Repository and Mining of Temporal Data

# RepoMining

User Manual

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**Project Website:**
https://jlnguy.github.io/RepoMining/

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# Introduction

Repository and Mining of Temporal Data is an application designed to help users understand more about their data. It focuses on answering three main questions:

1.) Is there a significant change in the target variable?
2.) Why was there a significant change, and what are the top-k variables that have affected the target variable?
3.) What is the value in the next timestamp?

RepoMining aims to simplify the visualization and analysis of information (in the form of a .csv file with timestamps and data) by answering the previous questions, and by creating a system that is simple, easy to navigate, and easy to use.

Eight (8) visualizations will be returned to the user: Four (4) in Question 1, three (3) in Question 2, and one (1) in Question 3. The program analyzes data selected against all the data in the program provided that it has the same granularity and timestamp thresholds. The application is hosted on the web using Localhost.

The application has two types of users, Data Providers and Data Consumers. The first type of user contributes to the system by uploading their files, and the second type of user uploads the files (target variables) they want the program to analyze and obtain results on it.

The first question is answered by 4 graphs: time vs values, time vs change in values, time vs z-score, and time vs change in z-score. The visualizations include a zoom option for viewing the points and color coding in order to detect the most change. For the purposes of the program, Green indicates Low/No Change, Yellow indicates Some change, and Red indicates areas of High change and areas of interest.

The second question shows the top-k variables which could be affecting the target variable (of the Data Consumer) which is set to a default of three top variables. There top-k variables are picked depending if they have the same granularity (daily/monthly/yearly timestamps); if they fall within the same period of time; if they have data before the starting timestamp of the target; if they have data after the ending timestamp (for answering the third question using Linear Regression); and if they have correlation at all.

The first graph shows time vs the values of all 4 files, the target and other three variables in order to detect some type of pattern between them (ex. As the target variable goes up, the other goes down). The second graph shows the target vs the correlation values generated of the

three variables, with the scale being from 0.0 to 1.0. The closer to 1.0 a score is, the more correlated to the target variable it is. In only one case should the correlation be exactly 1.0: the target variable calculating correlation to itself. The correlation values are presented in absolute values. The last graph shows the top-1 correlation values calculated for each lag time.

Currently the program assumes a lag time of 5, with whatever the granularity indicates. For example, a granularity type of Yearly would assume that the lag time would go as far back as 5 Years. With a granularity type of Daily the lag time would go as far back as 5 Days.

The last question consists on only 1 graph which aims to 'predict' or forecast the next possible value for the target (whether it will go up or down in the next time period). It shows the time vs values and adds the newly generated point in red.

## Glossary

Data Consumers - Users that are looking to use RepoMining to analyse their data. May or may not consist of uploading their own data to analyze, or searching through the repository for data to analyze.
Data Provider - Users looking to help populate the repository by uploading their own files.
Granularity - Refers to the timescale of a dataset (daily, monthly, yearly).
Metadata - Refers to the additional information that users put in when uploading files. Contains the file name, tags, type of granularity, first timestamp, last timestamp, and ID number in the repository.
Q1 - Shorthand for Question 1.
Q2 - Shorthand for Question 2.
Q3 - Shorthand for Question 3.

# Getting Started

## *Setting Up the System*

Download the repository

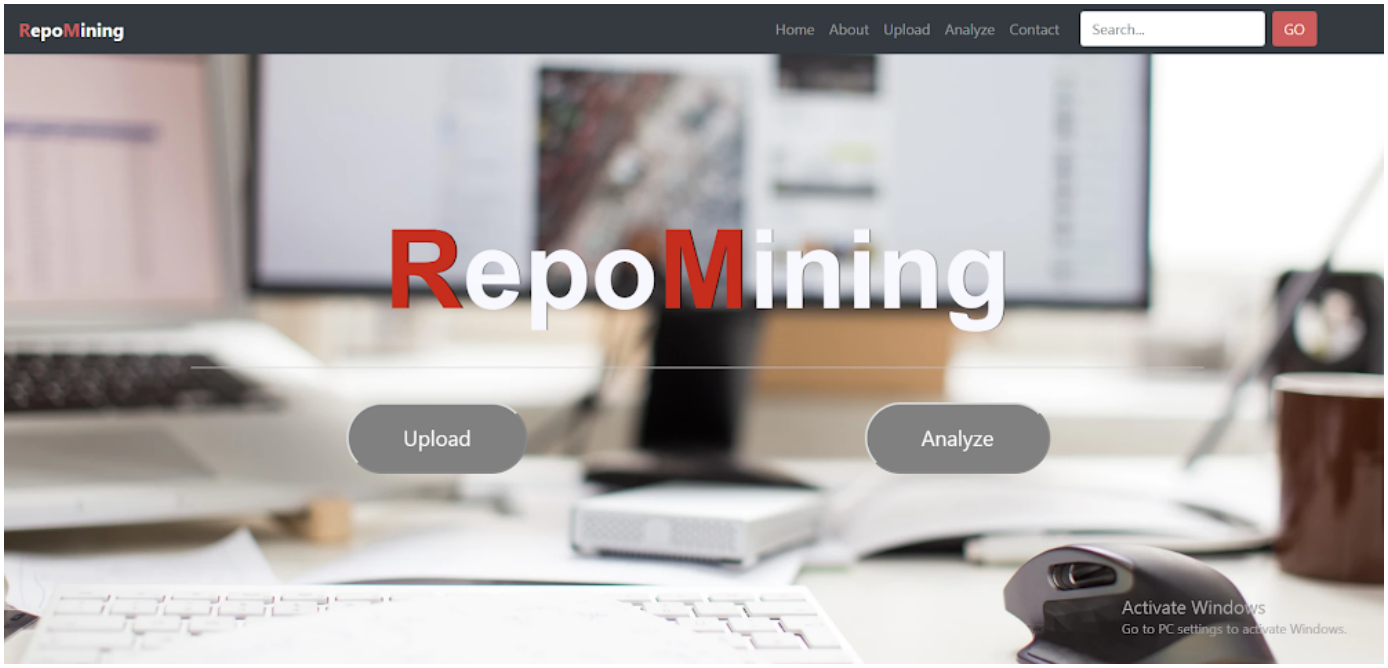
Open cmd (or terminal)

Go in the ‘repo’ folder

cd repo

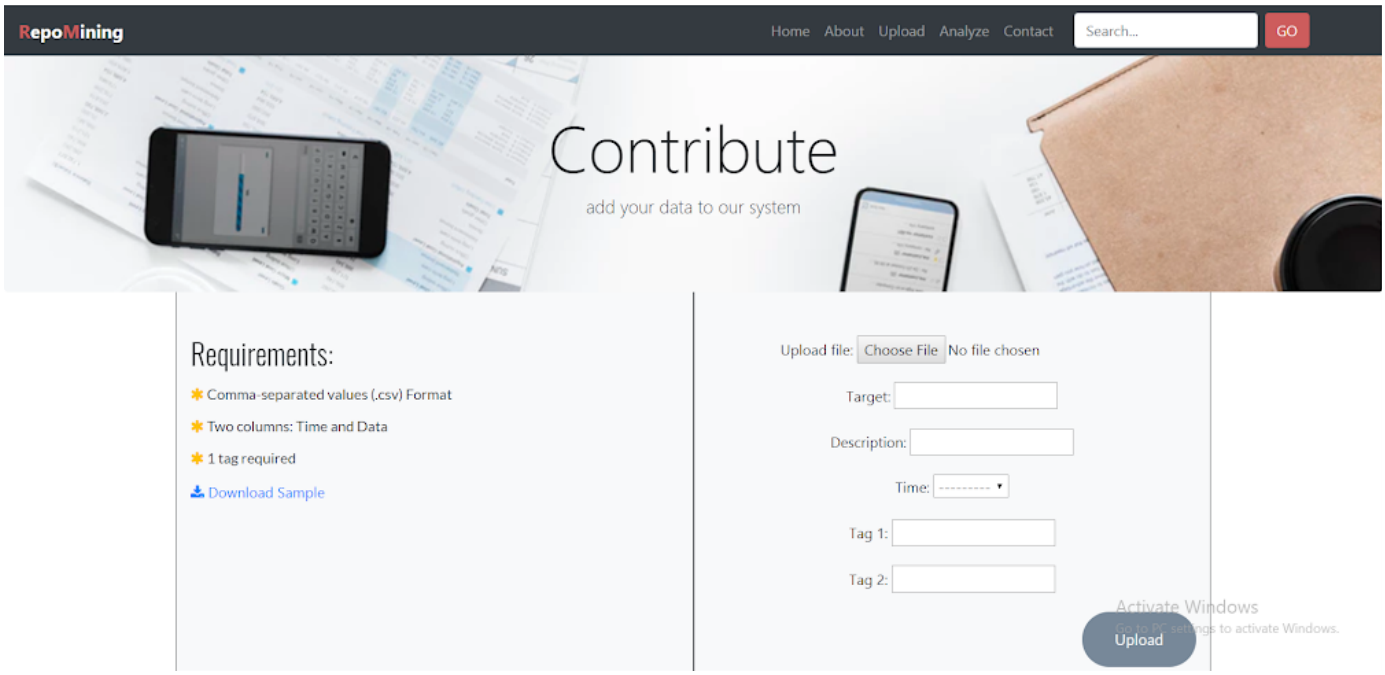
Type python manage.py runserver

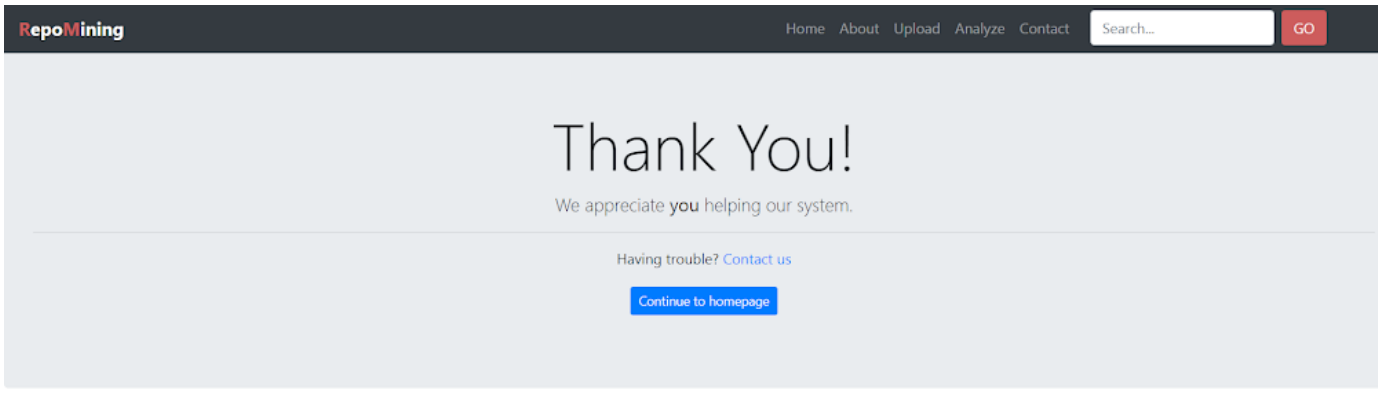
The server will be available at 127. .0.0.1:800 (LocalHost)

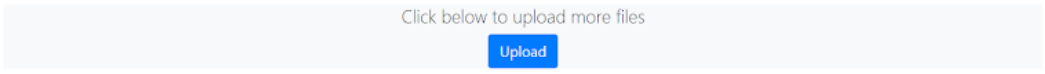


*Uploading a file*

Click the Upload button on the navigation bar or on the homepage
Select a file (.csv file)
Add metadata (target variable, description, tags, granularity)
Upload
If the file is accepted, it will be saved on the system's database and redirected to a thank-you page

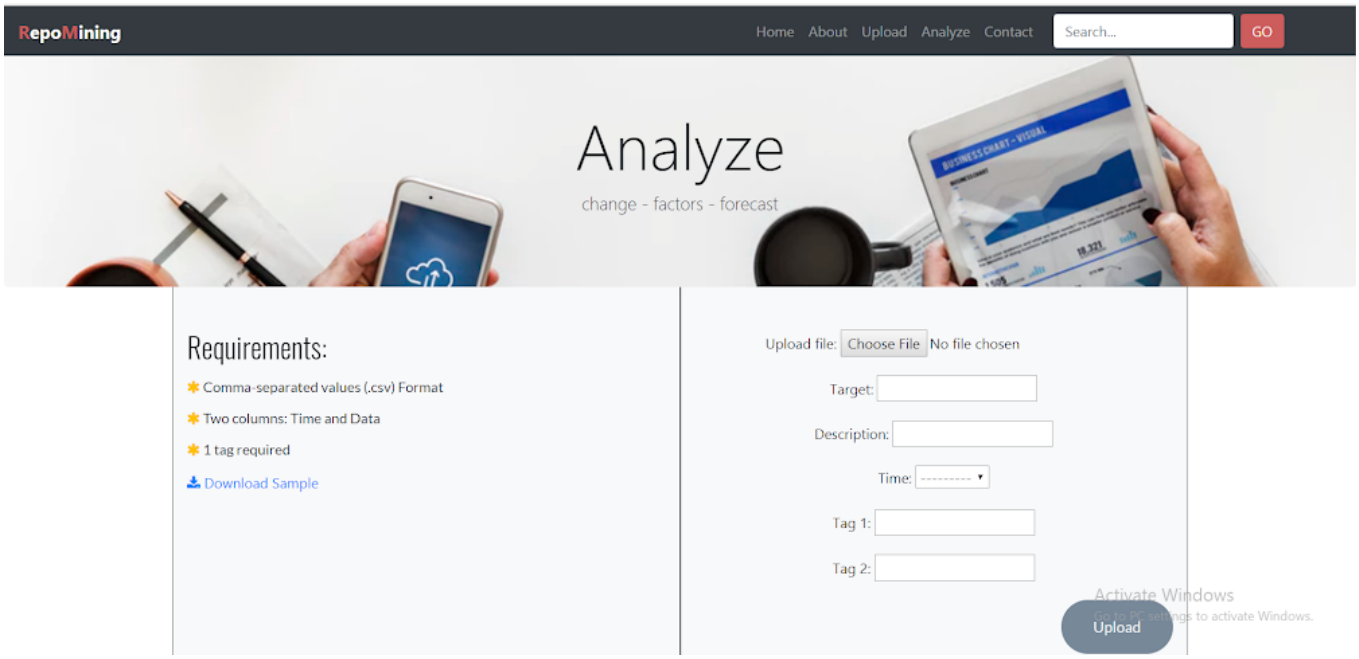


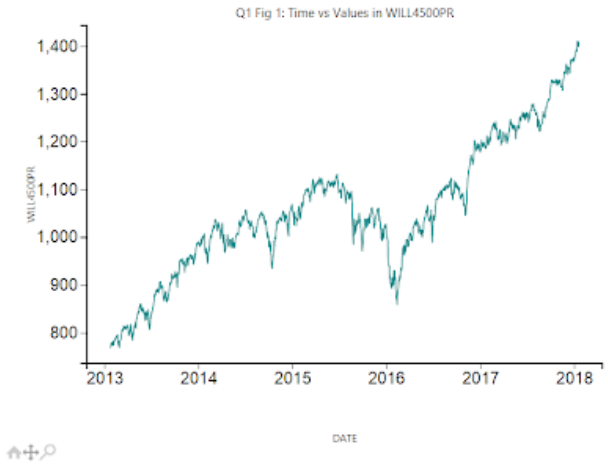
*Analyzing a Target*

Click the Analyze button on the navigation bar or on the homepage
Select the target file to analyze
Add metadata (target variable, description, tags, granularity)
Click Upload
Wait (less than 1 minute, depending on the file size)
Results will be displayed on the new page (Q1, Q2, Q3)



*Moving points in graph*

Hover over graph (Q1, Q2, or Q3)
Click the pan button
Move around the graph

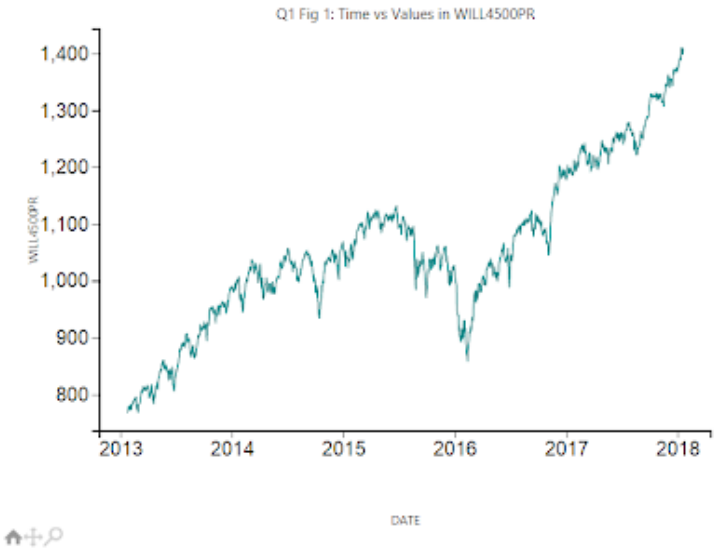



*Zooming in points in graph*

Hover over graph (Q1, Q2, or Q3)
Click the magnifier button on the lower left
Select the points

## *Reset graph*

Hover over graph (Q1, Q2, or Q3)
Click the house button on the lower left



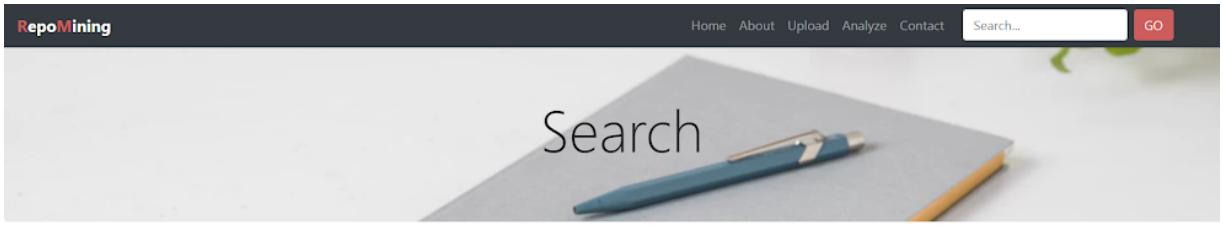

## *Interpreting Results*

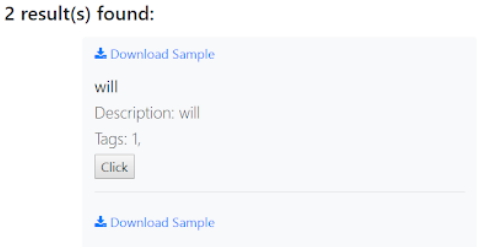
At the moment of writing this document, the website does not handle showing the predicted vs actual results of the analysis, but can be viewed on the Command-Prompt/Terminal.

```
Analysis:
R^2 prediction:  0.8582406760014895
---
Mean Absolute Error: 41.57615061070526
Mean Squared Error: 2775.5948483795796
Root Mean Squared Error: 52.68391451268195
Percent Error: 4.051213614638982
Percent Difference: 8.102427229277964
---

   Coefficient
0     0.110758
1     0.034280
2     0.034280

Last timestamp on graph:  2018-01-18 00:00:00
Last value on graph:  1404.46
X-Value:  2018-01-19 00:00:00
Y-Value:  1322.0403898712543
```

*Target Variable Search*

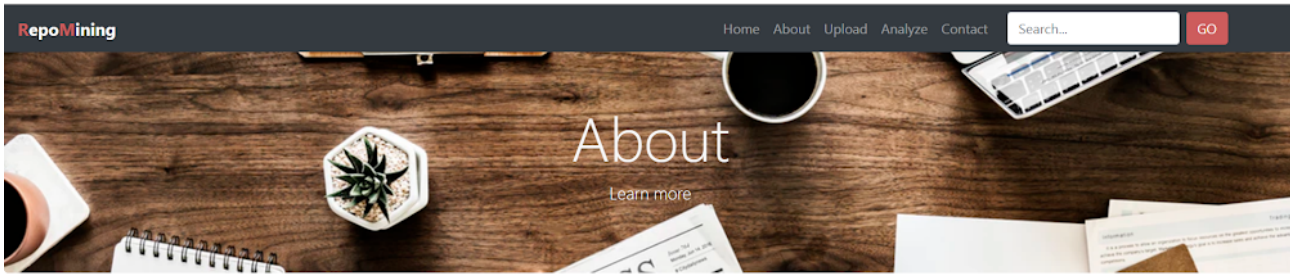
Go on the navigation bar (while on any page of the website)
Type on the search bar
Click enter
Visualize the search result




*Navigating through the site*

Go around the site as any other webpage
All buttons work as desired redirecting to the correct pages



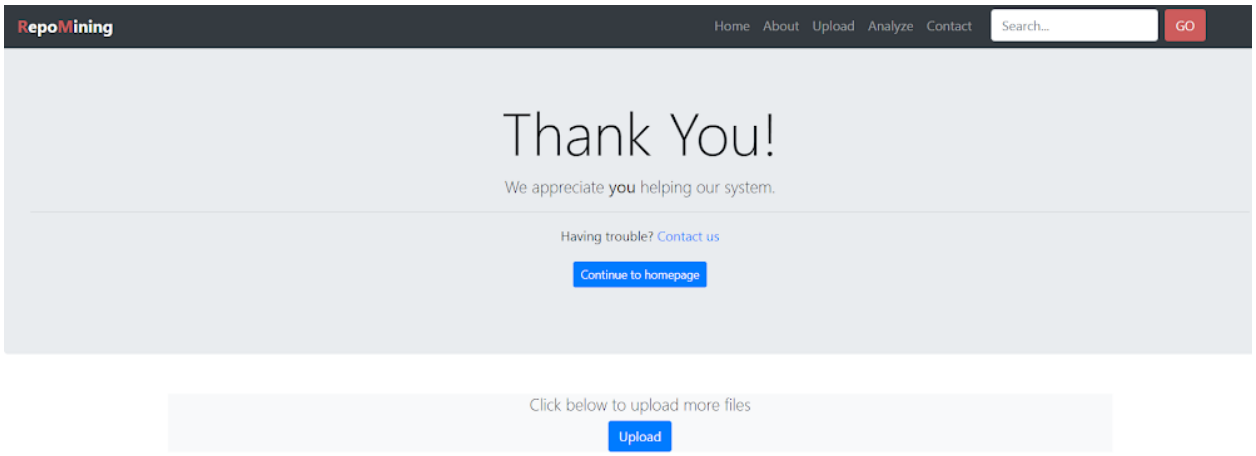

RepoMining is a web-application designed to simplify the appearance of **data mining**, **collection** and **analysis** as well as be able to predict future trends based on a variety of types of information.

The system saves .csv files uploaded by Data Providers and allows users to calculate and visualize the change in their target data, the correlation between variables that are affecting it, and the next possible date and value in the future.

## Example for Data Providers

Contributing with their data to the system:

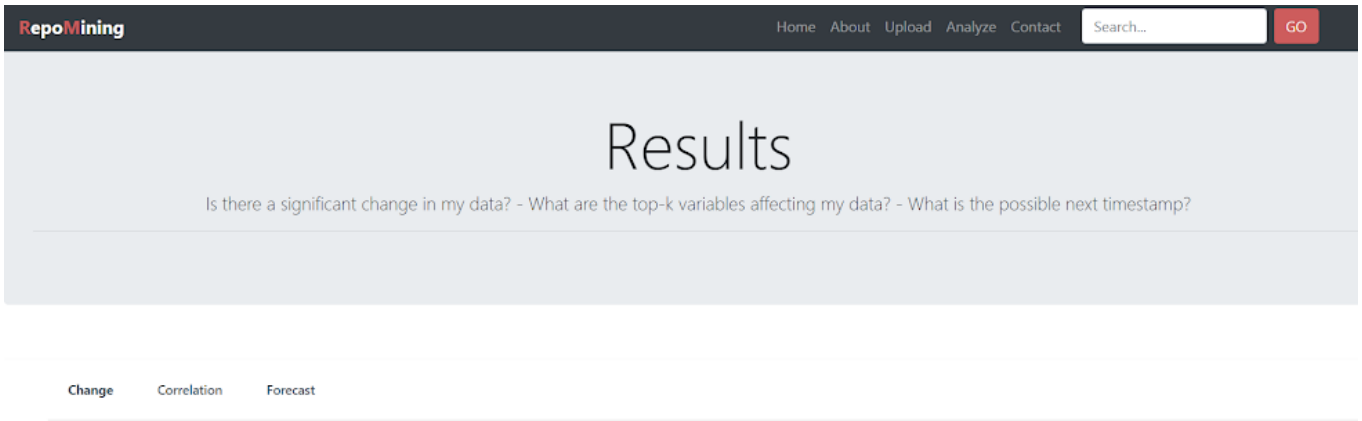
1. Click the ‘Upload’ button on the home page or navigation bar
2. Choose a file (.csv format, two columns)
3. Fill out metadata (target, description, granularity, tags)
4. Click ‘Upload’
5. If performed correctly, a thank you page should load.




## Example for Data Consumers

Analyzing their data:

1. Click the ‘Analyze’ button on the homepage or navigation bar
2. Choose the file to be analyzed (.csv format, two columns)
3. Fill out the metadata (target, description, granularity, tags)
4. Click ‘Upload’
5. Next page will show the results.



# For Developers

The following pages details structure, code, and API used in creating RepoMining.

## *Code Overview*

RepoMining was implemented using Python 3, Django Framework, JavaScript, Bootstrap, and CSS. The program uses a sqlite3 database to store metadata. All the .csv files are saved locally in a folder.

## *Python source Code (Github repository)*

A summary of each class being used is listed. For reference, these files are stored in the ***src*** folder in the GitHub Repository.

Initialize.py - Code that creates a database with the current schema set. It creates an sqlite3 database called data.db and creates empty tables for the programmer to fill. It should be used to create a dummy (testing) database. For error fixing, a flush should be called on the database instead.

NarrowData.py - Main analysis of equation for the project. Is called during Q2.py. NarrowData.py's main area of analysis and retrieval is called in getID. The other classes are used for reference in Q2.py and used to prepare the arguments to be used in getID. All functions in NarrowData.py open a connection to the sqlite3 database and close it. This should be noted when one wants to change the database used or is using a dummy database for testing purposes.

ParseComma.py - Opens a csv file and reads it through. Converts the data to be a datetime type for ease of reading, analysis, and display.

ParseData.py - Prepares data to be used in Q2. Is called after NarrowData. This code shuffles the data to match up with the target data using the lag times as reference. Has two types of shuffles: one for the values in the data (shuffleData) and one for the y-axis (shuffleY). Also has a section named trimData that makes sure that all data sets are the same length so matplotlib does not have issues.

Q1.py - Answers the following question: Is there a significant change?. All visualizations are indicated in the code and should be easy to follow.

Q2.py - Answers the following question: What are the top-k values, and what is the correlation value of it?. Also calls NarrowData, ParseData, and several other classes. Imports several APIs. The analysis section happens in most of the code with the visualization section happening near the last 50 lines of code. Also calls Q3.py, passing through a matrix of correlation values to the next class.

Q3.py - Answers the following question: What is the value in the next timestamp?. Uses a matrix passed through in Q2.py to calculate correlation weights. The equation, Target = $w_0 + w_1x_0 + w_2x_1 + w_nx_{n-1}$ is used. Target being the value in the next timestamp, $w_0$ being the y-intercept, $x_n$ being the value of correlation, and $w_1$ to $w_n$ being the weights calculated using the linear regression. The timestamp is simply incremented by one based off the type of granularity used.

Upload.py - Code used to upload a file to the database. Requests that the user input several values: The file name, a description of the file, the target variable of the file (To be used for searching later on), granularity type, and 4 tags. If using on the Django site, it only requires 1 tag with 2 being visible.

csvReader.py - Reads and converts the file to two lists in Python so that Q1.py can use it to answer the question.

data.db - The database of files uploaded already.

parseCSV.py - Reads and converts the file to two lists in Python. Also converts the x-axis files into dateTime items.

Excerpts of these classes were used within the Django framework.

## *Django*

Used to handle the user interface and hosted locally.
The structure consists of multiple apps that handle the user requests (such as uploading and analyzing). Each app consists of python files containing the database models, forms, templates, urls, etc.

### *Apps*

The repository consists of five apps within the interface:

1. Repo:
    a. Templates: handles what the user sees throughout the entire website, stored in different folder depending on the app it is referring to. Written using HTML, CSS, Bootstrap, and Javascript. The results.html template is the one that handles the matplotlib graphs be shown in browser by using JSON and the mpld3 API and obtaining the resulting graphs from views.py in the Upload app.
    b. Settings.py: Handles the static files, the media files where the file uploads are saved in, the database, security key, user registration security, and installed apps.
    c. Urls.py: handles the urls the user can access within the system.
    d. View.py: consists of various functions to let the user navigate through the main page (home, search query, error 404, etc).

2. Upload: Upload and analysis of files
    a. Admin.py: registers the models so they can be easily accessed on the admin page while running the system, in this case, Files and Granularity from models.py (which are the tables the database saves the information).
    b. Apps.py: configuration of the current app, automatically generated by Django.
    c. Forms.py: handles the class for the uploading of a file, it shows the user the fields of 'Upload file', 'Target', 'Description', 'Time', 'Tag 1', and 'Tag 2' which were defined on models.py.
    d. Models.py: handles the database tables as well as errors for when the file is not in a csv format. There's two tables in the system, Files and Granularity; the first contains the uploaded file, target, description, tags, and time, whereas the second contains the target, starting timestamp, ending timestamp, and time. It also has the three choices for the time granularity (Daily, Monthly, Yearly).
    e. Test.py: for testing the system.
    f. Urls.py: handles the urls the user will be redirected to while uploading and analyzing their files.
    g. Views.py: handles the main part of the analysis and uploading of files as well as the creation of the graphs by using matplotlib. It has the function for showing the 'error 404' message whenever the user tries to access some inexistent url and the home page redirection. The function 'contribute' takes a request given by the user, calls forms.py with the fields filled by the user, reads the csv file (by calling the function 'read_csv'), goes on performing the saving the information on the database; if an error is raised, it will redirect to the same page showing the error or missing input. After the data has been saved, it redirects the user to a thank you template.

       The function 'upload_csv' performs the same steps as the function before, with the difference that rather than redirecting to the thank you page, it goes and

performs the analysis of information by using z-score, change in values, correlation, linear regression, etc. This function also handles the creation of the graphs and takes them as objects, then dumps them using JSON in order to be passed by mpld3 to the template where the user will see these visualizations. Each visualization is then called on the results template by creating variables with JavaScript and then called within the HTML code depending on their ID. Other functions include the calculation of correlation, saving the granularities in the database, etc.

3. Q2:
    a. Admin.py: registers the models so they can be easily accessed on the admin page while running the system.
    b. Apps.py: configuration of the current app, automatically generated by Django.
    c. Models.py: models that will be saved on the database.
    d. Tests.py: for testing the system.
    e. View.py: consists of various functions performing NarrowData and ShuffleDate which are called when analyzing a file and answering Q2. These are called by views.py in the Upload app.

4. Q3:
    a. Admin.py: same as above.
    b. Apps.py: same as above.
    c. Models.py: same as above.
    d. Tests.py: same as above.
    e. Views.py: consists of various functions performing the prediction of the next timestamp and value as well as the calculation of accuracy (percent error, mean absolute error, percent difference, etc.). Each of the functions are called when analyzing a file and answering Q3. These are called by views.py in the Upload app.

5. Reg: User registration
    a. Admin.py: same as above.
    b. Apps.py: same as above.
    c. Forms.py: handles the User class consisting of three fields (username, email, and password) that will shown to the user; when shown, the user is able to fill these up and submit their registration within the system.
    d. Models.py: same as above.
    e. Tests.py: same as above.
    f. Urls.py: handles the user registration url that the user can access.

g. Views.py: consists on calling the user class created in forms.py, showing the three fields for the user to fill up. This saves the username and password (hashed password) in the system's user section; this view performs authentication for logging into the system and successful account registration.

## *Imports*

Used in our program include but are not limited to:

csv, numpy, pandas, datetime, matplotlib, math, mpld3, scipy, sqlite3, and sklearn's LinearRegression.

## *Future Improvements*

A list of possible future improvements are as follows. Some are suggested by our faculty sponsor, others by the programmers themselves.

Fixing the display to show Q2 Fig.3.

Changing the visualization software from matplotlib to something else, such as Google Charts, or something else. The API, mpl3, is deprecated and is no longer being updated.

Color-coding the correlation values for Q2 Fig.2.

Optional download of graphs and/or .csv files once analysis is done. Add an option to download .csv files from the repository.

Implement tag search in NarrowData.

Depending if NarrowData is successful or returns a number less than 3 (currently set as top-k = 3), show the other analysis rather than showing nothing.

Optimize the program.

Allow users to analyze the information saved within the repository without having to upload anything.

## *GitHub Structure*

The structure of the GitHub repository, and items saved in the folders, is summarized as follows:

CSV Files - Contains the .csv files used for analysis. This folder also contains a data.db, which is a sqlite3 database that has all the current files uploaded, and a data.sql, which contains the schema of data.db. The file data.sql can be opened up in a text editor for ease of reading.

RepoMining/RepoMining - Contains Django version I code. (Very old - Not updated)

mysite - Contains initial tutorial django code.

repo - Contains the Django code. (Not updated)

seniorDesignDocs - Contains the documentation of the project. Includes Project Plans, Milestone Evaluations, Milestone Presentation, Showcase Poster, and the User Manual. Most of these files can be accessed via the ReadMe file, the description file on the GitHub site, or the Project website.

src - Contains the raw Python code for the program. The Python code can be run by itself, although many of the sections do not call each other. The main classes, Q1.py, Q2.py, and Q3.py do not run one after the other. Q2.py and Q3.py run one after the other. For more information, see above.

README.md - Contains the description and links to create the Project website.

Scribbles - Small note of what RepoMining is..

_config.yml - Creation and setting of the Project website theme.