Behavioral Patterns

JS Patterns and Anti Patterns

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Outline

- Behavior pattern in general
- Command
- Memento
- Chain of responsibility
- Observer

Behavior Pattern in general

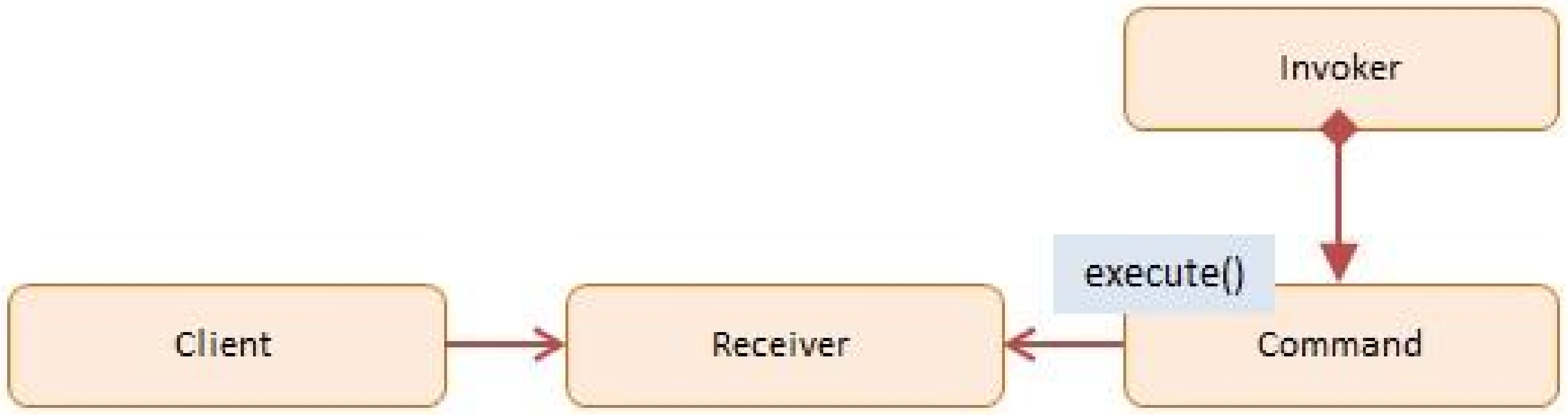
- Mainly concerned with the communication between objects.
- Describe a process or a flow
- encapsulating behavior and delegating of requests
- increases flexibility

Command

- Encapsulate a request as an object
- Request without knowing anything about the operation being requested. - “Black box execute()”
- Uses: GUI buttons, Networking, Multi-level undo, Progress bar

Command - Participants

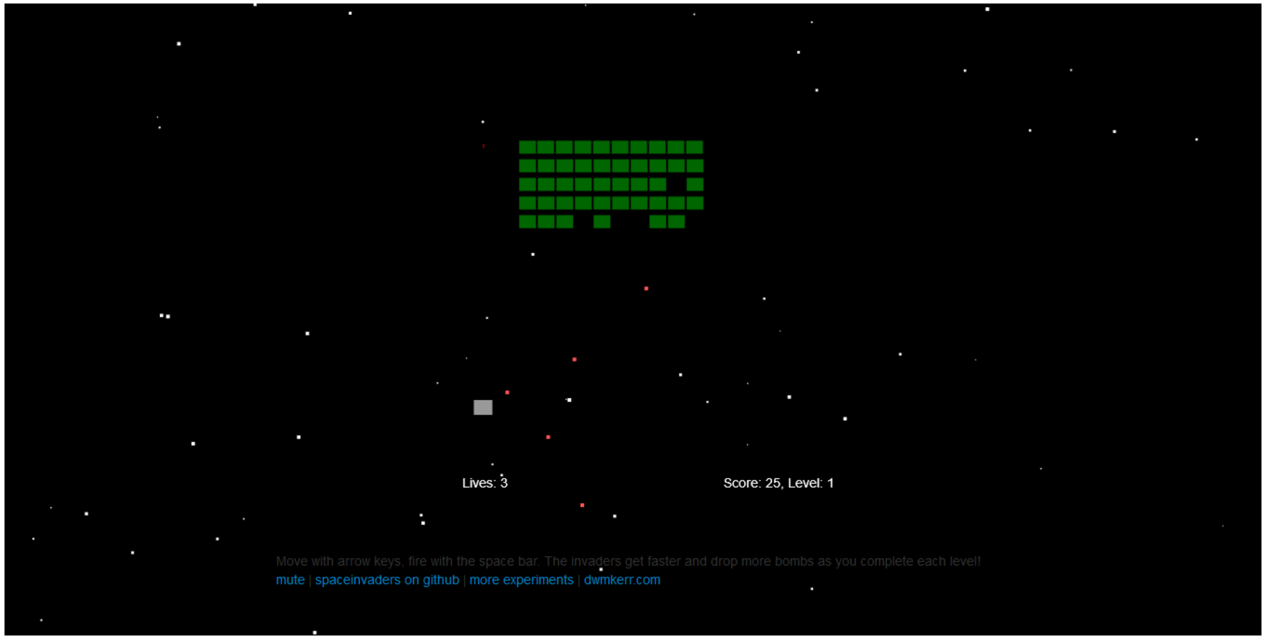
- **Client**: decides which command at which point
- **Receiver**: knows how to carry out the operation
- **Command**: execute()
- **Invoker**: knows how to execute



http://www.dofactory.com/images/diagrams/javascript/javascript-command.jpg

Spaceinvader

- Retro Game: shooting Spaceinvader
- Level bases
- State bases (Welcome-, GameOver-, PlayState, ect.)



Move with arrow keys, fire with the space bar. The invaders get faster and drop more bombs as you complete each level!
mute | spaceinvaders on github | more experiments | dwmkerr.com

Command - Spaceinvader 1/4

before:

```
old
new
```

```
if(game.pressedKeys[37]) {
    this.ship.x -= this.shipSpeed * dt;  //dt = Delta time
}                                        //   = 1/fps

if(game.pressedKeys[39]) {
    this.ship.x += this.shipSpeed * dt;
}
if(game.pressedKeys[32]) {
    this.fireRocket();
}
[…]
bomb.y += dt * bomb.velocity;
[…]
rocket.y -= dt * rocket.velocity;
```

Command - Spaceinvader 2/4

old
new

after: (Commands)

```
var goLeft = {
    execute : function(obj, speed) {
        obj.x -= speed * dt;
    }
}
var goRight = {
    execute : function(obj, speed) {
        obj.x += speed * dt;
    }
}
var shoot = {
    execute : function(obj) {
        obj.fireRocket();
    }
}
```

Command - Spaceinvader 3/4

```
old
new
```

after: (Commands)

```
var goUp = {
    execute : function(obj, speed) {
        obj.y -= speed * dt;
    }
}

var goDown = {
    execute : function(obj, speed) {
        obj.y += speed * dt;
    }
}
```

Command - Spaceinvader 4/4

after:

```
old
new
```

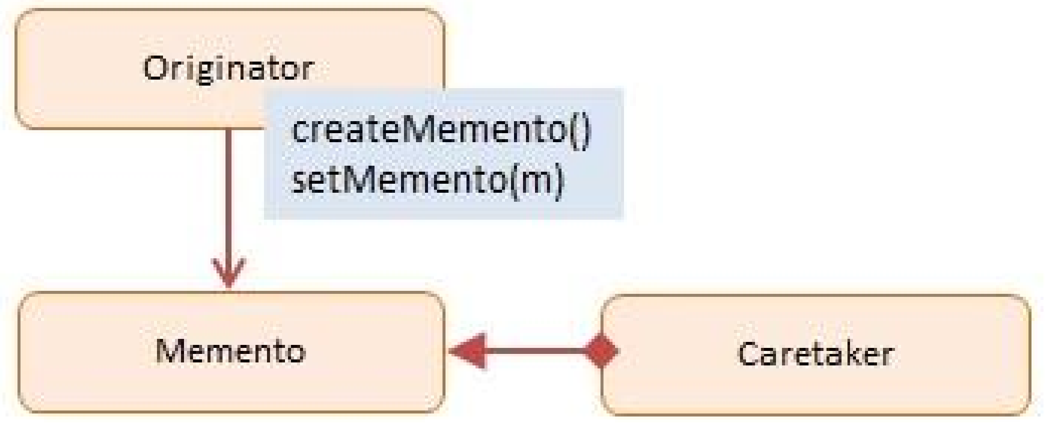
```
//The Client is the main loop and the invoker is the user
if(game.pressedKeys[37]) {               //<-receiver
    goLeft.execute(this.ship, this.shipSpeed);
}
if(game.pressedKeys[39]) {
    goRight.execute(this.ship, this.shipSpeed);
}
if(game.pressedKeys[32]) {
    shoot.execute(this);
}
[…]
goDown.execute(bomb, bomb.velocity);
[…]
goUp.execute(rocket, rocket.velocity);
```

Memento

- Capturing and externalizing an object’s internal state to be restored later.
- Database of “save point”
- Use: used to avoid disclosure of implementation details

Memento - Participants

- **Originator**: interface to create and restore mementos
- **Memento**: ordinator object
- **Caretaker**: stores mementos



http://www.dofactory.com/images/diagrams/javascript/javascript-memento.jpg

Memento - Spaceinvader 1/4

before:

```
old
new
```

```
WelcomeState.prototype.keyDown = function(game, keyCode) {
[…]
    game.moveToState(new LevelIntroState(game.level));
};
[…]


GameOverState.prototype.keyDown = function(game, keyCode)
[…]
    game.moveToState(new LevelIntroState(1));
}
```

Memento - Spaceinvader 2/4

after:

```
old
new
```

```
function Memento(state){
    this.state = state;
    this.getSavedState = function(){
        return this.state;
    };
};
function Caretaker(){
    var saveState = [];
    this.addMemento = function(memento){
        saveState.push(memento);
    };
    this.getMemento = function(index){
        return saveState[index];
    };
};
```

Memento - Spaceinvader 3/4

old
new

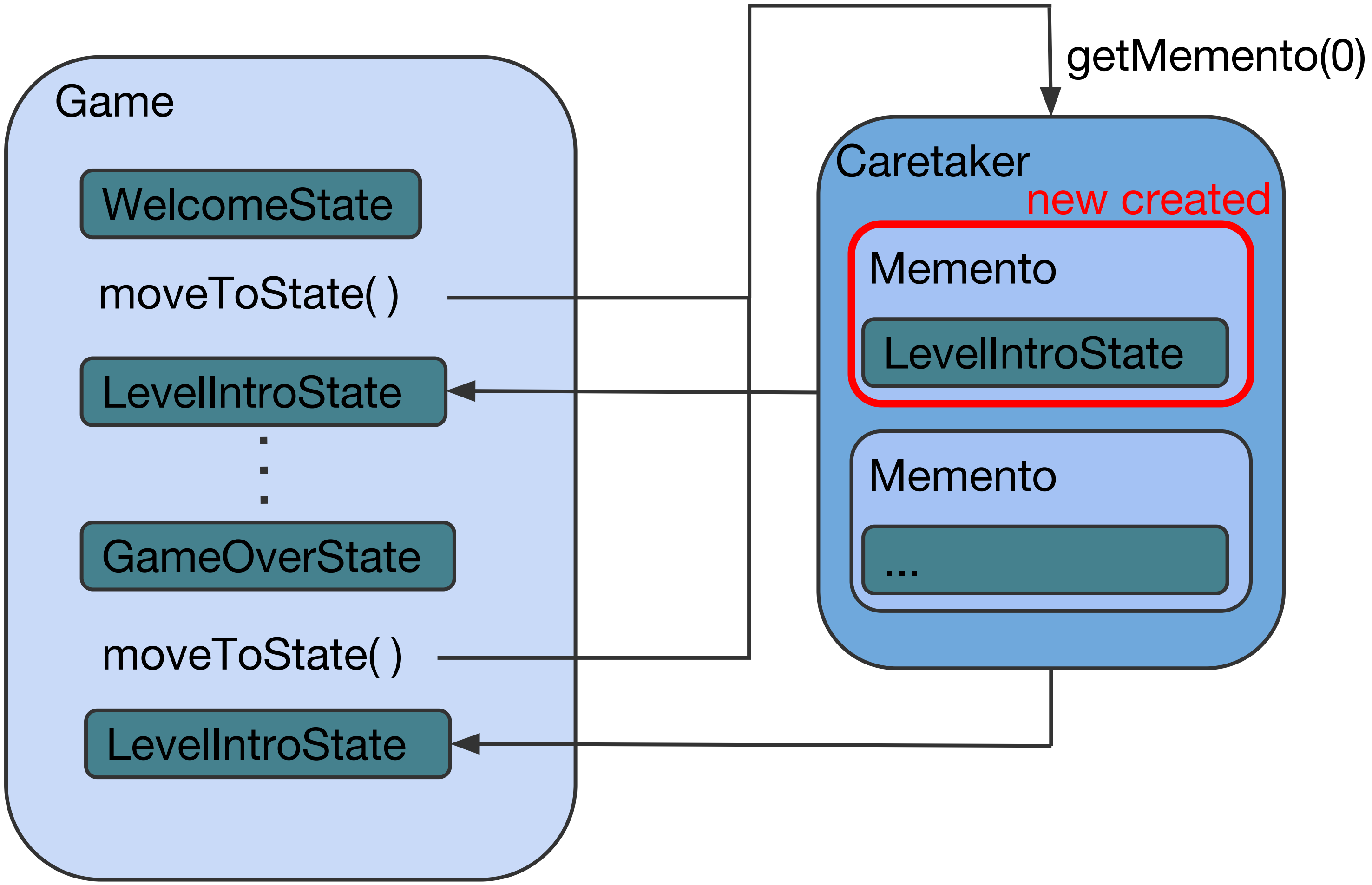
after:

```
//In this case an Originator is for example a LevelIntroState
caretaker = new Caretaker();
[…]

WelcomeState.prototype.keyDown = function(game, keyCode) {
[…]
caretaker.addMemento(new Memento(new LevelIntroState(game.level)));
game.moveToState((caretaker.getMemento(0)).getSavedState());
};
[…]

GameOverState.prototype.keyDown = function(game, keyCode) {
[…]
game.moveToState((caretaker.getMemento(0)).getSavedState());
};
```

Memento - Spaceinvader 4/4

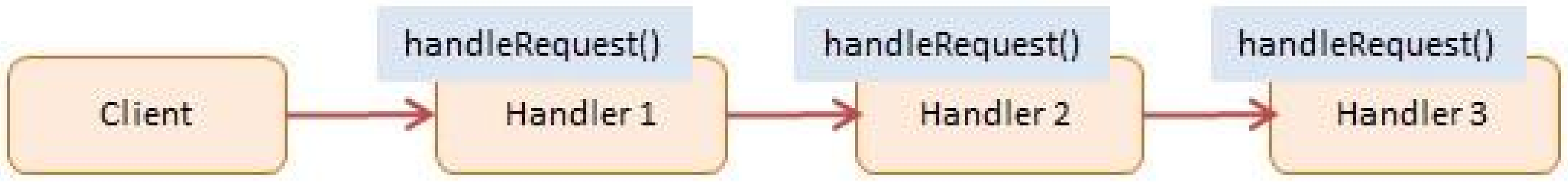


Chain of responsibility

- Avoid coupling between the sender and the receiver of a request.
- More than one object have the chance to handle the request.
- linear search for a handler

Chain of responsibility - Participants

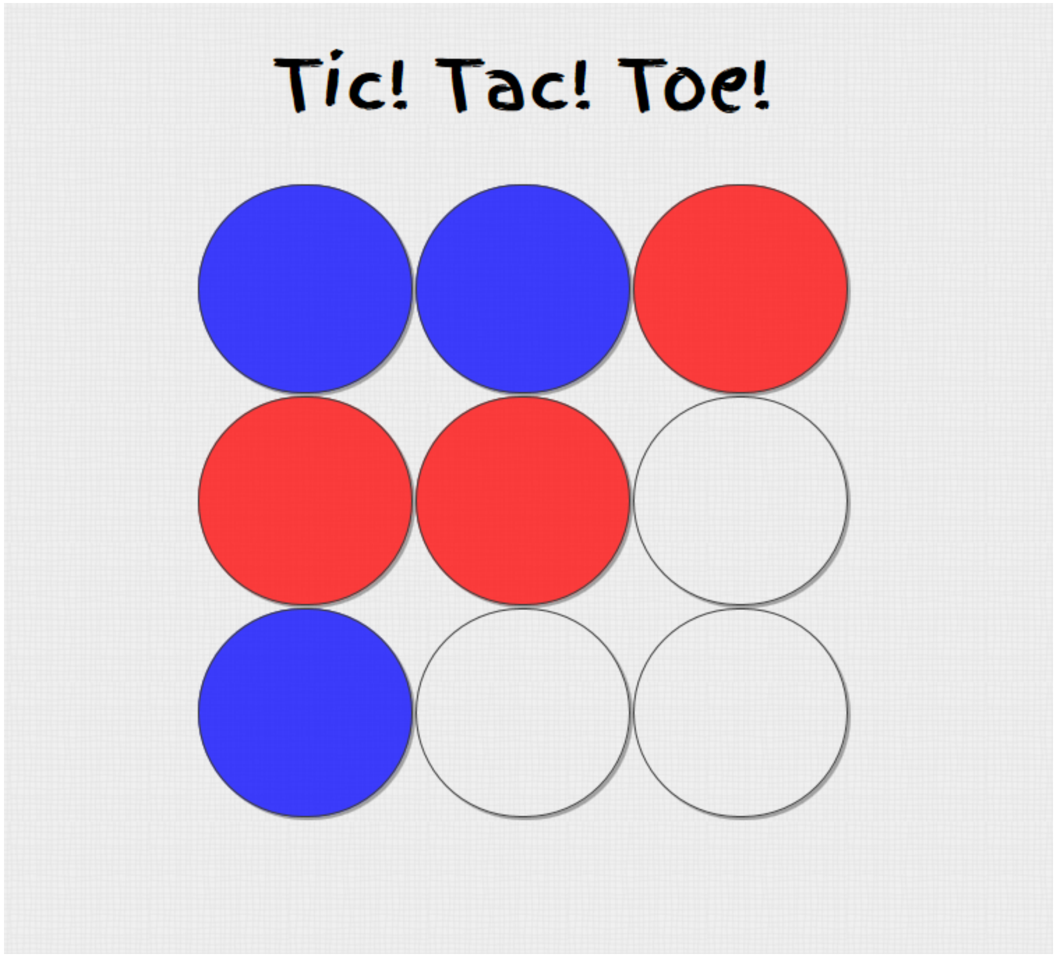
- **Client**: initiator of the request
- **Handler**: has an interface for handling the request



http://www.dofactory.com/images/diagrams/javascript/javascript-chain-of-responsibility.jpg

Tic Tac Toe

- retro Game
- 2 player
- checks winner or tie after each turn
- restarts



Chain of responsibility - Tic tac toe 1/7

before:

old
new

```
function checkWinner() {
    if (checkRows() === true || checkCols() === true ||
checkDiag() === true) {
        winningPlayer = turn.currentPlayerColor();
        // Alert winner
        endGame("Player " + winningPlayer + ", you win!");
    }
    else if (checkTie() === true) {
        endGame("It's a tie...");
    }
    else {
        turn.changeTurn();
    }
}
```

Chain of responsibility - Tic tac toe 2/7

old
new

before:

```
function checkRows() {
    for (i = 0; i < board.length; i++) {
        var same = true;
        for (j = 0; j < board[i].length; j++) {
            if (board[i][j] === 0 || board[i][j] !== board
[i][0]) {
                same = false;
            }
        }
        if (same) {
            return same;
        }
    }
}
```

Chain of responsibility - Tic tac toe 3/7

before:

```
old
new
```

```
function checkTie() {
    var flattenedBoard = Array.prototype.concat.apply([],
board);
    for(i = 0; i < flattenedBoard.length; i++){
        if(flattenedBoard[i] === 0){
            console.log(i);
            return false;
        }
    }
    return true;
}
```

Chain of responsibility - Tic tac toe 4/7

```
old
new
```

after:

```
function checkWinner() {
    checkRows();

}
```

Chain of responsibility - Tic tac toe 5/7

old
new

after:

```
function checkRows() {
    for (i = 0; i < board.length; i++) {
        var same = true;
        for (j = 0; j < board[i].length; j++) {
            if (board[i][j] === 0 || board[i][j] !== board[i][0])
{
                same = false;
            }
        }
        if (same) {
            winningPlayer = turn.currentPlayerColor();
            // Alert winner
            endGame("Player " + winningPlayer + ", you win!");
        }
    }
    checkCols();};
```

Chain of responsibility - Tic tac toe 6/7

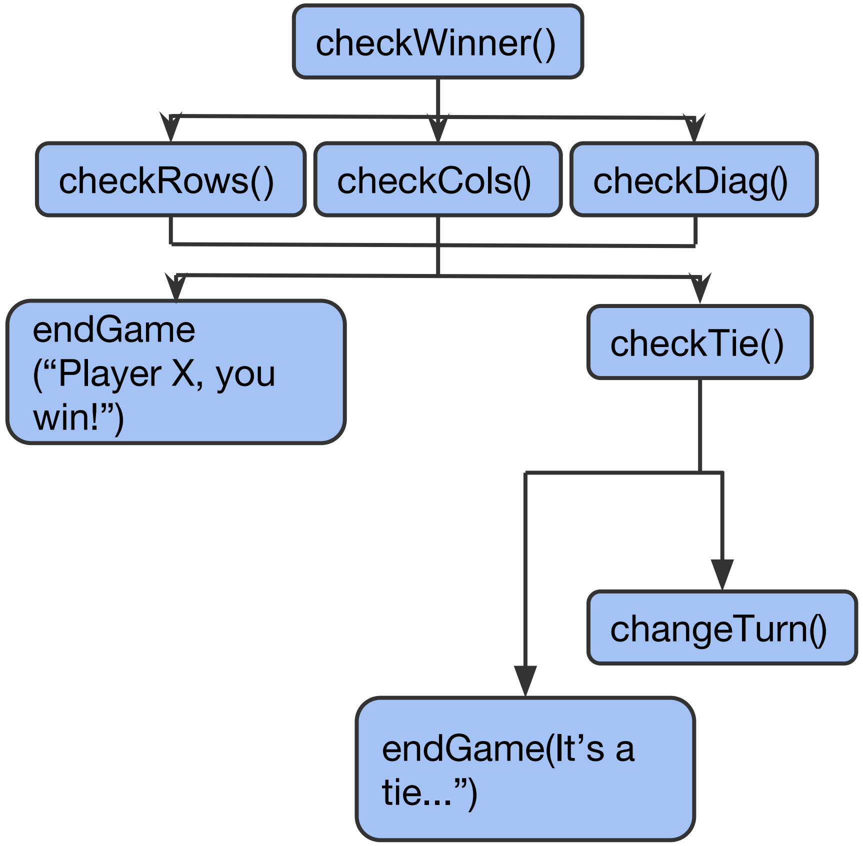
after:

```
old
new
```

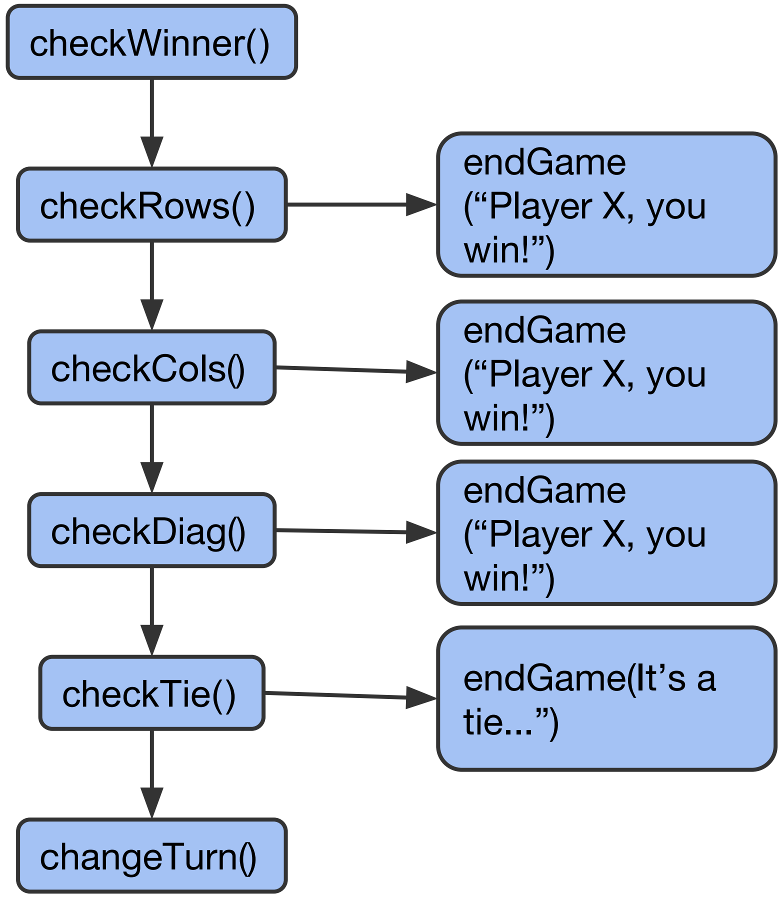
```
function checkTie() {
    var flattenedBoard = Array.prototype.concat.apply([], board);
    for(i = 0; i < flattenedBoard.length; i++){
        if(flattenedBoard[i] === 0){
            console.log(i);
            turn.changeTurn();
            return;
        }
    }
    endGame("It's a tie...");
}
```

Chain of responsibility - Tic tac toe 7/7

before:



after:

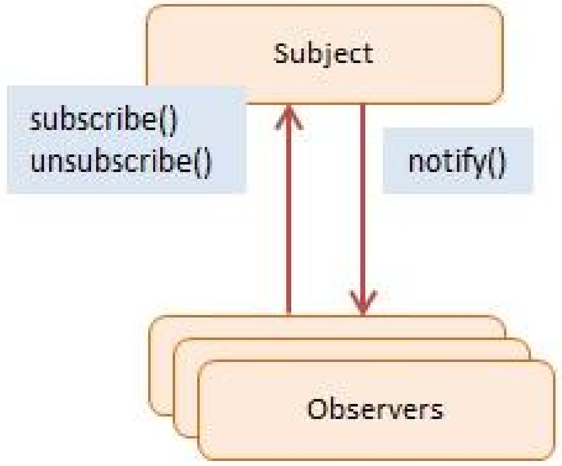

checkWinner()
checkRows()
endGame (“Player X, you win!”)
checkCols()
endGame (“Player X, you win!”)
checkDiag()
endGame (“Player X, you win!”)
checkTie()
endGame(It’s a tie…”)
changeTurn()

Observer

- Define a one-to-many dependency between objects
- When one object (Observable) changes its state, all dependent objects (Observers) are notified (usually with a message)
- Notified objects handle their own update

Observer - Participants

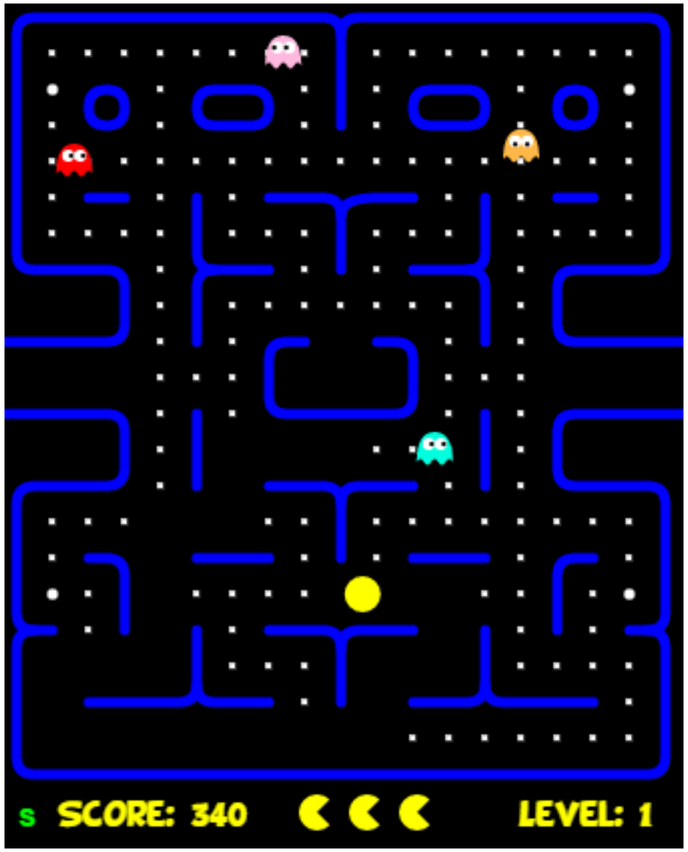
- **Subject / Observable**: maintains a list of observers, lets them subscribe/unsubscribe, and notifies them about changes
- **Observers**: has a function that can be invoked when notified



http://http://www.dofactory.com/images/diagrams/javascript/javascript-observer.jpg

Pac Man

- retro game (classic pacman)
- 3 lives
- avoid getting eaten by ghosts
- can eat and “jail” the ghosts for a short time after eating “beans”
- eat all the blocks to a level



Observer – Pac Man 1/7

before:

```
old
new
```

```
function startLevel() {
    user.resetPosition();
    for (var i = 0; i < ghosts.length; i += 1) {
        ghosts[i].reset();
    }
    audio.play("start");
    timerStart = tick;
    setState(COUNTDOWN);
}
```

Observer – Pac Man 2/7

old
new

before:

```
function eatenPill() {
    audio.play("eatpill");
    timerStart = tick;
    eatenCount = 0;
    for (i = 0; i < ghosts.length; i += 1) {
        ghosts[i].makeEatable(ctx);
    }
};
```

Observer – Pac Man 3/7

```
old
new
```

after:

```
function startLevel() {
    user.resetPosition();
    notifyObservers("levelstarted");
    timerStart = tick;
    setState(COUNTDOWN);
}

[…]

function eatenPill() {
    timerStart = tick;
    eatenCount = 0;
    notifyObservers("pilleaten");
};
```

Observer – Pac Man 4/7

after:

```
old
new
```

```
//REFACTOR: adding observable functionalities
function subscribe(o) {
    observers.push(o);
};

function unsubscribe(o) {
    observers = observers.filter(
        function(item) {
            if (item !== o) { return item; } }
    ); };

function notifyObservers(message) {
    for (var i = observers.length - 1; i >= 0; i--) {
        observers[i].notify(message);
    }; };
```

Observer – Pac Man 5/7

old
new

after:

```
//REFACTOR: subscribing ghosts and audio after creating
[…]
subscribe(ghost);
[…]
subscribe(audio);
[…]
```

Observer – Pac Man 6/7

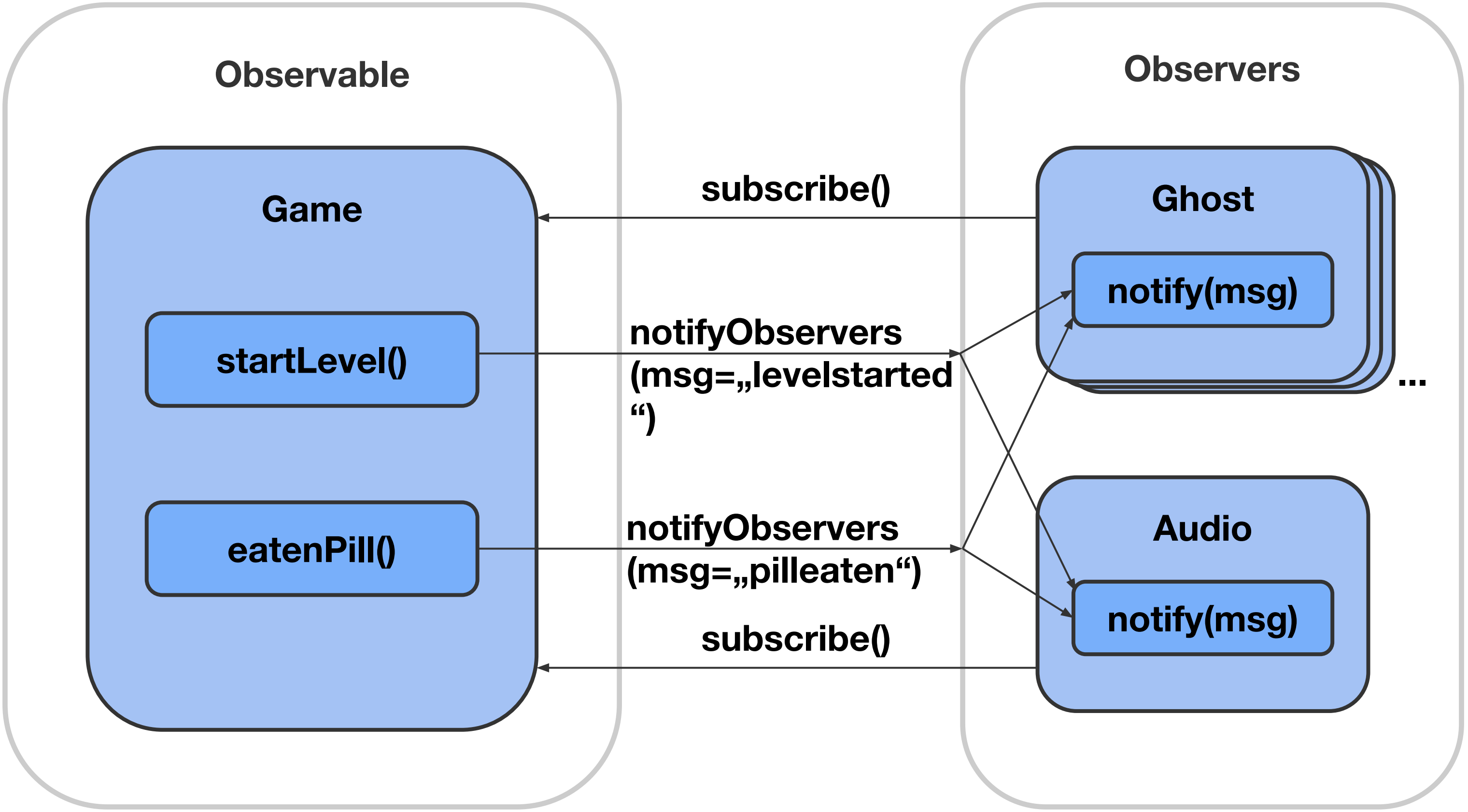
```
old
new
```

after:

```
//REFACTOR: adding observer functionalities for Ghost
function notify(message) {
    switch(message) {
        case "levelstarted":
            reset();
            break;
        case "pilleaten":
            makeEatable();
            break;
        default:
            break;
    }
};
```

(Analog for Audio)

Observer – Pac Man 7/7



Summary

Advantages of Behavioral Patterns:

- Increase flexibility of programs
- Well defined communication between objects (e.g. Observer)
- Ability to extend programs easily
- Simplify complex algorithms and control flows (e.g. Chain of Command)

Sources

http://www.dofactory.com/javascript/design-patterns

https://sourcemaking.com/design_patterns

http://www.blackwasp.co.uk/DesignPatternsArticles.aspx

https://en.wikipedia.org/wiki/Command_pattern

https://de.wikipedia.org/wiki/Memento_%28Entwurfsmuster%29

https://en.wikipedia.org/wiki/Chain-of-responsibility_pattern

Projects

Spaceinvader: https://github.com/dwmkerr/spaceinvaders

Tic Tac Toe: https://github.com/negomi/tic-tac-toe

Pacman: https://github.com/daleharvey/pacman

Iterator

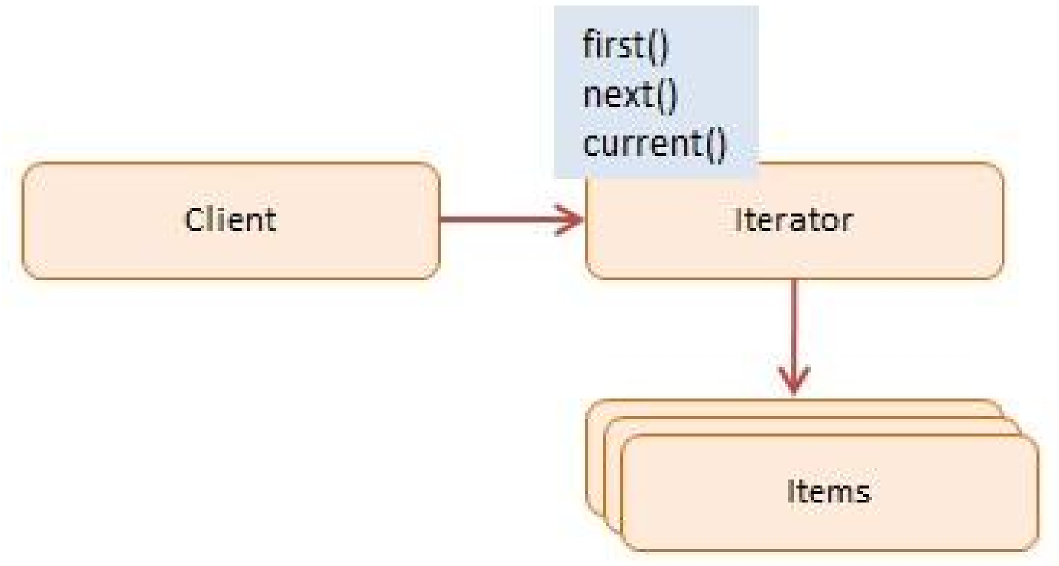
- access elements without knowing the underlying structure of the object
- effectively loop over a object collection
- object store as list, trees or more complex structures
- many language have build in iterator, but not JavaScript
- Iterator is the “secretary”

Iterator - Participants

Client: uses the iterator

Iterator: interface with methods like first(), next(), hasNext()

Items: individual objects



http://www.dofactory.com/images/diagrams/javascript/javascript-iterator.jpg

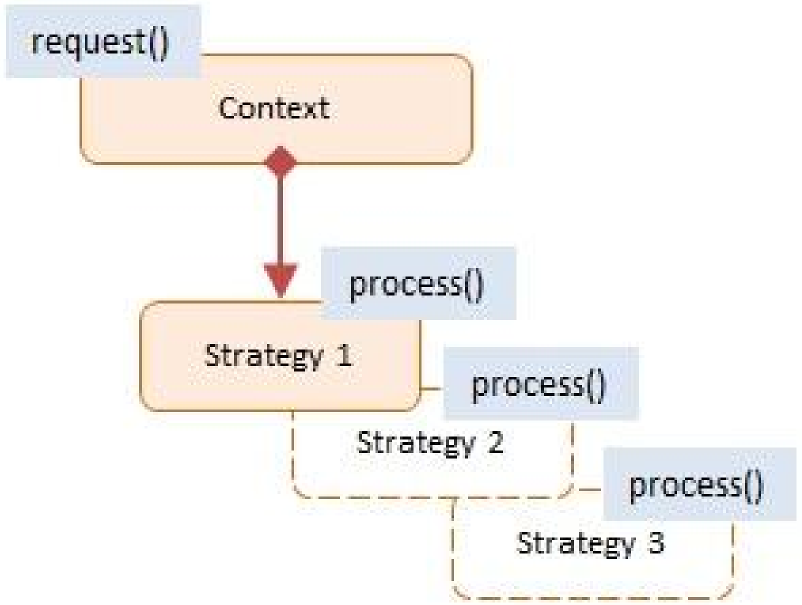
Strategie

- Interchangeable set of algorithms
- Swapped out at runtime
- Minimizing coupling
- Option to hide implementation

Strategie - Participants

Context: reference to the current Strategy, the option to change it and to calculate the “cost” of each strategy

Strategy: implementation of different option for a task



http://www.dofactory.com/images/diagrams/javascript/javascript-strategy.jpg

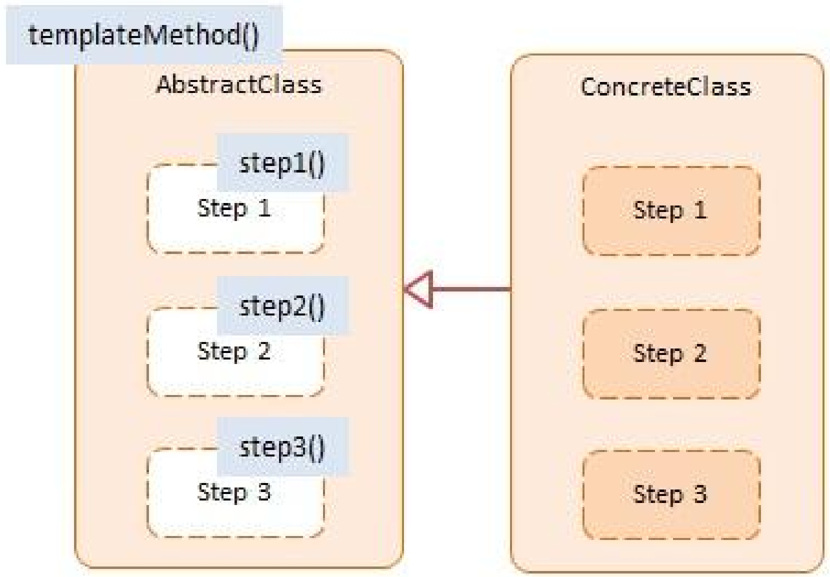
Template method

- Outline of a series of steps for an algorithm
- Subclasses can redefine certain steps of an algorithm without changing the algorithms structure
- Offers extensibility to the client developer

Template method - Participants

AbstractClass: template method defining the primitive steps for an algorithms

ConcreteClass: implements the primitive steps as defined



http://www.dofactory.com/images/diagrams/javascript/javascript-template-method.jpg

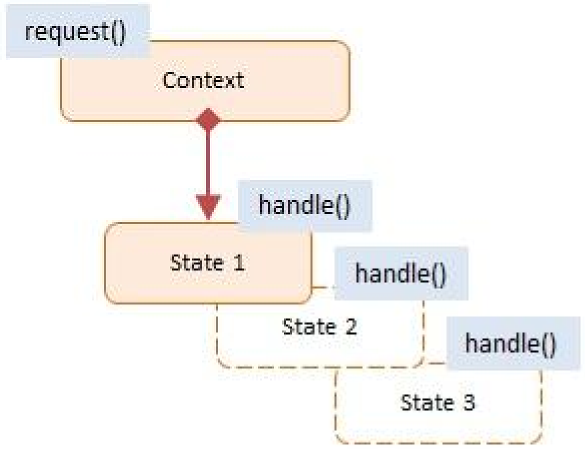
State

- A object can alter its behaviour when its internal state changes
- Object appears to have changed its class
- E.g. state machines

State - Participants

Context: maintains a reference to a object, defines its current state, and allows it to change its state

State: state values are associated with the according behaviour of the state



http://www.dofactory.com/images/diagrams/javascript/javascript-state.jpg