



Bachelor of IT (Computer Science)
Assignment 1
CAB301 - Algorithms and Complexity

Dane Madsen
n10983864@qut.edu.au

Contents

1	IsValidId Method	3
1.1	Algorithm Design	3
1.2	Testing	3
2	IsValidExecutionTime Method	4
2.1	Algorithm Design	4
2.2	Testing	4
3	IsValidPriority Method	5
3.1	Algorithm Design	5
3.2	Testing	5
4	IsTimeReceived Method	6
4.1	Algorithm Design	6
4.2	Testing	6
5	Add Method	7
5.1	Algorithm Design	7
5.2	Testing	7
6	Contains Method	8
6.1	Algorithm Design	8
6.2	Testing	8
7	Find Method	8
7.1	Algorithm Design	8
7.2	Testing	9
8	Remove Method	9
8.1	Algorithm Design	9
8.2	Testing	9
9	ToArray Method	9
9.1	Algorithm Design	9
9.2	Testing	10
10	FirstComeFirstServed Method	10
10.1	Algorithm Design	10
10.2	Analysis	10
10.3	Testing	11

11 Priority Method	12
11.1 Algorithm Design	12
11.2 Analysis	12
11.3 Testing	13
12 ShortestJobFirst Method	13
12.1 Algorithm Design	13
12.2 Analysis	13
12.3 Testing	13

1 IsValidId Method

1.1 Algorithm Design

This method checks whether a provided job ID is valid. It achieves this by checking that the provided ID is greater than the minimum valid ID (1) and less than the maximum valid ID (999). If the ID meets these criteria, the method returns true indicating the ID is valid, otherwise it returns false indicating the ID is invalid.

```
ALGORITHM IsValidId(v)  
  // Given an integer (v)  
  // Returns True if v is a valid job ID  
  // Otherwise returns False  
  if  $v \geq 1$  and  $v \leq 999$   
    return True  
  else  
    return False
```

1.2 Testing

This method uses unit testing to test that the method is correctly validating the job ID. Using a for loop, the unit test first tests every valid ID (1-999) to ensure that the method returns true. It then tests two invalid IDs (0 and 1000) to ensure that the method returns false.

Test Result: PASS

2 IsValidExecutionTime Method

2.1 Algorithm Design

This method simply checks whether a provided job execution time is valid. It achieves this by simply checking whether the execution time is greater than 0. If the execution time is greater than 0, the method returns true indicating the execution time is valid, otherwise it returns false indicating the execution time is invalid.

```
ALGORITHM IsValidExecutionTime(v)  
  // Given an integer (v)  
  // Returns True if v is a valid job execution time  
  // Otherwise returns False  
  if v > 0  
    return True  
  else  
    return False
```

2.2 Testing

This method uses unit testing to test that the method is correctly validating the job execution time. Using a for loop, the unit test first tests 100 valid execution times (1-100) to ensure that the method returns true. It then tests one invalid execution time (0) to ensure that the method returns false.

Test Result: PASS

3 IsValidPriority Method

3.1 Algorithm Design

This method checks whether a provided job priority is valid. It achieves this by checking that the provided priority is greater than or equal to the minimum valid priority (1) and less than or equal to the maximum valid priority (9). If the priority is meets these criteria, the method returns true indicating the priority is valid, otherwise it returns false indicating the priority is invalid.

```
ALGORITHM IsValidPriority(v)  
  // Given an integer (v)  
  // Returns True if v is a valid job priority  
  // Otherwise returns False  
  if  $v \geq 1$  and  $v \leq 9$   
    return True  
  else  
    return False
```

3.2 Testing

This method uses unit testing to test that the method is correctly validating the job priority. Using a for loop, the unit test first tests every valid priority (1-9) to ensure that the method returns true. It then tests two invalid priorities (0 and 10) to ensure that the method returns false.

Test Result: PASS

4 IsTimeReceived Method

4.1 Algorithm Design

This method checks whether a provided job time received is valid. It achieves this by checking that the provided time received is greater than zero. If the time received is greater than zero, the method returns true indicating the time received is valid, otherwise it returns false indicating the time received is invalid.

```
ALGORITHM IsTimeReceived(v)  
  // Given a job time received (v)  
  // Returns True if v is a valid time received  
  // Otherwise returns False  
  if v > 0  
    return True  
  else  
    return False
```

4.2 Testing

This method uses unit testing to test that the method is correctly validating the job time received. Using a for loop, the unit test first tests 100 valid time received (1-100) to ensure that the method returns true. It then tests one invalid time received (0) to ensure that the method returns false.

Test Result: PASS

5 Add Method

5.1 Algorithm Design

This method adds a job to the job collection. It achieves this by first checking that the job doesn't already exist in the collection. If the job does already exist in the collection, the method returns false indicating the job was not added to the collection. If the job does not already exist in the collection, the method adds the job to the collection, increments the count variable and returns true.

```
ALGORITHM Add(v)
  // Let (n) be count
  // Given a job (v)
  // Returns True if v was added to the jobs array (J)
  // Otherwise returns False
  for i  $\leftarrow$  0 in n - 1 do
    if v.id = J[i].id
      return False
  else
    J[n]  $\leftarrow$  v
    n  $\leftarrow$  n + 1
  return True
```

5.2 Testing

This method uses unit testing to test that the method is correctly adding jobs to the collection. First, the unit test creates a dummy job with valid properties, and then creates a dummy job collection. The unit test then attempts to add the dummy job to the dummy job collection. If this first attempt is successful, the unit test then attempts to add the dummy job to the dummy job collection again. If the second attempt is unsuccessful, the unit test passes. This ensures that the method can add a new job, but will not overwrite a job if a job in the job collection already has the same ID as the job being added.

Test Result: PASS

6 Contains Method

6.1 Algorithm Design

This method is used to check if a job exists in the job collection. It achieves this by checking if there is a job in the collection with the same ID as the provided job ID. If there is a job with the same ID the method returns true, otherwise it returns false.

ALGORITHM *Contains(v)*

```
// Let (n) be count
// Given an integer (v)
// Returns True if a job with the ID v exists in the jobs array (J)
// Otherwise returns False
for  $i \leftarrow 0$  in  $n - 1$  do
    if  $v = J[i].id$ 
        return True
else
    return False
```

6.2 Testing

7 Find Method

7.1 Algorithm Design

This method is used to find a job in the job collection. It achieves this by using the provided job ID to find the job in the collection. If the job is found, the method returns the job, otherwise it returns null.

ALGORITHM *Find(v)*

```
// Let (n) be count
// Given an integer (v)
// Returns the job with the ID v if it exists in the jobs array (J)
// Otherwise returns null
for  $i \leftarrow 0$  in  $n - 1$  do
    if  $v = J[i].id$ 
        return  $J[i]$ 
return null
```

7.2 Testing

8 Remove Method

8.1 Algorithm Design

This method is used to remove a job from the job collection. It achieves this by using the provided job ID to find the job in the collection. If the job is found, the method removes the job from the collection, decrements the count variable and returns true. If the job is not found, the method returns false.

```
ALGORITHM Remove(v)
  // Let ( $n$ ) be count
  // Given an integer ( $v$ )
  // Returns True if a job with the ID  $v$  was removed
  // from the jobs array ( $J$ )
  // Otherwise returns False
  for  $i \leftarrow 0$  in  $n - 1$  do
    if  $v = J[i].id$ 
      for  $j \leftarrow 0$  in  $n - 2$  do
         $J[j] \leftarrow J[j + 1]$ 
       $n \leftarrow n - 1$ 
      return True
  return False
```

8.2 Testing

9 ToArray Method

9.1 Algorithm Design

This method is used to convert the job collection to an array. It achieves this by creating a new array of the same size as the job collection and then copying the jobs from the job collection to the new array. The method then returns the new array.

```
ALGORITHM ToArray()
  // Let ( $n$ ) be count
  // Returns a new array of copied from the jobs array ( $J$ )
   $A \leftarrow newJob[n]$ 
```

```

for  $i \leftarrow 0$  in  $n - 1$  do
     $A[i] \leftarrow J[i]$ 
return  $A$ 

```

9.2 Testing

10 FirstComeFirstServed Method

10.1 Algorithm Design

This method is used to sort jobs for first come first served scheduling. It achieves this by using the selection sort algorithm to sort the jobs by their arrival time.

ALGORITHM *FirstComeFirstServed()*
 // Returns a new array of jobs sorted by their arrival time
 $A \leftarrow Jobs.ToArray()$
for $i \leftarrow 0$ **in** $A.Length - 1$ **do**
 for $j \leftarrow i + 1$ **in** $A.Length$ **do**
 if $A[i].TimeRecieved > A[j].TimeRecieved$
 $temp \leftarrow A[i]$
 $A[i] \leftarrow A[j]$
 $A[j] \leftarrow temp$
return A

10.2 Analysis

To implement selection sort, this method uses a nested for loop to iterate through the array of jobs. The outer loop performs $n - 1$ iterations, and the inner loop performs $1, 2, \dots, n - 2, n - 1$ iterations for every iteration of the outer loop, where n is the length of the jobs array. Therefore, the total number of iterations can be expressed as $1 + 2 + \dots + (n - 2) + (n - 1)$, and using the rule of sum of an arithmetic sequence this equation can be further simplified to $n(n - 1)/2$. By dropping the constant factor and the lower order terms, the total number of iterations can be expressed as $O(n^2)$. Therefore, the worst case time complexity of this method is $O(n^2)$.

10.3 Testing

11 Priority Method

11.1 Algorithm Design

This method is used to sort jobs for priority scheduling. It achieves this by using the insertion sort algorithm to sort the jobs by their priority.

```
ALGORITHM Priority()
// Returns a new array of jobs sorted by their priority
A  $\leftarrow$  Jobs.ToArray()
for i  $\leftarrow$  1 in A.Length do i ++
    for j  $\leftarrow$  i in 0 do j --
        if A[j].Priority < A[j - 1].Priority
            temp  $\leftarrow$  A[j]
            A[j]  $\leftarrow$  A[j - 1]
            A[j - 1]  $\leftarrow$  temp
        else
            break
return A
```

11.2 Analysis

To implement insertion sort, like the previous method this method uses a nested for loop to iterate through the array of jobs. However, this time the inner loop iterates in reverse. The outer loop performs n iterations, and the inner loop performs $n - 1, n - 2, \dots, 2, 1$ iterations for every iteration of the outer loop, where n is the length of the jobs array. Therefore, the total number of iterations can be expressed as $(n - 1) + (n - 2) + \dots + 2 + 1$, and by again using the rule of sum of an arithmetic sequence this equation can be further simplified to $n(n - 1)/2$. This is the same as the previous method so therefore, the worst case time complexity of this method is $O(n^2)$.

11.3 Testing

12 ShortestJobFirst Method

12.1 Algorithm Design

This method is used to sort jobs for shortest job first scheduling. It achieves this by using the bubble sort algorithm to sort the jobs by their execution time.

```
ALGORITHM ShortestJobFirst()
// Returns a new array of jobs sorted by their execution time
A ← Jobs.ToArray()
for i ← 0 in A.Length - 1 do
    for j ← 0 in A.Length - i - 1 do
        if A[j].ExecutionTime > A[j + 1].ExecutionTime
            temp ← A[j]
            A[j] ← A[j + 1]
            A[j + 1] ← temp
return A
```

12.2 Analysis

To implement bubble sort, again this method uses a nested for loop to iterate through the array of jobs. The outer loop performs $n - 1$ iterations, and the inner loop performs 1, 2, ..., $n - 3$, $n - 2$ iterations for every iteration of the outer loop, where n is the length of the jobs array. Therefore, the total number of iterations can be expressed as $1 + 2 + \dots + (n - 3) + (n - 2)$, and by again using the rule of sum of an arithmetic sequence this equation can be further simplified to $n(n - 1)/2$. This is the same as the previous two methods so therefore, the worst case time complexity of this method is $O(n^2)$.

12.3 Testing