School of Computing

ST0503 Back End Web Development

Practical 6

RESTFul APIs with Express and MySQL

Objectives:

After completing this lab, you should be able to:

- Understand when to use Get, Post, Put or Delete
- Use NodeMon
- Test API endpoints with POSTMAN

Table of content

1. Introduction to REST APIs

1.1. What is an API?

An API (Application Programming Interface) defines a set of operations that allow applications to communicate with it. Examples of APIs include web APIs and software libraries (like those on NPM).

We will focus on web APIs in this practical. Our web API should allow us to manipulate and retrieve data on our MySQL database through HTTP requests.

1.2. What are REST APIs?

REST is an architectural style we will be using to design our API.

Data (resources) in the database is exposed through the endpoints (URLs) of our API. Resources can be created, read, updated, and deleted (CRUD) through the endpoints.

You can read more about REST here:

https://docs.microsoft.com/en-us/azure/architecture/best-practices/api-design

1.3. HTTP Methods

CRUD (create, read, update, delete) operations correspond to HTTP methods that our browsers can send.

- A `GET` request is used to retrieve (read) resources.
- A `POST` request is used to create resources.
- A `PUT` request is used to update resources.
- A `DELETE` request is used to delete resources.

Because we can only manually send GET requests to endpoints through our browser, we will have to use a program called Postman that can fire all sorts of HTTP methods to our API.

Download Postman here:

https://www.getpostman.com/downloads/

1.4. The Express framework

Express.js is a Node.js web framework used to create REST APIs. We can use Express to easily create endpoints for our server to handle requests and serve resources.

Install `express` in our `friendbook` project with the following command:

```
>> npm install --save express
```

1.5. HTTP response status codes

When we send a HTTP request, the response will contain a status code that tells us whether our operation was successful or not.

Here are the important one's that will be used in the practical:

2xx Success

200 OK

Standard response when a request has succeeded. It used when a `GET` request succeeds.

201 Created

Request has succeeded and a new resource has been created. It is used when a `POST` request succeeds.

204 No Content

Same as `200 OK`, but used when there is no content to be sent back. Typically used when `PUT` or `DELETE` succeeds but there is nothing to be sent back.

4xx Client errors

400 Bad Request

The server cannot processs the request due to invalid syntax. The client should not repeat the same request.

404 Not Found

Server cannot find the requested resource. It used when we request for a nonexistent resource.

5xx Server errors

500 Internal Server Error

The server has encountered a situation it does not know how to handle. Used as a generic error message for handling unexpected errors.

You can find the full list of status codes here:

https://developer.mozilla.org/en-US/docs/Web/HTTP/Status

2. Automatically restart server upon changes with Nodemon

Remember that we had to manually restart our server when we made changes to the code for them to take effect?

`nodemon` is a command-line interface (CLI) that automatically detects changes to the codebase and restarts the server for us.

Install `nodemon` with the following command:

```
>> npm install -g nodemon
```

To start our server with `nodemon`, run the following command:

```
nodemon server.js
```

The server should start.

Try making a change to one of the files in the friendbook project. You should see the server automatically restart.

Let's save it as an NPM script. Make the follow changes to the scripts section of `package.json`:

```
{
  ...
  "scripts": {
    "start-dev": "nodemon server.js",
    "test": "echo \"Error: no test specified\" && exit 1"
  },
  ...
}
```

Run the following command to start the server:

```
>> npm run start-dev
```

We will use this command from now on to start our server instead of `node server.js`.

3. Handling requests with Express

3.1. User Endpoints

Here are the endpoints we will create for the user endpoint:

Endpoint	HTTP Method	Description	Succeed Response	Error Response
/users/	GET	Returns all users.	`200`	`500`
/users/	POST	Add a new user.	`201`	`500`
/users/:userID/	GET	Returns user with the given id.	`200`	If no user with the id: `404`.Otherwise `500`.
/users/:userID/	PUT	Edits a user with the given id.	`204`	`500`
/users/:userID/friends	GET	Returns the friends of the user of the given id.	`200`	`500`
/users/:userID/friends/:friendID	POST	Create friendship between users with ids `id` and `friendID`	`201`	If `userID === friendID`, send a `400`.If friendships already exists (`error.code === "ER_DUP_ENTRY"`), send a `201`.If either one or both of the ids are non-existent (`error.code === "ER_NO_REFERENCED_ROW`

				_2"), send a 400.Otherwise, 500
/users/:userID/friends/:friendID	DELETE	Destroys a friendship between user of id id and friendID	204	500

3.2. Initializing Our Express Server

An Express "app" has methods like `app.get()`, `app.post()`, `app.put()`, `app.delete()` to handle `GET`, `POST`, `PUT`, `DELETE` requests respectively.

Refer to the Express documention on the "app" object and it's methods:

https://expressjs.com/en/4x/api.html#app

Create a file named **`app.js`** in a new **controller** directory with the following inside:

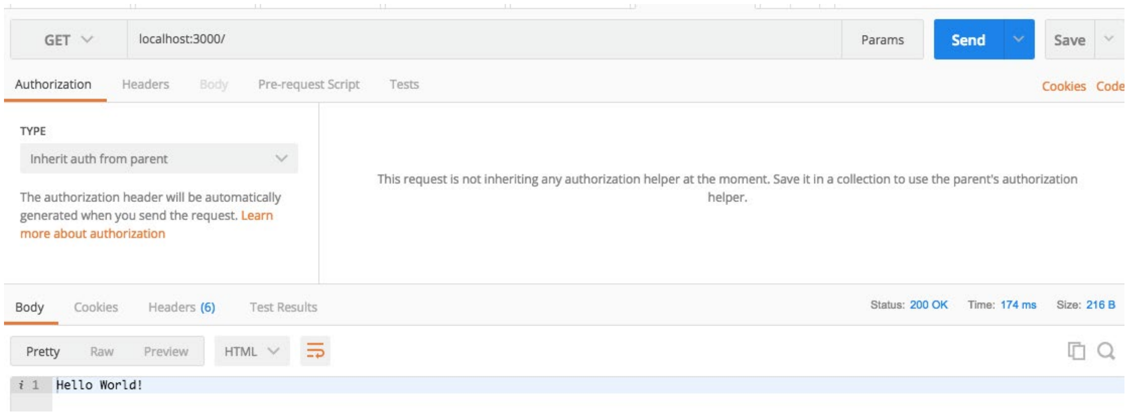
```
const express = require("express");
const app = express();

app.get("/", (req, res) => {
    res.send("Hello World!");
});

module.exports = app;
```

Import the app object in the root `server.js` and use the `app.listen()` method to listen for requests on port `3000`:

```
const app = require("./controller/app");

const PORT = 3000;
app.listen(PORT, () => {
    console.log(`Server started on port ${PORT}`);
});
```

Our Express server is now listening for requests made through port `3000` on `localhost`.

Make a `GET` request made to `localhost:3000/` through Postman. `"Hello World!"` should be send back.



localhost:3000/

TYPE

Inherit auth from parent

The authorization header will be automatically generated when you send the request. Learn more about authorization

This request is not inheriting any authorization helper at the moment. Save it in a collection to use the parent's authorization helper.

Status: 200 OK Time: 174 ms Size: 216 B

```
Hello World!
```

3.3. `GET /users/` endpoint

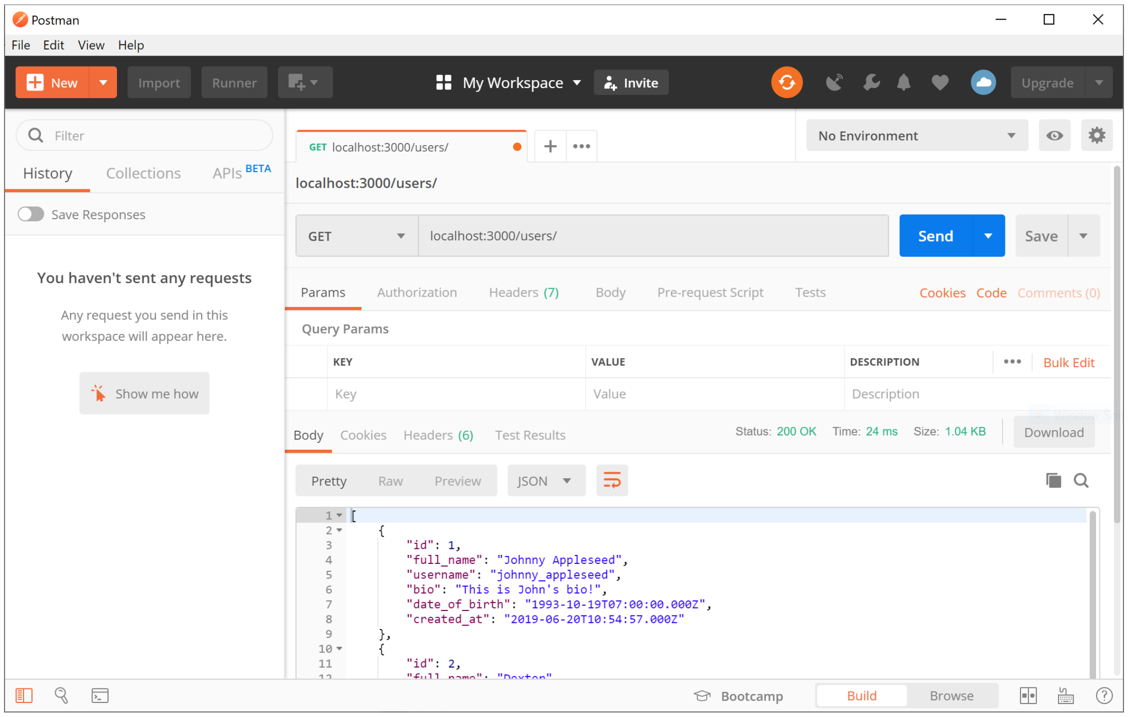
Create the route handler and use the `User.findAll()` method to retrieve all the users:

```
const express = require("express");
const app = express();

// import the User model
const User = require("../models/User");

app.get("/", (req, res) => {
    res.send("Hello World!");
});

app.get("/users/", (req, res, next) => {
  User.findAll((error, users) => {
    if (error) {
      console.log(error);
      res.status(500).send();
    };
    res.status(200).send(users);
  });
});

module.exports = app;
```

When a client sends a `GET` request to `localhost:3000/users/`, the server should send back all the users in the database using the User model with a status code of `200 OK`.

In the event an error occurs and we cannot identify and handle it, we send a status code of `500 Internal Server Error`.

Send a `GET` request to `localhost:3000/users/` through Postman. You should see all the users in the database in JSON format:



GET localhost:3000/users/

Status: 200 OK Time: 24 ms Size: 1.04 KB

```
[
    {
        "id": 1,
        "full_name": "Johnny Appleseed",
        "username": "johnny_appleseed",
        "bio": "This is John's bio!",
        "date_of_birth": "1993-10-19T07:00:00.000Z",
        "created_at": "2019-06-20T10:54:57.000Z"
    },
    {
        "id": 2,
        "full_name": "Dexter"
```

Notice the similarity between JSON and a object literal in Javascript?

JSON (JavaScript Object Notation) is a data-interchange format used for transmitting information between the frontend and the backend of a web application. While it looks similar to an object literal in Javascript, they are different things. JSON is received in a string format and has to be parsed to be read from in our application as an object literal.

3.4. `GET /users/:userID` endpoint

Similar to how functions can have parameters, routes can be dynamic and have parameters.

We will now implement an endpoint to retrieve information of a single user given his `id`.

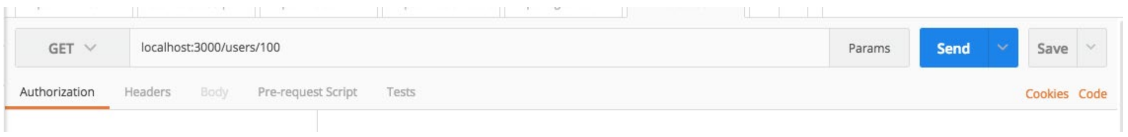
A `GET` request to `localhost:3000/users/5` should retrieve a user with `id` 5. If the user does not exist, send back a status code of `404 Not Found`.

3.4.1. Add the request handler for `GET` requests to `/users/:userID` to `controller.js`:

```
app.get("/users/:userID/", (req, res, next) => {
  console.log(req.params);

  // this is in string format instead of an integer like it is in the databas
e.
  console.log(typeof(req.params.userID));

  // parse it to an integer
  const userID = parseInt(req.params.userID)
  console.log(typeof(userID));
});
```

We can extract the `userID` through `req.params`. `req.params` is an object that maps the parameter name to the supplied value for that request. We have to manually parse the `userID` to an integer.

3.4.2. Make a `GET` request to `localhost:3000/users/100/` through Postman:



You should see the following output in the terminal:

```
{ userID: '100' }
string
number
```

You can read more about `req.params` here:

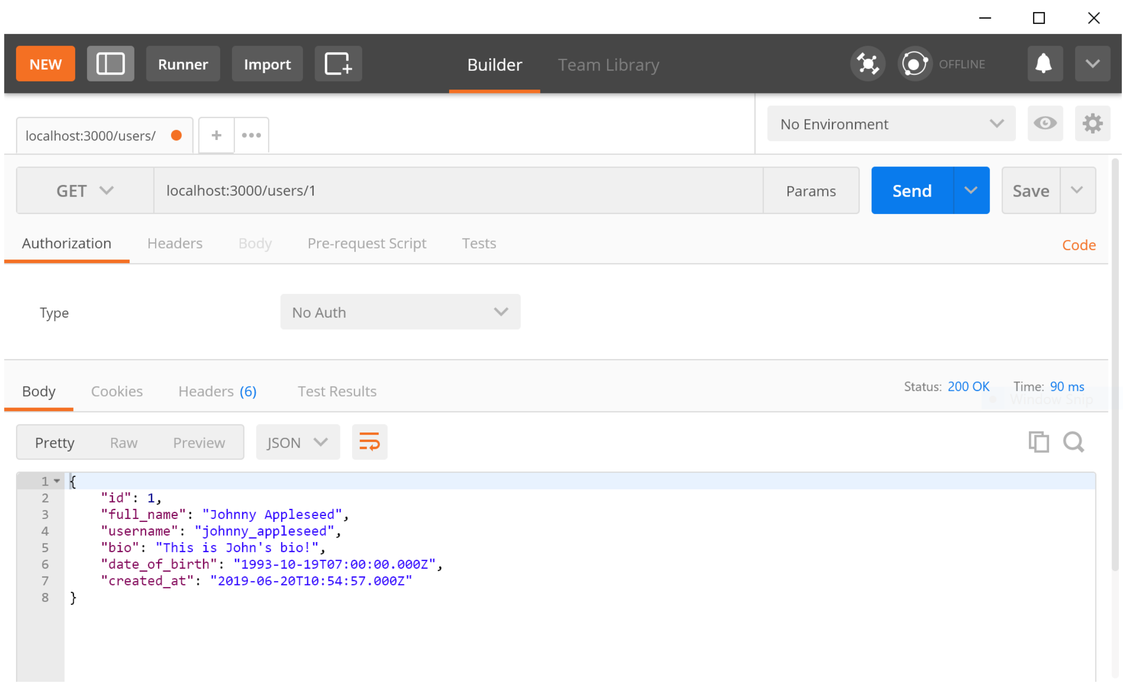
https://expressjs.com/en/4x/api.html#req.params

3.4.3. Use the `User.findByID()` method we wrote in the previous practical to retrieve a user given a user id:

```
app.get("/users/:userID/", (req, res, next) => {
  const userID = parseInt(req.params.userID);
  // if userID is not a number, send a 400.
  if (isNaN(userID)) {
    res.status(400).send();
    return;
  }

  User.findByID(userID, (error, user) => {
    if (error) {
      res.status(500).send();
      return;
    };

    // send a 404 if user is not found.
    if (user === null) {
      res.status(404).send();
      return;
    };
    res.status(200).send(user);
  });
});
```

Test out the endpoint by finding a user of id 1 (which exists):

You should see the user "Johnny Appleseed". The response status code should be `200 OK`:



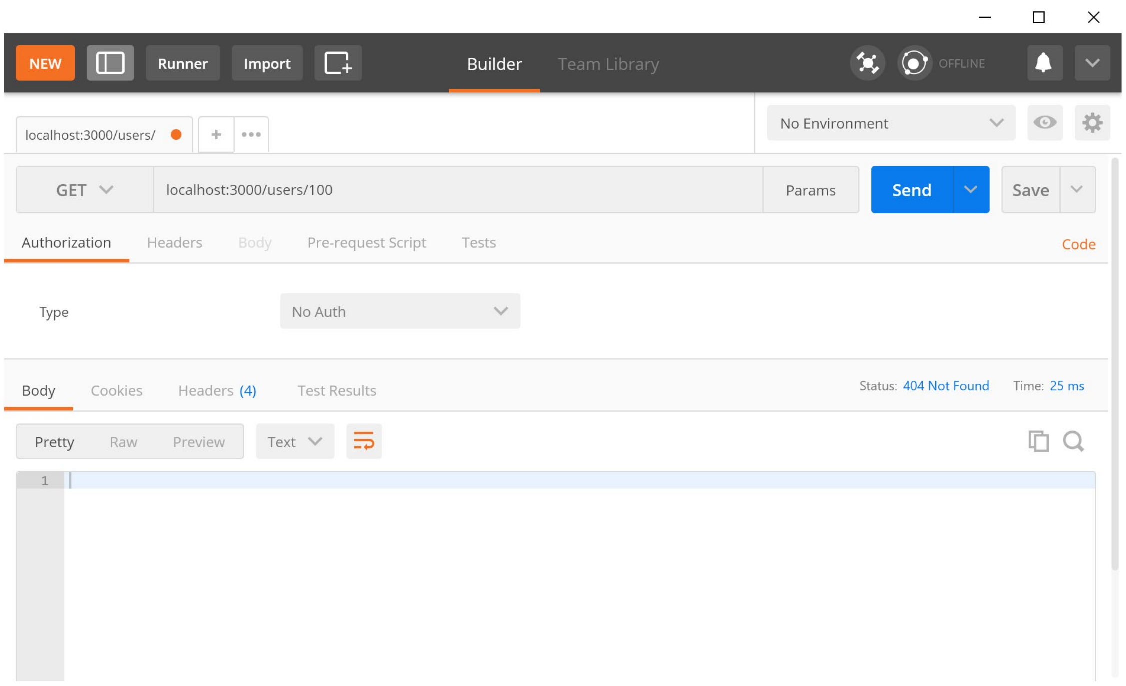
GET localhost:3000/users/1

Type: No Auth

Status: 200 OK Time: 90 ms

```
{
    "id": 1,
    "full_name": "Johnny Appleseed",
    "username": "johnny_appleseed",
    "bio": "This is John's bio!",
    "date_of_birth": "1993-10-19T07:00:00.000Z",
    "created_at": "2019-06-20T10:54:57.000Z"
}
```

Let's test if a `404 Not Found` is returned when a non-existent user id is provided. Provide an id that no user in the database has:



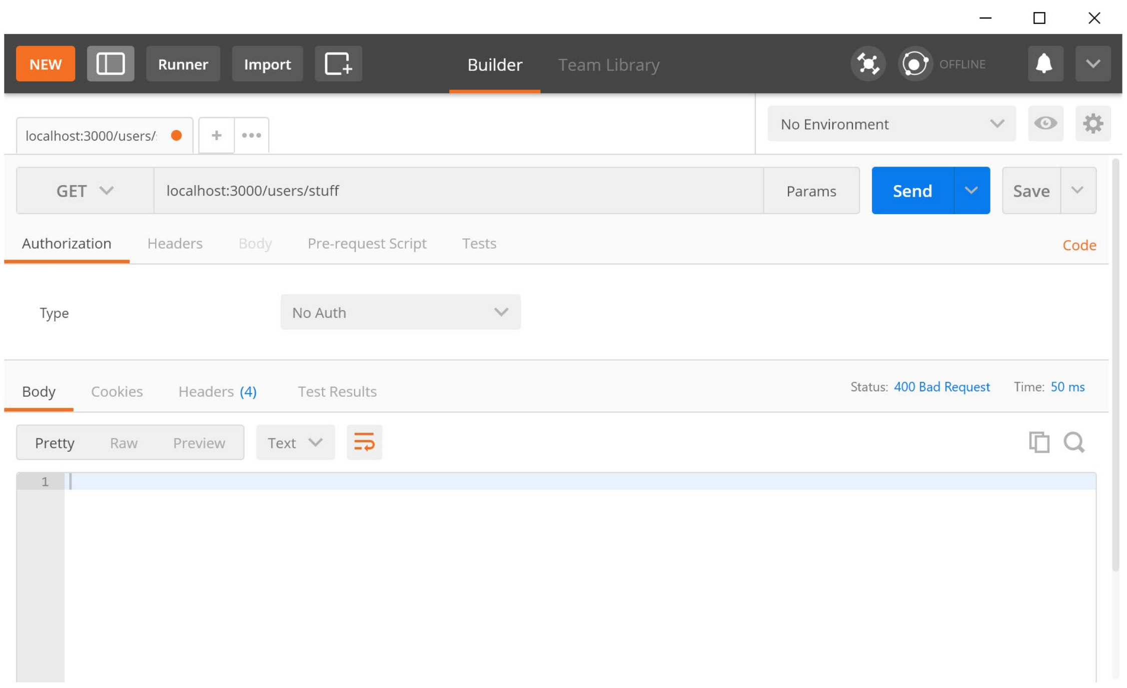
GET localhost:3000/users/100

Type: No Auth

Status: 404 Not Found Time: 25 ms

You should see the status of `404 Not Found`.

Provide a string that cannot be converted to an integer for the user id:



The response should have a status code of `400 Bad Request`.

3.5. `POST /users/` endpoint

We will create the endpoint `POST /users/` for creating users using `app.post()`:

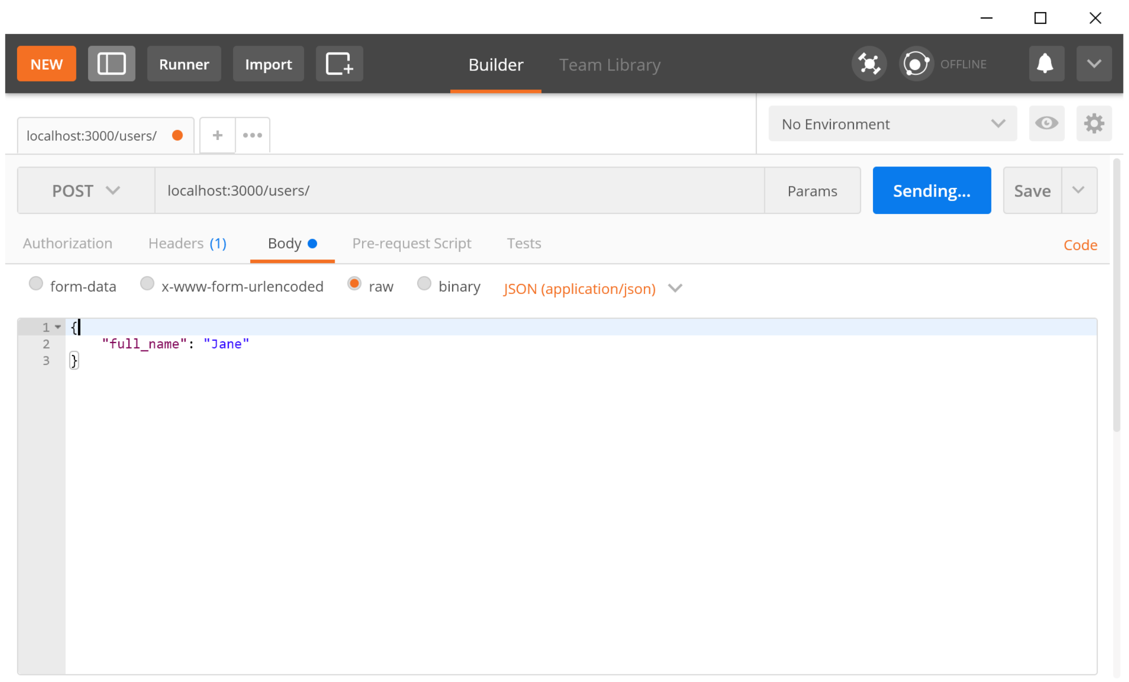
Three things to note about `POST` requests:

1. `POST` requests are used to create a new resource.
2. The created resource should be sent back with a status code of `201 Created` if it's a success.
3. While we could put all the new user information in the parameters, it is a better practice to put it in the request body in the form of JSON.

3.5.1. Add the route handler to `controller.js`:

```
app.post("/users/", (req, res, next) => {
  // we can access the request body through req.body
  console.log(req.body);
});
```

Make a `POST` request to `localhost:3000/users/` from Postman with the following body:



```
{
    "full_name": "Jane"
}
```

Take a look at the printed output in the terminal and you should see undefined.

Strange. Read the Express documentation on `req.body`:

https://expressjs.com/en/api.html#req.body

According to the docs, We need a body-parsing "middleware". We need to parse the body because it is in JSON format and our Node.js application works with normal Javascript objects instead.

An Express middleware is a function that performs actions before our route handlers are called. The `body-parser` middleware parses the request body from JSON to Javascript object and stores it in `req.body`.

3.5.2. Kill the Node.js server with `CTRL-C`. Then install `body-parser` and start the server again:

```
npm install --save body-parser
...
...
...
npm run start-dev
```

3.5.3. Mounting the `body-parser` middleware.

In `app.js`, import `body-parser` and use it with `app.use()`:

```
const express = require("express");
const app = express();

const User = require("../models/User");
```

```
// import body-parser middleware
const bodyParser = require("body-parser");

// use the middleware
app.use(bodyParser.json());

...
```

Make sure that the middleware is mounted before all the route handlers.

3.5.5. Make the same request from Postman as before. You should see the request body being printed.

3.5.6 Insert user into database using the `User.insert()` method

Use the `User.insert()` method. We assume that the request body will contain the `full_name`, `username`, `bio`, and `date_of_birth` attributes:

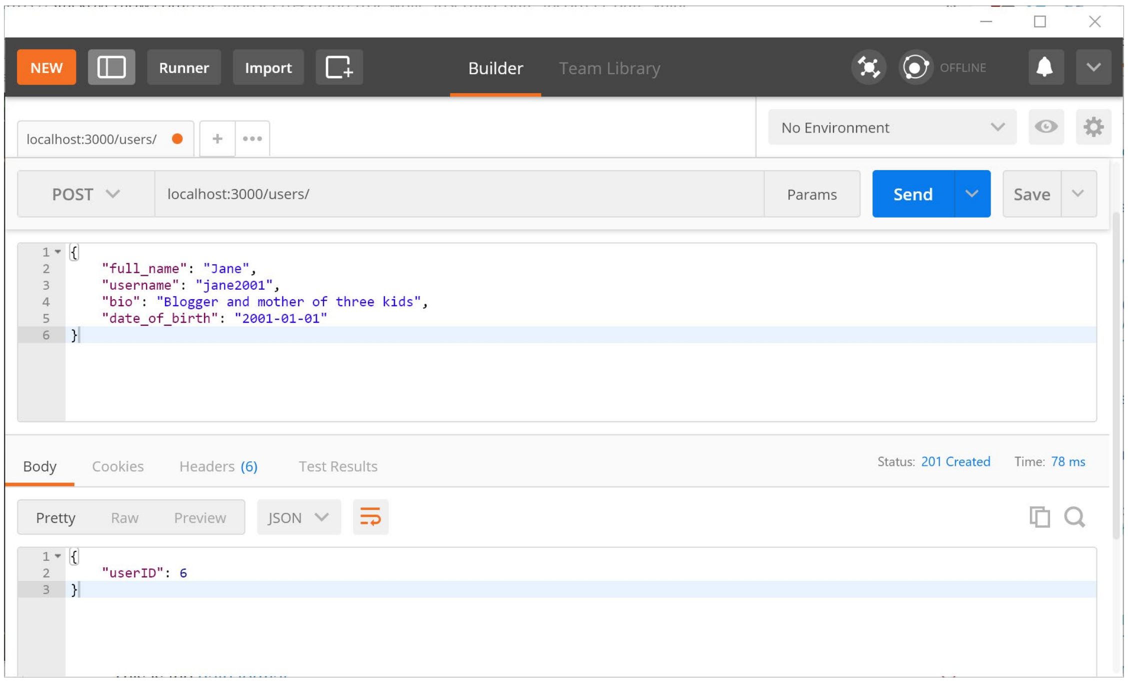
```
app.post("/users/", (req, res, next) => {
  User.insert(req.body, (error, userID) => {
    if (error) {
      console.log(error);
      res.status(500).send();
      return;
    };
    res.status(201).send({
      userID
    });
  });
});
```

We send a `201 Created` instead of a `200 OK` when a resource is created.

The `userID` is also sent back as a response so that we can query for the newly inserted user by sending a `GET` request to `localhost:3000/users/:userID`.

3.5.7. Testing the new endpoint

Test out the `POST /users/` endpoint on Postman:



POST localhost:3000/users/

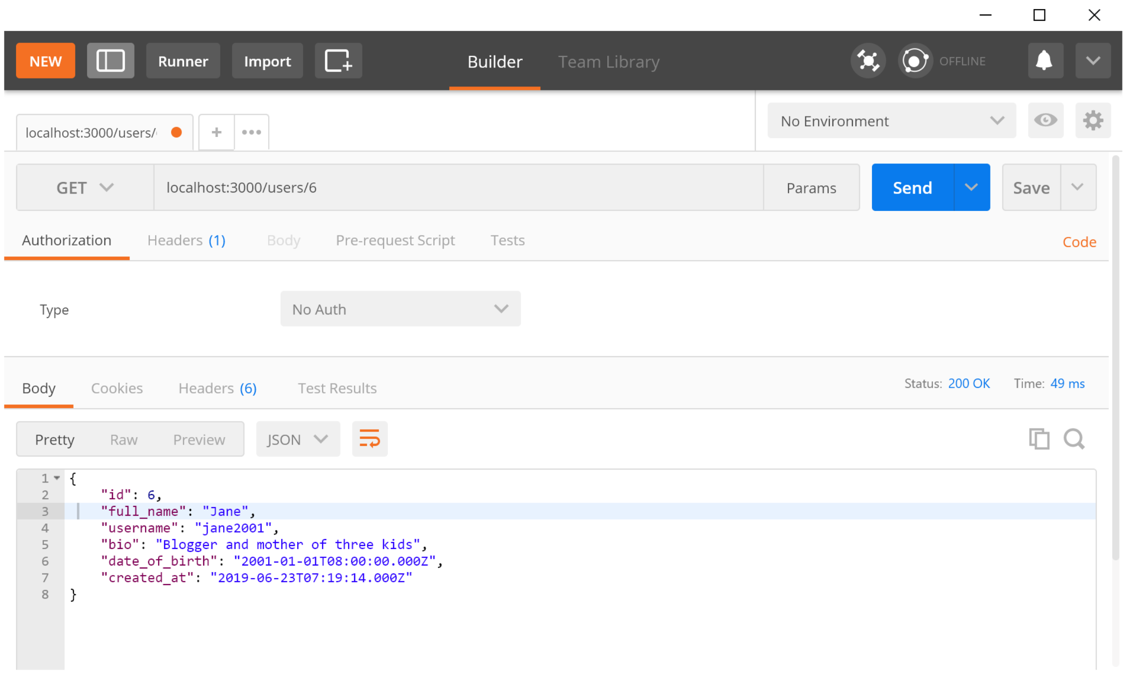
```
{
    "full_name": "Jane",
    "username": "jane2001",
    "bio": "Blogger and mother of three kids",
    "date_of_birth": "2001-01-01"
}
```

Status: 201 Created Time: 78 ms

```
{
    "userID": 6
}
```

You should see the inserted user's id as a response.

Let's query for the new user with the `GET /users/:userID` endpoint:



GET localhost:3000/users/6

Type: No Auth

Status: 200 OK Time: 49 ms

```
{
    "id": 6,
    "full_name": "Jane",
    "username": "jane2001",
    "bio": "Blogger and mother of three kids",
    "date_of_birth": "2001-01-01T08:00:00.000Z",
    "created_at": "2019-06-23T07:19:14.000Z"
}
```

3.6. `PUT /users/:userID`

Here are some things to note about `PUT` requests:

1. `PUT` is used to update a resource.

2. PUT only allows full replacement of the resource. You must provide all the attributes to be changed or kept.
3. A 204 No Content is sent back if the request was successful. The body of a 204 should be empty.

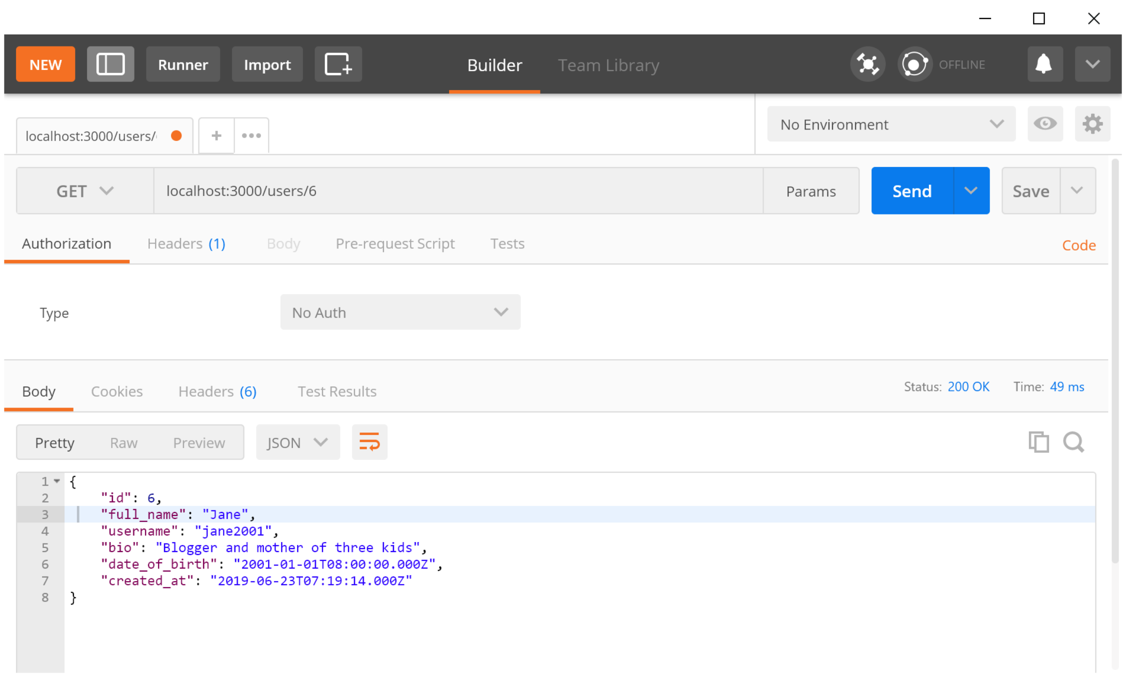
3.6.1. Add the route handler to controller.js:

```
app.put("/users/:userID/", (req, res, next) => {
  const userID = parseInt(req.params.userID);
  if (isNaN(userID)) {
    res.status(400).send();
    return;
  }

  User.edit(userID, req.body, (error) => {
    if (error) {
      console.log(error);
      res.status(500).send();
      return;
    };
    res.status(204).send();
  });
});
```

We assume that req.body contains all four attributes. If they are not provided then a 500 Internal Server Error code will be sent. We will address this in a future practical with input validation.

3.7.2. Test out the endpoint

Let's edit user with id of 6's full_name from "Jane" to "Jane Doe". Since you must provide all the attributes of the resource, we must first do a GET to find the user:



GET localhost:3000/users/6

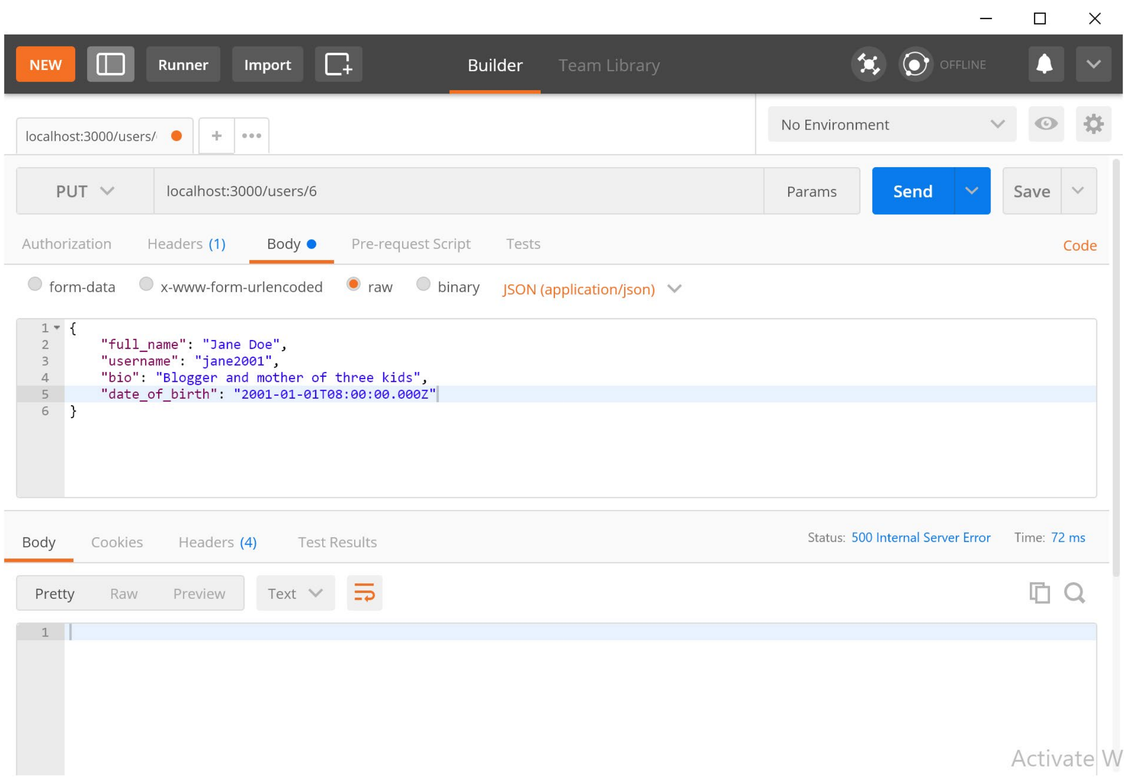
Type: No Auth

Status: 200 OK Time: 49 ms

JSON

```
{
    "id": 6,
    "full_name": "Jane",
    "username": "jane2001",
    "bio": "Blogger and mother of three kids",
    "date_of_birth": "2001-01-01T08:00:00.000Z",
    "created_at": "2019-06-23T07:19:14.000Z"
}
```

Make a PUT request to `/users/:userID/` with the returned JSON in the previous request. Omit the `id` and `created_at`, and make sure to provide `full_name` of "Jane Doe":



PUT localhost:3000/users/6

● raw JSON (application/json)

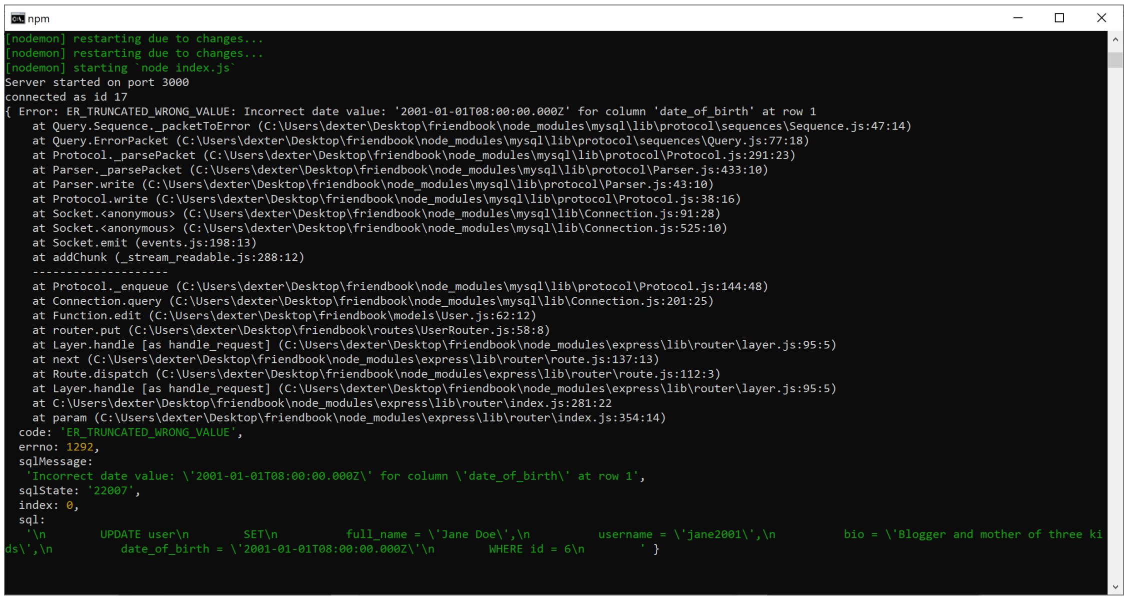
```
{
    "full_name": "Jane Doe",
    "username": "jane2001",
    "bio": "Blogger and mother of three kids",
    "date_of_birth": "2001-01-01T08:00:00.000Z"
}
```

Status: 500 Internal Server Error Time: 72 ms

Text

Ensure that the "raw" option is selected, and `JSON (application/json)` is selected from the dropdown menu.

Instead of getting a `200 OK`, we receive a `500 Internal Server Error` instead. Let's inspect the error in the terminal:



```
[nodemon] restarting due to changes...
[nodemon] restarting due to changes...
[nodemon] starting `node index.js`
Server started on port 3000
connected as id 17
{ Error: ER_TRUNCATED_WRONG_VALUE: Incorrect date value: '2001-01-01T08:00:00.000Z' for column 'date_of_birth' at row 1
    at Query.Sequence._packetToError (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\protocol\sequences\Sequence.js:47:14)
    at Query.ErrorPacket (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\protocol\sequences\Query.js:77:18)
    at Protocol._parsePacket (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\protocol\Protocol.js:291:23)
    at Parser._parsePacket (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\protocol\Parser.js:433:10)
    at Parser.write (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\protocol\Parser.js:43:10)
    at Protocol.write (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\protocol\Protocol.js:38:16)
    at Socket.<anonymous> (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\Connection.js:91:28)
    at Socket.<anonymous> (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\Connection.js:525:10)
    at Socket.emit (events.js:198:13)
    at addChunk (_stream_readable.js:288:12)
    --------------------
    at Protocol._enqueue (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\protocol\Protocol.js:144:48)
    at Connection.query (C:\Users\dexter\Desktop\friendbook\node_modules\mysql\lib\Connection.js:201:25)
    at Function.edit (C:\Users\dexter\Desktop\friendbook\models\User.js:62:12)
    at router.put (C:\Users\dexter\Desktop\friendbook\routes\UserRouter.js:58:8)
    at Layer.handle [as handle_request] (C:\Users\dexter\Desktop\friendbook\node_modules\express\lib\router\layer.js:95:5)
    at next (C:\Users\dexter\Desktop\friendbook\node_modules\express\lib\router\route.js:137:13)
    at Route.dispatch (C:\Users\dexter\Desktop\friendbook\node_modules\express\lib\router\route.js:112:3)
    at Layer.handle [as handle_request] (C:\Users\dexter\Desktop\friendbook\node_modules\express\lib\router\layer.js:95:5)
    at C:\Users\dexter\Desktop\friendbook\node_modules\express\lib\router\index.js:281:22
    at param (C:\Users\dexter\Desktop\friendbook\node_modules\express\lib\router\index.js:354:14)
  code: 'ER_TRUNCATED_WRONG_VALUE',
  errno: 1292,
  sqlMessage:
   'Incorrect date value: \'2001-01-01T08:00:00.000Z\' for column \'date_of_birth\' at row 1',
  sqlState: '22007',
  index: 0,
  sql:
   '\n        UPDATE user\n        SET\n          full_name = \'Jane Doe\',\n          username = \'jane2001\',\n          bio = \'Blogger and mother of three ki
ds\',\n          date_of_birth = \'2001-01-01T08:00:00.000Z\'\n        WHERE id = 6\n        ' }
```

It looks like something is wrong with the format of `date_of_birth`, which is weird, considering we copied the result of the `GET` request.

As it turns out, the `mysql` library automatically casts `DATE` into a Javascript `Date` object, which has a timestamp format and it not valid when inserted.

We want to retain the string format of `DATE` types. According to the `mysql` documentation, this is can done using by setting the `dateStrings` option in the connection options to `true`:

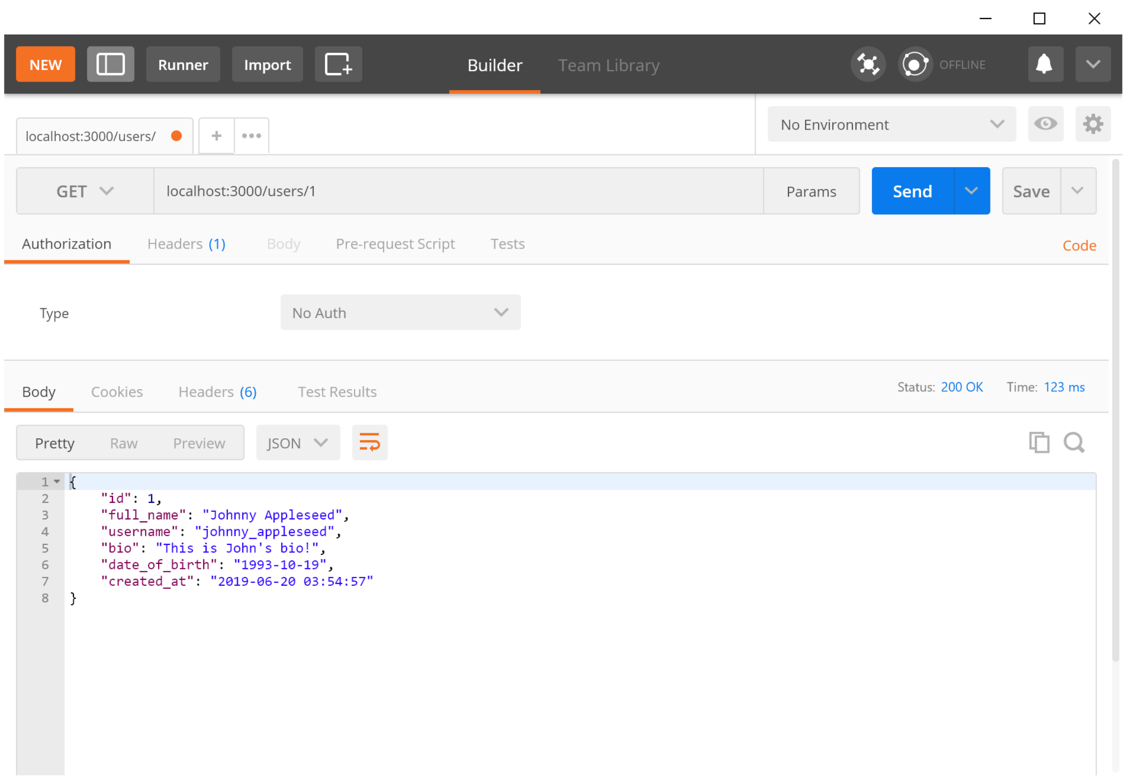
`dateStrings`: Force date types (TIMESTAMP, DATETIME, DATE) to be returned as strings rather than inflated into JavaScript Date objects. Can be `true`/`false` or an array of type names to keep as strings. (Default: `false`)

From: https://github.com/mysqljs/mysql#connection-options

Add the `dateStrings` option in the databaseConfig`.js` file:

```
const mysql = require("mysql");
const connection = mysql.createConnection({
    host: 'localhost',
    port: 3306,
    user: 'root',
    password: 'password',
    database: 'friendbook',
    // retain DATE as a string
    dateStrings: true
});

...
```

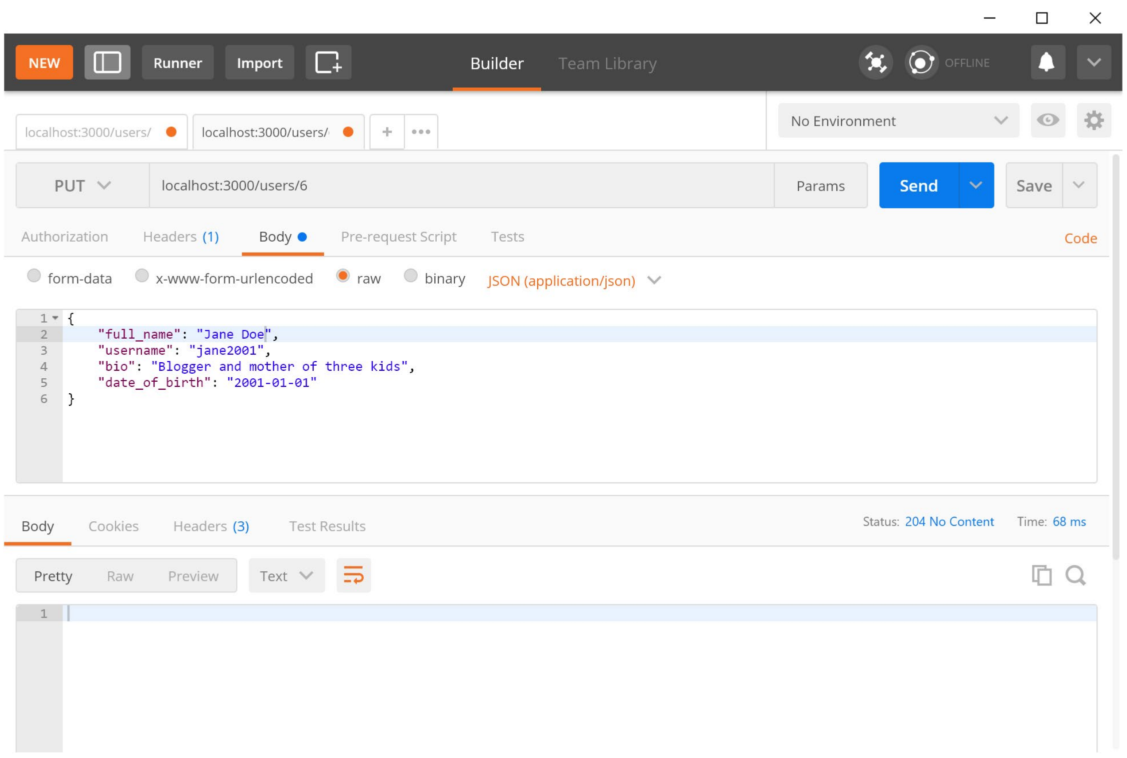
Let's query for Johnny Appleseed again:



```
{
    "id": 1,
    "full_name": "Johnny Appleseed",
    "username": "johnny_appleseed",
    "bio": "This is John's bio!",
    "date_of_birth": "1993-10-19",
    "created_at": "2019-06-20 03:54:57"
}
```

As you can see, we no longer get a timestamp format as it is not a Javascript `Date` object, but a string `DATE` that the database returns.

Perform the `PUT` request again with the correct date. You should receive a `204 No Content` to indicate a success:



PUT localhost:3000/users/6

JSON (application/json)

```
{
    "full_name": "Jane Doe",
    "username": "jane2001",
    "bio": "Blogger and mother of three kids",
    "date_of_birth": "2001-01-01"
}
```

Status: 204 No Content   Time: 68 ms

Body: Text

Inspect the database to ensure that the `full_name` was changed.

3.8. Implementing the rest of the User endpoints

Refer to the table in Section 3.1 and implement the remaining three endpoints that have not been covered.

3.9. Implementing the Post endpoints

As an exercise left to the readers, implement the following endpoints:

Endpoint	HTTP Method	Description	Succeed Response	Error Response
/posts/	GET	Returns all posts.	`200`	`500`
/posts/	POST	Add a new user.	`201`	`500`
/posts/:postID/	GET	Returns post with the given id.	`200`	`404` if cannot find post.`500` otherwise.
/posts/:postID/	DELETE	Deletes a post with the given id.	`204`	`500`
/posts/:postID/	PUT	Edits a post with the	`204`	`500`

		given id. Only allow `text_body` to be edited.		
/posts/:postID/likers/:likerID	POST	User with id `likerID` likes post with `postID`.	`201`	`500`. If user already liked (`error.code === "ER_DUP_ENTRY"`), then send a `201`.
/posts/:postID/likers/:likerID	DELETE	Unlike the post	`204`	`500`
/users/:userID/posts	GET	Returns all posts of user with id `userID`.	`200`	`500`
/posts/:postID/likers	GET	Returns users that liked the post with id `postID`.	`200`	`500`

4. Conclusion

Now that we have a working REST API with Express, we will build a simple front-end application in the next practical.