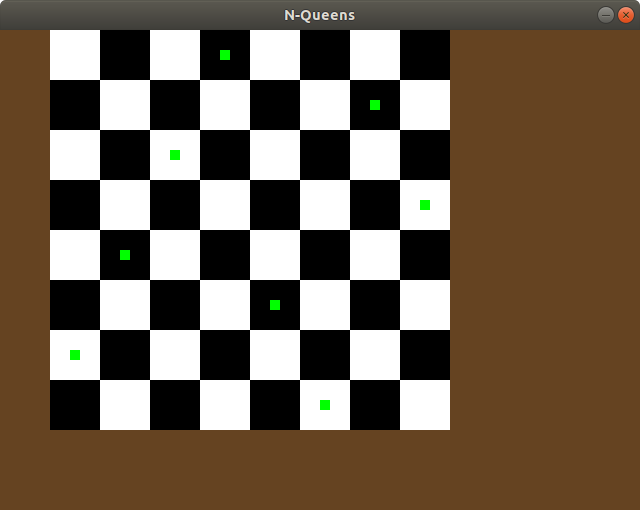
Εργασία 1

Υλοποιήθηκε η μέθοδος πλήρης αναζήτησης. Ανάλογα με το seed της srand()

(η αρχικοποίηση του οποίου βρίσκεται στο body της main) ο αλγόριθμος βρίσκει και μια διαφορετική λύση (μία από τις 92 πιθανές).

Για seed = 42, ο αλγόριθμος εκτελεί 312 βήματα και επιστρέφει την εξής λύση:



Εκτελέστηκαν οι εξής εντολές:

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_base.cpp $(pkg-config --cflags --libs sdl2)

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Final board:

0 0 0 1 0 0 0 0

0 0 0 0 0 0 1 0

0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 1

0 1 0 0 0 0 0 0

0 0 0 0 1 0 0 0

1 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0

Queen positions:

6,0----4,1----2,2----0,3----5,4----7,5----1,6----3,7----

seed: 42

Steps took: 312

real 0m0.004s

user 0m0.004s

sys 0m0.000s

Εργασία 2

Ο χρόνος εκτέλεσης του προγράμματος είναι αρκετά μικρός ώστε δεν υπάρχει προφανής λόγος παραλληλοποίησης. Πέρα από αυτό το πιο χρονοβόρο τμήμα του προγράμματος είναι αυτό που εκτελεί τους ελέγχους εγκυρότητας της λύσης (συνάρτηση CheckCollisions() ). Χωρίζοντάς τη σε sections, ο χρόνος εκτέλεσης είναι υπερδιπλάσιος λόγω του overhead που προσθέτει η παραλληλοποίηση.

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_omp.cpp $(pkg-config --cflags --libs sdl2) -fopenmp

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ export OMP\_NUM\_THREADS=4

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Final board:

0 0 0 1 0 0 0 0

0 0 0 0 0 0 1 0

0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 1

0 1 0 0 0 0 0 0

0 0 0 0 1 0 0 0

1 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0

Queen positions:

6,0----4,1----2,2----0,3----5,4----7,5----1,6----3,7----

seed: 42

Steps took: 312

real 0m0.010s

user 0m0.015s

sys 0m0.004s

Ο προσωπικός υπολογιστής μου έχει 2 physical cores και 4 threads. Αν είχε 6 threads θεωρητικά ο χρόνος εκτέλεσης του κώδικα θα ήταν πιο μικρός με export OMP\_NUM\_THREADS=6.

Για σκακιέρα 16x16:

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_base.cpp $(pkg-config --cflags --libs sdl2)

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Final board:

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0

1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0

0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0

0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

Queen positions:

6,0----4,1----1,2----13,3----15,4----12,5----7,6----11,7----3,8----5,9----2,10----9,11----14,12----10,13----8,14----0,15----

seed: 42

Steps took: 37753

real 0m0.020s

user 0m0.016s

sys 0m0.004s

και η παράλληλη εκδοχή του αλγορίθμου:

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_omp.cpp $(pkg-config --cflags --libs sdl2) -fopenmp

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ export OMP\_NUM\_THREADS=4

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Final board:

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0

1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0

0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0

0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

Queen positions:

6,0----4,1----1,2----13,3----15,4----12,5----7,6----11,7----3,8----5,9----2,10----9,11----14,12----10,13----8,14----0,15----

seed: 42

Steps took: 37753

real 0m0.123s

user 0m0.423s

sys 0m0.032s

Ο χρόνος εκτέλεσης συνεχίζει να είναι μεγαλύτερος λόγω του overhead.

Για σκακιέρα 35x35:

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_base.cpp $(pkg-config --cflags --libs sdl2)

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Final board:

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0

0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0

1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Queen positions:

26,0----30,1----11,2----7,3----31,4----10,5----28,6----9,7----6,8----32,9----27,10----14,11----8,12----4,13----24,14----15,15----17,16----2,17----34,18----3,19----12,20----33,21----29,22----1,23----23,24----18,25----20,26----13,27----0,28----19,29----25,30----5,31----21,32----16,33----22,34----

seed: 42

Steps took: 329756

real 0m0.182s

user 0m0.178s

sys 0m0.004s

και η παράλληλη εκδοχή του αλγορίθμου:

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_omp.cpp $(pkg-config --cflags --libs sdl2) -fopenmp

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ export OMP\_NUM\_THREADS=4

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Final board:

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0

0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0

1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Queen positions:

26,0----30,1----11,2----7,3----31,4----10,5----28,6----9,7----6,8----32,9----27,10----14,11----8,12----4,13----24,14----15,15----17,16----2,17----34,18----3,19----12,20----33,21----29,22----1,23----23,24----18,25----20,26----13,27----0,28----19,29----25,30----5,31----21,32----16,33----22,34----

seed: 42

Steps took: 329756

real 0m0.947s

user 0m3.472s

sys 0m0.231s

Εργασία 3

Υλοποιήθηκε ο γενετικός αλγόριθμος, ως εξής:

//initialize population to p permutations of the rows (duplicates might exist)

//calculate fitness - how many collisions there are

//do

//select

//crossover

//mutate

//fitness

//while fitness not N

Ως συνάρτηση evaluation (fitness) ορίστηκε ο αριθμός των βασιλισσών που δεν έχουν collision.

Για σκακιέρα 8x8:

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_GA.cpp $(pkg-config --cflags --libs sdl2)

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Initialize population...

Calculate Fitness...

Start GA iterations...

Finished.

Pop 14 has converged

Took 73 iterations

Seed 42

0 0 0 0 0 0 1 0

0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 1

0 1 0 0 0 0 0 0

0 0 0 0 1 0 0 0

1 0 0 0 0 0 0 0

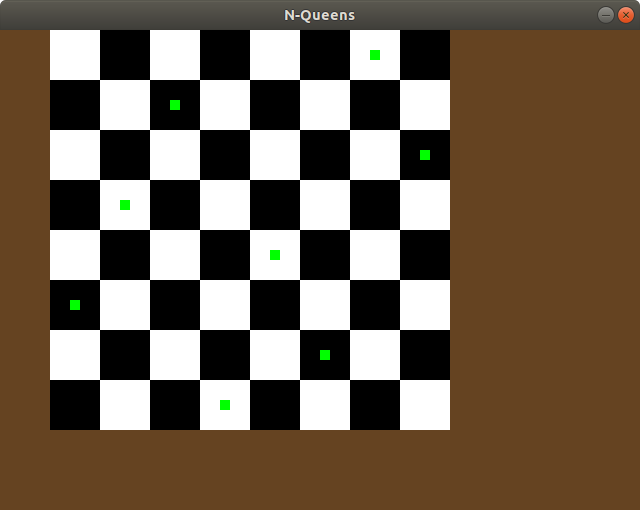
0 0 0 0 0 1 0 0

0 0 0 1 0 0 0 0

real 0m0.023s

user 0m0.020s

sys 0m0.004s



Για σκακιέρα 16x16:

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ g++ NQueens\_GA.cpp $(pkg-config --cflags --libs sdl2)

perhaps@perhaps-X555LAB:~/Desktop/Chatzidoukas/N-Queens$ time ./a.out

Initialize population...

Calculate Fitness...

Start GA iterations...

Finished.

Pop 2 has converged

Took 97 iterations

Seed 42

0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0

0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0

0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0

1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0

0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

real 0m0.656s

user 0m0.652s

sys 0m0.004s

Ο αλγόριθμος στην τρέχουσα μορφή, “κολλάει” σε τοπικά μέγιστα. Για να αποφευχθεί αυτό, καθορίζονται διαφορετικές παράμετροι POP\_NUM, P1\_BOUND και P2\_BOUND με εμπειρικό τρόπο.