Late binding

Ch 15.3

Highlights

- Late binding for variables

```
Parent* x = new Child;
```

- Late binding for runctions

```
class Person{
public:
    virtual void swing()
};

class Boxer : public Person
{
public:
    void swing();
};
```

Review: Derived classes

Today we will deal more with inheritance

Mainly we will focus on how you can store a child class in a parent container (sort of)

```
Parent p = Child();
```

Questions we will answer:
What is this line of code doing exactly?
Are there other ways of doing this?

Early vs late binding

<u>Static binding</u> (or early) is when the computer determines what to use when you hit the compile button

<u>Dynamic binding</u> (late) is when the computer figures out the most appropriate action when it is actually running the program

Much of what we have done in the later parts of class is similar to late binding

Static binding

When you go to a fast-food-ish restaurant, you get one tray, regardless of what you order

The key is before they knew what you were ordering, they determined you needed one tray

Dynamic binding

When you order a drink, they do not just give you a standard cup and say “fill to this line”

Now, they have to react to what you want and give you the correct cup size (not a predetermined action, thus dynamic binding)

Static binding

Checking out at a grocery store, all items are scanned and added to the bill in the same way

The same program on the computer runs for all items and just identifies their price

Dynamic binding

After you pay, you put the food into bags (paper/plastic/your own)

What items go where depends on what you want to use and the item properties (weight, dampness, rigidness, etc.)

Static/dynamic binding

Consider this code:

```
int x = 2;
cout << x << endl;
```

You know the output even before the program runs (you know at compile time = static)

While this code, you only know the output when the program runs (i.e. dynamic):

```
int y;
cin >> y;
cout << y << endl;
```

(See: compleVsRun.cpp)

Static/dynamic binding

static = rigid/constant
dynamic = flexible/adaptive

Static/dynamic binding

Static/dynamic binding is similar to how we originally made arrays: (static/early binding)

```
// need to know the size when compiling
int x[20];
```

To dynamic memory arrays: (dynamic/late)

```
cin >> size;
// may not how big x is until this line
int* x = new int[size];
```

Mini-quiz (ungraded)

```
class Parent {
public: // bad bad bad
    int x;
};
```

```
class Child : public Parent {
public: // bad bad bad
    int y;
};
```

What is in p at end of main()?

1. x=2
2. x=2, y=10
3. x=1, y=10
4. x=1

(Hint: what happens on this:)

```
int z = 2.5;
```

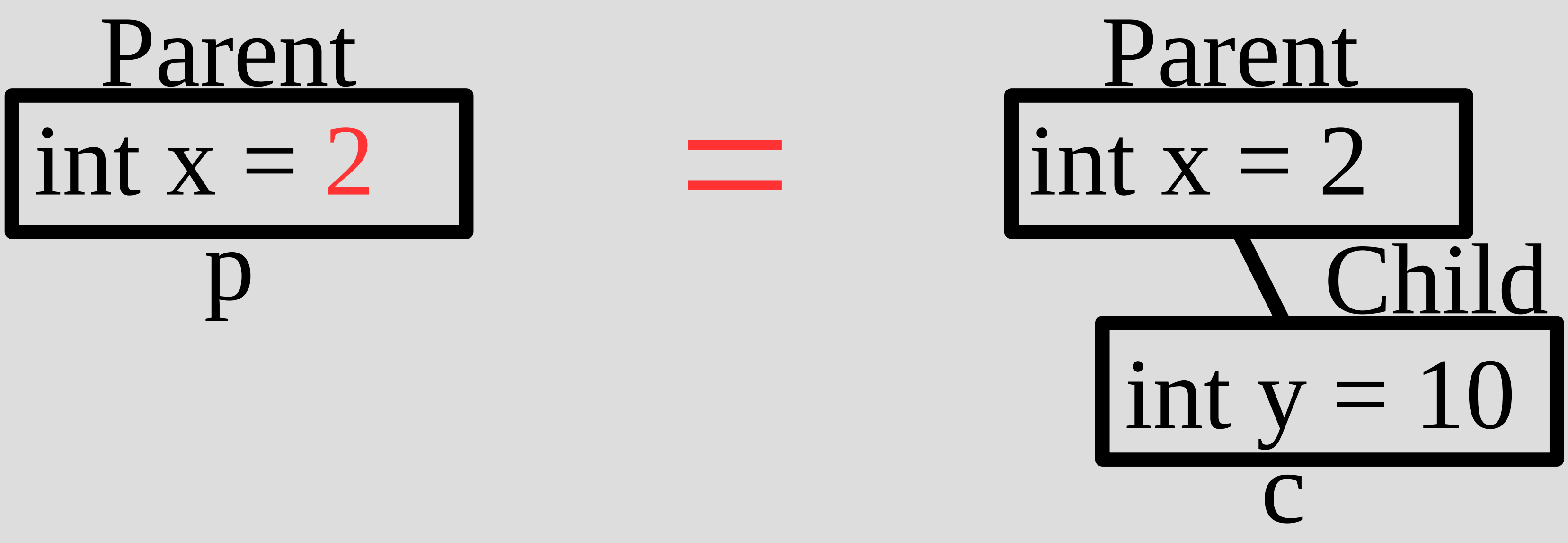
```
int main()
{
    Parent p;
    p.x = 1;

    Child c;
    c.x = 2;
    c.y = 10;

    p=c;
}
```

= between parent/child

It is debatable how we should interpret line:

```
p=c;
```

In C++ (not some other languages), this just copies the parts of the parent class over



Mini-quiz (ungraded)

```
class Parent {
public: // bad bad bad
    int x;
};
```

```
class Child : public Parent {
public: // bad bad bad
    int y;
};
```

What is at p now?

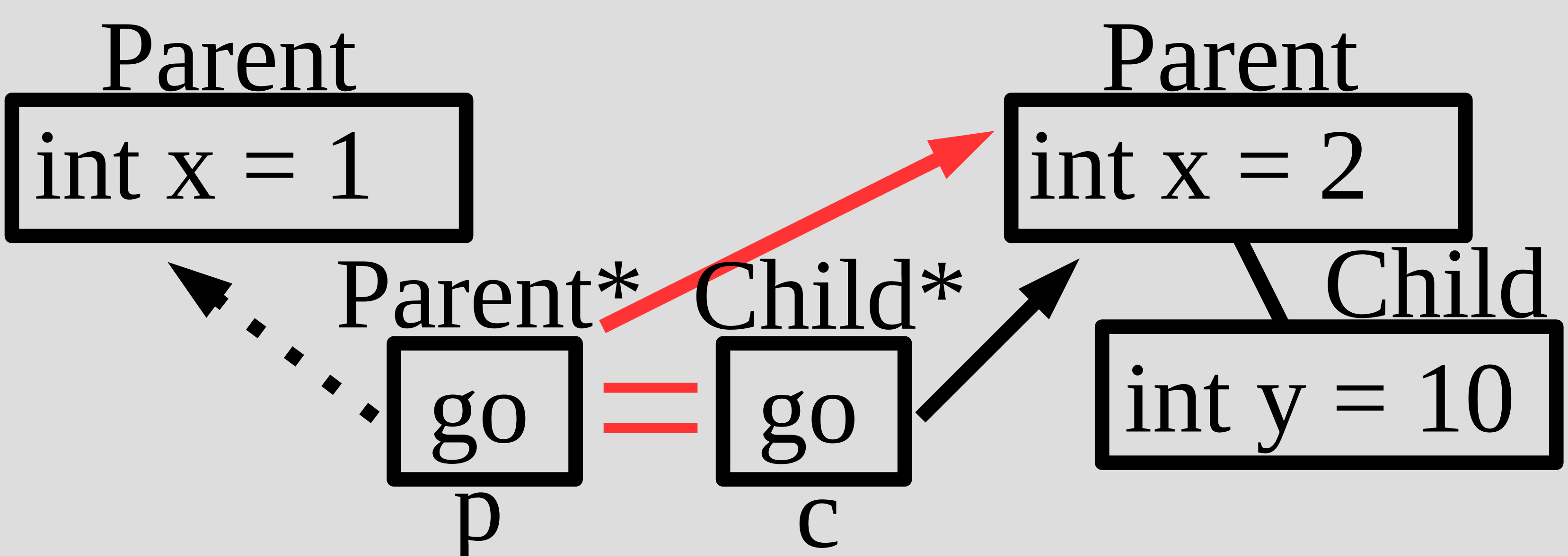
1. x=2
2. x=2, y=10
3. x=1, y=10
4. x=1

```
int main()
{
    Parent* p = new Parent;
    p->x = 1;

    Child* c = new Child();
    c->x = 2;
    c->y = 10;

    p=c;
}
```

= between parent/child pointers

When the objects are pointers, lines line just changes the object being pointed to (but not any information inside either class)

```
p=c;
```



Dynamic variable binding

If a Parent type is pointing to a Child instance, we cannot directly access them (variables cannot be "virtual"...)

```
p->y = 20; // red angry underlines!
```

Instead, we have to tell it to act like a Child* by casting it: (bad practice as y public)

```
static_cast<Child*>(p)->y = 20; // happy
```

(see: dynamicObject.cpp)

Dynamic variable binding

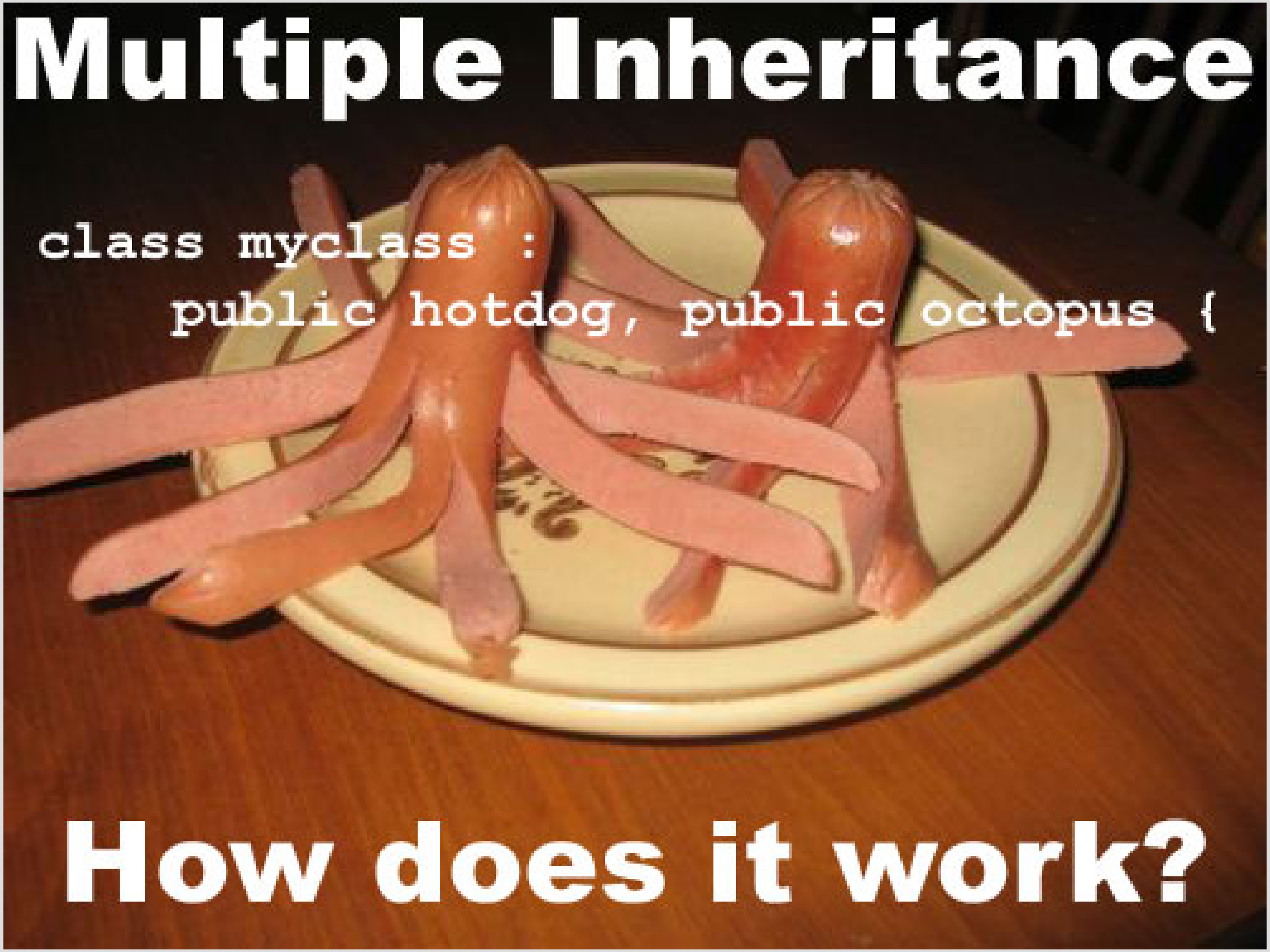
If p points to a Parent instance, the below line is VERY BAD (but it might work... sorta...)

```
Parent* p = new Parent;
static_cast<Child*>(p)->y = 10; // happy..?
```

You will be fooling around in some part of memory that is not really associated p (though you might not crash...)

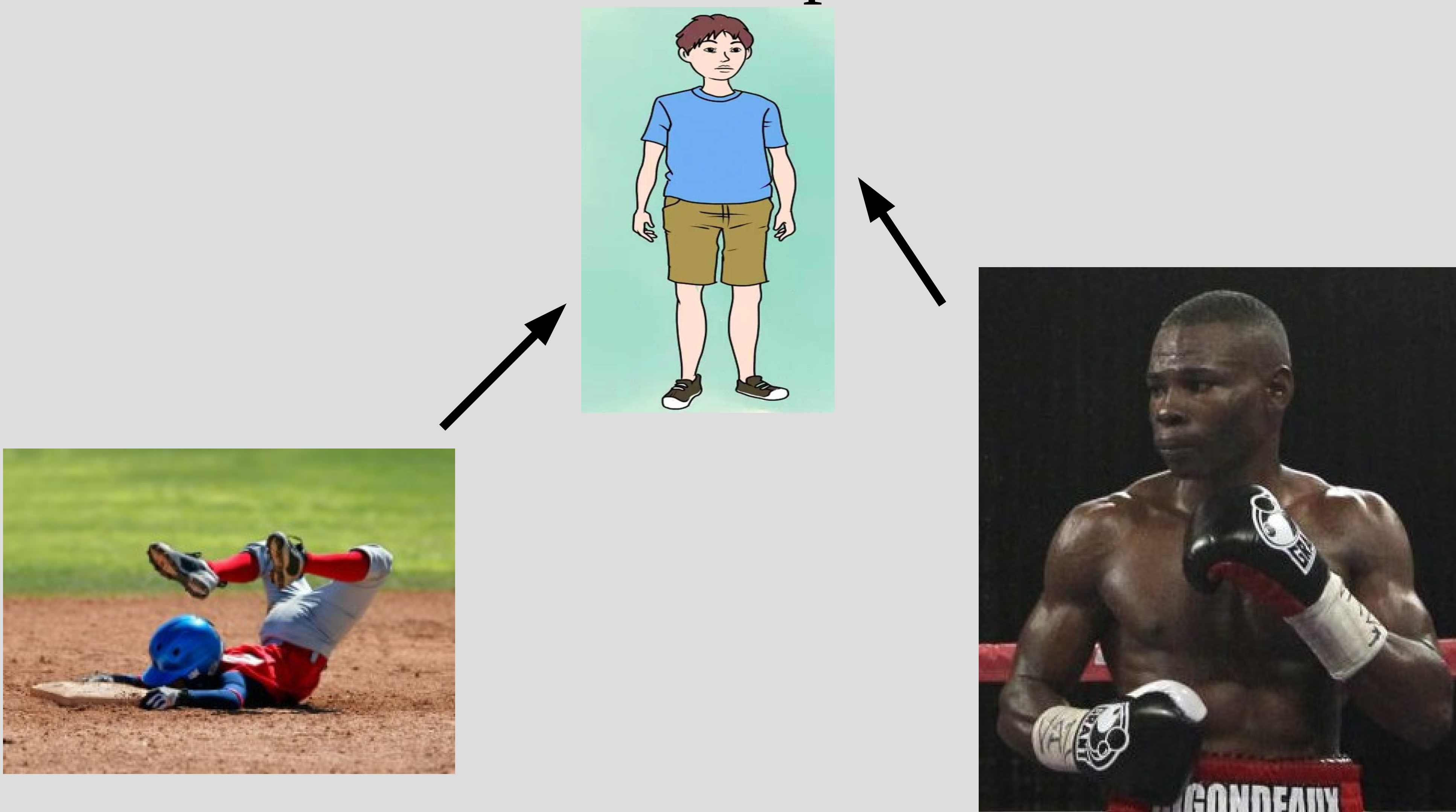
(see: badMemoryManagement.cpp)
(see: memoryOops.cpp)

Break


Multiple Inheritance
class myclass :
public hotdog, public octopus {
How does it work?

Dynamic binding

Consider this relationship:



Dynamic binding

Tell each of them to swing()!

Dynamic function binding

Who's swing function is being run?

```
Person p = Person();
Boxer b = Boxer();
p = b;
p.swing();
```

Dynamic function binding

Who's swing function is being run?

```
Person p = Person();
Boxer b = Boxer();
p = b;
p.swing();
```

Answer: the Person's

If you have normal variables, p=b only copies b's Person parts into p's Person box, so you still only have one swing function

Dynamic function binding

Who's swing function is being run now?

```
Person* p = new Person();
Boxer* b = new Boxer();
p = b;
p->swing();
```

Dynamic function binding

Who's swing function is being run now?

```
Person* p = new Person();
Boxer* b = new Boxer();
p = b;
p->swing();
```

Answer: the Person's still...

p is pointing to a full Boxer object, but it only thinks there is the Person part due to type (see: incorrectChildFunction.cpp)

Dynamic function binding

If we want the computer to not simply look at the “type” of pointer and instead determine what action to take based on the object...

... we need to add virtual (this is slower)

```
class Person{
public:
    virtual void swing()
};
```

(see: dynamicBindingFunctions.cpp)

Dynamic function binding

If you use a function to run an object and you want to use virtualization, you need to pass-by-reference (i.e. use an &)

If you do not, it will make a copy an this will ignore the Child's part

Always a Person

```
void doSwing(Person p)
{
    p.swing();
}
```

Can be Person, Boxer or Baseballer

```
void doSwing(Person& p)
{
    p.swing();
}
```

Dynamic function binding

If you want to use this virtualization:

1. Pass in a pointer
2. Pass by reference (i.e. use &)

Needs to be memory address so the computer can look at what type is actually there

If you give it a Parent box, it cannot do anything but run normal Parent stuff
(see: dynamicBindingFunctionV2.cpp)

virtual deconstructors

If you use Parent* to dynamically create a instance of a Child class, by default it will ONLY run the parent's deconstructor

With a virtual deconstructor it will run the deconstructor for whatever it is pointing at (the Child's deconstructor in this case)

```
class Parent {
public:
    virtual ~Parent();
};
```

Thus it avoids memory leak

(see: yetAnotherMemoryLeak.cpp)