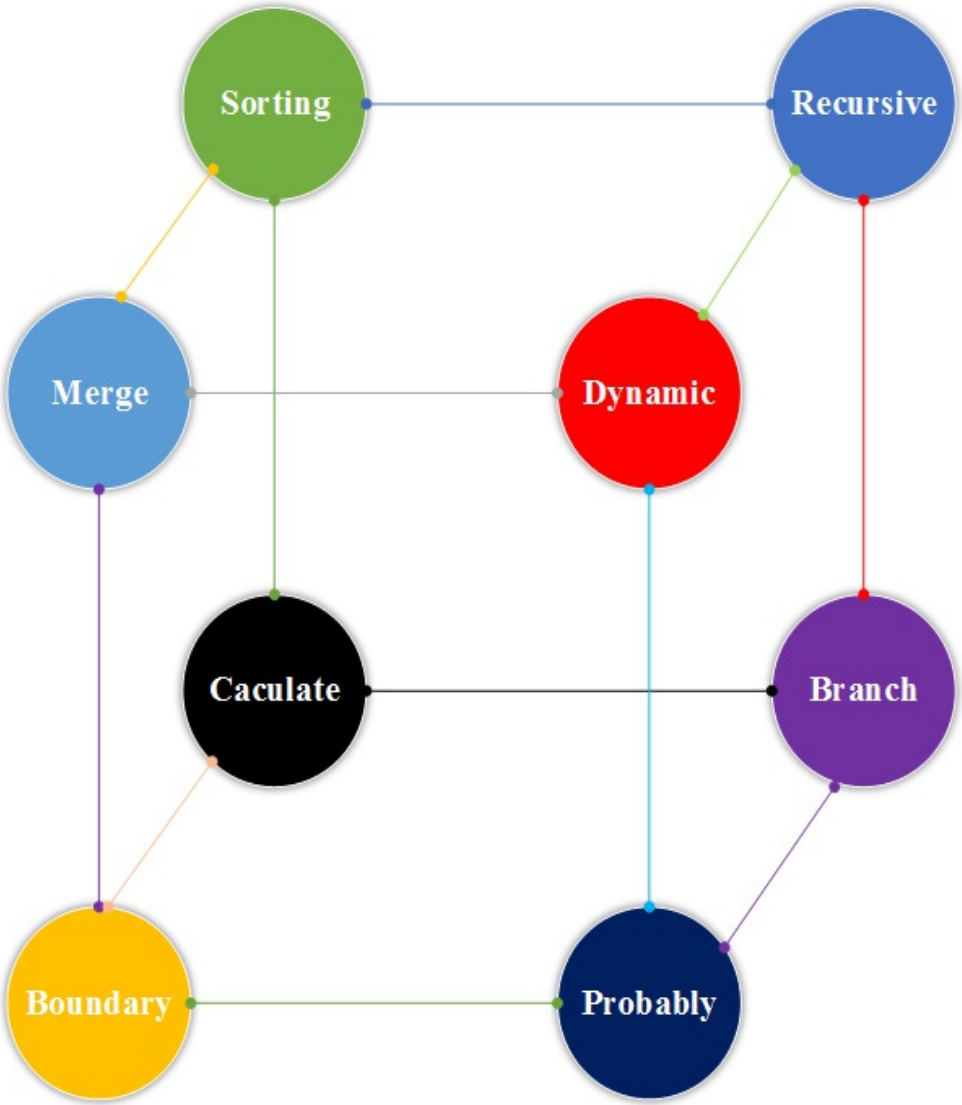
Algorithms JavaScript



Algorithms Explain With Beautiful Pictures

Algorithms JavaScript

YANG HU

Simple is the beginning of wisdom. the essence of practice, to briefly explain the concept, and vividly cultivate programming interest, this book deeply analyzes Data Structures Algorithms Javascript and fun of programming.

http://en.verejava.com

ISBN: 9798667448785

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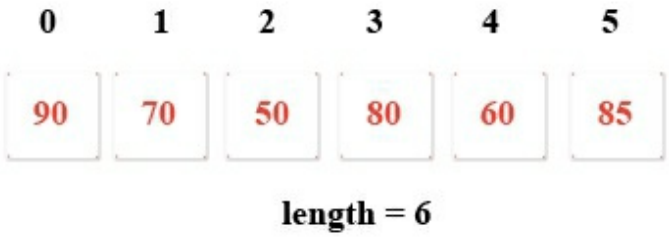
Linear Table Definition

Linear Table:
Sequence of elements, is a one-dimensional array.

1. Define a one-dimensional array of student scores



1. Create a TestOneArray.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    var scores = new Array( 90, 70, 50, 80, 60, 85 );

    //print out the score of the array scores
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }
</script>
```

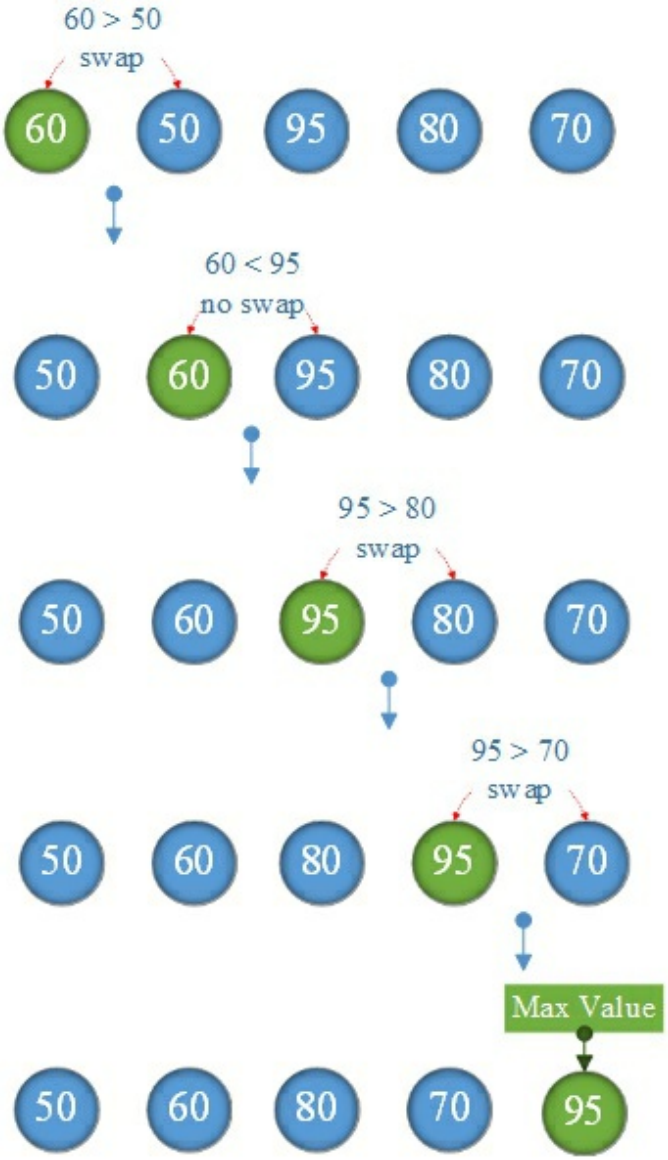
Result:

Maximum Value

Maximum of Integer Sequences:

1. Algorithmic ideas

Compare arrays[i] with arrays[i + 1], if arrays[i] > arrays[i + 1] are exchanged. So continue until the last number, arrays[length - 1] is the maximum.



1. Create a TestMaxValue.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function max(arrays) {
        // Maximum initialization value is 0
        for (var i = 0; i < arrays.length - 1; i++) {
        if (arrays[i] > arrays[i + 1]) { // swap
           var temp = arrays[i];
           arrays[i] = arrays[i + 1];
           arrays[i + 1] = temp;
        }
        }
        var maxValue = arrays[arrays.length - 1];
        return maxValue;
    }

    //////////////////////testing//////////////////

    var scores = [ 60, 50, 95, 80, 70];
    var maxValue = max(scores);
    document.write("maxValue = " + maxValue);

</script>
```

Result:

Bubble Sorting Algorithm

Bubble Sorting Algorithm:
Compare arrays[j] with arrays[j + 1], if arrays[j] > arrays[j + 1] are exchanged.
Remaining elements repeat this process, until sorting is completed.

Sort the following numbers from small to large

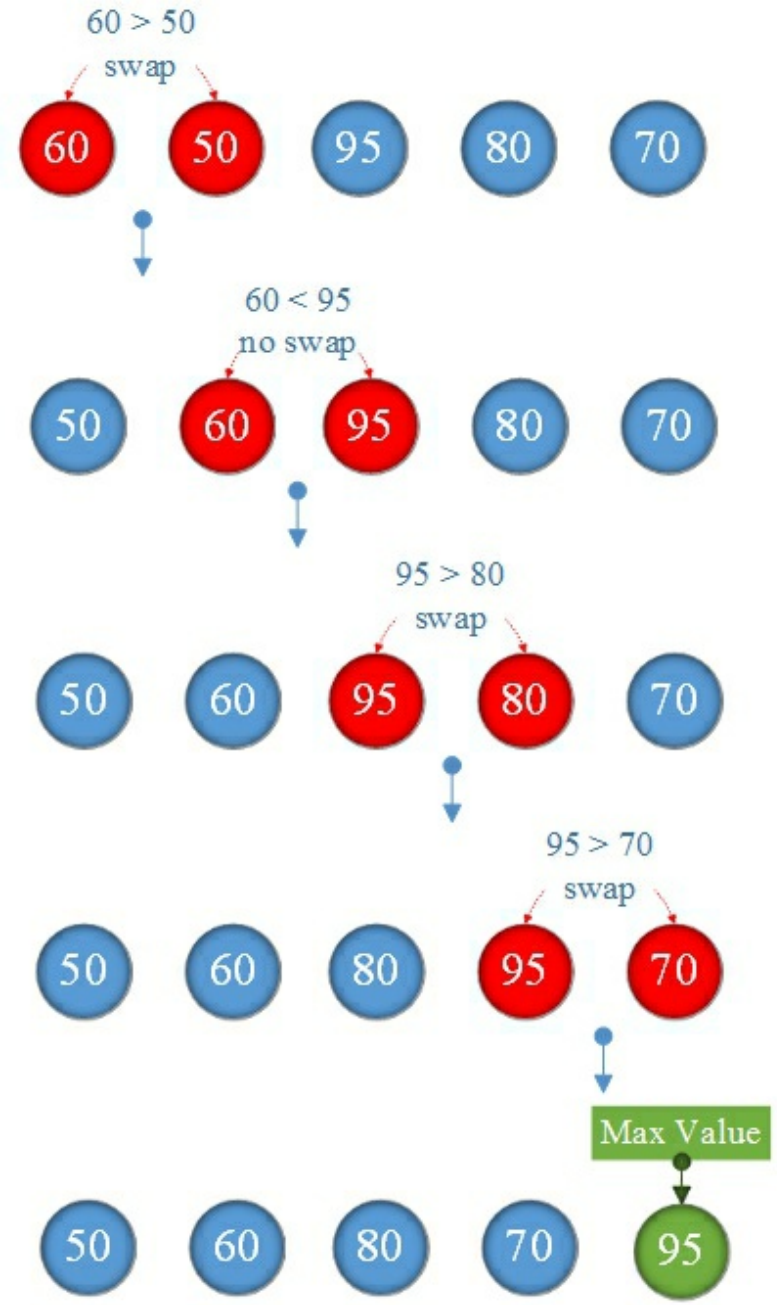
Explanation:


No sorting,

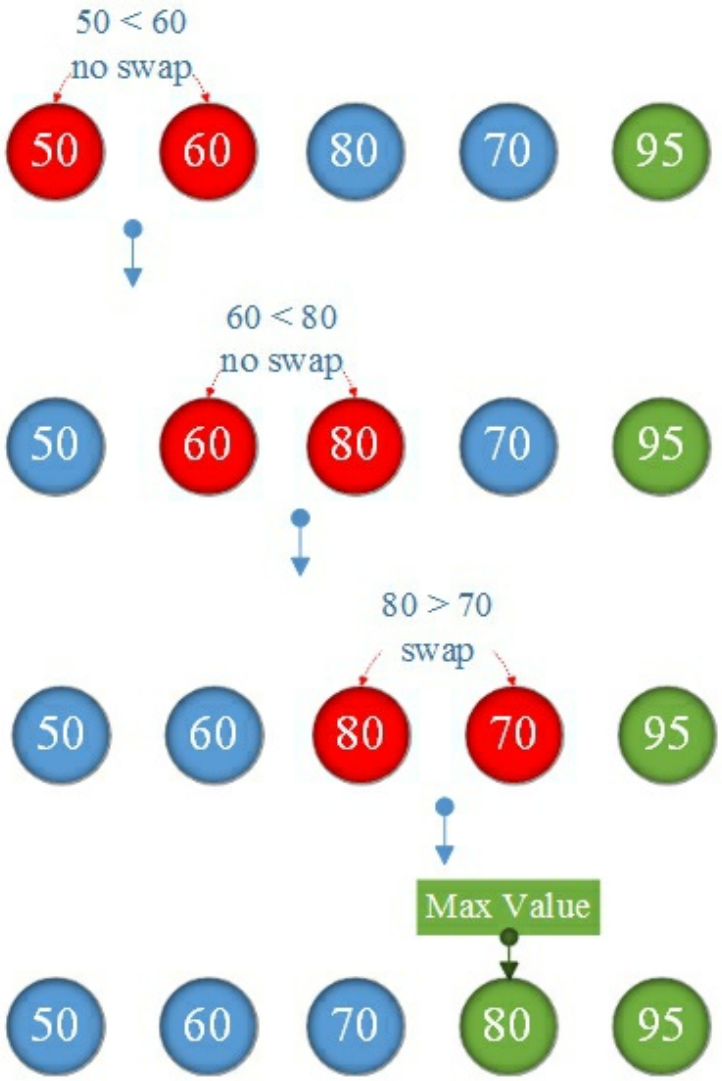

Comparing,


Already sorted

1. **First sorting:**



2. Second sorting:



3. Third sorting:

No swap so terminate sorting : we can get the sorting numbers from small to large

1. Create a TestBubbleSort.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    class BubbleSort{
        static sort(arrays) {
       for (var i = 0; i < arrays.length - 1;
i++) {
          for (var j = 0; j < arrays.length - i -
1; j++) {
             //swap
             if (arrays[j] > arrays[j + 1]) {
               var flag = arrays[j];
               arrays[j] = arrays[j + 1];
               arrays[j + 1] = flag;
             }
          }
       }
        }
    }

    //////////////////////testing//////////////////

    var scores = [ 60, 50, 95, 80, 70 ];
    BubbleSort.sort(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }
</script>
```

Result:

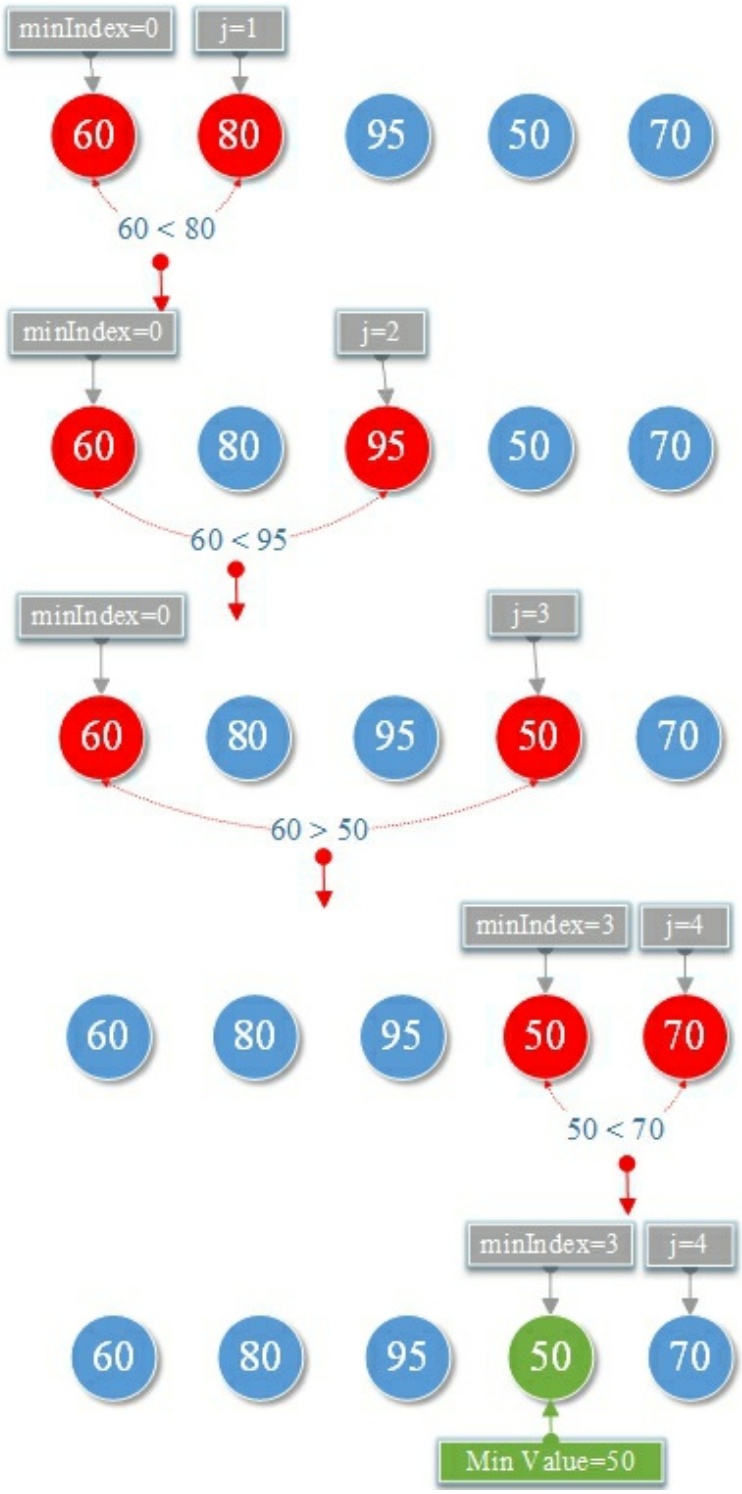

TestBubbleSort.html
文件 | E:/js/TestBubbleSort.html
50,60,70,80,95,

Minimum Value

Search the Minimum of Integer Sequences:

1. Algorithmic ideas

Initial value minIndex=0, j=1 Compare arrays[minIndex] with arrays[j] if arrays[minIndex] > arrays[j] then minIndex=j, j++ else j++. continue until the last number, arrays[minIndex] is the Min Value.


minIndex=0
j=1
60
80
95
50
70
60 < 80
minIndex=0
j=2
60
80
95
50
70
60 < 95
minIndex=0
j=3
60
80
95
50
70
60 > 50
minIndex=3
j=4
60
80
95
50
70
50 < 70
minIndex=3
j=4
60
80
95
50
70
Min Value=50

1. Create a TestMinValue.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function min(arrays) {
        var minIndex = 0;// the index of the minimum
        for (var j = 1; j < arrays.length; j++) {
        if (arrays[minIndex] > arrays[j]) {
            minIndex = j;
        }
        }
        return arrays[minIndex];
    }

    //////////////////////testing//////////////////

    var scores = [ 60, 80, 95, 50, 70 ];
    var minValue = min(scores);
    document.write("Min Value = " + minValue);

</script>
```

Result:

Select Sorting Algorithm

Select Sorting Algorithm:
Sorts an array by repeatedly finding the minimum element from unsorted part and putting it at the beginning.

Sort the following numbers from small to large

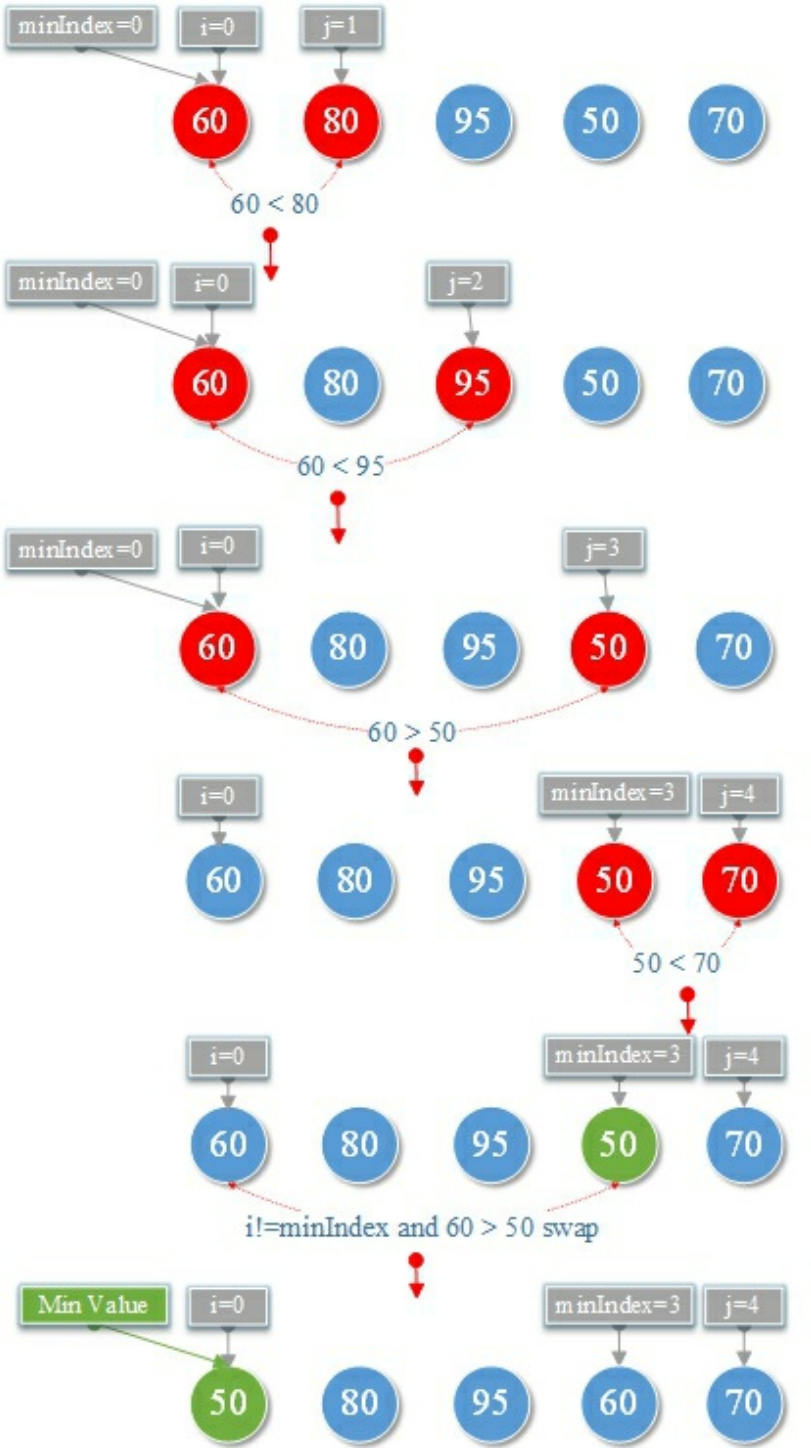
Explanation:


No sorting,

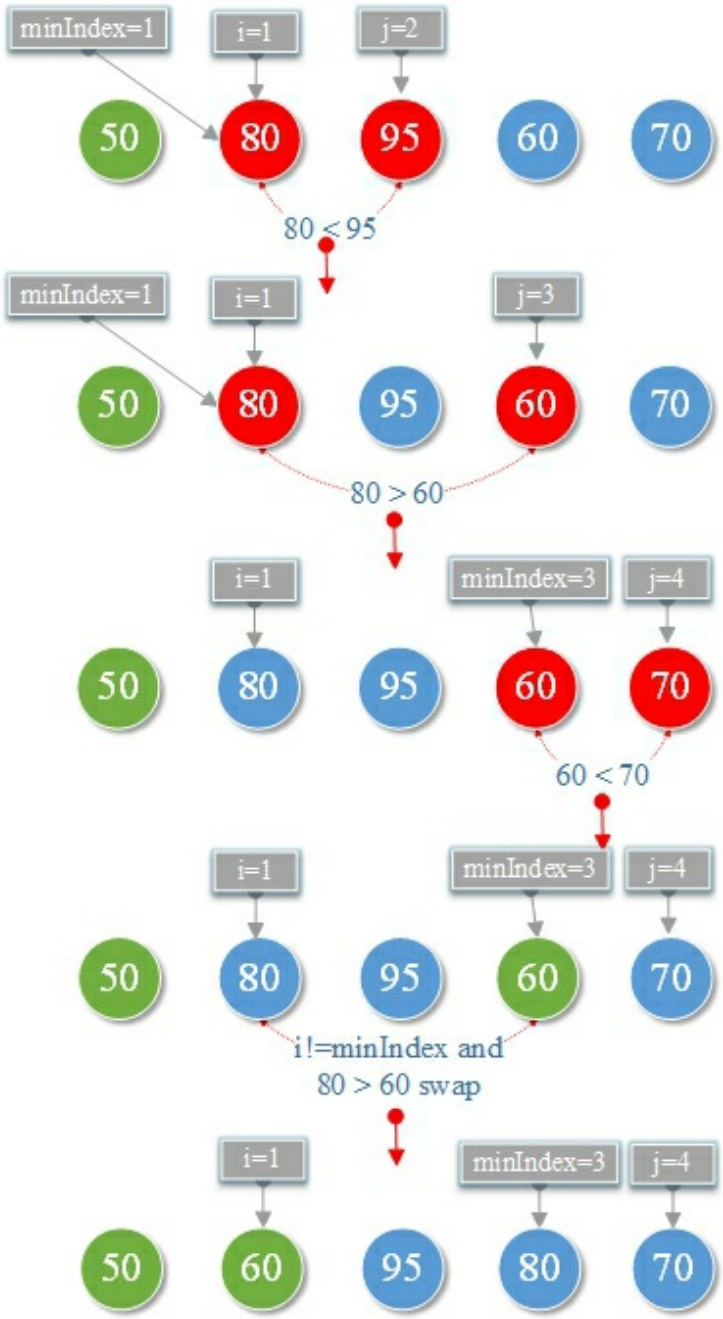

Comparing,


Already sorted.

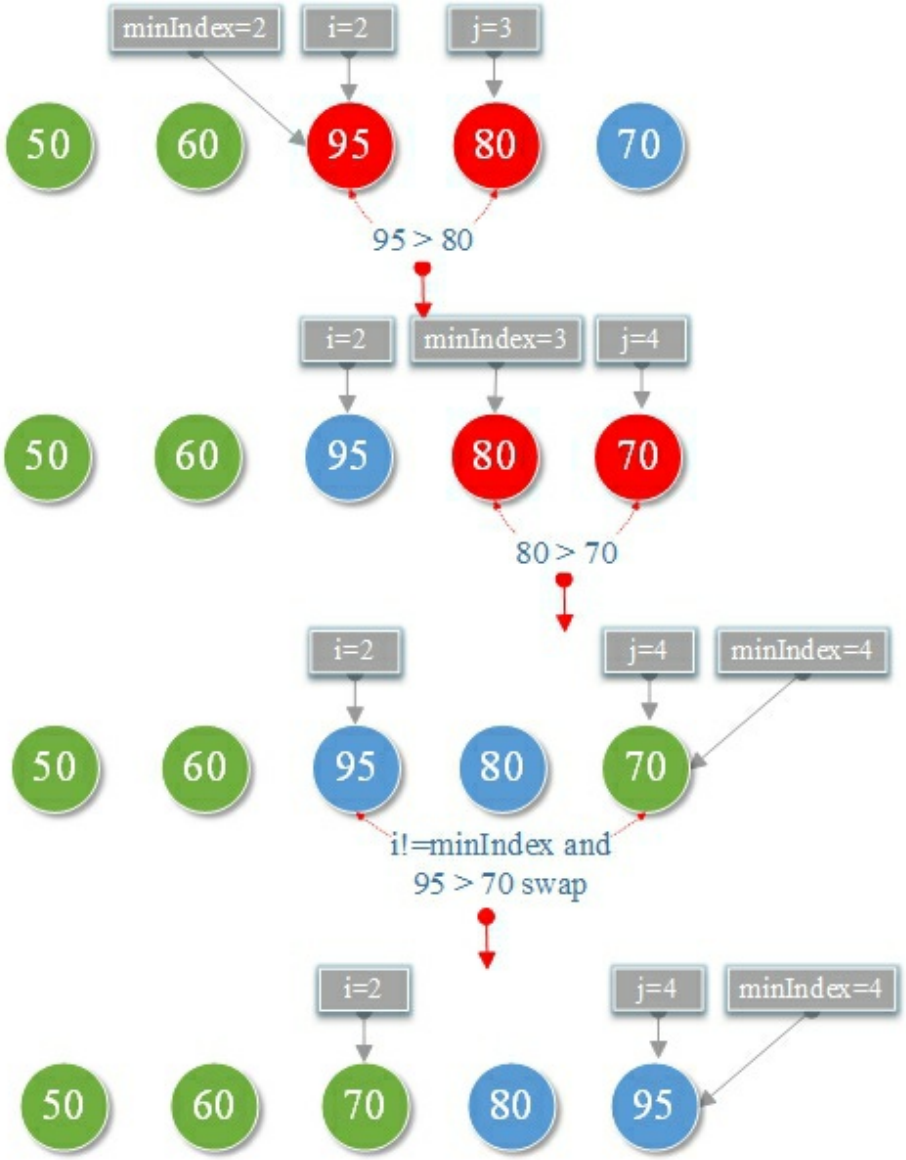
1. **First sorting:**



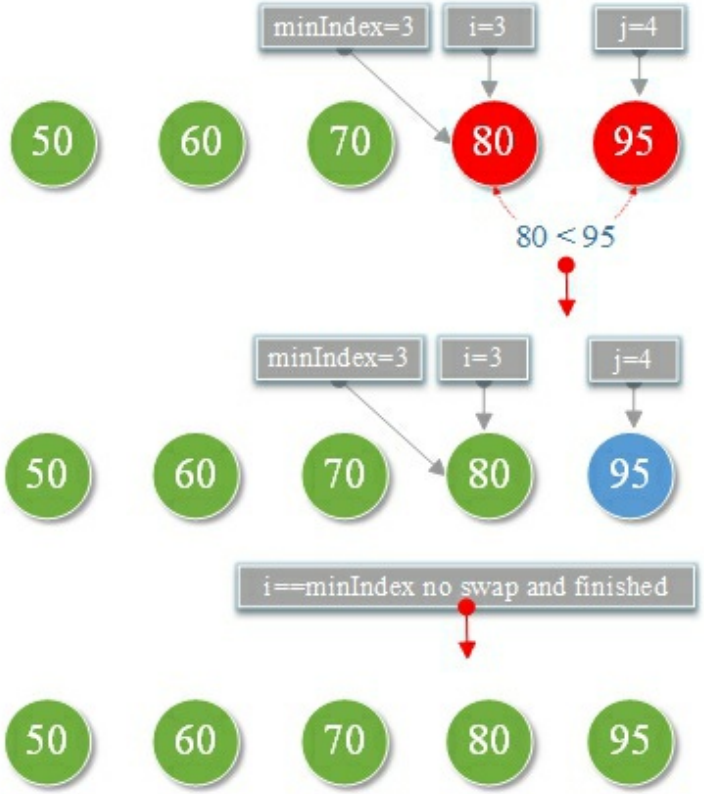
2. Second sorting:



3. Third sorting:



4. Forth sorting:



we can get the sorting numbers from small to large

1. Create a TestSelectSort.html with Notepad and open it in your browser.

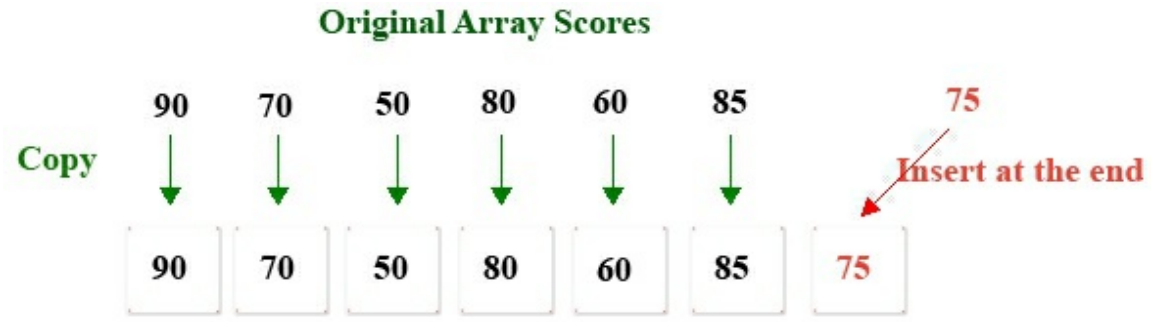
```
<script type="text/javascript">
    class SelectSort{
        static sort(arrays) {
            var len = arrays.length - 1;
            var minIndex;// Save the index of the selected minimum

            for (var i = 0; i < len; i++) {
                minIndex = i;
                //Save the minimum value of each loop as the first element
                var minValue = arrays[minIndex];
                for (var j = i; j < len; j++) {
                    if (minValue > arrays[j + 1]) { // minimum value
exchange with the minIndex
                        minValue = arrays[j + 1];
                        minIndex = j + 1;
                    }
                }

                //if minimum index changes, current minimum is exchanged
with the minIndex
                if (i != minIndex){
                    var temp = arrays[i];
                    arrays[i] = arrays[minIndex];
                    arrays[minIndex] = temp;
                }
            }
        }
    }

    ////////////////////testing//////////////////
    var scores = [ 90, 70, 50, 80, 60, 85 ];
    SelectSort.sort(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }
```

```
</script>
```

Result:
50,60,70,80,95,

Linear Table Append

1. Add a score 75 to the end of the one-dimensional array scores.



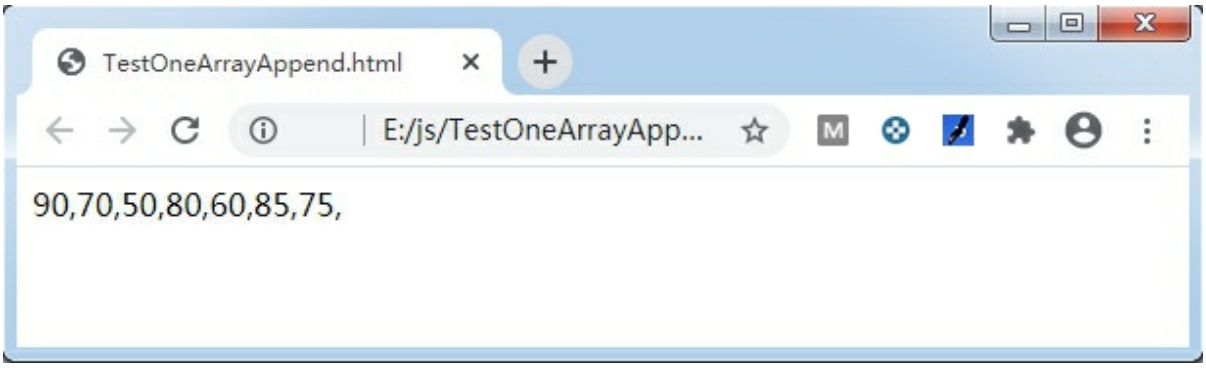
Analysis:

1. First create a temporary array(tempArray) larger than the original scores array length
2. Copy each value of the scores to tempArray
3. Assign 75 to the last index position of tempArray
4. Finally assign the tempArray pointer reference to the original scores;

1. Create a TestOneArrayAppend.html with Notepad and open it in your browser.

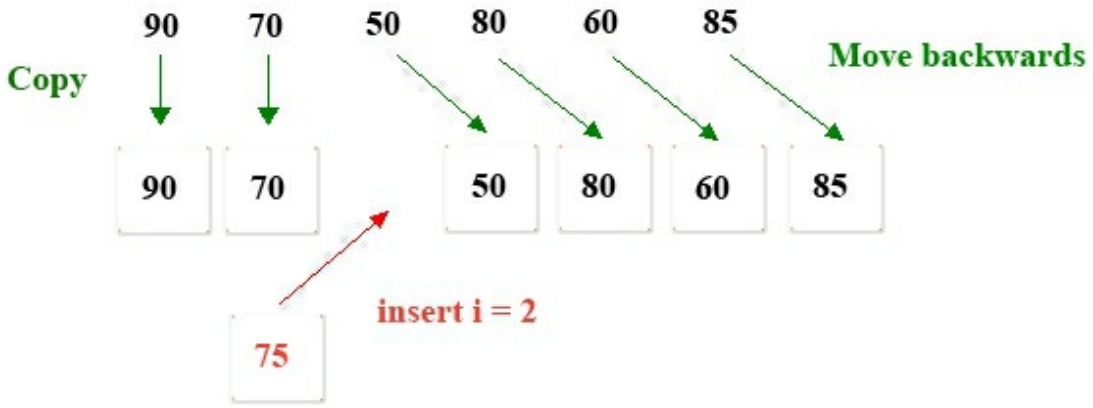
```
<script type="text/javascript">

    function append(array, value) {
      //create a new array, length = array.length + 1
        var tempArray = new Array(array.length + 1);

        for (var i = 0; i < array.length; i++) {
        tempArray[i] = array[i];
        }
        tempArray[array.length] = value
        return tempArray;
    }

    //////////////////////testing//////////////////////
    var scores = new Array( 90, 70, 50, 80, 60, 85 );

    scores = append(scores, 75);

    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }
</script>
```

Result:



Linear Table Insert

1. Insert a student's score anywhere in the one-dimensional array scores.



Analysis:

1. First create a temporary array tempArray larger than the original scores array length
2. Copy each value of the previous value of the scores array from the beginning to the insertion position to tempArray
3. Move the scores array from the insertion position to each value of the last element and move it back to tempArray
4. Then insert the score 75 to the index of the tempArray.
5. Finally assign the tempArray pointer reference to the scores;

1. Create a TestOneArrayInsert.html with Notepad and open it in your browser.

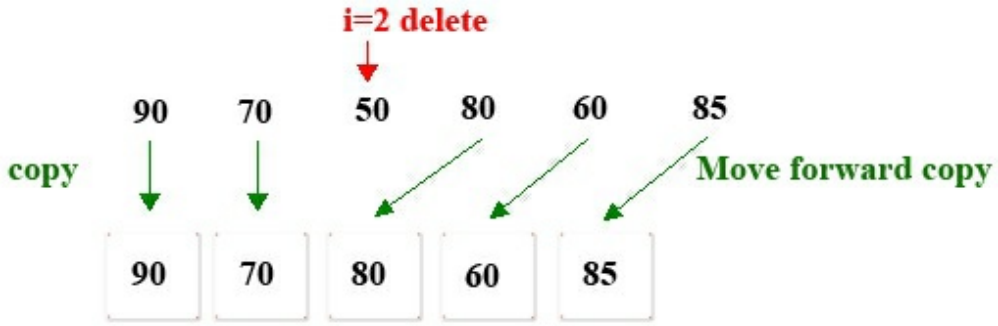
```
<script type="text/javascript">

    function insert(array, score, insertIndex) {
        var tempArray = new Array(array.length + 1);
        for (var i = 0; i < array.length; i++) {
        if (i < insertIndex) {
            tempArray[i] = array[i];
        } else {
            tempArray[i + 1] = array[i];
        }
        }
        tempArray[insertIndex] = score;
        return tempArray;
    }

    ////////////////////testing//////////////////
    var scores = new Array( 90, 70, 50, 80, 60, 85 );

    //Insert 75 into the position: index = 2
    scores = insert(scores, 75, 2);

    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }

</script>
```

Result:


TestOneArrayInsert.html
文件 | E:/js/TestOneArrayInse...
90,70,75,50,80,60,85,

Linear Table Delete

1. **Delete the value of the index=2 from scores array**



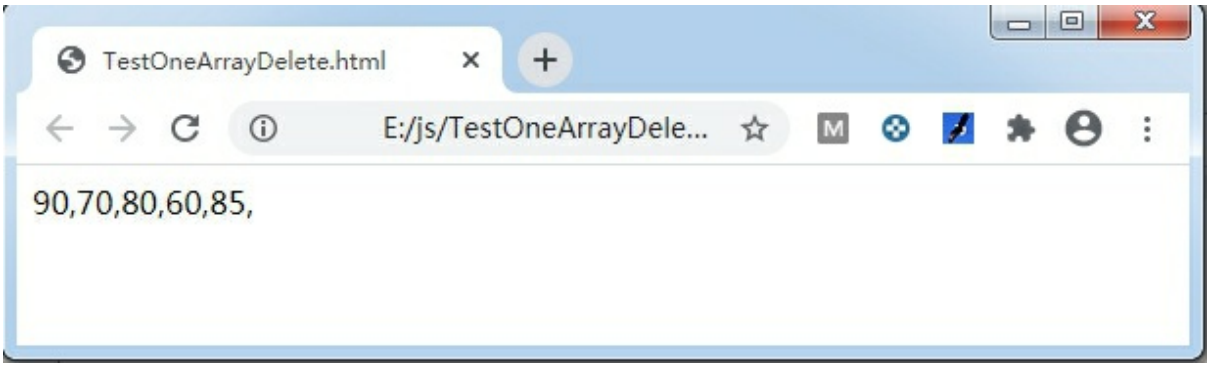
Analysis:

1. Create a temporary array tempArray that length smaller than scores by 1.
2. Copy the data in front of i=2 to the front of tempArray
3. Copy the array after i=2 to the end of tempArray
4. Assign the tempArray pointer reference to the scores
5. Printout scores

1. Create a TestOneArrayDelete.html with Notepad and open it in your browser.

```
<script type="text/javascript">

    function remove(array, index){
        // create a new array, length = array.length - 1
        var tempArray = new Array(array.length - 1);

        for (var i = 0; i < array.length; i++) {
            if (i < index) // Copy the data in front of index to the front of
tempArray
                tempArray[i] = array[i];
            if (i > index)  // Copy the array after index to the end of
tempArray
                tempArray[i - 1] = array[i];
        }
        return tempArray;
    }

    //////////////////////testing//////////////////
    var scores = new Array( 90, 70, 50, 80, 60, 85 );

    scores = remove(scores, 2);//delete score that index = 2

    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }

</script>
```

Result:


TestOneArrayDelete.html
E:/js/TestOneArrayDele...
90,70,80,60,85,

Insert Sorting Algorithm

Insert Sorting Algorithm:
Take an unsorted new element in the array, compare it with the already sorted element before, if the element is smaller than the sorted element, insert new element to the right position.

Sort the following numbers from small to large

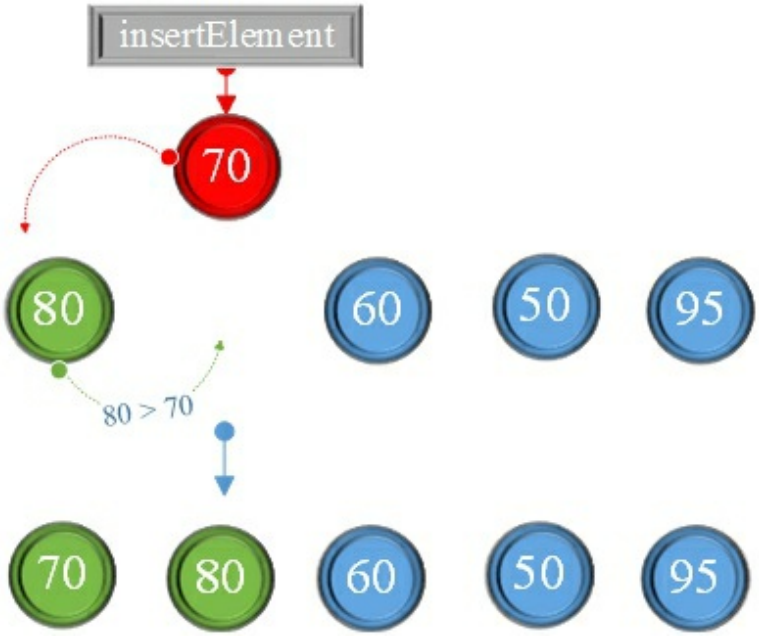
Explanation:


No sorting,

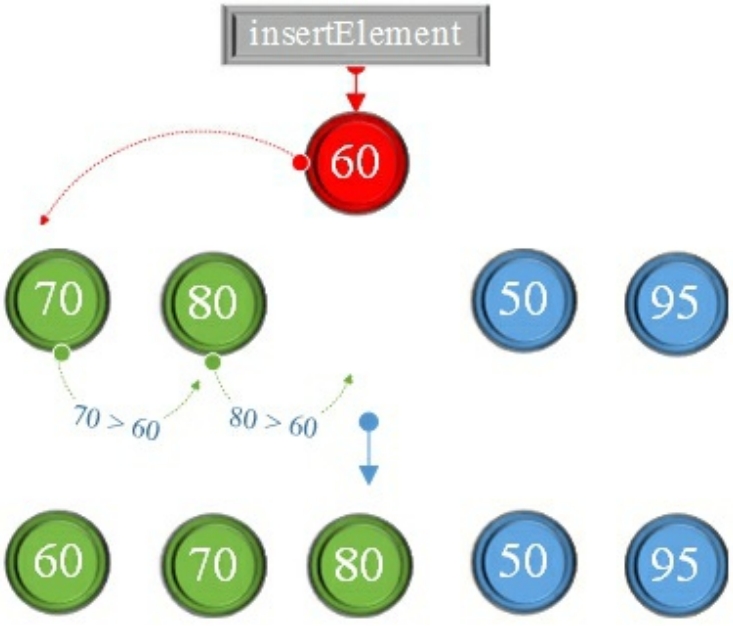

Inserting,


Already sorted

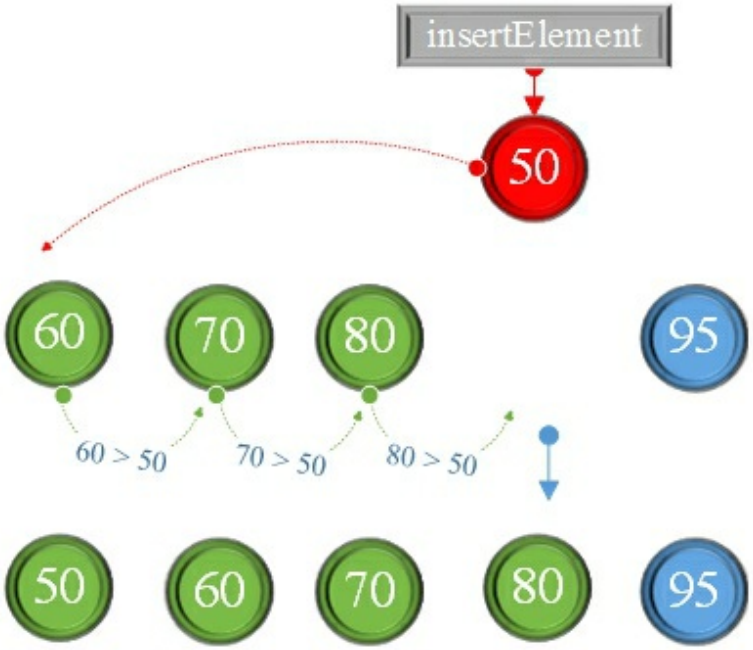
1. **First sorting:**



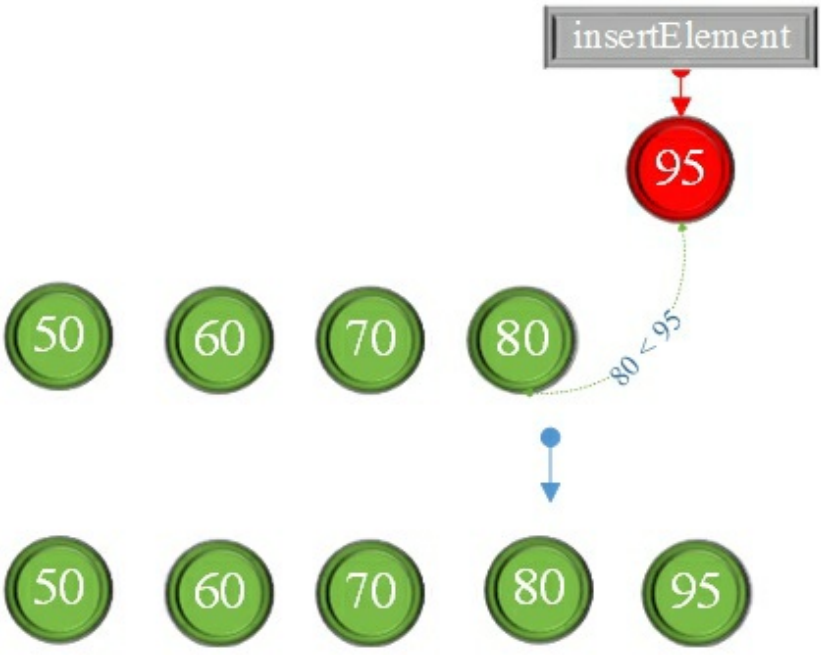
2. **Second sorting:**



3. Third sorting:



4 Third sorting:



1. Create a TestInsertSort.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    class InsertSort{
        static sort(arrays) {
            for (var i = 0; i < arrays.length; i++) {
                var insertElement = arrays[i];//Take unsorted new elements
                var insertPosition = i; //Inserted position
                for (var j = insertPosition - 1; j >= 0; j--) {
                    //If the new element is smaller than the sorted element,
shifted to the right
                    if (insertElement < arrays[j]) {
                        arrays[j + 1] = arrays[j];
                        insertPosition--;
                    }
                }
                arrays[insertPosition] = insertElement;//Insert the new
element
            }
        }
    }

    ////////////////////testing//////////////////

    var scores = [ 90, 70, 50, 80, 60, 85 ];
    InsertSort.sort(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }
</script>
```

Result:

50,60,70,80,95,

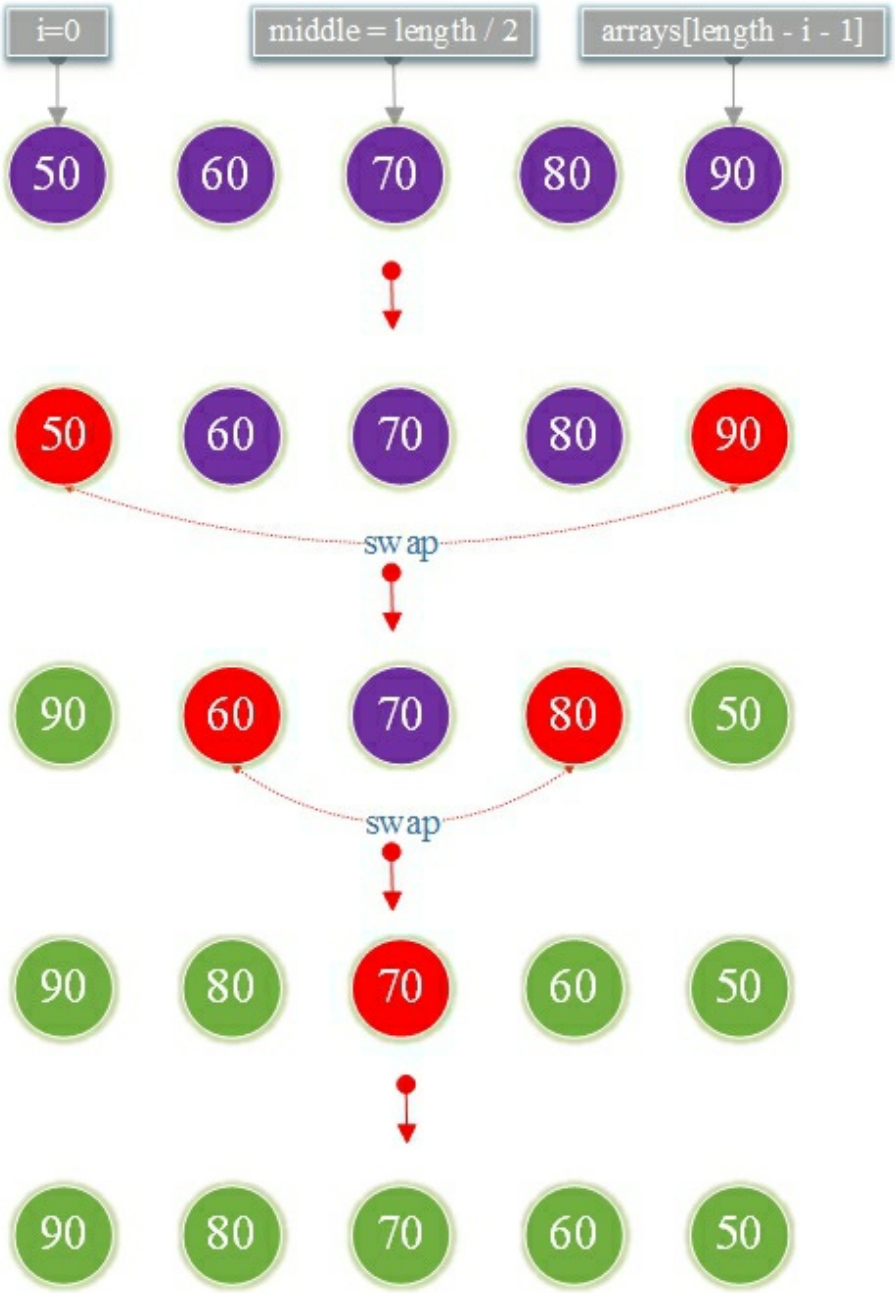
Reverse Array

Inversion of ordered sequences:

1. Algorithmic ideas

Initial i = 0 and then swap the first element arrays[i] with last element arrays[length - i - 1]

Repeat until index of middle i == length / 2.


i=0
middle = length / 2
arrays[length - i - 1]
50
60
70
80
90
50
60
70
80
90
swap
90
60
70
80
50
swap
90
80
70
60
50
90
80
70
60
50

1. Create a TestReverse.html with Notepad and open it in your browser.

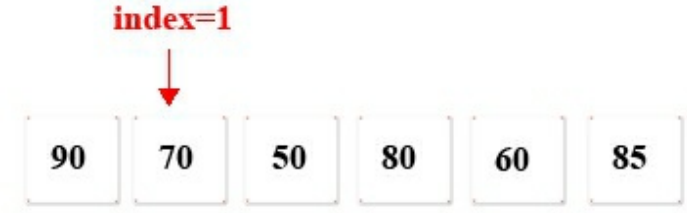
```
<script type="text/javascript">
    function reverse(arrays) {
        var length = arrays.length;
        var middle = length / 2;
        for (var i = 0; i <= middle; i++) {
       var temp = arrays[i];
       arrays[i] = arrays[length - i - 1];
       arrays[length - i - 1] = temp;
        }
    }

    ////////////////////testing//////////////////

    var scores = [ 50, 60, 70, 80, 90 ];
    reverse(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }

</script>
```

Result:

90,80,70,60,50,

Linear Table Search

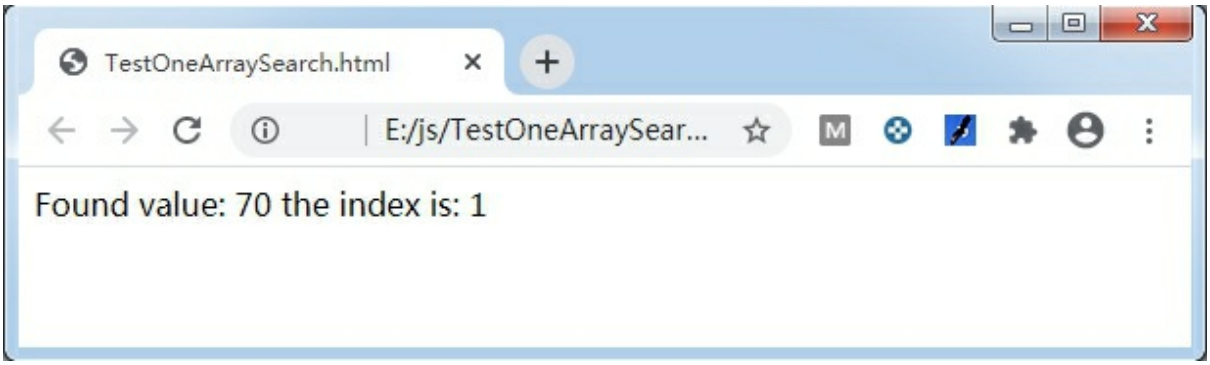
1. Please enter the value you want to search like : 70 return index.



1. Create a TestOneArraySearch.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function search(array, value){
        for (var i = 0; i < array.length; i++) {
            if (array[i] == value) {
                return i;
            }
        }
        return -1;
    }
    //////////////////////testing//////////////////
    var scores = new Array( 90, 70, 50, 80, 60, 85 );
    var value = 70;
    var index = search(scores, value);

    if (index > 0) {
        document.write("Found value: " + value + " the index is: " + index);
    }else{
        document.write("The value was not found : " + value);
    }
</script>
```

Result:

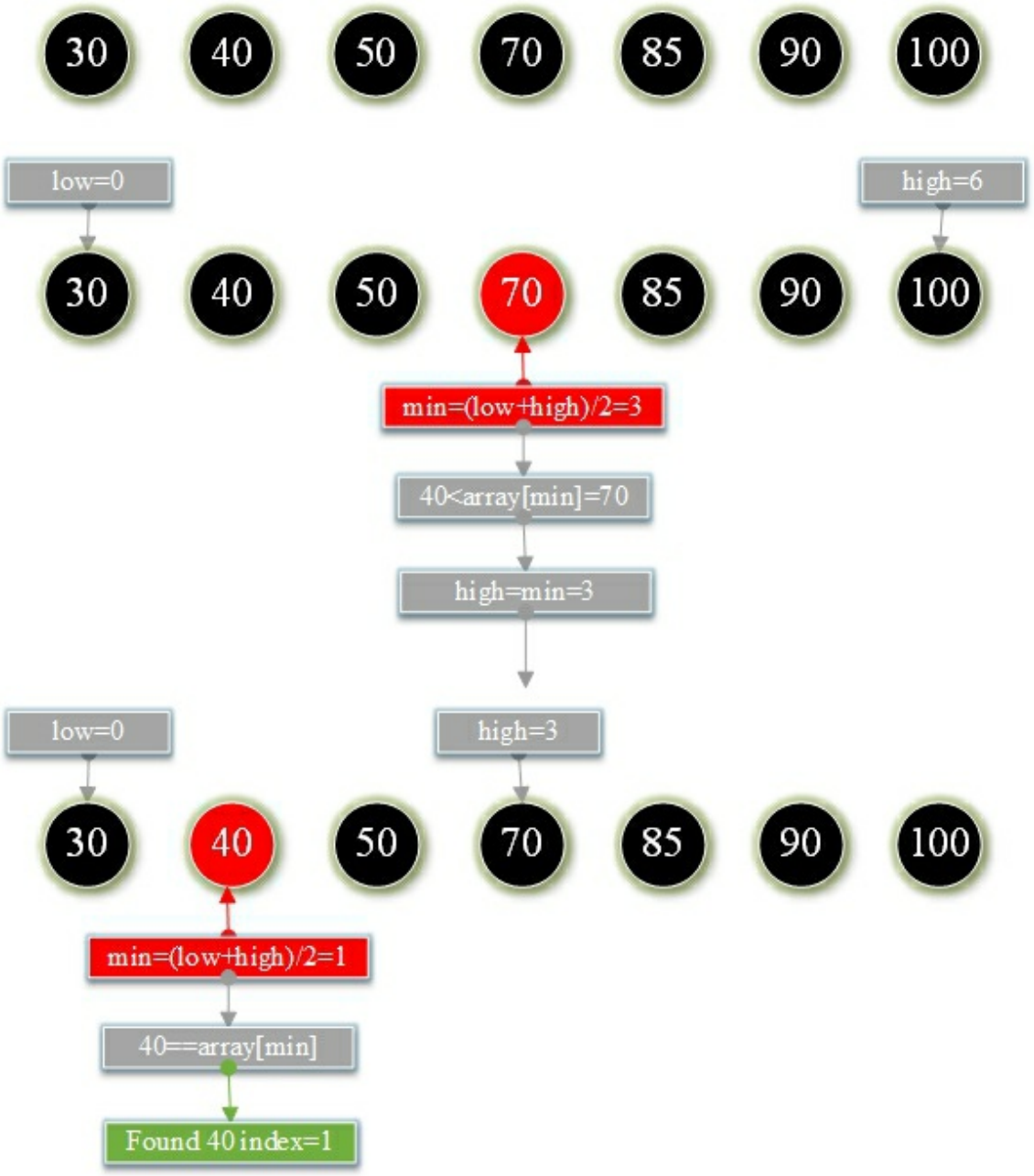

TestOneArraySearch.html
E:/js/TestOneArraySear...
Found value: 70 the index is: 1

Dichotomy Binary Search

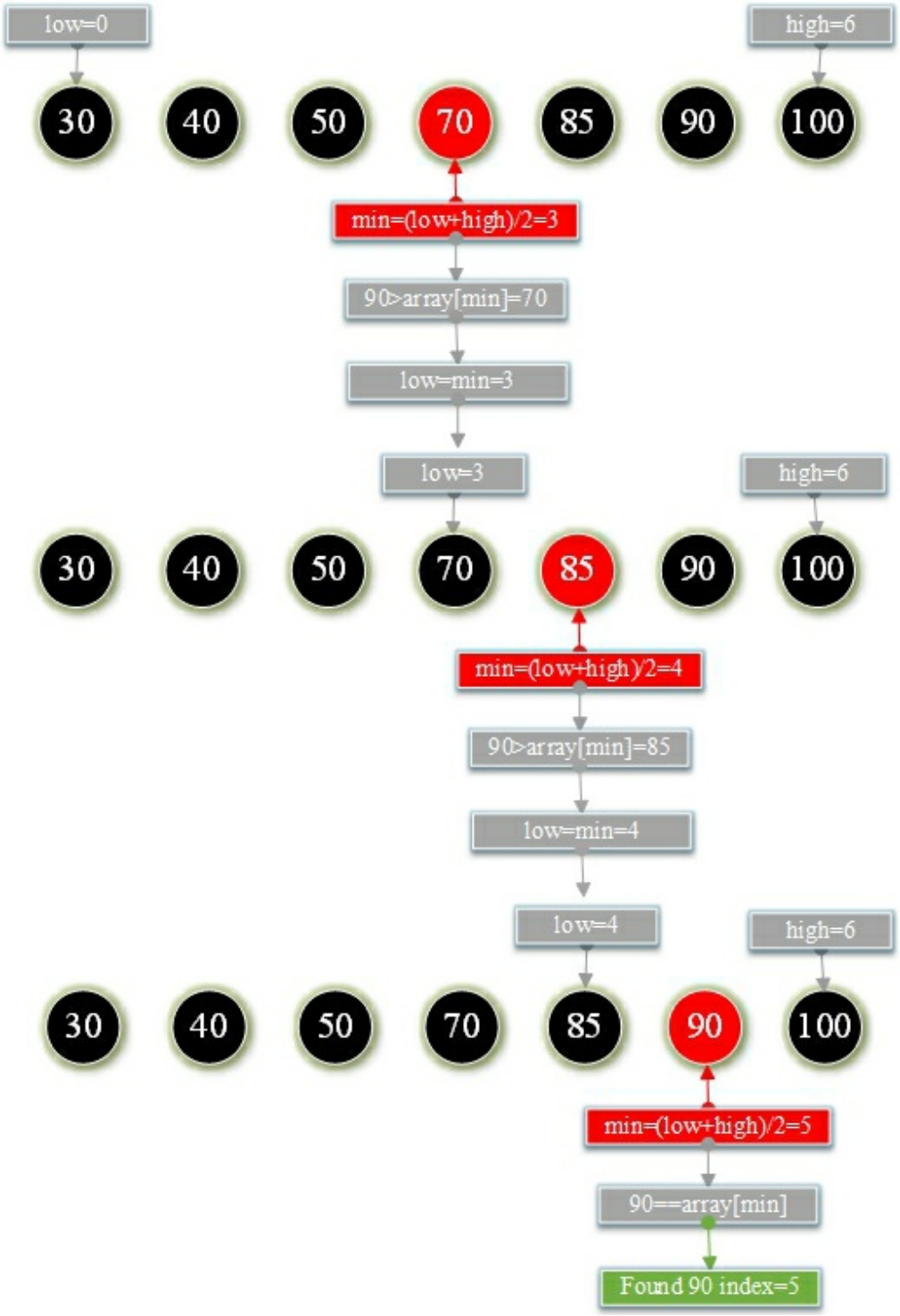
Dichotomy Binary Search:
Find the index position of a given value from an already ordered array.

1. Initialize the lowest index low=0, the highest index high=scores.length-1
2. Find the searchValue of the middle index mid=(low+high)/2 scores[mid]
3. Compare the scores[mid] with searchValue
   If the scores[mid]==searchValue print current mid index,
   If scores[mid]>searchValue that the searchValue will be found between low and mid-1
4. And so on. Repeat step 3 until you find searchValue or low>=high to terminate the loop.

Example 1 : Find the index of searchValue=40 in the array that has been sorted below.



Example 2 : Find the index of searchValue=90 in the array that has been sorted below.



1. Create a TestBinarySearch.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    class BinarySearch{
        static search(arrays, searchValue) {
          var low = 0;
          var high = arrays.length - 1;
          var mid = 0;
          while (low <= high) {
              mid = (low + high) / 2;
              if (arrays[mid] == searchValue) {
                  return mid;
              } else if (arrays[mid] < searchValue) {
                  low = mid + 1;
              } else if (arrays[mid] > searchValue) {
                  high = mid - 1;
              }
          }
          return -1;
        }
    }

    ////////////////////testing//////////////////

    var scores = [ 30, 40, 50, 70, 85, 90, 100 ];

    var searchValue = 40;
    var position = BinarySearch.search(scores, searchValue);
    document.write(searchValue + " position:" + position);

    document.write("<br>--------------------------<br>");

    searchValue = 90;
    position = BinarySearch.search(scores, searchValue);
    document.write(searchValue + " position:" + position);
</script>
```

Result:
40 position:1
---
90 position:5

Shell Sorting

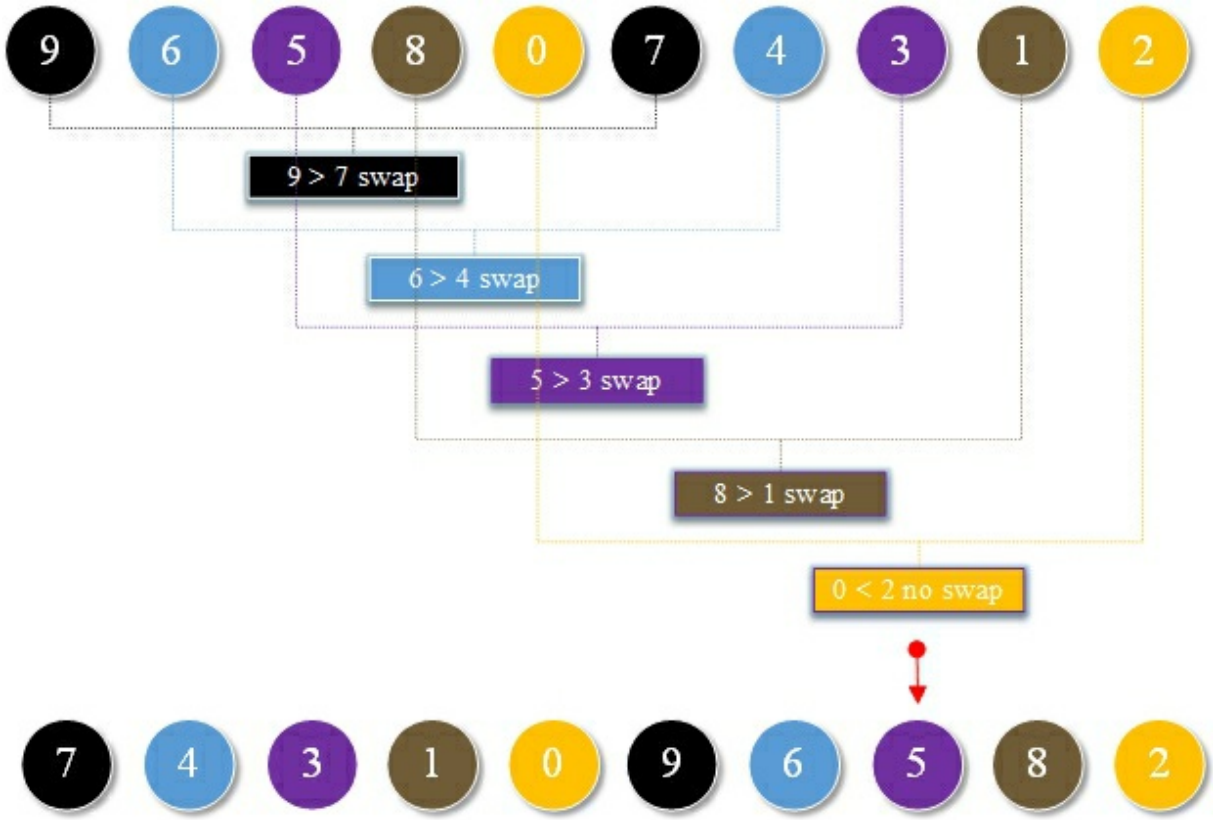
Shell Sorting:
Shell sort is a highly efficient sorting algorithm and is based on insertion sort algorithm. This algorithm avoids large shifts as in case of insertion sort, if the smaller value is to the far right and has to be moved to the far left.

Sort the following numbers from small to large by Shell Sorting

Algorithmic result:
The array is grouped according to a certain increment of subscripts, and the insertion of each group is sorted. As the increment decreases gradually until the increment is 1, the whole data is grouped and sorted.

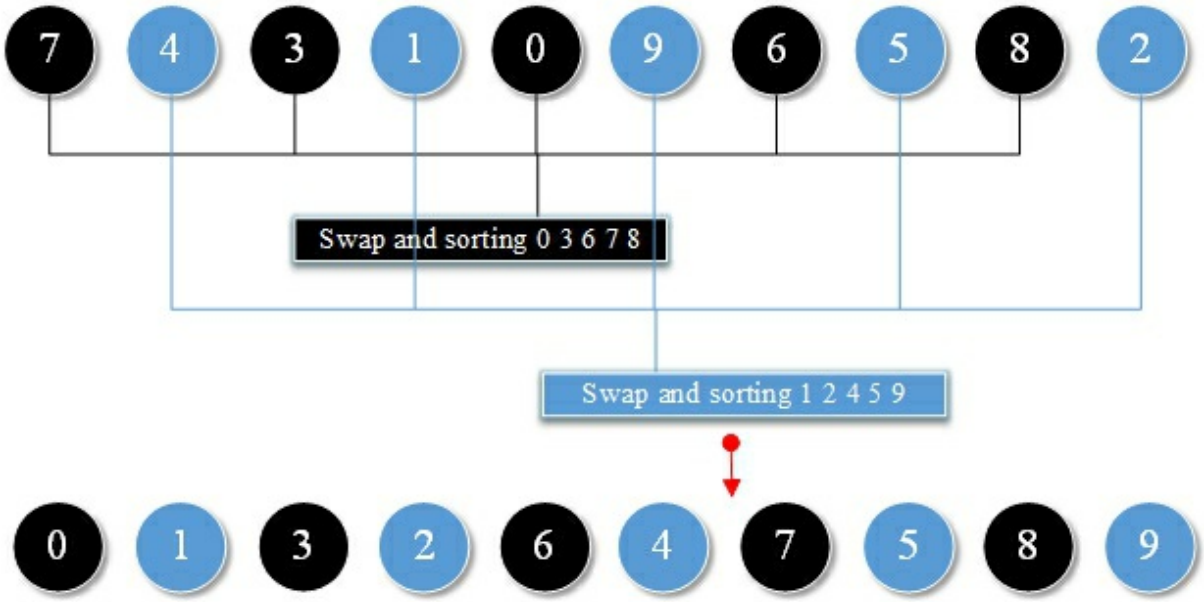
1. **The first sorting :**

   gap = array.length / 2 = 5



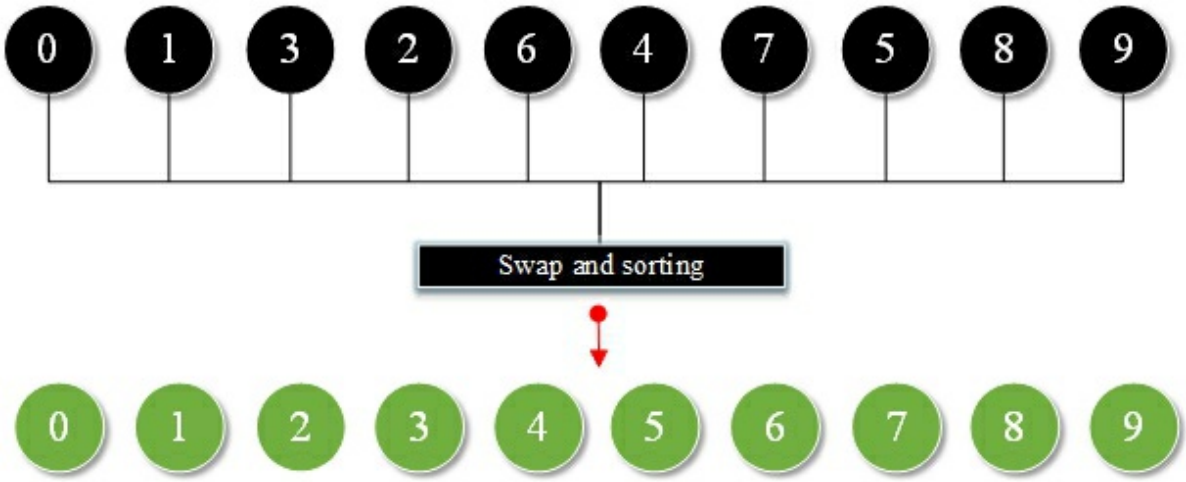
2. The second sorting :

gap = 5 / 2 = 2



3. The third sorting :

gap = 2 / 2 = 1



1. Create a TestShellSort.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function shellSort(array) {
        var middle = parseInt(array.length / 2);
        for (var gap =middle ; gap > 0; gap = parseInt(gap / 2)) {
          for (var i = gap; i < array.length; i++) {
              var j = i;
              while (j - gap >= 0 && array[j] < array[j - gap]) {
                  swap(array, j, j - gap);
                  j = j - gap;
              }
          }
        }
    }

    function swap(array, a, b) {
        array[a] = array[a] + array[b];
        array[b] = array[a] - array[b];
        array[a] = array[a] - array[b];
    }

    //////////////////////testing//////////////////

    var scores = [ 9, 6, 5, 8, 0, 7, 4, 3, 1, 2 ];
    shellSort(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }

</script>
```

Result:

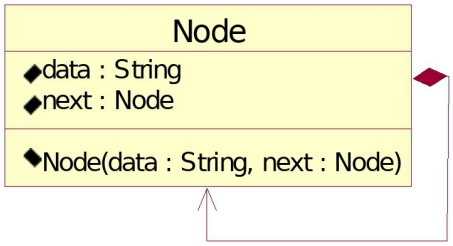
0,1,2,3,4,5,6,7,8,9,

Unidirectional Linked List

Unidirectional Linked List Single Link:

Is a chained storage structure of a linear table, which is connected by a node. Each node consists of data and next pointer to the next node.

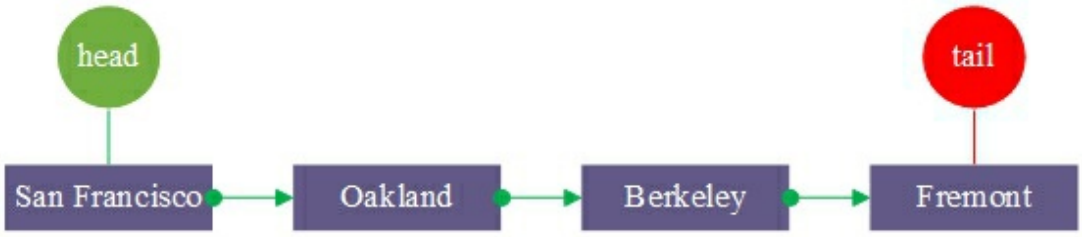
UML Diagram



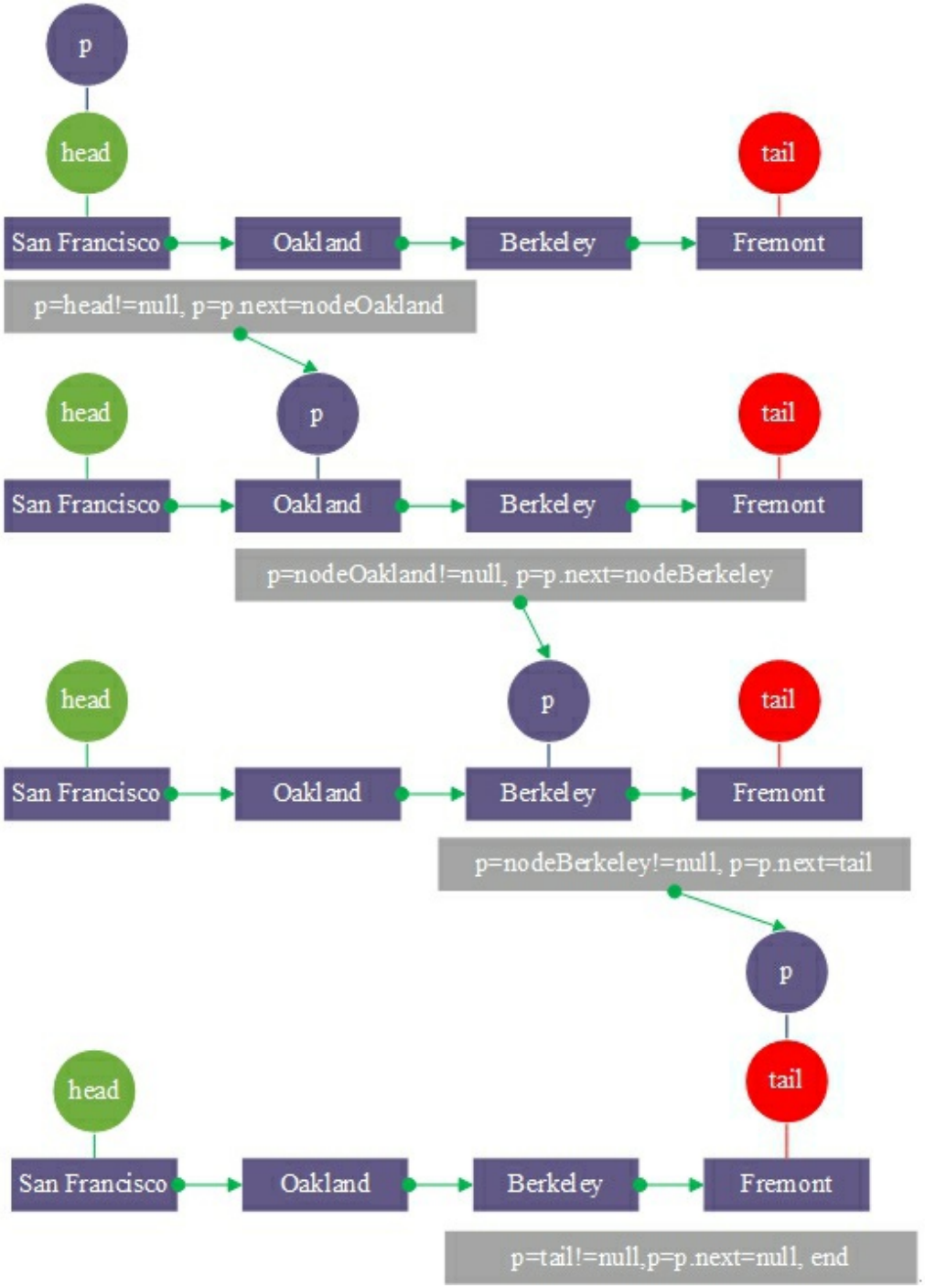

```
class Node{
    constructor(data, next){
 this.data = data;
 this.next = next;
    }

    getData(){
 return this.data;
    }
}
```

1. Unidirectional Linked List initialization.

Example : Construct a San Francisco subway Unidirectional linked list



2. traversal output.

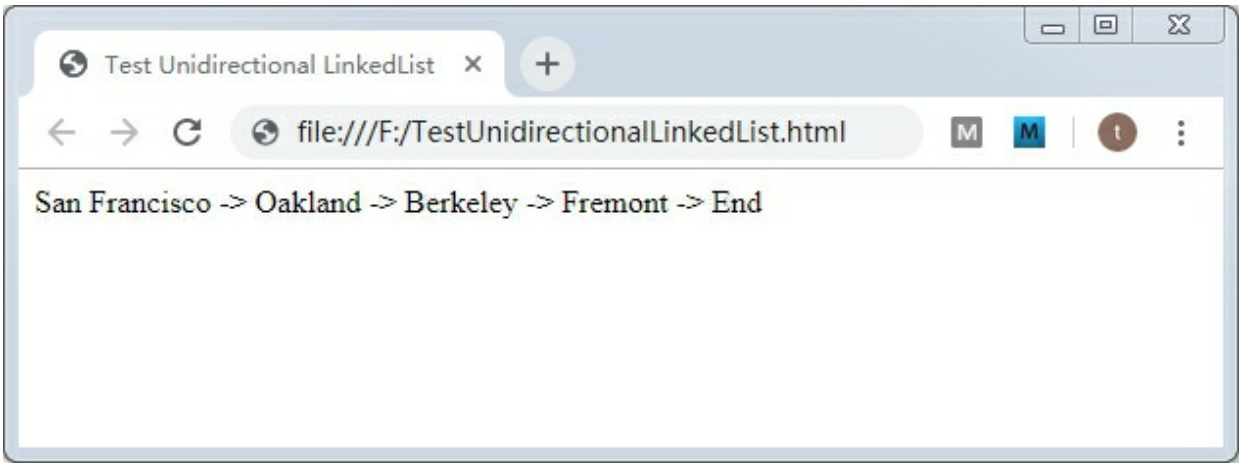


1. Create a TestUnidirectionalLinkedList.html with Notepad and open it in your browser.

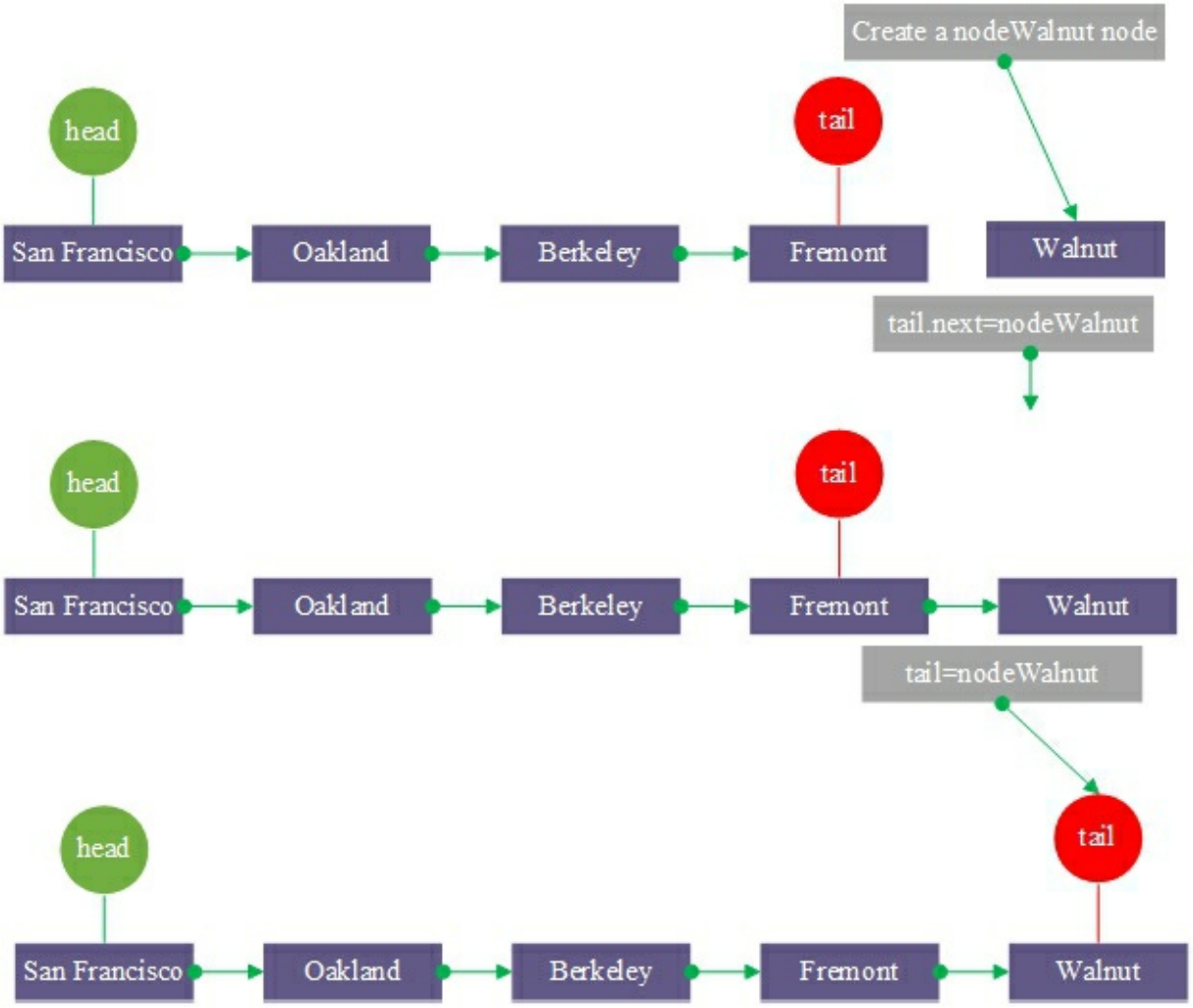
```
<script type="text/javascript">
    class Node{
        constructor(data, next){
        this.data = data;
        this.next = next;
        }

        getData(){
        return this.data;
        }
    }

    class LinkedList{
        init() {
        // the first node called head node
        this.head = new Node("San Francisco",
null);

        var nodeOakland = new Node("Oakland",
null);
        this.head.next = nodeOakland;

        var nodeBerkeley = new
Node("Berkeley", null);
        nodeOakland.next = nodeBerkeley;

        // the last node called tail node
        this.tail = new Node("Fremont", null);
        nodeBerkeley.next = this.tail;

        return this.head;
        }

        print(node) {
        var p = node;
        while (p != null) // From the beginning to
```

```
the end
        {
           var data = p.getData();
           document.write(data + " -> ");
           p = p.next;
        }
        document.write("End<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var linkedList = new LinkedList();
    var head = linkedList.init();
    linkedList.print(head);
</script>
```

Result:



3. Append a new node name: Walnut to the end.

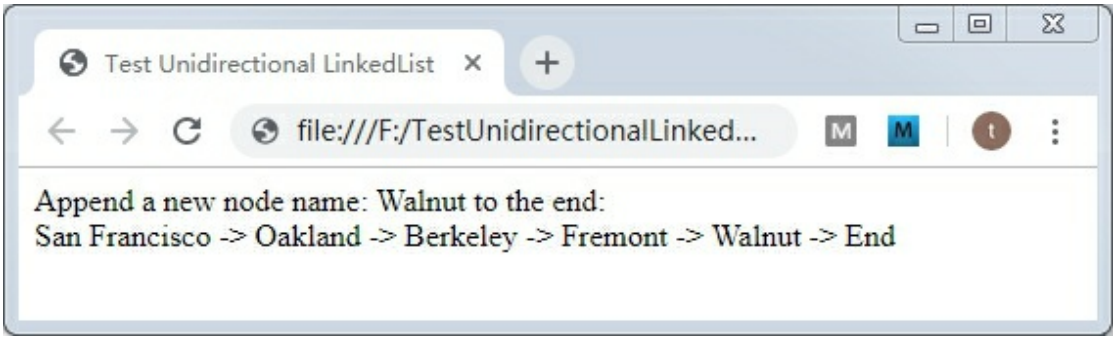


1. Create a TestUnidirectionalLinkedListAppend.html with Notepad

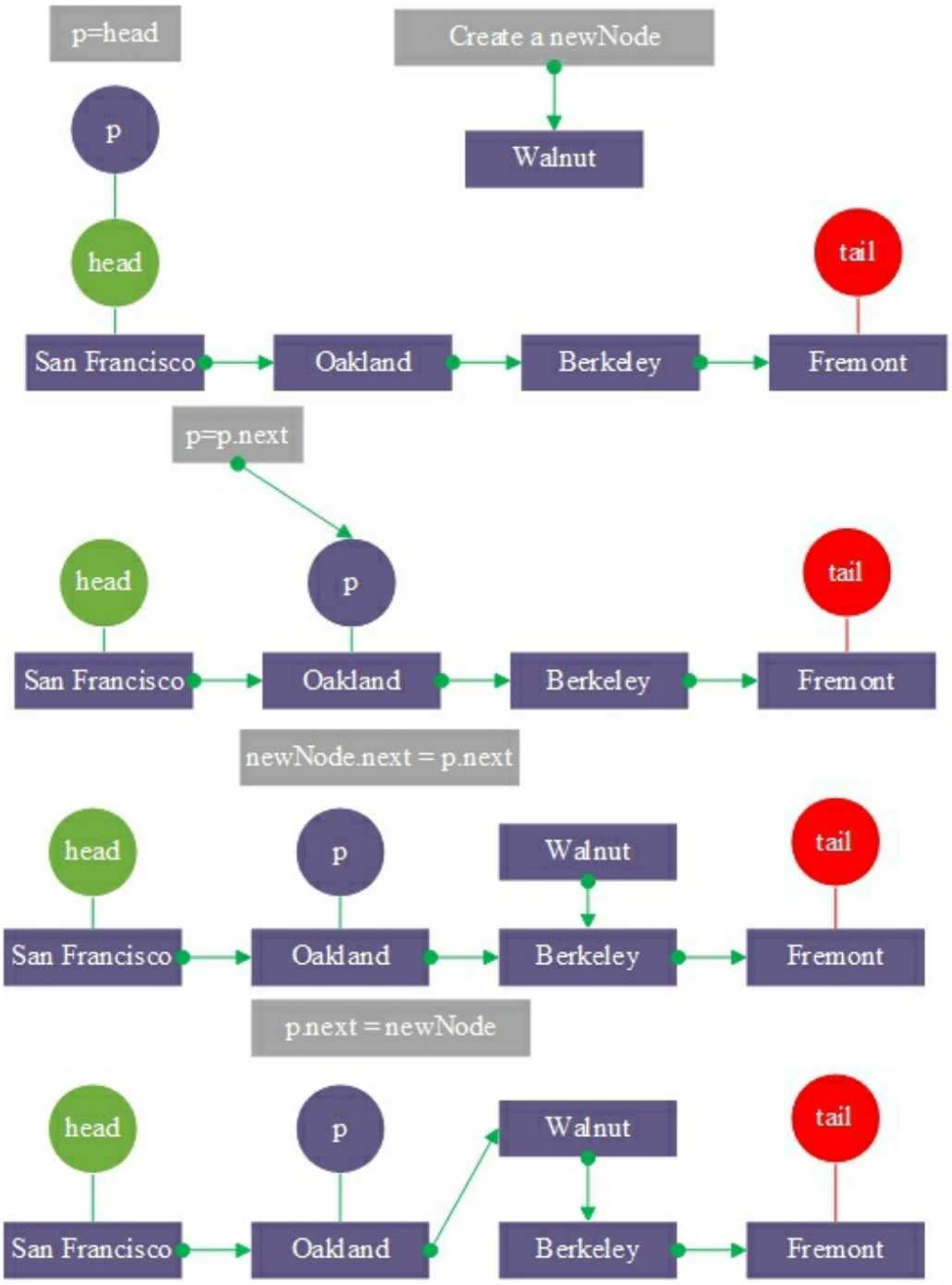
```
<script type="text/javascript">
    class Node{
        constructor(data, next){
            this.data = data;
            this.next = next;
        }

        getData(){
            return this.data;
        }
    }

    class LinkedList{

        init() {
            // the first node called head node
            this.head = new Node("San Francisco", null);

            var nodeOakland = new Node("Oakland", null);
            this.head.next = nodeOakland;

            var nodeBerkeley = new Node("Berkeley", null);
            nodeOakland.next = nodeBerkeley;

            // the last node called tail node
            this.tail = new Node("Fremont", null);
            nodeBerkeley.next = this.tail;

            return this.head;
        }

        add(newNode) {
            this.tail.next = newNode;
            this.tail = newNode;
        }
```

```
        print(node) {
            var p = node;
            while (p != null) // From the beginning to the end
            {
                var data = p.getData();
                document.write(data + " -> ");
                p = p.next;
            }
            document.write("End<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var linkedList = new LinkedList();
    var head = linkedList.init();

    document.write("Append a new node name: Walnut  to the end: <br>");
    linkedList.add(new Node("Walnut", null));

    linkedList.print(head);
</script>
```

Result:



3. Insert a node Walnut in position 2.

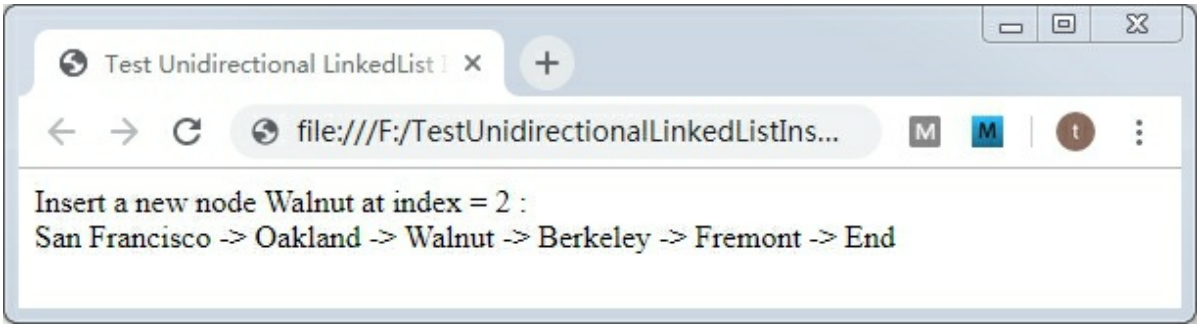


1. Create a TestUnidirectionalLinkedListInsert.html with Notepad

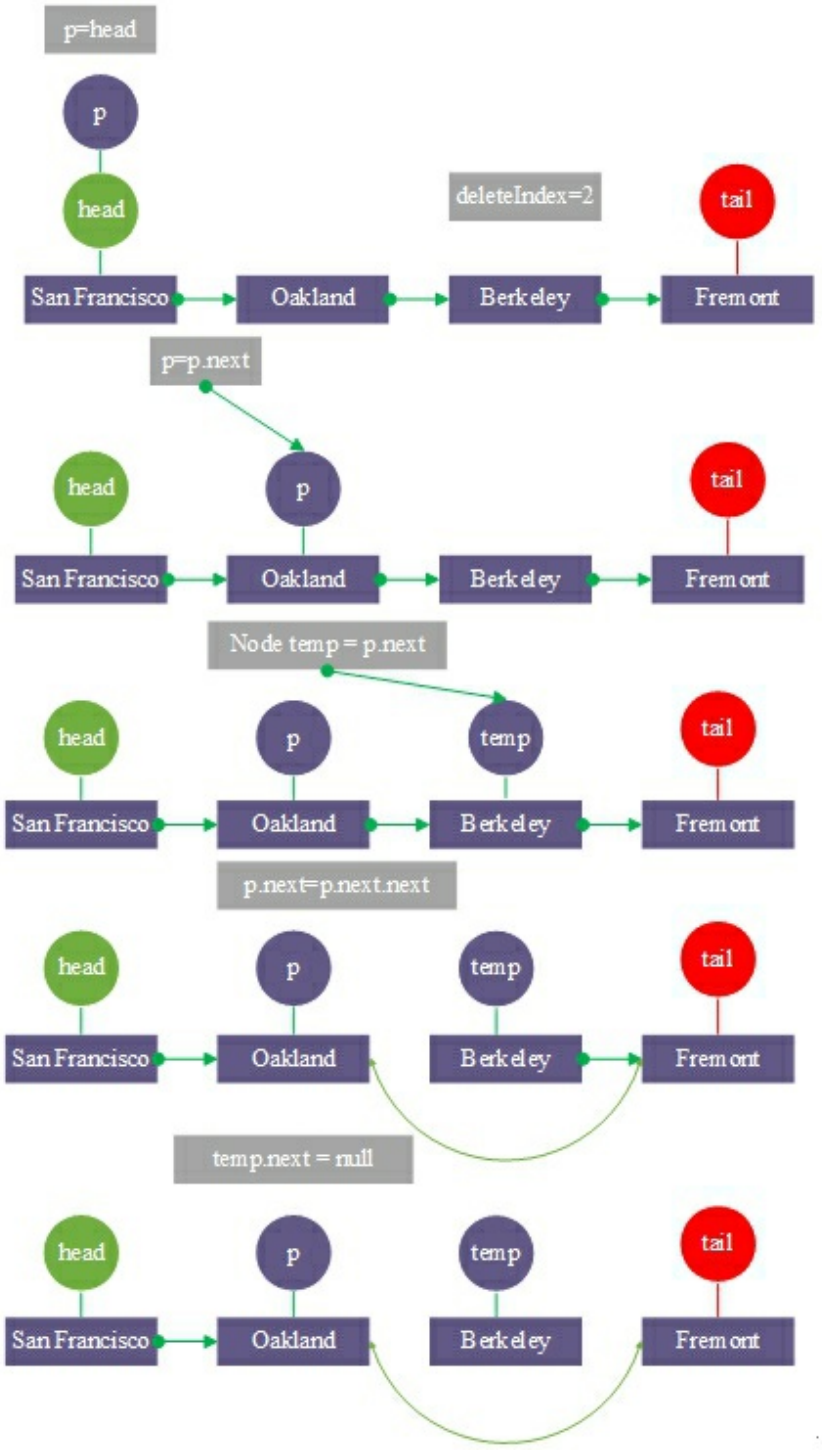
```
<script type="text/javascript">
    class Node{
        constructor(data, next){
            this.data = data;
            this.next = next;
        }

        getData(){
            return this.data;
        }
    }

    class LinkedList{
        init() {
            // the first node called head node
            this.head = new Node("San Francisco", null);

            var nodeOakland = new Node("Oakland", null);
            this.head.next = nodeOakland;

            var nodeBerkeley = new Node("Berkeley", null);
            nodeOakland.next = nodeBerkeley;

            // the last node called tail node
            this.tail = new Node("Fremont", null);
            nodeBerkeley.next = this.tail;

            return this.head;
        }

        insert(insertPosition, newNode) {
            var p = this.head;
            var i = 0;
            // Move the node to the insertion position
            while (p.next != null && i < insertPosition - 1) {
                p = p.next;
                i++;
```

```
            }
            newNode.next = p.next; // newNode next point to next
node
            p.next = newNode; // current next point to newNode
        }

        print(node) {
            var p = node;
            while (p != null) // From the beginning to the end
            {
                var data = p.getData();
                document.write(data + " -> ");
                p = p.next;
            }
            document.write("End<br><br>");
        }
    }

    ////////////////////testing//////////////////

    var linkedList = new LinkedList();
    var head = linkedList.init();

    document.write("Insert a new node Walnut at index = 2 : <br>");
    linkedList.insert(2, new Node("Walnut", null));

    linkedList.print(head);
</script>
```

Result:



4. Delete the index=2 node.

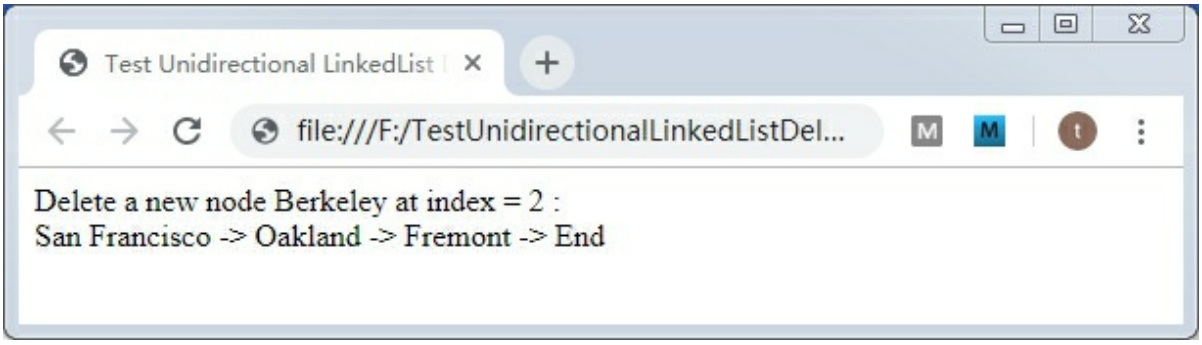


1. Create a TestUnidirectionalLinkedListDelete.html with Notepad

```
<script type="text/javascript">
    class Node{
        constructor(data, next){
            this.data = data;
            this.next = next;
        }

        getData(){
            return this.data;
        }
    }

    class LinkedList{
        init() {
            // the first node called head node
            this.head = new Node("San Francisco", null);

            var nodeOakland = new Node("Oakland", null);
            this.head.next = nodeOakland;

            var nodeBerkeley = new Node("Berkeley", null);
            nodeOakland.next = nodeBerkeley;

            // the last node called tail node
            this.tail = new Node("Fremont", null);
            nodeBerkeley.next = this.tail;
            return this.head;
        }

        remove(removePosition) {
            var p = this.head;
            var i = 0;
            // Move the node to the previous node position that was deleted
            while (p.next != null && i < removePosition - 1) {
                p = p.next;
                i++;
            }
```

```
            var temp = p.next;// Save the node you want to delete
            p.next = p.next.next;// Previous node next points to next of
delete the node
            temp.next = null;
        }

        print(node) {
            var p = node;
            while (p != null) // From the beginning to the end
            {
                var data = p.getData();
                document.write(data + " -> ");
                p = p.next;
            }
            document.write("End<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var linkedList = new LinkedList();
    var head = linkedList.init();

    document.write("Delete a new node Berkeley at index = 2 : <br>");
    linkedList.remove(2);

    linkedList.print(head);
</script>
```

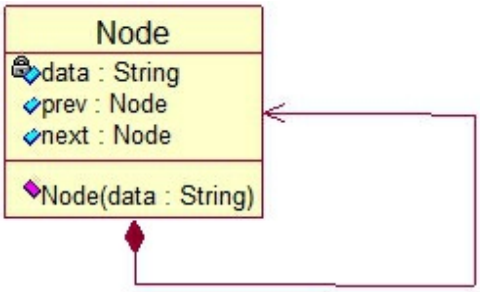
Result:



Doubly Linked List

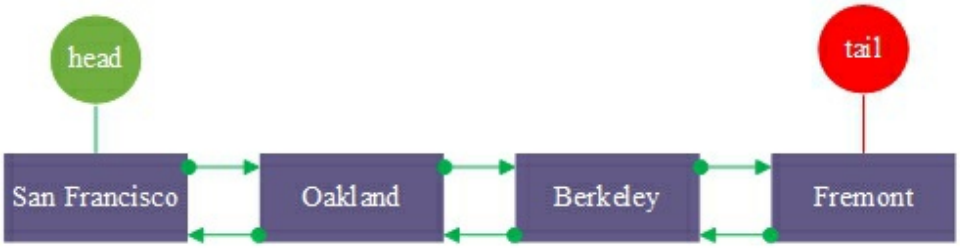
Doubly Linked List:
It is a chained storage structure of a linear table. It is connected by nodes in two directions. Each node consists of data, pointing to the previous node and pointing to the next node.

UML Diagram




```
class Node{
    constructor(data, prev, next){
  this.data = data;
  this.prev = prev;
  this.next = next;
    }

    getData(){
  return this.data;
    }
}
```

1. Doubly Linked List initialization.
Example : Construct a San Francisco subway Doubly linked list



2. Create a TestDoubleLink.html with Notepad

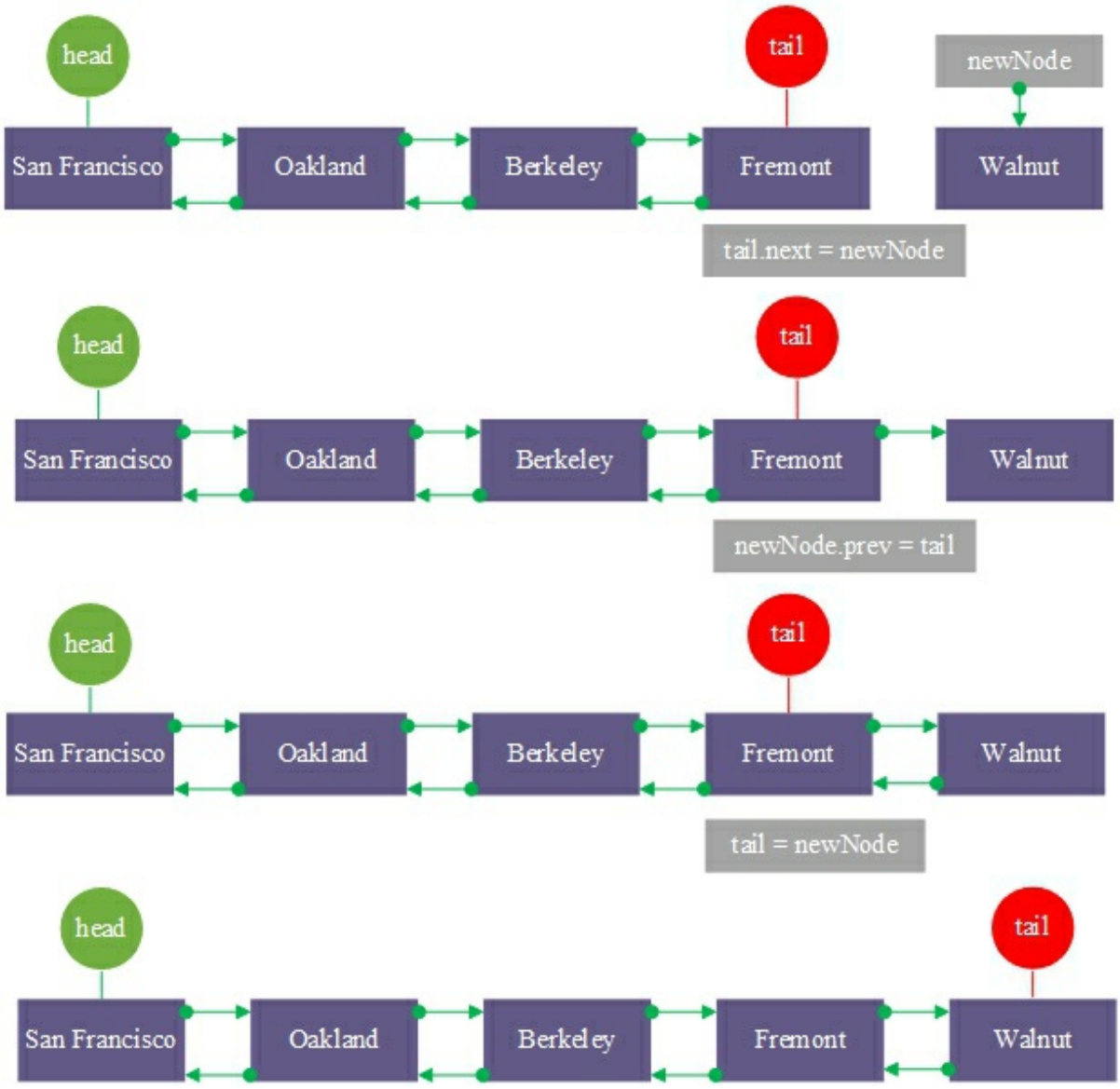
```
<script type="text/javascript">
    class Node{
         constructor(data, prev, next){
        this.data = data;
        this.prev = prev;
        this.next = next;
         }

         getData(){
        return this.data;
         }
    }

    class DoubleLinkList{
         init() {
        this.head = new Node("San Francisco");
        this.head.prev = null;
        this.head.next = null;

        var nodeOakland = new
Node("Oakland");
        nodeOakland.prev = this.head;
        nodeOakland.next = null;
        this.head.next = nodeOakland;

        var nodeBerkeley = new
Node("Berkeley");
        nodeBerkeley.prev = nodeOakland;
        nodeBerkeley.next = null;
        nodeOakland.next = nodeBerkeley;

        this.tail = new Node("Fremont");
        this.tail.prev = nodeBerkeley;
        this.tail.next = null;
        nodeBerkeley.next = this.tail;
        return this.head;
```

```
        }



        print(node) {
        var p = node;
        var end = null;
        while (p != null)
        {
           var data = p.getData();
           document.write(data + " -> ");
           end = p;
           p = p.next;
        }
        document.write("End <br><br>");

        p = end;
        while (p != null)
        {
           var data = p.getData();
           document.write(data + " -> ");
           p = p.prev;
        }
        document.write("Start<br><br>");
        }
    }

    //////////////////////testing//////////////////
    var doubleLinkList = new DoubleLinkList();
    var head = doubleLinkList.init();
    doubleLinkList.print(head);
</script>
```

Result:


Test Double Link
file:///F:/TestDoubleLink.html
San Francisco -> Oakland -> Berkeley -> Fremont -> End
Fremont -> Berkeley -> Oakland -> San Francisco -> Start

3. add a node Walnut at the end of Fremont.



Create a TestDoubleLinkAdd.html with Notepad

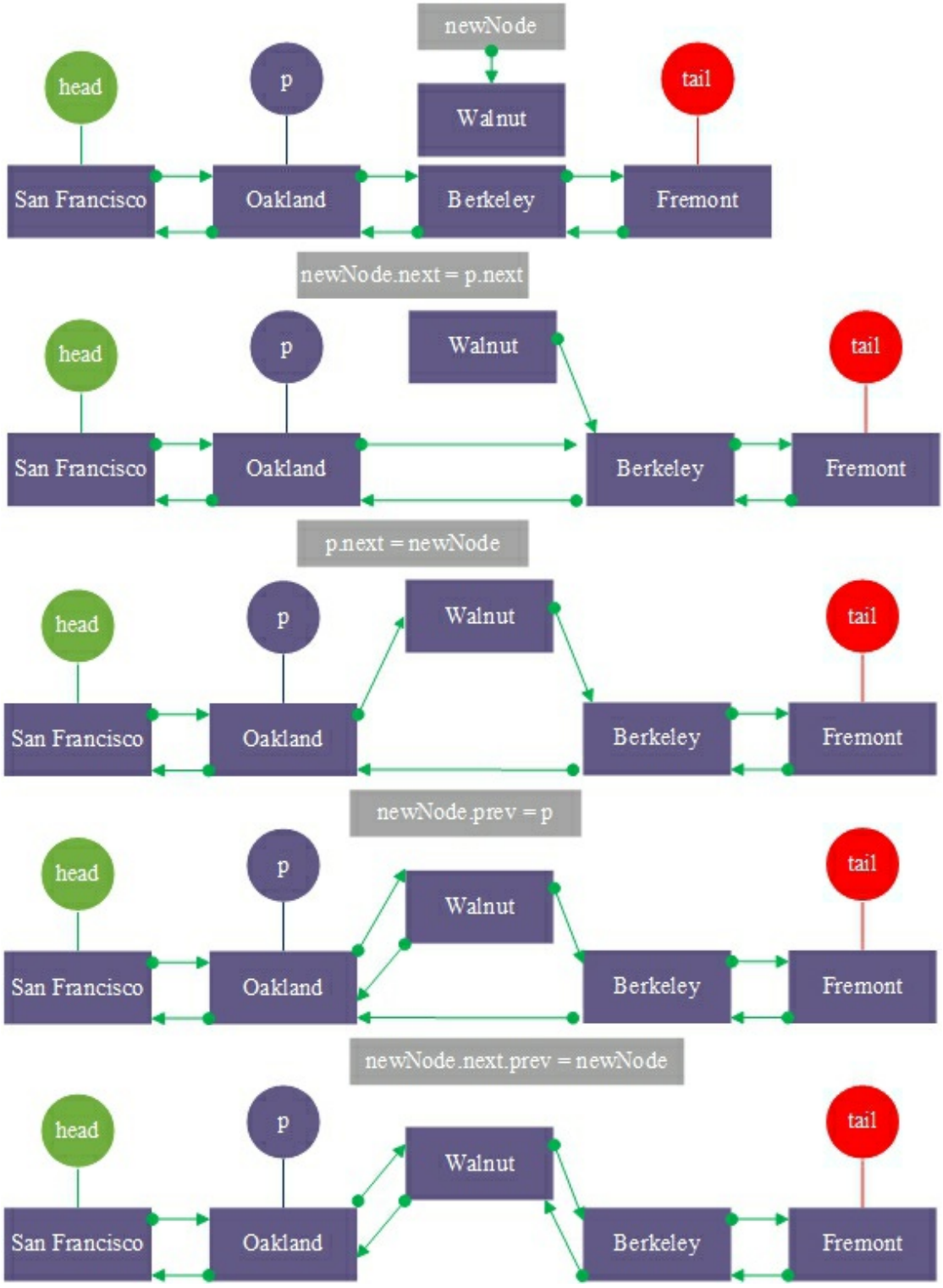
```
<script type="text/javascript">
    class Node{
         constructor(data, prev, next){
        this.data = data;
        this.prev = prev;
        this.next = next;
         }

         getData(){
        return this.data;
         }
    }

    class DoubleLinkList{
         init() {
        this.head = new Node("San Francisco");
        this.head.prev = null;
        this.head.next = null;

        var nodeOakland = new
Node("Oakland");
        nodeOakland.prev = this.head;
        nodeOakland.next = null;
        this.head.next = nodeOakland;

        var nodeBerkeley = new
Node("Berkeley");
        nodeBerkeley.prev = nodeOakland;
        nodeBerkeley.next = null;
        nodeOakland.next = nodeBerkeley;

        this.tail = new Node("Fremont");
        this.tail.prev = nodeBerkeley;
        this.tail.next = null;
        nodeBerkeley.next = this.tail;
        return this.head;
```

```
        }

        add(newNode) {
        this.tail.next = newNode;
        newNode.prev = this.tail;
        this.tail = newNode;
        }

        print(node) {
        var p = node;
        var end = null;
        while (p != null)
        {
           var data = p.getData();
           document.write(data + " -> ");
           end = p;
           p = p.next;
        }
        document.write("End <br><br>");

        p = end;
        while (p != null)
        {
           var data = p.getData();
           document.write(data + " -> ");
           p = p.prev;
        }
        document.write("Start<br><br>");
        }
    }

    //////////////////////testing//////////////////
    var doubleLinkList = new DoubleLinkList();
    var head = doubleLinkList.init();
    doubleLinkList.add(new Node("Walnut"));
    doubleLinkList.print(head);
</script>
```

Result:


Test Double Link Add
file:///F:/TestDoubleLinkAdd.html
San Francisco -> Oakland -> Berkeley -> Fremont -> Walnut -> End
Walnut -> Fremont -> Berkeley -> Oakland -> San Francisco -> Start

3. Insert a node Walnut in position 2.



Create a TestDoubleLinkInsert.html with Notepad

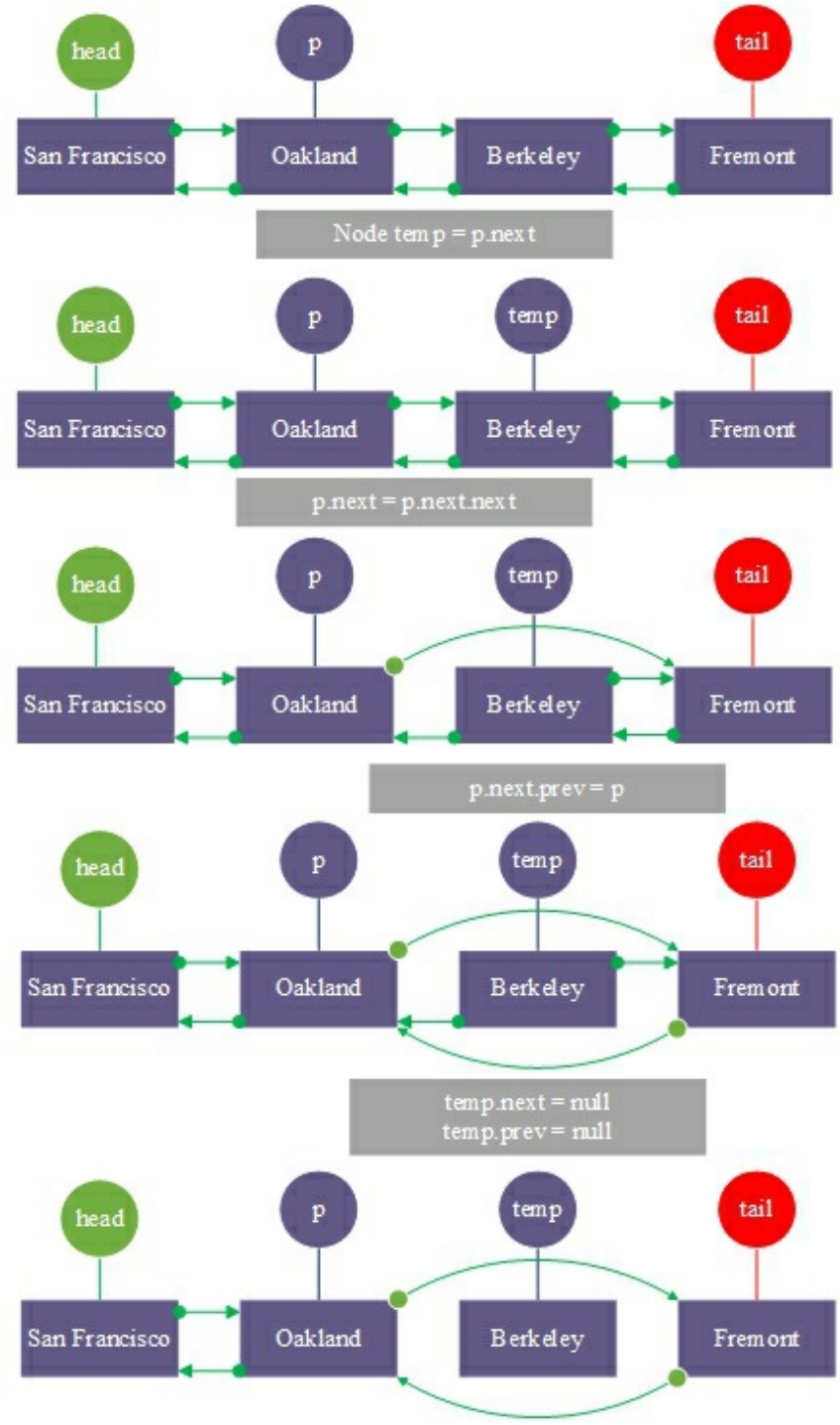
```
<script type="text/javascript">
    class Node{
        constructor(data, prev, next){
            this.data = data;
            this.prev = prev;
            this.next = next;
        }

        getData(){
            return this.data;
        }
    }

    class DoubleLinkList{

        init() {
            this.head = new Node("San Francisco");
            this.head.prev = null;
            this.head.next = null;

            var nodeOakland = new Node("Oakland");
            nodeOakland.prev = this.head;
            nodeOakland.next = null;
            this.head.next = nodeOakland;

            var nodeBerkeley = new Node("Berkeley");
            nodeBerkeley.prev = nodeOakland;
            nodeBerkeley.next = null;
            nodeOakland.next = nodeBerkeley;

            this.tail = new Node("Fremont");
            this.tail.prev = nodeBerkeley;
            this.tail.next = null;
            nodeBerkeley.next = this.tail;
            return this.head;
        }
```

```
    insert(insertPosition, newNode) {
        var p = this.head;
        var i = 0;
        // Move the node to the insertion position
        while (p.next != null && i < insertPosition-1) {
            p = p.next;
            i++;
        }

        newNode.next = p.next;
        p.next = newNode;
        newNode.prev = p;
        newNode.next.prev = newNode;
    }

    print(node) {
        var p = node;
        var end = null;
        while (p != null)
        {
            var data = p.getData();
            document.write(data + " -> ");
            end = p;
            p = p.next;
        }
        document.write("End <br><br>");

        p = end;
        while (p != null)
        {
            var data = p.getData();
            document.write(data + " -> ");
            p = p.prev;
        }
        document.write("Start<br><br>");
    }
}
```

```
    //////////////////////testing//////////////////////
    var doubleLinkList = new DoubleLinkList();
    var head = doubleLinkList.init();

    document.write("Insert a new node Walnut at index = 2 : <br>");
    doubleLinkList.insert(2,new Node("Walnut"));

    doubleLinkList.print(head);
</script>
```

Result:

4. Delete the index=2 node.



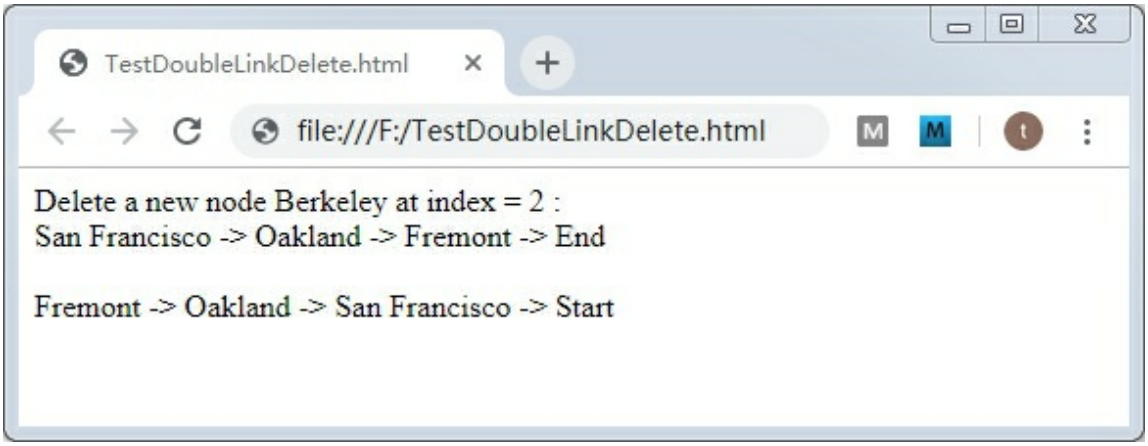
Create a TestDoubleLinkDelete.html with Notepad

```
<script type="text/javascript">
    class Node{
        constructor(data, prev, next){
            this.data = data;
            this.prev = prev;
            this.next = next;
        }

        getData(){
            return this.data;
        }
    }

    class DoubleLinkList{

        init() {
            this.head = new Node("San Francisco");
            this.head.prev = null;
            this.head.next = null;

            var nodeOakland = new Node("Oakland");
            nodeOakland.prev = this.head;
            nodeOakland.next = null;
            this.head.next = nodeOakland;

            var nodeBerkeley = new Node("Berkeley");
            nodeBerkeley.prev = nodeOakland;
            nodeBerkeley.next = null;
            nodeOakland.next = nodeBerkeley;

            this.tail = new Node("Fremont");
            this.tail.prev = nodeBerkeley;
            this.tail.next = null;
            nodeBerkeley.next = this.tail;
            return this.head;
        }
```

```
    remove(removePosition) {
        var p = this.head;
        var i = 0;
        // Move the node to the previous node  that was deleted
        while (p.next != null && i < removePosition - 1) {
            p = p.next;
            i++;
        }

        var temp = p.next;// Save the node you want to delete
        p.next = p.next.next;
        p.next.prev = p;
        temp.next = null;// Set the delete node next to null
        temp.prev = null;// Set the delete node prev to null
    }

    print(node) {
        var p = node;
        var end = null;
        while (p != null)
        {
            var data = p.getData();
            document.write(data + " -> ");
            end = p;
            p = p.next;
        }
        document.write("End <br><br>");

        p = end;
        while (p != null)
        {
            var data = p.getData();
            document.write(data + " -> ");
            p = p.prev;
        }
        document.write("Start<br><br>");
    }
}
```

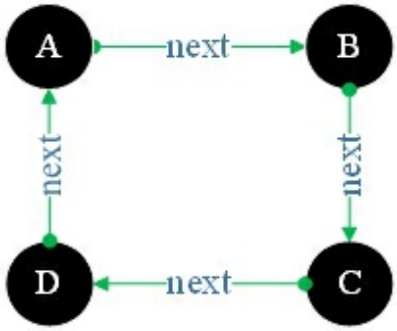
```
    //////////////////////testing//////////////////
    var doubleLinkList = new DoubleLinkList();
    var head = doubleLinkList.init();

    document.write("Delete a new node Berkeley at index = 2 : <br>");
    doubleLinkList.remove(2);

    doubleLinkList.print(head);
</script>
```

Result:

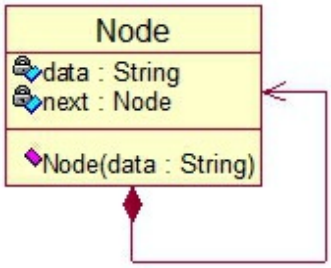


One-way Circular LinkedList

One-way Circular List:
It is a chain storage structure of a linear table, which is connected to form a ring, and each node is composed of data and a pointer to next.

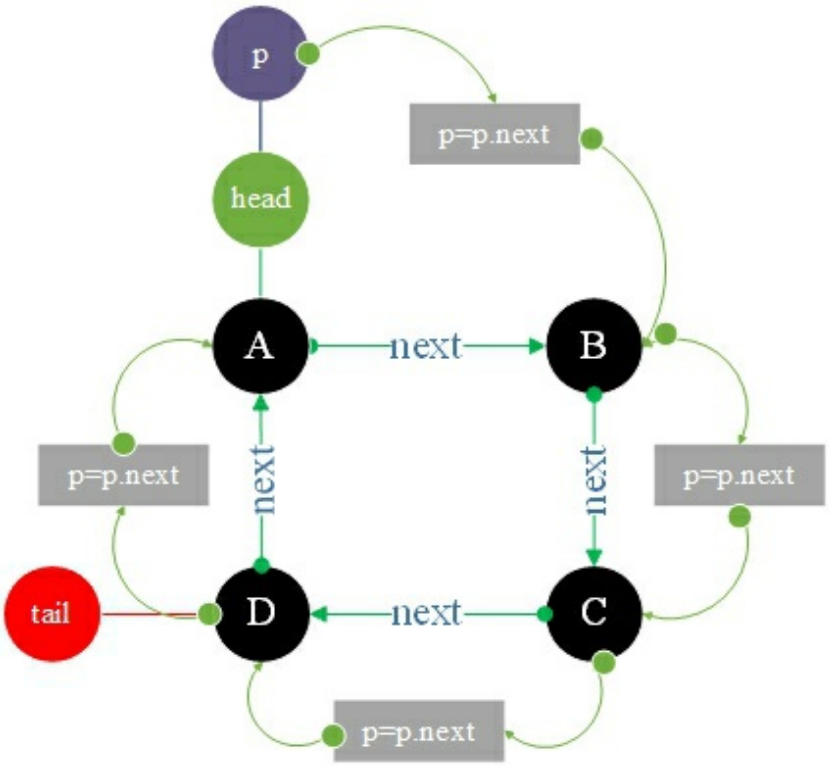


UML Diagram




```
class Node{
    constructor(data, next){
 this.data = data;
 this.next = next;
    }

    getData(){
 return this.data;
    }
}
```

1. One-way Circular Linked List initialization and traversal output.



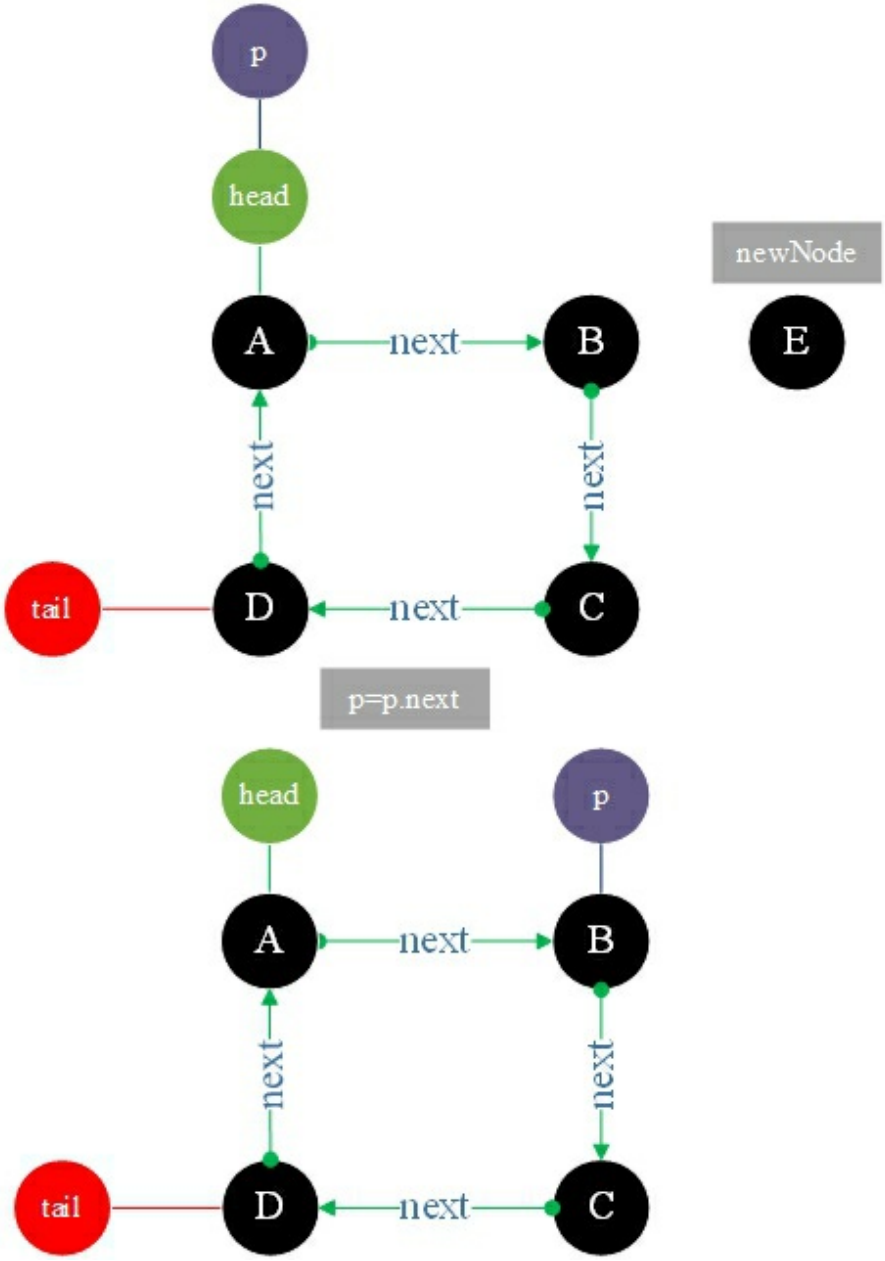
Create a TestSingleCircleLink.html with Notepad

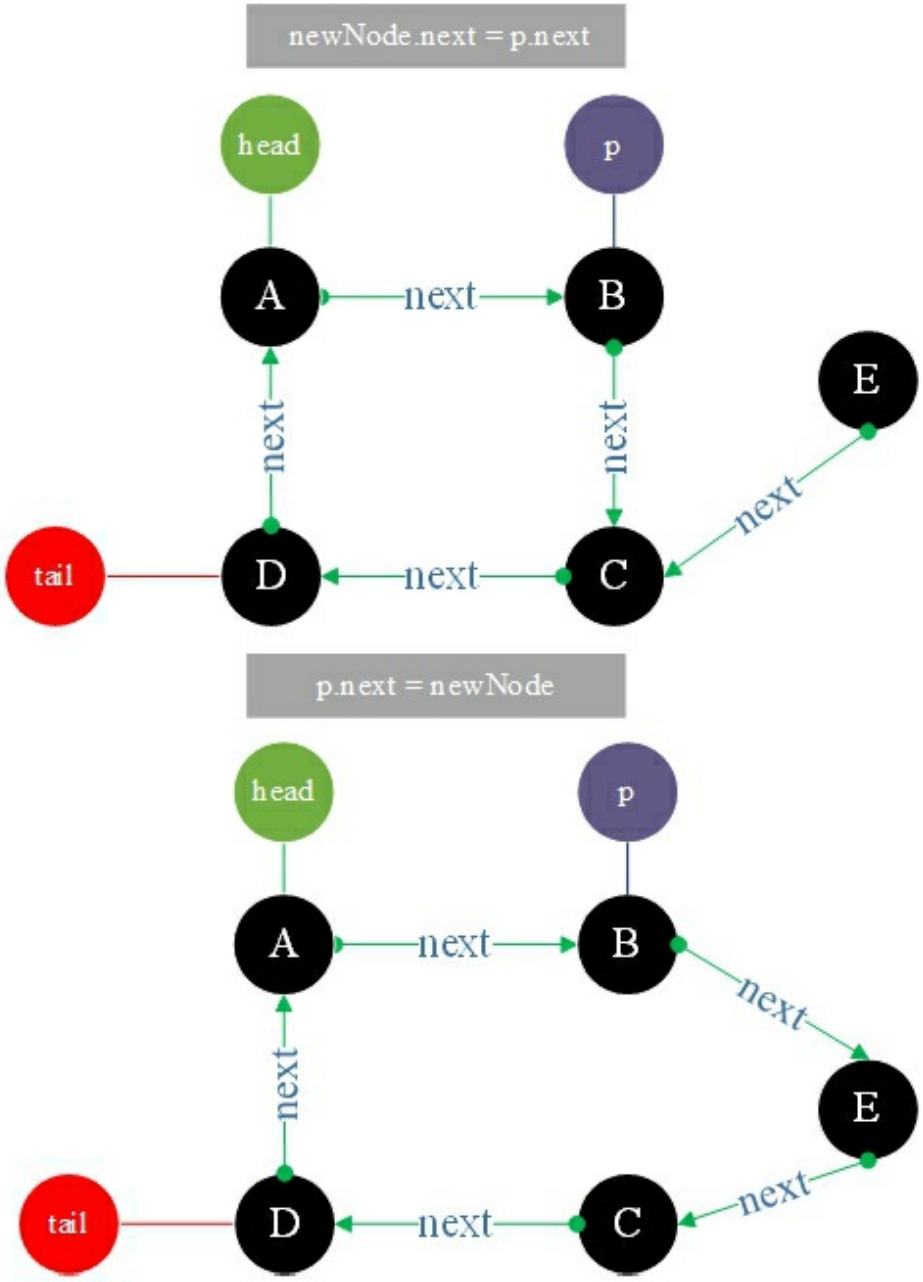
```
<script type="text/javascript">
    class Node{
        constructor(data, next){
        this.data = data;
        this.next = next;
        }

        getData(){
        return this.data;
        }
    }

    class SingleCircleLink{
        init() {
        // the first node called head node
        this.head = new Node("A");
        this.head.next = null;

        var nodeB = new Node("B");
        nodeB.next = null;
        this.head.next = nodeB;

        var nodeC = new Node("C");
        nodeC.next = null;
        nodeB.next = nodeC;

        // the last node called tail node
        this.tail = new Node("D");
        this.tail.next = this.head;
        nodeC.next = this.tail;
        }
```

```
        print() {
        var p = this.head;
        do{
            var data = p.getData();
            document.write(data + " -> ");
            p = p.next;
        }while(p != this.head);

        var data = p.getData();
        document.write(data + "<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var singleCircleLink = new SingleCircleLink();
    var head = singleCircleLink.init();
    singleCircleLink.print(head);
</script>
```

Result:

3. Insert a node E in position 2.



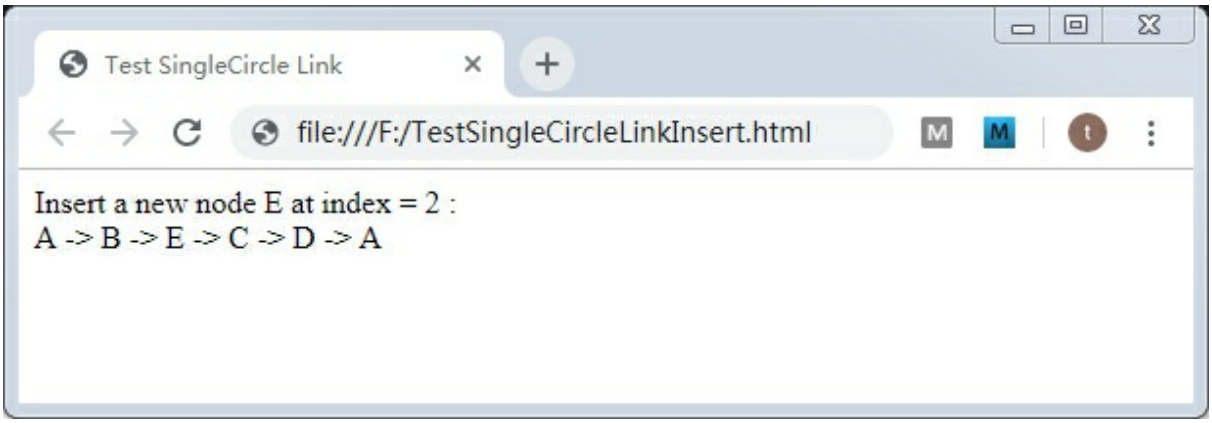

newNode.next = p.next
head
p
A
next
B
E
next
next
next
tail
D
next
C
p.next = newNode
head
p
A
next
B
next
E
next
tail
D
next
C

Create a TestSingleCircleLinkInsert.html with Notepad

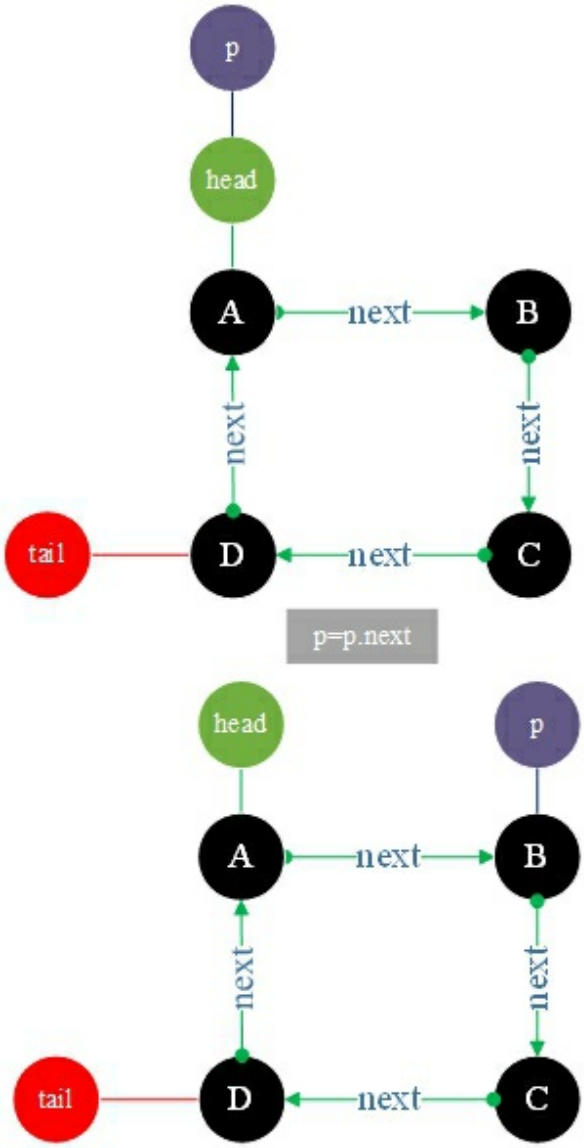
```
<script type="text/javascript">
    class Node{
        constructor(data, next){
          this.data = data;
          this.next = next;
        }
        getData(){
          return this.data;
        }
    }

    class SingleCircleLink{
        init() {
          // the first node called head node
          this.head = new Node("A");
          this.head.next = null;

          var nodeB = new Node("B");
          nodeB.next = null;
          this.head.next = nodeB;

          var nodeC = new Node("C");
          nodeC.next = null;
          nodeB.next = nodeC;

          // the last node called tail node
          this.tail = new Node("D");
          this.tail.next = this.head;
          nodeC.next = this.tail;
        }

        insert(insertPosition, newNode) {
          var p = this.head;
          var i = 0;
          while (p.next != null && i < insertPosition - 1) {
              p = p.next;
```

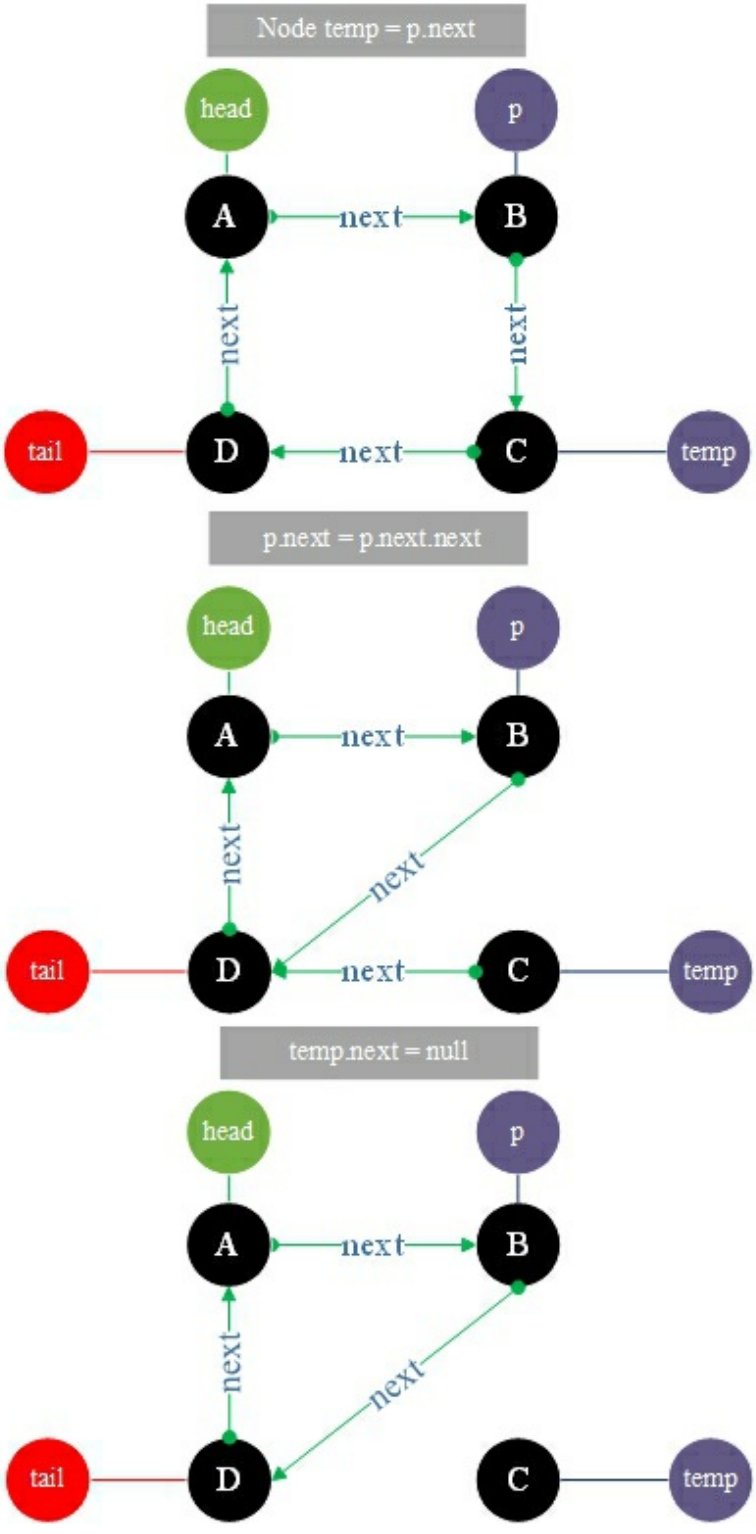
```
            i++;
          }
          newNode.next = p.next;
          p.next = newNode;
        }

        print() {
          var p = this.head;
          do{
            var data = p.getData();
            document.write(data + " -> ");
            p = p.next;
          }while(p != this.head);

          var data = p.getData();
          document.write(data + "<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var singleCircleLink = new SingleCircleLink();
    var head = singleCircleLink.init();

    document.write("Insert a new node E at index = 2 : <br>");
    singleCircleLink.insert(2,new Node("E"));

    singleCircleLink.print(head);
</script>
```

Result:


Test SingleCircle Link
file:///F:/TestSingleCircleLinkInsert.html
Insert a new node E at index = 2 :
A -> B -> E -> C -> D -> A

4. Delete the index=2 node.



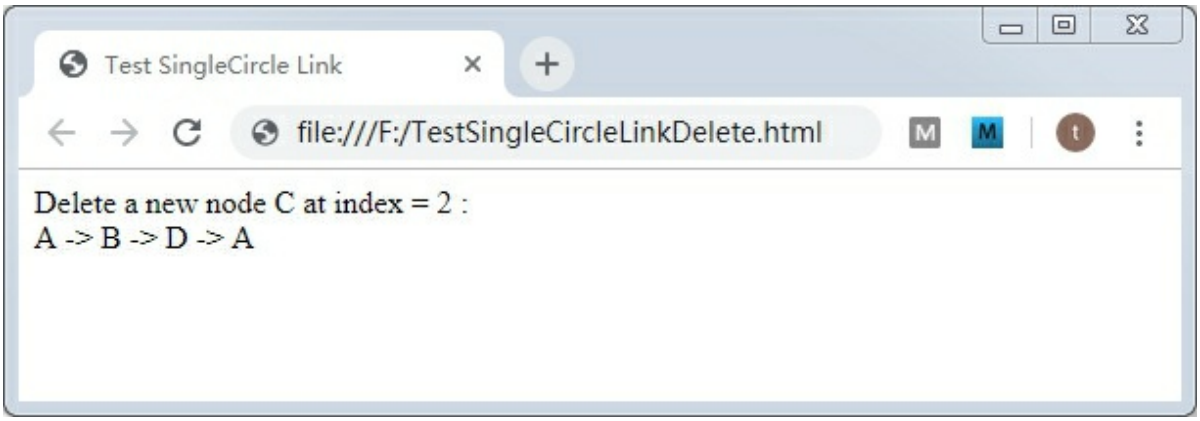

Node temp = p.next
head
p
A
next
B
next
next
tail
D
next
C
temp
p.next = p.next.next
head
p
A
next
B
next
next
tail
D
next
C
temp
temp.next = null
head
p
A
next
B
next
next
tail
D
C
temp

Create a TestSingleCircleLinkDelete.html with Notepad

```
<script type="text/javascript">
    class Node{
        constructor(data, next){
          this.data = data;
          this.next = next;
        }
        getData(){
          return this.data;
        }
    }

    class SingleCircleLink{
        init() {
          this.head = new Node("A");
          this.head.next = null;

          var nodeB = new Node("B");
          nodeB.next = null;
          this.head.next = nodeB;

          var nodeC = new Node("C");
          nodeC.next = null;
          nodeB.next = nodeC;

          this.tail = new Node("D");
          this.tail.next = this.head;
          nodeC.next = this.tail;
        }

        remove(removePosition) {
          var p = this.head;
          var i = 0;
          while (p.next != null && i < removePosition - 1) {
              p = p.next;
              i++;
          }
```

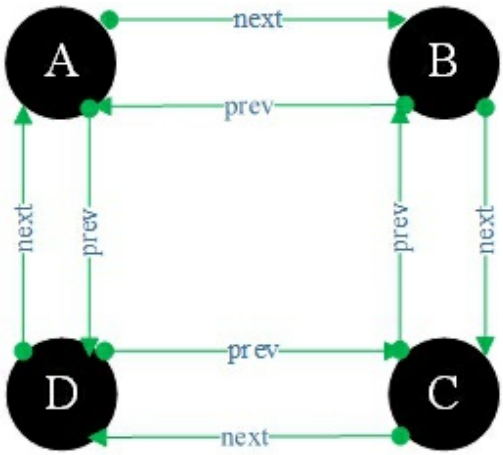
```
            var temp = p.next;
            p.next = p.next.next;
            temp.next = null;
        }


        print() {
            var p = this.head;
            do{
                var data = p.getData();
                document.write(data + " -> ");
                p = p.next;
            }while(p != this.head);

            var data = p.getData();
            document.write(data + "<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var singleCircleLink = new SingleCircleLink();
    singleCircleLink.init();

    document.write("Delete a new node C at index = 2 : <br>");
    singleCircleLink.remove(2);

    singleCircleLink.print();
</script>
```

Result:

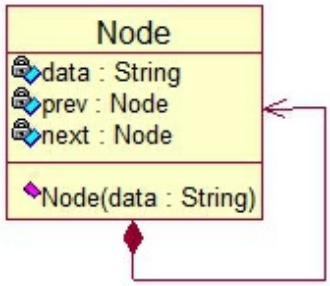

Test SingleCircle Link
file:///F:/TestSingleCircleLinkDelete.html
Delete a new node C at index = 2 :
A -> B -> D -> A

Two-way Circular LinkedList

Two-way Circular List:
It is a chain storage structure of a linear table. The nodes are connected in series by two directions, and is connected to form a ring. Each node is composed of data, pointing to the previous node prev and pointing to the next node next.

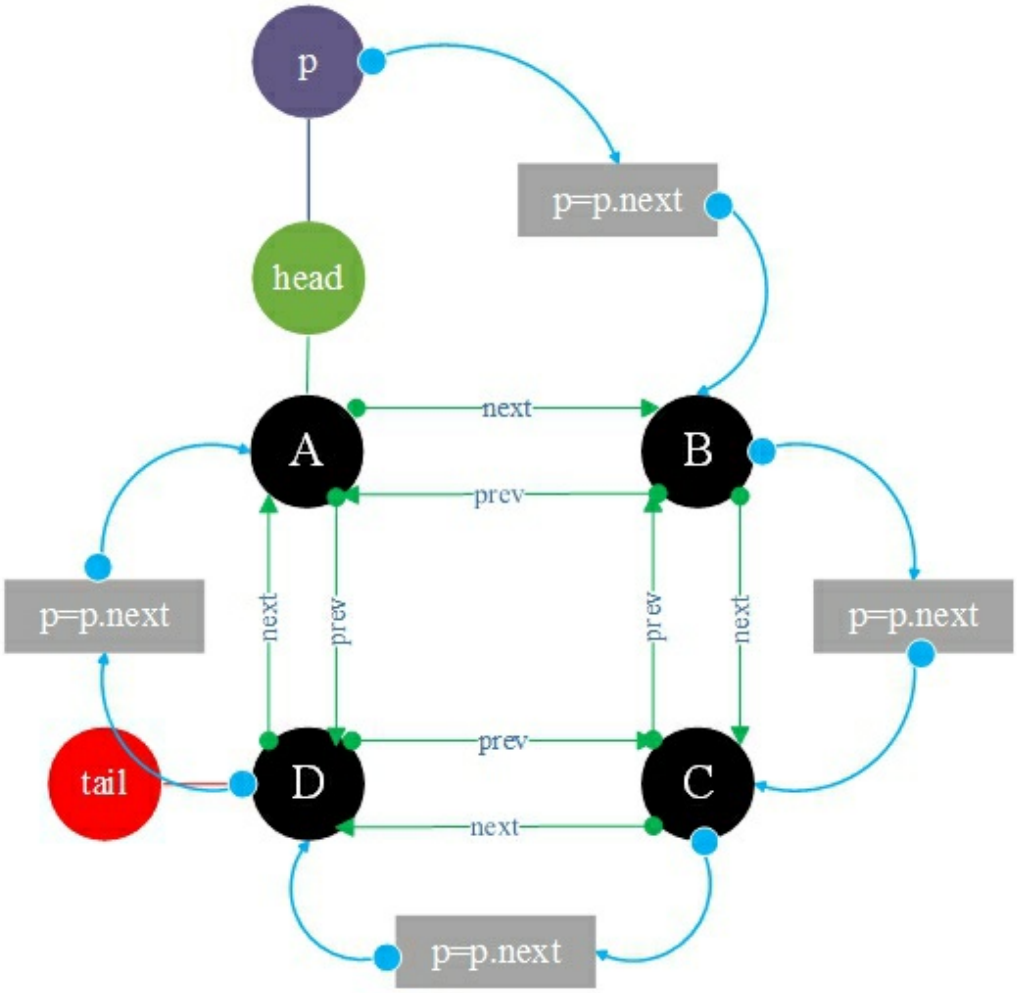


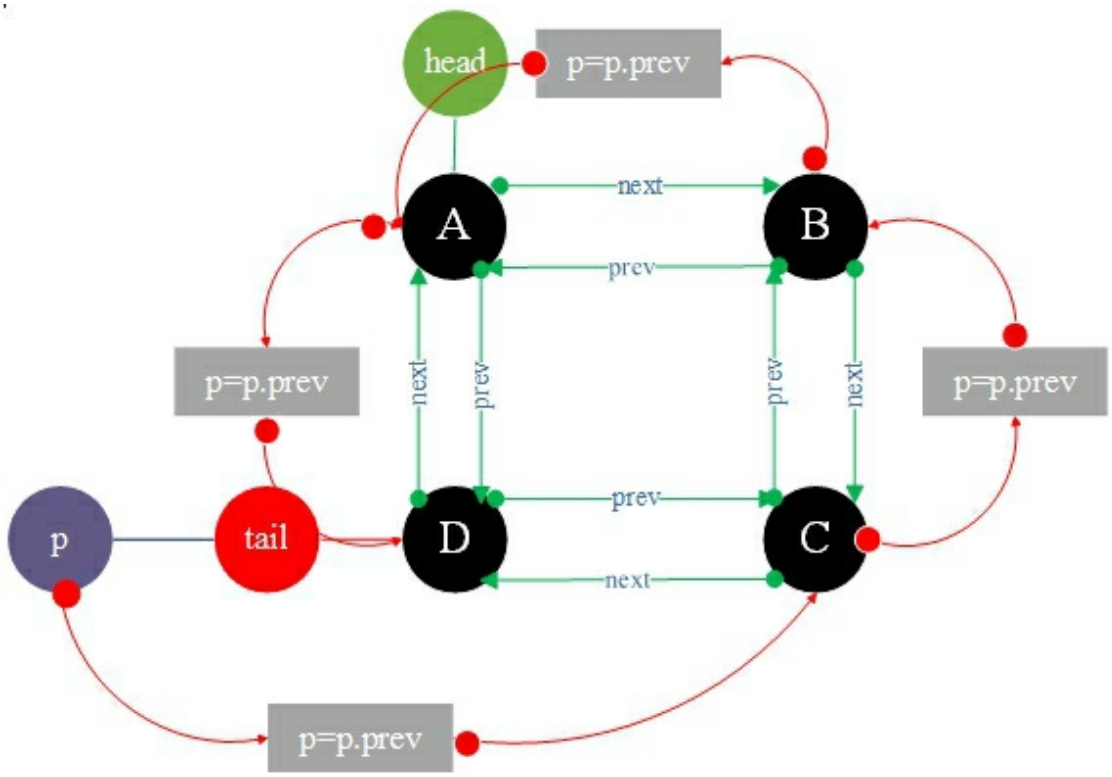
UML Diagram




```
class Node{
    constructor(data, prev, next){
  this.data = data;
  this.prev = prev;
  this.next = next;
    }

    getData(){
  return this.data;
    }
}
```

1. Two-way Circular Linked List initialization and traversal output.



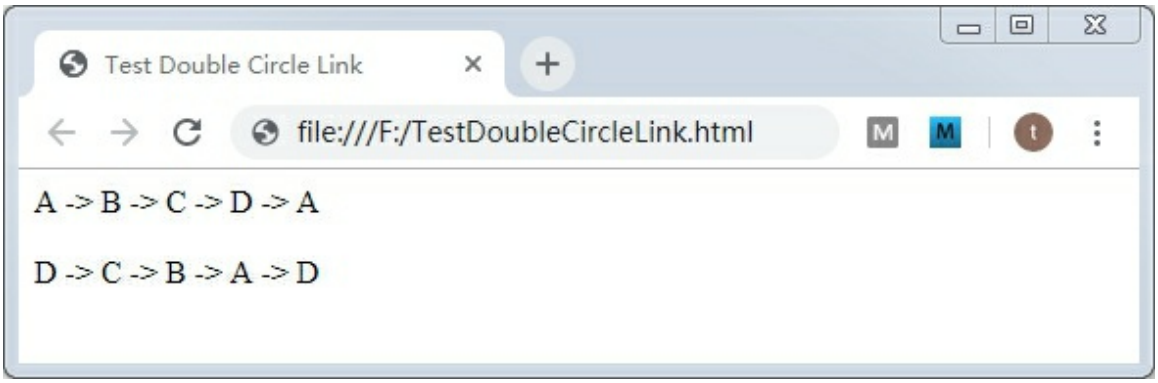

head
p=p.prev
next
A
B
prev
p=p.prev
next
prev
prev
next
p=p.prev
p
tail
D
prev
C
next
p=p.prev

Create a TestDoubleCircleLink.html with Notepad

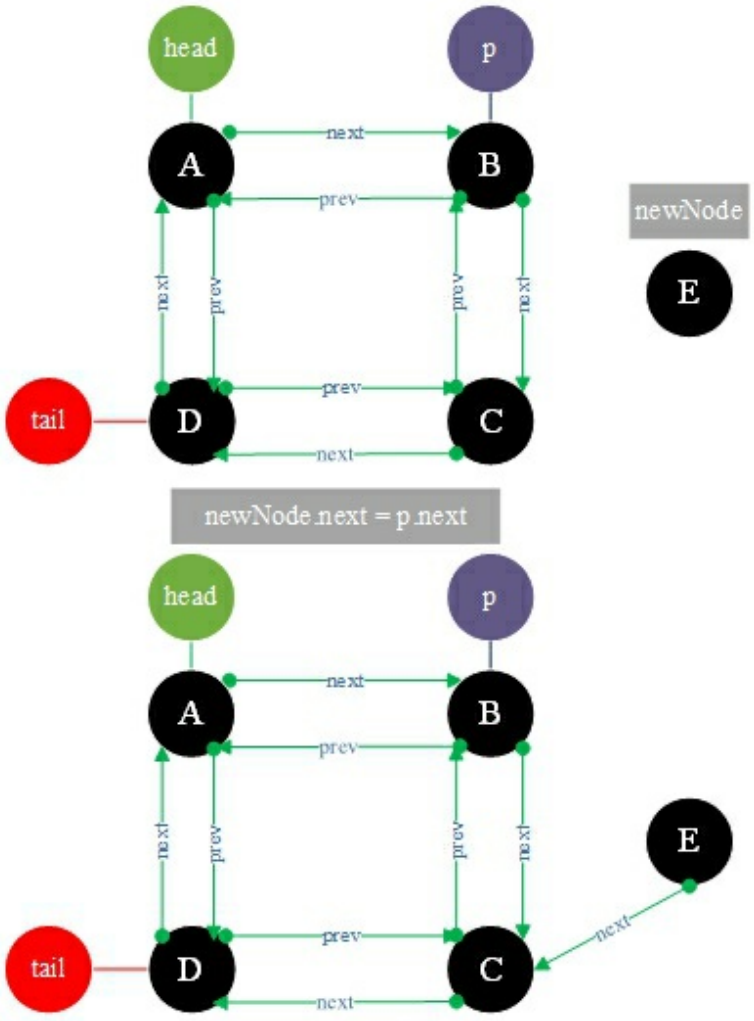
```
<script type="text/javascript">
    class Node{
        constructor(data, prev, next){
        this.data = data;
        this.prev = prev;
        this.next = next;
        }

        getData(){
        return this.data;
        }
    }

    class DoubleCircleLink{
        init() {
        // the first node called head node
        this.head = new Node("A");
        this.head.next = null;
        this.head.prev = null;

        var nodeB = new Node("B");
        nodeB.next = null;
        nodeB.prev = this.head;
        this.head.next = nodeB;

        var nodeC = new Node("C");
        nodeC.next = null;
        nodeC.prev = nodeB;
        nodeB.next = nodeC;

        // the last node called tail node
        this.tail = new Node("D");
        this.tail.next = this.head;
        this.tail.prev = nodeC;
        nodeC.next = this.tail;
        this.head.prev = this.tail;
```

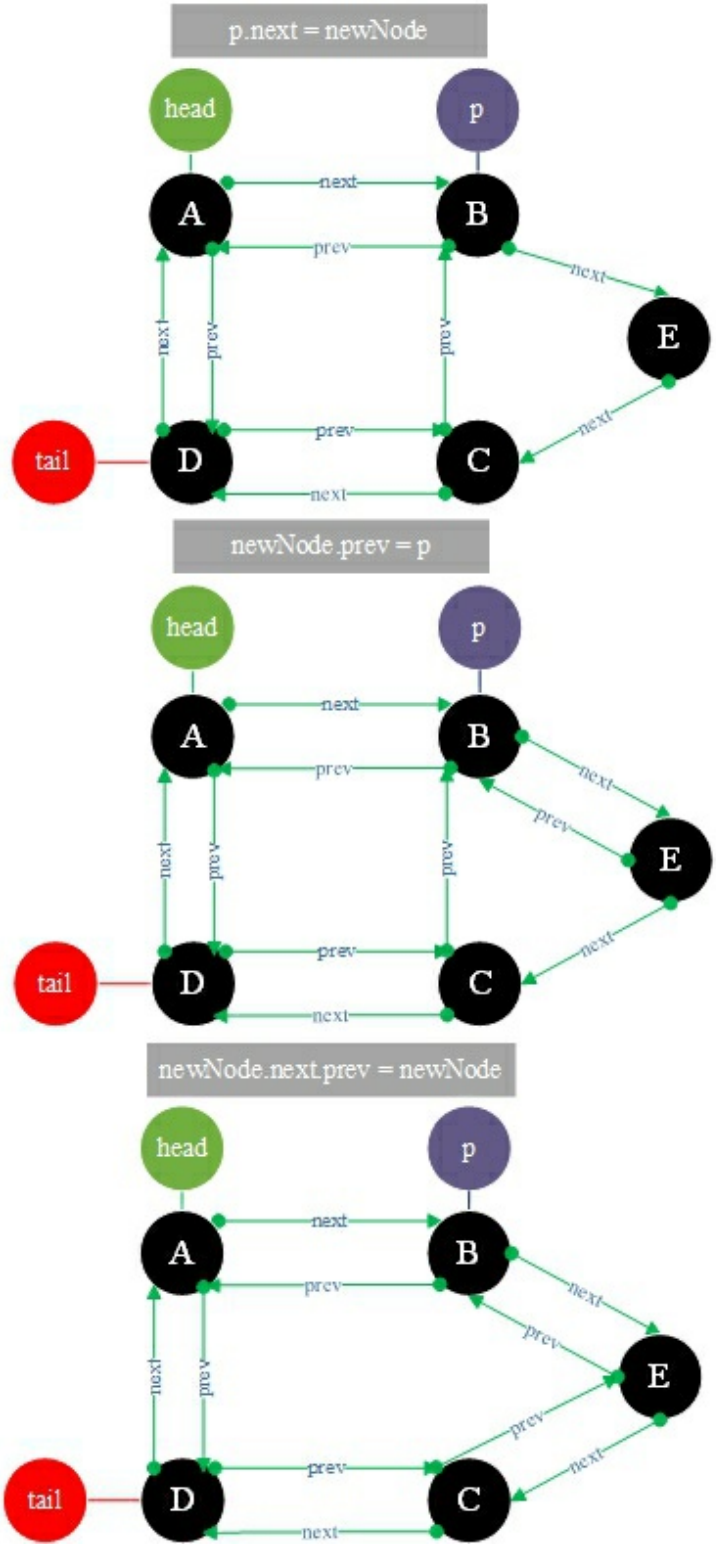
```
        }



        print() {
        var p = this.head;
        do {
            var data = p.getData();
            document.write(data + " -> ");
            p = p.next;
        } while (p != this.head);

        var data = p.getData();
        document.write(data + "<br><br>");

        p = this.tail;
        do {
            data = p.getData();
            document.write(data + " -> ");
            p = p.prev;
        } while (p != this.tail);

        data = p.getData();
        document.write(data + "<br><br>");
        }
    }

    //////////////////////testing//////////////////
    var doubleCircleLink = new DoubleCircleLink();
    doubleCircleLink.init();
    doubleCircleLink.print();
</script>
```

Result:


Test Double Circle Link
file:///F:/TestDoubleCircleLink.html
A -> B -> C -> D -> A
D -> C -> B -> A -> D

3. Insert a node E in position 2.




p.next = newNode
head
p
A
B
E
tail
D
C
next
prev
newNode.prev = p
newNode.next.prev = newNode

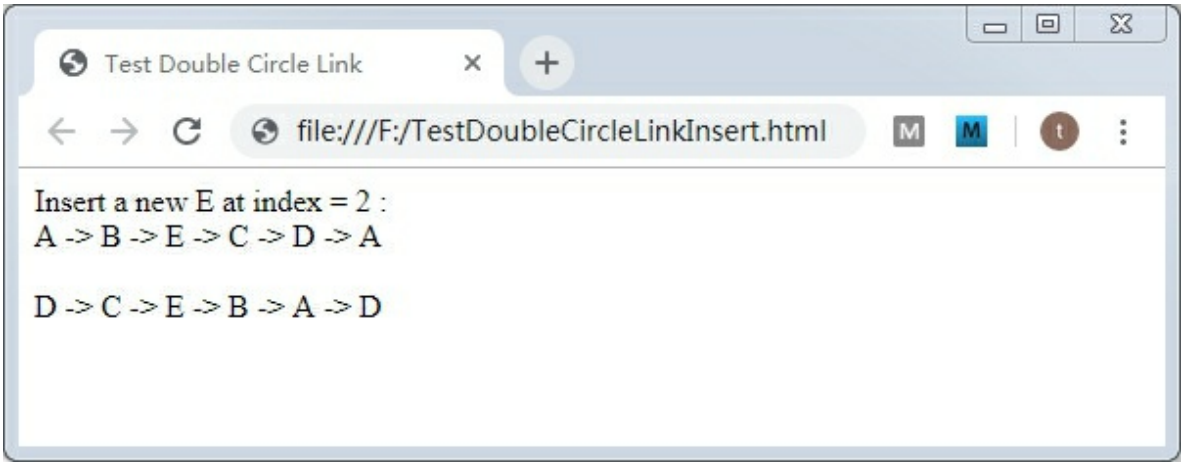
Create a TestDoubleCircleLinkInsert.html with Notepad

```
<script type="text/javascript">
    class Node{
        constructor(data, prev, next){
         this.data = data;
         this.prev = prev;
         this.next = next;
        }

        getData(){
         return this.data;
        }
    }

    class DoubleCircleLink{
        init() {
         // the first node called head node
         this.head = new Node("A");
         this.head.next = null;
         this.head.prev = null;

         var nodeB = new Node("B");
         nodeB.next = null;
         nodeB.prev = this.head;
         this.head.next = nodeB;

         var nodeC = new Node("C");
         nodeC.next = null;
         nodeC.prev = nodeB;
         nodeB.next = nodeC;

         // the last node called tail node
         this.tail = new Node("D");
         this.tail.next = this.head;
         this.tail.prev = nodeC;
         nodeC.next = this.tail;
         this.head.prev = this.tail;
```

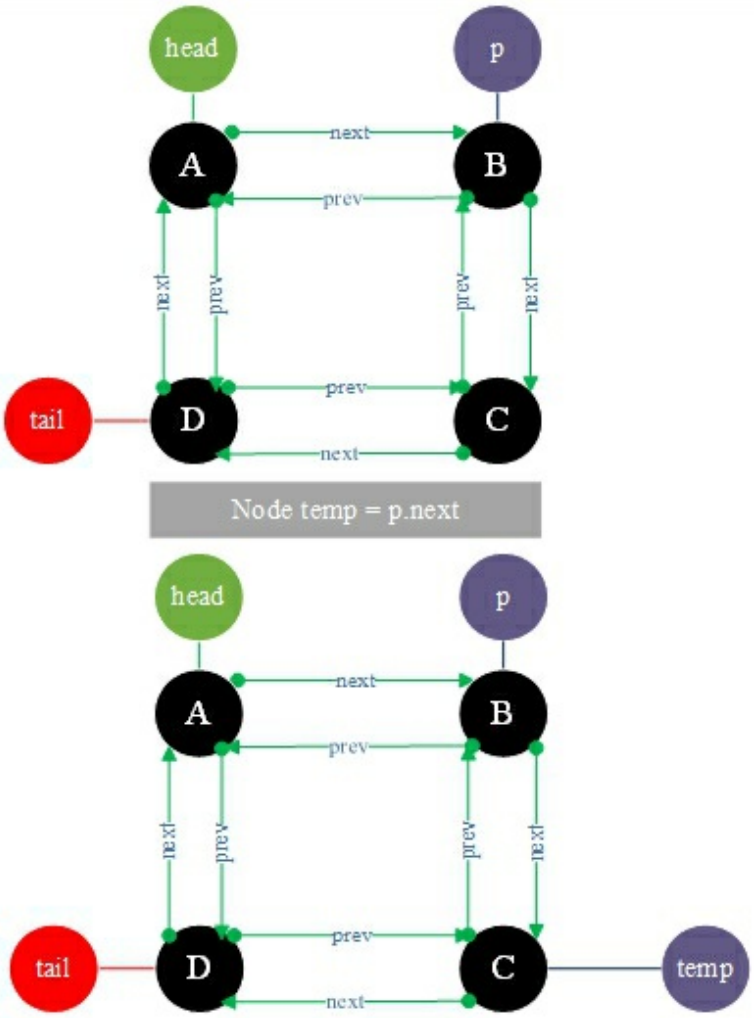
```
}



insert(insertPosition, newNode) {
 var p = this.head;
 var i = 0;
 //Move the node to the insertion position
 while (p.next != null && i < insertPosition - 1) {
    p = p.next;
    i++;
 }

 newNode.next = p.next;
 p.next = newNode;
 newNode.prev = p;
 newNode.next.prev = newNode;
}

print() {
 var p = this.head;
 do {
    var data = p.getData();
    document.write(data + " -> ");
    p = p.next;
 } while (p != this.head);

 var data = p.getData();
 document.write(data + "<br><br>");

 p = this.tail;
 do {
    data = p.getData();
    document.write(data + " -> ");
    p = p.prev;
 } while (p != this.tail);

 data = p.getData();
```

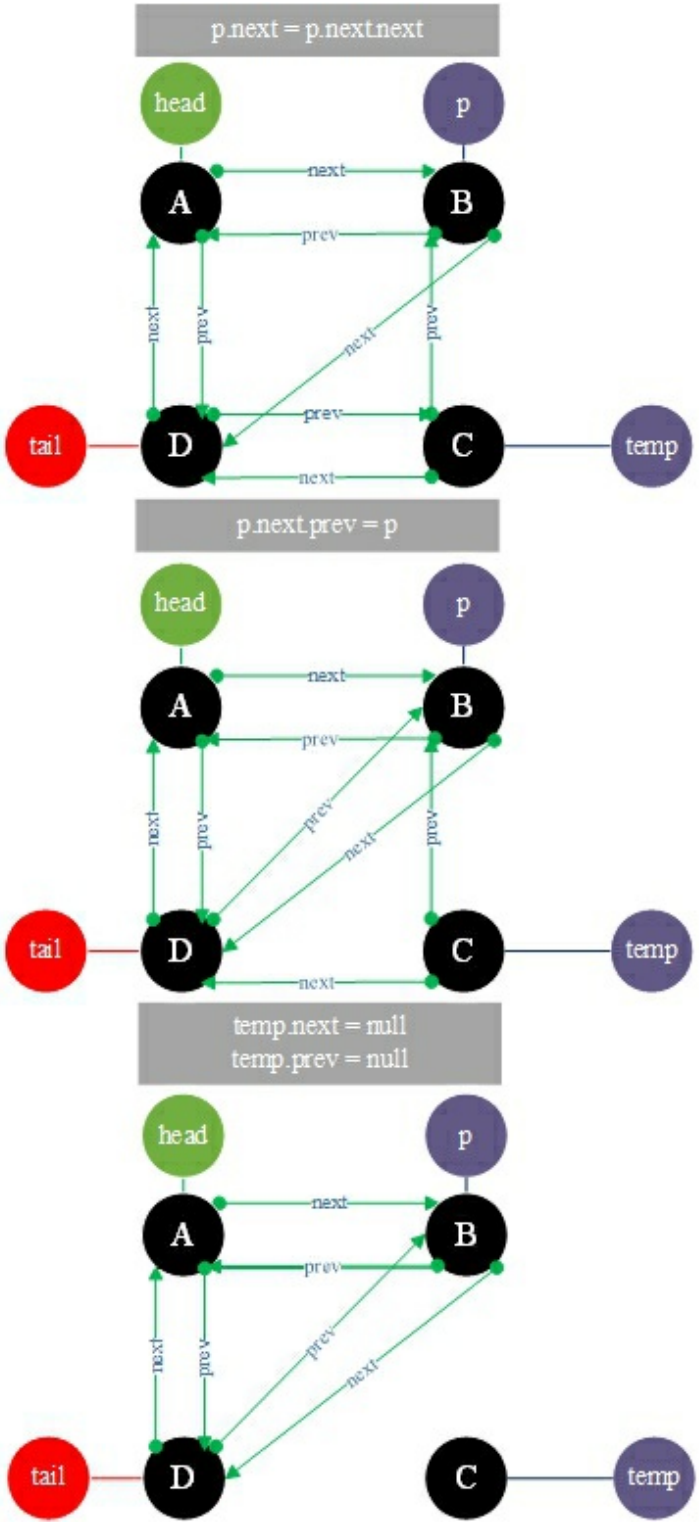
```
            document.write(data + "<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var doubleCircleLink = new DoubleCircleLink();
    doubleCircleLink.init();

    document.write("Insert a new E at index = 2 : <br>");
    doubleCircleLink.insert(2,new Node("E"));

    doubleCircleLink.print();
</script>
```

Result:



4. Delete the index=2 node.




p.next = p.next.next
head
p
A
B
next
prev
next
prev
next
prev
tail
D
C
temp
next
p.next.prev = p
head
p
A
B
next
prev
prev
next
prev
next
tail
D
C
temp
next
temp.next = null
temp.prev = null
head
p
A
B
next
prev
prev
next
next
prev
tail
D
C
temp

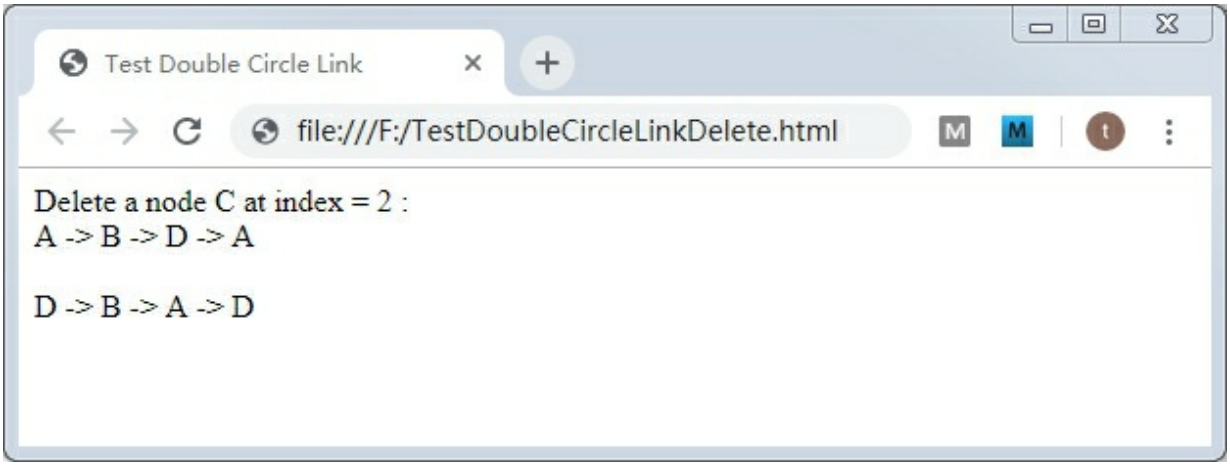
Create a TestDoubleCircleLinkDelete.html with Notepad

```
<script type="text/javascript">
    class Node{
        constructor(data, prev, next){
         this.data = data;
         this.prev = prev;
         this.next = next;
        }

        getData(){
         return this.data;
        }
    }

    class DoubleCircleLink{
        init() {
         // the first node called head node
         this.head = new Node("A");
         this.head.next = null;
         this.head.prev = null;

         var nodeB = new Node("B");
         nodeB.next = null;
         nodeB.prev = this.head;
         this.head.next = nodeB;

         var nodeC = new Node("C");
         nodeC.next = null;
         nodeC.prev = nodeB;
         nodeB.next = nodeC;

         // the last node called tail node
         this.tail = new Node("D");
         this.tail.next = this.head;
         this.tail.prev = nodeC;
         nodeC.next = this.tail;
         this.head.prev = this.tail;
```

```
}



remove(removePosition) {
 var p = this.head;
 var i = 0;
 while (p.next != null && i < removePosition - 1) {
    p = p.next;
    i++;
 }

 var temp = p.next;
 p.next = p.next.next;
 p.next.prev = p;
 temp.next = null;//Set the delete node next to null
 temp.prev = null;// Set the delete node prev to null

}

print() {
 var p = this.head;
 do {
    var data = p.getData();
    document.write(data + " -> ");
    p = p.next;
 } while (p != this.head);

 var data = p.getData();
 document.write(data + "<br><br>");

 p = this.tail;
 do {
    data = p.getData();
    document.write(data + " -> ");
    p = p.prev;
 } while (p != this.tail);

 data = p.getData();
```

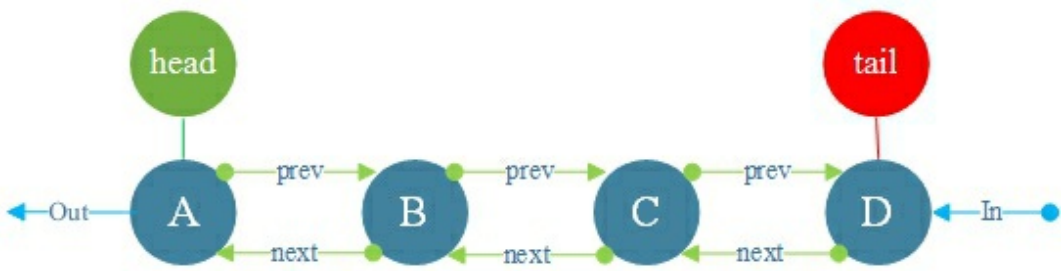
```
            document.write(data + "<br><br>");
        }
    }

    //////////////////////testing//////////////////

    var doubleCircleLink = new DoubleCircleLink();
    doubleCircleLink.init();

    document.write("Delete a node C at index = 2 : <br>");
    doubleCircleLink.remove(2);

    doubleCircleLink.print();
</script>
```

Result:

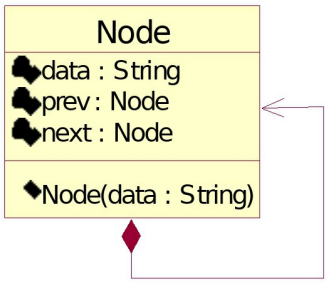


Queue

Queue:
FIFO (First In First Out) sequence.



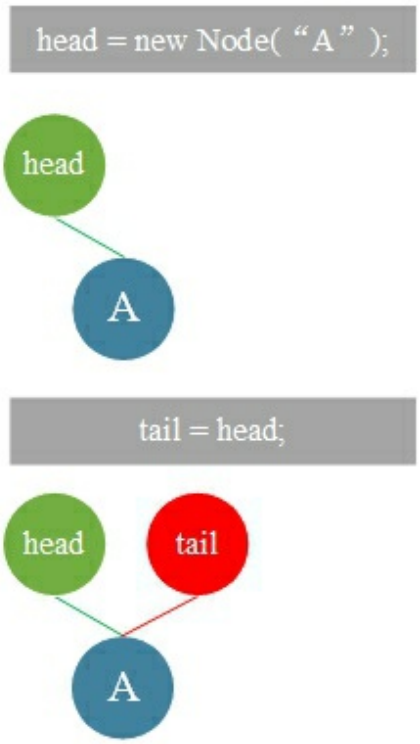
UML Diagram



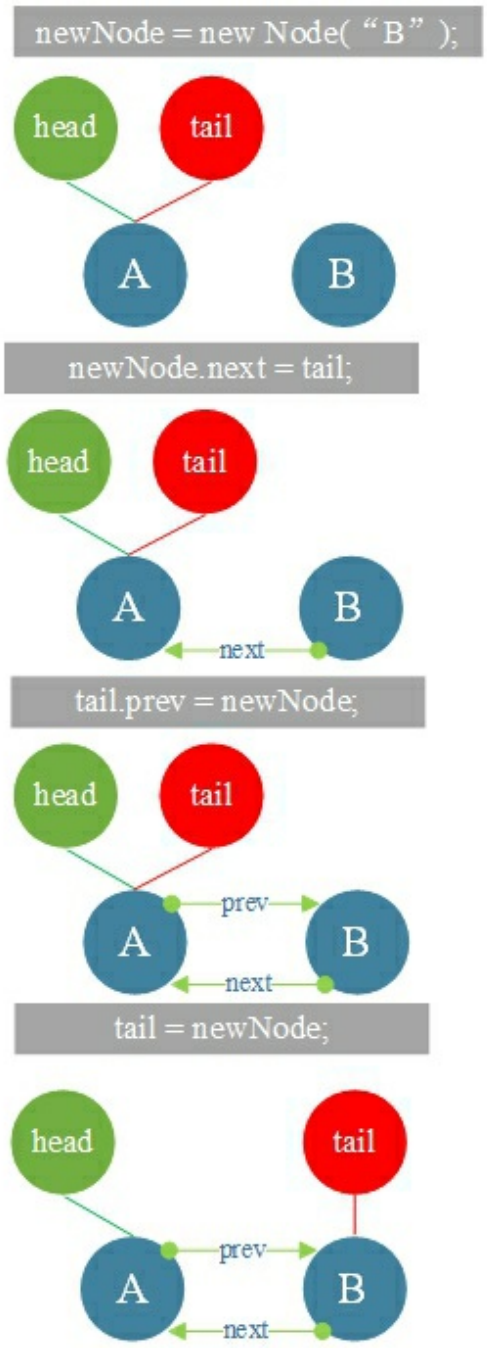

```
class Node{
    constructor(data, prev, next){
  this.data = data;
  this.prev = prev;
  this.next = next;
    }

    getData(){
  return this.data;
    }
}
```

1. Queue initialization and traversal output.

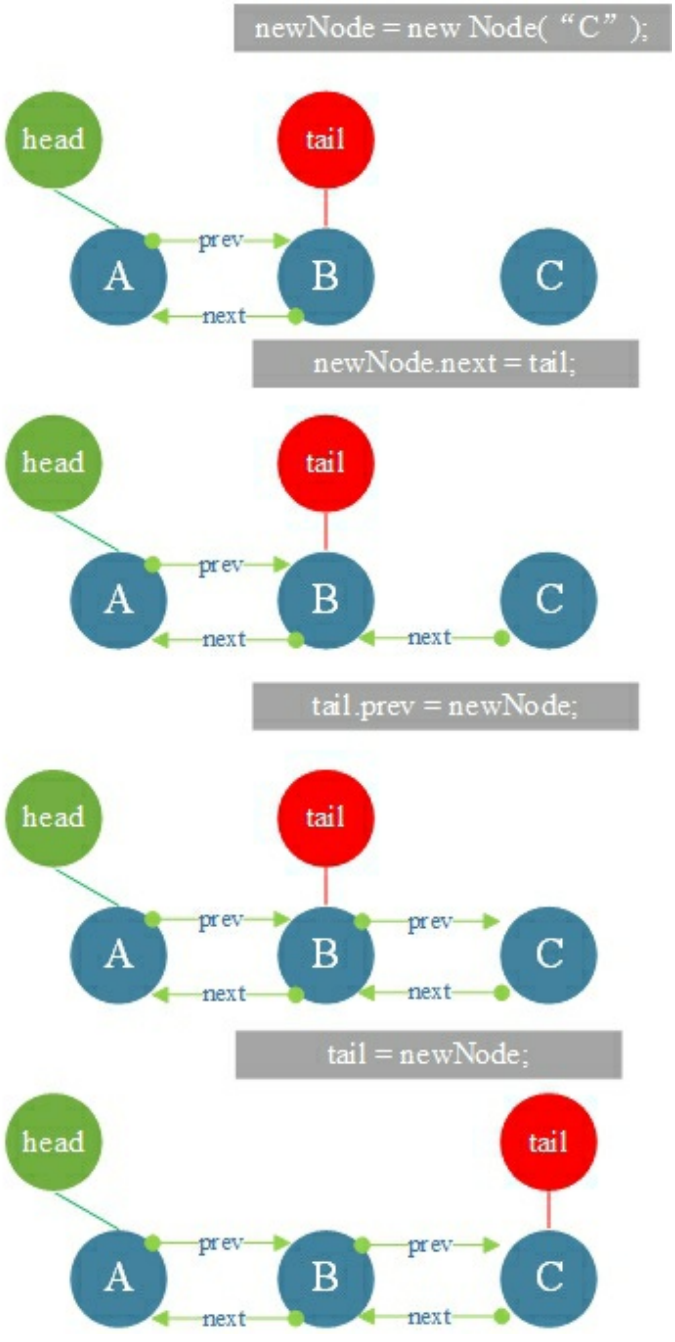
Initialization Insert A



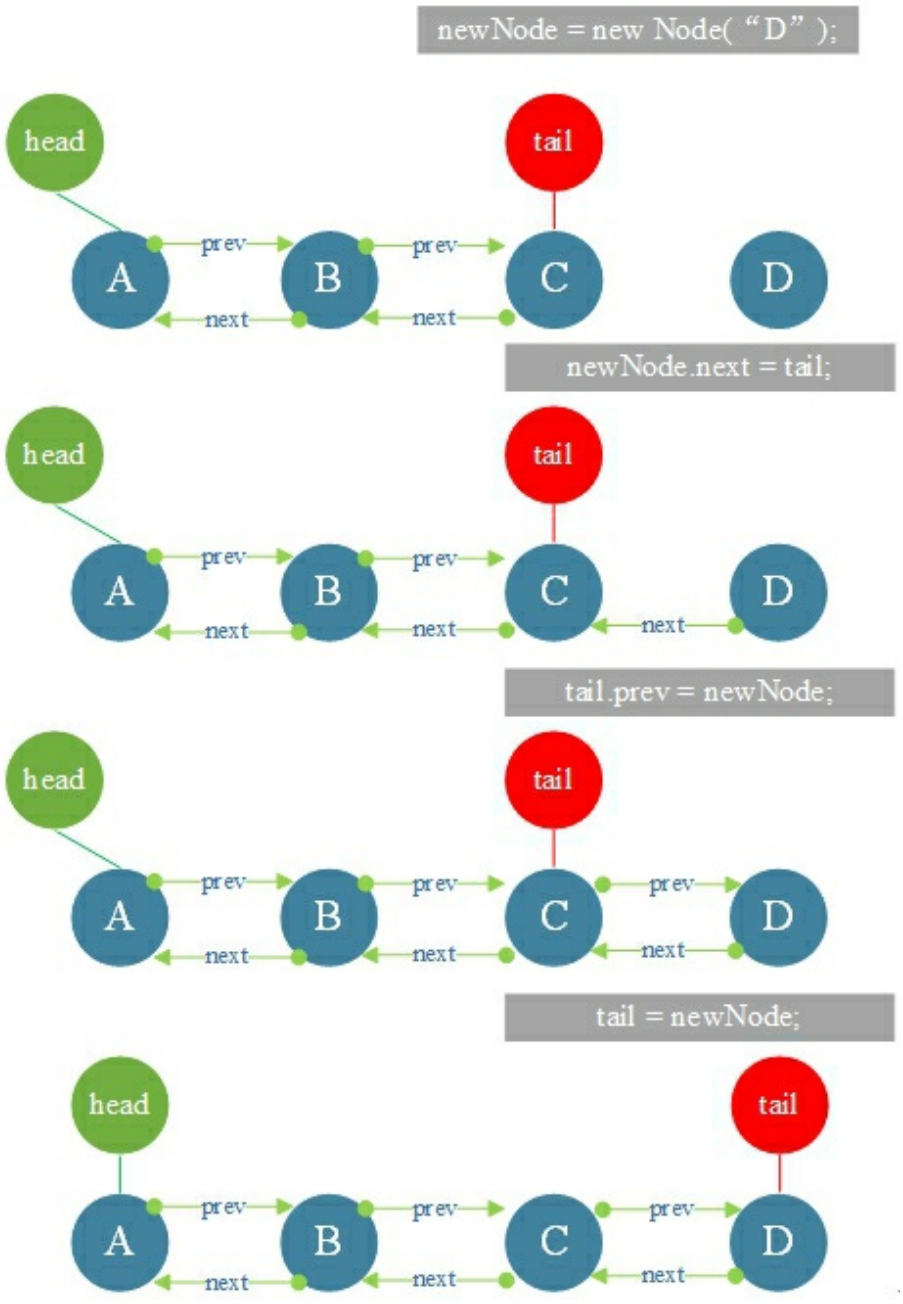
Initialization Insert B



Initialization Insert C



Initialization Insert D



Create a TestQueue.html with Notepad

```
<script type="text/javascript">
    class Node{
         constructor(data, prev, next){
        this.data = data;
        this.prev = prev;
        this.next = next;
         }
         getData(){
        return this.data;
         }
    }

    class Queue{
         constructor(){
        this.head = null;
        this.tail = null;
        this.size = 0;
         }

         offer(element) {
        if (this.head == null) {
           this.head = new Node(element);
           this.tail = this.head;
        } else {
           var newNode = new
Node(element);
           newNode.next = this.tail;
           this.tail.prev = newNode;
           this.tail = newNode;
        }
        this.size++;
         }

         poll() {
        var p = this.head;
        if (p == null) {
           return null;
```

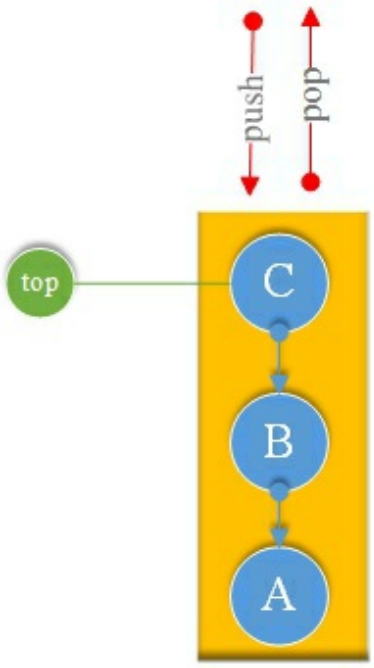
```
        }
        this.head = this.head.prev;
        p.next = null;
        p.prev = null;
        this.size--;
        return p;
         }

         size() {
        return this.size;
         }
    }

    //////////////////////testing//////////////////

    function print(queue) {
         document.write("Head ");
         var node = null;
         while ((node = queue.poll())!=null) {
        document.write(node.getData() + " <-
");
         }
         document.write("Tail <br>");
    }

    var queue = new Queue();
    queue.offer("A");
    queue.offer("B");
    queue.offer("C");
    queue.offer("D");

    print(queue);
</script>
```

Result:

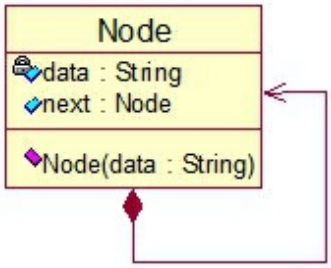

Test Queue
file:///F:/TestQueue.html
Head A <- B <- C <- D <- Tail

Stack

Stack:
FILO (First In Last Out) sequence.



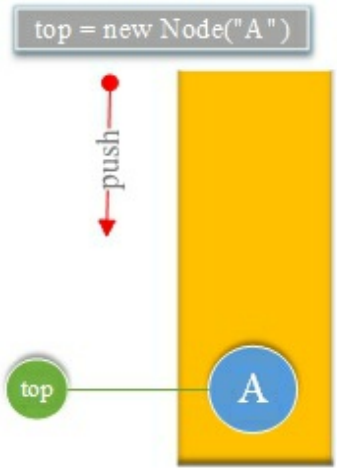
UML Diagram



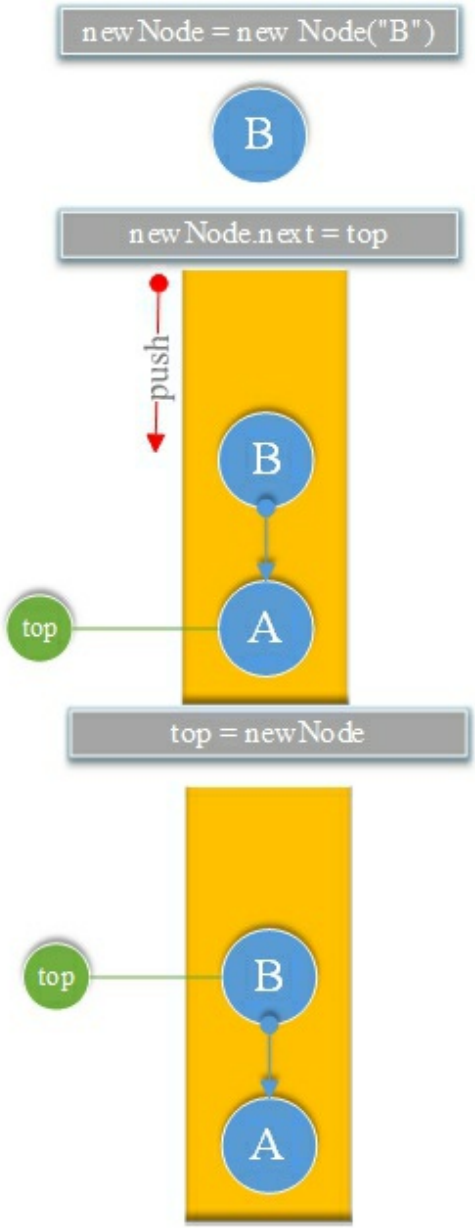
```
class Node{
    constructor(data, next){
 this.data = data;
 this.next = next;
    }

    getData(){
 return this.data;
    }
}
```

1. Stack initialization and traversal output.

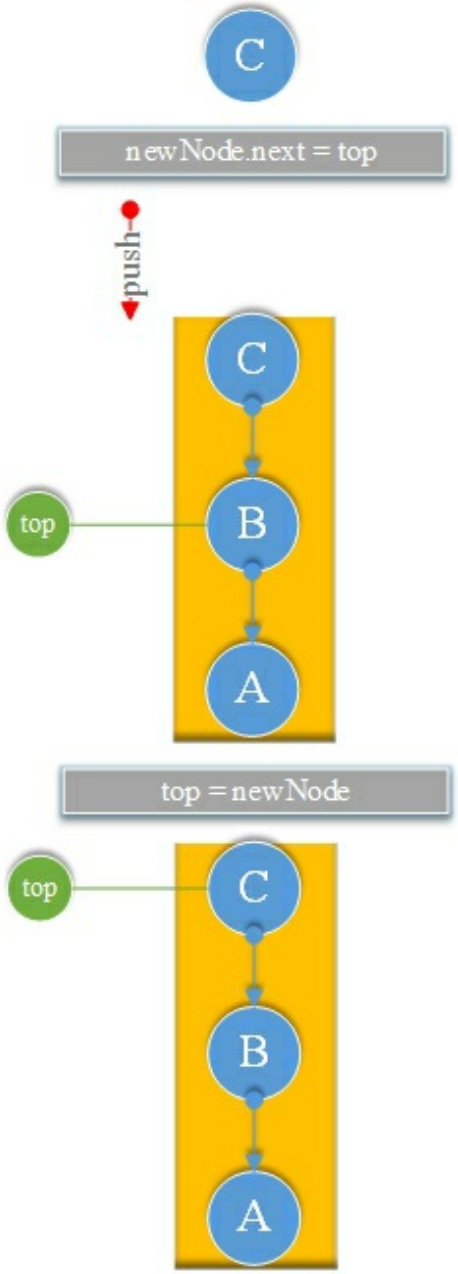
Push A into Stack



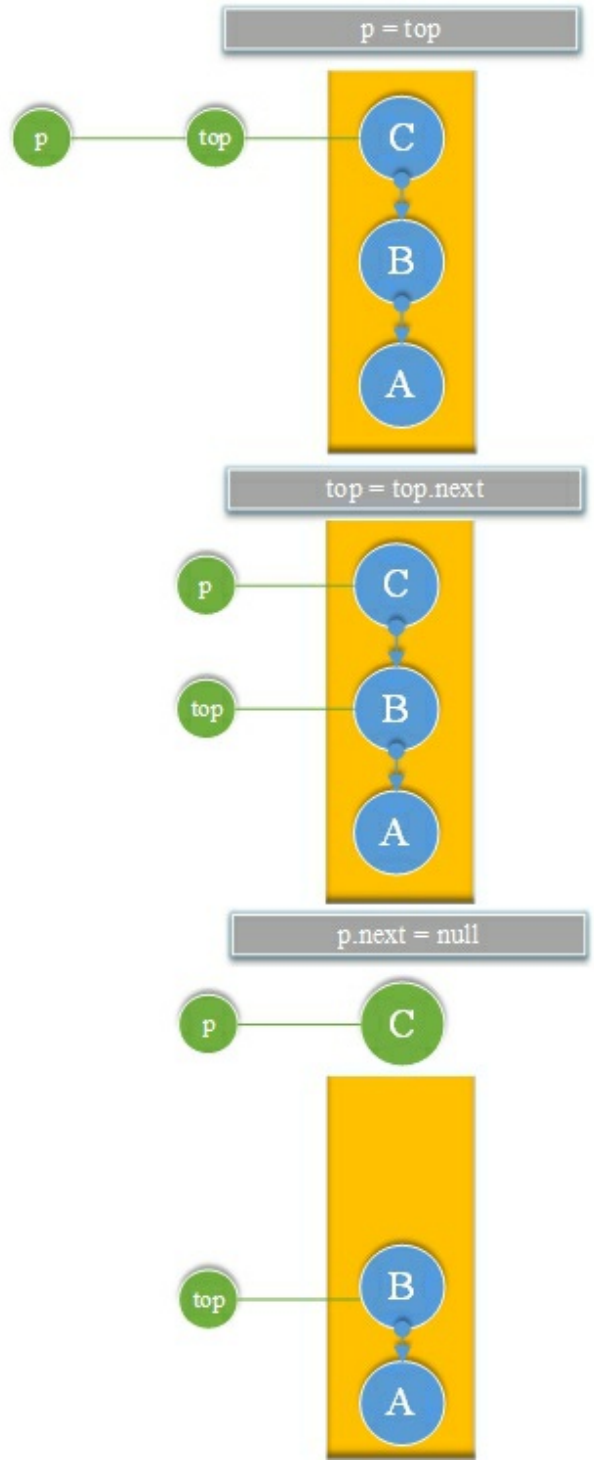
Push B into Stack



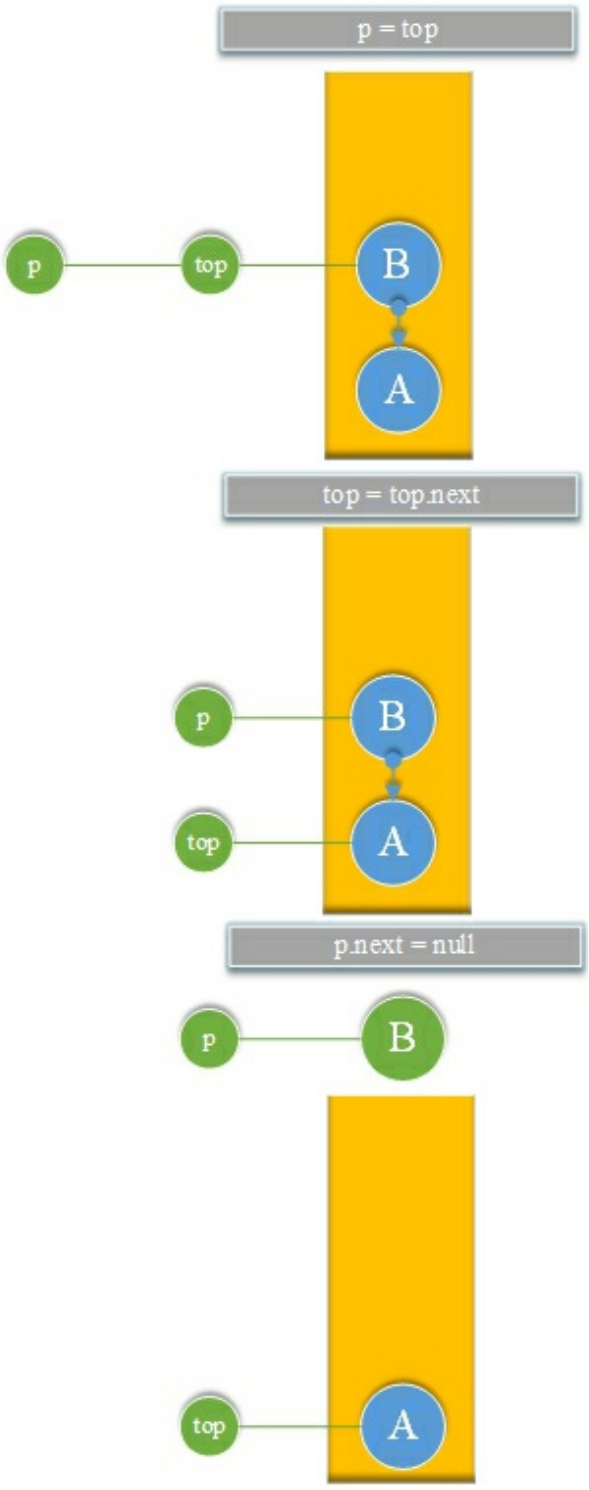
Push C into Stack



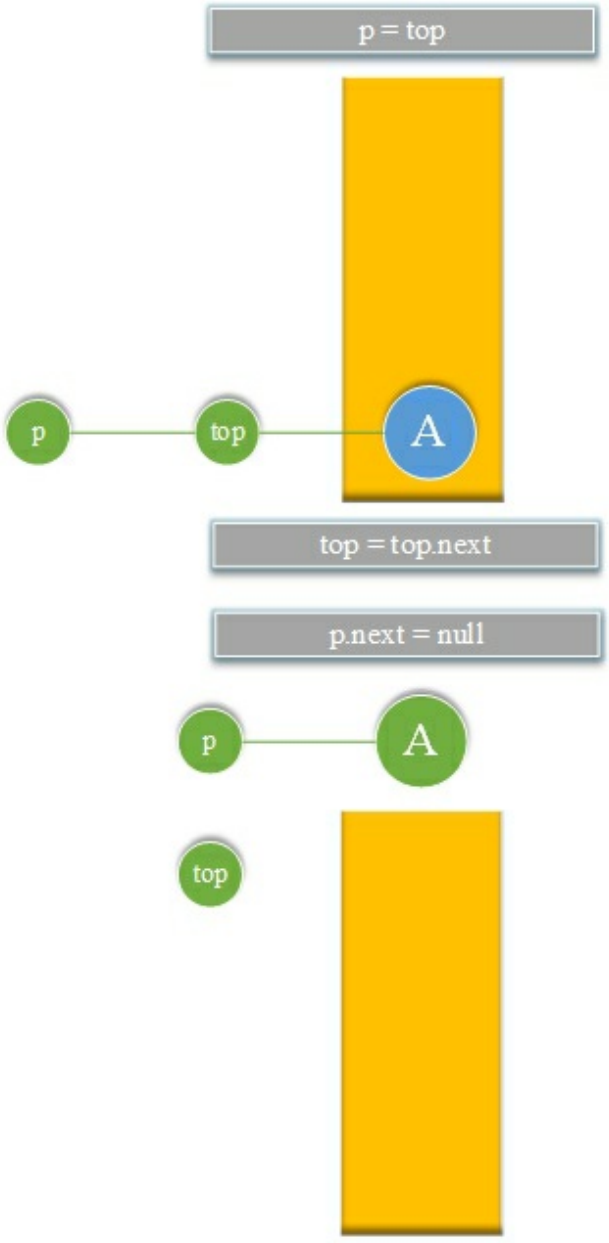
If pop C from Stack:



If pop B from Stack:



If pop A from Stack:



Create a TestStack.html with Notepad

```
<script type="text/javascript">
    class Node{
         constructor(data, next){
        this.data = data;
        this.next = next;
         }
         getData(){
        return this.data;
         }
    }

    class Stack {
         constructor(){
        this.top = null;
        this.size = 0;
         }

         push(element) {
        if (this.top == null) {
          this.top = new Node(element);
        } else {
          var newNode = new
Node(element);
          newNode.next = this.top;
          this.top = newNode;
        }
        this.size++;
         }

         pop() {
        if(this.top == null){
          return null;
        }

        var p = this.top;
        this.top = this.top.next;// top move
```

```
down
        p.next = null;

        this.size--;
        return p;
         }


         size() {
        return this.size;
         }
    }

    //////////////////////testing//////////////////

    function print(stack) {
         document.write("Top ");
         var node = null;
         while ((node = stack.pop())!=null) {
        document.write(node.getData() + " -
> ");
         }
         document.write("End <br>");
    }

    var stack = new Stack();
    stack.push("A");
    stack.push("B");
    stack.push("C");
    stack.push("D");
    print(stack);

</script>
```

Result:


Test Stack
file:///F:/TestStack.html
Top D -> C -> B -> A -> End

Recursive Algorithm

Recursive Algorithm:
The program function itself calls its own layer to progress until it reaches a certain condition and step by step returns to the end..

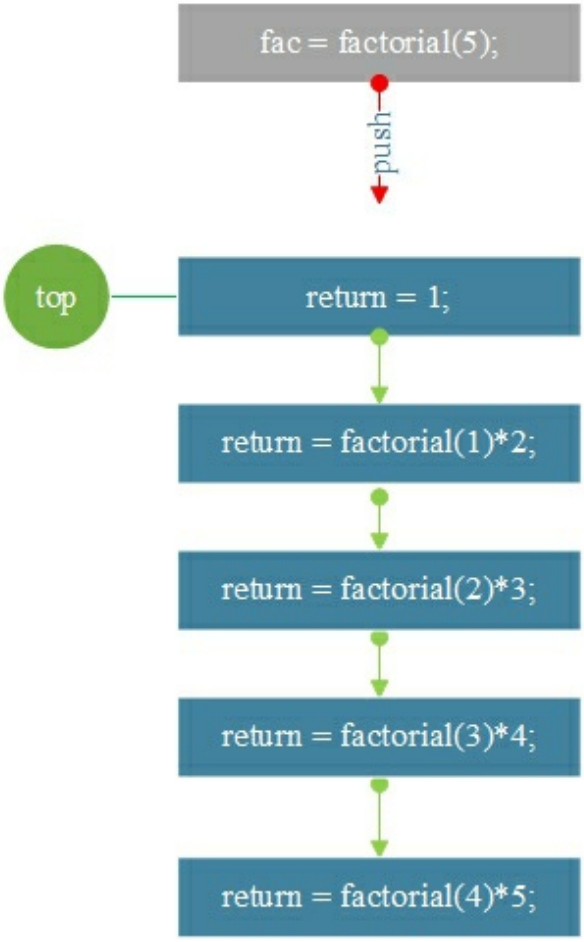
1. Factorial of n : n*(n-1)*(n-2) *2*1

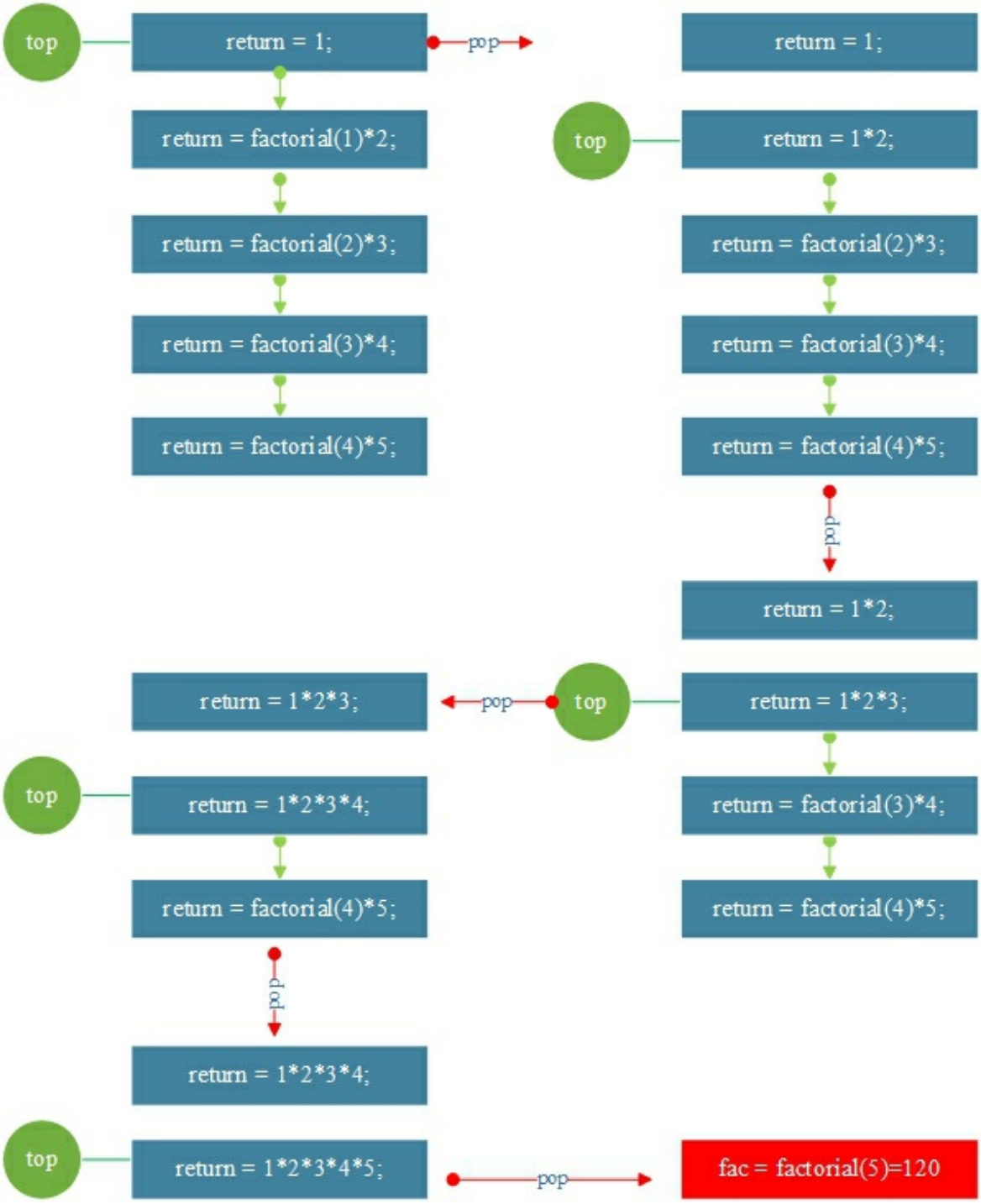
Create a TestRecursive.html with Notepad

```
<script type="text/javascript">
    function factorial(n) {
     if (n == 1) {
        return 1;
     } else {
        //Recursively call yourself until the end of
the return
        return factorial(n - 1) * n;
     }
     }

     //////////////////////testing//////////////////

     var n = 5;
     var fac = factorial(n);
     document.write("The factorial of 5 is :" + fac);
```

Result:

Graphical analysis:

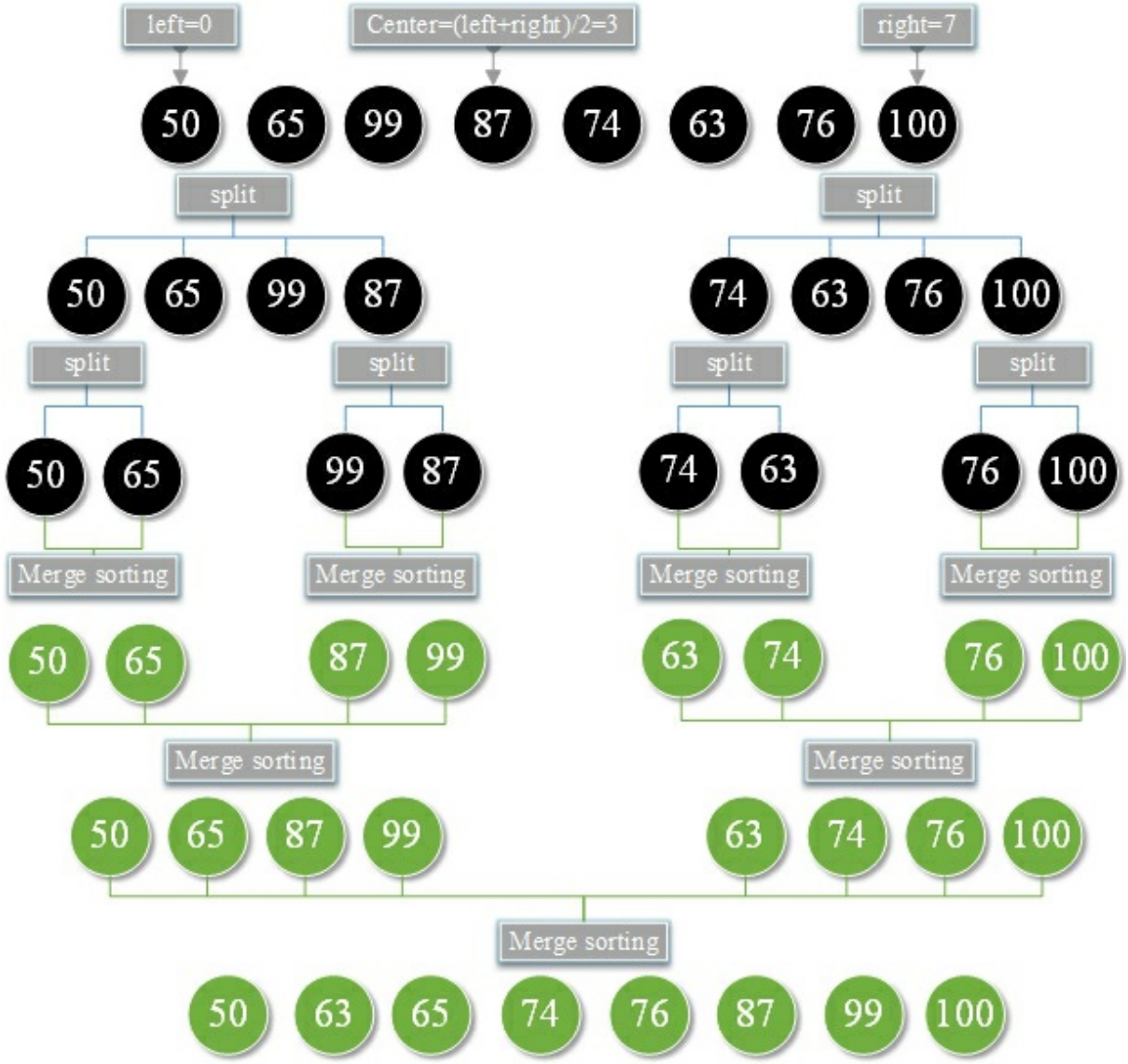



top
return = 1;
pop
return = 1;
return = factorial(1)*2;
top
return = 1*2;
return = factorial(2)*3;
return = factorial(2)*3;
return = factorial(3)*4;
return = factorial(3)*4;
return = factorial(4)*5;
return = factorial(4)*5;
pop
return = 1*2;
return = 1*2*3;
pop
top
return = 1*2*3;
top
return = 1*2*3*4;
return = factorial(3)*4;
return = factorial(4)*5;
return = factorial(4)*5;
pop
return = 1*2*3*4;
top
return = 1*2*3*4*5;
pop
fac = factorial(5)=120

Two-way Merge Algorithm

Two-way Merge Algorithm:
The data of the first half and the second half are sorted, and the two ordered sub-list are merged into one ordered list, which continue to recursive to the end.

1. The scores {50, 65, 99, 87, 74, 63, 76, 100} by merge sort

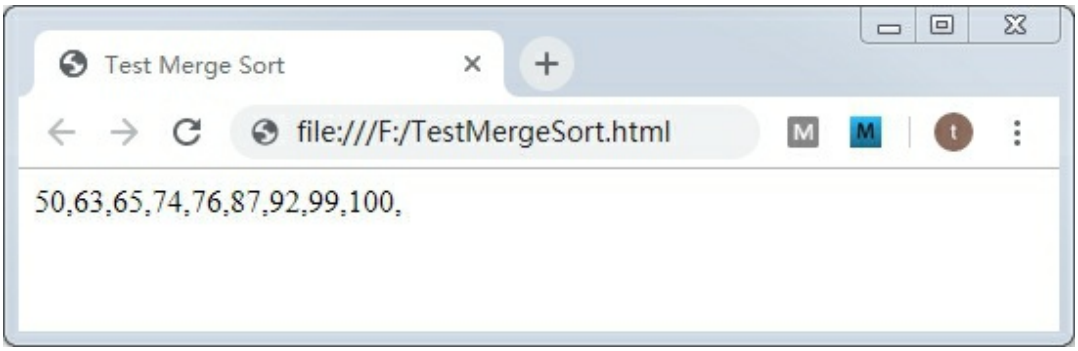


Create a TestMergeSort.html with Notepad

```
<script type="text/javascript">
    class MergeSort{
        sort(array) {
            var temp = new Array(array.length);
            this.mergeSort(array, temp, 0, array.length - 1);
        }

        mergeSort(array, temp, left, right) {
            if (left < right) {
                var center = parseInt((left + right) / 2);
                this.mergeSort(array, temp, left, center); // Left merge sort
                this.mergeSort(array, temp, center + 1, right); // Right merge
sort
                this.merge(array, temp, left, center + 1, right); // Merge two
ordered arrays
            }
        }

        merge(array, temp, left, right, rightEndIndex) {
            var leftEndIndex = right - 1; // End subscript on the left
            var tempIndex = left; // Starting from the left count
            var elementNumber = rightEndIndex - left + 1;

            while (left <= leftEndIndex && right <= rightEndIndex) {
                if (array[left] <= array[right])
                    temp[tempIndex++] = array[left++];
                else
                    temp[tempIndex++] = array[right++];
            }

            while (left <= leftEndIndex) { // If there is element on the left
                temp[tempIndex++] = array[left++];
            }

            while (right <= rightEndIndex) { // If there is element on the
right
                temp[tempIndex++] = array[right++];
            }
```

```
            // Copy temp to array
            for (var i = 0; i < elementNumber; i++) {
                array[rightEndIndex] = temp[rightEndIndex];
                rightEndIndex--;
            }
        }
    }

    //////////////////////testing//////////////////

    var scores = [ 50, 65, 99, 87, 74, 63, 76, 100, 92 ];
    var mergeSort = new MergeSort();
    mergeSort.sort(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }

</script>
```

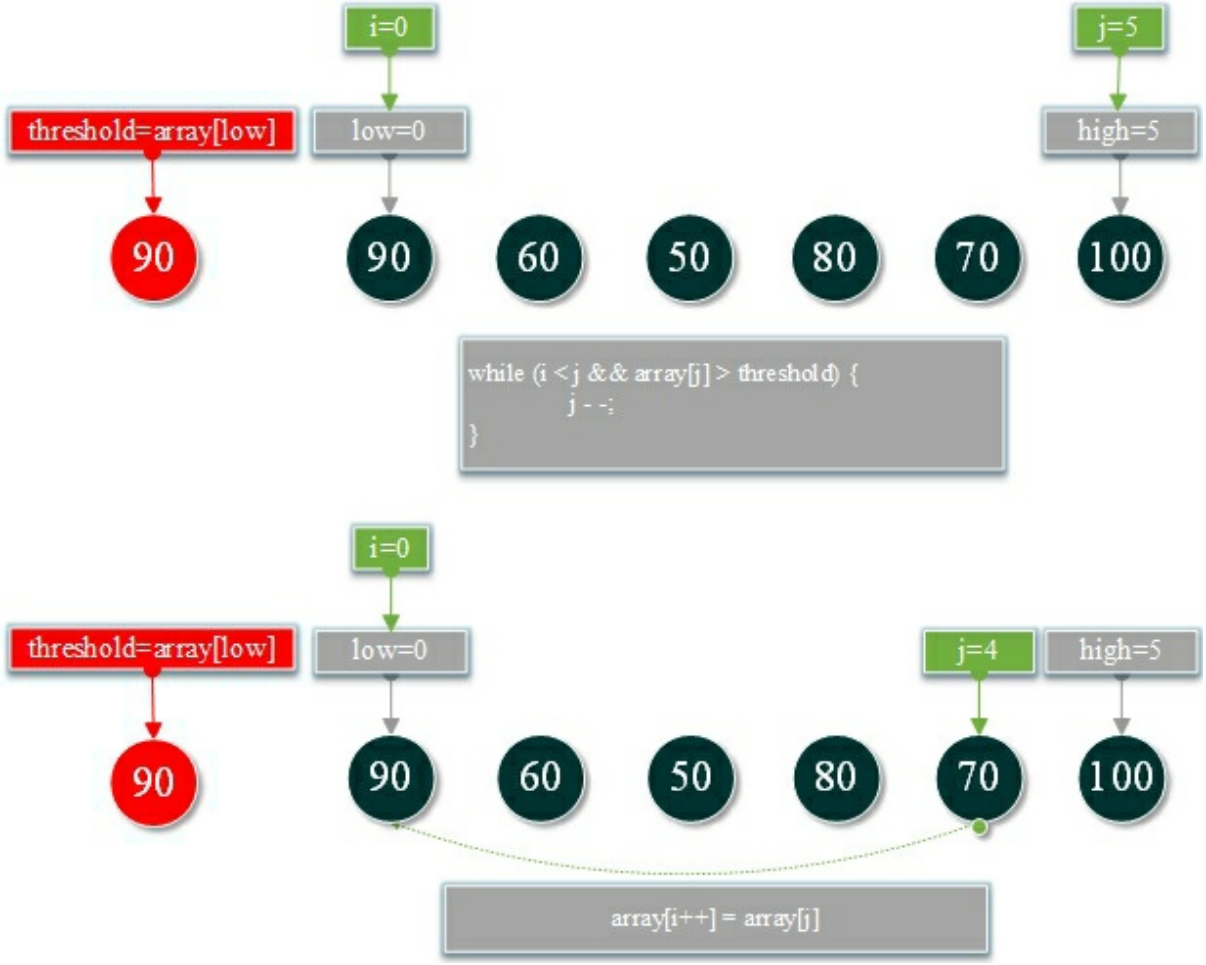
Result:

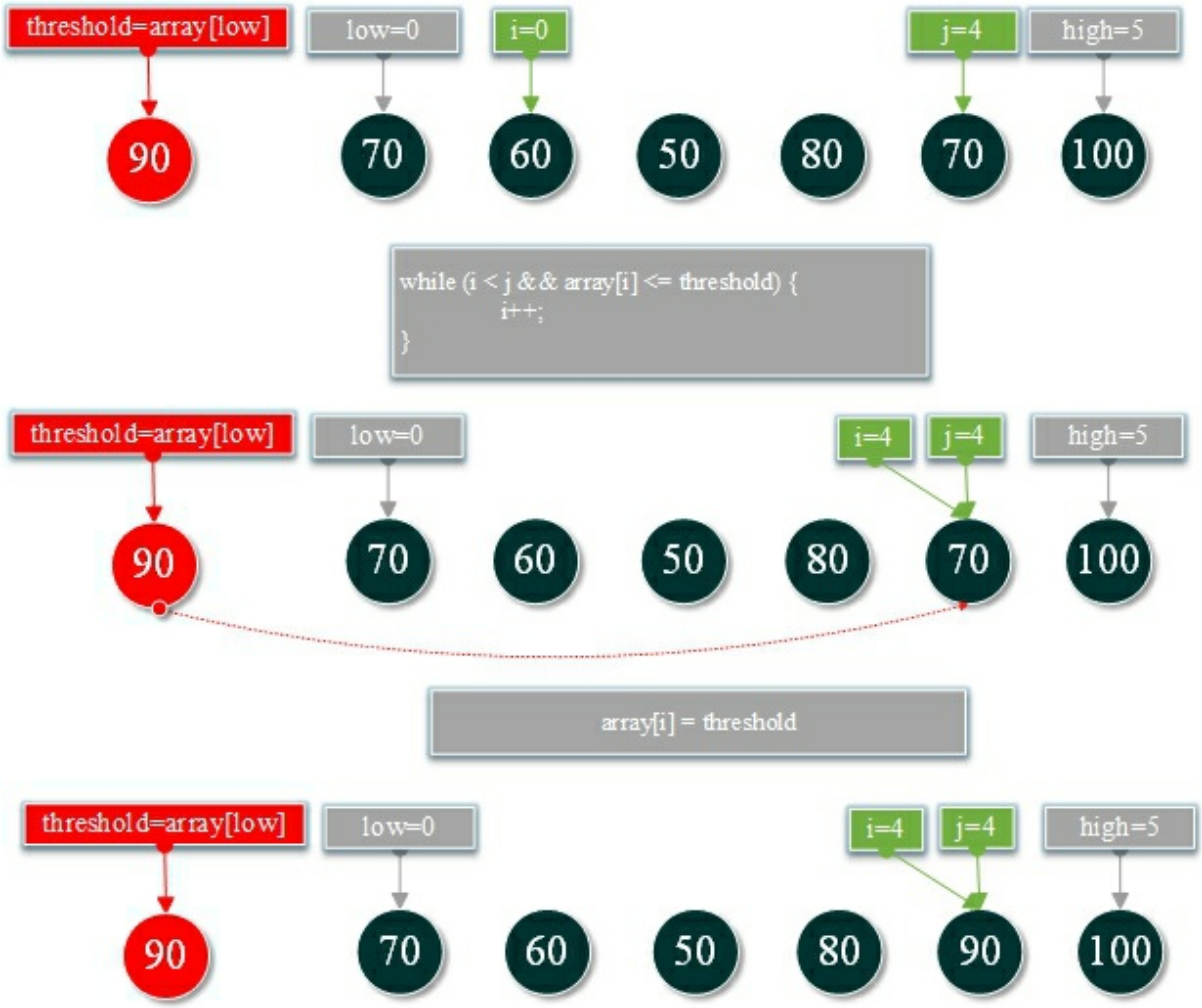


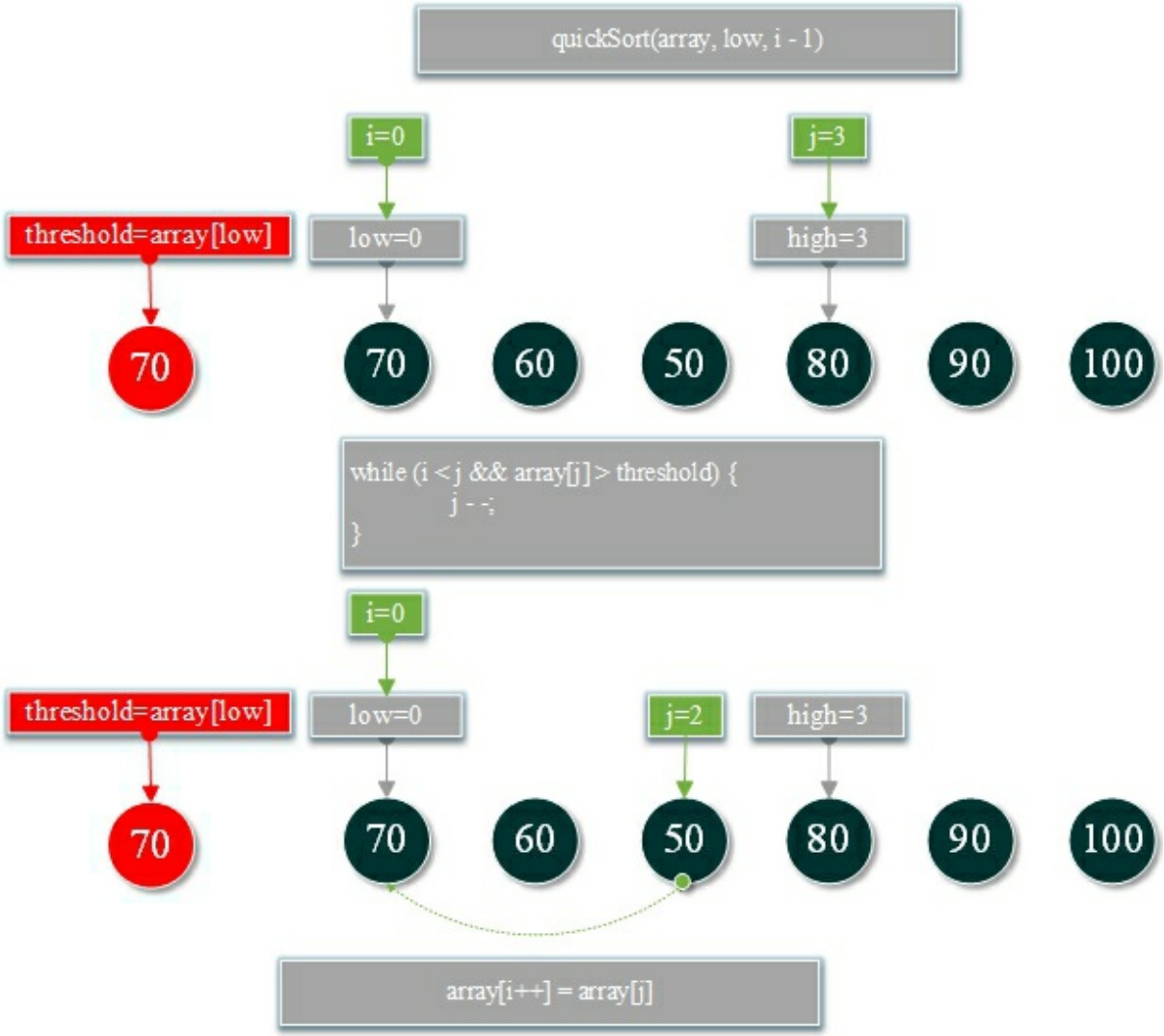
Quick Sort Algorithm

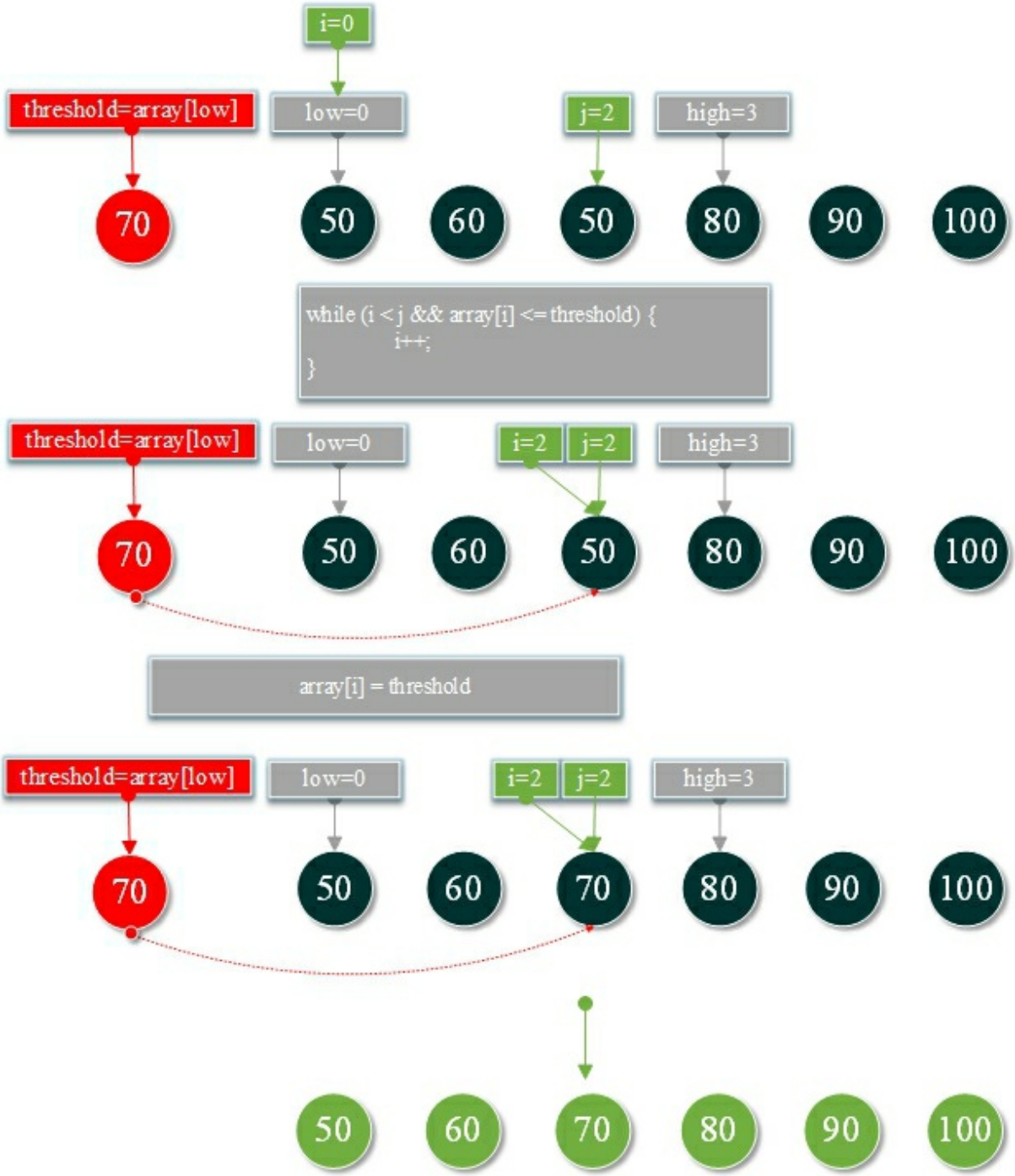
Quick Sort Algorithm:
Quicksort is a popular sorting algorithm that is often faster in practice compared to other sorting algorithms. It utilizes a divide-and-conquer strategy to quickly sort data items by dividing a large array into two smaller arrays.

1. The scores {90, 60, 50, 80, 70, 100} by quick sort




threshold=array[low]
low=0
i=0
j=4
high=5
90
70
60
50
80
70
100
while (i < j && array[i] <= threshold) {
i++;
}
threshold=array[low]
low=0
i=4
j=4
high=5
90
70
60
50
80
70
100
array[i] = threshold
threshold=array[low]
low=0
i=4
j=4
high=5
90
70
60
50
80
90
100


quickSort(array, low, i - 1)
i=0
j=3
threshold=array[low]
low=0
high=3
70
70
60
50
80
90
100
while (i < j && array[j] > threshold) {
j - -;
}
i=0
threshold=array[low]
low=0
j=2
high=3
70
70
60
50
80
90
100
array[i++] = array[j]


i=0
threshold=array[low]
low=0
j=2
high=3
70
50
60
50
80
90
100
while (i < j && array[i] <= threshold) {
i++;
}
threshold=array[low]
low=0
i=2
j=2
high=3
70
50
60
50
80
90
100
array[i] = threshold
threshold=array[low]
low=0
i=2
j=2
high=3
70
50
60
70
80
90
100
50
60
70
80
90
100

Create a TestQuickSort.html with Notepad

```
<script type="text/javascript">
    class QuickSort{
        sort(array) {
          if (array.length > 0) {
              this.quickSort(array, 0, array.length - 1);
          }
        }

        quickSort(array, low, high) {
          if (low > high) {
              return;
          }
          var i = low;
          var j = high;
          var threshold = array[low];
          // Alternately scanned from both ends of the list
          while (i < j) {
              // Find the first position less than threshold from
right to left
              while (i < j && array[j] > threshold) {
                  j--;
              }
              //Replace the low with a smaller number than the
threshold
              if (i < j)
                  array[i++] = array[j];

              // Find the first position greater than threshold from
left to right
              while (i < j && array[i] <= threshold) {
                  i++;
              }

              //Replace the high with a number larger than the
threshold
              if (i < j)
```

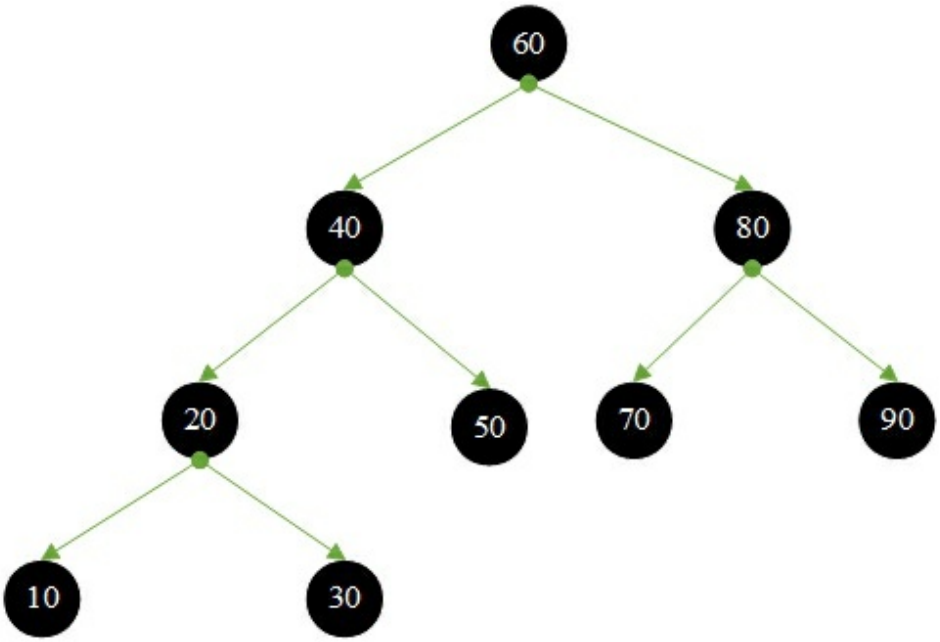
```
                array[j--] = array[i];
            }
            array[i] = threshold;

            this.quickSort(array, low, i - 1); // left quickSort
            this.quickSort(array, i + 1, high); // right quickSort
        }
    }

    //////////////////////testing//////////////////

    var scores = [ 90, 60, 50, 80, 70, 100 ];
    var quickSort = new QuickSort();
    quickSort.sort(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ",");
    }
</script>
```

Result:

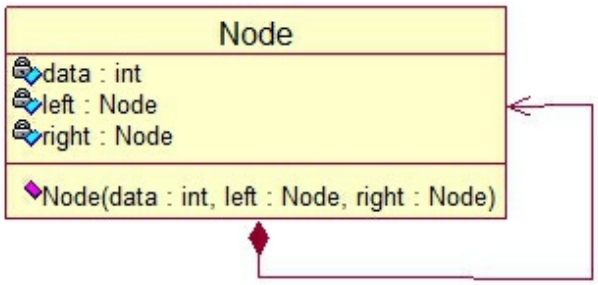
Binary Search Tree

Binary Search Tree:

1. If the left subtree of any node is not empty, the value of all nodes on the left subtree is less than the value of its root node;
2. If the right subtree of any node is not empty, the value of all nodes on the right subtree is greater than the value of its root node;
3. The left subtree and the right subtree of any node are also binary search trees.



Node UML Diagram



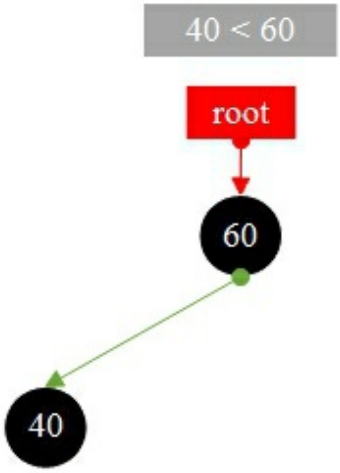

```
class Node{
    constructor(data, left, right){
  this.data = data;
  this.left = left;
  this.right = right;
    }

    getData(){
  return this.data;
    }
}
```

1.Construct a binary search tree, insert node

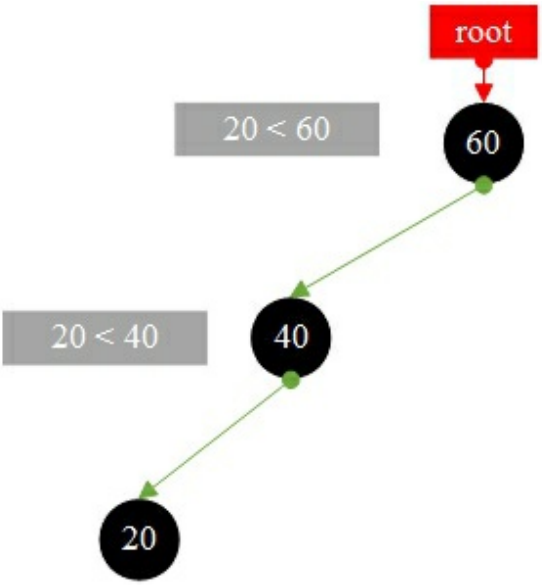
The inserted nodes are compared from the root node, and the smaller than the root node is compared with the left subtree of the root node, otherwise, compared with the right subtree until the left subtree is empty or the right subtree is empty, then is inserted.

Insert 60

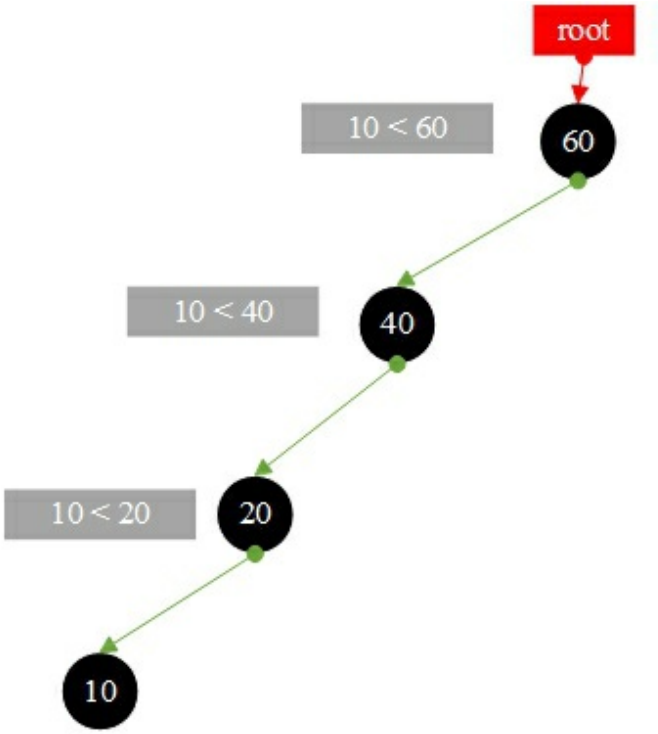
Insert 40



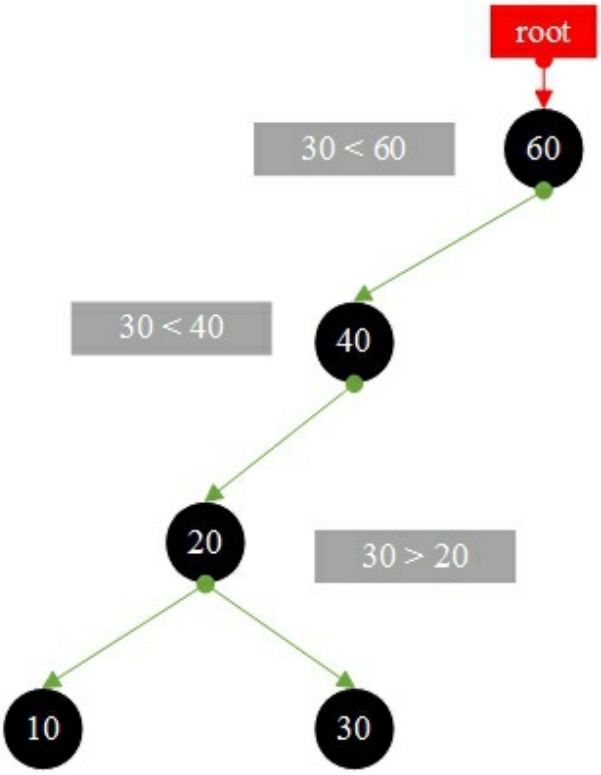
Insert 20



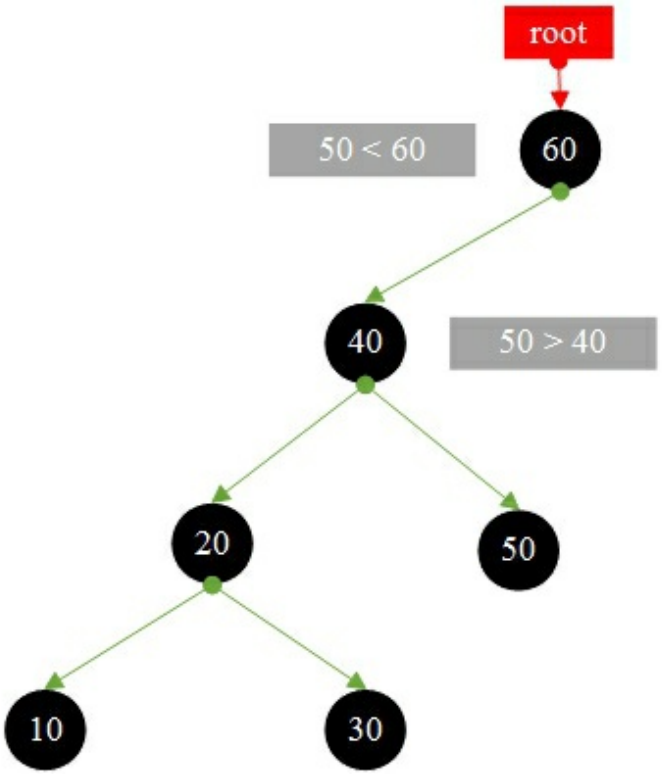
Insert 10



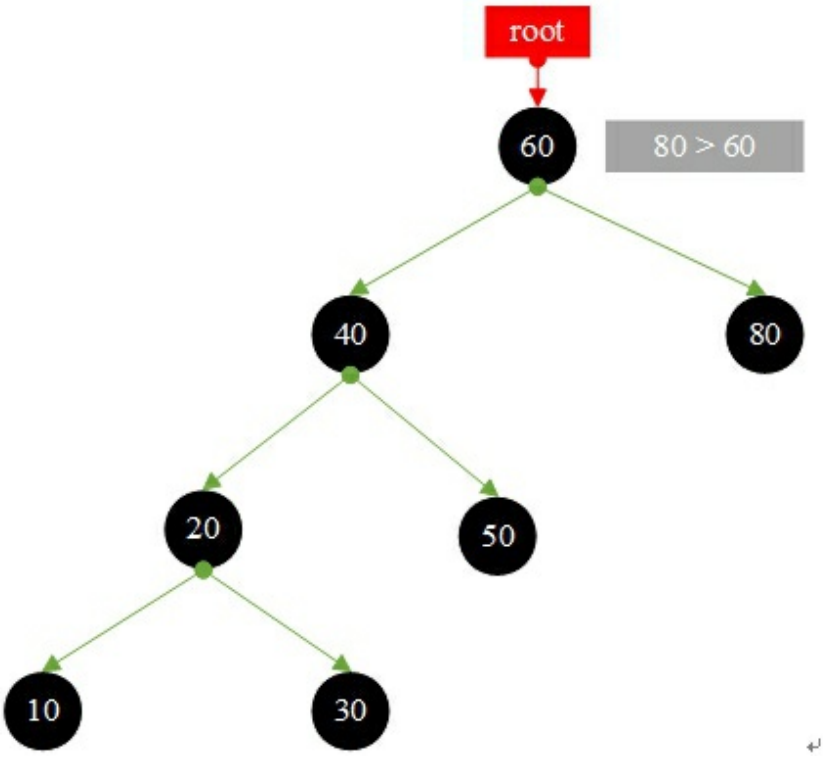
Insert 30



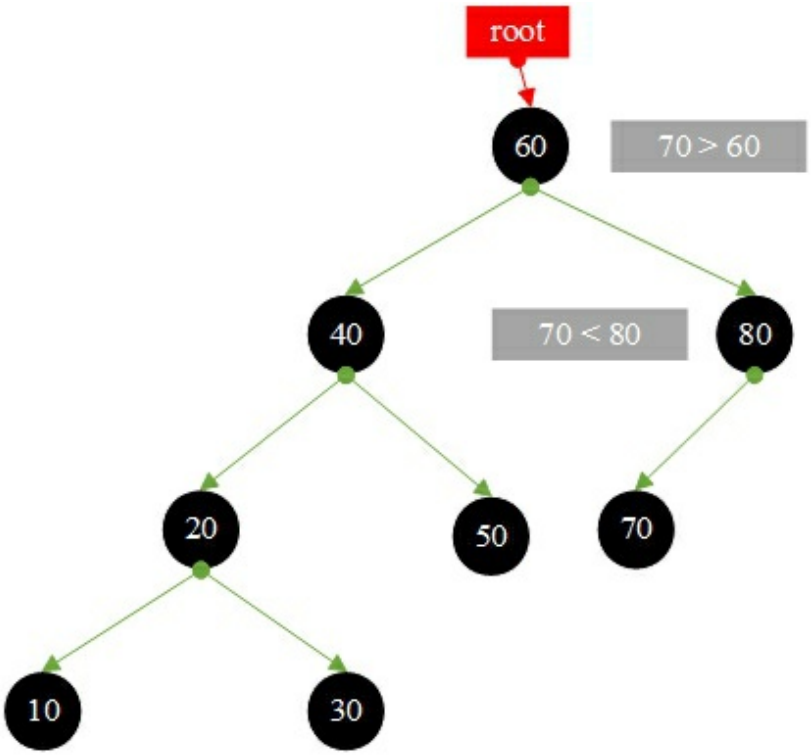
Insert 50



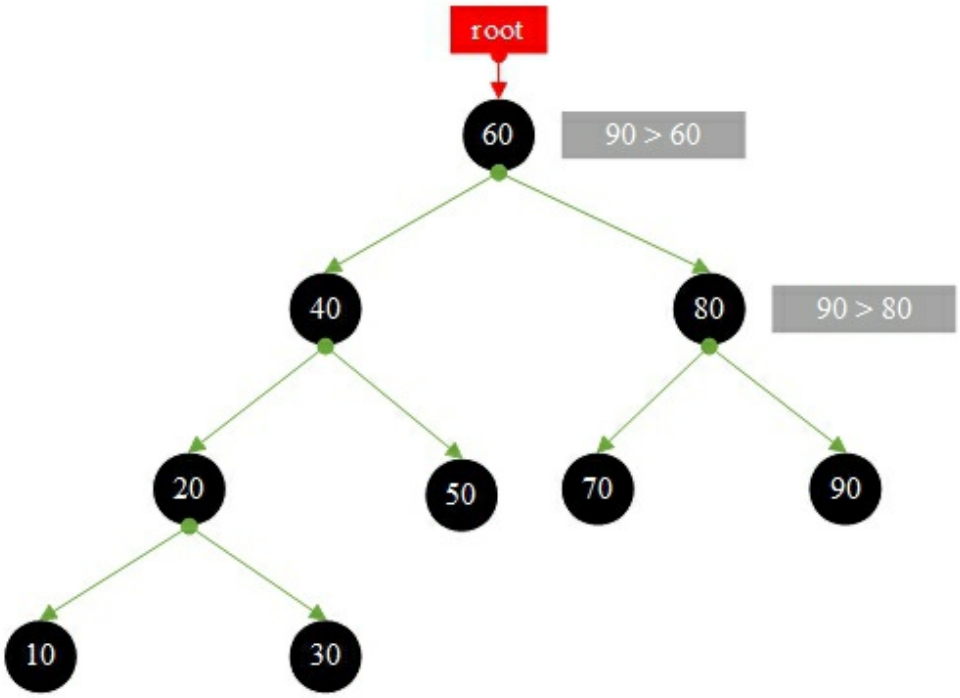
Insert 80



Insert 70

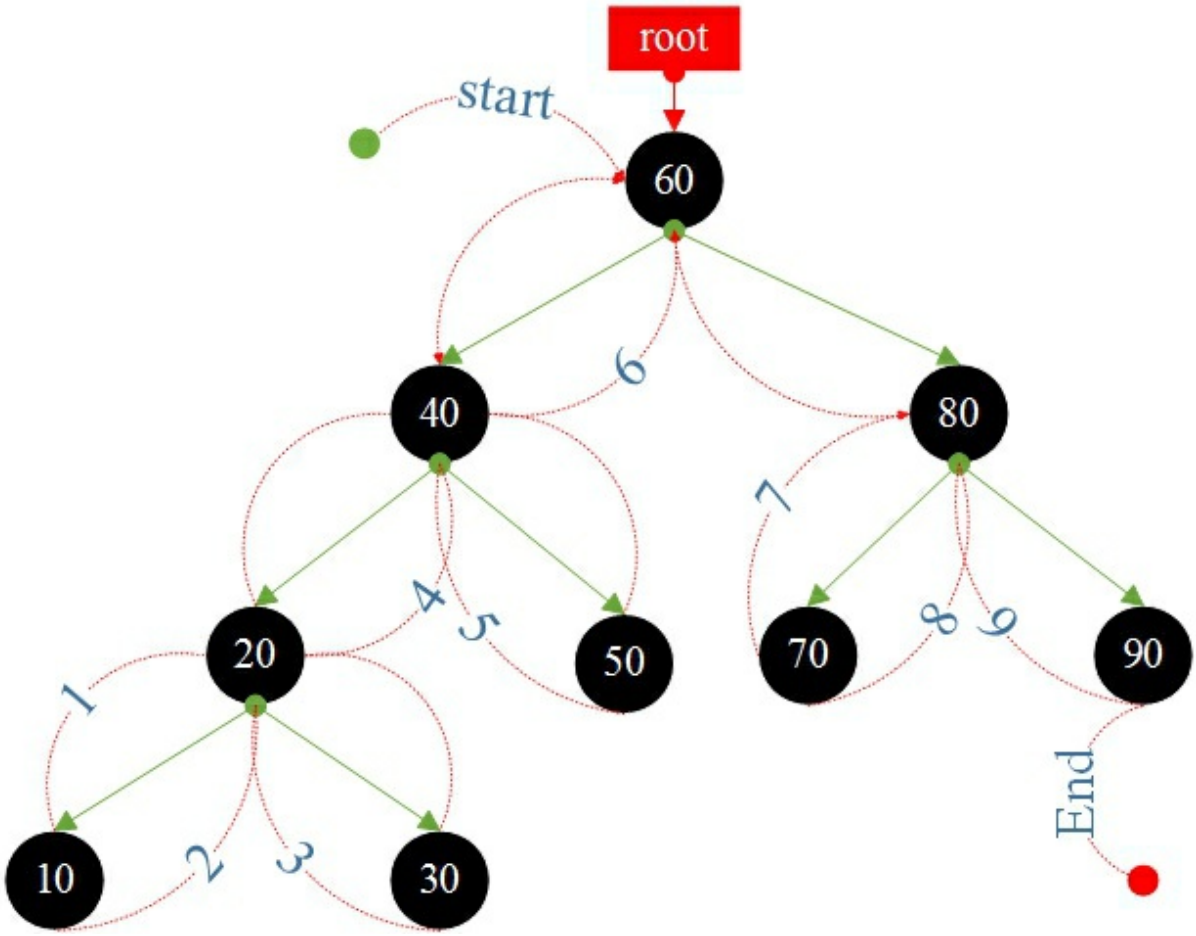


Insert 90

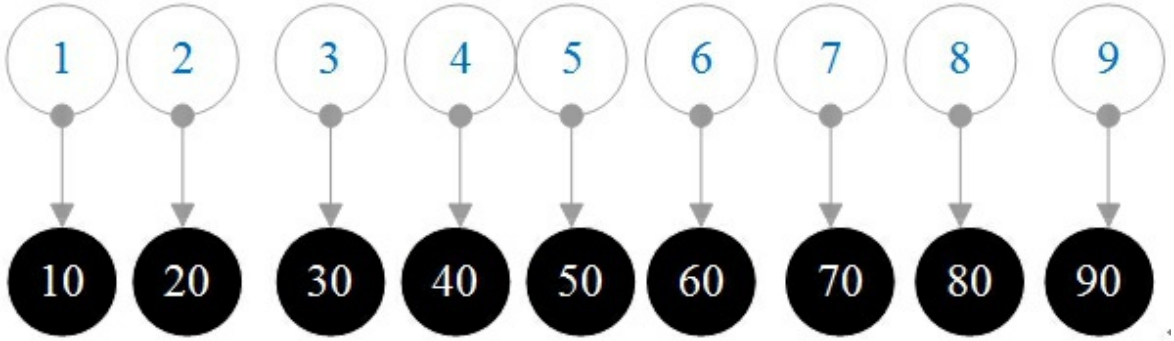


2. binary search tree In-order traversal

In-order traversal : left subtree -> root node -> right subtree



Result:

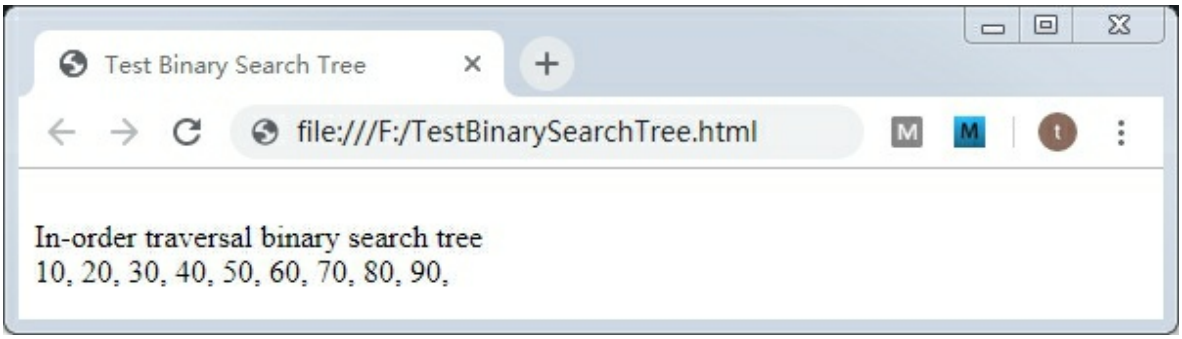


Create a TestBinarySearchTreeInOrder.html with Notepad

```
<script type="text/javascript">
    class BinaryTree {
        getRoot() {
            return this.root;
        }

        // In-order traversal binary search tree
        inOrder(root) {
            if (root == null) {
                return;
            }
            this.inOrder(root.left); // Traversing the left subtree
            document.write(root.getData() + ", ");
            this.inOrder(root.right); // Traversing the right subtree
        }

        insert(node, newData) {
            if (this.root == null) {
                this.root = new Node(newData, null, null);
                return;
            }

            var compareValue = newData - node.getData();

            //Recursive left subtree, continue to find the insertion position
            if (compareValue < 0) {
                if (node.left == null) {
                    node.left = new Node(newData, null, null);
                } else {
                    this.insert(node.left, newData);
                }
            } else if (compareValue > 0) {////Recursive right subtree, find the
insertion position
                if (node.right == null) {
                    node.right = new Node(newData, null, null);
                } else {
```

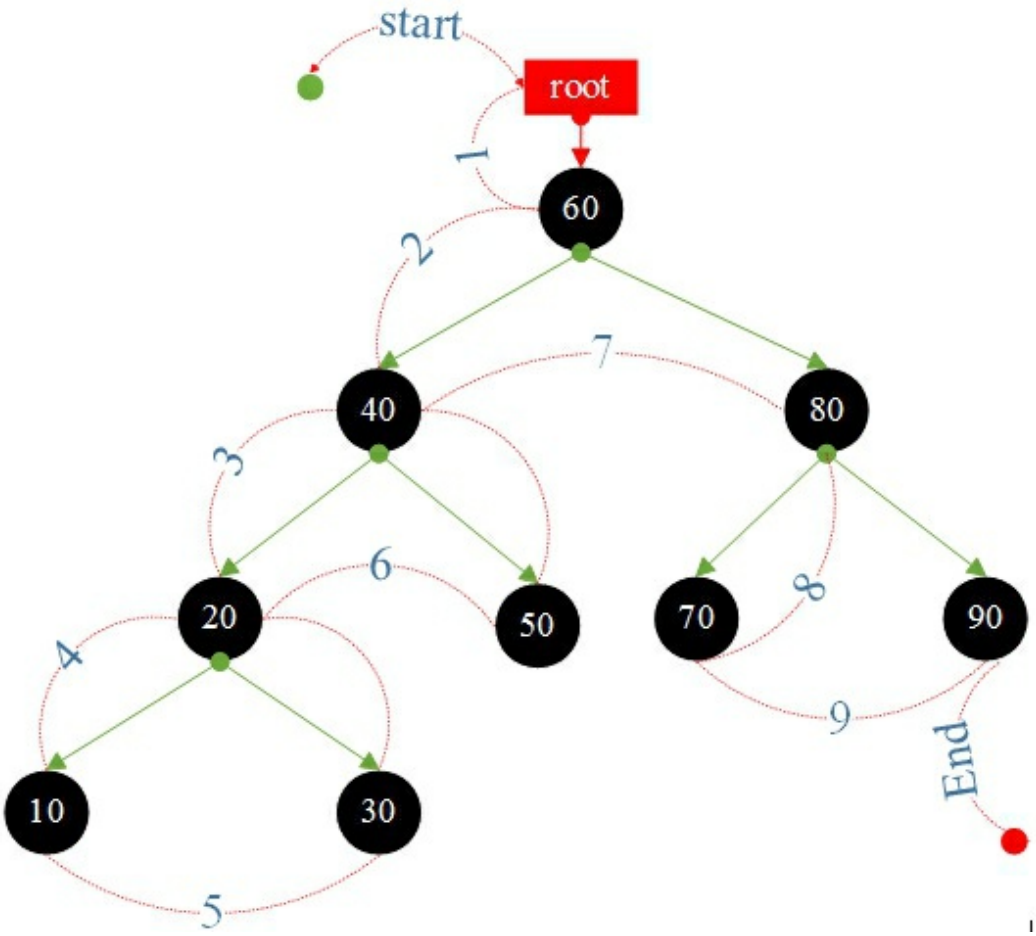
```
                this.insert(node.right, newData);
            }
        }
    }
}

class Node{
    constructor(data, left, right){
        this.data = data;
        this.left = left;
        this.right = right;
    }

    getData(){
        return this.data;
    }
}

//////////////////////testing//////////////////

var binaryTree=new BinaryTree();
//Constructing a binary search tree
binaryTree.insert(binaryTree.getRoot(), 60);
binaryTree.insert(binaryTree.getRoot(), 40);
binaryTree.insert(binaryTree.getRoot(), 20);
binaryTree.insert(binaryTree.getRoot(), 10);
binaryTree.insert(binaryTree.getRoot(), 30);
binaryTree.insert(binaryTree.getRoot(), 50);
binaryTree.insert(binaryTree.getRoot(), 80);
binaryTree.insert(binaryTree.getRoot(), 70);
binaryTree.insert(binaryTree.getRoot(), 90);
document.write("<br> In-order traversal binary search tree <br>");
binaryTree.inOrder(binaryTree.getRoot());
</script>
```

Result:

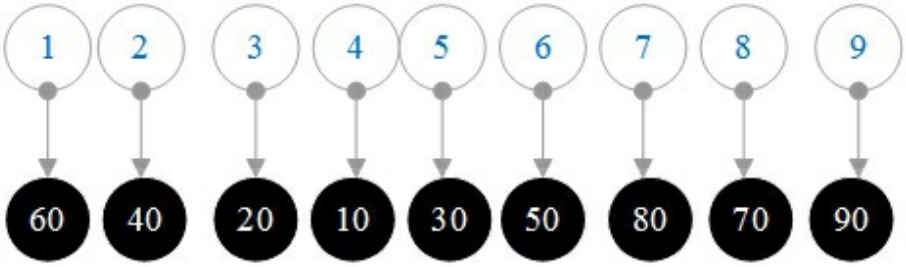

Test Binary Search Tree
file:///F:/TestBinarySearchTree.html
In-order traversal binary search tree
10, 20, 30, 40, 50, 60, 70, 80, 90,

3. binary search tree Pre-order traversal

Pre-order traversal : root node -> left subtree -> right subtree



Result:

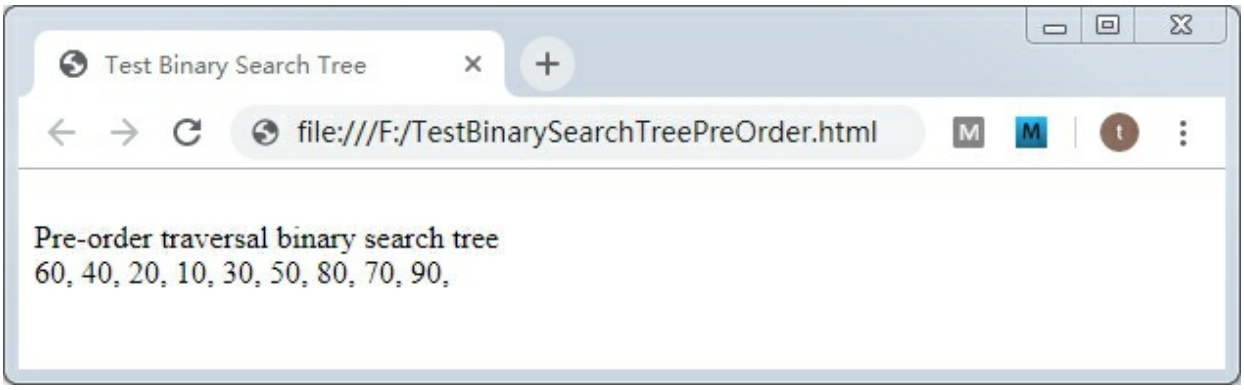


Create a TestBinarySearchTreePreOrder.html with Notepad

```
<script type="text/javascript">
    class BinaryTree {
        getRoot() {
            return this.root;
        }

        //Preorder traversal binary search tree
        preOrder(root) {
            if (root == null) {
                return;
            }
            document.write(root.getData() + ", ");
            this.preOrder(root.left); // Recursive Traversing the left subtree
            this.preOrder(root.right); // Recursive Traversing the right
subtree
        }

        insert(node, newData) {
            if (this.root == null) {
                this.root = new Node(newData, null, null);
                return;
            }

            var compareValue = newData - node.getData();
            //Recursive left subtree, continue to find the insertion position
            if (compareValue < 0) {
                if (node.left == null) {
                    node.left = new Node(newData, null, null);
                } else {
                    this.insert(node.left, newData);
                }
            } else if (compareValue > 0) {////Recursive right subtree,
continue to find the insertion position
                if (node.right == null) {
                    node.right = new Node(newData, null, null);
                } else {
```

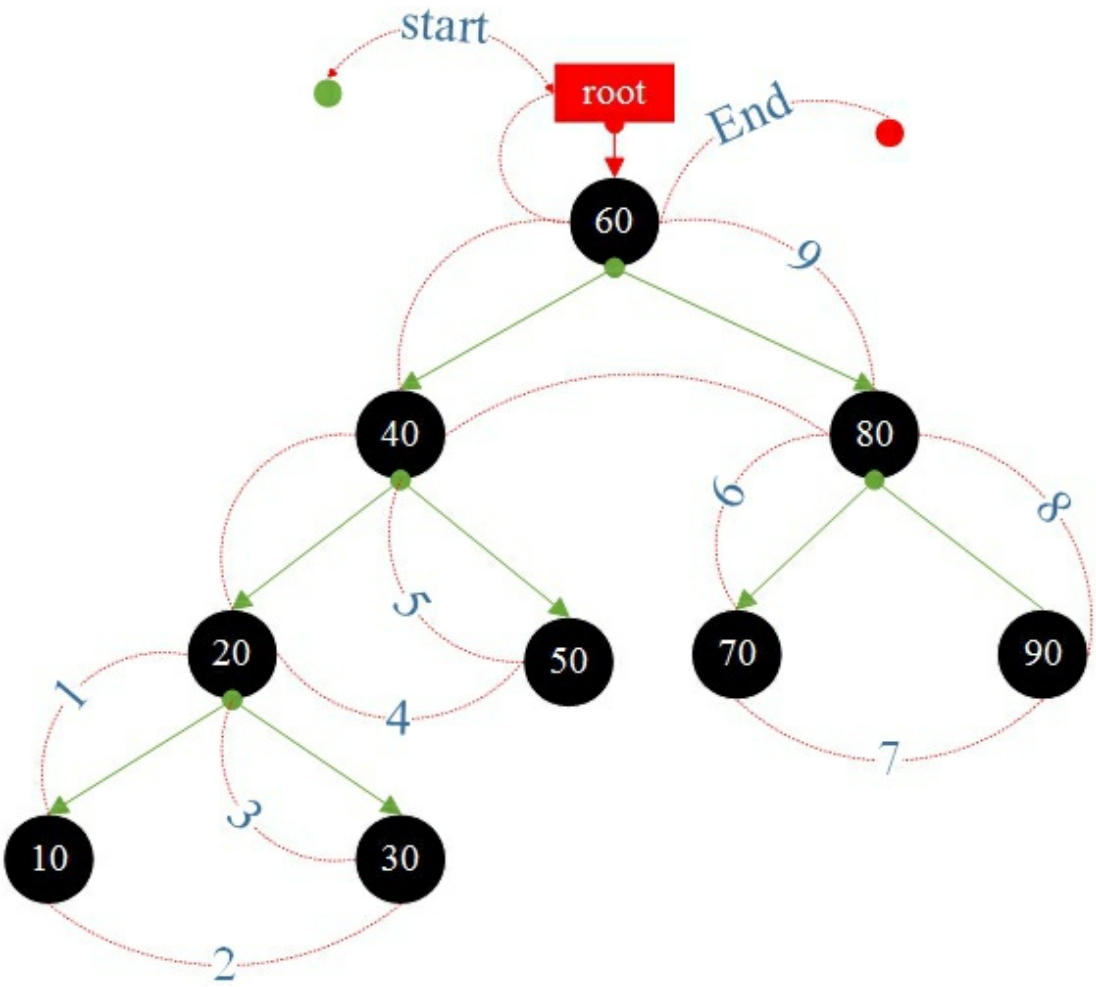
```
                    this.insert(node.right, newData);
                }
            }
        }
    }

    class Node{
        constructor(data, left, right){
            this.data = data;
            this.left = left;
            this.right = right;
        }

        getData(){
            return this.data;
        }
    }

    //////////////////////testing//////////////////

    var binaryTree=new BinaryTree();
    //Constructing a binary search tree
    binaryTree.insert(binaryTree.getRoot(), 60);
    binaryTree.insert(binaryTree.getRoot(), 40);
    binaryTree.insert(binaryTree.getRoot(), 20);
    binaryTree.insert(binaryTree.getRoot(), 10);
    binaryTree.insert(binaryTree.getRoot(), 30);
    binaryTree.insert(binaryTree.getRoot(), 50);
    binaryTree.insert(binaryTree.getRoot(), 80);
    binaryTree.insert(binaryTree.getRoot(), 70);
    binaryTree.insert(binaryTree.getRoot(), 90);

    document.write("<br> Pre-order traversal binary search tree <br>");
    binaryTree.preOrder(binaryTree.getRoot());
</script>
```

Result:

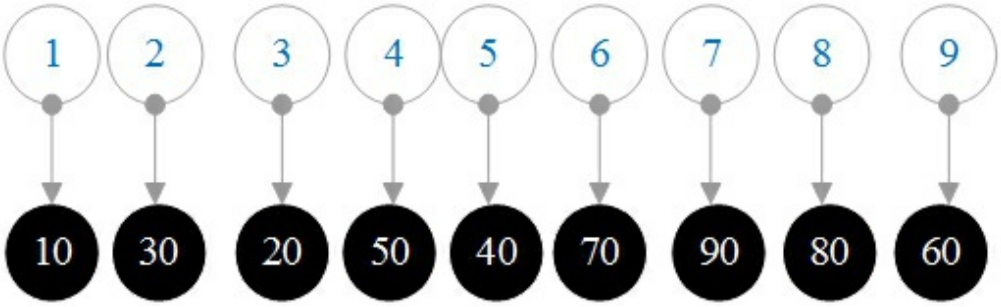

Test Binary Search Tree
file:///F:/TestBinarySearchTreePreOrder.html
Pre-order traversal binary search tree
60, 40, 20, 10, 30, 50, 80, 70, 90,

4. binary search tree Post-order traversal

Post-order traversal : right subtree -> root node -> left subtree



Result:

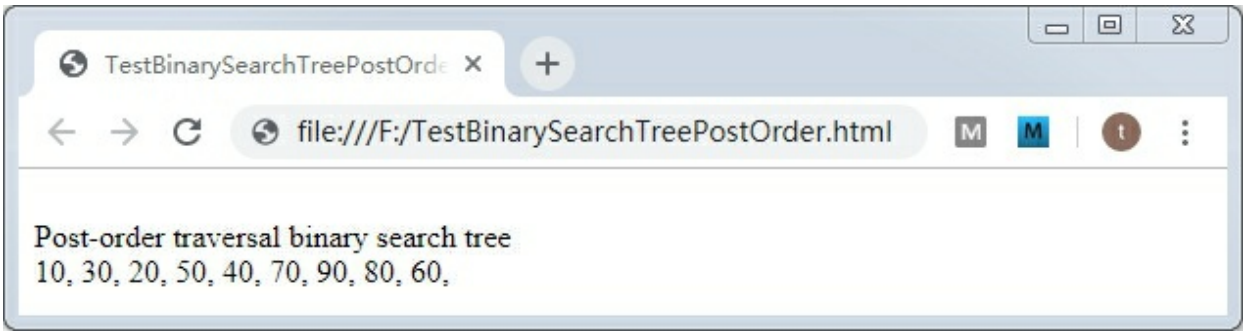


Create a TestBinarySearchTreePostOrder.html with Notepad

```
<script type="text/javascript">
    class BinaryTree {
        getRoot() {
            return this.root;
        }

        //Post-order traversal binary search tree
        postOrder(root) {
            if (root == null) {
                return;
            }
            this.postOrder(root.left); // Recursive Traversing the left subtree
            this.postOrder(root.right); // Recursive Traversing the right
subtree
            document.write(root.getData() + ", ");
        }

        insert(node, newData) {
            if (this.root == null) {
                this.root = new Node(newData, null, null);
                return;
            }

            var compareValue = newData - node.getData();
            //Recursive left subtree, continue to find the insertion position
            if (compareValue < 0) {
                if (node.left == null) {
                    node.left = new Node(newData, null, null);
                } else {
                    this.insert(node.left, newData);
                }
            } else if (compareValue > 0) {////Recursive right subtree,
continue to find the insertion position
                if (node.right == null) {
                    node.right = new Node(newData, null, null);
                } else {
```

```
                    this.insert(node.right, newData);
                }
            }
        }
    }

    class Node{
        constructor(data, left, right){
            this.data = data;
            this.left = left;
            this.right = right;
        }

        getData(){
            return this.data;
        }
    }

    //////////////////////testing//////////////////

    var binaryTree=new BinaryTree();

    //Constructing a binary search tree
    binaryTree.insert(binaryTree.getRoot(), 60);
    binaryTree.insert(binaryTree.getRoot(), 40);
    binaryTree.insert(binaryTree.getRoot(), 20);
    binaryTree.insert(binaryTree.getRoot(), 10);
    binaryTree.insert(binaryTree.getRoot(), 30);
    binaryTree.insert(binaryTree.getRoot(), 50);
    binaryTree.insert(binaryTree.getRoot(), 80);
    binaryTree.insert(binaryTree.getRoot(), 70);
    binaryTree.insert(binaryTree.getRoot(), 90);

    document.write("<br> Post-order traversal binary search tree <br>");
    binaryTree.postOrder(binaryTree.getRoot());
</script>
```

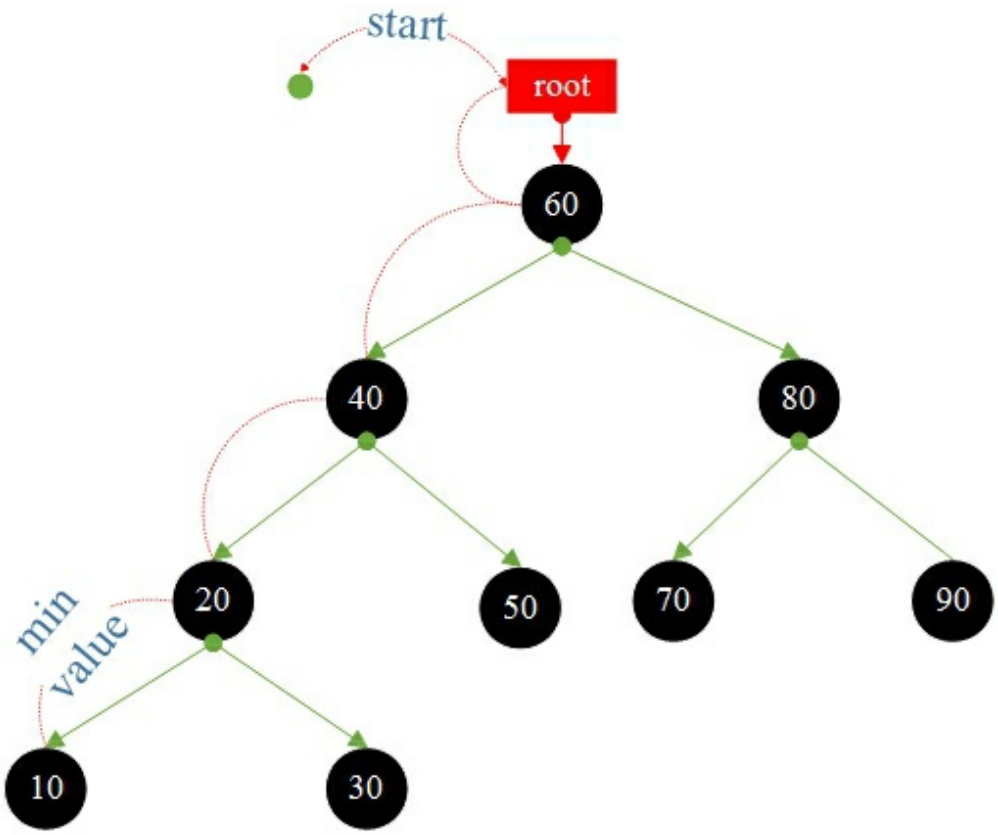
Result:

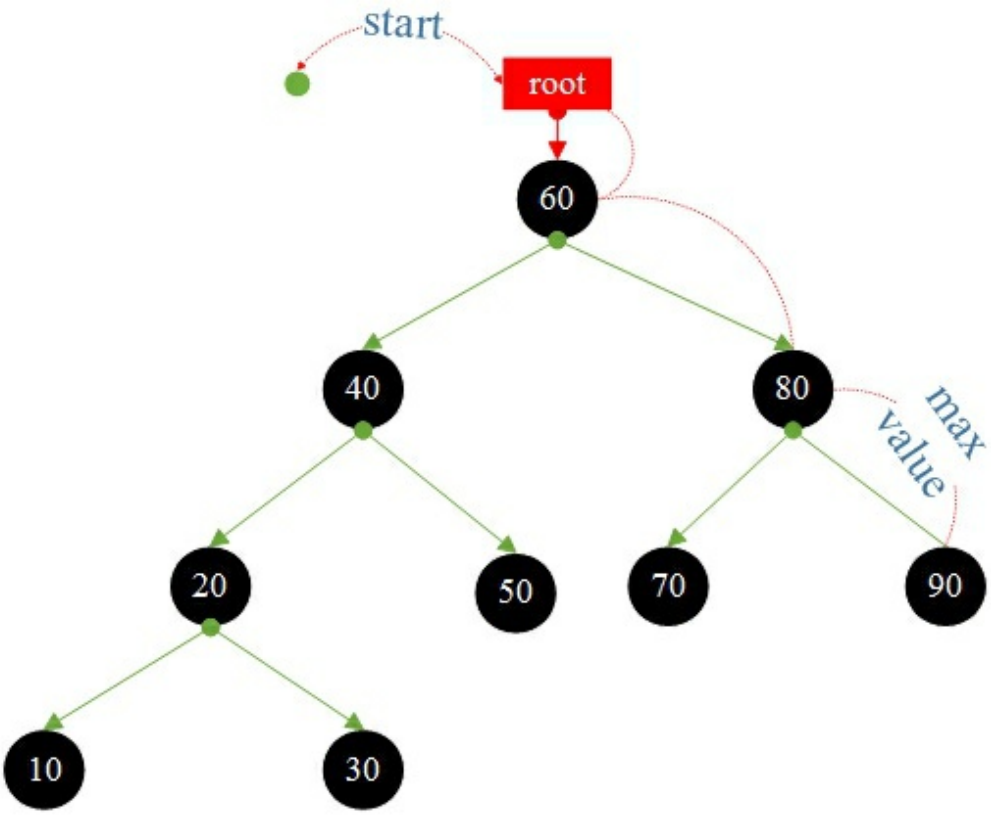

TestBinarySearchTreePostOrde
file:///F:/TestBinarySearchTreePostOrder.html
Post-order traversal binary search tree
10, 30, 20, 50, 40, 70, 90, 80, 60,

5. binary search tree Maximum and minimum

Minimum value: The small value is on the left child node, as long as the recursion traverses the left child until be empty, the current node is the minimum node.

Maximum value: The large value is on the right child node, as long as the recursive traversal is the right child until be empty, the current node is the largest node.




start
root
60
40
80
max
value
20
50
70
90
10
30

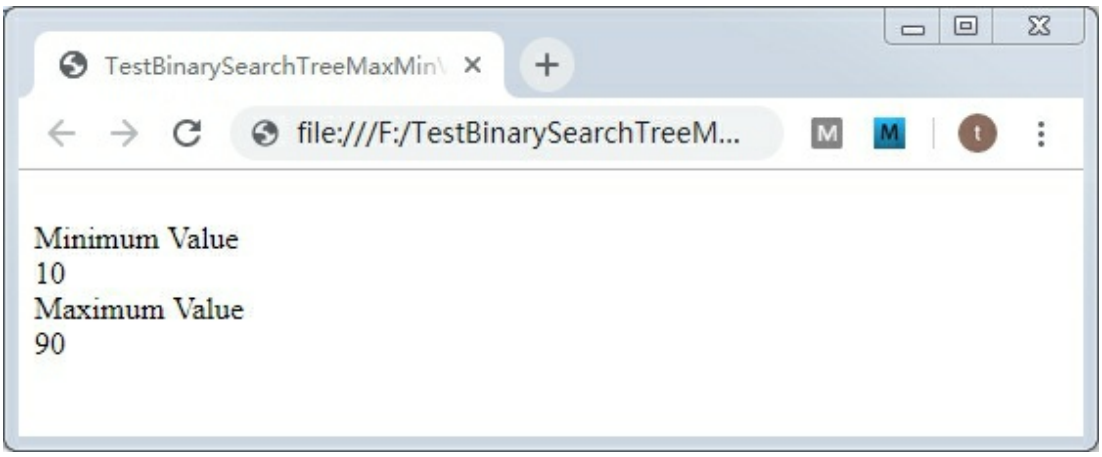
Create a TestBinarySearchTreeMaxMinValue.html with Notepad

```
<script type="text/javascript">
    class BinaryTree {
        getRoot() {
            return this.root;
        }

        //Minimum value
        searchMinValue(node) {
            if (node == null || node.getData() == 0)
                return null;
            if (node.left == null) {
                return node;
            }
            //Recursively find the minimum from the left subtree
            return this.searchMinValue(node.left);
        }

        //Maximum value
        searchMaxValue(node) {
            if (node == null || node.getData() == 0)
                return null;
            if (node.right == null) {
                return node;
            }
            //Recursively find the minimum from the right subtree
            return this.searchMaxValue(node.right);
        }
```

```
        insert(node, newData) {
            if (this.root == null) {
                this.root = new Node(newData, null, null);
                return;
            }

            var compareValue = newData - node.getData();
            //Recursive left subtree, continue to find the insertion position
            if (compareValue < 0) {
                if (node.left == null) {
                    node.left = new Node(newData, null, null);
                } else {
                    this.insert(node.left, newData);
                }
            } else if (compareValue > 0) {////Recursive right subtree,
continue to find the insertion position
                if (node.right == null) {
                    node.right = new Node(newData, null, null);
                } else {
                    this.insert(node.right, newData);
                }
            }
        }
    }

    class Node{
        constructor(data, left, right){
            this.data = data;
            this.left = left;
            this.right = right;
        }

        getData(){
            return this.data;
        }
    }
```

```
    //////////////////////testing//////////////////

    var binaryTree=new BinaryTree();

    //Constructing a binary search tree
    binaryTree.insert(binaryTree.getRoot(), 60);
    binaryTree.insert(binaryTree.getRoot(), 40);
    binaryTree.insert(binaryTree.getRoot(), 20);
    binaryTree.insert(binaryTree.getRoot(), 10);
    binaryTree.insert(binaryTree.getRoot(), 30);
    binaryTree.insert(binaryTree.getRoot(), 50);
    binaryTree.insert(binaryTree.getRoot(), 80);
    binaryTree.insert(binaryTree.getRoot(), 70);
    binaryTree.insert(binaryTree.getRoot(), 90);

    document.write("<br> Minimum Value<br> ");
    var minNode = binaryTree.searchMinValue(binaryTree.getRoot());
    document.write(minNode.getData());

    document.write("<br> Maximum Value<br> ");
    var maxNode = binaryTree.searchMaxValue(binaryTree.getRoot());
    document.write(maxNode.getData());
</script>
```

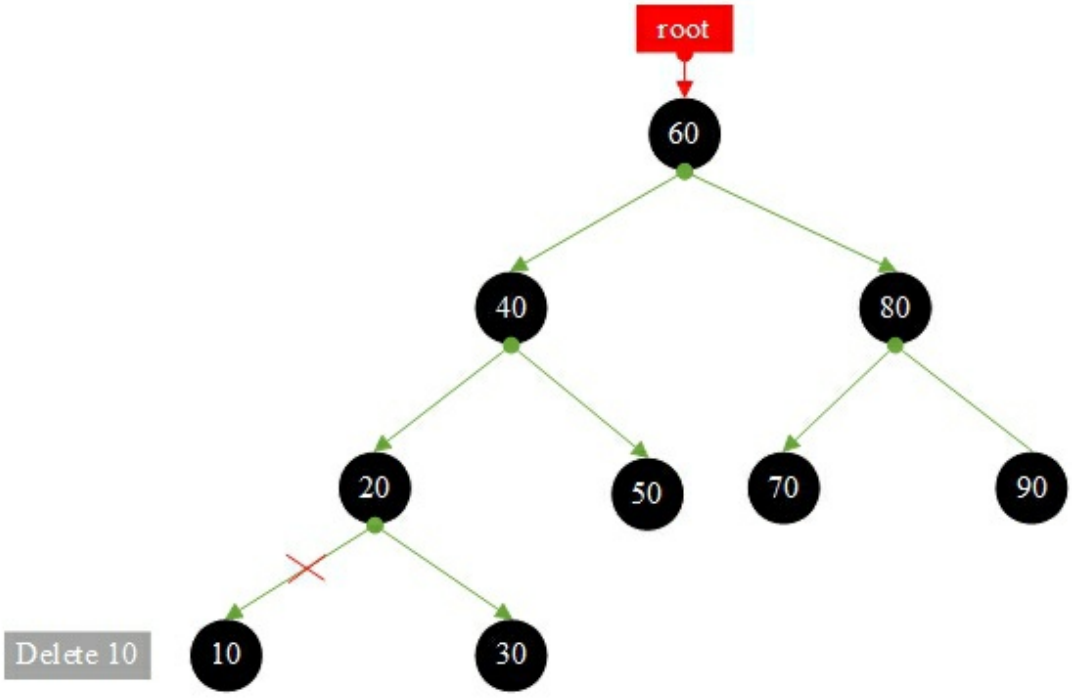
Result:

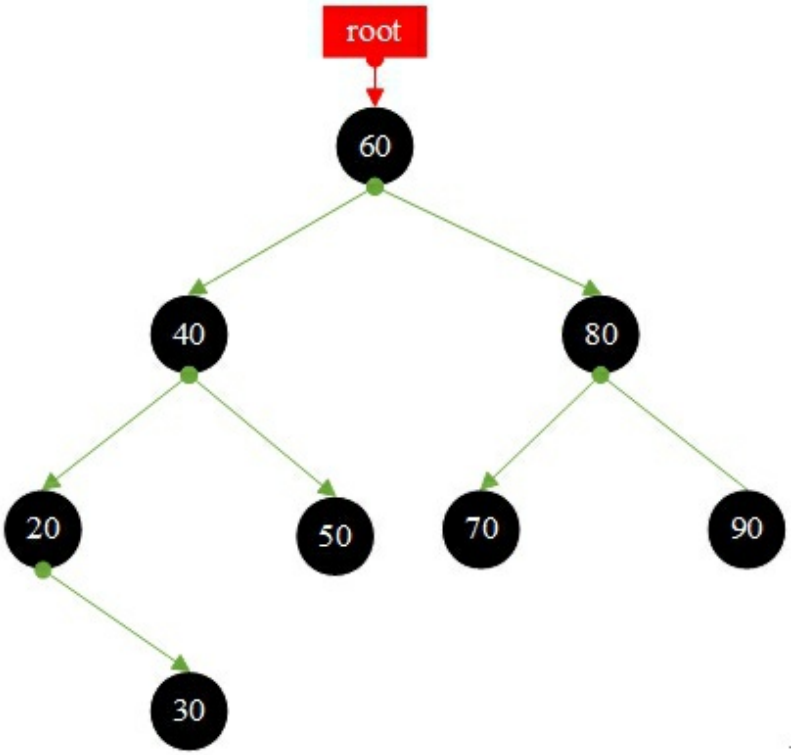


6. binary search tree Delete Node

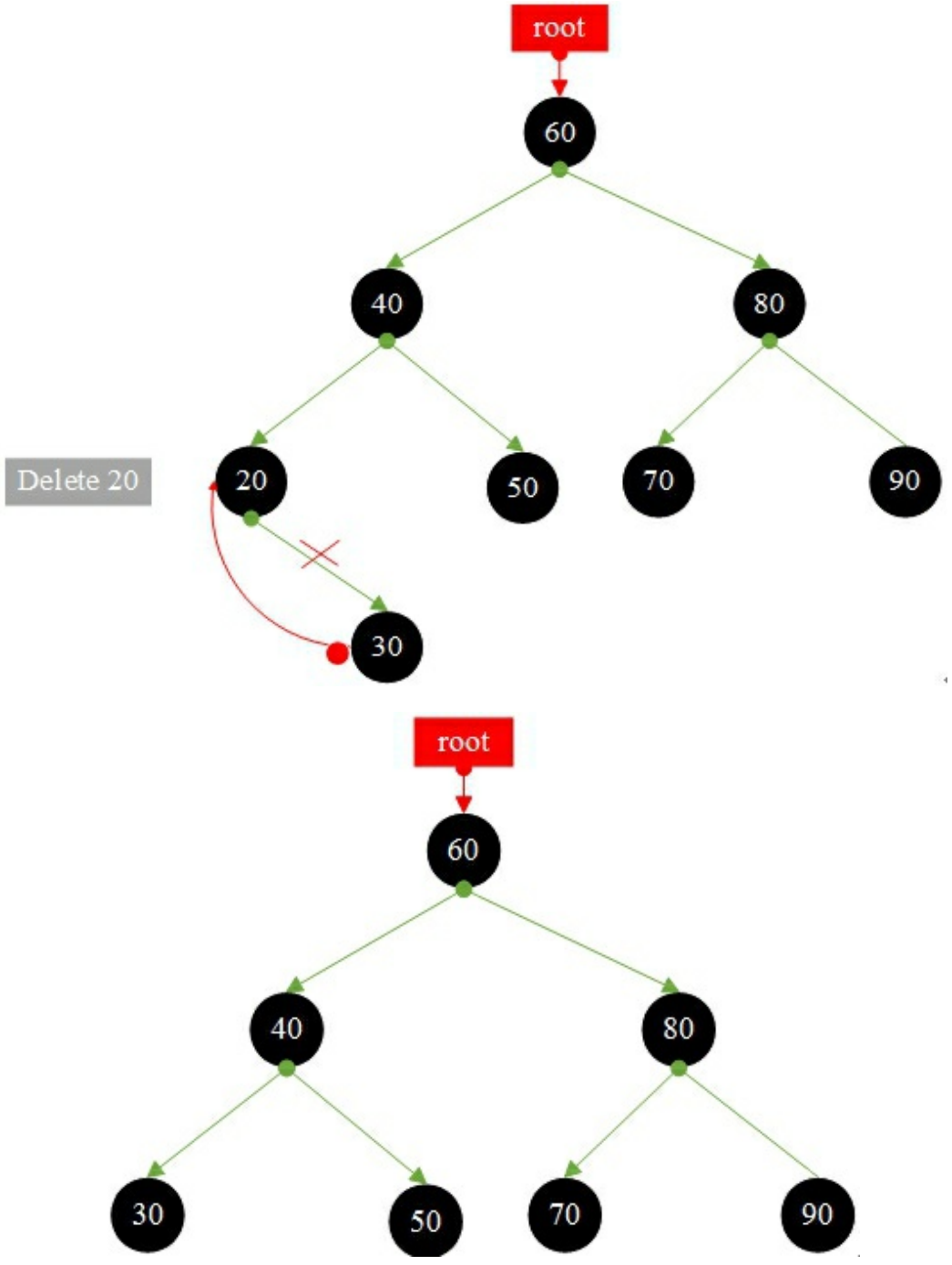
Binary search tree delete node 3 cases
1. If there is no child node, delete it directly
2. If there is only one child node, the child node replaces the current node, and then deletes the current node.
3. If there are two child nodes, replace the current node with the smallest node from the right subtree, because the smallest node on the right is also larger than the value on the left.

1. If there is no child node, delete it directly: delete node 10

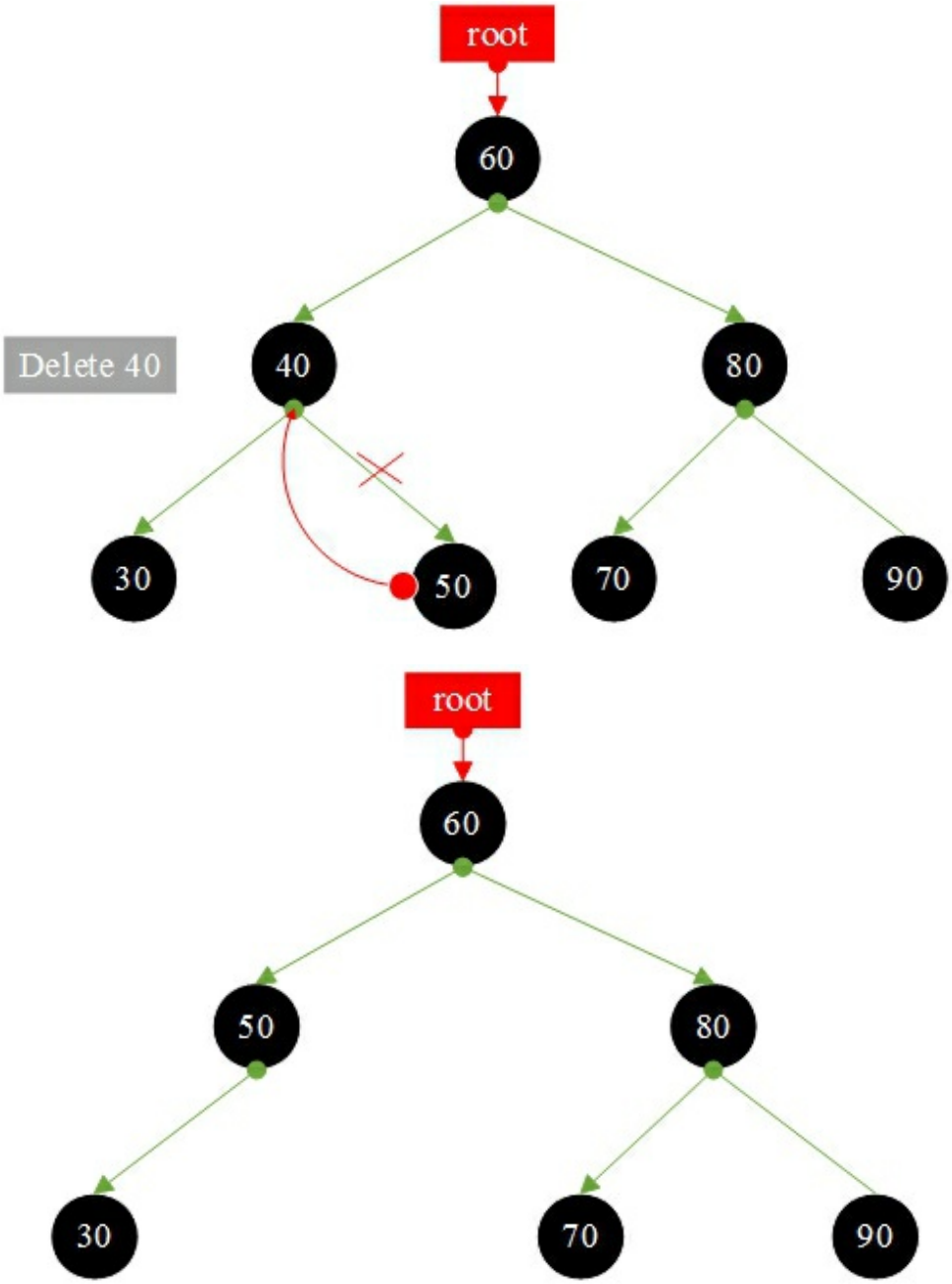



root
60
40
80
20
50
70
90
30

2. If there is only one child node, the child node replaces the current node, and then deletes the current node. Delete node 20



3. If there are two child nodes, replace the current node with the smallest node from the right subtree, Delete node 40



Create a TestBinarySearchTreeDelete.html with Notepad

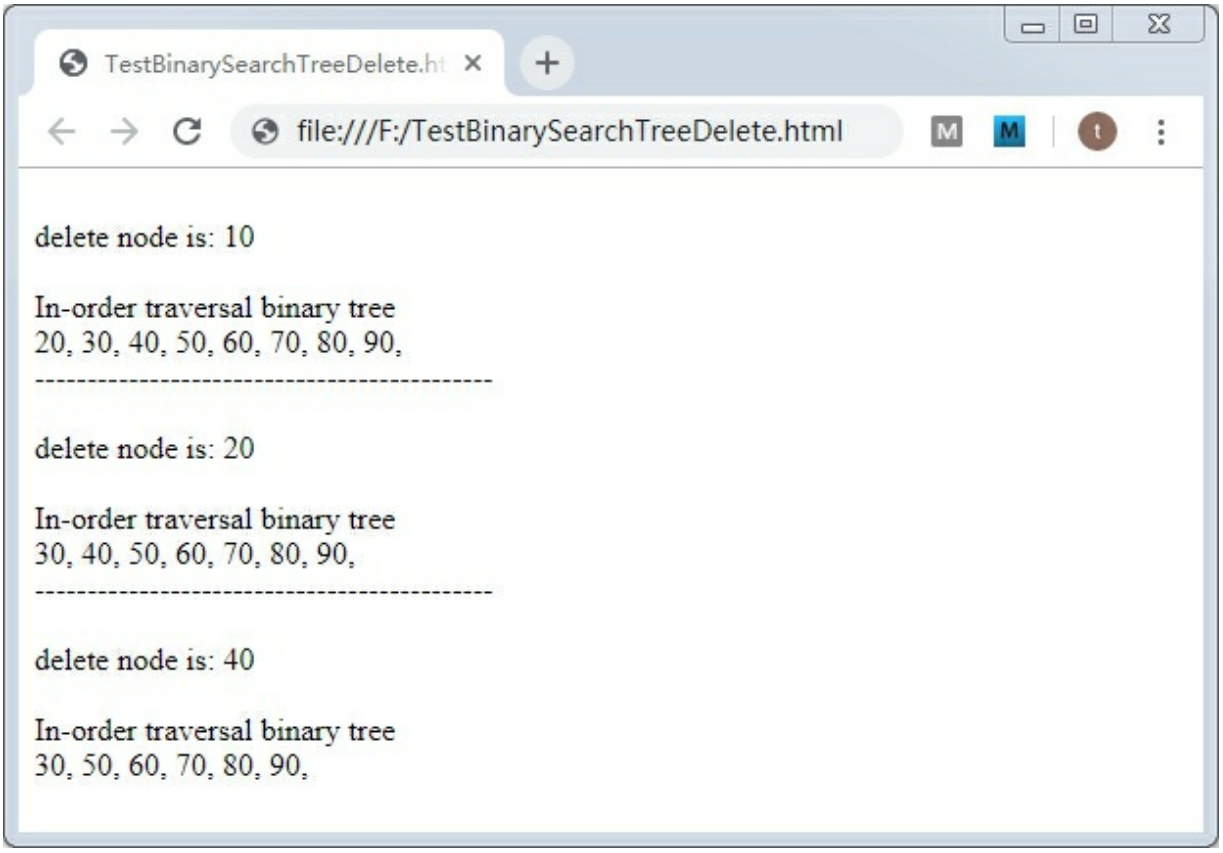
```
<script type="text/javascript">
    class BinaryTree {
        getRoot() {
            return this.root;
        }

         // In-order traversal binary search tree
        inOrder(root) {
            if (root == null) {
                return;
            }
            this.inOrder(root.left); // Traversing the left subtree
            document.write(root.getData() + ", ");
            this.inOrder(root.right); // Traversing the right subtree
        }

        remove(node, newData) {
            if (node == null)
                return node;
            var compareValue = newData - node.getData();
            if (compareValue > 0) {
                node.right = this.remove(node.right, newData);
            } else if (compareValue < 0) {
                node.left = this.remove(node.left, newData);
            } else if (node.left != null && node.right != null) {
                //Find the minimum node of the right subtree to replace the
current node
                node.setData(this.searchMinValue(node.right).getData());
                node.right = this.remove(node.right, node.getData());
            } else {
                node = (node.left != null) ? node.left : node.right;
            }
            return node;
        }
```

```
        //Search minimum
        searchMinValue(node) {
            if (node == null || node.getData() == 0)
                return null;
            if (node.left == null) {
                return node;
            }
            //Recursively find the minimum from the left subtree
            return this.searchMinValue(node.left);
        }

        insert(node, newData) {
            if (this.root == null) {
                this.root = new Node(newData, null, null);
                return;
            }

            var compareValue = newData - node.getData();
            //Recursive left subtree, continue to find the insertion position
            if (compareValue < 0) {
                if (node.left == null) {
                    node.left = new Node(newData, null, null);
                } else {
                    this.insert(node.left, newData);
                }
            } else if (compareValue > 0) {////Recursive right subtree,
continue to find the insertion position
                if (node.right == null) {
                    node.right = new Node(newData, null, null);
                } else {
                    this.insert(node.right, newData);
                }
            }
        }
    }
```

```
class Node{
    constructor(data, left, right){
        this.data = data;
        this.left = left;
        this.right = right;
    }

    getData(){
        return this.data;
    }
    setData(data){
        this.data = data;
    }
}

//////////////////////testing//////////////////
var binaryTree=new BinaryTree();

//Constructing a binary search tree
binaryTree.insert(binaryTree.getRoot(), 60);
binaryTree.insert(binaryTree.getRoot(), 40);
binaryTree.insert(binaryTree.getRoot(), 20);
binaryTree.insert(binaryTree.getRoot(), 10);
binaryTree.insert(binaryTree.getRoot(), 30);
binaryTree.insert(binaryTree.getRoot(), 50);
binaryTree.insert(binaryTree.getRoot(), 80);
binaryTree.insert(binaryTree.getRoot(), 70);
binaryTree.insert(binaryTree.getRoot(), 90);

document.write("<br>delete node is:  10 <br>");
binaryTree.remove(binaryTree.getRoot(), 10);

document.write("<br>In-order traversal binary tree <br>");
binaryTree.inOrder(binaryTree.getRoot());

document.write("<br>----------------------------------------<br>");

document.write("<br>delete node is:  20<br>");
binaryTree.remove(binaryTree.getRoot(), 20);
```

```
    document.write("<br>In-order traversal binary tree<br>");
    binaryTree.inOrder(binaryTree.getRoot());


    document.write("<br>----------------------------------------<br>");

    document.write("<br>delete node is:  40<br>");
    binaryTree.remove(binaryTree.getRoot(), 40);

    document.write("<br>In-order traversal binary tree<br>");
    binaryTree.inOrder(binaryTree.getRoot());
</script>
```

Result:



Binary Heap Sorting

Binary Heap Sorting:
The value of the non-terminal node in the binary tree is not greater than the value of its left and right child nodes.

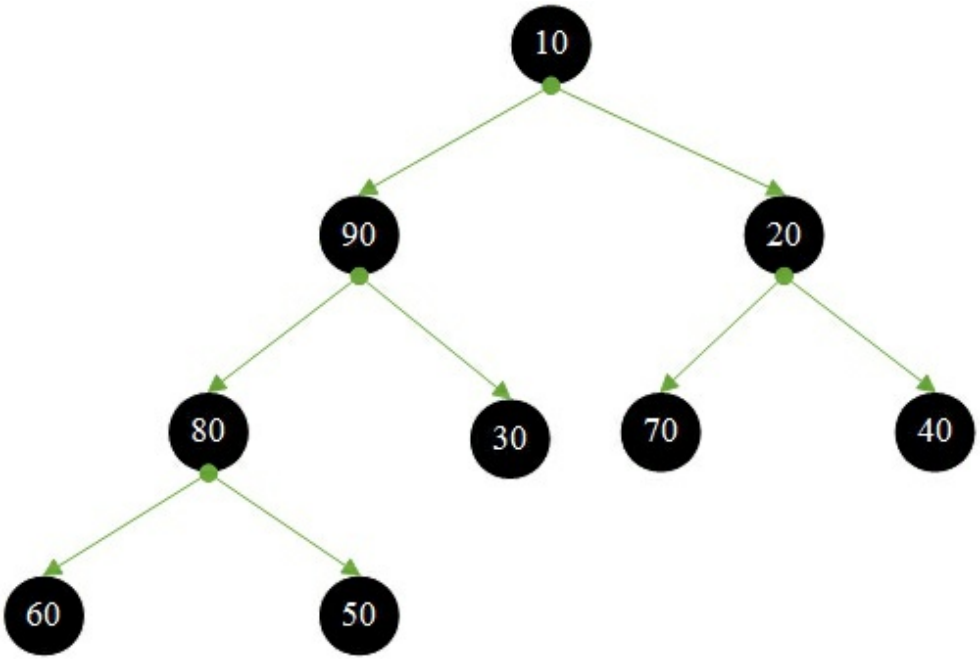
Small top heap : ki <= k2i and ki <= k2i+1
Big top heap :ki >= k2i and ki >= k2i+1

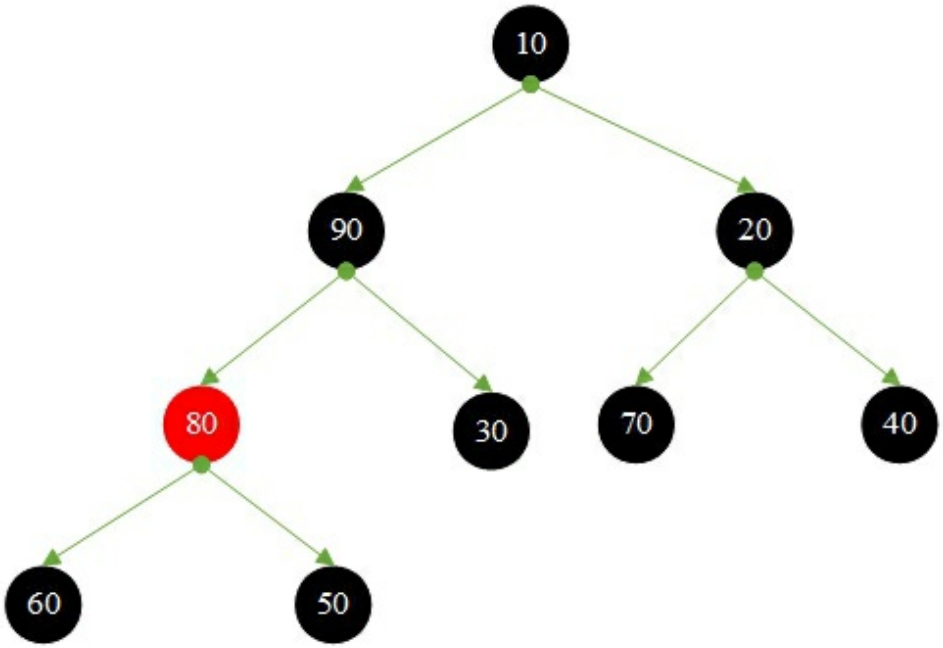
Parent node subscript = (i-1)/2
Left subnode subscript = 2*i+1
Right subnode subscript = 2*i+2

Heap sorting process:
1. Build a heap
2. After outputting the top element of the heap, adjust from top to bottom, compare the top element with the root node of its left and right subtrees, and swap the smallest element to the top of the heap; then adjust continuously until the leaf nodes to get new heap.

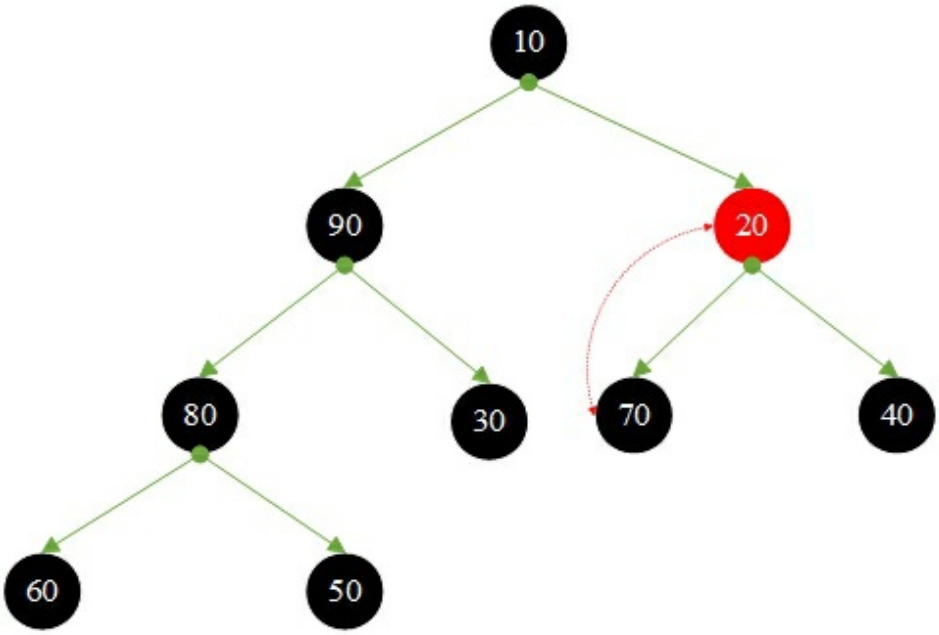
1. {10, 90, 20, 80, 30, 70, 40, 60, 50} build heap and then heap sort output.

Initialize the heap and build the heap

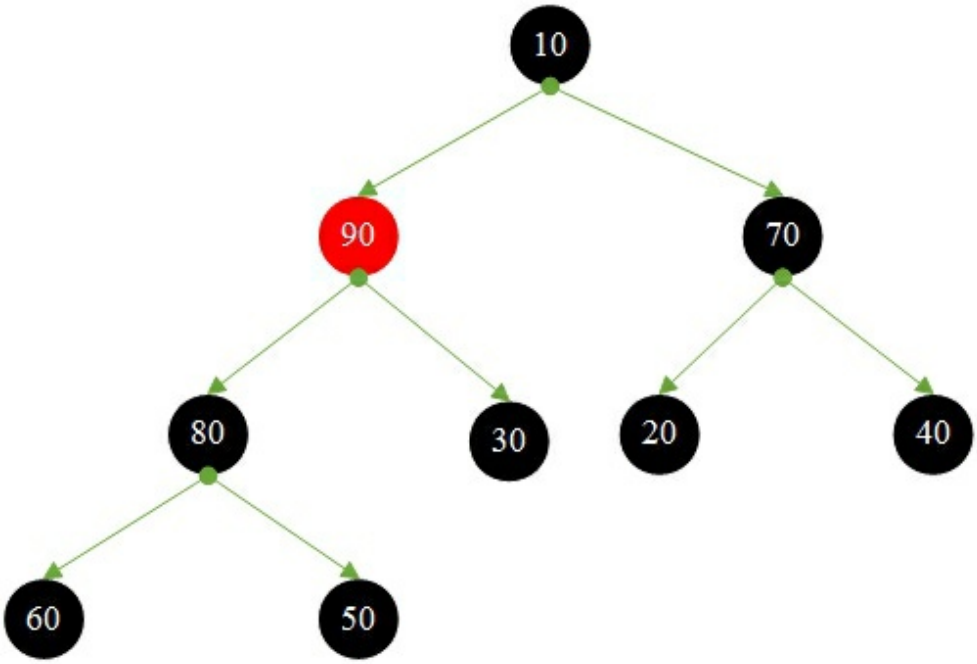




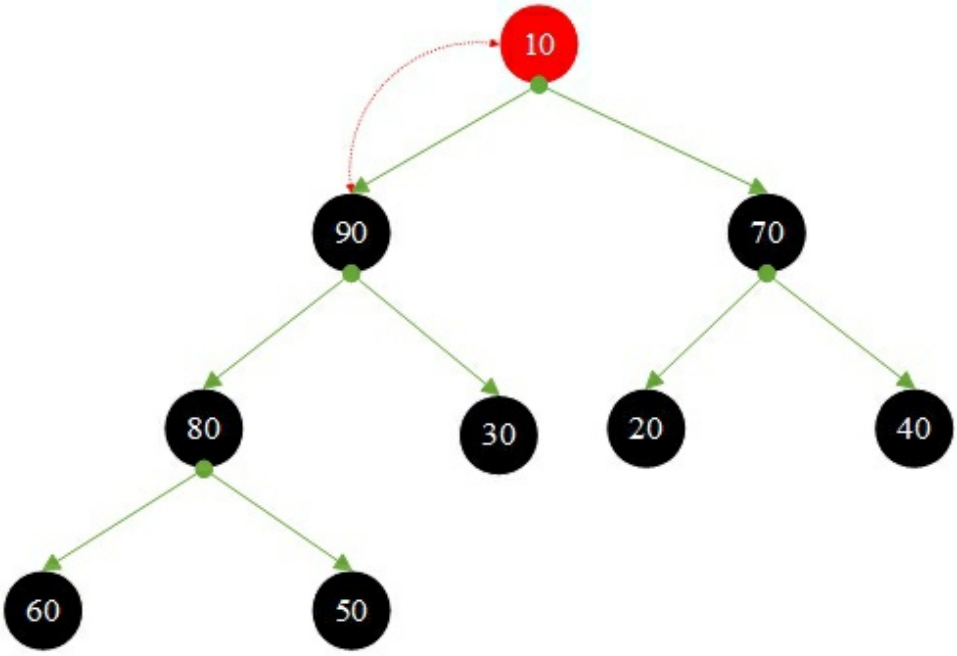
Not Leaf Node = 80 > left = 60 , 80 > right = 50 No need to move



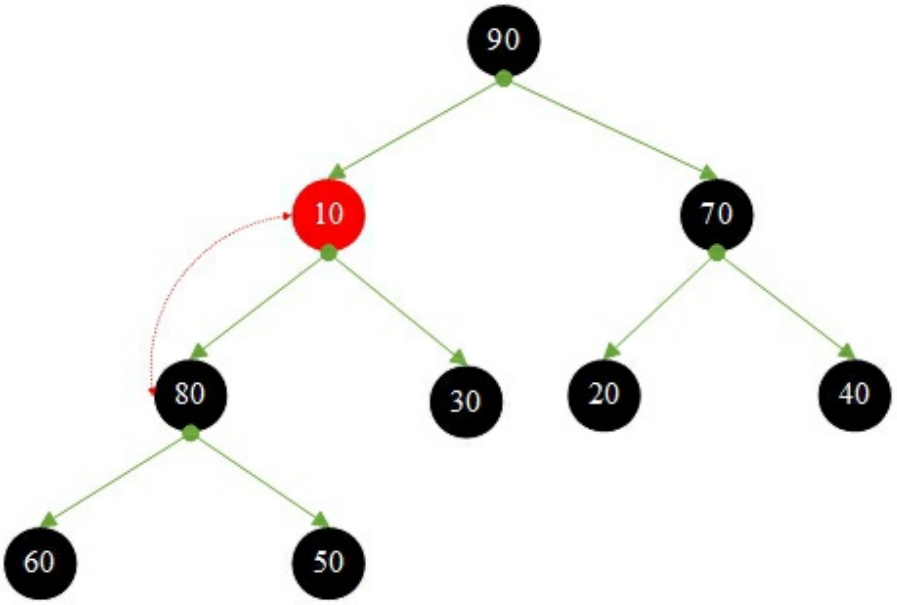
Not Leaf Node = 20 < left = 70 , 70 > right = 40 , 20 swap with 70



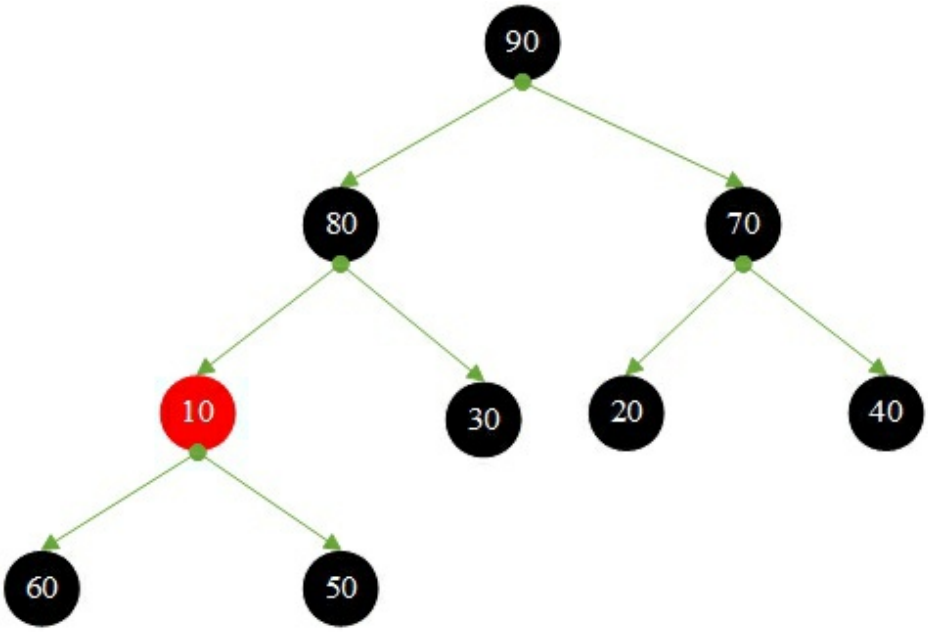
Not Leaf Node = 90 > left = 80 , 80 > right = 30 No need to move



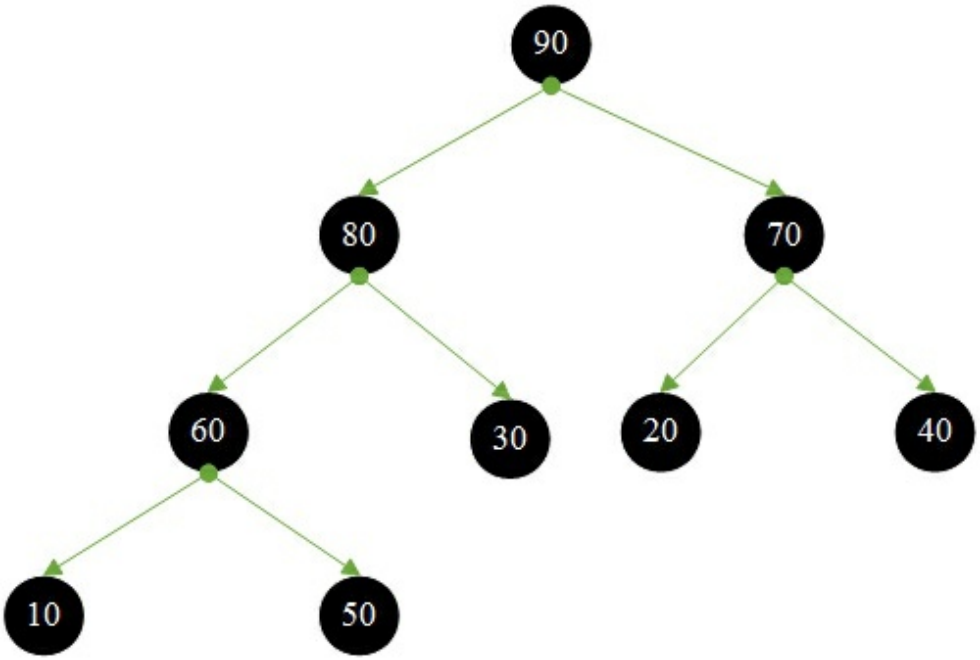
Not Leaf Node = 10 < left = 90 , 90 > right = 70 , 10 swap with 90



Still Not Leaf Node = 10 <1eft = 80 , 80 > right =30 , 10 swap with 80

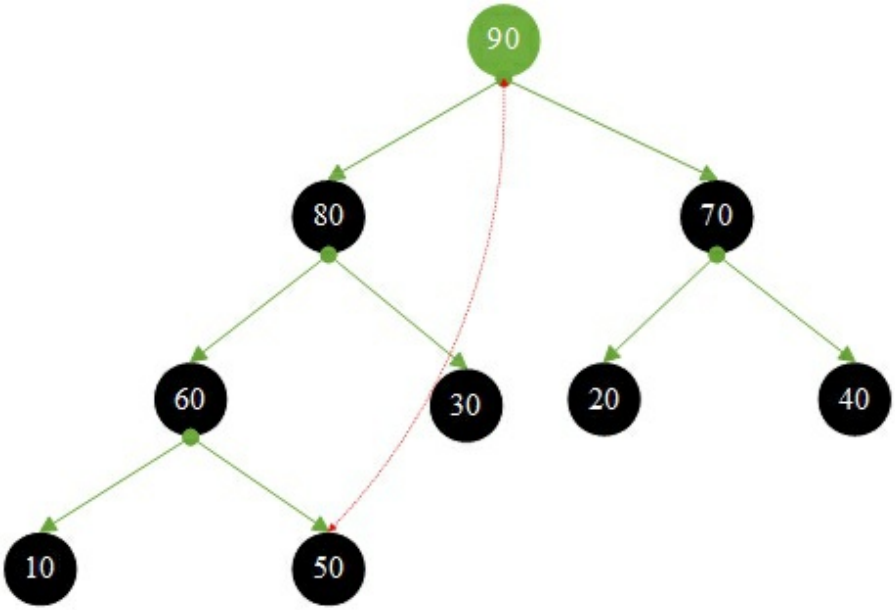


Still Not Leaf Node = 10 < left = 60 , 60 > right =50 , 10 swap with 60

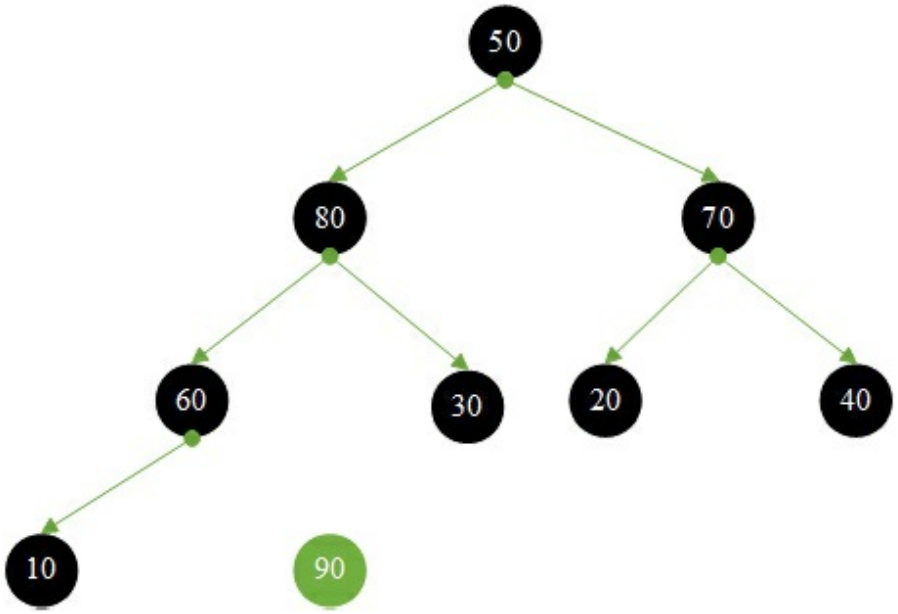


Create the heap finished

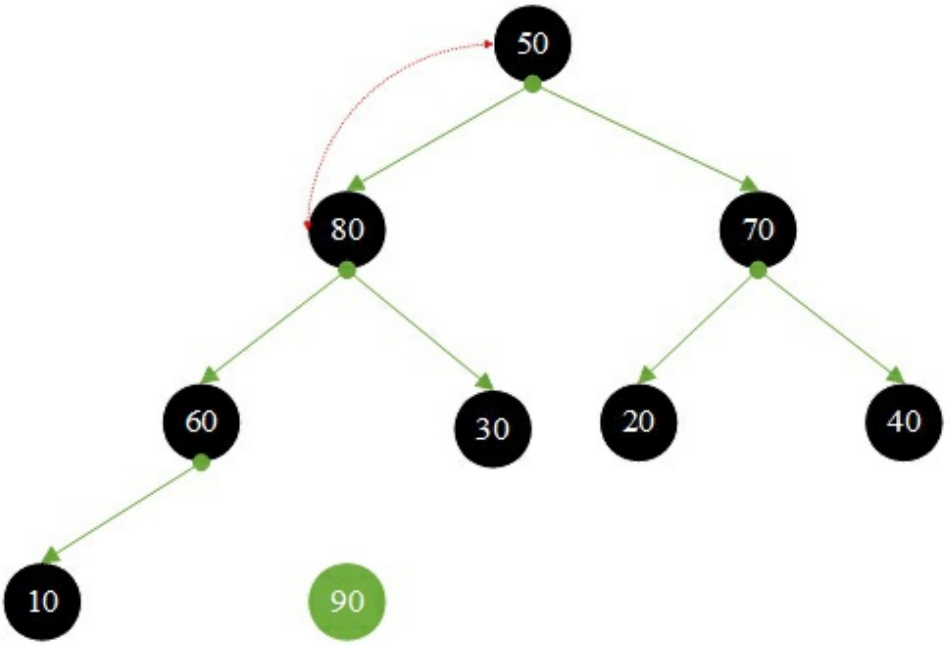
2. Start heap sorting

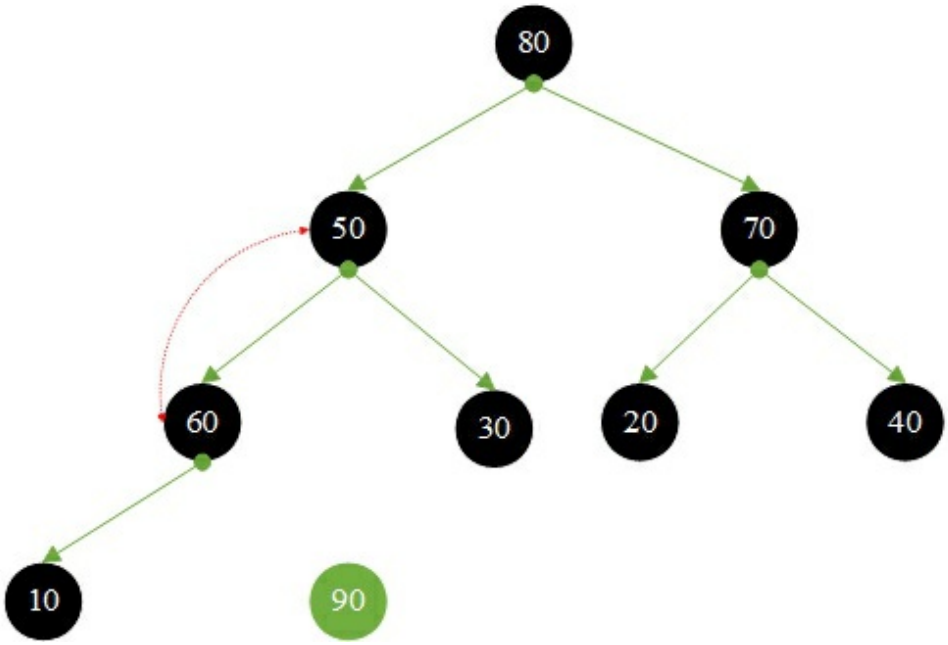


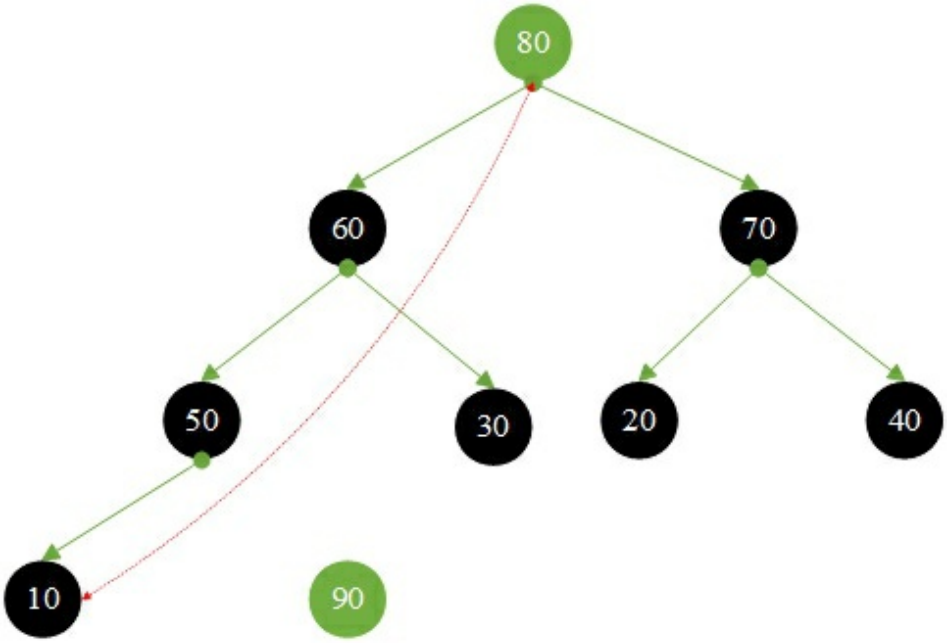
root = 90 and tail = 50 are exchanged



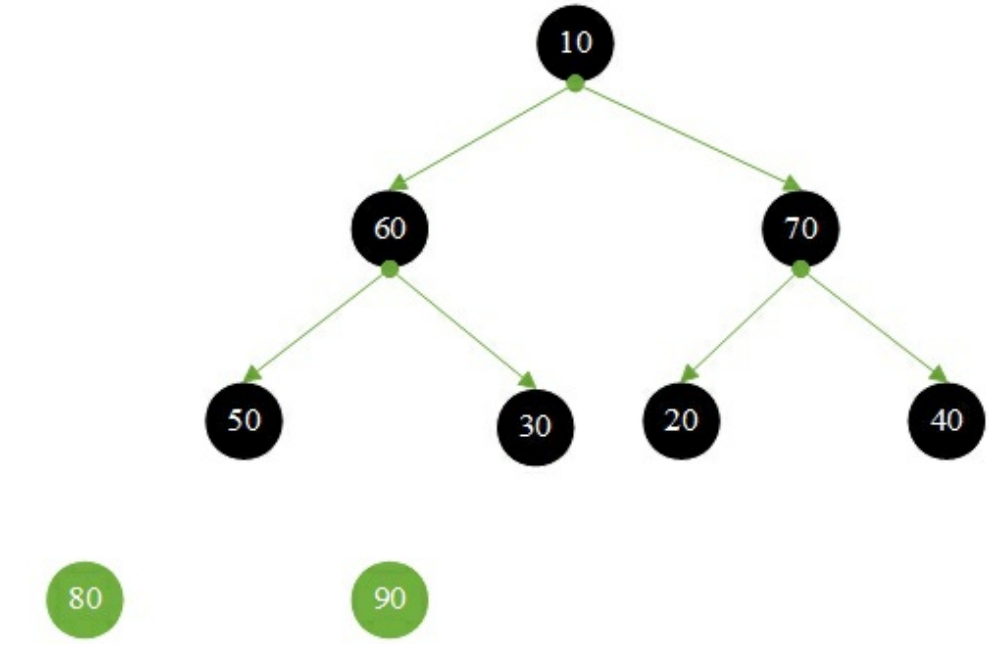
adjust the heap



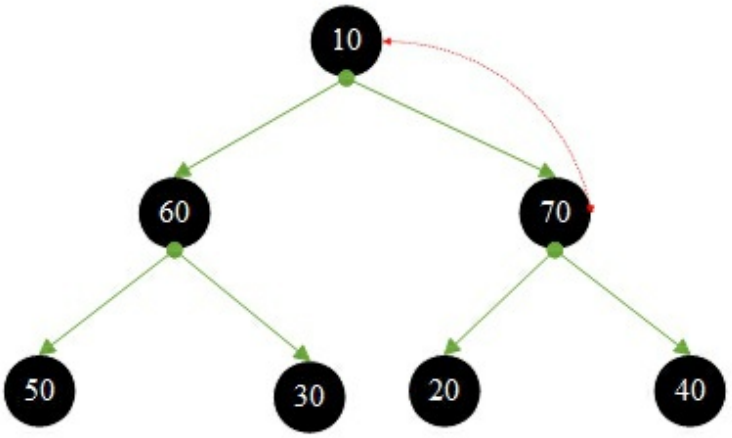




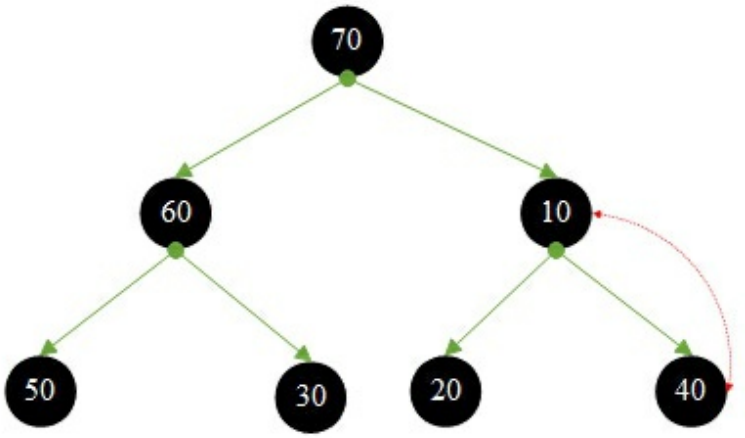
root = 80 and tail = 10 are exchanged



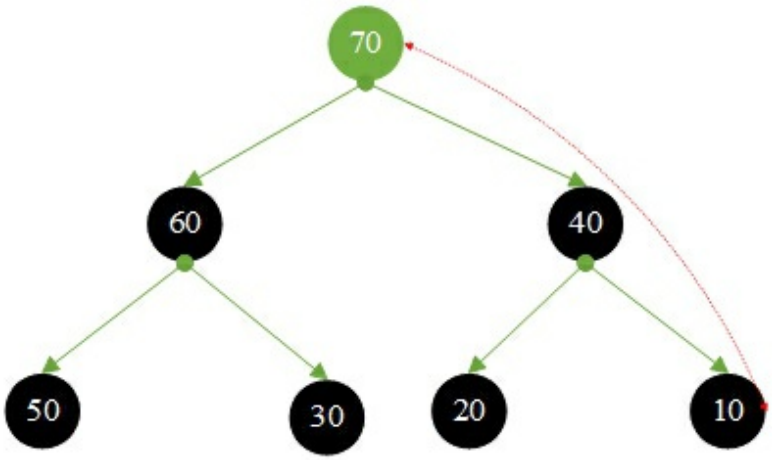
adjust the heap



80 90

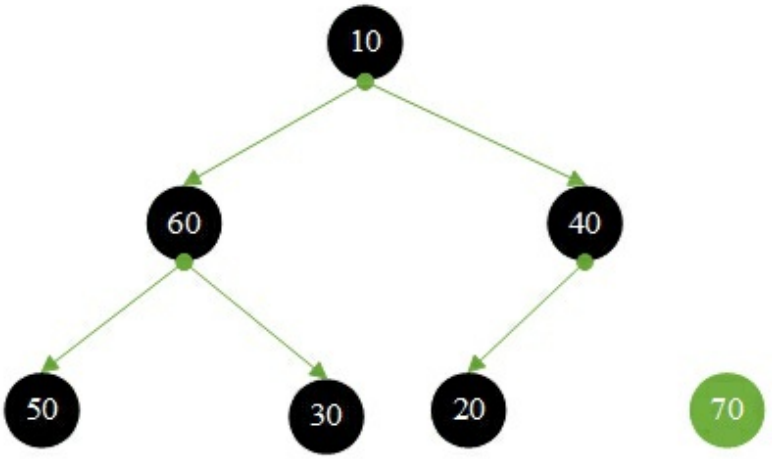


80 90



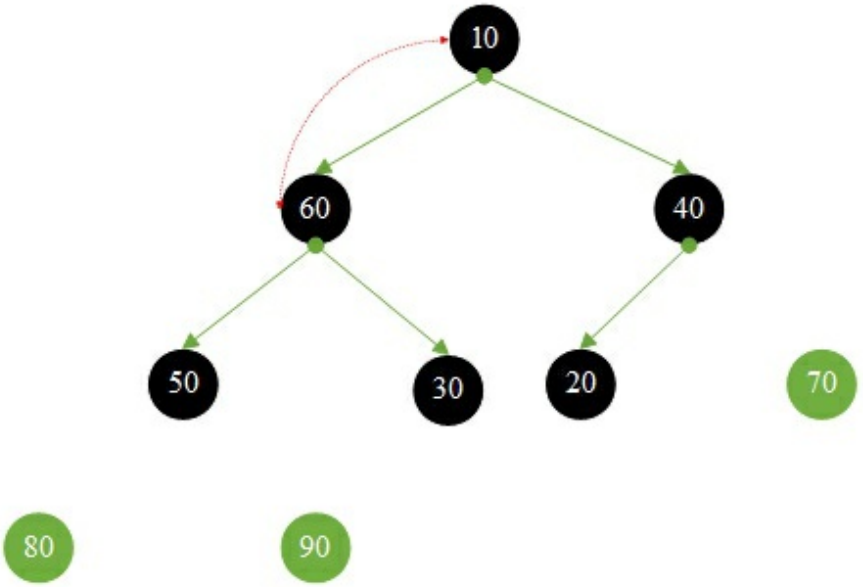
80 90

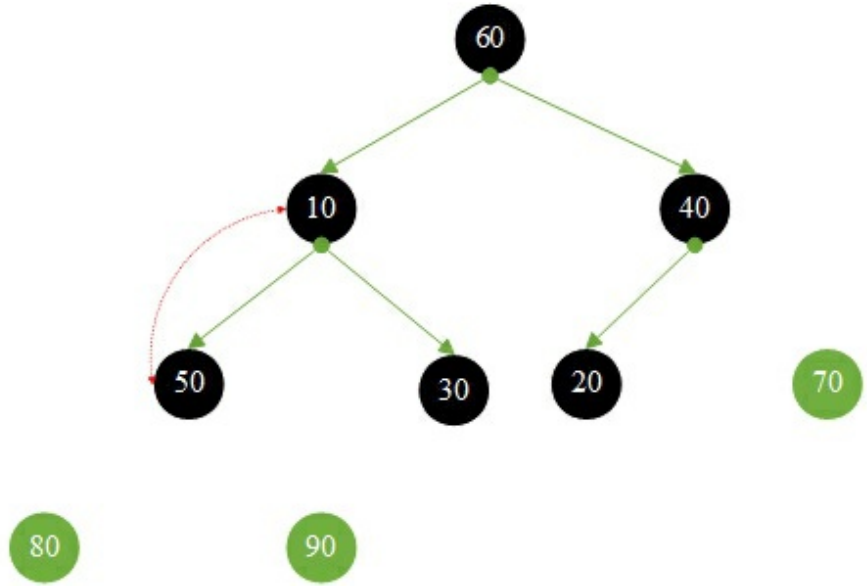
root = 70 and tail = 10 are exchanged

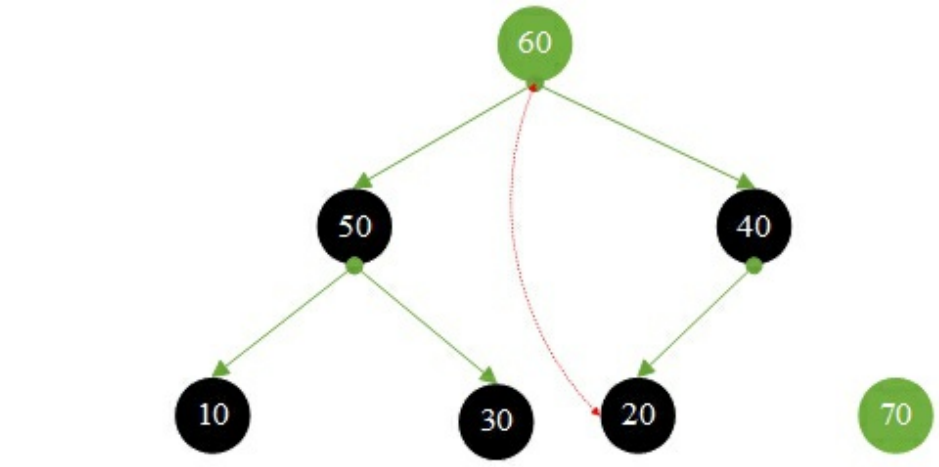


80 90

adjust the heap

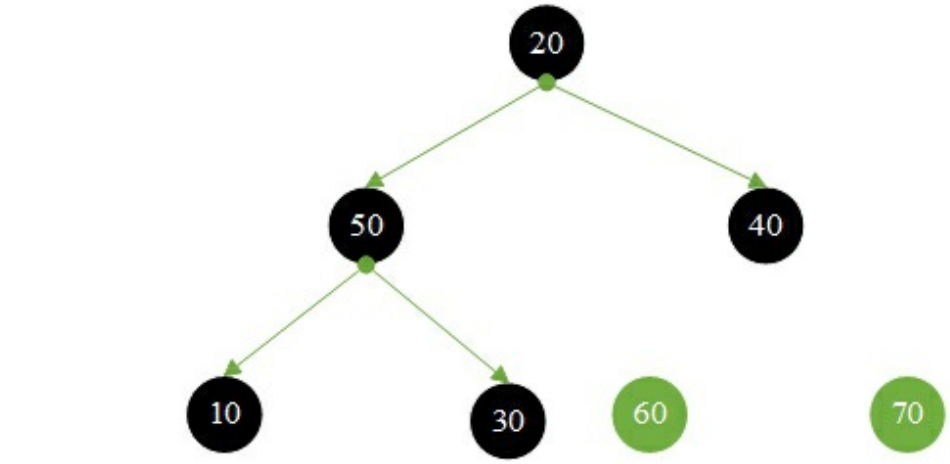






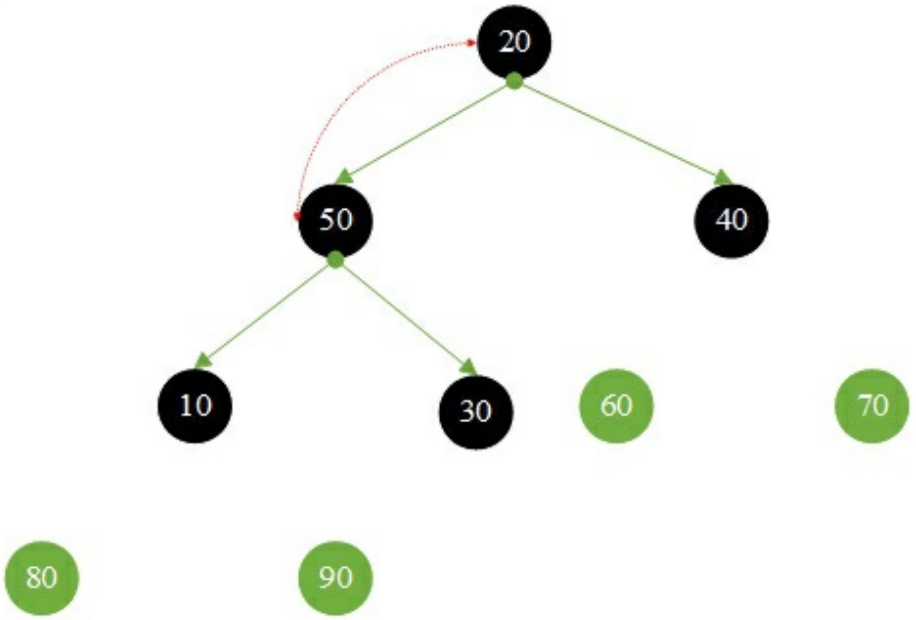
80 90

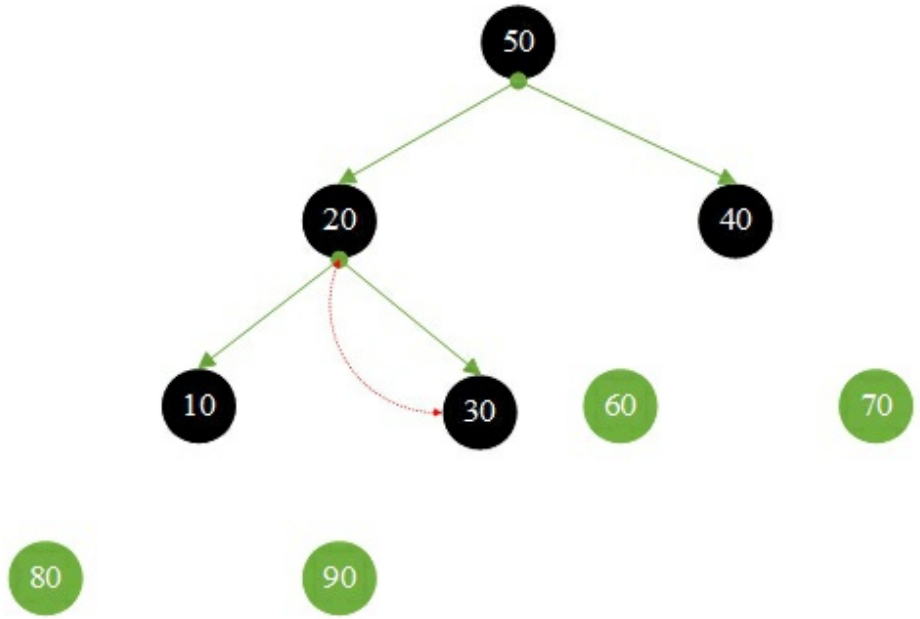
root = 60 and tail = 20 are exchanged

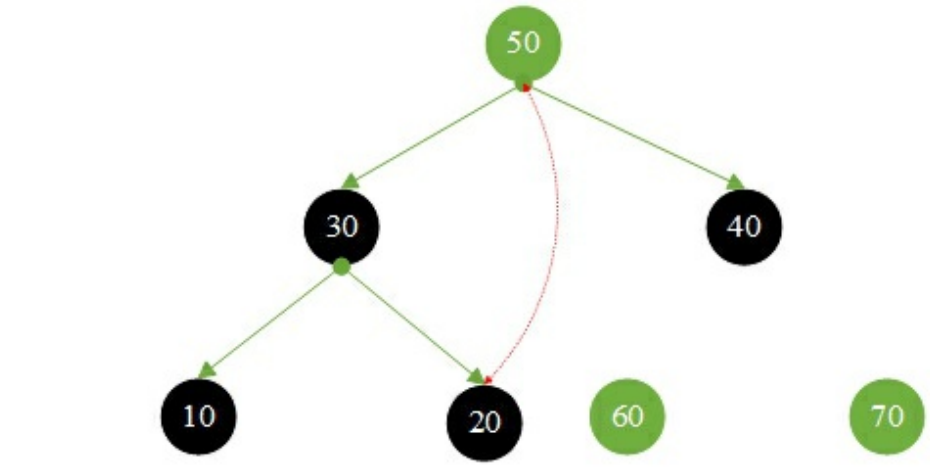


80 90

adjust the heap

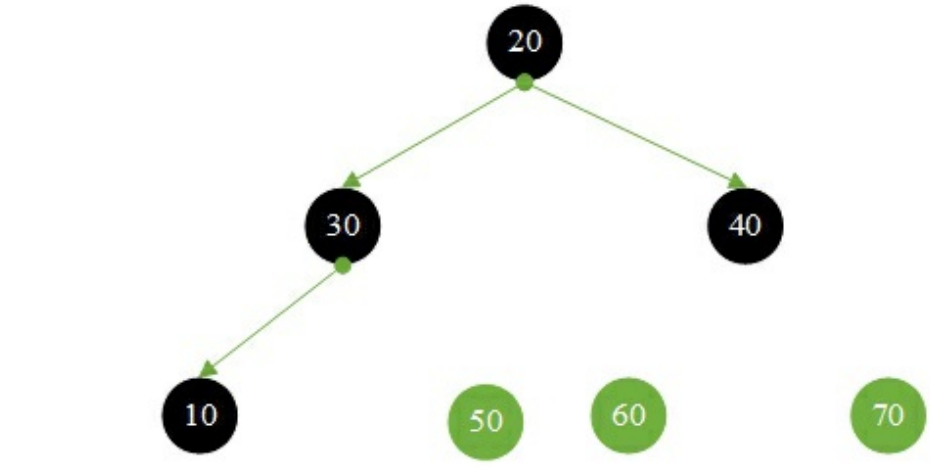






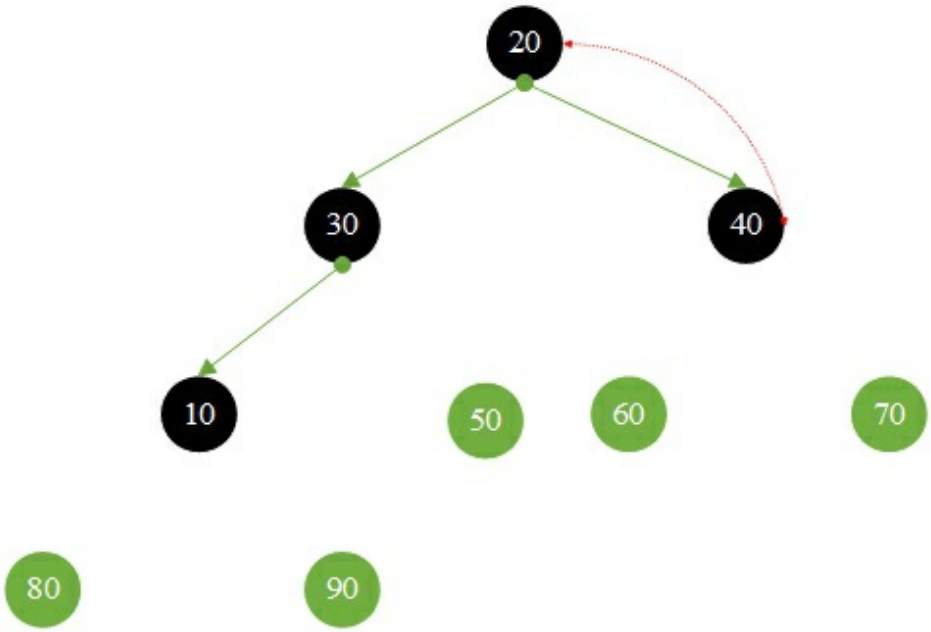
80 90

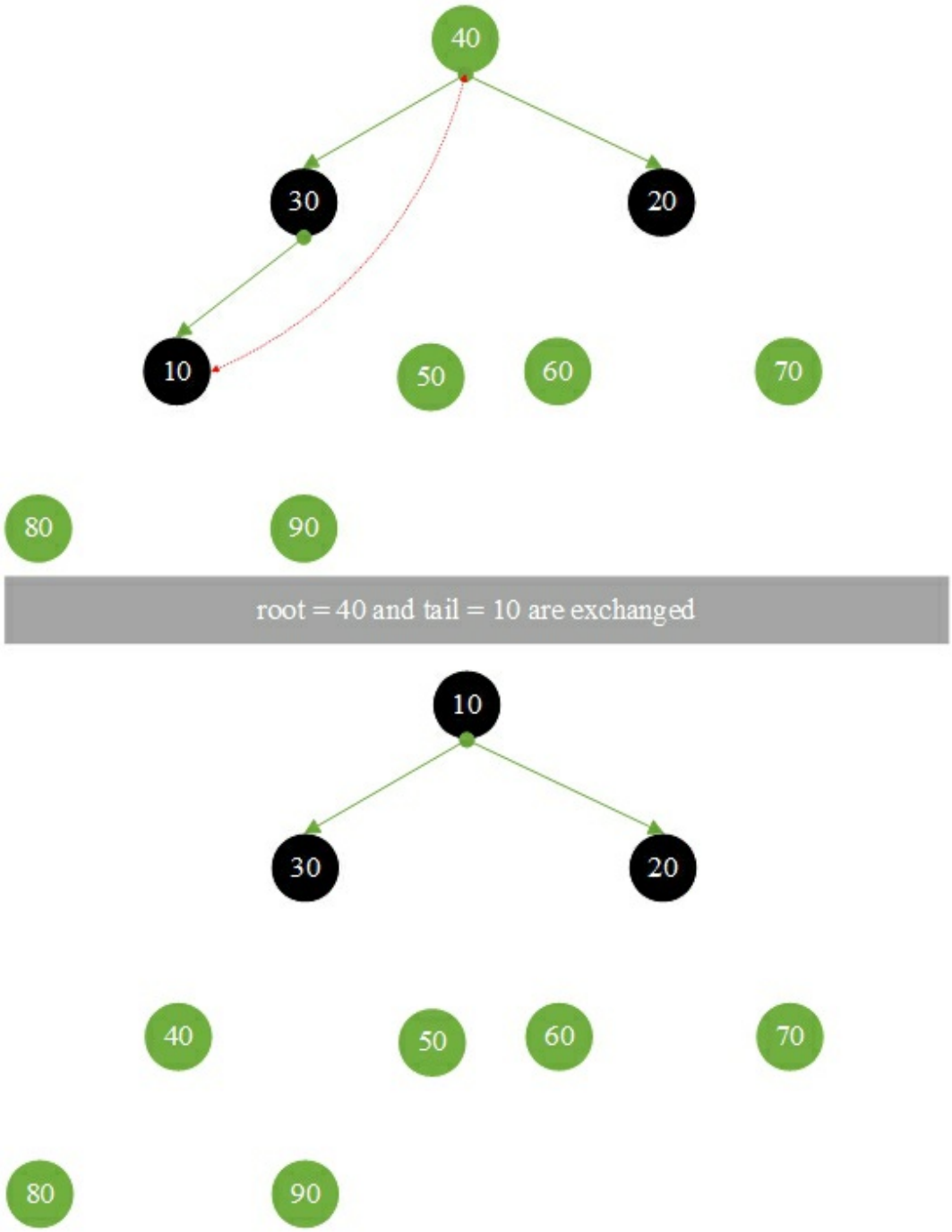
root = 50 and tail = 20 are exchanged



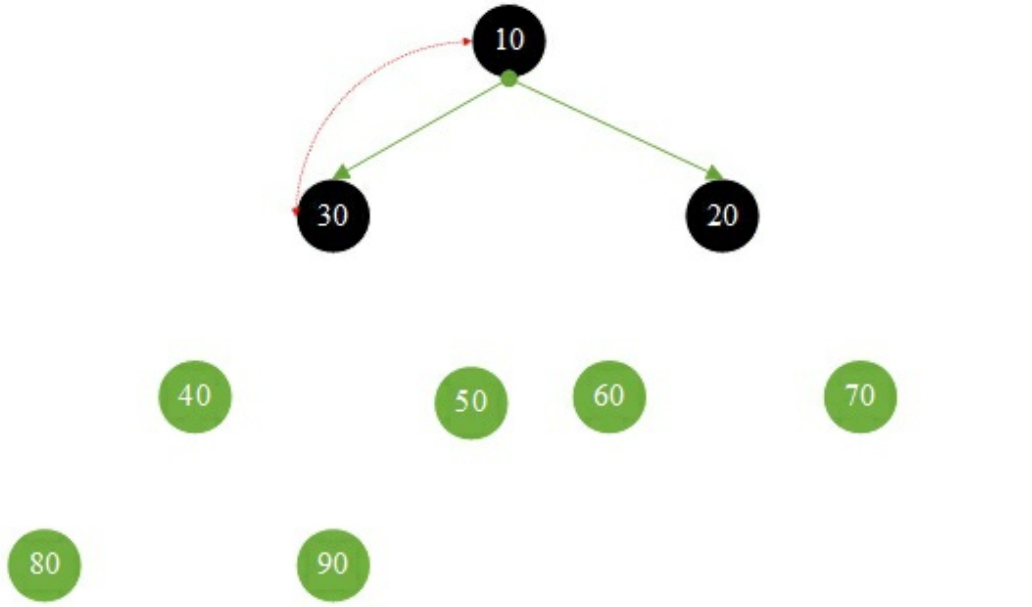
80 90

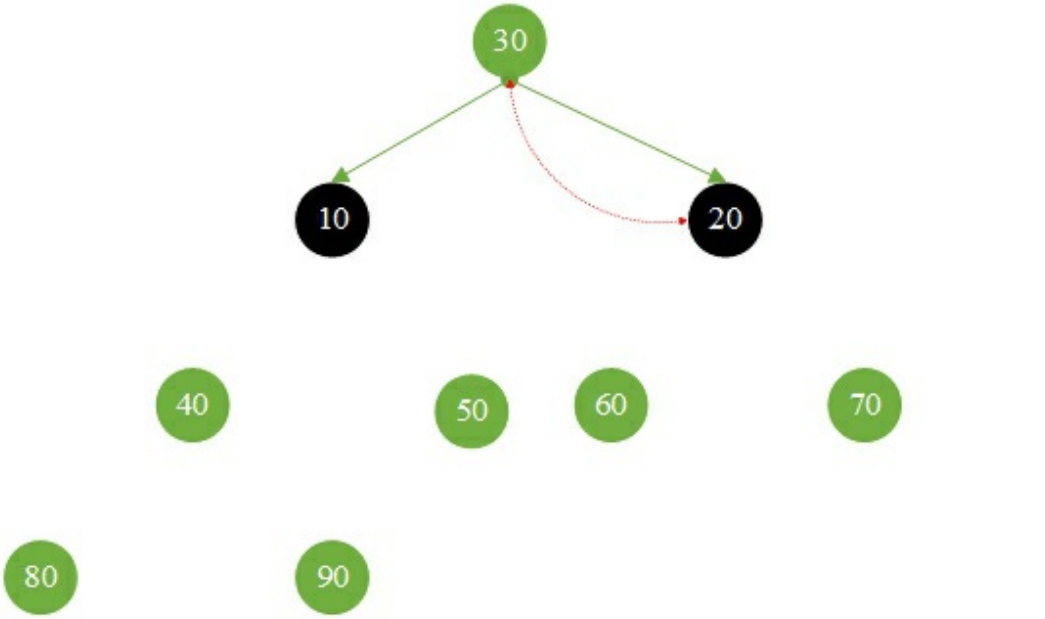
adjust the heap



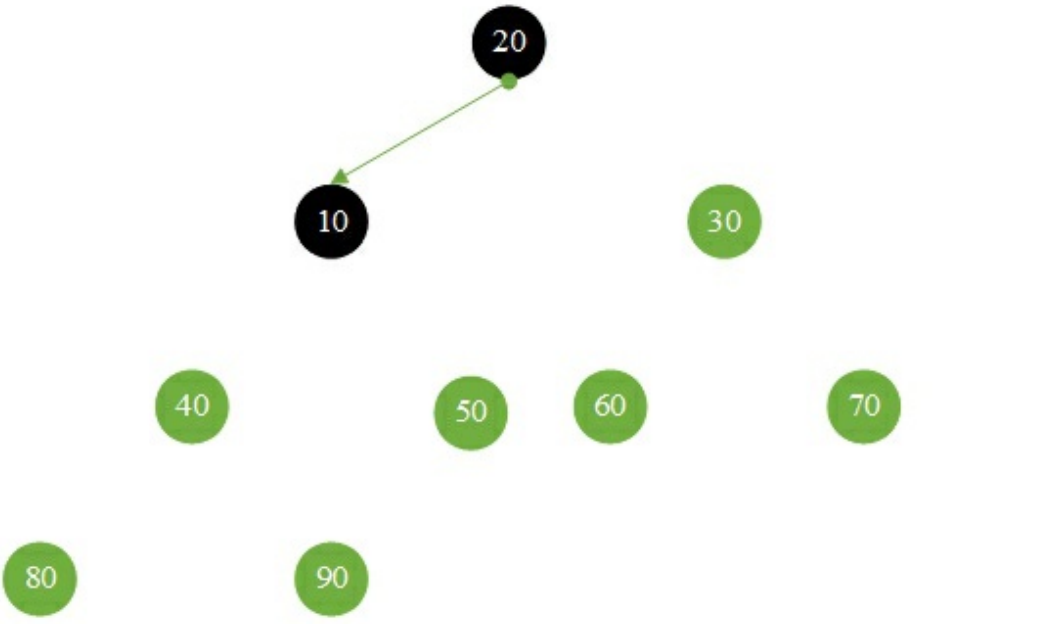

40
30
20
10
50
60
70
80
90
root = 40 and tail = 10 are exchanged
10
30
20
40
50
60
70
80
90

adjust the heap

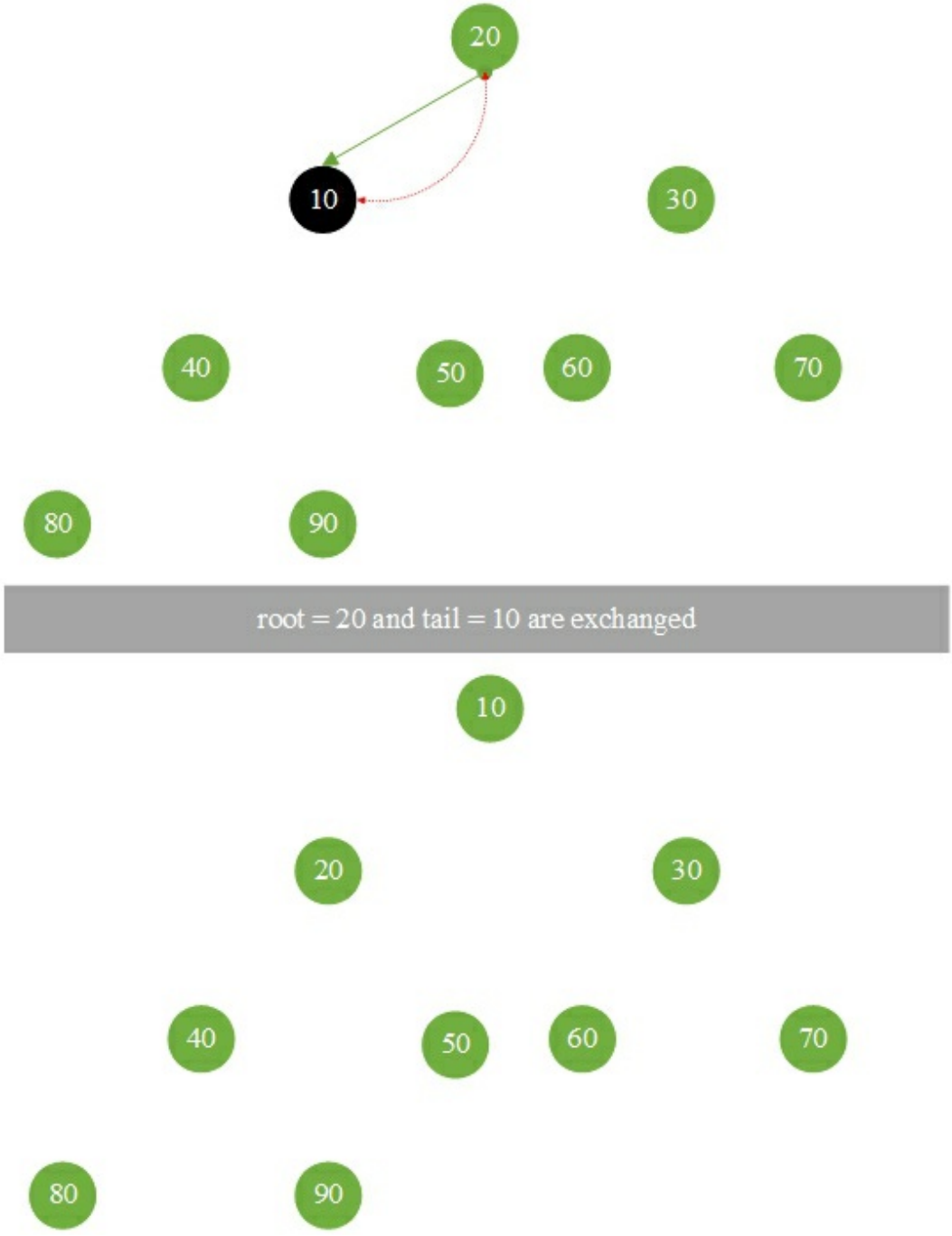




root = 30 and tail = 20 are exchanged



no need adjust the heap


20
10
30
40
50
60
70
80
90
root = 20 and tail = 10 are exchanged
10
20
30
40
50
60
70
80
90

Heap sort result

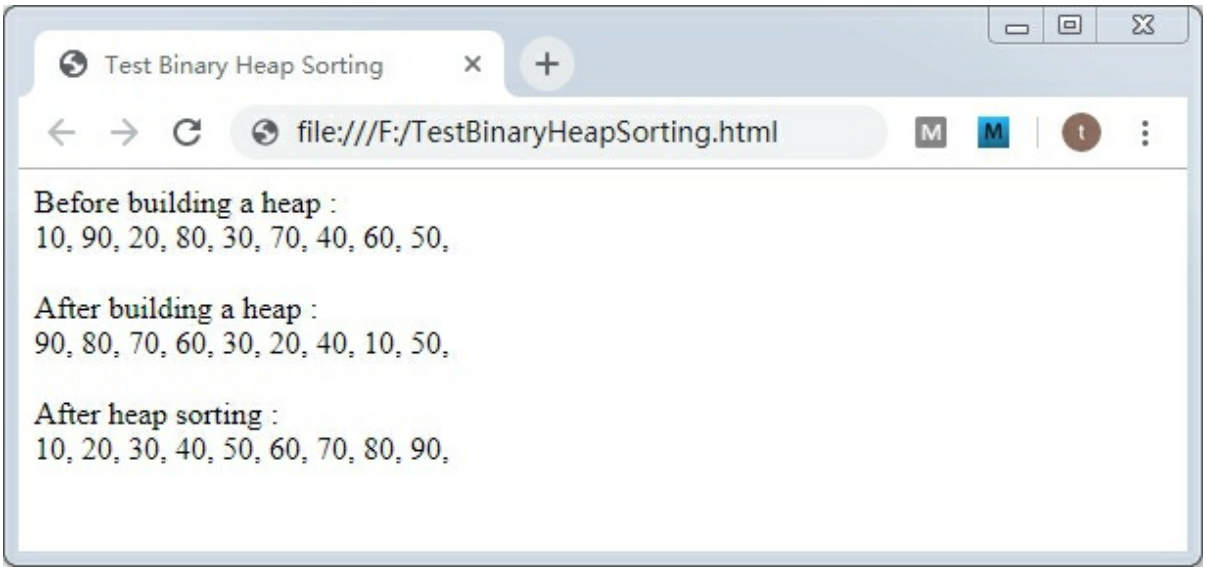
Create a TestBinaryHeapSorting.html with Notepad

```
<script type="text/javascript">
    class HeapSort {
        constructor(){
            this.array = [];
        }

        //Initialize the heap
        createHeap(array) {
            this.array = array;
            // Build a heap, (array.length - 1) / 2 scan half of the nodes with
child nodes
            for (var i = (array.length - 1) / 2; i >= 0; i--) {
                this.adjustHeap(i, array.length - 1);
            }
        }

        //Adjustment heap
        adjustHeap(currentIndex, maxLength) {
            var noLeafValue = this.array[currentIndex]; // Current non-leaf
node

            //2 * currentIndex + 1  Current left subtree subscript
            for (var j = 2 * currentIndex + 1; j <= maxLength; j =
currentIndex * 2 + 1) {
                if (j < maxLength && this.array[j] < this.array[j + 1]) {
                    j++; // j Large subscript
                }
                if (noLeafValue >= this.array[j]) {
                    break;
                }
                this.array[currentIndex] = this.array[j]; // Move up to the
```

```
parent node
                currentIndex = j;
            }

            this.array[currentIndex] = noLeafValue; // To put in the position
        }


        heapSort() {
            for (var i = this.array.length - 1; i > 0; i--) {
                var temp = this.array[0];
                this.array[0] = this.array[i];
                this.array[i] = temp;
                this.adjustHeap(0, i - 1);
            }
        }
    }

    //////////////////////testing//////////////////

    var heapSort = new HeapSort();

    var scores = [ 10, 90, 20, 80, 30, 70, 40, 60, 50 ];

    document.write("Before building a heap : <br>");
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ", ");
    }
    document.write("<br><br>");

    ////////////////////////////////////////////////////////

    document.write("After building a heap : <br>");
    heapSort.createHeap(scores);
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ", ");
    }
    document.write("<br><br>");

    ////////////////////////////////////////////////////////
```

```
    document.write("After heap sorting : <br>");
    heapSort.heapSort();
    for (var i = 0; i < scores.length; i++) {
        document.write(scores[i] + ", ");
    }
</script>
```

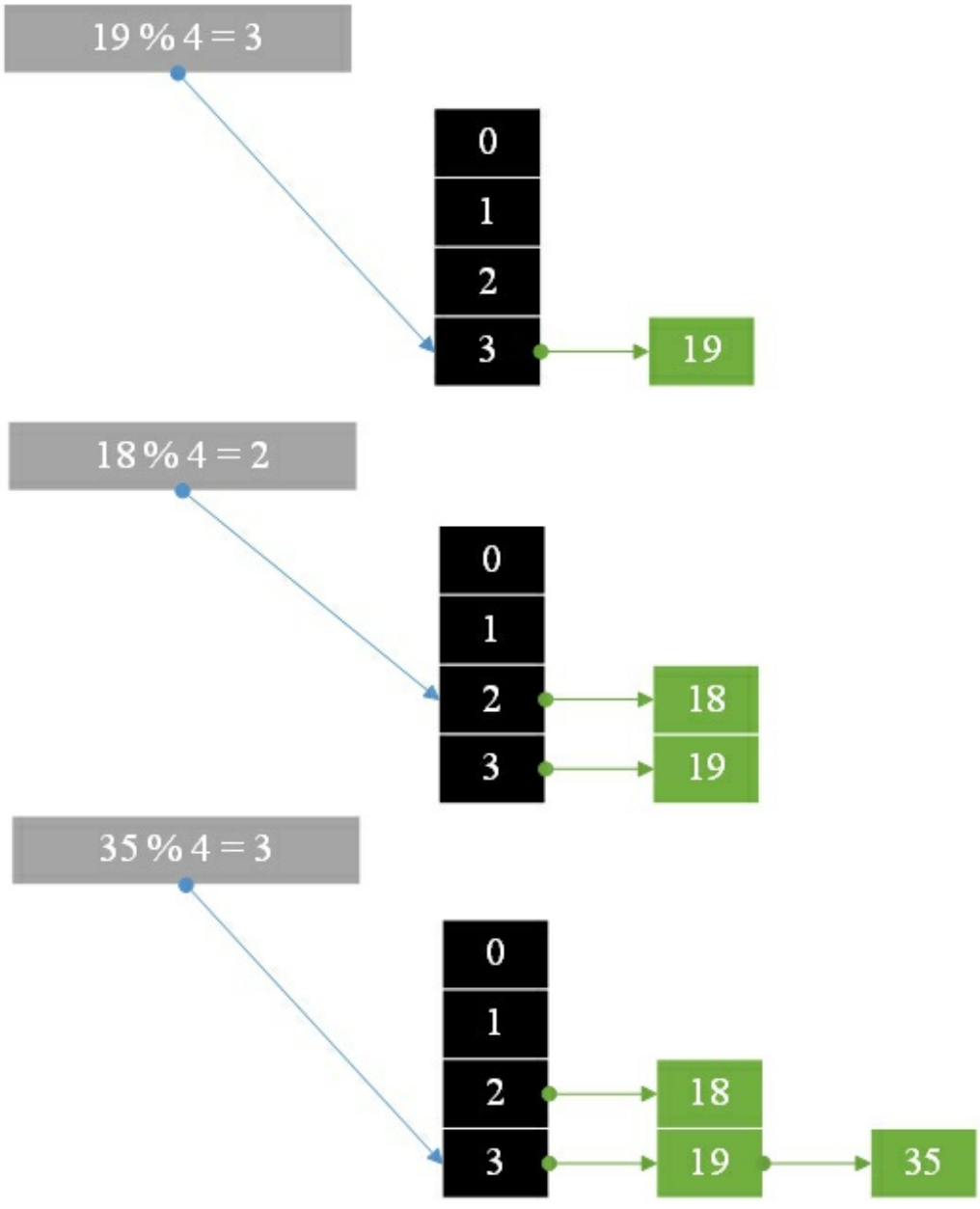
Result:

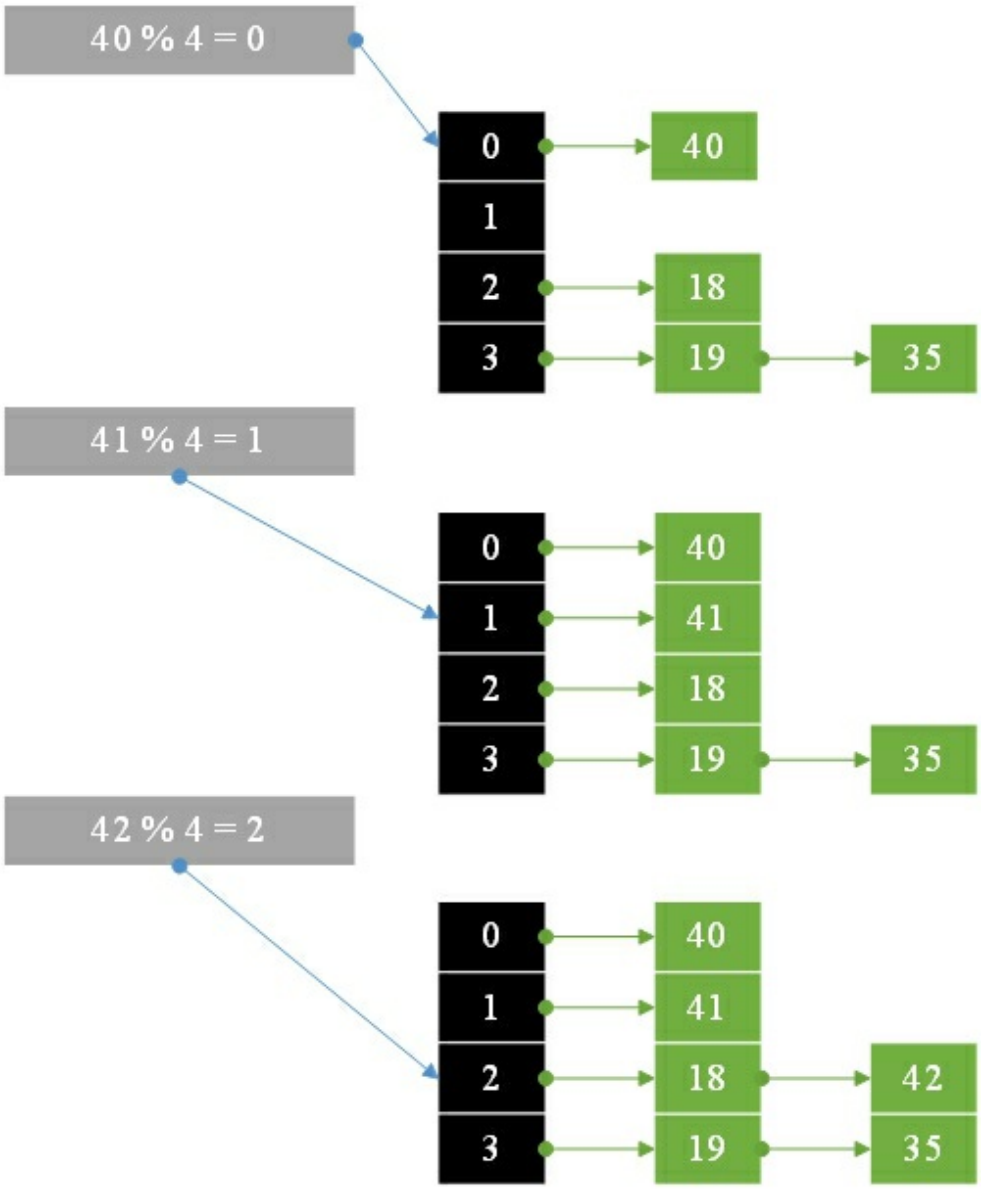

Test Binary Heap Sorting
file:///F:/TestBinaryHeapSorting.html
Before building a heap :
10, 90, 20, 80, 30, 70, 40, 60, 50,
After building a heap :
90, 80, 70, 60, 30, 20, 40, 10, 50,
After heap sorting :
10, 20, 30, 40, 50, 60, 70, 80, 90,

Hash Table

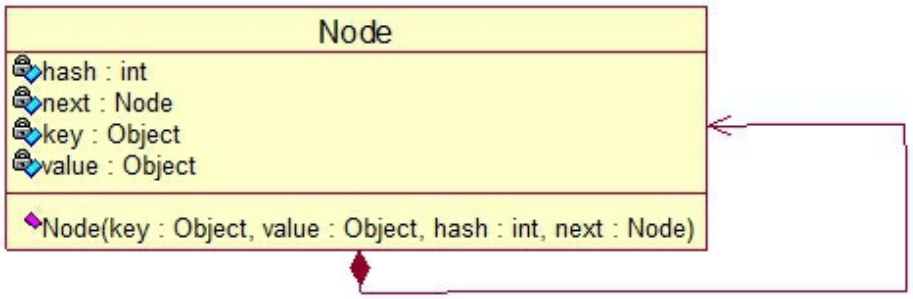
Hash Table:
Access by mapping key => values in the table.

1. Map {19, 18, 35,40,41,42} to the HashTable mapping rule key % 4




40 % 4 = 0
0
1
2
3
40
18
19
35
41 % 4 = 1
0
1
2
3
40
41
18
19
35
42 % 4 = 2
0
1
2
3
40
41
18
19
42
35

2. Implement a Hashtable



Create a TestHashtable.html with Notepad

```
<script type="text/javascript">
    class Node {
        constructor(key, value, hash, next){
            this.key = key;
            this.value = value;
            this.hash = hash;
            this.next = next;
        }

        getKey() {
            return this.key;
        }
        setKey(key) {
            this.key = key;
        }

        getValue() {
            return this.value;
        }
        setValue(value) {
            this.value = value;
        }

        getHash() {
            return this.hash;
        }
        setHash(hash) {
            this.hash = hash;
```

```
        }
    }

    class Hashtable {
        constructor(){
            this.capacity = 16;
            this.table = new Array(this.capacity);
            this.size = 0;
        }

        size() {
            return this.size;
        }

        isEmpty() {
            return this.size == 0 ? true : false;
        }

        hash(key) {
            var hash = 0;
            for (var i = 0; i < key.length; i++) {
                hash += key.charCodeAt(i);
            }
            return hash % 37;
        }

        //Calculate the hash value according to the key hash algorithm
        hashCode(key) {
            var avg = this.hash(key) * (Math.pow(5, 0.5) - 1) / 2 //hash
policy for middle-square method
            var numeric = avg - Math.floor(avg)
            return parseInt(Math.floor(numeric * this.table.length))
        }
```

```
    put(key, value) {
        if (key == null) {
            throw new IllegalArgumentException();
        }

        var hash = this.hashCode(key);
        var newNode = new Node(key, value, hash, null);
        var node = table[hash];
        while (node != null) {
            if (node.getKey().equals(key)) {
                node.setValue(value);
                return;
            }
            node = node.next;
        }
        newNode.next = this.table[hash];
        this.table[hash] = newNode;
        this.size++;
    }

    get(key) {
        if (key == null) {
            return null;
        }

        var hash = this.hashCode(key);
        var node = this.table[hash];
        while (node != null) {//Get value according to key
            if (node.getKey() == key) {
                return node.getValue();
            }
            node = node.next;
        }
        return null;
    }

}
```

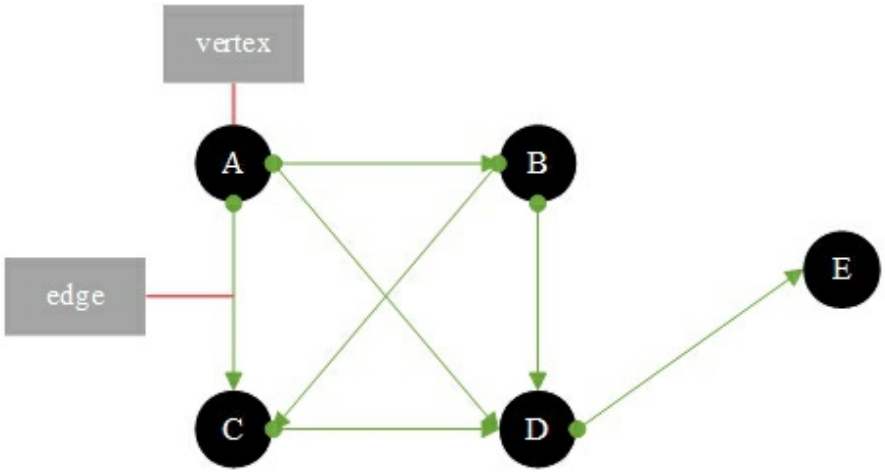
```
    //////////////////////testing//////////////////////

    var table = new Hashtable();

    table.put("david", "Good Boy Keep Going");
    table.put("grace", "Cute Girl Keep Going");

    document.write("david => " + table.get("david") + "<br>");
    document.write("grace => " + table.get("grace") + "<br>");

</script>
```

Result:

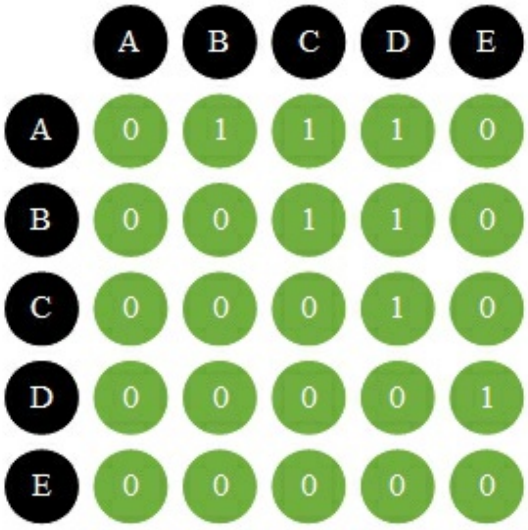
Directed Graph and Depth-First Search

Directed Graph:
The data structure is represented by an adjacency matrix (that is, a two-dimensional array) and an adjacency list. Each node is called a vertex, and two adjacent nodes are called edges.

Directed Graph has direction : A -> B and B -> A are different

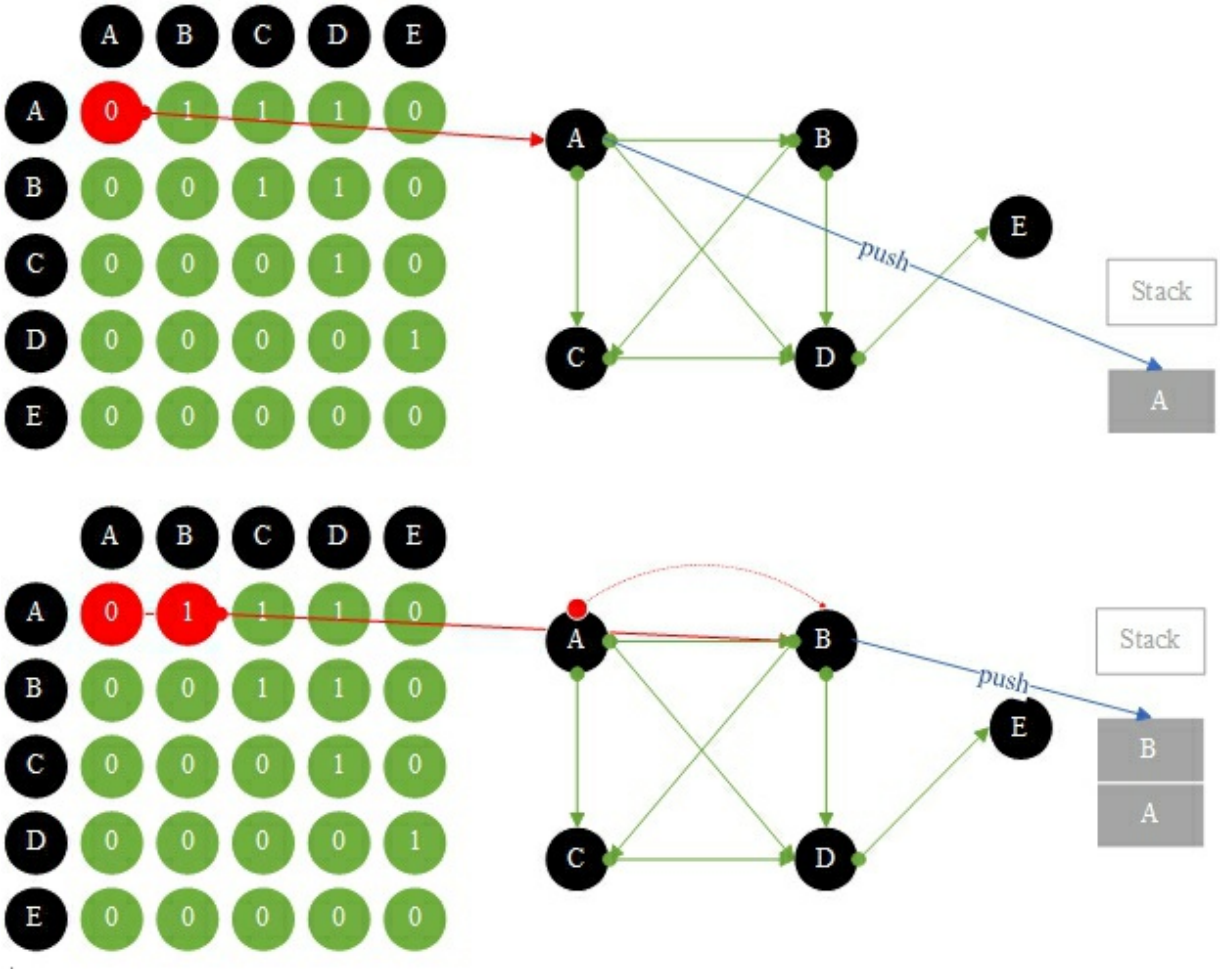


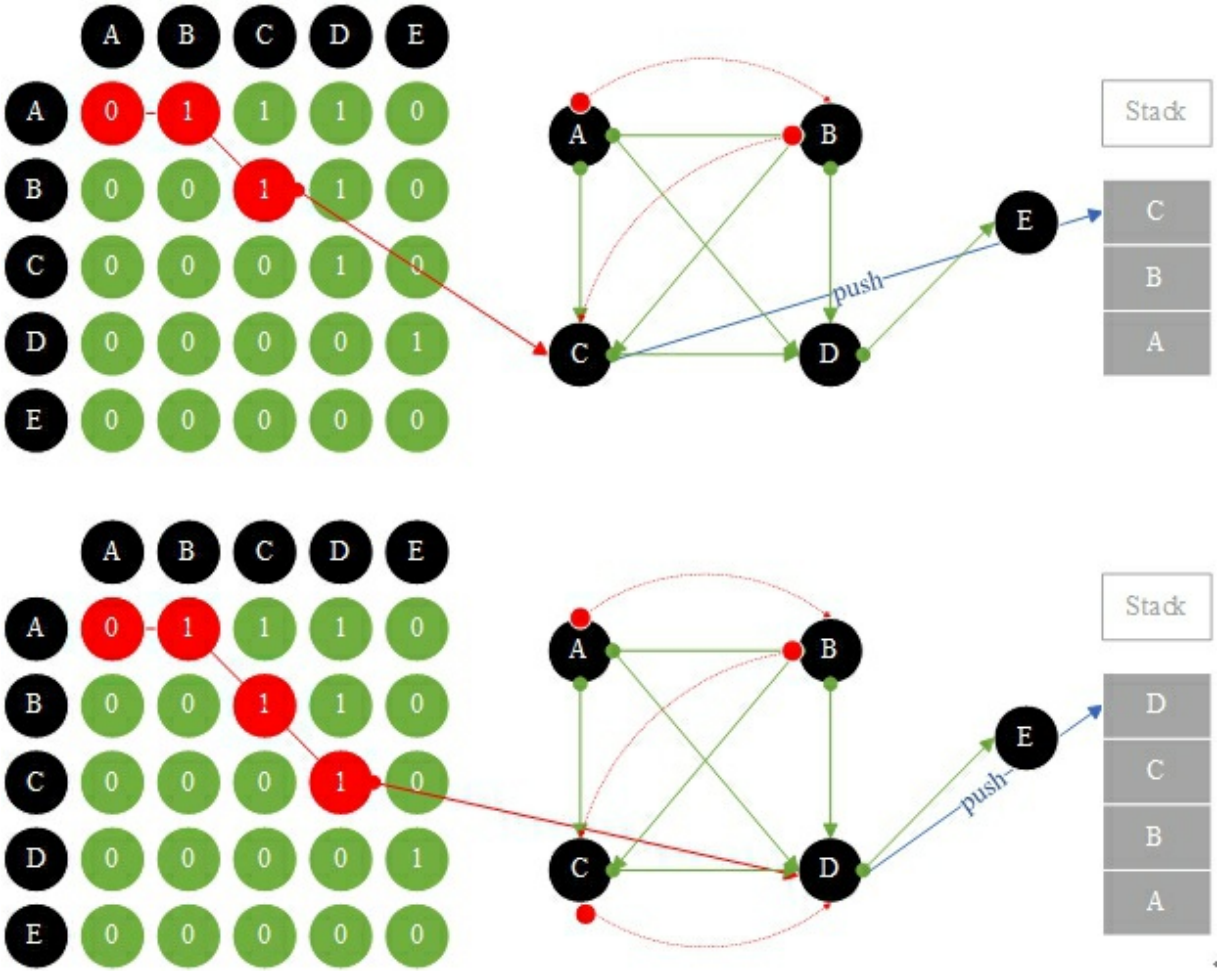
1. The adjacency matrix is described above:
The total number of vertices is a two-dimensional array size, if have value of the edge is 1, otherwise no value of the edge is 0.

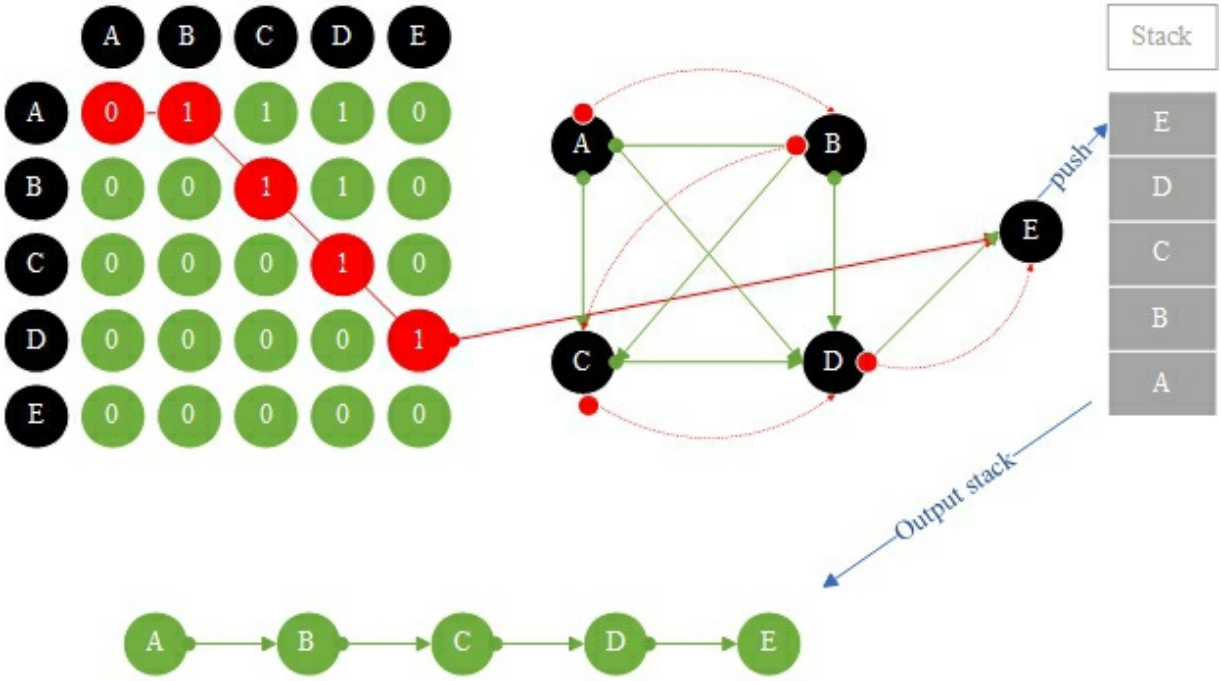


2. Depth-First Search:

Look for the neighboring edge node B from A and then find the neighboring node C from B and so on until all nodes are found A -> B -> C -> D -> E.




A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
A
B
C
D
E
push
Stack
C
B
A
A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
A
B
C
D
E
push
Stack
D
C
B
A


A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
A
B
C
D
E
Stack
E
D
C
B
A
push
Output stack
A → B → C → D → E

Create a TestDirectedGraphDepthFrstSearch.html with Notepad

```
<script type="text/javascript">
    class Vertex {
        constructor(data, visited){
            this.data = data;
            this.visited = visited; // Have you visited
        }

        getData() {
            return this.data;
        }
        setData(data) {
            this.data = data;
        }

        isVisited() {
            return this.visited;
        }
        setVisited(visited) {
            this.visited = visited;
        }
    }
```

```
class Stack {
    constructor(){
        this.stacks = new Array();
        this.top = -1;
    }

    push(element) {
        this.top++;
        this.stacks[this.top] = element;
    }

    pop() {
        if(this.top == -1){
            return -1;
        }

        var data = this.stacks[this.top];
        this.top--;
        return data;
    }

    peek() {
        if(this.top == -1){
            return -1;
        }

        var data = this.stacks[this.top];
        return data;
    }

    isEmpty() {
        if(this.top <= -1){
            return true;
        }
        return false;
    }
}
```

```
    class Graph {
        constructor(maxVertexSize){
            this.maxVertexSize = maxVertexSize;// Two-dimensional array
size
            this.vertexs = new Array(maxVertexSize);
            this.size = 0; // Current vertex size
            this.adjacencyMatrix = new Array(maxVertexSize);
            for (var i = 0; i < maxVertexSize; i++) {
                this.adjacencyMatrix[i] = new Array();
                for (var j = 0; j < maxVertexSize; j++) {
                    this.adjacencyMatrix[i][j] = 0;
                }
            }
            this.stack = new Stack();// Stack saves current vertices
        }

        addVertex(data) {
            var vertex = new Vertex(data, false);
            this.vertexs[this.size++] = vertex;
        }

        addEdge(from, to) {
            this.adjacencyMatrix[from][to] = 1; // A -> B  and B -> A are
different
        }

        depthFirstSearch() {
            var firstVertex = this.vertexs[0]; // Start searching from the first
vertex
            firstVertex.setVisited(true);
            document.write(firstVertex.getData());
            this.stack.push(0);
            while (!this.stack.isEmpty()) {
                var row = this.stack.peek();
                // Get adjacent vertex positions that have not been visited
                var col = this.findAdjacencyUnVisitedVertex(row);
                if (col == -1) {
                    this.stack.pop();
```

```
                } else {
                    this.vertexs[col].setVisited(true);
                    document.write(" -> " + this.vertexs[col].getData());
                    this.stack.push(col);
                }
            }
            this.clear();
        }

        // Get adjacent vertex positions that have not been visited
        findAdjacencyUnVisitedVertex(row) {
            for (var col = 0; col < this.size; col++) {
                if (this.adjacencyMatrix[row][col] == 1 &&
!this.vertexs[col].isVisited()) {
                    return col;
                }
            }
            return -1;
        }

        clear() {
            for (var i = 0; i < this.size; i++) {
                this.vertexs[i].setVisited(false);
            }
        }

        getAdjacencyMatrix() {
            return this.adjacencyMatrix;
        }

        getVertexs() {
            return this.vertexs;
        }
    }

    function printGraph(graph) {
        document.write("Two-dimensional array traversal output vertex
edge and adjacent array :  <br>");
        document.write("   ");
```

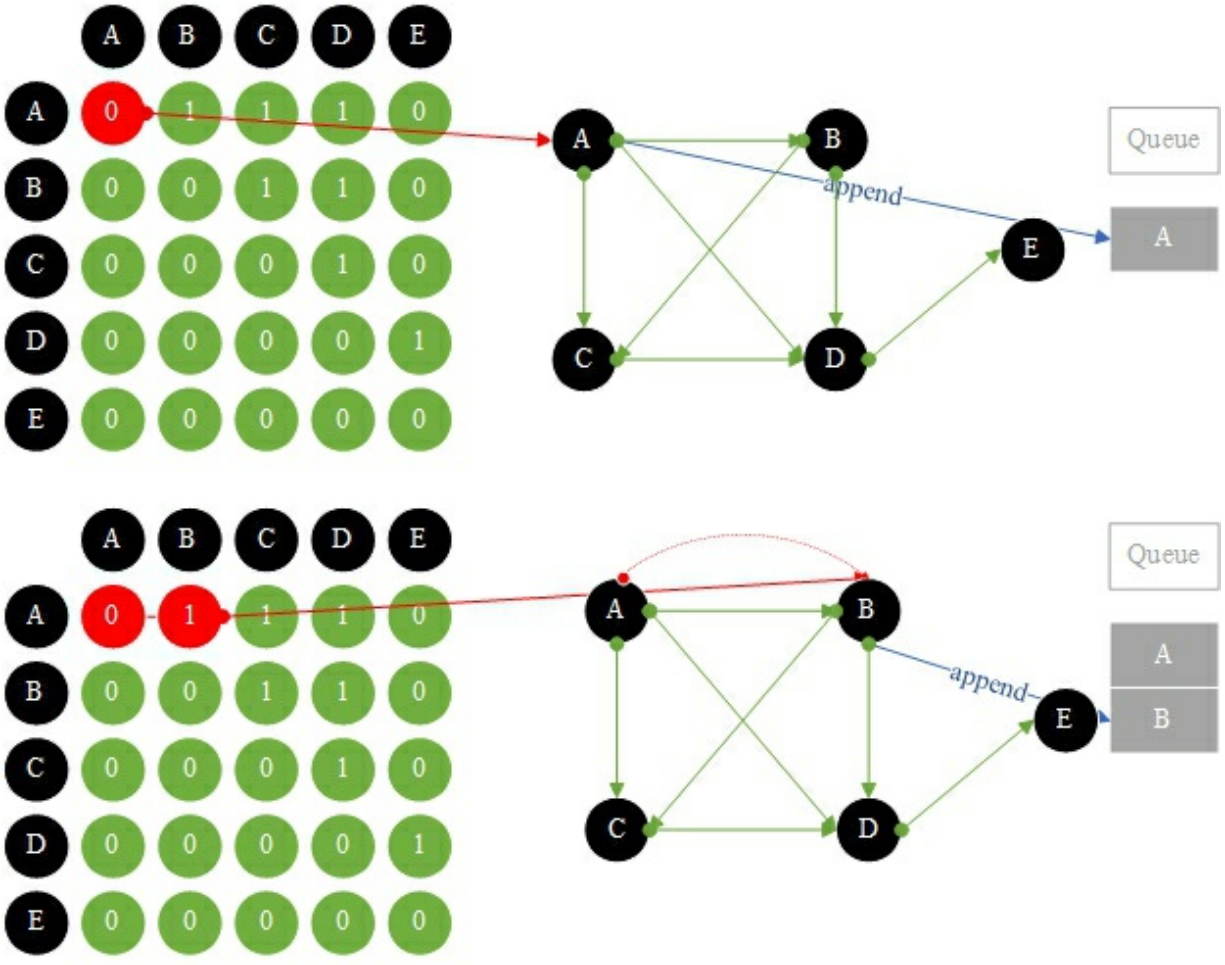
```
        for (var i = 0; i < graph.getVertexs().length; i++) {
            document.write(graph.getVertexs()[i].getData() +
"    ");
        }
        document.write("<br>");

        for (var i = 0; i < graph.getAdjacencyMatrix().length; i++) {
            document.write(graph.getVertexs()[i].getData() + "  ");
            for (var j = 0; j < graph.getAdjacencyMatrix().length; j++) {
                document.write(graph.getAdjacencyMatrix()[i][j] +
"    ");
            }
            document.write("<br>");
        }
    }

    var graph = new Graph(5);
    graph.addVertex("A");
    graph.addVertex("B");
    graph.addVertex("C");
    graph.addVertex("D");
    graph.addVertex("E");

    graph.addEdge(0, 1);
    graph.addEdge(0, 2);
    graph.addEdge(0, 3);
    graph.addEdge(1, 2);
    graph.addEdge(1, 3);
    graph.addEdge(2, 3);
    graph.addEdge(3, 4);

    // Two-dimensional array traversal output vertex edge and adjacent
array
    printGraph(graph);
    document.write("<br>Depth-first search traversal output : <br>");
    graph.depthFirstSearch();
</script>
```

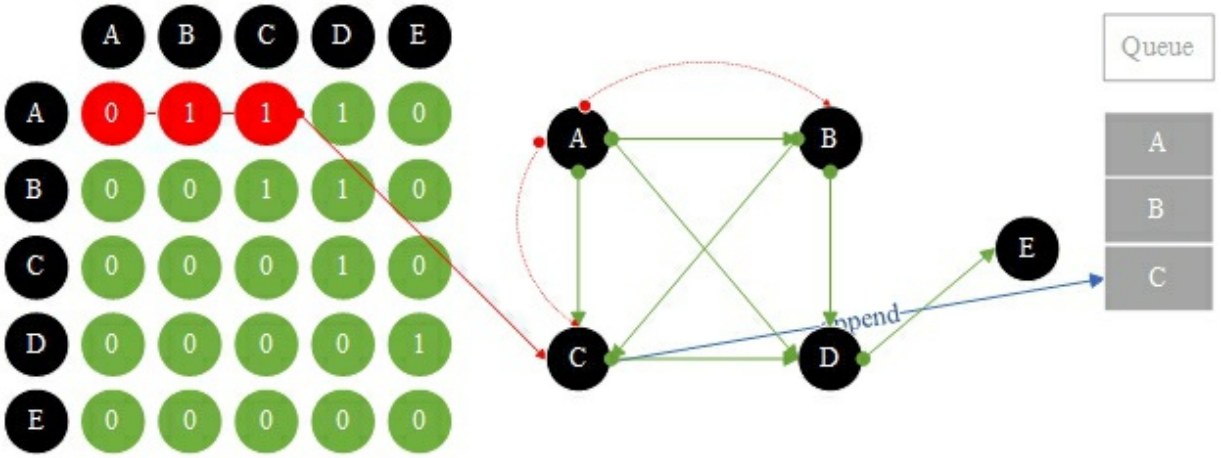
Result:

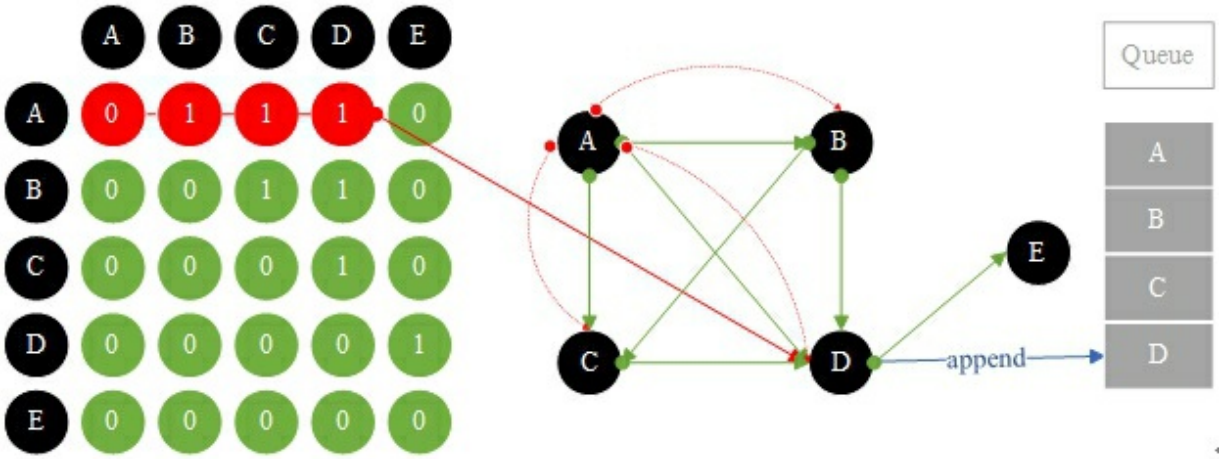

TestDirectedGraphDepthFrstS
file:///F:/TestDirectedGraphDepthFrst...
Two-dimensional array traversal output vertex edge and adjacent array :
A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
Depth-first search traversal output :
A -> B -> C -> D -> E

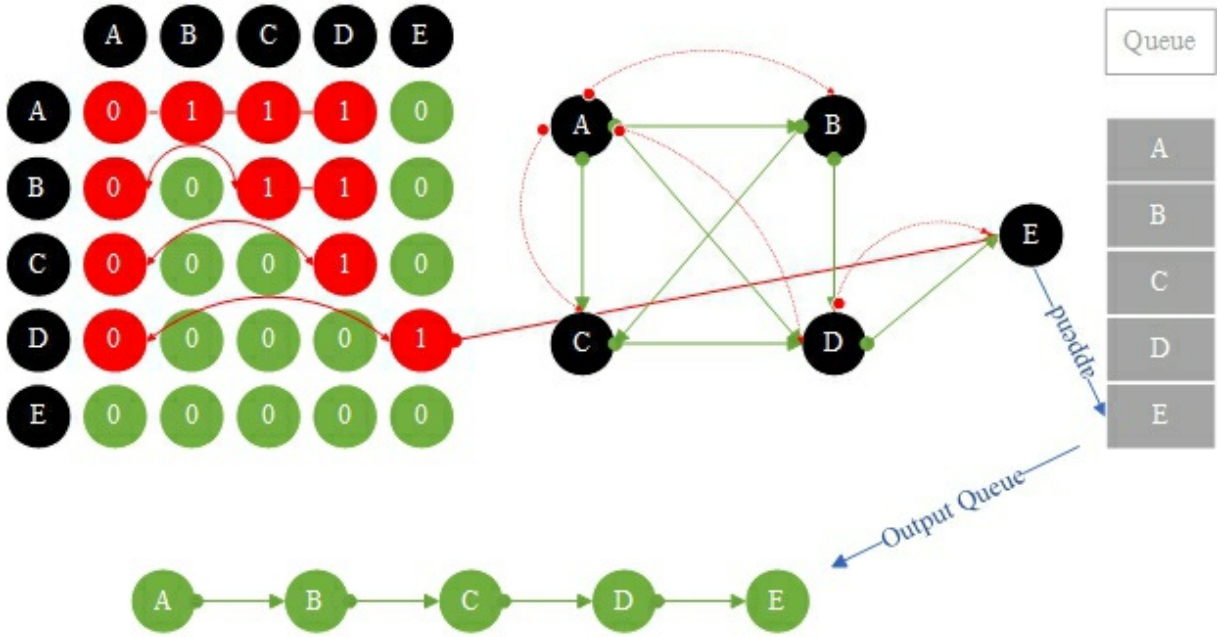
Directed Graph and Breadth-First Search

Breadth-First Search:
Find all neighboring edge nodes B, C, D from A and then find all neighboring nodes A, C, D from B and so on until all nodes are found A -> B -> C -> D -> E.




A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
A
B
C
D
E
Queue
A
B
C
append


A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
A
B
C
D
E
Queue
A
B
C
D
append


A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
A
B
C
D
E
Queue
A
B
C
D
E
append
Output Queue
A
B
C
D
E

Create a TestDirectedGraphBreadthFrstSearch.html with Notepad

```
<script type="text/javascript">
    class Vertex {
        constructor(data, visited){
            this.data = data;
            this.visited = visited; // Have you visited
        }

        getData() {
            return this.data;
        }
        setData(data) {
            this.data = data;
        }

        isVisited() {
            return this.visited;
        }
        setVisited(visited) {
            this.visited = visited;
        }
    }
```

```
class Queue {
    constructor(){
        this.queues = new Array();
    }

    add(element) {
        this.queues[this.queues.length] = element;
    }

    remove() {
        if(this.queues.length <= 0){
            return -1;
        }
        return this.queues.shift();
    }

    isEmpty() {
        if(this.queues.length <= 0){
            return true;
        }
        return false;
    }
}
```

```
class Graph {
```

```
    constructor(maxVertexSize){
        this.maxVertexSize = maxVertexSize;// Two-dimensional array
size
        this.vertexs = new Array(maxVertexSize);
        this.size = 0; // Current vertex size
        this.adjacencyMatrix = new Array(maxVertexSize);
        for (var i = 0; i < maxVertexSize; i++) {
            this.adjacencyMatrix[i] = new Array();
            for (var j = 0; j < maxVertexSize; j++) {
                this.adjacencyMatrix[i][j] = 0;
            }
        }
        this.queue = new Queue();// Queue  saves current vertices
    }

    addVertex(data) {
        var vertex = new Vertex(data, false);
        this.vertexs[this.size] = vertex;
        this.size++;
    }

    // Add adjacent edges
    addEdge(from, to) {
        // A -> B  and B -> A are different
        this.adjacencyMatrix[from][to] = 1;
    }
```

```
        breadthFirstSearch() {
            // Start searching from the first vertex
            var firstVertex = this.vertexs[0];
            firstVertex.setVisited(true);
            document.write(firstVertex.getData());
            this.queue.add(0);

            var col = 0;
            while (!this.queue.isEmpty()) {
                var head = this.queue.remove();
             // Get adjacent vertex positions that have not been visited
                col = this.findAdjacencyUnVisitedVertex(head);

              //Loop through all vertices connected to the current vertex
                while (col != -1)
                {
                    this.vertexs[col].setVisited(true);
                    document.write(" -> " + this.vertexs[col].getData());
                    this.queue.add(col);
                    col = this.findAdjacencyUnVisitedVertex(head);
                }
            }
            this.clear();
        }

        // Get adjacent vertex positions that have not been visited
        findAdjacencyUnVisitedVertex(row) {
            for (var col = 0; col < this.size; col++) {
                if (this.adjacencyMatrix[row][col] == 1 &&
!this.vertexs[col].isVisited()) {
                    return col;
                }
            }
            return -1;
        }

        // Clear reset
        clear() {
```

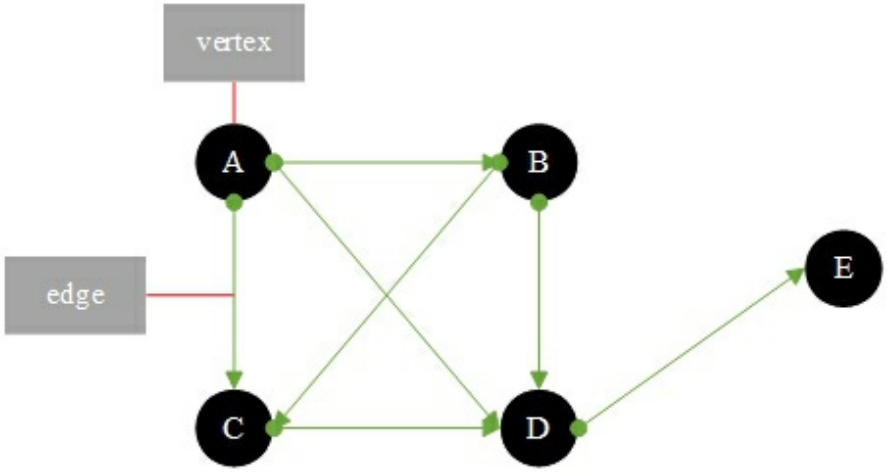
```
            for (var i = 0; i < this.size; i++) {
                this.vertexs[i].setVisited(false);
            }
        }


        getAdjacencyMatrix() {
            return this.adjacencyMatrix;
        }

        getVertexs() {
            return this.vertexs;
        }
    }

    function printGraph(graph) {
        document.write("Two-dimensional array traversal output vertex
edge and adjacent array :  <br>");
        document.write("   ");
        for (var i = 0; i < graph.getVertexs().length; i++) {
            document.write(graph.getVertexs()[i].getData() +
"    ");
        }
        document.write("<br>");

        for (var i = 0; i < graph.getAdjacencyMatrix().length; i++) {
            document.write(graph.getVertexs()[i].getData() + "  ");
            for (var j = 0; j < graph.getAdjacencyMatrix().length; j++) {
                document.write(graph.getAdjacencyMatrix()[i][j] +
"    ");
            }
            document.write("<br>");
        }
    }

    var graph = new Graph(5);
    graph.addVertex("A");
    graph.addVertex("B");
```

```
    graph.addVertex("C");
    graph.addVertex("D");
    graph.addVertex("E");

    graph.addEdge(0, 1);
    graph.addEdge(0, 2);
    graph.addEdge(0, 3);
    graph.addEdge(1, 2);
    graph.addEdge(1, 3);
    graph.addEdge(2, 3);
    graph.addEdge(3, 4);


    // Two-dimensional array traversal output vertex edge and adjacent array
    printGraph(graph);

    document.write("\nBreadth-First Search traversal output : <br>");
    graph.breadthFirstSearch();

</script>
```

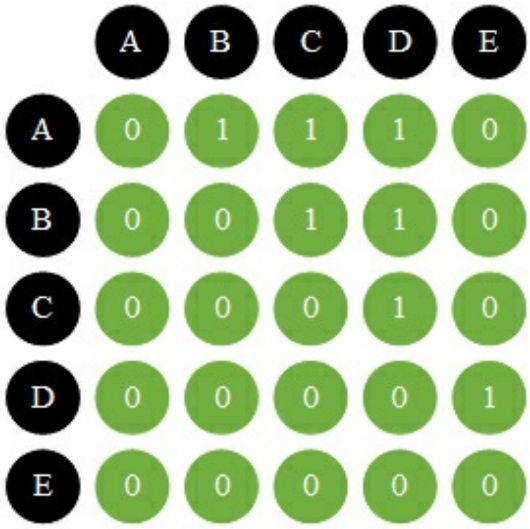
Result:

Directed Graph Topological Sorting

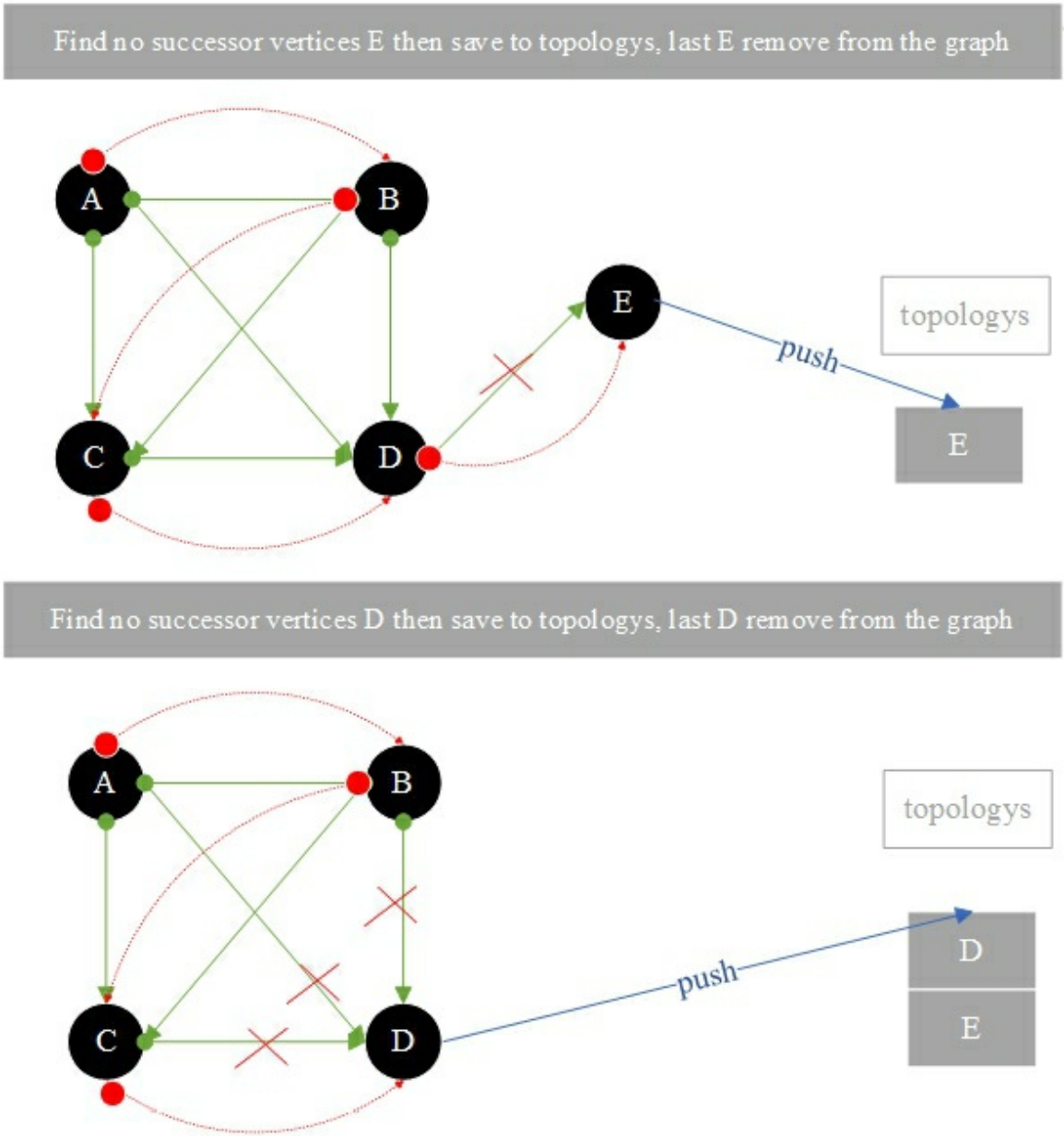
Directed Graph Topological Sorting:
Sort the vertices in the directed graph with order of direction
.
Directed Graph has direction : A -> B and B -> A are different



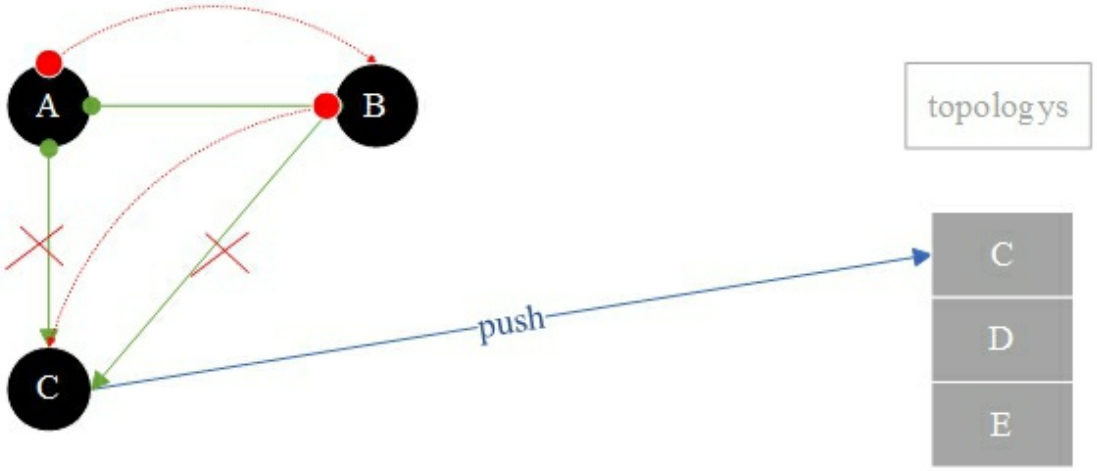
1. The adjacency matrix is described above:
The total number of vertices is a two-dimensional array size, if have value of the edge is 1, otherwise no value of the edge is 0.



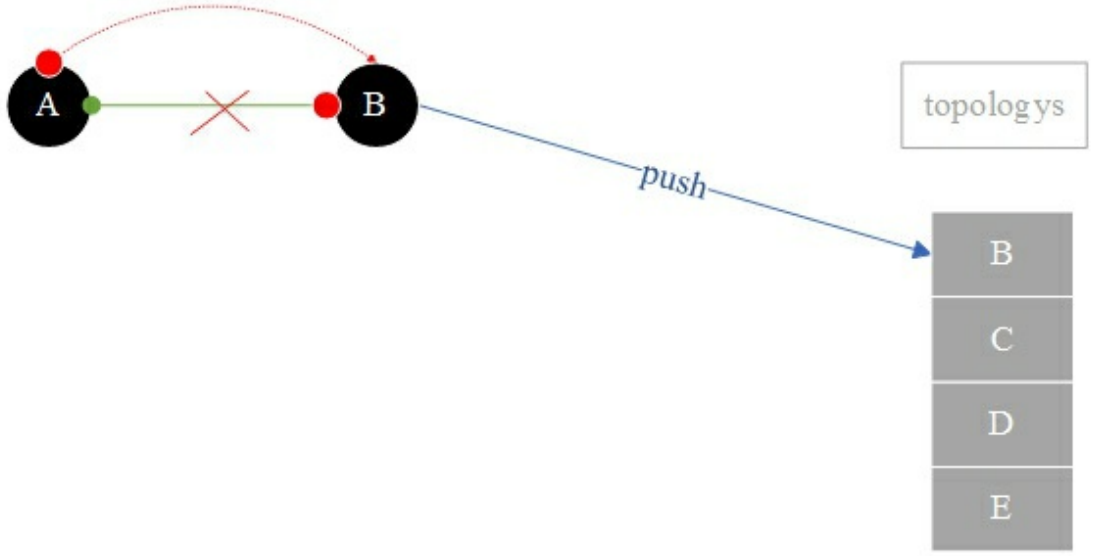
Topological sorting from vertex A : A -> B -> C -> D -> E



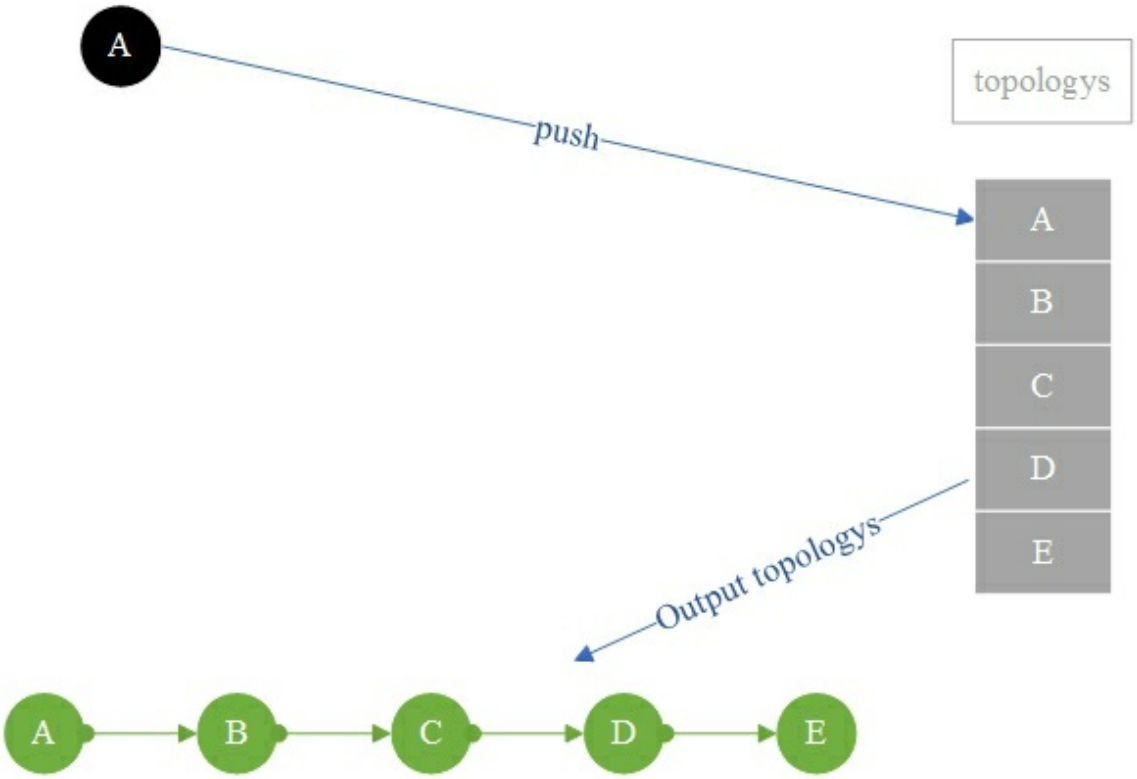
Find no successor vertices C then save to topologys, last C remove from the graph



Find no successor vertices C then save to topologys, last C remove from the graph



Find no successor vertices C then save to topologys, last C remove from the graph



Create a TestTopologicalSorting.html with Notepad

```
<script type="text/javascript">
    class Vertex {
        constructor(data, visited){
            this.data = data;
            this.visited = visited; // Have you visited
        }

        getData() {
            return this.data;
        }
        setData(data) {
            this.data = data;
        }

        isVisited() {
            return this.visited;
        }
        setVisited(visited) {
            this.visited = visited;
        }
    }
```

```
    class Graph {
        constructor(maxVertexSize){
            this.maxVertexSize = maxVertexSize;// Two-dimensional array size
            this.vertexs = new Array(maxVertexSize);
            this.topologys = new Array();
            this.adjacencyMatrix = new Array(maxVertexSize);
            for (var i = 0; i < maxVertexSize; i++) {
                this.adjacencyMatrix[i] = new Array();
                for (var j = 0; j < maxVertexSize; j++) {
                    this.adjacencyMatrix[i][j] = 0;
                }
            }
            this.size = 0;
        }

        addVertex(data) {
            var vertex = new Vertex(data, false);
            this.vertexs[this.size] = vertex;
            this.size++;
        }

        // Add adjacent edges
        addEdge(from, to) {
            // A -> B  and B -> A are different
            this.adjacencyMatrix[from][to] = 1;
        }

        topologySort() {
            while (this.size > 0) {
                var noSuccessorVertex = this.getNoSuccessorVertex();// Get a no successor node
                if (noSuccessorVertex == -1) {
                    document.write("There is ring in Graph ");
                    return;
                }
                // Copy the deleted node to the sorted array
                this.topologys[this.size - 1] =
```

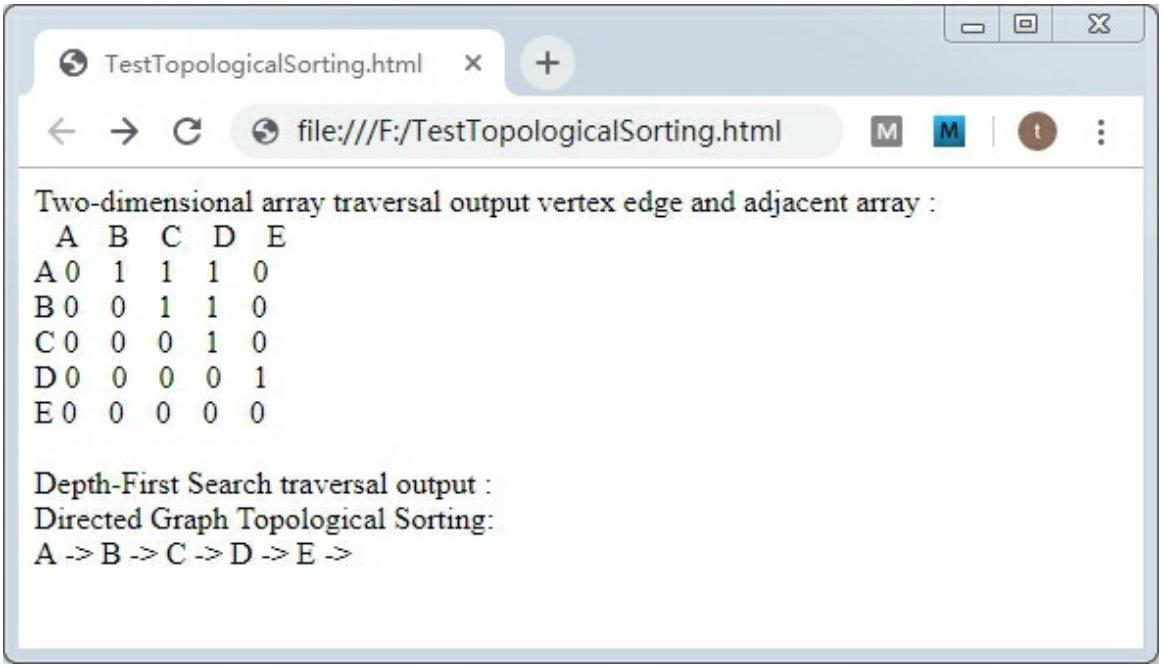
```
this.vertexs[noSuccessorVertex];
                this.removeVertex(noSuccessorVertex);// Delete no successor node
            }
        }



        getNoSuccessorVertex() {
            var existSuccessor = false;
            for (var row = 0; row < this.size; row++) {// For each vertex
                existSuccessor = false;
                //If the node has a fixed row, each column has a 1, indicating that the node has a successor, terminating the loop
                for (var col = 0; col < this.size; col++) {
                    if (this.adjacencyMatrix[row][col] == 1) {
                        existSuccessor = true;
                        break;
                    }
                }

                if (!existSuccessor) {// If the node has no successor, return its subscript
                    return row;
                }
            }
            return -1;
        }

        removeVertex(vertex) {
            if (vertex != this.size - 1) { //If the vertex is the last element, the end
                for (var i = vertex; i < this.size - 1; i++) {// The vertices are removed from the vertex array
                    this.vertexs[i] = this.vertexs[i + 1];
                }

                for (var row = vertex; row < this.size - 1; row++) {// move
```

```
up a row
                    for (var col = 0; col < this.size - 1; col++) {
                        this.adjacencyMatrix[row][col] =
this.adjacencyMatrix[row + 1][col];
                    }
                }

                for (var col = vertex; col < this.size - 1; col++) {// move left
a row
                    for (var row = 0; row < this.size - 1; row++) {
                        this.adjacencyMatrix[row][col] =
this.adjacencyMatrix[row][col + 1];
                    }
                }
            }
            this.size--;// Decrease the number of vertices
        }


        // Clear reset
        clear() {
            for (var i = 0; i < this.size; i++) {
                this.vertexs[i].setVisited(false);
            }
        }

        getAdjacencyMatrix() {
            return this.adjacencyMatrix;
        }

        getVertexs() {
            return this.vertexs;
        }

        getTopologys() {
            return this.topologys;
        }
    }
```

```
    //////////////////////testing//////////////////

    function printGraph(graph) {
        document.write("Two-dimensional array traversal output vertex edge and adjacent array :  <br>");
        document.write("   ");
        for (var i = 0; i < graph.getVertexs().length; i++) {
            document.write(graph.getVertexs()[i].getData() + "    ");
        }
        document.write("<br>");

        for (var i = 0; i < graph.getAdjacencyMatrix().length; i++) {
            document.write(graph.getVertexs()[i].getData() + "  ");
            for (var j = 0; j < graph.getAdjacencyMatrix().length; j++) {
                document.write(graph.getAdjacencyMatrix()[i][j] + "    ");
            }
            document.write("<br>");
        }
    }



    var graph = new Graph(5);

    graph.addVertex("A");
    graph.addVertex("B");
    graph.addVertex("C");
    graph.addVertex("D");
    graph.addVertex("E");

    graph.addEdge(0, 1);
    graph.addEdge(0, 2);
    graph.addEdge(0, 3);
    graph.addEdge(1, 2);
    graph.addEdge(1, 3);
    graph.addEdge(2, 3);
    graph.addEdge(3, 4);
```

```
    printGraph(graph);

    document.write("<br>Depth-First Search traversal output : <br>");
    document.write("Directed Graph Topological Sorting:<br>");

    graph.topologySort();

    for(var i=0;i< graph.getTopologys().length ; i++){
        document.write(graph.getTopologys()[i].getData()+" -> ");
    }

</script>
```

Result:


TestTopologicalSorting.html
file:///F:/TestTopologicalSorting.html
Two-dimensional array traversal output vertex edge and adjacent array :
A B C D E
A 0 1 1 1 0
B 0 0 1 1 0
C 0 0 0 1 0
D 0 0 0 0 1
E 0 0 0 0 0
Depth-First Search traversal output :
Directed Graph Topological Sorting:
A -> B -> C -> D -> E ->

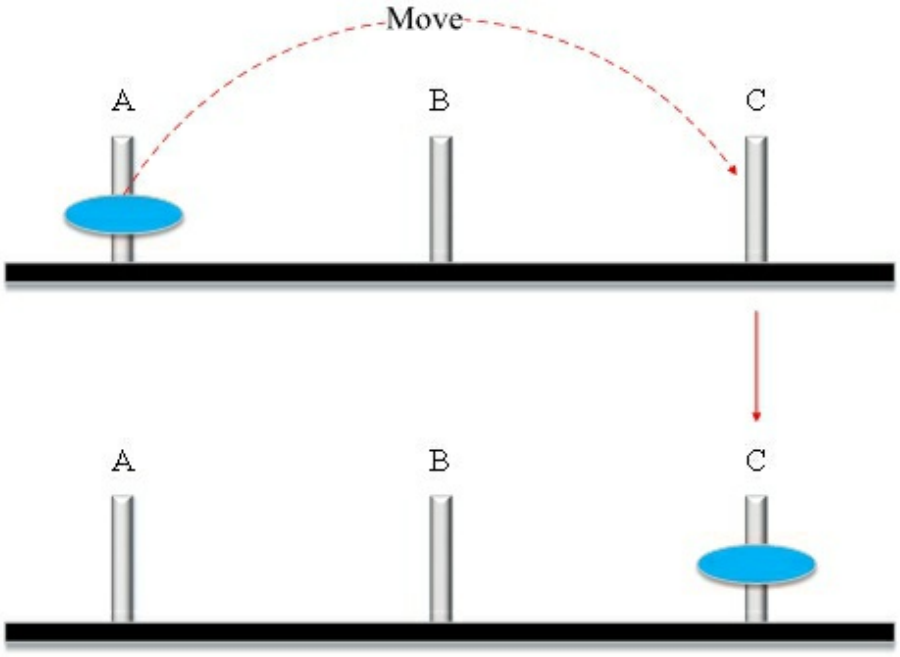
Towers of Hanoi

The Hanoi Tower that a Frenchman M. Claus (Lucas) from Thailand to France in 1883. Hanoi Tower which is supported by three diamond Pillars. At the beginning, God placed 64 gold discs from top to bottom on the first Pillar. God ordered the monks to move all gold discs from the first Pillar to the third Pillar. The principle of large plates under small plates during the handling process. If only one plate is moved daily, the tower will be destroyed. when all the discs are moved that is the end of the world.

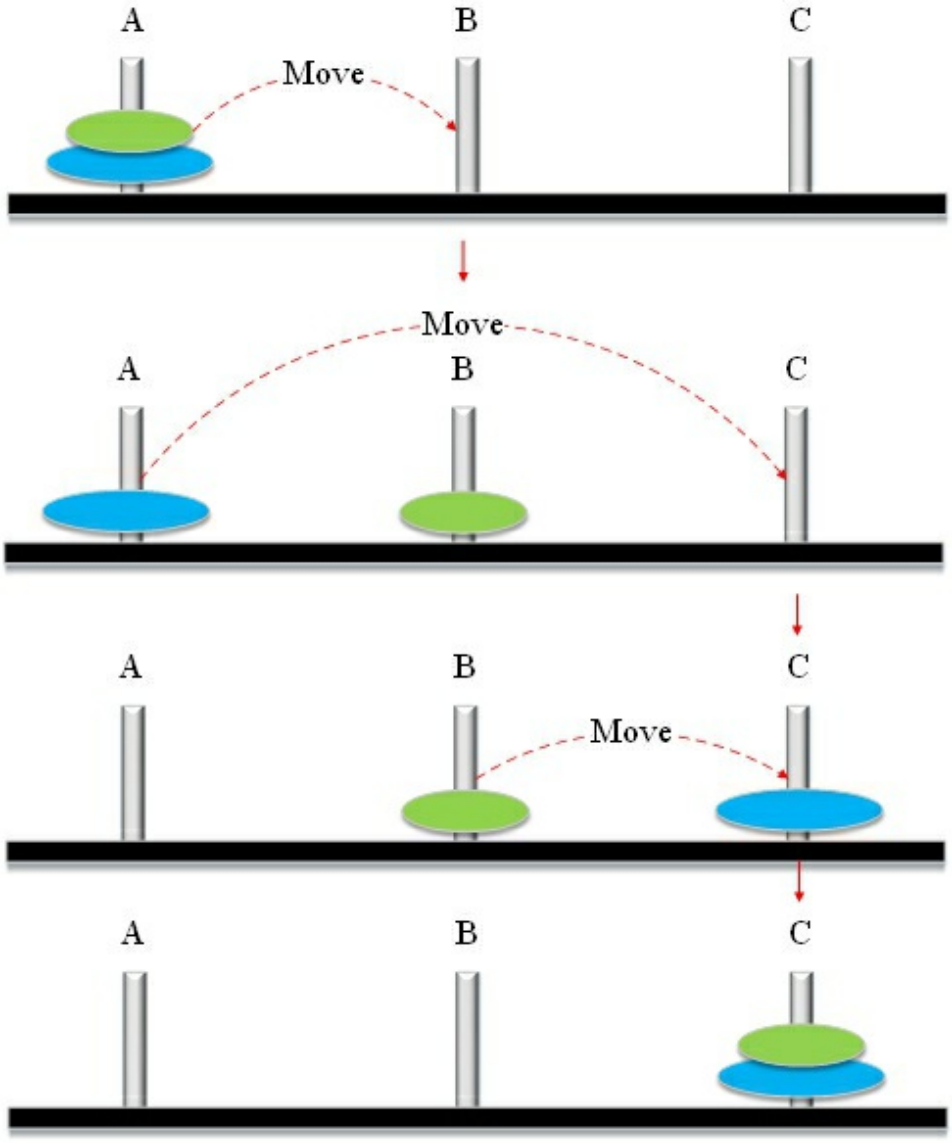
Let's turn this story into an algorithm:

Mark the three columns as ABC.
1. If there is only one disc, move it directly to C (A->C).
2. When there are two discs, use B as an auxiliary (A->B, A->C,B->C).
3. If there are more than two discs, use B as an auxiliary(A->B, A->C,B->C), and continue to recursive process.

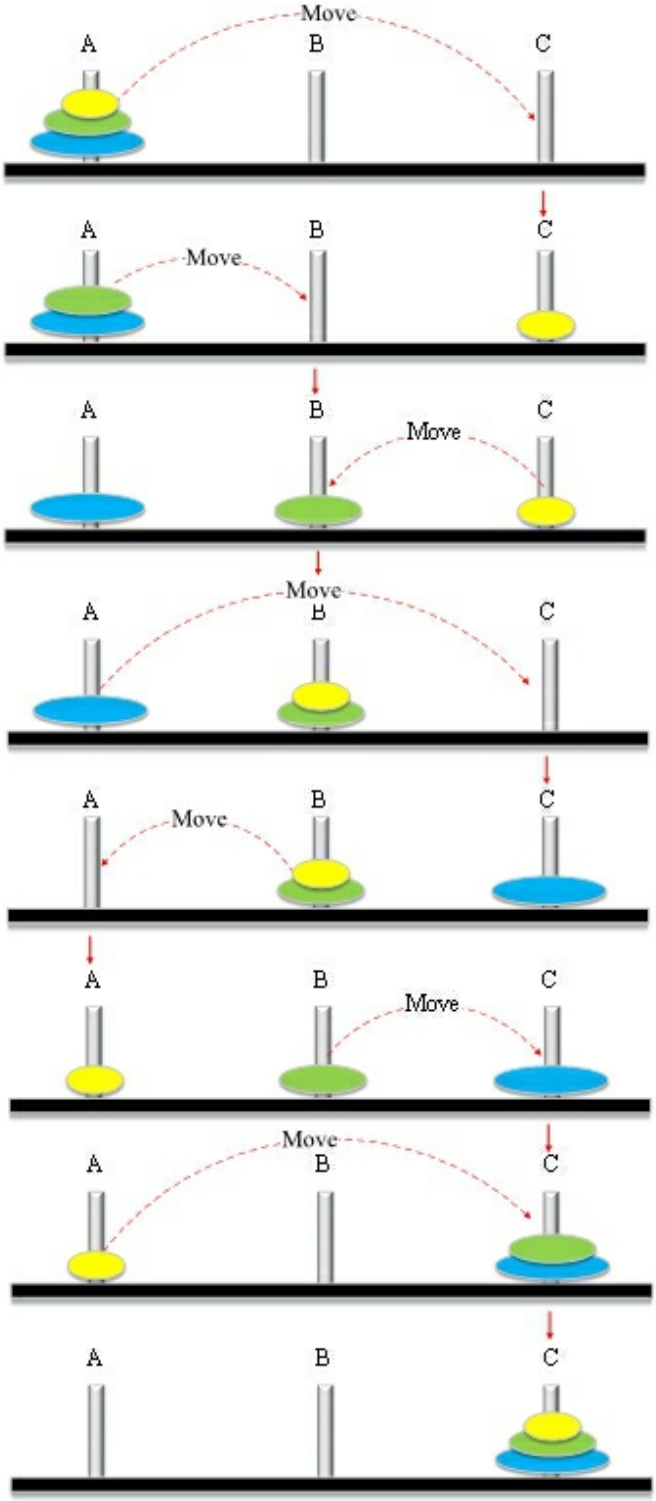
1. If there is only one disc, move it directly to C (A->C).



2. When there are two discs, use B as an auxiliary (A->B, A->C,B->C).



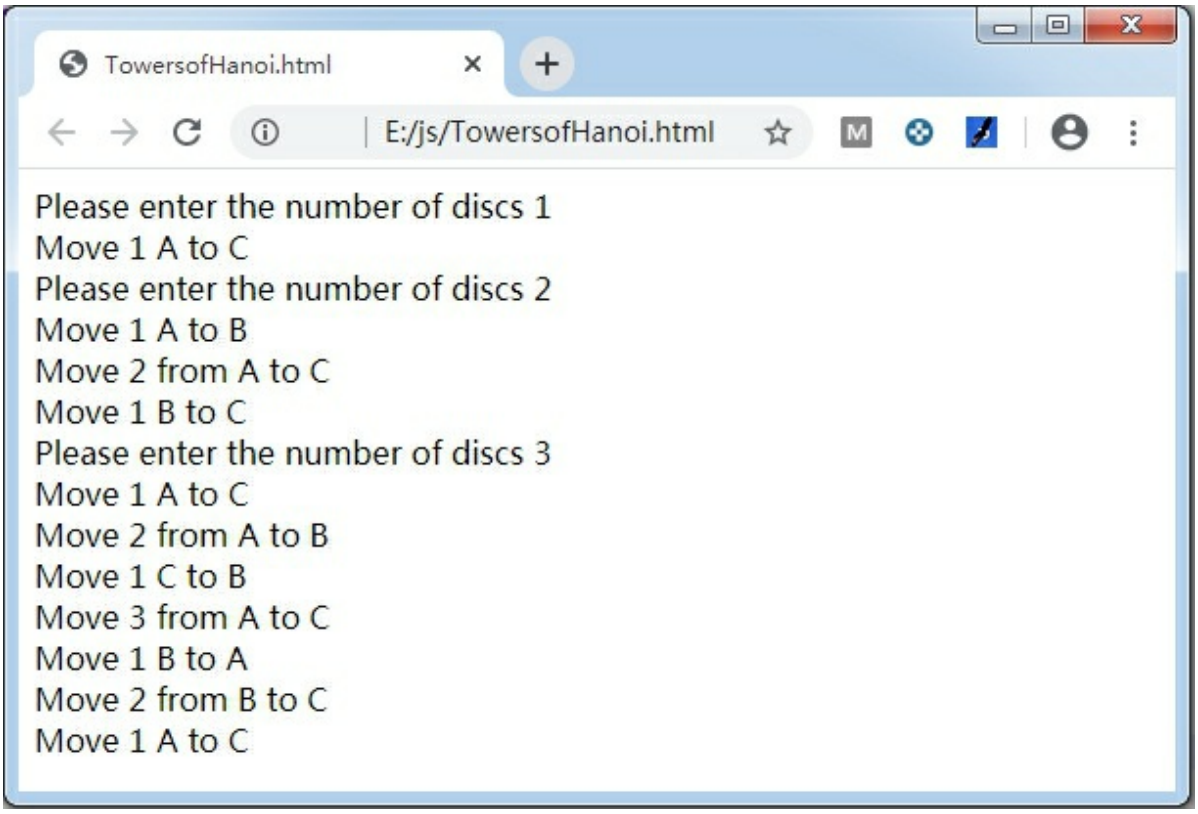
3. If more than two discs, use B as an auxiliary, and continue to recursive process.



1. Create a TowersofHanoi.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function hanoi(n, A, B, C) {
        if (n == 1) {
            document.write("Move " + n + " "+A + "  to " + C + "
<br>");
        } else {
            hanoi(n - 1, A, C, B); // Move the n-1th disc on the
A  through C to  B
            document.write("Move " + n + " from " + A + "  to " + C + "
<br>");
            hanoi(n - 1, B, A, C); //Move the n-1th disc on the
B  through  A to  C
        }
    }

    ////////////////////testing//////////////////
    document.write("Please enter the number of discs 1 <br>");
    var n = 1;
    hanoi(n, 'A', 'B', 'C');

    document.write("Please enter the number of discs 2 <br>");
    var n = 2;
    hanoi(n, 'A', 'B', 'C');

    document.write("Please enter the number of discs 3 <br>");
    var n = 3;
    hanoi(n, 'A', 'B', 'C');
</script>
```

Result:

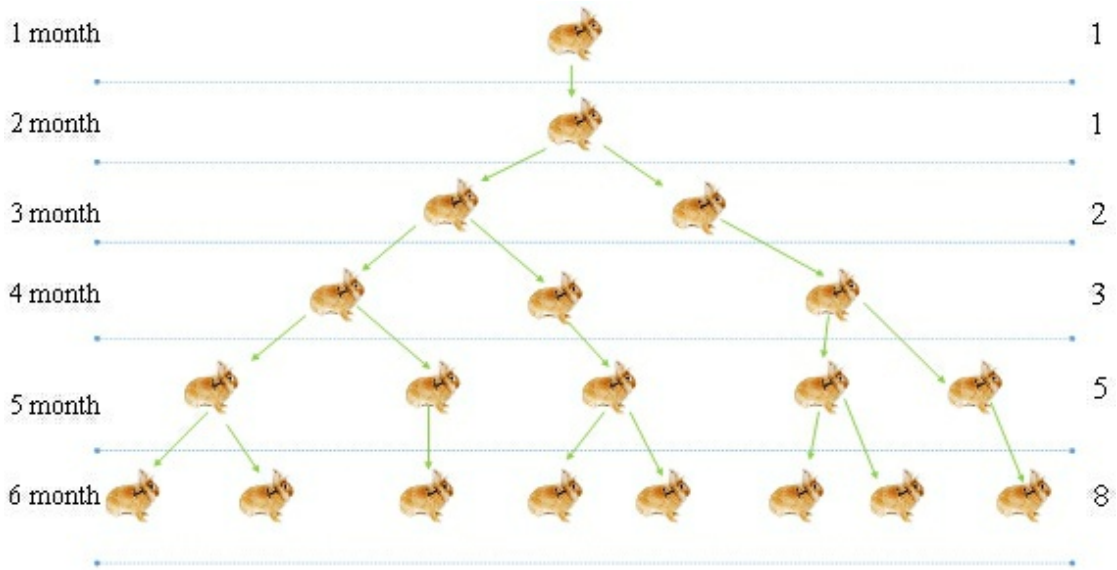

TowersofHanoi.html
E:/js/TowersofHanoi.html
Please enter the number of discs 1
Move 1 A to C
Please enter the number of discs 2
Move 1 A to B
Move 2 from A to C
Move 1 B to C
Please enter the number of discs 3
Move 1 A to C
Move 2 from A to B
Move 1 C to B
Move 3 from A to C
Move 1 B to A
Move 2 from B to C
Move 1 A to C

Fibonacci

Fibonacci : a European mathematician in the 1200s, in his writings: "If there is a rabbit
After a month can birth to a newborn rabbit. At first there was only 1 rabbit, after one month still 1 rabbit. after two month 2 rabbit, and after three months there are 3 rabbit .....
for example: 1, 1, 2, 3, 5, 8, 13 ...

Fibonacci definition:

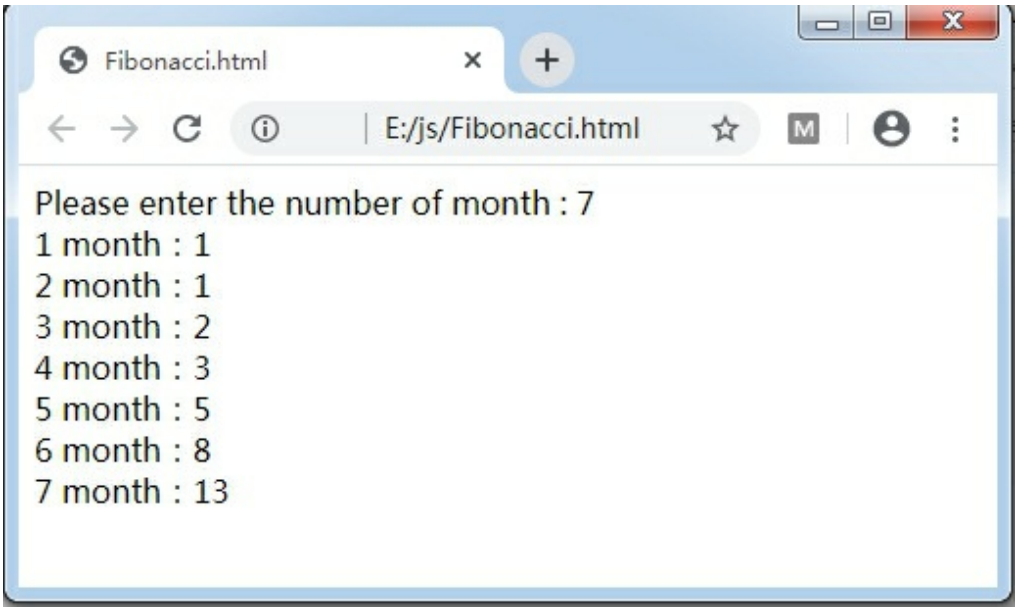
if n = 0, 1
    fn = n
if n > 1
    fn = fn-1 + fn-2



1. Create a Fibonacci.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function fibonacci(n) {
        if (n == 1 || n == 2) {
          return 1;
        } else {
          return fibonacci(n - 1) + fibonacci(n - 2);
        }
    }

    //////////////////////testing//////////////////
    document.write("Please enter the number of month : 7 <br>");
    var number = 7;

    for (var i = 1; i <= number; i++) {
        document.write(i + " month : " + fibonacci(i) + "<br>");
    }
</script>
```

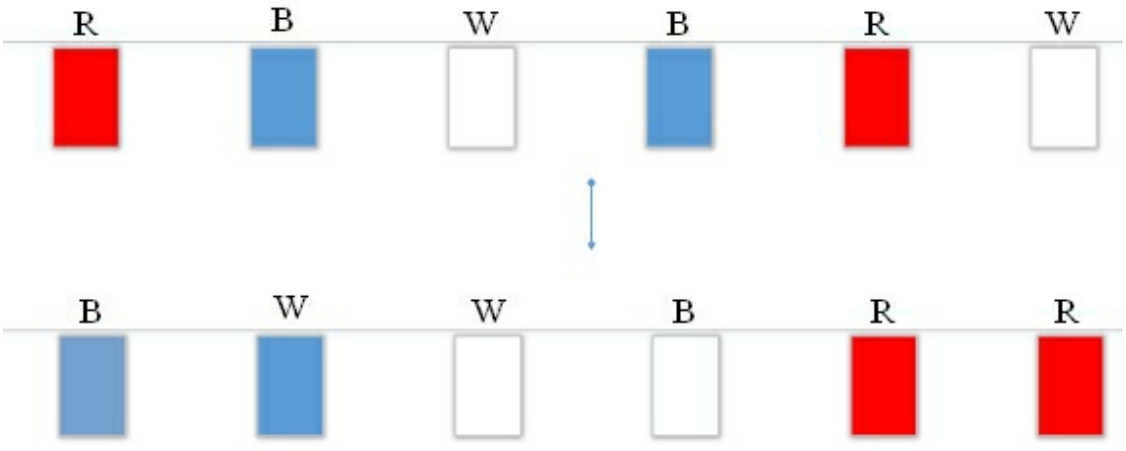
Result:



Dijkstra

The tricolor flag was originally raised by E.W. Dijkstra, who used the Dutch national flag (Dijkstra is Dutch).

Suppose there is a rope with red, white, and blue flags. At first all the flags on the rope are not in order. You need to arrange them in the order of blue -> white -> red. How to move them with the least times. you just only do this on the rope, and only swap two flags at a time.



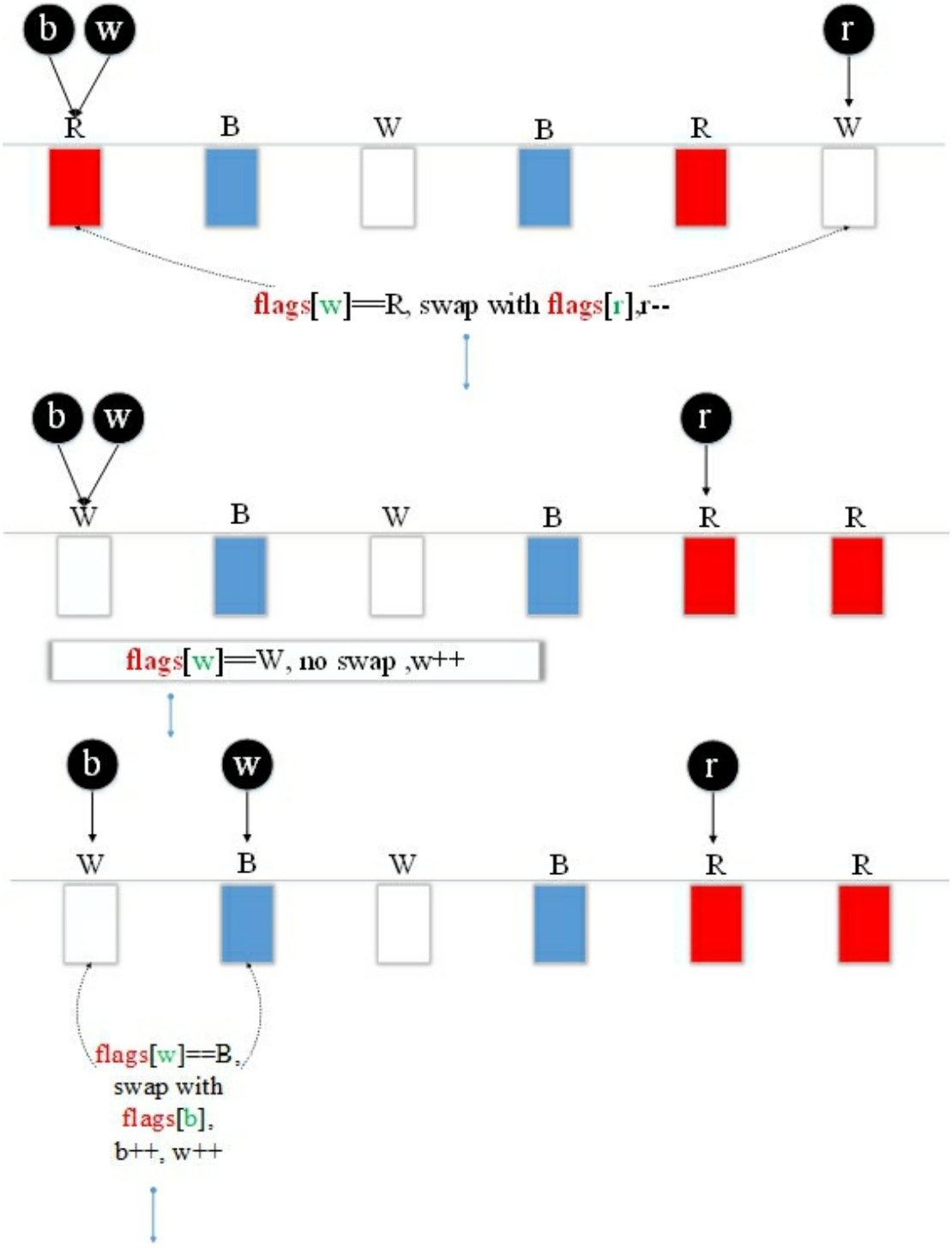
Solution:

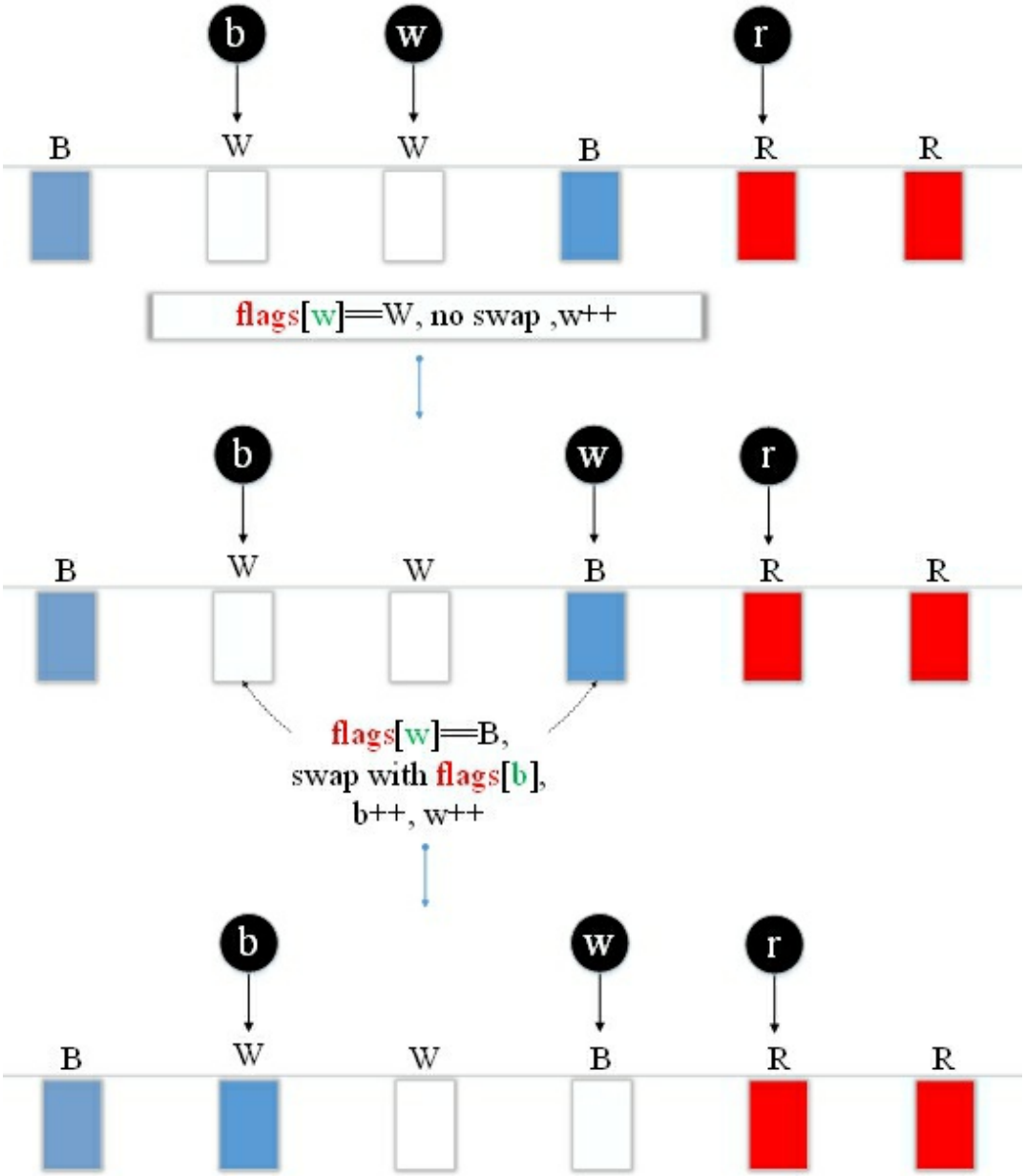
Use the char arrays to store the flags. For example, b, w, and r indicate the position of **blue**, **white** and **red** flags. The beginning of b and w is 0 of the array, and r is at the end of the array.

(1) If the position of w is a blue flag, flags[w] exchange with flags[b]. And whiteIndex and b is moved backward by 1.
(2) If the position of w is a white flag, w moves backward by 1.
(3) If the position of w is a red flag, flags[w] exchange with flags[r]. r moves forward by 1.

In the end, the flags in front of b are all blue, and the flags behind r are all red.

Graphic Solution




b
w
r
B
W
W
B
R
R
flags[w]==W, no swap ,w++
b
w
r
B
W
W
B
R
R
flags[w]==B,
swap with flags[b],
b++, w++
b
w
r
B
W
W
B
R
R

1. Create a Dijkstra.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function dijkstra(flags) {
        var b = 0, w = 0, r = flags.length - 1;
        var count = 0;
        while (w <= r) {
       if (flags[w] == 'W') {
          w++;
       } else if (flags[w] == 'B') {
          var temp = flags[w];
          flags[w] = flags[b];
          flags[b] = temp;
          w++;
          b++;
          count++;
       } else if (flags[w] == 'R') {
          var m = flags[w];
          flags[w] = flags[r];
          flags[r] = m;
          r--;
          count++;
       }
        }
    }

    var flags = [ 'R', 'B', 'W', 'B', 'R', 'W' ];
    dijkstra(flags);
    for (var i = 0; i < flags.length; i++) {
        document.write(flags[i]);
    }
</script>
```

Result:


Dijkstra.html
E:/js/Dijkstra.html
BBWWRR

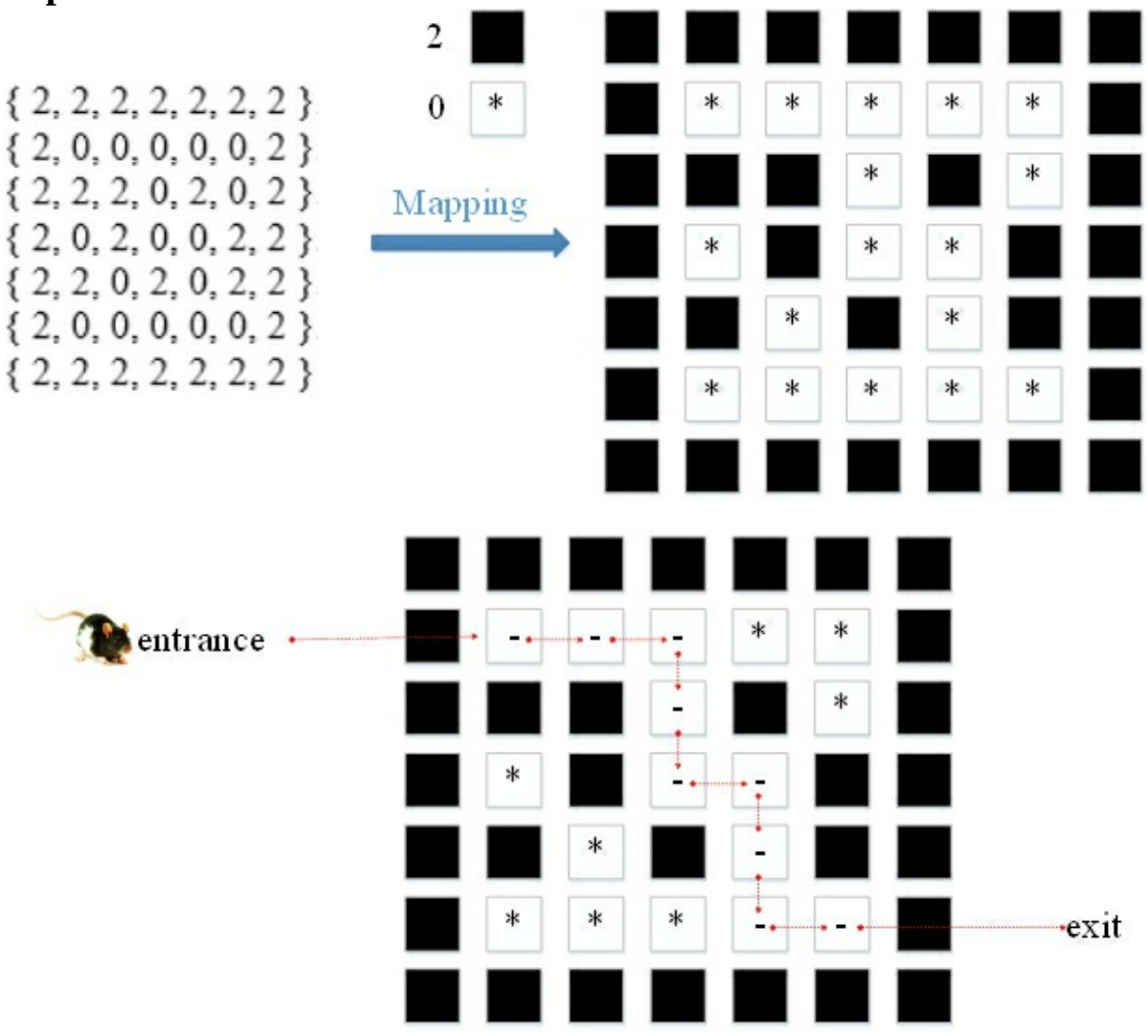
Mouse Walking Maze

Mouse Walking Maze is a basic type of recursive solution. We use 2 to represent the wall in a two-dimensional array, and use 1 to represent the path of the mouse, and try to find the path from the entrance to the exit.

Solution:

The mouse moves in four directions: up, left, down, and right. if hit the wall go back and select the next forward direction, so test the four directions in the array until mouse reach the exit.

Graphic Solution

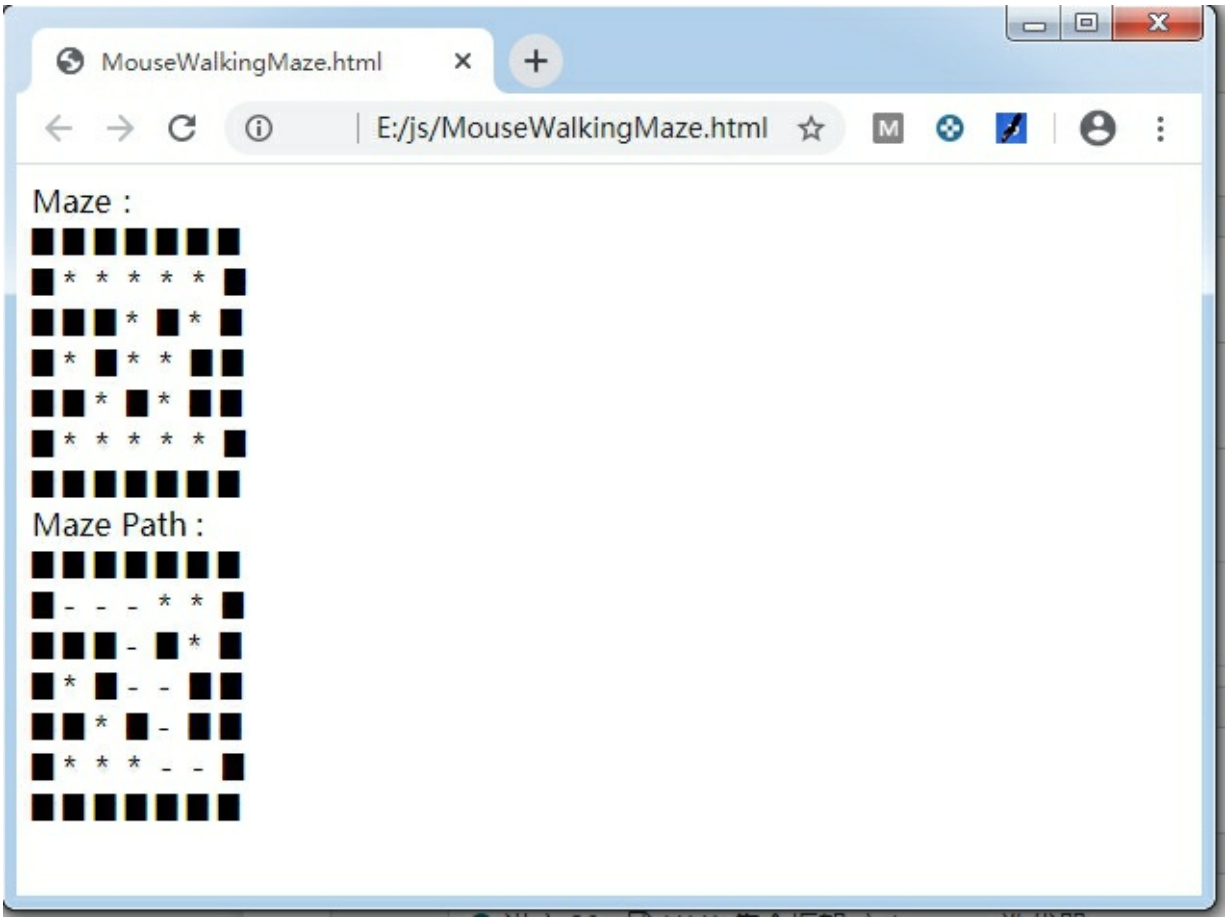


1. Create a MouseWalkingMaze.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    var maze = [
        [ 2, 2, 2, 2, 2, 2, 2 ],
        [ 2, 0, 0, 0, 0, 0, 2 ],
        [ 2, 2, 2, 0, 2, 0, 2 ],
        [ 2, 0, 2, 0, 0, 2, 2 ],
        [ 2, 2, 0, 2, 0, 2, 2 ],
        [ 2, 0, 0, 0, 0, 0, 2 ],
        [ 2, 2, 2, 2, 2, 2, 2 ]
        ];

    var startI = 1;
    var startJ = 1;
    var endI = 5;
    var endJ = 5;
    var success = 0;

    //The mouse moves in four directions: up, left, down, and right. if hit the wall go back and select the next forward direction
    function visit(i, j) {
        maze[i][j] = 1;
        if (i == endI && j == endJ) {
            success = 1;
        }
        if (success != 1 && maze[i][j + 1] == 0)
            visit(i, j + 1);
        if (success != 1 && maze[i + 1][j] == 0)
            visit(i + 1, j);
        if (success != 1 && maze[i][j - 1] == 0)
            visit(i, j - 1);
        if (success != 1 && maze[i - 1][j] == 0)
            visit(i - 1, j);
        if (success != 1)
            maze[i][j] = 0;
```

```
        return success;
    }



    //////////////////////testing//////////////////
    document.write("Maze:<br>");
    for (var i = 0; i < 7; i++) {
        for (var j = 0; j < 7; j++) {
            if (maze[i][j] == 2) {
                document.write("&#9608; ");
            } else {
                document.write("*  ");
            }
        }
        document.write("<br>");
    }

    if (visit(startI, startJ) == 0) {
        document.write("No exit found <br>");
    } else {
        document.write("Maze Path : <br>");
        for (var i = 0; i < 7; i++) {
            for (var j = 0; j < 7; j++) {
                if (maze[i][j] == 2) {
                    document.write("&#9608; ");
                } else if (maze[i][j] == 1) {
                    document.write("-  ");
                } else {
                    document.write("*  ");
                }
            }
            document.write("<br>");
        }
    }
</script>
```

Result:


MouseWalkingMaze.html
E:/js/MouseWalkingMaze.html
Maze :
Maze Path :

Eight Coins

There are eight coins with the same appearance, one is a counterfeit coin, and the weight of counterfeit coin is different from the real coin, but it is unknown whether the counterfeit coin is lighter or heavier than the real coin. Please design a efficient algorithm to detect this counterfeit coin.

Solution:

Take six a, b, c, d, e, f from eight coins, and put three to the balance for comparison. Suppose a, b, c are placed on one side, and d, e, f are placed on the other side.

1.a + b + c> d + e + f
2.a + b + c = d + e + f
3.a + b + c <d + e + f

If a + b + c> d + e + f, there is a counterfeit coin in one of the six coins, and g, h are real coins. At this time, one coin can be removed from both side. Suppose that c and f are removed. At the same time, one coin at each side is replaced. Suppose the coins b and e are interchanged, and then the second comparison. There are also three possibilities:

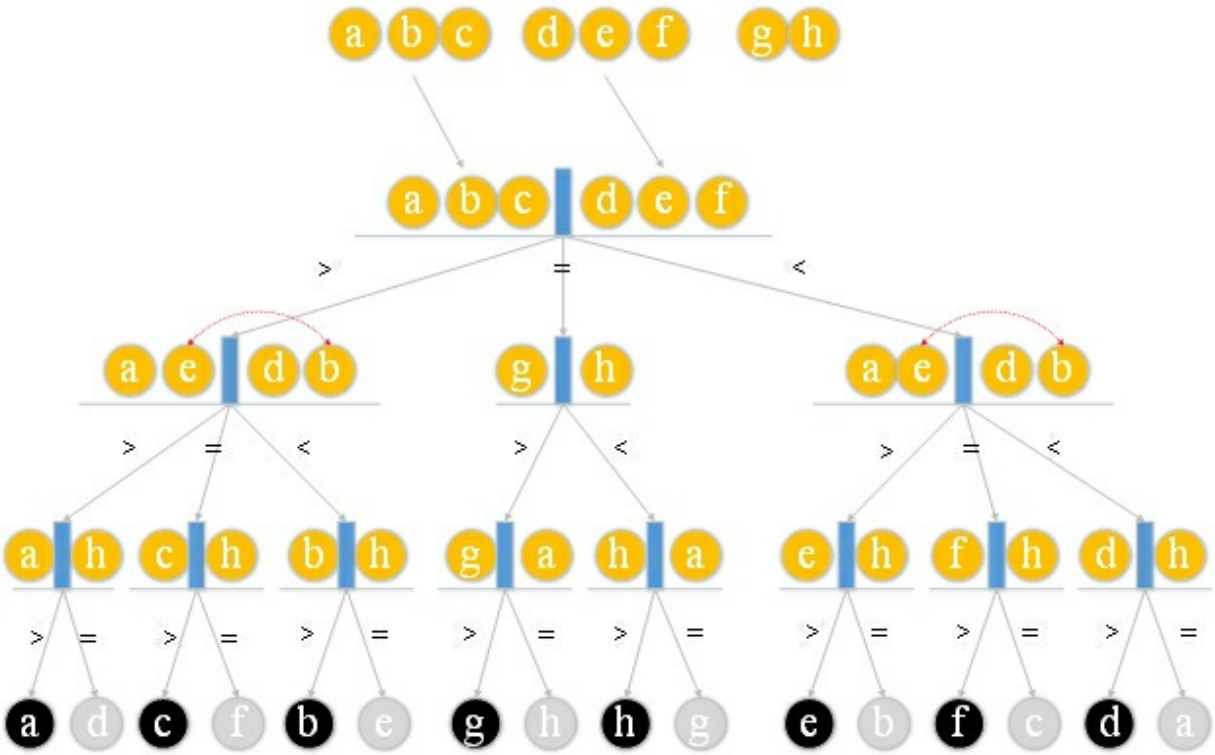
1. a + e> d + b: the counterfeit currency must be one of a, d. as long as we compare a real currency h with a, we can find the counterfeit currency. If a> h, a is a heavier counterfeit currency; if a = h, d is a lighter counterfeit currency.

2. a + e = d + b: the counterfeit currency must be one of c, f, and the real coin h is compared with c. If c> h, c is a heavier counterfeit currency; if c = h, then f is a lighter counterfeit currency.

3. a + e <d + b: one of b or e is a counterfeit coin , Also use the real coin h to compare with b, if b> h, then b is a heavier counterfeit currency; if b = h, then e is a lighter counterfeit currency;

Graphic Solution

Heavy **Light**

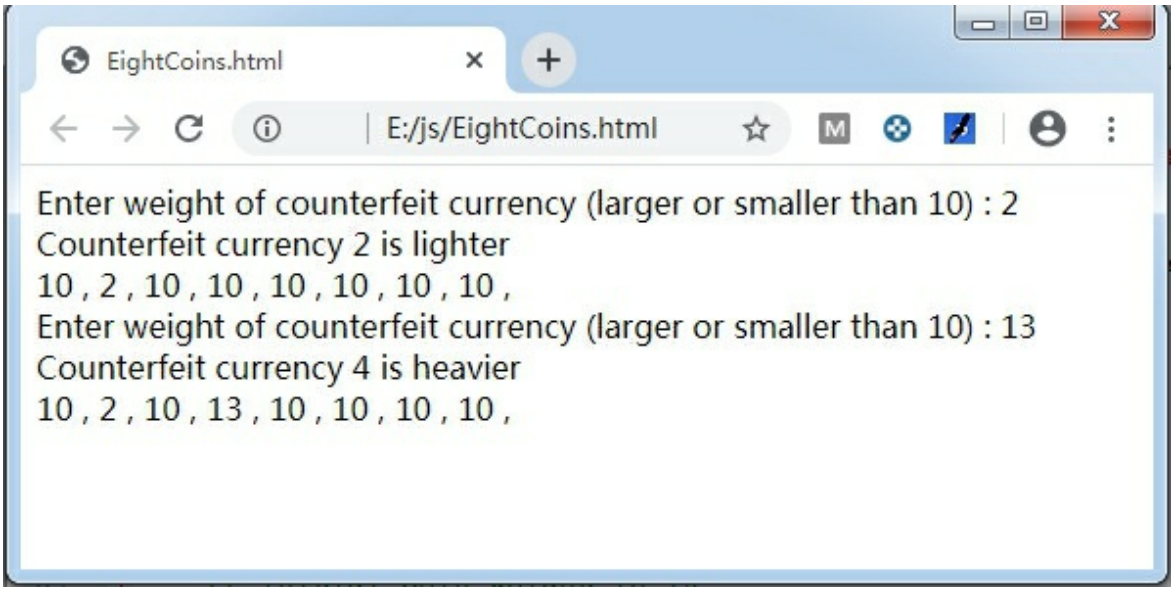

a b c d e f g h
a b c d e f
> = <
a e d b
g h
a e d b
> = <
> <
> = <
a h
c h
b h
g a
h a
e h
f h
d h
> = > = > = > = > = > = > = > =
a d c f b e g h h g e b f c d a

1. Create a EightCoins.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    function compare(coins, i, j, k) {//coin[k] true,coin[i]>coin[j]
        if (coins[i] > coins[k]) //coin[i]>coin[j]&&coin[i]>coin[k] -----
>coin[i] is a heavy counterfeit coin
            document.write("\nCounterfeit currency " + (i + 1) + " is heavier
<br>");
        else //coin[j] is a light counterfeit coin
            document.write("\nCounterfeit currency " + (j + 1) + " is lighter
<br>");
    }

    function eightcoins(coins) {
        if (coins[0] + coins[1] + coins[2] == coins[3] + coins[4] + coins[5]){
//(a+b+c)==(d+e+f)
            if (coins[6] > coins[7]) //g>h?(g>a?g:a):(h>a?h:a)
                compare(coins, 6, 7, 0);
            else //h>g?(h>a?h:a):(g>a?g:a)
                compare(coins, 7, 6, 0);
        } else if (coins[0] + coins[1] + coins[2] > coins[3] + coins[4] +
coins[5]){ //(a+b+c)>(d+e+f)
            if (coins[0] + coins[3] == coins[1] + coins[4]) //(a+e)==(d+b)
                compare(coins, 2, 5, 0);
            else if (coins[0] + coins[3] > coins[1] + coins[4]) //(a+e)>(d+b)
                compare(coins, 0, 4, 1);
            if (coins[0] + coins[3] < coins[1] + coins[4]) //(a+e)<(d+b)
                compare(coins, 1, 3, 0);
        } else if (coins[0] + coins[1] + coins[2] < coins[3] + coins[4] +
coins[5]) {//(a+b+c)<(d+e+f)
            if (coins[0] + coins[3] == coins[1] + coins[4]) //(a+e)>(d+b)
                compare(coins, 5, 2, 0);
            else if (coins[0] + coins[3] > coins[1] + coins[4]) //(a+e)>(d+b)
                compare(coins, 3, 1, 0);
            if (coins[0] + coins[3] < coins[1] + coins[4]) //(a+e)<(d+b)
                compare(coins, 4, 0, 1);
        }
```

```
    }




    //////////////////////testing//////////////////
    var coins = new Array();
    // Initial coin weight is 10
    for (var i = 0; i < 8; i++)
        coins[i] = 10;

    document.write("Enter weight of counterfeit currency  (larger or
smaller than 10) : 2<br>");
    coins[1] = 2;
    eightcoins(coins);
    for (var i = 0; i < 8; i++)
        document.write(coins[i]+" , ");

    document.write("<br>");

    document.write("Enter weight of counterfeit currency  (larger or
smaller than 10) : 13<br>");
    coins[3] = 13;
    eightcoins(coins);
    for (var i = 0; i < 8; i++)
        document.write(coins[i]+" , ");
</script>
```

Result:


EightCoins.html
E:/js/EightCoins.html
Enter weight of counterfeit currency (larger or smaller than 10) : 2
Counterfeit currency 2 is lighter
10 , 2 , 10 , 10 , 10 , 10 , 10 , 10 ,
Enter weight of counterfeit currency (larger or smaller than 10) : 13
Counterfeit currency 4 is heavier
10 , 2 , 10 , 13 , 10 , 10 , 10 , 10 ,

Josephus Problem

There are 9 Jewish hid in a hole with Josephus and his friends . The 9 Jews decided to die rather than be caught by the enemy, so they decided In a suicide method, 11 people are arranged in a circle, and the first person reports the number. After each number is reported to the third person, the person must commit suicide. Then count again from the next one until everyone commits suicide.But Josephus and his friends did not want to obey. Josephus asked his friends to pretend to obey, and he arranged the friends with himself. In the 2th and 7st positions, they escaped this death game.

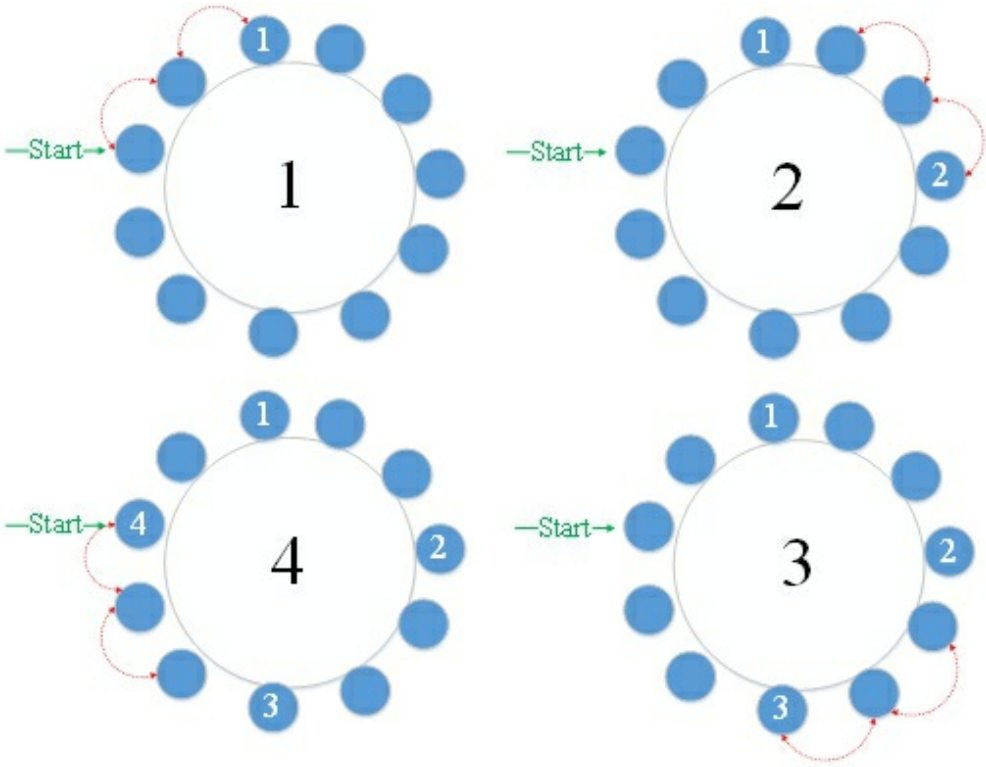
Solution:

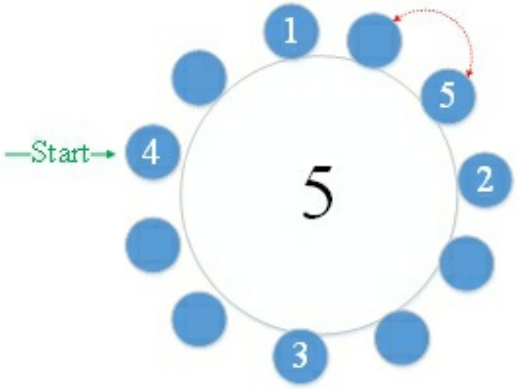
As long as the array is treated as a ring. Fill in a count for each dataless area, until the count reaches 11, and then list the array from index 1, you can know that each suicide order in this position is the Joseph's position. The 11-person position is as follows:

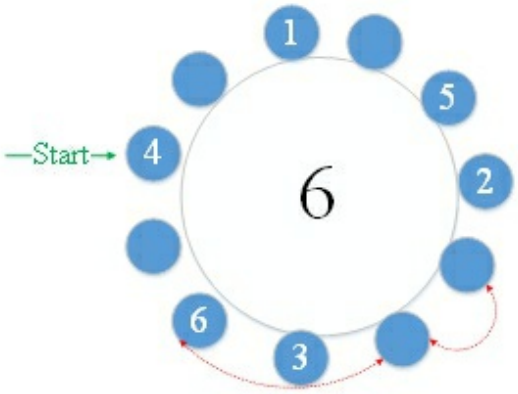
4 10 1 7 5 2 11 9 3 6 8

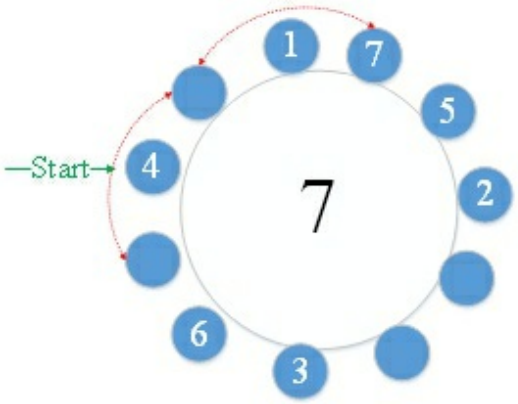
From the above, the last two suicide was in the 31st and 16th position. The previous one

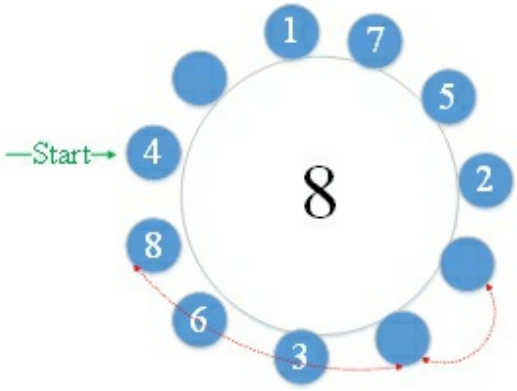
Everyone died, so they didn't know that Joseph and his friends didn't follow the rules of the game.

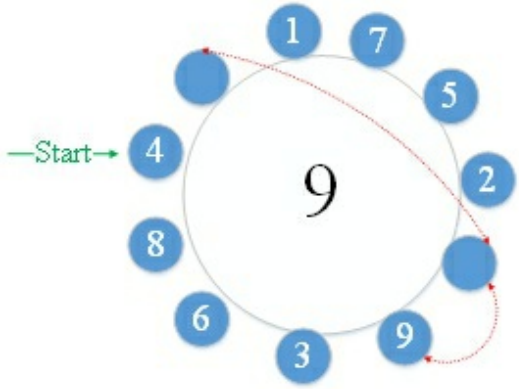

Start
1
Start
2
Start
4
Start
3

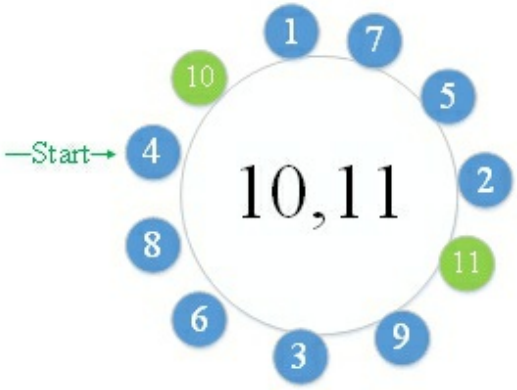

Start
1
5
2
3
4
5


Start
1
5
2
3
6
4
6


Start
1
7
5
2
3
6
4
7


Start
1
7
5
2
3
6
8
4
8


Start
1
7
5
2
3
9
6
8
4
9


Start
1
7
10
5
2
11
3
9
6
8
4
10,11

1. Create a Josephus.html with Notepad and open it in your browser.

```
<script type="text/javascript">
    var N = 11;
    var M = 3;

    function joseph(man) {
        var count = 1;
        var i = 0, pos = -1;
        var alive = 0;
        while (count <= N) {
        do {
          pos = (pos + 1) % N; // Ring
          if (man[pos] == 0)
            i++;
          if (i == M) {
            i = 0;
            break;
          }
        } while (true);
        man[pos] = count;
        count++;
         }

    }

    ////////////////////testing//////////////////
    var man = new Array();
    for (var i = 0; i < N; i++)
        man[i] = 0;

    joseph(man);

   document.write("\nJoseph sequence:<br>");
    for (var i = 0; i < N; i++)
        document.write(man[i] + " , ");
</script>
```

Result:

Joseph sequence：
4 , 10 , 1 , 7 , 5 , 2 , 11 , 9 , 3 , 6 , 8 ,

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I wish you all the best in your future success!