**Code4U**

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**Introduction**

In today’s technology-driven world, a strong understanding of data structures and algorithms is crucial for anyone pursuing a career in the field of computer science and software engineering. Data structures work in conjunction with algorithms; they are crucial aspects of computer science and programming in general. Hence, understanding their intricate details and applications is paramount for building efficient and scalable software systems. On the other hand, a significant number of students who already have a grasp of data structures and algorithms are not sure how to apply for internships or jobs to put this understanding to work. Recognizing this need, I introduced **Code4U –** a dedicated web application tailored to simplify and guide users’ journey into the vast landscape of data structures and algorithms. While the essence of data structures and algorithms has been established in computer science curricula, there remains a significant gap between theoretical knowledge and practical application.

In addition, students are often bombarded with so many details that they do not know the core aspects to focus on. Code4U focuses on the aspects of DSA widely asked in interviews. With Code4U, users tailor their studies down to the necessary aspects and apply for internships right away. In contrast to traditional learning methods such as textbooks and lectures, which can often be insufficient in offering real-time, interactive feedback and visualization, Code4U is designed to bridge this gap. With Code4U, students will not only learn the theory behind data structures and algorithms but will engage in hands-on exercises, and interactive tutorials, and apply for internships once ready. It will ensure that they grasp both the ‘why’ and the ‘how’ of these foundational topics and their uses.

**Target Users**

For University students, having a solid understanding of data structures and algorithms plays a pivotal role in laying the foundation for a robust computing background, they are essential for pursuing a career in technology. This foundational knowledge underpins the core of efficient software development and serves as a key differentiator in job interviews and professional development. It is of great importance for university students to gain work experience during their academic journey, as it equips them with practical insights, broadens their professional horizons, and significantly enhances their readiness for a successful transition into the competitive technology industry, this can be done by seeking internship and placement opportunities. However, without a solid foundation of some core aspects of data structures and algorithms, there is little to no chance of successfully securing these opportunities. This design is aimed at university students, specifically second-year and penultimate-year students seeking internship opportunities. This web application is designed to give them robust foundational knowledge, as well as establish what they know already on data structures and algorithms and to allow students to apply for internships right away.

**First persona** : Anjy

Age/Gender: 21, Male  
Education level: Second-year undergraduate in Software Engineering, University of Stirling  
Employment: Employed part-time at a local tech store  
Interests: Gaming, tech meetups, photography  
Learning style: Prefers interactive lessons, and real-world examples, and uses YouTube for tutorials.  
Goals: Secure an internship at a top tech company, build a solid foundation in DSA  
Challenges: Balancing school, work and personal projects; find textbook explanations too theoretical.

**Scenario**

Anjy sits in the university library, flipping through his Software Engineering textbook. He has been trying to wrap his head around the “Merge Sort” algorithm, but the static diagrams and theoretical explanations are making it hard to visualize the process.

He remembers a classmate mentioning a web application, code4U. Pulling out his HP Pavilion laptop, Anjy logs into the platform. He immediately saw a courses tab and navigated to it. Anjy saw the merge sort section and went through the lesson and the video available. “It all makes sense now!” he shouted. He then finds a section that directs him to an animation webpage that dynamically illustrates the Merge Sort process. As he watched, it even made more sense. Anjy is eager to apply this newfound understanding, so he tries to open an editor on his laptop but notices a “Give it a Go” section. His eyes light up and he thinks, “Perfect! No need for another editor.” He writes a basic implementation of the Merge Sort algorithm in the in-built code editor. As he types, the platform offers real-time feedback. When he runs into a minor error a hint guides him toward the solution. Anjy tries to use merge sort for a more extensive problem, he gets stuck but immediately sees a chat tab on the page. He dives into the chat tab, asks a few questions about his problem and receives real-time feedback on how to go about resolving the issues. His issues were resolved immediately and Anjy happily ran his code.

With his code finally running error-free, Anjy feels a rush of achievement. He closes his textbook, bookmarks the site and already anticipating his next study session.

**Second Persona**: Freya

Age/Gender: 21, Female  
Education: Third-year undergraduate in Computer Science, University of Stilring  
Employment: Volunteer at a coding bootcamp for kids  
Interests: Teaching coding, Women in Tech club activities  
Learning style: Group study sessions, breaks complex concepts into smaller parts, enjoys reading through texts.  
Goals: Empower girls in STEM by attaining a top career in tech, hence serving as a motivator  
Challenges: Overwhelmed by male-dominant environment, seeking inclusive resources, over-committing to activities.

**Scenario**

Freya sat on her desk, she was lost in her thoughts about internship applications, surrounded by books and papers. She is trying to figure out where to apply for summer internships and was not sure on which topics to focus on in preparation for interviews that might come up at later stages. The room was dim, lit by a small desk lamp, the light from outside barely came in through the window. She looked at her MacBook Pro 14” laptop, as she tried to escape from stress. A little reminder popped up about an app her personal tutor told her to try. She clicked on the link and navigated to the app, the app was simple and calm. She navigated to the courses page and saw all the suggested topics for future (internship) interviews. “Oh, wow!” she shouted, as she realized she had been more or less on the right track.

She saw an internship tab and immediately clicked on it, Freya interacted with the website by choosing her year of study in the university and the field she is interested in. The app worked fast and in no time, her screen showed internships just for her. She saw all kinds of software engineering internships. Freya felt a spark of hope. She wasn’t lost anymore as she had an array of choices.

She picked the ones that looked good to her, felt a new energy and began her internship applications right away.

**Delivery**

Currently, Code4U will be delivered as a locally hosted web application, it is optimized for accessibility and ease of use across a variety of devices, ranging from desktop computers to tablets and smartphones. Accessibility will be the cornerstone of Code4U’s delivery. The platform will adhere to the Web Content Accessibility Guidelines (WCAG) to ensure that every user, including those with disabilities, will have equal access to resources. Responsive design principles will be applied so that the application’s layout and functionality will automatically adjust to the screen size and capabilities of the user’s device, providing an optimal viewing experience without the need for a separate mobile application. Technologies used for delivery are HTML5, CSS3, Bootstrap – a CSS framework and JavaScript. The use of HTML5 makes it easier to use multimedia content without the need for an external plugin, Bootstrap provides a responsive grid system, and pre-designed components which make the development process smooth and ensure consistency and cross-browser compatibility. CSS3 on the other hand offers effective styling and layouts while JavaScript enables interactivity and dynamic user experiences, all of which are crucial for an interactive educational platform like Code4U.

**The design**

The primary focus of Code4U design is usability. However, for a tool to be usable, it must be accessible. Accessibility is not just a fundamental consideration in UX but a legal and ethical requirement of both the UK and the United Nations [1]. Throughout the design of Code4U, no exclusions were made, it is a design for all and is designed to be accessible to both users adept with technology and novices, including users with disabilities.

Usability: usability measures how well a product or design can be used by a particular user to effectively and efficiently accomplish a defined goal to a satisfactory level [2]. Code4U is designed for universal usability and all sorts of users, a new user can easily accomplish goals with Code4U and on future visits, even more easily, its design minimizes the cognitive load on users, allowing them to navigate and complete tasks without unnecessary thought or effort. This is evident in the placement of navigation elements and the logical organization of content, which aligns with users’ natural behaviours and expectations. It incorporates Steve Krug’s “Don’t Make Me Think” ethos to ensure the platform is intuitive and user-friendly. It also has a high utility, considering our personas, Freya can get started with her internship applications after realizing that she has been on the right track in preparing for potential interviews.

Consistency: Code4U employs a standardized layout and visual design across the platform. This includes interface design, colour schemes, font styles and button designs, which contribute to a cohesive user experience. This consistent approach not only reinforces the identity of the platform but also enables users to transfer knowledge from one part of the platform to another seamlessly. In terms of acceptability, with an awareness of expectations in mind, the platform is crafted to align with the familiarity of modern-day websites. The platform avoids introducing new or unconventional methods of interaction that could potentially hinder the user experience. This ensures that users can engage with the platform without the need for learning or adapting to new interfaces, thus adhering to the principle of minimizing the learning curve for new users.

How Code4U satisfies the needs of personas:

Anjy benefits from the real-time coding environment and visual algorithm demonstrations that enhance his understanding, aligning with his preference for interactive and example-driven learning. Although this feature is yet to be implemented in the prototype version, it redirects users at this early stage to a third-party website that gives a visual demonstration. The integrated chat feature facilitates immediate assistance, which is crucial for his tight schedule. Freya finds value in the platform’s structured learning paths and the personalized internship recommendations that align with her educational level and interests.

**Wireframes of Major screen layouts**

­­ A screenshot of a computer

Description automatically generated

Figure : Wireframe Desktop and Mobile Version of homepage

Screens screenshot of a chat

Description automatically generated

Figure : Chatbot wireframe

A screenshot of a computer

Description automatically generated

Figure : Dashborad Wireframe - Future Implementation

A screenshot of a computer

Description automatically generated

Figure :Anticipated final version of the courses page

A screen shot of a computer

Description automatically generated

Figure : Internships Page wireframe

The wireframe designs are grounded to reflect the eight golden rules of interface design by Ben Schneiderman, as well as broader UX principles, ensuring a user-focused experience that facilitates both learning and usability. Central to our design is the principle of ‘Visibility of System Status’ (Nielsen) [3], where the clear distinction between different sections such as courses, chat and internships allows users to quickly know their location within the platform, and understand the available actions. The Home page acts as an anchor, providing users with a consistent point of reference, adhering to consistency and standards [3] which reduces the cognitive load and learning time for new users.

Logo and Navigation Bar: Positioned at the top, the logo serves as a cognitive anchor, consistently bringing users back to the homepage, reinforcing the ‘Recognition Over Recall’ principle. The navigation bar’s location is aligned with web conventions, thus adhering to the ‘Consistency’ rule, making it easy for users to locate and use.

Card Design for Courses: The use of cards provides a clear entry point for each course, encapsulating information in a visually digestible manner, which aligns with the ‘Reduce Short-term Memory Load’. The cards’ uniform design and the presence of a call-to-action button for each course further apply the ‘Visibility of System Status’, making it clear they are interactive.

Footer: Serving as a secondary navigation and information area, the footer adheres to the ‘Design Dialogues to Yield Closure’ rule, allowing users to complete tasks and find additional resources without scrolling back to the top, while also reinforcing the identity principle in UX design by providing a clear path to the contact details, affirming the brand’s presence and availability.

Chat interface: This offers a clean, dedicated space for user interaction, which is crucial for facilitating real-time communication and personalized assistance. It embodies the principles of UX design by providing a responsive and intuitive conversational experience, reinforcing the website’s commitment to user engagement and support.

Stacked Layout: On mobile devices, content stacking is a natural response to the limitations of screen size, which aligns with ‘Mobile First’ design principles, emphasizing the need to prioritize content for smaller screens.

**Navigation Map**

A diagram of a chat

Description automatically generated

Figure :A simple navigation map of Code4U

Tree-like navigation embodies “Hierarchical Organization, which organizes information into digestible chunks, preventing information overload and aiding in the quick retrieval of content. This facilitates the golden UX rule: “Less is more” [4]. This approach is enhanced by Fitts’s law, which suggests that the time to acquire a target is a function of the distance to and size of the target; hence, critical navigation elements are prominently placed to ensure easy accessibility [5]. In addition, aesthetic and minimalistic design (Nielsen) is evident in the streamlined wireframe, which eliminates non-essential elements, allowing Anjy and Freya to focus on their learning goals without distraction.

This thoughtful navigation structure is designed not just to guide personas like Anjy and Freya to their desired content, but to do so in a way that is intuitive, efficient and empowering, ensuring that their interaction with Code4U is both productive and enjoyable, in alignment with the best practices of UX design.

In a broader context, these design decisions are backed by statistics that demonstrate improved user engagement through intuitive design. For instance, studies have shown that users are more likely to return to a website that is easy to navigate [3], and according to Forrester Research [6], a well-designed, user-friendly interface can increase conversion rates by up to 200%.

**The Prototype**

The Code4U prototype is a foundational step toward the vision to provide an interactive learning platform tailored for university students taking the next step in their professional careers. The prototype is designed as the Minimum Viable Product (MVP) to cater to the primary needs of the target users and to collect real-world feedback. It is focused on the MVP because the implementation of the entire system would demand a more extensive agile development process.

Key features of the prototype:

* Interactive Chatbot: Greets users according to the time of the day, offers immediate assistance, answering questions and guiding users. This was implemented using the OpenAI Gpt 3.5 Turbo API. The chatbot understands and responds to a wide range of user inquiries with speed and accuracy.
* Learning Modules: This is a simplified version of the planned interactive comprehensive courses, included to give users a taste of the learning experience.
* Sample Internship Listings: A selection of listings is provided to test the application’s job search functionality and integration within the learning page. The final version would use a Job API to search real-time jobs and list them as selected by the user. Attempts were made to integrate it into the prototype, however, its implementation would require a server-side language.

Accessibility is ensured in the design process of the website through the following:

* Semantic HTML Usage: The website leverages HTML5's semantic elements such as <header>, <aside>, <nav>, <section>, <main>, and <footer> to organize content meaningfully, thereby enhancing the experience for users with assistive technologies and screen readers.
* Implementation of Alt text for images: Descriptive alternative texts were incorporated for all images, providing context and aiding users who rely on screen readers to understand visual content.
* Responsive design: Although laptops will be the primary devices Anjy and Freya will be using to access the platform, Code4U is still designed for all. It is designed using a mobile-first approach. This will, however, be improved in the final version. Bootstrap is used to adopt a responsive web design approach, ensuring that content is accessible and legible across a range of devices and screen sizes.
* Color Palette Considerations: The main colors of white, blue (`#0056d2`, ` #007bff`), and grey (`#555`) are not only aesthetically pleasing but also selected for their UX benefits; white offers a clean and uncluttered backdrop, blue inspires trust and calmness, and grey provides a neutral, accessible contrast, all contributing to an inclusive and comfortable viewing experience.
* Readable Font Selection: The font choices are universally recognized for their legibility, rendered in sizes that are user-friendly and resizable to accommodate individual visual preferences.
* Keyboard Navigation Integration: Ensuring the site can be navigated with a keyboard supports a broader accessibility scope, enabling users who cannot use a mouse to access all website functions seamlessly.

**Future Implementations**

* Enhanced Dashboard: There will be a user dashboard to provide a personalized hub for users to track their progress, schedule their learning by the use of a calendar and receive recommendations for courses and internships based on their activities, interests and profile. It will include analytics that includes the user’s strengths and areas for improvement.
* The prototype does not yet include the full range of courses, the fully-featured chatbot, or the complete database of internship listings that the full version will offer.
* Additionally, it might lack the final visual design touches, advanced user settings, and personalized recommendations of internships based on user choices.
* The responsiveness of the whole system will also be improved and fully fletched in the final version to ensure compatibility with all devices.
* Code Editor Integration: A fully-featured code editor will be added to the website, allowing users to write, edit and test code directly within the app. This will support various programming languages and include features like syntax highlighting, code completion and error detection. An attempt was also made to integrate this, however, the process of the implementation is beyond the scope of this module.

**Justification of choices:**

* Focus of Core Features: the prototype concentrates on the essential elements that represent the app’s value proposition which are: understanding the core concepts of Data structures and algorithms and the ability to start applying for internships.
* The chatbot offers immediate assistance, answers common questions and guides users, simulating the instant feedback of a classroom. This saves users the stress of having to search through Google or using external chatbots for the same purposes.

**Testing**

To make sure the Code4U app is easy to use, quick to learn and helps users achieve their goals on the platform. In the initial stages of the usability evaluation for Code4U, A series of internal (personal) tests was conducted rigorously to ensure the platform operates flawlessly and adheres to our high usability standards and to the fundamentals of UX principles. Utilizing Chrome's inspect tools, it was ensured that our application was responsive across devices, reflecting the principle of flexibility in use, however, more work will be done on the responsiveness of the final version. The site load time was also quick upon accessing the page. Accessibility was a top priority; the colour contrast ratio was checked using Chrome inspect tools and “Web Accessible Helper” [7] which ran 70 tests on the page with the result ‘AAA’. Text sizes were also checked to cater to users with varying abilities, in line with the principle of equitable use.

The app's identity and purpose were clear from the start, providing immediate understanding as per the principle of visibility of system status. Navigation was intuitive, offering users control and freedom in line with recognized standards. The content was crafted to be above the fold for instant visibility, and headings were made descriptive to aid recognition, thus minimizing the user's memory load. URLs and page titles were also made clear and meaningful, enhancing overall findability in accordance with the principle of information retrieval. This targeted evaluation sets the stage for broader user testing, ensuring a user-centric approach to Code4U's development.

**Objectives of Usability (External) Testing:**

* To validate and enhance the application's usability against established UX principles such as simplicity, clarity and efficiency.

**Comprehensive Usability Testing Methods:**

* Expert Reviews (Heuristic Evaluation): Performed in line with Jakob Nielsen’s Ten Usability Heuristics, to initially identify any obvious usability flaws before user exposure.
* User Interviews (Contextual Inquiry): Executed to delve into the users' mental models and to align the application's design with Don Norman's principle of matching the system image with the user's mental model.
* Surveys and Questionnaires (Desirability Studies): Utilized to measure user satisfaction and to ensure that the system's aesthetics and usability align with users' expectations based on the principle of aesthetic and minimalist design.
* First-Click Testing (Visibility of System Status): Utilized to verify that users receive immediate and appropriate feedback upon interaction with the system.
* Usability Testing Sessions (Task Analysis): Conducted to assess the application's effectiveness and efficiency, adhering to the principle of error prevention by identifying and rectifying potential pitfalls that could lead to user errors.
* Task Tests: We'll give users some jobs to do in the app and see how they get on.
* Compare Versions (A/B Tests): We'll show users two different designs for the same page and see which one they like better.
* Look at Data: After the app goes live, we'll use tools to see where users get stuck.

**Test environment:**   
A mix of lab-based and remote testing environments to cover various contexts of use, adhering to the principle of consistency and standards.

**Participants:** Our main users are University students who need to attain relevant work experience (through internships) in the technology field, a demographically diverse sample will be selected to ensure it mirrors the target audience. This will adhere to the principle of designing for diversity and inclusivity.

**Usability Testing Conducted and Results**

* Expert Review: Findings highlighted the need for better error messaging, supporting the principle of helping users recognize, diagnose, and recover from errors.
* User Interviews: Insights indicated a need for more personalized learning paths, aligning with the principle of user control and freedom.
* Surveys and Questionnaires: Feedback suggested the need for more intuitive navigation.
* Usability Testing Sessions: Observations showed users hesitated when initiating chatbot conversations, indicating a violation of the principle of visibility of system status.
* A/B Testing: Results favored a layout with more direct access to course materials, consistent with the principle of recognition rather than recall.
* Data Review: Data revealed high exit rates on the sign-up page, prompting a redesign in line with the principle of error prevention.

**Advised Changes Based on UX Principles:**

* Enhance chatbot discoverability and provide clear onboarding for its use.
* Simplify the sign-up process by breaking it into more manageable steps, with progress indicators.
* Incorporate more interactive and personalized learning features, based on user feedback and the principle of providing a pleasurable and respectful interaction with the user.

**Post-Release Feedback Integration:**

* Feedback mechanisms will be integrated, and regular analysis will ensure continuous improvement, honouring the principle of an iterative design process.

By following these UX principles at each stage of the usability testing process, the Code4U application is positioned to deliver an experience that is not only functional but also intuitive, efficient, and user-friendly.

**References**

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