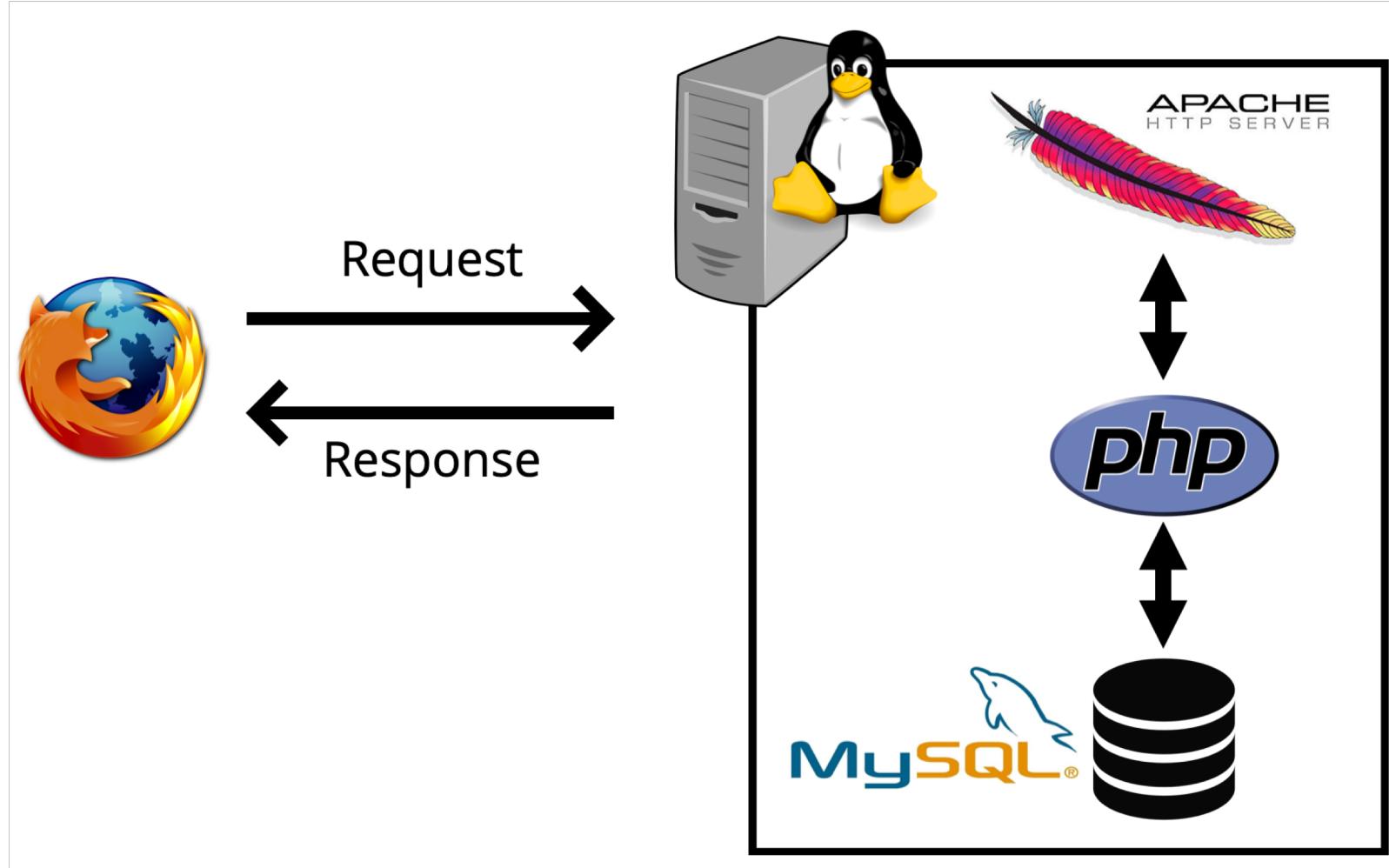


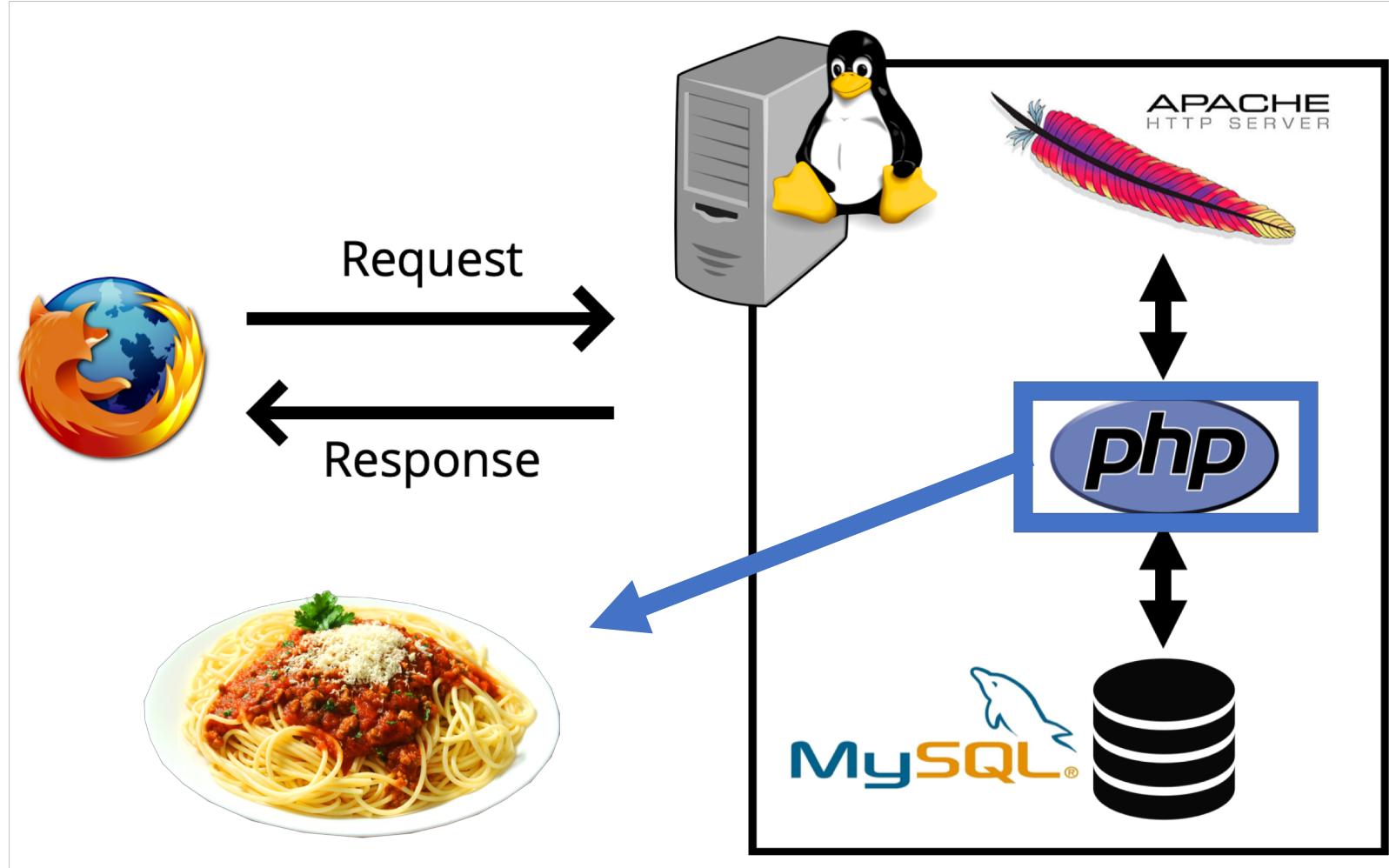
Developing a web application with **Flask**

Pau Andrio [pau.andrio@bsc.es]

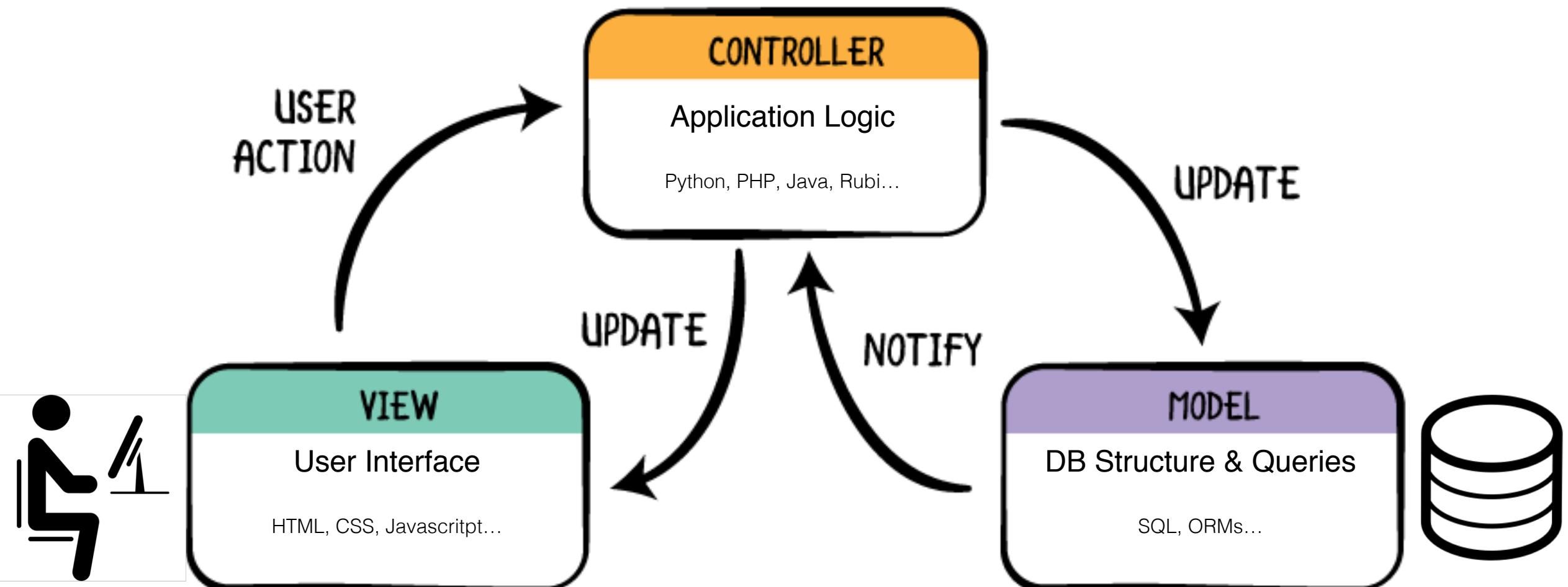
LAMP: Linux, Apache, MySQL, PHP



LAMP: Linux, Apache, MySQL, PHP



MVC: Model View Controller



(Big) Frameworks



(Micro μ) Frameworks





python



Flask

web development,
one drop at a time

The hangman game

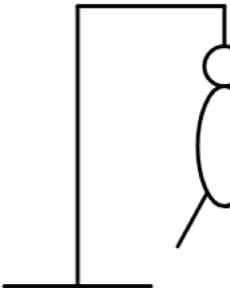
Hangman game

Your name Play!

Top 10

#	Player	Word	Errors	Points
1	Phoebe	CONFIRMATION		130
2	Chandler	REPRESENTS	U	112
3	Ross	CONFIDENTIAL	W Q	112
4	Rachel	EXPLICITLY	W R Q	96
5	Monica	ACQUISITIONS	B G W X Y	80
6	Joey	MECHANICAL	Z G Y T O	76

Hangman game

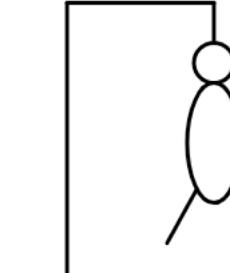


C _ N _ R _ _ _ R

Errors (3/6): V G A

Try letter

Hangman game



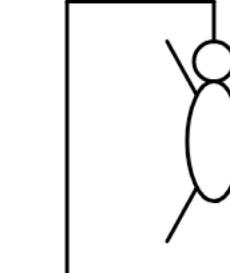
CONTROLLER

You won!

[Home](#) [Play again](#)

Errors (3/6): V G A

Hangman game



CONTROLLER

You lost :-(

[Home](#) [Play again](#)

Errors (6/6): I Y U P A W

Home view

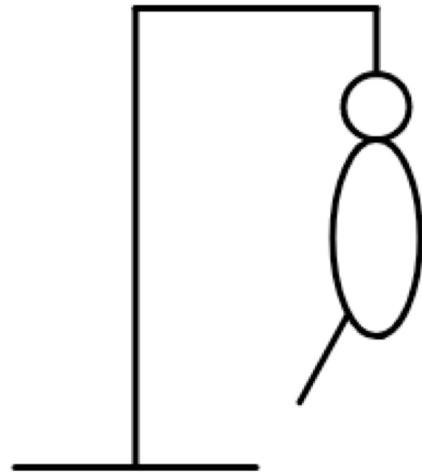
Hangman game

Your name Play!

Top 10				
#	Player	Word	Errors	Points
1	Phoebe	CONFIRMATION		130
2	Chandler	REPRESENTS	U	112
3	Ross	CONFIDENTIAL	W Q	112
4	Rachel	EXPLICITLY	W R Q	96
5	Monica	ACQUISITIONS	B G W X Y	80
6	Joey	MECHANICAL	Z G Y T O	76

Play view

Hangman game



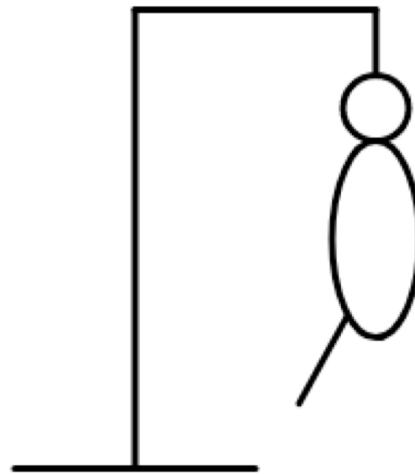
C _ N _ R _ _ _ _ R

Errors (3/6): V G A

Try letter

Play view

Hangman game



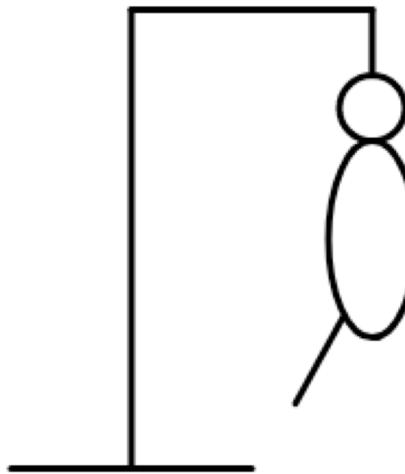
C _ N _ R _ _ _ R

Errors (3/6): V G A

Try letter



Hangman game



CONTROLLER

You won!

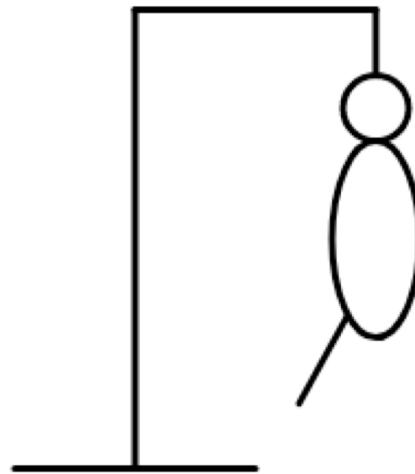
Home

Play again

Errors (3/6): V G A

Play view

Hangman game

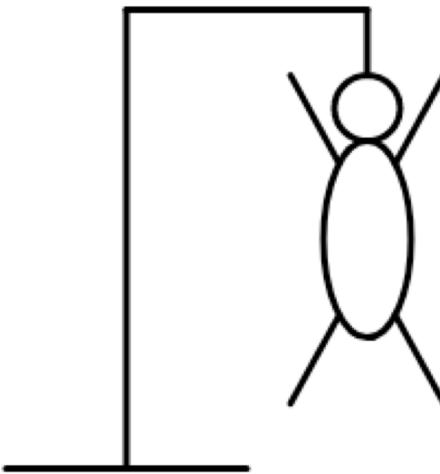


C _ N _ R _ _ _ R

Errors (3/6): V G A

Try letter

Hangman game



C O N T R O L L E R

You lost :-(

Home

Play again

Errors (6/6): I Y U P A W

Download & Execute hangman

Terminal:

```
pip install Flask Flask-SQLAlchemy
```

```
git clone https://github.com/vlopezferrando/hangman.git
```

```
cd hangman
```

```
python -c 'from hangman import db; db.create_all()'
```

```
python hangman.py
```

Firefox:

```
http://localhost:5000/
```

Project Structure

```
hangman
|__ hangman.db
|__ hangman.py
|__ static
    |__ bootstrap.min.css
    |__ bootstrap.min.js
    |__ jquery.min.js
    |__ main.css
    |__ main.js
|__ templates
    |__ home.html
    |__ index.html
    |__ play.html
|__ words.txt
```

Project Structure: The View

```
hangman
|__ hangman.db
|__ hangman.py
|__ static
    |__ bootstrap.min.css
    |__ bootstrap.min.js
    |__ jquery.min.js
    |__ main.css
    |__ main.js
|__ templates
    |__ home.html
    |__ index.html
    |__ play.html
|__ words.txt
```

Project Structure: The View + Ajax

```
hangman
|__ hangman.db
|__ hangman.py
|__ static
    |__ bootstrap.min.css
    |__ bootstrap.min.js
    |__ jquery.min.js
    |__ main.css
    |__ main.js
|__ templates
    |__ home.html
    |__ index.html
    |__ play.html
|__ words.txt
```

main.css:

```
1 th {  
2   text-align: center  
3 }  
4  
5 .vspace {  
6   margin-top: 25px;  
7 }  
8  
9 .spaced {  
10  letter-spacing: 15px;  
11 }  
12  
13 /* Drawing */  
14  
15 #drawing {  
16   fill: none;  
17   stroke: black;  
18   stroke-width: 3;  
19   stroke-linecap: round;  
20 }  
21  
22 #hangman-drawing > * {  
23   display: none  
24 }
```

Hangman game

Your name Play!

Top 10				
#	Player	Word	Errors	Points
1	Phoebe	CONFIRMATION		130
2	Chandler	REPRESENTS	U	112
3	Ross	CONFIDENTIAL	W Q	112
4	Rachel	EXPLICITLY	W R Q	96
5	Monica	ACQUISITIONS	B G W X Y	80
6	Joey	MECHANICAL	Z G Y T O	76

Hangman game

Your name

Play!

Top 10

#	Player	Word	Errors	Points
1	Phoebe	CONFIRMATION		130
2	Chandler	REPRESENTS	U	112
3	Ross	CONFIDENTIAL	Q W	112
4	Rachel	EXPLICITLY	R Q W	96
5	Monica	ACQUISITIONS	W G X B Y	80
6	Joey	MECHANICAL	G T Z O Y	76

Inspector

Console

Debugger

Style Editor

Performance

»

...

X

+

✖

bootstrap.min.css
1186 rules.

* main.css
5 rules.

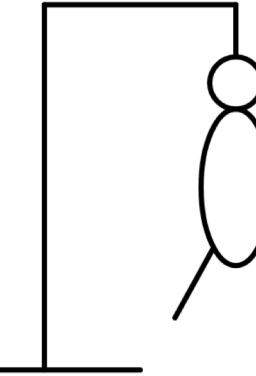
Save

```
1
2 ▼ th {
3   text-align: right
4 }
5
6 ▼ .vspace {
7   margin-top: 25px;
8 }
9
10 ▼ .spaced {
11   letter-spacing: 15px;
12 }
13
14 ▼ /* Drawing */
15
16 #drawing {
```

main.css:

```
1 th {  
2   text-align: center  
3 }  
4  
5 .vspace {  
6   margin-top: 25px;  
7 }  
8  
9 .spaced {  
10  letter-spacing: 15px;  
11 }  
12  
13 /* Drawing */  
14  
15 #drawing {  
16   fill: none;  
17   stroke: black;  
18   stroke-width: 3;  
19   stroke-linecap: round;  
20 }  
21  
22 #hangman-drawing > * {  
23   display: none  
24 }
```

Hangman game



F O _ _ D _ T _ O _ _

Errors (3/6): C X Z

Try letter

□ Inspector □ Console □ Debugger { } Style Editor ⌂ Performance » ⌂ ... ×

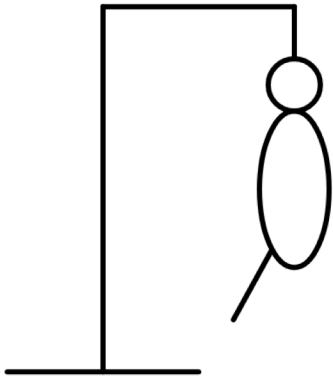
+ ↕ ⌂

bootstrap.min.css
1186 rules.

main.css
5 rules. Save

```
4 s  
5  
6 .vspace {  
7   margin-top: 25px;  
8 }  
9  
10 .spaced {  
11   letter-spacing: 15px;  
12 }  
13
```

Hangman game



FO__D_T_O__

Errors (3/6): CXZ



Try letter

A screenshot of a browser's developer tools, specifically the Style Editor tab. The interface includes a toolbar with icons for Inspector, Console, Debugger, Style Editor (which is selected), and Performance. Below the toolbar is a list of CSS files: bootstrap.min.css (1186 rules) and main.css (5 rules). The main area shows the code for main.css. The code is as follows:

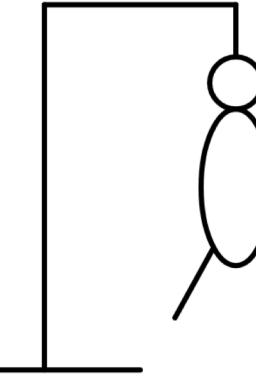
```
4   r
5
6  .vspace {
7
8  }
9
10 .spaced {
11
12 }
```

A blue bar highlights the line ".vspace {". On the far right of the code area, there is a "Save" button.

main.css:

```
1 th {  
2   text-align: center  
3 }  
4  
5 .vspace {  
6   margin-top: 25px;  
7 }  
8  
9 .spaced {  
10  letter-spacing: 15px;  
11 }  
12  
13 /* Drawing */  
14  
15 #drawing {  
16   fill: none;  
17   stroke: black;  
18   stroke-width: 3;  
19   stroke-linecap: round;  
20 }  
21  
22 #hangman-drawing > * {  
23   display: none  
24 }
```

Hangman game



F O _ _ D _ T _ O _ _

Errors (3/6): C X Z

Try letter

□ Inspector □ Console □ Debugger { } Style Editor ⌂ Performance » ⌂ ... ×

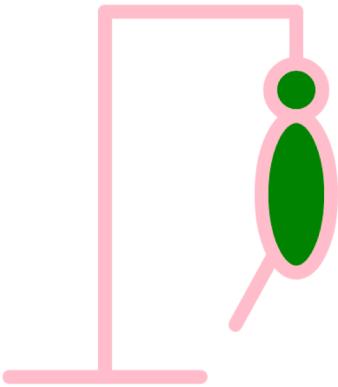
+ ↕ ⌂

bootstrap.min.css
1186 rules.

main.css
5 rules. Save

```
4 s  
5  
6 .vspace {  
7   margin-top: 25px;  
8 }  
9  
10 .spaced {  
11   letter-spacing: 15px;  
12 }  
13
```

Hangman game



F O _ _ D _ T _ O _ _

Errors (3/6): C X Z



Try letter

Screenshot of a browser developer tools Style Editor tab showing CSS code for a hangman drawing.

The tabs at the top are: Inspector, Console, Debugger, Style Editor (selected), Performance, and others.

The sidebar shows two files:

- bootstrap.min.css: 1186 rules.
- * main.css: 5 rules.

The main area displays the following CSS code:

```
16 ▾ #drawing {  
17   fill: green;  
18   stroke: pink;  
19   stroke-width: 8;  
20   stroke-linecap: round;  
21 }  
22  
23 ▾ #hangman-drawing > * {  
24   display: none  
25 }
```

Project Structure: The View + Ajax

```
hangman
|__ hangman.db
|__ hangman.py
|__ static
    |__ bootstrap.min.css
    |__ bootstrap.min.js
    |__ jquery.min.js
    |__ main.css
    |__ main.js
|__ templates
    |__ home.html
    |__ index.html
    |__ play.html
|__ words.txt
```

index.html: html + Jinja2

```
1 <!DOCTYPE html>
2 <html lang="en">
3   <head>
4     <meta charset="utf-8">
5     <meta http-equiv="X-UA-Compatible" content="IE=edge">
6     <meta name="viewport" content="width=device-width, initial-scale=1">
7
8     <title>Hangman game</title>
9
10    <!-- Bootstrap -->
11    <link rel="stylesheet"
12      href="{{ url_for('static', filename='bootstrap.min.css') }}">
13    <link rel="stylesheet"
14      href="{{ url_for('static', filename='main.css') }}">
15  </head>
16  <body>
17    <div class="container text-center">
18      <h1>Hangman game</h1>
19      <div class="row vspace">
20        <div class="col-md-6 col-md-offset-3">
21          {% block content %}{% endblock %}
22        </div>
23      </div>
24    </div>
25
26    <script src="{{ url_for('static', filename='jquery.min.js') }}"/></script>
27    <script src="{{ url_for('static', filename='bootstrap.min.js') }}"/></script>
28
29    {% block bottom %}{% endblock %}
30  </body>
31 </html>
```

home.html: html + Jinja2

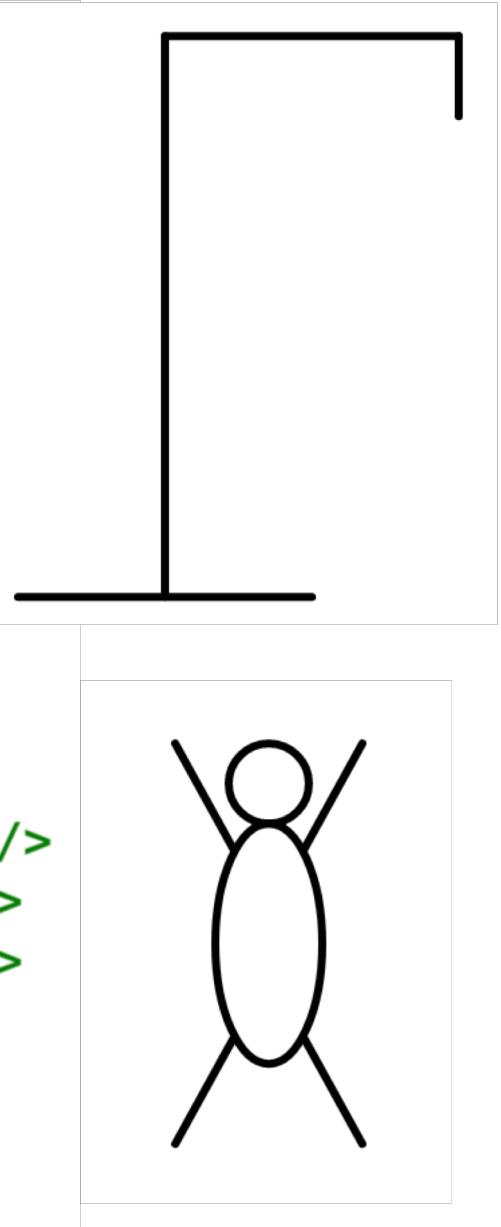
```
1  {% extends 'index.html' %}  
2  
3  {% block content %}  
4      <form action="{{ url_for('new_game') }}" class="form-inline">  
5          <div class="form-group vspace">  
6              <input name="player" class="input-lg" required="required"  
7                  placeholder="Your name">  
8              <button class="btn btn-primary btn-lg" type="submit">Play!</button>  
9          </div>  
10     </form>  
11  
12     <div class="panel panel-default vspace">  
13         <div class="panel-heading">Top 10</div>  
14         <table class="table">  
15             <thead>  
16                 <tr>  
17                     <th>#</th>  
18                     <th>Player</th>  
19                     <th>Word</th>  
20                     <th>Errors</th>  
21                     <th>Points</th>  
22             <tbody>  
23                 {% for game in games %}  
24                     <tr>  
25                         <td>{{ loop.index }}</td>  
26                         <td>{{ game.player }}</td>  
27                         <td class="text-success">{{ game.current }}</td>  
28                         <td class="text-danger spaced">{{ game.errors }}</td>  
29                         <td>{{ game.points }}</td>  
30                 {% endfor %}  
31             </tbody>  
32         </table>  
33     </div>  
34 {% endblock %}
```

home.html:

```
1 <!DOCTYPE html>
2 <html lang="en">
3   <head>
4     <meta charset="utf-8">
5     <meta http-equiv="X-UA-Compatible" content="IE=edge">
6     <meta name="viewport" content="width=device-width, initial-scale=1">
7
8     <title>Hangman game</title>
9
10    <!-- Bootstrap -->
11    <link rel="stylesheet" href="/static/bootstrap.min.css">
12    <link rel="stylesheet" href="/static/main.css">
13
14  </head>
15  <body>
16    <div class="container text-center">
17      <h1>Hangman game</h1>
18      <div class="row vspace">
19        <div class="col-md-6 col-md-offset-3">
20
21        <form action="/play" class="form-inline">
22          <div class="form-group vspace">
23            <input name="player" class="input-lg" required="required"
24              placeholder="Your name">
25            <button class="btn btn-primary btn-lg" type="submit">Play!</button>
26          </div>
27        </form>
28
29        <div class="panel panel-default vspace">
30          <div class="panel-heading">Top 10</div>
31          <table class="table">
32            <thead>
33              <tr>
34                <th>#</th>
35                <th>Player</th>
36                <th>Word</th>
37                <th>Errors</th>
38                <th>Points</th>
39            <tbody>
40
41              <tr>
42                <td>1</td>
43                <td>Phoebe</td>
44                <td class="text-success">CONFIRMATION</td>
45                <td class="text-danger spaced"></td>
46                <td>130</td>
47
48              <tr>
49                <td>2</td>
50                <td>Chandler</td>
51                <td class="text-success">REPRESENTS</td>
52                <td class="text-danger spaced">U</td>
53                <td>112</td>
54
55              <tr>
56                <td>3</td>
57                <td>Ross</td>
58                <td class="text-success">CONFIDENTIAL</td>
59                <td class="text-danger spaced">QW</td>
60                <td>112</td>
61
```

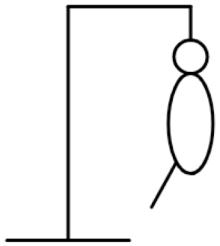
play.html: html + Jinja2 1/3

```
1  {% extends 'index.html' %}  
2  
3  {% block content %}  
4      <svg width="250" height="230" id="drawing">  
5          <!-- Structure -->  
6          <line y1="220" y2="220" x1="10" x2="120" />  
7          <line y1="10" y2="220" x1="65" x2="65" />  
8          <line y1="10" y2="10" x1="65" x2="175" />  
9          <line y1="10" y2="40" x1="175" x2="175" />  
10  
11         <!-- Hangman -->  
12         <g id="hangman-drawing">  
13             <circle cx="175" cy="55" r="15" />  
14             <ellipse cx="175" cy="115" rx="20" ry="45" />  
15             <line y1="150" y2="190" x1="162" x2="140" />  
16             <line y1="150" y2="190" x1="188" x2="210" />  
17             <line y1="80" y2="40" x1="162" x2="140" />  
18             <line y1="80" y2="40" x1="188" x2="210" />  
19         </g>  
20     </svg>
```



play.html: 2/3

Hangman game

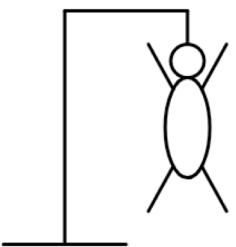


C _ N _ R _ _ _ _ R

Errors (3/6): V G A

 Try letter

Hangman game



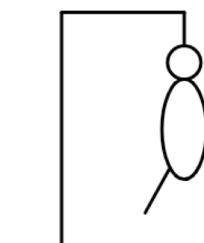
CONTROLLER

You lost :-(

[Home](#) [Play again](#)

Errors (6/6): I Y U P A W

Hangman game



CONTROLLER

You won!

[Home](#) [Play again](#)

Errors (3/6): V G A

```
22  {% if game.finished %}  
23      <h1>  
24          {% for letter in game.word %}  
25              <span class="text-{{ if letter in game.tried }}success{{ else }}danger{{ endif }}">  
26                  {{ letter }}  
27              </span>  
28          {% endfor %}  
29      </h1>  
30      <h3>  
31          {% if game.won %} You won! {% else %} You lost :-( {% endif %}  
32      </h3>  
33      <p>  
34          <a class="btn btn-default" href="{{ url_for('home') }}>Home</a>  
35          <a class="btn btn-primary"  
36              href="{{ url_for('new_game') }}?player={{ game.player }}>  
37                  Play again  
38              </a>  
39          </p>  
40      {% else %}  
41          <h1 id="current" class="spaced">{{ game.current }}</h1>  
42      {% endif %}  
43  
44      <h2 class="vspace" id="errors">  
45          Errors ({{ game.errors|length }}/6):  
46          <span class="text-danger spaced">{{ game.errors }}</span>  
47      </h2>  
48  
49      {% if not game.finished %}  
50          <form method="post" id="letter-form" class="form-inline vspace">  
51              <div class="form-group">  
52                  <input class="input-lg text-uppercase" maxlength="1" size="1"  
53                      name="letter" autocomplete="off" autofocus>  
54              </div>  
55              <button type="submit" class="btn btn-default btn-lg">Try letter</button>  
56          </form>  
57      {% endif %}  
58  {% endblock %}
```

play.html: html + Jinja2 3/3

```
61  {% block bottom %}  
62      <script src="{{ url_for('static', filename='main.js') }}"></script>  
63      <script>  
64          updateDrawing('{{ game.errors }}');  
65      </script>  
66  {% endblock %}
```

How do we update the values of play.html without reloading every time we send a letter?

AJAX

AJAX

Asynchronous JavaScript and XML

AJAX

Asynchronous JavaScript and XML

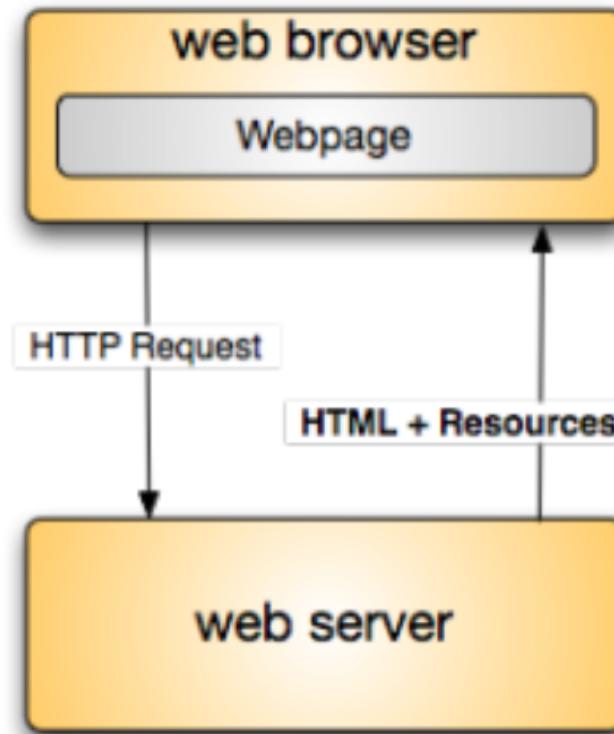
Change web content without reloading

AJAX

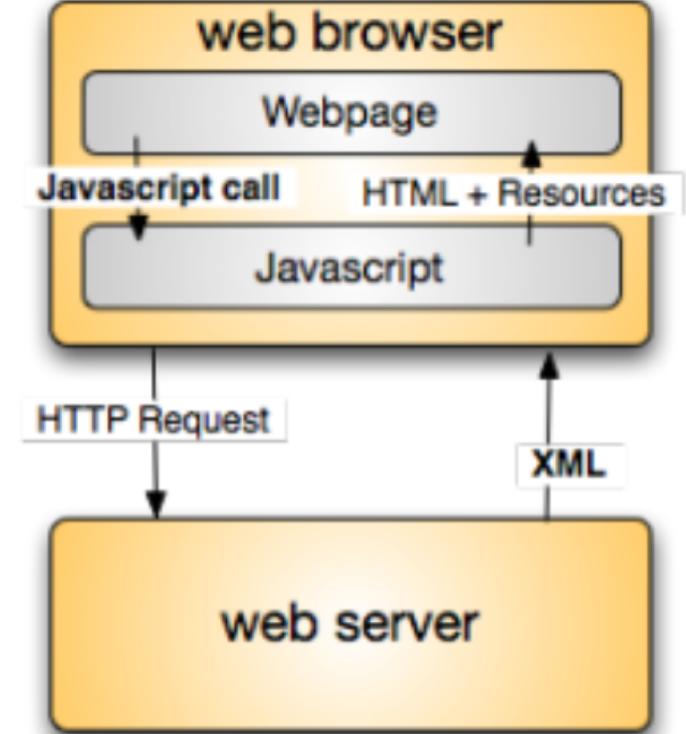
Change web content without refreshing



Traditional web model



AJAX web model



main.js: Javascript Jquery

```
1 /* Submit letter */
2
3 $('#letter-form').submit(function(e) {
4     var data = $("#letter-form").serialize();
5
6     /* Empty input */
7     $('#letter-form input').val('');
8
9     $.ajax({
10        type: "POST",
11        url: '',
12        data: data,
13        success: function(data) {
14            /* Refresh if finished */
15            if (data.finished) {
16                location.reload();
17            }
18            else {
19                /* Update current */
20                $('#current').text(data.current);
21
22                /* Update errors */
23                $('#errors').html(
24                    'Errors (' + data.errors.length + '/6): ' +
25                    '<span class="text-danger spaced">' + data.errors + '</span>');
26
27                /* Update drawing */
28                updateDrawing(data.errors);
29            }
30        }
31    });
32    e.preventDefault();
33 });
34
35 function updateDrawing(errors) {
36    $('#hangman-drawing').children().slice(0, errors.length).show();
37 }
```

main.js: Javascript + Jquery

Status	Method	File	Domain	Cause	Type	Transferred	Size
200	GET	bootstrap.min.css	localhost:5000	stylesheet	css	cached	118.42 KB
200	POST	1748091743	localhost:5000	xhr	json	216 B	70 B

Headers Cookies Params Response Timings Stack Trace

Request URL: <http://localhost:5000/play/1748091743>

Request method: POST

Remote address: 127.0.0.1:5000

Status code: 200 OK [?](#) Edit and Resend Raw headers

Version: HTTP/1.0

[Filter headers](#)

Response headers (146 B)

- Content-Length: 70
- Content-Type: application/json
- Date: Tue, 29 Jan 2019 22:30:32 GMT
- Server: Werkzeug/0.14.1 Python/3.7.1

Request headers (419 B)

- Accept: */*
- Accept-Encoding: gzip, deflate
- Accept-Language: en-US,en;q=0.5
- Connection: keep-alive
- Content-Length: 8
- Content-Type: application/x-www-form-urlencoded; charset=UTF-8
- Host: localhost:5000
- Referer: <http://localhost:5000/play/1748091743>
- User-Agent: Mozilla/5.0 (Macintosh; Intel ...) Gecko/20100101 Firefox/63.0
- X-Requested-With: XMLHttpRequest

Headers Cookies Params

[Filter request parameters](#)

Form data

letter: B

Headers Cookies Params Response

[Filter properties](#)

JSON

current: B
errors: A
finished: false

Response payload

```
1 {  
2   "current": "____B____",  
3   "errors": "A",  
4   "finished": false  
5 }  
6 
```

Project Structure: The Model

```
hangman
├── hangman.db
├── hangman.py
└── static
    ├── bootstrap.min.css
    ├── bootstrap.min.js
    ├── jquery.min.js
    ├── main.css
    └── main.js
└── templates
    ├── home.html
    ├── index.html
    └── play.html
└── words.txt
```

hangman.py (Model): SQLAlchemy + SQLite

```
8 # Database
9
10 app.config['SQLALCHEMY_DATABASE_URI'] = 'sqlite:///hangman.db'
11 db = SQLAlchemy(app)
12
13 # Model
14
15 def random_pk():
16     return random.randint(1e9, 1e10)
17
18 def random_word():
19     words = [line.strip() for line in open('words.txt') if len(line) > 10]
20     return random.choice(words).upper()
21
22 class Game(db.Model):
23     pk = db.Column(db.Integer, primary_key=True, default=random_pk)
24     word = db.Column(db.String(50), default=random_word)
25     tried = db.Column(db.String(50), default='')
26     player = db.Column(db.String(50))
27
28     def __init__(self, player):
29         self.player = player
30
31     @property
32     def errors(self):
33         return ''.join(set(self.tried) - set(self.word))
34
35     @property
36     def current(self):
37         return ''.join([c if c in self.tried else '_' for c in self.word])
38
39     @property
40     def points(self):
41         return 100 + 2*len(set(self.word)) + len(self.word) - 10*len(self.errors)
42
43     # Game status
44
45     @property
46     def won(self):
47         return self.current == self.word
48
49     @property
50     def lost(self):
51         return len(self.errors) == 6
52
53     @property
54     def finished(self):
55         return self.won or self.lost
56
57     @property
58     def score(self):
59         return 100 + 2*len(set(self.word)) + len(self.word) - 10*len(self.errors)
```

Project Structure: The Controller

```
hangman
|__ hangman.db
|__ hangman.py
|__ static
    |__ bootstrap.min.css
    |__ bootstrap.min.js
    |__ jquery.min.js
    |__ main.css
    |__ main.js
|__ templates
    |__ home.html
    |__ index.html
    |__ play.html
|__ words.txt
```

hangman.py (Controller): Flask

```
65 # Controller
66
67 @app.route('/')
68 def home():
69     games = sorted(
70         [game for game in Game.query.all() if game.won],
71         key=lambda game: -game.points)[:10]
72     return flask.render_template('home.html', games=games)
73
74 @app.route('/play')
75 def new_game():
76     player = flask.request.args.get('player')
77     game = Game(player)
78     db.session.add(game)
79     db.session.commit()
80     return flask.redirect(flask.url_for('play', game_id=game.pk))
81
82 @app.route('/play/<game_id>', methods=['GET', 'POST'])
83 def play(game_id):
84     game = Game.query.get_or_404(game_id)
85
86     if flask.request.method == 'POST':
87         letter = flask.request.form['letter'].upper()
88         if len(letter) == 1 and letter.isalpha():
89             game.try_letter(letter)
90
91     if flask.request.is_xhr:
92         return flask.jsonify(current=game.current,
93                             errors=game.errors,
94                             finished=game.finished)
95     else:
96         return flask.render_template('play.html', game=game)
```

```
44
45     def try_letter(self, letter):
46         if not self.finished and letter not in self.tried:
47             self.tried += letter
48             db.session.commit()
```