İSTANBUL TECHNICAL UNIVERSITY
FACULTY OF COMPUTER AND INFORMATICS

A MOBILE HR GAME FOR ASSESSING INDIVIDUALS' BEHAVIOUR

Graduation Project Final Report

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Statement of Authenticity

I hereby declare that in this study

1. all the content influenced from external references are cited clearly and in detail,
2. and all the remaining sections, especially the theoretical studies and implemented software/hardware that constitute the fundamental essence of this study is originated by my/our individual authenticity.

İstanbul, January 2020

Recep Can Babaoğlu

A MOBILE HR GAME FOR ASSESSING INDIVIDUALS' BEHAVIOUR

(SUMMARY)

As a result of globalization of the industrial revolution, different types of professions arose. It has become necessary to find the right person in the right position as soon as possible. In the last decade, with the development of communication technology, connections have been established between employers and candidates easier. It has become a tough task to find suitable employees for organizations and the companies. The human resources has become important. Although the human resources process has been implemented with different names in many places in the past, it can be accepted that it started to develop rapidly in the 1980s.

The human resources and human resources management includes many sub-fields and professions. In the presented project, problems experienced during the recruitment process of the human resources unit will be identified and will be worked on. In the recruitment process, the human resources department applies many different interview techniques. The interview phase consists of several steps and varies according to the profession. Nowadays, the classical method is widely used. In the classical method, multiple answer tests are applied on the candidate. The test questions are determined according to the traits to be measured. These tests are performed manually. After the assessments, the results are evaluated according to some scales. In this method, applicant is aware of the fact that he is in the interview. The applicant may mislead the assessments. He/she could hesitate to give real answers and can try to choose right answers instead of his real answers. In addition, the applicability of the classical method has decreased in today's technology. Web based classic testing has become preferred. The web based and mobile based applications also uses same old method. Another disadvantage of the classical method is that range of the test is limited. Because of the measurement interval limited to question set, number of questions in the assessment is too much. If the applicant give an answer which around the bounds, asking same question is useless and waste of time. As a result of need of dynamic question set, adaptive test method has been developed and started to be used.

The project presented in the report, the problems experienced during the recruitment process of the human resources have been identified and a project have implanted to improve them. In the project have implemented put forward with the help of computer science and psychology. A game has developed to focus on traits that can be measurable with the game. Experience based traits have tested in the game. Risk-taking behavior, behavior under pressure, speed of process, selective attention are the features to be tested via game. The advantage of the assessment with the game is to be able to get results without revealing the real purpose and the subject. Candidate cannot mislead the test easily.

BİREYLERİN DAVRANIŞLARINI DEĞERLENDİREN MOBİL İK OYUNU

(ÖZET)

Endüstri devriminden sonra farklı meslek türleri ortaya çıkmış bunun sonucu olarak kalifiye iş gücüne ihtiyaç artmıştır. Doğru kişiyi doğru pozisyona en kısa zamanda yerleştirmek gerekli hale gelmiştir. Son yıllarda iletişim teknolojinin gelişmesi ile iş verenlerin ve adayların birbirine ulaşması oldukça kolaylaşmıştır. Bu durumun sonucu olarak uygun çalışan bulmak şirketler ve organizasyonlar için başlı başına bir uğraş halini almıştır. Dolayısıyla, insan kaynakları biriminin önem kazanması da bu tarihlere denk gelmektedir. Bu süresin geçmişte birçok yerde farklı isimlerle uygulanmasına rağmen hızla gelişmeye başlaması 1980'ler kabul edilir. İnsan kaynakları ve insan kaynakları yönetimi birimi bünyesinde birçok alt alanı içerir, birçok meslek grubuyla da birlikte çalışır.

Geçmişten günümüze işe alım sürecinde insan kaynakları birimi farklı bir çok mülakat tekniği uygulamaktadır. Mülakat aşaması birçok adımdan oluşmaktadır ve pozisyona göre farklılıklar göstermektedir. Günümüzde yaygın olarak klasik yönteme başvurulmaktadır. Klasik yöntemde adayın düşünüldüğü pozisyona uygun olarak adayda ölçülmek istenilen özelliklerle ilgili çoktan seçmeli testler uygulanmaktadır. Bu testler fiziksel olarak gerçeklenmektedir. Testin sonrasında sonuçları belirli ölçeklere göre değerlendirilmektedir. Bu yöntem adayın testin sonuçlarını yanıltmasına açıktır. Adayın mülakatta olduğunun bilincinde olarak soruları cevaplaması gerçek cevaplarını verdiği konusunda tereddüt oluşturmaktadır. Ayrıca günümüz teknolojisinde klasik yöntemin uygulanabilirliği düşmüştür. Yerini web tabanlı klasik test sistemi almaya başlamıştır. Web tabanlı sistemde ve mobil uygulamalarla da test soruları ile analizler yapılmaya çalışılmaktadır. Klasik yöntemin zayıf olduğu bir diğer alan ise testlerin ölçüm aralığının soru seti ile sınırlı olması ve çok fazla soru içermesidir. Eğer aday sınırda bir cevap verdiyse benzer sorular sormak zaman kaybı olmaktadır. Bunun üzerine yapılan araştırmalar sonucunda uyarlanabilir test yöntemi geliştirilmiştir, yaygın olmasa da kullanılmaya başlanmıştır.

Raporda sunulan projede işe alım sürecinde insan kaynakları biriminin uyguladığı yöntemlerdeki sorunlar tespit edilmiştir ve gerçeklenen projede bilgisayar bilimlerinin öncülüğünde psikoloji alanından yardım alınarak bir çözüm ortaya koyulmuştur. Eski ve alışılagelmiş yöntemler yerine teknolojinin getirdiği yeniliklerden yararlanarak dinamik bir yöntem geliştirilmiştir. Test için bir oyun geliştirilip kullanıcının oyun ile ölçülebilecek özelliklerine odaklanılmıştır. Bu özellikler seçilirken deneyim tabanlı olması temel alınmıştır. Risk alma durumu, baskı altında çalışma durumu, işlem hızı, odaklanma gücü oyun ile test edilen özelliklerdir. Mobil oyun ile testi uygulamanın getirisi adaya gerçek amacı ve test edilen konuyu belli etmeden sonuçlara ulaşabilecek olmaktır. Adayın testi yanıltması zorlaşacaktır.

Contents

1 Introduction and Problem Definition

The history of Human Resources Management dates back to BC. The earlier known applications are the pricing systems in Hammurabi laws, the first division of labor and expertise in the Chinese in the 1600s, etc. Scientifically the most significant historical development in the importance of human resources was the Industrial Revolution (18th century) that began with the invention of James Watt's Steam Machine in 1768 [1]. Human resource has changed in name various times throughout history. The name change was mainly due to the change in social and economic activities throughout history. The word of human resources began to be used instead of the older concepts such as personnel management in the 1980s. Human resource management is the scientific approach to the effective management of people in an organization, it focuses on policies and systems to maximize employee performance [2]. Basically, it is management of human capital. The human resource management departments responsible for many subdivisions which are employee recruitment and staffing, compensation and benefits, training, labor and employee relations, organization development etc.

The companies which want to survive in business life knows that it can only be achieved when they have the perfectly combine the employees. Therefore, the recruitment process is become utmost important part. According to Edwin B. Flippo, “Recruitment is the process of searching the candidates for employment and stimulating them to apply for jobs in the organization” [3]. As a result of complexity of personnel recruitment, companies start to get professional help from HR experts. The human resources department has begun to conduct tests to find the appropriate employee. According to the needs of companies and requirements many types of tests have been developed and used.

There have been wide variations in recruitment and selection practices considering an organization’s strategy. The practices have been consisted of different steps. To illustrate, recruiter builds relationships, candidate applies, resume stored & screened, candidate interviewed, candidate hired or resume stored. The candidate interview step is main concern of the project.

The candidate interviews differs from each other in terms of test types. The test types are varied because the desired traits differ for occupational positions. Also, assessment types differ from each other in terms of application form. One of the common form of the assessment is classical methods.

Today, classical method is widely used in interviews. The classical method can be defined as a hard copy assessments answered by applicant. In the classical method, most of the question consist of multiple answer question. Some web-based applications and a few mobile applications have been developed instead of classic method. Most of them just changed the platform of the classical method, not the form. Also, one downside of the classical method is that applicant may try to mislead the result. Because of the possible

cheating in classical method, a new approach become necessary. In addition to downsides of the classical approach, question set is predefined. The same set of questions is applied to everyone over and over again. Some modern approaches have been applied an adaptive method to can calibrate question set. The adaptive assessments decrease the application time and increase the precision.

In the project a new approach has developed to improve downsides of the old studies. Firstly, the project is an experience based game which focus on traits can measurable with game. The game figures out risk taking behavior, behavior under time pressure, speed of processing and selective attention. The advantage of the assessment with the game is to be able to get results without revealing the real purpose and the subject. Candidate cannot mislead the test easily. The risk taking behavior has been understood by evaluating user decisions. The user behavior under time pressure has been observed by using limited time in the game. The speed of processing and selective attention has been monitored using Stroop Effect method. Also game has been adaptive according the user decisions next stages rearranged. The adaptive game allows to understand the limit/boundary points.

In the project 4 stages implemented. Stage 1 was designed as a basic risk taking game like a tutorial. Then user got experience about game stages become difficult and complex. In the second stage user start the play color game which designed as a new version of stroop effect test. In the stage 2 the stroop effect test designed to measure users attention level and focusing. Next stage is 3, which includes a timer on the screen when the user chooses a color button. The user show a countdown from three to zero. The short selection time earns more points. The game try to understand user behaviors under time pressure. In the final stage user faces a new difficulty, if the user selects wrong color button their point will be reduced. This stage try to understand award sensitivity and control perception. To sum it all up, the HR Game try to measure risk taking behavior, the speed of processing, selective attention, mental flexibility, behavior change under time pressure, control perception, reward sensitivity.

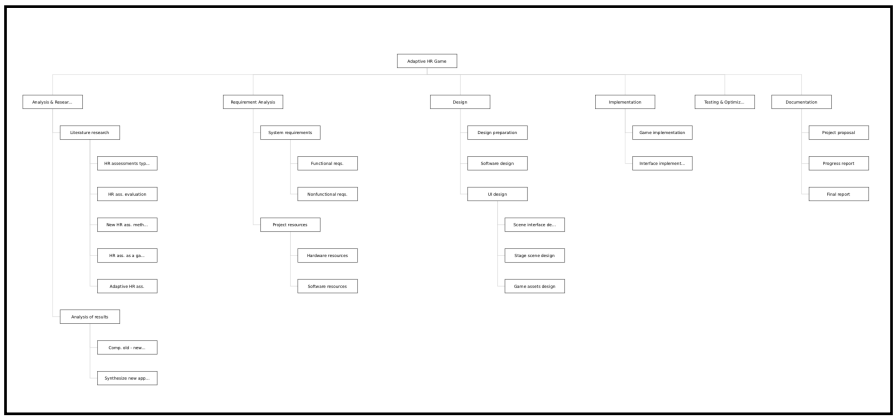


Figure 1.2: Work Breakdown Structure in tree format

According to work breakdown structure (Figure 1.2) development includes six subsection. Based on the tasks in the work breakdown structure (Figure 1.2) a Gantt Chart is prepared before the project. According to task due date on the gantt chart most of task finished in

scheduled time. Also, some new unplanned problems occurred. But final project finished in time. If the project had ended before expected, the dynamic method would have been applied.The implementation part would be extended. The not scheduled but considered and researched parts given in section six which is conclusion and future work.

2 Comparative Literature Survey

There are many relevant studies on human resources assessments methods but none of them directly address an adaptive human resources assessment as a game.
A few studies focus on game based assessment. According to Ohr, by using game based talent assessment, companies can easily hire appropriate employers [4]. An Athens based human resources tech startup Owiwi, proved that game based assessments are best way to hire and candidates give positive feedback. Companies who have tried the Owiwi get remarkable results. It brings 50% time reduction, 47% number of interviews reduction. But one downside is that it is a story based game, candidates can easily mislead the answers. Although it reduces wasting time in hiring process, misleading is a common problem which needs to be fixed. Therefore, the proposed project focused the experience based game instead of story based game. In the story based games, the user act as in a multiple choice test. In the experience based games there is a flow, the user cannot realize background logic easily.

There are various experience based assessments methods but most of them not practicable as a game. Few of them are appropriate the game flow. Risk taking, decision making under pressure, speed of process and selective attention are practicable in a game.
Firstly, the risk taking behavior of the applicant, can be measured by evaluating their decisions. The frequently used measurements of decision making in psychology are the Iowa Gambling Test (IGT), the Balloon Analogue Risk Task (BART) and the Columbia Card Task (CCT) [5]. The IGT and the CCT are card games, their flow are not suitable for a progressive game. They have different kind of flow it is not suitable expected experience based game story. However, the BART has a proper flow for an experience based game assessment. The BART is a computerized test, candidates can make different decisions then get different amount of points. Test consist of 20 low, 20 medium and 20 hard different risky stages. The candidate try to get maximize the point by pumping balloons [6]. Also, the BART approach is suitable for a mobile game. The risk taking part of the game have inspired by BART.

Secondly, the Stroop Effect tests are another suitable method. The Stroop Effect measures applicant's speed of processing and selective attention. It is a common method for recruitment process. Basically, in the Stroop Effect assessment, applicant try to say the printed word colors instead of meaning of the word [7]. There are several different version of the method. The basic version which is the color naming version is suitable for the project. According to the selective attention theory, naming the color of the words harder than reading the text. It requires more focus and to give more attention. The speed of processing theory mentions that reading speed of the word more than the naming the color of the word. Lack of correlation between reading and naming speed, makes the test harder.
The Stroop Effect test has adapted to mobile game. In the game, there was different colored and different named balls user tries to find the right color which typed in front of

the ball instead of background color of the ball. The optimized color set implemented after the comparing participant reactions.

Lastly, the project would be designed as an adaptable game. In other words, the game is going to be an application of dynamic test method. In literature, there is an appropriate method which is named as Computerized Adaptive Test (CAT). The CAT is a difficulty level adjustable test which mostly applied to students. If the user give wrong answer, computer ask easier questions. So according to knowledge base of the applicant, computer sets appropriate next questions. The CAT has many advantages. For example it reduces 50% test time, increases motivation of the applicant by asking related questions, increases security, decreases labor cost and increases accuracy. When it combined with Item Response Theory (IRT) it became more effective. Different questions sets estimates different characteristic levels using IRT [8]. Its basic logic applicable to a mobile game. when designing the next stage of the game, CAT based approach brings many advantages. In the game expected benefits are increased accuracy and much more user motivation. But the dynamic part of the game not implemented because of the time problem. Previous stage took more time than expected.

3 Developed Approach and System Model

IOS is a mobile operating system based on OS X developed by Apple and it works on iPad, iPhone and iPod devices. The one way to develop native iOS application is to use XCode. XCode only works on OS X operating system. Considering the given requirements the project developed on Mac Book Pro 13, with the recent version of XCode which is 13.3.

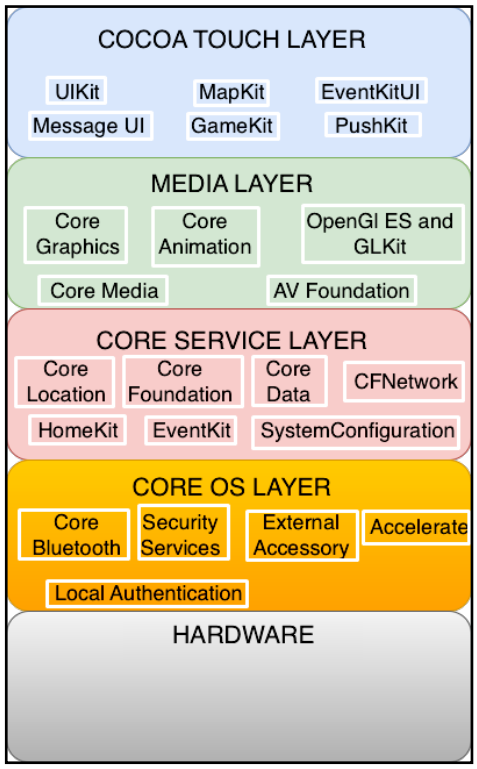


Figure 3.1: iOS Architecture

iOS architecture has 4 layers (Figure 3.1 [11]). The bottom layer is core OS related to hardware and networking. It is low level and closely work with computational instructions. Second layer is core services layer it is fundamental services for low level network communication. The third layer is media layer. Last layer is Cocoa Touch. The Cocoa Touch layer is appropriate to application development, it provides application user interfaces and responds to user behavior. The project mostly related the cocoa touch layer.

Suitable programming language selected as Swift 4 and Swift 5 for interaction with Cocoa Touch layer between users. If needed, Objective-C code implemented for old methods and frameworks.

Also, Apple provide 3 different approaches to development of user interface design. Applications can be designed directly by code or designed from storyboard or using Xml in Xib files. First one and second one of them utilized in the project.

In the Cocoa Touch Layer the native frameworks are used in the project two of them are GameKit and SpriteKit which includes some game development approaches. Also third important framework is The UIKit, it used for user interface designs. MVC (Model View Controller) architecture which is most well known and accepted approach is used in the project.

Use Case #1: Game stages
Scope: Start to test
Primary Actor: User
Preconditions:
- Program must be downloaded.
- User has already run the program.
- User information must be taken from the user.
- Tutorial stage must be completed.
- Start stage must be chosen.

Basic Flow:
1. User selects the stage button which is on the main menu.
2. Then application starts the stages.
3. User plays the stages.
4. Game updates the score label.
5. The game prompt some information messages between stages.
6. Game section terminated.
7. Result scene should be opened.

Extensions:
2.-3.-4 -5.
   1. If the user touches the pause button on the screen.
   2. Game prompt a message “paused the game”.
   3. Game does nothing.
   4. Game waits for touch to resume button.

Use Case #2: Tutorial stage
Scope: Teaches user how to play
Primary Actor: User
Preconditions:
- Program must be downloaded.
- User has already run the program.
- User information must be taken from the user.
- Tutorial stage must be chosen.

Basic Flow:
1. User selects the tutorial button which is on the top of main menu.
2. Then application open the tutorial stage.
3. User reads tutorial infos and warnings.
4. Then tutorial stage starts.
5. User catches balls.
6. Game updates the score label.
7. The game prompt some information messages considering ball types.
8. Tutorial section terminated.
9. Main menu scene will be opened.

Extensions:
5. a
   1. If the user does not catch the ball.
   2. Game prompt a message “ be-careful you miss the ball ”.
   3. Game starts to throw balls again.

Use Case #3: Exit game
Scope: Close the game
Primary Actor: User
Preconditions:
- Program must be downloaded.
- User has already run the program.

Basic Flow:
1. User selects the exit button which is on the main menu.
2. Then application closed.

Use Case #4: Result
Scope: Check the result
Primary Actor: User
Preconditions:
- Program must be downloaded.
- User has already run the program.
- Stages will be completed.

Basic Flow:
1. User selects the result button which is on the main menu.
2. Then shows the result from stages.
3. Then user clicks the close result button.
4. Game scene turn back to main menu scene.

Figure 3.2: Uses Cases

According to uses-cases decided before the project interim report (Figure 3.2) project designed more detailed than planned uses cases. Some of new stages and behaviors are implemented. Some new screens added to existing ones given in use-cases but main game flow kept same. For example, an information screen opens when user select a stage. Then user slides the character toward the start button when it pressed, stage starts. Detailed flow presented on next chapters of the report.

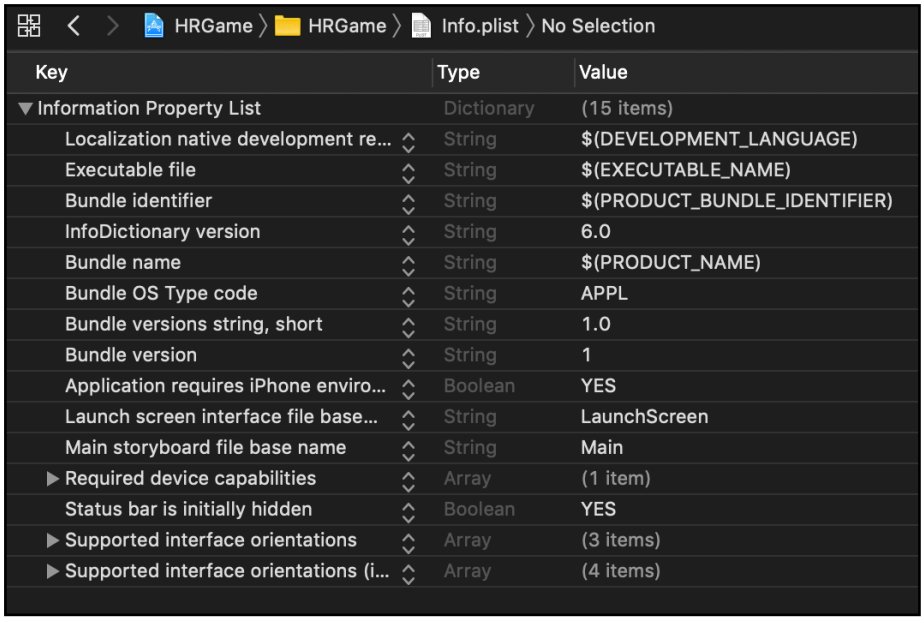


Figure 3.3: Info.plist

In the figure 3.3 info.plist (information property list) added. A property list is a way to set data that the system can access at runtime. An information property list is a specialized type of property list that contains configuration data for an application. The keys and values in the property list describes the various configuration and settings about application. An Xcode project template typically specifies an information property list file with an initial set of keys and appropriate default values. The info.plist file edited to change or add keys and values, as appropriate for project. The application not request unnecessary permissions from user. For example, the fourth line given Figure 3.3 describes the bundle identifier which is a unique id, it uniquely identifies an application in Apple's ecosystem.

3.1 Data Model

The static data structures used in project presented in this section. E-R diagrams presented and explained in detail.

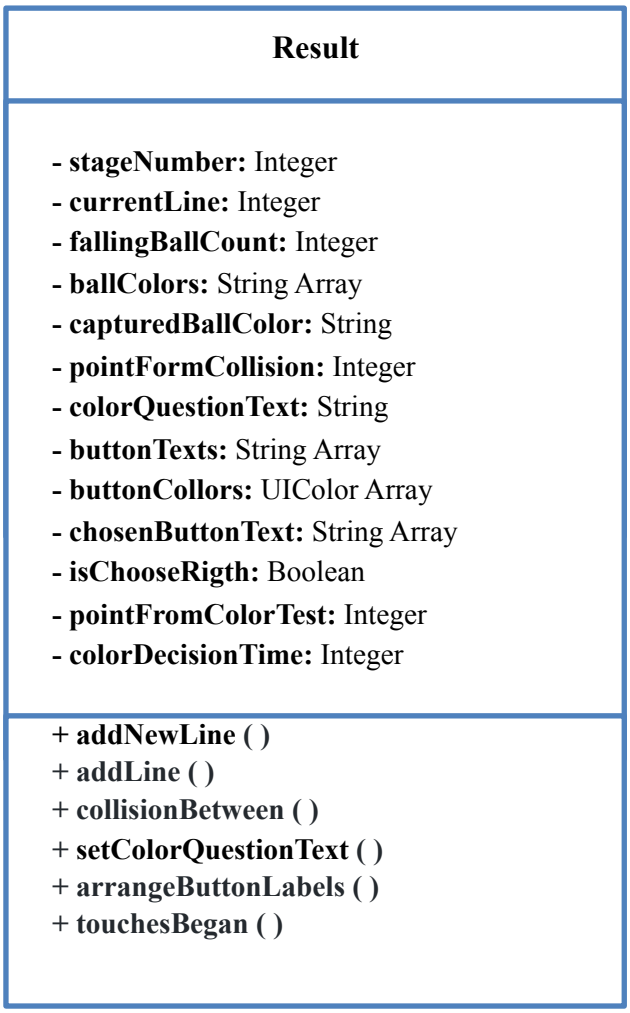


Figure 3.4: Class Diagram for Result Struct

In the project for storing result data a struct is created which called as result. Structs are value type classes are reference type in swift language. When the copy a value type struct each instance keeps a unique copy of the data. If user change one instance, the other doesn't change too. Because of this static behavior struct preferred to class. Each line has their unique result struct. Each stage has 20 lines. To store 20 times a result struct an array of struct defined. Each line appended to this result array. When the stage end result array printed out to an txt file. The results could be found in mobile application application data AppData/Document/<StageName>.txt. To distinguish the data stored from different user each user has unique id. The id taken from cpu timer, when the stage end id saved with result array.

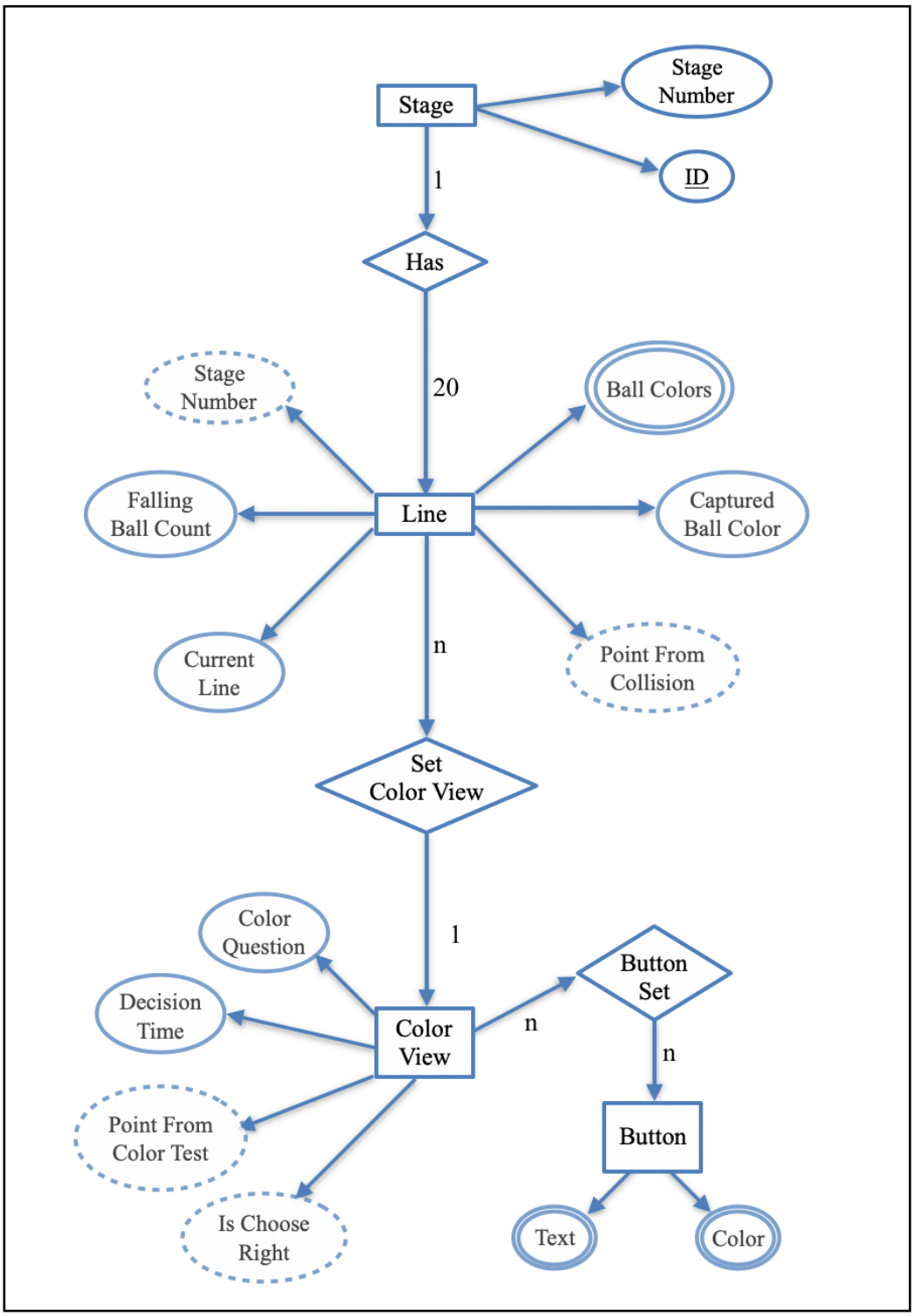


Figure 3.5: Entity Relation Diagram

The entity-relation diagram given in Figure 3.2. (on the next page) states the entities were used project. In the project when one the of four stage was started, stage number and unique id entities set. The id taken from device cpu time. The id is a key attribute it uniquely identify each entity in the entity set. Stages and lines has a relation between them. The cardinality of relation is one-to-many. Each stages creates 20 different line. The lines have ball colors which stores the color array. The ball color array include number of falling ball count UIColors. Also, line stores current line entity for indexing. The captured ball color attribute stored for evaluation of point so, point from collision attribute related to captured ball color. When specific color test stage selected, color view set. Each line has one color view which includes 2 attributes 2 derived attribute and one entity. Color question attribute selected according to stage number. The decision time considered time from button appear to button tap. The point from color test and “is choose right” attributes derived from selection evaluation. The another relation between color view and button is button set. It has a one-to-one cardinality. Each button have 2 multivalued attribute which are text and color. The multivalued means they are arrays of color and text.

3.2 Structural Model

In the section some of key algorithms, developed approach, flow of the game and stage creation presented.

In the project AppDelegate starts the GameViewController then it adjust the scenes. In the AppDelegate there is no necessary change. Considering user experience status bar adjusted hidden for full screen, device orientation adjusted as upside-down and auto rotation enabled in the GameViewController. Also some analyze indicators added to all view controllers to understand performance issues such as show game FPS, show node count.

In the HR Game there are 3 main scenes (SKScenes, SpriteKit Scenes) which is an object organizes all of the active nodes. It is the root node on the node tree. It includes other nodes which are its child such as labels, points, buttons etc. The project consists of three different scenes:

- MenuScene
- StartScene
- GameScene

The menu scene is first user interaction scene, it designed for user interaction such as selecting the stage number or starting game, terminating the game. The second scene is start scene, which gives gameplay information and game rules in a text box. The last but most important one is game scene, which adjusts views, nodes, timers and labels considering the previous stage selections. Each scene and their children were introduced detailed with images in the next chapter (3.3 Dynamic Model). In structural model chapter the project report focused on GameScene which contains main algorithms.

The main flow in the game scene can be shown in Figure 3.6. Related methods attached each other and arrows show interaction directions.

Game scene set process:
It adjusts the game world physics such as gravity and collisions. Then adds permanent and fixed nodes in each stages. Also it connects code block with design on scene. Fixed nodes in game scene:

- Background
- Buttons: play, pause, menu
- Labels: point counter, remainder line counter, gained point label.
- Nodes: character, ball positions
- Views: point view, remainder view

Game scene check the user defaults to identify which stage will be set. Then adjust other nodes which are depending the stage:

- Color questions
- Color views
- Color labels
- Color buttons
- Stage timer
- Color countdown timer

One of the important part of the game is **stage timer**. Stage timer regulates the line creation intervals.The game has different flow speed in each stage. Set timer then each repetition it calls another method. It is a loop until defined bound reached. Given behavior arranges the game speed. (Figure 3.6)

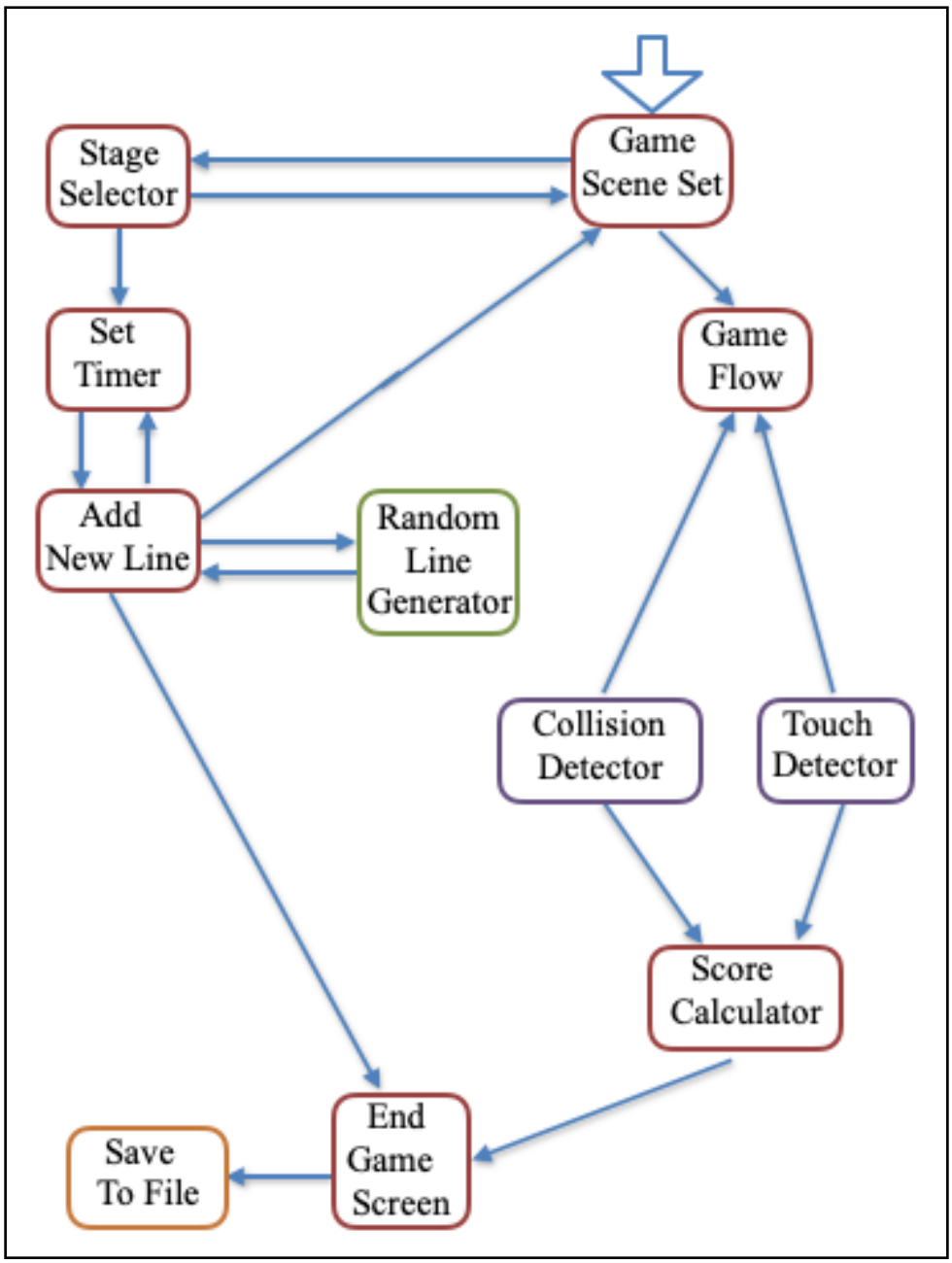


Figure 3.6: Game Flow Diagram

The game scene sets given children. Checks stage number in a if-else block then gives a value to a timer which regulates game flow speed. Set timer method arranges the speed. According the stage selector timer calls add new line method.

Add new line process:
First of all add new line method checks the remaining line count. If the remaining counter became zero game should be terminated. It sends invalidate prompt to stage timer and awakes end game method.
If the remaining line not equal to zero, new line will be created. Add new line method choose number of ball count between two to five. There is no defined parameter each ball count has same possibility. If the game improved as dynamic a parameter can be added there. Then add new line method sends the ball count to line generator.

Line generator:
According to ball count line generator generates the ball positions. Each counts have different initial position value and delta value. Then it should generate random balls without no duplicates. Also the ball generation part adaptable to dynamic improvements.

```
while( a < each ){
    randNumber = Int.random(in: 0 ... 6)
    for b in 0..<noDupArraySize{
        if(randNumber  == noDuplicateArray[b]){
            flag = true
        }
    }
    if(flag == false){
        noDuplicateArray.append(randNumber)
        a = a + 1
    }
    noDupArraySize = noDuplicateArray.count
    flag = false
}
```

The duplications should be avoided because same answer for a question is unacceptable considering quality of test. To eliminate duplications given block figure 3.7 is coded. *Each* parameter is adjustable from line generator it stores ball numbers. Then the ball array sent to game scene. If necessary game scene arranges the color labels and buttons.

Figure 3.7: Avoid Duplication

In the gameplay two main behavior expected which are collisions and touches. The collisions can be observed between every moving objects. The touches is main concern of the game, it allows to user to play game.

Collision Detector:
In the game there are many collisions. In the scene many objects contacts each other without movement. The collision detector detects all of them. For example each balls collides with background or bottom pad. The collision detector optimized to catching meaningful collisions. The intended collisions are balls between character collisions. In a line first collision is enough to understand user decisions another collision should be detect and second collided ball in same line should be bounced from character.

```
func didBegin(_ contact: SKPhysicsContact) {
    character.name = "character"
    guard let nodeA = contact.bodyA.node else { return }
    guard let nodeB = contact.bodyB.node else { return }
    if nodeA.name == "character" {
        collisionBetween(character: nodeA, ball: nodeB)
    } else if nodeB.name == "character" {
        collisionBetween(character: nodeB, ball: nodeA)
    }
}
```

The code block given left side become active if a collision occurs. Compares node names to identifying them. Sends them to collision comparison method (collisionBetween).

Figure 3.8: Collision Identification

Score calculator calculates the points according the collided object names. Then destroy method invoked to clear created nodes to deallocate memory. Score calculator interacts the game scene set, it sends to point gained from collision.

Touch Detector:
There is a method which named “touchesBegan” in swift. It catches the each user interaction between user and screen. It gets the touch location then check the scene if there is a node on touched location, appends the detected node an array. Then compares name of the node, object touch become identified. Button interactions evaluated in touch detect method then sends score calculator if the touch necessary.
Another significant method is “touchesMoved” which helps to move character. It gets user sliding direction then keeps the character on same y position, it only changes the x position.

End game screen is called from add new line method if the remaining line count become zero. It adjust a new view in front of the existing screen, adjusts the z position of the objects, shows a stage completed note and stage point. Then menu button appears above on the screen. It calls the save to file method automatically.

Save to file process checks the user defaults for stage number and user id. It stores the data given in figure 3.4 to specific file using user id. The result array printed out to an txt file. The results could be found in mobile application data AppData/Document/ <StageName>.txt. To distinguish the stored data each user has unique id. First time the id taken from cpu timer, when the stage end id saved with result array.

3.3 Dynamic Model

This section contains dynamic models (both overall and component based) based on system behavior. Also the flow between interface mockups presented.

Figure 3.9: Game Scene Flow

In the HR Game there are 3 main scenes (SKScenes, SpriteKit Scenes) which organize all of the active nodes. It is the root node on the node tree. It includes other nodes which are its child such as labels, points, buttons etc. The project consists of three main scenes:

- MenuScene (Figure 3.9: image 1)
- StartScene (Figure 3.9: image 2)
- GameScene (Figure 3.9: image 3, image 4, image 5)

The “menu scene” is first scene to user interaction, main task is providing stage selection option to user. Firstly it connects necessary nodes (background, buttons and their labels). When user tap the start game button view controller sets the user default values with a specific key. The specific key name is “stageKey”. Then “start scene” presented. Also there is an exit game button top-right side of the screen. In swift language and iOS devices there is no exit method. To close the program, exit button crashes the application, game becomes terminated.

Then second scene start scene gives some information about the game. Firstly it connects necessary nodes and adjust views, textfields. User should slide the character through menu button or start button. When character reach any of the buttons, button becomes pushed and scene changed. Menu button to go menu scene and start button to game scene. The main purpose of the start scene is giving information to user about stage behaviors game rules. They short tutorials and instructions about gameplay. Each stages have some information which are addition the previous infos. Stage rules:

- Stage 1: At this stage you should catch falling balls. Each ball gives you a different score (green scores below the balls). There is a risk of penalty (minus half of the ball scores). The risk probability written in the balls. Becareful! If you are ready, swipe the character to the start button.
- Stage 2: At this stage, there is an additional color matching question. When you catch a ball, colored buttons will appear at the bottom. You should match the ball color with the color name that will appears at the bottom. Keep in mind the button countdown is 3 seconds.
- Stage 3: At this stage, there are two different color matching questions. According the question you should match the ball color with the name of the color or color of the texts. Keep in mind the button countdown is still 3 seconds.
- Stage 4: At this stage, if you choose a wrong color match you will get 5 point penalty. If you don’t choose any button you will get same penalty (5 point). Keep in mind the button countdown is still 3 seconds.

According to given information user should understand the gameplay. Also there are some visual information in Figure 3.9 image 2. Balls are arranged according to their risk levels left side has lower risk, right side has higher risk. Every stages have same risk distribution, scores and penalties. Green scores are rewards and red scores are penalties. Next scene is game scene.

Figure 3.10: Game Scene

Game scene is the main gameplay scene. Everything about the game flow happens there. According to figure 3.10 there are many different nodes in the screen:

1. Remaining label: It shows the remaining line count. Add new line method counts line values each time then checks if the remaining will be 0 it terminates the timer then give signal to end game method.
2. Score label: It shows instant score. Score calculator decide the point then send it to game scene. Game scene sets the score adding with present value to incoming value.
3. Point area: It shows point there is rotation animation on stars if the point changes, stars starts turning around. There are 3 possibilities to point calculation:
    1. Collision between character and balls.
    2. Touches (user touches a color button) (Figure 3.11 touch area given)
    3. No touch, if the stage 4 is playing. There is a no touch penalty.
4. Risk order view: It shows the same order with previous scene. Each stage has same risk order so each of them have same risk view.
5. Balls: There are two to five balls falling from upside to bottom pad. User slides character towards them to get point.
6. Question type icon: It is a visual icon to understand question type instead of reading the text.

7. Character: Moves left or right according to user swipe. It can collide with balls. The first collision makes sense. Second one bounces from character.
8. Question view: It shows the question text.

Figure 3.11: Game Scene

9.Button timer: When the color buttons appears on the bottom. A timer starts to count down from 3 to 1. Each remaining seconds reduce to possibility of reward point. When timer become 0 without any selection user gets 5 point penalty in stage 4.
10. Color buttons: It is adjusted according the ball colors Their colors and texts are same the falling balls. If user makes right match gain points.
11. Performance indicators: there are two indicator to measure performance nodes count and fps.

When the game line finished and stage terminated. End game view presented. User can go to menu scene.

4 Experimentation Environment and Experiment Design

The HR Game Project contains many experiments in development cycle. Because user interaction is significant. The results of the project not precise due to the project related to human behavior. The measured behaviors are abstract. Understanding the human behaviors are so complicated. As a result of implementing abstract methods, many experiments have been carried out. Most of the implemented methods are well known in literature but combined versions are not mentioned. Also known methods combined and applied in a new approach as game. The conducted intermediate experiments have helped too much in design process of the stages. Many user feedbacks helped to determine stage flows. The stages, each time optimized and conducted on again another user group. As a result of each experiment, stages were optimized with a psychologist. For example, timer for falling ball interval, risk percentages, penalties etc. optimized with the result of experiments.

At the end of the project, it was tested with detailed experiments. The focused user group in IT sector. 10 different people in IT sector selected, 5 of them are male another 5 are female. The results evaluated considering gender behaviors. The experiments were performed in the same environment for all. Everyone was given the same prior information.The experiments try to understand human behavior considering genders. Another concern is try to understand human behavior considering reward-penalty.

Risk Measurements Metrics	Risk
	Risk After Penalty
	Risk After Reward
Color matching Measurements Metrics	Selective Attention
	Flexibility
	Speed of Process
Metrics used for Stages	Behavior Under Time Pressure
	Reward Penalty Sensitivity

Table 4.1: Metrics to Evaluate Experiments

Given metrics on Table 4.1 used to evaluate experiment, stages designed again after each experiment. Lastly, final product have prepared. At the end of the project, users compared using given metrics in Table 4.1.

Participant	University	Department	Age	Gender
Anıl	İTÜ	Mathematics Eng.	24	E
Ali	İTÜ	Civil Eng.	26	E
Orçun	İTÜ	Electronic Eng.	24	E
Tolunay	İTÜ	Metallurgy Eng.	25	E
Sabit	İTÜ	Architecture	25	E
Can	İTÜ	Computer Eng.	24	E
Enes	Haliç Üni.	Computer Eng.	23	E
Bilge	Hacettepe Üni.	Physics Eng.	22	K
Merve	İstanbul Üni.	Psychology	23	K
Katre	İstabul Üni.	Biological Eng.	24	K
Elif	Haliç Üni.	Physiotherapist	25	K
Gülizar	İTÜ	Mathematics Eng.	24	K
Şeyma	*other	*other	20	K
Lal	*other	*other	24	K

Table 4.2: Tested users

To final experiments applied to 14 people. Table 4.2 shows all of the applicants, they allowed their names and data to be shared in the report. According to their result comparative evaluation and discussion part prepared.

5 Comparative Evaluation and Discussion

There are many approaches similar to project in literature. But none of them combine all methods in HR Game. The compassion between them was not gave full coverage. Each method in the project applied were compared with samples in the literature.

At the end of project some of the meaningful results were evaluated and reported. Given graphics in the figures some of them. Graphics prepared considering each user result in the game. Each stage has 20 random line there are 4 stages in a game and 3 of the stages containing color question and timer consequently there are many different data. Some of them meaningful for reports. For example gender, speed, focus capability, number of questions answered, number of right or wrong choice and their changes according to stages. Some metrics defined considering psychological approaches. Risk, risk after penalty, risk after reward, selective attention, flexibility, speed of process, behavior under time pressure, reward-penalty sensitivity.

$$risk = \frac{\sum riskPercentage}{\sum capturedBall}$$

Risk: sum of the risk percentage on captured balls / number of captured ball.

$$riskAfterPenalty = \frac{\sum riskPercentageAfterPenalty}{\sum capturedBallAfterPenalty}$$

Risk After Penalty: sum of the risk percentage on captured balls after penalty / captured balls after penalty.

$$riskAfterReward = \frac{\sum riskPercentageAfterReward}{\sum capturedBallAfterReward}$$

Risk After Reward: sum of the risk percentage on captured balls after reward / captured balls after reward

$$selectiveAttention = \frac{\sum trueAnswerinColorMatching}{\sum colorMatchingquestions} * 10$$

Selective Attention: number of the right answers in color matching questions / number of color matching questions

$$flexibility = \frac{\sum trueAnswerinStage2ColorMatchingQuestions}{\sum trueAnswerinStage3ColorMatchingQuestions}$$

Flexibility or Adaptability to Change: number of the right answer in color matching questions in stage 2 and 3 /number of color matching questions in stage 2 and 3 (in stage 2 and 3 the color question changeable)

$$speedofProcess = \frac{\sum trueAnswersinColorMatching}{(\sum ColorMatchingQuestions) * ElapsedTime} * 100$$

Speed of Process: Number of right color matching answer / Elapsed time * Number of color matching question.

$$behaviorUnderTimePressure = \frac{\sum pointsinStage1}{\sum pointsinStage2}$$

Behavior Under Time Pressure: Stage 1 result compare with Stage 2

$$RewardPenaltySensitivity = \frac{\sum pointsinStage3ColorQuestions}{\sum pointsinStage4ColorQuestions}$$

Reward Penalty Sensitivity: Stage 3 point from color questions / Stage 4 point from color questions

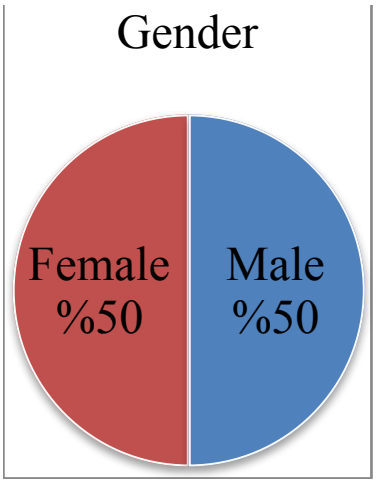


Figure 5.1: Gender Dist.

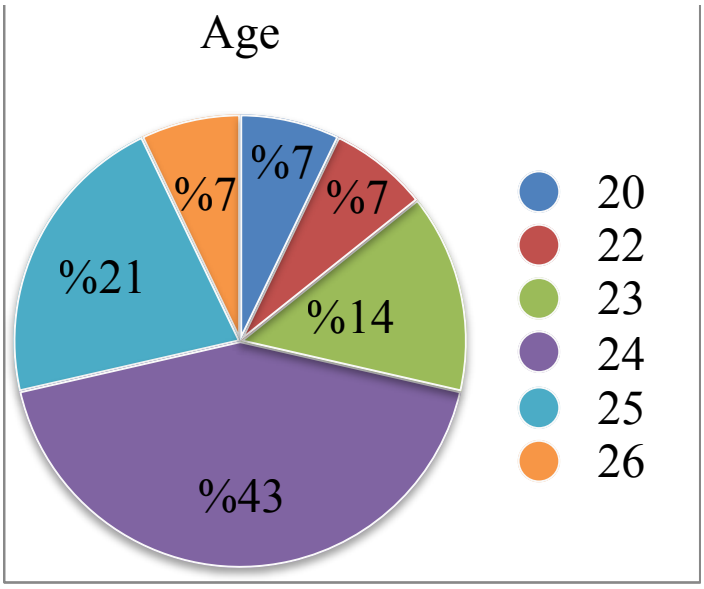


Figure 5.2: Age Distribution

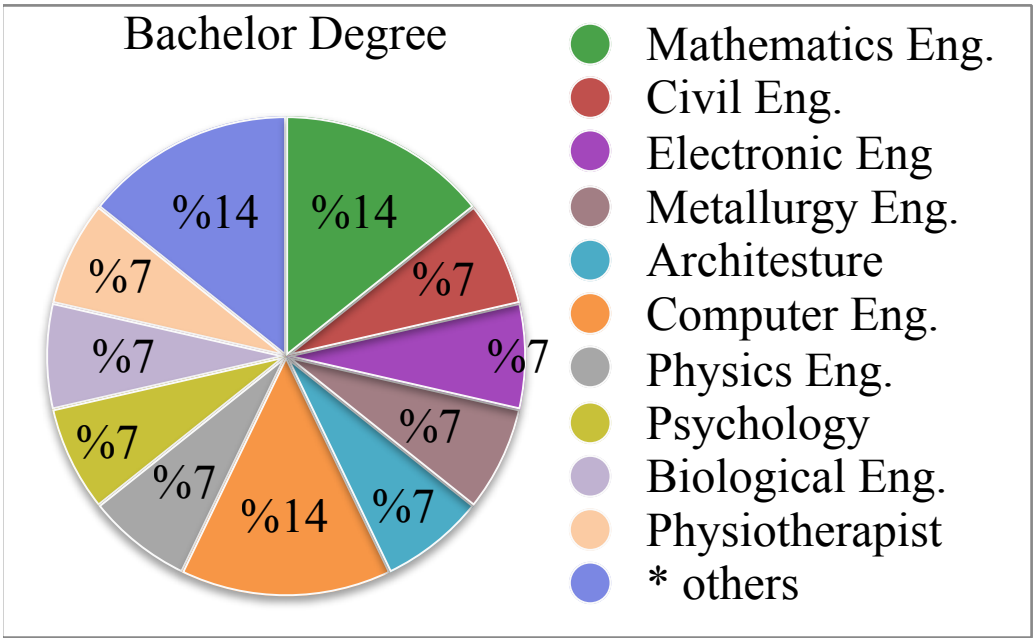
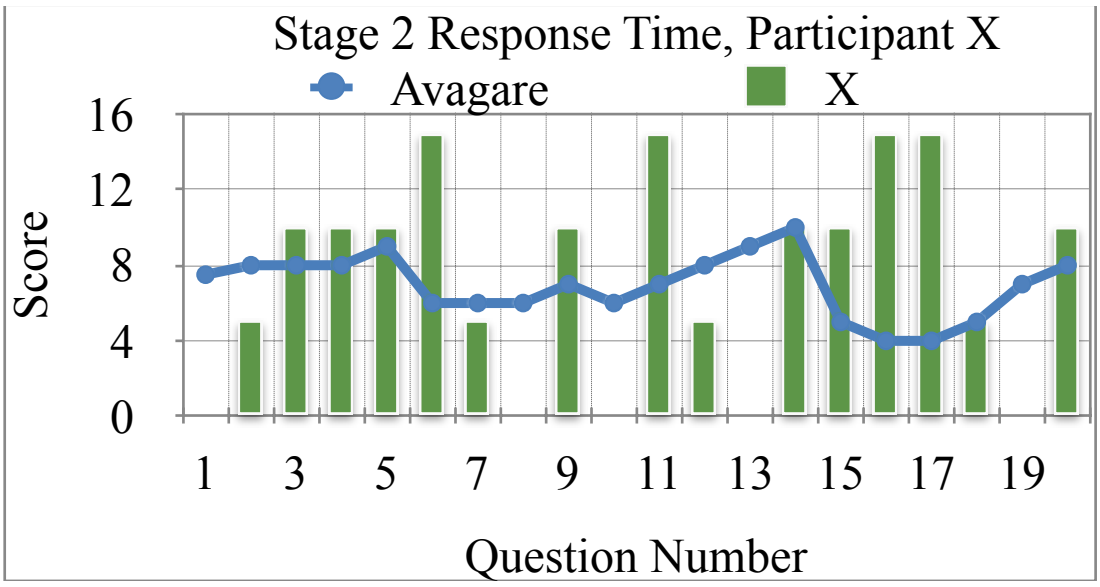
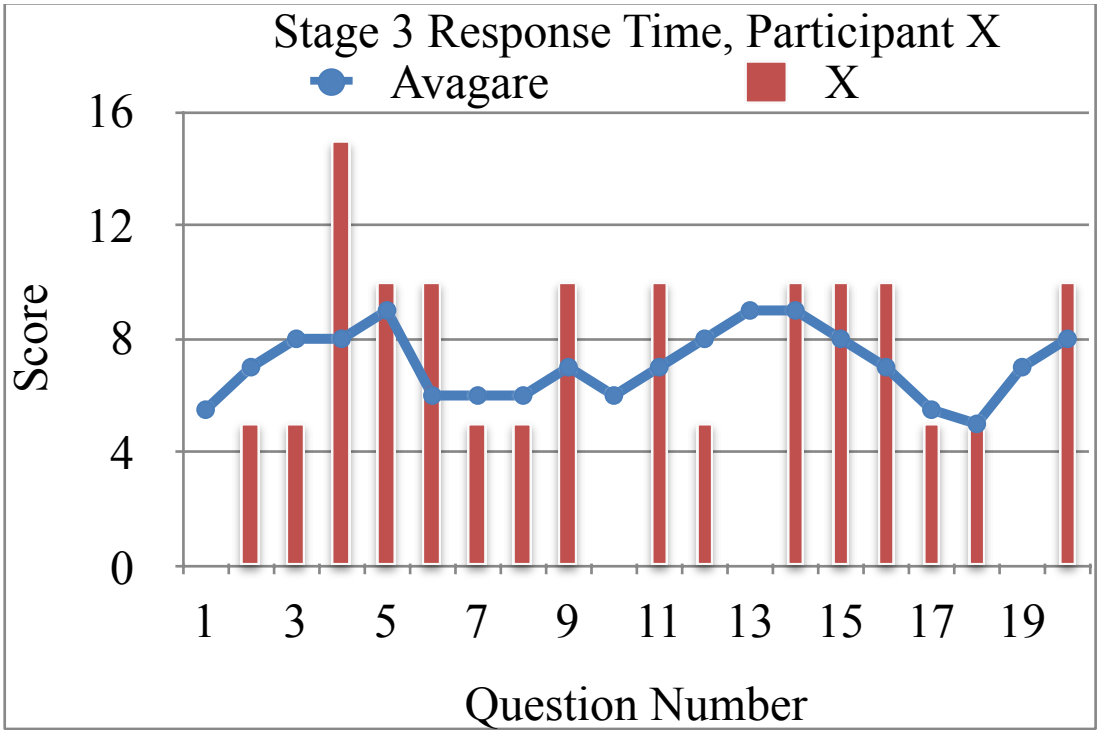


Figure 5.3: Bachelor Degree Distribution

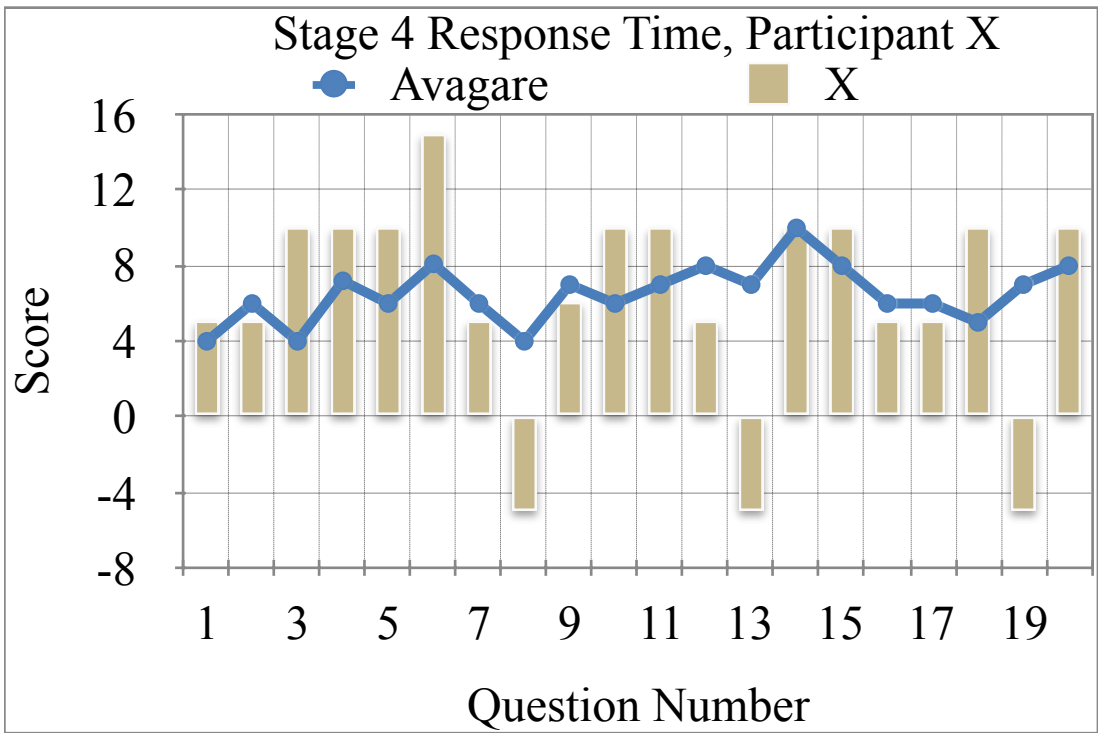
Metrics on Table 4.1 applied and their results collected from test group. Figure 5.1, Figure 5.2, Figure 5.3 show some information about the test group. Comments were evaluated considering the distributions given. Gender distribution was tried to kept equal because experiment tries to figure out behaviors according to gender. Also keeping the age interval wider than Figure 5.2, may affect to results variation too much. The experiment group was selected in the same age range and the age effect was ignored. In the Figure 5.3 education of the applicants presented. The majority of the experiment group are engineers and university students. (* those who do not attend university).



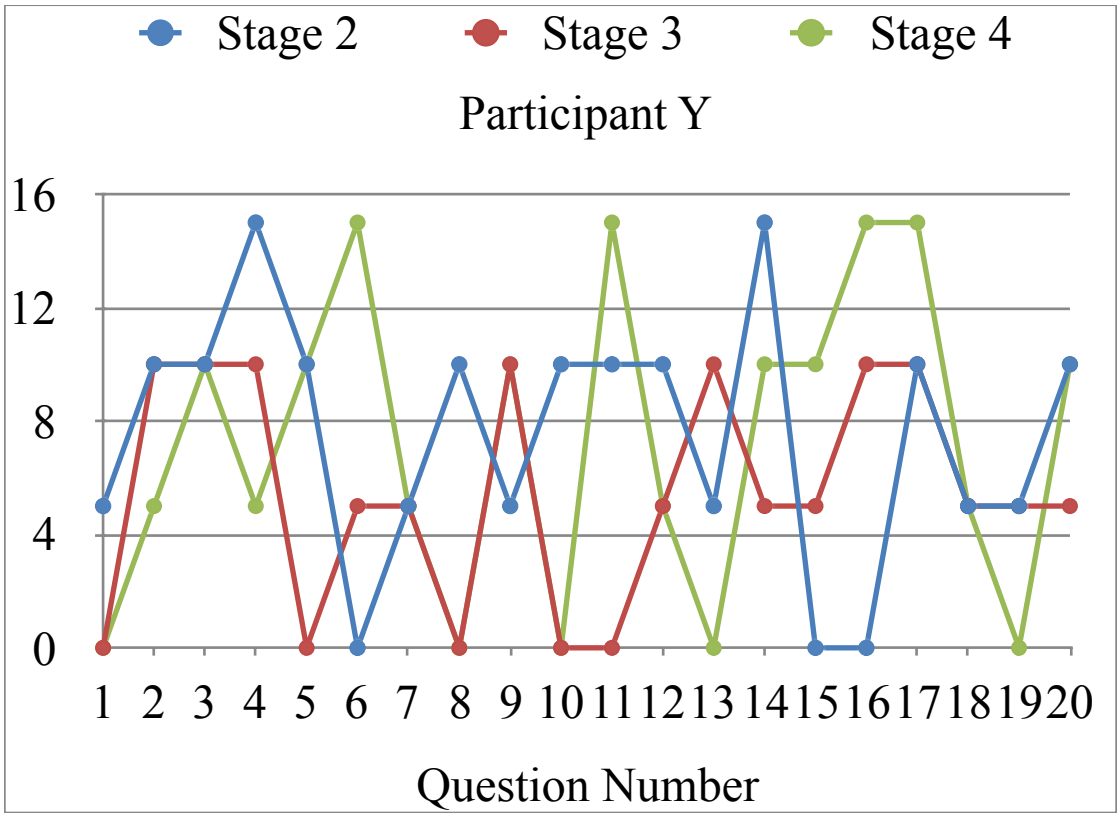
Graph 5.4: Stage 2 response time for a participant



Graph 5.5: Stage 3 response time for a participant



Graph 5.6: Stage 4 response time for a participant



Graph 5.7: Stage 2-3-4 response time for a participant

Graph 5.4, Graph 5.5, Graph 5.6, Graph 5.7 show test group results. All of the graphs are related to metrics. If a column empty, it means user made a wrong color match so user cannot gain point. There are some columns which has negative value, it is possible in stage 4. If the user does not choose any button, user gets a 5 point penalty.

The response time indicates selective attention metric, behavior under time pressure metric and speed of process metric. Graph 5.4, Graph 5.5 and Graph 5.6 have average response time line. Comparison between average value and user answers give results about the user behavior. For example applicant X better than average of the applicants in Stage 2 (Graph 5.4). Stage 2 is a basic color match stage there is no penalty and flexibility test. It does not give any idea about other metrics. To illustrate second graph (Graph 5.5) about stage 3, in stage 3 user faces flexibility test. There are two type of color match question, then randomly one of them prompted (match the text or match the color). Also stage 3 measures same metrics from stage 2, which are speed of process, selective attention and behavior under pressure. When comparison between stage 2 and stage 3 in Graph 5.7 indicates flexibility metrics. The last graphics about the stage 4 which are most complicated one. User knows if he does not make a selection, he will get minus 5 point. The graph 5.6 shows that behavior of the under penalty pressure. It shows reward penalty sensitivity metrics. Graph 5.7 is a sample of the combination graph. It shows user performance on each stage in one graph.

Metric Type	Metrics	Average Value	Applicant Z
Risk Measurements Metrics	Risk	**%44.1**	**%53.2**
	Risk After Penalty	**%37**	**%43**
	Risk After Reward	**%47.4**	**%51.8**
Color matching Measurements Metrics	Selective Attention	**7.3**	**6.4**
	Flexibility	**No data in stage 4**	
	Speed of Process	**1.71**	**1.65**
Metrics used for Stages	Behavior Under Time Pressure	**No data in stage 4**	
	Reward Penalty Sensitivity		

Table 5.8: Average and a specific user metric values for Stage 4

Stage 4 is most complicated stage, almost all metrics has value. *Flexibility*, *behavior under time pressure*, *reward penalty sensitivity* metrics need data from previous stages. Table 5.8 shows average value and user value. Every stage and every applicant has same table. For a user there are 4 table which are about to stage 1, stage 2, stage 3, stage 4. The comparison between average value and user value provided by those tables.

There are 14 applicant each one have 4 table, at least 4 graphics etc. the result of experiment has too much data and data visualization.

For applicant Z given on table 5.8, he looks a risk taker, when he get a penalty he motivated more than average. Selective attention and speed of process are better than average but flexibility almost same the average. Also he is a reward penalty sensitive. But the comparison made on a user group those results are not precise indicator to interpret a person. To measure flexibility, behavior under time pressure and reward penalty sensitivity metrics stage 1,2,3 and 4 metrics values should be known.

6 Conclusion and Future Work

In this section short summary, final evaluation, the future of the project and the possible improvements will be presented.

The HR Game is designed adaptable to future improvements. There are many features of the application that can be improved. When these improvements are made, The HR Game will serve to good purposes for HR processes. It will help the understand complex applicant behaviors. The current version of the project not ready for public use. It should be tested better.

First of all the design and user interface can be improved. The game was designed without any professional help from a designer. All of the assets taken from free sources. The integrity of the design has not compatible in each part such as stage-button, menu-stage etc. If the game designed better the game will attract many users and customers.

In the user data collection part of the application can be improved. The final version of project just gets a unique id taken from cpu timer. Each app launch creates another id. The id identify the user that test itself. According the id, test data stored in the mobile device documents folder as text file. The saved data in text file transferred to computer via physical connection. To provide better performance and usability user data can be posted to a web service. Also it increases the data safety. According to transferred data via api, a dashboard can be automatically created for each user. Evaluation of the project can be easy. The project become appropriate to public usage.

The test method can be improved and it will become applicable. A new HR Game that gives accurate results can be obtained by comparing with methods accepted in the literature. According to the results of the comparison between the tests on literature and hr game that correlation will be provided. As a result of these verification and validation, the applicability and reliability of the test will increase.

Lastly, the HR Game project can combined with artificial intelligence that is today's popular technology and can provide many benefits to project. When designing the project, a new approach which is adaptive test method has been analyzed. It offers dynamic question selection instead of classical methods. The flow of the game is coded compatible to dynamic method improvements. Also, this dynamism can be provided by artificial intelligence. A supervised learning method with parametric model can be added. As a result of them, game can understand the previous selections and behaviors, then creates new line, adjusts the ball orders and ball colors. The new lines will be optimized to understand limit values and user bounds. It will creates more accurate results. The user attention and motivation will be maintained. Each time the game will create different stage flow, sustainability will be increased, reputation will be decreased. The game will terminated when the user reaches a certain threshold, that will save time reduce the effort.

7 References

[1] F. Chukwunonso, "The Development of Human Resource Management from a Historical Perspective and Its Implications for the Human Resource Manager", in Strategic Human Resource Management at Tertiary Level. Rivers Publisher, 87-101 Jan. 2013, [Online]. Available: https://www.researchgate.net/publication/234017585_the_development_of_human_resource_management_from_a_historical_perspective_and_its_implications_for_the_human_resource_manager

[2] A. Al Adresi, M. R Darun, "Determining relationship between strategic human resource management practices and organizational commitment," International Journal of Engineering Business Management, Nov. 22, 2017, [Online]. DOI: https://doi.org/10.1177/1847979017731669

[3] B. Raghavendra, B. Sai Charitha, K. R. Rajitha, "Recruitment and Selection: Recent Development of Recruitment and Selection," International Journal of Science Technology and Management, Vol 6(1), Jan. 01, 2017, pp. 420-427. [Online]. Available: http://www.ijstm.com/images/short_pdf/1484306666_D510ijstm.pdf

[4] T. Ohr, "Talent platform Owiwi gamifies to assess applicant soft skills", June 2018, [Online]. Available: https://www.eu-startups.com/2018/06/try-the-game-based-talent-platform-owiwi-to-assess-the-soft-skills-your-applicants-sponsored/

[5] M. T. Buelow, A. L. Blaine, "The assessment of risky decision making: A factor analysis of performance on the Iowa Gambling Task, Balloon Analogue Risk Task, and Columbia Card Task", Psychological Assessment, Vol. 27(3), 2015, pp. 777-785. Available: DOI: 10.1037/a0038622

[6] T. L. White, C. W. Lejuez, H. Witt, "Test-Retest Characteristics of the Balloon Analogue Risk Task (BART)", Dec, 2015, Vol. 16(6), pp. 565-570. Available: DOI: 10.1037/a0014083

[7] C. M. MacLeod, "The Stroop Effect", Encyclopedia of Color Science and Technology, New York, 2015, pp 1-6. [Online]. DOI: 10.1007/978-3-642-27851-8_67-1, Available: http://imbs.uci.edu/~kjameson/ECST/MacLeod_TheStroopEffect.pdf

[8] A. M. Hol, C. M. Vorst, G. J. Mellenbergh, "Computerized Adaptive Testing of Personality Traits", Journal of Psychology, Vol. 216(1) 2008, pp 12-21. [Online]. DOI: 10.1027/0044-3409.216.1.12

[9] Copyright © 2018 Apple Inc., “About Info.plist Keys and Values", Documentation Archive, 2018-06-04, [Online]. Available: https://developer.apple.com/library/archive/documentation/General/Reference/InfoPlistKeyReference/Introduction/Introduction.html

[10] All of the game assets are free for use, taken from:
character: (the boy) https://www.gameart2d.com/freebies.html
balls: (pachinko) https://www.hackingwithswift.com
buttons and ui: (cga ui gold) https://itch.io/game-assets/free/tag-gui

[11] Image taken from: iOS Programming Tricks: iOS Layered Architecture.
Available: https://codeingwithios.blogspot.com/2017/09/ios-layered-architecture.html