

# Front End Programming

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# Brief history of Web Applications

- Initially: static HTML files only with HTML forms for input
- Common Gateway Interface (CGI)
  - Certain URLs map to executable programs that generate web page
  - Program exits after Web page complete
  - Introduced the notion of stateless servers: each request independent, no state carried over from previous requests. (Made scale-out architectures easier)
  - Perl typically used for writing CGI programs

# First-generation web app frameworks

Examples: (PHP, ASP.net, Java servlets)

- Incorporate language runtime system directly into Web server
- **Templates:** mix code and HTML
- Web-specific library packages:
  - URL handling
  - HTML generation
  - Sessions
  - Interfacing to databases

# Second-generation frameworks

Examples: (Ruby on Rails, Django):

- **Model-view-controller**: stylized decomposition of applications
- Object-relational mapping (**ORM**): simplify the use of databases (make database tables and rows appear as classes and objects)
  - Easier fetching of dynamic data

# Third-generation frameworks

## Example: AngularJS

- JavaScript frameworks running in browser - More app-like web apps
  - Interactive, responsive applications
- Frameworks not dependent on particular server-side capabilities
  - Node.js - Server side JavaScript
  - No-SQL database (e.g. MongoDB)
- Many of the concepts of previous generations carry forward
  - Model-view-controllers
  - Templates

# Model-View-Controller (MVC) Pattern

- **Model:** manages the application's data
  - JavaScript objects. Photo App: User names, pictures, comments, etc.
- **View:** what the web page looks like
  - HTML/CSS. Photo App: View Users, View photo with comments
- **Controller:** fetch models and control view, handle user interactions,
  - JavaScript code. Photo App: DOM event handlers, web server communication

MVC pattern been around since the late 1970's

- Originally conceived in the Smalltalk project at Xerox PARC

# View Generation

- Web App: Ultimately need to generate HTML and CSS
- **Templates** are commonly used technique. Basic ideas:
  - Write HTML document containing parts of the page that are always the same.
  - Add bits of code that generate the parts that are computed for each page.
  - The template is expanded by executing code snippets, substituting the results into the document.
- **Benefits of templates** (Compare with direct JavaScript to DOM programming)
  - Easy to visualize HTML structure
  - Easy to see how dynamic data fits in
  - Can do either on server or browser

# AngularJS view template (HTML/CSS)

```
...  
<body>  
  <div class="greetings">  
    Hello {{models.user.firstName}},  
  </div>  
  <div class="photocounts">  
    You have {{models.photos.count}} photos to review.  
  </div>  
</body>
```

Angular has rich templating language (loops, conditions, subroutines, etc.). Later...



# Controllers

- Third-generation: JavaScript running in browser

## Responsibilities:

- Connect models and views
  - Server communication: Fetch models, push updates
- Control view templates
  - Manage the view templates being shown
- Handle user interactions
  - Buttons, menus, and other interactive widgets

# AngularJS controller (JavaScript function)

```
function userGreetingView ($scope, $modelService) {  
    $scope.models = {};  
  
    $scope.models.users = $modelService.fetch("users");  
    $scope.models.photos = $modelService.fetch("photos");  
  
    $scope.okPushed = function okPushed() {  
        // Code for ok button pushing  
    }  
}
```

Angular creates \$scope and calls controller function called when view is instantiated

# Model Data

- All non-static information needed by the view templates or controllers
- Traditionally tied to application's database schema
  - Object Relational Mapping (ORM) - A model is a table row
- Web application's model data needs are specified by the view designers

But need to be persisted by the database

- Conflict: Database Schemas don't like changing frequently but web application model data might (e.g. user will like this view better if we add ... and lose ...)

# Angular doesn't specify model data (JavaScript objs)

- Angular provides support for fetching data from a web server
  - REST APIs
  - JSON frequently used

On Server:

- Mongoose's Object Definition Language (ODL) has "models"

```
var userSchema = new Schema({
  firstName: String,
  lastName: String,
});
var User = mongoose.model('User', userSchema);
```

# Fourth-generation frameworks

Examples: React.js, Vue.js, Angular(v2)

- Many of the concepts of previous generations carry forward
  - JavaScript in browser
  - Model-view-controllers
  - Templates
- Focus on JavaScript components rather than pages/HTML
  - Views apps as assembled reusable components rather than pages.
  - Software engineering focus: modular design, reusable components, testability, etc.
- Virtual DOM
  - Render view into DOM-like data structure (not real DOM)
  - Benefits: Performance, Server-side rendering, Native apps