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Game Geek

IT 497: Graduation Project Report
Product Release-2

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Game Geek

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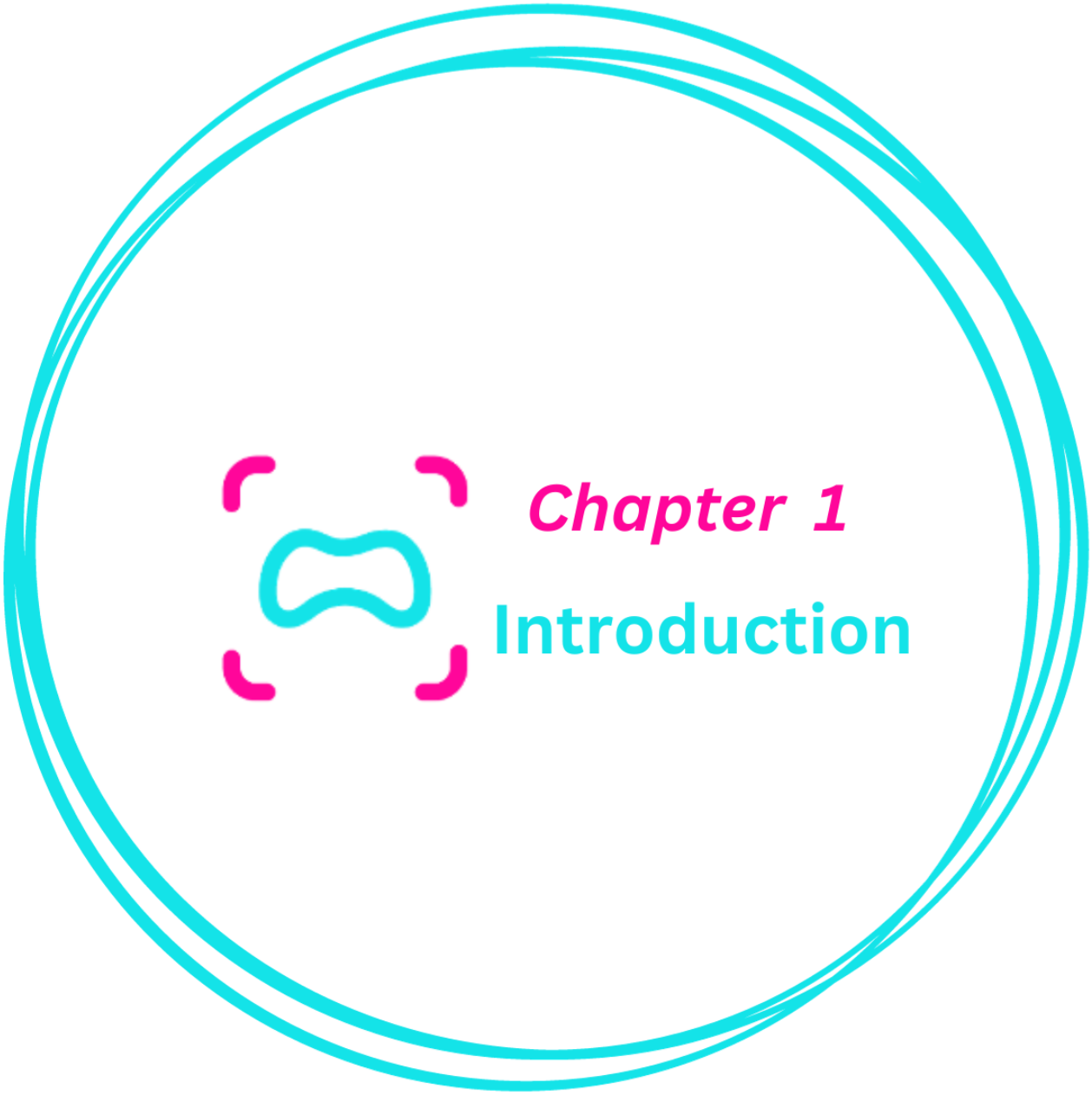
Abstract:
Video games are an essential source of entertainment for a lot of people. Producers are competing to release highly anticipated games in an extremely competitive marketplace. However, a significant problem occurs when people play games that are inappropriate for their age group, potentially leading to negative consequences. Upon identifying this issue, our team developed a system that offers video games according to users' age groups. The system has features collected from interviewing end-users. It displays games by estimating the user's age group using a CNN model developed and trained on a collected dataset designed for this system. After the estimating process, games with suitable age group are displayed. The methodology used to develop this system is Agile, wherein in each sprint we design, implement, and test some features. As a result, we have a working software that was tested on our end users to ensure its features and performance meet their needs. The testing results were highly positive, and the users enjoyed the system.

Abstract (Arabic):
تعد ألعاب الفيديو مصدرًا أساسيًا للترفيه لكثير من الناس ونظرًا لإقبال المهتمين لها يتنافس المنتجون لإصدار ألعاب مميزة في سوق تنافسي للغاية. ولكن مع الأسف غالبًا ما يواجه الأشخاص ألعابًا غير مناسبة لفئتهم العمرية مما قد يؤول إلى عواقب وخيمة تؤثر على حياتهم. بعد إدراكنا لهذه المشكلة، قام فريقنا بتطوير نظام يقدم ألعاب الفيديو وفقًا للفئات العمرية للمستخدمين. يحتوي النظام على ميزات تم جمعها بعد إجراء مقابلات مع المستخدمين النهائيين. يعمل النظام على عرض الألعاب من خلال تقدير الفئة العمرية للمستخدم باستخدام نموذج الآلة الذي تم تطويره وتدريبه على مجموعة بيانات مجمعة خصيصًا لهذا النظام. بعد عملية تقدير العمر، يتم عرض الألعاب ذات الفئة العمرية المناسبة وفقًا للعمر المقدّر. أثناء تطوير النظام اتبعنا منهجية "الأجايل"، حيث نقوم في كل فترة بتصميم بعض الميزات وتنفيذها ثم اختبارها. ونتيجة لذلك، طوّرنا نظام تم اختباره على المستخدمين النهائيين لدينا للتأكد من أن ميزاته وأدائه يلبي احتياجاتهم. كانت نتائج الاختبار إيجابية للغاية، حيث استمتع المستخدمون بالنظام ونال على إعجابهم المستخدمين.

Keywords: Video games; Age group; Deep learning model; Age Estimation; Age appropriated games.



Chapter 1

Introduction

1 Introduction

Individuals are exposed to various content on multiple platforms such as social media and video games. Concentrating on video games, most people play video games as a way of entertainment, socializing, and a method to unwind. Along with spending time with friends and family, playing video games is another way to entertain. However, many users have trouble choosing the video games that are appropriate for their needs, particularly children who sometimes enjoy playing new video games without being aware of what suits their age. Unfortunately, in most cases, exposure to harmful content may lead children to risks such as in-game bullying, identity theft, credit card fraud, and sexual exploitation. Without the right guidance on what video games are appropriate for them to play, children are prone to one of these risks. Therefore, we thought of building a system that helps find the appropriate video games for each user based on their age group.

1.1 Problem

With so many video games out there, it can certainly be overwhelming for the majority to find the perfect game that satisfies their preferences and favors, especially for young players. Parents often have numerous worries regarding the content their children are exposed to, particularly when playing video games. Children might be exposed to inappropriate content that may lead to harmful risks. According to eSafety research, a high proportion of young people aged 12 to 17 in Australia have encountered inappropriate or hateful content online [1]. Taking a real-life example, some children download a lot of video games on their devices based on the advertisements they see. Unfortunately, in most cases, the type of these video games is inappropriate for their age. Some of these video games include violence, where others have sexual content or in-game bullying. This problem inspired us to think about developing a system that suggests video games to users based on their age group.

1.2 Solution

The project aims to provide Web-based software that provides the users with video games appropriate for their age group. First, a Deep Learning model (Custom CNN Model) will be trained to estimate the user's age group. The Custom CNN model will use a the facial age dataset [2], the Age prediction dataset [3], the Flickr-Faces-HQ Dataset (Nvidia) - Resized 256px dataset [4], the 1 Million Fake Faces dataset [5] , and the Egyptian Kids Faces dataset [6] for training, these datasets will be cleaned, preprocessed, and classified into 5 categories based on AppStore Age Rating. The labels for the CNN model will be toddlers (0-3), 4+, 9+, 12+, and 17+. After training the CNN model, the system will integrate the Trained CNN model with the website. It will ask the users to take a picture of their faces and classify them into their appropriate age group. Once the user's age group has been estimated, the system will provide a list of video games from the AppStore dataset [7] that match their age group. Depending on the user's age group, certain features and filters will be shown to the user to manage the search process.

The system ensures that only video games suitable for the user's age group are displayed, minimizing the necessity for parental oversight during their children's playtime. The system will help to reduce the potential negative impact of video games on children, such as promoting undesirable behavior [8], potential cognitive issues, and hindering proper growth [9]. Also, for adult gamers, this approach ensures a refined search experience, presenting games that directly align with their interests.

1.3 Product Vision

For children and individuals interested in video games who face difficulties in finding suitable video games for their age group and interests. Game Geek is a system that helps users find their favourite video games according to their age group and interests. Unlike searching for video games in game stores such as GooglePlay and AppStore, our product saves users time and effort by providing direct links to video games that match their age group and interests.

1.4 Software Process Methodology

We deployed the Agile methodology in our system, to ensure that user demands are recognized and satisfied at all stages of the product lifecycle:

During the Requirements Elicitation and Planning stage, we understand the user needs through the interviews and questionnaires.

Moving on to the Design and Development stage, we developed the website interfaces along a custom CNN model in parallel, for the custom CNN model we started by collecting the data, then cleaning it to ensure the model would learn correctly, after that we trained several models Machine learning models and Deep learning models, based on the results we choose the highest result model to be our model, then once both components are ready, we seamlessly integrate them. Subsequently, we complete all the features for our system.

In the testing of the product stage: we Tested system functionality, usability, and performance, and gathered user feedback and insights through testing for continuous improvement. Finally, in the deployment and Maintenance: we deploy the system for access by individuals, then monitor users' feedback and implement updates and enhancements to the system.

1.5 Main Contribution

Our main contribution lies in developing a system that tailors game selections to users' age groups, utilizing a proprietary custom CNN model for age estimates. This addresses the issue of inappropriate game exposure across age demographics. By providing a secure game download environment, our system ensures a safer, more enjoyable gaming experience for all ages.

This initiative impacts both local and global communities by promoting responsible gaming habits and advocating for digital safety standards. Ultimately, our solution sets a new standard for online gaming platforms, emphasizing personalized and secure experiences worldwide.

1.6 Summary

This document consists of nine sections. In Section One, we propose the introduction, the problem, the solution, the product roadmap, objectives, and scope. Section Two discusses the domain knowledge and theoretical background to help the reader understand the project. In Section Three, we provide the literature review, which includes related work and competitors' analysis. Chapter Four discusses system design and development in detail. This section covers the project methodology, system requirements, system design, data design, interface design, and system implementation. Following this section is the evaluation section, Section Five. Here, we present the experimental results of our model, user acceptance testing, quality attributes testing, and a discussion of the evaluation results. Chapter Six provides the conclusion and outlines future work. We discuss the global and local impact, problems and challenges during development, limitations of the system, the main contribution, and future work. In Section Seven, we provided our acknowledgments. Finally, Section Eight includes the references, and Section Nine contains the appendices.

1.7 Hardware and Software Tools and Cost

Hardware Tools	
Name and Description	Cost
Laptops	No Cost
Software Tools	
Name and Description	Cost
Visual Studio for frontend and backend development	No Cost
Pycharm for frontend and backend development	No Cost
Django is a web framework that uses Python as its programming language	No Cost
Github to share development files among team members	No Cost
Jira to manage project work and track project progress	No Cost
Microsoft Word for creating and editing project documentation	No Cost
Microsoft PowerPoint for creating project presentation	No Cost

Table 1:Hardware and Software Tools and Cost

1.7.1 Software Tools

- Visual Studio is an integrated development environment from Microsoft. It is a creative launching pad that can be used to edit, debug, and build code, and then publish an app. Over and above the standard editor and debugger that most IDEs provide, Visual Studio includes compilers, code completion tools, graphical designers, and many more features to enhance the software development process [10].
- Django is a Python framework that makes it easier to create websites using Python. it takes care of the difficult stuff so that you can concentrate on building your web applications [11].
- GitHub is a code hosting platform for version control and collaboration. It lets groups work together on projects from anywhere [12].
- Jira Work Management makes it easy for business teams to plan, collaborate, deliver, and report on work – all in one place [13].
- Microsoft Word is a word processing program from Microsoft that is used to create and edit documents.
- Microsoft PowerPoint is a presentation program from Microsoft that is used to create and deliver presentations.

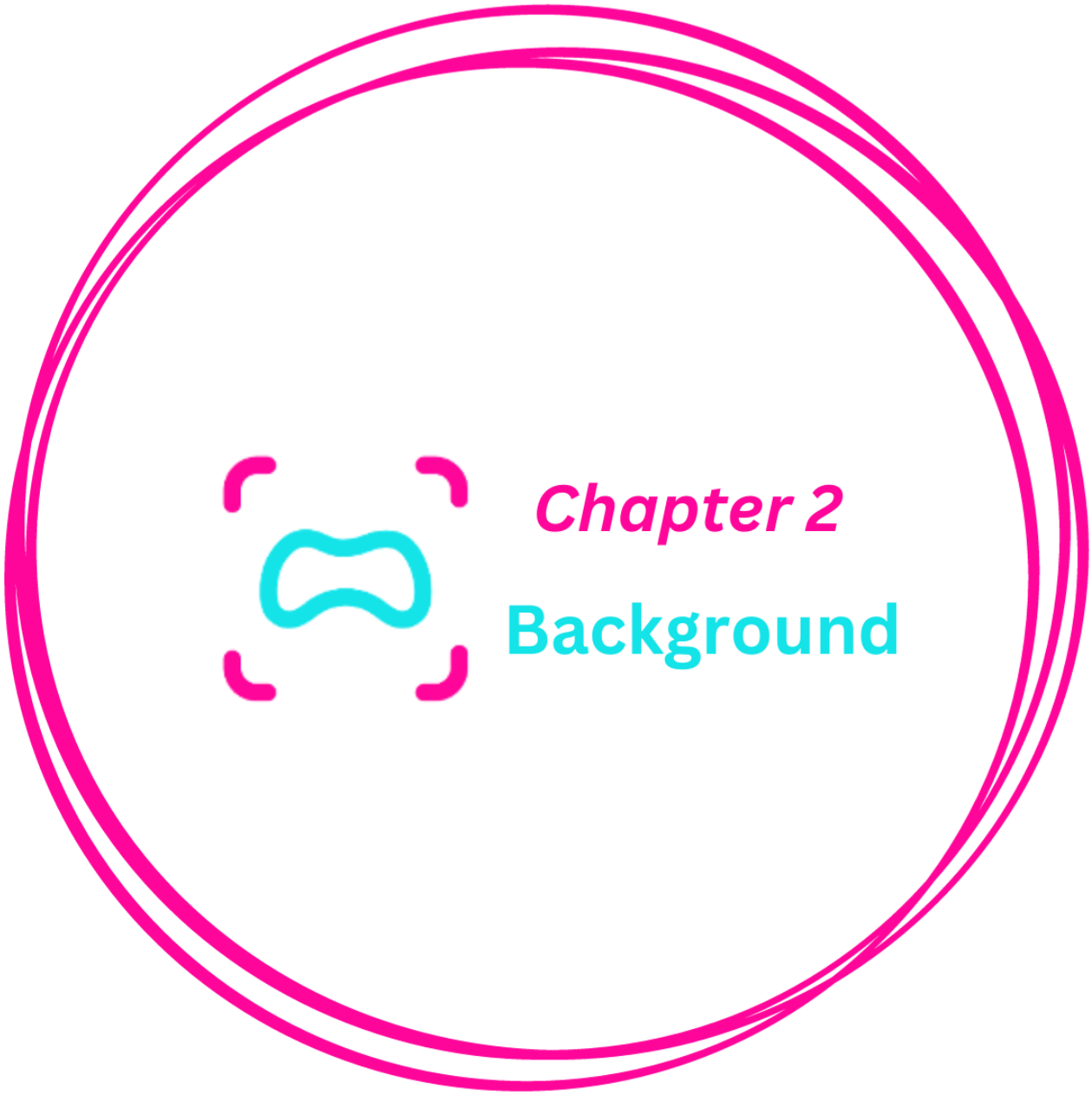
1.7.2 Hardware Tools

- Laptops: A laptop is a personal computer that can be easily moved and used in a variety of locations [14].
- GPUs: Graphics processing technology has evolved to deliver unique benefits in the world of computing [15].

1.8 Skill Set Requirements

Technical Skill Required	What is the current level of the team
Python programming language with Django framework	Beginner-we will utilize YouTube for instructional exercises and begin taking online courses as our learning plan
HTML markup language skills	Advanced
CSS style sheet language skills	Advanced
JavaScript programming language skills	Intermediate
Visual studio usage skills markup language skills	Intermediate
User experience design skills	Intermediate

Table 2:Skill Set Requirements



Chapter 2

Background

2 Background

Our domain comprises facial age group estimation and game classification. In this section, we provide a comprehensive description of the necessary domain knowledge and theoretical background required for understanding the project. This knowledge is intended to facilitate a deeper comprehension of both the problem domain and the solution domain. Furthermore, this section will offer in-depth descriptions of technologies and important terminologies relevant to our topic.

2.1 Domain knowledge and theoretical background

2.1.1 Facial Age Group Estimation

Nowadays, we are surrounded by internet-enabled devices and platforms that are being used for various purposes such as social interactions and entertainment. However, that raises the need to have constraints on the content individuals are exposed to, especially children. Strict restrictions must be taken to prevent exposure to inappropriate content, such as sexual content, violence, and drug use. This content can be harmful to young users' growth and development. Psychology research has long shown that young individuals who are exposed to material that normalizes drug use, sex, or violence are more likely to engage in those behaviors themselves [16], [17], [18], [19]. Therefore, it is vital to create and provide a safer and controllable environment. One of the prominent technological advancements to use for this purpose is facial age group estimation.

Facial age group estimation models can be built as a supervised learning model, unsupervised learning model, or semi-supervised learning model. In our context, the use of predefined age groups serves as labeled data, making supervised learning the most appropriate approach due to its reliance on such data. Our project task is to build a model that estimates an individual's age group and classifies it into predefined age groups: *toddlers 0-3, 4+, 9+, 12+* and *17+*. However, in advance of beginning the training process, a fundamental step is acquiring a suitable dataset. Currently, there are plenty of publicly available datasets with labeled samples of various illuminations, head poses, and conditions [20].

In our case, we had to use five distinct datasets: the facial age dataset [2], the Age prediction dataset [3], the Flickr-Faces-HQ Dataset (Nvidia) - Resized 256px dataset [4], the 1 Million Fake Faces dataset [5], and the Egyptian Kids Faces dataset [6] to work on. This requirement resulted from our predefined age groups being within proximity, which increased the likelihood of overlap. Therefore, using several datasets was necessary to achieve the best classification outcomes.

The implementation of data preparation encompasses data pre-processing. It includes various techniques such as data augmentation, data labeling, removing outliers, data cleaning and further relevant techniques. The choice of techniques applied depends on the chosen dataset; in our specific scenario, data cleaning, data labeling, data cropping, data resizing and data augmentation, were necessary. However, an essential technique for a facial age group estimation model is data splitting. In this technique, data is split into three datasets: training, validation, and testing. The choice of splitting strategies depends on both the dataset size and the nature of the model under consideration. For models that require an enormous amount of data for effective training, prioritizing larger training sets is crucial to ensure robust performance [21]. In the context of our project, where our model requires a large amount of data, we needed a large training set compared to smaller validation and test sets to achieve the best performance.

A supervised model may work as a classifier or a regression-based model, which learns the different patterns of each age group. The model that serves our needs is a classifier model. Unlike a regression-based model, which produces a continuous numerical value representing the estimated age, a classifier model classifies individuals into discrete age groups and provides a discrete class label representing the age group to which the individual belongs [22]. As for a classification model that extracts facial features and estimates an individual's age group task, several machine learning approaches are available. Support vector machine (SVM), as well as deep learning models such as convolutional neural network (CNN) are well known approaches within this domain.

In general, each approach has its strengths and weaknesses. For large datasets, SVM are impractical because they require a significant amount of training time. Also, they perform poorly when the number of features for each data point exceeds the total number of training data samples [23]. On the other hand, SVM performs well even in situations where there are more features than samples. Their efficient handling of high-dimensional data makes them appropriate for feature-rich applications [24]. In the context of deep leaning models, the specific requirements of the task at hand determine which architecture is the most appropriate. For instance, ResNet (Residual Neural Network), VGGNet (Visual Geometry Group), and MobileNet are widely utilized given their distinctive capabilities and applicability to various tasks. When a high level of accuracy is required, ResNet is a well-known architecture that is frequently used for image classification tasks. With fewer parameters than ResNet, MobileNet is faster and more effective because it is designed to run on mobile and embedded devices. Although VGGNet was a successful architecture in the past, performance has dropped as the VGG group has not updated it. The quality of the data is another factor to consider. ResNet and VGGNet may be more appropriate for larger or higher quality images, whereas MobileNet is meant to handle smaller input images [20].

Deep learning models can be either customized and trained from scratch or based on pre-trained models. In our project, we used the first approach, customizing and training a CNN model from scratch. This approach allows us to define convolutional neural networks that consist of several layers as needed with flexibility. With each layer, the CNN increases in complexity and identifies greater portions of the image. Earlier layers focused on simple features, such as colors and edges. As the image data progresses through the layers of the CNN, it starts to recognize larger elements or shapes of the object until they finally identify the intended object [25]. In general, they have three main types of layers:

- Convolutional layer: It uses convolution to extract features from input images. It takes dot products within the filter's size (MxM) and applies a filter of size MxM to the input image by sliding the filter over it. The result, known as a feature map, offers details about edges and corners. To learn more features, this map is then passed to later layers [26].

- Pooling layer: It decreases computational costs by reducing the convoluted feature map's size. It achieves this by working independently on every feature map and minimizing connections between layers [26].

- Fully connected layer: It links neurons from one layer to another using weights, biases, and neurons. Usually located ahead of the output layer. The flattened vector from the previous layers is passed through multiple fully connected layers where mathematical operations are carried out to start the classification process. When compared to a single connected layer, performance is improved by using multiple connected layers [26].

The second approach employs pre-trained models. We use networks that have been trained for a more complicated task to extract features from an image. The strength of this method is that several pre-trained models are initially trained on complex tasks with millions of images such as VGG16 (16 layers) or ResNet50 (50 layers). Therefore, when these models are employed for a less complex task such as age group estimation, they require little to no modification to solve the given problem [20]. So, they can speed up and simplify the training process, instead of starting from scratch. On the other hand, the fact that these pre-trained models were designed and optimized for specific datasets and objectives raises the concern that they may be not fully compatible or transferable to their desired tasks [27].

The evaluation of a machine learning model's performance is a crucial step that helps to determine the efficiency of a proposed model. Several ways can be used to evaluate the performance of age group estimation models [20]. Such as a resampling technique called cross-validation. It can be used to train and test a model on different iterations using different subsets of the data [28]. However, this method is suitable for various types of data but also introduces complexity to the evaluation process. In our experiment, we used a confusion matrix and plotted loss and accuracy, wherein the first methodology we employed statistical measures, such as True Positives (TP - both prediction and actual are yes), True Negatives (TN - prediction is no and actual is yes), False Positives (FP - prediction is yes and actual is no), and False Negatives (FN - both prediction and actual are not), to evaluate the accuracy of the data. As seen in Figure 2.1, all these components combine to form the confusion matrix, which is used to explain how well the classification model performs.

	Predicted: No	**Predicted: Yes**
Actual: No	TN	FP
Actual: Yes	FN	TP

Figure 1:Confusion Matrix

A model's performance can be evaluated using a variety of metrics. Precision, for instance, is the proportion of overall predicted yes to TP. Specificity, on the other hand, is the proportion of overall predicted no to TP, among other metrics [29]. Furthermore, in plotting accuracy and loss, the graphical plotting of accuracy is used to visualize a model's accurately predicted outcomes. Conversely, graphical plotting of loss is used to visualize the total amount of the model's errors [30]. These methodologies were employed to perform a detailed evaluation of the model's performance, specifically in its capacity to identify and classify predicted age groups. In instances of errors, the evaluation also investigates whether the model tends to predict an adjacent age group or deviates distinctly.

2.1.2 Game Classification

In 2022, mobile game downloads increased by 0.5% to reach 55.6 billion [31]. With this exponential growth in the gaming industry, there is a pressing need for a system to organize and classify these video games. Such a system would not only facilitate adult gamers in finding their preferred video games but also provide a safe system. It will control and restrict children's access to age-appropriate video games. This aligns with our objective, which is creating a controllable system that can work smoothly with the highly accurate classification model we've obtained.

Video games can be classified in many aspects: genre, age group rating, user ratings and much more. In AppStore, the age group rating is an important attribute that helps in parental control. For rating attributes, the possible values are *4+, 9+, 12+ and 17+*. Applications allowed for the *4+* age group are the applications that do not include any objectionable material. While the applications allowed for the *9+* age group, are the applications that might include mild or infrequent physical abuse in cartoons, swearing, crude humor, and sexual or horror content. Applications allowed for the *12+* age group are applications that might include infrequent or mild content related to medicine or treatments, realistic violence, simulated gambling, nudity, or sexual content may be included. Also, frequent content of fierce competitions, severe swearing offensive humor or cartoon or fantasy violence.

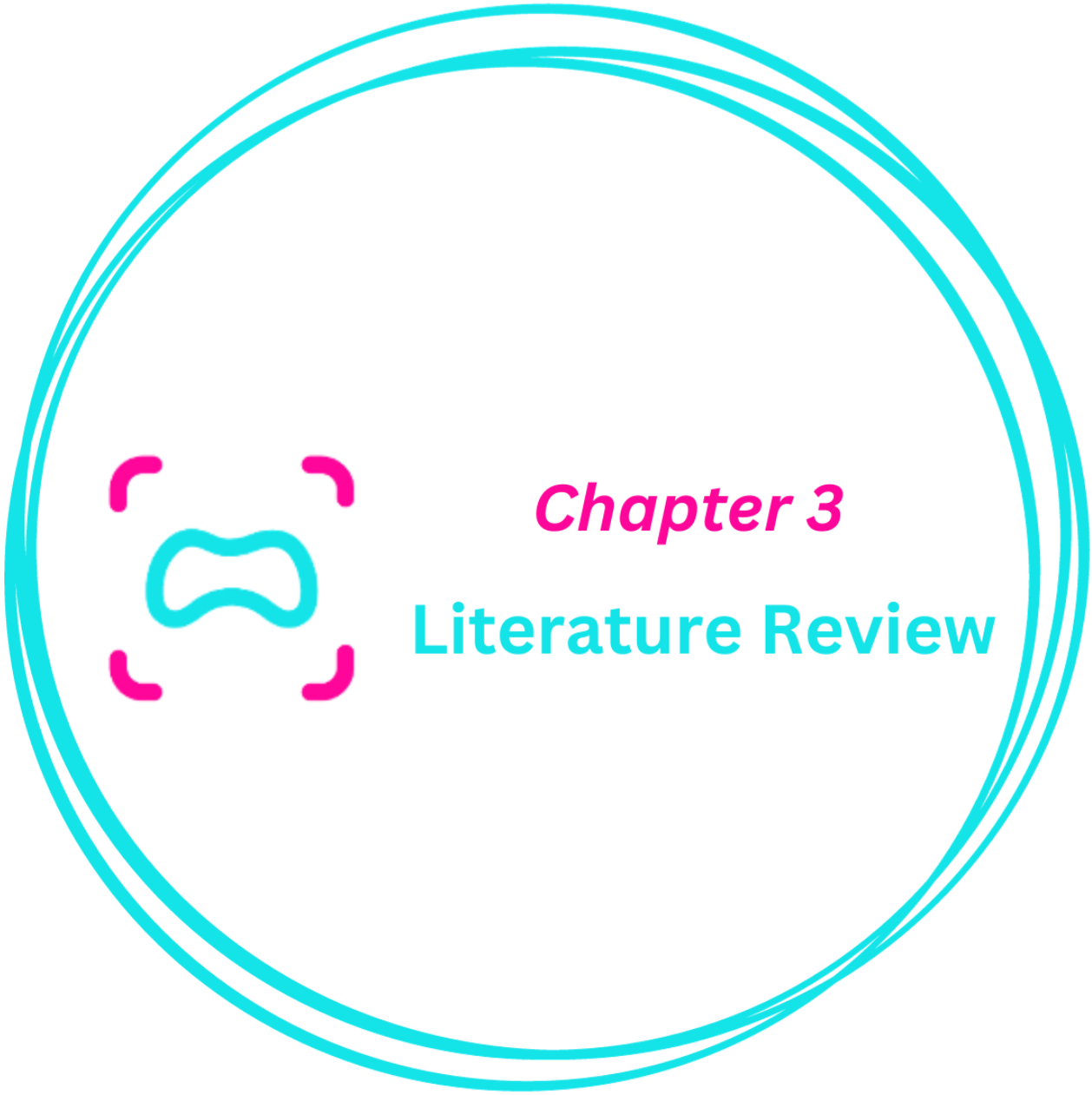
For the *17+* age group are the applications that might include unrestricted access to the web using a browser that is embedded, gambling, and frequent content of focused medicine or treatments, strong, mature, or suggestive content, strong, mature, or suggestive content, and strong references to nudity, sexual or violence content [32].

A system that is capable of classifying video games efficiently requires a good-quality dataset. This implies the main technology applied in this section, which is data pre-processing, which is employed to enhance the quality of the dataset. In our project, we chose to work with the AppStore dataset [7]. Performing effective data pre-processing involves considering several tasks, such as understanding the data requirements of the project and the most suitable way to deal with it. Generally, there are two main types of data, numerical and nominal. The first type can be further divided into integers and continuous.

Similarly, the second type is subdivided into unordered, ordered, and binary. This diversity suggests that different approaches are needed for each type [33]. In our project, these data will be employed for sorting, filtering, and displaying purposes. As a result, most of the numerical data types will be encoded into nominal data types for enhanced usability. Furthermore, real-world data is normally unclean. This explains why it requires pre-processing to be effectively used for any given task. Unclean data can contain various issues such as missing values arising from unavailability, duplicate records resulting from data integration or human errors, and the presence of unnecessary or irrelevant information that could be handled by data cleaning [33]. However, these issues must be resolved depending on their context. For instance, duplicate records can be removed, unacceptable format may require data transformation to a specific scale, for example, 0 to 1. Missing values may be filled manually which is impractical and time-consuming if they are a lot; alternatively, we can address them by utilizing measures of central tendency for the respective attributes, employing a global constant, or using the most probable value [33].

2.2 Terminology

- **Facial Age Group Estimation:** A machine learning task that involves estimating an individual's age group based on facial features captured in an image [34].
- **Age Group:** Five predefined age groups *(toddlers 0-3, 4+, 9+, 12+ and 17+)* inspired by AppStore video games' age ratings.
- **Game Classification:** The process of classifying video games based on the user's selected features and the age group to which they belong.
- **Video Game:** An electronic game where players interact with a video device's user interface to produce visual feedback [35].
- **App-Store Age Ratings:** An essential application characteristic that the App Store's parental control features rely on [32].



Chapter 3

Literature Review

3 Literature Review

In this section, we will conduct the related work, specifically focusing on facial age estimation and game classification methodologies. Additionally, we delve into a Competitive Product Analysis to gain insights from existing solutions in our project domain.

3.1 Related Work

This section will offer an exhaustive examination of the existing research in facial age group estimation relevant to our system, emphasizing the methodologies employed in prior studies. The review will encompass a wide spectrum of techniques employed in the field, spanning the period from 2019 to 2024.

3.1.1 Facial Age group Estimation

In the context of our project, which involves creating a Custom CNN model for classifying users into distinct age groups *toddlers (0-3), 4+, 9+, 12+,* and *17+. a* comprehensive review of recent literature on facial age group estimation methodologies is presented.

The foundational study [34] reveals challenges in facial age estimation, distinguishing between controllable (e.g., head pose, image quality) and uncontrollable factors (e.g., lifestyle, genetics). Researchers prefer transfer learning, leveraging pre-trained models for efficiency. Gaps include low-resolution training images and variations in aging patterns.

In another study [36] introduces a novel Gaussian process-based hierarchical framework for facial age estimation, diverging from traditional SVM-SVR approaches. Pioneering hierarchical Gaussian process regression and efficient group specific WGP regression, the model captures aging patterns across life stages. Overcoming computational challenges, it proves efficient at both hierarchy levels. Notably, learning costs align for multi-class and binary problems at the first level, while the second Leve achieves efficiency by learning separate hyperparameters for each age group. Experimental results as shown in Figure 3.1 and Figure 3.2 on the MORPH-II and FG-NET datasets in Figure 3.3 demonstrate its superiority over state-of-the-art methods.

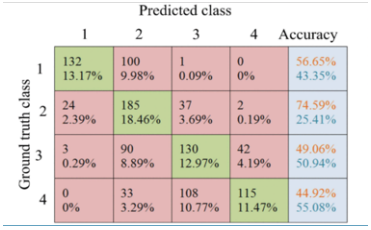


Figure 3:Experiments on MORPH-II dataset

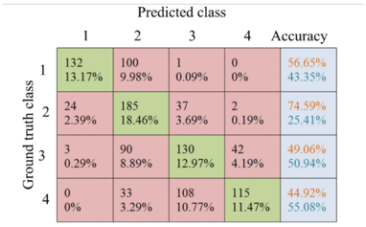


Figure 2:Experiments on FG-Net dataset

Group	FG-NET		MORPH II	
	Age Span	# images	Age Span	# images
1	0-5	233	16-22	5866
2	6-12	248	23-35	8943
3	13-21	265	36-45	6772
4	22-69	256	46-74	3419

Figure 4:FG-Net and MORPH-II datasets

Furthermore, a previous study [37], which was a master project, the primary focus was on addressing age estimation challenges using deep learning. A novel convolutional neural network was proposed and thoroughly investigated to assess its viability for age estimation. The theoretical background and four datasets used in the experiments were introduced. Six experiments were conducted to delve into the model's performance. The initial experiment uncovered an overfitting issue within the age group with four class labels, attributed to the limited data size and the complexity of the model structure. Subsequent attempts to mitigate overfitting included data augmentation, which proved ineffective due to disparities in image quality among original datasets. L2 regularization emerged as a successful strategy in the third experiment, achieving a macro average accuracy of 75% and a weighted average accuracy of 72%.

The fourth experiment explored the model's classification accuracy with varying age class labels, revealing higher accuracy for fewer class labels and decreased accuracy as the number of class labels increased. The fifth experiment addressed imbalanced data using downsampling and weight adjustment techniques, with downsampling proving impractical due to increased overfitting risk. Conversely, weight adjustment demonstrated effectiveness in handling imbalanced data.

The final experiment compared the proposed model with state-of-the-art models, including LeNet, AlexNet, VGG-16, and GoogLeNet. Notably, the proposed model outperformed LeNet and AlexNet with a one-off accuracy of 97.7%, but GoogLeNet surpassed all models with a one-off accuracy of 98.7%. The study provides comprehensive insights into the challenges and strategies in deep learning-based age estimation, emphasizing the proposed model's competitive performance in comparison to established architectures.

The last study [38] introduces the Deep EXpectation (DEX) method for apparent age estimation in face images, employing convolutional neural networks (CNNs) with the VGG-16 architecture. The model is notable for its pretraining on a large-scale dataset, comprising 524,230 face images, and subsequent fine-tuning on the other datasets. DEX adopts a novel approach to age regression by framing it as a deep classification problem, with 101 output neurons corresponding to rounded age values from 0 to 100. This classification formulation, coupled with a softmax expected value refinement, contributes to substantial improvements, achieving a competitive 0.278 ǫ-error and 3.221 MAE on the LAP validation set.In the ChaLearn LAP 2015 challenge, DEX demonstrated its prowess by securing the first-place position, surpassing the human reference performance. The ensemble prediction from 20 networks, trained on varied splits of the data, further enhanced the model's accuracy. Despite its success, DEX is distinctive for its avoidance of explicit facial landmarks, indicating the effectiveness of its architecture and training strategy in addressing the nuanced task of apparent age estimation from facial images.

In conclusion, the previous studies on facial age group estimation underscore the considerable challenges associated with accurately determining age from facial features. The intricacies arise from factors such as unpredictable aging effects, diverse lifestyles, external influences, and limited datasets, all contributing to the complexity of the task. The specific methodologies employed further accentuate the computational intricacies, necessitating the development of efficient strategies. Additionally, the potential for identity overlap in training and testing sets underscores the critical importance of refining evaluation methodologies. Recognizing and addressing these challenges are pivotal for the successful development of an accurate and robust the facial age group estimation model that can be used in game classification in our system.

3.2 Competitive Product Analysis

Before building the system, we examined similar systems to identify their strengths and weaknesses. The following section will discuss the characteristics of our competitors' systems, followed by a comparison between our system characteristics and those of our competitors.

- **GameFAQs:**

Figure 5 shows GameFAQs, GameFAQs a website that provides game walkthroughs and FAQs. The website features a database of reviews, box art photos, screenshots, cheat codes, game saves, and information about video games that is nearly entirely contributed by volunteers. Computer and mobile games are among the systems covered, along with the 8-bit Atari platform and contemporary consoles. [39].

Figure 5:GameFAQs logo

GameFAQs features [40]**:**

- Video game database has a database of over 500,000 games, including information on release dates, platforms, genres, publishers, screenshots, videos, cheats, and reviews.
- Walkthroughs: These walkthroughs can be helpful for gamers who are stuck on a particular part of a game, or who want to get the most out of their gaming experience.
- FAQs: these FAQs can answer common questions about the game, such as how to control the characters, and how to solve puzzles.
- Cheats: gamers can find cheat codes for various of games. his can be used to unlock secret features, make the game easier, or simply have more fun.
- Message boards: Every game listed on GameFAQs has its own message board, where both novice and experienced gamers can discuss game strategies and other game-related topics.

- Message boards: Every game listed on GameFAQs has its own message board, where both novice and experienced gamers can discuss game strategies and other game-related topics.

Figure 6 shows the GameFAQs:

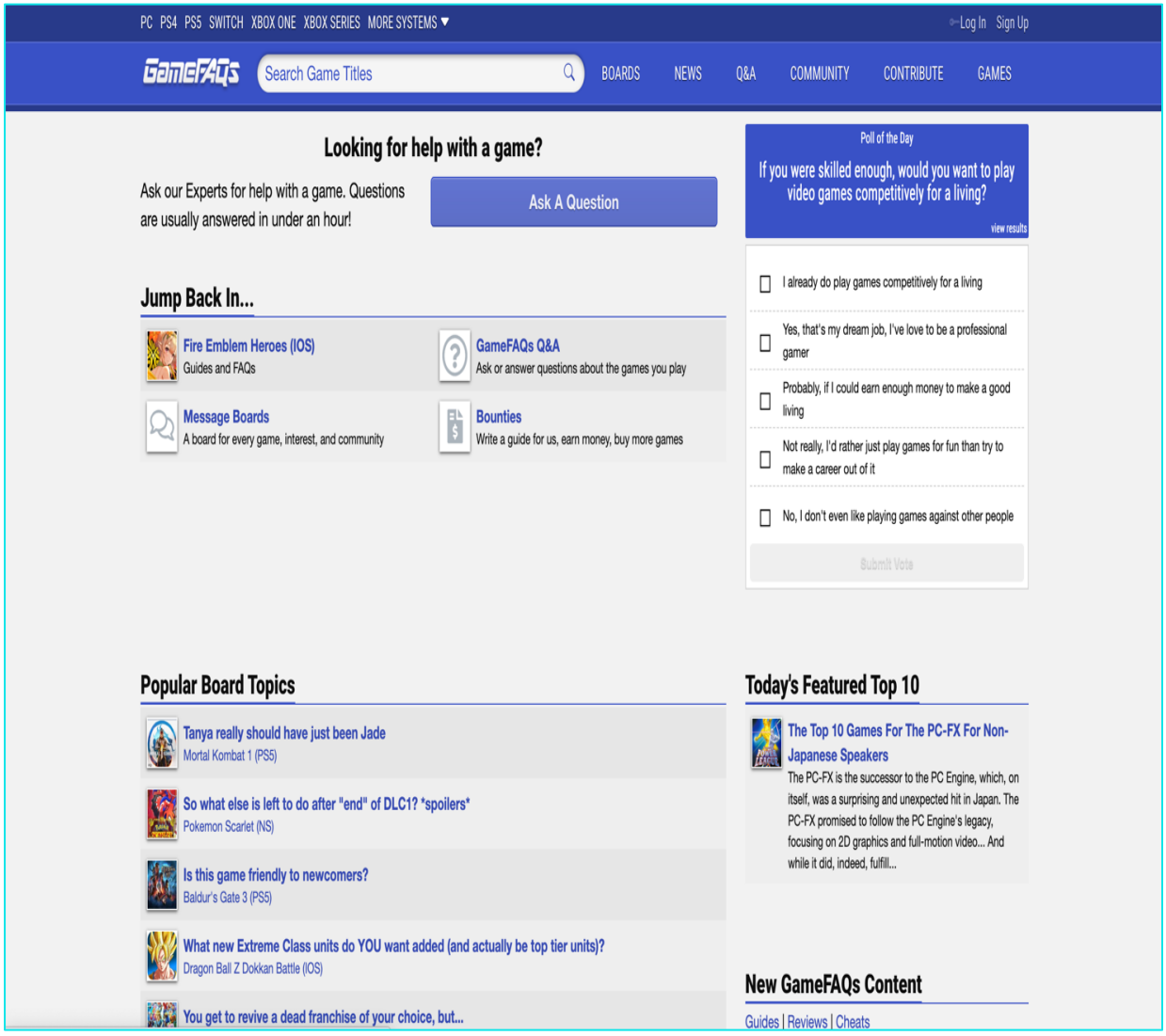


Figure 6:GameFAQs interface

- **TouchArcade:**

Figure 7 shows TouchArcade, TouchArcade is an online platform that features the latest games and applications for Apple's iPhone and iPod Touch. It was launched in 2008. since become one of the most popular websites for mobile gaming news, reviews, and previews. Also, it has a forum where users can discuss mobile games with each other [41].

Figure 7: Toucharcade's logo

TouchArcade features:

- News: publishes daily news articles about mobile games, including new releases, updates, and sales.
- Reviews: publish weekly reviews of new mobile games.
- Forum: has a forum where users can discuss mobile games with each other its forum is a great place to get help with specific games, ask questions about mobile gaming, and connect with other mobile gamers.
- App: iOS and Android that allow users to access the website's content on the go. Also includes features such as push notifications for new articles and reviews and an offline mode.

Figure 8 shows the TouchArcade interface.

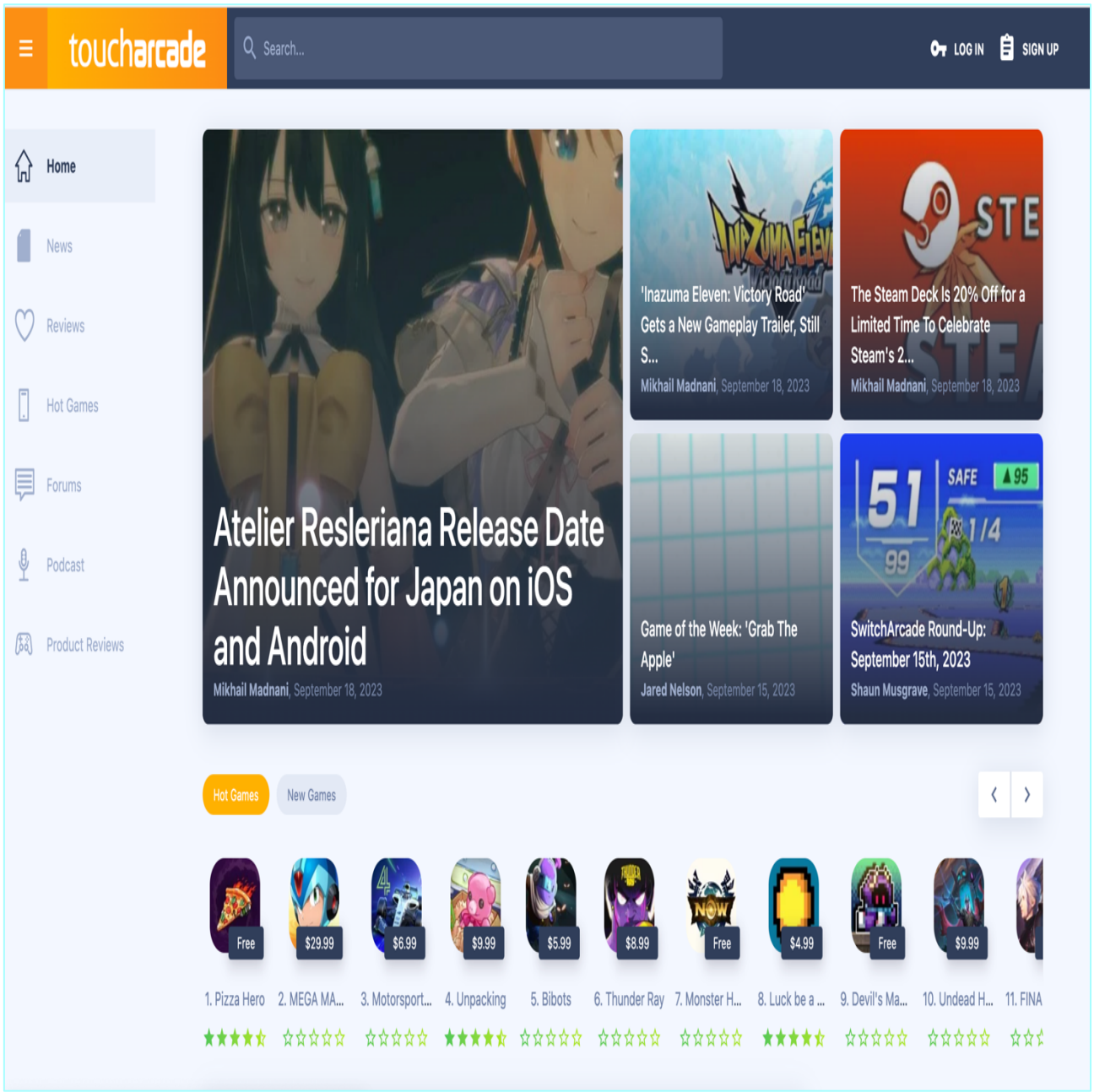


Figure 8: Toucharcade's interface

IGDB:

Figure 9 shows IGDB, A list of game companies, cast, and details can be found on the IGDB. Like its larger site, Amazon's Internet Movie Database, IGDB allows registered users to rate, list, and review games. Users can also add, edit, and create pages; these are published once IGDB staff members have verified them. IGDB also shows reviews from over 55 sources. The site wants to provide information about games (especially to highlight indie games) and build a community of gamers and people from the gaming industry [42].

Figure 9: IGDB's logo

IGDB features:

- An extensive game database: One of the biggest game databases out there is found on IGDB. It contains more details about many obscure games in addition to all the independent releases.
- Game reviews and ratings: Users can rate and review games on IGDB. That gives you the benefit of using that to look for games you might like.
- Game pages: Each game in the IGDB database has its own page for more detailed information, such as the game's release date, genre, platforms, and more.
- Developer and publisher pages: it has pages for game developers and publishers. the information provided, such as the developer's or publisher's history, upcoming games, and contact information.
- API: IGDB offers an API that allows developers to access the database's data. This can be used to create games, apps, and other projects that involve video game information.

Figure 10 shows the IGDB interface:

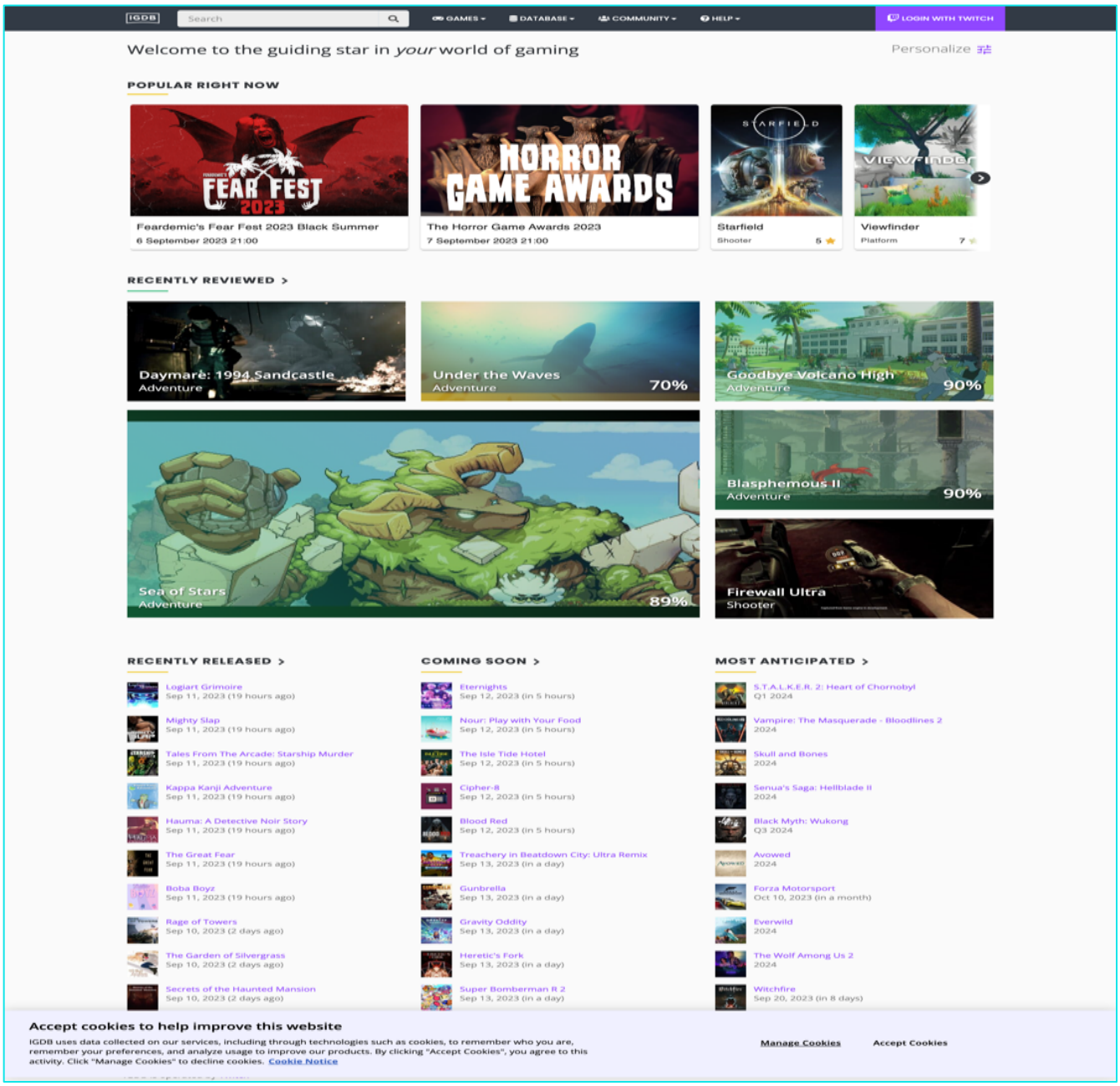


Figure 10: IGDB's interface

Games Finder:

Figure 11 shows the Games Finder. Games Finder is a website that helps gamers find games that they will enjoy. It does this by using a variety of factors, including their gaming preferences, the platforms they own, and their budget.

Figure 11: Games Finder's logo

Games Finder features:

- A search bar that allows you to search for specific games.
- The ability to filter games by genre, platform, and price.
- The ability to create a Wishlist of games that you want to play.
- The ability to follow other users and see their game recommendations.

Figure 12 shows Games Finder interface:

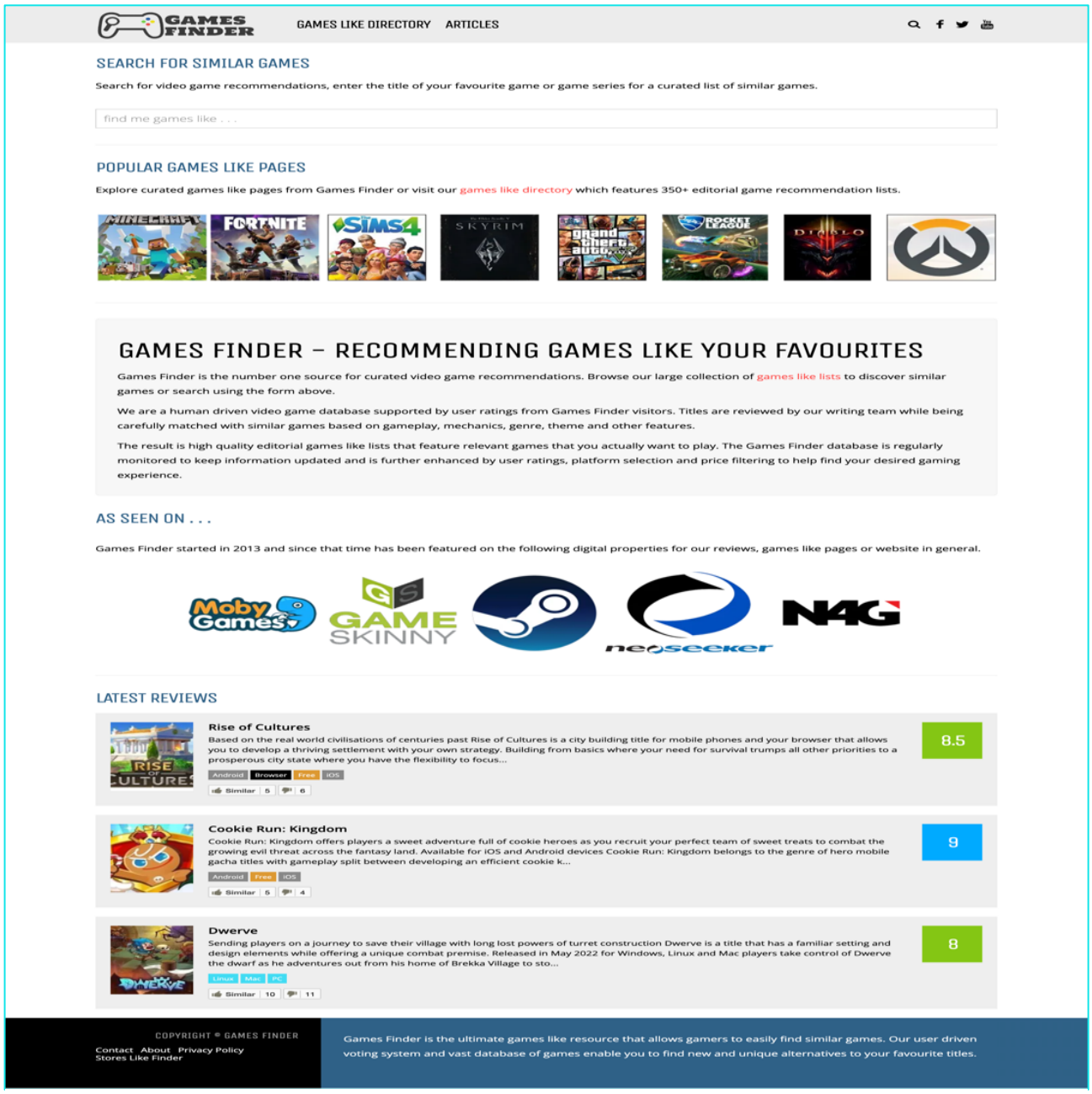


Figure 12: Games Finder's interface

- **RAWG:**

Figure 13 shows the RAWG.io. RAWG.io is a video game discovery platform and a community-powered database with over 350,000 games across half a hundred platforms [43].

Figure 13:RAWG's logo

RAWG features [44]:

• Cross-Platform Recommendation Service: Provides suggested games based on platform reviews.

• Comprehensive Database: Offers a comprehensive game database, similar to IMDb.

• Personal Library and Recommendation System: Combines personal library with recommendation system for personalized game recommendations.

• Social Service: Connects users with friends and influencers in the gaming community.

• Event and Game Release Calendar: Keeps users updated on upcoming titles and events.

• Blockchain Integration: Utilizes blockchain technology for real-life benefits and targeted advertising.

• ERC-20-based Token: Offers discounts for advertisers and rewards gamers.

Figure 14 shows RAWG's interface

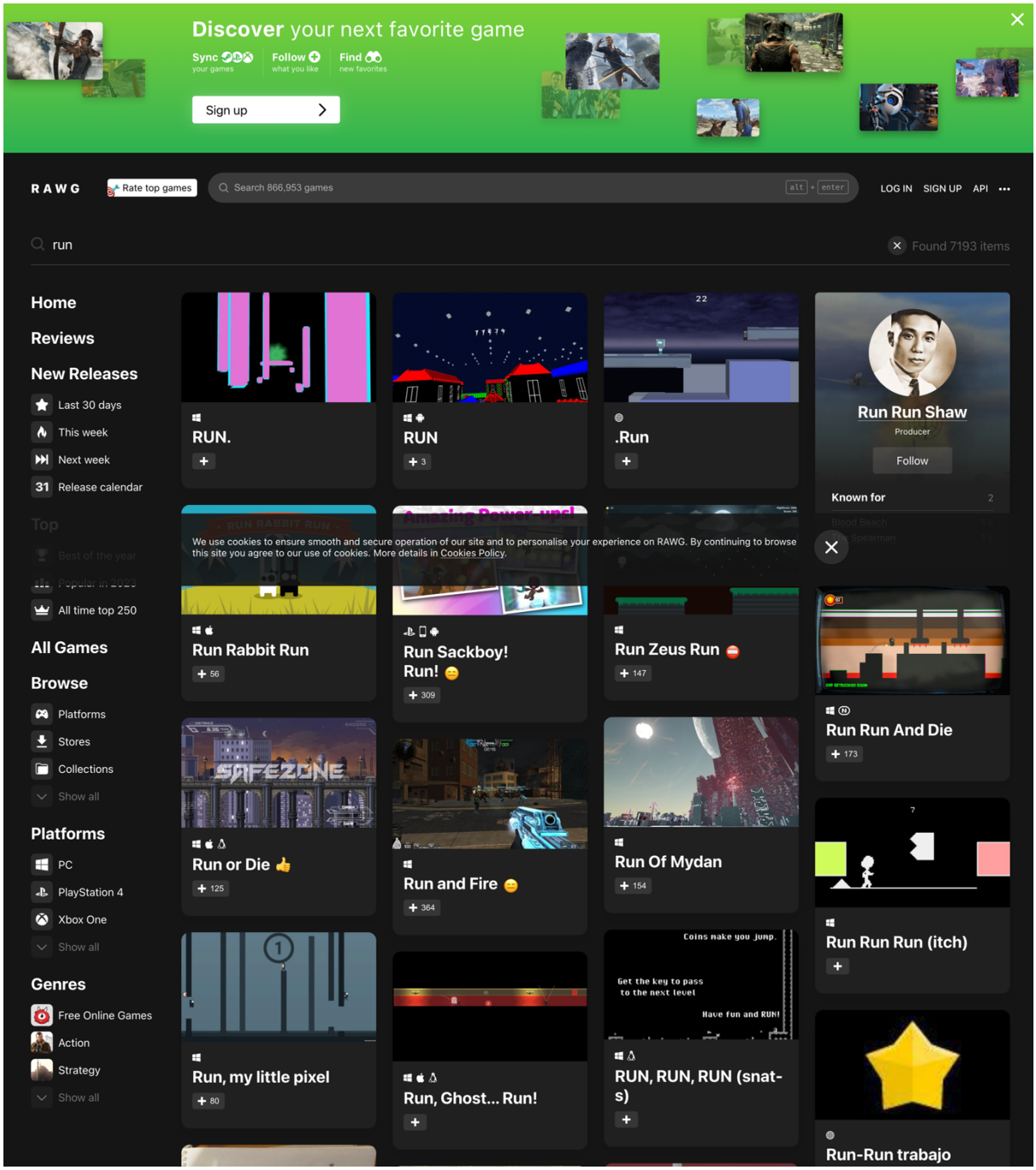


Figure 14:RAWG's interface

Features\ Systems	Game Geek	GameFAQs	TouchArcade	IGDB	Games Finder	RAWG
Estimate age group based on face images	☑					
View games based on their age group.	☑					
Filter games	☑	☑	☑	☑	☑	☑
Sort games	☑	☑	☑	☑	☑	☑
Go to the download page of games with just a click	☑		☑	☑	☑	☑
see recently viewed video games.	☑					

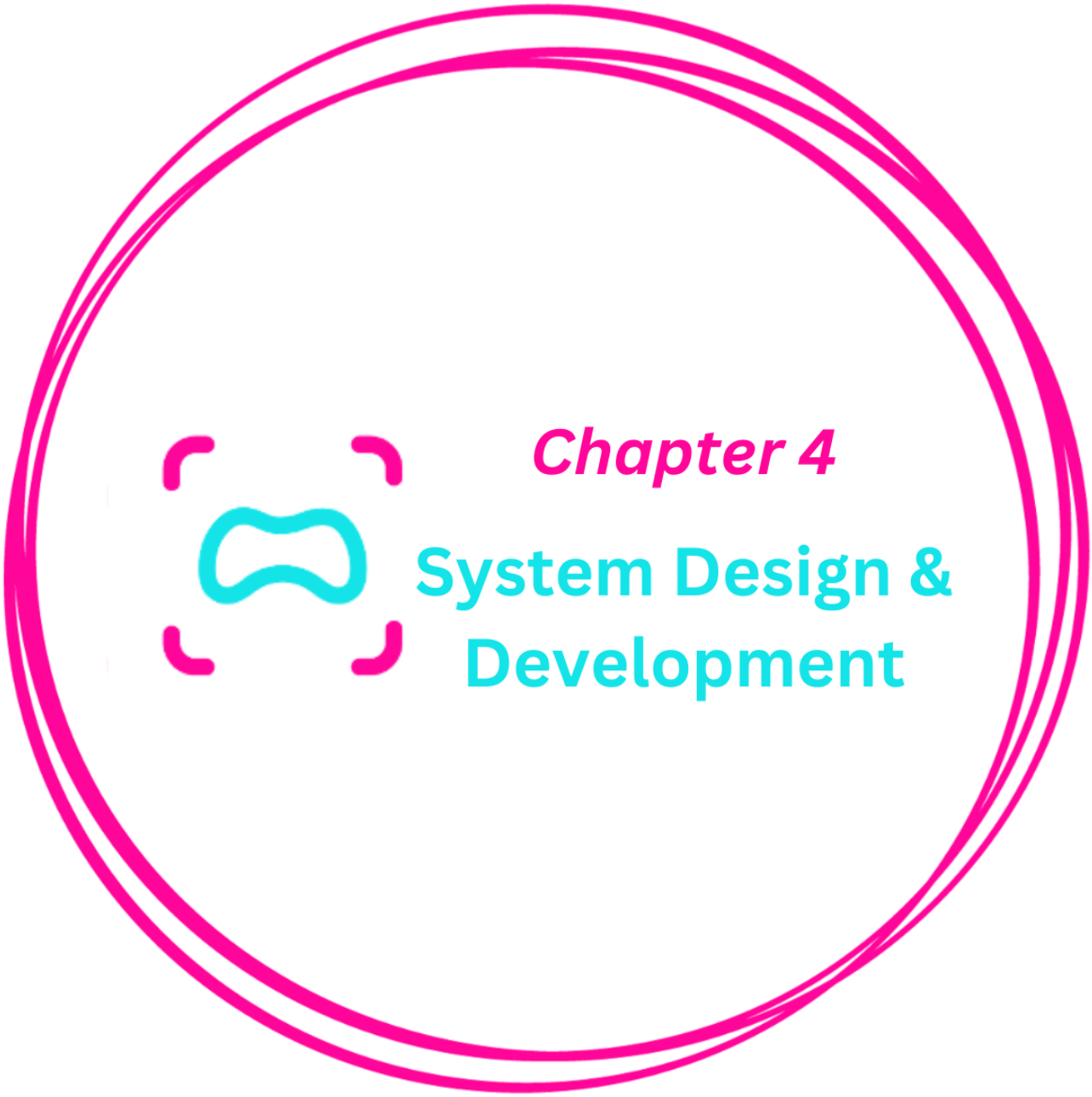
Validate the age group of the user	☑					
Create an account.	☑	☑	☑	☑		☑
Have a favourites section	☑	☑		☑		☑
Have a history section.	☑	☑		☑		
Support more than one video game store.		☑	☑	☑	☑	☑

Table 3:Competitive analysis

As a summary of all the above systems, Table 3 compares Game Geek and all other competitors' systems. GameFAQs, TouchArcade, IGDB, Games Finder and RAWG systems are similar to Game Geek but without age group assurance. The notable difference between Game Geek and all other systems is that Game Geek utilizes a facial age group estimation feature. Game Geek scans the face and then estimates the age group that the user falls into. Based on the estimated age group, the system only displays games appropriate for the user's age group. This is an important feature to prevent users from getting exposed to games inappropriate for their age.

Furthermore, GameFAQs do not offer links to download games immediately. This means users need to search in the App Store for the name of the games, which is time- and effort-consuming. Also, Games Finder does not allow users to create accounts, which prevents users from having a personal profile for themselves. Likewise, Games Finder and Touch Arcade do not offer favourite or history sections, negatively impacting the user's experience. Finally, although validating the age of the user is critical and important to ensure users are playing appropriate games for their age, this feature is not found in any competitor system. On the other hand, Game Geek supports only one store application, which is AppStore, whereas all competitors support more than one.

In conclusion, there are some similar features between our system and other competitors' systems. However, none of the competitor's systems include all the advantages that our system does, especially the age group estimation feature. There is no currently available system that combines facial age estimation and game classification. This makes our system, Game Geek, stand out compared to other competitors' systems.



Chapter 4

System Design & Development

4 System Design and Development

4.1 Methodology

Our system development process was rooted in the Agile methodology, which organizes projects into dynamic phases known as sprints, facilitating effective value delivery to customers and adaptation to evolving requirements [45]. Central to our strategy was the Scrum framework, a specific Agile methodology defined by its roles, events, and artifacts, following the 3x5x3 structure.

Throughout our Agile journey, we embraced five key Scrum events: regular sprint planning, Daily Scrums, Backlog Refinement, Sprint reviews, and Sprint retrospectives, adhering to the 3x5x3 structure for events. These events were instrumental in fostering alignment, adaptability, and continuous improvement. By incorporating customer feedback and delivering increments of working software at the end of each sprint, we iteratively refined our product to meet evolving needs.

In adherence to Scrum principles, we designated roles within our team as outlined in Table 4 . The Product Owner took charge of defining and prioritizing the product backlog, ensuring alignment with stakeholder needs. The Scrum Master facilitated the Scrum process, removing obstacles and nurturing adherence to Agile practices. Simultaneously, the Development Team, comprised of cross-functional members, collaborated to deliver increments of working software during each sprint.

Additionally, the Scrum framework encompasses three key artifacts, maintaining the 3x5x3 structure. These artifacts include the Product Backlog, a prioritized list of all desired work on the project; the Sprint Backlog, containing the work committed to completing during a sprint; and the Increment, the sum of all completed product backlog items at the end of a sprint. These artifacts played a pivotal role in guiding our work and tracking progress throughout the project.

To support our Agile process, we utilized Jira for project management and GitHub for version control and collaboration. Jira played a pivotal role in organizing our backlog, planning sprints, and tracking progress[1], while GitHub facilitated seamless code collaboration, version control, and code review processes[2]. These tools provided invaluable visibility into project progress, streamlined communication, and enhanced our development workflow, thus contributing significantly to the success of our Agile software development process.

Scrum Team	
Product Owner:	Dr. Wejdan Alkaldi
Developers:	Reem Almusharraf Deema Alresheed Reema Alhenaki Hana Alfozan
Scrum Master (SM):	Dr. Wejdan Alkaldi
Stakeholders:	Children, and anyone who has an interest in video games.

Table 4:Scrum Team

[1] https://jira.external-share.com/issue/ddcf143f-48ca-4207-be3d-5af71744e286
[2] https://github.com/HanaAlfozan/2023-GP1-5

4.2 System Requirements

4.2.1 System Users

People looking for video games that are appropriate for their age group are the target audience for this project. Therefore, our users are any individual who is interested in discovering a video game appropriate for their age group. The user must be over the age of 4 and have a basic understanding and ability to work with technology.

4.2.2 Requirements Elicitation and Analysis

For requirements elicitation, we employed a variety of methods to gather the project's requirements. We first searched for systems that were like our system. We then met with the stakeholders to gain a deeper understanding of the project. In addition, we as the project's team members held several focus group meetings that lasted between 30 minutes and an hour to generate more ideas. Furthermore, we published a survey to our final users and conducted four interviews to gather further information and expand our understanding of the required requirements.

- Interviews

We conducted interviews with four participants—two parents and two adult gamers. The first participant is the mother of a seven-year-old daughter. Since her daughter has tried playing video games multiple times, she has a ton of insightful ideas. The second participant is the mother of a 5-year-old girl who has also tried playing video games numerous times. The third participant is an accounting student who has much expertise with video games due to her intensive playing. The final participant is a worker and video game fan, from an early age, she has enjoyed playing video games and treats them as a relief of stress method.

In consideration of their high level of experience in video games, each participant was carefully selected. In addition, all interviews took place at the interviewer's house so that the interviewee could be asked in person and their facial reactions could be observed. Finally, the interview summaries will be discussed in this section.

The first paragraph summarizes the interviews with the adult gamers, while the second paragraph summarizes the interviews with the parents. The detailed questions and answers for each interview are found in Appendix A.

First, adult gamers interviewees were asked about their typical free-time activities, each mentioned many things, including social media surfing, baking, watching movies, and playing video games. Then, they were asked if they play video games, and both interviewees answered with "yes." One interviewee added that she had been playing them since she was a child and used them to unwind. Next, we asked them if they had ever encountered inappropriate content while playing a video game, they both admitted having done so and said that the content had come through pop-up advertisements rather than the actual game. After that, we asked them if they had trouble finding a game that was suitable for their age group. They both replied that they did not have any trouble doing so since they were adults and that all video games were age appropriate. One additionally stated that because she always plays the same video games, she has no issues at all. They were then asked if they would utilize a system that offered video games based on their age group, both stated they would because it might offer them new video games. After that, we asked them what details of a video game they thought were essential to know. One responded that she did not care about any details because she preferred to download the game and try it herself. The other respondent mentioned a couple of things, including the rating average and number of ratings, the genre, the size of the game, the ability to play online with several players, the pricing, and whether the game supports English or Arabic. Finally, we asked them if they had anything else to add. One said she preferred the system to ask her about her preferences because she did not think the age group was enough information for offering video games. The other interviewee stated she wishes there were more regulations over advertisements that appear in video games since some children lie about their true ages and are exposed to improper content.

In the interviews with the mothers, we started asking them about what their daughters enjoy doing in their spare time, both replied that their daughters like playing with their dolls and toys. Next, we asked them if their daughters had played video games, and both stated they did. However, both mothers mentioned that the little girls only play video games when they are given permission to do so. After that, we asked them if their girls had ever been exposed to inappropriate content while playing video games, both mothers said yes and declared that the content was encountered through pop-up advertisements rather than the game itself. We then asked them if they had trouble finding video games that were age-appropriate for their daughters. One mother struggled to find appropriate video games. However, the other mother did not seem so, she believes the challenge was the advertisements that forced her daughter to download another inappropriate game to keep playing the current one. Next, we asked if they would let their daughters use a system that offers video games suitable for their daughter's age group. Both mothers agreed on allowing their girls to. After that, we asked them what features of a video game they think are crucial to know. They both provided many things, including ratings, whether the game included strobe and intense lighting, whether the game violated their religious beliefs, reviews because they provide trustworthy data, the genre, the size of the game, the capability to play with other players online, and the cost of the game. Finally, we asked them if they had additional things that they wanted to share. One mother suggested that game levels should have time limits to prevent children from playing for extended periods of time.

In conclusion, responses revealed that playing video games in free time is fun for adult gamers and children. In addition, we discovered that improper content was exposed to both adult gamers and children through the pop-up adverts while they were playing. Furthermore, we found that while children have trouble locating appropriate video games for their age group, adult gamers do not. As a result, each mother states that she will permit her daughter to utilize the system. The idea was also well received by adult gamers, who look forward to new video games on the system. We also found that parents and adult gamers share a common interest in some video game features. However, parents had additional concerns like their children's ability to expose intense light while playing a video game. Finally, we discovered a demand for developing a system that provides users with appropriate video games suitable for their age group.

- Questionnaires

To better understand our users, we sent them a questionnaire that included seven closed-ended questions and one open-ended question. The questionnaire was meant for adults who are interested in video games and parents whose children play video games. 141 replies were submitted, of which 60 were from adult gamers representing themselves and 81 were from parents representing their child's voice. The word "Parents" in the questions' analysis section is intended to indicate the child's point of view since parents' responses represent their child's voice. The term "Adult gamers" refers to people over 18 playing video games. The questionnaire's detailed questions and answers are found in Appendix B.

In Question 1, respondents were asked about the things they do, or their children do in their spare time. For adult gamers, 88.3% enjoy browsing social media during their free time, 48.3% watch movies, 30% play video games, 20% enjoy reading, 11.7% bake, and 8.3% watch TV. For parents, 58.6 % of their children enjoy playing video games in their free time. While those who enjoyed watching TV were 44.4%, and only 32.1% preferred playing with toys. The rest of the responses were between reading and other activities.

In Question 2, respondents were asked if they were interested in video games. Only 51.7% of the adult gamers were interested in video games. On the other hand, 81.5% of parents agreed that their children are interested in playing video games. This shows that children are more interested in playing video games than adult gamers.

In Question 3, respondents were asked if they were ever exposed to inappropriate content while playing video games. We found that 76.6% of the adult gamers approved they were exposed to inappropriate content; while 55.6% of parents agreed that their children were exposed to inappropriate content. This indicates that most adult gamers and children were exposed to inappropriate content at least once while playing a video game.

In response to Question 4, respondents were asked whether they find it challenging to find the appropriate video game that suits their age group. 71.7% of adult gamers find it challenging or sometimes challenging to find the appropriate video game.

On the other hand, 84% of parents find it challenging for their children to find the appropriate game that suits their age group. This indicates that adult gamers and children both encounter some difficulties and face challenges in finding suitable video games that suit their age group.

In Question 5, respondents were asked what details about a video game they thought should be known. For adult gamers, 73.3% responded with genre, 53.3% price, 38% ratings, 35% size of the game, and 35% considered language as essential information. For parents, 77.8% said genre, 45.7% ratings, 27.2% price, 18.5% language, and 12.3% considered the size of the game is important to know. This shows that most respondents find the genre the most essential information.

In Question 6, respondents were asked whether they would use or permit their child to use a system that offers video games based on the user's age group. 46.7% of adult gamers stated they will use the system. On the other hand, 66.7% of parents admitted that they would allow their children to use the system, while 33.3% said "Maybe". This indicates that some adult gamers will use the system. In addition, parents are willing to allow their children to utilize the system.

In response to Question 7, respondents were asked if they had any other opinions. Some parents said they would prefer to set a time limit on playing video games, while others said they demand video games that adhere to their religious beliefs. Additionally, some people expressed their desire for Arabic-language video games to be available. Others believe that to provide appropriate video games, it is a good idea to understand the user's interests in addition to their age group. One parent said that it is essential to have control over any online chats that may be present in some video games.

After reviewing the responses, we concluded that many people love playing video games in their free time as a fun activity. We also discovered that while playing video games, the majority had at least once exposed inappropriate material. Additionally, we found that individuals, particularly children, struggle to locate the ideal video games for their age group. Finally, there is a strong demand for a system that provides video games for users based on their age group, particularly from parents who want to let their children play with video games that are appropriate for their age group.

4.2.3 User Interactions

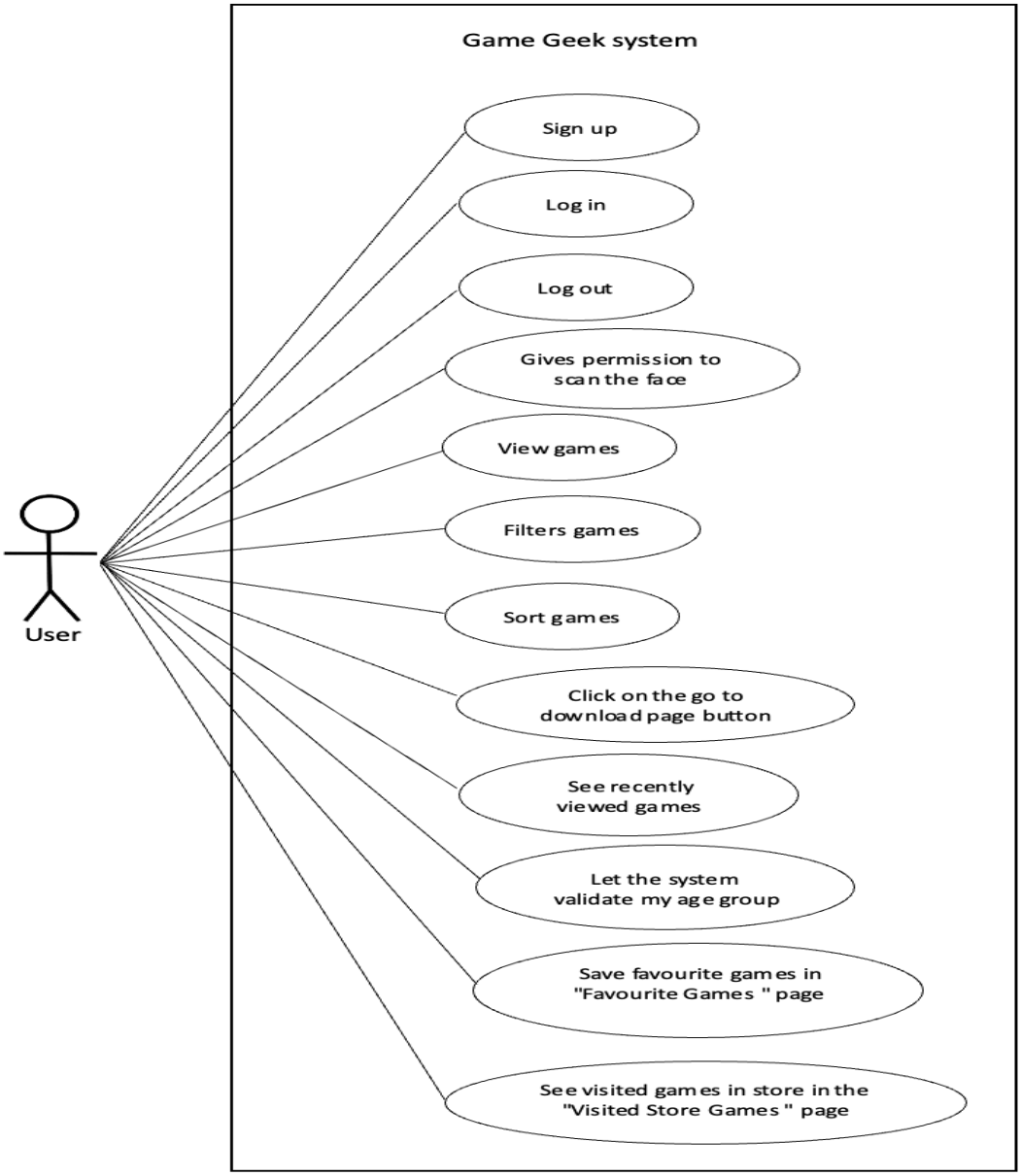


Figure 15:Use Case diagram

4.2.4 Roadmap and Product Backlog

- Roadmap

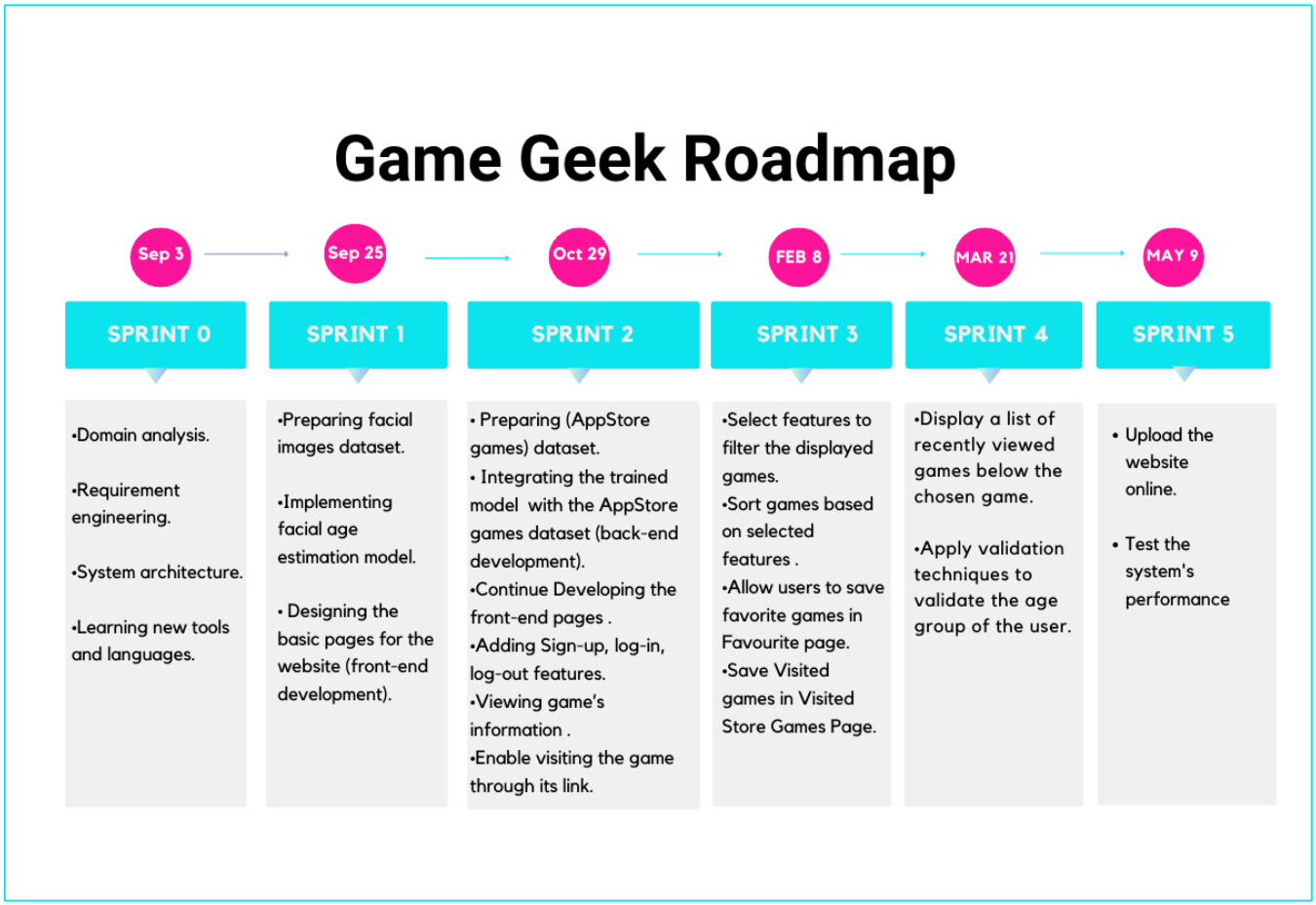


Figure 16:Game Geek Roadmap

- Product Backlog

ID	PBIs (User Stories)	Size	Type	Status	Acceptance Criteria
1.	**As a** user, I want to be classified according to my age group **so that** I can only view video games that are appropriate for my age group.	6	Feature	Done	- **As a** user, **if** the system scanned my face though asking me to take a picture, **then** it will classify me into the appropriate age group. - **As a** user, **if** my face cannot be scanned properly, **then** the system will ask me to re-scan my face and give me some directions to follow. - **As a** user, **if** I scan my face but wrong age group are estimated, **then** I can retake scanning three times until have the correct estimation. - **As a** user, **if** I scan my face 3 times but wrong age group are estimated, **then**

					the system will send an email to set my age group. - **As a** user, **if** I scan my face and system have the right estimation, **then** I should confirm my account using sent email. - **As a** user, **if** I scan my face and system have the right estimation and confirmed, **then** I will be navigated to my account games.
2.	**As a** non-registered user, I want to be able to sign up **so that** I can gain access to the system.	4	Feature	Done	- **As a** non-registered user, **if** I go to the home page and click on the "JOIN US" button, **then** the system should navigate to the sign-up page. - **As a** non-registered user who wants to sign up, **if** I go to the sign-up page, the system will ask me to enter username, email,

					password, and confirm the password and choose security question, enter answer to it, and check agree the condition and then click on "JOIN US." After that, the system will scan my face by taking a picture, and **then** I will gain access to the system after some confirmations. - **As** a non-registered user, **if** I leave any of the fields empty and click on the "JOIN US" button, **then** sign-up fails with an error message. - **As a** non-registered user, **if** I go to the sign-up page to enter a username that already exists and click on "JOIN US" button, **then** I should see an error message. - **As a** non-registered user, **if** I go to the sign-up page to enter a invalid username and click on "JOIN US" button, **then** I should see an

					error message with needed condition of a correct username. - **As a** non-registered user, **if** I go to the sign-up page to enter a invalid email and click on "JOIN US" button, **then** I should see an invalid email error message. - **As a** non-registered user, **if** I go to the sign-up page to enter a password that does not match specifications and click on "JOIN US" button, **then** I should see an error message with needed condition of a correct password. - **As a** non-registered user, **if** I go to the sign-up page to enter a mismatch password and click on "JOIN US" button, **then** I should see a mismatch password error message.

3.	**As a** user, I want to be able to log-in with my username and password **so that** I can access the system and use all the features.	3	Feature	Done	- **As a** user, **if** I go to the home page and click on the "Log In" button, **then** the system should navigate to the log-in page. - **As a** user, **If** I enter a wrong username or password and clicked on "Log In" button, **then** the system will display an error message and the log-in fails. - **As a** user, **if** I leave the username or password fields empty and click on "Log In" button, **then** the log-in fails with an error message. - **As a** user, **if** I enter my username and password correctly, and click on the “Log In" button, **then** the system will navigate to the age estimation page then Games page.

					- **As a** user, **if** I forget my username and click on the "Forgot Username?" button, **then** the system will display the fields of the email along with the Security question and answer it to fill in to reset my username. **- As a** user, **if** I forget my Password, and click on the "Forgot Password?" button, **then** the system will display the field of the username to fill in and reset my password.
4.	**As a** user, I want to be able to log-out **so that** I can access the system again at my own convenience.	3	Feature	Done	- **As a** user, **if** click on the "Log out" button on the top bar, **then** the system will navigate to the home page.
5.	**As a** user**,** I want to view game information **so that** I can know more details about it.	2	Feature	Done	- **As a** user, **if** I click on a "More info" button of the game **then** I can see more information about it.

6.	**As a** user, I want to view video games based on my age group **so that** I can easily find video games that I am interested in.	4	Feature	Done	- **As a** user, **if** the system classifies me into the appropriate age group, **then** all games displayed are suitable for my age group.
7.	**As a** user, I want to go to the download page of the video games I like with just a click **so that** I can easily start playing the video games that I want.	2	Feature	Done	- **As a** user, **if** I click on the "Go to The Download Page!" button for a game that I like, **then** I am taken to the download page for that game.
8.	**As a** user, I want to check the video games that I visited in the store **so that** I can see my history of visiting video games that may interest me again.	4	Feature	Done	- **As a** user, **if** I click on the “Go to The Download Page!” button next to a game's title in the game library, **then** the game is added to my “Visited Store Games " section. - **As a** user, **if** I click on the " Visited Store Games " section in my profile, **then** I can see a list of all the video games that I have visited in the store with

					visited date to my " Visited Store Games " section. - **As a** user, **if** I close the tab or reopen it later, **then** the visited video games are still saved in my " Visited Store Games " section. - **As a** user, if I click on “Go to The Download Page!” that I have visited before, **then** the visited data will update to the most recent date and come at the top of the list of video games in the "Visited Store Games" section. - **As a** user, **if** I have not clicked on “Go to The Download Page!” of any video games **then** the empty message will appear in the " Visited Store Games " section.

9.	**As a** user, I want to filter the video games by price (free or paid) **so that** I can choose the video games that suit me.	3	Feature	Done	- **As a** user, **if** I select the desired option (free or paid) for video games from the filter by price, **then** I will see a list of selected (free or paid) video games.
10.	**As a** user, I want to filter the video games by genre **so that** I can view multiple video games with the same genre.	3	Feature	Done	- **As a** user, **if** I select the desired genre from the filter by genre, **then** I will see a list of the selected-genre video games.
11.	**As a** user, I want to be able to filter the video games by language **so that** I can select ones that are in my native language.	3	Feature	Done	- **As a** user, **if** I select the desired language from the filter by language, **then** I will see a list of selected-language video games.
12.	**As a** user, **I want to** filter the video games by In-App purchases video games **so that** I can know if there are any or not.	3	Feature	Done	- **As a** user, **if** I select the availability of In-App purchases option from the filter by In-App purchases, **then** I will see a list of video games that are selected as preferred.

13.	**As a** user, I want to be able to filter video games by their rating **so that** I can easily find rated video games that I select.	3	Feature	Done	- **As a** user, **if** I select the wanted game rating, **then** only video games with selected-rating should be displayed.
14.	**As a** user, I want to be able to sort video games alphabetically by their game name **so that** I can easily find the game I'm looking for.	4	Feature	Done	- **As a** user, **if** I choose the "Sort by Game's Name (Alphabetically)" option, **then** the video games should be sorted alphabetically by their names.
15.	**As a** user, I want to be able to sort video games by their age rating **so that** I can easily choose games I am interested in.	4	Feature	Done	- **As a** user, **if I** select to sort the results by their age rating (highest or lowest), **then** the video games should be displayed in the selected order at the top of the list.

16.	**As a** user, I want to be able to sort video games by their release date **so that** I can easily choose games I prefer.	4	Feature	Done	- **As a** user, **if I** select to sort the results by their release date (oldest or newest), **then** the video games should be displayed in the selected order at the top of the list.
17.	**As a** user, I want to be able to sort video games by their average rating **so that** I can compare game average ratings faster with a single click.	4	Feature	Done	- **As a** user, **if I** select to sort the results by wanted rating (highest or lowest), **then** the video games should be displayed in the selected order at the top of the list.
18.	**As a** user, I want to be able to sort video games by their size **so that** I can see different arrangement options for video games of various sizes.	4	Feature	Done	**- As a** user, **if I** select to sort the results by wanted size (largest or smallest), **then** the video games should be displayed in the selected order at the top of the list.
19.	**As a** user, I want to be able to save my favourite video games in a **"** Favourite Games **"** section **so that** I can easily find and play them later.	4	Feature	Done	- **As a** user, **if** I click on the “Add to Favourite Game” button next to a game's title in the game library, **then** the game is added to my “Favourite Games " section.

					- **As a** user, **if** I click on the " Favourite Games " section in my profile, **then** I can see a list of all the video games that I have saved to my " Favourite Games " section. -As **a** user, **if** I click on the "X" button of the video game in the "Favourite Games" section, **then** the video game “Undo” button will appear for 8 seconds before being removed from my "Favourite Games" section. -As **a** user, **if** I click on the “Undo” button of the video game in the "Favourite Games" section, **then** the video game will remain in the "Favourite Games" section.

					- **As a** user, **if** I close the tab or reopen it later, **then** my favourite video games are still saved in my " Favourite Games " section. - **As a** user, **if** I have not added any video games to the " Favourite Games " section, **then** the empty message will appear.
20.	**As a** user, I want to let the system validate my age group **so that** the system can display video games that are appropriate for me.	4	Feature	Done	- **As a** user, if I log-in to the system, **then** face scanning will appear to validate my age group to ensure it's the same as the age group registered. - **As a** user, if I log-in to the system and the scanning was the same of my age group, **then** I will be navigated to my account.

					- **As a** user, if I log-in to the system and the scanning was not the same of my age group, **then** system will display a message to send email link to confirm my account.
21.	**As a** user, I want to be able to view a list of the recently viewed video games below the chosen game **so that** I can easily find and choose a game that I have recently looked at.	4	Feature	Done	- **As a** user, **if** I click on a "More Info" button of game in the game library, **then** a list of three video games that I recent viewed is displayed below the chosen game. - **As a** user, **if** I click on a "More Info" button of game in the game library, **then** I see the recent viewed games below the chosen games ordered by the recent one on the right to left. - **As a** user, If I log back in, **then** I find that the recently viewed video game list is empty once more.

					- **As a** user, **if** I scroll down the list of recently viewed video games, **then** I can see more video games that I have recently viewed. - **As a** user, **if** I click on a video game in the list of recently viewed video games, **then** I will be navigated to the video game's info page - **As a** user, **if** I have not viewed any video games recently, **then** the empty message will appear.
Non-Functional Requirement					
22.	**As a** user, I want the system to response for any operation within 3-25 seconds **so that** I can use the system without waiting so long.	-	Feature	Done	- **As a** user, **if** I do any action, **then** the system should respond with the result and display the content within 3-25 seconds.

23.	**As a** user, I want the website's interface to be user-friendly **so that** I can quickly and easily select the video games I want.			Done	- **As a** user, **if** I am using one of the system pages, **then** the page layout should be clear and organized. - **As a** user, **if** I see a message that the system displayed, **then** it shouldn't have an ambiguous meaning. - **As a** user, **if** I see a button or icon, **then** I should understand the meaning and the idea of it without any confusion.
24.	**As a** user, I want the system to be secure **so that** I can trust that my personal information is safe and secure.	-	Feature	Done	- **As a** user, **if** I enter my personal information into the system, **then** the system should encrypt my personal information.
25.	**As a** user, I want to be able to use the system on my laptop, desktop, and mobile phone **so that** I can access it from anywhere and on any device.	-	Feature	Done	- **As a** user, **if** I am using Microsoft Windows, macOS, or Linux operating systems, **then** the system must be running so that I can use it.

					- **As a** user, **if** I am using Chrome, Firefox, Safari, or Edge, **then** the system must be running so that I can use it.
26.	**As** a user, I want the system to be reliable 99% of times **so that** I can use it without experiencing unexpected downtime or errors.	-	Feature	Done	- **As a** user, **if** I access the system any time, **then** I should be able to browse the system and view video games without any problems.

Table 5: Product Backlog

4.3 System Design

In this section, we will provide the system's architectural design, the class diagram, the component level design which consists of the main features' flowcharts. Also, we will provide the data design which include the data models and data collection and preparation. Next, we will provide the system's interface design by illustrating the system's site map and discussing the applied UX guidelines in our system. Finally, we will discuss the model's and system's implementation process.

4.3.1 Architectural Diagram

The client-server architecture, as shown in Figure 17 , is an appropriate choice for our system. This architecture allows for easy scalability and provides a clear separation between the client-side and server-side components.

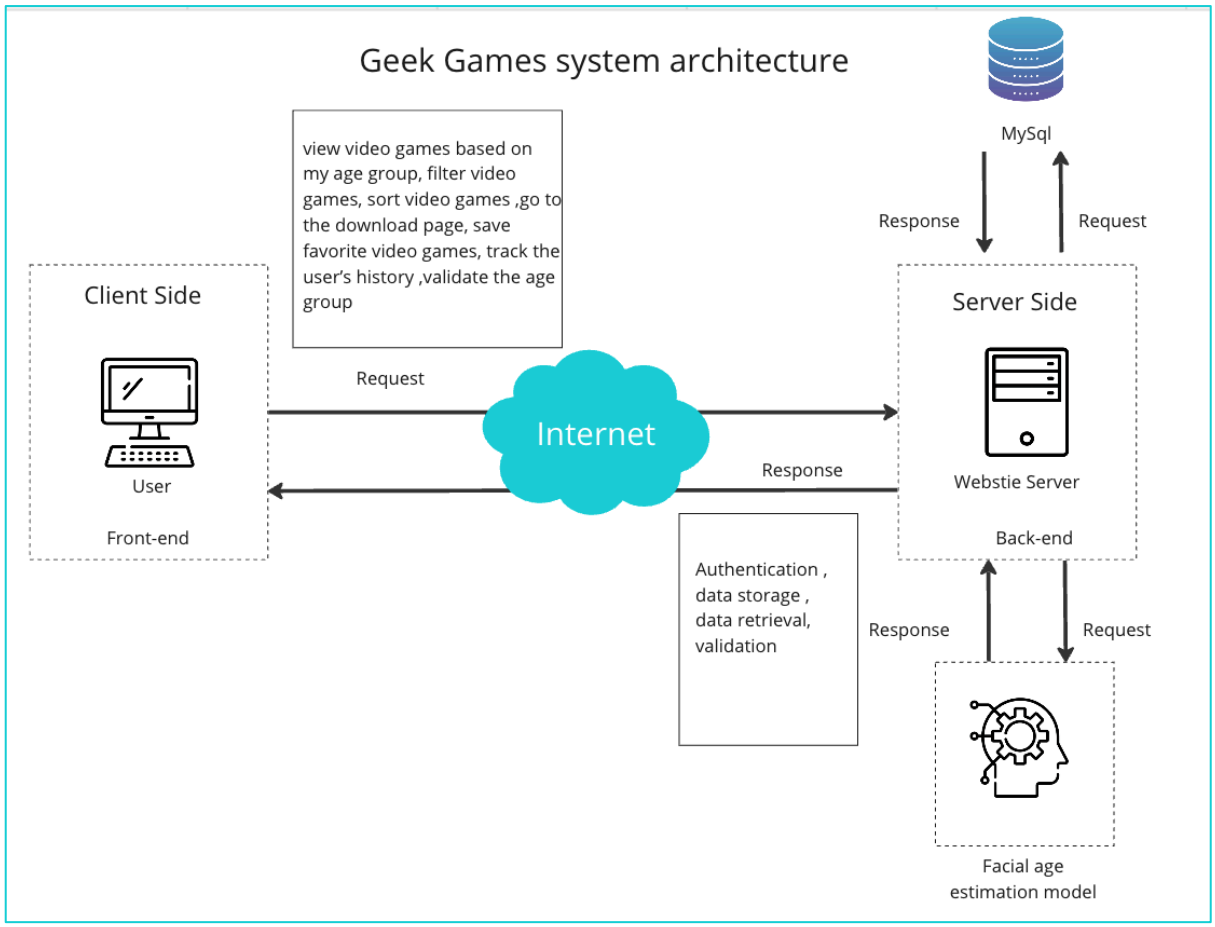


Figure 17:System's architectural diagram

4.3.2 Class Diagram

The class diagram in Figure 18 illustrates user interactions, games, and a Custom Convolutional Neural Network (CNN) model. Users can have favourite and Visited games. The CNN model predicts age groups for personalized games suits their age group. Users can view, mark favourite, and download preferred games.

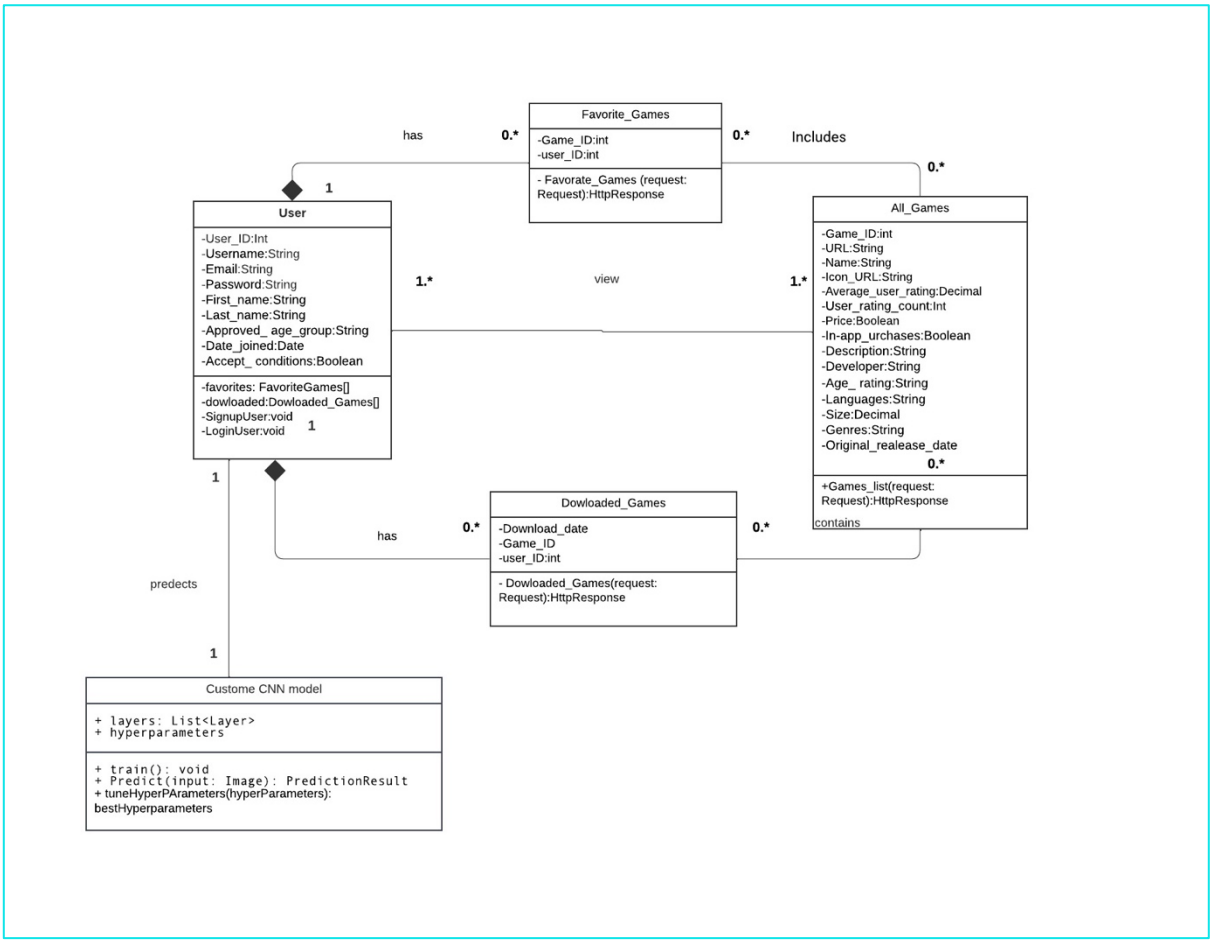


Figure 18:System's Class UML

4.3.3 Component Level Design

In this section we will provide the flowcharts of the system's main features. Figure 19 represents the model's flowchart, Figure 20 shows Age group classifying feature's flowchart, where Figure 21 illustrates displaying games feature's flowchart and Figure 22 shows the logic of adding games to favorite.

- Model's Flowchart

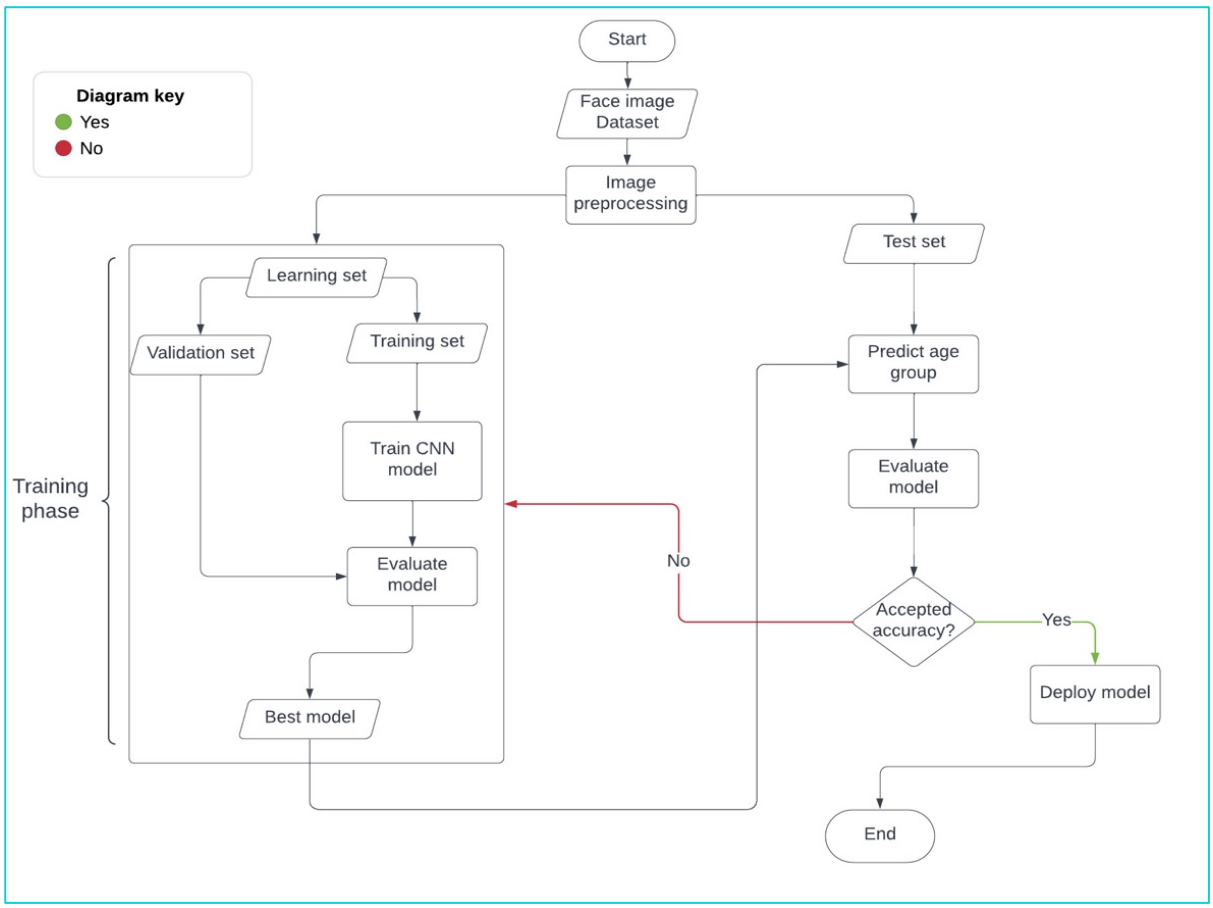


Figure 19: Model's flowchart

- Age group estimating flowchart

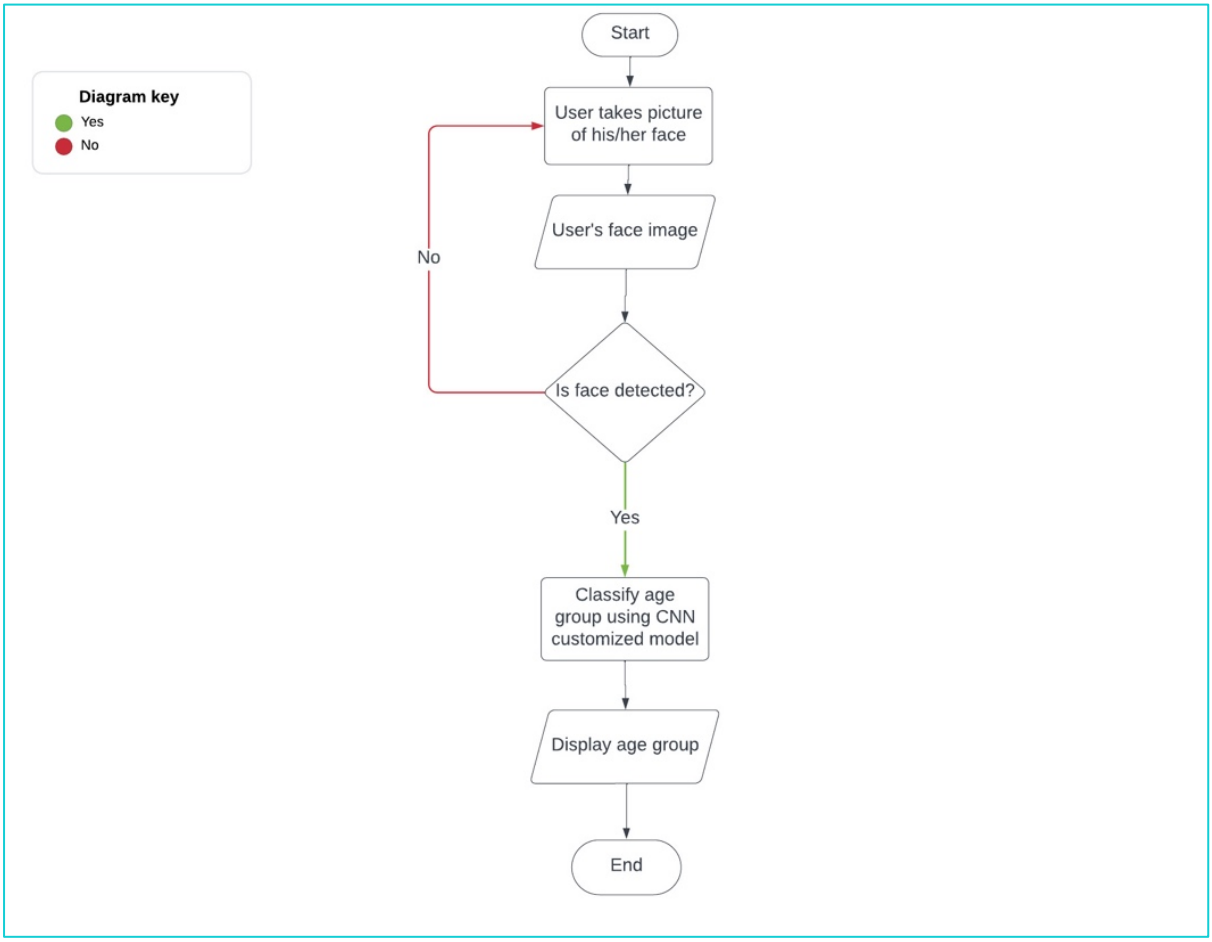


Figure 20: Age group classifying feature's flowchart

- Display games Flowchart

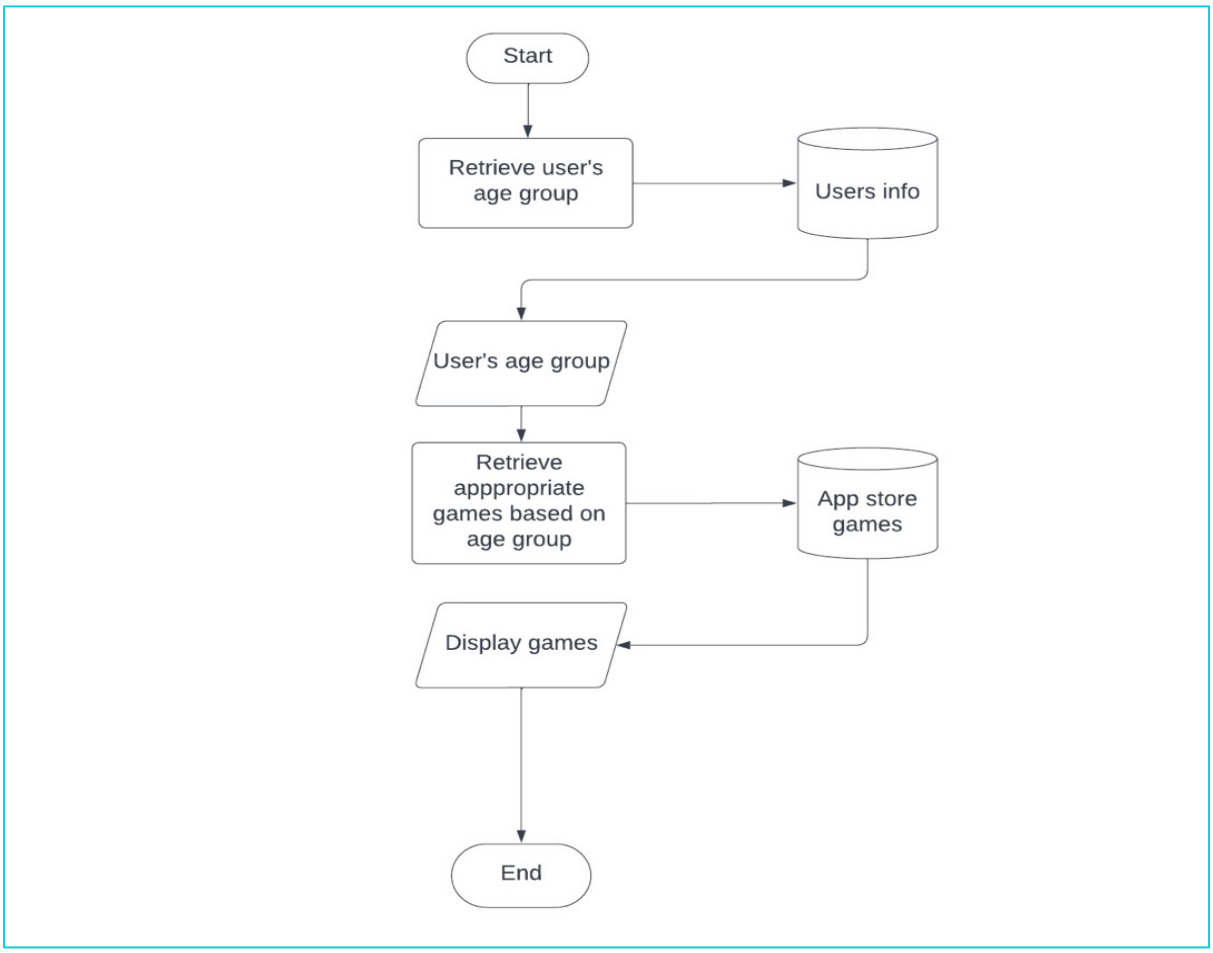


Figure 21: Display games feature's flowchart

- Add game to favourite flowchart

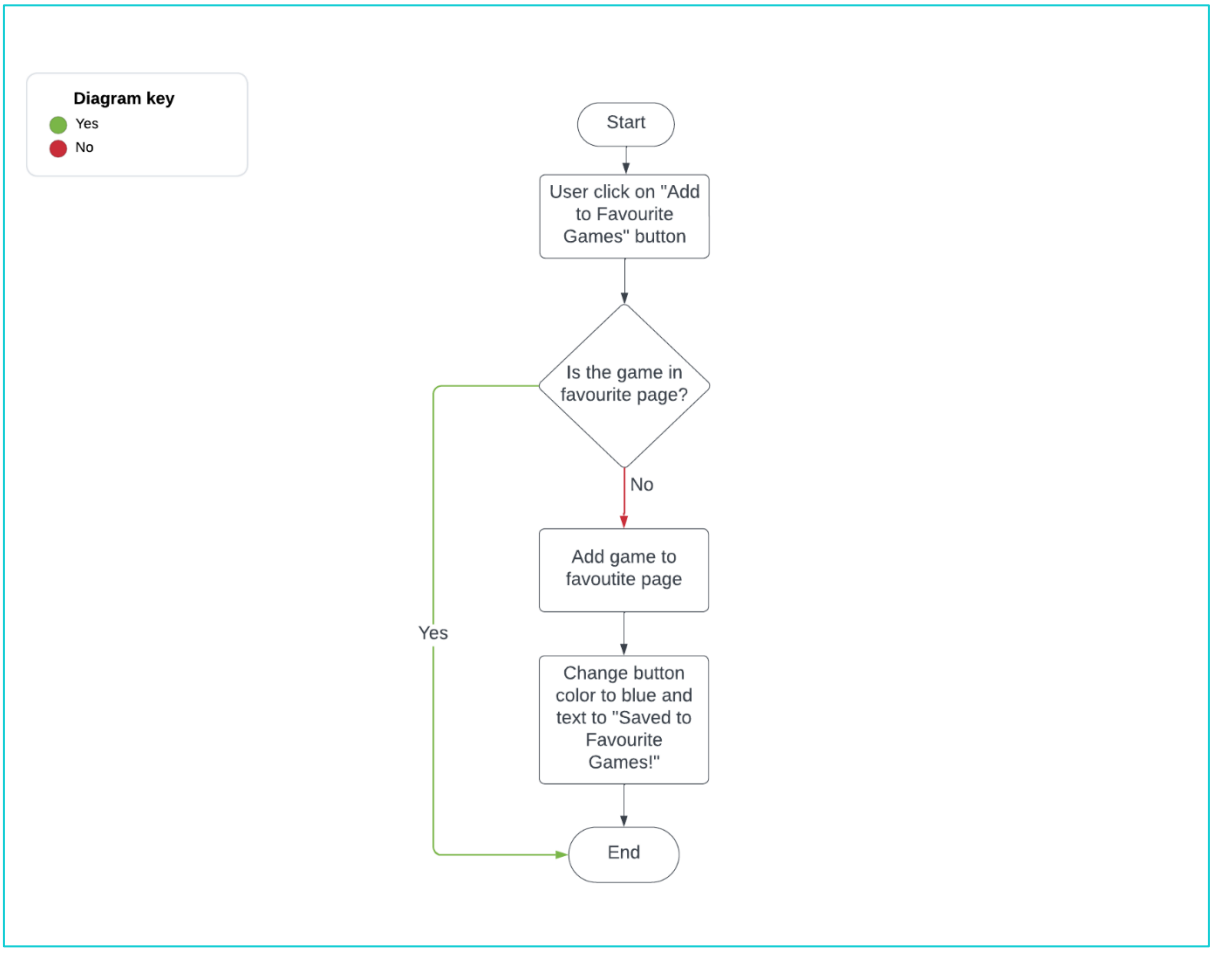


Figure 22:Add game to favourite feature's flowchart

4.4 Data Design

In this section, we will discuss the data models of our system such as the ER diagram shown in Figure 23, relational schema, and the data dictionary. After that, we will discuss the data collection and preparation process.

4.4.1 Data Models

- ER Diagram

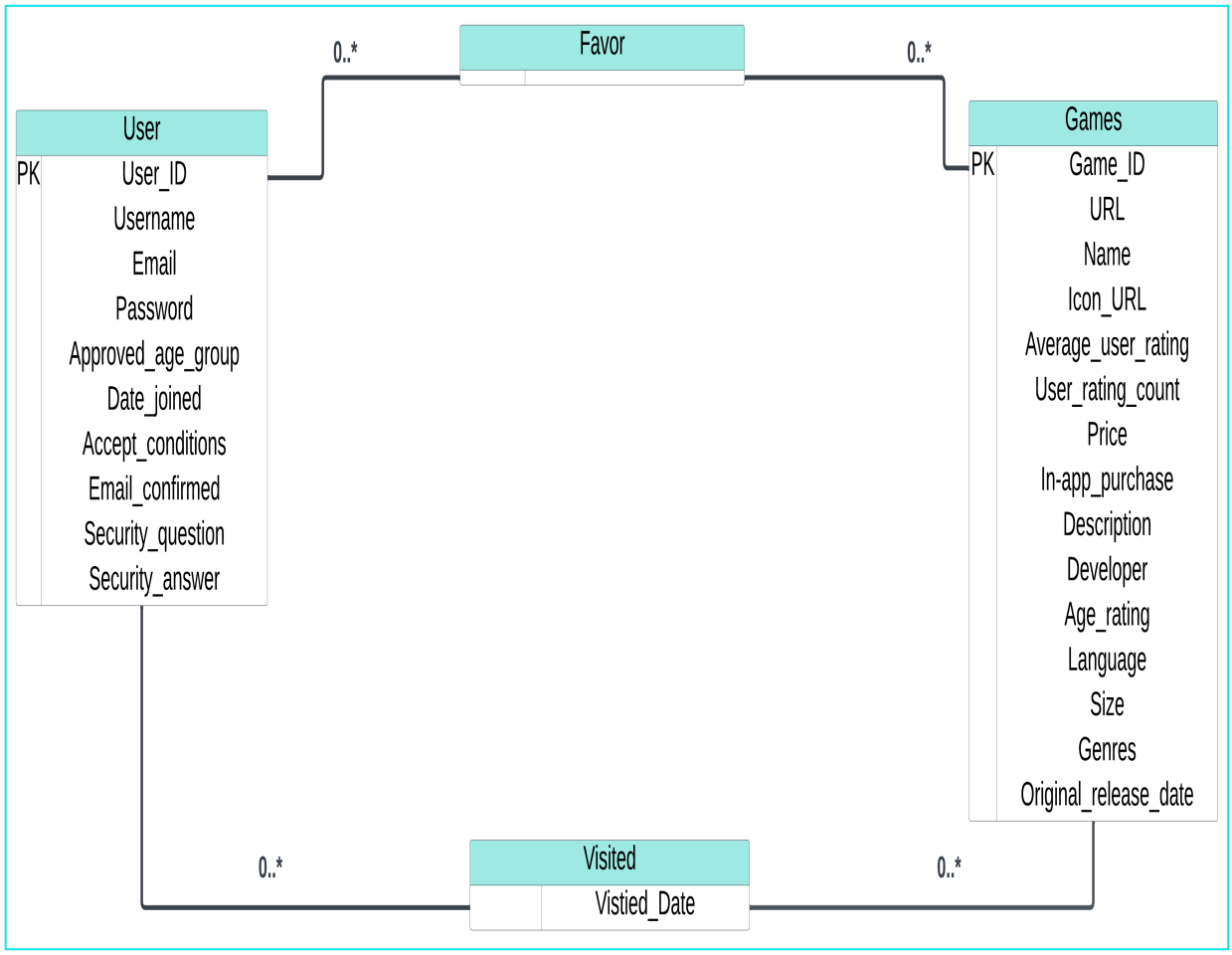


Figure 23: ER Diagram

- Relational Schema

Games Table:

Games (Game_ID, URL, Name, Icon_URL, Average_user_rating, User_rating_count, Price, In-app_purchases, Description, Developer, Age_rating, Languages, Size, Genres, Original_release_date)

Primary key: Game_ID

User Table:

User (User_ID, Username, Email, Password, Approved_age_group, Date_joined, Accept_conditions, Email_confirmed,Security_question, Security_answer)

Primary key: User_ID

Favor Table:

Favor (User_ID, Game_ID)

Composite Primary Key: (User_ID, Game_ID)

Foreign Key: User_ID references User(User_ID)

Foreign Key: Game_ID references Games(Game_ID)

Visited Table:

Visited (User_ID, Game_ID, Visited_date)

Composite Primary Key: (User_ID, Game_ID)

Foreign Key: User_ID references User(User_ID)

Foreign Key: Game_ID references Games(Game_ID)

- Data Dictionary

Entity	Attributes	Description	Data type	Length	Nulls	Multi-valued	Default value	Range	PK
	Game_ID	Unique identifier for each game.	INT	10	No	No	No	No	Yes
	URL	The link of the game in app store.	VARCHAR	255	No	No	No	No	
	Name	The name of the game.	VARCHAR	255	No	No	No	No	
	Icon_URL	The URL of the game's icon.	VARCHAR	255	No	No	No	No	
	Average_user_rating	The average user rating for the game	DECIMAL	10	Yes	No	No	No	
	User_rating_count	The number of user ratings for the game.	INT	10	Yes	No	No	No	
	Price	The price of the game.	BOOLEAN		No	No	No	True/ False	
	In-app_purchases	Information about in-app purchases within the game.	BOOLEAN		No	No	No	True/ False	
	Description	Detailed description of the game.	TEXT		No	No	No	No	

Games	Developer	The name of the game's developer.	VARCHAR	255	No	No	No	No	
	Age_ rating	The game's age rating.	VARCHAR	10	No	No	No	No	
	Languages	The languages which the game supports.	VARCHAR	255	No	No	No	No	
	Size	The size of the game.	DECIMAL		No	No	No	No	
	Genres	The genre of the game.	VARCHAR	255	No	No	No	No	
	Original_ release_ date	The date when the game was originally released.	DATE		No	No	No	No	

Table 6: Games' table dictionary

Entity	Attributes	Description	Data type	Length	Nulls	Multi-valued	Default value	Range	PK
	User_ID	Unique identifier for each user.	INT	10	No	No	No	No	Yes
	Username	User's username.	VARC-HAR	255	No	No	No	No	
	Email	User's email.	VARC-HAR	255	No	No	No	No	

User	Password	User's password.	VARC-HAR	255	No	No	No	No	
	Approved_ age_group	User's actual age group.	VARCHAR	10	No	No	No	No	
	Date_joined	The date the user joins the system.	DATETIME		No	No	No	No	
	Accept_ conditions	Determine whether a user has agreed to the conditions of the system.	BOOLEAN		No	No	TRUE	True/False	
	Email_ confirmed	Determine whether the user's account is confirmed or not.	BOOLEAN		No	No	TRUE	True/False	
	Security_ question	User's security question.	VARC-HAR	255	No	No	No	No	
	Security_ answer	The answer to the security question.	VARC-HAR	255	No	No	No	No	

Table 7: User's table dictionary

Entity	Attributes	Description	Data type	Length	Nulls	Multi-valued	Default value	Range	PK
Favor	User_ID	Foreign key references the user_id in the users table it shows the relation between users and their favourite games.	INT	10	No	No	No	No	Yes
	Game_ID	Foreign key references the game_id in the games table, it shows the relation between games and the users who have favourited them.	INT	10	No	No	No	No	Yes

Table 8: Favor's table dictionary

Entity	Attributes	Description	Data type	Length	Nulls	Multi-valued	Default value	Range	PK
Visited	User_ID	Foreign key references the user_id in the users table it shows the relation between users and their favourite games.	INT	10	No	No	No	No	Yes
	Game_ID	Foreign key references the game_id in the games table, it shows the relation between games and the users who have favourited them.	INT	10	No	No	No	No	Yes
	Visited_date	The date the games have been visited in store	DATE		No	Yes	No	No	

Table 9: Visited's table dictionary

4.4.2 Data Collection and Preparation

- Face images dataset

For the model training, we need a dataset with face images for each age group based on the App Store age rating, which is 0-3, 4+, 9+, 12+, and 17+. So, we end up collecting a dataset consisting of five folders, each representing an age group. Note that the 17+ age group, which ranges from 17 to 50 years old, assumes that those who are interested in video games or have children are responsible for them.

We began by using the "Facial-Age" dataset [2], owned by Fazle Rabbi. This dataset has folders from 0 to 110, each representing age and containing several images corresponding to the folder age number. To start creating our own dataset, we grouped the files into folders named based on age groups by using dataset folders from folder 00 to folder 49, which contain 7,338 face images. After labeling and cleaning, it came to 1,877 face images in total; we discovered that the data was imbalanced and had huge differences. Thus, to resolve this issue, we added additional images from the "Age prediction" dataset [3], Owned by Maria Frențescu. It contains folders from 1 to 100 face images. However, we used folders from 1 to 20 to solve the unbalanced issue, for a total of 19,503 face images. After cleaning, it became 3,575 face images faces. We attempted to use the generated dataset to train the model. However, the model revealed poor performance because of the small amount of data.

To enrich our dataset, we decided to include additional images from various datasets by adding more images to reach 3,400 face images for each age group. However, the difficulty arose due to a lack of labeled face image datasets published online. After extensive investigation, we discovered two unlabeled face image datasets: datasets "1 Flickr-Faces-HQ Dataset (Nvidia) - Resized 256px" [4] developed by NVlabs (NVIDIA Research), which contains 70,000 images of faces, we take 8,604 face images, and "1 Million Fake Faces – 1" [5] owned by Bojan Tunguz, which contains four folders each with another four folders with 10,000 face images for each one and we take 2,881 face images to reach our goal.

Moreover, we ensured a diverse range of racial backgrounds in our data to help the model learn more effectively. Since the Middle Eastern race has a low representation in the dataset, we integrated a face image dataset, “Egyptian Kids Faces," [6] which consists of 1,121 Egyptian children’s face images. After cleaning, we got 82 face images since it was very dirty.

While collecting the images, we cleaned and preprocessed the dataset using the following steps: Initially, we removed any images that did not belong to the age group file and any redundant images. In addition, we removed all images that included faces wearing sunglasses, objects covering the face such as hands, painted faces, and any face side image, ending with 17,028 face images for each age group and almost 3,400 images, and all these datasets from Kaggle.

For preprocessing, we used the OpenCV (cv2) library for face detection, image manipulation, cropping, and resizing images. First, it detects whether there is a face, and then it crops only the face part. To ensure high crop quality, we manually cropped over 12,000+ images. This cropping task took more than 40 hours to complete.

We also scaled every image to 224 by 224 pixels and eliminated all low-resolution images. Furthermore, we split the dataset into 80% for training, 10% for testing, and 10% for validation sets using the os module for automated splitting.

- App Store game dataset

The game dataset we used in our system is “17K Mobile Strategy Games” dataset, owned by Tristan from Kaggle [7]. It consists of over 17,000 app store games. The columns represent the attributes of each game, where each row holds a game. To get the most out of our data, we preprocessed it using multiple techniques and a variety of software libraries and algorithms.

The libraries we used and were crucial in this process were Pandas, which allowed for data transformation and manipulation, and NumPy, which made basic numerical operations easier.

First, we removed duplicate rows as part of a data-cleaning process. Furthermore, we modified the data type of the 'Size' attribute from bytes to megabytes to align it with the representation used in the app store, ensuring consistency. Afterward, we implemented categorical encoding for "Price" and "In-app Purchases," reassigning them as "paid" and "free," thus simplifying their representation. For the 'Original Release Date' attribute, datetime parsing was applied to ensure consistency and standardization.

Furthermore, we filled in the missing values in the 'Language' attribute with the value "English." We chose English as the language to fill in because the description of the games in the app store is in English. All these methods of data preparation ensure that our dataset was ready and optimized to be used in our system.

4.5 Interface Design

In this section, we will provide the system's sitemap shown in Figure 24 and the UX guidelines applied in our system.

4.5.1 System's sitemap

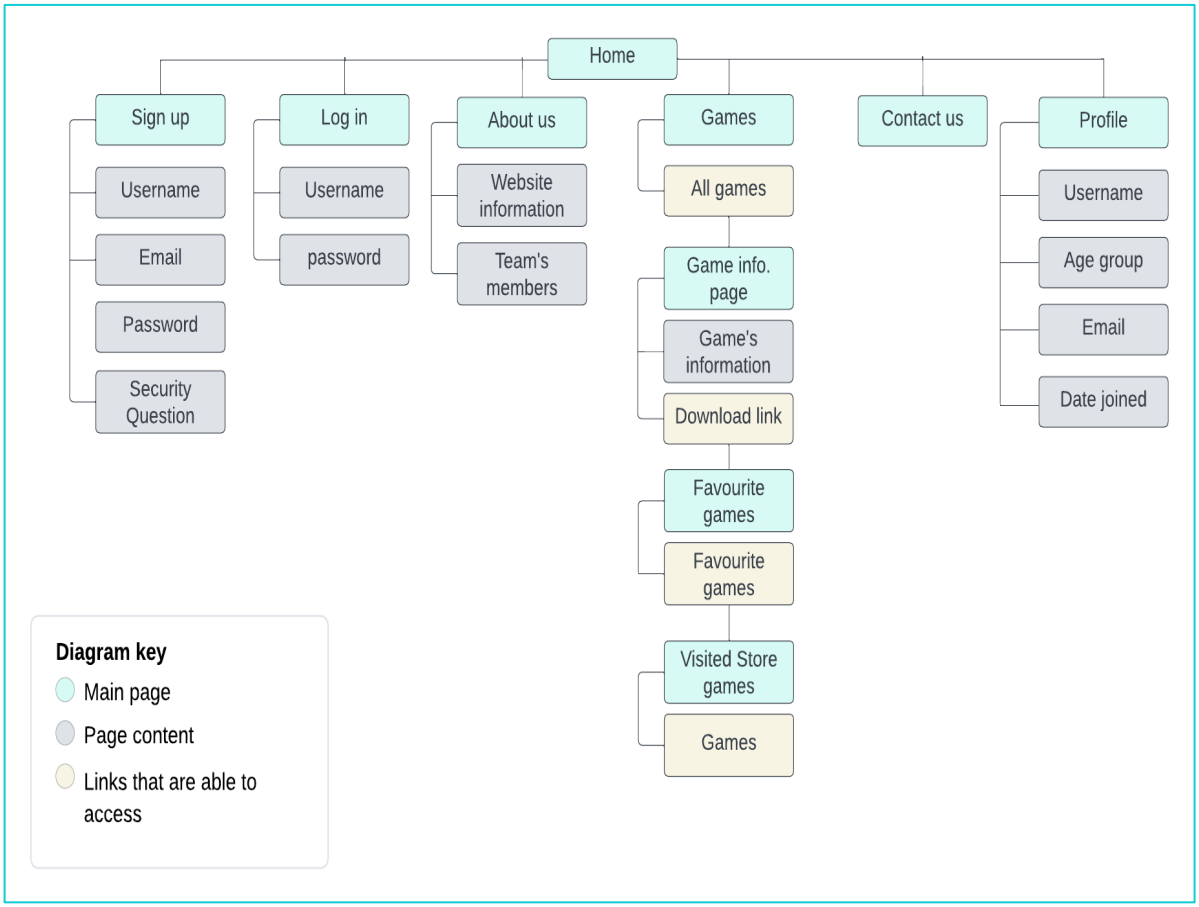


Figure 24: System's sitemap

4.5.2 UX guidelines

- Familiarity: It is about how users first see the system and if they can easily figure out how to start using it [46]. This is applied in our system in the sign-up and login processes, where the processes are designed similarly to other systems as shown in Figure 25 and Figure 26 .

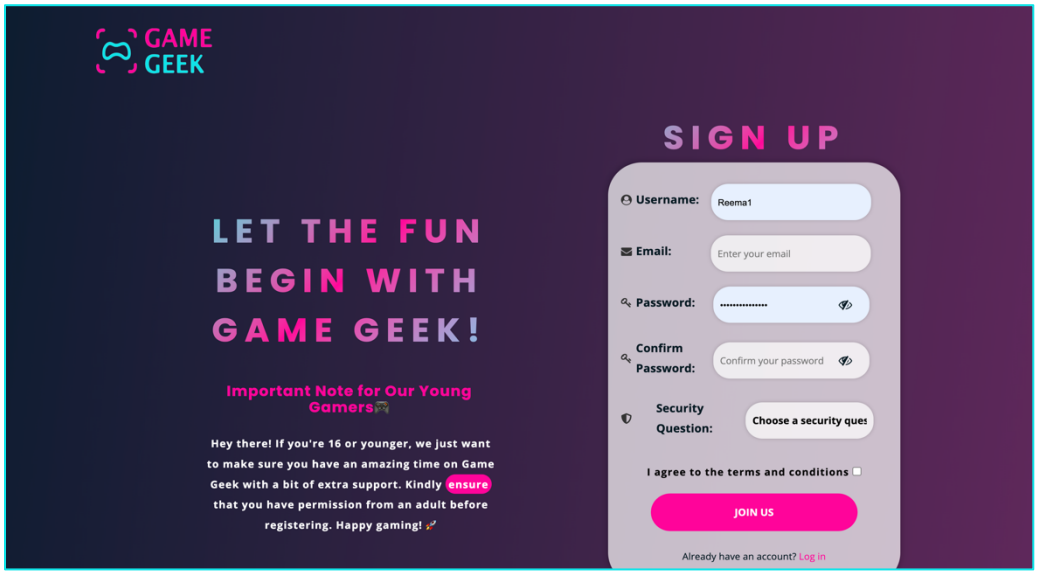


Figure 25: Sign-up page

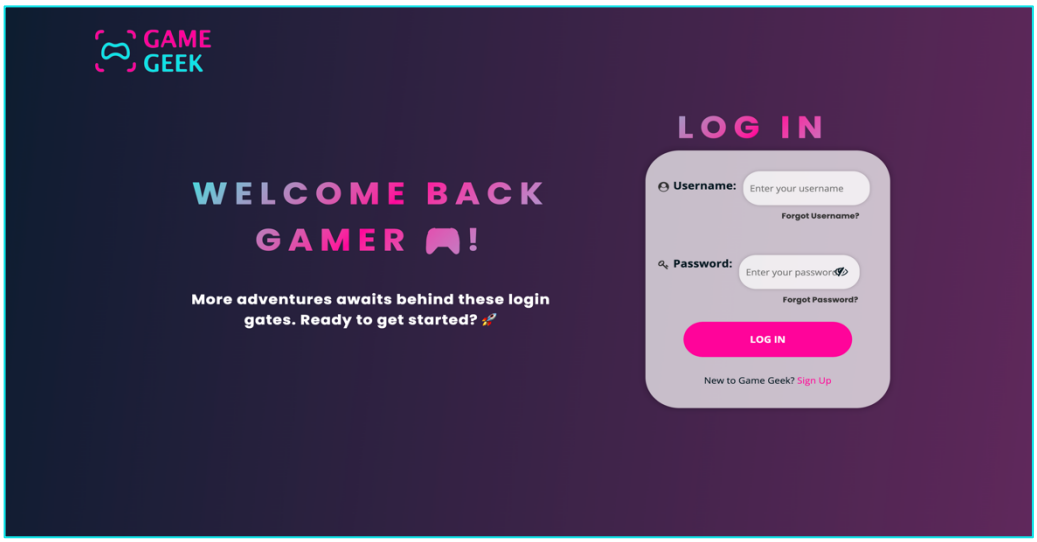


Figure 26: Log-in page

- Synthesizability: This involves communicating to users about changes that occur because of their actions [46]. In our system this principle is applied when the user adds a game to favorite, it will be added in Favourite Games page as shown in Figure 28 and Figure 29 .

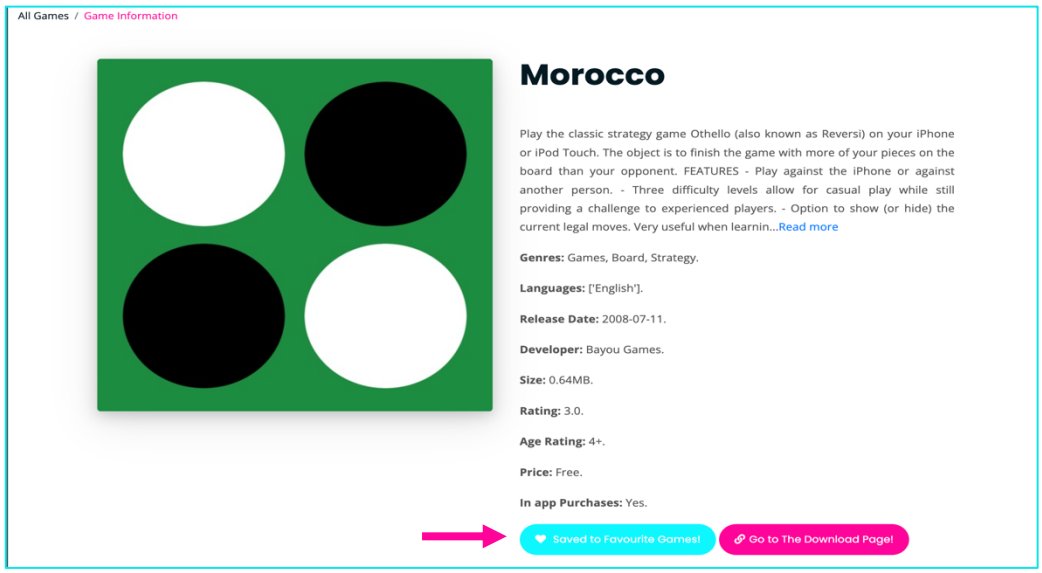


Figure 28: Add game to Favourite Games

Figure 29: Game is added to Favourite Games page

- Predictability: This idea relates to how easy it is for a user to predict the outcome of an action or event they are taking [46]. This principle is applied in our system in many cases. For example, if a user presses the log in button, she will predict that she will be able to enter her account and browse through the system as shown in Figure 30 and Figure 31.

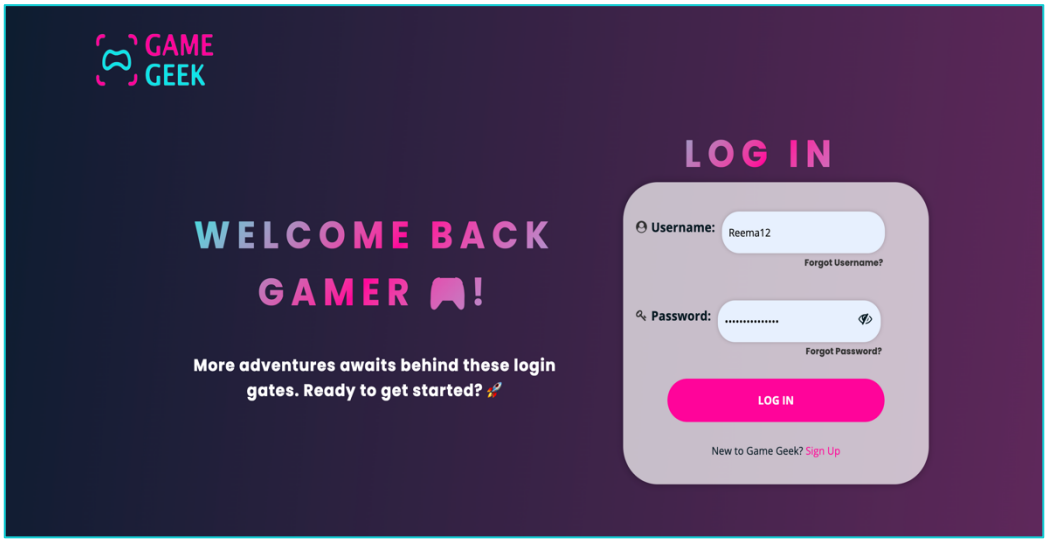


Figure 30: Log in page

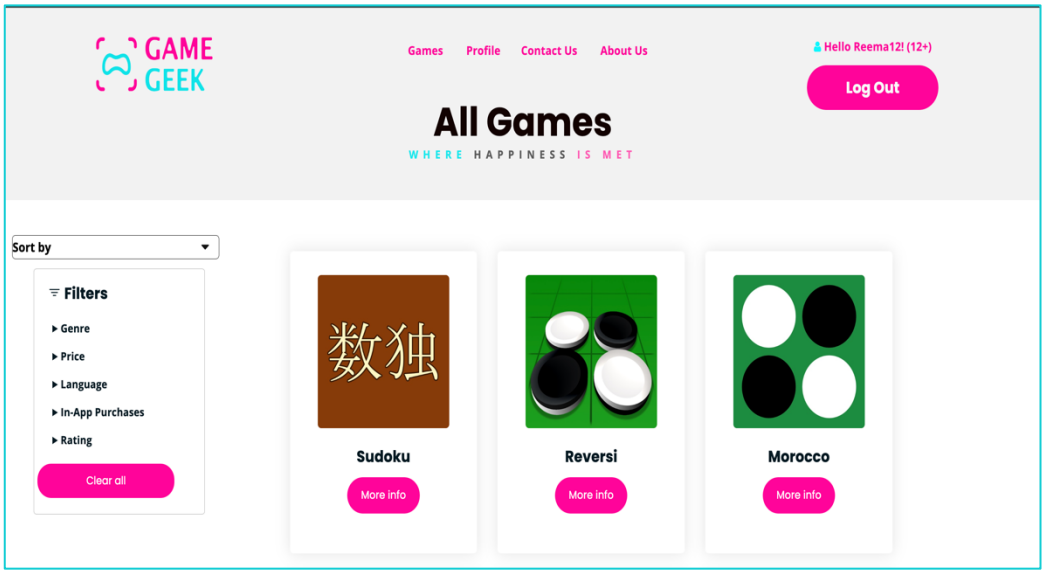


Figure 31: All Games page

- Reachability: is the ability to navigate through observable states inside the user system's viewport [46] .This is applied where the user can navigate to different pages through the navigation bar as shown in Figure 32.

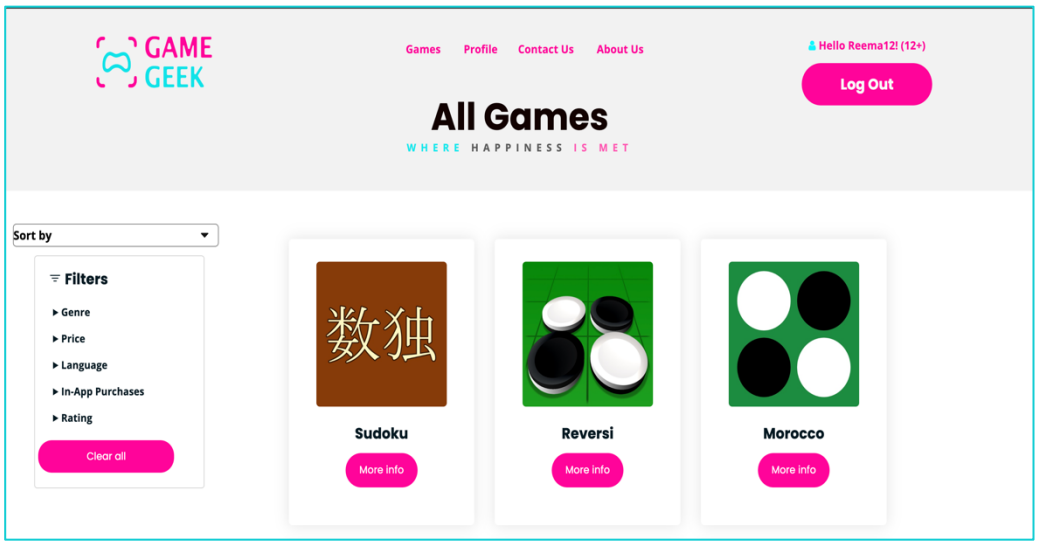


Figure 32: Navigation bar in All Games page

- Generalizability: The ability to design common tasks or elements across various systems or platforms in a way that conforms to users' familiar [46]. This principle applied in our system by using common symbols such as “x” to remove a game from Favourite Games page as shown in Figure 33.

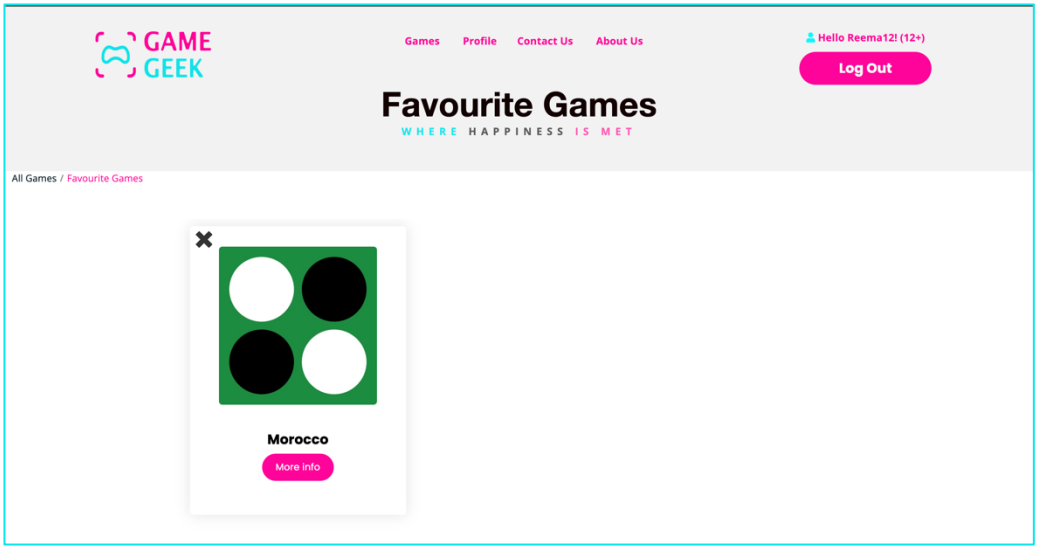


Figure 33: “x” symbol in Favourite Games page

- Consistency: Employing the same concepts, response techniques, and communication patterns within a consistent scope of design [46]. This principle applied in our system where all buttons have the same color as shown in Figure 34.

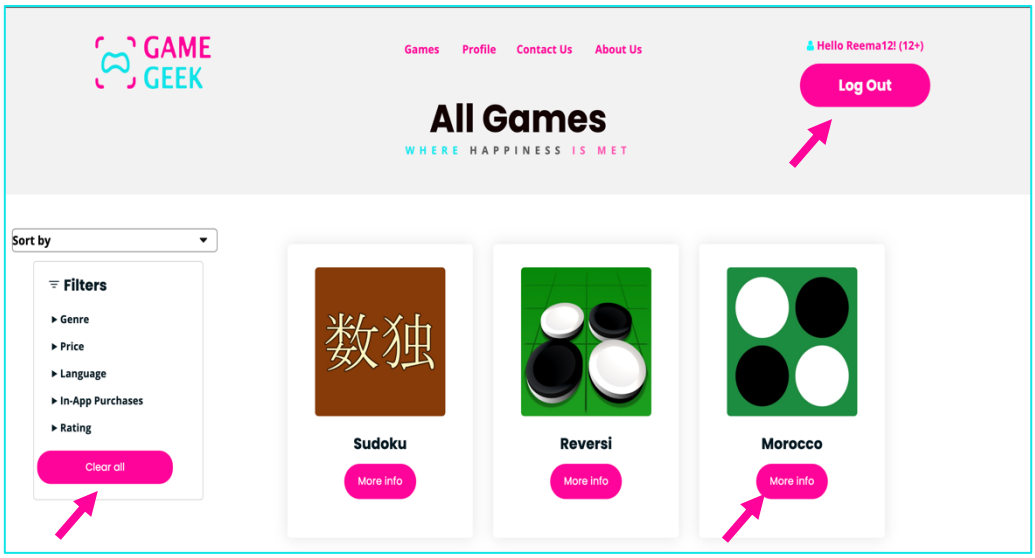


Figure 34: Buttons in All Games page

4.6 Implementation

4.6.1 Model's implementation

We initiated our project by using two popular pre-trained deep learning models: VGG-16 and ResNet with Python language. We selected these models due to their demonstrated effectiveness in diverse computer vision tasks. We began with an uncleaned dataset that contained various challenges, such as poor quality and an imbalance in the number of images between age group folders. In the initial stages, we attempted to apply data augmentation to the entire dataset, which can help enhance model generalization. However, it became clear that applying data augmentation to the entire dataset could lead to overfitting.

To address the challenges posed by the dataset, we took several steps. First, we conducted extensive data cleaning and preprocessing to enhance data quality and solve the imbalance within the dataset. It included removing noise by cropping only the face part, removing the background, and ensuring uniformity in data representation by resizing all images to 224 by 224 pixels. Furthermore, we discovered an imbalance in the data, particularly within the *'4+'* and *'9+'* age groups, where the number of images was lower than the image count in other age group folders. To resolve this problem, we searched for more face image datasets and added some image files to our dataset.

After resolving the dataset issue, we tried several machine learning and deep learning models, including ResNet, VGG16, SVM, RandomForest, and InceptionV3. However, these models' performance was inefficient.

Therefore, we built a custom CNN architecture to match our dataset's specific characteristics. We adjusted the number of layers, the number of filters in each convocational layer, and the number of neurons in the dense layer. We also added regularization techniques like dropout layer, data augmentation, and fine-tuning convolutional layers.

In the experimentation phase, we conducted over 140 experiments using the custom CNN architecture, which was challenging. These experiments involved trying different hyperparameters, the arrangement and configuration of layers, the number of neurons in each layer, and regularization techniques until we got the optimal model architecture that is shown in Figure 35.

Moreover, essential Python libraries were used in this process. We used NumPy for effective numerical operations and TensorFlow for creating neural network models. We used Keras for model building. We also use the Keras class ImageDataGenerator for image loading, processing, and augmenting. For data splitting, we used the os module from standard Python libraries, which allows splitting the dataset manually. To evaluate the performance of our models, we used Scikit-learn, which offers tools such as a confusion matrix. Finally, for results visualization, we used Seaborn and Matplotlib libraries.

In summary, our project initially faced challenges related to dataset quality, distribution, and the suitability of pre-trained models. We have made significant strides in addressing these challenges through data cleaning, preprocessing, data augmentation, and model architecture modifications. In chapter 5, we will discuss some of the outcomes of these efforts, including the classification accuracy of the experiments.

```
#### Step 4 - Building the CNN Model and compiling it and Early Stopping and Learning Rate Schedule
# Building the model
input_layer = Input(shape=(224, 224, 3))

# Convolutional Block 1
x = Conv2D(32, (3, 3), activation='relu', padding='same', kernel_regularizer=l2(0.01))(input_layer)
x = BatchNormalization()(x)
x = MaxPooling2D((2, 2))(x)

# Convolutional Block 2
x = Conv2D(64, (3, 3), activation='relu', padding='same', kernel_regularizer=l2(0.01))(x)
x = BatchNormalization()(x)
x = MaxPooling2D((2, 2))(x)

# Convolutional Block 3
x = Conv2D(128, (3, 3), activation='relu', padding='same', kernel_regularizer=l2(0.01))(x)
x = BatchNormalization()(x)
x = MaxPooling2D((2, 2))(x)

# # Convolutional Block 4
x = Conv2D(256, (3, 3), activation='relu', padding='same', kernel_regularizer=l2(0.01))(x)
x = BatchNormalization()(x)
x = MaxPooling2D((2, 2))(x)

# Convolutional Block 5
x = Conv2D(512, (3, 3), activation='relu', padding='same', kernel_regularizer=l2(0.01))(x)
x = BatchNormalization()(x)
x = MaxPooling2D((2, 2))(x)

# Flatten and Fully Connected Layers with Dropout
x = Flatten()(x)
x = Dense(128, activation='relu', kernel_regularizer=l2(0.01))(x)
x = BatchNormalization()(x)
x = Dropout(0.5)(x)

# Output Layer
output_layer = Dense(5, activation='softmax')(x)

# Create the model
model = tf.keras.models.Model(inputs=input_layer, outputs=output_layer)

# Compiling the Model
model.compile(optimizer=Adam(lr=0.0001), loss='categorical_crossentropy', metrics=['accuracy'])


# Print the model summary
model.summary()

# Early Stopping and Learning Rate Schedule
early_stopping = EarlyStopping(monitor='val_loss', patience=5, restore_best_weights=True)
reduce_lr = ReduceLROnPlateau(monitor='val_loss', factor=0.1, patience=2, min_lr=1e-7)
```

Figure 35: Model Architecture

4.6.2 Website's implementation

To construct our website, we first had to decide which libraries and frameworks needed to build the system. As a result, we searched for Python-based frameworks for website development. After searching, we chose Django, an advanced and free open-source Python web framework [47]. Since this framework had a complex structure, the first step was trying to learn and understand it. Next, we start working on the front-end development using HTML, CSS, and JavaScript. We started by creating the entire front end of our website from scratch. During the processing phase, we thought to improve our website's user experience and creativity, so we used elements from a free open source called "Fruitika" [48] . We read the license to ensure we were not violating its terms. Next, we began utilizing some of its components. However, not all pages were taken from the template, so we still developed pages on our own. Additionally, we integrated the Mediastream library to enable picture-taking since the trained model will use the picture taken to classify the age group.

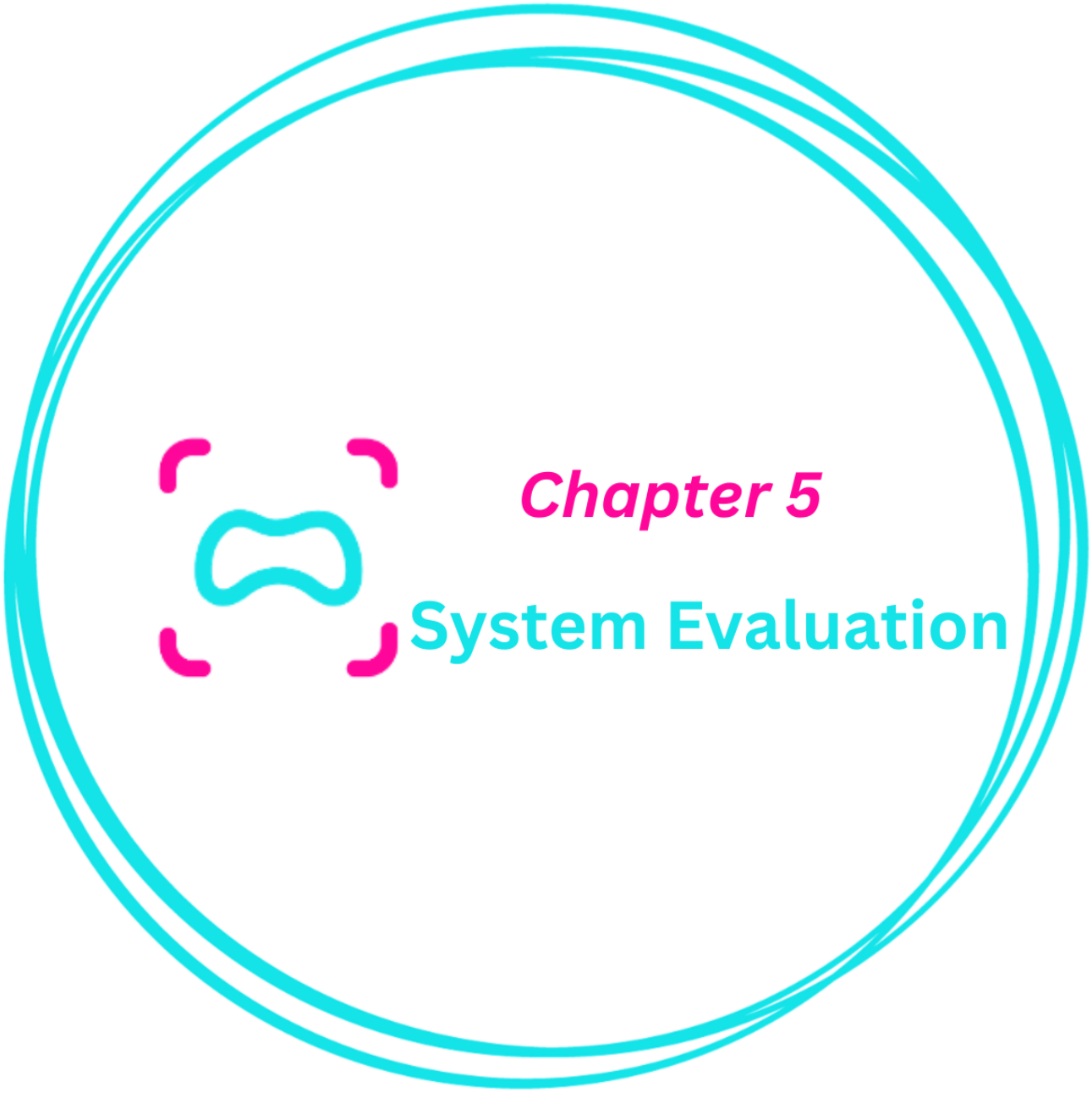
The backend development process begins after the frontend phase. Initially, we constructed the Postgres databases for the system. Next, we start working on the features we want to include in this release: signing up, logging in, classifying users based on their age group, allowing the authorized user to browse games, activating the button that navigates to the game's page in the app store, filtering and sorting the displayed games based on user preference, checking the visited App Store games on the visited Store page, adding a favorite game by adding it to the Favouire games, seeing the game information and the recently viewed games below it, and lastly, logging out. Furthermore, we load the trained model into the system using the Keras library. We implemented a pre-trained OpenCV model designed for face detection to guarantee that the system accurately detects faces in images. Then, we applied the same preprocessing step to the images that were applied to dataset images. The IDEs we used in this process were Pycharm and Visual Studio Code.

Moreover, many challenges arose while we were developing the website. Initially, mastering the Django framework required a lot of time and effort, necessitating extra time as we had to take courses on how to use it. Moreover, the creation of the database presented additional difficulties. For instance, the structure of making and updating tables differed from what we were familiar with.

Finally, regarding hosting challenges, we tried many hosting providers, such as Heroku, PythonAnyWhere, Railway, Vertical, Elastic Beanstalk, and Render, but they were unsuitable for many reasons, such as the heavy size of the model and dataset. Until we found the best one, a digital ocean provider with features such as scalability, simplicity, performance, and reliability, we also used NameCheap to buy GameGeek's domain name.

4.6.3 GitHub Repository

https://github.com/HanaAlfozan/2023-GP1-5



Chapter 5

System Evaluation

5 System Evaluation

In this section, we will provide the experiments of our model. We will also discuss the user acceptance testing, the testing's results, and the result's discussion.

5.1 Experimental Results

We conducted over 180 experiments using various algorithms, including SVM, RandomForest, VGG19, and custom CNN models, to explore different machine learning and deep learning approaches before getting the final CNN model. Each experiment involved tuning hyperparameters specific to the algorithm. For example, SVM experiments varied in hyperparameters like gamma and C, while in RandomForest, we tuned the maximum depth of each decision tree and a number of decision trees in the forest. In deep learning, we adjusted parameters like the number of epochs, batch size, and neurons in each layer. In the CNN experiments, we tested different numbers of layers, both with and without data augmentation in training set. All experiments were conducted using the final dataset we collected.

The first experiment involved using RandomForest, the maximum depth was 10 and the number of trees was 300. The result showed significant overfitting, with a training accuracy of 95% and a test accuracy of 57%. Due to this mismatch, we decided not to pursue this approach further.

The second experiment involved was the SVM model. First, a feature extraction was used to extract features from the faces, and then a grid search was used to find the optimal hyperparameter. The optimal parameters resulted for C and gamma were determined, resulting in the selection of C=10 and gamma=0.01. The ultimate accuracy achieved in this experiment was 64%.

The third experiment focused on fine-tuning the VGG16 pre-trained model. We adjusted hyperparameters, setting the batch size to 32, the number of neurons in the dense layer to 128, and the number of epochs to 40 but the model halts training through the early stopping technique due to a lack of improvement in epoch 23. Data augmentation was applied only to the training set to prevent overfitting. The final accuracy achieved was 70%, which, while an improvement, was not the optimal result.

The fourth experiment involved customizing a CNN model with two convolutional layers. Parameters included a batch size of 32, 128 neurons in the dense layer, and 30 epochs but the model halts training through the early stopping technique due to a lack of improvement in epoch 27. Data augmentation was not applied, resulting in an accuracy of 64%.

The fifth experiment involved customizing a CNN model with three convolutional layers included a batch size of 32, 64 neurons in the dense layer However, in this experiment, we applied data augmentation to the training set. This led to improved model performance, achieving a final accuracy of 70.6%.

The sixth experiment involved customizing a CNN model with five convolutional layers. The parameters included a batch size of 32, 128 neurons in the dense layer, and 20 epochs. Furthermore, we applied data augmentation to the training set, which improved the model's performance. The final accuracy was 75.3%, which is the highest accuracy among all experiments. Table 10 shows the accuracy of several machine learning and deep learning model. Table 11 shows a comparison between several deep learning models accuracy.

Model	**Accuracy**
RandomForest	57%
SVM	64%
VGG16	70%
CNN	75.3%

Table 10: Comparison between different model's accuracy

Model	Number of convolutional layers	Augmented data in training set	Accuracy
VGG16	16	Yes	70%
CNN	2	No	64%
CNN	3	Yes	70.6%
CNN	5	Yes	75.3%

Table 11: Comparison between different deep learning model's accuracy

5.2 User Acceptance Testing

To test the system, we picked twenty-one people from different age groups as our system's testers. We ensured they all knew how to use websites so we could get accurate feedback. These testers were chosen carefully to represent the users of the system. First, we had them try out the active features we created: signing up, logging in, taking a picture to classify their age, browsing games, clicking the "Go to the download page" button, filtering and sorting games, adding games to favourite, explore the games visited in the app store, view recently viewed games, and logging out. After using the system, they filled out a form to share their suggestions and feedback. During the test, a project's team member was available to answer any questions. For testers under 17, an adult helped with the signing-up process and filling the form, but the testers themselves handled all the other features.

5.2.1 Demographics of Participants

This table shows the details of the testers' demographics. We aimed to include testers from different age groups to gather diverse opinions and feedback. We considered their education level, their knowledge of using technology, and their interest in video games. Table 12 illustrates the demographics.

Participant demographics		
Age group	4+	19%
	9+	14.3%
	12+	23.8%
	17+	42.9%
Education level	Kindergarten	9.5%
	Primary School	38.1%
	High School	23.8%
	Bachelor	23.8%
	Master	4.8%
	PHD	0%
Technical background level	Low	42.9%
	Neutral	38.1%
	High	19%
Level of interest in video games	Low	33.3%
	Neutral	19%
	High	47.6%

Table 12: Participant demographics

5.2.2 Questionnaire's Results

Once the testers tested the system, we requested them to complete a form to assess and express their experience. The form included 22 rating questions and nine optional short-answer questions where they could note any difficulties they faced. The purpose of questions 1 to 16 was to assess the efficacy of the system's features. Additionally, we sought the tester's opinion on the system's usability, helpful error messages, validation acknowledgment, colors, and responsive performance, through questions from 17 to 22. Finally, we asked testers to share any suggestions or feedback. Table 13 shows the results of the questionnaire. The questionnaire's detailed questions and answers are found in Appendix E.

Question number	Question	Result
1	I was able to sign up easily	57% Strongly agree 28% Agree 14% Neutral 0% Disagree 0% Strongly disagree
2	I was able to log in easily	85% Strongly agree 14% Agree 0% Neutral 0% Disagree 0% Strongly disagree
3	When I clicked on "Forget Password" link, I was able to change the password easily	71% Strongly agree 29% Agree 0% Neutral

		0% Disagree 0% Strongly disagree
4	When I clicked on "Forget Username" link, I was able to change the username easily	76% Strongly agree 14% Agree 4% Neutral 4% Disagree 0% Strongly disagree
5	I was able to take a picture and retake (when needed) easily	85% Strongly agree 5% Agree 10% Neutral 0% Disagree 0% Strongly disagree
6	The system was able to detect my face	85% Strongly agree 10% Agree 5% Neutral 0% Disagree 0% Strongly disagree
7	The system classified my age group, and the classifying result was correct and clear for me	71% Strongly agree 14% Agree 10% Neutral 5% Disagree 0% Strongly disagree

8	After logging in, I found it easy to verify my age group by taking a picture of my face	76% Strongly agree 14% Agree 10% Neutral 0% Disagree 0% Strongly disagree
9	I was able to browse all games and view each game's information easily	85% Strongly agree 15% Agree 0% Neutral 0% Disagree 0% Strongly disagree
10	When I clicked on “Go to the download page” button, the system navigated to the game's page in the app store	81% Strongly agree 19% Agree 0% Neutral 0% Disagree 0% Strongly disagree
11	I was able to filter and sort games, allowing me to easily view the games I am interested in	81% Strongly agree 14% Agree 5% Neutral 0% Disagree 0% Strongly disagree
12	I was able to save the games I am interested in when I clicked “Add to Favourite Games” button, and view it on the “Favourite Games” page easily	71% Strongly agree 19% Agree 10% Neutral

		0% Disagree 0% Strongly disagree
13	I was able to browse all games that I explored previously on the App Store on the "Visited Store Games " page easily	76% Strongly agree 24% Agree 0% Neutral 0% Disagree 0% Strongly disagree
14	I was able to view recently viewed games below listed below on the game information page	90% Strongly agree 10% Agree 0% Neutral 0% Disagree 0% Strongly disagree
15	I was able to get in touch with Game Geek team via the 'Contact Us' page easily	57% Strongly agree 33% Agree 10% Neutral 0% Disagree 0% Strongly disagree
16	I was able to log out from the system easily	95% Strongly agree 5% Agree 0% Neutral 0% Disagree 0% Strongly disagree

17	The system was easy to use, and all pages were clear	43% Strongly agree 52% Agree 5% Neutral 0% Disagree 0% Strongly disagree
18	The website's features displayed on the screen are easy to understand and navigate	48% Strongly agree 47% Agree 5% Neutral 0% Disagree 0% Strongly disagree
19	The website provides clear guidance messages in case of errors, effectively informing me of how to resolve them	67% Strongly agree 23% Agree 5% Neutral 5% Disagree 0% Strongly disagree
20	The website consistently acknowledges any required validation and verification processes	71% Strongly agree 24% Agree 5% Neutral 0% Disagree 0% Strongly disagree
21	The colors of the system were engaging and creative	70% Strongly agree 10% Agree 15% Neutral

		0% Disagree 5% Strongly disagree
22	When I click on any button, link, or page, I get an immediate response.	90% Strongly agree 10% Agree 0% Neutral 0% Disagree 0% Strongly disagree

Table 13: Questionnaire's results

5.3 Quality Attributes (NFR testing)

To test the non-functional requirements, we began by defining each requirement related to our user story. After that, we established the measures we will follow to evaluate the requirements. Finally, we obtained the results. Our team members tested all the requirements on our 21 testers by setting a timer and observing their interaction with the system. All results and details are provided in Table 14.

User story	Quality Attribute	Measure	Results
As a user, I want the system to response for any operation within 3-25 seconds **so that** I can use the system without waiting so long.	Performance: How fast does the system response when the user takes an action? [49]	- Compute the time the system responds to an action. - The system should respond in 3 to 25 seconds.	- All 21 users were asked to apply different actions while testing the system. - 21 users completed the test. - The average response time was 2 seconds, where the minimum was 1 second and maximum 10 seconds.
As a user, I want the website's interface to be user-friendly so that I can quickly and easily select the video games I want.	Usability: How fast is it for users to complete the main actions once they see the interface? [49]	- Compute the time for finding and selecting a game from the games page. - Users need less than 8 minutes to find and select a game.	- All 21 users were asked to log in then select the game they want. - 21 users completed the test.

			- The average time took them to select the game they want was 3 min on average, maximum time was 5 minutes and minimum time was 1:30 minutes.
As a user, I want the system to be secure **so that** I can trust that my personal information is safe and secure.	Security: Is the system able to protect the user's data from malware or attacks? [49]	- Protect users' data by using a hash algorithm on passwords before storing them in the database.	All 21 users' passwords are hashed using PBKDF2 algor ithm with a SHA256 hash before storing them in the database [50].
As a user, I want to be able to use the system on my laptop, desktop, and mobile phone **so that** I can access it from anywhere and on any device.	Portability: Is the website able to maintain a consistent user experience across various mobile devices? [49]	- Try the system on several devices with different sizes. - All system's components should be clear to the user on their device whether it is a phone, tablet, or laptop.	- All 21 users were asked to use the system in the device they prefer. - 8 users used phones, 3 users used tablets, 10 users used laptops.

			- All system's components were clear to all users regard the size of the device they were using.
As a user, I want the system to be reliable 99% of times **so that** I can use it without experiencing unexpected downtime or errors.	Reliability: The probability that a system or component will execute its function without encountering failure at a particular moment. [51]	- The system must remain stable and operational during user interactions, without experiencing crashes or failures.	- All 21 users have used the system in different time periods. - All 21 users did not face any downtime errors while using the system.

Table 14: NFR Testing results

5.4 Discussion

To evaluate our system performance, we asked participants from our end users as testers to try the system and give their feedback. After they tested the system, we noticed few features that need improvement.

First, most testers did not have problems while signing up or logging in. However, some testers found it hard to use the system due to the current language it supports. This indicates that language could be an obstacle for some users. Moreover, all testers did not have issues while changing passwords, which means the features works well. Most testers were able to change their usernames. Also, all testers found it easy to take or retake pictures of their faces using the camera in the system. Additionally, the system can detect if there is a face in a picture, and most agreed that their faces were successfully recognized. Furthermore, we wanted to see if the system could classify the testers age group and it did. However, the results were not very accurate for all testers. We have also observed that all users were able to take a picture of themselves to verify their age group after logging in.

For browsing games, all testers said it was easy. They also agreed that the system smoothly took them to the game page in the app store when they clicked the "Go to the download page" button. All testers agreed that they could sort, and filter games based on their choices. They were also able to save the games they liked to the "Favorite Games" page by clicking the "Add to Favorite Games" button. Moreover, testers were able to track the games they visited in the app store on the "Visited Store Games" page. They were also able to see the recent games they clicked on while testing the system in the session. Most testers also found it easy to contact the Game Geek support system through the "Contact Us" page. Additionally, all testers could successfully log out from the system.

Furthermore, all testers thought the system was easy to use, and all the pages were clear. They also agreed that all features were clearly displayed and easy to navigate. Most testers agreed that the system provided clear guidance messages in case of errors, effectively informing them of how to resolve them. Also, most of them agreed that the system consistently acknowledges any required validation and verification processes. Moreover, most of them liked the system’s colors. Additionally, after clicking any button or link, all testers agreed that they received an immediate response, which shows that the system has great performance .

We also noticed that while the testers were using the system, they did not face any crashes, which shows that the system was reliable to use. Finally, testers were also able to use the system from different devices with different sizes.

After we asked the testers for their suggestions and feedback, they suggested the following:

“Thank you for this amazing system, I like it too much”.

“I would like to have it in the Arabic language and add more games in the Saudi Arabia region, adding more newer games like VR games, thank you for providing this system”.

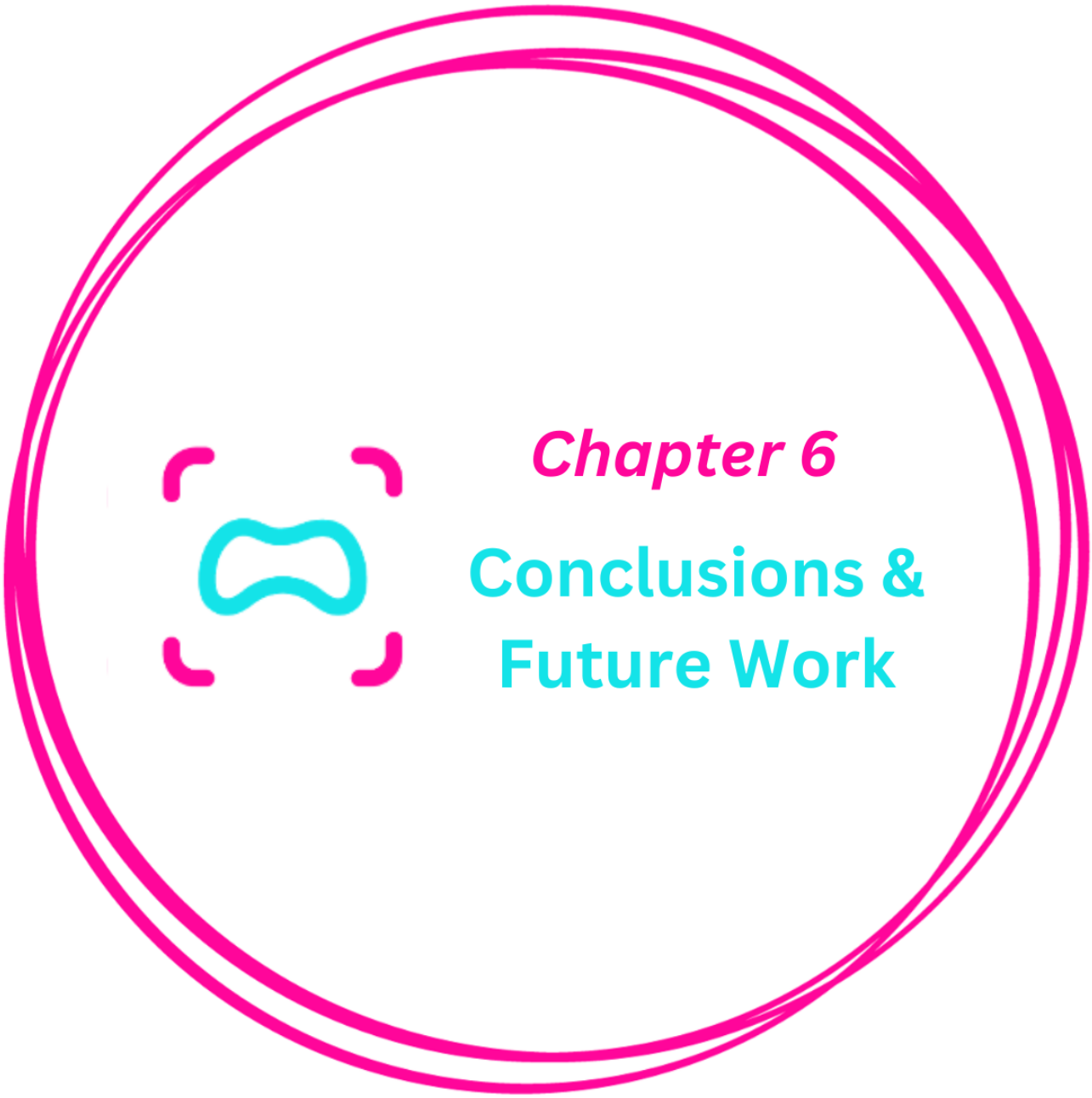
“Add more car games and police games, Thank you for this system.”

“Very excellent website, hope u the best.”

“that’s an amazing website!”

“Improve the face detection, the system is beautiful and needed in games fields, and the effort you put in is shown and there is an amazing touch.”

Overall, the responses were good, and it revealed that testers enjoyed using the system due to its easiness and clarity. However, from the above suggestions, we can improve the system by enhancing the design of the frontend pages and supporting languages other than English. We also can improve the performance of our age estimation model to make better predictions.



Chapter 6

Conclusions & Future Work

6 Conclusions and Future Work

6.1 Conclusion

Video games are an essential source of entertainment for a lot of people. Producers are competing to release highly anticipated games in an extremely competitive marketplace. However, a significant problem occurs when people play games that are inappropriate for their age group, potentially leading to negative consequences. Upon identifying this issue, our team developed a system that customizes game offers according to users' age groups.

We began by introducing this idea to the appropriate authorities. We started describing the problem that needed to be solved and our suggested approach to solve it. We stated the product vision, product roadmap, objectives, scope, and required hardware and software tools. We also estimated the associated costs. After the project was approved, we focused on conducting an in-depth domain review. Also, we included conducting a comprehensive analysis of related work and competitors. Additionally, as well as providing background information that helped in understanding.

Our feature selection process was built upon our end-user interviews and questionnaire, which helped us better understand users' needs. As a result, a backlog with every expected system feature has developed. Afterward, we concentrated on designing system components, organizing databases, and collecting data for model training. We started preprocessing data to feed the age group classification model. At the same time, we started working on the frontend and backend of the system. After implementing a working software, we tested it with end users to get beneficial feedback. The effort invested in this project was to develop a system that would satisfy the needs of video gamers, ensuring that the video games were appropriate for their age groups.

6.2 Global and local impact.

Game Geek serves all individuals interested in video games regardless of age, region, or nationality. We assume that our system has a local and global impact on those video games players. In addition, we believe it will help them find video games that suit their age group. We also think it will reduce the inappropriate video games they usually play with. Moreover, it will help parents find suitable video games for their children’s age group.

6.3 Problems and challenges encountered during the software development.

During the system's development, we faced many challenges. Some had to do with gathering data for training the model, whereas others had to do with the system's frontend and backend development. First, it was challenging to find a clean dataset of face images. As a result, we had to gather data from several datasets. The second problem was the quality of the collected data. Many of the images were not clean enough for training the model. Thus, cleaning those datasets in a short amount of time presented a challenge. In addition, training the model encountered a challenge where each training trial lasted between fifteen and eighteen hours. Also, each training trial needed numerous computational resources. Nevertheless, developing the website was difficult since we used the Django framework for building the website. We also had challenges with hosting the website. We experimented with different hosting providers. However, many of them did not work with our system. Therefore, this led to additional work and research that took a significant amount of time. Unfortunately, besides all the mentioned challenges, we were on a very tight schedule to learn about a new technology and professionally apply what we learned to our project.

6.4 Limitations of the system.

Game Geek helps individuals interested in video games find suitable games based on their age group. Our main goal is to ensure that individuals are not exposed to age-inappropriate content while playing. Therefore, Game Geek offers games to users based on their age group. However, our system does not control the type of pop advertisements that appear to users.

In addition, Game Geek allows users to filter games based on rating, but it does not allow them to rate the games. Furthermore, the games offered are available for iOS devices only. The only language that the system supports is English.

6.5 The main contribution of the project

The primary contribution of the Game Geek system emerged from observing challenges individuals encounter when attempting to play or find appropriate video games based on their age group. Unfortunately, many video games' players are exposed to offensive material while playing. This problem could have terrible effects, particularly on children.

After realizing these issues, we discovered that developing a system that provides games according to the age group rating was essential. Therefore, we considered creating this system in hopes that it would reduce the issue's effects. We are proud to state that our system is the only one with video games provided based on the users' age group. This characteristic distinguishes Game Geek from other gaming platforms.

6.6 Future work

As we are dedicated to delivering an exceptional system, we have created a strategic plan for future improvements. Our primary goal is to increase the number of languages we support, especially Arabic. In addition, we are focused on incorporating video games that are compatible with a diverse range of game stores such as Google play. Finally, we always prioritize improving our user interface to make users more satisfied with their experience.

Chapter 7

Acknowledgements

7 Acknowledgements

This project is an outcome of numerous helping hands who have contributed and are emotionally connected to us throughout our life journey. We want to express our gratitude to those whose support and contribution have been crucial in completing this project.

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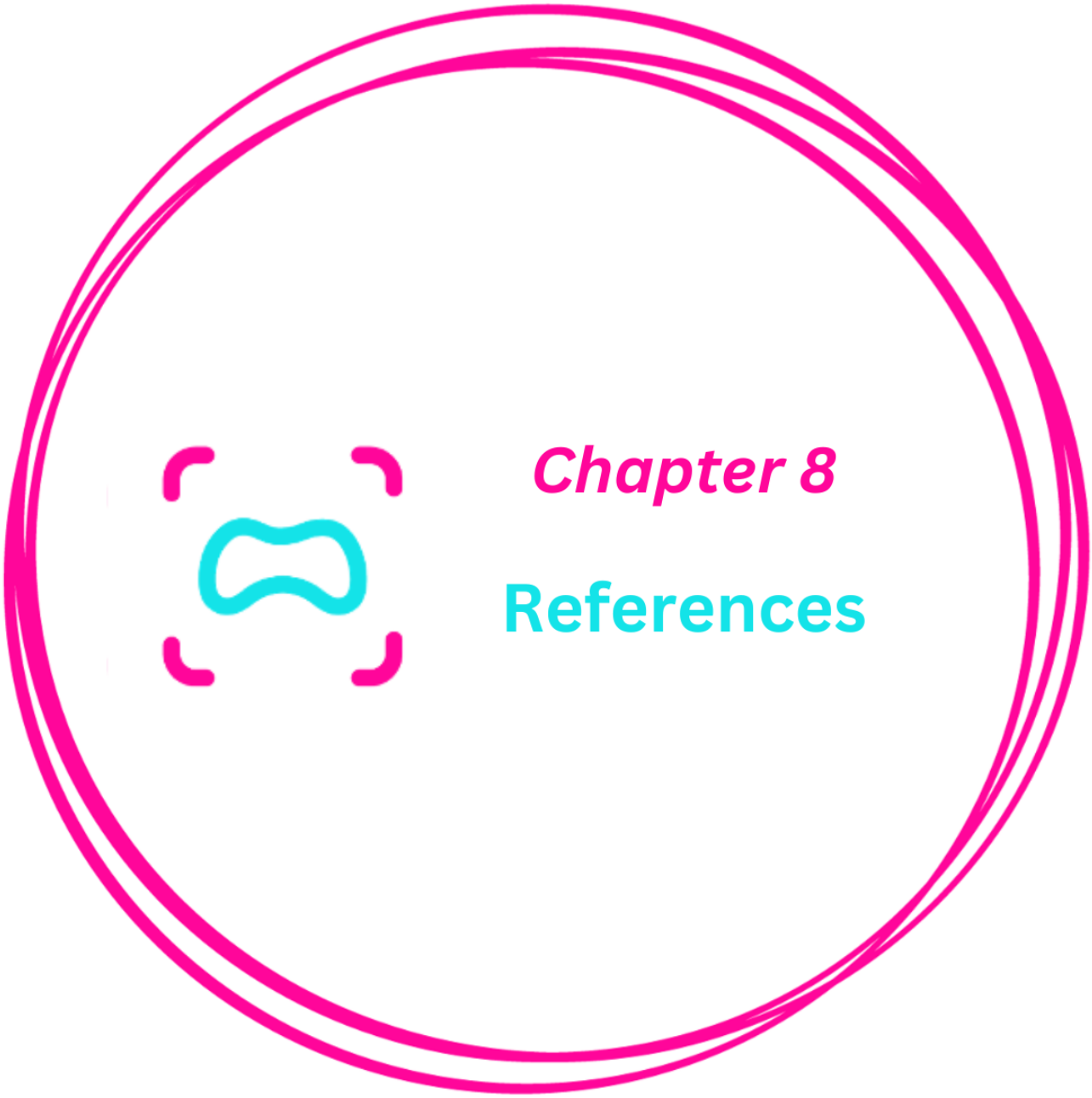
We also appreciate the GP committee and help desk for their invaluable guidance and assistance. Their unwavering guidance ensured the delivery of the project at its best. Lastly, we thank our colleagues and all individuals who supported our work and provided us with insightful ideas. Their words were invaluable and enriched our delivered project.

Each of these individuals has left an unforgettable mark on our hearts. Their support, guidance, and love have made this endeavor possible and shaped us into the individuals we are today. We are forever grateful for their presence in our lives.



Chapter 8

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Chapter 9

Appendix

9 Appendix

9.1 Appendix A: Interviews

9.1.1 First Interview

Interview outlines	
Interviewee: Abeer Hamad	**Interviewer:** Reema Alhenaki
Location: Home	**Appointment Date:** 10/09/2023 **Start Time:** 6:15 pm **End Time:** 6:35 pm
Objectives: Collect Data	**Reminders:** The interviewee is a mother of a little girl and cares about her child healthy growth.
Agenda: Introduction Background on Project Overview of Interview Topics to be Covered. Permission to Record Topic1: Question1 Topic2: Question2 Topic3: Question3 Topic4: Question4 Topic5: Question5 Topic6: Question6 Topic7: Question7 Summary of Major Points. Questions from interviewee. Closing	**Approximate Time:** 2min 2min 1min 2min 1min 4min 4min 3min 2min 2min 3min 3min 2min
General Observations: The interviewee seemed busy. However, she was full of ideas and valuable information**.**	**Unresolved Issues: We** did not discuss the features our app might include. We also did not discuss any non- functional requirements.

Interviewee: Abeer Hamad	**Date:** 10/09/2023
Questions:	**Notes:**
Question 1: What do you enjoy doing in your spare time?	**Answer 1:** My daughter usually plays with her toys. If she gets access to a device, she prefers to play video games. **Observations:** No observations.
Question 2: Do you play video games? **If yes, go to question3**	**Answer 2:** Yes, if she has permission to use her device. **Observations:** No observations.
Question 3: Have you ever been exposed to inappropriate content while playing video games, what were they?	**Answer 3:** Of course, a lot of advertisements with sexual and violent content appear while she is playing. **Observations:** No observations.
Question 4: Do you find it difficult to find the appropriate video game for you that suits your age?	**Answer 4:** No, but the challenge is the advertisement that force my daughter to download another inappropriate game so she could keep playing the current one. **Observations:** The interviewee seemed very annoyed about this point.
Question 5: If there is a system that offers you video games based on your age group, would you use it?	**Answer 5:** Yes, I think it will help me choose the ones thatsuits my child age group, the ones that do not include violence and other harmful content. **Observations:** No observations.

Question 6: What information do you consider important to know about a video game?	**Answer 6:** 1. The content of the game. 2. Does not include strobe and intense lightening. 3. The size of game 4. The rating and the reviews since the reviews give more accurate information. 5. The price of game, I prefer free video games., 6. Whether the game offers online playing with other anonymous users. 7. Does not violate religious beliefs. **Observations:** No observations.
Question 7: Is there anything you would like to add?	**Answer 7:** I suggest video games have limited time on each level so that kids do not spend a lot of time playing. **Observations:** No observations.

9.1.2 Second Interview

Interview outlines	
Interviewee: Alya Alnasser	**Interviewer:** Reema Alhenaki
Location: Home	**Appointment Date:** 10/09/2023 **Start Time:** 9:00 pm **End Time:** 9:20 pm
Objectives: Collect Data	**Reminders:**
Agenda: Introduction Background on Project Overview of Interview Topics to be Covered. Permission to Record Topic1: Question1 Topic2: Question2 Topic3: Question3 Topic4: Question4 Topic5: Question5 Topic6: Question6 Topic7: Question7 Summary of Major Points. Questions from interviewee. Closing	**Approximate Time:** 2min 2min 1min 2min 1min 4min 4min 3min 2min 2min 3min 3min 2min
General Observations: The interviewee seemed busy. However, she was full of ideas and valuable information that will help us choose requirements.	**Unresolved Issues: We** did not discuss the features our app might include. We also did not discuss any non- functional requirements.

Interviewee: Alya Alnasser	**Date:** 10/09/2023
Questions:	**Notes:**
Question 1: What do you enjoy doing in your spare time?	**Answer 1:** **My** daughter enjoys playing with her dolls and toys. **Observations:** No observations.
Question 2: Do you play video games? **If yes, go to question3**	**Answer 2:** Absolutely! That is our favourite entertainment to do when it comes to my little daughter and me. **Observations:** No observations.
Question 3: Have you ever been exposed to inappropriate content while playing video games, what were they?	**Answer 3:** Unfortunately, yes, even though I try to avoid them, they always come as an ad in the middle of a game no matter how hard I try to limit them. **Observations:** No observations.
Question 4: Do you find it difficult to find the appropriate video game for you that suits your age?	**Answer 4:** Sure! I always try hard to limit the video games she interacts with because I do not know the content of the video games. Sometimes when I am not in the house, I get scared that she is alone playing something that is not suitable for her because there are a lot of video games that are not for her age. I do not find video games for kids fast; it is sure a hard mission to take care of.

	Observations: The interviewee seemed interested in this point.
Question 5: If there is a system that offers you video games based on your age group, would you use it?	**Answer 5:** That is exactly what I am looking for, anything that will help controlling what my daughter faces and interacts with in her device particularly when I am not around her checking. **Observations:** No observations.
Question 6: What information do you consider important to know about a video game?	**Answer6**: 1. The average ages of the users, are they adults or children? 2. Is it individual gaming or do I get to communicate with others and play with them? 3. Is it a game that is affordable for everyone? 4. Is it a game based on levels? If yes how many levels it consists of? 5. Is the game often updated by the developers with new things that attract me? **Observations:** No observations.
Question 7: Is there anything you would like to add?	**Answer 7:** No thank you nothing additional, that is everything I want. **Observations:** No observations.

9.1.3 Third Interview

Interview outlines	
Interviewee: Dena Alrumaih	**Interviewer:** Reema Alhenaki
Location: Home	**Appointment Date:** 11/09/2023 **Start Time:** 5:00 pm **End Time:** 5:30 pm
Objectives: Collect Data	**Reminders:** The interviewee has a lot of interests in video games and tried bunch of them.
Agenda: Introduction Background on Project Overview of Interview Topics to be Covered. Permission to Record Topic1: Question1 Topic2: Question2 Topic3: Question3 Topic4: Question4 Topic5: Question5 Topic6: Question6 Topic7: Question7 Summary of Major Points. Questions from interviewee. Closing	**Approximate Time:** 2min 2min 1min 2min 1min 4min 4min 3min 2min 2min 3min 3min 2min
General Observations: The interviewee seemed relaxed and excited to answer. However, she was full of ideas and valuable information that will help us choose requirements.	**Unresolved Issues: We** did not discuss the features our app might include. We also did not discuss any non- functional requirements.

Interviewee: Dena Alrumaih	**Date:** 11/09/2023
Questions:	**Notes:**
Question 1: What do you enjoy doing in your spare time?	**Answer 1:** **I** usually cook, bake, and watch movies. I sometimes browse social media and sometimes play video games on my devices. **Observations:** No observations.
Question 2: Do you play video games? **If yes, go to question3**	**Answer 2:** Yes, I frequently play especially if it is a game I have recently downloaded, and I am interested in. **Observations:** No observations.
Question 3: Have you ever been exposed to inappropriate content while playing video games, what were they?	**Answer 3**: Yes, while I play a lot of advertisements pop out including inappropriate behaviors and sexual contents. However, I have not been exposed to inappropriate content in the game itself. **Observations:** No observations.
Question 4: Do you find it difficult to find the appropriate video game for you that suits your age?	**Answer 4:** No, since I am an adult, all video games suit my age, so the options are unlimited. **Observations:** No observations.

Question 5: If there is a system that offers you video games based on your age group, would you use it?	**Answer 5:** Yes, since I like exploring new things and I am curious when it comes to video games. However, it is possible that I do not like the suggested video games. **Observations:** No observations.
Question 6: What information do you consider important to know about a video game?	**Answer 6:** 1. Number of raters and the rating itself. If the rating is high but the number of raters is low, I will not take rating into consideration. 2. The type of game, the genre. 3. Size of the game, if the game is interesting and its gigas is big I will not download it. 4. The ability to play online with other users. 5. The price of the game. 6. The language it supports whether English or Arabic. Observations: No observations.
Question 7: Is there anything you would like to add?	**Answer 7:** **I would** prefer the system to ask me about my preferences in video games before offering them. I also I think if I give the system the names of video games, I like then it offers me similar video games would be a great idea. **Observations:** No observations.

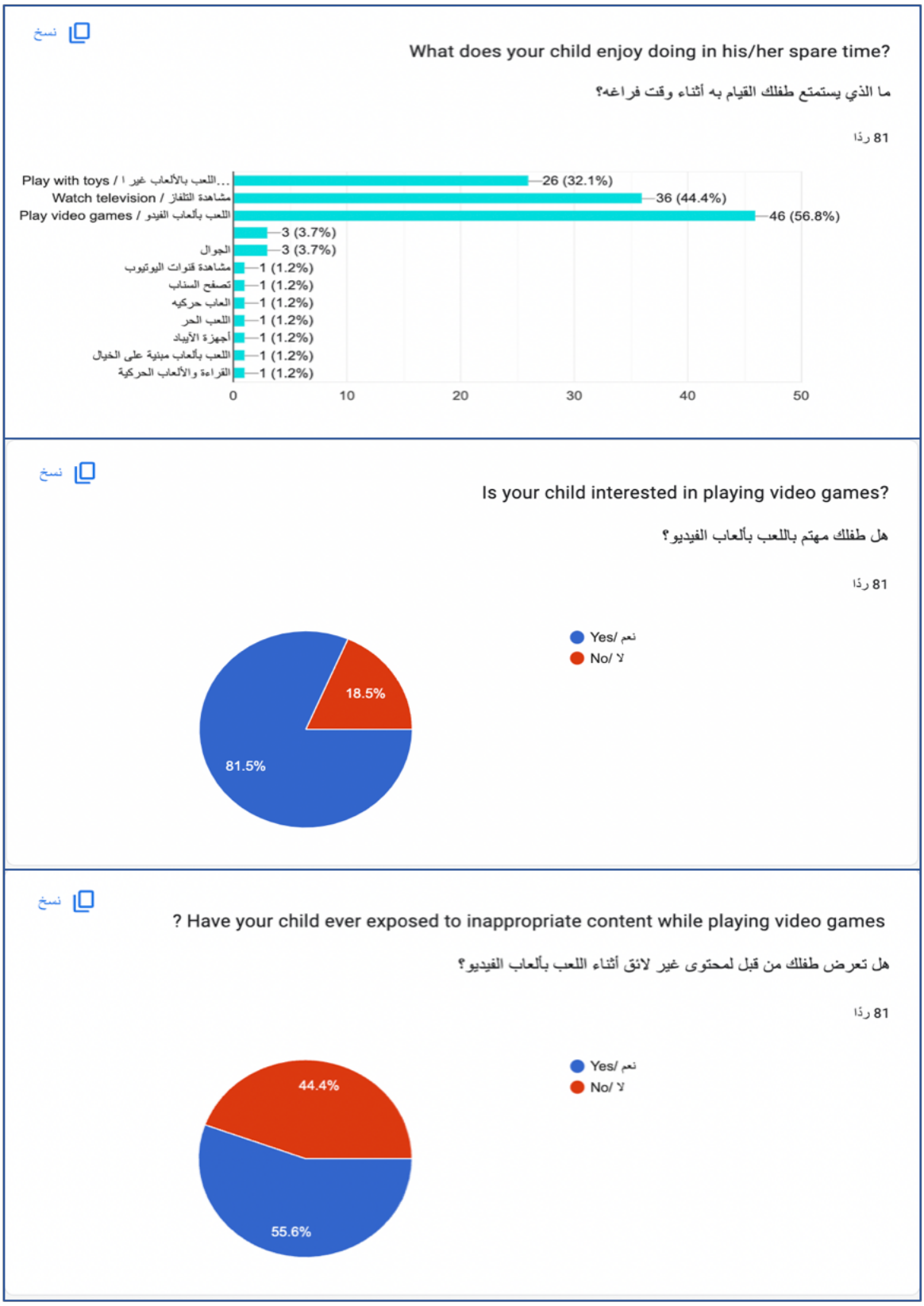
9.1.4 Fourth Interview

Interview outlines	
Interviewee: Hanan Alenazi	**Interviewer:** Reema Alhenaki
Location: Home	**Appointment Date:** 11/09/2023 **Start Time:** 8:20 pm **End Time:** 8:45 pm
Objectives: Collect Data	**Reminders:** The interviewee is a huge fan of video games. She plays video games regularly.
Agenda: Introduction Background on Project Overview of Interview Topics to be Covered. Permission to Record Topic1: Question1 Topic2: Question2 Topic3: Question3 Topic4: Question4 Topic5: Question5 Topic6: Question6 Topic7: Question7 Summary of Major Points. Questions from interviewee. Closing	**Approximate Time:** 2min 2min 1min 2min 1min 4min 4min 3min 2min 2min 3min 3min 2min
General Observations: The interviewee seemed relaxed. In addition, she was full of ideas and valuable information related to our topic.	**Unresolved Issues: We** did not discuss the features our app might include. We also did not discuss any non- functional requirements.

Interviewee: Hanan Alenazi	**Date:** 11/09/2023
Questions:	**Notes:**
Question 1: What do you enjoy doing in your spare time?	**Answer 1:** I usually browse social media, and really enjoy playing video games. **Observations:** No observations.
Question 2: Do you play video games? **If yes, go to question3**	**Answer 2:** **Yes**, I have played them since I was young. For me, video games change my mood effectively and reduce my stress feelings. **Observations:** No observations.
Question 3: Have you ever been exposed to inappropriate content while playing video games, what were they?	**Answer 3:** Yes, a lot of advertisements pop- up while I play which are very awful, they include a lot of sexual and pornography content. **Observations:** The interviewee is really annoyed about this point.
Question 4: Do you find it difficult to find the appropriate video game for you that suits your age?	**Answer 4:** **No** because I have a certain number of video games that I play regularly. **Observations:** No observations.

Question 5: If there is a system that offers you video games based on your age group, would you use it?	**Answer 5:** Yes, since it might suggest video games that suit me and save me time while searching. **Observations:** No observations.
Question 6: What information do you consider important to know about a video game?	**Answer 6:** **I** do not care about any information. I usually download the game and try it myself. **Observations:** No observations.
Question 7: Is there anything you would like to add?	**Answer 7:** I wish there was high control on the type of advertisements that pop up to players while playing. Since in some cases, kids lie about their actual age and therefore they might be exposed to inappropriate content. **Observations:** No observations.

9.2 Appendix B: Requirement's Elicitation Questionnaire

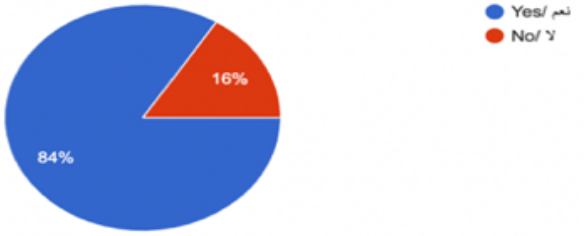


نسخ

Do you find it challenging to find the appropriate video game for your child that suits his/her age group?

هل تجد صعوبة في العثور على لعبة الفيديو تناسب فئة طفلك العمرية؟

81 ردًا

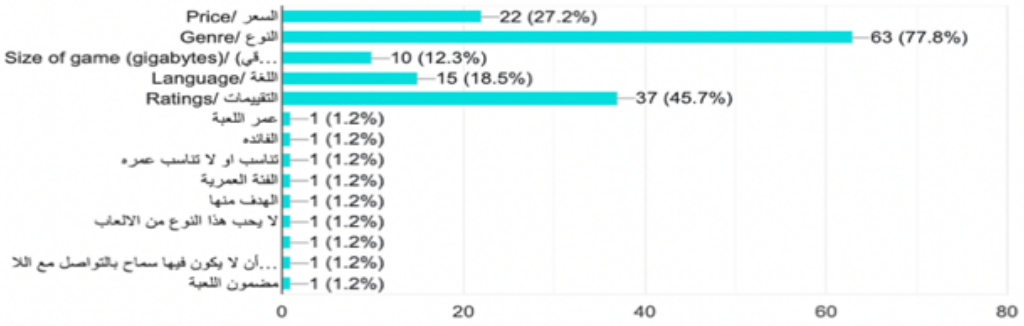


نسخ

What information do you consider important to be known about a video game?

ما هي المعلومات التي يهمك معرفتها عن أي لعبة فيديو؟

81 ردًا

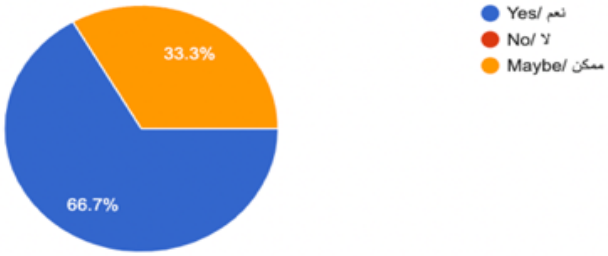


نسخ

If there is a system that offers your child video games based on his/her age group, would you allow your child to use it?

إذا كان هناك نظام يوفر ألعاب الفيديو لطفلك بناءً على فئته العمرية، هل ستسمح لطفلك باستخدامه؟

81 ردًا

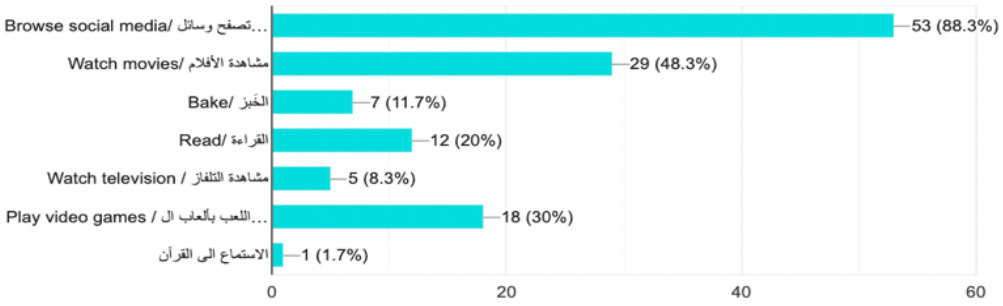


نسخ

What do you enjoy doing in your spare time?

ما الذي تستمتع بالقيام به أثناء وقت فراغك؟

60 ردًا

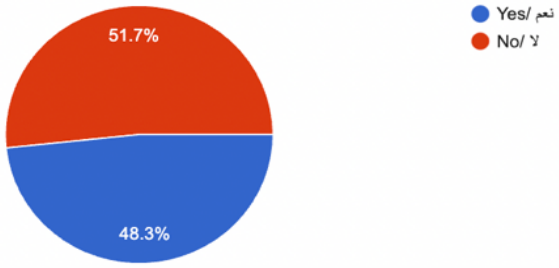


نسخ

Are you interested in playing video games?

هل أنت مهتم بلعب ألعاب الفيديو؟

60 ردًا

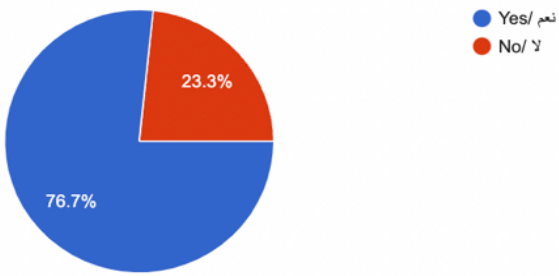


نسخ

?Have you ever exposed to inappropriate content while playing video games

هل تعرضت من قبل لمحتوى غير لائق أثناء اللعب بألعاب الفيديو؟

60 ردًا

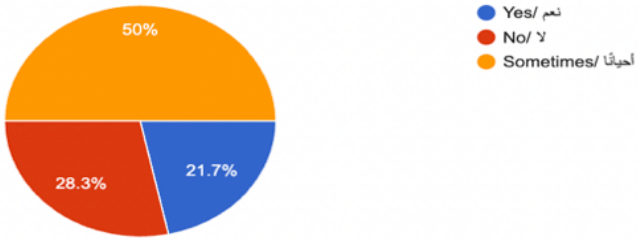


نسخ

Do you find it challenging to find the appropriate video game for you that suits your age group?

هل تجد صعوبة في العثور على لعبة فيديو تناسب فئتك العمرية؟

60 ردًا

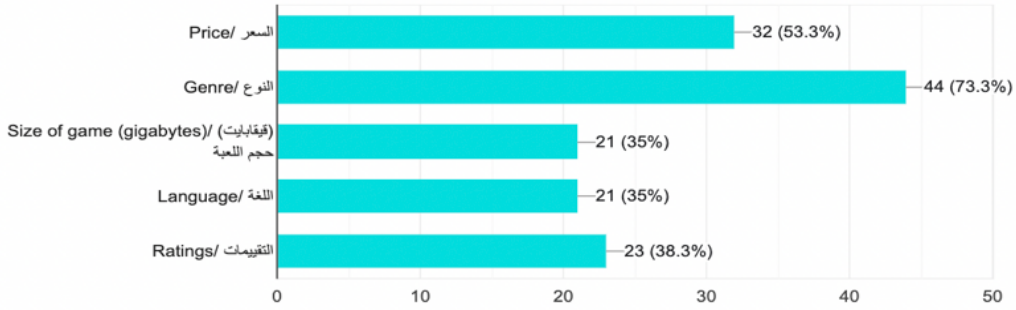


نسخ

What information do you consider important to be known about a video game?

ما هي المعلومات التي تهمك معرفتها عن أي لعبة فيديو؟

60 ردًا

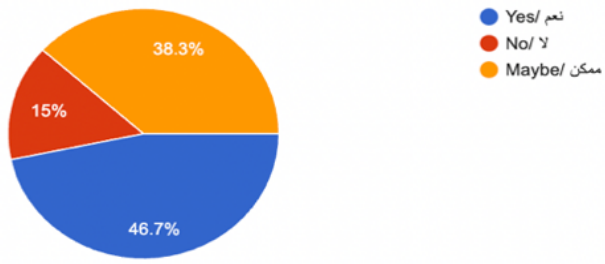


نسخ

If there is a system that offers your video games based on your age group, would you use it?

إذا كان هناك نظام يوفر ألعاب الفيديو لك بناءً على فئتك العمرية، هل ستستخدمه؟

60 ردًا



Would you like to add anything?
آرائك محل اهتمامنا، هل تود إضافة شيء؟

29 ردًا

نتمنى وجود تطبيق يحد من نوعية المقاطع التي يشاهدها الطفل

انواع لاالعاب تعليمي او ترفيهي او مهارات وتيضا يكون له وقت محدد وبس بدعتو انتم😍

اتمنى وجود العاب اطفال بسيطه غير معقده باللغه العربيه

بعض الالعاب يكون لها ترسيخ معتقد من خلال مراحل اللعبه قد لايميزه نظرا لصغره لكنه يعتاد على رؤيته وبالتالي تقبله كذلك الالعاب في الاغلب تكون عنيفه سواءا ضرب او قتال

ان نرى هذا الجهد ع ارض الواقع مو مجرد استبيان

برأي أنها فكرة جداً رائعة .. حيث يتم تحديد المرحلة العمرية ومن ثم يتم اقتراح ألعاب الفديو المناسبة للمرحلة.. كل التوفيق

التحكم بالفديوات التي تسمح بالمحادثات والتواصل

خلو الالعاب الالكترونيه من المقاطع المسيئة للاخلاق والدين

اتمنى ايجاد تطبيق او برنامج جيد يحدد الالعاب التي تناسب قيمنا و مبادئنا الاسلامية

لا شكرا

أتمنى يكون هناك نظام يوفر ألعاب بناء على عمر الطفل وبناءا على الالعاب التي يلعبها الطفل دائما يعني يحدد ميوله لمعرفه ما هي اهتمامته وتزويده بالعاب تناسب هذه الاهتمامات وتنميها.. وطبعا يكون هناك وقت محدد للعب..

الله يوفقكم ويسهل عليكم 🤍🤍🤍

ارى أنا زمن اللعب مهم جدًا للأطفال

بالتوفيق

ألعاب الفيديو عموما لاينصح بها للأطفال ، والأجدر بالمربين تقنينها قدر المستطاع

لأ

لو فيه تطبيق يراعي الدين والأعراف والتقاليد ويهتم بعدم وشع موسيقى وخيارية ذلك طبعا سيكون محل اهتمام مني

9.3 Appendix C: Jira project

- **Jira dashboard:**

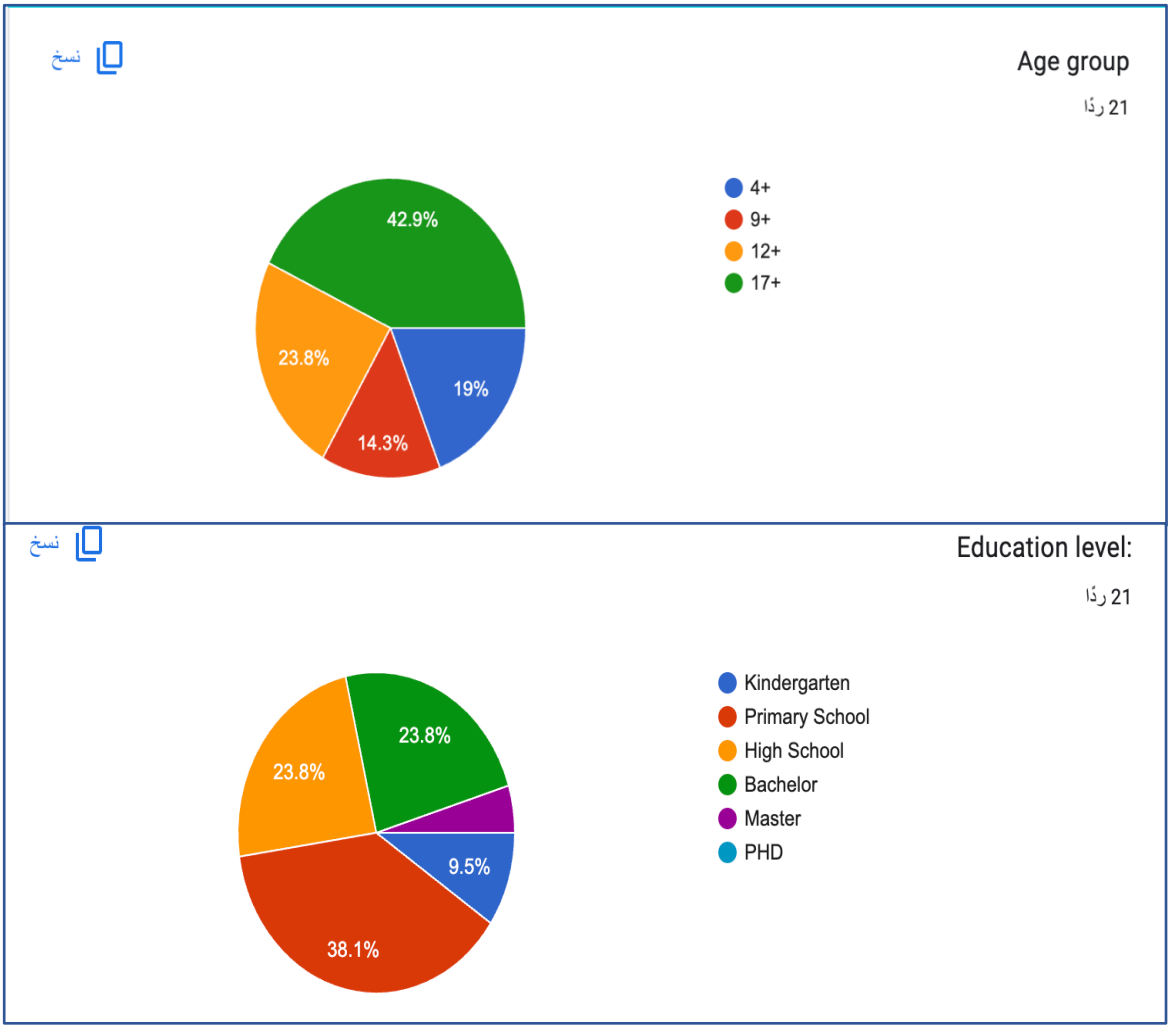
https://jira.external-share.com/issue/ddcf143f-48ca-4207-be3d-5af71744e286

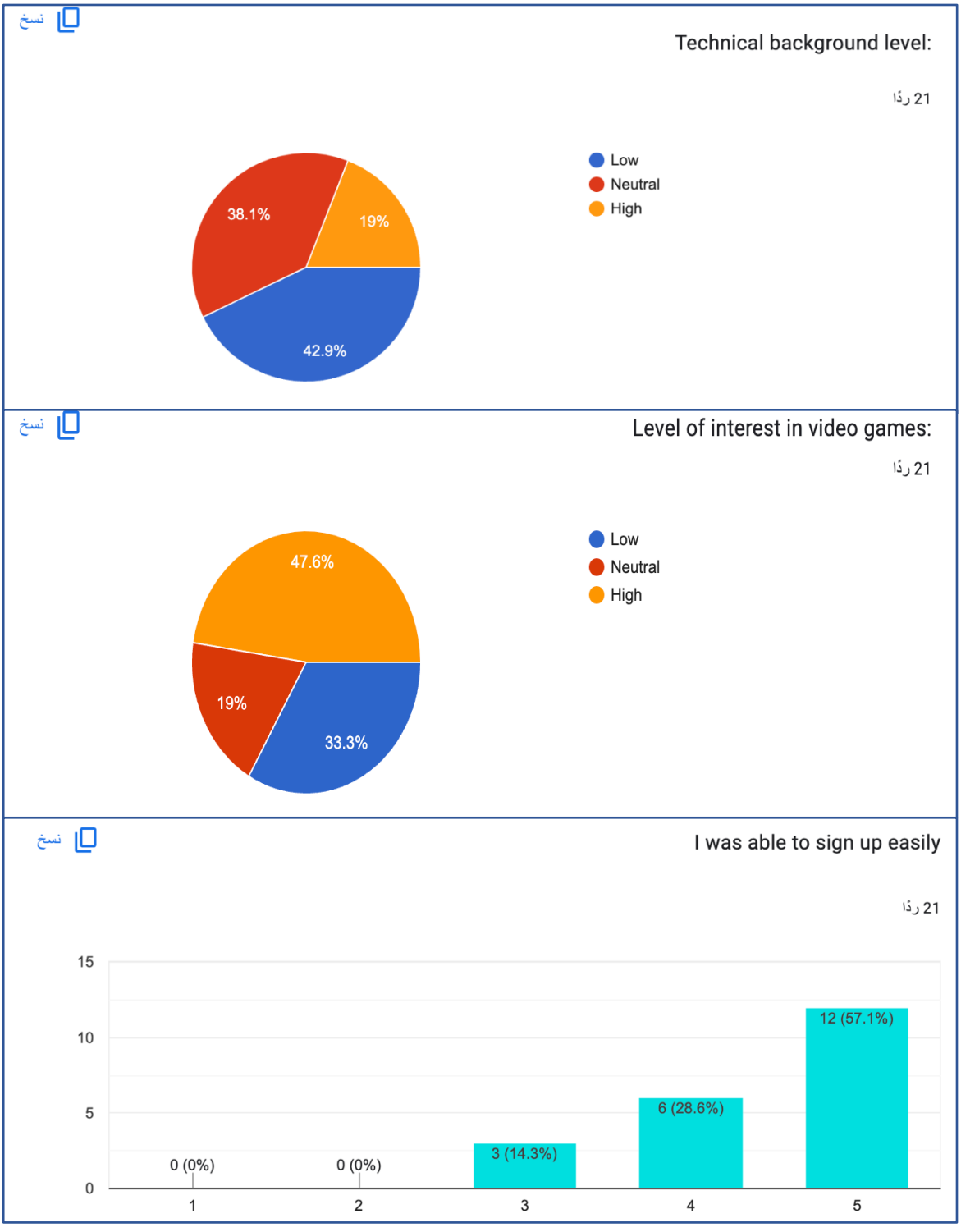
9.4 Appendix D: GitHub Repository

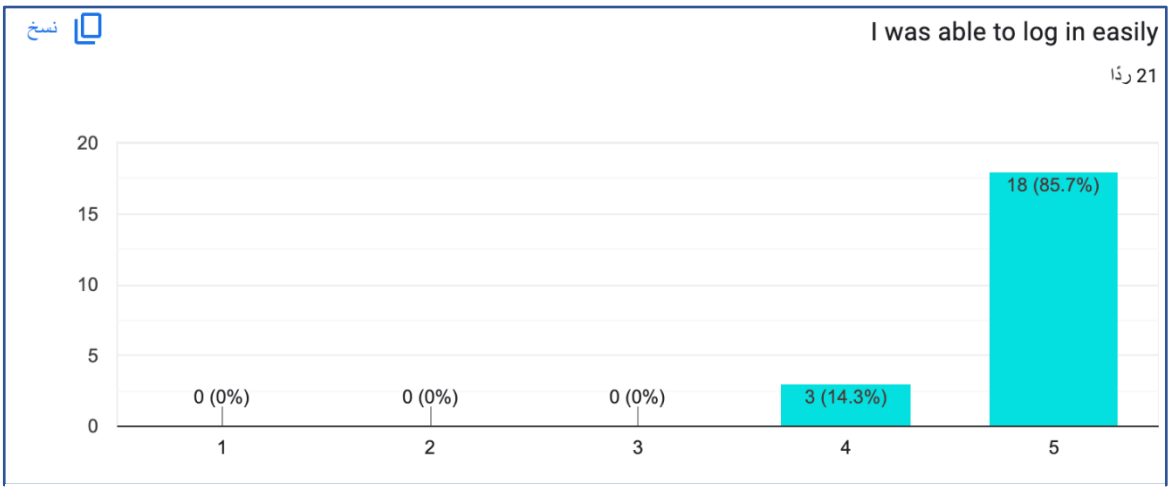
- **GitHub Repository Link:**

https://github.com/HanaAlfozan/2023-GP1-5

9.5 Appendix E: System's Testing Questionnaire




نسخ
Technical background level:
21 ردًا
38.1%
19%
42.9%
Low
Neutral
High
نسخ
Level of interest in video games:
21 ردًا
47.6%
19%
33.3%
Low
Neutral
High
نسخ
I was able to sign up easily
21 ردًا
15
10
5
0
0 (0%)
0 (0%)
3 (14.3%)
6 (28.6%)
12 (57.1%)
1
2
3
4
5



If you faced any difficulties while signing up or logging in, please mention them here

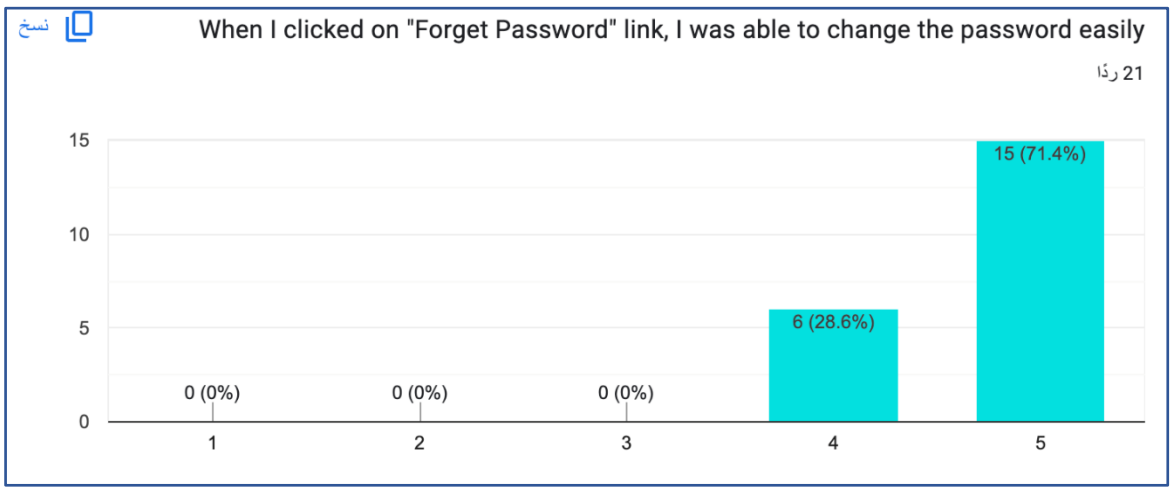
4 ردود

.

No

—

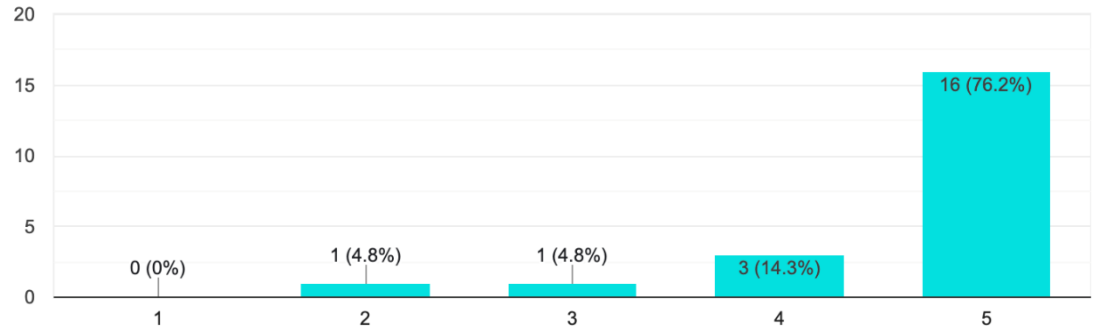
No instructions to give a permission to the camera before taking the photo



نسخ

When I clicked on "Forget Username" link, I was able to change the Username easily

21 ردًا



.If you faced any difficulties while changing password or username , please mention them here

3 ردود

.When changing username, I couldn't choose the sequrity question

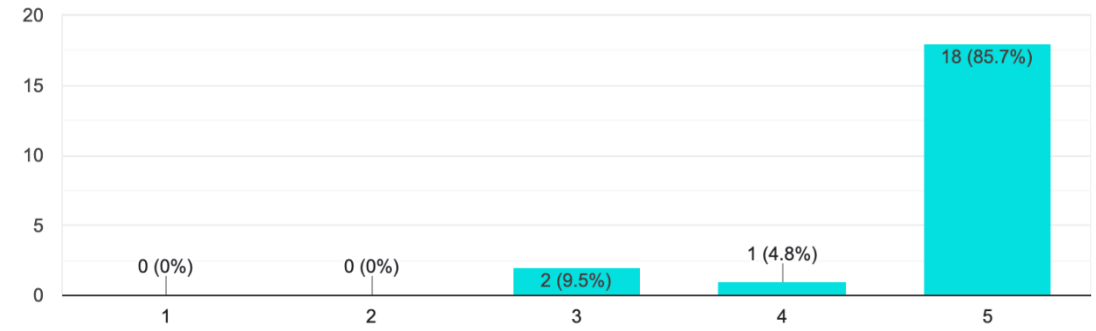
No

-—

نسخ

I was able to take a picture of my face and retake (when needed) easily

21 ردًا



If you faced any difficulties while taking picture, please mention it here

4 ردود

.

No

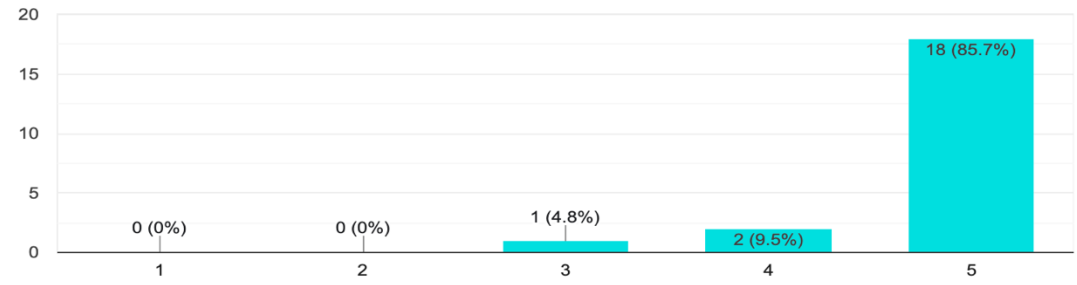
——

No instructions to give a permission to the camera before taking the photo

نسخ

The system was able to detect my face

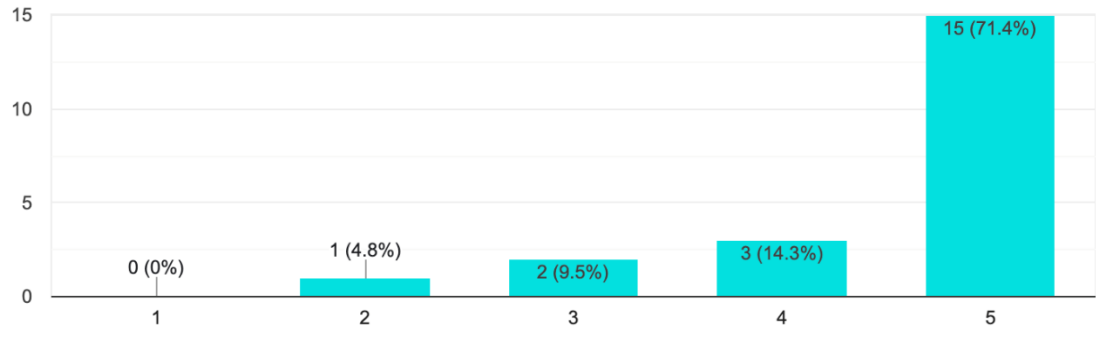
21 ردًا



نسخ

The system classified my age group and the classifying result was correct and clear for me

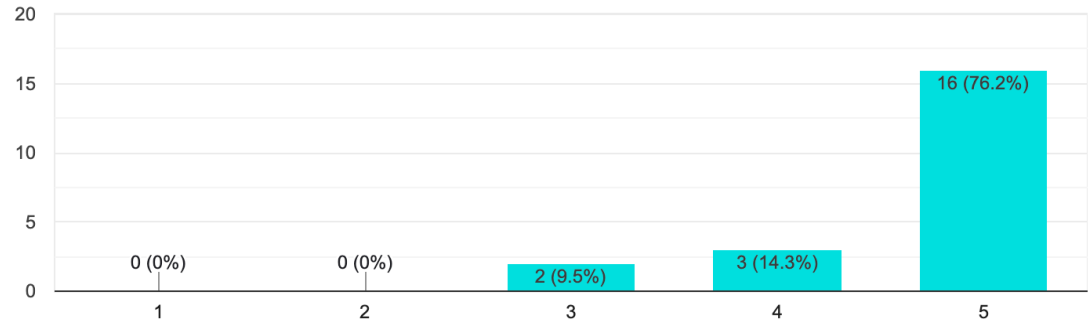
21 ردًا



نسخ

.After logging in, I found it easy to verify my age group by taking a picture of my face

21 ردًا



If you faced any difficulties regarding detecting face or classifying / validating age group, please mention them here

5 ردود

.

No

——

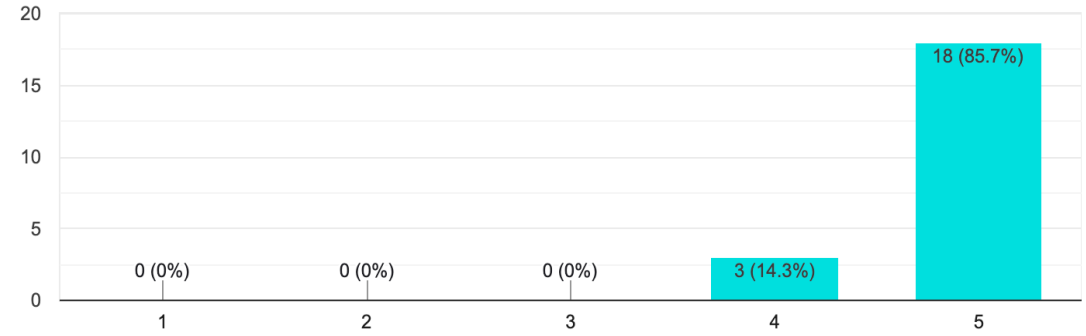
The system classified my face to 12+ while I am an adult

After 2 times is now my age group

نسخ

I was able to browse all games and view each game's information easily

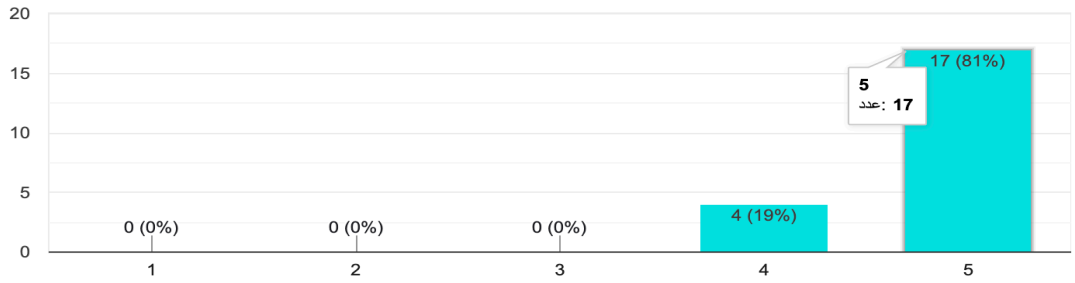
21 ردًا



نسخ

When I clicked on "Go to the download page!" button, the system navigated to the game's page in the app store

21 ردًا



If you faced any difficulties while browsing games, viewing game's information or clicking on "Go to the download page!" button, please mention them here

ردان (2)

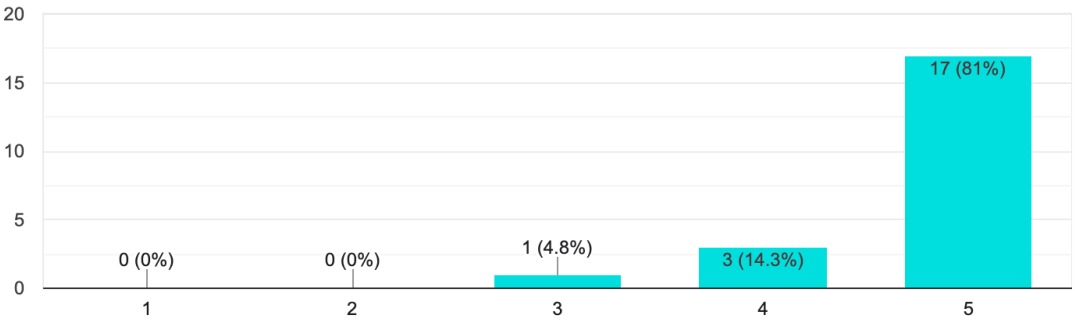
No

–

نسخ

I was able to Filter and sort games, allowing me to easily view the games I am interested in

21 ردًا



If you faced any difficulties while filtering or sorting games , please mention them here

ردان (2)

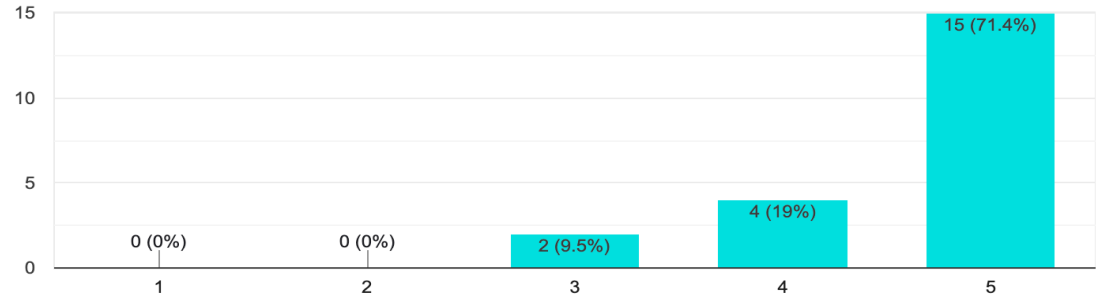
No

–

نسخ

I was able to Save the game I'm interested in when I clicked on "Add to Favourite Games " button, and view it on the "Favourite Games" page easily

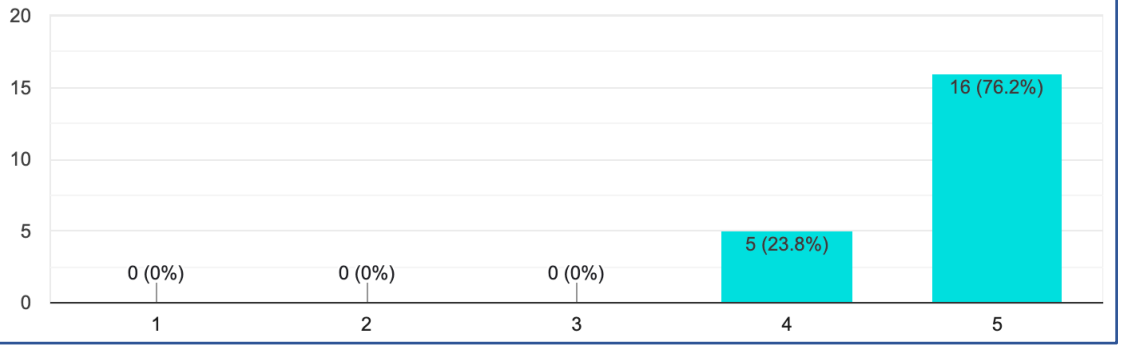
21 ردًا

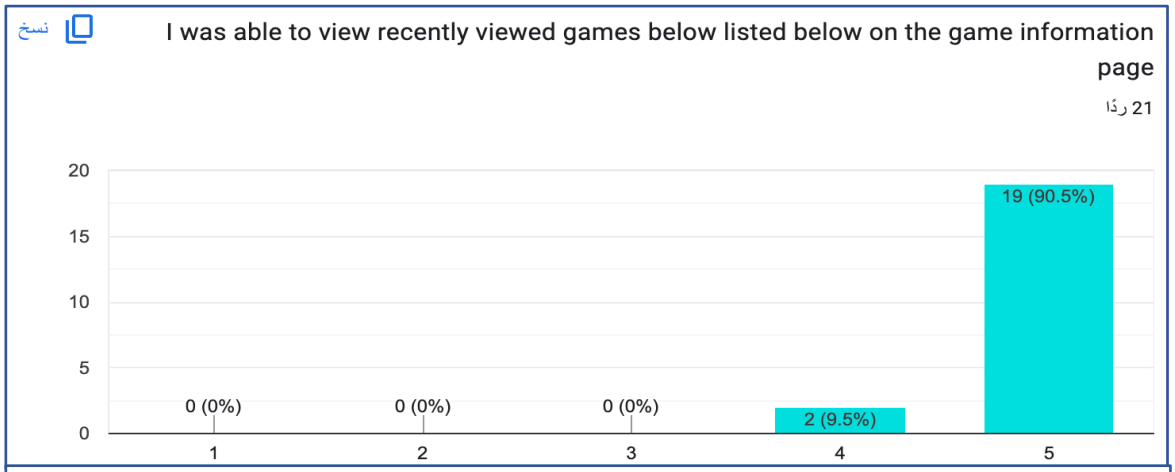


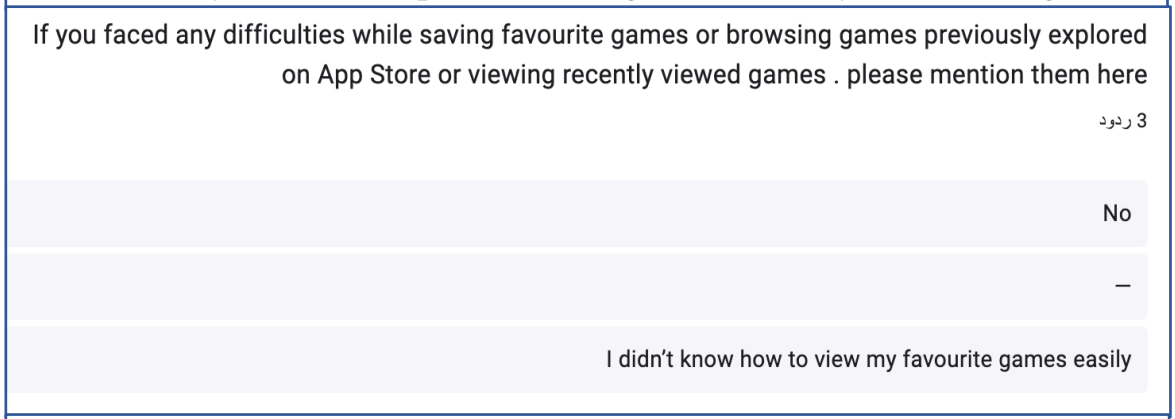
نسخ

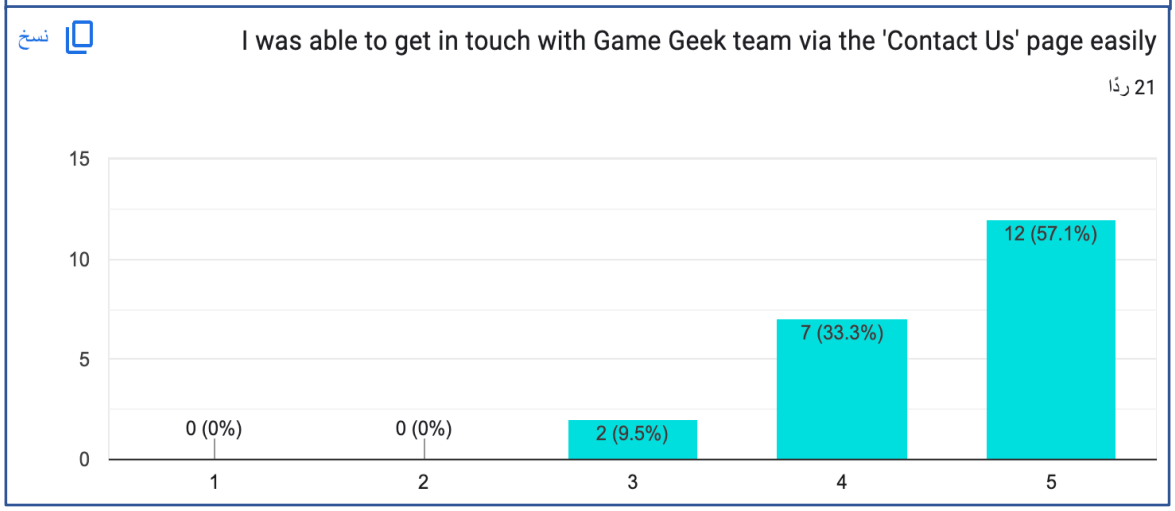
I was able to browse all games that I explored previously on the App Store on the "Visited Store Games " page easily

21 ردًا




نسخ
I was able to view recently viewed games below listed below on the game information page
21 ردًا
20
15
10
5
0
0 (0%)
0 (0%)
0 (0%)
2 (9.5%)
19 (90.5%)
1
2
3
4
5


If you faced any difficulties while saving favourite games or browsing games previously explored on App Store or viewing recently viewed games . please mention them here
3 ردود
No
–
I didn’t know how to view my favourite games easily


نسخ
I was able to get in touch with Game Geek team via the 'Contact Us' page easily
21 ردًا
15
10
5
0
0 (0%)
0 (0%)
2 (9.5%)
7 (33.3%)
12 (57.1%)
1
2
3
4
5

If you faced any difficulties while contacting with Game Geek team. please mention them here

ردان (2)

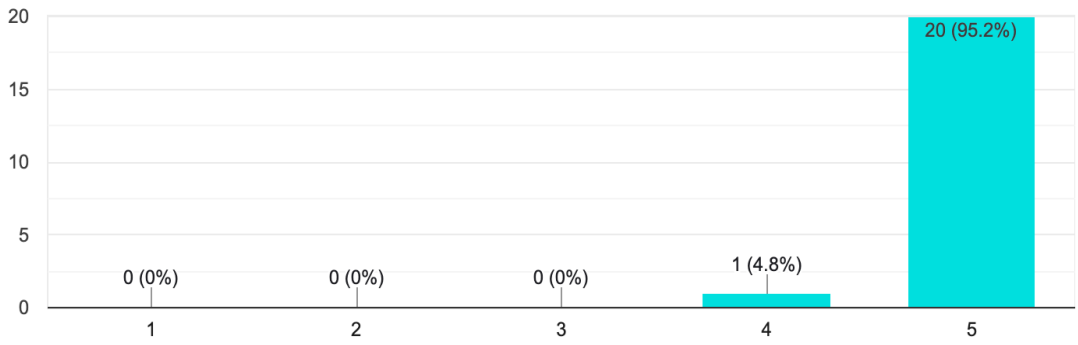
No

–

نسخ

I was able to log out from the system easily

21 ردًا

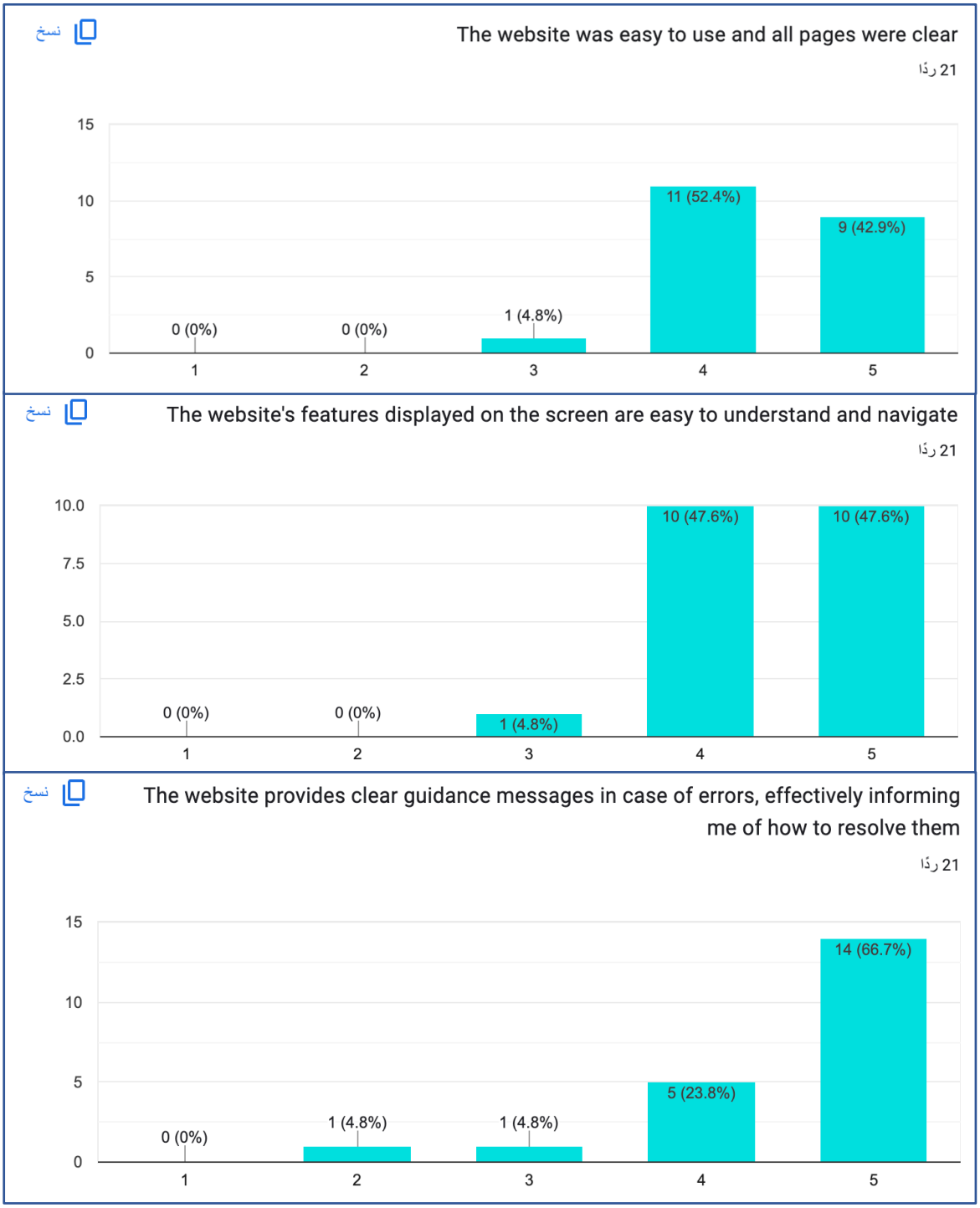


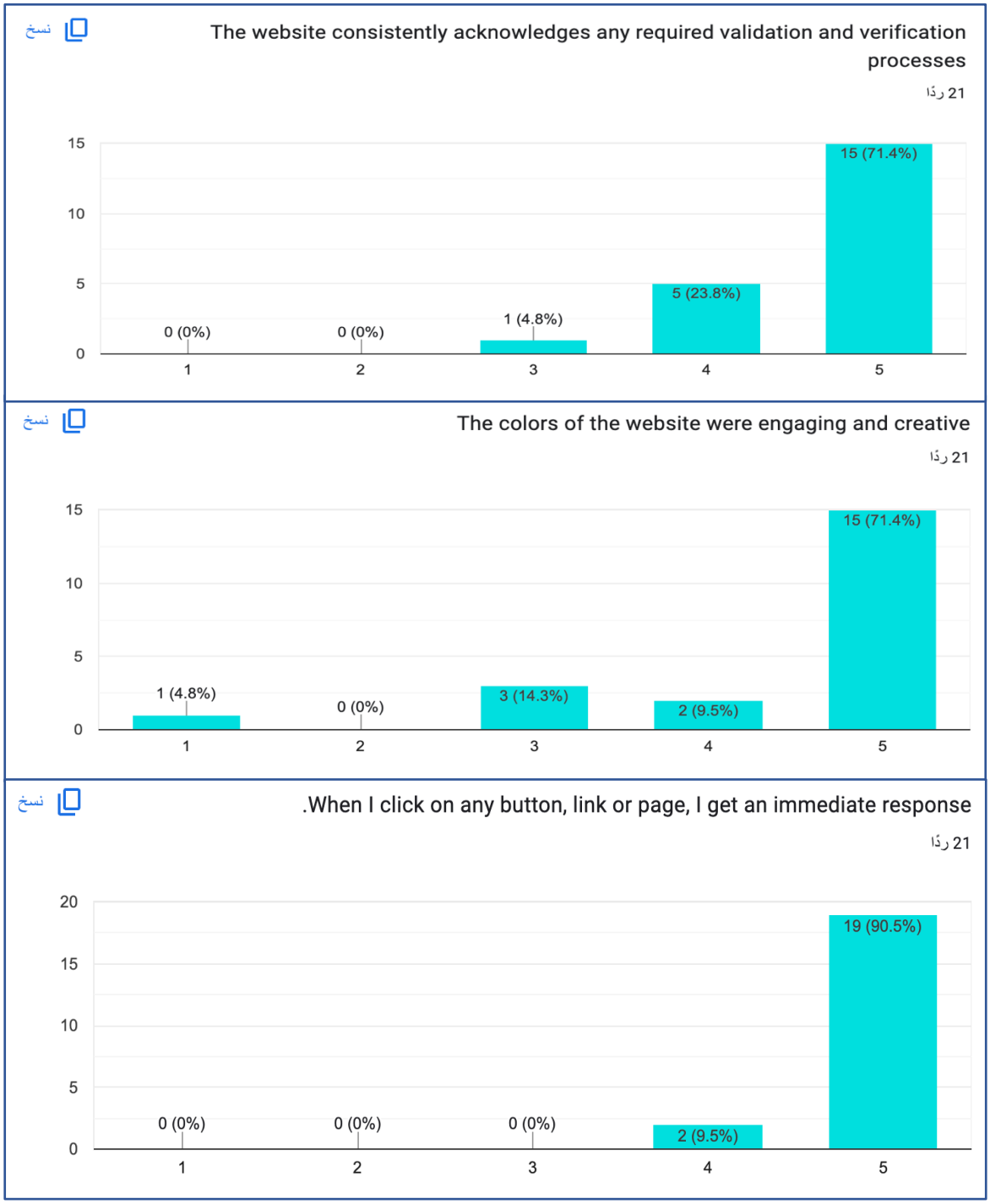
If you faced any difficulties while logging, please mention them here

ردان (2)

No

–


نسخ
The website was easy to use and all pages were clear
21 ردًا
15
10
5
0
0 (0%)
0 (0%)
1 (4.8%)
11 (52.4%)
9 (42.9%)
1
2
3
4
5
نسخ
The website's features displayed on the screen are easy to understand and navigate
21 ردًا
10.0
7.5
5.0
2.5
0.0
0 (0%)
0 (0%)
1 (4.8%)
10 (47.6%)
10 (47.6%)
1
2
3
4
5
نسخ
The website provides clear guidance messages in case of errors, effectively informing me of how to resolve them
21 ردًا
15
10
5
0
0 (0%)
1 (4.8%)
1 (4.8%)
5 (23.8%)
14 (66.7%)
1
2
3
4
5


نسخ
The website consistently acknowledges any required validation and verification processes
21 ردًا
15
10
5
0
0 (0%)
0 (0%)
1 (4.8%)
5 (23.8%)
15 (71.4%)
1
2
3
4
5
نسخ
The colors of the website were engaging and creative
21 ردًا
15
10
5
0
1 (4.8%)
0 (0%)
3 (14.3%)
2 (9.5%)
15 (71.4%)
1
2
3
4
5
نسخ
.When I click on any button, link or page, I get an immediate response
21 ردًا
20
15
10
5
0
0 (0%)
0 (0%)
0 (0%)
2 (9.5%)
19 (90.5%)
1
2
3
4
5

We are happy to hear your suggestions and feedback, please mention them if you have any

6 ردود

💖 Thank you for this amazing system, I like it too much

I would like to have it in the Arabic language and add more games in the Saudi Arabia region, adding more newer games like VR games, Thank you for providing this system.

💙Add more car games and police games, Thank you for this system

💖Veryy excellent website , hope u the best

!that's an amazing website

Improve the face detection, the system is beautiful and needed in games fields, and the effort you put in is shown and there is an amazing touch