

# VARUN BHARGAVA – 241010282

## DATA STRUCTURES TASK-9

### Task 01: Restore File Directory from Creation and Listing Logs:

(<https://github.com/varunnnb/dsa-sem3-iiitnr/blob/main/lab9/lab9-1.c>)

A computer system stores the folder structure of files as a binary tree. Unfortunately, the directory system crashed, and you only have two logs left:

- preorder → the order in which directories and files were created.
- inorder → the order in which files/directories appear when listed alphabetically.

Your task is to rebuild the original folder structure tree and return it. You may assume there are no duplicate directory/file names.

Input:

preorder = ["root", "docs", "assignments", "photos", "music"]

inorder = ["assignments", "docs", "root", "photos", "music"]

Output:

["root", "docs", "music", "assignments", null, "photos", null]

```
lab9-1.c x lab9-2.c U lab9-3.c U
lab9 > lab9-1.c > newNode(char *)
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <string.h>
4
5 typedef struct TreeNode
6 {
7     char *val;
8     struct TreeNode *left;
9     struct TreeNode *right;
10 } TreeNode;
11
12 TreeNode *newNode(char *val)
13 {
14     TreeNode *node = (TreeNode *)malloc(sizeof(TreeNode));
15     node->val = strdup(val);
16     node->left = node->right = NULL;
17     return node;
18 }
19
20 int findIndex(char *arr[], int start, int end, char *value)
21 {
22     for (int i = start; i <= end; i++)
23     {
24         if (strcmp(arr[i], value) == 0)
25             return i;
26     }
27     return -1;
28 }
29
30 TreeNode *buildTreeUtil(char *preorder[], char *inorder[], int inStart, int inEnd, int *preIndex)
31 {
32     if (inStart > inEnd)
33         return NULL;
34
35     TreeNode *root = newNode(preorder[*preIndex]);
36     (*preIndex)++;
37
38     if (inStart == inEnd)
39         return root;
40
41     int inIndex = findIndex(inorder, inStart, inEnd, root->val);
42
43     root->left = buildTreeUtil(preorder, inorder, inStart, inIndex, preIndex);
44     root->right = buildTreeUtil(preorder, inorder, inIndex + 1, inEnd, preIndex);
45
46     return root;
47 }
48
49 int main()
50 {
51     char *preorder[] = {"root", "docs", "assignments", "photos", "music"};
52     char *inorder[] = {"assignments", "docs", "root", "photos", "music"};
53     int inStart = 0, inEnd = 4;
54     int preIndex = 0;
55     TreeNode *root = buildTreeUtil(preorder, inorder, inStart, inEnd, &preIndex);
56     printf("Restored Directory Structure: ");
57     printTree(root);
58     return 0;
59 }
60
61 void printTree(TreeNode *root)
62 {
63     if (root == NULL)
64         return;
65     printf("%s ", root->val);
66     printTree(root->left);
67     printTree(root->right);
68 }
```

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```
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3> cd "c:\Users\varun\Desktop\VB\College\IIITNR\assignment\sem3\dsa\lab9\"; if ($?) { gcc lab9-1.c -o lab9-1 }; if ($?) { .\lab9-1 }
["root", "docs", "photos", "assignments", null, null, "music"]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9>
```

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lab9-1.c U X lab9-2.c U lab9-3.c U
lab9 > C lab9-1.c > @newNode(char *)
30  TreeNode *buildTreeUtil(char *preorder[], char *inorder[], int inStart, int inEnd, int *preIndex)
31  {
32      int inIndex = findIndex(inorder, inStart, inEnd, root->val);
33
34      root->left = buildTreeUtil(preorder, inorder, inStart, inIndex - 1, preIndex);
35      root->right = buildTreeUtil(preorder, inorder, inIndex + 1, inEnd, preIndex);
36
37      return root;
38  }
39
40  Tree *buildTree(char *preorder[], char *inorder[], int n)
41  {
42      int preIndex = 0;
43      return buildTreeUtil(preorder, inorder, 0, n - 1, &preIndex);
44  }
45
46  typedef struct Queue
47  {
48      Tree *data;
49      int front, rear, size;
50  } Queue;
51
52  Queue *createQueue(int size)
53  {
54      Queue *q = (Queue *)malloc(sizeof(Queue));
55      q->data = (Tree *)malloc(sizeof(Tree) * size);
56      q->front = q->rear = 0;
57      q->size = size;
58      return q;
59  }
60
61  int isEmpty(Queue *q)
62  {
63      return q->front == q->rear;
64  }
65
66  void enqueue(Queue *q, Tree *node)
67  {
68      if (q->rear < q->size)
69          q->data[q->rear++] = node;
70  }
71
72  80
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81  main+ 41.0t Run Testcases 0.0.0
82  lab9 > C lab9-1.c > @newNode(char *)
83  81  TreeNode *dequeue(Queue *q)
84  {
85      if (isEmpty(q))
86          return NULL;
87      return q->data[q->front++];
88  }
89
90  void printLevelOrder(Tree *root)
91  {
92      if (!root)
93      {
94          printf("[ ]\n");
95          return;
96      }
97
98      Queue *q = createQueue(100);
99      enqueue(q, root);
100
101      Tree *levelOrder[200];
102      int idx = 0;
103
104      while (!isEmpty(q))
105      {
106          Tree *node = dequeue(q);
107          levelOrder[idx++] = node;
108          if (node)
109          {
110              enqueue(q, node->left);
111              enqueue(q, node->right);
112          }
113      }
114
115      int lastNonNull = idx - 1;
116      while (lastNonNull >= 0 && levelOrder[lastNonNull] == NULL)
117          lastNonNull--;
118
119      printf("[");
120      for (int i = 0; i <= lastNonNull; i++)
121      {
122          if (levelOrder[i])
123              printf("%s", levelOrder[i]->val);
124      }
125  }
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```

```
lab9 > C lab9-1.c X C lab9-2.c U C lab9-3.c U
lab9 > C lab9-1.c > newNode(char *)
88 void printLevelOrder(TreeNode *root)
116 {
117     printf("[");
118     for (int i = 0; i <= lastNonNull; i++)
119     {
120         if (levelOrder[i])
121             printf("%s\\", levelOrder[i]->val);
122         else
123             printf("null");
124         if (i < lastNonNull)
125             printf(",");
126     }
127     printf("\\n");
128 }
129
130 int main()
131 {
132     char *preorder[] = {"root", "docs", "assignments", "photos", "music"};
133     char *inorder[] = {"assignments", "docs", "root", "photos", "music"};
134     int n = sizeof(preorder) / sizeof(preorder[0]);
135
136     TreeNode *root = buildTree(preorder, inorder, n);
137
138     printLevelOrder(root);
139
140     return 0;
141 }
142
```

```
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9> cd "c:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9"; if ($?) { gcc lab9-1.c -o lab9-1 }; if ($?) { .\lab9-1 }
["root", "docs", "photos", "assignments", null, null, "music"]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9>
```

## Task 02: Restore Family Tree from Birth Records:

( <https://github.com/varunnnb/dsa-sem3-iiitnr/blob/main/lab9/lab9-2.c>)

A genealogy company stores family data in two forms:

- inorder → listing of people in chronological order of birth within families.
- postorder → listing of children before their parents.

The database was corrupted, and you must reconstruct the original family tree.

You may assume all names are unique.

Input:

inorder = ["Eve", "Adam", "Cain", "Abel", "Seth"]

postorder = ["Eve", "Cain", "Abel", "Seth", "Adam"]

Output:

["Adam", "Eve", "Seth", null, null, "Cain", "Abel"]

```
lab9 > C lab9-1.c U C lab9-2.c U X C lab9-3.c U
lab9 > C lab9-2.c > 58 TreeNode
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <string.h>
4
5 typedef struct TreeNode
6 {
7     char *val;
8     struct TreeNode *left;
9     struct TreeNode *right;
10 } TreeNode;
11
12 TreeNode *newNode(char *val)
13 {
14     TreeNode *node = (TreeNode *)malloc(sizeof(TreeNode));
15     node->val = strdup(val);
16     node->left = node->right = NULL;
17     return node;
18 }
19
20 int findIndex(char *arr[], int start, int end, char *value)
21 {
22     for (int i = start; i <= end; i++)
23     {
24         if (strcmp(arr[i], value) == 0)
25             return i;
26     }
27     return -1;
28 }
29
30 TreeNode *buildTreeUtil(char *inorder[], char *postorder[], int inStart, int inEnd, int *postIndex)
31 {
32     if (inStart > inEnd)
33         return NULL;
34
35     TreeNode *root = newNode(postorder[*postIndex]);
36     (*postIndex)--;
37
38     if (inStart == inEnd)
39         return root;
40
41     int inIndex = findIndex(inorder, inStart, inEnd, root->val);
42
43     root->left = buildTreeUtil(inorder, postorder, inStart, inIndex, postIndex);
44     root->right = buildTreeUtil(inorder, postorder, inIndex + 1, inEnd, postIndex);
45
46     return root;
47 }
48
49 int main()
50 {
51     char *inorder[] = {"Eve", "Adam", "Cain", "Abel", "Seth"};
52     char *postorder[] = {"Eve", "Cain", "Abel", "Seth", "Adam"};
53     int inStart = 0, inEnd = 4, postIndex = 4;
54
55     TreeNode *root = buildTreeUtil(inorder, postorder, inStart, inEnd, &postIndex);
56
57     printLevelOrder(root);
58
59     return 0;
60 }

```

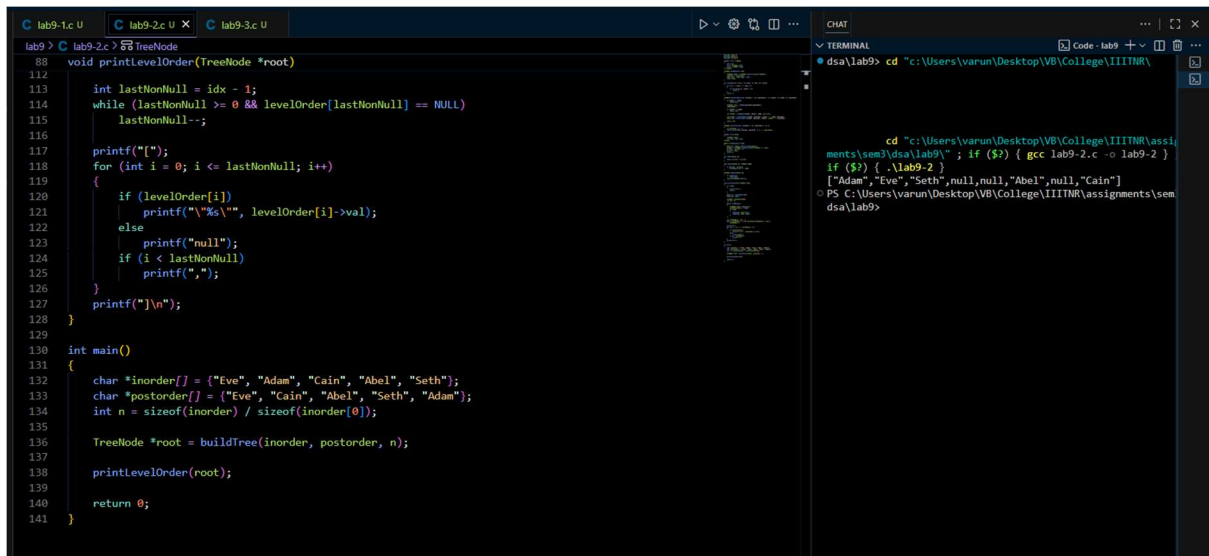
```
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9> cd "c:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9"; if ($?) { gcc lab9-2.c -o lab9-2 }; if ($?) { .\lab9-2 }
["Adam", "Eve", "Seth", null, null, "Cain", "Abel"]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9>
```

```
lab9-1.c U lab9-2.c U X lab9-3.c U
lab9 > C lab9-2.c > 88 TreeNode
30  TreeNode *buildTreeUtil(char *inorder[], char *postorder[], int inStart, int inEnd, int *postIndex)
43      root->right = buildTreeUtil(inorder, postorder, inIndex + 1, inEnd, postIndex);
44      root->left = buildTreeUtil(inorder, postorder, inStart, inIndex - 1, postIndex);
45
46      return root;
47  }
48
49  TreeNode *buildTree(char *inorder[], char *postorder[], int n)
50  {
51      int postIndex = n - 1;
52      return buildTreeUtil(inorder, postorder, 0, n - 1, &postIndex);
53  }
54
55  typedef struct Queue
56  {
57      TreeNode **data;
58      int front, rear, size;
59  } Queue;
60
61  Queue *createQueue(int size)
62  {
63      Queue *q = (Queue *)malloc(sizeof(Queue));
64      q->data = (TreeNode **)malloc(sizeof(TreeNode *) * size);
65      q->front = q->rear = 0;
66      q->size = size;
67      return q;
68  }
69
70  int isEmpty(Queue *q)
71  {
72      return q->front == q->rear;
73  }
74
75  void enqueue(Queue *q, TreeNode *node)
76  {
77      if (q->rear < q->size)
78          q->data[q->rear++] = node;
79  }
80
81  TreeNode *dequeue(Queue *q)
82  {
83      if (isEmpty(q))
84          return NULL;
85      return q->data[q->front++];
86  }
87
88  void printLevelOrder(TreeNode *root)
89  {
90      if (!root)
91      {
92          printf("[ ]\n");
93          return;
94      }
95
96      Queue *q = createQueue(100);
97      enqueue(q, root);
98
99      TreeNode *levelOrder[200];
100      int idx = 0;
101
102      while (!isEmpty(q))
103      {
104          TreeNode *node = dequeue(q);
105          levelOrder[idx++] = node;
106          if (node)
107          {
108              enqueue(q, node->left);
109              enqueue(q, node->right);
110          }
111      }
112
113      int lastNonNull = idx - 1;
114      while (lastNonNull >= 0 && levelOrder[lastNonNull] == NULL)
115          lastNonNull--;
116
117      printf("[");
118      for (int i = 0; i <= lastNonNull; i++)
119      {
120          if (levelOrder[i])
121              printf("%s", levelOrder[i]->val);
122      }
123      printf("]\n");
124  }
125
126  int main()
127  {
128      char inorder[] = "BACEDFGH";
129      char postorder[] = "BCEADFGH";
130      int n = 8;
131      TreeNode *root = buildTree(inorder, postorder, n);
132      printLevelOrder(root);
133      return 0;
134  }
```

```
dsa\lab9> cd "c:\Users\varun\Desktop\VB\College\IIITNR\assig
ments\sem3\dsa\lab9\" ; if ($?) { gcc lab9-2.c -o lab9-2 } ;
if ($?) { .\lab9-2 }
["Adam","Eve","Seth",null,null,"Abel",null,"Cain"]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9>
```

```
lab9-1.c U lab9-2.c U X lab9-3.c U
lab9 > C lab9-2.c > 88 TreeNode
81  TreeNode *dequeue(Queue *q)
82  {
83      if (isEmpty(q))
84          return NULL;
85      return q->data[q->front++];
86  }
87
88  void printLevelOrder(TreeNode *root)
89  {
90      if (!root)
91      {
92          printf("[ ]\n");
93          return;
94      }
95
96      Queue *q = createQueue(100);
97      enqueue(q, root);
98
99      TreeNode *levelOrder[200];
100      int idx = 0;
101
102      while (!isEmpty(q))
103      {
104          TreeNode *node = dequeue(q);
105          levelOrder[idx++] = node;
106          if (node)
107          {
108              enqueue(q, node->left);
109              enqueue(q, node->right);
110          }
111      }
112
113      int lastNonNull = idx - 1;
114      while (lastNonNull >= 0 && levelOrder[lastNonNull] == NULL)
115          lastNonNull--;
116
117      printf("[");
118      for (int i = 0; i <= lastNonNull; i++)
119      {
120          if (levelOrder[i])
121              printf("%s", levelOrder[i]->val);
122      }
123      printf("]\n");
124  }
125
126  int main()
127  {
128      char inorder[] = "BACEDFGH";
129      char postorder[] = "BCEADFGH";
130      int n = 8;
131      TreeNode *root = buildTree(inorder, postorder, n);
132      printLevelOrder(root);
133      return 0;
134  }
```

```
dsa\lab9> cd "c:\Users\varun\Desktop\VB\College\IIITNR\assig
ments\sem3\dsa\lab9\" ; if ($?) { gcc lab9-2.c -o lab9-2 } ;
if ($?) { .\lab9-2 }
["Adam","Eve","Seth",null,null,"Abel",null,"Cain"]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem3\dsa\lab9>
```



```
lab9 > C lab9-2.c U X C lab9-3.c U
lab9 > C lab9-2.c U 58 TreeNode
88 void printLevelOrder(TreeNode *root)
112
113 int lastNonNull = idx - 1;
114 while (lastNonNull >= 0 && levelOrder[lastNonNull] == NULL)
115     lastNonNull--;
116
117 printf("[");
118 for (int i = 0; i <= lastNonNull; i++)
119 {
120     if (levelOrder[i])
121         printf("%s\\", levelOrder[i]->val);
122     else
123         printf("null");
124     if (i < lastNonNull)
125         printf(",");
126 }
127 printf("]\\n");
128 }
129
130 int main()
131 {
132     char *inorder[] = {"Eve", "Adam", "Cain", "Abel", "Seth"};
133     char *postorder[] = {"Eve", "Cain", "Abel", "Seth", "Adam"};
134     int n = sizeof(inorder) / sizeof(inorder[0]);
135
136     TreeNode *root = buildTree(inorder, postorder, n);
137
138     printLevelOrder(root);
139
140     return 0;
141 }
```

## Task 03: Reconstruct Network Topology from Connection Logs:

( <https://github.com/varunnnb/dsa-sem3-iiitnr/blob/main/lab9/lab9-3.c> )

In a distributed network, servers and routers form a tree topology.

- preorder → the order in which connections were established from the main server outward.
- postorder → the order in which messages were acknowledged back to the main server.

Given these two logs, reconstruct the network topology.

If the network is not a full binary tree (where every router has either 0 or 2 connections), the topology cannot be uniquely reconstructed.

Input:

preorder = [1,2,4,5,3,6,7]

postorder = [4,5,2,6,7,3,1]

Output:

[1,2,3,4,5,6,7]

Input:

preorder = [1,2,3]

postorder = [2,3,1]

Output:

"Network topology cannot be uniquely reconstructed"

```
lab9 > C lab9-3.c U X
1 #include <stdio.h>
2 #include <stdlib.h>
3
4 typedef struct TreeNode
5 {
6     int val;
7     struct TreeNode *left;
8     struct TreeNode *right;
9 } TreeNode;
10
11 TreeNode *newNode(int val)
12 {
13     TreeNode *node = (TreeNode *)malloc(sizeof(TreeNode));
14     node->val = val;
15     node->left = node->right = NULL;
16     return node;
17 }
18
19 TreeNode *buildFullBinaryTree(int *pre, int *post, int *preIndex, int postStart, int postEnd, int n)
20 {
21     if (*preIndex >= n || postStart > postEnd)
22         return NULL;
23
24     TreeNode *root = newNode(pre[*preIndex]);
25     (*preIndex)++;
26
27     if (postStart == postEnd || *preIndex >= n)
28         return root;
29
30     int leftChild = pre[*preIndex];
31     int i;
32     for (i = postStart; i <= postEnd; i++)
33     {
34         if (post[i] == leftChild)
35             break;
36     }
37     if (i > postEnd)
38         return NULL;
39     if (i < postEnd - 1)
40     {
41         // ...
42     }
43 }
```

```
cd "c:\Users\varun\Desktop\VB\College\IIITNR\assig
ments\sem3\dsa\lab9\" ; if ($?) { gcc lab9-3.c -o lab9-3 } ;
if ($?) { .\lab9-3 }
[1,2,3,4,5,6,7]
[1,2,3]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem
dsa\lab9>
```

```
lab9 > C lab9-3.c U X
19 TreeNode *buildFullBinaryTree(int *pre, int *post, int *preIndex, int postStart, int postEnd, int n)
20 {
21     if (i < postEnd - 1)
22     {
23         root->left = buildFullBinaryTree(pre, post, preIndex, postStart, i, n);
24         root->right = buildFullBinaryTree(pre, post, preIndex, i + 1, postEnd - 1, n);
25     }
26     else
27     {
28         return NULL;
29     }
30     return root;
31 }
32
33 void printLevelOrder(TreeNode *root)
34 {
35     if (!root)
36     {
37         printf("[ ]\n");
38         return;
39     }
40     TreeNode *queue[100];
41     int front = 0, rear = 0;
42     queue[rear++] = root;
43     int idx = 0;
44     int vals[100];
45     while (front < rear)
46     {
47         TreeNode *node = queue[front++];
48         vals[idx++] = node->val;
49         if (node->left)
50             queue[rear++] = node->left;
51         if (node->right)
52             queue[rear++] = node->right;
53     }
54     printf("[");
55     for (int i = 0; i < idx; i++)
56     {
57         printf("%d", vals[i]);
58         if (i < idx - 1)
59             printf(",");
60     }
61     printf("]\n");
62 }
```

```
cd "c:\Users\varun\Desktop\VB\College\IIITNR\assig
ments\sem3\dsa\lab9\" ; if ($?) { gcc lab9-3.c -o lab9-3 } ;
if ($?) { .\lab9-3 }
[1,2,3,4,5,6,7]
[1,2,3]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem
dsa\lab9>
```

```
lab9-1.c U lab9-2.c U lab9-3.c U X
lab9> C lab9-3.c > main()
52 void printLevelOrder(TreeNode *root)
74 for (int i = 0; i < idx; i++)
75 {
76     printf("%d", vals[i]);
77     if (i < idx - 1)
78         printf(",");
79 }
80 printf("\n");
81 }
82 }
83 int main()
84 {
85     int preorder1[] = {1, 2, 4, 5, 3, 6, 7};
86     int postorder1[] = {4, 5, 2, 6, 7, 3, 1};
87     int n1 = sizeof(preorder1) / sizeof(preorder1[0]);
88     int preIndex1 = 0;
89     TreeNode *root1 = buildFullBinaryTree(preorder1, postorder1, &preIndex1, 0, n1 - 1, n1);
90     if (root1)
91         printLevelOrder(root1);
92     else
93         printf("\nNetwork topology cannot be uniquely reconstructed\n");
94
95     int preorder2[] = {1, 2, 3};
96     int postorder2[] = {2, 3, 1};
97     int n2 = sizeof(preorder2) / sizeof(preorder2[0]);
98     int preIndex2 = 0;
99     TreeNode *root2 = buildFullBinaryTree(preorder2, postorder2, &preIndex2, 0, n2 - 1, n2);
100     if (root2)
101         printLevelOrder(root2);
102     else
103         printf("\nNetwork topology cannot be uniquely reconstructed\n");
104
105     return 0;
106 }
```

```
CHAT
TERMINAL
dsa\lab9> cd "c:\Users\varun\Desktop\VB\College\IIITNR\assig
cd "c:\Users\varun\Desktop\VB\College\IIITNR\assig
ments\sem3\dsa\lab9\"; if ($?) { gcc lab9-3.c -o lab9-3 } ;
if ($?) { .\lab9-3 }
[1,2,3,4,5,6,7]
[1,2,3]
PS C:\Users\varun\Desktop\VB\College\IIITNR\assignments\sem:
dsa\lab9>
```