Recap: Object Composition
Classes can have static or instance variables.

These can be primitives or references to objects.

When they are references to objects from other classes, we call this composition.

How does this connect with the concept of class objects being thread-safe and properly published?
Recap: Thread-safe class design

Class specification of invariants regarding data in the class and the class objects.

Pre-conditions, post-conditions, exception-conditions for individual methods.

Identify the state variables, consider the invariants and method conditions, decide on a synchronization policy such that use by multiple threads following the synchronization policy preserves the rest.

Instance Confinement and Monitor Pattern

If you have a class that isn’t thread-safe and you want to make a quick and dirty thread-safe version, create a new class that wraps it up as a private instance member so you can control access to it more easily.

Set all of the methods as synchronized, never let the field escape, and you’ve got a “thread-safe” class following the Java monitor pattern using each object instance’s intrinsic lock as a guard.
Unsafe LinkedList becomes a “thread-safe” Queue

```java
public class QueueOfStrings {
    private final LinkedList<String> theList = new LinkedList<String>();

    public synchronized void enqueue(String strToAdd) {
        theList.addFirst(strToAdd);
    }

    public synchronized String dequeue() {
        return theList.removeLast();
    }

    public synchronized int size() {
        return theList.size();
    }
}
```

Delegating thread-safety via composition

If you create a new class that only contains final references to thread-safe class objects, never refer to anything other than instance variables or local variables, you’ve delegated responsibility for thread-safety off to those classes if…

- The fields are independent: your class invariants don’t include more than one field of the class.
- Your method pre-conditions don’t involve the fields.
- You never publish any of the fields (note that there might be scenarios where it’s safe to publish them but this slide is only presenting absolutes).