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# Risk Calculation System

## User Guide

This is the official user guide for  
MATH GR 5320 Term Project: Risk Calculation System v1.3  
Developed by Yunxiao Zhao & Ophelia Jiang.

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# 1 Installation

The system is developed in Python 3.7 on Windows 10. All packages used are included in the Python 3.7 Standard Library. If not, one may use pip commands to install the required packages. For example, in a *cmd* window try:

- `>python m pip install pandas`
- `>python m pip install pandas_datareader`
- `>python m pip install scipy`

Or in a JupyterNotebook try:

- `!pip install pandas`
- `!pip install pandas_datareader`
- `!pip install scipy`

For more installation help please visit the official Python document: <https://docs.python.org/3/installing/index.html>.

For Windows users, no additional actions are needed. The system will run properly as long as all the required packages are installed.

For Mac users, since the software is built using Tkinter GUI toolkit, if someone is using macOS 10.6 or later, the Apple-supplied Tcl/Tk 8.5 has serious bugs that can cause application crashes. To launch the software, DO NOT use the Apple-supplied Pythons. Instead, install and use a newer version of Python from python.org or a third-party distributor that supplies or links with a newer version of Tcl/Tk. See <https://www.python.org/download/mac/tcltk/#built-in-8-6-8> for more information.

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## 2 Getting Started

Before opening the software, make sure the “Option\_Data” folder, the ‘Portfolio.txt’ file and the ‘my\_utils.py’ file are located under the same working directory with the software launchers. Once the setup is done, there are three versions of the launcher, one in Python script and two in JupyterNotebook.

To run the UI version in Python scripts (RCSys`tem.py`):

1. Open a *cmd* window
2. Set the current working directory to where the launcher locates
3. Launch the software by  
`>python RCSystem.py`

To run the UI version in notebooks (RCSys`tem_GUI_Ver`):

1. Open RCSys`tem_GUI_Ver.ipynb` file in JupyterNotebook
2. Run the cell

To run the plain dash version in notebooks (RCSys`tem_Notebook_Ver`):

This version is used for demonstration only when the previous two versions are unavailable due to unresolvable issues, for example, the incompetence under macOS 10.6. All the instructions in the following sections will focus on how to operate the system with the intentionally designed UI.

1. Open RCSys`tem_Notebook_Ver.ipynb` file in JupyterNotebook
2. Select ‘Run all cells’ in JupyterNotebook toolbar

Once the software is launched, click the start button and switch to the calculation page. Figure 4.1 is how the index page looks like when the software is launched.

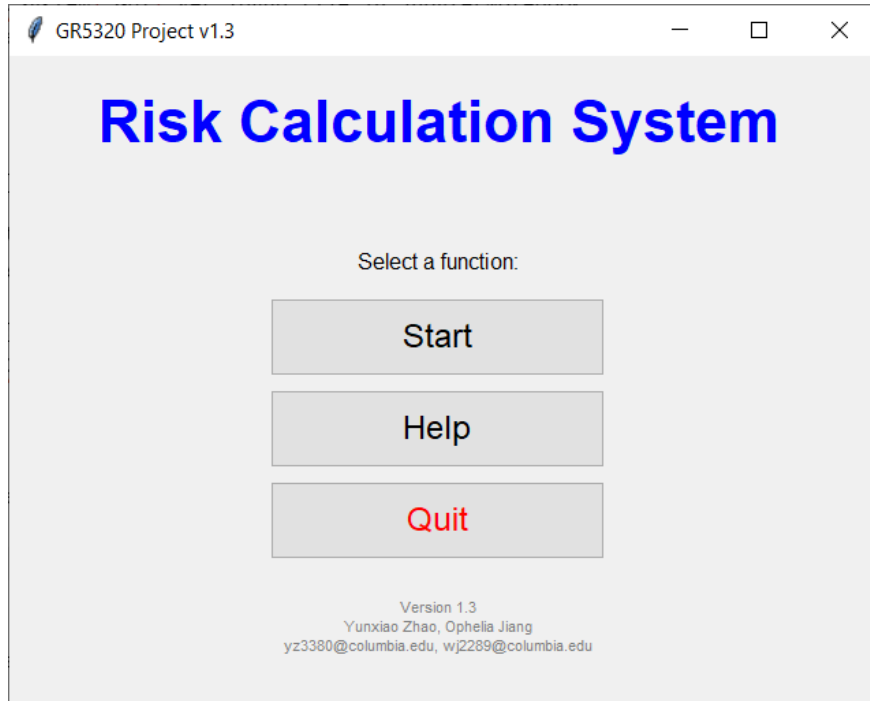


Figure 4.1: Index Page

### 3 Setup Portfolio

Before starting the calculation, one may want to create his own portfolio. The portfolio's positions are stored in the 'Portfolio.txt' file. Any saved changes to this file will affect the calculation in the software. If positions are modified after a calculation, redo calculation to update the results.

The stocks should be formatted as  $\langle \text{ticker} \rangle$ ,  $\langle \text{position} \rangle$ , one in each line. The ticker should be on file on Yahoo finance and position should be in the form of floats, while negative numbers stand for short positions. For example:

AAPL, -3.5

The options should be formatted as  $\langle \text{underlying} \rangle$ ,  $\langle \text{position} \rangle$ ,  $\langle \text{type} \rangle$ ,  $\langle \text{maturity} \rangle$ , one in each line. Due to limited access to Bloomberg terminal, we only have ATM options with 11 underlying as illustrations, they are AAPL, AMZN, BKNG, COF, CVS, DATE, GE,

KO, NKE, NVDA, SPX, XRX. The position should be floats, with negative numbers stand for short positions. The type should be either call or put. And maturity (in months) should be chosen from 3, 6 and 12 according to Bloomberg implied volatility data. For example:

GE, 5, put, 12

Once an option is chosen, the investment period will be restricted from Jan 1, 2015 to Nov 22, 2019 due to limited historical data of implied volatility and interest rate.

## 4 Change Parameters

There are eight parameters in total on the calculation page. See figure 4.2.

GR5320 Project v1.3

Please enter valid inputs:

Starting Time:	1890-08-09	VaR Level:	0.99
Ending Time:	2077-07-07	ES Level:	0.975
Portfolio Value:	10000.0	Window Length:	5.0
Est. Method:	Window Exponential	Horizon Period:	5

Default Calculate

Portfolio Plot VaR Plot ES Backtest

Back Save Quit

Figure 4.2: Parameter Entries

Rather than use the default parameters, one can customize the experiment by entering his own parameters:

1. **Starting Time:** String formatted as YYYY-MM-DD, the starting time of investment period

- 
2. **Ending Time:** String formatted as YYYY-MM-DD, the ending time of investment period
  3. **Portfolio Value:** Float  $> 0$ , the normalized portfolio value for VaR calculation
  4. **Estimation Method:** Either “Window” or “Exponential” in calibrating GBM parameters
  5. **VaR Level:** Float in  $(0, 1)$ , the level of probability for VaR
  6. **ES Level:** Float in  $(0, 1)$ , the level of probability for ES
  7. **Window Length:** Float  $> 0$ , number of years used for parameter calibration
  8. **Horizon period:** Integer  $> 0$ , number of days used in defining VaR

The 'Default' button will set all the parameters to the default value.

## 5 Calculation

Click the 'Calculate' button if all parameters and inputs are set. If any of the requirements is not met, there will be a pop-up message informing the user to modify the inputs or parameters. Otherwise, the system will proceed to calculation and provide a notice when finishing. If the number of assets in the portfolio is not too large, it will take less than 2 minutes to complete the calculation process (may vary for different CPUs).

Notice that the time period will be automatically adjusted to fit for stocks with the shortest available historical data during the calculation.

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The screenshot shows a software window titled "GR5320 Project v1.3". Inside, there is a section titled "Please enter valid inputs:". Below this, there are several input fields arranged in two columns. The left column contains: "Starting Time:" with the value "1890-08-09", "Ending Time:" with "2077-07-07", "Portfolio Value:" with "10000.0", and "Est. Method:" with a dropdown menu showing "Window" and "Exponential". The right column contains: "VaR Level:" with "0.99", "ES Level:" with "0.975", "Window Length:" with "5.0", and "Horizon Period:" with "5". Below the input fields, there is a red rectangular box containing a grid of buttons. The top row of the box has "Default" and a green "Calculate" button. The second row has "Portfolio", "Plot VaR", "Plot ES", and "Backtest". The bottom row of the box has "Back", "Save", and "Quit" (in red text).

Please enter valid inputs:	
Starting Time: 1890-08-09	VaR Level: 0.99
Ending Time: 2077-07-07	ES Level: 0.975
Portfolio Value: 10000.0	Window Length: 5.0
Est. Method: Window Exponential	Horizon Period: 5

Default

Calculate

Portfolio

Plot VaR

Plot ES

Backtest

Back

Save

Quit

Figure 4.3: Functional Buttons

## 6 Plots

Once the calculation is done. All the analysis of results can be visualized.

To view the portfolio information, click the 'Portfolio' button. There will be 4 subplots: the initial assets allocation, the historical prices of all stocks, the value of a portfolio without normalization, and calibrated GBM parameters. A sample plot is shown in figure 4.4.

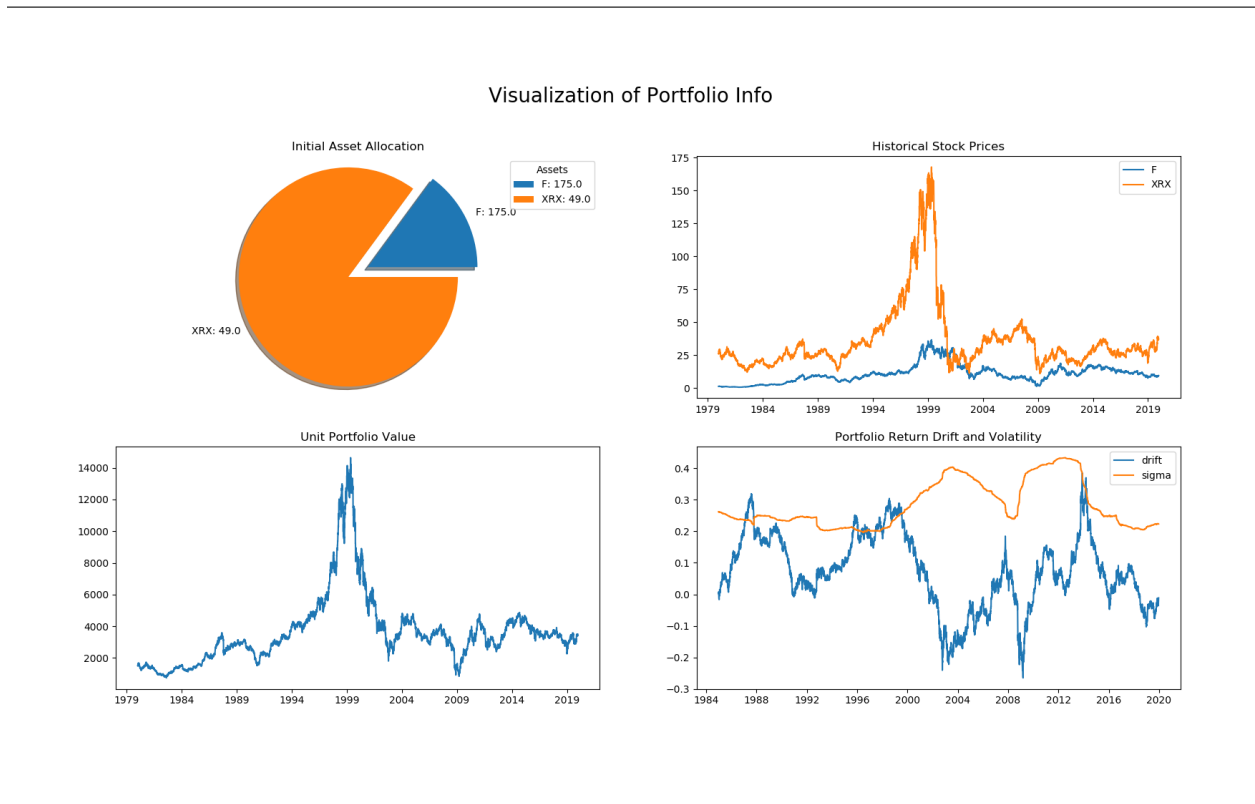
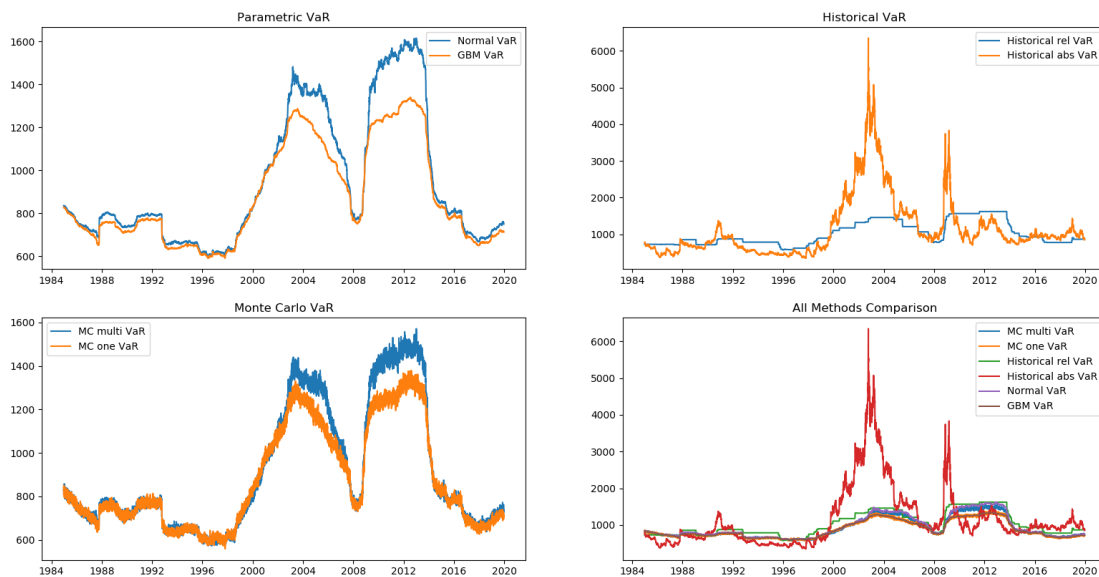


Figure 4.4: Portfolio Info

To view the analysis of VaR, click the 'VaR' button. There will be 4 subplots: the plot of Parametric VaR, the plot of Historical VaR, the plot of Monte Carlo VaR, and the plot of a comparison between all methods. See figure 4.5.

Plot of Portfolio 5 day 99.0% VaR





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Figure 4.5: Analysis of VaR

To view the analysis of ES, click the 'ES' button. There will be 3 subplots: the plot of Historical ES, the plot of Monte Carlo ES, and the plot of a comparison between all methods. See figure 4.6.

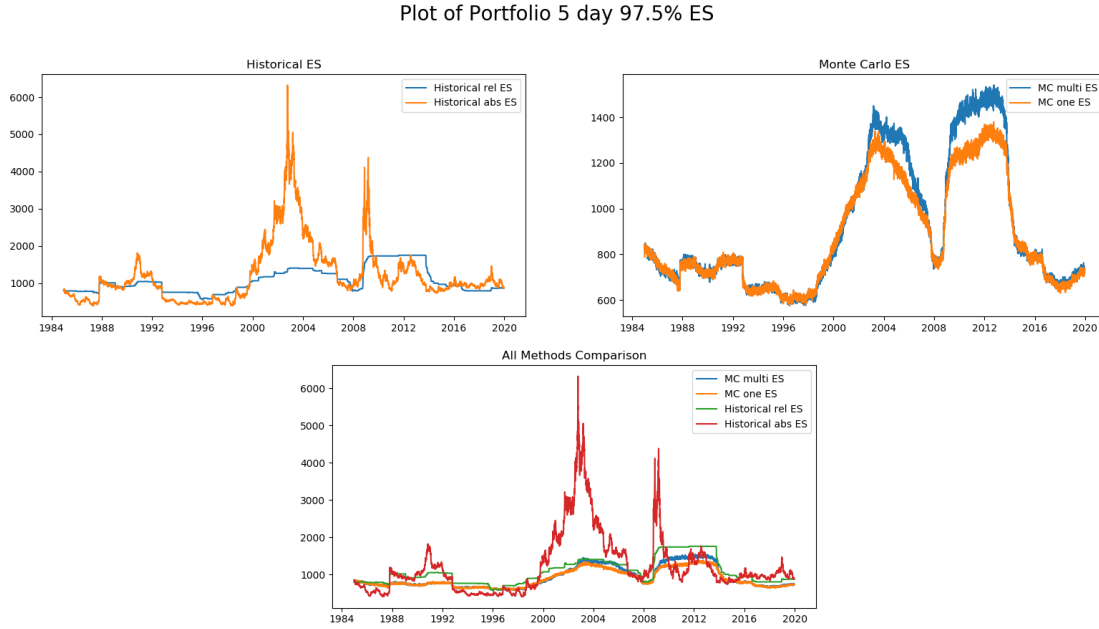


Figure 4.6: Analysis of ES

To view the analysis of validations, click the 'Backtest' button. There will be 2 subplots: one is calculated VaR vs. actual loss plot and the other one is the plot of the number of exceptions. As shown in figure 4.7.

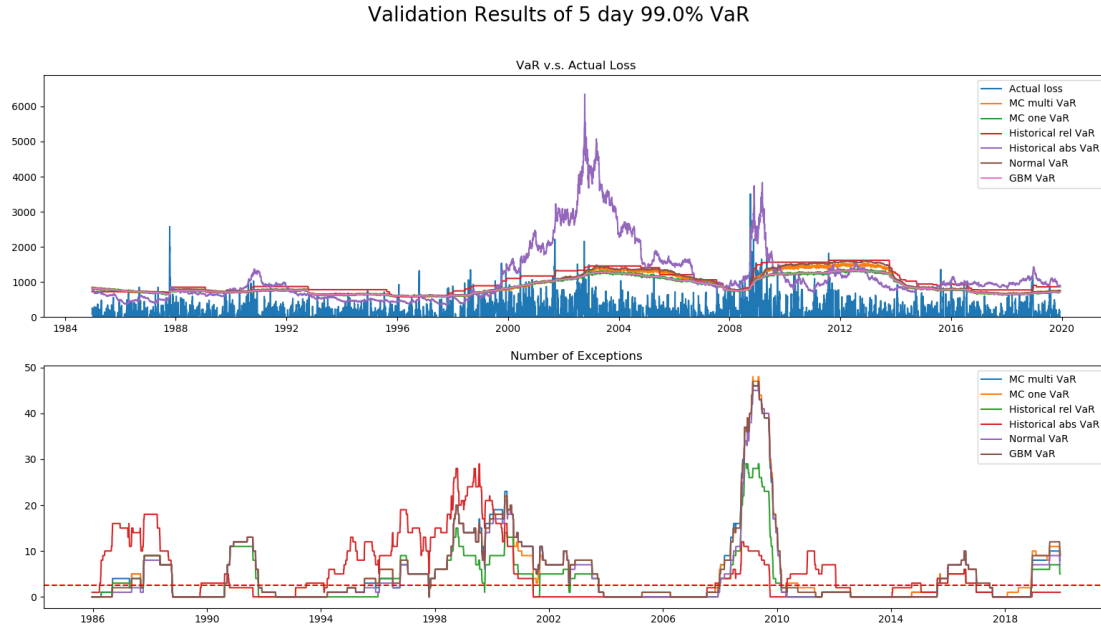


Figure 4.7: Validation Results

Users may adjust the plot size and style or save the plot figures to local drive by clicking the toolbar icons at the lower left corner of the plot window. The plot will be temporarily stored in the system until the next calculation.

## 7 Saving

Users can save all the calculation results by clicking the 'Save' button. The system will create a local folder named after current date time and store three CSV files in it. These CSV files are the detailed results of VaR and ES calculation in the form of data frame, as well as the result of validation data frame. The data will be sorted in reversed order to help the users easily access the most up-to-date data. One may read the data using other statistical tools for future reference.

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## 8 FAQ

### **My OS crashes after launching the software.**

Unfortunately, if someone is using macOS 10.6 or later, the Apple-supplied Tcl/Tk 8.5 has serious bugs that can cause application crashes. To launch the software, do not use the Apple-supplied Pythons. Instead, install and use a newer version of Python from [python.org](https://www.python.org) or a third-party distributor that supplies or links with a newer version of Tcl/Tk.

See <https://www.python.org/download/mac/tcltk/#built-in-8-6-8> for more information.

### **The software crashes once launched.**

You should check if all the required packages are installed correctly.

Typically, if the system reports ‘No module named ‘pandas\_datareader’, you should then install pandas\_datareader by:

```
>python -m pip install pandas_datareader
```

Or in a JupyterNotebook, try:

```
!pip install pandas_datareader
```

Gernerally,

```
>python -m pip install <package name> will solve this type of problem.
```

For more installation helps please visit the official Python document: <https://docs.python.org/3/installing/index.html>

### **The system reports Error ‘Input files not exist!’.**

The system needs a txt file as the input of the portfolio. Make sure the ‘Portfolio.txt’ is correctly named and located in the same working directory with the software launcher.

### **The system reports Error ‘Invalid inputs! Please check your Portfolio.txt’.**

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The inputs you write down in 'Portfolio.txt' is not correct. Make sure the stocks are written as *< ticker >*, *< position >* and options are written as *< ticker >*, *< position >*, *< type >*, *< maturity >*, one in each line. The position should be either 'call' or 'put'. The maturity should be chosen from '3', '6', '12'.

**The system reports Error 'Options must have provided underlying stock!'.**

To include options in a portfolio, the system requires option volatility data stored in the "Option\_Data" folder. Make sure you have downloaded the complete folder and set it in the same working directory with the software launcher. Also, the option cannot have underlying outside the given 11 illustrations. They are AAPL, AMZN, BKNG, COF, CVS, DATE, GE, KO, NKE, NVDA, SPX, XRX.

**The system reports Error 'Invalid inputs! Please check your setups'.**

This error message is caused by invalid input parameters. For example, entering 99 instead of 0.99 for VaR Level. Please check all the input entries on calculation page.

**The system reports Error 'WARNING: Portfolio value sign changes during the period, results may not be reliable!!!'.**

This is caused by target portfolio value does not change sign during the investment time period. The calculation results in this case are highly unreliable or completely trashed. You may take a look at unit portfolio value plot by clicking 'Portfolio' button, and consider modifying the positions

**The system reports Error 'Window size / Horizon length cannot be longer than total data!'.**

The input parameter 'Window Length' and 'Horizon period' should not be longer than the total investment time period.

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**The system reports Error 'RemoteDataError'.**

The ticker provided in 'Portfolio.txt' must be valid from Yahoo finance. Please check the spell of your tickers.

**The system reports Error 'Please calculate result first'.**

Please run the 'Calculation' button first before making any plots.