Things I Wrote On The Board

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Examples from OO Languages course

Java/C++ References

Java

```
class A { int i = 0; ... }
```

-
  ```
  void foo(int i) { i = 42; }
  int i = 0;
  foo(i); // on return i == 0
  ```

-
  ```
  void foo(A a) {a.i = 42; }
  A a = new A();
  foo(a); // on return a.i == 42
  ```

-
  ```
  void foo(A a) {
    a = new A();
    a.i = 42;
  }
  A a = new A();
  foo(a); // on return a.i == 0
  ```

C++

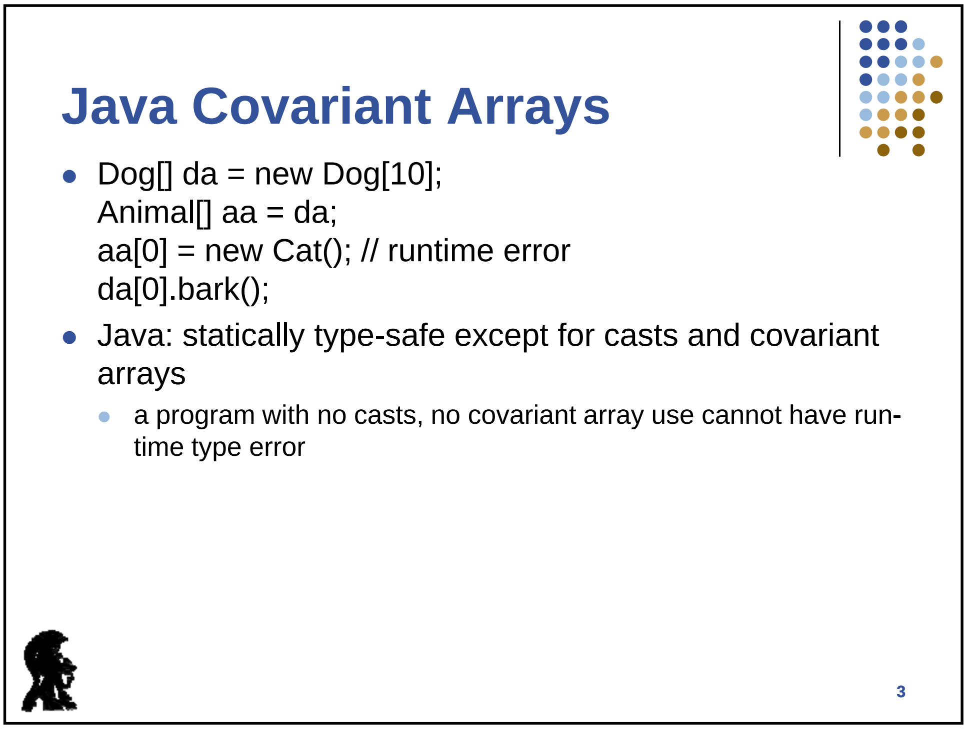
```
class A { int i; ... }; // i initially 0
```

-
  ```
  void foo(int i) { i = 42; }
  int i = 0;
  foo(i); // on return i == 0
  ```

-
  ```
  void foo(A &a) {a.i = 42; }
  A a;
  foo(a); // on return a.i == 42
  ```

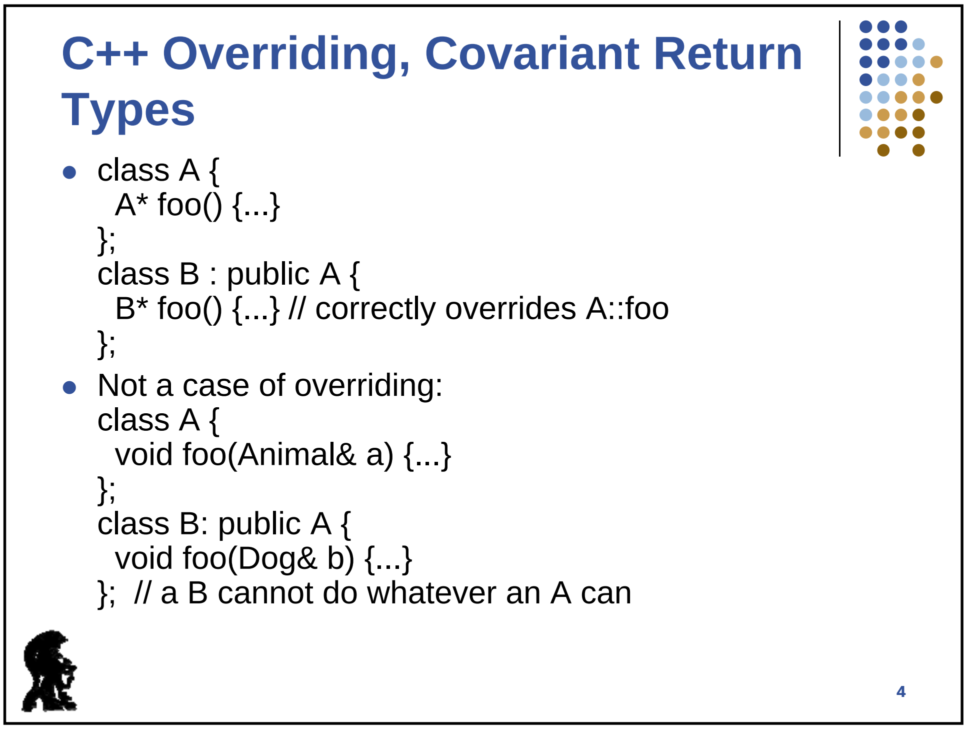
-
  ```
  class A {int i; ... };
  void foo(A *a) {a->i = 42;}
  A a;
  foo(&a); // on return a.i == 42
  ```

-
  ```
  class A {int i; ...};
  void foo(A &a) {
    a = A();
    a.i = 42;
  }
  A a;
  foo(&a); // on return a.i == 42
  ```



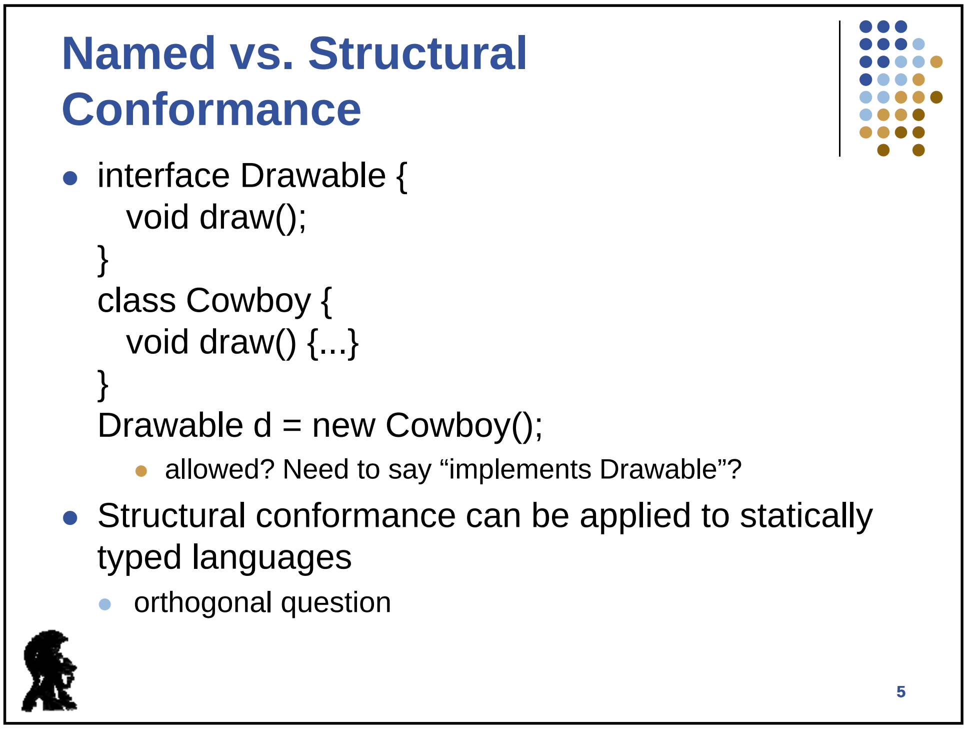
Java Covariant Arrays

-
  ```
  Dog[] da = new Dog[10];
  Animal[] aa = da;
  aa[0] = new Cat(); // runtime error
  da[0].bark();
  ```
- Java: statically type-safe except for casts and covariant arrays
  - a program with no casts, no covariant array use cannot have run-time type error



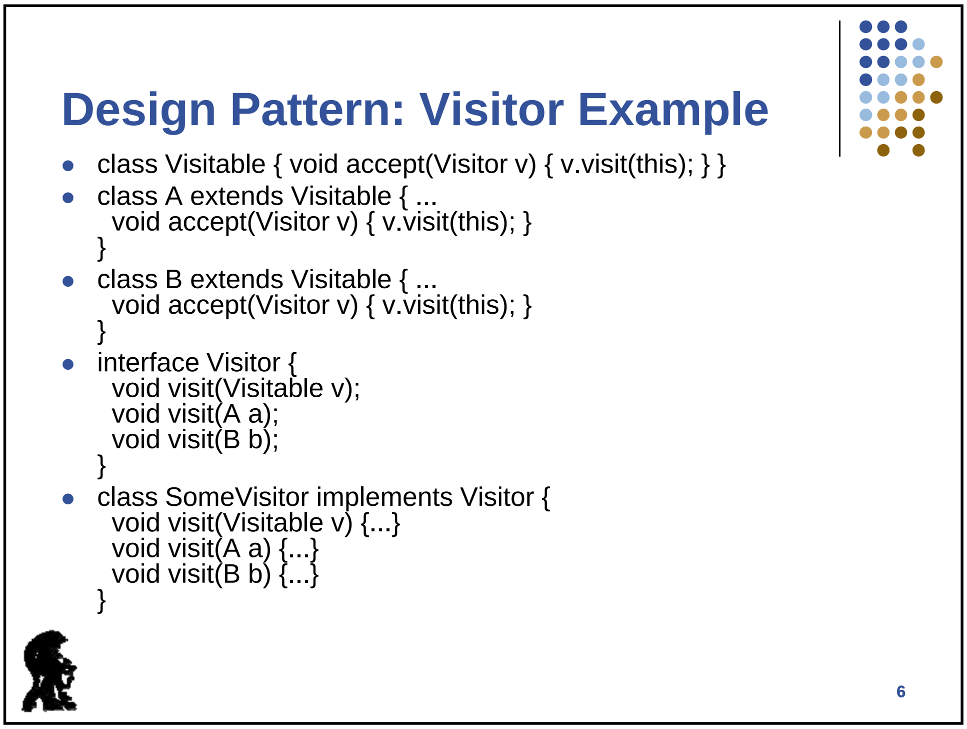
C++ Overriding, Covariant Return Types

-
  ```
  class A {
    A* foo() {...}
  };
  class B : public A {
    B* foo() {...} // correctly overrides A::foo
  };
  ```
- Not a case of overriding:
  ```
  class A {
    void foo(Animal& a) {...}
  };
  class B: public A {
    void foo(Dog& b) {...}
  };  // a B cannot do whatever an A can
  ```



Named vs. Structural Conformance

-
  ```
  interface Drawable {
    void draw();
  }
  class Cowboy {
    void draw() {...}
  }
  Drawable d = new Cowboy();
  ```
    - allowed? Need to say “implements Drawable”?
- Structural conformance can be applied to statically typed languages
    - orthogonal question



Design Pattern: Visitor Example

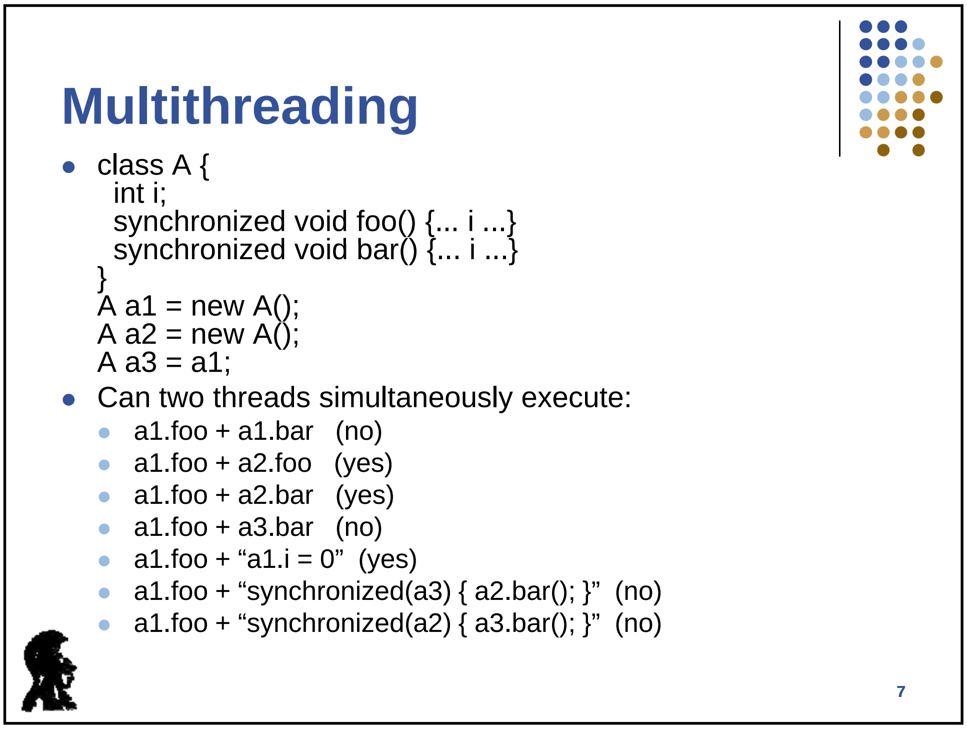
- class Visitable { void accept(Visitor v) { v.visit(this); } }

-
  ```
  class A extends Visitable { ...
    void accept(Visitor v) { v.visit(this); }
  }
  ```

-
  ```
  class B extends Visitable { ...
    void accept(Visitor v) { v.visit(this); }
  }
  ```

-
  ```
  interface Visitor {
    void visit(Visitable v);
    void visit(A a);
    void visit(B b);
  }
  ```

-
  ```
  class SomeVisitor implements Visitor {
    void visit(Visitable v) {...}
    void visit(A a) {...}
    void visit(B b) {...}
  }
  ```



Multithreading

- class A {
```
  int i;
  synchronized void foo() {... i ...}
  synchronized void bar() {... i ...}
}
A a1 = new A();
A a2 = new A();
A a3 = a1;
```
- Can two threads simultaneously execute:
  - a1.foo + a1.bar (no)
  - a1.foo + a2.foo (yes)
  - a1.foo + a2.bar (yes)
  - a1.foo + a3.bar (no)
  - a1.foo + “a1.i = 0” (yes)
  - a1.foo + “synchronized(a3) { a2.bar(); }” (no)
  - a1.foo + “synchronized(a2) { a3.bar(); }” (no)

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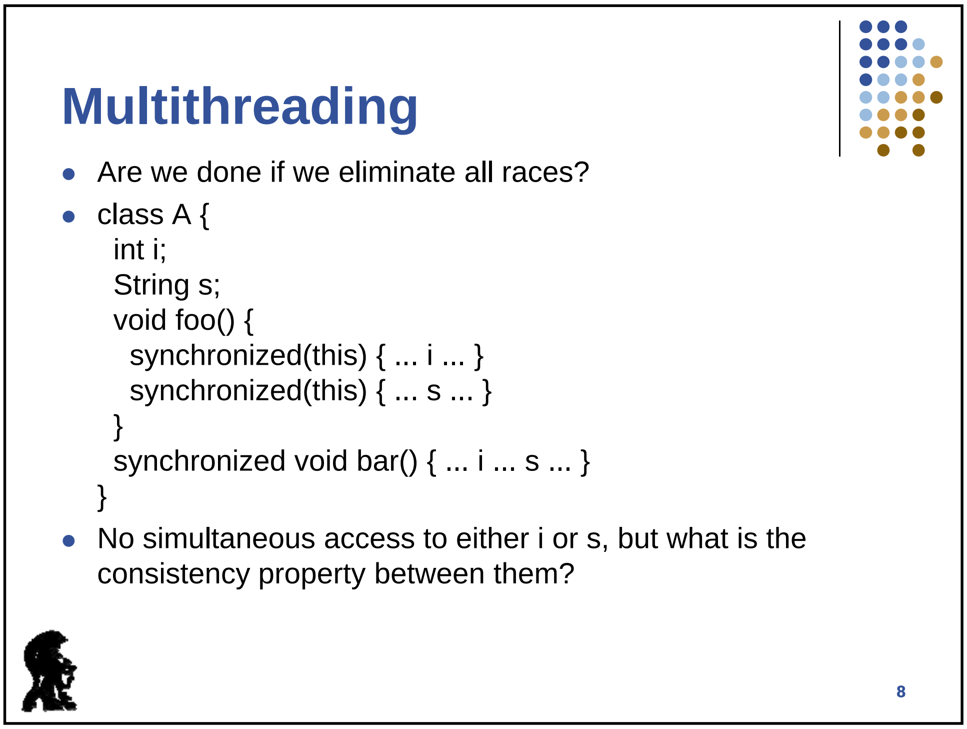

Multithreading

- Are we done if we eliminate all races?
- class A {
```
  int i;
  String s;
  void foo() {
    synchronized(this) { ... i ... }
    synchronized(this) { ... s ... }
  }
  synchronized void bar() { ... i ... s ... }
}
```
- No simultaneous access to either i or s, but what is the consistency property between them?

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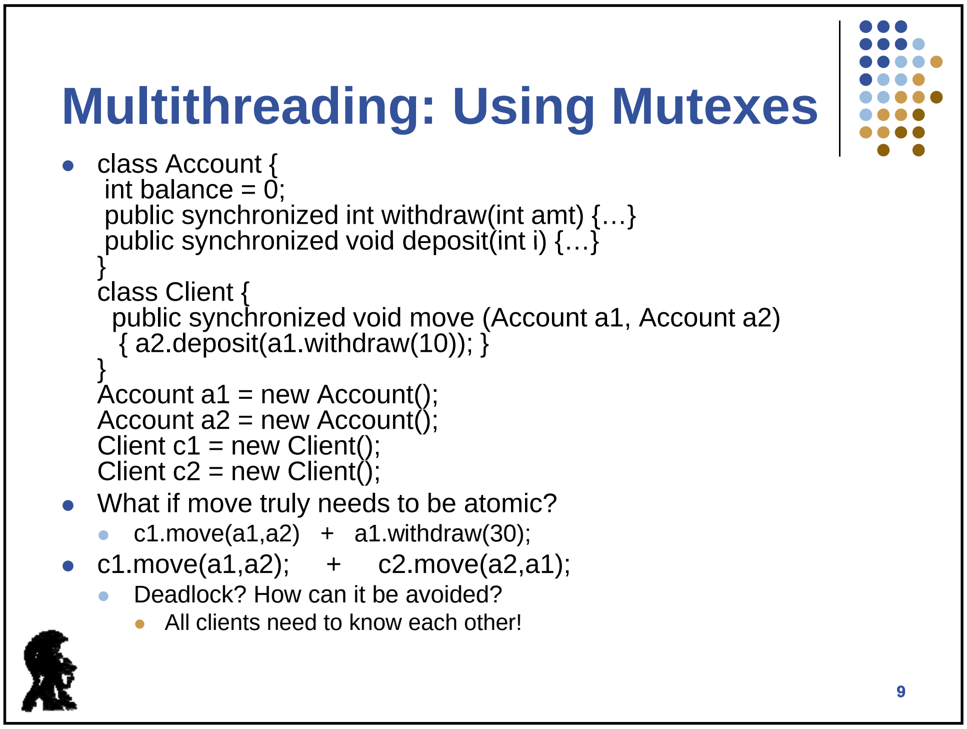
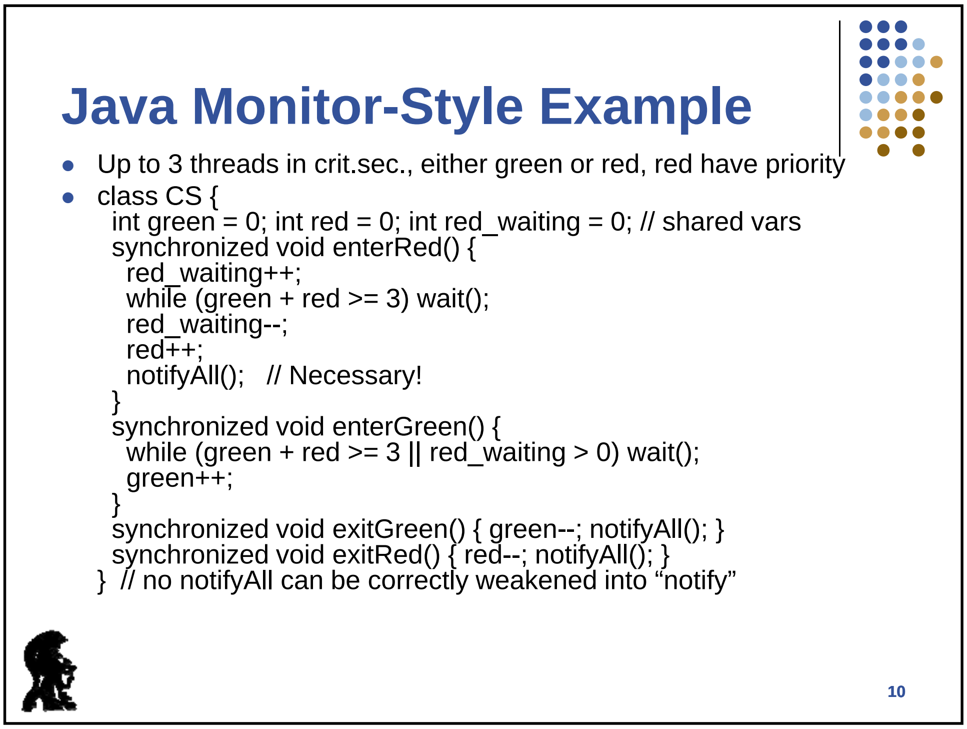


Multithreading: Using Mutexes

-
  ```
  class Account {
   int balance = 0;
   public synchronized int withdraw(int amt) {…}
   public synchronized void deposit(int i) {…}
  }
  class Client {
    public synchronized void move (Account a1, Account a2)
     { a2.deposit(a1.withdraw(10)); }
  }
  Account a1 = new Account();
  Account a2 = new Account();
  Client c1 = new Client();
  Client c2 = new Client();
  ```
- What if move truly needs to be atomic?
  - c1.move(a1,a2) + a1.withdraw(30);
- c1.move(a1,a2); + c2.move(a2,a1);
  - Deadlock? How can it be avoided?
    - All clients need to know each other!



Java Monitor-Style Example

- Up to 3 threads in crit.sec., either green or red, red have priority

-
  ```
  class CS {
    int green = 0; int red = 0; int red_waiting = 0; // shared vars
    synchronized void enterRed() {
      red_waiting++;
      while (green + red >= 3) wait();
      red_waiting--;
      red++;
      notifyAll();   // Necessary!
    }
    synchronized void enterGreen() {
      while (green + red >= 3 || red_waiting > 0) wait();
      green++;
    }
    synchronized void exitGreen() { green--; notifyAll(); }
    synchronized void exitRed() { red--; notifyAll(); }
  }  // no notifyAll can be correctly weakened into “notify”
  ```