Guide: Use, Maintain & Diagnose the Platform *[Debugging & Deployment]:*

Project Repository: https://github.com/gingebrigtsen/NMT_Schedule_Builder

Needed `` `FrontEnd/.next/` `` directory: here.

The front and backend production branch servers run at localhost `` `(127.0.0.1):3000` `` and `` `127.0.0.1:5000` `` respectively – these can be connected to the host domain URL in order to access the site at a larger scale and thru a cleaner address. The hosts/sysadmins will typically want to start the back-end first, as it has multiple threads and will take a little bit longer to start. This requires a pipenv environment, with the proper dependencies installed, as well as the Gunicorn WSGI server service. Starting the back-end properly can be done by:

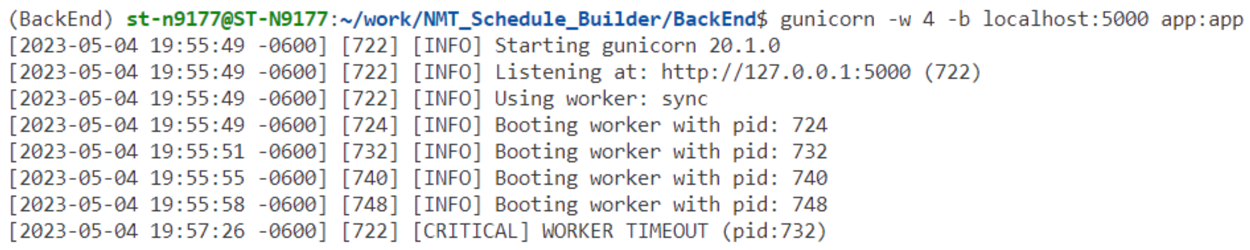
- Start the Flask-based back-end server using the pipenv environment, and install the proper requirements from the pipfile.lock using `` `pipenv install` ``.
  - Ensure that pipenv is locally or globally installed by installing it with pip.
- Next, start it with `` `pipenv shell` ``` ``.Then, execute the properly configured WSGI Python server with `` `gunicorn -w 4 -b localhost:5000 app:app` ``.
  - Ensure that Gunicorn is installed and up to date in the pipenv shell, it can be installed with `` `pip install gunicorn` `` and version-checked with `` `gunicorn --version` ``.
- Ensure the redis session management service is installed and running in the pipenv shell, with `` `sudo redis-cli ping` `` and expect `` `PONG` `` if working properly. This service is what maintains users' cart session data and must be running for Flask's configuration to work properly.

Next, when starting the front-end, it's a good idea to re-compile the build (in case of any issues or artifacts in the process of cloning from the project repository), then start the server using the native package manager, yarn. Here's how:

- If you need to install the project dependencies, use `` `yarn install` `` this will use the existing `` `package.json and yarn.lock` `` to fetch all the dependencies and requirements specified.
  - Sometimes, yarn will erroneously install nested `` `node_modules` `` folders inside packages within `` `node_modules` ``. These will stop the build from running or compiling.
  - They must be deleted before the front-end will work so if possible using the modules directly off the cloned repository would be the best way to avoid this issue.

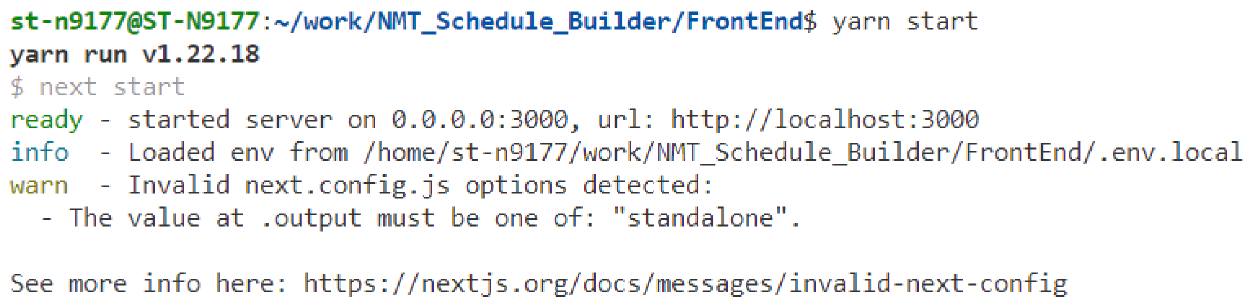
  - If you do need to find and delete them to resolve build errors, they're in `` `node_modules/@types/` ``:
    - hoist-non-react-statics
    - react-beautiful-dnd
    - react-redux
    - react-virtualized-auto-sizer
    - react-window
- `` `yarn build` ``
- `` `yarn start` ``

The back-end has a debugging route, a `Hello World` page that will display at the base URL if the backend server is working properly, and the front-end's base URL will render the index/home page of the website when fully up and running. A clean startup for the backend will look like:



```
(BackEnd) st-n9177@ST-N9177:~/work/NMT_Schedule_Builder/BackEnd$ gunicorn -w 4 -b localhost:5000 app:app
[2023-05-04 19:55:49 -0600] [722] [INFO] Starting gunicorn 20.1.0
[2023-05-04 19:55:49 -0600] [722] [INFO] Listening at: http://127.0.0.1:5000 (722)
[2023-05-04 19:55:49 -0600] [722] [INFO] Using worker: sync
[2023-05-04 19:55:49 -0600] [724] [INFO] Booting worker with pid: 724
[2023-05-04 19:55:51 -0600] [732] [INFO] Booting worker with pid: 732
[2023-05-04 19:55:55 -0600] [740] [INFO] Booting worker with pid: 740
[2023-05-04 19:55:58 -0600] [748] [INFO] Booting worker with pid: 748
[2023-05-04 19:57:26 -0600] [722] [CRITICAL] WORKER TIMEOUT (pid:732)
```

And a clean startup for the frontend will look like this (the next config warning is about exporting and can be ignored):



```
st-n9177@ST-N9177:~/work/NMT_Schedule_Builder/FrontEnd$ yarn start
yarn run v1.22.18
$ next start
ready - started server on 0.0.0.0:3000, url: http://localhost:3000
info  - Loaded env from /home/st-n9177/work/NMT_Schedule_Builder/FrontEnd/.env.local
warn  - Invalid next.config.js options detected:
  - The value at .output must be one of: "standalone".

See more info here: https://nextjs.org/docs/messages/invalid-next-config
```

This process can be automated by creating a bash file e.g. `` `start.sh` `` that runs these commands properly according to the host environment. That generally concludes the process of starting the web platform. To stop or shut down either branch, the goto method is the keyboard interrupt, `` `Ctrl + C` ``. This will abruptly but cleanly stop the front-end server, and issue an atexit thread cleanup in the back-end before a clean shutdown. This shutdown protocol should also be automatable with a bash script written according to the host environment. Or the automation of the web platform can be done using an external management library or software that SysAdmins are likely to already have access to in the host environment.

The back-end branch `` `/BackEnd` `` is relatively simple and stable compared to the front. The overhead `app.py` has all of the Flask, Flask-CORS, and Redis application and session configurations, as well as all of the routes/endpoints utilized by the front-end. There are also several subdirectories: Controllers, Models, and Services. For this project, the Controller branch is unused and unneeded – it's only included because it's an initial part of the boilerplate Flask project. The Models branch contains my Python scripts for scraping and parsing data from **Banweb**, which is then stored in a local subdirectory `` `csv` ``. These scripts are controlled by an autonomous thread started and managed by the overhead application, and will run every 24 hours. Finally, the Services branch contains a Python script for some side/helper functions that are key to both the back-end endpoints and the front-end course lookup. They regularly check, and update configuration data based on information provided on Banweb. After extensive testing, these routes, services, and scripts seem to be working properly and stably and thus shouldn't need much in the way of diagnosis, interference, or maintenance. But in the case they do, my Python code is well vertically separated for readability, and also very well commented. This branch should be easy to work with.

The front-end branch is much more complex: it came from a starter kit and as such it has numerous modules and dependencies. That being said, I only actually worked on a handful of files and anything that I've touched is extremely well commented and additionally formatted by prettier to be easier to read. Those can be found in `` `FrontEnd/src/pages/` ``; they're executable typescript files (.tsx) that utilize javascript, ElasticUI styling elements, and rely on the Next.js service and Node engine to run and render React pages. The Node packages, types, and modules can be found in `` `FrontEnd/node_modules` ``, these are the custom web programming JavaScript files the front-end relies on. As further explained and itemized in Section 3 of the Appendix, there ***may*** be occasional issues with this branch, in that certain Node @Types can end up with a nested modules folder in them, and it'll need to be removed in order to build/start the front-end server. There are several other directories and loose files in the FrontEnd branch, but they're of less significance. Things like the public directory (for local media and styles), package.json, and yarn.lock requirement configurations, and also some generic scripts and documents that came with the starter kit. Finally, there's the `` `FrontEnd/.next/` `` directory. This is the actual service that runs the production server, and it contains the static build (compiled) website pages, which will run and load much more efficiently and cleanly than on the development server. This directory is very straightforward but also problematic in that it's not available as a part of the GitHub repository. It contains numerous large files and will have to be transferred over an external medium such as Google Drive, etc from myself to the hosts/SysAdmins in order to include it in the FrontEnd branch. That being said, the build in the repository theoretically ***can*** generate this directory and its resources using `` `yarn build` ``, but to be safe I'd like to supply the existing build first which the host environment can then build on top of to correct any new issues.

There's also a significant issue in the build that the hosts/SysAdmins will need to resolve in a matter of weeks or months – once a particular package update is available. I contacted Alec Benson, former NMT CCoE project deployment manager, and we evaluated and discussed my primary issue, the @FullCalendar-react component, which works fine in development mode, but not in the build, in terms of styling/formatting. We tried several different versions of the package and other debugging options including reinstalling all node modules and changing the .next.config.js configurations. We scoured forums and documentation, tried tips, and I submitted a support ticket to the (relatively active) package management repository. We also noted a handful of existing other tickets and posts related to this exact issue, and the consensus is to wait a couple of weeks-months for the proper update to @FullCalendar-react. Until then, I can propose a handful of temporary solutions for the hosts:

- POSSIBLY: run the existing build with broken calendar formatting until the proper update becomes available and the front-end can be rebuilt
- OR: run your frontend server in the development branch until the update is available, at the cost of speed and cleanliness in page loading until the proper update becomes available and the front-end can be rebuilt
- OR: do not host the project until the packages can be updated properly and the front-end can be rebuilt
- THEN: when the fix is available re-install the modules with `` `yarn add @fullcalendar/react@latest` `` (being wary of the possibility of nested modules issues) and re-compile the front-end and host it properly.

I'm so sorry to pass on such an issue but it's essentially out of the scope of my control of this project so outlining this solution for the hosts is the best I can do to mitigate the risks to the quality and objectives of the website and project overall. I believe this will just be a temporary setback and not affect the platform in the long term.

Finally, it's strongly recommended but was unfortunately out of scope for me to handle, that both branches of the project, FrontEnd, and BackEnd, are containerized using a service like Docker. This would serve to support my projects' use of `` `localhost 3000/5000` ``, make it easier to simultaneously boot or shut down, and connect to the host/public domain URL. Containers have never been a particularly strong skill for me but in my development experience at CCoE, they were extraordinarily useful for the ending phases of development (and though I've never done it myself, the SysAdmins require them for ease of deployment and security), making sure that the branches can talk to each other coherently, and are presented at the proper public URL. The previously mentioned bash scripts for automating running the platform could then be controlled by the docker container instead, as configurations support startup command sequences. With access to a better environment than my WSL2 development IDE, and more resources than my laptop, configuring this container, and compressing/formatting the project shouldn't be too complicated and there may even be good templates available. In conclusion, this would likely be the easiest way to adapt the project to and stably deploy it within the destination host environment, but I couldn't handle this task because I couldn't access the proper packages/templates to do so as they were behind a paywall.

For any other information, refer to the included Appendix and Attachments section below, which provides more direct steps with less narrative explanation, and some tips/documentation.

Appendix and Attachments *[Code and Documentation]:*

Project Repository: https://github.com/gingebrigtsen/NMT_Schedule_Builder

Needed `` `FrontEnd/.next/` `` directory: here.

1. ***Front-End Code (excludes starter kit & components)[`FrontEnd/src/pages:`]***
   1.1. *header.tsx (The top bar, primary navigation menu for the website)*
   1.2. *footer.tsx (The bottom bar, secondary navigation menu for the website)*
   1.3. *index.tsx (The main/index/home page, the landing page for all users)*

1.4. *lookup.tsx (The course lookup and results page where users select courses)*
1.5. *calendar.tsx (The weekly calendar generated from users' cart of courses)*
1.6. *about.tsx (Largely static page about the purpose and uses of the website)*
1.7. *help.tsx (Completely static page, giving simple step-by-step directions, and site FAQ)*
1.8. *report.tsx (Simple report form on a plain page, for users to report glitches, technical issues, or other problems)*
1.9. *404.tsx (Completely static Error 404 graphic page, which offers a back button to return to the last page, though it still has the header and footer so users will still have navigation abilities)*
1.10. *_app.tsx (React Component template for the setup of each page, controls style, and <head> configuration for each page on the site)*

2. BackEnd Code (Main files, excludes data CSVs and minor files)

2.1. *app.py():*
2.2. *BackEnd/Models*
2.2.1. *conf.json: JSON formatted configuration for collecting and scraping from Banner, as well as populating search options from valid **Banweb** options.*
2.2.2. *CollectData.py(): actually scraping **Banweb** utilizing the requests library, BeautifulSoup4, and html5lib. Generates an un-parsed CSV file, which is then passed into the parser*
2.2.3. *ParseData.py(): parses broken CSV entries by fixing lines with missing data, secondary instructors, no CRN, etc.*
2.2.4. *DEBUG: Also included in the project repository are isolated debug functions for dumping banweb HTML, collecting, and parsing smaller sections of course data. These can be run as standalone methods using `` `python3 {script}.py` ``.*
2.3. *BackEnd/Services*
2.3.1. *requestService.py(): background helper functions for the scraping and parsing processes, managed by discrete threads in the overhead application.*
2.3.2. *Services are used to hold the actual Python scripts and methods the overall app and routes draw from and require – they're where actual computation tends to take place after being properly routed by the app or the controller.*
2.4. *BackEnd/Controllers*
2.4.1. *requestController.py(): unused.*
2.4.2. *Controllers are used to build more precise route blueprints, for properly finding and executing methods within the Flask back-end as a whole – typically for more intensive or less commonly used functions.*
2.4.3. *No controller was necessary for this project; though originally I had all of my routes templated here, later on in development I concluded doing this was not necessary for the stack to run effectively.*

3. General Guidelines for Startup & Use

3.1. *Start the Flask-based back-end server using the pipenv environment, and install the proper requirements from the pipfile.lock using `` `pipenv install` ``.*
3.2. *Next, start it with `` `pipenv shell` ``.Then, execute the properly configured WSGI Python server with `` `gunicorn -w 4 -b localhost:5000 app:app` ``.*
3.2.1. *Ensure that pipenv is locally or globally installed by installing it with pip.*

3.2.2. *Ensure that Gunicorn is installed and up to date in the pipenv shell, it can be installed with `` `pip install gunicorn` `` and version-checked with `` `gunicorn --version` ``.*

3.2.3. *Ensure redis is installed and running in the pipenv shell, with `` `sudo redis-cli ping` `` and expect `` `PONG` `` if working properly. This service is what maintains users' session data and must be running for Flask's configuration to work properly.*

3.2.4. *Note: Banweb Data is automatically collected and parsed every 24 hours.*

3.2.5. *Note: Updates to Banweb data are automatically checked every 24 hours. Term codes and subject codes will automatically be updated when new course data becomes available, corresponding to announcements on the Banweb page.*

3.3. *Ensure the yarn package manager is installed, `` `sudo apt update` `` then '`sudo apt install yarn`' (If the repository is already configured).*

3.4. *Even though the deployment-ready project stack will already have been built, it's a good idea to do it again, using `` `yarn build` `` from within the FrontEnd folder.*

3.5. *The project can also be exported to an extremely minimal production build that can be run with a Python HTTP server, for debugging purposes or if it's too resource intensive for the host environment. This can be done with `` `yarn export` ``.*

3.6. *Start the Node-based front-end using a terminal from using yarn to boot the server with `` `yarn start` ``.*

3.6.1. *Note: front-end pages are accessible via `` `url/page` ``, whereas back-end functions are accessed via `` `url/api/{route}` ``.*

3.6.2. *Note: watch out for peer dependency issues, the front-end has **a lot** and may need to be restarted if it overflows and stops working.*

3.7. *Navigate to the site in a web browser to ensure it's functioning properly.*

3.7.1. *Note: All main pages, including the users' cart, are accessible from the top header. The footer, help, and about pages all offer supplementary pages and links for users in the case of an error or if they need more information.*

3.7.2. *Note: Typically, the largest thing pages must load is the NMT logo, but it's been optimized to load fairly quickly.*

3.8. *This startup process for the front-end and the back-end can be automated by creating a bash file to run these commands – not included because I have no reference for the platform on which the project will be deployed. The sysadmins will need to either use their existing software management options or quickly put these commands together according to their environment.*

4. *Development Issues & Overcoming Them* ***[Problems and How I Addressed Them]:***

4.1. *During the design and development phases of this project, I encountered several issues with both the fundamental logic of my process and the actual code in the project stack. These were things that temporarily stunted project development or shifted my thinking, as well as things outside the project scope, such as my personal research/learning process, and my stress. I almost universally used my recognition of these issues to push myself past my comfort zone - in order to address known problems and complete the project as required, to the best of my ability. The following breaks down where and how I encountered issues during my Senior Project Design terms, and proceeds to address how I responded to them in order to meet the development goals and grow as both a developer and an IT student.*

4.2. *In order to meet the requirements of my Senior Project Design term, I needed to gain confidence in my capabilities in order to be less stressed while working - this was key to finding my resolve, and powering through to resolve final issues and address conflicts, and complete the project. More specifically, I overcame the known major issues I had, in the following ways, bolstered by an improved outlook/resolve and stress management strategy.*

4.3. *First, I was almost constantly making slight changes to the included modules and components, which occasionally had cascading effects like breaking peer dependencies or entire pages. This was because I was experimenting with packages to find out what's easiest to work with vs implement, and I eventually settled with one build in order to minimize both the number of requirements and the effort required to manage dependencies. The most direct example of this would be the calendar, where since I'm using such an open front-end stack, I had many compatible options, but there were several tradeoffs to each one such as appearance and functionality I had to balance in order to achieve the project's main goal of a slim but useable modern weekly calendar. This challenge was pretty consequential time-wise, but it was relatively easy to diminish its effects of it by finalizing decisions.*

4.4. *In response, I had to get a concrete project stack that I could associate with my objectives and to-do list. Finalizing these decisions allowed me to go through and systematically reinstall or add the unmet or corrupted peer dependencies that were causing the majority of this issue. To continue the direct example from the last section, this was the point where I decided to go with the FullCalendar-React module configured using minimal plugins; because between other components, and the pop-up information display I have there were numerous conflicts caused by the variety of plugins and calendars I tried. Choosing the best options for the course lookup, results table, and calendar components let me go through one final time and resolve this issue. The dependency documentation was updated and I ensured I had the latest version of all the components and I moved on with development.*

4.5. *Because of the disparity between Plan A and Plan B, much of the stack's back-end remained a very open-ended work in progress. I'd been working on Python implementations of both schemes simultaneously, because of the delays in communications with both CourseDog Support & Engineers and the Registrar's Office. However, as a result of developing 2 Model schemes, the rest of the back-end like the routing and services idled until a decision could be made. Eventually, I all but gave up on Plan A. This was pretty late in the Spring term, and I was tired of waiting and going back and forth; I additionally realized that I really needed to buckle down and finish development so that the website would be ready to deploy.*

4.6. *Accordingly, I became heavily invested in finishing and polishing the process of collecting and parsing data scraped from NMT's course offerings page for Plan B. Once that was working smoothly, and I had the front-end pages working I was able to start syncing up the routes, services, and capabilities of the Flask back-end to match the CSV data I have and the components I need to send it to. This meant that development could proceed as planned and I was one step closer to completion.*

4.7. *Finally, coordinating the conversion of course data from CSV to JSON mid-route from the back-end to the front-end proved to be unexpectedly challenging. Because many of my core pages feature largely pre-existing elements and plugins, I had to conform to their rules for data inputs; typically consisting of casting a data frame entry from CSV values into a JSON dictionary format like the following: { Column: 'Value', }. This was an absolute necessity to be able to serve my collected data into the elements I built to display them, but it proved to be problematic. This was largely due to my fading familiarity with the*

Pandas library (I had some conflicting logic based more on the csv library), and this also directly corresponded to the peaking stress of having an issue while implementing the final sync of the front-end and back-end branches and functions.

4.8. *To address this and finalize the project so it could be deployed, it honestly took mere brute force. I spent a handful of sleepless nights working on researching, outlining, configuring, building, and debugging all of my backend routes. It meant some of this conversion ended up taking place in front-end JavaScript, but the hard work paid off in the end because the setup ultimately functions sufficiently well.*

4.9. *Right at the very end of the development process (literally the last week of the term), as I was switching the back-end over to the production branch, and compiling the front-end for maximum efficiency, I encountered a really unfortunate problem. At first, I was just completely baffled; I'd never handled this process before and though it should've been straightforward it turned out to be a mess. I contacted my old boss at the NMT CCoE, Alec Benson, who was our deployment manager, and evaluated and discussed my issue with him. Primarily, it's that the Calendar component, which works completely fine in the development mode, is broken in the compiled build, styling and formatting-wise. We tried several different versions of the package and several debugging options like completely reinstalling all node modules. We scoured forums and documentation, tried tips, and I submitted a support ticket to the (relatively active) package management repository. We also noted a handful of existing other tickets and posts related to this exact issue, and largely – the consensus is to wait a couple of weeks-months for the proper update to @FullCalendar-react and use broken calendar formatting. Well, that or run your frontend server in the development branch until the update is available, at the cost of speed and cleanliness in page loading, until the point at which you can re-install the modules, and re-compile the front-end and host it properly. This was immensely stressful that such a serious issue was pressing me right at the end of the project development cycle, and that the solution was out of my control. Thus, the best I can do is provide an explanation of the issue and coherent solutions, and directions to the SysAdmins that will handle the deployment of the schedule-building website platform, on how to properly start the FrontEnd production branch server accordingly.*

4.10. *Overall, I honestly experienced some serious stress and hardships throughout the process of working on this project – because of being underprepared for web development, and because of being alone. But, I've grown as an IT developer, and especially as a student by learning how to work (with/against) my stress and the paralysis feeling it caused me at points. It hit me hardest as I had to recognize and overcome technical problems along the way, but it mentored me to learn better from my mistakes and eventually, I was able to pull through with a deliverable project for the IT Senior Design program.*

5. ***Project Final Thoughts* [Ending the Project]:**

5.1. *In conclusion, this project went approximately as expected. Though I've been reasonably confident with my skills in this field, Senior Design really put that to the test and force me to learn I was wrong. Not necessarily wrong about my Information Technology skillset, but more about my ability to apply them to a real project where there are things like time constraints, real problems to solve, and significant unknowns. However, I still conclude that the project ended as expected. I often must force myself to deal with my stress, which corresponds to the problems I'm having. So, while I felt very good about the prospects of the project at the beginning, I had some real struggles throughout; creating a resultant project largely similar to most of my other higher education endeavors. I start with an idea and am forced to evolve by both constraints and stress, before arriving at a final product shaped by the process. I expected to develop a specific workflow to ensure the completion of this project but ended up* *learning more about the nature of how I actually work through problems, learn, and respond to challenges. Overall, this web development project was stressful, but rewarding, thanks to the huge learning curve and the experience that it gave me in conflict resolution and working hard; it was a good fit for my Senior Design project and I only wish that I hadn't been alone to work on it.*

6. *Thank you for reading. and for working with me this year, and making my senior year an opportunity to really grow as an IT student and as an individual, thanks to the design and development practices I learned, as well as stress management strategies I ended up teaching myself in order to power through to the end. I also thoroughly enjoyed the connections I was able to make between what was taught to me in Project Management this semester and what I learned over the course of this project. It was illuminating and I look forward to working on and/or leading projects in my career in the future. -Gabe Ingebrigtsen*