

DeFi Notebook:

DAR Assignment 6

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Introductory Decentralized Finance (DeFi) Research Notebook

This notebook is broken into two main parts:

- * Part 1 is a basic introduction to github and RStudio Server
- * Part 2 is an introduction to the DeFi transaction dataset

This R Notebook and its related R scripts provide a very basic introduction to an interesting **Decentralized Finance (DeFi)** dataset. All data was obtained by querying an API on The Graph, an indexing protocol for querying networks like Ethereum, for transaction data based on the AAVE protocol. For more information on AAVE see the AAVE developer notes. The AAVE protocol is based on Ethereum, an important cryptocurrency platform.

The RPI github repository for all the code required for this notebook, including a snapshots of AAVE transaction and user data, may be found at:

- <https://github.rpi.edu/DataINCITE/IDEA-Blockchain>

The IDEA-Blockchain github also contains notebooks used to harvest the AAVE dataset, which you are welcome to examine.

BEFORE YOU BEGIN

To contribute or submit to any RPI github repository you must validate your RPI github.com ID and send a confirmation email to John Erickson at erickj4@rpi.edu. Please do the following **now**:

- Browse to <http://github.rpi.edu>
- Log in using your RPI credentials
- **PLEASE DO THIS IMMEDIATELY BEFORE READING ANY FURTHER!!**

DAR ASSIGNMENT 1: CLONING A NOTEBOOK AND UPDATING THE REPOSITORY

In this assignment we're asking you to...

- clone the **IDEA-Blockchain** github repository...
- create a personal branch using git...
- copy and change an R notebook...
- generate ("knit") a PDF based on that notebook, and...
- add these new files by "committing" and "pushing" to the github repository

The instructions which follow explain how to accomplish this.

NOTE: For DAR Fall 2021 you *must* be using RStudio Server on the IDEA Cluster. Instructions for accessing “The Cluster” appear at the end of this notebook. Also, don’t forget to validate your RPI github ID as above and email erickj4@rpi.edu

Cloning an RPI github repository

The recommended procedure for cloning and using this repository is as follows:

- Access the RPI network via VPN
 - See <https://itssc.rpi.edu/hc/en-us/articles/360008783172-VPN-Connection-and-Installation> for information
- Access RStudio Server on the IDEA Cluster at <http://lp01.idea.rpi.edu/rstudio-ose/>
 - You must be on the RPI VPN!!
- Access the Linux shell on the IDEA Cluster by clicking the **Terminal** tab of RStudio Server (lower left panel).
 - You now see the Linux shell on the IDEA Cluster
 - `cd` (change directory) to enter your home directory using: `cd ~`
 - Type `pwd` to confirm
 - NOTE: Advanced users may use `ssh` to directly access the Linux shell from a macOS or Linux command line
- Type `git clone https://github.rpi.edu/DataINCITE/IDEA-Blockchain.git` from within your home directory
 - This will create a new directory **IDEA-Blockchain**
- In the Linux shell, `cd` to **IDEA-Blockchain/DefiResearch/StudentNotebooks**
 - Type `ls -al` to list the current contents
 - Don’t be surprised if you see many files!
- In the Linux shell, type `git checkout -b dar-yourrcs` where `yourrcs` is your RCS id
 - For example, if your RCS is `erickj4`, your new branch should be `dar-erickj4`
 - It is *critical* that you include your RCS id in your branch id
- Now in the RStudio Server UI, navigate to the **IDEA-Blockchain/DefiResearch/StudentNotebooks** directory via the **Files** panel (lower right panel)
 - Under the **More** menu, set this to be your **R working directory**
 - *Setting the correct working directory is essential for interactive R use!*

REQUIRED FOR ASSIGMENT 1

1. In RStudio...
 - Open `blockchain-notebook-f21.Rmd`
 - **NOTE:** When opening this `.Rmd` RStudio may warning you that some required packages are not installed, and ask you if you wish to install them.
 - Go ahead and say yes. **DO NOT INTERRUPT PACKAGE INSTALLATION!**
 - **Save As...** using a *new, original, descriptive* filename that **includes your RCS ID!**
 - Example filename for user `erickj4`: `erickj4-assignment1-f21.Rmd`
 - You should see the file appear in the listing in your **Files** panel.
2. Edit your new notebook using RStudio and save your results...
 - Change the `title:` and `subtitle:` headers (at the top of the file)
 - Change the `author:`
 - Change the `date:`
 - **Save** your changes (`<ctrl-s>` works!)
3. Use the RStudio **Knit** command (top of the editing window) to create HTML and/or PDF files
 - Use the down arrow next to the word **Knit** and select **Knit to HTML** (Optional but handy for previewing)
 - Use the down arrow next to the word **Knit** and select **Knit to PDF** (Required for assignment)
 - Repeat as necessary
4. In the Linux terminal, use `git add` to add each new file you want to add to the repository

- Type: `git add yourfilename.Rmd`
 - Type: `git add yourfilename.html` (created when you knit to HTML)
 - Type: `git add yourfilename.pdf` (created when you knit to PDF)
5. When you're ready, in Linux commit your changes:
 - Type: `git commit -m "some comment"` where "some comment" is a useful comment describing your changes
 - This commits your changes to your local repo, and sets the stage for your next operation.
 6. Finally, "push" the commits in your working branch to the RPI github repo
 - Type: `git push origin dar-yourrcs` (where `dar-yourrcs` is the branch you've been working in)
 - Your changes are now safely on the RPI github, under your branch name.
 7. **REQUIRED:** On the RPI github, submit a pull request for your branch:
 - In a web browser, navigate to <https://github.rpi.edu/DataINCITE/IDEA-Blockchain>
 - In the drop-down that says **Master** (top left above the list of files) click and select *your* branch
 - It should give you the option to create a pull request
 - **Submit a pull request for your branch**
 - Eventually one of the DAR instructors will merge your branch into the master branch of the repo.
 8. Confirm what you just did; make the following additional edits:
 - What is the location of the github: `__https://github.rpi.edu/DataINCITE/IDEA-Blockchain/tree/dar-mink3__`
 - What is your github ID: `mink3`
 - What is the name of your new branch: `dar-mink3`
 - What is the name of your new (copied) notebook: `mink3-assignment1-f21.Rmd`
 - Save your changes and **knit** an updated PDF.
 9. Re-commit these fresh changes to the github
 - Confirm that you are still in your branch; type: `git branch`
 - `git add` your Rmd and PDF
 - `git commit -m` with a fresh message
 - `git push origin` your branch.
 - Go to github and select your branch again; if your previous push has already been merged, submit another pull request.
 - More than likely your previous pull request hasn't been merged and you newest commit was automatically added to your existing request.
 10. Download your PDF and upload to LMS:
 - In the RStudio **Files** panel, select your newly created PDF file (check the checkbox to its left) and select **Export** under the **More** menu.
 - This downloads your PDF file to your personal machine.
 - Now proceed to LMS and upload the PDF you created!

Please also see this handy github "cheatsheet": <https://education.github.com/git-cheat-sheet-education.pdf>

Exploring a DeFi Transaction Dataset using AAVE

This section is provided as background and is not required for Assignment 1.

What is AAVE?

From the developer site: *Aave is a decentralised non-custodial liquidity protocol where users can participate as depositors or borrowers. Depositors provide liquidity to the market to earn a passive income, while borrowers are able to borrow in an over-collateralised (perpetually) or under-collateralised (one-block liquidity) fashion... The (Aave) protocol is implemented as a set of smart contracts on top of the Ethereum blockchain. Smart contracts guarantee safety and do not require a middleman.*

For (much) more detail refer to the AAVE Protocol V2.0 Whitepaper

Prepare Transaction Data

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  
df<-read_rds('../Data/transactionsv2.rds')
```

```
# Let's take a quick look  
head(df)
```

```
##      amount borrowRate borrowRateMode  onBehalfOf      pool reserve  
## 1      15.00  0.2590658      Variable 1.117217e+48 1.034668e+48  WETH  
## 2     41501.63 6.2749368      Variable 8.502518e+47 1.034668e+48  DAI  
## 3 7000000.00 2.5896280      Variable 4.635974e+47 1.034668e+48  USDT  
## 4     15000.00 8.8025409      Variable 3.735263e+47 1.034668e+48  USDC  
## 5      8193.19 48.7470516      Stable 6.896232e+47 1.034668e+48  USDC  
## 6     11000.00 3.2250550      Variable 1.089455e+48 1.034668e+48  USDT  
##      timestamp      user      type reservePriceETH reservePriceUSD amountUSD  
## 1 1633275840 1.168069e+48 borrow      1.0000000000      3421.8708189 51328.06  
## 2 1621340435 8.502518e+47 borrow      0.0002852900      0.9948044 41286.00  
## 3 1622477822 4.635974e+47 borrow      0.0003812835      1.0000000 7000000.00  
## 4 1619775984 3.735263e+47 borrow      0.0003611000      1.0043389 15065.08  
## 5 1615481632 6.896232e+47 borrow      0.0005562201      0.9993909 8188.20  
## 6 1626914745 1.089455e+48 borrow      0.0004971100      1.0000000 11000.00  
##      collateralAmount collateralReserve liquidator principalAmount  
## 1              NA              NA              NA              NA  
## 2              NA              NA              NA              NA  
## 3              NA              NA              NA              NA  
## 4              NA              NA              NA              NA  
## 5              NA              NA              NA              NA  
## 6              NA              NA              NA              NA  
##      principalReserve reservePriceETHPrincipal reservePriceUSDPrincipal  
## 1              NA              NA              NA  
## 2              NA              NA              NA  
## 3              NA              NA              NA  
## 4              NA              NA              NA  
## 5              NA              NA              NA  
## 6              NA              NA              NA  
##      reservePriceETHCollateral reservePriceUSDCollateral amountUSDPrincipal  
## 1              NA              NA              NA  
## 2              NA              NA              NA  
## 3              NA              NA              NA  
## 4              NA              NA              NA  
## 5              NA              NA              NA  
## 6              NA              NA              NA  
##      amountUSDCollateral borrowRateModeFrom borrowRateModeTo stableBorrowRate  
## 1              NA              NA              NA  
## 2              NA              NA              NA  
## 3              NA              NA              NA  
## 4              NA              NA              NA  
## 5              NA              NA              NA  
## 6              NA              NA              NA  
##      variableBorrowRate fromState toState protocolContract      user_alias
```

```
## 1      NA      True Gladys Marquez
## 2      NA      False Angel Prather
## 3      NA      False Jack Crowley
## 4      NA      False Jim Dickens
## 5      NA      False Leonard Reyes
## 6      NA      False Jill Carn
```

```
## onBehalfOf_alias      datetime
## 1 Evelyn Terrazas 2021-10-03 15:44:00
## 2 Angel Prather 2021-05-18 12:20:35
## 3 Jack Crowley 2021-05-31 16:17:02
## 4 Jim Dickens 2021-04-30 09:46:24
## 5 Leonard Reyes 2021-03-11 16:53:52
## 6 Jill Carn 2021-07-22 00:45:45
```

```
str(df)
```

```
## 'data.frame': 745612 obs. of 33 variables:
## $ amount : num 15 41502 7000000 15000 8193 ...
## $ borrowRate : num 0.259 6.275 2.59 8.803 48.747 ...
## $ borrowRateMode : Factor w/ 3 levels "", "Stable", "Variable": 3 3 3 3 2 3 3 3 3 3 ...
## $ onBehalfOf : num 1.12e+48 8.50e+47 4.64e+47 3.74e+47 6.90e+47 ...
## $ pool : num 1.03e+48 1.03e+48 1.03e+48 1.03e+48 1.03e+48 ...
## $ reserve : Factor w/ 53 levels "", "AAVE", "AmmBptBALWETH",...: 50 29 48 47 47 48 48 ...
## $ timestamp : int 1633275840 1621340435 1622477822 1619775984 1615481632 1626914745 ...
## $ user : num 1.17e+48 8.50e+47 4.64e+47 3.74e+47 6.90e+47 ...
## $ type : Factor w/ 7 levels "borrow", "collateral",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ reservePriceETH : num 1 0.000285 0.000381 0.000361 0.000556 ...
## $ reservePriceUSD : num 3421.871 0.995 1 1.004 0.999 ...
## $ amountUSD : num 51328 41286 7000000 15065 8188 ...
## $ collateralAmount : num NA NA NA NA NA NA NA NA NA NA ...
## $ collateralReserve : Factor w/ 27 levels "", "AAVE", "AmmBptBALWETH",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ liquidator : num NA NA NA NA NA NA NA NA NA NA ...
## $ principalAmount : num NA NA NA NA NA NA NA NA NA NA ...
## $ principalReserve : Factor w/ 29 levels "", "AmmDAI", "AmmUSDC",...: 1 1 1 1 1 1 1 1 1 1 ...
## $ reservePriceETHPrincipal : num NA NA NA NA NA NA NA NA NA NA ...
## $ reservePriceUSDPrincipal : num NA NA NA NA NA NA NA NA NA NA ...
## $ reservePriceETHCollateral : num NA NA NA NA NA NA NA NA NA NA ...
## $ reservePriceUSDCollateral : num NA NA NA NA NA NA NA NA NA NA ...
## $ amountUSDPincipal : num NA NA NA NA NA NA NA NA NA NA ...
## $ amountUSDCollateral : num NA NA NA NA NA NA NA NA NA NA ...
## $ borrowRateModeFrom : Factor w/ 3 levels "", "Stable", "Variable": 1 1 1 1 1 1 1 1 1 1 ...
## $ borrowRateModeTo : Factor w/ 3 levels "", "Stable", "Variable": 1 1 1 1 1 1 1 1 1 1 ...
## $ stableBorrowRate : num NA NA NA NA NA NA NA NA NA NA ...
## $ variableBorrowRate : num NA NA NA NA NA NA NA NA NA NA ...
## $ fromState : Factor w/ 3 levels "", "False", "True": 1 1 1 1 1 1 1 1 1 1 ...
## $ toState : Factor w/ 3 levels "", "False", "True": 1 1 1 1 1 1 1 1 1 1 ...
## $ protocolContract : Factor w/ 2 levels "False", "True": 2 1 1 1 1 1 1 1 1 1 ...
## $ user_alias : Factor w/ 51421 levels "Aaron Adams",...: 17915 1861 20155 23570 29991 ...
## $ onBehalfOf_alias : Factor w/ 50705 levels "Aaron Adams",...: 15651 1831 19875 23236 29581 ...
## $ datetime : Factor w/ 406174 levels "2020-11-30 23:11:40",...: 395517 192373 222043
```

```
summary(df)
```

```
## amount borrowRate borrowRateMode onBehalfOf
## Min. : 0 Min. : 0.0 :635842 Min. :2.578e+33
```

```

## 1st Qu.:      24  1st Qu.:      3.3  Stable : 19665  1st Qu.:4.065e+47
## Median :     1500  Median :      4.0  Variable: 90105  Median :7.436e+47
## Mean  :    223490  Mean  :      9.2  Mean  :7.533e+47
## 3rd Qu.:    25435  3rd Qu.:     10.6  3rd Qu.:1.168e+48
## Max.   :600000000  Max.   :10002.0  Max.   :1.461e+48
## NA's   :203509    NA's   :635842    NA's   :203509
##      pool      reserve      timestamp      user
## Min.   :9.862e+47  WETH   :171895  Min.   :1.607e+09  Min.   :1.000e+00
## 1st Qu.:1.035e+48  USDC   :152630  1st Qu.:1.615e+09  1st Qu.:4.199e+47
## Median :1.035e+48  USDT   : 81628  Median :1.622e+09  Median :7.962e+47
## Mean   :1.034e+48  DAI    : 78570  Mean   :1.621e+09  Mean   :7.783e+47
## 3rd Qu.:1.035e+48  WBTC   : 42990  3rd Qu.:1.626e+09  3rd Qu.:1.168e+48
## Max.   :1.035e+48  LINK   : 42001  Max.   :1.634e+09  Max.   :1.461e+48
##      (Other):175898
##      type      reservePriceETH  reservePriceUSD
## borrow      :109770  Min.   :0.000e+00  Min.   :0.000e+00
## collateral  :193904  1st Qu.:0.000e+00  1st Qu.:1.000e+00
## deposit     :214707  Median :0.000e+00  Median :1.000e+00
## liquidation: 6731   Mean   :3.093e+05  Mean   :6.620e+08
## redeem      :147090  3rd Qu.:1.000e+00  3rd Qu.:1.808e+03
## repay       : 70536  Max.   :1.557e+10  Max.   :6.119e+13
## swap        : 2874  NA's   :203509    NA's   :203509
##      amountUSD  collateralAmount  collateralReserve  liquidator
## Min.   :      0  Min.   :      0  :738881  Min.   :2.379e+38
## 1st Qu.:    2986  1st Qu.:      1  WETH   : 2910  1st Qu.:2.755e+47
## Median :   17560  Median :     13  LINK   : 1391  Median :6.125e+47
## Mean   :   485120  Mean   :   5443  WBTC   : 719  Mean   :6.629e+47
## 3rd Qu.:   97638  3rd Qu.:    250  AAVE   : 342  3rd Qu.:1.048e+48
## Max.   :768950954  Max.   :4638724  UNI    : 244  Max.   :1.457e+48
## NA's   :203509    NA's   :738881  (Other): 1125  NA's   :738881
## principalAmount  principalReserve  reservePriceETHPrincipal
## Min.   :      0  :738881  Min.   : 0.0
## 1st Qu.:   1026  USDC   : 2322  1st Qu.: 0.0
## Median :   4651  USDT   : 1663  Median : 0.0
## Mean   :   69034  DAI    : 1540  Mean   : 0.2
## 3rd Qu.:  22599  GUSD   : 249  3rd Qu.: 0.0
## Max.   :4475668  TUSD   : 186  Max.   :42.0
## NA's   :738881  (Other): 771  NA's   :738881
## reservePriceUSDPrincipal  reservePriceETHCollateral  reservePriceUSDCollateral
## Min.   :   0.1  Min.   :1.502e+14  Min.   :0.000e+00
## 1st Qu.:   1.0  1st Qu.:9.482e+15  1st Qu.:2.100e+01
## Median :   1.0  Median :1.000e+18  Median :1.809e+03
## Mean   :  350.3  Mean   :2.113e+21  Mean   :4.411e+06
## 3rd Qu.:   1.0  3rd Qu.:1.000e+18  3rd Qu.:2.550e+03
## Max.   :83819.1  Max.   :9.471e+23  Max.   :2.607e+09
## NA's   :738881  NA's   :738881  NA's   :738881
## amountUSDPrincipal  amountUSDCollateral  borrowRateModeFrom  borrowRateModeTo
## Min.   :      0  Min.   :      0  :742738  :742738
## 1st Qu.:   1263  1st Qu.:   1365  Stable : 1349  Stable : 1525
## Median :   5022  Median :   5401  Variable: 1525  Variable: 1349
## Mean   :   71425  Mean   :   76506
## 3rd Qu.:   23803  3rd Qu.:   25882
## Max.   :4571839  Max.   :5029023
## NA's   :738881  NA's   :738881

```

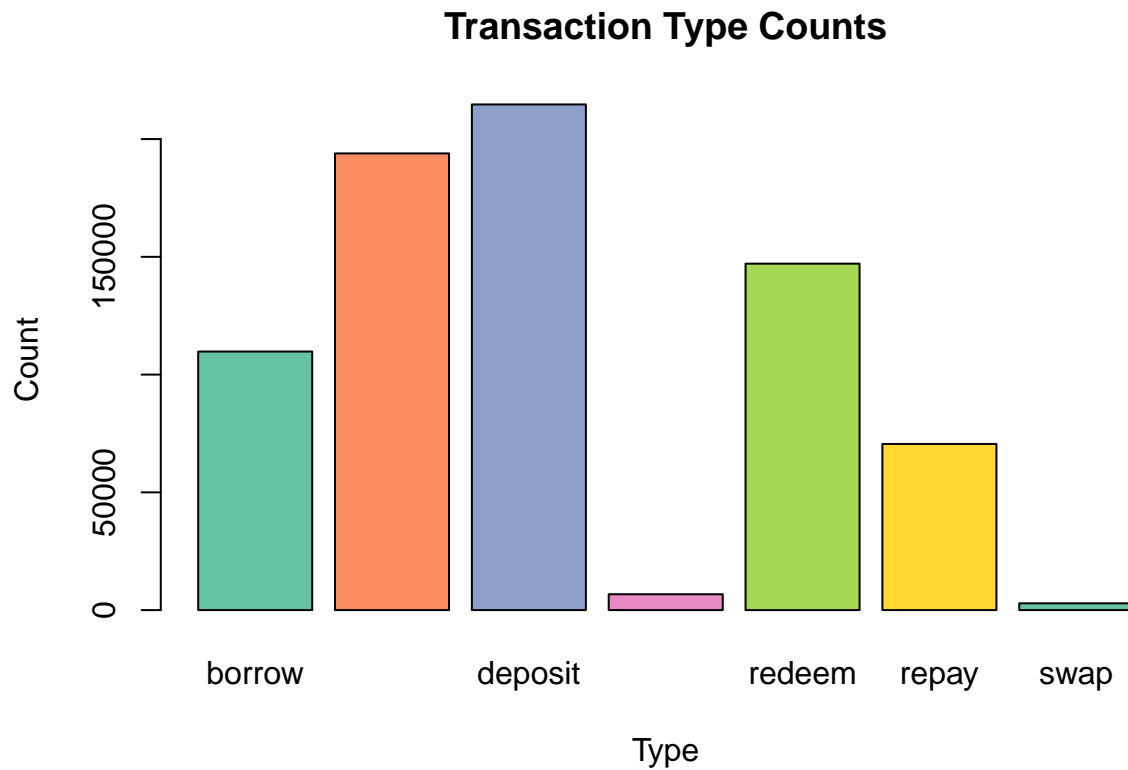
```
## stableBorrowRate variableBorrowRate fromState      toState
## Min.      : 0.0      Min.      : 0.0              :551708      :551708
## 1st Qu.:  8.9      1st Qu.:  3.8      False: 98690    False: 95938
## Median : 10.8      Median :  3.9      True  : 95214    True  : 97966
## Mean    : 11.8      Mean     :  5.8
## 3rd Qu.: 12.0      3rd Qu.:  5.2
## Max.     :154.7      Max.      :148.7
## NA's     :742738    NA's       :742738
## protocolContract      user_alias      onBehalfOf_alias
## False:685824      Gladys Marquez : 59787      John Dunn      :203509
## True : 59788      Shela Hazzard  : 32168      Shela Hazzard  : 32173
##                  Darla Haas   : 25899      Gladys Marquez : 20746
##                  Janelle Lazarus: 25468      Peggy Strawser : 11298
##                  Peggy Strawser : 21503      Janelle Lazarus:  9205
##                  Patrick Johnson: 13700      Darla Haas     :  6778
##                  (Other)        :567087      (Other)        :461903
##                  datetime
## 2021-01-16 18:28:22:    40
## 2021-06-18 06:49:50:    38
## 2021-06-18 06:49:44:    34
## 2021-01-17 08:22:32:    32
## 2021-01-16 18:29:12:    24
## 2021-03-06 05:35:28:    20
## (Other)                :745424
```

Analyze Transaction Types

Next, we will examine the different types of transactions present in the data. We make a 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")

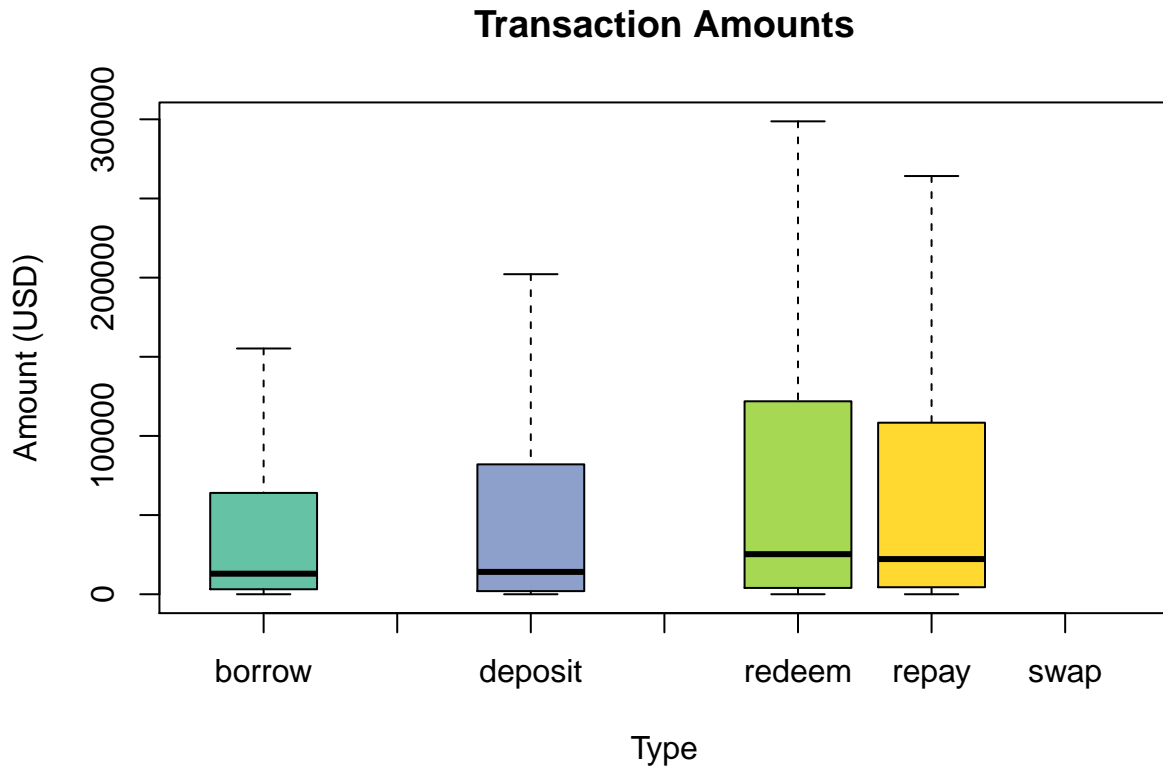
#create barplot
barplot(table(df$type), main='Transaction Type Counts', xlab='Type',ylab='Count',col=colors)
```



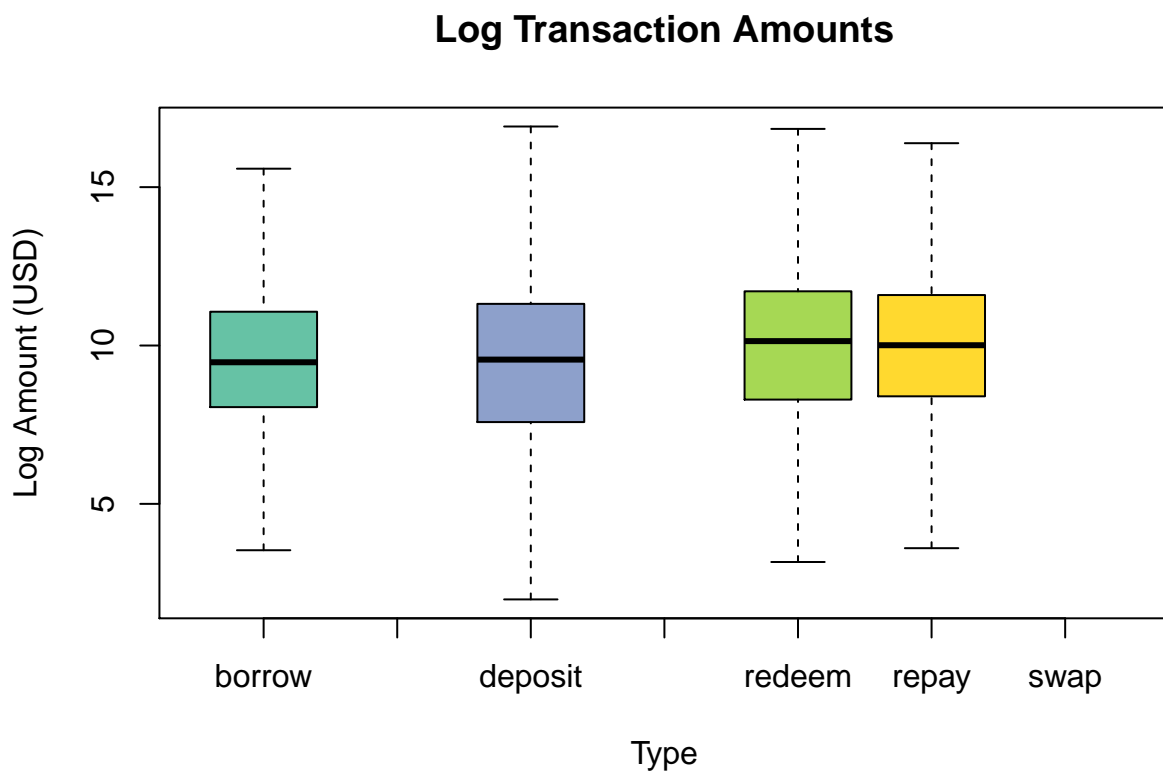
There are more deposits than borrows, because users often need to overcollateralize for loans.

Now, we will examine the amount of US dollars being used in the different types of transactions. We create box plots for the 4 types of transactions that have the amount feature associated with them, and 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")
```

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



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

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)

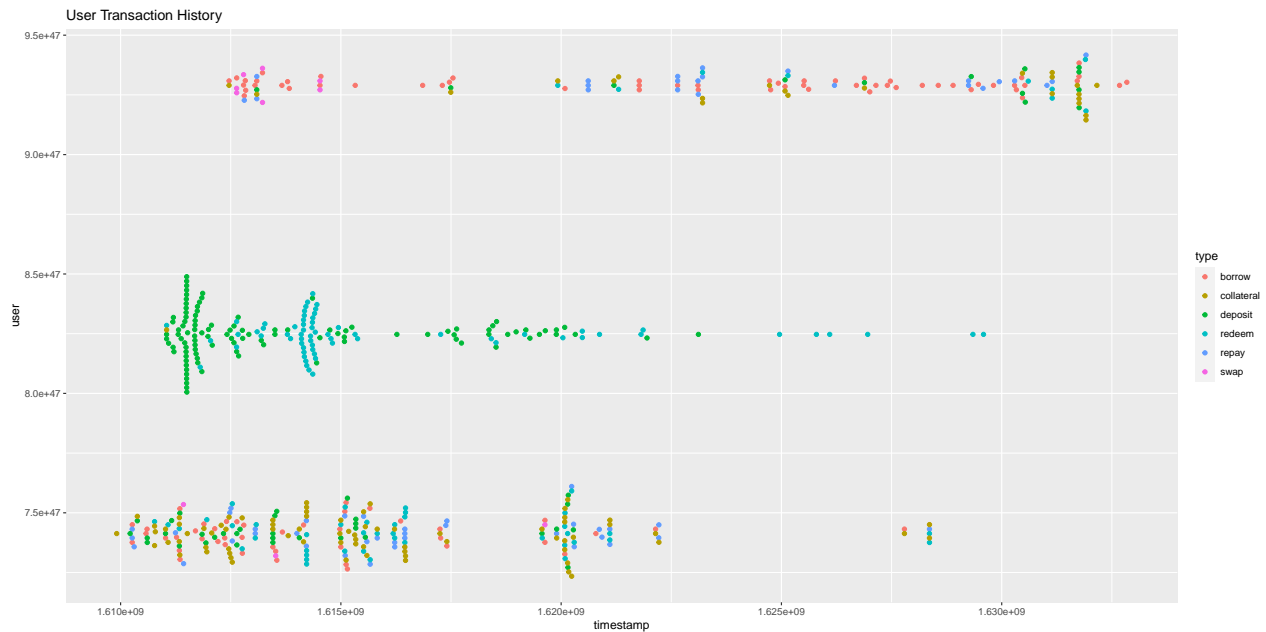
#get 3 random users that have between 100 and 300 transactions
users<-vector(length=3)
count<-0
while(count<=3){
  success<-FALSE
  while(!success){
    #get random user
    ruser<-sample(df$user,1)

    #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 swarmplot

#liquidations
#borrow
#deposit
#redeem
#repay
#swap

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



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

```
users <- plyr::count(as.factor(df$user_alias))
top20transactionuser <- users[order(users$freq, decreasing = TRUE),]$x[1:20]
```

```
df.1users<-filter(df, user_alias %in% top20transactionuser[1:5])
```

```
#ggplot(df.1users,aes(log10(amountUSD), timestamp,color=type)) +
#geom_beeswarm(cex=1)+
#coord_flip()+
#ggtitle("User Transaction History")
```

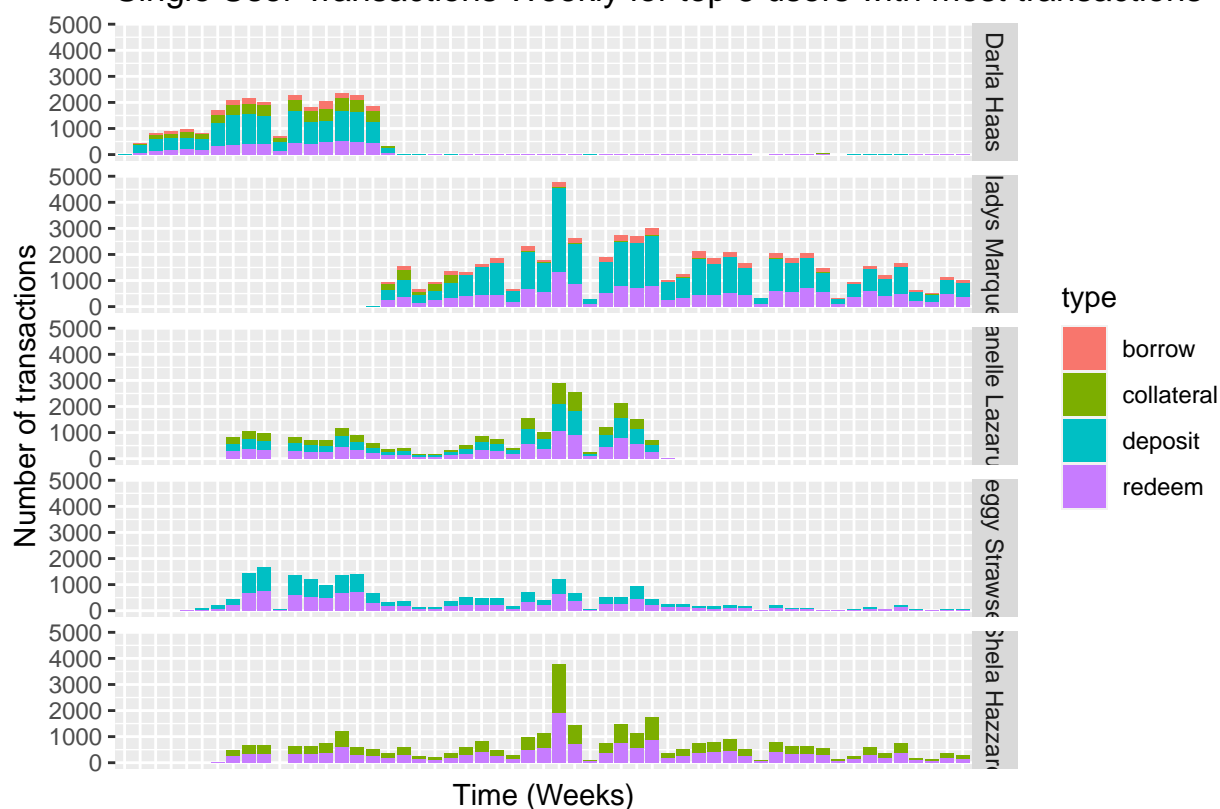
```
df.1users$ymd <- as_datetime(df.1users$timestamp) # fix times for the transactions
```

```
setDT(df.1users)[, ymd_new := format(as.Date(ymd), '%Y-%m-%V')] ## '%Y-%m' for just month-year
```

```
df.1user <- df.1users %>% dplyr::count(ymd_new, type, user_alias, protocolContract, name = "amount")
```

```
ggplot(df.1user) +
  geom_bar(aes(x=ymd_new,y= amount, fill = type),
    stat='identity') + ggtitle("Single User Transactions Weekly for top 5 users with most transa")
  theme(
    axis.text.x=element_blank(),
    axis.ticks.x=element_blank())+facet_grid(rows = df.1user$user_alias)
```

Single User Transactions Weekly for top 5 users with most transactions

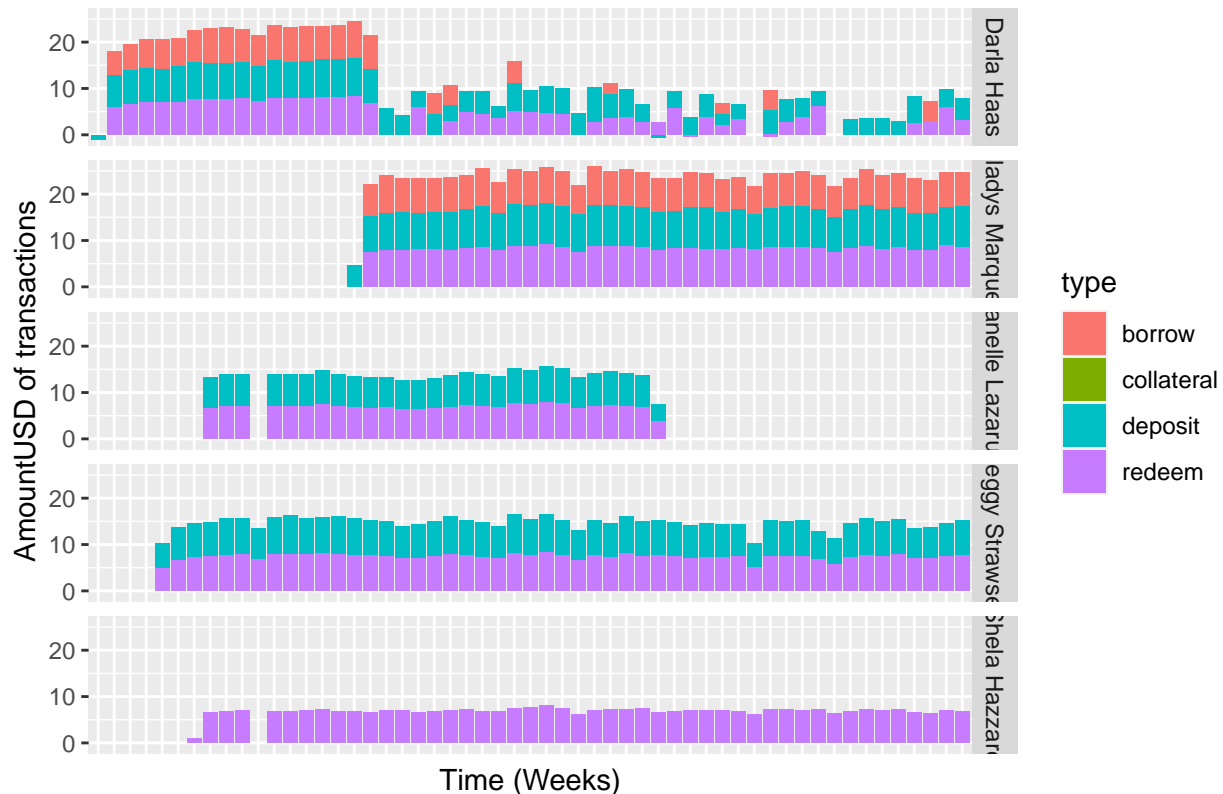


```
df.1user <- df.1users %>%
  dplyr::count(ymd_new, type, user_alias, wt=amountUSD, name = "amountUSD")

ggplot(df.1user) +
  geom_bar(aes(x=ymd_new, y= log10(amountUSD), fill = type),
    stat='identity') + ggtitle("Single User Transactions amountUSDWeekly top 5 users with most t")
  theme(
    axis.text.x=element_blank(),
    axis.ticks.x=element_blank())+facet_grid(rows = df.1user$user_alias)
```

Warning: Removed 158 rows containing missing values (geom_bar).

Single User Transactions amountUSDWeekly top 5 users with most transact



```
df.1user <- df.1users %>% dplyr::count(user_alias, protocolContract, name = "amount")
df.1user
```

```
##      user_alias protocolContract amount
## 1:   Darla Haas             False  25899
## 2: Gladys Marquez              True  59787
## 3: Janelle Lazarus            False  25468
## 4: Peggy Strawser            False  21503
## 5:  Shela Hazzard            False  32168
```

```
df.1user <- df.1users %>%
  dplyr::count(user_alias, wt=amountUSD, protocolContract, name = "amountUSD")
df.1user
```

```
##      user_alias protocolContract  amountUSD
## 1:   Darla Haas             False 2615264911
## 2: Gladys Marquez              True 27033268579
## 3: Janelle Lazarus            False  736965030
## 4: Peggy Strawser            False 4581506747
## 5:  Shela Hazzard            False  601088865
```

```
users <- df %>% dplyr::count(user_alias, wt=amountUSD, protocolContract, name = "amountUSD")
top20amountuser <- users[order(users$amountUSD, decreasing = TRUE),]$user_alias[1:20]
```

```
df.1users<-filter(df, user_alias %in% top20amountuser[1:5])
```

```
#ggplot(df.1users,aes(log10(amountUSD), timestamp,color=type)) +
  #geom_beeswarm(cex=1)+
  #coord_flip()+
```

```
#ggtitle("User Transaction History")
```

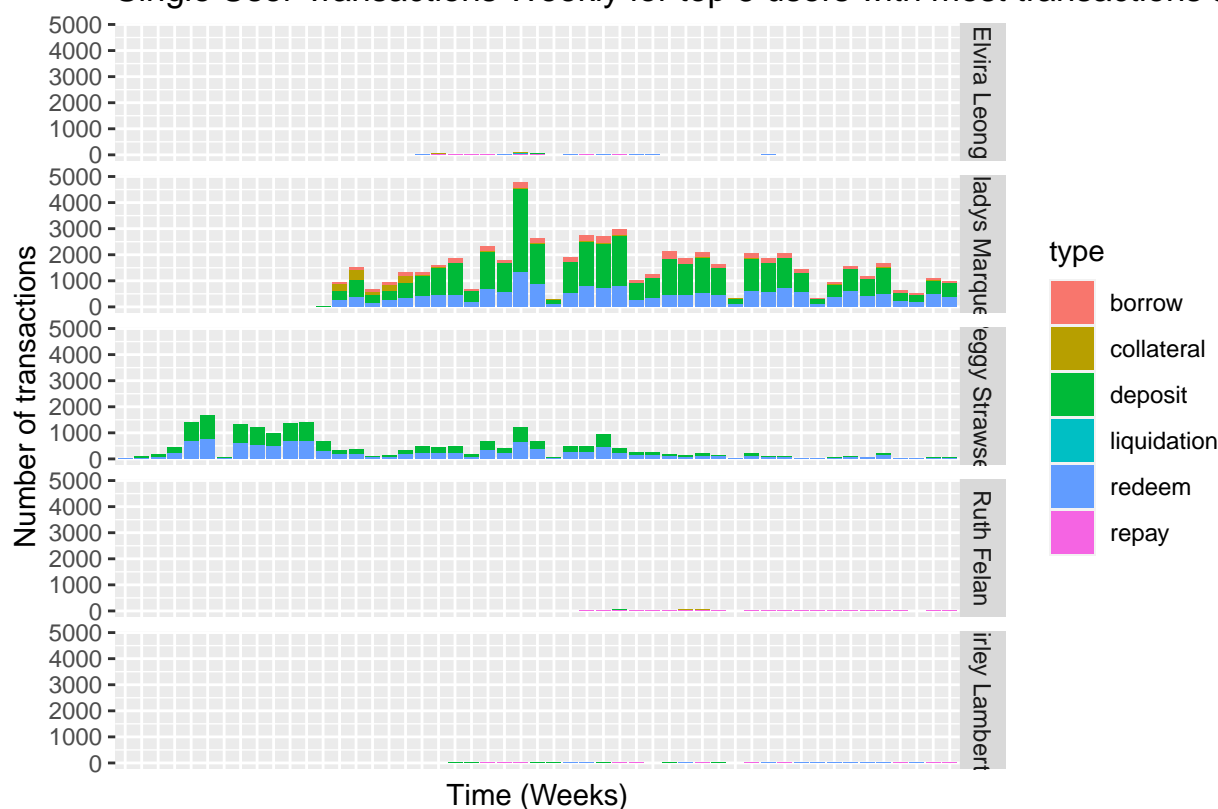
```
df.1users$ymd <- as_datetime(df.1users$timestamp) # fix times for the transactions

setDT(df.1users)[, ymd_new := format(as.Date(ymd), '%Y-%m-%V')] ## '%Y-%m' for just month-year

df.1user <- df.1users %>% dplyr::count(ymd_new, type, user_alias, protocolContract, name = "amount")

ggplot(df.1user) +
  geom_bar(aes(x=ymd_new, y= amount, fill = type),
    stat='identity') + ggtitle("Single User Transactions Weekly for top 5 users with most transa")
  theme(
    axis.text.x=element_blank(),
    axis.ticks.x=element_blank())+facet_grid(rows = df.1user$user_alias)
```

Single User Transactions Weekly for top 5 users with most transactions an

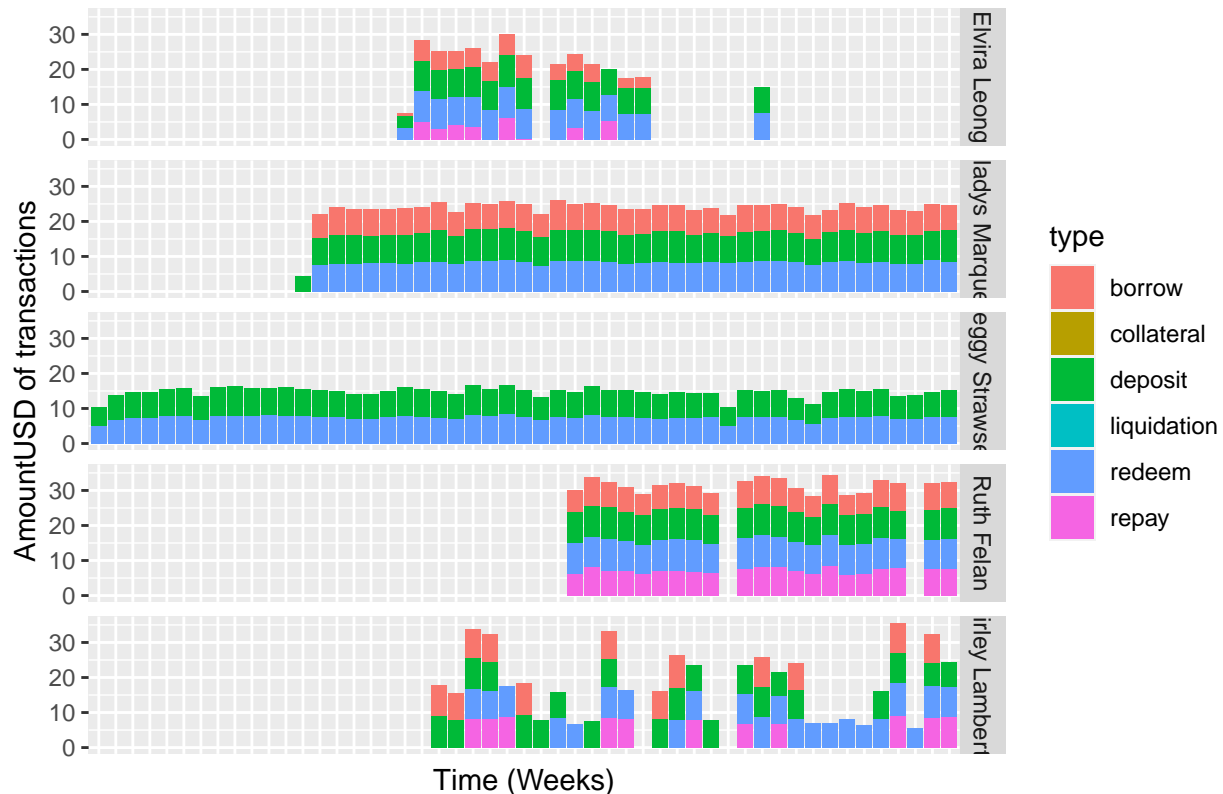


```
df.1user <- df.1users %>%
  dplyr::count(ymd_new, type, user_alias, wt=amountUSD, name = "amountUSD")

ggplot(df.1user) +
  geom_bar(aes(x=ymd_new, y= log10(amountUSD), fill = type),
    stat='identity') + ggtitle("Single User Transactions amountUSD Weekly top 5 users with most t")
  theme(
    axis.text.x=element_blank(),
    axis.ticks.x=element_blank())+facet_grid(rows = df.1user$user_alias)
```

```
## Warning: Removed 76 rows containing missing values (geom_bar).
```

Single User Transactions amountUSD Weekly top 5 users with most transac



```
df.1user <- df.1users %>% dplyr::count(user_alias, protocolContract, name = "amount")
df.1user
```

```
##      user_alias protocolContract amount
## 1:   Elvira Leong           False    424
## 2:   Gladys Marquez           True  59787
## 3:   Peggy Strawser          False  21503
## 4:     Ruth Felan           False    600
## 5: Shirley Lamberton          False    294
```

```
df.1user <- df.1users %>%
  dplyr::count(user_alias, wt=amountUSD, protocolContract, name = "amountUSD")
df.1user
```

```
##      user_alias protocolContract amountUSD
## 1:   Elvira Leong           False 6420573071
## 2:   Gladys Marquez           True 27033268579
## 3:   Peggy Strawser          False 4581506747
## 4:     Ruth Felan           False 22223351085
## 5: Shirley Lamberton          False 22146712515
```

APPENDIX: Accessing RStudio Server on the IDEA Cluster

The IDEA Cluster provides five compute nodes (4x 48 cores, 1x 80 cores, 1x storage server)

- The Cluster requires RCS credentials, enabled via registration in class
 - email John Erickson for problems erickj4@rpi.edu
- RStudio, Jupyter, MATLAB, GPUs (on two nodes); lots of storage and computes

- Access via RPI physical network or VPN only

RStudio GUI Access for DAR:

- Access the RPI VPN
- Browse to: <http://lp01.idea.rpi.edu/rstudio-ose/> (RStudio Server)
- Log in using your RCS username and password
 - If you cannot log in, contact John Erickson at erickj4@rpi.edu

Shared Data on Cluster:

- Users enrolled in DAR have access to `/academics/MATP-4910-F21`
 - Usually DAR users will see a symbolic (“soft”) link in their home directories
 - If you do not, type the following in the **Terminal** via RStudio: `ln -s /academics/MATP-4910-F21/MATP-4910-F21`

For advanced users:

- All `idea_` users have access to shared storage via `/data` (“data” in your home directories)
 - You might wish to use this for data sharing in team projects...
 - ...but we recommend using github for shared code development
- Shell access to nodes: You must access “landing pad” first, then compute node:
- `ssh your_rcs@lp01.idea.rpi.edu` For example: `ssh erickj4@lp01.idea.rpi.edu`
- Then, `ssh` to the desired compute node, e.g.: `ssh idea-node-02`