IWP: Internetwork- and web-programming

Written exam, June 8, 2020. Aalborg University

- You must upload you answers in a pdf-file to the "Digital-exam" system.
- Write your name and study-number at the front page
- You need not repeat the exercise text. It is sufficient to clearly identify the question using the question numbers in this assignment-sheet.
- You can produce the required pdf file using a normal word or text processing system and then using either its save-as-pdf or print-to-pdf, depending on the features of your chosen word processor. Alternatively, use a pdf-annotator to directly give your answers in the sheet (do not use yellow sticker notes that must be explicitly "clicked" to open to reveal their text).
- It is recommended that you read through the assignment sheet at the beginning of the examination to prioritize your time with respect to the number of points. While answering, ***monitor your time*** to ensure that you do not get sidetracked or stuck (especially in the practical part).
- If you think there is a mistake in an assignment, or lacks information, please state your assumptions with the answer.

This exam set contains 6 main assignments, each with a number of sub-questions. You can collect a total of 100 points.

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1. HTML and HTTP (15 pts)

Question 1.1

Q1.1.1 What is the correct HTML for creating a hyperlink?

```
1. <a href="http://www.cs.aau.dk">Computer Science</a>
2. <a url="www.cs.aau.dk "> Computer Science </a>
3. <a name="http://www.cs.aau.dk">www.cs.aau.dk</a>
4. <a>http:// http://www.cs.aau.dk </a>
```

Answer	

Q1.1.2 What is the correct HTML for making a text input field?

```
1. <textinput type="text">
2. <input type="text">
3. <input type="textfield">
4. <textfield>
```

Answer	

Q1.1.3 Which doctype is correct for HTML5?

```
1. <!DOCTYPE html>
2. <!DOCTYPE HTML5>
3. <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 5.0//EN"
   "http://www.w3.org/TR/html5/strict.dtd">
```

Answer	

Q1.1.4 Where is the correct place to insert a JavaScript?

1. In the `<head>` section
2. In the <body> section
3. Both are correct

Answer	

Q1.1.5 Inside which HTML element do we put the JavaScript?

```
1. <script>
2. <javascript>
3. <js>
4. <scripting>
```

Answer	

Q1.1.6 What is the correct JavaScript syntax to change the content of the HTML element below?

```
<p id="demo">This is a paragraph of text.</p>
```

1. `document.getElementByName("p").innerHTML = "Hello World!";`
2. `#demo.innerHTML = "Hello World`
3. `document.getElementById("demo").innerHTML = "Hello World";`
4. `document.getElement("p").innerHTML = "Hello World`

Answer	

Question 1.2

Consider the following sequence of request and response messages between a client and a web-server:

```
GET / HTTP/1.1\r\n
Host: test.com\r\n
Connection: keep-alive\r\n
Cache-Control: no-cache\r\n
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) \r\n
Accept: text/html, application/xhtml+xml, application/xml; \r\n
Accept-Encoding: gzip, deflate\r\n
Accept-Language: en-US,en;q=0.9,da;q=0.8,nb;q=0.7,de;q=0.6\r\n
\r\n
```

```
HTTP/1.1 200 OK \r\n
Connection: keep-alive\r\n
Content-Type: text/html;charset=utf-8\r\n
Etag: "15f0fff99ed5aae4edffdd6496d7131f"\r\n
Content-Length: 379\r\n
Date: Tue, 26 May 2020 11:06:55 GMT\r\n
\r\n
```

```
GET / HTTP/1.1\r\n
Host: test.com\r\n
Connection: keep-alive\r\n
Cache-Control: max-age=0\r\n
Accept: text/html, application/xhtml+xml, application/xml; \r\n
Accept-Encoding: gzip, deflate\r\n
Accept-Language: en-US,en;q=0.9,da;q=0.8,nb;q=0.7,de;q=0.6\r\n
If-None-Match: "15f0fff99ed5aae4edffdd6496d7131f"\r\n
\r\n
```

```
HTTP/1.1 304 Not Modified \r\n
Content-Length: 0\r\n
Connection: keep-alive\r\n
Etag: "15f0fff99ed5aae4edffdd6496d7131f"\r\n
Date: Tue, 26 May 2020 11:07:00 GMT\r\n
\r\n
```

Q1.2.1

Question	Answer
1. Which http method is used?	
2. Which protocol is used?	
3. What kind of document does the server send in its reply?	

Q1.2.2

Why does the server respond with code 304 to the second request?

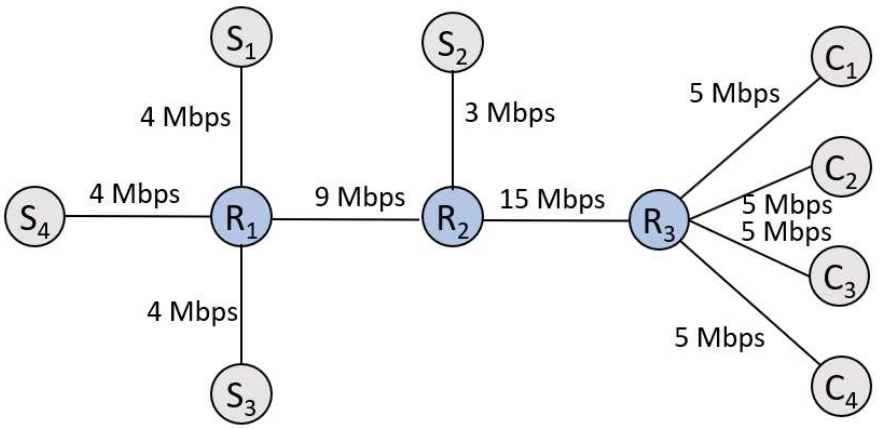
1. `Content-type` does not match the request.
2. `Cache-control` set max-age in the second request to 0
3. The request is unnecessary as the connection is kept alive (`Connection: keep alive`)
4. The client already received the requested document 5 seconds ago (`Date`: xxx).
5. The server's version of the document matches that of the client.
6. The document was deleted at the server

Answer:	

1. Computer Networks and the application layer (10 pts)

Question 2.1

Consider the network shown in the figure below that shows 4 servers (S_1… S_4) and 4 clients (C_1… C_4). The network is interconnected using the routers (R_1… R_3) with the possible transmission rates for each link. The clients simultaneously stream video from the corresponding server such that C_1 streams from S_1, C_2 streams from S_2 etc.



What is the possible end-to-end throughput for each client?

Answer	

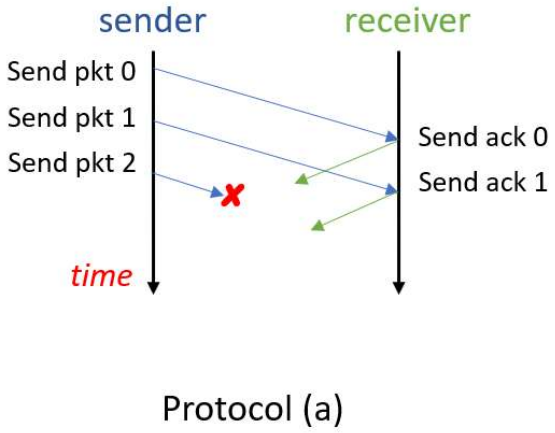
Question 2.2

Consider the Internet protocol stack. Which layers does the following tasks belong to? Mark by A (Application Layer), T (Transport Layer), N (Network Layer), L (Link Layer), P(Physical). If the task is handled by several layers, assign the letters for all layers involved.

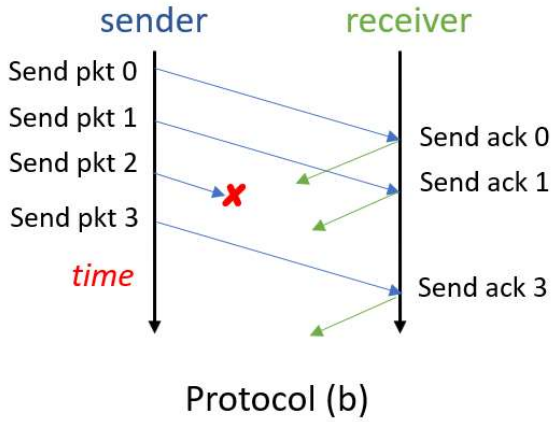
Task	Layer (A, T, N, L, P)
Translating a domain name into an IP address	
Translating an Ethernet-address to an IP address	
Performing congestion control	
Performing flow control	
Performing reliable delivery	
Computing link cost	
Doing 3-way handshakes	
Forwarding packets	
Providing End-to-End encrypted communication	

2. Reliable Data Transfer and the Transport Layer (16 pts)

Question 3.1



Protocol (a)



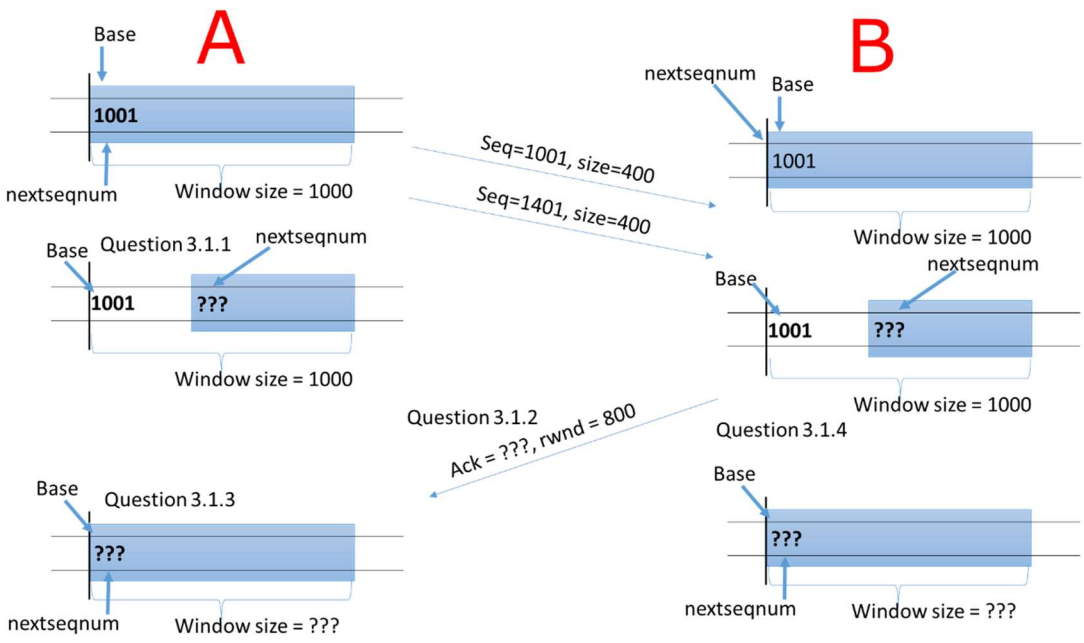
Protocol (b)

The above figure shows two sliding window protocols (a) and (b). For each protocol, indicate whether Go-Back-N, Selective Repeat is being used, or if insufficient information is available. Set "X".

	Protocol (a)	(Protocol (b)
Go-Back-N		
Selective Repeat		
Insufficient Information		

Question 3.2

Consider the following exchange of segments between A and B, where no message is lost. As usual, the TCP window of the sender is defined by the *base, nextseqnum* and the *window size* (see for example figure 3.19 of page 250 of the Curose&Ross textbook). A packet containing data reports a sequence number with byte granularity and the size of the data. An ACK packet specifies what is being ACKed and it can set the new size of the TCP window.



Q 3.2.1: After A sent two segments of 400 bytes each, what is the "nextseqnum" of A's window?

1. 1400
2. 1401
3. 1800
4. 1801

Answer	

Q 3.2.2: What is the value of the ACK field of the ACK packet?

1. 1001
2. 1401
3. 1801
4. 2001

Answer	

Q 3.2.3: Please complete the window of A with (base, nextseqnum, window size):

1. 1001, 1001, 800
2. 1401, 1401, 800
3. 1801, 1801, 800
4. 1801, 1801, 1000

Answer	

Q 3.2.4: Is there any difference between the second windows of A and B, or between the third windows of A and B?

1. No
2. In the second window, before sending the ACK packet B has still a 1401. Thus, the second window would have base, nextseqnum and window size = 1001, 1401, 1000
3. In the third window, B has still a large buffer, thus base, nextseqnum and window size = 1801, 1801, 1000

Answer	

Exercise 3.2 What information defines TCP socket and a UDP socket?

1. TCP: IP address and port of the sender. UDP: IP address and port of the receiver.
2. TCP: IP address and port of both sender and receiver. UDP: IP address and port of the sender.
3. TCP: either IP address and port of the sender, or IP address and port of both sender and receiver. UDP: IP address and port of the sender.

Answer	

3. The Network and Link Layer (16 pts)

Question 4.1

Consider that A is sending packets to B, and B sends back ACKs. Consider that the network is lossy and 10% of the packets from A to B are lost, and that the loss on ACKs is negligible. How many packets are sent by A on average, for each packet correctly received by B?

1. 0.1
2. 1
3. 1.1
4. Between 1.11 and 1.12

Answer	

Question 4.2

Consider TCP communication, and datagrams having headers of 20 bytes for the TCP protocol and 20 bytes for the IP protocol. An IP datagram of 2300 bytes is sent over wifi (MTU 2304), and it gets to an Ethernet network (MTU 1500). The datagrams gets fragmented. How much overhead there is in the two networks, with respect to the application layer?

1. 20 bytes in the first network, 40 bytes in the second network.
2. 20 bytes in the first network, 30 bytes in the second network.
3. 40 bytes in the first network, 60 bytes in the second network.
4. 40 bytes in the first network, 80 bytes in the second network.

Answer	

Question 4.3

A router has the following routing table:

Network Destination	Netmask	Interface	Gateway
192.168.10.0	255.255.255.0	eth0	----------
192.168.11.0	255.255.255.0	eth1	----------
0.0.0.0	0.0.0.0	eth2	192.168.15.1

Q 4.3.1: What happens to a packet with destination address 8.8.8.8 received on interface eth0?

1. it is dropped
2. it is delivered through interface eth0
3. it is sent to 192.168.15.1 via interface eth2

Answer	

Q4.3.2: What happens to a packet with destination address 192.168.10.1 received on interface eth2?

1. it is dropped
2. it is delivered through interface eth0
3. it is sent to 192.168.15.1 via interface eth2

Answer	

Question 4.4

A company has bought the IP domain 199.59.242.0/26, and it needs to subnet it to its 3 departments, which need respectively 20, 16 and 3 IP addresses. Which sentence is correct, regarding the subnetting strategy?

1. The first group can get 199.59.242.0/28, second can get 199.59.242.32/29, and the third gets 199.59.242.48/30.
2. The first group can get 199.59.242.0/27, second group can get 199.59.242.32/28, the third can get 199.59.242.48/29.
3. The first group needs a /27 subnetwork, the second group needs a /27 subnetwork, the third group needs a /29. The /26 domain bought by company is not enough, and there is no solution to the subnetting problem.

Answer	

4. Network and web-security (10 pts)

Question 5.1

Imagine a software has a defect, it sends out a private key, but keeps the corresponding public key secret. Which sentence is *false*?

1. Everything can work, if the private key is used in all the certificates, etc., and the public key is kept secret at all times.
2. Security can be weaker, since a public key tends to be shorter, thus it is easier to find when the private key is known.
3. It is not possible to put anything different from an original public key in a certificate.

Answer	

Question 5.2

Compare ApiKeys and OAuth2. Which of the following is an advantage of ApiKeys over OAuth2?

1. 1 – They allow to authorize a client for a short period of time.
2. 2 – Their usage is easier to program in a software.
3. 3 – They can provide a clear distinction between authentication, and authorization.

Answer	

5. Web-programming - Practical Assignment (33 pts)

A group of friends wish to ensure that they do not get drunk at parties. They therefore request a web-app to help them monitor their blood alcohol content (BAC). The app should have two main functionalities

1. Allow a user (identified by name) to report having consumed a drink.
2. Allow the user to track the BAC of (potentially another) person in the group.

BAC is the amount of alcohol per volume blood, typically measured in per-mille (DK: "promille"). A simple model[1] for estimating the BAC can be computed according to the formula below (assuming an initial BAC of zero).

$$BAC = \frac{alcohol\ (grams)}{weight\ (kg) \times F} - 0.15 \times T$$

- *Alcohol* is the amount of alcohol introduced by the drink. In this assignment a drink (DK "en genstand") equals 12 grams.
- *F* is a constant that represents physiological differences between men and female: it is 0.6 for female, and 0.7 for male.
- *T* is the amount of time elapsed since the drink was consumed.

For the assignment we assume that BAC calculation is additive, i.e., if a drink was consumed at t_1 and another drink is consumed at time t_2 (t_2 >= t_1), then the BAC evolves as the sum the BAC from each individual drink. Remark, that BAC never becomes negative.

The file (download appendix from digital exam) `NodeWeb-BAC.zip` contains a skeleton for this application. Unzip the archive to a suitable location on your machine. A visual studio workspace is included. The goal of the assignment is to add certain functionality to the skeleton.

A small node.js application (bac-`app.js`) acts as a http server that serves the front-page (stored in `bac.html`) and a web-API function that allows the app to store and retrieve JSON objects containing the information for BAC calculation. The information is stored in an in-memory "database" implemented as a simple array of records (`bacDB`). A record is a JavaScript object with the following properties *name, gender, weight, drinkTime;* drinkTime is a `Date` object containing the time that the server recorded the drink consumption. In the current state, the server accepts an HTTP POST to the URI `/bac-records` that stores a new record with information that the user has entered.

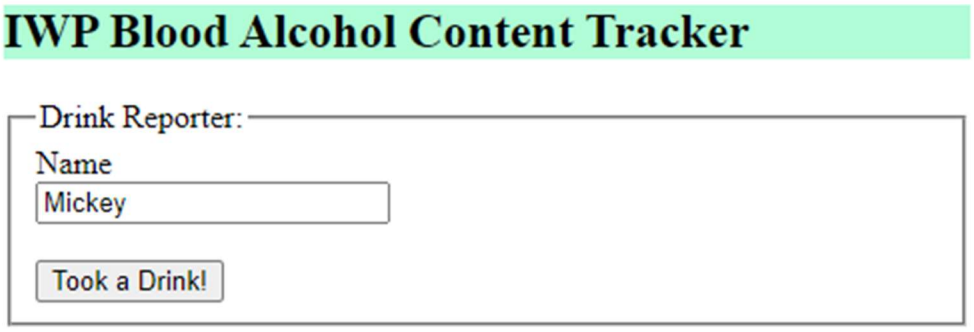
The node.js application code contains three main parts indicated by the comments: A part setting up the server and providing request/response helper functions, whose detailed implementation you need not be concerned with. A part containing the application functional code. A part containing processing of HTTP requests.

When the server is started (either run the app.js from within VisualStudioCode, or the command line

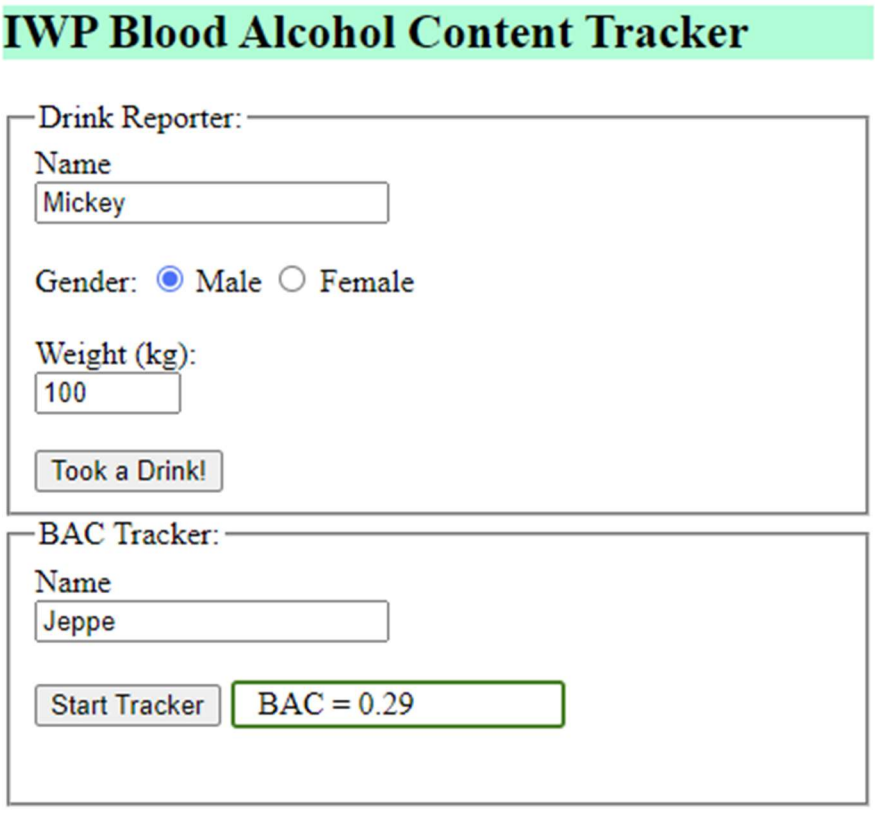
NodeWeb-BAC >`node node/bac-app.js`

[1] Source: https://www.sundhed.dk/borger/patienthaandbogen/psyke/sygdomme/alkohol/alkoholpromille-beregning/

and a web browser is pointed to the localhost (127.0.0.1) at port 3000, the browser should show the following page:



At the end of the assignment your frontpage should appear somewhat like the screenshot below: In the first part reports to the app that the named person has consumed a single drink at the time of submission. The second part *periodically* updates the named person's BAC from the server.



Remark, that the questions can be answered partially independently! If you get stuck in one step, try to proceed using fixed/dummy/stubs data and functions.

Question 6.1:

Extend the form with fields to enter weight (kg) fields and gender. Use *HTML validation* to ensure that they are filled out and satisfy the constraints: 1<=weight<=300, and gender is mandatory. Add the form for the tracker part. Do not spend time on layout and styling, but you are welcome to use the style in the attached stylesheet.

Question 6.2

When the form is submitted, a JavaScript function at the client is to extracts the drink data information in the form-fields (currently only name) and returns a JavaScript object. Augment the function to also extract weight and gender. Show the augmented function below:

Hint: If you use radio buttons, getting their state information can be done in numerous ways. A crude but fully acceptable solution is to assign an id to each input choice and then test its “checked” property.

Question 6.3

At the server bac-app.js a POST to the resource `/bac-records` results in that the received JSON object is converted into a JavaScript object with the new submitted drink data, validated, and then conditionally inserted in the "data base". Show the updated validation function that validates the new weight and gender fields.

Question 6.4

Implement a Javascript function `calcBAC(name)` that computes the current BAC for the person named "name". If you wish to skip this question for now, simply return a fixed value, e.g. 2.

Hint: The skeleton contains a helper function that computes the time difference in milli-seconds between two `Date` timestamps.

Question 6.5

Extend the server's web-api such that an HTTP call to the endpoint `/bac-records/`*`name`* returns a JSON object to the client containing the current BAC for the person named "name", e.g., a call to `/bac-records/Mickey` should return BAC for "Mickey" at the time of the request.

Q6.5.1 Which HTTP method would you use

1. GET, since this is a method that does not alter the DB
2. POST because it involves an expensive computation at the server, and need to be recomputed for each request (as more time has elapsed)
3. GET, but disables the caching of the response, and I consider the computation light.
4. Implement my own dedicated HTTP method.

Answer:	

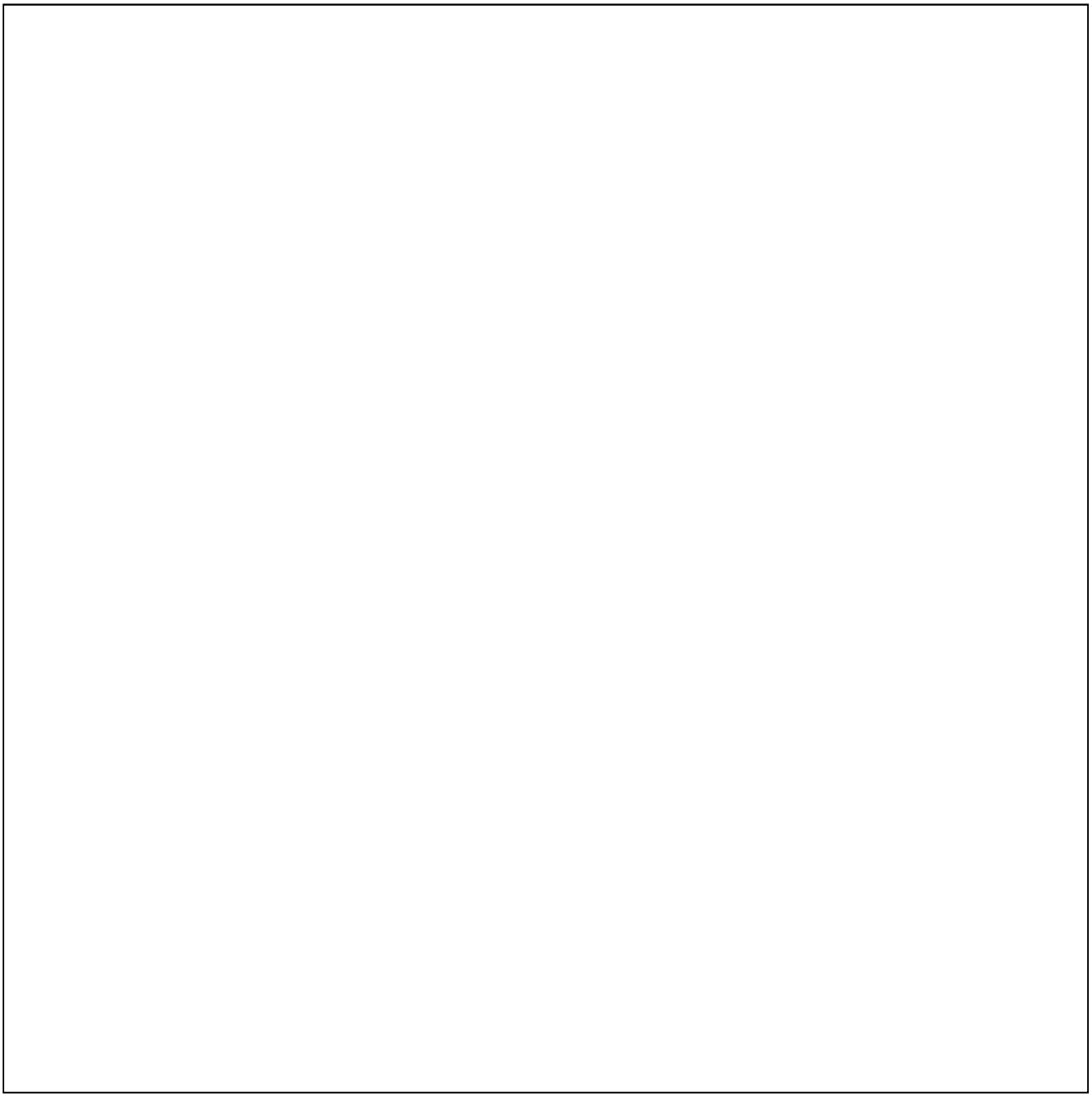
Q6.5.2 Show here your code for the route-handling and possible extra functions that you have added.

Question 6.6

Q6.6.1 Implement the client-side functionality for the tracker function. i.e. fetch the current BAC and update the HTML element that is to contain the result. Additionally, an entry to the console log containing the resulting BAC should be added when a new response is received.

HINT: A helper function to fetch json objects is provided. First perform a single fetch, and add the result to the log. Then update the element to contain information like "*BAC = <bac>"*. As a third step, set up an interval timer to periodically update the element, that starts running when the tracker is started. You need not implement functionality for stopping the tracker in this version.

Even if your fetch is not working correctly, the later steps can be completed using a fixed/dummy data at the client side.



Question 6.6.2

Show the client-side log contents resulting from the above code: (you may insert text or an image).