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The Stock Statistics Parser

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Abstract

This paper describes how use the *HTMLEditorKit* to perform web data mining on stock statistics for listed firms. Our focus is on making use of the web to get information about companies, using their stock symbols and YAHOO finance. We show how to map a stock ticker symbol into a company name gather statistics and derive new information. Our example shows how we extract the number of shares outstanding, total volume over a given time period and compute the *turnover* for the shares.

The methodology is based on using a parser-call-back facility to build up a data structure. Screen scraping is a popular means of data entry, but the unstructured nature of HTML pages makes this a challenge.

1 THE PROBLEM

Publicly traded companies have statistical data that is typically available on the web (using a browser to format the HTML data). Given an HTML data source, we would like to find a way to create an underlying data structure that is type-safe and well formulated.

We are motivated to study these problems for a variety of reasons. Firstly, for the purpose of conducting empirical studies, entering the data into the computer by hand is both error-prone and tedious. We seek a means to get this data, using free data feeds, so that we can perform data mining functions. Secondly, we find that easy to parse data enables us to teach our students the basic concepts of data mining. This example is used in a first course in network programming.

2 FINDING THE DATA

Finding the data on-line and free is a necessary first step toward this type of data mining. We obtain stock statistics by constructing a URL from the *ticker symbol*. The ticker symbol has a format that is exchange dependent. For example, NASDAQ (National Association of Securities Dealers Automated Quotations system) uses a four-character ticker symbol. In comparison, NYSE (New York Stock Exchange) uses a maximum of 3 characters in a ticker symbol. To obtain an HTML rendering of the key statistics for a company, try:

`http://finance.yahoo.com/q/ks?s=schw`

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This is shown in Figure 1-1.

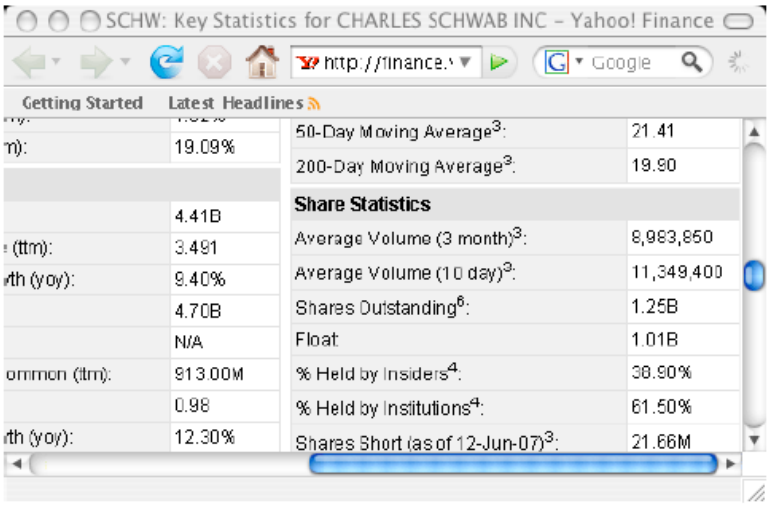


Figure 1-1. Yahoo Key Statistics

One of the first things to notice is the page title. Wouldn't it be nice if we could make use of the data, contained by the title and map the ticker symbol into a company name? The URL is decoded as:

```
s - ticker symbol
```

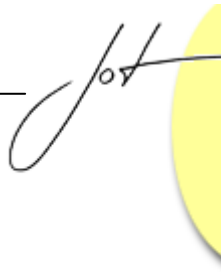
To synthesize the URL needed to get the data, we use:

```
public static URL getYahooSummaryUrl(String ticker) throws
MalformedURLException {
        return new URL("http://finance.yahoo.com/q/ks?s=" +
                ticker);
    }
```

3 ANALYSIS

In order to process HTML-based data we need to decide how we are going to store and parse the data. To parse the data, we make use of the *HTMLEditorKit* as a means to allow HTML tags to invoke callback methods:

```
/**
     * Parse the URL and store the data in the PCB
     * @param url a well-formed and correct url used to
obtain data
     * @param pcb a class responsible for parsing the data
     * @throws IOException
     * @throws BadLocationException
     */
    public static void url2Data(URL url, final
HTMLEditorKit.ParserCallback pcb)
            throws IOException, BadLocationException {
```



```
        InputStreamReader inputStreamReader = new
InputStreamReader(
                url.openConnection().getInputStream());
        EditorKit editorKit = new HTMLEditorKit();
        final HTMLDocument htmlDocument = new
HTMLDocument() {
            public HTMLEditorKit.ParserCallback
getReader(int pos) {
                return pcb;
            }
        };
        htmlDocument.putProperty("IgnoreCharsetDirective",
Boolean.TRUE);
        try {
            editorKit.read(inputStreamReader, htmlDocument,
0);
        }
        catch (ChangedCharSetException e) {
            //If the encoding is incorrect, get the correct
one
            inputStreamReader = new InputStreamReader(
                    url.openConnection().getInputStream(),
e.getCharSetSpec());
            try {
                editorKit.read(inputStreamReader,
htmlDocument, 0);
            }
            catch (ChangedCharSetException ccse) {
                System.out.println("Couldn't set correct
encoding: " + ccse);
            }
        }
    }
```

The *url2data* method is a means, given a *ParserCallBack* class, to process any correct URL. This is a general and compelling method for performing HTML driven data processing. Central to the proper function of the *url2data* method is the idea that the *ParserCallBack* is not only responsible for processing HTML tags, but it is responsible for building up a strongly-typed data structure that can be queried. This data structure is not serialized, due to its dynamic nature. Further, many *ParserCallBack* instances may exist in the system, one for every ticker symbol.

The *ParserCallBack* not only must handle HTML tags, but the data that follows them. For example, when we query *finance.yahoo.com* for the symbol *mgam* we see that the *title* tag appears to contain the name of the company. As the *title* tag occurs once, and only once, in the well-formed HTML document, we use our encounter with

the tag to indicate to our parser that the following text contains the title. We start with a ticker symbol and seek to store the statistics into a simple class:

```
public class YahooSummaryData  {
    private String companyName = null;
    private String tickerSymbol = null;
    private int sharesOutstanding = 0;
    private int stockFloat = 0;
```

Setters and getters are already in the *YahooSummaryData*.

A publicly traded firm has shares that are *outstanding*. To compute the number of shares outstanding, add all issued shares and subtract off any treasury stock. After the company computes the number of shares outstanding, it files a report with the SEC. Thus, the number of shares outstanding, obtained from YAHOO, is sourced from the latest annual or quarterly report to the SEC. Treasury stock is held in the treasury of the issuing company. It reduces the number of outstanding shares in the open market. When an issuing company engages in a stock repurchase, the treasury stock is not sold.

The stock *float* is the number of shares outstanding less the number of shares held by insiders, favored parties and employees. The shares in the float are restricted in terms of ownership and when and how they can be sold. Float is computed by subtracting the restricted shares from the number of shares outstanding. During a stock repurchase, if insiders promise not to tender their shares, we can use the float to compute the total number of shares that might be tendered. The float is reported with an SEC filing, just like the number of shares outstanding. When stock is issued to insiders, it increases the number of shares outstanding, but not the float. As the insiders proceed to sell their shares into the open market, the float increases.

The role of the *YahooSummaryParser* is to download the HTML data and fill the *YahooSummaryData*. We consider it important to separate the data store facility from the parsing mechanism, as the parsing could be implemented using any of several possible techniques. Further, by overriding the *toString* method, we can transform the data into a reasonable CSV representation of the underlying data. Thus, the goal is to make use of a simple API:

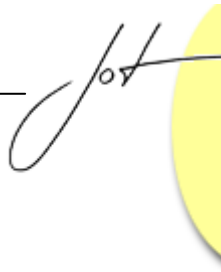
```
public static void main(String[] args) throws IOException,
BadLocationException {
        YahooSummaryData ysd = new
YahooSummaryParser("schw").getValue();
        System.out.println(ysd);
    }
```

In order to output:

```
schw,CHARLES SCHWAB INC,1250000000,1009999990
```

Recall that (from Figure 1-1), *schw* has 1.25B shares outstanding with 1.01B shares in the float.

In order to implement the parser, we need to know what the previous HTML tag is, and that is stored in our *startTag* and *endTag* variables:



```
public class YahooSummaryParser extends
HTMLEditorKit.ParserCallback {
    private HTML.Tag startTag = null;
    private HTML.Tag endTag = null;
    private final YahooSummaryData yahooSummaryData;

    public YahooSummaryParser(String tickerSymbol) throws
IOException, BadLocationException {
        yahooSummaryData = new
YahooSummaryData(tickerSymbol);
        DataMiningUtils dmu = new DataMiningUtils();
        dmu.url2Data(getYahooSummaryUrl(tickerSymbol),
this);
    }

    public YahooSummaryData getValue() {
        return yahooSummaryData;
    }

    public void handleEndTag(HTML.Tag endTag, int pos) {
        this.endTag = endTag;
    }

    public void handleStartTag(HTML.Tag startTag,
MutableAttributeSet a, int pos) {
        this.startTag = startTag;
    }

    public void handleText(char[] text, int position) {
        if (startTag.equals(HTML.Tag.TITLE))
processTitle(new String(text));
        else if (startTag.equals(HTML.Tag.TD))
processTd(new String(text));
    }
```

We are interested in HTML data of the form:

```
<title>SCHW: Key Statistics for CHARLES SCHWAB INC - Yahoo!
Finance</title>
```

Thus, we know when we are inside of the *title* tag, by virtue of our *startTag* variable, and we need only provide for a little ad-hoc string processing to identify the company name:

```
    private void processTitle(String titleText) {
            String preAmble = "Key Statistics for ";
            int startIndex = titleText.indexOf(preAmble);
            int endIndex = titleText.indexOf(" -");
            yahooSummaryData.setCompanyName(
                    titleText.substring(
                            preAmble.length() + startIndex,
                            endIndex));
        }
```

Since there is only one title tag in a document, this kind of parsing is relatively easy. The next section describes how to handle multiple instances of table data tags in a document.

4 CONTEXT-DRIVEN TABLE DATA

In the previous section, we showed that a tag that appears only once (i.e., the *title* tag) was pretty low-hanging fruit. However, there are some tags that appear multiple times, such as the table data tag *td*. These are unique, not for their attributes but for the *label text* that they contain. For example, table data that contains the labels "Shares Outstanding" or "Float:" have special significance. These labels appear in tables right before the data associated with them, thus we write:

```
    private void processTd(String text) {
            if (lastText.contains("Shares Outstanding"))

    yahooSummaryData.setSharesOutstanding(getYahooInt(text));
            else if (lastText.contains("Float:"))

    yahooSummaryData.setStockFloat(getYahooInt(text));
            lastText = text;
        }
```

This technique enables us to identify data encoded into a table of the form “unique label string” followed by “a consistent data string”. This allows us to make use of the technique for a whole class of table data on the web. As far as the consistent data string assumption goes, numbers take the form “nn.nnB” and “nn.nnM” (standing for billion and million).

```
    private int getYahooInt(String s) {
            double n = 0;
            String billion = "B";
            String million = "M";
            if (s.contains(billion))
                n = Math.pow(10,9) *
    Float.parseFloat(s.substring(0, s.indexOf(billion)));
            else if (s.contains(million))
```

```
            n = Math.pow(10,6) *
Float.parseFloat(s.substring(0, s.indexOf(million)));
        else throw new
NumberFormatException("getYahooInt:YahooSummaryParser ER:"
+ s);
        return (int)n;
    }
```

Our parser makes use of ad-hoc string manipulation, for handling numbers that are in the YAHOO table data. Perhaps there is a more general way to do this type of parsing, but such a technique has, so far, been elusive. The existing technique is sensitive to changes in table data label strings and numeric representation strings.

5 IMPLEMENTING A *STOCK VOLUME CHART*

We are interested in a new "killer application" for development, called the *JAddressBook* program. This program is able to chart historic stock volumes (and manage an address book, dial the phone, print labels, do data-mining, etc.). The program can be run (as a web start application) from:

http://show.docjava.com/book/cgij/code/jnlp/addbk.JAddressBook.Main.jnlp

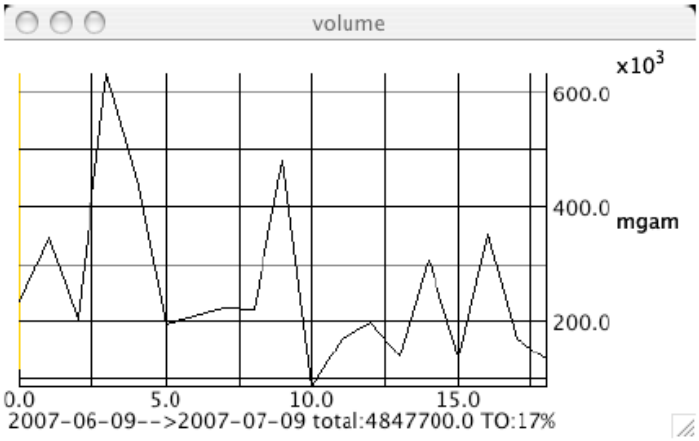


Figure 5-1. The Volume Chart

Figure 5-1 shows an image of the volume chart for MGAM. The mining of CSV data is not new, however, our use of it for graphing stock volume and computing turnover (TO) in Java may be [Lyon 04D]. Turnover is expressed as a percentage of the total number of shares that have changed hands divided by the total number of shares outstanding. MGAM intends to repurchase 8% of its outstanding shares on 7/10/07, yet 17% of the stock changed hands between 6/9/2007 and 7/9/2007. The question of how this impacts the repurchase activity is a topic of current research.

The stock volume chart is created using a graphing framework that makes use of the façade design pattern to simplify the interface:

```
public static void graphVolume() throws ParseException,
IOException, BadLocationException {
        System.out.println("Historical Volume Grapher
Version 1.0");
        String symbol = TickerUtils.getTickerGui();
        GregorianCalendar start = DateUtils.getCalendar();
        GregorianCalendar end = DateUtils.getCalendar();
        EODQuotes eodQuotes = new
EODQuotes(YahooEODQuotes.getEodCSVData(
                symbol,
                start,
                end));
        double[] volumes = eodQuotes.getVolumes();
        double total = Mat1.add(volumes);

        YahooSummaryData ysd = new
YahooSummaryParser(symbol).getValue();
        int TO =
(int)Math.round(100*total/ysd.getSharesOutstanding());
        Graph.graph(volumes,
                DateUtils.getISO8601_String(start) +
                        "-->" +
DateUtils.getISO8601_String(end) +
                        " total:" + total+ " TO:"+TO+"%",
                symbol, "volume");
    }
```

Having a programmatic means of computing turnover may help a shareholder to decide how much relative activity there has been in a stock. For example, MGAM had 17% turnover in the 30-day period preceding their repurchase activity. This is actually a little low, as turnover for the months of March and April was 25% and 24%.

6 SLIDING WINDOW TURNOVER COMPUTATIONS

This section describes how to compute turnover between two different dates using a window. Typically, we are inclined to move the window by the length of the window. Thus, if we have a 2 day window and a 50 day sample, we should move the window 25 times (if there is no overlap) and by a 2 day increment. This type of sample is, however, not necessarily correct in that it may introduce sampling artifacts. Thus, we suggest the use of a sliding window.

In order to normalize the volume so that we can understand it relative to the total number of shares outstand, we use the *turnover* (TO):

$$TO\% = \left\lfloor 100 \frac{\sum v_i}{N_o} \right\rfloor$$

where (6-1)

v_i = volume on day i

N_o = number of shares outstanding

The TO is computed using a sliding window, over a given period of days. The volume used is the historical end-of-day volume.

In order to provide a sliding window of turnover data, we need to establish the window size (in days) the window overlap (in percent) and the number of windows to be computed. For example, with a 50% overlap in a window of 30 days, a 12 window analysis would cover 0-30 days, 15-45 days, etc. For example:

```
public static double[] getTurnover(String symbol,
                                   Date startDate, Date
endDate,
                                   int period) throws
            IOException, BadLocationException,
ParseException {
        YahooSummaryData ysd = new
YahooSummaryParser(symbol).getValue();
        EODQuotes eodQuotes = new
EODQuotes(YahooEODQuotes.getEodCSVData(
                    symbol,
                    DateUtils.getCalendar(startDate),
                    DateUtils.getCalendar(endDate)));
        double volumes[] = eodQuotes.getVolumes();

        double toRatio = 100.0 /
ysd.getSharesOutstanding();
        Mat1.mult(volumes, toRatio);
        return Stats.getWindowedSums(volumes,period);
    }
```

Where:

```
public static void mult(double[] sma, double v) {
        for (int i=0; i < sma.length; i++){
            sma[i] = sma[i]*v;
        }
    }
```

And:

```
public static double[] getWindowedSums(double source[], int
period) {
        double sums[] = new double[source.length - period];
```

```
            for (int i = 0; i < source.length - period; i++) {
                sums[i] = getWindowSum(source, period, i);
            }
            return sums;
        }
```

We graph the turnover using:

```
    public static void graphTurnover() throws
                ParseException, IOException,
    BadLocationException {
            System.out.println("Historical Turnover Version
    1.0");
            Date endDate = new Date();
            Date startDate = DateUtils.getDate();
            int period = In.getInt("enter period in days
    [1..100]", 1, 100);
            String symbol = TickerUtils.getTickerGui();
            double to[] = getTurnover(
                    symbol,
                    startDate,
                    endDate,
                    period);
            String xs =
                    symbol+" Period:" + period ;
            String ys = "TO%";
            GregorianCalendar gc1 =
    DateUtils.getCalendar(startDate);
            GregorianCalendar gc2 =
    DateUtils.getCalendar(endDate);
            Graph.graph(to,
                    xs, ys,
                    DateUtils.getISO8601_String(gc1) + "..." +
                            DateUtils.getISO8601_String(gc2));
        }
```

Figure 6-1 shows the turnover for MGAM, with a 2 day period for the 30 days preceding the termination of its Dutch auction repurchase activity,

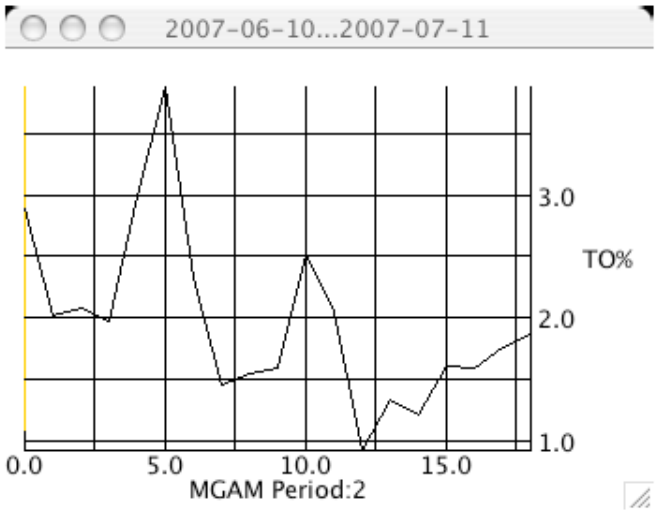


Figure 6-1. Turnover with a 2 day Window

7 CONCLUSION

In this paper we disclosed techniques that make use of the *HTMLEditorKit* and ad-hoc parsing to extract numeric, context-sensitive table data, from the web. This technique presents some reusable code, along with a plug-in style callback-parsing framework that is sensitive to changes in URL protocol and presentation data.

A new metric of trading volume, the *turnover*, was created using a GUI and a semi-automatic data mining technique that combined CSV-based historic stock volume and the summary stock statistics. The question of how turnover impacts repurchase operations remains open.

Also open is the question of how to extract data that is not tabular with table data prefixes. Relaxation of this assumption is a logical next step.

REFERENCES

[Lyon 04D] *Java for Programmers*, by Douglas A. Lyon, Prentice Hall, Englewood Cliffs, NJ, 2004.

About the author

Douglas A. Lyon (M'89-SM'00) received the Ph.D., M.S. and B.S. degrees in computer and systems engineering from Rensselaer Polytechnic Institute (1991, 1985 and 1983). Dr. Lyon has worked at AT&T Bell Laboratories at Murray Hill, NJ and the Jet Propulsion Laboratory at the California Institute of Technology, Pasadena, CA. He is currently the Chairman of the Computer Engineering Department at Fairfield University, in Fairfield CT, a senior member of the IEEE and President of DocJava, Inc., a consulting firm in Connecticut. Dr. Lyon has authored or co-authored three books (Java, Digital Signal Processing, Image Processing in Java

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