2 : [ 0.65 ] Fitness : 17.84

Generation value : [ 1 ]

x1 : [ 0.47 ] x2 : [ 0.78 ] Fitness : 17.21
x1 : [ 0.24 ] x2 : [ 0.67 ] Fitness : 12.60
x1 : [ 0.47 ] x2 : [ 0.88 ] Fitness : 19.34
x1 : [ 1.00 ] x2 : [ 0.04 ] Fitness : -1.73
x1 : [ 0.00 ] x2 : [ 0.61 ] Fitness : 8.98
x1 : [ 0.62 ] x2 : [ 0.95 ] Fitness : 22.95
x1 : [ 0.89 ] x2 : [ 0.96 ] Fitness : 26.51
x1 : [ 0.87 ] x2 : [ 0.18 ] Fitness : 3.39
x1 : [ 0.70 ] x2 : [ 0.94 ] Fitness : 23.73
x1 : [ 0.83 ] x2 : [ 0.03 ] Fitness : -1.08

Generation value : [ 2 ]

x1 : [ 0.47 ] x2 : [ 0.85 ] Fitness : 18.70
x1 : [ 0.47 ] x2 : [ 0.78 ] Fitness : 17.21
x1 : [ 0.24 ] x2 : [ 0.67 ] Fitness : 12.60
x1 : [ 0.47 ] x2 : [ 0.88 ] Fitness : 19.34
x1 : [ 1.00 ] x2 : [ 0.04 ] Fitness : -1.73
x1 : [ 0.00 ] x2 : [ 0.61 ] Fitness : 8.98
x1 : [ 0.62 ] x2 : [ 0.95 ] Fitness : 22.95
x1 : [ 0.89 ] x2 : [ 0.96 ] Fitness : 26.51
x1 : [ 0.87 ] x2 : [ 0.18 ] Fitness : 3.39
x1 : [ 0.70 ] x2 : [ 0.94 ] Fitness : 23.73

Generation value : [ 3 ]

x1 : [ 0.76 ] x2 : [ 0.96 ] Fitness : 24.77
x1 : [ 0.47 ] x2 : [ 0.85 ] Fitness : 18.70
x1 : [ 0.47 ] x2 : [ 0.78 ] Fitness : 17.21
x1 : [ 0.24 ] x2 : [ 0.67 ] Fitness : 12.60
x1 : [ 0.47 ] x2 : [ 0.88 ] Fitness : 19.34

Main x
x1 : [ 2.46 ] x2 : [ 2.62 ] Fitness : 125.97
x1 : [ 2.44 ] x2 : [ 2.61 ] Fitness : 124.98
x1 : [ 2.44 ] x2 : [ 2.61 ] Fitness : 125.05

Generation value : [ 1905 ]

x1 : [ 2.46 ] x2 : [ 2.62 ] Fitness : 126.21
x1 : [ 2.47 ] x2 : [ 2.63 ] Fitness : 126.95
x1 : [ 2.49 ] x2 : [ 2.61 ] Fitness : 126.43
x1 : [ 2.45 ] x2 : [ 2.61 ] Fitness : 125.03
x1 : [ 2.48 ] x2 : [ 2.60 ] Fitness : 125.60
x1 : [ 2.44 ] x2 : [ 2.61 ] Fitness : 124.98
x1 : [ 2.45 ] x2 : [ 2.61 ] Fitness : 125.47
x1 : [ 2.48 ] x2 : [ 2.61 ] Fitness : 126.17
x1 : [ 2.46 ] x2 : [ 2.62 ] Fitness : 125.97
x1 : [ 2.44 ] x2 : [ 2.61 ] Fitness : 124.98

Generation value : [ 1906 ]

x1 : [ 2.45 ] x2 : [ 2.63 ] Fitness : 125.99
x1 : [ 2.46 ] x2 : [ 2.62 ] Fitness : 126.21
x1 : [ 2.47 ] x2 : [ 2.63 ] Fitness : 126.95
x1 : [ 2.49 ] x2 : [ 2.61 ] Fitness : 126.43
x1 : [ 2.45 ] x2 : [ 2.61 ] Fitness : 125.03
x1 : [ 2.48 ] x2 : [ 2.60 ] Fitness : 125.60
x1 : [ 2.44 ] x2 : [ 2.61 ] Fitness : 124.98
x1 : [ 2.45 ] x2 : [ 2.61 ] Fitness : 125.47
x1 : [ 2.48 ] x2 : [ 2.61 ] Fitness : 126.17
x1 : [ 2.46 ] x2 : [ 2.62 ] Fitness : 125.97

Generation value : [ 1907 ]

x1 : [ 2.48 ] x2 : [ 2.63 ] Fitness : 127.32
x1 : [ 2.45 ] x2 : [ 2.63 ] Fitness : 125.99
x1 : [ 2.46 ] x2 : [ 2.62 ] Fitness : 126.21
x1 : [ 2.47 ] x2 : [ 2.63 ] Fitness : 126.95
x1 : [ 2.49 ] x2 : [ 2.61 ] Fitness : 126.43
x1 : [ 2.45 ] x2 : [ 2.61 ] Fitness : 125.03
x1 : [ 2.48 ] x2 : [ 2.60 ] Fitness : 125.60
x1 : [ 2.44 ] x2 : [ 2.61 ] Fitness : 124.98
x1 : [ 2.45 ] x2 : [ 2.61 ] Fitness : 125.47
x1 : [ 2.48 ] x2 : [ 2.61 ] Fitness : 126.17

Generation value : [ 1908 ]

Process finished with exit code 0
```

Rank Selection

```
Main x
/usr/lib/jvm/java-12-oracle/bin/java -javaagent:/opt/idea/li
02/Homework_02/out/production/Homework_02:/home/omer/Dowlo
Rank Selection Genetic Algorithm

x1 : [ 0.39 ]    x2 : [ 0.74 ]    Fitness : 15.52
x1 : [ 0.88 ]    x2 : [ 0.32 ]    Fitness : 7.80
x1 : [ 0.82 ]    x2 : [ 0.53 ]    Fitness : 13.67
x1 : [ 0.32 ]    x2 : [ 0.39 ]    Fitness : 7.80
x1 : [ 0.39 ]    x2 : [ 0.96 ]    Fitness : 19.83
x1 : [ 0.73 ]    x2 : [ 0.02 ]    Fitness : -0.94
x1 : [ 0.61 ]    x2 : [ 0.36 ]    Fitness : 8.38
x1 : [ 0.92 ]    x2 : [ 0.46 ]    Fitness : 11.90
x1 : [ 0.81 ]    x2 : [ 0.25 ]    Fitness : 5.55
x1 : [ 0.61 ]    x2 : [ 0.43 ]    Fitness : 10.04

Generation value : [ 1 ]

x1 : [ 0.74 ]    x2 : [ 0.21 ]    Fitness : 4.47
x1 : [ 0.39 ]    x2 : [ 0.74 ]    Fitness : 15.52
x1 : [ 0.88 ]    x2 : [ 0.32 ]    Fitness : 7.80
x1 : [ 0.82 ]    x2 : [ 0.53 ]    Fitness : 13.67
x1 : [ 0.32 ]    x2 : [ 0.39 ]    Fitness : 7.80
x1 : [ 0.39 ]    x2 : [ 0.96 ]    Fitness : 19.83
x1 : [ 0.73 ]    x2 : [ 0.02 ]    Fitness : -0.94
x1 : [ 0.61 ]    x2 : [ 0.36 ]    Fitness : 8.38
x1 : [ 0.92 ]    x2 : [ 0.46 ]    Fitness : 11.90
x1 : [ 0.81 ]    x2 : [ 0.25 ]    Fitness : 5.55

Generation value : [ 2 ]

x1 : [ 0.72 ]    x2 : [ 0.78 ]    Fitness : 19.86
x1 : [ 0.74 ]    x2 : [ 0.21 ]    Fitness : 4.47
x1 : [ 0.39 ]    x2 : [ 0.74 ]    Fitness : 15.52
x1 : [ 0.88 ]    x2 : [ 0.32 ]    Fitness : 7.80
x1 : [ 0.82 ]    x2 : [ 0.53 ]    Fitness : 13.67
x1 : [ 0.32 ]    x2 : [ 0.39 ]    Fitness : 7.80
x1 : [ 0.39 ]    x2 : [ 0.96 ]    Fitness : 19.83
x1 : [ 0.73 ]    x2 : [ 0.02 ]    Fitness : -0.94
x1 : [ 0.61 ]    x2 : [ 0.36 ]    Fitness : 8.38
x1 : [ 0.92 ]    x2 : [ 0.46 ]    Fitness : 11.90

Generation value : [ 3 ]

x1 : [ 0.58 ]    x2 : [ 0.25 ]    Fitness : 5.35
x1 : [ 0.72 ]    x2 : [ 0.78 ]    Fitness : 19.86
x1 : [ 0.74 ]    x2 : [ 0.21 ]    Fitness : 4.47
x1 : [ 0.39 ]    x2 : [ 0.74 ]    Fitness : 15.52
x1 : [ 0.88 ]    x2 : [ 0.32 ]    Fitness : 7.80
x1 : [ 0.82 ]    x2 : [ 0.53 ]    Fitness : 13.67
x1 : [ 0.32 ]    x2 : [ 0.39 ]    Fitness : 7.80
x1 : [ 0.39 ]    x2 : [ 0.96 ]    Fitness : 19.83
x1 : [ 0.73 ]    x2 : [ 0.02 ]    Fitness : -0.94
x1 : [ 0.61 ]    x2 : [ 0.36 ]    Fitness : 8.38
x1 : [ 0.92 ]    x2 : [ 0.46 ]    Fitness : 11.90

Generation value : [ 4 ]

x1 : [ 0.58 ]    x2 : [ 0.25 ]    Fitness : 5.35
x1 : [ 0.72 ]    x2 : [ 0.78 ]    Fitness : 19.86
x1 : [ 0.74 ]    x2 : [ 0.21 ]    Fitness : 4.47
x1 : [ 0.39 ]    x2 : [ 0.74 ]    Fitness : 15.52
x1 : [ 0.88 ]    x2 : [ 0.32 ]    Fitness : 7.80
x1 : [ 0.82 ]    x2 : [ 0.53 ]    Fitness : 13.67
x1 : [ 0.32 ]    x2 : [ 0.39 ]    Fitness : 7.80
x1 : [ 0.39 ]    x2 : [ 0.96 ]    Fitness : 19.83
x1 : [ 0.73 ]    x2 : [ 0.02 ]    Fitness : -0.94
x1 : [ 0.61 ]    x2 : [ 0.36 ]    Fitness : 8.38
x1 : [ 0.92 ]    x2 : [ 0.46 ]    Fitness : 11.90

Generation value : [ 5 ]

x1 : [ 2.95 ]    x2 : [ 2.12 ]    Fitness : 111.35
x1 : [ 2.92 ]    x2 : [ 2.14 ]    Fitness : 112.01
x1 : [ 2.95 ]    x2 : [ 2.13 ]    Fitness : 112.14
x1 : [ 2.76 ]    x2 : [ 2.00 ]    Fitness : 100.68

Generation value : [ 109 ]

x1 : [ 3.23 ]    x2 : [ 2.32 ]    Fitness : 129.76
x1 : [ 3.12 ]    x2 : [ 2.28 ]    Fitness : 124.95
x1 : [ 3.29 ]    x2 : [ 2.40 ]    Fitness : 136.65
x1 : [ 3.05 ]    x2 : [ 2.21 ]    Fitness : 118.70
x1 : [ 3.06 ]    x2 : [ 2.24 ]    Fitness : 121.37
x1 : [ 3.14 ]    x2 : [ 2.27 ]    Fitness : 125.03
x1 : [ 2.90 ]    x2 : [ 2.09 ]    Fitness : 108.52
x1 : [ 2.93 ]    x2 : [ 2.12 ]    Fitness : 111.35
x1 : [ 2.92 ]    x2 : [ 2.14 ]    Fitness : 112.01
x1 : [ 2.95 ]    x2 : [ 2.13 ]    Fitness : 112.14

Generation value : [ 110 ]

x1 : [ 3.46 ]    x2 : [ 2.53 ]    Fitness : 149.24
x1 : [ 3.23 ]    x2 : [ 2.32 ]    Fitness : 129.76
x1 : [ 3.12 ]    x2 : [ 2.28 ]    Fitness : 124.95
x1 : [ 3.29 ]    x2 : [ 2.40 ]    Fitness : 136.65
x1 : [ 3.05 ]    x2 : [ 2.21 ]    Fitness : 118.70
x1 : [ 3.06 ]    x2 : [ 2.24 ]    Fitness : 121.37
x1 : [ 3.14 ]    x2 : [ 2.27 ]    Fitness : 125.03
x1 : [ 2.90 ]    x2 : [ 2.09 ]    Fitness : 108.52
x1 : [ 2.93 ]    x2 : [ 2.12 ]    Fitness : 111.35
x1 : [ 2.92 ]    x2 : [ 2.14 ]    Fitness : 112.01

Generation value : [ 111 ]

x1 : [ 3.28 ]    x2 : [ 2.38 ]    Fitness : 135.17
x1 : [ 3.46 ]    x2 : [ 2.53 ]    Fitness : 149.24
x1 : [ 3.23 ]    x2 : [ 2.32 ]    Fitness : 129.76
x1 : [ 3.12 ]    x2 : [ 2.28 ]    Fitness : 124.95
x1 : [ 3.29 ]    x2 : [ 2.40 ]    Fitness : 136.65
x1 : [ 3.05 ]    x2 : [ 2.21 ]    Fitness : 118.70
x1 : [ 3.06 ]    x2 : [ 2.24 ]    Fitness : 121.37
x1 : [ 3.14 ]    x2 : [ 2.27 ]    Fitness : 125.03
x1 : [ 2.90 ]    x2 : [ 2.09 ]    Fitness : 108.52
x1 : [ 2.93 ]    x2 : [ 2.12 ]    Fitness : 111.35

Generation value : [ 112 ]

Process finished with exit code 0
```

Tournament Selection

```
Main x  
/usr/lib/jvm/java-12-oracle/bin/java -javaagent:/opt/idea...  
02/Homework_02/out/production/Homework_02:/home/omer/Dov...  
Tournament Selection Genetic Algorithm  
  
x1 : [ 0.46 ]    x2 : [ 0.71 ]    Fitness : 15.55  
x1 : [ 0.73 ]    x2 : [ 0.36 ]    Fitness : 8.72  
x1 : [ 0.51 ]    x2 : [ 0.56 ]    Fitness : 12.59  
x1 : [ 0.42 ]    x2 : [ 0.86 ]    Fitness : 18.16  
x1 : [ 0.25 ]    x2 : [ 0.44 ]    Fitness : 8.39  
x1 : [ 0.41 ]    x2 : [ 0.78 ]    Fitness : 16.48  
x1 : [ 0.52 ]    x2 : [ 0.60 ]    Fitness : 13.79  
x1 : [ 0.95 ]    x2 : [ 0.75 ]    Fitness : 20.92  
x1 : [ 0.29 ]    x2 : [ 0.14 ]    Fitness : 2.58  
x1 : [ 0.23 ]    x2 : [ 0.93 ]    Fitness : 16.91  
  
Generation value : [ 1 ]  
  
x1 : [ 0.59 ]    x2 : [ 0.56 ]    Fitness : 13.14  
x1 : [ 0.46 ]    x2 : [ 0.71 ]    Fitness : 15.55  
x1 : [ 0.73 ]    x2 : [ 0.36 ]    Fitness : 8.72  
x1 : [ 0.51 ]    x2 : [ 0.56 ]    Fitness : 12.59  
x1 : [ 0.42 ]    x2 : [ 0.86 ]    Fitness : 18.16  
x1 : [ 0.25 ]    x2 : [ 0.44 ]    Fitness : 8.39  
x1 : [ 0.41 ]    x2 : [ 0.78 ]    Fitness : 16.48  
x1 : [ 0.52 ]    x2 : [ 0.60 ]    Fitness : 13.79  
x1 : [ 0.95 ]    x2 : [ 0.75 ]    Fitness : 20.92  
x1 : [ 0.29 ]    x2 : [ 0.14 ]    Fitness : 2.58  
  
Generation value : [ 2 ]  
  
x1 : [ 0.59 ]    x2 : [ 0.56 ]    Fitness : 13.14  
x1 : [ 0.59 ]    x2 : [ 0.56 ]    Fitness : 13.14  
x1 : [ 0.46 ]    x2 : [ 0.71 ]    Fitness : 15.55  
x1 : [ 0.73 ]    x2 : [ 0.36 ]    Fitness : 8.72  
x1 : [ 0.51 ]    x2 : [ 0.56 ]    Fitness : 12.59  
x1 : [ 0.42 ]    x2 : [ 0.86 ]    Fitness : 18.16  
x1 : [ 0.25 ]    x2 : [ 0.44 ]    Fitness : 8.39  
x1 : [ 0.41 ]    x2 : [ 0.78 ]    Fitness : 16.48  
x1 : [ 0.52 ]    x2 : [ 0.60 ]    Fitness : 13.79  
x1 : [ 0.95 ]    x2 : [ 0.75 ]    Fitness : 20.92  
  
Generation value : [ 3 ]  
  
x1 : [ 0.53 ]    x2 : [ 0.63 ]    Fitness : 14.46  
x1 : [ 0.59 ]    x2 : [ 0.56 ]    Fitness : 13.14  
x1 : [ 0.59 ]    x2 : [ 0.56 ]    Fitness : 13.14  
x1 : [ 0.46 ]    x2 : [ 0.71 ]    Fitness : 15.55  
x1 : [ 0.73 ]    x2 : [ 0.36 ]    Fitness : 8.72  
x1 : [ 0.51 ]    x2 : [ 0.56 ]    Fitness : 12.59  
x1 : [ 0.42 ]    x2 : [ 0.86 ]    Fitness : 18.16  
x1 : [ 0.25 ]    x2 : [ 0.44 ]    Fitness : 8.39  
x1 : [ 0.41 ]    x2 : [ 0.78 ]    Fitness : 16.48  
x1 : [ 0.52 ]    x2 : [ 0.60 ]    Fitness : 13.79  
x1 : [ 0.95 ]    x2 : [ 0.75 ]    Fitness : 20.92  
  
Main x  
x1 : [ 2.58 ]    x2 : [ 2.52 ]    Fitness : 124.50  
x1 : [ 2.58 ]    x2 : [ 2.52 ]    Fitness : 124.49  
x1 : [ 2.56 ]    x2 : [ 2.52 ]    Fitness : 124.10  
x1 : [ 2.55 ]    x2 : [ 2.53 ]    Fitness : 124.52  
  
Generation value : [ 814 ]  
  
x1 : [ 2.64 ]    x2 : [ 2.52 ]    Fitness : 126.43  
x1 : [ 2.64 ]    x2 : [ 2.53 ]    Fitness : 126.88  
x1 : [ 2.62 ]    x2 : [ 2.54 ]    Fitness : 126.89  
x1 : [ 2.63 ]    x2 : [ 2.52 ]    Fitness : 125.98  
x1 : [ 2.62 ]    x2 : [ 2.52 ]    Fitness : 125.69  
x1 : [ 2.61 ]    x2 : [ 2.52 ]    Fitness : 125.48  
x1 : [ 2.61 ]    x2 : [ 2.52 ]    Fitness : 125.29  
x1 : [ 2.59 ]    x2 : [ 2.52 ]    Fitness : 124.90  
x1 : [ 2.58 ]    x2 : [ 2.52 ]    Fitness : 124.49  
x1 : [ 2.56 ]    x2 : [ 2.52 ]    Fitness : 124.10  
  
Generation value : [ 815 ]  
  
x1 : [ 2.65 ]    x2 : [ 2.53 ]    Fitness : 127.48  
x1 : [ 2.64 ]    x2 : [ 2.52 ]    Fitness : 126.43  
x1 : [ 2.64 ]    x2 : [ 2.53 ]    Fitness : 126.88  
x1 : [ 2.62 ]    x2 : [ 2.54 ]    Fitness : 126.89  
x1 : [ 2.63 ]    x2 : [ 2.52 ]    Fitness : 125.98  
x1 : [ 2.62 ]    x2 : [ 2.52 ]    Fitness : 125.69  
x1 : [ 2.61 ]    x2 : [ 2.52 ]    Fitness : 125.48  
x1 : [ 2.61 ]    x2 : [ 2.52 ]    Fitness : 125.29  
x1 : [ 2.59 ]    x2 : [ 2.52 ]    Fitness : 124.90  
x1 : [ 2.58 ]    x2 : [ 2.52 ]    Fitness : 124.49  
  
Generation value : [ 816 ]  
  
x1 : [ 2.65 ]    x2 : [ 2.55 ]    Fitness : 128.25  
x1 : [ 2.65 ]    x2 : [ 2.53 ]    Fitness : 127.48  
x1 : [ 2.64 ]    x2 : [ 2.52 ]    Fitness : 126.43  
x1 : [ 2.64 ]    x2 : [ 2.53 ]    Fitness : 126.88  
x1 : [ 2.62 ]    x2 : [ 2.54 ]    Fitness : 126.89  
x1 : [ 2.63 ]    x2 : [ 2.52 ]    Fitness : 125.98  
x1 : [ 2.62 ]    x2 : [ 2.52 ]    Fitness : 125.69  
x1 : [ 2.61 ]    x2 : [ 2.52 ]    Fitness : 125.48  
x1 : [ 2.61 ]    x2 : [ 2.52 ]    Fitness : 125.29  
x1 : [ 2.59 ]    x2 : [ 2.52 ]    Fitness : 124.90  
  
Generation value : [ 817 ]  
  
Process finished with exit code 0
```

2. Part 2

In that part, using each classes which are implemented in part 1. Only showing the results in GUI. I used *JFreeChart* library to show as chart the results. Threads have not been used. Also there was no time to implement buttons on clicking and there was no time to represent results change in chart runtime live. To get values for chart overloaded the template method which is called *geneticAlgorithm()* getting parameter as *XYSeries* of versions.

- **Class Diagram For Part 2**

Same as part 1 only main is different. *Main* class has createing data set methods.

- **Output Results For Part 2**

