

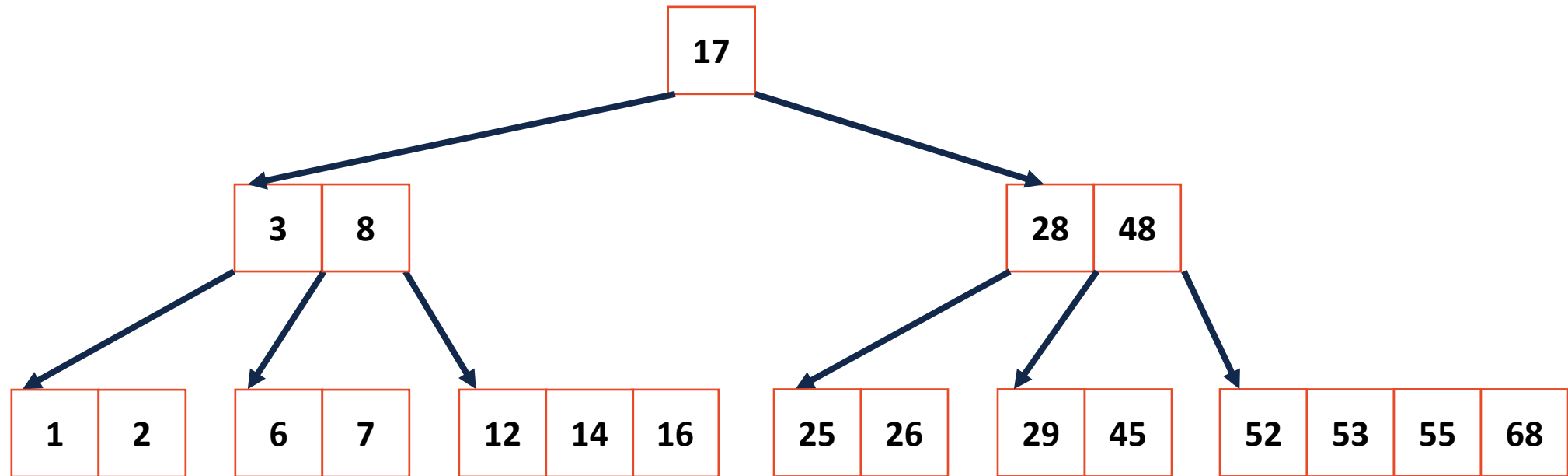


CS 225

Data Structures

Oct. 25 – BTree Analysis

BTree



Btree Properties

A **BTree** of order **m** is an m-way tree:

- All keys within a node are ordered
- All nodes contain no more than **m-1** keys.

- All internal nodes have exactly **one more child than keys**
- Root nodes can be a leaf or have **[2, m]** children.
- All non-root, internal nodes have **[ceil(m/2), m]** children.

- All leaves are on the same level

BTree Analysis

The height of the BTree determines maximum number of _____ possible in search data.

...and the height of the structure is: _____.

Therefore: The number of seeks is no more than _____.

...suppose we want to prove this!

BTree Analysis

In our AVL Analysis, we saw finding an upper bound on the height (given n) is the same as finding a lower bound on the nodes (given h).

We want to find a relationship for BTrees between the number of keys (n) and the height (h).

BTree Analysis

Strategy:

We will first count the number of nodes, level by level.

Then, we will add the minimum number of keys per node (n).

The minimum number of nodes will tell us the largest possible height (h), allowing us to find an upper-bound on height.

BTree Analysis

The minimum number of **nodes** for a BTree of order m **at each level:**

root:

level 1:

level 2:

level 3:

...

level h :

BTree Analysis

The **total number of nodes** is the sum of all of the levels:

BTree Analysis

The **total number of keys:**

BTree Analysis

The **smallest total number of keys** is:

So an inequality about **n** , the total number of keys:

Solving for **h** , since **h** is the number of seek operations:

BTree Analysis

Given $m=101$, a tree of height $h=4$ has:

Minimum Keys:

Maximum Keys:

Hashing

Locker Number	Name
103	Rick
92	Kiri
330	Mary Catherine
46	Blake
124	Erin

Hashing

Commonly:

Just use a “hash table” to implement a _____.

Dictionary ADT

Data is often organized into key/value pairs:

UIN → Advising Record

Course Number → Lecture/Lab Schedule

Node → Incident Edges

Flight Number → Arrival Information

URL → HTML Page

...

Dictionary.h

```
1 #ifndef DICTIONARY_H
2 #define DICTIONARY_H
3
4 template <class K, class V>
5 class Dictionary {
6     public:
7         void insert(K & k, V & v);
8         void remove(const K & k);
9         V & find(const K & k) const;
10
11
12
13
14
15
16     private:
17 };
18
19 #endif
20
21
22
```

Hashing

Goals:

We want to define a **keyspace**, a (mathematical) description of the keys for a set of data.

...use a function to map the **keyspace** into a small set of integers.

CS 225 – Things To Be Doing

Exam 7 is ongoing!

More Info: <https://courses.engr.illinois.edu/cs225/fa2017/exams/>

MP5: Available now!

Extra Credit +7 deadline: Monday, Oct. 30

Lab: lab_btree

Due Sunday, Oct. 29 at 11:59pm

POTD

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