

B-trees

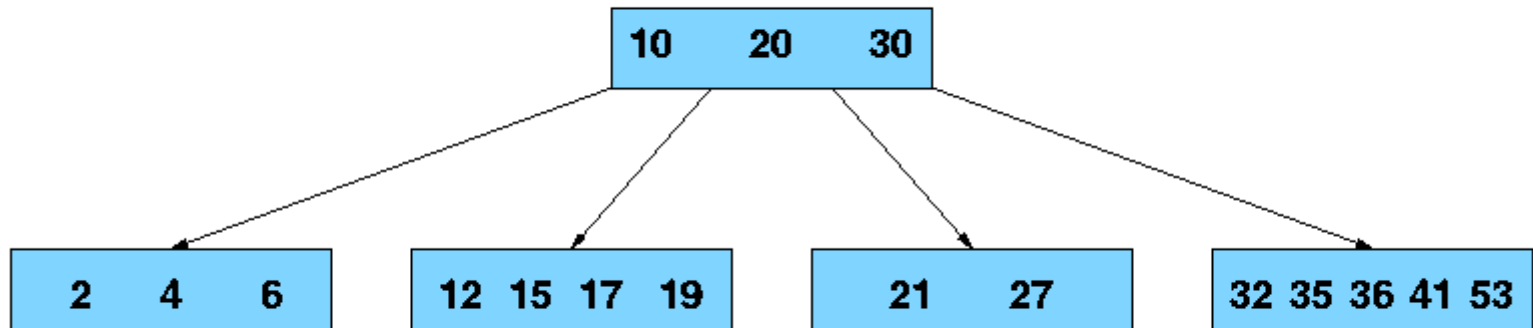
anhtt-fit@mail.hut.edu.vn

B-Tree

- Generalizes 2-3-4 trees by allowing up to M links per node.
- Main application: file systems.
 - Reading a page into memory from disk is expensive.
 - Accessing info on a page in memory is free.
 - Goal: minimize # page accesses.
 - Node size M = page size.
- Space-time tradeoff.
 - M large ! only a few levels in tree.
 - M small ! less wasted space.
 - Number of page accesses is $\log_M N$ per op.
 - Typical $M = 1000$, $N < 1$ trillion.

Search

B-Tree: Minimization Factor $t = 3$, Minimum Degree = 2, Maximum Degree = 5



Search(21)

Insert



B-Tree in the wild

- Red-black trees: widely used as system symbol tables
 - Java: `java.util.TreeMap`, `java.util.TreeSet`.
 - C++ STL: `map`, `multimap`, `multiset`.
 - Linux kernel: `linux/rbtree.h`.
- B-Trees: widely used for file systems and databases
 - Windows: HPFS.
 - Mac: HFS, HFS+.
 - Linux: ReiserFS, XFS, Ext3FS, JFS.
 - Databases: ORACLE, DB2, INGRES, SQL, PostgreSQL
- All nodes in B-Tree are assumed to be stored in secondary storage (disk) rather than primary storage (memory),
- There basic operations for accessing a page: *Disk-Read()*, *Disk-Write()*, *Allocate-Node()*

B-Tree Library

- Software and documentation is accessed at <http://www.hydrus.org.uk/doc/bt/html/index.html>!

API

- Creating a B Tree File

BTA* btcrt(char* *fid*, int *nkeys*, int *shared*);

- Opening a B Tree File

BTA* btopn(char* *fid*, int *mode*, int *shared*);

- Closing a B Tree File

int btcls(BTA* *btact*);

API (cont.)

- Inserting a key and data

```
int btins(BTA* btact, char* key, char* data, int dsize);
```

- Updating data for an existing key

```
int btupd(BTA* btact, char* key, char* data, int dsize);
```

- Locating data for an existing key

```
int btisel(BTA* btact, char* key, char* data, int dsize, int*  
rsiz);
```

- Deleting a key and associated data

```
int btidel(BTA* btact, char* key);
```

- Locating data for the next key in sequence

```
int btiseln(BTA* btact, char* key, char* data, int dsize, int*  
rsiz);
```


Building and installing the BT Library

- Unpack the tar file into a convenient directory.

```
$cd <bt library>
```

```
$make clean
```

```
$make
```

- Make built an UNIX static library **libbt.a**, a BT test harness **bt**, and a utility, **kcp**, which performs intelligent copies of BT index files.

Quiz 1

- Install and compile BT Library in your machine
- Run BT test harness to verify if successful installed
- See documentation at
<http://www.hydrus.org.uk/doc/bt/html/ch05.htm>

Quiz 2

- Use the BT library to write a phone book program that manipulates data on the secondary disk.

Another library for B-Tree

- Download at

<http://www.mycplus.com/utilitiesdetail.asp?iPro=10>

- This library allows specifying different comparison functions for keys.

Mini project 1

- Make a program to manage a computer dictionary
 - Add/Search/Delete a word (using B-Tree)
 - Auto complete search. Ex. When we enter “comput” and <tab>, the word “computer” should be auto completed (like in Bash Shell)
 - Suggestion search => Use soundex library
- Please test the performance of your program with a dictionary of millions words (the words can be randomly created)
 - Test for the two basic operations: search and insert
- Project in group of 3-4 persons