

CSE 333

Section 4

HW2 Overview, C++ Intro



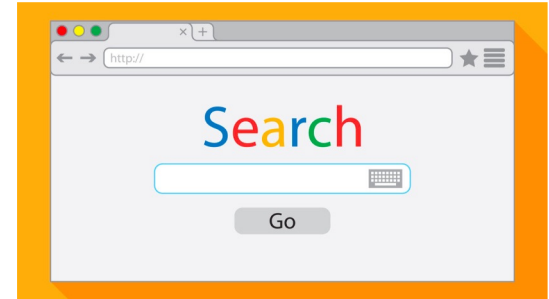
Logistics

- Homework 2
 - Due next **Thursday, 2/1 @ 11:00pm**
 - Indexing files to allow for searching
- Exercise 9
 - Out on Friday
 - Write a Vector class in C++
 - Due **Monday @ 10:00am**

Homework 2 Overview



Homework 2



- Main Idea: Build a search engine for a file system
 - It can **take in queries** and **output a list of files** in a directory that has that query
 - The query will be **ordered** based on the number of times the query is in that file
 - Should handle **multiple word queries** (*Note: all words in a query have to be in the file*)
- What does this mean?
 - Part A: **Parsing a file** and reading all of its contents into heap allocated memory
 - Part B: **Crawling a directory** (reading all regular files recursively in a directory) and building an index to query from
 - Part C: **Build a searchshell** (search engine) to query your index for results

Note: It will use the **LinkedList** and **HashTable** implementations from **HW1!**

Part A: File Parsing

Read a file and generate a HashTable of WordPositions!

Word positions will include the word and LinkedList of its positions in a file.

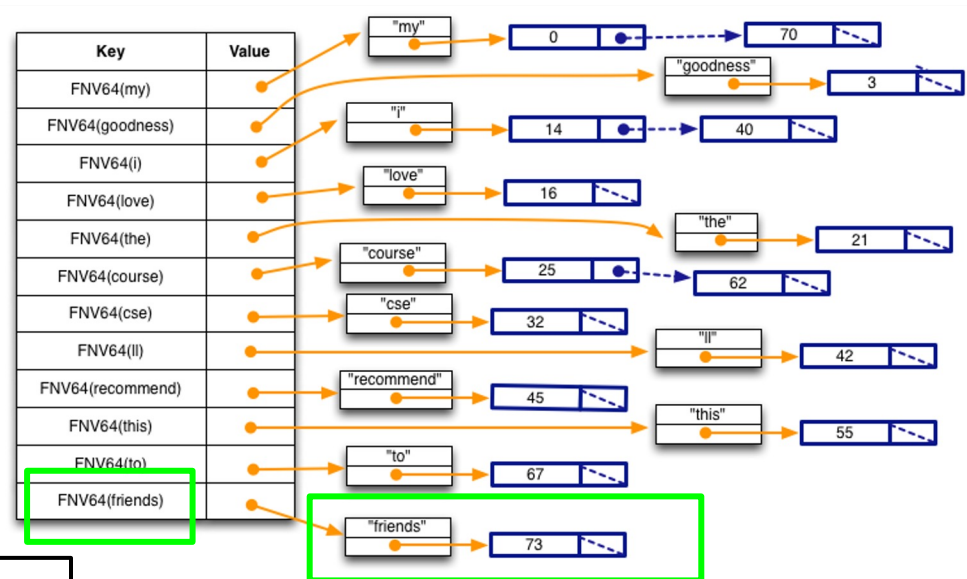
```
typedef struct WordPositions {  
    char *word; // normalized word. Owned.  
    LinkedList *positions; // list of DocPositionOffset_t.  
} WordPositions;
```

Note that the key is the hashed C-string of WordPositions

somefile.txt

My goodness! I love the course CSE333.\nI'll recommend this course to my friends.\n

ParseIntoWordPositionsTable(contents)



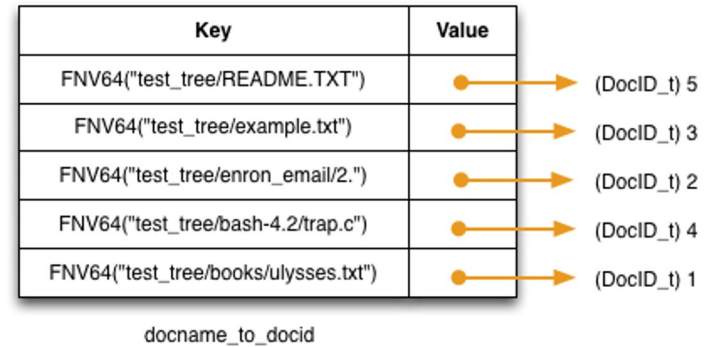
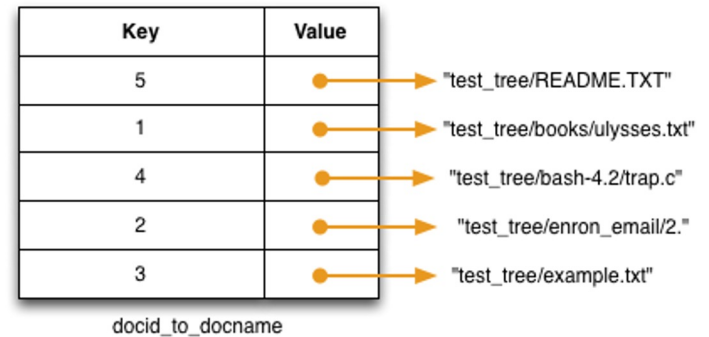
Part B: Directory Crawling – DocTable

Read through a directory in CrawlFileTree.c

For each file visited, build your DocTable and MemIndex!

DocTable maps document names to IDs. FNV64 is a hash function.

```
struct doctable_st {  
    HashTable *id_to_name; // mapping doc id to doc name  
    HashTable *name_to_id; // mapping docname to doc id  
    DocID_t    max_id;     // max docID allocated so far  
};  
DocID_t DocTable_Add(DocTable *table, char *doc_name);
```



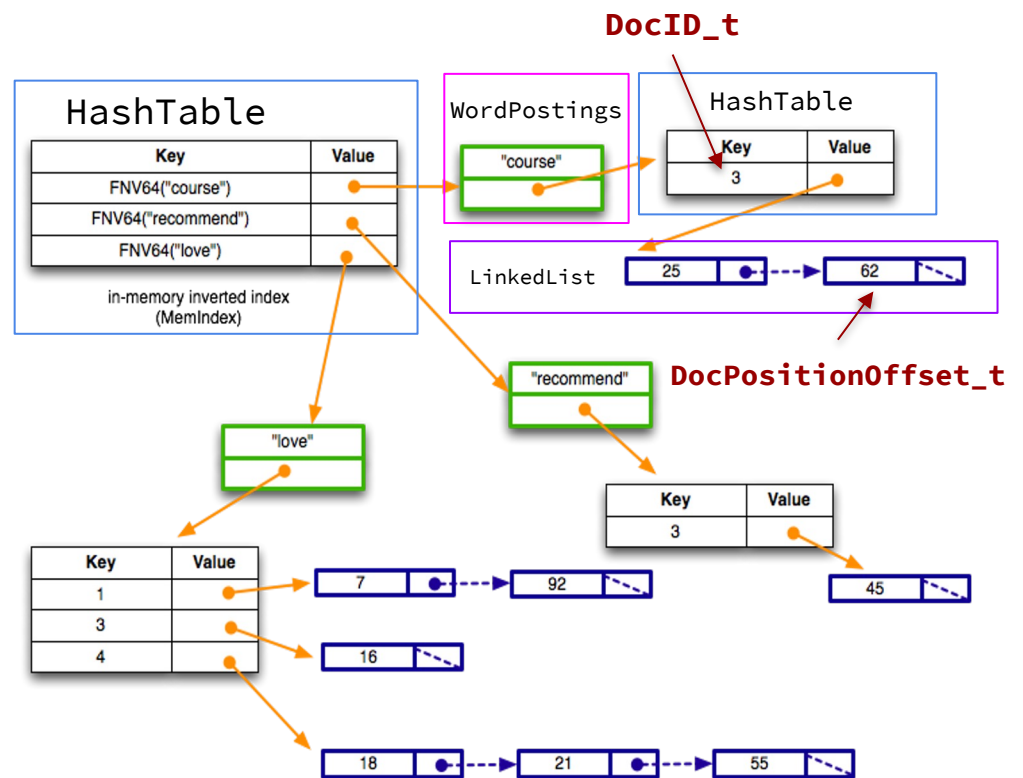
Part B: Directory Crawling – MemIndex

MemIndex is an index to view files.
It's a HashTable of WordPostings.

```
typedef struct {  
    char *word;  
    HashTable *postings;  
} WordPostings;
```

Let's try to find what contains
"course":

- WordPostings' postings has an element with key == 3 (Only DocID 3 has "course in its file")
- The value is the LinkedList of offsets the words are in DocID 3



Part C: Searchshell

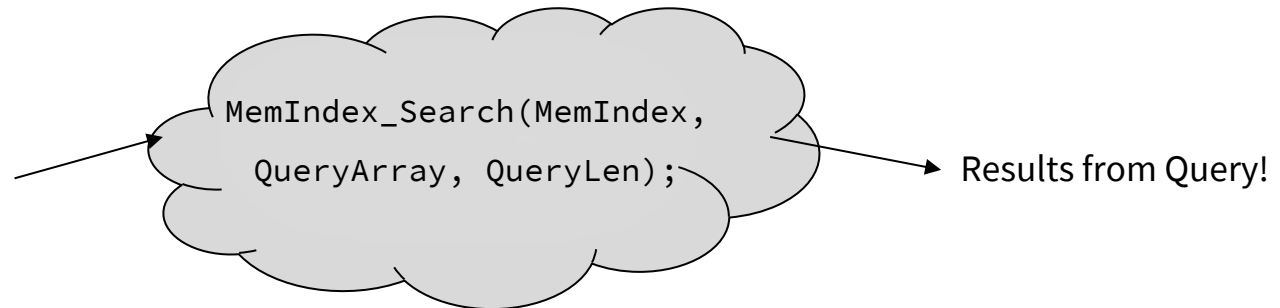
- Use queries to ask for a result!
 - Formatting should match example output
 - Exact implementation is up to you!

MemIndex.h

```
typedef struct SearchResult {  
    uint64_t docid; // a document that matches a search query  
    uint32_t rank; // an indicator of the quality of the match  
} SearchResult, *SearchResultPtr;
```

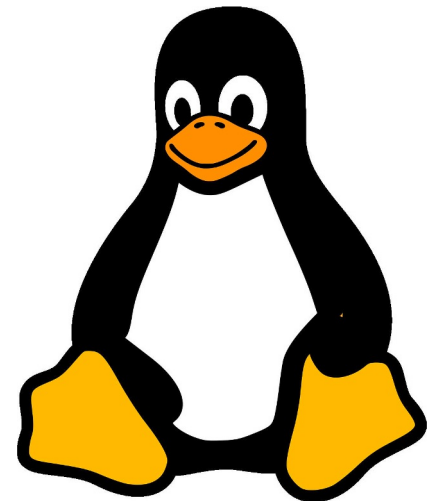
Query

course friends my



Hints

- Read the .h files for documentation about functions!
- Understand the high level idea and data structures before getting started
- Follow the suggested implementation steps given in the CSE 333 HW2 spec



Makefile Demo



Pointers, References, & Const



Example

Consider the following code:

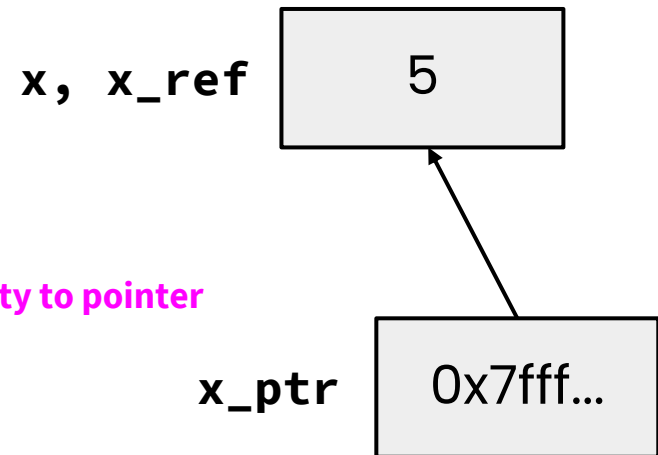
```
int x = 5;
```

```
int& x_ref = x;
```

```
int* x_ptr = &x;
```

Note syntactic similarity to pointer declaration

Still the address-of operator!



What are some tradeoffs to using pointers vs references?

Pointers vs. References

Pointers

- Can move to different data via reassignment/pointer arithmetic
- Can be initialized to **NULL**
- Useful for output parameters:
`MyClass* output`

References

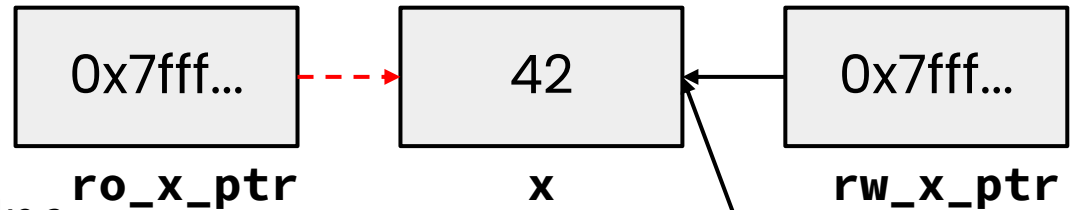
- References the same data for its entire lifetime - can't reassign
- No sensible “default reference,” must be an alias
- Useful for input parameters:
const `MyClass &input`

Pointers, References, Parameters

- `void func(int& arg)` vs. `void func(int* arg)`
- Use **references** when you don't want to deal with pointer semantics
 - Allows real pass-by-reference
 - Can make intentions clearer in some cases
- **STYLE TIP:** use references for input parameters and pointers for output parameters, with the output parameters declared last
 - Note: A reference can't be NULL

Const

- Mark a variable with `const` to make a compile time check that a variable is never reassigned
- Does not change the underlying write-permissions for this variable



```
int x = 42;
```

```
// Read only
```

```
const int* ro_x_ptr = &x;
```

```
// Can still modify x with  
rw_x_ptr!
```

```
int* rw_x_ptr = &x;
```

```
// Only ever points to x
```

```
int* const x_ptr = &x;
```

Legend

Red = can't change box it's next to

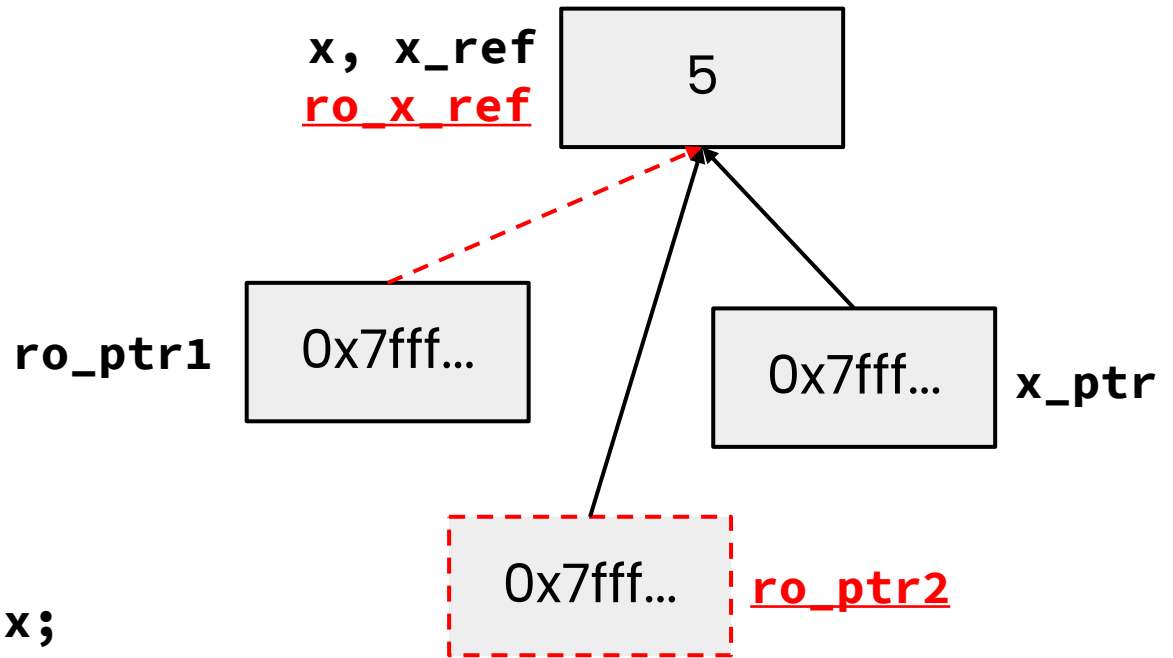
Black = read and write

Exercise 1



Exercise 1

```
int x = 5;  
int& x_ref = x;  
int* x_ptr = &x;  
const int& ro_x_ref = x;  
const int* ro_ptr1 = &x;  
int* const ro_ptr2 = &x;
```



“Const pointer to an int”

“Pointer to a const int”

Tip: Read the declaration “right-to-left”

Legend
Red = can't change box it's next to
Black = read and write

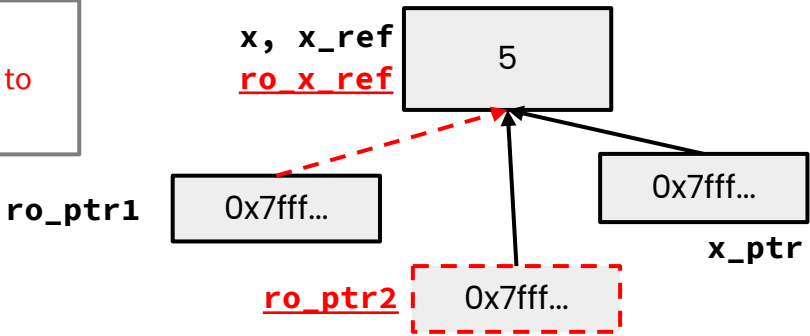
Exercise 1

When would you prefer `void Func(int &arg);` to `void Func(int *arg);`? Expand on this distinction for other types besides `int`.

- When you don't want to deal with pointer semantics, use references
- When you don't want to copy stuff over (doesn't create a copy, especially for parameters and/or return values), use references
- Style wise, we want to use **references for input parameters** and **pointers for output parameters**, with the output parameters declared last

Exercise 1

Legend
Red = can't change box it's next to
Black = "read and write"



```
void foo(const int& arg);
```

```
void bar(int& arg);
```

```
int x = 5;
```

```
int& x_ref = x;
```

```
int* x_ptr = &x;
```

```
const int& ro_x_ref = x;
```

```
const int* ro_ptr1 = &x;
```

```
int* const ro_ptr2 = &x;
```

Which lines result in a compiler error?

✓ OK ✗ ERROR

✓ bar(x_ref);

✗ bar(ro_x_ref); ro_x_ref is const

✓ foo(x_ref);

✓ ro_ptr1 = (int*) 0xDEADBEEF;

✗ x_ptr = &ro_x_ref; ro_x_ref is const

✗ ro_ptr2 = ro_ptr2 + 2; ro_ptr2 is const

✗ *ro_ptr1 = *ro_ptr1 + 1; (*ro_ptr1) is const

Objects and const Methods



```
#ifndef POINT_H_
#define POINT_H_

class Point {
public:
    Point(const int x, const int y);
    int  get_x() const { return x_; }
    int  get_y() const { return y_; }
    double Distance(const Point& p) const;
    void SetLocation(const int& x, const int& y);

private:
    int  x_;
    int  y_;
}; // class Point

#endif // POINT_H_
```

Cannot mutate the object it's called on.

Trying to change x_ or y_ inside will produce a compiler error!

A **const** class object can only call member functions that have been declared as **const**

Exercise 2



Exercise 2

Which *lines* of the snippets of code below would cause compiler errors?

✓ OK ✗ ERROR

```
class MultChoice {
public:
    MultChoice(int q, char resp) : q_(q), resp_(resp) { } // 2-arg ctor
    int get_q() const { return q_; }
    char get_resp() { return resp_; }
    bool Compare(MultChoice &mc) const; // do these MultChoice's match?

private:
    int q_; // question number
    char resp_; // response: 'A', 'B', 'C', 'D', or 'E'
}; // class MultChoice
```

✓ **const MultChoice** m1(1, 'A');
✓ **MultChoice** m2(2, 'B');
✗ cout << m1.get_resp();
✓ cout << m2.get_q();

✓ **const MultChoice** m1(1, 'A');
✓ **MultChoice** m2(2, 'B');
✓ m1.Compare(m2);
✗ m2.Compare(m1);

What would you change about the class declaration to make it better?

```
class MultChoice {
public:
    MultChoice(int q, char resp) : q_(q), resp_(resp) { } // 2-arg ctor
    int get_q() const { return q_; }
    char get_resp() { return resp_; }
    bool Compare(MultChoice &mc) const; // do these MultChoice's match?

private:
    int q_; // question number
    char resp_; // response: 'A', 'B', 'C', 'D', or 'E'
}; // class MultChoice
```



```

class MultChoice {
public:
    MultChoice(int q, char resp) : q_(q), resp_(resp) { } // 2-arg ctor
    int get_q() const { return q_; }
    char get_resp() const { return resp_; }
    bool Compare(const MultChoice &mc) const; // do these match?

private:
    int q_; // question number
    char resp_; // response: 'A', 'B', 'C', 'D', or 'E'
}; // class MultChoice

```

- Make `get_resp()` const
- Make the parameter to `Compare()` const
- Stylistically:
 - Add a setter method and default constructor
 - Disable copy constructor and assignment operator