

special attention



Exam Preparation

Web Engineering

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The Web

Publishing in an open way,
Sharing in a standard way,
Linking in an flexible way.
Collaboration, data submission
User Interfaces, applications

SGML Derivatives

Standard Generalised
Markup Language

HTML - XML - DocBook - RDF

HyperText Markup Language



HTML

<!DOCTYPE html>

Elements: <tag> *content* </tag>

Attributes: <tag name=value>

Entities: ö

Readers



People with Browsers

Screen Readers, OS Integration

Search Engines

Web crawlers, scrapers

Key Elements



HTML, HEAD, BODY
META, TITLE, LINK, BASE
H1, H2, H3, H4, H5, H6
P, A, DIV, SPAN, STYLE
SCRIPT

Media

FIGURE, FIGCAPTION
PICTURE, IMG, AUDIO, VIDEO
OBJECT, EMBED
CANVAS, MATH, SVG

Frames

IFRAME

FRAMESET, FRAME
no longer supported in HTML5

Presentational



EM, I, STRONG, B
INS, DEL, PRE,
SMALL, SUB, SUP
BR, HR

Collections

LI

OL, UL

DL, DT, DD

TABLE, COLGROUP, COL,
CAPTION, THEAD, TFOOT,
TBODY, TR, TH, TD



SEMANTIC

NAV, MENU, HEADER,
HGROUP, FOOTER, MAIN,
ASIDE, TIME, SECTION,
ARTICLE, ADDRESS, DFN,
ABBR, DETAIL, LEGEND,
PROGRESS, OUTPUT, SAMP

FORMS

FORM
INPUT, TEXTAREA, BUTTON,
SELECT, OPTION, OPTGROUP,
DATALIST
FIELDSET, LABEL, KEYGEN

Input types

button, checkbox, color, date,
datetime-local, mail, file, hidden,
image, month, number,
password, radio, range, reset,
search, submit, tel, text, time,
url, week

Some more...

CITE, BLOCKQUOTE, Q,
AREA, BDO, CODE, RUBY, VAR,
WBR, COMMAND, NOSCRIPT,
TEXT, ...



Elements

Block elements: P, DIV, ...

Inline elements: A, SPAN, ...

Inline elements are not allowed
to have block elements inside.

Elements

Some elements are self-closing:

 (not allowed)

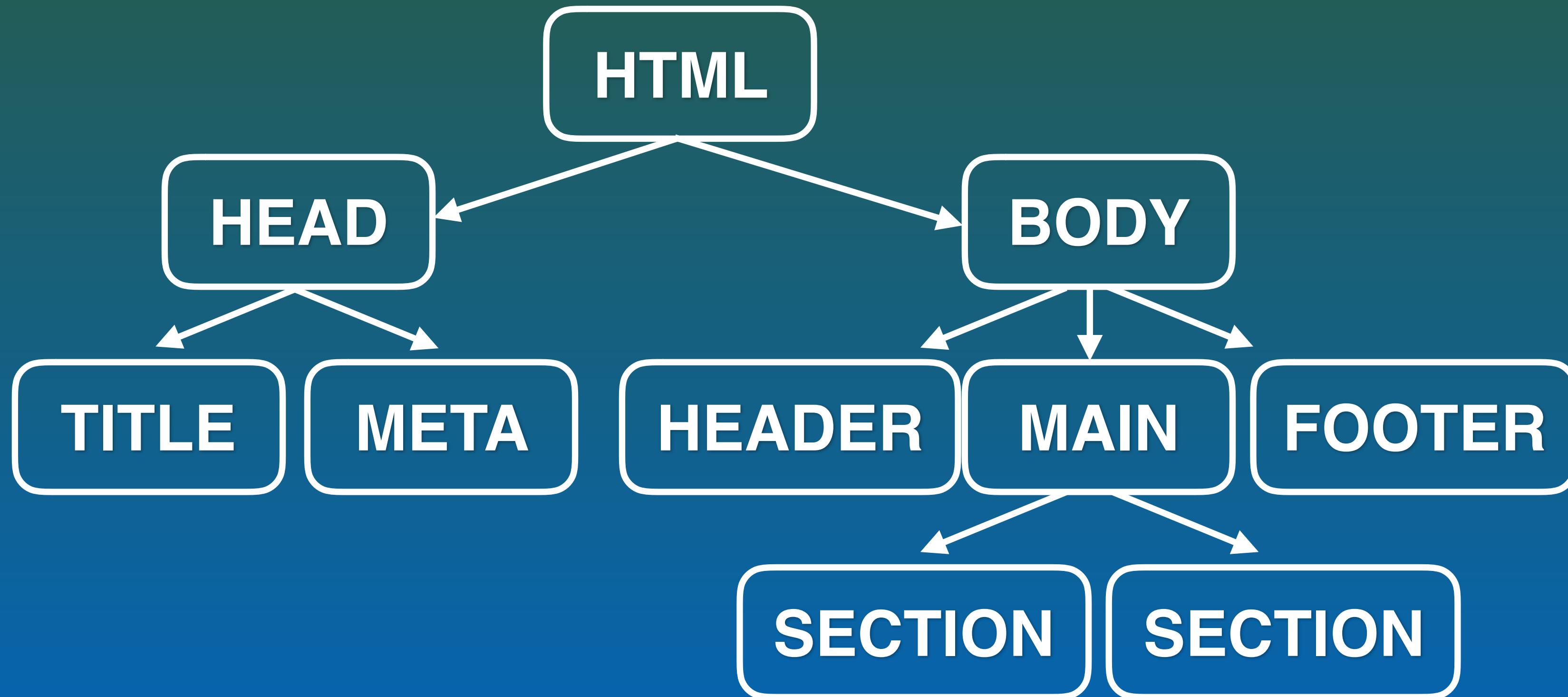
 (ok)

 (ok)



DOM

Document Object Model



Well-formed vs Valid

Well-formed:

tags syntactically correct

Valid:

tags nested according to DTD
(document type definition)

Which is Which?



<html><body></html></body>

<html><body ></body></html>

<div></div>

<p>x</p>

<p>x</p>

HTML is forgiving

Unknown tags are ignored

Unknown attributes are ignored

... and browsers display almost anything.



Meta

<meta charset=...>

<meta http-equiv=... content=...>

http-equiv: refresh, ...>

<meta name=... content=...>

name: author, description,
keywords, viewport

Global Attributes



id, class, title, lang,
accesskey, tabindex,
contextmenu, spellcheck,
draggable, dropzone, ...



Event Attributes

onClick,

onMouseOver,

onChange, onInput, ...

Attributes

are *sometimes* inherited
from parent to children
through the DOM

Attributes

User data

data-*

Microformats

itemscope, itemtype, itemprop



CSS



CSS Rule

selector

```
h1 { color: blue; }
```

value

property



CSS Selectors

h1

<h1></h1>

element

#top

<.. id="top">

id

.cool

<.. class="cool">

class

*

all

*can be a list like
"cool drink"*



Special Selectors

[title]

<.. title="..">

attribute

[title="x"]

<.. title="x">

attribute/value

$\wedge =$ $\$ =$ $* =$ $\sim =$

p:hover

<p ...>



pseudo-class



Special Selectors

h1+

next sibling

h1~

all siblings

P.S. there is much more that we don't cover
:not, :nth-child, :nth-child-of-type pseudo-class-functions
::first-letter pseudo-elements



Selector Combinations

h1, h2

union

main p

descendant

ul > li

direct child



Selector Combinations

div.cool

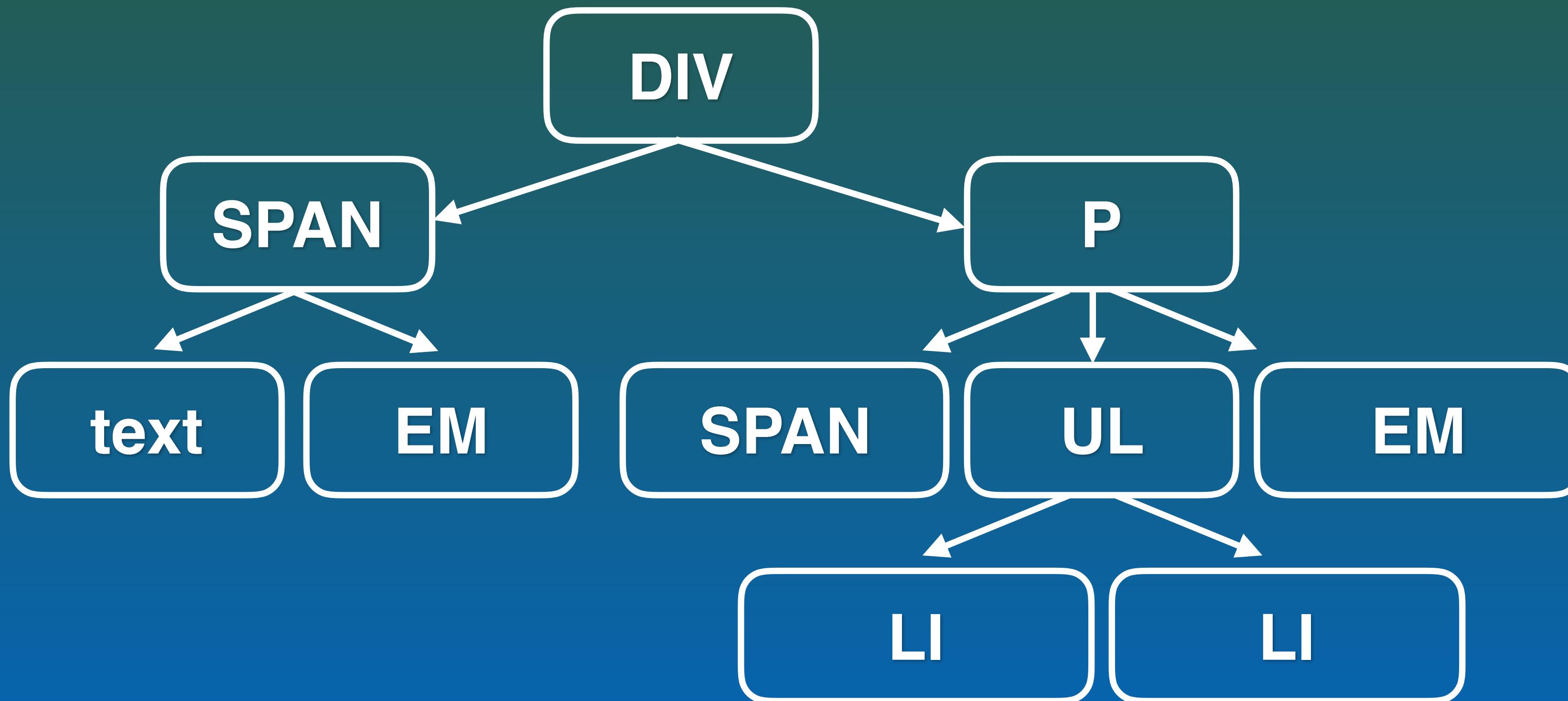
element with class

div[cool]

element with
attribute

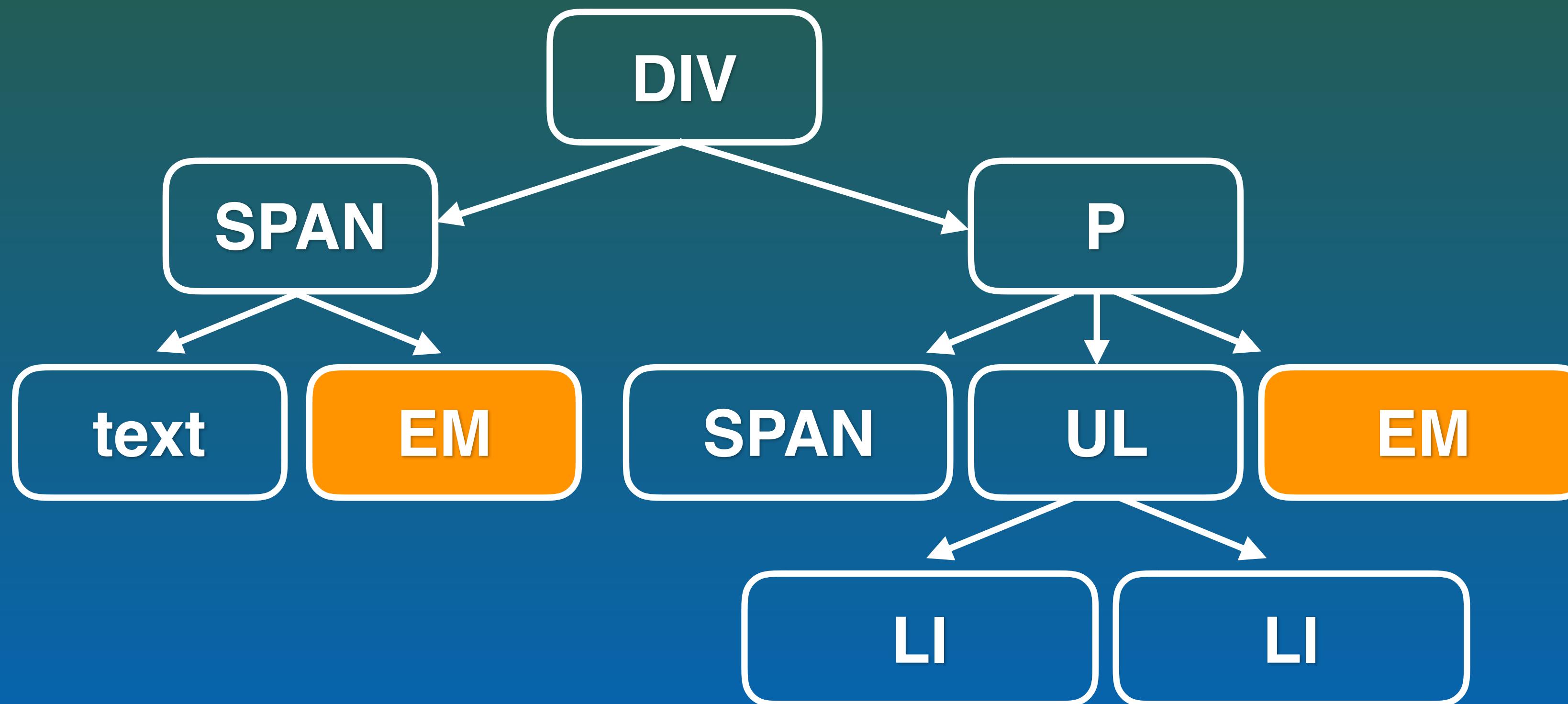


What selects: div em



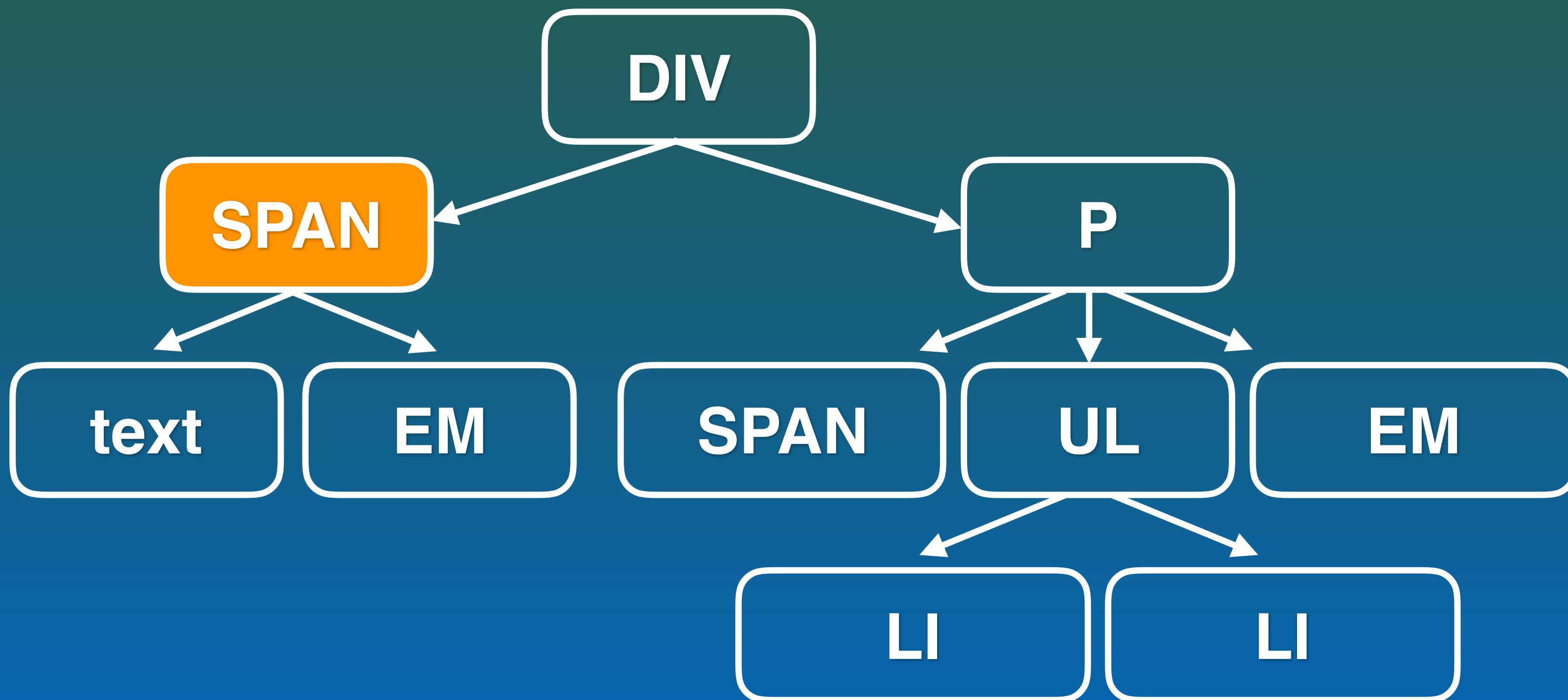


What selects: div em



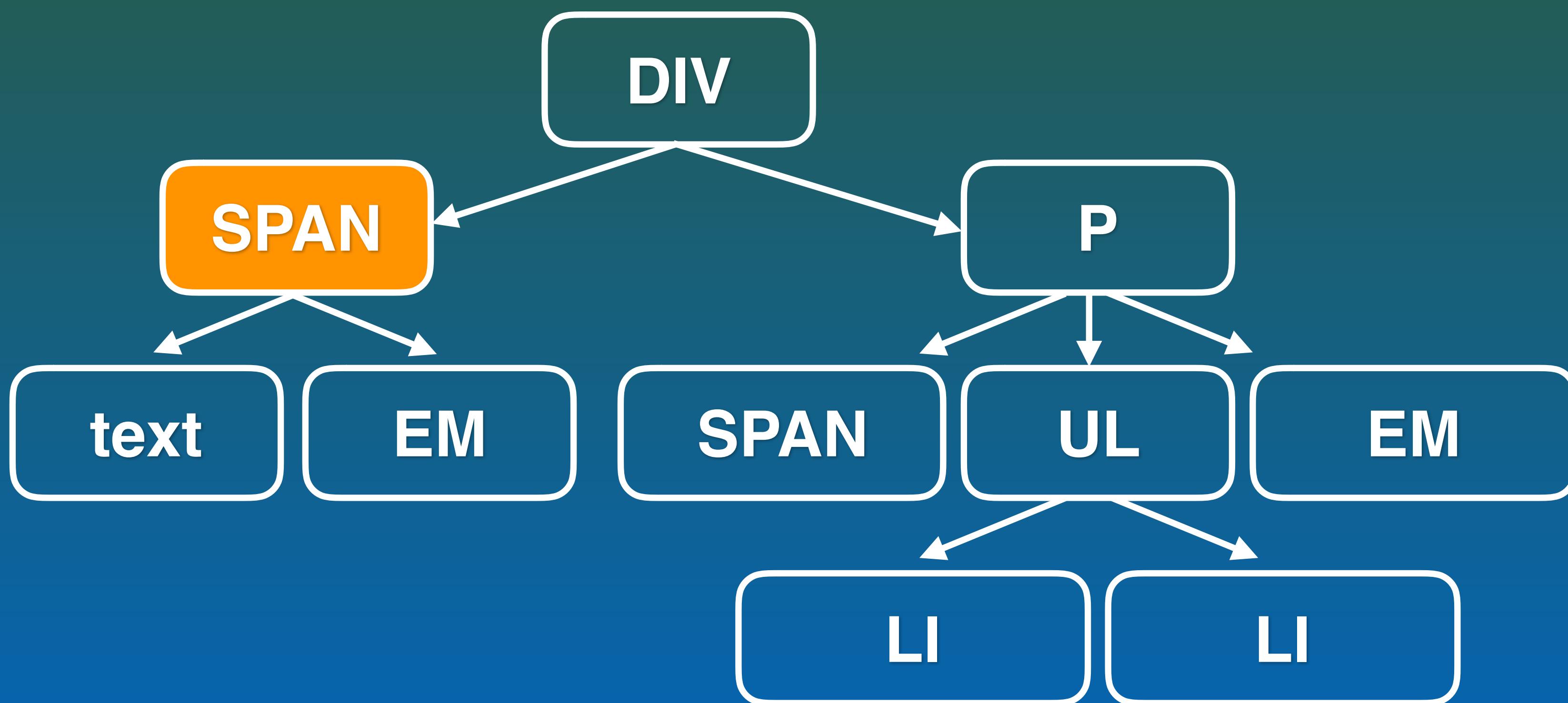


What selects: _____





What selects: div > span



CSS Inline

HTML

```
..  
<p style="color:blue;">  
..  
</p>  
..
```

Style Element

HTML

<head>

<style>

p { color:blue; }

</style>

</head>

Link Element

HTML

<head>

<link

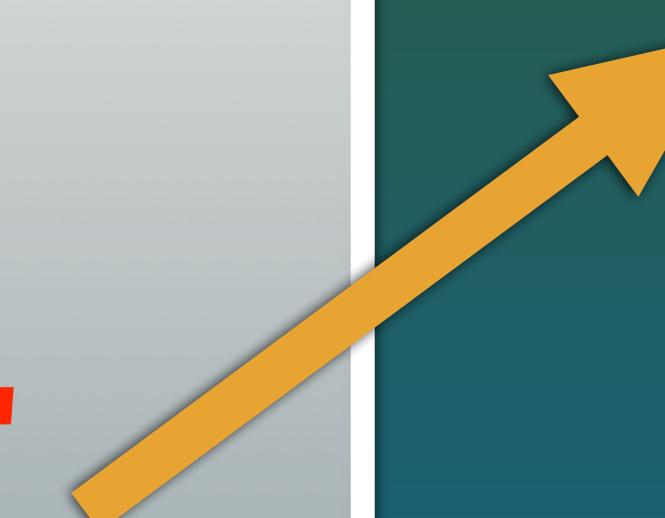
rel = "stylesheet"

href = "style.css">

</head>

style.css

p { color:blue; }



CSS Import

HTML

```
<head>
<link
  rel = "stylesheet"
  href = "style.css">
</head>
```

style.css

```
@import
"common.css"
```

common.css

```
p { color:blue; }
```



Cascade Rules of Thumb



DOM inheritance *for some properties*

Sheet importance *user > author > browser*

Specificity *id > class > element*

Count



Conflict Resolution



Source order

*latest wins,
unless important*

```
p { color: blue; }  
p { color: red; }
```

```
p { color: blue !important; }  
p { color: red; }
```



Cascade Rules of Thumb

Source order *latest wins*

Note:

`p { color: blue !important; }` overrides all the above!

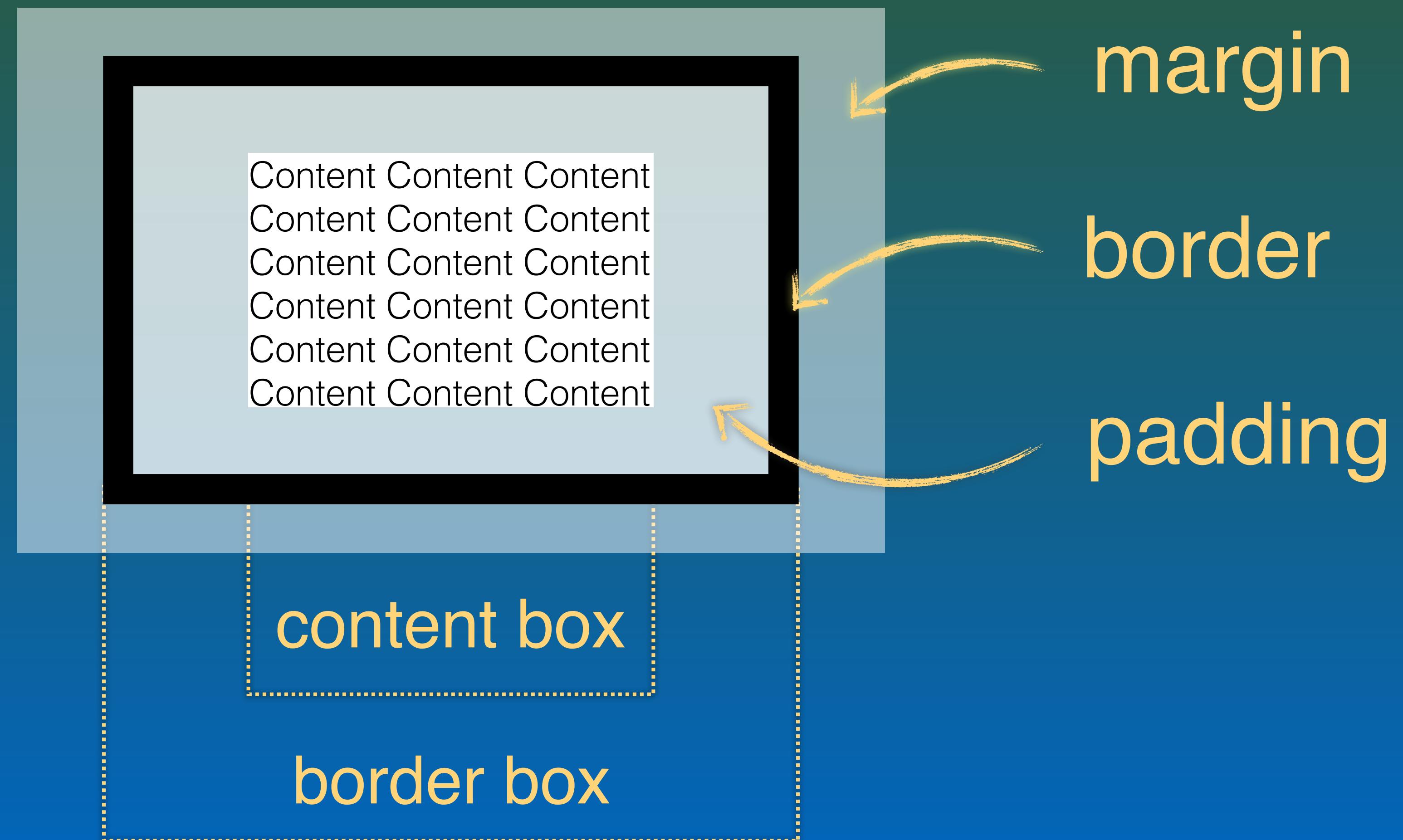
Properties

There are too many properties
and possible values to list here.

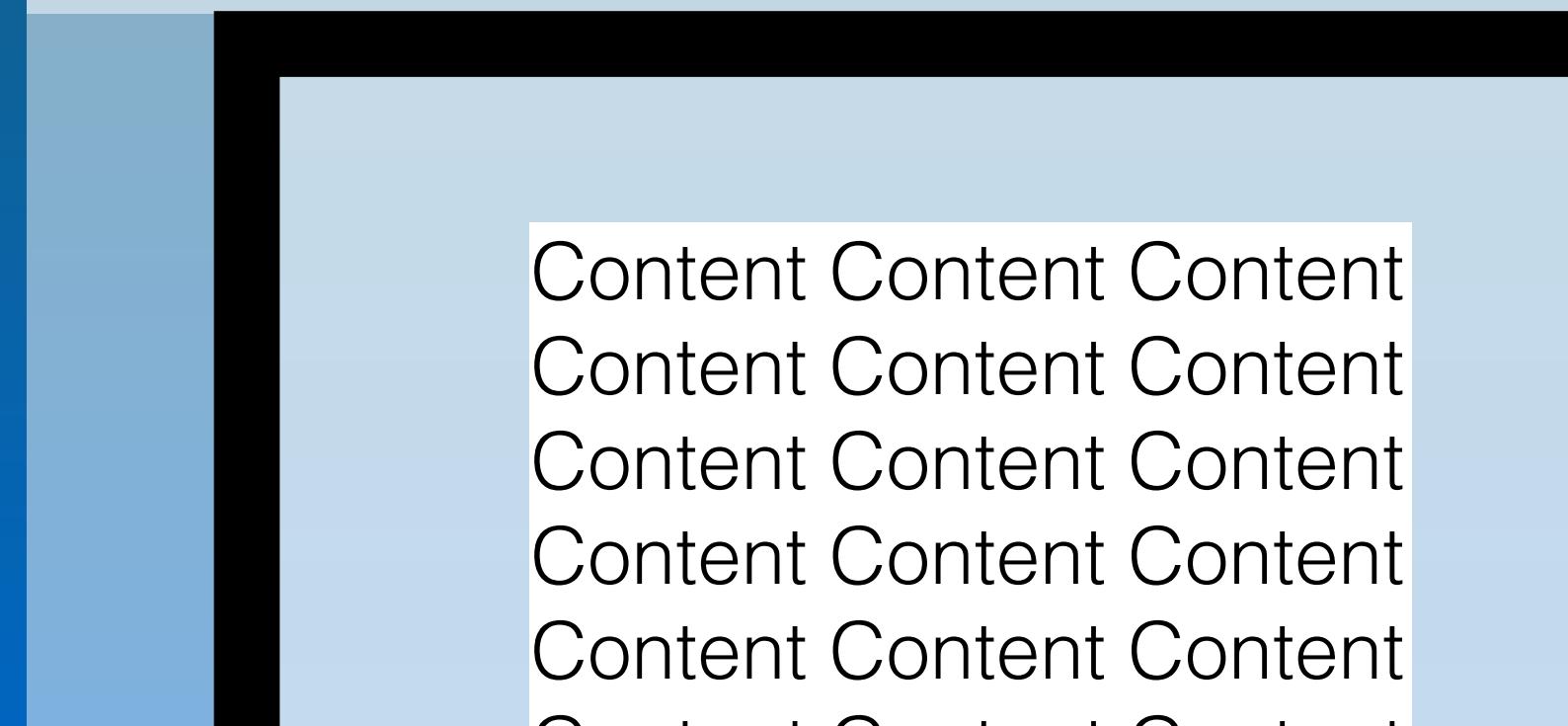
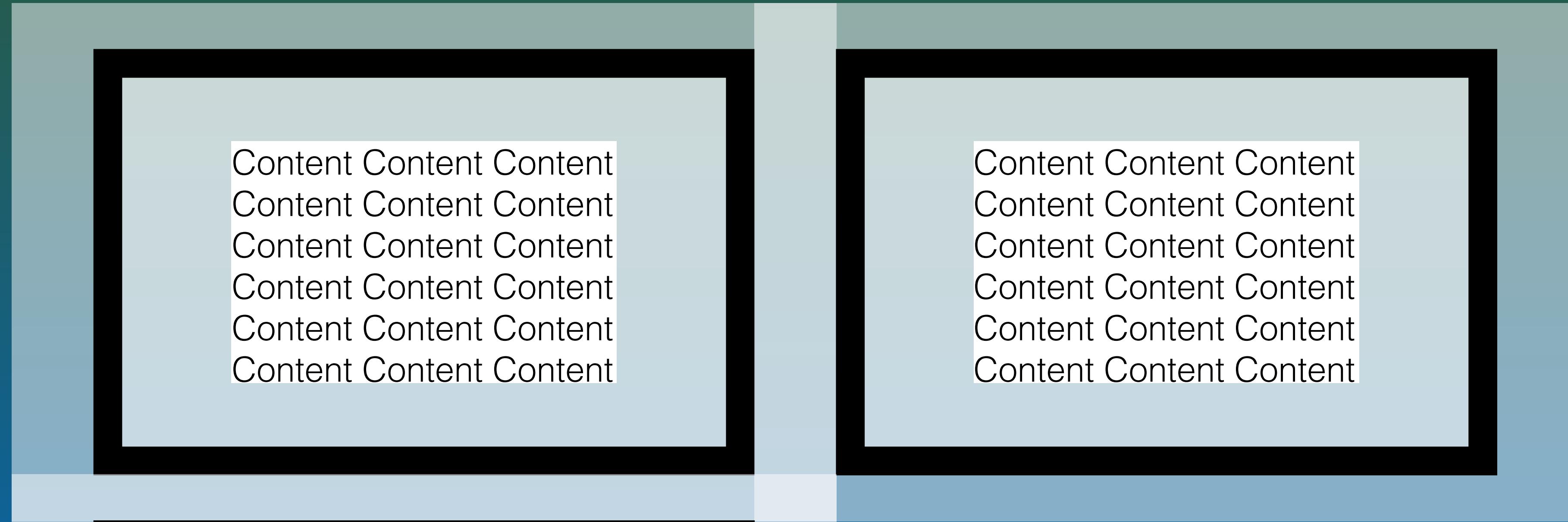
We can only cover how it works
in principle.



Box Model



Margins collapse





Units

px

pixel

cm, mm, in, pt

absolute length

em, rem

size of "M"

%

relative to parent size

Functions

calc(100% / 12)	<i>formula</i>
attr(<i>name</i>)	<i>attribute value</i>
url("backg.jpg")	<i>external reference</i>

Further Topics: layout



display

inline, block, none, ...

position

static, relative,

absolute, fixed

float, clear

left, right

Further Topics: color

red, blue, ...

color names

#FF0000

hex values

rgba(255,0,0,0.5)

opacity (alpha)

linear-gradient()

direction, color stops

radial-gradient()

shape, color, position

MVC

Testing

Is a core tenet of engineering.

Provides a validatable specification
as opposed to "just give it a try".



grails test-app

Functional integration tests to validate the behaviour as seen by the user.

Unit tests to validate controllers, models, and services in isolation.

Geb and Spock

Geb: user interactions with the
HTML page

Spock: structure test cases in
given - when - then - expect
and allow data-driven tests



Geb selector \$()

`$("div.cool")`

<div class="cool">

`$("a", href:"x")`

**

`$("a", text:"x")`

<a>x

`$("form").en`

<input name="en">

Web View-Controller



```
class MyController  
def myAction(en, exam)
```

Grade Calculator

Slocalhost:8080/static/GradeCalculator.html

continuous assessment grade

final exam

Daten absenden

Average

Slocalhost:8080/calculator/calc

Your average is 4.5.

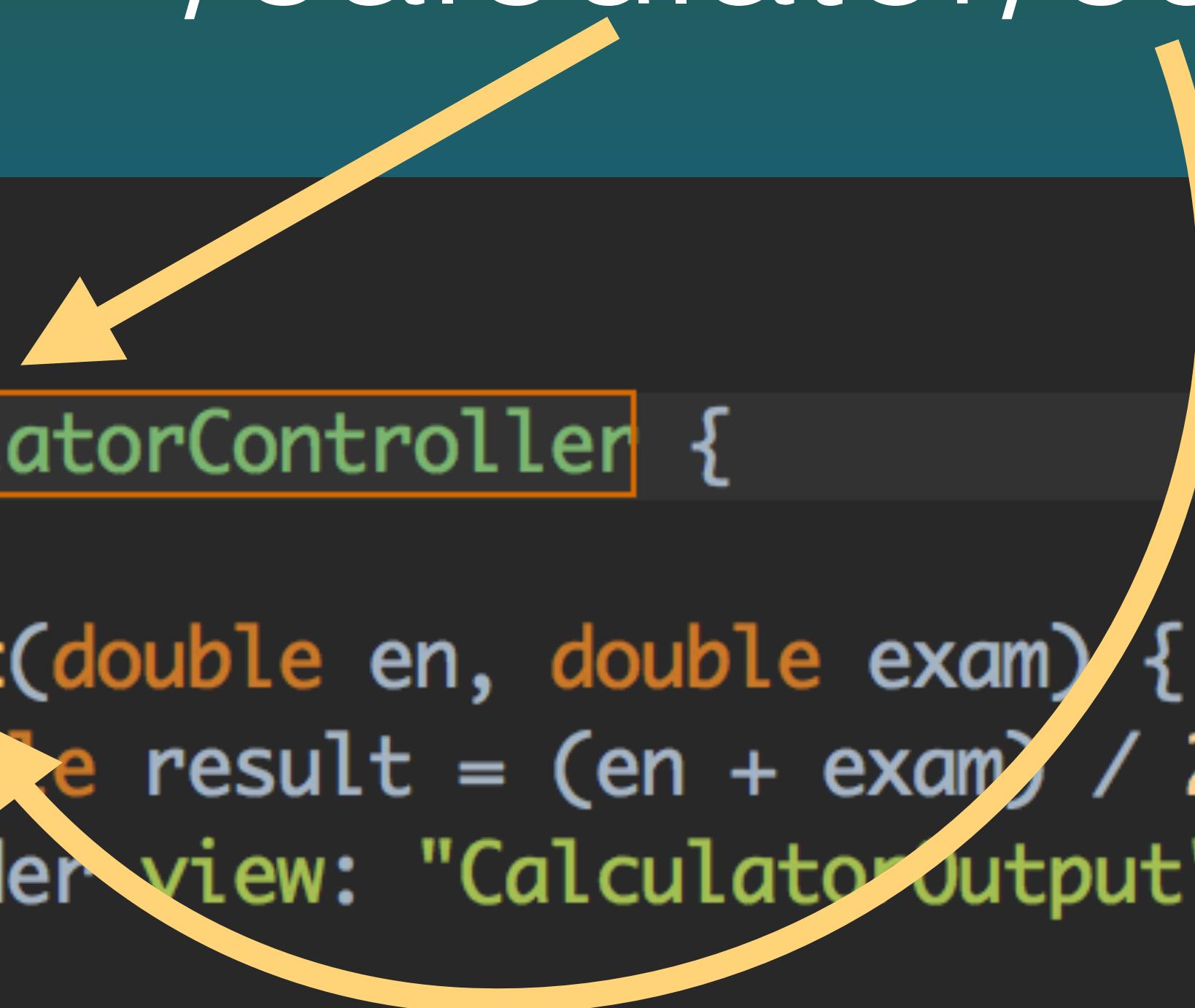
Back to the [calculator](#).

Dispatch

/calculator/calc

```
package mvc

class CalculatorController {
    def calc(double en, double exam) {
        double result = (en + exam) / 2
        render view: "CalculatorOutput", model: [result: result]
    }
}
```



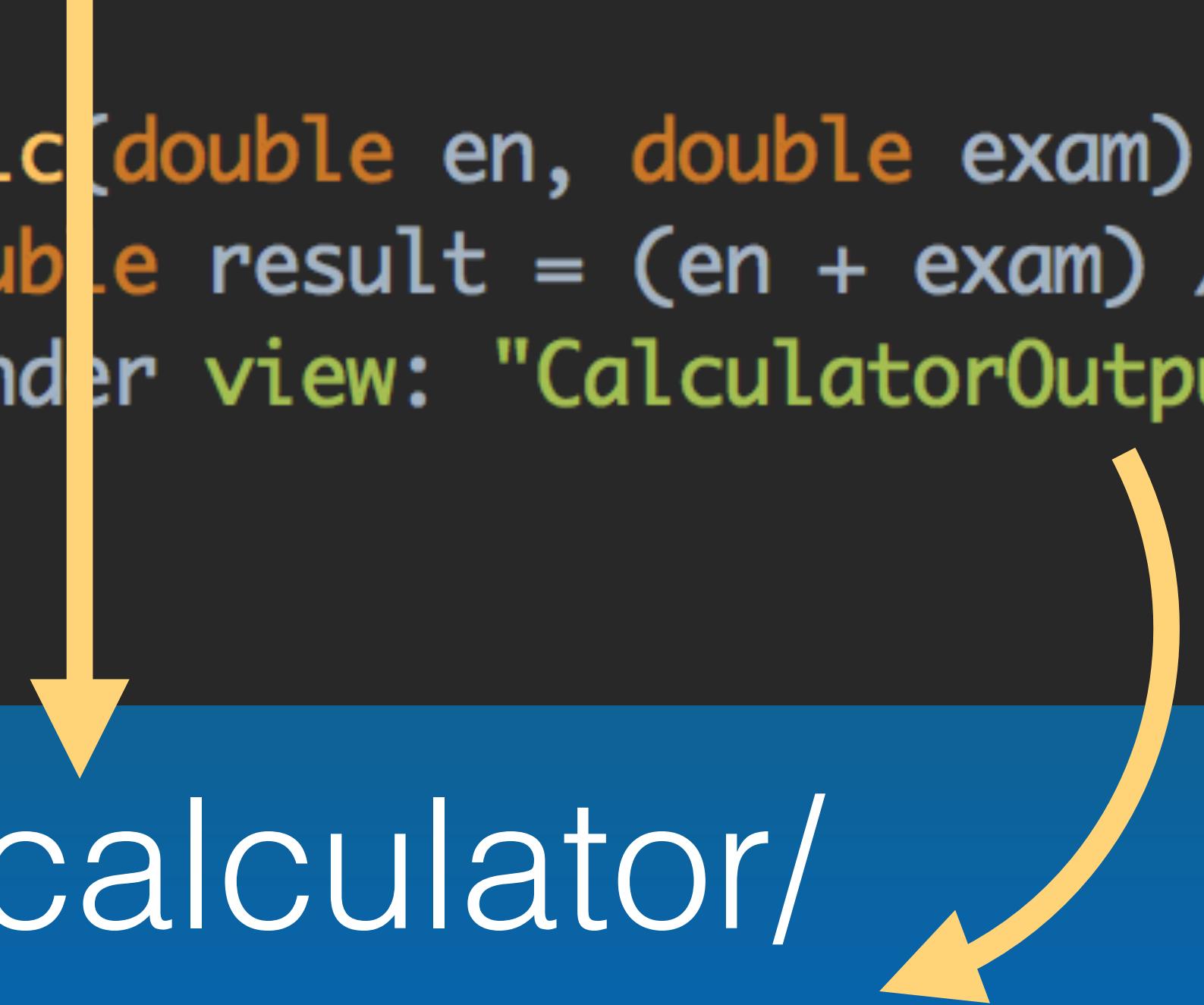
The diagram illustrates the mapping of a URL to a controller method. A yellow arrow points from the URL '/calculator/calc' at the top to the 'calc' method within the 'CalculatorController' class definition below. The 'CalculatorController' class is highlighted with a yellow border, and the 'calc' method is also highlighted with a yellow border.

View Selection

```
package mvc

class CalculatorController {
    def calc(double en, double exam) {
        double result = (en + exam) / 2
        render view: "CalculatorOutput", model: [result: result]
    }
}
```

views/calculator/
CalculatorOutput.gsp



A vertical yellow arrow points downwards from the word 'view' in the controller code to the file name 'CalculatorOutput.gsp' in the path below. A curved yellow arrow originates from the same point on the word 'view' and points to the 'CalculatorOutput' part of the file name.



View Binding

```
package mvc

class CalculatorController {
    def calc(double en, double exam) {
        double result = (en + exam) / 2
        render view: "CalculatorOutput", model: [result: result]
    }
}
```

views/calculator/
CalculatorOutput.gsp





GSP View

use of view binding

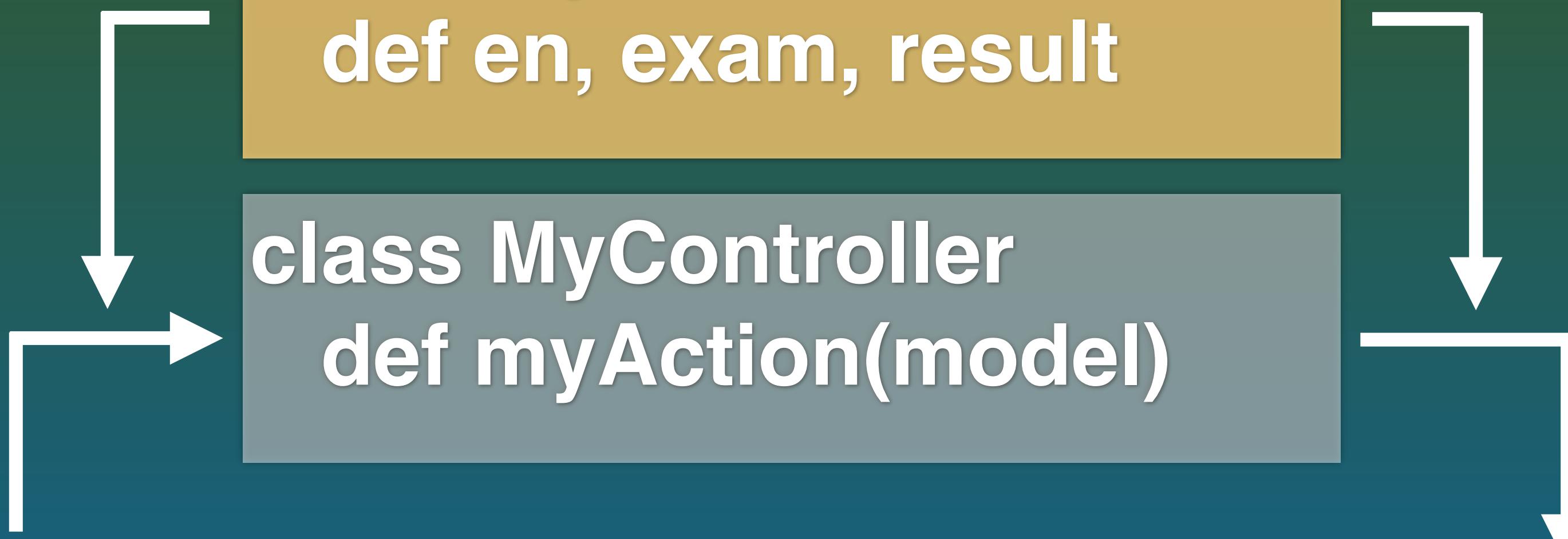
```
<p> Your average is <output>${ result }</output>.</p>
```

```
<p> Back to the <a href="/static/GradeCalculator.html">calculator</a>.</p>
```

Web MVC



data binding
dispatch



view binding
view selection

A screenshot of a web browser window titled "Grade Calculator". The address bar shows "localhost:8080/static/GradeCalculator.html". The page contains two input fields: "continuous assessment grade" and "final exam", both with dropdown arrows. Below the inputs is a button labeled "Daten absenden".

A screenshot of a web browser window titled "Average". The address bar shows "localhost:8080/calculator/calc". The page displays the text "Your average is 4.5." and a link "Back to the calculator".



Validation

In the view (trust: never!)

In the controller (imperative)

In the data binding (declarative)

Place of declaration: model constraints

Server Pages



Technology Overview

Grails



Web app platform

Groovy



"PHP" for Java

Geb & Spock

Test support

Gradle

Build system

Spring Boot

Enterprise Web



The story so far

Static Pages - HTML, CSS

MVC - Model, View, Controller

Static Page

Server Page



Engineering Aspects



Well-formed & valid HTML, CSS

Avoid duplication (in CSS)

Testing pages and navigation

Validating Models (imp., decl.)

MVC separation of concerns

Request - Response



server

controller

```
class MyController  
    def myAction(en, exam)
```

request

client

view

response

Grade Calculator

S ⓘ | localhost:8080/static/GradeCalculator.html | C

continuous assessment grade

final exam

Daten absenden

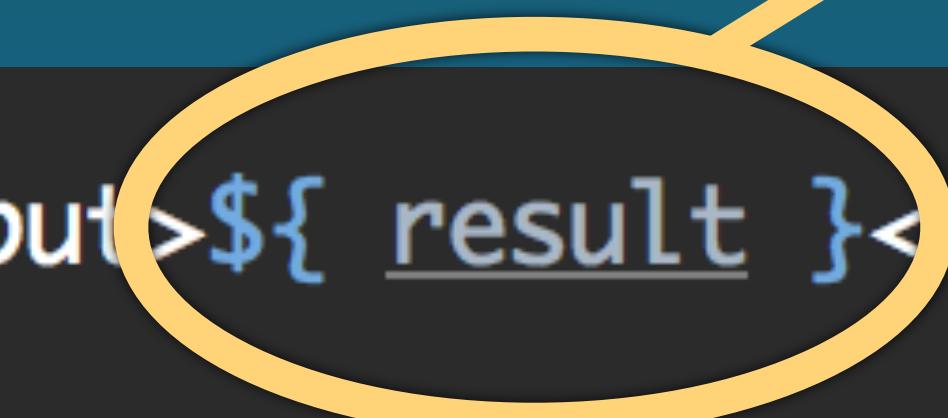
Server Page 1: GSP



use of view binding

```
<p> Your average is <output>$\{ result \}</output>.</p>
```

```
<p> Back to the <a href="/static/GradeCalculator.html">calculator</a>.</p>
```



Server Page 2: Template

gsp

```
<tmpl:form_row name="en"    label="En"    calculatorInstance="${calculatorInstance}" />
```

_form_row.gsp

```
<label for='${name}'>${label}</label>
<input type="number decimal" name="${name}" value="${calculatorInstance.getProperty(name)}"
       required="true" min="1.0" max="6.0" id="${name}"
```



Templates

static/structural

Parts of a page - as a page



Avoid in-page duplication

Sep. of concerns - abstraction

Compositional

Server Page 3: Taglib

gsp

```
<mvc:decorate grade="\${calculatorInstance.result}">
    <output>\${calculatorInstance.result}</output>
</mvc:decorate>
```

DecorationTagLib

```
def decorate = { attributes, body ->
    String grade = attributes.grade
    // ...
    out << body()
```

TagLibs

dynamic content

Parts of content - as a method

Can enclose a body

Can be used inside tags

All Grails tags are so defined

Templates & Taglibs

either can be used

as tag

as method



Server Page 4: Layout

gsp

```
<head>
    <meta name="layout" content="form"/>
```

layout/form.gsp

```
<h1><g:layoutTitle default="Form"/></h1>

<g:layoutBody/>
```



Layouts

Imposed embedding - as a page

Inverse composition (sitemesh)

Avoid duplication

Improve consistency

Allow multi-tenant apps



Page structure: four ways

GSP

Server page with values

Template

Local composition

TagLib

Global composition

Layout

Inverse composition

JS

JavaScript

Technology Overview



HTML

Validator

CSS

Web MVC

Unit Testing

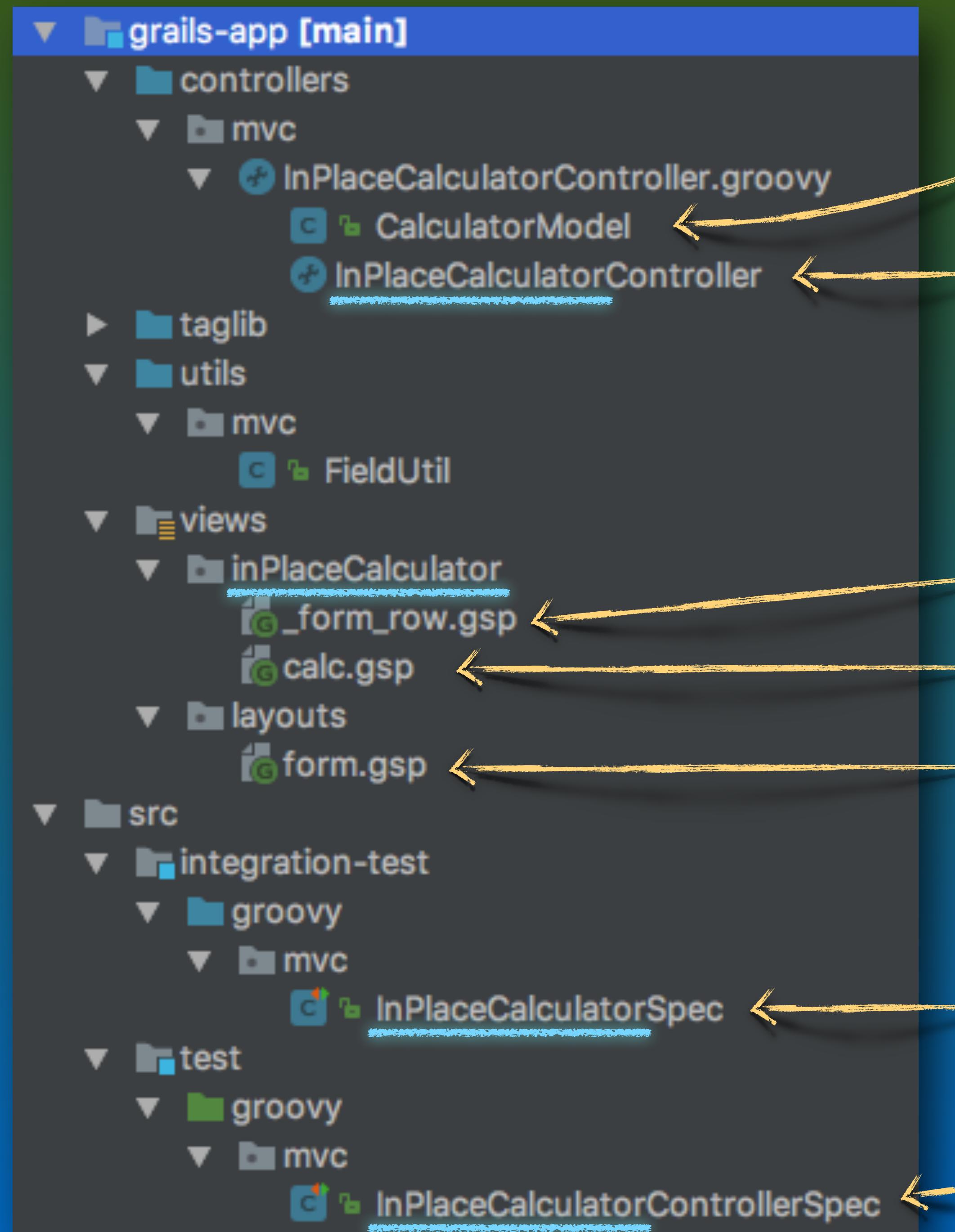
Server Pages

UI Testing

Javascript

UI Testing

Overall Structure





The story so far

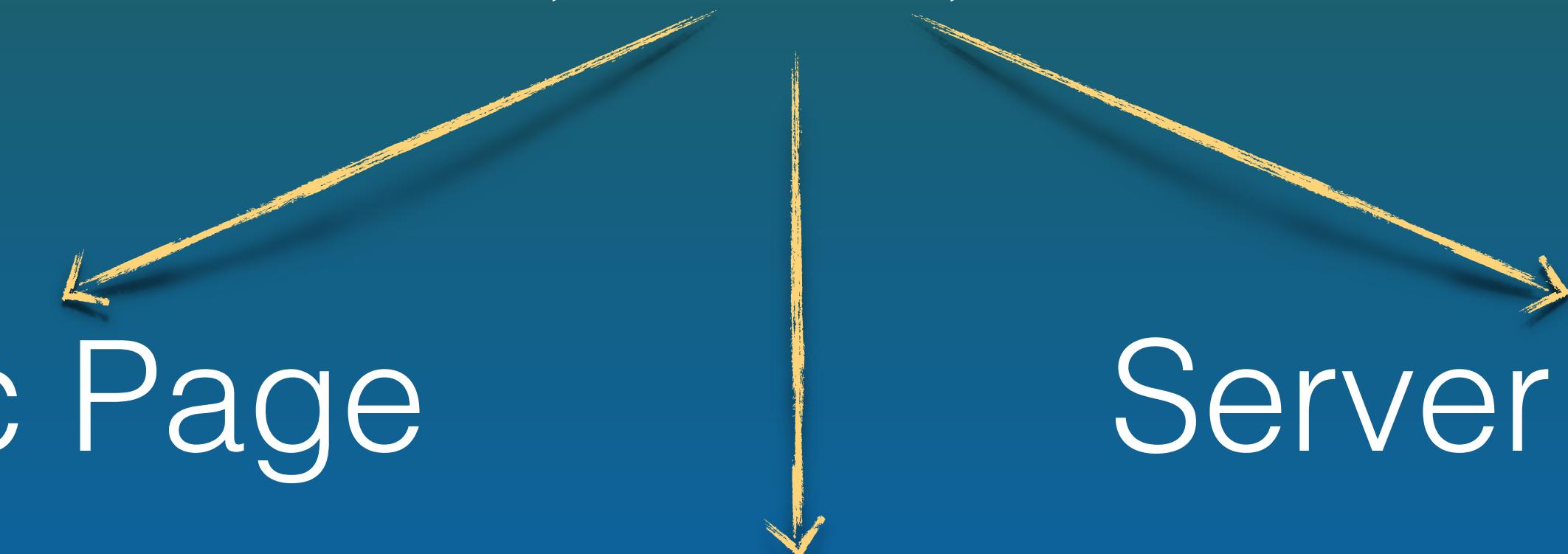
Static Pages - HTML, CSS

MVC - Model, View, Controller

Static Page

Server Page

Dynamic Page



Request - Response



code as
methods

strings

```
class MyController  
  def myAction(model)
```

A screenshot of a web browser window titled "localhost:8080/tempConverter". The page has a header "Temperature Converter". Below it is a form with two input fields: "Celsius" with value "0.0" and "Fahrenheit" with value "0.0". To the right of these fields are their respective converted values: "32.0" and "-17.8". A "Convert" button is at the bottom of the form.

Celsius	Fahrenheit	Converted Celsius	Converted Fahrenheit
0.0	0.0	32.0	-17.8

Direct Manipulation



Temperature Converter with JavaScript

A screenshot of a web-based temperature converter. The interface includes two input fields: 'Celsius' with the value '32' and 'Fahrenheit' with the value '89.6'. To the right of each input field is a corresponding output field, which is currently empty. A large, hand-drawn style yellow circle highlights the entire row of input and output fields. Two yellow arrows point from the text 'code as strings == scripting' below to the 'Celsius' input field and the 'Fahrenheit' input field respectively.

Celsius	32	
Fahrenheit	89.6	

code as strings == scripting

JavaScript



JS

Code as string

HTML attribute value

Text content of <script> element

External .js file



Event Attributes

onClick,

onMouseOver,

onChange,

onInput,

...



JS Document

`document.write(html);`

`document.getElementById(id);`

`document.querySelector(selector);`

...



JS Element

element.id

element.value = *newValue*;

element.innerHTML = *newContent*;

element.classList.add(*newStyle*);

...

JS Function Declaration



```
function times(x, y) {  
    return a * b;  
}
```

keyword → function

function name ↓

parameter names ↗

value returned ↑

The diagram illustrates the components of a JavaScript function declaration. It highlights the 'function' keyword in orange, the function name 'times' in white, the parameter names 'x' and 'y' in orange, the 'return' statement in orange, and the value being returned 'a * b' in white. Handwritten-style arrows and labels in orange point from each component to its corresponding part in the code. A large yellow star is positioned in the top right corner.

Engineering Aspects



Where to put JS code:

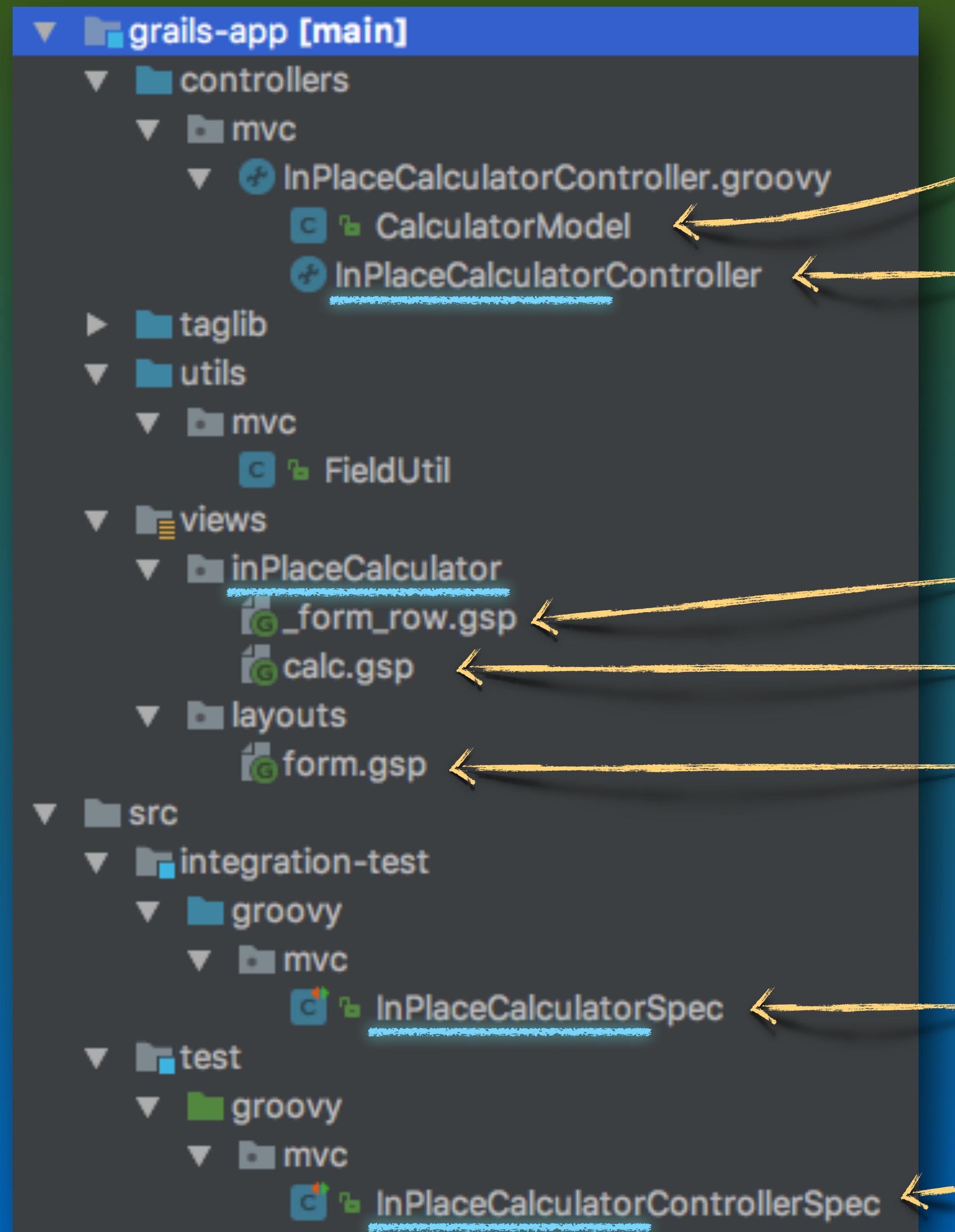
- in-line only for one-liners
- in-page for local functions
- .js files for cross-page sharing,
unit testing, linting, tool support, ...

JS Topics not covered

classes, objects, types, literal decl.
scoping, prototype inheritance
function expressions, self-invocation
hoisting, linting, unit testing, ...

Persistent State

Overall Structure

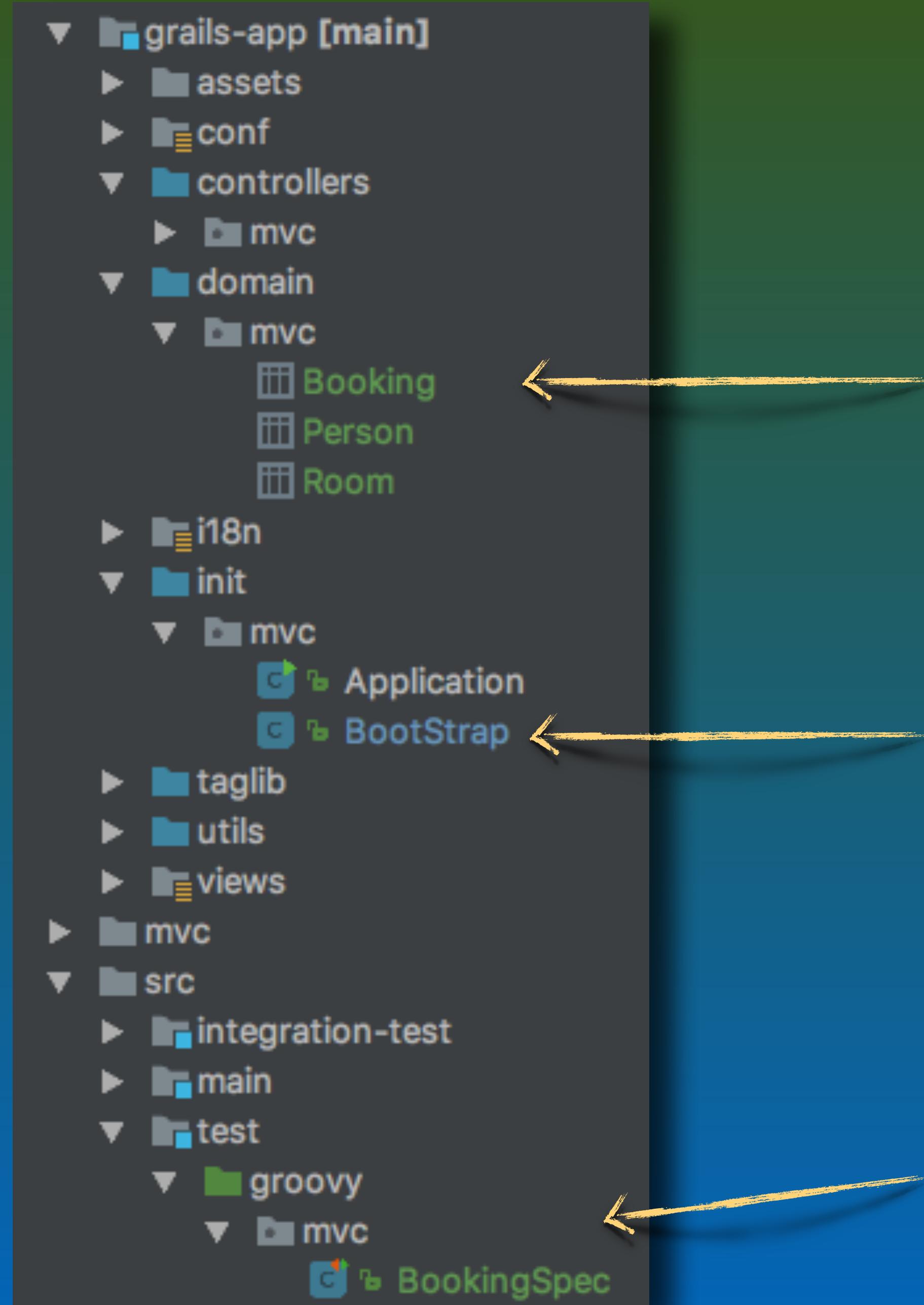


model
controller

template
server page
layout

UI test
unit test

Overall Structure



domain model

bootstrap

unit test

Domain Classes

```
package mvc

class Room {

    String description
    int    capacity

    String toString() { description + "(" + capacity + ")" }

    static constraints = {
    }
}
```

CRUD Methods



```
new Room(description: "5.3A17", capacity: 40).save()  
Room.list()  
Room.findAllByCapacityGreaterThan(20)  
def firstRoom = Room.get(1)  
firstRoom.delete()
```

Grails ORM

<http://docs.grails.org/latest/guide/GORM.html>

Domain classes serve as DAO/DTO/Model

DB is set up automatically

Dynamic finder methods simplify usage

Keep it simple

Scaffolding

`static scaffold = domainClassName`

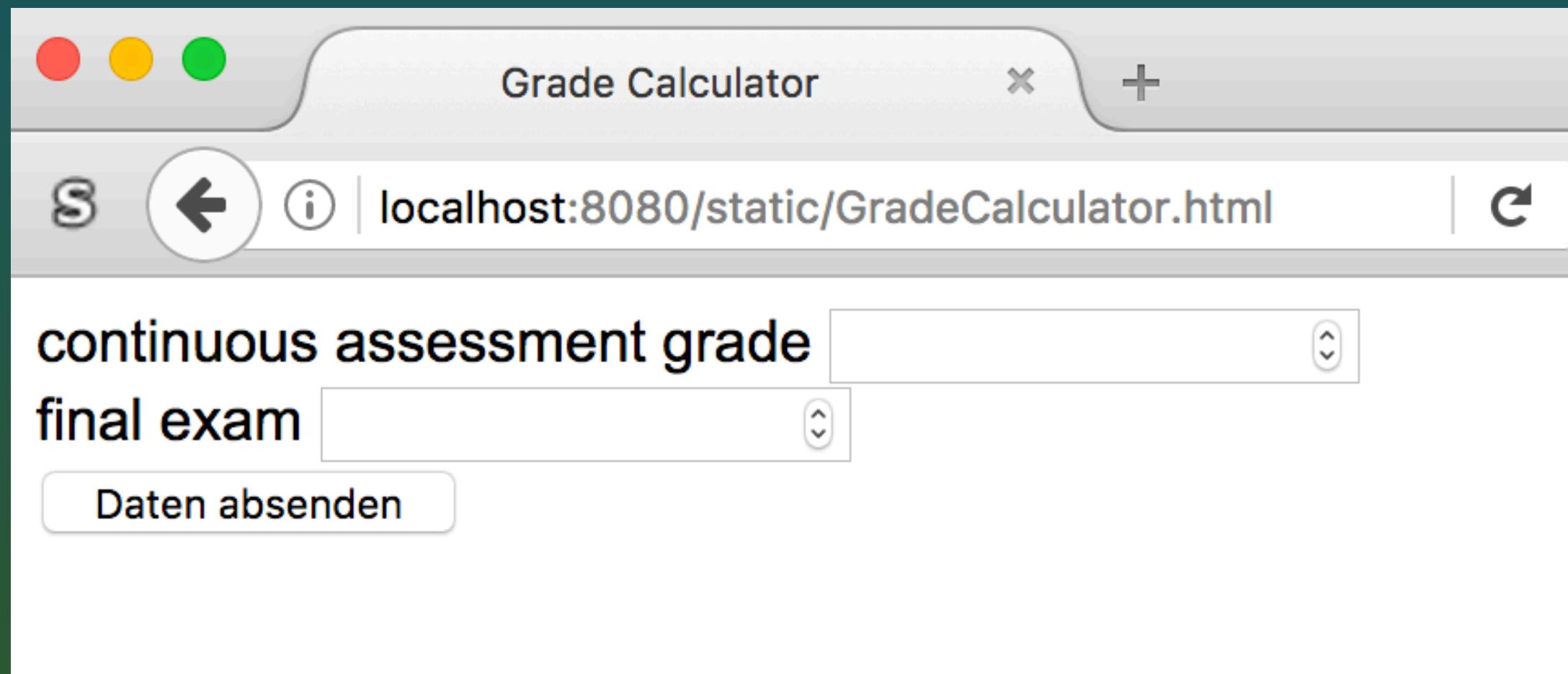
Controller actions and views are created transparently behind the scenes

We can selectively override

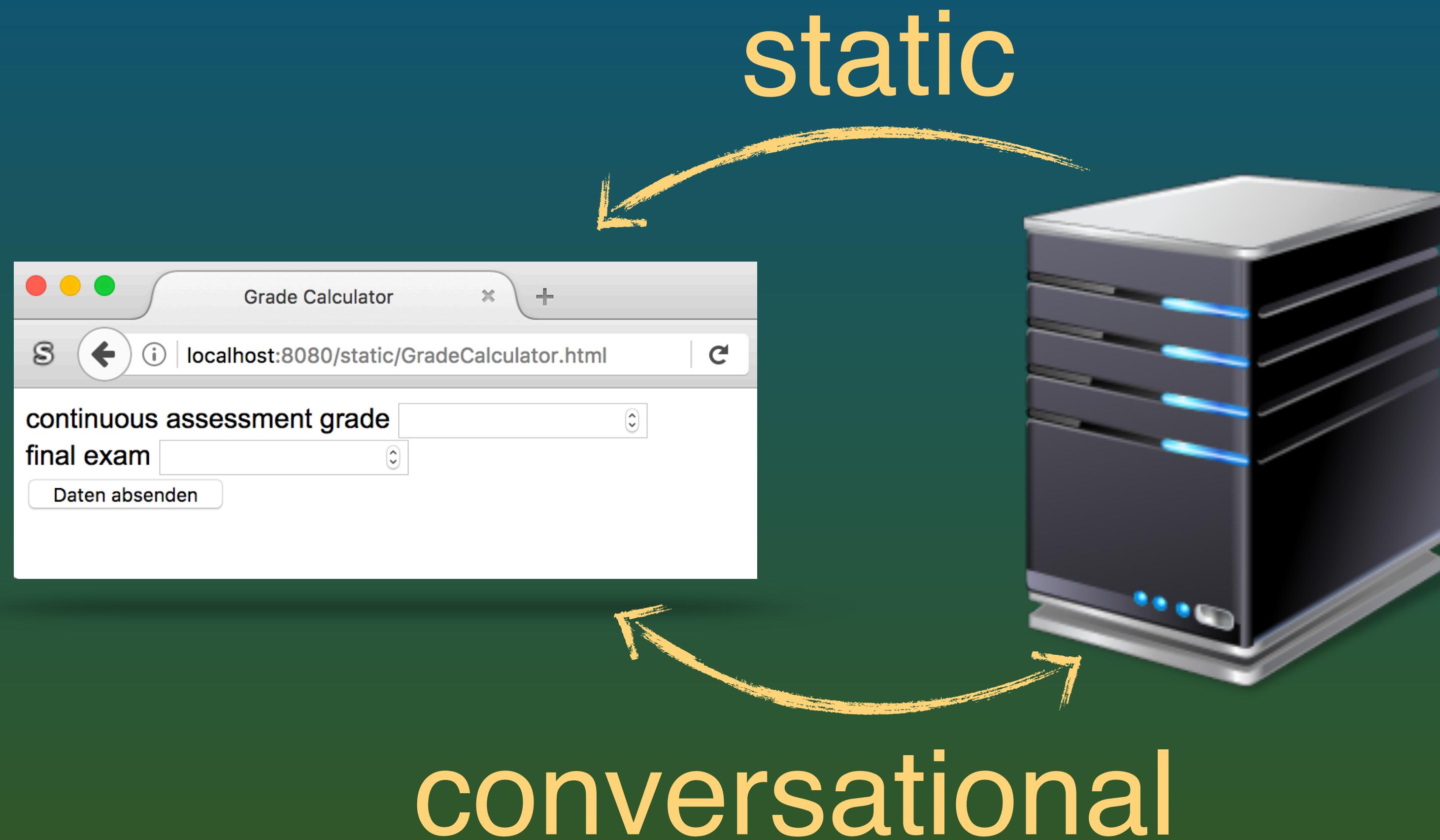
HTML, CSS, JavaScript

static

dynamic

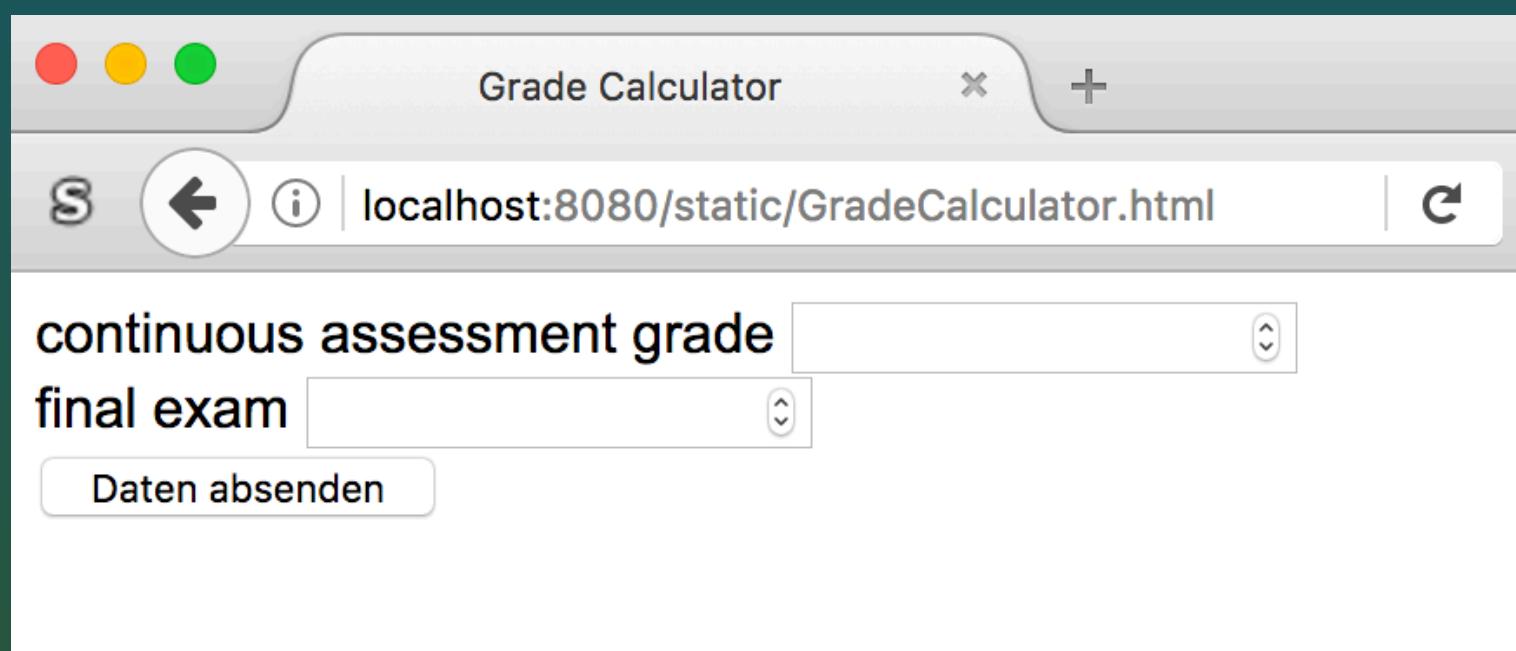


Web MVC, Server Pages



Three Tier Web Applications

Client



Server



persist

Where State Lives



HTML static

DOM, forms

HTML dynamic

JS, localstorage

Server static

Deployment

Conversation

Session

Persistent

Database

Services

Web Resilience

The Web has never gone down
since its inception
in 1989.



Web Resilience



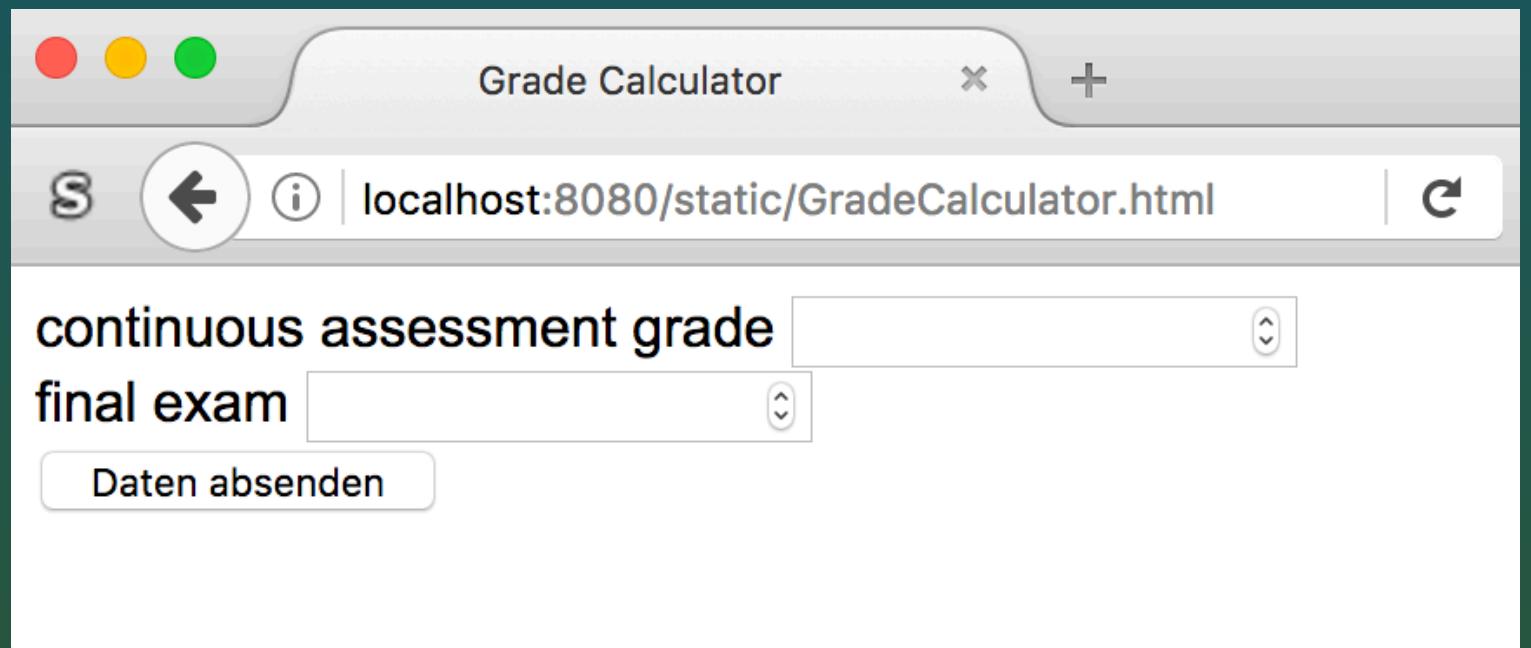
**Be restrictive
what you expose**

**Be tolerant
what you consume**

Three Tier Web Applications



Client



Server



DB



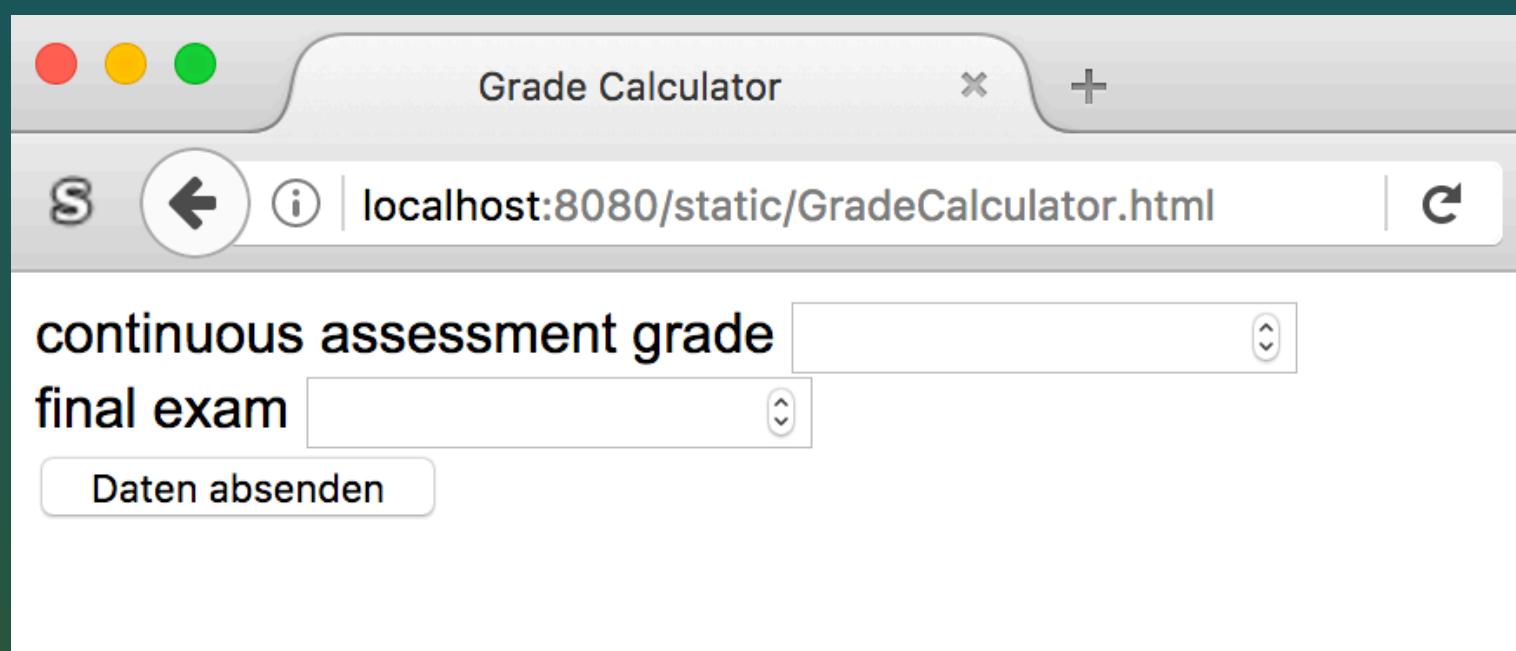
persist



Server with Service



Client



Server



req/resp

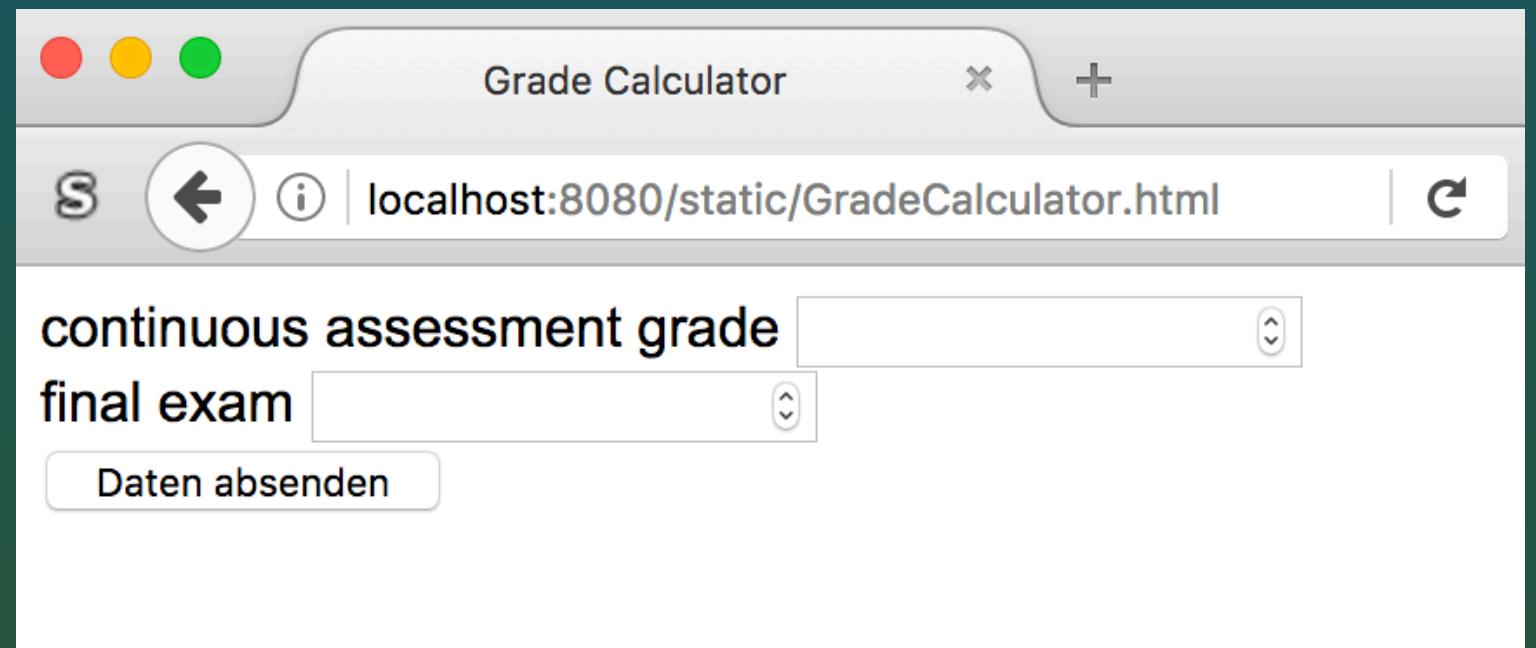
"Smart UI" with Service



Client

Server

Service



req/resp

URL



Uniform Resource Locator

protocol, host, port, path, query, fragment

scheme://[user:password@]host[:port]][/]path[?query][#fragment]

HTTP(s)

Hyper Text
Transfer Protocol

Very simple
Line/delimiter based

```
# First request
GET /quote?symb=YHOO HTTP/1.1
Host: www.example.org
```

```
HTTP/1.1 200 OK
Content-Type: text/plain; charset=UTF-8
```

15.96

```
# Second request 10 minutes later
GET /quote?symb=YHOO HTTP/1.1
Host: www.example.org
```

```
HTTP/1.1 200 OK
Content-Type: text/plain; charset=UTF-8
```

16.10



HTTP Verbs



Verb	Change	Use
GET	No	Single or collective read, may be cached
PUT	Yes	Modify resource in place
POST	Yes	Create new resource
DELETE	Yes	Delete resource
HEAD	No	
OPTIONS	No	

REST



Representational State Transfer

- Resource addressing by URL
- Uniform operations by HTTP verbs
- Self-containment (no conversational state)
- Choice of format (XML, JSON, ...)

REST Issues

Easy to get started - easy to get lost.

Type safety, Versioning, Documentation

Addressing Operations as Resources

REST Alternatives

SOAP (WSDL),

CORBA (IDL),

EJB, *-RPC, RMI,

local services

REST in Grails

<http://docs.grails.org/latest/guide/webServices.html>

Note the usage of `@Resource` in domain classes and "respond" instead of "render" in the controller actions.

Security

Why Do We Care?



Often, for good UX and plain functionality,
we need to **identify the user**.

But then...

With identification come further issues:
safe password management
user-creation denial of service attacks
lost passwords, revoking credentials, ...
use of external service (OAuth) ?

What can go wrong?

**Eine kurze Frage an T-Mobile
Österreich endete für den
Mobilfunkanbieter im Fiasko**

Der österreichische Mobilfunkprovider T-Mobile Austria steckt seit Tagen im Shitstorm. Heute gab das Unternehmen zu, Kundenpasswörter unverschlüsselt zu speichern. Ein Drama in zehn Akten.

Keep it simple

There is **much** to know about security.

We need a **simple** initial introduction.

Let's follow best practices and use
Spring Security

Access Control



Once I can identify the user, I often want to restrict access based on the user's characteristics (guest, regular, admin)

Some Concepts



Authentication: who am I ?

Authorisation: what am I allowed to do?

Principal, Role, Authority, Credentials,...

Strategies



Shield resource vs shield access path,

Allow all, shield selectively

Disallow all, open up selectively

Full Security

... is a topic that expands much more than what we can cover here.

Attend specialized modules.

We do a bare-bones introduction,
so let's start!

The Mobile Web

Responsive Design



Respond to varying screen sizes/resolutions

Prerequisite Knowledge:

HTML, CSS, JavaScript, Web-MVC

Testing the WebMile

The variety of devices, screen sizes, and resolutions makes any testing difficult.

Provider and products change quickly:
google, microsoft, saucelabs, mobiready, ...

Approaches



Flexible layout (CSS)

Media queries (CSS)

Dynamic in-page logic (HTML, JS)

Serve different views per capability (MVC)

Media Query (CSS)



```
#title { width: 50%; }
```

```
@media screen and (max-width: 800px) {
```

```
    #title { width: 100%; }
```

```
}
```

Media Query Attributes

max-width, max-device-width,
min-width, min-device-width, (*height*)
orientation (portrait, landscape),
[min-,max-,device-]aspect-ratio,
color, resolution, touch-enabled, ...

Dynamic in-page logic



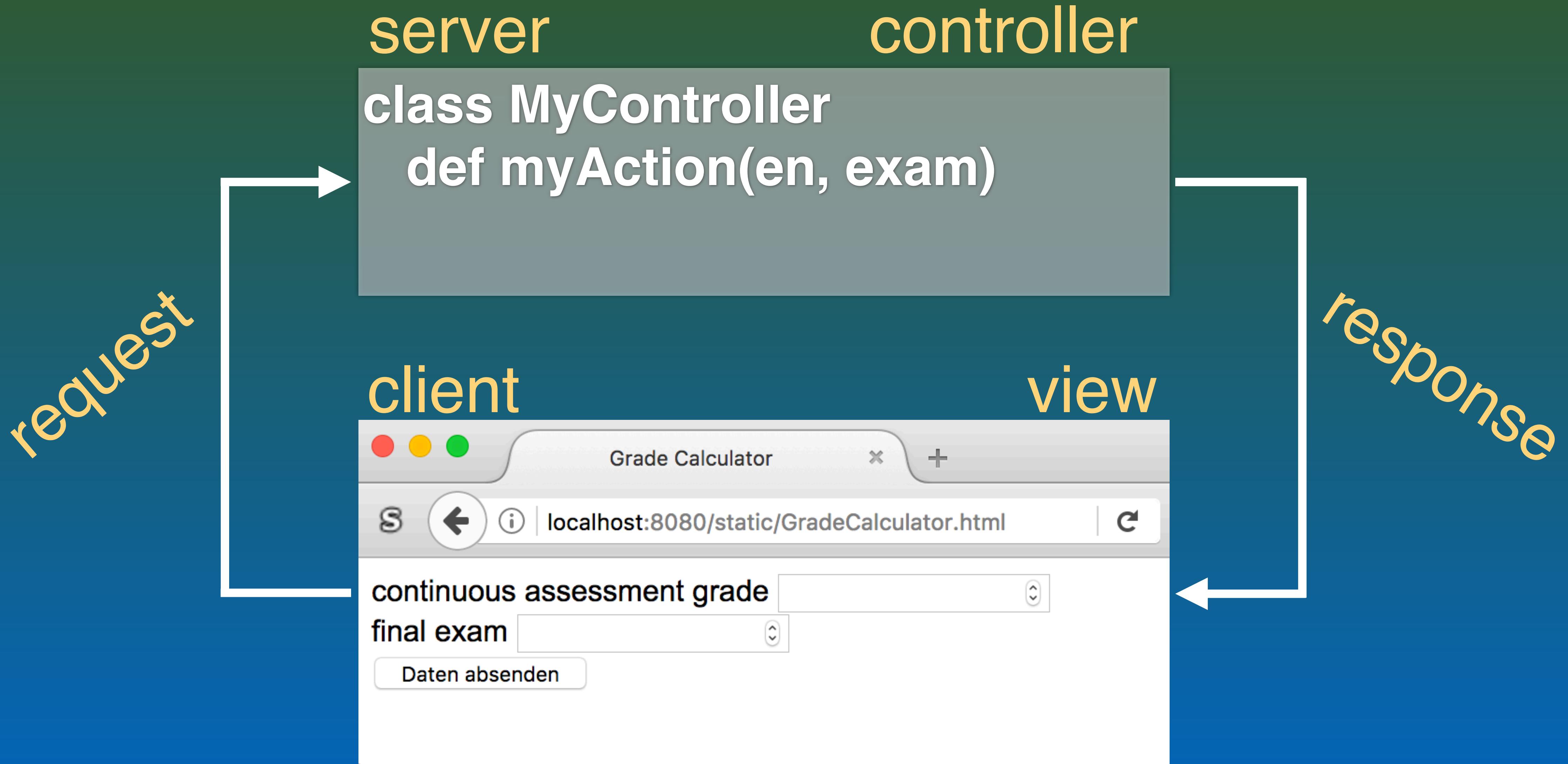
```
<body onresize="adapt()>  
  
<script>  
  function adapt() { ...; screen.size ... }  
</script>
```

View per Capability

How to detect the capability?

How to change the view?

Request - Response



How to change the View?



Use different CSS

Select a different layout

Rendering a different view

When to use: rule of thumb



CSS float

Always consider

@media

Mostly static content

onresize

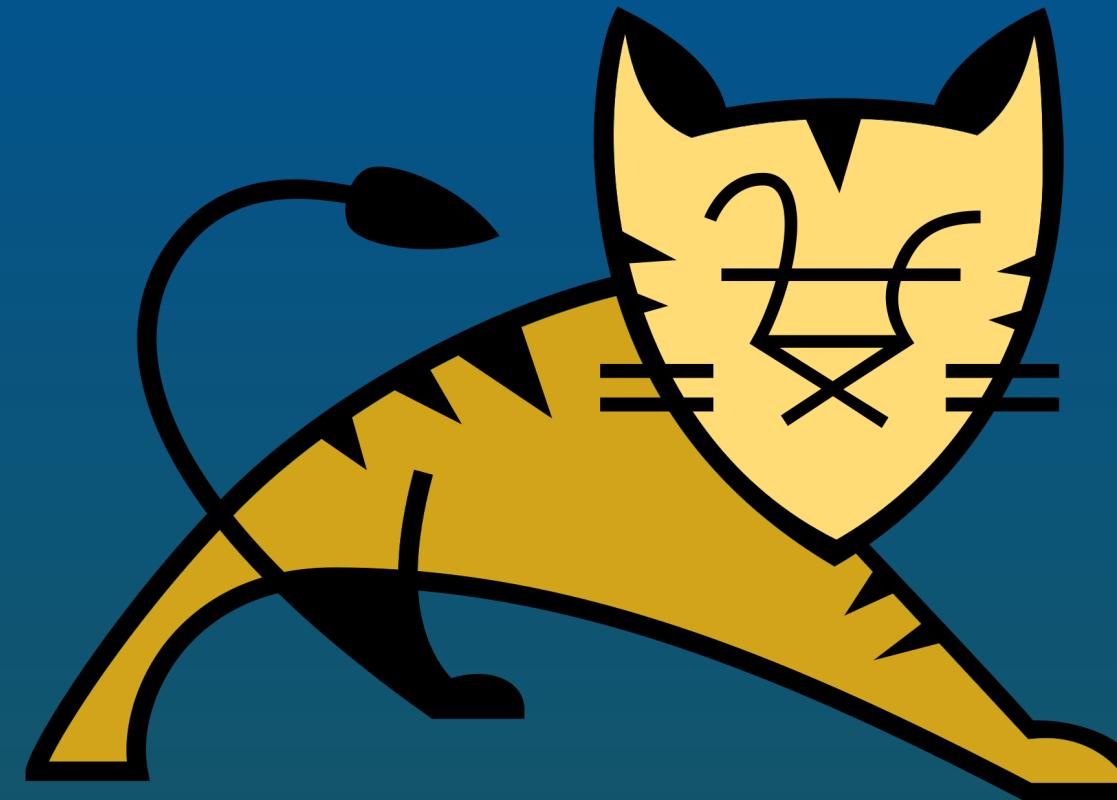
Fine-grained control

MVC

Default



Web Deployment



Deployment Option 1

`grails war`

upload war file to Java web server,
e.g. Tomcat

Deployment Option 2

gradlew stage

upload self-starting application to a Platform-as-a-Service (PaaS) provider,
e.g. Heroku

Web Atrocities



- Care for your data (download, backup)
- Data harvesting
- Data protection
- Forgetful data

Web Atrocities



- Denial of Service attacks, Spamming
- Proper Password handling, encryption
- Logging, Monitoring
- Localization
formats, timezones, character encoding