CS 225
Data Structures

Oct. 20 – AVL Applications
## Every Data Structure So Far

<table>
<thead>
<tr>
<th></th>
<th>Unsorted Array</th>
<th>Sorted Array</th>
<th>Unsorted List</th>
<th>Sorted List</th>
<th>Binary Tree</th>
<th>BST</th>
<th>AVL</th>
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</thead>
<tbody>
<tr>
<td><strong>Find</strong></td>
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<td><strong>Traverse</strong></td>
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</tbody>
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Share Your cs225animation

On Facebook/Twitter/Instagram:
#cs225animation
...I’ll search this tag every few days and like/heart your work!

On Piazza:
See pinned post: “MP4: Animation Sharing”
Mid-Point Grade Updates

Your mid-point grade update is on Compass 2g!
- Column: “Midpoint Total (without EC) /314”
- Column: “Midpoint % (without EC)”

Statistics:
- 314 total points
- Median Grade: 83%
- Average Grade: 80%
Range-based Searches

Q: Consider points in 1D: \( p = \{ p_1, p_2, ..., p_n \} \).
...what points fall in \([11, 42]\)?

Tree construction:
Range-based Searches

Balanced BSTs are useful structures for range-based and nearest-neighbor searches.

Q: Consider points in 1D: \( p = \{p_1, p_2, ..., p_n\} \).
   ...what points fall in \([11, 42]\)?

Ex:
Q: Consider points in 1D: $p = \{p_1, p_2, ..., p_n\}$.
...what points fall in $[11, 42]$?

Ex: 

\[3 \quad 6 \quad 11 \quad 33 \quad 41 \quad 44 \quad 55\]
Range-based Searches

Q: Consider points in 1D: \( p = \{ p_1, p_2, ..., p_n \} \).

...what points fall in [11, 42]?

Tree construction:
Range-based Searches
Range-based Searches

![Tree Diagram]

- **Node Values:**
  - 33
  - 6
  - 11
  - 44
  - 55

- **Nodes:**
  - 3
  - 6
  - 11
  - 33
  - 41
  - 44
  - 55

- **Connections:**
  - 33 to 6 and 44
  - 6 to 3 and 11
  - 11 to 33 and 41
  - 44 to 55

- **Example:**
  - Searching for a range from 3 to 11 will include nodes 3, 6, 11, and 33.
Q: Consider points in 1D: $p = \{p_1, p_2, ..., p_n\}$. ...what points fall in $[11, 42]$?
Range-based Searches
Running Time
Range-based Searches

Q: Consider points in 1D: $p = \{p_1, p_2, ..., p_n\}$. ...what points fall in [11, 42]?

Ex: 3 6 11 33 41 44 55
Range-based Searches

Consider points in 2D: $p = \{p_1, p_2, ..., p_n\}$.

Q: What points are in the rectangle: 
   $[ (x_1, y_1), (x_2, y_2) ]$?

Q: What is the nearest point to $(x_1, y_1)$?
Range-based Searches

Consider points in 2D: \( p = \{ p_1, p_2, ..., p_n \} \).

Tree construction:
Range-based Searches
kD-Trees
kD-Trees
MP5
Iterators

Why do we care?
Iterators

Why do we care?

```cpp
DFS dfs(...);
for ( ImageTraversal::Iterator it = dfs.begin(); it != dfs.end(); ++it ) {
    std::cout << (*it) << std::endl;
}
```
Iterators

Why do we care?

```cpp
DFS dfs(...);
for ( ImageTraversal::Iterator it = dfs.begin(); it != dfs.end(); ++it ) {
    std::cout << (*it) << std::endl;
}
```

```cpp
DFS dfs(...);
for ( const Point & p : dfs ) {
    std::cout << p << std::endl;
}
```
Iterators

Why do we care?

```cpp
DFS dfs(...);
for ( ImageTraversal::Iterator it = dfs.begin(); it != dfs.end(); ++it ) {
    std::cout << (*it) << std::endl;
}
```

```cpp
DFS dfs(...);
for ( const Point & p : dfs ) {
    std::cout << p << std::endl;
}
```

```cpp
ImageTraversal & traversal = /* ... */;
for ( const Point & p : traversal ) {
    std::cout << p << std::endl;
}
```
Iterators

```cpp
ImageTraversal *traversal = /* ... */;
for ( const Point & p : traversal ) {
    std::cout << p << std::endl;
}
```
Iterators

```cpp
std::list<Sphere> sphereList;
...
for (const Sphere & s : sphereList) {
    ...
}

std::vector<Sphere> sphereList;
...
for (const Sphere & s : sphereList) {
    ...
}

std::map<std::string, Sphere> sphereMap;
...
for (const std::pair<std::string, Sphere> & kv : sphereMap) {
    ...
}
```
CS 225 – Things To Be Doing

Exam 7 (theory) starts Monday!
Review Document: On Piazza
Review Session: 7pm, 1404 SC
More Info: https://courses.engr.illinois.edu/cs225/fa2017/exams/

MP4: Due Monday
Due: Monday, Oct. 23 at 11:59pm

Lab: lab_avl
Due Sunday, Oct. 22 at 11:59pm

POTD
Every Monday-Friday – Worth +1 Extra Credit /problem (up to +40 total)