DAR Defi Team Assignment 2 (Fall 2021)

DeFi Reserve Coins

Cole Paquin

09/08/2021

GITHUB UPDATE & SUBMISSION INSTRUCTIONS (Delete before submission!)

For this and subsequent assignments you'll follow the same basic github steps you used for Assignment 1, ie:

- **Option 1:** Update the copy of your team's repository currently in your home directory:
  - *This is the preferred option **if** you have already cloned the repository*
  - In the Linux terminal: `git pull origin master`
  - If there are errors, it's simplest to proceed to "Option 2"
  - If no errors, check your branch: `git branch` (should be something like `dar-rcsid`)
- **Option 2:** Get a fresh copy of your team's repository:
  - *Do this only if Option 1 fails!*
  - In Linux: `cd ~` to get to your login directory
  - In Linux: `rm -Rf IDEA-Blockchain` (deletes all your previous, uncommited work)
  - In Linux: `git clone https://github.rpi.edu/DataINCITE/IDEA-Blockchain.git`
  - In Linux: `cd IDEA-Blockchain`
  - In Linux: Recreate a personal branch to save your changes to: `git checkout -b dar-rcsid` (replace "rcsid" with your rcsid!)
- Locate and save a personal copy of the assignment notebook:
  - In RStudio "Files" tab, navigate to: `Home > IDEA-Blockchain > DefiResearch > StudentNotebooks > Assignment02`
  - Double-click on `blockchain-assignment2-f21.Rmd` to open
  - Under the "File" menu, "Save as" something like `rcsid-assignment2-f21.Rmd` (replace "rcsid" with your rcsid!)
  - You should see your file appear in the "Files" tab, usually at the bottom
  - Under "More" in the "Files" tab, select "Set as working directory"
- Edit your notebook, saving as you make changes.
  - `cntl-S` works!
- "Knit" your notebook, generating a PDF file:
  - You should see your new PDF appear in the "Files" tab, usually at the bottom
  - "Export" your file (under the "More" menu in the "Files" tab) and save to your local file system
- Add your changed file(s) to your personal branch, and commit:
  - In Linux: `cd ~/IDEA-Blockchain/DefiResearch/StudentNotebooks/Assignment02`
  - In Linux: `git add rcsid-assignment2.*` (replace "rcsid" with your rcsid!)
  - In Linux: `git commit -m "rcsid assignment 2"`
- Push your changes to the remote repository:
  - In Linux: `git push origin dar-rcsid` (replace "rcsid" with your rcsid)
- Issue a pull request:
  - Navigate to https://github.rpi.edu/DataINCITE/IDEA-Blockchain in your browser
  - It should notify you of your recent push and prompt you to make a pull request.

  - If not, find your branch under the popup (defaults to **master**), select and click to issue a pull request
  - One of the instructors
- Upload your downloaded `rcsid-assignment2-f21.pdf` to LMS (replace "rcsid" with your rcsid)
- **Be prepared to share your findings in the DeFi Meeting Thursday.**

Prepare Transaction Data and Explore

We begin by loading our prepared AAVE transaction data into a dataframe. The dataset has over 400,000 rows, and 27 columns.

We are directly loading the dataframe from an Rds archive instead of a CSV file to conserve space.

```
#load Rds (binary version of csv file) into dataframe
# Assumes this notebook is in: ~/IDEA-Blockchain/DefiResearch/StudentNotebooks/Assignment02
df<-read_rds('../../Data/transactions.Rds')

# Let's take a quick look at the first few observation
head(df)
```

```
##       amount borrowRate borrowRateMode   onBehalfOf         pool reserve
## 1   41501.63   6.274937       Variable 8.502518e+47 1.034668e+48     DAI
## 2 7000000.00   2.589628       Variable 4.635974e+47 1.034668e+48    USDT
## 3   15000.00   8.802541       Variable 3.735263e+47 1.034668e+48    USDC
## 4    8193.19  48.747052         Stable 6.896232e+47 1.034668e+48    USDC
## 5   11000.00   3.225055       Variable 1.089455e+48 1.034668e+48    USDT
## 6   40000.00   5.739208       Variable 2.178337e+47 1.034668e+48    USDT
##    timestamp         user   type reservePriceETH reservePriceUSD  amountUSD
## 1 1621340435 8.502518e+47 borrow    2.852900e+14       0.9948044   41286.00
## 2 1622477822 4.635974e+47 borrow    3.812835e+14       1.0000000 7000000.00
## 3 1619775984 3.735263e+47 borrow    3.611000e+14       1.0043389   15065.08
## 4 1615481632 6.896232e+47 borrow    5.562201e+14       0.9993909    8188.20
## 5 1626914745 1.089455e+48 borrow    4.971100e+14       1.0000000   11000.00
## 6 1620936688 2.178337e+47 borrow    2.725248e+14       1.0000000   40000.00
##   collateralAmount collateralReserve principalAmount principalReserve
## 1               NA                                NA
## 2               NA                                NA
## 3               NA                                NA
## 4               NA                                NA
## 5               NA                                NA
## 6               NA                                NA
##   reservePriceETHPrincipal reservePriceUSDPrincipal reservePriceETHCollateral
## 1                       NA                       NA                        NA
## 2                       NA                       NA                        NA
## 3                       NA                       NA                        NA
## 4                       NA                       NA                        NA
## 5                       NA                       NA                        NA
## 6                       NA                       NA                        NA
##   reservePriceUSDCollateral amountUSDPincipal amountUSDCollateral
## 1                        NA                NA                  NA
## 2                        NA                NA                  NA
## 3                        NA                NA                  NA
## 4                        NA                NA                  NA
## 5                        NA                NA                  NA
## 6                        NA                NA                  NA
```

```
##   borrowRateModeFrom borrowRateModeTo stableBorrowRate variableBorrowRate
## 1                                                    NA                 NA
## 2                                                    NA                 NA
## 3                                                    NA                 NA
## 4                                                    NA                 NA
## 5                                                    NA                 NA
## 6                                                    NA                 NA
```

Now look at the summaries to see the types, values, and missingness (NA's) of the data.

```r
summary(df)
```

```
##      amount            borrowRate       borrowRateMode     onBehalfOf
##  Min.   :        0   Min.   :    0.0           :386542   Min.   :2.578e+33
##  1st Qu.:       24   1st Qu.:    3.3   Stable  : 18408   1st Qu.:4.174e+47
##  Median :     1427   Median :    3.9   Variable: 76569   Median :7.522e+47
##  Mean   :   191103   Mean   :    9.5                     Mean   :7.592e+47
##  3rd Qu.:    24382   3rd Qu.:   10.8                     3rd Qu.:1.168e+48
##  Max.   :600000000   Max.   :10002.0                     Max.   :1.461e+48
##  NA's   :7289        NA's   :386542                      NA's   :7289
##       pool              reserve          timestamp              user
##  Min.   :9.862e+47   USDC   :105937   Min.   :1.607e+09   Min.   :2.578e+33
##  1st Qu.:1.035e+48   WETH   :105279   1st Qu.:1.615e+09   1st Qu.:4.199e+47
##  Median :1.035e+48   USDT   : 58266   Median :1.621e+09   Median :8.697e+47
##  Mean   :1.034e+48   DAI    : 55211   Mean   :1.620e+09   Mean   :8.082e+47
##  3rd Qu.:1.035e+48   LINK   : 26404   3rd Qu.:1.624e+09   3rd Qu.:1.173e+48
##  Max.   :1.035e+48   WBTC   : 26344   Max.   :1.629e+09   Max.   :1.461e+48
##                      (Other):104078
##           type         reservePriceETH     reservePriceUSD
##  borrow     : 94977   Min.   :1.000e+00   Min.   :0.000e+00
##  deposit    :192006   1st Qu.:2.865e+14   1st Qu.:1.000e+00
##  liquidation:  6289   Median :4.652e+14   Median :1.000e+00
##  redeem     :126705   Mean   :3.458e+23   Mean   :6.774e+08
##  repay      : 60542   3rd Qu.:9.411e+14   3rd Qu.:1.000e+00
##  swap       :  1000   Max.   :1.647e+28   Max.   :4.252e+13
##                       NA's   :7289        NA's   :7289
##    amountUSD          collateralAmount  collateralReserve principalAmount
##  Min.   :        0   Min.   :      0           :475230    Min.   :      0
##  1st Qu.:       70   1st Qu.:      1   WETH    :  2665    1st Qu.:    962
##  Median :     5836   Median :     14   LINK    :  1312    Median :   4362
##  Mean   :   245851   Mean   :   5451   WBTC    :   686    Mean   :  66005
##  3rd Qu.:    49871   3rd Qu.:    250   AAVE    :   333    3rd Qu.:  21533
##  Max.   :754379487   Max.   :4638724   UNI     :   230    Max.   :4475668
##  NA's   :7289        NA's   :475230    (Other):  1063    NA's   :475230
##  principalReserve reservePriceETHPrincipal reservePriceUSDPrincipal
##         :475230   Min.   :1.000e+00        Min.   :    0.0
##  USDC   :  2142   1st Qu.:4.062e+14        1st Qu.:    1.0
##  USDT   :  1549   Median :4.682e+14        Median :    1.0
##  DAI    :  1459   Mean   :1.556e+17        Mean   :  295.6
##  GUSD   :   242   3rd Qu.:5.363e+14        3rd Qu.:    1.0
##  TUSD   :   175   Max.   :4.203e+19        Max.   :83819.1
##  (Other):   722   NA's   :475230           NA's   :475230
##  reservePriceETHCollateral reservePriceUSDCollateral amountUSDPincipal
##  Min.   :1.000e+00         Min.   :0.000e+00         Min.   :      0
##  1st Qu.:1.000e+00         1st Qu.:0.000e+00         1st Qu.:   1022
```

```
##  Median :5.110e+14         Median :1.000e+00         Median :   4481
##  Mean   :2.177e+21         Mean   :4.543e+06         Mean   :  67361
##  3rd Qu.:1.110e+16         3rd Qu.:2.600e+01         3rd Qu.:  22066
##  Max.   :9.116e+23         Max.   :2.509e+09         Max.   :4571839
##  NA's   :475230            NA's   :475230            NA's   :475230
##  amountUSDCollateral borrowRateModeFrom borrowRateModeTo  stableBorrowRate
##  Min.   :      0              :480519           :480519   Min.   :  0.0
##  1st Qu.:      0     Stable  :   471    Stable  :   529   1st Qu.:  9.0
##  Median :    476     Variable:   529    Variable:   471   Median : 10.9
##  Mean   :  37060                                          Mean   : 11.7
##  3rd Qu.:   7457                                          3rd Qu.: 12.0
##  Max.   :5029023                                          Max.   :154.7
##  NA's   :475230                                           NA's   :480519
##  variableBorrowRate
##  Min.   :  0.0
##  1st Qu.:  3.8
##  Median :  3.9
##  Mean   :  5.7
##  3rd Qu.:  5.1
##  Max.   :148.7
##  NA's   :480519
```

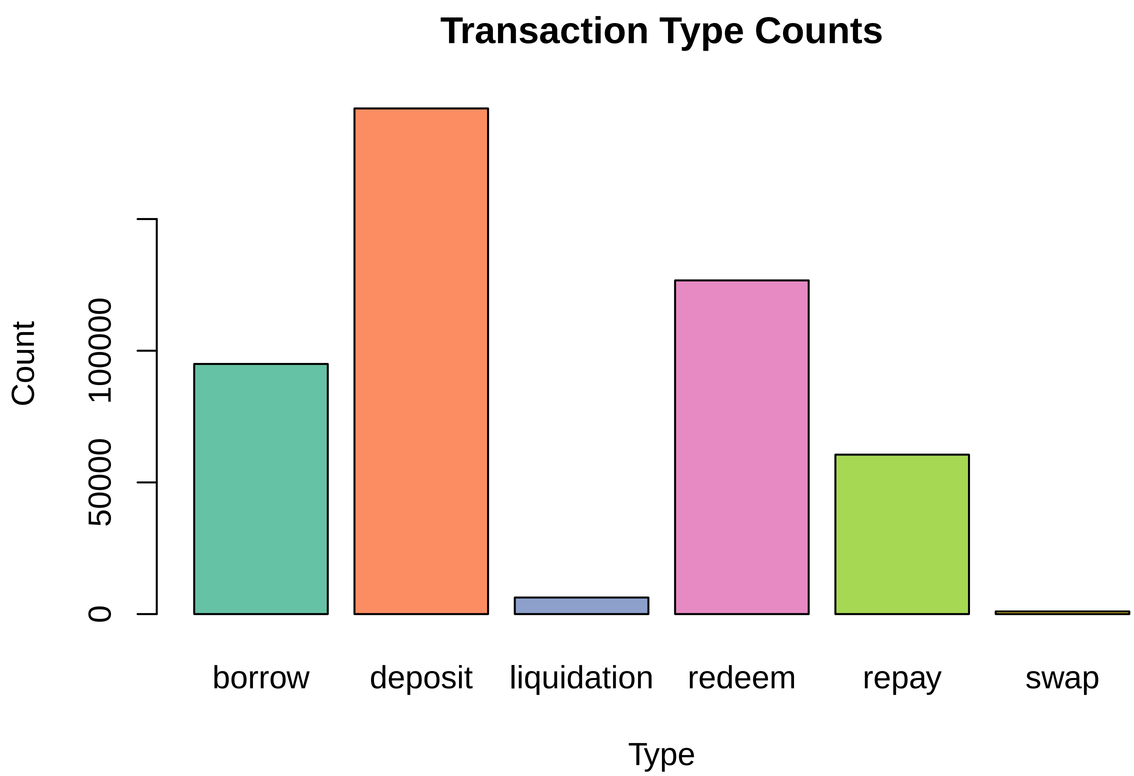
First we'll do some preliminary analysis before we ask detailed questions.

Analyze Transaction Types

Let's examine the different types of *transactions* present in the data. We'll make a simple bar plot to visualize the number of each transaction types. "Deposit" is the most common type of transaction, whereas "swaps" are the most rare.

```r
#set color palette
colors = brewer.pal(6,"Set2")

#create barplot
barplot(table(df$type), main='Transaction Type Counts', xlab='Type',ylab='Count',col=colors)
```

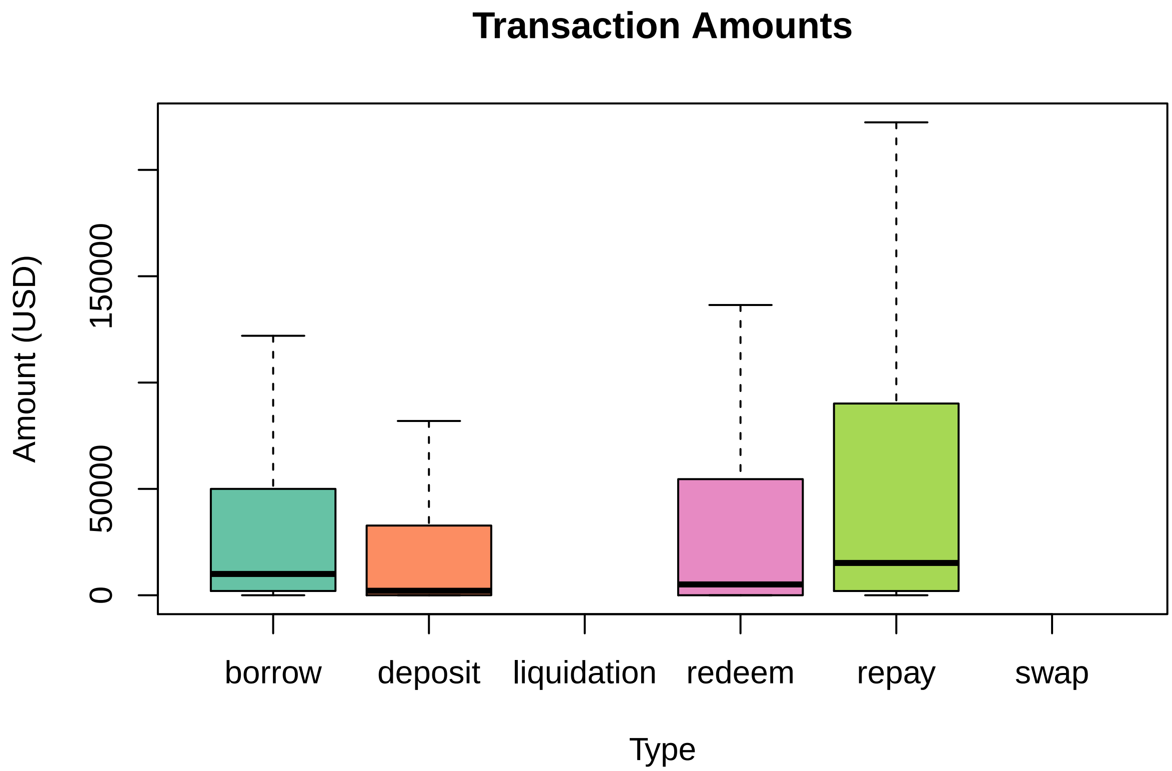


There are more "deposits" than "borrows," because users often need to overcollateralize for loans.

Now we'll examine the amount of US dollars being used in the different types of transactions. We create box plots for the four types of transactions that have the "amount" feature associated with them, and we visualize the distribution of that column for the different transactions.

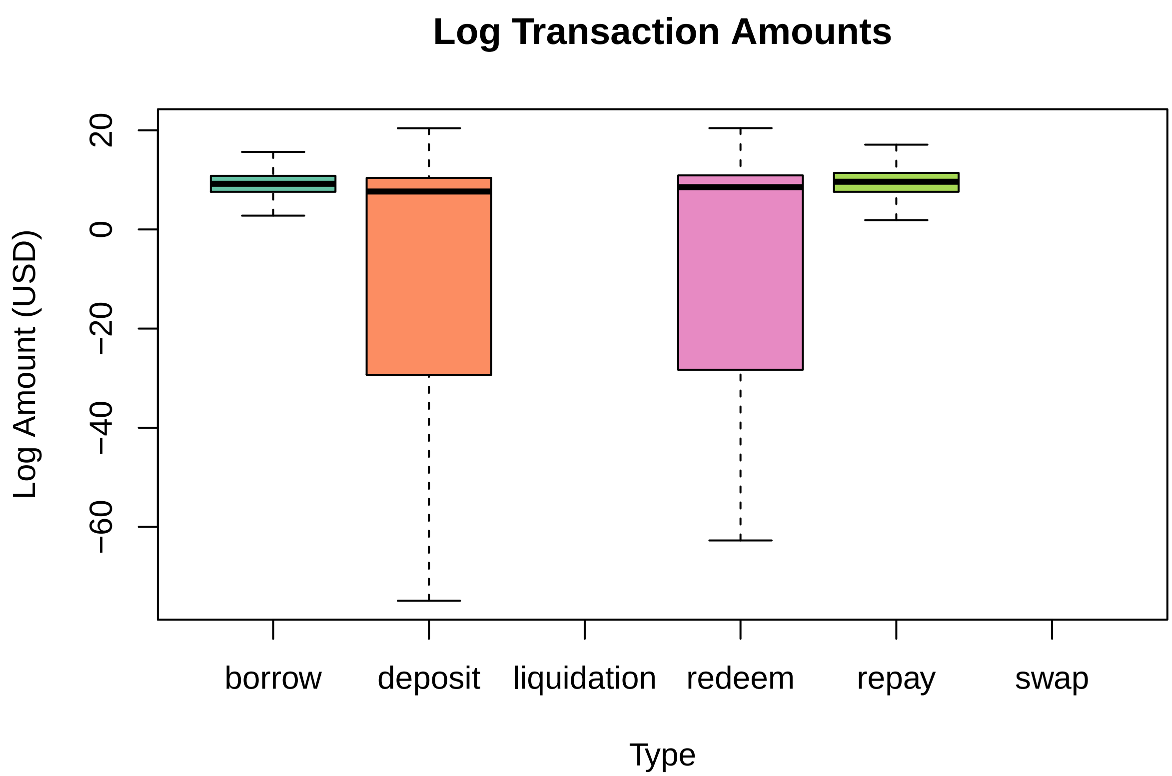
We can see that most transactions are completed with very little money.

```
#create boxplot
boxplot(amountUSD~type,data=df,outline=FALSE,col=colors,
        main="Transaction Amounts",xlab="Type",ylab="Amount (USD)")
```



We do find some very large amounts, so it's helpful to look at this on a log scale.

```
boxplot(log(amountUSD)~type,data=df,outline=FALSE,col=colors,
        main="Log Transaction Amounts",xlab="Type",ylab="Log Amount (USD)")
```



Observation: *There are many borrows and repays with high transactions amounts, but deposits and redeems* *have much lower transactions amounts.*

Examine Reserve Coins

There are 50 different "Reserve" coins used in transactions in AAVE. Let's create a table of those reserve coins with at least 500 transactions and rank order them by their volume.

```
# Use deplyr to drop NA reserves, add the counts and then kep only the top 20
reservecoins <- df %>%  drop_na(reserve) %>%
  count(reserve) %>%
  arrange(-n) %>%
  head(30)

# Add the rank to help keep track of the reserve coins
reservecoins <- reservecoins %>%
  mutate(rank=1:nrow(reservecoins),.before=reserve)

# List the results nicely with kable()
kable(reservecoins)
```

rank	reserve	n
1	USDC	105937
2	WETH	105279
3	USDT	58266
4	DAI	55211
5	LINK	26404
6	WBTC	26344
7	AAVE	12174
8	CRV	10593
9	UNI	7547
10	XSUSHI	7337
11	SNX	6938
12	SUSD	6542
13		6289
14	GUSD	6009
15	YFI	5919
16	BUSD	4863
17	TUSD	3317
18	BAL	3152
19	MKR	3101
20	REN	2638
21	ENJ	2457
22	MANA	1993
23	AmmWETH	1778
24	RAI	1532
25	AMPL	1497
26	AmmUSDC	1405
27	BAT	1377
28	KNC	1349
29	AmmDAI	1266
30	ZRX	905

Let's look at the number of transactions types for each currency.

```r
TopcoinSummary <- df %>% filter(reserve %in% reservecoins$reserve) %>%
  group_by(reserve) %>%
  count(type) %>%
  mutate(percent = n/sum(n)*100)

kable(TopcoinSummary)
```

reserve	type	n	percent
	liquidation	6289	100.0000000
AAVE	borrow	2	0.0164285
AAVE	deposit	7028	57.7295876
AAVE	redeem	5141	42.2293412
AAVE	repay	3	0.0246427
AmmDAI	borrow	529	41.7851501
AmmDAI	deposit	289	22.8278041
AmmDAI	redeem	209	16.5086888
AmmDAI	repay	239	18.8783570
AmmUSDC	borrow	283	20.1423488
AmmUSDC	deposit	537	38.2206406
AmmUSDC	redeem	369	26.2633452
AmmUSDC	repay	216	15.3736655
AmmWETH	borrow	180	10.1237345
AmmWETH	deposit	1014	57.0303712
AmmWETH	redeem	473	26.6029246
AmmWETH	repay	111	6.2429696
AMPL	borrow	438	29.2585170
AMPL	deposit	601	40.1469606
AMPL	redeem	301	20.1068804
AMPL	repay	157	10.4876420
BAL	borrow	215	6.8210660
BAL	deposit	2171	68.8769036
BAL	redeem	612	19.4162437
BAL	repay	154	4.8857868
BAT	borrow	158	11.4742193
BAT	deposit	750	54.4662309
BAT	redeem	335	24.3282498
BAT	repay	132	9.5860566
BAT	swap	2	0.1452433
BUSD	borrow	1685	34.6493934
BUSD	deposit	1135	23.3395024
BUSD	redeem	836	17.1910343
BUSD	repay	1207	24.8200699
CRV	borrow	1054	9.9499670
CRV	deposit	5780	54.5643349
CRV	redeem	2607	24.6105919
CRV	repay	1152	10.8751062
DAI	borrow	14133	25.5981598
DAI	deposit	18552	33.6019996
DAI	redeem	13381	24.2361124
DAI	repay	8895	16.1109199
DAI	swap	250	0.4528083
ENJ	borrow	234	9.5238095
ENJ	deposit	1302	52.9914530

reserve	type	n	percent
ENJ	redeem	681	27.7167277
ENJ	repay	239	9.7273097
ENJ	swap	1	0.0407000
GUSD	borrow	2282	37.9763688
GUSD	deposit	1493	24.8460642
GUSD	redeem	967	16.0925279
GUSD	repay	1267	21.0850391
KNC	borrow	136	10.0815419
KNC	deposit	643	47.6649370
KNC	redeem	411	30.4670126
KNC	repay	157	11.6382506
KNC	swap	2	0.1482580
LINK	borrow	1321	5.0030298
LINK	deposit	15270	57.8321466
LINK	redeem	8713	32.9987881
LINK	repay	1097	4.1546735
LINK	swap	3	0.0113619
MANA	borrow	220	11.0386352
MANA	deposit	1018	51.0787757
MANA	redeem	563	28.2488710
MANA	repay	192	9.6337180
MKR	borrow	188	6.0625605
MKR	deposit	1766	56.9493712
MKR	redeem	986	31.7961948
MKR	repay	159	5.1273783
MKR	swap	2	0.0644953
RAI	borrow	352	22.9765013
RAI	deposit	644	42.0365535
RAI	redeem	326	21.2793734
RAI	repay	210	13.7075718
REN	borrow	196	7.4298711
REN	deposit	1417	53.7149356
REN	redeem	840	31.8423048
REN	repay	183	6.9370735
REN	swap	2	0.0758150
SNX	borrow	433	6.2409916
SNX	deposit	4002	57.6823292
SNX	redeem	2052	29.5762468
SNX	repay	451	6.5004324
SUSD	borrow	1277	19.5200245
SUSD	deposit	2403	36.7318863
SUSD	redeem	1781	27.2240905
SUSD	repay	1081	16.5239988
TUSD	borrow	991	29.8763943
TUSD	deposit	853	25.7160084
TUSD	redeem	661	19.9276455
TUSD	repay	796	23.9975882
TUSD	swap	16	0.4823636
UNI	borrow	567	7.5129190
UNI	deposit	3912	51.8351663
UNI	redeem	2540	33.6557573
UNI	repay	527	6.9829071

reserve	type	n	percent
UNI	swap	1	0.0132503
USDC	borrow	35469	33.4812200
USDC	deposit	27586	26.0400049
USDC	redeem	22131	20.8907181
USDC	repay	20326	19.1868752
USDC	swap	425	0.4011818
USDT	borrow	22332	38.3276697
USDT	deposit	12593	21.6129475
USDT	redeem	10349	17.7616449
USDT	repay	12719	21.8291971
USDT	swap	273	0.4685408
WBTC	borrow	2082	7.9031278
WBTC	deposit	13994	53.1202551
WBTC	redeem	8442	32.0452475
WBTC	repay	1816	6.8934103
WBTC	swap	10	0.0379593
WETH	borrow	7234	6.8712659
WETH	deposit	56373	53.5462913
WETH	redeem	35505	33.7246744
WETH	repay	6155	5.8463701
WETH	swap	12	0.0113983
XSUSHI	borrow	242	3.2983508
XSUSHI	deposit	4382	59.7246831
XSUSHI	redeem	2454	33.4469129
XSUSHI	repay	259	3.5300532
YFI	borrow	403	6.8085825
YFI	deposit	2976	50.2787633
YFI	redeem	2146	36.2561243
YFI	repay	394	6.6565298
ZRX	borrow	76	8.3977901
ZRX	deposit	496	54.8066298
ZRX	redeem	279	30.8287293
ZRX	repay	53	5.8563536
ZRX	swap	1	0.1104972

Look at Sample User Transaction Histories

Finally, we will examine the transaction history of different users. To do this, we will select 3 random users from the data who have completed between 100 and 300 transactions. Then, we create swarmplots displaying the different types of transactions those users made over time.

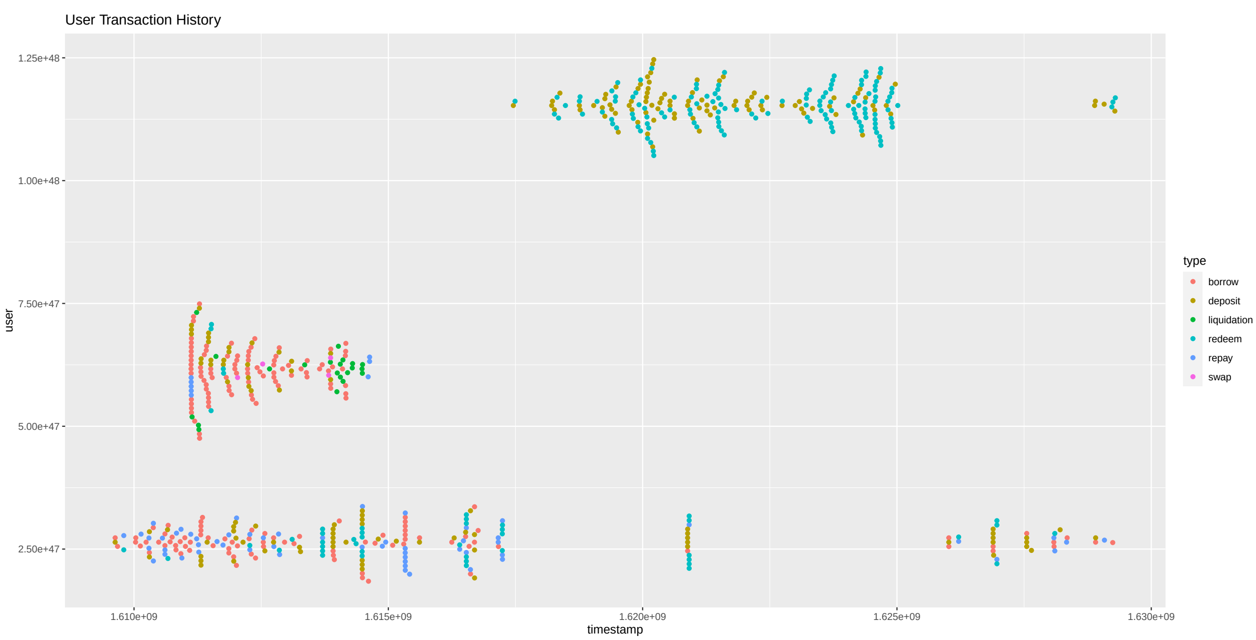
```r
#set seed
set.seed(1)

# Select three random users that have between 100 and 300 transactions
users<-vector(length=3)
count<-0
while(count<=3){
  success<-FALSE
  while(!success){
    #get random user
    ruser<-sample(df$user,1)
```

```
    #check for valid number of transactions
    length<-nrow(filter(df,user==ruser))
    if (length>100 && length<300){
      users[count]=ruser
      success<-TRUE
      count<-count+1
    }
  }
}
df.rusers<-filter(df, user %in%users)

# Create a "swarmplot"

ggplot(df.rusers,aes(user, timestamp,color=type)) +
        geom_beeswarm(cex=1)+
        coord_flip()+
        ggtitle("User Transaction History")
```



Observation: *Users have very different transactions patterns, which we will try to better understand.*

Activities

##*Exercise 1(10pts)*

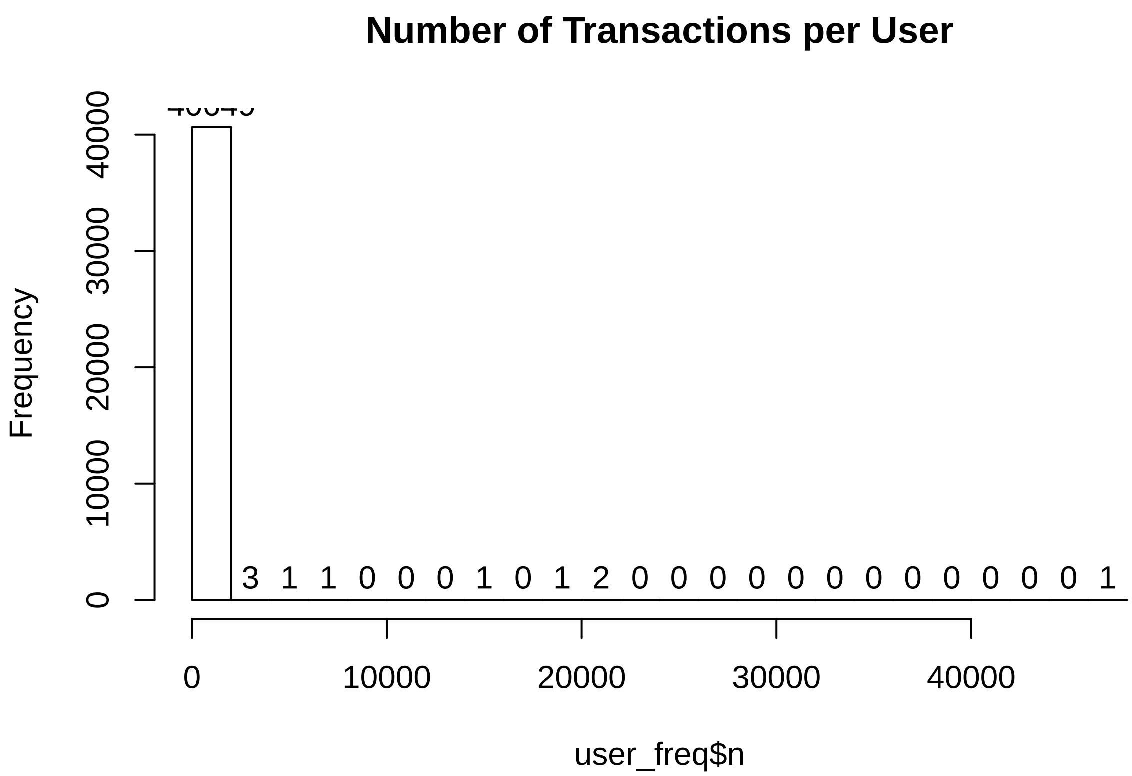
1. Divide the top 20 reserve coins between your team members so each team member has the same amount of coins; feel free to add or subtract coins if necessary.
2. Look up your coins on the internet to find out what they are. ProTip: Look them up on http://defipulse.com to see their *Total Value Locked (TVL)*.
3. Examine the percentage of transaction types for your coins. Hypothesize why a given coin might have more of one type of transaction than another.
4. *Prepare one slide with the findings for each of your coins.* (one slide summarizing each coin)

5. Coordinate with your team, to combine each of your member's coin descriptions into a single presentation. Please develop a common format or template for presenting your coin summaries so that the common information for a coin (e.g. TVL) is shown in the same format. (Your slide summaries should look the same!)
6. Be prepared to present your team presentation to your client in class on Thursday 9/16.

##*Exercise* 2(10*pts*)

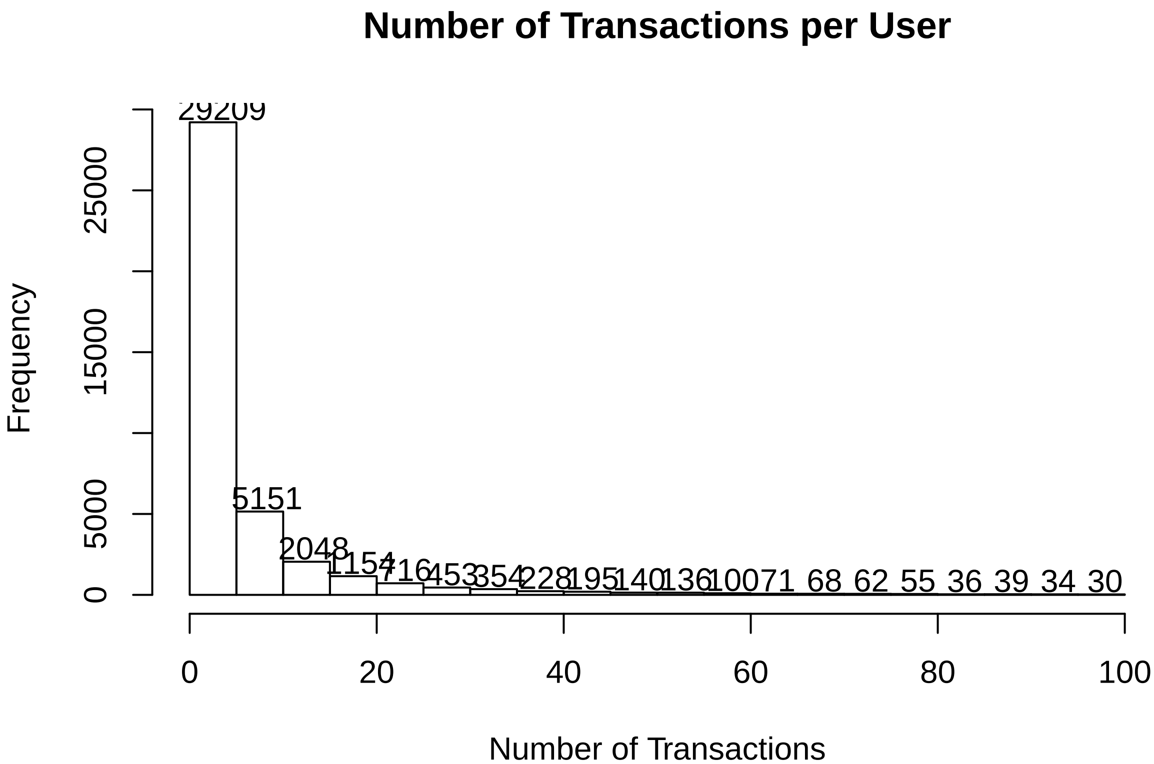
1. Perform a "creative exploration" of some aspect of the Defi data that you find interesting. Add your work in this notebook. *Your work should include at least one data visualization.*
2. Put your work in this notebook.

```
user_freq <- count(df, df$user)
h <- hist(user_freq$n, main = "Number of Transactions per User")
text(h$mids,h$counts,labels=h$counts, adj=c(0.5, -0.5))
```



Seeing how this histogram does not show us very much, I will filter down the number of transactions to remove outliers.

```
filter_count <- filter(user_freq, user_freq$n < 100)
h <- hist(filter_count[,2], main = "Number of Transactions per User", xlab = "Number of Transactions")
text(h$mids,h$counts,labels=h$counts, adj = c(0.4, -0.1))
```



This is a much more interesting graph because we now can better see the distribution of users. More than half of the users in the data set have between 1 and 5 transactions. In the future, this will allow me to look into how different groupings of these people may behave differently.

```
sorted_users <- user_freq[order(user_freq$n),]
top_user <- sorted_users[length(user_freq$n),]
TopUserSummary <- df %>% filter(user %in% top_user) %>%
  group_by(user) %>%
  count(type) %>%
  mutate(percent = n/sum(n)*100)

kable(TopUserSummary)
```

user	type	n	percent
1.168069e+48	borrow	4366	9.375336
1.168069e+48	deposit	29079	62.442827
1.168069e+48	redeem	13124	28.181838

This shows us what types of transactions are used by the user with more than 40,000 transactions, which is significantly more than the next highest. Now I will look at the actions of all individuals with only 1 transaction.

```
one_transaction <- filter(user_freq, user_freq$n == 1)
MinUserSummary <- df %>% filter(user %in% one_transaction$`df$user`) %>%
  count(type) %>%
  mutate(percent = n/sum(n)*100)

kable(MinUserSummary)
```

type	n	percent
borrow	740	7.5780850
deposit	7921	81.1162314
liquidation	2	0.0204813
redeem	845	8.6533538
repay	257	2.6318484

3. Write a paragraph describing your findings in the context of DeFi.

As seen in the previous illustrations, I looked into the distribution of users and how many transactions people made. These graphs can be helpful as we may end up grouping users by number of transactions. Although more than 9,000 users had only recorded 1 transaction, the top user had made over 40,000. For this person, we saw that they only have deposited, redeemed, and borrowed money. However, they borrowed less than 10% of the time. On the other side, for the people with only one transaction, 81% of them had deposited money. This appears to make sense as it seems natural for the first thing to do is to deposit some of your more traditional money. Going forward, it could be interesting to see if there is a reason for why there are a select few outliers that have made many transactions. Also, we could look into seeing if their is any pattern between people being liquidated and the number of previous transactions. Overall, this gives me a solid base in understanding how this dataset works and what the makeup is of the different users.

4. Be prepared to share (2 minutes) in team meeting.
5. *You'll receive extra credit for work that goes "above and beyond" this assignment!*