CS 213 – Software Methodology
Spring 2019

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Lecture 18 – Apr 2
Design Patterns – 2

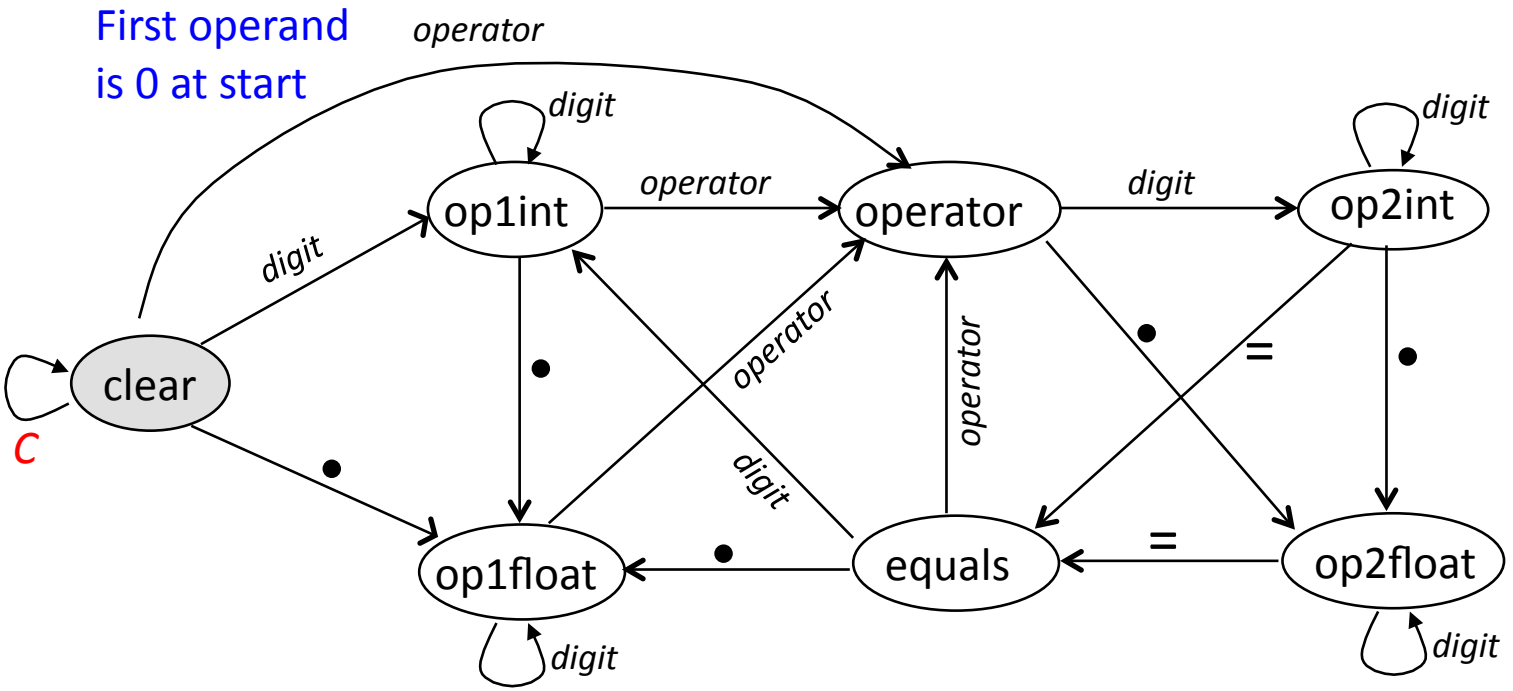
State and Singleton Patterns (Example: Calculator)

Building a Calculator: The State Design Pattern

State Design Pattern

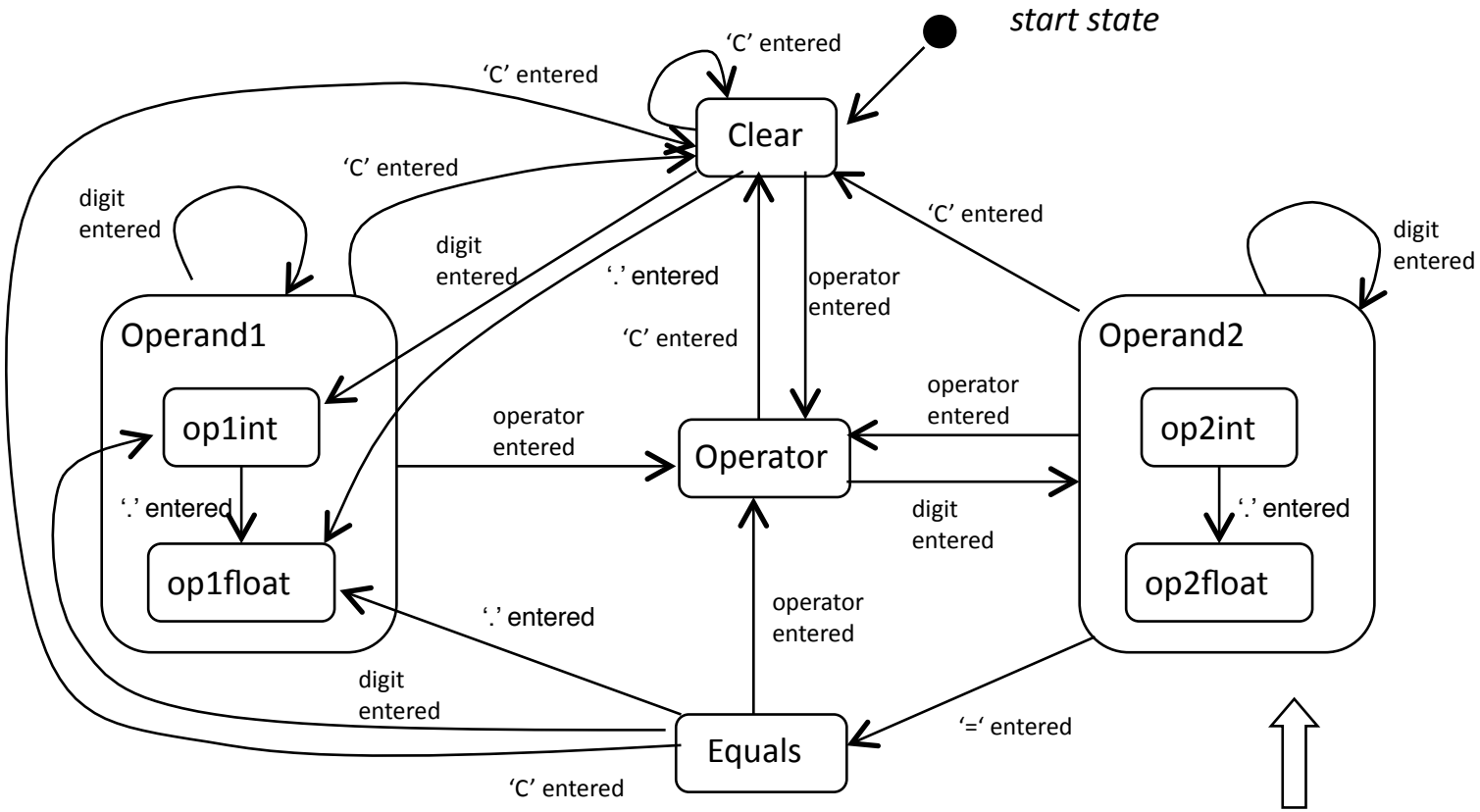
Allow an object to alter its behavior when the internal state changes. The object will appear to change its class.

Calculator: State Diagram



All states transition to clear state with C (Cancel)

Calculator: UML State(chart) Diagram



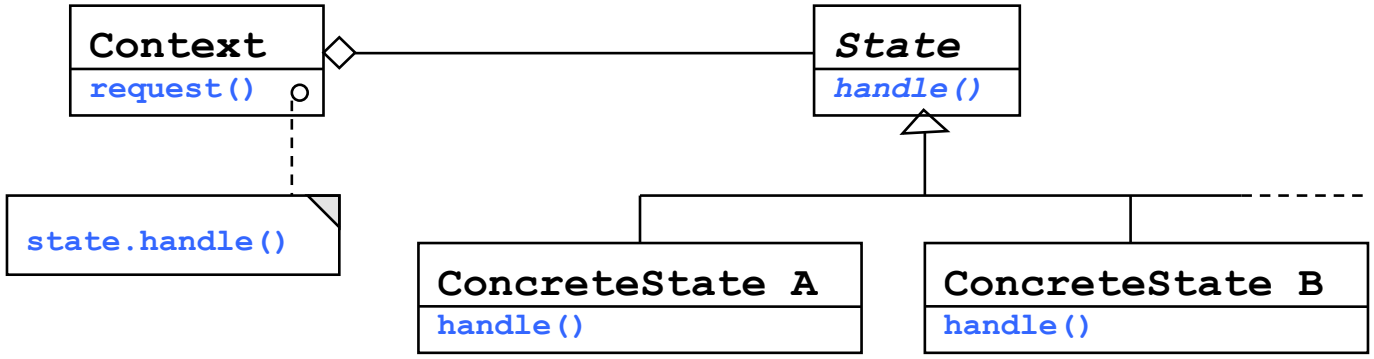
Every state is responsible for enabling and disabling buttons as appropriate

end state

(all states above can go to end state – transitions not shown because all transitions are same, and happen on exiting the application)

State Design Pattern: Behavioral

- Allow an object to change its behavior when its internal state changes – the "object" is a subclass of an abstract class, thus polymorphism

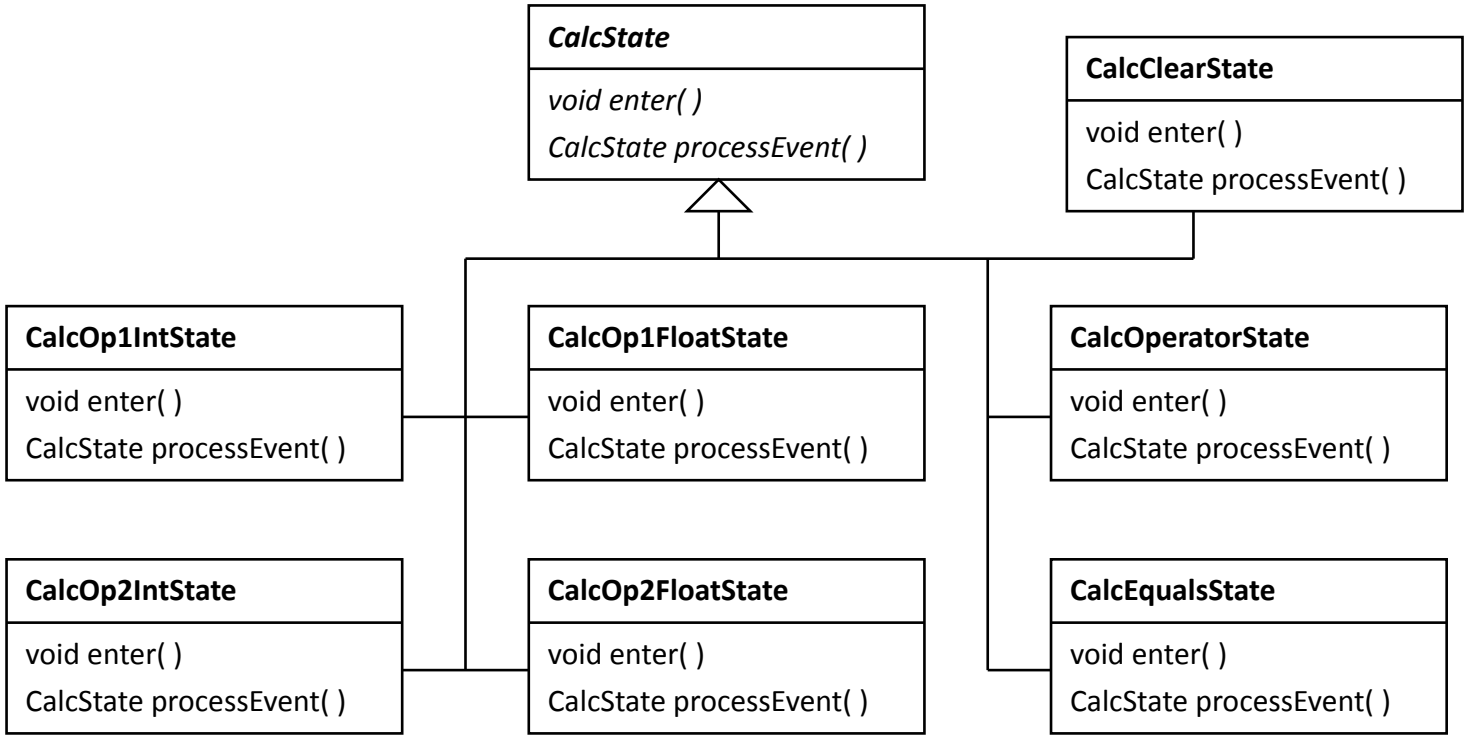


- Context (client code) has a state object that is one of the concrete instances: the request method executes `handle` on this concrete instance, dynamically binding the appropriate concrete class method – neat use of polymorphism

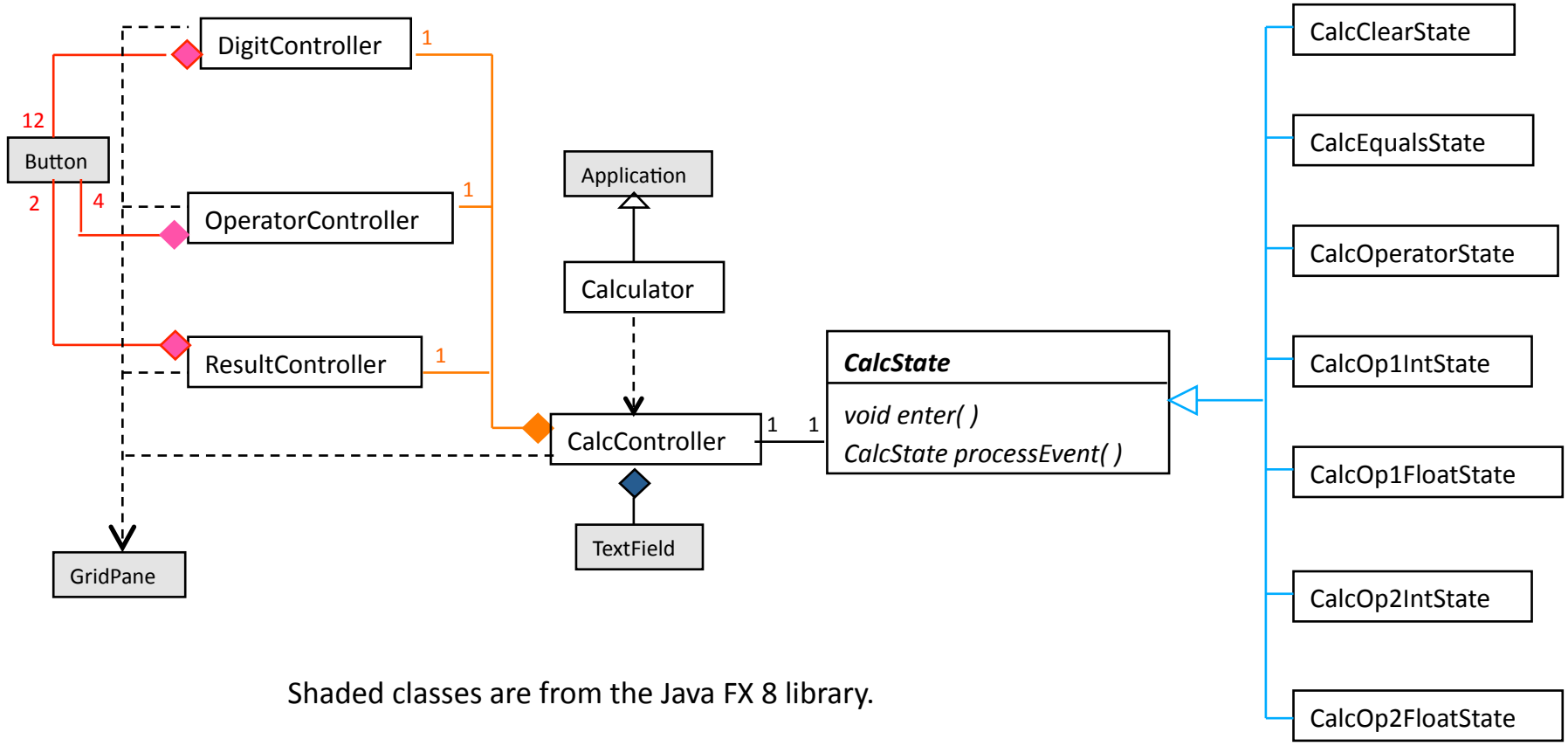
- Example: State classes `CalcState` (abstract) and `CalcClearState`, `CalcEqualsState`, etc. (concrete) in the state-based calculator application. The context is the `CalcController` class.

State Design Pattern: Applied to Calculator

- The general implementation of State pattern:
  - There is an abstract class that specifies state methods: in general these could be entry/body/exit methods
  - Subclasses of this abstract class define different specific states



State-based Calculator – UML Class Diagram

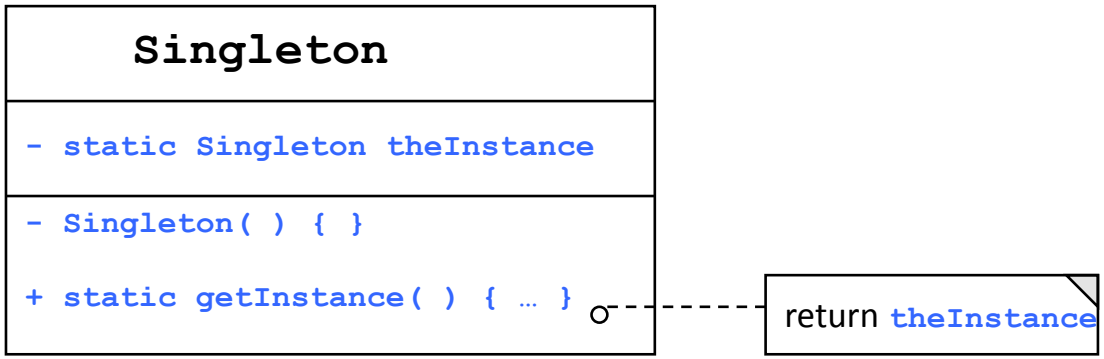


Shaded classes are from the Java FX 8 library.

All application classes are in the `view` package,
except `Calculator` which is in the `calc` package.

Singleton Design Pattern: Creational

- Ensure that a class has only one object (instance) and provide a global point of access to this single instance



- The single private constructor ensures that an instance of Singleton cannot be created using `new`

Singleton Design Pattern: Applied to Calculator

- Each of the concrete state classes implements the Singleton pattern. For instance, the `CalcClearState` class:

```
class CalcClearState {

   . . .
   private static CalcClearState instance = null;
   . . .
   private CalcClearState() {

   }
   . . .
   public static CalcClearState getInstance() {
      if (instance == null) {
         instance = new CalcClearState();
      }
      return instance;
   }
   ...
}
```