

# DAR Defi Team Assignment 2 (Fall 2021)

DeFi Reserve Coins

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## 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, uncommitted 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.
  - `ctrl-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.

```
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 amountUSDPrincipal
## 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
```

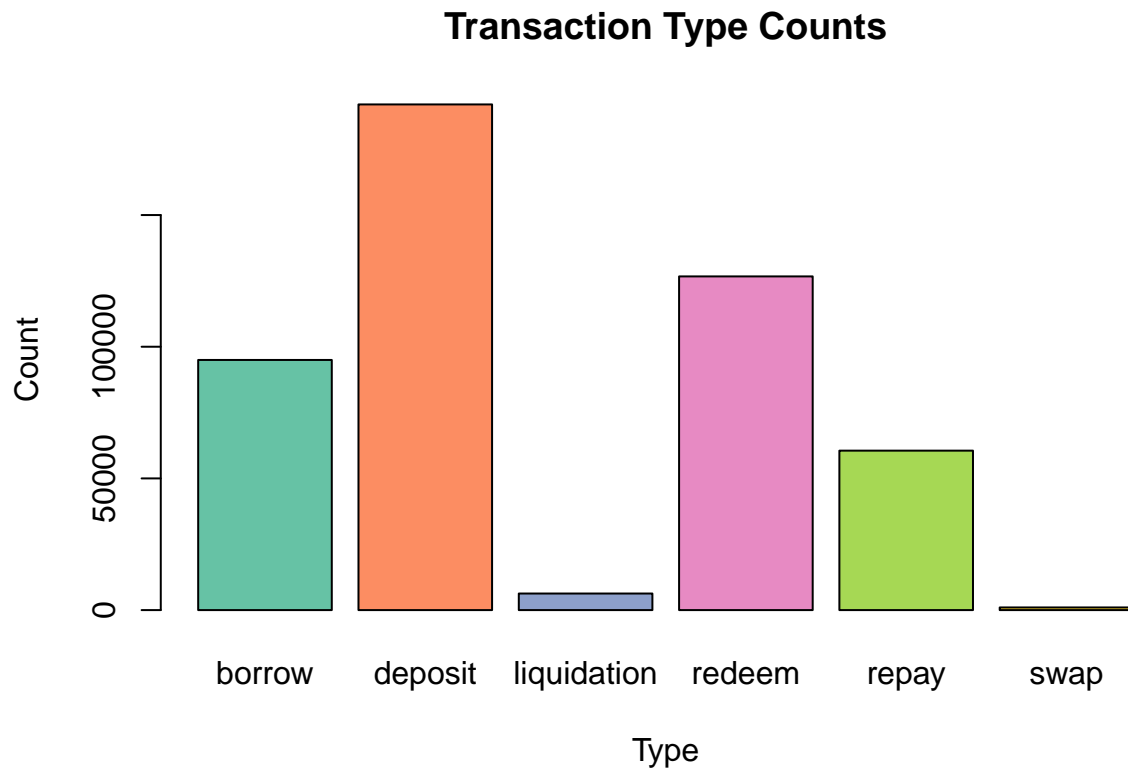
First we'll do some preliminary analysis before we ask detailed questions.

## 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.

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

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



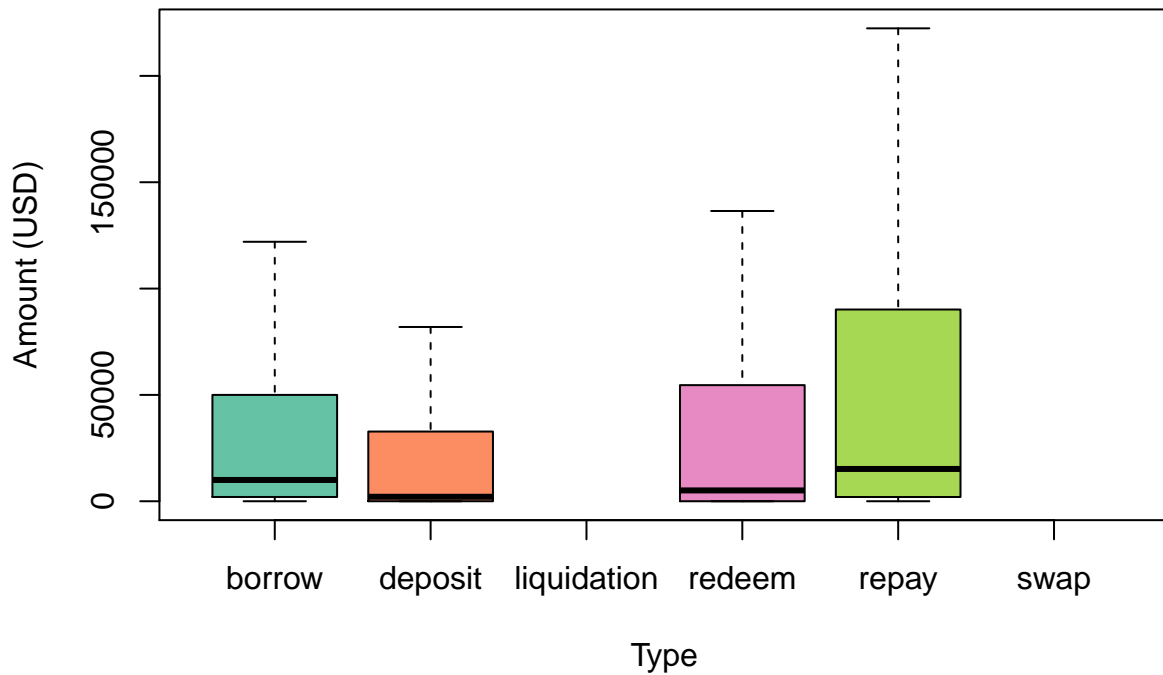
There are more “deposits” than “borrows,” because users often need to overcollateralize for loans.

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)")
```

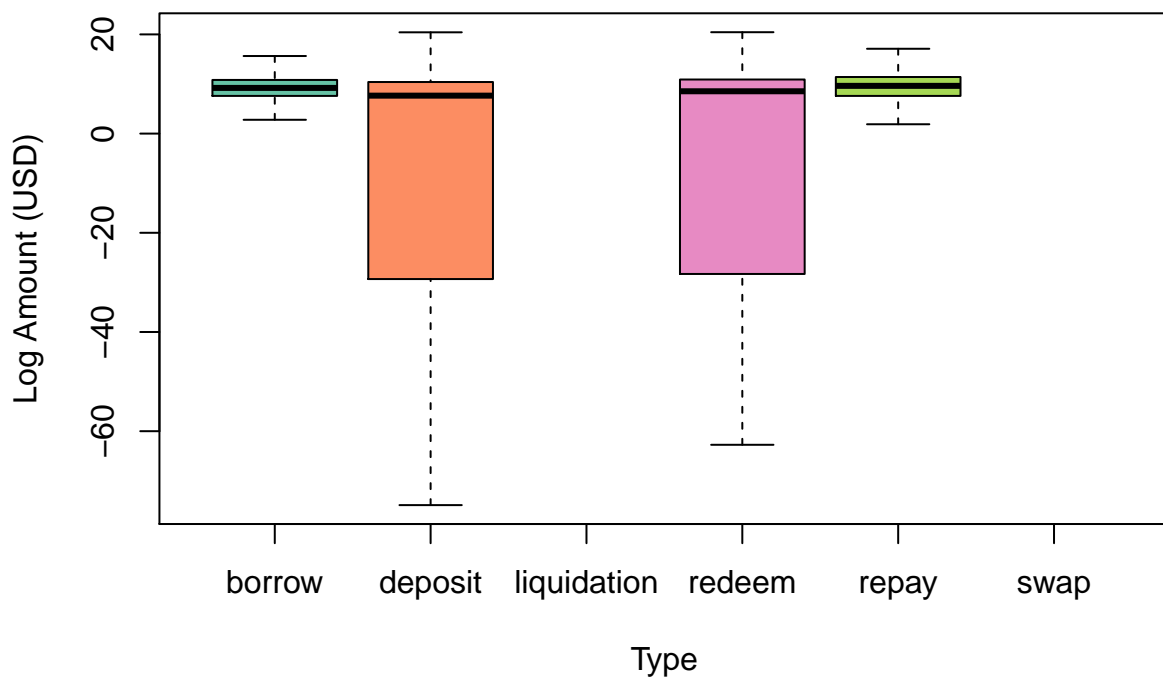
## Transaction Amounts



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)")
```

## Log Transaction Amounts



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 dplyr to drop NA reserves, add the counts and then keep only the top 20
reservecoins <- df %>% drop_na(reserve) %>%
  count(reserve) %>%
  arrange(-n) %>%
  head(50)

# 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
31	AmmUSDT	825
32	AmmWBTC	344
33	AmmBptBALWETH	244

rank	reserve	n
34	AmmBptWBTCWETH	159
35	AmmUniUSDCWETH	136
36	RENFIL	90
37	AmmUniUNIETH	68
38	AmmUniWBTCWETH	57
39	AmmUniDAIETH	52
40	AmmUniLINKETH	43
41	AmmUniAAVEETH	19
42	AmmUniCRVETH	11
43	PAX	11
44	AmmUniWBTCUSDC	10
45	AmmUniSNXETH	7
46	AmmUniRENETH	6
47	AmmUniYFIETH	6
48	AmmUniMKRETH	5
49	AmmUniBATETH	4
50	AmmUniDAIUSDC	3

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

```
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
AmmBptBALETH	deposit	171	70.0819672
AmmBptBALETH	redeem	73	29.9180328
AmmBptWBTCETH	deposit	97	61.0062893
AmmBptWBTCETH	redeem	62	38.9937107
AmmDAI	borrow	529	41.7851501
AmmDAI	deposit	289	22.8278041
AmmDAI	redeem	209	16.5086888
AmmDAI	repay	239	18.8783570
AmmUniAAVEETH	deposit	11	57.8947368
AmmUniAAVEETH	redeem	8	42.1052632
AmmUniBATETH	deposit	3	75.0000000
AmmUniBATETH	redeem	1	25.0000000
AmmUniCRVETH	deposit	8	72.7272727
AmmUniCRVETH	redeem	3	27.2727273
AmmUniDAIUSDC	deposit	2	66.6666667
AmmUniDAIUSDC	redeem	1	33.3333333
AmmUniDAIETH	deposit	32	61.5384615
AmmUniDAIETH	redeem	20	38.4615385
AmmUniLINKETH	deposit	30	69.7674419



reserve	type	n	percent
AmmUniLINKWETH	redeem	13	30.2325581
AmmUniMKRWETH	deposit	4	80.0000000
AmmUniMKRWETH	redeem	1	20.0000000
AmmUniRENWETH	deposit	3	50.0000000
AmmUniRENWETH	redeem	3	50.0000000
AmmUniSNXWETH	deposit	3	42.8571429
AmmUniSNXWETH	redeem	4	57.1428571
AmmUniUNIWETH	deposit	42	61.7647059
AmmUniUNIWETH	redeem	26	38.2352941
AmmUniUSDCWETH	deposit	82	60.2941176
AmmUniUSDCWETH	redeem	54	39.7058824
AmmUniWBTCUSDC	deposit	6	60.0000000
AmmUniWBTCUSDC	redeem	4	40.0000000
AmmUniWBTCWETH	deposit	37	64.9122807
AmmUniWBTCWETH	redeem	20	35.0877193
AmmUniYFIWETH	deposit	5	83.3333333
AmmUniYFIWETH	redeem	1	16.6666667
AmmUSDC	borrow	283	20.1423488
AmmUSDC	deposit	537	38.2206406
AmmUSDC	redeem	369	26.2633452
AmmUSDC	repay	216	15.3736655
AmmUSDT	borrow	180	21.8181818
AmmUSDT	deposit	297	36.0000000
AmmUSDT	redeem	209	25.3333333
AmmUSDT	repay	139	16.8484848
AmmWBTC	borrow	48	13.9534884
AmmWBTC	deposit	163	47.3837209
AmmWBTC	redeem	99	28.7790698
AmmWBTC	repay	34	9.8837209
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

reserve	type	n	percent
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
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
PAX	borrow	8	72.7272727
PAX	deposit	2	18.1818182
PAX	redeem	1	9.0909091
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
RENFIL	borrow	29	32.2222222
RENFIL	deposit	28	31.1111111
RENFIL	redeem	11	12.2222222
RENFIL	repay	22	24.4444444
SNX	borrow	433	6.2409916

reserve	type	n	percent
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
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.

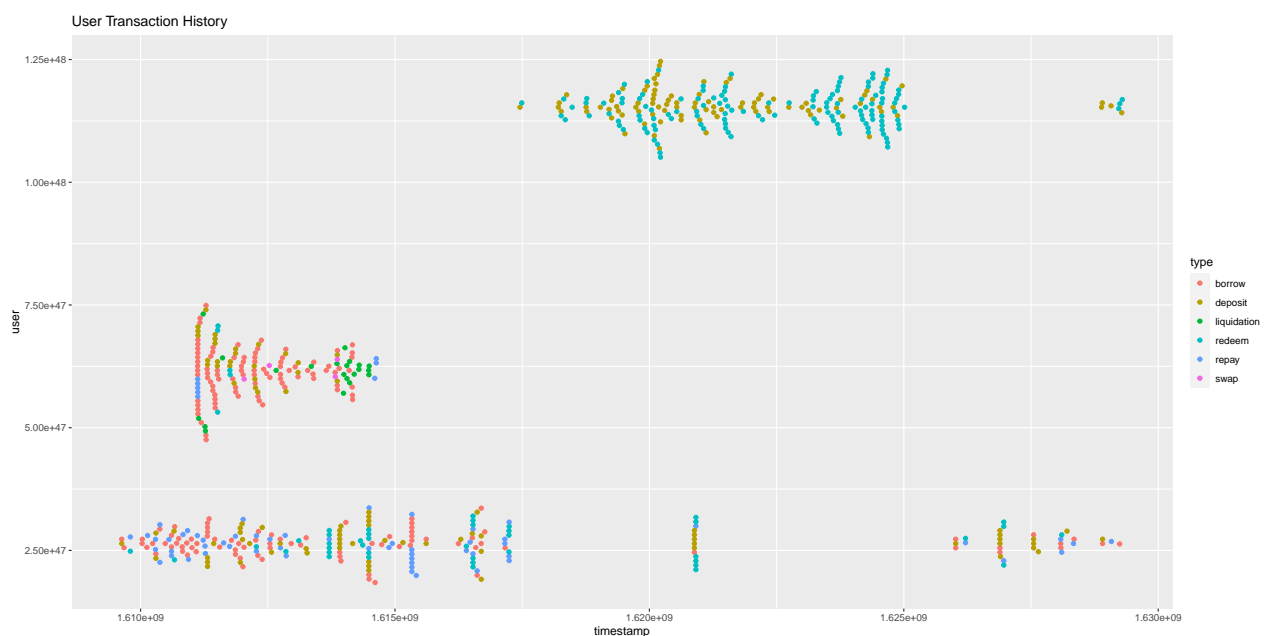
```
#set seed
set.seed(1)

# 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(10pts)

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