**Мета роботи**: реалізувати генетичний алгоритм пошуку максимального і мінімального значення цільової функції згідно варіанту.

**Завдання:** реалізувати генетичний алгоритм пошуку максимального і мінімального значення цільової функції f(x) = a + bx + cx2 + dx3 на інтервалі

x = [-10, 53].

В - 6

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| N варіанту | a | b | c | d |
| 6 | 50 | -63 | -25 | 1 |

**Максимальне і мінімальне значення цільової функції**

Графік функції згідно варіанту показаний на рис.1.

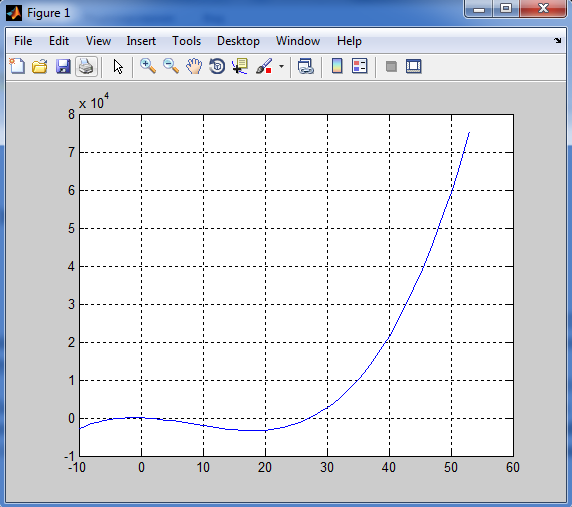
****

Рис.1. Графік функції на інтервалі [-10;53]

Для знаходження мінімуму функції було вибрано інтервал [-10;53]. Пошук мінімуму цільової функції для перевірки реалізовано у Matlab за допомогою функції fminbnd() і рівний: -3.3527e+03.

Для знаходження максимуму функції було вибрано інтервал [-10;10]. Пошук максимуму цільової функції для перевірки реалізовано у Matlab за допомогою функції fminbnd() , змінивши функцію на протилежну і рівний: 87.8872. Графік функції на інтервалі [-10;10] показаний на рис.2.

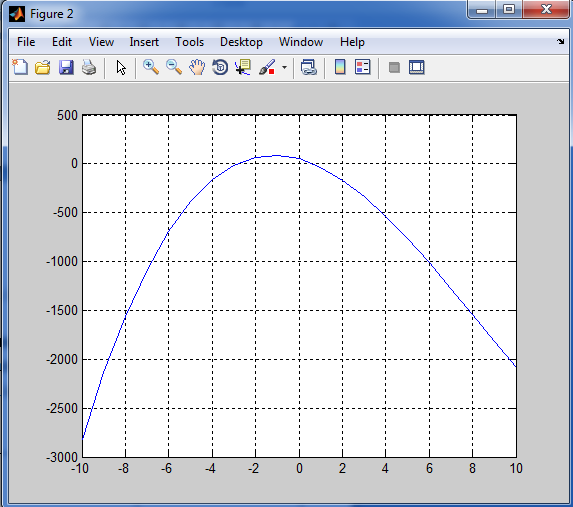


Рис.2. Графік функції на інтервалі[-10;10]

**Результати виконання програми**

Для виконання індивідуального завдання була вибрано використовувати турнірний відбір, рівномірне схрещування і класична мутація обміну.

Результати:

|  |  |  |  |
| --- | --- | --- | --- |
| Кількість поколінь, розмір популяції | 10 | 100 | 300 |
| fmin | -33519.73 | -33526.73 | -33526.83 |
| fmax | 87.79712 | 87.88631 | 87.88721 |

Отже похибка при знаходженні мінімуму і максимуму залежать від кількості поколінь і розміру популяції, при їхньому збільшенні похибки прямують до 0.

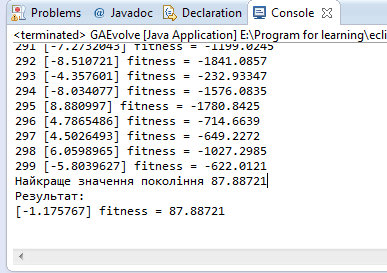


Рис.3. Результати виконання програми

Результат виконання програми для десяти поколінь з розміром популяції 30 для знаходження максимуму функції:

Початкова популяція

0 [9.643394] fitness = -1985.6223

1 [0.121644974] fitness = 41.968227

2 [-1.0329428] fitness = 87.299

3 [-1.8291178] fitness = 75.473

4 [-9.716902] fitness = -2615.742

5 [1.5502434] fitness = -104.02106

6 [-8.142044] fitness = -1634.1328

7 [-9.446028] fitness = -2428.4312

8 [-7.1178555] fitness = -1128.79

9 [-7.5295076] fitness = -1319.852

10 [2.0446072] fitness = -174.7734

11 [4.1669407] fitness = -574.24994

12 [-2.9248133] fitness = -4.620495

13 [-1.3081512] fitness = 87.39345

14 [7.354418] fitness = -1367.7332

15 [-8.062752] fitness = -1591.3888

16 [-9.303861] fitness = -2333.2615

17 [0.39224625] fitness = 21.502409

18 [4.1689625] fitness = -574.69324

19 [0.46643448] fitness = 15.277078

20 [7.50708] fitness = -1408.7814

21 [9.008881] fitness = -1815.3975

22 [8.511154] fitness = -1680.6504

23 [1.4184837] fitness = -86.812744

24 [7.767456] fitness = -1479.0472

25 [-9.326228] fitness = -2348.0928

26 [-6.5996695] fitness = -910.5645

27 [-5.846746] fitness = -636.1337

28 [-5.3915906] fitness = -493.7905

29 [2.0432386] fitness = -174.56447

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.0329428] fitness = 87.299

3 [-1.3081512] fitness = 87.39345

4 [-1.8291178] fitness = 75.473

5 [-1.3081512] fitness = 87.39345

6 [-1.3081512] fitness = 87.39345

7 [-1.3081512] fitness = 87.39345

8 [-1.3081512] fitness = 87.39345

9 [-1.0329428] fitness = 87.299

10 [-1.8291178] fitness = 75.473

11 [0.39224625] fitness = 21.502409

12 [-1.8291178] fitness = 75.473

13 [-1.3081512] fitness = 87.39345

14 [0.39224625] fitness = 21.502409

15 [-1.8291178] fitness = 75.473

16 [0.121644974] fitness = 41.968227

17 [1.4184837] fitness = -86.812744

18 [-1.3081512] fitness = 87.39345

19 [-1.3081512] fitness = 87.39345

20 [-1.0329428] fitness = 87.299

21 [-1.3081512] fitness = 87.39345

22 [0.46643448] fitness = 15.277078

23 [-1.3081512] fitness = 87.39345

24 [3.7354965] fitness = -482.05975

25 [-2.5458183] fitness = 31.856846

26 [-5.0764155] fitness = -405.25488

27 [-3.2025194] fitness = -37.490017

28 [-5.513774] fitness = -530.30286

29 [6.5257416] fitness = -1147.8535

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

3 [-1.3081512] fitness = 87.39345

4 [-1.3081512] fitness = 87.39345

5 [-1.3081512] fitness = 87.39345

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9 [-1.3081512] fitness = 87.39345

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14 [-1.3081512] fitness = 87.39345

15 [-1.3081512] fitness = 87.39345

16 [-1.3081512] fitness = 87.39345

17 [-1.8291178] fitness = 75.473

18 [-1.3081512] fitness = 87.39345

19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [-3.0593767] fitness = -19.889032

25 [0.37525082] fitness = 22.891712

26 [-0.2239275] fitness = 62.842613

27 [-4.1476526] fitness = -190.1256

28 [8.284954] fitness = -1619.2805

29 [-0.11850262] fitness = 57.11293

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

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18 [-1.3081512] fitness = 87.39345

19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [0.80485916] fitness = -16.379696

25 [7.3957405] fitness = -1378.8314

26 [1.4902592] fitness = -96.098465

27 [5.3481913] fitness = -849.03973

28 [-3.944497] fitness = -151.8458

29 [-5.5965433] fitness = -555.7413

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

3 [-1.3081512] fitness = 87.39345

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17 [-1.3081512] fitness = 87.39345

18 [-1.3081512] fitness = 87.39345

19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [-0.33856392] fitness = 68.42508

25 [8.987907] fitness = -1809.7349

26 [4.7628355] fitness = -709.1307

27 [5.311064] fitness = -839.9707

28 [7.2816963] fitness = -1348.2262

29 [-1.3336678] fitness = 87.182175

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

3 [-1.3081512] fitness = 87.39345

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19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [-3.606739] fitness = -94.9081

25 [0.4114685] fitness = 19.91449

26 [-8.285988] fitness = -1713.3186

27 [-9.993774] fitness = -2815.4138

28 [7.414364] fitness = -1383.8365

29 [-9.235062] fitness = -2287.975

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

3 [-1.3081512] fitness = 87.39345

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19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [-5.6708775] fitness = -579.07495

25 [-5.643152] fitness = -570.31775

26 [9.755039] fitness = -2015.2899

27 [-2.0752134] fitness = 64.13875

28 [8.76116] fitness = -1748.4127

29 [-5.083083] fitness = -407.04446

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

3 [-1.3081512] fitness = 87.39345

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16 [-1.3081512] fitness = 87.39345

17 [-1.3081512] fitness = 87.39345

18 [-1.3081512] fitness = 87.39345

19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [1.2137356] fitness = -61.50617

25 [-7.7900147] fitness = -1449.0691

26 [-7.2767425] fitness = -1200.6504

27 [-5.2539015] fitness = -454.11716

28 [-9.878004] fitness = -2730.9058

29 [-6.7164936] fitness = -957.6327

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

3 [-1.3081512] fitness = 87.39345

4 [-1.3081512] fitness = 87.39345

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9 [-1.3081512] fitness = 87.39345

10 [-1.3081512] fitness = 87.39345

11 [-1.3081512] fitness = 87.39345

12 [-1.3081512] fitness = 87.39345

13 [-1.3081512] fitness = 87.39345

14 [-1.3081512] fitness = 87.39345

15 [-1.3081512] fitness = 87.39345

16 [-1.3081512] fitness = 87.39345

17 [-1.3081512] fitness = 87.39345

18 [-1.3081512] fitness = 87.39345

19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [2.0977287] fitness = -182.93756

25 [3.962411] fitness = -529.93677

26 [8.582323] fitness = -1699.9512

27 [-9.426895] fitness = -2415.498

28 [-2.5508537] fitness = 31.434376

29 [-8.614039] fitness = -1901.5336

Найкраще значення покоління 87.39345

Нова популяція

0 [-1.3081512] fitness = 87.39345

1 [-1.3081512] fitness = 87.39345

2 [-1.3081512] fitness = 87.39345

3 [-1.3081512] fitness = 87.39345

4 [-1.3081512] fitness = 87.39345

5 [-1.3081512] fitness = 87.39345

6 [-1.3081512] fitness = 87.39345

7 [-1.3081512] fitness = 87.39345

8 [-1.3081512] fitness = 87.39345

9 [-1.3081512] fitness = 87.39345

10 [-1.3081512] fitness = 87.39345

11 [-1.3081512] fitness = 87.39345

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17 [-1.3081512] fitness = 87.39345

18 [-1.3081512] fitness = 87.39345

19 [-1.3081512] fitness = 87.39345

20 [-1.3081512] fitness = 87.39345

21 [-1.3081512] fitness = 87.39345

22 [-1.3081512] fitness = 87.39345

23 [-1.3081512] fitness = 87.39345

24 [9.655334] fitness = -1988.8

25 [-7.459303] fitness = -1286.1385

26 [7.3074036] fitness = -1355.1183

27 [-7.899252] fitness = -1505.2006

28 [3.3659286] fitness = -407.15616

29 [6.9715977] fitness = -1265.4482

Найкраще значення покоління 87.39345

Результат:

[-1.3081512] fitness = 87.39345

Результат виконання програми для десяти поколінь з розміром популяції 30 для знаходження мінімуму функції:

Початкова популяція

0 [17.452446] fitness = 3348.398

1 [39.36022] fitness = -19817.55

2 [10.250298] fitness = 2145.4995

3 [-0.072909355] fitness = -54.460007

4 [51.804398] fitness = -68721.164

5 [41.18895] fitness = -24920.133

6 [20.09362] fitness = 3196.8672

7 [45.476013] fitness = -39530.8

8 [46.18237] fitness = -42318.51

9 [-4.9962] fitness = 384.00494

10 [25.73928] fitness = 1081.793

11 [31.100574] fitness = -3991.42

12 [29.843887] fitness = -2484.082

13 [24.449932] fitness = 1819.1748

14 [-9.800312] fitness = 2675.0151

15 [-2.968668] fitness = 9.4615

16 [39.3651] fitness = -19830.324

17 [2.4828062] fitness = 245.22014

18 [-5.908684] fitness = 656.85376

19 [12.313604] fitness = 2649.33

20 [25.330658] fitness = 1333.669

21 [51.656746] fitness = -67927.0

22 [2.513752] fitness = 250.45581

23 [41.360077] fitness = -25430.785

24 [17.778118] fitness = 3352.58

25 [5.719907] fitness = 941.14734

26 [-9.0571785] fitness = 2173.1926

27 [12.384445] fitness = 2665.1245

28 [13.576748] fitness = 2910.9612

29 [19.843952] fitness = 3230.5308

Нова популяція

0 [17.452446] fitness = 3348.398

1 [12.384445] fitness = 2665.1245

2 [13.576748] fitness = 2910.9612

3 [17.778118] fitness = 3352.58

4 [13.576748] fitness = 2910.9612

5 [17.778118] fitness = 3352.58

6 [20.09362] fitness = 3196.8672

7 [17.452446] fitness = 3348.398

8 [17.778118] fitness = 3352.58

9 [17.452446] fitness = 3348.398

10 [17.452446] fitness = 3348.398

11 [13.576748] fitness = 2910.9612

12 [20.09362] fitness = 3196.8672

13 [-9.800312] fitness = 2675.0151

14 [17.452446] fitness = 3348.398

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [20.09362] fitness = 3196.8672

19 [19.843952] fitness = 3230.5308

20 [10.250298] fitness = 2145.4995

21 [19.843952] fitness = 3230.5308

22 [17.452446] fitness = 3348.398

23 [17.778118] fitness = 3352.58

24 [-1.3964596] fitness = -86.501236

25 [22.319244] fitness = 2691.5264

26 [21.25714] fitness = 2980.4707

27 [5.314946] fitness = 840.91785

28 [17.451038] fitness = 3348.3667

29 [2.2683868] fitness = 209.87567

Найкраще значення покоління -86.501236

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.452446] fitness = 3348.398

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [22.33622] fitness = 2686.1602

25 [15.871315] fitness = 3249.3958

26 [12.83441] fitness = 2762.509

27 [30.26912] fitness = -2970.7168

28 [34.536892] fitness = -9249.75

29 [7.891222] fitness = 1512.5342

Найкраще значення покоління -9249.75

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.778118] fitness = 3352.58

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [24.402737] fitness = 1843.0391

25 [41.208553] fitness = -24978.328

26 [-8.4591875] fitness = 1811.3389

27 [43.08577] fitness = -30909.719

28 [48.383575] fitness = -51742.1

29 [27.585018] fitness = -279.17188

Найкраще значення покоління -51742.1

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.778118] fitness = 3352.58

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [-3.7339559] fitness = 115.38188

25 [9.760372] fitness = 2016.7043

26 [24.619408] fitness = 1731.7041

27 [4.962531] fitness = 756.0965

28 [16.279753] fitness = 3286.7544

29 [5.0639744] fitness = 780.26654

Найкраще значення покоління 115.38188

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.778118] fitness = 3352.58

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [6.079731] fitness = 1032.3754

25 [35.835373] fitness = -11706.875

26 [34.66326] fitness = -9477.027

27 [4.1873217] fitness = 578.72375

28 [33.916702] fitness = -8170.51

29 [27.205326] fitness = 31.708984

Найкраще значення покоління -11706.875

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.778118] fitness = 3352.58

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [-4.3125067] fitness = 223.45767

25 [35.41559] fitness = -10882.715

26 [51.737354] fitness = -68359.875

27 [2.8432312] fitness = 308.23807

28 [11.448263] fitness = 2447.3682

29 [24.238922] fitness = 1924.2041

Найкраще значення покоління -68359.875

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.778118] fitness = 3352.58

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [7.909851] fitness = 1517.5784

25 [11.434937] fitness = 2444.1384

26 [-7.5081615] fitness = 1309.5519

27 [-5.1859865] fitness = 435.11853

28 [42.485962] fitness = -28936.543

29 [9.933571] fitness = 2062.5073

Найкраще значення покоління -28936.543

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.778118] fitness = 3352.58

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [10.442469] fitness = 2195.3037

25 [21.620749] fitness = 2891.7627

26 [32.334892] fitness = -5681.865

27 [27.400837] fitness = -126.31055

28 [33.157635] fitness = -6929.8066

29 [21.8266] fitness = 2836.8848

Найкраще значення покоління -6929.8066

Нова популяція

0 [17.778118] fitness = 3352.58

1 [17.778118] fitness = 3352.58

2 [17.778118] fitness = 3352.58

3 [17.778118] fitness = 3352.58

4 [17.778118] fitness = 3352.58

5 [17.778118] fitness = 3352.58

6 [17.778118] fitness = 3352.58

7 [17.778118] fitness = 3352.58

8 [17.778118] fitness = 3352.58

9 [17.778118] fitness = 3352.58

10 [17.778118] fitness = 3352.58

11 [17.778118] fitness = 3352.58

12 [17.778118] fitness = 3352.58

13 [17.778118] fitness = 3352.58

14 [17.778118] fitness = 3352.58

15 [17.778118] fitness = 3352.58

16 [17.778118] fitness = 3352.58

17 [17.778118] fitness = 3352.58

18 [17.778118] fitness = 3352.58

19 [17.778118] fitness = 3352.58

20 [17.778118] fitness = 3352.58

21 [17.778118] fitness = 3352.58

22 [17.778118] fitness = 3352.58

23 [17.778118] fitness = 3352.58

24 [43.269558] fitness = -31529.29

25 [-0.27775383] fitness = -65.54838

26 [2.5884113] fitness = 263.2247

27 [7.04628] fitness = 1285.3188

28 [22.27716] fitness = 2704.7295

29 [29.239098] fitness = -1832.0488

Найкраще значення покоління -31529.29

Результат:

[43.269558] fitness = -31529.29

Код програми

**public** GAPopulation generate(GAPopulation p, **int** xrate, **int** mrate,

**float**[] min\_range, **float**[] max\_range) {

//Створення нової популяції з р, xrate відсотків індивідумів нового населення є

//схрещування, mrate відсотків з них створюються в результаті мутації, а інші по відтворення.

**if** (xrate < 0 || xrate > 100 || mrate < 0 || mrate > 100

|| xrate + mrate > 100)

System.*err*.println("error: xrate і/чи mrate неправилно встановлені");

GAIndividual[] newg = **new** GAIndividual[p.pop\_size];

**int** newg\_index = 0;

**int** xn = xrate \* p.pop\_size / 100;

//xn: Кількість нащадків, які будуть схрешення

**int** mn = mrate \* p.pop\_size / 100;

// mn: кількість нащадків які будуть створенні мутацією

// схрещування:

**for** (**int** i = 0; i < xn; i++) {

**int** p1 = p.tr\_select();

**int** p2 = p.tr\_select();

newg[newg\_index++] = GAIndividual.*uniform*(p.ind[p1], p.ind[p2]);

}

// мутація:

**for** (**int** i = 0; i < mn; i++){

**int** n = (**int**)(Math.*random*() \* p.pop\_size);

newg[newg\_index++] = p.ind[p.tr\_select()].mutate(p.ind[n],max\_range);

}

// відтворення:

**for** (**int** i = newg\_index; i < p.pop\_size; i++)

newg[i] = p.ind[p.tr\_select()];

**return** **new** GAPopulation(newg);

}

**public** **int** tr\_select() {

//турнірна вибірка розміром pop\_size/10

//вона повертає індекс вибраного особи в ind []

**int** s\_index = *randg*.nextInt(pop\_size);

// індекс вибраного індивідума

**float** s\_fitness = ind[s\_index].fitness;

**int** tr\_size = Math.*min*(10, pop\_size);

**for** (**int** i = 1; i < tr\_size; i++) {

**int** tmp = *randg*.nextInt(pop\_size);

**if** (ind[tmp].fitness < s\_fitness) {//< для min//>для max

s\_index = tmp;

s\_fitness = ind[tmp].fitness;

}

}

**return** s\_index;

}

**public** **static** GAIndividual uniform(GAIndividual f, GAIndividual m) {

// рівномірне схрещення

**float**[] child = **new** **float**[f.genome\_size];

Random random = **new** Random();

**for** (**int** k = 0; k < f.genome\_size; k++) {

String fs = *floatToBinary*(f.genome[k]);

String ms = *floatToBinary*(m.genome[k]);

**int**[] maska = **new** **int**[fs.length()];

**for**(**int** i = 0; i < fs.length(); i++){

maska[i] = random.nextInt(2);

}

String childs = "";

**for** (**int** i = 0; i < fs.length(); i++) {

**if**(maska[i] == 0) childs += fs.charAt(i);

**else** childs += ms.charAt(i);

}

child[0] = *binaryToFloat*(childs);

}

**return** **new** GAIndividual(child);

}

**public** GAIndividual mutate(GAIndividual gaIndividual, **float**[] max\_reg) {

**float**[] result = **new** **float**[genome\_size];

**for** (**int** i = 0; i < genome\_size; i++)

result[i] = genome[i];

// класична мутація обміну

**for** (**int** i = 0; i < genome\_size; i++){

String string = *floatToBinary*( gaIndividual.genome[i]);

**int** n = string.indexOf(".");

**int** pp1 = (**int**)(Math.*random*()\*n);

**int** pp2 = (**int**)(Math.*random*()\*n);

**if**(pp1 > pp2) { **int** q = pp1; pp1 = pp2; pp2 = q;}

**char** [] charmas = string.toCharArray();

**char** c = charmas[pp1];

charmas[pp1] = charmas[pp2];

charmas[pp2] = c;

String end = "";

**for**(**int** j = 0; j < charmas.length; j++) {

end += charmas[j];}

result[i] = *binaryToFloat*(end);

**if**(result[i] > max\_reg[i]) result[i] = max\_reg[i];

}

**return** **new** GAIndividual(result);

}

**Висновки:** виконавши лабораторну роботу я реалізував за допомогою програмної мови Java програмне забезпечення для пошуку оптимумів функції, в якому використав турнірний відбір, рівномірне схрещування і класичну мутацію обміну. Програма показує результати за короткий період часу з невеликою похибкою навіть при невеликій кількості поколінь і розміру популяції, але при збільшенні цих параметрів похибка прямує до 0.