Trees

The definition of a tree

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- The empty tree is a tree.
- A nonempty tree `tree` has three parts.
    - `root` — an element.
    - `left-subtree` — a tree.
    - `right-subtree` — a tree.

my-tree

```
(define my-tree
'(4 (2 (1 () ()) (3 () ())) (6 (5 () ()) (7 () ()))))
```

my-tree

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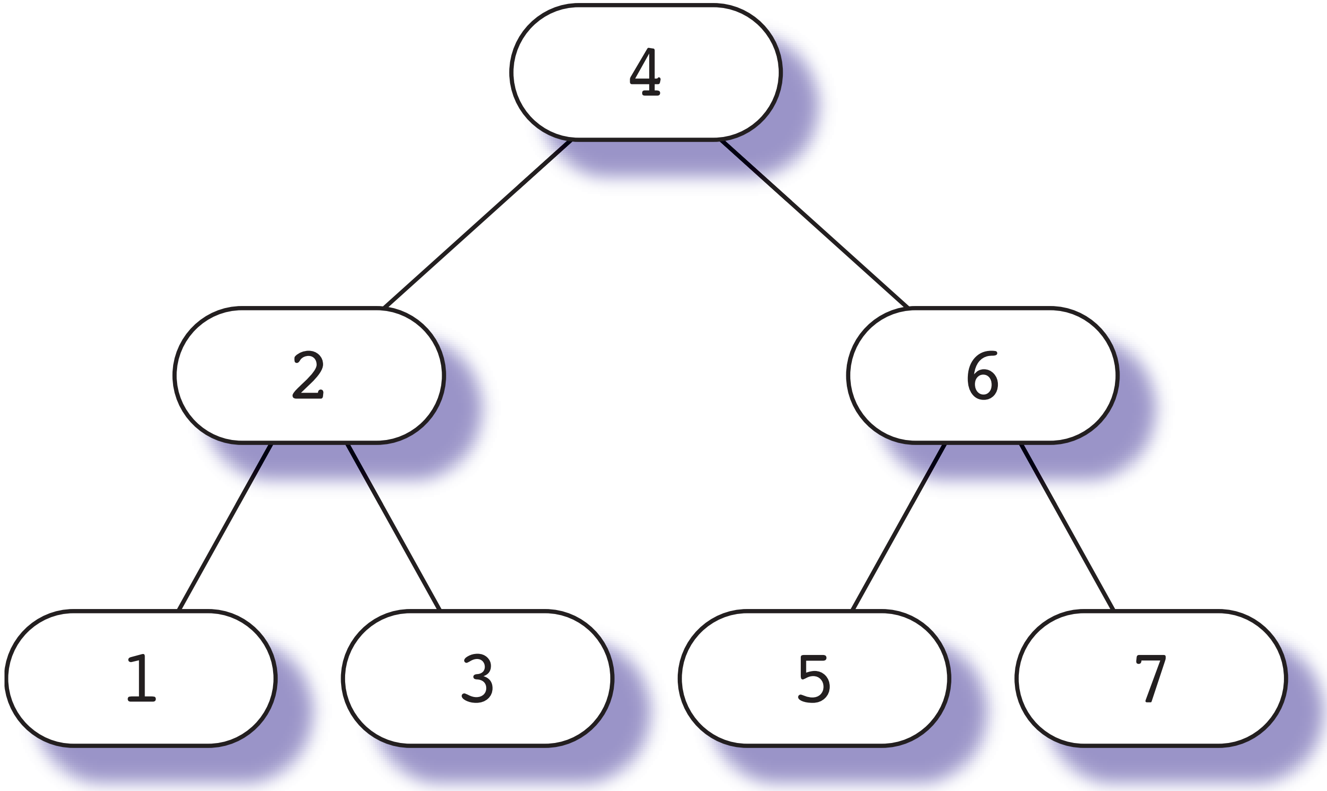
(define my-tree
'(4 (2 (1 () ()) (3 () ())) (6 (5 () ()) (7 () ()))))
```

my-tree

```
(define my-tree
'(4 (2 (1 () ()) (3 () ())) (6 (5 () ()) (7 () ()))))
```



The definition of a binary search tree (BST)

The definition of a binary search tree (BST)

- Every element in the left subtree is less than the root.
- Every element in the right subtree is greater than the root.
- The left subtree is a BST.
- The right subtree is a BST.

Preorder traversal

Returns a list

Preorder traversal

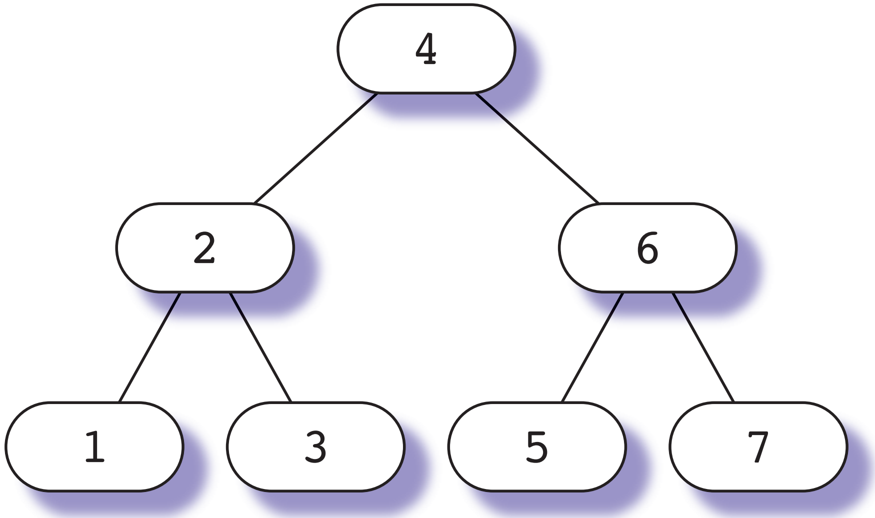
Returns a list

If the tree is not empty

- Visit the root.
- Do a preorder traversal of the left subtree.
- Do a preorder traversal of the right subtree.

Preorder traversal

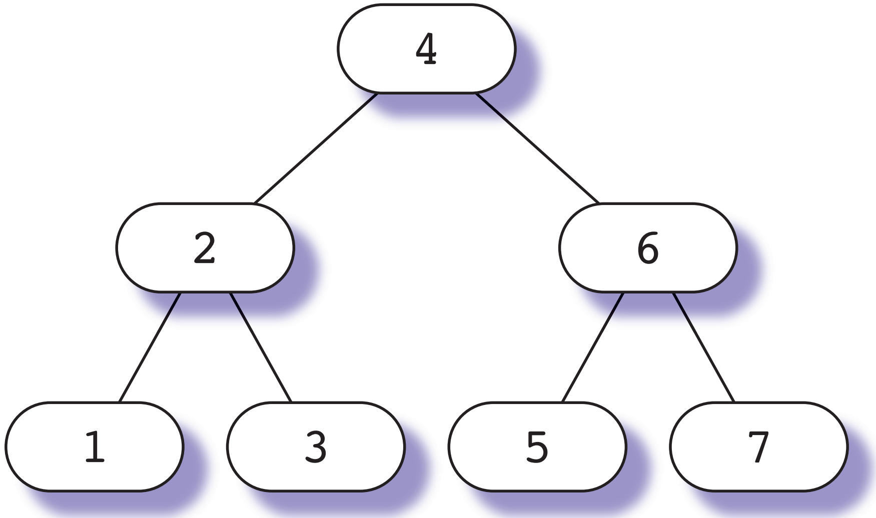
Returns a list



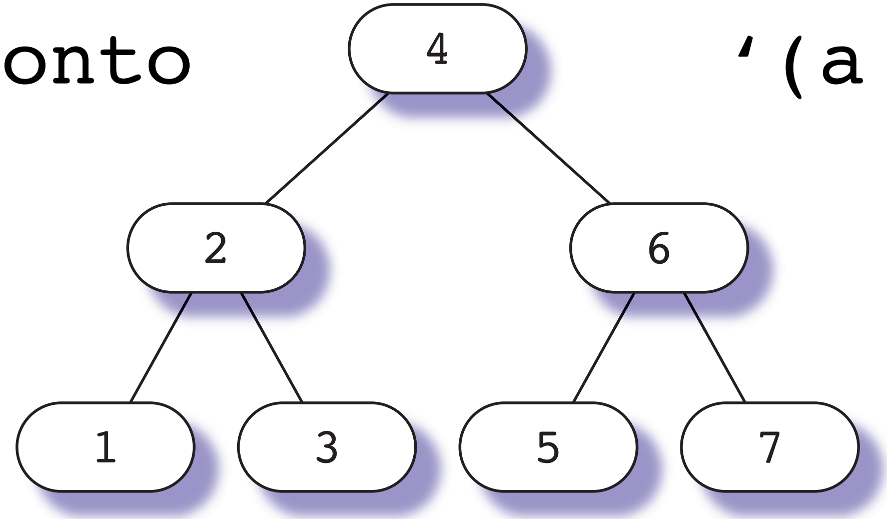
What is the preorder traversal?

Preorder traversal

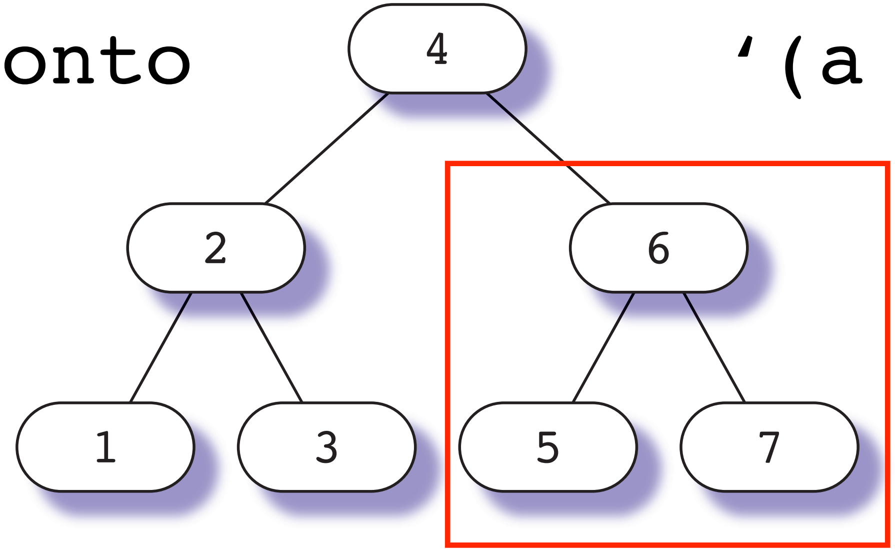
Returns a list

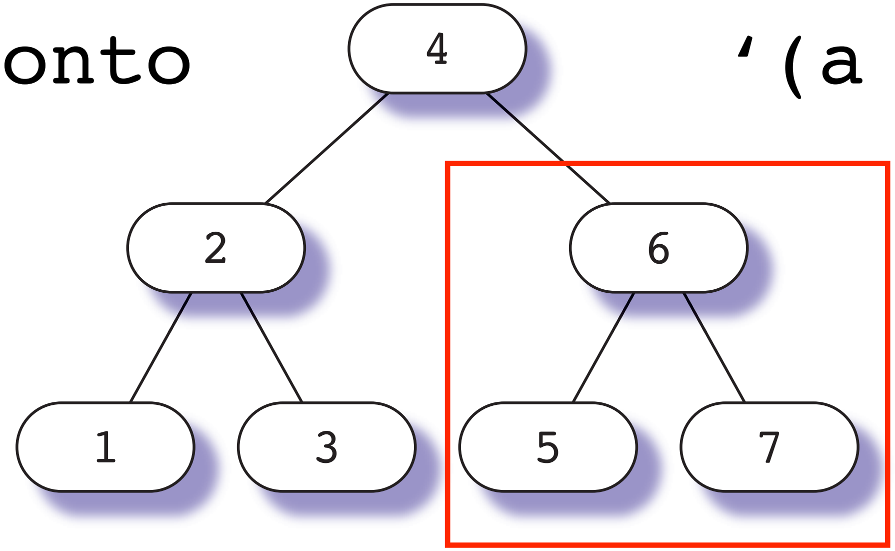


```
(4  2  1  3  6  5  7)
```

(preorder-onto 

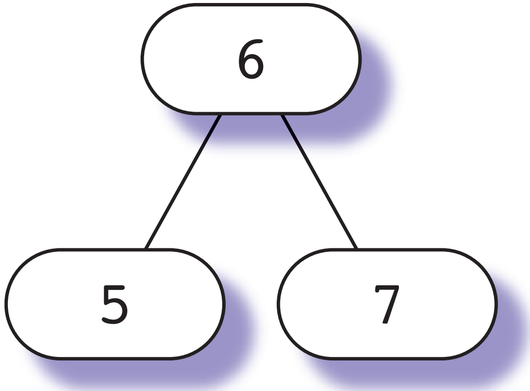
‘(a b c))

(preorder-onto  ‘(a b c)) (preorder-onto

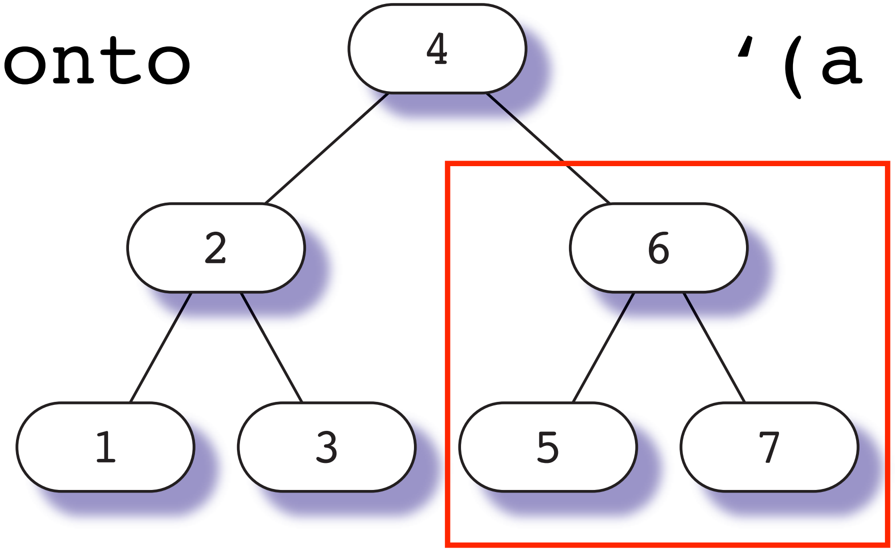


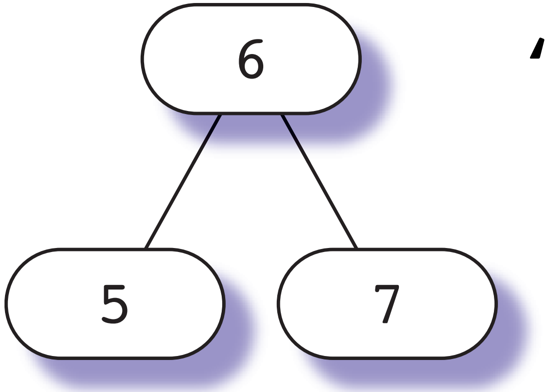
‘(a b c))

(preorder-onto



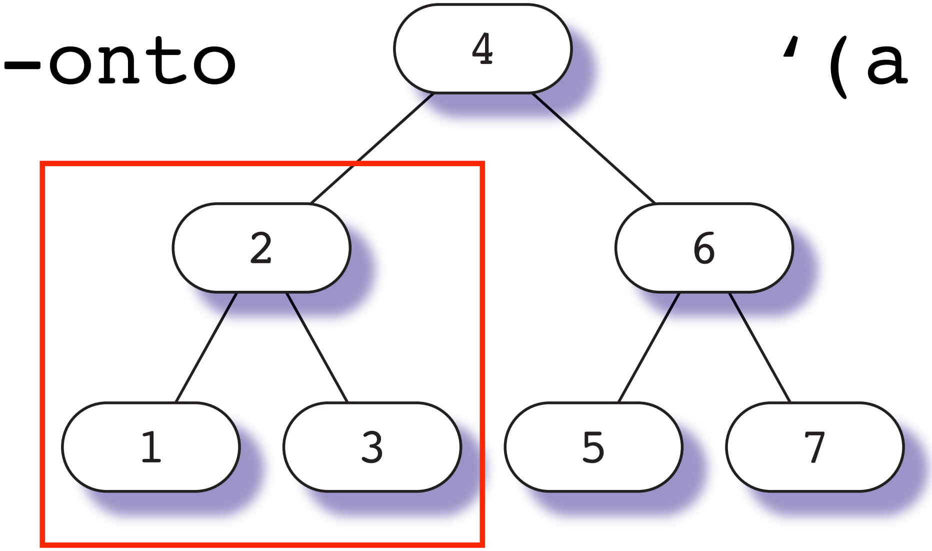
‘(a b c))

(preorder-onto  '(a b c))

(preorder-onto  '(a b c))

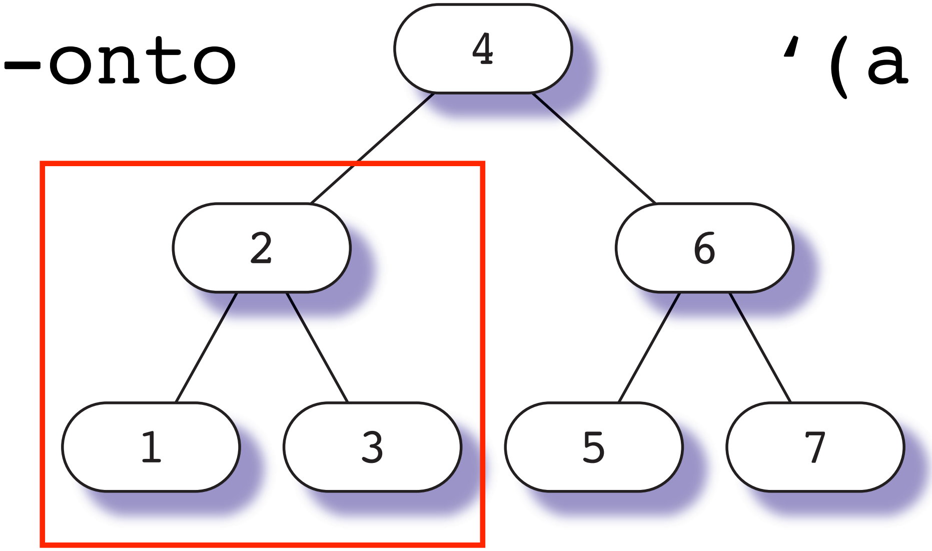
(6 5 7 a b c)

(preorder-onto



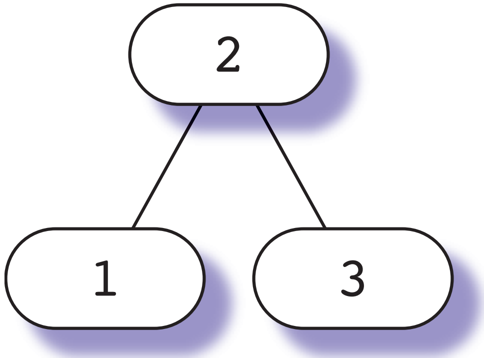
‘(a b c))

`(preorder-onto`



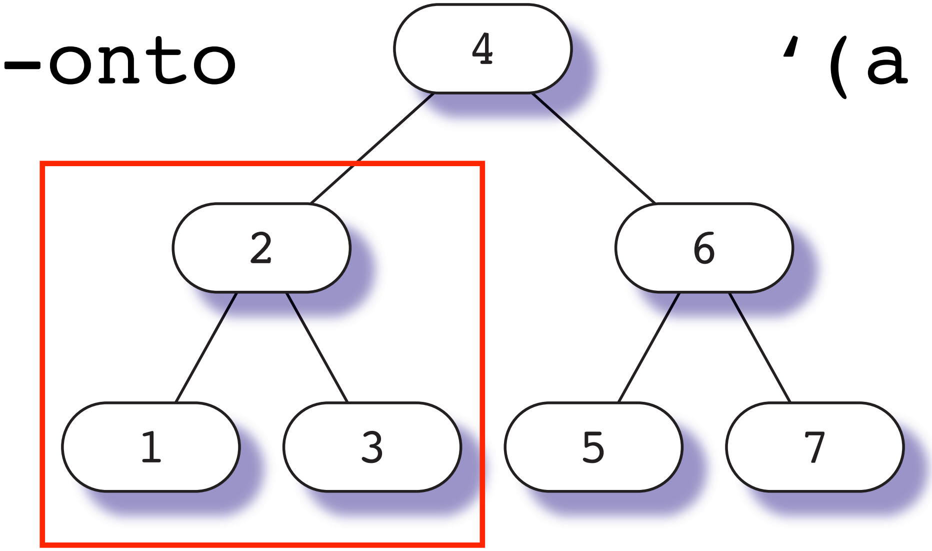
`‘(a b c))`

`(preorder-onto`



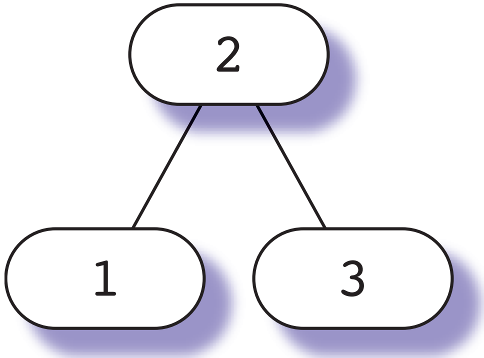
`‘(6 5 7 a b c))`

```
(preorder-onto
```



```
'(a b c))
```

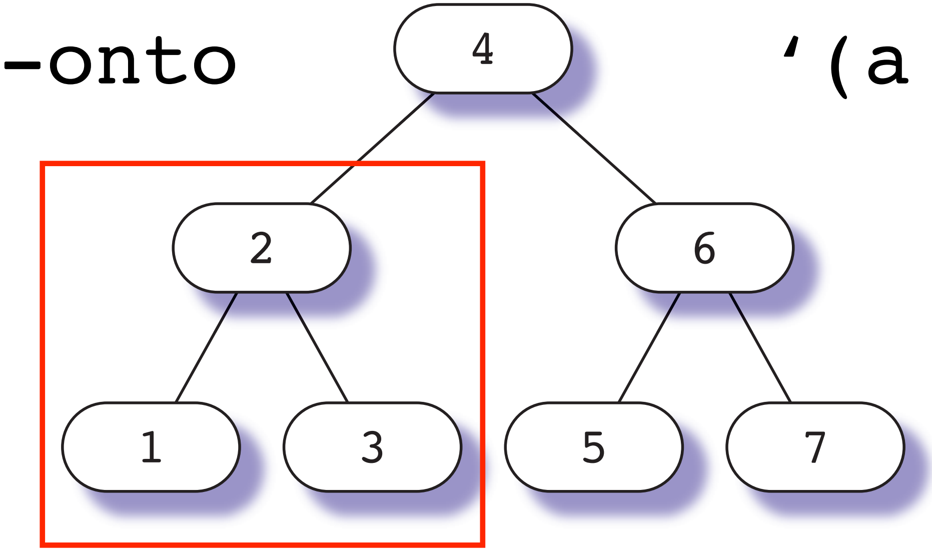
```
(preorder-onto
```



```
'(6 5 7 a b c))
```

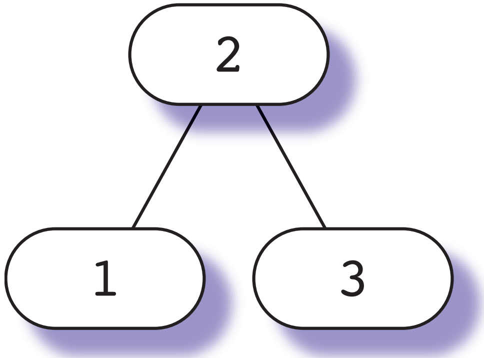
```
(2 1 3 6 5 7 a b c)
```

```
(preorder-onto
```



```
'(a b c))
```

```
(preorder-onto
```



```
'(6 5 7 a b c))
```

```
(2 1 3 6 5 7 a b c)
↑
4
```

Inorder traversal

Returns a list

If the tree is not empty

- Do an inorder traversal of the left subtree.
- Visit the root.
- Do an inorder traversal of the right subtree.

The definition of an expression tree

- A number is an expression tree.
- A non-number tree has three parts.
  - A left operand — an expression tree.
  - An operator name.
  - A right operand — an expression tree.

my-expression

```
(define my-expression
  '(1 + (2 * (3 - 5))))
```