C++ for C programmers

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Why?

- **Object oriented syntax, with C compatibility**
- **Language of choice of various projects**
- **Various flavors to choose from**

Object oriented C patterns

Reviewing C patterns

```c
#include <stdlib.h>

typedef struct _Person
{
  char *name;
  int age;
} Person;

int main()
{
    p = (Person *) malloc(sizeof(Person));
    p->age = 36;
    return 0;
}
```

Objects

- Imagine for a second we are not talking about Persons, but Cars
- We want the car go faster

car->fuelflow++;

car->.... ?

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Interfaces

Creating an interface...

```
/* person.h */

typedef struct _Person
{
  char *name;
  int age;
} Person;

Person * person_create();
void person_destroy( Person *p );
void person_set_name( Person *p, const char *name );
void person_set_age( Person *p, int age );

#endif
```


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Which can be now used...

```
int main()
{
    Person *p;
    p = person_create();
    person_set_age(p, 30);
    person_destroy(p);
    return 0;
}
```

Which can be now used...

```
int main()
{
    Person *p;
    p = person_create();
    person_set_age(p, 30);
    return 0;
}
```

Which can be now used...

```
int main()
{
    Person *p;
    p = person_create();
    person_set_age(p, 30);
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}
```
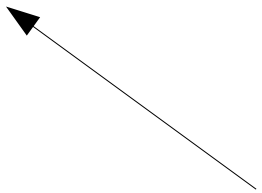



No knowledge about internals

methods

```
person_set_age(p, 30);
```

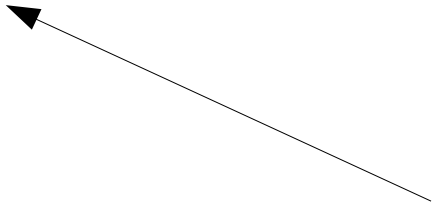
seems to be out of place... we already have the object where we want to perform `person_set_age` on.

(actually, prefixing it with `person_` is a hack to avoid collision with other structure's methods and to make it readable) Why not?:

```
p->set_age(30);
```

Destroying objects

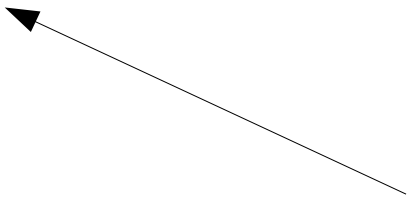
```
int main()
{
    Person *p;
    p = person_create();
     person_set_age(p, 30);
    return 0;
}
```



Destroy not called (expected)

Destroying objects

```
int main()
{
    Person p;
    person_init(&p);
     person_set_age(&p, 30);
    return 0;
}
```



Destroy not called (expected?)

Hierarchies

All employees are persons. However not every person is an employee.

```
typedef struct _Person
{
  char *name;
  int age;
} Person;
```

```
typedef struct _Employee
{
  Person *person;
  int salary;
} Employee;
```

```
Employee *e;
...
person_set_age(e, 30);
person_set_age(e->person, 30);
```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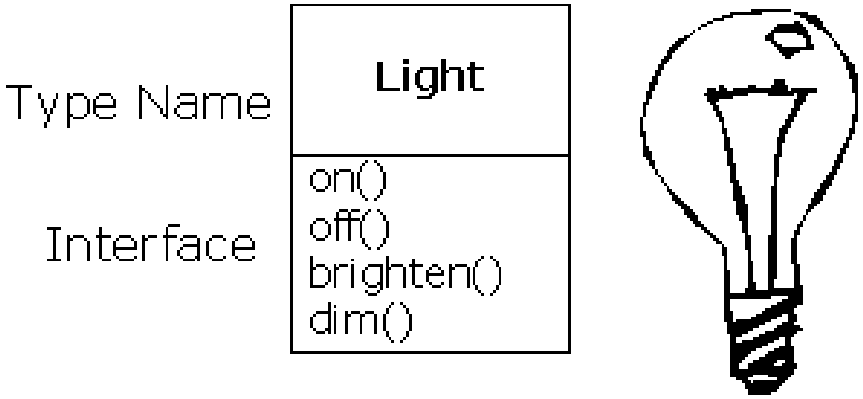
Object Oriented concepts and C++

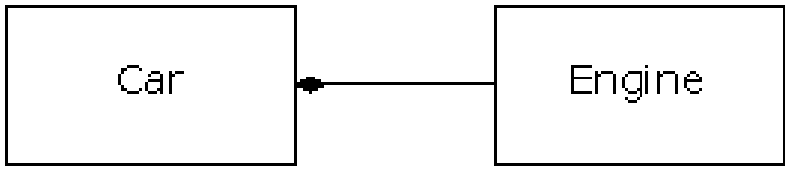
Classes

```
class Light
{
  public:
    void on();
    void off();
    void brighten();
    void dim();
  private:
    int _power;
};

Light light;
light.on();
light._power = 10;
```



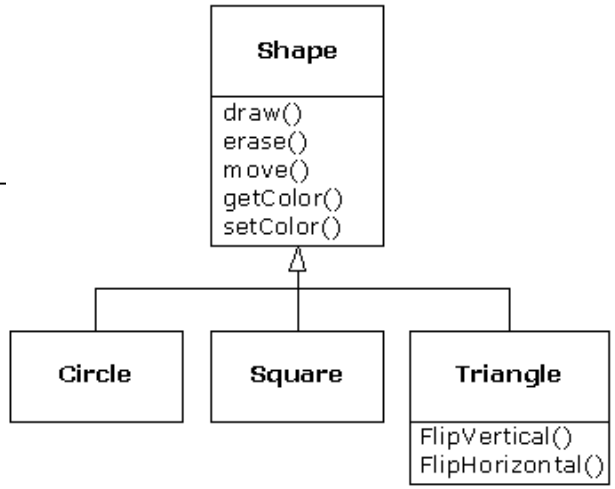
Composition (A has B)

```
class Engine;

class Car
{
  public:
    Engine * engine();
  private:
    Engine *_engine;
};

Engine * Car::engine()
{
  return _engine;
}
```



Inheritance (A is B)

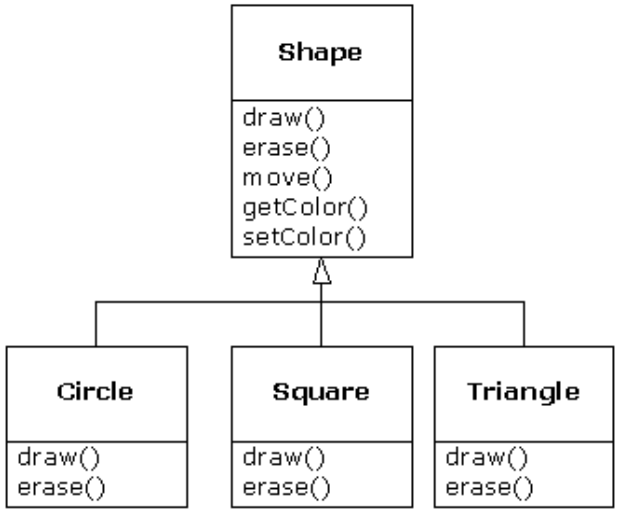
```
class Shape
{
public:
  void draw();
  void erase();
  void move();
  Color getColor();
  void setColor( Color color );
};

class Circle : public Shape
{
public:
  // has all Shape interface
  int radio();
};
```



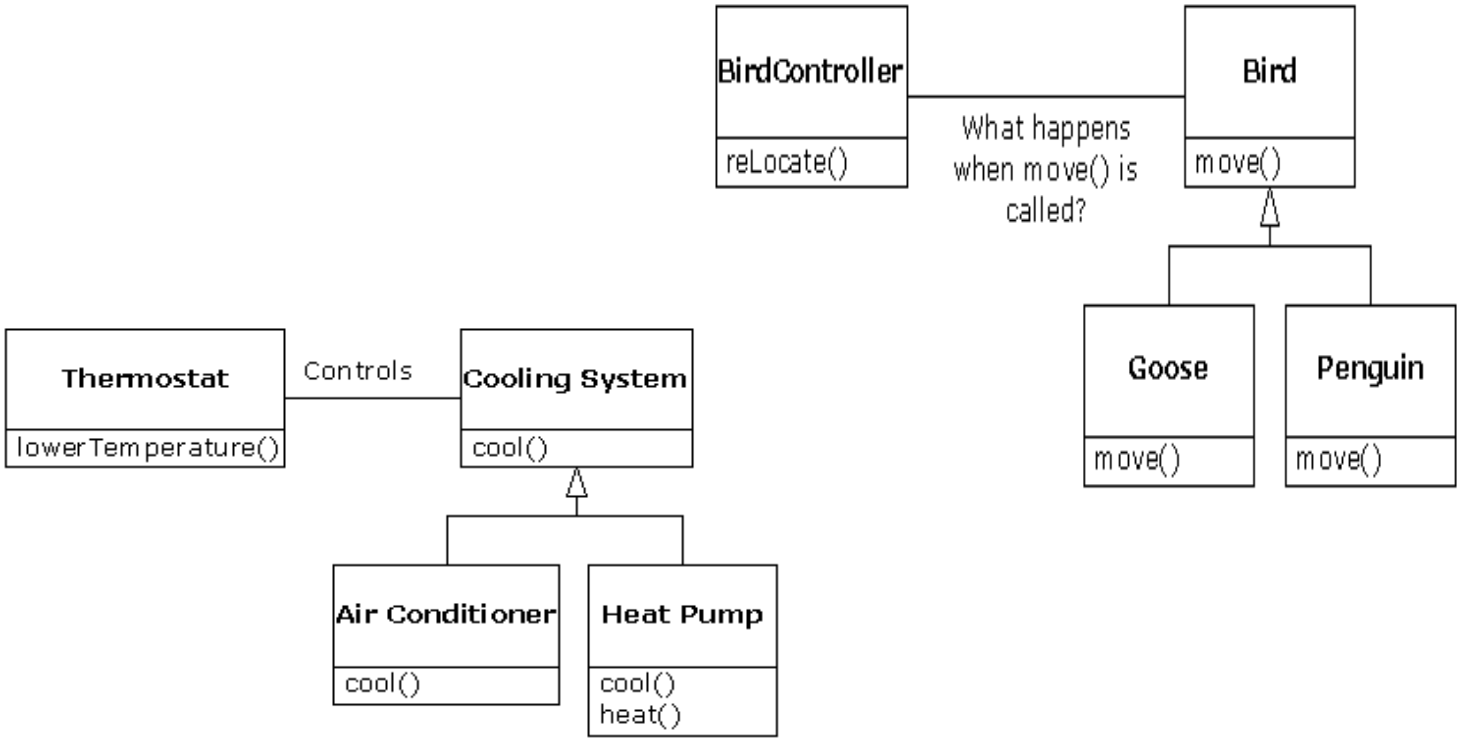

```
Shape *a = new Shape():
Shape *b = new Shape();
Circle *c = new Circle();

a->draw();
c->draw();
c->radio();
b->radio();

b = a; // OK
b = c; // OK
c = a; // wrong!
```

Overriding functions

```
class Circle : public Shape
{
  // overrides Shape's
  virtual draw();
};

Shape *a;
Shape *b;
Circle *c;
...
a->draw() // Shape *, calls Shape's draw
b = c;
b->draw() // Shape *, calls Circle's draw!!
c->draw() // Circle *, callas Circle's draw
```



Runtime polymorphism



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More syntax after the concepts

Methods / inline methods

```
class Shape
{
  void draw();
};

void Shape::draw();
{
  // blah
}
```

```
class Shape
{
  void draw()
  {
    // blah
  }
};
```

this *

```
void Circle::doNiceThings();
{
  // the same
  _radio = 10;
  this->_radio = 10;

  // doSomething( Shape * ) or
  // doSomething( Circle * )
  doSomething(this);
}
```

Constructors

```
typedef int Color;

class Shape
{
public:
  Shape();
  Shape( Color c );
private:
  Color _color;
};
```

```
Shape::Shape()
  : _color(0)
{
  // do more stuff here
}

Shape::Shape( Color c )
  : _color(c)
{
  // more stuff here
}
```

```
Shape s;
Shape s(10);
s.draw();
```

```
Shape *s = new Shape();
Shape *s = new Shape(10);
s->draw();
```

Calling superclass constructors

```
Circle::Circle( Color c, int radio )
  : Shape(c), _radio(radio)
{
  // more stuff here
}
```

Destructors

```
class Shape
{
public:
   Shape();
   ~Shape();
};

Shape::~Shape()
{
   // cleanup
}
```

```
Shape *s = new Shape();
delete s; // destructor called
```

```
// plain block
{
   Shape s;
   // destructor called
}
```

Compile time restrictions: const method

```
class Shape
{
public:
    int color() const
    {
      return _color;
    }
    void setColor( int c )
    {
      _color = c;
    }
private:
    int _color;
};
```


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Default arguments

```
class Shape
{
public:
    int color() const:
    void setColor( int c = 0 /* black */ );
private:
    int _color;
};
void Shape::setColor( int c )
{ ... }
s->setColor(2);
s->setColor();
```


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Templates
rethinking the linked list...

Templates

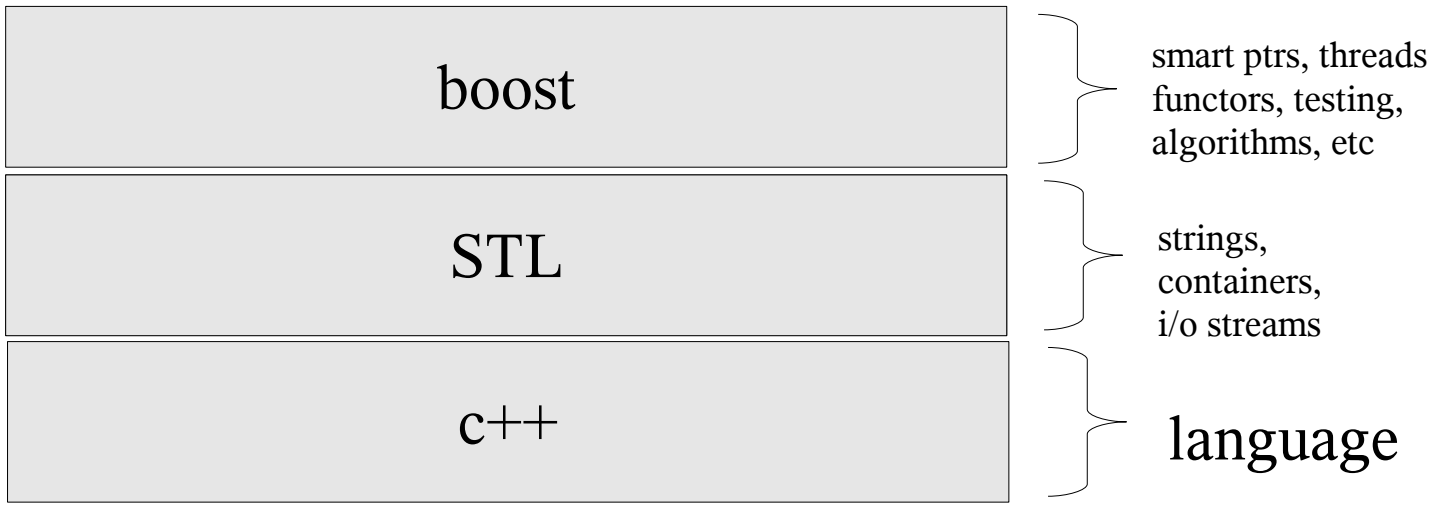
```
template <class T>
class mypair {
    T values [2];
  public:
    mypair (T first, T second)
    {
      values[0]=first; values[1]=second;
    }
};

mypair<int> myobject (115, 36);
```

Languages, Stacks and Frameworks

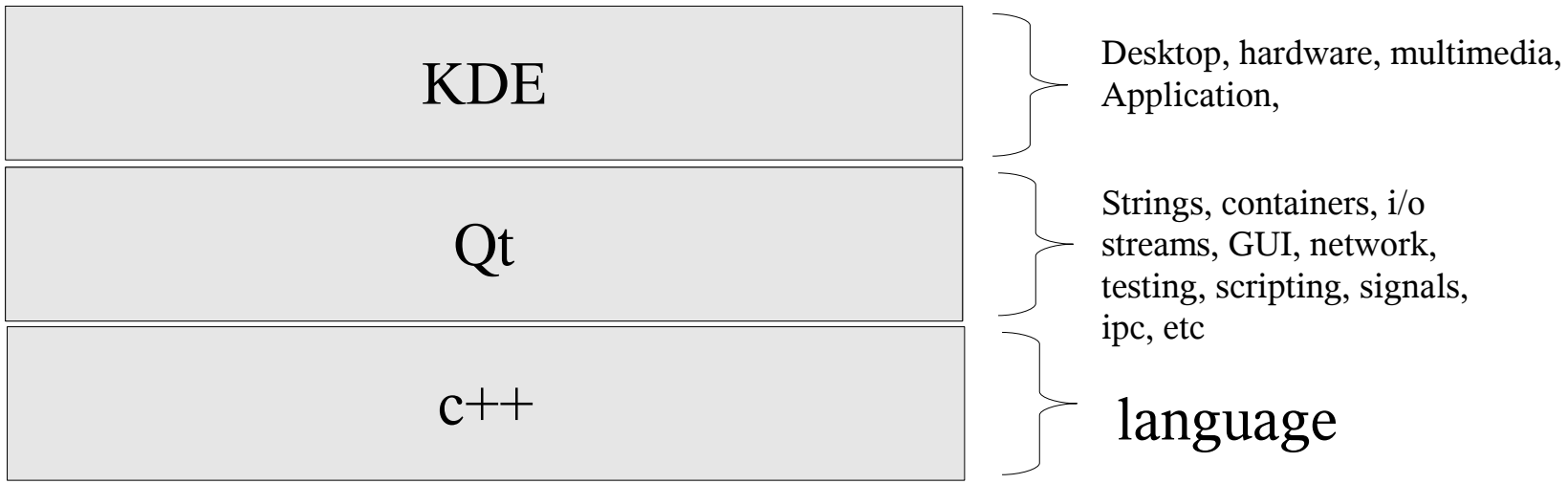
STL

http://www.sgi.com/tech/stl/table_of_contents.html
http://www.boost.org/doc/libs



Qt

http://doc.trolltech.com/
http://api.kde.org/



Forget const char *

```
string a("abcd efg");
string b("xyz ijk");
string c;

cout << a << " " << b << endl;                                  // Output: abcd efg xyz
ijk

cout << "String empty: "    << c.empty()    << endl;  // String empty: 1
// Is string empty? Yes it is empty. (TRUE)
c = a + b;                                                      // concatenation
cout << c << endl;                                              // abcd efgxyz ijk
cout << "String length: "   << c.length()   << endl;  // String length: 15
cout << "String size: "     << c.size()     << endl;  // String size: 15
cout << "String capacity: " << c.capacity() << endl;  // String capacity: 15
cout << "String empty: "    << c.empty()    << endl;  // String empty: 0
// Is string empty? No it is NOT empty. (FALSE)
string d = c;
cout << d << endl;                                              // abcd efgxyz ijk
```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How to compile

- Use g++ -o myprog myprog.cpp
- Or write a Makefile
- Or write a CmakeLists.txt

```
PROJECT(foo)
ADD_EXECUTABLE(foo foo.cpp)
```

Homework #1

Look at Qt toolkit class hierarchy

http://doc.trolltech.com/extras/qt41-class-chart.pdf

Find the parallel between inheritance concepts explained and the fact that every widget takes a QWidget * as a parent.

Read

http://doc.trolltech.com/qq/qq13-apis.html

How to design good APIs

Homework #2

Read

http://developer.kde.org/~wheeler/cpp-pitfalls.html

And learn about the difference between const method, const parameters, const return values.

Homework #3

- Find out a C library written in a more or less object oriented way.
- Wrap it in a C++ class hierarchy (no need to cover the full API)
  - Creating C structs in constructors
  - Destroying the data in the class destructors
  - Wrapping the methods as class methods
- Suggestions: curl easy API, SDL, dbus

Thanks a lot! Questions?
Dankeschön! Fragen?
Muchas gracias! Preguntas?

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