Day 34

- exercise 33 review
- day 34 recap questions
- final project overview

Announcements/reminders

- HW7 due Wed 4/20 by 11pm

- Please register your final project team no later than *tomorrow* (Tuesday 4/19) by 11am
  - see Piazza post 575 for link to google form
  - if you are not registered on a team by tomorrow at 11am, we will add you to a team

Exercise 33

Add accessor function for a member variable to class A:

```
int geta() const { return a; }
```

B (and other classed derived from A) will need these to get the values of this member variables. (The member variable d can be accessed directly because it is protected.)

Exercise 33

A::toString member function

```
  virtual std::string toString() const {
    std::stringstream ss;
    ss << "[Aclass: a = " << a
       << ", d = " << d
       << ", size = " << sizeof(*this)
       << "]";
    return ss.str();
  }
```

Exercise 33

B::toString member function

```
  virtual std::string toString() const override {
    std::stringstream ss;
    ss << "[Bclass: a = " << geta()
       << ", b = " << b
       << ", d = " << d
       << ", size = " << sizeof(*this)
       << "]";
    return ss.str();
  }
```

Because the a member variable in the base class A is private, it's necessary to call a getter function to access its value.

Exercise 33

In main(), the following statement does not compile:

bobj = aobj;

With a cast of bobj to A& (reference to A), we can assign to just the "A" part of bobj:

static_cast<A&>(bobj) = aobj;

Exercise 33

fun() pure virtual member function in class A:

```
  virtual int fun() const = 0;
```

Implementation in class B:

```
  virtual int fun() const override {
    return int(geta() * b * d);
  }
```

Note that A is no longer instantiable, so variables definitions like

```
  A aobj(10);
```

are no longer allowed.

Exercise 33

C class:

```
class C : public A {
private:
  int e;

public:
  C(int val = 0): e(val) { }  // automatically sets a & d to 0 w/ A()
  void sete(int e) { this->e = e; }

  virtual std::string toString() const override {
    std::stringstream ss;
    ss << "[Cclass: a = " << get_a()
       << ", d = " << d
       << ", e = " << e
       << ", size = " << sizeof(*this)
       << "]";
    return ss.str();
  }

  virtual int fun() const override {
    return int(get_a() * d * e);
  }
};
```

1. What is UML?
2. What type of class relationship is likely to exist between a class that represents bathroom objects and one that represents apartment objects?
3. What type of class relationship is likely to exist between a class that represents apartment objects and one that represents housing objects?
4. BONUS: which of bathroom, apartment, housing would likely be an abstract class?

1. What is UML?

UML = "Unified Modeling Language"

It is a visual language for describing object-oriented software.

UML class diagrams show essential details of classes and (importantly) *relationships* between classes.

UML class diagrams allow you to create a "blueprint" for an object-oriented system. This is useful because important properties of the system being designed can be reasoned about and validated before code is written.

2. What type of class relationship is likely to exist between a class that represents bathroom objects and one that represents apartment objects?

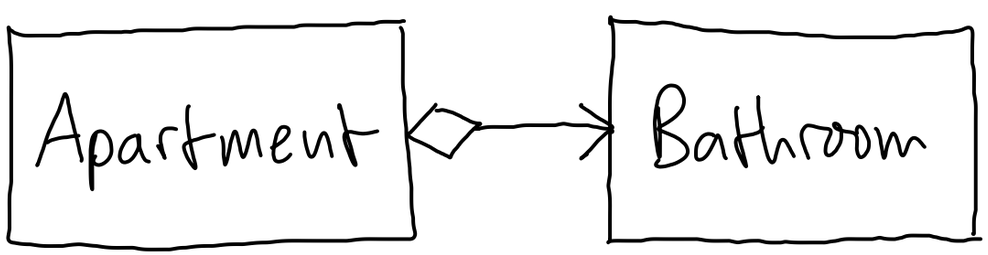
"Has-A". This is represented in UML as either

composition 

or

aggregation. 

For this example, we would say Apartment "has-a" Bathroom:

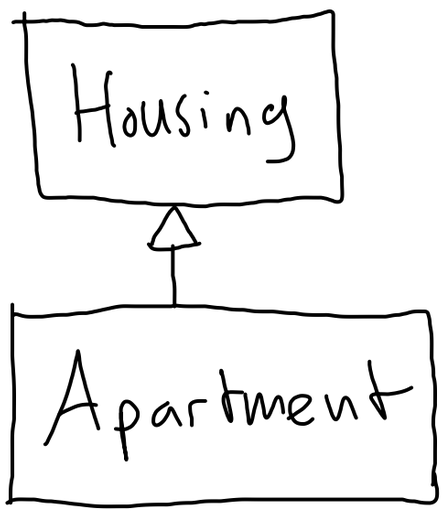


Opinion: there is no terribly important distinction between composition and aggregation. It's fine to just use aggregation to model "has-a" relationships.

3. What type of class relationship is likely to exist between a class that represents apartment objects and one that represents housing objects?

Generalization represents "is-a" relationships: 

In this example, Apartment "is-a" (type of) Housing:



This is the type of relationship between a base class and its derived classes.

4. BONUS: which of bathroom, apartment, housing would likely be an abstract class?

Most likely, Housing would be abstract. It is an abstract concept with a variety of concrete realizations, e.g., Apartment, House, Dorm, etc.

Final project overview

Implement chess
- If you're not 100% familiar with the rules, try chess.com website

Classes:

- Board: represents the 8x8 game board (rows 1-8, columns A-H)
  - configuration represented by map of Position to Piece*

- Position: typedef for std::pair<char,char> (first is column 'A'-'H', second is row '1'-'8')

Pieces

- Piece: base class for the various kinds of chess pieces
  - For the derived classes (Queen, Rook, Knight, Pawn, etc.) will will need to
    - override legal_move_shape
    - override legal_capture_shape (if necessary)
    - override to_ascii
    - override to_unicode

Mystery piece: you don't need to implement support for the Mystery piece. The default implementation provided with the starter code is just a placeholder. However, the autograder *will* test your code with a *real* implementation of a Mystery piece, and your code should work correctly with it.

MAKE SURE YOU CALL APPOPRIATE MEMBER FUNCTIONS OF Piece OBJECTS IN ORDER TO DETERMINE WHETHER MOVES AND CAPTURES ARE LEGAL.

You will need to create a source (.cpp) file for each class derived from Piece

Game

A Game object represents the game state (Board and its Pieces) and the game rules (allowing players to take turns, determining whether moves are legal, testing for check and stalemate, etc.)

Note: we don't expect "clever" algorithms for things like checking whether a player is in checkmate. A brute force approach (e.g., consider all possible moves and see if any of them result in a game state where the king is not in check) is fine.

Value semantics for Board and Game

Evaluating "what-if" scenarios is an essential part of the computation.

A nice way to make this easier is to allow Board and Game to have value semantics, i.e., copy constructor and assignment operator.

That way, if you need to evaluate the consequences of potential moves ("what happens if I move this pawn one position forward?"), you can just create a new Game object that is a copy of the current one, make the move, then see what happens.

Since the Board "owns" the Piece objects, Board will need to do a deep copy. (Be sure to use CreatePiece to create the actual piece objects.)