

State Pattern

State Pattern

- Used when a class naturally has multiple "states" with different behavior
- Class has a state variable containing the current state
- Defer behavior to the state
 - Avoids conditionals in behavior methods
 - Decisions made by changing state
- Decisions made on type (Polymorphism) not value (Conditionals)
- Modularizes code
 - More, but smaller, pieces of code
- Easy to add new features without breaking tested features

State Pattern

- State represented by an abstract class (or trait, interface)
 - Defines the methods that can be called
- Extend the state class for each concrete state
 - One class for each possible state of the class
- Each state will have a reference to the object to which it is attached
 - Use this reference access other state variables
 - Use this reference to change state

Tic-Tac-Toe

- Let's build a GUI for a tic-tac-toe game
 - We'll exclude checking for a winner and restarting the game

```
class Game {  
    var playerTurn = "X"  
  
    val movesMade = Array(  
        Array(" ", " ", " "),  
        Array(" ", " ", " "),  
        Array(" ", " ", " ")  
    )  
  
    def buttonClicked(x:Int, y:Int): Unit = {  
        if(this.movesMade(y)(x) == " "){  
            this.movesMade(y)(x) = this.playerTurn  
            this.playerTurn = if(this.playerTurn == "X") "O" else "X"  
        }  
    }  
}
```

```
class MoveAction(game: Game, button: Button, i:Int, j:Int) extends EventHandler[ActionEvent] {  
    override def handle(event: ActionEvent): Unit = {  
        game.buttonClicked(i, j)  
        button.text.value = game.movesMade(j)(i)  
    }  
}
```

Tic-Tac-Toe

- Build a 3x3 grid for all the squares
- Use nested if statements to decide how to react to a click

```
class Game {  
    var playerTurn = "X"  
  
    val movesMade = Array(  
        Array(" ", " ", " "),  
        Array(" ", " ", " "),  
        Array(" ", " ", " ")  
    )  
  
    def buttonClicked(x:Int, y:Int): Unit = {  
        if(this.movesMade(y)(x) == " "){  
            this.movesMade(y)(x) = this.playerTurn  
            this.playerTurn = if(this.playerTurn == "X") "O" else "X"  
        }  
    }  
}
```

```
class MoveAction(game: Game, button: Button, i:Int, j:Int) extends EventHandler[ActionEvent] {  
    override def handle(event: ActionEvent): Unit = {  
        game.buttonClicked(i, j)  
        button.text.value = game.movesMade(j)(i)  
    }  
}
```

Tic-Tac-Toe

- Not bad at all for a simple game like this
 - State design pattern will be overcomplicated in this example
 - Used as a smaller example

```
class Game {  
    var playerTurn = "X"  
  
    val movesMade = Array(  
        Array(" ", " ", " "),  
        Array(" ", " ", " "),  
        Array(" ", " ", " ")  
    )  
  
    def buttonClicked(x:Int, y:Int): Unit = {  
        if(this.movesMade(y)(x) == " "){  
            this.movesMade(y)(x) = this.playerTurn  
            this.playerTurn = if(this.playerTurn == "X") "O" else "X"  
        }  
    }  
}
```

```
class MoveAction(game: Game, button: Button, i:Int, j:Int) extends EventHandler[ActionEvent] {  
    override def handle(event: ActionEvent): Unit = {  
        game.buttonClicked(i, j)  
        button.text.value = game.movesMade(j)(i)  
    }  
}
```

Tic-Tac-Toe with State

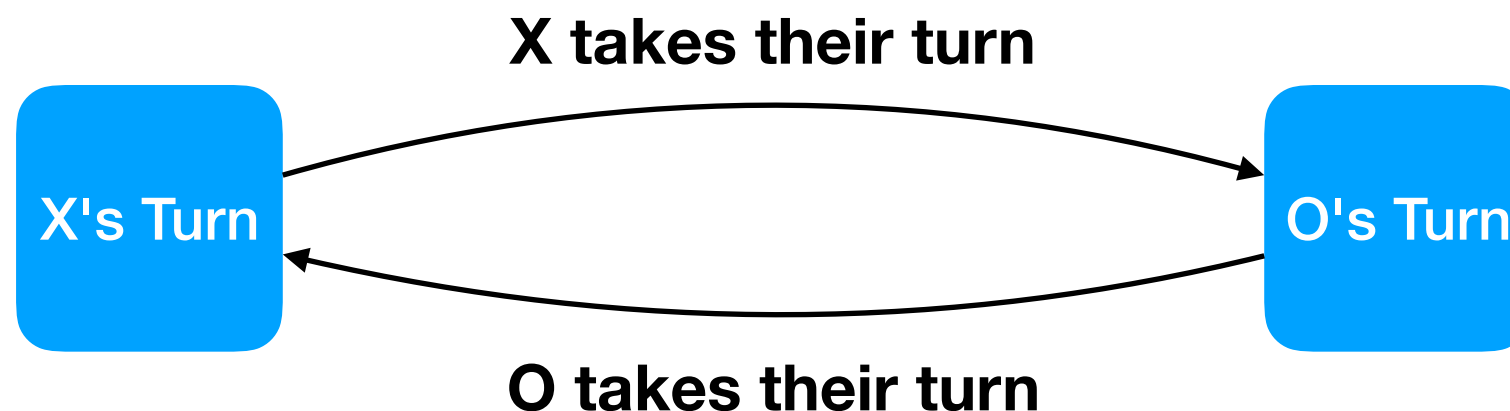
- Defer to state for functionality

```
class Game {  
  var gameState: GameState = new GameStateXTurn(this)  
  val boardSize = 3  
  val squares: Array[Square] = (  
    for {i <- 0 until boardSize  
        j <- 0 until boardSize} yield {  
      new Square(this, i, j)  
    }).toArray  
  
  def playerTurn(): String = {  
    this.gameState.playerTurn()  
  }  
  
  def takeTurn(): Unit = {  
    this.gameState.takeTurn()  
  }  
}
```

```
class Square(game: Game, val x:Int, val y:Int) extends EventHandler[ActionEvent] {  
  var state: SquareState = new SquareStateEmpty(game, this)  
  override def handle(event: ActionEvent): Unit = {  
    this.state.clicked()  
  }  
}
```

Tic-Tac-Toe with State

- Game can be in two different states depending whose turn it is
- Switch between these states as each player takes their turn
- State returns the symbol for the current player



Tic-Tac-Toe with State

- Game state changes depending on who's turn it is

```
trait GameState {  
    def playerTurn(): String  
    def takeTurn(): Unit  
}
```

```
class GameStateXTurn(game: Game) extends GameState {  
    override def playerTurn(): String = "X"  
    override def takeTurn(): Unit = game.gameState = new GameStateOTurn(game)  
}
```

```
class GameStateOTurn(game: Game) extends GameState {  
    override def playerTurn(): String = "O"  
    override def takeTurn(): Unit = game.gameState = new GameStateXTurn(game)  
}
```

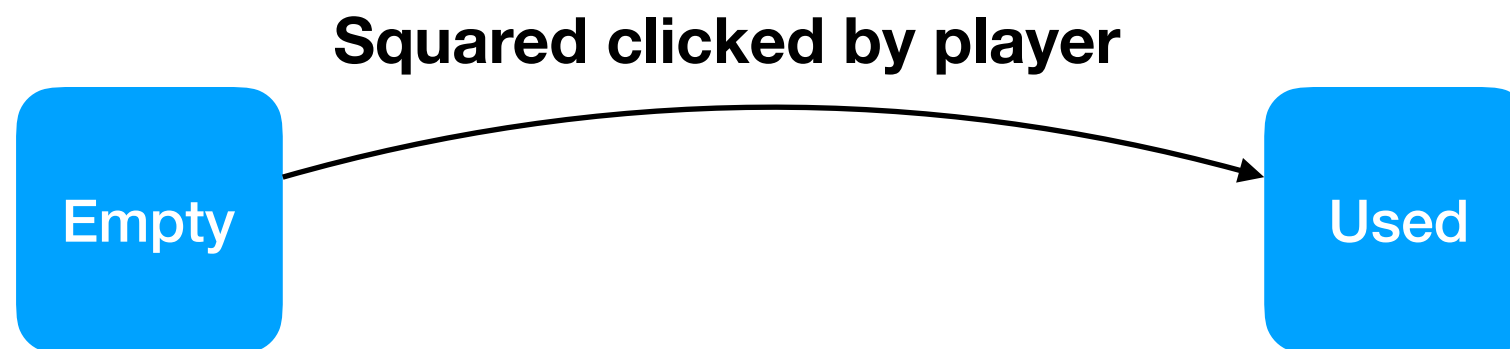
Tic-Tac-Toe with State

- Game start with state for X's turn
- defer to state for functionality

```
class Game {  
    var gameState: GameState = new GameStateXTurn(this)  
  
    val boardSize = 3  
  
    val squares: Array[Square] = (  
        for {i <- 0 until boardSize  
            j <- 0 until boardSize} yield {  
            new Square(this, i, j)  
        }).toArray  
  
    def playerTurn(): String = {  
        this.gameState.playerTurn()  
    }  
  
    def takeTurn(): Unit = {  
        this.gameState.takeTurn()  
    }  
}
```

Tic-Tac-Toe with State

- Square can either be empty or used
- Empty
 - Initial state of a square
 - When clicked, state becomes used
- Used
 - Remembers the player who used it
 - No action when clicked again



Tic-Tac-Toe with State

- Square can either be empty or used

```
trait SquareState {  
    var occupant: String  
    def clicked(): Unit  
}
```

```
class SquareStateEmpty(game: Game, square: Square) extends SquareState {  
    override var occupant: String = ""  
    override def clicked(): Unit = {  
        square.state = new SquareStateUsed(game, game.playerTurn())  
        game.takeTurn()  
    }  
}
```

```
class SquareStateUsed(game: Game, occupiedBy: String) extends SquareState {  
    override var occupant: String = occupiedBy  
    override def clicked(): Unit = {}  
}
```

Tic-Tac-Toe with State

- Squares start in empty state
- Defer to state for functionality when clicked
- A few extra lines to update the GUI
 - Could be handled in GUI itself

```
class Square(game: Game, val x:Int, val y:Int) extends EventHandler[ActionEvent] {  
  
  var button:Button = _ // set by GUI  
  var state: SquareState = new SquareStateEmpty(game, this)  
  
  override def handle(event: ActionEvent): Unit = {  
    this.state.clicked()  
    button.text.value = this.state.occupant  
  }  
}
```

Tic-Tac-Toe with State

- With states we created 6 new classes
- Spread out the functionality and decisions
 - Each class has very little logic and is easy to reason about
 - All classes combined create a more complex program
- The trade-offs
 - No nested if statement
 - More classes and complex project structure
- For tic-tac-toe the trade-offs might not be worth using the pattern
 - For more complex programs the trade-off can payoff

Lecture Question

Create a model for a vending machine. In a package named vending create a class named VendingMachine with these 4 methods (This defines the API of the model)

- insertCoin(Int):Unit
 - User inserts a coin with an integer representing the number of cents the coin was worth
- coinReturnedPressed(): Int
 - Returns all the coins to the user (You don't have to actually return the coins, but must update and state and state variables to reflect this). The return value is the number of cents returned to the user
- beverageButtonPressed(): Boolean
 - Returns true is enough coins are in the machine to afford a beverage costing 200 cents
 - Returns all coins to the user (you don't have to actually return anything for the coins, but the total value of all coins in the machine should be set to 0)
- destroy():Unit
 - Destroys the machine. After this method is called the functionality of the machine is broken (coin returns always returns 0; beverage is never dispensed)

* This question will be open until midnight

Lecture Question

- *You are encouraged to complete this using the state design pattern to gain practice for the calculator homework, but the grader only checks your functionality of the 4 methods and not your approach

