uCredit Backend Testing

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In this project, we were able to increase code testing coverage of almost all test files we implemented to over 90% for statement, branch, function, and line coverage from a practically untested backend codebase over the course of 167 tests.

1. Testing Tools and Artifacts

The testing tool we used in this project is the Jest Testing library and the Jest supertest for both unit tests route integration tests.

2. SUT

The express backend repository of uCredit, the degree planning app we are testing. We chose the backend of this app, as one of the group members have worked a bit on the frontend in the past. The repository below is a forked version of the official backend repository that we created tests on.
https://github.com/mliu78/uCredit-API

3. Test Files, Configuration Files, Tools

Test files include all .spec.js files in the tests folder:

- course.spec.js
- distribution.spec.js
- evaluation.spec.js
- experiments.spec.js
- majors.spec.js
- plan.spec.js
- planReview.spec.js
- search.spec.js
- sisData.spec.js
- SSO.spec.js
- user.spec.js
- year.spec.js
- distributionCreditUpdate.js
- distributionSamples.js
- experimentDAO.spec.js
- userSamples.spec.js

Configuration files include:

- package.json
- jest.config.js
- jest-mongodb-config.js
- .env

All files except the .env files should be included in the repository. You will have to create the .env file yourself in the root directory. Instructions below.

As mentioned before, the testing tool we used is the jest testing library

4. Presentation Slides

https://docs.google.com/presentation/d/1RORz4lgao8wrJCyd7ncSTC-8jTmMermjQ507cG31-lU/edit?usp=sharing

5. Instructions on Running Tests in Demo

1. Clone github repository
2. Make sure Mongodb, Node.js, and npm are installed on your computer
2. Add the secrets below to a .env file
2. Run “npm i” in folder of repository
3. Run “npm test”
4. Tests will run and report in terminal

Secrets (copy below to your .env file in your root directory):
DB_ADMIN_PASSWORD = "y0XQwI7fISy8U7kX" SIS_API_KEY = "c6DTXIBAujqzphi1T19D8pn3qajbp8BX" DOMAIN = "http://localhost:4567" SESSION_SECRET = "T$9s5~s%Qh`Y}n{'" PUBLIC_KEY = "-----BEGIN CERTIFICATE-----
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6. Screenshots of Running Tests

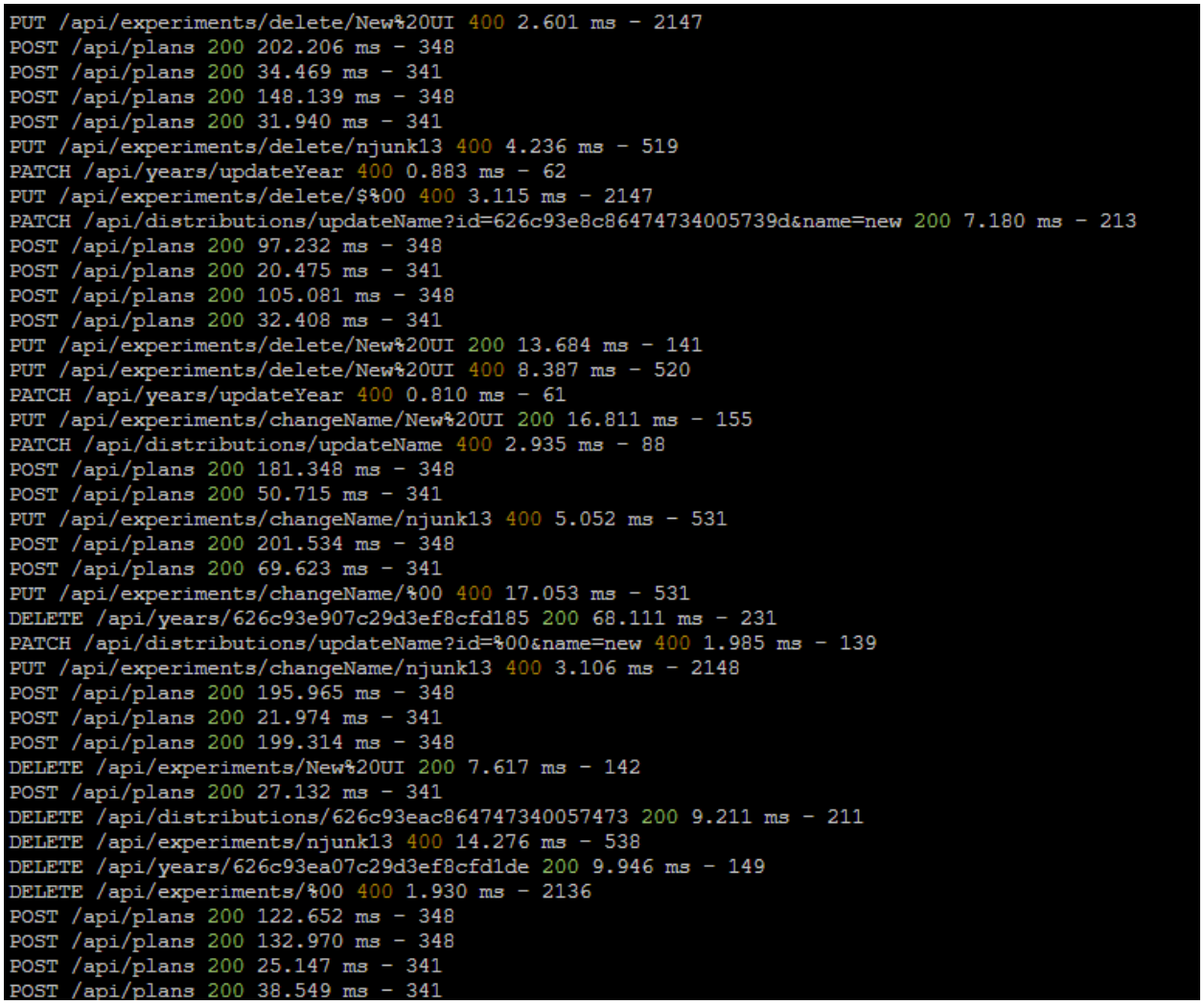


Figure 1: screenshot of backend route testing making requests to specific routes.

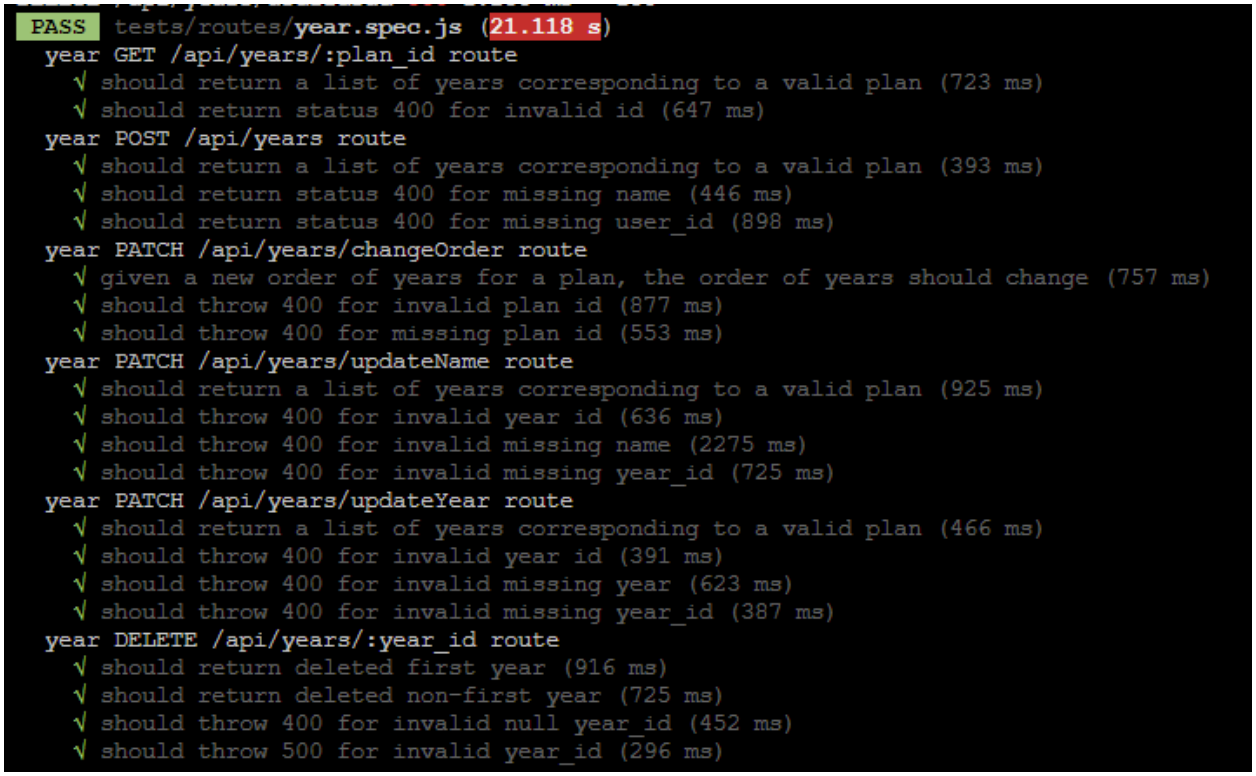


Figure 2: Image of passing and failing tests for a particular test file

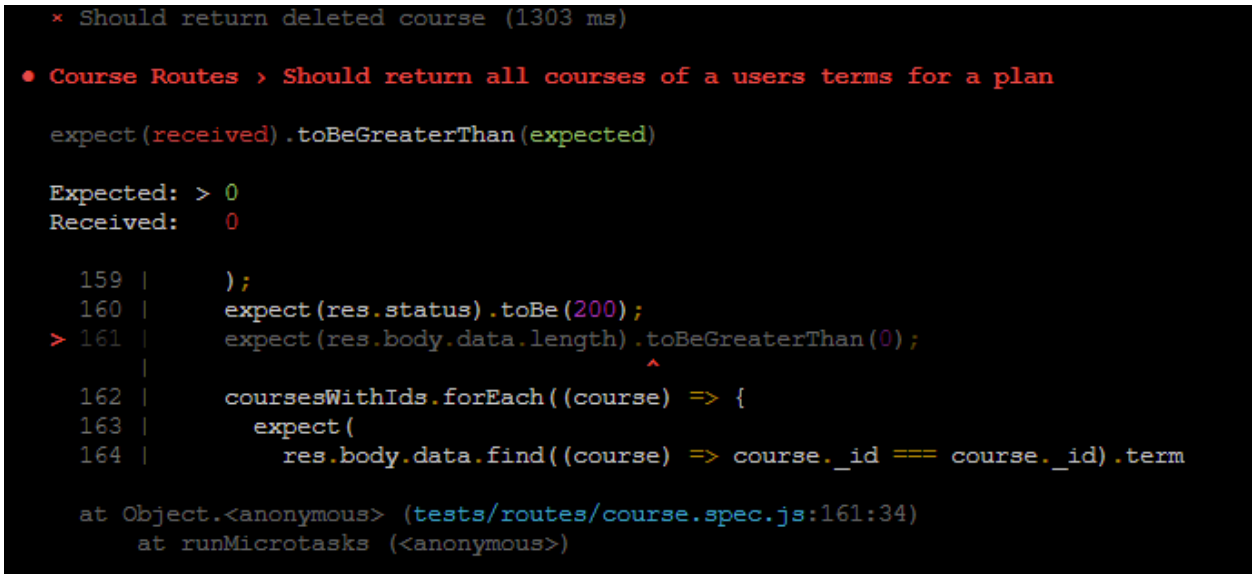
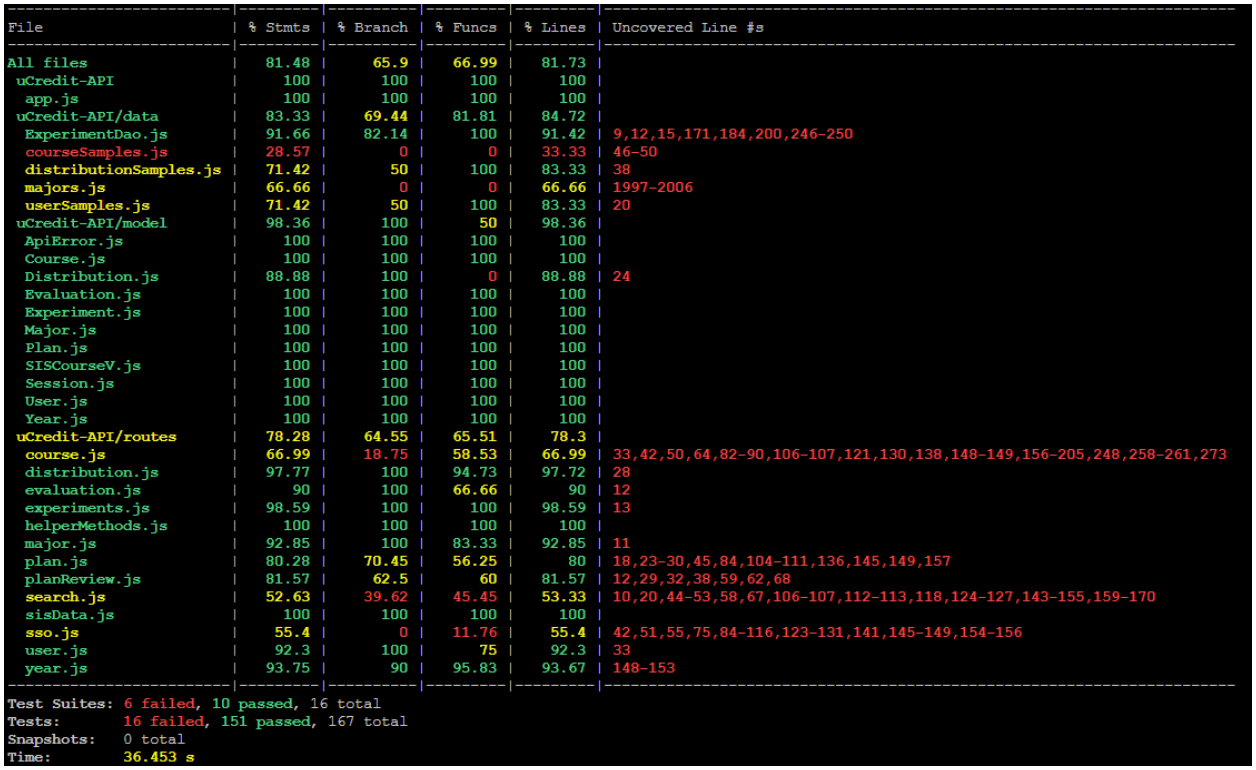


Figure 3: Image of failed test.



File	% Stmts	% Branch	% Funcs	% Lines	Uncovered Line #s
All files	81.48	65.9	66.99	81.73	
uCredit-API	100	100	100	100	
app.js	100	100	100	100	
uCredit-API/data	83.33	69.44	81.81	84.72	
ExperimentDao.js	91.66	82.14	100	91.42	9,12,15,171,184,200,246-250
courseSamples.js	28.57	0	0	33.33	46-50
distributionSamples.js	71.42	50	100	83.33	38
majors.js	66.66	0	0	66.66	1997-2006
userSamples.js	71.42	50	100	83.33	20
uCredit-API/model	98.36	100	50	98.36	
ApiError.js	100	100	100	100	
Course.js	100	100	100	100	
Distribution.js	88.88	100	0	88.88	24
Evaluation.js	100	100	100	100	
Experiment.js	100	100	100	100	
Major.js	100	100	100	100	
Plan.js	100	100	100	100	
SISCourseV.js	100	100	100	100	
Session.js	100	100	100	100	
User.js	100	100	100	100	
Year.js	100	100	100	100	
uCredit-API/routes	78.28	64.55	65.51	78.3	
course.js	66.99	18.75	58.53	66.99	33,42,50,64,82-90,106-107,121,130,138,148-149,156-205,248,258-261,273
distribution.js	97.77	100	94.73	97.72	28
evaluation.js	90	100	66.66	90	12
experiments.js	98.59	100	100	98.59	13
helperMethods.js	100	100	100	100	
major.js	92.85	100	83.33	92.85	11
plan.js	80.28	70.45	56.25	80	18,23-30,45,84,104-111,136,145,149,157
planReview.js	81.57	62.5	60	81.57	12,29,32,38,59,62,68
search.js	52.63	39.62	45.45	53.33	10,20,44-53,58,67,106-107,112-113,118,124-127,143-155,159-170
sisData.js	100	100	100	100	
sso.js	55.4	0	11.76	55.4	42,51,55,75,84-116,123-131,141,145-149,154-156
user.js	92.3	100	75	92.3	33
year.js	93.75	90	95.83	93.67	148-153

Test Suites: 6 failed, 10 passed, 16 total
Tests: 16 failed, 151 passed, 167 total
Snapshots: 0 total
Time: 36.453 s

Figure 4: Image of overall coverage information.

7. Unit Testing Information

The following unit tests below were performed via blackbox testing

1. ExperimentDAO.spec.js

Base case testing was used to verify valid and invalid inputs to check error edge cases. Testing was performed by documentation provided via chat messages with the developer of the app.

The following unit tests below were performed via whitebox testing:

1. distributionCreditUpdate.spec.js
2. distributionSamples.spec.js
3. userSamples.spec.js

Base case testing was used to verify valid and invalid inputs to check error edge cases.

We were initially going to perform unit testing on all files in the data file. However, we noticed that the majority of the files required connection to the production database. As we didn't want to possible perform any modifications on the production database, we erred on the side of caution and performed testing on the safe files, the files and functions associated with the tests above. Even so, we were able to increase overall coverage from less than 50% for statement, cranch, function, and lines to 83.33%, 69.44%, 81.81%, and 84.72% respectively, as seen in Figure 4 above.

8. API Testing Information

Although we weren't able to thoroughly test all helper functions and files, we were able to thoroughly test the backend api routes in over 130 tests. As seen in Figure 4 above, of the coverage information of the tests, we were able increase overall coverage of the routes from less than 10% for statement, cranch, function, and lines to 78.28%, 64.55%, 65.51%, and 78.3% respectively.

9. Main Faults Information

Error Handling: Specific cases of information could cause a 200 status code but error out after the status was returned, causing the header to be set after the response was returned to the client. The solution is to create more specific error cases instead of having a catch all method.

Note: Sometimes there are issues with asynchronous jest actions. Please run the test once or twice if the failing tests below don't match up.

Failing Tests below:

1. **search.spec.js:** Search routes
   Fail due to limited access to production database. There is little documentation on setting up the database with SIS courses and thus these tests could not be performed. Tests are passing when access to production database is accessible.
2. **course.spec.js:**
   a. **"Should return all courses of a users terms for a plan"**: CoursesByTerm fail in course.spec.jst: Empty array returned for valid query. Should return all courses of a users terms for a plan. Fails due to the improper packing of a search term variable during a method call. The solution to this fault is to wrap the matched term in curly braces on line 60 of routes/course.js.
   b. **"Should return deleted course":** Delete failed due to incorrect error handling for supertests.
3. **planReview.spec.js**:
   a. **"should create a new plan review and return the updated plan"**: user whitelisted_plan_ids is modified by attempting to push a plan id as a normal javascript array. However, arrays returned by MongoDB are sometimes of the MongoArray type and is thus unsafe to modify an array like this. Rather, findByIdAndUpdate with a $push into whitelisted_plan_ids would be the safer option
   b. "should delete a plan review and return the plan with the removed plan review": user whitelisted_plan_ids is modified by attempting to push a plan id as a normal javascript array. However, arrays returned by MongoDB are sometimes of the MongoArray type and is thus unsafe to modify an array like this. Rather, findByIdAndUpdate with a $push into whitelisted_plan_ids would be the safer option

4. **distributionSamples.spec.js:**
    a. **first distribution required credit count should match first sample required credit count**
    b. **second student required credit count should match for second sample required credit count**
    c. **third student required credit count should match for third sample required credit count**
    d. **fourth student required credit count should match for fourth sample required credit count**
    e. **fifth student required credit count should match for fifth sample required credit count**
    f. **sixth student required credit count should match for sixth sample required credit count**
    g. The tests above failed due to the fault where distributionSamples did not correctly add the “required” attribute to each sample distribution object.