

Integrated Computer Science
Trinity College Dublin, the University of Dublin

First Year Programming Project

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Stocks analysis and visualization in Processing

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1 Launching our program

The program works with standard .csv files. It requires a file called "daily_prices2GB.csv" to be put in the folder with the main script (Stocks.pde). If you want to test the program on a smaller dataset, simply change the file by renaming it to "daily_prices2GB.csv". We do not have a 2GB file on our svn repository. Therefore, when you check out the "Stocks" folder on your PC, put your local copy of the 2GB file to the folder.

2 Design

Our application shows a loading screen when launched. After the data is parsed the user is transferred to the main screen, which allows them to browse through the tickers and see information about them. The program provides the opportunity to search for the tickers by their name, sector and industry (and the same time), and exchange. It also allows the user to browse through the search results using the "forward" and "backward" buttons. The current ticker (when browsing is applicable) is highlighted in the blue box and all the other search results are highlighted in red. The main purpose of the graph screen is getting the input from the user: ticker/tickers, type of graph, data types (e.g. open price), the date range and the way tickers are sorted in the list. There are three types of graphs available for the user: candle graph, bar chart, and line graph. Candle graph is used to visualize the dynamics of the stock on each day of the specified date range. It displays the opening and the close price for a given data type. If the difference between them is greater than zero the candle is green, otherwise, it is red. The vertical lines of the candle indicate the peak and the lowest point of the day. The bar chart visualizes the average of a given data type for a list of tickers. It also has an option to display the average relative difference between the close and open prices for the specified dates. If the average is negative the bar is red, otherwise, the bar's color is set to green. Finally, the line graph shows how the given data type changes over time. The graphs have a consistent color scheme as well as provide labels and captions, where applicable. The user has an opportunity to navigate back to the main screen if they wish.

3 Teamwork organization

We had one in-person team meeting at the start of the semester, where we discussed our plans, set up subversion, and planned the way we were going to communicate. However, after the campus was closed all of our communication happened online. Mostly we used messenger, where we put updates about what we did as well as discussed the problems and ideas. Besides, we used discord for voice chat meetings and the blackboard system during the labs. After somebody committed the new version, they always wrote a comment about the changes. Moreover, we set weekly goals and did our best to achieve them before the next week. If somebody was having trouble with a particular issue for a long time, we always discussed the problem together to find a solution.

4 The way we split up the work

4.1 Pavel

I would say that I made equal contributions to the backend and frontend of our project. At the very start of the project, my main task was creating the simple UI controls and reviewing my teammates' code to optimize the program in terms of responding to queries and loading data. Then as we moved towards the labs, where we had to do demonstrations, I was responsible for creating them. That included merging the different versions of the program, fixing bugs and implementing the new UI elements. To be more specific in terms of UI, I implemented a textbox, search bar, scroll bar, text view (a kind of rich textbox). I also wrote events behind those controls and implemented a mechanism for searching tickers in the text view. During the last weeks, we encountered a problem with parsing a 2GB file, so I came up with the approach to separate it into many smaller files by the ticker. I implemented the `loadData()` and `getData()` methods. Finally, in the last week before the demonstration, my task was to merge the two versions of the project we had (one which had a graph screen as the main one and the other with a text view for browsing tickers). That took me quite a bit of time to accomplish. While I was merging the versions, I also fixed a significant number of bugs, implemented a loading screen, and made a few changes to the visualizations (graphs).

4.2 Enda

Most of my work was on the back end, although I did contribute a large amount to the implementation of the graph screen. The first objective I gave myself was to make a candle graph ("CandleGraph" class). This graph shows a series of open prices, close prices, the highs and lows for a given date all in one graphic. I found this to be an interesting problem. I ended up creating another class called "Candle" to represent each candle in the candle graph. Originally the design was very basic, but after adding new features to the graph gradually while working on other parts of the project, I believe the end result looks good. I reworked the entire class to implement it as a Widget and to make sure that it could be resized and given a different position easily. This took quite a long time to implement, however, none of these features were used in the final project. I designed and implemented the graph screen and its widgets, however, I think that a better approach could have been found if I had more time to develop it. As for the backend, I made the "StockInfoManipulator", "InfoImporter", "ScreenManipulator" and the "DataPointSort" classes. I made the StockInfoManipulator class to help everyone in the group build up their classes if they need to manipulate, parse or sort any of the information from the DataPoints or import information from a file. There are a number of methods that I am really happy with from this class, particularly methods involving dates such as `filterByDates()`, and `sortByDate()`. I struggled with various different methods of working with dates before I found quite an easy solution. I am very happy with how the `getCompanyInformation()` in the InfoImporter class was implemented. I learned about regular expressions and how to get the contents of a string between two quotation

marks. I made the `ScreenManipulator` class to change the contents of the screen, such as the contents of the graphs, the dates that will be shown on the slider to filter by date, and to initialize the contents of the graph screen. I made some other smaller classes such as the “Slider” and “Text” classes.

4.3 Filip

Most of my work for the first couple of weeks was on the `LineGraph` class. This graph shows a series of Dates on the x axis and one of the different types of information (open price, close price and others) on the y axis in a line graph. When writing this class I encountered an issue where processing increases the y values as you go down, this meant a big portion of my time writing this class was spent on researching ways to translate points in order to make the graph appear upside down and how to make the text the right way up. Later I had to rework the class in order to implement it as a widget which was an easy task as I did not run into many problems. The way this class handles data could be improved however as it is one of the slowest visualization classes in our program. Scaling the values in order to fit them between the start of the graph and the top was a major challenge for me as I couldn't find an easy way to do it but with some experimentation, I came up with a method that I think is quite efficient and I am happy with it.

I also worked on the `StockInfoManipulator` class for some of the functions that my `LineGraph` class needed like the `trimBetweenDates()` but I also wrote a version of the `sortByDate()` function that was later improved on by Enda with a more efficient algorithm. I struggled with comparing if a date was in the range passed into the function in the `trimBetweenDates()` however I figured out a method where the years are compared first then months and days which helped me later when sorting the dates by the chronological order in the `lineGraph` class.

A massive problem I encountered was understanding my teammates' code but by communicating with the person that wrote the specific piece of code I was having trouble understanding it was easy for me to get a grasp on what it does and how it works.

4.4 Brian

I began with the `Barchart` class. The version of this class deals with two queries. It displays the average of a datatype within a date range on the y-axis, each of the tickers selected is put on the x-axis. The other query is the open and close difference, which displays the open and close percentage difference. The bar is green when there is an increase in the close price compared to the open price.

However, it underwent multiple changes before that. In the beginning it was very simple and inefficient. I then changed it to extend the widget class which was a relatively simple task. This allowed it to be implemented in the program easily. After a team meeting, we agreed that our graphs should go for a similar style and aesthetic and I was asked to modify it to fit that and also to change it to only display one ticker and all the data of a datatype within the date range selected. While doing this modification I vastly improved the aesthetic

and more importantly the efficiency of this class. After some more deliberation, I decided that it was far too similar to the line graph so it was changed to deal with its original query of the averages of multiple tickers. I used the more efficient code of the new bar chart and modified it to display that query and added another query which I had previously done some work on of the open/close query. In the end, it resulted in a far superior class than the one at the start.

Other than the bar chart I also added to other classes in our code. I created methods in StockInfoManipulator which allowed for the creation of two queries to be displayed on bar chart (getAverage, getPercentageDifference, etc.). I also modified a multitude of other classes implementing Barchart into our program among some other minor additions I made to classes.

While working on this project I encountered and overcame many problems and learned a significant amount. The problem of understanding each other's code and their plans on how everything was going fit together was fixed with proper communication. I learned that communication was vital when working on a project in a team. Also of having a clear plan on how everything was going to fit together and goals to be achieved will be something that I'll do for all future team projects as I believe many problems could've been avoided with this.

5 Notes on teamwork

It is especially important to note that everybody contributed to all the aspects of the project. Although writing code is probably considered most important now, it is a big mistake not to take the ideas, suggestions, bug fixes, and peer code review into account. These were the things that greatly influenced our project and improved the quality of work we did.

6 Features

The features we implemented can be divided into three distinct groups: queries, UI, and backend. As for the queries, there are two general types of them: visualizing the data for a given ticker/tickers and providing information about the ticker. Our program allows users to plot all the types of data for a given ticker against the specified time range. Line graph and candle graph show how the given variable evolved, for example, adjusted close price, whereas the bar chart visualizes the averages of a given data type for a list of tickers, including the open-close price difference, which is not supported by the other graphs. Moreover, the program allows the user to sort the tickers in the list by their open price, close price, etc., so it is easier to choose the tickers for the visualization and analyze the data. In terms of providing information about the tickers, the program can search through the list of tickers by their parameters (name, exchange, sector, and industry). One can navigate through the list of search results.

Since it might take a while for our program to launch there is a loading screen imple-

mented. Moreover, the UI is built in a consistent color scheme and is made to be easy to use. There is a good amount of comments and labels so that the user knows what they need to enter.

For the data loading, we use a special method that separates the initial input file into the list of files sorted by the ticker, which makes it possible for our program to work with a 2GB dataset. Moreover, for the loading screen to be shown loading is done asynchronously in a separate thread. The loading screen is replaced with the main one once the loading is finished. Also, for each widget, there is an event code and its unique id. That is done to distinguish between the widgets of different types as well as the different widgets of one type in the program. Finally, we use the `Collections.sort` method with the implemented comparators to sort our objects.

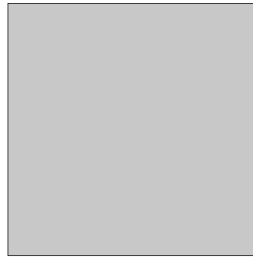
7 Problems encountered

As it was already mentioned, the greatest problem was to ensure our program can deal with a 2GB data set. Initially, all the data was stored in the array of objects. It worked even for the 100k dataset, however, there was no possibility to store over 20 million objects in the program for the 2GB data set. That required more than 8GB of RAM, which is impossible in the x64 processor configurations (for the programs with ordinary access permissions) not to mention the 32-bit configurations. The solution we came up with is to separate the initial file into several smaller files sorted by the ticker. That was done by reading the whole dataset and creating a `HashMap` of buffered writers to place the data entries into the new files. Once the program needs to access the given list of tickers for forming the results of the query it simply loads all the information from the respective files. Although it still might take a while (on 2GB dataset), this approach turns out to be sufficient to work with most queries, which can be made by the user.

There was also a less significant problem of outputting the rotated text on the screen. A `Text` class was implemented to deal with this issue. It uses the `push Matrix` and `pop Matrix` methods as well as the rotation of the coordinate system.

Finally, there was a problem that nothing could be shown on the screen before the setup was finished. Since the loading process takes a while, there was a need to implement the loading screen. We transferred the loading process into a separate method and ran it in a different thread. Now that the method was called asynchronously the loading screen could be shown. At the very end of the loading method, the flag is set to indicate that the loading has finished, which is then allows the main screen of the program to show up.

8 Screenshots



Loading... Time: 14 seconds
Seems like you are loading a 2 GB dataset
This will require around 1-3 minutes. Percentage loaded: 25



Figure 1: Loading screen

Stocks									
GRAPHS		Exchanges search	Tickers search	FINANCE		LIFE INSURANCE		BACKWARD	FORWARD
Number		Ticker	Exchange	Name	Sector	Industry			
1		A	NYSE	AGILENT TECHNOLOGIES, INC.	CAPITAL GOODS	BIOTECHNOLOGY: LABORATORY ANALYTICAL			
2		AA	NYSE	ALCOA CORPORATION	BASIC INDUSTRIES	ALUMINUM			
3		ABA	NASDAQ	ALTAIR INC.	TECHNOLOGY	EDP SERVICES			
4		AAC	NYSE	AAC HOLDINGS, INC.	HEALTH CARE	MEDICAL SPECIALTIES			
5		AAL	NASDAQ	AMERICAN AIRLINES GROUP, INC.	TRANSPORTATION	AIR FREIGHT/DELIVERY SERVICES			
6		AAME	NASDAQ	ATLANTIC AMERICAN CORPORATION	FINANCE	LIFE INSURANCE			
7		AAN	NYSE	AARON'S, INC.	TECHNOLOGY	DIVERSIFIED COMMERCIAL SERVICES			
8		AAOI	NASDAQ	APPLIED OPTOELECTRONICS, INC.	TECHNOLOGY	SEMICONDUCTORS			
9		AAON	NASDAQ	AAON, INC.	CAPITAL GOODS	INDUSTRIAL MACHINERY/COMPONENTS			
10		AAP	NYSE	ADVANCE AUTO PARTS INC	CONSUMER SERVICES	OTHER SPECIALTY STORES			
11		AAPL	NASDAQ	APPLE INC.	TECHNOLOGY	COMPUTER MANUFACTURING			
12		AAT	NYSE	AMERICAN ASSETS TRUST, INC.	CONSUMER SERVICES	REAL ESTATE INVESTMENT TRUSTS			
13		AAV	NYSE	ADVANTAGE OIL & GAS LTD	ENERGY	OIL & GAS PRODUCTION			
14		AAWW	NASDAQ	ATLAS AIR WORLDWIDE HOLDINGS	TRANSPORTATION	TRANSPORTATION SERVICES			
15		AAJ	NASDAQ	ISHARES MSCI ALL COUNTRY ASIA EX JAPAN	N/A	N/A			
16		AAJN	NASDAQ	AXON ENTERPRISE, INC.	CAPITAL GOODS	ORDNANCE AND ACCESSORIES			
17		AB	NYSE	ALLIANCEBERNSTEIN HOLDING LP.	FINANCE	INVESTMENT MANAGERS			
18		ABAC	NASDAQ	RENNIN TIANLI GROUP, INC.	CONSUMER NON-DURABLES	FARMING/SEEDS/MILLING			
19		ABAX	NASDAQ	ABAXIS, INC.	CAPITAL GOODS	INDUSTRIAL MACHINERY/COMPONENTS			
20		ABB	NYSE	ABB LTD	CONSUMER DURABLES	ELECTRICAL PRODUCTS			
21		ABBY	NYSE	ABBVIE INC.	HEALTH CARE	MAJOR PHARMACEUTICALS			
22		ABC	NYSE	AMERISOURCEBERGEN CORPORATION	HEALTH CARE	OTHER PHARMACEUTICALS			
23		ABCB	NASDAQ	AMERIS BANCORP	FINANCE	MAJOR BANKS			
24		ABCD	NASDAQ	CAMBIUM LEARNING GROUP, INC.	CONSUMER SERVICES	PUBLISHING			
25		ABDC	NASDAQ	ALCENTRA CAPITAL CORP.	N/A	N/A			
26		ABEO	NASDAQ	ABEONA THERAPEUTICS INC.	HEALTH CARE	MAJOR PHARMACEUTICALS			
27		ABEOW	NASDAQ	ABEONA THERAPEUTICS INC.	HEALTH CARE	MAJOR PHARMACEUTICALS			
28		ABEV	NYSE	AMBEV S.A.	CONSUMER NON-DURABLES	BEVERAGES (PRODUCTION/DISTRIBUTION)			
29		ABG	NYSE	ASBURY AUTOMOTIVE GROUP INC	CONSUMER DURABLES	BEVERAGES (PRODUCTION/DISTRIBUTION)			
30		ABIL	NASDAQ	ABILITY INC.	CONSUMER DURABLES	BEVERAGES (PRODUCTION/DISTRIBUTION)			
31		ABIO	NASDAQ	ARCA BIOPHARMA, INC.	HEALTH CARE	TELECOMMUNICATIONS EQUIPMENT			
32		ABIX	NASDAQ	ABLYNX NV	HEALTH CARE	BIOTECHNOLOGY: IN VITRO & IN VIVO			
33		ABM	NYSE	ABM INDUSTRIES INCORPORATED	FINANCE	BIOTECHNOLOGY: BIOLOGICAL PRODUCTS (NO			
34		ABMD	NASDAQ	ABIOMED, INC.	HEALTH CARE	DIVERSIFIED COMMERCIAL SERVICES			
35		ABP	NASDAQ	ABPRO CORPORATION	N/A	MEDICAL/DENTAL INSTRUMENTS			
36		ABR	NYSE	ARBOR REALTY TRUST	CONSUMER SERVICES	N/A			
37		ABR^A	NYSE	ARBOR REALTY TRUST	N/A	REAL ESTATE INVESTMENT TRUSTS			
38		ABR^B	NYSE	ARBOR REALTY TRUST	N/A	N/A			
39		ABR^C	NYSE	ARBOR REALTY TRUST	N/A	N/A			
40		ABT	NYSE	ABBOTT LABORATORIES	HEALTH CARE	MAJOR PHARMACEUTICALS			
41		ABTX	NASDAQ	ALLEGIANCE BANCSHARES, INC.	FINANCE	MAJOR BANKS			
42		ABUS	NASDAQ	ARBITUS BIOPHARMA CORPORATION	HEALTH CARE	MAJOR PHARMACEUTICALS			
43		ABX	NYSE	BARRICK GOLD CORPORATION	BASIC INDUSTRIES	PRECIOUS METALS			
44		AC	NYSE	ASSOCIATED CAPITAL GROUP, INC.	FINANCE	INVESTMENT BANKERS/BROKERS/SERVICE			
45		ACAD	NASDAQ	ACADIA PHARMACEUTICALS INC.	HEALTH CARE	MAJOR PHARMACEUTICALS			
46		ACBI	NASDAQ	ATLANTIC CAPITAL BANCSHARES, INC.	FINANCE	MAJOR BANKS			
47		ACC	NYSE	AMERICAN CAMPUS COMMUNITIES INC	CONSUMER SERVICES	REAL ESTATE INVESTMENT TRUSTS			
48		ACCO	NYSE	ACCO BRANDS CORPORATION	CONSUMER DURABLES	PUBLISHING			
49		ACER	NASDAQ	ACER THERAPEUTICS INC.	HEALTH CARE	MAJOR PHARMACEUTICALS			
50		ACET	NASDAQ	ACETO CORPORATION	HEALTH CARE	OTHER PHARMACEUTICALS			

Figure 2: Searching by sector and industry

Number	GRAPHS	Exchanges search	Ticker	Tickers search	Exchange	FINANCE	Name	LIFE INSURANCE	Sector	Industry	BACKWARD	FORWARD
102			ADUS		NASDAQ		ADDUS HOMECARE CORPORATION		HEALTH CARE	MEDICAL/NURSING SERVICES		
103			ADVM		NASDAQ		ADVERUM BIOTECHNOLOGIES, INC.		HEALTH CARE	BIOTECHNOLOGY: BIOLOGICAL PRODUCTS (NO		
104			ADX		NYSE		ADAMS DIVERSIFIED EQUITY FUND, INC.		N/A	N/A		
105			ADX		NASDAQ		ADVAXIS, INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
106			ADXS		NASDAQ		ADVAXIS, INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
107			AEU		NYSE		AEON NV		FINANCE	LIFE INSURANCE		
108			AEU		NYSE		AEON NV		FINANCE	LIFE INSURANCE		
109			AEE		NYSE		AMEREN CORPORATION		PUBLIC UTILITIES	POWER GENERATION		
110			AEG		NYSE		AEON NV		FINANCE	LIFE INSURANCE		
111			AEGN		NASDAQ		AEON CORP		BASIC INDUSTRIES	WATER SUPPLY		
112			AEH		NYSE		AEON NV		FINANCE	LIFE INSURANCE		
113			AHR		NASDAQ		AHR TEST SYSTEMS		CAPITAL GOODS	ELECTRICAL PRODUCTS		
114			AEIS		NASDAQ		ADVANCED ENERGY INDUSTRIES, INC.		CAPITAL GOODS	INDUSTRIAL MACHINERY/COMPONENTS		
115			AEKCL		NYSE		AEON NV		N/A	N/A		
116			AEL		NYSE		AMERICAN EQUITY INVESTMENT LIFE HOLDING		FINANCE	LIFE INSURANCE		
117			AEM		NYSE		AGNICO EAGLE MINES LIMITED		BASIC INDUSTRIES	PRECIOUS METALS		
118			AEMD		NASDAQ		AETHLON MEDICAL, INC.		CAPITAL GOODS	BIOTECHNOLOGY: LABORATORY ANALYTICAL		
119			AEO		NYSE		AMERICAN EAGLE OUTFITTERS, INC.		CONSUMER SERVICES	CLOTHING/SHOE/ACCESSORY STORES		
120			AEP		NYSE		AMERICAN ELECTRIC POWER COMPANY, INC.		PUBLIC UTILITIES	ELECTRIC UTILITIES: CENTRAL		
121			AER		NYSE		AERCAP HOLDINGS N.V.		TECHNOLOGY	DIVERSIFIED COMMERCIAL SERVICES		
122			AERI		NASDAQ		AERIE PHARMACEUTICALS, INC.		HEALTH CARE	BIOTECHNOLOGY: BIOLOGICAL PRODUCTS (NO		
123			AES		NYSE		THE AES CORPORATION		BASIC INDUSTRIES	ELECTRIC UTILITIES: CENTRAL		
124			AET		NYSE		AETNA INC.		HEALTH CARE	MEDICAL SPECIALTIES		
125			ATI		NASDAQ		AMERICAN ELECTRIC TECHNOLOGIES, INC.		ENERGY	INDUSTRIAL MACHINERY/COMPONENTS		
126			AELU		NYSE		ANADARKO PETROLEUM CORPORATION		ENERGY	OIL & GAS PRODUCTION		
127			AEY		NASDAQ		ADVANTAGE TECHNOLOGIES GROUP, INC.		CONSUMER SERVICES	OFFICE EQUIPMENT/SUPPLIES/SERVICES		
128			AEZS		NASDAQ		AETERNA ZENTARIS INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
129			AFB		NYSE		ALLIANCE NATIONAL MUNICIPAL INCOME		N/A	N/A		
130			AFI		NYSE		ARES CAPITAL CORPORATION		N/A	N/A		
131			AFG		NYSE		AMERICAN FINANCIAL GROUP, INC.		FINANCE	PROPERTY-CASUALTY INSURERS		
132			AFGE		NYSE		AMERICAN FINANCIAL GROUP, INC.		FINANCE	PROPERTY-CASUALTY INSURERS		
133			AFGH		NYSE		AMERICAN FINANCIAL GROUP, INC.		FINANCE	PROPERTY-CASUALTY INSURERS		
134			AFH		NASDAQ		ATLAS FINANCIAL HOLDINGS, INC.		FINANCE	PROPERTY-CASUALTY INSURERS		
135			AFHBL		NASDAQ		ATLAS FINANCIAL HOLDINGS, INC.		FINANCE	PROPERTY-CASUALTY INSURERS		
136			AFI		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
137			AFI		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
138			AFMD		NASDAQ		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
139			AFSI		NASDAQ		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
140			AFSI^A		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
141			AFSI^B		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
142			AFSI^C		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
143			AFSI^D		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
144			AFSI^E		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
145			AFSI^F		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
146			AFSS		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
147			AFST		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
148			AFI		NYSE		ARMSTRONG FLOORING, INC.		CONSUMER NON-DURABLES	PLASTIC PRODUCTS		
149			AG		NYSE		FIRST MAJESTIC SILVER CORP.		BASIC INDUSTRIES	PRECIOUS METALS		
150			AGC		NYSE		ADVENT CLAYMORE CONVERTIBLE SECURITIES		N/A	N/A		
151			AGCO		NYSE		AGCO CORPORATION		CAPITAL GOODS	INDUSTRIAL MACHINERY/COMPONENTS		

Figure 3: Navigation through the search results

Number	GRAPHS	NYSE	Ticker	Tickers search	Exchange	FINANCE	Name	LIFE INSURANCE	Sector	Industry	BACKWARD	FORWARD
1			A		NYSE		AGILENT TECHNOLOGIES, INC.		CAPITAL GOODS	BIOTECHNOLOGY: LABORATORY ANALYTICAL		
2			ABA		NYSE		ALCOA CORPORATION		BASIC INDUSTRIES	ALUMINUM		
3			ABAB		NASDAQ		ALTAIR INC.		TECHNOLOGY	EDP SERVICES		
4			AAC		NYSE		AAC HOLDINGS, INC.		HEALTH CARE	MEDICAL SPECIALTIES		
5			AAL		NASDAQ		AMERICAN AIRLINES GROUP, INC.		TRANSPORTATION	AIR FREIGHT/DELIVERY SERVICES		
6			AAME		NASDAQ		ATLANTIC AMERICAN CORPORATION		FINANCE	LIFE INSURANCE		
7			AAN		NYSE		PARSONS & SONS, INC.		TECHNOLOGY	DIVERSIFIED COMMERCIAL SERVICES		
8			AAOI		NASDAQ		APPLIED OPTOELECTRONICS, INC.		TECHNOLOGY	SEMICONDUCTORS		
9			AAON		NASDAQ		AAON, INC.		CAPITAL GOODS	INDUSTRIAL MACHINERY/COMPONENTS		
10			AAP		NYSE		ADVANCE AUTO PARTS INC.		CONSUMER SERVICES	OTHER SPECIALTY STORES		
11			AAPL		NASDAQ		APPLE INC.		TECHNOLOGY	COMPUTER MANUFACTURING		
12			AAT		NYSE		AMERICAN ASSETS TRUST, INC.		CONSUMER SERVICES	REAL ESTATE INVESTMENT TRUSTS		
13			AAY		NYSE		ADVANTAGE OIL & GAS LTD		ENERGY	OIL & GAS PRODUCTION		
14			AAWW		NASDAQ		ATLAS AIR WORLDWIDE HOLDINGS		TRANSPORTATION	TRANSPORTATION SERVICES		
15			AAJI		NASDAQ		ISHARES MSCI ALL COUNTRY ASIA EX JAPAN		N/A	N/A		
16			AAJN		NASDAQ		AXON ENTERPRISE, INC.		CAPITAL GOODS	ORDNANCE AND ACCESSORIES		
17			AB		NYSE		ALLIANCEBERNSTEIN HOLDING LP		FINANCE	INVESTMENT MANAGERS		
18			ABAC		NASDAQ		RENNMIN TIANLI GROUP, INC.		CONSUMER NON-DURABLES	FARMING/SEEDS/MILLING		
19			ABAX		NASDAQ		ABAXIS, INC.		CAPITAL GOODS	INDUSTRIAL MACHINERY/COMPONENTS		
20			ABB		NYSE		ABB LTD		CONSUMER DURABLES	ELECTRICAL PRODUCTS		
21			ABBY		NYSE		ABBVIE INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
22			ABC		NYSE		AMERISOURCEBERGEN CORPORATION		HEALTH CARE	OTHER PHARMACEUTICALS		
23			ABCB		NASDAQ		AMERISOURCEBERGEN CORPORATION		HEALTH CARE	OTHER PHARMACEUTICALS		
24			ABCD		NASDAQ		AMERISOURCEBERGEN CORPORATION		HEALTH CARE	OTHER PHARMACEUTICALS		
25			ABCO		NASDAQ		ALCENTRA CAPITAL CORP.		N/A	N/A		
26			ABEO		NASDAQ		ABEONA THERAPEUTICS INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
27			ABEOW		NASDAQ		ABEONA THERAPEUTICS INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
28			ABEV		NYSE		ABBEV S.A.		CONSUMER NON-DURABLES	BEVERAGES (PRODUCTION/DISTRIBUTION)		
29			ABG		NYSE		ASBURY AUTOMOTIVE GROUP INC.		CONSUMER DURABLES	AUTOMOTIVE AFTERMARKET		
30			ABIL		NASDAQ		ABILITY INC.		CONSUMER DURABLES	TELECOMMUNICATIONS EQUIPMENT		
31			ABIO		NASDAQ		ARCA BIOPHARMA, INC.		HEALTH CARE	BIOTECHNOLOGY: IN VITRO & IN VIVO		
32			ABIX		NASDAQ		ABLYNX NV		HEALTH CARE	BIOTECHNOLOGY: BIOLOGICAL PRODUCTS (NO		
33			ABM		NYSE		ABM INDUSTRIES INCORPORATED		FINANCE	DIVERSIFIED COMMERCIAL SERVICES		
34			ABMD		NASDAQ		ABIMED INC.		HEALTH CARE	MEDICAL/DENTAL INSTRUMENTS		
35			ABP		NASDAQ		ABPRO CORPORATION		N/A	N/A		
36			ABR		NYSE		ARBOR REALTY TRUST		CONSUMER SERVICES	REAL ESTATE INVESTMENT TRUSTS		
37			ABR^A		NYSE		ARBOR REALTY TRUST		N/A	N/A		
38			ABR^B		NYSE		ARBOR REALTY TRUST		N/A	N/A		
39			ABR^C		NYSE		ARBOR REALTY TRUST		N/A	N/A		
40			ABT		NYSE		ABBOTT LABORATORIES		HEALTH CARE	MAJOR PHARMACEUTICALS		
41			ABTX		NASDAQ		ALLEGIANCE BANCSHARES, INC.		FINANCE	MAJOR BANKS		
42			ABUS		NASDAQ		ARBITUS BIOPHARMA CORPORATION		HEALTH CARE	MAJOR PHARMACEUTICALS		
43			ABX		NYSE		BARRICK GOLD CORPORATION		BASIC INDUSTRIES	PRECIOUS METALS		
44			AC		NYSE		ASSOCIATED CAPITAL GROUP, INC.		FINANCE	INVESTMENT BANKERS/BROKERS/SERVICE		
45			ACAD		NASDAQ		ACADIA PHARMACEUTICALS INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
46			ACBI		NASDAQ		ATLANTIC CAPITAL BANCSHARES, INC.		FINANCE	MAJOR BANKS		
47			ACC		NYSE		AMERICAN CAMPUS COMMUNITIES INC		CONSUMER SERVICES	REAL ESTATE INVESTMENT TRUSTS		
48			ACCO		NYSE		ACCO BRANDS CORPORATION		CONSUMER DURABLES	PUBLISHING		
49			ACER		NASDAQ		ACER THERAPEUTICS INC.		HEALTH CARE	MAJOR PHARMACEUTICALS		
50			ACET		NASDAQ		ACETO CORPORATION		HEALTH CARE	OTHER PHARMACEUTICALS		

Figure 4: Searching by exchange

Number	GRAPHS	NYSE	BABA	Exchange	FINANCE	Name	LIFE INSURANCE	BACKWARD	FORWARD
574		AZPN		NASDAQ		ASPEN TECHNOLOGY, INC.	TECHNOLOGY		EDP SERVICES
575		AZRE		NYSE		AZURE POWER GLOBAL LIMITED	PUBLIC UTILITIES		ELECTRIC UTILITIES: CENTRAL
576		AZRX		NASDAQ		AZURRX BIOPHARMA, INC.	HEALTH CARE		MAJOR PHARMACEUTICALS
577		AZUL		NYSE		AZUL S.A.	TRANSPORTATION		AIR FREIGHT/DELIVERY SERVICES
578		AZZ		NYSE		AZZ INC.	CONSUMER DURABLES		BUILDING PRODUCTS
579		B		NYSE		BARNES GROUP, INC.	CAPITAL GOODS		METAL FABRICATIONS
580		BA		NYSE		BOEING COMPANY (THE)	CAPITAL GOODS		AEROSPACE
581		BABA		NYSE		ALIBABA GROUP HOLDING LIMITED	MISCELLANEOUS		BUSINESS SERVICES
582		BABY		NASDAQ		NATUS MEDICAL INCORPORATED	HEALTH CARE		BIOTECHNOLOGY: ELECTROMEDICAL &
583		BAC		NYSE		BANK OF AMERICA CORPORATION	FINANCE		MAJOR BANKS
584		BAC.WS.A		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
585		BAC.WS.B		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
586		BAC.A		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
587		BAC.C		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
588		BAC.D		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
589		BAC.E		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
590		BAC.F		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
591		BAC.L		NYSE		BANK OF AMERICA CORPORATION	N/A		N/A
592		BAC.W		NYSE		BANK OF AMERICA CORPORATION	FINANCE		MAJOR BANKS
593		BAC.Y		NYSE		BANK OF AMERICA CORPORATION	FINANCE		MAJOR BANKS
594		BAF		NYSE		BLACKROCK INCOME INVESTMENT QUALITY	N/A		N/A
595		BAH		NYSE		BOOZ ALLEN HAMILTON HOLDING	CONSUMER SERVICES		PROFESSIONAL SERVICES
596		BAK		NYSE		BRASKEM S.A.	BASIC INDUSTRIES		MAJOR CHEMICALS
597		BAM		NYSE		BROOKFIELD ASSET MANAGEMENT INC	CONSUMER SERVICES		BUILDING OPERATORS
598		BANC		NYSE		BANC OF CALIFORNIA, INC.	FINANCE		MAJOR BANKS
599		BANC.A.C		NYSE		BANC OF CALIFORNIA, INC.	N/A		N/A
600		BANC.A.D		NYSE		BANC OF CALIFORNIA, INC.	N/A		N/A
601		BANC.A.E		NYSE		BANC OF CALIFORNIA, INC.	N/A		N/A
602		BAND		NASDAQ		BANDWIDTH INC.	TECHNOLOGY		COMPUTER SOFTWARE: PREPACKAGED
603		BANF		NASDAQ		BANCFIRST CORPORATION	FINANCE		MAJOR BANKS
604		BANFP		NASDAQ		BANCFIRST CORPORATION	FINANCE		MAJOR BANKS
605		BANR		NASDAQ		BANNER CORPORATION	FINANCE		MAJOR BANKS
606		BANX		NASDAQ		STONECASTLE FINANCIAL CORP	N/A		N/A
607		BAP		NYSE		CREDICORP LTD.	FINANCE		COMMERCIAL BANKS
608		BAS		NYSE		BASIC ENERGY SERVICES, INC.	ENERGY		OILFIELD SERVICES/EQUIPMENT
609		BASI		NASDAQ		BIOANALYTICAL SYSTEMS, INC.	HEALTH CARE		BIOTECHNOLOGY: COMMERCIAL PHYSICAL &
610		BATRA		NASDAQ		LIBERTY MEDIA CORPORATION	CONSUMER SERVICES		BROADCASTING
611		BATRK		NASDAQ		LIBERTY MEDIA CORPORATION	CONSUMER SERVICES		BROADCASTING
612		BAX		NYSE		BAXTER INTERNATIONAL INC.	HEALTH CARE		MEDICAL/DENTAL INSTRUMENTS
613		BB		NYSE		BLACKBERRY LIMITED	TECHNOLOGY		COMPUTER SOFTWARE: PREPACKAGED
614		BBBY		NASDAQ		BED BATH & BEYOND INC.	CONSUMER SERVICES		HOME FURNISHINGS
615		BBC		NASDAQ		VIRTUS LIFESCI BIOTECH CLINICAL TRIALS ETF	N/A		N/A
616		BBD		NYSE		BANCO BRADESCO SA	FINANCE		MAJOR BANKS
617		BBDO		NYSE		BANCO BRADESCO SA	FINANCE		MAJOR BANKS
618		BBF		NYSE		BLACKROCK MUNICIPAL INCOME INVESTMENT	N/A		N/A
619		BBGI		NASDAQ		BEASLEY BROADCAST GROUP, INC.	CONSUMER SERVICES		BROADCASTING
620		BBH		NASDAQ		VANECK VECTORS BIOTECH ETF	N/A		N/A
621		BBK		NYSE		BLACKROCK MUNICIPAL BOND TRUST	N/A		N/A
622		BBL		NYSE		BHP BILLITON PLC	ENERGY		COAL MINING
623		BBN		NYSE		BLACKROCK TAXABLE MUNICIPAL BOND TRUST	N/A		N/A

Figure 5: Finding a particular ticker

Stocks

<

Choose Data Type To Display:

OPEN

CLOSE

ADJ. CLOSE

HIGH

LOW

VOLUME

Choose graph:

LINE GRAPH

BAR CHART

CANDLE GRAPH

TICKERS

AAPL

AFSI

AHH

AHL

AMSWA

APO

BRFS

CAAS

CCNE

CLWT

CRCM

DSKE

EGHT

FLWS

GHDX

GTN

GTS

GTT

ISTR

MMO

Sort Tickers By:

OPEN

CLOSE

ADJ. CLOSE

HIGH

LOW

VOLUME

OPEN/CLOSE DIFF

Welcome to the graph generator.

LineGraph:

Displays the volume of the data type that is selected on the y-axis and the date range specified on the x axis.

BarChart:

Displays the average between the date range specified of the data type selected of each tickers selected.

CandleGraph:

Displays the opening and close price of a ticker in the specified date range.

The candle is green when the close price is higher than the opening price and is red when the close price is lower than the opening price.

The vertical lines of the candle indicate the peak and lowest point of that day.

GENERATE GRAPH

Figure 6: Initial graph screen

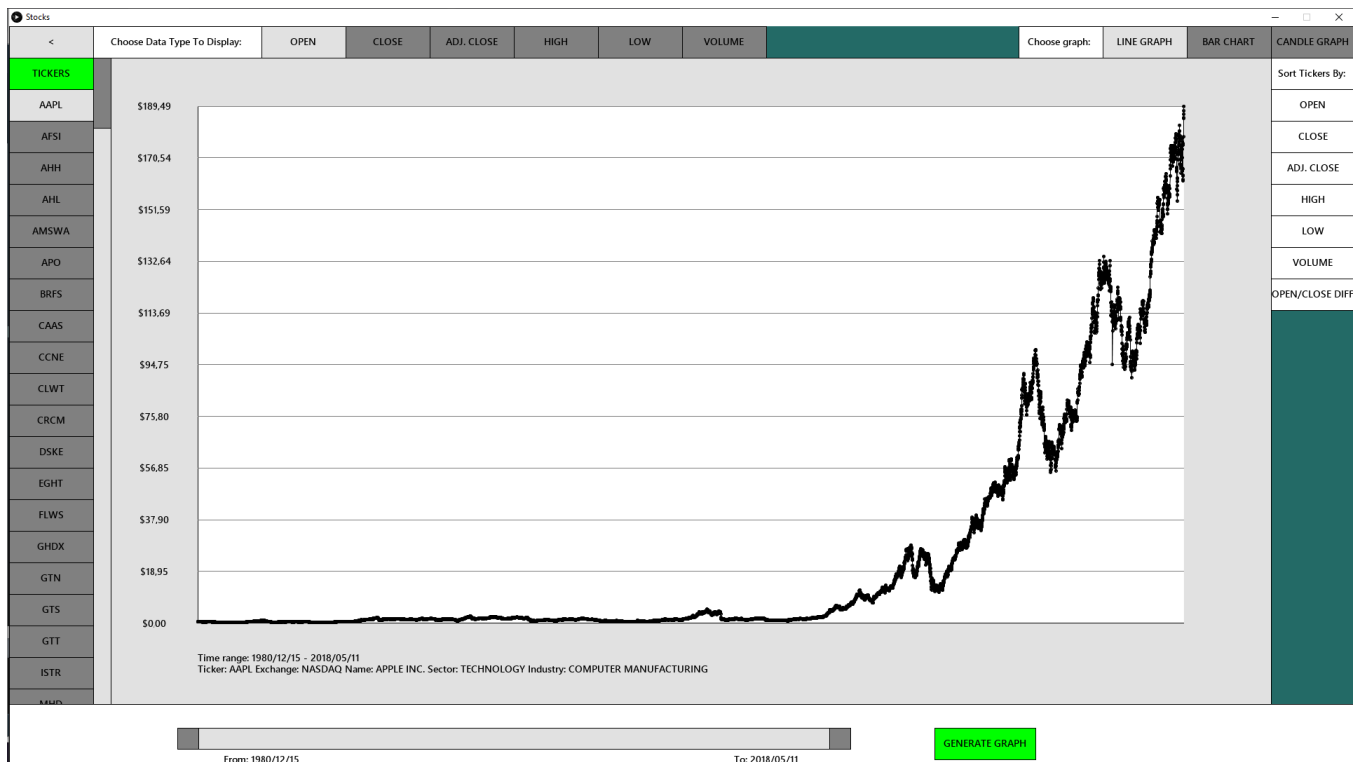


Figure 7: Line graph

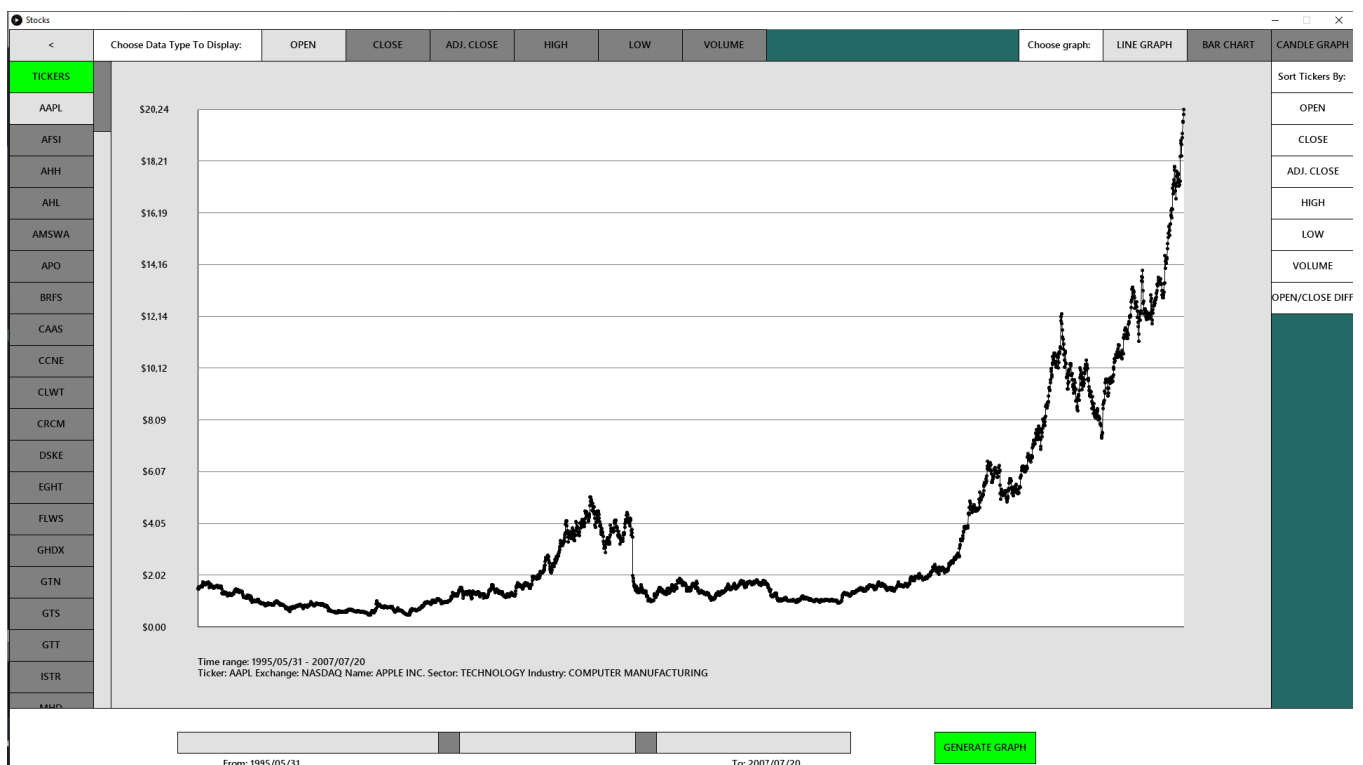


Figure 8: Line graph, different time range

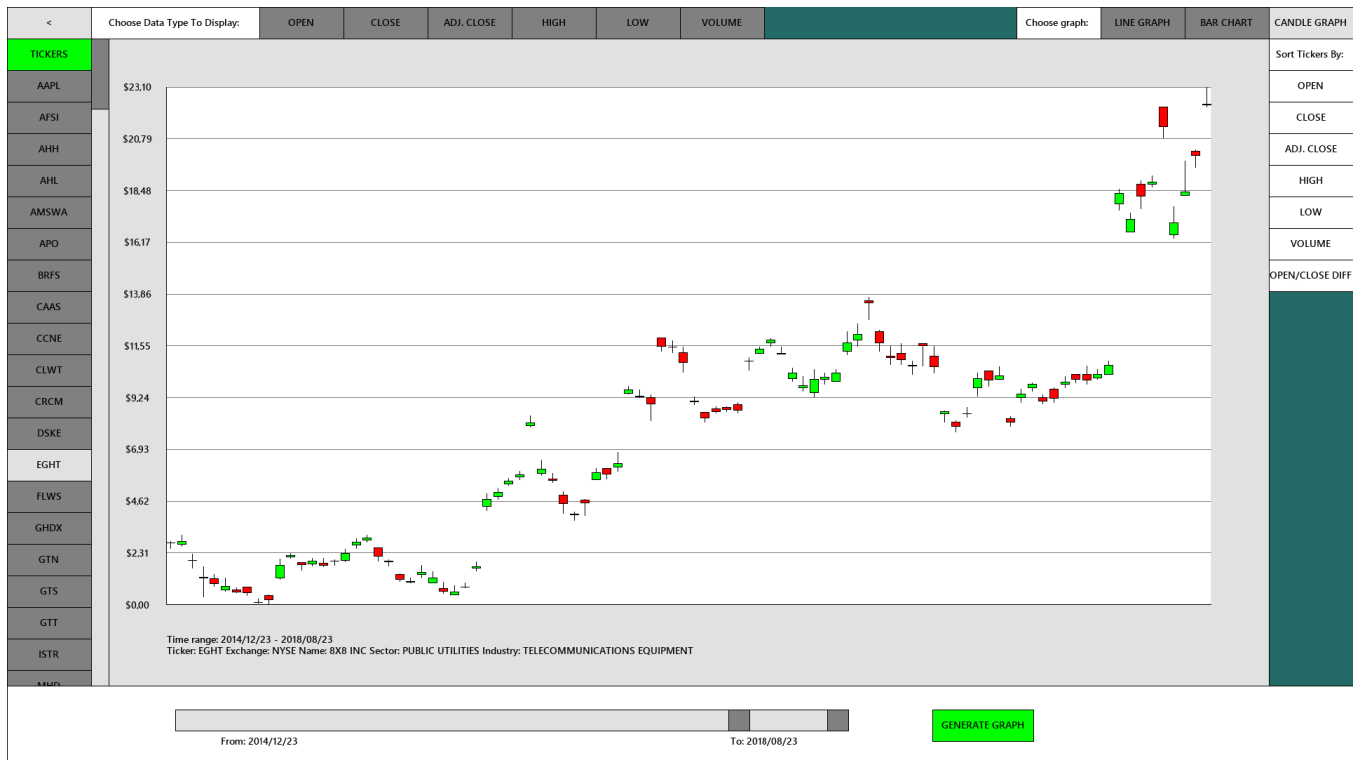


Figure 9: Candle graph

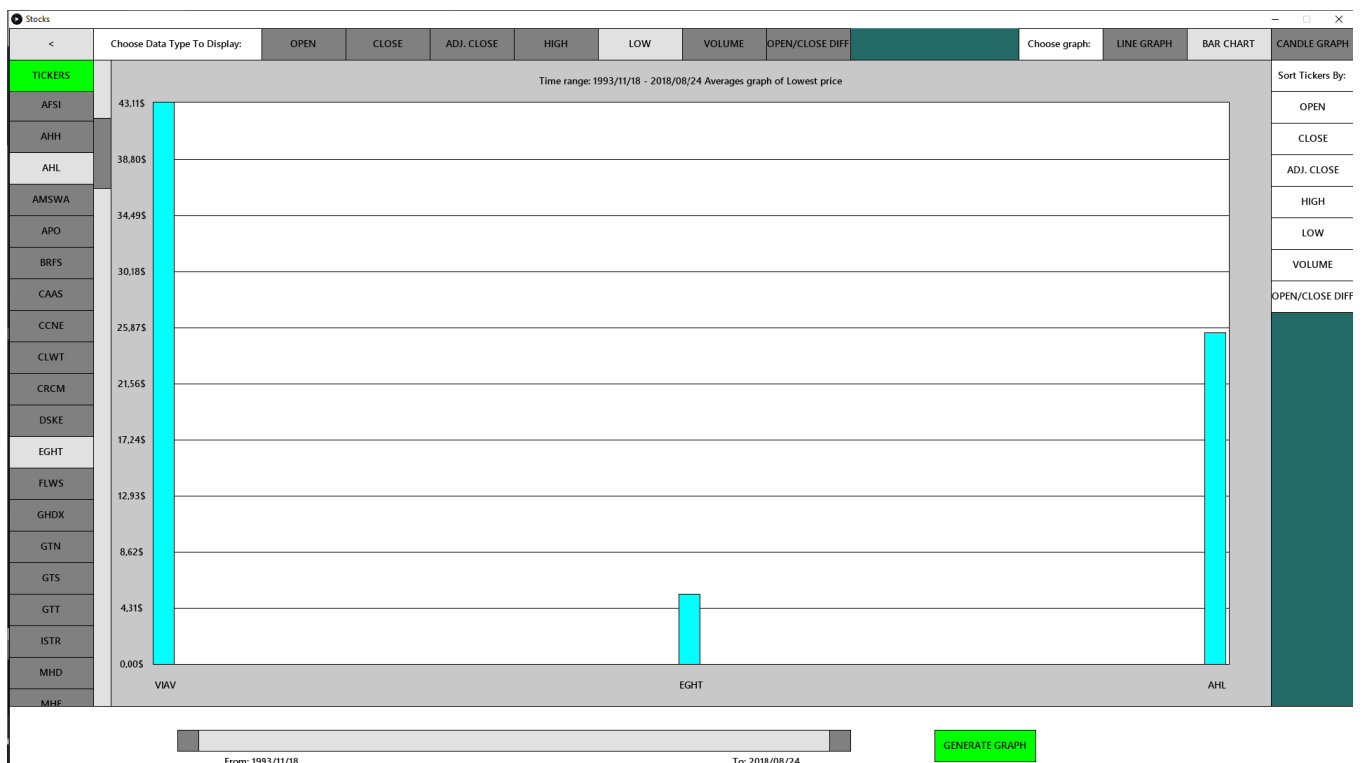


Figure 10: Bar chart (Low)

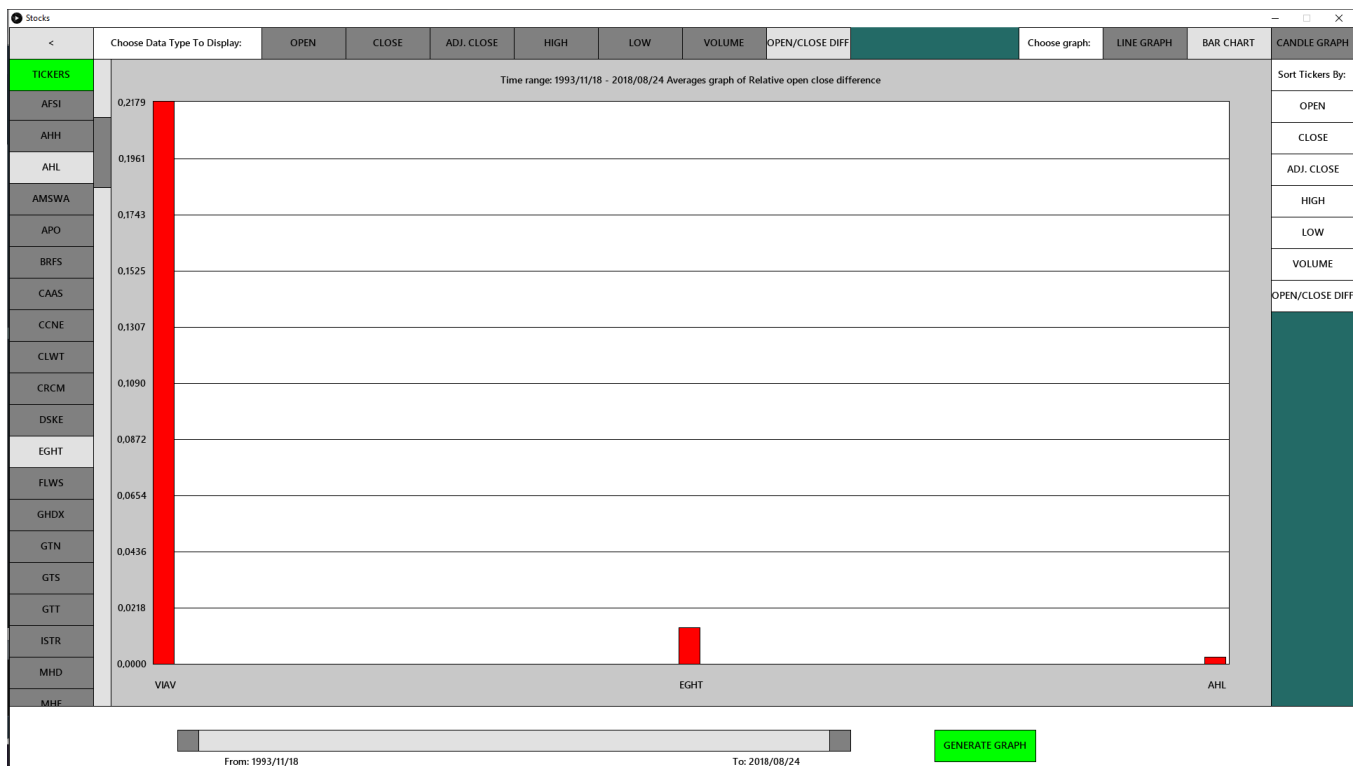


Figure 11: Bar chart (Open-close difference)