1

#03 Socket Programming

CLIENT/SERVER COMPUTING AND WEB TECHNOLOGIES

2

#Take tutorial at
http://www.codecademy.com/en/tracks/javascript

Intro to JavaScript

Language basics

3

- JavaScript and Java have the common C syntax, but unrelated.
- JavaScript is case sensitive
- Statements terminated by returns or semi-colons (;)
  - x = x+1; same as x = x+1
  - Semi-colons can be a good idea, to reduce errors
- "Blocks"
  - Group statements using { … }
  - Not a separate scope, unlike other languages
- Variables
  - Define a variable using the var statement
  - Define implicitly by its first use, which must be an assignment
    - Implicit definition has global scope, even if it occurs in nested scope?

JavaScript blocks

4

- Use { } for grouping; not a separate scope

```
js> var x=3;
js> x
3
js> {var x=4; x}
4
js> x
4
```

- Not blocks in the sense of other languages
  - Only function calls and the *with* statement cause a change of scope

JavaScript primitive datatypes

5

- Boolean
  - Two values: *true* and *false*
- Number
  - 64-bit floating point, similar to Java double and Double
  - No integer type
  - Special values *NaN* (not a number) and *Infinity*
- String
  - Sequence of zero or more Unicode characters
  - No separate character type (just strings of length 1)
  - Literal strings using ' or " characters (must match)
- Special values
  - *null* and *undefined*
  - *typeof(null) = object; typeof(undefined)=undefined*

Objects

6

- An object is a collection of named properties
  - Simple view: hash table or associative array
  - Can define by set of name:value pairs
    - objBob = {name: "Bob", grade: 'A', level: 3};
  - New members can be added at any time
    - objBob.fullname = 'Robert';
  - Can have methods, can refer to *this*
- Arrays, functions regarded as objects
  - A property of an object may be a function (=method)
  - A function defines an object with method called "( )"

```
function max(x,y) { if (x>y) return x; else return y;};
max.description = "return the maximum of two
 arguments";
```

Function Examples

- Anonymous functions make great callbacks

```
setTimeout(function() {
    console.log("done");
  }, 10000)
```

- Curried function

```
function CurriedAdd(x){
  return function(y){ return x+y}
};
g = CurriedAdd(2);
g(3)
```

- Variable number of arguments

```
function sumAll() {
   var total=0;
   for (var i=0; i< sumAll.arguments.length; i++)
        total+=sumAll.arguments[i];
   return(total);
}
sumAll(3,5,3,5,3,2,6);
```


Intro to Node.js

Node.js

- Evented I/O for V8 JavaScript with a goal of an easy way to build scalable network programs.
- High-performance **network applications framework**, well optimized for high concurrent environments.
- It's a **command line** tool.
- Node.js uses an **event-driven, non-blocking I/O** model, which makes it lightweight.
- It makes use of **event-loops** via JavaScript's **callback** functionality to implement the non-blocking I/O.
- Programs for Node.js are written in JavaScript but not in the same JavaScript we are use to. There is no DOM implementation provided by Node.js, i.e. you **can not** do this:

```
var element = document.getElementById("elementId");
```

- Everything inside Node.js runs in a **single-thread**.

Getting Started & Hello World

- Install/build Node.js.
- Open your favorite editor and start typing JavaScript.
- When you are done, open cmd/terminal and type this:

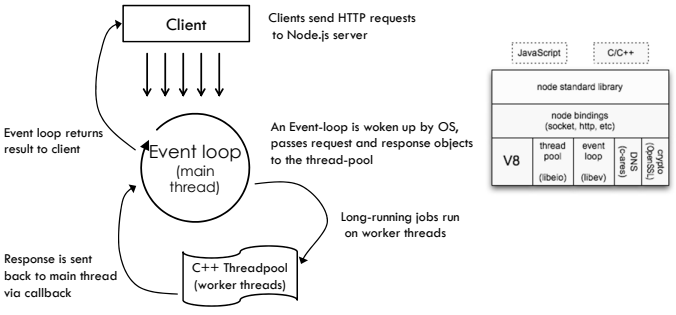
```
'node YOUR_FILE.js'
```

- Here is a simple example, which prints '*hello world*'

```
var sys = require("sys");
setTimeout(function(){
  sys.puts("world");
}, 3000);
sys.puts("hello");
//it prints 'hello' first and waits for 3 seconds and then prints
  'world'
```

Some Theory: Event-loops

- Event-loops are the core of event-driven programming, almost all the UI programs use event-loops to track the user event, for example: Clicks, Ajax Requests etc.



Some Theory: Non-Blocking I/O

- Traditional I/O

```
var result = db.query("select x from table_Y");
doSomethingWith(result); //wait for result!
doSomethingWithOutResult(); //execution is blocked!
```

- Non-traditional, Non-blocking I/O

```
db.query("select x from table_Y",function (result){
  doSomethingWith(result); //wait for result!
});
doSomethingWithOutResult(); //executes without any
  delay!
```

Node.js Ecosystem

- Node.js heavily relies on **modules**, in previous examples **require** keyword loaded the http & net modules.
- Creating a module is easy, just put your JavaScript code in a separate js file and include it in your code by using keyword require, like:

```
var modulex = require('./module');
```

- Libraries in Node.js are called packages and they can be installed by typing

```
npm install package_name
//package should be available in npm registry @ nmpjs.org
```

- **NPM** (Node Package Manager) comes bundled with Node.js installation.

Socket Programming

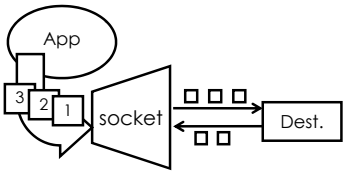
WITH NODE.JS

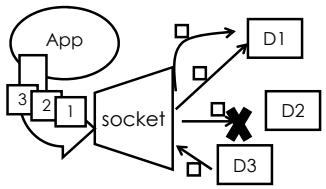
What is a socket?

- An interface between application and network
  - The application creates a socket
  - The socket *type* dictates the style of communication
    - reliable vs. best effort
    - connection-oriented vs. connectionless
- Once configured the application can
  - pass data to the socket for network transmission
  - receive data from the socket (transmitted through the network by some other host)

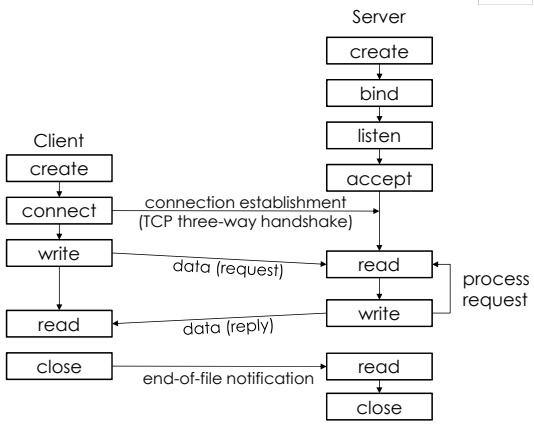
Two essential types of sockets

- TCP Socket
  - Stream-oriented
  - reliable delivery
  - in-order guaranteed
  - connection-oriented
  - bidirectional
- UDP Socket
  - Datagram-oriented
  - unreliable delivery
  - no order guarantees
  - no notion of "connection" – app indicates destination for each packet
  - can send or receive





TCP Socket Operations



TCP Server


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

var HOST = '127.0.0.1';
var PORT = 6969;

// Create a server instance, and chain the listen function to it
// The function passed to net.createServer() becomes the event handler for the 'connection' event
// The sock object the callback function receives UNIQUE for each connection
net.createServer(function(sock) {

    // We have a connection - a socket object is assigned to the connection automatically
    console.log('CONNECTED: ' + sock.remoteAddress +':'+ sock.remotePort);

    // Add a 'data' event handler to this instance of socket
    sock.on('data', function(data) {

        console.log('DATA ' + sock.remoteAddress + ': ' + data);
        // Write the data back to the socket, the client will receive it as data from the server
        sock.write('You said "' + data + '"');

    });

    // Add a 'close' event handler to this instance of socket
    sock.on('close', function(data) {
        console.log('CLOSED: ' + sock.remoteAddress +' '+ sock.remotePort);
    });

}).listen(PORT, HOST);

console.log('Server listening on ' + HOST +':'+ PORT);
```

TCP Server (another version)


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

var HOST = '127.0.0.1';
var PORT = 6969;

var server = net.createServer();
server.listen(PORT, HOST);


server.on('connection', function(sock) {

    // We have a connection - a socket object is assigned to the connection automatically
    console.log('CONNECTED: ' + sock.remoteAddress +':'+ sock.remotePort);

    // Add a 'data' event handler to this instance of socket
    sock.on('data', function(data) {

        console.log('DATA ' + sock.remoteAddress + ': ' + data);
        // Write the data back to the socket, the client will receive it as data from the server
        sock.write('You said "' + data + '"');

    });

    // Add a 'close' event handler to this instance of socket
    sock.on('close', function(data) {
        console.log('CLOSED: ' + sock.remoteAddress +' '+ sock.remotePort);
    });

});
```

TCP Client


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

var HOST = '127.0.0.1';
var PORT = 6969;

var client = new net.Socket();
client.connect(PORT, HOST, function() {

    console.log('CONNECTED TO: ' + HOST + ':' + PORT);
    // Write a message to the socket as soon as the client is connected,
    //the server will receive it as message from the client
    client.write('I am Chuck Norris!');

});

// Add a 'data' event handler for the client socket
// data is what the server sent to this socket
client.on('data', function(data) {

    console.log('DATA: ' + data);
    // Close the client socket completely
    client.destroy();

});

// Add a 'close' event handler for the client socket
client.on('close', function() {
    console.log('Connection closed');
});
```

UDP Socket


```
var dgram = require("dgram");

var server = dgram.createSocket("udp4");

server.on("message", function (msg, rinfo) {
   console.log("server got: " + msg + " from " +
       rinfo.address + ":" + rinfo.port);
});

server.bind(41234); // server listening 0.0.0.0:41234
```

UDP Server

```
var dgram = require('dgram');
var message = new Buffer("Some bytes");
var client = dgram.createSocket("udp4");

client.send(message, 0, message.length, 41234, "localhost",
    function(err, bytes) {
      client.close();
    }
);
```

UDP Client

dgram.createSocket(type, [callback])

- `type` String. Either 'udp4' or 'udp6'
- `callback` Function. Attached as a listener to `message` events. Optional
- Returns: Socket object

References

- John Mitchell, "JavaScript"
- Vikash Singh, "Node.js: The Server-side JavaScript"
- Jeff Kunkle, "Node.js Explained", http://kunkle.org/nodejs-explained-pres/
- Hacksparrow.com, "TCP Socket Programming in Node.js", http://www.hacksparrow.com/tcp-socket-programming-in-node-js.html