

GIFTWRAP

Keeping track of what I'm doing

To build brute force code I did use ChatGPT to generate some code, I would go in and adjust things as needed

Initially did in Python, but switched to C++ for team

### **Edgar Brute Force**

100 points - 0.009288 seconds

1000 points (uniform random) - 1.031116 seconds

### **Edgar Giftwrap**

#### ***Uniform Random***

#### **1000pts**

17 point hull size.

The Algorithm made 1016 operations.

The size of the array was 1000.

Hull computation time: 0.000144745 seconds

21 point hull size.

The Algorithm made 10020 operations.

The size of the array was 10000.

Hull computation time: 0.00249411 seconds

2<sup>10</sup>.txt

19 point hull size.

The Algorithm made 1042 operations.

The size of the array was 1024.

Hull computation time: 0.000212928 seconds

(496.6, 32.8)

(491.5, 479.5)

(8.9, 4.8)

(12.2, 477)

(499.5, 95.7)

(2.3, 469)

(493.2, 1.1)

(462.8, 498.5)

(123.7, 3.4)

(394.7, 499.6)

(493.7, 4.2)

(497.8, 383.5)

(0.7, 22.5)  
(499.9, 312.2)  
(1, 296.8)  
(27.9, 483)  
(483, 488.3)  
(78.7, 499.6)  
(0.6, 61.9)

2^11.txt

17 point hull size.

The Algorithm made 2064 operations.

The size of the array was 2048.

Hull computation time: 0.000423721 seconds

(491.2, 1)  
(331.5, 499.5)  
(0.6, 301.7)  
(498, 483.6)  
(1, 3.4)  
(34.7, 0.7)  
(471.1, 497.7)  
(499.6, 380.9)  
(134, 0.4)  
(387.2, 499.1)  
(499.5, 47.1)  
(490.6, 494.6)  
(499.4, 449.3)  
(3.1, 499.4)  
(499.7, 281.1)  
(275.8, 499.8)  
(0.2, 53.3)

2^12.txt

21 point hull size.

The Algorithm made 4116 operations.

The size of the array was 4096.

Hull computation time: 0.000978298 seconds

(0, 487.2)  
(499.9, 340.3)  
(497, 481.6)  
(496.2, 7.5)

(499.9, 287)  
(498.1, 440.7)  
(441.3, 0.3)  
(5.1, 0.3)  
(474.5, 499.3)  
(486.4, 498.8)  
(498.7, 27.3)  
(451.7, 1.1)  
(466.1, 499.6)  
(486, 4.4)  
(4.7, 499.8)  
(0.8, 169.7)  
(499.7, 152.3)  
(3.2, 16.5)  
(498.8, 410.1)  
(499.8, 187.2)  
(1.4, 55.5)

2^13.txt

22 point hull size.

The Algorithm made 8213 operations.

The size of the array was 8192.

Hull computation time: 0.00199062 seconds

(499.9, 447.1)  
(487.1, 2.4)  
(498, 498.5)  
(383, 0.7)  
(499.9, 466.1)  
(24.4, 499.4)  
(454.4, 499.9)  
(81.6, 499.8)  
(491.8, 499.7)  
(0.3, 433.6)  
(435.4, 1.5)  
(481.9, 499.9)  
(105.3, 0.1)  
(2.5, 3.3)  
(341.3, 0.1)  
(0, 15.7)  
(12.7, 0.1)

(499.8, 15.9)  
(0.9, 470.2)  
(499.9, 79.7)  
(0, 92.7)  
(4.4, 499.2)

2^14.txt

25 point hull size.

The Algorithm made 16408 operations.

The size of the array was 16384.

Hull computation time: 0.00359948 seconds

(0.1, 439.8)  
(499.5, 481.7)  
(121.8, 499.9)  
(19.4, 499.7)  
(164.7, 0)  
(492.9, 0.1)  
(8.8, 0.7)  
(420.5, 499.9)  
(8, 497.4)  
(7.1, 1)  
(1.5, 482.9)  
(22.8, 0.1)  
(473.1, 498.4)  
(496, 496)  
(0, 399.2)  
(368.7, 0)  
(3.2, 4.2)  
(499.5, 18.9)  
(0.3, 461.9)  
(499.8, 470.6)  
(1, 11.8)  
(455.1, 499.6)  
(1.7, 7.7)  
(500, 222.5)  
(0, 32.9)

2^15.txt

23 point hull size.

The Algorithm made 32790 operations.

The size of the array was 32768.

Hull computation time: 0.00670637 seconds

(165.9, 0)  
(482.9, 0.1)  
(489.8, 500)  
(499.5, 19.6)  
(8.5, 0.3)  
(0.4, 493.2)  
(499.9, 48.4)  
(1.1, 1.5)  
(0.1, 48.1)  
(500, 93.6)  
(493.3, 0.6)  
(1.5, 499.1)  
(0.2, 6.7)  
(360.2, 500)  
(498.4, 497.5)  
(497.1, 2.4)  
(6.7, 499.8)  
(499.6, 20.6)  
(31.9, 0.2)  
(0, 429.9)  
(0.3, 489.7)  
(500, 278)  
(499.9, 492.3)

2^16.txt

27 point hull size.

The Algorithm made 65562 operations.

The size of the array was 65536.

Hull computation time: 0.0173846 seconds

(500, 480.1)  
(36.9, 0.1)  
(55, 499.9)  
(496.1, 499.2)  
(0.5, 495.2)  
(153.5, 500)  
(0, 236.1)  
(0, 10.5)  
(499.7, 4.4)

(1.6, 0.3)  
(500, 65.6)  
(499.9, 5.5)  
(499.3, 2.7)  
(499.8, 498.2)  
(492, 499.9)  
(500, 486.8)  
(1.2, 2.2)  
(498, 0.1)  
(0.2, 474.5)  
(45.9, 499.9)  
(0.3, 486.1)  
(151.6, 0)  
(1.6, 499.3)  
(494.8, 499.7)  
(0.1, 441.5)  
(387.9, 0)  
(0, 406.4)

2^17.txt

21 point hull size.

The Algorithm made 131092 operations.

The size of the array was 131072.

Hull computation time: 0.0282224 seconds

(0.3, 0)  
(0, 297.7)  
(500, 497.6)  
(0.6, 496.8)  
(0, 88.2)  
(484.7, 500)  
(300.1, 500)  
(494, 499.4)  
(485.9, 0)  
(499, 0.2)  
(1.7, 499.7)  
(0.2, 495.2)  
(499.3, 498.4)  
(500, 32.4)  
(0, 490.6)  
(90.9, 500)

(0.1, 13)  
(3.3, 500)  
(0.9, 499)  
(491.3, 499.9)  
(499.7, 0.2)

2^18.txt

27 point hull size.

The Algorithm made 262170 operations.

The size of the array was 262144.

Hull computation time: 0.073359 seconds

(268.3, 0)  
(134.8, 500)  
(0, 65.4)  
(1.6, 499.8)  
(464.1, 0)  
(1.9, 500)  
(463.8, 500)  
(500, 399.9)  
(499.7, 496.9)  
(500, 458.8)  
(0.3, 4.4)  
(500, 481)  
(499.4, 499.2)  
(499.2, 0.3)  
(0, 48.5)  
(500, 3.7)  
(500, 494.9)  
(480.9, 0)  
(0.1, 498.9)  
(0, 21.3)  
(0.1, 5.5)  
(0.3, 2.2)  
(1.6, 0.1)  
(0, 490.3)  
(498.1, 499.7)  
(11.4, 0)  
(499.8, 1.4)

**GIFTWRAPFIX**

2^19.txt



34 point hull size.

The Algorithm made 18350079 operations.

The size of the array was 524288.

Hull computation time: 0.158048 seconds

(475.800000, 0.000000)  
(0.300000, 0.200000)  
(500.000000, 87.200000)  
(409.700000, 500.000000)  
(493.200000, 500.000000)  
(0.000000, 451.900000)  
(0.000000, 373.800000)  
(220.000000, 500.000000)  
(0.000000, 187.900000)  
(16.000000, 500.000000)  
(500.000000, 315.900000)  
(500.000000, 323.000000)  
(499.900000, 4.400000)  
(500.000000, 421.900000)  
(0.000000, 153.300000)  
(1.700000, 0.100000)  
(0.000000, 104.200000)  
(500.000000, 478.600000)  
(500.000000, 36.900000)  
(500.000000, 494.100000)  
(0.000000, 2.300000)  
(5.500000, 0.000000)  
(499.800000, 3.500000)  
(499.000000, 499.800000)  
(0.100000, 499.300000)  
(0.000000, 496.200000)  
(0.700000, 499.800000)  
(478.000000, 0.000000)  
(496.600000, 499.900000)  
(499.200000, 0.300000)  
(497.200000, 0.100000)  
(479.800000, 0.000000)  
(500.000000, 498.900000)  
(4.100000, 499.900000)

2^20.txt

34 point hull size.

The Algorithm made 36700159 operations.

The size of the array was 1048576.

Hull computation time: 0.320940 seconds

(500.000000, 453.400000)  
(367.000000, 0.000000)  
(162.600000, 500.000000)  
(71.800000, 500.000000)  
(393.600000, 0.000000)  
(0.000000, 112.600000)  
(500.000000, 463.000000)  
(0.000000, 37.500000)  
(415.200000, 0.000000)  
(430.600000, 0.000000)  
(0.100000, 2.500000)  
(9.700000, 500.000000)  
(0.000000, 497.000000)  
(468.300000, 0.000000)  
(0.000000, 17.400000)  
(500.000000, 478.900000)  
(498.100000, 499.900000)  
(499.100000, 499.700000)  
(0.300000, 0.600000)  
(499.900000, 0.400000)  
(472.200000, 0.000000)  
(1.900000, 0.000000)  
(476.600000, 0.000000)  
(500.000000, 1.200000)  
(0.200000, 499.500000)  
(492.100000, 0.000000)  
(0.000000, 11.800000)  
(1.000000, 500.000000)  
(487.600000, 500.000000)  
(499.900000, 497.900000)  
(498.800000, 0.000000)  
(0.500000, 499.800000)  
(500.000000, 494.900000)  
(0.900000, 0.200000)

2^21.txt

28 point hull size.

The Algorithm made 60817407 operations.

The size of the array was 2097152.

Hull computation time: 0.524613 seconds

(393.600000, 500.000000)

(12.400000, 0.000000)

(381.800000, 0.000000)

(0.000000, 15.900000)

(12.600000, 500.000000)

(500.000000, 381.500000)

(500.000000, 388.000000)

(484.700000, 0.000000)

(0.000000, 495.700000)

(2.900000, 500.000000)

(500.000000, 439.800000)

(0.100000, 1.700000)

(498.900000, 0.100000)

(500.000000, 488.600000)

(500.000000, 492.900000)

(0.200000, 499.800000)

(2.200000, 0.000000)

(1.200000, 500.000000)

(496.200000, 500.000000)

(485.400000, 0.000000)

(495.900000, 0.000000)

(500.000000, 2.500000)

(0.100000, 497.800000)

(499.800000, 0.400000)

(499.900000, 499.900000)

(1.500000, 0.100000)

(0.200000, 0.400000)

(500.000000, 496.400000)

2^22.txt

30 point hull size.

The Algorithm made 130023423 operations.

The size of the array was 4194304.

Hull computation time: 1.150199 seconds

(500.000000, 3.600000)

(219.500000, 0.000000)

(500.000000, 99.400000)  
(348.600000, 0.000000)  
(192.200000, 500.000000)  
(0.000000, 74.100000)  
(500.000000, 250.700000)  
(153.800000, 500.000000)  
(83.400000, 500.000000)  
(24.400000, 500.000000)  
(417.200000, 0.000000)  
(0.100000, 499.700000)  
(500.000000, 496.500000)  
(0.000000, 23.900000)  
(452.900000, 0.000000)  
(498.800000, 0.000000)  
(0.000000, 20.600000)  
(0.000000, 2.500000)  
(12.200000, 500.000000)  
(11.800000, 500.000000)  
(500.000000, 1.000000)  
(2.600000, 0.000000)  
(0.100000, 0.800000)  
(1.000000, 500.000000)  
(0.000000, 496.200000)  
(499.800000, 0.200000)  
(499.700000, 500.000000)  
(500.000000, 499.200000)  
(0.300000, 0.100000)  
(0.400000, 499.900000)

2^23.txt

37 point hull size.

The Algorithm made 318767103 operations.

The size of the array was 8388608.

Hull computation time: 3.107000 seconds

The points in the convex hull are:

(0.000000, 47.500000)  
(377.800000, 500.000000)  
(61.400000, 0.000000)  
(399.000000, 0.000000)  
(500.000000, 28.500000)

(317.500000, 500.000000)  
(500.000000, 34.500000)  
(162.200000, 500.000000)  
(500.000000, 202.700000)  
(500.000000, 422.800000)  
(91.900000, 500.000000)  
(28.600000, 500.000000)  
(460.300000, 0.000000)  
(8.200000, 500.000000)  
(465.000000, 0.000000)  
(500.000000, 486.600000)  
(500.000000, 487.200000)  
(479.200000, 0.000000)  
(0.000000, 38.300000)  
(500.000000, 488.200000)  
(0.000000, 35.400000)  
(498.000000, 0.000000)  
(3.500000, 500.000000)  
(500.000000, 493.700000)  
(0.200000, 500.000000)  
(0.000000, 2.900000)  
(500.000000, 498.000000)  
(500.000000, 499.400000)  
(0.000000, 1.200000)  
(0.100000, 0.100000)  
(500.000000, 0.400000)  
(500.000000, 499.900000)  
(499.400000, 500.000000)  
(0.000000, 0.400000)  
(0.000000, 498.600000)  
(0.700000, 0.000000)  
(499.800000, 0.000000)

2^24.txt

37 point hull size.

The Algorithm made 637534207 operations.

The size of the array was 16777216.

Hull computation time: 5.460348 seconds

The points in the convex hull are:

(500.000000, 479.200000)

(229.000000, 0.000000)  
(431.600000, 500.000000)  
(308.700000, 0.000000)  
(439.600000, 0.000000)  
(0.000000, 228.600000)  
(13.500000, 500.000000)  
(471.100000, 0.000000)  
(475.300000, 0.000000)  
(0.000000, 144.300000)  
(0.000000, 38.700000)  
(500.000000, 479.400000)  
(0.000000, 28.100000)  
(0.000000, 26.900000)  
(500.000000, 485.800000)  
(479.700000, 0.000000)  
(2.200000, 500.000000)  
(496.600000, 0.000000)  
(500.000000, 496.000000)  
(500.000000, 496.600000)  
(0.000000, 19.200000)  
(0.000000, 9.800000)  
(500.000000, 496.900000)  
(1.200000, 500.000000)  
(500.000000, 0.300000)  
(0.000000, 3.900000)  
(0.000000, 0.300000)  
(498.600000, 0.000000)  
(500.000000, 497.800000)  
(0.100000, 500.000000)  
(500.000000, 497.900000)  
(500.000000, 499.600000)  
(499.300000, 0.000000)  
(0.200000, 0.000000)  
(500.000000, 500.000000)  
(499.900000, 0.100000)  
(0.000000, 499.700000)

### **Shapes**

Circle.txt

39 point hull size.

The Algorithm made 3999 operations.

The size of the array was 100.

Hull computation time: 0.000040 seconds

The points in the convex hull are:

(444.000000, 310.900000)  
(453.400000, 268.200000)  
(454.800000, 248.500000)  
(47.200000, 274.000000)  
(345.300000, 431.100000)  
(445.800000, 200.100000)  
(64.400000, 172.800000)  
(122.500000, 92.800000)  
(394.800000, 393.400000)  
(428.600000, 349.300000)  
(103.400000, 389.900000)  
(45.700000, 235.300000)  
(114.400000, 398.900000)  
(154.300000, 68.800000)  
(328.200000, 62.800000)  
(63.300000, 323.400000)  
(45.300000, 244.600000)  
(249.300000, 454.800000)  
(219.700000, 448.000000)  
(352.800000, 426.600000)  
(417.900000, 139.700000)  
(194.800000, 53.500000)  
(398.400000, 389.600000)  
(131.300000, 411.000000)  
(329.500000, 438.200000)  
(312.900000, 444.300000)  
(298.700000, 53.500000)  
(54.600000, 202.000000)  
(449.400000, 296.500000)  
(244.600000, 45.300000)  
(165.000000, 433.500000)  
(358.300000, 79.600000)  
(84.000000, 363.800000)  
(436.100000, 172.800000)  
(356.900000, 78.800000)  
(172.000000, 61.700000)

(401.700000, 113.600000)  
(233.300000, 45.700000)  
(94.000000, 378.700000)

Star.txt

50 point hull size.

The Algorithm made 5099 operations.

The size of the array was 100.

Hull computation time: 0.000051 seconds

The points in the convex hull are:

(450.000000, 250.000000)  
(448.400000, 275.100000)  
(443.700000, 299.700000)  
(436.000000, 323.600000)  
(425.300000, 346.400000)  
(411.800000, 367.600000)  
(395.800000, 386.900000)  
(377.500000, 404.100000)  
(357.200000, 418.900000)  
(335.200000, 431.000000)  
(311.800000, 440.200000)  
(287.500000, 446.500000)  
(262.600000, 449.600000)  
(237.400000, 449.600000)  
(212.500000, 446.500000)  
(188.200000, 440.200000)  
(164.800000, 431.000000)  
(142.800000, 418.900000)  
(122.500000, 404.100000)  
(104.200000, 386.900000)  
(88.200000, 367.600000)  
(74.700000, 346.400000)  
(64.000000, 323.600000)  
(56.300000, 299.700000)  
(51.600000, 275.100000)  
(50.000000, 250.000000)  
(51.600000, 224.900000)  
(56.300000, 200.300000)  
(64.000000, 176.400000)  
(74.700000, 153.600000)



(88.200000, 132.400000)  
(104.200000, 113.100000)  
(122.500000, 95.900000)  
(142.800000, 81.100000)  
(164.800000, 69.000000)  
(188.200000, 59.800000)  
(212.500000, 53.500000)  
(237.400000, 50.400000)  
(262.600000, 50.400000)  
(287.500000, 53.500000)  
(311.800000, 59.800000)  
(335.200000, 69.000000)  
(357.200000, 81.100000)  
(377.500000, 95.900000)  
(395.800000, 113.100000)  
(411.800000, 132.400000)  
(425.300000, 153.600000)  
(436.000000, 176.400000)  
(443.700000, 200.300000)  
(448.400000, 224.900000)

Grid.txt

20 point hull size.

The Algorithm made 2099 operations.

The size of the array was 100.

Hull computation time: 0.000024 seconds

The points in the convex hull are:

(0.000000, 0.000000)  
(0.000000, 450.000000)  
(50.000000, 0.000000)  
(100.000000, 0.000000)  
(150.000000, 0.000000)  
(200.000000, 0.000000)  
(250.000000, 0.000000)  
(300.000000, 0.000000)  
(350.000000, 0.000000)  
(400.000000, 0.000000)  
(450.000000, 0.000000)  
(450.000000, 50.000000)  
(450.000000, 100.000000)

(450.000000, 150.000000)  
(450.000000, 200.000000)  
(450.000000, 250.000000)  
(450.000000, 300.000000)  
(450.000000, 350.000000)  
(450.000000, 400.000000)  
(450.000000, 450.000000)

Square.txt

100 point hull size.

The Algorithm made 10099 operations.

The size of the array was 100.

Hull computation time: 0.000082 seconds

The points in the convex hull are:

(0.000000, 0.000000)  
(20.000000, 0.000000)  
(40.000000, 0.000000)  
(60.000000, 0.000000)  
(80.000000, 0.000000)  
(100.000000, 0.000000)  
(120.000000, 0.000000)  
(140.000000, 0.000000)  
(160.000000, 0.000000)  
(180.000000, 0.000000)  
(200.000000, 0.000000)  
(220.000000, 0.000000)  
(240.000000, 0.000000)  
(260.000000, 0.000000)  
(280.000000, 0.000000)  
(300.000000, 0.000000)  
(320.000000, 0.000000)  
(340.000000, 0.000000)  
(360.000000, 0.000000)  
(380.000000, 0.000000)  
(400.000000, 0.000000)  
(420.000000, 0.000000)  
(440.000000, 0.000000)  
(460.000000, 0.000000)  
(480.000000, 0.000000)  
(500.000000, 0.000000)

(500.000000, 20.000000)  
(500.000000, 40.000000)  
(500.000000, 60.000000)  
(500.000000, 80.000000)  
(500.000000, 100.000000)  
(500.000000, 120.000000)  
(500.000000, 140.000000)  
(500.000000, 160.000000)  
(500.000000, 180.000000)  
(500.000000, 200.000000)  
(500.000000, 220.000000)  
(500.000000, 240.000000)  
(500.000000, 260.000000)  
(500.000000, 280.000000)  
(500.000000, 300.000000)  
(500.000000, 320.000000)  
(500.000000, 340.000000)  
(500.000000, 360.000000)  
(500.000000, 380.000000)  
(500.000000, 400.000000)  
(500.000000, 420.000000)  
(500.000000, 440.000000)  
(500.000000, 460.000000)  
(500.000000, 480.000000)  
(500.000000, 500.000000)  
(480.000000, 500.000000)  
(460.000000, 500.000000)  
(440.000000, 500.000000)  
(420.000000, 500.000000)  
(400.000000, 500.000000)  
(380.000000, 500.000000)  
(360.000000, 500.000000)  
(340.000000, 500.000000)  
(320.000000, 500.000000)  
(300.000000, 500.000000)  
(280.000000, 500.000000)  
(260.000000, 500.000000)  
(240.000000, 500.000000)  
(220.000000, 500.000000)  
(200.000000, 500.000000)

(180.000000, 500.000000)  
(160.000000, 500.000000)  
(140.000000, 500.000000)  
(120.000000, 500.000000)  
(100.000000, 500.000000)  
(80.000000, 500.000000)  
(60.000000, 500.000000)  
(40.000000, 500.000000)  
(20.000000, 500.000000)  
(0.000000, 500.000000)  
(0.000000, 480.000000)  
(0.000000, 460.000000)  
(0.000000, 440.000000)  
(0.000000, 420.000000)  
(0.000000, 400.000000)  
(0.000000, 380.000000)  
(0.000000, 360.000000)  
(0.000000, 340.000000)  
(0.000000, 320.000000)  
(0.000000, 300.000000)  
(0.000000, 280.000000)  
(0.000000, 260.000000)  
(0.000000, 240.000000)  
(0.000000, 220.000000)  
(0.000000, 200.000000)  
(0.000000, 180.000000)  
(0.000000, 160.000000)  
(0.000000, 140.000000)  
(0.000000, 120.000000)  
(0.000000, 100.000000)  
(0.000000, 80.000000)  
(0.000000, 60.000000)  
(0.000000, 40.000000)  
(0.000000, 20.000000)

### ***Gaussian Clusters***

G100.txt

12 point hull size.

The Algorithm made 1299 operations.

The size of the array was 100.  
Hull computation time: 0.000012 seconds  
The points in the convex hull are:  
(170.100000, 145.600000)  
(31.000000, 517.600000)  
(71.000000, 527.900000)  
(218.800000, 139.300000)  
(364.200000, 277.900000)  
(24.000000, 514.500000)  
(277.700000, 505.200000)  
(93.800000, 525.800000)  
(305.100000, 470.800000)  
(292.600000, 487.200000)  
(21.400000, 470.300000)  
(279.400000, 131.800000)

G500.txt  
14 point hull size.  
The Algorithm made 7499 operations.  
The size of the array was 500.  
Hull computation time: 0.000067 seconds  
The points in the convex hull are:  
(74.200000, 493.700000)  
(498.300000, 498.500000)  
(122.500000, 499.600000)  
(24.700000, 476.500000)  
(427.700000, 499.700000)  
(414.800000, 1.700000)  
(12.300000, 35.800000)  
(2.400000, 327.400000)  
(60.900000, 5.400000)  
(495.000000, 20.100000)  
(21.600000, 12.700000)  
(498.700000, 221.900000)  
(328.800000, 0.000000)  
(1.200000, 453.100000)

G1K.txt  
15 point hull size.  
The Algorithm made 15999 operations.

The size of the array was 1000.

Hull computation time: 0.000459 seconds

The points in the convex hull are:

(306.200000, 8.600000)  
(18.100000, 176.700000)  
(11.000000, 189.500000)  
(532.000000, 426.500000)  
(97.600000, 409.000000)  
(128.900000, 443.500000)  
(283.200000, 2.600000)  
(535.000000, 452.200000)  
(463.500000, 553.700000)  
(328.100000, 37.200000)  
(239.300000, -2.300000)  
(319.700000, 24.800000)  
(519.900000, 540.700000)  
(538.600000, 511.400000)  
(-7.000000, 261.200000)

G1.5K.txt

12 point hull size.

The Algorithm made 19499 operations.

The size of the array was 1500.

Hull computation time: 0.000175 seconds

The points in the convex hull are:

(62.600000, 162.300000)  
(106.200000, 283.600000)  
(391.100000, 31.100000)  
(69.300000, 249.000000)  
(485.700000, 86.000000)  
(342.200000, 11.300000)  
(80.600000, 261.000000)  
(467.300000, 518.700000)  
(81.500000, 136.500000)  
(541.200000, 476.900000)  
(333.500000, 10.800000)  
(294.300000, 15.600000)

G2K.txt

15 point hull size.

The Algorithm made 31999 operations.  
The size of the array was 2000.  
Hull computation time: 0.000330 seconds  
The points in the convex hull are:  
(234.700000, -23.000000)  
(235.300000, 518.200000)  
(61.000000, 116.500000)  
(250.200000, 464.800000)  
(336.700000, 24.300000)  
(25.200000, 392.700000)  
(122.900000, 543.500000)  
(19.600000, 437.400000)  
(26.900000, 456.800000)  
(336.000000, 39.700000)  
(141.000000, 554.200000)  
(284.000000, -37.300000)  
(327.500000, -9.400000)  
(221.900000, 543.900000)  
(107.700000, 58.600000)

G3K.txt  
18 point hull size.  
The Algorithm made 56999 operations.  
The size of the array was 3000.  
Hull computation time: 0.000530 seconds  
The points in the convex hull are:  
(424.100000, -22.000000)  
(474.000000, 26.000000)  
(-35.400000, 132.700000)  
(-18.700000, 95.000000)  
(235.200000, 489.700000)  
(466.200000, 4.100000)  
(-25.700000, 168.800000)  
(330.200000, 446.500000)  
(484.100000, 59.700000)  
(134.700000, -30.600000)  
(383.900000, -29.300000)  
(451.300000, -9.300000)  
(352.400000, 401.400000)  
(73.000000, -28.500000)

(281.100000, 499.400000)  
(2.800000, 219.500000)  
(304.100000, 492.400000)  
(413.200000, -24.500000)

G10K.txt

14 point hull size.

The Algorithm made 149999 operations.

The size of the array was 10000.

Hull computation time: 0.001219 seconds

The points in the convex hull are:

(-5.000000, 13.000000)  
(550.600000, 243.900000)  
(-15.700000, 232.300000)  
(102.200000, -68.000000)  
(49.700000, -54.700000)  
(133.600000, -52.900000)  
(507.600000, 204.000000)  
(475.800000, 178.800000)  
(73.300000, -67.300000)  
(4.100000, -3.900000)  
(257.900000, 377.000000)  
(450.800000, 379.000000)  
(537.400000, 331.500000)  
(294.500000, 380.000000)

G50K.txt

15 point hull size.

The Algorithm made 799999 operations.

The size of the array was 50000.

Hull computation time: 0.006526 seconds

The points in the convex hull are:

(-76.300000, 200.500000)  
(-27.100000, 107.100000)  
(118.600000, 553.100000)  
(8.400000, 97.100000)  
(-56.200000, 141.300000)  
(426.800000, 217.100000)  
(253.000000, 42.500000)  
(404.400000, 180.800000)



(222.000000, 588.600000)  
(191.200000, 587.200000)  
(428.400000, 240.300000)  
(327.200000, 531.000000)  
(374.300000, 143.100000)  
(285.400000, 54.400000)  
(182.100000, 55.900000)

G100K.txt

17 point hull size.

The Algorithm made 1799999 operations.

The size of the array was 100000.

Hull computation time: 0.013552 seconds

The points in the convex hull are:

(71.800000, 571.200000)  
(227.600000, -6.900000)  
(24.700000, 382.100000)  
(273.100000, -11.200000)  
(234.800000, -9.200000)  
(186.000000, 15.200000)  
(220.200000, 554.000000)  
(253.800000, -14.500000)  
(160.600000, 35.000000)  
(532.900000, 159.600000)  
(158.200000, 589.800000)  
(155.300000, 589.600000)  
(520.200000, 223.100000)  
(535.000000, 133.600000)  
(513.200000, 72.900000)  
(41.700000, 328.800000)  
(526.200000, 207.300000)

G500K.txt

23 point hull size.

The Algorithm made 11999999 operations.

The size of the array was 500000.

Hull computation time: 0.095747 seconds

The points in the convex hull are:

(448.900000, 398.800000)  
(23.400000, 4.900000)

(424.500000, 501.500000)  
(446.400000, 348.200000)  
(39.200000, 0.800000)  
(-51.200000, 162.500000)  
(-71.800000, 117.200000)  
(127.700000, -5.600000)  
(341.700000, 529.400000)  
(284.000000, 493.800000)  
(77.100000, -7.300000)  
(180.400000, 11.700000)  
(446.400000, 437.600000)  
(238.800000, 460.500000)  
(-29.700000, 28.300000)  
(317.600000, 516.600000)  
(-74.900000, 96.700000)  
(438.100000, 473.200000)  
(-69.600000, 127.700000)  
(-36.600000, 185.100000)  
(373.800000, 528.700000)  
(-52.800000, 55.900000)  
(227.900000, 44.800000)

G1M.txt

19 point hull size.

The Algorithm made 19999999 operations.

The size of the array was 1000000.

Hull computation time: 0.172953 seconds

The points in the convex hull are:

(181.500000, 77.500000)  
(313.000000, 311.300000)  
(557.000000, 263.500000)  
(450.800000, 406.700000)  
(426.400000, 406.700000)  
(279.100000, 251.500000)  
(525.400000, 357.000000)  
(539.600000, -79.400000)  
(333.900000, 337.900000)  
(578.800000, -23.300000)  
(269.200000, -103.300000)  
(163.100000, 25.400000)

(180.500000, -42.700000)  
(468.600000, -88.200000)  
(170.300000, -9.400000)  
(590.100000, 47.300000)  
(188.300000, -49.200000)  
(583.900000, 6.800000)  
(238.200000, -84.500000)

G5M.txt

18 point hull size.

The Algorithm made 94999999 operations.

The size of the array was 5000000.

Hull computation time: 0.855009 seconds

The points in the convex hull are:

(571.600000, 395.100000)  
(365.500000, -112.400000)  
(354.600000, 457.400000)  
(556.100000, 468.700000)  
(482.100000, 505.800000)  
(505.600000, 494.600000)  
(139.100000, 77.500000)  
(472.100000, -16.800000)  
(192.500000, -47.400000)  
(568.900000, 355.000000)  
(199.900000, 191.000000)  
(455.200000, -52.500000)  
(148.100000, 37.600000)  
(465.800000, 513.400000)  
(391.800000, 488.400000)  
(161.500000, -1.700000)  
(570.000000, 431.300000)  
(222.700000, -61.000000)

G10M.txt

24 point hull size.

The Algorithm made 249999999 operations.

The size of the array was 10000000.

Hull computation time: 2.217376 seconds

The points in the convex hull are:

(576.400000, 374.800000)

(340.400000, 22.400000)  
(9.800000, -49.600000)  
(558.500000, 576.500000)  
(-102.200000, 136.700000)  
(524.800000, 598.000000)  
(620.500000, 499.800000)  
(31.700000, -48.200000)  
(448.400000, 576.400000)  
(460.300000, 582.700000)  
(-39.000000, 189.300000)  
(407.500000, 88.700000)  
(351.300000, 28.200000)  
(367.300000, 43.500000)  
(-83.200000, -26.300000)  
(375.200000, 52.200000)  
(429.400000, 565.100000)  
(426.400000, 563.200000)  
(469.000000, 586.800000)  
(-108.900000, 116.500000)  
(607.600000, 537.100000)  
(594.200000, 548.200000)  
(-117.300000, 24.800000)  
(623.200000, 457.200000)

G15M.txt

19 point hull size.

The Algorithm made 299999999 operations.

The size of the array was 15000000.

Hull computation time: 2.782965 seconds

The points in the convex hull are:

(-126.300000, 196.800000)  
(538.500000, 312.100000)  
(508.900000, 116.900000)  
(-13.000000, 304.900000)  
(251.300000, -86.500000)  
(571.700000, 210.400000)  
(-90.900000, 44.000000)  
(575.000000, 219.900000)  
(-49.600000, 290.700000)  
(559.000000, 182.000000)

(489.700000, 353.000000)  
(-123.700000, 202.900000)  
(432.900000, 353.300000)  
(-121.600000, 165.700000)  
(-86.300000, 266.000000)  
(173.300000, -103.500000)  
(564.600000, 276.500000)  
(-96.000000, 259.400000)  
(-70.800000, -3.900000)

BRUTE FORCE

## BRUTE FORCE

### **Uniform random**

2^10.txt

19 point hull size.

The Algorithm made 2495453 operations.

The size of the array was 1024.

Hull computation time: 0.0169785 seconds

(0.6, 61.9)

(0.7, 22.5)

(1, 296.8)

(2.3, 469)

(8.9, 4.8)

(12.2, 477)

(27.9, 483)

(78.7, 499.6)

(123.7, 3.4)

(394.7, 499.6)

(462.8, 498.5)

(483, 488.3)

(491.5, 479.5)

(493.2, 1.1)

(493.7, 4.2)

(496.6, 32.8)

(497.8, 383.5)

(499.5, 95.7)

(499.9, 312.2)

2^11.txt

17 point hull size.

The Algorithm made 14088463 operations.

The size of the array was 2048.

Hull computation time: 0.0711982 seconds

(0.2, 53.3)

(0.6, 301.7)

(1, 3.4)

(3.1, 499.4)

(34.7, 0.7)

(134, 0.4)

(275.8, 499.8)

(331.5, 499.5)

(387.2, 499.1)

(471.1, 497.7)

(490.6, 494.6)

(491.2, 1)

(498, 483.6)  
(499.4, 449.3)  
(499.5, 47.1)  
(499.6, 380.9)  
(499.7, 281.1)

2^12.txt

23 point hull size.

The Algorithm made 46456751 operations.

The size of the array was 4096.

Hull computation time: 0.246671 seconds

(0, 487.2)  
(0.8, 169.7)  
(1.4, 55.5)  
(3.2, 16.5)  
(4.7, 499.8)  
(5.1, 0.3)  
(71.9, 158.4)  
(219, 0.3)  
(441.3, 0.3)  
(451.7, 1.1)  
(466.1, 499.6)  
(474.5, 499.3)  
(486, 4.4)  
(486.4, 498.8)  
(496.2, 7.5)  
(497, 481.6)  
(498.1, 440.7)  
(498.7, 27.3)  
(498.8, 410.1)  
(499.7, 152.3)  
(499.8, 187.2)  
(499.9, 287)  
(499.9, 340.3)

2^13.txt

28 point hull size.

The Algorithm made 176960048 operations.

The size of the array was 8192.

Hull computation time: 1.06148 seconds

(0, 15.7)  
(0, 92.7)  
(0.3, 433.6)  
(0.9, 470.2)



(2.5, 3.3)  
(4.4, 499.2)  
(12.7, 0.1)  
(24.4, 499.4)  
(81.6, 499.8)  
(105.3, 0.1)  
(185.3, 175.6)  
(279, 50.2)  
(341.3, 0.1)  
(383, 0.7)  
(435.4, 1.5)  
(454.4, 499.9)  
(481.9, 499.9)  
(487.1, 2.4)  
(491.8, 499.7)  
(498, 498.5)  
(499.8, 15.9)  
(499.9, 79.7)  
(499.9, 175.3)  
(499.9, 322.8)  
(499.9, 421.2)  
(499.9, 441.7)  
(499.9, 447.1)  
(499.9, 466.1)

2^14.txt

28 point hull size.

The Algorithm made 493296842 operations.

The size of the array was 16384.

Hull computation time: 3.82181 seconds

(0, 32.9)  
(0, 399.2)  
(0.1, 439.8)  
(0.3, 461.9)  
(1, 11.8)  
(1.5, 482.9)  
(1.7, 7.7)  
(3.2, 4.2)  
(7.1, 1)  
(8, 497.4)  
(8.8, 0.7)  
(19.4, 499.7)  
(22.8, 0.1)  
(121.8, 499.9)

(164.7, 0)  
(184, 499.9)  
(344.9, 499.9)  
(368.7, 0)  
(420.5, 499.9)  
(455.1, 499.6)  
(473.1, 498.4)  
(487.5, 421.7)  
(492.9, 0.1)  
(496, 496)  
(499.5, 18.9)  
(499.5, 481.7)  
(499.8, 470.6)  
(500, 222.5)

2^15.txt

51 point hull size.

The Algorithm made 3911536816 operations.

The size of the array was 32768.

Hull computation time: 20.7733 seconds

(0, 429.9)  
(0.1, 48.1)  
(0.2, 6.7)  
(0.3, 489.7)  
(0.4, 493.2)  
(1.1, 1.5)  
(1.5, 499.1)  
(6, 499.8)  
(6.8, 203)  
(8.5, 0.3)  
(31.9, 0.2)  
(37.5, 215.5)  
(41.1, 443.7)  
(41.4, 396.9)  
(49.7, 266.5)  
(60.7, 98.3)  
(80.5, 371.2)  
(136.4, 78.4)  
(139.3, 433.2)  
(140.5, 333)  
(143.4, 428.9)  
(155, 35)  
(165.9, 0)  
(216.9, 213.4)

(224.6, 368.8)  
(293.5, 100.2)  
(294.6, 187.6)  
(304, 389.1)  
(313.7, 136)  
(318.8, 282)  
(333.9, 233.6)  
(360.2, 500)  
(395.7, 115.6)  
(436.6, 153.3)  
(445.6, 269.1)  
(455.5, 95.3)  
(467.7, 493.4)  
(475.5, 80.7)  
(476.1, 478.6)  
(482.9, 0.1)  
(489.8, 500)  
(493.3, 0.6)  
(497.1, 2.4)  
(498.4, 497.5)  
(499.5, 19.6)  
(499.6, 20.6)  
(499.9, 48.4)  
(499.9, 492.3)  
(500, 93.6)  
(500, 185.1)  
(500, 278)

2^16.txt

129 point hull size.

The Algorithm made 13409485652 operations.

The size of the array was 65536.

Hull computation time: 78.1875 seconds

(0, 10.5)  
(0, 20.6)  
(0, 40)  
(0, 44.9)  
(0, 236.1)  
(0, 406.4)  
(0.1, 441.5)  
(0.2, 474.5)  
(0.3, 486.1)  
(0.5, 495.2)  
(1.2, 2.2)

(1.6, 0.3)  
(1.6, 499.3)  
(2.2, 179.1)  
(6.2, 118.9)  
(10.9, 426.7)  
(36.6, 338)  
(36.9, 0.1)  
(45.9, 499.9)  
(46.4, 353.4)  
(65, 315.9)  
(66.2, 221.8)  
(69.1, 367.5)  
(77, 340.2)  
(82, 135.5)  
(96.4, 5.1)  
(109.8, 296.7)  
(113.6, 388)  
(114.5, 494.9)  
(124.2, 369.9)  
(125.9, 197.2)  
(143.6, 288.6)  
(151.6, 0)  
(153.5, 500)  
(153.6, 453.4)  
(155.3, 33.6)  
(156.9, 179.3)  
(160.3, 88.9)  
(162.1, 454.2)  
(164.9, 437.6)  
(165.4, 395)  
(183.1, 281)  
(192.4, 340.6)  
(197.5, 211.9)  
(197.9, 41.8)  
(201.1, 74.1)  
(204, 384.2)  
(211.6, 324.4)  
(219.2, 2.8)  
(221.3, 293.3)  
(224.1, 407.3)  
(224.2, 151)  
(233.8, 183.7)  
(247.4, 249.4)  
(247.9, 96.5)

(267.1, 341.9)  
(277.7, 372.2)  
(287.5, 97.1)  
(291.5, 331.5)  
(300.7, 108.1)  
(305, 285.7)  
(305.3, 138.9)  
(306.7, 264.4)  
(309.4, 301.6)  
(317.4, 75.8)  
(332.1, 375.1)  
(338, 63.6)  
(339.8, 396.1)  
(340.2, 361.9)  
(340.7, 267.2)  
(345.5, 183.6)  
(353.4, 136)  
(357.8, 416)  
(360.2, 353.4)  
(364.6, 145.5)  
(365.5, 158.5)  
(373.5, 273.2)  
(382.6, 445)  
(386.8, 92.7)  
(387.9, 0)  
(388.5, 141.8)  
(390.6, 470)  
(400.2, 491.1)  
(401.6, 318.4)  
(403.9, 466.3)  
(407.1, 425.3)  
(409.1, 163.6)  
(411.6, 232)  
(418.6, 279.4)  
(432.8, 125.7)  
(435.9, 314)  
(447, 351.6)  
(447.2, 432.7)  
(451.2, 339.4)  
(453.2, 74.9)  
(454.9, 64.4)  
(465.4, 34.7)  
(466.2, 195.7)  
(469.3, 20.9)

(470.7, 457)  
(471, 397.7)  
(474.4, 328.2)  
(474.6, 498.5)  
(477.5, 306.6)  
(484.3, 480.6)  
(486.1, 12.9)  
(488.2, 275.6)  
(488.4, 222.8)  
(491.4, 51.9)  
(492, 499.9)  
(494.8, 499.7)  
(498, 0.1)  
(498.9, 379.6)  
(499.3, 2.7)  
(499.7, 4.4)  
(499.8, 498.2)  
(499.9, 5.5)  
(500, 65.6)  
(500, 205.9)  
(500, 308.5)  
(500, 313.3)  
(500, 314.4)  
(500, 340.3)  
(500, 362.2)  
(500, 364.2)  
(500, 456.6)  
(500, 462.1)  
(500, 480.1)  
(500, 486.8)

## **Shapes**

Star.txt

50 point hull size.

The Algorithm made 131337 operations.

The size of the array was 100.

Hull computation time: 0.000718333 seconds

(50, 250)  
(51.6, 224.9)  
(51.6, 275.1)  
(56.3, 200.3)  
(56.3, 299.7)  
(64, 176.4)  
(64, 323.6)

(74.7, 153.6)  
(74.7, 346.4)  
(88.2, 132.4)  
(88.2, 367.6)  
(104.2, 113.1)  
(104.2, 386.9)  
(122.5, 95.9)  
(122.5, 404.1)  
(142.8, 81.1)  
(142.8, 418.9)  
(164.8, 69)  
(164.8, 431)  
(188.2, 59.8)  
(188.2, 440.2)  
(212.5, 53.5)  
(212.5, 446.5)  
(237.4, 50.4)  
(237.4, 449.6)  
(262.6, 50.4)  
(262.6, 449.6)  
(287.5, 53.5)  
(287.5, 446.5)  
(311.8, 59.8)  
(311.8, 440.2)  
(335.2, 69)  
(335.2, 431)  
(357.2, 81.1)  
(357.2, 418.9)  
(377.5, 95.9)  
(377.5, 404.1)  
(395.8, 113.1)  
(395.8, 386.9)  
(411.8, 132.4)  
(411.8, 367.6)  
(425.3, 153.6)  
(425.3, 346.4)  
(436, 176.4)  
(436, 323.6)  
(443.7, 200.3)  
(443.7, 299.7)  
(448.4, 224.9)  
(448.4, 275.1)  
(450, 250)

Square.txt

100 point hull size.

The Algorithm made 238176 operations.

The size of the array was 100.

Hull computation time: 0.00113885 seconds

(0, 0)

(0, 20)

(0, 40)

(0, 60)

(0, 80)

(0, 100)

(0, 120)

(0, 140)

(0, 160)

(0, 180)

(0, 200)

(0, 220)

(0, 240)

(0, 260)

(0, 280)

(0, 300)

(0, 320)

(0, 340)

(0, 360)

(0, 380)

(0, 400)

(0, 420)

(0, 440)

(0, 460)

(0, 480)

(0, 500)

(20, 0)

(20, 500)

(40, 0)

(40, 500)

(60, 0)

(60, 500)

(80, 0)

(80, 500)

(100, 0)

(100, 500)

(120, 0)

(120, 500)

(140, 0)



(140, 500)  
(160, 0)  
(160, 500)  
(180, 0)  
(180, 500)  
(200, 0)  
(200, 500)  
(220, 0)  
(220, 500)  
(240, 0)  
(240, 500)  
(260, 0)  
(260, 500)  
(280, 0)  
(280, 500)  
(300, 0)  
(300, 500)  
(320, 0)  
(320, 500)  
(340, 0)  
(340, 500)  
(360, 0)  
(360, 500)  
(380, 0)  
(380, 500)  
(400, 0)  
(400, 500)  
(420, 0)  
(420, 500)  
(440, 0)  
(440, 500)  
(460, 0)  
(460, 500)  
(480, 0)  
(480, 500)  
(500, 0)  
(500, 20)  
(500, 40)  
(500, 60)  
(500, 80)  
(500, 100)  
(500, 120)  
(500, 140)  
(500, 160)

(500, 180)  
(500, 200)  
(500, 220)  
(500, 240)  
(500, 260)  
(500, 280)  
(500, 300)  
(500, 320)  
(500, 340)  
(500, 360)  
(500, 380)  
(500, 400)  
(500, 420)  
(500, 440)  
(500, 460)  
(500, 480)  
(500, 500)

Circle.txt

39 point hull size.

The Algorithm made 43334 operations.

The size of the array was 100.

Hull computation time: 0.000245512 seconds

(45.3, 244.6)  
(45.7, 235.3)  
(47.2, 274)  
(54.6, 202)  
(63.3, 323.4)  
(64.4, 172.8)  
(84, 363.8)  
(94, 378.7)  
(103.4, 389.9)  
(114.4, 398.9)  
(122.5, 92.8)  
(131.3, 411)  
(154.3, 68.8)  
(165, 433.5)  
(172, 61.7)  
(194.8, 53.5)  
(219.7, 448)  
(233.3, 45.7)  
(244.6, 45.3)  
(249.3, 454.8)  
(298.7, 53.5)

(312.9, 444.3)  
(328.2, 62.8)  
(329.5, 438.2)  
(345.3, 431.1)  
(352.8, 426.6)  
(356.9, 78.8)  
(358.3, 79.6)  
(394.8, 393.4)  
(398.4, 389.6)  
(401.7, 113.6)  
(417.9, 139.7)  
(428.6, 349.3)  
(436.1, 172.8)  
(444, 310.9)  
(445.8, 200.1)  
(449.4, 296.5)  
(453.4, 268.2)  
(454.8, 248.5)

Grid.txt

36 point hull size.

The Algorithm made 135647 operations.

The size of the array was 100.

Hull computation time: 0.000905799 seconds

(0, 0)  
(0, 50)  
(0, 100)  
(0, 150)  
(0, 200)  
(0, 250)  
(0, 300)  
(0, 350)  
(0, 400)  
(0, 450)  
(50, 0)  
(50, 450)  
(100, 0)  
(100, 450)  
(150, 0)  
(150, 450)  
(200, 0)  
(200, 450)  
(250, 0)  
(250, 450)

(300, 0)  
(300, 450)  
(350, 0)  
(350, 450)  
(400, 0)  
(400, 450)  
(450, 0)  
(450, 50)  
(450, 100)  
(450, 150)  
(450, 200)  
(450, 250)  
(450, 300)  
(450, 350)  
(450, 400)  
(450, 450)

### **Guassian**

G100.txt

12 point hull size.

The Algorithm made 24605 operations.

The size of the array was 100.

Hull computation time: 0.000172505 seconds

(21.4, 470.3)  
(24, 514.5)  
(31, 517.6)  
(71, 527.9)  
(93.8, 525.8)  
(170.1, 145.6)  
(218.8, 139.3)  
(277.7, 505.2)  
(279.4, 131.8)  
(292.6, 487.2)  
(305.1, 470.8)  
(364.2, 277.9)

G500.txt

14 point hull size.

The Algorithm made 758588 operations.

The size of the array was 500.

Hull computation time: 0.00441081 seconds

(1.2, 453.1)  
(2.4, 327.4)  
(12.3, 35.8)

(21.6, 12.7)  
(24.7, 476.5)  
(60.9, 5.4)  
(74.2, 493.7)  
(122.5, 499.6)  
(328.8, 0)  
(414.8, 1.7)  
(427.7, 499.7)  
(495, 20.1)  
(498.3, 498.5)  
(498.7, 221.9)

G1K.txt

15 point hull size.

The Algorithm made 4450244 operations.

The size of the array was 1000.

Hull computation time: 0.0250179 seconds

(-7, 261.2)  
(11, 189.5)  
(18.1, 176.7)  
(97.6, 409)  
(128.9, 443.5)  
(239.3, -2.3)  
(283.2, 2.6)  
(306.2, 8.6)  
(319.7, 24.8)  
(328.1, 37.2)  
(463.5, 553.7)  
(519.9, 540.7)  
(532, 426.5)  
(535, 452.2)  
(538.6, 511.4)

G1.5K.txt

13 point hull size.

The Algorithm made 7529103 operations.

The size of the array was 1500.

Hull computation time: 0.121067 seconds

(62.6, 162.3)  
(69.3, 249)  
(80.6, 261)  
(81.5, 136.5)  
(106.2, 283.6)  
(151.4, 217.3)

(294.3, 15.6)  
(333.5, 10.8)  
(342.2, 11.3)  
(391.1, 31.1)  
(467.3, 518.7)  
(485.7, 86)  
(541.2, 476.9)

G2K.txt

16 point hull size.

The Algorithm made 11284058 operations.

The size of the array was 2000.

Hull computation time: 0.0658291 seconds

(19.6, 437.4)  
(25.2, 392.7)  
(26.9, 456.8)  
(61, 116.5)  
(107.7, 58.6)  
(122.9, 543.5)  
(141, 554.2)  
(145.7, 139.5)  
(221.9, 543.9)  
(234.7, -23)  
(235.3, 518.2)  
(250.2, 464.8)  
(284, -37.3)  
(327.5, -9.4)  
(336, 39.7)  
(336.7, 24.3)

G3K.txt

18 point hull size.

The Algorithm made 32942656 operations.

The size of the array was 3000.

Hull computation time: 0.186087 seconds

(-35.4, 132.7)  
(-25.7, 168.8)  
(-18.7, 95)  
(2.8, 219.5)  
(73, -28.5)  
(134.7, -30.6)  
(235.2, 489.7)  
(281.1, 499.4)  
(304.1, 492.4)

(330.2, 446.5)  
(352.4, 401.4)  
(383.9, -29.3)  
(413.2, -24.5)  
(424.1, -22)  
(451.3, -9.3)  
(466.2, 4.1)  
(474, 26)  
(484.1, 59.7)

G10K.txt

31 point hull size.

The Algorithm made 333989033 operations.

The size of the array was 10000.

Hull computation time: 1.87101 seconds

(-15.7, 232.3)  
(-5, 13)  
(4.1, -3.9)  
(49.7, -54.7)  
(73.3, -67.3)  
(76, 17.5)  
(99.6, -21.4)  
(99.6, 1.4)  
(102.2, -68)  
(107.8, 10.7)  
(115.1, 1.8)  
(133.6, -52.9)  
(257.9, 377)  
(267.7, 312.4)  
(294.5, 380)  
(302.6, 281.6)  
(304.4, 295.8)  
(314.2, 286.1)  
(431.5, 292.7)  
(437.4, 297.5)  
(438.7, 243.1)  
(449.7, 275.3)  
(450.8, 379)  
(459.3, 275.9)  
(460.8, 276.6)  
(475.8, 178.8)  
(477.1, 284.6)  
(498.3, 297.1)  
(507.6, 204)

(537.4, 331.5)  
(550.6, 243.9)

G50K.txt

315 point hull size.

The Algorithm made 8467558100 operations.

The size of the array was 50000.

Hull computation time: 45.6951 seconds

(-76.3, 200.5)  
(-56.2, 141.3)  
(-27.1, 107.1)  
(-18.2, 184.8)  
(-12.8, 159.6)  
(-4.2, 187.9)  
(-3.3, 165)  
(-3.3, 175.2)  
(-2.7, 153.7)  
(-1.7, 182.2)  
(0.4, 193.3)  
(2.5, 162.9)  
(4.6, 187.3)  
(5.2, 165.3)  
(5.3, 130.7)  
(6.6, 163.6)  
(6.8, 156.2)  
(8.4, 97.1)  
(9.7, 192.1)  
(9.9, 203.6)  
(9.9, 218.6)  
(11.6, 174.5)  
(13.2, 173.2)  
(14.1, 172)  
(16.6, 174.3)  
(17.6, 198.2)  
(18.4, 158.1)  
(18.4, 173.8)  
(18.5, 193.8)  
(19.5, 167.6)  
(20.2, 194.7)  
(20.6, 195.6)  
(20.9, 173.4)  
(21.3, 149)  
(21.8, 165.4)  
(22.3, 202.8)



(22.6, 184.2)  
(23.9, 204.6)  
(24.1, 179.1)  
(25, 174.8)  
(25.2, 163.9)  
(26.2, 131.8)  
(27.4, 175.1)  
(29, 198.8)  
(29.2, 165.5)  
(31.2, 197.4)  
(32.4, 171.1)  
(32.9, 182.9)  
(33.5, 180.5)  
(33.8, 185.8)  
(33.8, 189.6)  
(35.1, 174.6)  
(36.7, 179)  
(36.7, 186.4)  
(37.9, 163.9)  
(38.5, 163.4)  
(40.6, 204.2)  
(41.9, 182.8)  
(42.5, 168.5)  
(43.4, 177.8)  
(45.3, 173.7)  
(54.2, 201.2)  
(55.3, 167.4)  
(57.5, 193)  
(59.2, 196.1)  
(61.7, 186.7)  
(64.9, 155.9)  
(69.7, 144.6)  
(71.6, 191.9)  
(118.6, 553.1)  
(164.2, 497.2)  
(167.8, 524.3)  
(168.6, 508.3)  
(170.1, 524)  
(170.3, 472.6)  
(171.6, 525)  
(172.4, 489.1)  
(172.8, 511)  
(173.4, 144.3)  
(180.9, 480.5)

(182.1, 55.9)  
(182.7, 476.6)  
(183.7, 486)  
(184, 483.8)  
(184.1, 131.9)  
(185.8, 503.5)  
(186.7, 508.5)  
(186.9, 508.6)  
(187.4, 488.3)  
(187.4, 510.6)  
(188.5, 501.1)  
(189.6, 484.8)  
(190, 157.3)  
(191.2, 587.2)  
(191.5, 496.9)  
(191.9, 490.9)  
(192.2, 114.2)  
(193.5, 503.9)  
(193.8, 132.7)  
(194.2, 477.8)  
(194.6, 529.9)  
(195.5, 498.5)  
(195.7, 170.6)  
(195.7, 497.5)  
(196.5, 462.7)  
(196.6, 513.9)  
(197.7, 126.7)  
(197.9, 509.4)  
(198.8, 110.4)  
(199.4, 130.7)  
(200.4, 125.3)  
(200.8, 105.7)  
(203.4, 490.5)  
(204.9, 171.7)  
(206, 127.3)  
(206.2, 492.5)  
(206.4, 494.1)  
(206.5, 121.6)  
(206.5, 506.5)  
(206.8, 131.7)  
(208.3, 507.8)  
(209.2, 106.2)  
(209.3, 470.4)  
(209.4, 148.2)

(209.4, 165.2)  
(209.5, 478.6)  
(209.5, 494.3)  
(211.2, 157.8)  
(211.3, 148)  
(211.5, 107.2)  
(211.8, 127.2)  
(212.7, 147.7)  
(212.8, 126.8)  
(213.1, 484.4)  
(214, 122.2)  
(214.3, 136.9)  
(215.5, 488.9)  
(215.6, 118.9)  
(218.1, 122.6)  
(218.3, 126.8)  
(218.5, 114.3)  
(218.6, 135)  
(218.7, 140.4)  
(219.5, 105.2)  
(219.9, 127.7)  
(220.1, 141)  
(220.4, 118.4)  
(221.3, 163.7)  
(221.5, 157.4)  
(221.6, 129.4)  
(221.7, 159)  
(222, 588.6)  
(222.3, 155.6)  
(222.8, 125.5)  
(223.2, 127)  
(223.4, 151.1)  
(223.8, 522.8)  
(224, 92.9)  
(224.1, 175.2)  
(225.3, 125.3)  
(225.7, 118)  
(226.1, 138.1)  
(226.2, 142.2)  
(226.5, 346.1)  
(226.9, 125.9)  
(227.1, 137)  
(227.3, 524.5)  
(227.5, 479.3)

(228, 134.3)  
(228.2, 145.1)  
(228.6, 129.7)  
(228.9, 118.8)  
(229.1, 124)  
(229.4, 126)  
(229.7, 516.6)  
(229.9, 160.9)  
(230.1, 359.8)  
(231.2, 124.9)  
(231.7, 127.8)  
(232.9, 347.9)  
(234, 145.7)  
(234.4, 149)  
(234.6, 152.9)  
(234.7, 136.9)  
(235.1, 120.5)  
(235.2, 100.7)  
(237.5, 100)  
(237.9, 317.2)  
(238.2, 502.2)  
(241, 147.1)  
(241, 352.7)  
(241.8, 106.6)  
(241.8, 361.2)  
(241.9, 155.3)  
(242.2, 151.6)  
(242.5, 170.4)  
(243.3, 142.9)  
(243.9, 168)  
(245.6, 319.3)  
(245.8, 363.6)  
(247.2, 373.9)  
(247.5, 372.5)  
(247.8, 342.3)  
(248, 368.6)  
(249.8, 350.5)  
(250.1, 352.5)  
(252.5, 345.2)  
(253, 42.5)  
(254, 353.5)  
(254.4, 364.5)  
(254.8, 341.7)  
(255.3, 321.7)

(257.3, 127.7)  
(257.7, 345.9)  
(258.5, 333.8)  
(259.5, 323.7)  
(260.1, 111)  
(260.8, 318.8)  
(262.4, 350.6)  
(262.8, 338.5)  
(264.5, 348.5)  
(265.4, 364.2)  
(267.3, 334.7)  
(268.5, 366.5)  
(269.5, 311.5)  
(269.5, 359.9)  
(269.5, 362.5)  
(269.8, 349.2)  
(270.1, 361.8)  
(270.4, 351.6)  
(271.9, 363.2)  
(273, 221.9)  
(273, 333.6)  
(273.1, 339.5)  
(274.3, 355.3)  
(274.4, 309.9)  
(276.6, 337.1)  
(277.2, 353.9)  
(277.9, 356.5)  
(278, 354.9)  
(279.1, 349.1)  
(280.9, 343.6)  
(284.4, 351.7)  
(285.4, 54.4)  
(289.2, 368.6)  
(290.1, 345.2)  
(290.4, 332.2)  
(293.5, 330.6)  
(296.1, 234.4)  
(297.1, 356.8)  
(303, 231.6)  
(303.1, 215.4)  
(305.9, 223.9)  
(306.2, 241.5)  
(307.9, 244.5)  
(312, 222.2)

(312.3, 226.6)  
(313.2, 198.5)  
(314.3, 250.2)  
(316.8, 224.2)  
(317.7, 237.7)  
(319.2, 237.4)  
(319.4, 256.5)  
(320.1, 219.6)  
(321.1, 219)  
(321.9, 237.1)  
(322.1, 243.6)  
(322.6, 212.4)  
(323.6, 236.4)  
(324.2, 243.6)  
(324.9, 247.4)  
(325.3, 231.5)  
(326.2, 249.4)  
(327.2, 531)  
(327.7, 211.7)  
(328.2, 223.7)  
(328.3, 212.5)  
(328.8, 201.9)  
(328.8, 238.9)  
(329, 238)  
(329.5, 267.9)  
(330, 201.4)  
(330.2, 221.4)  
(330.7, 244.8)  
(330.9, 243.1)  
(331.1, 217.4)  
(332, 220.9)  
(332.3, 194.8)  
(332.7, 214.5)  
(333, 247.9)  
(336.4, 235.4)  
(337, 243.1)  
(337.1, 239)  
(337.2, 212.4)  
(337.9, 250.6)  
(339.2, 232.8)  
(341.9, 224.2)  
(342.2, 231.1)  
(344.3, 234)  
(344.8, 235.1)

(345.1, 212.2)  
(345.3, 242.7)  
(346.7, 235.4)  
(348.1, 216)  
(350.1, 244.3)  
(352.5, 238.8)  
(353.2, 231.9)  
(358, 210.7)  
(359.4, 219)  
(359.9, 263.3)  
(367.4, 230.1)  
(374.3, 143.1)  
(404.4, 180.8)  
(426.8, 217.1)  
(428.4, 240.3)

DIVIDE&CONQUER



DIVIDE and CONQUER

**UNIFORMRANDOM**

2^10.txt

Hull computation time: 0.000502372 seconds

Operations: 9605

Hull points:

78.7,499.6

27.9,483

12.2,477

2.3,469

1,296.8

0.6,61.9

0.7,22.5

8.9,4.8

123.7,3.4

493.2,1.1

493.7,4.2

496.6,32.8

499.5,95.7

499.9,312.2

497.8,383.5

491.5,479.5

483,488.3

462.8,498.5

394.7,499.6

2^11.txt

Hull computation time: 0.000959839 seconds

Operations: 19020

2^12.txt

Hull computation time: 0.00186076 seconds

Operations: 37465

2^13.txt

hull computation time: 0.00430756 seconds

Operations: 72228

2^14.txt

hull computation time: 0.00663197 seconds

Operations: 137764

2^15.txt

Hull computation time: 0.0161251 seconds  
Operations: 261052

2<sup>16</sup>.txt  
Hull computation time: 0.0288225 seconds  
Operations: 498984

2<sup>17</sup>.txt  
Hull computation time: 0.0588437 seconds  
Operations: 965186

2<sup>18</sup>.txt  
Hull computation time: 0.100488 seconds  
Operations: 1889745

2<sup>19</sup>.txt  
Hull computation time: 0.245434 seconds  
Operations: 3732051

2<sup>20</sup>.txt  
Hull computation time: 0.728107 seconds  
Operations: 7410068

2<sup>21</sup>.txt  
Hull computation time: 1.05643 seconds  
Operations: 14757565

2<sup>22</sup>.txt  
Hull computation time: 2.11947 seconds  
Operations: 29445509

2<sup>23</sup>.txt  
Hull computation time: 5.57073 seconds  
Operations: 58813462

2<sup>24</sup>.txt  
Hull computation time: 10.8518 seconds  
Operations: 117542197

### ***Shapes***

Star.txt  
Hull computation time: 7.4743e-05 seconds  
Operations: 669

Circle.txt

Hull computation time: 7.1618e-05 seconds

Operations: 674

Grid.txt

Hull computation time: 6.3298e-05 seconds

Operations: 549

Square.txt

Hull computation time: 6.3773e-05 seconds

Operations: 534

### ***Guassian***

G100.txt

Hull computation time: 7.9311e-05 seconds

Operations: 727

G500.txt

Hull computation time: 0.000240496 seconds

Operations: 4574

G1K.txt

Hull computation time: 0.000744039 seconds

Operations: 9145

G1.5K.txt

Hull computation time: 0.000824123 seconds

Operations: 11707

G2K.txt

Hull computation time: 0.00107083 seconds

Operations: 18000

G3K.txt

Hull computation time: 0.00154862 seconds

Operations: 22669

G10K.txt

Hull computation time: 0.00711512 seconds

Operations: 117690

G50K.txt

Hull computation time: 0.0225451 seconds

Operations: 256355

G100K.txt

Hull computation time: 0.0516452 seconds

Operations: 493083

G500K.txt

Hull computation time: 0.278082 seconds

Operations: 3361491

G1M.txt

Hull computation time: 1.02253 seconds

Operations: 6660476

G5M.txt

Hull computation time: 2.75246 seconds

Operations: 50367472

G10M.txt

Hull computation time: 10.927 seconds

Operations: 100720921

G15M.txt

Hull computation time: 8.7985 seconds

Operations: 90884479

IncRand

## **Incremental randomized**

### **Uniform Random**

2^10.txt

19 point hull size.

The Algorithm made 16172 operations.

The size of the array was 1024.

Hull computation time: 0.000461327 seconds

The points in the convex hull are:

(0.6 61.9)  
(0.7 22.5)  
(8.9 4.8)  
(123.7 3.4)  
(493.2 1.1)  
(493.7 4.2)  
(496.6 32.8)  
(499.5 95.7)  
(499.9 312.2)  
(497.8 383.5)  
(491.5 479.5)  
(483 488.3)  
(462.8 498.5)  
(394.7 499.6)  
(78.7 499.6)  
(27.9 483)  
(12.2 477)  
(2.3 469)  
(1 296.8)

2^11.txt

17 point hull size.

The Algorithm made 33724 operations.

The size of the array was 2048.

Hull computation time: 0.000832087 seconds

The points in the convex hull are:

(0.2 53.3)  
(1 3.4)  
(34.7 0.7)  
(134 0.4)  
(491.2 1)  
(499.5 47.1)  
(499.7 281.1)  
(499.6 380.9)  
(499.4 449.3)  
(498 483.6)

(490.6 494.6)  
(471.1 497.7)  
(387.2 499.1)  
(331.5 499.5)  
(275.8 499.8)  
(3.1 499.4)  
(0.6 301.7)

2^12.txt

21 point hull size.

The Algorithm made 81586 operations.

The size of the array was 4096.

Hull computation time: 0.00155034 seconds

The points in the convex hull are:

(0 487.2)  
(0.8 169.7)  
(1.4 55.5)  
(3.2 16.5)  
(5.1 0.3)  
(441.3 0.3)  
(451.7 1.1)  
(486 4.4)  
(496.2 7.5)  
(498.7 27.3)  
(499.7 152.3)  
(499.8 187.2)  
(499.9 287)  
(499.9 340.3)  
(498.8 410.1)  
(498.1 440.7)  
(497 481.6)  
(486.4 498.8)  
(474.5 499.3)  
(466.1 499.6)  
(4.7 499.8)

2^13.txt

20 point hull size.

The Algorithm made 154459 operations.

The size of the array was 8192.

Hull computation time: 0.00275576 seconds

The points in the convex hull are:

(0 15.7)  
(2.5 3.3)

(12.7 0.1)  
(341.3 0.1)  
(383 0.7)  
(435.4 1.5)  
(487.1 2.4)  
(499.8 15.9)  
(499.9 79.7)  
(499.9 466.1)  
(498 498.5)  
(491.8 499.7)  
(481.9 499.9)  
(454.4 499.9)  
(81.6 499.8)  
(24.4 499.4)  
(4.4 499.2)  
(0.9 470.2)  
(0.3 433.6)  
(0 92.7)

2^14.txt

25 point hull size.

The Algorithm made 416776 operations.

The size of the array was 16384.

Hull computation time: 0.00766266 seconds

The points in the convex hull are:

(0 32.9)  
(1 11.8)  
(1.7 7.7)  
(3.2 4.2)  
(7.1 1)  
(8.8 0.7)  
(22.8 0.1)  
(164.7 0)  
(368.7 0)  
(492.9 0.1)  
(499.5 18.9)  
(500 222.5)  
(499.8 470.6)  
(499.5 481.7)  
(496 496)  
(473.1 498.4)  
(455.1 499.6)  
(420.5 499.9)  
(121.8 499.9)



(19.4 499.7)

(8 497.4)

(1.5 482.9)

(0.3 461.9)

(0.1 439.8)

(0 399.2)

2^15.txt

23 point hull size.

The Algorithm made 707717 operations.

The size of the array was 32768.

Hull computation time: 0.00995591 seconds

The points in the convex hull are:

(0 429.9)

(0.1 48.1)

(0.2 6.7)

(1.1 1.5)

(8.5 0.3)

(31.9 0.2)

(165.9 0)

(482.9 0.1)

(493.3 0.6)

(497.1 2.4)

(499.5 19.6)

(499.6 20.6)

(499.9 48.4)

(500 93.6)

(500 278)

(499.9 492.3)

(498.4 497.5)

(489.8 500)

(360.2 500)

(6 499.8)

(1.5 499.1)

(0.4 493.2)

(0.3 489.7)

2^16.txt

23 point hull size.

The Algorithm made 1516267 operations.

The size of the array was 65536.

Hull computation time: 0.0283743 seconds

The points in the convex hull are:

(0 10.5)

(1.2 2.2)  
(1.6 0.3)  
(36.9 0.1)  
(151.6 0)  
(387.9 0)  
(498 0.1)  
(499.3 2.7)  
(499.7 4.4)  
(499.9 5.5)  
(500 65.6)  
(500 486.8)  
(499.8 498.2)  
(494.8 499.7)  
(492 499.9)  
(153.5 500)  
(45.9 499.9)  
(1.6 499.3)  
(0.5 495.2)  
(0.3 486.1)  
(0.2 474.5)  
(0.1 441.5)  
(0 406.4)

2^17.txt

18 point hull size.

The Algorithm made 2638319 operations.

The size of the array was 131072.

Hull computation time: 0.0849858 seconds

The points in the convex hull are:

(0 88.2)  
(0.1 13)  
(0.3 0)  
(485.9 0)  
(499.7 0.2)  
(500 32.4)  
(500 497.6)  
(499.9 498)  
(499.3 498.4)  
(494 499.4)  
(491.3 499.9)  
(484.7 500)  
(3.3 500)  
(2.2 499.9)  
(1.7 499.7)

(0.9 499)  
(0.2 495.2)  
(0 490.6)

2^18.txt

19 point hull size.

The Algorithm made 6082001 operations.

The size of the array was 262144.

Hull computation time: 0.164231 seconds

The points in the convex hull are:

(0 21.3)  
(0.1 5.5)  
(0.3 2.2)  
(1.6 0.1)  
(11.4 0)  
(480.9 0)  
(499.2 0.3)  
(499.8 1.4)  
(500 3.7)  
(500 494.9)  
(499.8 499)  
(499.4 499.2)  
(498.1 499.7)  
(477.9 499.9)  
(463.8 500)  
(1.9 500)  
(0.7 499.3)  
(0.1 498.9)  
(0 490.3)

2^19.txt

19 point hull size.

The Algorithm made 11971173 operations.

The size of the array was 524288.

Hull computation time: 0.387302 seconds

The points in the convex hull are:

(0 2.3)  
(0.3 0.2)  
(1.7 0.1)  
(5.5 0)  
(479.8 0)  
(497.2 0.1)  
(499.2 0.3)  
(499.8 3.5)

(499.9 4.4)  
(500 36.9)  
(500 498.9)  
(499 499.8)  
(496.6 499.9)  
(493.2 500)  
(16 500)  
(4.1 499.9)  
(0.7 499.8)  
(0.1 499.3)  
(0 496.2)

2^20.txt

17 point hull size.

The Algorithm made 22375594 operations.

The size of the array was 1048576.

Hull computation time: 0.931436 seconds

The points in the convex hull are:

(0 11.8)  
(0.1 2.5)  
(0.3 0.6)  
(0.9 0.2)  
(1.9 0)  
(498.8 0)  
(499.9 0.4)  
(500 1.2)  
(500 494.9)  
(499.9 497.9)  
(499.1 499.7)  
(498.1 499.9)  
(487.6 500)  
(1 500)  
(0.5 499.8)  
(0.2 499.5)  
(0 497)

2^21.txt

16 point hull size.

The Algorithm made 38107886 operations.

The size of the array was 2097152.

Hull computation time: 2.03377 seconds

The points in the convex hull are:

(0 15.9)  
(0.1 1.7)

(0.2 0.4)  
(1.5 0.1)  
(2.2 0)  
(495.9 0)  
(498.9 0.1)  
(499.8 0.4)  
(500 2.5)  
(500 496.4)  
(499.9 499.9)  
(496.2 500)  
(1.2 500)  
(0.2 499.8)  
(0.1 497.8)  
(0 495.7)

2^22.txt

13 point hull size.

The Algorithm made 59566677 operations.

The size of the array was 4194304.

Hull computation time: 4.10863 seconds

The points in the convex hull are:

(0 2.5)  
(0.1 0.8)  
(0.3 0.1)  
(2.6 0)  
(498.8 0)  
(499.8 0.2)  
(500 1)  
(500 499.2)  
(499.7 500)  
(1 500)  
(0.4 499.9)  
(0.1 499.7)  
(0 496.2)

2^23.txt

9 point hull size.

The Algorithm made 99217025 operations.

The size of the array was 8388608.

Hull computation time: 9.69478 seconds

The points in the convex hull are:

(0 0.4)  
(0.1 0.1)  
(0.7 0)

(499.8 0)  
(500 0.4)  
(500 499.9)  
(499.4 500)  
(0.2 500)  
(0 498.6)

2^24.txt

8 point hull size.

The Algorithm made 162739101 operations.

The size of the array was 16777216.

Hull computation time: 21.2017 seconds

The points in the convex hull are:

(0 0.3)  
(0.2 0)  
(499.3 0)  
(499.9 0.1)  
(500 0.3)  
(500 500)  
(0.1 500)  
(0 499.7)

## Shapes

Star.txt

50 point hull size.

The Algorithm made 2665 operations.

The size of the array was 100.

Hull computation time: 0.00046554 seconds

The points in the convex hull are:

(50 250)  
(51.6 224.9)  
(56.3 200.3)  
(64 176.4)  
(74.7 153.6)  
(88.2 132.4)  
(104.2 113.1)  
(122.5 95.9)  
(142.8 81.1)  
(164.8 69)  
(188.2 59.8)  
(212.5 53.5)  
(237.4 50.4)  
(262.6 50.4)  
(287.5 53.5)

(311.8 59.8)  
(335.2 69)  
(357.2 81.1)  
(377.5 95.9)  
(395.8 113.1)  
(411.8 132.4)  
(425.3 153.6)  
(436 176.4)  
(443.7 200.3)  
(448.4 224.9)  
(450 250)  
(448.4 275.1)  
(443.7 299.7)  
(436 323.6)  
(425.3 346.4)  
(411.8 367.6)  
(395.8 386.9)  
(377.5 404.1)  
(357.2 418.9)  
(335.2 431)  
(311.8 440.2)  
(287.5 446.5)  
(262.6 449.6)  
(237.4 449.6)  
(212.5 446.5)  
(188.2 440.2)  
(164.8 431)  
(142.8 418.9)  
(122.5 404.1)  
(104.2 386.9)  
(88.2 367.6)  
(74.7 346.4)  
(64 323.6)  
(56.3 299.7)  
(51.6 275.1)

Square.txt

4 point hull size.

The Algorithm made 731 operations.

The size of the array was 100.

Hull computation time: 6.3894e-05 seconds

The points in the convex hull are:

(0 0)

(500 0)

(500 500)  
(0 500)

Grid.txt

4 point hull size.

The Algorithm made 608 operations.

The size of the array was 100.

Hull computation time: 6.4305e-05 seconds

The points in the convex hull are:

(0 0)  
(450 0)  
(450 450)  
(0 450)

Circle.txt

39 point hull size.

The Algorithm made 2512 operations.

The size of the array was 100.

Hull computation time: 0.000236915 seconds

The points in the convex hull are:

(45.3 244.6)  
(45.7 235.3)  
(54.6 202)  
(64.4 172.8)  
(122.5 92.8)  
(154.3 68.8)  
(172 61.7)  
(194.8 53.5)  
(233.3 45.7)  
(244.6 45.3)  
(298.7 53.5)  
(328.2 62.8)  
(356.9 78.8)  
(358.3 79.6)  
(401.7 113.6)  
(417.9 139.7)  
(436.1 172.8)  
(445.8 200.1)  
(454.8 248.5)  
(453.4 268.2)  
(449.4 296.5)  
(444 310.9)  
(428.6 349.3)  
(398.4 389.6)



(394.8 393.4)  
(352.8 426.6)  
(345.3 431.1)  
(329.5 438.2)  
(312.9 444.3)  
(249.3 454.8)  
(219.7 448)  
(165 433.5)  
(131.3 411)  
(114.4 398.9)  
(103.4 389.9)  
(94 378.7)  
(84 363.8)  
(63.3 323.4)  
(47.2 274)

### **Guassian**

G100.txt

12 point hull size.

The Algorithm made 995 operations.

The size of the array was 100.

Hull computation time: 7.1897e-05 seconds

The points in the convex hull are:

(21.4 470.3)  
(170.1 145.6)  
(218.8 139.3)  
(279.4 131.8)  
(364.2 277.9)  
(305.1 470.8)  
(292.6 487.2)  
(277.7 505.2)  
(93.8 525.8)  
(71 527.9)  
(31 517.6)  
(24 514.5)

G500.txt

14 point hull size.

The Algorithm made 6980 operations.

The size of the array was 500.

Hull computation time: 0.000212246 seconds

The points in the convex hull are:

(1.2 453.1)  
(2.4 327.4)

(12.3 35.8)  
(21.6 12.7)  
(60.9 5.4)  
(328.8 0)  
(414.8 1.7)  
(495 20.1)  
(498.7 221.9)  
(498.3 498.5)  
(427.7 499.7)  
(122.5 499.6)  
(74.2 493.7)  
(24.7 476.5)

G1K.txt

15 point hull size.

The Algorithm made 12759 operations.

The size of the array was 1000.

Hull computation time: 0.000315463 seconds

The points in the convex hull are:

(-7 261.2)  
(11 189.5)  
(18.1 176.7)  
(239.3 -2.3)  
(283.2 2.6)  
(306.2 8.6)  
(319.7 24.8)  
(328.1 37.2)  
(532 426.5)  
(535 452.2)  
(538.6 511.4)  
(519.9 540.7)  
(463.5 553.7)  
(128.9 443.5)  
(97.6 409)

G1.5K.txt

12 point hull size.

The Algorithm made 19652 operations.

The size of the array was 1500.

Hull computation time: 0.00045939 seconds

The points in the convex hull are:

(62.6 162.3)  
(81.5 136.5)  
(294.3 15.6)

(333.5 10.8)  
(342.2 11.3)  
(391.1 31.1)  
(485.7 86)  
(541.2 476.9)  
(467.3 518.7)  
(106.2 283.6)  
(80.6 261)  
(69.3 249)

G2K.txt

15 point hull size.

The Algorithm made 29752 operations.

The size of the array was 2000.

Hull computation time: 0.000819096 seconds

The points in the convex hull are:

(19.6 437.4)  
(25.2 392.7)  
(61 116.5)  
(107.7 58.6)  
(234.7 -23)  
(284 -37.3)  
(327.5 -9.4)  
(336.7 24.3)  
(336 39.7)  
(250.2 464.8)  
(235.3 518.2)  
(221.9 543.9)  
(141 554.2)  
(122.9 543.5)  
(26.9 456.8)

G3K.txt

18 point hull size.

The Algorithm made 48988 operations.

The size of the array was 3000.

Hull computation time: 0.00120355 seconds

The points in the convex hull are:

(-35.4 132.7)  
(-18.7 95)  
(73 -28.5)  
(134.7 -30.6)  
(383.9 -29.3)  
(413.2 -24.5)

(424.1 -22)  
(451.3 -9.3)  
(466.2 4.1)  
(474 26)  
(484.1 59.7)  
(352.4 401.4)  
(330.2 446.5)  
(304.1 492.4)  
(281.1 499.4)  
(235.2 489.7)  
(2.8 219.5)  
(-25.7 168.8)

G10K.txt

14 point hull size.

The Algorithm made 153714 operations.

The size of the array was 10000.

Hull computation time: 0.00320861 seconds

The points in the convex hull are:

(-15.7 232.3)  
(-5 13)  
(4.1 -3.9)  
(49.7 -54.7)  
(73.3 -67.3)  
(102.2 -68)  
(133.6 -52.9)  
(475.8 178.8)  
(507.6 204)  
(550.6 243.9)  
(537.4 331.5)  
(450.8 379)  
(294.5 380)  
(257.9 377)

G50K.txt

15 point hull size.

The Algorithm made 803640 operations.

The size of the array was 50000.

Hull computation time: 0.0257731 seconds

The points in the convex hull are:

(-76.3 200.5)  
(-56.2 141.3)  
(-27.1 107.1)  
(8.4 97.1)

(182.1 55.9)  
(253 42.5)  
(285.4 54.4)  
(374.3 143.1)  
(404.4 180.8)  
(426.8 217.1)  
(428.4 240.3)  
(327.2 531)  
(222 588.6)  
(191.2 587.2)  
(118.6 553.1)

G100K.txt

17 point hull size.

The Algorithm made 1877863 operations.

The size of the array was 100000.

Hull computation time: 0.043124 seconds

The points in the convex hull are:

(24.7 382.1)  
(41.7 328.8)  
(160.6 35)  
(186 15.2)  
(227.6 -6.9)  
(234.8 -9.2)  
(253.8 -14.5)  
(273.1 -11.2)  
(513.2 72.9)  
(535 133.6)  
(532.9 159.6)  
(526.2 207.3)  
(520.2 223.1)  
(220.2 554)  
(158.2 589.8)  
(155.3 589.6)  
(71.8 571.2)

G500K.txt

23 point hull size.

The Algorithm made 9251099 operations.

The size of the array was 500000.

Hull computation time: 0.357776 seconds

The points in the convex hull are:

(-74.9 96.7)  
(-52.8 55.9)

(-29.7 28.3)  
(23.4 4.9)  
(39.2 0.8)  
(77.1 -7.3)  
(127.7 -5.6)  
(180.4 11.7)  
(227.9 44.8)  
(446.4 348.2)  
(448.9 398.8)  
(446.4 437.6)  
(438.1 473.2)  
(424.5 501.5)  
(373.8 528.7)  
(341.7 529.4)  
(317.6 516.6)  
(284 493.8)  
(238.8 460.5)  
(-36.6 185.1)  
(-51.2 162.5)  
(-69.6 127.7)  
(-71.8 117.2)

G1M.txt

19 point hull size.

The Algorithm made 15061416 operations.

The size of the array was 1000000.

Hull computation time: 0.823641 seconds

The points in the convex hull are:

(163.1 25.4)  
(170.3 -9.4)  
(180.5 -42.7)  
(188.3 -49.2)  
(238.2 -84.5)  
(269.2 -103.3)  
(468.6 -88.2)  
(539.6 -79.4)  
(578.8 -23.3)  
(583.9 6.8)  
(590.1 47.3)  
(557 263.5)  
(525.4 357)  
(450.8 406.7)  
(426.4 406.7)  
(333.9 337.9)

(313 311.3)  
(279.1 251.5)  
(181.5 77.5)

G5M.txt

18 point hull size.

The Algorithm made 54108668 operations.

The size of the array was 5000000.

Hull computation time: 3.30627 seconds

The points in the convex hull are:

(139.1 77.5)  
(148.1 37.6)  
(161.5 -1.7)  
(192.5 -47.4)  
(222.7 -61)  
(365.5 -112.4)  
(455.2 -52.5)  
(472.1 -16.8)  
(568.9 355)  
(571.6 395.1)  
(570 431.3)  
(556.1 468.7)  
(505.6 494.6)  
(482.1 505.8)  
(465.8 513.4)  
(391.8 488.4)  
(354.6 457.4)  
(199.9 191)

G10M.txt

24 point hull size.

The Algorithm made 90314696 operations.

The size of the array was 10000000.

Hull computation time: 6.34277 seconds

The points in the convex hull are:

(-117.3 24.8)  
(-83.2 -26.3)  
(9.8 -49.6)  
(31.7 -48.2)  
(340.4 22.4)  
(351.3 28.2)  
(367.3 43.5)  
(375.2 52.2)  
(407.5 88.7)

(576.4 374.8)  
(623.2 457.2)  
(620.5 499.8)  
(607.6 537.1)  
(594.2 548.2)  
(558.5 576.5)  
(524.8 598)  
(469 586.8)  
(460.3 582.7)  
(448.4 576.4)  
(429.4 565.1)  
(426.4 563.2)  
(-39 189.3)  
(-102.2 136.7)  
(-108.9 116.5)

G15M.txt

19 point hull size.

The Algorithm made 101067777 operations.

The size of the array was 15000000.

Hull computation time: 8.65632 seconds

The points in the convex hull are:

(-126.3 196.8)  
(-121.6 165.7)  
(-90.9 44)  
(-70.8 -3.9)  
(173.3 -103.5)  
(251.3 -86.5)  
(508.9 116.9)  
(559 182)  
(571.7 210.4)  
(575 219.9)  
(564.6 276.5)  
(538.5 312.1)  
(489.7 353)  
(432.9 353.3)  
(-13 304.9)  
(-49.6 290.7)  
(-86.3 266)  
(-96 259.4)  
(-123.7 202.9)