BST

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BINARY SEARCH TREES

Problem Solving with Computers-I

https://ucsb-cs24-sp17.github.io/

Imposter panel: Tomorrow Thurs (06/01), 12:30pm to 1:50pm, HFH 1132

Come hear faculty, grad students and undergrad alumni talk about their careers and how they dealt with feeling like an Imposter!

Please RSVP : https://goo.gl/forms/ttvzHNPWAZ0GCPA92

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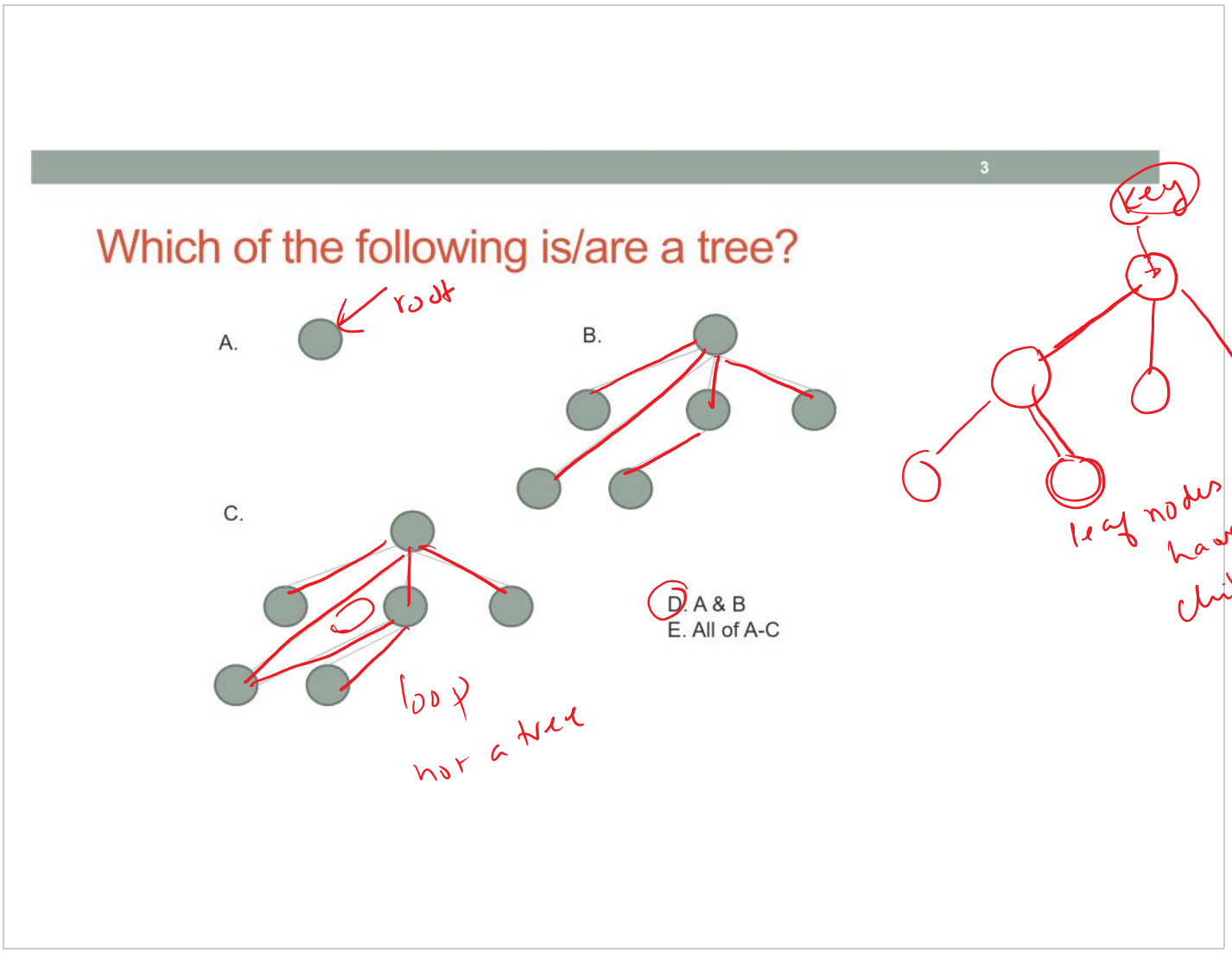

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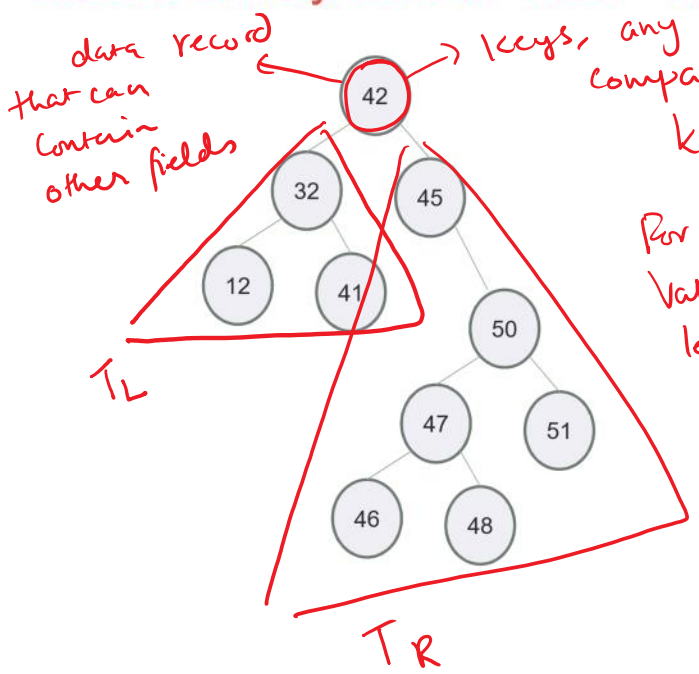
Lab08: Binary Search Tree – What is it?



Key: ← ordering is available on the keys

For any node in a BST

Value of all nodes in the left subtree ≤ value of the node

$T_L \leq$ value of node

value of node $< T_R$

What are the numbers in the nodes?

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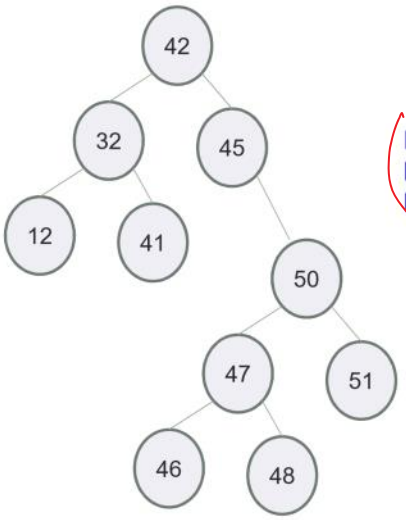
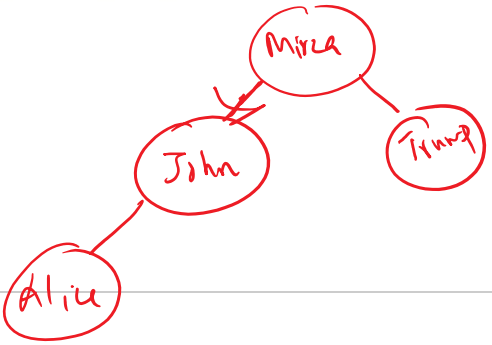
Binary Search Tree – What is it?



For any node,
Keys in node's left subtree <= Node key
Node key < Keys in node's right subtree

Do the keys have to be integers?



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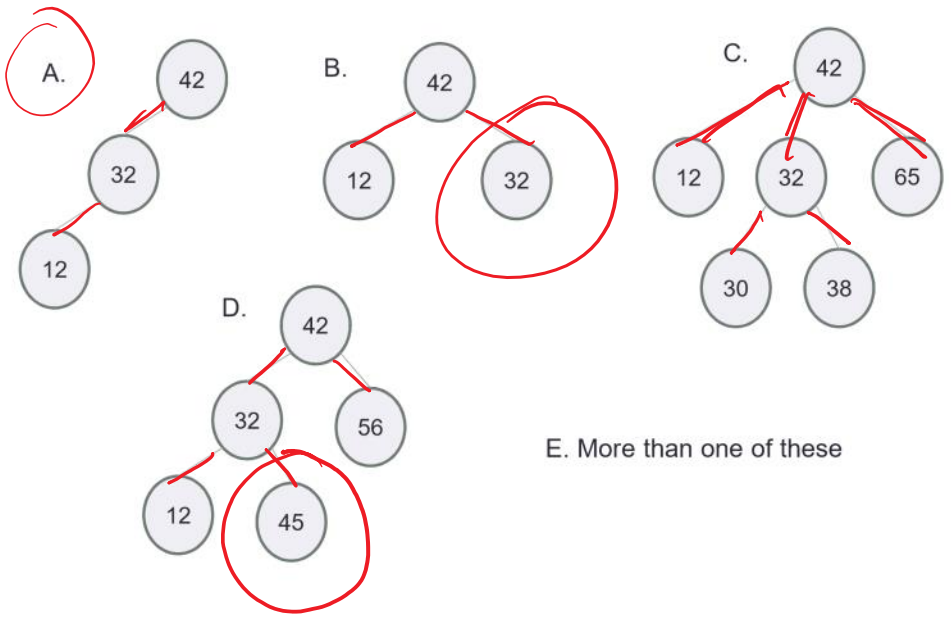
Which of the following is/are a binary search tree?



E. More than one of these

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Binary Search Trees

- What are the operations supported?
- What are the running times of these operations?
- How do you implement the BST i.e. operations supported by it?

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Binary Search Trees

- What is it good for?
  - If it satisfies a special property i.e. Balanced, you can think of it as a dynamic version of the sorted array

everything that is supported by a sorted array + Fast insert & delete

⇝ (under some conditions)

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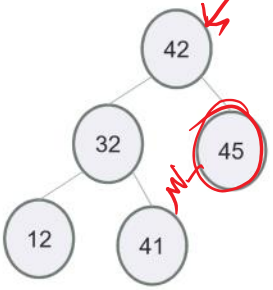
Under the hood: Searching an element in the BST

To search for element with key k

1. Start at the root
2. If k=key(root), found key, stop.
3. Else If k< key(root), recursively search the left subtree: T_L
   Else recursively search the right subtree: T_R



Search for 41.
Now search for 43.

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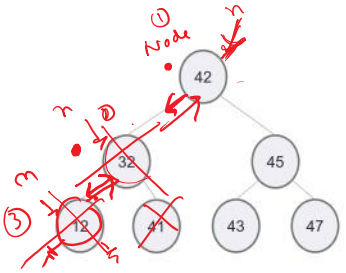
Traversing the BST

Different methods of tree traversal:

- In order traversal
- Pre order traversal
- Post order traversal




```
struct Node {
    int data;
    Node * left;
    Node * right;
    Node * parent;
}
```

```
void inorder (Node *n) {
    if (n == 0)
        return;
    inorder (n->left);
    cout << n->data << " ";
    inorder (n->right);
}
```

```
void preorder (Node *n) {
    if (n) {
        cout << n->data << " ";
        preorder (n->left);
        preorder (n->right);
    }
}
```

12 32 41 42 43 45 47

O(N)

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BST, with templates:

```
template<typename Data>

class BSTNode {
public:
  BSTNode<Data>* left;
  BSTNode<Data>* right;
  BSTNode<Data>* parent;
  Data const data;

  BSTNode( const Data & d ) :
     data(d) {
    left = right = parent = 0;
  }

};
```

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  Data const data;

  BSTNode( const Data & d ) :
     data(d) {
    left = right = parent = 0;
  }

};
```

How would you create **a BSTNode object** on the runtime stack?

A. BSTNode n(10);
B. BSTNode<int> n;
C. BSTNode<int> n(10);
D. BSTNode<int> n = new BSTNode<int>(10);
E. More than one of these will work

{ } syntax OK too

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BST, with templates:

```
template<typename Data>

class BSTNode {
public:
  BSTNode<Data>* left;
  BSTNode<Data>* right;
  BSTNode<Data>* parent;
  Data const data;

  BSTNode( const Data & d ) :
     data(d) {
    left = right = parent = 0;
  }

};
```

How would you create a **pointer** to BSTNode with integer data?

A. BSTNode* nodePtr;
B. BSTNode<int> nodePtr;
C. BSTNode<int>* nodePtr;

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BST, with templates:

```
template<typename Data>

class BSTNode {
public:
  BSTNode<Data>* left;
  BSTNode<Data>* right;
  BSTNode<Data>* parent;
  Data const data;

  BSTNode( const Data & d ) :
     data(d) {
    left = right = parent = 0;
  }

};
```

Complete the line of code to create a new BSTNode object with int data on the heap and assign nodePtr to point to it.

```
BSTNode<int>* nodePtr
```

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Working with a BST

```
template<typename Data>
class BST {

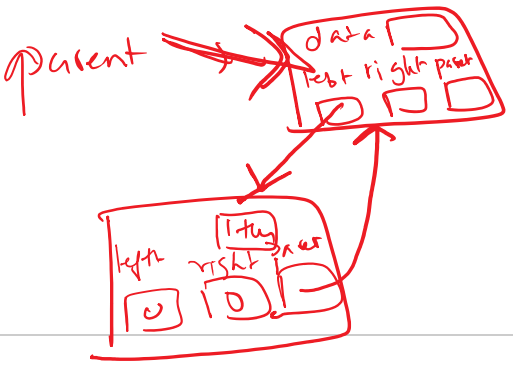
private:

  /** Pointer to the root of this BST, or 0 if the BST is empty */
  BSTNode<Data>* root;

public:

  /** Default constructor. Initialize an empty BST. */
  BST() : root(nullptr){  }

  void insertAsLeftChild(BSTNode<Data>* parent, const Data & item)
  {
     // Your code here
  }
```



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Working with a BST: Insert

```
void insertAsLeftChild(BSTNode<Data>* parent, const Data & item)
  {
     // Your code here
  }
```

Which line of code correctly inserts the data item into the BST as the left child of the parent parameter.

A. `parent.left = item;`
B. `parent->left = item;`
C. `parent->left = BSTNode(item);`
D. `parent->left = new BSTNode<Data>(item);`
E. `parent->left = new Data(item);`

parent→left → parent = parent;

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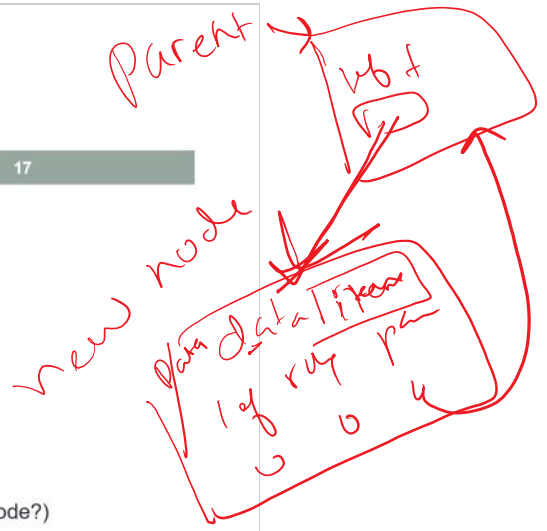
Working with a BST: Insert

```
void insertAsLeftChild(BSTNode<Data>* parent, const Data & item)
{
    parent->left = new BSTNode<Data>(item);
}
```

Is this function complete? (i.e. does it to everything it needs to correctly insert the node?)

A. Yes. The function correctly inserts the data
B. No. There is something missing.



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Working with a BST: Insert

```
void insertAsLeftChild(BSTNode<Data>* parent, const Data & item)
{

    parent->left = new BSTNode<Data>(item);


}
```