

Integration of Artificial Intelligence in User Interfaces

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Abstract—User Interfaces are one of the most important aspects when it comes to creating a product. They have become more vital to selling and defining a product on the market. Companies are focusing much more on creating a more memorable interface and experience that draws the user to stay with that brand. Over the recent years, user interfaces have been evolving, attaining a closer balance of functionality and usability, and this is mainly because of integrating AI into user interfaces. This paper will focus on the implementation and integration of artificial intelligence in user interfaces and how they have had a significant impact on users.

Index Terms—CMPE185, LATEX IEEEtran, LATEX, Journal, User Interface Integration, Artificial Intelligence.

INTRODUCTION

ARTIFICIAL intelligence is concept of computers being able to perform human tasks such as small operations like spell checking to much more specific and precise applications like voice and pattern recognition. Artificial Intelligence has exponentially grown in the last few years, being integrated into newer technologies such as operating systems, websites, and even something as simple as a text editor. This integration has made our technology usage not only simpler, but more personalized, providing a better experience for users, resulting in some of the most personalized and best designs interfaces the market has seen. This combination has also given a lot of software more of a personality, creating more of a connection between the user and device.

1 BACKGROUND

1.1 What is Artificial Intelligence?

Artificial Intelligence, or AI, is the idea of computers being able to perform actions that a human can. This ranges from simple decision problems to complex problem solving. AI is one of the most applicable concepts in software development because of the rapidly evolving

technologies that allow software and hardware to more accurately follow the cognitive decisions of natural intelligence.

AI is the general idea that is applied to many different branches, two of the most well known are machine learning and deep learning. While there are many other branches of AI, these two are the most common when it comes to reading data and inference to make decisions. The main difference between these two is that machine learning (ML) requires structured data, while deep learning uses artificial neural networks to make inferences and decisions.

1.2 What is a User Interface?

A User Interface (UI) is a general term that's used in many places in the tech industry. The proper definition of a user interface is the interaction between a human and any piece of tech. This includes software, hardware or both. Many consider UI to be limited to software, but in order to use that software, it needs to run on a usable piece of hardware.

Creating software that balances usability and functionality is exceptionally difficult, which is why companies dedicate entire teams to research the market to understand the good and bad parts the experience. Using that data,

updates are made to the product as well as improvements for the next generation of the product.

2 HOW DATA IS USED TO CHANGE UI AND UX

Initially, user interfaces were made in a way to capture a broad audience, and had to wait long periods of time to update since there was no method to update to each specific user per device. For example, in previous iOS versions, new updates would come out annually, adding a game changing feature that would effect how the operating system is used. But in more recent years, iOS is not updating in as much of a drastic way as it did before. Updates now change something that make the experience smoother and seamless rather than adding a revolutionary feature. The reason for this change in updates is the utilization of user and usage data.

2.1 Why does Usage Data Help?

Utilizing user data is an essential factor when it comes to designing a user interface. When an application asks to use your data, the information collected is based on usage factors of that application. A few of these factors are: time spent in the app, screen time overall, and when the app is opened during the day.

The data that is collected from users is used to personalize the experience. What this means is that based on the factors listed above and more, there are algorithms that are constantly running on the users data to adjust itself to make the interface more tuned for that user and how they use that device or application.

2.2 Usage Visualization

Usage statistics help with the algorithm when it learns the specific way and style the user uses the device. This could mean anything on the device such as just the general operating system, an app or even their typing patterns. All of it is being recorded for analysis purposes such that the device can create an experience that fits that person the best.

In the figures, the breakdown of application use categories as well as different application suggestions are shown. Using different variables as well as usage statistics, factoring these together allows the device to understand how we use it, and then adjusts itself in that such that it seems more connected to the user.

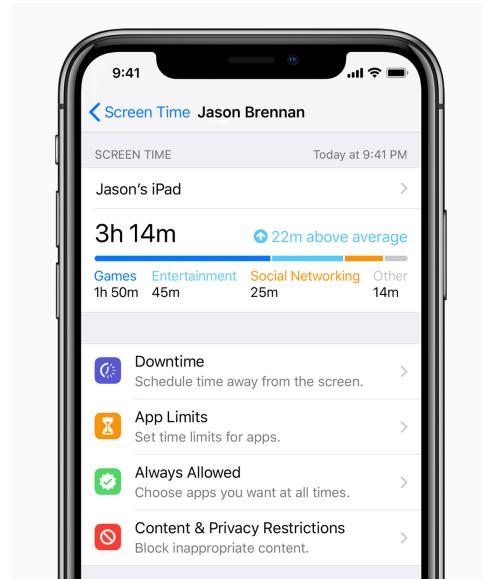


Fig. 1. iOS 12 Feature: Tracks app usage by category, overall screen time, and breaks down amount of time spent on each app used. [1]

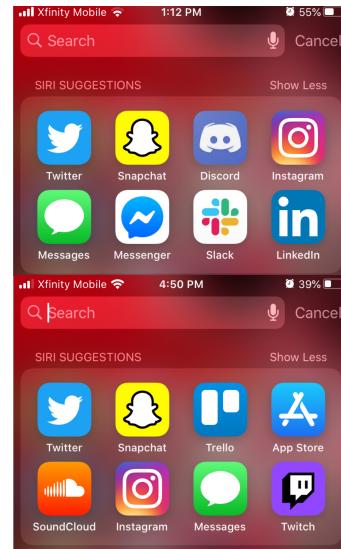


Fig. 2. App suggestions change depending on the time of the day, your device tracks app usage seeing which ones you use most overall as well as specific times of the day. Source: Dodd, Nikhil. iOS Screenshot 2019. .png

By analyzing and recording data of users, adjustments are made using this data allows such that the device essentially 'learns', creat-

ing a personalized experience that match your needs closer the more it is used. This application of machine learning is called predictive analytics [12].

3 WHAT MAKES A USER INTERFACE WELL MADE?

With the recent evolution of UI as well as the spike in AI applications, operating systems, a variety of applications and more are starting to develop their own "personality" when it comes to design. The overall smart ability of the interface allows for the software to connect with the user such that it adapts to the user rather than forcing the user to adapt to the system. When creating a user interface, the creator has to consider both the dynamic and static abilities of the interface. Essentially what has to stay as a default when using the software or what has to change or can change while in use.

3.1 Integrating Libraries to Adapt

One of the most common machine learning libraries that are used in web applications is TensorFlow. TensorFlow is a ML library that is implemented to essentially learn how the user uses that website and creates suggestions based off of that data. There are many aspects when it comes to creating a website that uses ML, and one of the websites that utilizes ML very efficiently is YouTube.

YouTube is one of the most adaptive websites, suggesting videos based on the user's video interests, creating playlists based on different video categories, view time and more. Being able to track all this data, then implement it into an optimal user interface is not easy. This is where these dynamic aspects of the website come in, the portions that use ML knowing where to place what suggestions, all while presenting this information using a clean UI.

3.2 YouTube's Algorithm

On the surface, YouTube seems like it has a simple UI with simple shapes, colors and overall features. However, there are multiple algorithms running to create the most personalized

front page for you. By tracing through the figure, we can get a high-level idea of how this is done. After the user watches a video, many videos are generated that match the genre of the video as well as the similarity in terms of the video. Along with this there are videos generated that are similar to general interests of that user, and based on the history, time watched, and context of that viewer [3]. Then all the videos are presented in that ranked order predicting what the user would want to view next.

While this is a very high level understanding of the YouTube algorithm, it gives a much better idea of how AI is being implemented into user interfaces. With AI creating these suggestions that predicts what the person wants to see next, it's personalizing the experience for them. Features on the website include a manual option that allow the user to directly state they are not interested in certain videos, which contributes to the learning algorithm and takes that factor into consideration.

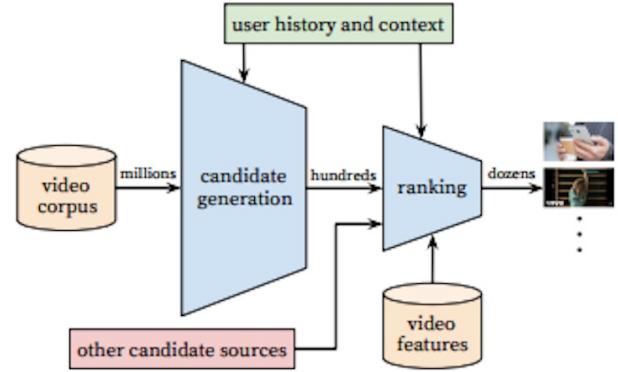


Figure 2: Recommendation system architecture demonstrating the "funnel" where candidate videos are retrieved and ranked before presenting only a few to the user.

Fig. 3. A basic diagram of how YouTube suggests videos and utilizes viewership analytics. [2]

3.3 Mobile Device Use Over Time

As AI applications have rapidly increased recently as well as its integration, the number of mobile phone users, specifically smartphones, has increased as well. This has given companies

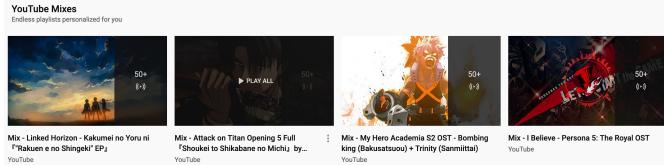


Fig. 4. An example of how the algorithm creates personalized mixes. Source: Dodd, Nikhil. YouTube Homepage Screenshot 2019. .png

motivation to create products that more people can pick up and use right away. Smartphones utilize AI fairly frequently due to their convenience and plethora of features packed into them. The number of smartphone users has spiked as well, going from less than 40% to more than 80% .

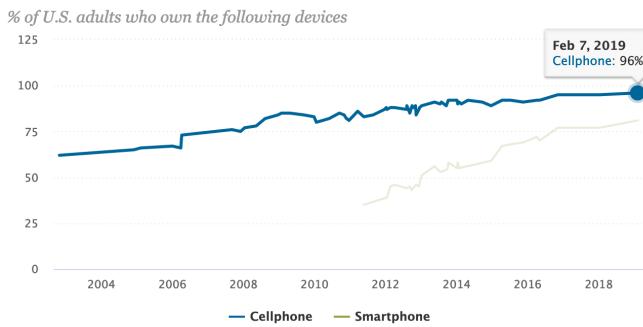


Fig. 5. Percentage of adult cellphone users in US. [4]

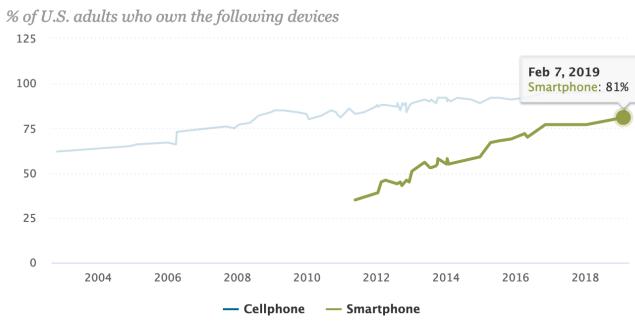


Fig. 6. Percentage of adult smartphone users in US. [4]

We see that there are many more smartphone users now, which means that the amount of access to these tools and interfaces is increasing as well.

4 FACE ID - A DIFFERENT APPROACH TO AI INTEGRATION IN UI

There are many applications of AI, and one of them was the way YouTube uses it in creating personalized mixes and suggesting videos. Another way AI is implemented is into operating systems. Apple has developed one of the most accurate facial detection systems in the market, and its implementation into iPhone's is seamless.

4.1 How does Face ID Work?

Face ID is an advanced authentication system developed by Apple. The way it is able to recognize multiple faces, differentiate faces and detect them in low light situations is once again accomplished through AI. Face ID generates 30,000 dots on the users face to create the 3D facial structure. The reason this many dots are used is more accuracy, and to differentiate any minute details of faces. Along with the dots, an infrared camera is used to detect heat patterns of facial scans. To ensure this works in the dark, there is a flood illuminator, which is an IR light that essentially lights up the environment being checked [5].

Integrating this technology into iPhones initially was received as unnecessary, but now it has become a default. Compared to Samsung's facial recognition, Apple uses 'true depth' which makes your face in 3D rather than a flat image [6]. This not only creates a more secure way of authentication, but makes it harder to replicate, thus making your experience more secure.

Face ID was seen as something that would be less convenient than fingerprint ID, but that was proven wrong fairly quickly. Having minimal interaction with a device to unlock, approve, and protect your information while at the same time had the most security made the user interface more enjoyable as well as bringing back the idea of personalization. Being able to unlock your device as well as have adjustments being made to one's operating system based on usage creates that connection between the user and device.



Fig. 7. FaceID use in iPhones. [7]

5 RESEARCH PAPERS

AI integration in UI has many other aspects to it, and the amount of potential this concept has has led to different articles and different research papers/books discussing different ways of AI implementation in UI. There are other branches of AI such as AutoML, which is automating the process of ML, which speeds up the simpler tasks of ML and is automatically executed. The following papers discuss the different implementations and considerations one needs to take in when creating an adaptive or smart user interface.

5.1 Artificial Intelligence (AI): What About the User Experience

This article is written by a technology specialist Tom Taulli from Forbes. Taulli describes how artificial intelligence is continuously evolving, but those that are developing the new applications are skipping over creating a proper user interface[9]. When data scientists use algorithms to develop learning patterns, the UX is usually a forgotten portion of creating the application. This is when AutoML comes into play, it allows for people who have no data science background to use these applications/tools that are usually limited to data or computer scientists. Functionality and usability is what companies should be aiming to do. However, the balance between functionality and usability is difficult to find in each application. However, if it is found, it truly makes the experience memorable.

5.2 Computer Vision Face Tracking For Use in a Perceptual User Interface

This article was written by Gary R. Bradski, the founder of OpenCV which is a library for real-time computer vision. Facial tracking and recognition is a growing area, and is constantly being updated according to the article. There are many factors to creating an accurate facial tracker, such as working through any distortion or noise as well as movement.

Facial tracking and generalized computer vision can have many applications, and one of the applications discussed in the paper is using facial movement to control objects in 3D games like your player. This is done using a part of OpenCV called CamShift, which is a tracking algorithm that can track simple targets using color. Camshift is a fairly powerful algorithm, but it can only track simple objects that do not have too many variables[10]. So using it for things like facial recognition for authentication would not be a wise choice.

5.3 Adaptive User Support

Written by Reinhard Oppermann, who is a professor at the German National Research Center for Information Technology, this book discusses Adaptive User Interfaces, and how they can adapt based on the user and how it's more convenient that they do. book discusses Adaptive User Interfaces, and how they can adapt based on the user and how it's more convenient that they do.

In a biological system, such as our own human bodies, if there is an issue, the body does what it can to fight and fix the issue. For example a paper cut, at first there is blood, but after a few minutes, cells are patching up the cut and it can stop but the skin is very thin. Over time it heals itself, and has adapted to the situation[11]. This idea links to the artificial intelligence concept of neural networks.

6 DESIGN THAT COMPLEMENTS AI

While integrating AI into UI creates a personalized experience, the UI has to complement the AI in the same way. Creating a user interface

that is simple, but has functionality that incorporates all the data analysis done by the AI algorithms is the other half of the personalized experience developers are aiming for. When it comes to designing the user interface, it has to work well with a more dynamic design such that it can adapt and change without losing the functionality. This is done by making the interface be simple and welcoming, but have the functionality that users are looking for.

6.1 Fonts

Fonts play a much more significant role than people think. It has to be used in such a way that it fits with the overall design and can work across the entire application. The 2 main types of fonts that are used are Serif and Sans-Serif. The noticeable difference between these 2 is that Serif has 'feet' and Sans-Serif is more rounded and smooth.

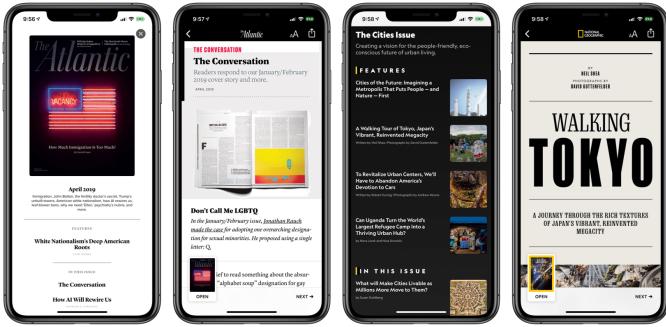


Fig. 8. Combining the use of serif and sans-serif in different applications. [8]

6.2 Color Choice

Color choice plays a significant role when it comes to using an application. Colors act as the type of environment for the application, and usually consist of gradients or a specific palette of colors that are limited to four or five colors.

6.3 Object Choice

Lastly, we have object choices. Most UI use common shapes such as rectangles and circles, sometimes modified in a way so that the edges are rounded. Usually rounded edges and/or simple shapes create a sense of simplicity when using an application, website or device.



For your protection, please verify your identity.



Email address

Password

[Sign in](#)

[Forgot password?](#)

Not a member yet? [Get an Adobe ID](#)

Want to use your company or school account?

[Sign in with an Enterprise ID](#)

Or

Continue with Facebook

Continue with Google

Continue with Apple

Fig. 9. Simple shapes and colors create a more welcoming experience. Source: Adobe Creative Cloud login screen. Photographed by Nikhil Dodd. .png

7 CONCLUSION

AI's implementation in UI has allowed for developers and companies to create some of the most intuitive designs in recent years. AI is rapidly evolving in such a way that it constantly is gaining more applications. With this vast number of applications, the number of smart interfaces as drastically increased, giving people a much more personalized experience when they use their devices. The application of AI gives our devices whether it be software, hardware or both has made experiences interacting with these devices much more personalized and adaptive to our usage data.

As this improves, the AI implementation in user interfaces continues to evolve as well. We see this in something much larger than smart phones and web applications: self-driving cars. Self-driving cars are utilizing the data picked up by surroundings, applying computer vision to identify different objects and being able to drive itself. However, all this information is not displayed the same way as the developers see it, but instead displayed in a clean manner such that the feature can be used by anyone.

There are constant updates and changes being made to make the product more open and usable for everyone. Simplifying the display, making all the objects and features more noticeable and clear for the user and in general working for the user rather than making the user adapt to the interface. At the same time, the interface takes our usage data and makes it more usable for us. Along with it, there are research papers written about smart user interfaces and the different methods artificial intelligence can be implemented to create unique ways of interacting with computers.

While UI development is seen as mostly a design field, it requires many more technical aspects to create an interface that not only connects with the user, but understands them as well. Artificial intelligence is definitely the future in terms of development, but when it comes to usage, it has to be usable for anyone: those with or without technology backgrounds. Having smart interfaces not only creates a more memorable experience, but returning users because of the personalization done by different learning algorithms to make the product more unique for the user.

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