

# Informatics Large Practical

## Coursework 2

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# Introduction

This is a report for a prototype of a location-based game called Coinz, following its implementation and use. The game's main focus is on collecting virtual coins of 4 different currencies (QUID, DOLR, PENY, SHIL) scattered around the Central area of the University of Edinburgh, transferring them to a virtual Bank (as another currency - GOLD) or sending them to another User. The following is a detailed description of my implementation of all the functionalities of the game.

## Creating an account

I implemented two ways of creating an account – one by signing up with email and password (in SignUpActivity) and the other for signing in with Google account (in LoginActivity). If the User has successfully created an account a dialog window appears asking the User to provide a username. (Fig.1) This username is later used when displaying a list of all Users (see Sending coins, Stealing coins and Ranking). The username has to be unique so when the User inputs a username, a query is ran to check whether it is being used by another Player. If this is the case, the User is asked to provide another one. Information about the Users is stored in Firestore in a collection called “users”. When creating an account all of the default values for the fields are set in a single document for that User. (Fig.2)

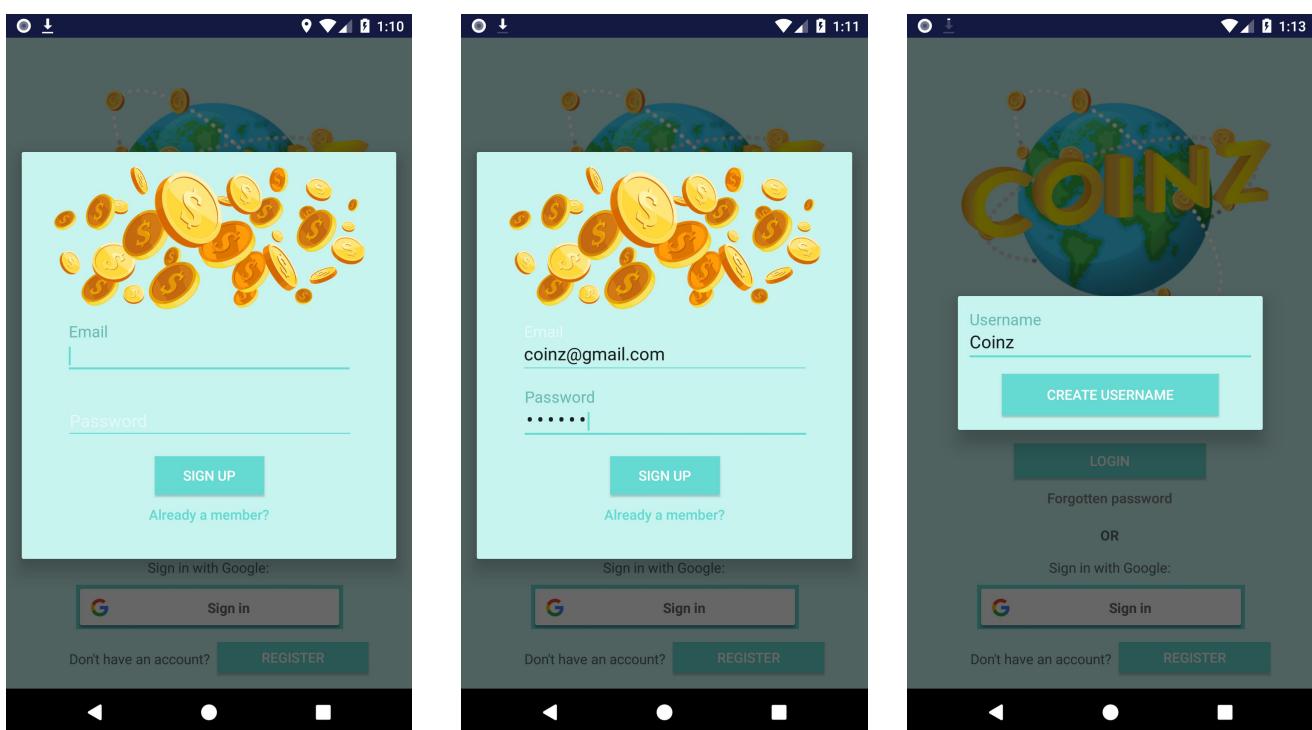


Fig.1 Screen for creating an account and username

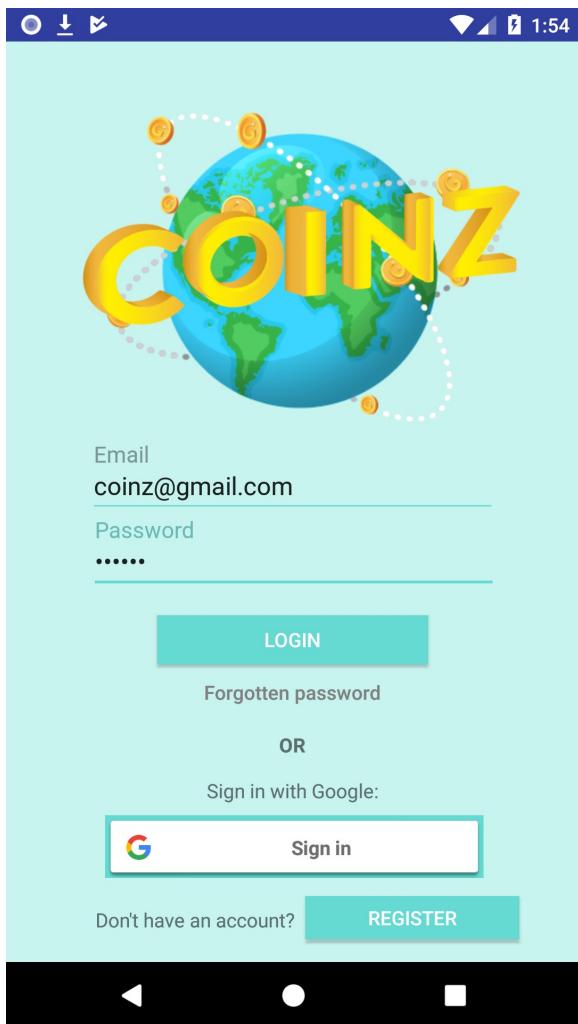
The screenshot shows the Firebase Database console for a project named "Coinz". The left sidebar contains navigation links for Project Overview, Authentication, Database (selected), Storage, Hosting, Functions, ML Kit, Quality, Crashlytics, Performance, Test Lab, Analytics, and Spark. The main area displays the "Database" section with tabs for Data, Rules, Indexes, and Usage. Under the Data tab, the path "users > S05eE3lnZYXlk..." is selected. The database structure shows a collection "users" containing documents with IDs such as "7i1pBQKNDExh0JtrUmMXDCtaWcE3", "7ksQPr0511PveUcRlWTaNd5pVns2", and "S05eE3lnZYXlkC1tEWdy6C2b0ym1". The document "S05eE3lnZYXlkC1tEWdy6C2b0ym1" is expanded, showing fields like "cantStealFrom", "coinsLeft", "email", "magnetMode", "magnetUnlocked", "money", "password", "piggybank", "piggybankProtected", "provider", "shieldUnlocked", and "stealUnlocked".

This screenshot shows the same Firebase Database interface as the first one, but the document "S05eE3lnZYXlkC1tEWdy6C2b0ym1" has been modified. The "piggybank" field now contains an object with properties "money: 0", "password: '123456'", and "treasureFound: false". The "wallet" field is also present. The other fields remain the same.

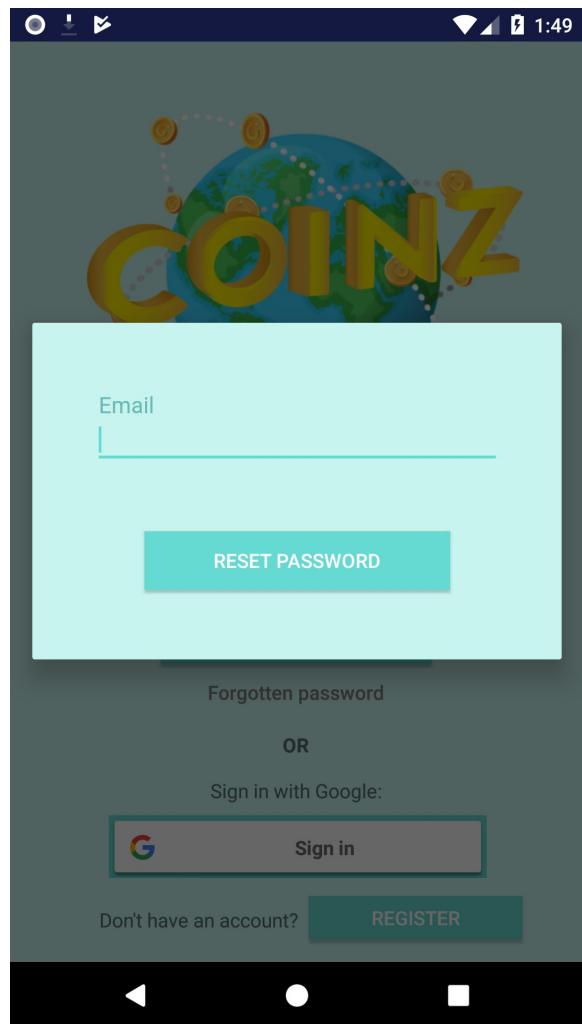
**Fig.2 Default fields for the created User in Firestore (if the User has signed in with Google instead of creating an account the “provider” field has a value “Google” and the password field is the empty string; all of the other fields are the same)**

## Log in

This is the screen that appears if the app is opened for the first time. There are two ways of logging in – the first using the email and password created when signing up and the second – signing in with Google. (Fig.3a) If the User has signed in with Google before, the fields in the database are not changed, if this is the first time of signing in with Google, the fields are set to the default ones (see Creating an account).



(a)



(b)

Fig.3 Screens for signing in (a) and resetting password (b).

## Forgotten password

If the User has forgotten their password, there is the option of resetting it by sending an email to the User asking to provide a new password. (Fig.3b)

## Profile Screen

Once the User has logged in a profile screen is displayed. From there the User has the option to start playing, get acquainted with the rules of the game, log out, delete their account or exit the app. (Fig.4) At the top of the screen “hello”-message is displayed by retrieving the User’s username from Firestore.

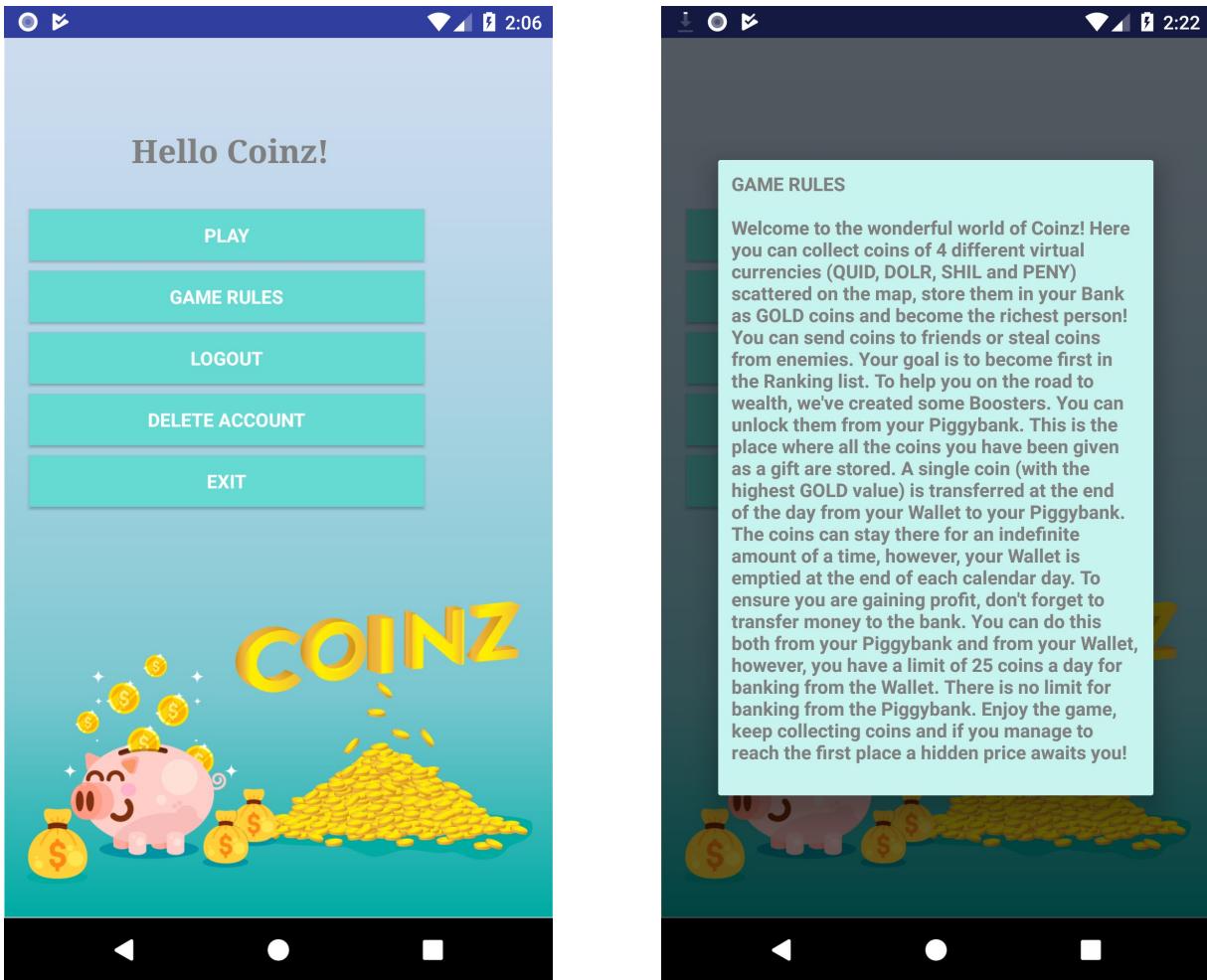


Fig.4 Profile screen and screen for the game rules

## Log out

I implemented the logging out by using the default Firebase function. The User can log out from the profile screen (as shown in Fig.4) and from the Navigation Drawer (see Navigation Drawer).

## Delete account

I implemented the deleting of an account by using the default Firebase function. The User can delete their account from the profile screen (as shown in Fig.4).

## Play

By clicking the Play button from the Profile Screen the User is send to a new activity containing a map with the coins to be collected (MapActivity).

## Map

This is the map with the virtual coins shown as markers. If this is the first time of the day when the map is opened, the file with all the coins and currency rates is downloaded from the provided website and then stored in the local storage of the phone as a geojson file (this is done in the function `onDownloadComplete` in the `DownloadCompleteRunner` class) and the date of the last download is stored in a shared preference file in the local storage. In the `onDownloadComplete` method the features are extracted from the geojson String by first converting them to a feature collection and then extracting the properties of each feature. After this a marker is created with a title containing the value and the currency of the coin and a snippet with its ID. The icons of the coins are customised for each of the 4 currencies. (Fig.5) This method is called every time when the map is being created (`MapActivity.onCreate`) but if the file has already been downloaded on this day, it is read from the local storage instead of being redownloaded. On top of the map, the current rates of all the currencies are displayed. (Fig.6)



Fig.5 Icons for coins of the different currencies

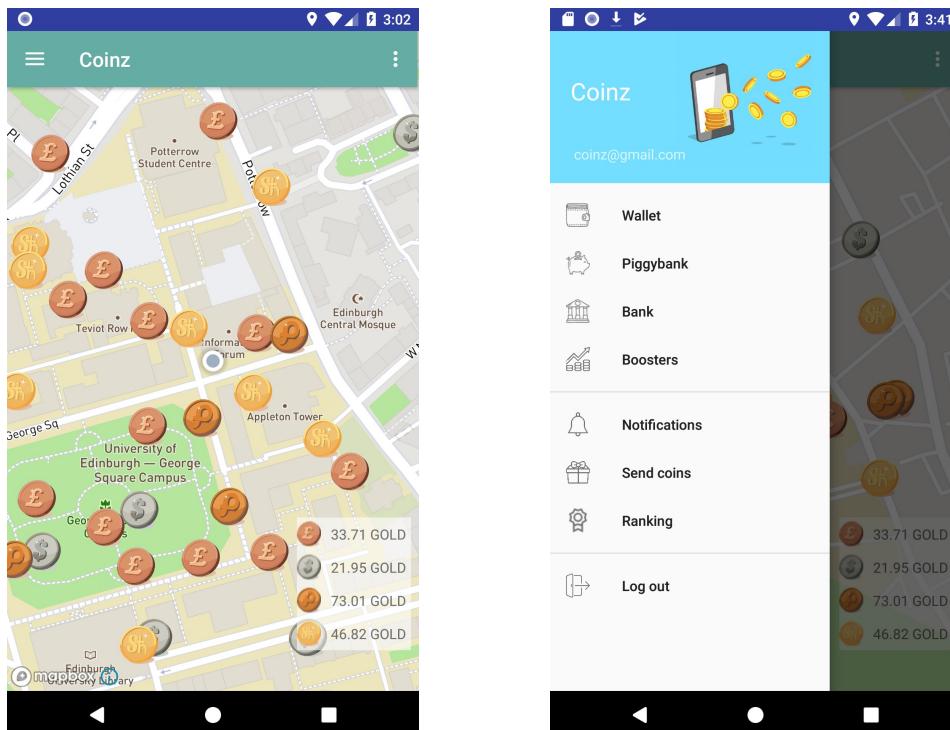


Fig.6 Map View and Navigation Drawer

## Collection of Coins

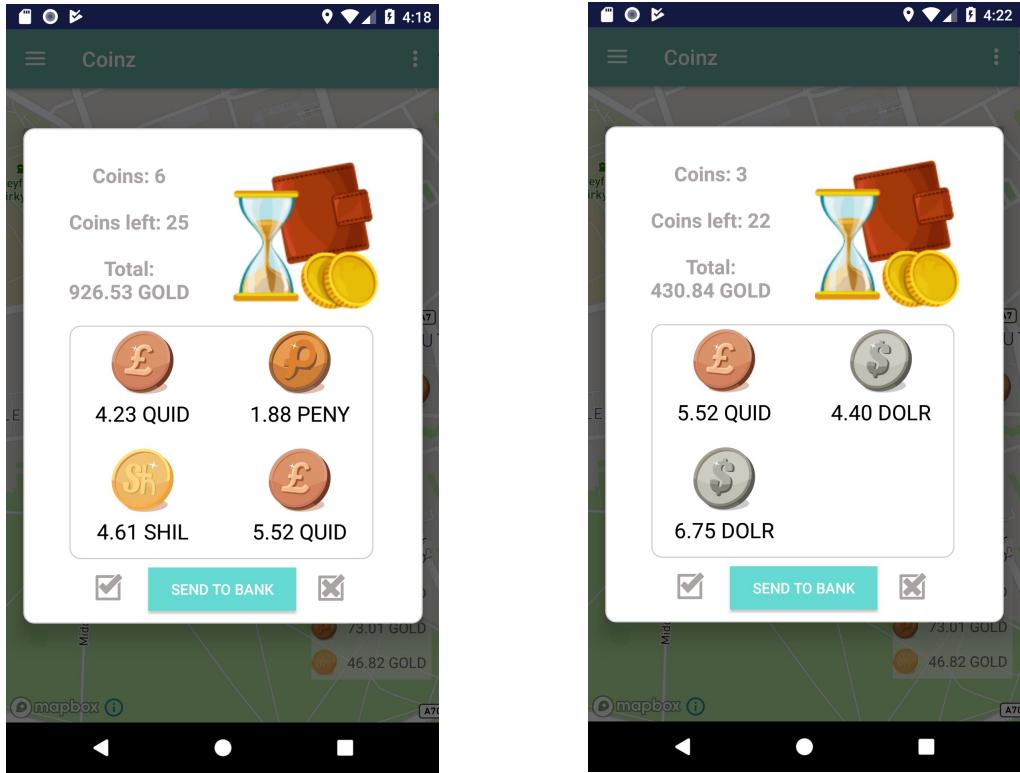
When the User is in close proximity to a coin (25 meters or less) the coin is automatically collected and stored in their Wallet (see Wallet). This is done in the onLocationChanged method in MapActivity. When the User changes their location, the distance to each of the markers in the map is computed. If the distance to a marker is 25 or less, it disappears from the map. The new map without the collected coins is converted to a geojson file in the onStop and onDestroy methods and it overwrites the coinzmap.geojson file in the local storage. This ensures that when the User leaves the game, the progress of coins collection is saved. When writing the code I considered storing the map in Firestore instead of locally, however, since it is very unlikely that multiple Players would use a single phone to play the game or a single User would have multiple phones from which they would play the game, I decided that local storage is sufficient for the purpose of this app (however, since this is a prototype of the game, a further improvement might be to store it in the database).

## Navigation Drawer

From the map view the User can open a Navigation Drawer displaying the different features of the game (Wallet, Piggybank, Bank, Boosters, Notifications, Sending coins, Ranking and an option to log out (see Log out)). (Fig.6)

## Wallet

When a User collects a coin it is stored in their Wallet. This is done by updating the field “wallet” in Firestore for each User. This field contains a list of Strings where each String in that list corresponds to a coin. Each String contains the value of the coin, its currency and its ID, separated by a space (“ ”). (Fig.7c) When the Wallet is opened from the Navigation Drawer, its contents are loaded from the database. The coins are displayed in a Grid View containing the image for the particular currency of each coin (see Fig.5) and a text displaying the value and the currency. At the left corner of the Wallet screen an information is displayed regarding the total GOLD value of all coins in the wallet, their number as well as the number of coins left for banking. (Fig.7a) A User can bank only 25 coins on any given day. If the User tries to bank more coins a Toast is displayed notifying the Player that they have reached their limit. When selecting coins (or a single coin) and clicking on the “Send to Bank” button the GOLD value of these coins/coin is added to the total Bank money of the User (see Bank). After that the selected coins disappear from the Grid View and the “Coins left” text view is updated (both on the screen and in Firestore). (Fig.7b) At the end of each calendar day the Wallet is emptied so on the next day the User starts collecting coins from scratch with an empty Wallet. This is done in the onDownloadComplete method where if the map has not already been downloaded on that day, the coin with highest GOLD value in the wallet is moved to the Piggybank (see Piggybank) and the rest of the wallet is emptied.



Document ID	username	wallet
S05eE3lnZYXLkCitEW... (selected)	Colinz	<ul style="list-style-type: none"> <li>0 "4.23 QUID 1e45-a685-3774-cbc6-bd77-db6f"</li> <li>1 "1.88 PENY c315-3c0f-bbcc-91ea-1190-6025"</li> <li>2 "4.61 SHIL 05da-22a3-00de-09d4-7ca6-558a"</li> <li>3 "5.52 QUID a84d-fb8-13ab-1f44-43cc-ee4f"</li> <li>4 "4.4 DOLR d974-77d1-8b48-4336-7600-332e"</li> <li>5 "6.75 DOLR 2330-b13f-1978-4e38-d5b4-507a"</li> </ul>

**(c)**

Fig.7 The Wallet screen (a) and “wallet” field in Firestore after the Player has collected some coins (c) and the wallet screen after the User has banked the first three of the coins in the Wallet

# Bank

As mentioned above, when a User transfers money from the Wallet to the Bank, the total Bank money of the User is incremented. This is done by updating the field “money” in Firestore. When the User opens the Bank Activity, they can see the total GOLD money they have in their Bank account (it is loaded from Firestore).

Previously, when displaying the value of money I rounded it to 2 digits after the decimal point in order to improve the appearance of the app, however in this activity I decided to show the entire GOLD value to the User in order to keep them aware of their total gains. (Fig.8)

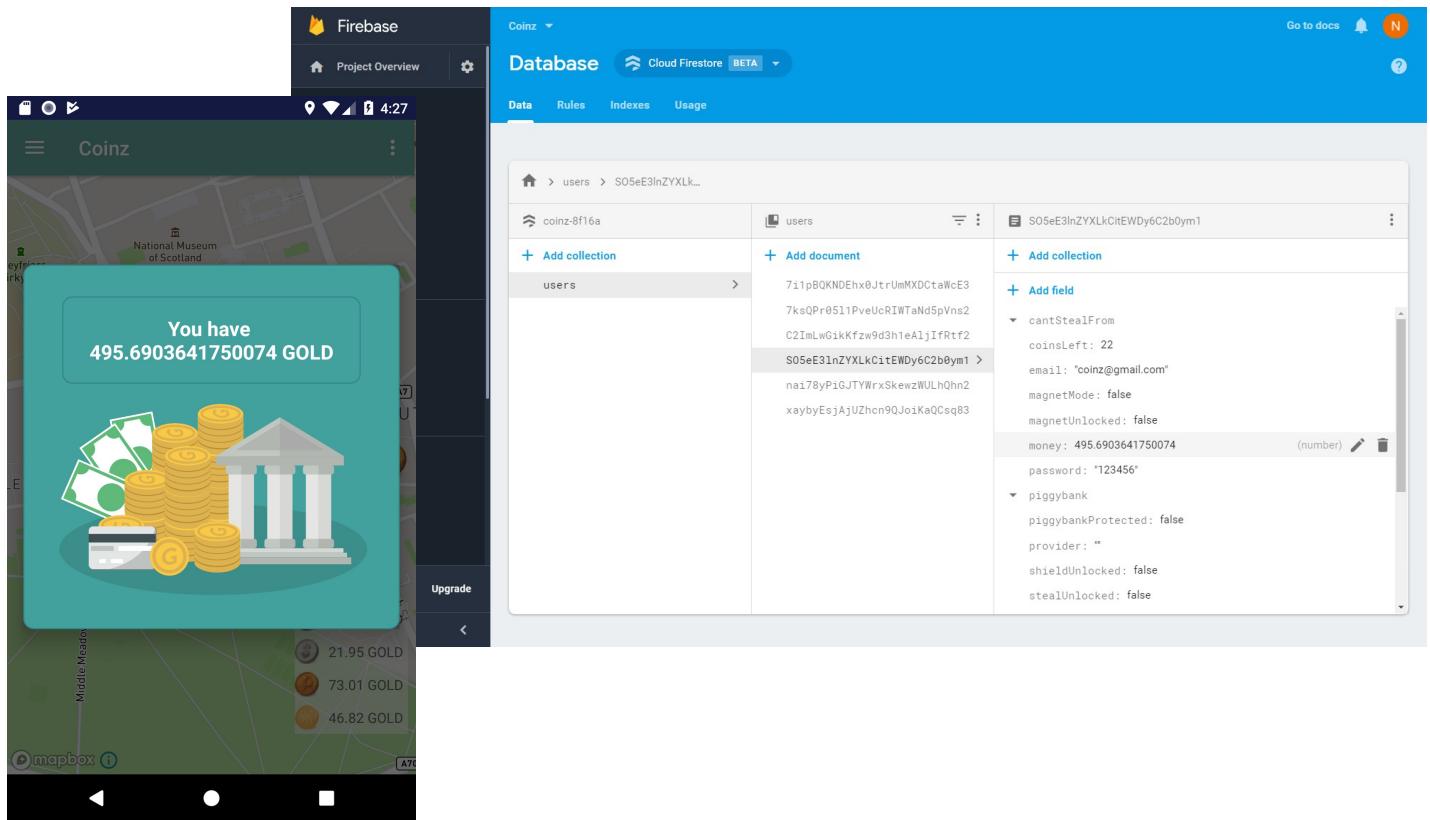


Fig.8 The Bank screen and the “money” field in Firestore after the User has banked some coins

## Sending coins

As mentioned above, the User can send money to other Users as a gift. This is allowed only after the User has banked all the 25 coins for the day. The User can send the other 25 coins (at most), left as spare change, to other Users by clicking on the “Send coins” button in the Navigation Drawer. If the User hasn't transferred all the 25 coins, a Toast will appear asking the User to bank all of them first and then use the rest for gifts.

A List View of all the Users is presented and the Player has to select a recipient for their gift. There is a search option in the list of all Users, so if the current Player types the name of a particular User, a query is ran to the database and if successful (if such

a User exists) the List View is updated to show only the particular User. (Fig.9) When a User is selected a similar to the Wallet screen is presented showing a Grid View of all the coins collected. The User can select a coin or multiple coins and click “Send as gift”. The coins then disappear from the current User’s wallet and are added to the selected Users’s Piggybank (see Piggybank) and a notification is added for the recipient by updating the “piggybank” and “notifications” field in their Firestore document resepctively. (Fig.10, Fig.11) Also, the boolean field “newNotifications” is updated to true (for more information see Notifications).

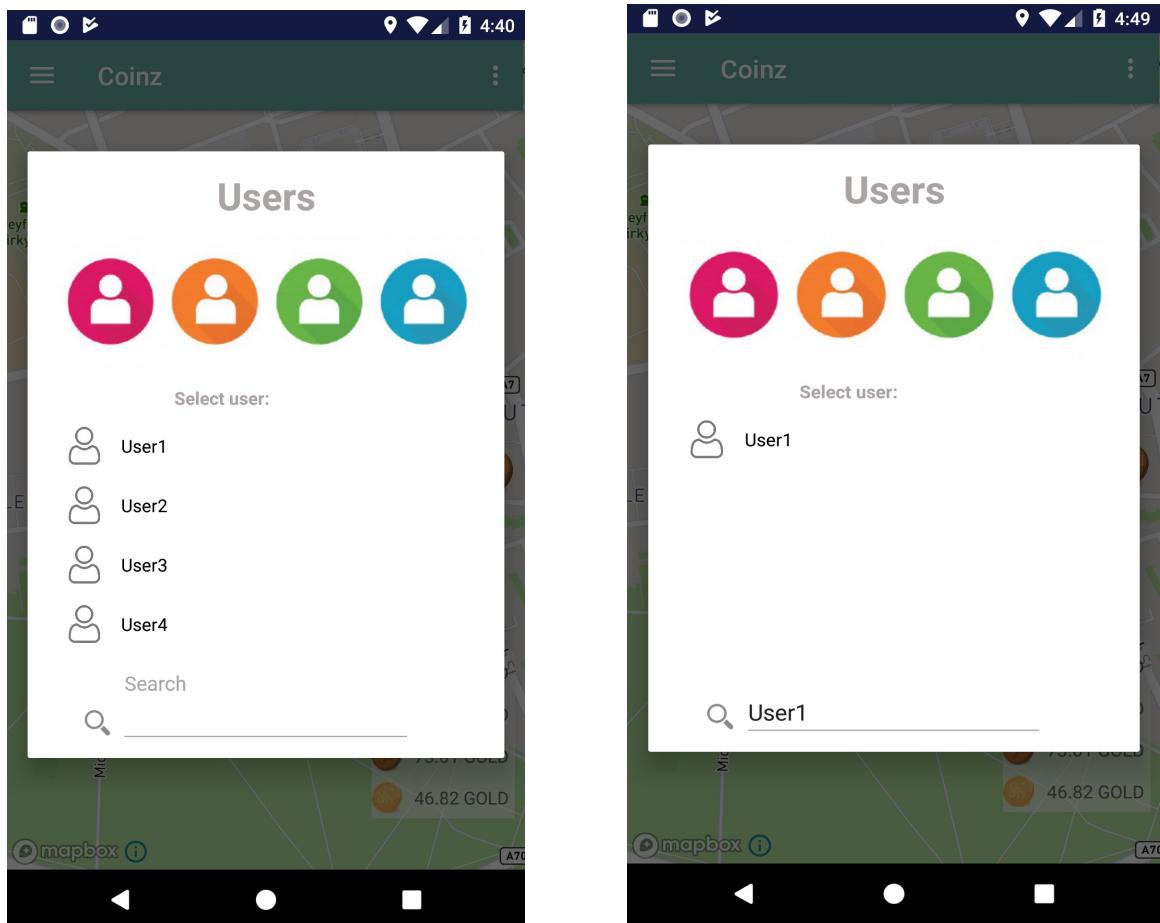


Fig.9 The complete User List View (left) and the User List View after a search for a particular User (right)

Once User A has sent a coin to User B, User B can no longer steal (see Boosters) from User A – a field called “cantStealFrom” is updated with a list of all the Users that have given a gift to User B on that day. I decided to add this constraint because many Users might be hesitant to use the Send Coin functionality as this would give more money to others and will thus allow them to use Boosters and potentially steal from the User who gave them a coin. This would discourage Players from sending coins. By adding this constraint I believe that Users are more likely to even be encouraged to send more and more coins and in that way make the game more interesting for everyone.

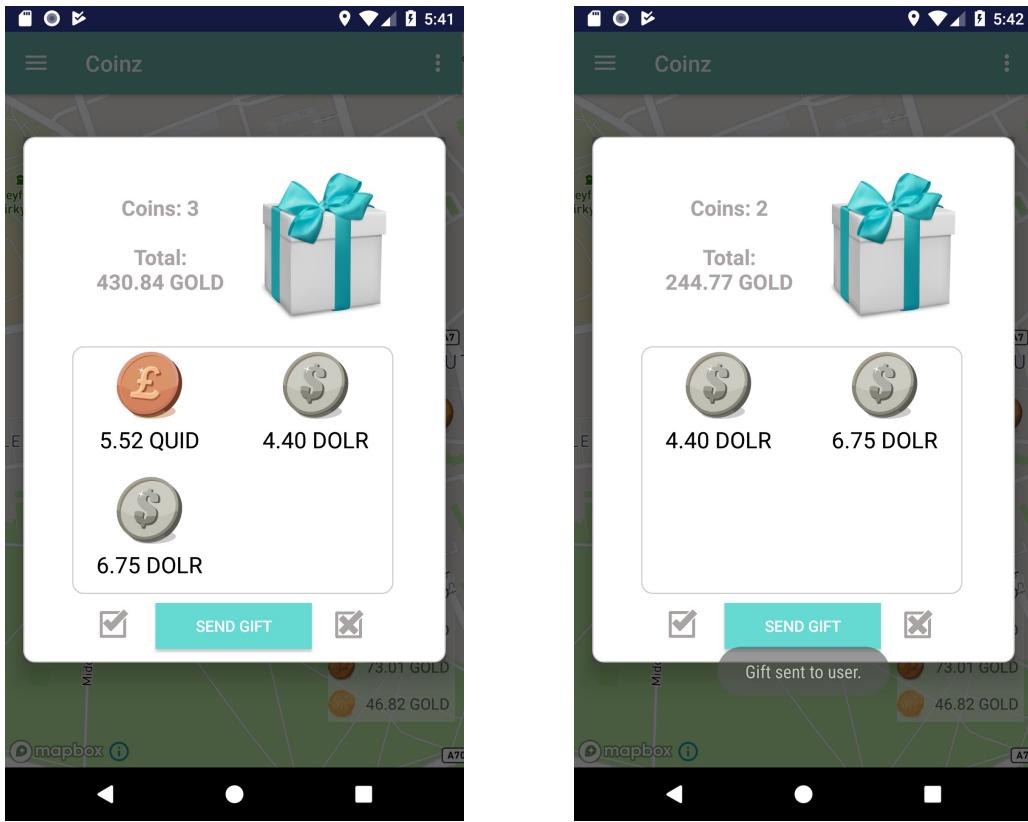


Fig.10 Screen for sending gifts containing all the coins in the wallet (left) and screen after the first coin has been sent

The screenshot shows the Firebase Database console under the 'Database' tab. On the left, the navigation sidebar includes 'Project Overview', 'Develop' (selected), 'Database' (selected), 'Storage', 'Hosting', 'Functions', and 'ML Kit'. Under 'Quality', it lists 'Crashlytics', 'Performance', and 'Test Lab'. Under 'Analytics', it lists 'Dashboard', 'Events', and 'Conversions'. At the bottom, it says 'Spark Free \$0/month' and 'Upgrade'.

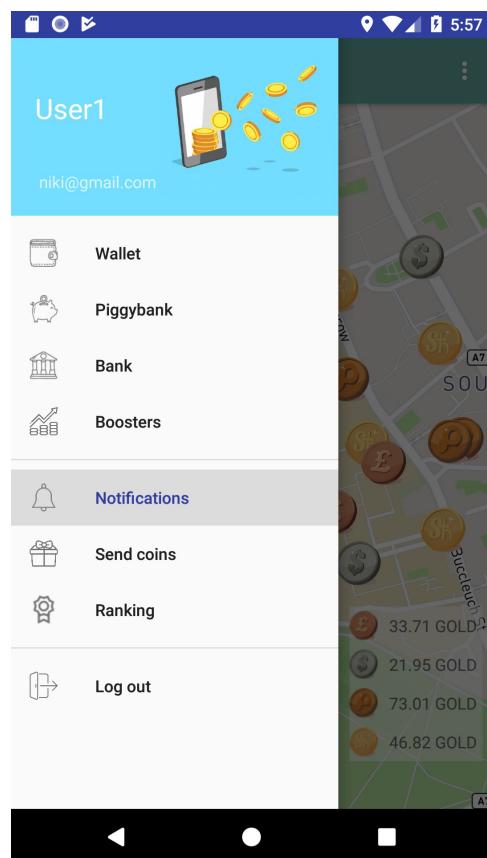
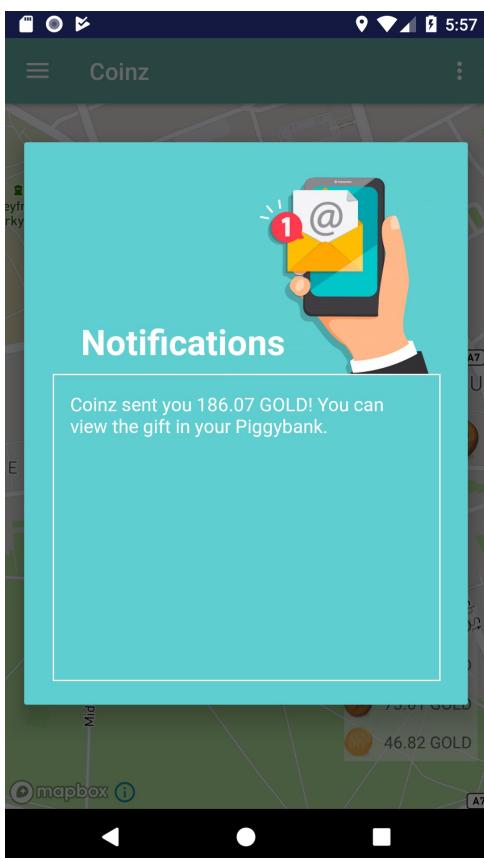
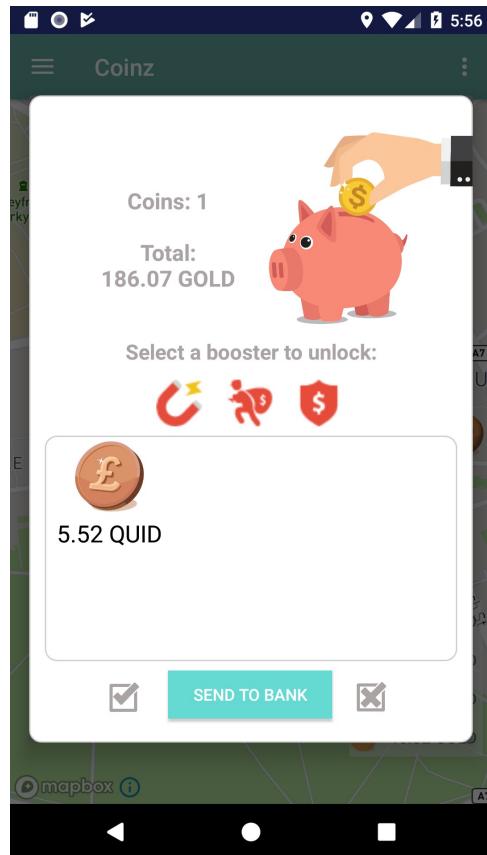
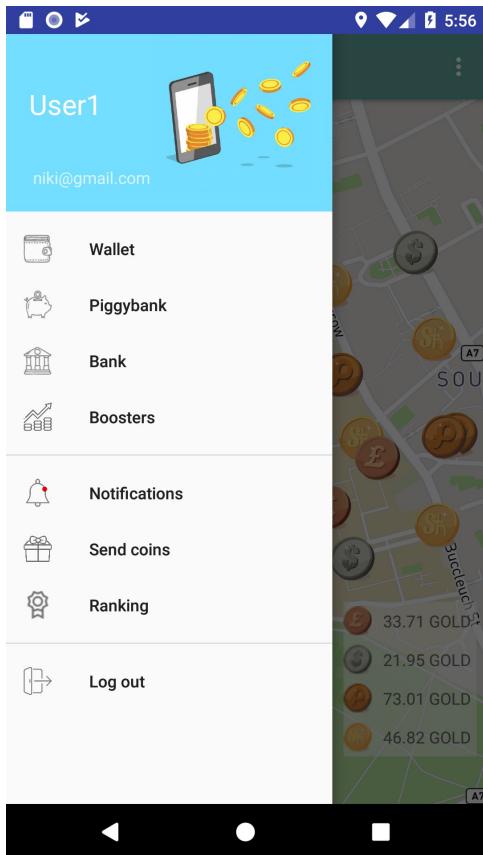
The main area shows a user document structure:

```

users > 7i1pBQKNDExh0JtrUmMXDCtaWcE3
  + Add collection
  + Add document
  + Add collection
  + Add field
    magnetMode: false
    magnetUnlocked: false
    money: 631.1244103291579
    newNotifications: true
  - notifications
    0 "Coinz sent you 186.07 GOLD! You can view the gift in your Piggybank."
    password: "123456"
  - piggybank
    0 "5.52 QUID a84d-ff8-13ab-1f44-43cc-ee4f"
    piggybankProtected: false
    provider: ""
    shieldLocked: false
  
```

Fig.11 Gift added to “piggybank” field of the selected User and a new notification added to the “notifications” field.

We will now have a look of the profile of the recipient of the gift:



# Piggybank

The gifts sent by other Users are saved in the Player's Piggybank and shown (as in the Wallet) in a Grid View. (Fig.12) The User can again transfer them to Bank but unlike the Wallet money, there is no limit in the number of coins available for banking per day. Another difference is that coins in the Piggybank are not discarded at the end of each calendar day. Since being given a gift is not something the User can control, I've added the functionality of transferring the highest valued coin from the Wallet to the Piggybank at the end of the day before the Wallet is emptied. I decided to add this feature in order to ensure that the User will be able to collect some coins in their Piggybank even if they are not given any gifts.

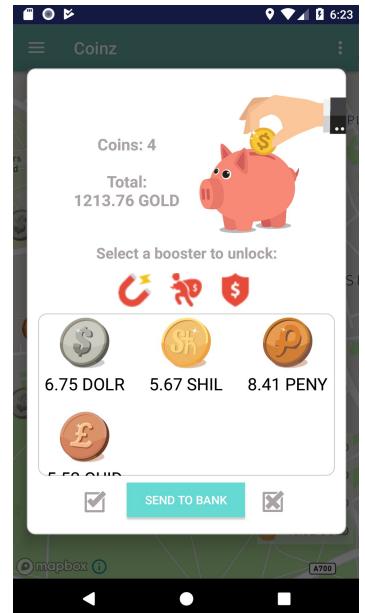


Fig.12 Piggybank

## What can the Player do with their Piggybank money

Aside from transferring them to Bank, the User can also use these coins in order to earn Boosters (see Boosters). Each Booster needs a particular collection of coins in the Piggybank in order to be unlocked. To unlock a Booster, the Player must go to their Piggybank select a Booster they would like to unlock and then a Toast will appear prompting the User to select 4 coins for the needed collection (different for each Booster). If the selected collection is valid, the Booster will be unlocked. (Fig.13)

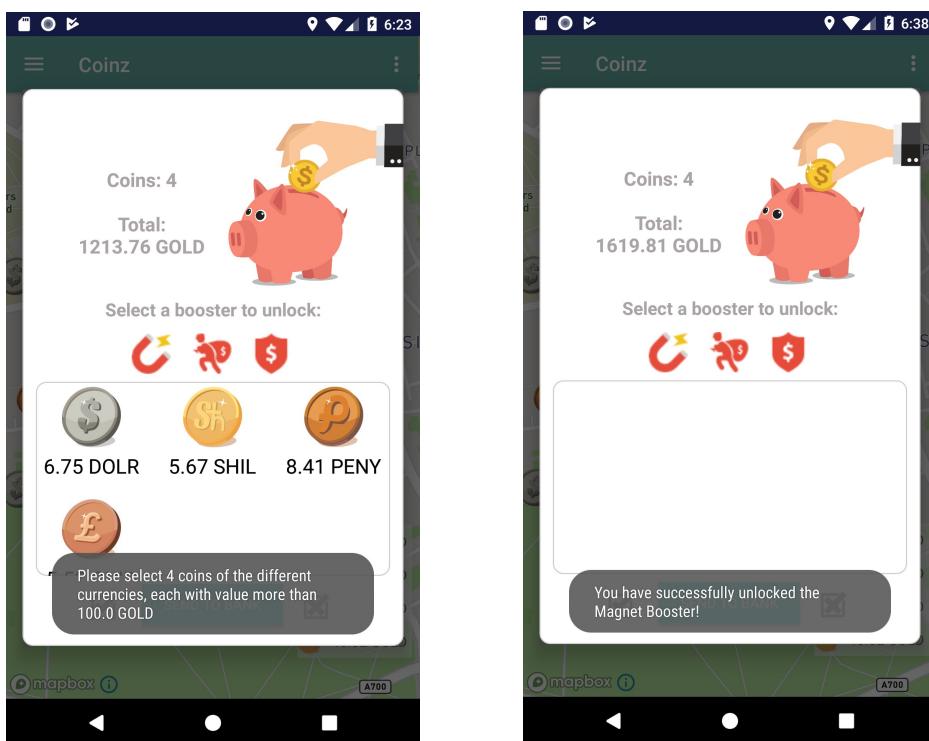


Fig.13 Unlocking the Magnet Booster

## Boosters

I've added three Boosters to the game – Magnet, Steal coins and Shield. Boosters are located in the Booster section available from the Navigation Drawer. This section contains a button for each of the three Boosters. All the Boosters are initially locked, which is displayed by a picture of a lock next to the button. (Fig.14) If the User unlocks one of them, a description is shown together with the option to use the Booster. (Fig.15) There are three boolean fields in the database showing whether a particular Booster has been unlocked – magnetUnlocked, stealUnlocked and shieldUnlocked. I decided not to allow Players to use the same Booster twice on a given day in order to prevent Users from abusing this functionality. This is handled by storing an additional boolean field in Firestore – stealUsed which is set to true for the entire day once the Steal has been used and then set to false at the end of each calendar day. Since using the other two Boosters twice a day is not possible because their effects last for the entire duration of the day, this is not a problem for them. However, I have added two boolean fields – piggybankProtected and magnetMode which are set to true for the day once a Player starts using them. This is necessary in order for the app to remember that the Player is using them even if they close the app and reopen it.

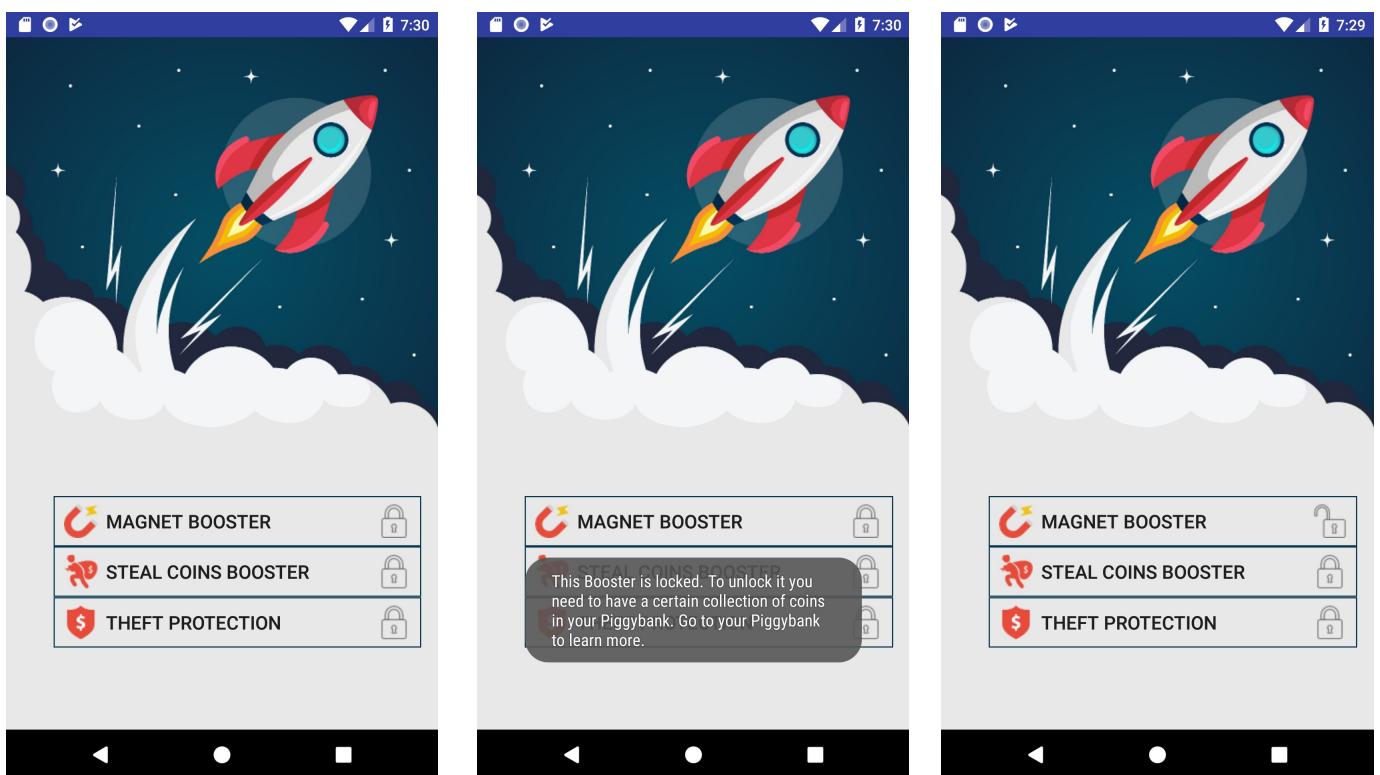


Fig.14 Booster screen: all Boosters locked (left), trying to open a locked Booster (middle), one Booster unlocked (right)

## Magnet

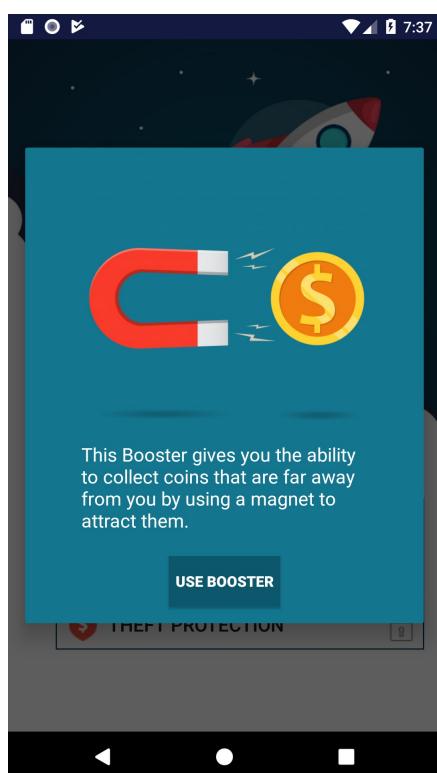
This allows the User to collect coins from farther distance – 75 meters, for a period of one day. I do this by checking for each User location in the onLocationChanged method whether the “magnetMode” field in Firestore is set to true. If this is the case I change the collection distance to 75 instead of 25.

## Stealing

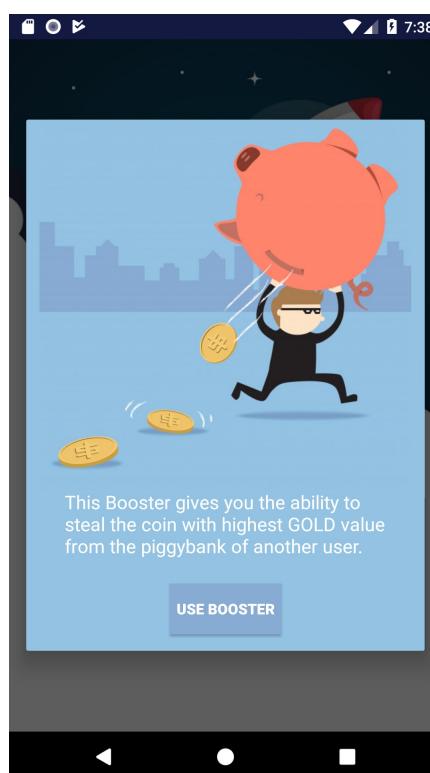
This allows the User to steal the highest valued coin from another User’s Piggybank. The current Player is presented with a list of Users to choose from (Fig.9). Once they have selected a User, the stolen coin is removed from the selected User’s Piggybank and added to the Piggybank of the “thief”. If the selected User has no money in their Piggybank, or has given a coin as a gift to the current User on the same day, or is using the Shield Booster, the current User would be asked to select another Player. A notification is generated for the selected User, informing them that someone has stolen their coin. The username of the “thief” is not specified in order not to promote hate in the game.

## Shield

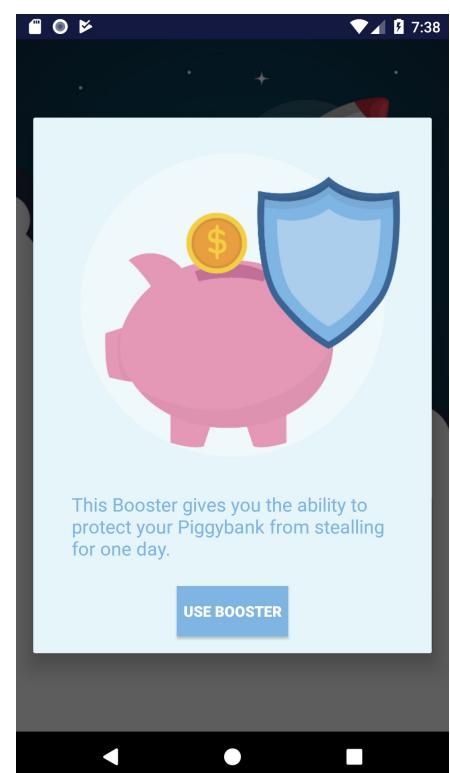
This allows Players to protect their Piggybank from stealing for the duration of the day.



Magnet Booster



Steal Booster



Shield Booster

Fig.15 Boosters

# Notifications

Each User has a section with notifications accessed by their Navigation Drawer. This section displays all the notifications a User has received. Two types of notifications exist – one for receiving gifts (of format “[username] sent you [value] GOLD! You can view the gift in your Piggybank.”) and one for being stolen from (of format “Someone stole a coin worth [value] GOLD from your Piggybank!”). Once a User receives a new notification, the “newNotifications” field is updated to true. When displaying the Navigation Drawer, it is checked whether the User has a new notification (by retrieving the field from Firestore) and if so the icon for the notifications is set to one with a red dot, showing that the User has unread notifications. (Fig.16) Once the User opens the section, the icon is reset to default (Fig.17) and the “newNotifications” field is updated to false as this means that the User has seen the notifications.



Fig.16 Notifications icon without (left) and with (right) new notifications

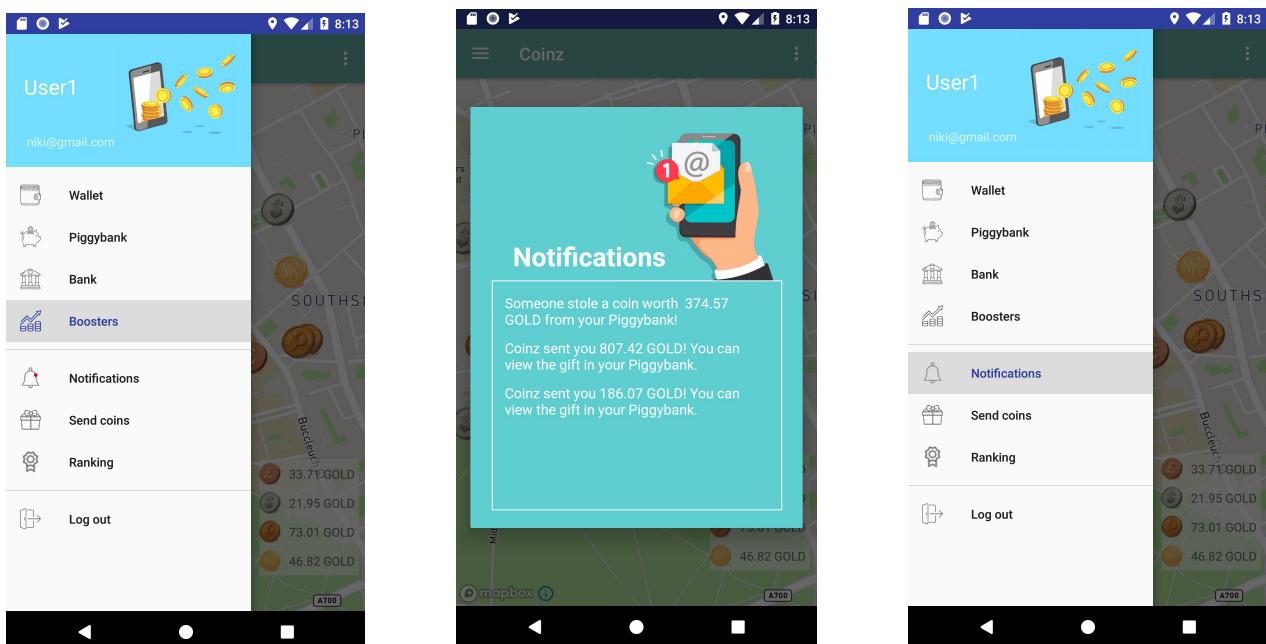


Fig.17 The picture on the left shows a Navigation Drawer informing Users that they have unread notifications, the picture in the middle – the Notification Activity, the picture on the right shows a Navigation Drawer with no new notifications

# Ranking

Up until now no use was made of the Bank money. To deal with that I've created a Ranking system based on the Users' total Bank money. This is done in the Ranking section accessed from the Navigation Drawer. It displays a List View of all Users (represented by their usernames) sorted in a decreasing order with regards to the total money in their Bank account. Also, it tells the User at which place they currently are. (Fig.18) This utilizes the Bank money, adding a competitive factor to the game and thus stimulating Users to collect and deposit more coins in order to become first. To increase the User's interest even further, I've added a hidden prize (for which the User is informed in the Game Rules Activity) to be unlocked once the User has reached the first place.

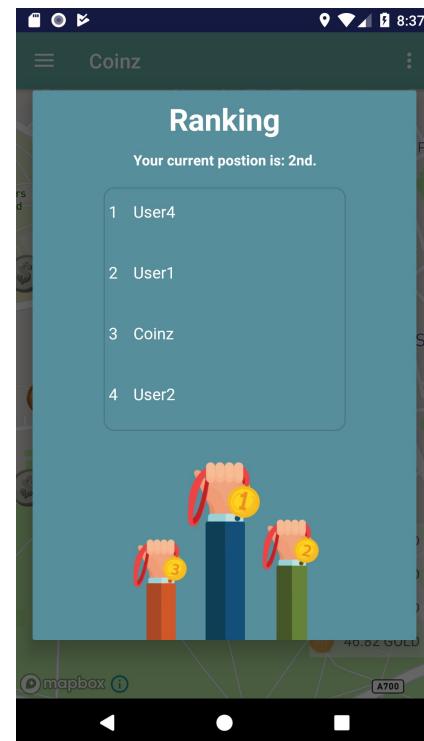


Fig.18 Ranking List View

# Treasure

As stated above, once the User has become first in the Ranking List, a hidden prize is unlocked. The User is shown a puzzle to solve related to the location of a hidden treasure. (Fig.19a) This treasure is based on a true (but speculative) story for a ship called El Pensamiento which was carrying a treasure which allegedly was transferred to the Royal Bank of Scotland. [1] The User has to solve the puzzle which would lead them to the Royal Bank of Scotland's main branch near the Main Campus. Once there, a dialog window will appear telling the User they've won 1000 GOLD coins which are added to their Bank account. (Fig.19b)

This is implemented by creating two boolean fields in Firestore: "treasureUnlocked" and "treasureFound". Every time the User changes their location in the onLocationChanged method it is checked whether the treasure has been unlocked but not found. If this is the case, it checks whether the User's current location is in 15 meters proximity to RBS and if so the treasure has been obtained: 1000 GOLD is added to the User's "money" field in Firestore, "treasureFound" is set to true and "treasureUnlocked" also remains true. I decided the distance for finding the treasure to be only 15 meters in order to ensure that the User doesn't find it "by mistake" while looking for other coins.

[1] <https://www.scotsman.com/lifestyle/lost-treasure-of-el-pensamiento-1-499091>

Once a User has found the treasure they can never again use that functionality even if they become first several times after this. This is handled by making sure that the two booleans “treasureUnlocked” and “treasureFound” remain true. A User can find the treasure only if “treasureUnlocked” is true and “treasureFound” is false.

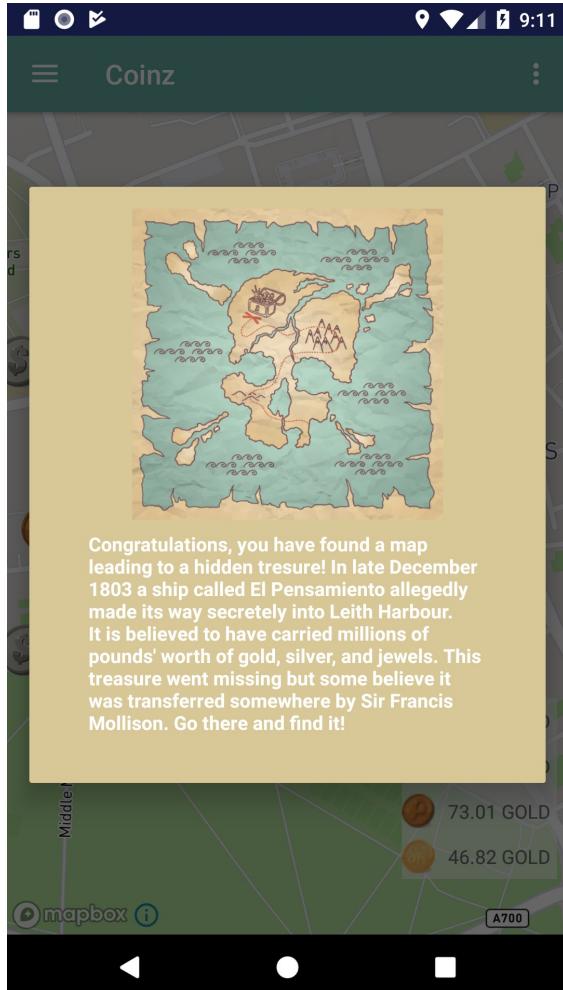


Fig.19a Treasure has been unlocked

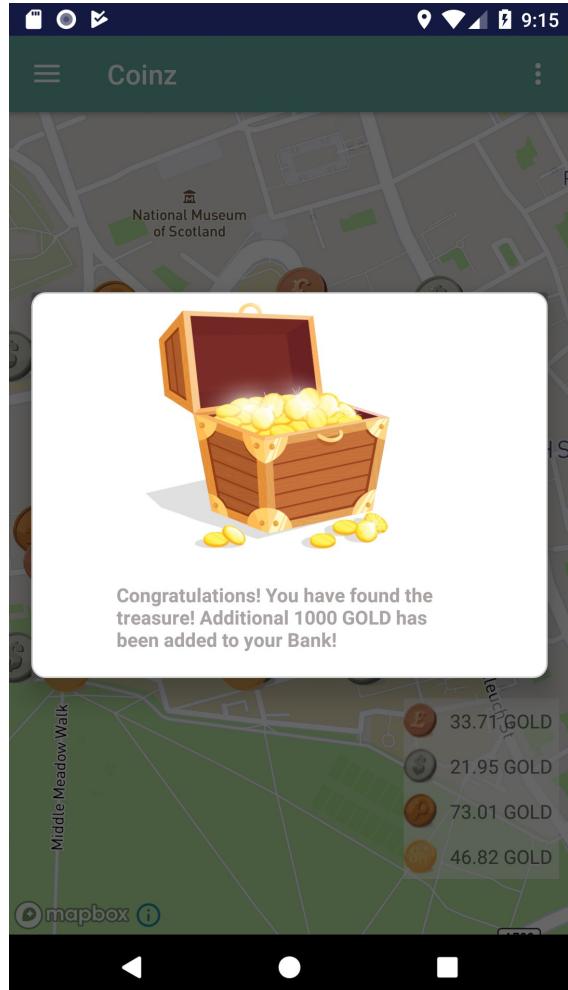


Fig.19b Treasure has been found

## Changes from the first coursework

I have changed numerous things from the first coursework and have added additional features that were not mentioned because I decided that implementing the game in the way it is now would be more user-friendly and interesting to the Players. Here is a list of the changes I've made and the reasons for doing so:

- Users are allowed to bank the same coin more than once. IDs of the coins do not play an important part of the game. I decided to store them with the consideration that for further work on the code it might be useful to have the IDs stored instead of losing them.

- First Booster increases the minimum collection distance instead of the number of coins available for banking. This is done because I decided that a much more interesting feature would be to use a “magnet” and collect coins more easily. This would make it easier to collect more than 25 coins and thus use the spare change for sending gifts which encourages the interaction between Users and the purchase of Boosters which are an essential part of the game.
- At the end of each calendar day the highest valued coin from the Wallet is transferred to the Piggybank. This is done to increase the number of coins in the Piggybank and thus make it easier to obtain certain collections needed for the purchase of Boosters.
- Gifts go directly to the Piggybank to reduce complexity of the game and thus not lose the User’s interest.
- Money in the Piggybank can be banked and, furthermore, there isn’t a limit for the number of coins allowed for transfer per day. This is done to follow the specification of the coursework.
- Boosters section is not initially blank for every User. They can see the different Boosters, but they are locked initially. If the User unlocks them, access is gained to their descriptions together with the ability to use them. I omitted the blank screen in order to improve the appearance - it is much more interesting to see the different Boosters instead of seeing a blank screen.
- Instead of automatically prompting the User when a collection for a given Booster has been obtained, the User is given the freedom to go to the Piggybank and manually select the coins they would like to use for the given collection. This simplifies things and allows the User to decide exactly which coins to use for what (useful if, for example, a given collection can unlock more than one Booster).
- Changed the prices of the 3 Boosters. I found that the previous prices were extremely easy to obtain and thus everyone could be able to afford the Boosters, which is not really the purpose of a Booster.
- Added a new feature for displaying a Ranking List of all Users. This is done to utilize the Bank money because they are not used for purchasing anything in the game. In this way, the main goal of the Users will be to collect as much Bank money as possible in order to reach the first place in the Ranking List. To stimulate this further, I have added another feature which includes a prize for the winner. By winning this prize, the User unlocks a “map” that leads to a hidden treasure in Edinburgh Central Area. The User is given a puzzle to solve which gives them the exact place of the treasure. The treasure is worth 1000 GOLD coins and is based on the story of the mysterious El Pensamiento ship which is believed to have arrived at Leith Harbour in 1803 carrying a large amount of gold, silver and jewels. Allegedly, the money has then been transferred to the Royal Bank of Scotland. The User has to guess this place and if they go in 15 metres proximity to the main branch of RBS (near the Main Campus), 1000 GOLD is added to the User’s Bank money. The User can unlock this feature only once. If at any time later on they become first again, this feature is not accessed.

# Acknowledgements

## Image vectors/ images:

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### **Code:**

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