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Developing a Multi-Platform Application to Facilitate Internal Campus Hiring

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Abstract

Undergraduate research has proven to be highly beneficial to students, yet there are many students who do not know how to get involved or who are too timid to approach professors to inquire about potential research opportunities. Our hypothesis is that a cross-platform application has the potential to bridge the gap and help more students get involved in undergraduate research by providing them information about open positions and the faculty or staff members who are mentoring the projects. The key focus of this thesis is to develop an application that provides details about participating faculty or staff including their research interests, biography, and posted positions in their lab or elsewhere that can provide students the information necessary to come to a conclusion about what sort of research to pursue and under whom they will research. Creating an application that provides searchable and filterable details about open positions helps further refine students' searches and identify positions most geared toward the students' interests. This paper discusses the development of an Ionic Angular application that will assist students in finding undergraduate research opportunities or other on-campus positions and that will assist faculty and staff in filling their open positions with students who have the particular background, interests, and skills best suited to the requirements of those positions. In facilitating both key objectives, the application supports the University of Arkansas' emphasis on promoting research.

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1 Introduction

In Spring of 2022, initial work was started with the Office of Undergraduate Research to create an application that would aid students in finding on-campus research opportunities. By Fall 2022, preliminary decisions about application framework and basic design had been made, so it would be my task to utilize the existing framework and improve the design, create functionality, and complete objectives so that the application can be published and used by students and faculty campus-wide.

Undergraduate research is an important aspect of University activities, having been proven to greatly impact an undergraduate student's experience. Students have reported hesitancy in reaching out to faculty to engage in research, representing a current gap in the ability to arrive at a beneficial research arrangement. It is our hypothesis that a robust web presence could reduce this gap.

1.1 Motivation

Following the Coronavirus pandemic, innumerable operating norms changed for everyone, from grade-schoolers to adults. University students were greeted with a drastic shift, moving to a remote learning environment from what was largely a face-to-face experience. Students surveyed by Top Hat in 2020 "overwhelmingly preferred face-to-face over remote instruction," but in the midst of a global pandemic, remote learning was considered the only option for universities to continue educating their students in a safe manner [1]. Not only did this situation affect students, but professors as well, with Forbes noting that hybrid and fully remote work is likely to stay in higher education after the pandemic [2].

While many classes at the University of Arkansas are back to face-to-face lectures or a hybrid model, typical communication has shifted as a result of the COVID-19 pandemic. While completing online coursework, students were learning

from and communicating with professors remotely and are likely to continue to do so in a post-pandemic era. While it is not particularly difficult to communicate a few questions regarding a class to a specific professor via email, it becomes much more challenging to remotely try to find a professor to be a research mentor, learn about areas of potential interest, or even try to secure a position to pursue undergraduate research under a faculty member with the current methods in place offered to students. As course content becomes increasingly available online in a streamlined manner after professors have learned ways to effectively and directly communicate information to students during the pandemic, it has become obvious that there needs to be a way to effectively and directly communicate information about undergraduate research as well.

Not only has the pandemic shifted ways of learning, but students have been shown to be hesitant or too intimidated to approach faculty, despite being "very interested in working with faculty on research projects" and learning more about their research areas [3]. Upon informally surveying a few students at the University of Arkansas in the Computer Science and Computer Engineering Department, this fact becomes undeniably clear. Many are interested in getting involved with undergraduate research but do not know how to find a professor researching in their area of interest, the best way to approach a faculty member about pursuing research, or when they should start the process of researching. This leads students to approach other students that they know are involved in research to answer their questions, but many on the University of Arkansas campus may not know other students involved in research and thus would not have that opportunity to discuss desired research positions with other students. The current methods in place provide a good starting point for finding opportunities, but a new way of finding research topics, mentors, and projects would be extremely beneficial to students and could help grow the research presence at the University of Arkansas.

Undergraduate research allows students the opportunity to "establish a personal connection" to their work and have a "feeling of ownership" [4]. It offers a "short-term, risk-free way" to determine if a research career would be a good fit

for the student, allowing them also to forge a relationship with a faculty mentor and gain valuable experience to place on a resume to help students earn admission into graduate programs [4]. However, in a study done in 2017 by CERP, 72% of the 9,610 undergraduate students surveyed had indicted that they had not participated in a formal research experience and 50% of students were not even aware of research opportunities [5]. The fact that large numbers of students are missing out on opportunities to participate in research because they are simply unaware of these opportunities indicates a need for a platform to provide information about research opportunities to undergraduate students.

Historically, underrepresented students who are economically disadvantaged, first-generation students, or ethnic minorities are not as involved in experiences such as undergraduate research. However, those who get to pursue research positions "gain hands-on experience" and more "applied learning opportunities" which helps lead to increased academic success and higher retention rates especially for "traditionally underserved students" [6]. Providing a place for students of all backgrounds to easily find opportunities and clearly displaying what positions are paid can help encourage students to not only pursue research, but also to do so with less hesitation due to financial concerns.

Specifically at the University of Arkansas, Chancellor Charles Robinson vowed to continue and enhance "the university's emphasis on research endeavors" in 2023 [7]. Research was a key focus of this town hall, as the university "hauled in more than $142 million in research awards" [7]. He emphasized a desire to pursue more research and retain the "Research 1 - Doctoral University: Very High Research Activity" distinction. The need for an application allowing students to find research opportunities will be critical to ensuring students are discovering and seizing opportunities to be involved in the research opportunities offered by the University of Arkansas.

The Office of Undergraduate Research at the University of Arkansas has decided to undertake this task, developing a web application that will allow students to see information about professors, areas of research for each professor, and

available jobs all in one place. Additionally, faculty and staff would be able to post open positions, see information on students who have expressed interest in certain topics, and post their areas of interest regarding their research.

1.2 Personal Experience

During my four years at the University of Arkansas, I have participated in research in two different departments. As the result of having personal connections with someone who had previously done undergraduate research with Dr. Jamie Hestekin, I spent a year researching under him with Leticia Santos de Souza as my mentor in the Chemical Engineering Department. The goal of the project was to create a portable kidney dialysis machine, so my mentor and I ran experiments to try to create wafers that would be selective for different key ions, specifically Sodium, Calcium, Potassium, and Magnesium, and filter them out of a solution that was similar to blood. Using AWEDI, or activated wafer electrodeionization, we worked to simulate the filtration capabilities of the kidney. The group that I worked with published their findings at the conclusion of their research on this topic [8].

After having a class with Dr. Alexander Nelson and hearing about his research, during my junior year I made a shift to working in the Computer Science and Computer Engineering Department to be able to research an area more closely related to my studies. I earned an Honors Research Grant to study the use of capacitive sensors in a toolbelt, to detect the position of the lumbar spine. Using noninvasive sensors, this project had the potential to help reduce lumbar spine injuries on construction sites by being able to warn workers of potentially harmful positions. I worked with capacitive sensors on the Texas Instruments' MSP CapTIvate Capacitive Touch MCU Development Board and then shifted to using fabric capacitive sensors and observing changes that occurred when the sensors were bent around a curve. Bending the fabric would be similar to how the sensors would ultimately work in the toolbelt detecting bends and posture changes in the

user's belt. Utilizing the software provided by Texas Instruments, I could see the capacitive sensor data in real time and analyze that information to see how the data changed based on curvature [9].

In both cases, becoming aware of these research projects was the result of personal connections, but it would have been significantly easier had I had access to an app with functionality like that of this proposed project. I would have been able to review all available positions and areas of research, providing the ability to more easily find a research position which suited my interests and skills.

1.3 Project Objectives

Ensuring that the objectives are met is crucial to guaranteeing a successful project. The Office of Undergraduate Research had overarching goals that they wanted to accomplish, so it was our job to design and execute tasks that would result in an application conducive to meeting those objectives. These initial objectives included:

1. The application should be accessible by students and faculty or staff.
2. The application should show to students open positions and information on faculty and their research.
3. The application should allow faculty to post, edit, and remove positions, as well as post, edit, or remove information regarding their research interests that would be visible to students.
4. The application should be hosted at a route off of the Office of Undergraduate Research page so that students or faculty can get to the new application from the existing Office of Undergraduate Research website.
5. The application should be available for mobile devices.

The Office of Undergraduate Research initially wanted a native mobile application but were convinced to shift to a different, cross-platform option that

would allow users to use the application on a mobile device or a computer. The Office of Undergraduate Research let the students working on the application take the lead in determining what information was necessary or beneficial for students to have access to when finding potential research positions. This meant that we created another set of more specific objectives, including:

1. Determine the information required to provide students adequate information about research positions and professors.
2. Determine where the aforementioned information was stored and how to leverage that for our use.
3. Determine features that would be beneficial for students in their process of finding positions.
4. Determine features that would be beneficial for professors to have to be able to communicate information effectively to students.
5. Determine Ionic components to utilize to create features.
6. Determine existing libraries that could be leveraged for the application.
7. Determine the best way to distinguish between a faculty or student accessing the page.
8. Investigate and start the process for communicating with Campus IT to approve the application to be deployed.

1.4 Parties Involved

While the Office of Undergraduate Research was crucial in initiating this project, other parties became involved, particularly when beginning discussion of hosting this application on a University of Arkansas server and making it accessible to students. Communication with the University of Arkansas IT Services team

began in the Fall of 2022, and we were able to gain approval to start the process of hosting the application in the Spring of 2023. Dr. Alexander Nelson was essential to this effort, helping to get meetings with the correct individuals as well as ensuring that information was shared with the students working on the project so that we were up to date on any and all conversations with IT Services regarding this application.

2 Background and Prior Study

The preliminary decisions regarding required features as well as the application platform and framework are crucial to the overall development. If potentially key features are overlooked, they can be more challenging to add in later in the process. Additionally, looking at how other universities provide information about undergraduate research to their students can be beneficial and ensure that the application provided by the University of Arkansas for its students to find research positions is on par with or better than applications utilized by other universities and provide a basis for further development.

2.1 Background

The current methods for finding research opportunities are clunky and require large amounts of effort from the students to be successful in finding an area of research they are interested in and then a position in a lab studying that area of interest. The Office of Undergraduate Research provides guidance to students on their website, indicating that students should research potential mentors and make a list, decide how involved they want to be in the research, and schedule interviews with several potential mentors to discuss getting involved in their labs [10]. While there are some bullets providing additional information that provide a good overview of how to approach the process, a majority of the work lies with the student to take initiative and search campus websites to find mentors and research areas. This can be a significant obstacle to many students getting involved in research if they do not know where to start looking for these things, so there ought to be an alternative that makes this process more appealing and less overwhelming to students wanting to participate in research.

Many departments have "Research" areas on their websites, but these also fail to provide the necessary information to help students find positions. For exam-

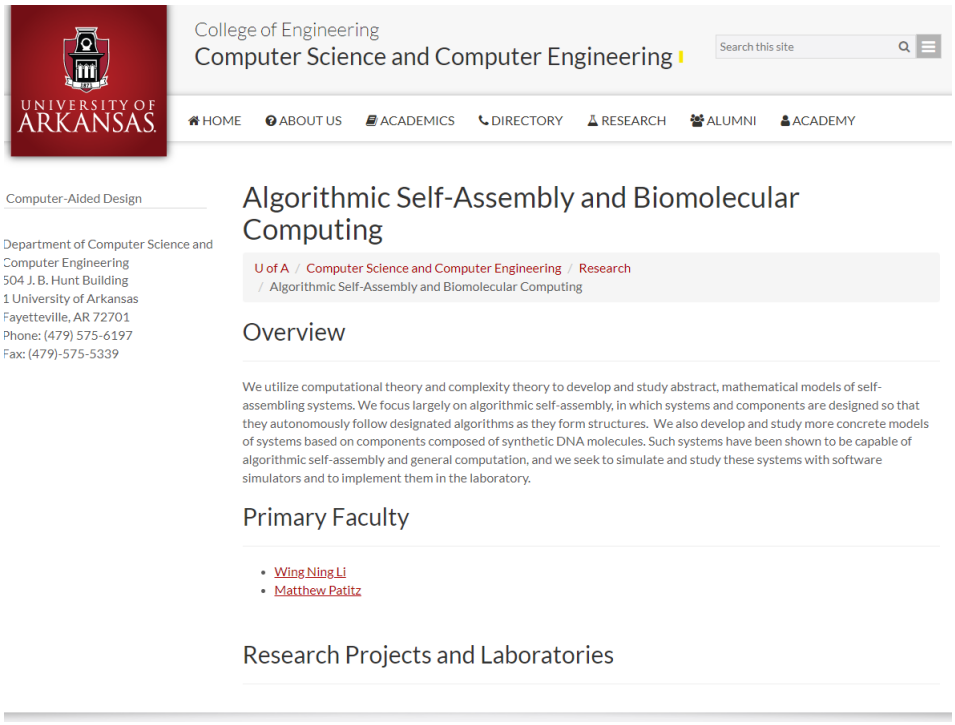


Figure 2.1: Current UARK CSCE Research Page

ple, on the Computer Science and Computer Engineering website, the "Research" tab shows topics of research and faculty associated with each area but fails to show if these faculty are interested in taking on students or what research projects or laboratories fall into that category of research [11]. As seen in Figure 2.1, Dr. Li is listed as being a faculty member researching in the "Algorithmic Self-Assembly and Biomolecular Computing" area. However, he has recently retired and that information was not updated on the campus web data. Errors like this could potentially lead students to pursue an opportunity that in reality fails to exist. If Dr. Li had more control of the research information that was posted, he could have removed his name from lists like this upon retirement.

While the University posts research interests of faculty on the respective faculty member's profile page, students have to look at each page individually and try to find an area of interest that they might be able to pursue a position in.

Unfortunately for the students, these faculty profile pages do not show if there are currently open research positions in their labs, what their most up-to-date research topic areas are, or even what current projects are being worked on. This makes it challenging for students to get accurate information and can make it even harder to find a lab with research aligned with the student's interests. This current process of finding mentors and research can be streamlined significantly, and that is what this application aims to do.

The current methods are also not conducive to research across departments. If a project could benefit from including a student from another department, there is currently no way to communicate this to students. Being able to find all research opportunities in one place and what sorts of majors might be beneficial on the project will be critical to start seeing more of these cross-disciplinary projects come to fruition and truly enhance the type of research done at the University of Arkansas.

It can also be challenging for students to find an on-campus job, as they have to look through Workday to try to find jobs. With the high cost associated with gaining an undergraduate education, many students need to work paying jobs to support themselves through their studies. Having a place to easily find on-campus jobs and see immediately which are paid can be very beneficial to a range of students.

2.2 Study of Other Universities

As mentioned previously, various other schools already have an application implemented that allows students to find research opportunities. For example, the University of Missouri has a web page detailing current open positions with general information about the job, information about the faculty mentor or sponsor, a job description, requirements, and the application process [12]. The University of North Carolina at Chapel Hill has an "Opportunities Database" that allows students to search or filter positions, as well as view the various different jobs and

their descriptions along with the respective advisors and mentors [13]. The University of Arizona has a database of faculty members who "welcome undergraduate students into their research projects" [14]. This page displays the faculty members along with their department, prerequisites for joining the research, and the type of opportunity, whether it be for credit, volunteer hours, or pay.

Arguably the best example of what ought to be replicated is what is present at the University of Washington [15]. They have a Research Opportunities Database that is accessible to students and staff at the University and holds information regarding research opportunities located on campus or the surrounding area. This database is filterable as well as searchable by title, department, and description or the mentor's name or contact. Detailed information about each position includes the contact name and email, department, project name, project description, student learning benefit, minimum requirements, location, and if it is a paid position or a work study [15]. Having all of this information can help students make informed decisions about what research project they want to pursue, as they can view all of the different potential options in one place and with enough detail to get a good understanding of what the project would entail.

2.3 Essential Features of the Application

As a tool meant to aid students in finding on-campus positions and help faculty and staff post and fill these positions, there were various essential components that needed to be implemented to make it a useful tool. Ensuring that the application fulfills the needs of students as well as faculty and staff would help guarantee that the application would be utilized once development was complete. To meet these requirements, the essential features were determined and are as follows:

1. Show open positions to students.

2. Show details about an open position.

3. Allow for students to be able to find information about any faculty or staff member of any department, with preliminary focus on the Computer Science and Computer Engineering Department that would later be expanded to include other departments and colleges.
4. Allow students to view information about research interests of professors.
5. Allow students to search for positions.
6. Allow faculty and staff to post open positions.
7. Allow faculty and staff to edit available positions that have already been created.
8. Allow faculty and staff to delete positions once they have been filled.
9. Allow faculty to edit information regarding their research interests that will be shown to students.
10. Provide different views to the user based on whether they were a student or a faculty or staff member.

This list includes only what was initially established as use cases that would need to be developed. The actual features that have been developed as part of the application go beyond those on this list, as additional features have been added for convenience or for the benefit of the user, and these will be discussed later in this paper.

3 Implementation and Results

3.1 Framework

Ionic Angular was utilized to build this application. Ionic Angular combines "the core Ionic experience" with the Application Programming Interfaces (APIs) that are "tailored to Angular Developers" [16]. Ionic provides an Angular toolkit, which "builds and integrates" with the Angular Command Line Interface [16]. The user interface components from Ionic along with an Angular back end to implement the logic help to create a cohesive cross-platform application that can be optimized for mobile or web use.

Ionic is an open source User Interface (UI) toolkit that focuses on the components of the application that a user will interact with. This includes theming, the use of pre-built components, and integration with native device plugins. All of these are leveraged by developers to create a visually appealing user interface without having to write numerous lines of additional code to manually do what Ionic provides. It is "built on top of reliable, standardized web technologies" allowing for the Ionic components to have a stable API [16]. In addition, the Ionic Command Line Interface aids developers in updating, building, and debugging Ionic applications.

In terms of theming, Ionic has various features that have built in colors that can be used on most of the components. For this application, the colors utilized were those that corresponded to the school colors of the University of Arkansas, including white, black, and red. Ionic also has adaptive styling, which allows developers to utilize the same codebase across multiple platforms but Ionic components "adapt their look and behavior" based on whatever platform that the app is running on [17]. This allows for a native feel across various platforms without requiring code changes. This native feel comes from the utilization of

(a) (b)

Figure 3.1: (a) iOS Version of Page, (b) Android Version of Page

specific thematic choices that are common use for a specific platform, making the application look as if it was a natively developed Android app when running on an Android device, and the same for both iOS and web. To visualize this, note Figures 3.1(a), 3.1(b), and 3.2, which show how the same page appears on different platforms. Each platform has a unique feel based on the styling which can be seen by the buttons, text style, and some shading on these figures. Ionic adapts to each of the platforms so that the user sees what they would be accustomed to seeing on an ordinary app on their phone or on a website.

The pre-built user interface components of Ionic aided in swift development. Stock components such as buttons, badges, cards, checkboxes, modals, and more are detailed in the Ionic documentation, along with code examples so that it can be easily added [18]. Being able to use pre-built components not only makes

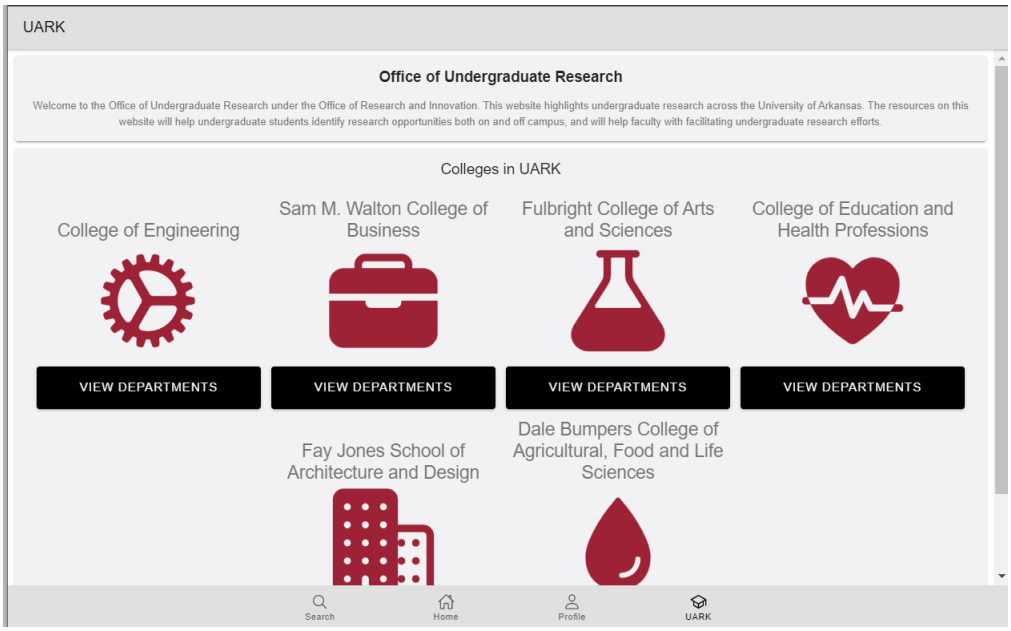


Figure 3.2: Web Version of Page

the code cleaner but also allows for consistency across pages by utilizing these same components across various. The components are customizable, allowing the developer creative freedom to make the application look exactly as desired.

Utilizing Ionic with Angular allows for seamless integration between the user interface and logic. Whenever a user interacts with an element on the screen, whether that be a button, a pop-up dialog, or changing pages, some logic must be implemented so that it will function as expected. Angular is a TypeScript-based language, which is a "typed superset of JavaScript" [19]. Unlike AngularJS, which is based on JavaScript, Angular provides mobile support, which is important for this application. Angular utilizes data binding, which allows for changes to be reflected on the screen when the data are changed by the logic code.

The life cycle components provided by Angular are utilized in Ionic, and these components are extremely beneficial to developers. For example, the life cycle event that is triggered when a component is first initialized can be used to also initialize local variables or make calls to services that only need to be run

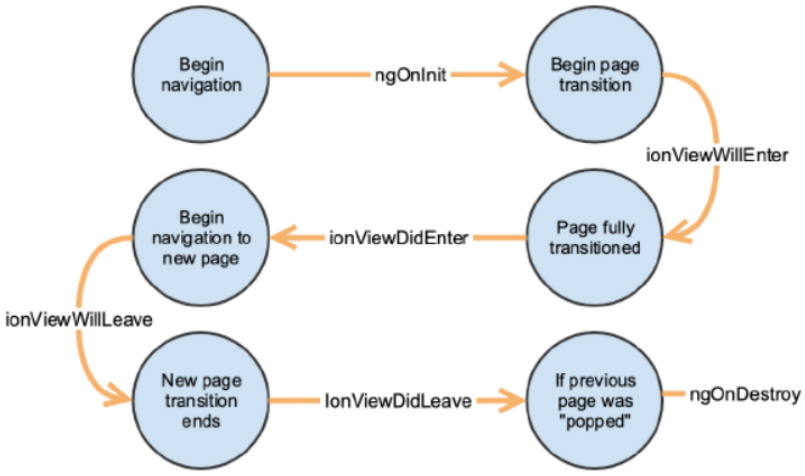


Figure 3.3: Page Life Cycle and Corresponding Functions

once. Figure 3.3 shows the various functions that line up with the life cycle of a page of an Ionic application [20].

Additional Ionic page events are provided to work in conjunction with the Angular life cycle events. These include events that are fired when the component being routed to is about to animate into view or has finished animating and when the component being routed from is about to animate or has finished animating [20]. Having events fire on transitions aids in development as certain functions might only need to be called when one page is switching to another.

The structure of this project helped ensure successful development. That basic skeleton of the application included folders entitled node_modules, resources, src, www, angular.json, package.json, and tsconfig.json [21]. The node modules folder contains all of the required npm packages and the resources folder automatically generates the required resources for each platform as well as included the src folder as a subfolder. This src folder contains the raw, uncompiled code written by the developer of the application [21]. The folder entitled www is also automatically generated, and it holds all of the compiled files [21]. The angular.json and tsconfig.json are both configuration files, and the package.json file helps to manage

the "third-party libraries and the modules" utilized by the application [21].

The code for each component or page was organized into sections. This structure allowed for sections of code to be modified without affecting other portions of the code. The html code that was displayed to the user was separated from the file that contained styling information which was separated from the back-end Angular logic files. This allowed for development of a basic UI skeleton that would not require significant changes once more back-end logic was written to make the front-end functional.

Utilizing Ionic and Angular allowed for a smooth front-to-back development framework. While Ionic provided mainly the user interface and Angular was used for the logic, the seamless combination allowed for creation of a functional cross-platform application.

3.2 Application Features

Upon establishing what framework would be used, a basic user interface (UI) was created so that the Office of Undergraduate Research could approve the appearance. The only functionality at this point in the project was the utilization of Campus Web Data to get the photos, emails, and phone numbers of faculty and staff as well as a connection to Firebase Firestore, which was the database used to store information. The job information was entered into Firebase Firestore and pulled onto the screen, where a user could click on a job title and be able to view all the information saved in Firebase Firestore for the corresponding job. These tasks were done prior to my joining this project, which meant my main focus was on making the rest of the UI functional. This included completing the following tasks:

1. Create functionality to add, edit, and delete posted positions.

2. Create different views on the "Home" and "Profile" pages so that faculty and staff would have different functionality than the students when logged in.

3. Create a functional "Search" page that would allow for filtering or keyword searches.

4. Update the sequential pages that allow users to find a specific faculty or staff member to include more information on a given faculty or staff member's detailed page.

5. Add additional fields to the existing job table in Firebase Firestore for increased functionality.

6. Add additional table for students to store information about the students' job interests.

7. Add additional table for faculty and staff that would store their research interests and bio, allowing the faculty and staff to edit their research interests.

8. Update application to utilize the new Firebase Firestore tables and fields and show the information to the user.

9. Add ability for users to login and logout of the application.

10. Improve overall appearance of application.

11. Ensure the application fulfills accessibility guidelines.

When it came to accomplishing these tasks, various steps were required to complete them fully. Starting with the first task mentioned, calls to Firebase Firebase had to be written so that when a user made changes on the interface, it would be reflected and stored in Firebase. Functions were written to add a job as well as edit or delete an existing position. User input fields were created so that a user could add the required information to create a job. Once the information was input, a function that added the position to Firebase was called so that it would be stored there to reflect the user's changes. Similarly, when a user edited information for a position in editable text fields, a function was called that would

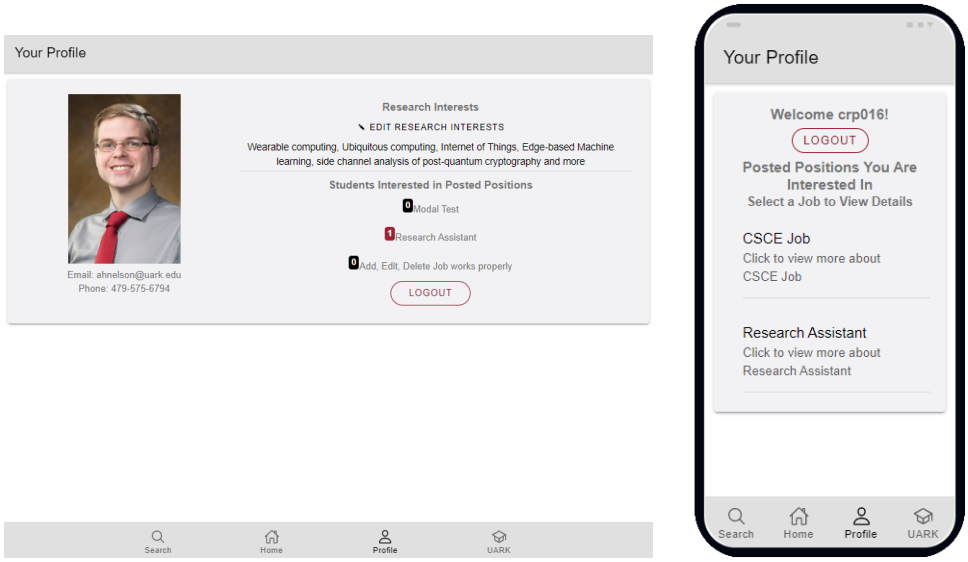
update Firebase to store the new changes to the position. When a user deleted a job, the information for the selected job was sent to the back-end and then the Firebase function was called so that the position would also be removed from Firebase.

To develop different pages based on the logged-in user, desired features and appearance had to be determined for each respective page. For the profile pages, faculty and staff would need the ability to see and edit their research interests that were posted to students, to see who was interested in the posted positions so they could gauge potential student interest, and to logout of their account. When faculty logged in, it would also be easy to add their profile photo, email, and phone number, which come from Campus Web Data. This allows the faculty and staff to see that information and verify that it is correct not only on this application, but campus wide where that information is posted. A sample faculty page is seen in Figure 3.4(a).

For the student profile, less information is saved to protect their information privacy and therefore less is shown to the student in comparison to what is shown on the faculty profile page. The only fields saved for students are their username and positions that they have noted interest in, so that is displayed on the student profile page as seen in Figure 3.4(b). Students, like the faculty and staff, also have the ability to logout of their accounts from this page.

As seen in the two screenshots included in Figure 3.4, the student has expressed interest in a job entitled "Research Assistant". This is a position that was posted by Dr. Alexander Nelson, whose profile is displayed in Figure 3.4(a). In the list of "Students Interested in Posted Positions", Dr. Nelson can see that there is a student interested in the job of "Research Assistant" as noted by the number of interested students (1 in this case) preceding the job name and shown in the red color instead of black. Faculty and staff will not see what particular students are interested on this application but can use that information to gauge what sorts of descriptions and areas of research are of most interest to students.

In Figure 3.4, a web view and an Android view are shown. The card that

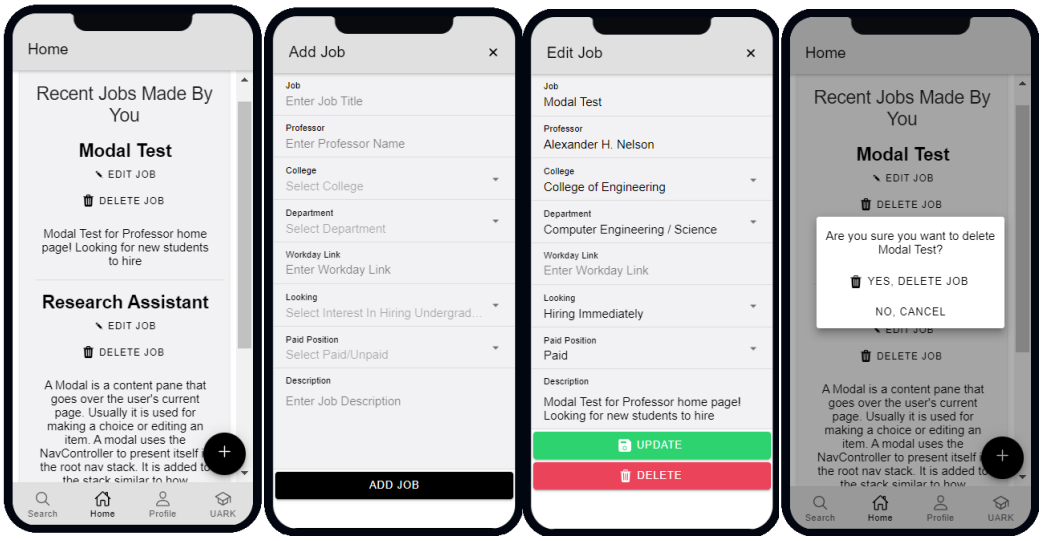


(a) (b)

Figure 3.4: (a) Faculty and Staff Profile Page View on Web, (b) Student Profile View on Android

holds the information is used in both, but it is formatted slightly differently depending on the platform. If there is more information than can be displayed on a single page, the user can scroll to see the remainder of the information.

Similar to the profile page, the home page requires different information to be shown to the user, depending on if they are faculty or staff or a student. For faculty and staff, they only need to see jobs they have posted. Additionally, they should be able to add, edit, or delete these positions. Figure 3.5(a) shows the home landing page that faculty or staff would see upon clicking the "Home" tab. Figure 3.5(c) and Figure 3.5(d) show the dialog boxes that pop up when the user presses the "Edit Job" or "Delete Job" buttons on that respective position. The added dialog for deletion helps ensure nothing is unintentionally deleted from the application. The "Add Job" option shown in Figure 3.5(b) is available by clicking the floating action button in the lower right of the screen. It is a dialog that is nearly identical to the "Edit Job" dialog so that consistency is maintained across the screens and therefore it is more intuitive for users. The only difference



(a) (b) (c) (d)

Figure 3.5: (a) Faculty and Staff Home Page View on iOS, (b) Add Job Dialog, (c) Edit Popup Dialog, (d) Delete Popup Dialog

in the "Add Job" dialog compared with the "Edit Job" dialog is that the fields are blank, allowing users to type or select from dropdown options to create a job. Whenever a user makes changes, these modifications to the positions are reflected in the Firebase database so that the information is saved.

Via the student home page, a student can view the three most recently posted position titles and descriptions that any faculty or staff member has published. Students do not have the ability to add, edit, or delete any positions as students, but can keep up to date by seeing what was most recently added as an opportunity. It is currently set to only show the three latest postings but can easily be edited to show any number of new positions. The student view is shown in Figure 3.6. In the figure, the positions are those posted only by Dr. Alexander Nelson as his jobs were the ones that were being modified, added, and removed during the testing process and hence they were the newest to be published in comparison to the other positions stored in Firebase.

During development, each page was created independently and the naviga-

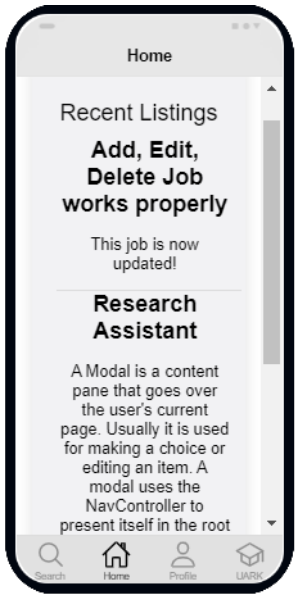


Figure 3.6: Student Home Page on Android

tion to the page was hard coded to go to either the faculty and staff view or the student view. Later, the navigation was updated to route to appropriate pages based on the user login rather than manually changing the route in the code itself.

When it came to implementing the "Search" page, various features were to be developed. To use the search bar itself, a fuzzy search through Fuse.js was utilized so that if the user typed anything that was "approximately equal to a given pattern", it would find and display the results to the user [22]. This meant the user could potentially mistype and still find results, as well as type letters from the middle of words and get results. In this case, if the user typed anything similar to words in the job details or to words describing the faculty or staff member associated with the position, then the application would display the jobs that matched the search criteria. With the ability to search by title, department, faculty or staff member associated with it, and more, finding positions will be far easier, especially as more positions are added into the application for students to view.

For a specific example, a user could type "wear" to indicate they want to research something dealing with wearable components. Based on the information

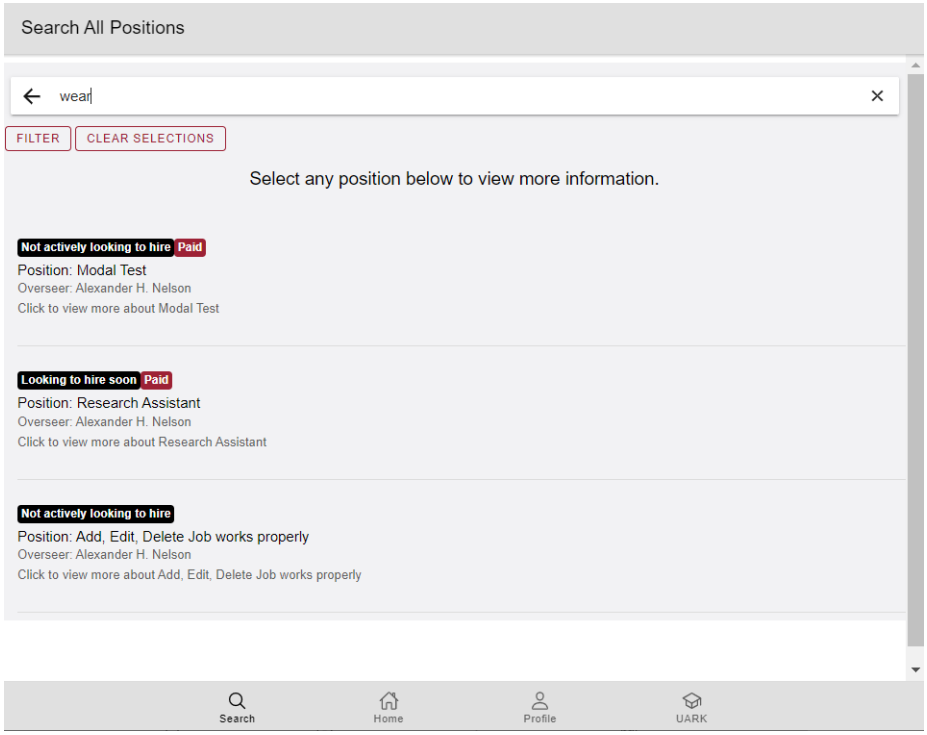
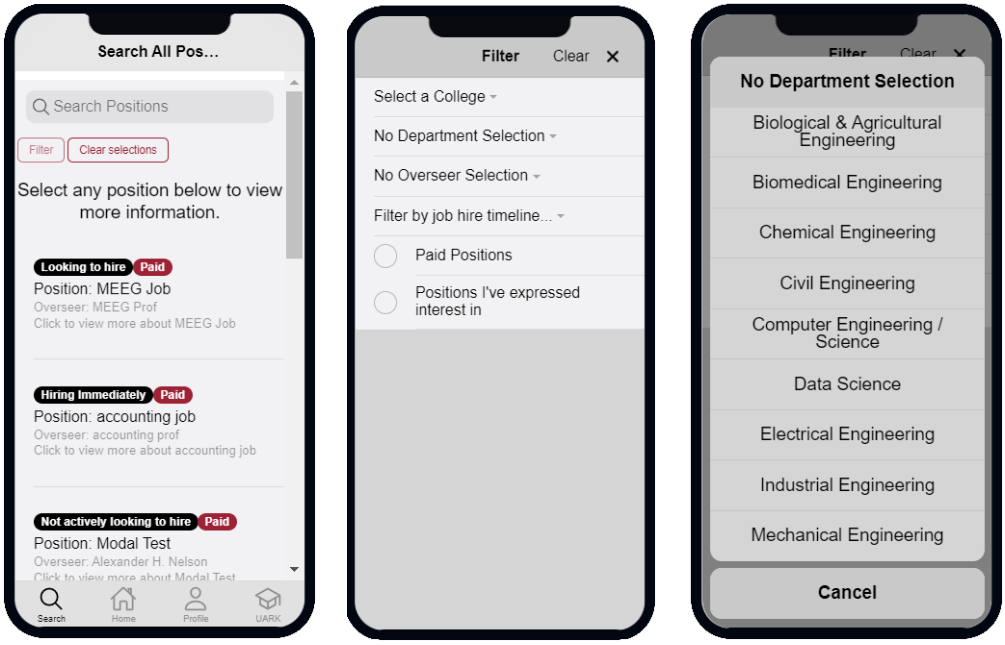


Figure 3.7: Searching for "wear" on Search Page

currently in Firebase that is used for the application, there are no jobs with "wear" in the title or job description, but Dr. Alexander Nelson has "wearable research" in his research interests, so the search will show all open positions that Dr. Nelson oversees, as these have the highest potential of matching the sorts of jobs the user wants to see. This example search and results are seen in Figure 3.7.

The other key component of the "Search" page is the filtering capability. A user could filter by college, department, faculty or staff member associated with the project, paid and unpaid positions, or they could filter based on how eager a faculty or staff member was to fill the posted position. They could also filter by jobs that they had previously expressed interest in so that the user could easily pull those jobs up to apply. These filters could be used independently of one another or together to create a finer filter on the positions and help students find exactly what position they are seeking. To see the user flow, Figure 3.8 shows the iOS



(a) (b) (c)

Figure 3.8: (a) Select Filter option from top left, (b) Filter modal dialog, (c) Selecting from the filter dropdowns

version of the 3 main screens that a user would interact with. To filter, a user must first select the "Filter" button below the search bar in the upper left of the page seen in Figure 3.8(a). Next, they will see a popup dialog that shows the various filter options, with some in dropdown menus and others as buttons as seen in Figure 3.8(b). If the user chooses to select from a dropdown, Figure 3.8(c) shows the popup that appears from the buttom that allows a user to select from any of the departments in a previously selected college. In this case, the user is looking at departments within the College of Engineering, which was required to be selected prior to choosing a department. Additionally, users have the option to select "No Department Selection" and similar options in other dropdowns, allowing them to not filter by that specific field.

The last main page that needed to be updated was the public profile pages that could be found by sequentially navigating from college to department to fac-

ulty or staff member's name. This page originally just displayed the faculty or staff member's photo, email, and phone number. While that has remained, additional information was added based on updates to the Firebase tables. These new fields displayed include the faculty or staff member's research interests, open positions they had posted, as well as a biography. This page helps students get a comprehensive idea of each faculty or staff member's academic background and areas of research they are interested in pursuing which will help students narrow down which professors they might want to work with. Having the posted positions of the given faculty or staff member on that same page helps give students an idea of what sort of work they might be doing, and ultimately helps them to decide what opportunity to pursue.

The sequential navigation is shown on a web view in Figure 3.9 where large amounts of information are viewable in a single screenshot. The same information can be easily seen on a mobile device, but the user must scroll, so for the sake of showing the pages, the web view was used. Looking at Figure 3.9, starting in the upper left, the user sees all of the colleges at the University of Arkansas to choose from. Upon clicking the button to "View Departments" for the College of Engineering in this example figure, the user is navigated to a page that shows all of the departments within the College of Engineering as shown in the upper right of Figure 3.9. Selecting the "View Professors" button allows the user to navigate to a page that shows all the faculty and staff for the respective department (lower left image). Upon selecting the button to "View More Information About" a given professor, the user is navigated to that faculty or staff member's profile page, displaying the information noted above (lower right image). On each page, the user has the option to navigate back a page by clicking the button in the upper left corner of the screen. This ensures that a user will not get stuck on a given page and that they can go back and change their selection if they want to view something else or inadvertently pressed a wrong button. The titles on each page also update so that the user knows exactly what they are selecting at any given time.

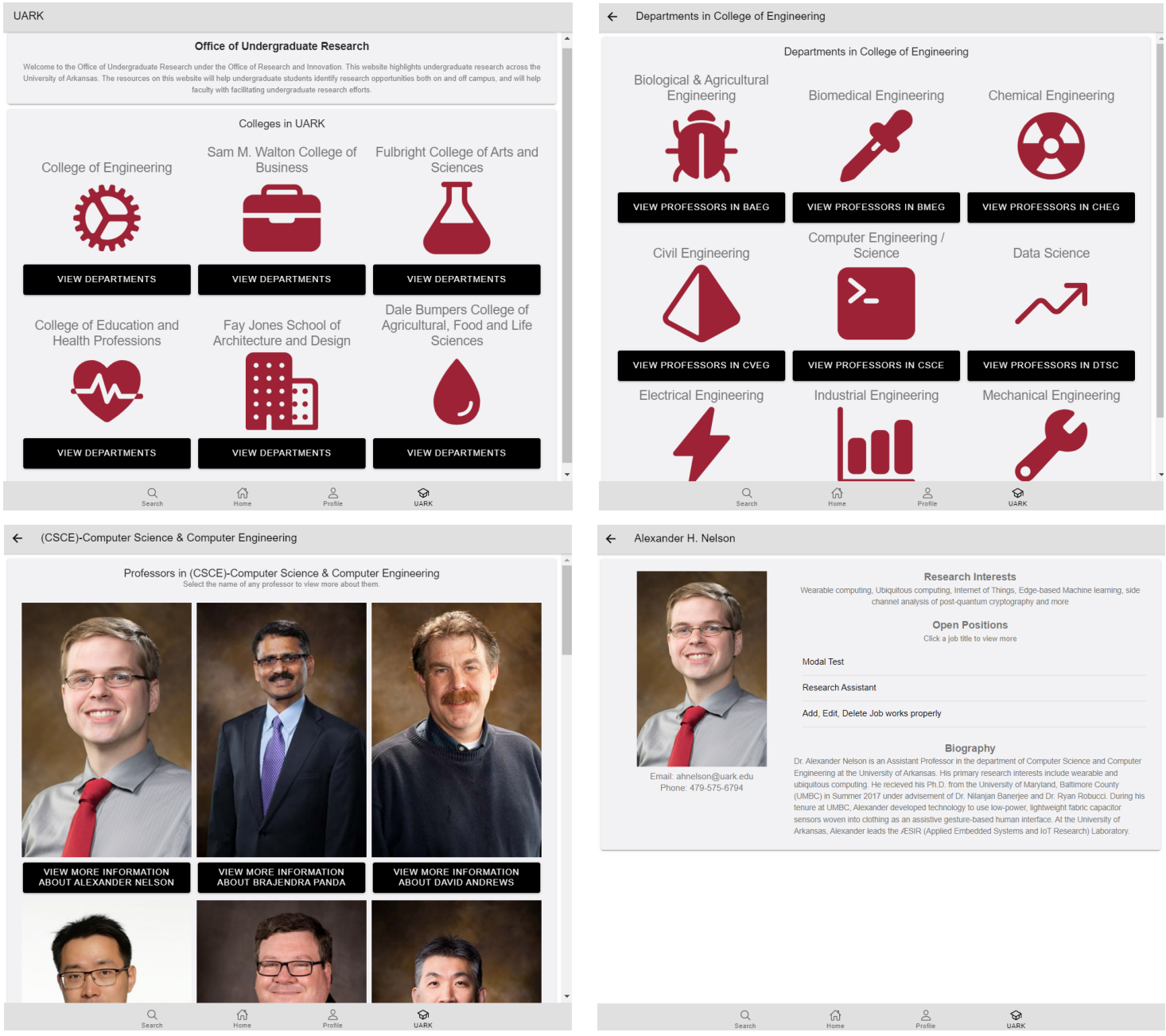


Figure 3.9: Sequential Navigation to See Faculty or Staff Information

The next main tasks noted were ensuring all required fields were in Firebase so that everything could be stored properly. Key updates to the "jobs" table included adding a field for faculty and staff interest in hiring for a given position, a field displaying whether the job was paid or not, and a field noting the date the position was created so that the most recent job additions could be shown to the students on their "Home" page. The "students" table that was added allowed for student usernames and their interest in posted positions to be saved. The "overseerdetails" table was created to store information about the faculty or staff member's name, research interests, and biographical information. Since the research interests and biographical information are posted publicly, that was copied to Firebase, where it could locally be edited in the Firebase database. As the database was updated, the code was changed to reflect these changes so that information could be properly sent back and forth. Ensuring the connection to Firebase with the modifications is correct helps guarantee the users are seeing accurate and updated information.

The next key task was adding the ability for users to login and logout of the application. The routing for the various pages could be done properly once this was set up. While Azure Single Sign On is the end goal for user sign in, due to the short timeline of this project, the current application utilizes Firebase authentication. This allows users to easily login and logout out of the application while developers can set up the logic for the code to account for information about the signed-in user. The routing to appropriate student or faculty and staff pages could be set up along with blocking access to certain pages when a user was not logged in so that they could not see or edit the information they should not be able to interact with. Having most of this set up will make the shift to Azure Single Sign On much easier and will require minimal logic updates.

A task that was worked on throughout the development process was improving the overall appearance of the application. Visual improvements included updating text positioning and size, adding icons with buttons, and changing components utilized so that it was easier to work with across the different platforms.

These small changes made a big difference in overall aesthetics and make the application less unwieldy when a user is trying to interact with popups or dialogs. This task went hand in hand with ensuring accessibility guidelines were met, which is discussed in more detail in the next section.

3.3 Accessibility

As this application is intended to be made available to all students as well as faculty and staff, accessibility is crucial to ensuring that everyone can utilize the application. While this application is cross-platform, it has a web presence and accordingly, it ought to meet all necessary standards that a web application would be required to satisfy. To aid in verifying that these standards were met, the University of Arkansas IT Services provided a template for a VPAT, or a Voluntary Product Accessibility Template. This document had links to accessibility guides and accepted standards as well as a place to note if each standard was met. This template helped the development process because if any of the standards were not yet met, shortcomings could be noted and implemented.

The World Wide Web Consortium Accessibility Guidelines covered four main principles [23]. These included ensuring that the app was:

1. Perceivable
2. Operable
3. Understandable
4. Robust

These principles were broken down into many various, specific sub-points. This specificity would help ensure that required accessibility needs were met during the development process, allowing developers to note any place where the application might be lacking necessary features.

Making the application perceivable meant consideration of factors involving the text on the screen, non-text content displayed on the screen, audio played to the user, and timed components. A key idea presented in the Guidelines was providing alternatives to make the screen easier to read or hear. As this application did not involve audio or timed components, consideration of those elements was not applicable. However, additional issues were addressed with the text and non-text content. This work included ensuring that a screen reader would read any and all important text to the user while disregarding reading image titles or other non-text content. This meant that any header, button, or navigation option needed to be read out, so edits were made to ensure this worked as intended. A Windows screen reader was used to test this, making sure that a user would be able to hear descriptive information that would allow them to effectively utilize the application. Another factor to be considered was the use of colors on the screen, as they needed to contrast enough to be easily read. This ultimately led to a very simple color theme of the application that only used the University of Arkansas' colors and did so sparingly to avoid distracting the eyes from the content being displayed. Colors were also not used as the only means of conveying information, as that would not allow users requiring screen readers to obtain that information.

The next key principle was ensuring the application was operable, specifically referring to user interface components and navigation. Many users might only use a keyboard rather than interacting with a mouse, so the keyboard needed to be able to move to allow information on the screen to be read and not trap the user at a certain point. A crucial guideline within this principle was not designing content in a way that might trigger seizures that could be detrimental to a user's health. To prevent this, the application should not flash more than three times within a second. This application meets that criterion, as the only time it flashes at all is when redirecting a user to a different page. Additionally, users should be able to "navigate, find content, and determine where they are" [23]. This involves providing titles for the pages, presenting data and navigating users in a logical way, and ensuring the purpose of links can be determined just from the text provided to

the user. Other criteria within this larger section included various timing concerns, making sure that timing could be adjusted for the user to perform certain actions. Regarding moving, blinking, and scrolling on the application, a user should be able to stop, pause, or hide any of these actions. As this application does not have timing restraints or moving, blinking, or automatic scrolling, modifications did not need to be made as they were not applicable. Upon going through this section of the guidelines, the code was modified to ensure the keyboard navigation would work with a screen reader and those crucial elements were able to be reached by just the keyboard. Testing was also done to make sure that a user would not be blocked on a certain page or component when they were solely using a keyboard.

The third key principle was ensuring the application was understandable. This includes making text content readable, utilizing default human language, and reducing the usage of unusual words, abbreviations, or content that requires an advanced reading level. Additionally, the pages should "appear and operate in predictable ways" by allowing components to be focused on, keeping navigation consistent when it is repeated on various pages, and allowing users to initiate the change of context or turn off automatic changes of context [23]. Error identification and prevention is another key concern noted in the guidelines, ensuring that users are aware of any issues and able to fix them. Labels should also be utilized to inform users of any content that they have to input. While the code already utilized the same components across various pages so that there was consistency, additional error checking was included to confirm with users that they wanted to complete a certain operation when it came to removing positions.

Lastly, the application ought to be robust. In the context of accessibility, this means that the code should be written to be compatible with current assistive technologies while being robust enough to accommodate future technologies that aid accessibility. Appropriate start and end tags along with programmatically determining as much as possible aid in achieving this goal. Ensuring compatibility for future assistive technologies allows this application to have a longer lifespan and to be used for years in the future with minimal significant changes required

to ensure compatibility.

Keeping these accessibility guidelines in mind while developing is not only good and accepted practice, but it will also ensure that everybody can utilize this tool as intended.

4 Conclusion and Future Work

Overall, this application met all objectives as set forth. From determining the necessary information to displaying it to the user so that they can utilize this application as intended, the requirements for this project were accomplished. Next steps that should occur in coming months include adding in Azure Single Sign On (SSO) like other University of Arkansas applications and migrating the application to Ionic Red Hat so that it can be deployed for student and faculty or staff use. Most of the logic for routing and for blocking pages from access based on the logged-in user has already been completed, so the code will just need to shift slightly so that the same logic works with Azure SSO. Migrating the application itself and the databases used by the application to Ionic Red Hat will be crucial to widespread use in the future because it will allow this application to be used as intended across campus, benefiting all students, faculty, and staff [24]. Red Hat allows for deployment of the application as well as the utilization of enhanced security services [24]. Prior to deployment of the application on something like Red Hat, nobody but the developers can access the application, so the benefits from this project will not be reaped until the application can start being used regularly. Another future task would be compiling all of the Campus Web Data in one place, including information about faculty and staff members' phone numbers, emails, research interests, biographies, and more. Having all of the data accessed by this application along with other campus web data in one place will streamline the process of accessing this information and allow for easier development of other applications in the future.

Considering the shift to online learning and the general concern of reaching out to professors to discuss research opportunities, this application can help bridge the gap. Students with easy access via the application to information about faculty and staff members' research interests and open positions for jobs or research op-

portunities will be able to choose research areas they are interested in. Supporting the University of Arkansas's institutional priority on research, this application will help more students become aware of the various opportunities across the different departments on campus. Once they learn of these positions and can identify jobs that are of interest, they can easily act on the information and get involved in research. This application along with the aforementioned future deployment and development tasks will greatly aid students in finding opportunities and becoming involved in research. In so doing, they can enrich their education and contribute to finding solutions to problems in whatever area of research the students pursue.

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