The University Of Sheffield.

Programming With Node and Express

Professor Fabio Ciravegna
Department of Computer Science,
University of Sheffield
fabio@dcs.shef.ac.uk

COM3504/6504
“The Intelligent Web”

The University Of Sheffield.

Exchanging data

JSON

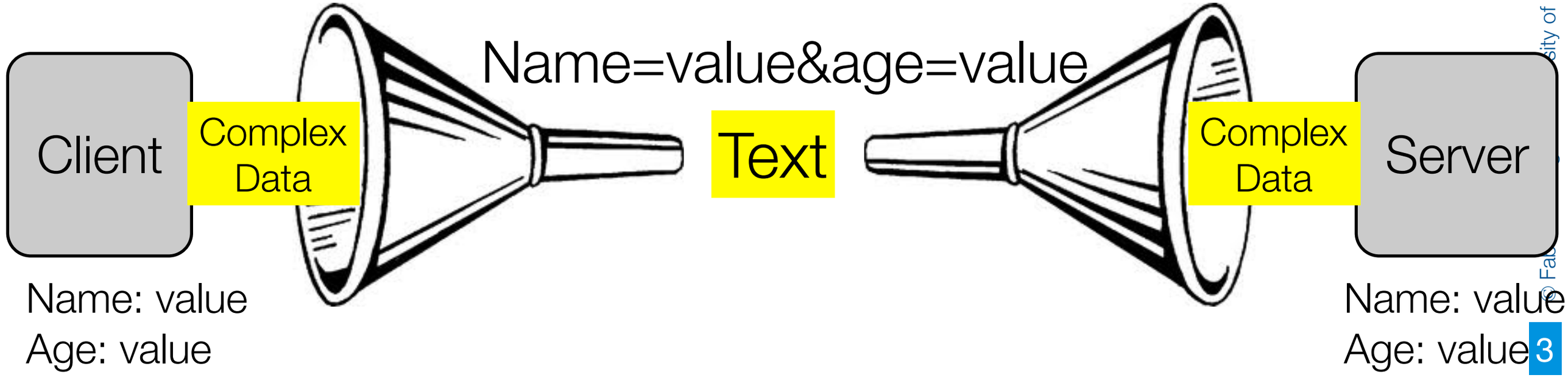
http://json.org/

Introducing JSON

Client-Server communication

- Different environments
  - E.g. JavaScript on browser and server
  - Difficult communication
- Solution?
  - Serialisation/de-serialisation of data into text
  - e.g. used in TML forms

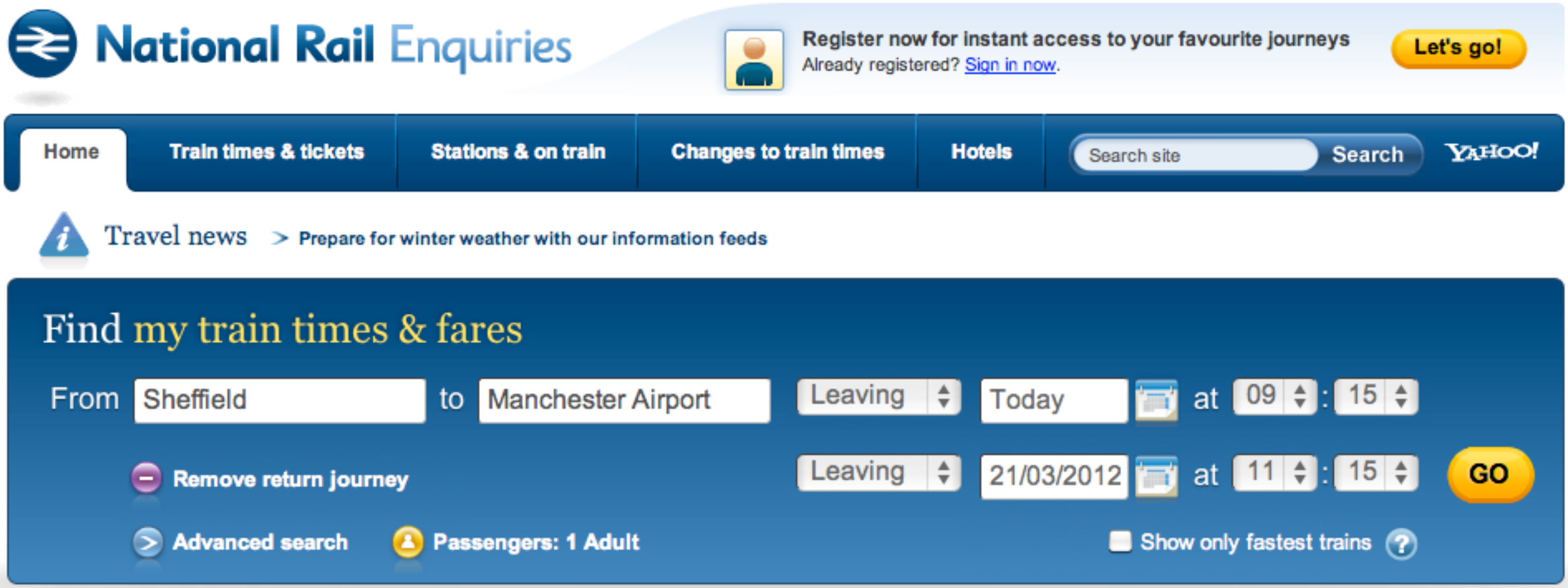
This approach is really cumbersome



The University Of Sheffield.

Example: National Rail Enquiry

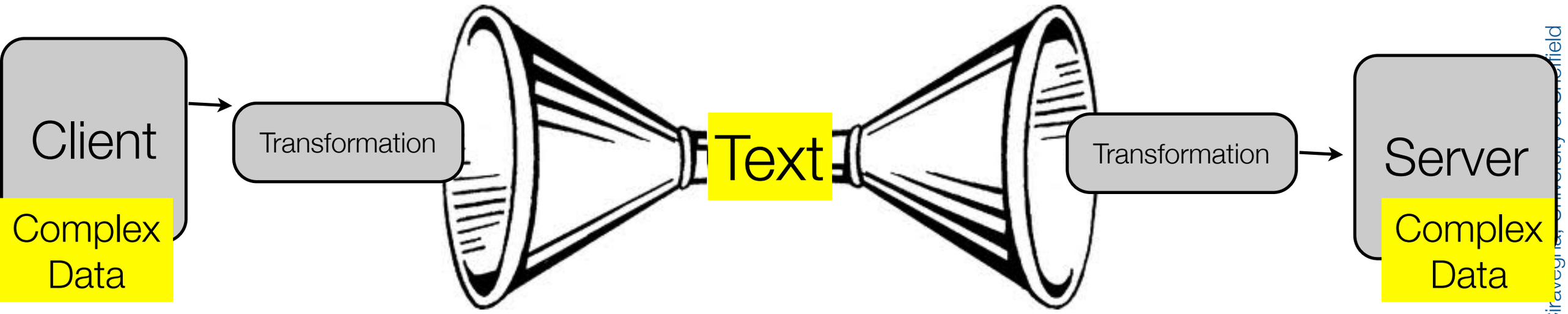
http://www.nationalrail.co.uk/



Traditional solution

- Client and server exchange
  - Client to Server (POST)
    - fromStation=”Shf”&toStation=”MncAir”&dateOut=”Today”&hourOut=”9”&minOur=”15”&dateIn=”21/03/2012”&….
  - Server to Client: HTML string

This approach is really cumbersome



Not for turning the data into text
but because of the complex manual way we encode it

The University Of Sheffield.

JSON

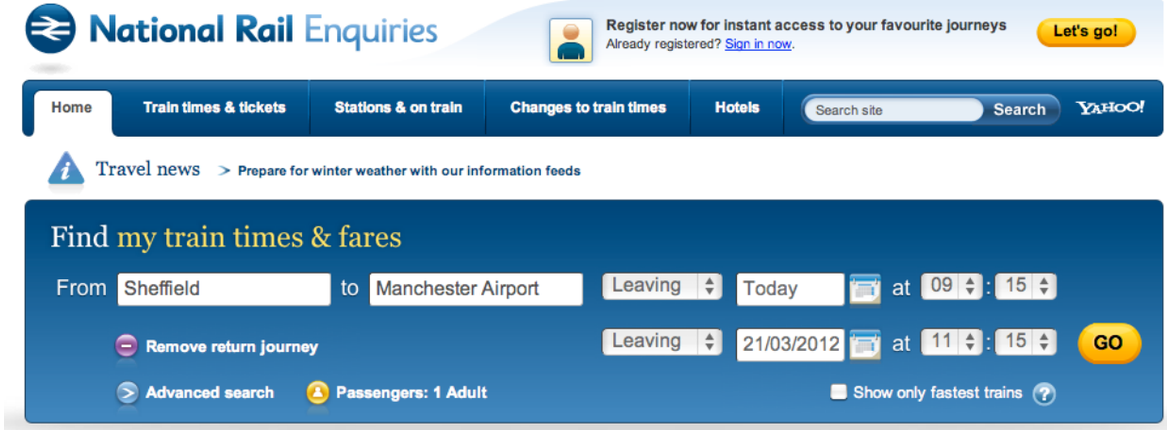
http://www.json.org/

- JSON (JavaScript Object Notation) is a lightweight data-interchange format.
  - It is easy for humans to read and write. It is easy for machines to parse and generate.
  - It is based on a subset of the JavaScript Programming Language
- JSON is a text format that is completely language independent but uses conventions that are familiar to programmers of the C-family of languages, including C, C++, C#, Java, JavaScript, Perl, Python, and many others.
- These properties make JSON an ideal data-interchange language.

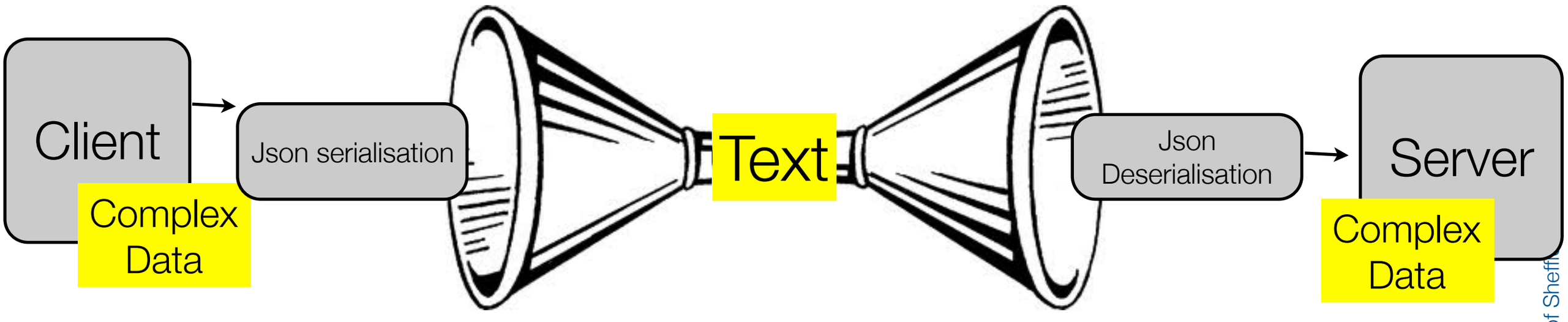
The University Of Sheffield.

JSON (2)

- JSON is built on two structures:
  - A collection of name/value pairs. In various languages, this is realized as an object, record, struct, dictionary, hash table, keyed list, or associative array.
  - An ordered list of values. In most languages, this is realized as an array, vector, list, or sequence.
- These are universal data structures. Virtually all modern programming languages support them in one form or another. It makes sense that a data format that is interchangeable with programming languages also be based on these structures.



- Client and server exchange
  - Client to Server: JSON
  - Server to Client: JSON or HTML code



We do not need to find a clever way to encode the data structure. Json does it for you

```
{ fromStation: 'Shf', toStation: 'MncAir', dateOut: 'Today', hourOut: '9',
minOur: '15', dateIn: ’21/03/2012' }
```

Sender Side (Javascript)

```
var myJSONText = JSON.stringify(myObject, replacer);
```

- Serialisation

- in the context of data storage and transmission, serialization is the process of converting a data structure or object state into a format that can be stored (for example (…) transmitted across a network connection link) and "resurrected" later in the same or another computer environment (wikipedia)

- The `stringify` method can take an optional replacer function.

  - called after the toJSON method on each of the values in the structure.
  - It will be passed each key and value as parameters, and this will be bound to object holding the key.
  - The value returned will be stringified.

```
function replacer(key, value) {
    if (typeof value === 'number' && !isFinite(value)) {
        return String(value);
    }
    return value;
```

Receiving side (Javascript)

http://www.json.org/js.html

- Deserialisation
  - The opposite operation: extracting a data structure from a series of bytes

```
var myObject = JSON.parse(myJSONtext, reviver);
```

- The optional *reviver* function will be called for every key and value at every level of the final result.
  - Each value will be replaced by the result of the reviver function.
  - This can be used e.g. to transform date strings into Date objects.

```
myData = JSON.parse(text, function (key, value) {
    var type;
    if (value && typeof value === 'object') {
        type = value.type;
        if (typeof type === 'string' && typeof window[type] === 'funct
{
            return new (window[type])(value);
        }
```

GSON

A Google library for JSON in Java

- Gson is a Java library that can be used to convert Java Objects into their JSON representation. It can also be used to convert a JSON string to an equivalent Java object. Gson can work with arbitrary Java objects including pre-existing objects that you do not have source-code of
  - Download the gson library in order to use it (it is not in the standard java distribution)

http://code.google.com/p/google-gson/

Serialisation (toGson)

- Serialisation:

```
/* create Gson object */
Gson gson = new Gson();
/* create the object to serialise (any Java object)*/
class BagOfPrimitives {
  private int value1 = 1;
  private String value2 = "abc";
  private transient int value3 = 3;
  BagOfPrimitives() {
    // no-args constructor
  }
}
BagOfPrimitives obj = new BagOfPrimitives();
String json = gson.toJson(obj);
```

The University Of Sheffield.

Deserialisation

```
BagOfPrimitives obj2 =
    gson.fromJson(jsonString,
                  BagOfPrimitives.class);
```

Expected Object class

Why use it?

- Client server architecture can now return data structures as opposed to HTML code
  - Client can send complex objects (as opposed to just variable-value pairs
  - Client is no longer passive: now it interprets the code and displays it as required

How to return JSON data

```
var http = require('http');

var app = http.createServer(function(req,res){

    res.setHeader('Content-Type', 'application/json');
    res.send(JSON.stringify({ a: 1 }));

});
app.listen(3000);
```

declare that you are returning JSON in header

Stringify the data before sending back

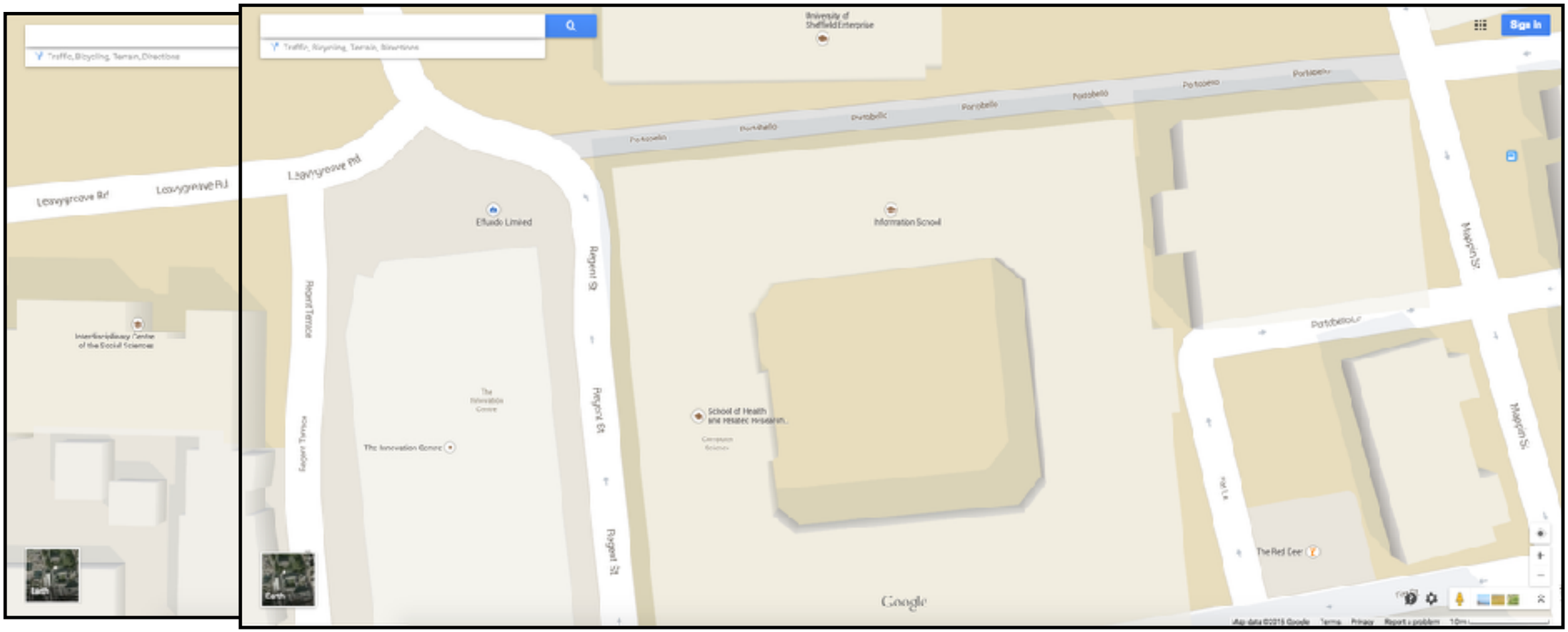
The University Of Sheffield.

Ajax

Asynchronous client-server communication

The traditional Web

- Http protocol is memoryless
- you have to send a complete request every time



- If I want to move towards Mapping Street, typically I would have to send a request for a complete map

Towards a different Client-Server

Ajax: A New Approach to Web Applications
by Jesse James Garrett
http://adaptivepath.com/publications/essays/archives/000385.php

- Classic web application model
  - Most user actions in the interface trigger an HTTP request back to a web server.
  - The server does some processing — retrieving data, crunching numbers, talking to various legacy systems — and then returns an HTML page to the client.
- This approach makes a lot of technical sense, but it doesn't make for a great user experience.
  - While the server is doing its thing, what's the user doing?
  - That's right, waiting.
  - And at every step in a task, the user waits some more.
- Obviously, if we were designing the Web from scratch for applications, we wouldn't make users wait around. Once an interface is loaded, why should the user interaction come to a halt every time the application needs something from the server? In fact, why should the user see the application go to the server at all?

As we have seen HTTP2 is redesigning the web so that the server and the client cooperate to reduce traffic and improve speed

The University Of Sheffield.

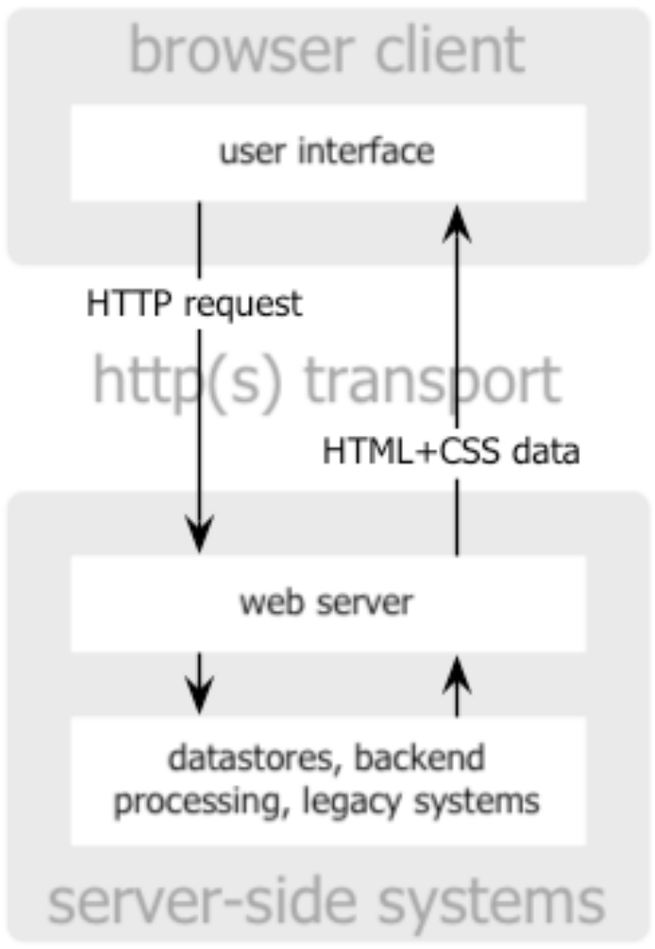
Ajax is different

- An Ajax application eliminates the start-stop-start-stop nature of interaction on the Web by introducing an intermediary — an Ajax engine — between the user and the server
- At the start of the session, the browser loads an Ajax engine (not just a Web page)
  - Written in JavaScript
  - This engine is responsible for both rendering the interface the user sees and communicating with the server on the user's behalf.
- The Ajax engine allows the user's interaction with the application to happen asynchronously — independent of communication with the server. So the user is never staring at a blank browser window and an hourglass icon, waiting around for the server to do something.

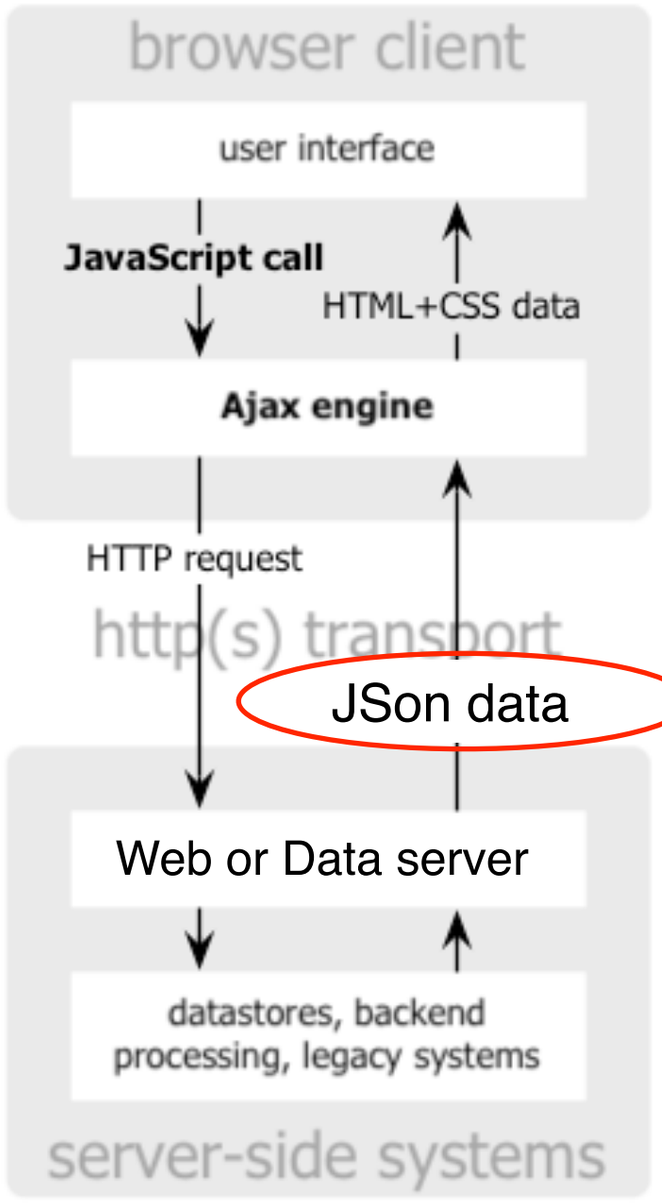
Ajax: A New Approach to Web Applications
by Jesse James Garrett
http://adaptivepath.com/publications/essays/archives/000385.php

The University Of Sheffield.

Ajax: A New Approach to Web Applications
by Jesse James Garrett
http://adaptivepath.com/publications/essays/archives/000385.php



classic
web application model



Ajax
web application model

What does the Ajax engine do?

- Every user action that normally would generate an HTTP request takes the form of a JavaScript call to the Ajax engine instead.
- Any response to a user action that doesn't require a trip back to the server — such as simple data validation, editing data in memory, and even some navigation — the engine handles on its own.
- If the engine needs something from the server in order to respond — if it's submitting data for processing, loading additional interface code, or retrieving new data — the engine makes those requests asynchronously, usually using JSon, without stalling a user's interaction with the application.
- Example:
  - visualise a Google Map http://maps.google.com/
  - grab the top right corner of the map
  - pull towards left bottom corner

Ajax FAQ

- Do Ajax applications always deliver a better experience than traditional web applications?
- A. Not necessarily. Ajax gives interaction designers more flexibility.
  - However, the more power we have, the more caution we must use in exercising it.
  - We must be careful to use Ajax to enhance the user experience of our applications, not degrade it.

http://www.xul.fr/en-xml-ajax.html

A little Ajax program

- Ajax uses a programming model with display and events. These events are user actions, they call functions associated to elements of the web page.
- Interactivity is achieved with forms and buttons.
- To get data on the server, XMLHttpRequest provides two methods:
  - open: create a connection.
  - send: send a request to the server.
- Data returned by the server will be found in the attributes of the XMLHttpRequest object:
  - responseXml for an XML file or
  - responseText for a plain text.

The XMLHttpRequest object

- Allows to interact with the servers, thanks to its methods and attributes

Attributes

readyState	the code successively changes value from 0 to 4 that means for "ready".
status	200 is OK 404 if the page is not found.
responseText	holds loaded data as a string of characters.
responseXml	holds an XML loaded file, DOM's method allows to extract data.
onreadystatechange	property that takes a function as value that is invoked when the readystatechange ev

Methods

open(mode, url, boolean)	mode: type of request, GET or POST url: the location of the file, with a path. boolean: true (asynchronous) / false (synchronous). optionally, a login and a password may be added to arguments.
send("string")	null for a GET command.

The University Of Sheffield.

First step: create an instance

```
if (window.XMLHttpRequest)    // Object of the current windows
{
   xhr = new XMLHttpRequest();    // Firefox, Safari, ...
}
else
 if (window.ActiveXObject)   // ActiveX version
 {
   xhr = new ActiveXObject("Microsoft.XMLHTTP");  // Internet Explorer
 }
```

Second Step: wait for the response

```
xhr.onreadystatechange = function() { // instructions to process the response };

if (xhr.readyState == 4)
{
  // Received, OK
} else
{
  // Wait...
}
```

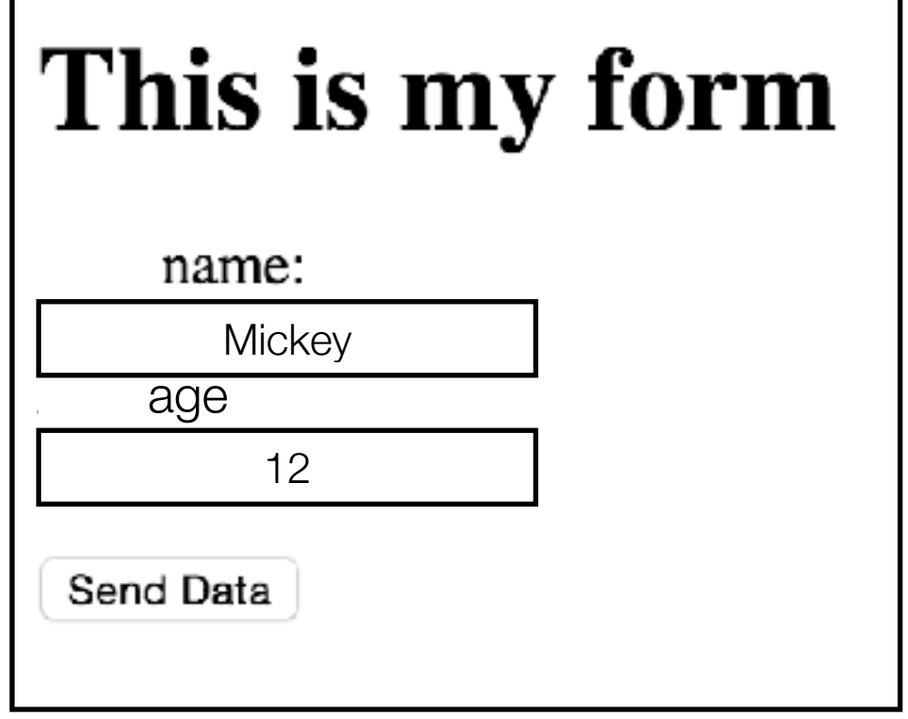
This is the usual JavaScript event based way of working we have seen with node.js

Third step: make the request

- Two methods of XMLHttpRequest are used:
  - open: command GET or POST, URL of the document, true for asynchronous.
  - send: with POST only, the data to send to the server.

- The request below read a document on the server.
  - xhr.open('GET', 'http://www.xul.fr/somefile.xml', true);
  - xhr.send(null);

FORM




```
<!DOCTYPE html>
<html>
<head lang="en">
    <meta charset="UTF-8">
    <title>Ajax form</title>
    <script src="http://ajax.googleapis.com/ajax/libs/jquery/1.11.2/jquery.min.js">
    </script>
</head>
<body>
<h1>This is my form</h1>


<form id="myForm">
    First name:<br>
    <input type="text" name="name" value="Mickey">
    <br>
    Last name:<br>
    <input type="text" name="age" value="12">
    <br><br>
    <INPUT type="BUTTON" value="Send Data"  ONCLICK="submitForm()">
</form>
<body>
```

Complete Code

Create object

Post to server

What to do when server responds

(processChange is a function that will be called)

```
<html><head>
    <script>
    function submitForm() {
       var xhr;
       try {  xhr = new ActiveXObject('Msxml2.XMLHTTP');   }
       catch (e)     {
          try {   xhr = new ActiveXObject('Microsoft.XMLHTTP');    }
          catch (e2)        {
            try {  xhr = new XMLHttpRequest();     }
            catch (e3) {  xhr = false;   }
          }     }
        xhr.onreadystatechange  = processChange;
       xhr.open(POST, "data.txt",  true);
       xhr.setRequestHeader("Content-type","application/x-www-form-urlencoded");
       var namevalue=encodeURIComponent(document.getElementById("name").value)
       var agevalue=encodeURIComponent(document.getElementById("age").value)
       var parameters="name="+namevalue+"&age="+agevalue
        xhr.send(parameters)

    }

function processChange()    {
      if(xhr.readyState  == 4)      {
          if(xhr.status  == 200)
             document.ajax.dyn="Received:"  + xhr.responseText;
          else
            document.ajax.dyn="Error code " + xhr.status;
      }     };

    </script>
    </head>
```

When the function terminates, the request has been sent and the browser is free to do something else

When server responds, do something

Better - use JQuery

```
<head>
<script src="https://ajax.googleapis.com/ajax/libs/jquery/3.3.1/
jquery.min.js"></script>
</head>
…
<script>
sendAjaxQuery(url, data){
    $.ajax({
        url: url,
        type: "POST",
        data: data,
        context: this,
        dataType: 'json',
        error: function () {
          // do something here
        },
        success: function (response) {
          // do something here
        }
    });}
</script>
```

the url to contact

declare the action (POST)

the data to send (no need to stringily if declared datatype is JSON - done automatically by jQuery)

declare a Json interaction

if an error is returned

if 200 is returned

The University Of Sheffield.

What is jQuery?

jQuery is a lightweight, "write less, do more", JavaScript library.

The purpose of jQuery is to make it much easier to use JavaScript on your website.

jQuery takes a lot of common tasks that require many lines of JavaScript code to accomplish, and wraps them into metho
that you can call with a single line of code.

jQuery also simplifies a lot of the complicated things from JavaScript, like AJAX calls and DOM manipulation.

The jQuery library contains the following features:

- HTML/DOM manipulation
- CSS manipulation
- HTML event methods
- Effects and animations
- AJAX
- Utilities

Tip: In addition, jQuery has plugins for almost any task out there.

http://www.w3schools.com/jquery/jquery_intro.asp

If you do not know JQuery, come to the next Web Technology class on Thursday

The University Of Sheffield.

FORM


```
<!DOCTYPE html>
<html>
<head lang="en">
    <meta charset="UTF-8">
    <title>Ajax form</title>
    <script src="http://ajax.googleapis.com/ajax/libs/jquery/1.11.2/jquery.min.js">
    </script>
</head>
<body>
<h1>This is my form</h1>


<form id="myForm" onsubmit="return false;" >
    First name:<br>
    <input type="text" name="firstname" value="Mickey">
    <br>
    Last name:<br>
    <input type="text" name="lastname" value="Mouse">
    <br><br>
    <button id="sendButton" onclick=sendData()>Send Data</button>
</form>
```

FORM MUST return false when Ajax is used

rather than using submit for form, just declare a button and the associated onclick event

Serialise form

```
function sendData() {
    var form = document.getElementById('myForm');
    sendAjaxQuery('/index.html', JSON.stringify(serialiseForm()));
}
```

```
function serialiseForm(){
 var formArray= $("form").serializeArray();
 var data={};
 for (index in formArray){
    data[formArray[index].name]= formArray[index].value;
 }
 return data;
}
```

Ajax

data must be JSON stringify-ed before calling ajax

```
<script>
    function sendAjaxQuery(url, stringified-data) {
    $.ajax({
        url: url ,
        data: stringified-data,
        contentType: 'application/json',
```

You MUST declare type JSON

I suggest to us this rather than dataType: ‘json',
as it may have unpredictable behaviour in my experience

```
        type: 'POST',
        success: function (dataR) {

    // no need to JSON parse the result, as we are using
    // dataType:json, so JQuery knows it and unpacks the
    // object for us before returning it

            var ret = dataR;
            // in order to have the object printed by alert
            // we need to JSON stringify the object
            // otherwise the alert will just print ‘[Object]’
            alert('Success: ' + JSON.stringify(ret));
        },
        error: function (xhr, status, error) {
            alert('Error: ' + error.message);
        }
    });
}
```

Server (routes/index.js)

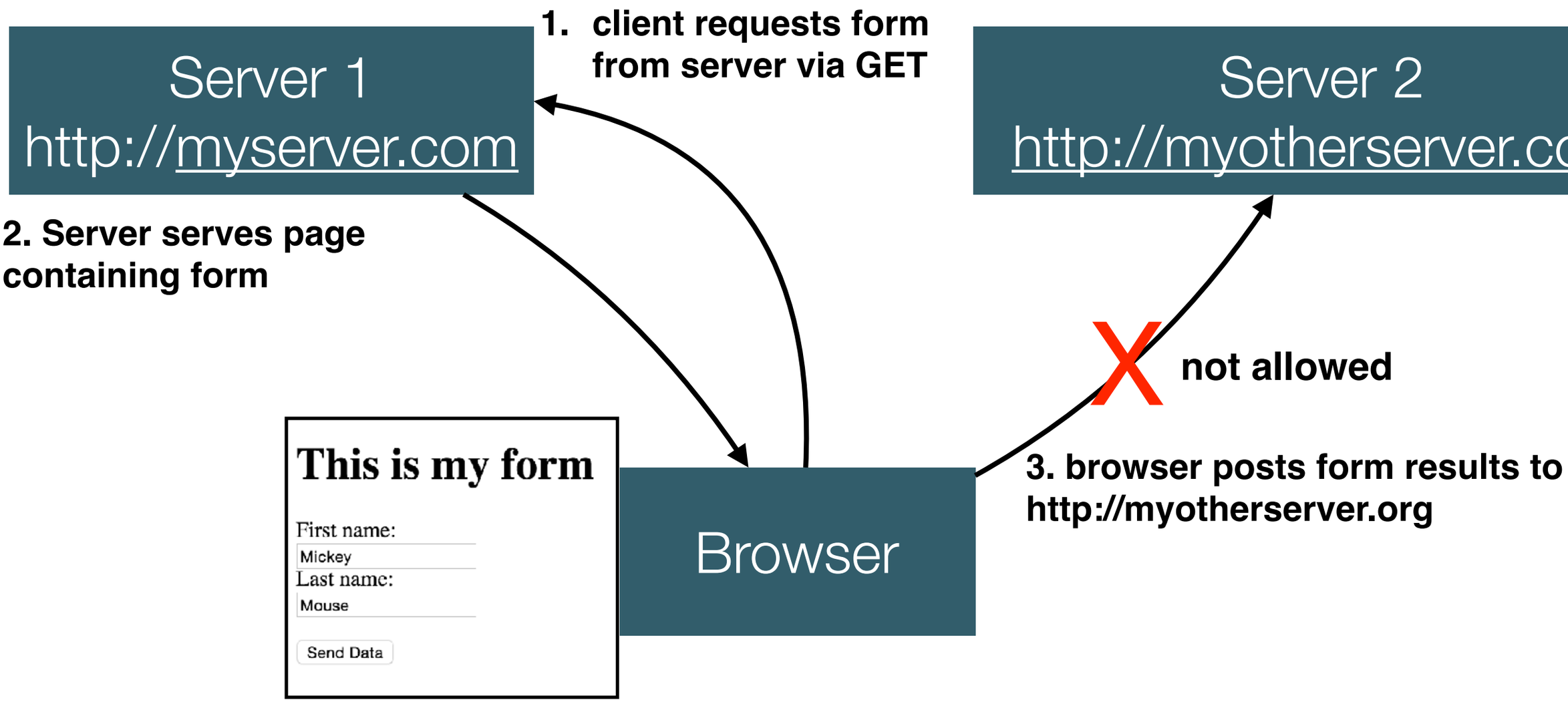
```
var express = require('express');
var router = express.Router();
var bodyParser= require("body-parser");


/* GET home page. */
router.get('/postFile.html', function(req, res, next) {
  res.render('index', { title: 'My Form' });
});

router.post('/postFile.html', function(req, res, next) {
  var body= req.body;
    res.writeHead(200, { "Content-Type": "application/json"});
    res.end(JSON.stringify(body));
});


module.exports = router;
```

You MUST declare type JSON and Stringify before returning

What if…

- if while debugging you ever discover on either side (client or server) that when you expect to receive an object like
  {"firstname":"Mickey","lastname":"Mouse","year":"1900","age":118}
- and instead the data received by body-parser or by Ajax is an object like
  - i.e. an object with the entire expected object as only field
  - **{** '{"firstname":"Mickey","lastname":"Mouse","year":"1900","age":118}' **: ""}**
- **then it means that you are either**
  - **not stringify-ing the data**
  - **OR not using**
    - **contentType**: 'application/json',

Beware! CORS



If the server sending the page is **http://myserver.org:63342,** you are not allowed to post to another server (e.g. http://myotherserever.org:3000). This is to avoid man in the middle attacks. You must post to the same server. You are not even allowed to post the the same server on another port. Origin '**http://myserver.org:63342**' is therefore not even allowed posting to '**http://myserver.org**:3000'.

Beware!

- you must post to the same server serving the html file (including port!) otherwise the browser will refuse to send your request
- To avoid this block, the server *must* declare that the page is allowed to post elsewhere,

i.e. the server serving the html file you must set

- response.writeHead(200,
  {(…)
  '**Access-Control-Allow-Origin' : '**http://myotherserver.org:3000'
  });

See also Cross-origin resource sharing: a simple method to perform cross-domain requests by introducing a small proxy server able to query outside the current domain
There is a simple way of doing it in node.js, php, etc.

CORS! The right way

1. client requests form from server via GET

Server 1
http://myserver.com

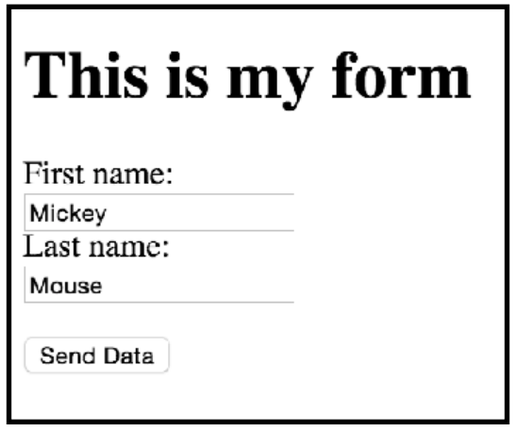
Server 2
http://myotherserver.com

2. Server serves page containing form and specifying

```
response.writeHead(200,
    {(…)
    'Access-Control-Allow-Origin' :
    'http://myotherserver.com});
```

allowed!

Browser



form posts to
http://myotherserver.com/

Never ever ever return
'Access-Control-Allow-Origin' : '*'
as it opens your server to man in the middle attacks

The University Of Sheffield.

Why?

http://stackoverflow.com/questions/10636611/how-does-access-control-allow-origin-header-work

Access-Control-Allow-Origin is a CORS (Cross-Origin Resource Sharing) header.

When Site A tries to fetch content from Site B, Site B can send an Access-Control-Allow-Origin response header to tell the browser that the content of this page is accessible to certain origins. (An origin is a domain, plus a scheme and port number.) By default, Site B's pages are not accessible to any other origin; using the Access-Control-Allow-Origin header opens a door for cross-origin access by specific requesting origins.

For each resource/page that Site B wants to make accessible to Site A, Site B should serve its pages with the response header:

Access-Control-Allow-Origin: http://siteA.com
Modern browsers will not block cross-domain requests outright. If Site A requests a page from Site B, the browser will actually fetch the requested page on the network level and check if the response headers list Site A as a permitted requester domain. If Site B has not indicated that Site A is allowed to access this page, the browser will trigger the XMLHttpRequest's error event and deny the response data to the requesting JavaScript code.

Note

- Please do not confuse posting (i.e. sending data) and getting (retrieving a file)
  - of course you can have gets in any html file pointing to different servers.
  - e.g. this is allowed

```
<head lang="en">
    <meta charset="UTF-8">
    <title>Ajax form</title>
    <script
src="http://ajax.googleapis.com/ajax/libs/jquery/1.11.2/jquery.min.j
    </script>
</head>
```

- You just cannot post elsewhere with a browser without being allowed to do so explicitly by the server
  - so that your personal data is not sent to unauthorised people

The University Of Sheffield.

Callbacks Hell

http://callbackhell.com/

What are callbacks?

- Callbacks are used in asynchronous functions
  - These are functions that take some times to execute
    - E.g. communicating with a server or saving a file
- When you call a normal function you can use its return value immediately:

```
var result = multiplyTwoNumbers(5, 10)
console.log(result)
// 50 gets printed out
```

- But in async functions this cannot be done

```
var photo = downloadPhoto('http://coolcats.com/cat.gif')
// photo is 'undefined'!
```

- the var photo is undefined until the file has finished downloading

ctd

- So instead you store the code that you want to execute at the end of the downloading as a callback function

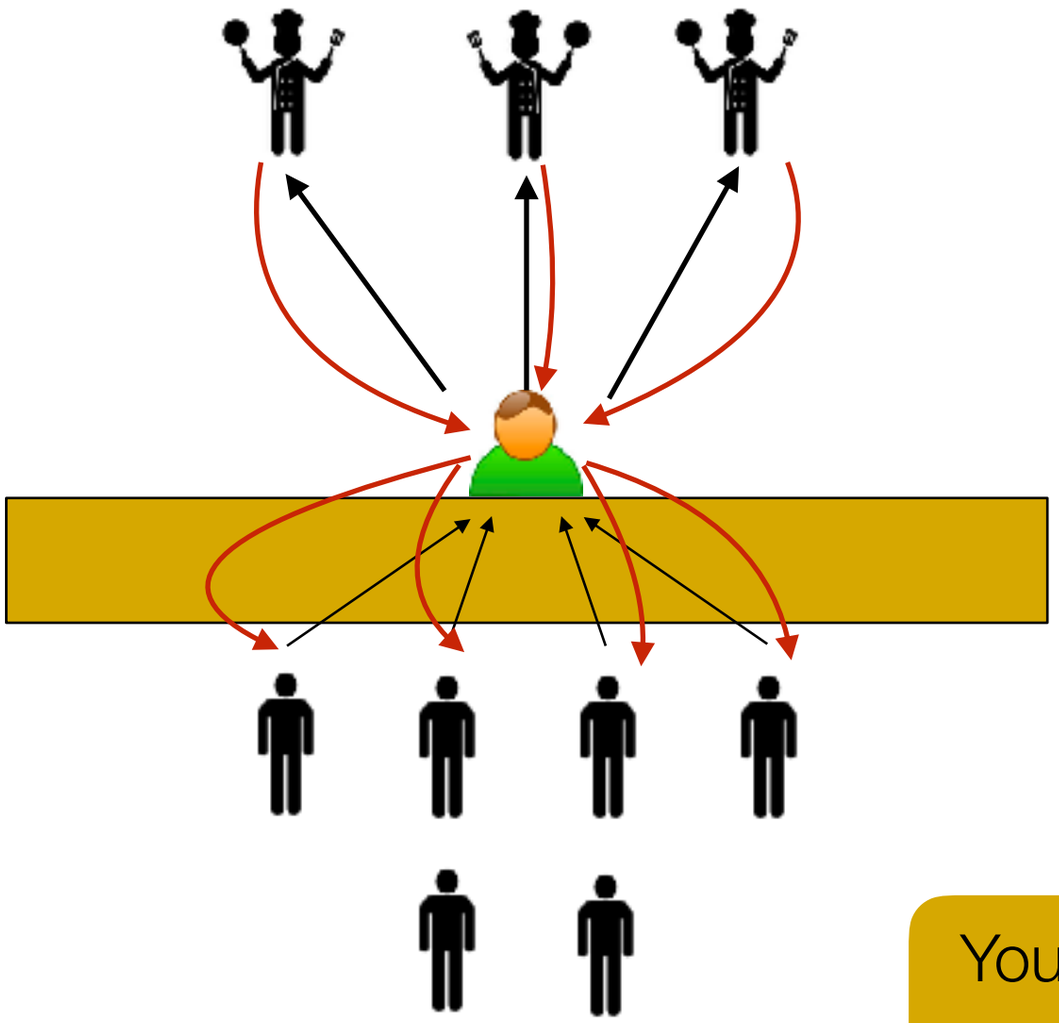
```
downloadPhoto('http://coolcats.com/cat.gif', handlePhoto)

function handlePhoto (error, photo) {
  if (error) console.error('Download error!', error)
  else console.log('Download finished', photo)
}

console.log('Download started')
```

- Log on console:
  - Download started
  - …
  - Download finished (show photo)

Event Driven and non-

Remember the last lecture?

- This is very similar to a fast food outlet organisation



- Requests are posted to the till (the node.js server) which will direct them to the right cook (e.g. a database)
- When the cooks has prepared the food (the data), the counter (node.js server) will return it to the client
- While the food is being prepared, the till can serve other requests

You cannot start eating immediately after ordering. You must wait for the food to arrive first

How do I fix callback hell?

- Keep your code shallow

```
var form = document.querySelector('form')
form.onsubmit = function (submitEvent) {
  var name = document.querySelector('input').value
  request({
    uri: "http://example.com/upload",
    body: name,
    method: "POST"
  }, function (err, response, body) {
    var statusMessage = document.querySelector('.status')
    if (err) return statusMessage.value = err
    statusMessage.value = body
  })
}
```

This code has two anonymous functions. Let's give em names!

```
var form = document.querySelector('form')
form.onsubmit = function formSubmit (submitEvent) {
  var name = document.querySelector('input').value
  request({
    uri: "http://example.com/upload",
    body: name,
    method: "POST"
  }, function postResponse (err, response, body) {
    var statusMessage = document.querySelector('.status')
    if (err) return statusMessage.value = err
    statusMessage.value = body
  })
}
```

The University Of Sheffield.

shallow (ctd)

As you can see naming functions is super easy and has some immediate benefits:

- makes code easier to read thanks to the descriptive function names
- when exceptions happen you will get stacktraces that reference actual function names instead of "anonymous"
- allows you to move the functions and reference them by their names

Now we can move the functions to the top level of our program:

```
document.querySelector('form').onsubmit = formSubmit

function formSubmit (submitEvent) {
  var name = document.querySelector('input').value
  request({
    uri: "http://example.com/upload",
    body: name,
    method: "POST"
  }, postResponse)
}

function postResponse (err, response, body) {
  var statusMessage = document.querySelector('.status')
  if (err) return statusMessage.value = err
  statusMessage.value = body
}
```

Always handle errors

The first two rules are primarily about making your code readable, but this one is about making your code stable. When dealing with callbacks you are by definition dealing with tasks that get dispatched, go off and do something in the background, and then complete successfully or abort due to failure. Any experienced developer will tell you that you can never know when these errors happen, so you have to plan on them always happening.

With callbacks the most popular way to handle errors is the Node.js style where the first argument to the callback is always reserved for an error.

```
var fs = require('fs')

fs.readFile('/Does/not/exist', handleFile)

function handleFile (error, file) {
  if (error) return console.error('Uhoh, there was an error', error)
  // otherwise, continue on and use `file` in your code
}
```

Having the first argument be the `error` is a simple convention that encourages you to remember to handle your errors. If it was the second argument you could write code like `function handleFile (file) { }` and more easily ignore the error.

Code linters can also be configured to help you remember to handle callback errors. The simplest one to use is called **standard**. All you have to do is run `$ standard` in your code folder and it will show you every callback in your code with an unhandled error.

Callbacks in callbacks

- The callback hell does not stop there
- You can understand the callback function and forget about it when you are inside a callback itself
- Example:
  - create a server that
    - retrieves a set of photos from another server
    - return the whole set of photos as one zipped file
- I am sure you know what to do by now
  - you will have two functions: one to retrieve the photos and one to zip them

A very common error

- Most people will do this

This will not do what you expect (aka the code is wrong!!)

Also, I have not checked if the Javascript is completely correct - it is the spirit that is important

```
var listofphotos= [‘cat.gif’, ‘dog.gif’, ‘giraffe.gif’];
for (var ph as listofphotos)
   downloadPhoto(ph, function handlePhoto (error, photo) {
            if (error) console.error('Download error!', error)
            else photolist.push (photo);
}

zipPhotos(aCallbackofChoice, photolist);    // we suppose there is a callback
                                                // function of choice defined
```

A very common error

```
var photolist= [];
// function that gets a list of photos taken from the file system and zips it
// and returns some metadata (e.g. average image size and number of photos) */
function zipPhotos(functionDoingStuff, photolist){
  var numOfPhotos=photolist.length;
  var totSize=0;
  for (var photo as photolist)
    totalSize+=getFileSize(photo);  // we suppose to have defined somewhere a
                                    // function getting the size of a file
var averageSize=totalSize/numOfPhotos;
var zippedPhotos= zipFiles(photolist); // we suppose to have defined
                                       // somewhere a
                                       // function zipping a set of files
functionDoingStuff(null,{numOfPhotos: numOfPhotos, averageSize: averageSize
                         zippedPhotos: zippedPhotos});
}
```

The University Of Sheffield.

Why?

- This code is wrong
  - zipphotos will receive an empty list of files
  - zipPhotos will be called before all the callbacks have finished
- Even worse:
  - this code will seem to work
- that is because sometimes - the download of the photos is fast enough for zipPhotos to find some files in the list, while the loop in zip photos is run, some photos are added to the variable list-photos
- So the user thinks this is working but it will be by chance: very often lots of photos will be missed.
    - It is the worst that can happen to you as a programmer:
      - an inexplicably temperamental program with bugs you are unlikely to be able to recreate in testing conditions

But this is equivalent

- To go to the burger stall and thinking that you can start eating immediately after paying
  - Now, sometimes you could be able to do just that because maybe the fries are quick to come and after you have finished inputting your credit card pin code, they are already on the tray
- So
    - you eat the fries
    - see the tray is empty
    - you leave
    - when the burger comes you have already left
      - (and you are still hungry!)
- So remember to make sure that you wait for all your food before leaving

More clever people will

This will not do what you expect (aka the code is wrong!!)

Also, I have not checked if the Javascript is completely correct - it is the spirit that is important

```
for (var ph as listofphotos)
   downloadPhoto(ph, function handlePhoto (error, photo) {
          if (error) console.error('Download error!', error)
          else {
          photolist.push (photo);
          zipPhotos(photolist, aCallbackofChoice);
```

- This is even worse
  - Your callback will be called several times, you will get a number of zipped filed all containing one photo
    - if your callback returns to the client, it will always just return the zipped cat

The University Of Sheffield.

So how do you do it?

- Exactly as the burger joint does
- You keep a list of all the items you have to receive
- then you keep track of the items you have received
- when you have received them all, you leave

The University Of Sheffield.

McDonald's Restaurant #4525
NORTH 3416 MARKET
SPOKANE,WA 99207
TEL# 509 489 9723

KS# 3 09/12/2017 08:42 AM
Side1 Order 75

1 Egg Cheese Biscuit	2.69
1 L Coke	1.00
Subtotal	3.69
Tax	0.32
Eat-In Total	4.01

So how do you do it?

- You keep a list of all the items you have to receive
- When the callback realises that all the elements have been processed,
  - it will call the final function

```
for (var ph as listofphotos)
  downloadPhoto(ph, function handlePhoto (error, photo
 {
        if (error) console.error('Download error!', er
        else {
            photolist.push (photo);
            if (photolist.length==listofphotos.length
              zipPhotos(photolist, aCallbackofChoice
```

now you are sure that photos contains all the pictures required

The University Of Sheffield.

You must understand how to get out of the callback hell

So that you can sleep peacefully at night

The University Of Sheffield.

But you must avoid to find yourself in one at all cost

Although that is not always possible, we will now see a mechanism to avoid most (although not all) cases

The University Of Sheffield.

Promises

Escaping the callback hell

https://scotch.io/tutorials/javascript-promises-for-dummies

Promises

- Promises are a way to create asynchronous code that allows easy sequencing of async processes
  - Following a very familiar structure:
    - if x
    - do Y
    - then do W
    - then do Z
- where
  - every .then branch is called when the results of the previous branch is returned
  - every part of this code is asynchronous
  - every synch part if executed in sequence

Promises

https://scotch.io/tutorials/javascript-promises-for-dummies

- Imagine you are a kid. Your mom promises you that she'll get you a new phone next week.
  - You don't know if you will get that phone until next week.
  - Your mom can either really buy you a brand new phone
  - Or stand you up and withhold the phone if she is not happy
- A promise has 3 states:
  - Pending:
    - You don't know if you will get that phone until next week.
  - Resolved:
    - Your mom really buy you a brand new phone.
  - Rejected:
    - You don't get a new phone because your mom is not happy


```
/* ES5 */
var isMomHappy = false;

// Promise
var willIGetNewPhone = new Promise(
    function (resolve, reject) {
        if (isMomHappy) {
            var phone = {
                brand: 'Samsung',
                color: 'black'
            };
            resolve(phone); // fulfilled
        } else {
            var reason = new Error('mom is not happy');
            reject(reason); // reject
        }

    }
);
```

- The code is quite expressive in itself.
  - We have a boolean isMomHappy, to define if mom is happy.
  - We have a promise willIGetNewPhone.
    - The promise can be either resolved (if mom get you a new phone)
    - or rejected(mom is not happy, she doesn't buy you one).

- Syntax:

```
new Promise(/* executor*/ function (resolve, reject) { ... } );
```

when the result is successful, call `resolve(your_success_value)`,
if the result fails, call `reject(your_fail_value)` in your promise.

If mom is happy, we will get a phone.

Therefore, we call `resolve` function with `phone` variable.
If mom is not happy, we will call `reject` function with a reason `reject(reason)`;

Consuming Promises

- So far we have just defined the behaviour of the promise.
  - We have not started the counter to the day we will get the phone
- Consuming a promise means to activate them,
  - i.e. when we fire the rule and check if mum is happy and therefore we will get the phone

The University Of Sheffield.

Here is our promise declaration again

remember: if it is successful we receive an object of type phone

if unsuccessful we get an error string

```
/* ES5 */
var isMomHappy = false;

// Promise
var willIGetNewPhone = new Promise(
    function (resolve, reject) {
        if (isMomHappy) {
            var phone = {
                brand: 'Samsung',
                color: 'black'
            };
            resolve(phone); // fulfilled
        } else {
            var reason = new Error('mom is not happy');
            reject(reason); // reject
        }

    }
);
```

The University Of Sheffield.

consuming the promise:

if the promise was successful we show the phone to our friends on the console
(note: you should really stringily the object to see it properly on the console)

Otherwise we explain to our friends why we did not get it

```
/* ES5 */
...

// call our promise
var askMom = function () {
    willIGetNewPhone
        .then(function (fulfilled) {
            // yay, you got a new phone
            console.log(fulfilled);
        // output: { brand: 'Samsung', color: 'black' }
        })
        .catch(function (error) {
            // oops, mom don't buy it
            console.log(error.message);
         // output: 'mom is not happy'
        });
};

askMom();
```

- A function called `askMom` will consume our promise `willIGetNewPhone`
- We want to take some action once the promise is resolved or rejected
  - `.then function(fulfilled)`
    - The fulfilled value is the value you passed in the promise `resolve(your_success_value)`
      - phone in our example
- `.catch function(error){ ... }`
  - Catch will receive the value passed in `reject(your_fail_value)`
    - . The reason for not buying the phone in our example

Chaining Promises

- Let's say, you, the kid, promise your friend that you will show them the new phone when your mom buy you one. This is a promise based on the outcome of another promise

```
// 2nd promise
var showOff = function (phone) {
    return new Promise(
        function (resolve, reject) {
            var message = 'Hey friend, I have a new ' +
                phone.color + ' ' + phone.brand + ' phone';

            resolve(message);
        }
    );
```

- In this example, we didn't call the `reject`. It's optional.
- We can shorten this sample like using `Promise.resolve` instead.

```
// 2nd promise
var showOff = function (phone) {
    var message = 'Hey friend, I have a new ' +
                phone.color + ' ' + phone.brand + ' phone';

    return Promise.resolve(message);
};
```

Chaining

```
// call our promise
var askMom = function () {
    willIGetNewPhone
    .then(showOff) // chain it here
        .then(function (fulfilled) {
            console.log(fulfilled);
         // output: 'Hey friend, I have a new black Samsung phone.'
        })
        .catch(function (error) {
            // oops, mom don't buy it
            console.log(error.message);
         // output: 'mom is not happy'
        });
};
```

Two promises concatenated each of them is async (you do not know when mum buy it will, you do not know when you will see your friends but you know the events will happen in that order and one is the direct consequence of the other)

Action based on return of last promise

Call Back Hell

- Concatenation allows escaping the callback hell
  - because with promises, we flatten the callback with .then. In a way, it looks cleaner because of no callback nesting.

```
addAsync(1, 2, success => {
    // callback 1
    resultA = success; // you get result = 3 here

    addAsync(resultA, 3, success => {
        // callback 2
        resultB = success; // you get result = 6 here

        addAsync(resultB, 4, success => {
            // callback 3
            resultC = success; // you get result = 10 he

            console.log('total' + resultC);
            console.log(resultA, resultB, resultC);
```

```
addAsync(1, 2)
    .then(success => {
        resultA = success;
        return resultA;
    })
    .then(success => addAsync(success, 3))
    .then(success => {
        resultB = success;
        return resultB;
    })
    .then(success => addAsync(success, 4))
    .then(success => {
        resultC = success;
        return resultC;
    })
```

ES6 / ES2015

- Different versions of Javascript have improved expressivity
  - ES6 supports promises natively.
  - In addition we can further simplify the code with fat arrow =>
    - and use **`const`** (constants) and **`let`** (variables local to the block)

- Note: if you want to use ES6 in IntelliJ you must enable ES6
  - https://hackernoon.com/quickstart-guide-to-using-es6-with-babel-node-and-intellij-a83670afbc49
  - read until the math example, the rest is irrelevant

```
/* ES6 */
const isMomHappy = true;

// Promise
const willIGetNewPhone = new Promise(
    (resolve, reject) => { // fat arrow
        if (isMomHappy) {
            const phone = {
                brand: 'Samsung',
                color: 'black'
            };
            resolve(phone);
        } else {
            const reason = new Error('mom is not happy');
            reject(reason);
        }
```

```
const showOff = function (phone) {
    const message = 'Hey friend, I have a new ' +
                phone.color + ' ' + phone.brand + ' phone';
    return Promise.resolve(message);
};

// call our promise
const askMom = function () {
    willIGetNewPhone
        .then(showOff)
        .then(fulfilled => console.log(fulfilled)) // fat arrow
        .catch(error => console.log(error.message)); // fat arrow
};

askMom();
```

The University Of Sheffield.

Connecting to MySQL

Connecting to DB

MySQL

Module: mysql
Installation

http://expressjs.com/guide/database-integration.html

```
$ npm install mysql
```

Example

```
var mysql      = require('mysql');
var connection = mysql.createConnection({
  host     : 'localhost',
  user     : 'dbuser',
  password : 's3kreee7'
});

connection.connect();

connection.query('SELECT 1 + 1 AS solution', function(err, rows, fields) {
  if (err) throw err;
  console.log('The solution is: ', rows[0].solution);
});

connection.end();
```

The callback has the same syntax as the standard nodejs one

More Express

Things you should be sure to know before starting doing something sophisticated in Express

The University Of Sheffield.

Defining user variables

either lasting until you turn off the server
or lasting for the duration of the request

app.locals

app.locals

The `app.locals` object is a JavaScript object, and its properties are local variables within the application.

```
app.locals.title
// => 'My App'

app.locals.email
// => 'me@myapp.com'
```

Once set, the value of `app.locals` properties persist throughout the life of the application, in contrast with res.locals properties that are valid only for the lifetime of the request.

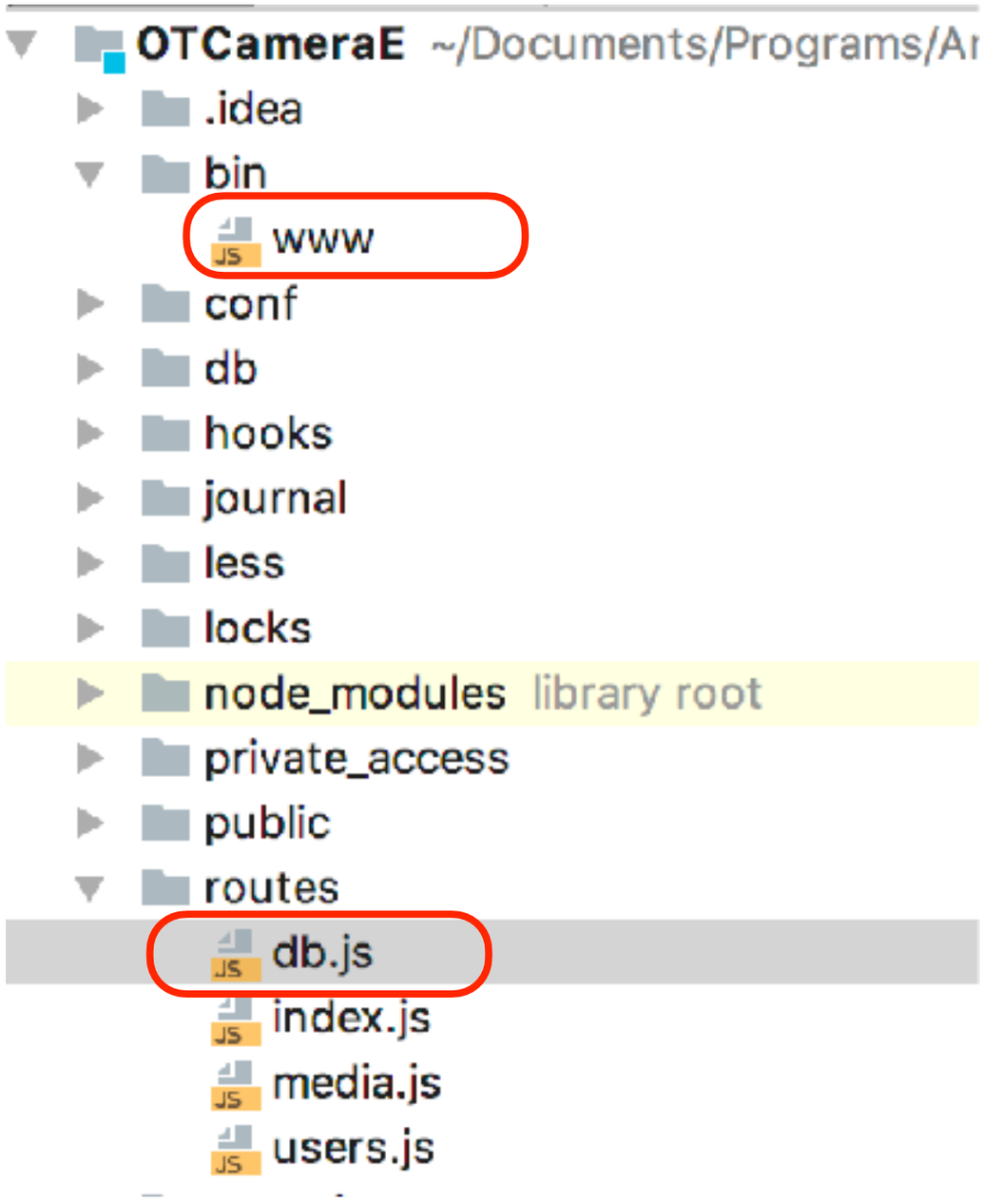
You can accesss local variables in templates rendered within the application. This is useful for providing helper functions to templates, as well as app-level data. Note, however, that you cannot access local variables in middleware.

```
app.locals.title = 'My App';
app.locals.strftime = require('strftime');
app.locals.email = 'me@myapp.com';
```

- **app.locals** variables persist for the lifetime of the server
- **res.locals** for the lifetime of the request
- (all the above are user-defined variables)

why you want to use it?

- app.locals is typically used to pass data across routes



db route

```
router.post('/find_clients_from_remote', function (req, res) {
    console.log('find_clients_from_remote: ');
    var body = req.body;
    Database.getClient(body, function (err, dataX) {
        if (err || dataX.length == 0) {
            res.writeHead(400);
            res.end(err || 'user not found');
        } else {
            dataX = dataX[0];
            console.log('found client ' + JSON.stringify(dataX));
            var cidX = dataX._id.toString();
            console.log('cidx ' + cidX);

            // if cid is inexistent it means it is not available
            if (isUndefined(cidX)) {
                console.log('cidx (NOT passed test) ' + cidX);
                res.writeHead(400);
                err = {status: 400, statusText: 'user not found'};
                res.end(JSON.stringify(err));
                return;
            }
            console.log('cidx (Passed test) ' + cidX);
            var npo = req.app.locals.getNewRoom();
            console.log(JSON.stringify(npo));
            var data = {
                cid: cidX.
```

ignore this part, it is irrelevant

app locals is retrieved using the request object

bin/www

```
function getNewRoom() {
    var ctrlRoomId = Math.floor((Math.random() * 10000) + 1);
    var useridCitizen = Math.floor((Math.random() * 10000) + 1);
    var roomid = Math.floor((Math.random() * 100000) + 1);
    var password = Math.floor((Math.random() * 100000) + 1);
    app.locals.allowedCtrlRooms["CR" + ctrlRoomId] = "R" + roomid;
    app.locals.allowedCitRooms["CT" + useridCitizen] = "R" + roomid;
    app.locals.validPorts["R" + roomid] = "P" + password;
    return ([roomid, ctrlRoomId, useridCitizen, password]);
}

app.locals.getNewRoom= getNewRoom;
```

ignore this part, it is irrelevant

note: it is not assigned using the request object

Request parameter

http://expressjs.com/4x/api.html

req.hostname

Contains the hostname from the "Host" HTTP header.

```
// Host: "example.com:3000"
req.hostname
// => "example.com"
```

req.ip

The remote IP address of the request.

If the `trust proxy` is setting enabled, it is the upstream address; see Express behind proxies for more information.

```
req.ip
// => "127.0.0.1"
```

req.path

Contains the path part of the request URL.

```
// example.com/users?sort=desc
req.path
// => "/users"
```

req.protocol

The request protocol string, "http" or "https" when requested with TLS. When the "trust proxy" setting trusts the socket address, the value of the "X-Forwarded-Proto" header ("http" or "https") field will be trusted and used if present.

```
req.protocol
// => "http"
```

req.query

An object containing a property for each query string parameter in the route. If there is no query string, it is the empty object, `{}`.

```
// GET /search?q=tobi+ferret
req.query.q
// => "tobi ferret"

// GET /shoes?order=desc&shoe[color]=blue&shoe[type]=converse
req.query.order
// => "desc"
```

req.accepts(types)

Checks if the specified content types are acceptable, based on the request's `Accept` HTTP header field. The method returns the best match, or if none of the specified content types is acceptable, returns `undefined` (in which case, the application should respond with `406 "Not Acceptable"`).

The `type` value may be a single MIME type string (such as "application/json"), an extension name such as "json", a comma-delimited list, or an array. For a list or array, the method returns the ***best*** match (if any).

```
// Accept: text/html
req.accepts('html');
// => "html"

// Accept: text/*, application/json
req.accepts('html');
// => "html"
req.accepts('text/html');
// => "text/html"
req.accepts('json, text');
// => "json"
req.accepts('application/json');
// => "application/json"

// Accept: text/*, application/json
req.accepts('image/png');
req.accepts('png');
// => undefined

// Accept: text/*;q=.5, application/json
req.accepts(['html', 'json']);
req.accepts('html, json');
// => "json"
```

req.get(field)

Returns the specified HTTP request header field (case-insensitive match). The `Referrer` and `Referer` fields are interchangeable.

```
req.get('Content-Type');
// => "text/plain"

req.get('content-type');
// => "text/plain"

req.get('Something');
// => undefined
```

Aliased as `req.header(field)`.

req.is(type)

Returns `true` if the incoming request's "Content-Type" HTTP header field matches the MIME type specified by the `type` parameter. Returns `false` otherwise.

```
// With Content-Type: text/html; charset=utf-8
req.is('html');
req.is('text/html');
req.is('text/*');
// => true

// When Content-Type is application/json
req.is('json');
req.is('application/json');
req.is('application/*');
// => true
```

The University Of Sheffield.

Getting parameters (POST)

http://stackoverflow.com/questions/5710358/how-to-get-post-query-in-express-node-js

```
var bodyParser = require('body-parser')
// to support JSON-encoded bodies
app.use( bodyParser.json() );

//OR to support URL-encoded bodies (i.e. forms)
app.use(bodyParser.urlencoded({
 extended: true
}));

.. in your route

// assuming POST: name=foo&color=red      <-- URL encoding
// OR POST: {"name":"foo","color":"red"}  <-- JSON encoding

app.post('/test-page', function(req, res) {
    var name = req.body.name,
        color = req.body.color;
});
```

The University Of Sheffield.

Response object

res.attachment([filename])

Sets the HTTP response `Content-Disposition` header field to "attachment". If a `filename` is given, then it sets the Content-Type based on the extension name via `res.type()`, and sets the `Content-Disposition` "filename=" parameter.

```
res.attachment();
// Content-Disposition: attachment

res.attachment('path/to/logo.png');
// Content-Disposition: attachment; filename="logo.png"
// Content-Type: image/png
```

res.end([data] [, encoding])

Ends the response process. Inherited from Node's http.ServerResponse.

Use to quickly end the response without any data. If you need to respond with data, instead use methods such as res.send() and res.json().

```
res.end();
res.status(404).end();
```

res.json([body])

Sends a JSON response. This method is identical to `res.send()` with an object or array as the parameter. However, you can use it to convert other values to JSON, such as `null`, and `undefined`. (although these are technically not valid JSON).

```
res.json(null)
res.json({ user: 'tobi' })
res.status(500).json({ error: 'message' })
```

Response methods

The methods on the response object (`res`) in the following table can send a response to the client and terminate the request response cycle. If none of them is called from a route handler, the client request will be left hanging.

Method	Description
res.download()	Prompt a file to be downloaded.
res.end()	End the response process.
res.json()	Send a JSON response.
res.jsonp()	Send a JSON response with JSONP support.
res.redirect()	Redirect a request.
res.render()	Render a view template.
res.send()	Send a response of various types.
res.sendFile	Send a file as an octet stream.
res.sendStatus()	Set the response status code and send its string representation as the response body.

- very similar to node.js basic methods

By the way Jsonp

https://en.wikipedia.org/wiki/JSONP

- JSONP is a trick that allows a web browser
  - to fetch JSON data from a JSON server and
  - feed them to a Javascript script in the browser.

```
<script type="application/javascript"
        src="http://server.example.com/Users/1234?callback=parseResponse">
</script>
…
<script>
  function parseResponse(param){
    …
  }
</script>
```

Response: redirection

res.redirect([status,] path)

> Express passes the specified URL string as-is to the browser in the `Location` header, without any validation or manipulation, except in case of `back`.
>
> Browsers take the responsibility of deriving the intended URL from the current URL or the referring URL, and the URL specified in the `Location` header; and redirect the user accordingly.

Redirects to the URL dervied from the specified `path`, with specified HTTP status code `status`. If you don't specify `status`, the status code defaults to "302 "Found".

```
res.redirect('/foo/bar');
res.redirect('http://example.com');
res.redirect(301, 'http://example.com');
res.redirect('../login');
```

Redirects can be a fully-qualified URL for redirecting to a different site:

```
res.redirect('http://google.com');
```

Redirects can be relative to the root of the host name. For example, if the application is on `http://example.com/admin/post/new`, the following would redirect to the URL `http://example.com/admin`:

```
res.redirect('/admin');
```

A `back` redirection redirects the request back to the referer, defaulting to `/` when the referer is missing.

```
res.redirect('back');
```

note! useful for login requests!!!

res.send([body])

Sends the HTTP response.

The `body` parameter can be a `Buffer` object, a `String`, an object, or an `Array`. For example:

```
res.send(new Buffer('whoop'));
res.send({ some: 'json' });
res.send('<p>some html</p>');
res.status(404).send('Sorry, we cannot find that!');
res.status(500).send({ error: 'something blew up' });
```

This method performs many useful tasks for simple non-streaming responses: For example, it automatically assigns the `Content-Length` HTTP response header field (unless previously defined) and provides automatic HEAD and HTTP cache freshness support.

When the parameter is a `Buffer` object, the method sets the `Content-Type` response header field to "application/octet-stream", unless previously defined as shown below:

```
res.set('Content-Type', 'text/html');
res.send(new Buffer('<p>some html</p>'));
```

When the parameter is a `String`, the method sets the `Content-Type` to "text/html":

```
res.send('<p>some html</p>');
```

When the parameter is an `Array` or `Object`, Express responds with the JSON representation:

```
res.send({ user: 'tobi' });
res.send([1,2,3]);
```

res.sendStatus(statusCode)

Set the response HTTP status code to `statusCode` and send its string representation as the response body.

```
res.sendStatus(200); // equivalent to res.status(200).send('OK')
res.sendStatus(403); // equivalent to res.status(403).send('Forbidden')
res.sendStatus(404); // equivalent to res.status(404).send('Not Found')
res.sendStatus(500); // equivalent to res.status(500).send('Internal Server Error')
```

If an unsupported status code is specified, the HTTP status is still set to `statusCode` and the string version of the code is sent as the response body.

```
res.sendStatus(2000); // equivalent to res.status(2000).send('2000')
```

res.set(field [, value])

Sets the response's HTTP header `field` to `value`. To set multiple fields at once, pass an object as the parameter.

```
res.set('Content-Type', 'text/plain');

res.set({
  'Content-Type': 'text/plain',
  'Content-Length': '123',
  'ETag': '12345'
})
```

Aliased as `res.header(field [, value])`.

res.status(code)

Use this method to set the HTTP status for the response. It is a chainable alias of Node's response.statusCode.

```
res.status(403).end();
res.status(400).send('Bad Request');
res.status(404).sendFile('/absolute/path/to/404.png');
```

res.type(type)

Sets the `Content-Type` HTTP header to the MIME type as determined by mime.lookup() for the specified `type`. If `type` contains the "/" character, then it sets the `Content-Type` to `type`.

```
res.type('.html');              // => 'text/html'
res.type('html');               // => 'text/html'
res.type('json');               // => 'application/json'
res.type('application/json');   // => 'application/json'
res.type('png');                // => image/png:
```

The University Of Sheffield.

IntelliJ does it for you

Express application generator

Use the application generator tool, `express`, to quickly create a application skeleton.

Install it with the following command.

```
$ npm install express-generator -g
```

Display the command options with the `-h` option:

```
$ express -h

  Usage: express [options] [dir]

  Options:

    -h, --help          output usage information
    -V, --version       output the version number
    -e, --ejs           add ejs engine support (defaults to jade)
        --hbs           add handlebars engine support
    -H, --hogan         add hogan.js engine support
    -c, --css <engine>  add stylesheet <engine> support (less|stylus|compass) (defaults to plain css)
    -f, --force         force on non-empty directory
```

For example, the following creates an Express app named ***myapp*** in the current working directory.

```
$ express myapp

   create : myapp
   create : myapp/package.json
   create : myapp/app.js
   create : myapp/public
   create : myapp/public/javascripts
   create : myapp/public/images
   create : myapp/routes
   create : myapp/routes/index.js
   create : myapp/routes/users.js
   create : myapp/public/stylesheets
   create : myapp/public/stylesheets/style.css
   create : myapp/views
   create : myapp/views/index.jade
   create : myapp/views/layout.jade
   create : myapp/views/error.jade
   create : myapp/bin
   create : myapp/bin/www
```

Then install dependencies:

```
$ cd myapp
$ npm install
```

The University Of Sheffield.

Questions?