

Task 1

1. Create 100 random binary-chromosomes each with 1000 genes.
2. Fitness is the number of "1" in one chromosome - the more the better.
3. Select 2 chromosomes at random from the better half of the population.
4. Create a child chromosome by a one-point-crossover.
5. Give the child a mutation with a probability of $1/1000 = 0.001$.
6. Repeat from 2. to 5. 100 times and create the next generation.
7. Repeat 6. until the fitness value does not change any more.
8. Show the result:
 - (1) Display the best chromosome in the 1st, an intermediate & final generation.
 - (2) Display the best and average fitness vs. generation.

Source code (Java)

```
import java.util.ArrayList;
import java.util.Arrays;
import java.util.Random;

public class Main
{
    static class Chromosome
    {
        int[] genes;
        Chromosome()
        {
            genes = new int[1000];
            for(int i = 0; i < genes.length; i++)
                genes[i] = random.nextInt(2);
        }
        int GetFit()
        {
            int cnt = 0;
            for(int i : genes)
                if(i == 1)
                    cnt++;
            return cnt;
        }
    }

    static class Generation
    {
        Chromosome[] chromosomes;
        boolean isSorted = false;
        Generation()
        {
            chromosomes = new Chromosome[100];
        }
    }
}
```

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        for(int i = 0; i < chromosomes.length; i++)
            chromosomes[i] = new Chromosome();
    }
    int getAverageFit()
    {
        int cnt = 0;
        for(Chromosome i : chromosomes)
            cnt += i.GetFit();
        return cnt / chromosomes.length;
    }
    void sort()
    {
        Arrays.sort(chromosomes, (o1, o2) ->
        {
            int o1fit = o1.GetFit();
            int o2fit = o2.GetFit();
            if(o1fit < o2fit)
                return 1;
            else if(o1fit > o2fit)
                return -1;
            else
                return 0;
        });
        isSorted = true;
    }
    Chromosome[] TwoChromes()
    {
        if(!isSorted)
            sort();
        Chromosome[] random2 = new Chromosome[2];

        random2[0] = chromosomes[random.nextInt(50)];
        random2[1] = chromosomes[random.nextInt(50)];

        return random2;
    }
    Chromosome BestChrom()
    {
        if(!isSorted)
            sort();
        return chromosomes[0];
    }
}

static Random random;
static ArrayList<Generation> generations;
static ArrayList<Integer> fitnessHistory;

static Chromosome crossover(Chromosome first, Chromosome second)
{
    int crossoverPoint = random.nextInt(first.genes.length);

    Chromosome child = new Chromosome();

    System.arraycopy(first.genes, 0, child.genes, 0, crossoverPoint);
    System.arraycopy(second.genes, crossoverPoint, child.genes, crossoverPoint,
        second.genes.length - crossoverPoint);

    if(random.nextInt(1000) == 871)
    {
        int pos = random.nextInt(child.genes.length);

```

```

        if(child.genes[pos] == 0)
            child.genes[pos] = 1;
        else
            child.genes[pos] = 0;
    }

    return child;
}

static boolean EndEvolution()
{
    int tmp = fitnessHistory.get(fitnessHistory.size() - 1);
    if(tmp==1000)
        return true;
    if(fitnessHistory.size() <= 100)
        return false;
    for(int i = 0; i < 100; i++)
        if(fitnessHistory.get(fitnessHistory.size()-i-1) != tmp)
            return false;
    return true;
}

public static void main(String[] args) throws InterruptedException
{
    random = new Random(312456723);
    fitnessHistory = new ArrayList<>();
    generations = new ArrayList<>();
    generations.add(new Generation());
    generations.get(0).sort();
    fitnessHistory.add(generations.get(0).getAverageFit());
    /*System.out.println("Generation: 0; Fitness: " +
        generations.get(0).getAverageFit() +
        "; Best chromosome: " + generations.get(0).BestChrome().GetFit());*/
    System.out.println("0 " +
        /*generations.get(0).getAverageFit() +*/
        " " + generations.get(0).BestChrome().GetFit());

    for(int i = 1; ; i++)
    {
        Generation newGeneration = new Generation();
        for(int j = 0; j < newGeneration.chromosomes.length; j++)
        {
            Chromosome[] random2 = generations.get(generations.size()-
1).TwoChromes();
            newGeneration.chromosomes[j] = crossover(random2[0], random2[1]);
        }
        newGeneration.sort();
        generations.add(newGeneration);
        generations.remove(0);
        fitnessHistory.add(newGeneration.getAverageFit());
        System.out.println(i /*+ " " + newGeneration.getAverageFit()*/ + " " +
newGeneration.BestChrome().GetFit());

        if(EndEvolution())
            break;
    }

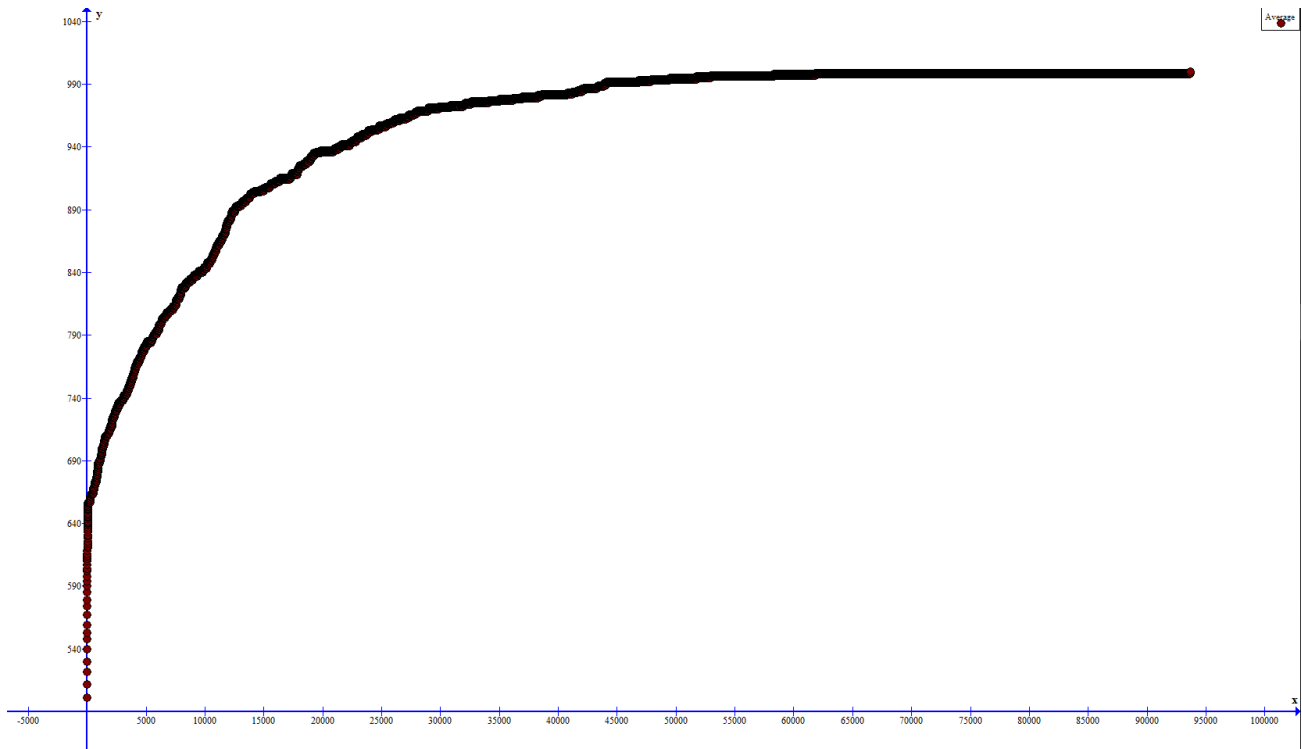
    Thread.sleep(1000);
}
}

```

Result

- 1) The best chromosome in the 1st generation - 561;
The best chromosome in the 46000th generation - 992;
The best chromosome in the last (93666th) generation - 1000;
2)

Average:



Best:

