CSE 331
Software Design & Implementation

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Modern Web GUIs

JS Example

register-js/index.js

Remaining Problems

- ~~Code is extremely **verbose**~~
  - ~~can be improved using Lambdas~~
- Code is *not sufficiently* **modular**
  - one JS mixes data, display, interaction
- ~~**Too much work** involved with laying out elements~~
- Poor **tool support**
  - HTML is created in strings!
  - (and other issues not mentioned so far…)

ES6

From last time: Fake Classes

- JavaScript started as an OO language w/out classes
- Can do some of what we need already:

```
let obj = {f: (x) => x + 1};
console.log(obj.f(2));  // 3
```

- Use "`this`" to read fields of `obj` in `obj.f`

Classes

```
class Foo {
  constructor(val) {
    this.secretVal = val;
  }

  secretMethod(val) {
    return val + this.secretVal;
  }
}

let f = new Foo(3);   // {secretMethod: …, secretVal: …}
console.log(f.secretMethod(5));  // 8
```

Classes

- **`new Foo`** creates an object already containing methods
  - also calls the constructor

- Still has the same issue with this:

```
class Foo { … }

let f = new Foo(3);
let s = f.secretMethod;
console.log(s(5));                    // NaN

let t = (x) => f.secretMethod(x);
console.log(t(5));                    // 8
```

JS vs Java Classes

- JS method signatures are just the name
  - JS objects are just HashMaps
  - field names are the keys

```
obj.avg(3, 5)
```

- Java methods signatures are name + arg types
  - e.g., `avg(int,int)`
- JS has only one method with a given name
  - language allows different numbers of arguments
    - missing arguments are undefined
  - can strengthen a spec by accepting a wider set of possible input types

Modules

- Each file is a separate unit ("namespace")
- Only exported names are visible outside:

```
export function average(x, y) { … }
```

- Others can import using:

```
import { average } from './filename';
```

  - file extension is sometimes not included

ES6 Example

register-js2/…

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UI is still in one file

- ~~**Too much work** involved with laying out elements~~

- Poor **tool support**
  - No compile-time types
  - HTML is created in strings!
  - (and other issues not mentioned so far…)

TypeScript

TypeScript

- Adds type constraints to the code:
  - arguments and variables

```
let x: number = 0;
```

  - fields of classes (now declared)

```
quarter: string;
```

- **`tsc`** performs type checking
  - outputs version with type annotations removed

TypeScript Types

- Basics from JavaScript:
  number, string, boolean, string[], Object

- But also
  - specific classes `Foo`
  - tuples: `[string, number]`
  - unions: `string | number`
  - enums (as in Java)
  - allows `null` to be included or excluded (unlike Java)
  - `any` type allows any value
  - abbreviations: `type Point = [number, number]`
  - …

Simple Examples

points1.ts

points2.ts

UI Example

register-ts/…

TypeScript

- Type system is unsound
  - can't promise to find prevent all errors
  - can be turned off at any point with any types
    - `x as Foo` is an unchecked cast to `Foo`
    - `x!` casts to non-null version of the type (useful!)

- Full description of the language at `typescriptlang.org`

JSX

JSX

- Fix another problem by adding HTML as a JS type
- This is supported in `.jsx` files:

```
let x = <p>Hi, {name}.</p>;
```

- Compiler can now check that this is valid HTML
- {…} replaced with string value of expression

JSX Gotchas

- Put (..) around HTML if it spans multiple lines

- Cannot use `class="btn"` in your HTML
  - `class`, `for`, etc. are reserved words in JS
  - use `className=".."`, `htmlFor=".."`, etc.

- Must have a single top-level tag:
  - not: `return <p>one</p><p>two</p>;`
  - usually fixed by wrapping those parts in a `div`

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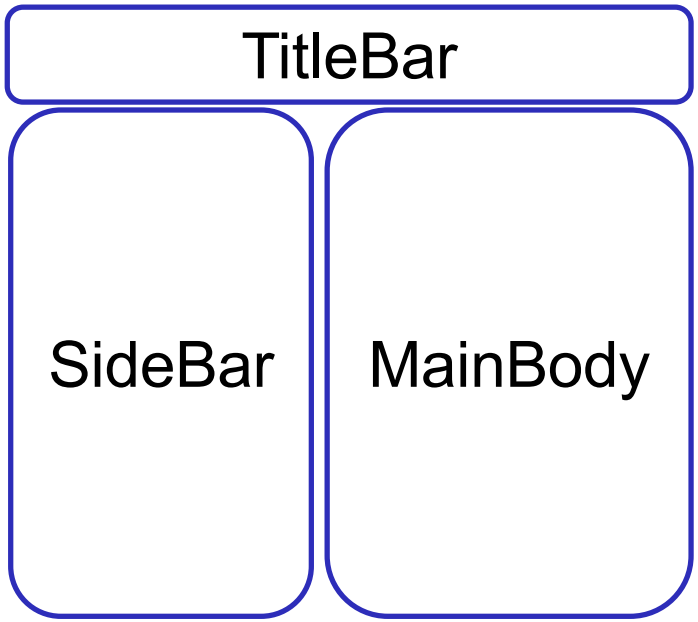
UI Modularity

- **Key idea**: break the *visible* UI into pieces that can become separate components



Component Tree

- App
  - Title Bar
  - Side Bar
  - Main Body
    - children…

UI Modularity

- **Key idea**: break the *visible* UI into pieces that can become separate components
  - each component should know how to turn itself into GUI components (panels, buttons, etc.)

- **Problem**: How do all the pieces get put together?
  - the GUI must be **one tree**, not many

REACT

React

- Improve modularity by allowing custom tags

```
let app = (
    <div>
      <TitleBar name="My App"/>
      <EditPane rows="80" />
    </div>);
```

- `TitleBar` and `EditPane` can be separate modules
  - their HTML gets substituted in these positions

React

- Custom tags implemented using classes

```
class TitleBar extends React.Component {
```

- Attributes (`name="My App"`) passed in `props` arg
- Method `render` produces the HTML for component
- Framework joins all the HTML into one blob
  - can update in a single call to `innerHTML = …`

React Example

register-react/…

React Components

- Each React component renders into HTML elements

```
let app = (
    <div>
      <TitleBar name="My App"/>
      <EditPane rows="80" />
    </div>);
```

- React components corresponds to *portions* of the document
  - `TitleBar` is one subtree
  - `EditPane` is another subtree
  - `App` contains the two of those