Announcements/Reminders:

- HW2, P1 feedback should be visible.
- Midterm logistics
- Readings

Last class:

- Recursion (cont'd)

Today:

- Recursion (end)
- Search
- Trees (intro)
Recursion Example: Palindromes

Write a recursive method to determine if a given input String is a palindrome. Palindrome examples:

- eye
- kayak
- racecar
- Was it a rat I saw?
- Never odd or even!
- Amy, must I jujitsu my ma?
- Are we not drawn onward to new era?

Assume: input String is not null, all spaces and punctuation removed, all lowercase.

Useful String methods:

```java
char charAt(int index)
int length()
String substring(int begin, int end)
```
Analyzing Complexity of Recursive Methods
Recursion Examples: Matrix Multiplication
Recursion Example: Fibonacci Sequences and Towers of Hanoi

How bad is $2^n$ anyway?

<table>
<thead>
<tr>
<th>n</th>
<th>$n^2$</th>
<th>$2^n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>1024</td>
</tr>
<tr>
<td>15</td>
<td>225</td>
<td>32,768</td>
</tr>
<tr>
<td>20</td>
<td>400</td>
<td>1,048,576</td>
</tr>
<tr>
<td>40</td>
<td>1600</td>
<td>1,099,511,627,776</td>
</tr>
<tr>
<td>50</td>
<td>2500</td>
<td>1,125,899,906,842,624</td>
</tr>
</tbody>
</table>
Search techniques

Linear/Sequential Search

Binary Search
Another way to categorize ADTs

Linear

Non-linear
Tree Data Structures
Tree Terminology
Implementing Trees (general)

(Tree) Nodes:

```
    class TreeNode<E> {

        private E data;

        private <children> children;

        ...
    }
```

Tree:

```
    @public class Tree<E> {
        private TreeNode<E> root;

        ...

        public Tree() {
            root = null;
            ...
        }

        ...
    }
```
Working with Trees: Example

Write a method to determine the height of a general tree.

    public int height() {