CSCI 136:
Data Structures
and
Advanced Programming

Lecture 5

Abstraction / Generics

Instructor: Dan Barowy

Williams

Topics

- Abstraction
- Generics
- Vectors

Your to-dos

1. Lab 1, **due Tuesday 9/20 by 10pm**.
2. Read **before Wed**: Bailey, all of Ch 2.
   Suggestion: read *actively*.

Active reading

Code provided in the book/in class is there for a reason: **to teach you a lesson**!

Retype—**don't copy and paste**—**that code** into your editor, compile it, and run it.

In the process, you will notice detail you wouldn't otherwise. **Programming is all about the detail.**

I did not invent this idea. One famous practitioner…

Active reading

"I would advise you to read with a pen in your hand, and enter in a little book short hints of what you find […]; for this will be the best method of imprinting such particulars in your memory."
—Benjamin Franklin

This is sometimes called "**learning the hard way**."

Thing is, it's actually **one of the easiest ways** to learn.

Remember: **learning feels inefficient**.

Abstraction

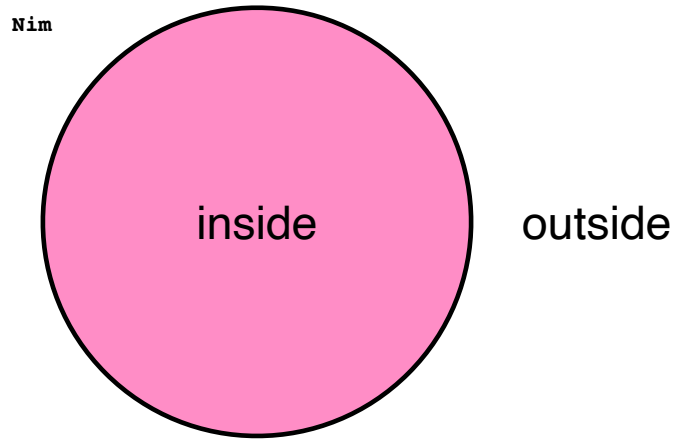
The purpose of a class:

To "abstract away" implementation detail.

Abstraction

Abstraction is the process of **removing irrelevant detail** so that a problem contains **only necessary information**.

Think of a class as having two sides.



Design so "user" never needs to "look inside".

Think of a class as having two sides.

The outside: A class should represent **one concept**, and the class's methods should support working with that one concept.

E.g., `Nim`**:** Represents a Nim game board.

You can ask it to:

- set up a new game (the **constructor**),
- print out its board (`displayBoard`),
- check whether a move is valid (`isValidMove`),
- check whether the game is over (`isGameOver`),
- prompt the user to take a turn (`takeATurn`),
- etc.

Think of a class as having two sides.

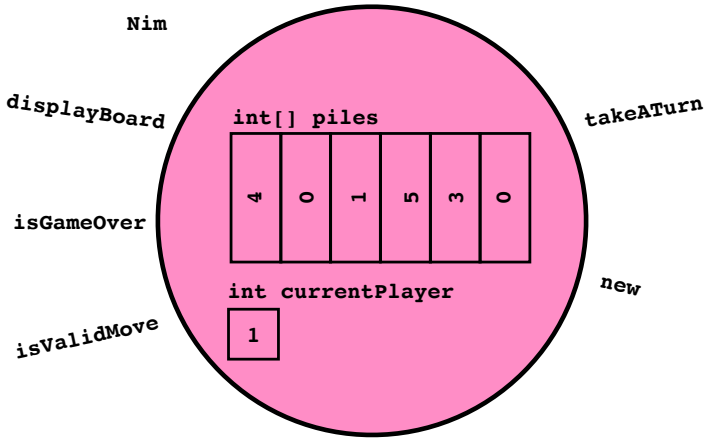
The inside: A class should contain whatever code is necessary to implement that **one concept** and nothing else.

E.g., `Nim`**:** Represents a Nim game board.

Stores:
- `int[]` of piles
- `int` representing the current player
- etc.

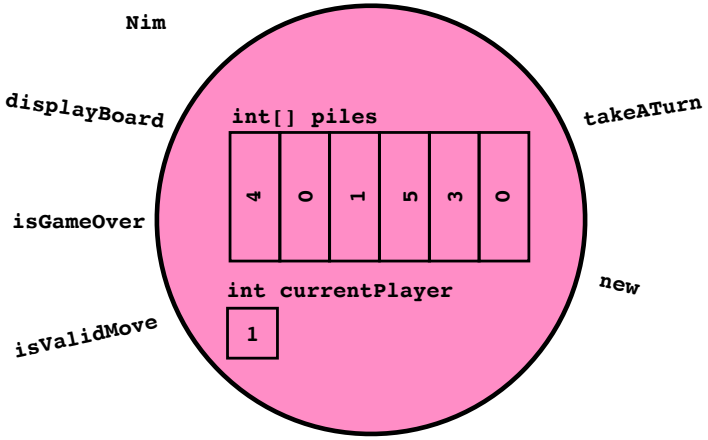
Ensures:
- Board is initialized correctly (`new`)
- Board is represented naturally to a user (`displayBoard`)
- Moves are valid (via `isValidMove` when taking a turn).
- etc.

Think of a class as having two sides.

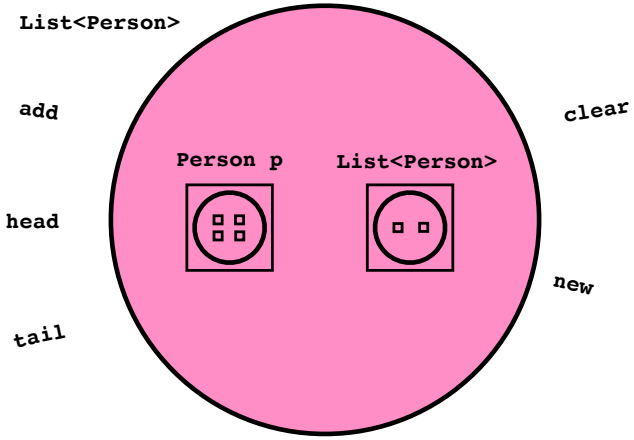


Design so user never needs to "look inside".

Hiding data inside a class is called:
encapsulation



Classes can encapsulate other classes!



This is how we construct complex software.

Suppose we wanted to write **a function** that reverses **an array of ints**.

Let's try to do that together.

(code)

Suppose we wanted to write **one function** that reverses **an array of any type**.

Let's try to modify our program.

(code)

Problem: Java has **no (type safe) way** to express the idea of "**any array**."

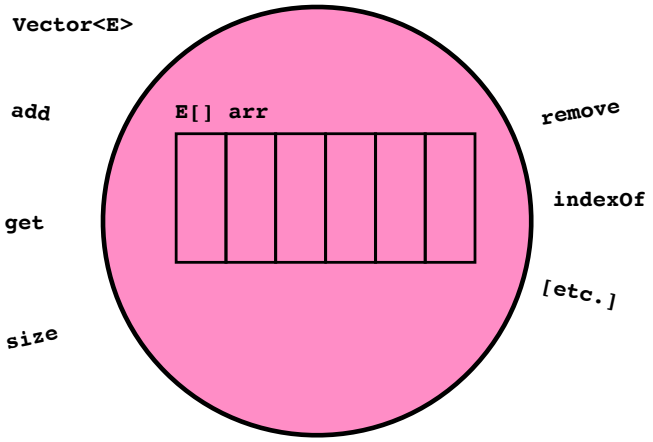
However, there is an alternative…

Generic types

A **generic type** is a placeholder (a **type variable**) for a type **to be specified later**. Generic types permit the creation of common algorithms and data structures (e.g., a generic sequence), thus **reducing code duplication**. Generics allow for **data type abstraction**.

In this class, we will focus on **use**.
Later, we will revisit **how to make your own** (i.e., **definition**)

`Vector<E>` is a sequence of **any type** `E`



The **`Vector<E>`** class itself handles **growing its internal array** if space is insufficient.

`Vector` is a generic class; it works with any type. ★

Generic class

```
Vector<E> v = new Vector<E>();
```

Type parameter (**fill in** with the type you want)

https://williams-cs.github.io/cs136-f22-www/assets/JavaStructures/doc/structure5/index.html

★ The type parameter you use must be a class type.

~~`Vector<int> v = new Vector<int>();`~~

Primitives (like `int`) do not work. Use "boxed" types instead.

```
Vector<Integer> v = new
  Vector<Integer>();
```

Suppose we wanted to write **one function** that reverses ~~**any array**~~ any Vector.

Let's try again.

(code)

Recap & Next Class

Today:

- Abstraction
- Generics
- Vector

Next class:

- How Java computes things