CSIT884:
Web Development

Asynchronous JavaScript and XML - AJAX

School of Computing and Information Technology
University of Wollongong

AJAX: Asynchronous JavaScript and XML

- AJAX technology provides Web-based applications with rich user interfaces and responsiveness
  - it is a process of using asynchronous requests from the browser to the server to fetch data

- AJAX can be used to update a part of the web document, by
  - making requests to the server without reloading the page
  - receive and work with data from the server

- AJAX technology shortens the required time for transmitting and rendering the document

AJAX: Asynchronous JavaScript and XML

- AJAX is not a new programming language or API
- AJAX uses JavaScript as primary programming language
  - other technologies used include DOM and CSS
  - besides XML format, AJAX can exchange information using JSON, HTML, and text files
- AJAX just can use a combination of:
  - a XMLHttpRequest object (for the request)
  - JavaScript and HTML DOM (to display or use the data)

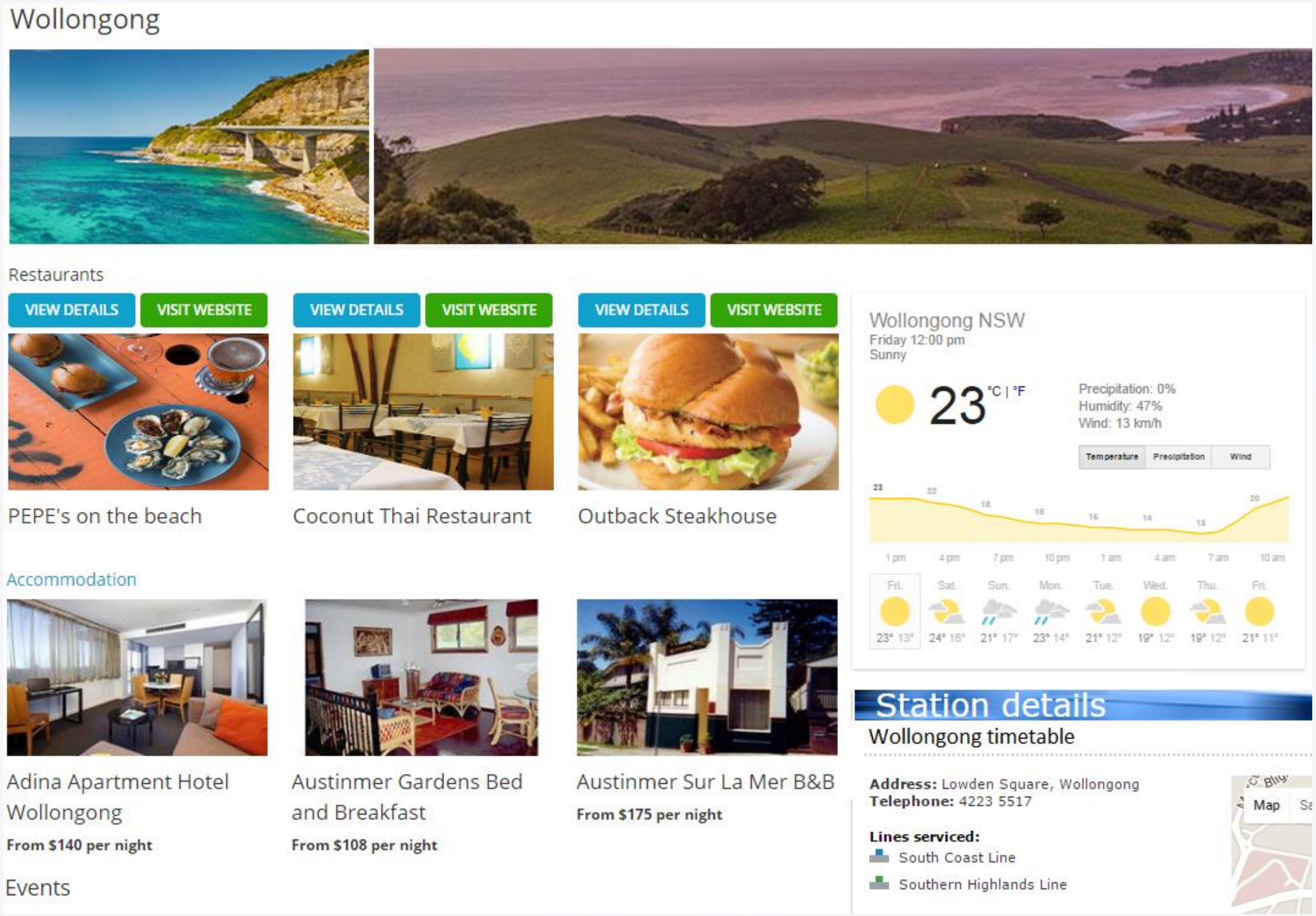
AJAX: Asynchronous JavaScript and XML

Consider the following scenario:

Suppose we want to build a website about Wollongong.
We want to display information about

- Accommodation
- Attractions
- Events
- Restaurants
- Timetable
- Weather

AJAX



Wollongong

Restaurants

VIEW DETAILS VISIT WEBSITE

PEPE's on the beach

VIEW DETAILS VISIT WEBSITE

Coconut Thai Restaurant

VIEW DETAILS VISIT WEBSITE

Outback Steakhouse

Accommodation

Adina Apartment Hotel Wollongong

From $140 per night

Austinmer Gardens Bed and Breakfast

From $108 per night

Austinmer Sur La Mer B&B

From $175 per night

Events

Wollongong NSW
Friday 12:00 pm
Sunny

23 °C | °F

Precipitation: 0%
Humidity: 47%
Wind: 13 km/h

Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.
23° 13°	24° 16°	21° 17°	23° 14°	21° 12°	19° 12°	19° 12°	21° 11°

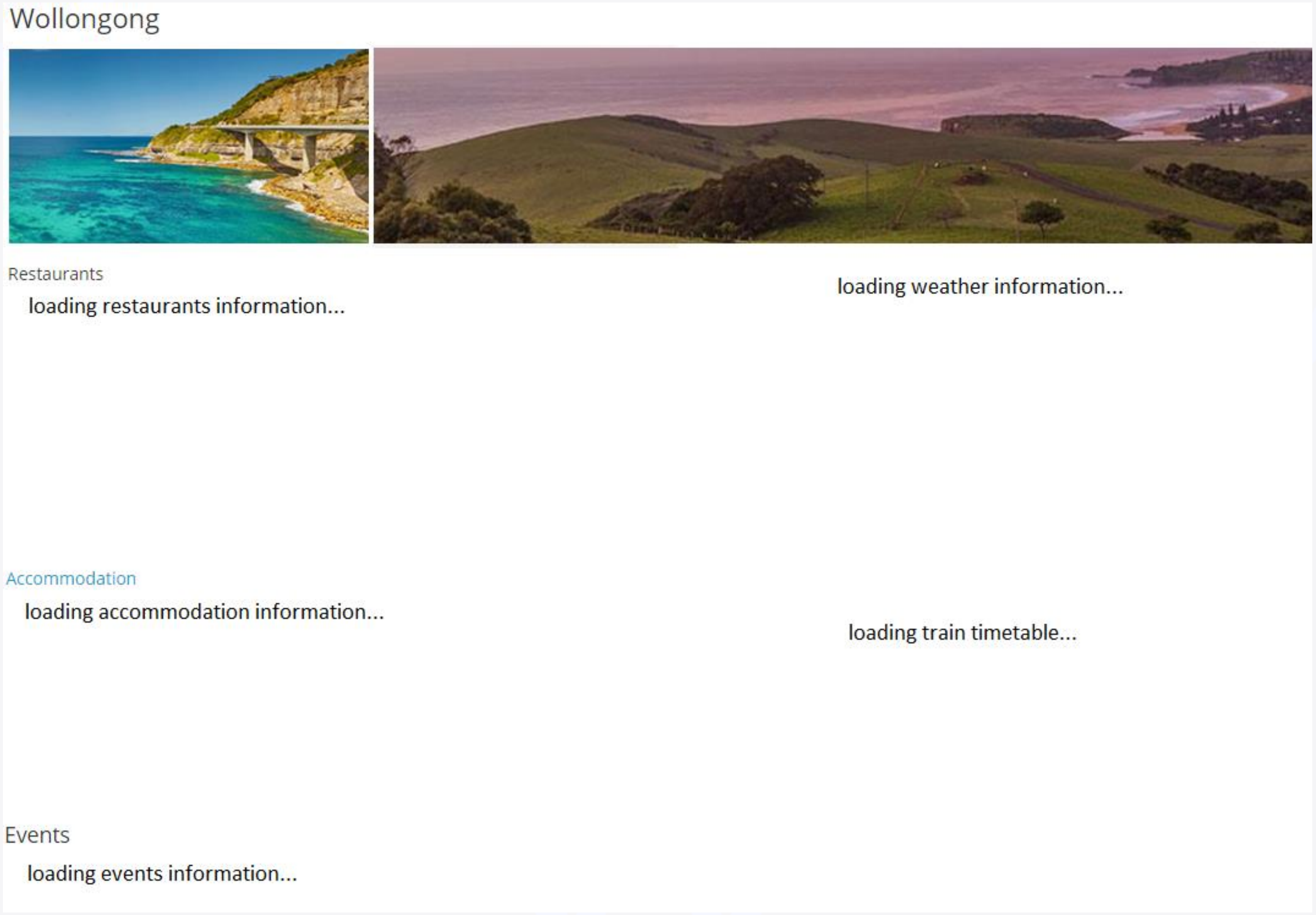
Station details

Wollongong timetable

Address: Lowden Square, Wollongong
Telephone: 4223 5517

Lines serviced:
South Coast Line
Southern Highlands Line

AJAX


Wollongong

Restaurants

loading restaurants information...

loading weather information...

Accommodation

loading accommodation information...

loading train timetable...

Events

loading events information...

AJAX

if we use synchronous calls to load informations

- loading info 1…
- loading info 2…
- loading info 3…
- …

then the webpage will freeze and is not responsive during the loading.

AJAX

asynchronous allows us to send all the requests simultaneously and register **callback functions**

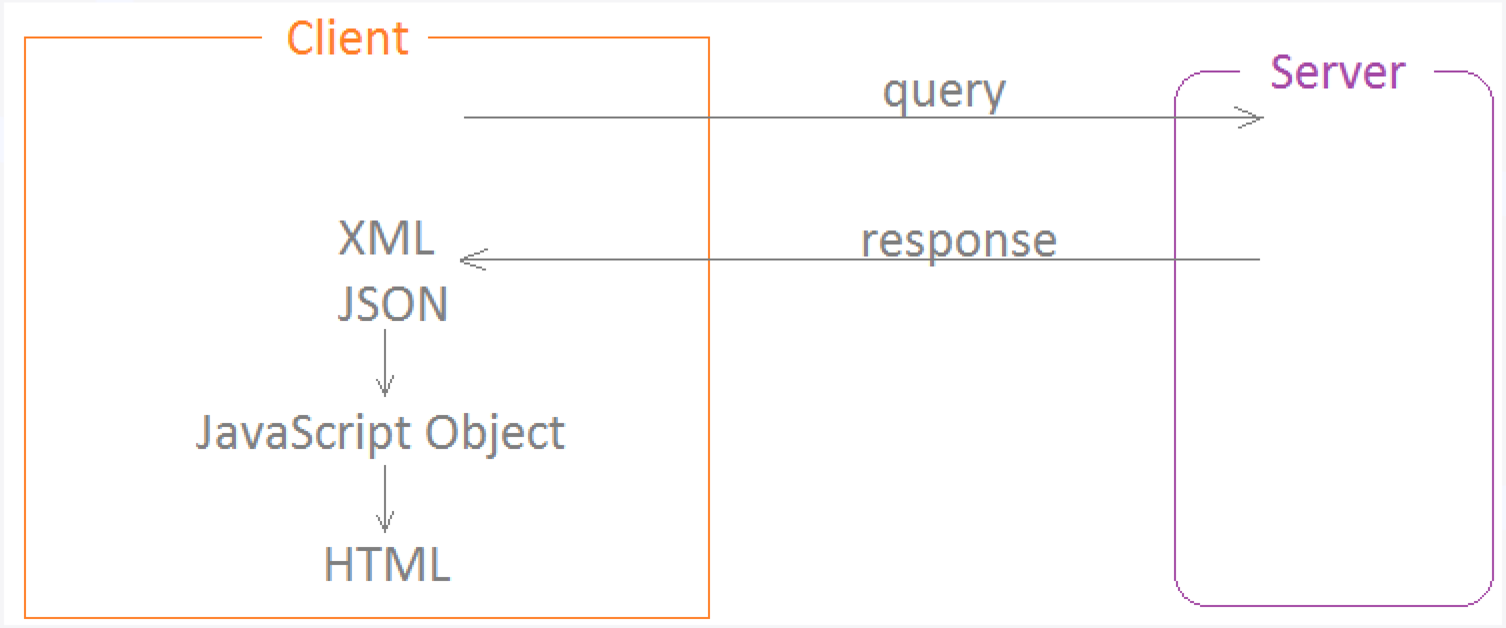
- sending request 1… if success then do this callback1
- sending request 2… if success then do this callback2
- sending request 3… if success then do this callback3
- …
- request 2 success -> invoke callback2 function
- request 3 success -> invoke callback3 function
- request 1 success -> invoke callback1 function
- ...

AJAX

With AJAX we can

- update a web page without reloading the page
- request data from a server - after the page has loaded
- receive data from a server - after the page has loaded
- send data to a server - in the background

AJAX



Writing AJAX/JSON application:

- **Step 1**: Make the query
- **Step 2**: Get the response – XML or JSON
- **Step 3**: Parse the response into a JavaScript object
- **Step 4**: Display the JavaScript object in a HTML page

A sample AJAX/JSON program

A sample AJAX/JSON program

This is the main function:

Step 1: Make the query

```
function makeAJAXQuery(){
  // create an XMLHttpRequest
  var xhttp = new XMLHttpRequest();   . . . . (1)

  // create a handler for the readyState change
  xhttp.onreadystatechange = function() { . . . . (2)
    readyStateChangeHandler(xhttp);
  };

  // making query by async call
  xhttp.open("GET", "url-to-query-the-server", true);
  xhttp.send();                                       . . . .(3)
}


// handler for the readyState change
function readyStateChangeHandler(xhttp){ … }
```

A sample AJAX/JSON program

This is the callback function:

```
// handler for the readyState change
function readyStateChangeHandler(xhttp){
  if (xhttp.readyState == 4){
    // readyState = 4 means DONE
    if(xhttp.status == 200){
      // status = 200 means OK
      handleStatusSuccess(xhttp);
    }else{
      // status is NOT OK
      handleStatusFailure(xhttp);
    }
  }
}

// XMLHttpRequest failed
function handleStatusFailure(xhttp){ … }
// XMLHttpRequest success
function handleStatusSuccess(xhttp){ … }
```

A sample AJAX/JSON program

```
// XMLHttpRequest success
function handleStatusSuccess(xhttp){

  var jsonText = xhttp.responseText;

  // parse the json into an object
  var obj = JSON.parse(jsonText);

  // display the object on the page
  display(obj);
}
```

Step 2: *Get the response JSON*

Step 3: *Parse the JSON response into a JavaScript object*

Step 4: Display the object in a HTML page

A sample AJAX/JSON program

```
// parse the json into an object
var obj = JSON.parse(jsonText);
```

Step 3: *Parse the JSON response into a JavaScript object.*

Note that this step is done by an easy function call JSON.parse()

```
// display the object on the page
function display(obj){
  // construct HTML code to display the object
  ...
}
```

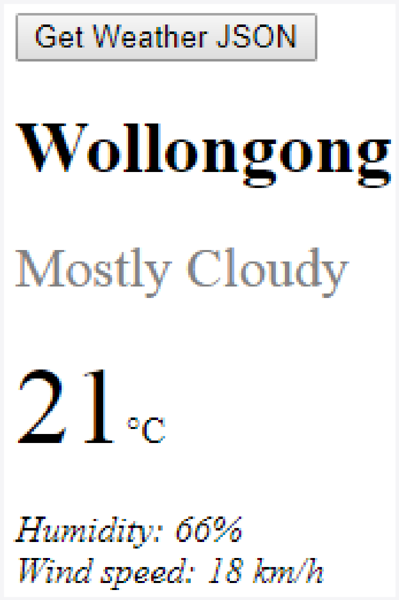
Step 4: Display the object in a HTML page

The main job the AJAX/JSON program is to write the function: **`display`**

AJAX/JSON Example:

Weather Forecast

This example emulates an application where a server allows the user to retrieve a current weather forecast for a queried location.



Wollongong

Mostly Cloudy

21 °C

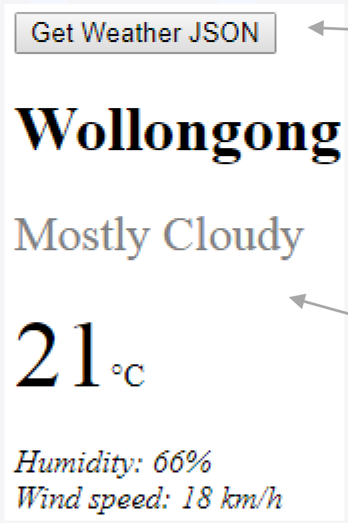
Humidity: 66%
Wind speed: 18 km/h

AJAX/JSON Example: Weather Forecast

The purpose of this example is

- to show how to distinguish between a failed request and a successful request
- when the request fails, an error message is displayed
- when the request is successfully, then the weather information is displayed:
    1. parse the JSON response to a JavaScript weather object;
    2. display the weather object on the web page.

AJAX/JSON Example: Weather Forecast


Get Weather JSON

Wollongong

Mostly Cloudy

21 °C

Humidity: 66%
Wind speed: 18 km/h

```
<button onClick="makeAJAXQueryWeather()">
Get Weather JSON
</button>

<br /><br />

<div id="display">
</div>
```

```
function makeAJAXQueryWeather(){
  // create an XMLHttpRequest
  var xhttp = new XMLHttpRequest();
  // create a handler for the readyState change
  xhttp.onreadystatechange = function() {
    readyStateChangeHandler(xhttp);
  };
  // get JSON file by making async call
  xhttp.open("GET", "weather.json", true);
  xhttp.send();
}
```

AJAX/JSON Example: Weather Forecast

```
// handler for the readyState change
function readyStateChangeHandler(xhttp){
  if (xhttp.readyState == 4){
    // readyState = 4 means DONE
    if(xhttp.status == 200){
      // status = 200 means OK
      handleStatusSuccess(xhttp);
    }else{
      // status is NOT OK
      handleStatusFailure(xhttp);
    }
  }
}

function handleStatusFailure(xhttp){ … }

function handleStatusSuccess(xhttp){ … }
```

AJAX/JSON Example: Weather Forecast

When the request is failed, display an error message

```
// XMLHttpRequest failed
function handleStatusFailure(xhttp){

  // display error message

  var displayDiv = document.getElementById("display");

  displayDiv.innerHTML =
              "XMLHttpRequest failed: status " + xhttp.status;
}
```

AJAX/JSON Example: Weather Forecast

When the request is successful

```
// XMLHttpRequest success
function handleStatusSuccess(xhttp){

  var jsonText = xhttp.responseText;

  // parse the json into an object
  var weatherObj = JSON.parse(jsonText);

  // display the object on the page
  displayWeather(weatherObj);
}
```

Get the response JSON

Parse the JSON response into a JavaScript object

Display the object in a HTML page

AJAX/JSON Example: Weather Forecast

```
// parse the json into an object
var weatherObj = JSON.parse(jsonText);
```

What is the `weatherObj` look like?

```
{
  "queryLocation": "Wollongong",
  "forecast": "Mostly Cloudy",
  "temperature": {
    "degree": "21",
    "scale": "C"
  },
  "humidity": "66%",
  "windSpeed": "18 km/h"
}
```

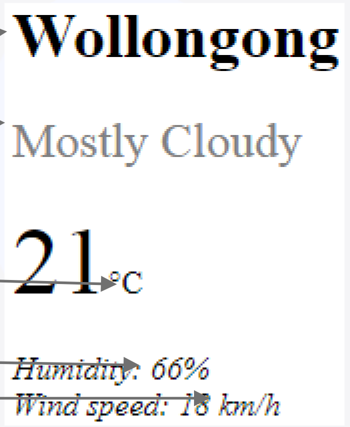
```
weatherObj {
  queryLocation: "Wollongong",
  forecast: "Mostly Cloudy",
  temperature: {
    degree: "21",
    scale: "C"
  },
  humidity: "66%",
  windSpeed: "18 km/h"
}
```

parse the JSON response into a JavaScript object

AJAX/JSON Example: Weather Forecast

```
// display the weather object on the page
function displayWeather(weatherObj){
   ...
}
```

```
weatherObj {
  queryLocation: "Wollongong",
  forecast: "Mostly Cloudy",
  temperature: {
    degree: "21",
    scale: "C"
  },
  humidity: "66%",
  windSpeed: "18 km/h"
}
```



Wollongong

Mostly Cloudy

21°C

Humidity: 66%
Wind speed: 18 km/h

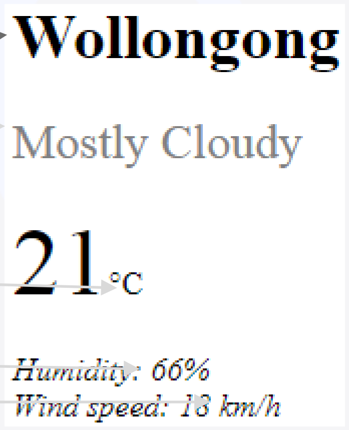
*We need to construct the following **HTML code** to display the weather information*

```
<h1>Wollongong</h1>
<font size='5' color='gray'>Mostly Cloudy</font>
<br /><br />

<font size='7'>21</font>
&deg; C
<br /><br />

<i>Humidity: 66%</i>
<br />

<i>Wind speed: 18 km/h</i>
```

AJAX/JSON Example: Weather Forecast

```
// display the weather object on the page
function displayWeather(weatherObj){
   ...
}
```

```
weatherObj {
  queryLocation: "Wollongong",
  forecast: "Mostly Cloudy",
  temperature: {
    degree: "21",
    scale: "C"
  },
  humidity: "66%",
  windSpeed: "18 km/h"
}
```



Wollongong

Mostly Cloudy

21 °C

Humidity: 66%
Wind speed: 18 km/h

```
<h1>Wollongong</h1>
<font size='5' color='gray'>Mostly Cloudy</font>
<br /><br />

<font size='7'>21</font>
&deg; C
<br /><br />

<i>Humidity: 66%</i>
<br />

<i>Wind speed: 18 km/h</i>
```

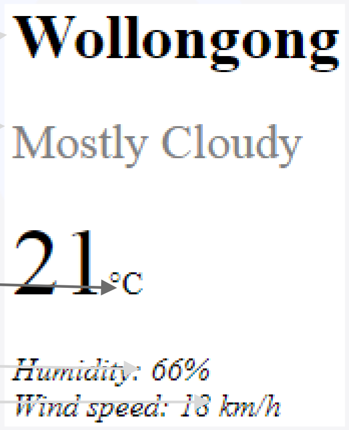
Q: How to we get the query location?

A:
weatherObj.queryLocation

AJAX/JSON Example: Weather Forecast

```
// display the weather object on the page
function displayWeather(weatherObj){
   ...
}
```

```
weatherObj {
  queryLocation: "Wollongong",
  forecast: "Mostly Cloudy",
  temperature: {
    degree: "21",
    scale: "C"
  },
  humidity: "66%",
  windSpeed: "18 km/h"
}
```


Wollongong

Mostly Cloudy

21°C

Humidity: 66%
Wind speed: 18 km/h

```
<h1>Wollongong</h1>
<font size='5' color='gray'>Mostly Cloudy</font>
<br /><br />

<font size='7'>21</font>
&deg; C
<br /><br />

<i>Humidity: 66%</i>
<br />

<i>Wind speed: 18 km/h</i>
```

Q: How to we get the temperature scale?

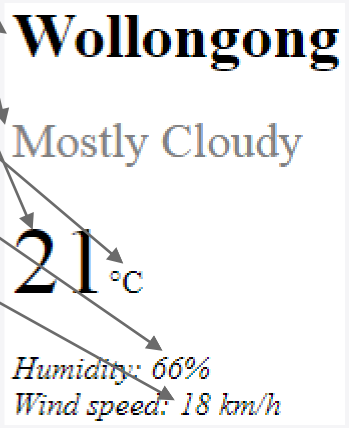
A:

weatherObj.temperature.degree

weatherObj.temperature.scale

AJAX/JSON Example: Weather Forecast

```
// display the weather object on the page
function displayWeather(weatherObj){
   // construct HTML code to display weather information
  var html = "<h1>" + weatherObj.queryLocation + "</h1>";

  html = html + "<font size='5' color='gray'>" + weatherObj.forecast + "</font>";
  html = html + "<br /><br />";

  html = html + "<font size='7'>" + weatherObj.temperature.degree + "</font>";
  html = html + "&deg;" + weatherObj.temperature.scale;
  html = html + "<br /><br />";

  html = html + "<i>Humidity: " + weatherObj.humidity + "</i>";
  html = html + "<br />";

  html = html + "<i>Wind speed: " + weatherObj.windSpeed + "</i>";

  // show the constructed HTML code in the display div
  var displayDiv = document.getElementById("display");
  displayDiv.innerHTML = html;
}
```



Wollongong

Mostly Cloudy

21°C

Humidity: 66%
Wind speed: 18 km/h

AJAX/JSON Example:

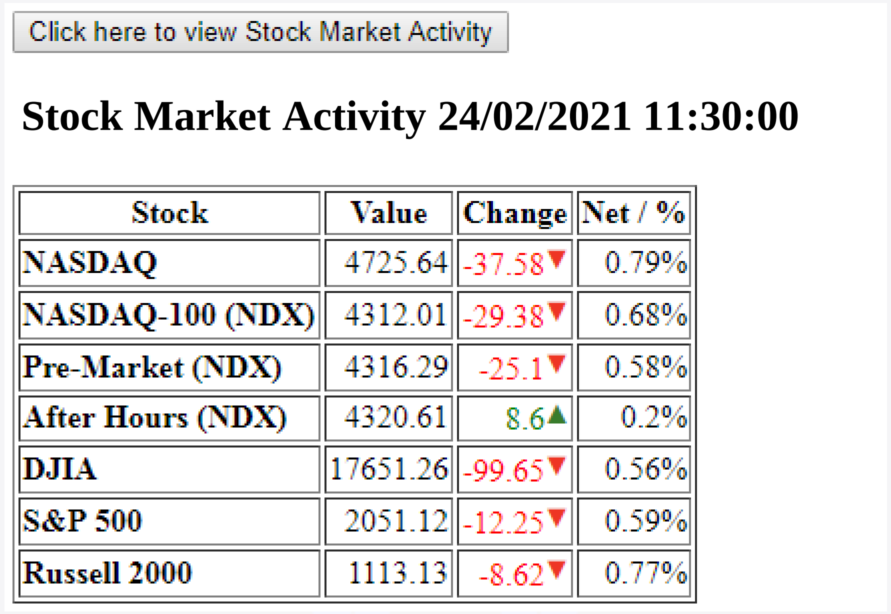
Stock Market

This example emulates an application where a server allows the user to retrieve stock market information.

AJAX/JSON Example: Stock Market

Assume that there is a JSON file, called `market.json`. Write HTML and JavaScript codes that do the following:

There is a button “Click here to view Stock Market Activity”. When the user clicks on this button, make an AJAX call to get the stock information from the json file and display them in a table.



Stock Market Activity 24/02/2021 11:30:00

Stock	Value	Change	Net / %
NASDAQ	4725.64	-37.58▼	0.79%
NASDAQ-100 (NDX)	4312.01	-29.38▼	0.68%
Pre-Market (NDX)	4316.29	-25.1▼	0.58%
After Hours (NDX)	4320.61	8.6▲	0.2%
DJIA	17651.26	-99.65▼	0.56%
S&P 500	2051.12	-12.25▼	0.59%
Russell 2000	1113.13	-8.62▼	0.77%

AJAX/JSON Example: Stock Market

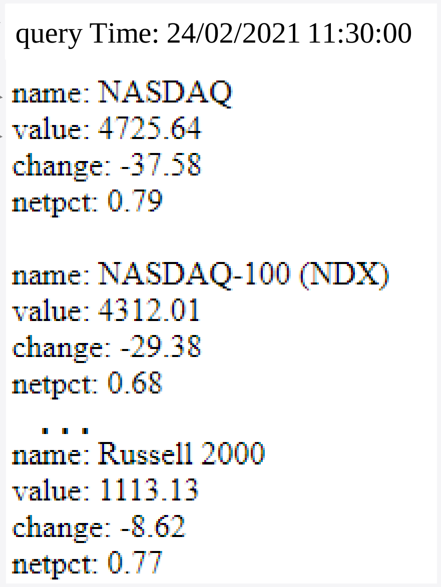
This is the content of the JSON file `market.json`

```
{
  "queryTime": "24/02/2021 11:30:00",
  "stockList": [
    {
      "name": "NASDAQ",
      "value": 4725.64,
      "change": -37.58,
      "netpct": 0.79
    },
    {
      "name": "NASDAQ-100 (NDX)",
      "value": 4312.01,
      "change": -29.38,
      "netpct": 0.68
    },
    ....
    {
      "name": "Russell 2000",
      "value": 1113.13,
      "change": -8.62,
      "netpct": 0.77
    }
  ]
}
```

Version 0 - plain display

```
marketObj {
  queryTime: "24/02/2021 11:30:00",
  stockList: [
    {
      name: "NASDAQ",
      value: 4725.64,
      change: -37.58,
      netpct: 0.79
    },
    {
      name: "NASDAQ-100 (NDX)",
      value: 4312.01,
      change: -29.38,
      netpct: 0.68
    },
    ....
    {
      name: "Russell 2000",
      value: 1113.13,
      change: -8.62,
      netpct: 0.77
    }
  ]
}
```

```
// display the market object on the page
function displayMarket(marketObj){
  // construct HTML code to display market information
  var html = "";

  html += "queryTime: " + marketObj.queryTime;
  html += "<br /><br />";

  for(var i=0; i < marketObj.stockList.length; i++){
    var stockObj = marketObj.stockList[i];

    html += "name: " + stockObj.name;
    html += "<br />";

    html += "value: " + stockObj.value;
    html += "<br />";

    html += "change: " + stockObj.change;
    html += "<br />";

    html += "netpct: " + stockObj.netpct;
    html += "<br /><br />";
  }

  // show the constructed HTML code in the display div
  var displayDiv = document.getElementById("display");
  displayDiv.innerHTML = html;
}
```



```
query Time: 24/02/2021 11:30:00

name: NASDAQ
value: 4725.64
change: -37.58
netpct: 0.79

name: NASDAQ-100 (NDX)
value: 4312.01
change: -29.38
netpct: 0.68
 . . .
name: Russell 2000
value: 1113.13
change: -8.62
netpct: 0.77
```

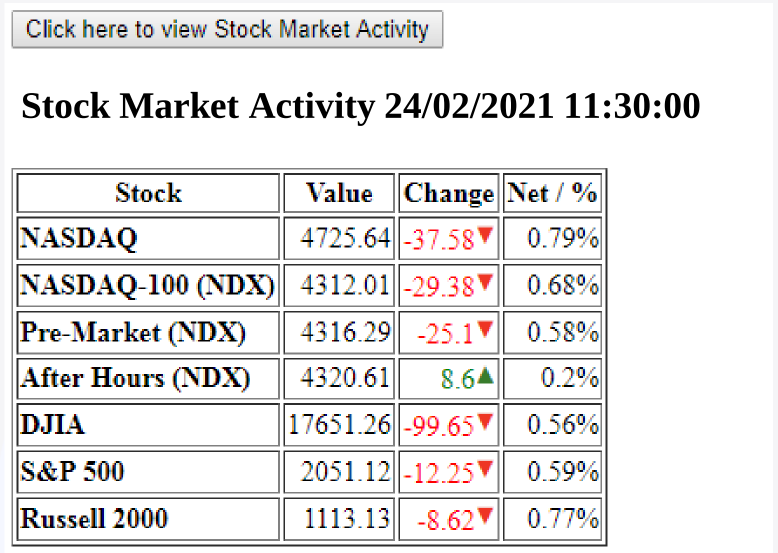
Version 1 - table display

```
// display the object on the page
function displayMarket(marketObj){
   ...
}
```

```
marketObj{
   queryTime: "24/02/2021 11:30:00",
   stockList: [
      {
        name: "NASDAQ",
        value: 4725.64,
        change: -37.58,
        netpct: 0.79
      },
      {
        name: "NASDAQ-100 (NDX)",
        value: 4312.01,
        change: -29.38,
        netpct: 0.68
      }, ...
   ]
}
```

```
<h2>Stock Market Activity 24/02/2021 11:30:00</h2>

<table border='1'>

  <tr> <th>Stock</th> <th>Value</th> <th>Change</th>
  <th>Net / %</th> </tr>

  <tr>
    <td><b>NASDAQ</b></td>
    <td align='right'>4725.64</td>
    <td style='color:red' align='right'>
      -37.58
      <img src='stockDown.png' />
    </td>
    <td align='right'>0.79%</td>
  </tr>

  <tr>
    <td><b>After Hours (NDX)</b></td>
    <td align='right'>4320.61</td>
    <td style='color:green' align='right'>
      8.6
      <img src='stockUp.png' />
    </td>
    <td align='right'>0.2%</td>
  </tr>
</table>
```

*We need to construct the following **HTML code** to display the stock market information*



Click here to view Stock Market Activity

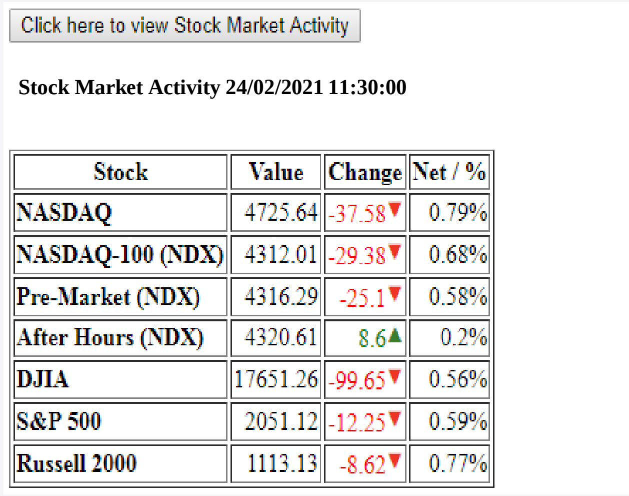
Stock Market Activity 24/02/2021 11:30:00

Stock	Value	Change	Net / %
NASDAQ	4725.64	-37.58▼	0.79%
NASDAQ-100 (NDX)	4312.01	-29.38▼	0.68%
Pre-Market (NDX)	4316.29	-25.1▼	0.58%
After Hours (NDX)	4320.61	8.6▲	0.2%
DJIA	17651.26	-99.65▼	0.56%
S&P 500	2051.12	-12.25▼	0.59%
Russell 2000	1113.13	-8.62▼	0.77%

Version 1 - table display

```
// display the market object on the page
function displayMarket(marketObj){
  // construct HTML code to display market information
  var html = "<h2>Stock Market Activity "
                              + marketObj.queryTime + "</h2>";
  html += "<table border='1'>";
  html += "<tr><th>Stock</th><th>Value</th><th>Change</th>
           <th>Net / %</th></tr>";
  for(var i=0; i < marketObj.stockList.length; i++){
    var stockObj = marketObj.stockList[i];
    html += "<tr>";

    html += "<td><b>" + stockObj.name + "</b></td>";
    html += "<td align='right'>" + stockObj.value + "</td>";

    if(stockObj.change < 0){
      html += "<td style='color:red' align='right'>";
      html += stockObj.change;
      html += "<img src='stockDown.png' />";
      html += "</td>";
    }else{
      html += "<td style='color:green' align='right'>";
      html += stockObj.change;
      html += "<img src='stockUp.png' />";
      html += "</td>";
    }

    html += "<td align='right'>" + stockObj.netpct + "%</td>";
    html += "</tr>";
  }
  html += "</table>";

  // show the constructed HTML code in the display div
  var displayDiv = document.getElementById("display");
  displayDiv.innerHTML = html;
}
```

```
marketObj {
  queryTime: "24/02/2021 11:30:00",
  stockList: [
    {
      name: "NASDAQ",
      value: 4725.64,
      change: -37.58,
      netpct: 0.79
    },
    {
      name: "NASDAQ-100 (NDX)",
      value: 4312.01,
      change: -29.38,
      netpct: 0.68
    },
    ....
    {
      name: "Russell 2000",
      value: 1113.13,
      change: -8.62,
      netpct: 0.77
    }
  ]
}
```


Click here to view Stock Market Activity

Stock Market Activity 24/02/2021 11:30:00

Stock	Value	Change	Net / %
NASDAQ	4725.64	-37.58▼	0.79%
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DJIA	17651.26	-99.65▼	0.56%
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