CSE 333
Section 4

C++ Const & References; Makefiles; HW2

Some slides referenced from CSE 333 Winter 2020

Logistics

- **Exercise 9** is out Soon
  - due **Someday** (October ?), ? PDT
- **HW2** is out
  - due next **Thursday** (October 28), 23:00 PDT

Section Plan

- C++ `const` & References
  - Example (Exercise 1)
  - MultChoice class (Exercise 3)
- Makefiles practice (Exercise 5)
- HW2 Q&A

Pointers, References, and Const

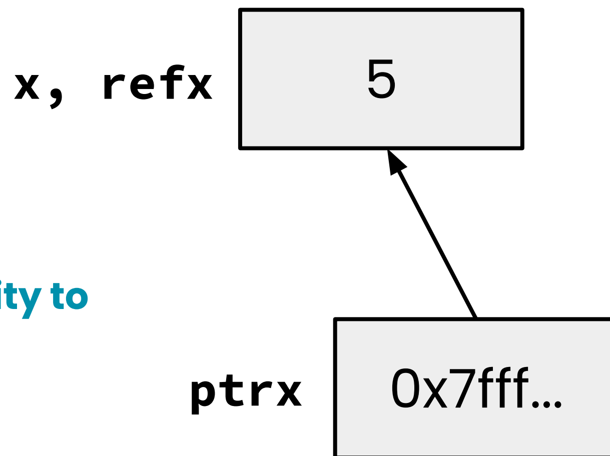
Example

- Consider the following code:

```
int x = 5;
int &refx = x;
int *ptrx = &x;
```

Note syntactic similarity to pointer declaration

Still the address-of operator!



What are some tradeoffs to using pointers vs references?

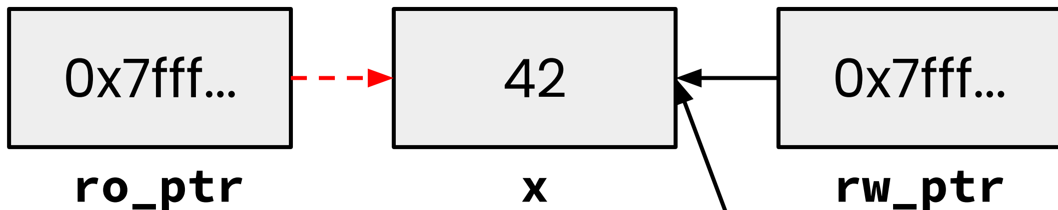
Pointers Versus References

Pointers	**References**
Can move to different data via reassignment/pointer arithmetic	References the same data for its entire lifetime - *can't reassign*
Can be initialized to **`NULL`**	No sensible "default reference," must be an alias
Useful for output parameters: `MyClass* output`	Useful for input parameters: **`const`** `MyClass& input`

Pointers, References, and Parameters

- When would you prefer:
  - `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 wise, we want to use **references** for **input** parameters and **pointers** for **output** parameters, with the output parameters declared last
  - Note: A reference can't be NULL

Const



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

- 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

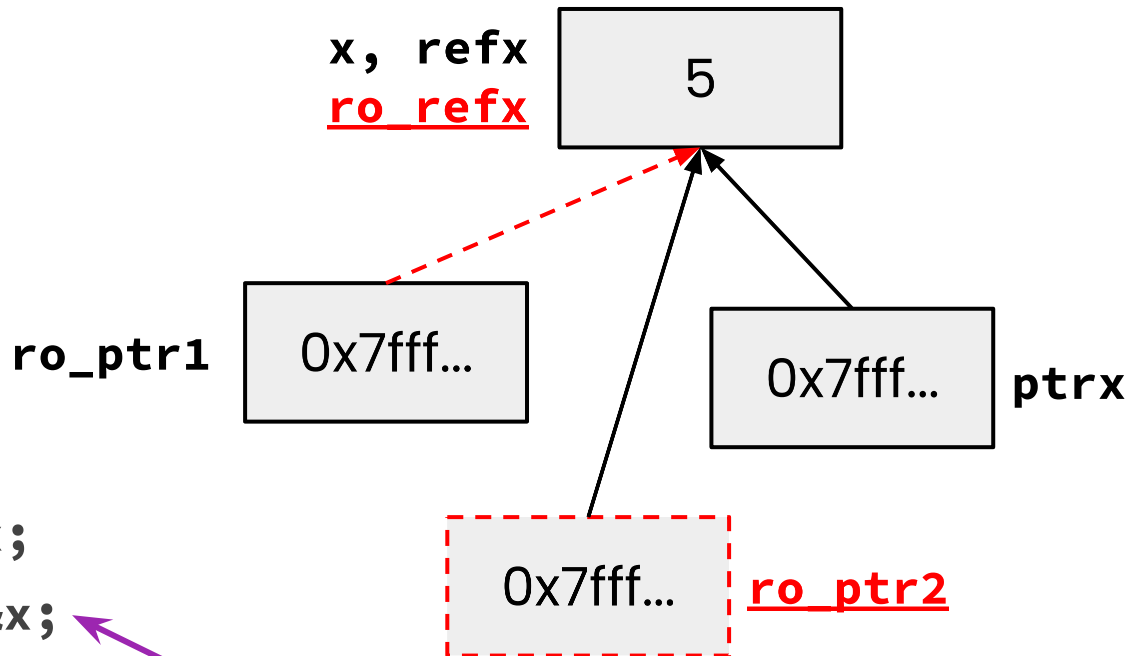
```
int x = 42;

// Read only
const int *ro_ptr = &x;

// Can still modify x with rw_ptr!
int *rw_ptr = &x;

// Only ever points to x
int *const ptr = &x;
```

Exercise 1

```
int x = 5;
int &refx = x;
int *ptrx = &x;
const int &ro_refx = x;
const int *ro_ptr1 = &x;
int *const ro_ptr2 = &x;
```

“Const pointer to an int”

“Pointer to a const int”

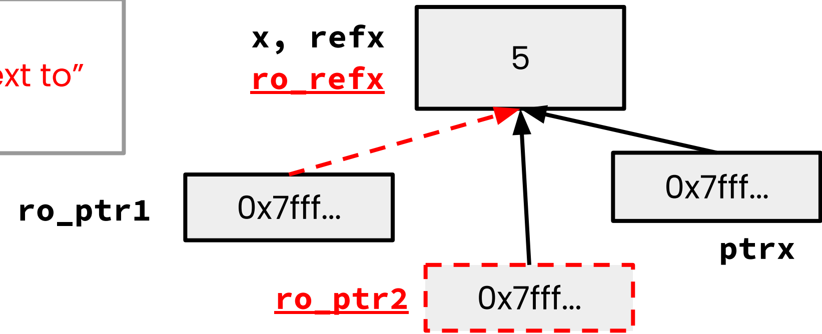


Tip: Read the declaration “right-to-left”

Legend
Red = “can’t change box it’s next to”
Black = “read and write”

Exercise 1

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 &refx = x;
int *ptrx = &x;
const int &ro_refx = x;
const int *ro_ptr1 = &x;
int *const ro_ptr2 = &x;
```

Which result in a compiler error?

✔ OK ❌ ERROR

- ✔ `bar(refx);`
- ❌ `bar(ro_refx);` ro_refx is const
- ✔ `foo(refx);`
- ✔ `ro_ptr1 = (int*) 0xDEADBEEF;`
- ❌ `ptrx = &ro_refx;` ro_refx is const
- ❌ `ro_ptr2 = ro_ptr2 + 2;` ro_ptr2 is const
- ❌ `*ro_ptr1 = *ro_ptr1 + 1;` (*ro_ptr1) is const

Objects and Const Methods

```cpp
#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 throw a compiler error!

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

Exercise 3

Exercise 3

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

✔ OK ❌ ERROR

```
✔ int z = 5;
✔ const int *x = &z;
✔ int *y = &z;
✔ x = y;
❌ *x = *y;
```

```
✔ int z = 5;
✔ int *const w = &z;
✔ const int *const v = &z;
❌ *v = *w;
✔ *w = *v;
```

Exercise 3

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
```

Makefiles

```
target: src1 src2 … srcN
    command/commands
```

Makefiles are used to manage project recompilation. Project structure and dependencies can be represented as a directed acyclic graph (DAG), which a Makefile encodes to recursively build the minimum number of files for a specified target.

Exercise 5

File	Contents
Point.h	`class Point { … };`

UsePoint.cc	`#include "Point.h"`
	`#include "Thing.h"`
	`int main( … ) { … }`

UseThing.cc	`#include "Thing.h"` `int main( … ) { … }`

File	Contents
Point.cc	`#include "Point.h"` `// defs of methods`
Thing.h	`struct Thing { … };` `// full struct def here`
Alone.cc	`int main( … ) { … }`

1. Draw out the DAG
   - The direction of the arrows are not important, but be consistent
2. Write a suitable Makefile

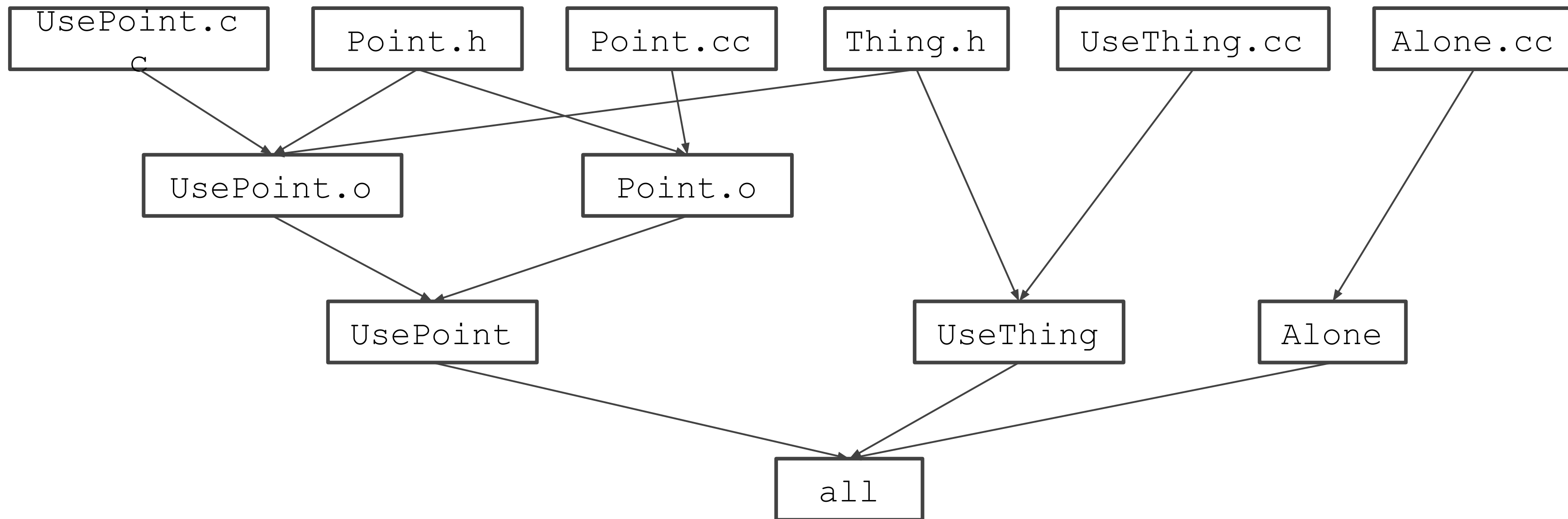
https://courses.cs.washington.edu/courses/cse333/21sp/lectures/08/08-make-21sp.pdf#page=24

DAG

File	Contents
Point.h	`class Point { … };`

UsePoint.cc	`#include "Point.h"`
	`#include "Thing.h"`
	`int main( … ) { … }`

UseThing.cc	`#include "Thing.h"` `int main( … ) { … }`
Point.cc	`#include "Point.h"` `// defs of methods`
Thing.h	`struct Thing { … };` `// full struct def here`
Alone.cc	`int main( … ) { … }`



Makefile

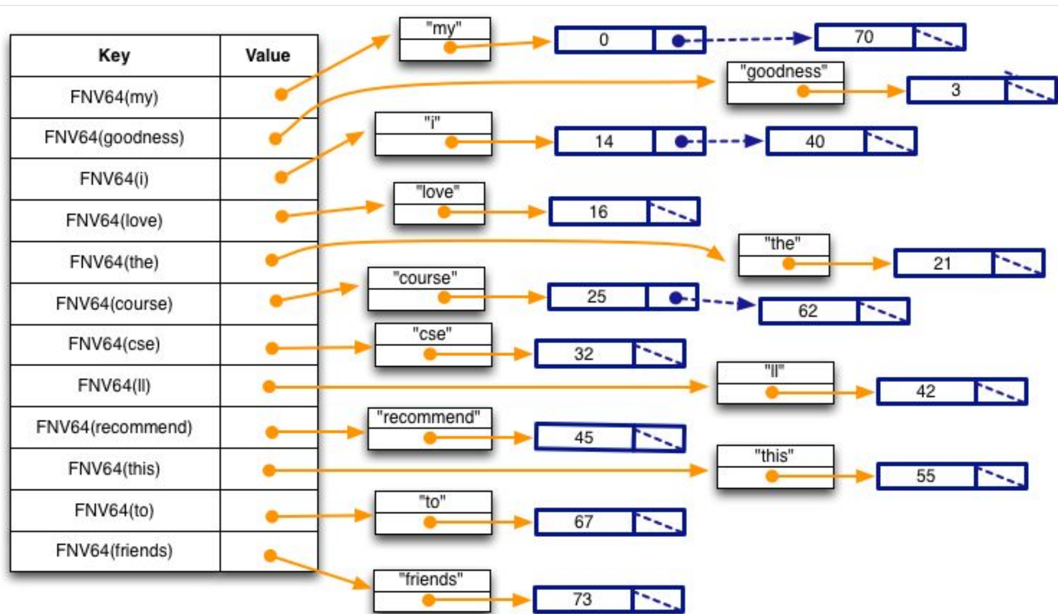
Variable

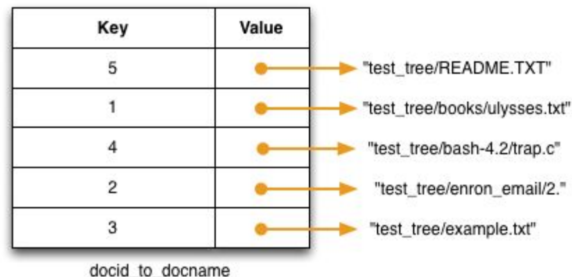
Phony target
Note: `all` first

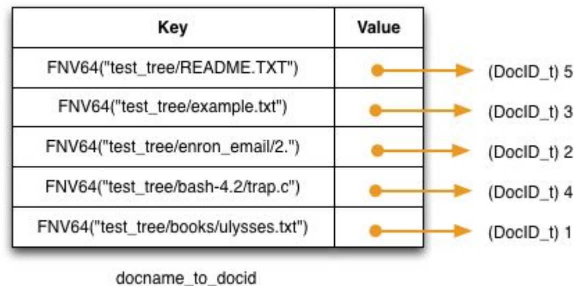
```
CFLAGS = -Wall -g -std=c++17

all: UsePoint UseThing Alone

UsePoint: UsePoint.o Point.o
	g++ $(CFLAGS) -o UsePoint UsePoint.o Point.o

UsePoint.o: UsePoint.cc Point.h Thing.h
	g++ $(CFLAGS) -c UsePoint.cc

Point.o: Point.cc Point.h
	g++ $(CFLAGS) -c Point.cc

UseThing: UseThing.cc Thing.h
	g++ $(CFLAGS) -o UseThing UseThing.cc

Alone: Alone.cc
	g++ $(CFLAGS) -o Alone Alone.cc

clean:
	rm UsePoint UseThing Alone *.o *~
```

Homework 2

Document Parsing







The parser produces these WordPosition structures for each file, which are stored in a hash table by word.

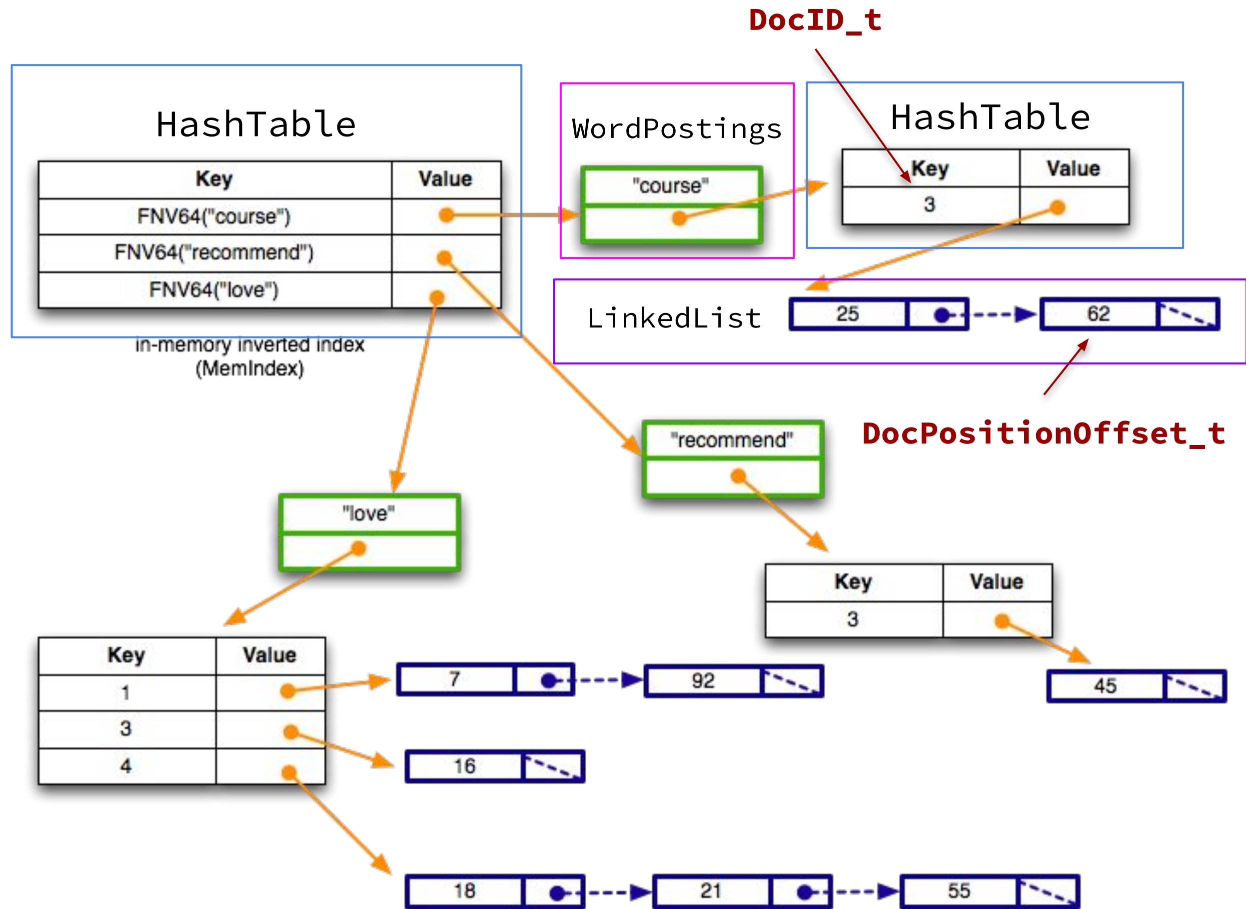
Map document names to IDs. FNV64 is a hash function.

MemIndex

The file crawler builds up a MemIndex structure, which is just a hash table of “word postings.”

A word posting is a pair of a word and a hash table with DocID keys and list of positions as a value.

Based on the figure, you can see that the word "course" appeared in a single document with docID 3, at byte offsets 25 and 62 from the start of file. Similarly, the word "love" appears in three documents: docID 1 at positions 7 and 92, docID 3 at position 16, and docID 4 at positions 18, 21, and 55.



Q&A
Thanks for Attending Section!