

# Генетический алгоритм

Дана начальная популяция из четырех хромосом с двумя генами  $x$  и  $y$ . Показатель качества хромосомы оценивается функцией  $Z$ . При равном качестве хромосом предпочтение отдается хромосоме с большим номером. На каждом этапе хромосома  $a$  с высшим качеством порождает четыре новые хромосомы  $b_1, c_1, b_2, c_2$ , обмениваясь генами с двумя хромосомами  $b$  и  $c$  более низкого качества по указанной схеме. Последняя хромосома (с низшим качеством) выбывает из популяции.

Найти максимальный показатель качества хромосомы в популяции и общее качество популяции после четырех этапов эволюции.

**Задача 14.1.** 1

$x$	-2	-1	0	1
$y$	-2	-1	0	1

$$Z = \frac{x - 3y + 1}{3x^2 + 3y^2 + 1}$$

**Задача 14.2.** 1

$x$	-4	-2	0	2
$y$	-1	1	0	-2

$$Z = \frac{x - 2y - 3}{x^2 + 3y^2 + 1}$$

**Задача 14.3.** 1

$x$	-1	0	2	3
$y$	-2	1	0	-1

$$Z = \frac{x - 3y - 2}{x^2 + y^2 + 1}$$

**Задача 14.4.** 1

$x$	-1	0	2	4
$y$	-2	1	-1	0

$$Z = \frac{x + 3y}{3x^2 + y^2 + 1}$$

**Задача 14.5.** 1

$x$	-2	-1	0	2
$y$	-2	0	-1	1

$$Z = \frac{x - 3y + 1}{3x^2 + y^2 + 1}$$

**Задача 14.6.** 1

$x$	-5	-3	-2	-1
$y$	-1	-2	0	1

$$Z = \frac{x + 3y}{x^2 + y^2 + 1}$$

**Задача 14.7.** 1

$x$	-5	-3	-2	0
$y$	-1	-2	0	1

$$Z = \frac{x + 3y - 3}{3x^2 + y^2 + 1}$$

**Задача 14.8.** 1

$x$	-5	-3	-2	-1
$y$	-1	-2	0	1

$$Z = \frac{x - 3y - 3}{x^2 + 2y^2 + 1}$$

**Задача 14.9.** 1

$x$	-1	0	2	3
$y$	0	-1	-2	1

$$Z = \frac{x - 2y}{x^2 + y^2 + 1}$$

**Задача 14.10.** 1

$x$	-1	0	2	3
$y$	0	1	-2	2

$$Z = \frac{x - 3y}{2x^2 + 2y^2 + 1}$$

**Задача 14.11.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x - 2y + 1}{x^2 + y^2 + 1}$ .

$x$	-5	-3	-2	0
$y$	1	-2	-1	0

**Задача 14.12.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x - 3y - 3}{x^2 + 2y^2 + 1}$ .

$x$	-1	0	2	3
$y$	0	-1	1	2

**Задача 14.13.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x - y}{2x^2 + 2y^2 + 1}$ .

$x$	-2	-1	0	2
$y$	-2	-1	1	0

**Задача 14.14.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x - 2y - 3}{3x^2 + y^2 + 1}$ .

$x$	-5	-3	-2	0
$y$	-1	-2	0	1

**Задача 14.15.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x + y + 2}{2x^2 + 2y^2 + 1}$ .

$x$	-4	-2	0	1
$y$	1	2	0	3

**Задача 14.16.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x + 3y + 1}{3x^2 + y^2 + 1}$ .

$x$	-2	-1	0	2
$y$	-2	-1	1	0

**Задача 14.17.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x + 3y}{2x^2 + y^2 + 1}$ .

$x$	-2	-1	0	1
$y$	0	-2	-1	1

**Задача 14.18.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x - y + 1}{3x^2 + 2y^2 + 1}$ .

$x$	-1	0	2	4
$y$	-2	-1	1	0

**Задача 14.19.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x + 2y + 3}{x^2 + y^2 + 1}$ .

$x$	-2	-1	0	2
$y$	0	1	-1	2

**Задача 14.20.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x + y}{3x^2 + 3y^2 + 1}$ .

$x$	-2	-1	0	2
$y$	0	-2	1	2

**Задача 14.21.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x + 3y - 1}{2x^2 + y^2 + 1}$ .

$x$	-1	0	2	3
$y$	-2	1	-1	0

**Задача 14.22.**

Diagram showing two sets of colored blocks (I and II) and their corresponding algebraic expression  $Z$ . Set I consists of three blocks labeled  $a$ ,  $b$ , and  $c$ . Set II consists of four blocks labeled  $b_1$ ,  $c_1$ ,  $b_2$ , and  $c_2$ . Arrows indicate the mapping from blocks in set I to blocks in set II. The algebraic expression is  $Z = \frac{x + 3y - 1}{2x^2 + y^2 + 1}$ .

$x$	-1	0	2	3
$y$	-2	1	0	2

**Задача 14.23.**

$x$ 

-2	-1	0	1
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 $y$ 

0	1	2	3
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$Z = \frac{x + 2y + 3}{2x^2 + y^2 + 1}$

**Задача 14.24.**

$x$ 

-5	-3	-2	0
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 $y$ 

1	-2	2	-1
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$Z = \frac{x - 3y - 1}{x^2 + 2y^2 + 1}$

**Задача 14.25.**

$x$ 

-1	0	2	4
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 $y$ 

-2	1	2	0
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$Z = \frac{x + 2y}{x^2 + 3y^2 + 1}$

**Задача 14.26.**

$x$ 

-1	0	2	4
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 $y$ 

0	-1	1	2
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$Z = \frac{x - 2y - 2}{2x^2 + 2y^2 + 1}$

**Задача 14.27.**

$x$ 

-1	0	2	4
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 $y$ 

-2	1	-1	0
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$Z = \frac{x - 3y - 2}{x^2 + y^2 + 1}$

**Задача 14.28.**

$x$ 

-1	0	2	3
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 $y$ 

-2	1	0	-1
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$Z = \frac{x + 3y + 3}{3x^2 + 2y^2 + 1}$

**Задача 14.29.**

$x$ 

-4	-2	0	1
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 $y$ 

1	2	0	3
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$Z = \frac{x - y + 2}{2x^2 + 3y^2 + 1}$

**Задача 14.30.**

$x$ 

-1	0	2	4
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 $y$ 

0	-1	1	2
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$Z = \frac{x + y - 2}{x^2 + 3y^2 + 1}$

**Задача 14.31.**

$x$ 

-5	-3	-2	0
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 $y$ 

1	0	2	3
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$Z = \frac{x + y - 3}{x^2 + 2y^2 + 1}$

**Задача 14.32.**

$x$ 

-5	-3	-2	0
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 $y$ 

-1	-2	0	1
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$Z = \frac{x + y}{2x^2 + 2y^2 + 1}$

**Генетический алгоритм**

№	1	2	3	4	max
1	1.486	1.462	2.967	3.538	1.000
2	-3.949	-0.412	-0.272	0.374	0.176
3	-1.636	-0.333	2.167	2.333	0.667
4	0.635	-1.003	2.151	2.214	1.500
5	2.294	0.971	4.824	5.829	2.000
6	-0.672	-1.741	0.359	1.426	0.667
7	-0.902	-4.968	-0.343	-0.168	0.000
8	-2.929	-0.832	-0.268	0.095	0.077
9	1.258	0.921	3.167	3.467	1.000
10	-0.974	0.775	0.925	1.729	0.471
11	1.087	2.100	3.667	5.000	1.500
12	-2.905	-2.464	-0.003	0.821	0.286
13	-0.111	-0.048	0.639	1.003	0.273
14	-3.025	-0.461	-0.249	-0.221	-0.050
15	2.375	1.708	4.740	5.444	2.000
16	1.219	0.571	4.154	5.429	2.000
17	-1.722	0.219	1.267	2.600	1.000
18	1.069	0.767	1.738	1.933	0.667
19	3.033	4.667	6.400	7.733	2.500
20	0.069	0.279	0.814	0.841	0.250
21	-0.238	-2.350	1.761	2.650	1.000
22	0.316	0.650	2.886	3.400	1.000
23	3.344	5.400	6.300	7.900	2.500
24	-0.236	-0.968	1.444	1.806	0.667
25	0.731	1.108	1.653	1.853	0.500
26	-1.231	-1.704	0.061	0.478	0.182
27	-1.382	0.944	1.548	2.214	0.667
28	2.151	3.833	4.599	7.533	3.000
29	1.821	1.154	4.333	5.250	2.000
30	-1.987	0.318	0.463	0.563	0.150
31	-1.081	-0.978	-0.431	-0.201	0.000
32	-0.187	-0.726	0.044	0.496	0.333