Announcements

- Midterm next Monday
- Homework assignment due today
- Read chapters 5-7 in book
- Programming assignment oral review in lab this week
Binary Search Trees

- Store data in a tree
- Each node can have up to two child nodes
  - one left child
  - one right child
Binary Search Trees

• For balanced tree, we can search for n nodes for a key in $O(\log_2 n)$ steps
Can we do better?

- Can we find a key/value pair in constant time?
Can we do better?

- For small keys, we could index into an array with the key, and return the corresponding element
Can we do better?

- Doesn’t work for large key spaces, but what if we compute inputkey % sizeofarray as index
Can we do better?

- Doesn’t work for large key spaces, but what if we compute inputkey % sizeofarray
- Could potentially have a collision – two keys that correspond to the same array element
Use linked list of items

- Can use an array that points to linked lists of key/value pairs
Idea:

- Data structure known as hash table
- Idea is to grow the array so that the linked lists are always short – gives constant time access to key/value pairs
- Hash function takes key (in this case an integer) and tells us what index in the array to look – in this case we use key % arraysize as the hash function
Search

- Looking for value corresponding to key=8
- First compute key % arraysize(6)=2
- Look in element 2 of array

```
[2, 31] → [8, 12]
```
Search

- Looking for value corresponding to key=8
- First compute key % arraysize(6)=2
- Look in element 2 of array

```
X
```

```
2, 31 -> 8, 12
```
Search

• Look in element 2 of array
• Follow linked list until we find element with key=8
Search

- Follow linked list until we find element with key=8
- Found key=8, value=12
Search

- If we didn’t find it, then key/value pair isn’t in the hashtable
Adding a key/value pair

- Compute proper array element using the hash function
- Add key/value pair to beginning of the linked list for that element
Advanced Topic

• Typically, hashtable automatically resize themselves when linked lists begin to get long
  • Have to reallocate array
  • Rebuild linked list of key/value pairs for the new array
  • Free old array