

1^η Εργασία

Το προγράμμά μας αποτελείται από 4 κλάσεις : Cube.java (περιέχει συναρτήσεις και ιδιότητες για την υλοποίηση του κύβου) , SpaceSearcher.java (Περιέχει αλγόριθμο A*) , main.java (Βασικός κώδικας για εκτέλεση)

Για k=4,5,6 η εύρεση τελικής κατάστασης είναι λιγότερο συχνή. Επίσης ο αριθμός των moves που χρειάζονται για να λυθεί ο κύβος μπορεί να φτάσουν αρκετά ψηλά ενώ άλλες φορές είναι σε φυσιολογικά επίπεδα

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- **Cube.java**

Όλη η υλοποίηση βασίζεται στη χρήση 3d array[x][y][z] όπου (x:γραμμή , y:στήλη , z:πλευρά) . Ο πίνακας περιέχει αριθμούς [1,6] όπου (1: red , 2 : white , 3 : blue , 4 : yellow , 5 : orange , 6 : green)

Επίσης χρησιμοποιούμε έναν πίνακα current ο οποίος απεικονίζει το τελικό αποτέλεσμα χρωματος που πρέπει να χει μια πλευρά για να είναι λυμένη

Χρησιμοποιούμε δύο είδη Constructor : Cube(String perfect) , ο οποίος δημιουργεί ήδη λυμένο κύβο βάζοντας τα σωστά νούμερα στον array Cube , ο 2ος constructor είναι Copy Constructor Cube(Cube other) ο οποίος φτιάχνει State του Cube με χρήση του State του ορίσματος . Και στους δύο

Η μεταβλητή m αποθηκεύει αριθμό [0,17] , (δηλαδή οι 18 κινήσεις) , ο οποίος περιγράφει τη κίνηση που έγινε για να δημιουργηθεί αυτό το State .

Η συνάρτηση perform_move(int i) δέχεται ως όρισμα τον αριθμό της κίνησης για εκτέλεση και τρέχει τη κατάλληλη συνάρτηση κίνησης.

Κάθε State Cube θα παράγει 18 παιδιά Cube , τα οποία θα έχουν το current State ως πατέρα.

Όταν το πρόγραμμα ξεκινάει ο κύβος είναι ήδη λυμένος , χρησιμοποιούμε την `scramble_cube()` για να «χαλάσουμε» τον κύβο με τυχαίες κινήσεις.

Η συνάρτηση `check_one(int k)` δέχεται ως όρισμα το στόχο των πλευρών `k` που θέλουμε να έχουν λυθεί και ελέγχει κάθε πλευρά αμα είναι λυμμένη η όχι χρησιμοποιώντας τις `check_colours (check_red , check_blue etc)` . Αμα το άθροισμα `counter` είναι $\geq k$ τότε επιστρέφει `true` , αν όχι `false`

Η συνάρτηση `num_wrong_tiles()` είναι η συνάρτηση της ευρετικής που χρησιμοποιούμε η οποία αθροίζει των **αριθμό των χρωμάτων που βρίσκονται σε λάθος θέση** και στο τέλος **διαίρεται δια 3 επειδή μετακινούμε 3 κυβάρια ανα ένα move**. Η σύγκριση για **το αν ένα χρώμα είναι σε λάθος θέση βασίζεται στον πίνακα `current[6]`**

Η παραγωγή των παιδιών `States` του `Cube` γίνεται με τη χρήση της `get_children()` η οποία δημιουργεί αντίγραφα του `current State` , εκτέλει κάθε διαφορετική κίνηση σε αυτά και επιστρέφει το παραγόμενο `State` σε ένα πίνακα `Array List`. Επίσης υπολογίζει το συνολικό κόστος της κάθε κίνησης.

Στη συνέχεια βρίσκονται οι συναρτήσεις έλεγχου κάθε πλευράς για το αν είναι λυμένη η όχι οι οποίες καλούνται στη συνάρτηση `check_one` που εξηγήσαμε πιο πάνω. Κάθε μία από αυτές συγκρίνει κάθε χρώμα της πλευράς με βάση το `target colour` , της `current`. Κάθε φορά που το χρώμα είναι σωστό αυξάνουμε τον `counter` κατά ένα και στο τέλος αμα `counter == 9` τότε η πλευρά είναι λυμένη.

Για την εκτύπωση του πίνακα στο τερματικό χρησιμοποιούμε την `print_cube` όπου εκτυπώνει κάθε πλευρά με τη σειρά

Τέλος έχουμε υλοποιήσει 9 συναρτήσεις με όρισμα την κατεύθυνση της κίνησης ($9*2=18$ κινήσεις συνολικά).

Για τις κινήσεις είναι σημαντικό να αναφέρουμε ότι κοιτάμε τον κύβο από μία πλευρά μόνο (την `side 0`) ! .

Για την υλοποίηση των `swaps` μέσα στο πίνακα χρησιμοποιούμε μεταβλητές `temp` για να αλλάξουμε τα χρώματα με βάση της λογική της κίνησης. (Στις 3 τελευταίες συναρτήσεις χρησιμοποιείται μια βοηθητική συνάρτηση `rotate`.

Τελευταία συνάρτηση της cube είναι η override της συνάρτησης compareTo() η οποία χρησιμοποιείται στον αλγόριθμο A* για τη σύγκριση του κόστους κάθε κίνησης.

- SpaceSearcher.java

Αρχικά όταν καλείται η συνάρτηση , αρχικοποιούνται η ArrayList που λειτουργεί ως frontier και αποθηκεύει states του Cube , καθώς και το κλειστό σύνολο HashSet

Έπειτα η συνάρτηση A_Star δέχεται ως όρισμα τον αρχικό κύβο που θέλουμε να λύσουμε μαζί με τον επιθυμητό αριθμό πλευρών που θέλουμε να λυθεί. Σε περίπτωση που η αρχική κατάσταση είναι τελική επιστρέφει αμέσως , αλλιώς την προσθέτει στην frontier. Έπειτα παίρνουμε την Cube που βρίσκεται στη πρώτη θέση (αν είναι η πρώτη επανάληψη θα είναι η αρχική). Αν η current state δεν ανήκει στο κλειστό σύνολο closed set (**δημιουργούμε τα παιδιά και τα προσθετούμε στη frontier και την ταξινομούμε με βάση την ευρετική ώστε η προτιμότερη κατάσταση να είναι πρώτη στο frontier**) Στη συνέχεια η κατάσταση στην πρώτη θέση γίνεται παδί της current state για να συνεχιστεί το δεντρό.

- Main.java

Στην αρχή του προγράμματος ζητείται από το χρήστη να δώσει σαν input τον k αριθμό πλευρών που θέλουμε να λυθεί.

Δημιουργούμε ένα instance του κύβου , τον κάνουμε scramble , τον εκτυπώνουμε και τον δίνουμε ως όρισμα στην συνάρτηση A_Star της SpaceSearcher.

Σε περίπτωση αποτυχίας εκτυπώνει στο χρήστη «Could not find a solution».

Έπειτα βρίσκει τον πατέρα και καθώς «κατεβαίνει» πίσω στην τελική κατάσταση πέρναι από όλα τα παιδιά και εκτυπώνει τις κινήσεις που έγιναν με τη σειρά και στο τέλος εκτυπώνει τη τελική κατάσταση του κύβου

Ενδεικτικές λύσεις του προγράμματος (K=1)

| | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| How many sides you want to solve: 1 Number 1 is: red Number 2 is: white Number 3 is: blue Number 4 is: yellow Number 5 is: orange Number 6 is: green STARTING CUBE | | |
| Side0 2 1 1 - - - - - 2 1 1 - - - - - 6 1 1 - - - - - | Side0 1 1 1 - - - - - 1 1 1 - - - - - 1 1 1 - - - - - | Move 1 was : Behind Side Left Move 2 was : Vertical Left Up Move 3 was : Behind Side Right Move 4 was : Front Side Right Move 5 was : Front Side Left Move 6 was : Vertical Left Down Move 7 was : Horizontal Bottom Left Move 8 was : Horizontal Bottom Right Move 9 was : Horizontal Middle Right Move 10 was : Horizon Middle Left Move 11 was : Horizontal Top Right Move 12 was : Horizontal top Left Move 13 was : Middle Side Left Move 14 was : Vertical Middle Up Move 15 was : Vertical Middle Down Move 16 was : Vertical Right Up Move 17 was : Vertical Right Down Move 18 was : Middle Side Right Move 19 was : Horizontal Bottom Left Move 20 was : Front Side Left Move 21 was : Front Side Right Move 22 was : Vertical Left Up Move 23 was : Vertical Left Down Move 24 was : Horizontal Bottom Right Move 25 was : Behind Side Left Move 26 was : Behind Side Left Move 27 was : Vertical Right Up Move 28 was : Vertical Right Down Move 29 was : Horizontal Middle Right Move 30 was : Horizon Middle Left Move 31 was : Horizontal Top Right Move 32 was : Horizontal top Left Move 33 was : Behind Side Right Move 34 was : Behind Side Left Move 35 was : Middle Side Right Move 36 was : Middle Side Left Move 37 was : Behind Side Left Move 38 was : Vertical Left Up |
| Side1 2 2 2 - - - - - 5 5 5 - - - - - 3 6 6 - - - - - | Side1 2 2 2 - - - - - 6 6 6 - - - - - | |
| Side2 5 3 3 - - - - - 4 3 3 - - - - - 4 3 3 - - - - - | Side2 2 3 3 - - - - - 3 3 3 - - - - - 3 3 3 - - - - - | |
| Side3 1 5 5 - - - - - 6 6 4 - - - - - 1 4 4 - - - - - | Side3 5 5 5 - - - - - 4 4 4 - - - - - 4 4 4 - - - - - | |
| Side4 2 4 5 - - - - - 2 4 5 - - - - - 2 1 5 - - - - - | Side4 2 5 5 - - - - - 2 5 5 - - - - - 2 5 5 - - - - - | |
| Side5 6 2 6 - - - - - 6 2 6 - - - - - 4 3 4 - - - - - | Side5 6 6 4 - - - - - 6 6 4 - - - - - 6 6 4 - - - - - | |
| FINAL CUBE | | |

(K=2)

How many sides you want to solve? :

2

Number 1 is: red

Number 2 is: white

Number 3 is: blue

Number 4 is: yellow

Number 5 is: orange

Number 6 is: green

STARTING CUBE

Side0

4 | 3 | 3 |

- - - - -

1 | 1 | 2 |

- - - - -

1 | 1 | 2 |

- - - - -

Side1

3 | 2 | 2 |

- - - - -

3 | 2 | 2 |

- - - - -

3 | 2 | 2 |

- - - - -

Side2

3 | 3 | 4 |

- - - - -

3 | 3 | 4 |

- - - - -

2 | 1 | 1 |

- - - - -

Side3

4 | 4 | 1 |

- - - - -

4 | 4 | 1 |

- - - - -

4 | 4 | 1 |

- - - - -

Side4

6 | 6 | 6 |

- - - - -

5 | 5 | 5 |

- - - - -

5 | 5 | 5 |

- - - - -

Side5

5 | 5 | 5 |

- - - - -

6 | 6 | 6 |

- - - - -

6 | 6 | 6 |

FINAL CUBE

Side0

1 | 1 | 1 |

- - - - -

1 | 1 | 1 |

- - - - -

1 | 1 | 1 |

- - - - -

Side1

2 | 2 | 2 |

- - - - -

2 | 2 | 2 |

- - - - -

2 | 2 | 2 |

- - - - -

Side2

3 | 3 | 3 |

- - - - -

3 | 3 | 3 |

- - - - -

3 | 3 | 3 |

- - - - -

Side3

4 | 4 | 4 |

- - - - -

4 | 4 | 4 |

- - - - -

4 | 4 | 4 |

- - - - -

Side4

5 | 5 | 5 |

- - - - -

5 | 5 | 5 |

- - - - -

5 | 5 | 5 |

- - - - -

Side5

6 | 6 | 6 |

- - - - -

6 | 6 | 6 |

- - - - -

6 | 6 | 6 |

- - - - -

Move 1 was : Vertical Right Up

Move 2 was : Horizontal Top Right

Move 3 was : Horizontal top Left

Move 4 was : Vertical Left Up

Move 5 was : Vertical Right Down

Move 6 was : Vertical Left Down

Move 7 was : Horizontal Bottom Right

Move 8 was : Horizontal Bottom Left

Move 9 was : Horizontal Middle Right

Move 10 was : Horizon Middle Left

Move 11 was : Behind Side Right

Move 12 was : Behind Side Left

Move 13 was : Middle Side Right

Move 14 was : Middle Side Left

Move 15 was : Front Side Right

Move 16 was : Front Side Left

Move 17 was : Vertical Middle Up

Move 18 was : Vertical Middle Down

Move 19 was : Vertical Right Up

Move 20 was : Horizontal Top Right

Move 21 was : Vertical Right Up

Move 22 was : Horizontal top Left

Move 23 was : Vertical Left Up

Move 24 was : Vertical Left Down

Move 25 was : Vertical Right Up

Move 26 was : Vertical Right Down

Move 27 was : Horizontal Top Right

Move 28 was : Horizontal top Left

Move 29 was : Behind Side Right

Move 30 was : Behind Side Left

Move 31 was : Horizontal Bottom Right

Move 32 was : Horizontal Bottom Left

Move 33 was : Horizontal Middle Right

Move 34 was : Horizon Middle Left

Move 35 was : Middle Side Right

Move 36 was : Middle Side Left

Move 37 was : Front Side Right

Move 38 was : Front Side Left

Move 39 was : Horizontal top Left

Move 40 was : Horizontal Top Right

Move 41 was : Vertical Middle Up

Move 42 was : Vertical Middle Down

Move 43 was : Vertical Right Down

Move 44 was : Front Side Right

Move 45 was : Front Side Left

Move 46 was : Vertical Right Down

Move 47 was : Behind Side Right

Move 48 was : Behind Side Left

Move 49 was : Vertical Left Down

Move 50 was : Vertical Right Up

Move 51 was : Vertical Right Up

Move 52 was : Vertical Right Down

Move 53 was : Horizontal Bottom Right

Move 54 was : Horizontal top Left

Move 55 was : Horizontal Bottom Left

Move 56 was : Horizontal Top Right

Move 57 was : Vertical Right Up

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(K=3)

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How many sides you want to solve? :
3
Number 1 is: red
Number 2 is: white
Number 3 is: blue
Number 4 is: yellow
Number 5 is: orange
Number 6 is: green
STARTING CUBE

Side0
5 | 5 | 4 |
- - - - -
1 | 1 | 4 |
- - - - -
1 | 1 | 3 |
- - - - -

Side1
6 | 6 | 5 |
- - - - -
2 | 2 | 1 |
- - - - -
2 | 2 | 1 |
- - - - -

Side2
3 | 3 | 1 |
- - - - -
3 | 3 | 2 |
- - - - -
3 | 3 | 2 |
- - - - -

Side3
4 | 4 | 6 |
- - - - -
4 | 4 | 6 |
- - - - -
5 | 5 | 6 |
- - - - -

Side4
5 | 5 | 3 |
- - - - -
5 | 5 | 3 |
- - - - -
2 | 2 | 2 |
- - - - -

Side5
4 | 1 | 1 |
- - - - -
4 | 6 | 6 |
- - - - -
4 | 6 | 6 |
- - - - -

FINAL CUBE

Side0
1 | 1 | 1 |
- - - - -
1 | 1 | 1 |
- - - - -
1 | 1 | 1 |
- - - - -

Side1
2 | 2 | 2 |
- - - - -
2 | 2 | 2 |
- - - - -
2 | 2 | 2 |
- - - - -

Side2
3 | 3 | 3 |
- - - - -
3 | 3 | 3 |
- - - - -
3 | 3 | 3 |
- - - - -

Side3
4 | 4 | 4 |
- - - - -
4 | 4 | 4 |
- - - - -
4 | 4 | 4 |
- - - - -

Side4
5 | 5 | 5 |
- - - - -
5 | 5 | 5 |
- - - - -
5 | 5 | 5 |
- - - - -

Side5
6 | 6 | 6 |
- - - - -
6 | 6 | 6 |
- - - - -
6 | 6 | 6 |
- - - - -

Move 1 was : Vertical Right Down
Move 2 was : Behind Side Left
Move 3 was : Vertical Right Up
Move 4 was : Horizontal Top Right
Move 5 was : Behind Side Right
Move 6 was : Horizontal Bottom Right
Move 7 was : Horizontal Bottom Left
Move 8 was : Horizontal Middle Right
Move 9 was : Horizon Middle Left
Move 10 was : Horizontal top Left
Move 11 was : Middle Side Right
Move 12 was : Middle Side Left
Move 13 was : Front Side Right
Move 14 was : Front Side Left
Move 15 was : Vertical Left Up
Move 16 was : Vertical Left Down
Move 17 was : Vertical Middle Up
Move 18 was : Vertical Middle Down
Move 19 was : Behind Side Left
Move 20 was : Horizontal Top Right
Move 21 was : Behind Side Right
Move 22 was : Vertical Right Down
Move 23 was : Horizontal Top Right
Move 24 was : Horizontal top Left
Move 25 was : Horizontal top Left
Move 26 was : Horizontal Top Right
PS C:\Users\johnp\Desktop\3200149_3200227_3200278>
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(K=4)

How many sides you want to solve? :
4

Number 1 is: red
Number 2 is: white
Number 3 is: blue
Number 4 is: yellow
Number 5 is: orange
Number 6 is: green
STARTING CUBE

Side0

1 | 1 | 2 |

- - - - -

1 | 1 | 2 |

- - - - -

1 | 1 | 3 |

- - - - -

Side1

2 | 2 | 3 |

- - - - -

2 | 2 | 3 |

- - - - -

6 | 6 | 5 |

- - - - -

Side2

3 | 3 | 1 |

- - - - -

3 | 3 | 4 |

- - - - -

5 | 5 | 4 |

- - - - -

Side3

5 | 5 | 6 |

- - - - -

4 | 4 | 6 |

- - - - -

4 | 4 | 6 |

- - - - -

Side4

1 | 5 | 5 |

- - - - -

1 | 5 | 5 |

- - - - -

2 | 2 | 2 |

- - - - -

Side5

3 | 3 | 4 |

- - - - -

6 | 6 | 4 |

- - - - -

6 | 6 | 4 |

- - - - -

FINAL CUBE

Side0

1 | 1 | 1 |

- - - - -

1 | 1 | 1 |

- - - - -

1 | 1 | 1 |

- - - - -

Side1

2 | 2 | 2 |

- - - - -

2 | 2 | 2 |

- - - - -

2 | 2 | 2 |

- - - - -

Side2

3 | 3 | 3 |

- - - - -

3 | 3 | 3 |

- - - - -

3 | 3 | 3 |

- - - - -

Side3

4 | 4 | 4 |

- - - - -

4 | 4 | 4 |

- - - - -

4 | 4 | 4 |

- - - - -

Side4

5 | 5 | 5 |

- - - - -

5 | 5 | 5 |

- - - - -

5 | 5 | 5 |

- - - - -

Side5

6 | 6 | 6 |

- - - - -

6 | 6 | 6 |

- - - - -

6 | 6 | 6 |

- - - - -

Move 1 was : Vertical Right Up
Move 2 was : Front Side Left
Move 3 was : Vertical Right Down
Move 4 was : Horizontal top Left
Move 5 was : Front Side Right
Move 6 was : Horizontal Bottom Right
Move 7 was : Horizontal Bottom Left
Move 8 was : Horizontal Middle Right
Move 9 was : Horizon Middle Left
Move 10 was : Horizontal Top Right
Move 11 was : Behind Side Right
Move 12 was : Behind Side Left
Move 13 was : Middle Side Right
Move 14 was : Middle Side Left
Move 15 was : Vertical Left Up
Move 16 was : Vertical Left Down
Move 17 was : Vertical Middle Up
Move 18 was : Vertical Middle Down
Move 19 was : Front Side Left
Move 20 was : Horizontal top Left
Move 21 was : Front Side Right
Move 22 was : Vertical Right Up
Move 23 was : Horizontal top Left
Move 24 was : Horizontal Top Right
Move 25 was : Horizontal Top Right
Move 26 was : Horizontal top Left

PS C:\Users\johnp\Desktop\3200149_3200227_3200278>

(K=5)

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| <pre> C:\Users\john\Desktop\3200149_3200227_3200278 How many sides you want to solve? : 5 Number 1 is: red Number 2 is: white Number 3 is: blue Number 4 is: yellow Number 5 is: orange Number 6 is: green STARTING CUBE Side0 5 1 4 - - - - - 5 1 4 - - - - - 5 5 4 - - - - - Side1 1 2 1 - - - - - 1 2 1 - - - - - 2 6 5 - - - - - Side2 2 6 2 - - - - - 2 3 2 - - - - - 6 3 6 - - - - - Side3 4 4 6 - - - - - 3 4 3 - - - - - 3 4 3 - - - - - Side4 3 2 2 - - - - - 3 5 5 - - - - - 3 5 5 - - - - - Side5 4 4 1 - - - - - 6 6 1 - - - - - 6 6 1 - - - - - </pre> | <pre> FINAL CUBE Side0 4 4 4 - - - - - 4 4 4 - - - - - 4 4 4 - - - - - Side1 1 1 1 - - - - - 1 1 1 - - - - - 1 1 1 - - - - - Side2 2 2 2 - - - - - 2 2 2 - - - - - 2 2 2 - - - - - Side3 3 3 3 - - - - - 3 3 3 - - - - - 3 3 3 - - - - - Side4 5 5 5 - - - - - 5 5 5 - - - - - 5 5 5 - - - - - Side5 6 6 6 - - - - - 6 6 6 - - - - - 6 6 6 - - - - - </pre> | <pre> Move 1 was : Vertical Right Down Move 2 was : Vertical Left Down Move 3 was : Horizontal Bottom Right Move 4 was : Horizontal Top Right Move 5 was : Vertical Left Up Move 6 was : Vertical Right Up Move 7 was : Horizontal Bottom Left Move 8 was : Horizontal Middle Right Move 9 was : Horizontal top Left Move 10 was : Behind Side Left Move 11 was : Middle Side Left Move 12 was : Front Side Right Move 13 was : Horizon Middle Left Move 14 was : Behind Side Right Move 15 was : Middle Side Right Move 16 was : Front Side Left Move 17 was : Vertical Middle Up Move 18 was : Vertical Middle Down Move 19 was : Horizontal Bottom Right Move 20 was : Vertical Left Down Move 21 was : Vertical Left Up Move 22 was : Horizontal Bottom Left Move 23 was : Front Side Left Move 24 was : Horizontal Middle Right Move 25 was : Horizontal Top Right Move 26 was : Behind Side Left Move 27 was : Middle Side Left Move 28 was : Front Side Right Move 29 was : Vertical Right Down Move 30 was : Horizon Middle Left Move 31 was : Horizontal top Left Move 32 was : Behind Side Right Move 33 was : Middle Side Right Move 34 was : Front Side Right Move 35 was : Vertical Middle Up Move 36 was : Vertical Middle Down Move 37 was : Vertical Right Up Move 38 was : Vertical Right Down Move 39 was : Horizontal Bottom Right Move 40 was : Front Side Left Move 41 was : Vertical Left Down Move 42 was : Vertical Left Down Move 43 was : Vertical Right Down Move 44 was : Vertical Right Down Move 45 was : Horizontal Top Right Move 46 was : Vertical Right Up Move 47 was : Horizontal Bottom Left Move 48 was : Behind Side Left Move 49 was : Front Side Right Move 50 was : Vertical Right Down Move 51 was : Horizontal Middle Right Move 52 was : Horizontal Top Right Move 53 was : Behind Side Right Move 54 was : Behind Side Left Move 55 was : Front Side Right Move 56 was : Horizontal Bottom Right Move 57 was : Vertical Right Down Move 58 was : Vertical Right Down Move 59 was : Vertical Right Down Move 60 was : Vertical Left Down Move 61 was : Vertical Right Down Move 62 was : Vertical Right Down Move 63 was : Behind Side Left </pre> | <pre> Move 61 was : Vertical Right Down Move 62 was : Vertical Right Down Move 63 was : Behind Side Left Move 64 was : Front Side Left Move 65 was : Vertical Left Down Move 66 was : Vertical Left Up Move 67 was : Vertical Left Down Move 68 was : Horizontal Middle Right Move 69 was : Horizontal Top Right Move 70 was : Horizontal top Left Move 71 was : Behind Side Right Move 72 was : Middle Side Right Move 73 was : Middle Side Left Move 74 was : Vertical Left Up Move 75 was : Vertical Right Up Move 76 was : Horizontal Bottom Right Move 77 was : Horizontal Bottom Left Move 78 was : Horizon Middle Left Move 79 was : Horizontal top Left Move 80 was : Middle Side Left Move 81 was : Front Side Left Move 82 was : Vertical Left Up Move 83 was : Vertical Middle Down Move 84 was : Vertical Right Up Move 85 was : Horizontal Bottom Left Move 86 was : Horizontal Middle Right Move 87 was : Horizontal Top Right Move 88 was : Horizontal top Left Move 89 was : Behind Side Right Move 90 was : Behind Side Left Move 91 was : Vertical Left Down Move 92 was : Horizontal Bottom Right Move 93 was : Horizontal Top Right Move 94 was : Behind Side Left Move 95 was : Horizontal Bottom Right Move 96 was : Horizontal Bottom Right Move 97 was : Horizontal Top Right Move 98 was : Horizontal Bottom Right Move 99 was : Behind Side Left Move 100 was : Horizontal Bottom Left Move 101 was : Middle Side Left Move 102 was : Vertical Right Down Move 103 was : Horizontal top Left Move 104 was : Front Side Right Move 105 was : Front Side Left Move 106 was : Horizontal Bottom Right Move 107 was : Horizontal Top Right </pre> |
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