Задача 4

QR-алгоритм

Вывод программы

A =

[[ 7.5 3.1 10.6 4.1]

[ 3.1 1. -2. 5.7]

[10.6 -2. 3. -1.8]

[ 4.1 5.7 -1.8 6.2]]

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Iteration 1

a1 =

[[13.9653 2.0422 6.9973 3.9211]

[ 0. 1.5072 -0.2726 5.7858]

[ 0. -0.2657 8.9066 -1.5068]

[ 0. 6.3708 0.4846 6.3134]]

a2 =

[[13.9653 2.0422 6.9973 3.9211]

[ 0. 6.5521 0.0473 7.5308]

[ 0. 0. 8.9235 -1.4148]

[ 0. -0. 0.0807 4.1097]]

a3 =

[[13.9653 2.0422 6.9973 3.9211]

[ 0. 6.5521 0.0473 7.5308]

[ 0. 0. 8.9238 -1.3776]

[ 0. 0. 0. -4.1223]]

Q =

[[ 0.537 0.3057 0.7651 -0.1809]

[ 0.222 0.0834 -0.3986 -0.8859]

[ 0.759 -0.5418 -0.2561 0.2544]

[ 0.2936 0.7784 -0.436 0.3431]]

R =

[[13.9653 2.0422 6.9973 3.9211]

[ 0. 6.5521 0.0473 7.5308]

[ 0. 0. 8.9238 -1.3776]

[ 0. 0. 0. -4.1223]]

A =

[[14.4157 3.7013 6.369 -1.2103]

[ 3.7013 6.3834 -5.9076 -3.209 ]

[ 6.369 -5.9076 -1.6848 1.7975]

[-1.2103 -3.209 1.7975 -1.4142]]

delta = 7.61424

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Iteration 2

Q =

[[ 0.888 0.1389 0.437 0.0346]

[ 0.228 0.6004 -0.6818 0.3503]

[ 0.3923 -0.7227 -0.5592 -0.1051]

[-0.0746 -0.3129 0.1773 0.9301]]

R =

[[16.2339 2.6636 3.5137 -0.9957]

[-0. 9.6203 -2.0074 -2.9513]

[-0. 0. 8.072 0.403 ]

[-0. 0. 0. -2.6701]]

A =

[[16.4757 1.6259 3.1368 0.1991]

[ 1.6259 8.1504 -5.9598 0.8356]

[ 3.1368 -5.9598 -4.4426 -0.4735]

[ 0.1991 0.8356 -0.4735 -2.4835]]

delta = 2.75781

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Iteration 3

Q =

[[ 0.9777 0.0371 0.2066 -0.0054]

[ 0.0965 0.7884 -0.6006 -0.0916]

[ 0.1861 -0.6087 -0.7711 0.0129]

[ 0.0118 0.0806 -0.0441 0.9957]]

R =

[[16.8514 1.2765 1.6593 0.1578]

[ 0. 10.1814 -1.9164 0.7542]

[ 0. -0. 7.6742 0.014 ]

[-0. 0. -0. -2.5565]]

A =

[[16.9096 0.6345 1.4287 -0.0302]

[ 0.6345 9.2545 -4.6702 -0.206 ]

[ 1.4287 -4.6702 -5.9186 0.1128]

[-0.0302 -0.206 0.1128 -2.5455]]

delta = 1.47598

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Iteration 4

Q =

[[ 0.9958 0.005 0.0919 0.0008]

[ 0.0374 0.8902 -0.4534 0.0228]

[ 0.0841 -0.4551 -0.8865 0.0012]

[-0.0018 -0.0198 0.0114 0.9997]]

R =

[[16.9817 0.5851 0.75 -0.0238]

[-0. 10.3711 -1.4593 -0.1846]

[-0. 0. 7.4968 -0.0383]

[-0. 0. -0. -2.5494]]

A =

[[16.9946 0.2651 0.6308 0.0045]

[ 0.2651 9.9004 -3.4107 0.0504]

[ 0.6308 -3.4107 -6.6462 -0.029 ]

[ 0.0045 0.0504 -0.029 -2.5488]]

delta = 0.72761

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Iteration 5

Q =

[[ 0.9992 -0.0026 0.0401 -0.0001]

[ 0.0156 0.9451 -0.3264 -0.0056]

[ 0.0371 -0.3268 -0.9444 -0.0015]

[ 0.0003 0.0048 -0.0032 1. ]]

R =

[[17.0084 0.2927 0.3306 0.0036]

[-0. 10.4708 -1.0534 0.0448]

[ 0. -0. 7.4151 0.0194]

[-0. 0. 0. -2.549 ]]

A =

[[17.0114 0.1241 0.275 -0.0007]

[ 0.1241 10.2403 -2.423 -0.0122]

[ 0.275 -2.423 -7.0027 0.0083]

[-0.0007 -0.0122 0.0083 -2.5489]]

delta = 0.35655

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Iteration 6

Q =

[[ 0.9998 -0.0034 0.0174 0. ]

[ 0.0073 0.9731 -0.2304 0.0014]

[ 0.0162 -0.2305 -0.9729 0.0007]

[-0. -0.0012 0.001 1. ]]

R =

[[17.0141 0.1596 0.1441 -0.0005]

[ 0. 10.5225 -0.7444 -0.0109]

[-0. -0. 7.3763 -0.0078]

[-0. -0. 0. -2.5489]]

A =

[[17.0149 0.0647 0.1192 0.0001]

[ 0.0647 10.4107 -1.7003 0.003 ]

[ 0.1192 -1.7003 -7.1767 -0.0026]

[ 0.0001 0.003 -0.0026 -2.5489]]

delta = 0.17394

---------------------------------------

Iteration 7

Q =

[[ 1. -0.0026 0.0075 -0. ]

[ 0.0038 0.9869 -0.1612 -0.0003]

[ 0.007 -0.1613 -0.9869 -0.0003]

[ 0. 0.0003 -0.0003 1. ]]

R =

[[17.0154 0.0924 0.0625 0.0001]

[-0. 10.5484 -0.5211 0.0026]

[ 0. -0. 7.3576 0.0029]

[-0. 0. 0. -2.5489]]

A =

[[17.0157 0.0365 0.0516 -0. ]

[ 0.0365 10.4944 -1.1864 -0.0007]

[ 0.0516 -1.1864 -7.2611 0.0008]

[-0. -0.0007 0.0008 -2.5489]]

delta = 0.08447

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Iteration 8

Q =

[[ 1. -0.0018 0.0033 0. ]

[ 0.0021 0.9937 -0.1123 0.0001]

[ 0.003 -0.1124 -0.9937 0.0001]

[-0. -0.0001 0.0001 1. ]]

R =

[[17.0158 0.0554 0.027 -0. ]

[-0. 10.5611 -0.3632 -0.0006]

[ 0. 0. 7.3486 -0.001 ]

[ 0. 0. -0. -2.5489]]

A =

[[17.0159 0.0215 0.0223 0. ]

[ 0.0215 10.5351 -0.8256 0.0002]

[ 0.0223 -0.8256 -7.302 -0.0003]

[ 0. 0.0002 -0.0003 -2.5489]]

delta = 0.04089

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Iteration 9

Q =

[[ 1. -0.0012 0.0014 -0. ]

[ 0.0013 0.9969 -0.0781 -0. ]

[ 0.0013 -0.0781 -0.9969 -0. ]

[ 0. 0. -0. 1. ]]

R =

[[17.0159 0.0338 0.0117 0. ]

[-0. 10.5673 -0.2526 0.0002]

[ 0. 0. 7.3442 0.0004]

[-0. 0. 0. -2.5489]]

A =

[[17.0159 0.013 0.0096 -0. ]

[ 0.013 10.5548 -0.5738 -0. ]

[ 0.0096 -0.5738 -7.3218 0.0001]

[-0. -0. 0.0001 -2.5489]]

delta = 0.01975

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Iteration 10

Q =

[[ 1. -0.0007 0.0006 0. ]

[ 0.0008 0.9985 -0.0543 0. ]

[ 0.0006 -0.0543 -0.9985 0. ]

[-0. -0. 0. 1. ]]

R =

[[17.016 0.0208 0.005 -0. ]

[-0. 10.5703 -0.1755 -0. ]

[ 0. 0. 7.3421 -0.0001]

[ 0. 0. 0. -2.5489]]

A =

[[17.016 0.008 0.0041 0. ]

[ 0.008 10.5643 -0.3986 0. ]

[ 0.0041 -0.3986 -7.3313 -0. ]

[ 0. 0. -0. -2.5489]]

delta = 0.00953

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Iteration 11

Q =

[[ 1. -0.0005 0.0003 -0. ]

[ 0.0005 0.9993 -0.0377 -0. ]

[ 0.0002 -0.0377 -0.9993 -0. ]

[ 0. 0. -0. 1. ]]

R =

[[17.016 0.0129 0.0022 0. ]

[-0. 10.5718 -0.1219 0. ]

[ 0. -0. 7.3411 0. ]

[-0. 0. -0. -2.5489]]

A =

[[17.016 0.0049 0.0018 -0. ]

[ 0.0049 10.5689 -0.2768 -0. ]

[ 0.0018 -0.2768 -7.3359 0. ]

[-0. -0. 0. -2.5489]]

delta = 0.00460

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Iteration 12

Q =

[[ 1. -0.0003 0.0001 0. ]

[ 0.0003 0.9997 -0.0262 0. ]

[ 0.0001 -0.0262 -0.9997 0. ]

[-0. -0. 0. 1. ]]

R =

[[17.016 0.008 0.0009 -0. ]

[ 0. 10.5725 -0.0846 -0. ]

[-0. -0. 7.3406 -0. ]

[-0. -0. -0. -2.5489]]

A =

[[17.016 0.0031 0.0008 0. ]

[ 0.0031 10.5711 -0.1922 0. ]

[ 0.0008 -0.1922 -7.3381 -0. ]

[ 0. 0. -0. -2.5489]]

delta = 0.00222

---------------------------------------

Iteration 13

Q =

[[ 1. -0.0002 0. -0. ]

[ 0.0002 0.9998 -0.0182 -0. ]

[ 0. -0.0182 -0.9998 -0. ]

[ 0. 0. -0. 1. ]]

R =

[[17.016 0.005 0.0004 0. ]

[-0. 10.5728 -0.0588 0. ]

[ 0. 0. 7.3404 0. ]

[-0. -0. 0. -2.5489]]

A =

[[17.016 0.0019 0.0003 -0. ]

[ 0.0019 10.5721 -0.1334 -0. ]

[ 0.0003 -0.1334 -7.3392 0. ]

[-0. -0. 0. -2.5489]]

delta = 0.00107

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Iteration 14

Q =

[[ 1. -0.0001 0. 0. ]

[ 0.0001 0.9999 -0.0126 0. ]

[ 0. -0.0126 -0.9999 0. ]

[-0. -0. 0. 1. ]]

R =

[[17.016 0.0031 0.0002 -0. ]

[-0. 10.573 -0.0408 -0. ]

[ 0. -0. 7.3403 -0. ]

[ 0. -0. 0. -2.5489]]

A =

[[17.016 0.0012 0.0001 0. ]

[ 0.0012 10.5727 -0.0926 0. ]

[ 0.0001 -0.0926 -7.3397 -0. ]

[ 0. 0. -0. -2.5489]]

delta = 0.00051

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Iteration 15

Q =

[[ 1. -0.0001 0. -0. ]

[ 0.0001 1. -0.0088 -0. ]

[ 0. -0.0088 -1. -0. ]

[ 0. 0. -0. 1. ]]

R =

[[17.016 0.0019 0.0001 0. ]

[-0. 10.5731 -0.0283 0. ]

[ 0. 0. 7.3402 0. ]

[-0. -0. 0. -2.5489]]

A =

[[17.016 0.0007 0.0001 -0. ]

[ 0.0007 10.5729 -0.0643 -0. ]

[ 0.0001 -0.0643 -7.34 0. ]

[-0. -0. 0. -2.5489]]

delta = 0.00025

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Iteration 16

Q =

[[ 1. -0. 0. 0. ]

[ 0. 1. -0.0061 0. ]

[ 0. -0.0061 -1. 0. ]

[-0. -0. 0. 1. ]]

R =

[[17.016 0.0012 0. -0. ]

[-0. 10.5731 -0.0197 -0. ]

[ 0. -0. 7.3402 -0. ]

[ 0. 0. 0. -2.5489]]

A =

[[17.016 0.0005 0. 0. ]

[ 0.0005 10.573 -0.0446 0. ]

[ 0. -0.0446 -7.3401 -0. ]

[ 0. 0. -0. -2.5489]]

delta = 0.00012

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Iteration 17

Q =

[[ 1. -0. 0. -0. ]

[ 0. 1. -0.0042 -0. ]

[ 0. -0.0042 -1. -0. ]

[ 0. 0. -0. 1. ]]

R =

[[17.016 0.0007 0. 0. ]

[-0. 10.5731 -0.0137 0. ]

[ 0. -0. 7.3402 0. ]

[-0. 0. 0. -2.5489]]

A =

[[17.016 0.0003 0. -0. ]

[ 0.0003 10.5731 -0.031 -0. ]

[ 0. -0.031 -7.3401 0. ]

[-0. -0. 0. -2.5489]]

delta = 0.00006

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**Answer:**

**17.0160, 10.5731, -7.3401, -2.5489**