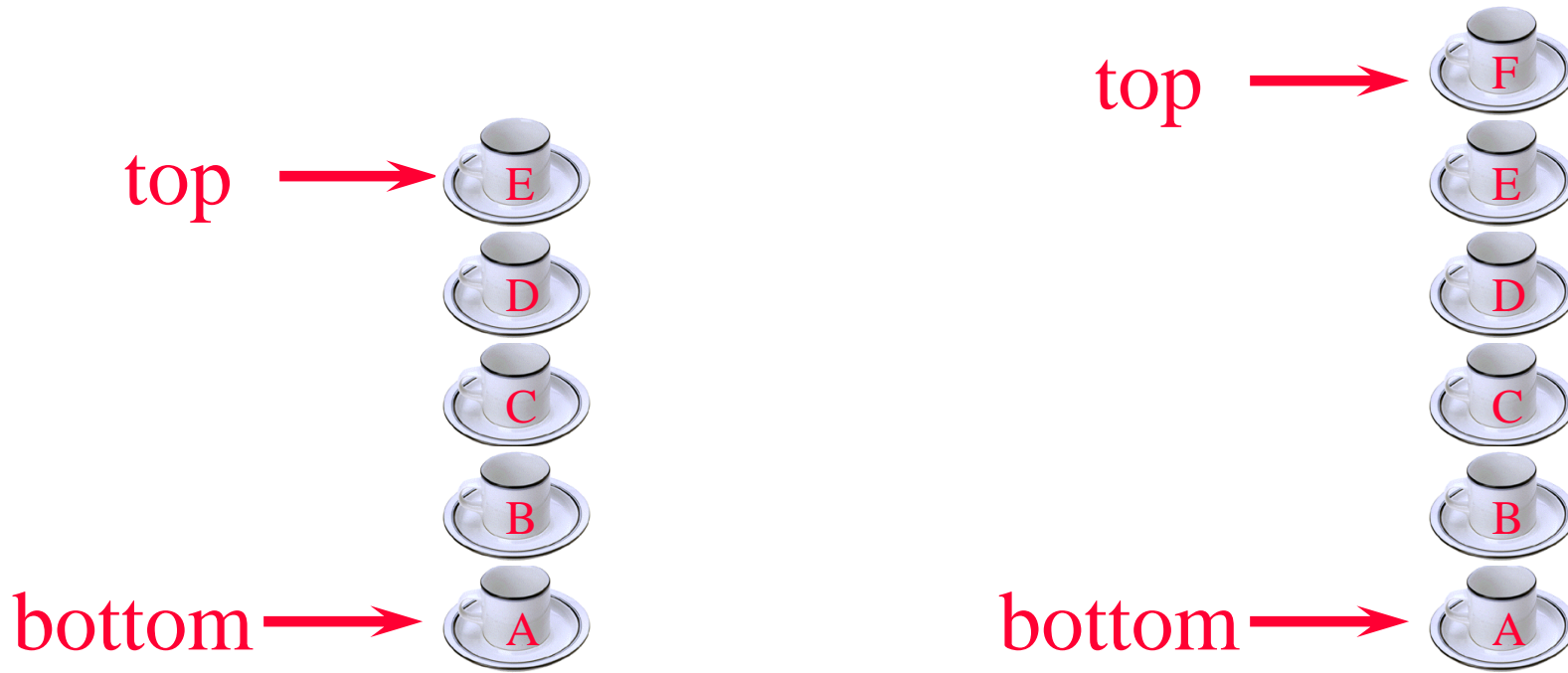


Stacks

- Linear list.
- One end is called **top**.
- Other end is called **bottom**.
- Additions 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();
}
```

Reversing data items

- Reversing data items requires that a given set of data items be reordered so that the first and last items are exchanged, with all of the positions between the first and last also being relatively exchanged.
- For example, the list (2, 4, 7, 1, 6, 8) becomes
(8, 6, 1, 7, 4, 2).

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

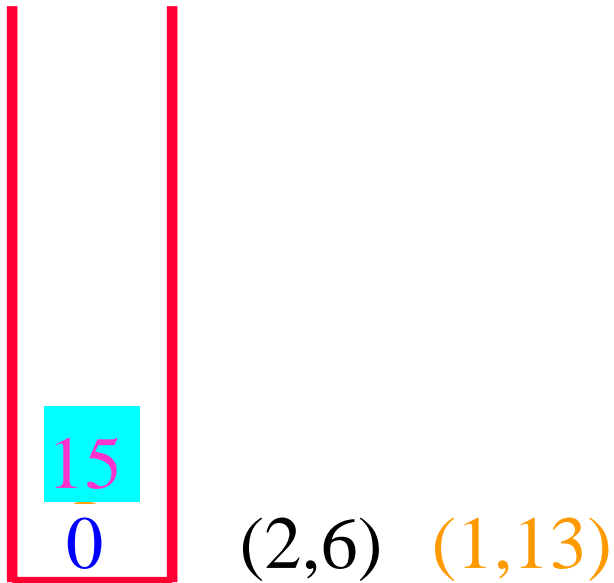
Example

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

2
1
0

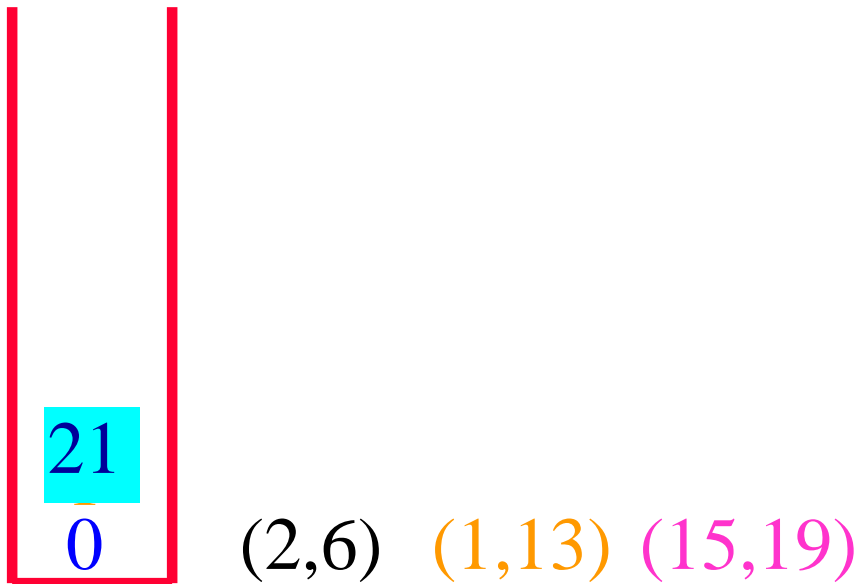
Example

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



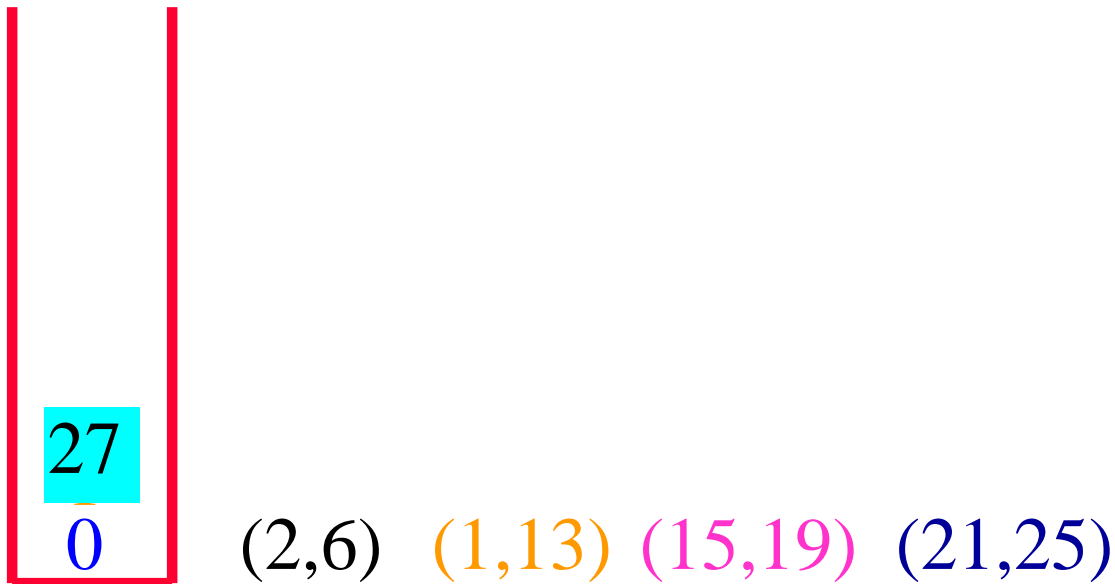
Example

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



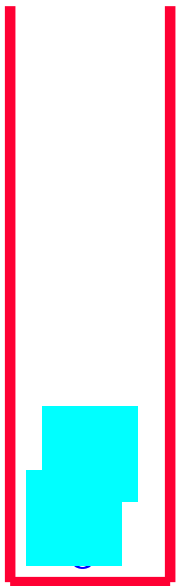
Example

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



Example

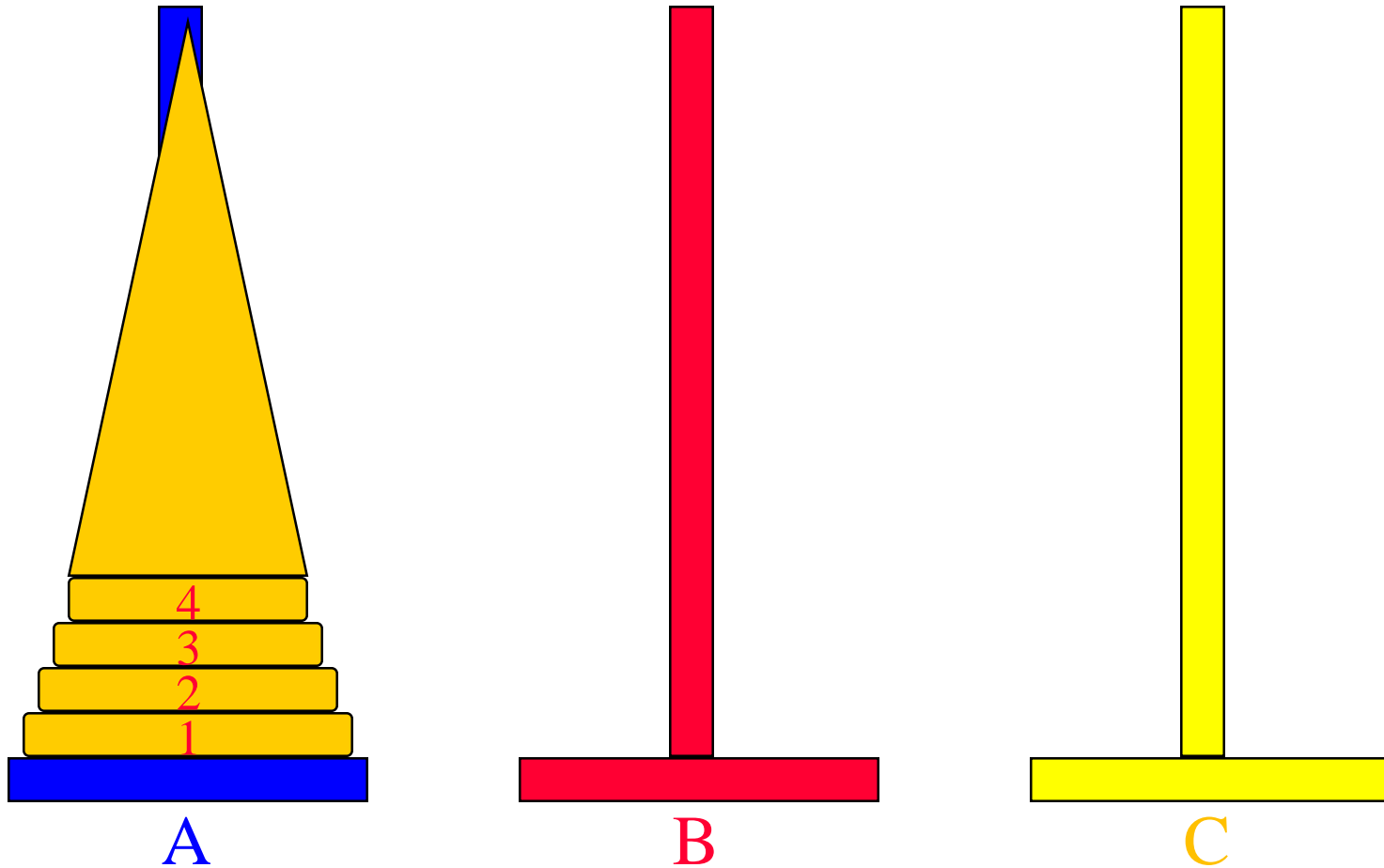
- $((a+b)*c+d-e)/(f+g)-(h+j)*(k-l))/(m-n)$



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

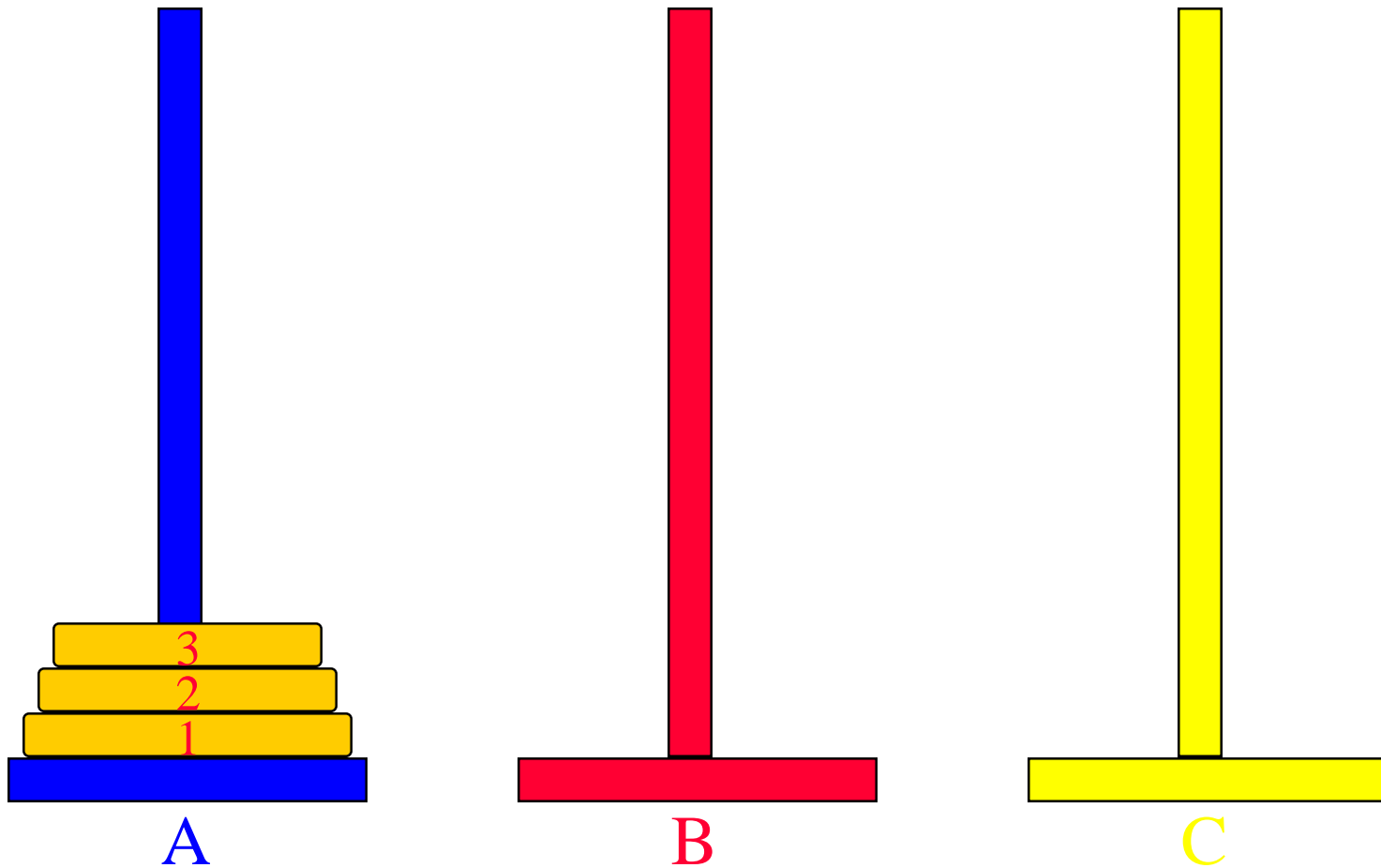
- and so on

Towers Of Hanoi/Brahma



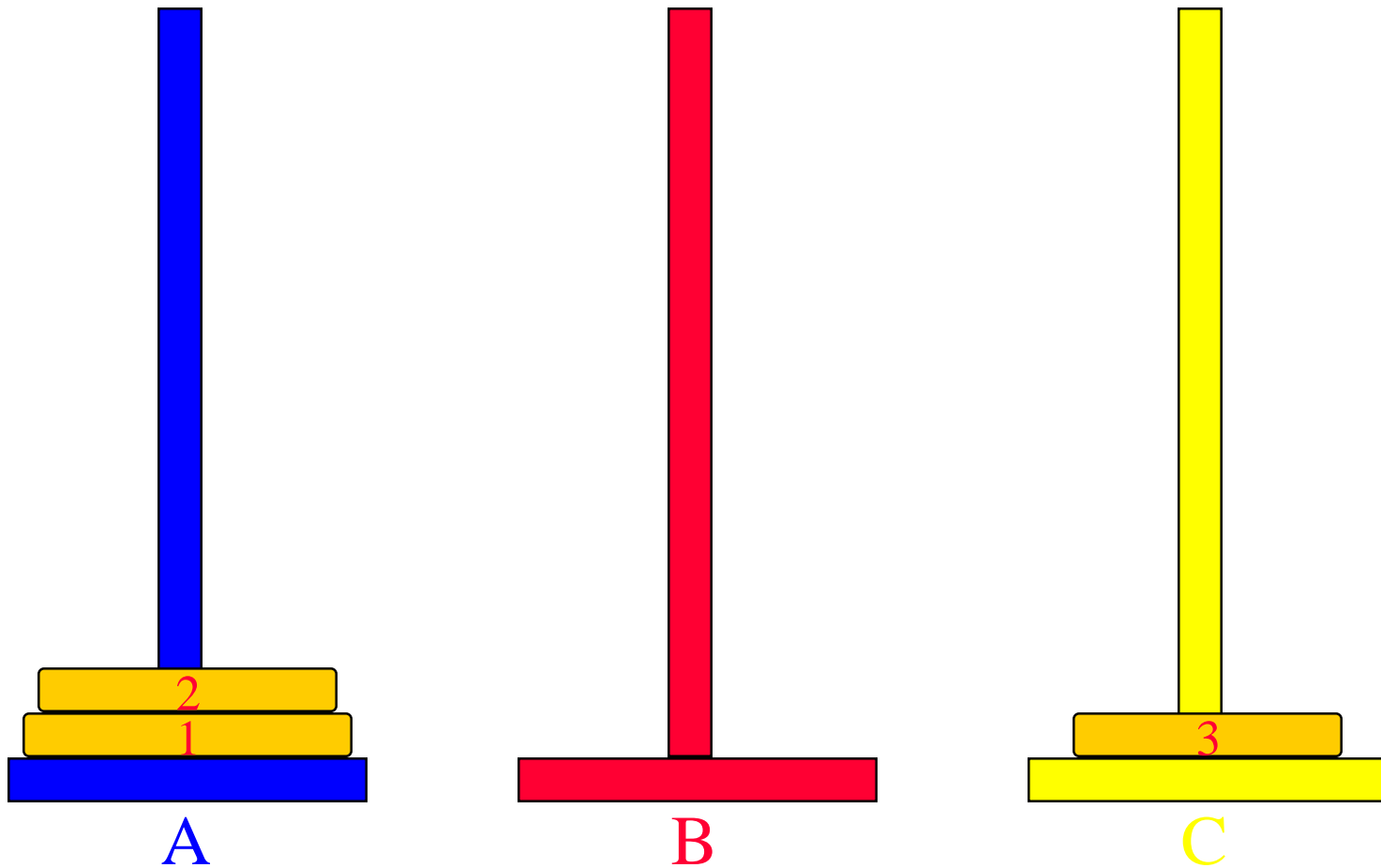
- 64 gold disks to be moved from tower A to tower C
- each tower operates as a stack
- cannot place big disk on top of a smaller one

Towers Of Hanoi/Brahma



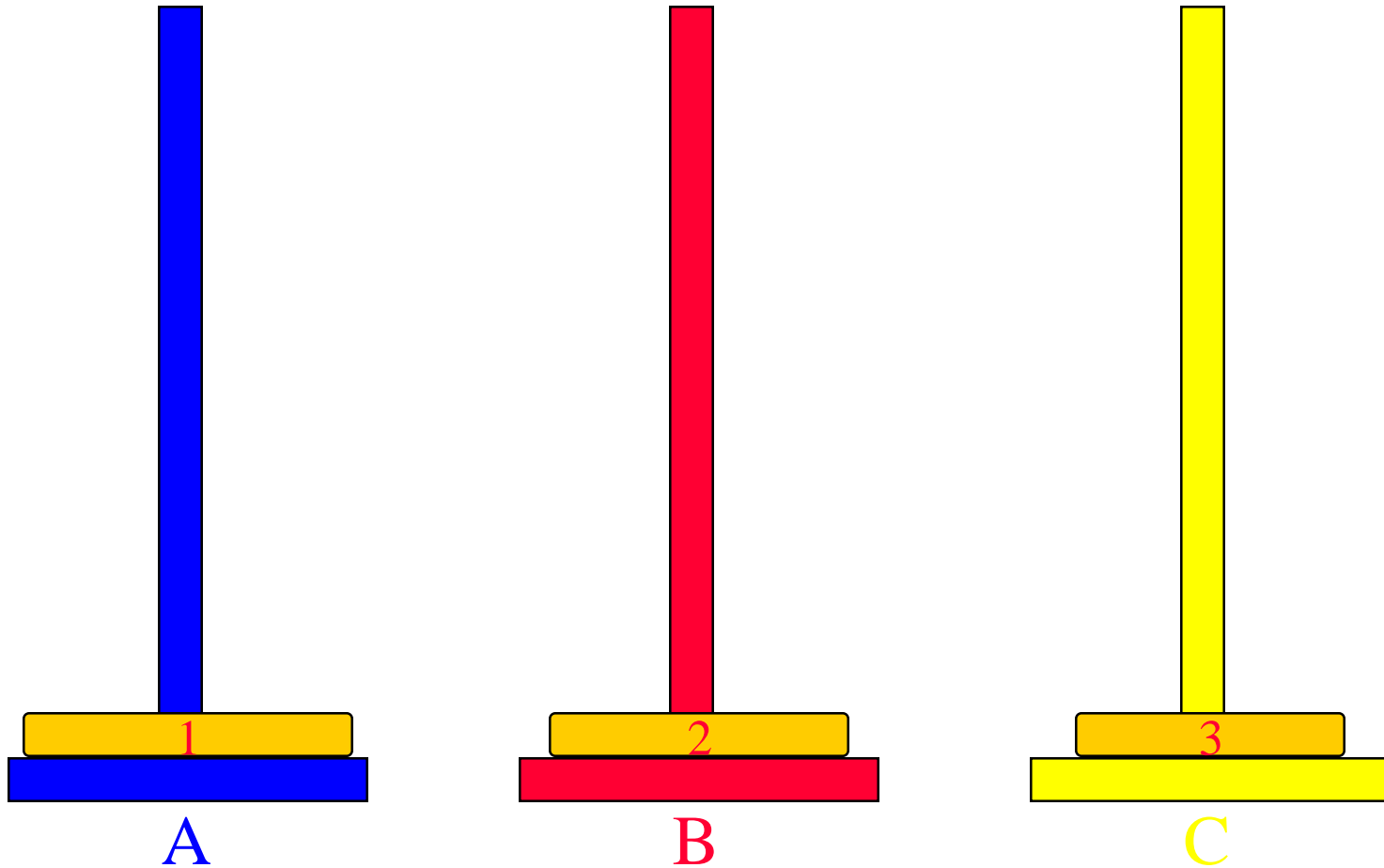
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



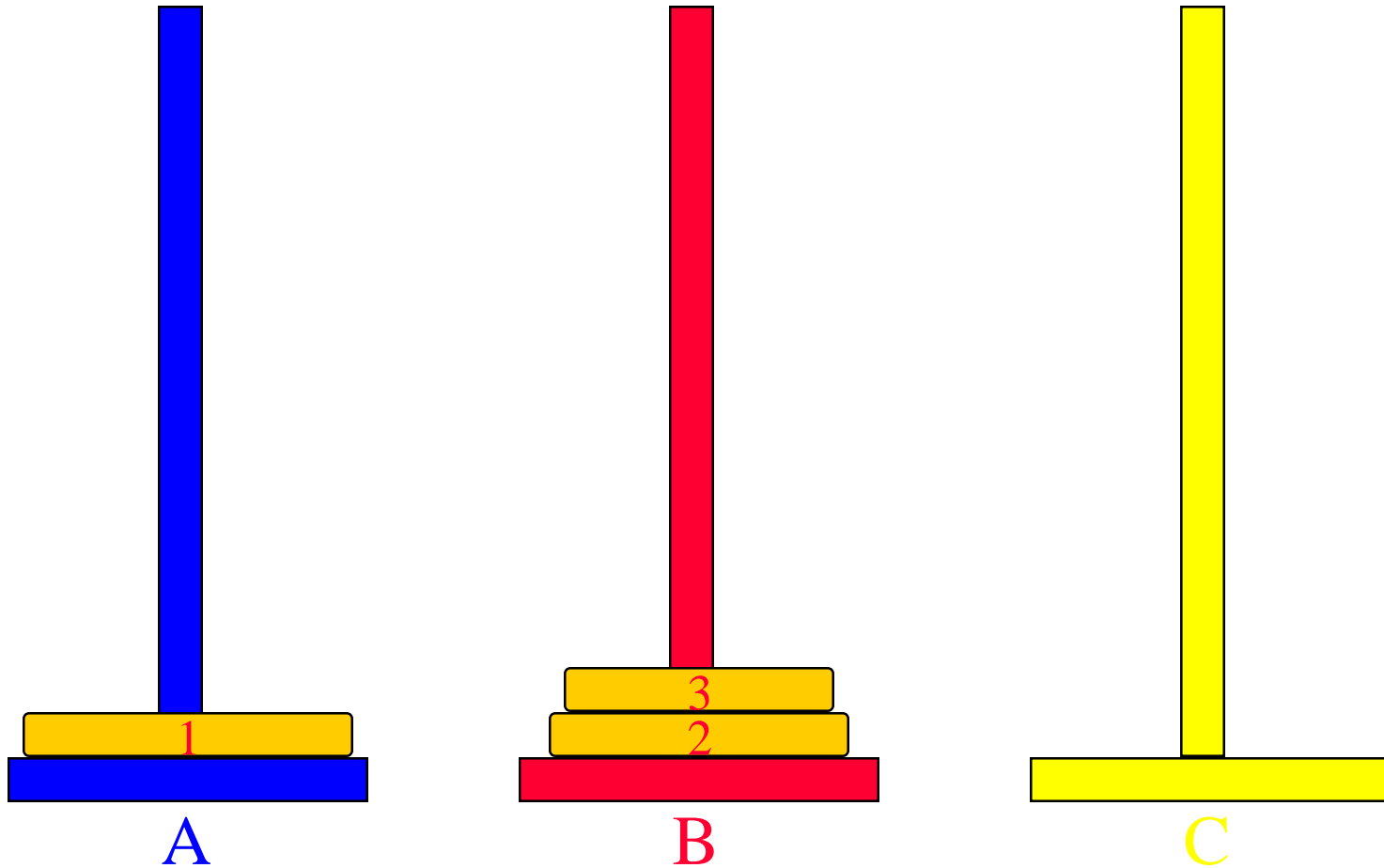
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



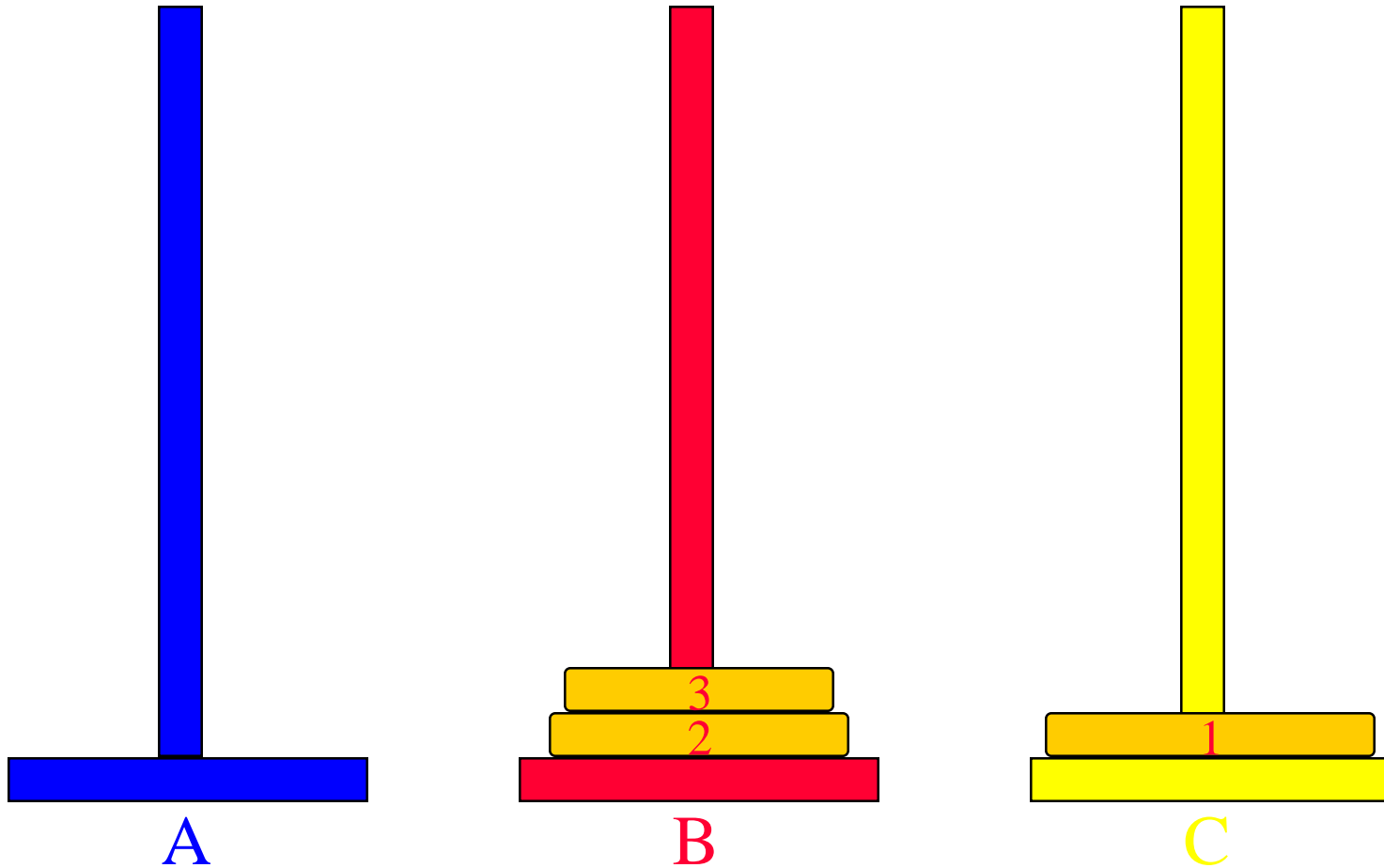
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



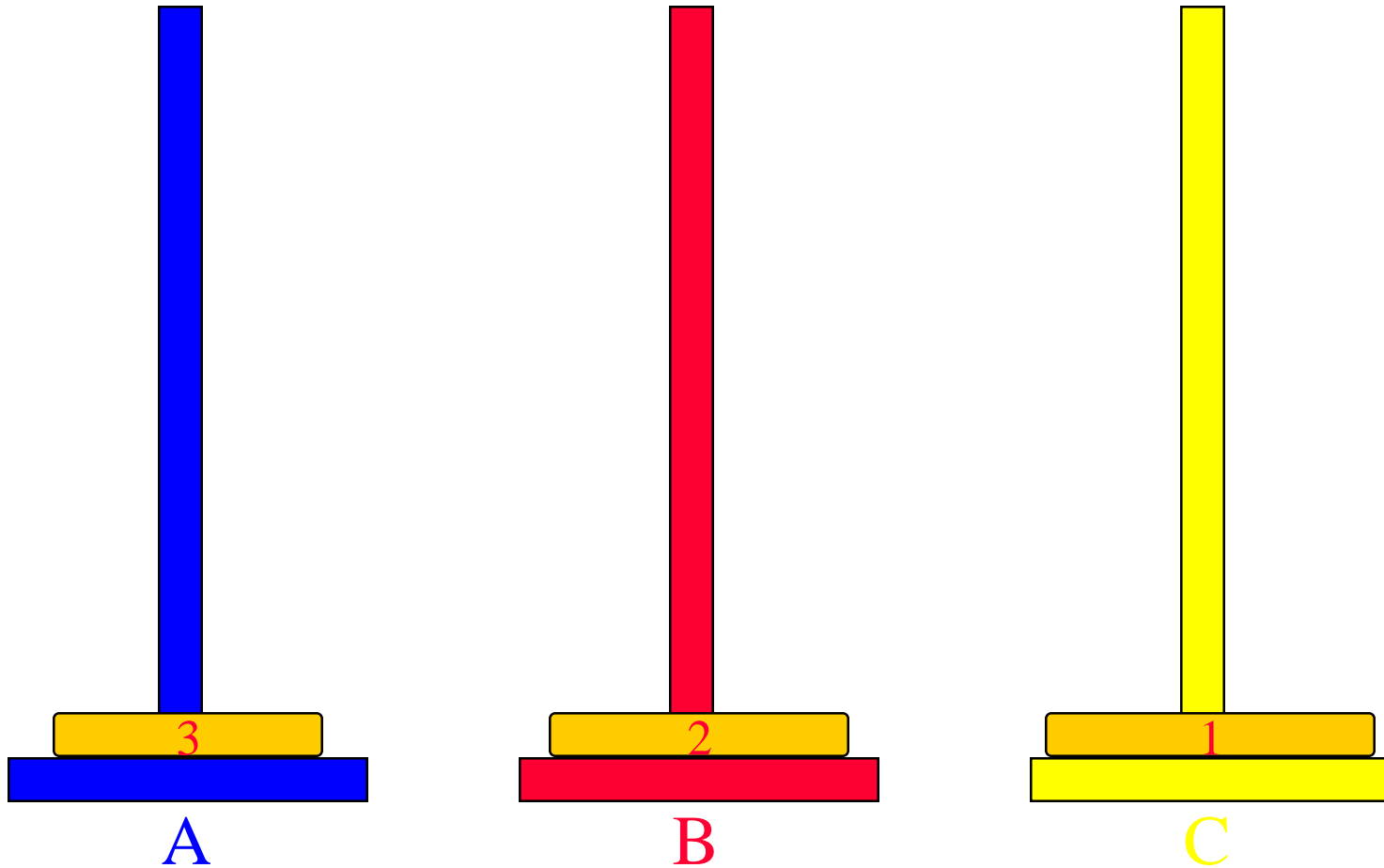
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



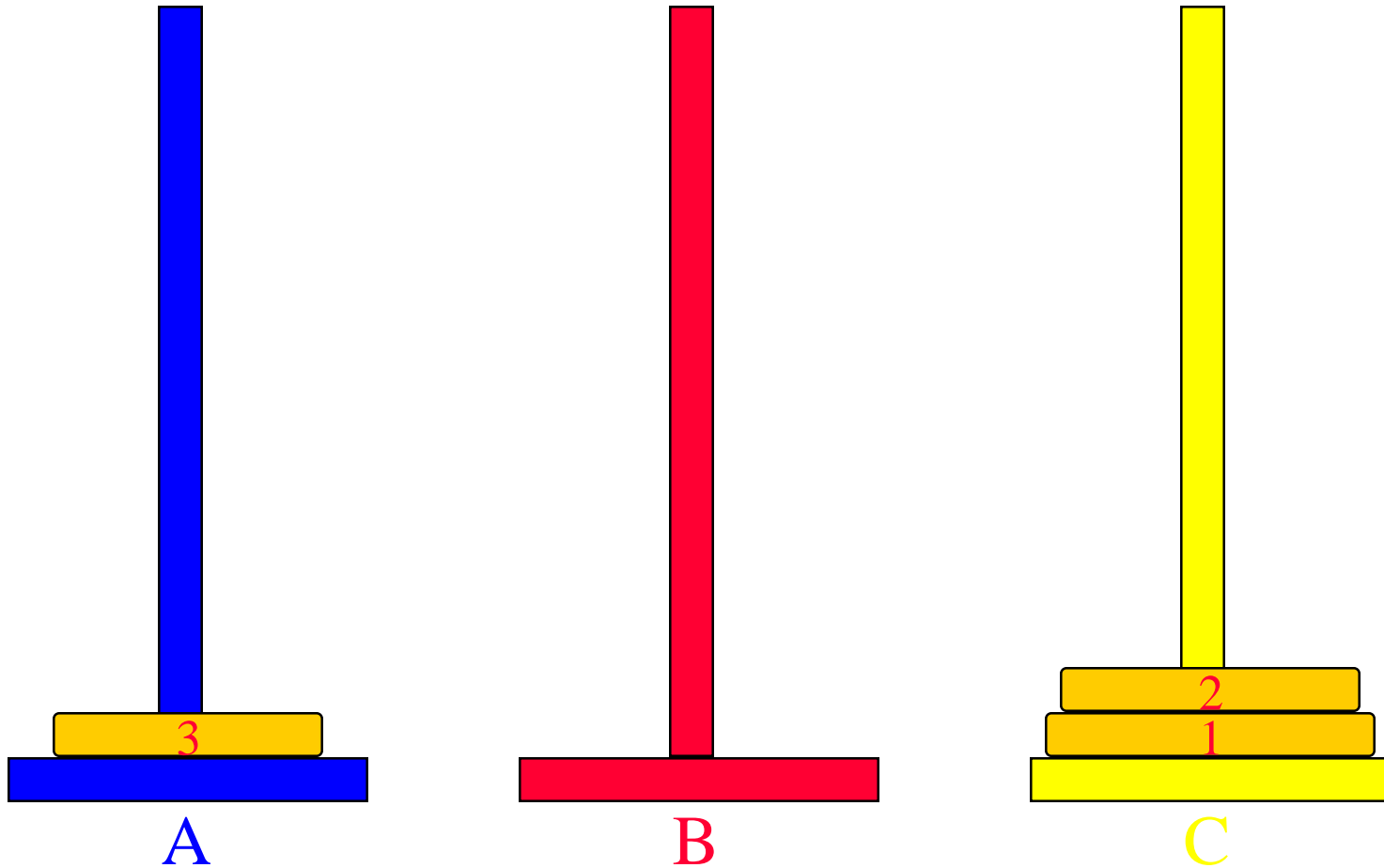
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



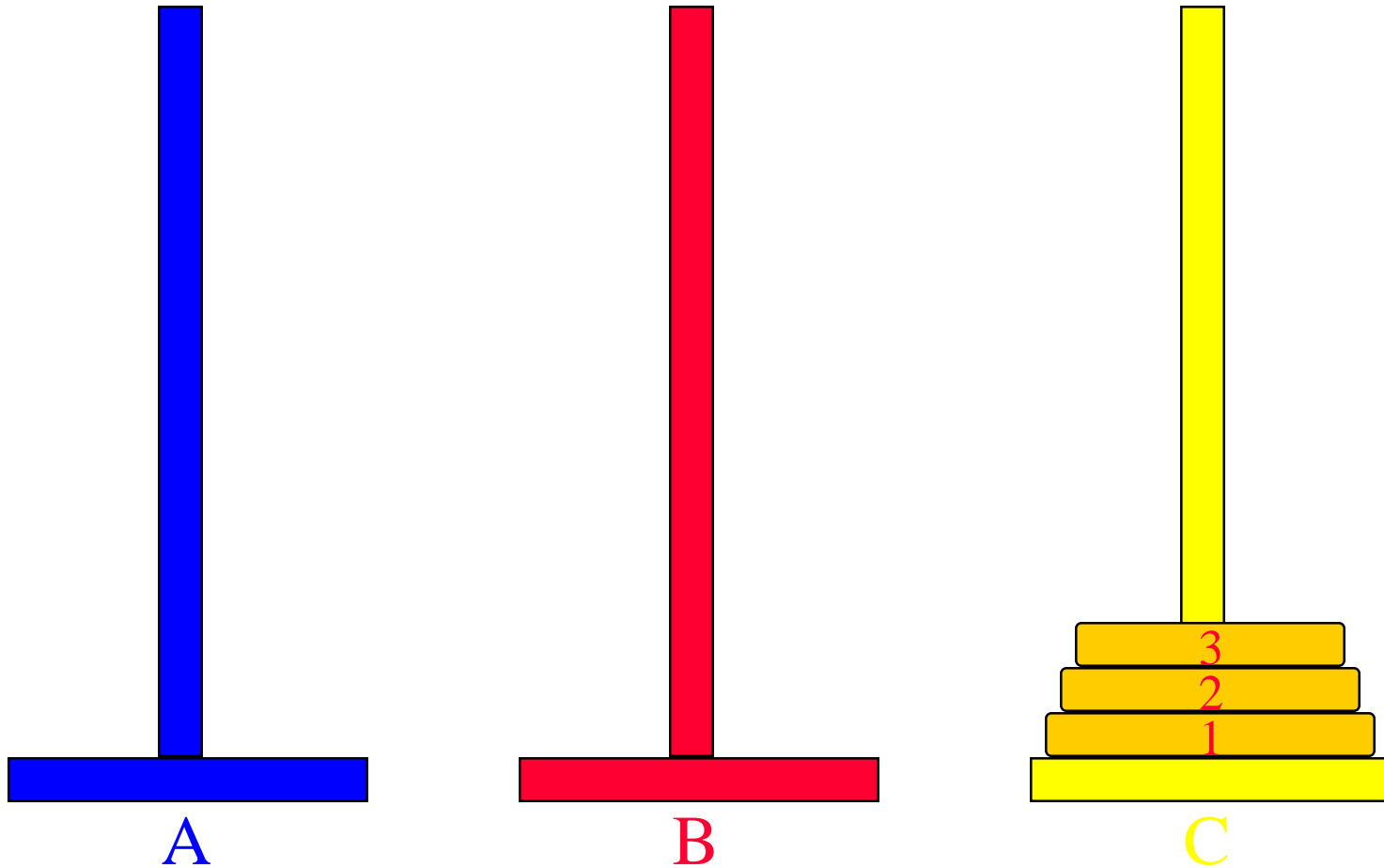
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



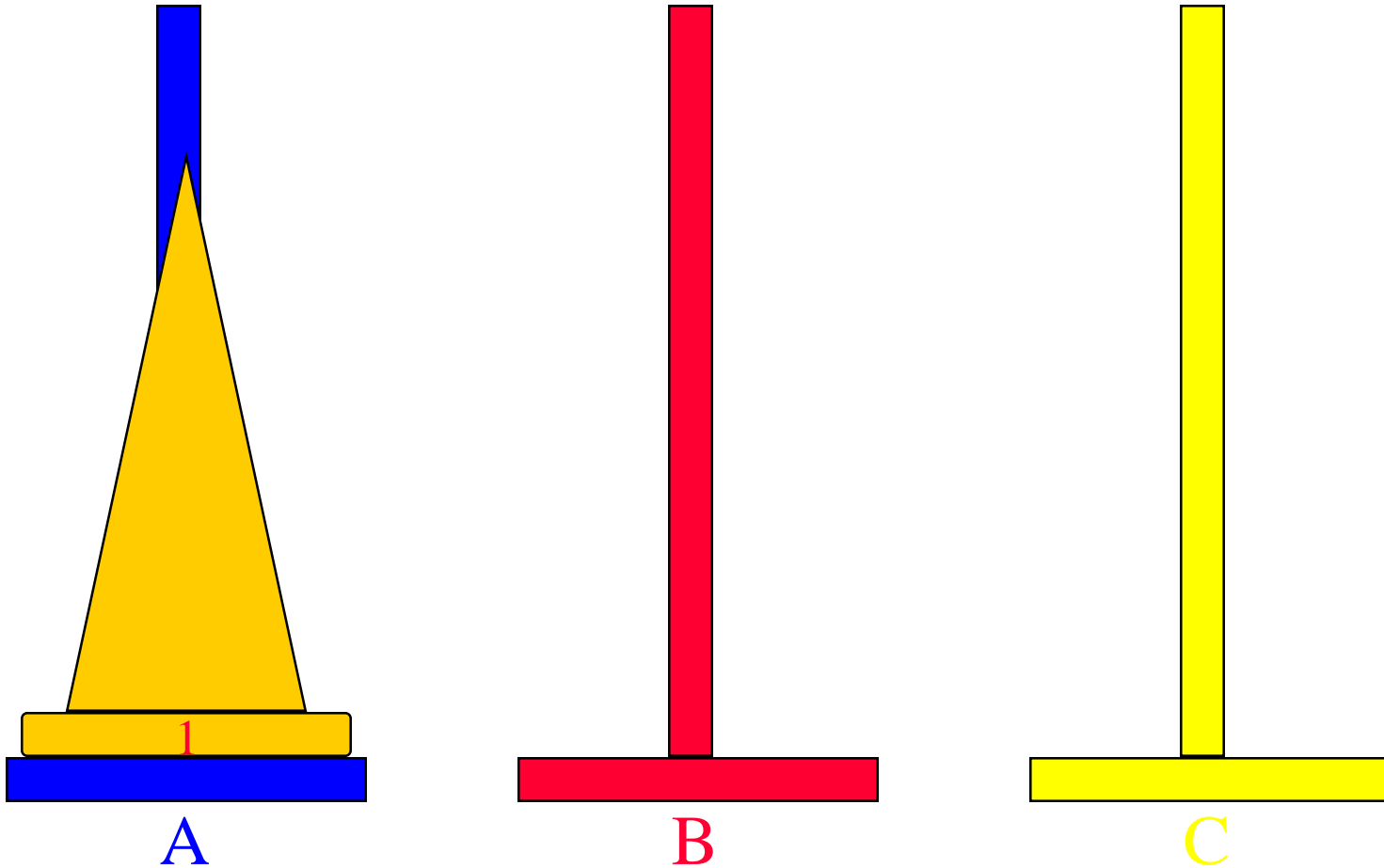
- 3-disk Towers Of Hanoi/Brahma

Towers Of Hanoi/Brahma



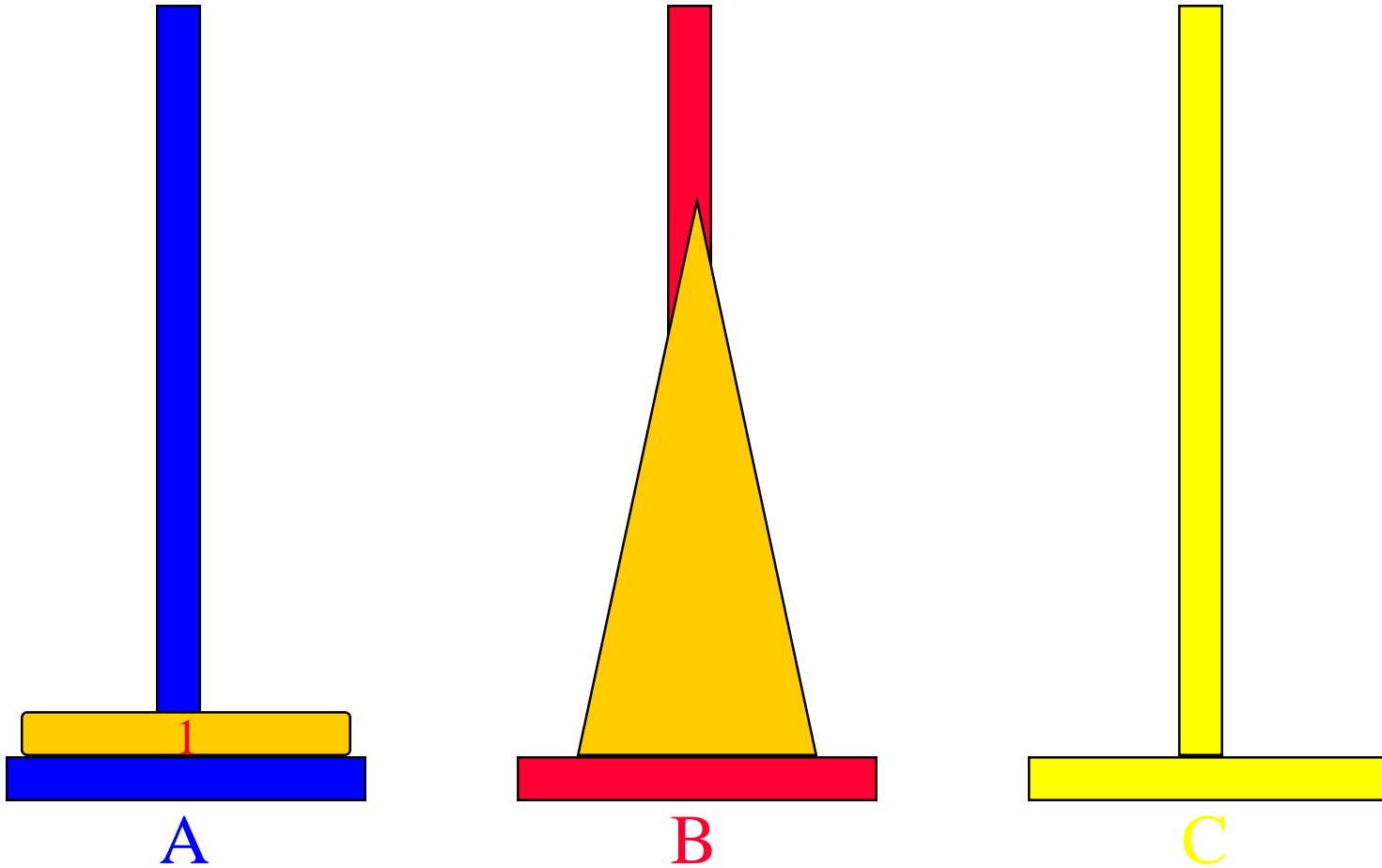
- 3-disk Towers Of Hanoi/Brahma
- 7 disk moves

Recursive Solution



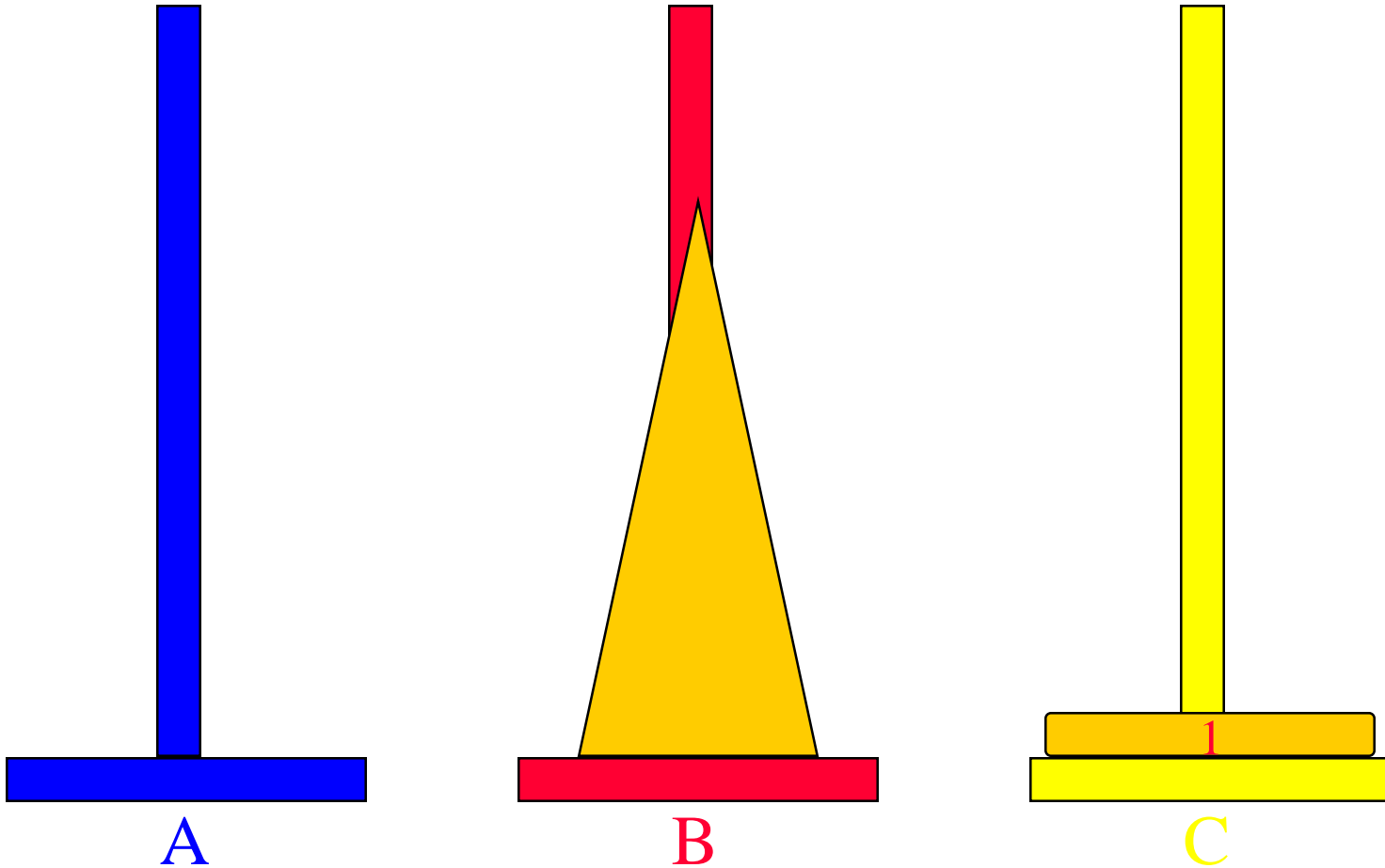
- $n > 0$ gold disks to be moved from A to C using B
- move top $n-1$ disks from A to B using C

Recursive Solution



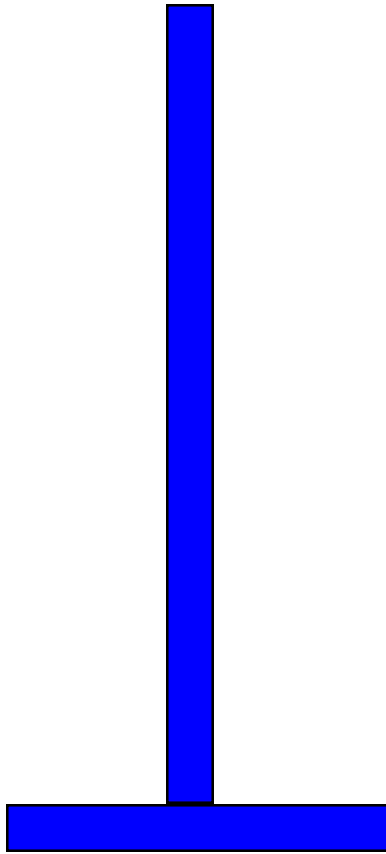
- move top disk from A to C

Recursive Solution

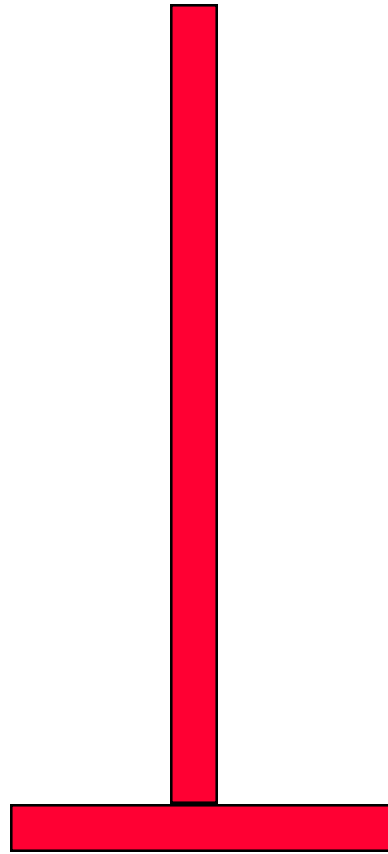


- move top $n-1$ disks from **B** to **C** using **A**

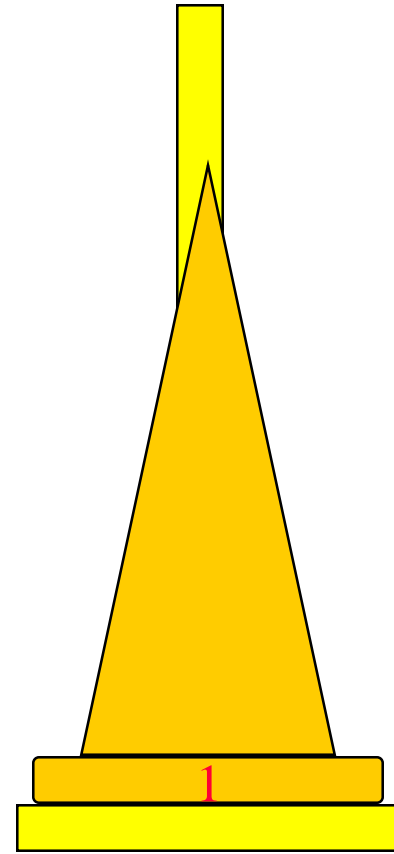
Recursive Solution



A



B



C

- $\text{moves}(n) = 0$ when $n = 0$
- $\text{moves}(n) = 2 * \text{moves}(n-1) + 1 = 2^n - 1$ when $n > 0$

Towers Of Hanoi/Brahma

- $\text{moves}(64) = 1.8 * 10^{19}$ (approximately)
- Performing 10^9 moves/second, a computer would take about 570 years to complete.

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.

Decimal to binary

```
DecimaltoBinary()  
{ createStack(S)  
  while(number != 0)  
    remainder = number % 2  
    push(S,remainder)  
    number = number / 2  
  while(not Empty(S))  
    pop(S,x)  
    print(x)  
}
```

Other examples

- Traversing in tree
- Solving expressions
- Find shortest path (in graphs)
-

Questions