

# CurrencyHFT

Cha Ching

## **PROJECT INCEPTION:**

Jack Cusick  
James Nakashian  
Patrick Engelsman  
Matthew Cordone  
Ayushi Mishra

## **VISION STATEMENT:**

### **Elevator Summary**

One of the hassles of traveling to a new country is the need to exchange money from the currency you have to a form usable at your destination. Exchanges have fees and currency exchange rates vary daily, which can complicate travel plans and impose additional costs. Making matters worse, there are numerous exchange services all with different rates. If you want to avoid losing extra money, you would have to do extensive research beforehand - which could very well be out of date by the time you actually make the exchange. CurrencyHFT alleviates this headache by finding the optimal exchange path between two currencies using up-to-date exchange rates. Using our site, you might even be able to find an exchange path that makes you money! All you have to do is open our web page using your preferred computer, smartphone, or tablet Internet browser, enter your desired exchange, and the site will do the rest. CurrencyHFT will give you the most profitable path for your currency exchange needs.

### **Project Description**

CurrencyHFT is a currency exchange analysis web application, providing informational tools to users interested in exchanging currencies. The app solves the problem of trying to efficiently spend money in a currency that the user does not possess. Users can select a starting currency and a target currency, and CurrencyHFT will find the optimal sequence of currency transactions that link the two, taking into account currency exchange rates across many different financial institutions. If the user inputs a value for the starting currency, CurrencyHFT will calculate the maximum final value of the target currency achievable. Alternatively, if the user inputs a value for the target currency, the app will calculate the minimum value of the starting currency needed to produce the desired amount of target currency. In each case, the sequence of currency exchanges is represented in a graph, displaying the different currencies and banks the user should move through and their respective exchange rates. If the user is more interested in capturing currency arbitrage opportunities, the app also provides the ability to find sequences of

currency transactions that produce net profits, including cycles. Users are able to customize CurrencyHFT's searches by excluding currencies and/or banks that they wish to exclude in their transactions.

CurrencyHFT also provides tools to help analyze currency exchange rate trends. The app can display current and historical exchange rates between currencies and banks, track statistics about profitable transaction paths, and provide other general information about specific currencies and banks. Users can leverage these tools to educate themselves about the trading of currencies and help predict future exchange rates.

## **Business Case**

The foreign exchange market (also known as forex) is a global decentralized marketplace in which the world's currencies are traded. It is the largest and most liquid market, with trading exceeding trillions of dollars each day. With such a large volume of money, many companies have built businesses around forex and other financial markets like credit, capital and derivatives. Some of the big players include: Thomson Reuters<sup>[1]</sup>, Bloomberg<sup>[2]</sup>, Factset<sup>[3]</sup> and Capital IQ<sup>[4]</sup>. These companies provide extensive toolsets to corporate investors and banks via their terminals. These terminals are used to view, analyze and trade in financial markets. Google<sup>[5]</sup> and Yahoo<sup>[6]</sup> also provide tools to view market data, but on a smaller scale and with fewer advanced analytics.

In the early 2000s, many financial professionals had access to multiple companies' terminals and were able to leverage the comparative advantages of each. However, following the 2008 financial crisis, many financial professionals lost funding for all but one terminal. Financial companies were forced to pick between the competitors mentioned above. This created a market opportunity for supplemental financial tools that persists today. CurrencyHFT aims to capitalize on this opportunity by targeting the niche market of arbitrage and high frequency trading in forex.

High frequency trading (HFT) uses the speed advantages of computer algorithms and optic fiber to front run orders on capital market exchanges. When a buy order arrives at a HFT exchange, say for 2000 shares of Microsoft, the high frequency trader can quickly buy Microsoft shares at other exchanges and resell them back to the original buyer. Companies like Citadel<sup>[7]</sup> have used this process for years to gain billions in profit. Forex remains relatively untouched by high frequency traders, due to its global scale, which gives CurrencyHFT a comparative advantage over other strictly capital market HFT firms. Arbitrage through high frequency trading is a lucrative market and CurrencyHFT would sit at the bleeding edge.

CurrencyHFT's other use case targets a different market: individual travel and foreign purchases. Converting to a foreign currency can be a costly endeavour if currencies are exchanged at poor rates. CurrencyHFT addresses this issue by finding the most efficient way to exchange currency. For example, consider a trip from the United States to Canada. Buying CAD

with USD is not necessarily the most efficient way to exchange currency. A traveler can often fair better if he or she first exchanges through a third, intermediate currency, like GBP or JPY. This is called triangular arbitrage. CurrencyHFT aids travelers by exposing these routes of higher efficiency exchange, in a fashion that other businesses don't. Big names like Bloomberg and Thomson Reuters charge too large a subscription fee for the average person to use for personal transactions. Services like Google and Yahoo do not enable the individuals to take full advantage of the forex market. Mobile applications like Currency Converter<sup>[8]</sup> pose more serious competition, but lack individual financial institutions' exchange rates. In short, CurrencyHFT captures a unique market opportunity for individuals exchanging currency and stands alone in harnessing triangular arbitrage.

## **Project Stakeholders**

The main project stakeholders of CurrencyHFT are the Development Team and the Class Instructors.

The Development Team consists of Jack Cusick, James Nakashian, Patrick Engelsman, Matthew Cordone, and Ayushi Mishra. The Team's primary stake in the project is succeeding in the course, but also includes producing a complete application that captures the desired functionality and increasing their experience in team-based software development.

The Class Instructors includes Prof. Sturman, Lili Li, and Frank Liu. The Instructors' stake in the project is fostering the Development Team's software development education and receiving a completed project for grading at the end of the semester.

## **Major Features**

- Currency Arbitrage
  - Ability to find optimal path to exchange one currency to another
    - From fixed amount of starting currency to max amount of destination currency
    - From fixed amount of destination currency to min amount of starting currency
  - Ability to detect opportunities to generate money through currency exchange
    - Find paths with net profit
    - Find positive cycles
  - Ability to restrict paths to certain banks and currencies
- Informational Tools
  - Display conversion rate info for currencies and banks
  - Display graphs of historical data and trends
  - Track statistics about profitable paths
  - Present other information about currencies and banks

## **Major Risks**

- Finding real-time data sources for zero or low cost
- Banks do not make their rates easily accessible
- The extent of SEC regulation of high frequency trading and arbitrage
- Ability to implement cross-browser and cross-platform compatibility
- Computational complexity may negatively affect performance and User Experience

## ***USER SCENARIOS:***

### **Joe Steele**

Joe Steele is a normal guy in his late thirties with a wife, Jane, and a 12 year old son named Alex. He has a bachelor's degree in business administration from the University of Albany. He works as a paralegal at Emmet Marvin & Martin LLP. He is a conservative spender and seizes every opportunity to save money. He loves to travel the world and takes his family on week long vacations to a new destination every year to get away from life's many stresses.

Some of his favorite interests include travel, hockey, and bowling. His main goal in life is to make as much money as he can to provide the best life for his family.

### **Goals**

Save as much money as possible when purchasing items with other currencies

### **Setup**

Joe Steele's son's birthday is coming up in 2 weeks and Alex wants the newest toy, the Megazoid 3000. However, Joe cannot find the toy in stock in any US store or website, but finds it on a Japanese website. Being shrewd when it comes to spending money he wants to make sure he isn't over spending for the toy. He wants to be able to check the exchange rate and make sure he gets the best deal possible through his bank, even if it is just a difference of pennies, but he is a busy man so he can't spend hours doing research. Right as he is about to give up and just buy the toy, he remembers the website CurrencyHFT.

### **Actions**

Joe goes to [www.currencyhft.com](http://www.currencyhft.com) in his Google Chrome browser and clicks the tools button on the toolbar. The page scrolls down to display the currency exchange tool. Joe selects USD in the "Starting Currency" dropdown menu, selects JPY in the "Desired Currency" dropdown menu, and enters the value of the toy in the textbox. Joe then clicks the "Exchange" button. Next to the dropdown menu the value of the American Dollars in Japanese Yen is displayed. Joe discovers that the Japanese website actually is cheaper than any US price. But Joe still wants to get the best deal possible, so he clicks on the "Best Exchange" button on the toolbar and the page scrolls to the optimal currency exchange tool. Joe enters the amount of Yen that the website is charging in the "Desired Value" box and selects Yen for the currency. He then selects USD for

the starting currency. Joe hits the exchange button which displays a graphical representation of the most profitable path to reach the desired value. Joe then proceeds to follow the suggested path when getting the money to make the toy purchase, and thus saves as much money as possible.

## **System Responses**

Joe goes to [www.currencyhft.com](http://www.currencyhft.com)

Chrome loads up the webpage. Chrome displays CurrencyHFT's landing page, including the logo, a short description of the site, and a toolbar at the top of the page.

Joe clicks "Tools" button

The page scrolls down to where the tools are located.

Currency Exchange tool

Web page sends selection of USD for starting currency, JPY for target currency, and the value to convert from USD to JPY to backend. Web page displays value of the USD converted to JPY.

Joe clicks "Best Exchange" button

Page scrolls to where the best exchange feature is located.

Best Exchange tool

Web page sends selection of USD for starting currency, JPY for target currency, and value to convert from JPY to USD to the backend. The feature box on the page expands. The optimal sequence of exchanges to make from USD to JPY is displayed as a graph with each currency being nodes and exchange rates being edges. The minimum starting value of USD needed to reach the desired amount of JPY is displayed.

## **Jordan Belfort**

Jordan Belfort is your classic Wall Street tycoon. Jordan only wears custom made shirts because they "visually enhance his posture and by extension his influence." Though he prefers Tupac and other 90s Rappers, Jordan now exclusively attends Symphonies and the Opera. Jordan frequents the Gentlemen's club after work for visual stimulus and for casual banter with fellow brokers, but he ensures his wife it is strictly business.

Refusing to conform to the standards imposed by large banks, Jordan co-founded a brokerage firm on a dare. As anticipated to his colleagues, Jordan's risky venture proved wildly lucrative. He celebrated his monetary success by spending a small portion of his fortune on a luxury yacht. The vessel spends most of the year docked in the New York City Harbor, but Jordan does smoke an occasional Cuban cigar on the deck. His wife asked him why he didn't just buy a condo instead of a yacht he never sails. But obviously, Jordan can't throw floating parties in a condo. Money well spent.

Jordan's life goals include making money, making a lot of money, and making a stupid amount of money. He is eager to gain profits from several ventures. Recently, his friend introduced him

to CurrencyHFT, an excellent prospect for seeking returns from high frequency currency exchanges. This is Moonlight Sonata to Jordan's ears.

## Goals

Earn a profit from high speed currency exchanges. View currency exchange trends.

## Setup

It is the last week of the year, and Jordan is angry because he only made 51 million this past year, just shy of a million a week. Jordan's wife insists he take the week off and spend some time at home. Jordan is pacing back and forth in front of his 30 foot tall imported Christmas tree, contemplating how he could make his final million at home. He's stumped. He opens up his laptop to distract himself from his frustrations, and suddenly, he has an idea. Jordan's friend introduced him to CurrencyHFT, a website that tracks trends in profitable currency exchange paths. Jordan can achieve his financial goal for the year, right from the comfort of his own Plume Blanche diamond encrusted sofa.

## Actions

Jordan goes onto [www.currencyhft.com](http://www.currencyhft.com) using his Firefox browser. He clicks the "Currency Arbitrage" button on the taskbar. The page scrolls down to the currency arbitrage tool. He then selects his USD as his starting currency from a dropdown menu, and enters the amount he wishes to exchange underneath. He clicks the "Make Money" button. The page displays the top 5 most profitable exchange paths starting with USD. Jordan still wants more information, so he clicks the "Research" button on the toolbar, and the page scrolls to the research section. There, Jordan presses the "Profitable Path Trends" button, and the page displays graphs of the top 5 most frequently occurring profitable paths and visualizes trends. Jordan studies the information so he can use it the following days to make money by watching the markets for opportunities to trade along these paths.

## System Responses

Jordan goes to [www.currencyhft.com](http://www.currencyhft.com)

Firefox loads up the webpage. Firefox displays CurrencyHFT's landing page, including the logo, a short description of the site, and a toolbar at the top of the page.

Jordan clicks "Currency Arbitrage" button

The page scrolls down to where the tools are located, with type of computation set to "Currency Arbitrage".

Currency Arbitrage tool

Web page sends the selection of USD as the starting currency to backend. Web page displays the top 5 most profitable exchange paths found graphically.

Jorgan clicks "Research" button

The page scrolls to the research section.

Jordan clicks the "Profitable Paths" button

The page displays the top 5 most frequently occurring profitable paths as graphs.

## ***PROJECT SCHEDULE:***

### Inception

1/26 - 1/30

- Set up means of communication
- Established meeting times
- Decided to create web app
- Discussed rough overview and goals of project

1/31 - 2/2

- Decided to use C++ for backend
- Created Peer Review rubric
- Chose Jack to be the “Costumer” of the project
- Set up Git milestones

2/3 - 2/6

- Set up a web server that uses Node.js
- Investigated data sources
- Began work on user stories
- Asked an industry contact for supplemental material

2/7 - 2/13

- Looked into use cases, discussed features
- Sketched out plans for front end design
- Discussed project timeline
- Bought currencyhft.com domain name
- Wrote server documentation

### Elaboration

2/14 - 2/26

- Complete wire frames for application
- Establish specifications for the database and other backend functionality
- Finalize list of data sources

### Construction

#### **Iteration 1: Interconnectivity** (40 story points)

2/27 - 3/6

- Local servers setup by team members (5)
- Frontend can hit endpoint and display received response (10)
- Backend endpoints for frontend to send and receive information (15)
- Database API for the use by the backend to request data (10)
- **Demonstration:**

- User visits [www.currencyhft.com](http://www.currencyhft.com)
- User types something in a textbox and clicks submit
- Screen echos text response from server

## **Iteration 2: Basic Frontend & Data Collection (50 story points)**

3/7 - 3/13

- Database manually populated with mock or historical data (5)
- Historical forex market data downloaded (5)
- Basic UI for displaying database's exchange rates, tabular and/or graphical (15)
- Requests to different marketplace APIs and write web scrapers if necessary (20)
- Investigate and choose a shortest path algorithm (5)
- **Demonstration:**
  - User selects currency exchange from drop down list
  - User clicks submit
  - Screen displays exchange rate data in tabular and/or graphical view

## **Iteration 3: Algorithm, Database API/Collection, & More Frontend (60 story points)**

3/14 - 3/20

- Implement and test shortest path algorithm (30)
- Set up continuous updating of data (5)
- Finalize backend calls to database (5)
- Add UI for the rest of frontend functionality (tool queries, research queries) (20)
- **Demonstration:**
  - User selects currency exchange from drop down list
  - User inputs value of starting currency
  - User clicks submit
  - Screen displays currency exchange path and ending value in tabular and/or graphical view

## **Iteration 4: Modified Versions of Algorithm & Frontend Visuals (55 story points)**

3/21 - 3/27

- Modify algorithm to suit the different server requests (input ending value, exclude selected currencies/banks/locations, find profitable paths) (25)
- Add visuals to frontend for the web page functions (i.e. best exchange, profitable paths, tools) (25)
- Database to store trends of efficient/positive paths (5)
- **Demonstration:**
  - User selects currency exchange from drop down list
  - User inputs value of ending currency
  - User selects currencies/banks/locations to exclude from drop down list
  - User clicks submit



- Screen displays currency exchange path and starting value needed in graphical view

### **Iteration 5: Tools & Frontend Styling (35 story points)**

3/28 - 4/3

- Implement display of currency conversion rates tool functionality on backend (5)
- Implement display of historical trends tool functionality on backend (10)
- Add styling to make web page more user friendly and nice to look at (20)
- **Demonstration:**
  - Walk through new graphics of web page
  - User navigates to informational tools and selects currency conversion
  - Screen displays currency conversion information
  - User navigates to informational tools and selects historical trends
  - Screen displays historical trend information graphically

### **Iteration 6: Finish Tools & Finish Version of Frontend (35 story points)**

4/4 - 4/10

- Implement display of profitable path trends tool on backend (15)
- Implement other informational tool functionality on backend (10)
- Put finishing touches on initial build (10)
- **Demonstration:**
  - User navigates to informational tools and selects profitable path trends
  - Screen displays profitable path trends information graphically
  - User navigates to informational tools and selects other tools
  - Screen displays other tool information

### **Iteration 7: Documentation, Unit Testing and End to End Testing (40 story points)**

4/11 - 4/17

- Finish Documentation for all parts of project (20)
- Bug fixing jam session (10)
- Complete unit and end to end testing of application (10)
- **Demonstration:**
  - Portray user scenario 1: traveler finding efficient exchange rate in one marketplace
  - Portray user scenario 2: financial professional investigating forex arbitrage opportunities
  - Utilize tools during one or both user scenarios

### **Transition**

4/18 - 4/30

- Create and deliver final presentation
- Make changes based on feedback and testing

- Finalize and deploy application
- Finalize documentation

## ***CONTRIBUTION SUMMARY:***

All team members contributed to editing, reviewing, and approving the Inception deliverable for final submission. Breakdown of individual contributions is as follows:

### Jack Cusick

Wrote the Business Case and ensured completion of the Vision Statement. Added Citations section with links to potential competitors. Brainstormed the user scenarios, major features and risks. Helped fill out Schedule bullet points, end-of-iteration demonstrations, and assign story points.

### James Nakashian

Filled out structure of document. Ensured completion of Contribution Summary. Wrote Executive Summary. Rewrote Elevator Summary, based on Pat's original version. Wrote Project Stakeholders. Wrote Major Features and some of the Major Risks. Transferred to-date status report bullet points to Schedule. Helped fill out Schedule bullet points, end-of-iteration demonstrations, and assign story points. Edited both User Scenario Actions and System Responses sections.

### Patrick Engelsman

Wrote the original detailed schedule for the elaboration, iterations and transition. Helped finalize dates for features and assign story points. Wrote initial elevator summary and some of the major risks. Created the user scenario for Joe Steele and some of the actions and responses in the scenario for Jordan Belfort. Also helped come up with the different useful features to implement.

### Matthew Cordone

Wrote user profile for Joe Steele persona. Helped to come up with different features to implement. Helped come up with the front end design. Helped to create the iteration schedule. Ensured the completion of the user scenarios.

### Ayushi Mishra

Wrote user scenario for Jordan Belfort persona and wrote Status Report summary. Brainstorming core functionality and features of app. Design work for logo, brand, and GUI elements for major features on web page. User Experience for financial software research.

## ***STATUS REPORT:***

In regards to project management and communication, we have set up Slack, a Github account for our code repository, Google Drive folder, and established compatible meeting times. We will track milestones, create and assign issues, and maintain a wiki through Github services. We are working towards designing a logo and brand.

In terms of project initiation, we decided to create a web app. The backend will be written in C++, and the frontend will use a framework to achieve a look and feel that suits our brand. We have purchased a domain name, [www.currencyhft.com](http://www.currencyhft.com), and set up a web server that uses Node.js. We have a wiki on Github set up to provide documentation on connecting to the currency server, setting up a local server, pulling the server repository, restarting the server, resolving issues on server caused by DNS, and installing MySQL. We have established an ssh server and remotely accessible MySQL server. We will continue to update our wiki with the necessary documentation as we begin construction.

As far as future development, we have decided to develop our algorithm starting with a static data source. We are reaching out to industry contacts in search for real time currency exchange rates and other supplemental material. We have established the key features of our application and discussed elements of the GUI that coincide with CurrencyHFT's core functionality.

## **Citations:**

- [1] Thomson Reuters Corporation, est. Apr. 17, 2008. *New York, NY*. Web. <http://thomsonreuters.com/en.html>
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- [6] Yahoo!, est. Mar. 2, 1995. *Sunnyvale, CA*. Web. <https://www.yahoo.com/>
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