

**Modern intelligent IT**  
**Lab 3 (22.04.2016)**  
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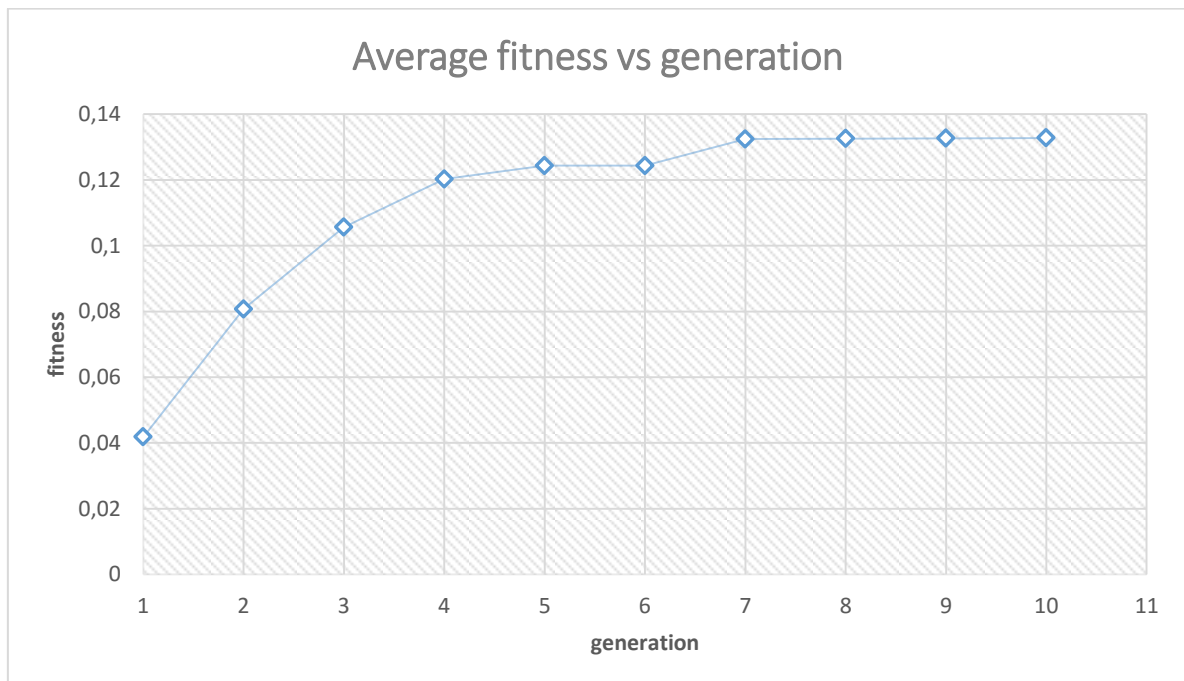
**A maximization of 3D function with Crowding Algorithm**

Our goal in this problem is to create a population of 10 binary chromosomes of 22 genes each of which represents one point in x – y plane  $-2 \leq x; y \leq 2$ , then to build a function

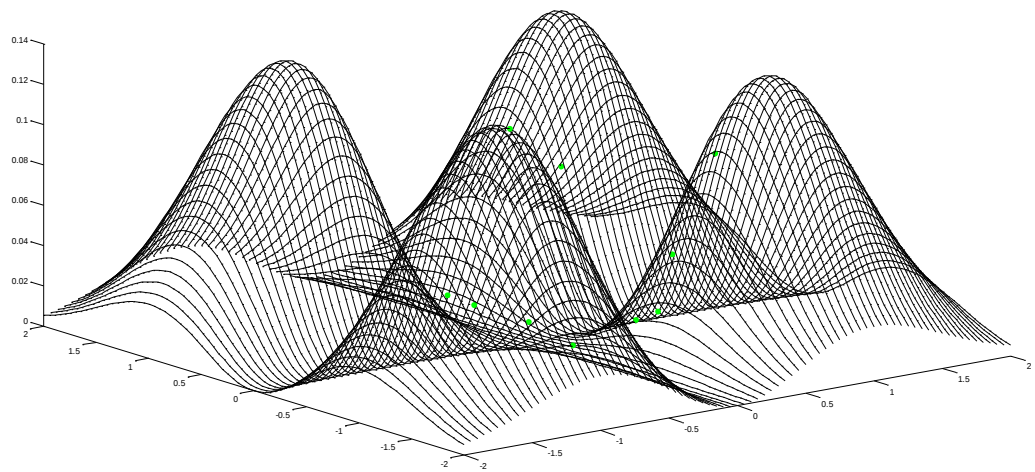
$$z = x^2 * y^2 * e^{-x^2} * e^{-y^2}$$

With fitness being value of Z, we should maximize Z applying to Crowding Algorithm.

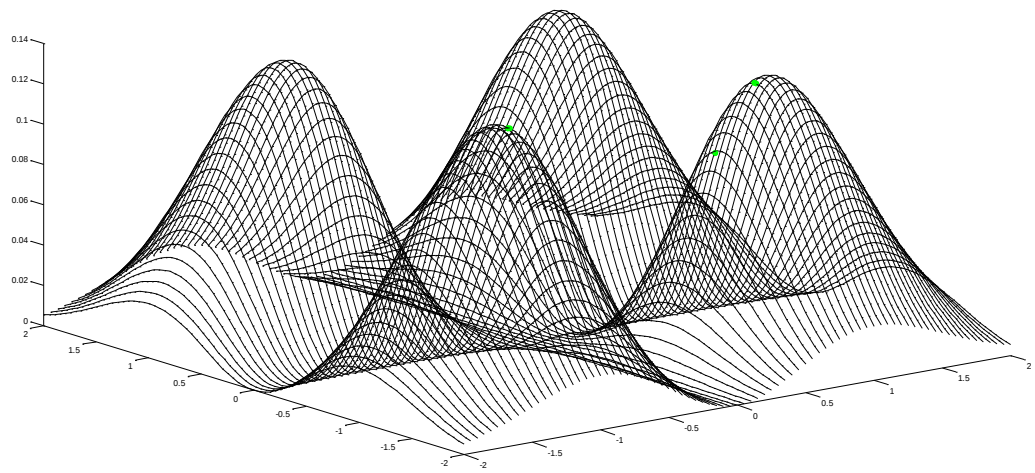
There are presented graphs of Fitness vs Generation and 4 3D graphs including 10 points on different generations.



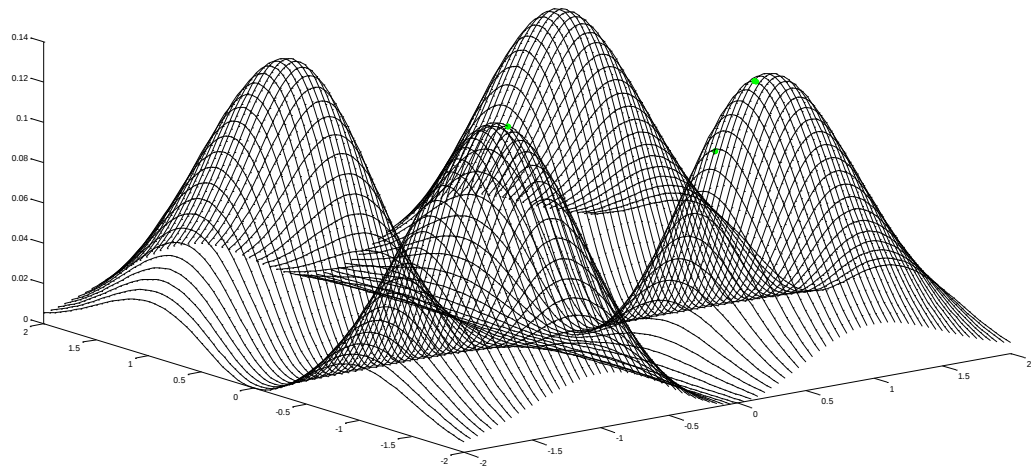
**3D Graphic, Beginning**



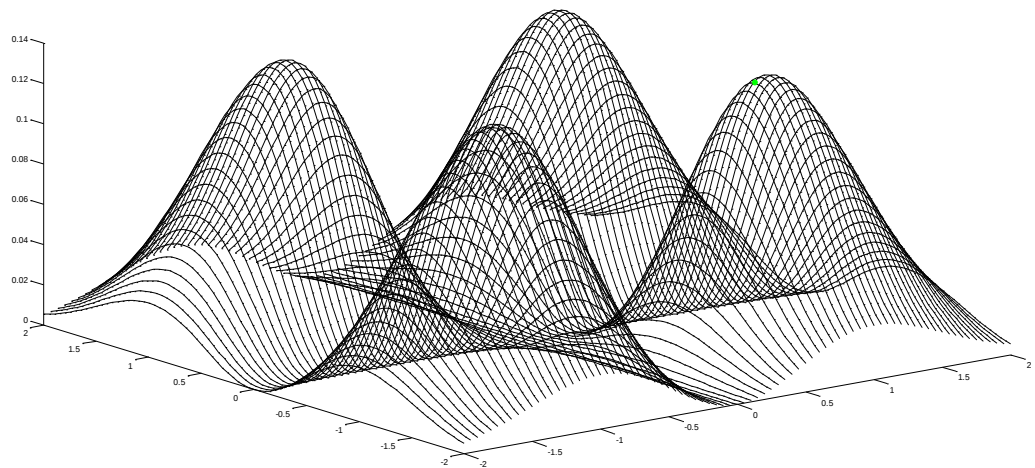
**3D Graphic, 5 iteration**



**3D Graphic, 6 generation**



3D Graphic, the end



| Generation 1                                                                                                           |                                                                                                                        |                       |                       |                                                          |
|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|----------------------------------------------------------|
| Selected parents & fitness                                                                                             | Created children & fitness                                                                                             | D(p1,c1)+<br>d(p2,c2) | D(p1,c2)+<br>d(p2,c1) | New chromosomes                                          |
| p1: (1110001011000101111110) = (0.7722;-0.3734) z=0.0398<br>p2: (111001110101001101100) = (0.9042;-0.6061) z=0.0918    | c1: (1111001110101001101100) = (0.9042;-0.6061) z=0.0918<br>c2: (1110001011000101111110) = (0.7722;-0.3734) z=0.0398   | 0.5349                | 0.0000                | 1100111110111111<br>010101<br>1100111110111111<br>010101 |
| p1: (0101010100000101101101) = (-0.6647;-0.3568) z=0.0318<br>p2: (0111001011001111111111) = (-0.8974;-1.0000) z=0.1324 | c1: (0101001011001111111111) = (-0.6471;-1.0000) z=0.1013<br>c2: (0111010100000101101101) = (-0.9150;-0.3568) z=0.0406 | 1.2869                | 0.5005                | 0101001011001111<br>111111<br>0111001011001111<br>111111 |
| p1: (1000111101000100011010) = (0.1193;-0.2757) z=0.0010<br>p2: (0101010100000101101101) = (-0.6647;-0.3568) z=0.0318  | c1: (1000110100000101101101) = (0.1017;-0.3568) z=0.0011<br>c2: (0101011101000100011010) = (-0.6823;-0.2757) z=0.0206  | 0.1660                | 1.5679                | 0101011101000100<br>011010<br>0101010100000101<br>101101 |
| p1: (1101101000100001110011) = (0.7048;-0.1124) z=0.0038<br>p2: (0111001011001111111111) = (-0.8974;-1.0000) z=0.1324  | c1: (1101101000100001111111) = (0.7048;-0.1241) z=0.0046<br>c2: (0111001011001111110011) = (-0.8974;-0.9883) z=0.1324  | 0.0235                | 3.6519                | 0111001011001111<br>110011<br>0111001011001111<br>111111 |
| p1: (1101011101111001001010) = (0.6833;0.5728) z=0.0692<br>p2: (1000111101000100011010) = (0.1193;-0.2757) z=0.0010    | c1: (1101011101000100011010) = (0.6823;-0.2757) z=0.0206<br>c2: (10001111011111001001010) = (0.1202;0.5728) z=0.0034   | 1.6970                | 1.1261                | 1101011101111001<br>001010<br>1000111101111001<br>001010 |

| Generation 2                                                                                                                 |                                                                                                                              |                       |                       |                                                          |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|----------------------------------------------------------|
| Selected parents & fitness                                                                                                   | Created children & fitness                                                                                                   | D(p1,c1)+<br>d(p2,c2) | D(p1,c2)+<br>d(p2,c1) | New chromosomes                                          |
| p1: (1111001110101001101100)<br>= (0.9042;-0.6061) z=0.0918<br>p2: (0111001011001111111111)<br>= (-0.8974;-1.0000) z=0.1324  | c1: (1111001110101001111111) =<br>(0.9042;-0.6246) z=0.0953<br>c2: (0111001011001111101100) =<br>(-0.8974;-0.9814) z=0.1323  | 0.0371                | 3.6805                | 0111001011001<br>111101100<br>0111001011001<br>111111111 |
| p1: (0111001011001111111111)<br>= (-0.8974;-1.0000) z=0.1324<br>p2: (1101011101111001001010)<br>= (0.6833;0.5728) z=0.0692   | c1: (0111001011001111001010) =<br>(-0.8974;-0.9482) z=0.1317<br>c2: (1101011101111001111111) =<br>(0.6833;0.6246) z=0.0773   | 0.1036                | 4.4603                | 0111001011001<br>111111111<br>0111001011001<br>111001010 |
| p1: (1111001110101001101100)<br>= (0.9042;-0.6061) z=0.0918<br>p2: (0111001011001111110011)<br>= (-0.8974;-0.9883) z=0.1324  | c1: (1111001011001111100111) =<br>(0.8974;-0.9883) z=0.1324<br>c2: (0111001110101001101100) =<br>(-0.9042;-0.6061) z=0.0918  | 0.7645                | 3.6031                | 1111001110101<br>001101100<br>0111001011001<br>111110011 |
| p1: (0101011101000100011010)<br>= (-0.6823;-0.2757) z=0.0206<br>p2: (0101010100000101101101)<br>= (-0.6647;-0.3568) z=0.0318 | c1: (0101010100000101101101) =<br>(-0.6647;-0.3568) z=0.0318<br>c2: (0101011101000100011010) =<br>(-0.6823;-0.2757) z=0.0206 | 0.1660                | 0.0000                | 0101010100000<br>101101101<br>0101010100000<br>101101101 |
| p1: (0101011101000100011010)<br>= (-0.6823;-0.2757) z=0.0206<br>p2: (0111001011001111111111)<br>= (-0.8974;-1.0000) z=0.1324 | c1: (0101011101001111111111) =<br>(-0.6823;-1.0000) z=0.1075<br>c2: (0111001011000100011010) =<br>(-0.8974;-0.2757) z=0.0253 | 1.4487                | 0.4301                | 0101011101001<br>111111111<br>0111001011001<br>111111111 |

| Generation 3                                                                                                                   |                                                                                                                                |                       |                       |                                                          |
|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|----------------------------------------------------------|
| Selected parents & fitness                                                                                                     | Created children & fitness                                                                                                     | D(p1,c1)+<br>d(p2,c2) | D(p1,c2)+<br>d(p2,c1) | New chromosomes                                          |
| p1: (1111001110101001101100) =<br>(0.9042;-0.6061) z=0.0918<br>p2: (0111001011001111111111) = (-<br>0.8974;-1.0000) z=0.1324   | c1: (1111001110101111111111) = (0.9042;-<br>1.0000) z=0.1328<br>c2: (0111001011001001101100) = (-0.8974;-<br>0.6061) z=0.0916  | 0.7879                | 3.6031                | 1111001110101001<br>101100<br>1111001110101111<br>111111 |
| p1: (0111001011001111111111) = (-<br>0.8974;-1.0000) z=0.1324<br>p2: (0111001011001111110011) = (-<br>0.8974;-0.9883) z=0.1324 | c1: (0111001011001111110011) = (-0.8974;-<br>0.9883) z=0.1324<br>c2: (0111001011001111111111) = (-0.8974;-<br>1.0000) z=0.1324 | 0.0235                | 0.0000                | 0111001011001111<br>111111<br>0111001011001111<br>111111 |
| p1: (0101010100000101101101) = (-<br>0.6647;-0.3568) z=0.0318<br>p2: (0111001011001111101100) = (-<br>0.8974;-0.9814) z=0.1323 | c1: (0101010100000101101100) = (-0.6647;-<br>0.3558) z=0.0317<br>c2: (0111001011001111101101) = (-0.8974;-<br>0.9824) z=0.1323 | 0.0020                | 1.3349                | 0111001011001111<br>101101<br>0111001011001111<br>101100 |
| p1: (0111001011001111101100) = (-<br>0.8974;-0.9814) z=0.1323<br>p2: (1111001110101001101100) =<br>(0.9042;-0.6061) z=0.0918   | c1: (0111001110101001101100) = (-0.9042;-<br>0.6061) z=0.0918<br>c2: (1111001011001111101100) = (0.8974;-<br>0.9814) z=0.1323  | 0.7509                | 3.6031                | 0111001011001111<br>101100<br>1111001110101001<br>101100 |
| p1: (1111001110101001101100) =<br>(0.9042;-0.6061) z=0.0918<br>p2: (0111001011001111111111) = (-<br>0.8974;-1.0000) z=0.1324   | c1: (1111001011001111111111) = (0.8974;-<br>1.0000) z=0.1324<br>c2: (0111001110101001101100) = (-0.9042;-<br>0.6061) z=0.0918  | 0.7880                | 3.6031                | 1111001110101001<br>101100<br>0111001011001111<br>111111 |

| Generation 4                                                                                                                   |                                                                                                                                |                       |                       |                                                          |
|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|----------------------------------------------------------|
| Selected parents & fitness                                                                                                     | Created children & fitness                                                                                                     | D(p1,c1)+<br>d(p2,c2) | D(p1,c2)+<br>d(p2,c1) | New chromosomes                                          |
| p1: (0111001011001111101101) = (-<br>0.8974;-0.9824) z=0.1323<br>p2: (1111001110101001101100) =<br>(0.9042;-0.6061) z=0.0918   | c1: (0111001110101001101100) = (-0.9042;-<br>0.6061) z=0.0918<br>c2: (1111001011001111101101) = (0.8974;-<br>0.9824) z=0.1323  | 0.7528                | 3.6031                | 0111001011001111<br>101101<br>1111001110101001<br>101100 |
| p1: (0111001011001111101100) = (-<br>0.8974;-0.9814) z=0.1323<br>p2: (1111001110101111111111) =<br>(0.9042;-1.0000) z=0.1328   | c1: (0111001011001111111111) = (-0.8974;-<br>1.0000) z=0.1324<br>c2: (1111001110101111101100) = (0.9042;-<br>0.9814) z=0.1327  | 0.0371                | 3.6031                | 1111001110101111<br>101100<br>1111001110101111<br>111111 |
| p1: (1111001110101001101100) =<br>(0.9042;-0.6061) z=0.0918<br>p2: (0111001011001111101100) = (-<br>0.8974;-0.9814) z=0.1323   | c1: (1111001011001111101100) = (0.8974;-<br>0.9814) z=0.1323<br>c2: (0111001110101001101100) = (-0.9042;-<br>0.6061) z=0.0918  | 0.7509                | 3.6031                | 1111001110101001<br>101100<br>0111001011001111<br>101100 |
| p1: (0111001011001111101101) = (-<br>0.8974;-0.9824) z=0.1323<br>p2: (0111001011001111101100) = (-<br>0.8974;-0.9814) z=0.1323 | c1: (0111001011001111101100) = (-0.8974;-<br>0.9814) z=0.1323<br>c2: (0111001011001111101101) = (-0.8974;-<br>0.9824) z=0.1323 | 0.0020                | 0.0000                | 0111001011001111<br>101101<br>0111001011001111<br>101101 |
| p1: (0111001011001111111111) = (-<br>0.8974;-1.0000) z=0.1324                                                                  | c1: (0111001011001111111111) = (-0.8974;-<br>1.0000) z=0.1324                                                                  | 0.0000                | 0.0000                | 0111001011001111<br>111111                               |

|                                                           |                                                           |  |  |                      |
|-----------------------------------------------------------|-----------------------------------------------------------|--|--|----------------------|
| p2: (0111001011001111111111) = (-0.8974;-1.0000) z=0.1324 | c2: (0111001011001111111111) = (-0.8974;-1.0000) z=0.1324 |  |  | 01110010110011111111 |
|-----------------------------------------------------------|-----------------------------------------------------------|--|--|----------------------|

| Generation 5                                                                                                           |                                                                                                                        |                       |                       |                                                  |
|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|--------------------------------------------------|
| Selected parents & fitness                                                                                             | Created children & fitness                                                                                             | D(p1,c1)+<br>d(p2,c2) | D(p1,c2)+<br>d(p2,c1) | New chromosomes                                  |
| p1: (1111001110101001101100) = (0.9042;-0.6061) z=0.0918<br>p2: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323  | c1: (1111001110101111101101) = (0.9042;-0.9824) z=0.1327<br>c2: (0111001011001001101100) = (-0.8974;-0.6061) z=0.0916  | 0.7527                | 3.6031                | 1111001110101001101100<br>1111001110101111101101 |
| p1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>p2: (1111001110101001101100) = (0.9042;-0.6061) z=0.0918  | c1: (0111001010101001101100) = (-0.8964;-0.6061) z=0.0915<br>c2: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328  | 0.7527                | 3.6031                | 1111001111001111101101<br>1111001110101001101100 |
| p1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>p2: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323 | c1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>c2: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323 | 0.0000                | 0.0000                | 0111001011001111101101<br>0111001011001111101101 |
| p1: (1111001110101111111111) = (0.9042;-1.0000) z=0.1328<br>p2: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323  | c1: (1111001011001111101101) = (0.8974;-0.9824) z=0.1323<br>c2: (0111001110101111111111) = (-0.9042;-1.0000) z=0.1328  | 0.0378                | 3.6031                | 1111001110101111111111<br>0111001011001111101101 |
| p1: (1111001110101001101100) = (0.9042;-0.6061) z=0.0918<br>p2: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323  | c1: (1111001110101001101100) = (0.9042;-0.6061) z=0.0918<br>c2: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323  | 0.0000                | 3.6805                | 0111001011001111101100<br>0111001011001111101100 |

| Generation 6                                                                                                           |                                                                                                                        |                       |                       |                                                  |
|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|--------------------------------------------------|
| Selected parents & fitness                                                                                             | Created children & fitness                                                                                             | D(p1,c1)+<br>d(p2,c2) | D(p1,c2)+<br>d(p2,c1) | New chromosomes                                  |
| p1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>p2: (1111001110101001101100) = (0.9042;-0.6061) z=0.0918  | c1: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323<br>c2: (1111001110101001101101) = (0.9042;-0.6070) z=0.0920  | 0.0020                | 3.6805                | 0111001011001111101101<br>0111001011001111101100 |
| p1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>p2: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323 | c1: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323<br>c2: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323 | 0.0020                | 0.0000                | 0111001011001111101101<br>0111001011001111101101 |
| p1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>p2: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323 | c1: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323<br>c2: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323 | 0.0020                | 0.0000                | 0111001011001111101101<br>0111001011001111101101 |
| p1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>p2: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328  | c1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>c2: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328  | 0.0000                | 3.6051                | 1111001111001111101101<br>1111001111001111101101 |
| p1: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323<br>p2: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323 | c1: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323<br>c2: (0111001011001111101100) = (-0.8974;-0.9814) z=0.1323 | 0.0000                | 0.0000                | 0111001011001111101100<br>0111001011001111101100 |

| Generation 7                                                                                                          |                                                                                                                       |                       |                       |                                                  |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|--------------------------------------------------|
| Selected parents & fitness                                                                                            | Created children & fitness                                                                                            | D(p1,c1)+<br>d(p2,c2) | D(p1,c2)+<br>d(p2,c1) | New chromosomes                                  |
| p1: (0111001011001111101101) = (-0.8974;-0.9824) z=0.1323<br>p2: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328 | c1: (0111001111001111101101) = (-0.9052;-0.9824) z=0.1328<br>c2: (1111001011001111101101) = (0.8974;-0.9824) z=0.1323 | 0.0156                | 3.6051                | 0111001011001111101101<br>1111001111001111101101 |
| p1: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328<br>p2: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328  | c1: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328<br>c2: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328  | 0.0000                | 0.0000                | 1111001111001111101101<br>1111001111001111101101 |
| p1: (1111001111001111101101) = (0.9052;-0.9824) z=0.1328<br>p2: (0111001011001111101101) = (-0.8974;-0.9052) z=0.1328 | c1: (1111001011001111101101) = (0.8974;-0.9824) z=0.1323<br>c2: (0111001111001111101101) = (-0.9052;-0.9052) z=0.1328 | 0.0156                | 3.6051                | 1111001111001111101101<br>0111001011001111101101 |

