§14.7-14.8, Py ch20: Binary Search Trees (cont.)

- *HW11 due today*
- *See rubric for paper*

1 Dec 2006
CMPT14x
Dr. Sean Ho
Trinity Western University

TRINITY WESTERN UNIVERSITY

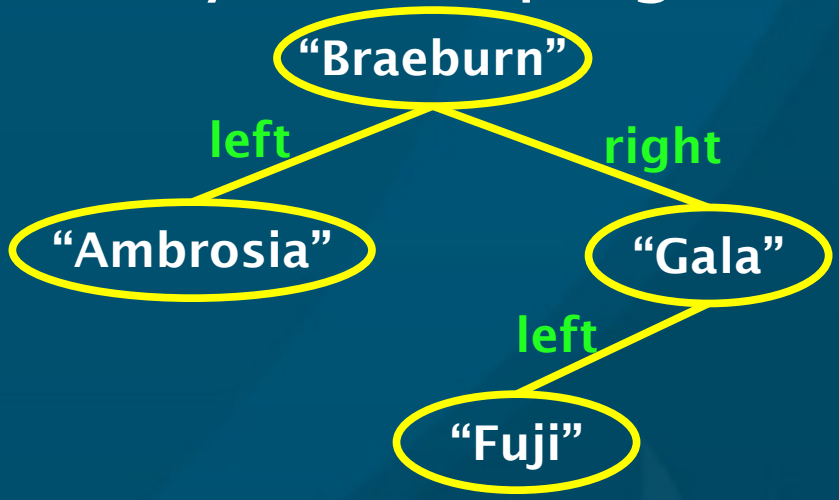
What's on for today

- Trees:
  - Definition of terms:
    - Parent, children, root, leaves, degree, depth, level, forest
  - Depth-first vs. breadth-first search
  - Binary trees: pre/in/post-order traversal
  - Binary search trees (BST):
    - Type definition
    - Search, Insert, Delete
    - Algorithmic efficiency of BST Search

Binary search trees

- Binary trees (degree=2) are handy for keeping things in sorted order:

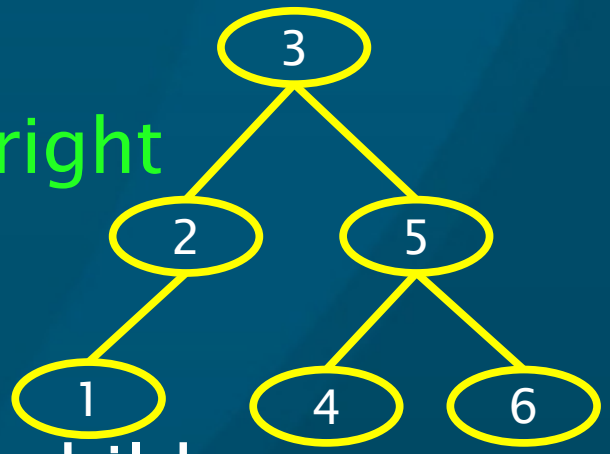
```
class BST:
    def __init__(self, data=None):
        self.data = data
        self.left = None
        self.right = None
            (* could also have a parent ptr *)
root = BST( 'Braeburn' )
root.left = BST( 'Ambrosia' )
root.right = BST( 'Gala' )
root.right.left = BST( 'Fuji' )
```



- Everything in left subtree is smaller
- Everything in right subtree is bigger

Binary tree traversals

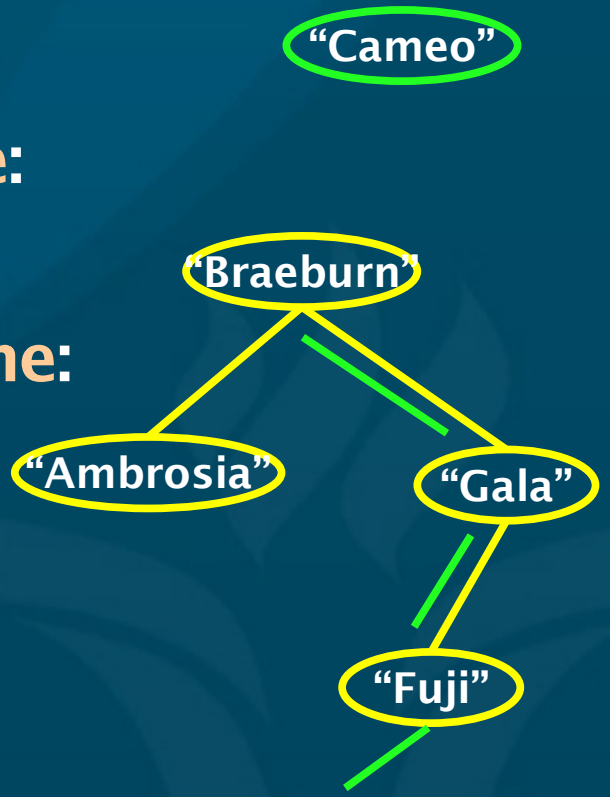
- Pre-order traversal of binary tree:
  - Do self first, then left child, then right
    - 3 – 2 – 1 – 5 – 4 - 6
- In-order traversal:
  - Do left child, then self, then right child
    - 1 – 2 – 3 – 4 – 5 – 6 (sorted order in BST)
    - e.g. expressions: "12 + (2 * 5)"
- Post-order traversal:
  - Do both children first before self
    - 1 – 2 – 4 – 6 – 5 - 3
    - e.g. Reverse Polish Notation: 12, 2, 5, *, +



Searching a BST

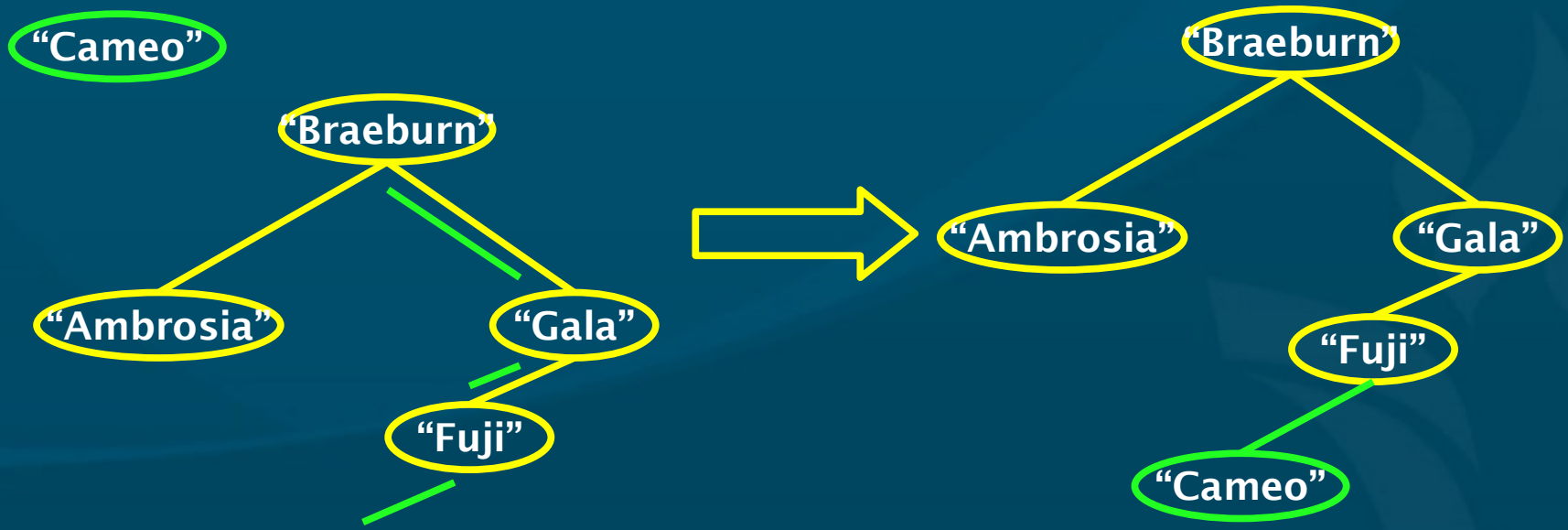
- Recursive algorithm:

```
def search (self, key):
    if key == self.data:
        return self
    elif key < self.data and self.left != None:
        return self.left.search(key)
    elif key > self.data and self.right != None:
        return self.right.search(key)
    else:
        return None
```



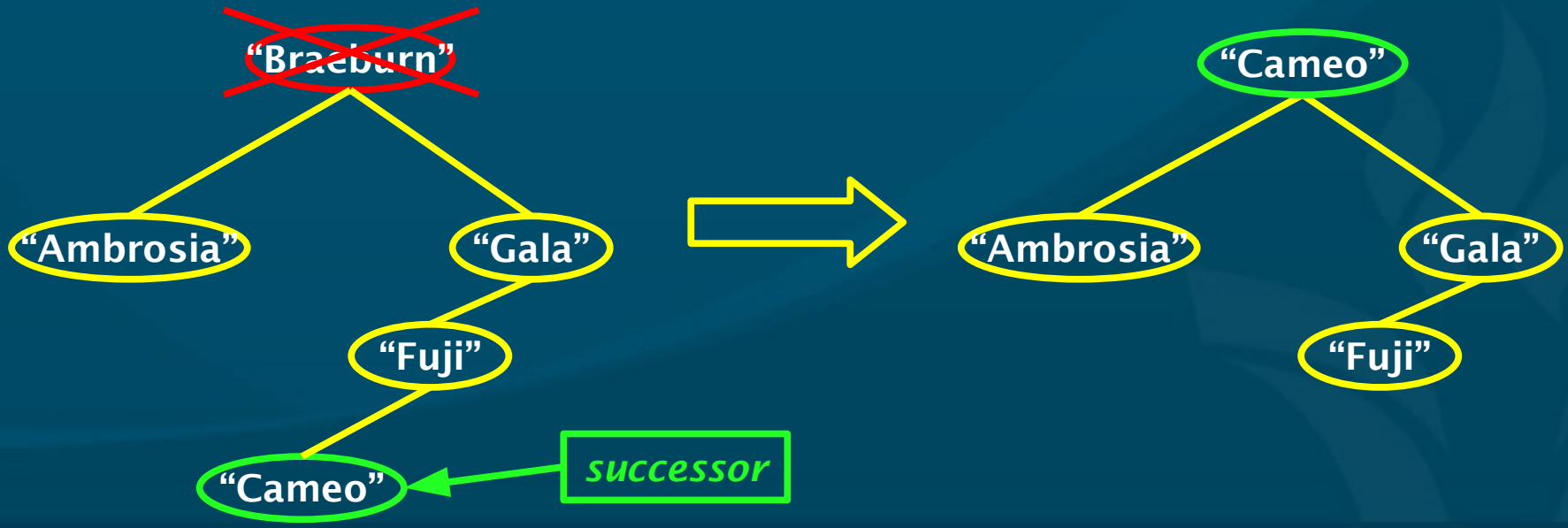
Inserting into a BST

- Keep it sorted: insert in a proper place
- One choice: always insert as a leaf
  - Use search() algorithm to hunt for where the node ought to be if it were already in the tree



Deleting from a BST

- Need to maintain sorted structure of BST
- Replace node with predecessor or successor leaf
  - Predecessor: largest node in left subtree
  - Successor: smallest node in right subtree



BSTs and algorithmic efficiency

- Searching in a balanced binary search tree takes worst-case O(log n) running time:
  - Depth of balanced tree is $\log_2 n$
  - Compare with arrays/linked lists: O(n)
- But depending on order of inserts, tree may be unbalanced:
  - Insert in order: Ambrosia, Braeburn, Fuji, Gala:
  - Tree degenerates to linked-list
  - Searching becomes O(n)
- Keeping a BST balanced is a larger topic
  - e.g., Splay-trees

Review of today

- Trees:
  - Definition of terms:
    - Parent, children, root, leaves, degree, depth, level, forest
  - Depth-first vs. breadth-first search
  - Binary trees: pre/in/post-order traversal
  - Binary search trees (BST):
    - Type definition
    - Search, Insert, Delete
    - Algorithmic efficiency of BST Search

TODO

- Lab10 due next week:
  - No Lab11
  - Implement one of your old labs 2-7 in M2
  - Full lab-writeup (may reuse old writeup)
- Quiz11 next Mon:
  - Trees (lectures 45, 47)
- Paper due Wed 6Dec
  - If by paper, due by 5pm to me
  - If by email, by midnight