

```

#include "stdafx.h"
#include <iostream>
#include <vector>
#include <ctime>
#include <utility>
#include <cmath>
#include <fstream>

using namespace std;

vector<vector<int>> evolution(vector<vector<int>> gen, unsigned number_of_chr, unsigned
number_of_gen, unsigned number_of_par);
void mutation(vector<vector<int>> &generation, unsigned procent);
void vector_output(vector<vector<int>> vec);
pair<int,int> fitness(vector<int> chromosome);
int hemming(vector<int> str1, vector<int> str2);
bool comp(vector<int> v1, vector<int> v2);

int main()
{
    srand(time(0));
    vector<vector<vector<int>>> library;
    ofstream fout;
    fout.open("D:\\test\\test.txt");
    fout.close();
    fout.open("D:\\test\\test.txt");

    int size = 1000; //размер хромосомы
    int num = 20; //количество хромосом в поколении
    int par = 5; //количество родителей
    int aspects = 5; //количество видов

    vector<vector<int>> generation;
    for (int i = 0; i < num; i++) {
        vector<int> temp;
        for (int j = 0; j < size; j++) {
            temp.push_back(rand() % 4);
        }
        generation.push_back(temp);
    }
    library.push_back(generation);
    cout << "generation 0:" << endl;
    vector_output(generation);
    int score = 1;
    while (true) {
        generation = evolution(generation, num, size, par);
        mutation(generation, 5);
        score++;
        //cout << "generation " << score << ":" << endl;
        //vector_output(generation);
        //if (score == 1000) break;
        bool check = 0;
        int max = 0;
        for (int i = 0; i < generation.size(); i++) {
            if (fitness(generation[i]).first != 0) check = 1;
            if (fitness(generation[i]).second > max) max =
fitness(generation[i]).second;
        }
        fout << score - 1 << " " << max << '\n';
        cout << max << endl;
        if (check == 1) break;
    }
    return 0;
}

```

```

vector<vector<int>> evolution(vector<vector<int>> gen, unsigned number_of_chr, unsigned
number_of_gen, unsigned number_of_par) {
    vector<vector<int>> par;
    vector<vector<int>> gen1 = gen;
    vector<int> mark;
    for (int i = 0; i < gen.size(); i++) {
        pair<int, int> temp = fitness(gen[i]);
        mark.push_back(temp.second);
    }
    for (int i = 0; i < number_of_par; i++) {
        int min = 1000;
        int point = 0;
        for (int j = 0; j < gen1.size(); j++) {
            if (mark[j] < min) {
                min = mark[j];
                point = j;
            }
        }
        par.push_back(gen1[point]);
        gen1[point] = gen1[gen1.size() - 1];
        gen1.pop_back();
    }
    vector<vector<int>> result;
    for (int i = 0; i < number_of_chr; i++) {
        unsigned mother = rand() % par.size();
        unsigned father;
        while (true) {
            father = rand() % par.size();
            if (mother != father) break;
        }
        unsigned point = rand() % number_of_gen;
        vector<int> child;
        for (int j = 0; j < number_of_gen; j++) {
            if (j % 2 == 0) child.push_back(par[mother][j]);
            else child.push_back(par[father][j]);
        }
        result.push_back(child);
    }
    return result;
}

void mutation(vector<vector<int>> &generation, unsigned procent) {
    for (int i = 0; i < generation.size(); i++) {
        if (rand() % 100 + 1 >= procent) {
            int j = rand() % generation[i].size();
            generation[i][j] = rand() % 4;
        }
    }
}

void vector_output(vector<vector<int>> vec) {
    for (int i = 0; i < vec.size(); i++) {
        for (int j = 0; j < vec[i].size(); j++) {
            cout << vec[i][j];
        }
        cout << " ";
        if (i % 2 == 0 && i != 0) cout << endl;
    }
    cout << endl;
}

pair<int,int> fitness(vector<int> chromosome) {
    int result = 0;

```

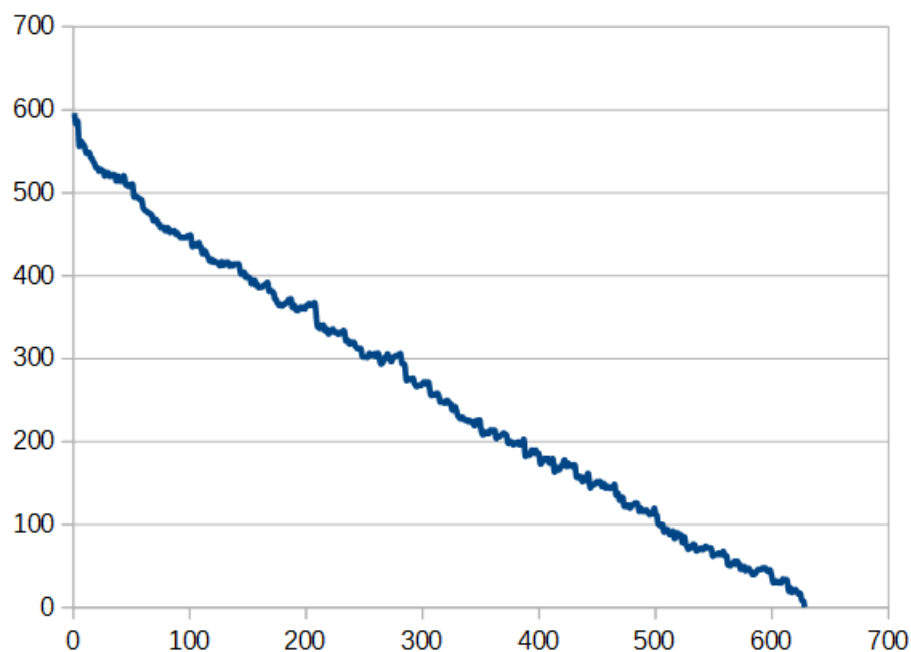
```

int position_X = 500;
int position_Y = 500;
int min = 1000;
pair<int, int> answer;
for (int i = 0; i < chromosome.size(); i++) {
    if (chromosome[i] == 0) position_Y++;
    else if (chromosome[i] == 1) position_X++;
    else if (chromosome[i] == 2) position_Y--;
    else if (chromosome[i] == 3) position_X--;
    if (position_X == 200 && position_Y == 200) {
        result = i + 1;
        break;
    }
    if (position_X == 800 && position_Y == 800) {
        result = i + 1;
        break;
    }
}
answer.first = result;
for (int i = 0; i < chromosome.size(); i++) {
    int res1, res2;
    res1 = abs(position_X - 200 + position_Y - 200);
    res2 = abs(position_X - 800 + position_Y - 800);
    if (res1 < res2 && res1 < min) min = res1;
    else if (res2 < res1 && res2 < min) min = res2;
}
answer.second = min;
return answer;
}

int hemming(vector<int> str1, vector<int> str2) {
    int result = 0;
    for (int i = 0; i < str1.size(); i++) {
        if (str1[i] != str2[i]) result++;
    }
    return result;
}

bool comp(vector<int> v1, vector<int> v2) {
    bool result = 0;
    pair<int, int> fit1, fit2;
    fit1 = fitness(v1);
    fit2 = fitness(v2);
    if (fit1.first == 0 && fit2.first == 0) {
        if (fit1.second <= fit2.second) result = 1;
    }
    else if (fit1.first != 0 && fit2.first == 0) {
        result = 1;
    }
    else if (fit1.first != 0 && fit2.first != 0) {
        if (fit1.first <= fit2.first) result = 1;
    }
    return result;
}

```



X is iteration

Y is best distance between dog and sausage (fitness) in generation

Generation 1:

Way	Fitn ess	Final point
12200133032012111231323013333113211012013232122330232113332021123133111311113212010323133111122120313232303113121322222223322302120303111103312003211201101001031212220230321301111202130102001101330310223122231212301113203131323320103111121301303132003002131112100013012300223132033213310222130310023221130110310000201002213301231110302012020030320011102221021233323002211311002312322011320231221121312212221331100112022102032130333211200201132231012133103000002301320011201131020132232121332033111213033213310013322232320231303323302033013123233310113221031323220010103032231022103022111112232022033102330003003311011013033210130131202112032020020033221102313332211310011131003203232203301121323021131130313220212223232302010300021311231322320223102022311031322331001303232031210222200321130113001000012310311301020023322123312121103222211101312332321122122233312231303101010212021030122101212123230120002030131010122330100110112322031010102111323232333021001023102000110010330222232132321233013	598	531x467
0000230122331311311120320000100121200100211102130300312231020221331123332132121001030333230213113311021023300210232311213301031320212201033110133012100100221101301232203020012130211001230032023312133022100033213120320321020132222011223321133120203001202010111322230003222003012200120202213103011101300013303130012130333112003313010023211330232300031133211032223032213203300102123112213120311332010031113302022300000132300100003210102031001223011323300010010101133130300123331012213013311002323301023310111200011221231003311003003031321010131001103202302001303230331220321300130331122	516	524x560

231000023213020111000133013222101333031332130102322010131211323310 033331333310233011031122121100201001212331223001331011102233021031 032201013300231112220311113211021221213002232030310121220103210113 023201210232103131011230031213002032320311132012231321333213130310 203030031130203213022011202232111021202113111303011121200023131032 211033012333223133211201100030130002303321201213303030121123122101 0320013003		
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3332020132		
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10203311130223112012033032322331331111101031013012221322330213323 331220231311322330222313023011110331223001133112300230232033102011 23033132021213333033331233013112031222033120121310022203012130032 313230211332320013010331010331031001311133101211200331332031133301 300232300311323301032121002032211320101300110112232223031032231021 210212121022003020131133332312133320022231222130230301222201103110 331000100011210123122013021011121302032102000030100022322110122023 220333210200033223030313223201002202311003322110232102303012331200 222020031110321110032301110110130301100223231223123230101023220232 202210200222121023103332213113323112220231022231332311003331110031 113222301320120001023111312020320312221320020213103222003230012103 301203320203013321331233110003221222023133113120133330212300232302 312100002122001023331312123033322311003303320211023113232130212101 200003320012200113022012320223133001003303022203022202012232101023 032201011330211113020103302001233131213100103333303213132023110333 2103130320	568	477x491
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0330131233112031212302203231011301231103023010133113200121203202112200020110103132010301221223311130322013233010101011232310302103130120201220332321102022112202010313030130210303031203310223333131220110013123203301010313301112011011320322301330231113131233001200002323220232		
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Middle generation:

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Example of successful dog's way

