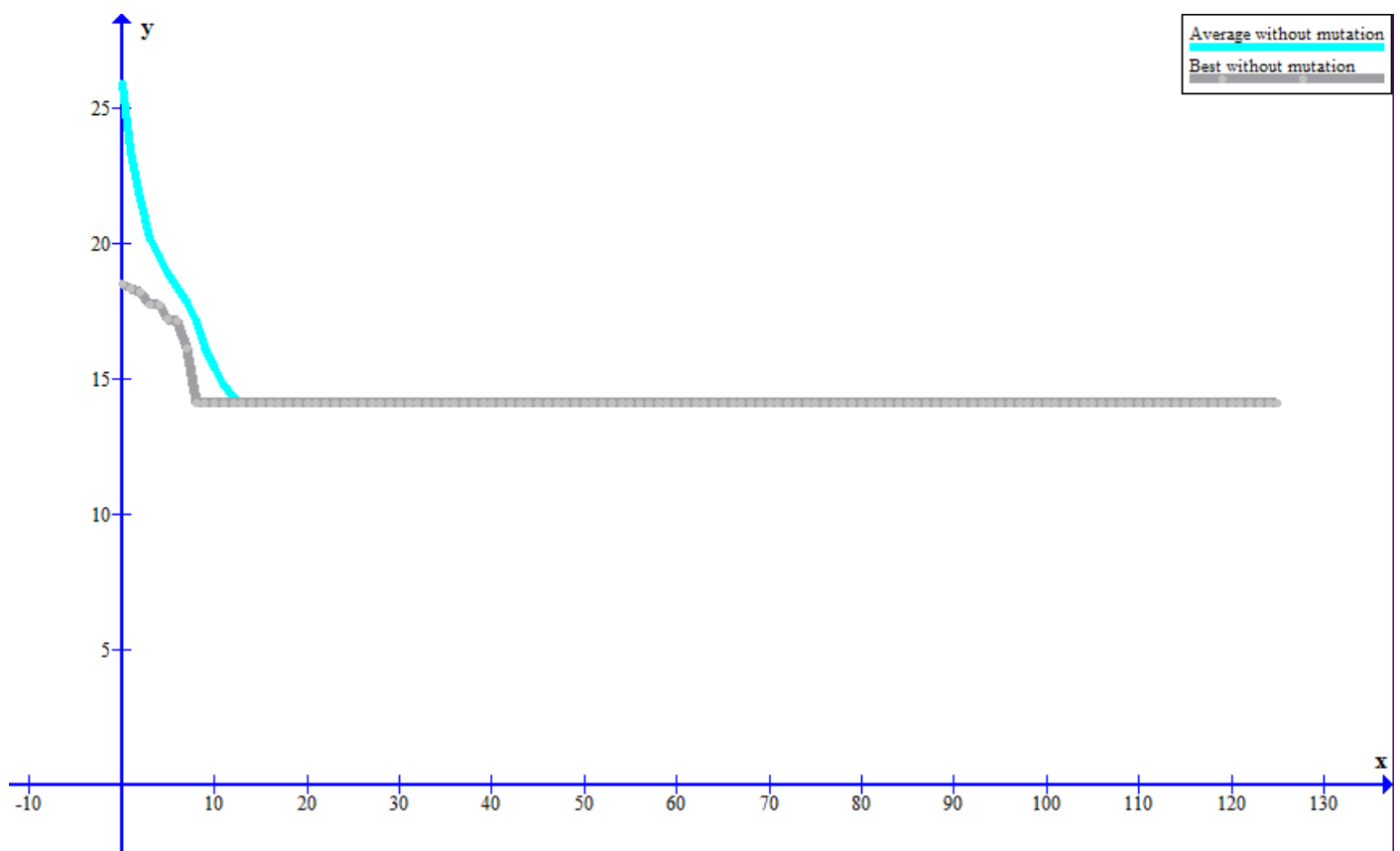
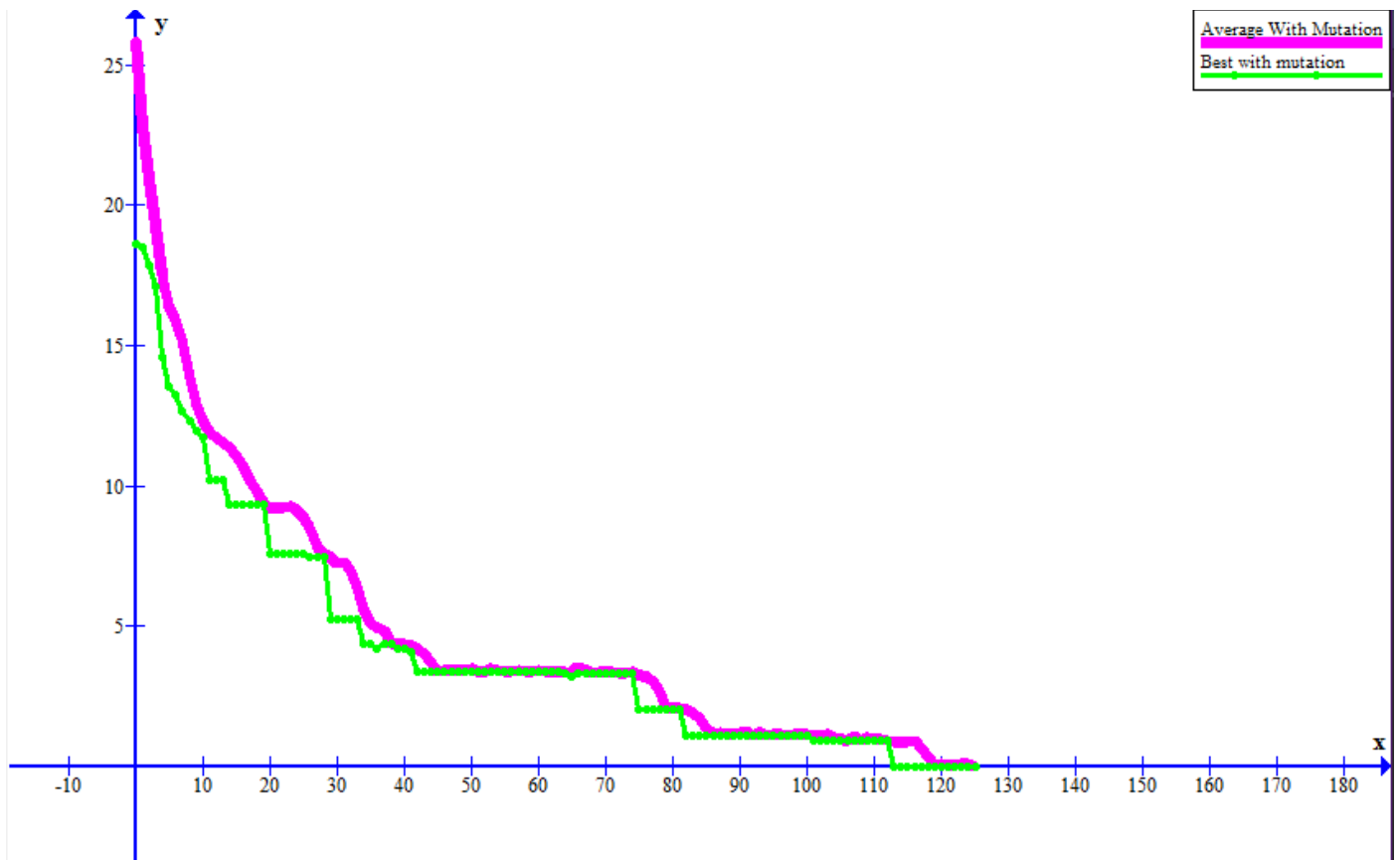
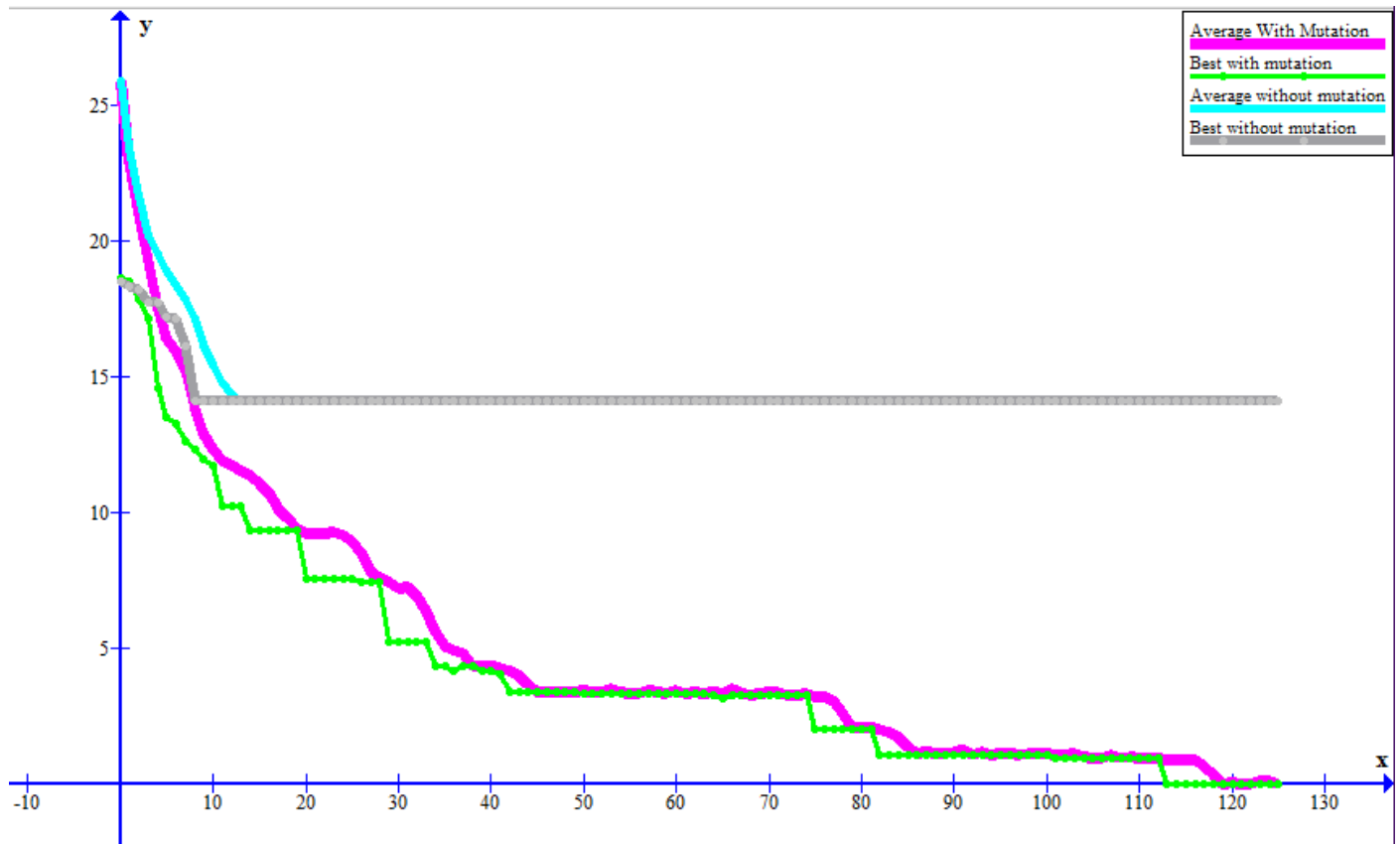


Task 1





Source code:

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

public class MainTask1
{
    static Random random = new Random(System.currentTimeMillis());

    static class Chromosome
    {
        double[] genes;
        public Chromosome()
        {
            genes = new double[20];
            for(int i = 0; i < 20; i++)
                genes[i] = random.nextDouble() * 2 - 1;
        }
        double getFitness()
        {
            double y = 20;
            for(int i = 0; i < 20; i++)
                y += genes[i] * genes[i] - Math.cos(2 * Math.PI * genes[i]);
            return y;
        }
    }

    static class Generation
    {
        Chromosome[] chromosomes;
        public Generation()
        {

```

```

        chromosomes = new Chromosome[20];
        for(int i = 0; i < 20; i++)
            chromosomes[i] = new Chromosome();
    }
    double getAverageFitness()
    {
        double counter = 0;
        for(Chromosome i : chromosomes)
            counter += i.getFitness();
        return counter / 20;
    }
    void sort()
    {
        Arrays.sort(chromosomes, (o1, o2) ->
        {
            double o1fit = o1.getFitness();
            double o2fit = o2.getFitness();
            if(o1fit < o2fit)
                return -1;
            else if(o1fit > o2fit)
                return 1;
            else
                return 0;
        }));
    }
    Chromosome[] get2RandomChromosomes()
    {
        Chromosome[] random2 = new Chromosome[2];

        random2[0] = chromosomes[random.nextInt(10)];
        random2[1] = chromosomes[random.nextInt(10)];

        return random2;
    }

    Chromosome getBestChromosome()
    {
        return chromosomes[0];
    }
}

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);

    /*Mutation block*/

    if(random.nextInt(20) == 13)
    {
        int pos = random.nextInt(child.genes.length);
        if(child.genes[pos] == 0)
            child.genes[pos] = 1;
        else

```

```

        child.genes[pos] = 0;
    }

    return child;
}

static ArrayList<Double> fitnessHistory;
static boolean isLastGenerationUnchanged()
{
    double tmp = fitnessHistory.get(fitnessHistory.size() - 1);
    if(tmp == 0.0)
        return true;
    if(fitnessHistory.size() <= 124)
        return false;
    for(int i = 0; i < 124; i++)
        if(fitnessHistory.get(fitnessHistory.size() - i - 1) != tmp)
            return false;
    return true;
}

public static void main(String[] args) throws InterruptedException
{
    ArrayList<Generation> generations = new ArrayList<>();
    generations.add(new Generation());
    generations.get(0).sort();
    fitnessHistory = new ArrayList<>();
    fitnessHistory.add(generations.get(0).getAverageFitness());
    System.out.println(String.format("%d\t\t%.4f\t\t%.4f", 0,
generations.get(0).getAverageFitness(),
                                generations.get(0).getBestChromosome().getFitness()));

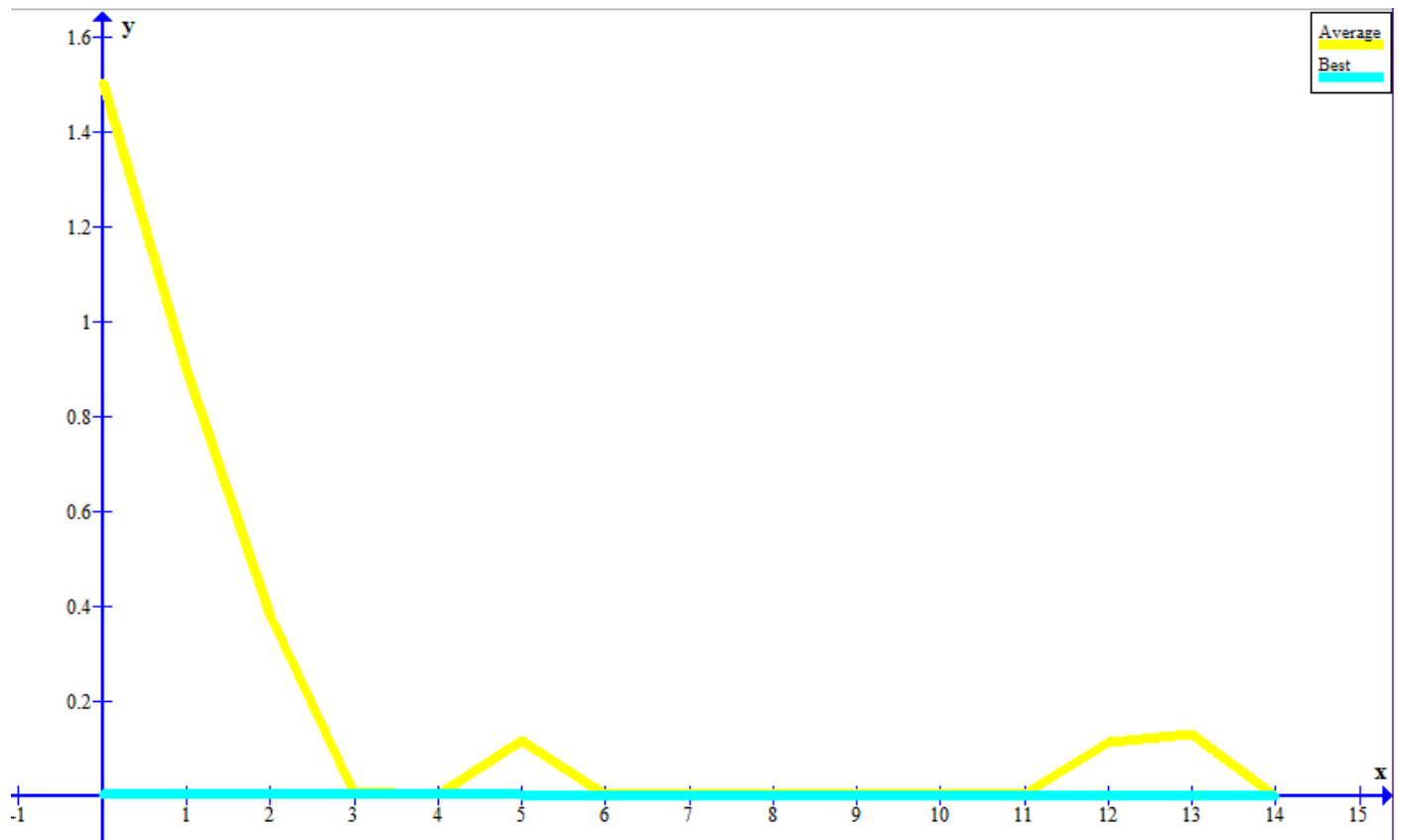
    for(int i = 1; ; i++)
    {
        Generation newGeneration = new Generation();
        for(int j = 0; j < newGeneration.chromosomes.length; j++)
        {
            Chromosome[] random2 = generations.get(generations.size() -
1).get2RandomChromosomes();
            newGeneration.chromosomes[j] = crossover(random2[0], random2[1]);
        }
        newGeneration.sort();
        generations.add(newGeneration);
        generations.remove(0);
        fitnessHistory.add(newGeneration.getAverageFitness());
        System.out.println(String.format("%d\t\t%.4f\t\t%.4f", i,
newGeneration.getAverageFitness(),
                                newGeneration.getBestChromosome().getFitness()));

        if(isLastGenerationUnchanged())
            break;
    }

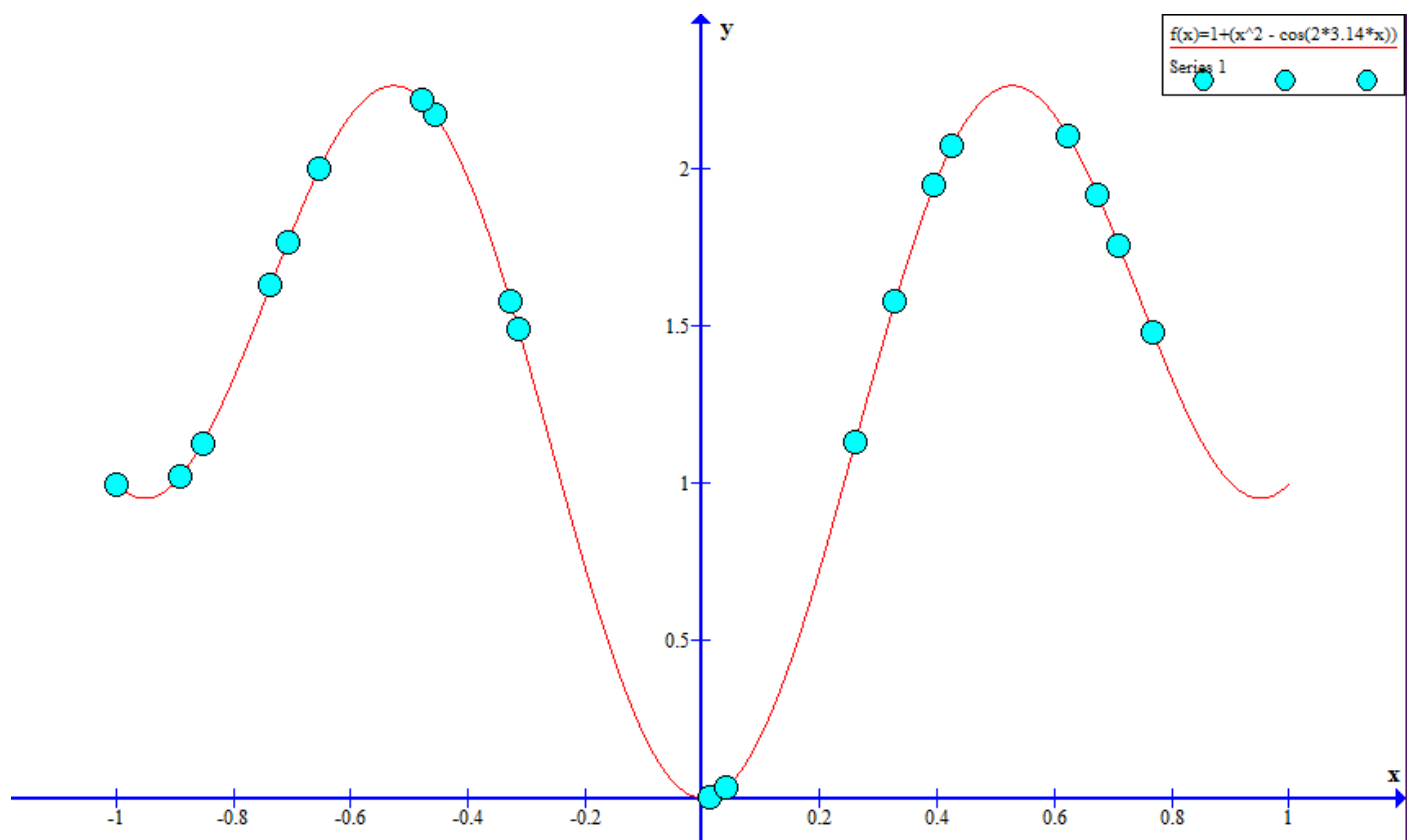
    Thread.sleep(1000);
}
}

```

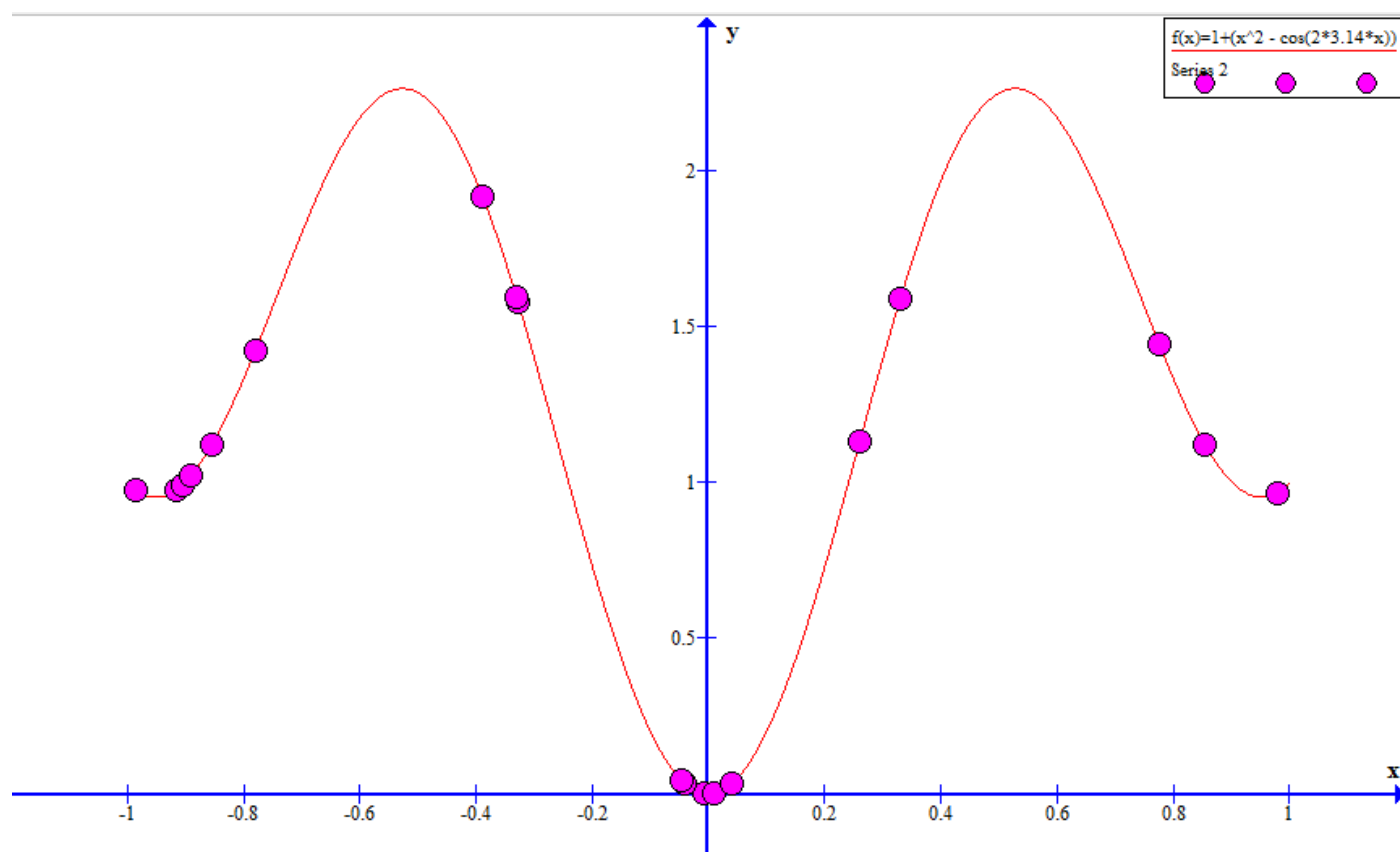
Task 2



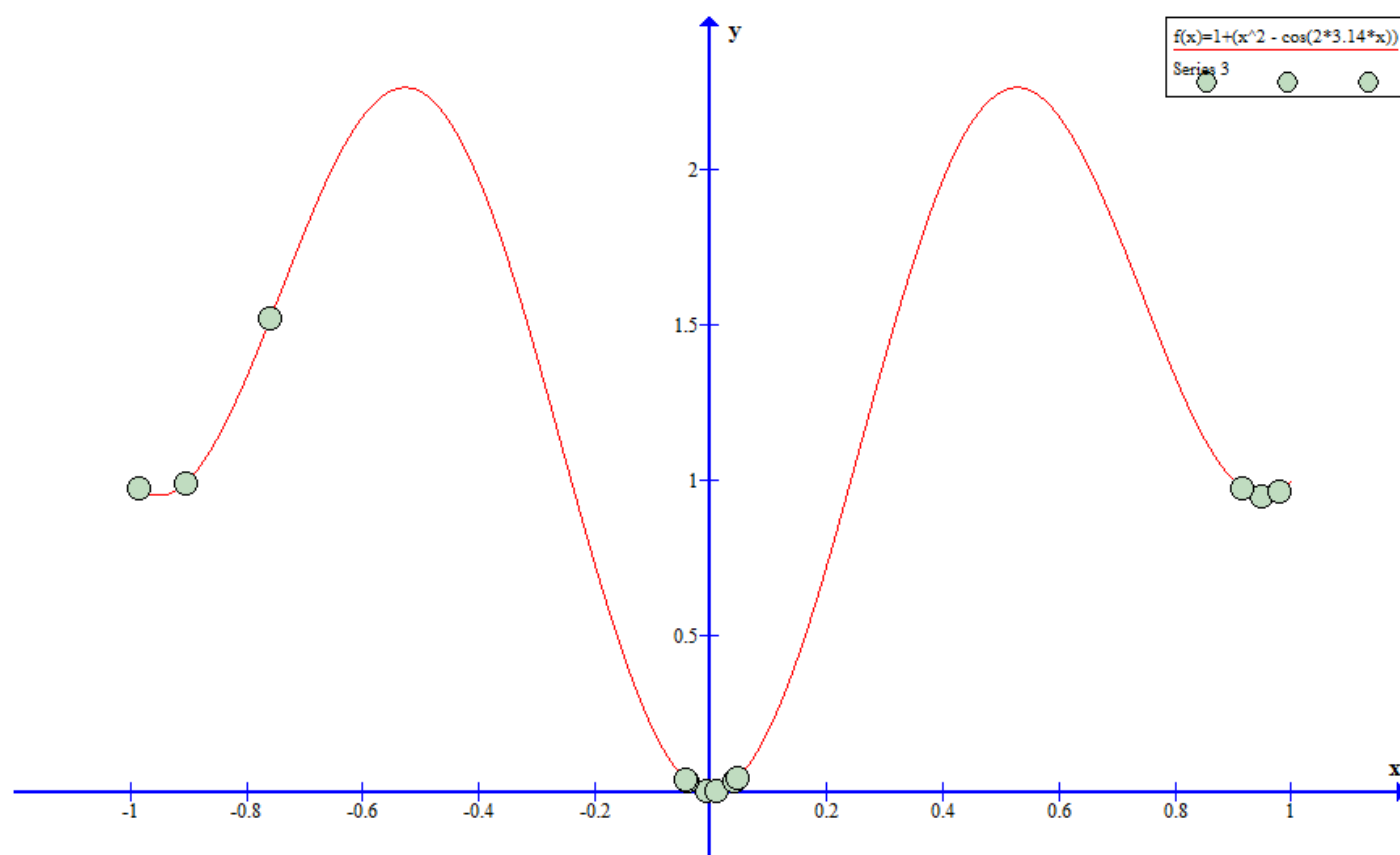
Generation 0



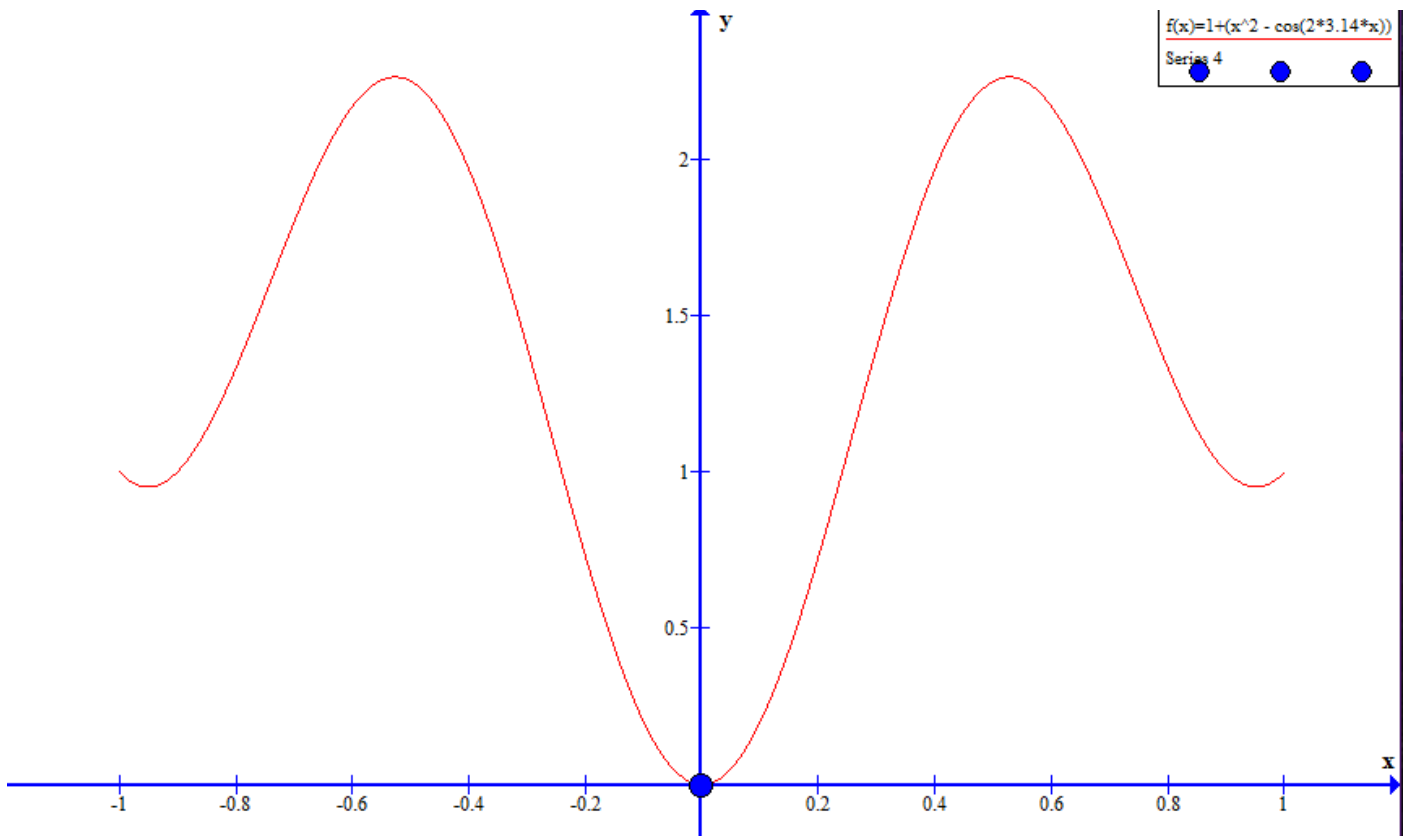
Generation 1



Generation 2



Generation 14



Source code:

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

public class MainTask2
{
    static Random random = new Random(System.currentTimeMillis());

    static class Chromosome
    {
        double[] genes;
        public Chromosome()
        {
            genes = new double[11];
            for(int i = 0; i < 11; i++)
                genes[i] = random.nextInt(2);
        }
        double getFitness()
        {
            double x = 0;
            for(int i = 1; i < 11; i++)
                if(genes[i] == 1)
                    x += Math.pow(2, i - 1);
            x/=1023;
            if(genes[0] == 0)
                x *= -1;
            return 1 + (x * x - Math.cos(Math.PI * 2 * x));
        }
    }

    static class Generation
```

```

{
    Chromosome[] chromosomes;
    public Generation()
    {
        chromosomes = new Chromosome[20];
        for(int i = 0; i < 20; i++)
            chromosomes[i] = new Chromosome();
    }
    double getAverageFitness()
    {
        double counter = 0;
        for(Chromosome i : chromosomes)
            counter += i.getFitness();
        return counter / 20;
    }
    void sort()
    {
        Arrays.sort(chromosomes, (o1, o2) ->
        {
            double o1fit = o1.getFitness();
            double o2fit = o2.getFitness();
            if(o1fit < o2fit)
                return -1;
            else if(o1fit > o2fit)
                return 1;
            else
                return 0;
        }));
    }
    Chromosome[] get2RandomChromosomes()
    {
        Chromosome[] random2 = new Chromosome[2];

        random2[0] = chromosomes[random.nextInt(10)];
        random2[1] = chromosomes[random.nextInt(10)];

        return random2;
    }

    Chromosome getBestChromosome()
    {
        return chromosomes[0];
    }
}

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(20) == 13)
    {
        int pos = random.nextInt(child.genes.length);
        if(child.genes[pos] == 0)
            child.genes[pos] = 1;
        else
            child.genes[pos] = 0;
    }

    return child;
}

```

```

}

static ArrayList<Double> fitnessHistory;
static boolean isLastGenerationUnchanged()
{
    double tmp = fitnessHistory.get(fitnessHistory.size() - 1);
    if(tmp == 0.0)
        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)
{
    ArrayList<Generation> generations = new ArrayList<>();
    generations.add(new Generation());
    generations.get(0).sort();
    fitnessHistory = new ArrayList<>();
    fitnessHistory.add(generations.get(0).getAverageFitness());
    System.out.println(String.format("%d\t\t%.4f\t\t%.4f", 0,
generations.get(0).getAverageFitness(),
                                generations.get(0).getBestChromosome().getFitness()));

    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).get2RandomChromosomes();
            newGeneration.chromosomes[j] = crossover(random2[0], random2[1]);
        }
        newGeneration.sort();
        generations.add(newGeneration);
        generations.remove(0);
        fitnessHistory.add(newGeneration.getAverageFitness());
        System.out.println(String.format("%d\t\t%.4f\t\t%.4f", i,
newGeneration.getAverageFitness(),
                                newGeneration.getBestChromosome().getFitness()));

        if(isLastGenerationUnchanged())
            break;
    }
}
}

```