CSC215

Math and Computer Science

SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

A Legacy of Excellence

Binary Search

- Much like the game “I am thinking of a number between 1 and 100”.
  - Fewest guesses: always pick the middle (50)
  - Higher
- Now “I am thinking of a number between 51 and 100”
  - Guess: Pick middle (75)
  - Lower
- Now “I am thinking of a number between 51 and 74”
  - Guess: Pick middle (62)
  - Correct

Binary Search

- Much like that game
- Must have a sorted list
- Search for the target value between left and right inclusive, start at the middle (left + right) / 2
- If equal, return that value
- If left index becomes greater than right index, target not found, return -1
- If target value is less than array[middle], search left half
- If target value is greater than array[middle], search right half

Binary Search Criteria

• left > right	return -1
• Array[middle] == Target	return middle
• Target < Array[middle]	search left half, adjust right index
• Target > Array[middle]	search right half, adjust left index

Writing the function

```
int binarySearch(int arr[], int left, int right, int tgt)
{
    int mid = ( left + right ) / 2;
    // not found
    if( left > right )
        return -1;

    // see if it is in the middle
    if( arr[ mid ] == tgt )
        return mid;
}
```

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Writing the function

```
int binarySearch(int arr[], int left, int right, int tgt)
{   int mid = ( left + right ) / 2;
    // not found
    if( left > right )
        return -1;
    // see if it is in the middle
    if( arr[ mid ] == tgt )
        return mid;

    // see what half of list to search
    if( tgt < arr[mid] ) // Left half
        right = mid -1;
    else                 // Right half
        left = mid + 1;
    return binarySearch( arr, left, right, tgt );
}
```

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Box Method

```
int main()
{   int arr[11] = { 5,6,9,10,13,14,19,20,22,24,30};
    int tgt, pos;

    cin >> tgt;
    pos = binarySearch( arr, 0, 10, tgt);
    if( pos != -1 )
        cout << "the number is found in the " << pos
             << " position" << endl;

    return 0;
}
```

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Box Method

Array (a)	5	6	9	10	13	14	19	20	22	24	30
Index	0	1	2	3	4	5	6	7	8	9	10

Main
tgt =10
pos=b(a,0,10,tgt)

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Box Method

Array (a)	5	6	9	10	13	14	19	20	22	24	30
Index	0	1	2	3	4	5	6	7	8	9	10

Main
tgt =10
pos=b()

→

B(0, 10)
tgt = 10
Left = 0
Right = 10
Mid = 5

A[mid] != tgt
tgt < a[mid] search left half
  right = mid – 1 = 4
Make function call and return results

Box Method

Array (a)	5	6	9	10	13	14	19	20	22	24	30
Index	0	1	2	3	4	5	6	7	8	9	10

Main
tgt =10
pos=b()

→

B(0, 10)
tgt = 10
Left = 0
Right = 10
Mid = 5

→

B(0, 4)
tgt = 10
Left = 0
Right = 4
Mid = 2

A[mid] != tgt
tgt > a[mid] search Right half
    Left = mid + 1 = 1
Make function call and return results

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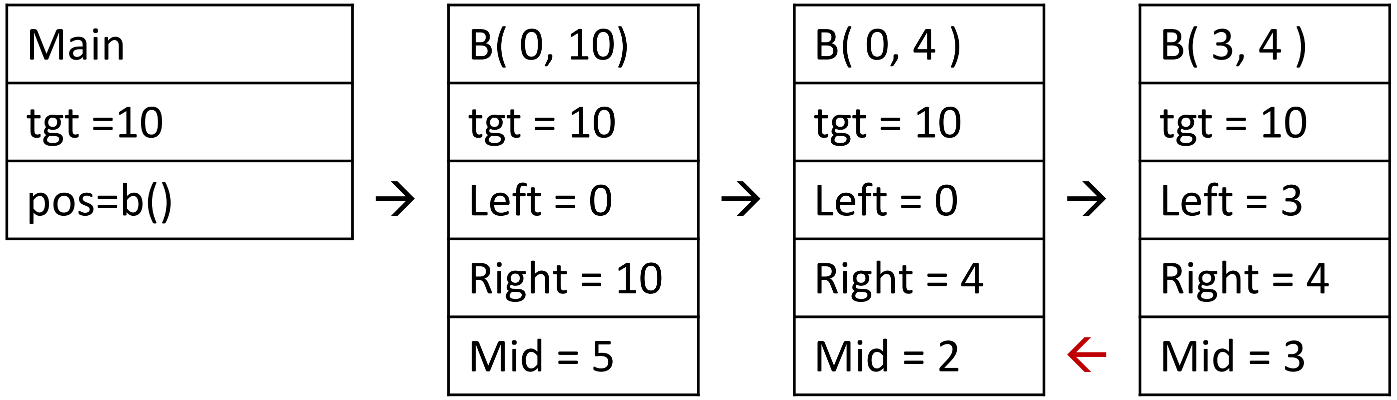
Box Method

Array (a)	5	6	9	10	13	14	19	20	22	24	30
Index	0	1	2	3	4	5	6	7	8	9	10



A[mid] == tgt
return mid

Box Method

Array (a)	5	6	9	10	13	14	19	20	22	24	30
Index	0	1	2	3	4	5	6	7	8	9	10

Main		B(0, 10)		B(0, 4)		B(3, 4)
tgt =10		tgt = 10		tgt = 10		tgt = 10
pos=b()	→	Left = 0	→	Left = 0	→	Left = 3
		Right = 10		Right = 4		Right = 4
		Mid = 5	←	Mid = 2	←	Mid = 3

A[mid] == tgt
return mid

Box Method

Array (a)	5	6	9	10	13	14	19	20	22	24	30
Index	0	1	2	3	4	5	6	7	8	9	10

Main		B(0, 10)		B(0, 4)		B(3, 4)
tgt =10		tgt = 10		tgt = 10		tgt = 10
pos=b() = 3	→	Left = 0	→	Left = 0	→	Left = 3
		Right = 10		Right = 4		Right = 4
	←	Mid = 5	←	Mid = 2	←	Mid = 3

A[mid] == tgt
return mid

Iterative Binary Search

```
int ibinarySearch( int arr[], int size, int tgt)
{   int left=0, right=size-1;
    int mid;
    while (left <= right )
    {
        mid = (left + right) / 2;
        if( arr[mid] == tgt )
            return mid;
        if( tgt < arr[mid] )
            right = mid -1;
        else
            left = mid + 1;
    }
    return -1;  }
```

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