CISC/CMPE320

- Notices:

- Teams are being assembled – the members will be listed in the course web site before Monday.
- Everyone should have Jira accounts now – if you don't, email me.
- Assignment 1 due next Friday at 7pm.
- On Monday, I will talk about your first team meeting and a bit about "being agile".
- Next Tuesday's lecture will be virtual only – no "in person" lecture.

Today

- Back to the struct demo to look at parameter passing.

- Operators.

- Bitwise Operators.

- Boolean Expressions.

Structures

- A kind of **`class`**.
- Defined as an aggregate of other types.
- For example:

```
struct address {
     string name;
     int streetNumber;
     string street;
     string city;
     string province;
     string postalCode;
};
```

Note ";"

Structures, Cont.

- See StructureDemo.cpp

Watch for clarification of addresses, etc.

- Demonstrate:
  - Passing by value.
  - Passing by reference.
  - Passing by constant reference.
  - Passing a pointer.
  - Passing a pointer to a constant.
  - Passing a constant pointer.

Passing…

- Does it make any sense to pass by constant value?

- Do you understand the difference between a "pointer to const" and a "const pointer"? It does matter where you position the `const` when typing a pointer.

- The best technique to use, if you can, is to pass by constant reference.

Member Selection Operators

- The example also demonstrated the use of the two member selection operators:
- The "dot operator":

```
    object.member
```

- De-referencing and membership:

```
    pointer->member
```

- The latter is the same as:

```
    (*pointer).member
```

- ("Members" are attributes or methods (or member functions)…)

Structures, Cont.

- A struct is a primitive object definition with no privacy for it's members.
- Why use them in C++?
- (*It was great to use the struct in this demo because it behaved like a very simple class!*)

Operators

- Discussed in order of highest to lowest precedence.
- See: http://en.cppreference.com/w/cpp/language/operator_precedence
- Highest Precedence:
- Scope resolution (when defining only):
  class_name*::*member
- Or ***namespace_name*::*member***

Operators, Cont.

- Next Highest Precedence (level 2):
- Member selection **.** (see slide 5).
- Subscripting arrays: ***pointer*[*expr*]**
- **( )** when used with function calls or value constructors.
- Post increment or post decrement: ***var*++ *var*--**
- Type identification: **typeid(*type or expr*)**
- Casts like **static_cast<*type*>(*expr*)**

Aside – typeid()

- Used to find out the types of pointers.
- More useful in a function:
- A trivial example:

```
int aVal = 100;
int* ptr_aVal = &aVal;
cout << typeid(ptr_aVal).name() << endl;
```

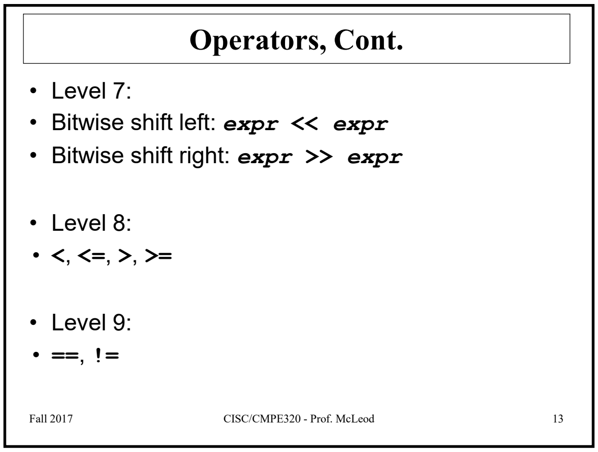
- Displays: Pi

Operators, Cont.

- Level 3 Precedence:
- **sizeof(*type*)**
- Pre-increment and pre-decrement.
- Complement: **~*expr***
- Not: **!*expr***
- Negation: **-*expr***
- Address of and dereference (**&** and *****)
- The heap operators: **new**, **delete** and **delete[]**
- C – style cast: **(*type*)*expr***

Operators, Cont.

- Level 4:
- Member selection (and dereference) **->**
- Level 5:
- Multiply, Divide, Modulo: *****, **/**, **%**
- Level 6:
- Add, subtract: **+**, **-**

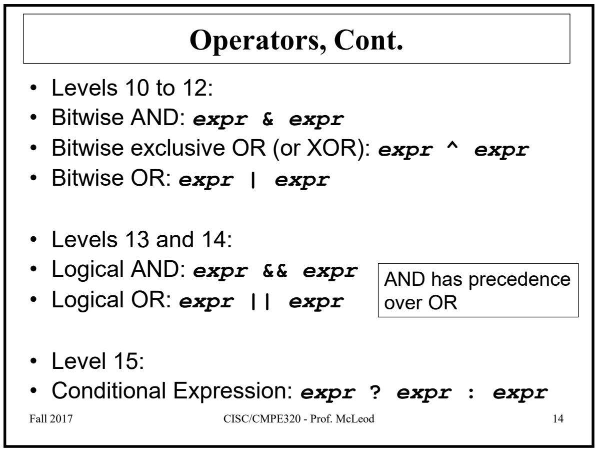


Operators, Cont.

- Level 7:
- Bitwise shift left: ***expr* `<<` *expr***
- Bitwise shift right: ***expr* `>>` *expr***

- Level 8:
- `<`, `<=`, `>`, `>=`

- Level 9:
- `==`, `!=`



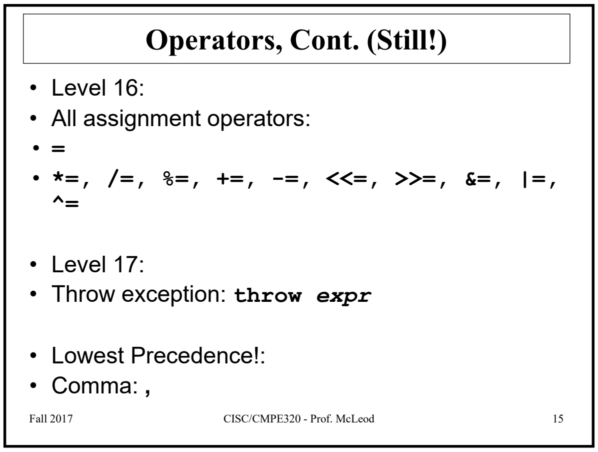
Operators, Cont.

- Levels 10 to 12:
- Bitwise AND: ***expr* `&` *expr***
- Bitwise exclusive OR (or XOR): ***expr* `^` *expr***
- Bitwise OR: ***expr* `|` *expr***

- Levels 13 and 14:
- Logical AND: ***expr* `&&` *expr***
- Logical OR: ***expr* `||` *expr***

AND has precedence over OR

- Level 15:
- Conditional Expression: ***expr* `?` *expr* `:` *expr***

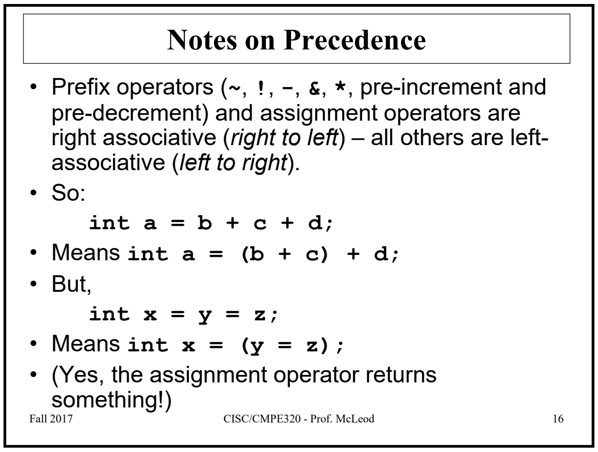


Operators, Cont. (Still!)

- Level 16:
- All assignment operators:
- `=`
- `*=, /=, %=, +=, -=, <<=, >>=, &=, |=, ^=`

- Level 17:
- Throw exception: **`throw` *expr***

- Lowest Precedence!:
- Comma: ,



Notes on Precedence

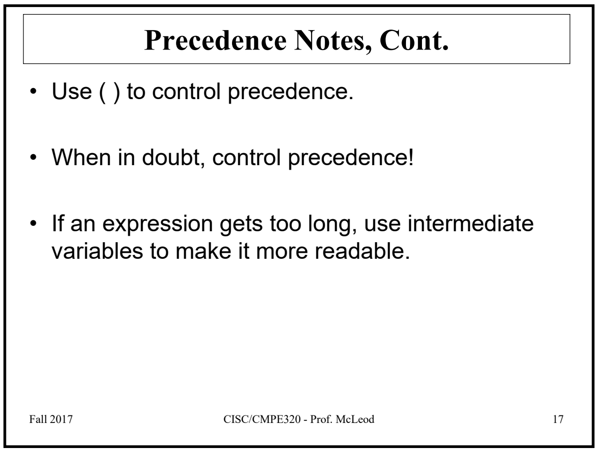
- Prefix operators (`~`, `!`, `-`, `&`, `*`, pre-increment and pre-decrement) and assignment operators are right associative (*right to left*) – all others are left-associative (*left to right*).
- So:

```
int a = b + c + d;
```

- Means `int a = (b + c) + d;`
- But,

```
int x = y = z;
```

- Means `int x = (y = z);`
- (Yes, the assignment operator returns something!)

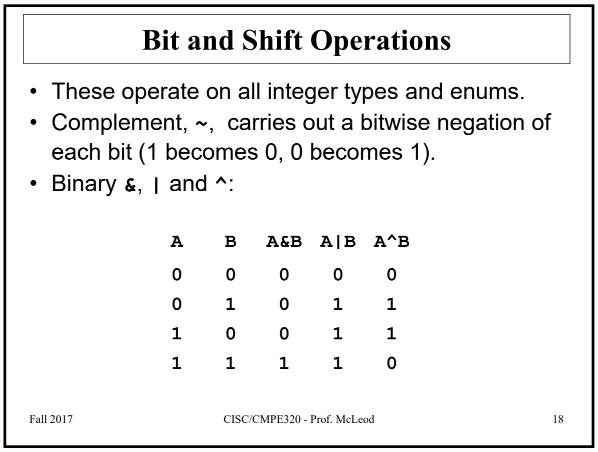


Precedence Notes, Cont.

- Use ( ) to control precedence.

- When in doubt, control precedence!

- If an expression gets too long, use intermediate variables to make it more readable.



Bit and Shift Operations

- These operate on all integer types and enums.
- Complement, `~`, carries out a bitwise negation of each bit (1 becomes 0, 0 becomes 1).
- Binary `&`, `|` and `^`:

A	B	A&B	A|B	A^B
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

Bit and Shift Operations, Cont.

- The left shift operator, `<<`, moves all bits in ***`val`*** to the left by **`n`** positions: ***`val`*** **`<< n`**.
- Zeros are added to the least significant bits.
- This is the same as multiplying a number by 2^n.

- Right shift, `>>`, moves all bits to the right.
- For unsigned integers zeros are added to the most significant bits – same as dividing by 2^n.
- For signed integers, the result is not predicable as the sign bit may be duplicated.

Bitwise Operations, Examples

- Set the n^{th} bit in a number and the rest are zeros:

```
1 << n
```

- To set the n^{th} bit of any number, **`x`**, and not change the rest:

```
x = x | 1 << n
```

- To check to see if the n^{th} bit is set:

```
if ((x & 1 << n) != 0)…
```

Boolean Expressions

- We have seen the boolean operators already. Here are a few notes:

- Something like

  ```
  a < b < c
  ```

  will compile and run, but may not produce the desired result. Better to use:

  ```
  a < b && b < c
  ```

- Remember that **`&`** and **`|`** are bitwise operators, not logical ones.

Boolean Expressions, Cont.

- The **`&&`** and **`||`** logical operators use “short circuit evaluation”:
- For **`&&`** if the LHS is **`false`** then the RHS is not evaluated.
- For **`||`** if the LHS is **`true`** then the RHS is not evaluated.

- (Same as in Java.)

Boolean Expressions, Cont.

- Non zero integers are treated as being **`true`**, and zero is treated as being **`false`**. (*Ouch*!)
- So, you can use logical operators, **`&& ||`** and **`!`**, with integers.
- For example, the code:

  ```
  int x = 10;
  if (x)
  ```

- is the same as:

  ```
  int x = 10;
  if (x != 0)
  ```

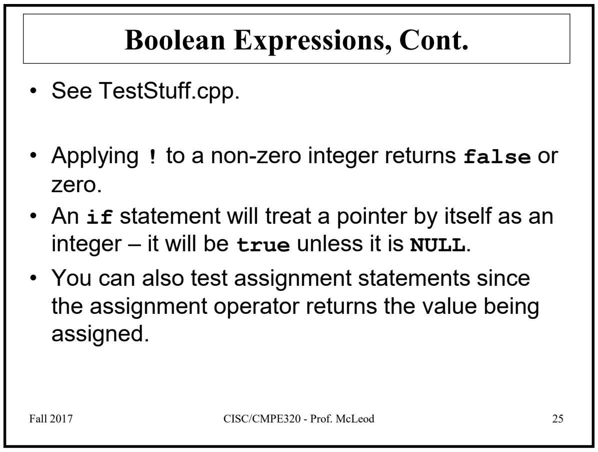
Boolean Expressions, Cont.

- Also, this is legal syntax:

  ```
  if (x = 10)
  ```

- The assignment operator returns the value being assigned, which in this case is a `true`! But suppose `x` is `12` and you really meant to type `==`…

- *Ouch, again*!



Boolean Expressions, Cont.

- See TestStuff.cpp.

- Applying **`!`** to a non-zero integer returns **`false`** or zero.
- An **`if`** statement will treat a pointer by itself as an integer – it will be **`true`** unless it is **`NULL`**.
- You can also test assignment statements since the assignment operator returns the value being assigned.