ACCELERATING THE SEARCH OF FRAUDULENT XBRL INSTANCE DOCUMENTS

Guang Yih Sheu

Department of Accounting and Information System,
Chang-Jung Christian University, Gueiren District, Tainan, Taiwan
xsheu@hotmail.com

Abstract: This study presents the preliminary development of a new mobile computing application. Android and iOS apps are created to find XBRL (eXtensible Business Reporting Language) instance documents conforming unacceptably to the Benford's law. Such XBRL instance documents are more possibly fraudulent. Required input data are the uniform resource locator of an XBRL instance document and significance level for concluding Chi-square, Kuiper, and Kolmogorov-Smirnov test statistics. Except for these three types of test statistics, XBRL instance documents conforming unacceptably to the Benford's law are found based on visual comparison of actual and theoretical digital probabilities and mean absolute deviation test statistics. The proposed smartphone apps are executed without needing any XBRL taxonomy or definition file. Two practical examples demonstrate that they can be employed to quicken the audit of numerous XBRL instance documents. In conclusion, we can use a smartphone as a tool of reducing the burden of accountants.

Keywords: smartphone; XBRL; Benford's law; mean absolute deviation test; Chi-square test; Kuiper test; Kolmogorov-Smirnov test; digital probability

INTRODUCTION

Nowadays a smartphone is Taiwan's citizens' favorite tool for surfing the Internet. A smartphone even is an essential tool for their daily works. For example, salespersons check the availability of merchandises by scanning QR codes with smartphones. Crew in a working team collaborate each other through smartphones. A hospital assigns tasks to its staff through smartphones.

Nevertheless, smartphone users are under the danger of browsing fraudulent documents. For example, a company may announce a fraudulent financial report to mislead that this company is worthy of investments. Investors may suffer from huge loss due to this fraudulent financial report.

In an attempt of helping to accelerate the search of fraudulent documents, this study presents a new mobile computing application. Smartphones apps have been coded for accelerating the search of fraudulent documents. Preliminarily, this study presents Android and iOS apps for finding XBRL instance documents, conforming unacceptably to the Benford's law [1]. Such XBRL instance documents are more possibly fraudulent [2].

The Benford's law provides theoretical digital probabilities in a document. We extract digital data from a document and calculate actual digital probabilities using these extracted digital data. If the resulting actual digital probabilities are unacceptably different from theoretical values, we say this document conforms unacceptably to the Benford's law or the conformity of it to the Benford's law is unacceptable [2].

The XBRL instance document is one of the popular formats of financial reports at Taiwan. Other formats are JSON (JavaScript Object Notation), HTML (HyperText Markup Language), and PDF (Portable Document Format). The XBRL was developed to facilitate the communication or exchange of business information between business systems. It is based on the XML (eXtensible Markup Language) technique. An XBRL instance document is expressed using the XML syntax and relating XML technologies such as XML Schema and Namespaces. Many XBRL documents are available on the Internet for describing financial facts of companies.

Evaluating the conformity of an XBRL instance document can be implemented using the next four steps [2]:

1. Download this XBRL instance document and extract digital data in this document.
2. Calculate actual digital probabilities based on the extracted digital data. The digital probability is equal to the total occurrences of a bin at such as leading and first-two digits divided by the total occurrences of all bins at the same digit.
3. Use the resulting digital probabilities to compute such as mean absolute deviation [3], Chi-square [4], Kuiper [5], and Kolmogorov-Smirnov [6,7] test statistics. The resulting test statistics are quantitative measures of differences between actual and theoretical digital probabilities. They are used to indicate the conformity of an XBRL instance document to the Benford's law is determined.
4. If possible, compare visually actual and theoretical digital probabilities. This visual comparison helps to determine the conformity of an XBRL instance document to the Benford's law.

Since most of the Taiwan's citizens' smartphones are either Android phones or iPhones, this study codes both Android and iOS apps. The Android app is written in the App Inventor 2; whereas, the iOS app is written in the Swift 4.0. These Android and iOS apps are coded to compute actual leading and first-two digital probabilities from an XBRL instance document. The input data are the uniform resource locator (URL) of XBRL instance document and significance level. This significance level is the probability of defeating the conclusions drawn from Chi-square, Kuiper, and Kolmogorov-Smirnov test statistics. Preliminarily this study limits the significance level to 0.1, 0.05, 0.01, and 0.001.

The remainder of this study is organized into five sections. In the next section, existing XBRL tools are reviewed. The objective of this review is searching any existing XBRL tool, which can be a useful reference to this study. In Sec. 3, the
Benford’s law is reviewed. Sec. 4 describes the proposed Android and iOS apps. These apps are tested to evaluate the conformity of some XBRL instance documents to the Benford’s law in Sec. 5. Sec. 6 presents the conclusion drawn from this test. Appendix A lists the Swift and App Inventor codes for extracting digital data from an XBRL instance document.

RELATED WORKS

Currently, a smartphone app, Company Financials [8] can be used to present information within an XBRL instance document. The name of this smartphone app is Company Financials. It is created to visualize XBRL fillings in the SEC’s EDGAR database. This Company Financials app also outputs various financial ratios such as the cash ratio and return on assets margin. But, a MobileTogether server should be installed to extract data from an XBRL instance document. In addition, the Company Financials app doesn’t possess the function of evaluating the conformity of an XBRL instance document to the Benford’s law.

Another web page https://www.xbrl.org/view/tools-and-services/ lists other existing XBRL tools. For example, the Abax site [9] is a platform for creating, validating, and viewing XBRL instance documents, XBRL collaboration tools, processors, and software libraries are also available on this web site http://abax.xbrl.mx. The Litix site [10] is another platform, available on iPads and through a web interface that allows an instant analysis of financial reports submitted by companies to the US Securities and Exchange Commission. It processes XBRL instance documents and enables analysts and investors to view, compare, and analyze data with a user-friendly graphical interface.

However, on https://abax.xbrl.mx and https://litix.brag.eu, it has not been found any XBRL tool, which can be used to evaluate the conformity of an XBRL instance document to the Benford’s law. Therefore, general audit software such as Excel, ACL [11], and IDEA [12] are studied.

The Excel was originally a spreadsheet software. It can be used to evaluate the conformity of an XBRL instance document to the Benford’s law, if the add-in [2] is installed. We can easily expect that an XBRL instance document should be imported into the Excel before running the add-in [2]. But, correctly importing an XBRL instance document into the Excel requires the corresponding XBRL taxonomy. This XBRL taxonomy describes the structure of an XBRL instance document. However, importing different XBRL instance documents may require different XBRL taxonomies. A web blog [13] therefore concludes that an XBRL taxonomy impacts what we can do with an XBRL instance document.

On the other hand, the ACL [11] or IDEA [12] can be used to evaluate the conformity of an XBRL instance document to the Benford’s law. This conformity evaluation is implemented in an XBRL instance document. Instead, a definition file is generated when an XBRL instance document is imported into the ACL or IDEA. The resulting definition file is applicable to XBRL instance documents of the same structure. Accordingly, the impact of XBRL taxonomies on what we can do with XBRL instance documents is still unresolved [13].

The review of existing XBRL tools leads to a motive of removing the impact of XBRL taxonomies on the development of proposed smartphone apps. In such away, the audit of considerable XBRL instance documents is truly quickened by first evaluating the conformity of these XBRL instance documents to the Benford’s law.

**Benford’s Law**

Suppose the conformity of an XBRL instance document to the Benford’s law is to be evaluated. Thus, digital data are extracted from this XBRL instance document and total occurrences of bins at such as leading and first-two digits are counted. The resulting occurrences of bins are divided by total number of extracted digital data to compute leading and first-two digital probabilities.

If \( d_{1}, d_{2}, ..., d_{9} \) denote the resulting leading digital probabilities and \( d_{10}, d_{11}, ..., d_{99} \) denote the resulting first-two digital probabilities, these \( d_{1}, d_{2}, ..., d_{9} \) and \( d_{10}, d_{11}, ..., d_{99} \) are usually not equal to theoretical leading and first-two digital probabilities. This study computes the mean absolute deviation, Chi-square, Kuiper, Kolmogorov-Smirnov test statistic to measure quantitatively the difference between theoretical and empirical leading and first-two digital probabilities. Suppose \( \xi_{1}, \xi_{2}, ..., \xi_{9} \) and \( \xi_{10}, \xi_{11}, ..., \xi_{99} \) represent theoretical leading and first-two digital probabilities. These \( \xi_{1}, \xi_{2}, ..., \xi_{9}, \xi_{10}, \xi_{11}, ..., \xi_{99} \) are equal to

\[
\xi_{i} = \log \left( 1 + \frac{i}{9} \right) \quad (1)
\]

where \( i = 1, 2, ..., 99 \).

**Mean deviation test**

The mean absolute deviation test statistic is equal to [3]

\[
\text{Mean deviation test statistic} = \frac{\sum_{n=1}^{N} |d_{i} - \xi_{i}|}{N(n+1)} \quad (2)
\]

where \( n = 1 \) and \( N = 9 \) for leading digital probabilities, \( n = 10 \) and \( N = 99 \) for first-two digital probabilities, and \(|.|\) is the absolute function.

Table 1 lists the critical values for concluding mean absolute deviation test statistics [2].

<table>
<thead>
<tr>
<th>Digits</th>
<th>Range</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading</td>
<td>0 to 0.006</td>
<td>Close conformity</td>
</tr>
<tr>
<td></td>
<td>0.006 to 0.012</td>
<td>Acceptable conformity</td>
</tr>
<tr>
<td></td>
<td>0.012 to 0.015</td>
<td>Marginally acceptable conformity</td>
</tr>
<tr>
<td></td>
<td>&gt; 0.015</td>
<td>Unacceptable conformity</td>
</tr>
<tr>
<td>First-two</td>
<td>0 to 0.012</td>
<td>Close conformity</td>
</tr>
<tr>
<td></td>
<td>0.012 to 0.018</td>
<td>Acceptable conformity</td>
</tr>
<tr>
<td></td>
<td>0.018 to 0.022</td>
<td>Marginally acceptable conformity</td>
</tr>
<tr>
<td></td>
<td>&gt; 0.022</td>
<td>Unacceptable conformity</td>
</tr>
</tbody>
</table>

**Chi-square test**

The Chi-square test statistic is [4]

\[
\text{Chi-square test statistic} = \sum_{i=1}^{N} \frac{(M_{i} - M_{\xi})^{2}}{M_{\xi}} \quad (3)
\]

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Critical values for concluding Kuiper test statistics are computed from the inverse of right-tailed probability of the Chi-square distribution. We can easily obtain these critical values using the CHIINV built-in function of the Excel. The required input data are the significance level and N-1. If \( p \) is the significance level and leading digital probabilities are used, the CHIINV function outputs 13.362 (p = 0.1), 15.507 (p = 0.05), 20.09 (p = 0.01), and 26.124 (p = 0.001). If one obtains a Chi-square test statistic above these outputs, an unacceptably conformity of \( d_1, d_2, \ldots, d_9 \) to the \( \xi_1, \xi_2, \ldots, \xi_9 \) is concluded. This conclusion can be defeated with the probability of \( (p) \).

Similarly, if the first-two digital probabilities are calculated, the CHIINV function outputs 106.649 (p = 0.1), 112.022 (p = 0.05), 122.942 (p = 0.01), and 135.978 (p = 0.001).

### Kuiper Test

The Kuiper test statistic is calculated based on cumulative probabilities [5]; hence, digital probabilities \( d_1, d_2, \ldots, d_9 \) and \( d_{10}, d_{11}, \ldots, d_{99} \) are summed to obtain cumulative digital probabilities. For \( d_1, d_2, \ldots, d_9 \), the corresponding cumulative digital probabilities are calculated by

\[
D_1 = d_1, \quad D_2 = d_1 + d_2, \quad \cdots, \quad D_9 = \sum_{i=1}^{9} d_i
\]

\[
\Xi_1 = \xi_1, \quad \Xi_2 = \xi_1 + \xi_2, \quad \cdots, \quad \Xi_9 = \sum_{i=1}^{9} \xi_i
\]

where \( M \) is the total number of collected bins for computing digital probabilities. The higher calculated Chi-square test statistics, the more digital probabilities \( d_1, d_2, \ldots, d_9 \) deviate from \( \xi_1, \xi_2, \ldots, \xi_9 \).

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\Xi_1 = \xi_1, \quad \Xi_2 = \xi_1 + \xi_2, \quad \cdots, \quad \Xi_9 = \sum_{i=1}^{9} \xi_i
\]

\[
\Xi_{10} = \sum_{i=10}^{19} d_i, \quad \Xi_{11} = \sum_{i=11}^{20} d_i, \quad \cdots, \quad \Xi_{99} = \sum_{i=90}^{99} \xi_i
\]

in which \( D \) and \( \Xi \) are the actual and theoretical cumulative digital probabilities, respectively. Similarly, for the first-two digital probabilities, the corresponding cumulative digital probabilities are calculated by

\[
D_{10} = d_{10}, \quad D_{11} = d_{10} + d_{11}, \quad \cdots, \quad D_{99} = \sum_{i=10}^{99} d_i
\]

\[
\Xi_{10} = \xi_{10}, \quad \Xi_{11} = \xi_{10} + \xi_{11}, \quad \cdots, \quad \Xi_{99} = \sum_{i=10}^{99} \xi_i
\]

Based on Eqs. (4) and (5), the Kuiper test statistic is defined by [5]

\[
\text{Kuiper test statistic} = \max(D_i-\Xi_i) + \max(\Xi_i-D_i) \tag{6}
\]

where \( i = 1, 2, \ldots, 9 \) (for \( d_1, d_2, \ldots, d_9 \)) or \( i = 10, 11, \ldots, 99 \) (for \( d_{10}, d_{11}, \ldots, d_{99} \)) and max is the maximum function.

Critical value for concluding Kuiper test statistics are computed from the total number of bins for computing digital probabilities. If over 100 bins have been employed to calculate digital probabilities, a reference paper suggested [4]:

\[
\text{Critical values for Kuiper test statistics} = \frac{K_u}{\sqrt{N}} \tag{7}
\]

where \( K_u \) is equal to 1.62 (p = 0.1), 1.747 (p = 0.05), 2.001 (p = 0.01), and 2.303 (p = 0.001).

### Kolmogorov-Smirnov Test

Like the Kuiper test statistic, the Kolmogorov-Smirnov test statistic is also calculated from \( D_1, D_2, \ldots, D_{99} \) and \( \Xi_1, \Xi_2, \ldots, \Xi_{99} \). The Kolmogorov-Smirnov test statistic is [6,7]

\[
\text{Kolmogorov – Smirnov test statistic} = \max|D_i-\Xi_i| \tag{8}
\]

\[
\text{Critical value for Kolmogorov – Smirnov test statistic} = \frac{K_S}{\sqrt{M}} \tag{9}
\]

where \( K_S \) is equal to 1.22 (p = 0.1), 1.36 (p = 0.05), 1.63 (p = 0.01), and 1.95 (p = 0.001).

### User Interface

Figs. 1(a)-1(b) present user interfaces of proposed Android and iOS apps in which \( P \) denotes the digital probability, \( L \) is the significance level, \( \text{MAD} \) is the mean deviation test statistic, \( \text{Chi-square} \) is the Chi-square test statistic, \( \text{Kuiper} \) is the Kuiper test statistic, and \( K_S \) is the Kolmogorov-Smirnov test statistic. These two figures are created on emulators of the Android phone and iPhone 8. They are created with an XBRL example [4]

\[
\text{http://xbrl.squarespace.com/storage/examples/HelloWorld.xml}
\]

The essential significance level is set to 0.1.

This significance level and the URL (Uniform Resource Locator) of an XBRL instance document are the input data. The significance level is required in computing Eqs. (3), (7), and (9).
After inputting required data, it is scheduled to press two buttons of proposed smartphone apps to calculate actual leading and first-two digital probabilities; thus, the conformity of input XBRL instance document to the Benford's law is evaluated. The titles of these two buttons are "Leading" and "First-two"; respectively. The resulting actual digital probabilities are further used to compute mean deviation, Chi-square, Kuiper, and Kolmogorov-Smirnov test statistics. After concluding with the selected significance level, these resulting test statistics and conclusions are also presented by proposed smartphone apps.

The graph presenting the resulting actual digital probabilities, mean deviation, Chi-square, Kuiper, and Kolmogorov-Smirnov test statistics can be next outputted to an email account by pressing the third button. The title of this button is "Output". A pop-up dialog will appear for accepting the e-mail address.

Different colors are employed to present mean deviation, Chi-square, Kuiper, and Kolmogorov-Smirnov test statistics. These colors represent the different conclusions obtained based on Table 1, Eqs. (3), (7), and (9). The meanings of these colors are explained below:

1. Any test statistic presenting in the red color denote the unacceptable conformity of input XBRL instance document to the Benford's law.
2. Chi-square, Kuiper, and Kolmogorov-Smirnov test statistics presented in the green color represent the acceptable conformity of input XBRL instance document to the Benford's law.
3. Mean deviation test statistics presented in the green color represent the close conformity of input XBRL instance document to the Benford's law.
4. Mean deviation test statistics presented in the cyan color denote the acceptable conformity of input XBRL instance document to the Benford's law.
5. Mean deviation test statistics shown in the yellow color denote the marginally acceptable conformity of input XBRL instance document to the Benford's law.
6. We can also determine approximately whether the input XBRL instance document conforms unacceptably or acceptably to the Benford's law by comparing visually the resulting actual and theoretical digital probabilities presented by proposed smartphone apps.

Adding the significant level as one of the input data is for the educational purpose. The significant level may be set to a specific value for further simplifying the use of proposed Android and iOS apps. Due to the limited screen size of Android emulator, the significant level is selected through a combo box control in executing the proposed Android app; whereas, the significant level is selected through a segment control in the proposed iOS app.

**Capability**

The proposed smartphone apps are programmed to evaluate the conformity of XBRL instance document to the Benford’s law. The only limitation is that the input XBRL instance document can be browsed using a browser. A user...
can even input a short URL of an XBRL instance document.

Since digital data in an XBRL instance document have been extracted to compute actual digital probabilities, it is not difficult to add new codes to implement other statistical methods for providing newconformity evaluation results of an XBRL instance document to the Benford’s law.

In addition to the necessary event handling, the flowchart of proposed smartphone apps is presented in Fig. 2. In more details, the Web component (for the AppInventor 2) and NSURLRequest (for the Swift4.0) built-in object are used to send a Get request to the input XBRL instance document. Digital data are extracted from the response contents. Experiences of teaching accountant students programming languages indicate that such a step of extracting digital data from the response contents is the most critical. If digital data can be accurately extracted, it is not difficult to calculate actual leading and first-two digital probabilities.

![Flowchart of proposed Android and iOS apps](image)

In addition, it is desired to implement the visualization of actual and theoretical digital probabilities and presenting mean absolute deviation, Chi-square, Kuiper, Kolmogorov-Smirnov test statistics.

Calculating the Benford’s law-based theoretical digital probabilities

Visual comparison of actual and theoretical digital probabilities and presenting mean absolute deviation, Chi-square, Kuiper, Kolmogorov-Smirnov test statistics

Output the conformity evaluation results to an e-mail account

The structure of an XBRL instance document begins with a root element. In addition to this root element, the structure of an XBRL instance document includes the following sections:

1. Business Facts: This section can be further divided into items and tuples. An item holds a single value; whereas, a tuple is used to express multiple values.
2. Contexts: In this section, the entities used within the document are defined.
3. Units: In this section, it is defined the units used in the document and plotting histograms and line graphs should be。
4. Footnotes: This section is used to associate one or more facts with some contents.
5. References: The references to an XBRL taxonomy are described in this section.

Obviously, digital data for computing digital probabilities are in the Business Facts section of an XBRL instance document. In the aforementioned class of teaching accountant students programming languages, an experimental Android app was coded to extract digital data from an XBRL document. This experimental Android app was created using the App Inventor 2. It was tested to retrieve digital data from an XBRL instance document.

![HTTP GET Request](image)

Two methods were experimented: The first method is employing the Web built-in object to send a Get request to an XBRL instance document. A parsing method of this Web objective is next called to parse the response contents. Three List objects are generated in order to filter out element values. These element values are stored in components of List objects. Nevertheless, the Android emulator crashes due to these three List components. Consequently, this method fails to retrieve digital data from an XBRL instance document.

Alternatively, a Get request is sent using the Web object to an XBRL instance document. However, the response contents are split at characters “>” and “<”. Digital data are then filtered out from split results. No List components were needed in implementing this method; thus, the Android emulator didn’t crash correspondingly. Digital data are successfully extracted from an XBRL instance document.

Visual comparison of actual and theoretical digital probabilities

Published studies (e.g. [2]), which were devoted to studying the Benford’s law, usually combined histograms and line graphs to compare visually theoretical and actual digital probabilities. Histograms are used to present theoretical digital probabilities whereas, line graphs are used to present actual digital probabilities. Either the App Inventor 2 or Swift 4.0 provides sufficient built-in objects to plot histograms and line graphs.

Nevertheless, it may be worthy noted that if the Swift4.0 is employed, extracting digital data from an XBRL instance document and plotting histograms and line graphs should be implemented within different threads. Otherwise, an exception is obtained. Programming the App Inventor 2 codes doesn’t encounter similar problems.

SAMPLE PROGRAM RUNS

Time histories of consolidated financial statements of a

As a preliminary test, consolidated financial statements of the Taiwan Sampo Company (https://www.sampo.com.tw)
are selectively introduced to test the proposed smartphone apps. These consolidated financial statement was created to present financial information over 2015. XBRL instance documents of these consolidated financial statement are obtained from http://mops.twse.com.tw.

The Taiwan Sampo Company is one of the listed companies at the Taiwan stock exchange market. It produces mainly home appliances. During the first, second, third, and fourth quarters of 2015, the stock prices of Taiwan Sampo company range from NT$11.65 to 13.10, NT$13.15 to NT$14.10, NT$12.00 to NT$13.35, and NT$11.60 to NT$12.85; respectively.

The iOS version of proposed smartphone apps is applied to evaluate the conformity of four succeeding XBRL instance documents to the Benford’s law. Figs. 3(a)-3(d) and 4(a)-4(d) show the resulting actual and theoretical digital probabilities, mean deviation, Chi-square, Kuiper, and Kolmogorov-Smirnov test statistics. Total 794 bins have been obtained to create Figs. 3(a) and 4(a). Total 730 bins are extracted to plot Figs. 3(b) and 4(b); whereas, 915 bins are extracted to plot Figs. 3(c) and 4(c). As to Figs. 3(d) and 4(d), 774 bins are extracted to create these two figures. The significant level is still chosen as 0.01.
Fig. 4(a) is first inspected. The resulting Chi-square test statistic in this figure indicates the unacceptable conformity of input XBRL instance document to the Benford’s law. Visual comparing actual and theoretical first-two digital probabilities finds that the most apparent differences between actual and theoretical digital probabilities are approximately at digits “20”, “50”, and “80”. We may focus on digital data starting with such first-two digits as a beginning of auditing the studied XBRL instance documents of this example. Moreover, Figs. 3(a)-(d) and 4(a)-(d) are compared. It is found the XBRL instance document of the second quarter of 2015 conforms the most unacceptably to the Benford’s law. Since a highest stock price was obtained at the second quarter of this year, it may be interesting to inspect further the conformity of XBRL instance documents with respect to the stock price or other financial ratios. We may adopt the stock price or other financial ratios to warn the coming of fraudulent XBRL instance documents.

Furthermore, observing Figs. 3(a)-3(d) and 4(a)-4(d) finds that the “My law” concept may be applicable to the audit of four XBRL instance documents of this example. Figs. 3(a)-3(d) present that actual leading digital probabilities at the digit 5 are always above the theoretical values. Except for the first quarter, the resulting mean deviation test statistics range limitedly (0.014 to 0.017).

Similarly, Figures 4(a)-4(d) indicates that resulting actual first-two digital probabilities at the digits 20 and 50 are also above the theoretical values. Except for the first quarter, the resulting mean deviation test statistics range limitedly (0.003 to 0.004). But, it is suggested we need to check more XBRL instance documents of the Taiwan Sampo company.

Moreover, the scatter of actual leading and first-two digital probabilities is inspected. Means and standard deviations of them are computed and shown in Figs. 5(a)-5(b). Lines and error bars in these two figures describe the mean and standard deviations; respectively.

The objective of plotting Figs. 5(a) and 5(b) is inspecting the opportunity of applying the “My law” concept. Observing these two figures finds that employing first-two digital probabilities to conform the “My law” concept is suggested. In comparison with actual first-two digital probabilities, actual leading digital probabilities scatter more widely.

Seasonal consolidated financial statements of four companies

In the previous example, the most unacceptable conformity is obtained in inspecting the XBRL instance document showing financial facts of the second quarter of 2015. It is then interested in inspecting XBRL instance documents of other companies recorded at the same quarter. Do we have more opportunities of obtaining the unacceptable conformity of XBRL instance documents to the Benford’s law at the second quarter of 2015? Is this a seasonal phenomenon?

Therefore, the conformity of XBRL instance documents of four other companies created at the second quarter of 2015 are selectively studied. The tool is selectively the proposed Android app. These four companies are all listed companies at the Taiwan stock exchange market.

The first company is the Formosa Plastic Corporation (http://www.fpc.com.tw). This company produces plastic products. The stock price of it ranges from NTS 670.7 to NTS 80.3 during the second quarter of 2015.

The second company is the China Steel Corporation (http://www.csc.com.tw). This company provides steel products. The stock prices are between NTS 24.0 to NTS 26.2 over the second quarter of 2015.

The third company is the Taiwan Semiconductor Manufacturing Company (http://www.tsmc.com). It is a wafer foundry company. The stock price of this company ranges from NTS 138.50 to NTS 152.50 over the second quarter of 2015.

The final company is the ASUSTek Computer Inc. (http://www.asus.com). This company produces personal computers and relating products. The stock price of it is
between NT$ 284.50 and NT$ 343.0 over the second quarter of 2015.

The conformity of four studied XBRL instance documents to the Benford's law is evaluated and shown in Figs.6(a)-6(d) and 7(a)-7(d). In creating these eight figures, the significance level is set to 0.01. Figs.6(a)-6(d) are plotted based on leading digital probabilities. Figs.7(a)-7(d) are drawn based on first-two digital probabilities. The total amount of bins retrieved to plot Figs. 6(a) and 7(a) is 1006. The total amount of bins retrieved to plot Figs.6(b) and 7(b) is 2493. Figures 6(c) and 7(c) are created with 983 bins. Figures 7(d) and 8(d) are drawn with 1451 bins.

Observing Figs.6(a)-6(d) and 7(a)-7(d) finds that XBRL instance documents of China Steel Corporation and Taiwan Semiconductor Manufacturing Company conform unacceptably to the Benford's law. For example, in Figs.6(b) and 7(b), the resulting Chi-square, Kuiper, and Kolmogorov test statistics are presented with the red color. As to XBRL instance documents of the Formosa Plastic Corporation and ASUSTek Computer Inc., only the resulting Chi-square test statistics indicate that XBRL instance documents of these two companies conform unacceptably to the Benford's law. But, this unacceptable conformity may attribute to that the Chi-square test statistic is sensitive to small differences between actual and theoretical digital probabilities [2].

Conclusively, it is not seasonal to obtain the unacceptable conformity of XBRL instance documents created at the second quarter of 2015 to the Benford's law. However, based on Secs. 5.1 and 5.2, this study suggests that evaluating the conformity of financial reports of a company created at the second quarter of any year may be a starting point of auditing financial reports of this company.

![Figure 6](image.png)

Figure 6. Conformity evaluation of seasonal consolidated financial statements of four companies to the Benford's law (second quarter of 2015, leading digital probabilities)
CONCLUSION AND CONCLUDING REMARKS

This study creates Android and iOS apps for evaluating the conformity of XBRL instance documents to the Benford’s law. If an unacceptable conformity of an XBRL instance document is obtained, this XBRL instance document is more possibly fraudulent. Thus, the proposed smartphone apps can be used to accelerate the search of fraudulent XBRL instance documents.

Testing the proposed Android and iOS apps presents the help of them on the audit of considerable XBRL instance documents. Providing this help using conventional XBRL tools is inefficient. It is first found the "My law" concept may be useful in auditing considerable XBRL instance documents. But, we need a lot of XBRL instance documents to ensure that actual digital probabilities vary in similar patterns. Employing the proposed Android and iOS apps can shorten the time spent to compute variation of actual digital probabilities.

It is also found that the conformity of XBRL instance document to the Benford’s law goes more unacceptably when the stock price flocculates apparently. Thus, it may be possible to use the stock price or other financial ratios to warn the appearance of fraudulent XBRL instance documents. However, implementing such a warn needs to evaluate conformity of considerable XBRL instance documents to the Benford’s law. The proposed smartphone apps can reduce the time spent to complete such conformity evaluation.

In conclusion, this study demonstrates that a new mobile computing application. This new mobile computing application reduces the burden of an auditor. We can create similar mobile computing applications to help accountant workers.

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REFERENCES

On the other hand, Swift codes for the same purpose are listed below:

```swift
let request = NSMutableURLRequest(url: file! as URL)
    request.httpMethod = "GET"
let task = URLSession.shared.dataTask(with: request)
    data, response, error in
    if error != nil {
        DispatchQueue.main.async {
            let alert = UIAlertController(title: "Error",
                                           message: error as! String?,
                                           preferredStyle: .actionSheet)
            alert.addAction(UIAlertAction(title: "OK",
                                          style: .default,
                                          handler: nil))
            self.present(alert, animated: true, completion: nil)
        }
    }

    let responseString = NSString(data: data!,
                                   encoding: String.Encoding.utf8.rawValue)
    for lines in responseString!
    {
        if lines.contains(">") && !lines.contains("identifier")
        {
            let piece = lines.components(separatedBy: ">")
            for datatosearch in piece
            {
                let digitdata = Int(datatosearch)
                if (digitdata != nil &&
                    datatosearch.substring(to: datatosearch.index(datatosearch.startIndex, offsetBy: 1)) != "0")
                {
                    total += 1
                    if (digitdata! > 0)
                    {
                        let first = String(digitdata!
                                             startIndex, offsetBy: 1))
                        let firsttwo = datatosearch.
                                        substring(to: datatosearch.
                                                  index(digitdata!, offsetBy: 1))
                        let pdffirst = Double(digitdata!)
                        pdf[first!-1] += 1.0
                    }
                }
            }
        }
    }
```

Figure A1 presents codes of the proposed Android app for extracting digital data from an XBRL instance document.
let firsttwoi = Int(firsttwo)
pdf[firsttwoi!-1] += 1.0
}
else {
    let stringtodigit=datatosearch.
    substring(from:
    datatosearch.index(datatosearch.
    startIndex, offsetBy: 1))
    if(stringtodigit.startIndex !=
    stringtodigit.endIndex) {
        let first=String(
        stringtodigit[stringtodigit.startIndex])
        let firsttwo=stringtodigit.
    let firsti = Int(first)
    pdf[firsti!-1] += 1.0
    let firsttwoi= Int(firsttwo)
    pdf[firsttwoi!-1] += 1.0
    }
}

**SHORT BIODATA OF ALL THE AUTHOR**

Guang Yih Sheu is one of the staff of Department of Accounting and Information System, Chang-Jung Christian University, Tainan, Taiwan. One of his current courses is teaching accountant students programming languages. This study presents a teaching example on this course.