```
/****
 *
 * TreeNode is the abstract parent class for a parse tree node.  It contains an
 * integer ID data field that is common to all types of node.  The ID defines
 * what type of tree node this is, e.g., an IF node, a PLUS, etc.  The ID
 * values are those defined for symbols in <a href="sym.html">sym.java</a>.
 *                                                                        <p>
 * Extensions of TreeNode add additional data fields to hold information
 * necessary for a particular node type.  The TreeNode extensions are the
 * following:
 *                                                                  <ul><li>
 *     <a href="TreeNode1.html">TreeNode1</a> -- a node with one subtree
 *              reference, used to define unary expressions, or other unary
 *              constructs, such as a single declaration
 *                                                                  <p><li>
 *     <a href="TreeNode2.html">TreeNode2</a> -- a node with two subtree
 *              references, used to define binary expressions, or other binary
 *              constructs, such an assignment statement
 *                                                                  <p><li>
 *     <a href="TreeNode3.html">TreeNode3</a> -- a node with three subtree
 *              references, used to define trinary expressions, or other
 *              trinary constructs, such as an if-then-else statement
 *                                                                  <p><li>
 *     <a href="TreeNode4.html">TreeNode4</a> -- a node with four subtree
 *              references, used to define quartinary constructs
 *                                                                  <p><li>
 *     <a href="TreeNodeList.html">TreeNodeList</a> -- a node with an
 *              indefinite number of subtree references, used to define node
 *              lists of any form, or equivalently, n-ary constructs
 *                                                                  <p><li>
 *     <a href="LeafNode.html">LeafNode</a> -- a leaf node with value
 *              information, but no subtree references
 *                                                                  <p><li>
 *     <a href="LeafNode.html">LeafNode</a> -- an extension of TreeNode4
 *              specialized to represent type trees
 *                                                               </ul><p>
 * See the documentation for each of these extending classes for further
 * detail.
 *
 */
public abstract class TreeNode {

    /**
     * Construct a tree node with id = 0.  This is used, e.g., for nodes in a
     * list, that don't need individual id's.
     */
    public TreeNode() {
        this.id = 0;
    }

    /**
     * Construct a tree node with the given id.  Set the line and column fields
     * to -1 to indicate that they have not been explicitly initialized.n
     */
    public TreeNode(int id) {
        this.id = id;
        line = -1;
        column = -1;
    }

    /**
     * Construct a tree node with the given id, with the given line and column
     * source file character positions.
     */
    public TreeNode(int id, int line, int column) {
        this.id = id;
        this.line = line;
        this.column = column;
    }

    /**
     * Output the String representation of a pre-order tree traversal.  The
     * value of each node is written on a separate line, with subtree nodes
     * indented two spaces per each level of depth, starting at depth 0 for the
     * root.
     *                                                                      <p>
     * For example, the following tree
     *                                                                      <p>
     *     <img src= "images/expr-tree.gif">
     *                                                                      <p>
     * looks like this from TreeNode.toString
     *                                                                    <pre>
     * +
     *   a
     *   *
     *     b
     *     c
     *                                                                   </pre>
     * The implementation of toString() uses an int-valued overload to perform
     * recursive traversal, passing an incrementing level value to successive
     * recursive invocations.  See the definitions of toString(int) in each
     * TreeNode extension for further details.
     */
    public String toString() {
        return toString(0);
    }

    /**
     * This is the recursive work-doer for toString.  See its definition in
     * extending classes for details.
     */
    public abstract String toString(int level);

    /**
     * Common method for subclasses' toStrings to append line number and column
     * positions, if they have been explicitly set for this node.
     */
    public String toStringLineAndColumn(String indent) {
        return
            (line >= 0) ?
                (indent + " (at line " +
                Integer.toString(line + 1 ) + ", col " +
```

```
113                 Integer.toString(column)) + ")"
114             : "";
115     }
116
117     /**
118      * Print a readable string value for a numeric-valued tree ID.  This method
119      * uses the mapping defined in the symNames class.
120      */
121     public static String symPrint(int id) {
122         return symNames.map[id];
123     }
124
125     /** The ID of this node.  Yea, it's public.  Take that, you pain-in-the-xxx
126      * software engineers. */
127     public int id;
128
129     /** The line number position of this node in the input file. */
130     int line;
131
132     /** The column position of this node in the input file, relative to the
133      * line. */
134     int column;
135
136 }
```