Pointers and memory

Ch 9 & 13.1
Highlights

- new & delete

```cpp
int *xp;
xp = new int;
*xp = 5;
delete xp;
```
Pointers

A pointer is used to store a memory address and denoted by a * (star!)

```
int x=6;
int *xp;
xp = &x;
```

Here variable xp is a integer pointer

```
cout << *(&x); // *(&x) same as x
```

The * goes from address to variable (much like when you hit ENTER on a url) (See last time: pointerBasics.cpp)
Person class

How would you make your grandmother? How could you get your grandmother using only yourself as a named object?

```cpp
class person{
    string name;
    person* mother;
    person* father;
};
```

(See: personV2.cpp)
When dealing with classes, often you need to deference (*) and access a member (.)

There is a shortcut to de-reference and call a member (follow arrow and go inside a box)

You can replace (*var).x with var->x, so...

```cpp
(*me.mother).name;
```

... same as ...

```cpp
me.mother->name;
```
What is comes next in this pattern?

Basic programming: \texttt{int x;}
Ask for one box with a name

Intermediate programming: \texttt{int x[20];}
Ask for multiple boxes with one name

Advanced programming: ???
???
Boxes

What is comes next in this pattern?

Basic programming: int x;
Ask for one box with a name

Intermediate programming: int x[20];
Ask for multiple boxes with one name

Advanced programming: new int;
Ask for a box without giving it a name
Pointers are also especially useful to use with the `new` command.

The `new` command will create a variable (box) of the type you want. The new integer has no separate name, just part of `xp` (as array boxes part of array name). (See: newMemory.cpp)
What does this do?

```cpp
int main()
{
    while(true)
    {
        int *x = new int;
    }
    return 0; //totally going to get here!
}
```
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    return 0;  //totally going to get here!
}
```

Asking for a lot of boxes there...
(See: memoryLeak.cpp)
When your program exits, the operating system will clean up your memory.

If you want to clean up your memory while the program is running, use `delete` command.

```cpp
int *imaPointer; // pointer box (holds address)
imaPointer = new int; // point here!
// do some stuff...
delete imaPointer; // goodbye pointer
```

(See: deleteMemory.cpp)
This is also a memory leak:

```cpp
int *ptr; // make a pointer
ptr = new int; // point here
ptr = new int; // more the merrier
delete ptr; // ERASE
```

By the 3\textsuperscript{rd} line, there is no link back to the box on the 2\textsuperscript{nd} line (dangling pointer)

There should be a “delete” for every “new”
As you can manage how you want to create new variables/boxes, using new/delete is called **dynamic memory**

Before, the computer took care of memory by creating variables/boxes when you use a type then deleting when the function ends.
Memory management is a hard part of C++

You need to ensure you delete all your boxes after you are done with them, but before the pointer falls out of scope (see: lostPointer.cpp)

Some other languages manage memory for you
The ability to have non-named boxes allows you to more easily initialize pointers.

```cpp
class person{
    string name;
    person* mother;
    person* father;
};
```

(See: personV3.cpp)
Pointer to pointer

You can have multiple stars next to types:

```c
int*** x;
```

Each star indicates **how many arrows** you need to follow before you find the variable

```
int***   int**   int*   int
\     \     \     \\
X     \     \     \\
```

(See: pointerPointers.cpp)