Nonlinear Data Structure

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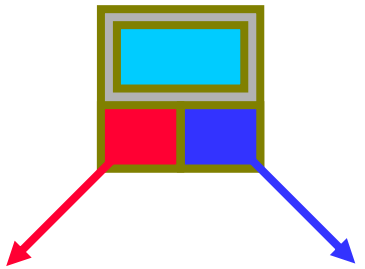
핸드폰으로 언제든 전화하시오.

Traversing a Binary Tree
(이진트리순회방문)

The Scenario

- **Imagine we have a binary tree**
- **We want to traverse the tree**
  - **It's not linear**
  - **We need a way to visit all nodes**

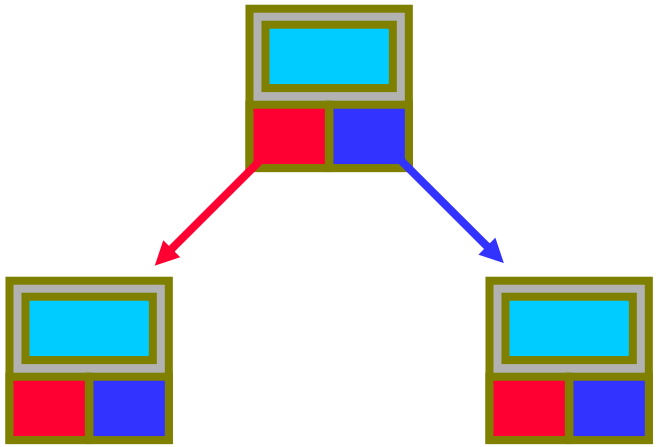


- **Three things must happen:**
  - **Deal with the entire left sub-tree** L
  - **Deal with the current node** P
  - **Deal with the entire right sub-tree** R

Outline of In-Order Traversal
중위순회

- **Three principle steps:3원칙**
  - **Traverse Left(왼쪽으로간다)**
  - **Do work (Current)-Data(인쇄)**
  - **Traverse Right(오른쪽으로간다)**

- **Work can be anything(어떤 작업도 가능)**
- **Separate work from traversal**



- Traverse the tree "In order":
  - Visit the tree's left sub-tree — L
  - Visit the current and do work — P
  - Visit right sub-tree — R

Inorder traversal(중위순회)

```
inorder(T)
    if (T ≠ null) then {
            inorder(T.left);      L
            visit T.data;         P
            inorder(T.right);     R
    }
end inorder()
```

Preorder traversal(전위 순회)

- In preorder, the root is visited *first*
- Here's a preorder traversal to print out all the elements in the binary tree:

```
preorder(T)
    if (T ≠ null) then {
            visit T.data;          P
          preorder(T.left);        L
          preorder(T.right);       R
    }
end preorder()
```

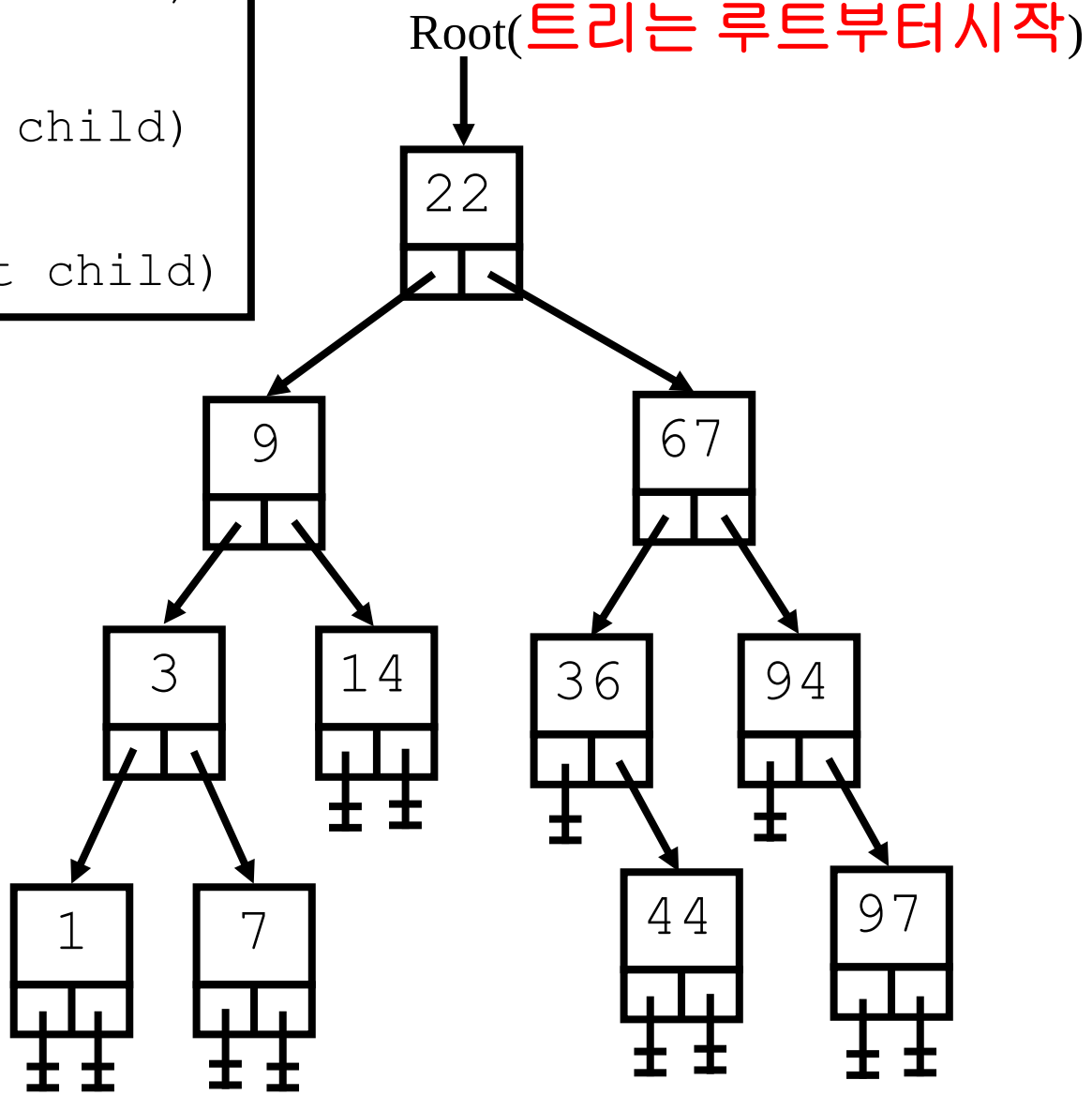
Postorder traversal(후위순회)

- In postorder, the root is visited *last*
- Here's a postorder traversal to print out all the elements in the binary tree:

```
postorder(T)
    if (T ≠ null) then {
        postorder(T.left);
        postorder(T.right);
        visit T.data;
    }
```

L
R
P

```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```



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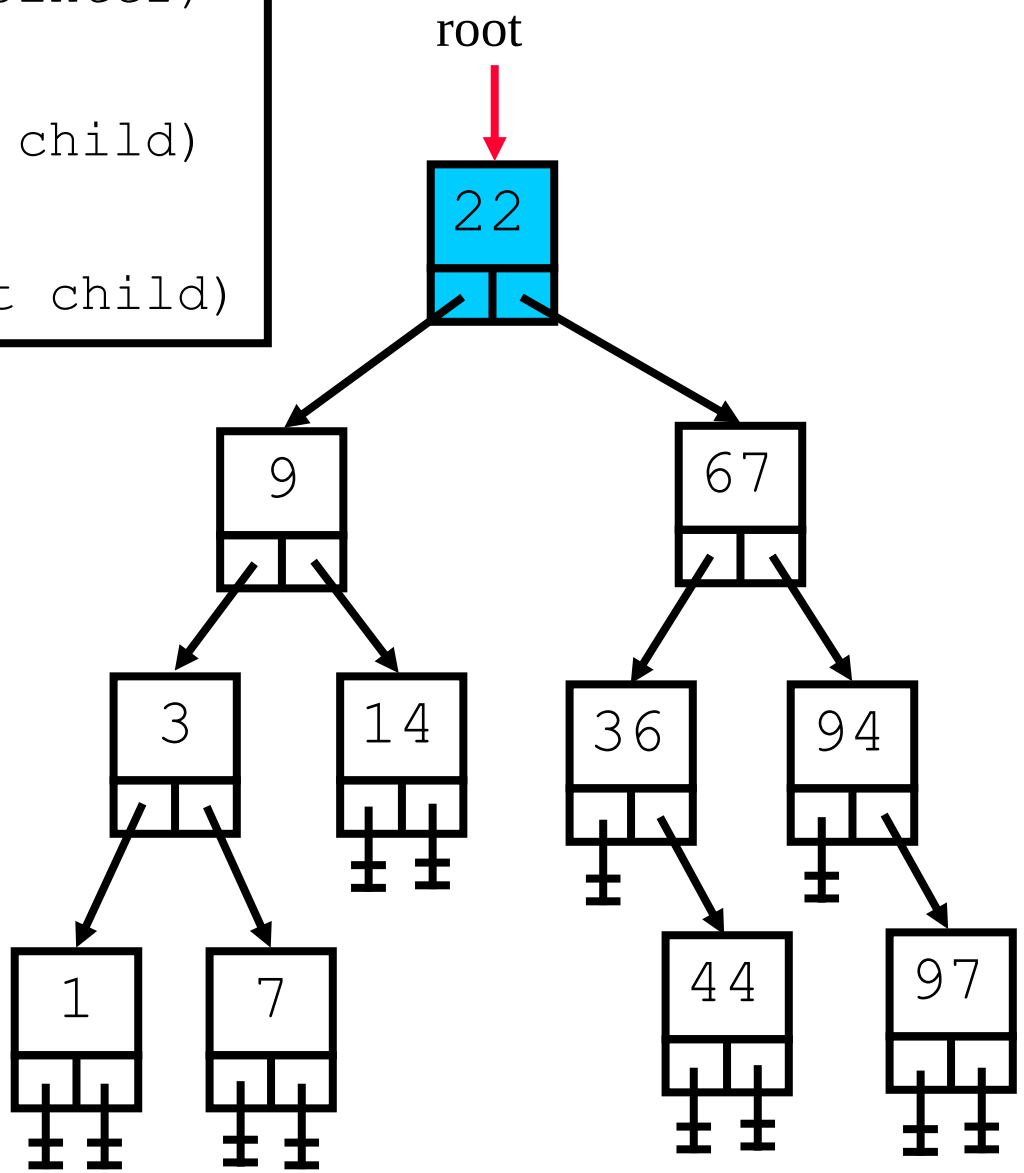

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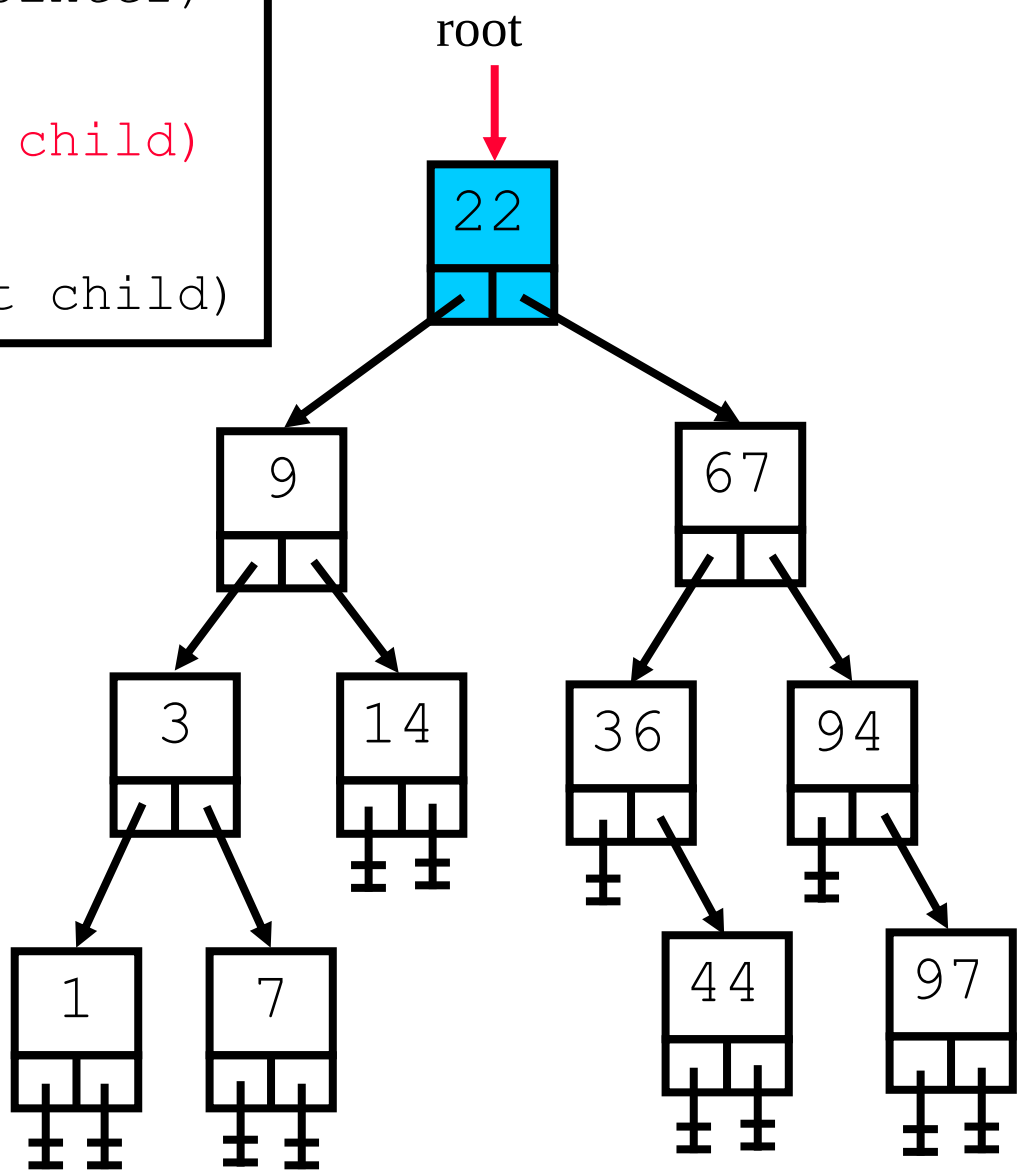

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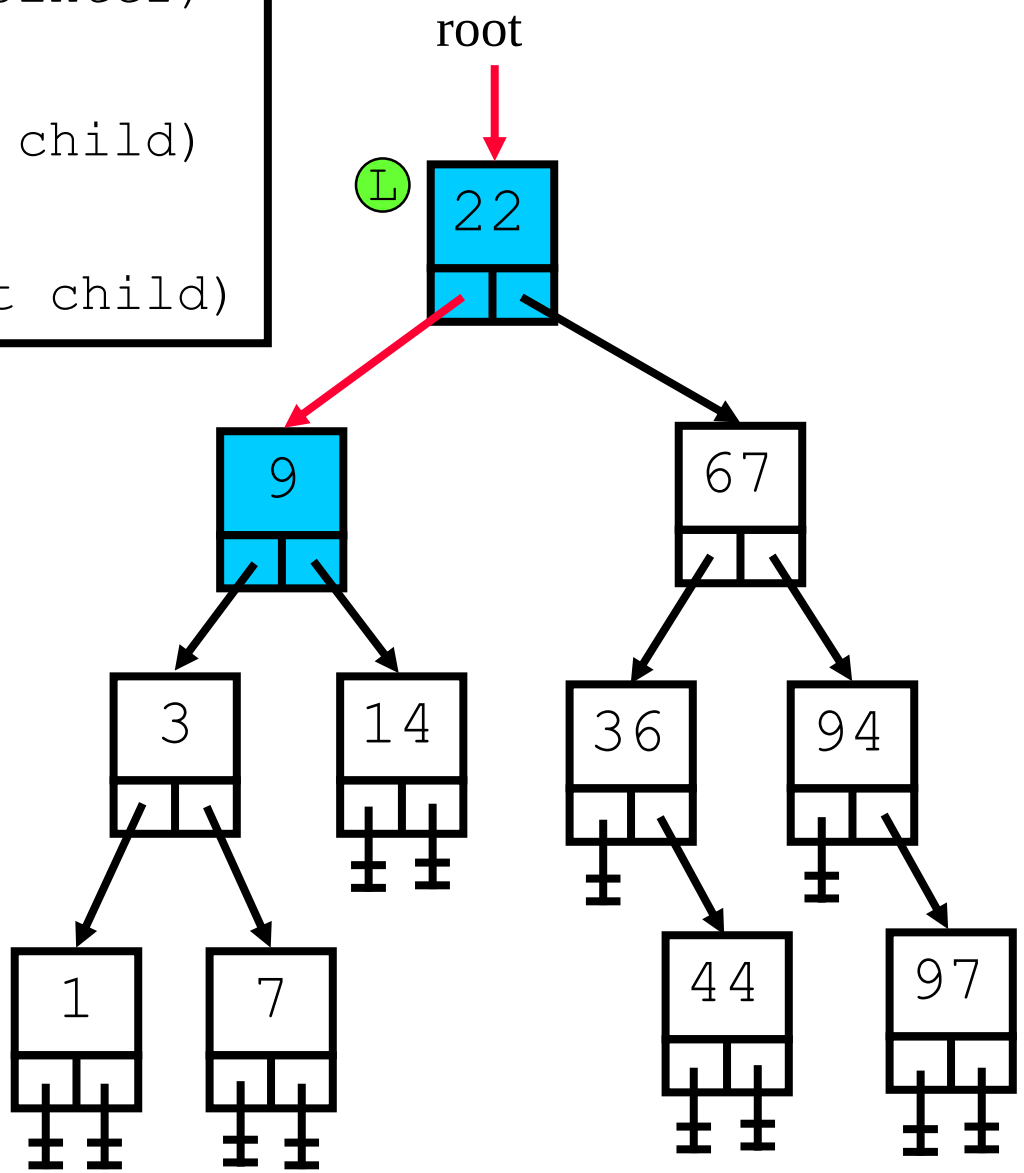

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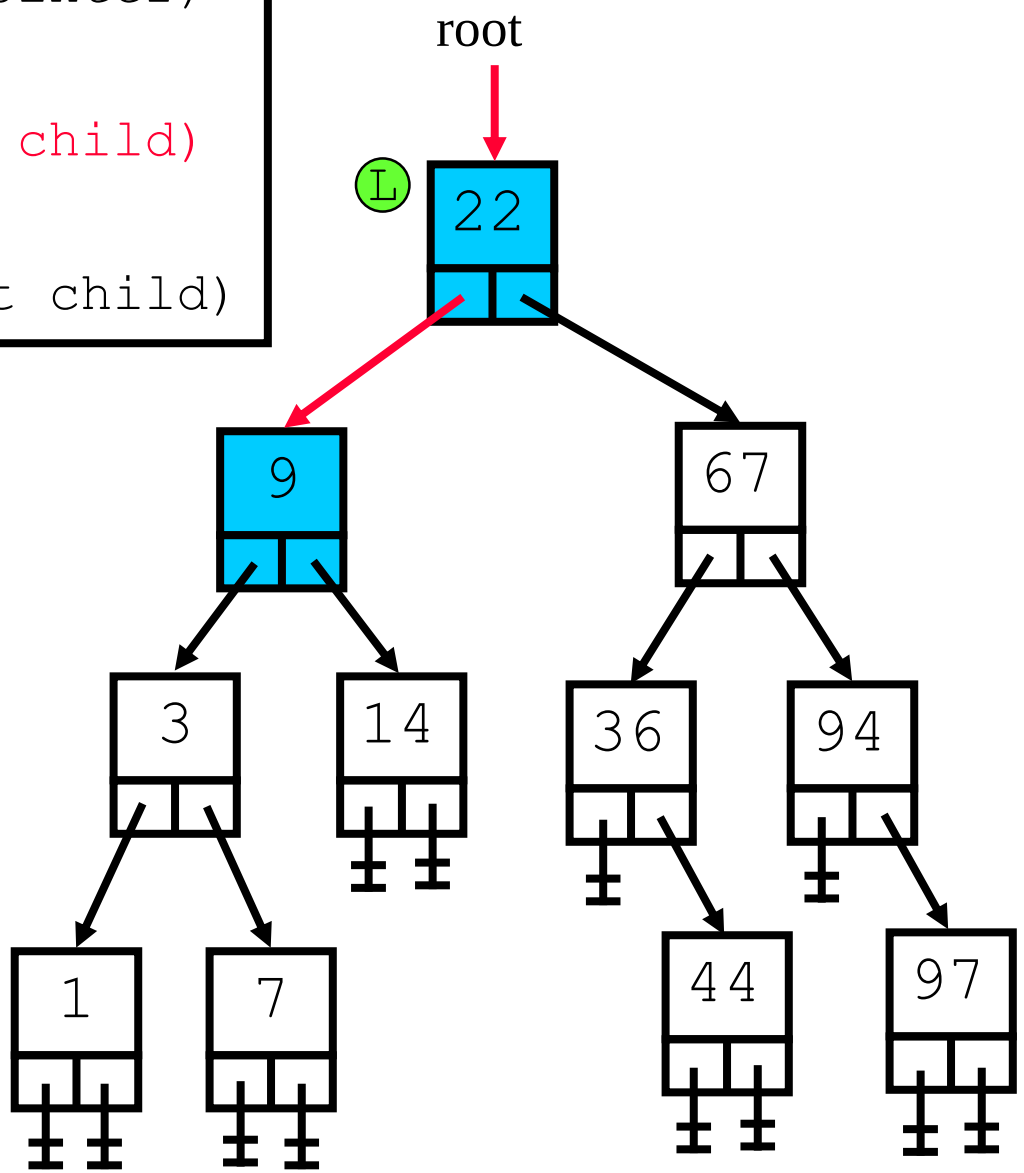

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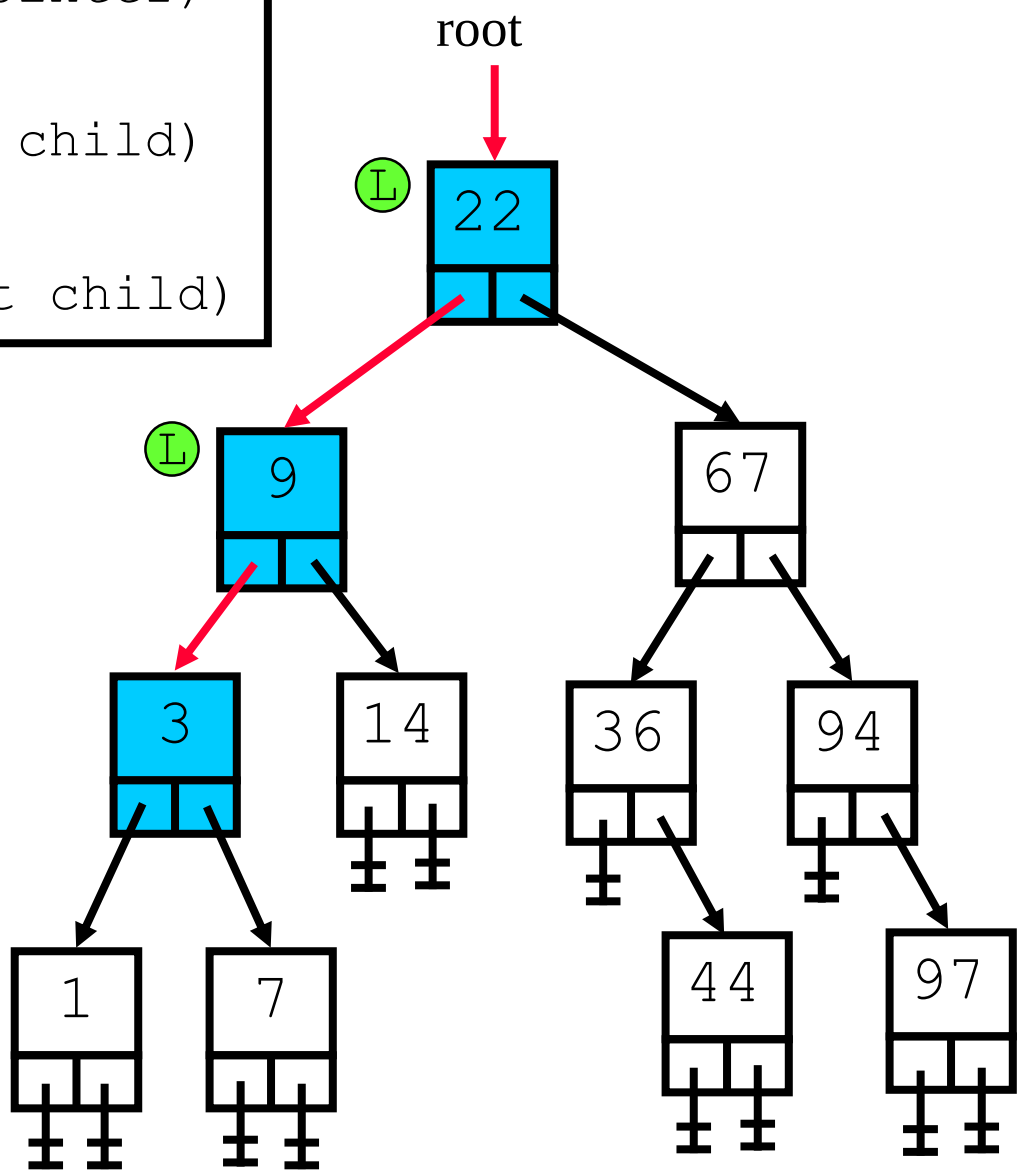

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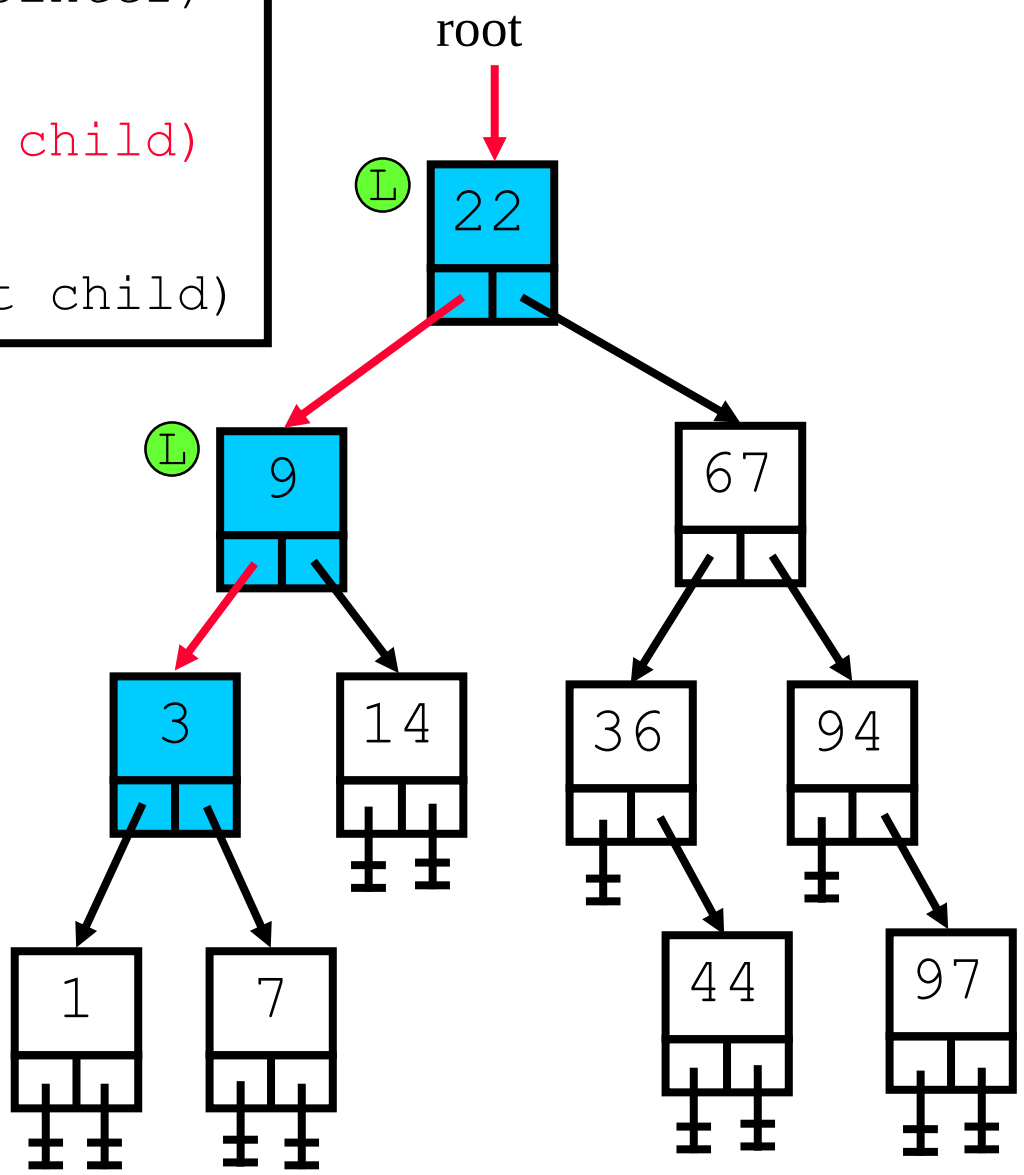

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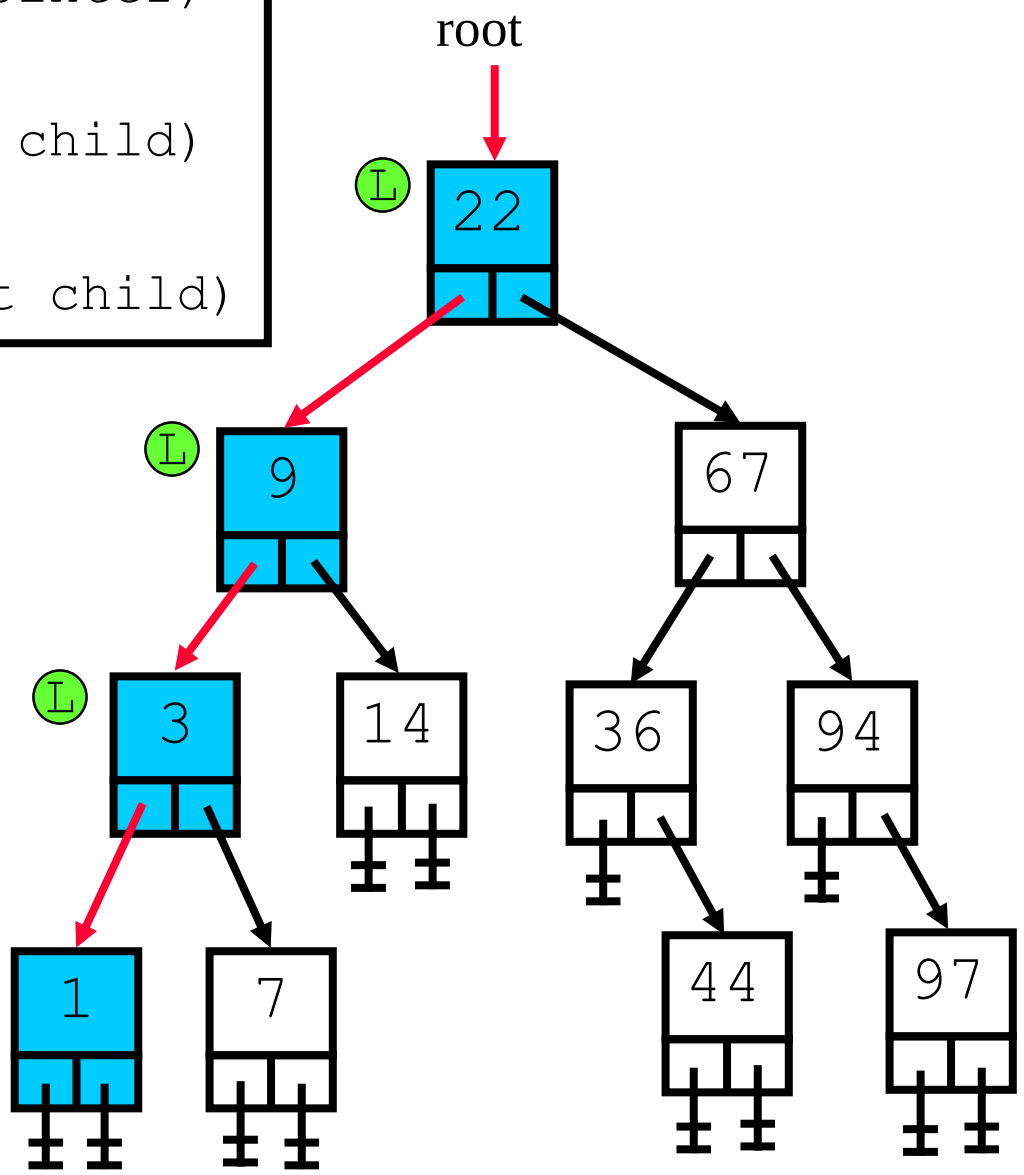

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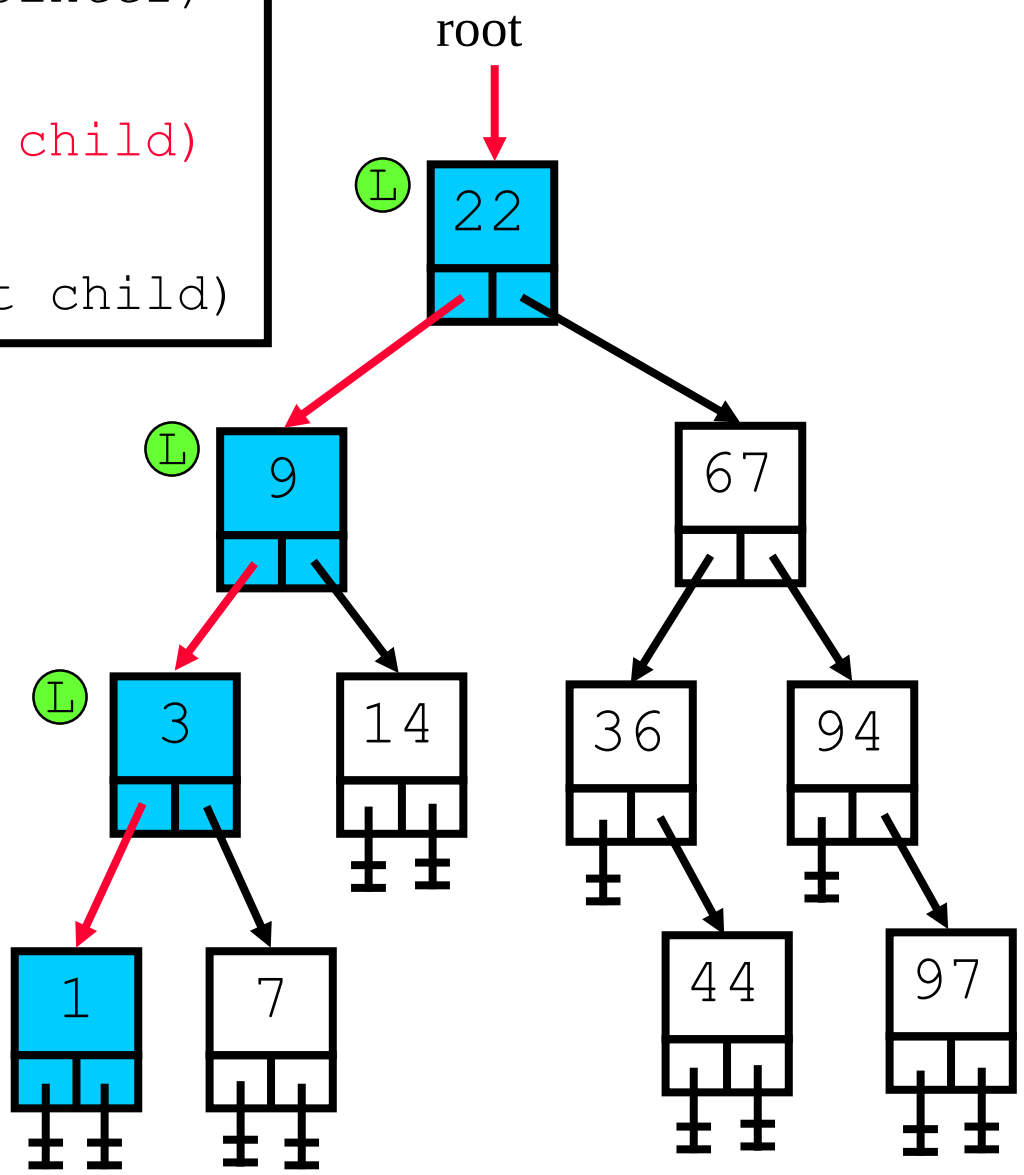

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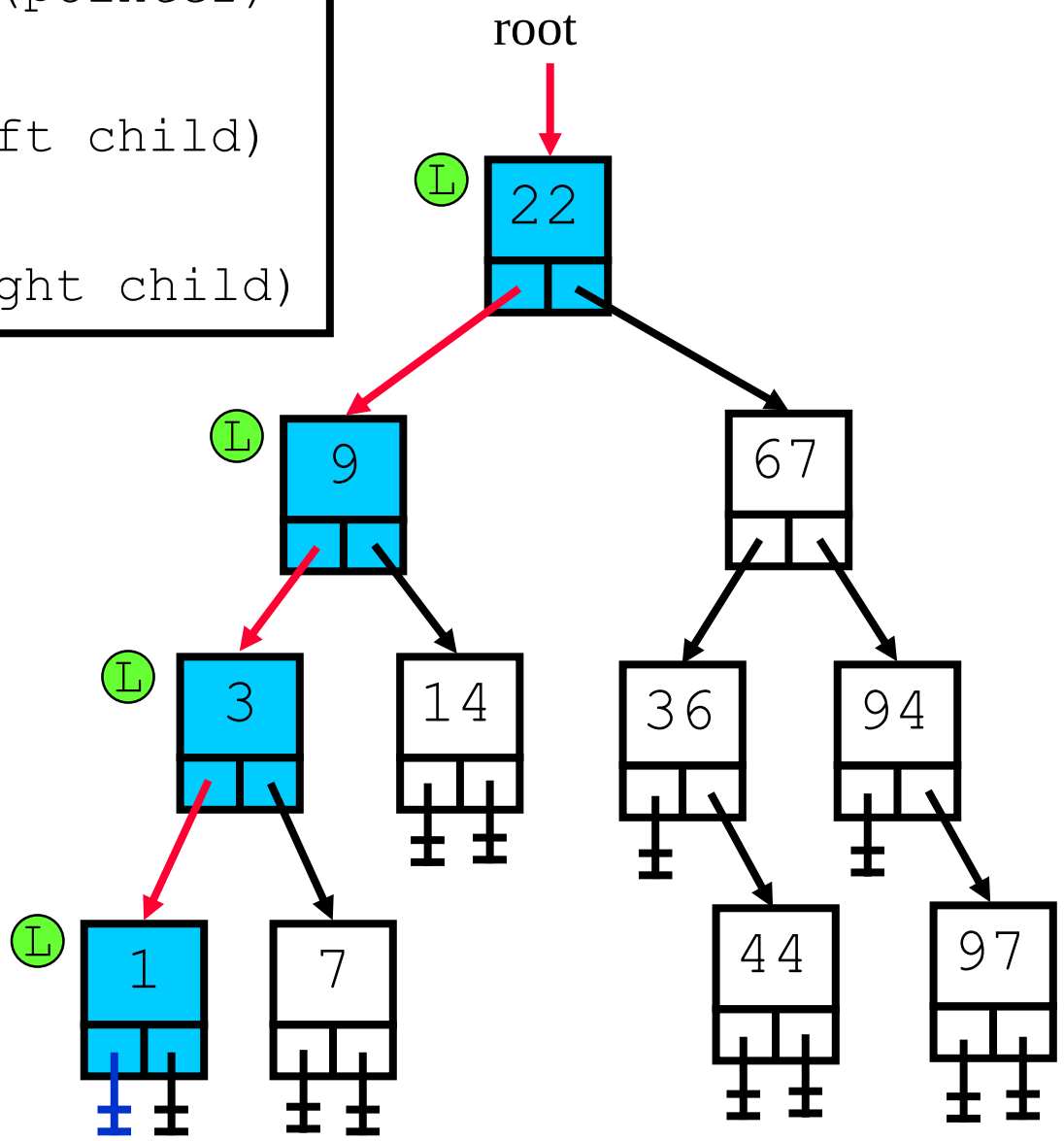

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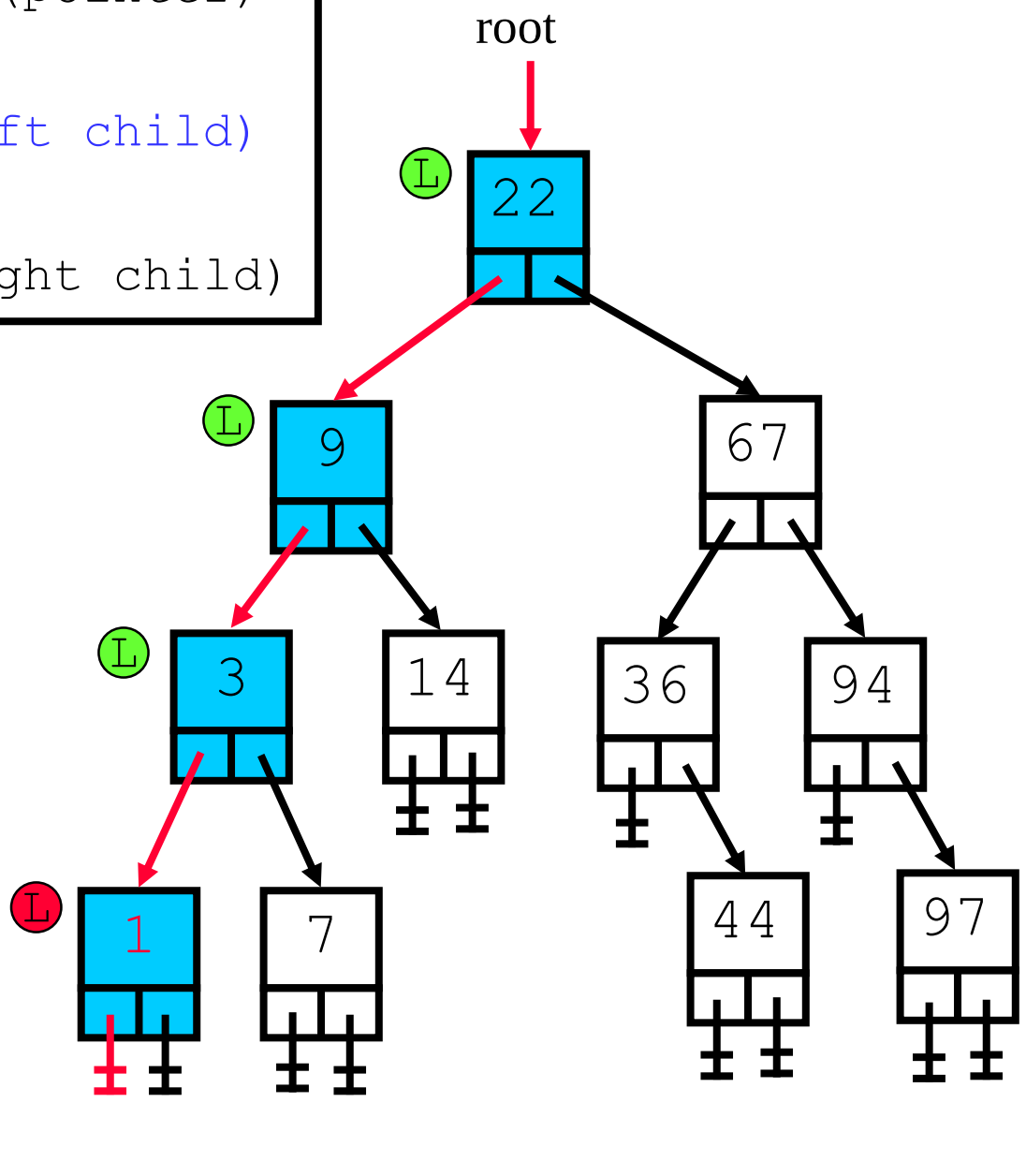

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Proc InOrderPrint(pointer)
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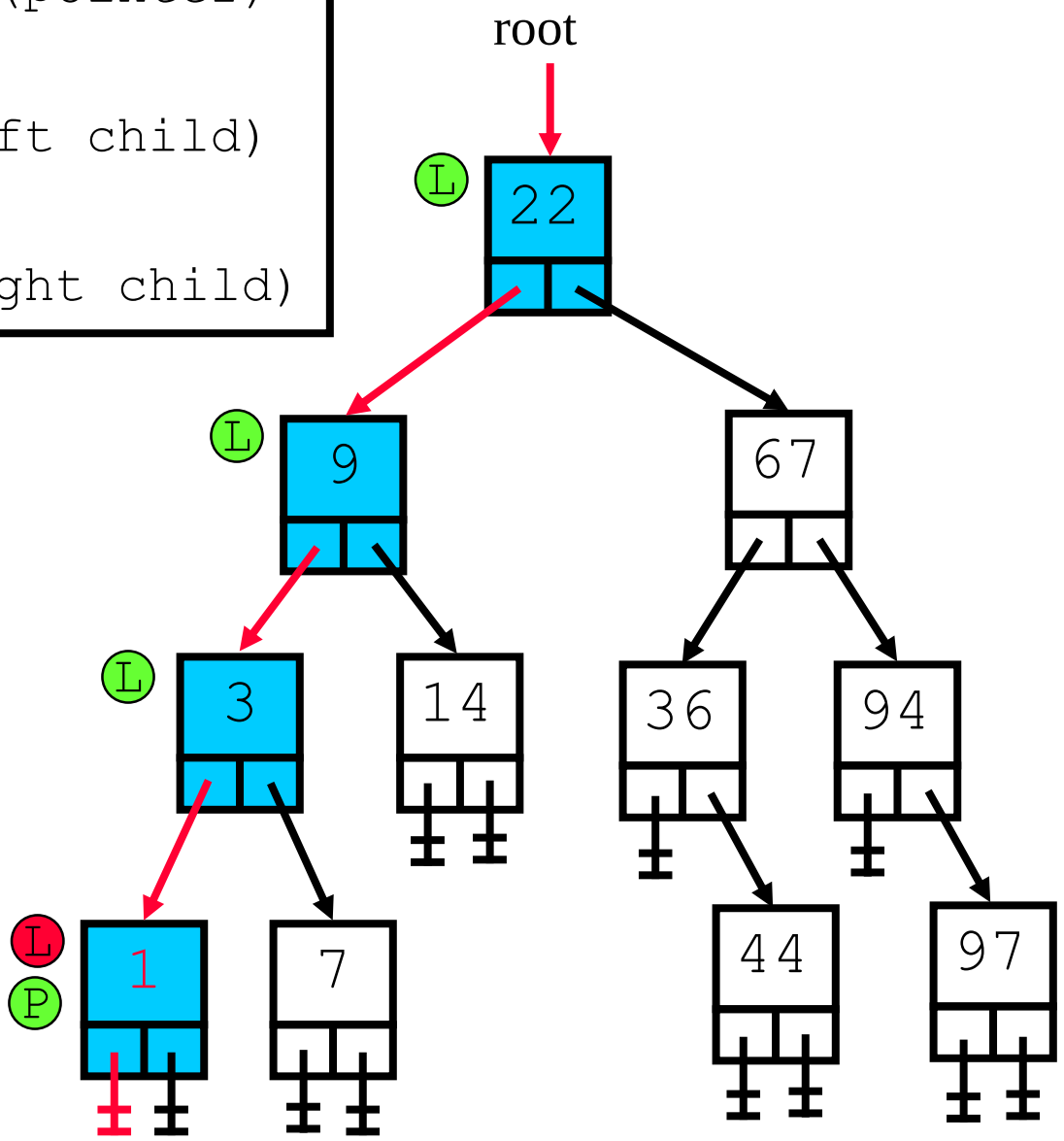
```

```
Output: 1
```



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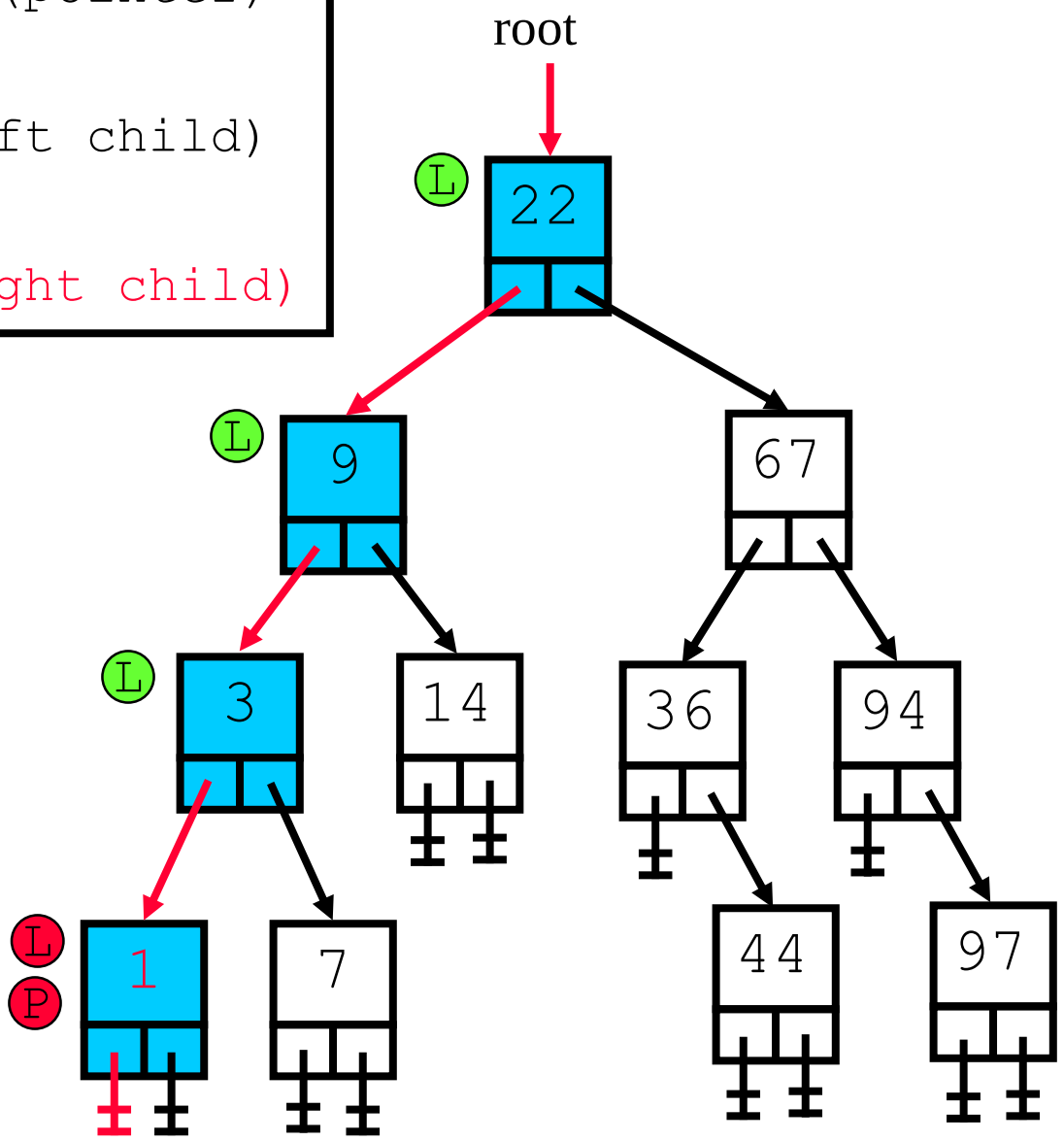
```

```
Output: 1
```



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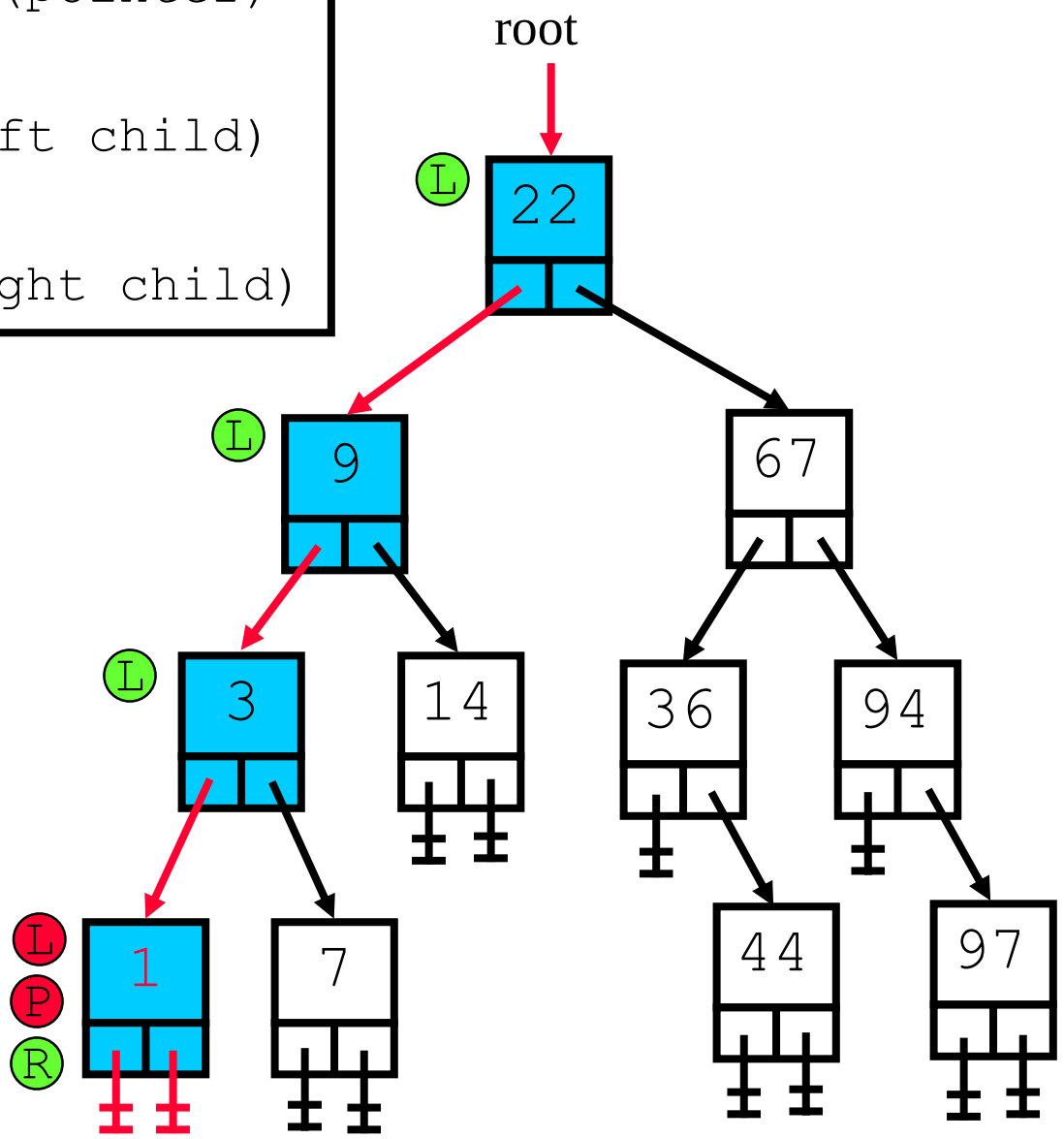

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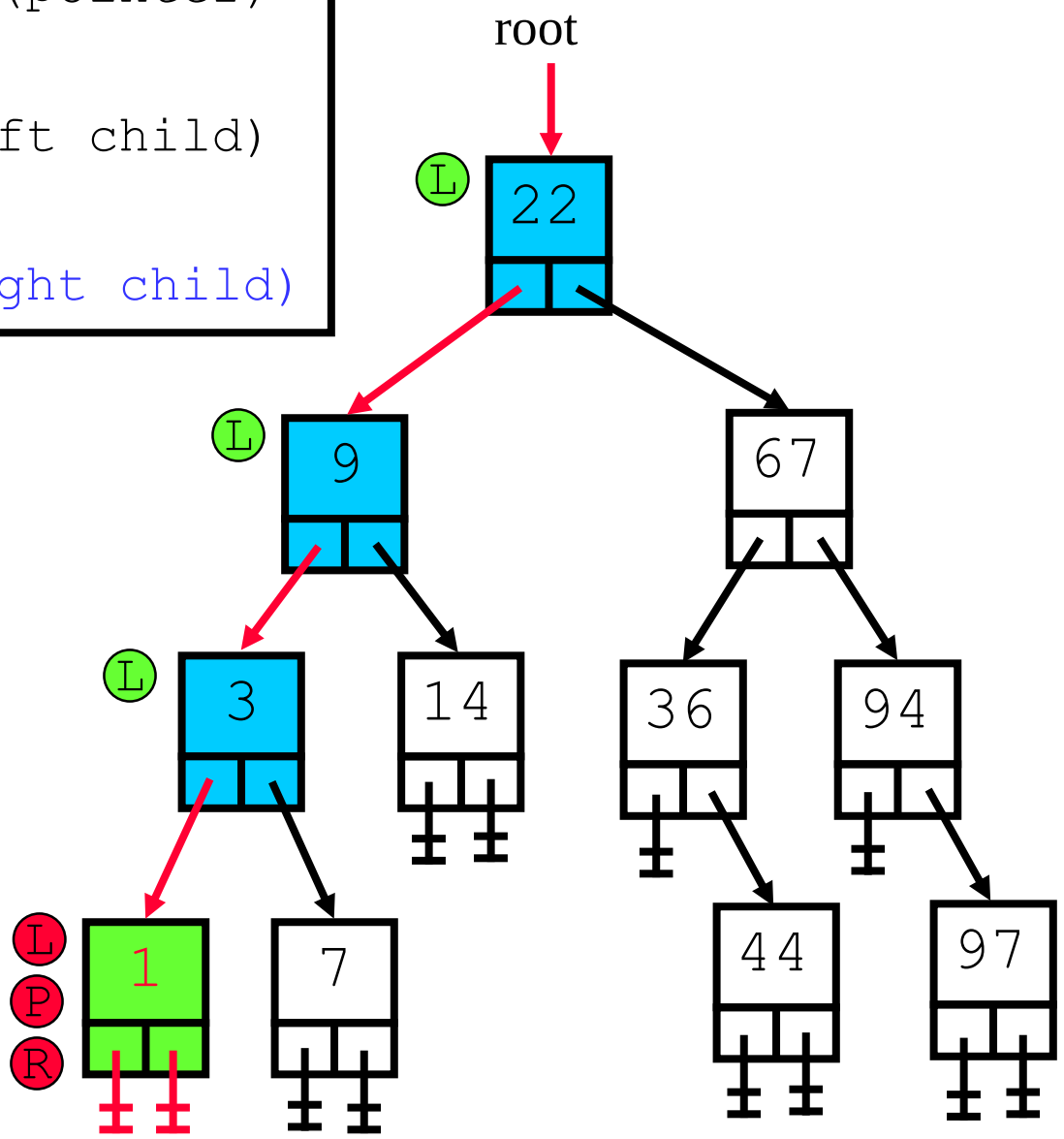

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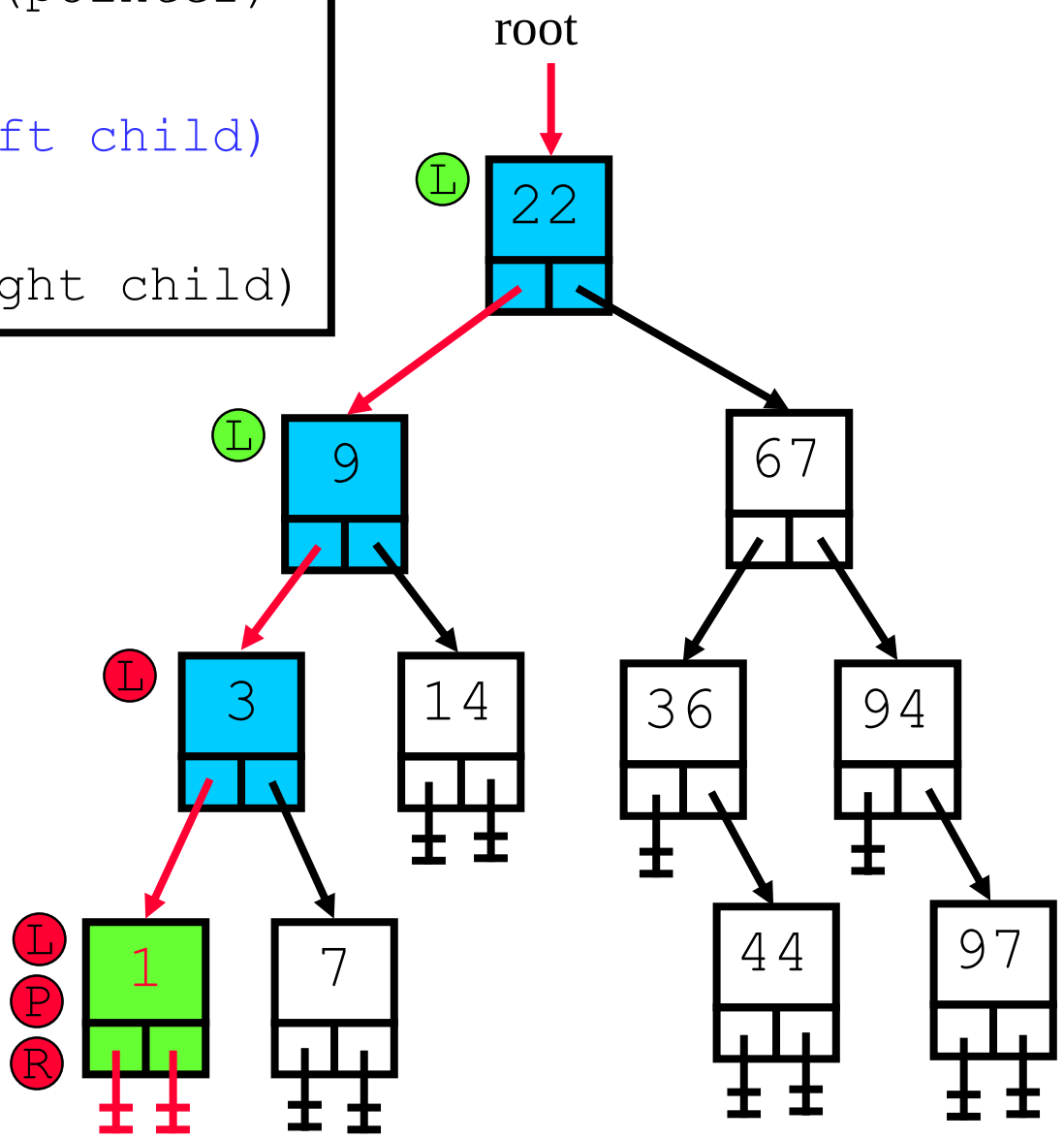

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Output: 1 3
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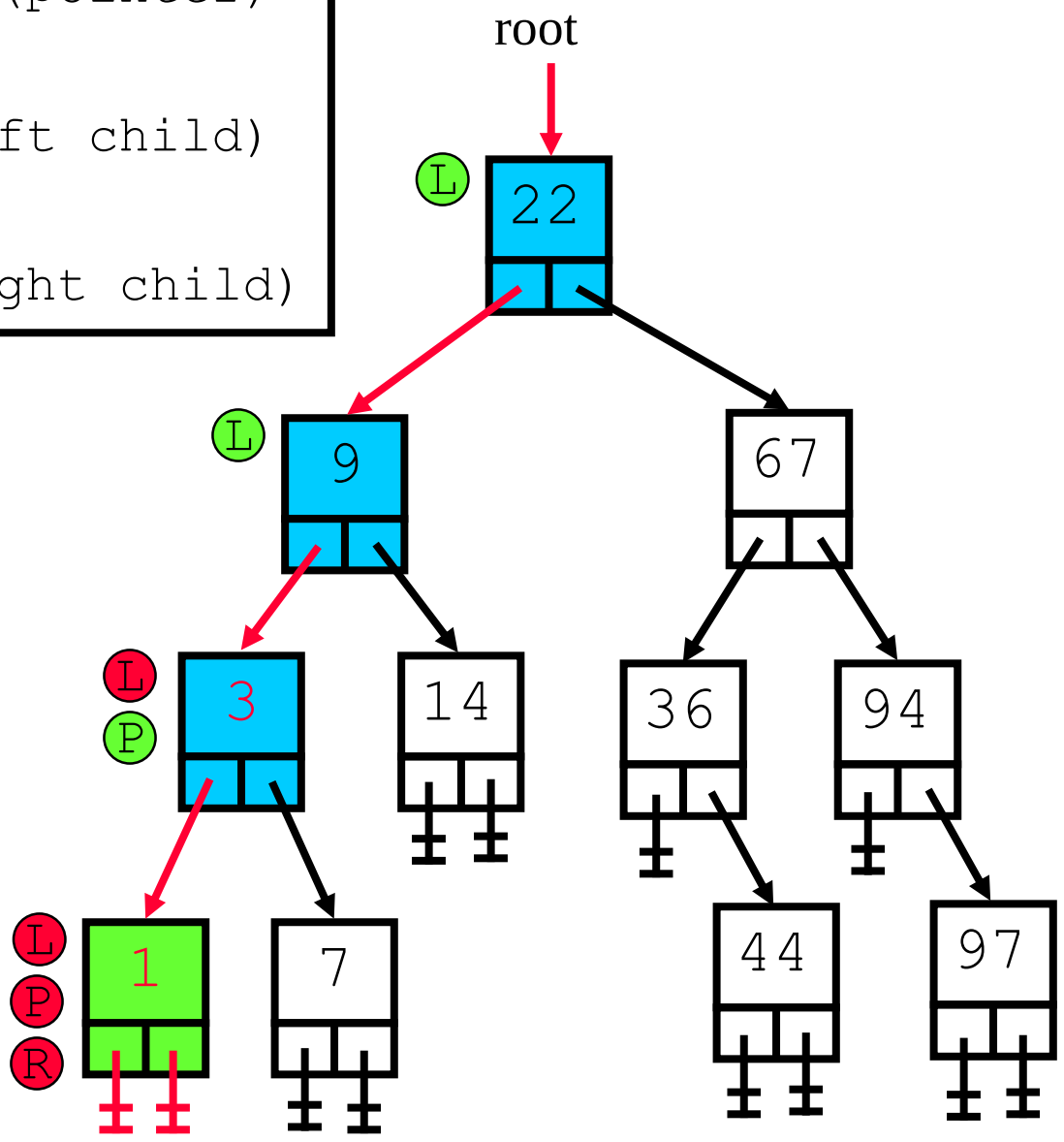

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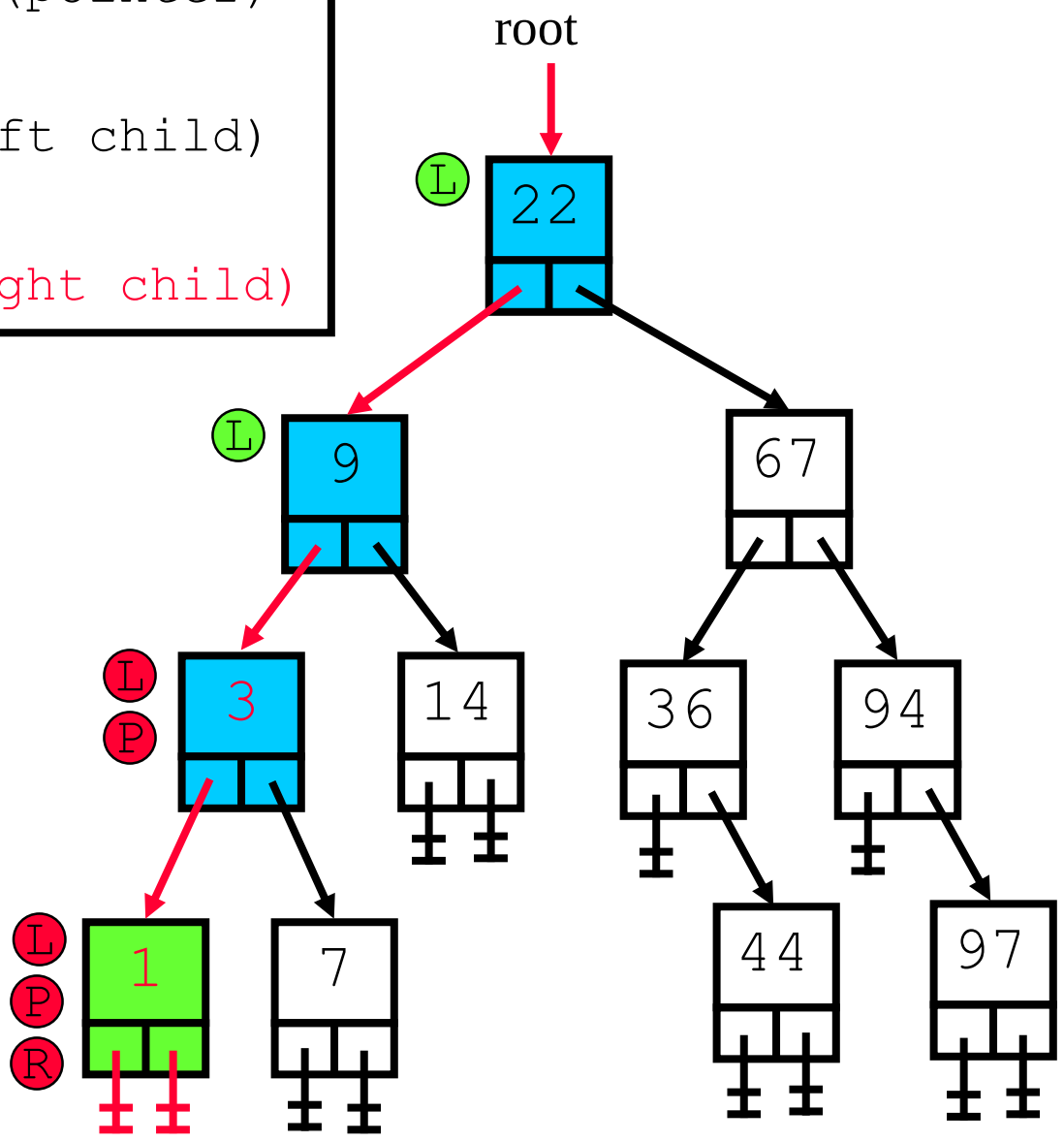

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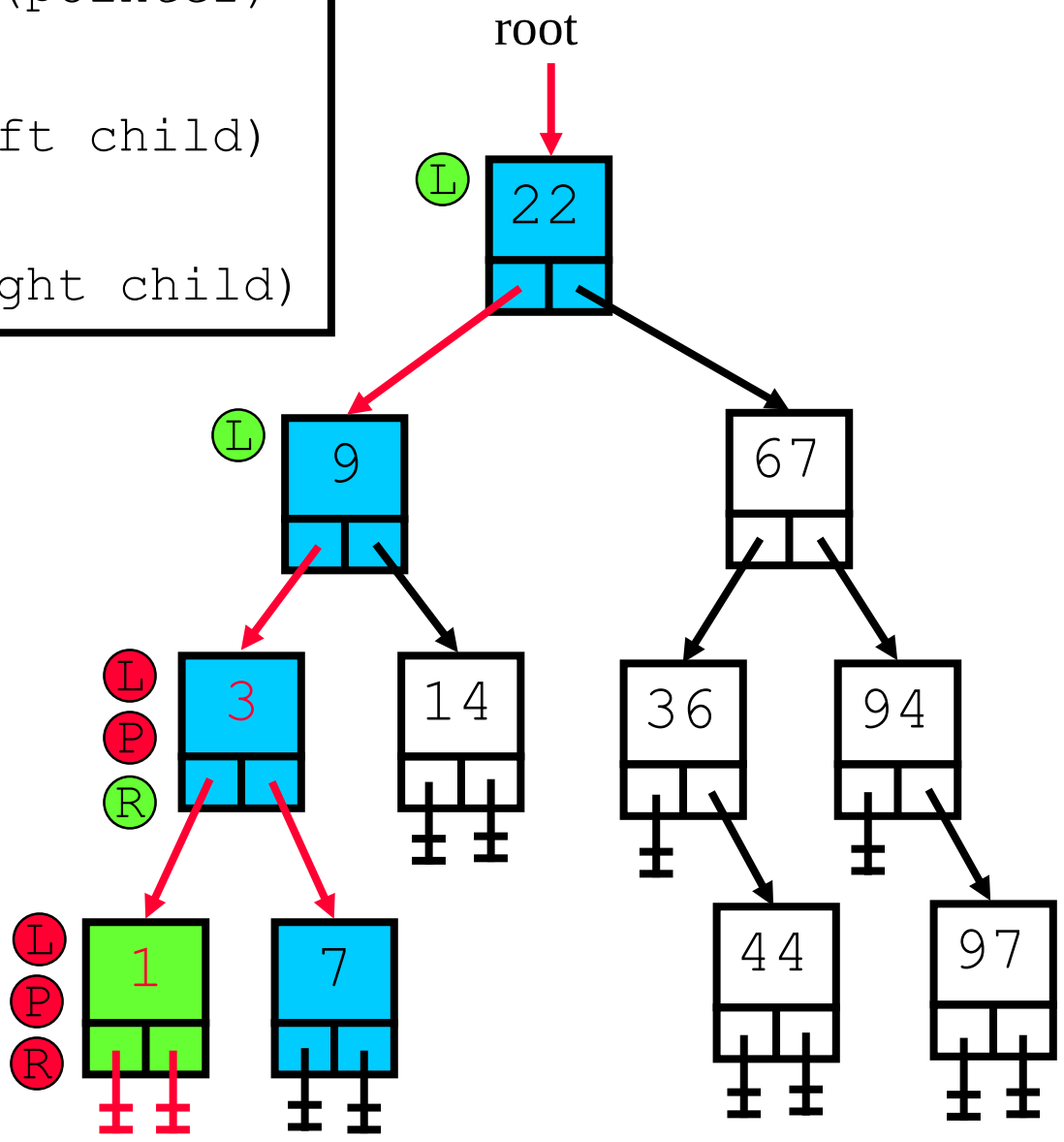

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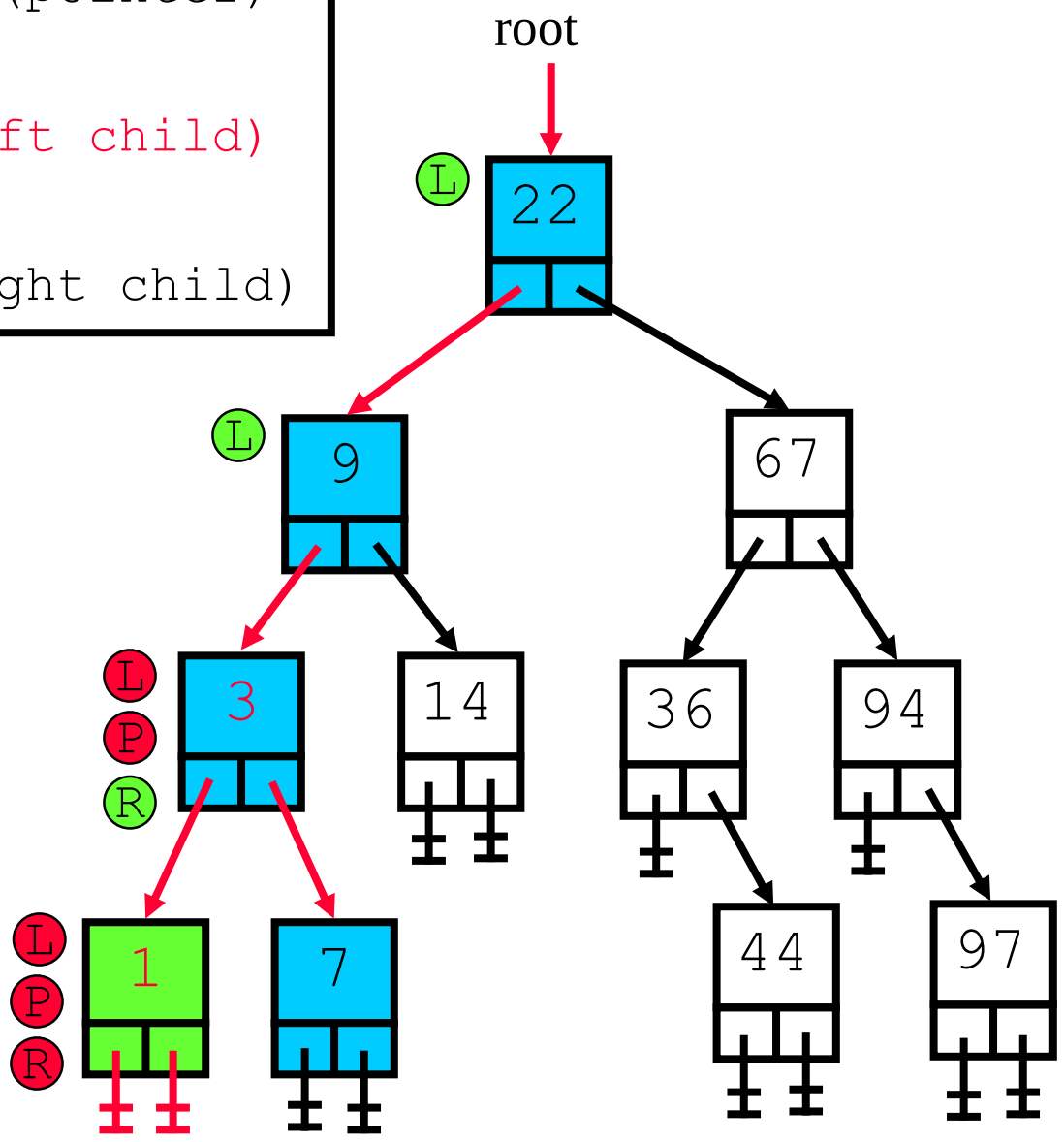

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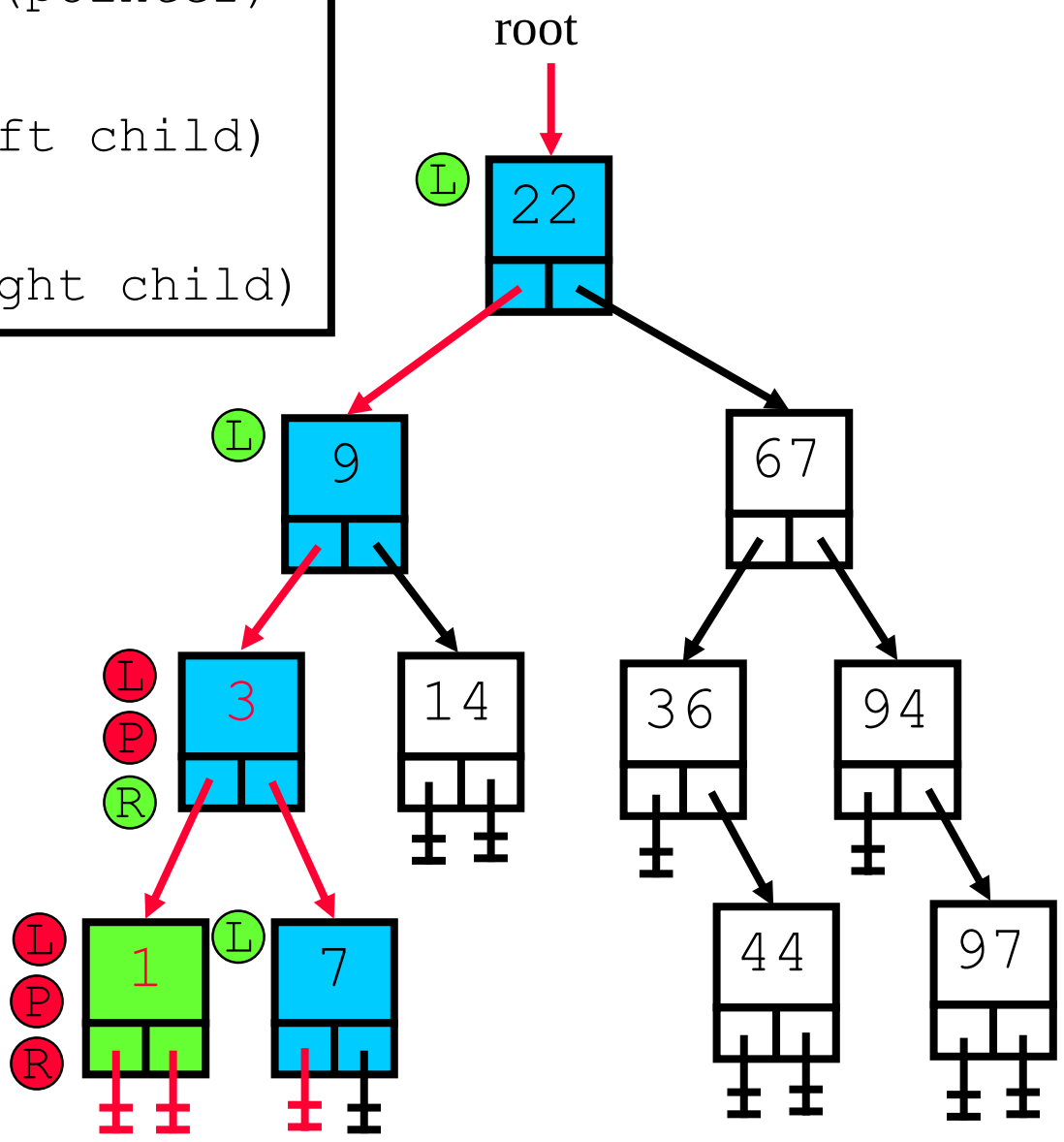

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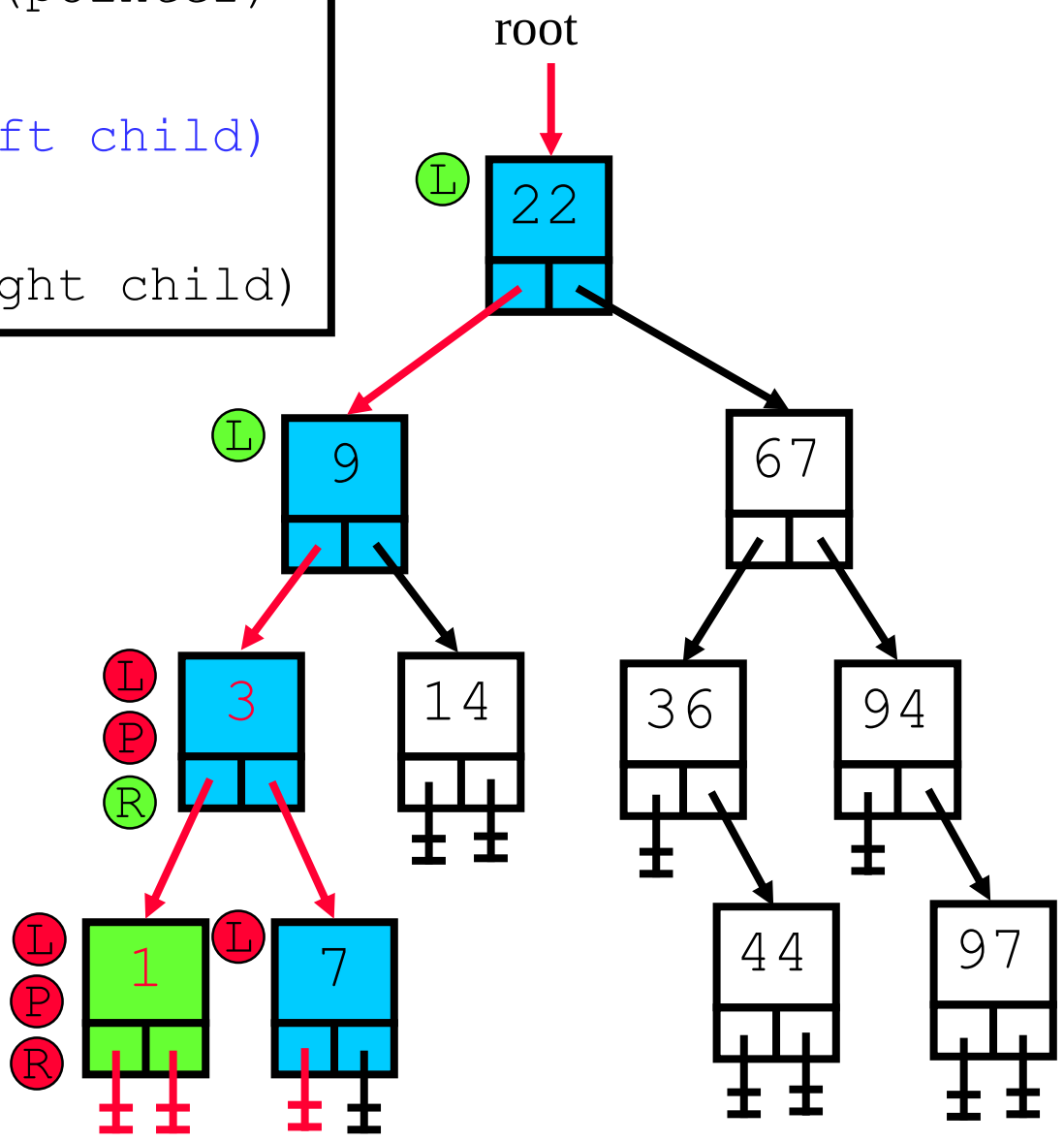

```
Proc InOrderPrint(pointer)
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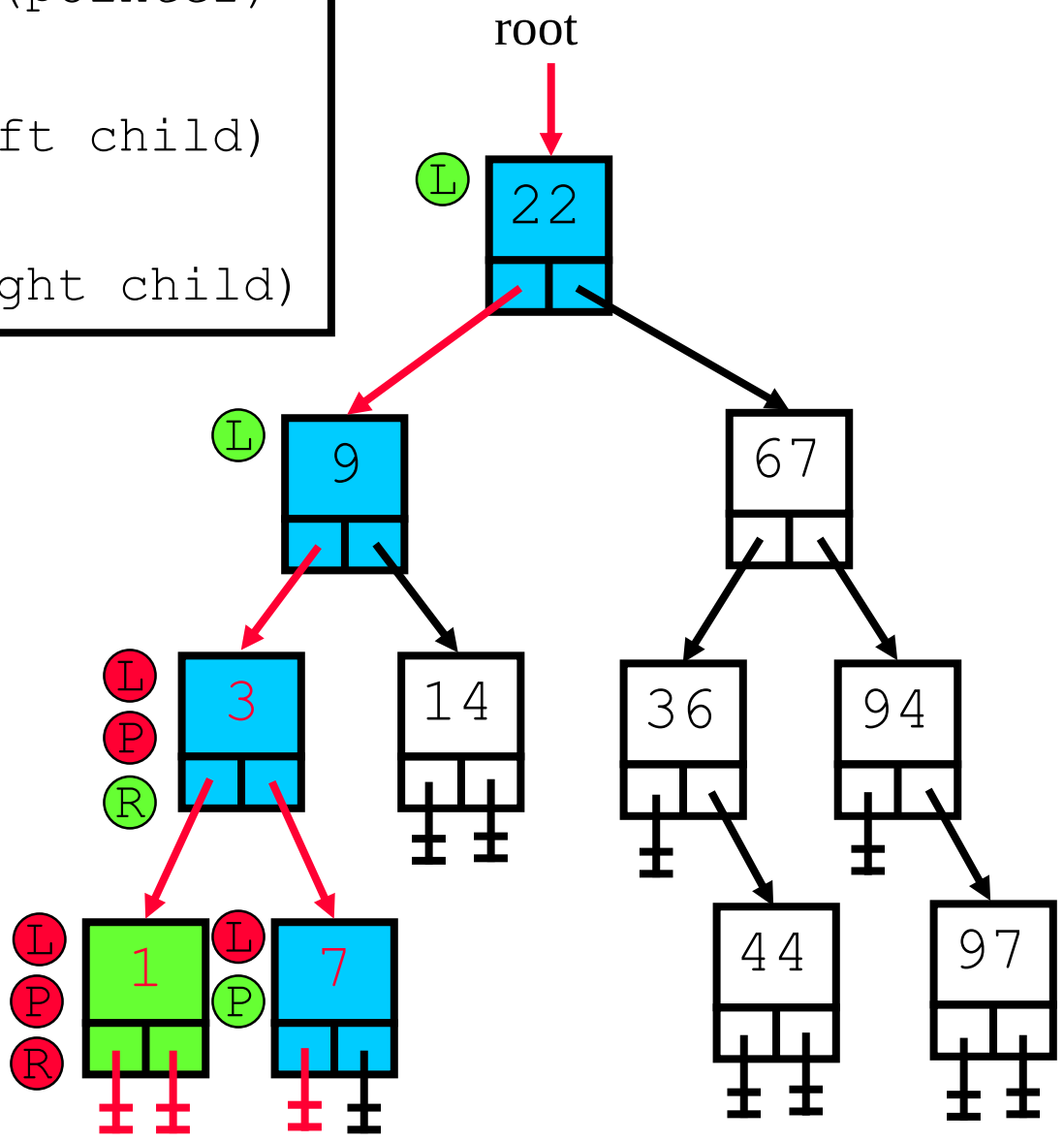
```

```
Output: 1 3 7
```



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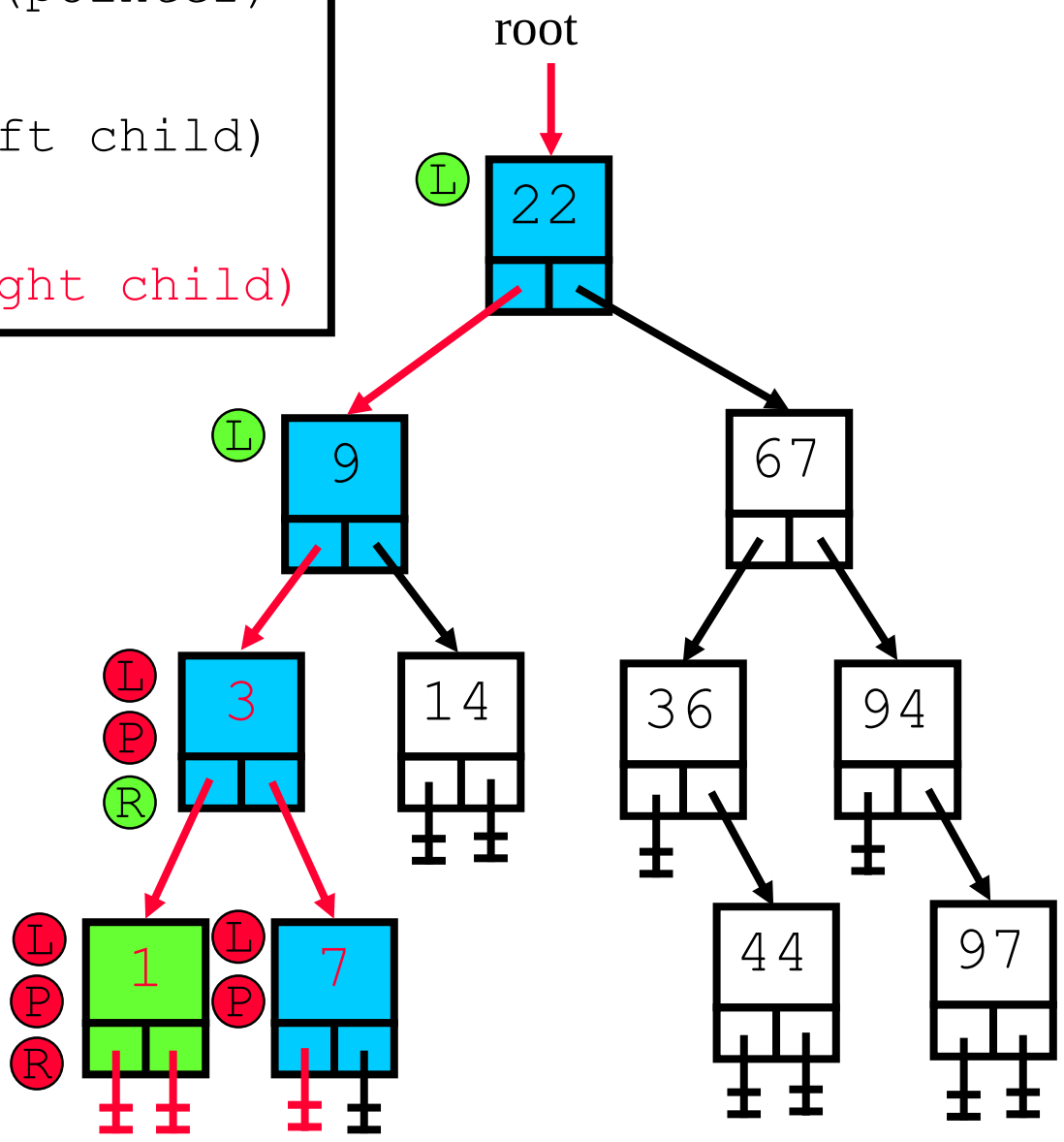

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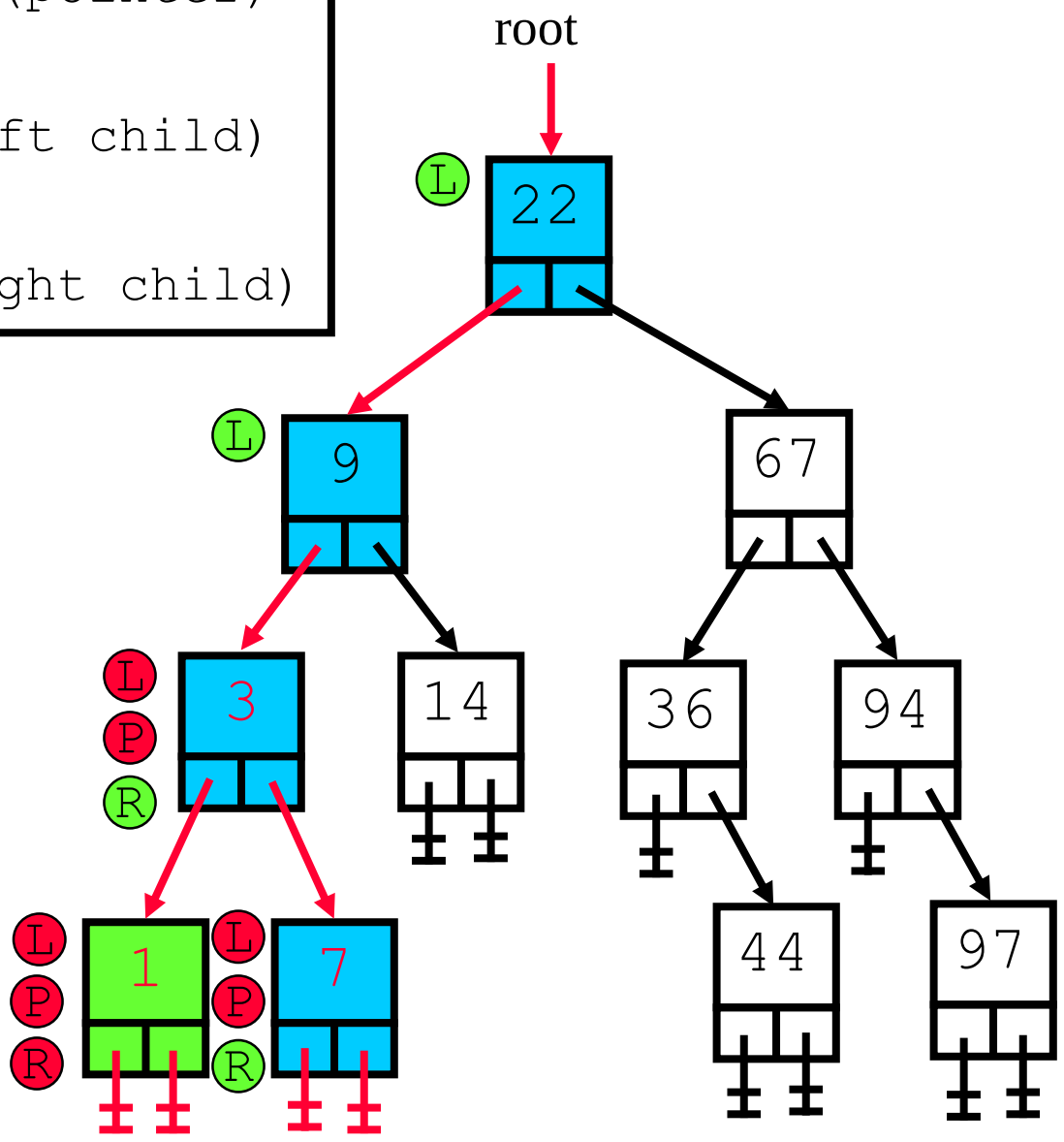

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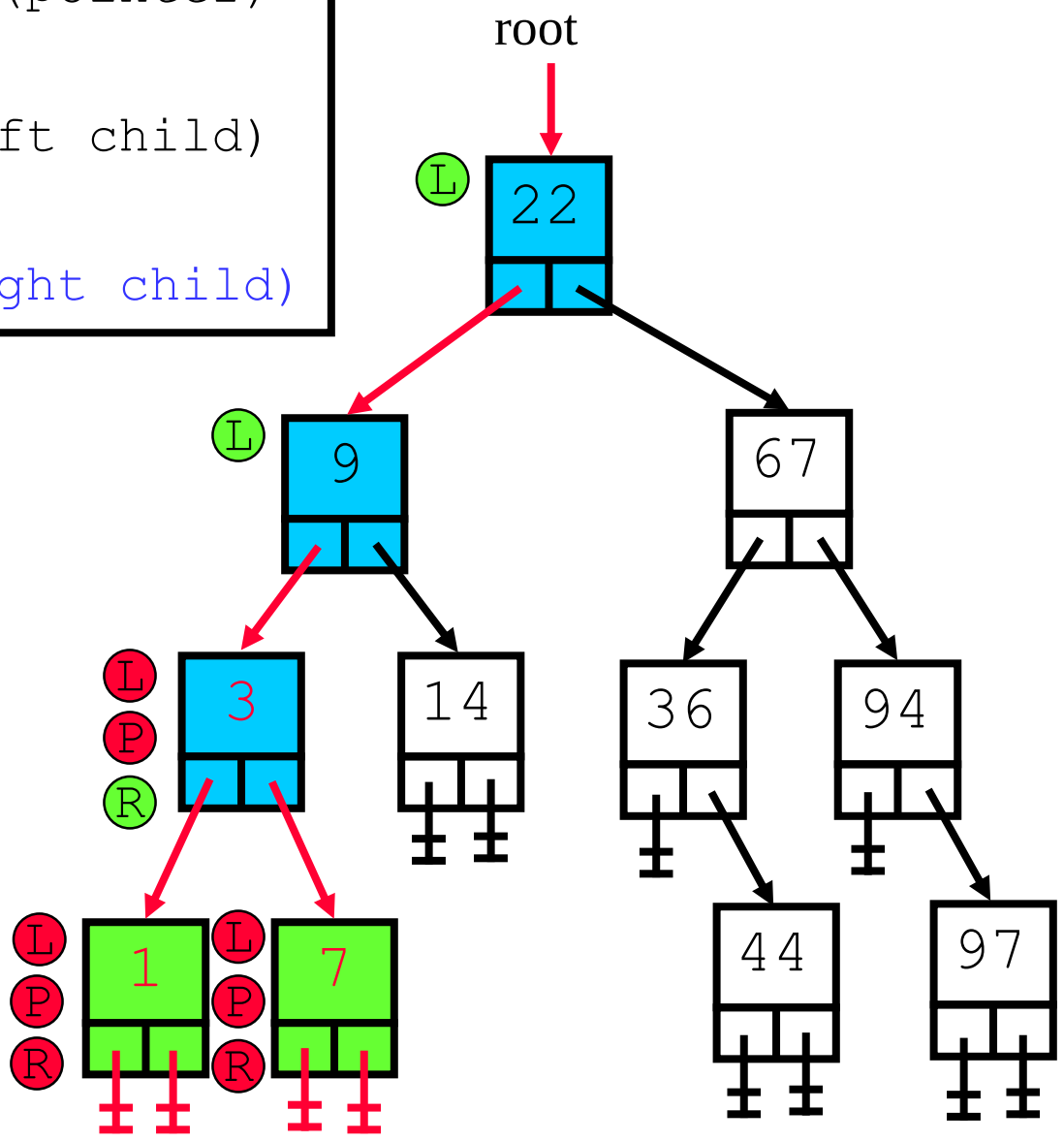

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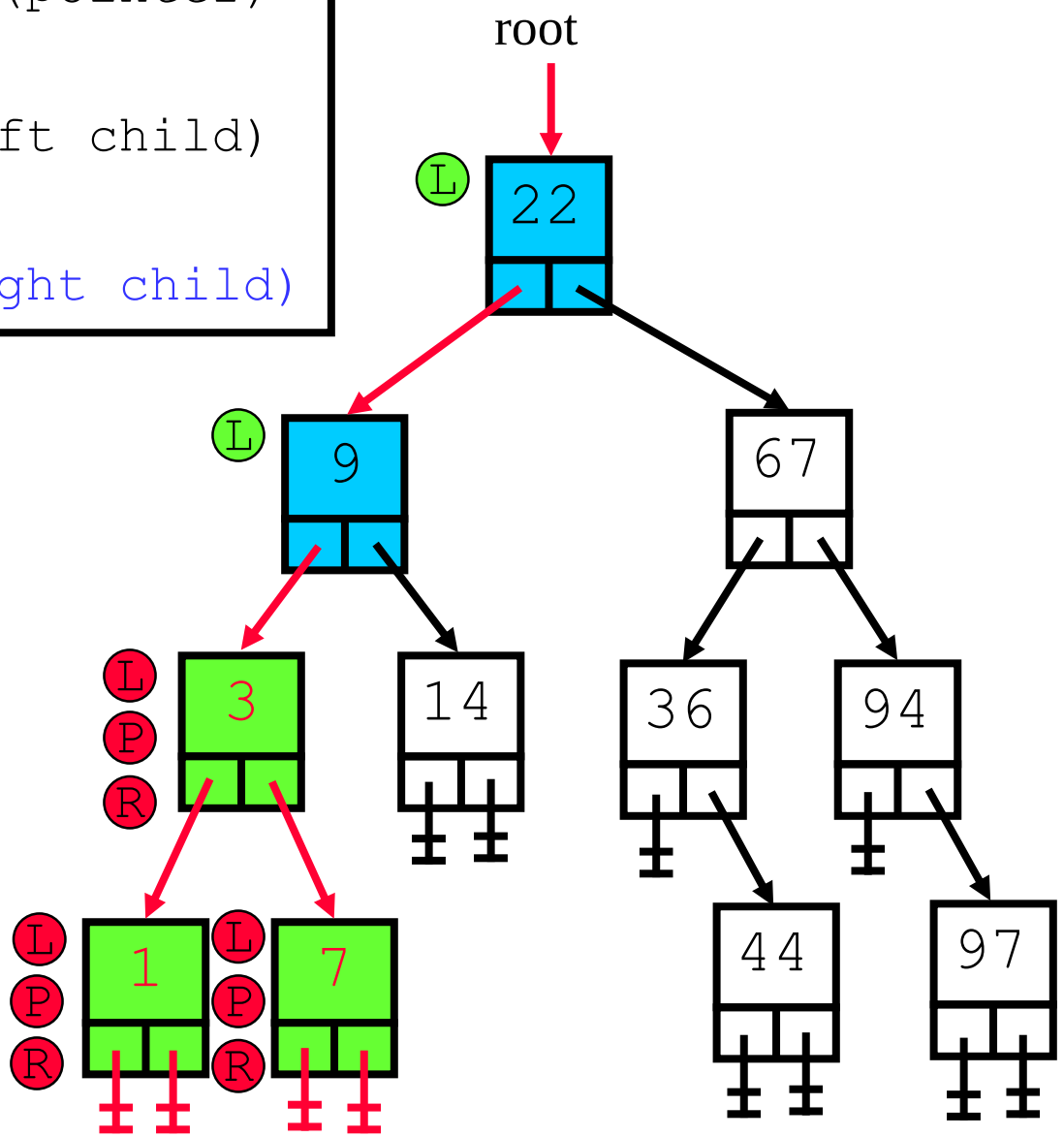

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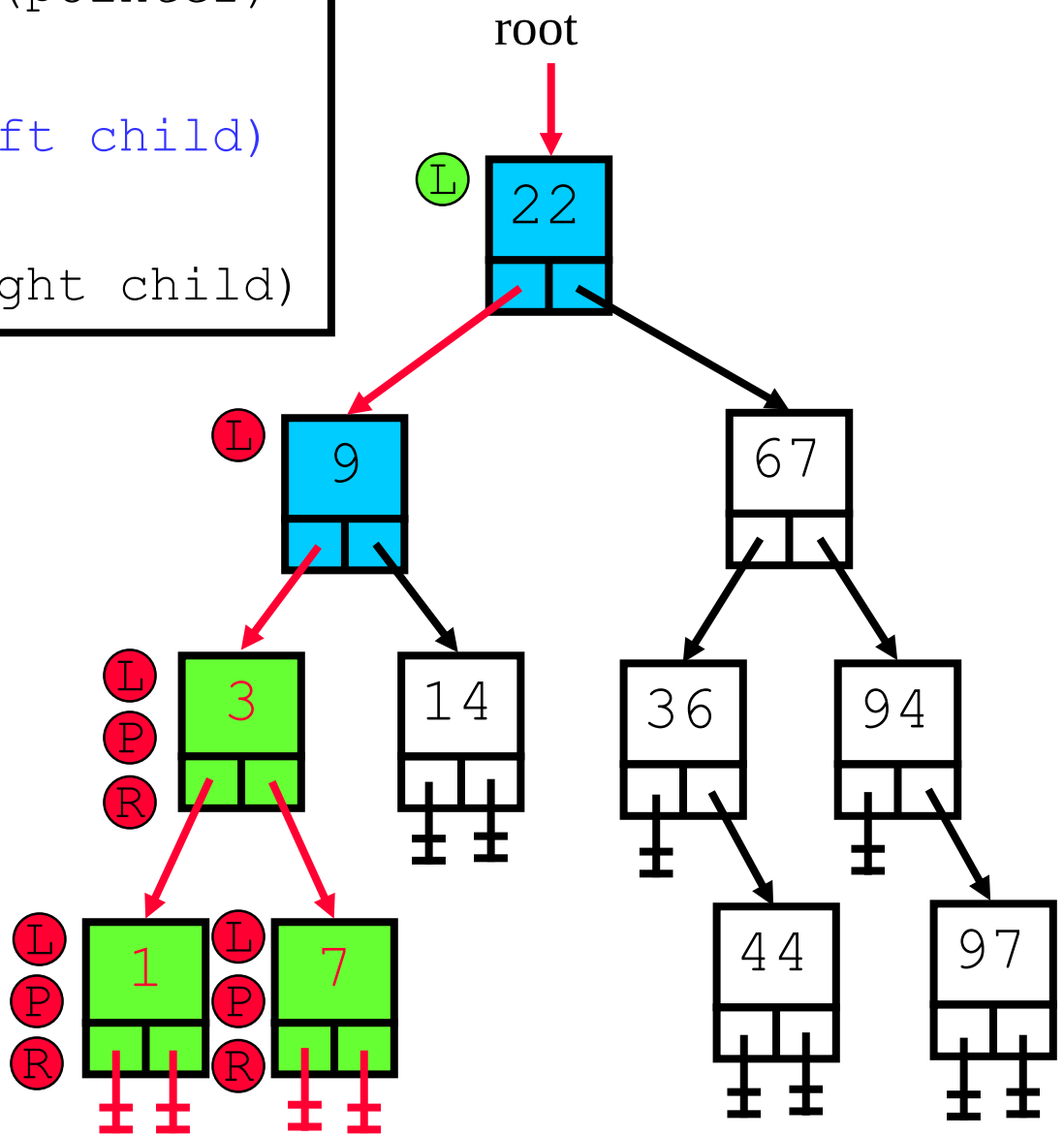

```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
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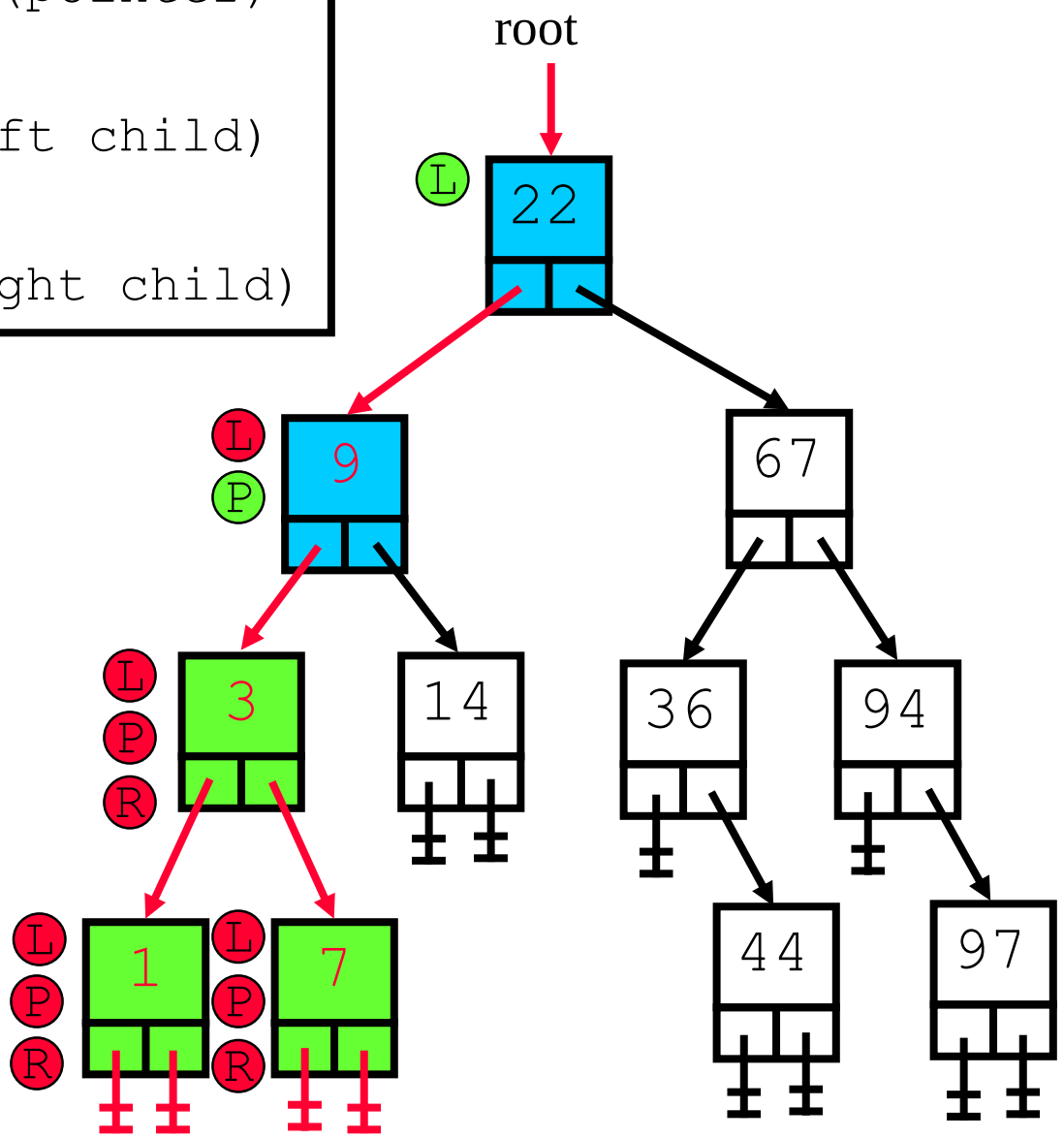
```

```
Output: 1 3 7 9
```



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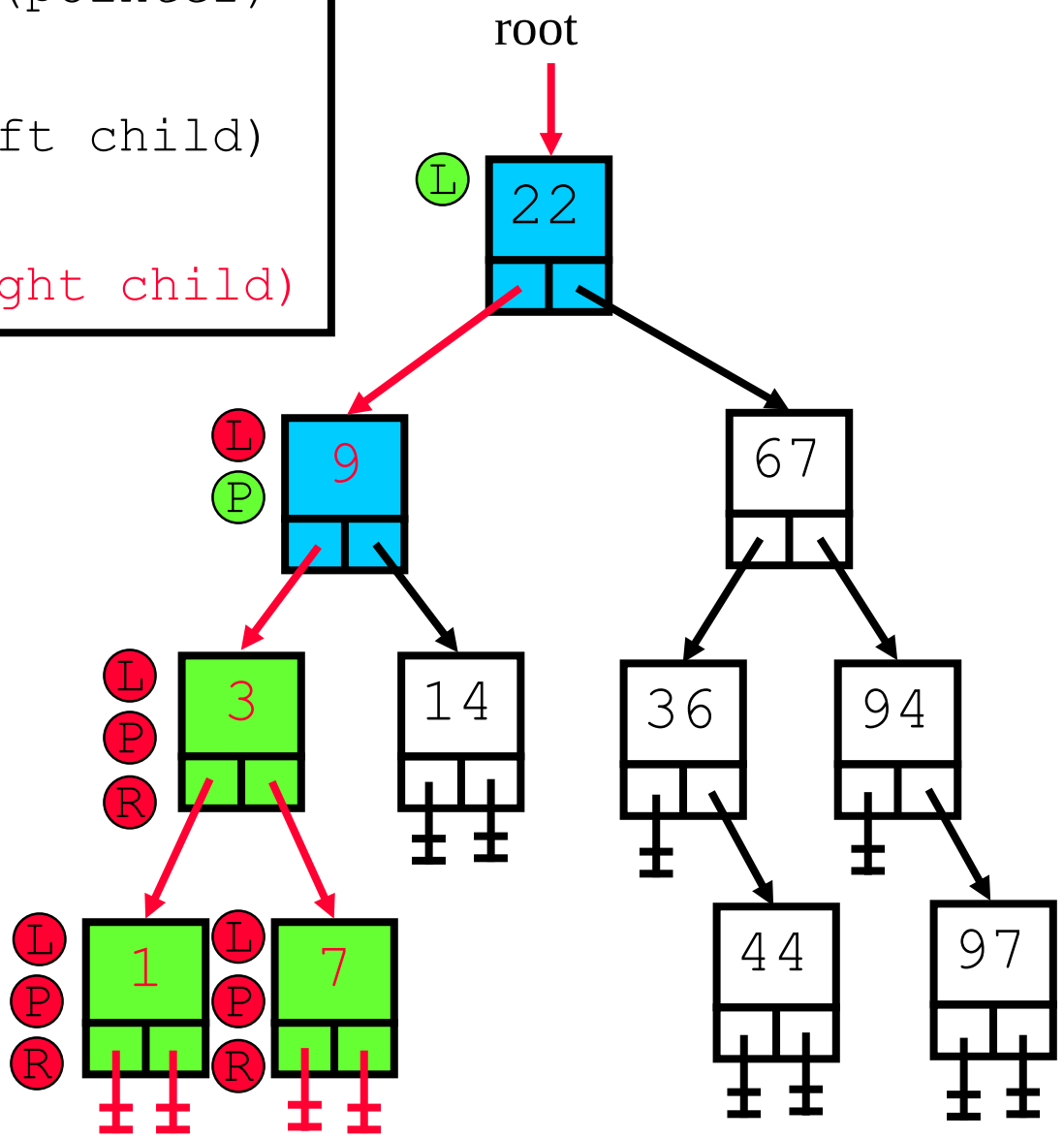

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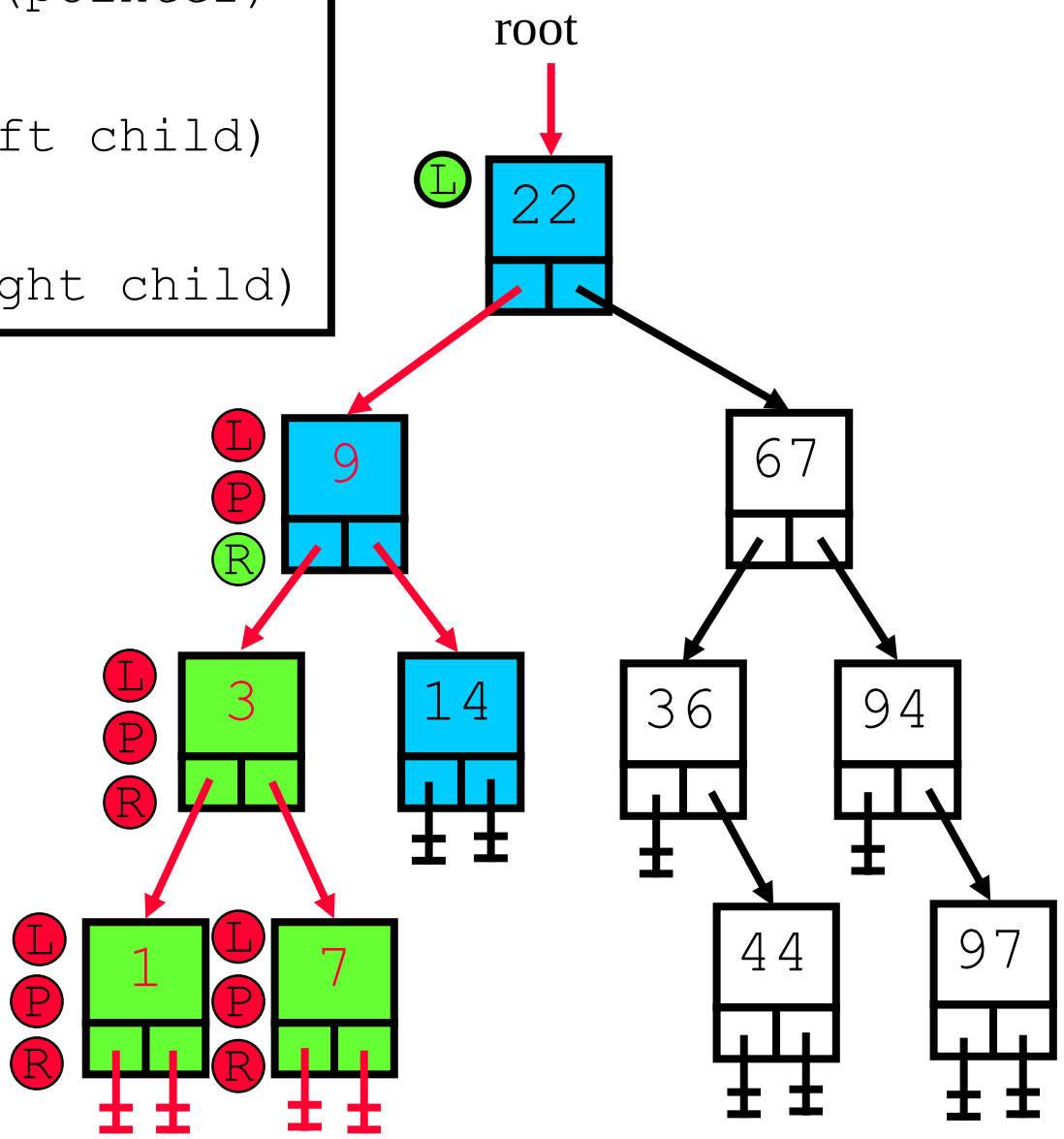

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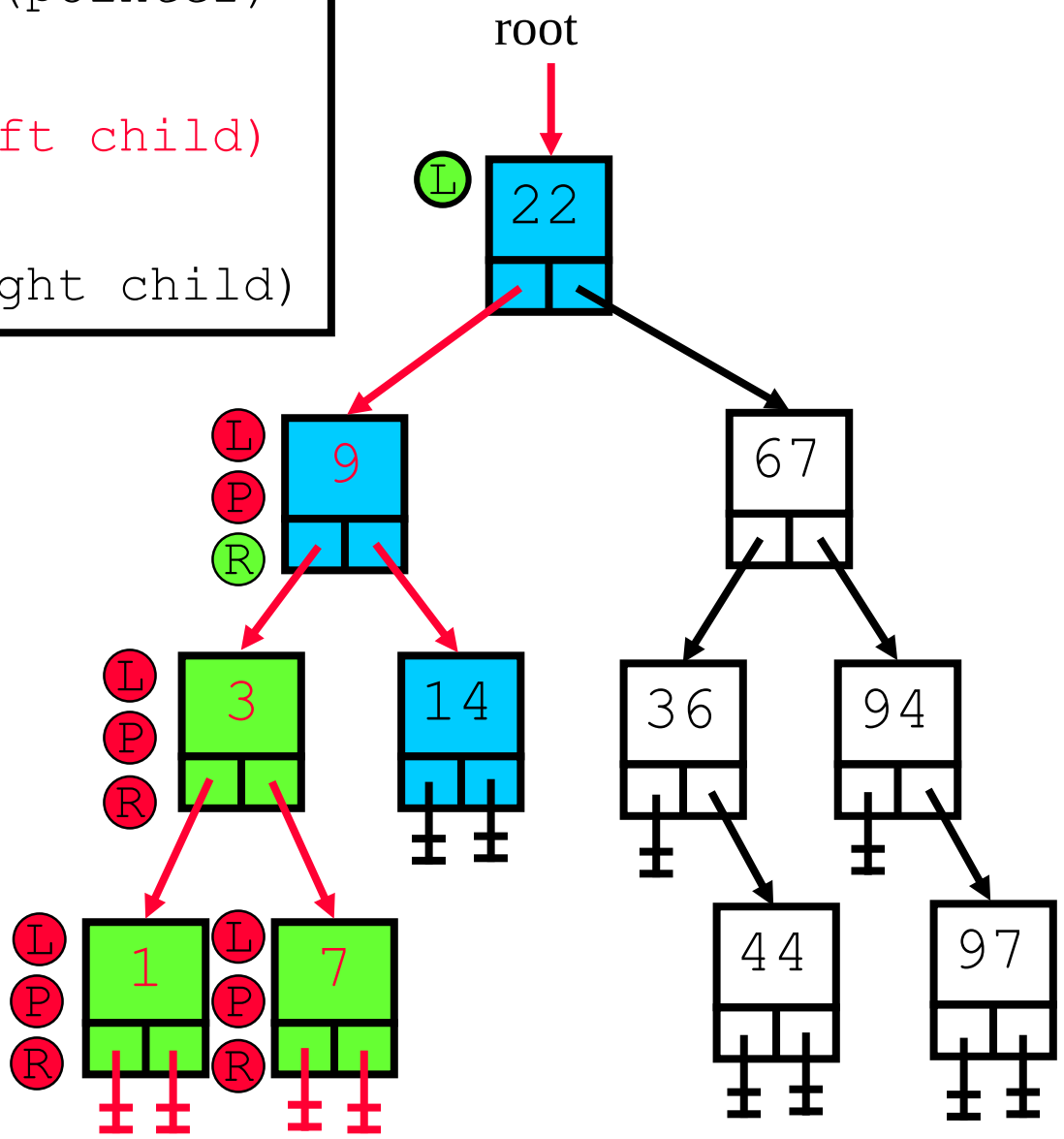

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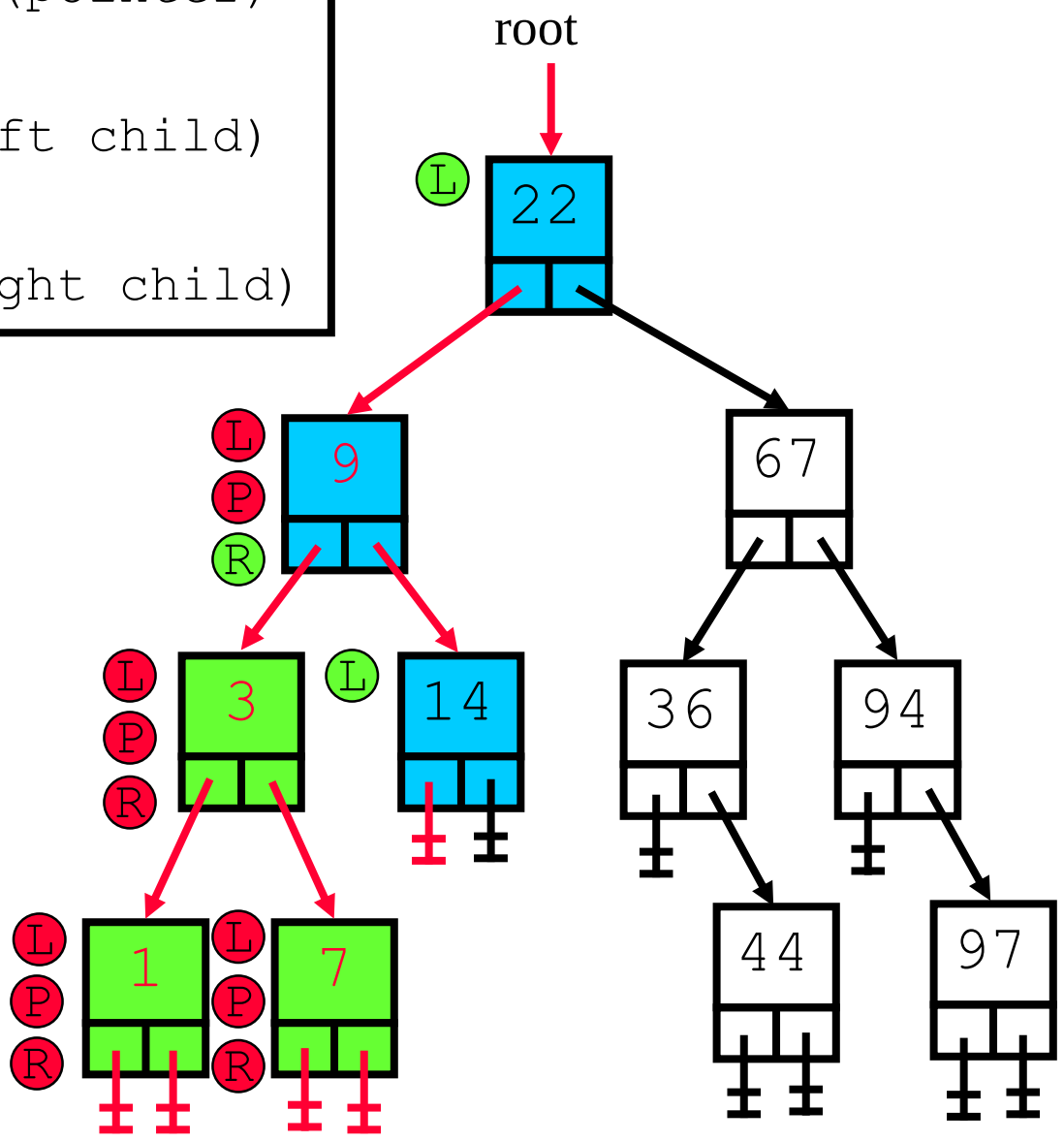

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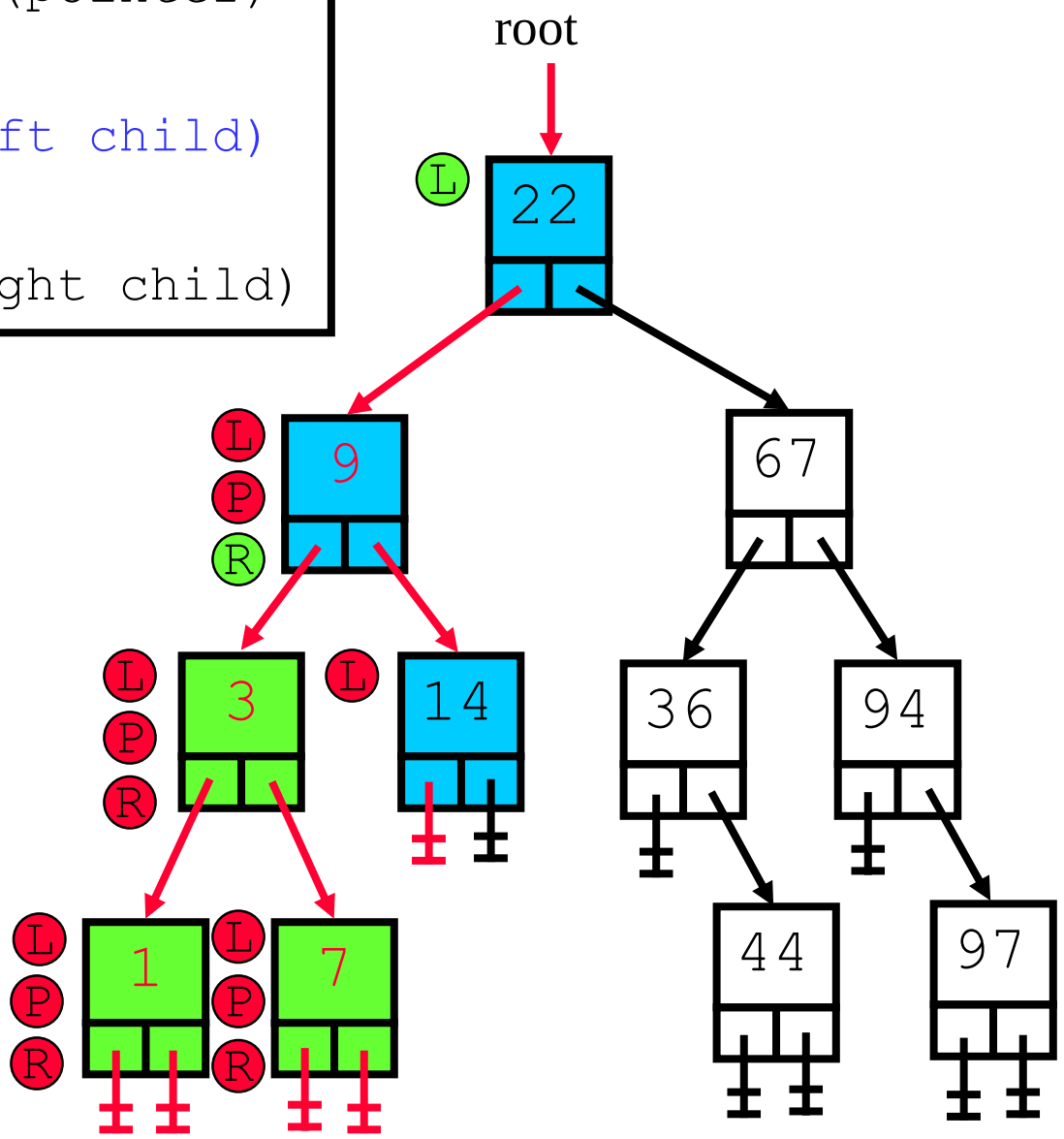
```

```
Output: 1 3 7 9
```



```
Proc InOrderPrint(pointer)
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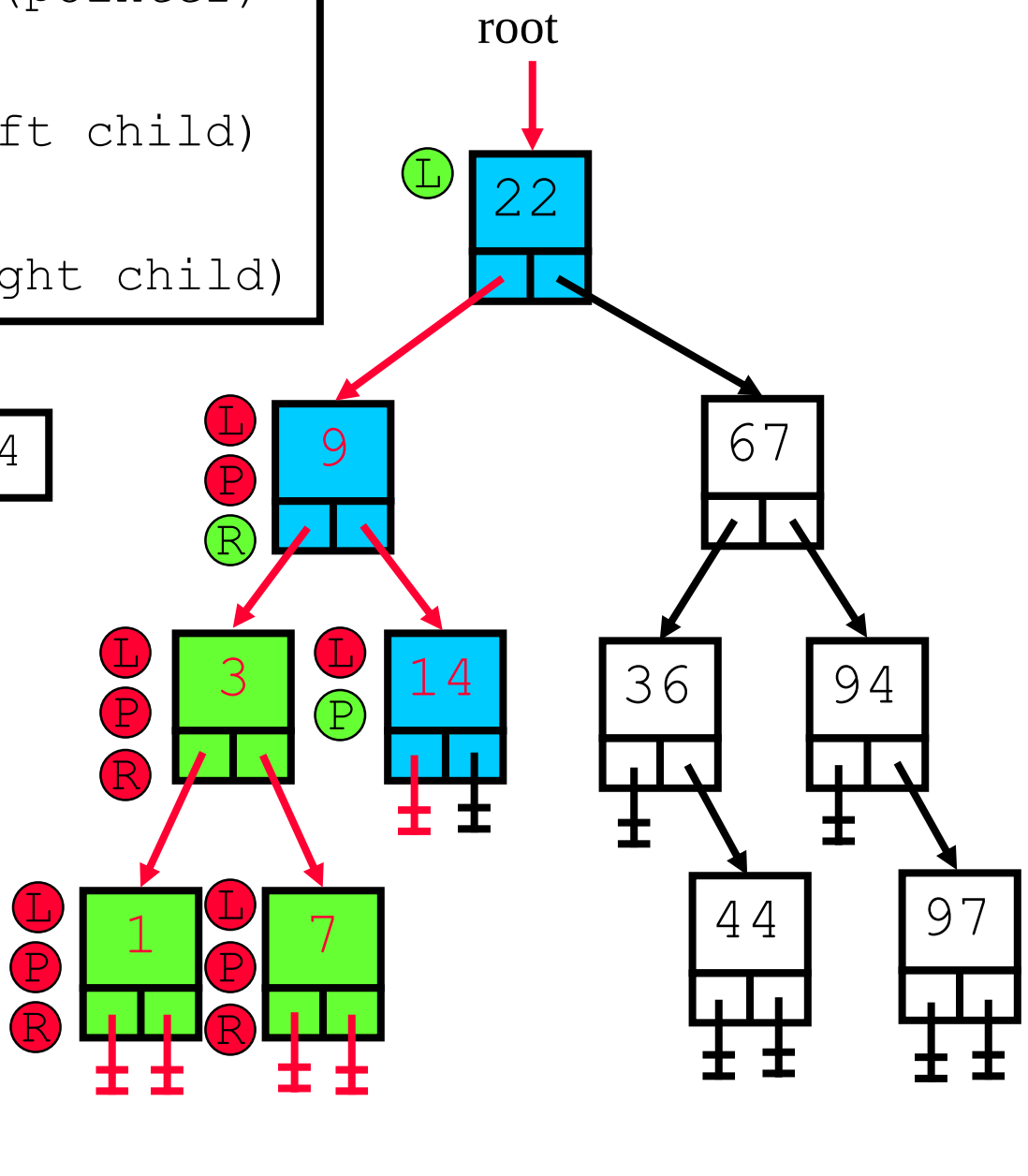
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14
```



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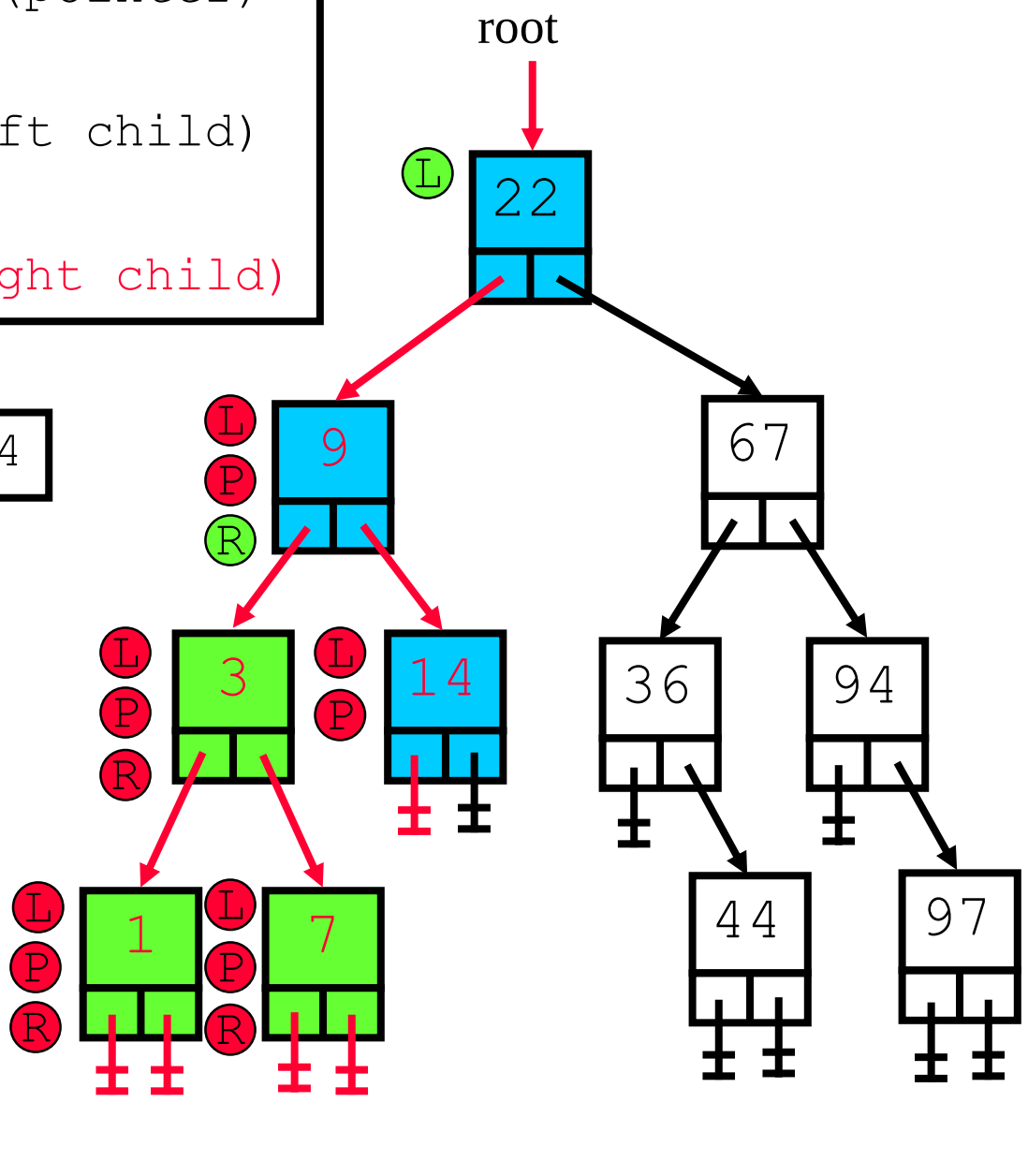
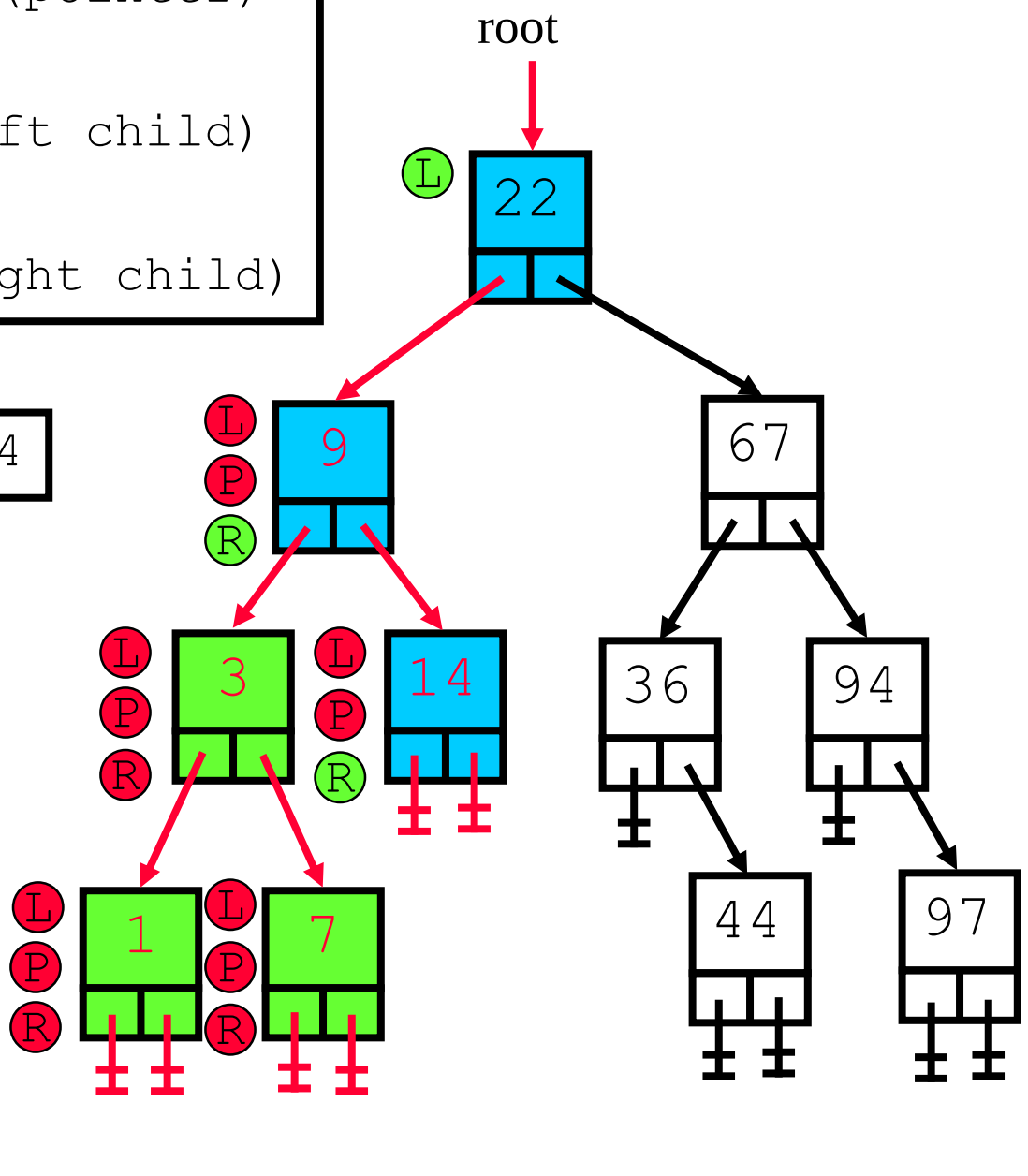
```
Output: 1 3 7 9 14
```



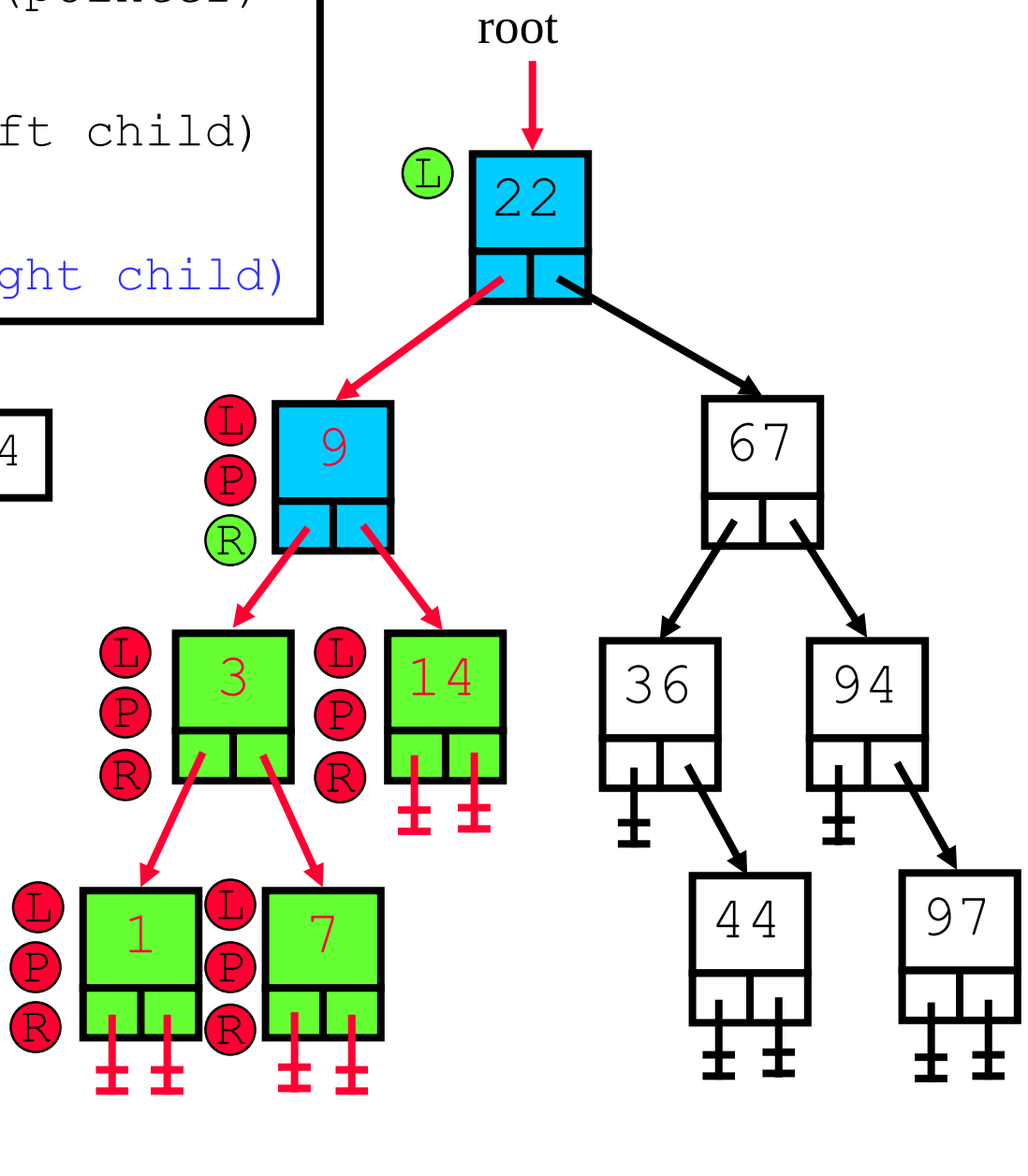
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14
```



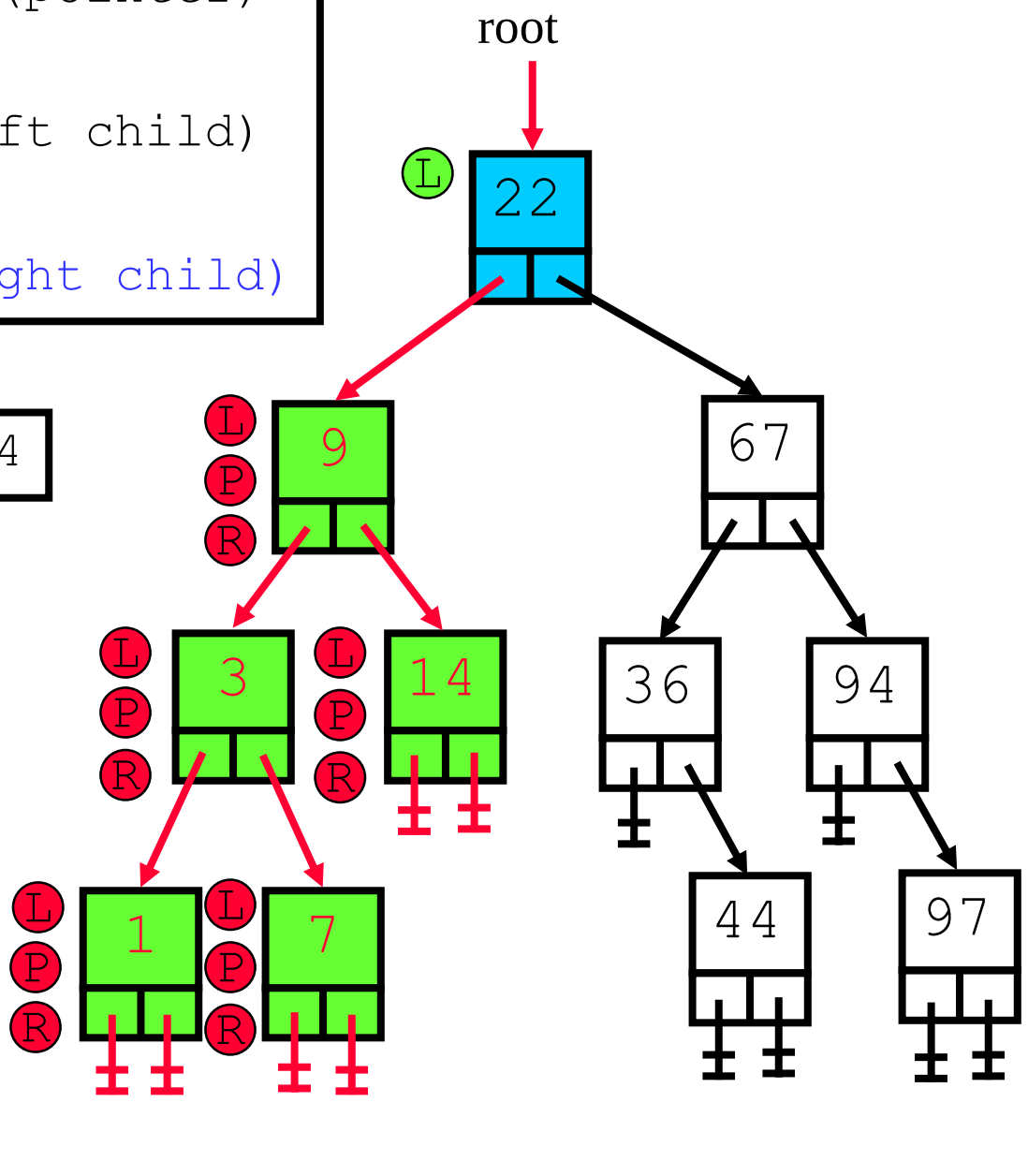
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14
```



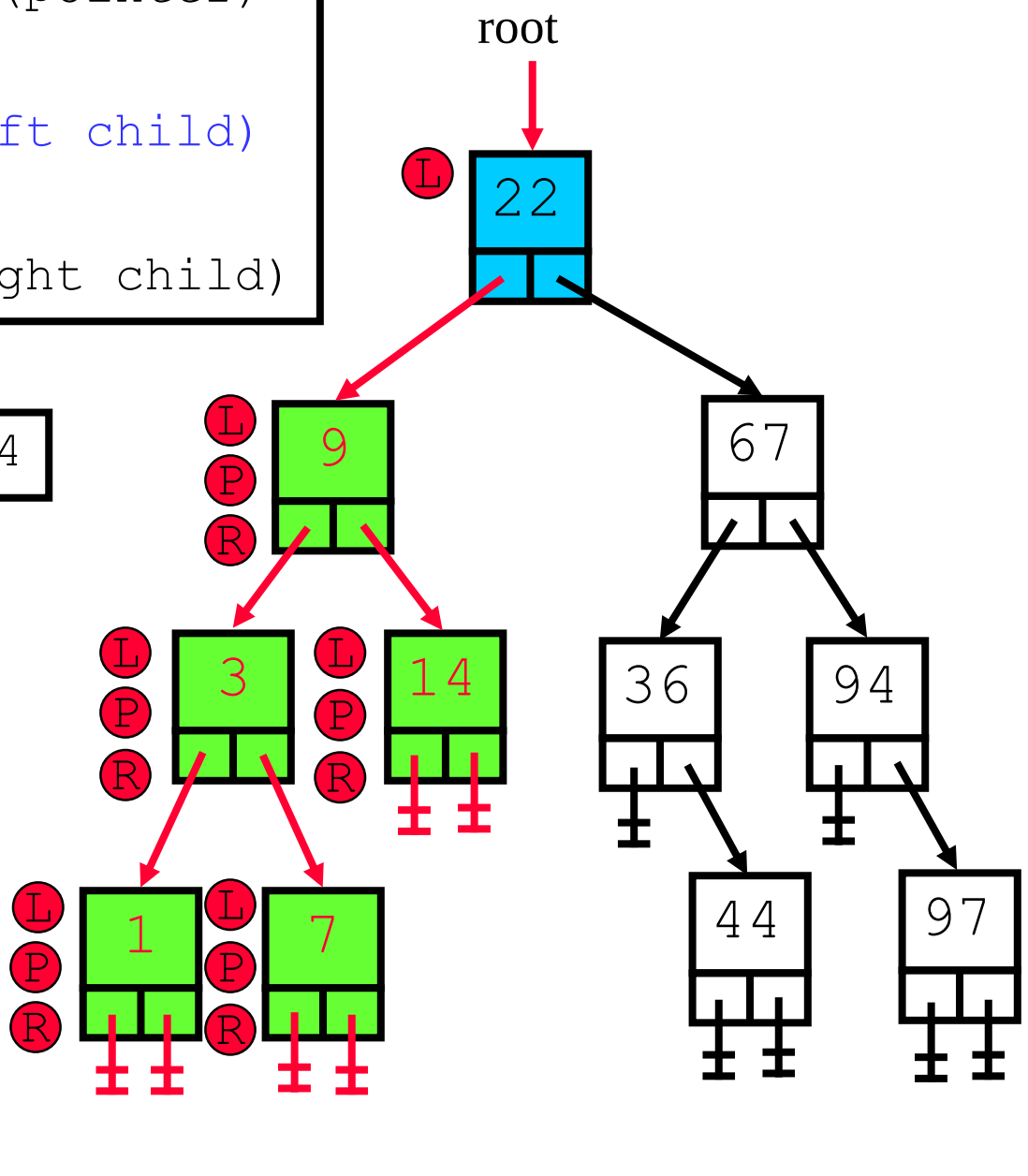
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14
```



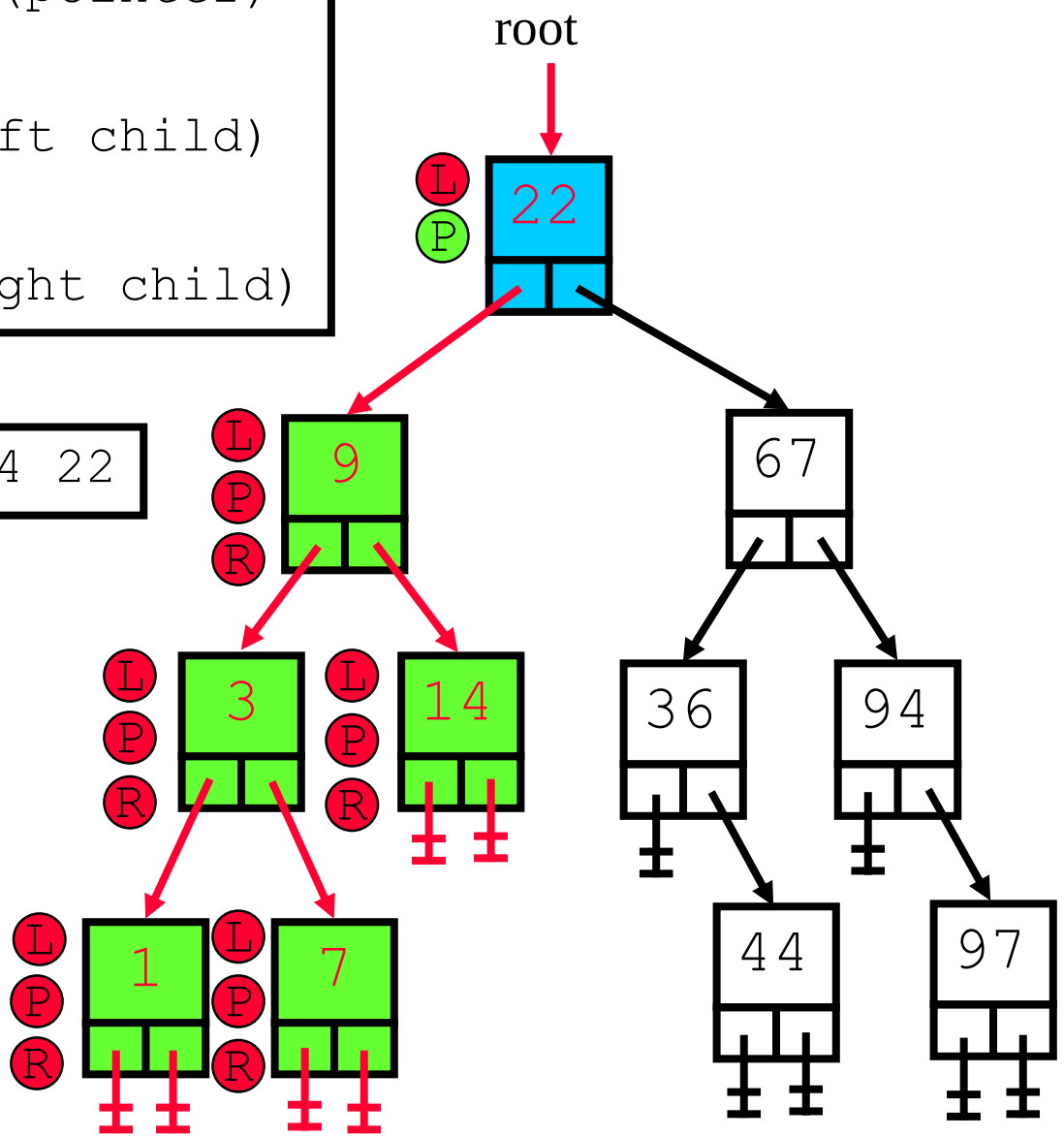
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14
```



```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



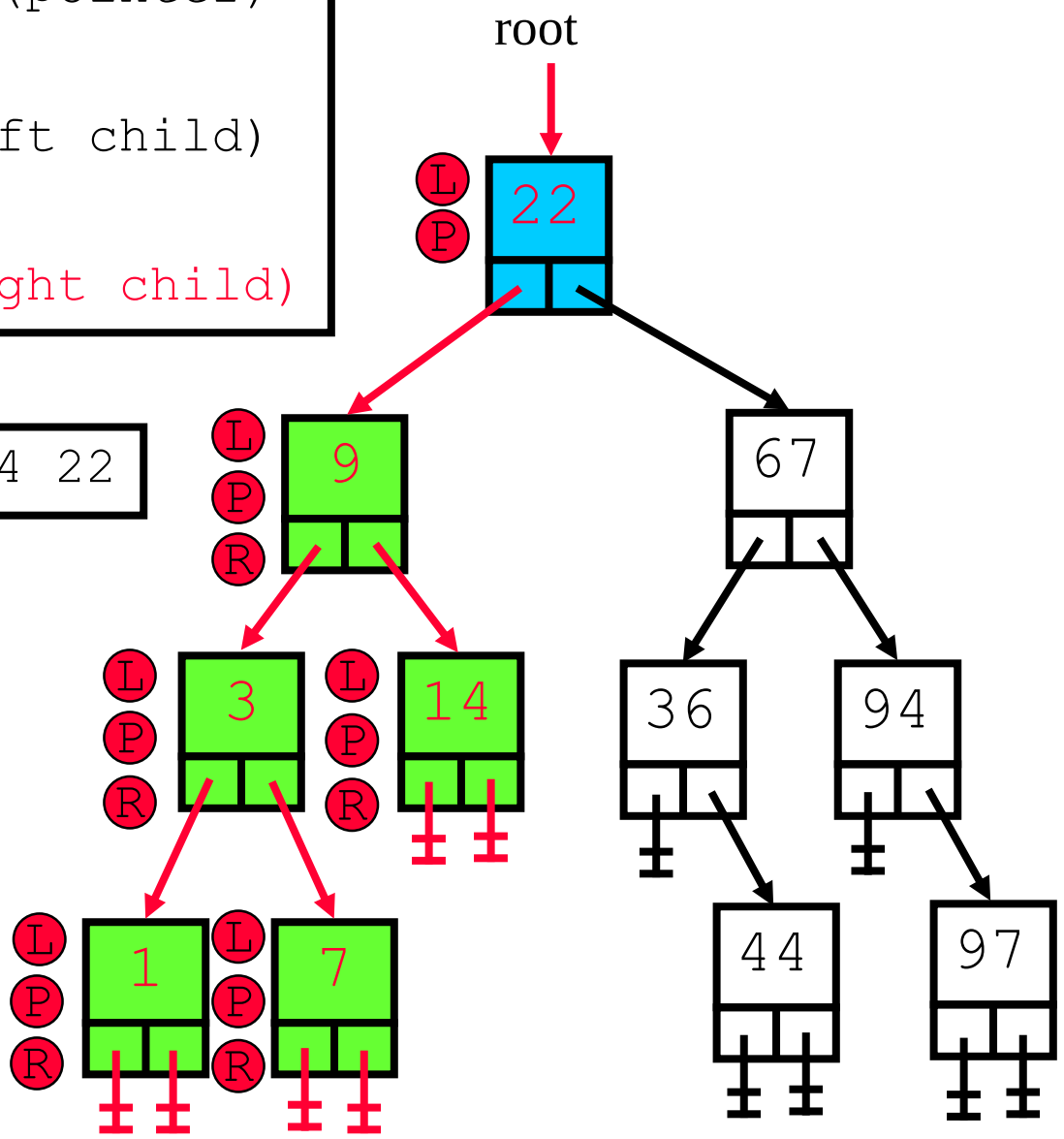
Continue?

Yes!

Enough Already!

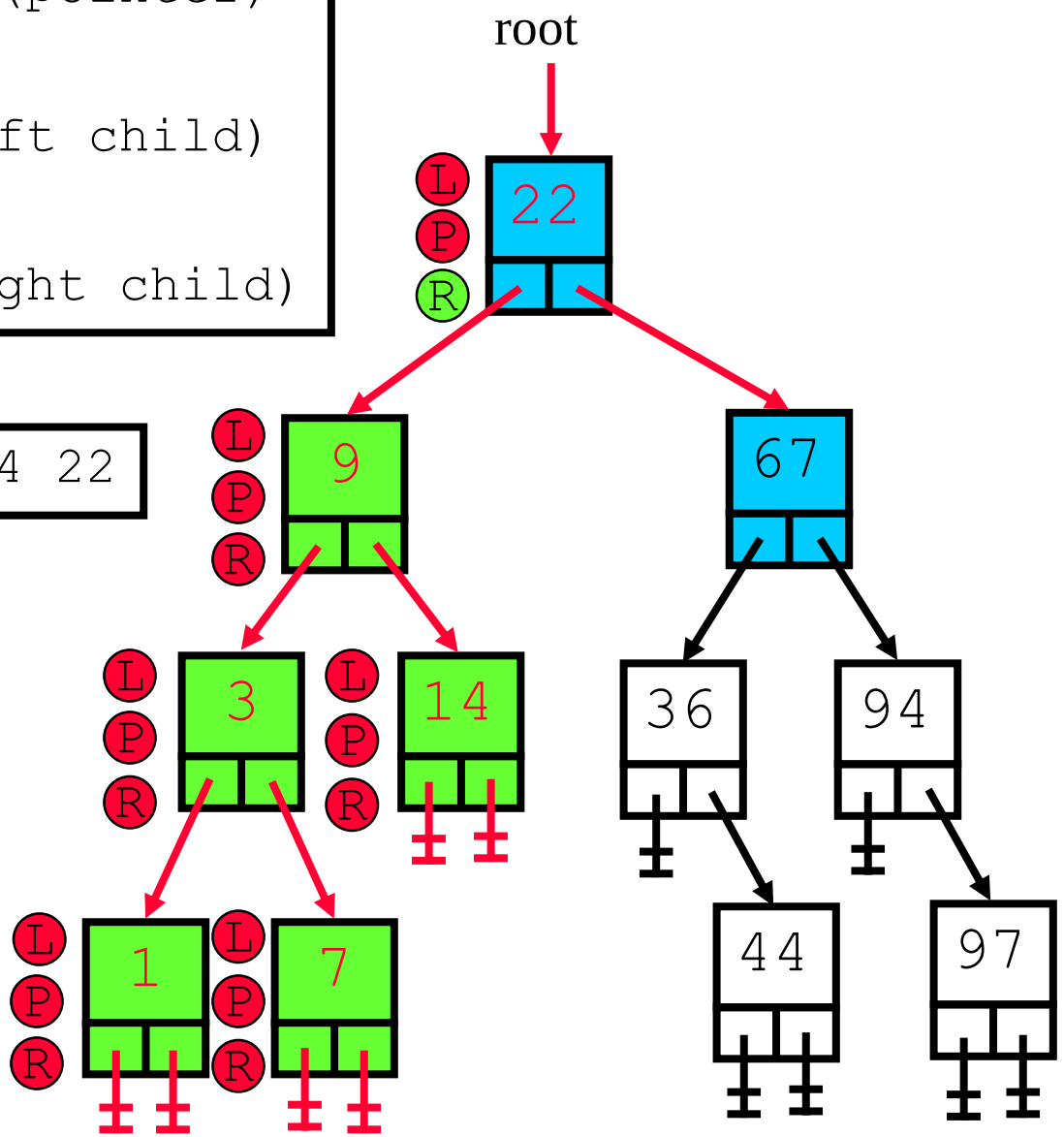
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



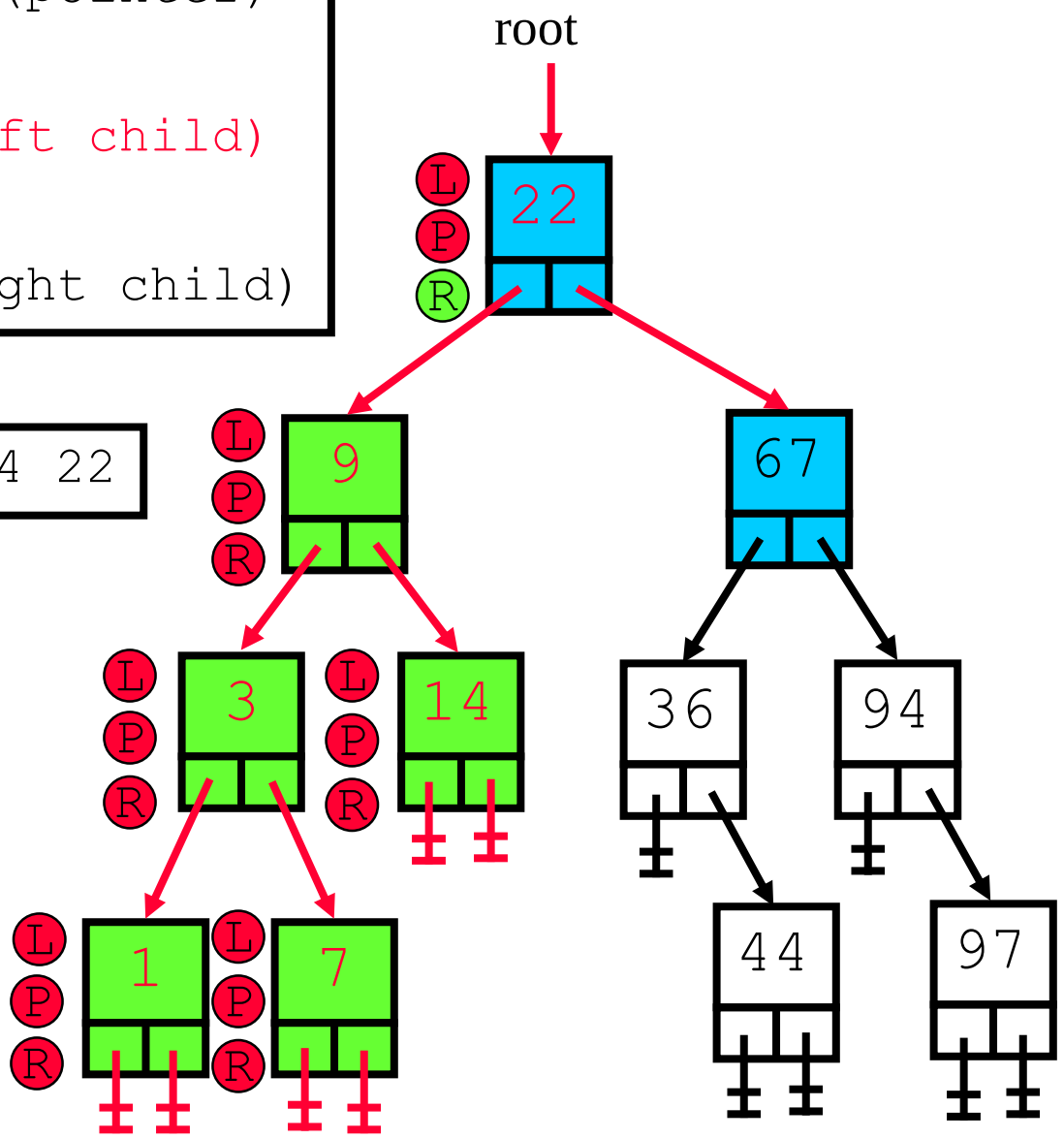
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



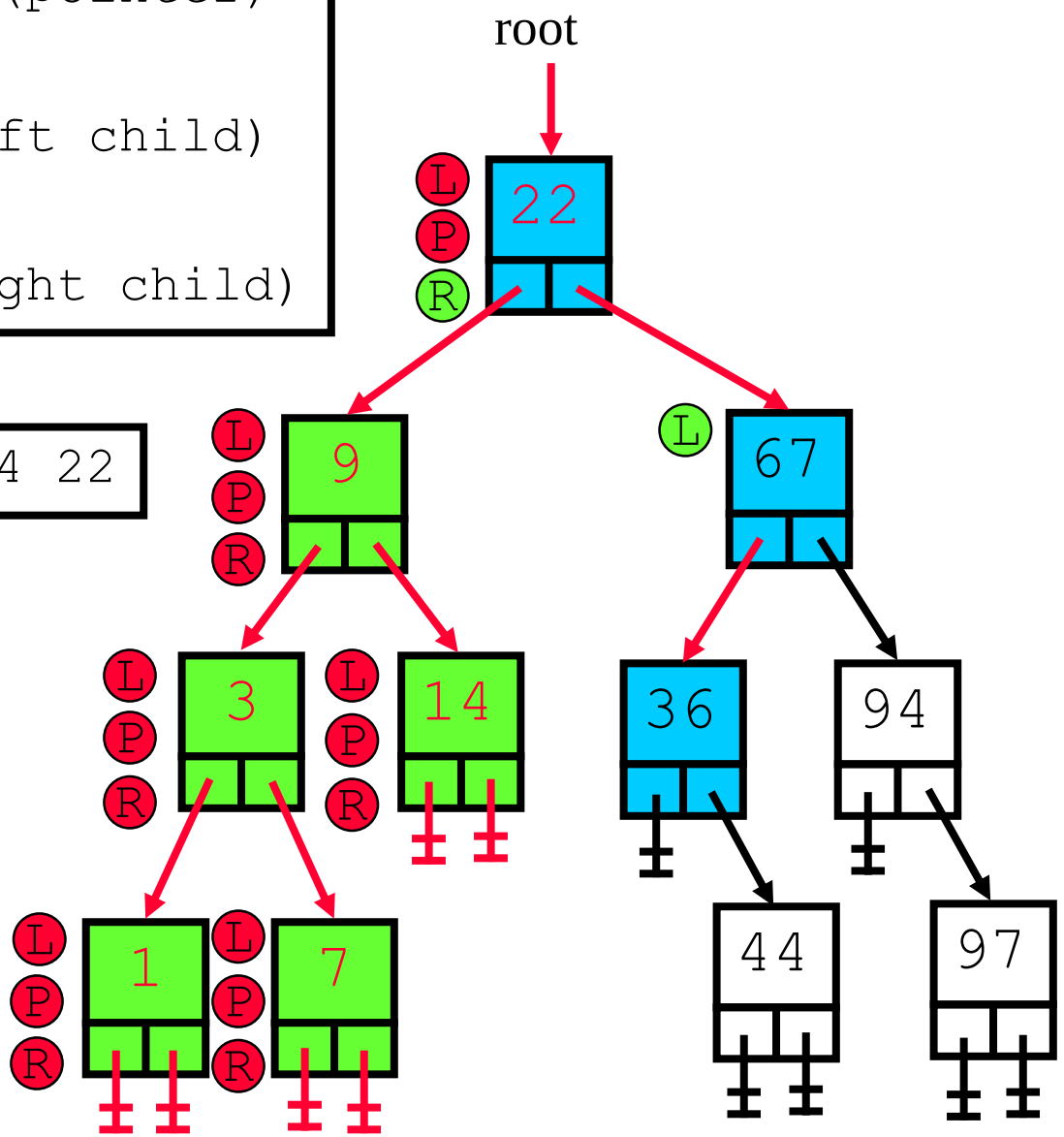
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



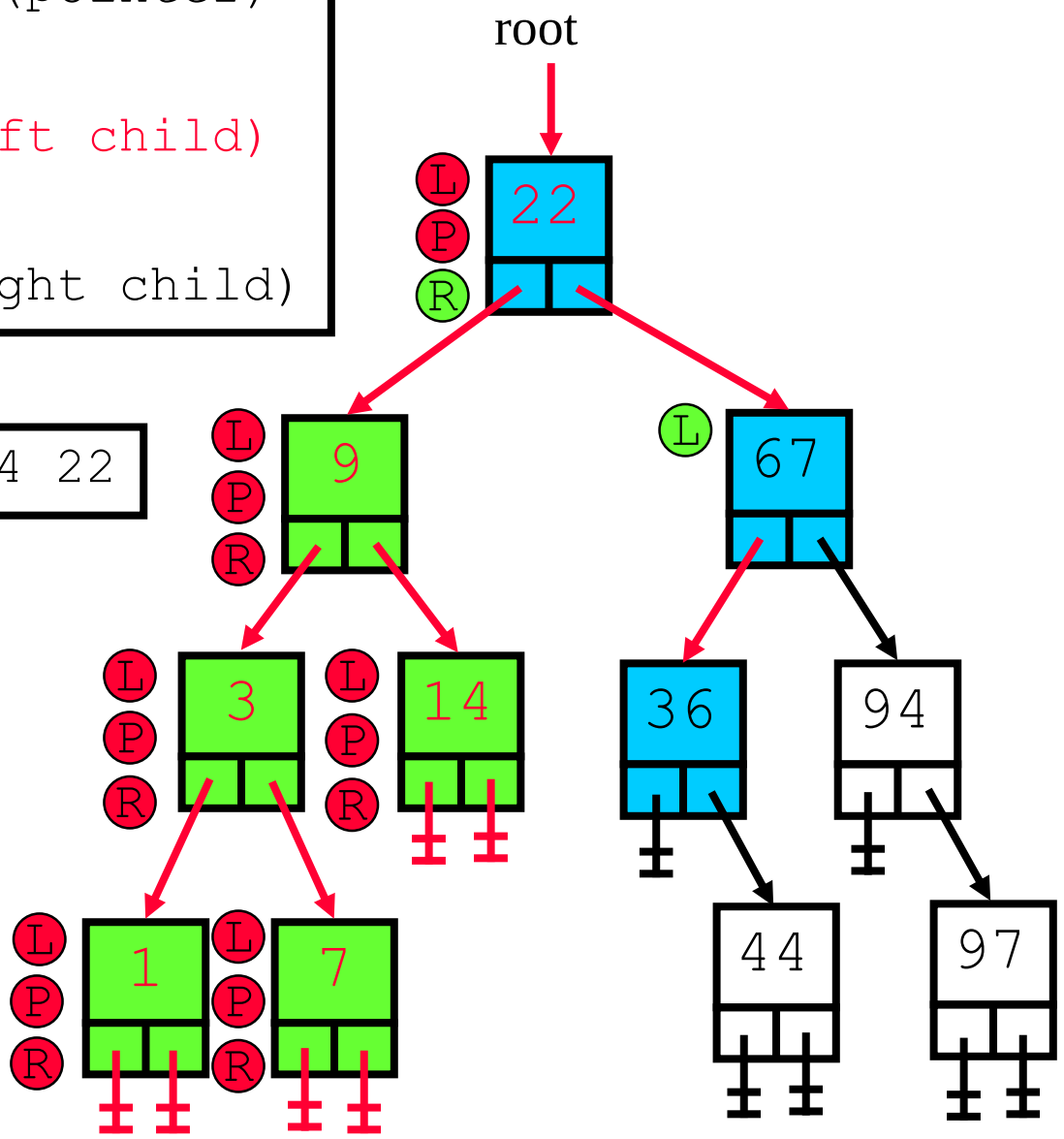
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



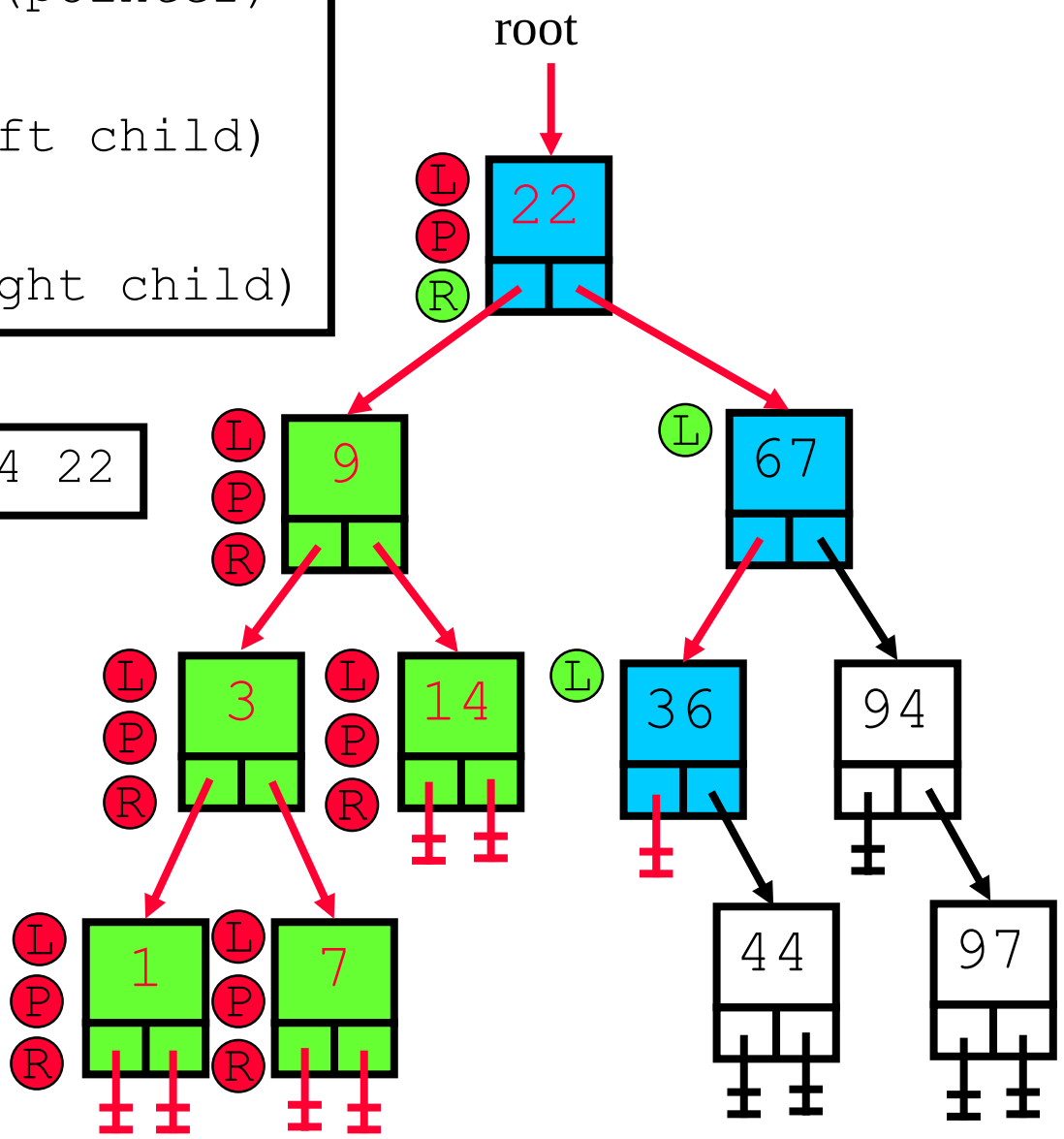
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



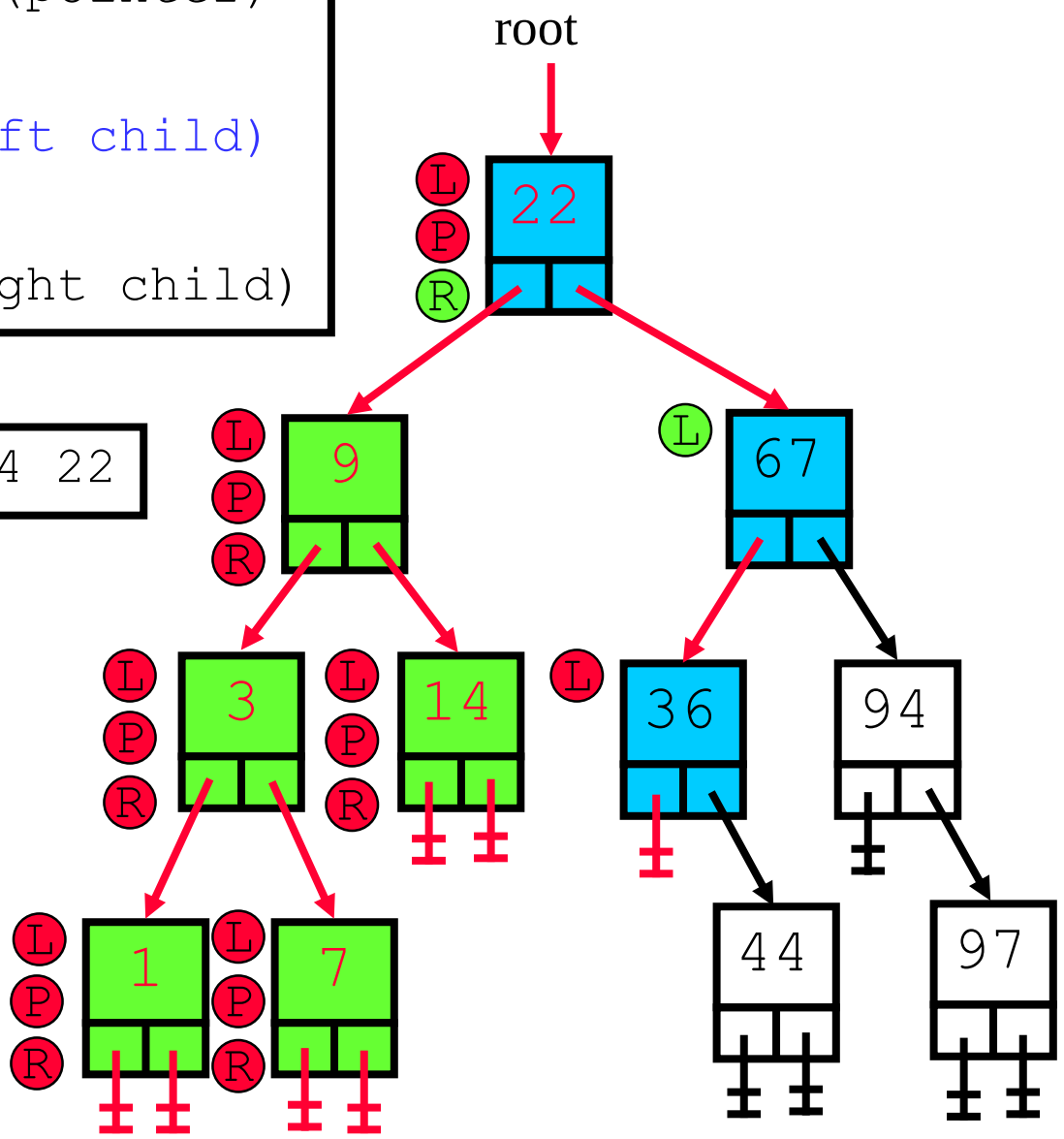
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



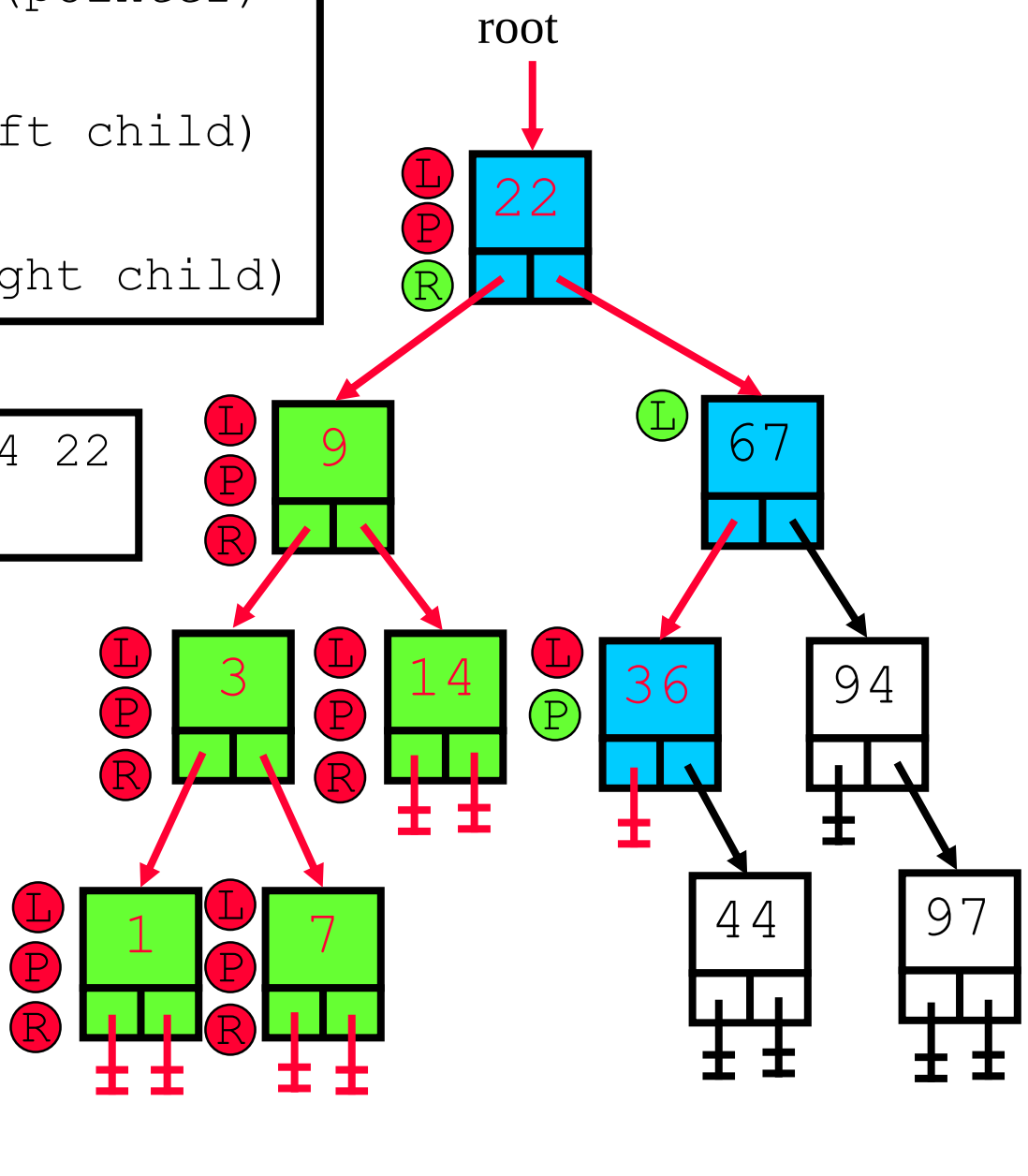
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
```



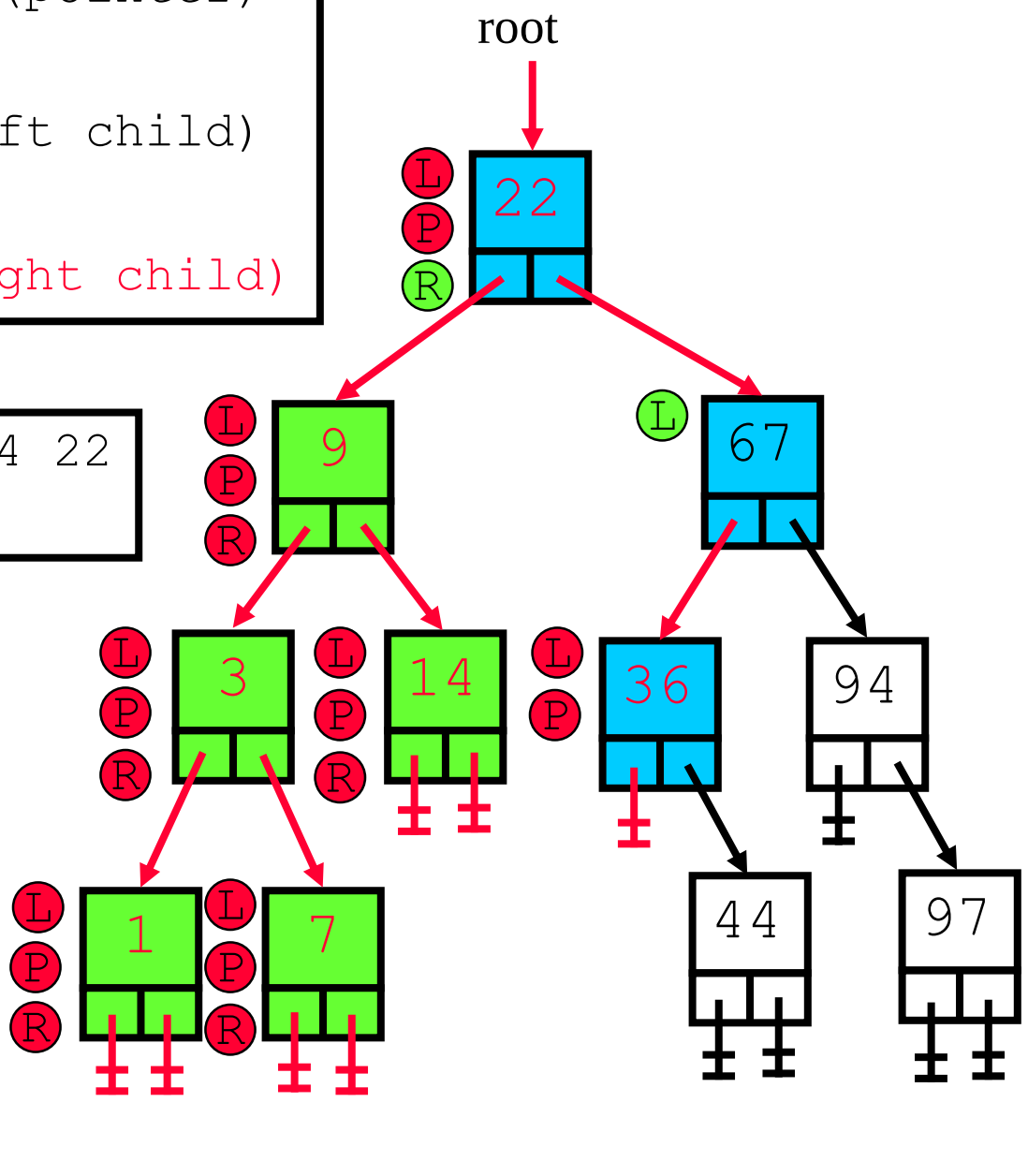
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36
```



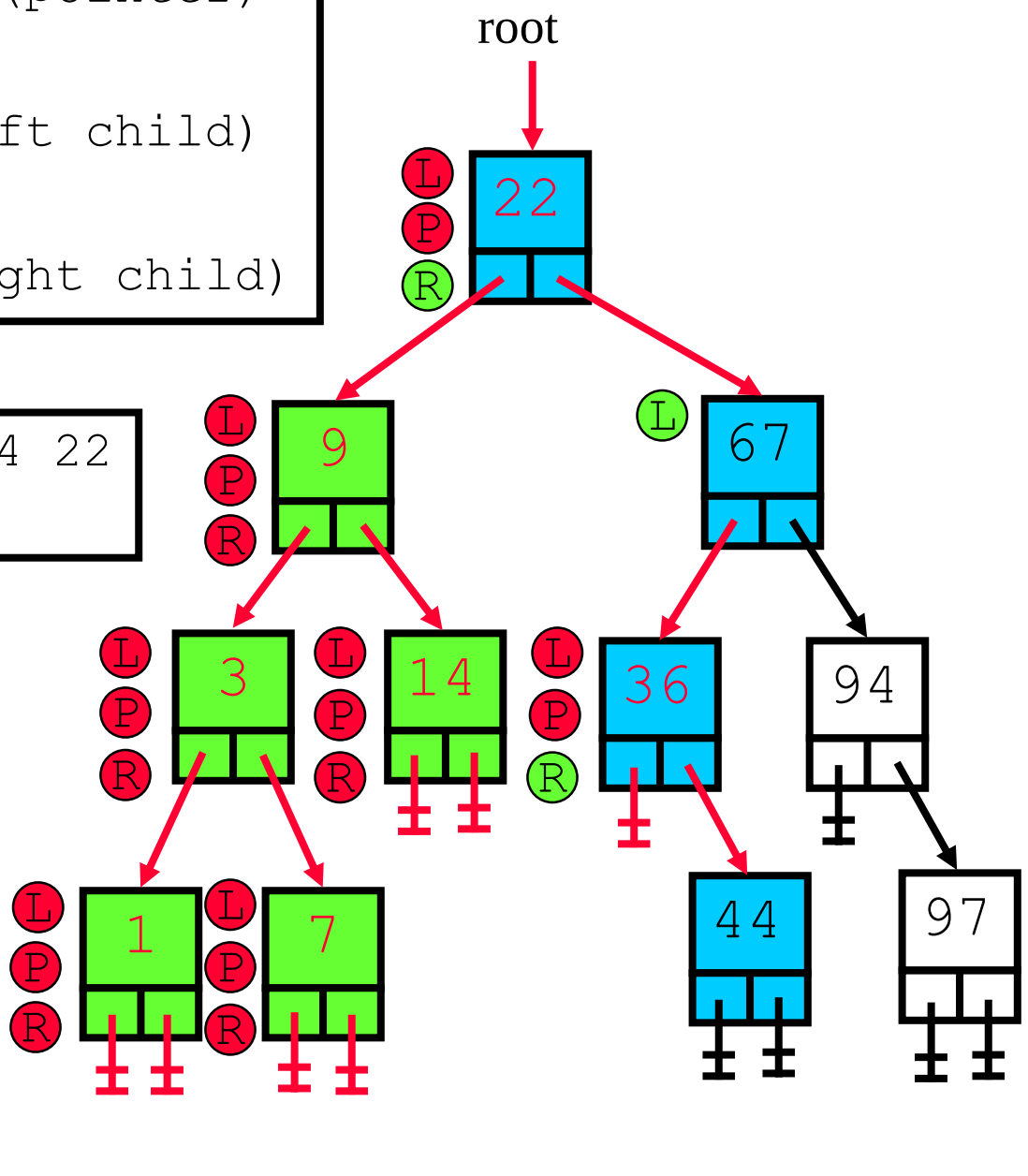
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36
```



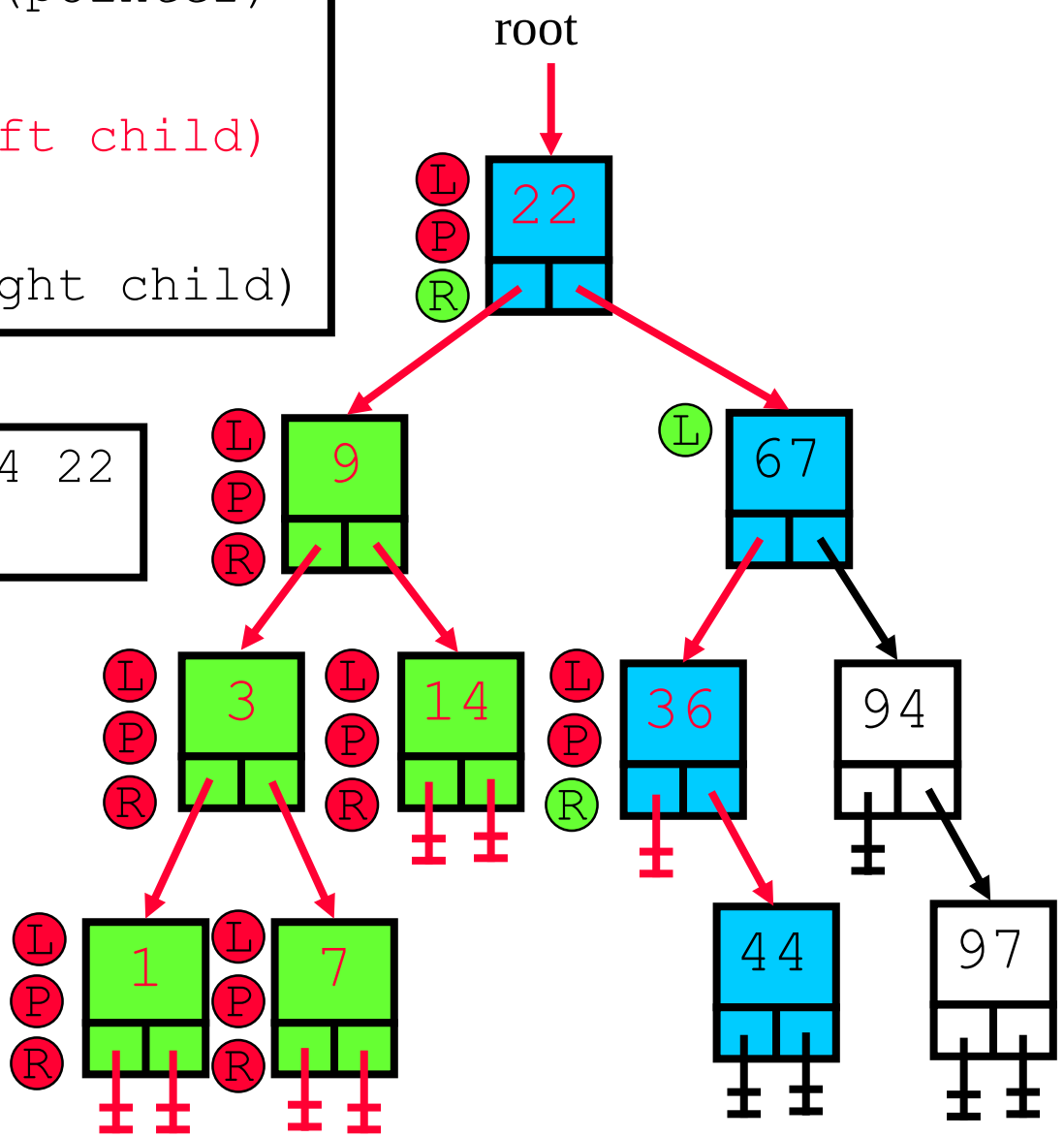
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36
```



```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36
```



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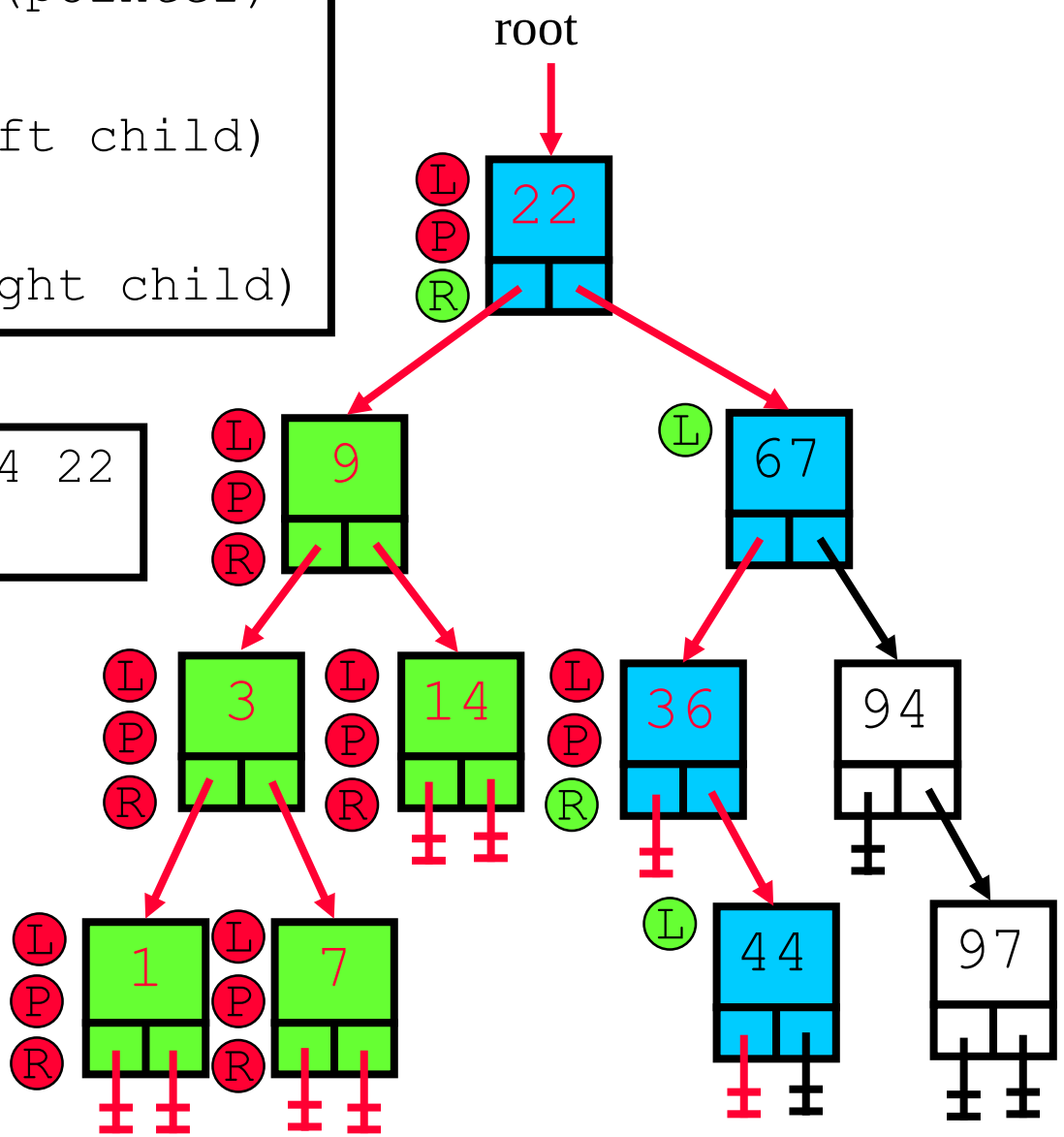
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36
```



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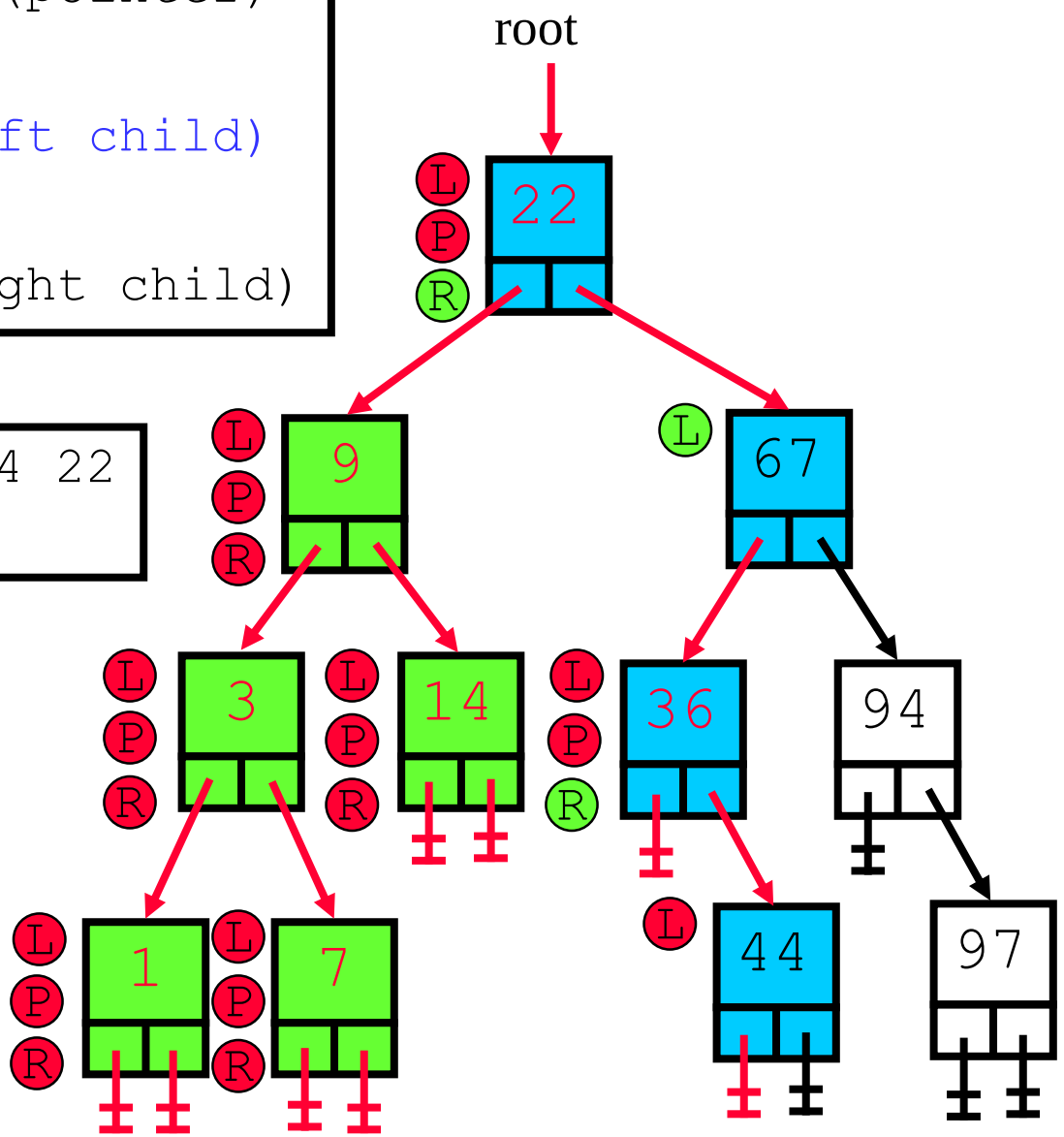
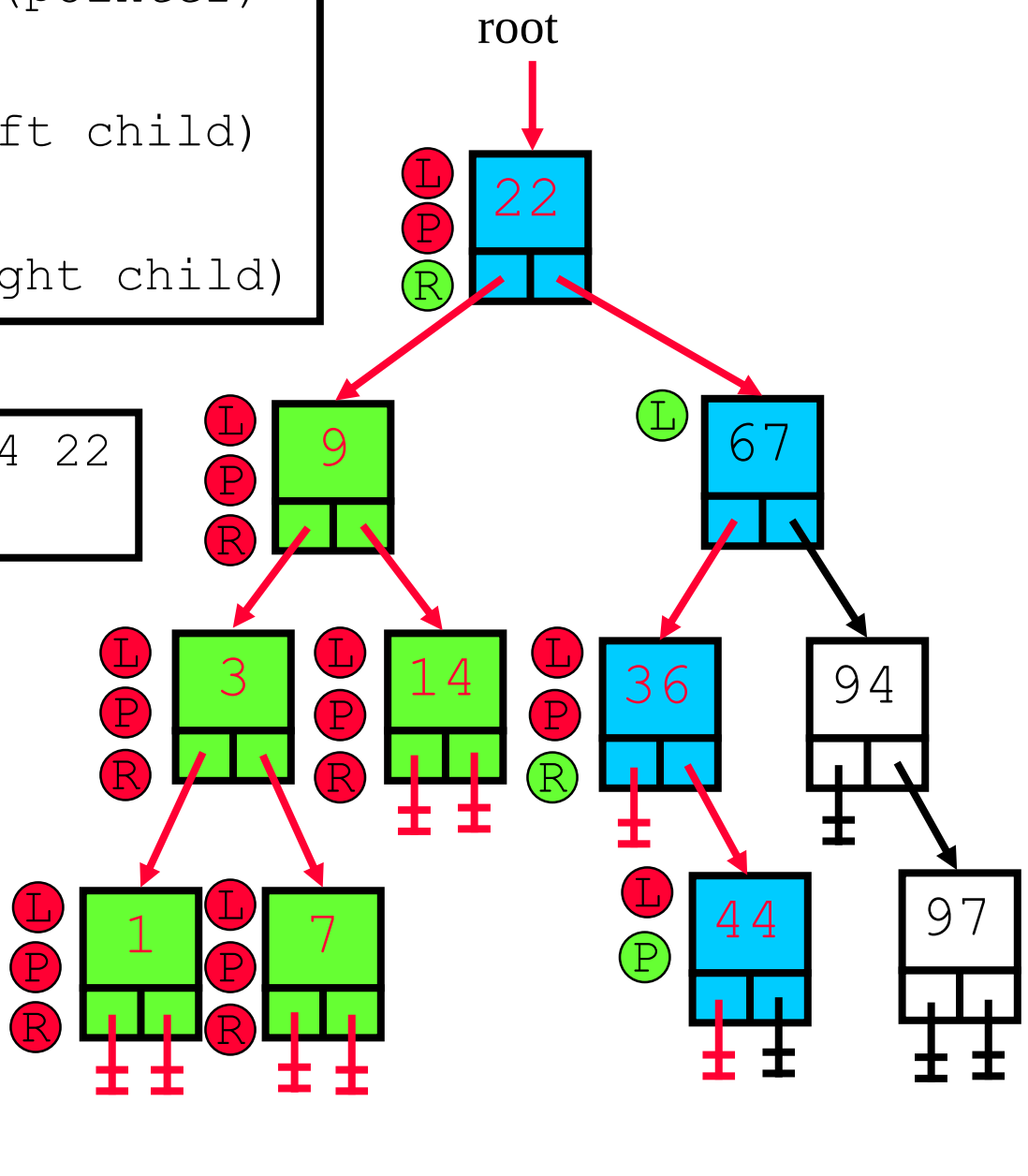
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36
```



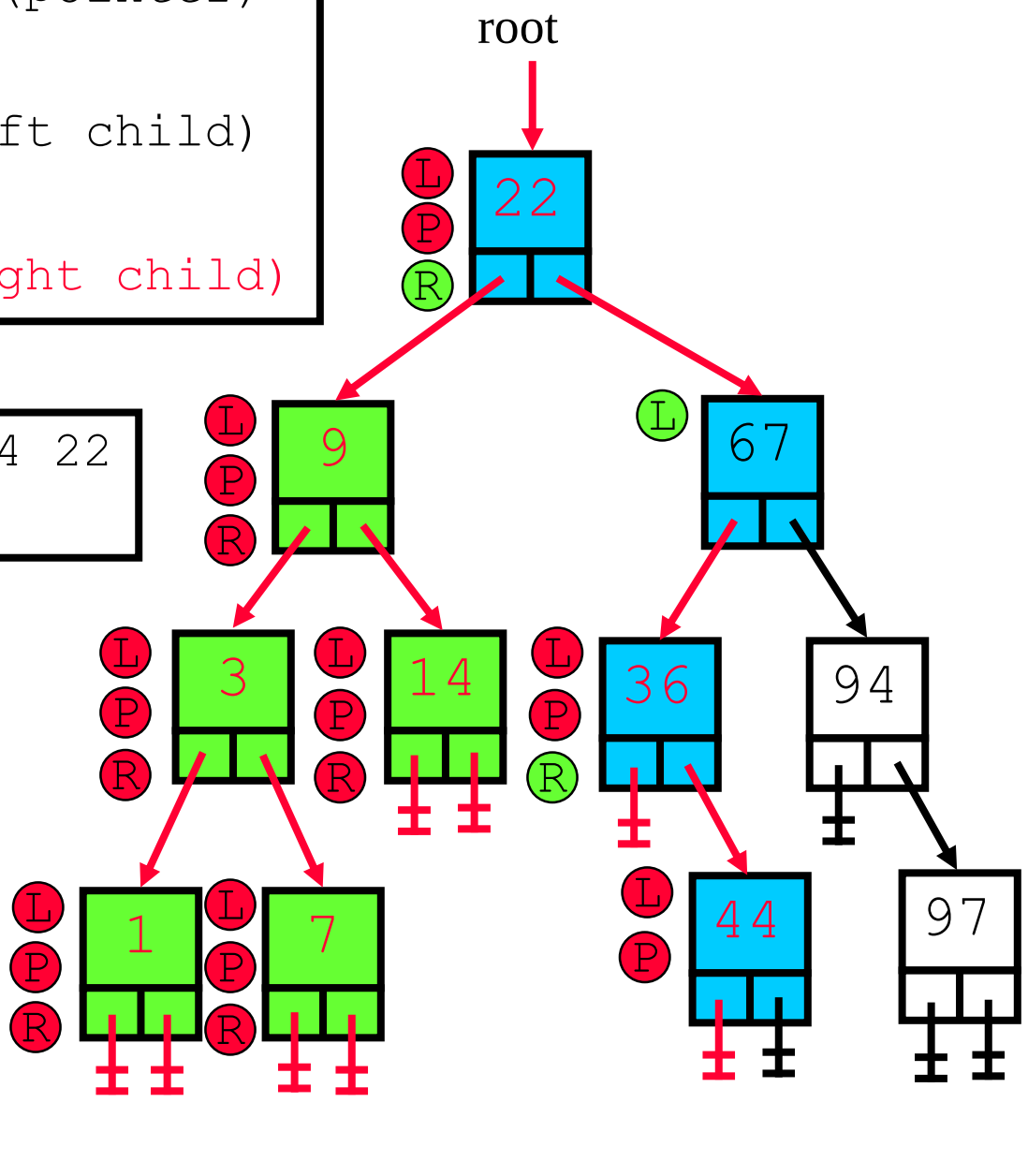
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44
```



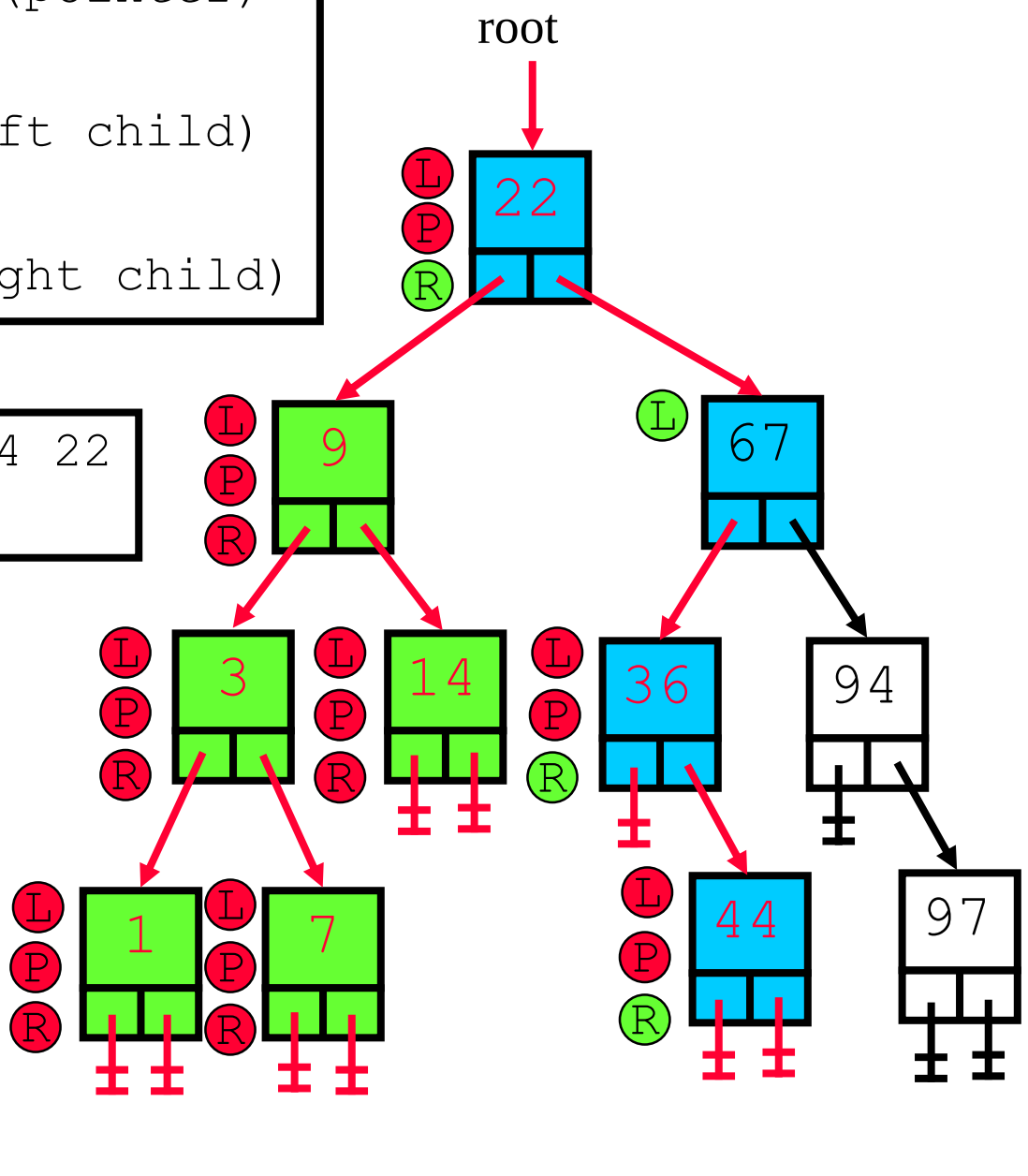
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44
```



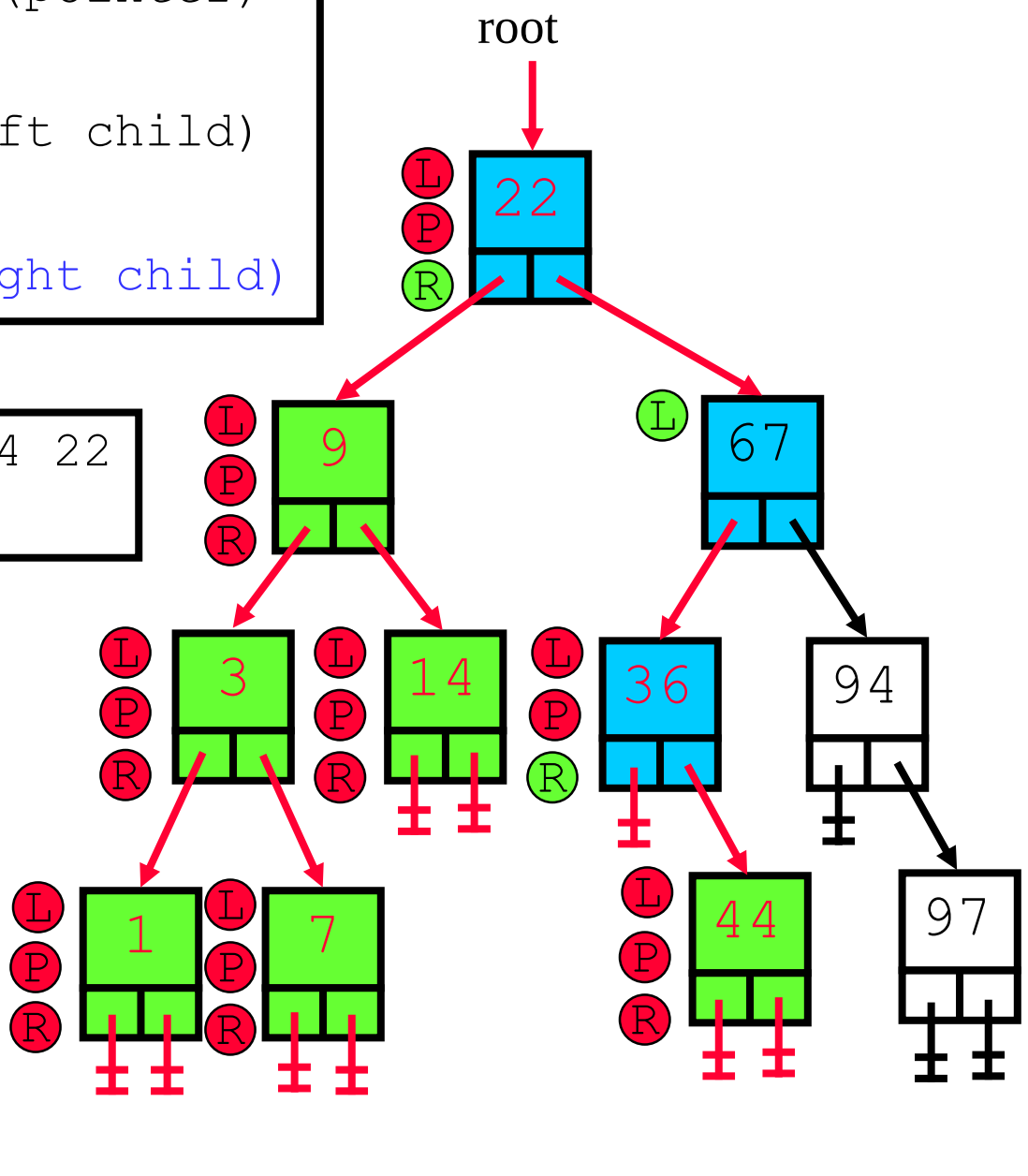
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44
```



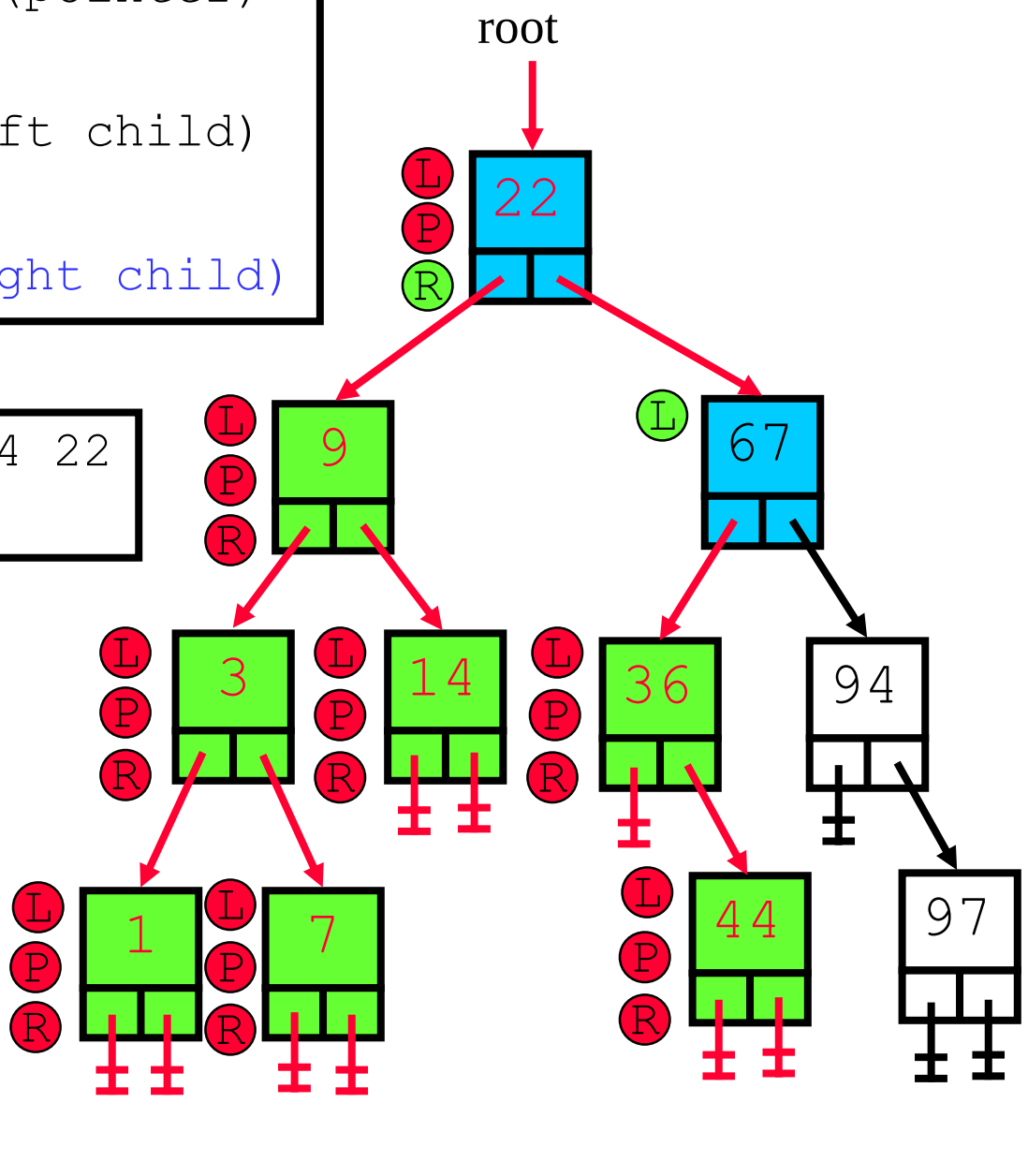
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44
```



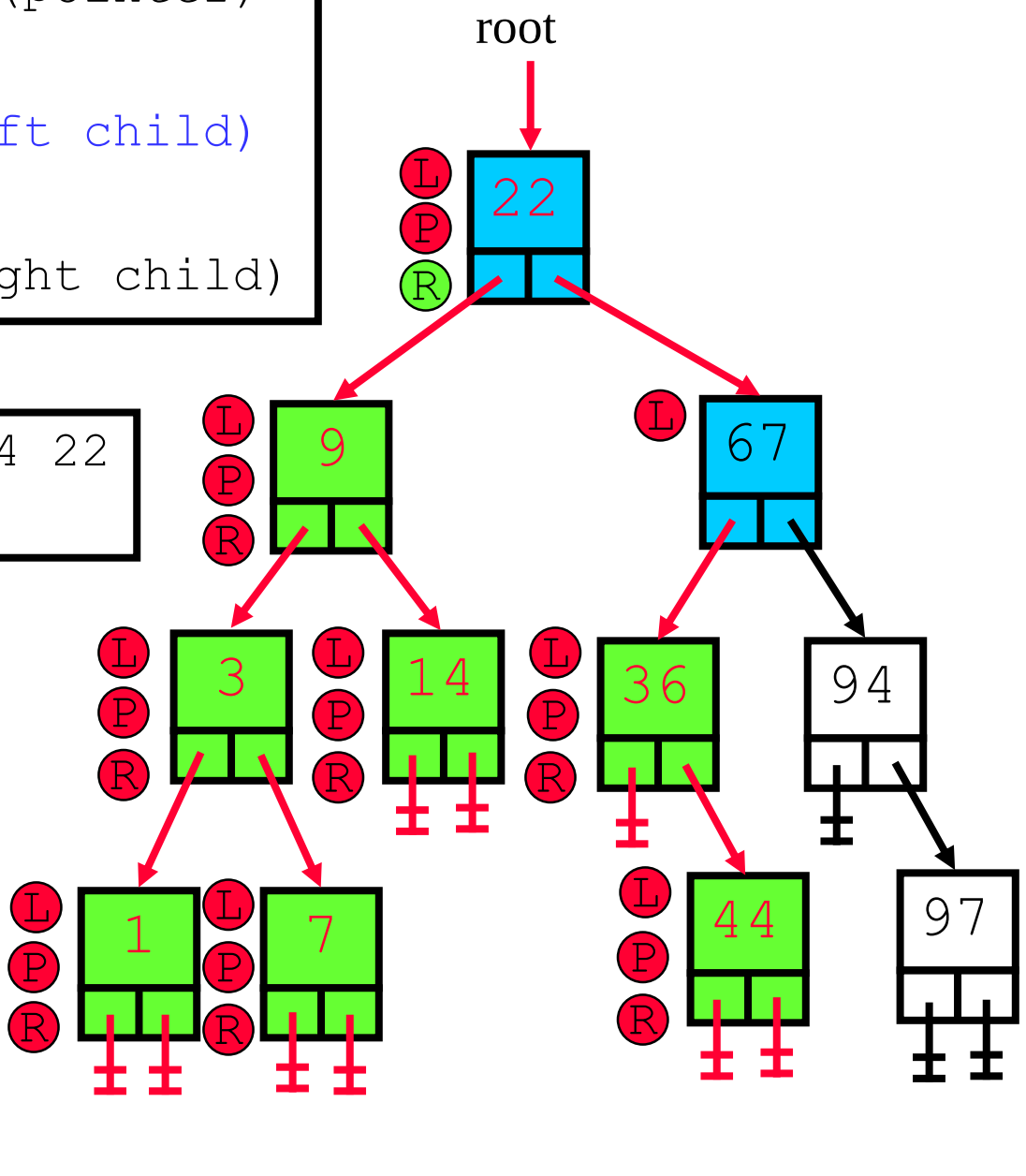
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44
```



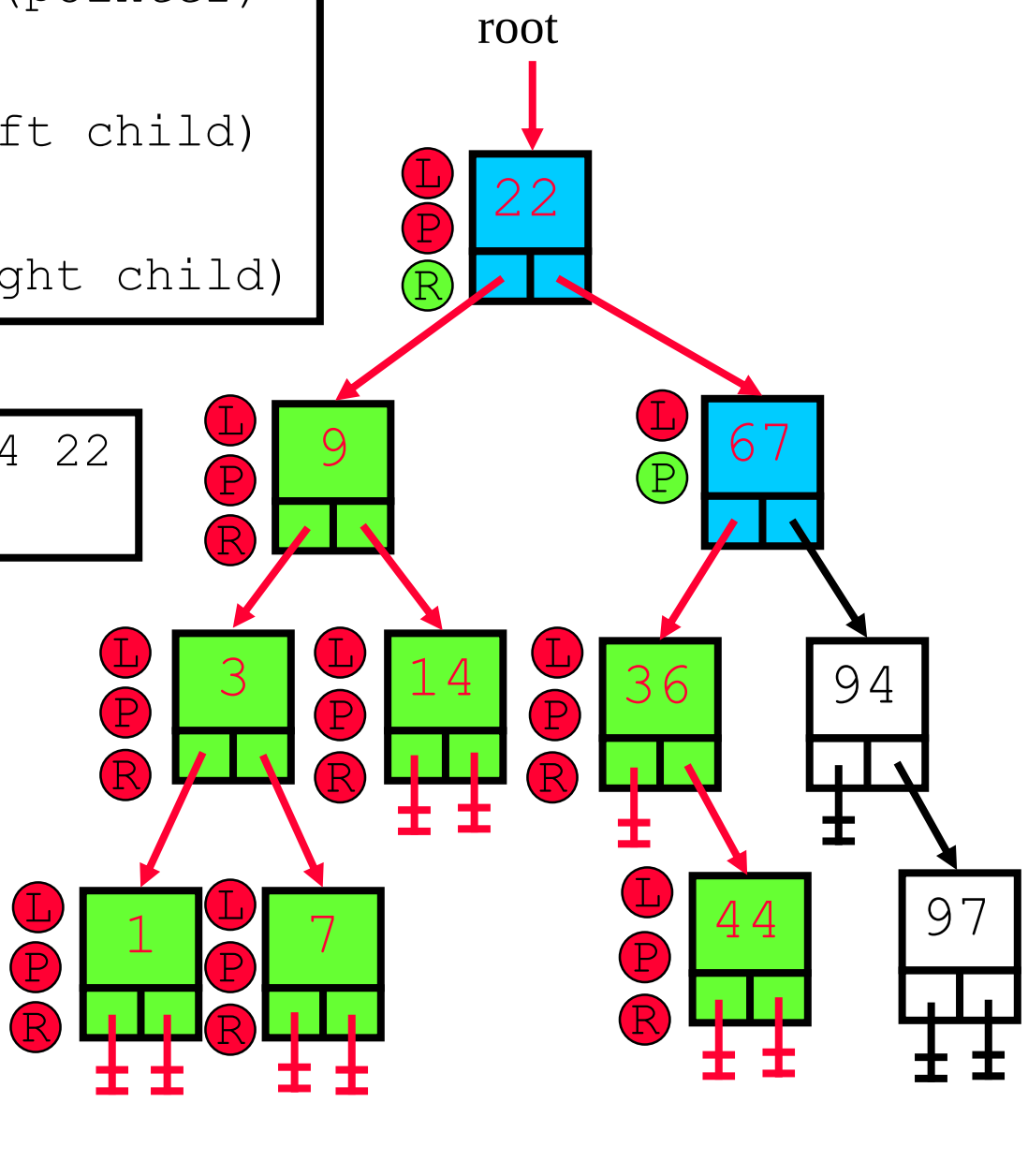
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44
```



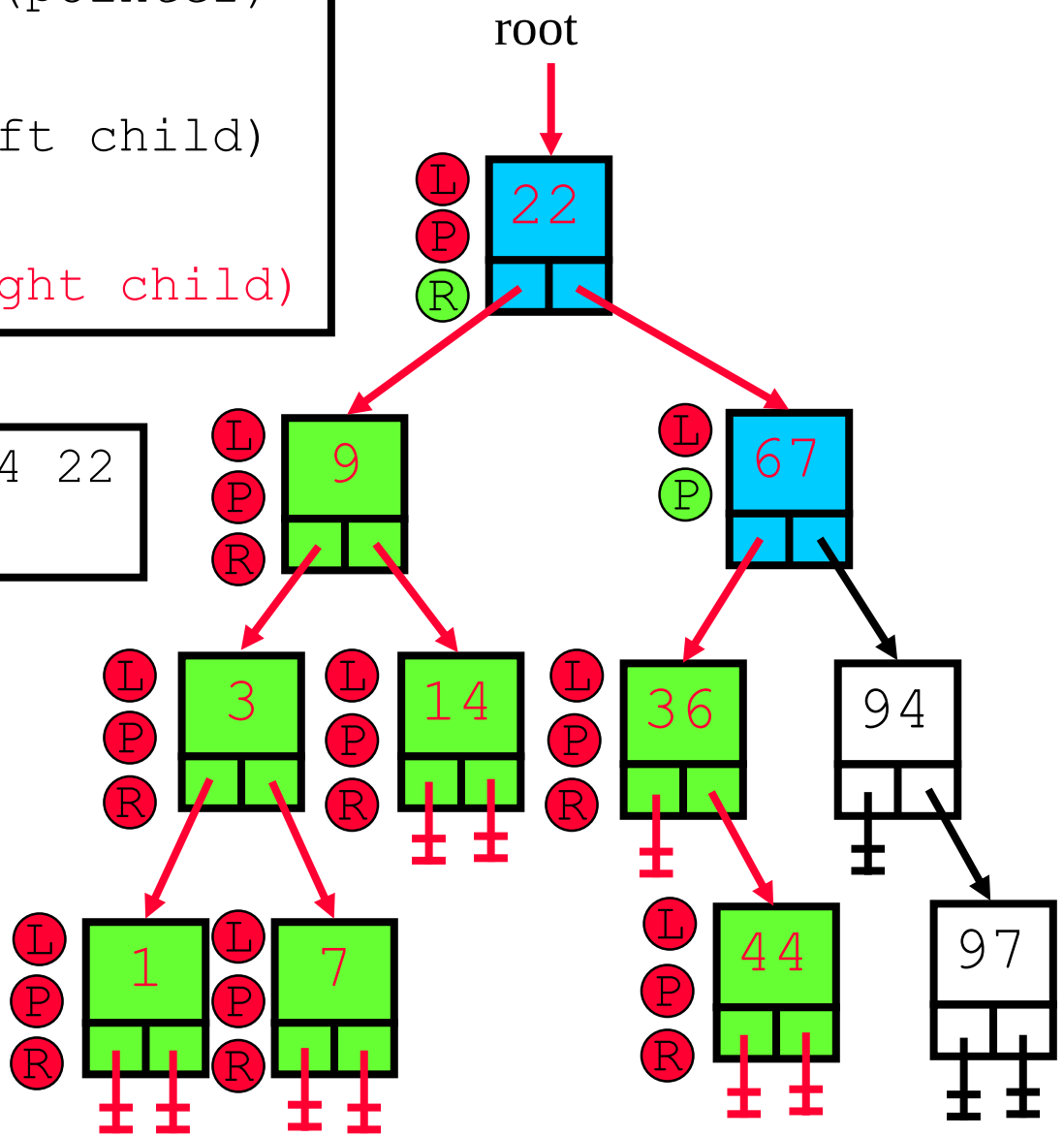
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67
```



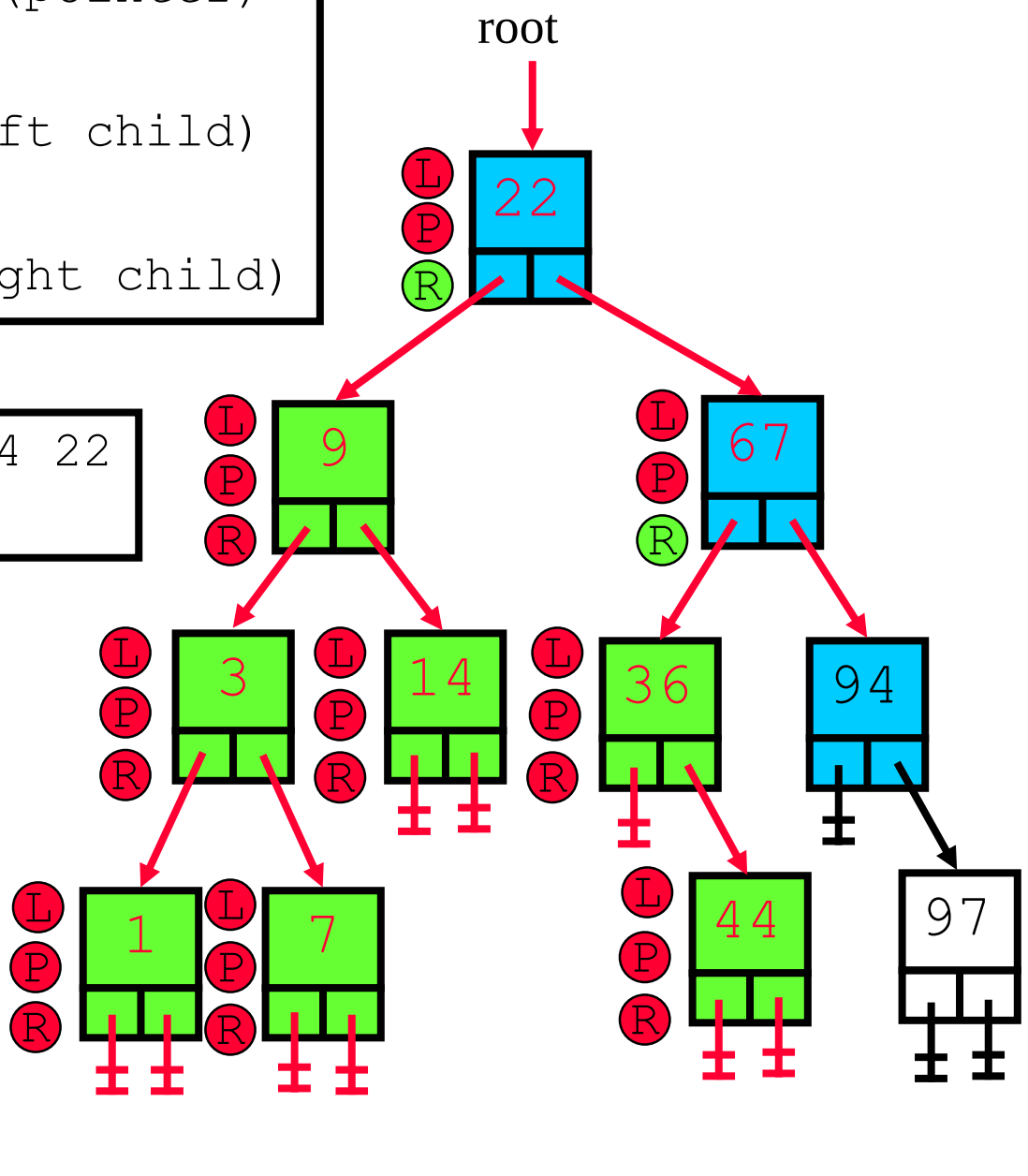
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67
```



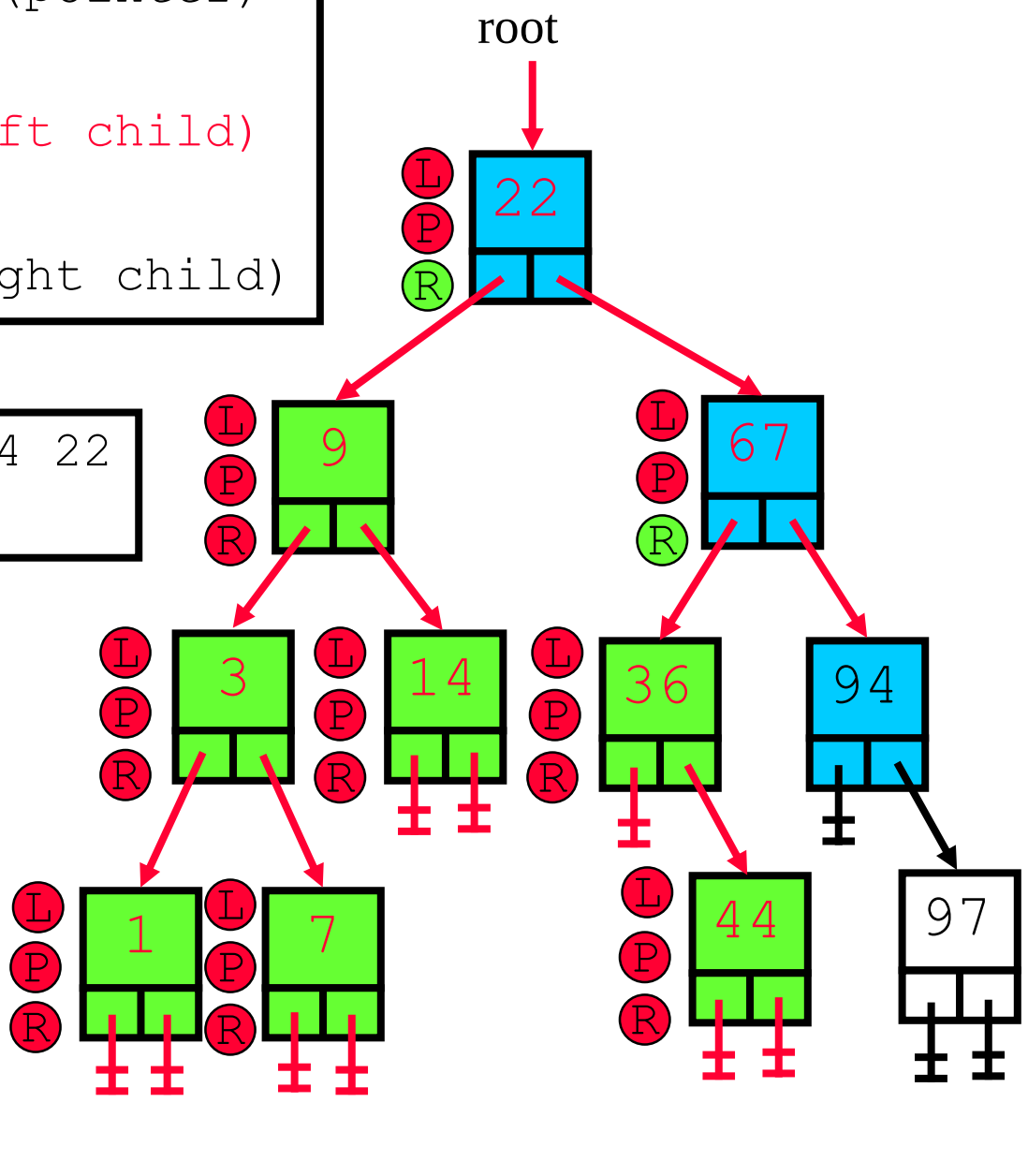
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67
```



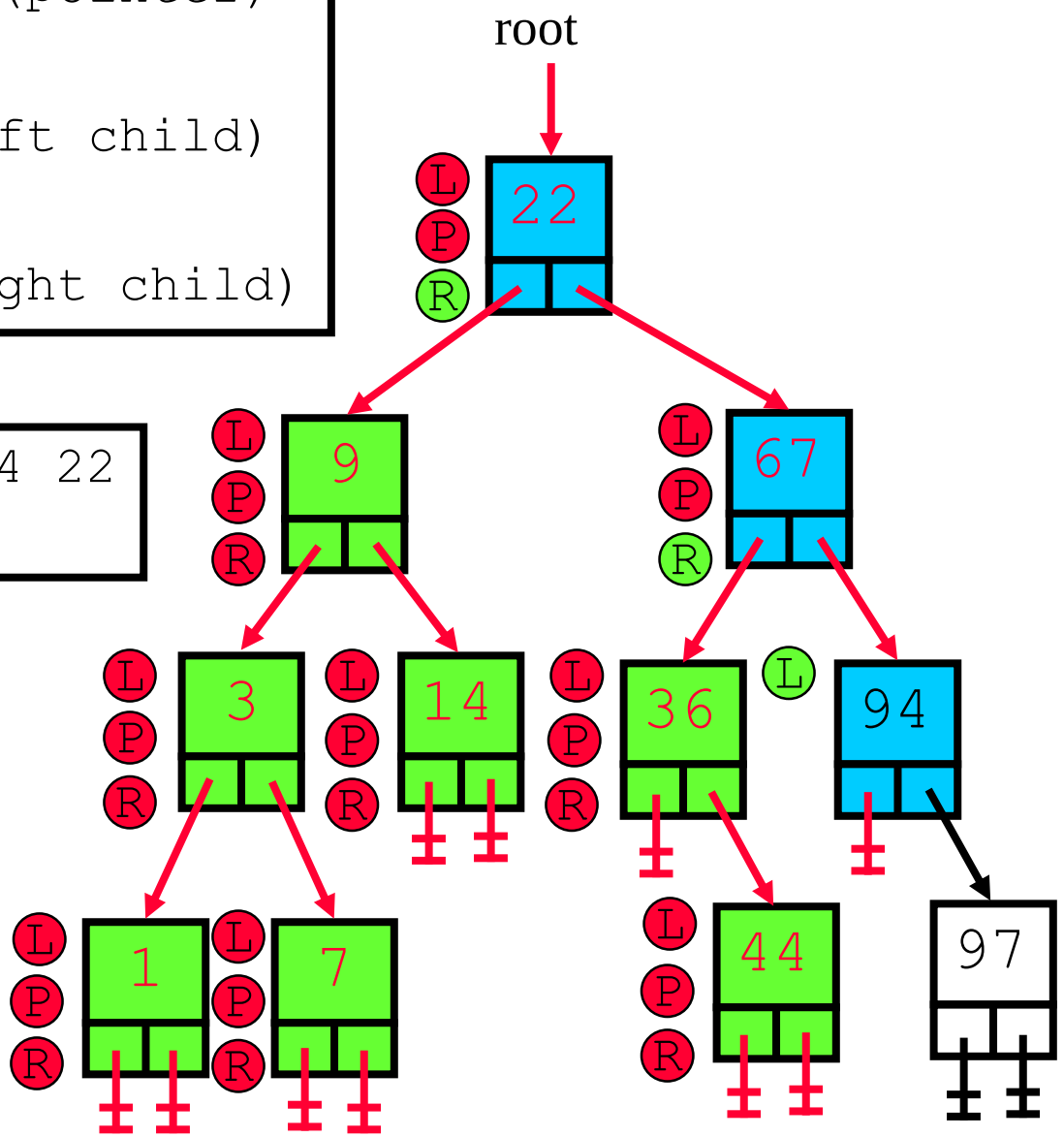
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67
```



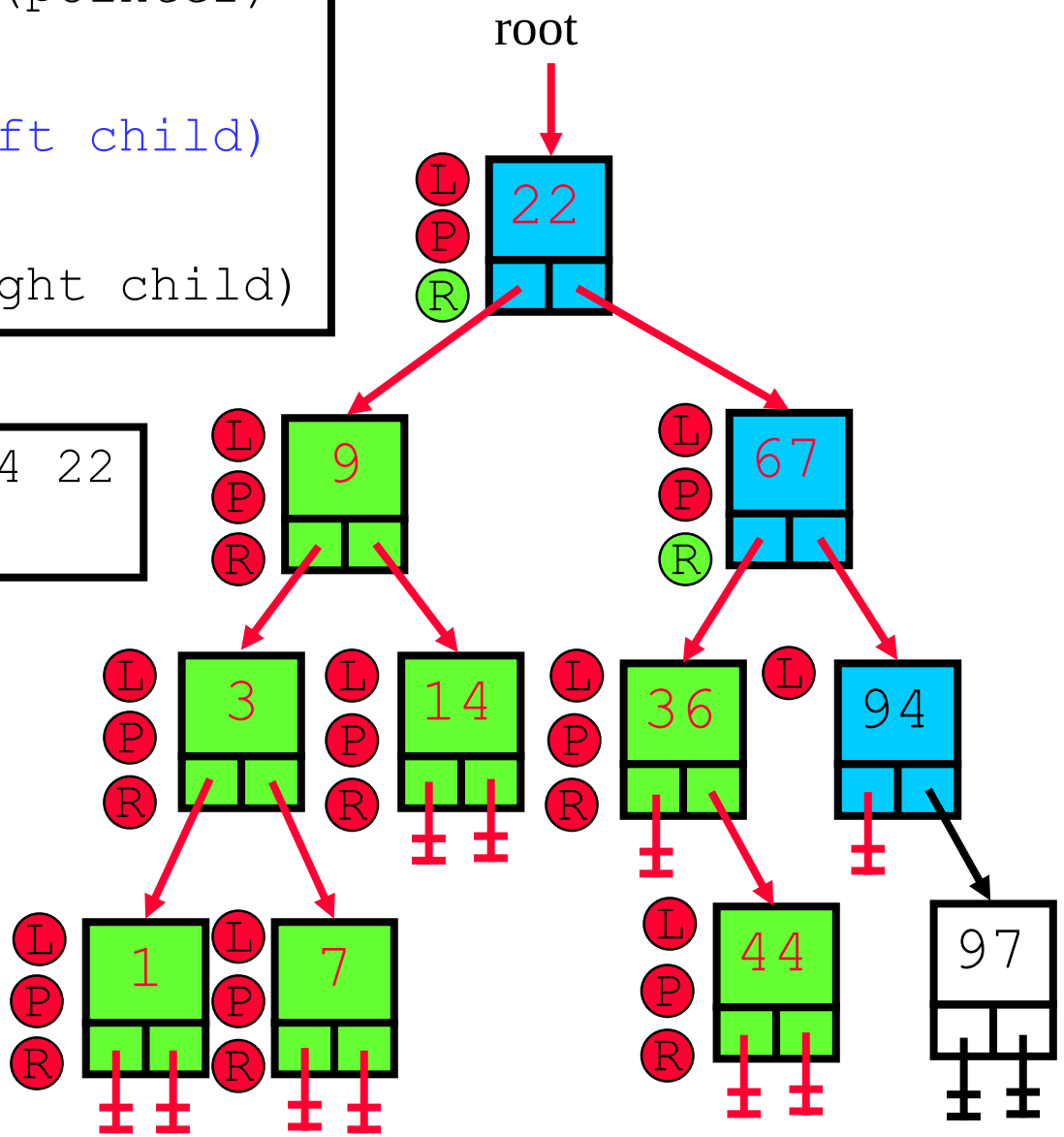
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67
```



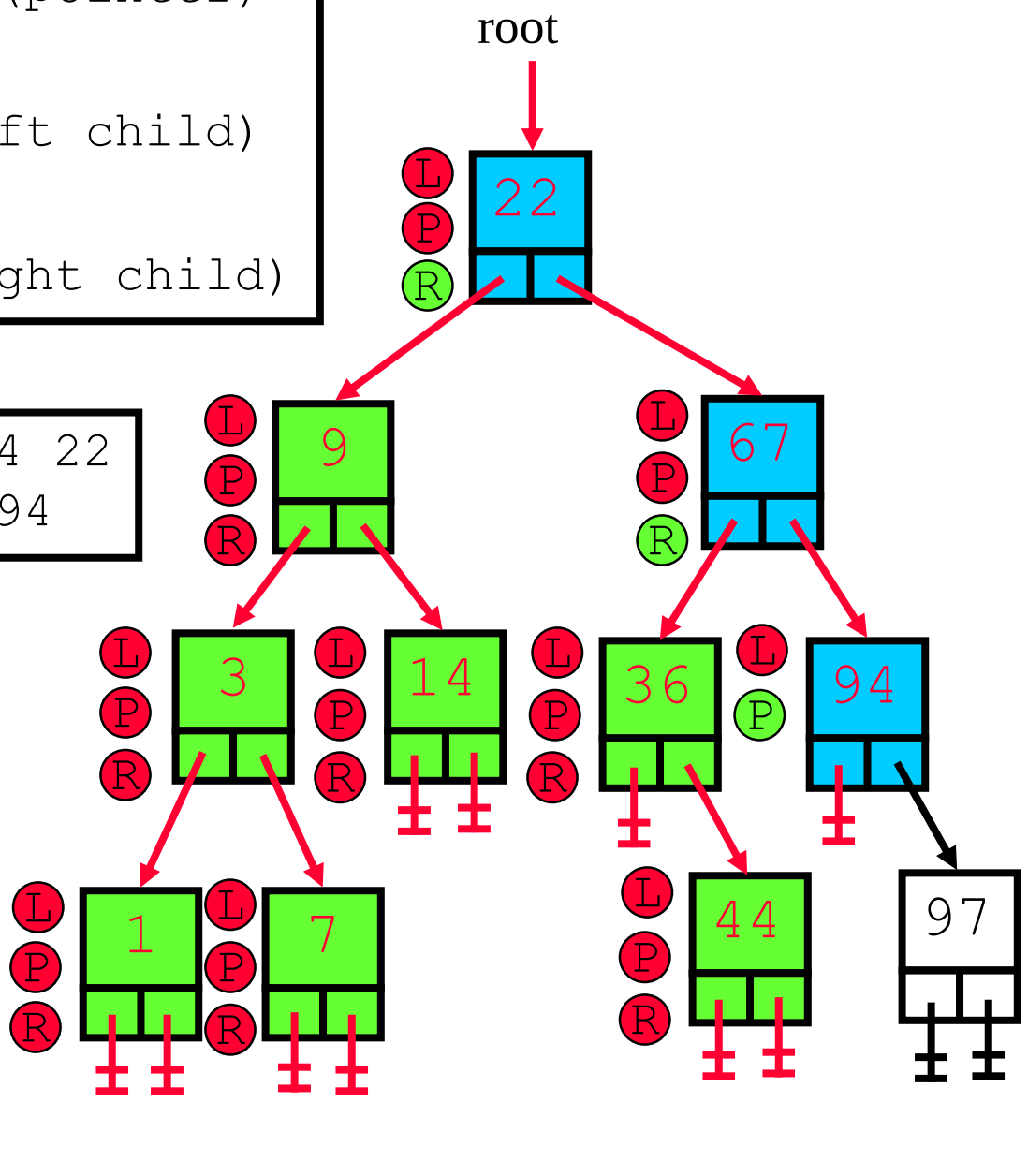
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67
```



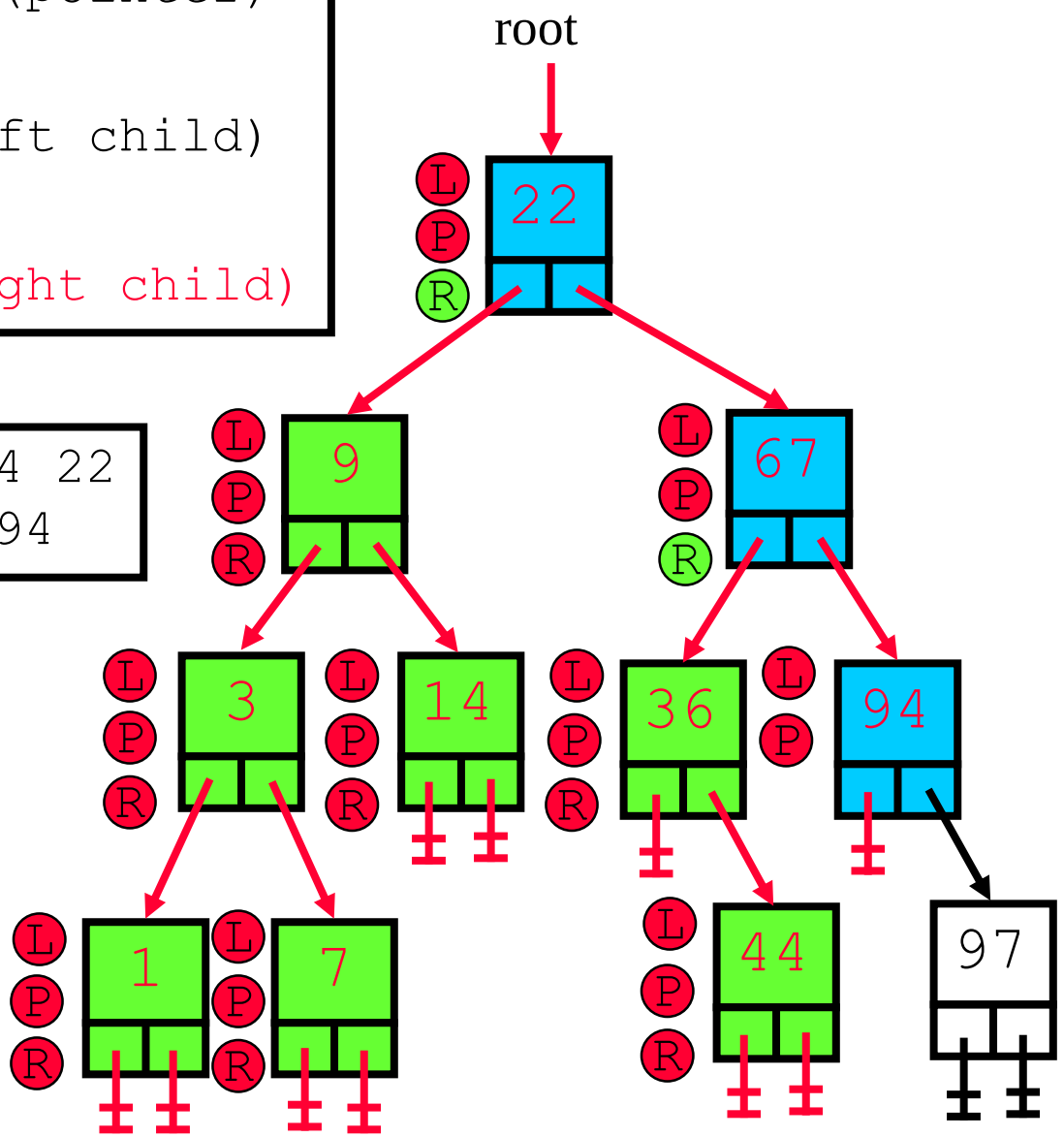
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94
```



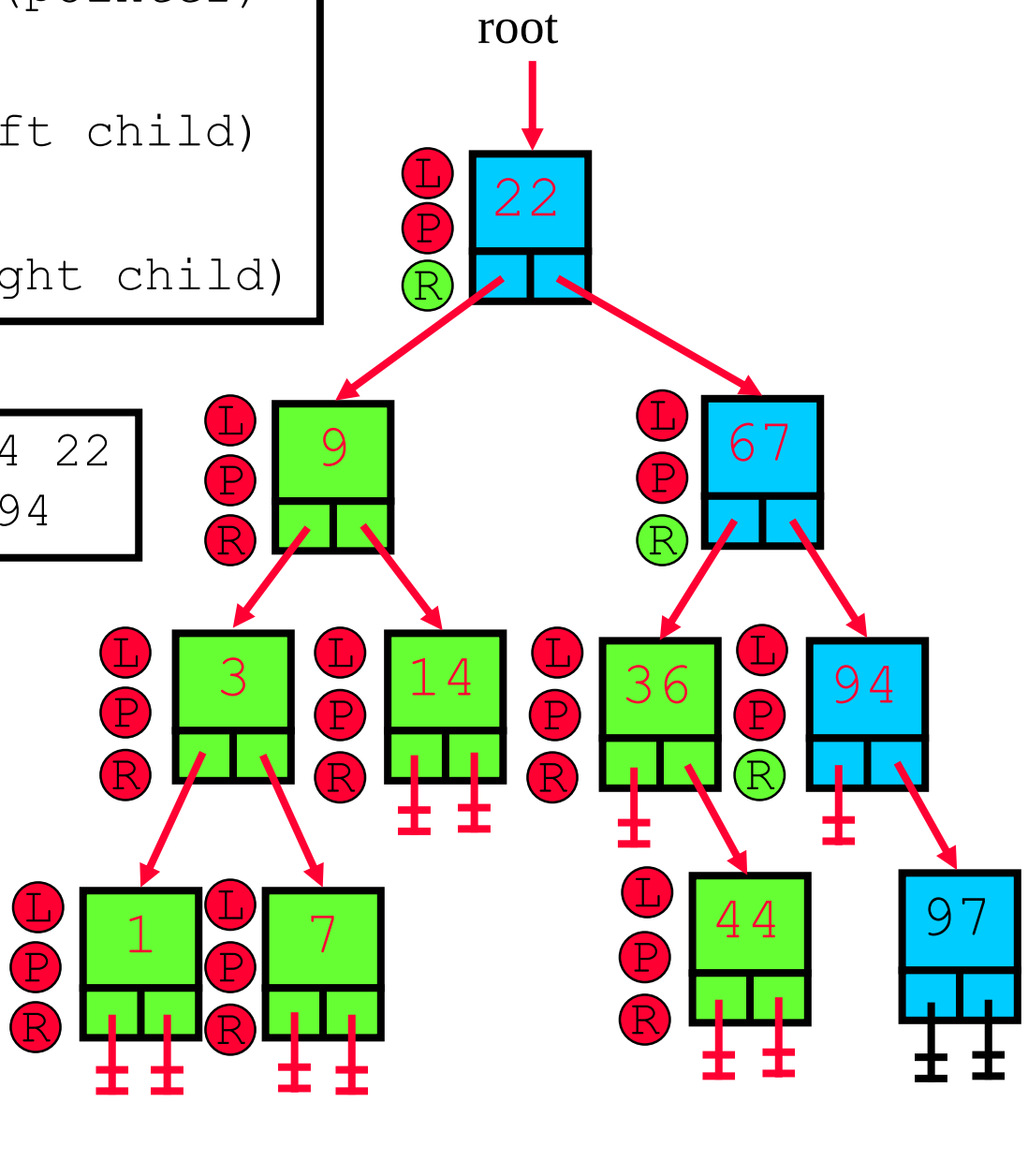
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94
```



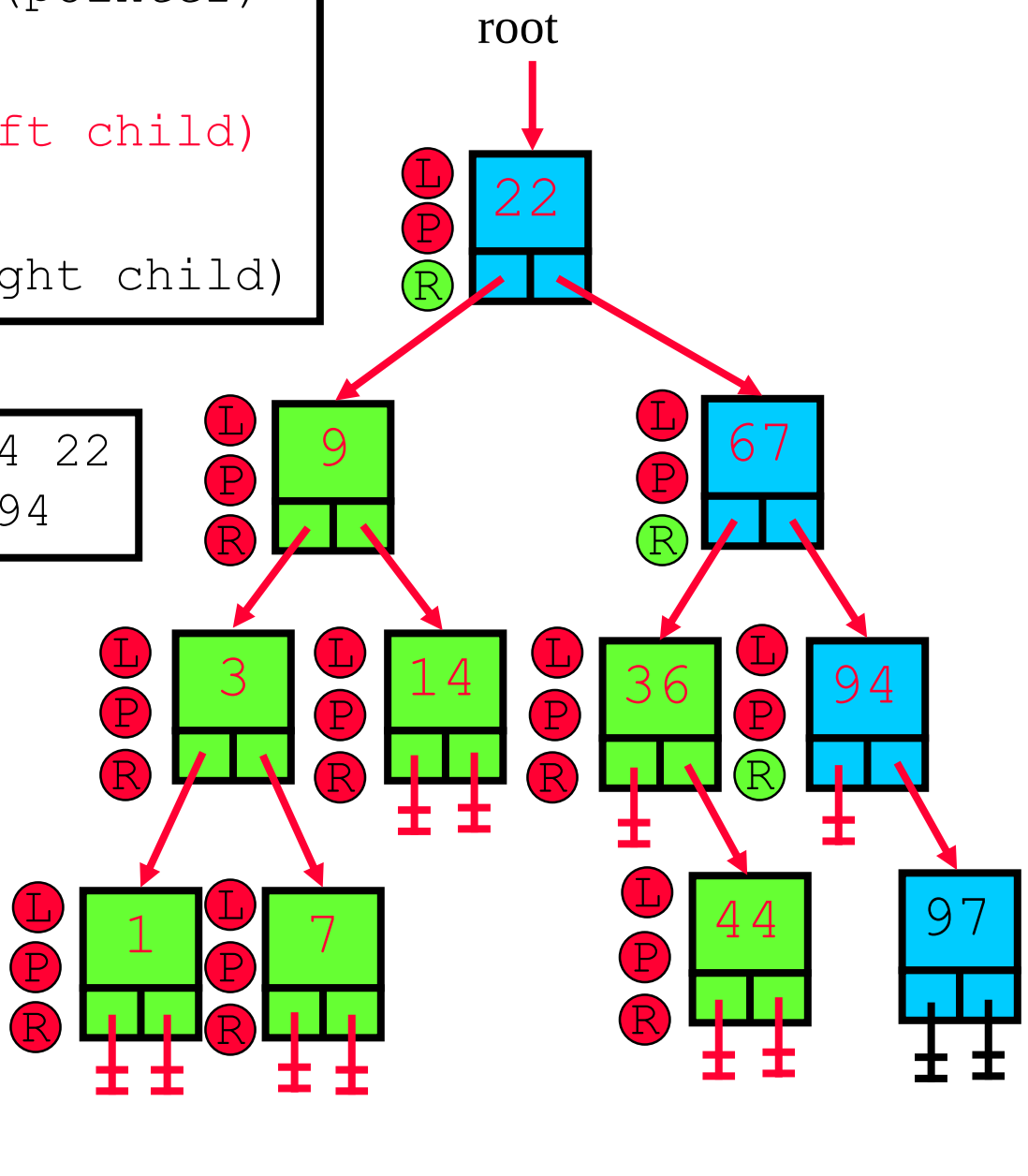
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94
```



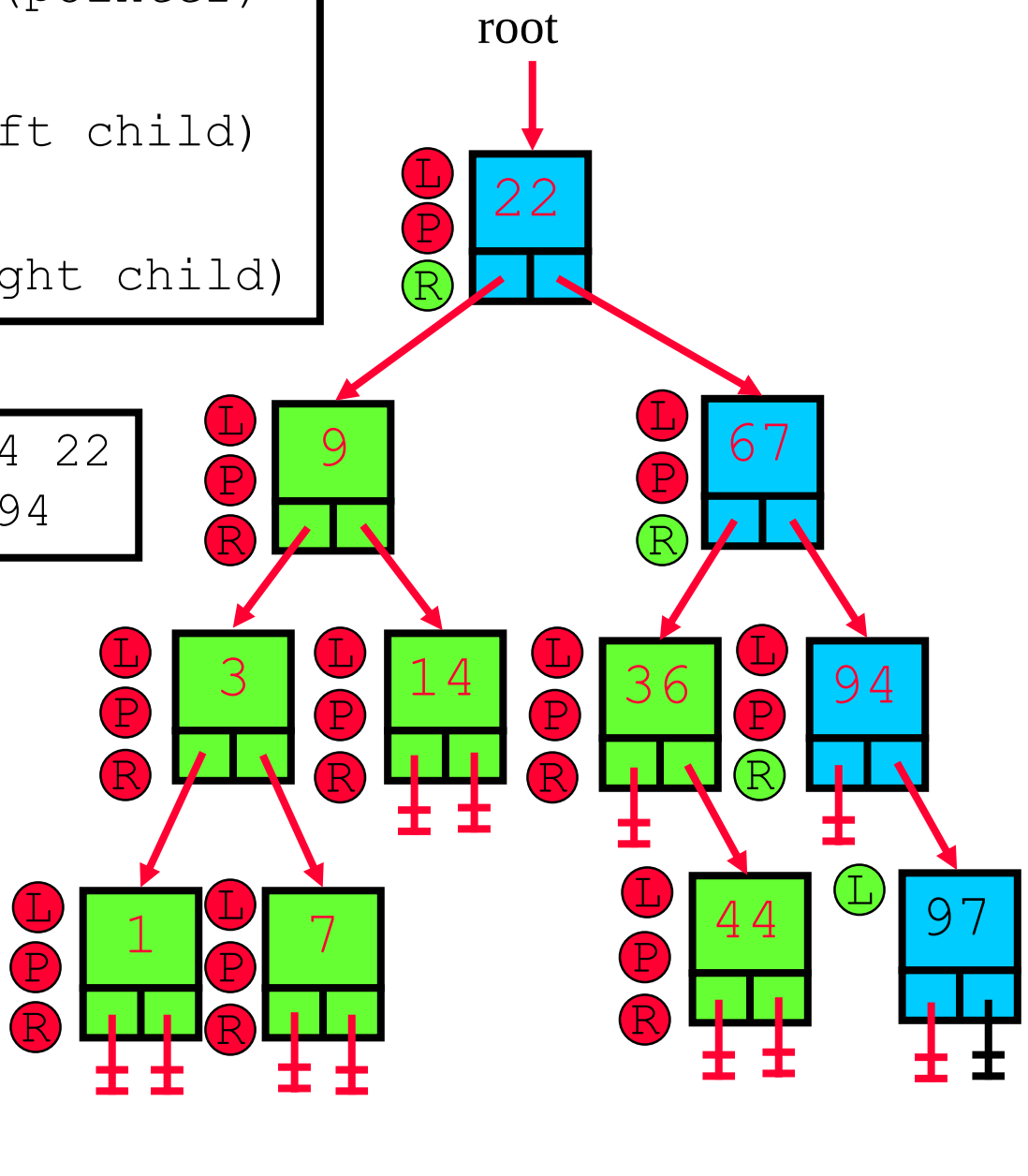
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94
```



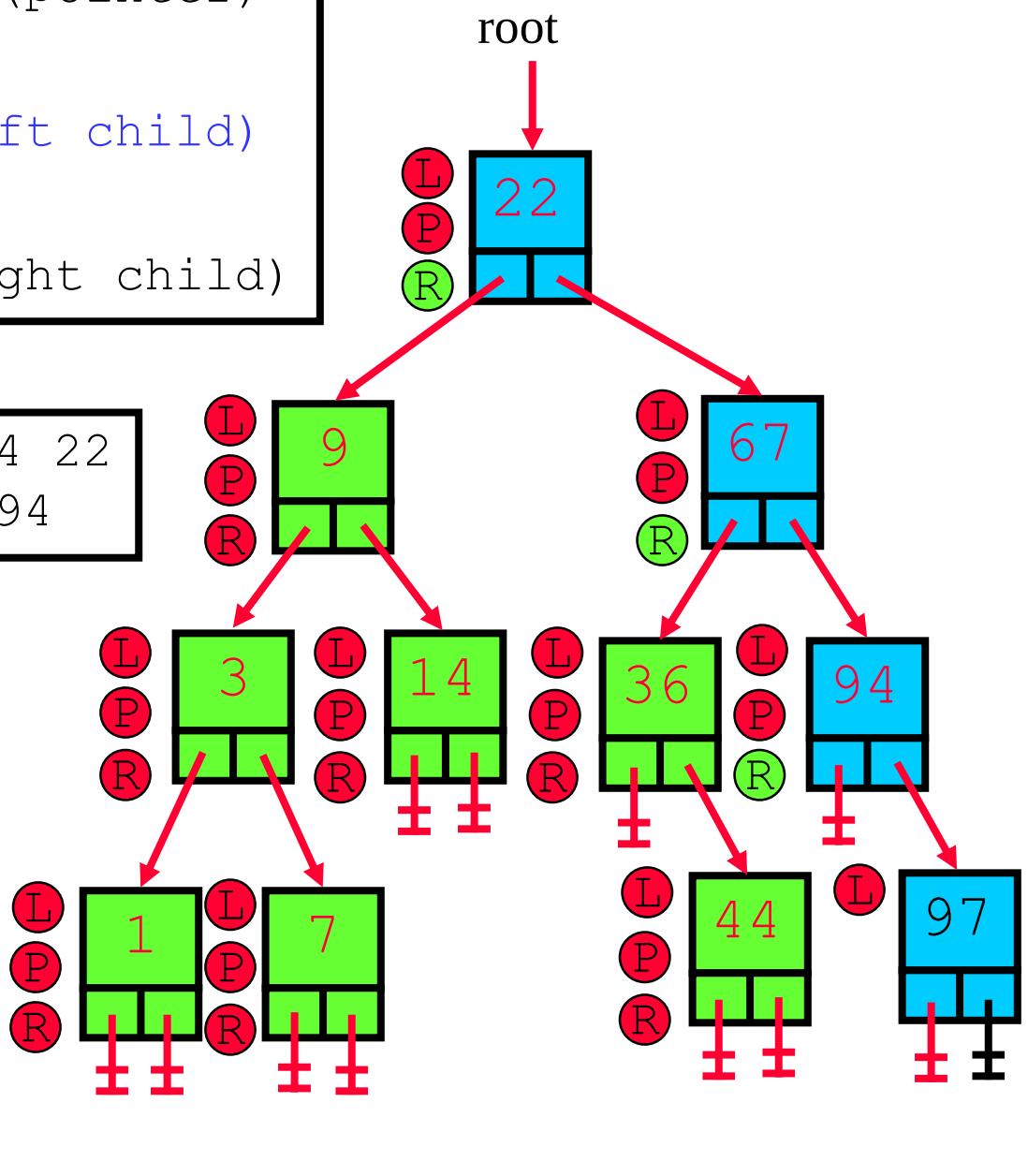
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94
```



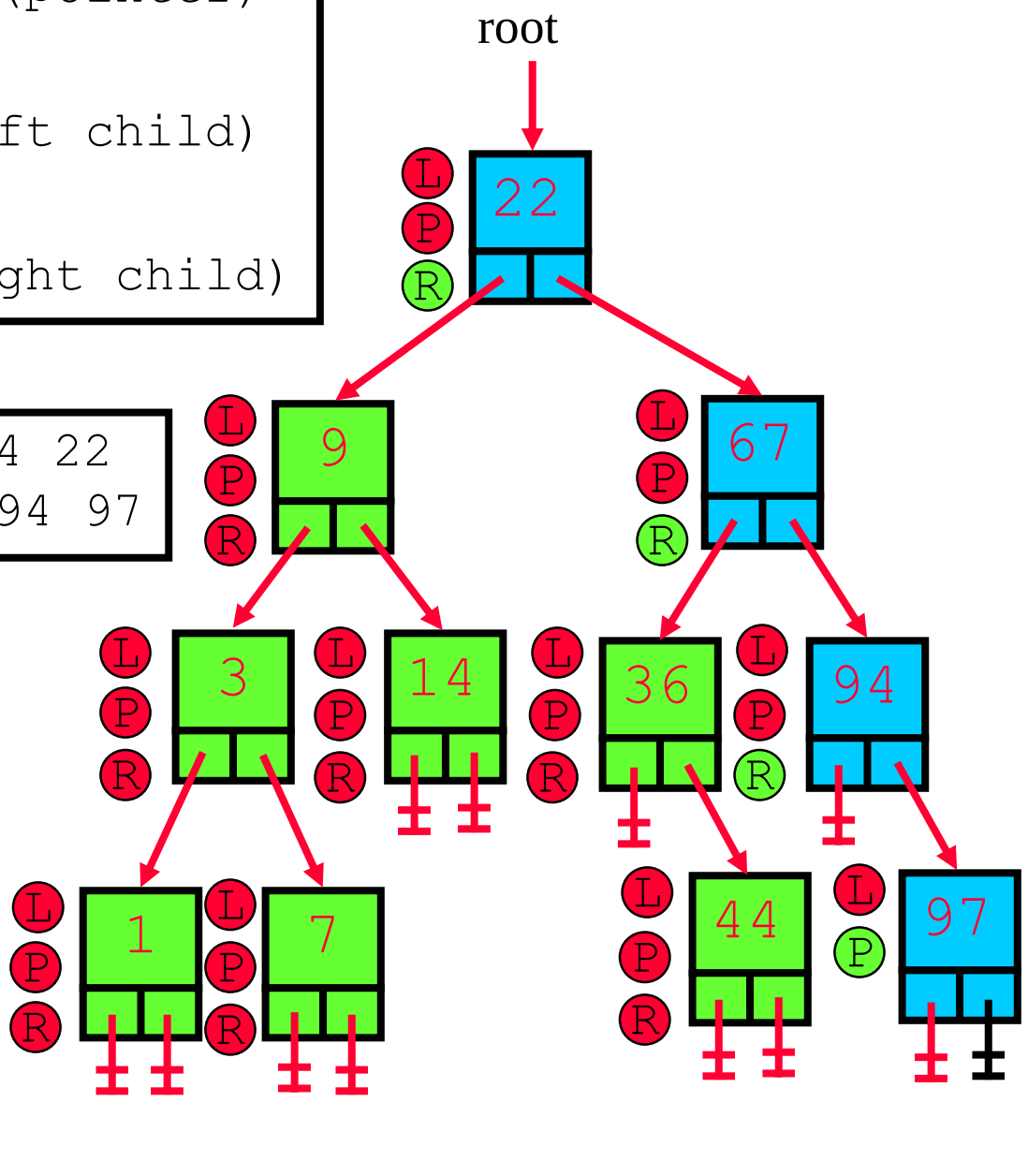
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94
```



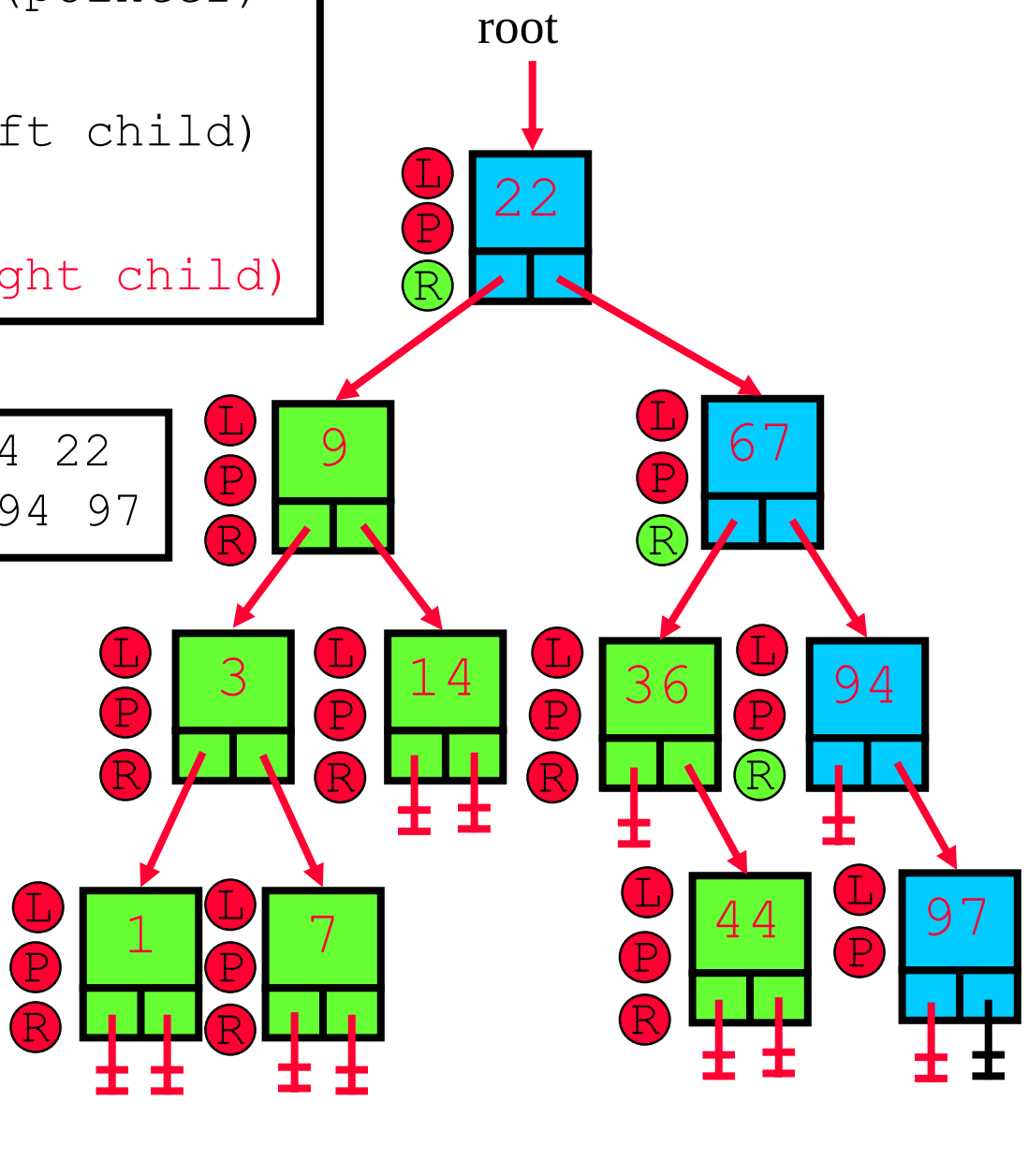
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```



```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```



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Proc InOrderPrint(pointer)
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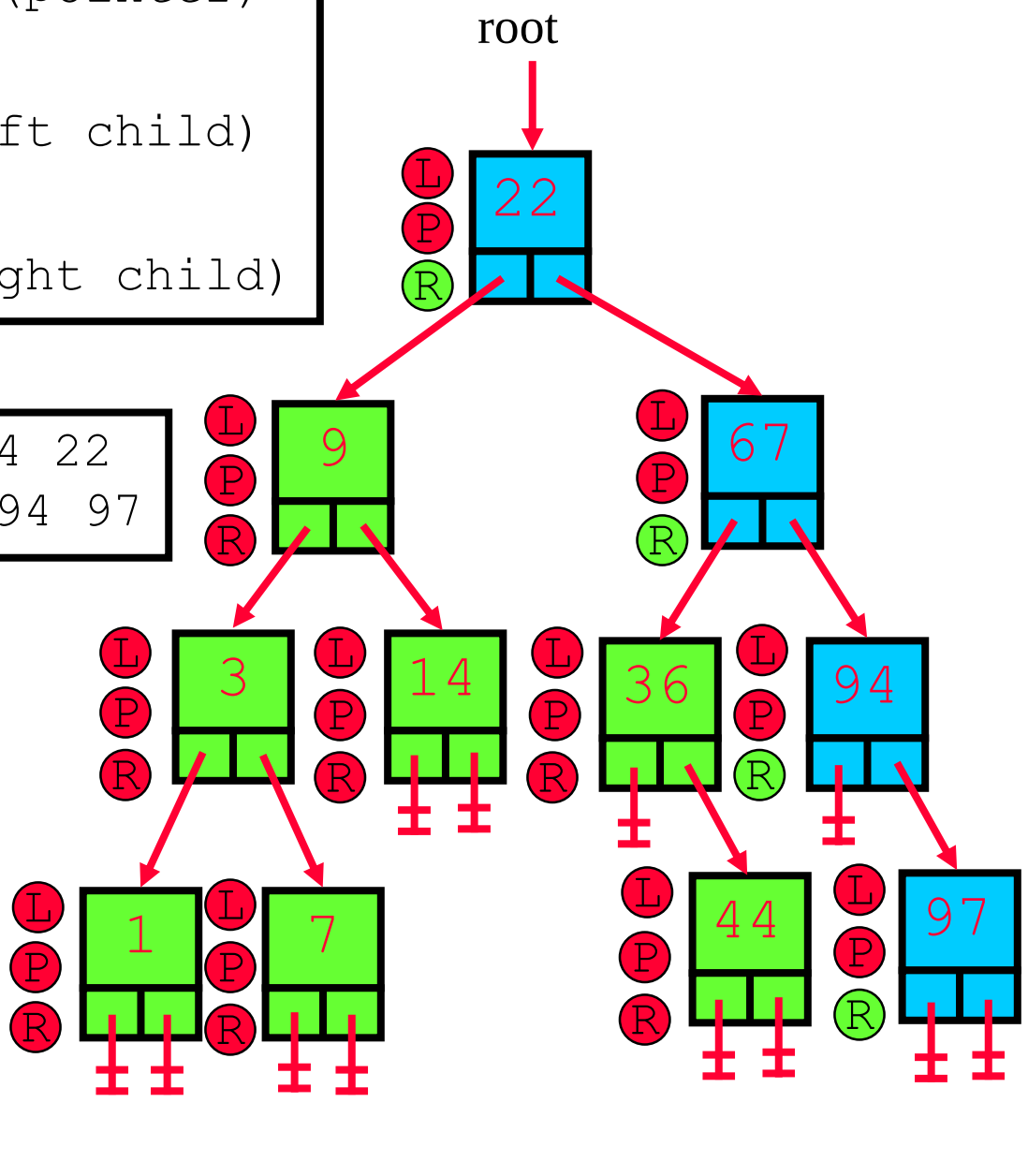
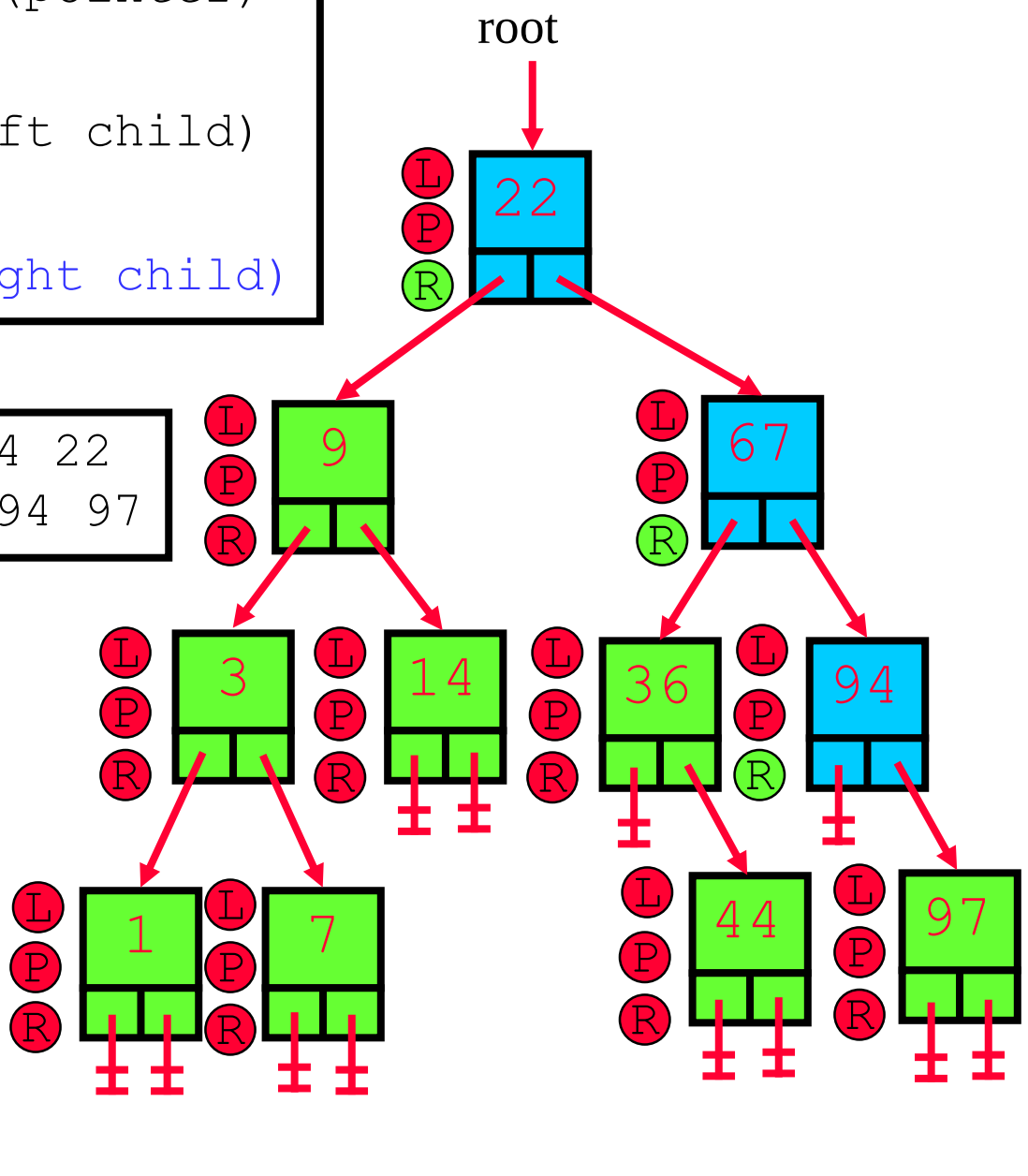
```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```



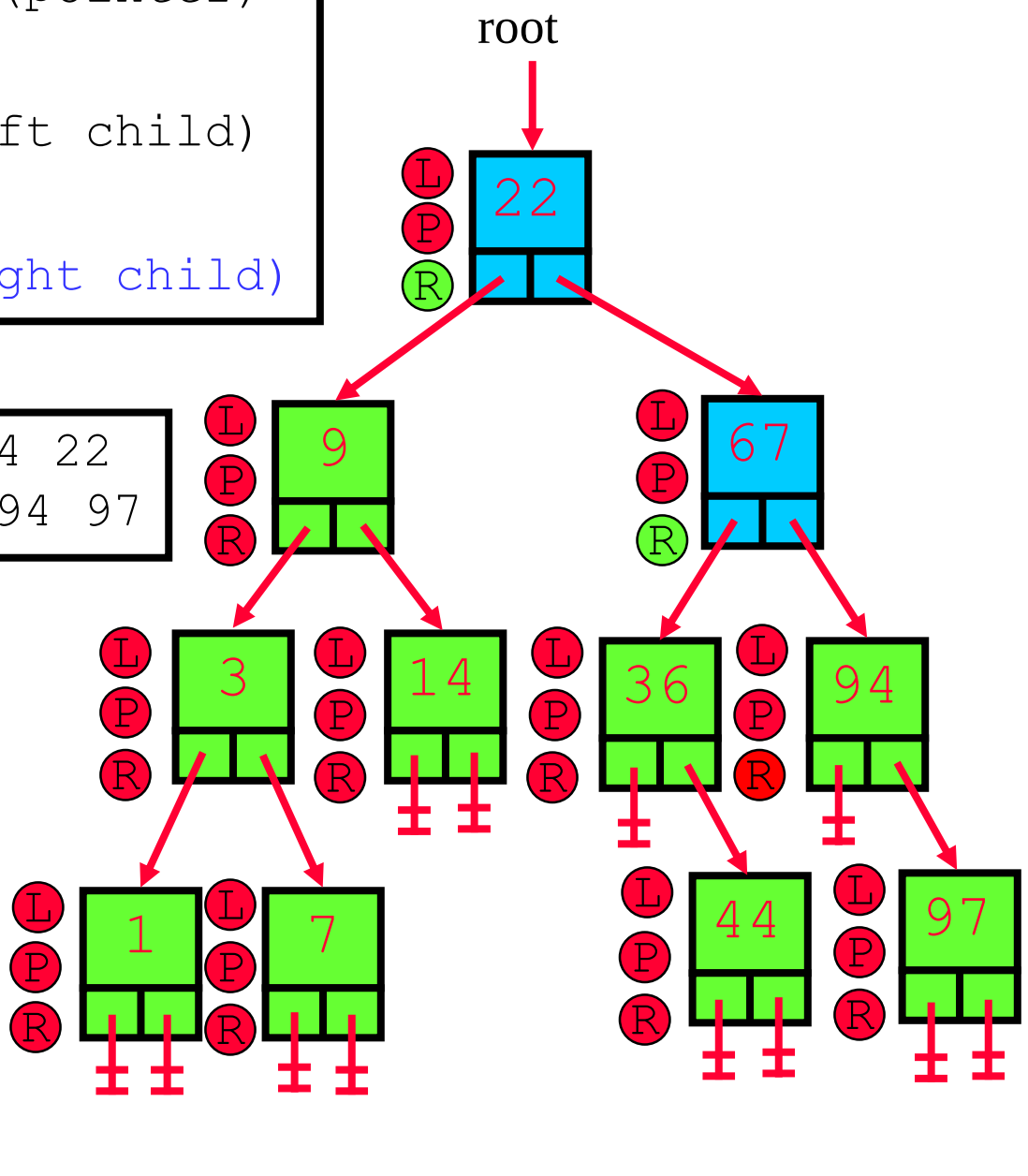
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```



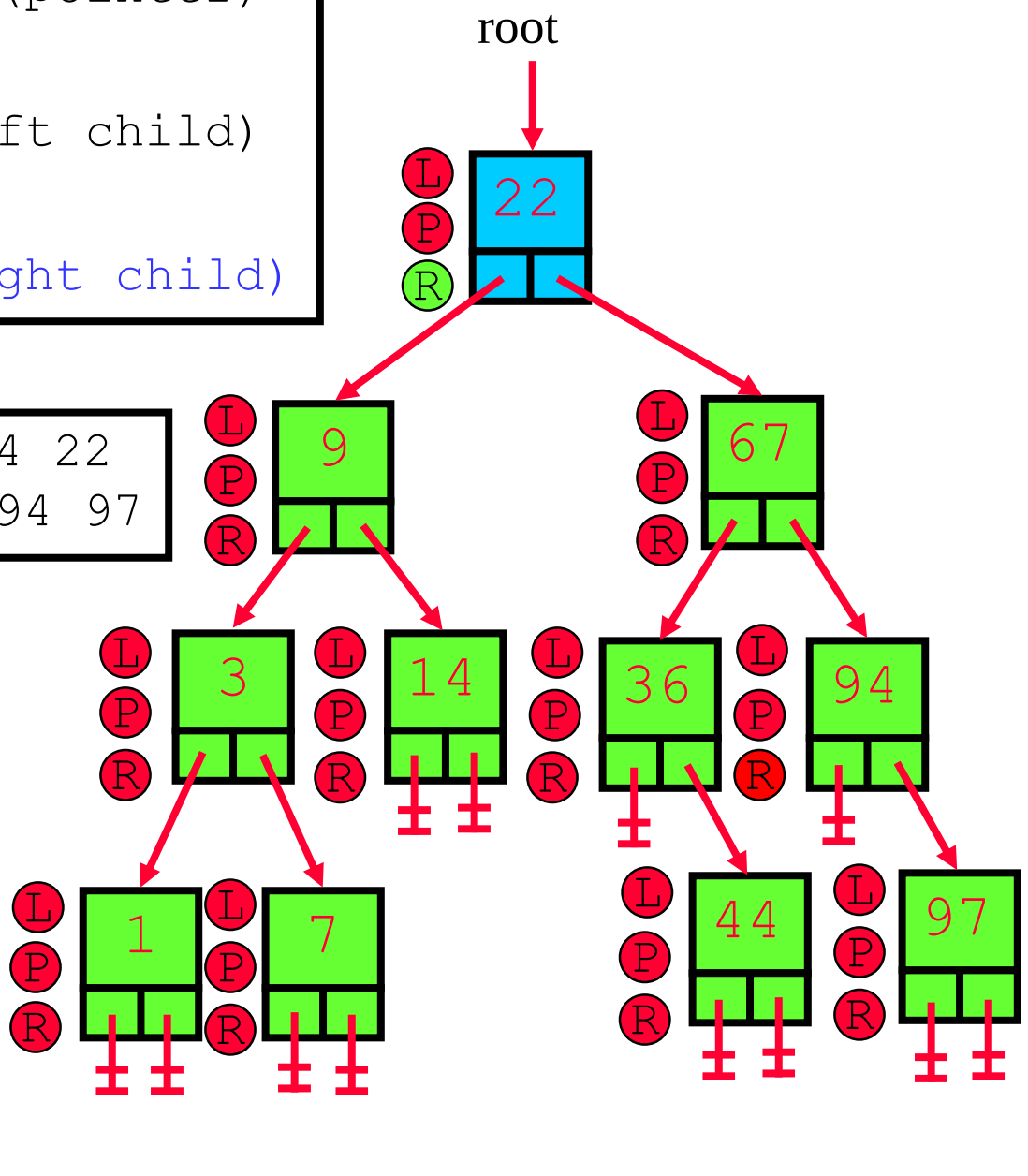
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```



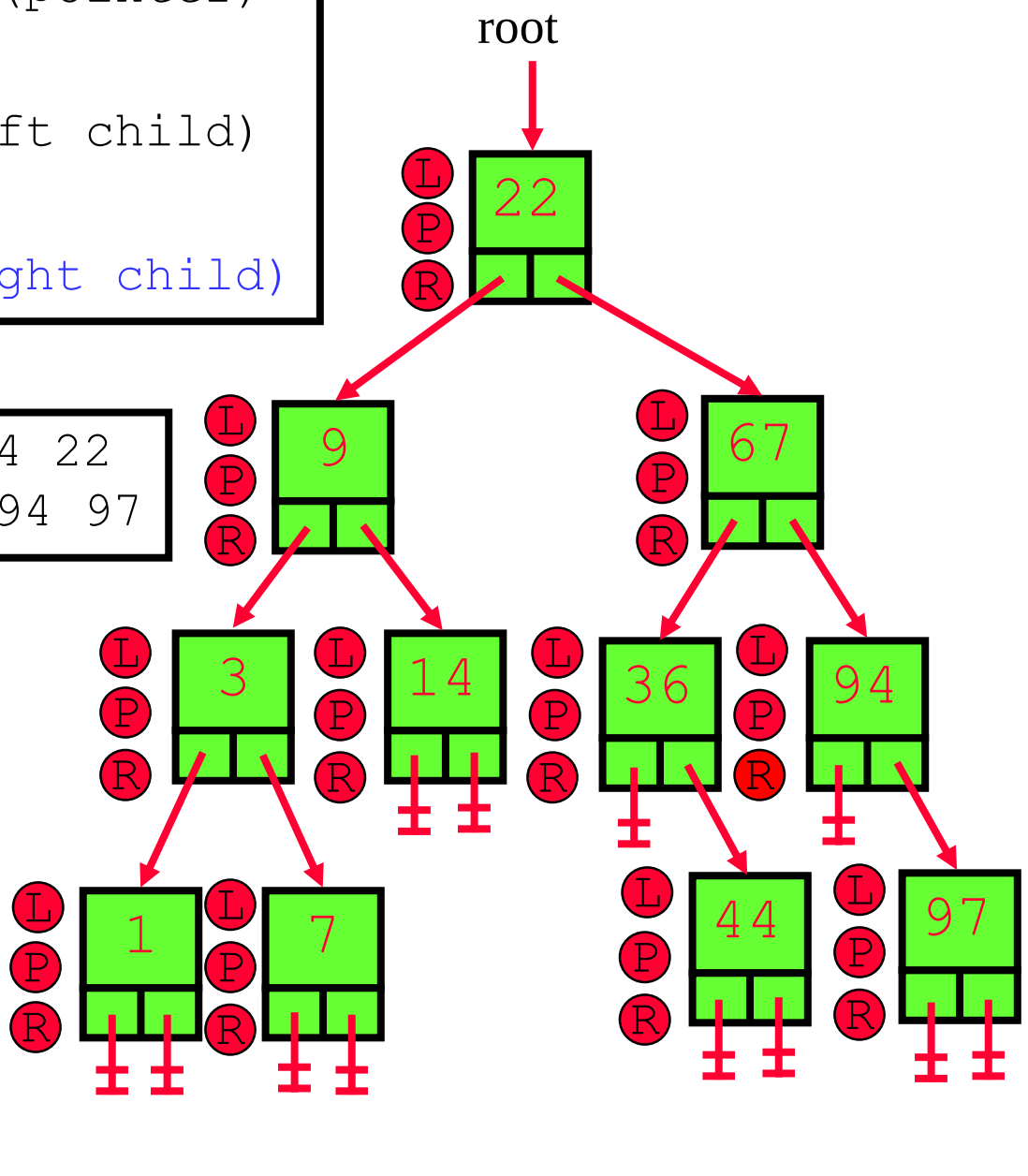
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```



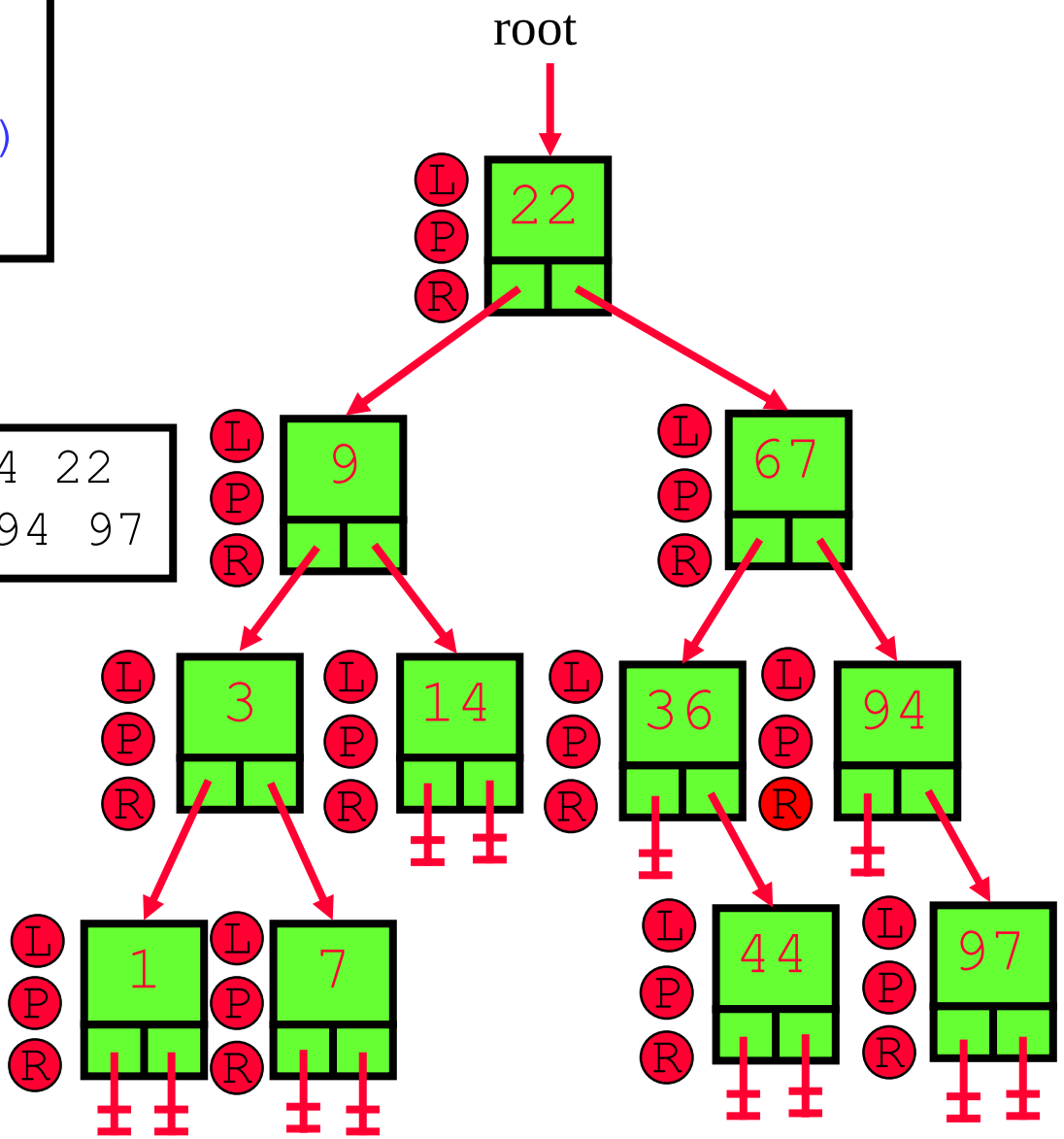
```
Proc InOrderPrint(pointer)
 pointer NOT NIL?
L InOrderPrint(left child)
P print(data)
R InOrderPrint(right child)
```

```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```



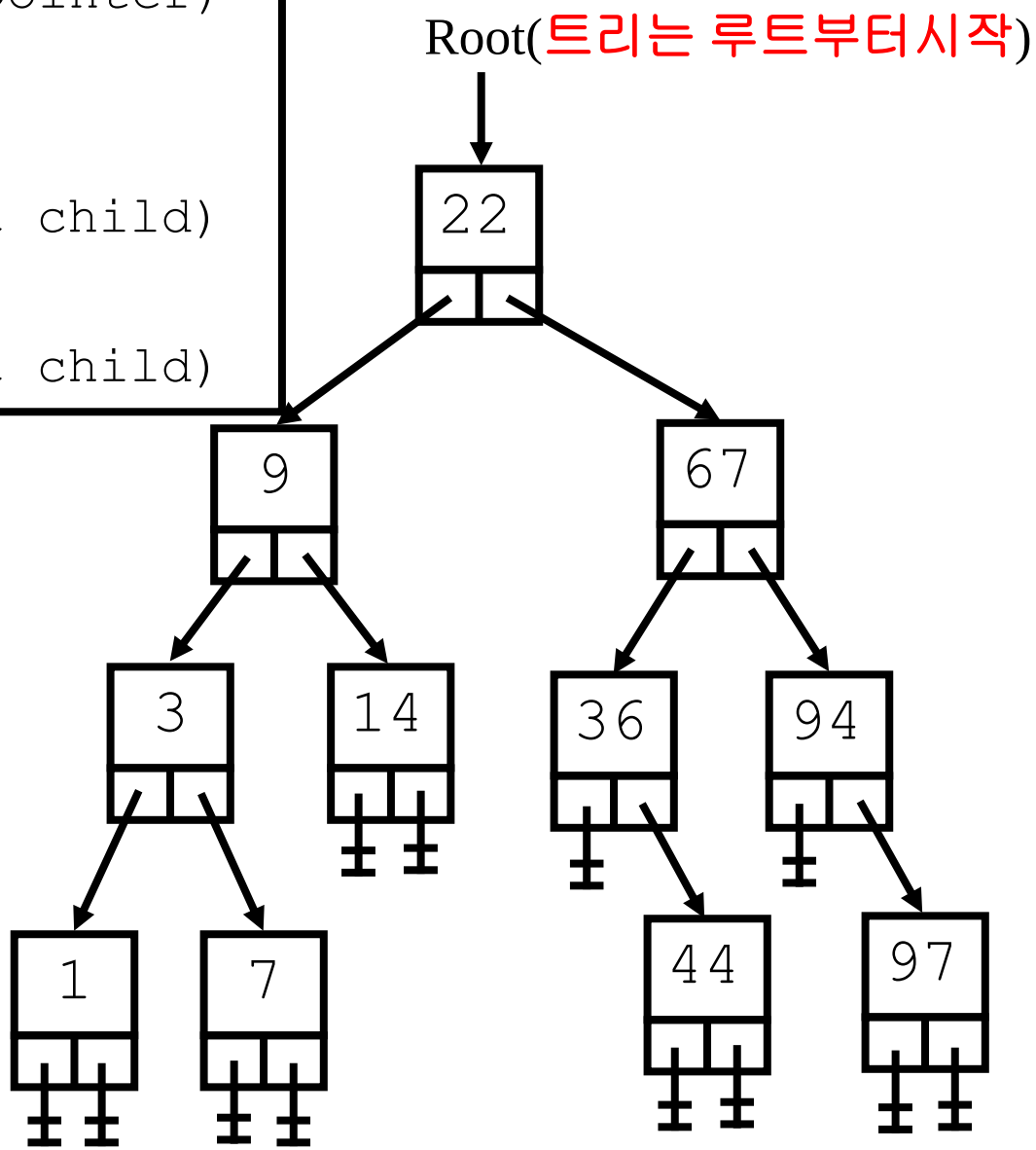
```
Algorithm Example
. . .
InOrderPrint(root)
. . .
```

```
Output: 1 3 7 9 14 22
        36 44 67 94 97
```

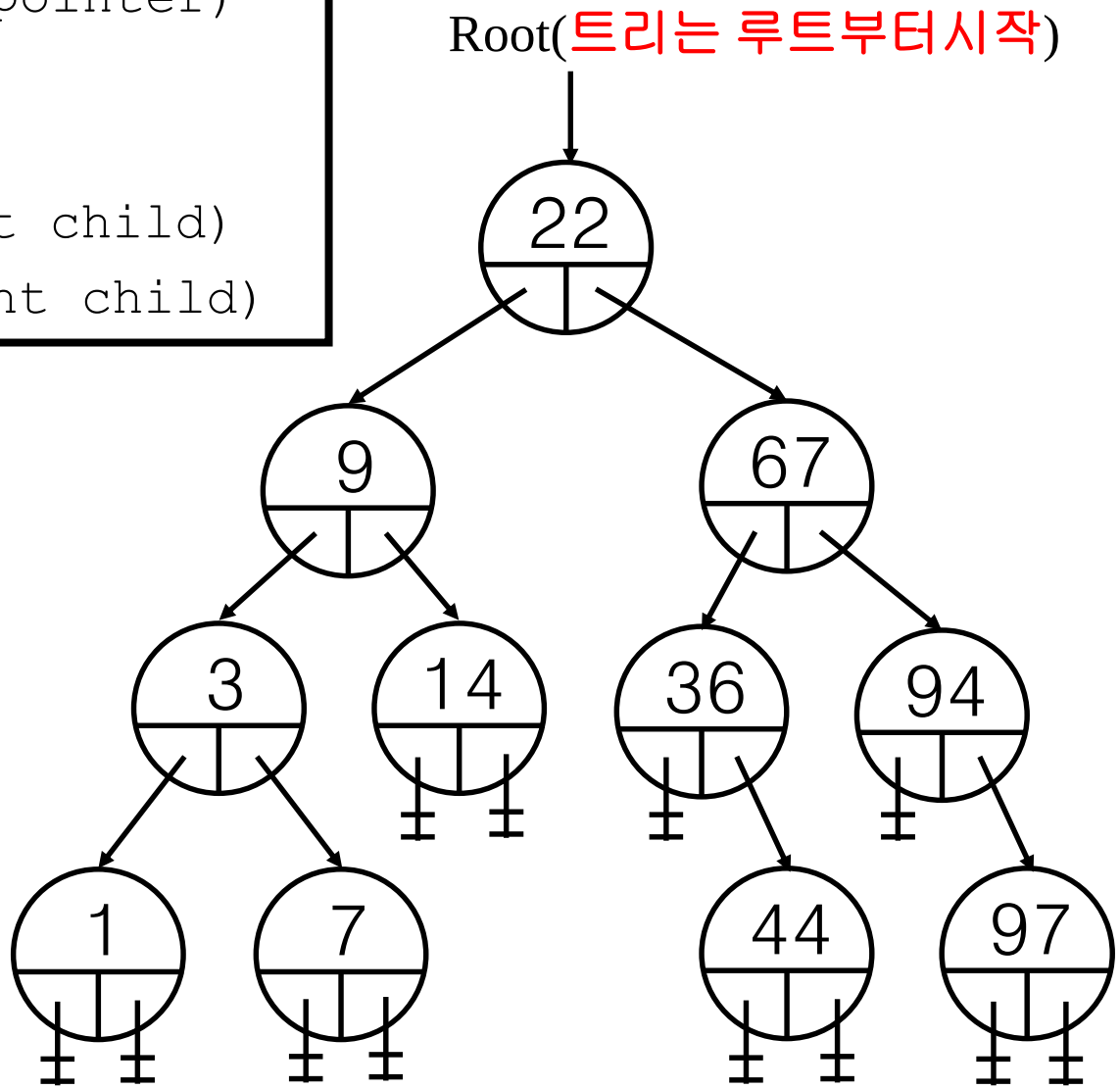


Preorder traversal(전위순회)

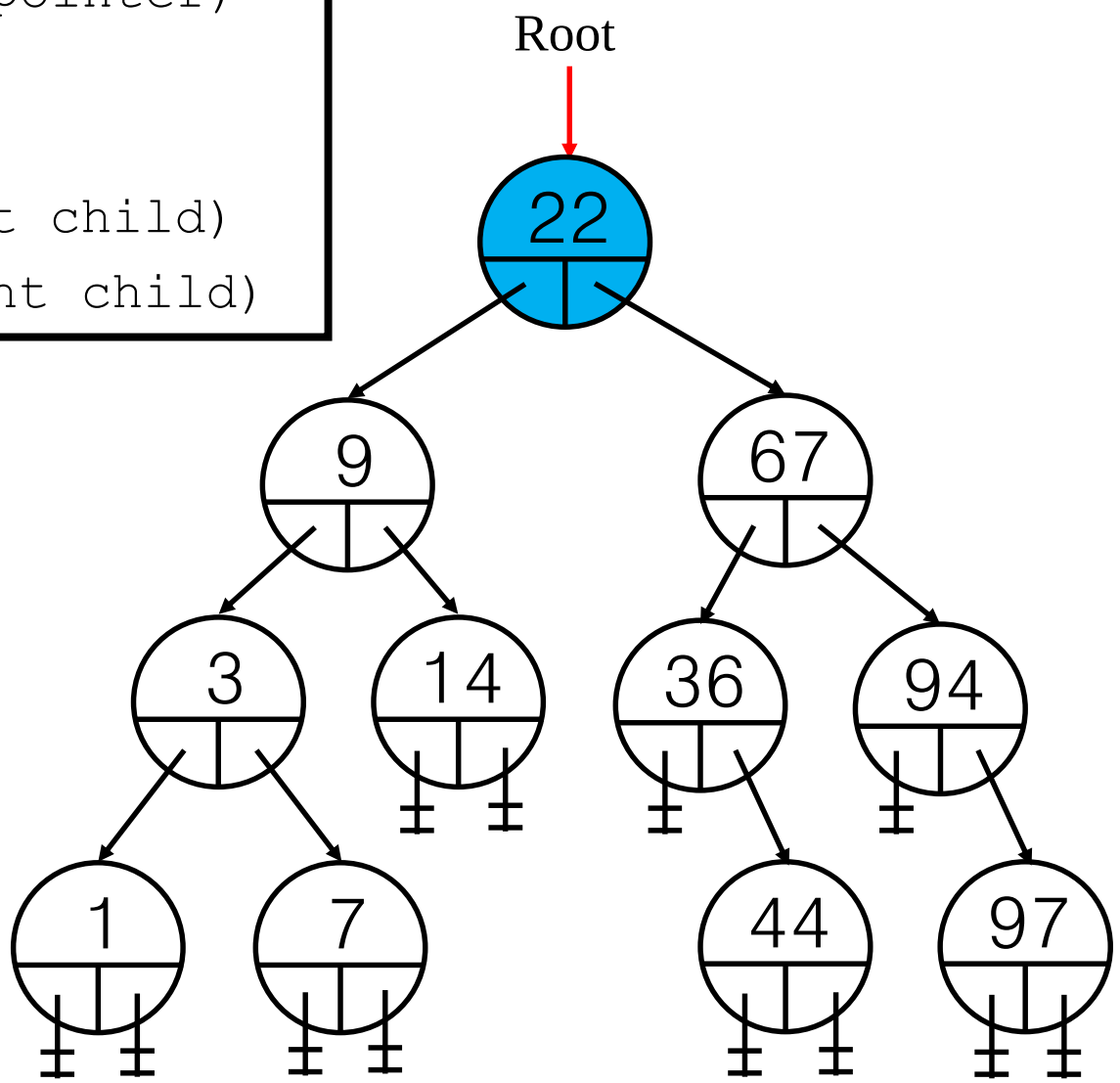
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R print(data)
  InOrderPrint(right child)
```



```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

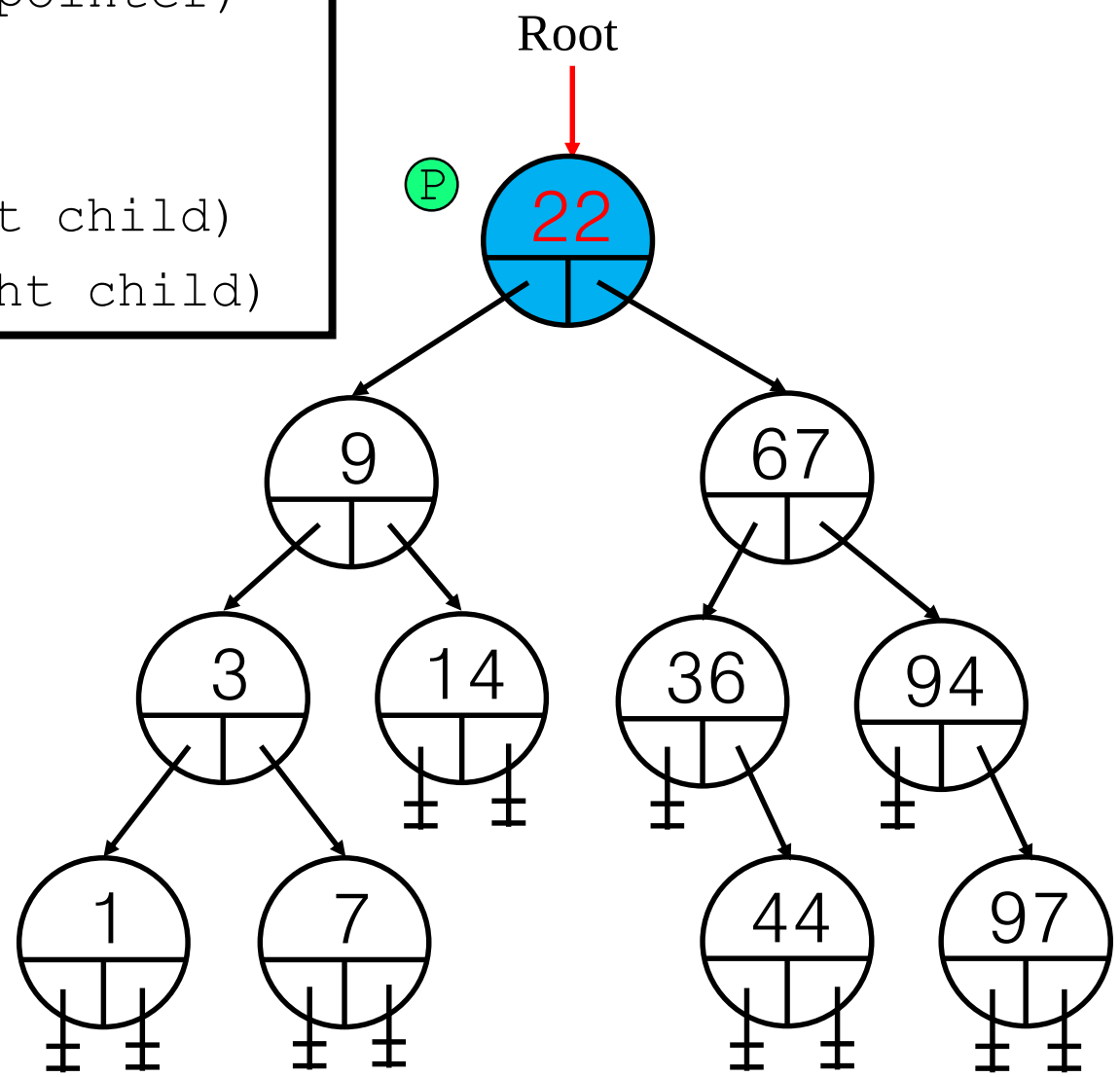


```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```



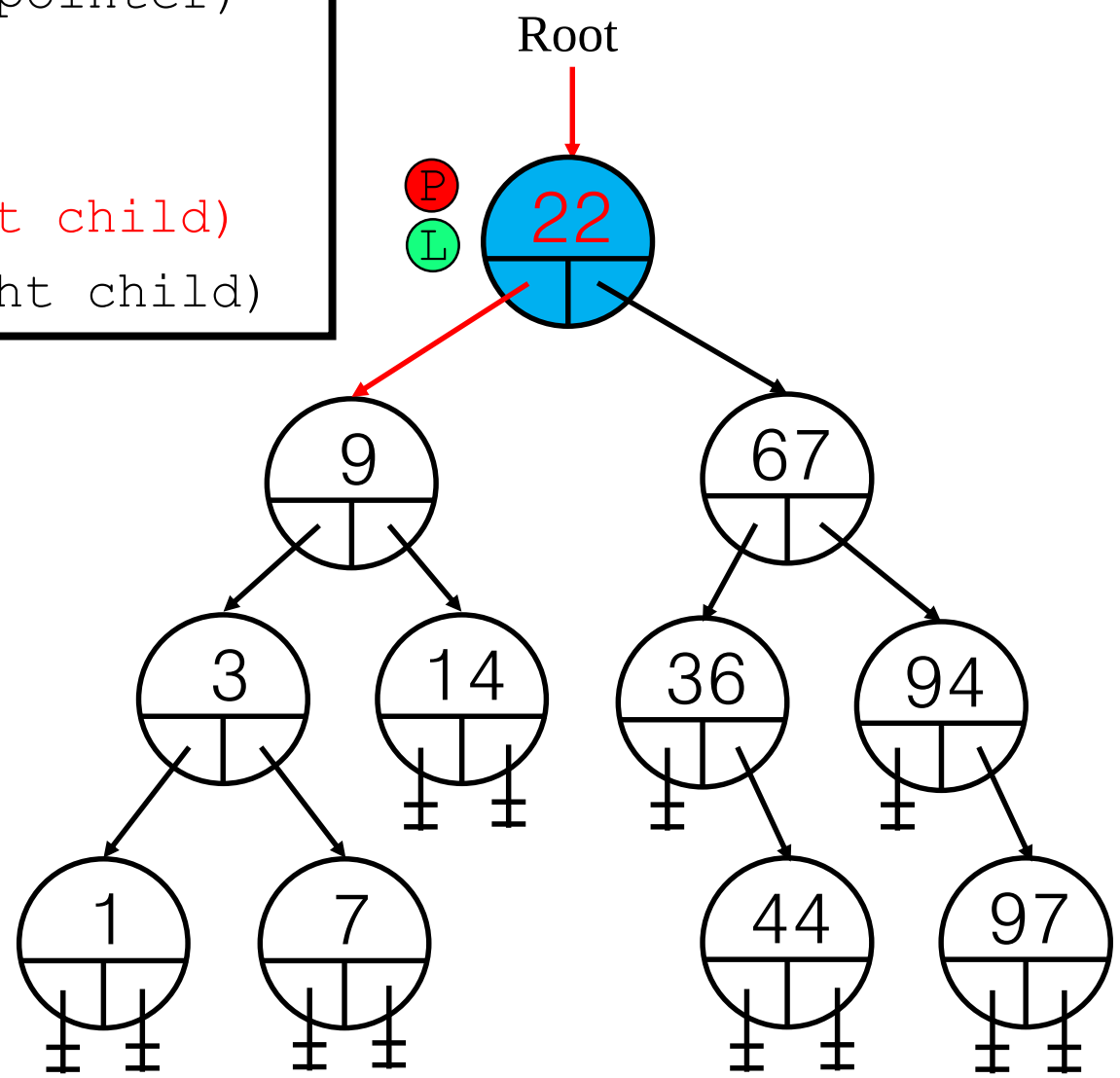
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22
```



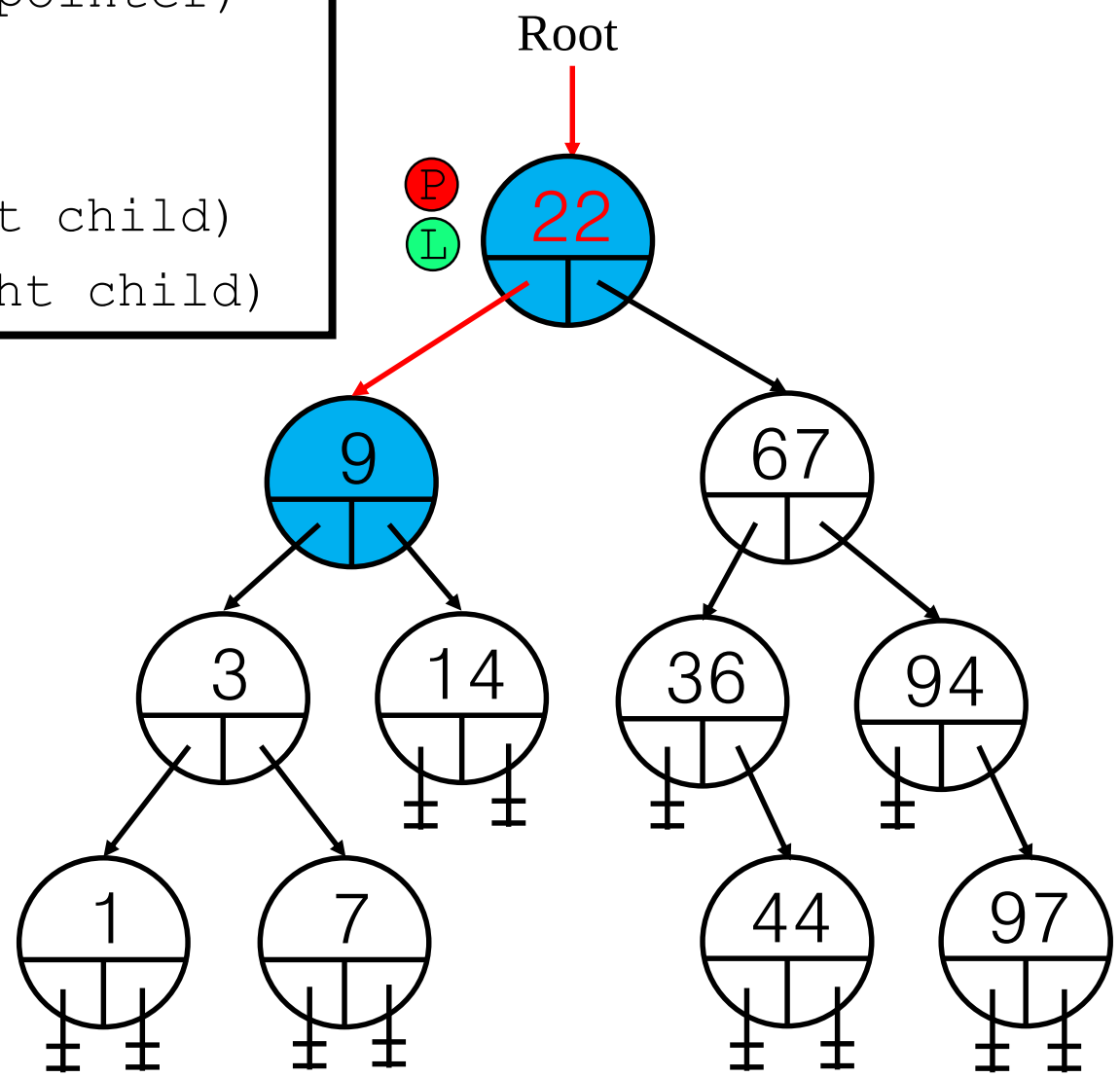
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22
```



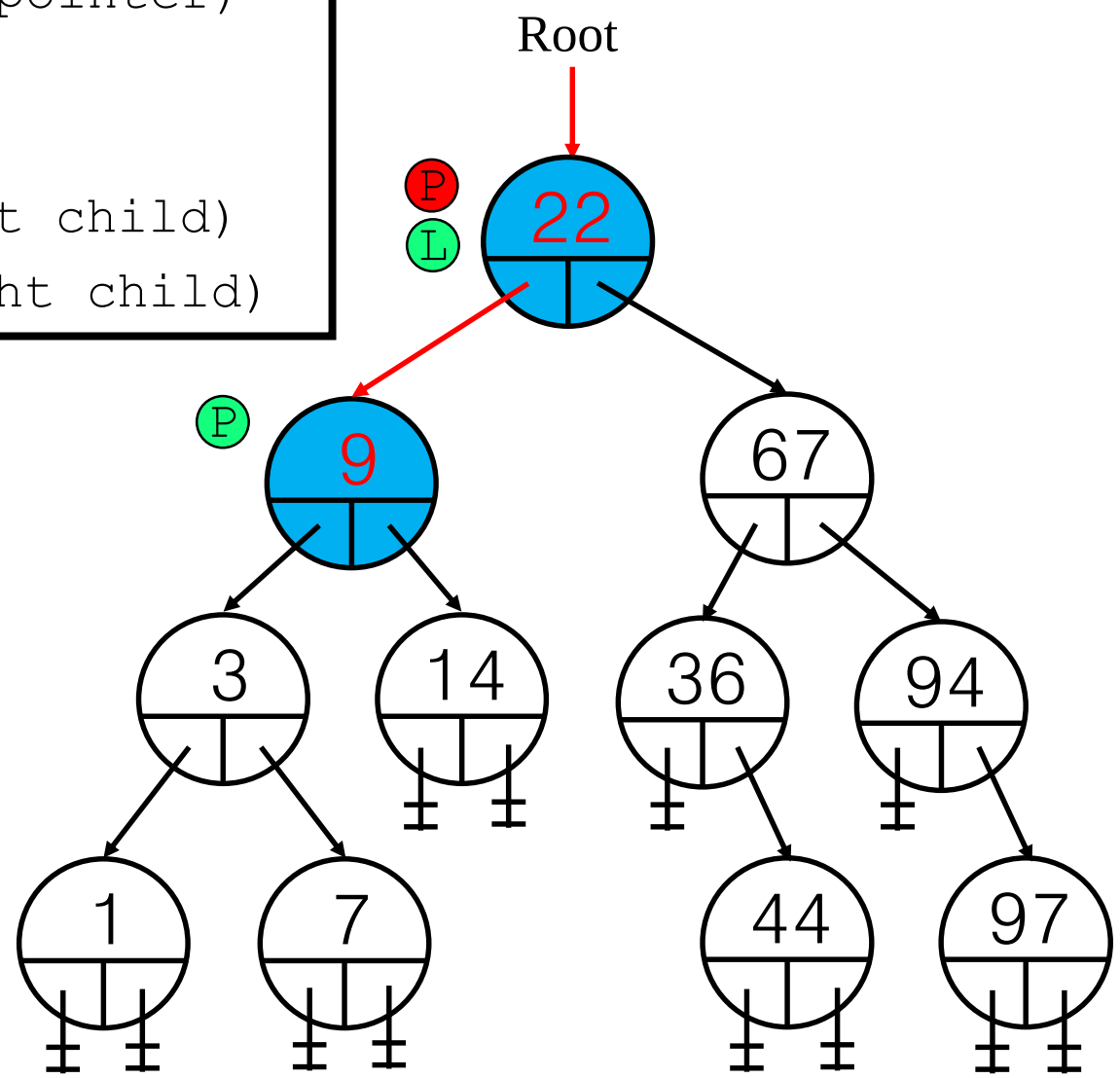
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22
```



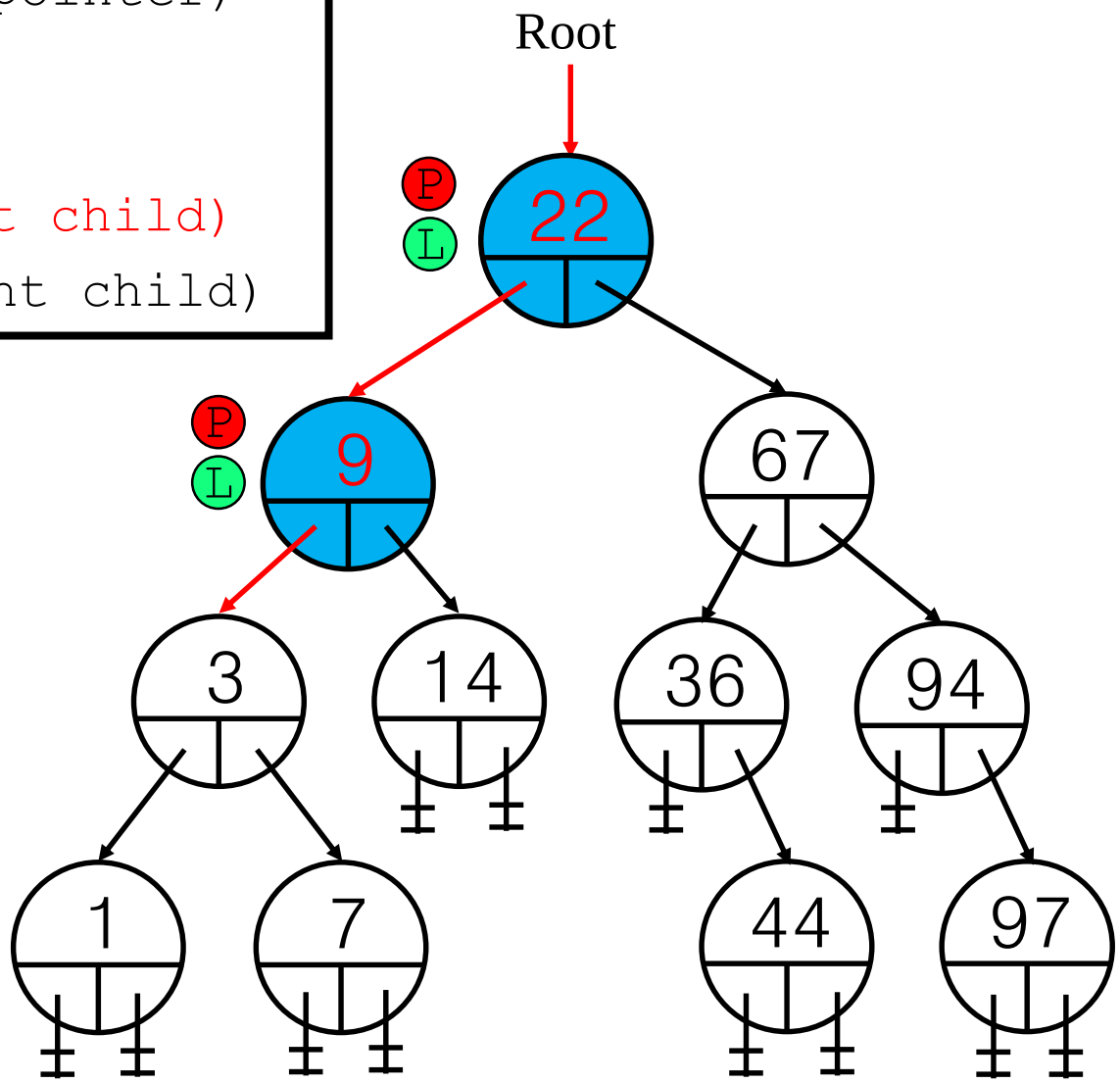
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9
```



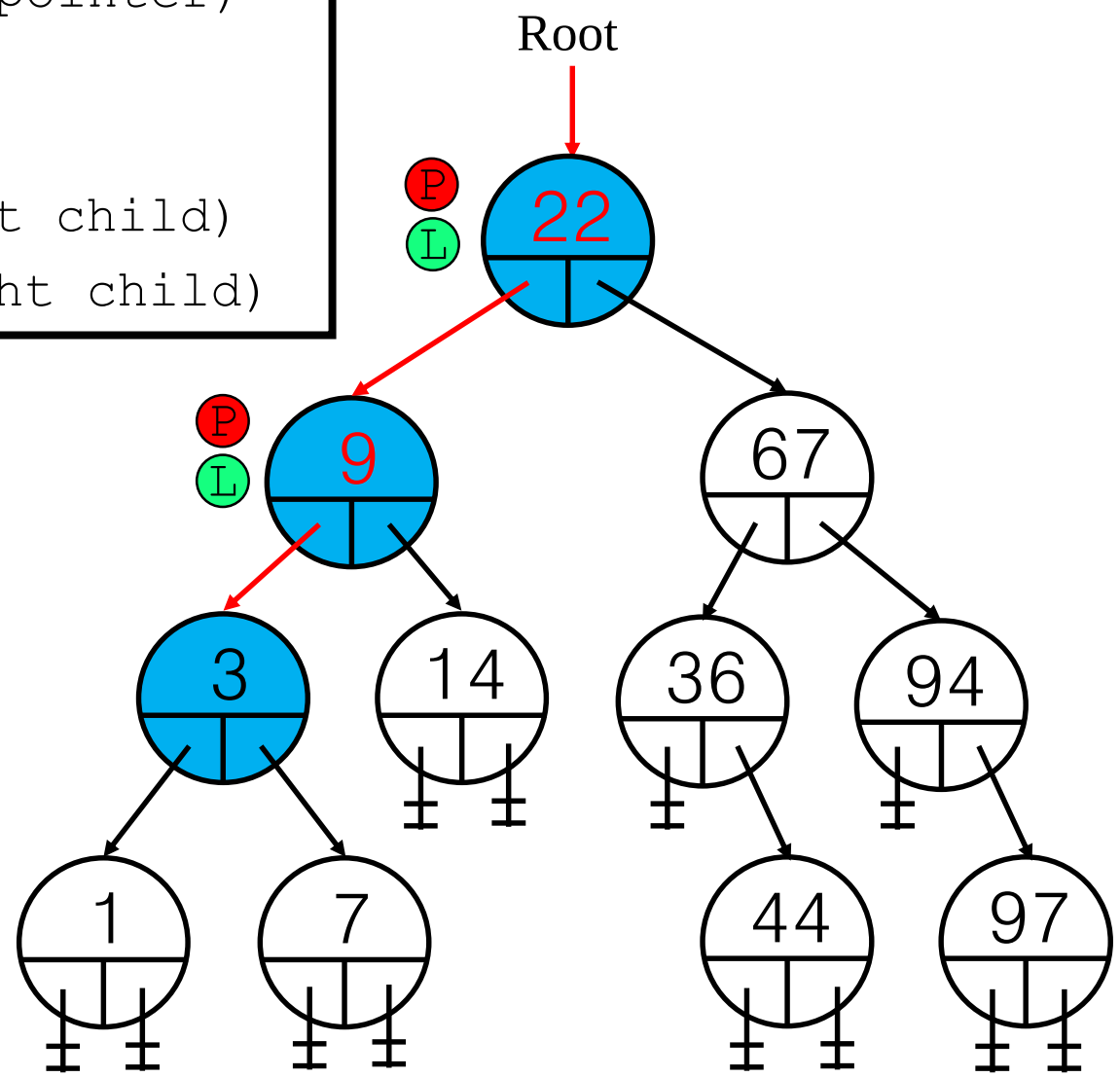
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9
```



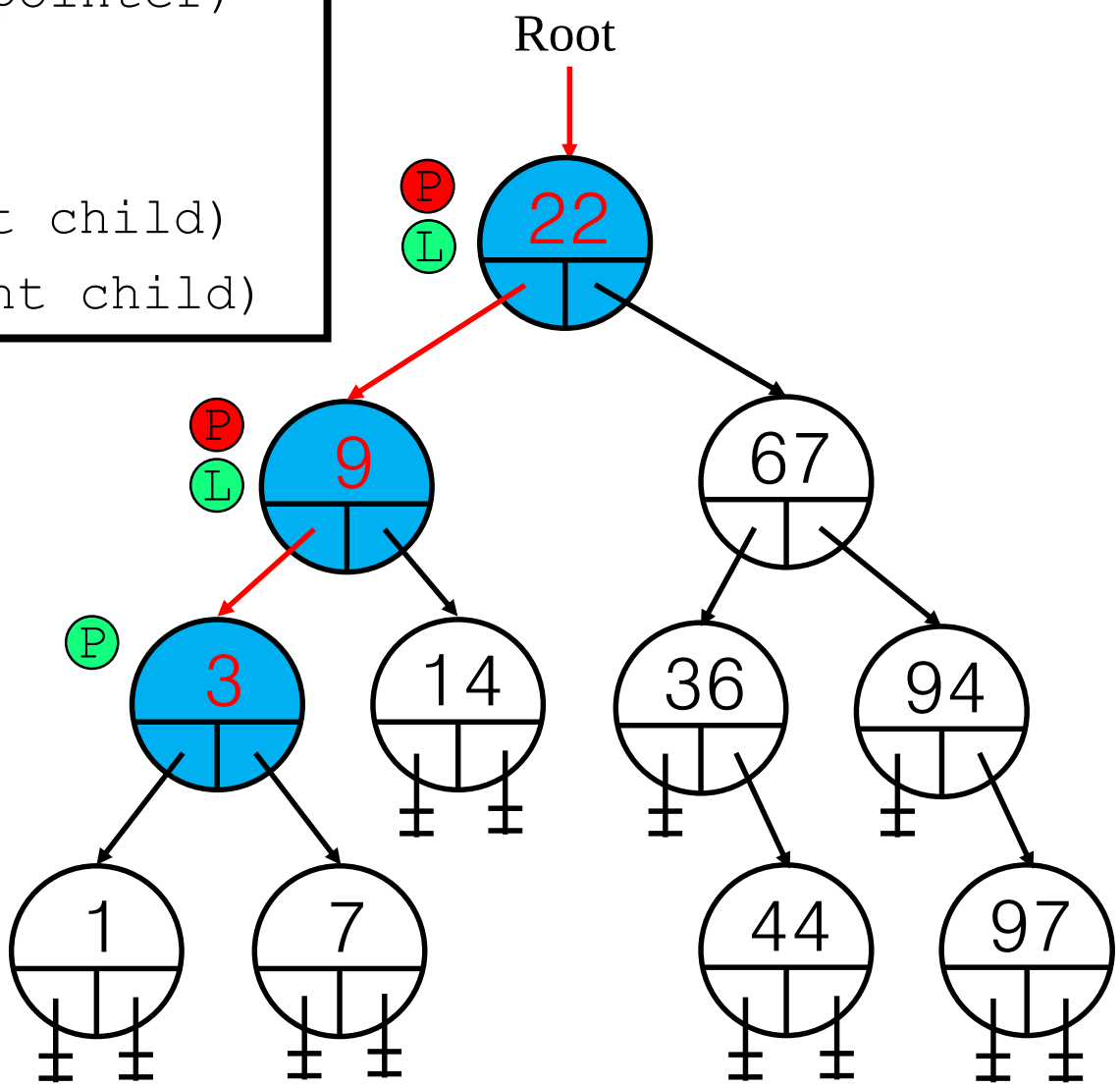
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9
```



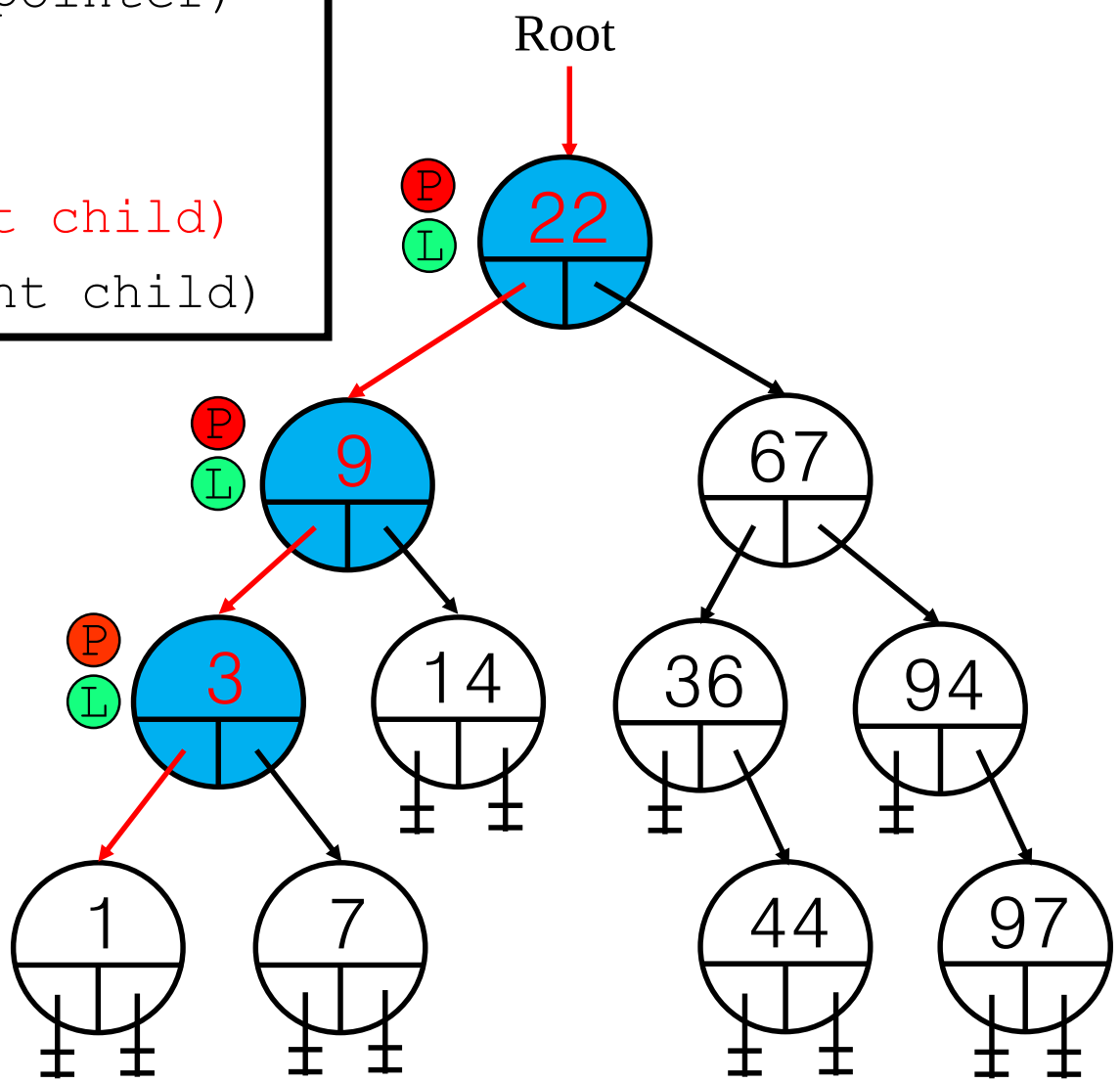
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3
```



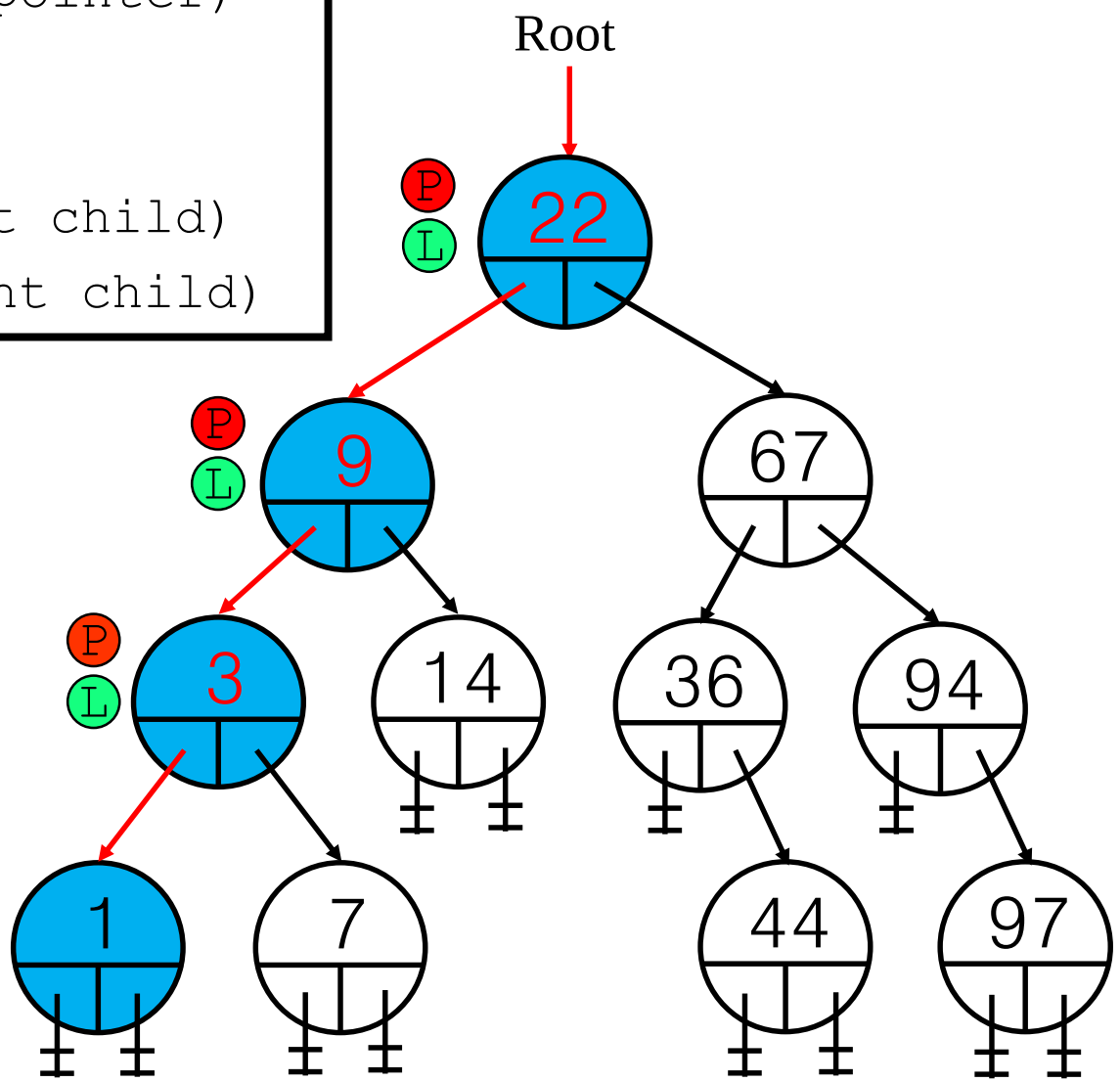
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3
```



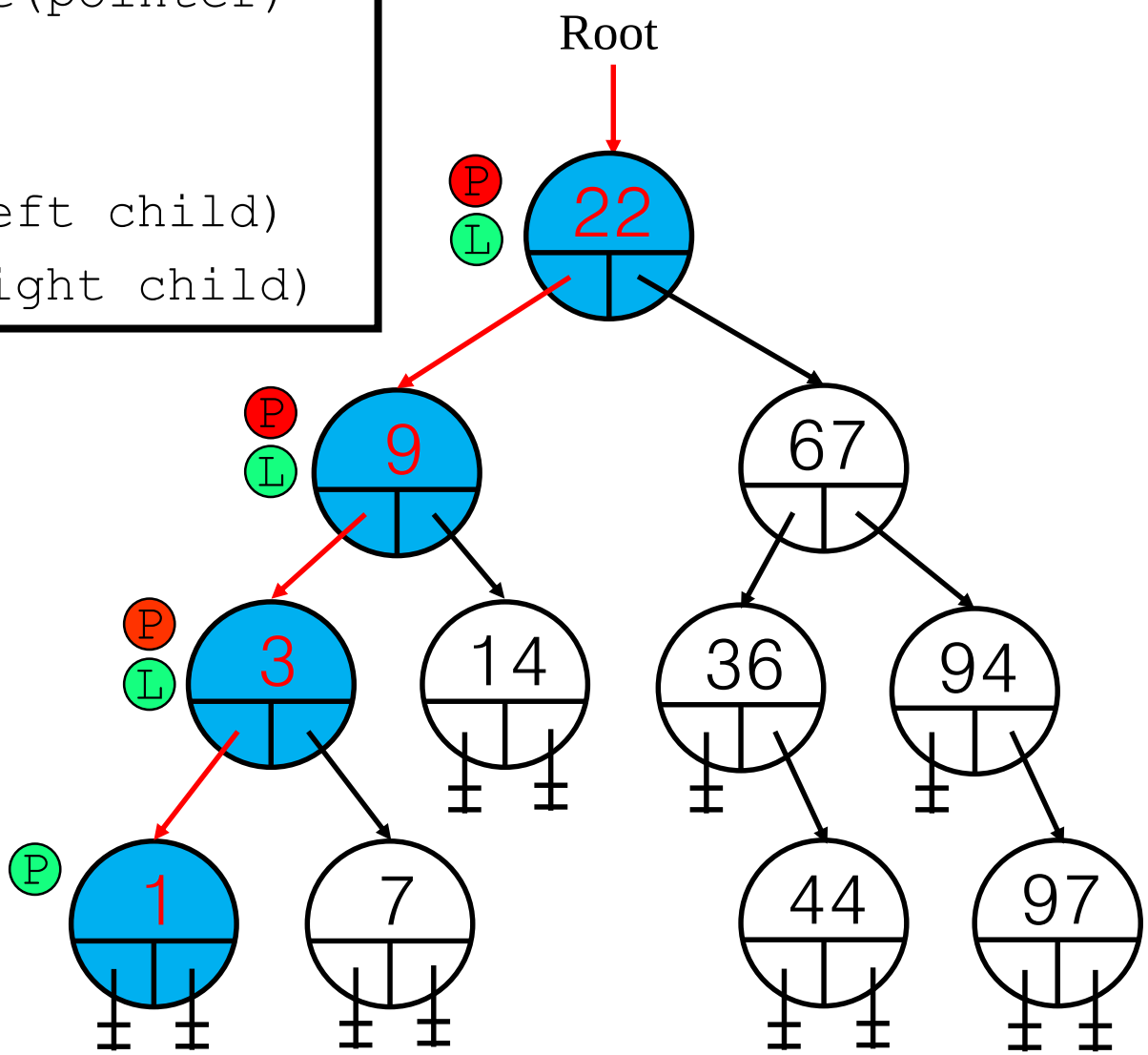
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3
```



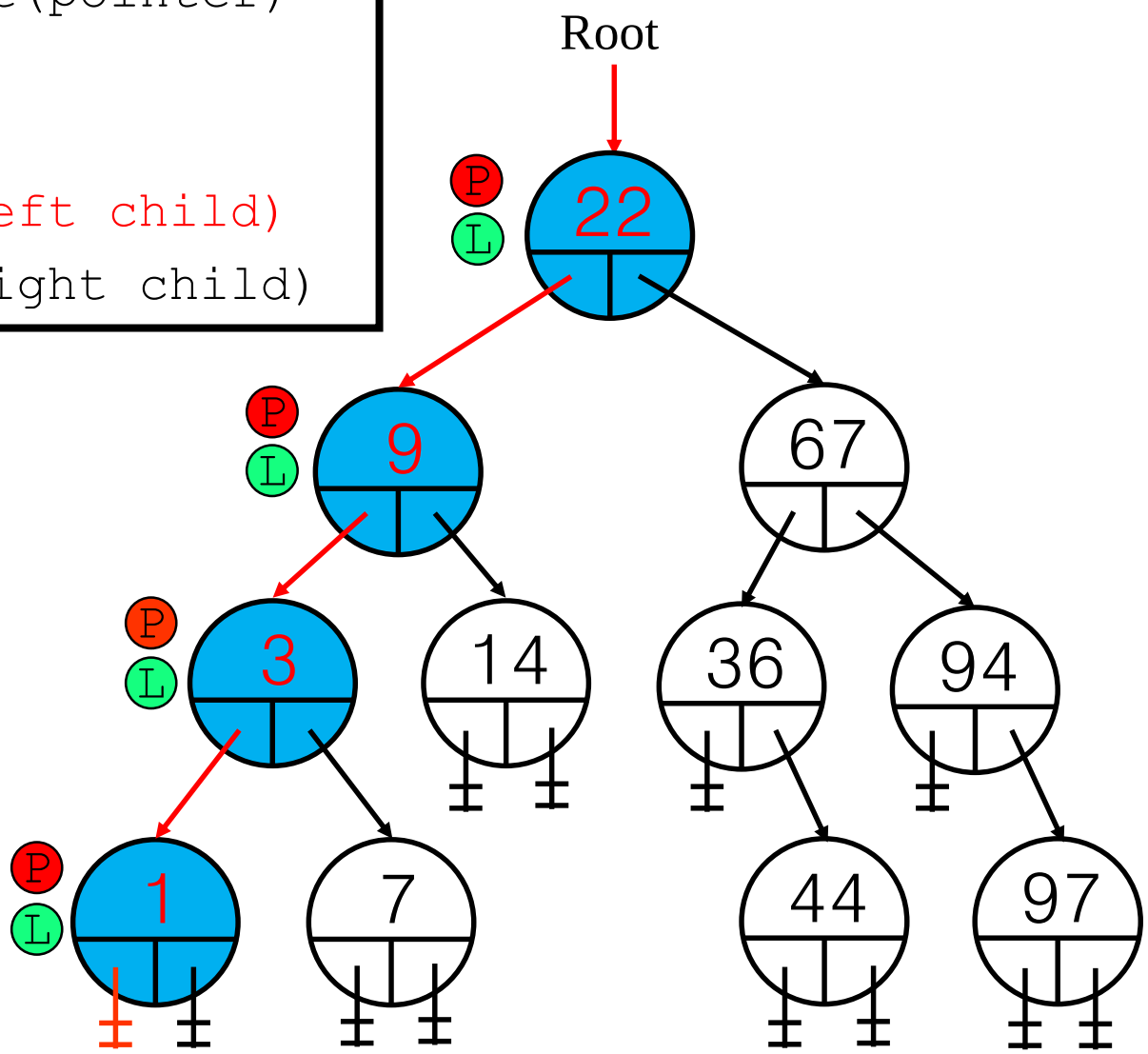
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



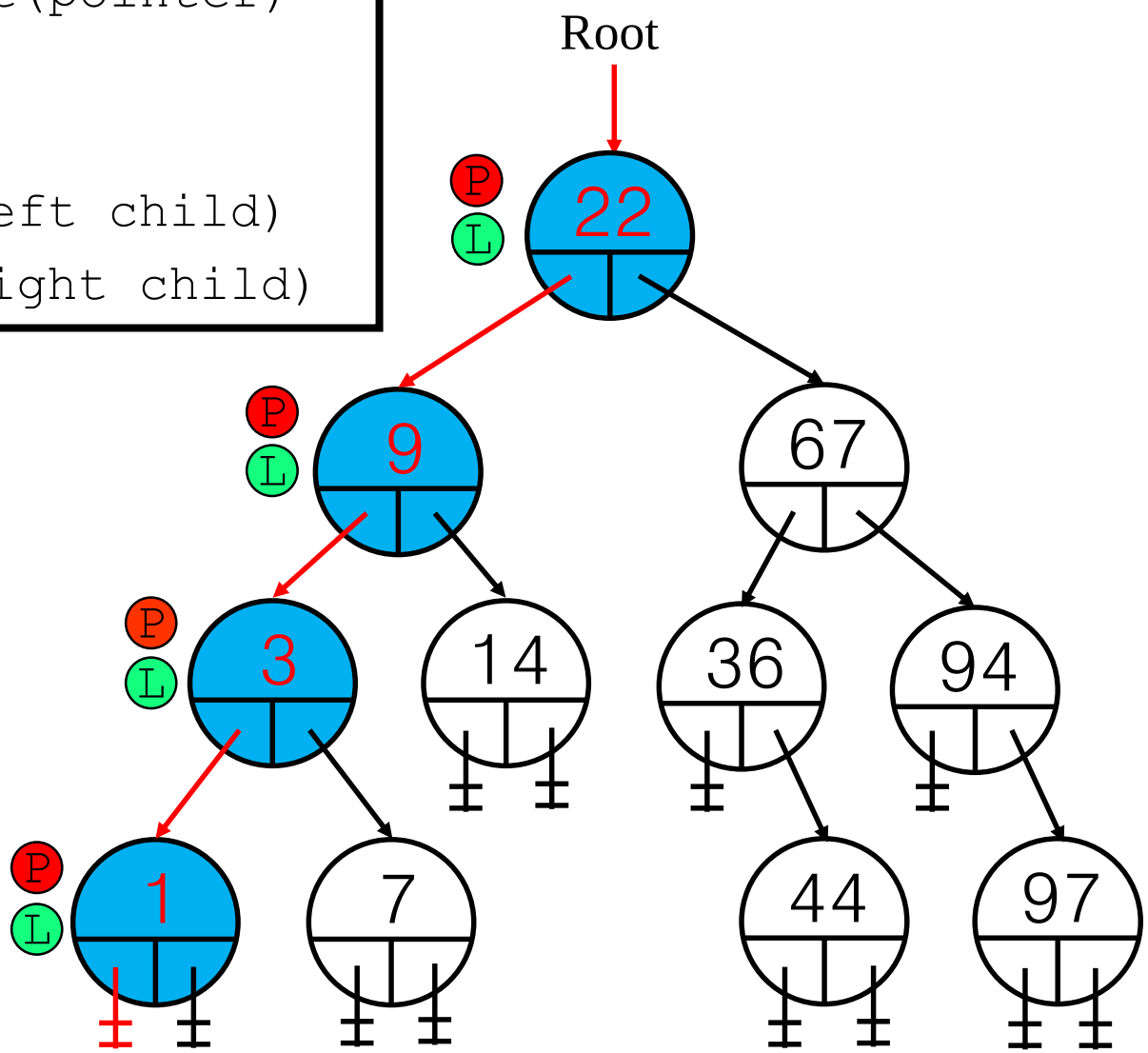
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



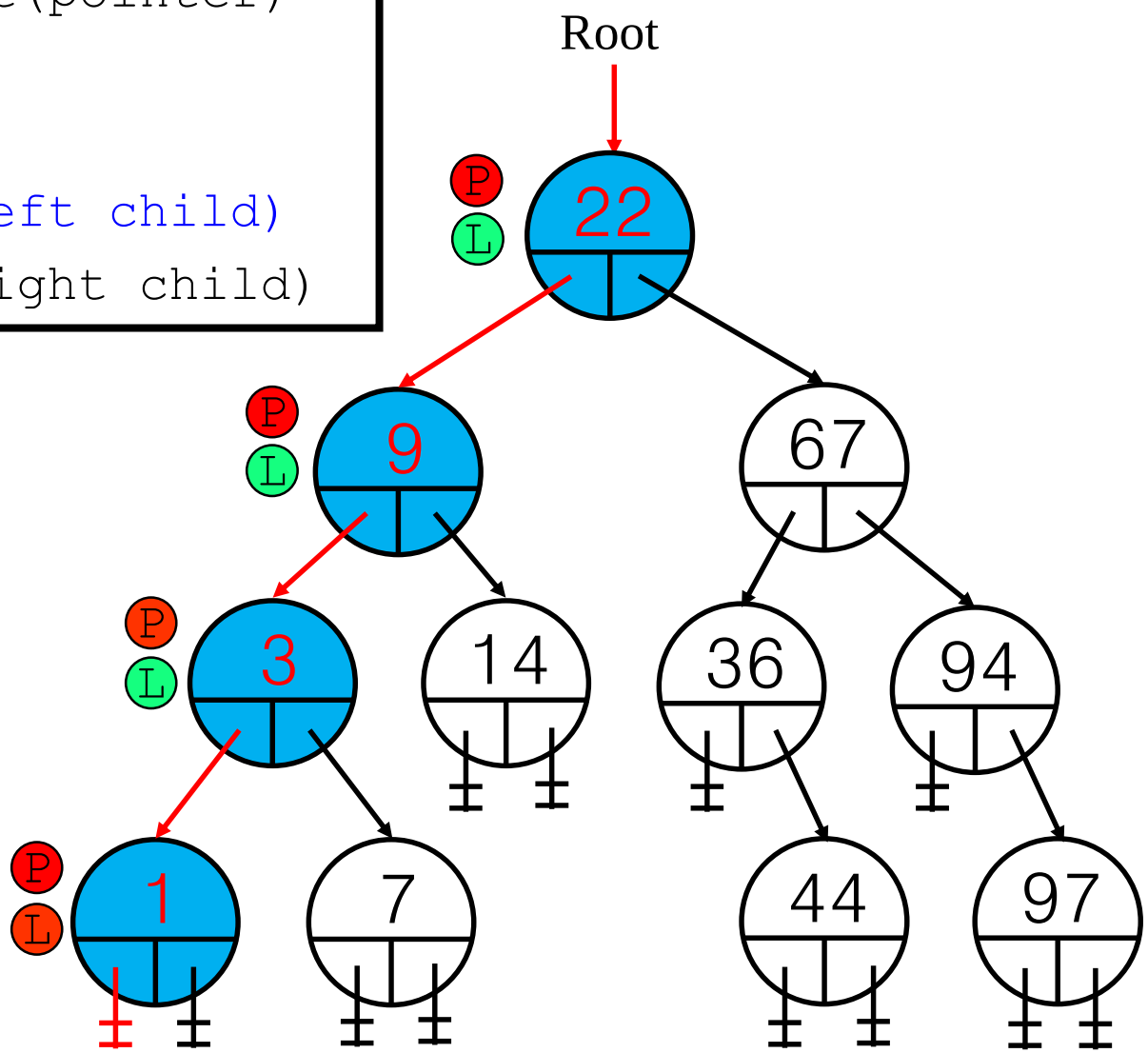
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



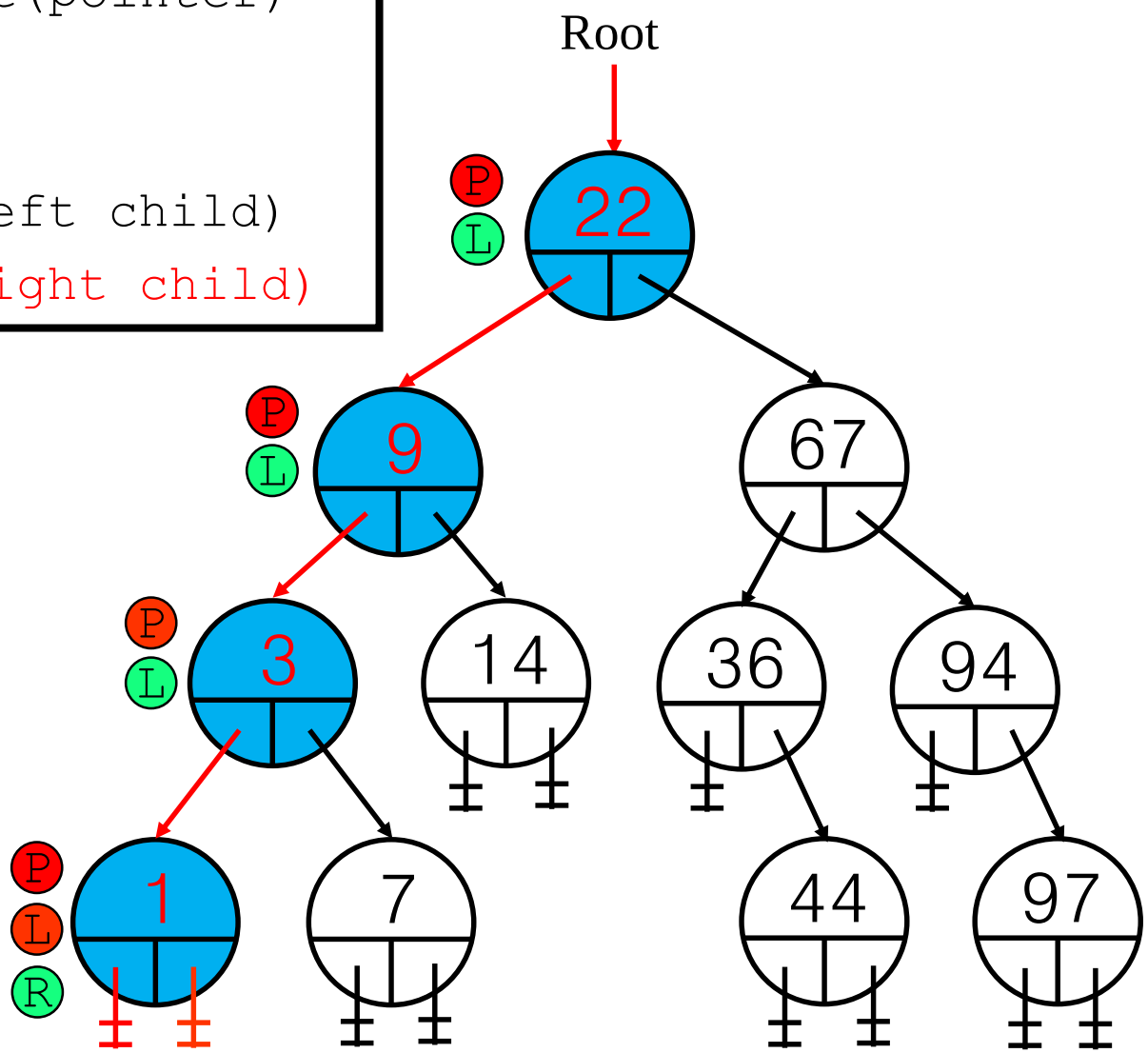
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



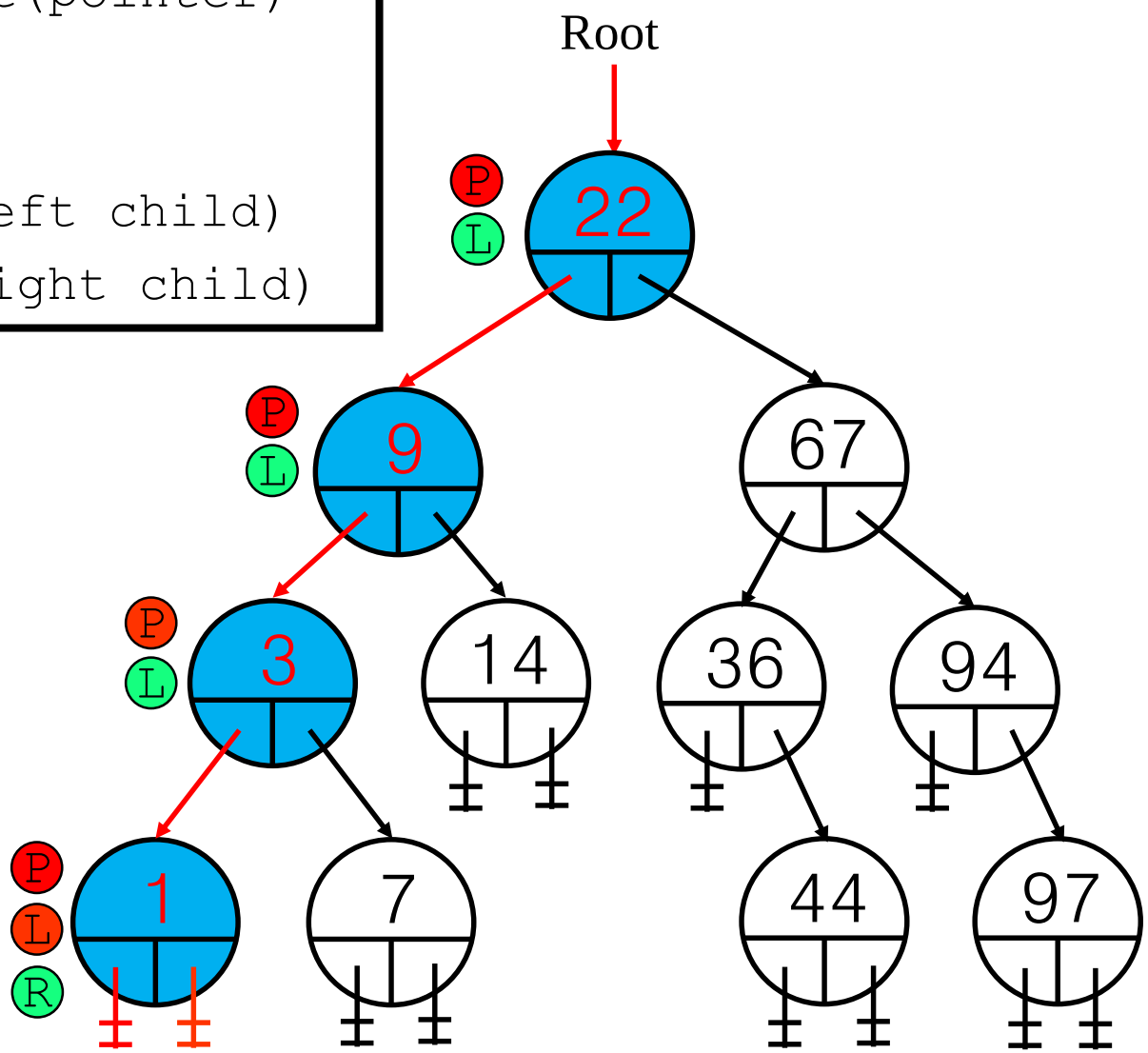
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



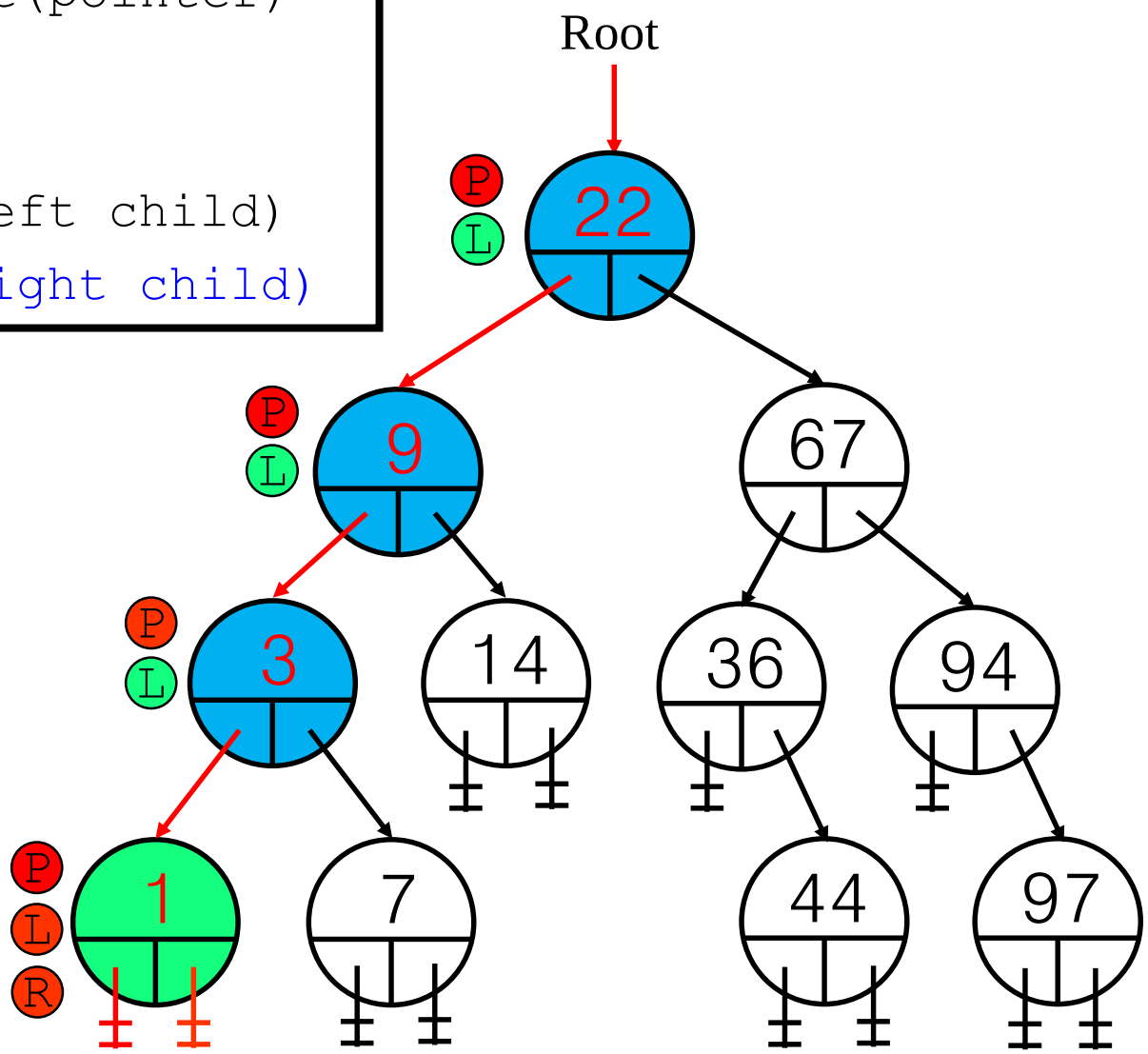
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



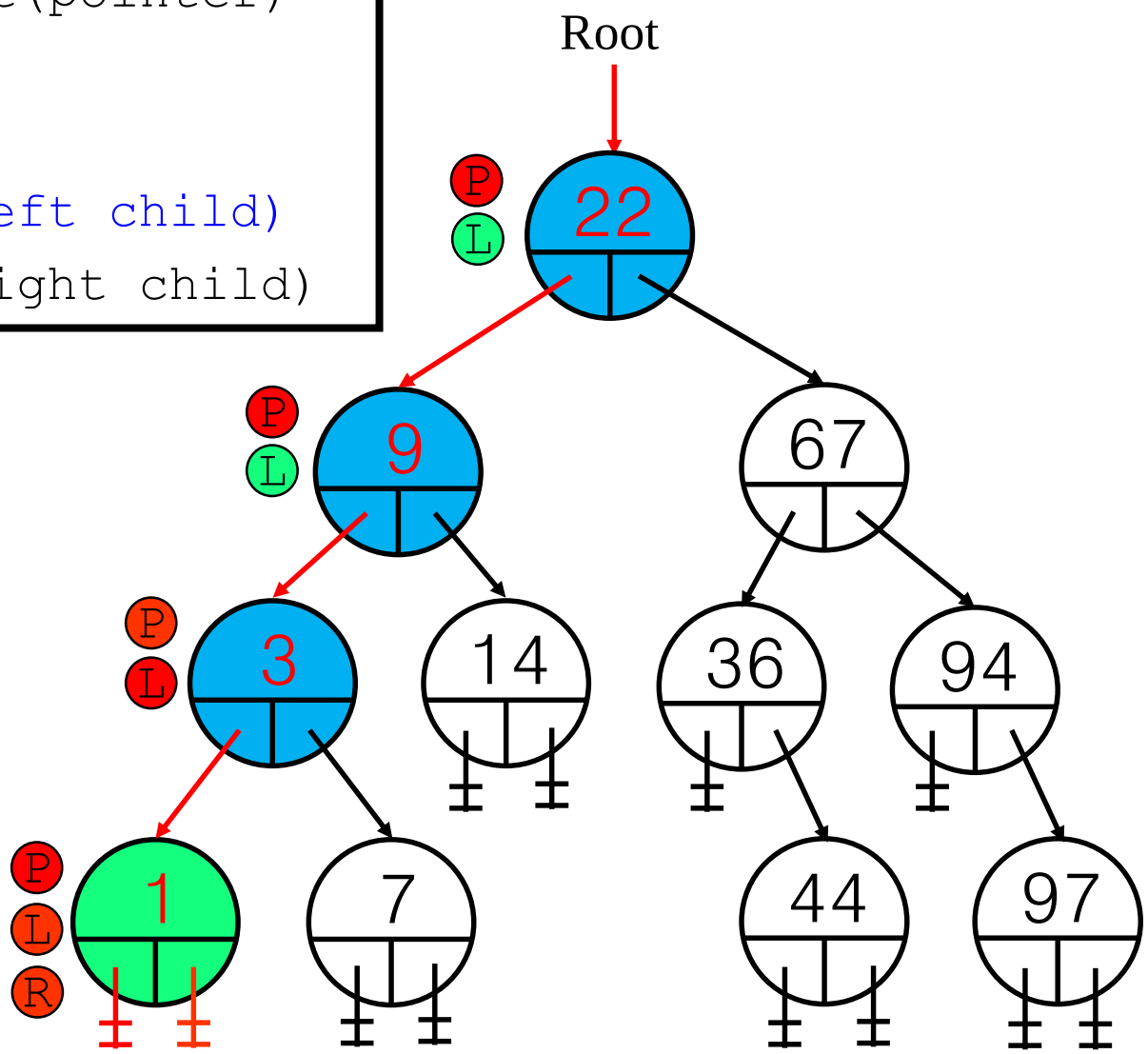
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



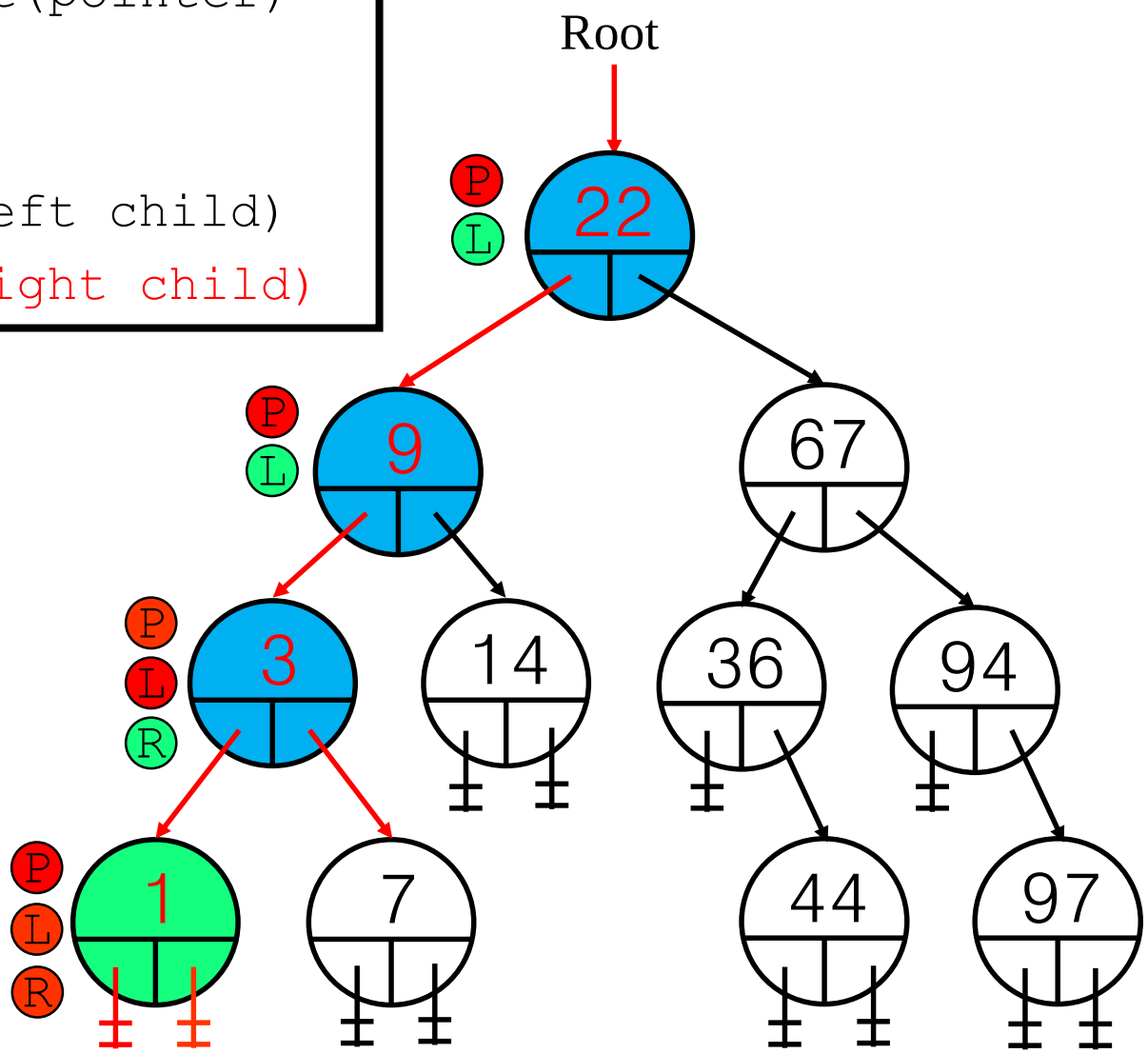
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



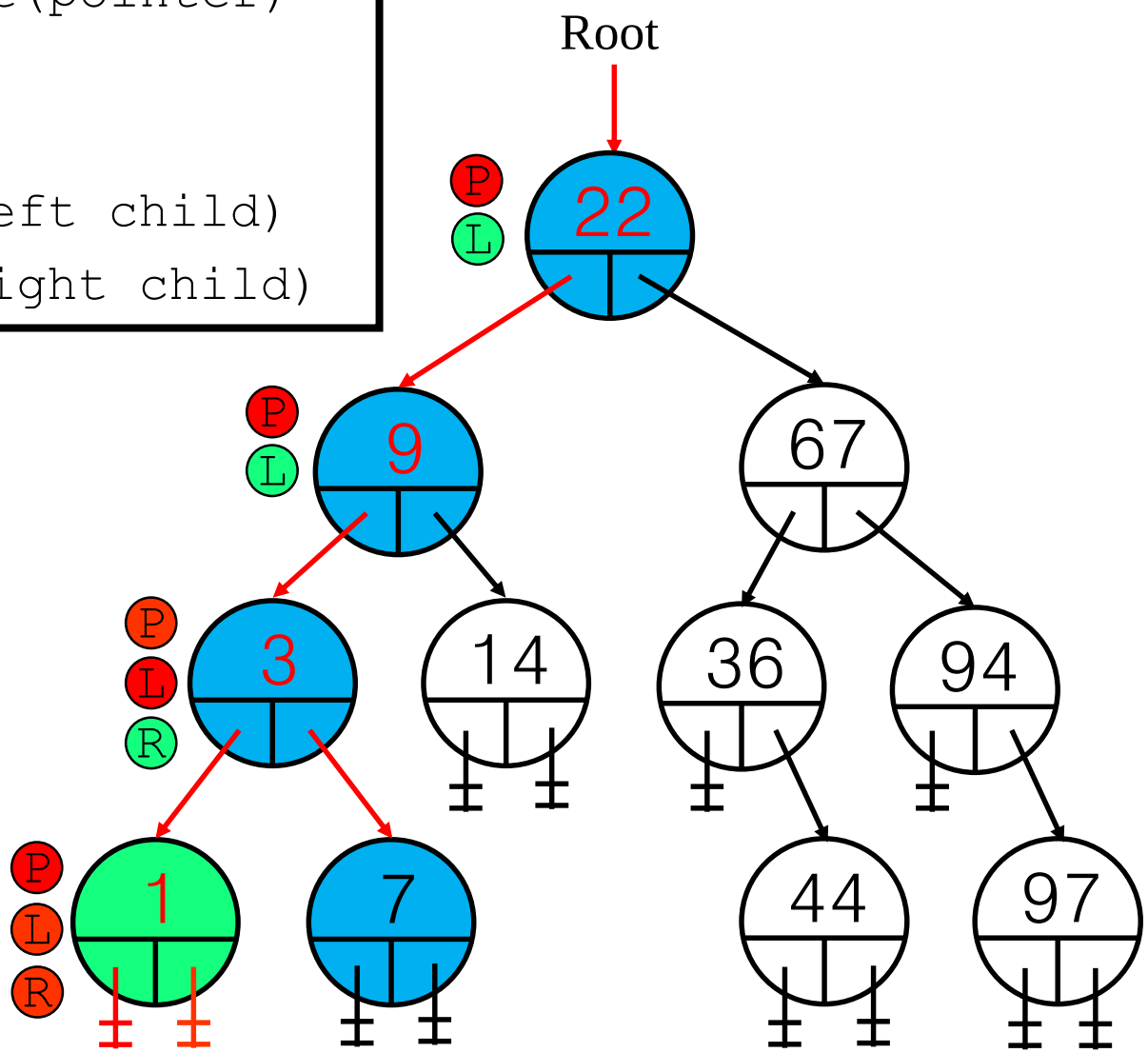
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



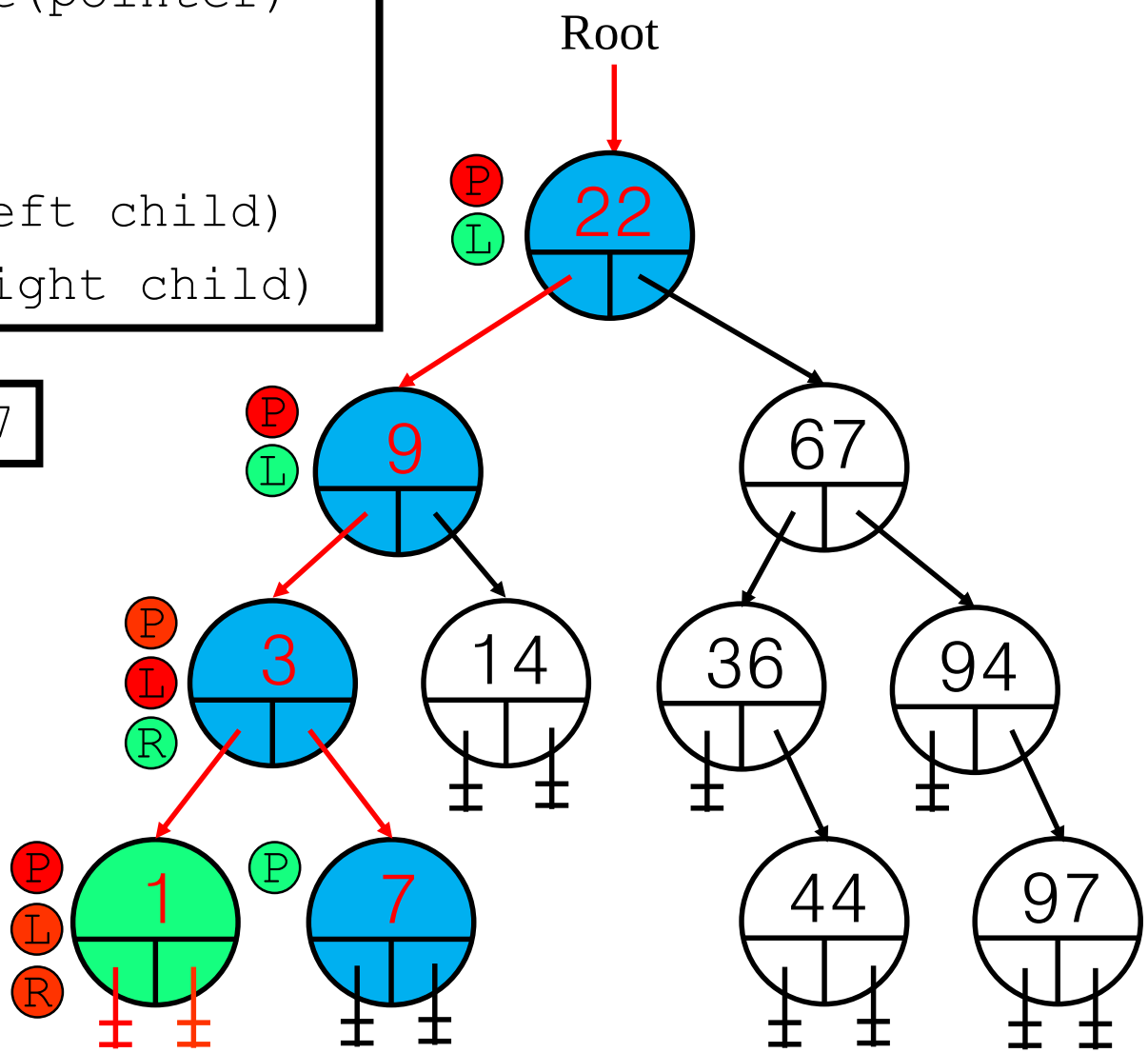
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1
```



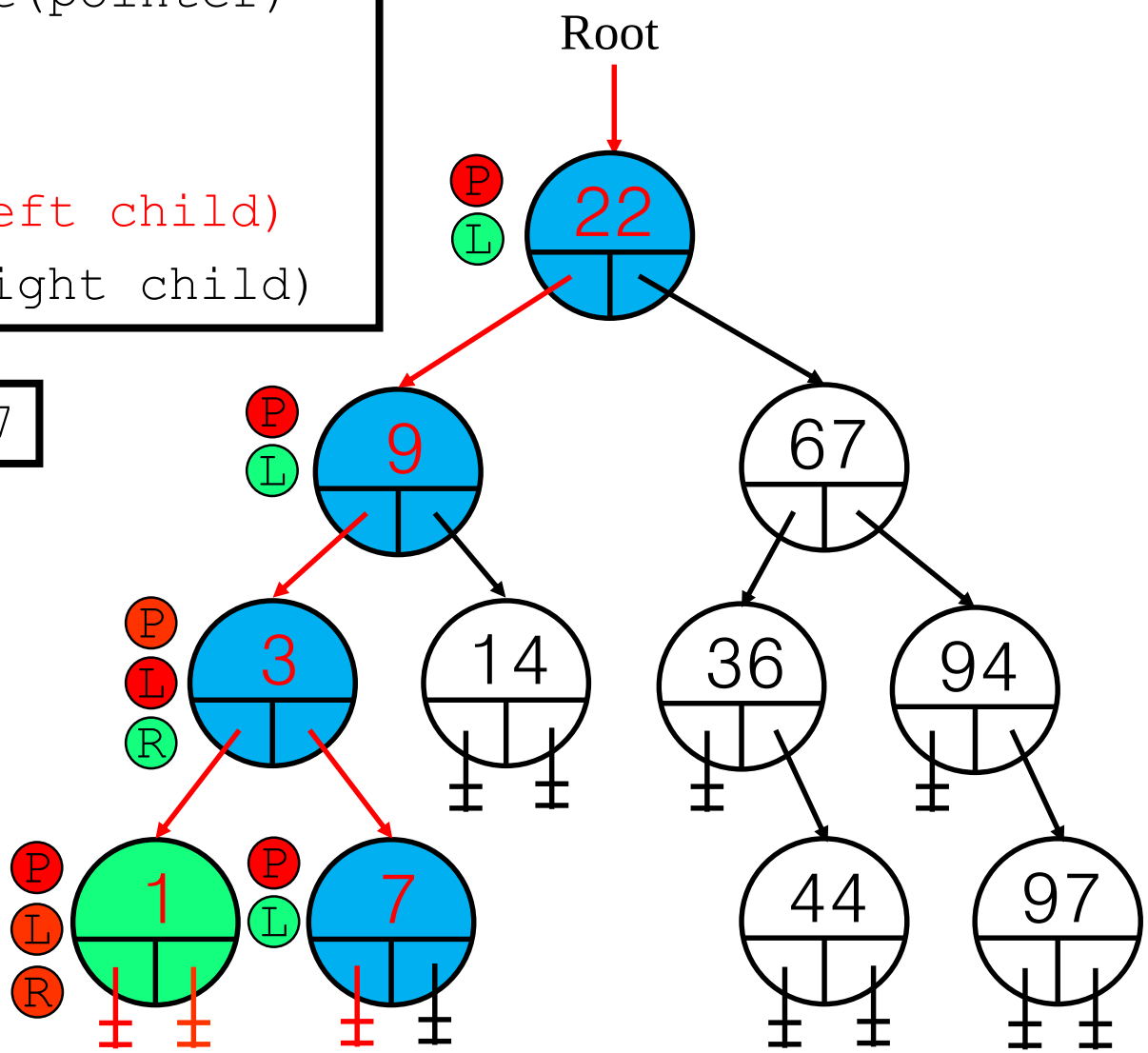
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



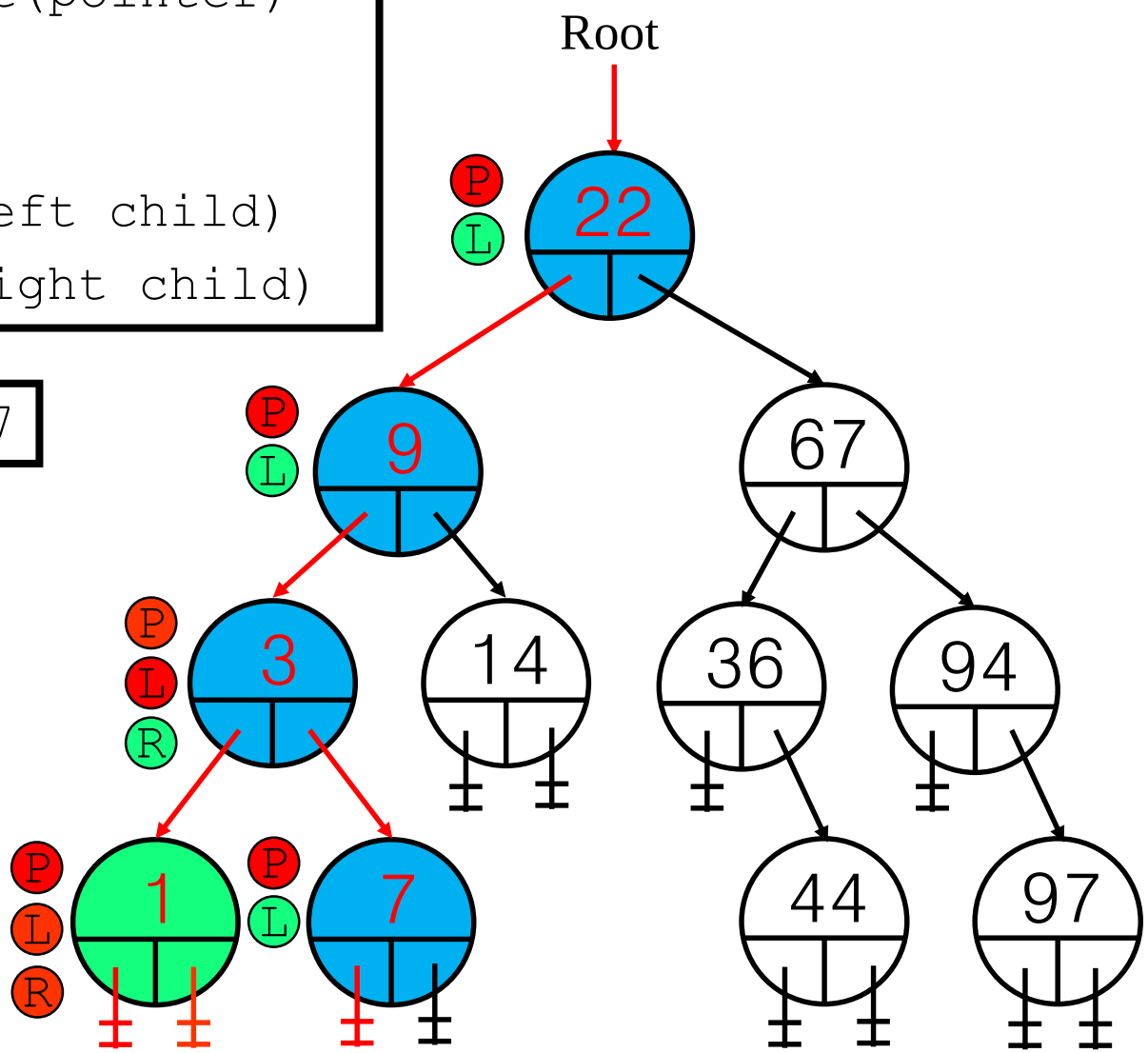
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



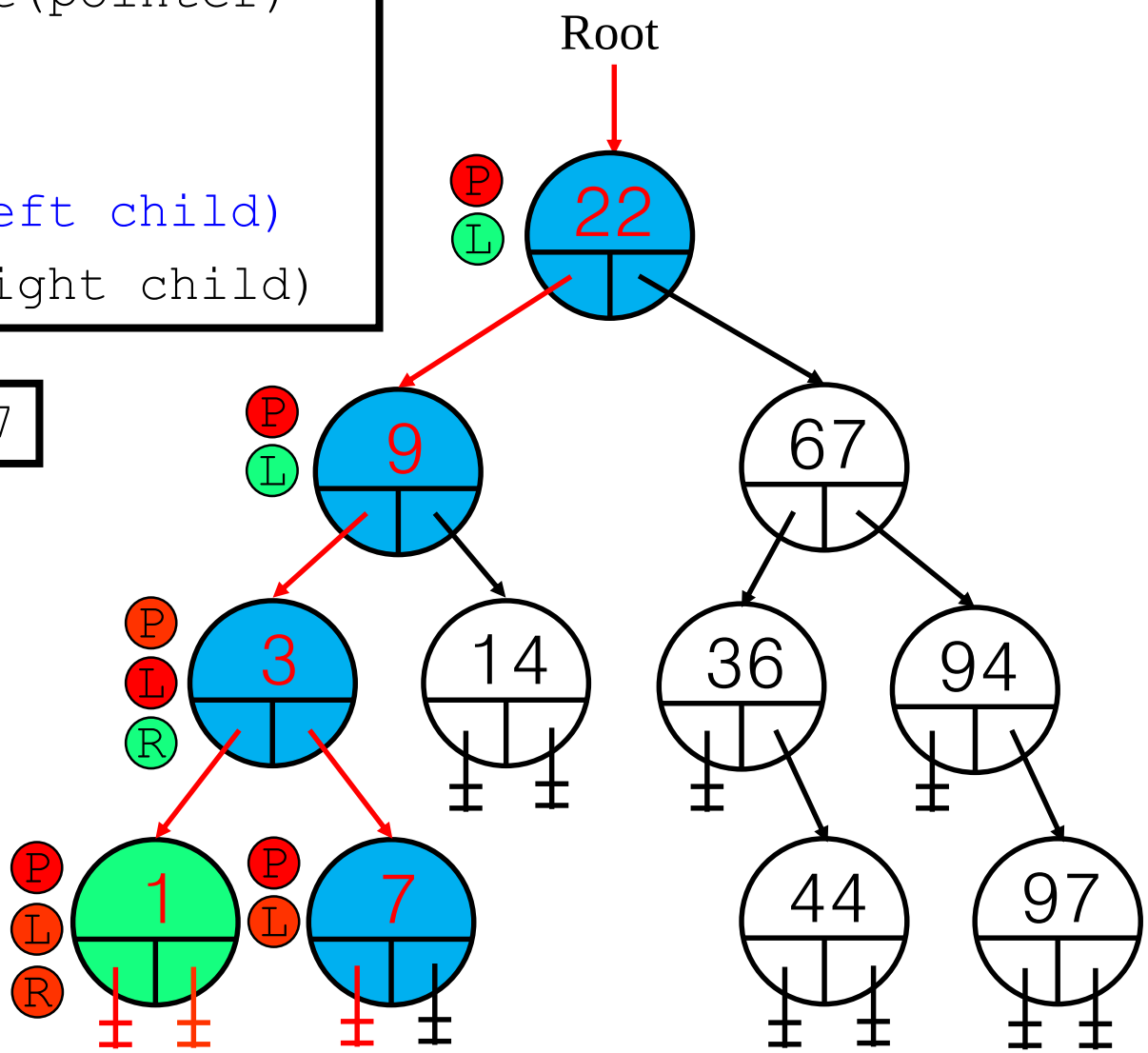
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



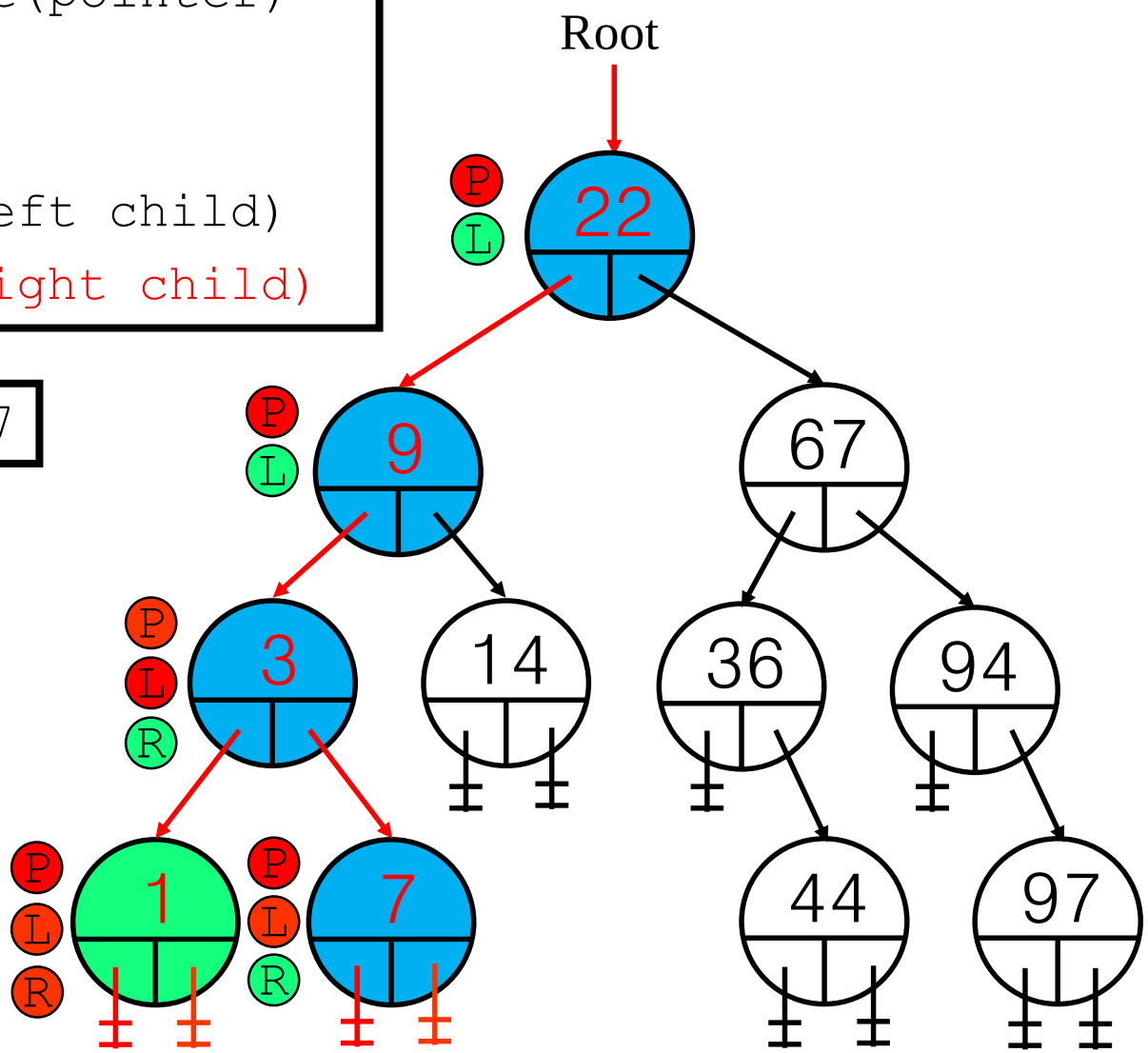
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



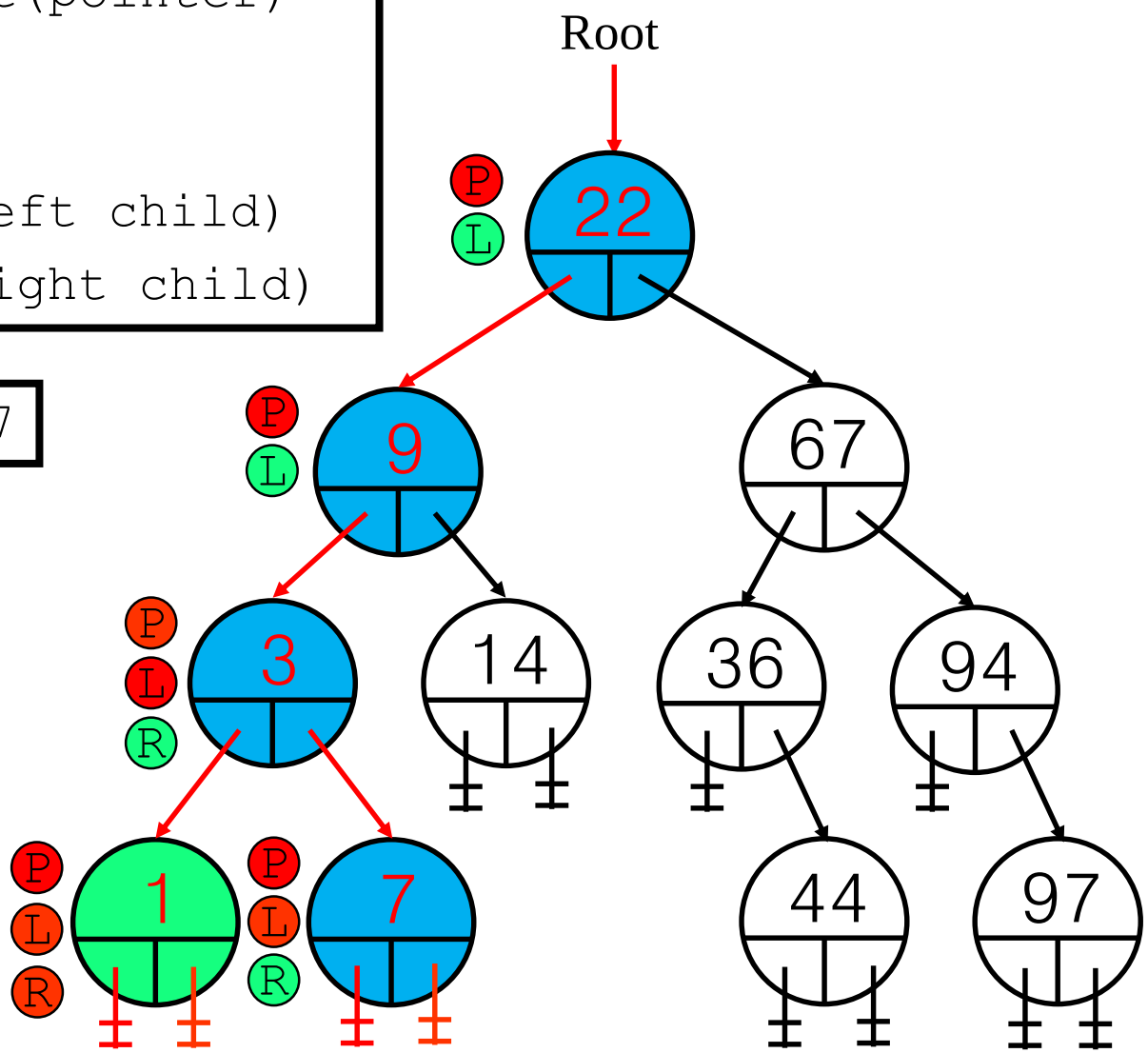
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



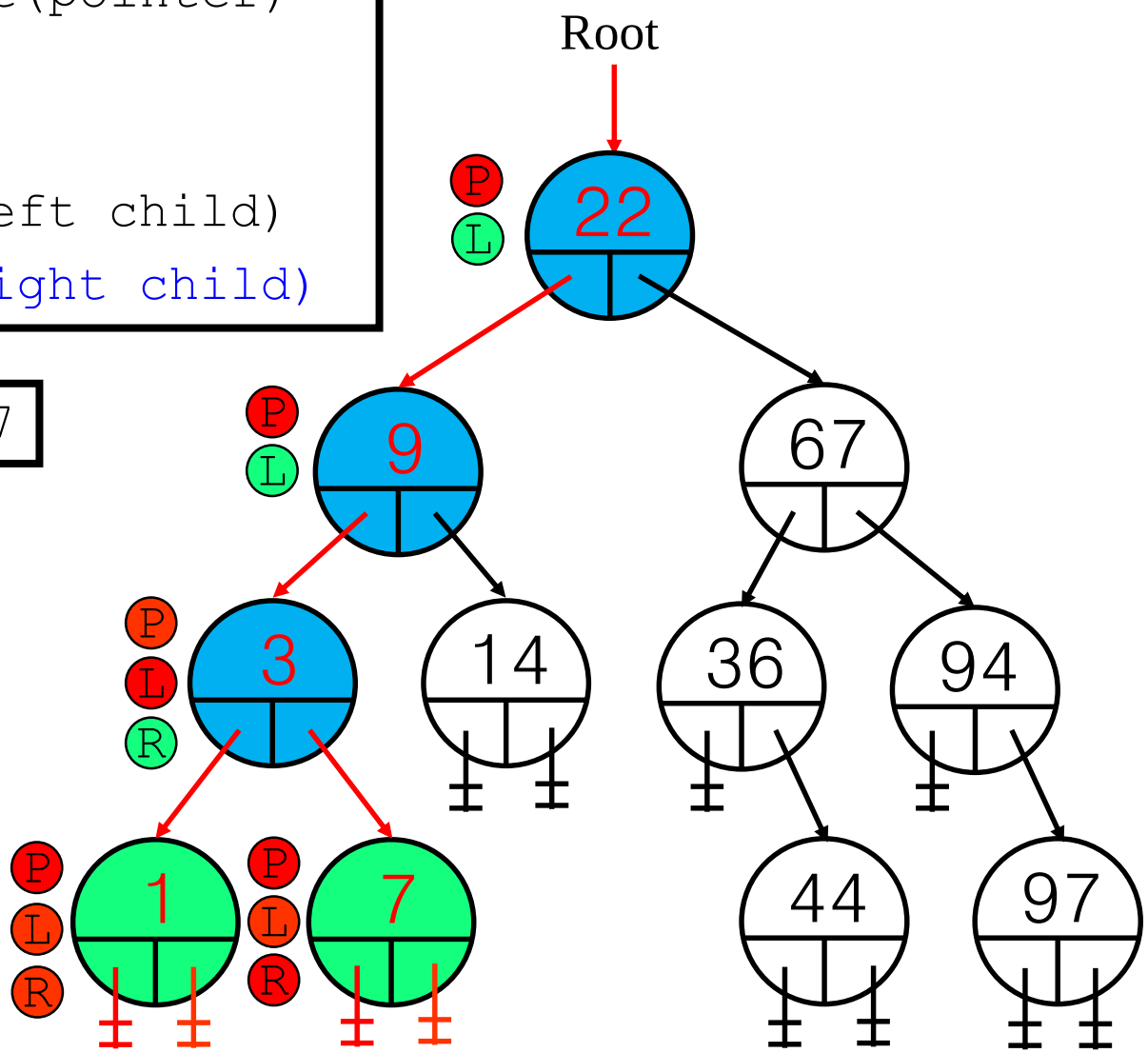
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



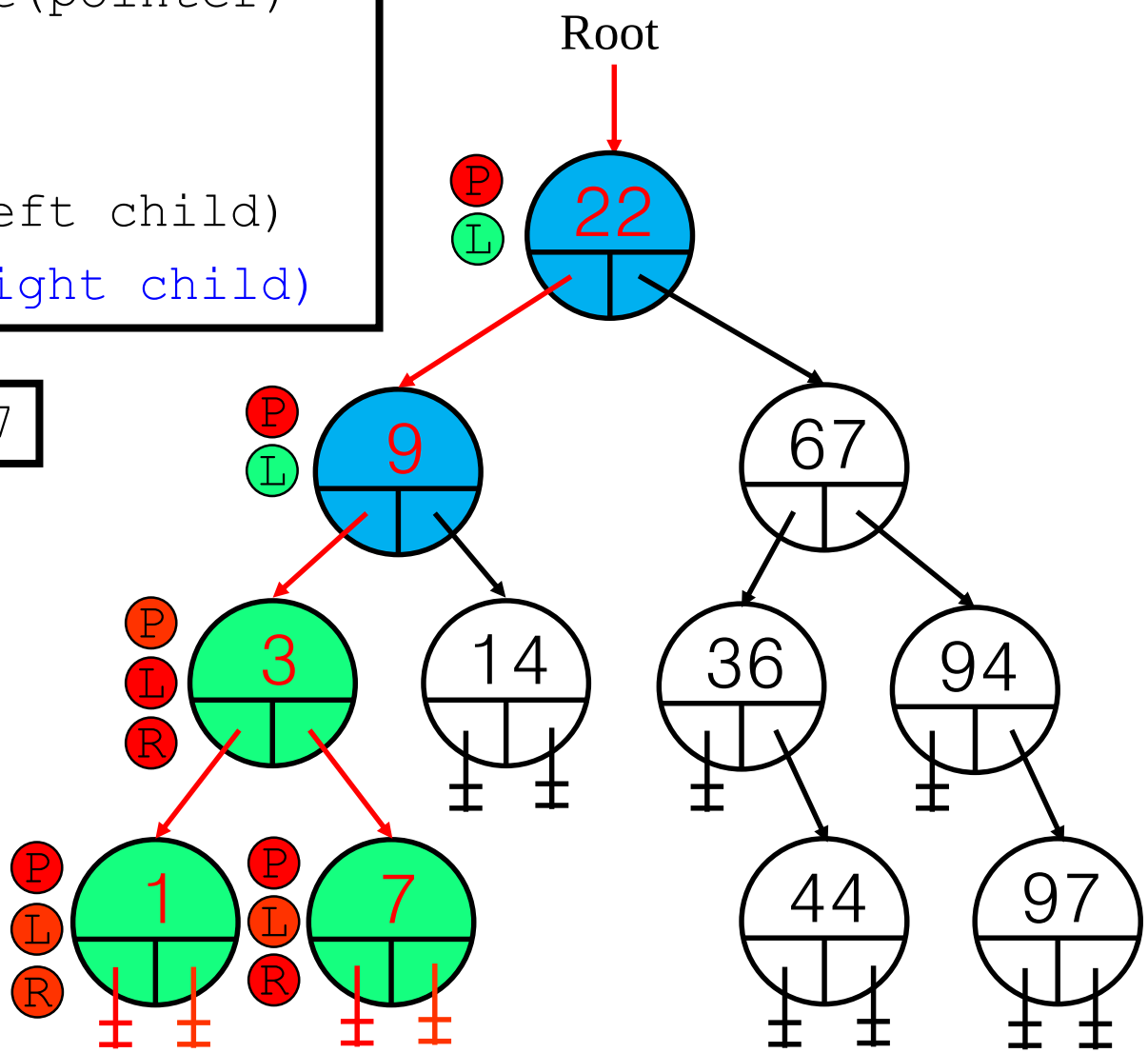
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



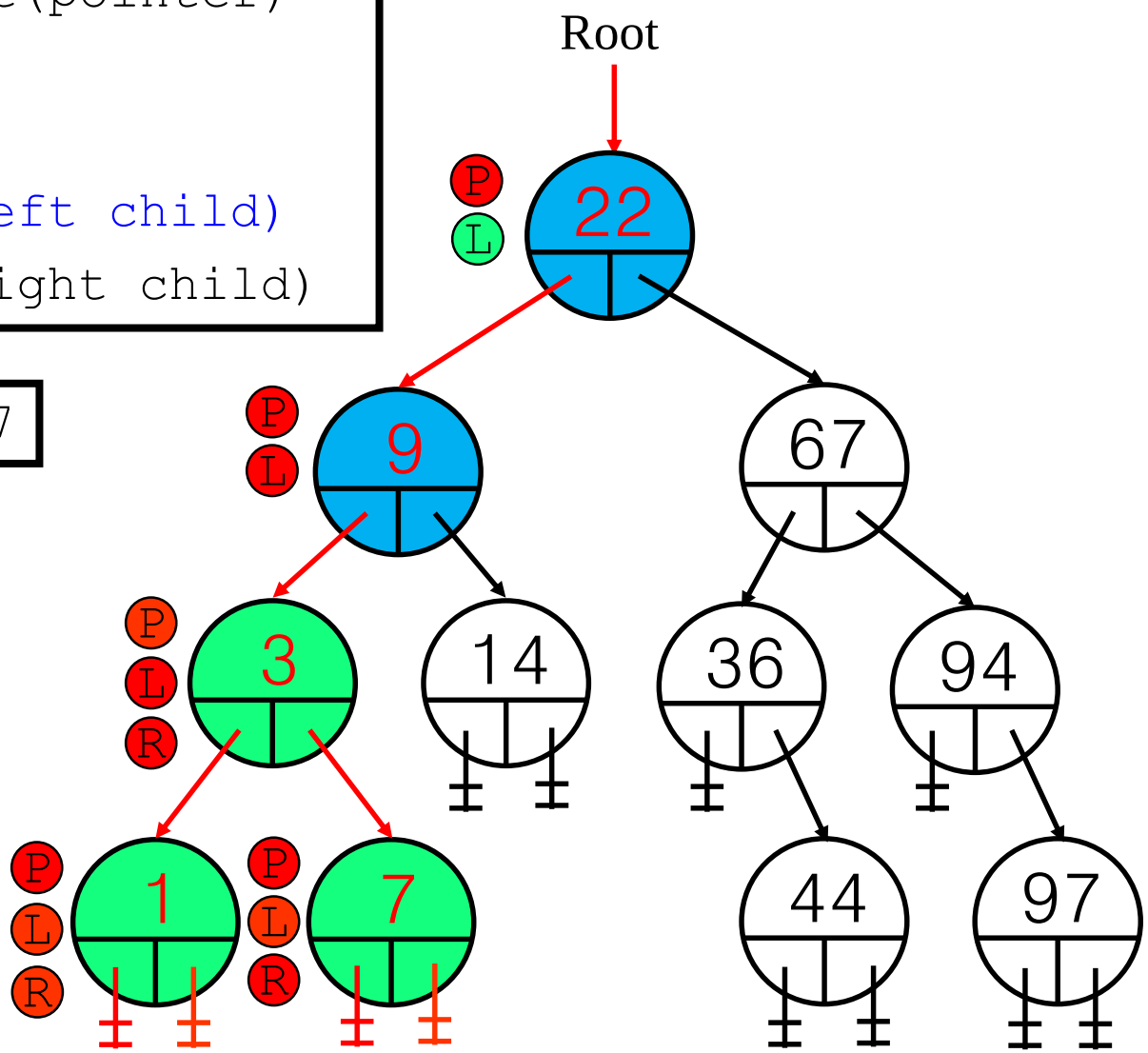
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



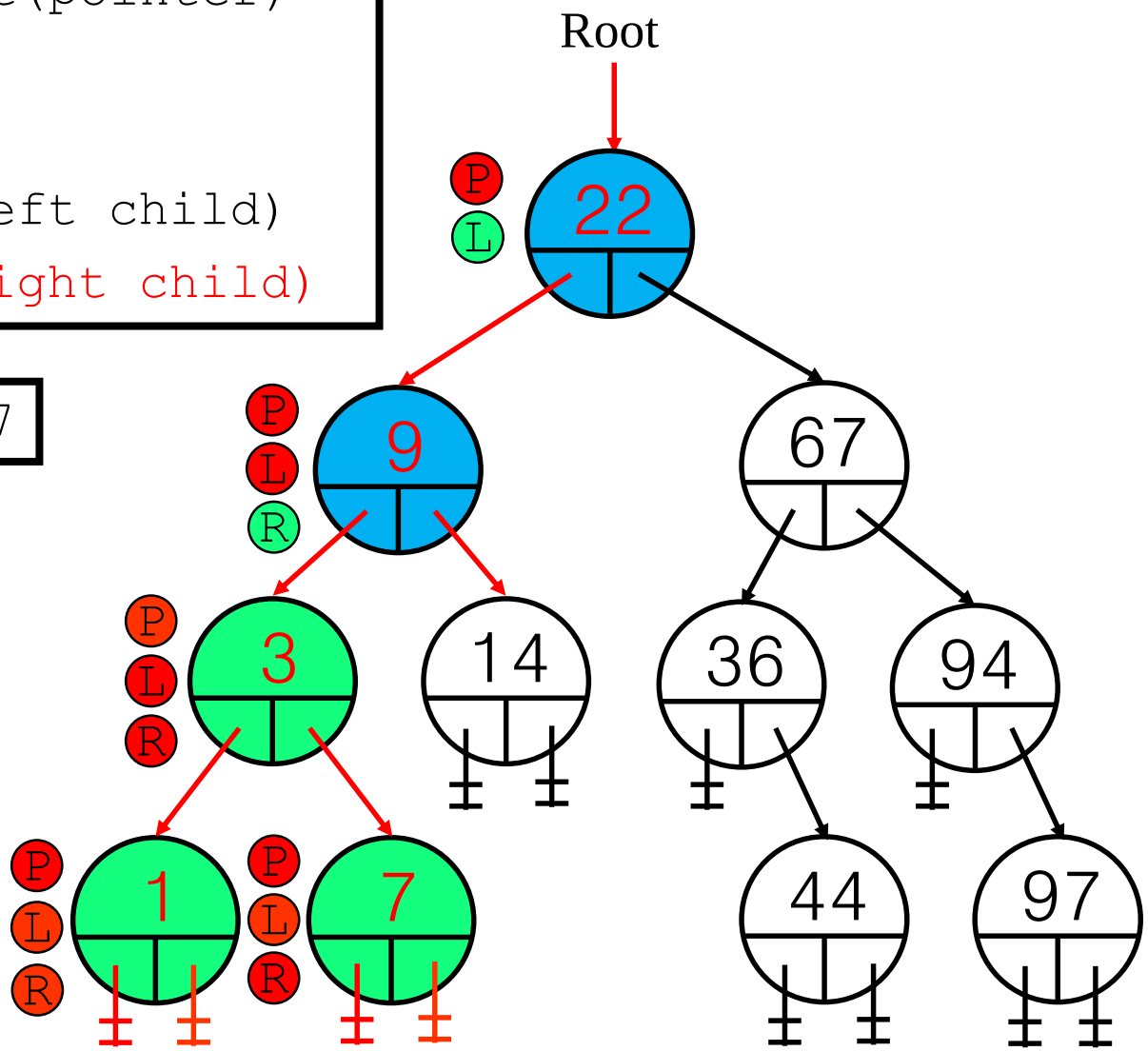
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



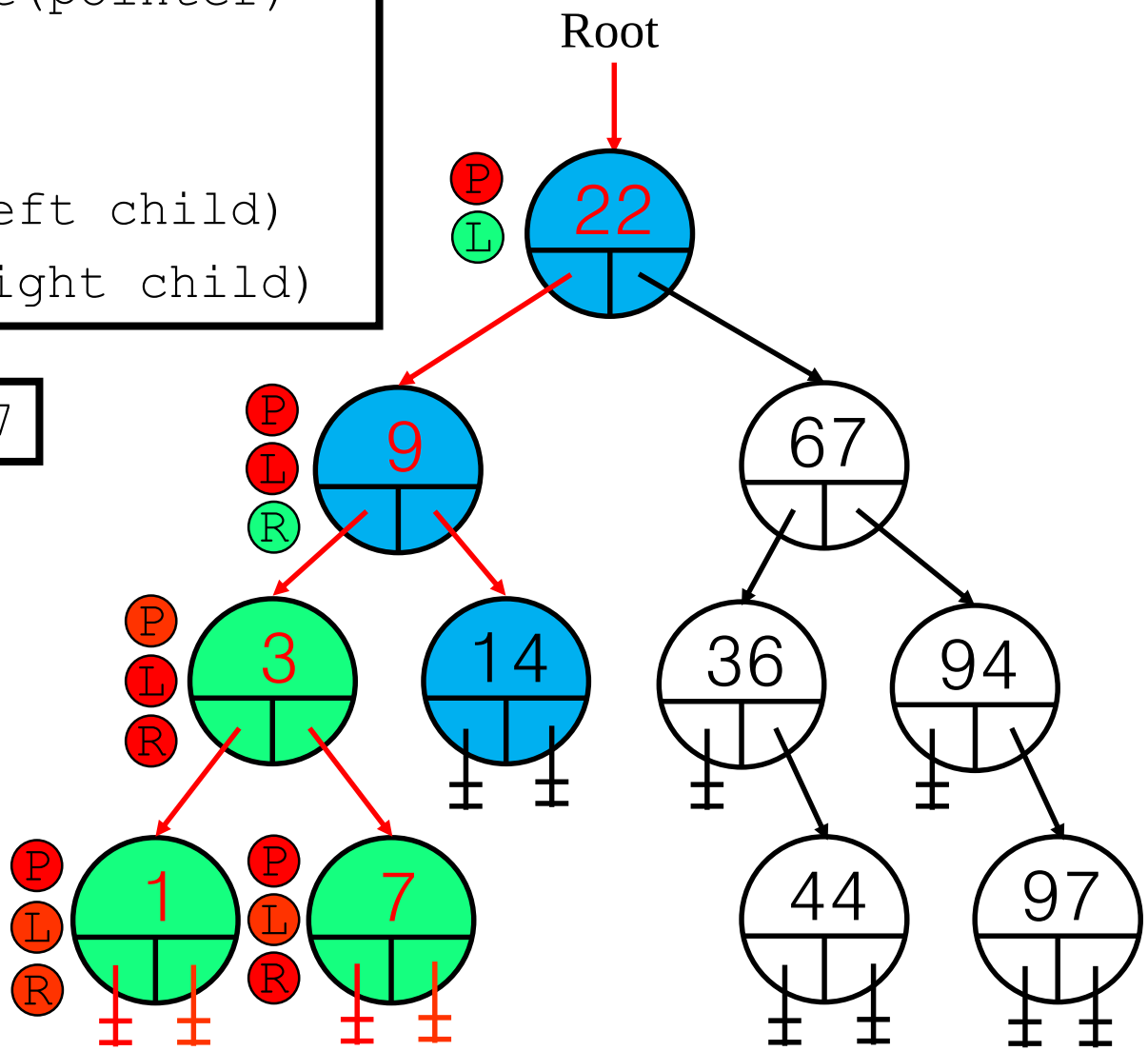
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



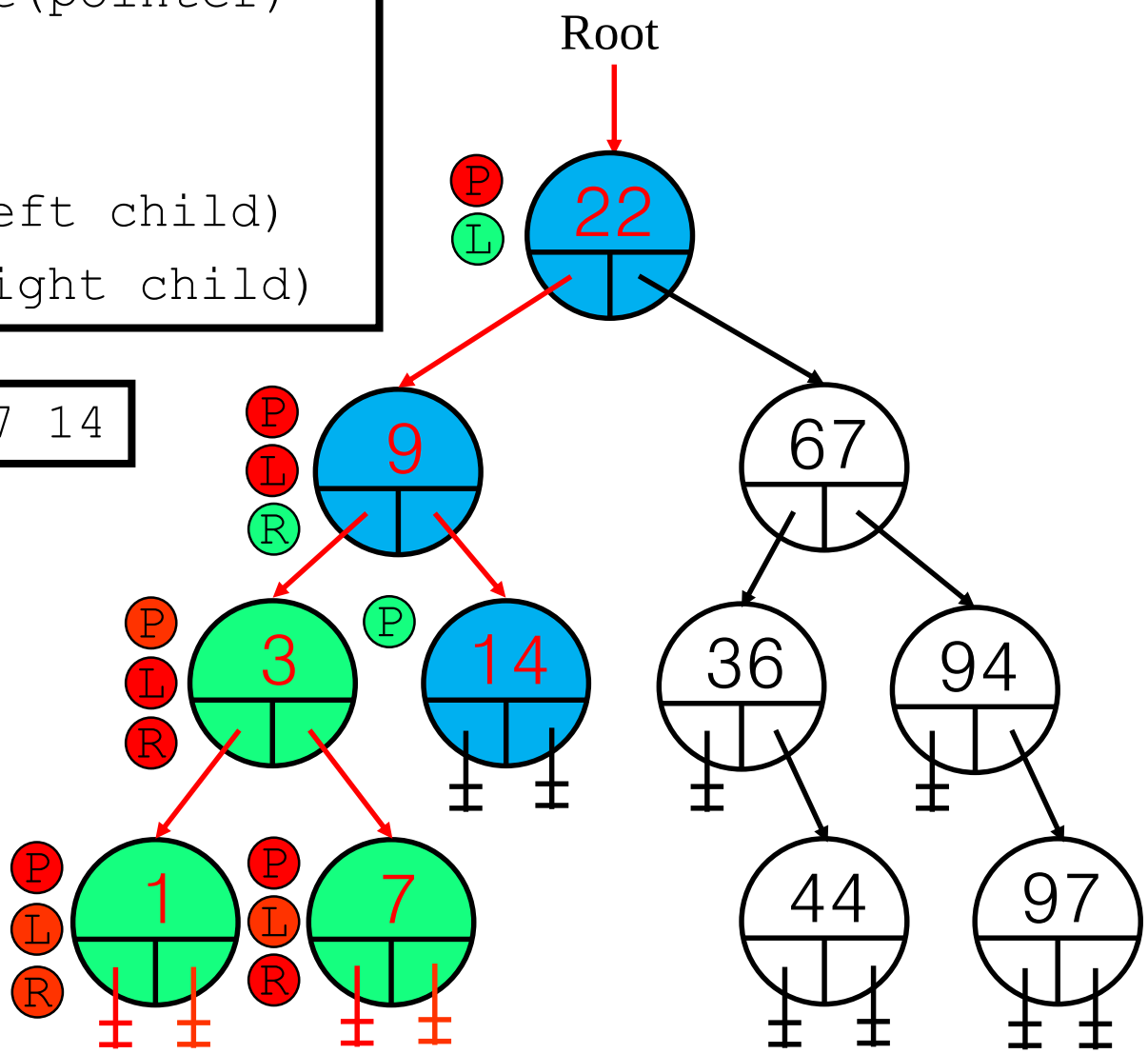
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7
```



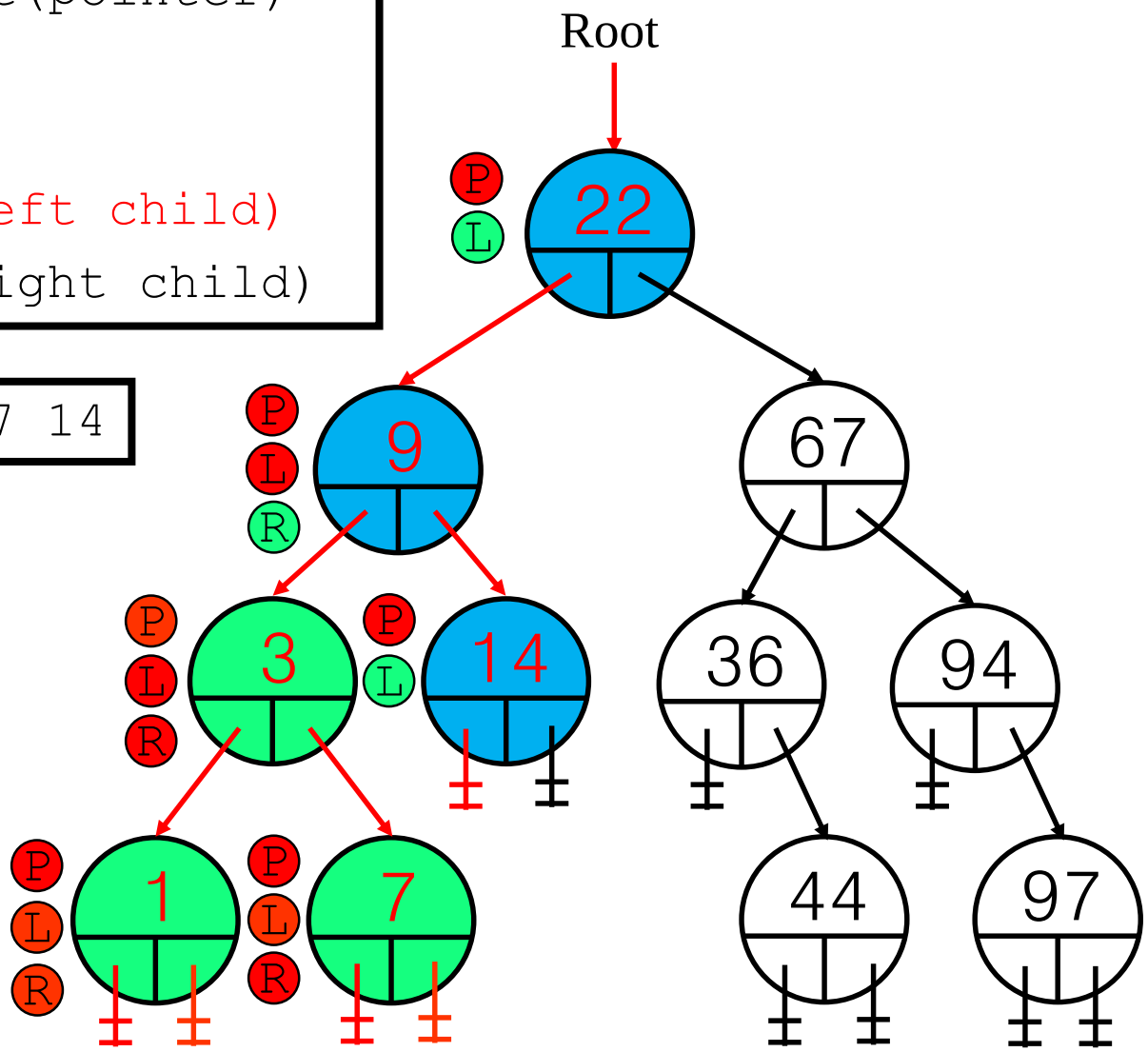
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



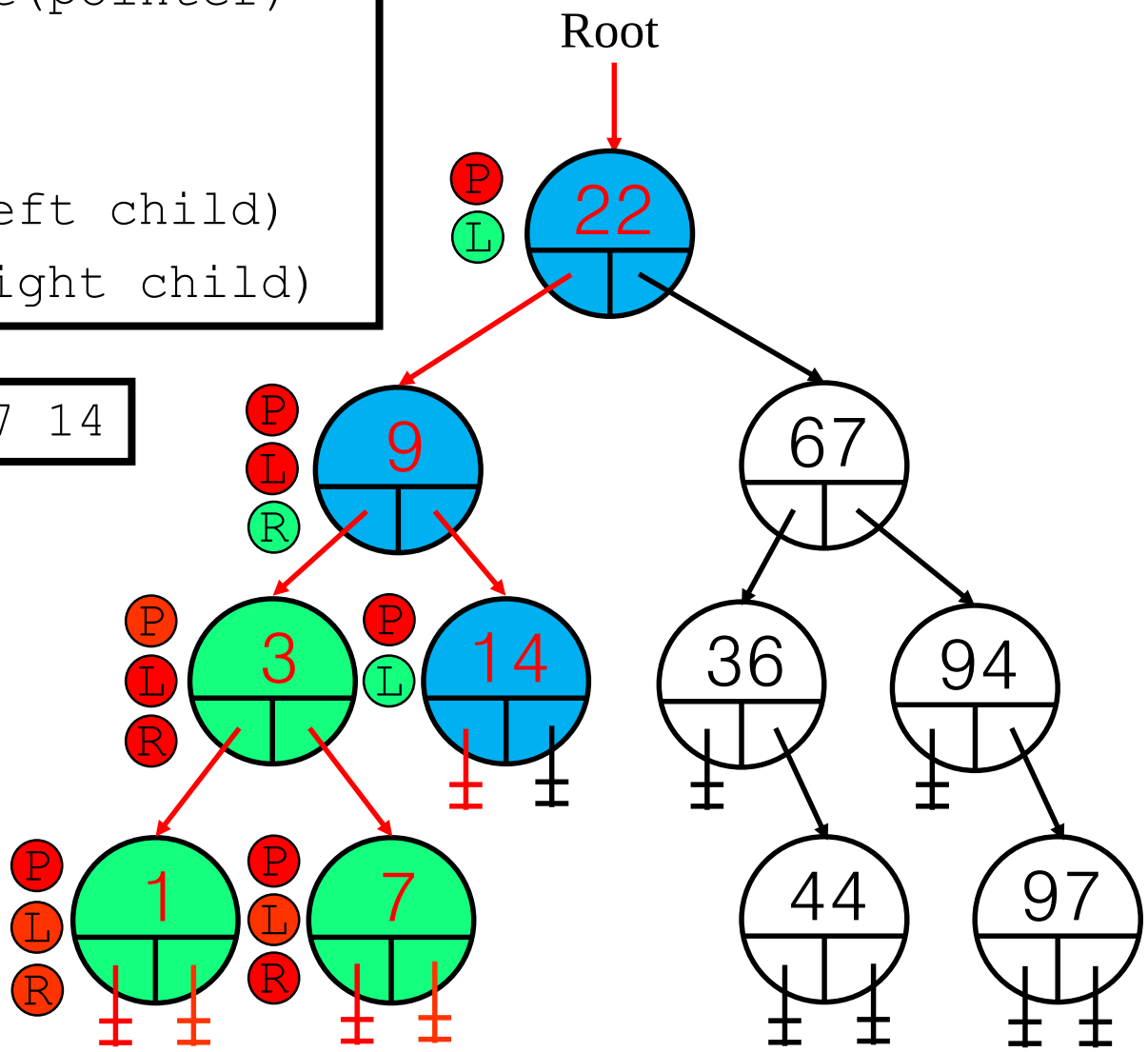
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



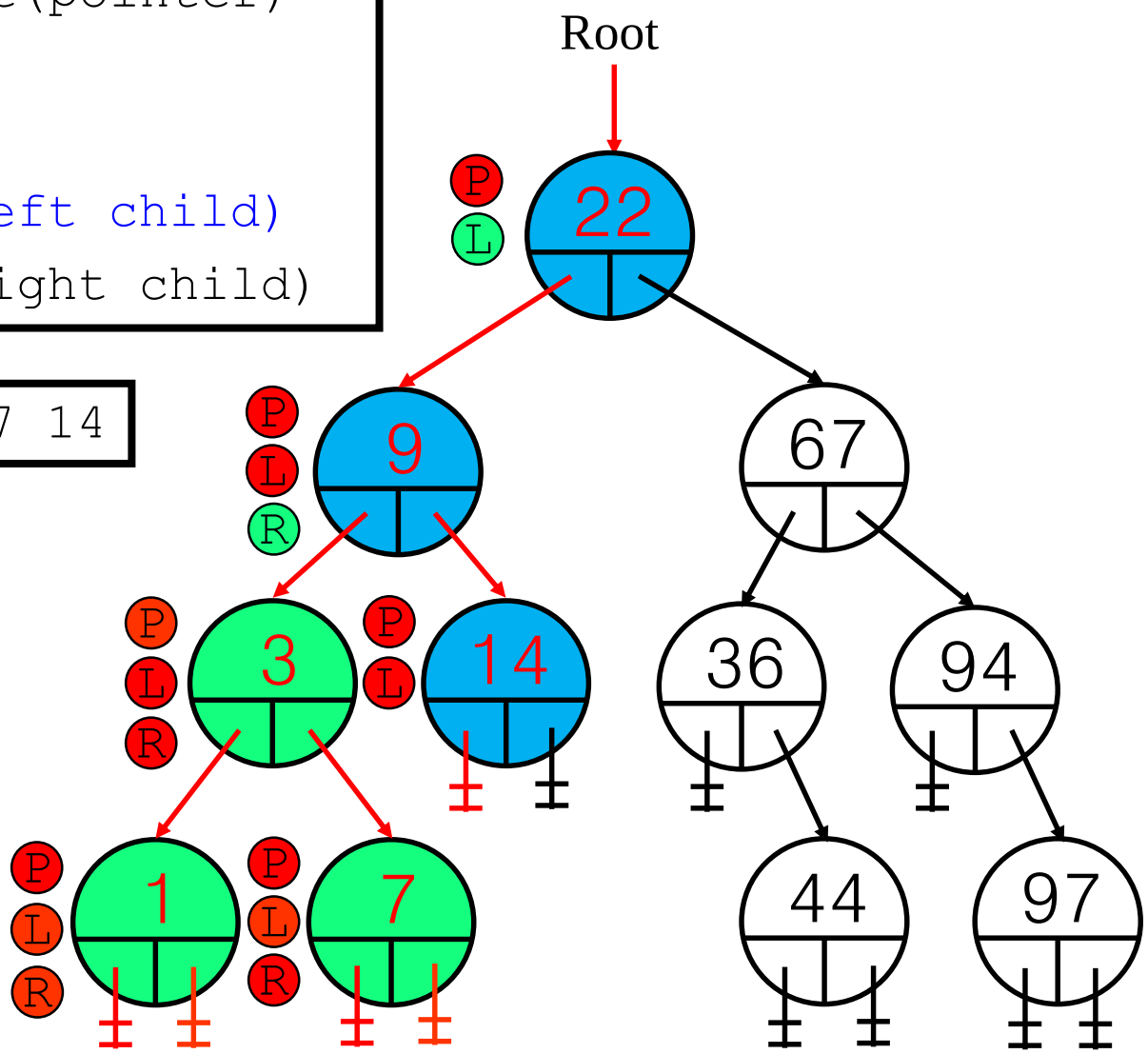
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



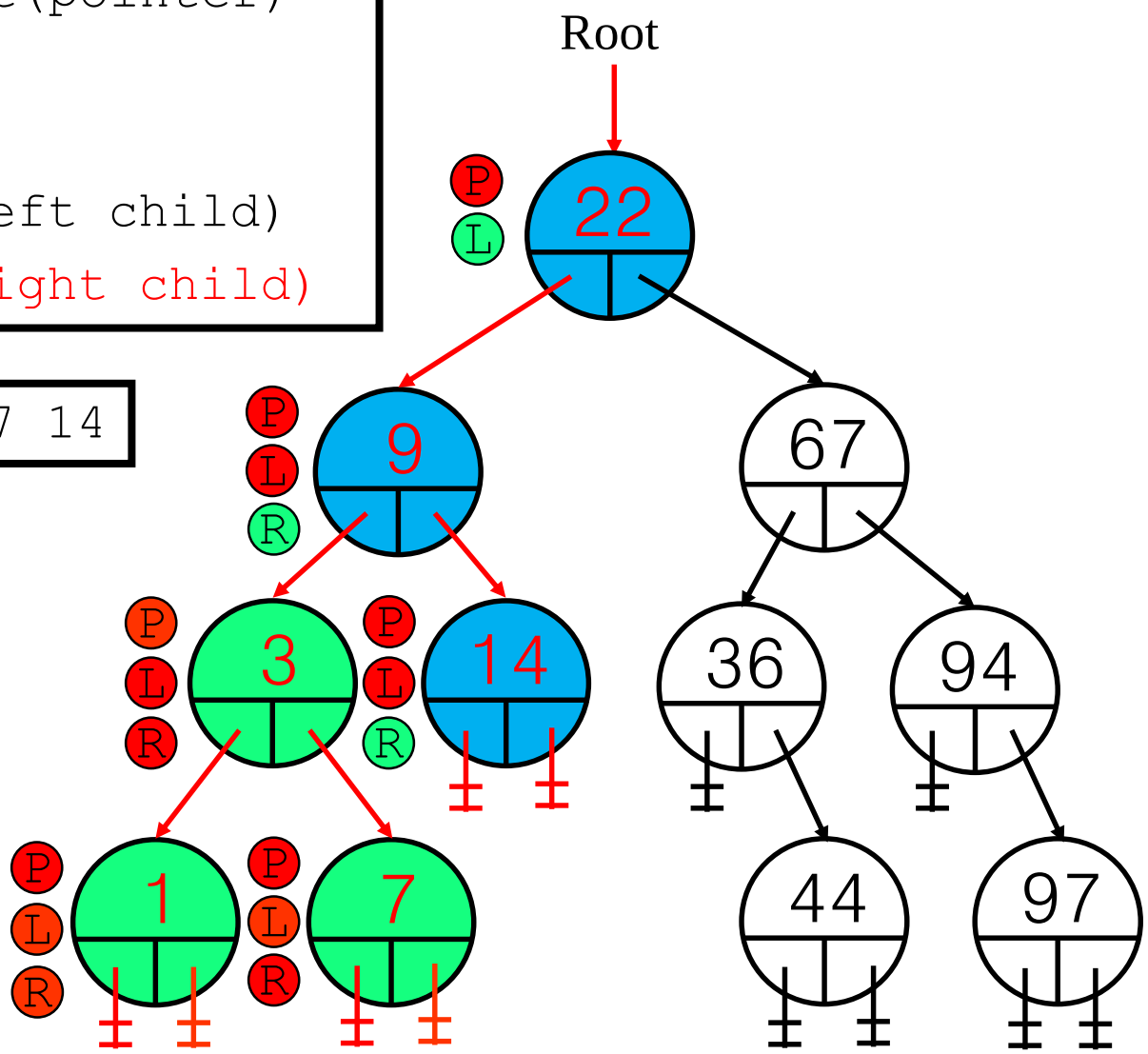
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



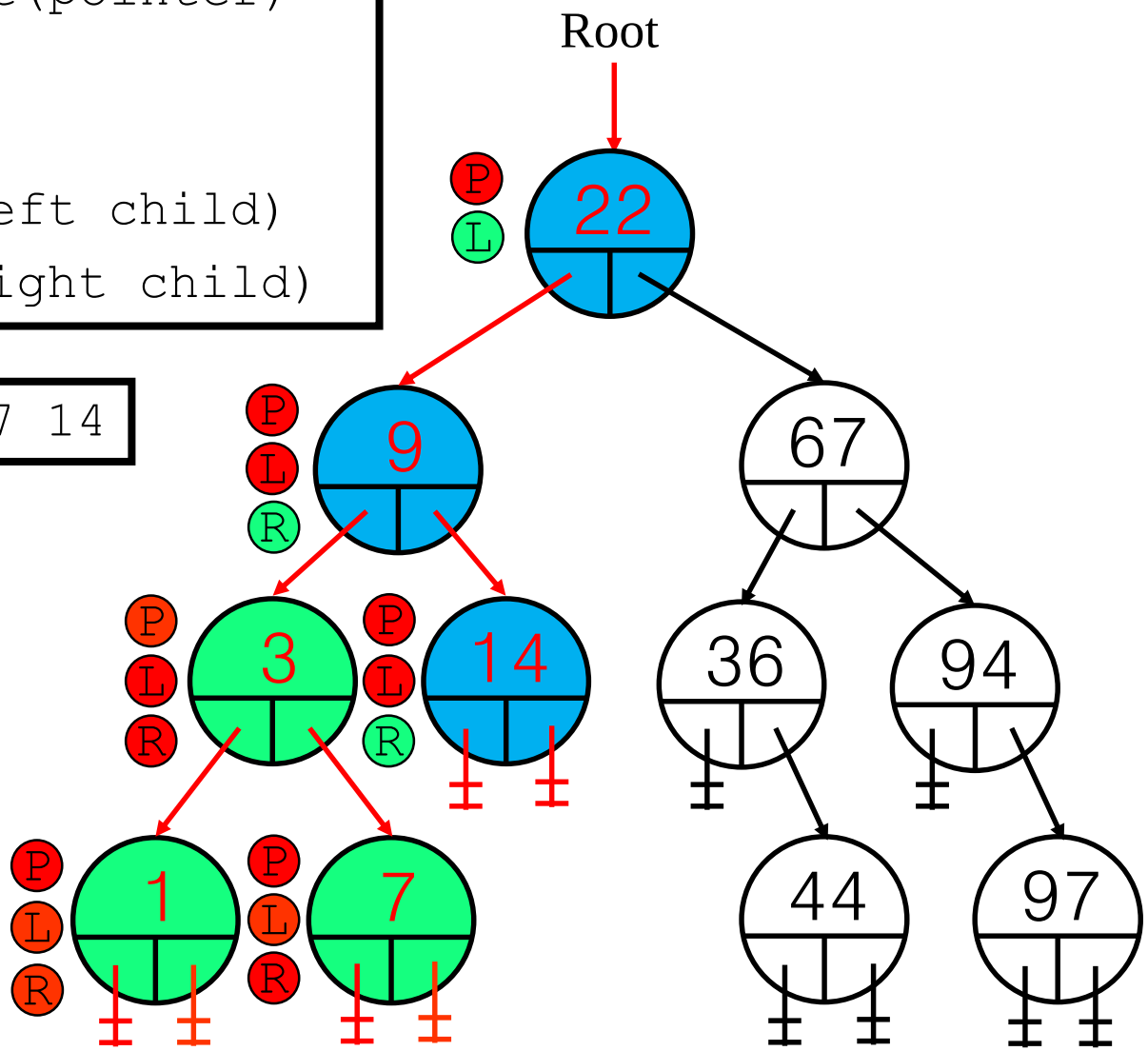
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



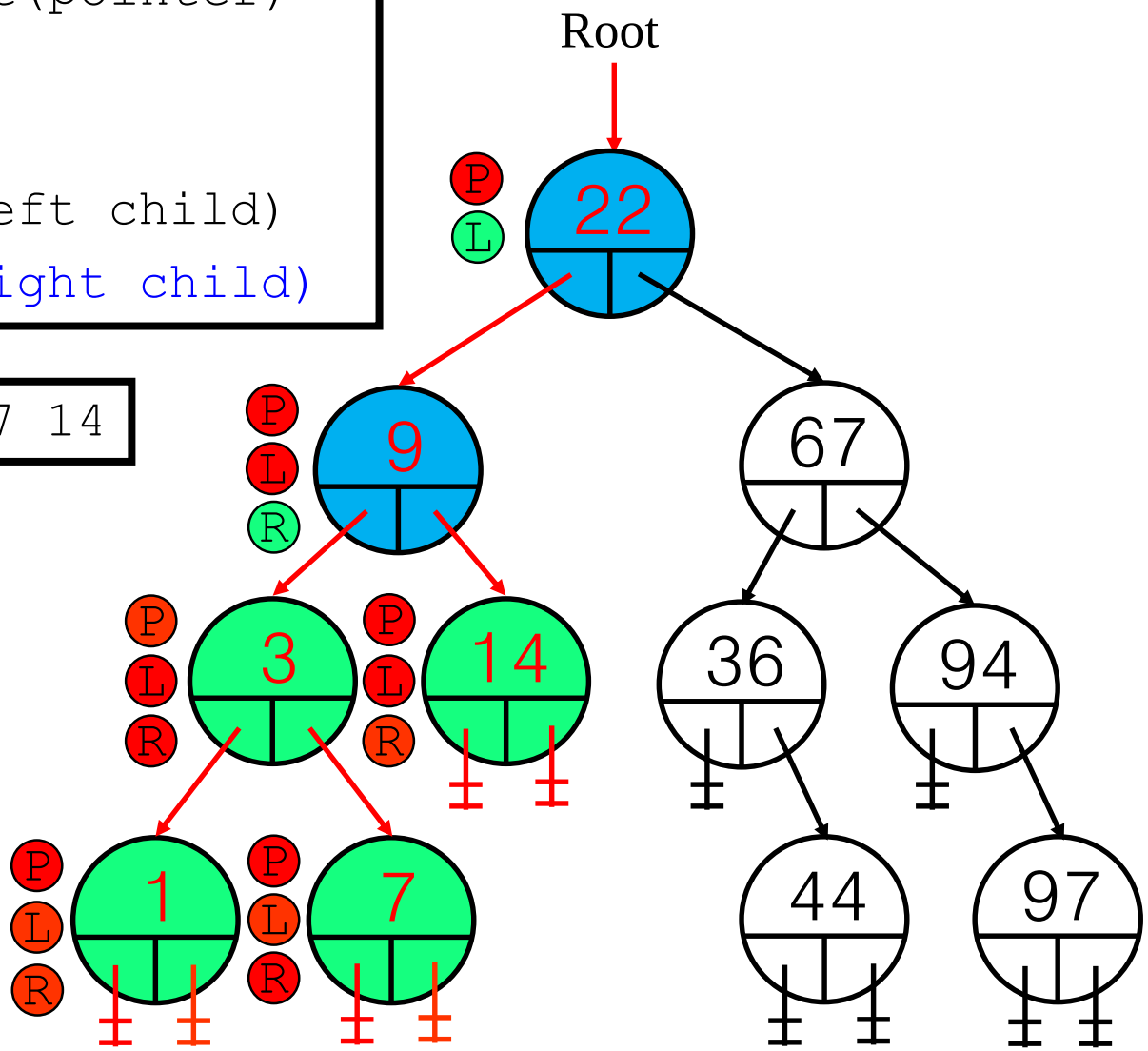
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



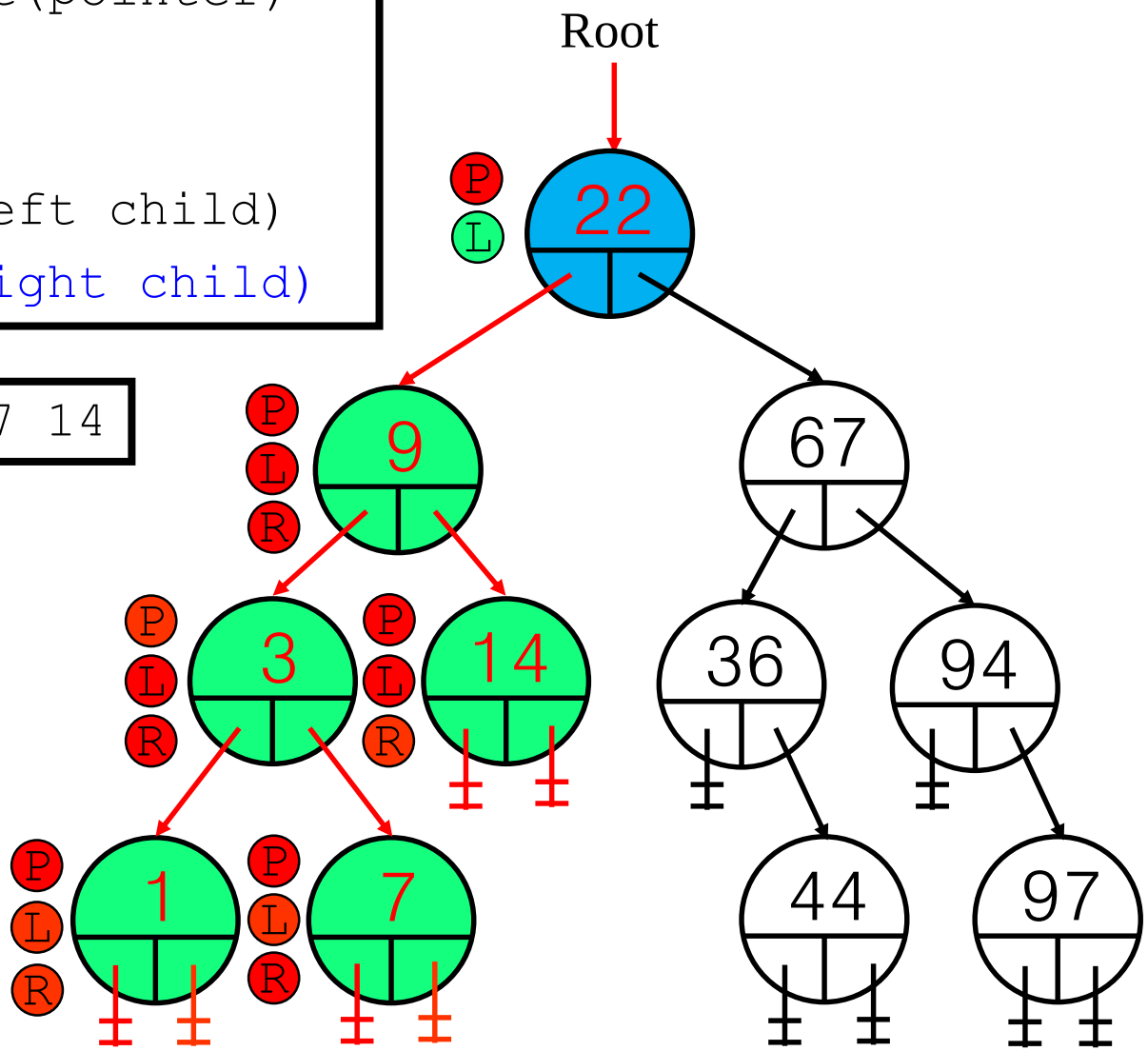
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



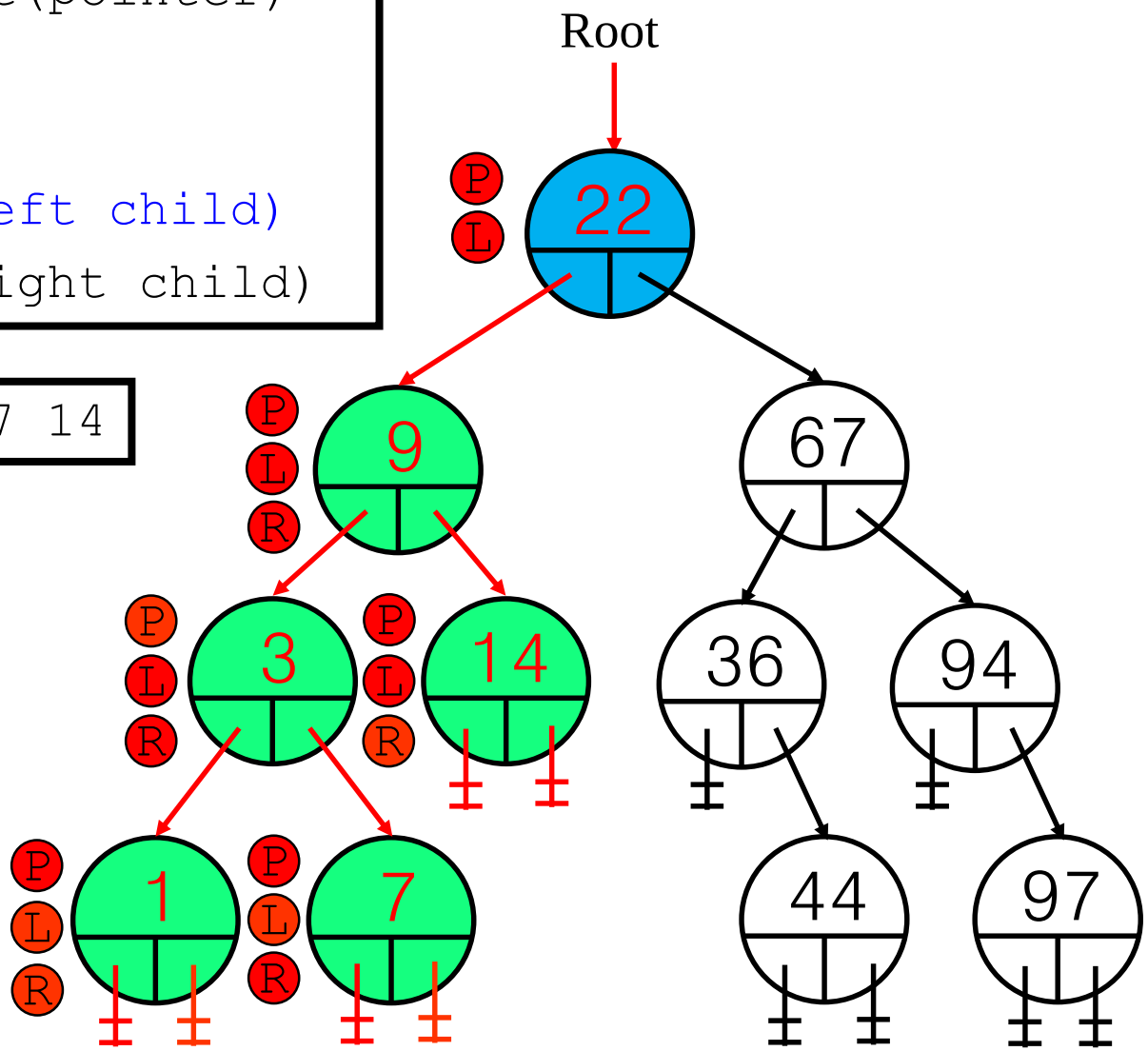
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



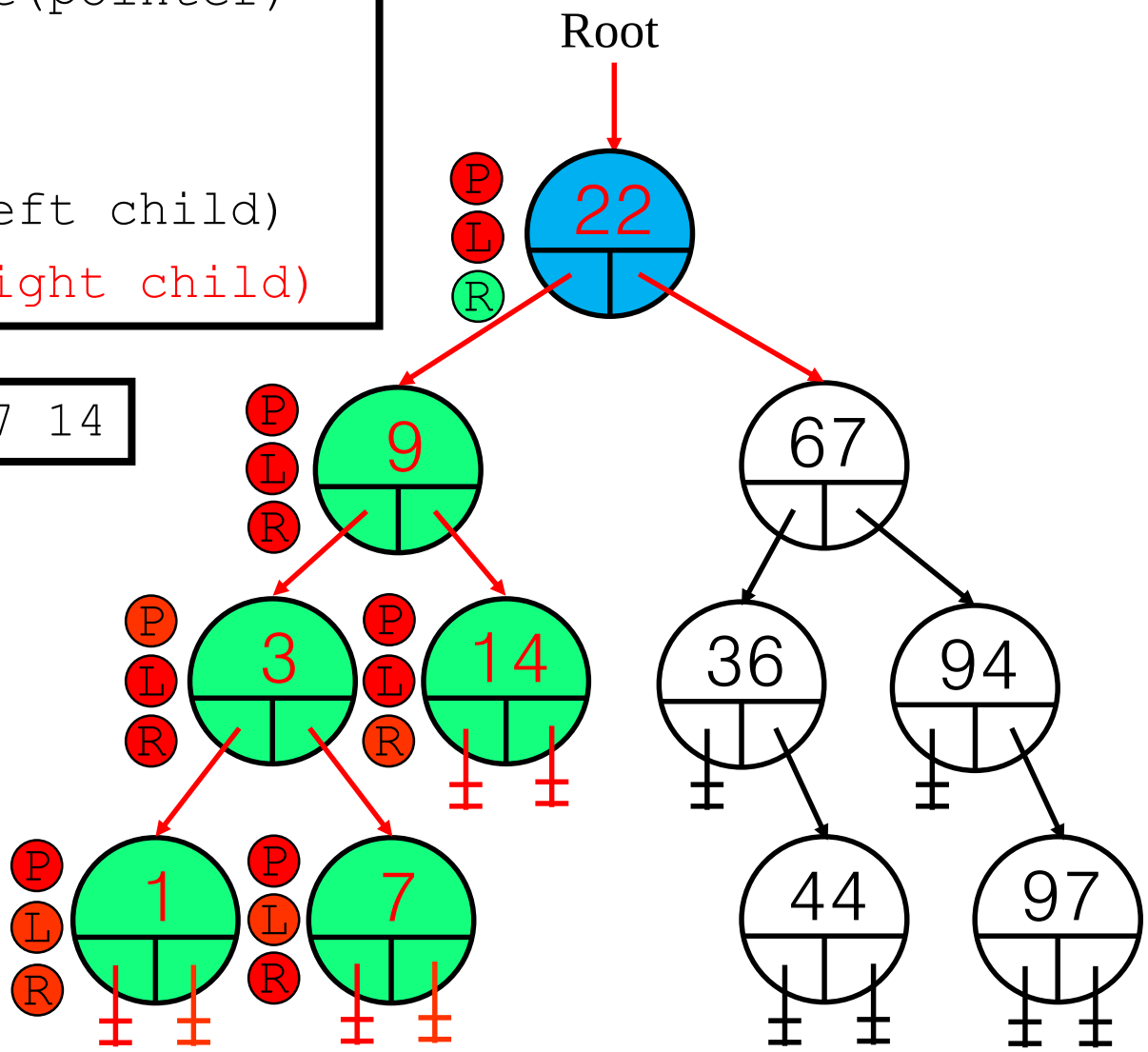
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



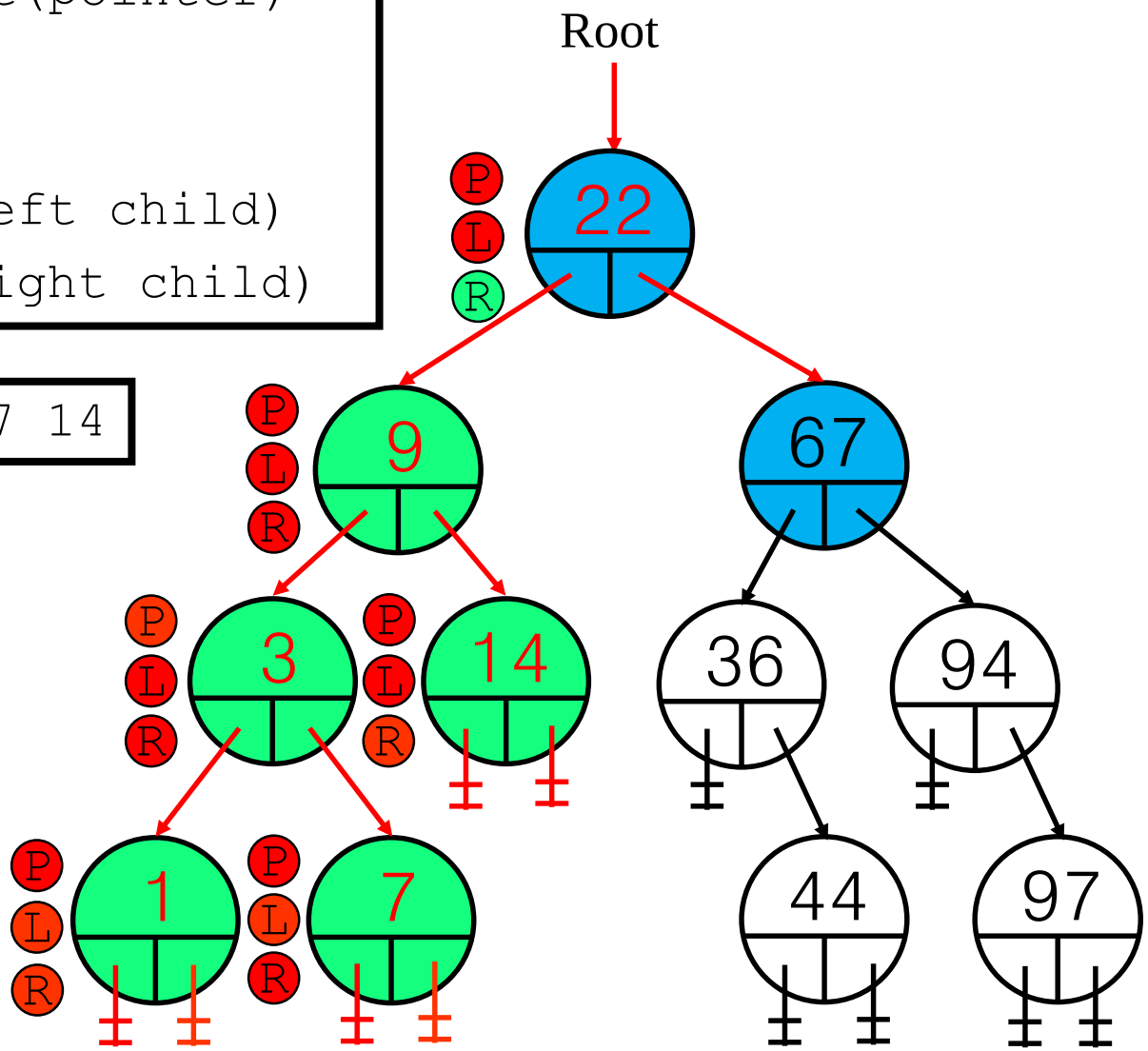
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



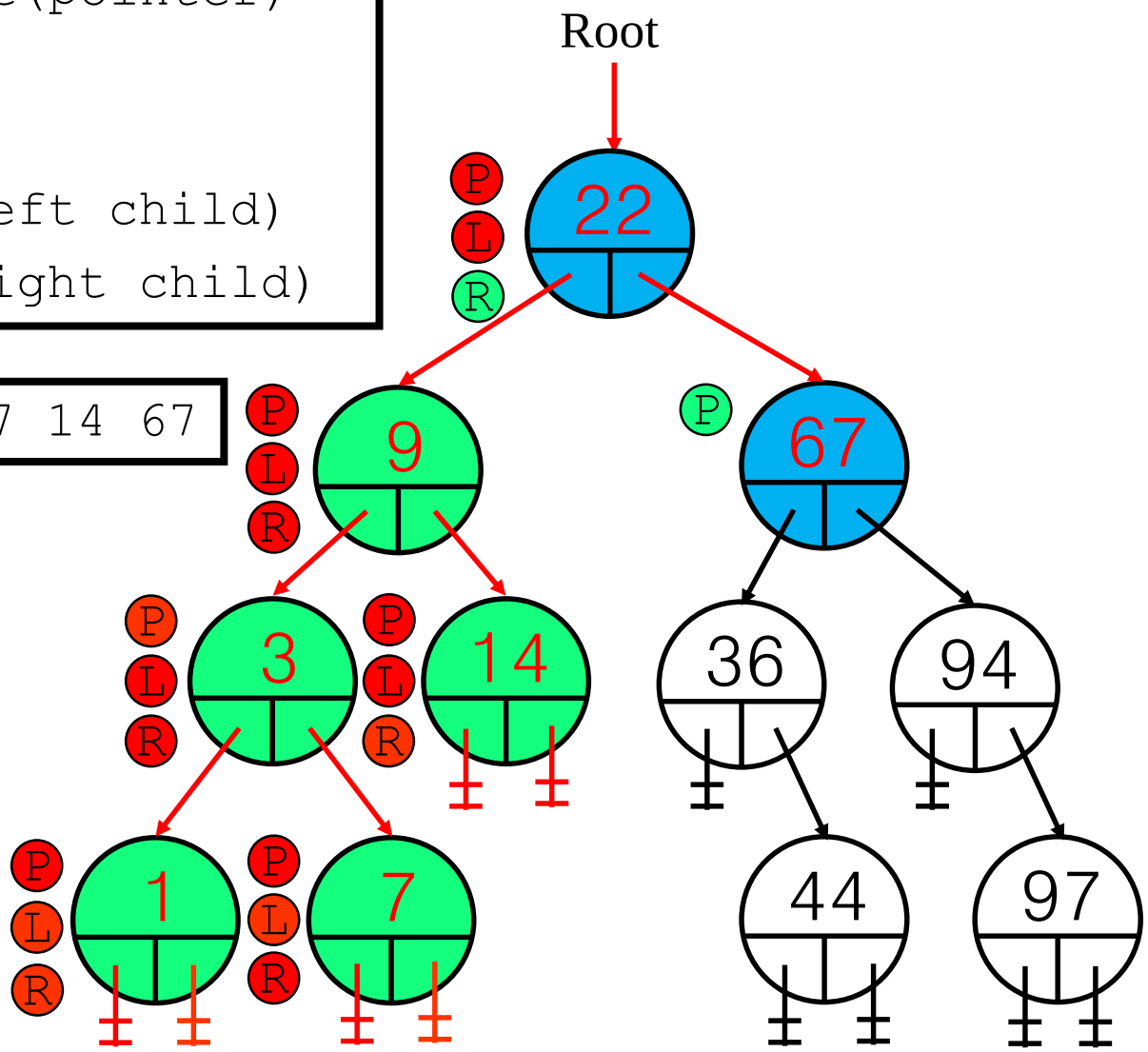
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14
```



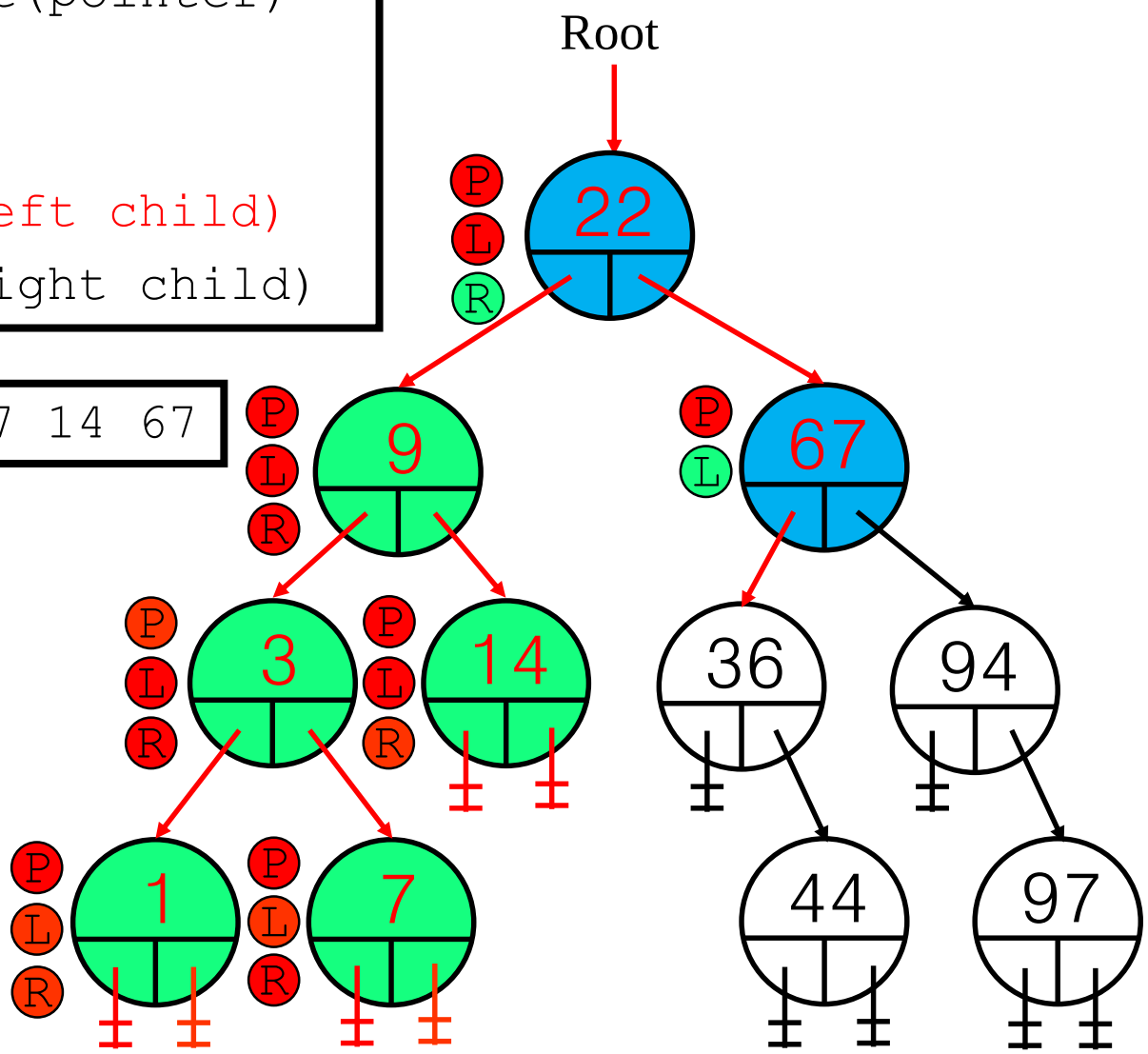
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
```



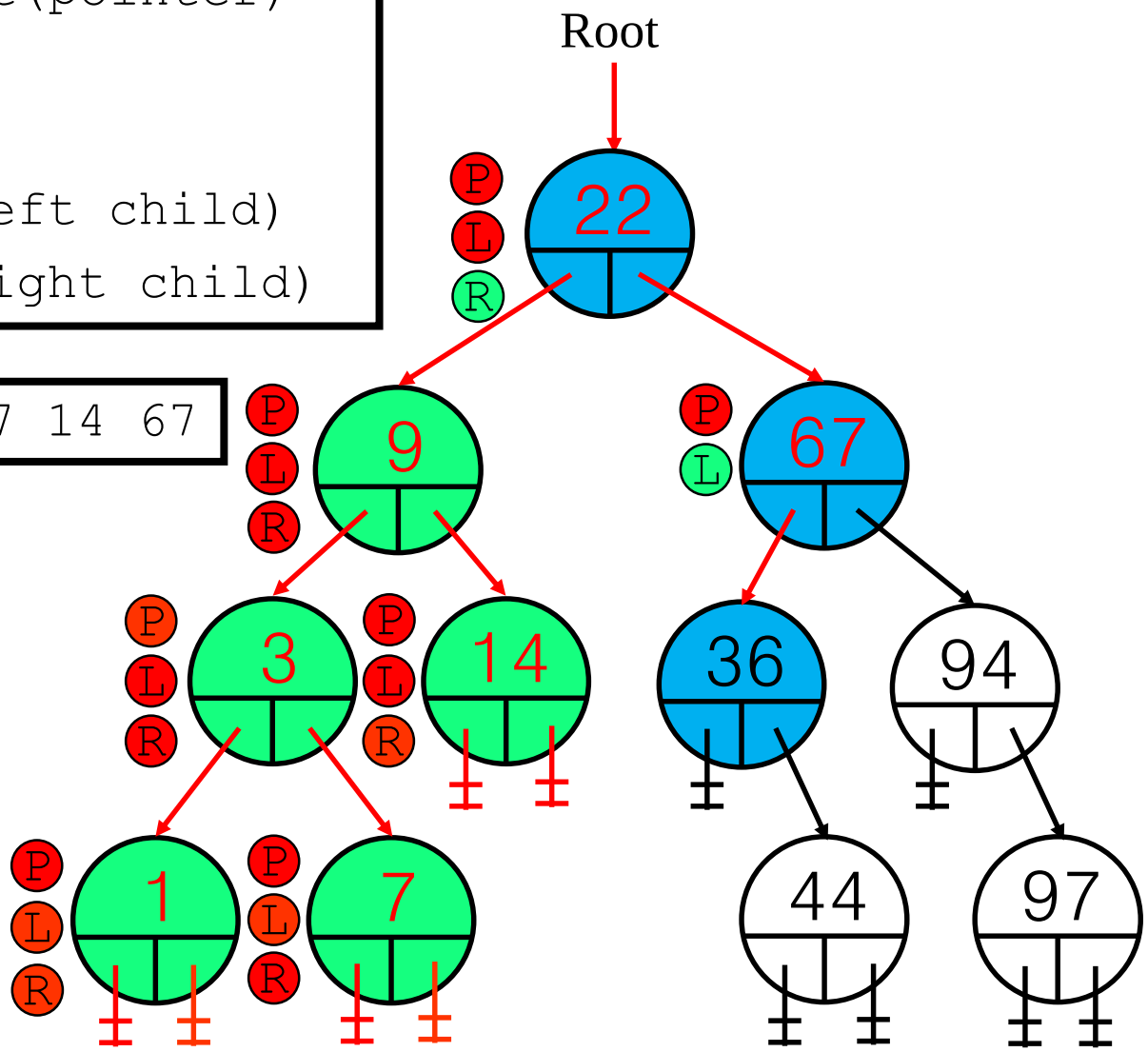
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
```



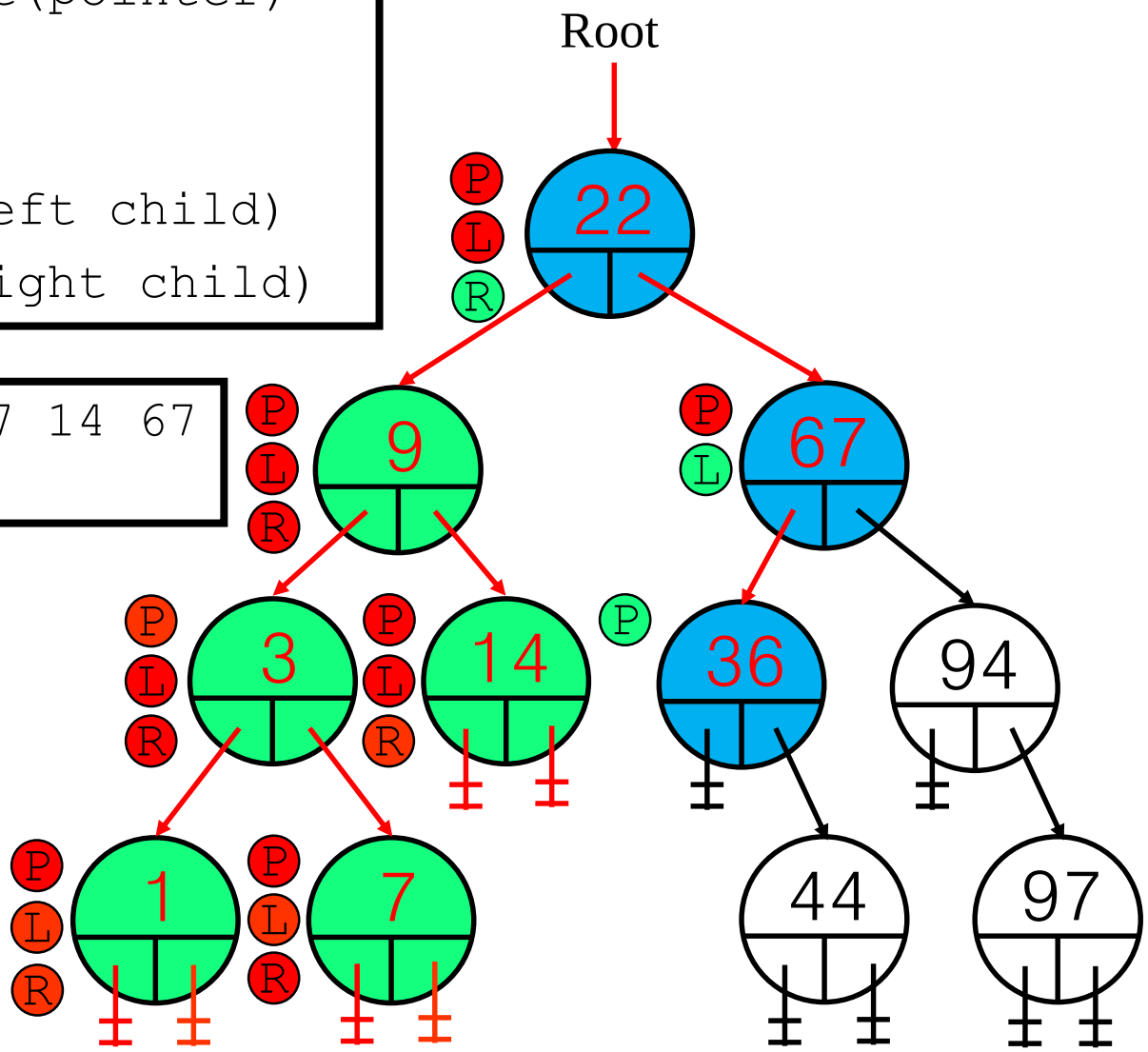
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
```



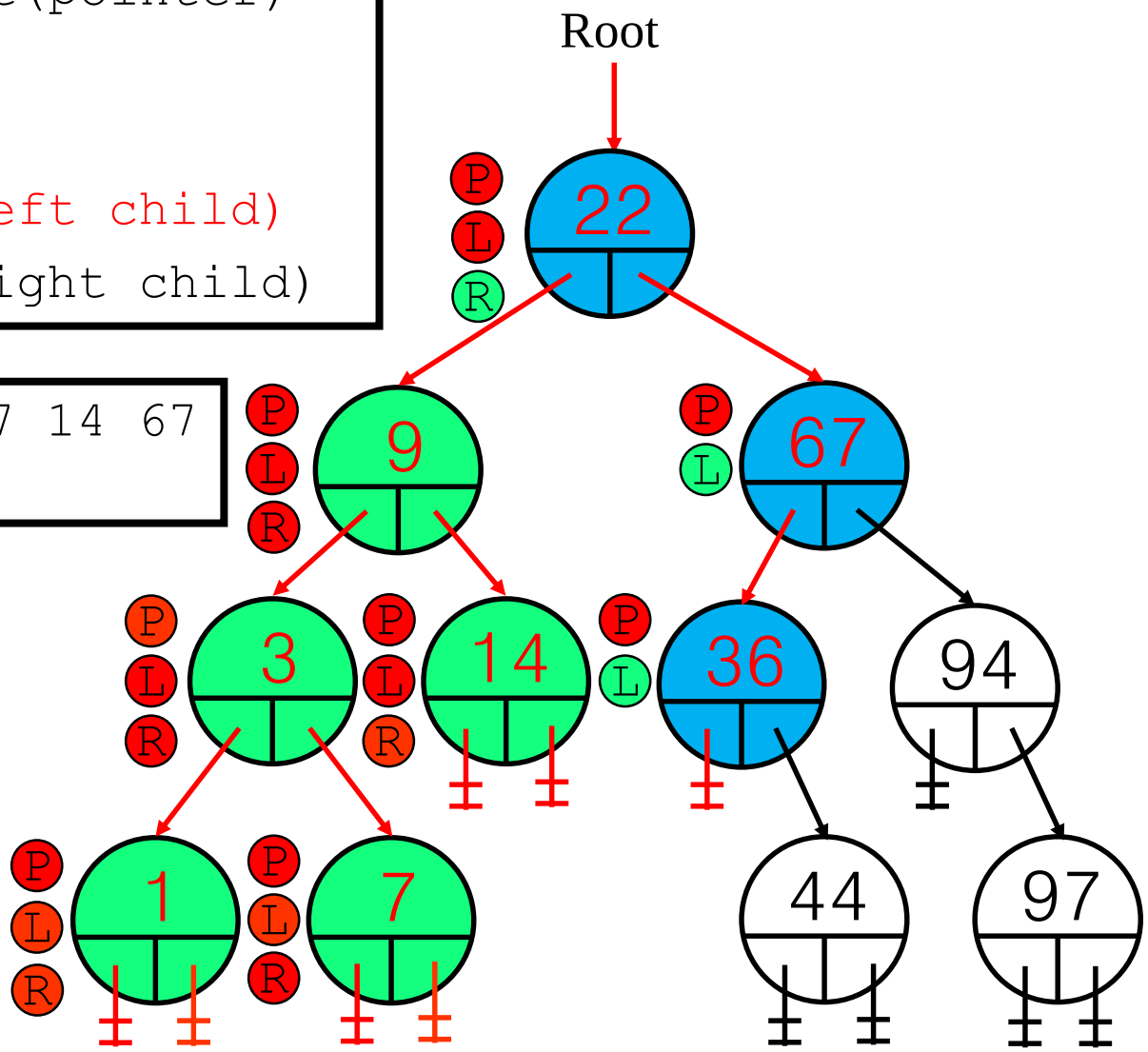
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36
```



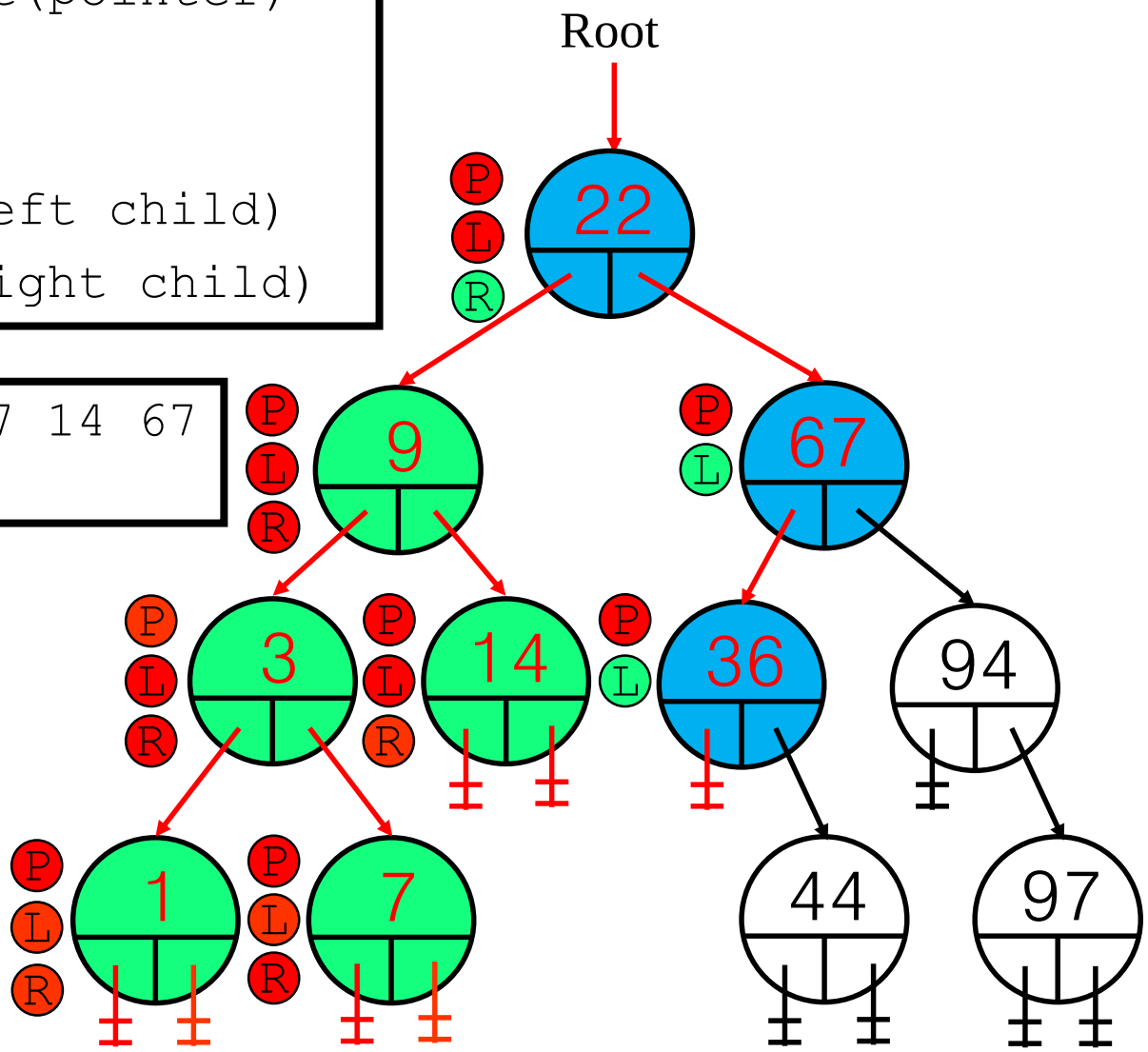
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36
```



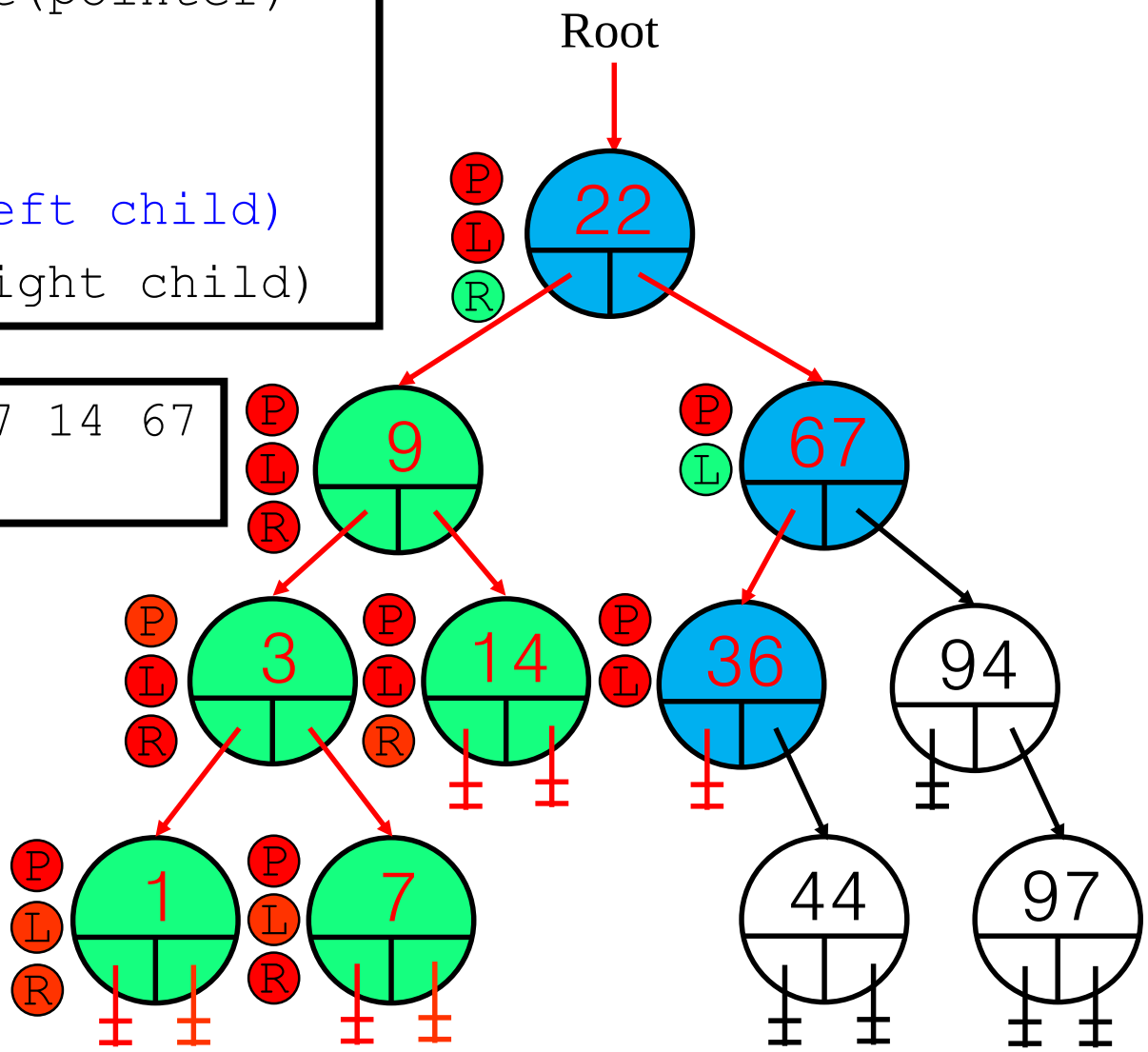
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36
```



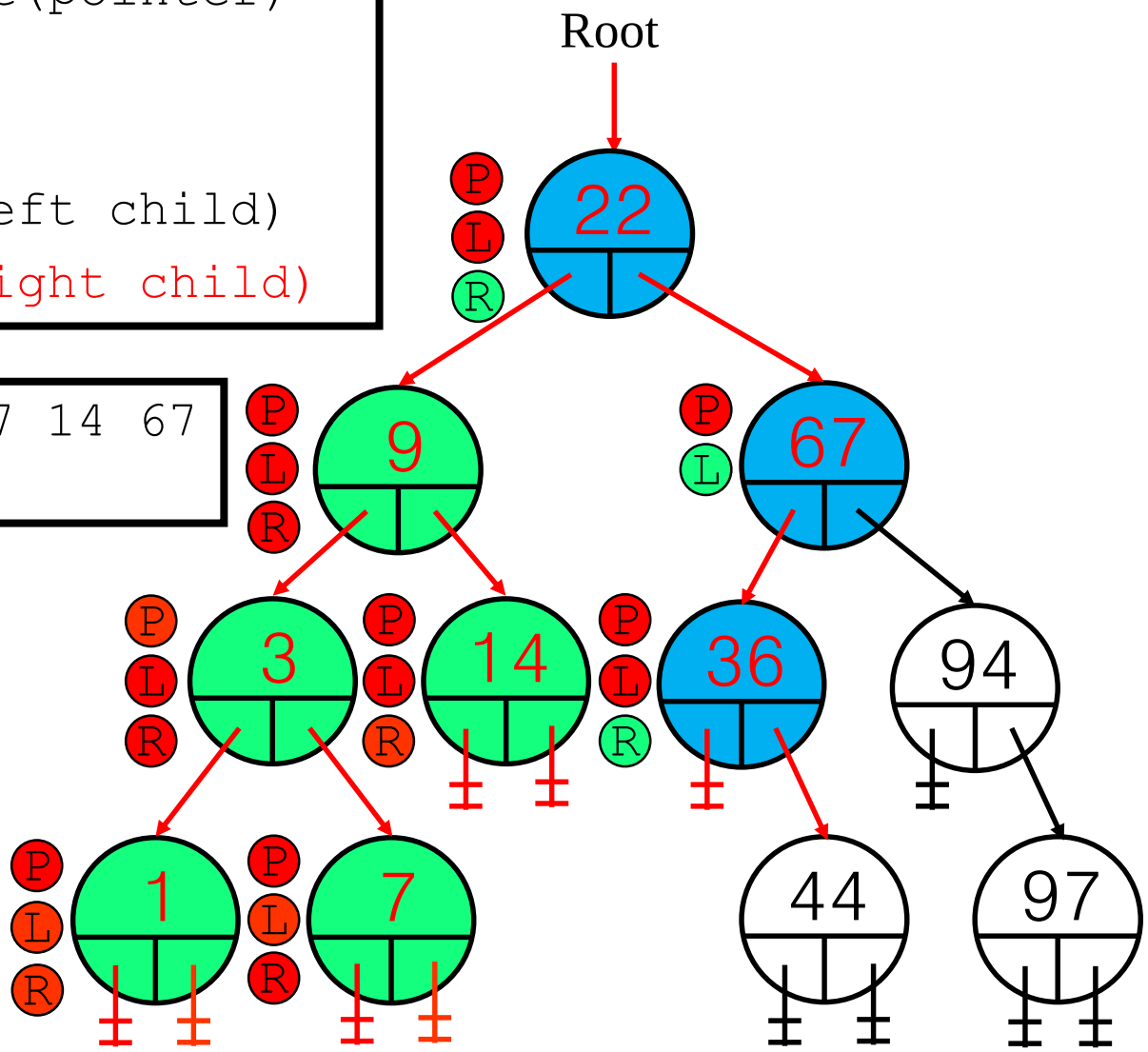
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36
```



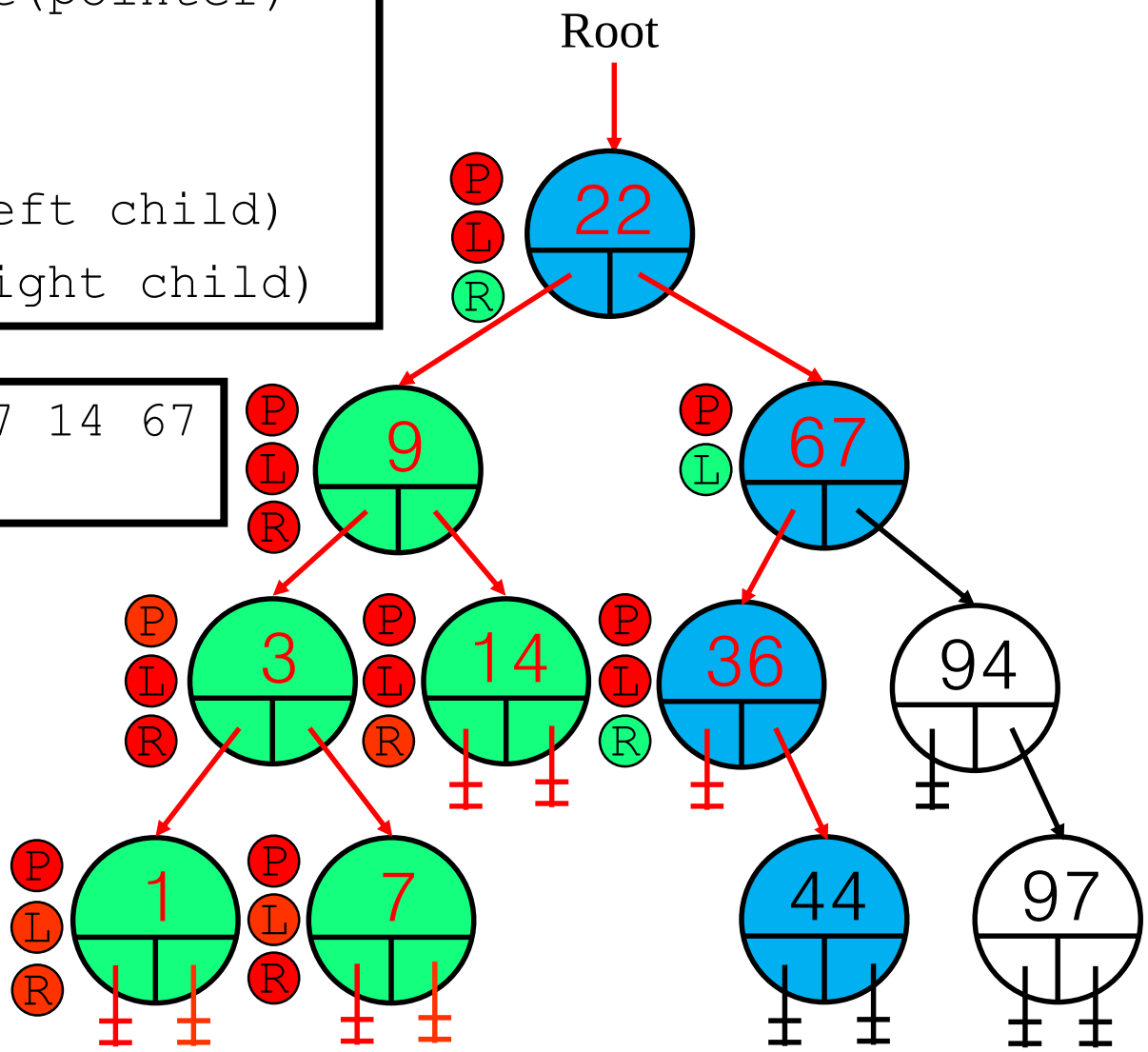
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36
```



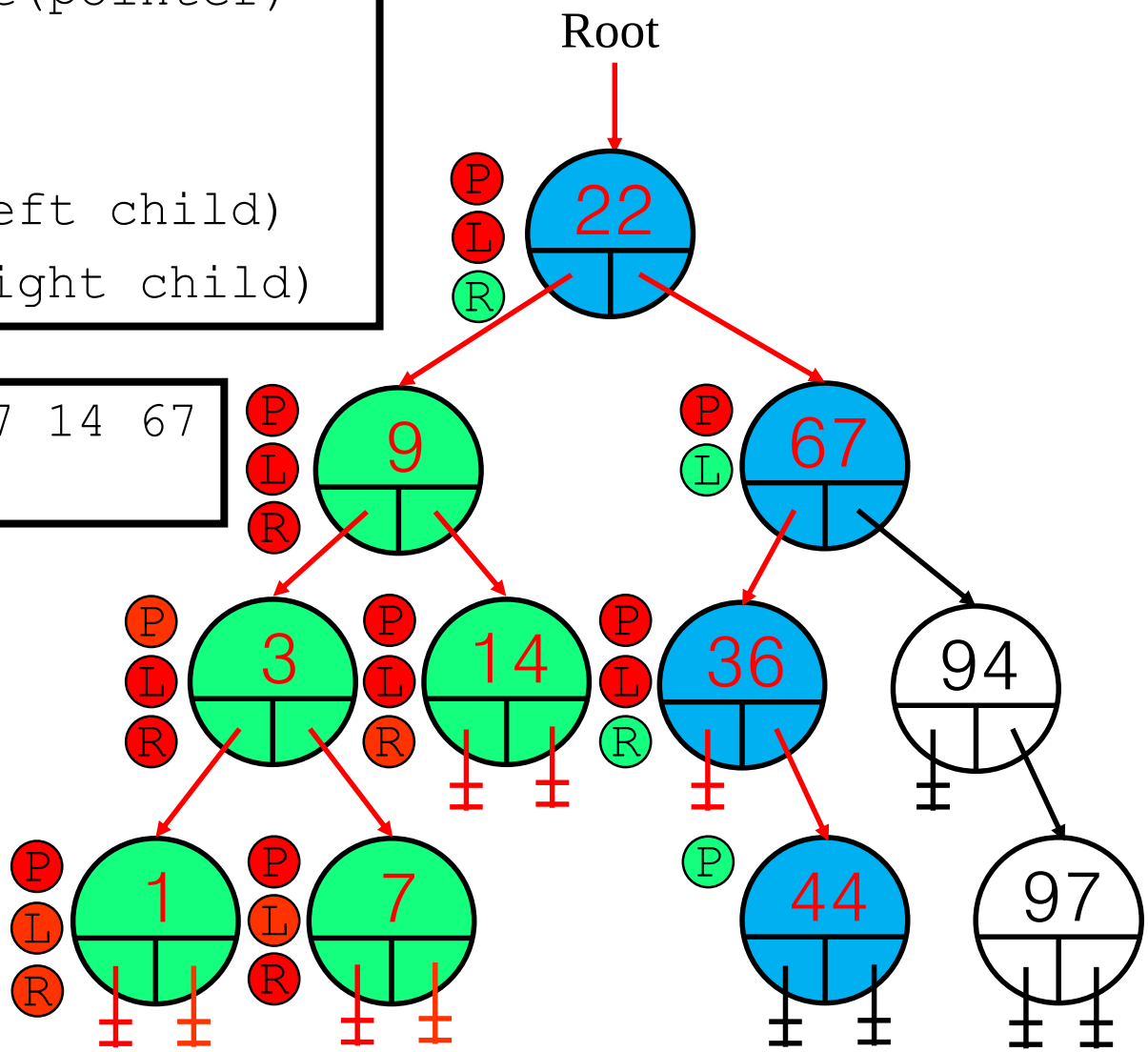
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36
```



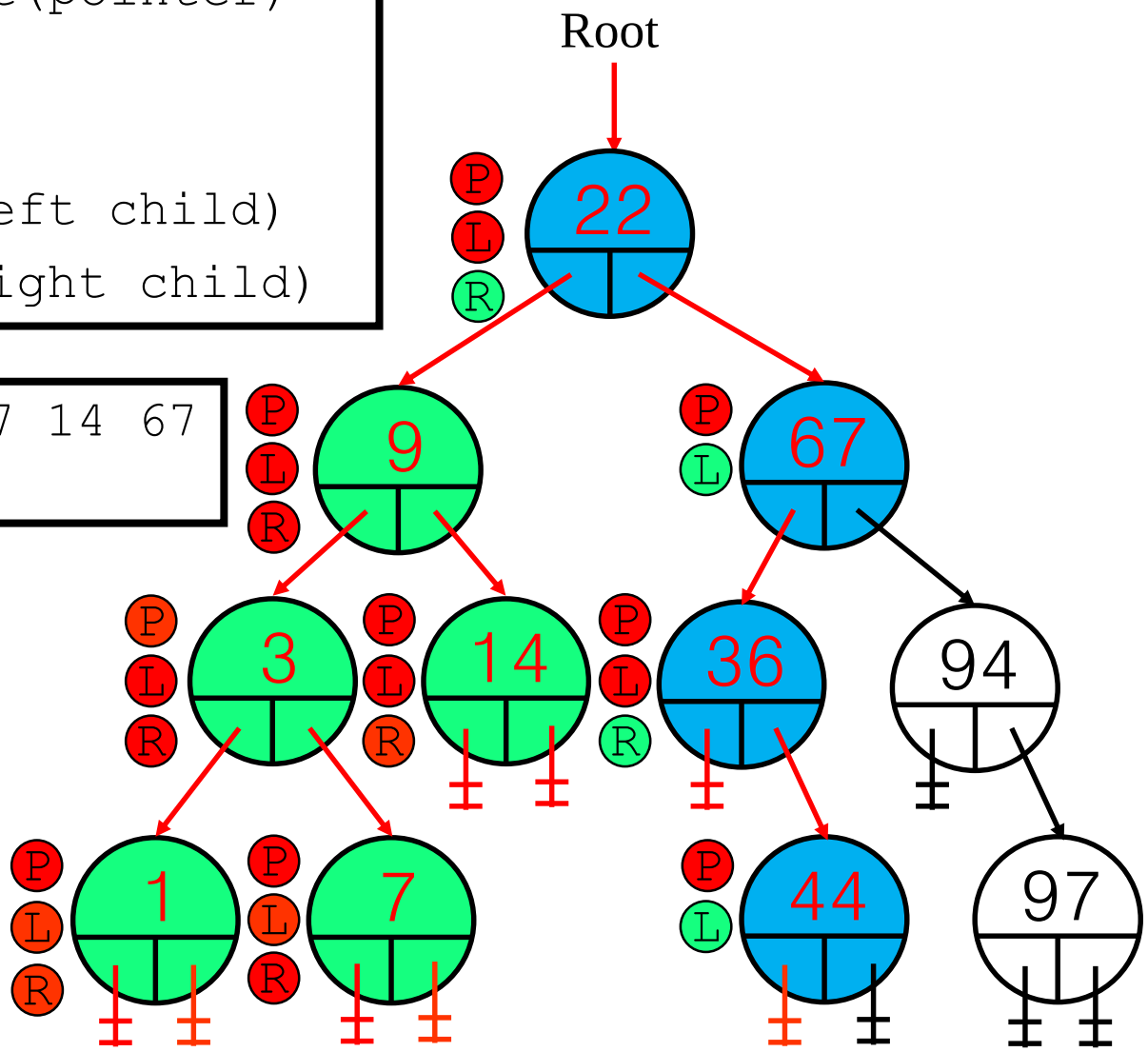
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



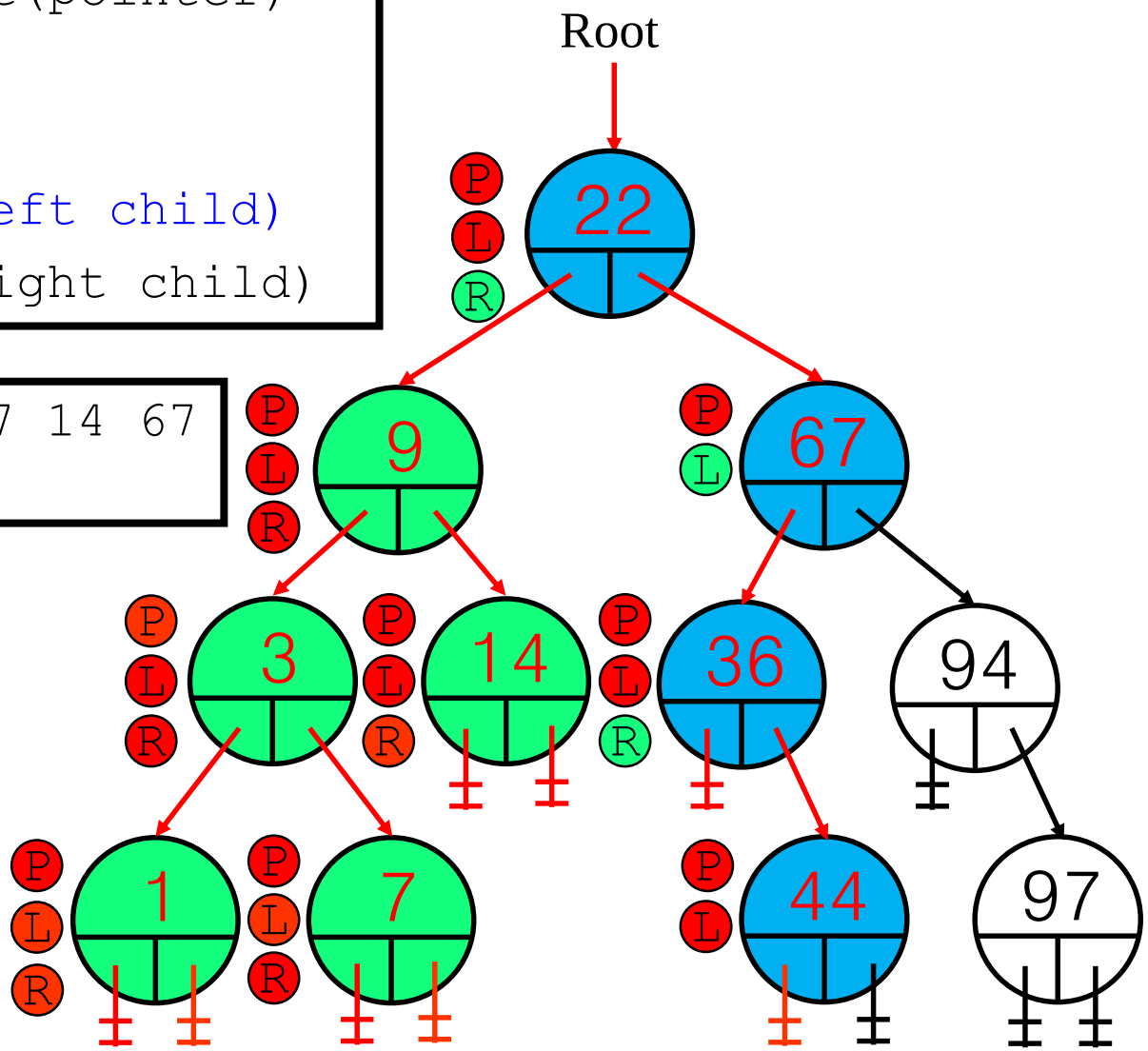
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



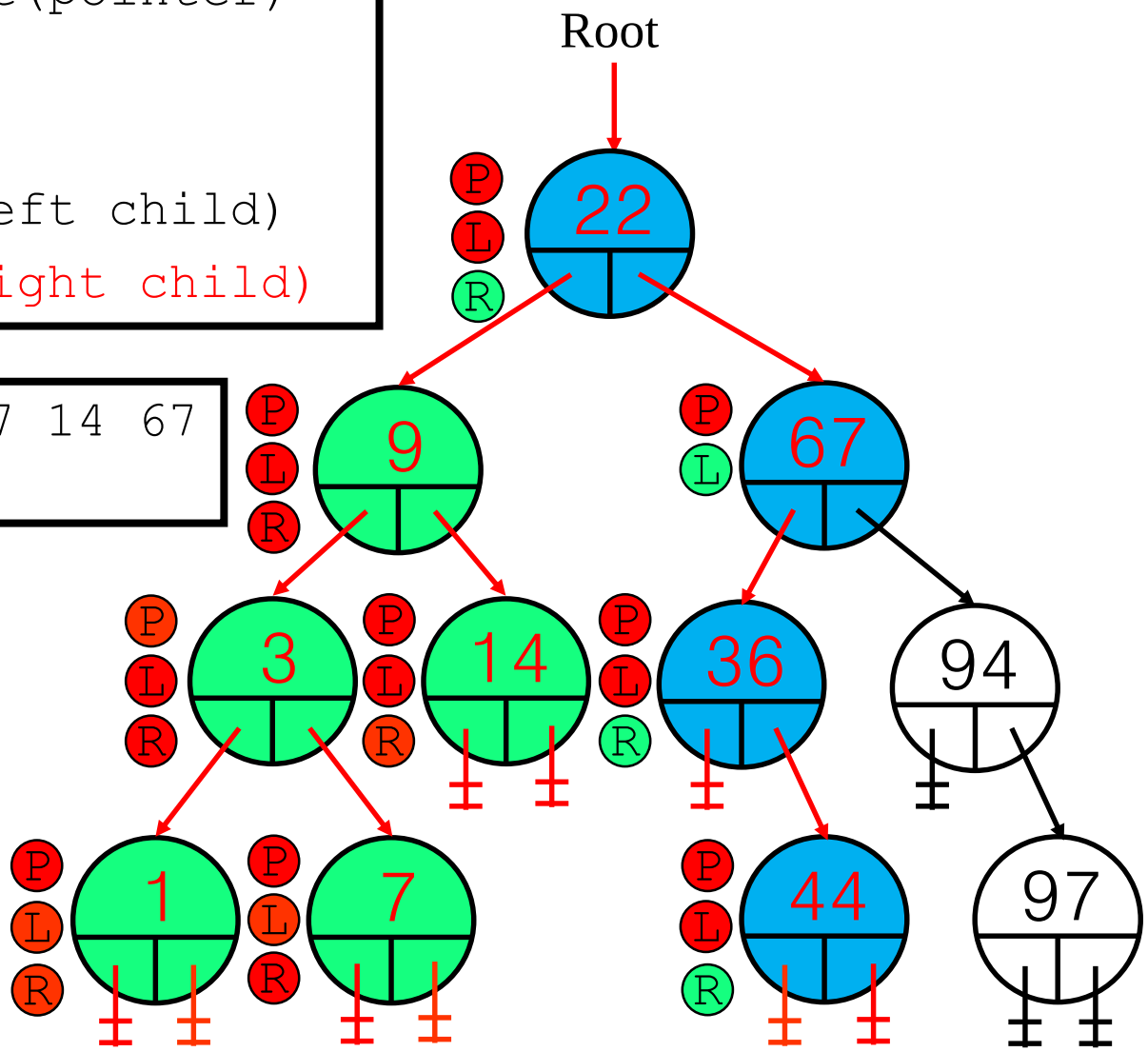
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



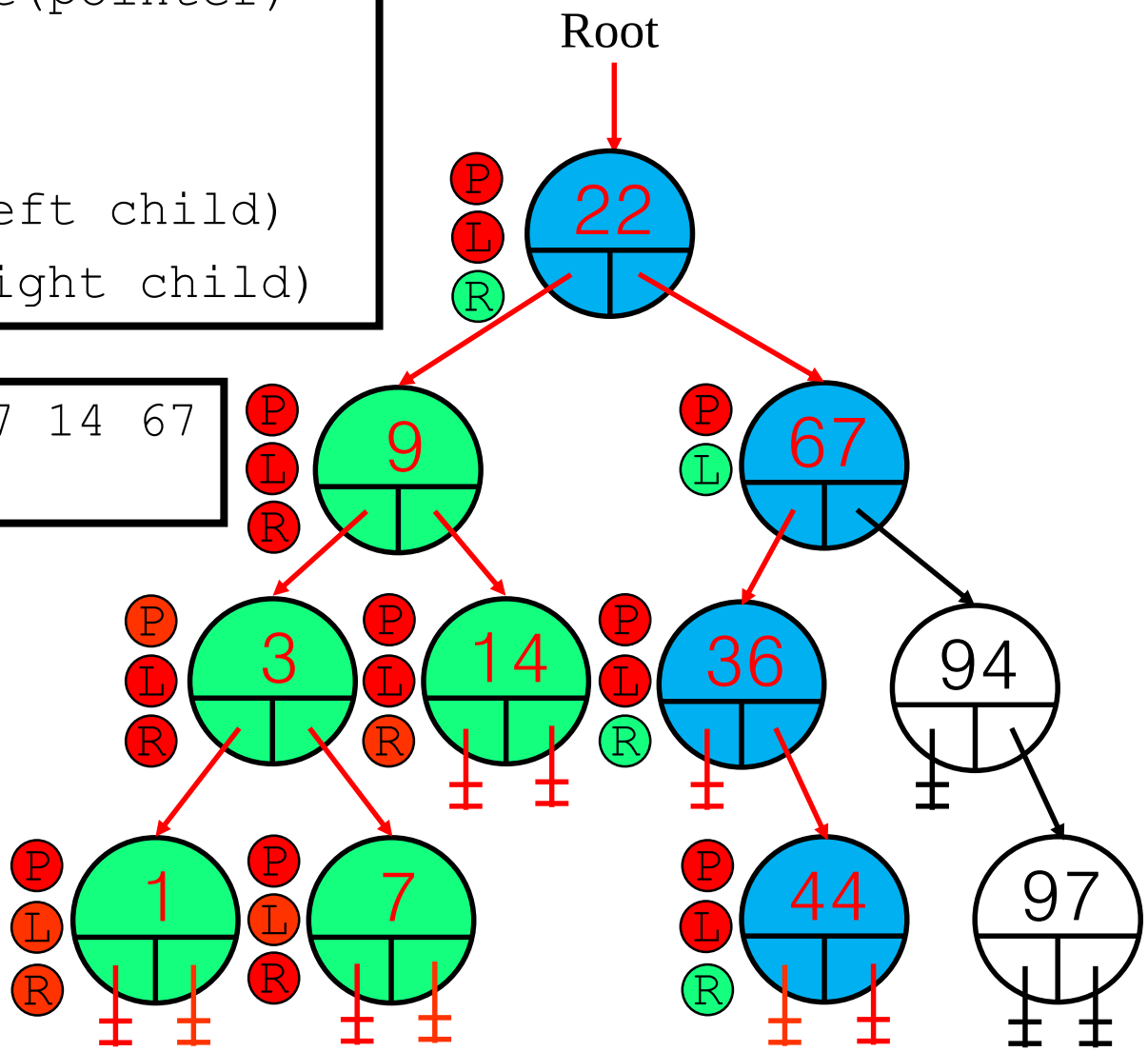
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



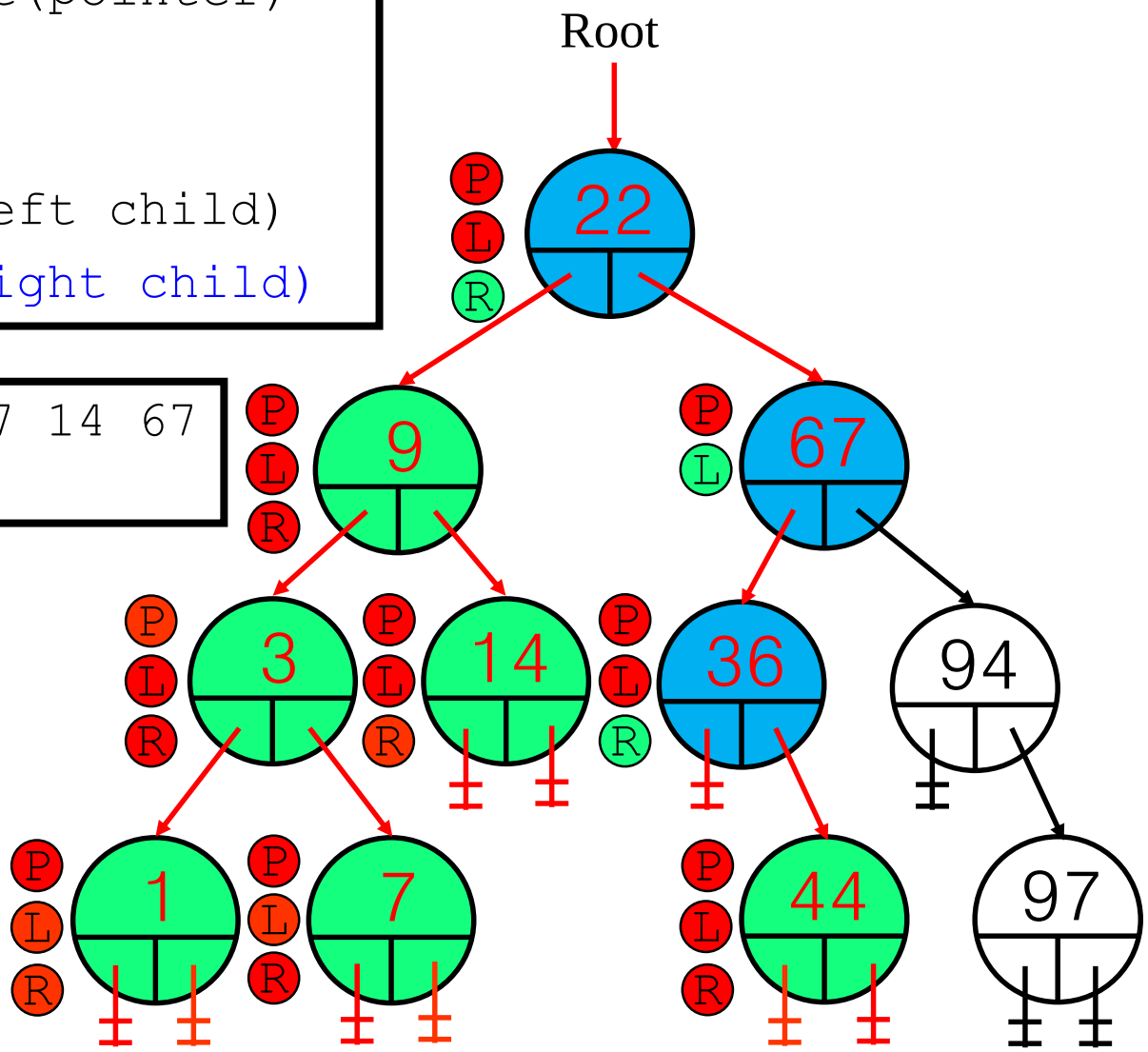
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



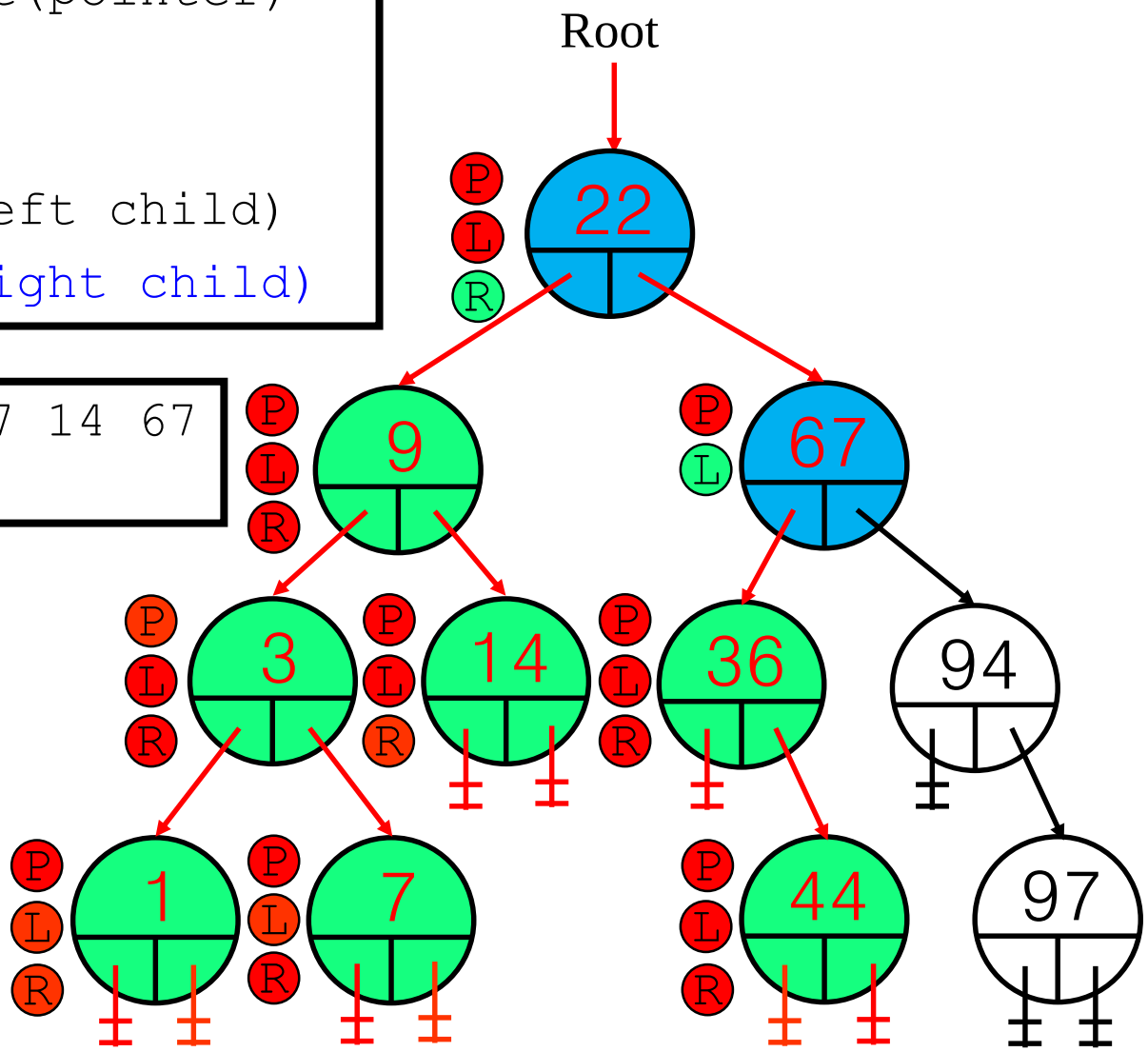
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



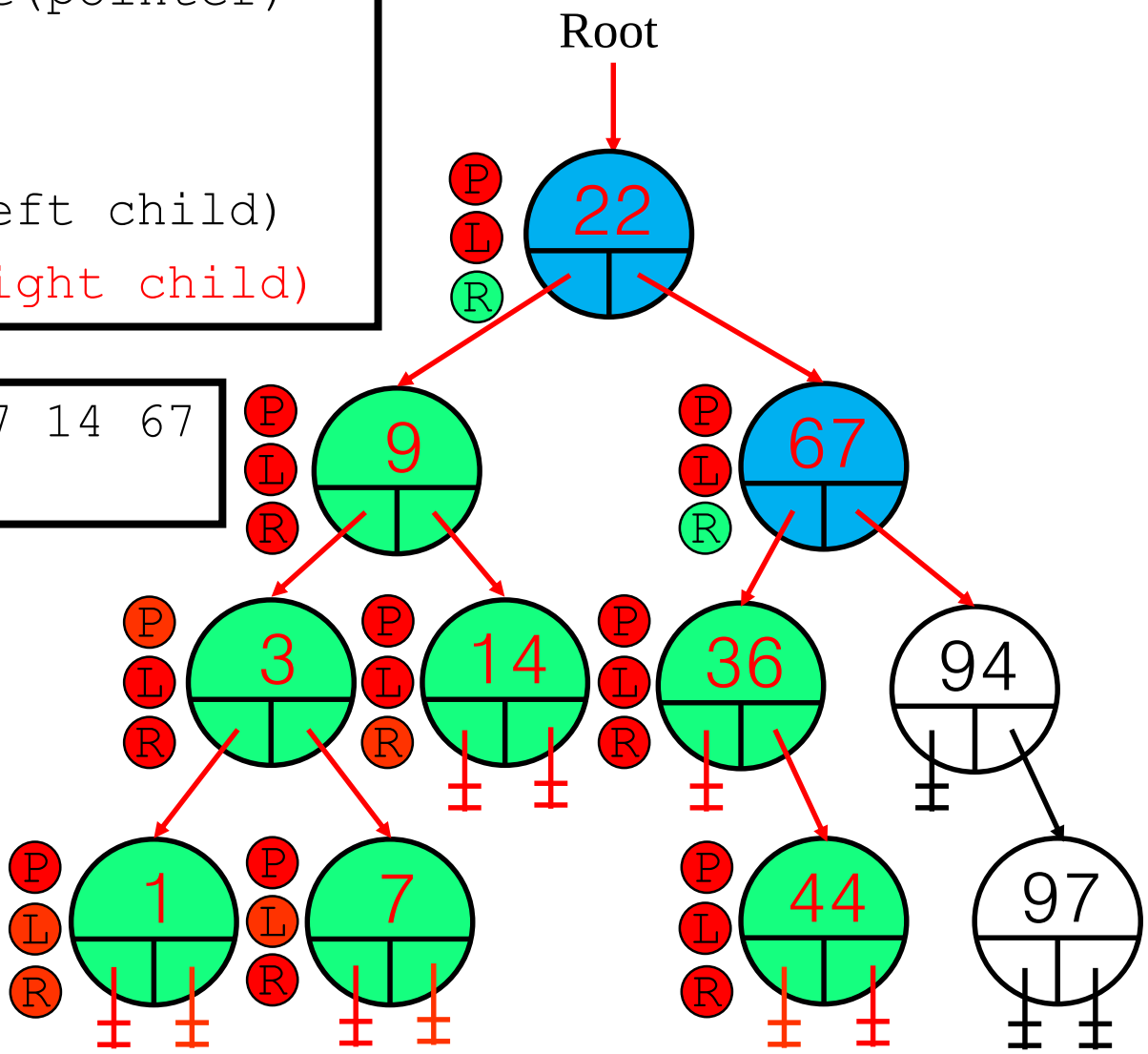
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



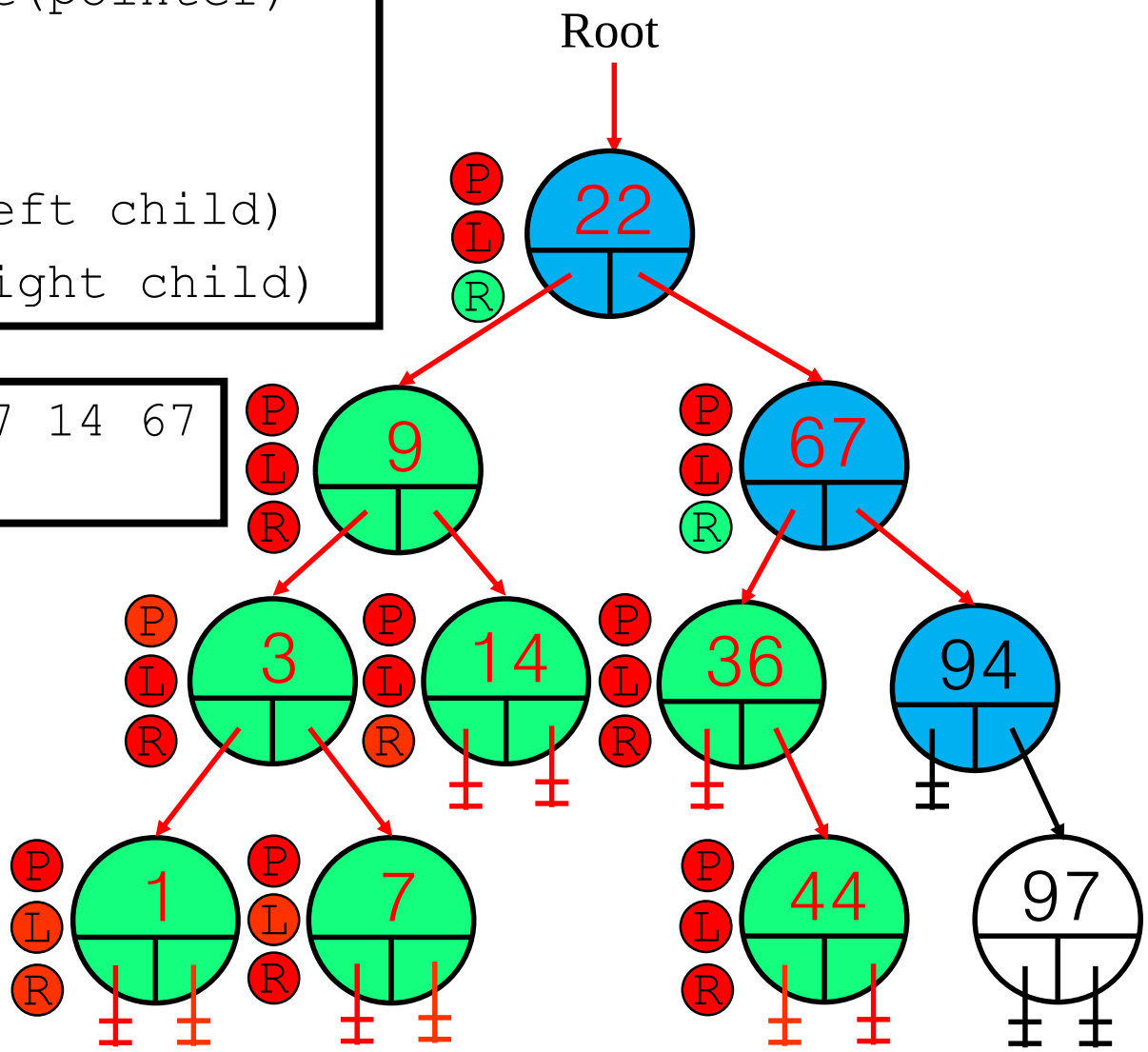
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



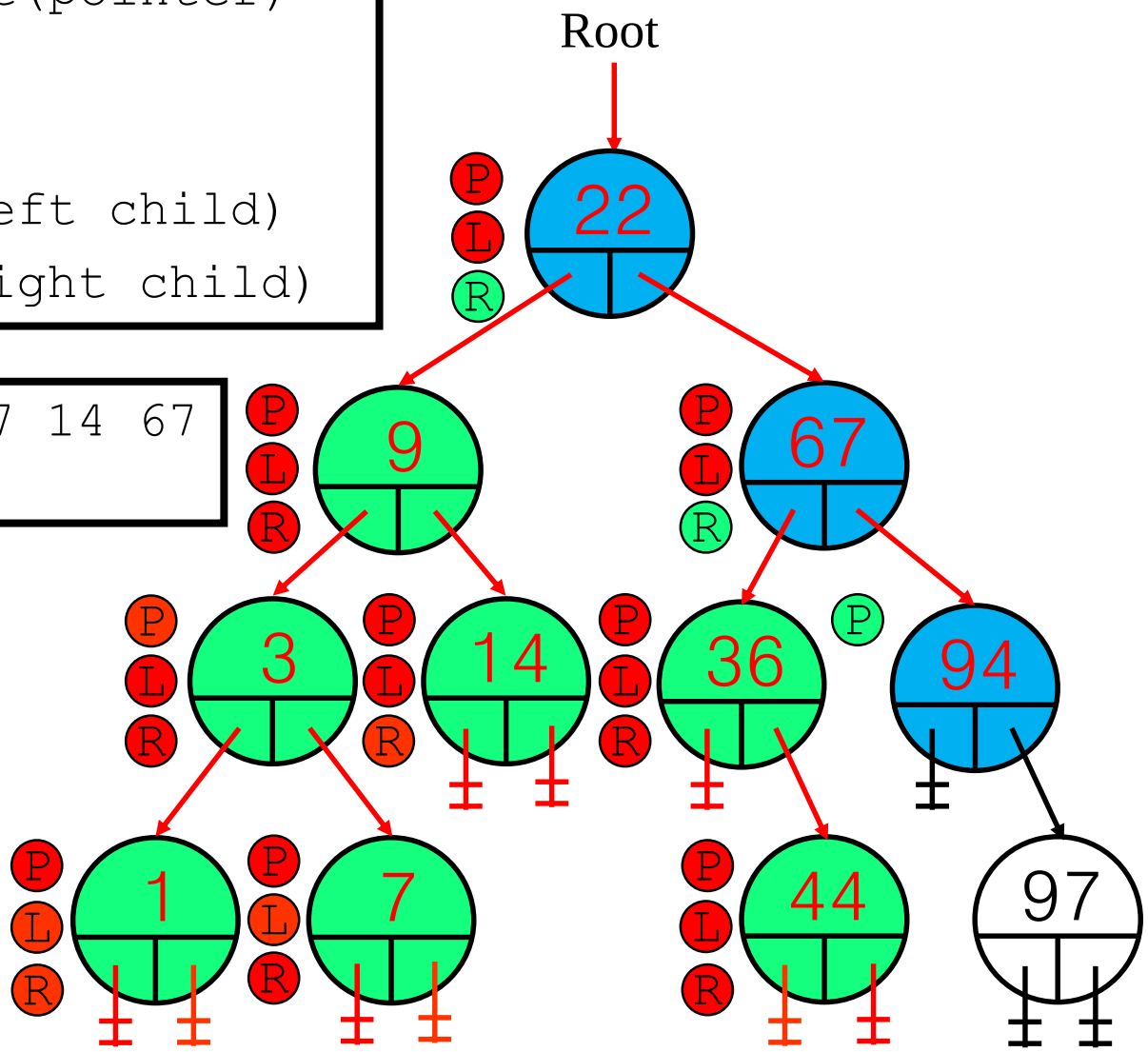
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44
```



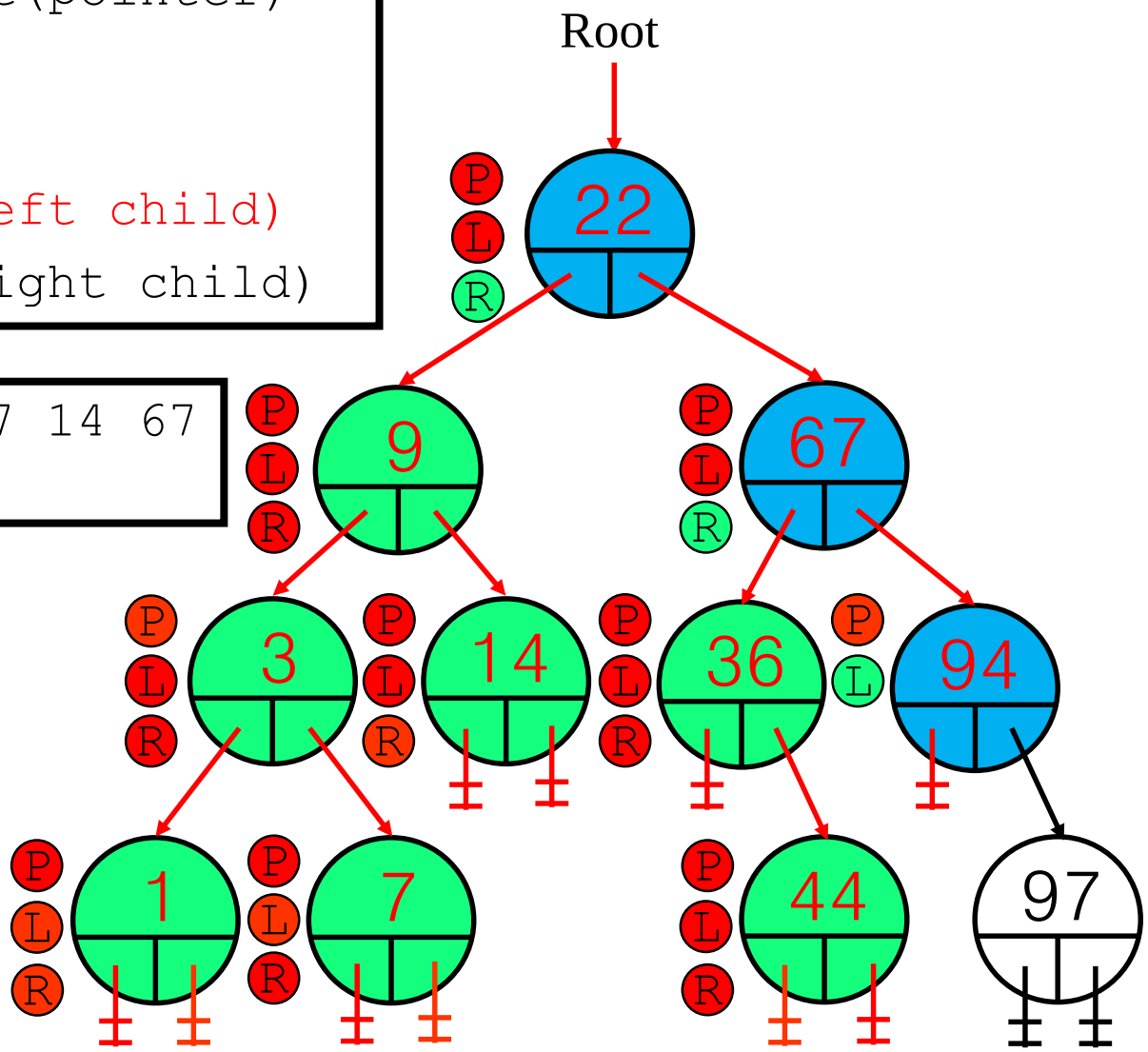
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94
```



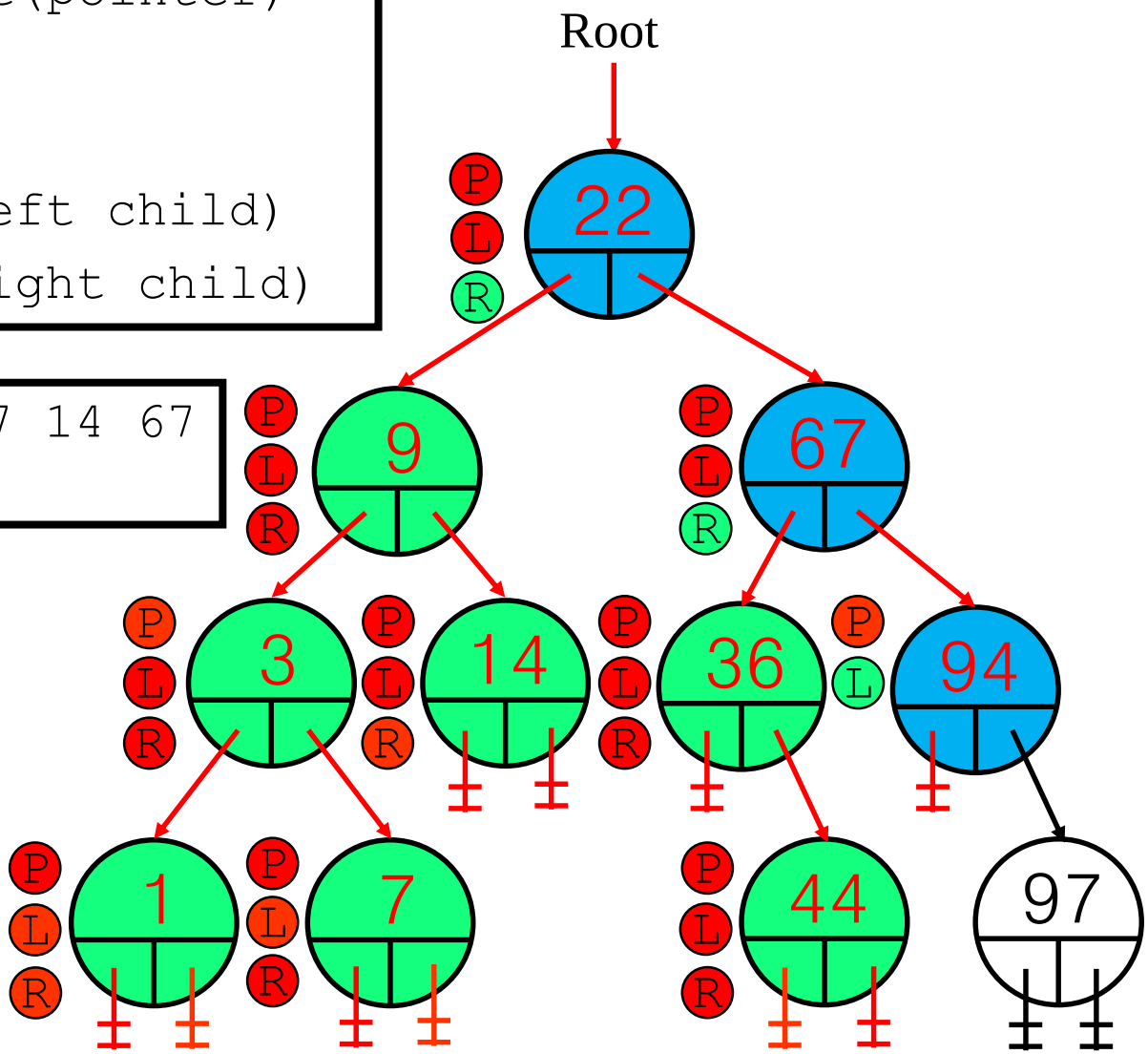
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94
```



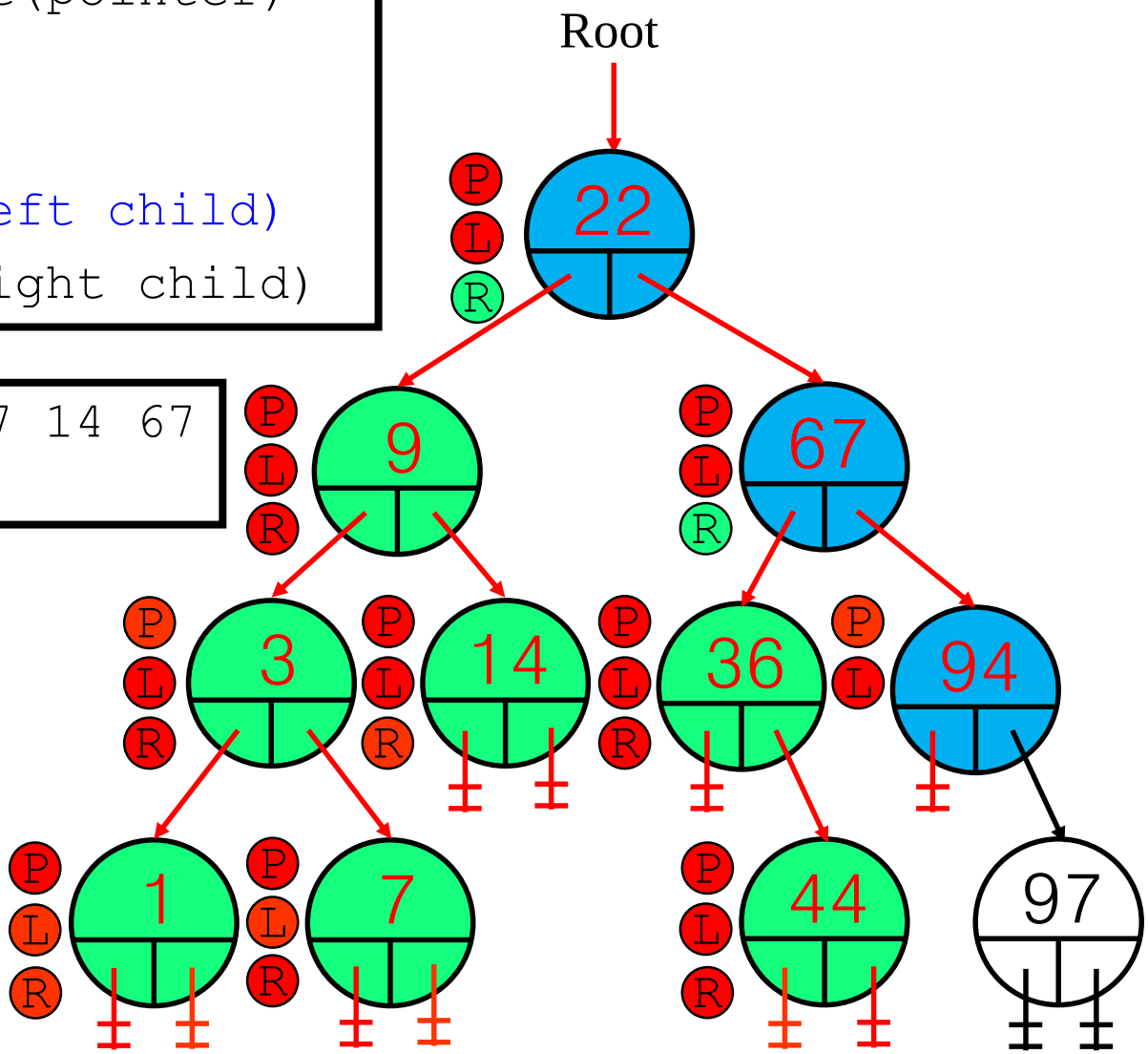
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94
```



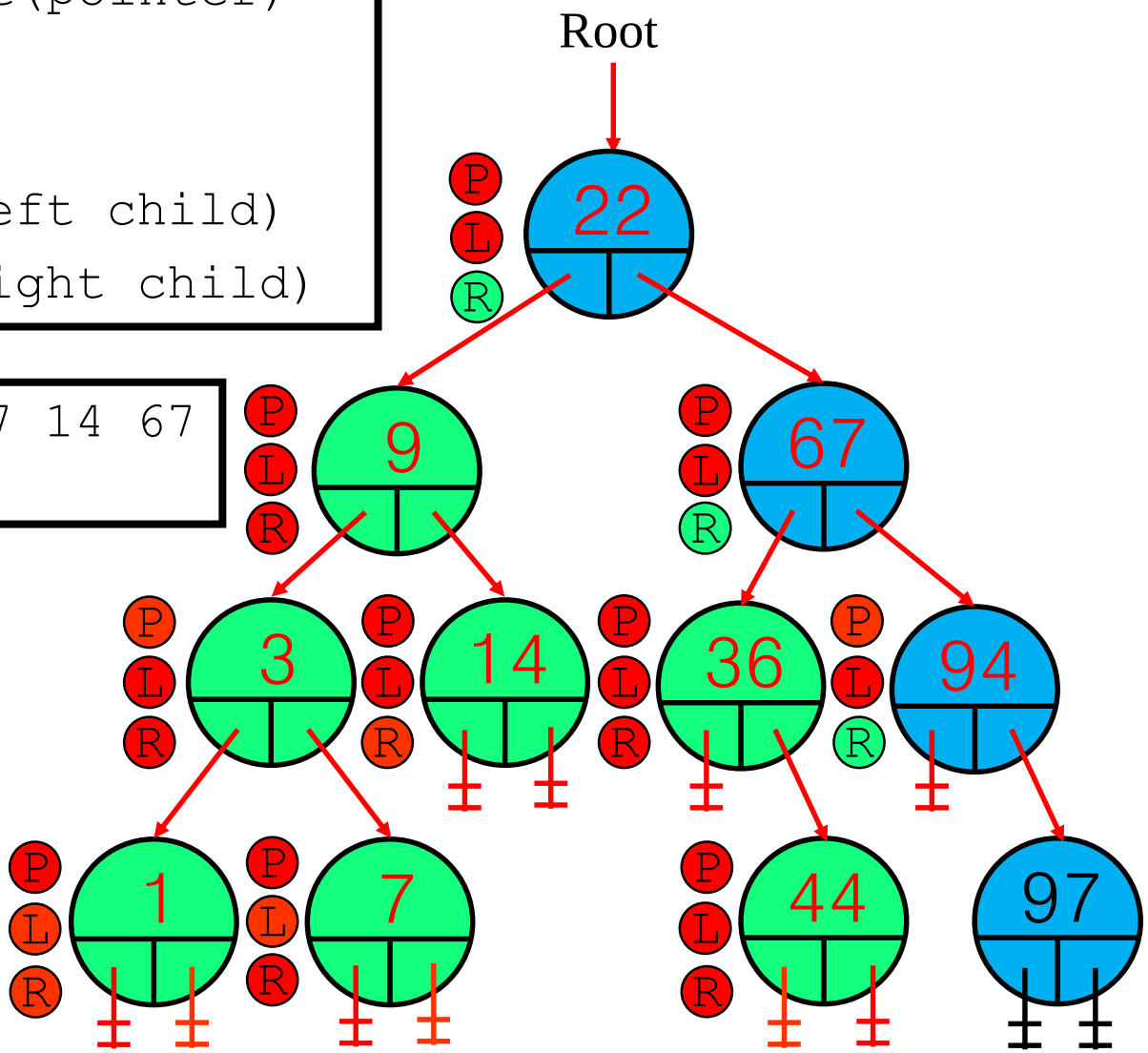
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94
```



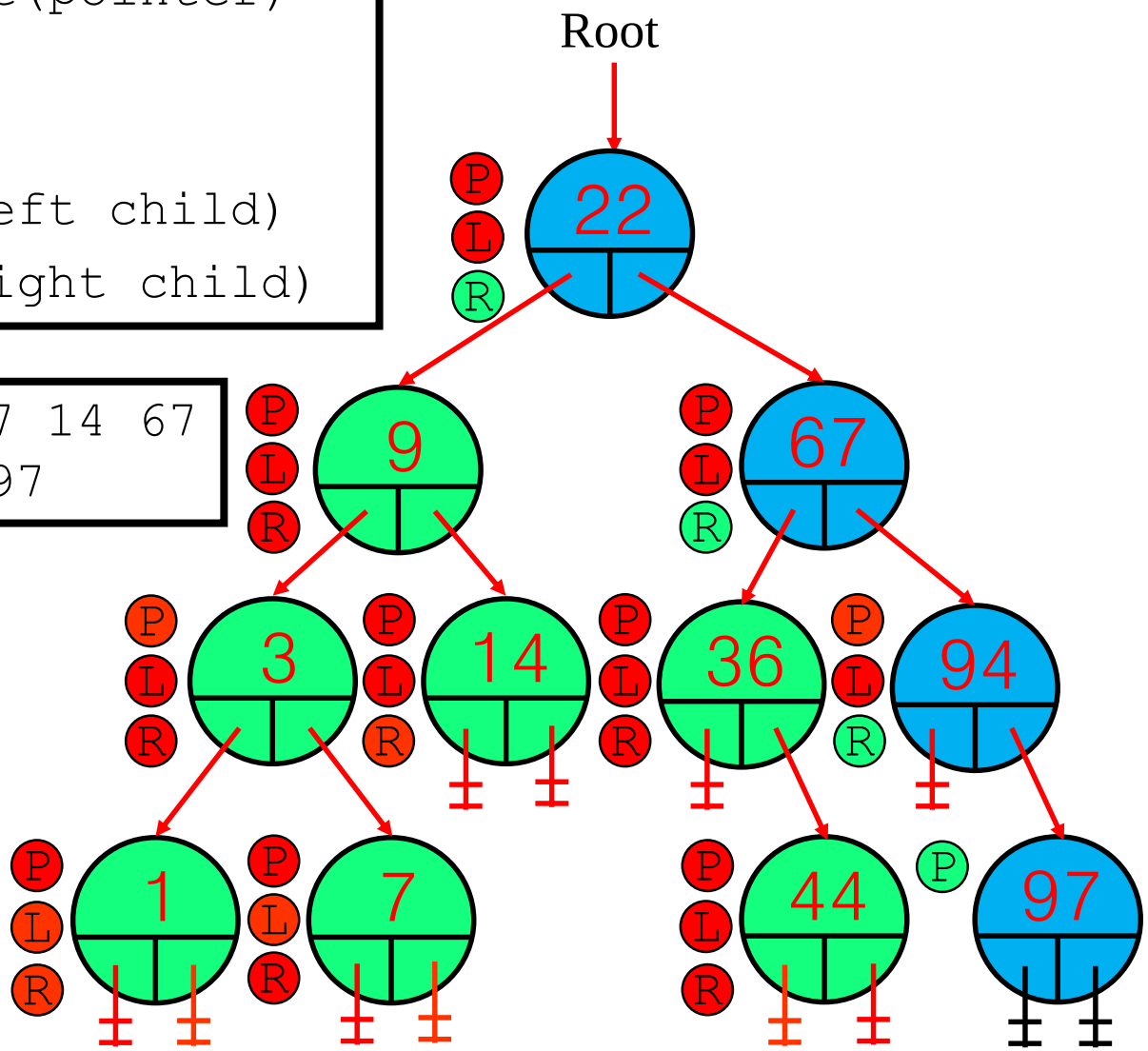
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94
```



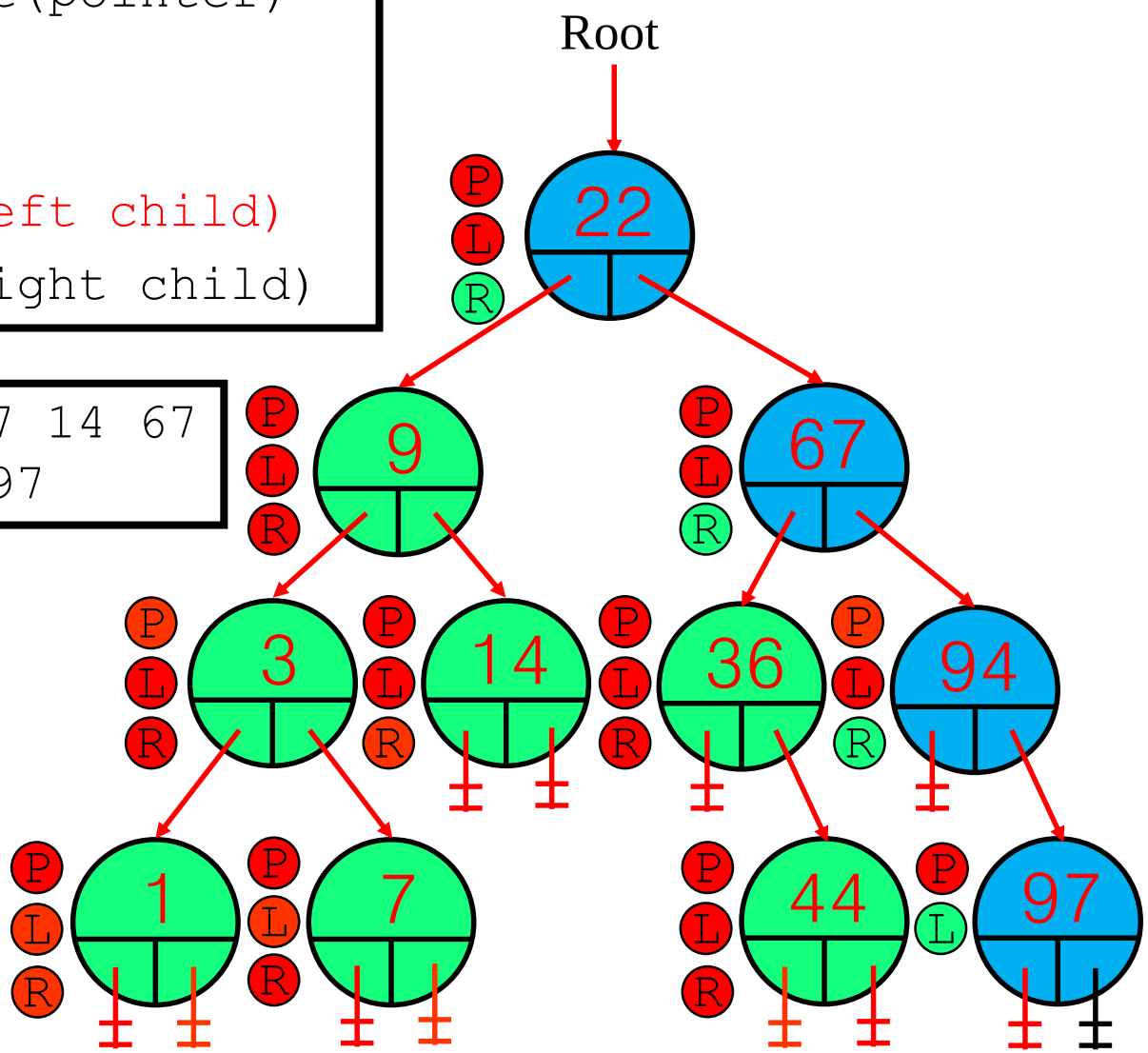
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94 97
```



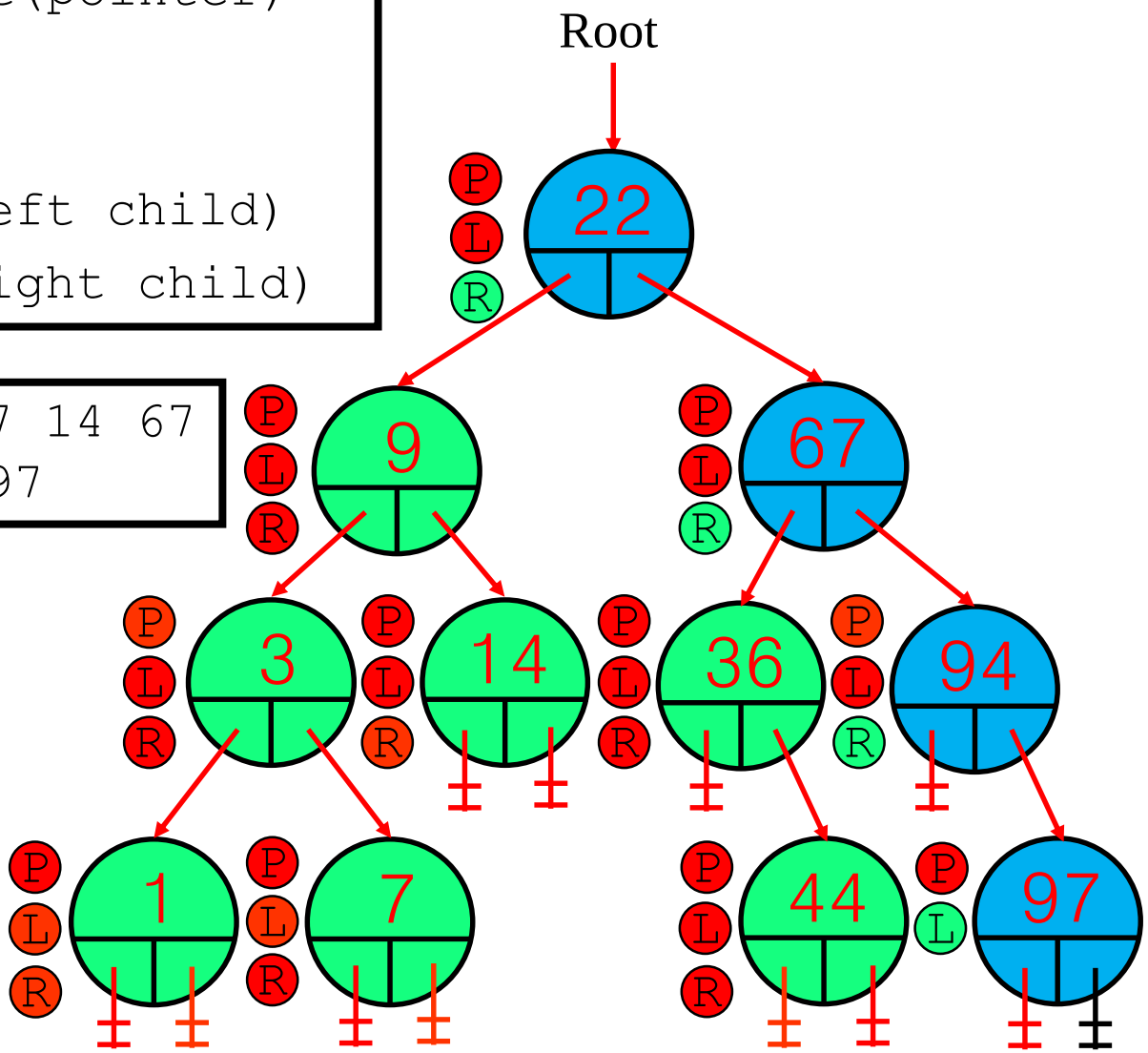
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22  9  3  1  7  14  67
        36  44  94  97
```



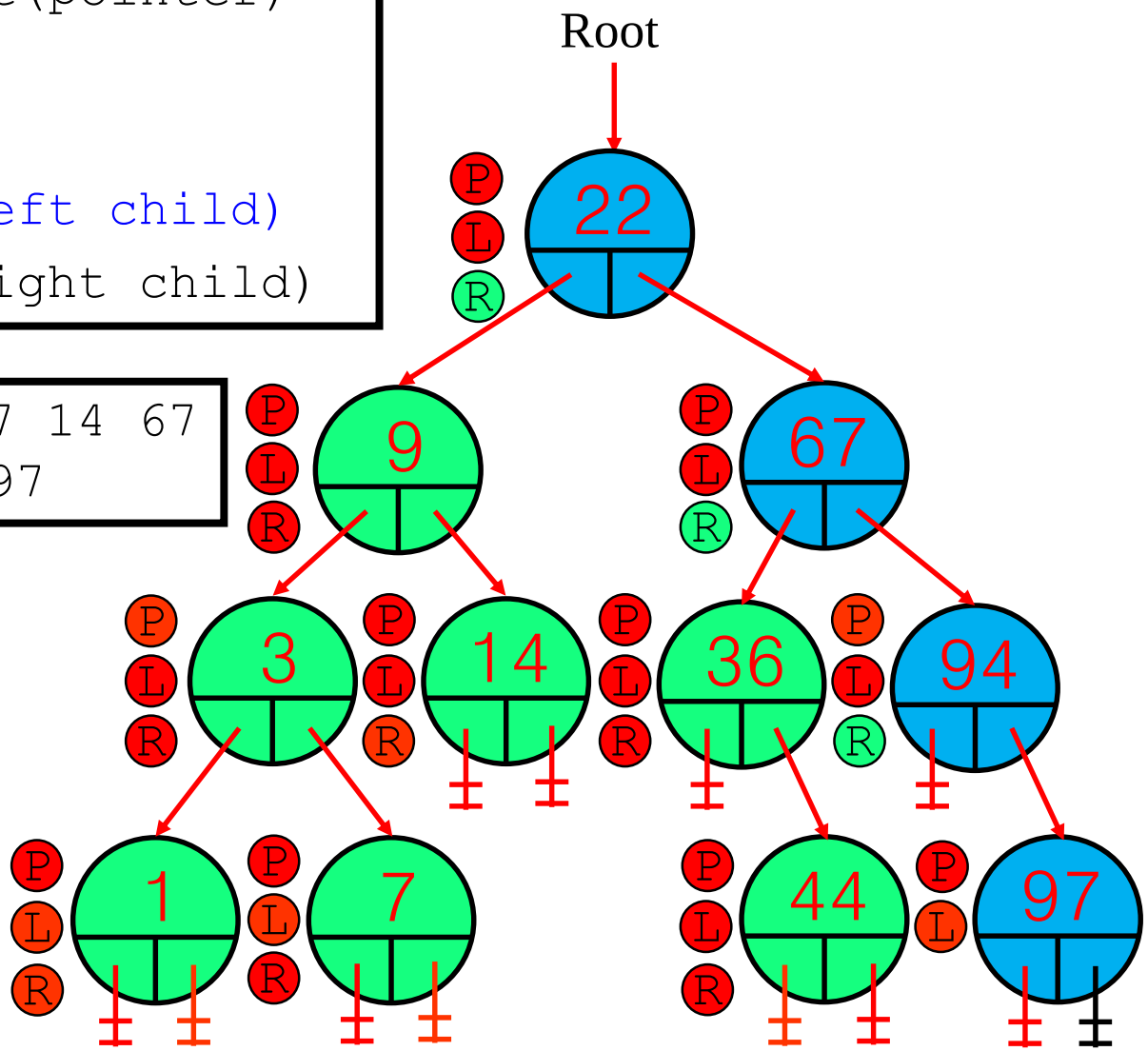
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94 97
```



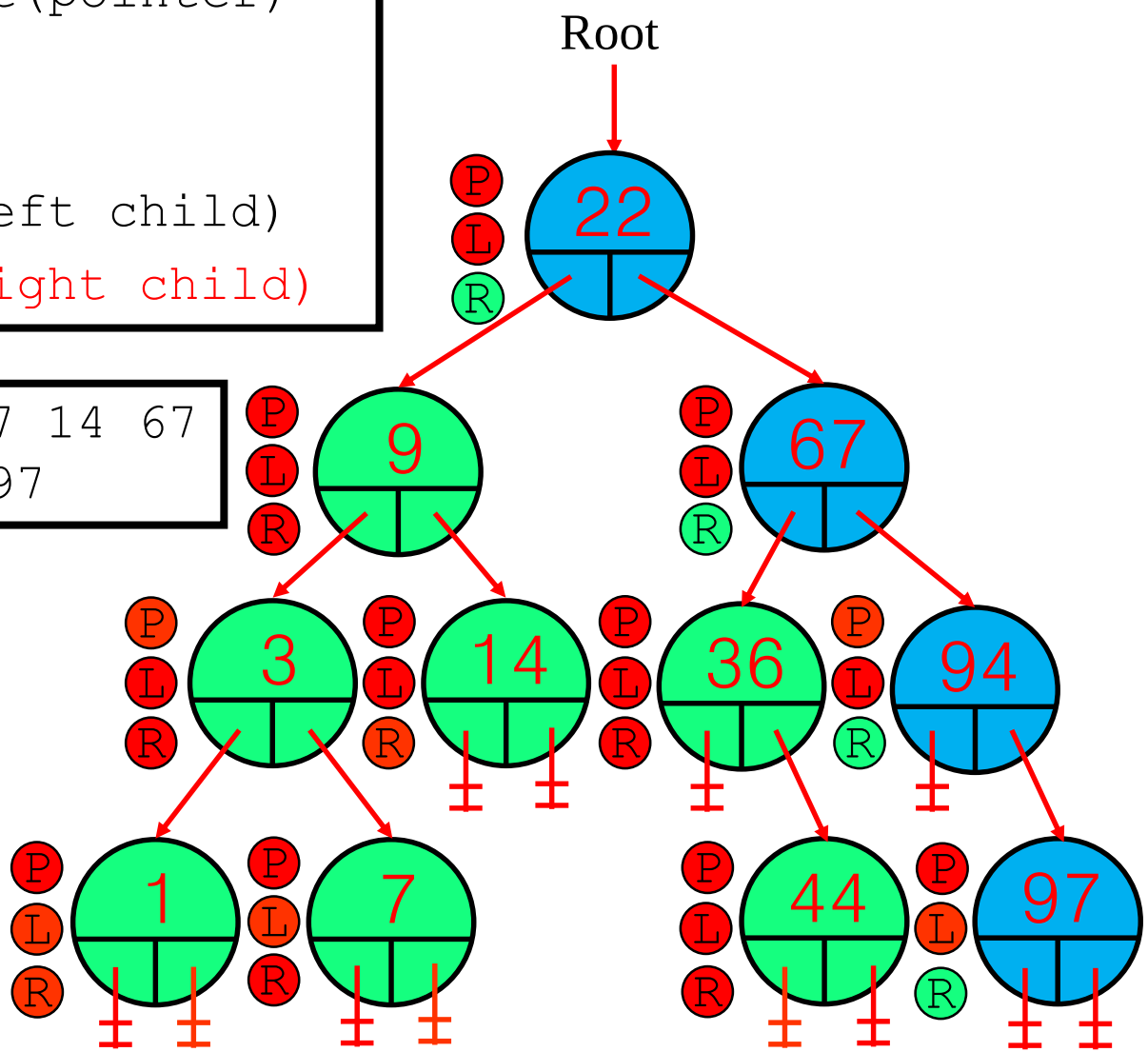
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94 97
```



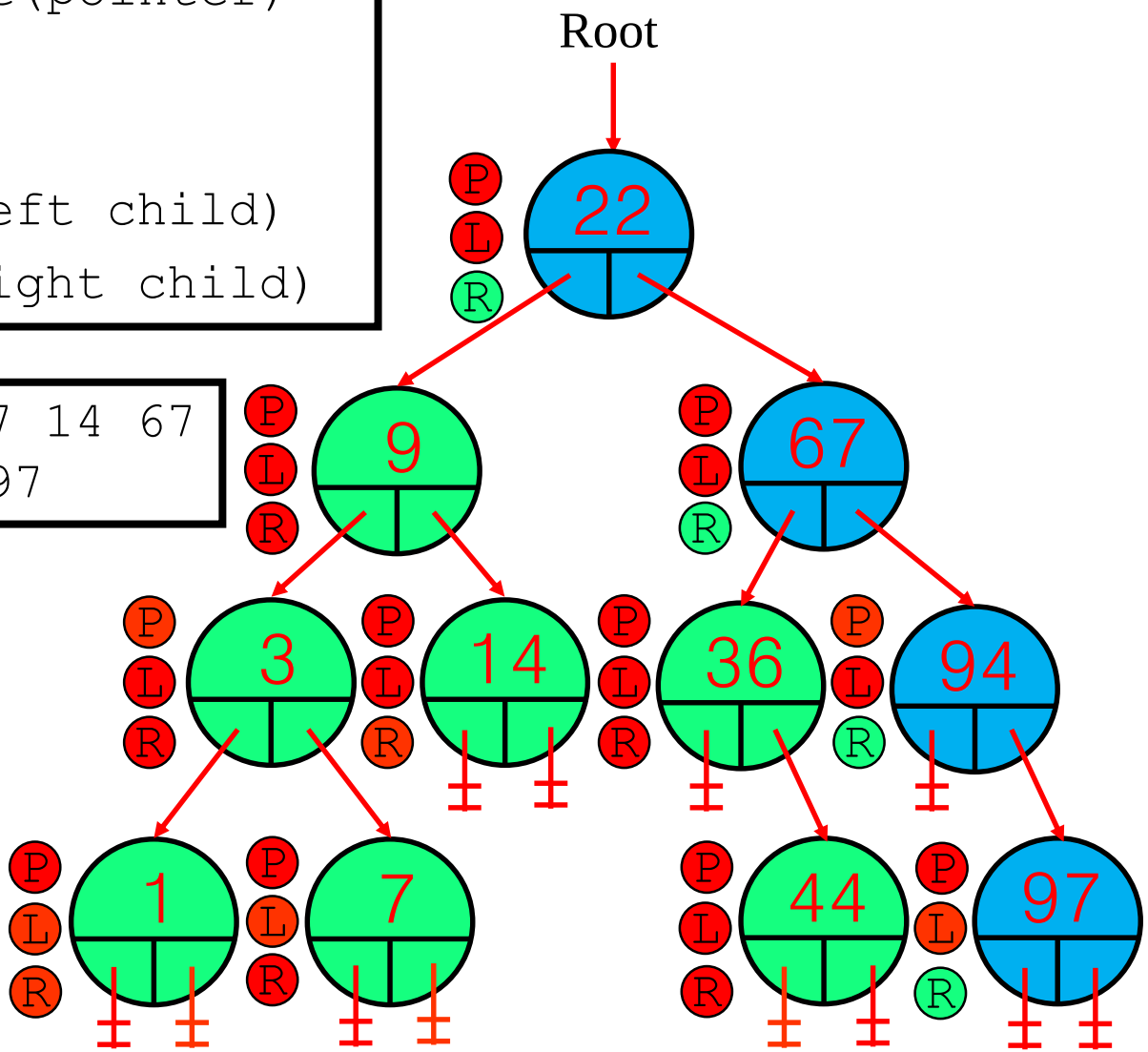
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22  9  3  1  7  14  67
        36  44  94  97
```



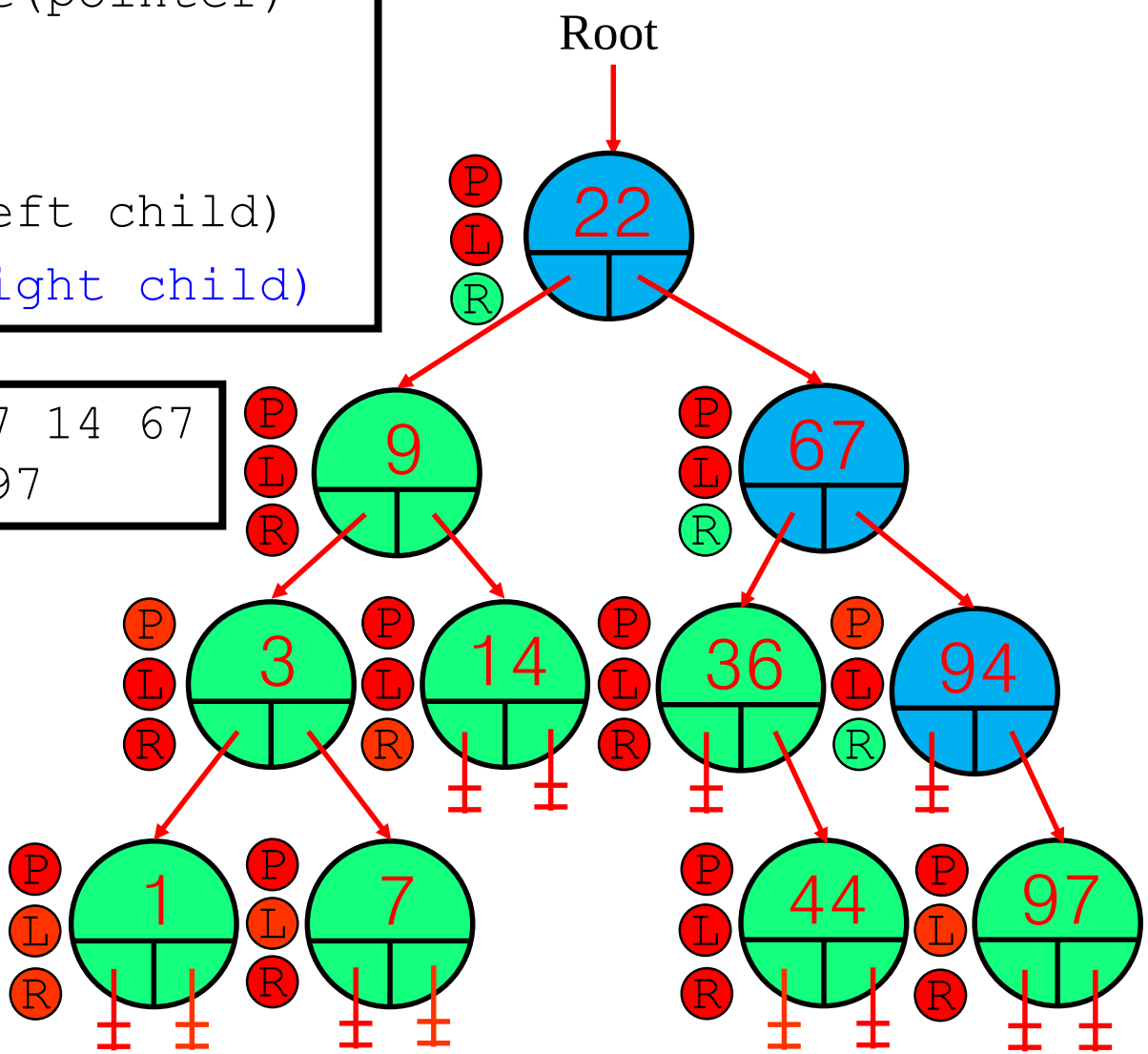
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94 97
```



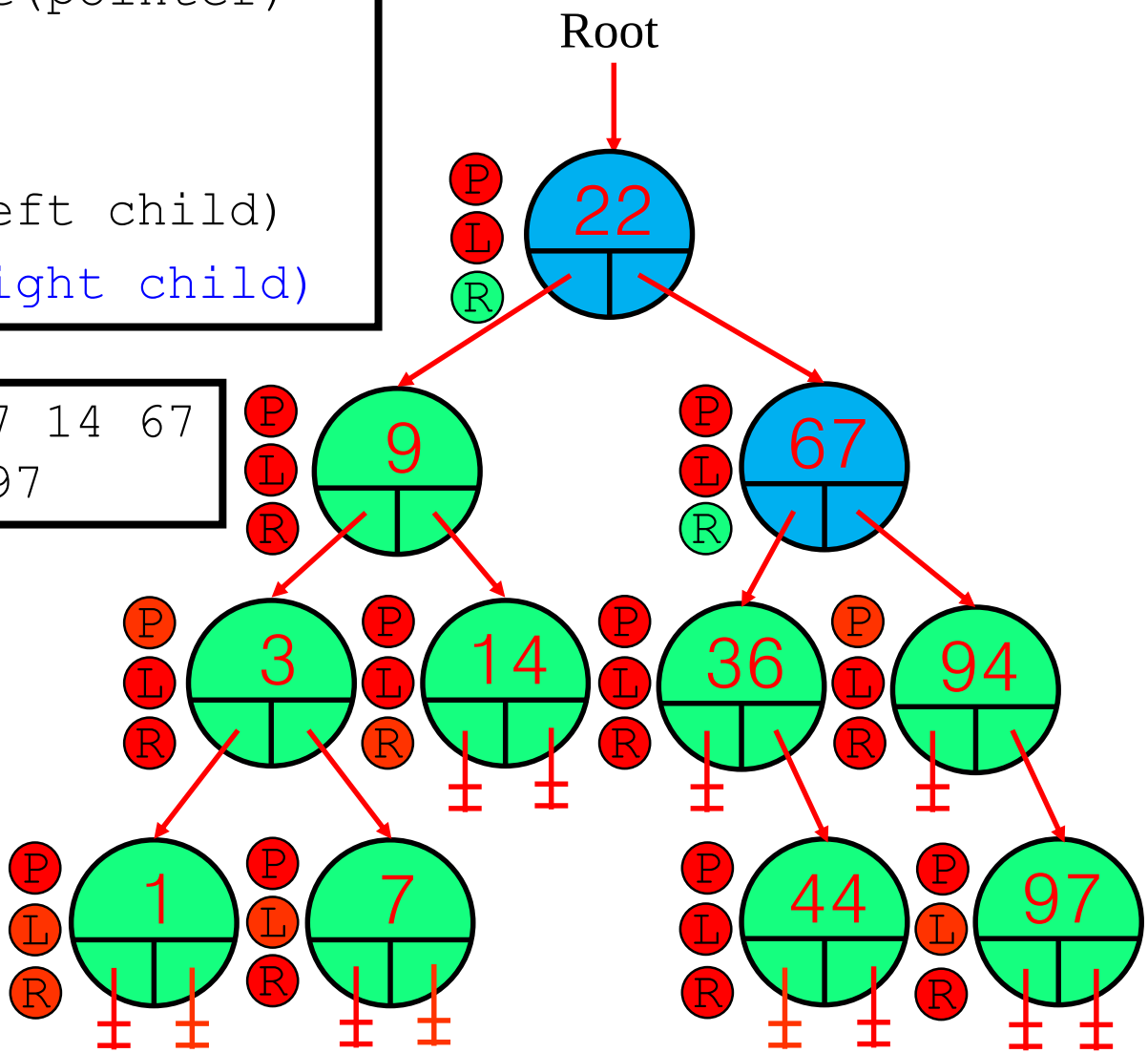
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22  9  3  1  7  14  67
          36  44  94  97
```



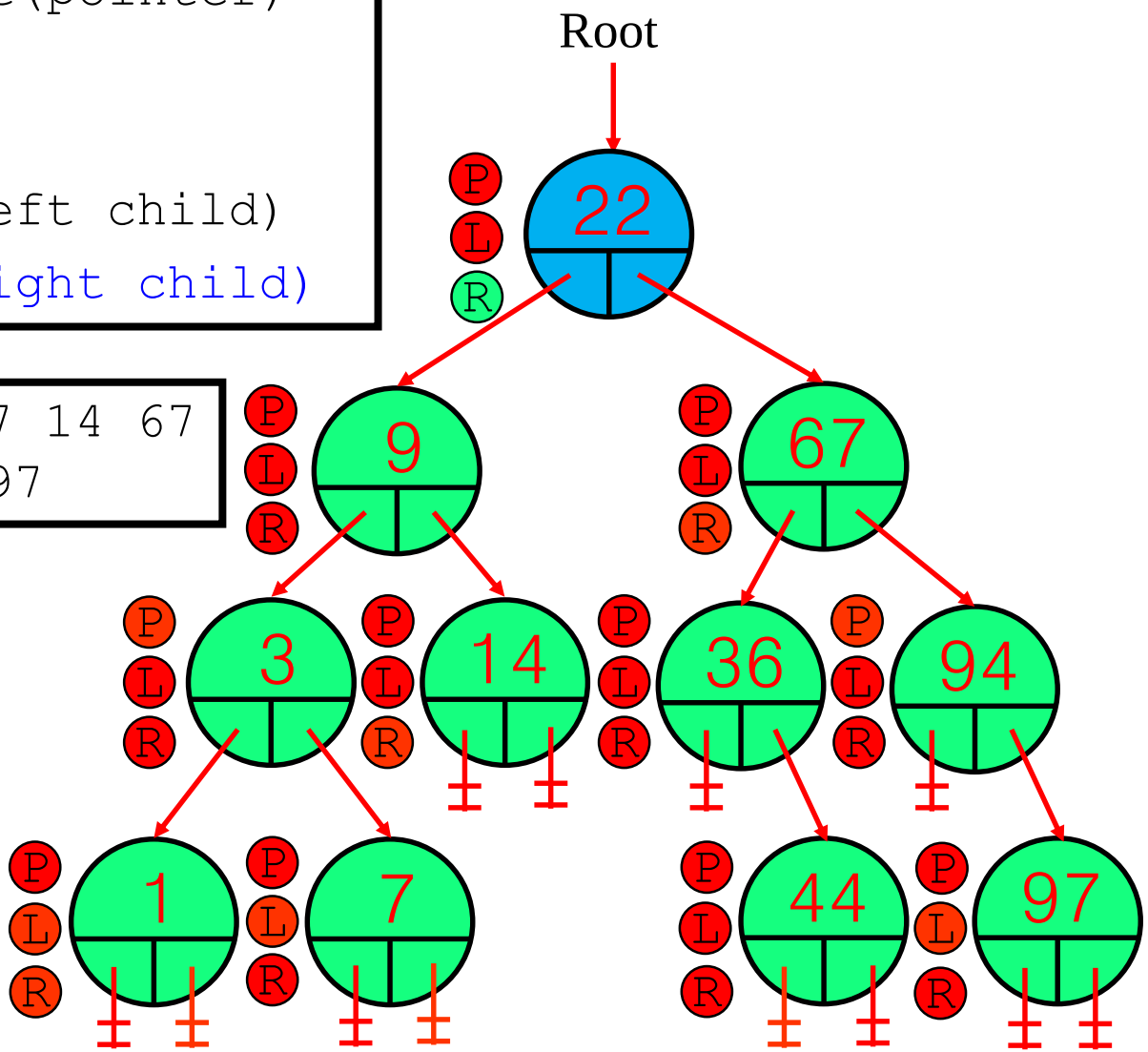
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22  9  3  1  7  14  67
        36  44  94  97
```



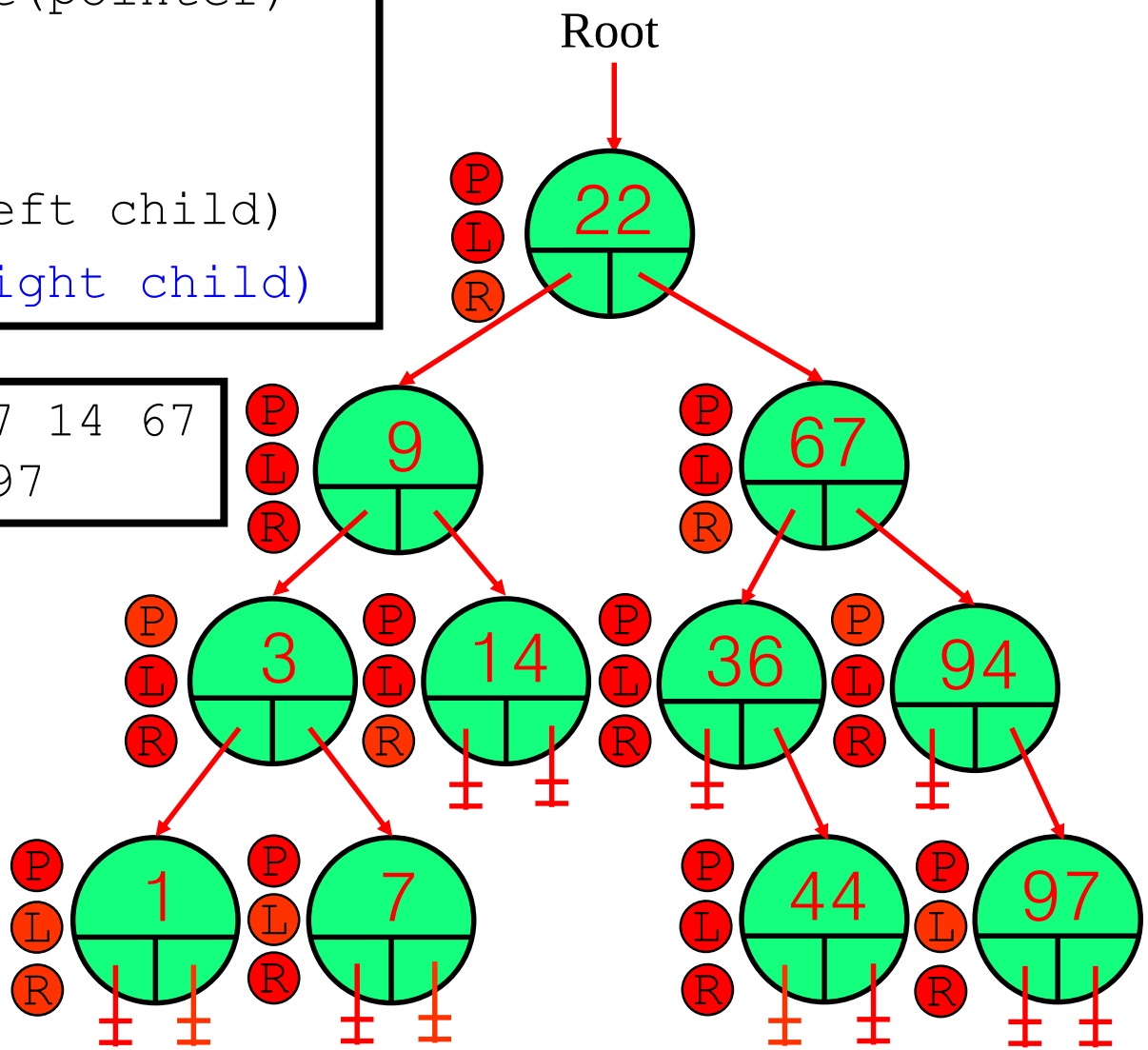
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94 97
```



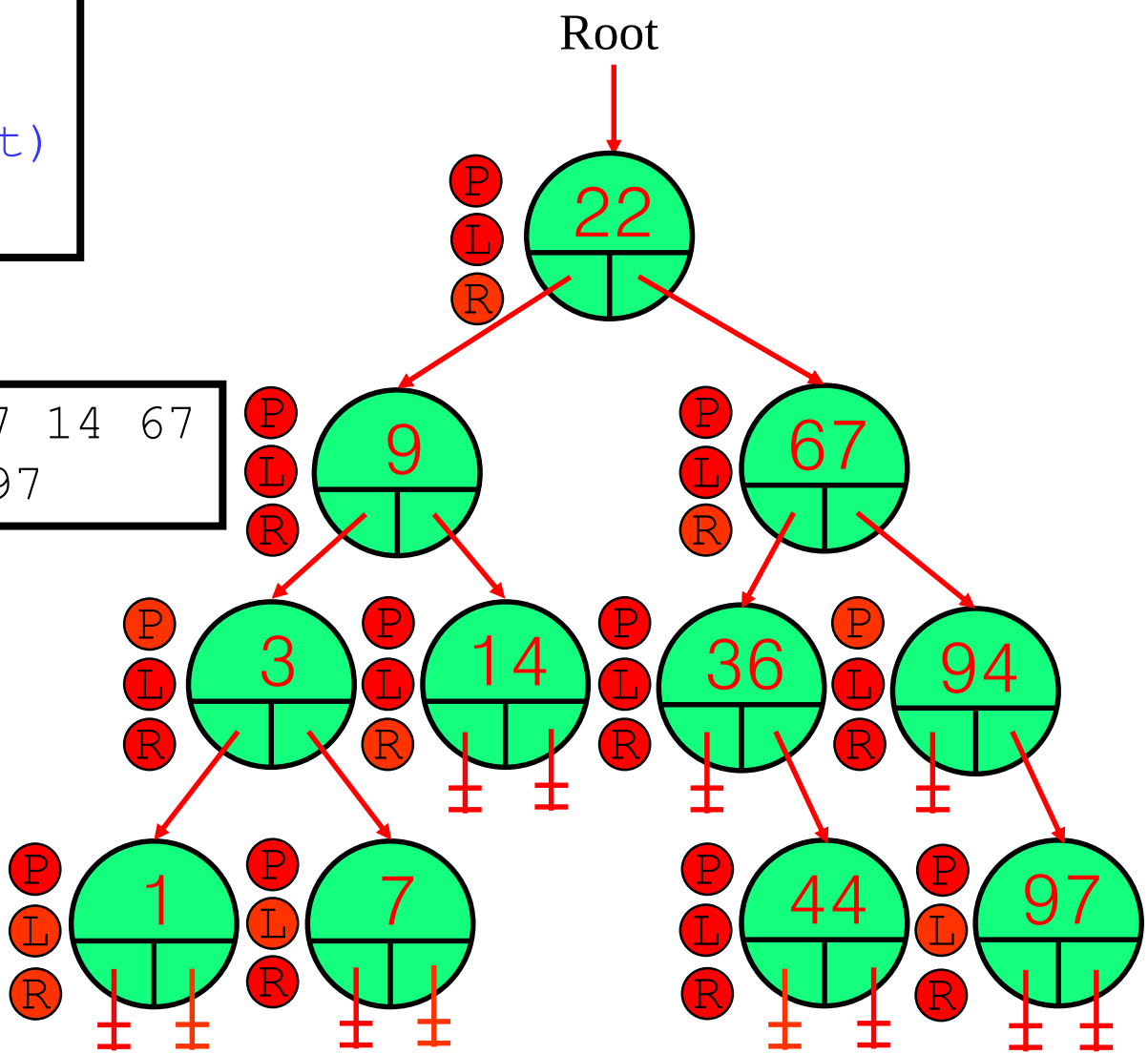
```
Proc PreOrderPrint(pointer)
 pointer NOT NIL?
P print(data)
L PreOrderPrint(left child)
R PreOrderPrint(right child)
```

```
Output: 22 9 3 1 7 14 67
        36 44 94 97
```



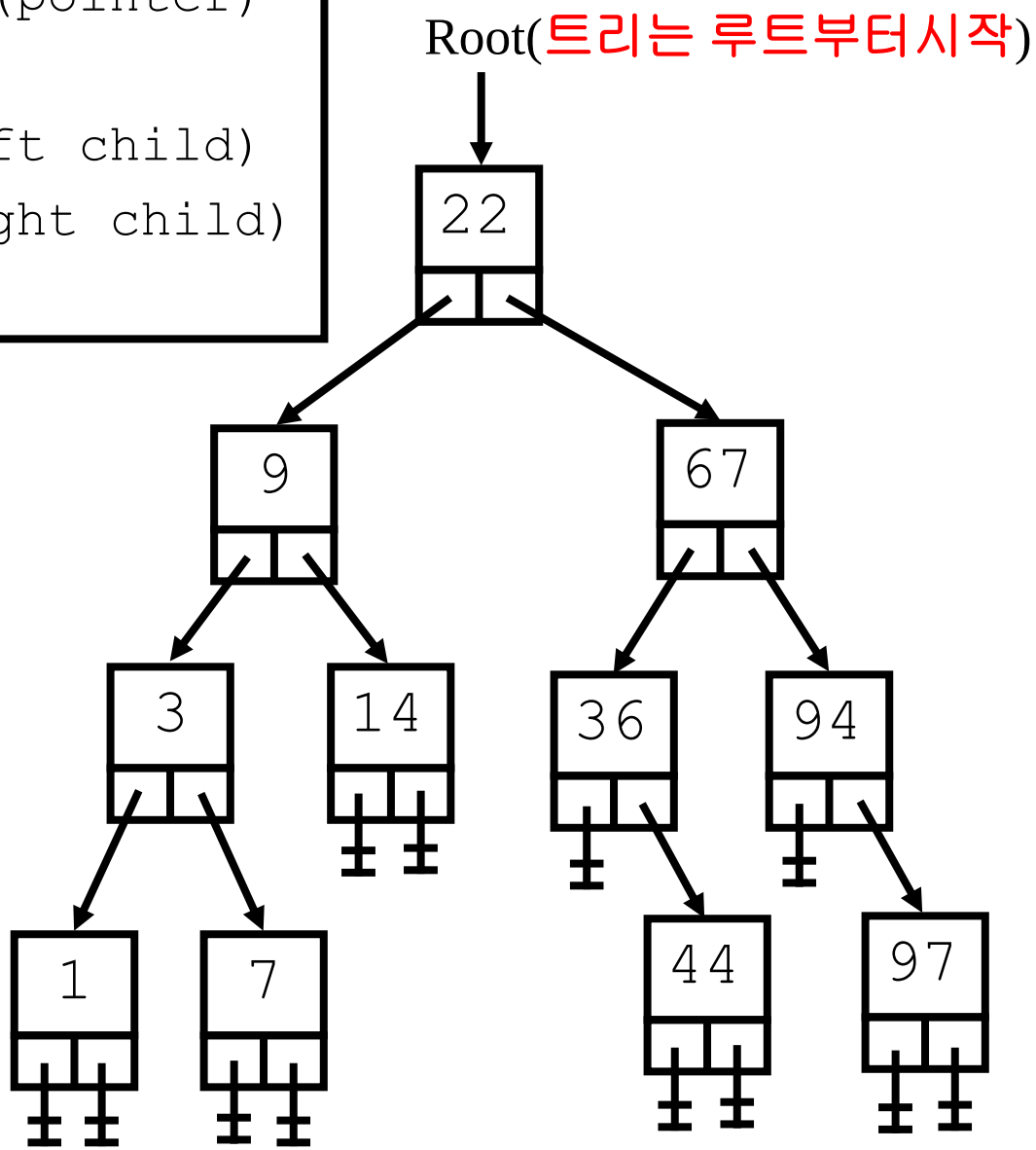
```
Algorithm Example
. . .
PreOrderPrint(root)
. . .
```

```
Output: 22 9 3 1 7 14 67
        36 44 94 97
```

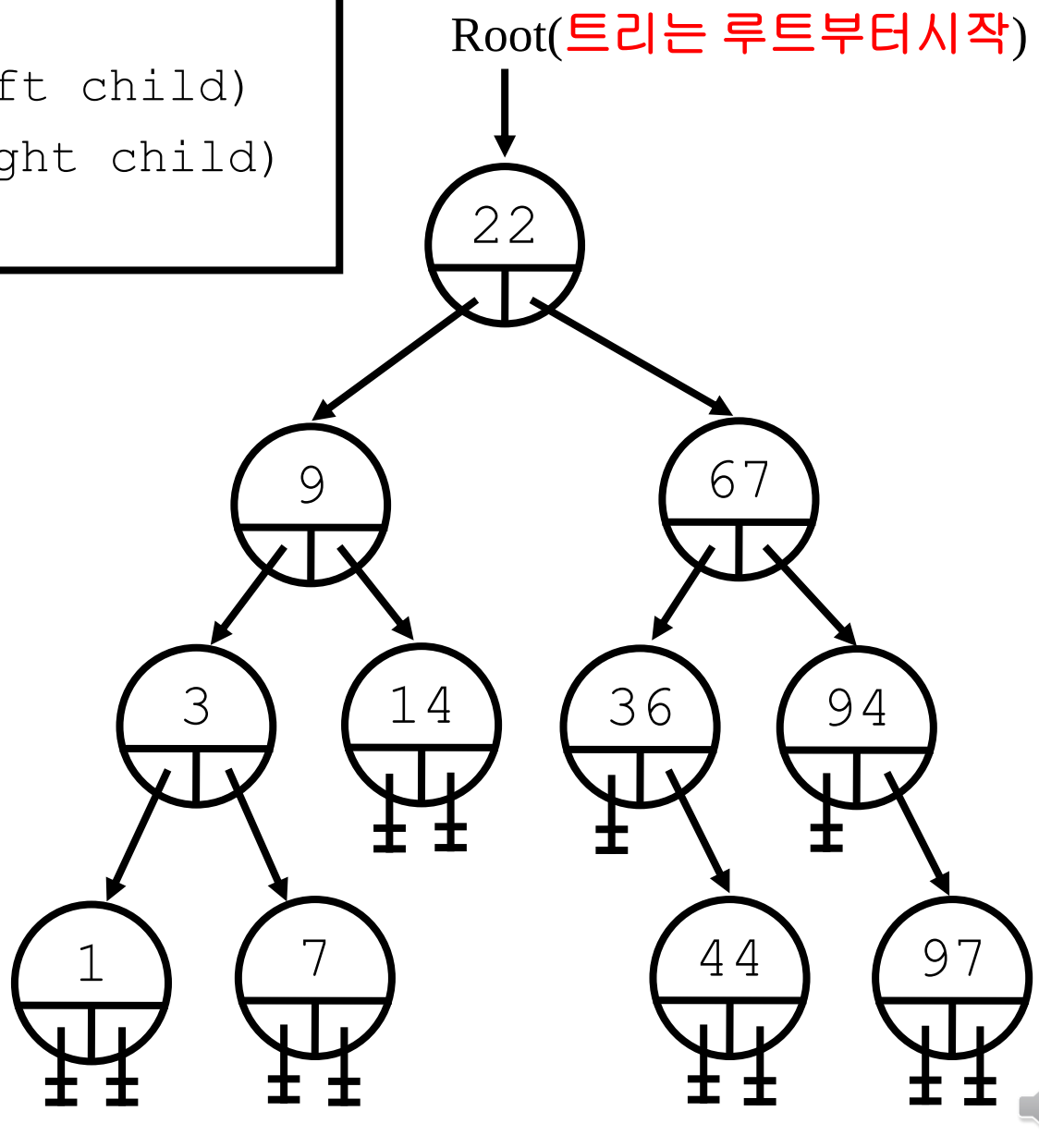


Postorder traversal(후위순회)

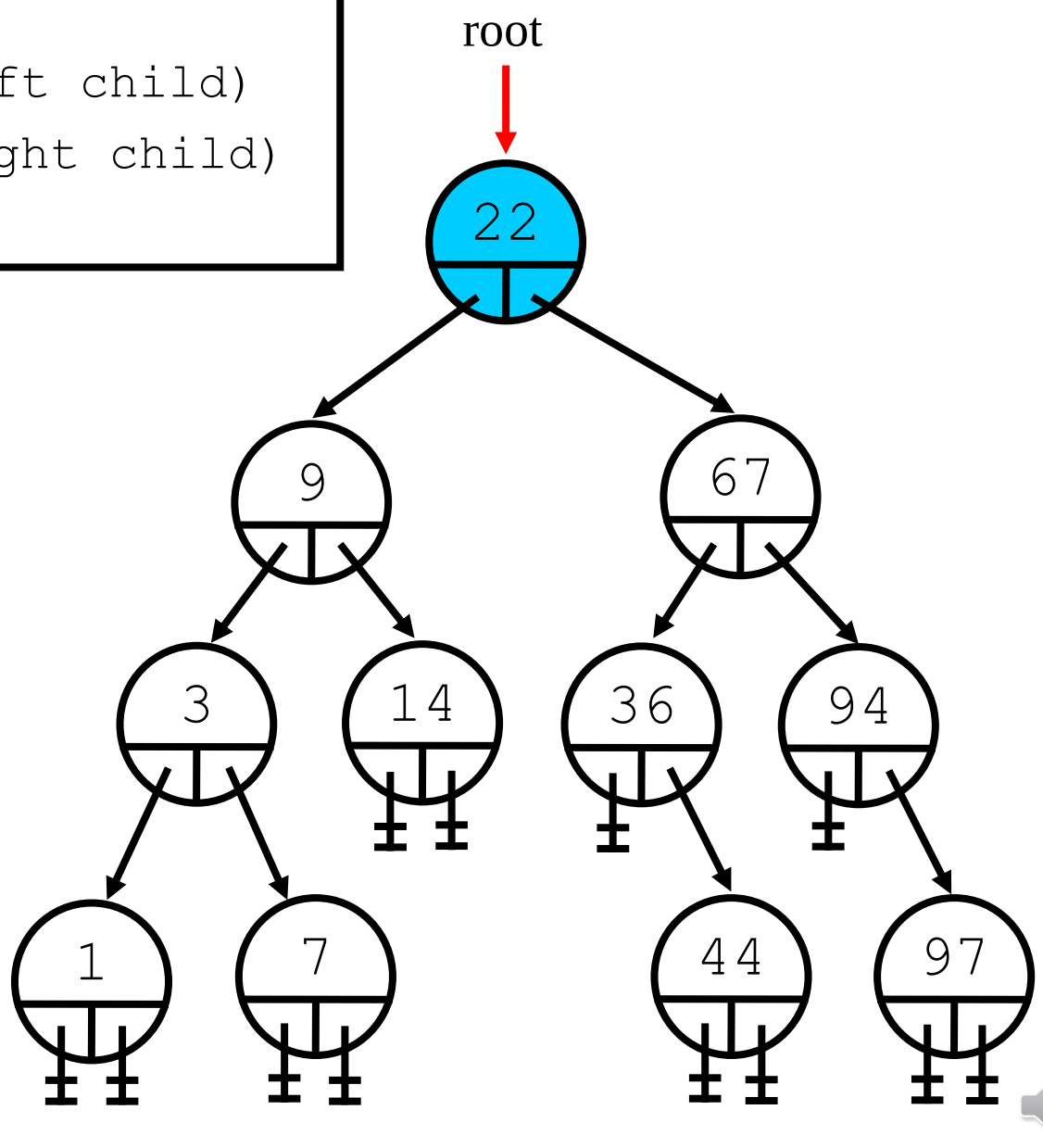
```
Proc PostOrderPrint(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



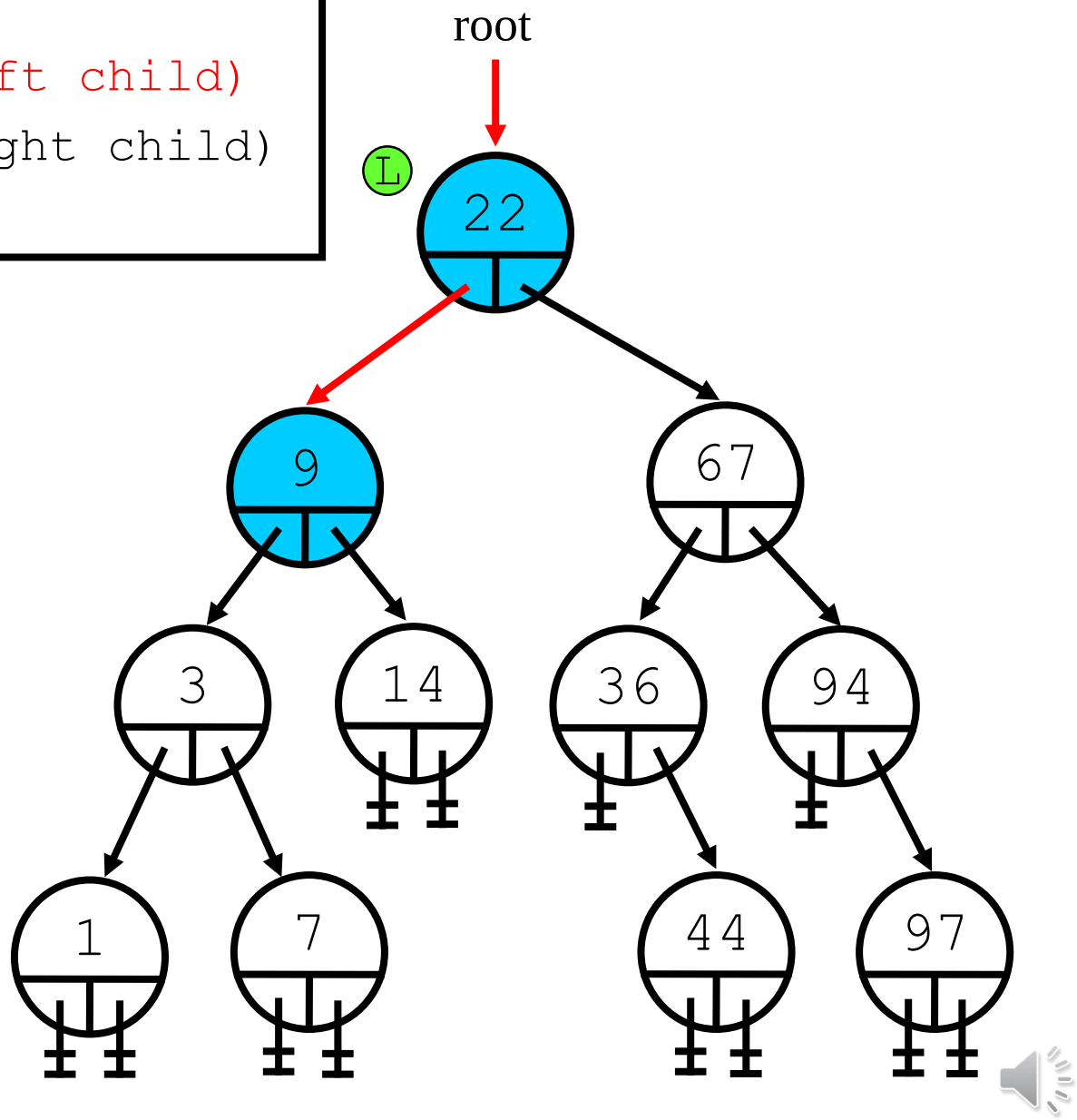
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
(L)PostOrderPrint(left child)
(R)PostOrderPrint(right child)
(P)print(data)
```



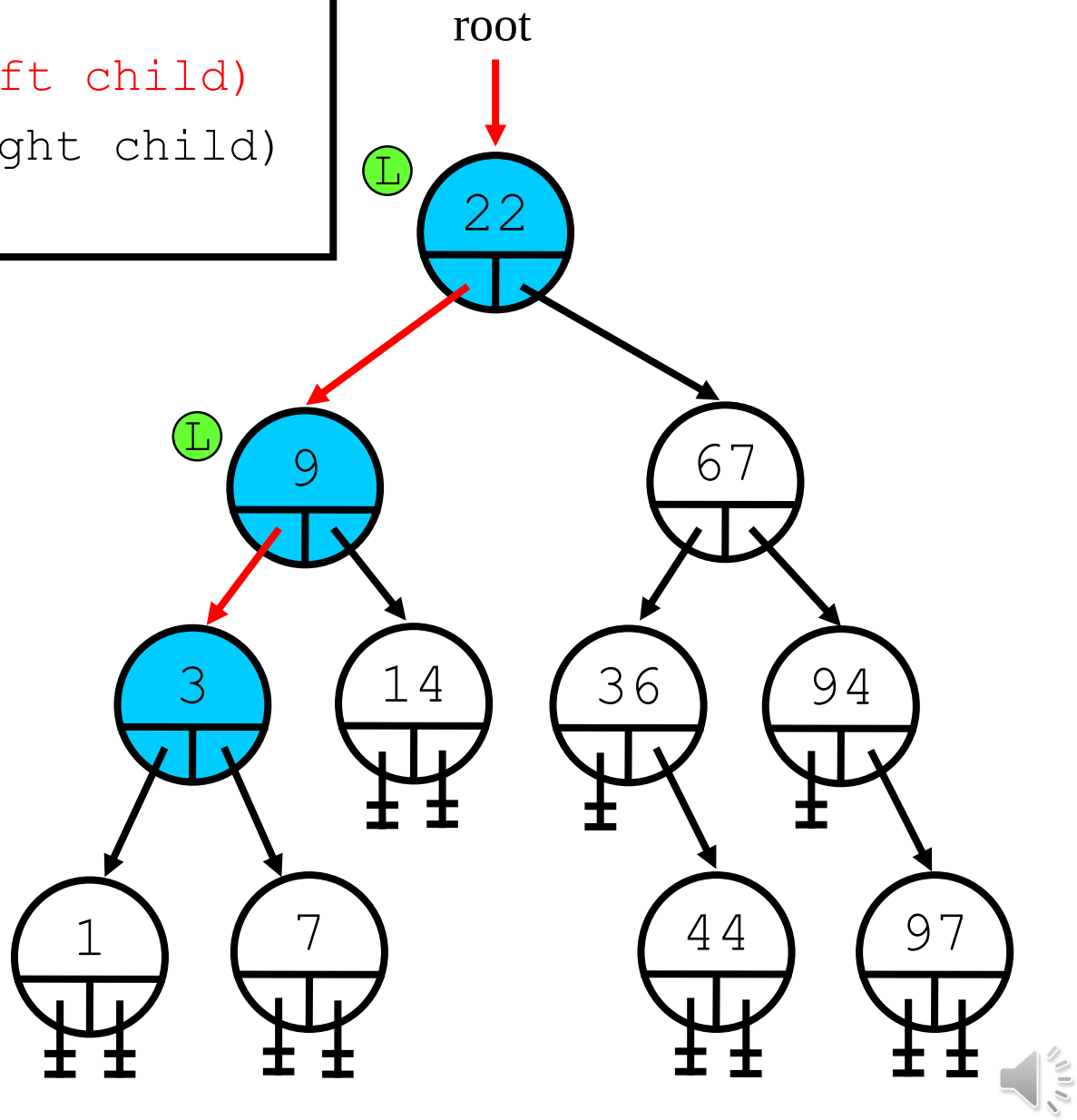
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



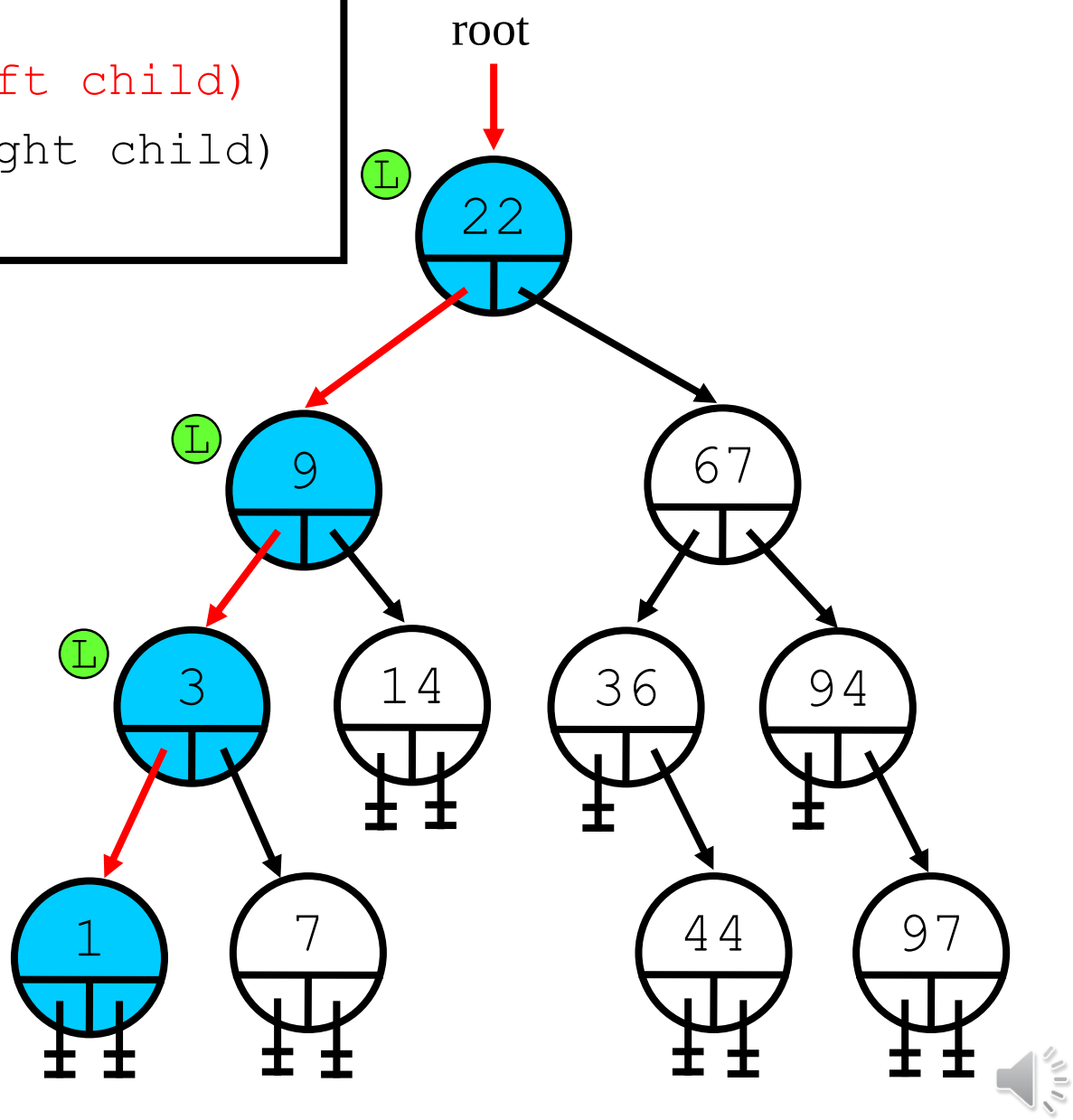
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



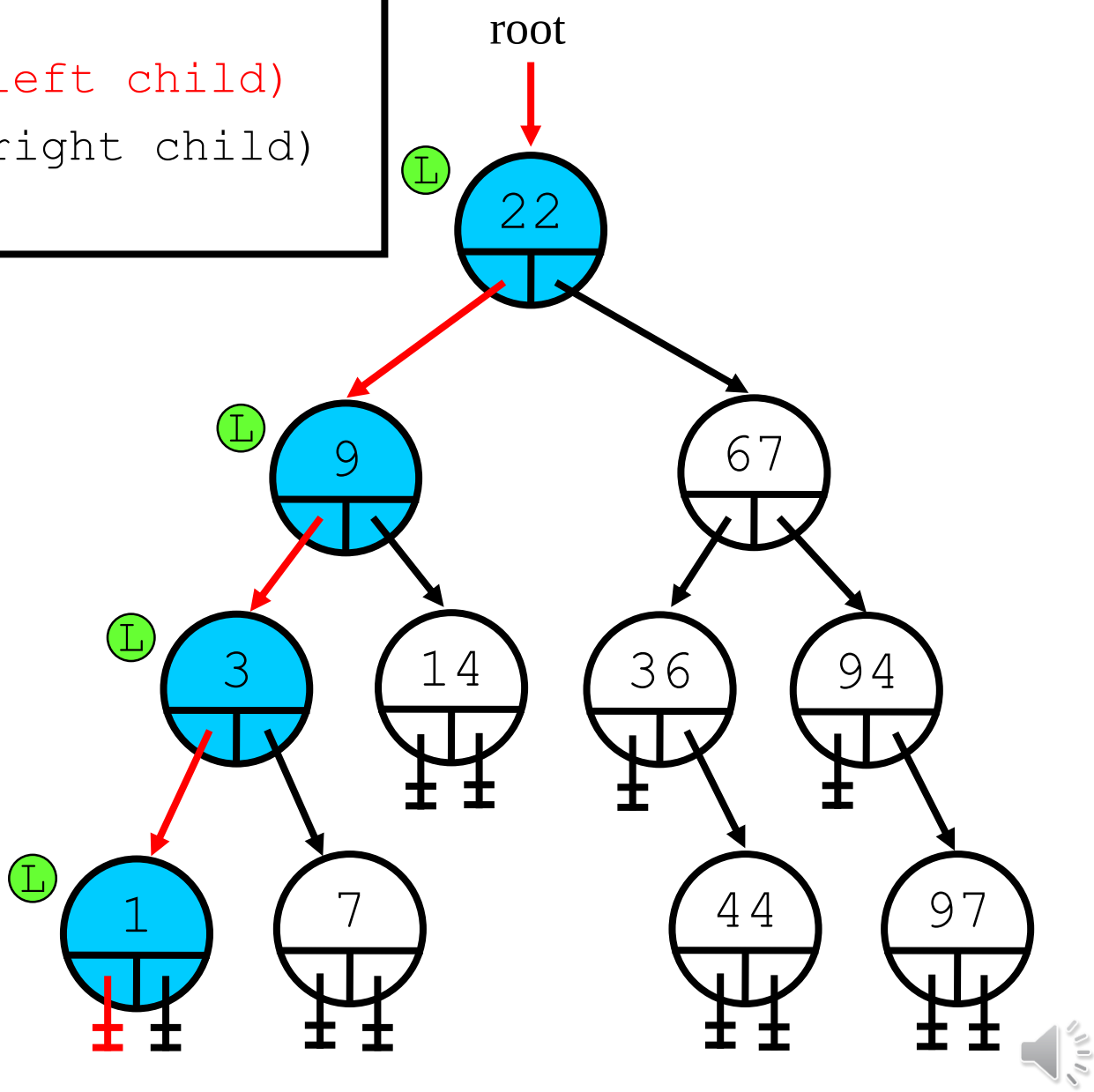
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



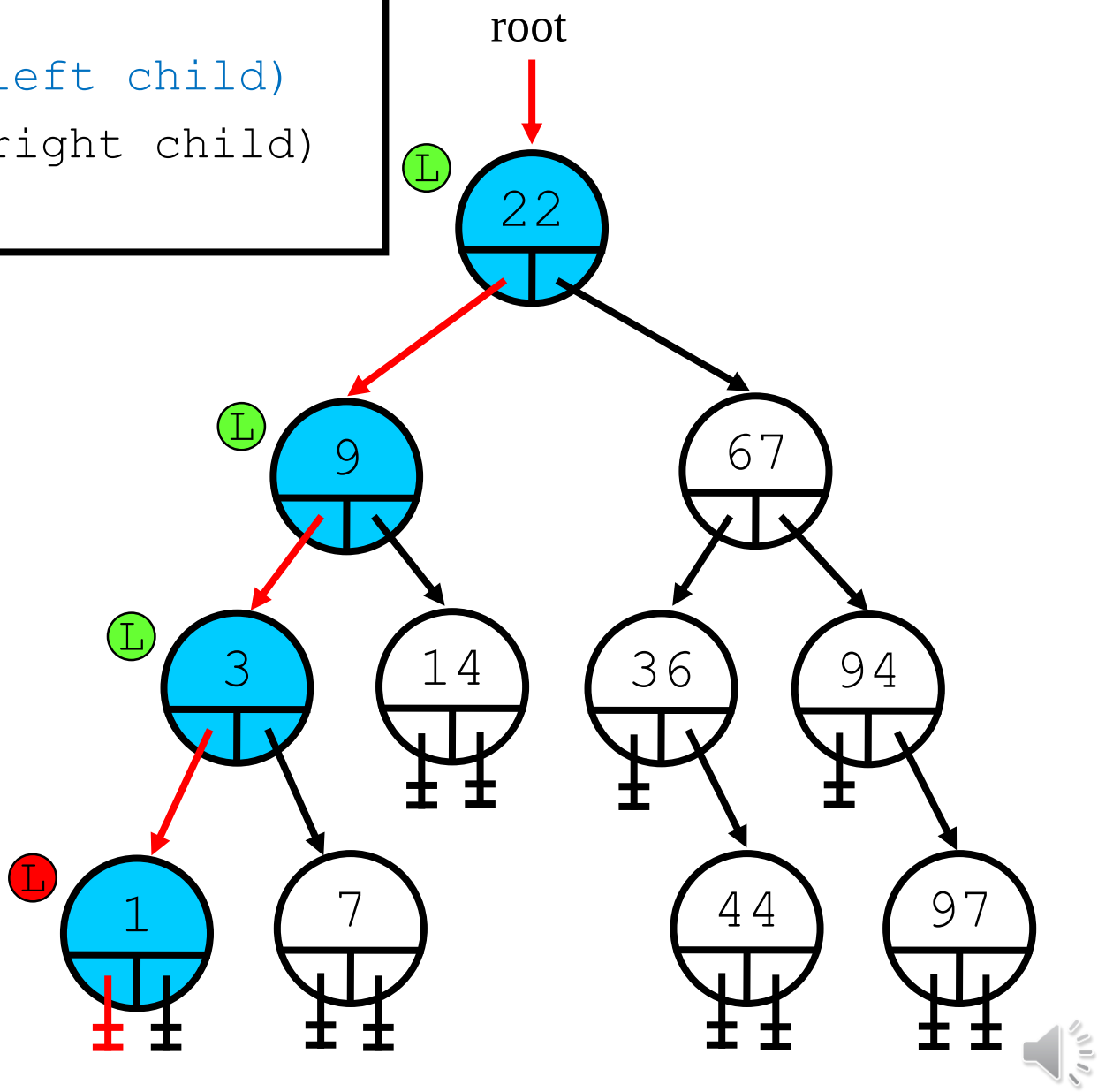
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



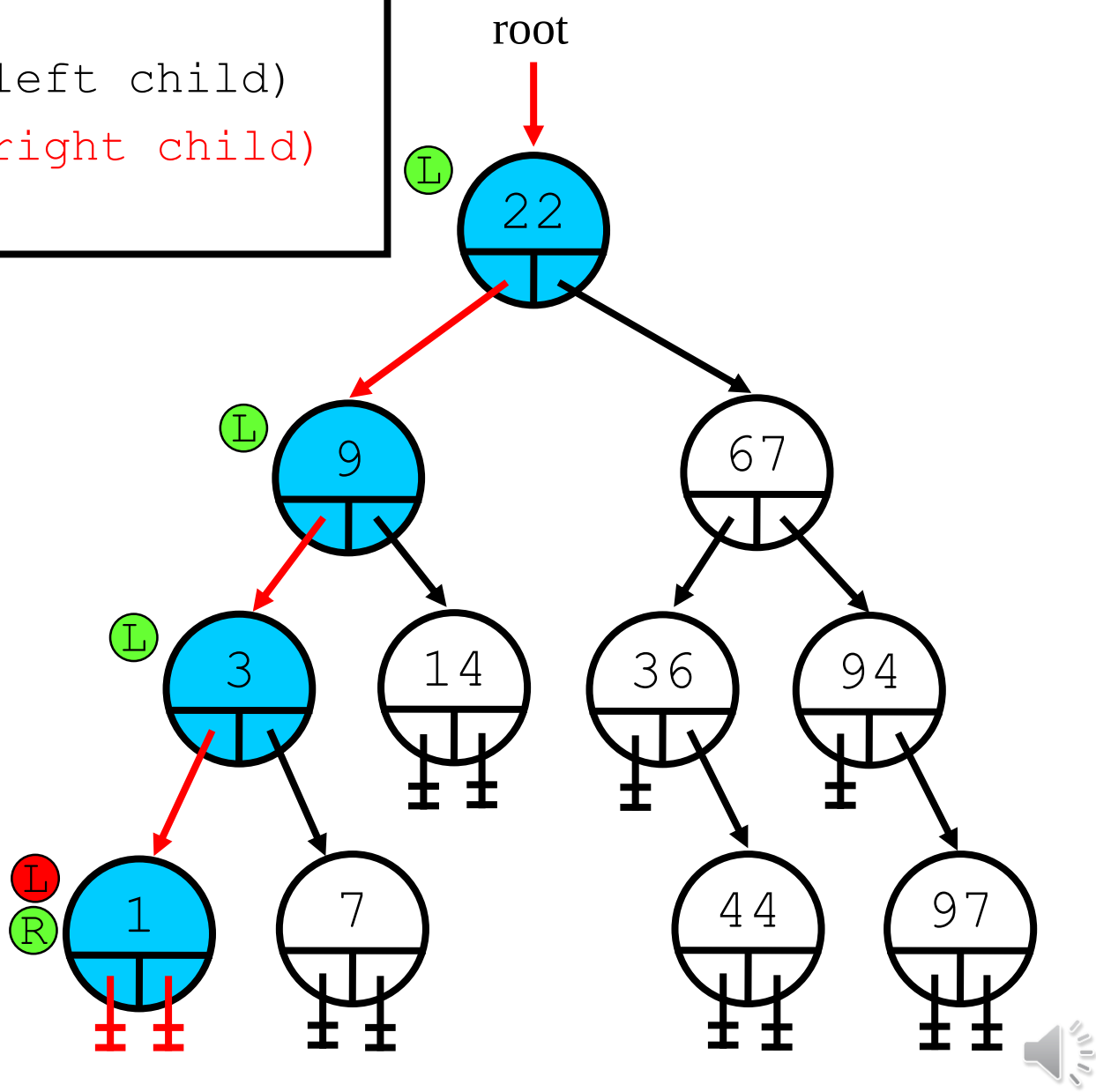
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



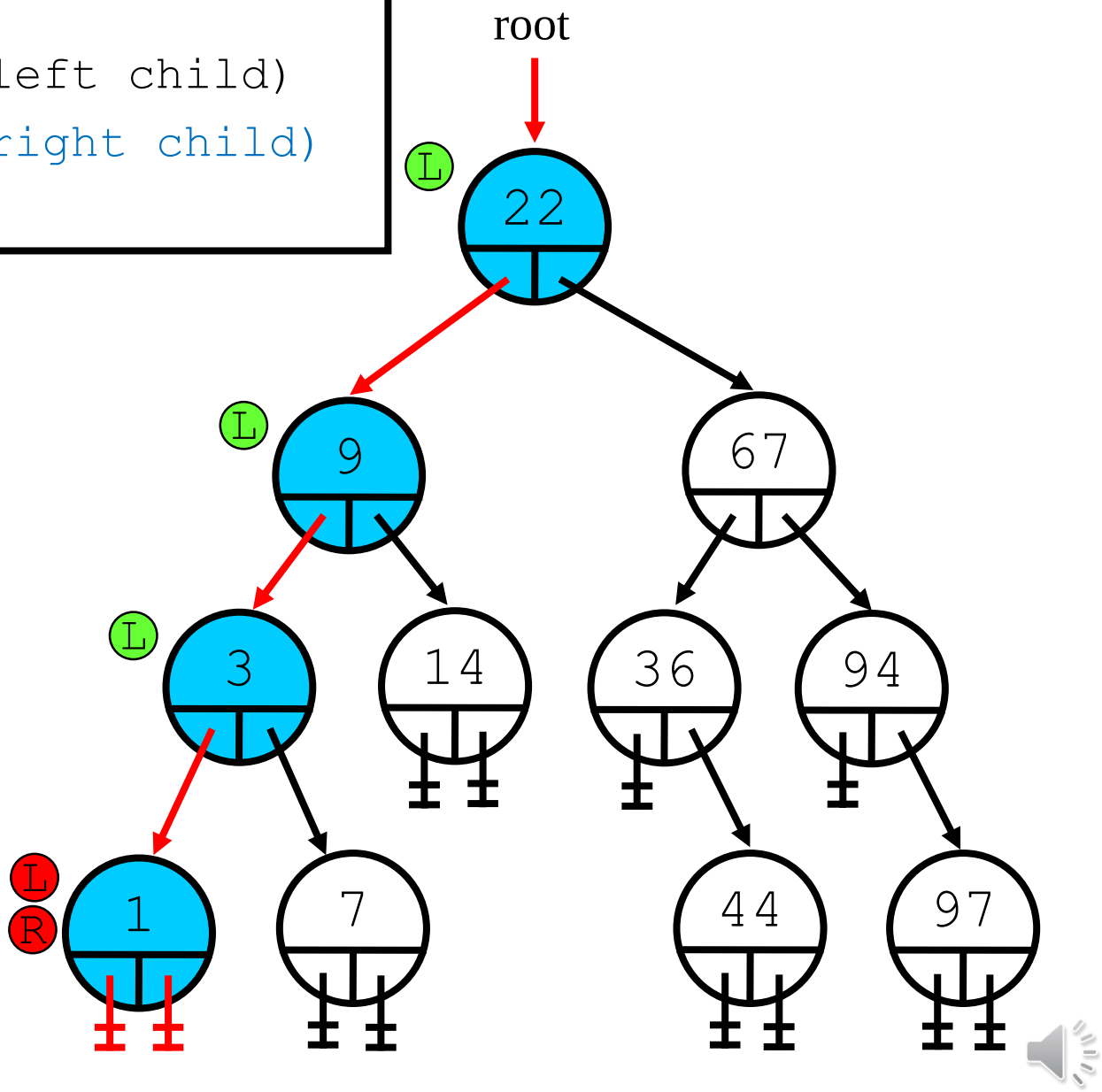
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

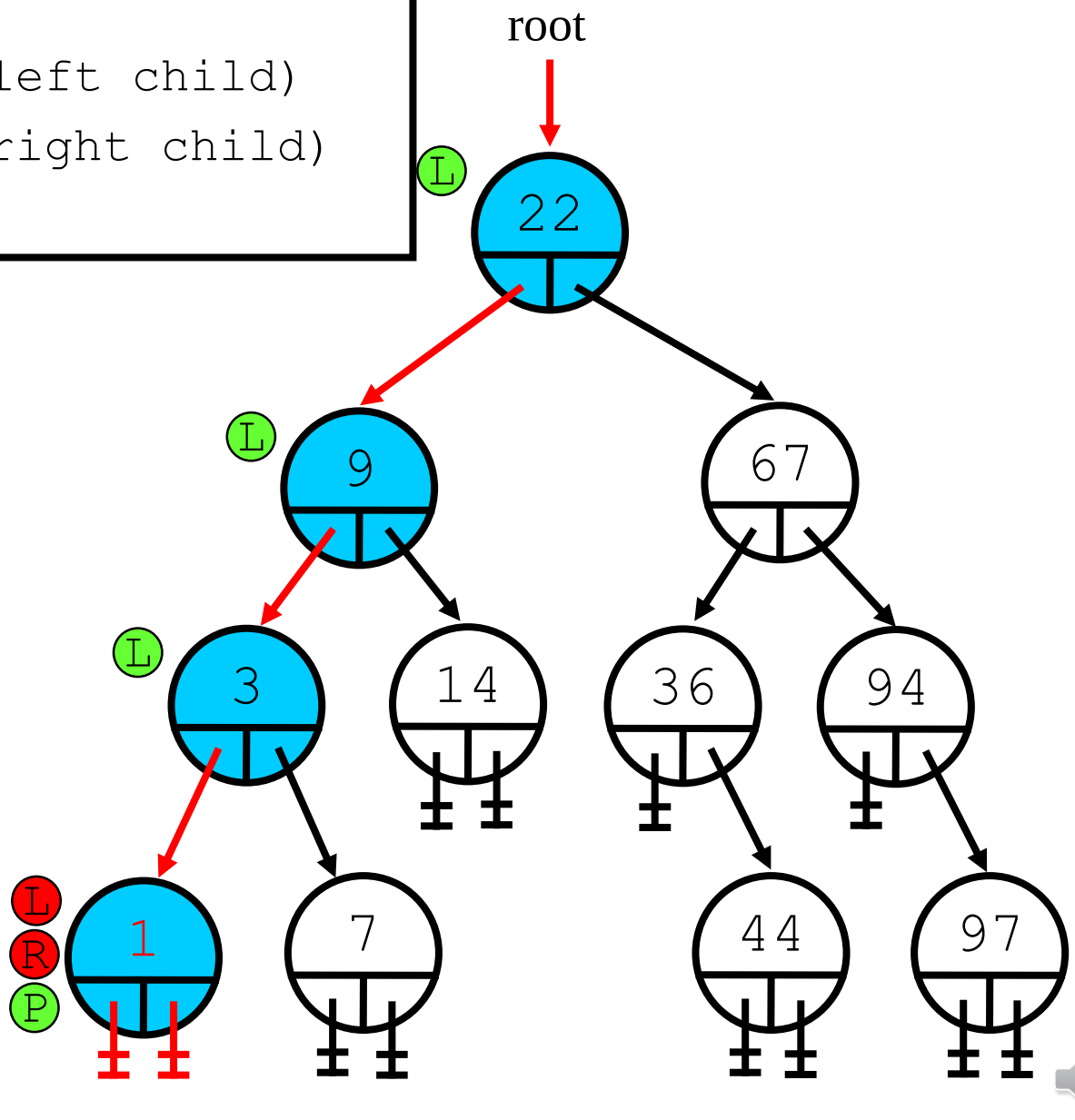


```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```



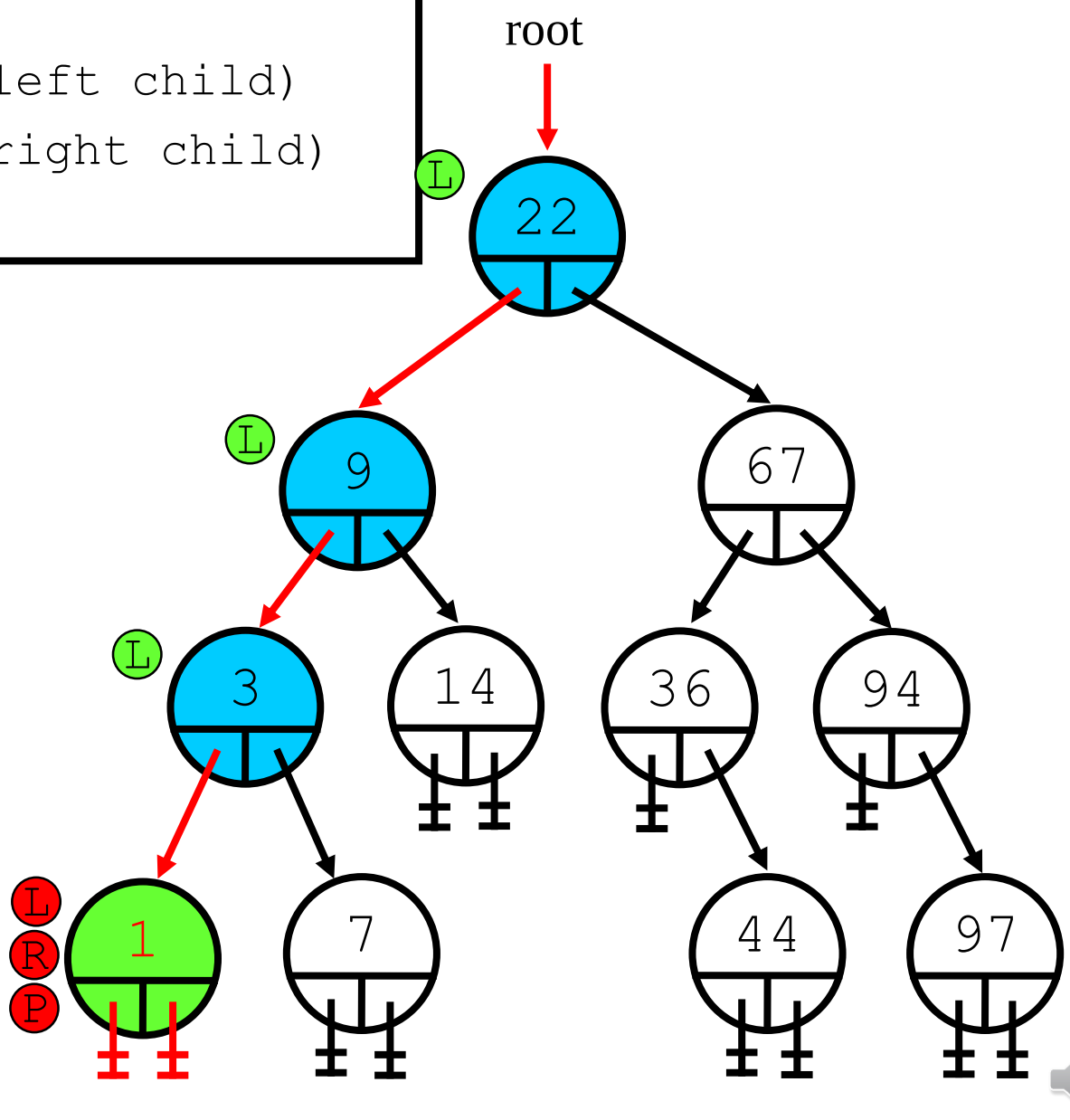
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



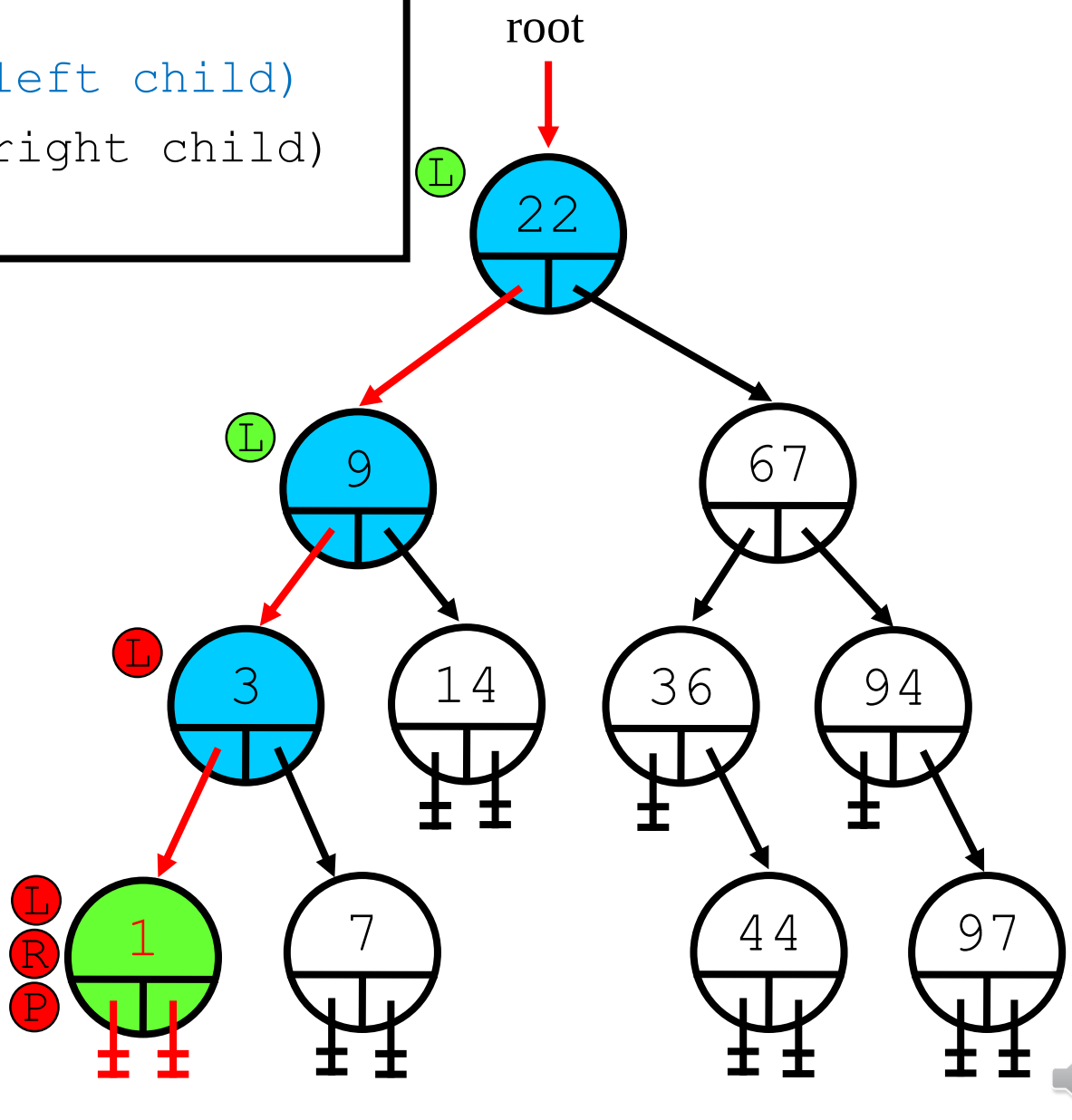
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



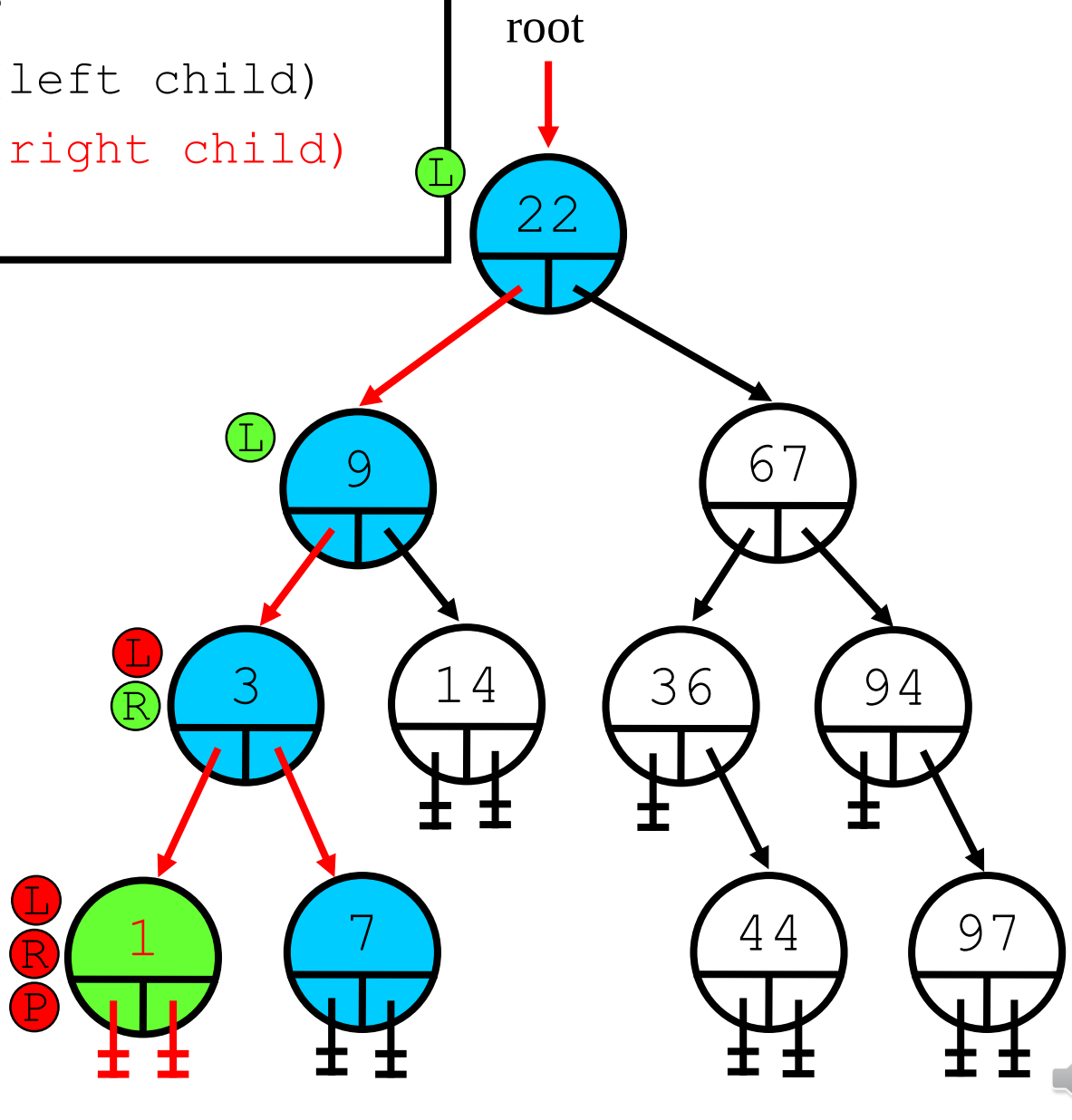
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



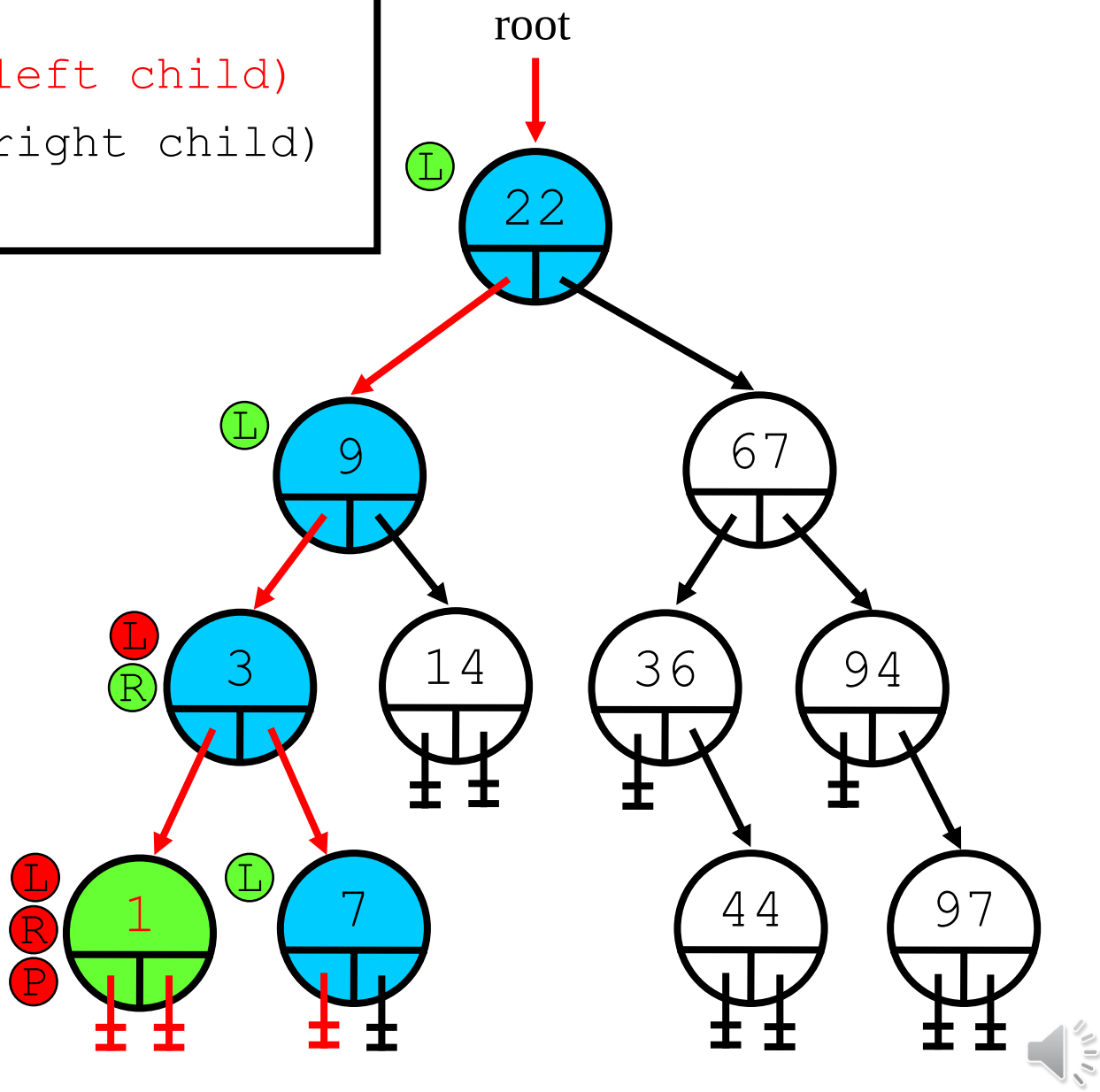
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



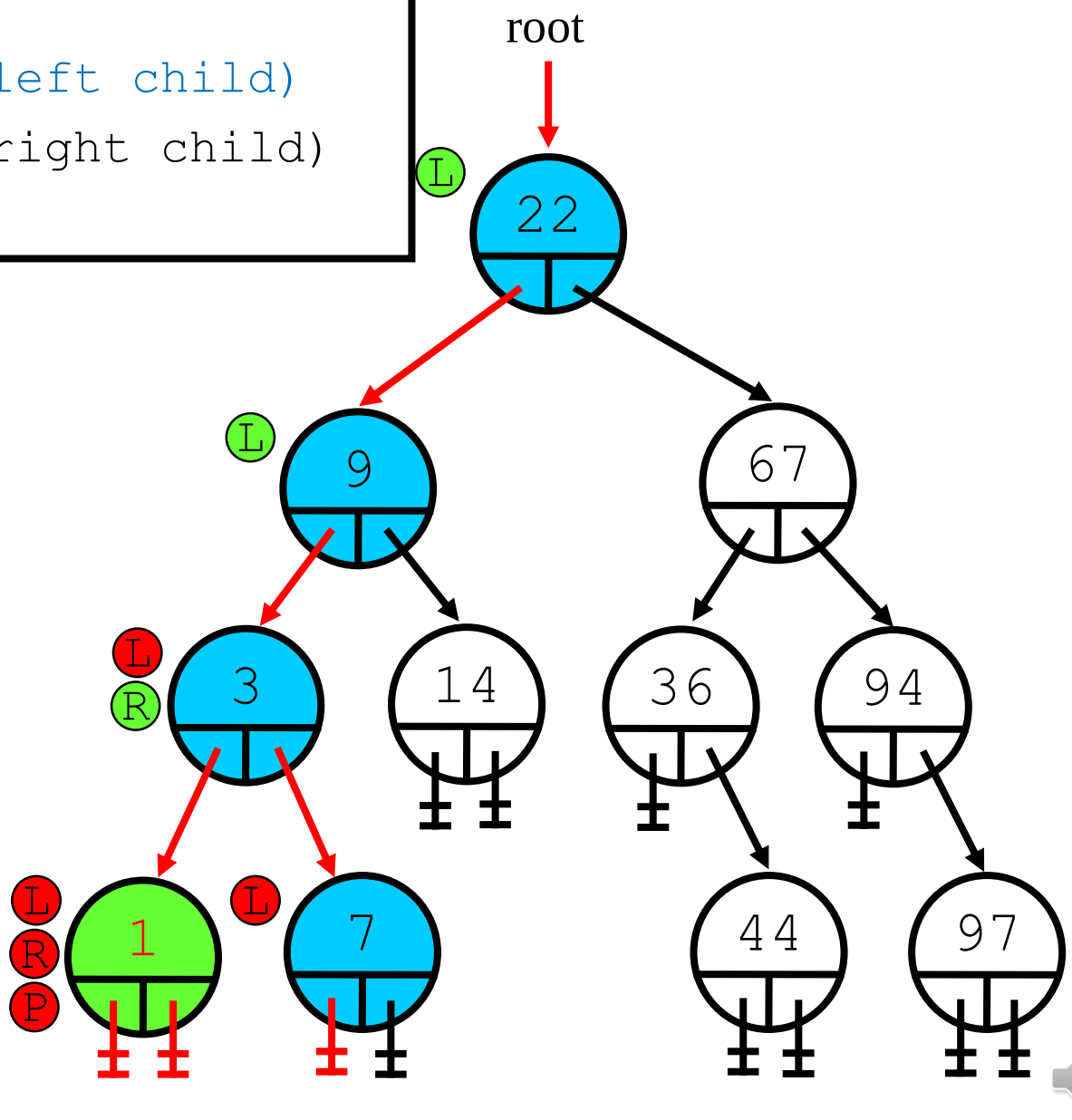
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



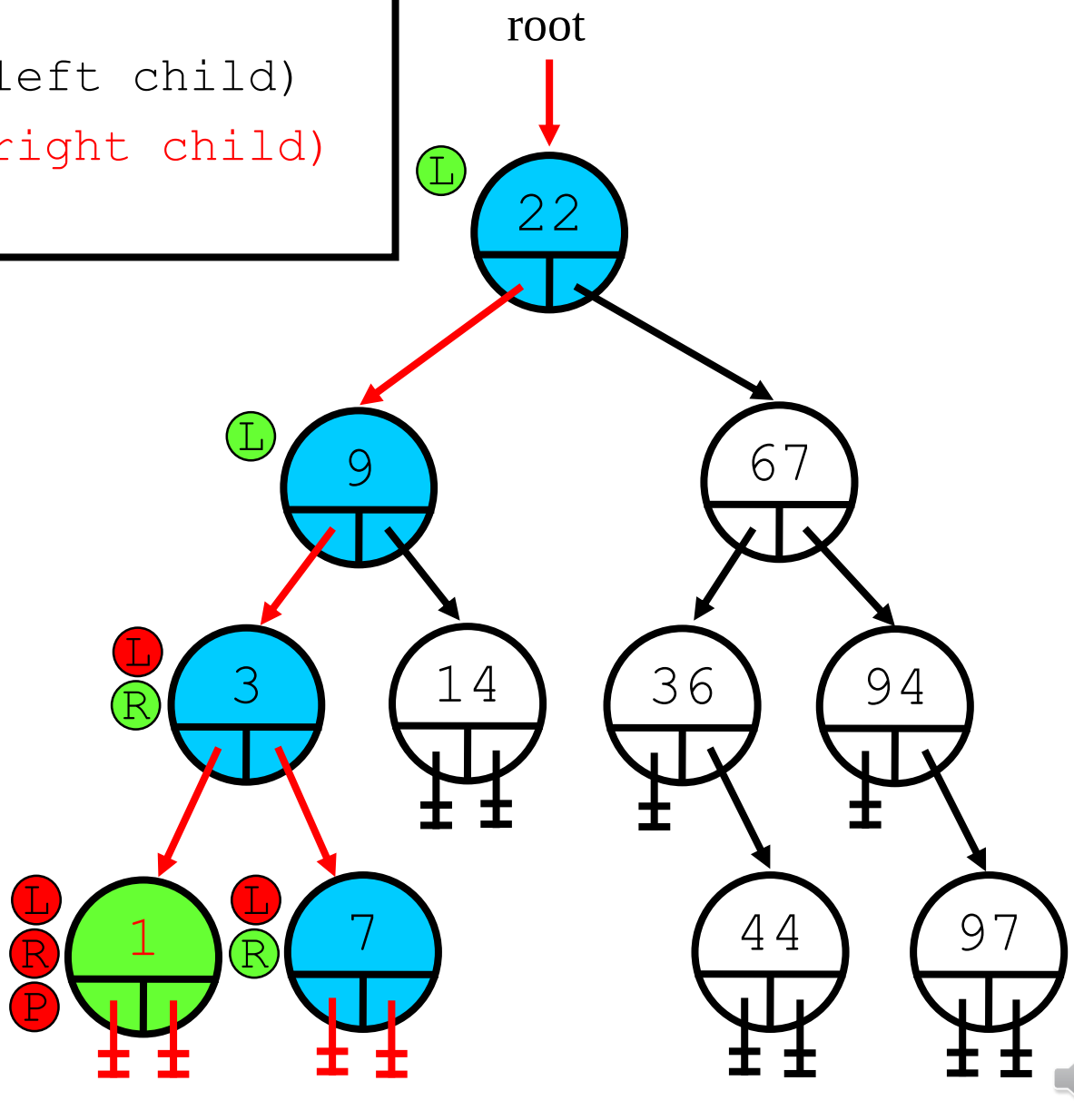
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



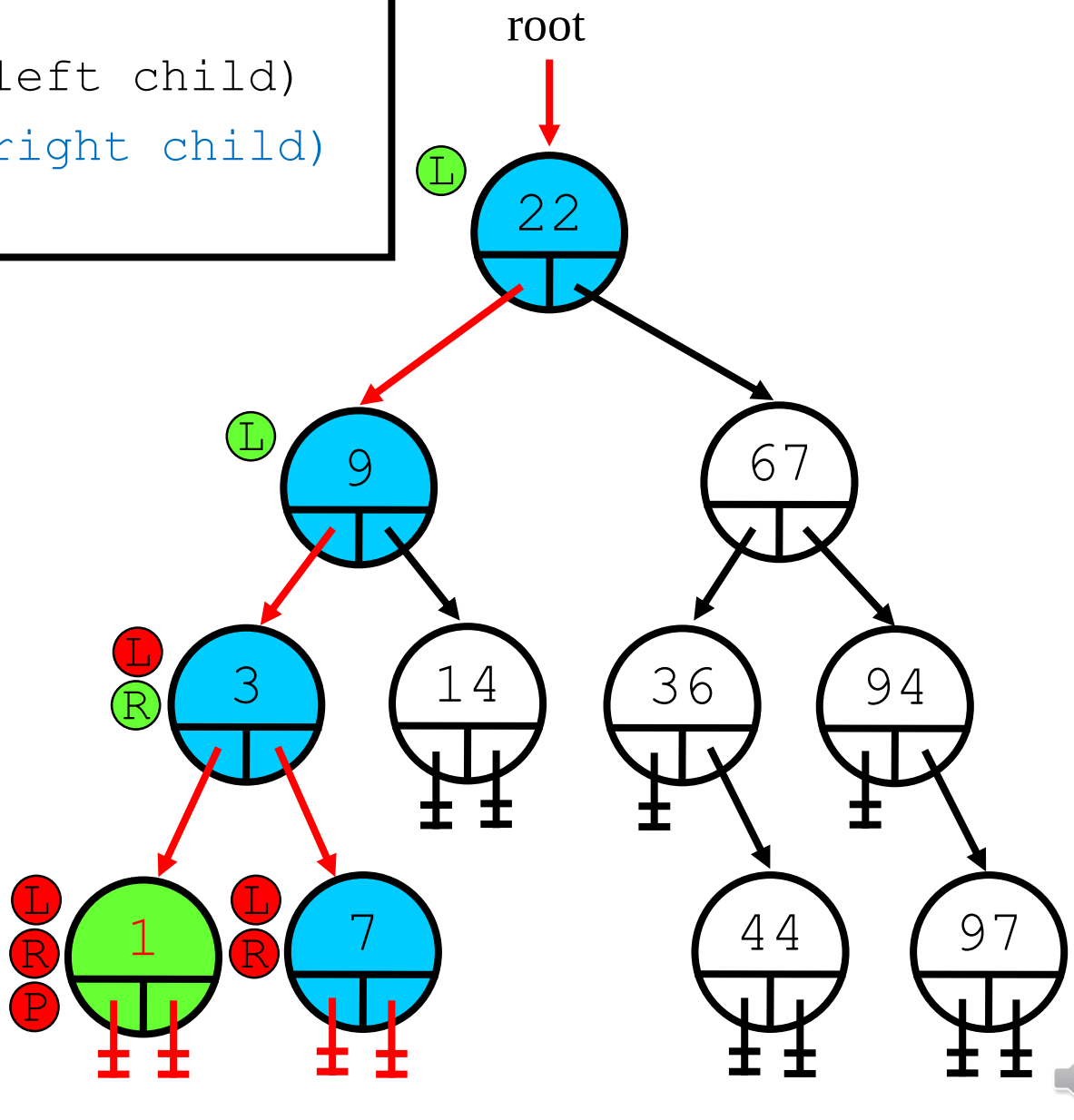
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



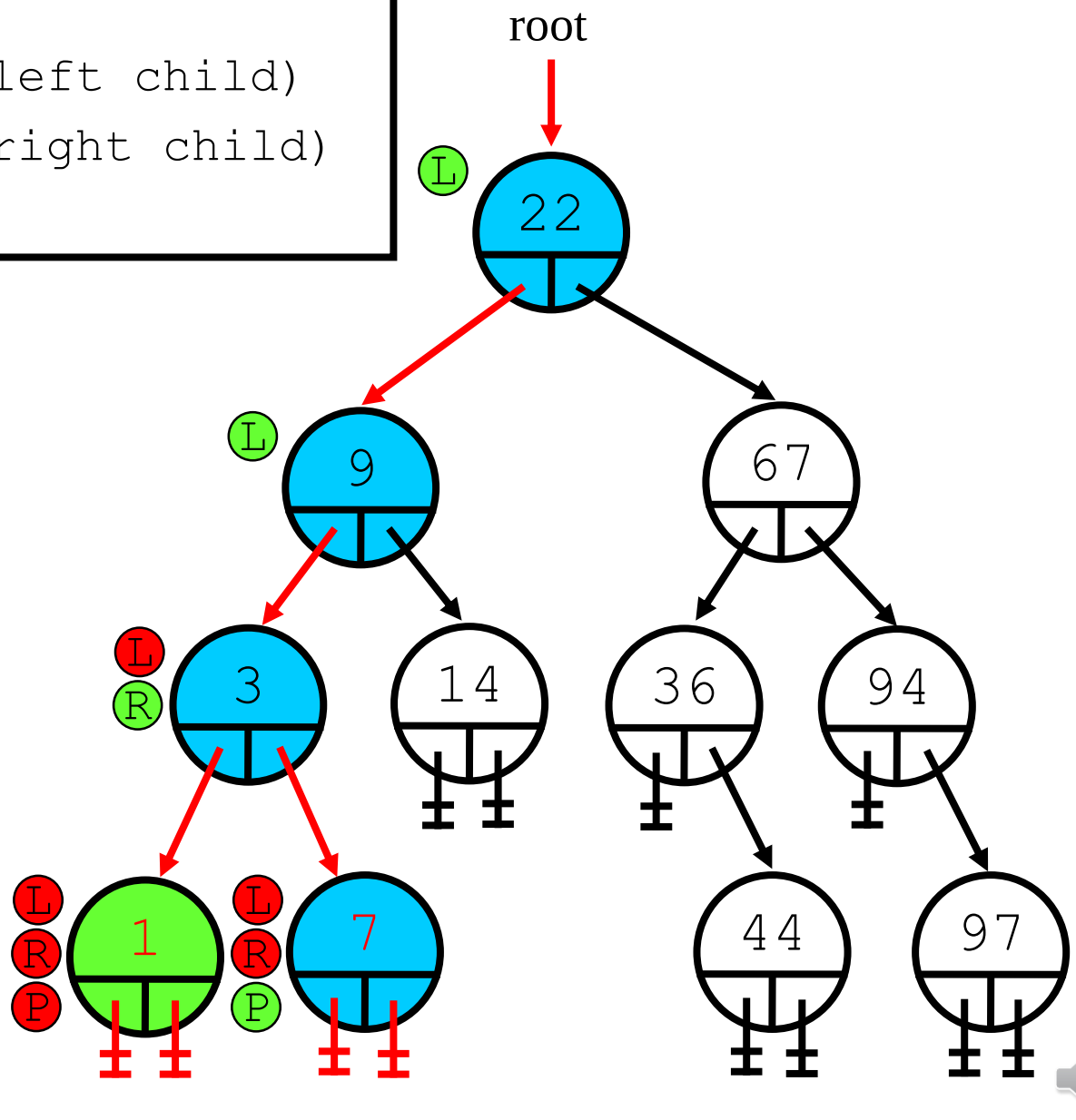
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1
```



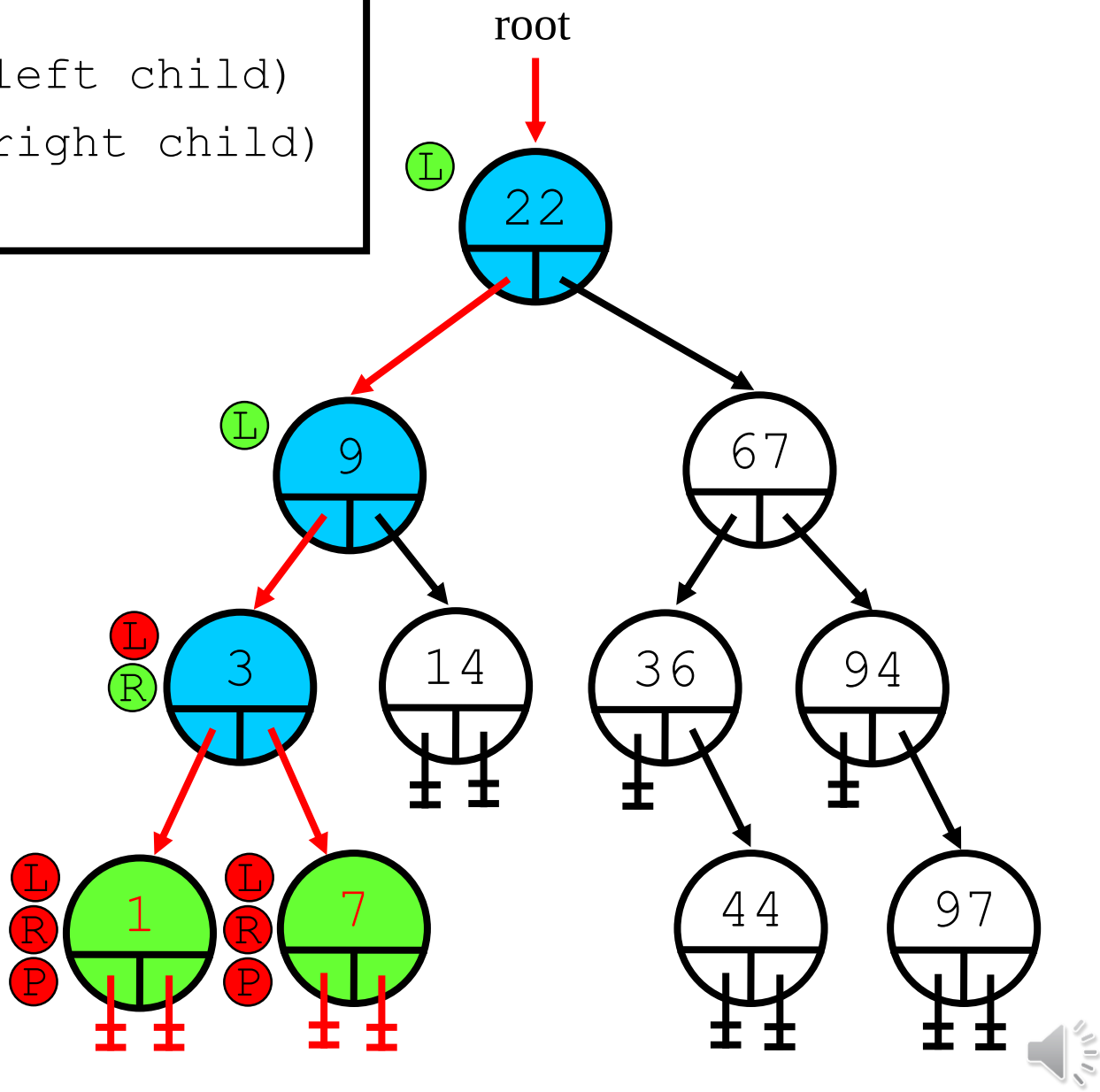
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7
```



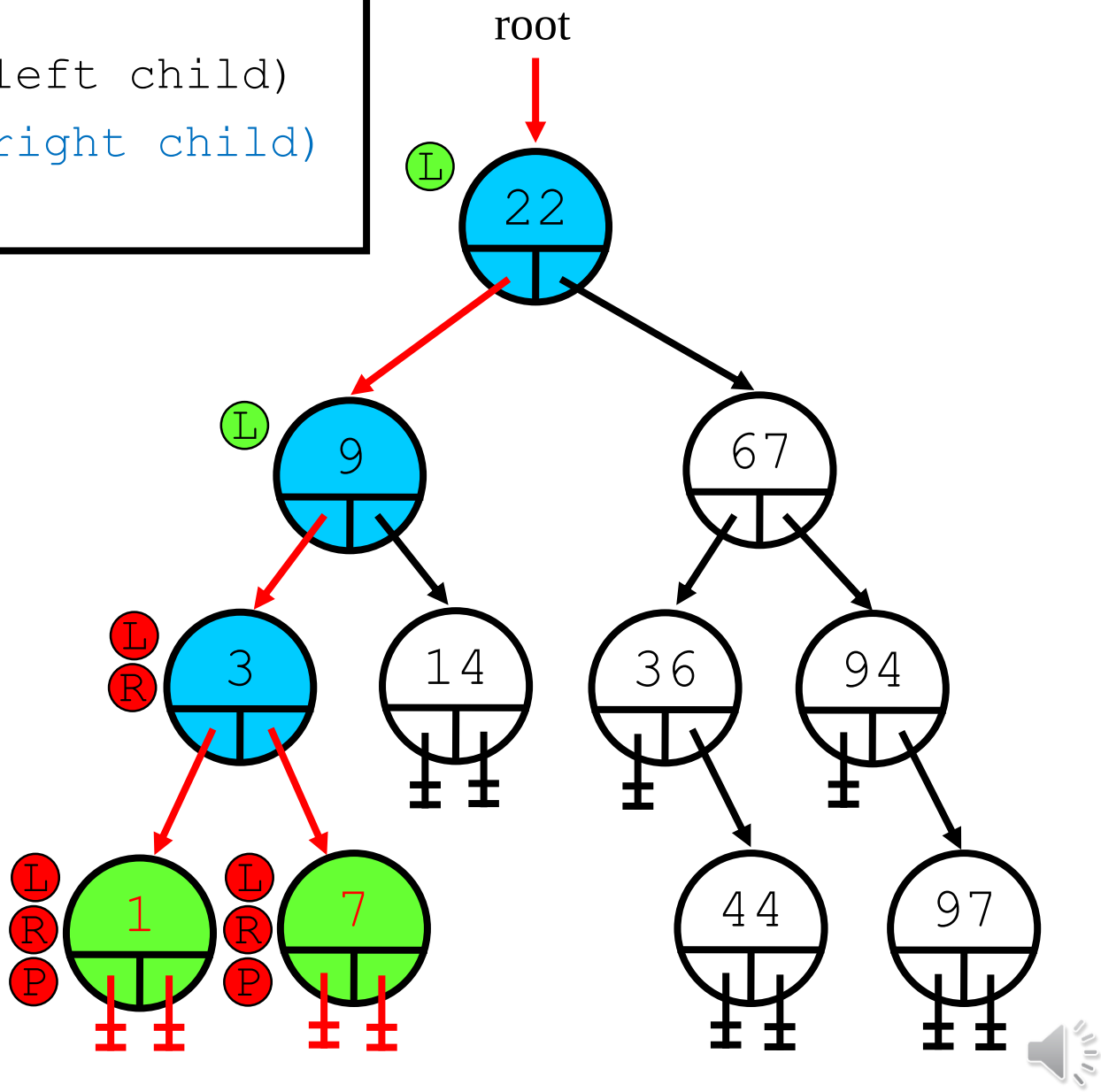
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7
```



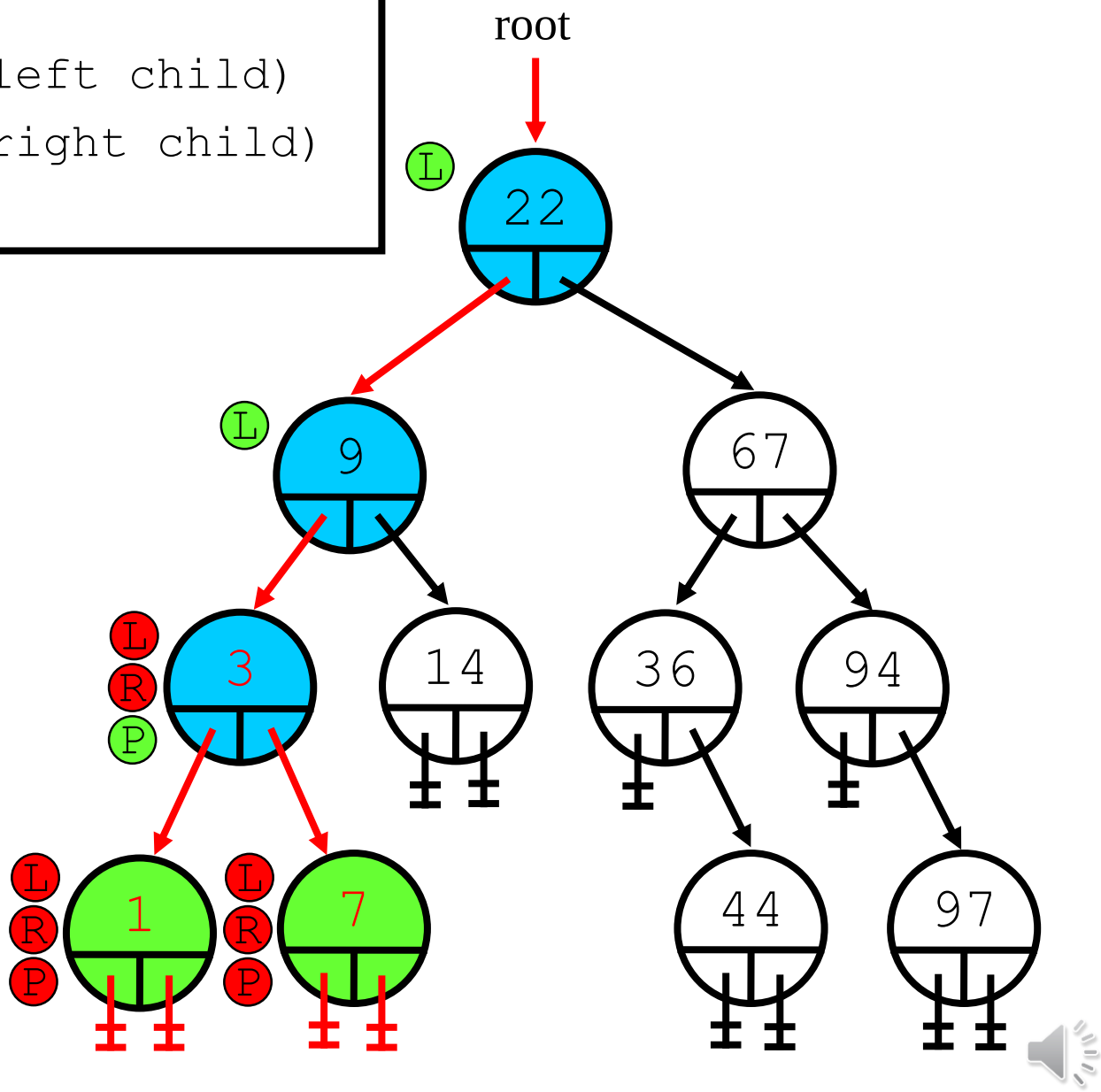
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7
```



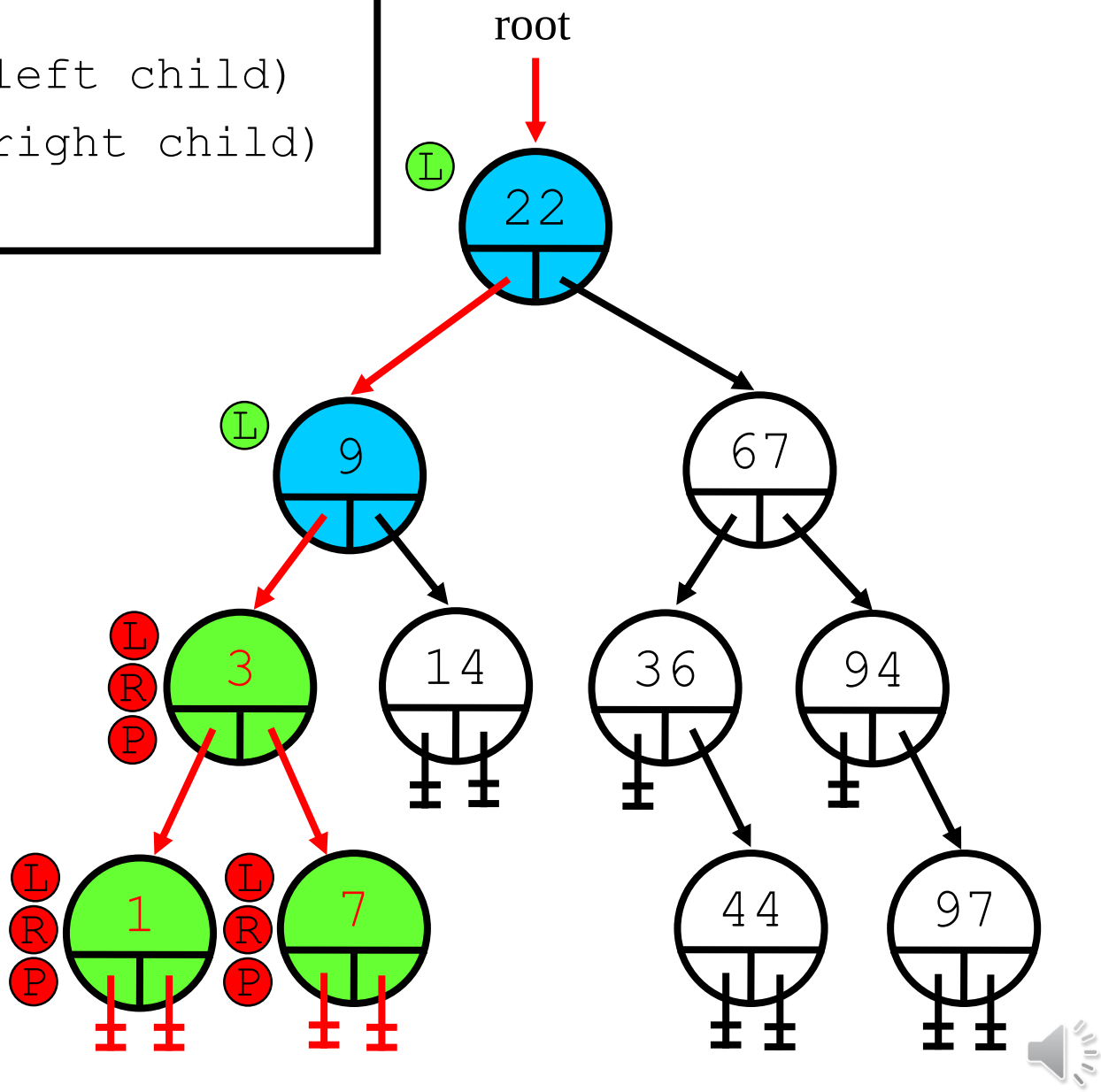
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



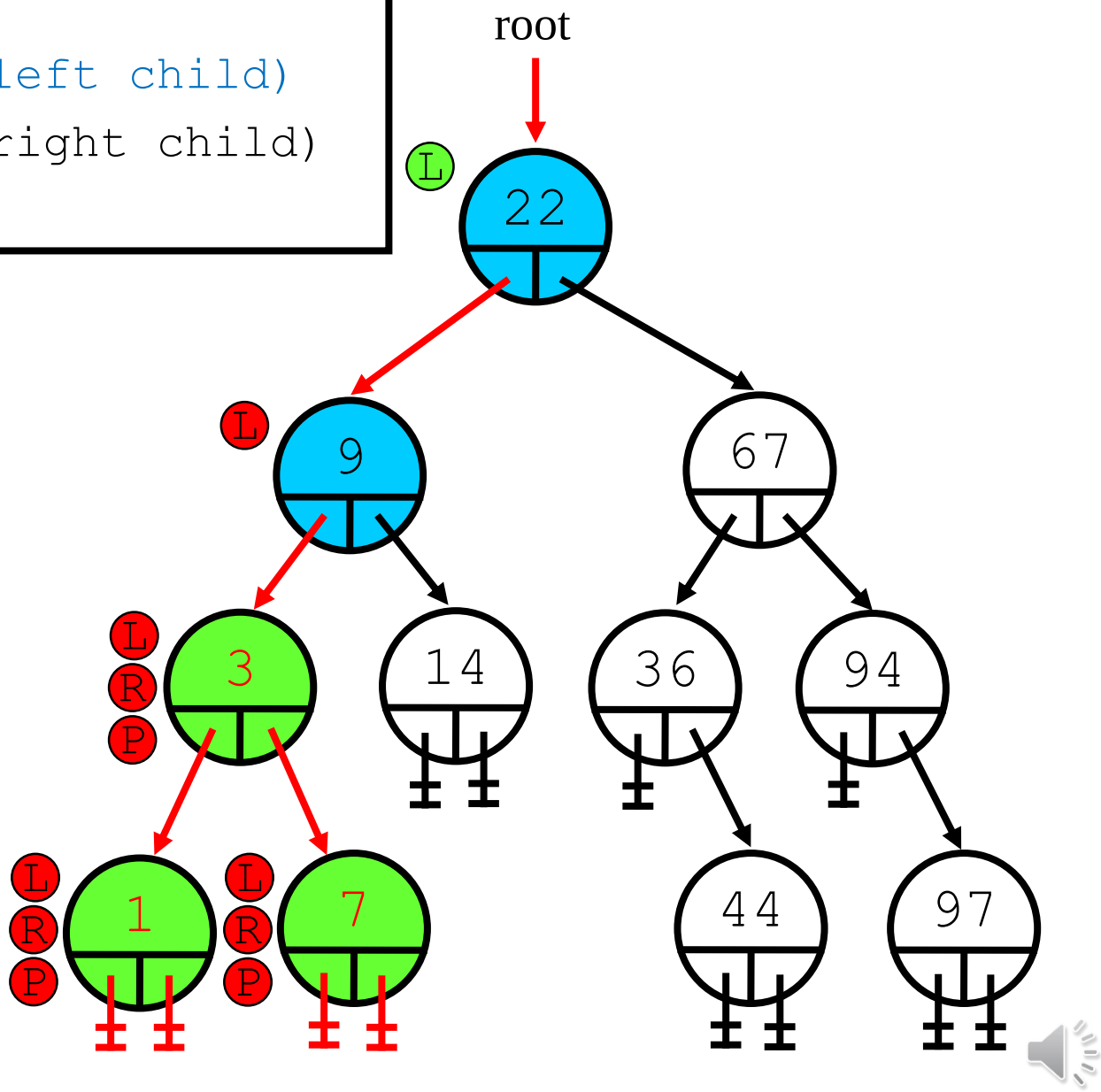
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



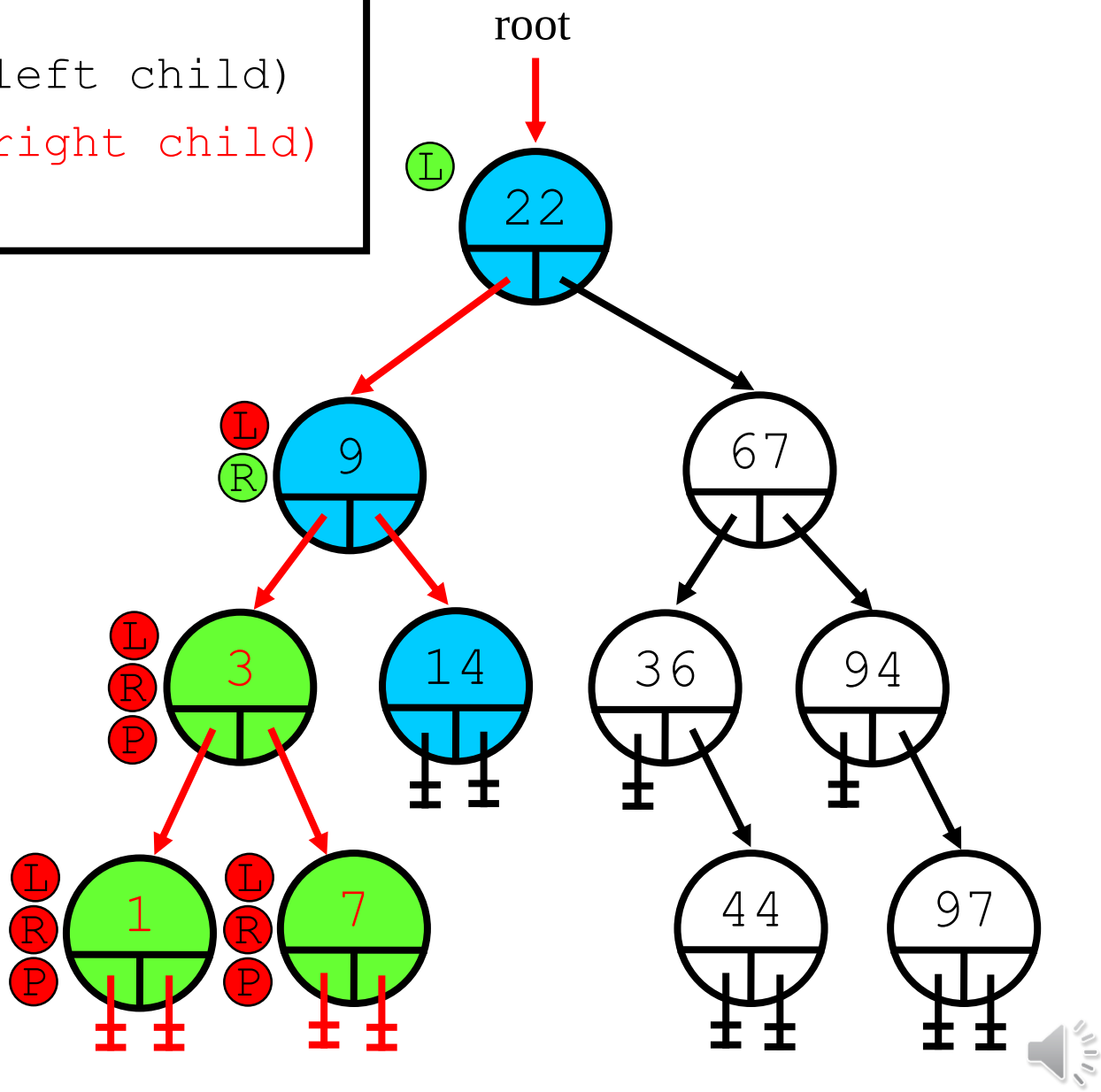
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



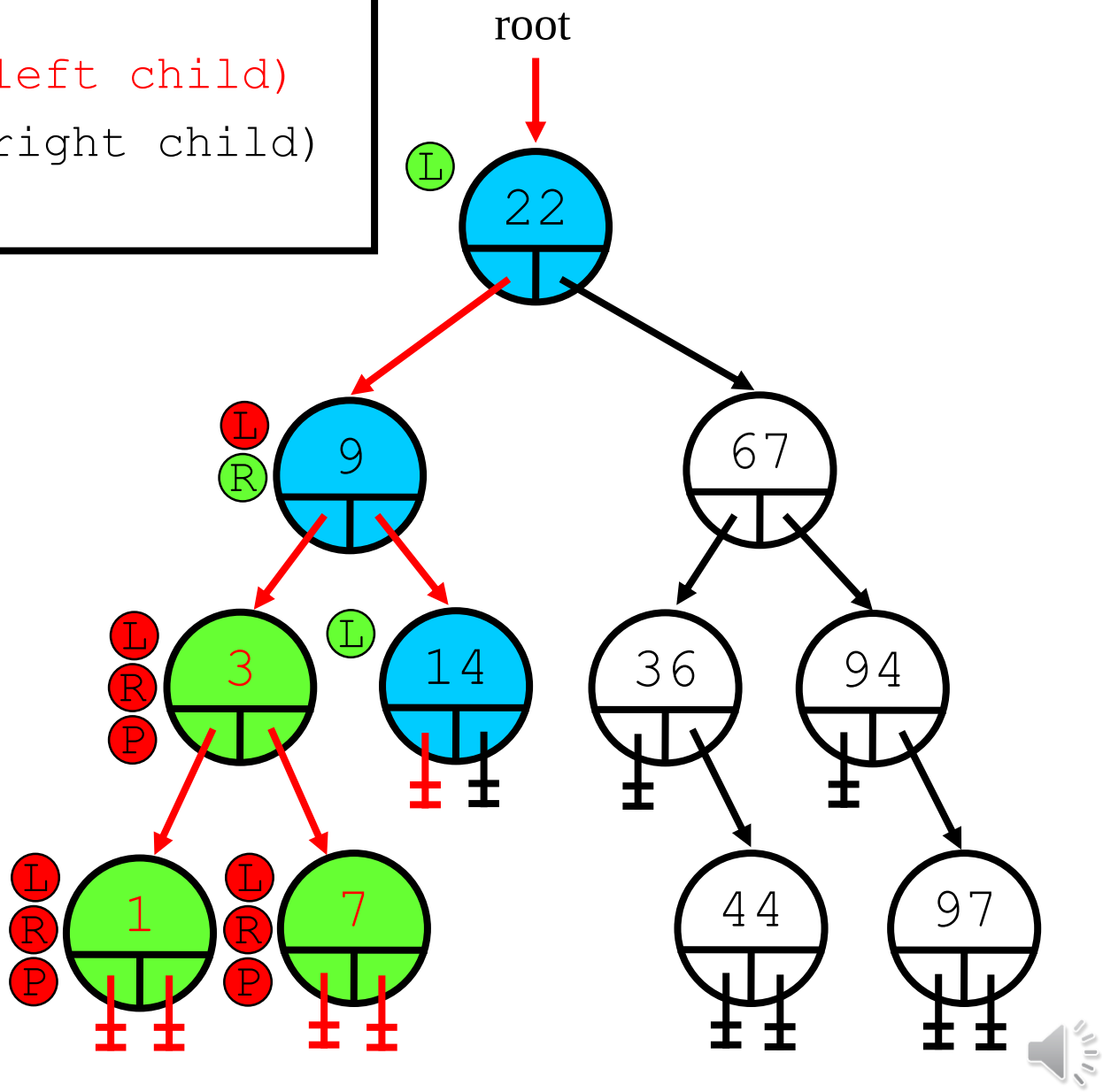
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



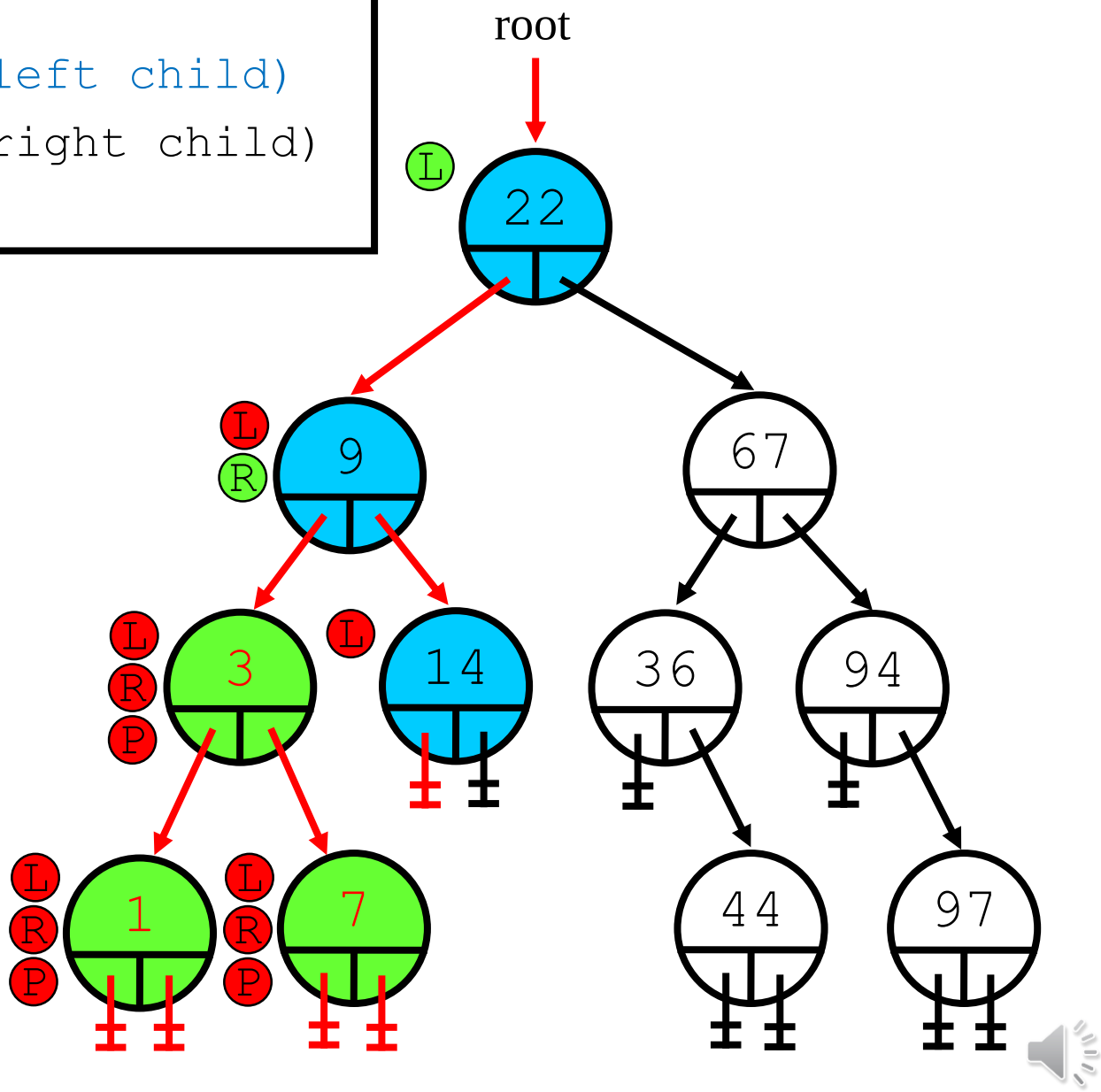
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



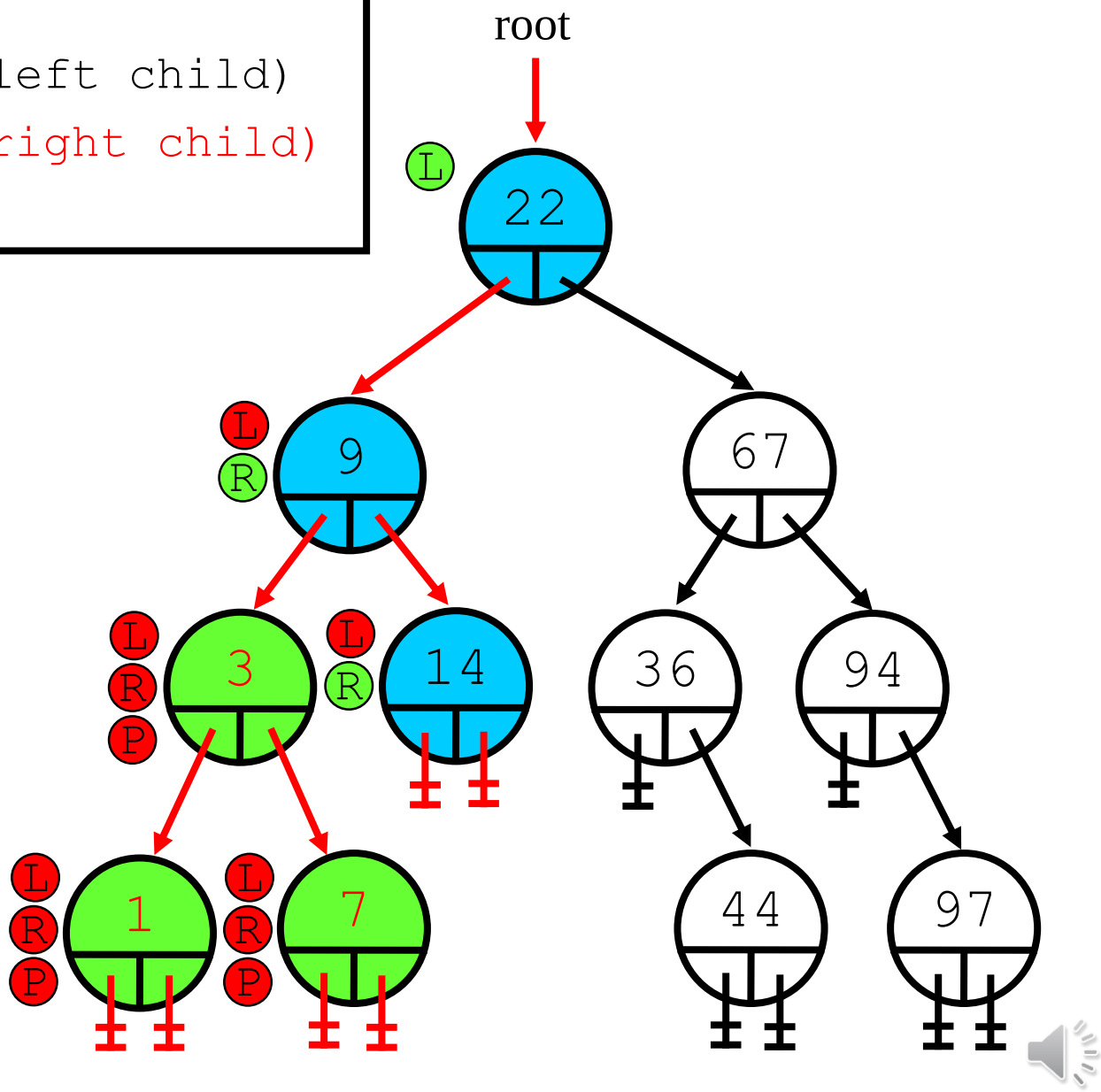
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



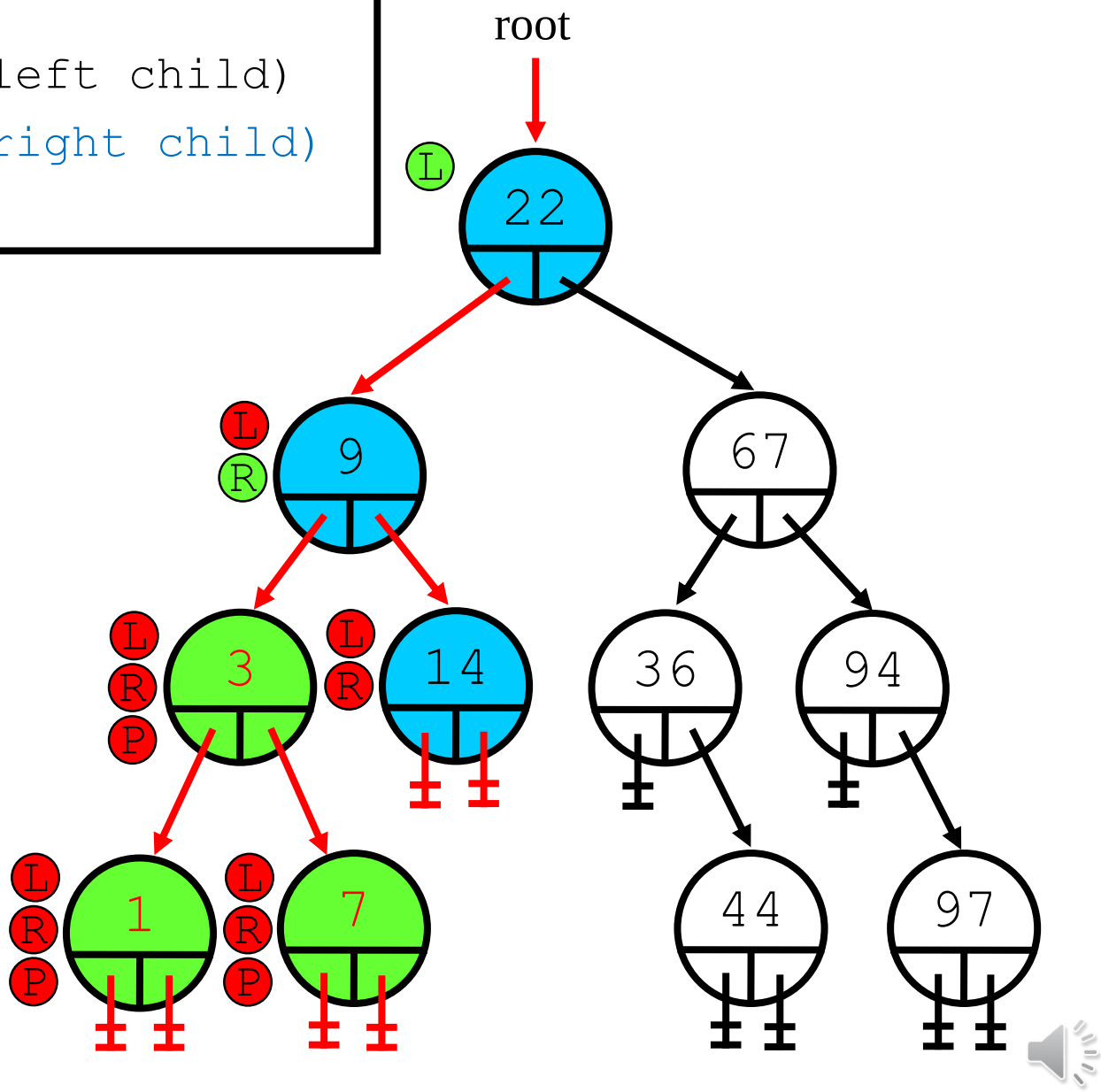
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



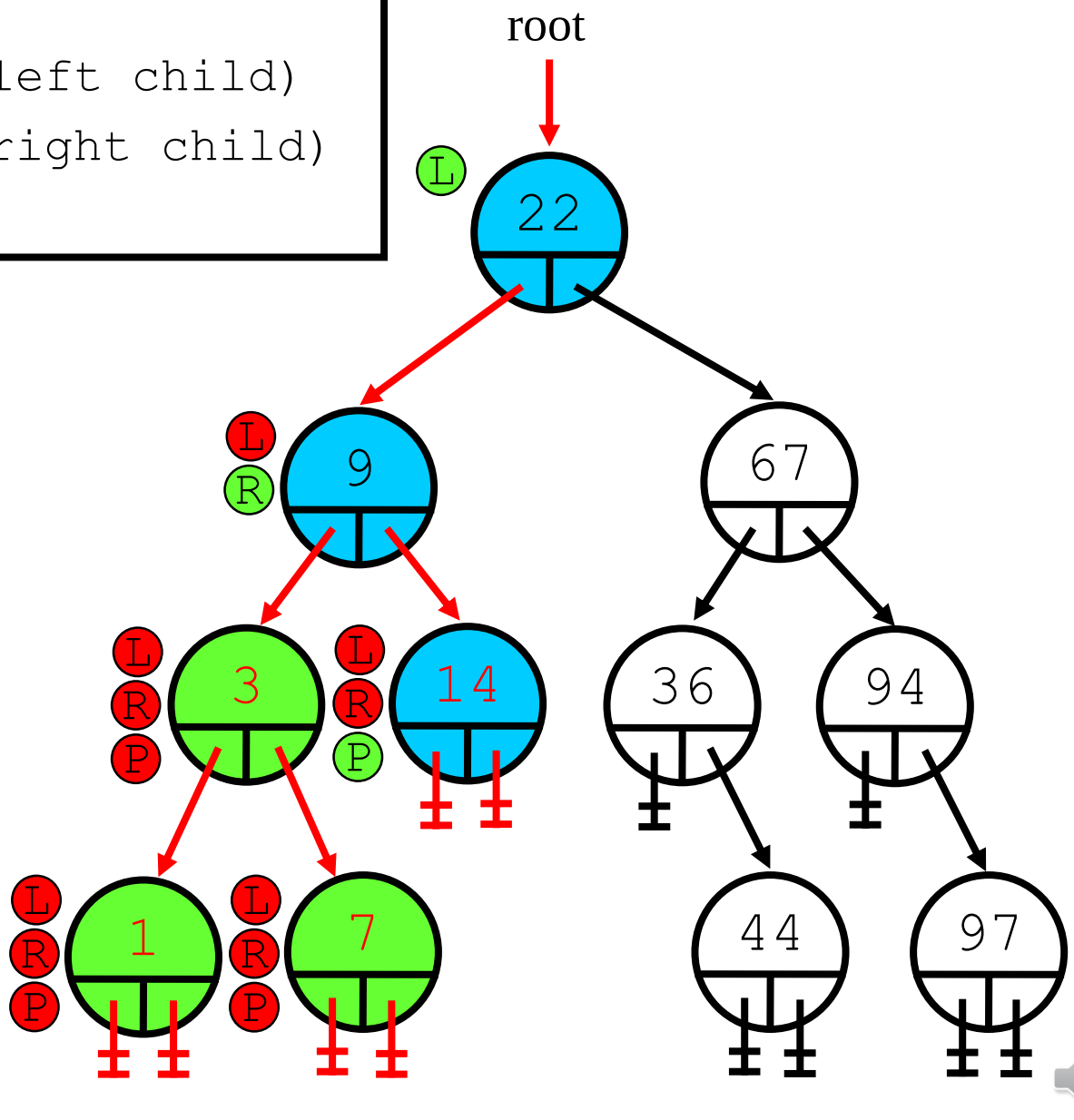
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3
```



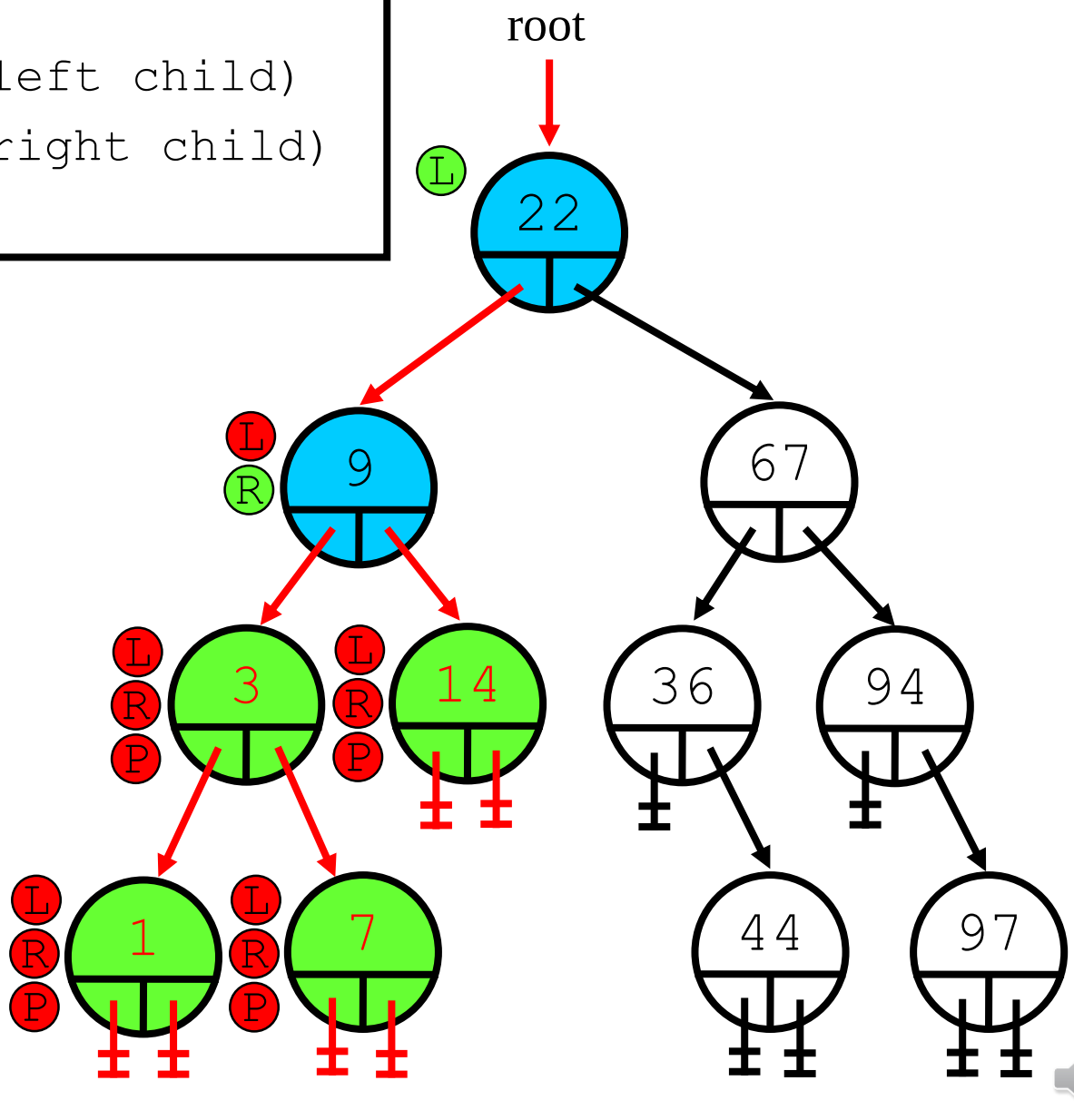
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14
```



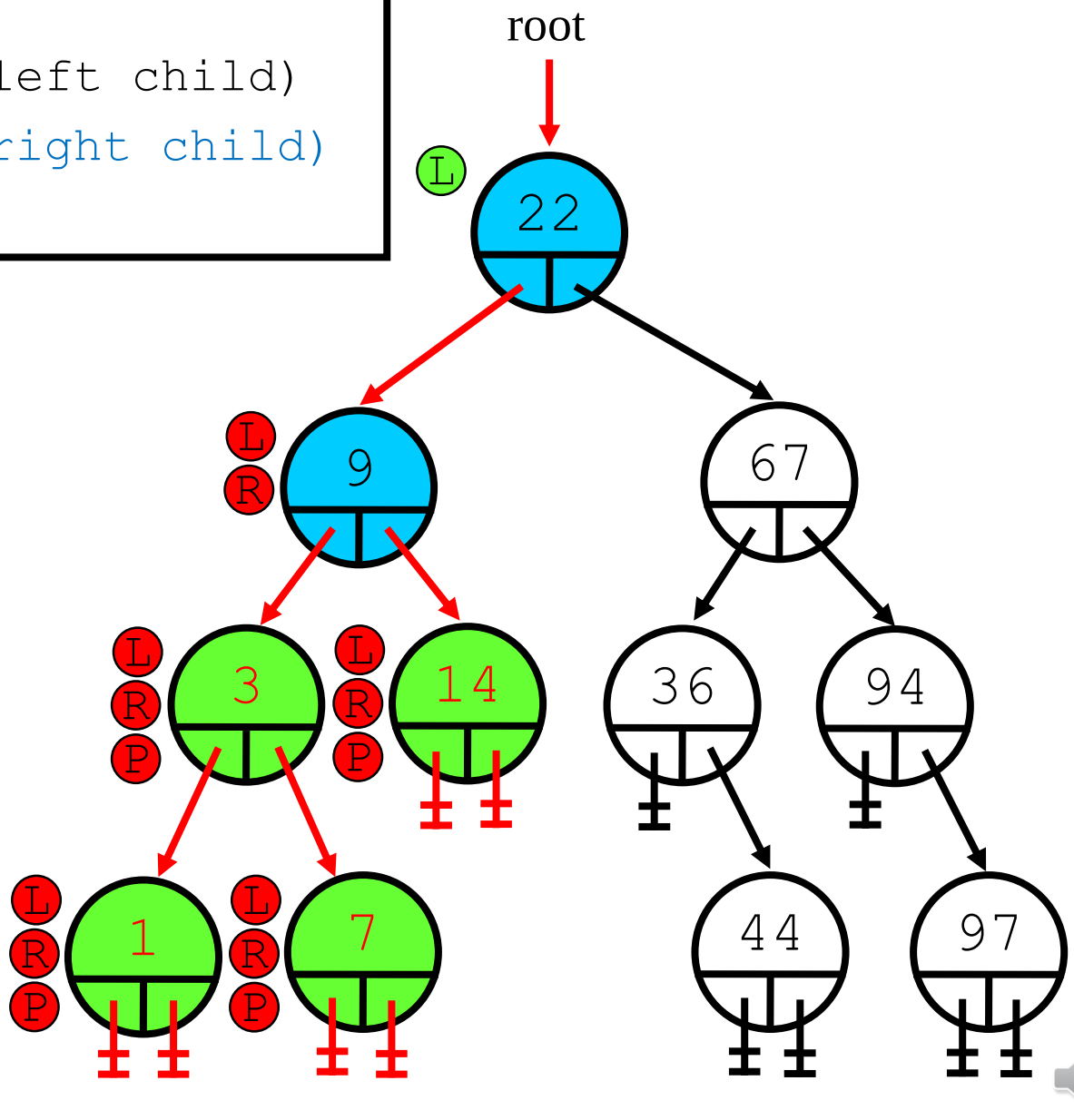
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14
```



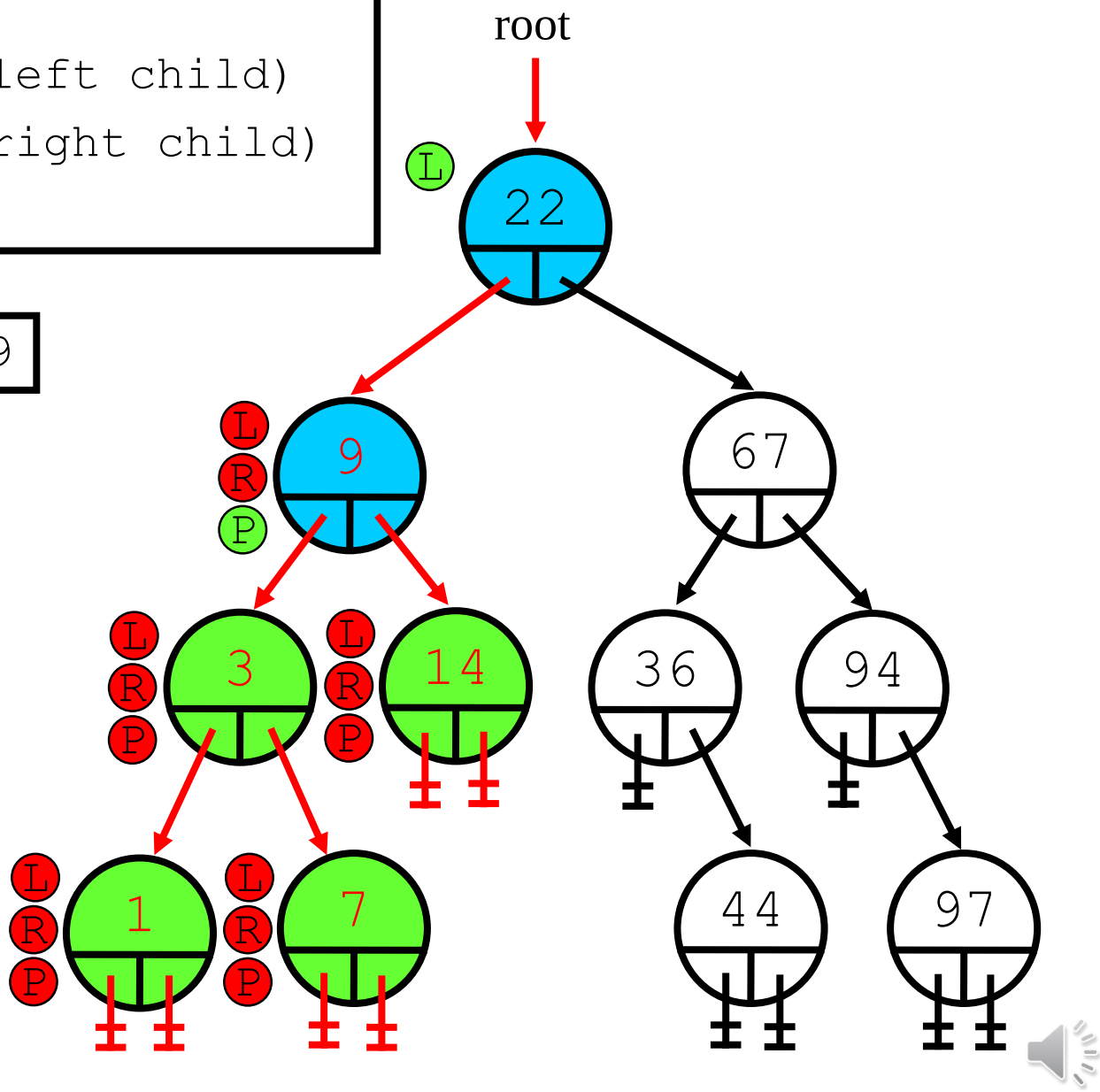
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14
```



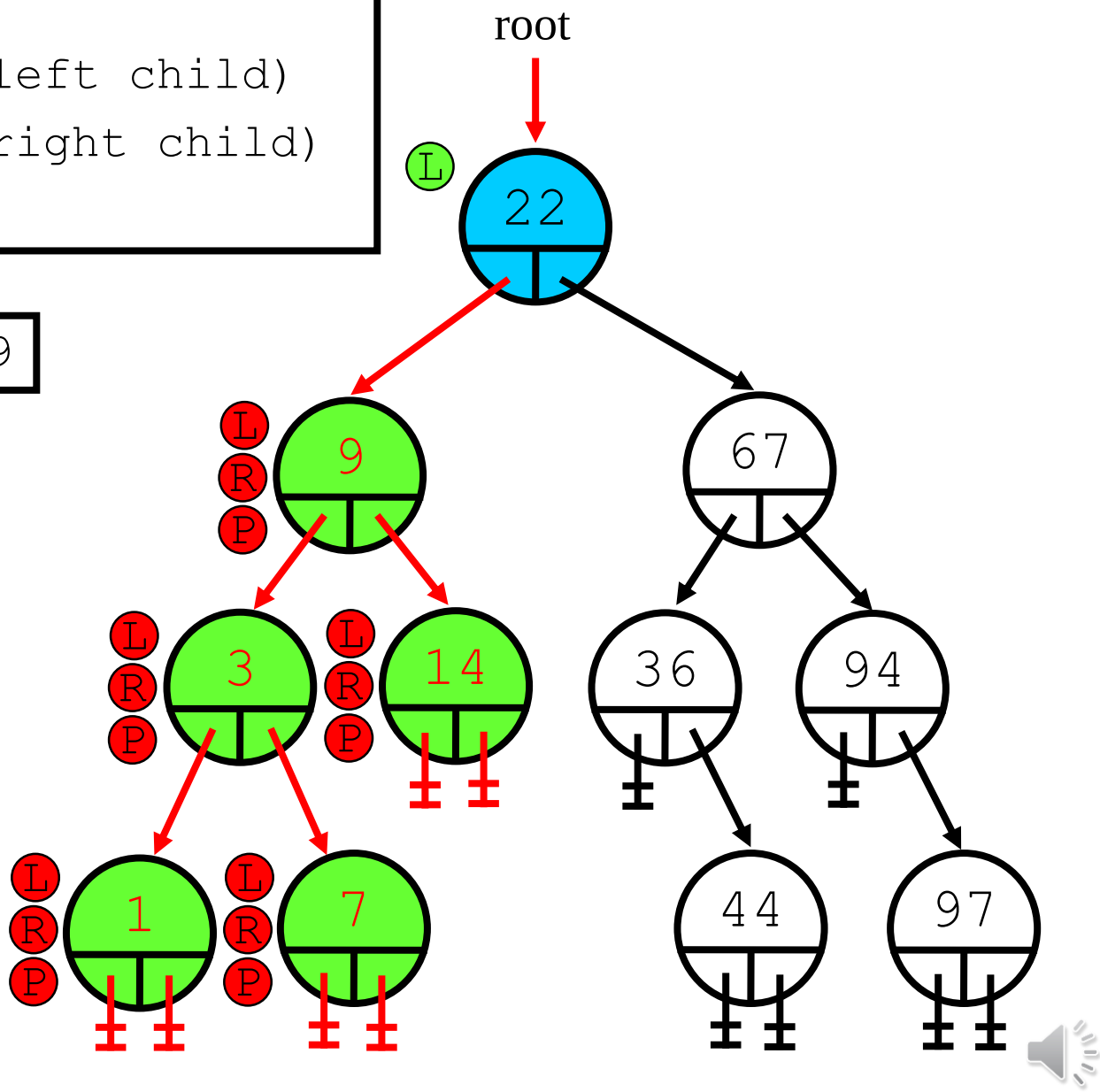
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



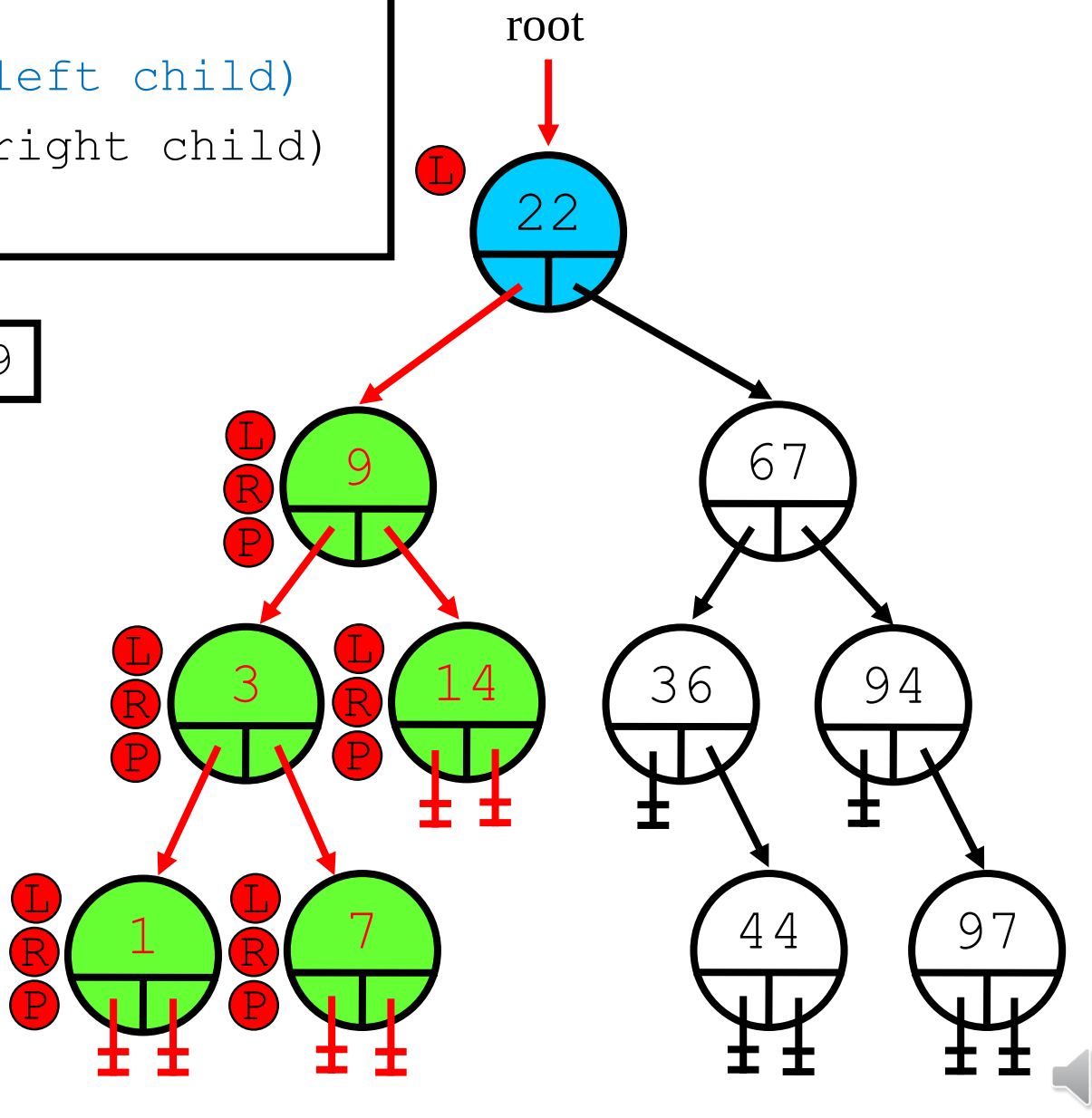
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



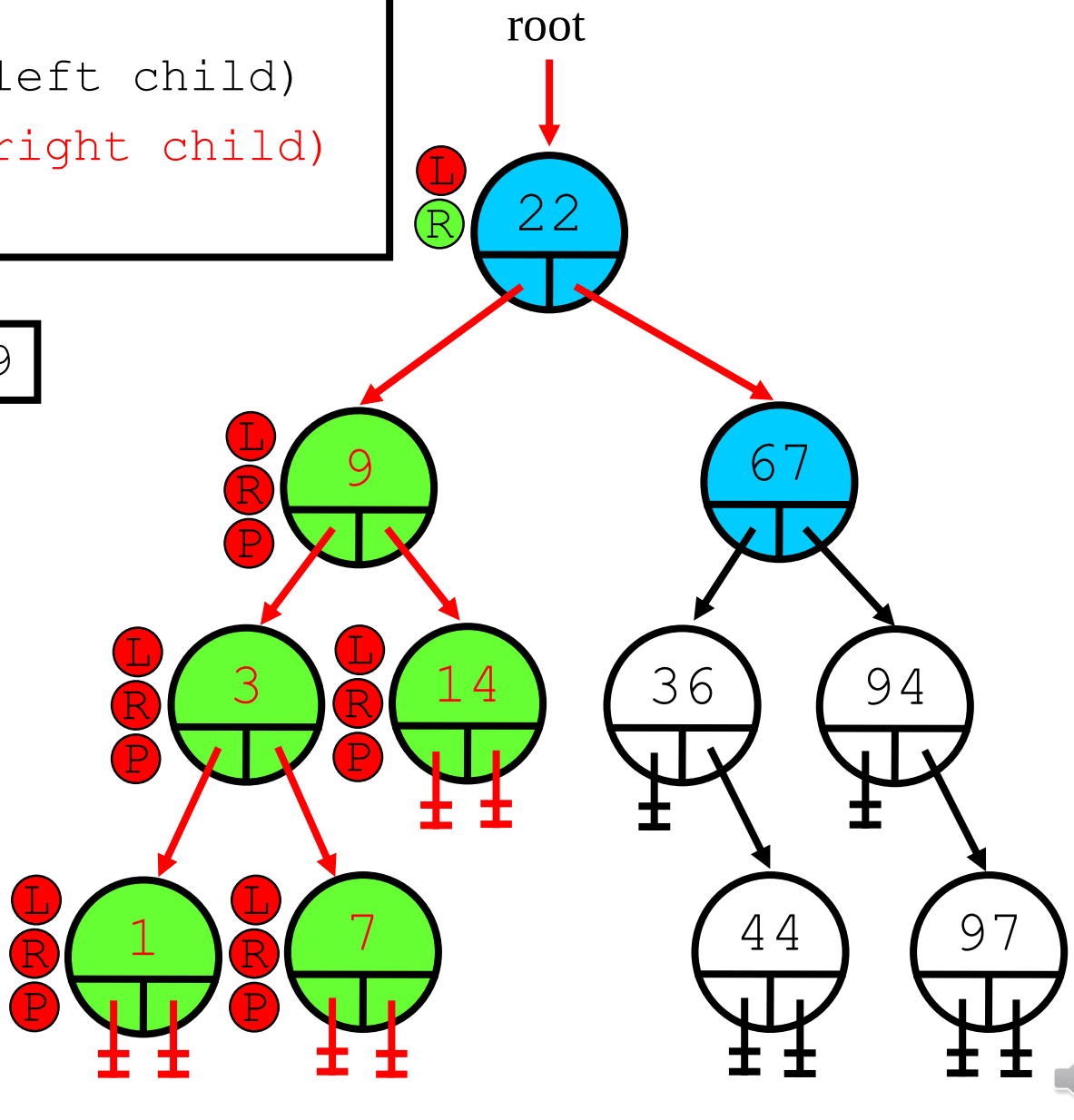
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



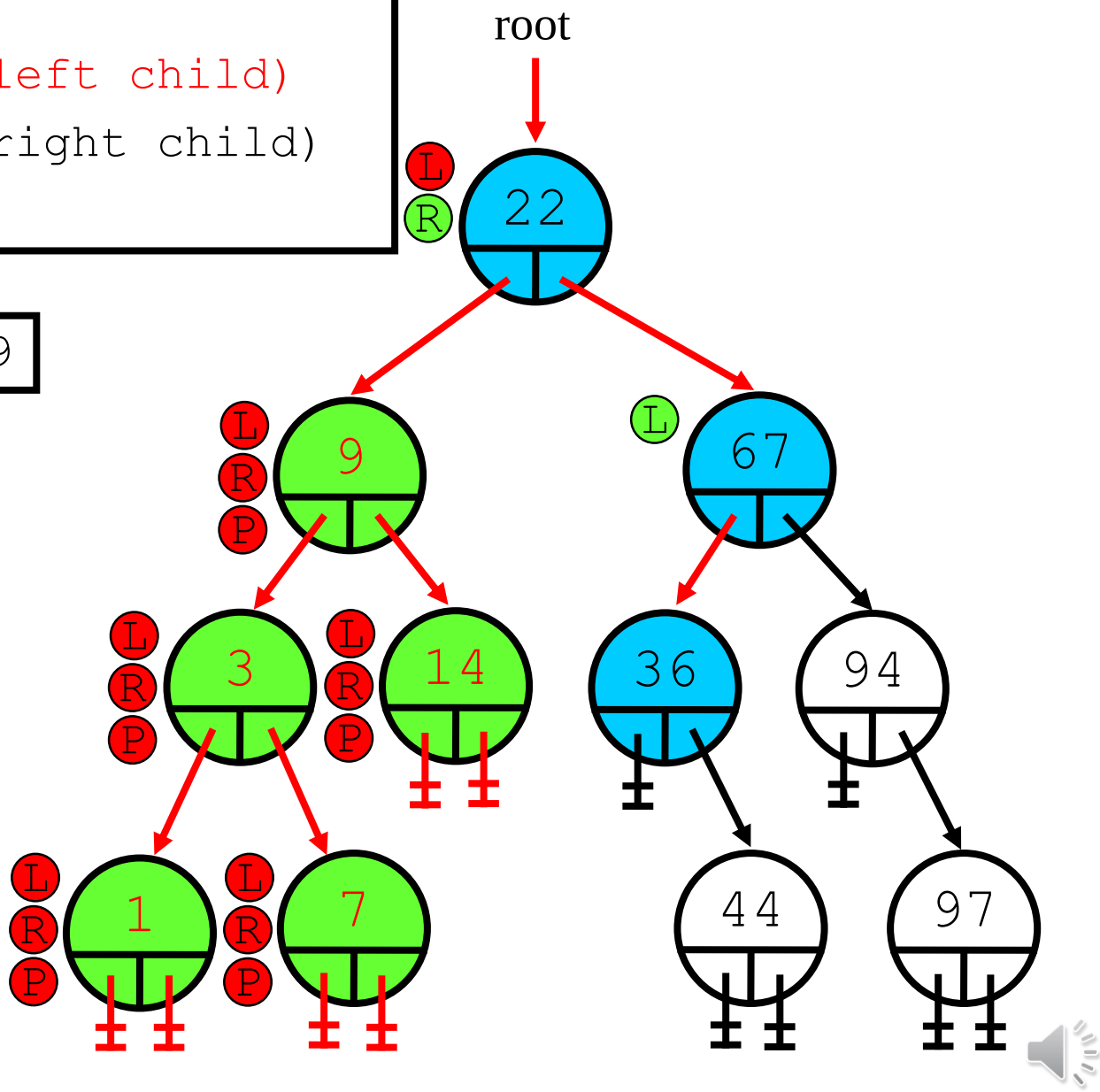
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



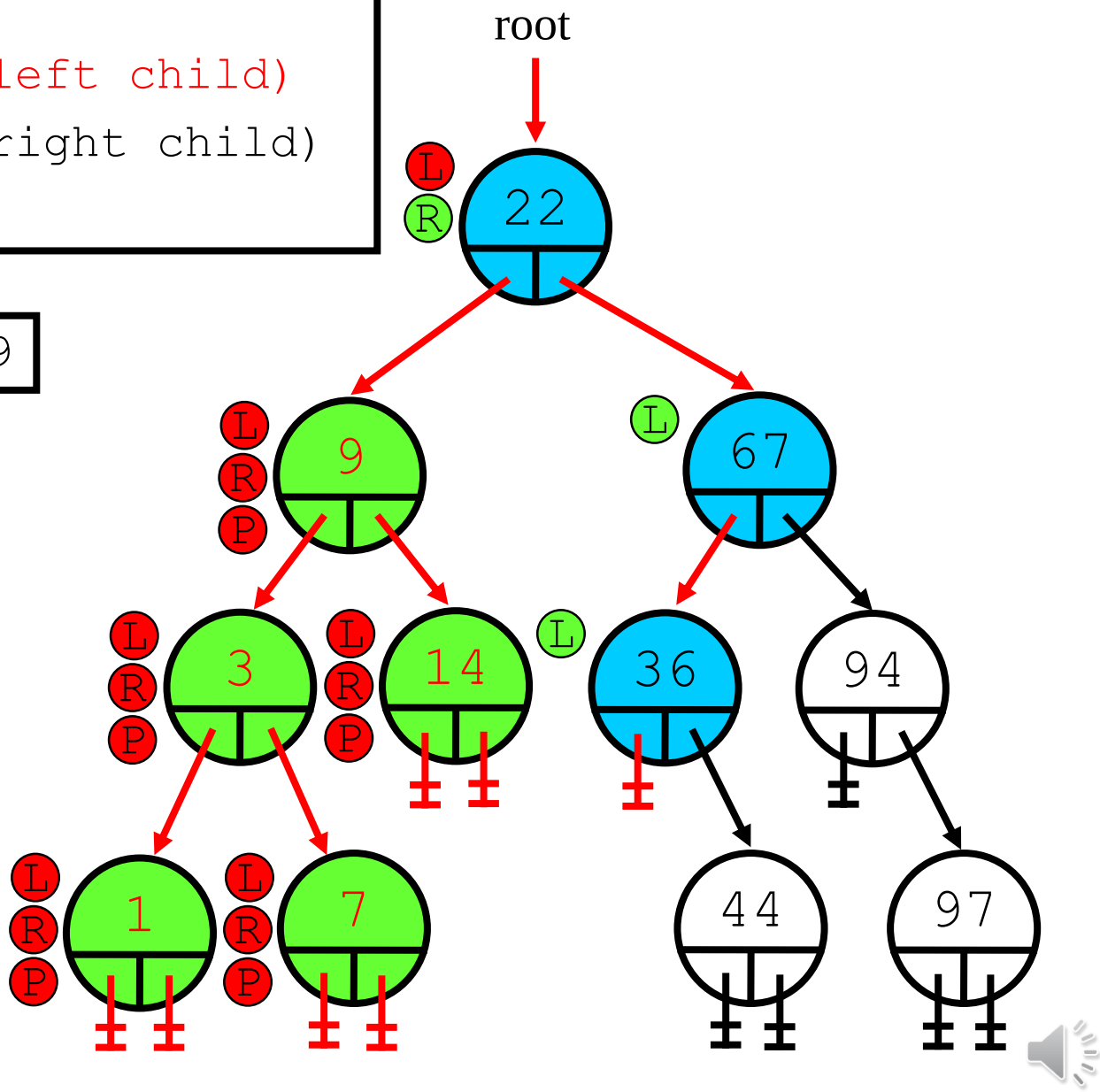
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



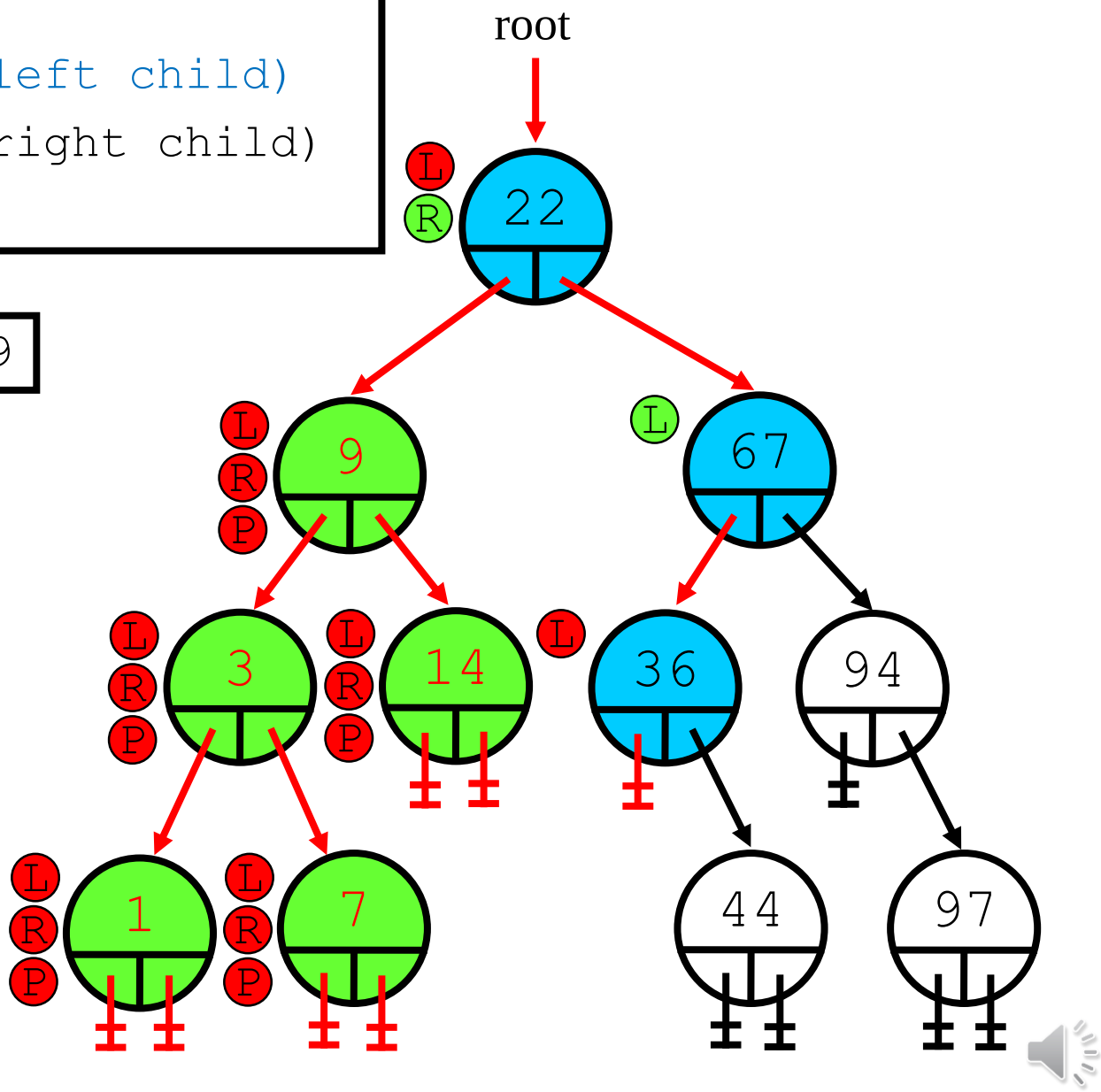
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



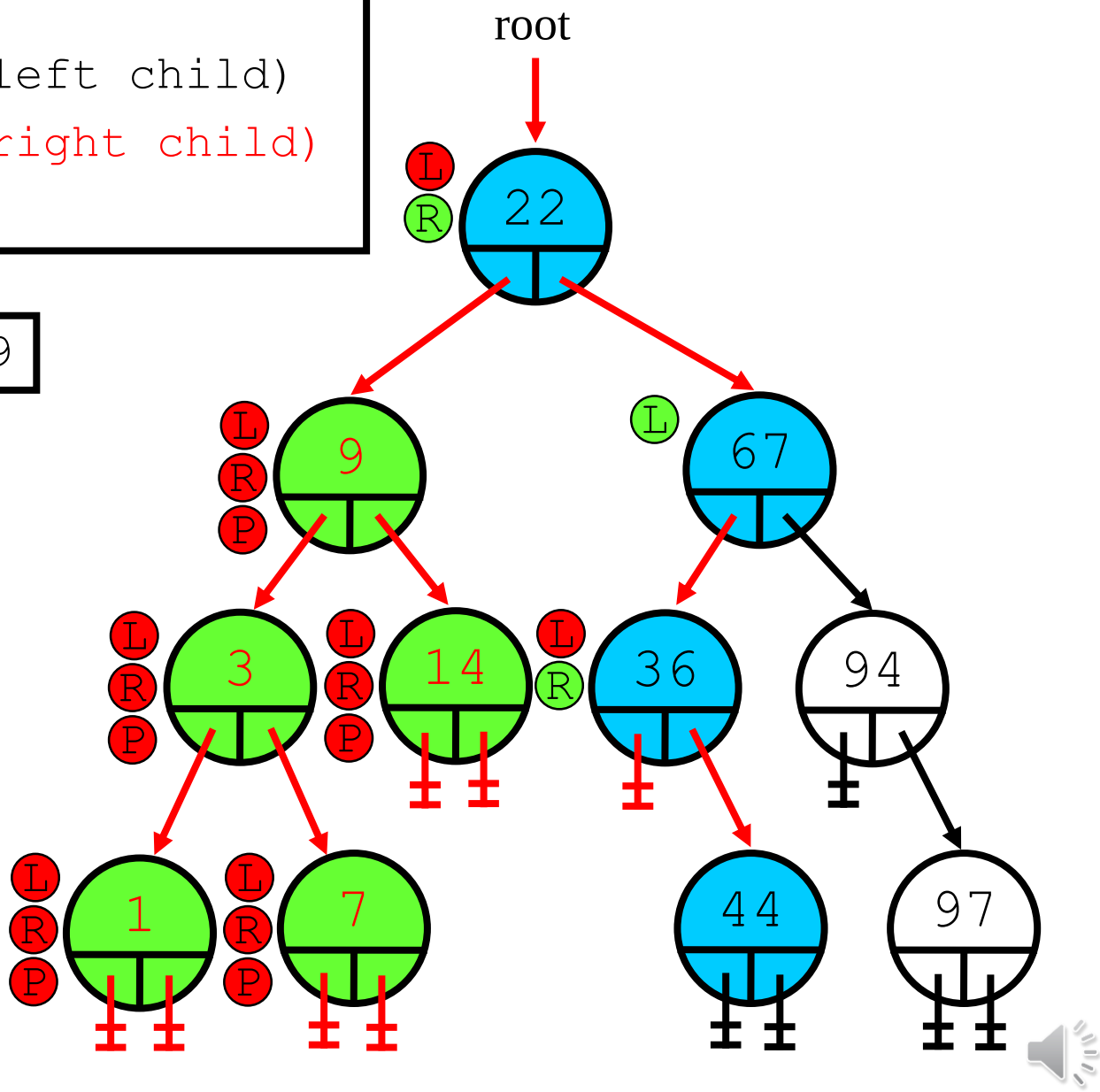
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



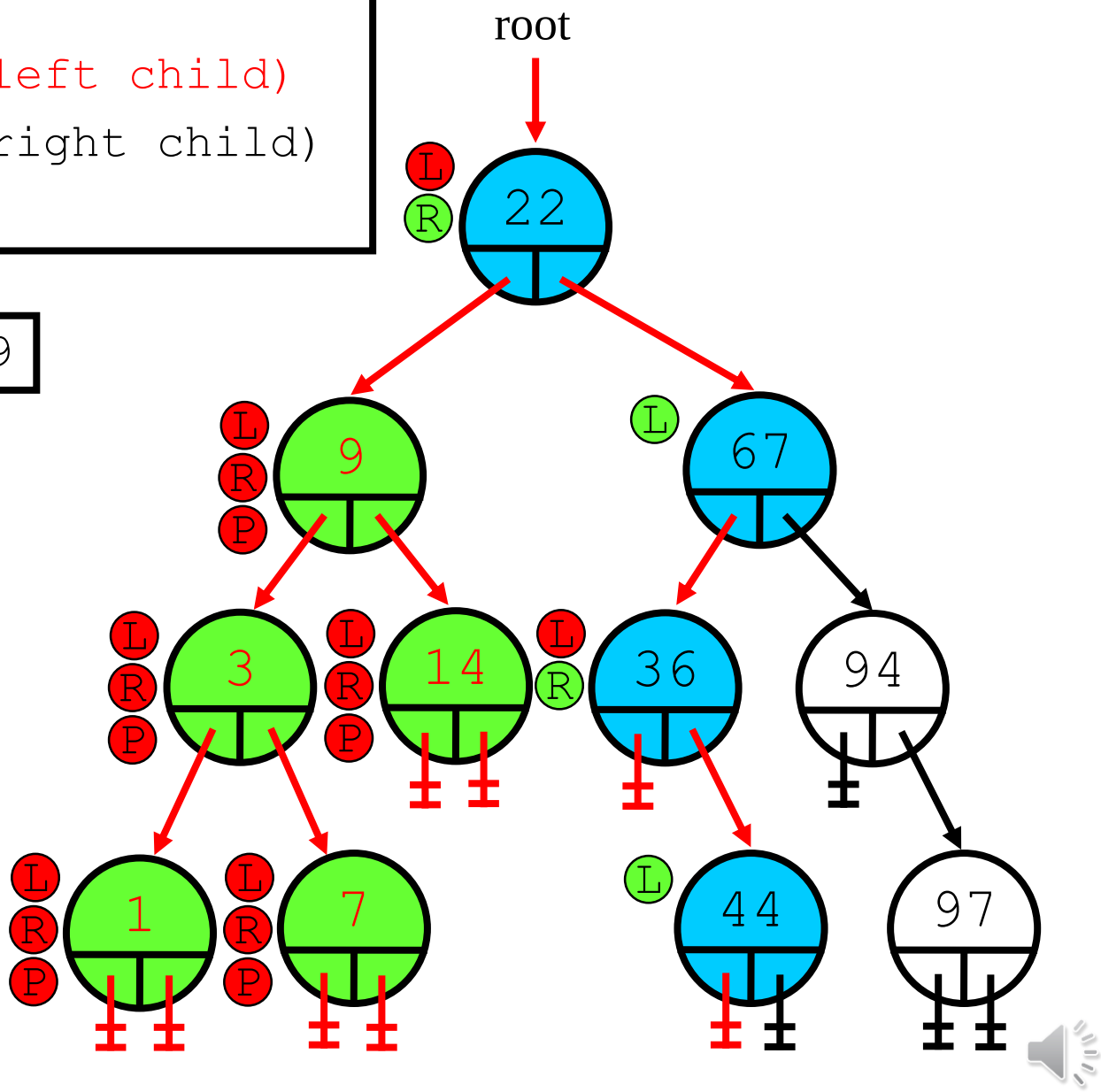
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



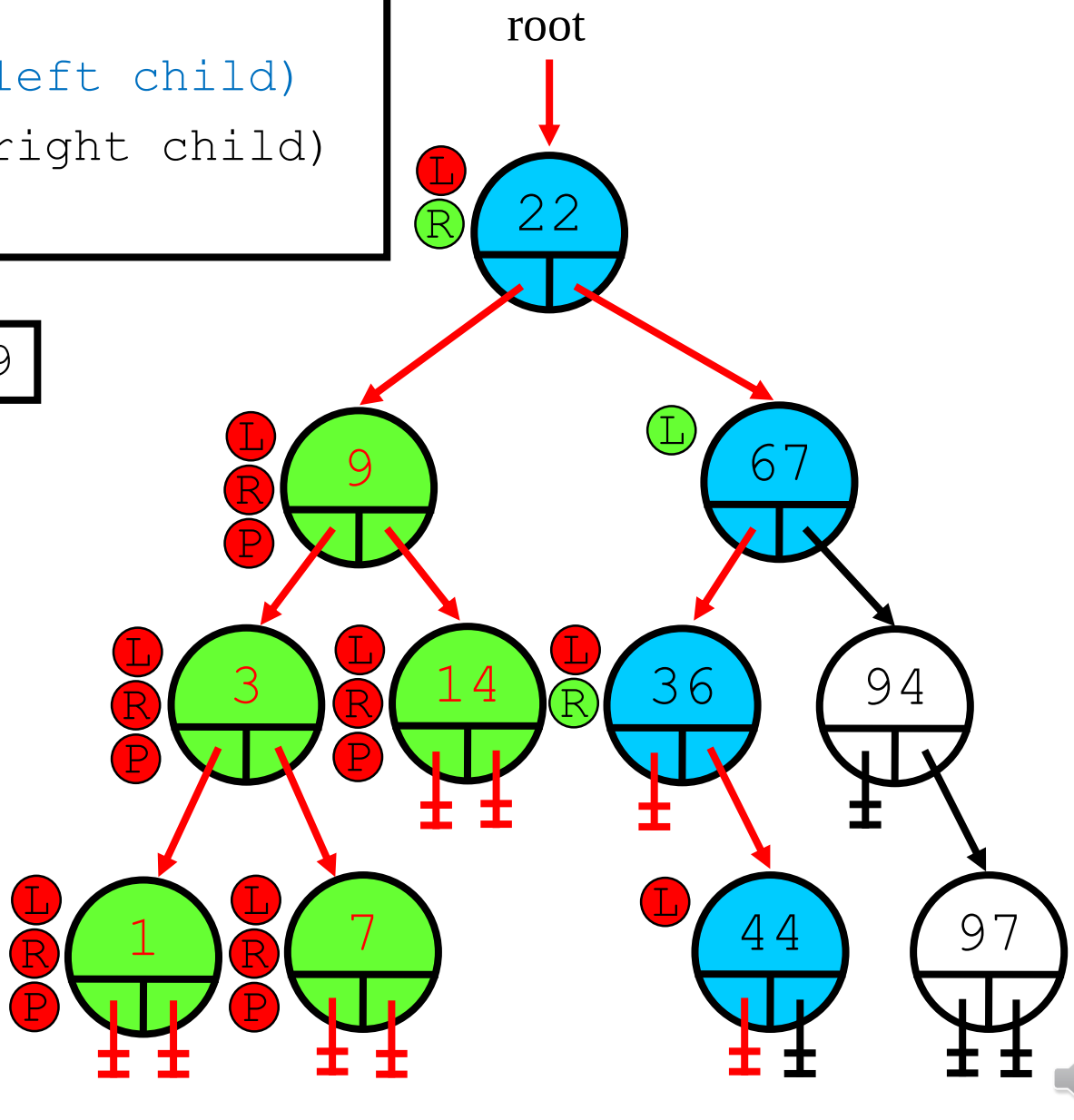
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



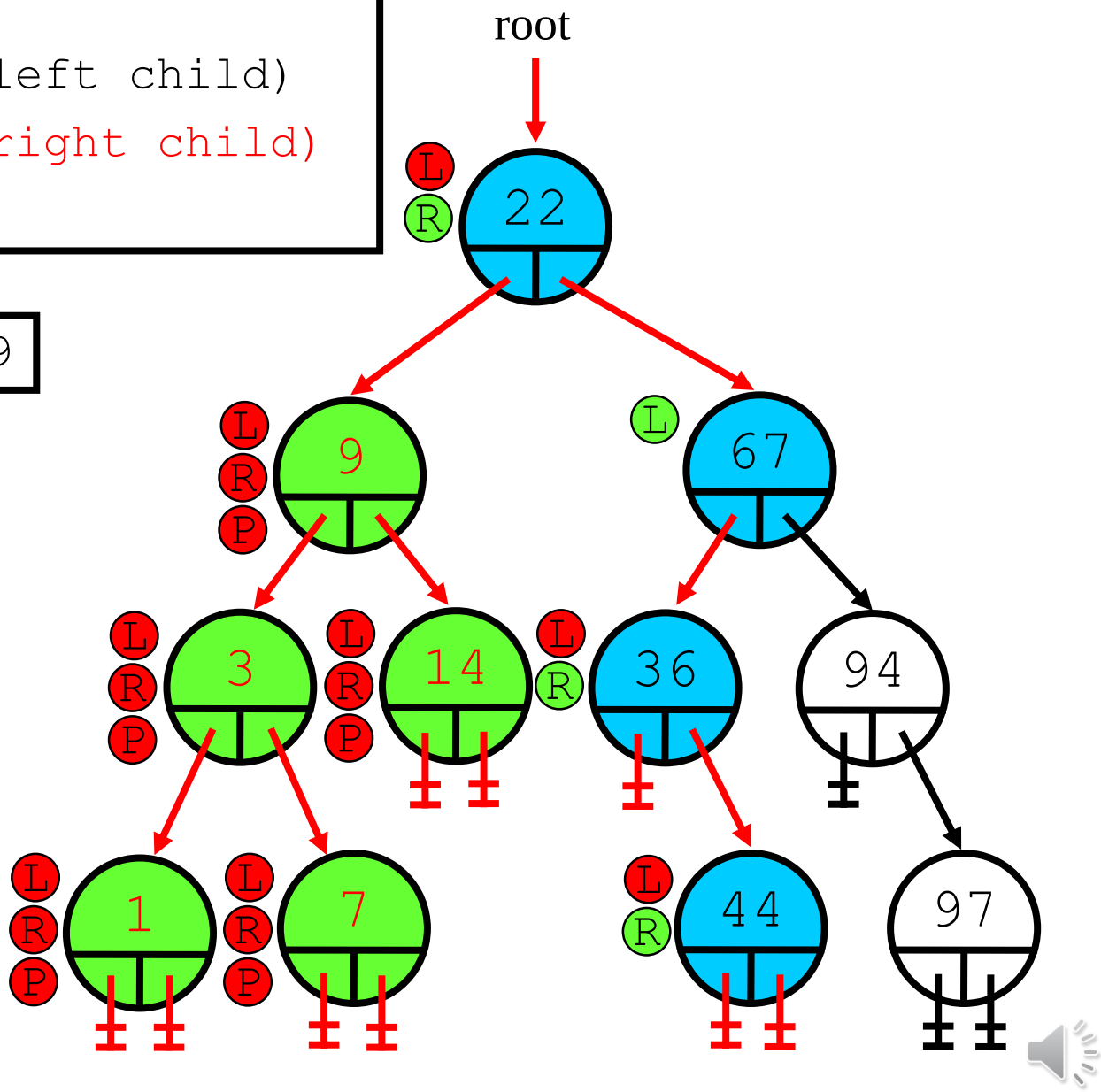
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



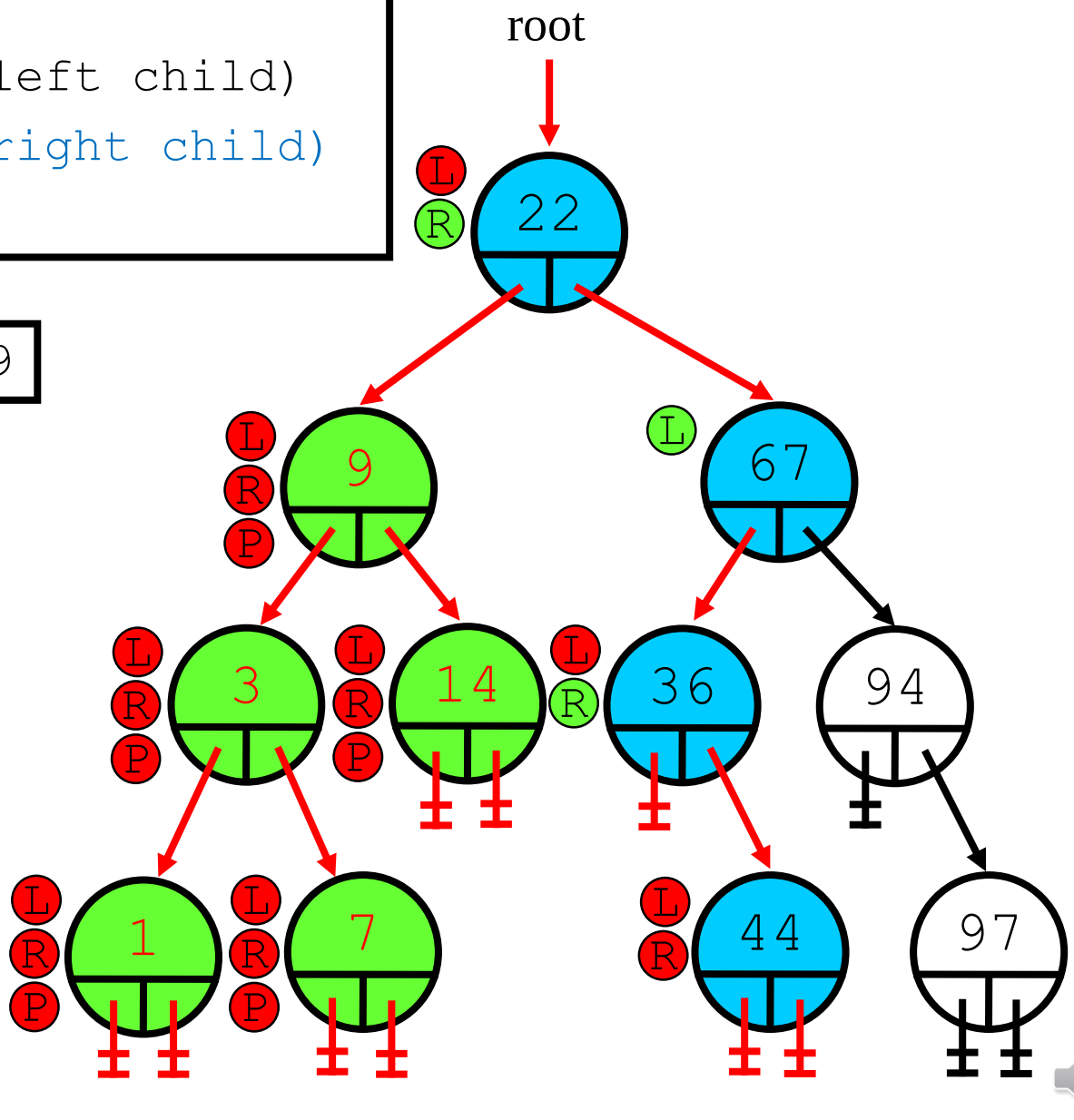
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



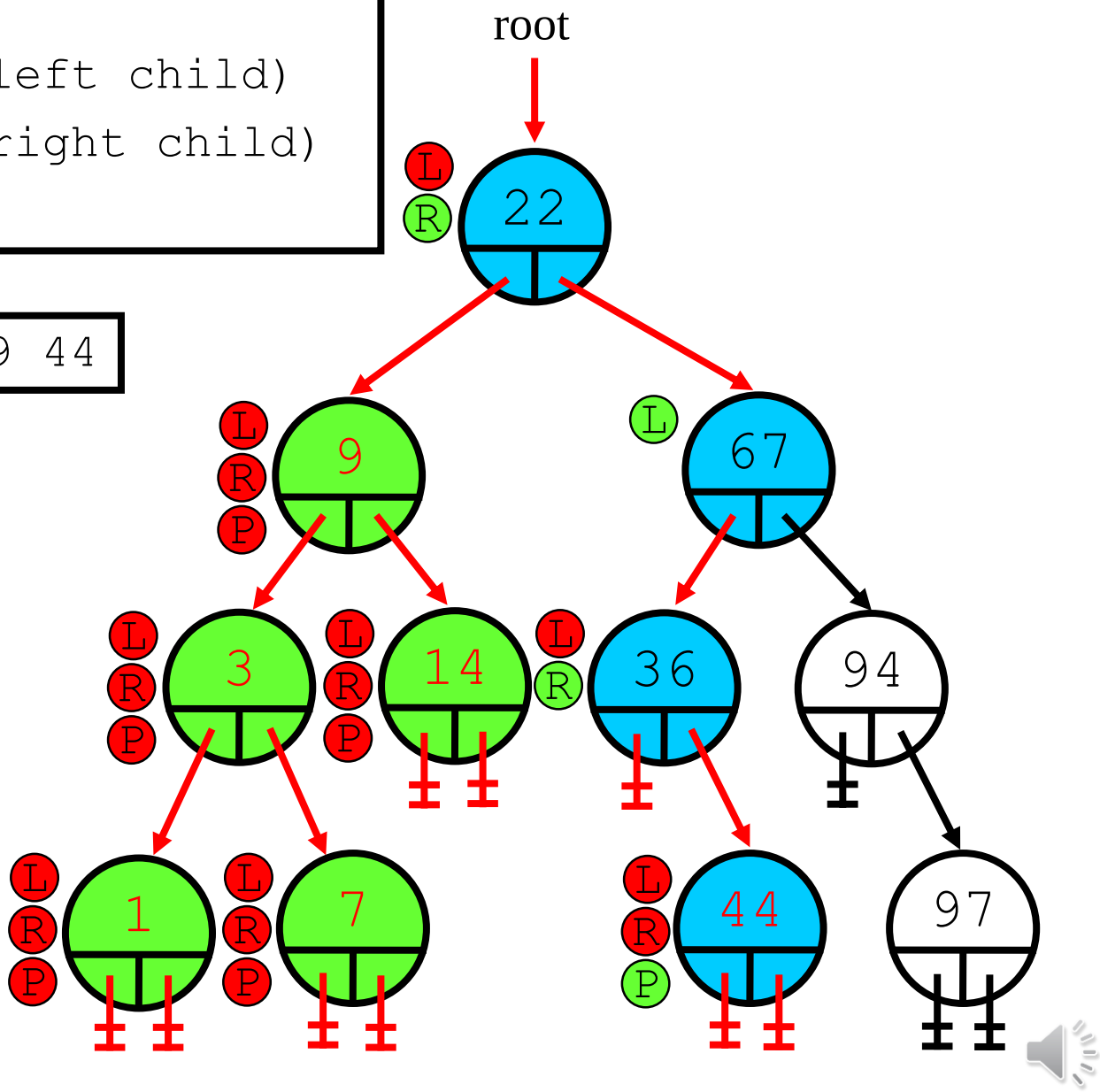
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9
```



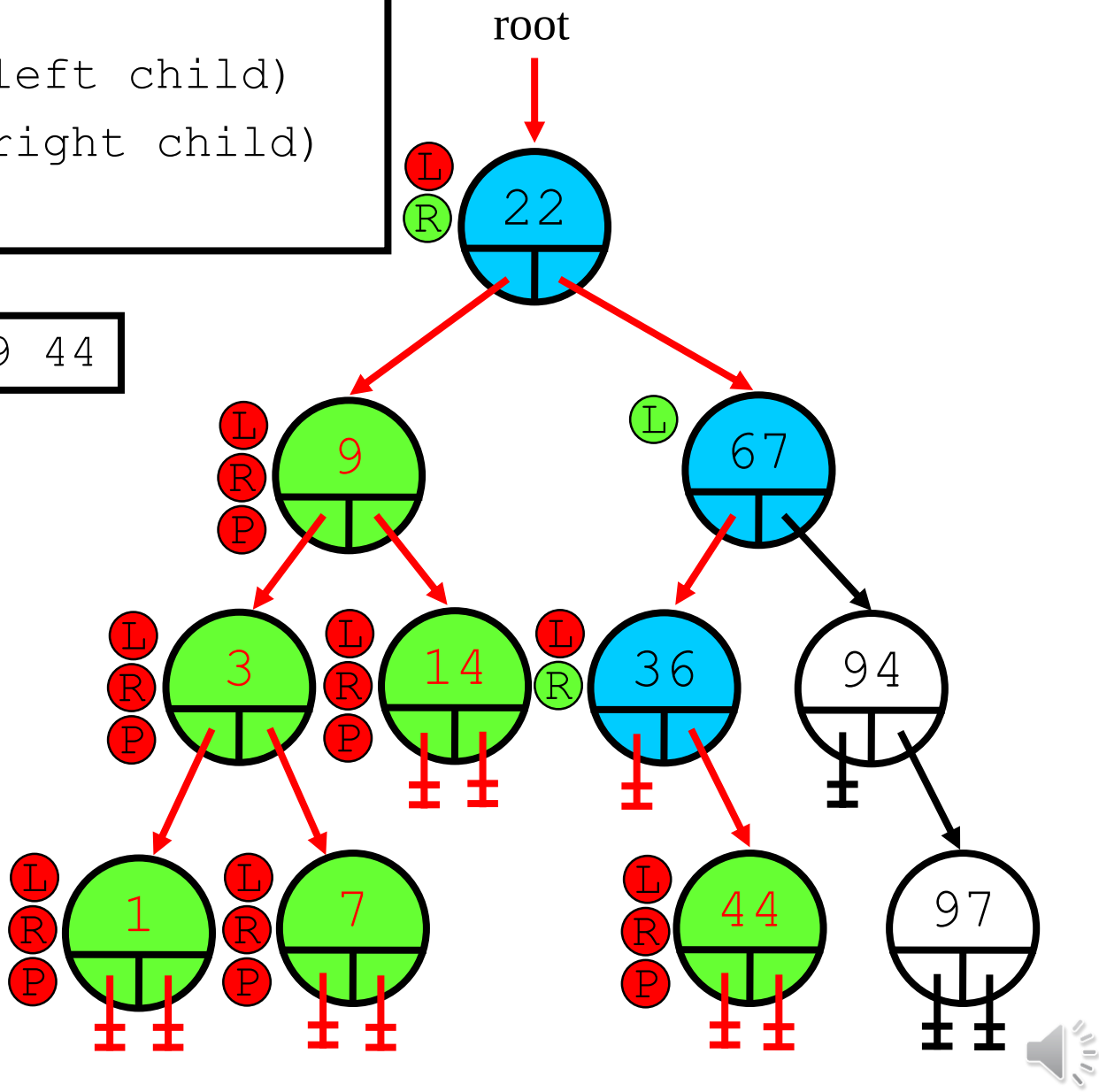
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44
```



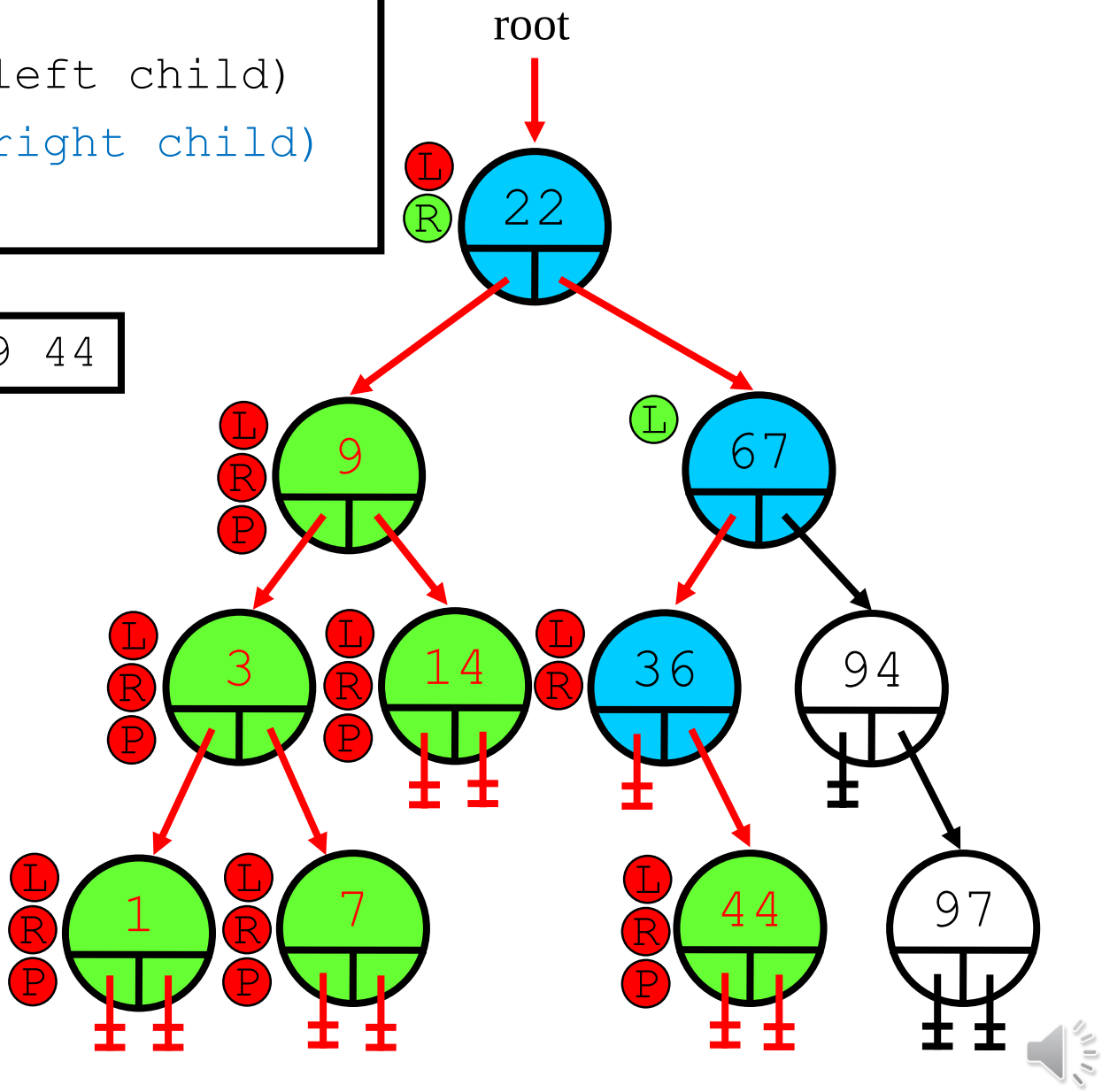
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44
```



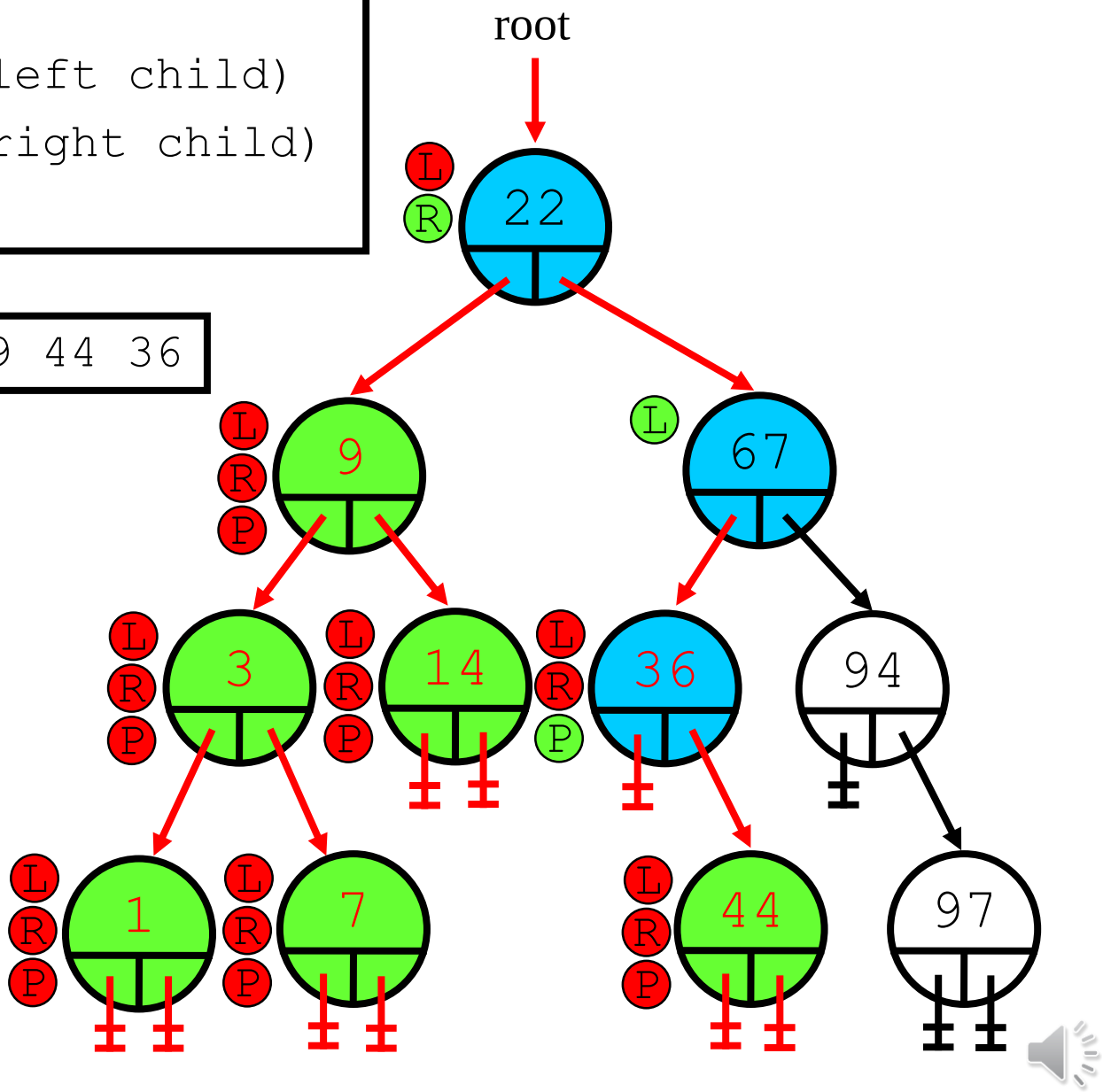
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44
```



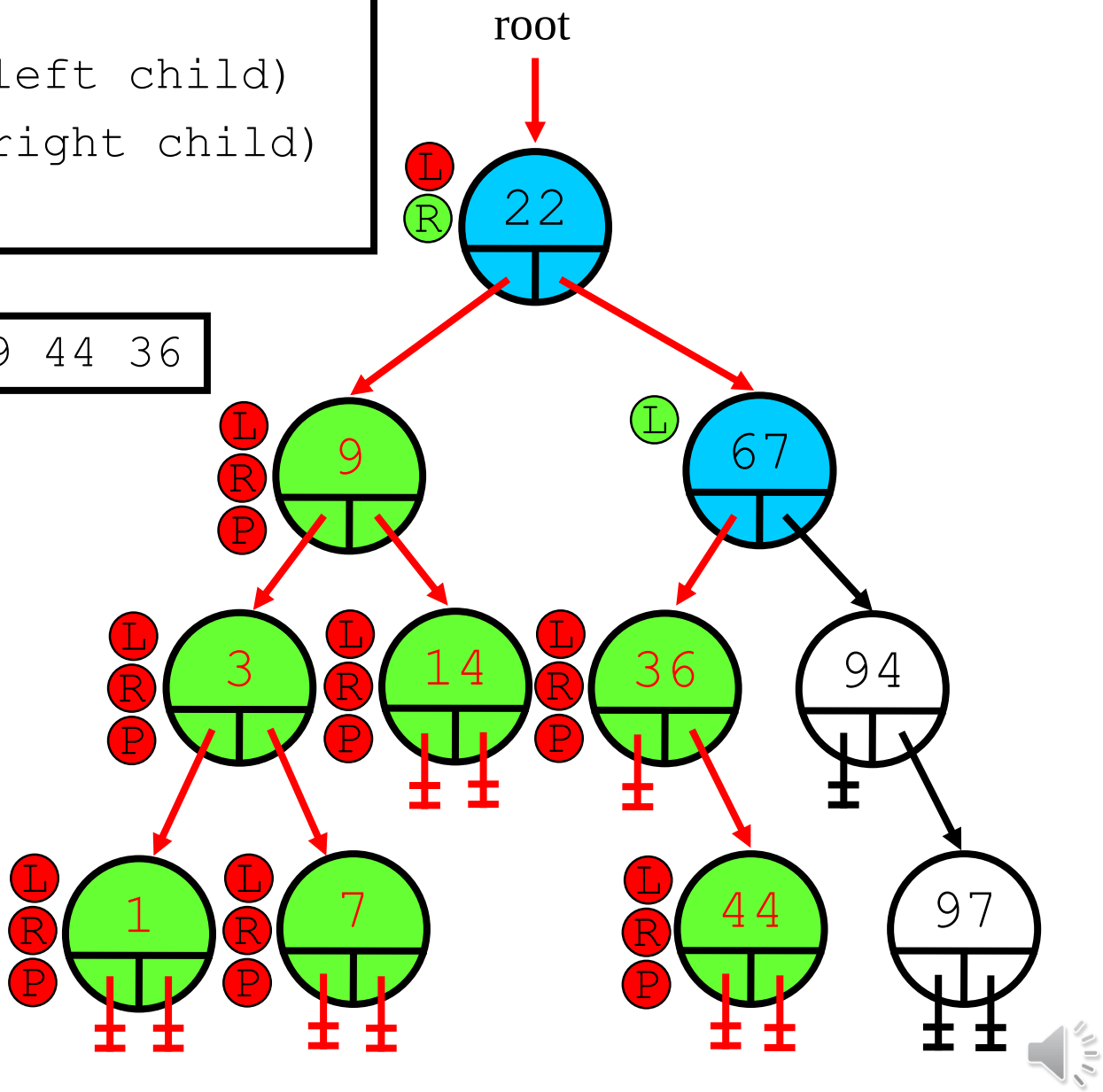
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



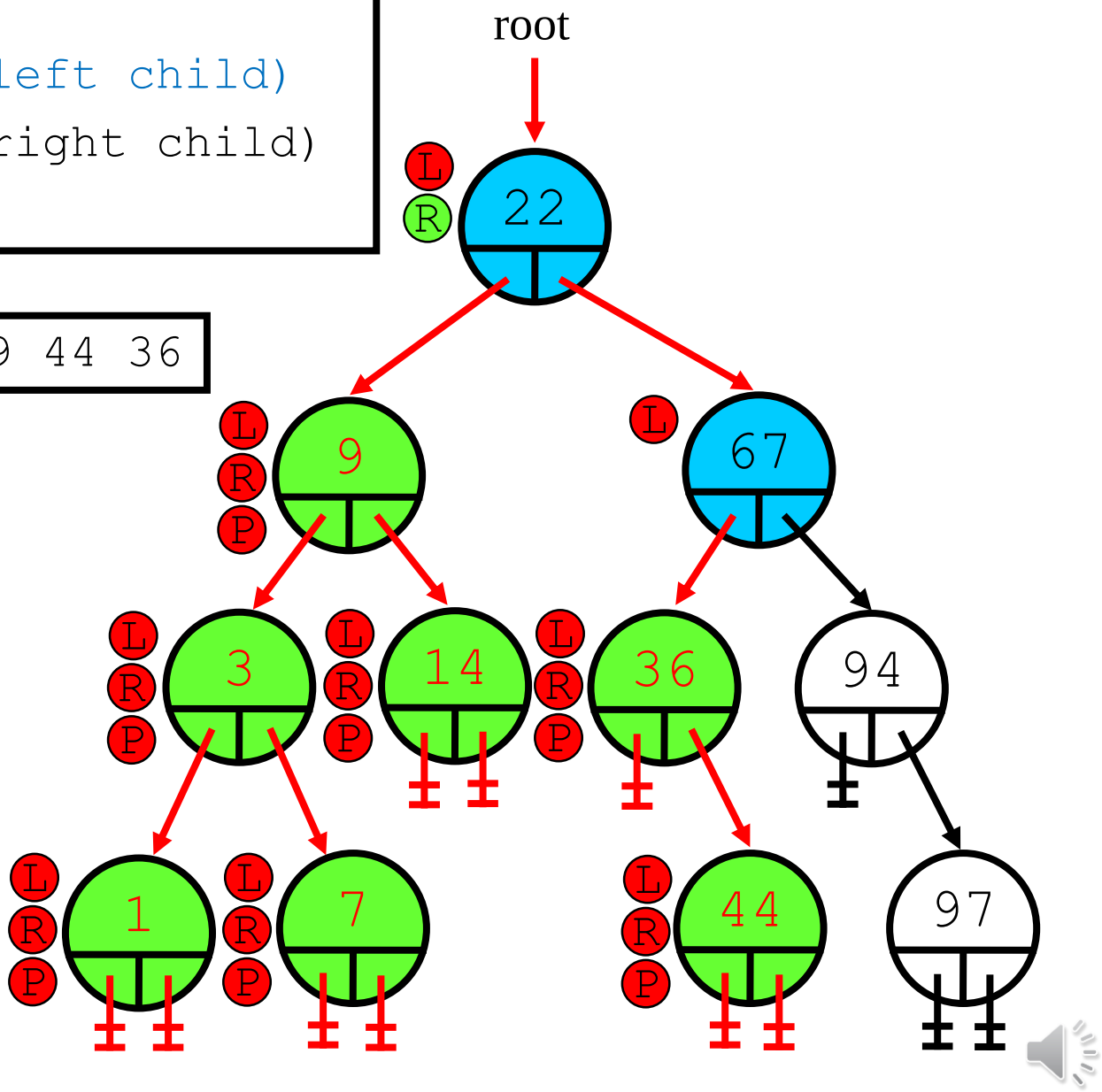
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



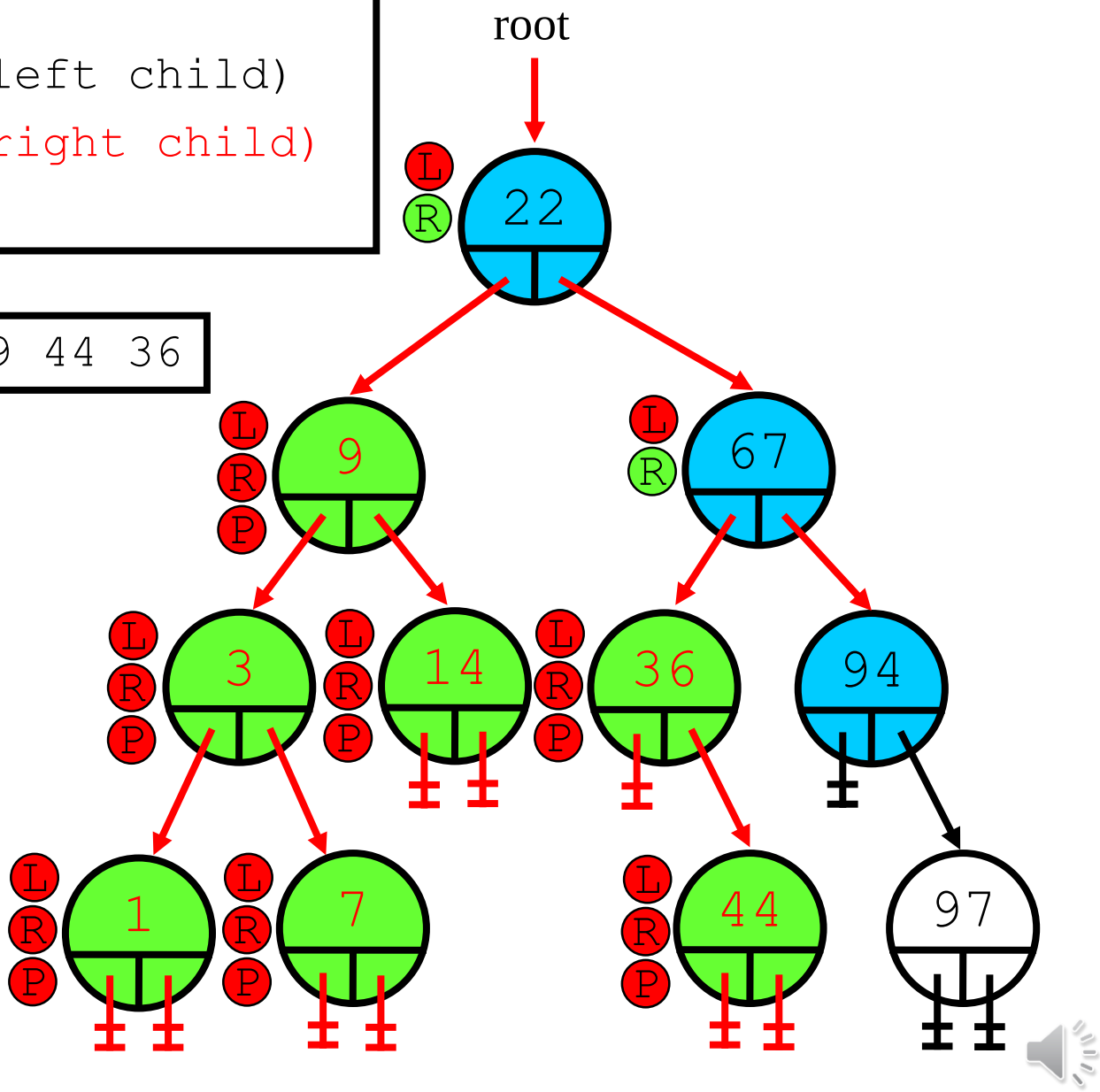
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



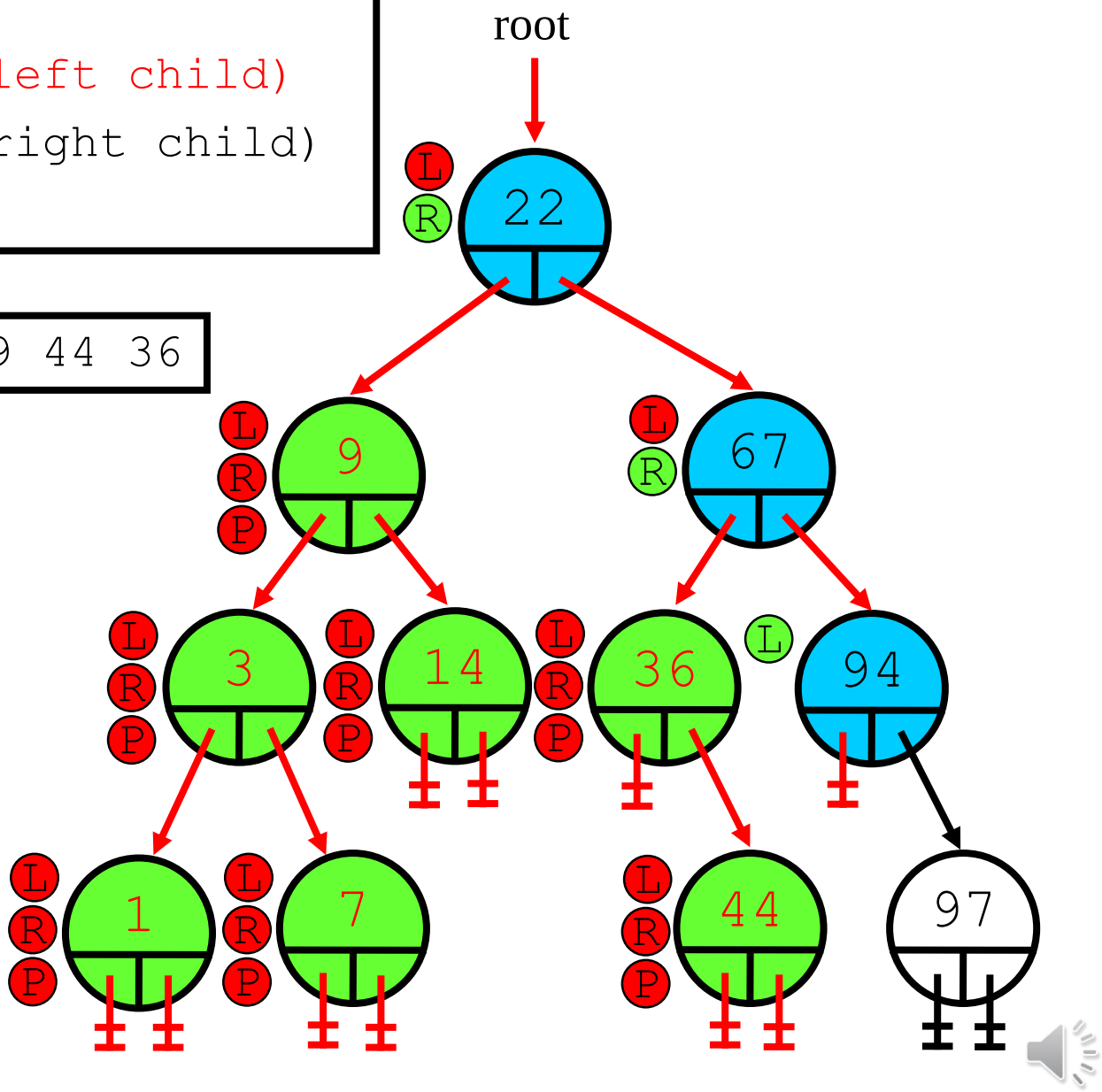
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



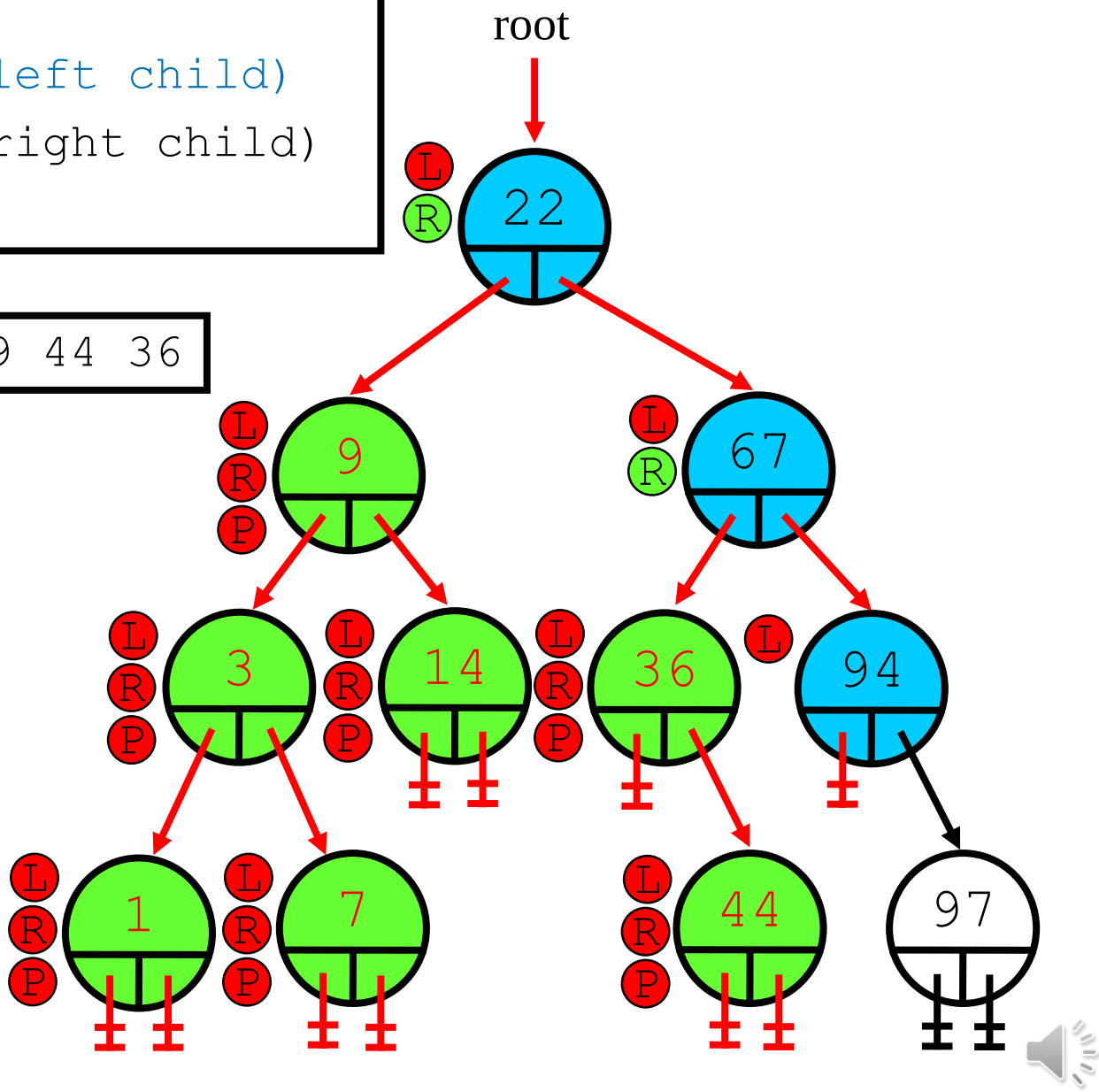
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



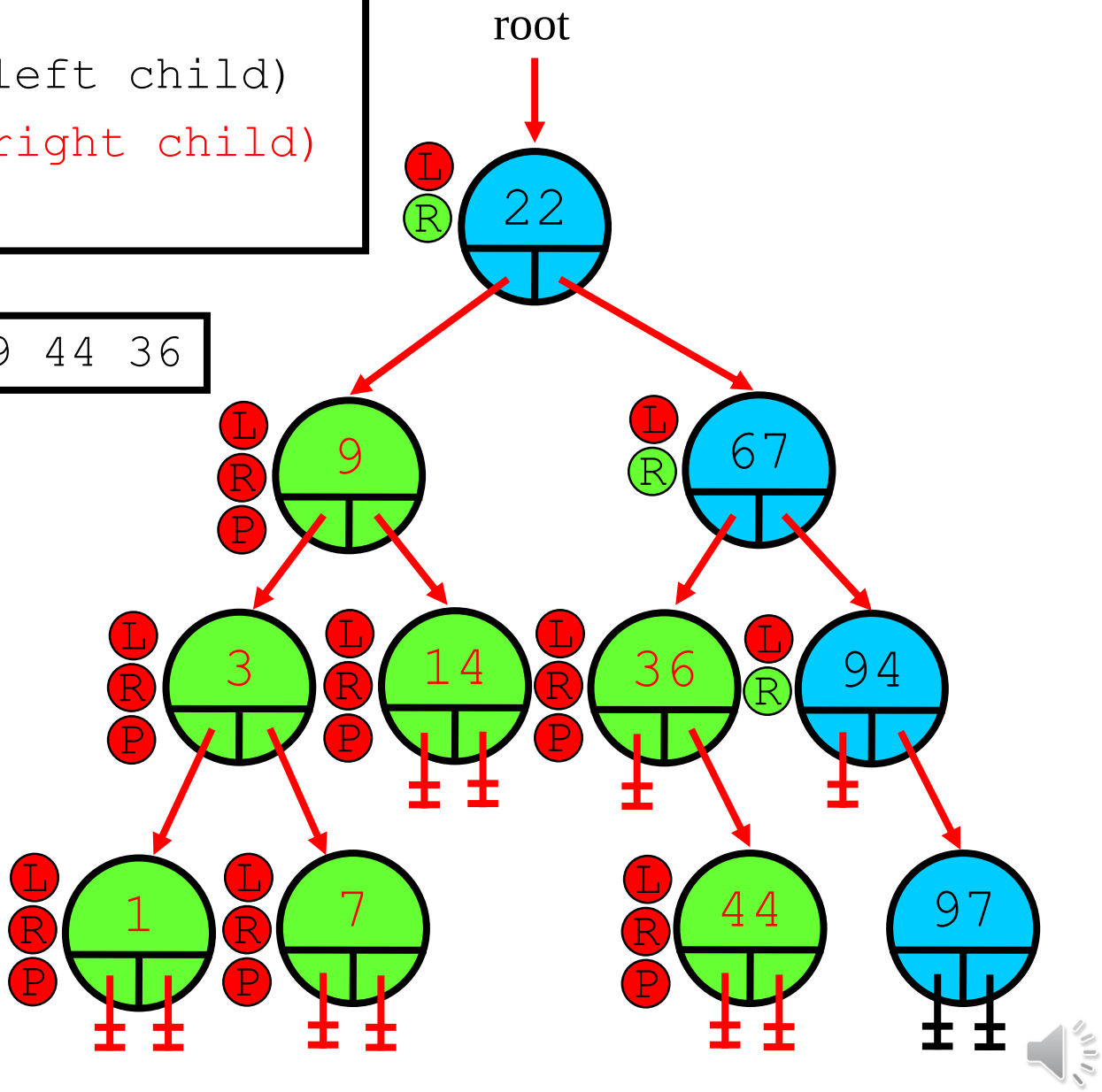
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



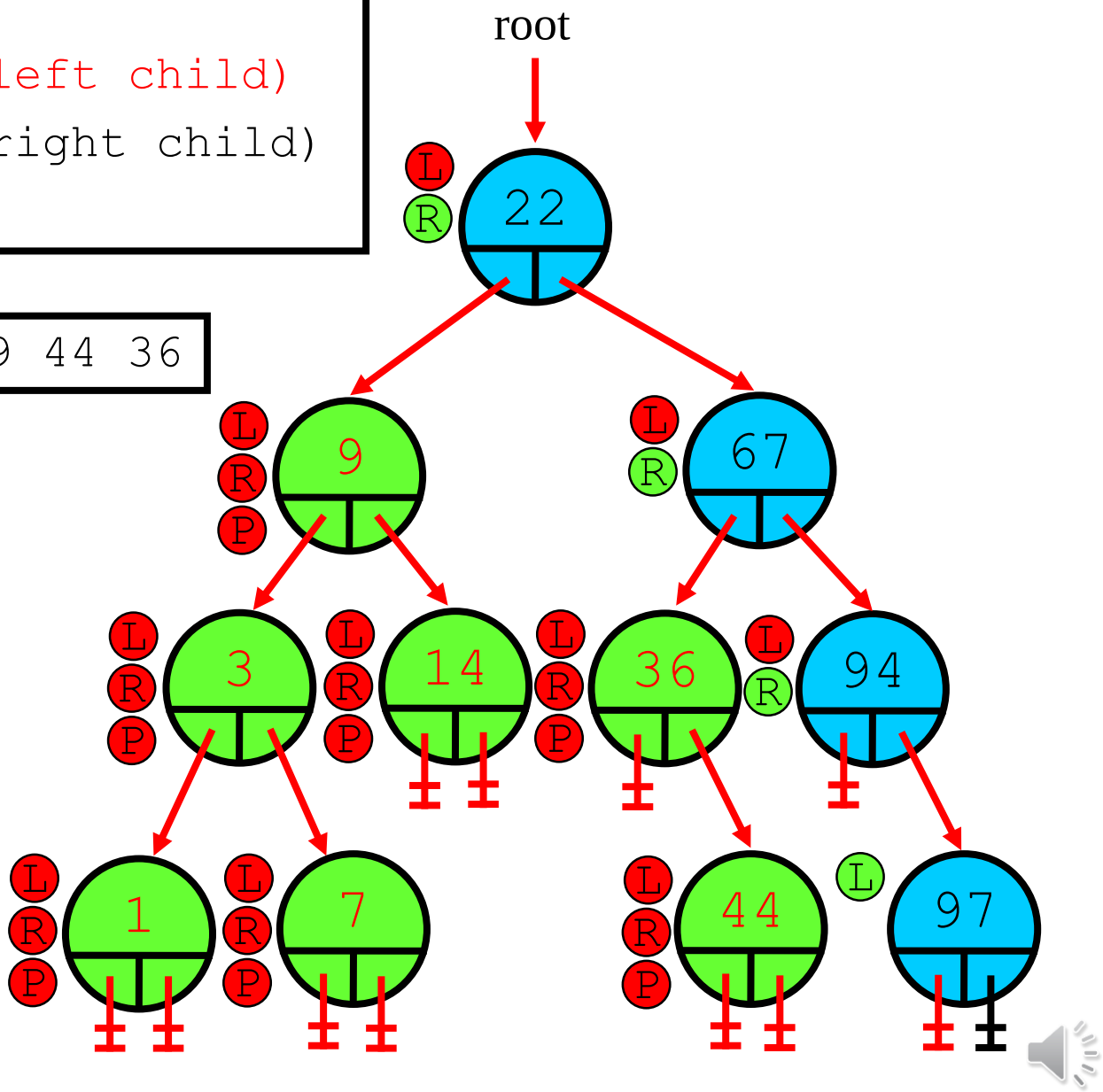
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



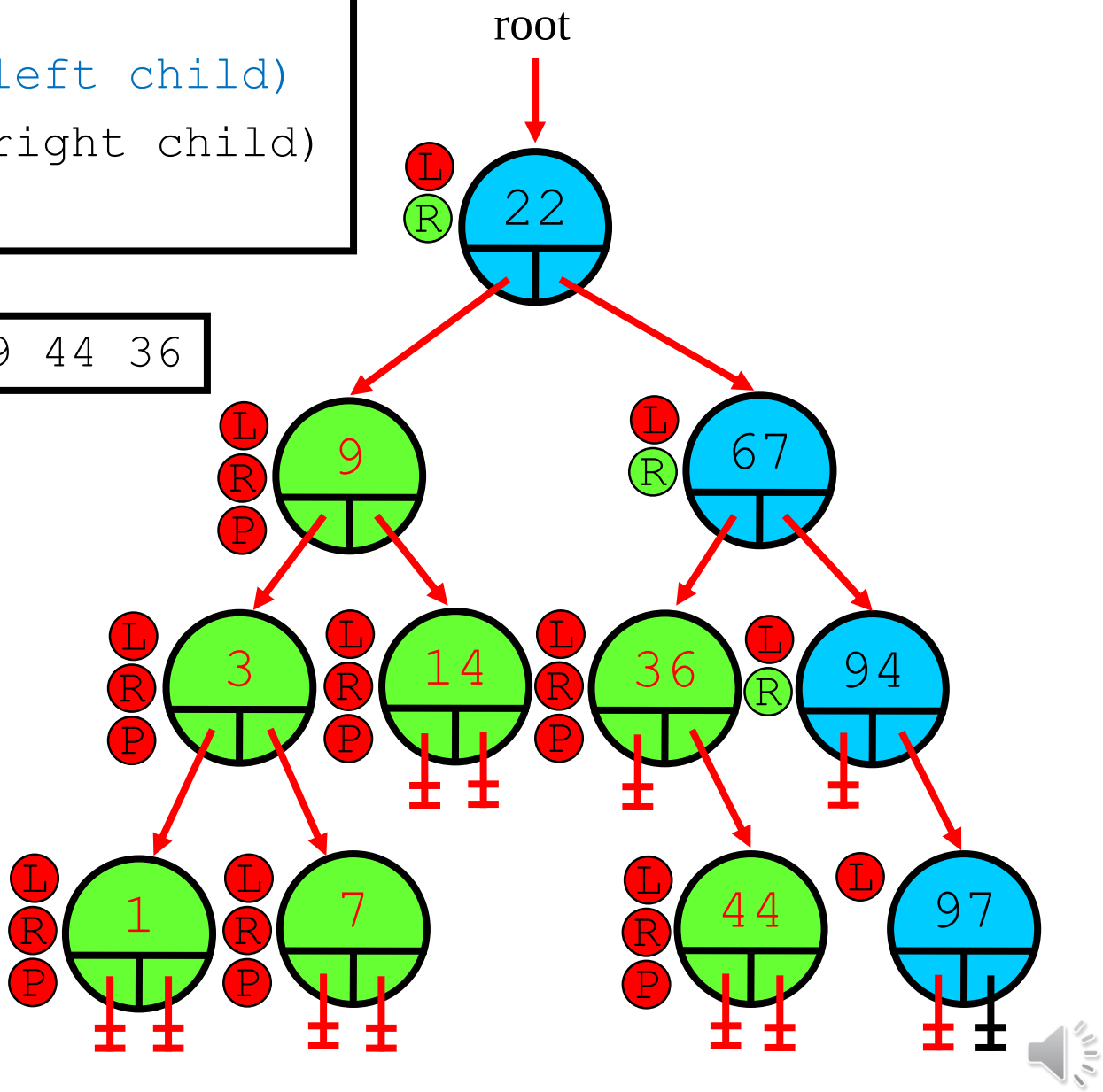
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



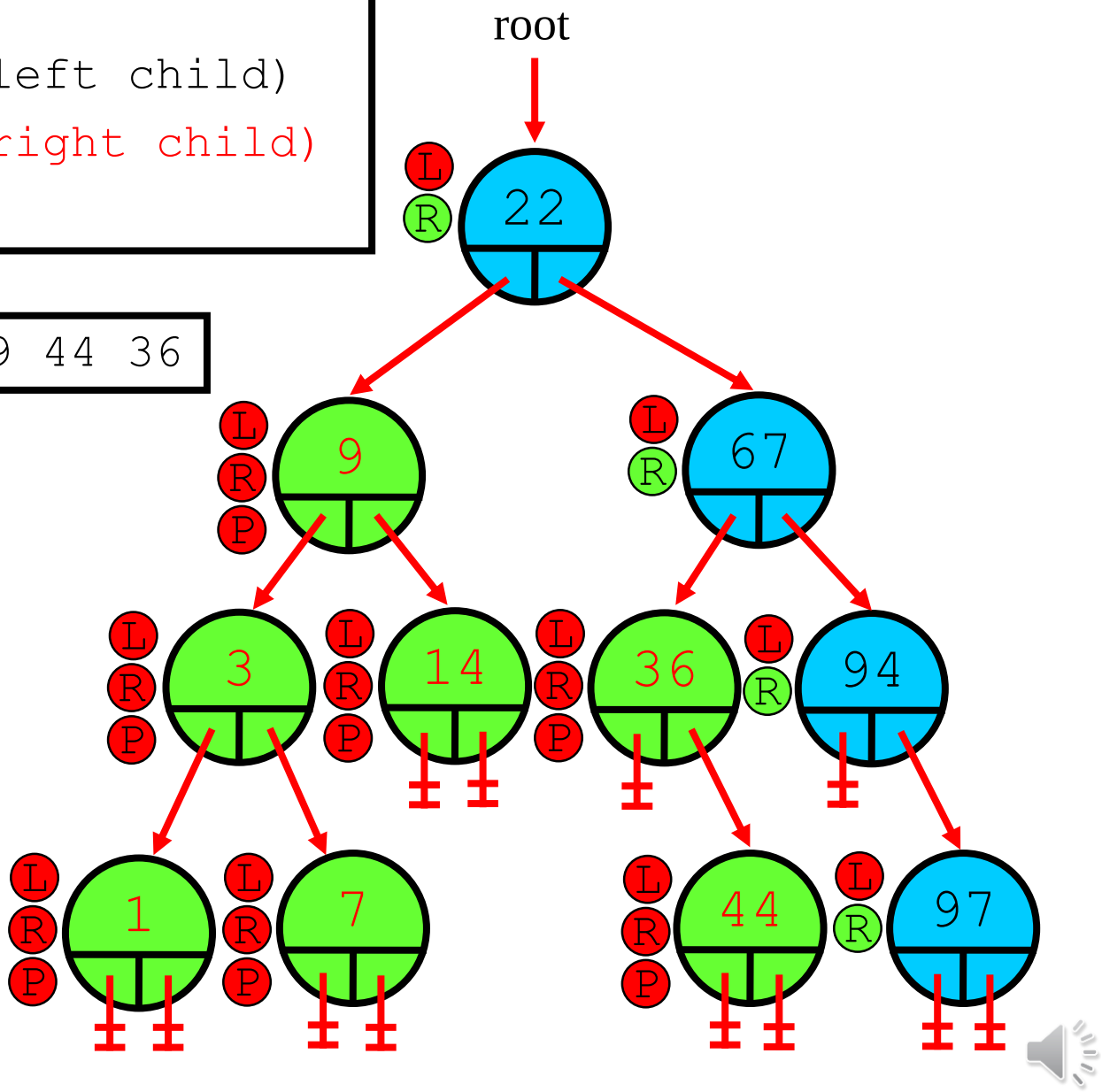
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



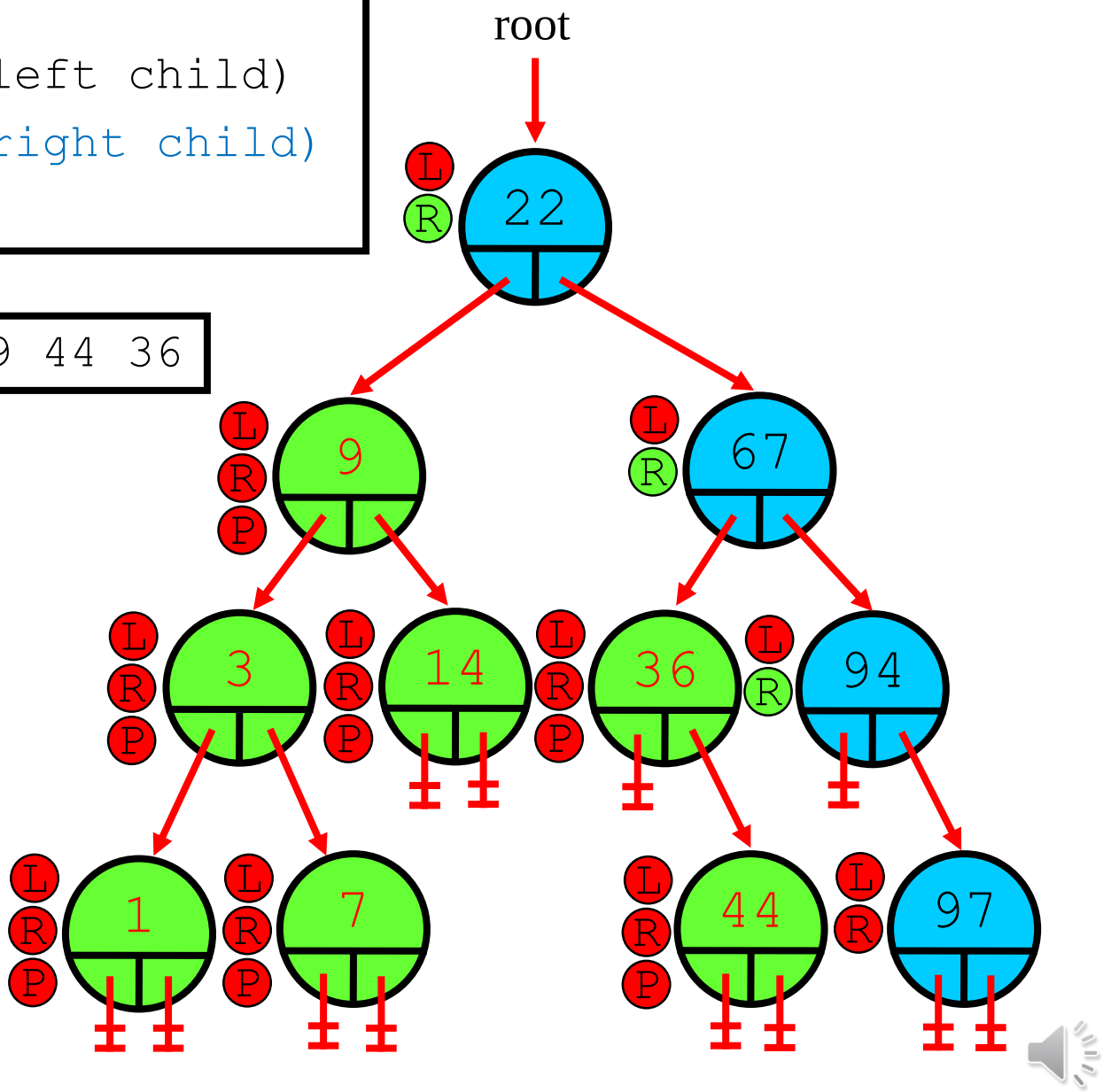
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



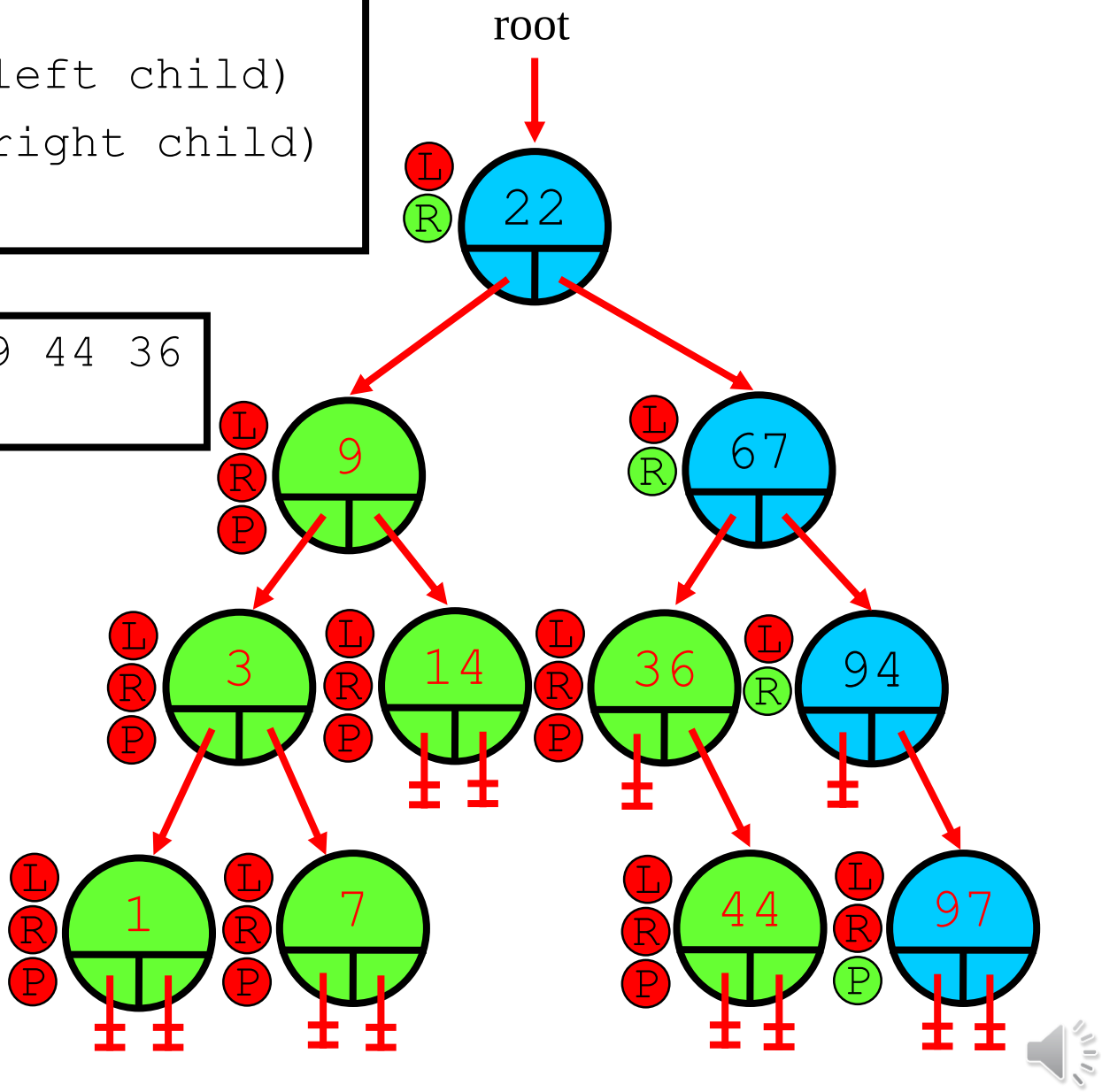
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
```



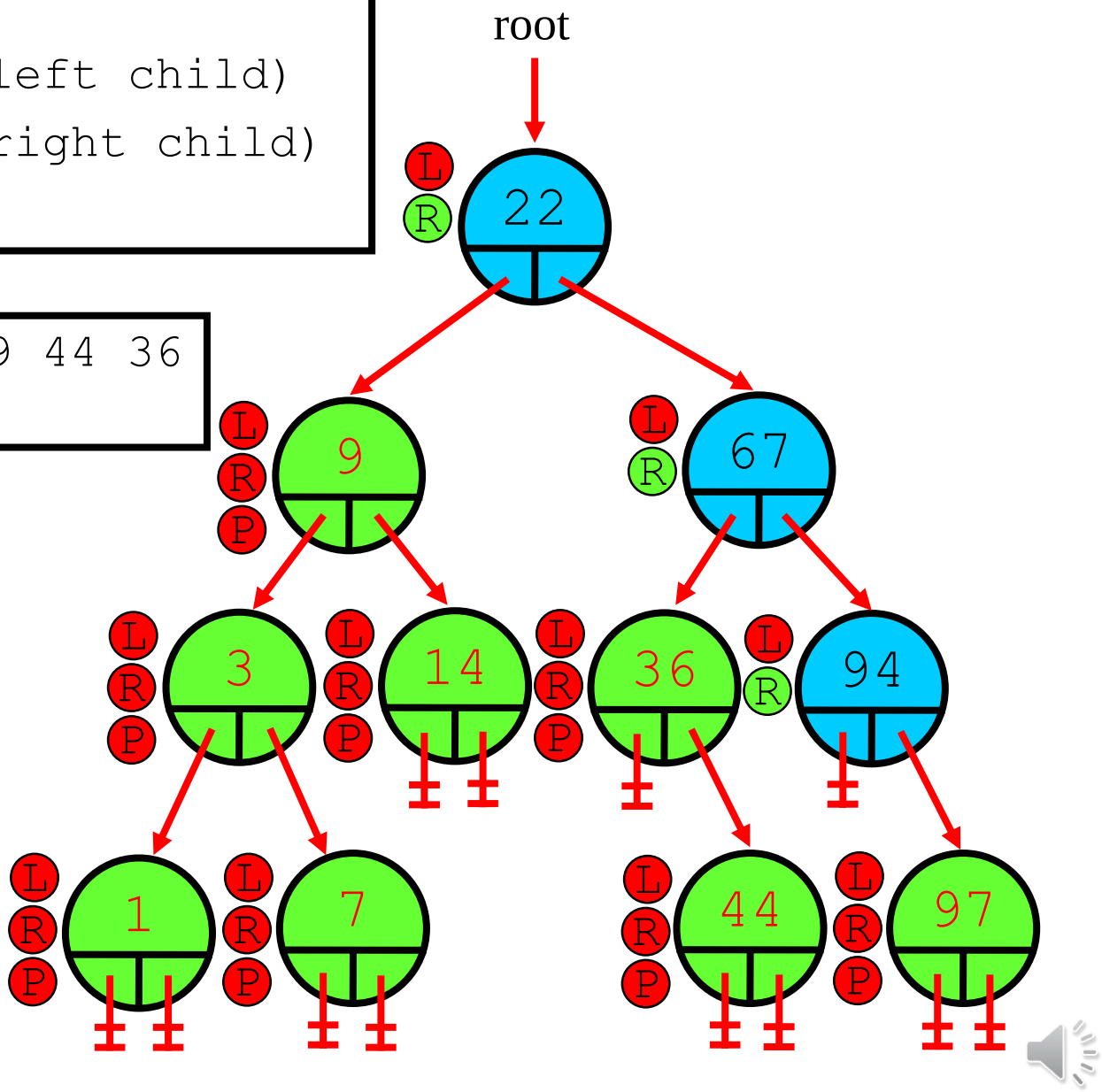
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97
```



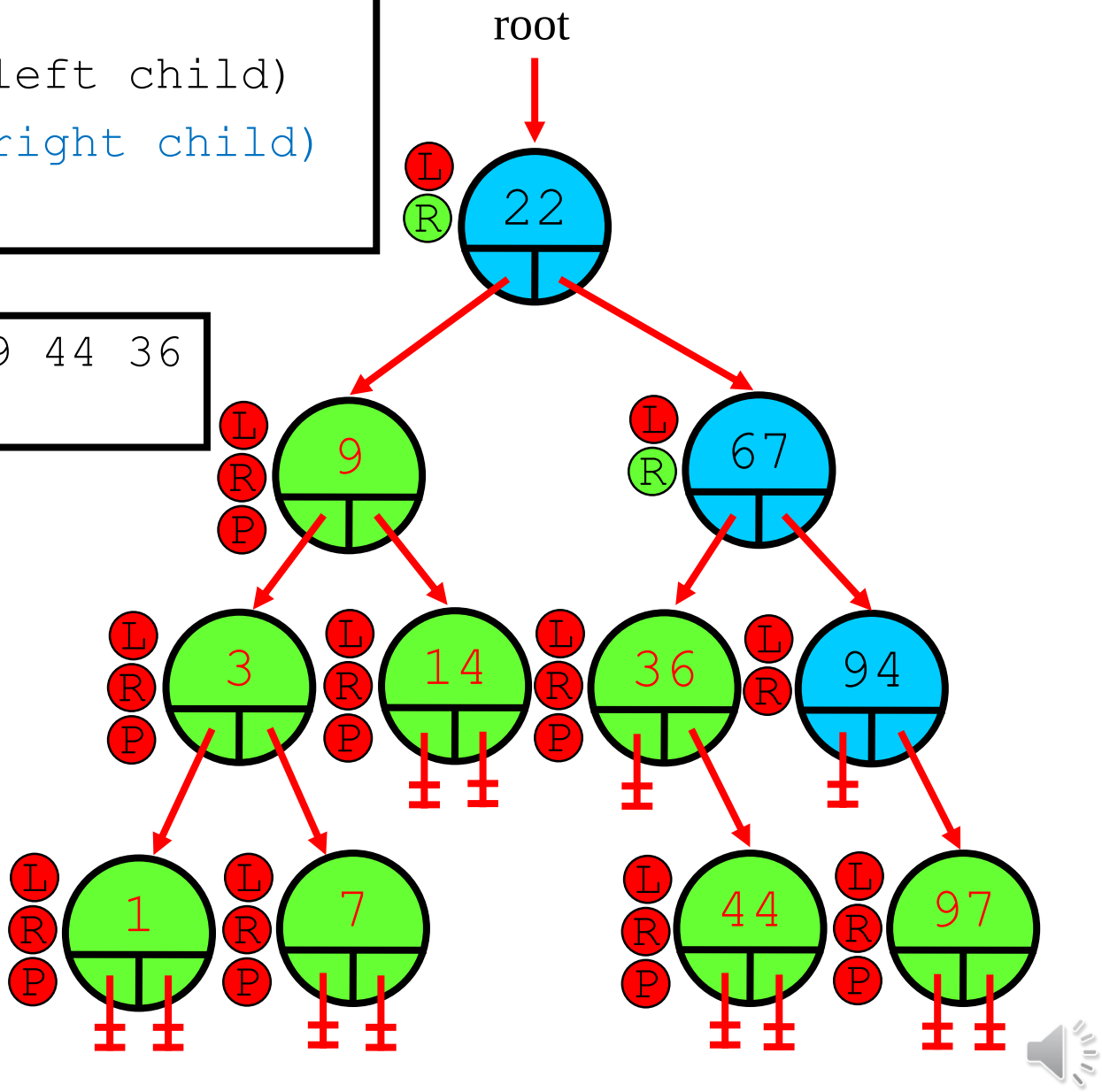
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97
```



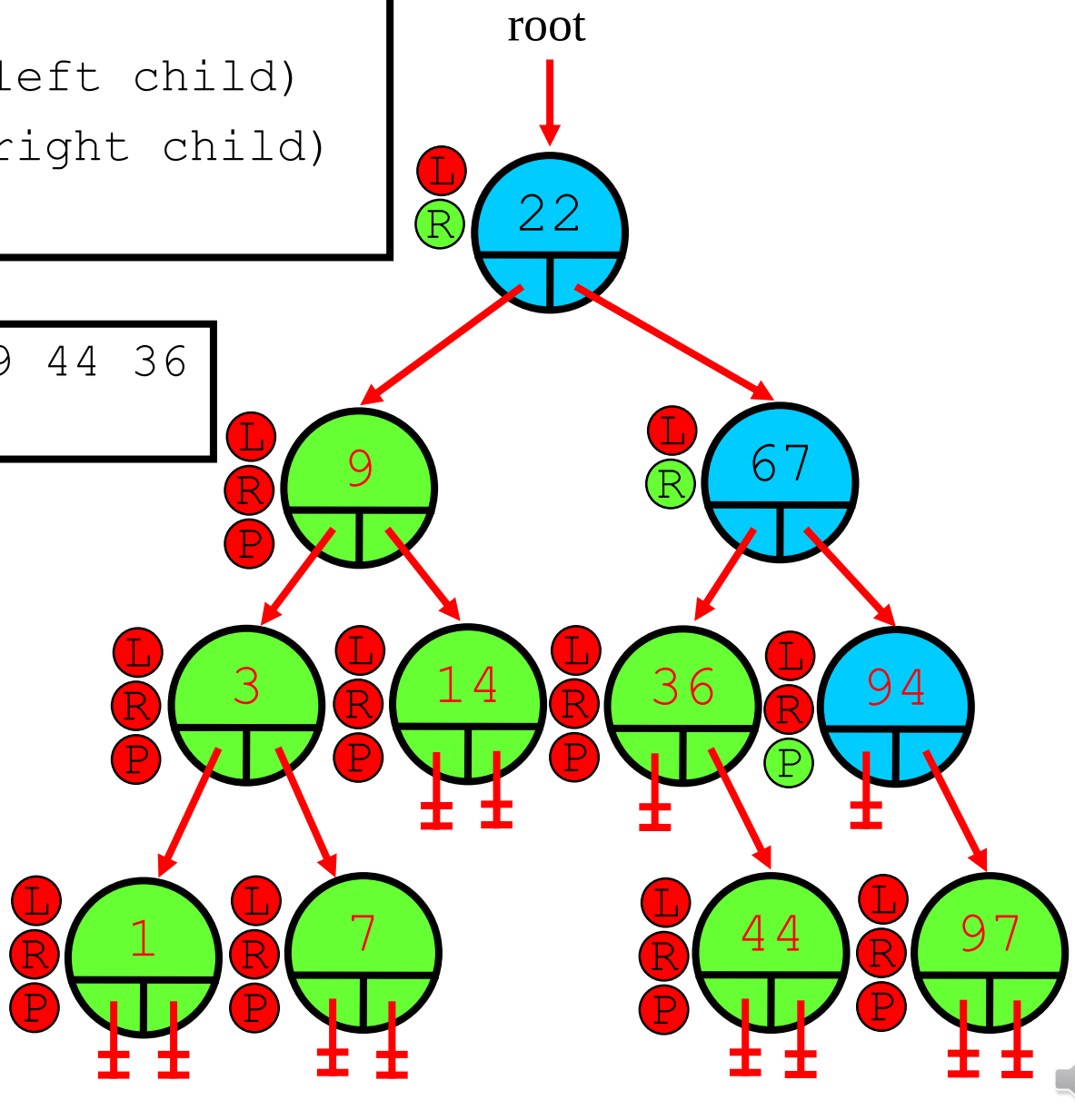
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97
```



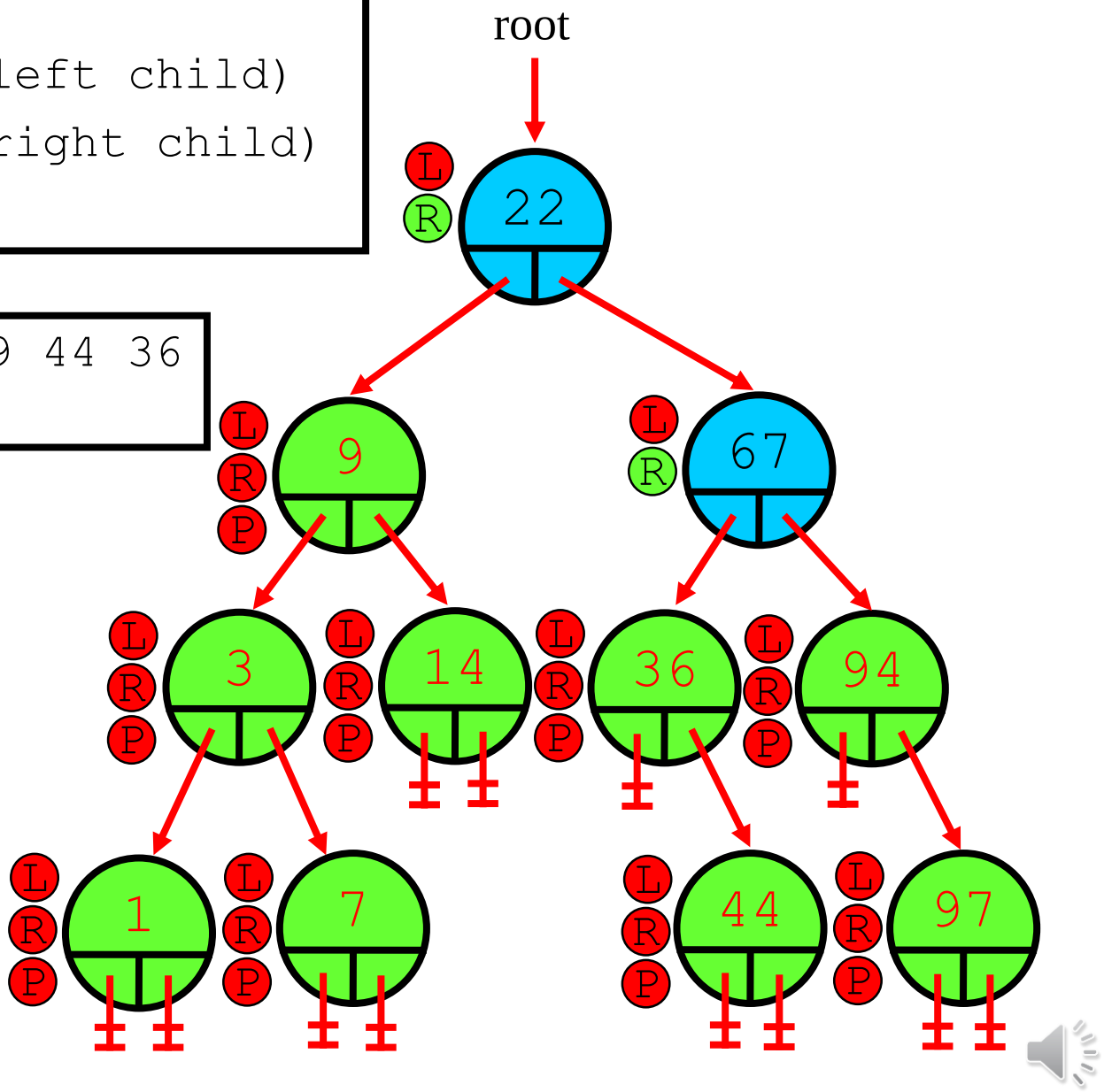
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94
```



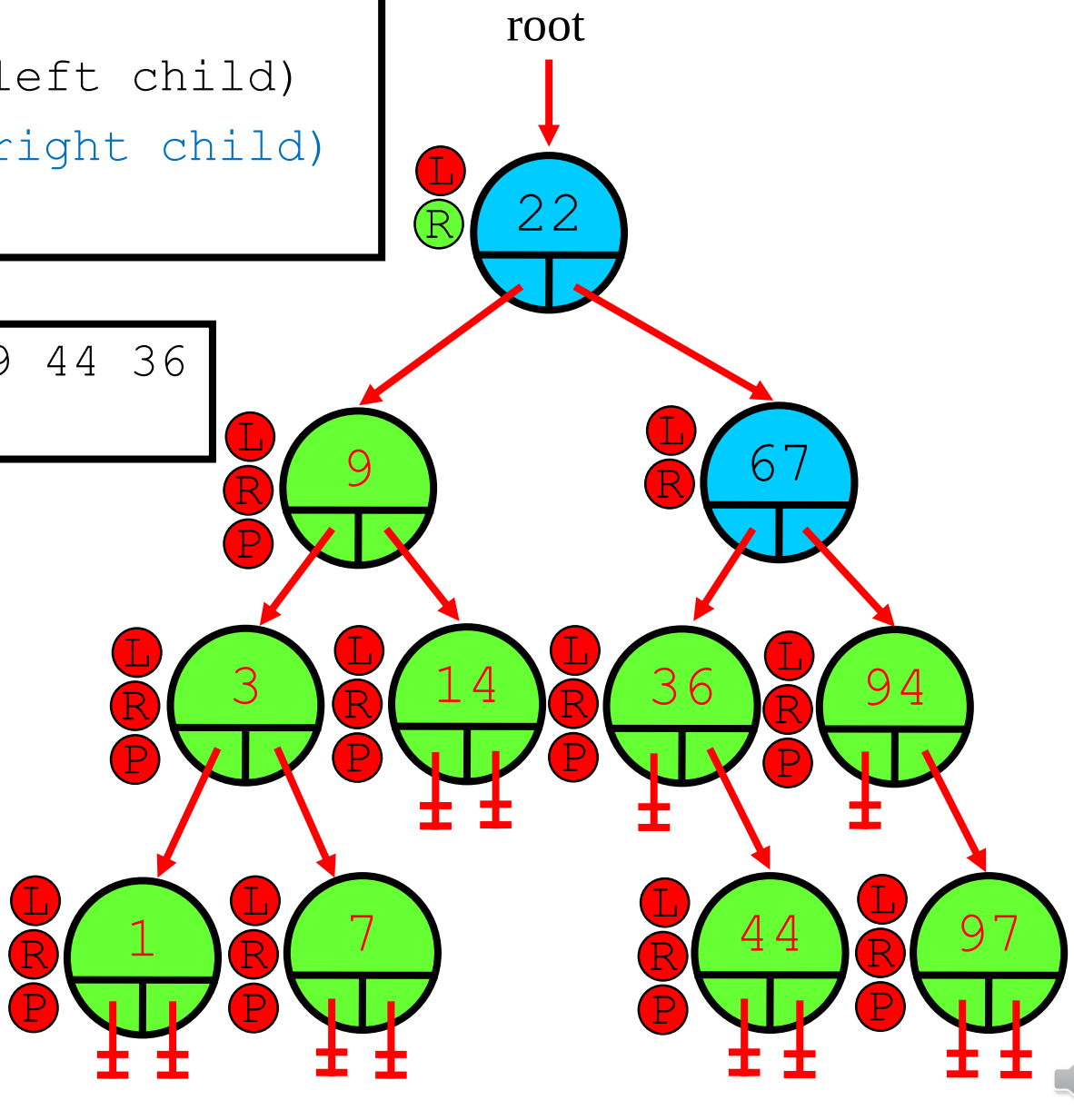
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94
```



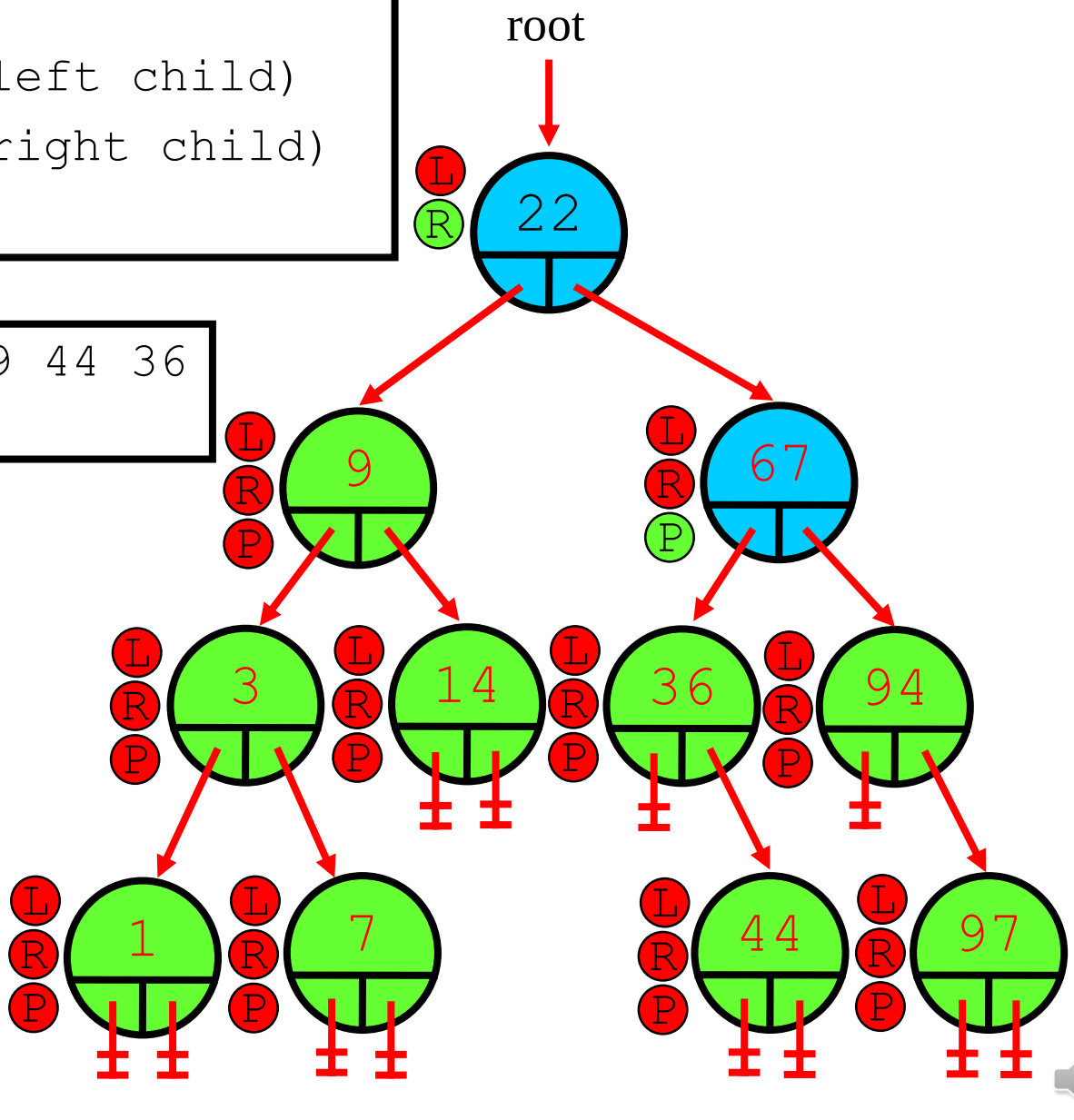
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94
```



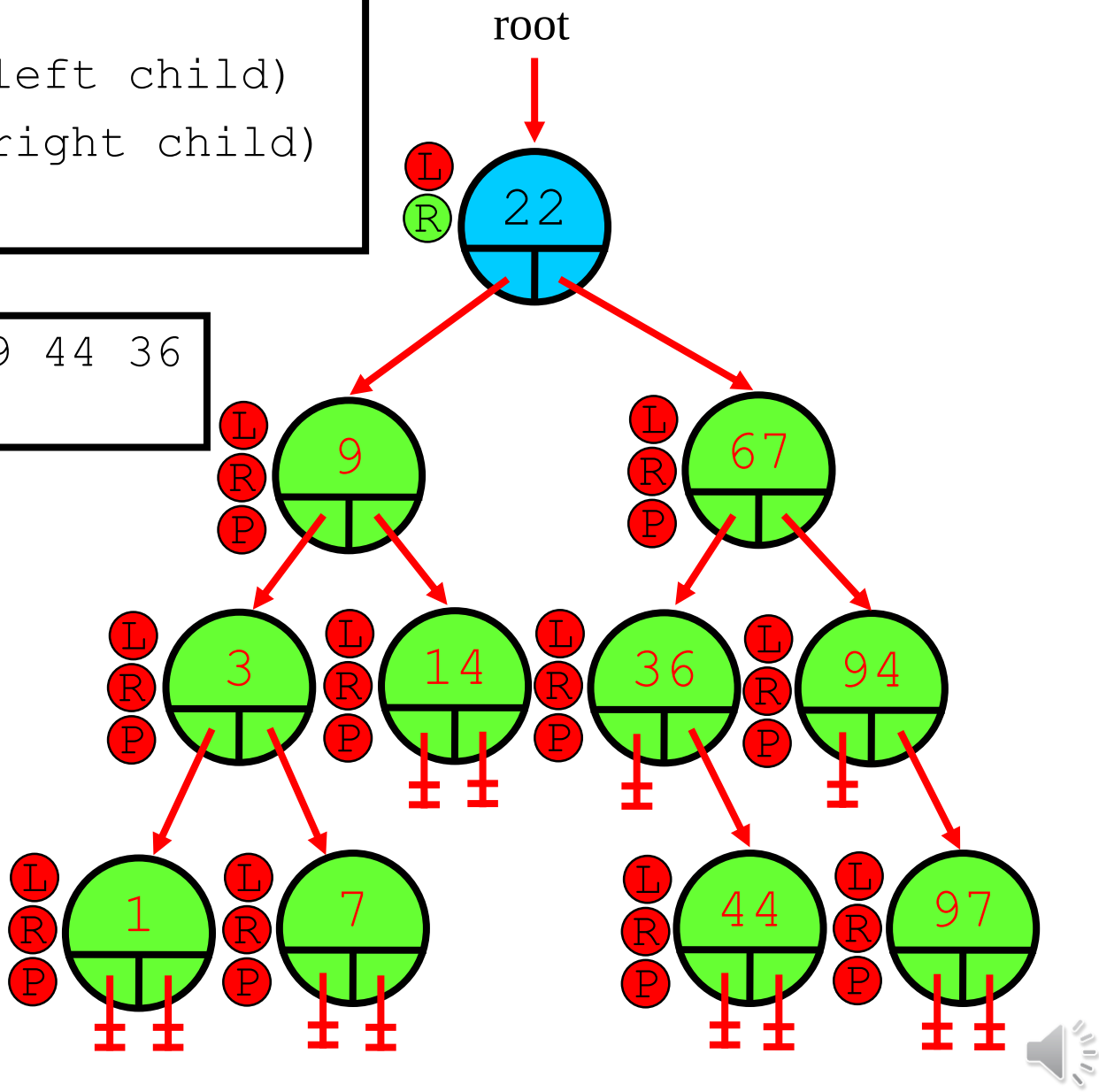
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94 67
```



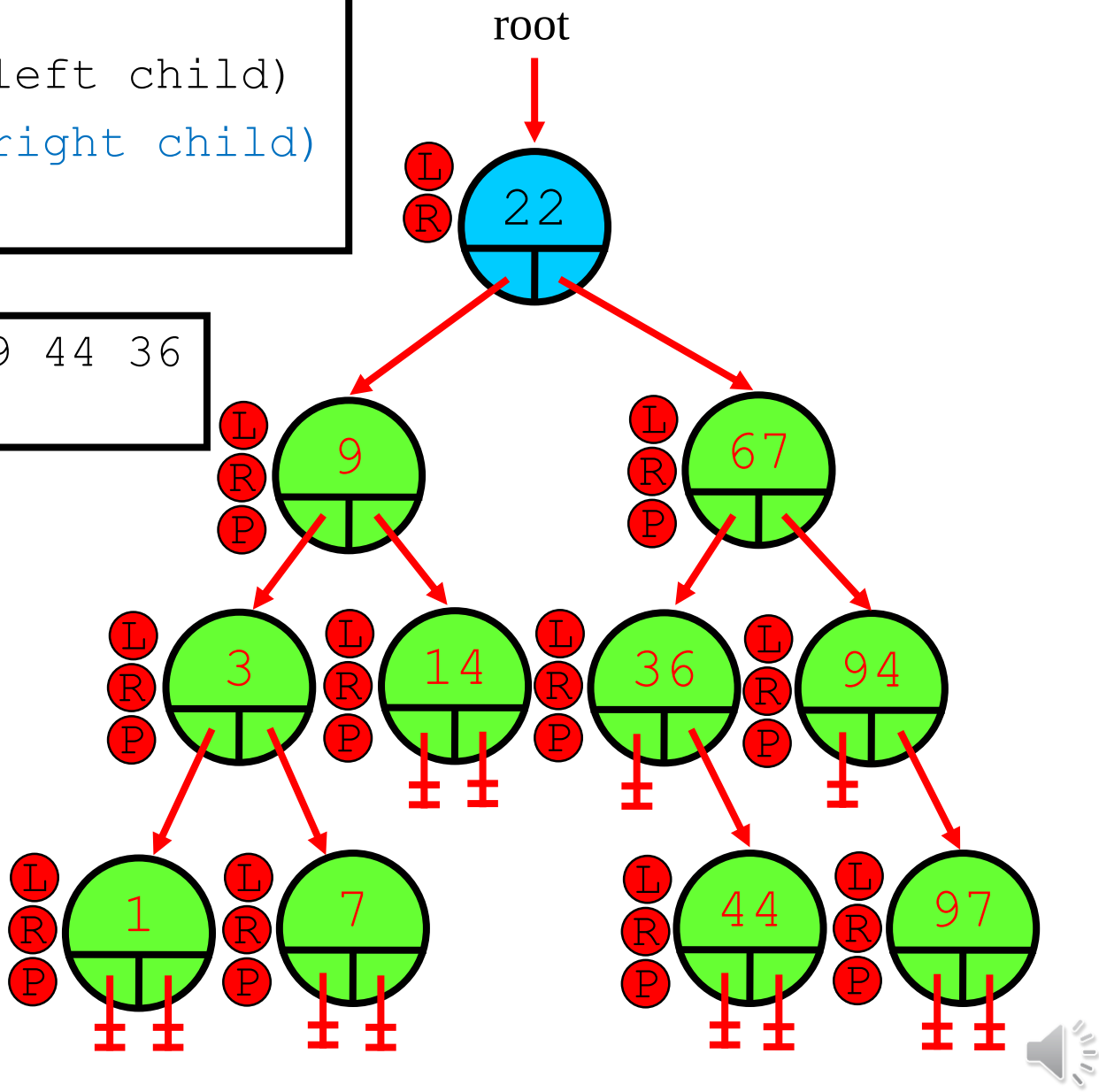
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94 67
```



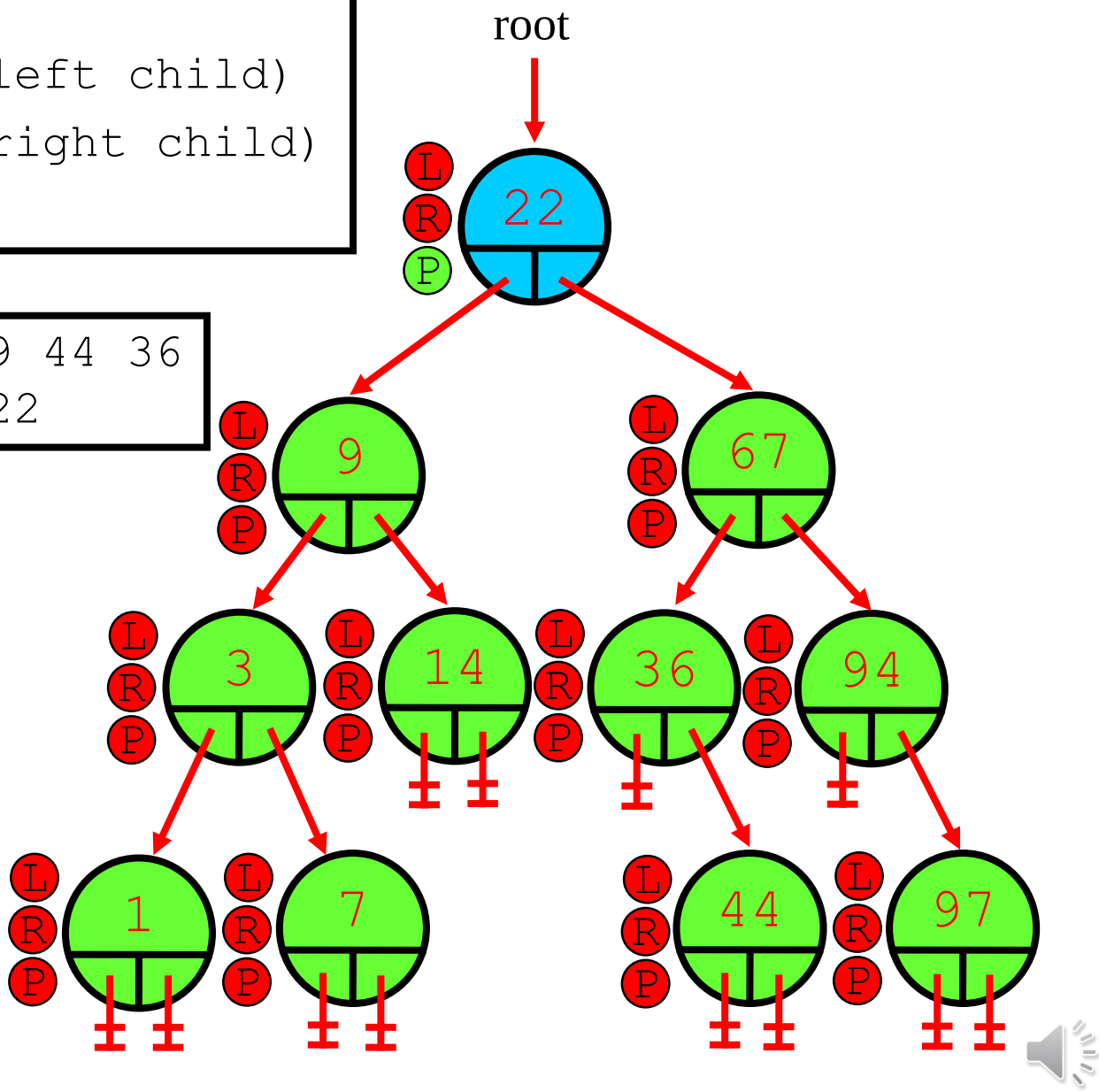
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94 67
```



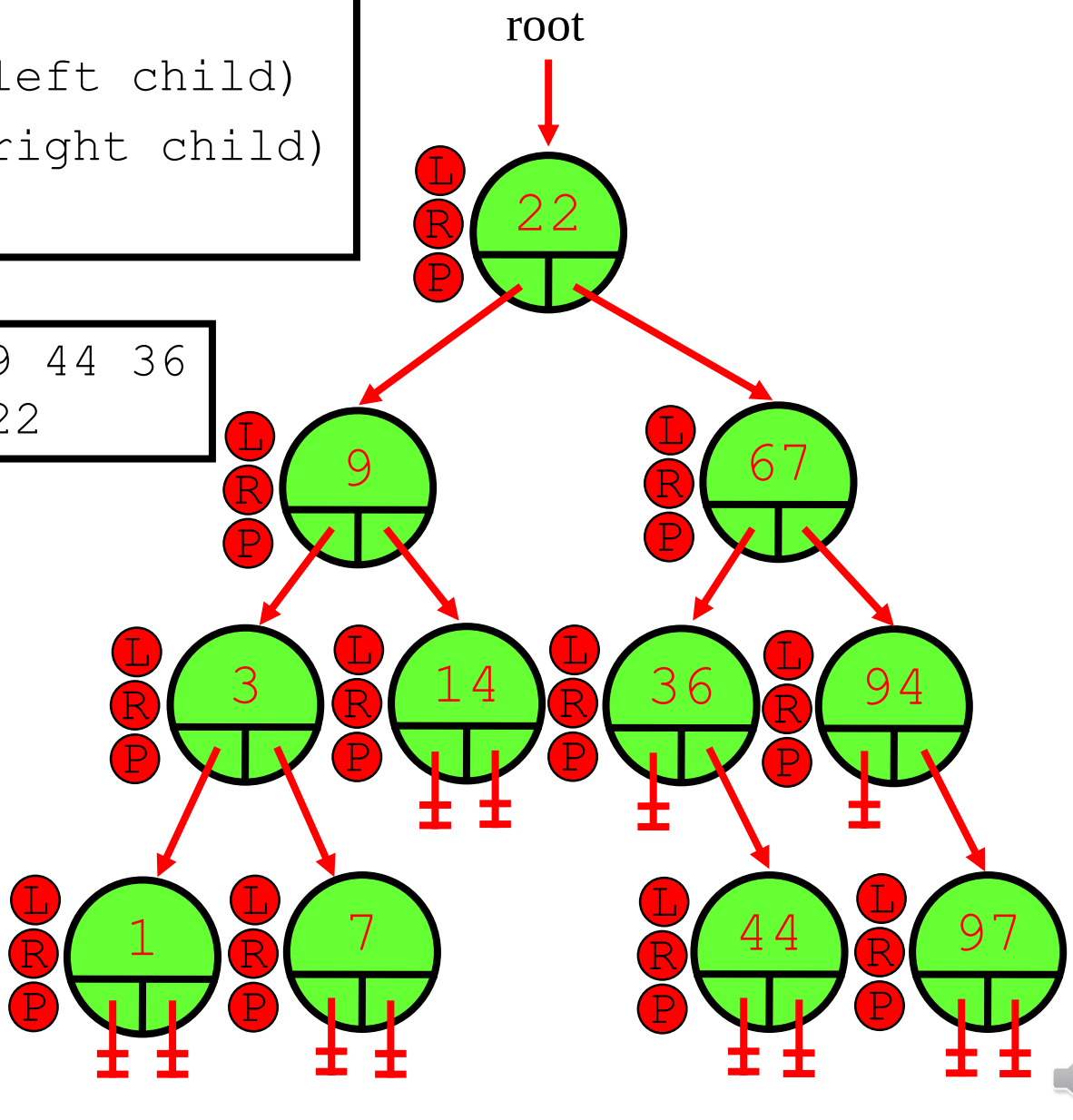
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94 67 22
```



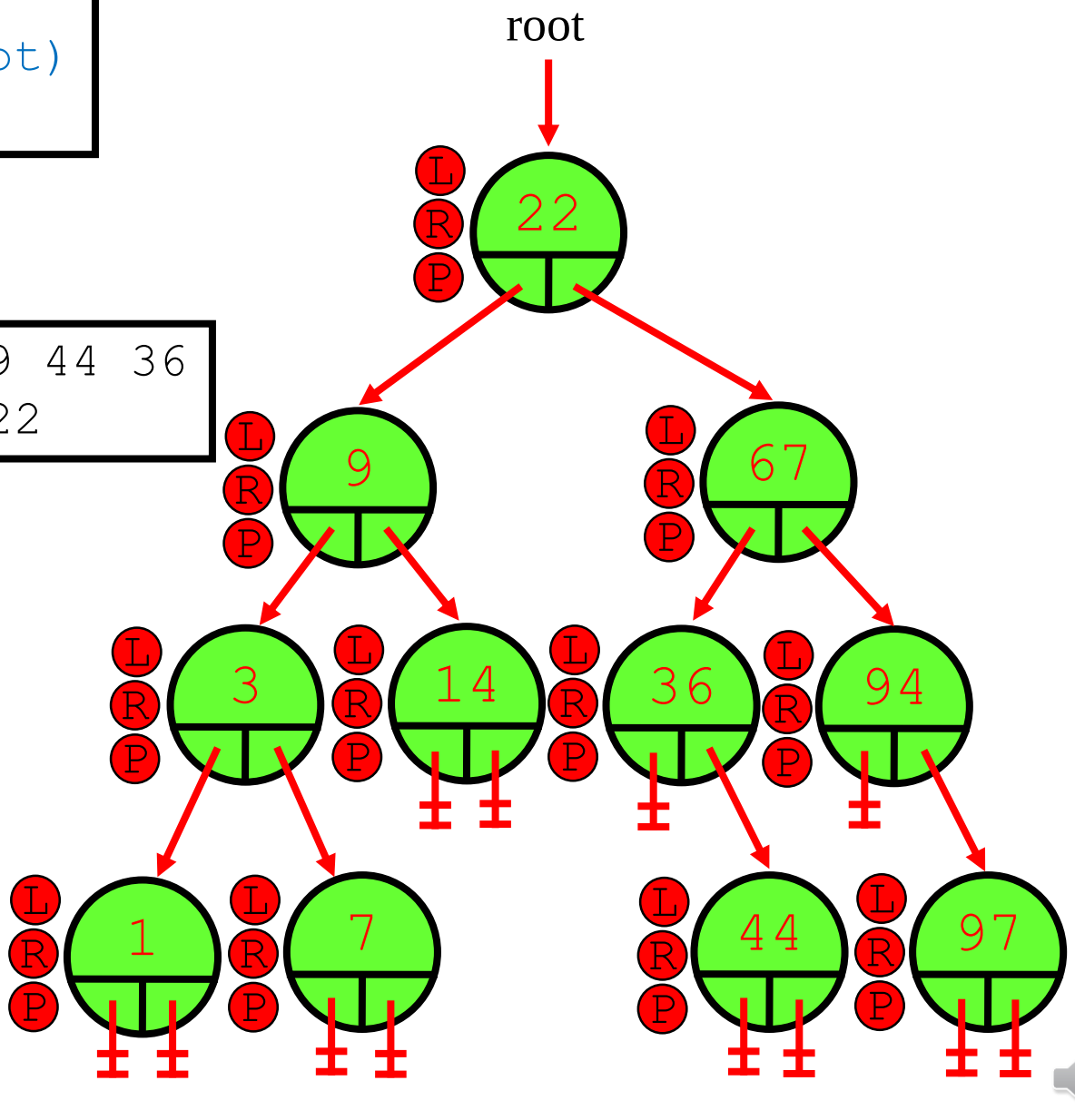
```
Proc PostOrder Print(pointer)
 pointer NOT NIL?
L PostOrderPrint(left child)
R PostOrderPrint(right child)
P print(data)
```

```
Output: 1 7 3 14 9 44 36
        97 94 67 22
```



```
Algorithm Example
. . .
PostOrderPrint(root)
. . .
```

```
Output: 1 7 3 14 9 44 36
        97 94 67 22
```

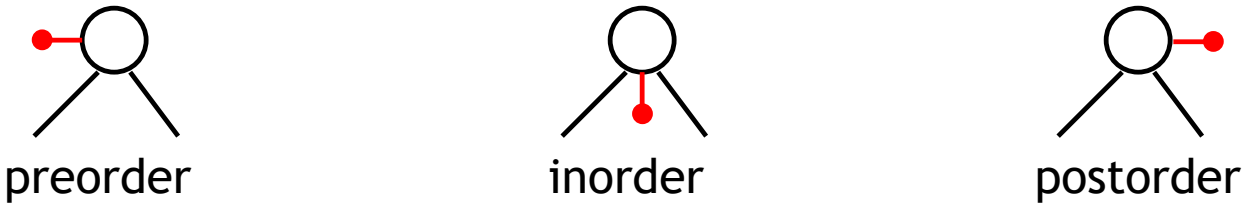


Summary

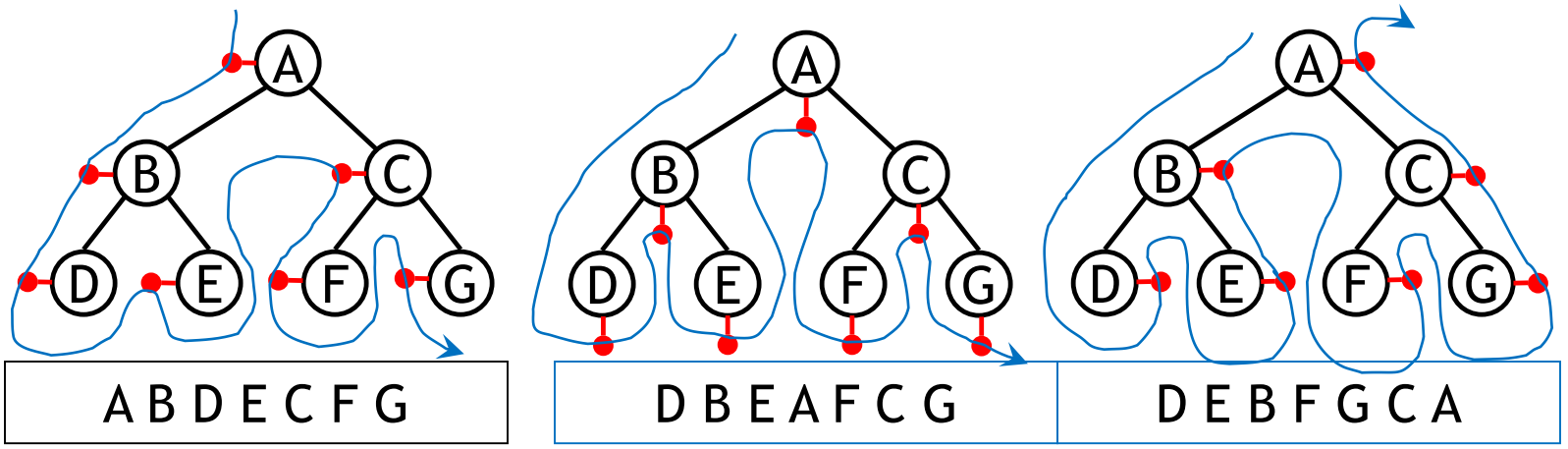
- **An In-Order traversal visits every node**
  - **Recurse left first**
  - **Do something with current**
  - **Recurse right last**
- **The "left, current, right" logic is repeated recursively at every node.**
- **For a BST, an in-order traversal accesses the elements in ascending order.**

Tree traversals using “flags”
깃발을 사용하여 순회

- The order in which the nodes are visited during a tree traversal can be easily determined by imagining there is a “flag” attached to each node, as follows:



- To traverse the tree, collect the flags:



Questions?

감사합니다.