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Structs and Classes

To build great programs, often you will want to define your own variable types. In CS106B we have introduced two ways to do so: with structs and classes. When you define Stucts or Classes you are providing a blueprint that tells the computer how to make variables of that type.

Structs

A struct makes a variable type that packages a set of "instance" variables together. For example

```
struct StudentStruct {
  string name;
  int age;
  Vector<string> classes;
};
```

creates a new variable type called Student. Each time you create a new variable of type student, that variable will have its own copy of each instance-variable. You can access them using the . operator (or the -> operator if you are using pointers. More on that later).

```
StudentStruct chris;
chris.name = "Chris Piech"
chris.classes.add("CS106B");
cout << chris.name << endl;
```

Classes

Structs leave a few things to be desired. Often you don't want to expose all your instance variables directly to the user of the variable type (think of a Vector which has a complex representation under the hood that the user doesn't need to know about and shouldn't mess with). And in addition its common to want to add methods that you can call on your new variable type. A class is an extension of a struct that allows for extra functionality.

In order to create a new variable type as a class you need to specify four things (1) the instance variables, just like a struct (2) what happens when a new object of your type is created/destroyed (3) what are the methods that a user can call on an instance of that class. Finally (4) you have to implement the methods. You write the code that answers these four things in two files: a dot h and a dot cpp.

The Dot h

In a file with name <type>.h you define: (1) the instance variables, just like a struct, (2) what parameters must be provided when creating a new object (3) what are the methods that a user can call on an instance of that class.

```
class Student {
  public:

  // (2) what parameters must be provided to make a new student?
  Student(string name, int age);

  // what happens when a student is destroyed?
  ~Student();

  // (3) The methods you can call on a student
  void addClass(string class);

  // (3) more methods
  void setBuddy(Student * other);

  // (3) more methods
  Student * getBuddy();


  private:
  // (1) what are the variables that this class packages together?
  // just like a struct, each Student has one of these.
  string name;
  int age;
  Vector<string> classes;
  Student * buddy;
};
```

I made each student have an instance variable called buddy (which is of type pointer-to-a-student) to emphasize the point that classes can have pointers as instance variables.

The Dot cpp

In a file with name <type>.cpp you define each of the methods including the constructor (that's the name of the method called when you a new object of that type is created) and the desructor (the name of the method called when an object is destroyed)

```
Student::Student(string n, int a) {
  name = n;  // here name refers to the instance variable
  age = a;   // here age refers to the instance variable
  buddy = NULL // buddy is an instance variable.
  classes.add("CS106B"); // all students are in CS106B!
}

Student::~Student() {
  // the job of the destructor is to call delete on all instance
  // that this class allocated using new.
}

void Student::addClass(string class) {
  classes.add(class);  // classes is an instance variable.
}

void Student::setBuddy(Student * other) {
  buddy = other; // uses pointer assignment.
}

Student * Student::getBuddy() {
  return buddy;
}
```

That's all

Classes can sound harder than they are because of all of the syntax. But remember that they are just glorified structs. The package together instance variables and allow you to define what methods can be called on a variable of the newly defined time.

In C++ you can also "overload operators". That lets you do things like define what it means to use the + operator on a variable of your type. On the final I won't ask you to do so.

For full measure, I want to emphasize that once a class is declared, the user now has a brand new variable type. Here is a potential main function

```
int main() {
  Student * a = new Student("Chris Piech", 27);
  Student * b = new Student("Waddie Crazyhorse", 27);
  a->setBuddy(b);
  b->setBuddy(a);
  Vector<Student *> allStudents;
  allStudents.add(a);
  allStudents.add(b);
  addLotsOfOtherStudents(allStudents);
  goOnFieldTrip(allStudents);
  return 0;
}
```