Start Operation

```
// position current before the first
// list element
void start() {
     lastCurrentNode = headNode;
     currentNode = headNode;
};
```

Remove Operation

- Deletion is more than one step process.
- First, locate the current node to be removed, by using searching algorithms.
- The last current node now should point to the next node of the current node.

lastCurrentNode->setNext(currentNode->getNext());

Remove Operation

- Now we simply deallocate memory and wipe off the current node completely.

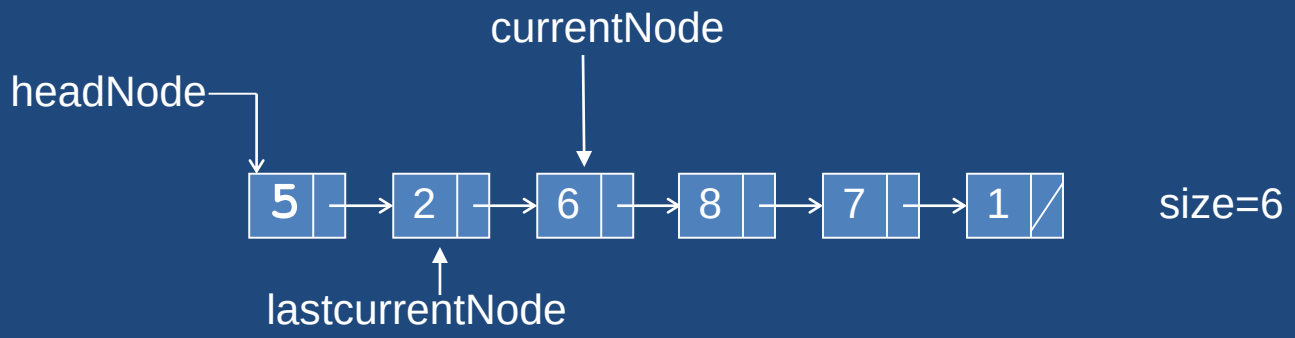
```
delete currentNode;
```

- Change the current pointer and decrease the size.

```
currentNode = lastCurrentNode->getNext();
size--;
```

Remove Operation

```
void remove() {
  if( currentNode != NULL || currentNode != headNode)
    {
        lastCurrentNode->setNext(currentNode->getNext());
        delete currentNode;
        currentNode = lastCurrentNode->getNext();
        size--;
  }
};
```



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void remove() {
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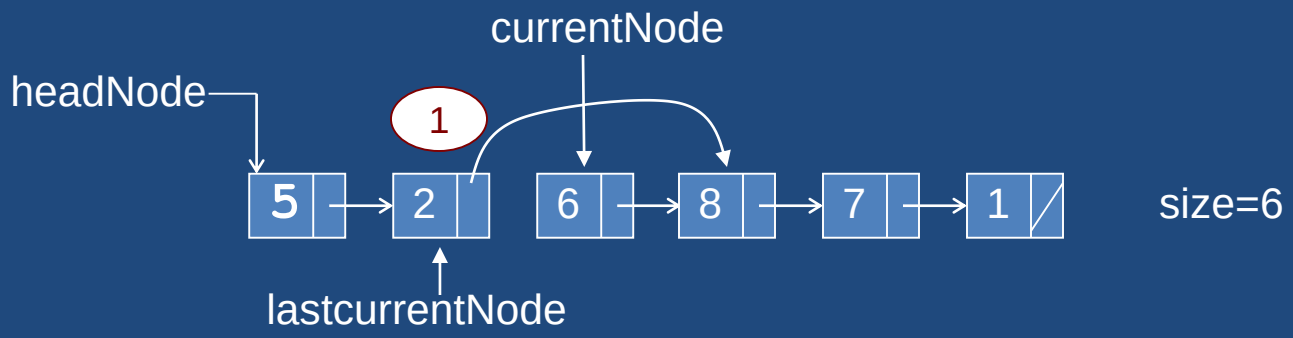

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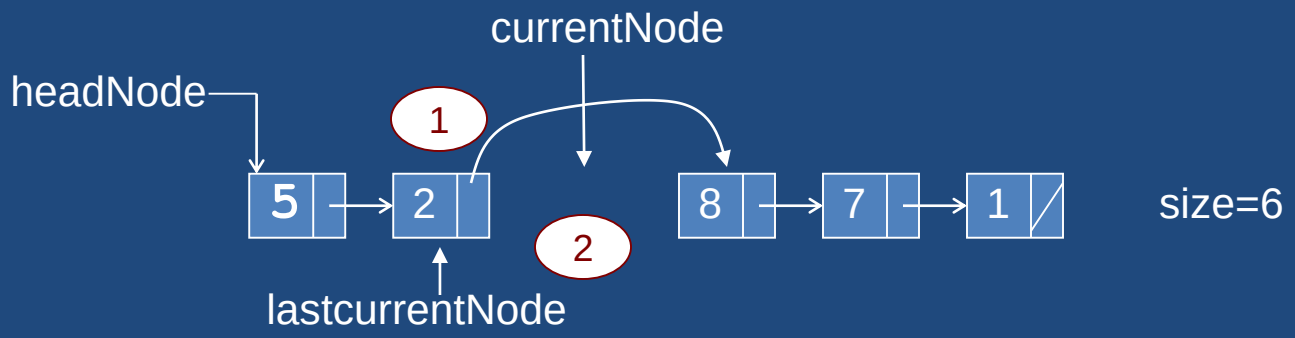

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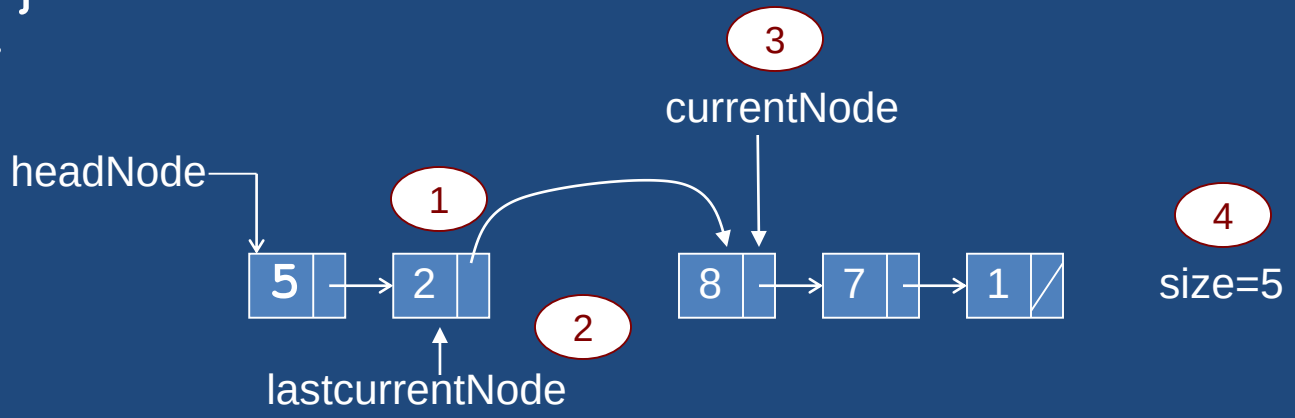

C++ Code for Linked List

```
int length()
{
   return size;
};

private:
   int size;
   Node *headNode;
   Node *currentNode, *lastCurrentNode;
```

Example of List Usage

```
#include <iostream>
#include <stdlib.h>
#include "List.cpp"

int main(int argc, char *argv[])
{
    List list;

    list.add(5); list.add(13); list.add(4);
    list.add(8); list.add(24); list.add(48);
    list.add(12);
    list.start();
    while (list.next())
       cout << "List Element: "<< list.get()<<endl;
}
```

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- Back

  moving the current pointer back one node requires traversing the list from the start until the node whose next pointer points to current node.

Doubly-linked List

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- To move back one node, we have to start at the head of the singly-linked list and move forward until the node before the current.
- To avoid this we can use *two* pointers in a node: one to point to next node and another to point to the previous node:

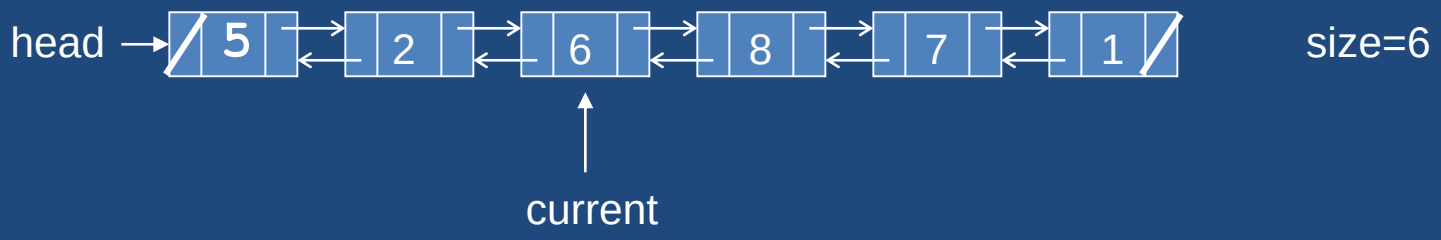
Doubly-Linked List Node

```
class Node {
public:
    int get() { return object; };
    void set(int object) { this->object = object; };

    Node* getNext() { return nextNode; };
    void setNext(Node* nextNode)
          { this->nextNode = nextNode; };
    Node* getPrev() { return prevNode; };
    void setPrev(Node* prevNode)
          { this->prevNode = prevNode; };
private:
    int object;
    Node* nextNode;
    Node* prevNode;
};
```

Doubly-linked List

- Need to be more careful when adding or removing a node.
- Consider add: the order in which pointers are reorganized is important:



Doubly-linked List

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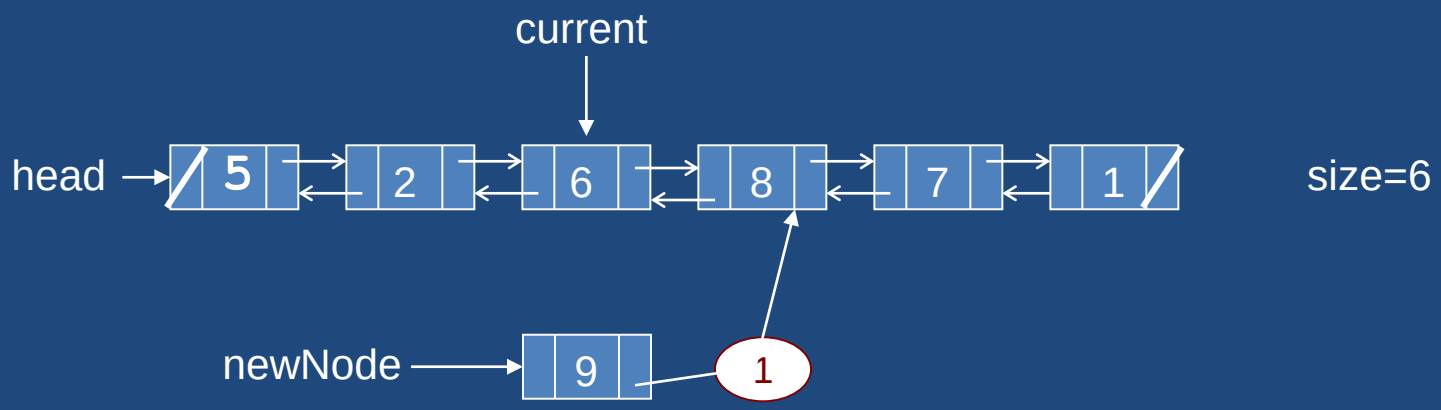
1.   newNode->setNext( current->getNext() );
```



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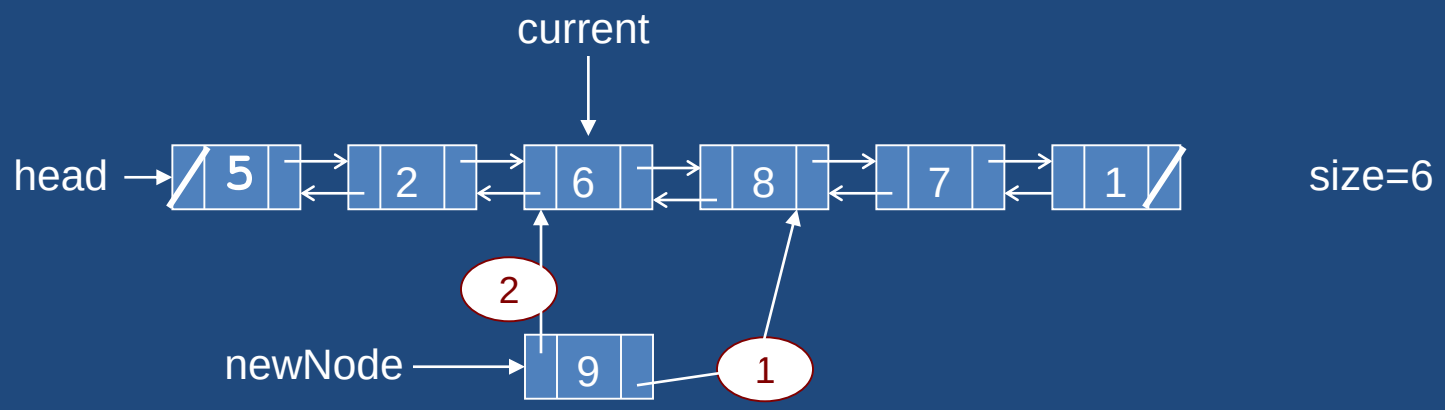

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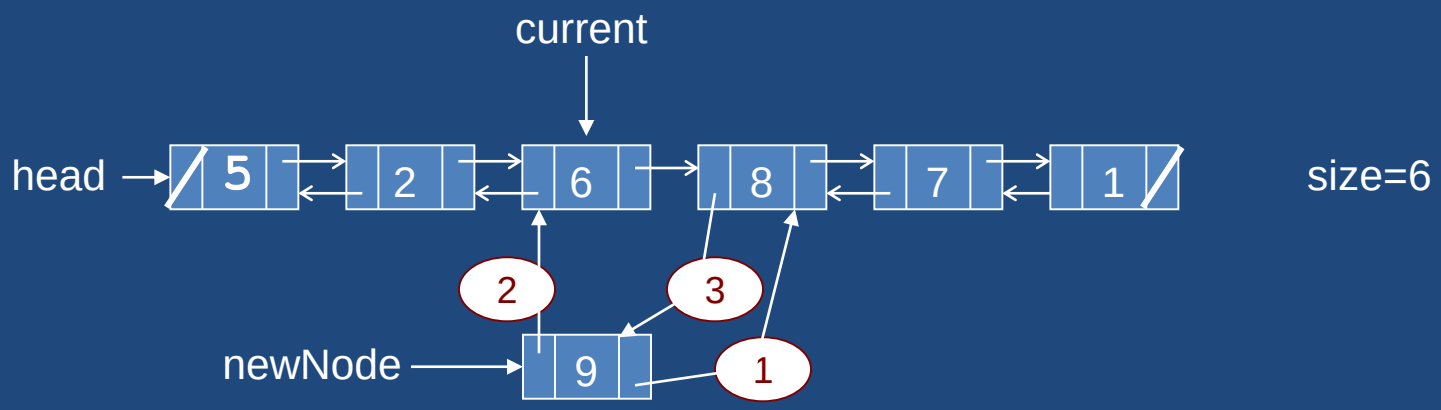

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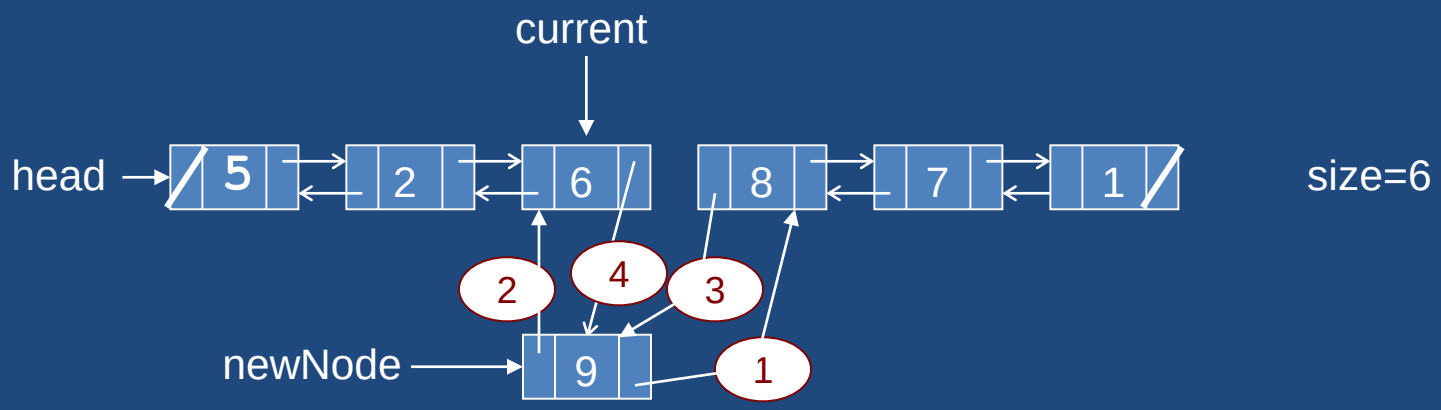

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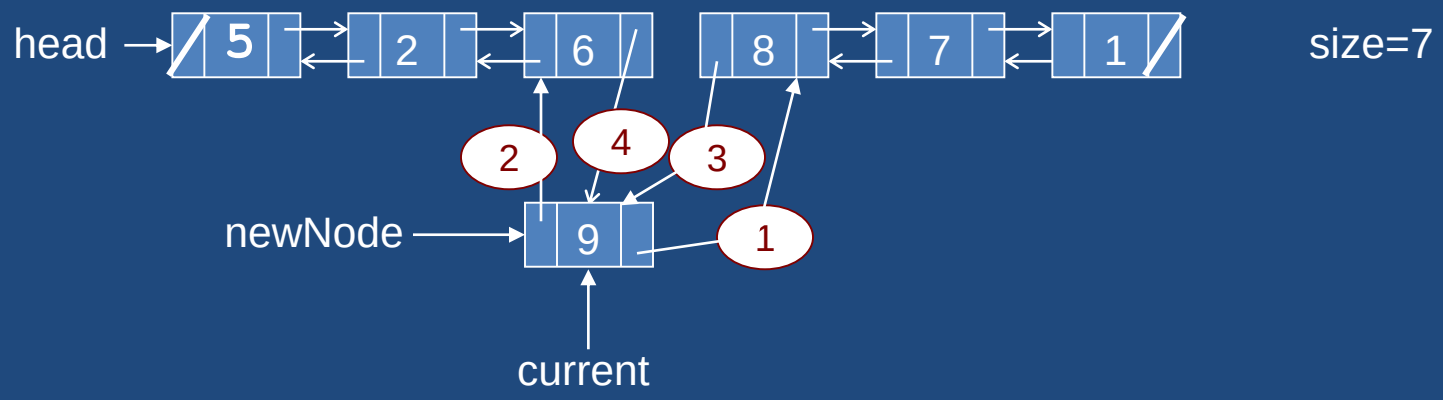
5.   current = newNode;
6.   size++;
```



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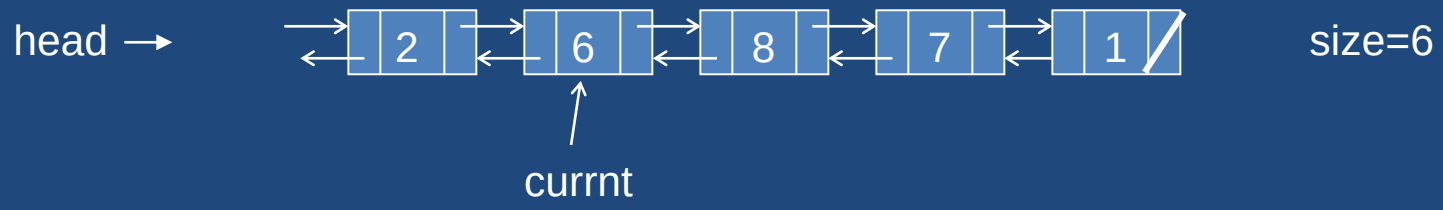

Circularly-linked lists

- The next field in the last node in a singly-linked list is set to NULL.
- Moving along a singly-linked list has to be done in a watchful manner.
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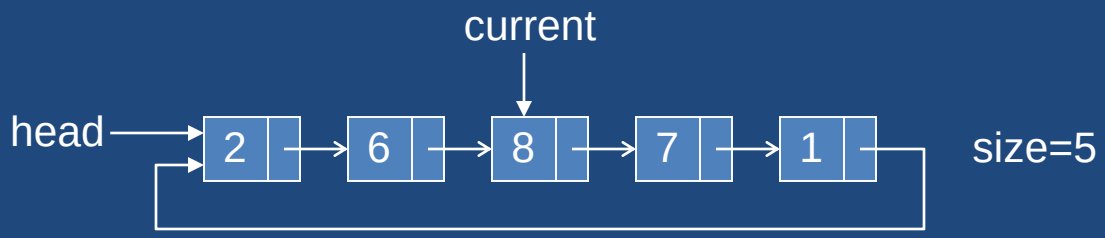
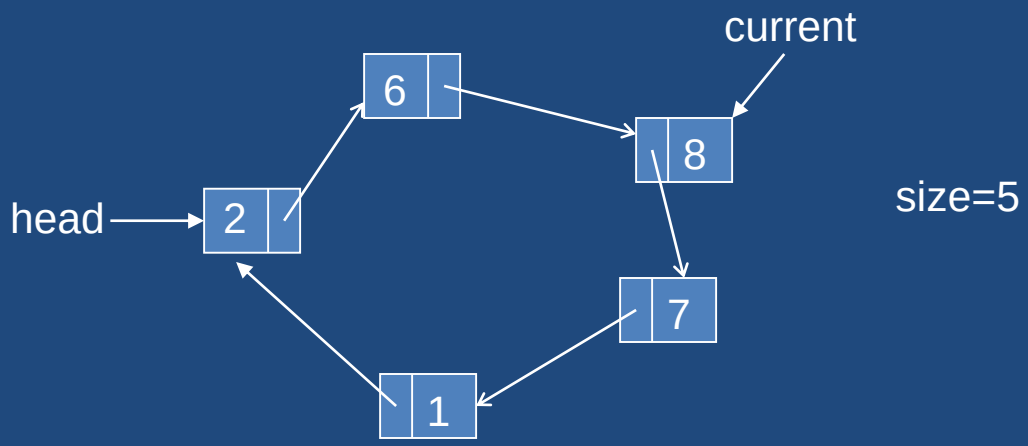
Cicularly Linked List

- Two views of a circularly linked list:





Josephus Problem

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- The count starts with the fifth and the next person to go is the fourth in count.
- Eventually, a single person remains.

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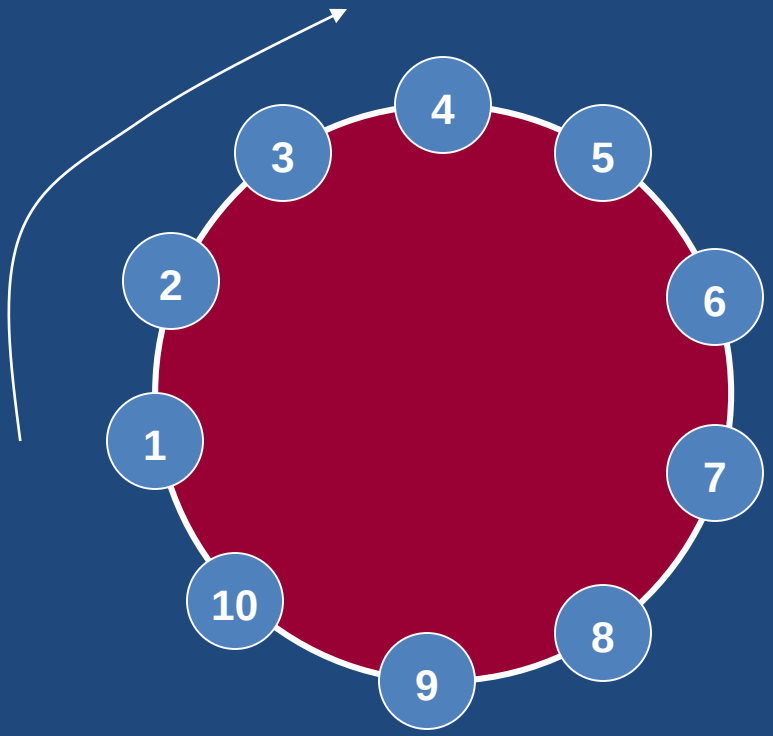

Josephus Problem

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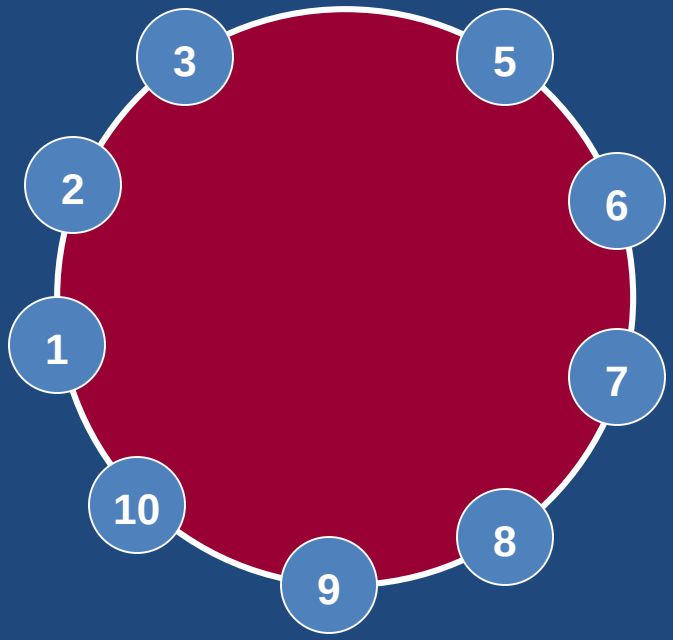
eliminated

4



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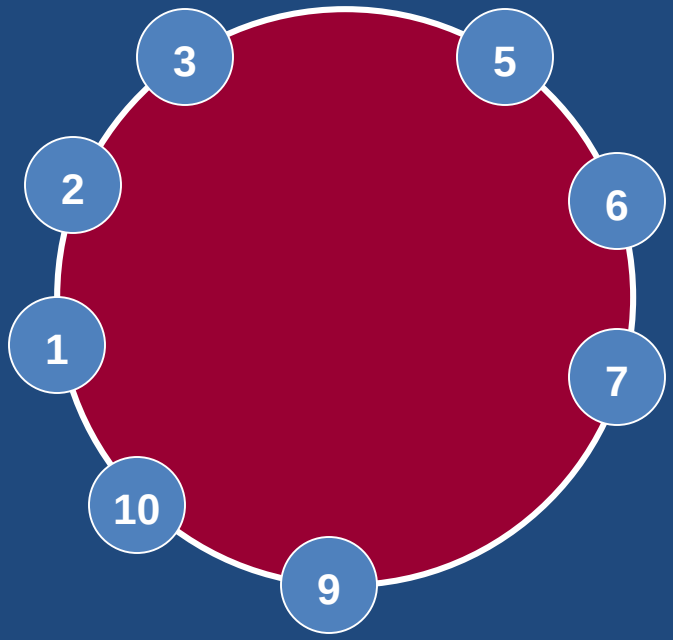

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4

8

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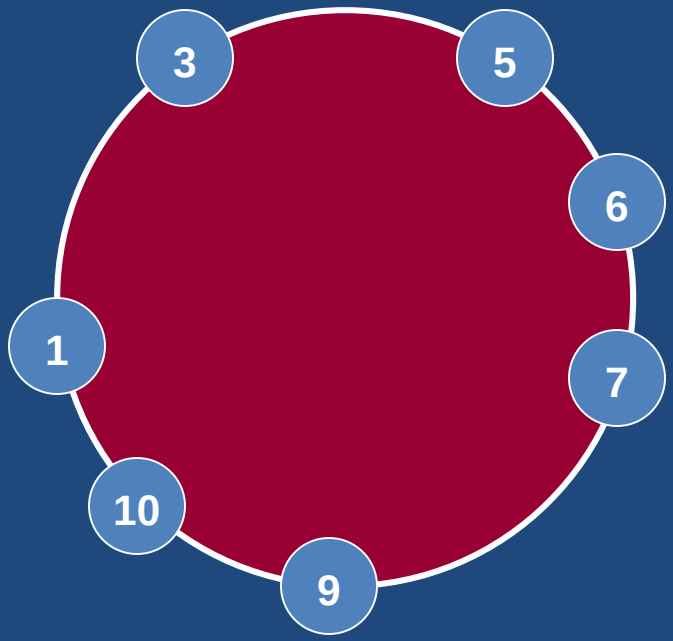

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4

8

2

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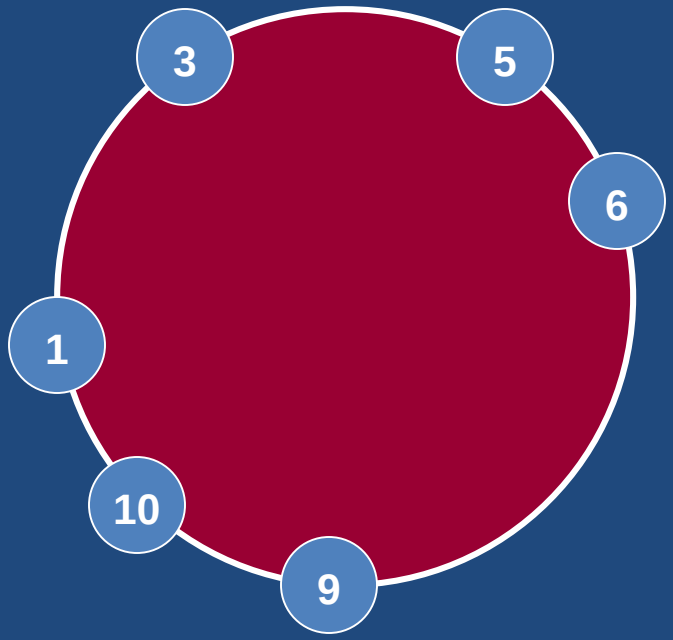

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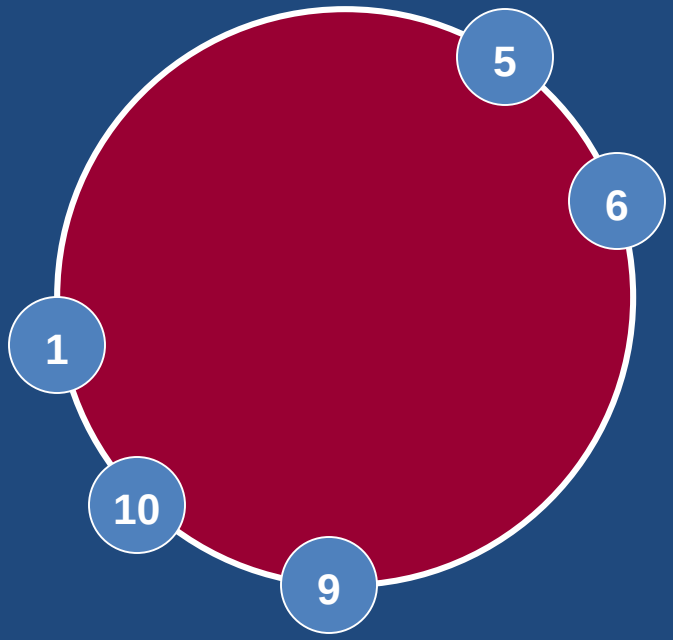

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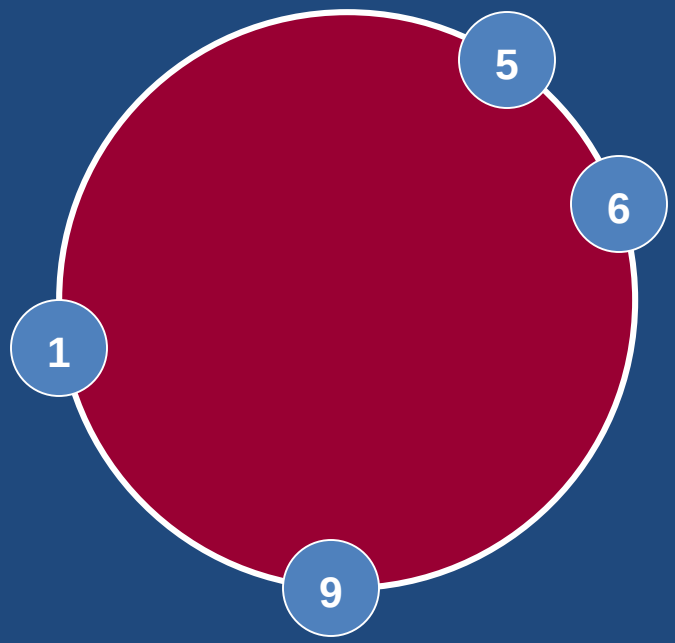

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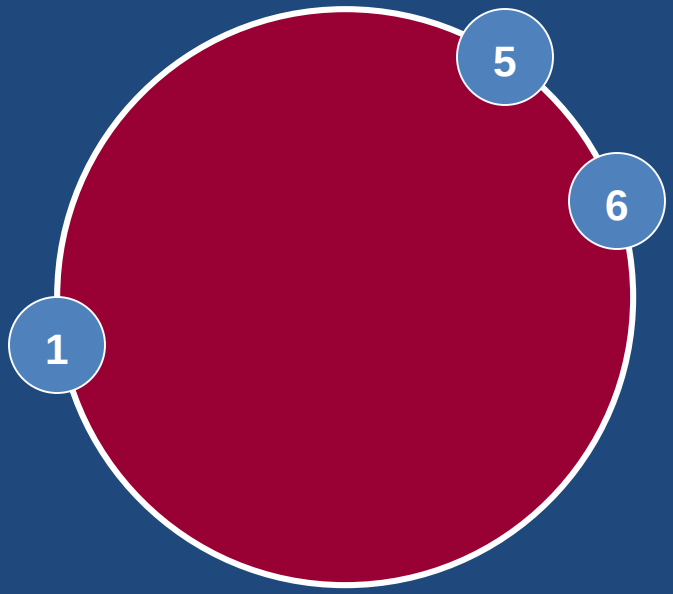

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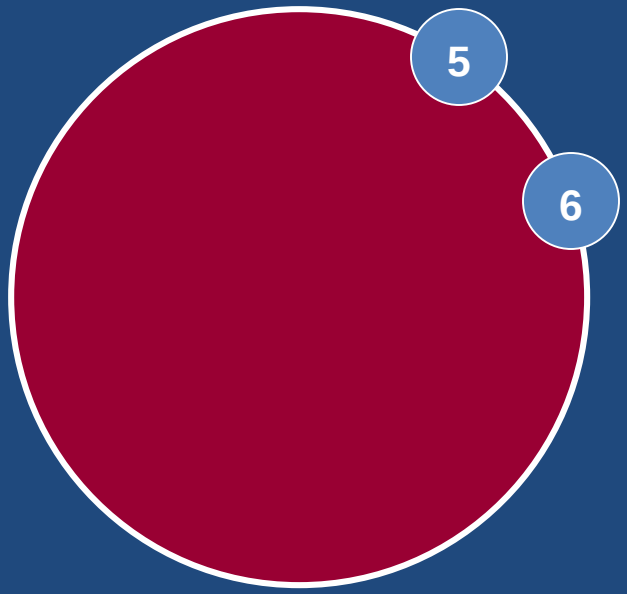

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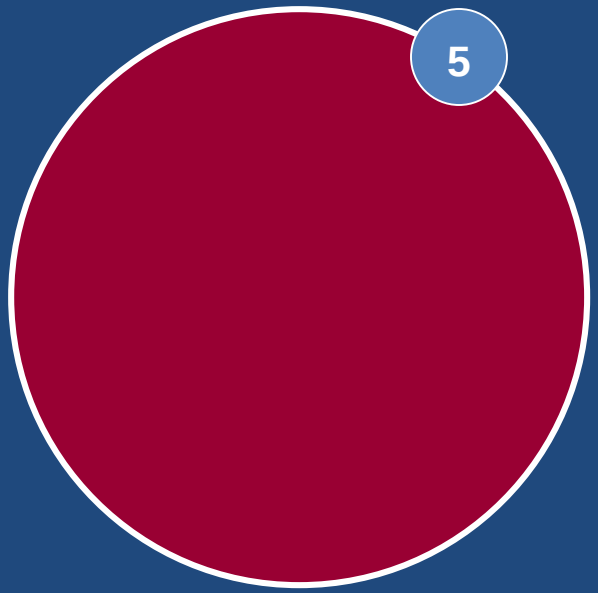

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#include "CList.cpp"
void main(int argc, char *argv[])
{
    CList list;
    int i, N=10, M=3;
    for(i=1; i <= N; i++ ) list.add(i);

    list.start();
    while( list.length() > 1 ) {
        for(i=1; i <= M; i++ ) list.next();
        cout << "remove: " << list.get() << endl;
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Josephus Problem

```
// Add elements in the list
   int i, N=10, M=3;
   for(i=1; i <= N; i++ ) list.add(i);

//Start josephus selection

   list.start();
   while( list.length() > 1 )
       for(i=1; i <= M; i++ ) list.next();
       cout << "remove: " << list.get() << endl;
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- The solution would have been more difficult if an array had been used.
- This illustrates the fact that the choice of the appropriate data structures can significantly simplify an algorithm. It can make the algorithm much faster and efficient.