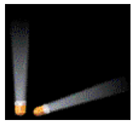
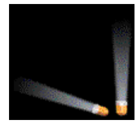
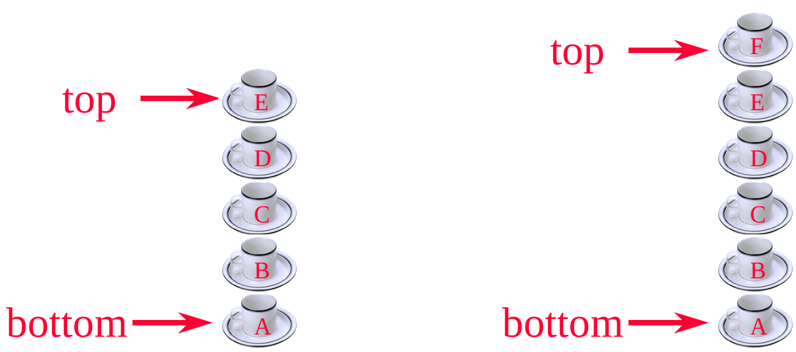
Stacks

- Linear list.
- One end is called top.
- Other end is called bottom.
- Additions to and removals from the top end only.

Stack Of Cups



- Add a cup to the stack.
- Remove a cup from new stack.
- A stack is a LIFO list.

The Interface Stack

```
public interface Stack
{
    public boolean empty();
    public Object peek();
    public void push(Object theObject);
    public Object pop();
}
```

Parentheses Matching

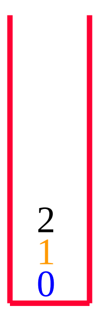
- (((a+b)*c+d-e)/(f+g)-(h+j)*(k-l))/(m-n)
  - Output pairs (u,v) such that the left parenthesis at position u is matched with the right parenthesis at v.
    - (2,6) (1,13) (15,19) (21,25) (27,31) (0,32) (34,38)
- (a+b))*((c+d)
  - (0,4)
  - right parenthesis at 5 has no matching left parenthesis
  - (8,12)
  - left parenthesis at 7 has no matching right parenthesis

Parentheses Matching

- scan expression from left to right
- when a left parenthesis is encountered, add its position to the stack
- when a right parenthesis is encountered, remove matching position from stack

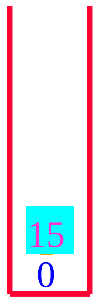
Example

- (((a+b)*c+d-e)/(f+g)-(h+j)*(k-l))/(m-n)



Example

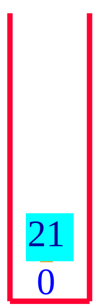
- (((a+b)*c+d-e)/(f+g)-(h+j)*(k-l))/(m-n)



(2,6) (1,13)

Example

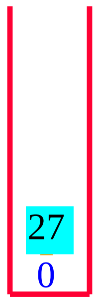
- (((a+b)*c+d-e)/(f+g)-(h+j)*(k-l))/(m-n)



(2,6) (1,13) (15,19)

Example

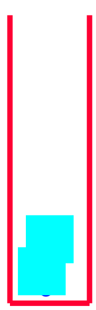
- (((a+b)*c+d-e)/(f+g)-(h+j)*(k-l))/(m-n)



(2,6) (1,13) (15,19) (21,25)

Example

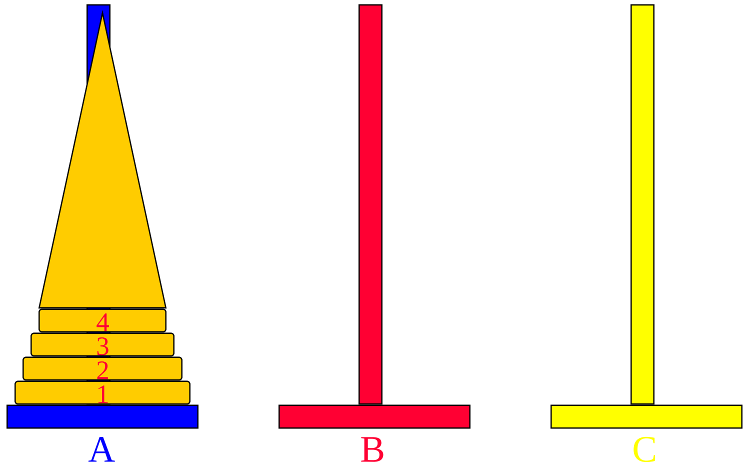
- (((a+b)*c+d-e)/(f+g)-(h+j)*(k-l))/(m-n)



(2,6) (1,13) (15,19) (21,25)(27,31) (0,32)

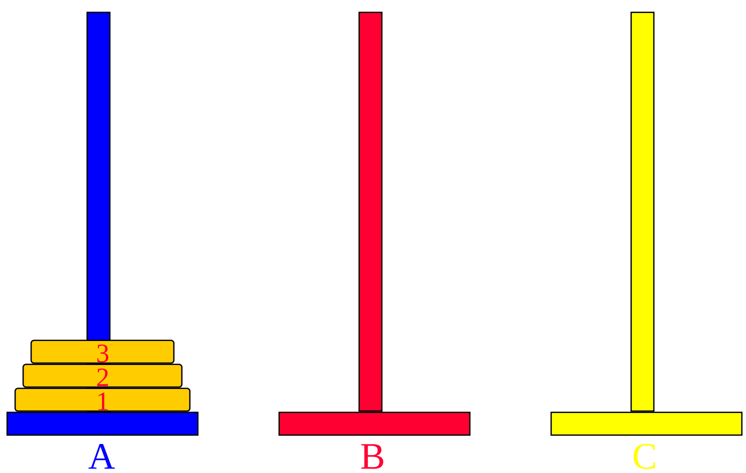
- and so on

Towers Of Hanoi/Brahma



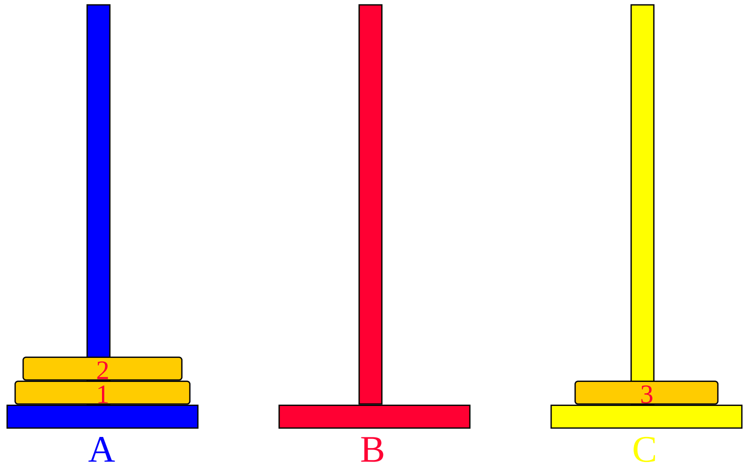
- 64 gold disks to be moved from tower A to tower C
- each tower operates as a stack
- cannot place big disk on top of a smaller one

Towers Of Hanoi/Brahma



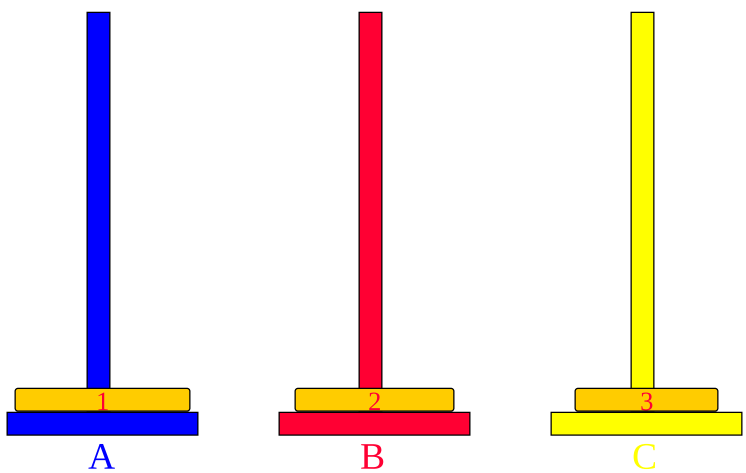
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



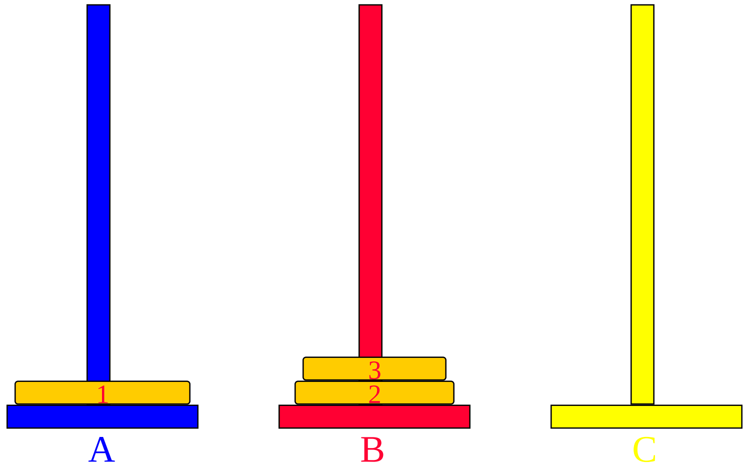
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



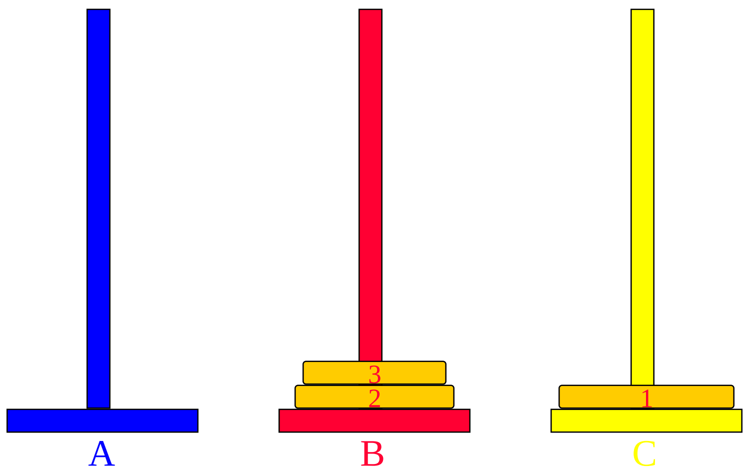
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



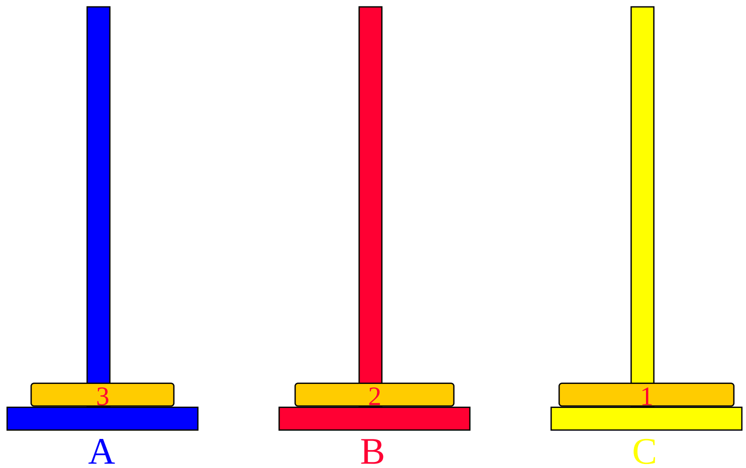
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



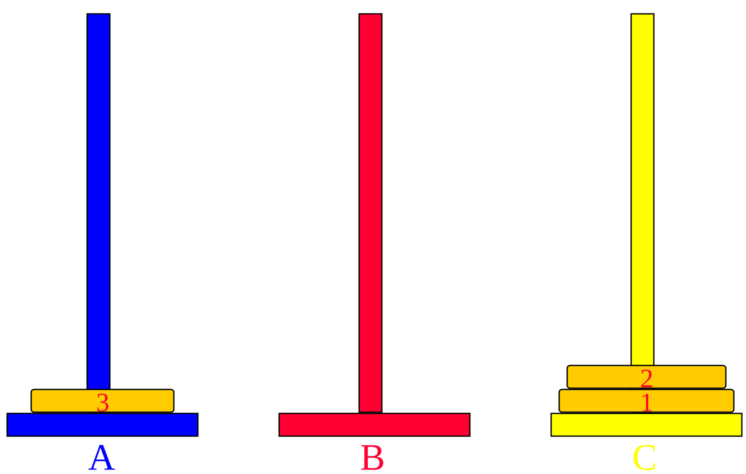
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



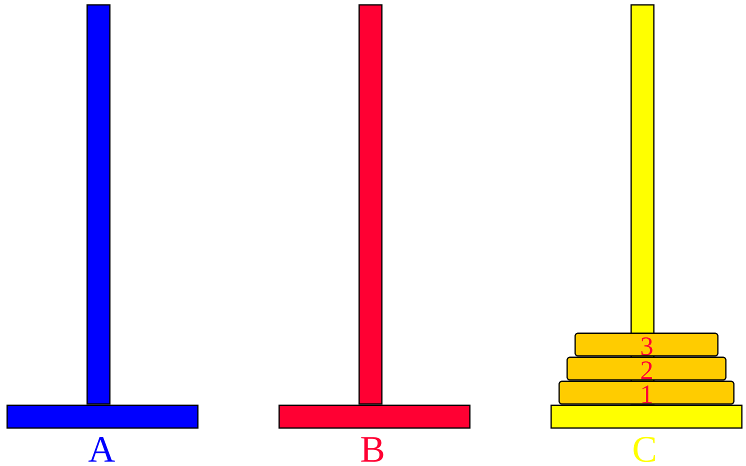
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



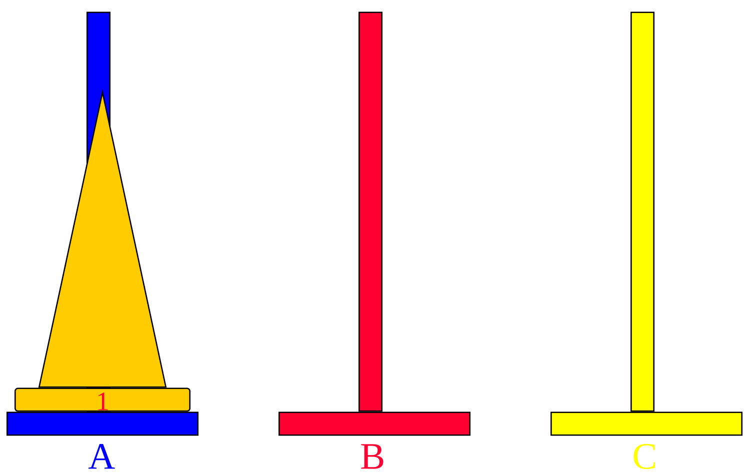
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



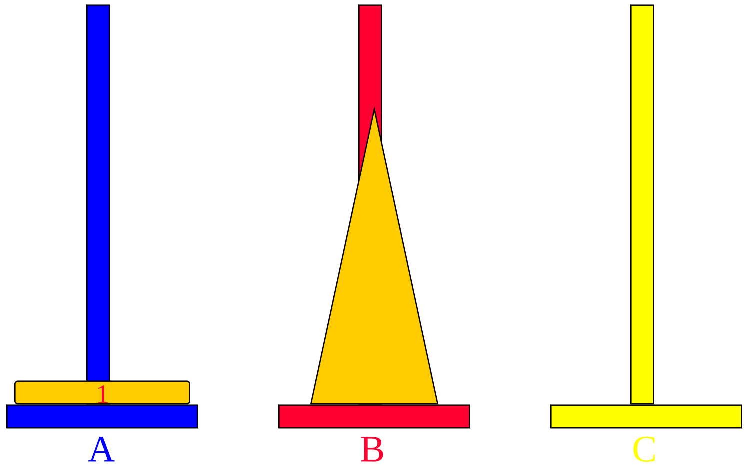
- 3-disk Towers Of Hanoi/Brahma
- 7 disk moves

Recursive Solution



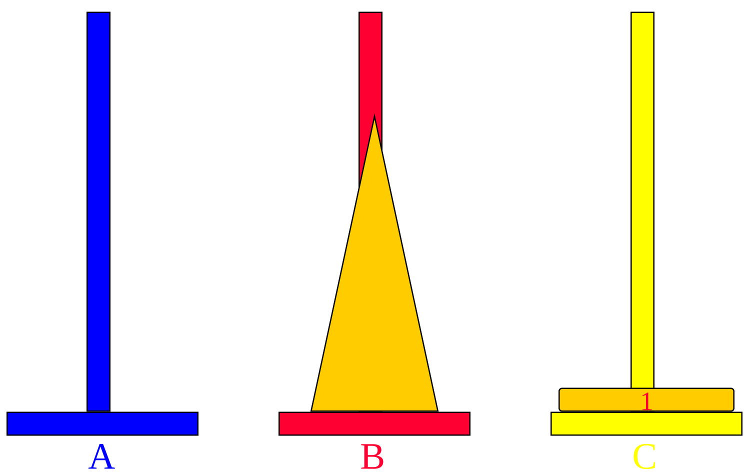
- n > 0 gold disks to be moved from A to C using B
- move top n-1 disks from A to B using C

Recursive Solution



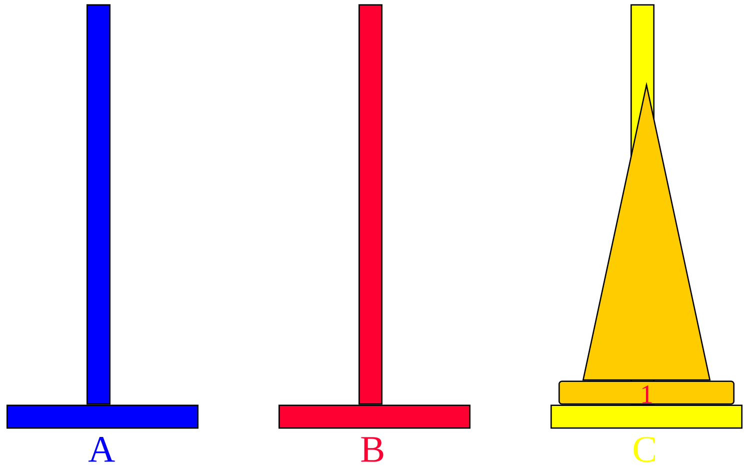
- move top disk from A to C

Recursive Solution



- move top n-1 disks from B to C using A

Recursive Solution

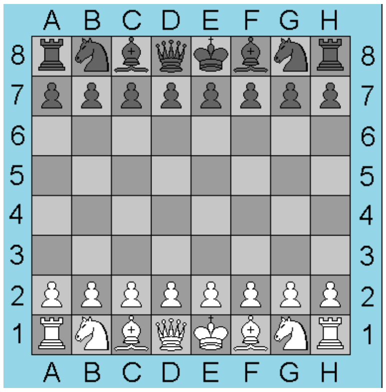


- moves(n) = 0 when n = 0
- moves(n) = 2*moves(n-1) + 1 = 2^n-1 when n > 0

Towers Of Hanoi/Brahma

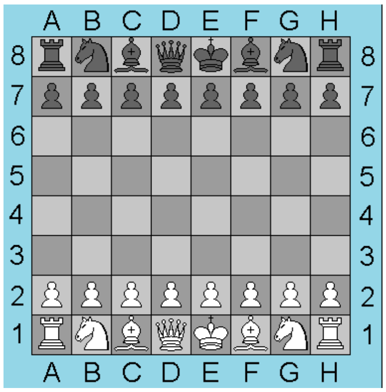
- moves(64) = 1.8 * 10^{19} (approximately)
- Performing 10^9 moves/second, a computer would take about 570 years to complete.
- At 1 disk move/min, the monks will take about 3.4 * 10^{13} years.

Chess Story



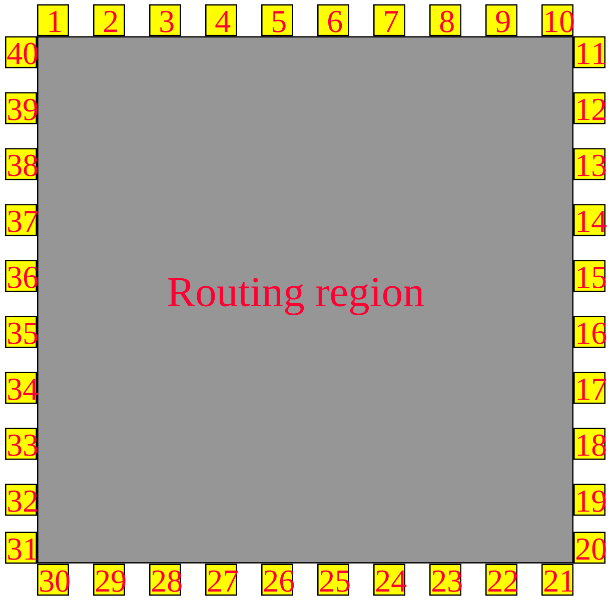
- 1 grain of rice on the first square, 2 for next, 4 for next, 8 for next, and so on.
- Surface area needed exceeds surface area of earth.

Chess Story



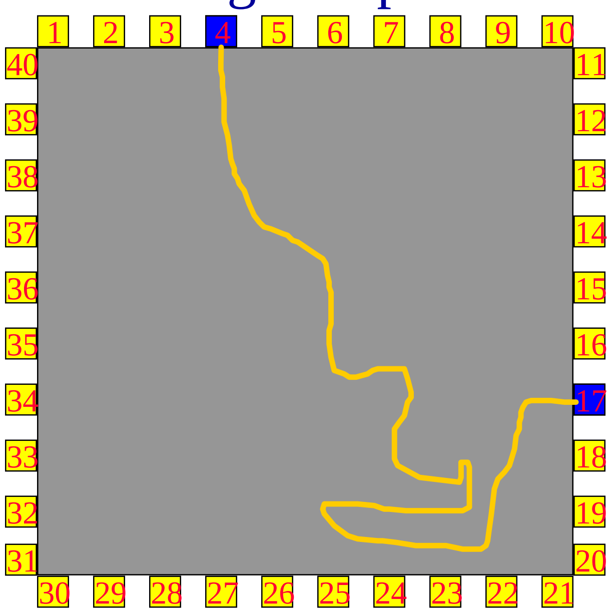
- 1 penny for the first square, 2 for next, 4 for next, 8 for next, and so on.
- $3.6 * 10^{17} (federal budget ~ $2 * 10^{12}) .

Switch Box Routing



Routing A 2-pin Net

Routing for pins 1-3 and 18-40 is confined to lower left region.



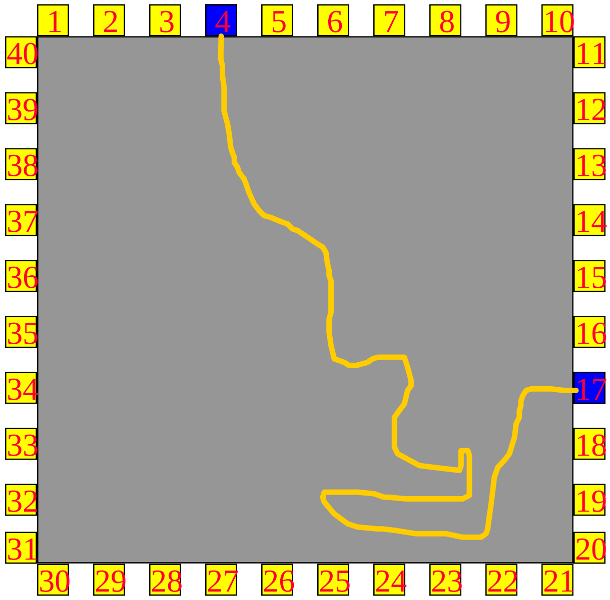
Routing for pins 5 through 16 is confined to upper right region.

Routing A 2-pin Net

(u,v), u<v is a 2-pin net.

u is start pin.

v is end pin.

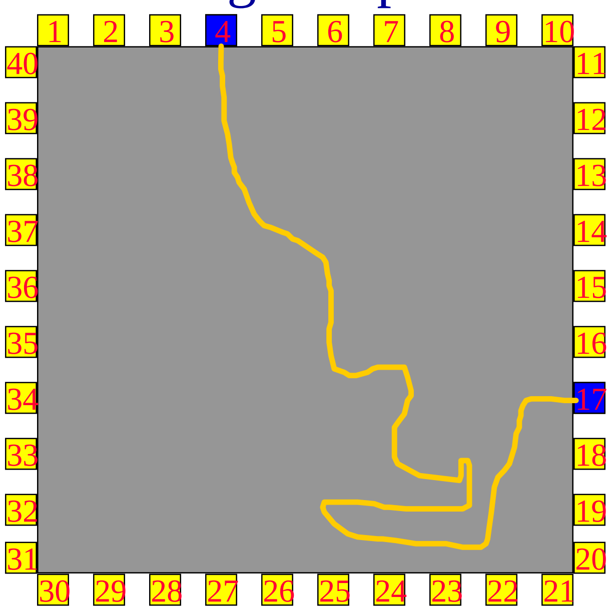


Examine pins in clock-wise order beginn-ing with pin 1.

Routing A 2-pin Net

Start pin => push onto stack.

End pin => start pin must be at top of stack.



Method Invocation And Return

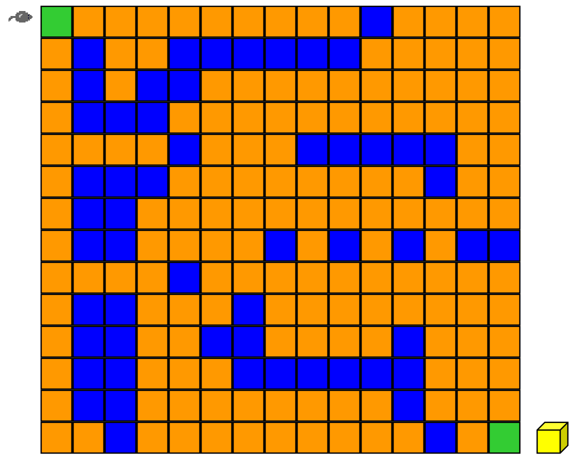
public void a()
{ …; b(); …}
public void b()
{ …; c(); …}
public void c()
{ …; d(); …}
public void d()
{ …; e(); …}
public void e()
{ …; c(); …}

return address in d()
return address in c()
return address in e()
return address in d()
return address in c()
return address in b()
return address in a()

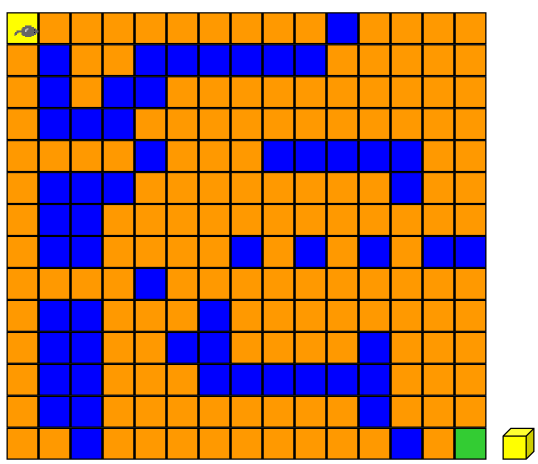
Try-Throw-Catch

- When you enter a try block, push the address of this block on a stack.
- When an exception is thrown, pop the try block that is at the top of the stack (if the stack is empty, terminate).
- If the popped try block has no matching catch block, go back to the preceding step.
- If the popped try block has a matching catch block, execute the matching catch block.

Rat In A Maze

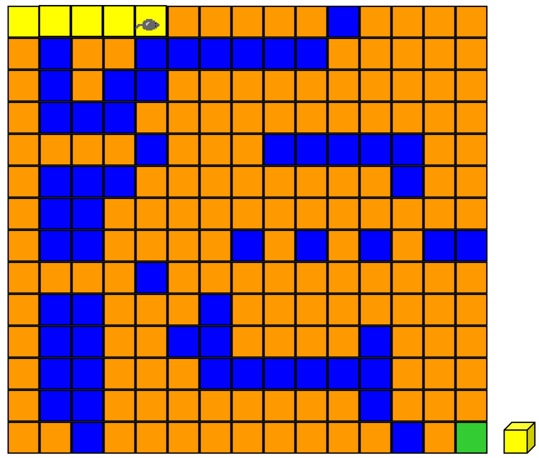


Rat In A Maze



- Move order is: right, down, left, up
- Block positions to avoid revisit.

Rat In A Maze



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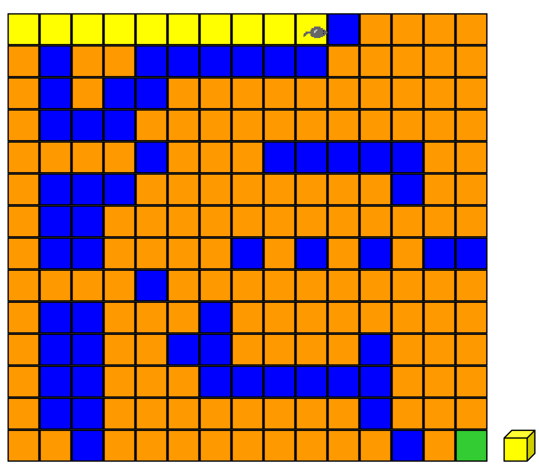
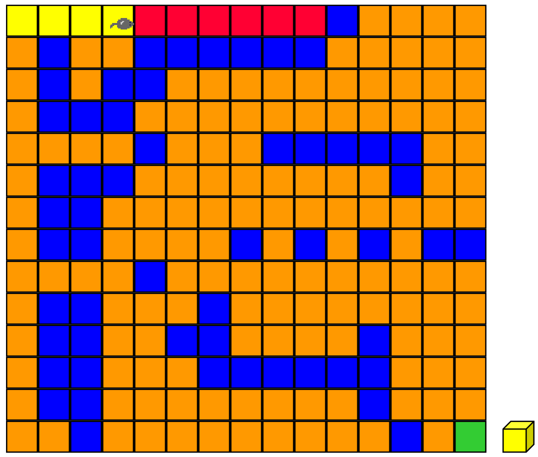
Rat In A Maze



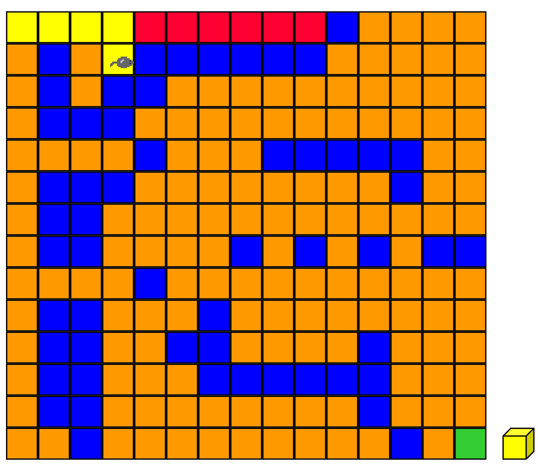
- Move backward until we reach a square from which a forward move is possible.

Rat In A Maze



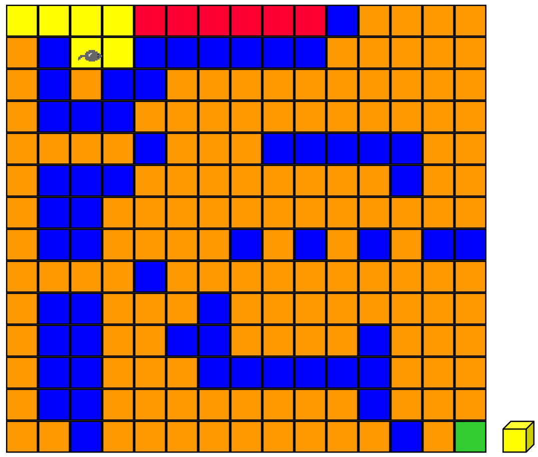
- Move down.

Rat In A Maze



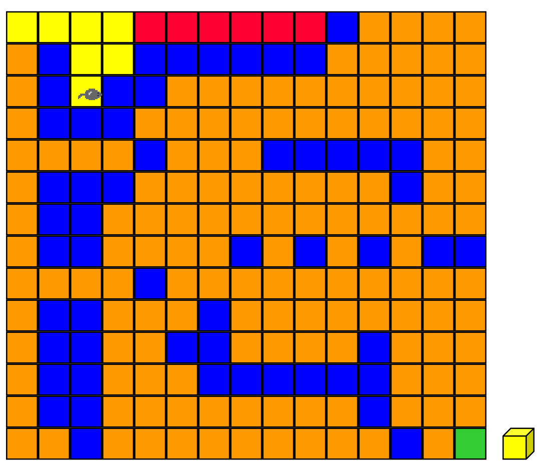
- Move left.

Rat In A Maze



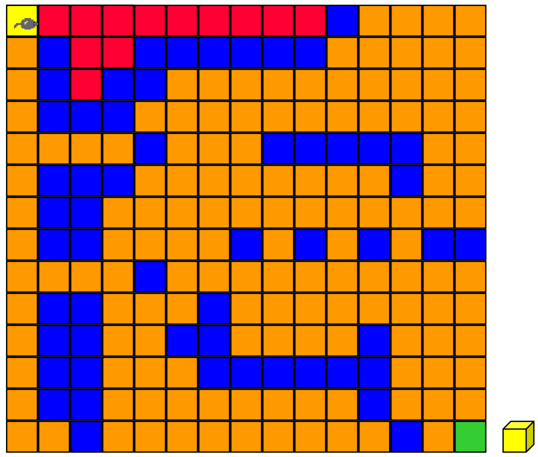
- Move down.

Rat In A Maze



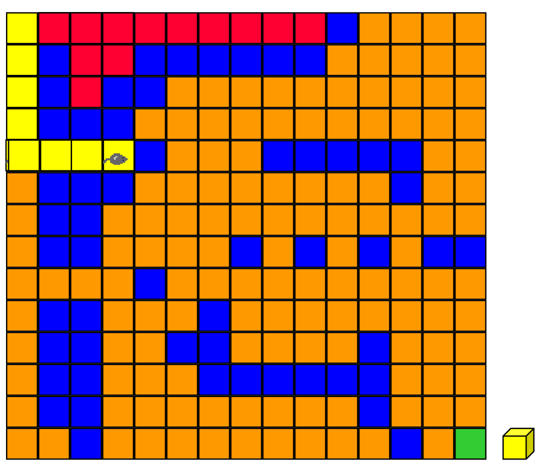
- Move backward until we reach a square from which a forward move is possible.

Rat In A Maze



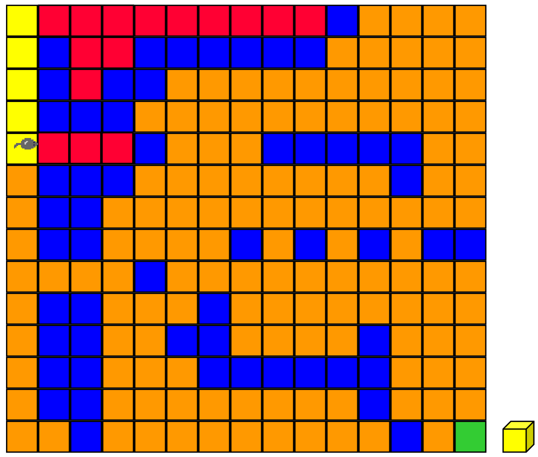
- Move backward until we reach a square from which a forward move is possible.
- Move downward.

Rat In A Maze



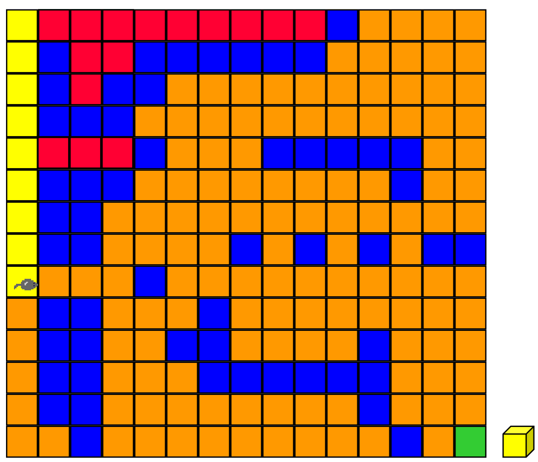
- Move right.
- Backtrack.

Rat In A Maze



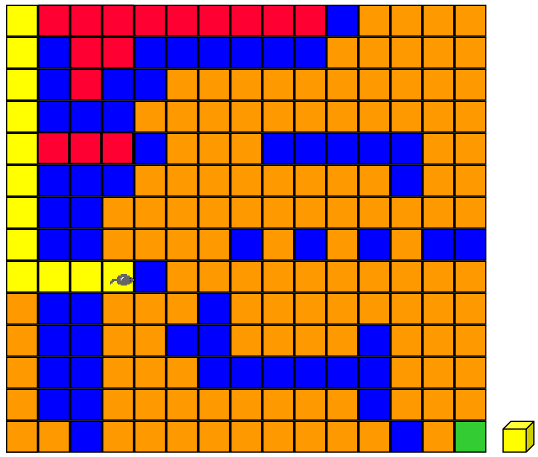
- Move downward.

Rat In A Maze



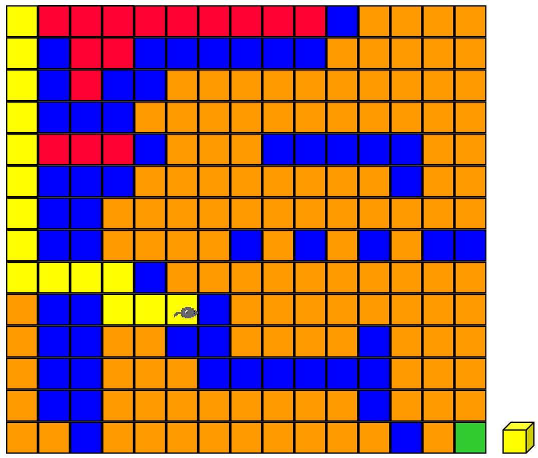
- Move right.

Rat In A Maze



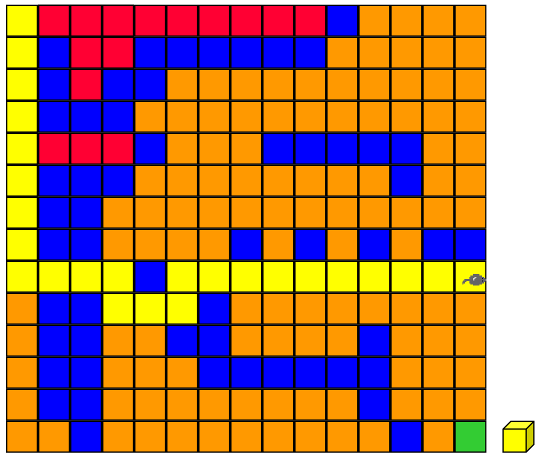
- Move one down and then right.

Rat In A Maze



- Move one up and then right.

Rat In A Maze



- Move down to exit and eat cheese.
- Path from maze entry to current position operates as a stack.