

An Online User Interface for Tracking Stock Portfolios

Joseph B. Hess

12 June 2003

Abstract

Currently, an abundance of websites offer online services to track the performance of stock portfolios. However, the most comprehensive options to this effect may require a fee and usually do not provide advice tailored to the investor. Additionally, the online environment is often subjected to undesired amounts of clutter and advertising, distracting users from their main purpose and unnecessarily complicating the online experience. An online user interface offers wide-ranging analysis of stock performance and counsel on managing the portfolio based on a concurrent study in technical analysis and other strategies used to predict stock movements. This project represents the confluence of the convenience of other online interfaces, the personalized guidance typically reserved for other media, the efficiency of data storage in databases manipulated by simple query languages, and basic principles of the design of user interfaces in order to create a single destination for viewing past performance, current conditions, and future possibilities.

1 Introduction

An online interface that obtains information through a relational database accessed and modified by MySQL is used to track stock movements and related data. Pricing data (current price and daily change in dollars and in percent), technical data (Price/Earnings ratio and P/E-to-growth ratio), market information (the market on which the stock is traded, the levels of the major American indices, market capitalization daily volume, and average daily volume), and a variety of charts are available to the user, who is able to select scales, frames of time, and other variables and settings.

The presentation of advice specific to the investor and analysis is based on the results of the simultaneous project regarding the performance of various strategies in predicting stock movements. As more patterns emerge from this project, the level of advice is elevated to include the newest conclusions on managing a portfolio. Although the program incorporates a view to large profits in the short term and hot stocks, the primary focus is based on a long period of investment and solid, reliable performers.

This document will often refer to the capabilities of the final version of the product intended to be created. However, the author was unable to include all desired features in the currently available version of the interface, given the need for extensive research on a variety of topics, the need to learn new programming languages in order to code the interface, and the ambitious nature of the ultimate goal of the project. Details on work performed in the Computer Systems Laboratory are included in the Development section. Also, the Conclusion sections discusses the project in terms of accomplishments to date.

2 Purpose

The purpose of this project is to increase technical knowledge of Internet languages and simple query languages—for the design on user interfaces and database organization and management, respectively—and financial knowledge of investment by combining the various fields of endeavor in order to create a informationally comprehensive, aesthetically pleasing interface that allows users to examine past performance of the stocks in their portfolio, assess their current condition, and consider future investments. Research in the aforementioned areas will culminate in the creation of a product reflecting the newly acquired knowledge.

3 Research

This project combines the application of databases and the concept of an interface. Accordingly, a variety of topics were researched in order to gain an appreciation for accomplishments in these fields. Database organization and management are key topics for ensuring the accuracy of data provided in the interface and providing easy access to needed information. The art of creating visually appealing interfaces that do not detract from the actual content of the product is another issue with high priority in this project.

3.1 Database

A database is a tool for structuring available data in a logical form. Specialized software allowing users to manage considerable information is found in a database management system. Database management systems are characterized by several features—lasting and flexible

storage of vast amounts of data, the ability to access and modify data through the interface of a simple query language (SQL), and the ability to handle a variety and large quantity of "transactions" performed on the data without subjecting the data to the pitfalls of multiple points of access.

Three main types of databases exist—the object-oriented model, in which the database is composed of objects with given properties; the entity-relationship model, in which diagrams showing the relationships between entities comprise the database; and the relational model, a single table that separates logical, external elements from physical, internal elements and is derived from a design in one of the other models.

The relational model is the preferred model for databases for a number of reasons. Implementations of databases such as SQL are based on this method of structuring data. The simplicity of the relational model—requiring a single table—is another justification for its widespread use for databases. Additionally, of the models presented, the relational model best approximates human thought, making it a convenient method for programmers.

Database modeling is the process of structuring the database before its creation, beginning with thought on the relationships, properties, and limitations needed to be embodied by the database. This process yields a database in object-oriented or entity-relationship form. The attributes of such a system must be converted to relations—and, possibly, modified subsequently in order to provide for optimal effectiveness—prior to implementation.

In this project, a series of relational MySQL databases was created for processing by PHP functions in order to provide the content of the interface. A set of users—Mr. Latimer and

Yosemite Sam—are assigned passwords. For each user, tables containing the ticker symbols of their holdings and the corresponding quantities were created.

The information for portfolio is shown in the following MySQL command and response:

```
mysql> select * from portfolio;
```

```
+-----+-----+
| name          | password |
+-----+-----+
| Mr. Latimer   | compsys  |
| Yosemite Sam  | boots    |
+-----+-----+
2 rows in set (0.00 sec)
```

The information for the accounts of Mr. Latimer and Yosemite Sam, respectively, is shown below:

```
mysql> select * from latimer;
```

```
+-----+-----+
| stock | qty |
+-----+-----+
| MSFT  | 100 |
| DELL  | 100 |
+-----+-----+
2 rows in set (0.00 sec)
```

```
mysql> select * from sam;
```

```
+-----+-----+
```

```
| stock | qty |
```

```
+-----+-----+
```

```
| CSC0  | 100 |
```

```
| K0     | 100 |
```

```
+-----+-----+
```

```
2 rows in set (0.00 sec)
```

3.2 Interface

Joel Spolsky, who runs Fog Creek Software, is an expert in the design of user interfaces. A substantial portion of his book on the subject, *User Interface Design for Programmers*, appears on his personal website. His precepts in the field of design form the basis of this project. At the core of his designing philosophy is the dictum, "A user interface is well-designed when the program behaves exactly how the user thought it would." Accordingly, the online interface created in this project attempts to meet expectations for electronic portrayal of a portfolio and to make self-explanatory navigation on the interface.

Spolsky stresses that the design of user interfaces is, at essence, an enterprise that is best undertaken with rational, methodical thought. No special creative or artistic talents are needed to design a user interface of quality. Instead, he advises, simplicity and consideration for the potential needs and desires of the user are the ingredients for creating a useful

interface. Viewing the user as a logical person who expects the interface's responses to his actions to match his expectations and act in accordance with his intuition. The interface, in Spolsky's view, is to remain unobtrusive *and* responsive to the user.

Although not all of the content in *User Interface Design for Programmers* pertained to this project, given the nature of this interface and guidance related to Microsoft products, much of his material was useful in the construction of the interface. Spolsky's emphasis on simplicity and ease of use was the driving factor behind the final version of the interface, which uses four colors—white, green, gold, and blue (for the background)—and remains uncluttered by superfluous elements.

4 Development

This project, which primarily uses PHP and MySQL, consists of four main phases. The first major step is extensive research of online user interfaces, database organization, and data retrieval. Following this preparatory period, the interface is created with a basic level of functionality. Next, advice and analysis are combined with a refined interface that is marked by thoroughness and ease of use. Finally, all features are further enhanced to incorporate additional conclusions of the related project in a final testing of sample portfolios.

The aforementioned work is conducted through the iterative process of planning, designing, coding, and testing incrementally to create ultimately the final product. Described below are the iterations, completed and scheduled, for this project, organized by quarter.

4.1 Research

Quarter I: Research of Internet languages and online interfaces. The first phase of this project entailed determining an area to research, beginning the portfolio for recording progress on the project, and attaining the coding proficiency necessary to write programs for research.

- Iteration I: Planning and creation of website. The website serves as a portfolio containing all work related to the project. Included in this element of the project are journals, reports on iterations, various assignments, technical research, and code.
- Iteration II: Java and PHP. The languages of Java and PHP were explored with small, sample programs and assorted reading in order to determine the language necessary for the project. PHP offered the ability to extract data from other websites and its ease of use in conjunction with MySQL underscored its usefulness.
- Iteration III: Proposal and completion of requirements for Quarter I. Among the administrative requirements for the end of the quarter was producing a formal proposal for the project and making an oral report of work completed to date.

4.2 Prelude to the Interface

Quarter II: Obtaining pertinent data. The second step in this project involved extracting desired data regarding the major American indices and listings on those indices from Yahoo! Finance (finance.yahoo.com) as desired by the user, as a prelude to constructing the interface.

- Iteration IV: Retrieval of current value of major indices using PHP. The values of the

Dow Jones Industrial, NASDAQ, and Standard and Poor's 500, in addition to the daily changes in those values (in terms of points and percent) were obtained as the initial exercise for later use in the interface.

- Iteration V: Retrieval of technical data for listings on the major indices. The code used in Iteration IV was expanded substantially in order to obtain data for listings on the major indices, including market capital (in dollars), price-to-earnings ratio (P/E), P/E-to-growth ratio (PEG), daily volume, and average daily volume. A PHP form allowed users to enter a ticker symbol through which they obtained the aforementioned information regarding the stock.
- Iteration VI: Digital version of poster. In preparation for a paper version of the poster, an online edition was created using nested tables to show an abstract, an introduction, a methodology, the result, visual aids to comprehension, and other related items. Following the completion of the online draft, the project was presented in paper form. Also included in this iteration were the final administrative requirements for Quarter II.

4.3 Preliminary Interface

Quarter III: Displaying data in a preliminary interface. The third round of work on the interface was to create an initial version of the interface using the findings of previous work to gradually expand the capabilities of the interface. In addition to obtaining a basic level of functionality, the interface was to represent adherence to the fundamental precepts of the

design of user interfaces.

- Iteration VII: Comprehensive analysis of progress and goals. During Iteration VII, a comprehensive review of progress to date and future plans was performed. The description of the project provides a summary of the methodology and intended results for this project, including information on visual display of the results. The scientific method applied to this project is unique in its concentration on research of many subject and on ultimately obtaining a product, as opposed to theoretical exploration. However, the scientific method is still valid for An Online User Interface for Tracking Stock Portfolios. Version 3.1 of the interface is depicted in the form available at the end of Quarter II. Included in these documents are information regarding the features of Version 3.1, goals for the subsequent iterations, and the ultimate aims of this project.
- Iteration VIII: Creation of initial interface. Relying on MySQL tables to provide information regarding sample accounts and Yahoo! Finance for data regarding the holdings of the accounts, the initial interface was created, allowing users entering the correct password to view the prices of their individual holdings, the changes of those holdings on the day (in dollars and in percent), and the levels of the major American indices. New functions for displaying data were created in order to achieve the proper format, given the guidelines of the design of user interface asserted by Joel Spolsky. The product of Iteration VIII represented the first combination of the studies in data retrieval and interface design.
- Iteration IX: Documentation for Quarter III. Administrative tasks for the end of the

quarter, including a draft of the technical paper, were completed.

4.4 Enhancing the Interface

Quarter IV: Completing and enhancing the interface. In the fourth and final part of this project, the capabilities of the interface were to be expanded as much as possible, including introducing technical data to the display. Modifications to the design and the format of the output were expected in order to maintain the principles of the design of user interfaces in the final product.

- Iteration X: Expanding functionality of interface. The technical data first displayed in Iteration V were added to the interface. The format of these additions and of the previously included information was changed in order to increase the clarity of the interface and to display all data in a manner that would not detract from the content.
- Iteration XI: Adding advice to interface. Due to the extensive requirements in research required for the concurrent study of portfolio management, this stage of the project was canceled.
- Iteration XII: Final administrative requirements. The technical paper, research of other technical papers, and other assignments for the end of the course were completed.

5 Results

The final result is an online financial manager that provides detailed analysis of stock movements and personalized advice, presented according to the aesthetic preferences of the user. Thorough research in the technical, visual, and financial aspects of the project allows the combination of the online user interface, supported by the underlying database, and the analytical program to give users reliable suggestions and ease of use in the uncertain world of portfolio management.

6 Conclusion

Although the interface is not nearly complete, much was learned in the process of researching databases and interfaces and in coding the early versions of the interface. The basic principles of database organization and management and those of the design of user interfaces were employed in the version currently available—a crisply presented, informative display of the current status of the portfolio. The online user interface for tracking stock portfolios does not include features regarding previous movements of listings in question. Nor does the version reached in the Computer Systems Laboratory comprise capabilities for advice regarding future investment behavior. Despite the inability to attain all of the objectives set at the beginning of the project—an ambitious agenda, to be sure—the project successfully demonstrates the product of combining the lessons of databases and interfaces with respect to the financial world.

6.1 Limitations

The extensive research required to attain competence in the myriad skills and vast background knowledge required for this project required the devotion of considerable time to this singularly important task. This process, though accomplished in many ways, is a continuous process that leaves limited time for applying the lessons learned during the research to the more concrete task of creating the interface and the requisite databases. However, given the author's initial inexperience in virtually all areas of this endeavor, much was accomplished despite the severely restricted opportunities for programming.

6.2 Future Work

Although it is unlikely that the author will continue working on this particular project after completing his work in the Computer Systems Laboratory, he intends to earn a major computer science or computer engineering, a commitment in which his knowledge of databases and user interfaces gained through this project likely will serve him well. Future studies may also include work in the field of economics, a discipline in which the author has some interest. The author believes that the focus on computers and finance will result in his obtaining critical skills for modern life, an age of technology and of an expanding participation in financial investment.

6.3 Recommendations

Future students in the Computer Systems Laboratory are advised that they undoubtedly will encounter significant obstacles in the development of their project. A large amount of research is necessary—and desirable—in this laboratory. This requirement will restrict time for coding but will not restrict the ultimate potential for their work in their chosen aspect of computer systems. As is true of much in life, value is found in the journey, not the destination. Therefore, an awareness of the opportunity to learn many skills and ideas and the knowledge of the limited chances to put such learning into use are critical attitudes to bring to the Computer Systems Laboratory.

7 Appendix I: Code

Users can access their accounts by entering the correct password on interface.php. Code on viewer.php will lead to the resulting page, portfolio.php, which includes code to obtain the necessary data from the MySQL tables and Yahoo! Finance and to display them appropriately. Functions that manipulate tables will be used to retrieve data from the MySQL account. The code contained in fn.php includes functions for the proper display of all data gathered in the process described above. All told, over 1000 lines of code were written for this project.

7.1 interface.php

<HTML>

```

<HEAD>

<TITLE>Enter the interface</TITLE>

</HEAD>

<STYLE>  A {text-decoration: none;} A:hover {color: gold;}

<!--potential formatting for Internet Explorer (MS)

BODY {SCROLLBAR-FACE-COLOR: "";

        SCROLLBAR-HIGHLIGHT-COLOR: "";

        SCROLLBAR-SHADOW-COLOR: "";

        SCROLLBAR-3DLIGHT-COLOR: "";

        SCROLLBAR-ARROW-COLOR: "";

        SCROLLBAR-TRACK-COLOR: "";

        SCROLLBAR-DARKSHADOW-COLOR: "";

    }-->

</STYLE>

<BODY BGCOLOR="#19638c" TEXT="#FFFFFF" LINK="red" ALINK="red" VLINK="red">

<FONT FACE="arial" SIZE=2>

<!-- USER >> -->

<!--user selects from user options

form for user to enter password-->

<FORM ACTION="viewer.php" name="user">

<SELECT NAME = "ViewMethod">

```

```

<OPTION> Mr. Latimer

<OPTION> Yosemite Sam

</SELECT><BR>USER<P>

<!-- PASSWORD >> -->

<P><INPUT TYPE="password" NAME="password"><BR>PASSWORD<P>

<INPUT TYPE="submit" value="GO">

</BODY>

</HTML>

```

7.2 viewer.php

```

<?

/*connection to MySQL account, selection of database, accessing table of users
and passwords*/

//magnesium.tjhsst.edu is the alias for mysql.tjhsst.edu

$link = mysql_connect("magnesium.tjhsst.edu", "jhess", "939525");

mysql_select_db("jhess", $link);

$query = "select * from portfolio";

```



```

$result = mysql_query($query, $link);

$num_rows = mysql_num_rows($result);


//check for correct password

//only users are Mr. Latimer and Yosemite Sam


if ($ViewMethod=="Mr. Latimer")
{
    if ($password=="compsys")

        header("Location: portfolio.php?ViewMethod=$ViewMethod&password=compsys");

    else header ("Location: reject.php");
}


if ($ViewMethod=="Yosemite Sam")
{
    if ($password=="boots")

        header("Location: portfolio.php?ViewMethod=$ViewMethod&password=boots");

    else header ("Location: reject.php");
}

?>

```

7.3 portfolio.php

```
<HTML>

<!--Updated every 15 seconds-->

<META HTTP-EQUIV="Refresh" CONTENT="15">

<HEAD><TITLE>Portfolio</TITLE></HEAD>

<STYLE>  A {text-decoration: none;} A:hover {color: gold;}

<!--potential formatting for Internet Explorer (MS)

BODY {SCROLLBAR-FACE-COLOR: "";

        SCROLLBAR-HIGHLIGHT-COLOR: "";

        SCROLLBAR-SHADOW-COLOR: "";

        SCROLLBAR-3DLIGHT-COLOR: "";

        SCROLLBAR-ARROW-COLOR: "";

        SCROLLBAR-TRACK-COLOR: "";

        SCROLLBAR-DARKSHADOW-COLOR: "";

    }-->

</STYLE>

<BODY BGCOLOR="#19638c" TEXT="#FFFFFF" LINK="gold" ALINK="gold" VLINK="gold">

<FONT FACE="arial" SIZE="-1">

<?php
```

```

echo "<B>American Markets</B><BR>";

//Day Date Month Year [Time (24-hour system)]

print(date("l d F Y"));

print(" ");

print(date("H"));

print(date("i"));

print("<P>");


//include fn.php for use below

$dir='.';

include($dir.'/fn.php');


//call retrieving function in fn.php for the major indices

//^DJI, ^IXIC, and ^GSPC are Yahoo! Finance designations for the indices

//retrieve obtains current value, change in points, and change in percent

//retrieve also continues printing in table started below


echo "<TABLE CELLPADDING=0 CELLSPACING=0><TR><TD WIDTH=144>";

echo "<FONT SIZE=2 FACE=arial>Dow Jones Industrial</FONT></TD>";

$markets = '^DJI';

```

```

$quotes = retrieve($markets);

echo "<TR><TD WIDTH=144><FONT SIZE=2 FACE=arial>NASDAQ Composite</FONT></TD>";

$markets = '^IXIC';

$quotes = retrieve($markets);

echo "<TR><TD WIDTH=144><FONT SIZE=2 FACE=arial>";

echo "Standard & Poor's 500</FONT></TD>";

$markets = '^GSPC';

$quotes = retrieve($markets);

echo "</TABLE><P>";

echo "<P><FONT COLOR=white><B>Portfolio of $ViewMethod</B><BR>";

echo "<HR COLOR=FFFFFF>";

/*

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

```

```

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;</FONT><BR>";

*/

$link = mysql_connect("mysql.tjhsst.edu", "jhess", "939525");

mysql_select_db("jhess", $link);

if ($ViewMethod=="Mr. Latimer")

    $query = "select * from latimer";

if ($ViewMethod=="Yosemite Sam")

    $query = "select * from sam";

$result = mysql_query($query, $link);

$num_rows = mysql_num_rows($result);

echo "<TABLE CELLSPACING=0 CELLPADDING=0><TR>";

echo "<TD WIDTH=60><FONT FACE=arial SIZE=2><B>Stock</B></TD>";

echo "<TD WIDTH=75><FONT FACE=arial SIZE=2><B>Quantity</B></TD>";

echo "<TD WIDTH=60><FONT FACE=arial SIZE=2><B>Price</B></TD>";

echo "<TD WIDTH=75><FONT FACE=arial SIZE=2><B>Change</B></TD>";

echo "<TD WIDTH=420><FONT FACE=arial SIZE=2><B>Information</B></TD>";

```

```

echo "<TD WIDTH=75><FONT FACE=arial SIZE=2><B>Net Worth</B></TD>";

echo "</TR></TABLE>";


echo "<HR COLOR=FFFFFF>";


/*

echo "<FONT COLOR=white>&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;</FONT><BR>";

*/


echo "<TABLE CELLSPACING=0 CELLPADDING=0>";


for ($c = 0; $c < $num_rows; $c++)
{

    $row = mysql_fetch_array($result);

```

```

$stock = $row["stock"];

$qty = $row["qty"];


//obtain a page containing data regarding $symbols

$url = "http://finance.yahoo.com/q?s=$stock&d=t";

if (!($fp = fopen($url, "r")))

{

    echo "Unable to open page.";

    exit;

}


//if opening is successful, read 100000 bytes from opened page

$contents = fread($fp, 100000);


//close page

fclose($fp);


if (preg_match("/(<b>[0-9]+\.[0-9]+</b>)/", $contents, $quote))

    $price = $quote[1];


if (preg_match("/(Change<br><font color=ff0020>\-[0-9]+\.[0-9]+)/",

```

```

    $contents, $chg))

{

    $chg[1] = substr($chg[1], 29);

    $change = $chg[1];

}


if (preg_match("/(\+[0-9]+\.[0-9]+)/", $contents, $chg))

    $change = $chg[1];


if (preg_match("/(<font face=arial size=-1>0\.[0-9]+)/", $contents, $chg))

{

    $chg[1] = substr($chg[1], 25);

    $change = $chg[1];

}


if (preg_match("/(\-[0-9]+\.[0-9]+\%)/", $contents, $chgp))

    $change = $chgp[1];

if (preg_match("/(\+[0-9]+\.[0-9]+\%)/", $contents, $chgp))

    $change = $chgp[1];


$worth = substr_replace($price, '', 5, 1);

```



```

echo "<TR><TD WIDTH=60 VALIGN=TOP><FONT FACE=arial SIZE=2><B>$stock</B></TD>";

echo "<TD WIDTH=75 VALIGN=TOP><FONT FACE=arial SIZE=2><B>$qty</B></TD>";

echo "<TD WIDTH=60 VALIGN=TOP><FONT FACE=arial SIZE=2><B>$price</B></TD>";

if (preg_match("/(\+)/", $chgp[1], $extra))
{
    echo "<TD WIDTH=75 VALIGN=TOP><FONT FACE=arial SIZE=2 COLOR=00FF00><B>";

    echo "$change<BR>$change</B></FONT></TD>";
}

else
{
    echo "<TD WIDTH=75 VALIGN=TOP><FONT FACE=arial SIZE=2 COLOR=FFFFFF><B>";

    echo "$change<BR>$change</B></FONT></TD>";
}

echo "<TD WIDTH=420><FONT FACE=arial SIZE=2><B>";

data($stock, $c, $num_rows);

echo"</B></TD>";

if (strlen($price)==12)

    echo "<TD WIDTH=75 VALIGN=TOP><FONT FACE=arial SIZE=2><B>$worth.00</B></TD>";

else echo "<TD WIDTH=75 VALIGN=TOP><FONT FACE=arial SIZE=2><B>N/A</B></TD>";

```

```

    echo "</TR>";

}

echo "</TABLE>";

echo "<HR COLOR=FFFFFF><P>";

/*

echo "<FONT COLOR=white>&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;</FONT><P>";

*/

?>

<FONT SIZE="-1">

Stock data retrieved from <A HREF="http://finance.yahoo.com" TARGET="_new">

Yahoo! Finance</A>

```

<P>

</BODY>

</HTML>

7.4 fn.php

<?php

//various methods of displaying data for stocks and indices

/*basic information, additional information in column, additional information
for interface*/

//retrieve(\$symbols) obtains basic data relating to the variable

//\$symbols is the symbol for an index or listing on Yahoo! Finance

function retrieve(\$symbols)

{

//obtain a page containing data regarding \$symbols

\$url = "http://finance.yahoo.com/q?s=\$symbols&d=t";

if (!(\$fp = fopen(\$url, "r")))

{

echo "Unable to open page.";

```

    exit;
}

//if opening is successful, read 100000 bytes from opened page

$contents = fread($fp, 100000);

//close page

fclose($fp);

//if the value of $symbols is less than 1000 points or dollars

//for indices and listings (companies and corporations in indices, respectively
if (preg_match("/(<b>[0-9]+\.[0-9]+<\b>)/", $contents, $quote))
{
//print value of index or listing

    echo "<TD WIDTH=64 VALIGN=RIGHT><FONT SIZE=2 FACE=arial>$quote[1]</FONT></TD>";

//print change in points or dollars

//green for positive, white for negative

if (preg_match("/(Change<br><font color=ff0020>\-[0-9]+\.[0-9]+)/",
    $contents, $quote))
{

```

```

//extra specificity of string searched due to possibility of negative EPS

//and positive change, resulting in two numbers displayed as change

    $quote[1] = substr($quote[1], 29);

    echo "<TD WIDTH=48 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=FFFFFF>$quote[1]</FONT>"

}

if (preg_match("/(\+[0-9]+\.[0-9]+)/", $contents, $quote))

    echo "<TD WIDTH=48 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=00FF00>$quote[1]</FONT>"

//print change in percent

//green for positive, white for negative

if (preg_match("/(\-[0-9]+\.[0-9]+\%)/", $contents, $quote))

    echo "<TD WIDTH=64 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=FFFFFF>$quote[1]</FONT>"

if (preg_match("/(\+[0-9]+\.[0-9]+\%)/", $contents, $quote))

    echo "<TD WIDTH=64 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=00FF00>$quote[1]</FONT>"

}

//if the value of $symbols exceeds 1000 points (indices only)

else if (preg_match("/(<b>[0-9]+\,[0-9]+\.[0-9]+</b>)/", $contents, $quote))

{

//print value of index

```

```

echo "<TD WIDTH=72 VALIGN=RIGHT><FONT SIZE=2 FACE=arial>$quote[1]</FONT></TD>";

//print chage in points or dollars

//green for positive, white for negative

if (preg_match("/(\-[0-9]+\.[0-9]+)/", $contents, $quote))

    echo "<TD WIDTH=64 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=FFFFFF>$quote[1]</FONT>";

if (preg_match("/([0-9]+\.[0-9]+)/", $contents, $quote))

    echo "<TD WIDTH=64 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=00FF00>$quote[1]</FONT>";

//print change in percent

//green for positive, white for negative

if (preg_match("/(\-[0-9]+\.[0-9]+\%)/", $contents, $quote))

    echo "<TD WIDTH=64 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=FFFFFF>$quote[1]</FONT>";

if (preg_match("/([0-9]+\.[0-9]+\%)/", $contents, $quote))

    echo "<TD WIDTH=64 VALIGN=RIGHT><FONT SIZE=2 FACE=arial COLOR=00FF00>$quote[1]</FONT>";

}

//if the value of $symbols cannot be determined

else

{

```

```

    echo "No quote available.<P>";
}
}

//end function retrieve($symbols)


//if $symbols is not an index

//display technical data

function techdata($symbols)
{
//obtain a page containing data regarding $symbols

$url = "http://finance.yahoo.com/q?s=$symbols&d=t";
if (!($fp = fopen($url, "r")))
{
    echo "Unable to open page.";
    exit;
}

//if opening is successful, read 100000 bytes from opened page

$content = fread($fp, 100000);

//close page

```

```

fclose($fp);

if ($symbols != "^DJI" && $symbols != "^IXIC" && $symbols != "^GSPC"
    && $symbols != "^dji" && $symbols != "^ixic" && $symbols != "^gspc")
{
    echo "<TABLE CELLSPACING=0 CELLPADDING=0>";

//Market

//NYSE - New York Stock Exchange

//NasdaqNM - Nasdaq National Market

//AMEX - American Stock Exchange

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Exchange</TD>";

    if (preg_match("/(NYSE:$symbols)/", $contents, $quote))

        echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>NYSE</TD></TR>";

    if (preg_match("/(NasdaqNM:$symbols)/", $contents, $quote))

        echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>NASDAQ</TD></TR>";

    if (preg_match("/(AMEX:$symbols)/", $contents, $quote))

        echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>American</TD></TR>";

//P/E Ratio - Price to Earnings

    if (preg_match("/(P\\E<br>[0-9]+\\. [0-9]+)/", $contents, $quote))

    {

        $quote[1] = substr($quote[1], 7);
    }
}

```



```

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>P/E</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD></TR>";

}

else {

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>P/E</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

//PEG - P/E / Growth

if (preg_match("/(PEG<br>[0-9]+\.[0-9]+)/", $contents, $quote))

{

    $quote[1] = substr($quote[1], 7);

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>PEG</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD></TR>";

}

else {

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>PEG</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

//EPS - Earnings Per Share

/*

if (preg_match("/(<small>(ttm)</small><br>[0-9]+\.[0-9]+)/",

```

```

        $contents, $quote))

{

    //$quote[1] = substr($quote[1], 11);

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Earnings</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote</TR>";

}

else if (preg_match("/(<small>(ttm)</small><br>\-[0-9]+\.[0-9]+)/",

        $contents, $quote))

{

    //$quote[1] = substr($quote[1], 11);

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Earnings</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote</TR>";

}

else {

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Earnings</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TR>";

}

}

/*

//Market Capitalization

if (preg_match("/(Mkt Cap<br>[0-9]+\.[0-9]+)/", $contents, $quote))

{

```

```

$quote[1] = substr($quote[1], 11);

echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Market Cap</TD>";

echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$$quote[1] ";

if (preg_match("/(Mkt Cap<br>[0-9]+\.[0-9]+B)/", $contents, $quote))

    echo "Billion</TD></TR>";

if (preg_match("/(Mkt Cap<br>[0-9]+\.[0-9]+M)/", $contents, $quote))

    echo "Million</TD></TR>";

}

else {

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Market Cap</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

//Volume - Shares Traded (Daily)

if (preg_match("/(Volume<br>[0-9]+\,[0-9]+\,[0-9]+)/", $contents, $quote)

|| preg_match("/(Volume<br>[0-9]+\,[0-9]+)/", $contents, $quote)

|| preg_match("/(Volume<br>[0-9]+)/", $contents, $quote))

{

    $quote[1] = substr($quote[1], 10);

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD></TR>";

}

```

```

else {

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

//Volume - Shares Traded (Daily)

if (preg_match("/(Avg Vol<br>[0-9]+\,[0-9]+\,[0-9]+)/", $contents, $quote)
|| preg_match("/(Avg Vol<br>[0-9]+\,[0-9]+)/", $contents, $quote))
{

    $quote[1] = substr($quote[1], 11);

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Average Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD></TR>";

}

else {

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Average Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

echo "</TABLE><BR>";

}

}

//if $symbols is not an index

```

```

//display technical data for final interface

function data($symbols, $c, $r)

{

//obtain a page containing data regarding $symbols

$url = "http://finance.yahoo.com/q?s=$symbols&d=t";

if (!($fp = fopen($url, "r")))

{

    echo "Unable to open page.";

    exit;

}


//if opening is successful, read 100000 bytes from opened page

$content = fread($fp, 100000);


//close page

fclose($fp);


if ($symbols != "^DJI" && $symbols != "^IXIC" && $symbols != "^GSPC"

    && $symbols != "^dji" && $symbols != "^ixic" && $symbols != "^gspc")

{

    echo "<TABLE CELLSPACING=0 CELLPADDING=0>";

```

```

//Market

//NYSE - New York Stock Exchange

//NasdaqNM - Nasdaq National Market

//AMEX - American Stock Exchange

echo "<TR><TD WIDTH=80><FONT FACE=arial SIZE=2>Exchange</TD>";

if (preg_match("/(NYSE:$symbols)/", $contents, $quote))

echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>NYSE</TD>";

if (preg_match("/(NasdaqNM:$symbols)/", $contents, $quote))

echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>NASDAQ</TD>";

if (preg_match("/(AMEX:$symbols)/", $contents, $quote))

echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>American</TD>";

//Market Capitalization

if (preg_match("/(Mkt Cap<br>[0-9]+\.[0-9]+)/", $contents, $quote))

{

$quote[1] = substr($quote[1], 11);

echo "<TD WIDTH=120><FONT FACE=arial SIZE=2>Market Cap</TD>";

echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$$quote[1] ";

if (preg_match("/(Mkt Cap<br>[0-9]+\.[0-9]+B)/", $contents, $quote))

echo "Billion</TD></TR>";

if (preg_match("/(Mkt Cap<br>[0-9]+\.[0-9]+M)/", $contents, $quote))

echo "Million</TD></TR>";

```

```

}

else {

    echo "<TD WIDTH=120><FONT FACE=arial SIZE=2>Market Cap</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

//P/E Ratio - Price to Earnings

if (preg_match("/(P\\E<br>[0-9]+\\. [0-9]+)/", $contents, $quote))

{

    $quote[1] = substr($quote[1], 7);

    echo "<TR><TD WIDTH=80><FONT FACE=arial SIZE=2>P/E</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD>";

}

else {

    echo "<TR><TD WIDTH=80><FONT FACE=arial SIZE=2>P/E</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD>";

}

//PEG - P/E / Growth

if (preg_match("/(PEG<br>[0-9]+\\. [0-9]+)/", $contents, $quote))

{

    $quote[1] = substr($quote[1], 7);

    echo "<TD WIDTH=120><FONT FACE=arial SIZE=2>PEG</TD>";

```

```

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD></TR>";
}

else {

    echo "<TD WIDTH=120><FONT FACE=arial SIZE=2>PEG</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

//EPS - Earnings Per Share

/*

if (preg_match("/(<small>(ttm)</small><br>[0-9]+\.[0-9]+)/",
    $contents, $quote))
{
    //$quote[1] = substr($quote[1], 11);

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Earnings</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote</TR>";

}

else if (preg_match("/(<small>(ttm)</small><br>\-[0-9]+\.[0-9]+)/",
    $contents, $quote))
{
    //$quote[1] = substr($quote[1], 11);

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Earnings</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote</TR>";
}

```



```

}

else {

    echo "<TR><TD WIDTH=120><FONT FACE=arial SIZE=2>Earnings</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TR>";

}

/**

//Volume - Shares Traded (Daily)

if (preg_match("/(Volume<br>[0-9]+\,[0-9]+\,[0-9]+)/", $contents, $quote)

    || preg_match("/(Volume<br>[0-9]+\,[0-9]+)/", $contents, $quote)

    || preg_match("/(Volume<br>[0-9]+)/", $contents, $quote))

{

    $quote[1] = substr($quote[1], 10);

    echo "<TR><TD WIDTH=80><FONT FACE=arial SIZE=2>Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD>";

}

else {

    echo "<TR><TD WIDTH=80><FONT FACE=arial SIZE=2>Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD>";

}

//Volume - Shares Traded (Daily)

```

```

if (preg_match("/(Avg Vol<br>[0-9]+\,[0-9]+\,[0-9]+)/", $contents, $quote)
|| preg_match("/(Avg Vol<br>[0-9]+\,[0-9]+)/", $contents, $quote))
{
    $quote[1] = substr($quote[1], 11);

    echo "<TD WIDTH=120><FONT FACE=arial SIZE=2>Average Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>$quote[1]</TD></TR>";
}

else {

    echo "<TD WIDTH=120><FONT FACE=arial SIZE=2>Average Volume</TD>";

    echo "<TD WIDTH=100><FONT FACE=arial SIZE=2>N/A</TD></TR>";

}

if ($c < $r - 1)

    echo "<TR><TD><BR></TD></TR>";

echo "</TABLE>";

}

}

?>

```

7.5 reject.php

<HTML>

```

<META HTTP-EQUIV="Refresh" CONTENT="15">

<HEAD><TITLE>Techlab 2002-2003</TITLE></HEAD>

<STYLE>  A {text-decoration: none;} A:hover {color: gold;}

<!--potential formatting for Internet Explorer (MS)

BODY {SCROLLBAR-FACE-COLOR: "";

        SCROLLBAR-HIGHLIGHT-COLOR: "";

        SCROLLBAR-SHADOW-COLOR: "";

        SCROLLBAR-3DLIGHT-COLOR: "";

        SCROLLBAR-ARROW-COLOR: "";

        SCROLLBAR-TRACK-COLOR: "";

        SCROLLBAR-DARKSHADOW-COLOR: "";

        }--><!--AF color 19638c; regular, 000040-->

</STYLE>

<BODY BGCOLOR="#19638c" TEXT="#FFFFFF" LINK="gold" ALINK="gold" VLINK="gold">

<FONT FACE="arial" SIZE="-1">

<CENTER>

<?

print("ERROR: Invalid password.");

?>

<P>

<A HREF="interface.php">Return to Interface</A>

```

```
</FONT>

</CENTER>

</BODY>

</HTML>
```

7.6 result.php

This file was developed in the early stages of this project as a prelude to portfolio.php. The following code is used to display the results obtained from entering a ticker symbol on a preceding page (the home page used during this project).

```
<HTML>

<HEAD><TITLE>Techlab 2002-2003</TITLE></HEAD>

<STYLE>  A {text-decoration: none;} A:hover {color: gold;}

BODY {SCROLLBAR-FACE-COLOR: "red";

      SCROLLBAR-HIGHLIGHT-COLOR: "gold";

      SCROLLBAR-SHADOW-COLOR: "gold";

      SCROLLBAR-3DLIGHT-COLOR: "red";

      SCROLLBAR-ARROW-COLOR: "gold";

      SCROLLBAR-TRACK-COLOR: "red";

      SCROLLBAR-DARKSHADOW-COLOR: "red";

      }

</STYLE>
```

```

<BODY BGCOLOR="#000040" TEXT="#FFFFFF" LINK="red" ALINK="red" VLINK="red">

<FONT FACE="arial" SIZE="-1">

<CENTER>

<A HREF="index.php">Home</A>

|

<A HREF="assign.html">Assignments</A>

|

<A HREF="journal.html">Journal</A>

|

<A HREF="progress.html">Progress</A>

|

<A HREF="proposal.html">Proposal</A>

|

<A HREF="techlab.html">Techlab</A>

<P>

<H3>An Online User Interface for<BR>Tracking Stock Portfolios</H3>

<P>

</CENTER>

<B>American Markets</B><BR>

<?php

```

```

//Day Date Month Year [Time (24-hour system)]

print(date("l d F Y"));

print(" ");

print(date("H"));

print(date("i"));

print("<P>");


//include fn.php for use below

$dir='.';

include($dir.'/fn.php');


// echo "<B>Major Indices</B><BR>";


//call retrieving function in fn.php for the major indices

//^DJI, ^IXIC, and ^GSPC are Yahoo! Finance designations for the indices

//retrieve obtains current value, change in points, and change in percent

//retrieve also continues printing in table started below

echo "<TABLE CELLPADDING=0 CELLSPACING=0><TR><TD WIDTH=144><FONT SIZE=2 FACE=arial>";

echo "Dow Jones Industrial</FONT></TD>";

$markets = '^DJI';

$quotes = retrieve($markets);

```

```

echo "<TR><TD WIDTH=144><FONT SIZE=2 FACE=arial>NASDAQ Composite</FONT></TD>";

$markets = '^IXIC';

$quotes = retrieve($markets);


echo "<TR><TD WIDTH=144><FONT SIZE=2 FACE=arial>Standard & Poor's 500</FONT></TD>";

$markets = '^GSPC';

$quotes = retrieve($markets);

echo "</TABLE>";


/*

echo "<P><FONT COLOR=gold>##151;##151;##151;##151;##151;##151;##151;##151;";

echo "##151;##151;##151;##151;##151;##151;##151;##151;";

echo "##151;##151;##151;##151;##151;##151;##151;##151;";

echo "##151;##151;##151;##151;##151;##151;##151;##151;</FONT><P>";

*/


/*

//LISTINGS

echo "<TABLE><TR><TD WIDTH=243><FONT SIZE=2 FACE=arial>";

echo "<B>Selected Quotes</B></FONT>";

```

```

$markets = 'CSCO';

echo "<TR><TD WIDTH=243><FONT SIZE=2 FACE=arial>Cisco Systems";

echo " [$markets, NASDAQ]</FONT></TD>";

$quotes = retrieve($markets);


$markets = 'KO';

echo "<TR><TD WIDTH=243><FONT SIZE=2 FACE=arial>Coca-Cola Company";

echo " [$markets, NYSE]</TD>";

$quotes = retrieve($markets);


$markets = 'MSFT';

echo "<TR><TD WIDTH=243><FONT SIZE=2 FACE=arial>Microsoft Corporation";

echo " [$markets, NASDAQ]</TD>";

$quotes = retrieve($markets);

echo "</TABLE>";

*/


echo "<P><FONT COLOR=gold>&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

```



```

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;</FONT><P>";

echo "<TABLE CELLSPACING=0 CELLPADDING=0><TR><TD WIDTH=120><FONT SIZE=2 FACE=arial>$quo
retrieve ($quote);

echo "</TABLE>";

techdata ($quote);

?>

<!--

<FORM NAME="form" METHOD="post" ACTION="result.php">

<INPUT TYPE="text" NAME="quote" SIZE="6" MAXLENGTH="6">

<INPUT TYPE="submit" NAME="retrieve" VALUE="GET QUOTE!">

-->

<?php

echo "<P><FONT COLOR=gold>&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;&#151;";

echo "&#151;&#151;&#151;&#151;&#151;&#151;&#151;</FONT><P>";

?>

<P>Joseph Hess<BR>

<A HREF="mailto:jhess@lan.tjhsst.edu">jhess@lan.tjhsst.edu</A>

<P>

```

```
<FONT SIZE="-2">
```

```
LAST MODIFIED DECEMBER 2002<BR>
```

```
STOCK DATA RETRIEVED FROM <A HREF="http://finance.yahoo.com" TARGET="_new">
```

```
YAHOO! FINANCE</A><BR>
```

```
</BODY>
```

```
</HTML>
```

7.7 Other Files

Other files were written throughout the year as the precursors of the interface were developed. These files have features in the intermediate area between `result.php`, created for viewing market data and information pertaining to a single stock, and `portfolio.php`, the extent of the final project reached in the Computer Systems Laboratory. Therefore, these files, which constitute approximately 200 additional lines of code, are not included in this document. Additional code was written in order to create the MySQL tables used in the interface.

8 Appendix II: Testing and Visuals



Figure 1. Mr. Latimer's portfolio.

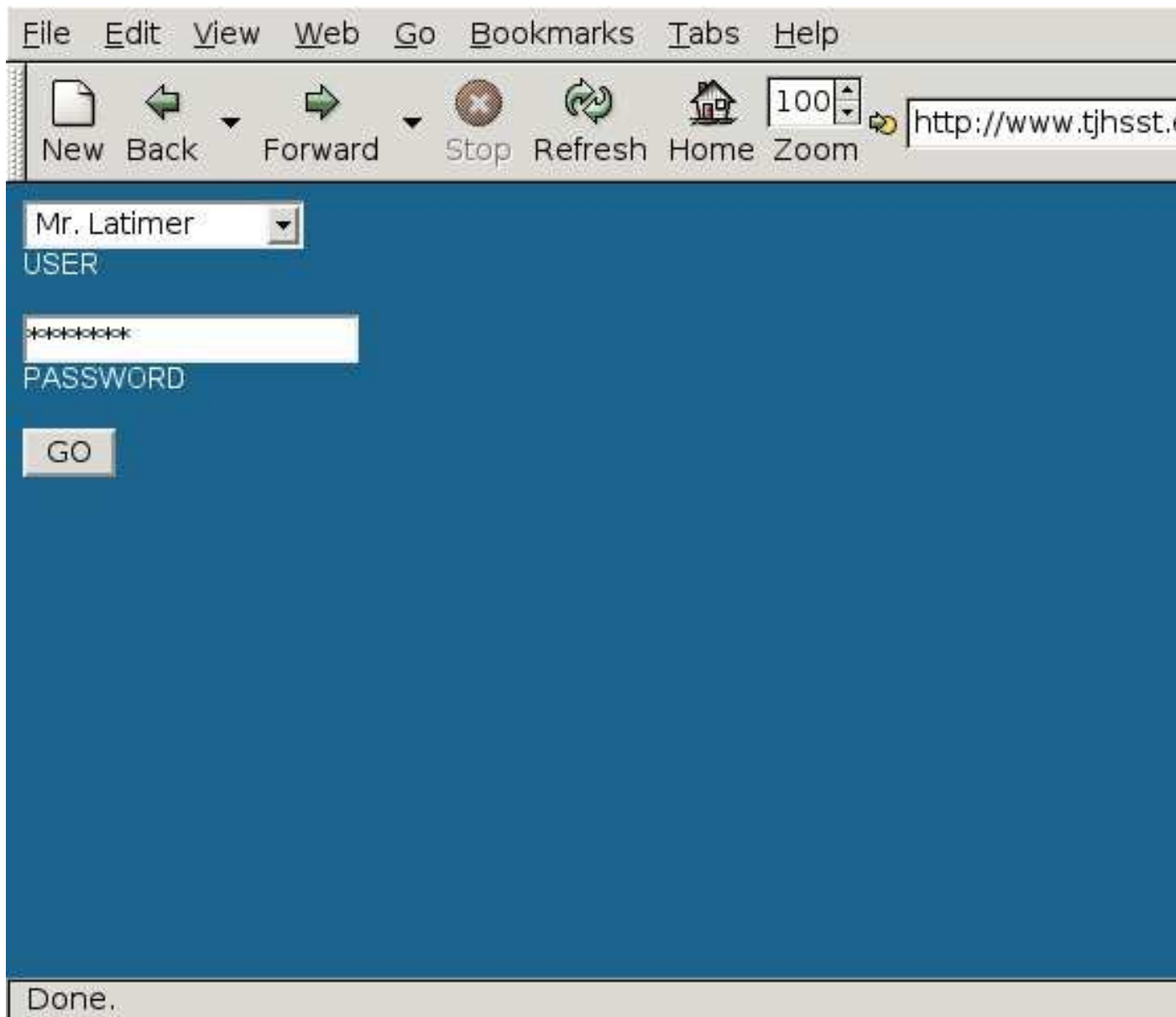


Figure 2. Mr. Latimer enters the interface.



Figure 3. Yosemite Sam's portfolio.

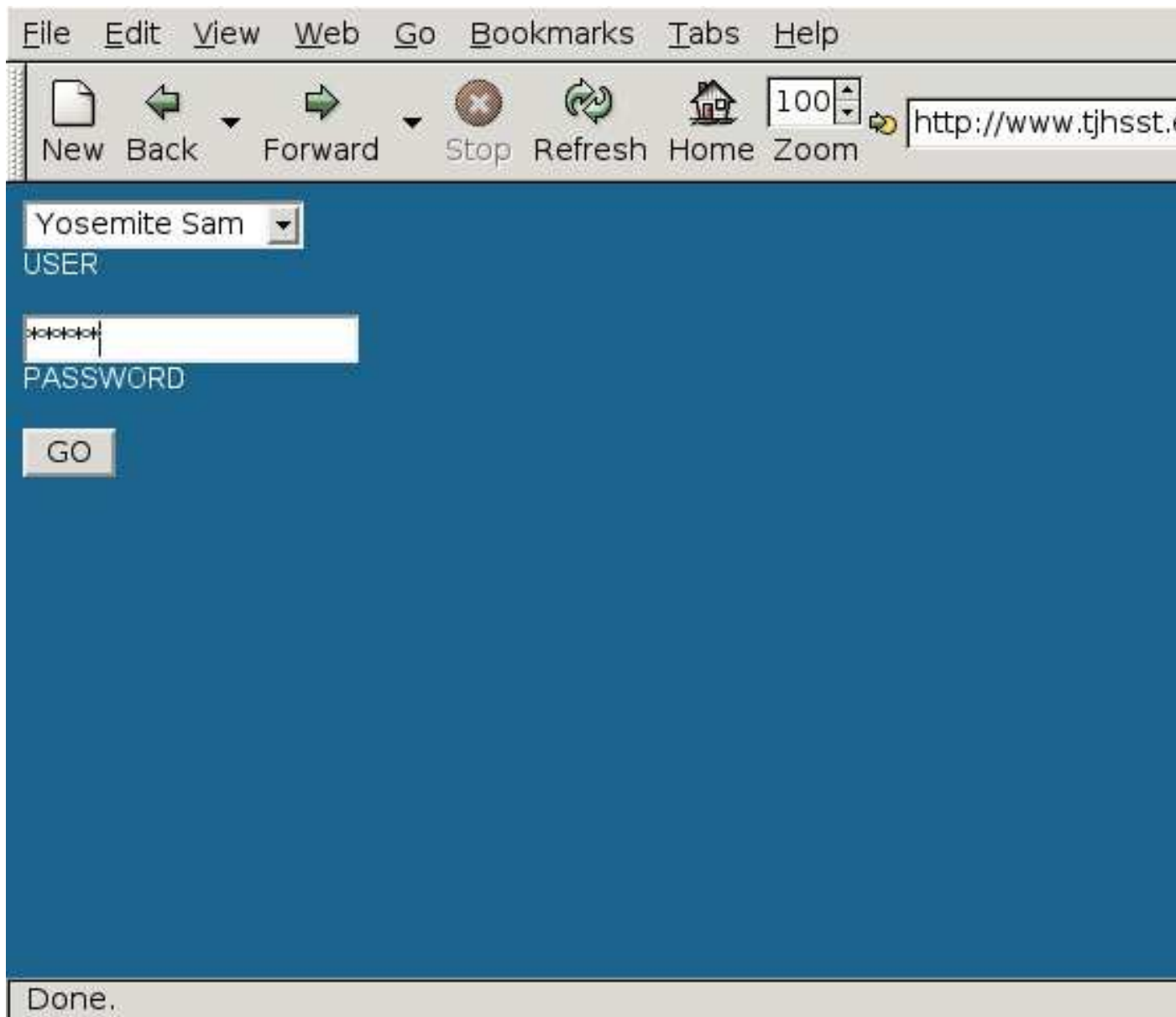


Figure 4. Yosemite Sam enters the interface.

9 References

The following resources were of aid in this endeavor:

- Financial Data: Yahoo! Finance (finance.yahoo.com)

- Financial Data: Dow Jones (www.dowjones.com)
- Financial Data: NASDAQ (www.nasdaq.com)
- Financial Data: Standard and Poor's 500 (www.standardpoor.com)
- Financial Advice: *24 Rules for Investment Success* by William O'Neil
- PHP: www.php.net
- PHP: www.PHPBuilder.com
- MySQL: www.mysql.com
- Databases: CS462 ("Database Systems") at the University of Virginia (www.cs.virginia.edu/son/cs462)
- Databases: CS4604 ("Introduction to Database Management Systems") at Virginia Polytechnic Institute (courses.cs.vt.edu/cs4604/notes.html)
- Databases: *A First Course in Database Systems* by Jeff Ullman and Jennifer Widom, available in part online (www-db.stanford.edu/ullman/fcdb.html)
- Design of User Interfaces: *User Interface Design for Programmers* by Joel Spolsky, available in part online (www.joelonsoftware.com/uibook/chapters/fog0000000057.html)
- Design of User Interfaces: Computer-Human Interaction (www.acm.org/sigchi/)

10 Acknowledgements

The author wishes to extend special thanks to Mr. Latimer and Nicholas Shelly for their numerous contributions to this project. Their patience and helpfulness were essential to the author's accomplishments in the Computer Systems Laboratory.