CS193X: Web Programming Fundamentals

Spring 2017

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Course logistics

Remember how we said the following on Day 1?

This is the first ever offering of CS193X, meaning:

- **Everything is subject to change.**

→ We're making some changes to the schedule!

Grades

Homework: ~~*60%*~~ **65%**

~~*Mini-HWs: 5%*~~

Final Project: 35%

- **We're dropping Mini-Homeworks**: Too much hassle for everyone. We're totally ignoring the first mini-HW you turned in for HW1. Might try again next year.

CS193X Structure

"Homework 0" + ~~*6 homeworks*~~ 5 homeworks

- Each homework will be a standalone web page or a very small standalone web app
- ~~*Each homework with have a multiple choice "mini homework" attached to it*~~

1 final project

- Choice of open-ended OR structured
  - Basically you can do HW6 for your final project
- ~1 week in scope; **individual** project; no groups

0 exams

- No final, no midterm, no exams

Yes, another HW extension

Tentative schedule for the rest of the quarter:

~~Fri May 5~~

Mon, May 8:

- HW3 due -- Moved from this Friday to next Monday!
- HW4 goes out

Wed, May 17:

- HW4 due
- HW5 goes out

Tentative schedule

Tentative schedule for the rest of the quarter:

Fri, May 26

HW5 due

Final Project goes out

Wed, June 7:

Last day of lecture!

Mon, June 12

Final project due EOD: No late submissions

Disclaimer

This is the plan for the rest of the quarter.

However, there's still a lot of quarter left!

Everything I just said is still subject to change.

Classes in JavaScript

Public methods

```
class ClassName {
  constructor(params) {
    ...
  }
  methodName() {
    ...
  }
  methodName() {
    ...
  }
}
```

`constructor` is optional.

Parameters for the constructor and methods are defined in the same they are for global functions.

You do not use the `function` keyword to define methods.

Public methods

```
class ClassName {
  constructor(params) {
    ...
  }
  methodOne() {
    this.methodTwo();
  }
  methodTwo() {
    ...
  }
}
```

Within the class, you must always refer to other methods in the class with the **`this.`** prefix.

Public methods

```
class ClassName {
  constructor(params) {
    ...
  }
  methodName() {
    ...
  }
  methodName() {
    ...
  }
}
```

All methods are **public**, and you **cannot** specify private methods… yet.

Public methods

```
class ClassName {
  constructor(params) {
    ...
  }
  methodName() {
    ...
  }
  methodName() {
    ...
  }
}
```

As far as I can tell, private methods aren't in the language only because they are still figuring out the spec for it. (They will figure out private fields first.)

Public fields

```
class ClassName {

  constructor(params) {
    this.fieldName = fieldValue;
    this.fieldName = fieldValue;
  }

  methodName() {
    this.fieldName = fieldValue;
  }
}
```

Define public fields by setting **`this.`*fieldName*** in the constructor… or in any other function.

(This is slightly hacky underneath the covers and there is a draft to add public fields properly to ES.)

Public fields

```
class ClassName {
  constructor(params) {
    this.someField = someParam;
  }
  methodName() {
    const someValue = this.someField;
  }
}
```

Within the class, you must always refer to fields with the `this.` prefix.

Public fields

```
class ClassName {

  constructor(params) {
    this.fieldName = fieldValue;
    this.fieldName = fieldValue;
  }

  methodName() {
    this.fieldName = fieldValue;
  }
}
```

You cannot define private fields… yet.

(Again, there are plans to add add private fields to ES once the spec is finalized.)

Instantiation

Create new objects using the new keyword:

```
class SomeClass {
  ...
  someMethod() { … }
}

const x = new SomeClass();
const y = new SomeClass();
y.someMethod();
```

Example: Present

Let's create a Present class inspired by our present example from last week.

Starter / Finished

Don't forget `this`

```
// Create image and append to container.
const image = document.createElement('img');
image.src = 'https://s3-us-west-2.amazonaws.com/s.cdpn.io/1083533/gift-icon.png';
image.addEventListener('click', this._openPresent);
```

If the event handler function you are passing to `addEventListener` is a method in a class, you must pass "`this.`***functionName***" (finished)

"Private" with _

A somewhat common JavaScript coding convention is to add an underscore to the beginning or end of private method names:

```
_openPresent() {
   ...
}
```

I'll be doing this in this class for clarity, but note that it's frowned upon by some.

Present class

present.js

```
class Present {
  constructor(containerElement) {
    this.containerElement = containerElement;

    // Create image and append to container.
    const image = document.createElement('img');
    image.src = 'https://s3-us-west-2.amazonaws.com/s.cdpn.io/1083533/gift-icon.png';
    image.addEventListener('click', this._openPresent);
    this.containerElement.append(image);
  }

  _openPresent(event) {
    const image = event.currentTarget;
    image.src = 'https://media.giphy.com/media/27ppQUOxe7KlG/giphy.gif';
    image.removeEventListener('click', this._openPresent);
  }
}
```

Present class

main.js

```
const container = document.querySelector('#presents');
const present = new Present(container);
```

index.html

```
<head>
  <meta charset="UTF-8" />
  <title>Simple class: present</title>
  <link rel="stylesheet" href="styles/index.css">
  <script src="scripts/present.js" defer></script>
  <script src="scripts/main.js" defer></script>
</head>
<body>
  <div id="presents"></div>
</body>
```

`this` in event handler

```
class Present {
  constructor(containerElement) {
    this.containerElement = containerElement;

    // Create image and append to container.
    const image = document.createElement('img');
    image.src = 'https://s3-us-west-2.amazonaws.com/s.cdpn.io/1083533/gift-icon.png';
    image.addEventListener('click', this._openPresent);
    this.containerElement.append(image);
  }

  _openPresent(event) {
    const image = event.currentTarget;
    image.src = 'https://media.giphy.com/media/27ppQUOxe7KlG/giphy.gif';
    image.removeEventListener('click', this._openPresent);
  }
}
```

Right now we access the image we create in the constructor in `_openPresent` via `event.currentTarget`.

`this` in event handler

```
  _openPresent(event) {
    this.image.src = 'https://media.giphy.com/media/27ppQUOxe7KlG/giphy.gif';
    this.image.removeEventListener('click', this._openPresent);
  }
}
```

Q: What if we make the `image` a field and access it `_openPresent` via `this.image` instead of `event.currentTarget`?

`this` in event handler

Error message!

CodePen / Debug

What's going on?

JavaScript `this`

The `this` keyword in JavaScript is **dynamically assigned**, or in other words: `this` means different things in different contexts (mdn list)

- In our constructor, `this` refers to the instance
- When called in an event handler, `this` refers to… the element that the event handler was attached to (mdn).

`this` in event handler

```
  _openPresent(event) {
    this.image.src = 'https://media.giphy.com/media/27ppQUOxe7KlG/giphy.gif';
    this.image.removeEventListener('click', this._openPresent);
  }
}
```

That means `this` refers to the `<img>` element, not the instance variable of the class...

...which is why we get this error message.

Solution: `bind`

To make `this` always refer to the instance object for a method in the class (i.e. to get `this` to behave as you'd expect), you can add the following line of code in the `constructor`:

```
this.methodName = this.methodName.bind(this);
```

```
class Present {
  constructor(containerElement) {
    this.containerElement = containerElement;

    // Bind event listeners.
    this._openPresent = this._openPresent.bind(this);
```

Solution: `bind`

Now `this` in the `_openPresent` method refers to the instance object (CodePen / Debug):

```
_openPresent(event) {
  this.image.src = 'https://media.giphy.com/media/27ppQUOxe7KlG/giphy.gif';
  this.image.removeEventListener('click', this._openPresent);
}
```

Moral of the story:

Don't forget to `bind()` event listeners in your constructor!!

```
class Present {
  constructor(containerElement) {
    this.containerElement = containerElement;

    // Bind event listeners.
    this._openPresent = this._openPresent.bind(this);
```

One more time:

Don't forget to `bind()` event listeners in your constructor!!

Communicating between classes

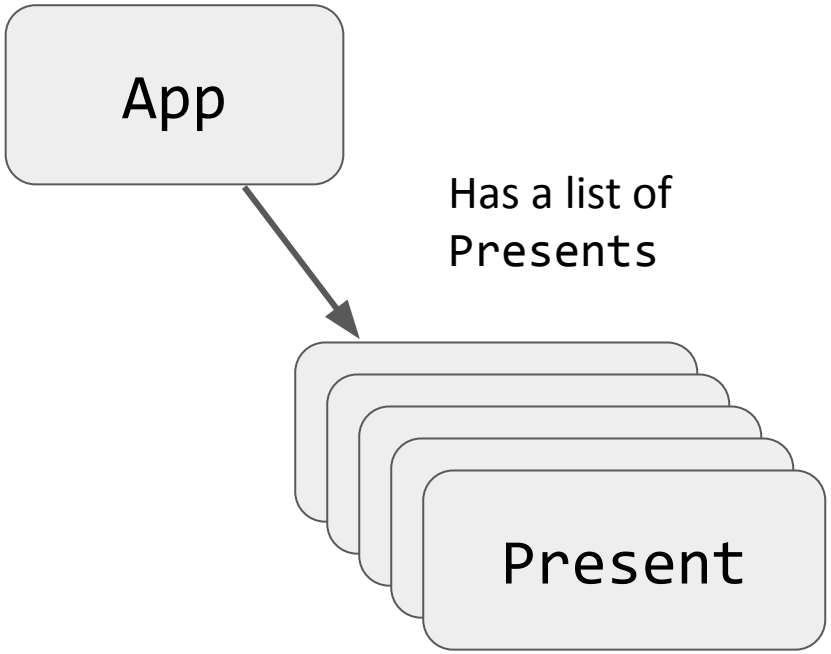
Multiple classes

Let's say that we have multiple presents now (CodePen):

Multiple classes

And we have implemented this with two classes:

- App: Represents the entire page
  - `Present`: Represents a single present



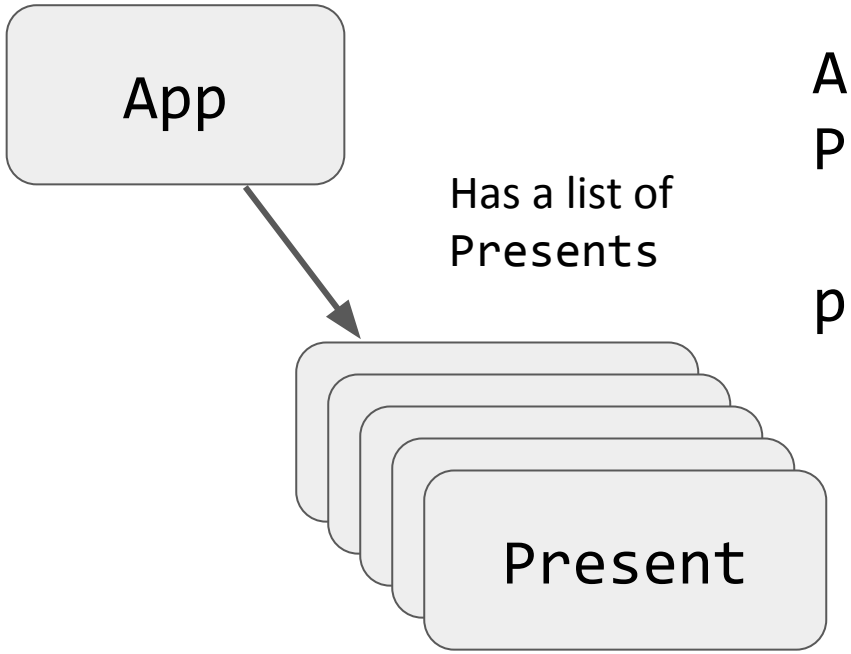
CodePen

Communicating btwn classes

What if we want to change the **title** when all present have been opened? (CodePen)

Communication btwn classes

Communicating from App → `Present` is easy, since App has a list of the `Present` objects.

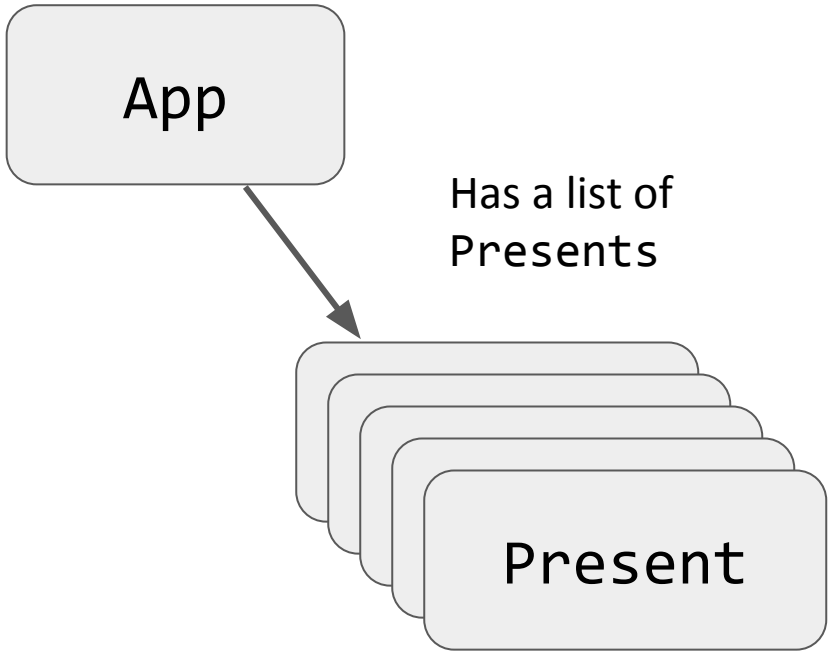


App can just call methods on `Present`:

```
present.doWhatever();
```

Communication btwn classes

However, communicating `Present` → App is not as easy, because `Presents` do not have a reference to App



Communicating btwn classes

You have three general approaches:

1. Add a reference to App in Photo

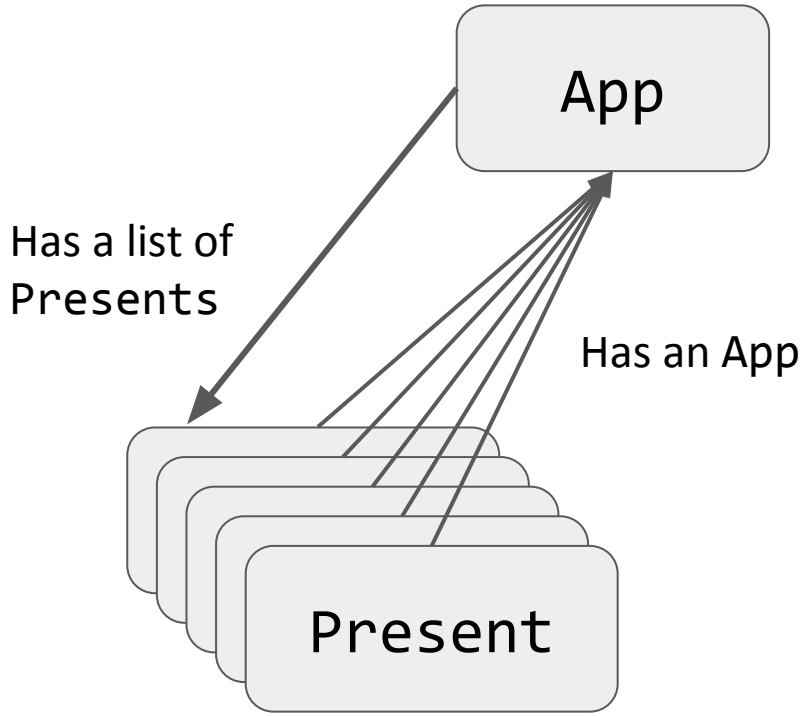
   This is poor software engineering, though we will allow it on the homework because this is not an OO design class
2. Fire a custom event

   OK (don't forget to bind)
3. Add onOpened "callback function" to Present

   Best option (don't forget to bind)

Terrible style: Presents own App

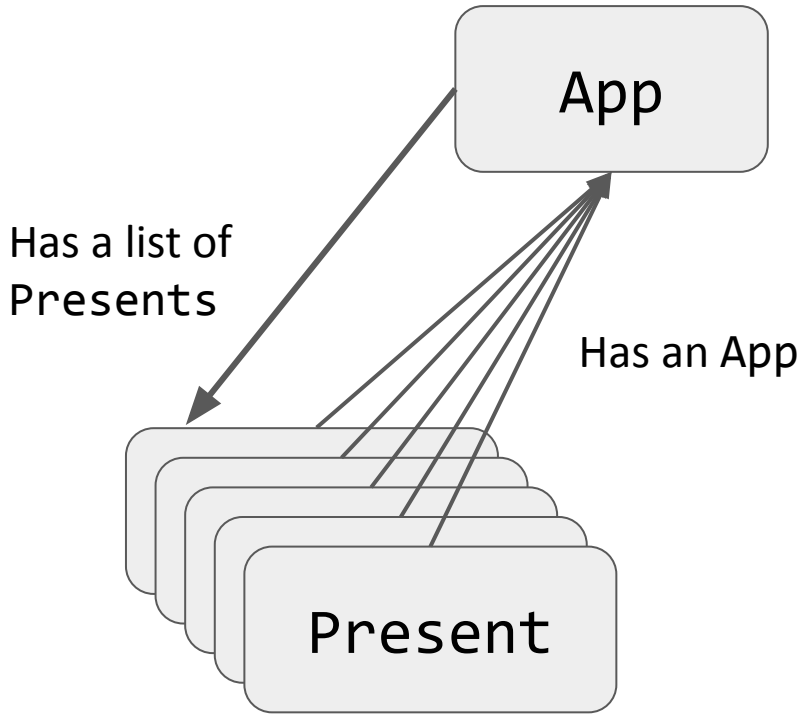
A naive fix is to just give `Present` a reference to App in its constructor: CodePen



(Please don't do this.)

Terrible style: Presents own App

This is the easiest workaround, but **it's terrible software engineering.**



- Logically doesn't make sense: a Present doesn't have an App
- Gives Present way too much access to App
- Especially bad in JS with no private fields, methods yet

Custom events

Custom Events

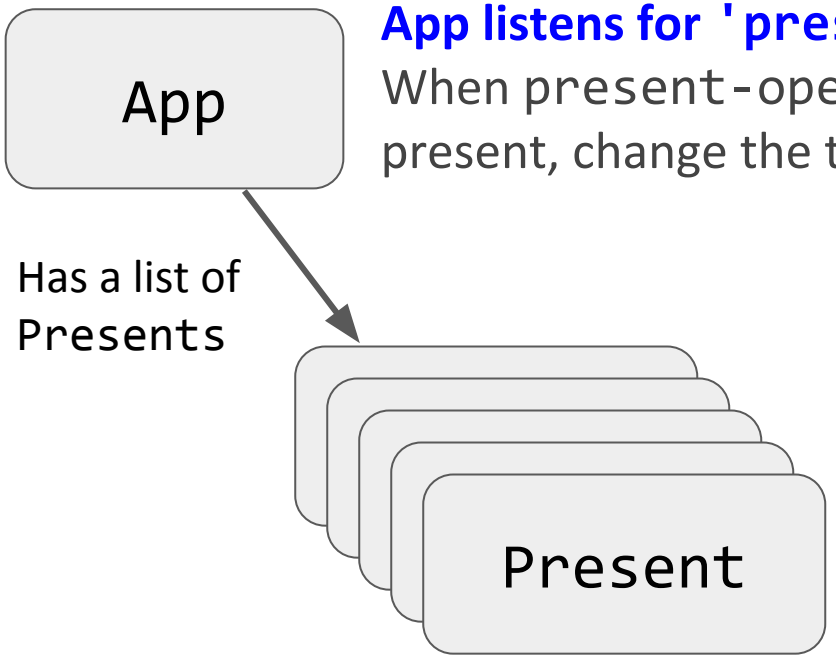
You can listen to and dispatch Custom Events to communicate between classes (mdn):

```
const event = new CustomEvent(
    eventNameString, optionalParameterObject);
element.addEventListener(eventNameString);
element.dispatchEvent(eventNameString);
```

However, CustomEvent **can only be listened to / dispatched on HTML elements,** and not on arbitrary class instances.

Custom Events: Present example

Let's have the App listen for the `'present-open'` event...

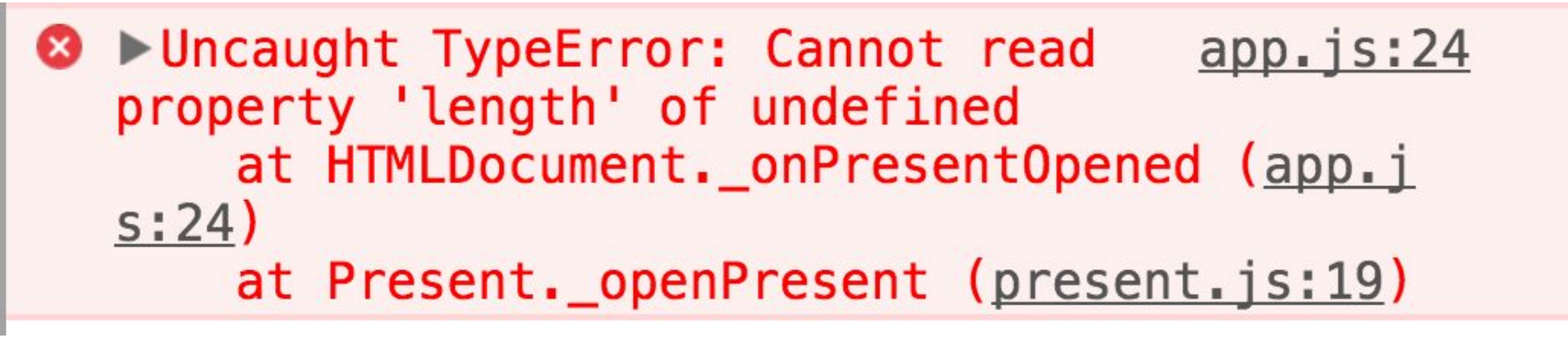


App listens for `'present-open'`
When `present-open` has fired for each present, change the title.

Each present fires `'present-open'` when clicked

[CodePen attempt]

`this` in event handler



Our first attempt at solution results in errors again!

([CodePen attempt])

Solution: `bind`

To make `this` always refer to the instance object for a method in the class (i.e. to get `this` to behave as you'd expect), you can add the following line of code in the `constructor`:

```
this.methodName = this.methodName.bind(this);
```

```
this._onPresentOpened = this._onPresentOpened.bind(this);
```

CodePen solution

First-class functions

Recall: `addEventListener`

Over the last few weeks, we've been using **functions** as a parameter to `addEventListener`:

```
dragon.addEventListener(
    'pointerdown', onDragStart);

image.addEventListener(
    'click', this._openPresent);
```

First-class functions

JavaScript is a language that supports **first-class functions**, i.e. functions are treated like variables of type Function:

- Can be passed as parameters
- Can be saved in variables
- Can be defined without a name / indentifier
  - Also called an **anonymous function**
  - Also called a **lambda function**
  - Also called a **function literal value**

Function variables

You can declare a function in several ways:

```
function myFunction(params) {
}

const myFunction = function(params) {
};

const myFunction = (params) => {
};
```

Function variables

```
function myFunction(params) {
}

const myFunction = function(params) {
};

const myFunction = (params) => {
};
```

Functions are invoked in the same way, regardless of how they were declared:

```
myFunction();
```

Simple, contrived example

```
function greetings(greeterFunction) {
  greeterFunction();
}

const worldGreeting = function() {
  console.log('hello world');
};

const hawaiianGreeting = () => {
  console.log('aloha');
};

greetings(worldGreeting);
greetings(hawaiianGreeting);
```

CodePen

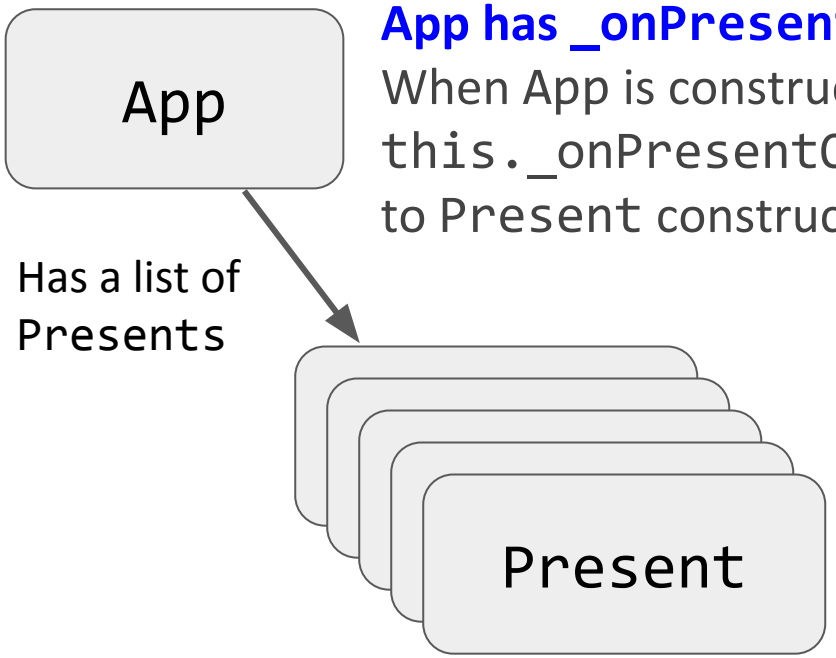
A real example: Callbacks

Another way we can communicate between classes is through callback functions:

- **Callback**: A function that's passed as a parameter to another function, usually in response to something.

Callback: Present example

Let's have `Presents` communicate with App via callback `parameter`: (CodePen attempt)



App has `_onPresentOpened` method

When App is constructing `Presents`, pass its `this._onPresentOpened` method as parameter to `Present` constructor

Each `Present` saves an `onOpenCallback` parameter in the constructor

When the present is opened, fire the callback

`this` in event handler

Say, it's another error in our event handler...

Solution: `bind`

Unless explicitly bound, "`this`" refers to the object that owns the method being called.

To make `this` always refer to the instance object for a method in the class (i.e. to get `this` to behave as you'd expect), you can add the following line of code in the `constructor`:

```
this.methodName = this.methodName.bind(this);
```

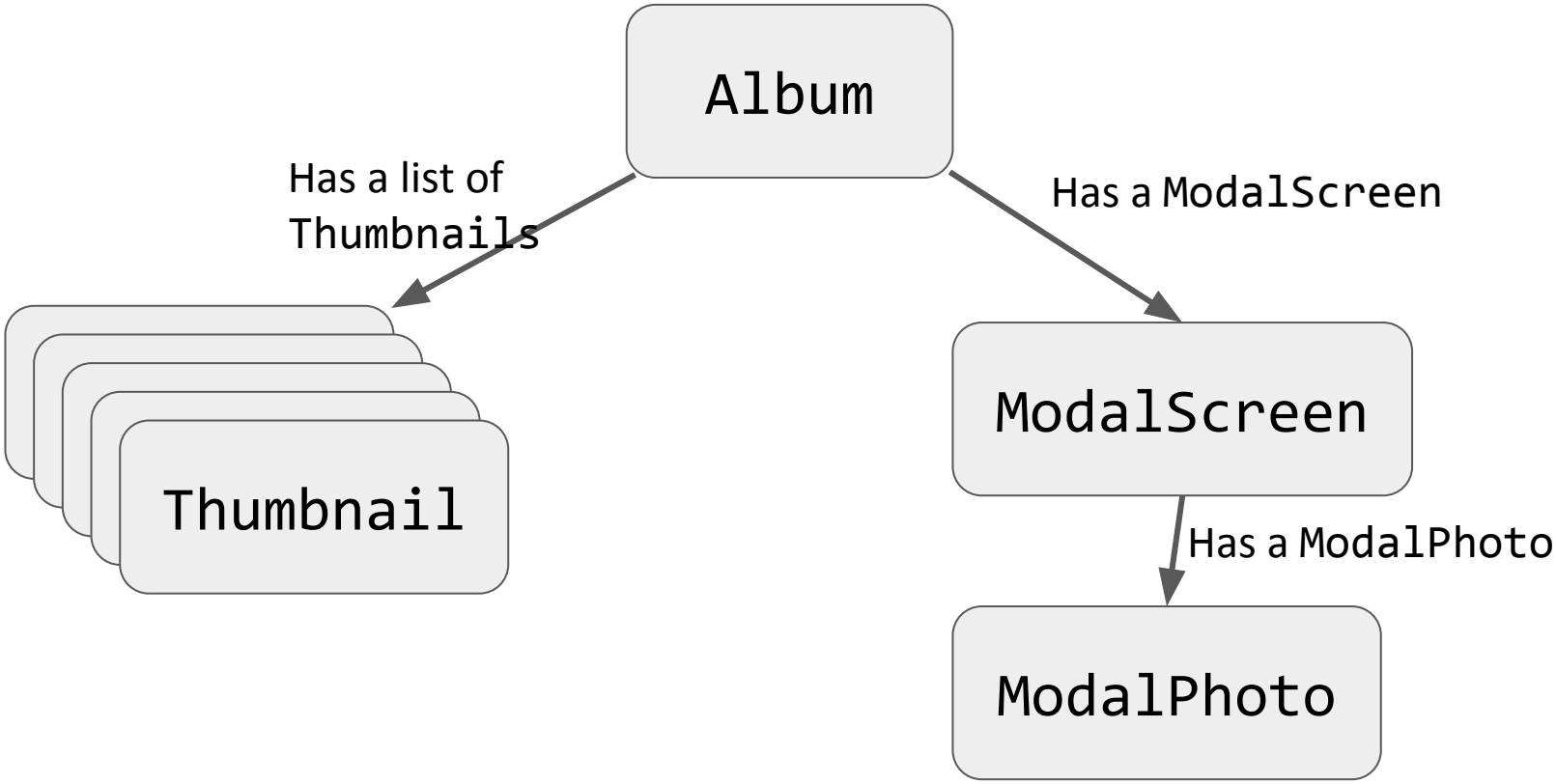
```
this._onPresentOpened = this._onPresentOpened.bind(this);
```

CodePen solution

Object-oriented photo album

Let's look at an object-oriented version of the photo album:

CodePen / Debug



Organizing code

How to choose classes

In the previous examples, you may be wondering:

- Why was there a `Present` class but no `Title` class?
- Do I really need an App class?
- Why isn't there an AlbumView / AlbumModel / AlbumController?

In other words, how do you decide what classes to write?

Disclaimer

This is not a software engineering class, and this is not an object-oriented design class.

As such, we will not grade your OO design skills.

However, this also means we won't spend too much time explaining *how* to break down your app into well-composed objects.

(It takes practice and experience to get good at this.)

A general strategy

"Component-based" approach: Use classes to add functionality to HTML elements ("components")

Each component:

- Has exactly one container element / root element
- Handles attaching/removing event listeners
- Can own references to child components / child elements

(Similar strategy to ReactJS, Custom Elements, many other libraries/frameworks/APIs before them)