CSCI 136
Data Structures & Advanced Programming

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Lecture 22

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Administrative Details

- Lab 7 due today
  - Any questions?
- Handout: Lab 8
  - Ideally you should bring LexiconNode design doc to lab so we can discuss at beginning
  - LexiconNode is the recursive data structure
  - LexiconTrie manipulates LexiconNodes
  - LexiconNode at root? Use ' ' (single blank space) character

Last Time

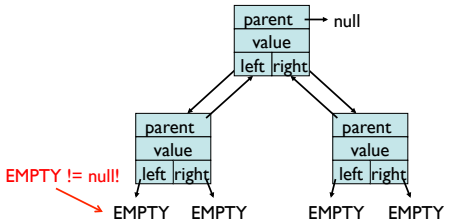
- Looked at binary expression trees
- Began talking about how to implement binary trees in Java
  - Defined weird "empty" trees
  - Defined three constructors

Today's Outline

- Continue discussing trees
  - Implement BinaryTree
  - Prove tree properties
  - Take a closer look at decision trees
  - Learn how to traverse trees

BinaryTree Recap

- BinaryTree class
  - Instance variables
    - BT parent, BT left, BT right, Object value



Implementing BinaryTree

- Methods (on board last time – see Ch 12 for more info):
- (All "left" methods have equivalent "right" methods)
  - public BinaryTree()
    - // generates an empty node (EMPTY)
    - // parent and value are null, left=right=this
  - public BinaryTree(E value)
    - // generates a tree with a non-null value and two empty (EMPTY) subtrees
  - public BinaryTree(E value, BinaryTree<E> left, BinaryTree<E> right)
    - // returns a tree with a non-null value and two subtrees
  - public void setLeft(BinaryTree<E> newLeft)
    - // sets left subtree to newLeft
    - // re-parents newLeft (if not null) by calling newLeft.setParent(this)
  - protected void setParent(BinaryTree<E> newParent)
    - // sets parent subtree to newParent
    - // called from setLeft and setRight to keep all "links" consistent

Implementing BinaryTree

- Methods:
  - public BinaryTree<E> left()
    - // returns left subtree
  - public BinaryTree<E> parent()
    - // post: returns reference to parent node, or null
  - public boolean isLeftChild()
    - // returns true if this is a left child of parent
  - public E value()
    - // returns value associated with this node
  - public void setValue(E value)
    - // sets the value associated with this node
  - public Iterator<E> iterator()
    - // returns an in-order iterator of the elements

BT Methods

- Other useful methods to consider
  - `size()`: number of descendants
  - `height()`: height of node in tree
  - Left as an exercise…think about these. How would they be defined?
- An aside: visualizing binary trees

BT Questions/Proofs

- Prove that number of nodes at level n <= 2^n.
- Prove that number of nodes in tree of height n is <= $2^{(n+1)}$-1.

Representing Knowledge

- Trees can be used to represent knowledge
  - Example: InfiniteQuestions game
- We often call these trees **decision trees**
  - Leaf: object
  - Internal node: question to distinguish objects
- Move down decision tree until we reach a leaf node
- Check to see if the leaf is correct
  - If not, add another question, make new and old objects children

Decision Trees

- Applications
  - InfiniteQuestions game
  - Medical diagnosis
- Issues with decision trees
  - How do we pick the right questions?
    - We want fewest number of questions on average path through tree, which highest confidence of obtaining correct answer
  - What problems occur when we pick the wrong questions?

Building Decision Trees

- Gather/obtain data
- Run correlation analysis
  - Make greedy choices: Find good questions that divide data into halves (or as close as possible)
- Construct tree with shortest height
- Example