Paper 34-28

A Pinch of SAS®, a Fraction of HTML, and a Touch of JavaScript Serve Up a Grand Recipe

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ABSTRACT

Proper ingredients, precise measurements, and personal attention all contribute significantly to the creation of a perfect meal – the same can be said about implementing an effective software application. By knowing some fundamental SAS, HTML, and JavaScript elements and applying the right touch of each medium, one can easily develop practical and insightful programs for managing business systems. More specifically, by making use of these three languages, one can design valuable web-based solutions that exploit a number of technologies the Internet has to offer.

This paper will explain how basic components of SAS, HTML, and JavaScript can be fused together for implementing rather useful applications that function via the Internet. A background discussion on the SAS/IntrNet software will shed light on the advantages of integrating Internet technologies for realizing business solutions. Subsequently, a case study will focus on how these concepts were recently drawn together in a particular application deployed by the Data Processing Team of the Continuous Measurement Office at the United States Census Bureau. Finally, some information will be provided to offer insight on other programming tools that could be used together with SAS to create more extensive and comprehensive web-based applications, such as JavaServer Pages (JSP) and Servlets.

INTRODUCTION

There are a number of people who have only a basic understanding of SAS: those who have just begun learning the language and those who merely apply common PROC and DATA step functions to their everyday programming assignments. For those individuals, the thought of crafting useful software applications may not seem plausible. However, with the innovative, yet straightforward tools now available through SAS, the prospect of implementing purposeful applications becomes more promising. In particular, SAS/IntrNet software allows programmers with even the most basic SAS abilities to serve up colorful reports, queries, and graphs straight to their clients' web browser without bearing much complexity.

It is important to recognize how each programming language contributes to the formation of these Internet applications. Fittingly, SAS would be used as the underlying tool for manipulating data and generating the desired output for clients to observe. HTML and JavaScript would be utilized for creating the web forms used for passing parameters to the SAS programs, as well as for rendering the output to appear more rich and comprehensible to the user. Collectively, just a basic understanding of these three languages could open doors for all programmers hoping to provide their clients with a more practical system for viewing data.

This paper serves as an informative roadmap with the purpose of directing the reader to the range of tools available for deriving Internet applications from SAS programs. This paper is intended for users with a basic understanding of SAS techniques and a general knowledge of HTML. JavaScript is not required for designing web-based applications; rather, knowledge of this programming language can aid in the enhancement and enrichment of the webpages already created. Nevertheless, those individuals with advanced SAS abilities could benefit from this paper if they have not yet dealt directly with web development and the evolving link between SAS and the Internet.

BACKGROUND

- ***HTML***

Webpages are written in a basic scripting language: HTML, or HyperText Markup Language. Essentially, HTML is a means of specifying layout information within documents. It is important to mention that HTML is not a programming language; rather, the markup grammar dictates the contents of an HTML file with no connection to instruction processing. In effect, a web browser renders an HTML document by seeking out distinctive HTML syntax used for altering the layout of the file, inserting images, and establishing links to other pages.

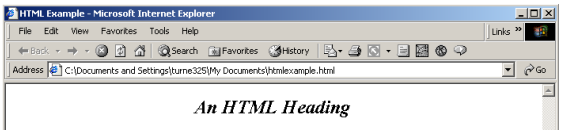
There are 3 fundamental components to HTML: elements, tags, and attributes. The HTML directives, together with the text to which they apply, are called *elements*. A *tag* conveys the structure of the element to which it refers to rather than its appearance. Tags are denoted by enclosing < and > characters, and typically nest the elements. Start tags, those placed at the beginning of an element, may have *attributes* to define various characteristics of the contained elements, such as

text alignment, format, or size. The following HTML code demonstrates all three of these components together:

```
<H2 ALIGN="center"><I>An HTML Heading</I></H2>
```

The whole entity is an H2, or Heading, element, uses the start *<H2>* and *<I>* and closing *</H2>* and *</I>* tags, and utilizes the *ALIGN="center"* attribute. When rendered through a web browser, this statement would result in a large, italicized heading centered possibly at the top of a webpage, or perhaps above a subsection of text.

↓

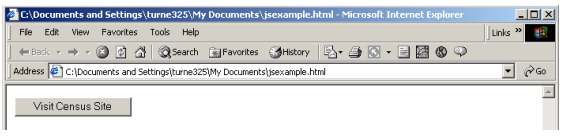


- ***JavaScript***

JavaScript, a client-side scripting language executed by the user's Internet browser, can conveniently be imbedded into HTML documents. Those designing webpages can benefit greatly from JavaScript because it can be exploited like a genuine object-based programming language. Given that JavaScript can be programmed to execute during or react to specific events, it is possible to dynamically change the content of an HTML element. Thus, JavaScript can be used to create responses to mouse clicks and keypress events, as well as being applicable for other practical functions, such as validating user entries before submitting a form to the web server. This can therefore help to reduce the overhead of server-side processing. The following scriptlet, inserted into HTML code, redirects the web browser to the U.S. Census Bureau's homepage when the user clicks on the "Visit Census Site" button:

```
<HTML>
  <HEAD>
    <SCRIPT LANGUAGE="JavaScript">
      function goToURL() {
        window.location = "http://www.census.gov";
      }
    </SCRIPT>
  </HEAD>

  <BODY>
    <FORM>
      <INPUT TYPE=button VALUE="Visit Census Site"
      onClick="goToURL()">
    </FORM>
  </BODY>
</HTML>
```

↓



- ***SAS – ODS***

The Output Delivery System, known as ODS, is a means for transforming SAS output into a variety of formats available to users, such as PDF, RTF, and HTML. By using the ODS HTML statement, one can create and store static HTML documents by denoting the destination path in the statement declaration:

ODS HTML *HTML-file-specification(s) <option(s)>*;

The HTML document generated is comprised of all the necessary HTML tags and attributes for it to be properly displayed within an Internet browser. These documents can be edited and later stored on a production web server so that users may view and evaluate these pages over the Internet.

What's more significant is the ability to generate dynamic HTML content, which is where SAS/IntrNet software comes into play. Under the dynamic approach, a user request is sent from a web browser to a web server, which handles this request by invoking a SAS session. After processing the request, the program's results are routed directly back to the web browser as HTML content, namely, a webpage. By creating webpages with this approach, Internet users retain control over what parameters are to be applied to the SAS program. Additionally, since these requests are all broadcasted via the web browser, users can send out requests merely by filling out uncomplicated web forms; thus, avoiding the need to write custom SAS code for programming each individual request.

- ***SAS/IntrNet***

SAS/IntrNet is a valuable software tool used for processing dynamic SAS applications via the Internet. In particular, SAS/IntrNet enables communication between a web browser running on a local computer and a SAS session operating on a remote machine, namely, a web server.

The component most essential to the implementation of SAS/IntrNet is that of the *application dispatcher*. The application dispatcher, a program that runs on the same server where SAS and SAS/IntrNet are installed, governs the process of recognizing and responding to user requests relayed though an Internet browser. This process is quite straightforward and very effective in practice. To begin with, a user simply completes an HTML form using a web browser, such as Internet Explorer or Netscape Navigator. The entries recorded among the form's fields will soon thereafter be used as parameters to an existing SAS program. The content of the form's fields can depend on the complexity of the underlying SAS

program, or simply on how much control the programmer wants to grant the user. The information obtained though the user input is then delivered to the web server, which in turn launches the *application broker*. The broker subsequently uses this information to determine which server should manage the request. At this time, the application broker passes the data to the SAS/IntrNet *application server*, another important piece to the dispatcher. Next, the application server invokes a SAS program, which ultimately processes the original information. The results are finally sent through the application broker and output back to the user's browser as an HTML document – a webpage – for normal web viewing.

The application dispatcher is significant in that it provides the functionality of SAS to Internet users without accruing the overhead of installing SAS software on each client's computer. Accordingly, a user simply needs a web browser to interact with and process SAS data; thus, users are not required to possess any SAS programming skills to be able to fashion colorful and constructive reports. In short, establishing a controlled and easily accessible system for managing data can readily be accomplished with this approach.

IMPLEMENTATION

• *Problem*

The Data Processing Team of the Continuous Measurement Office at the U.S. Census Bureau is responsible for processing the American Community Survey, or ACS. Traditionally, this group produces a variety of reports for subject-matter specialists to use when reviewing the edited ACS data. By and large, these specialists have been accustomed to sorting through extensive reports and substantial documentation in order to analyze data pertinent to their variables of interest.

A particular working example involves the analysts having to examine records relating to hot-decking matrix counts by state. However, there are so many records to consider, many of which are redundant or irrelevant, that viewing only the records that exist above a certain threshold would suffice.

• *Solution*

Implementing individual SAS programs to narrow down the sought-after data is an obvious solution; however, many of the analysts do not have enough, if any, SAS programming skills to achieve this. Furthermore, some analysts have too many requests – varying thresholds evaluated among different states – that any strategy for continually writing or modifying SAS code doesn't seem viable. Therefore, for this instance and others alike, the employment of SAS/IntrNet software, along with common SAS and web development techniques, emerges as a logical and effective approach.

▸ *HTML*

HTML can easily be applied to create Internet accessible forms, allowing users to select from a range of fields and/or enter in their own preferred values. After the user submits the form, the values are passed as parameters to an existing SAS program via the application dispatcher. This program is then executed on a remote server, which ultimately returns the results of the SAS code to the user's web browser as an HTML document.

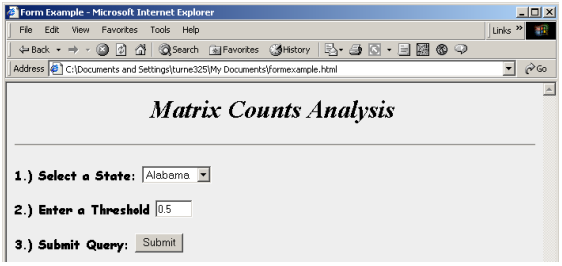
The <FORM> tag, along with some key attributes, is used for designing a form for maintaining the variables to be passed, as follows:

```
<HTML>
  <HEAD><TITLE>Form Example</TITLE></HEAD>
    <BODY>
      <H1 ALIGN="center"><I><FONT COLOR="#000000">
      Matrix Counts Analysis</FONT></I></H1><HR><BR>

      <FORM NAME=check METHOD=get ACTION="/../sas/
      scripts/broker.exe">

        <FONT FACE="Comic Sans MS" SIZE="3">
        <B>1.) Select a State: </B></FONT>
        <SELECT NAME=state>
          <OPTION VALUE="01">Alabama
          <OPTION VALUE="02">Alaska
          <insert more options here>
          <OPTION VALUE="56">Wyoming
        </SELECT><BR><BR>

        <FONT FACE="Comic Sans MS" SIZE="3">
        <B>2.) Enter a Threshold </B></FONT>
        <INPUT VALUE="0.5" SIZE="4" MAXLENGTH="4"
        NAME=thresh><BR><BR>

        <FONT FACE="Comic Sans MS" SIZE="3">
        <B>3.) Submit Query: </B></FONT>
        <INPUT TYPE=submit VALUE="Submit">
        <INPUT TYPE=hidden NAME=_program
        VALUE="prgs.matrixcounts.sas">
        <INPUT TYPE=hidden NAME=_service VALUE="dp">
        <INPUT TYPE=hidden NAME=_debug VALUE="2">
      </FORM>

    </BODY>
</HTML>
```

The *Method*= attribute used within the <FORM> tag defines the mode for passing the parameters, either *get* or *post*. The *Action*= attribute specifies the location of the application dispatcher program to be invoked somewhere on the web server. In general, the *Name*= attribute designates a unique variable name for a particular HTML element. A selection box and a textbox were utilized in this form, granting the user the ability to choose a particular state and enter a specific threshold. Other types of HTML data entry fields, such as textareas, multiple selection boxes, checkboxes, and radio buttons are also available. After making these selections, the user can submit the form using

the corresponding button. Following submission, the application dispatcher launches the methodical process discussed in the SAS/IntrNet section above. In this particular case, there are 5 parameters delivered through the application dispatcher: 2 user-defined parameters and 3 hidden parameters defined by the programmer. The two parameters specified by the user are the chosen state code, *state*, and the threshold value entered, *thresh*. These will subsequently be used as macro variables in the SAS program, and referred to as *&state* and *&thresh*. The other three parameters, hard-coded into the HTML form, are central to the dispatcher process. The *_program* parameter determines the SAS program to be executed – in this instance, *matrixcounts.sas*. This program is located in the directory associated with the fileref *prgs*, which was defined on the SAS server beforehand. The parameter *_service* indicates the specific service assigned with the application dispatcher; generally, the value *default* can be used, but in this case, *dp* is employed since it has been prepared specifically by the system administrators. The final parameter, *_debug,* denotes the debugging mode exercised during the testing phase. For the most part, the SAS log is output to the web browser for error-checking and evaluation.

↓



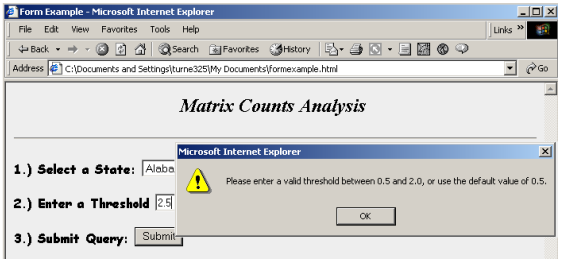
▸ JavaScript

With the aid of JavaScript, webpages can be programmed to respond to various user events. In this particular case, JavaScript can be used to validate the user threshold entry prior to submitting the form to the web server. This can help reduce the overhead of server-side processing. To grasp this, consider the case where the user enters too small a threshold: in this situation, too many observations would be encountered in the data set, leading to a great deal of processing inside the SAS session. Consequently, the system may timeout due to a large execution time, or the browser may crash due to an overabundance of output. Also, bear in mind the case where the user enters an invalid numeric value. In this occurrence, the SAS program wouldn't compile, yielding abnormal output, or possibly nothing at all. Hence, invoking a simple scriptlet to verify the threshold entry before the form submission would not only prevent unwarranted server-side processing, but would also circumvent the transmission of inadequate data.

```
<HTML>
  <HEAD><TITLE>Form Example</TITLE>
    <SCRIPT LANGUAGE="JavaScript1.2">
      function checkNum() {
        var x=document.check.thresh.value
        var anum=/^-?[0-9]*(\.[0-9]+)?$/
        if (x=="" || anum.test(x)==false || x<0.5 || x>2.0) {
          alert("Please enter a valid threshold between 0.5
          and 2.0, or use the default value of 0.5.")
          document.check.thresh.value = "0.5"
        }
      }
    </SCRIPT>
  </HEAD>
  <BODY>
    <H1 ALIGN="center"><FONT COLOR="#000000">
    Matrix Counts Analysis</FONT></H1><HR><BR>

    <FORM NAME=check METHOD=get ACTION="/../sas/
    scripts/broker.exe" onSubmit="return false">

      <FONT FACE="Comic Sans MS" SIZE="3">
      <B>1.) Select a State: </B></FONT>
      <SELECT NAME=state>
        <OPTION VALUE="01">Alabama
        <insert more options here>
      </SELECT><BR><BR>

      <FONT FACE="Comic Sans MS" SIZE="3">
      <B>2.) Enter a Threshold </B></FONT>
      <INPUT VALUE="0.5" SIZE="4" MAXLENGTH="4"
      NAME=thresh onBlur="checkNum()"><BR><BR>

      <FONT FACE="Comic Sans MS" SIZE="3"><B>
      3.) Submit Query: </B></FONT>
      <INPUT TYPE=submit VALUE="Submit"
      onClick="document.check.submit()">
      <INPUT TYPE=hidden NAME=_program
      VALUE="prgs.matrixcounts.sas">
      <INPUT TYPE=hidden NAME=_service VALUE="dp">
      <INPUT TYPE=hidden NAME=_debug VALUE="2">
    </FORM>

  </BODY>
</HTML>
```

The added JavaScript here forces the user to enter a valid threshold between 0.5 and 2.0. After the user enters a value in the threshold textbox, the *checkNum()* function is called either if the cursor moves outside the textbox, or the user clicks somewhere else on the page (*onBlur="checkNum()"*). There is a unique case which this checkNum() function is not able to handle, namely, the case where a number is entered into the threshold textbox and the user then presses the ENTER key to submit the form. The *onBlur* event handler does not recognize any changes to the page, so the checkNum() function is never invoked. The form is then submitted even though the threshold entry may be invalid or vacant. Thus, the two other JavaScript pieces *onClick="document.check.submit()"* and *onSubmit="return false"* can be added to prevent the user from submitting the form with the ENTER key. The form can now be submitted with the mouse only after it has been properly completed. In brief, with

the minor addition of these simple JavaScript elements, any prospect of passing an invalid or unusable parameter to the SAS program is avoided.



SAS – ODS

HTML and JavaScript are used for designing the front-end workings of these Internet applications; however, the most significant ingredient for creating these resourceful and practical web-based applications is the back-end program used for processing the data. SAS programs can use a parameter passed from an HTML form as a macro variable. For the current example, the user-selected state and keyed-in threshold value will be used as macro variables, as follows:

```
%global file ;
%let file=lib.state&state ;
libname lib '/2001/adp5/edit_web/mtxdata/' ;

data gpratbad getnoput ;
  set &file ;
  if getvalue = . then getvalue = 0 ;
  if putvalue = . then putvalue = 0 ;
  if putvalue > 0 then do ;
    gpratio = getvalue / putvalue ;
    format gpratio 4.2 ;
      if gpratio > &thresh and abs(getvalue - putvalue) > 5 then
      output gpratbad ;
  end ;
  else if getvalue > 5  then output getnoput ;
run ;

<additional code inserted here>
```

The parameters *state* and *thresh* are treated as macro variables in the fragment of code above. The data sets holding the pertinent calculations are stored as state<##>, where ## refers to the designated SAS state code. Therefore, the results of this execution will reflect only the state selected by the user. The threshold variable will help to narrow the margin of records generated by each execution of this SAS program.

By applying the functionality of the Output Delivery System, reports and tables generated by the SAS code can be displayed colorfully in the client's web browser. It is always important that the output is recognizable to the clients using these applications; thus, by knowing the users' needs ahead of time and understanding how they would like the tables to appear, the SAS code can be written accordingly.

```
<additional code inserted here>

ods html body = _webout style=statdoc ;

data _null_ ;
  file _webout ;
  abbrev = fipnamel(&state) ;
  put '<br><center><b><i><font color="#003399">'abbrev'
  -- 2001</font></i></b></center><br><hr size=3>' ;
run ;

proc print data=gpratbdx noobs label ;
  title "<center>Get/Put Ratios > &thresh</center>" ;
  label getvalue ='gets'
  putvalue = 'puts'
  gpratio = 'ratio' ;
run ;

%let fn=<center><form><input type="button" value="Back"
onClick="parent.location='javascript:history.back()'">
</form></center> ;

proc print data=getnoptx noobs label ;
  title "<center>Gets and No Puts</center>" ;
  label getvalue ='gets'
  putvalue = 'puts'
  gpratio = 'ratio';
  footnote &fn ;
run ;

ods html close ;
```

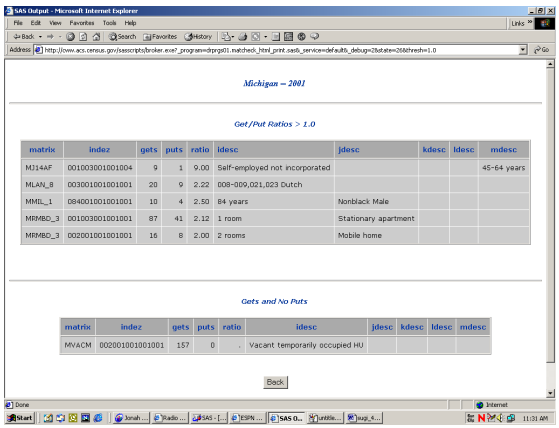
The above code produces the HTML reports that are to be displayed in the user's web browser. It is important to note that the output destination *webout* is used to target the results of this execution directly to the web browser making the original request. Contrary to this dynamic approach, an actual path location can be written in place of _webout. Then, after executing the program, the resulting HTML documents can be stored in the appropriate location on the web server. In this fashion, the programmer can hard-code hyperlinks pointing to these documents, so that any user can view their content directly by clicking on the particular link.

It is also apparent that HTML and JavaScript can be embedded directly into the SAS code giving the user more control over the ODS output. In the above example, a title and footer will be added to the resulting HTML document. The title will include the user's state selection and the footer will contain a button that links to the previous webpage.

The option *STYLE=* applies predefined SAS styles, such as Brick, Beige, or D3D, to the output HTML documents. These can be applied to enhance the appearance of a webpage; however, the use of a style will not affect the actual content of that page. The SAS procedure *PROC TEMPLATE* can be used to craft new styles, which may be more applicable to the programmer's taste, or the project's requirements. Another practical ODS HTML option is *STYLESHEET=*, which the programmer can use to create new or apply existing *Cascading Style Sheets*. Cascading Style Sheets, or CSS, define a unique layout for a web document by describing

how HTML elements should be displayed. Furthermore, CSS allow developers to control the style and layout of multiple webpages all at one time; so, making a global change to a number of documents can be achieved through a single modification. Other ODS HTML options give way to the construction of navigational menus and frames, namely, the *BODY=*, *CONTENTS=*, *PATH=*, *PAGE=*, and *FRAME=* options.

↓



ADDITIONAL TOOLS

- ***htmSQL***

htmSQL is a CGI program that allows users to carry out SQL procedures though the Internet. Essentially, programmers can insert SQL statements right into their HTML documents. Users can subsequently make updates and submit queries to certain SAS datasets directly from these webpages. Plus, given that SQL is handled dynamically in response to a user request, only the most current data is processed.

- ***SAS/GRAPH***

SAS/GRAPH is another valuable software package available through SAS. This collection of tools can be utilized to build an assortment of graphs, charts, and plots in a variety of styles and colors. When used in conjunction with SAS/IntrNet, SAS/GRAPH software can extend the liveliness of these Internet applications by fashioning elaborate, vibrant graphics and displaying them directly within the client's web browser.

- ***JavaServer Pages & Servlets***

JavaServer Pages is a newer technology that enables developers the ability to create insightful, dynamic webpages for managing business systems. JavaServer Pages are really an extension of Servlet technology. Servlets are platform-independent, server-side programs used for generating and returning HTML code to a client's web browser. Together, JavaServer Pages and Servlets provide a favorable alternative to other types of dynamic web programming. There are many benefits to exploiting these two technologies, some of which include: scalability, maintainability, platform independence, enhanced performance, and ease of use. Using webAF™ software, a professional development environment for Java applications, one can create client- or server-side applications that fully integrate the existing services that SAS has to offer.

CONCLUSION

By applying an appropriate measure of SAS and other programming components, it is possible to design a controlled system for managing data that is accessible via the Internet. To begin with, developers can craft webpages using HTML (and possibly JavaScript) that contain forms to encapsulate user input. After a user completes and submits a given form, the request is then routed to a web server, which in turn launches a SAS session. Ultimately, the request is processed and the results are directed back to the client's web browser as a colorful and comprehensive webpage. SAS/IntrNet essentially provides a channel for clients, perhaps those who lack programming skills, to interact with SAS data through their web browsers. There are other tools available which can be used to form more complex webpages that may include colorful graphs or navigational menus. It should be apparent that with the tools now available through SAS, coupled with the modern technologies of the Internet, providing clear and readable data to clients can, convincingly, be achieved.

RESOURCES

SAS® Institute, Inc. – Instructor-Based Training:

- SAS® Web Tools: Static and Dynamic Solutions Using Sas/IntrNet Software
- SAS® Web Tools: Advanced Dynamic Solutions Using SAS/IntrNet Software
- SAS® Web Tools: Developing JavaServer Pages and Servlets Using webAF™ Software

SAS® Institute, Inc. – Base SAS Community:

- *http://www.sas.com/rnd/base/*

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