

## SAS® Studio: We Program

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### ABSTRACT

Have you investigated SAS® Studio? From the 1980s into the 2010s I used SAS Display Manager (PC SAS front end) for all of my clinical table, listing, figure and database program development. I became accustomed to the program editor, log window, output window and being able to view my working and saved datasets via this programming IDE. I resisted new coding editors through the years UNTIL SAS® Studio came to fruition.

SAS Studio is a web-based application that accesses your SAS environment – cloud, local server(s), grid or PC. With the environment, you can access your data libraries, files and existing programs ... and write new programs! Additionally, SAS Studio contains pre-defined tasks that generate code for you. Have a specific set of clinical programming code you always use? Snippets! Want to define a personal or global task for AE table summarization? Define it within SAS Studio!

### INTRODUCTION

SAS Studio is the web browser development interface that allows you to access your data and run code from any machine, anywhere. It's designed with programmers in mind, and has many features that make programming more efficient that we will discuss in this paper. Highlights for clinical programmers are: (1) a dataset viewer that allows you to hide columns, perform elaborate filters, and save the code that executed the filter, (2) a coding editor with auto-formatting, logs that link directly to the errors, and a submission history to roll-back submitted code, (3) a code snippet system that comes with several existing code blocks and allows you to store and share your own, and (4) a task system that generates SAS code for you based on helpful wizards.

SAS Studio was first released in March 2014, and is included in installs of SAS version 9.4. It can run locally, with a URL that points to your local SAS install, or users can access a server (or the grid manager) by nearly any web browser from any operating system by using their server credentials. SAS Studio can also be integrated with a metadata server, allowing granular permissions for data access and for metadata defined library access.

### DATASET BROWSING

Let's start by looking at Studio's dataset browser (Figure 1). In the left-hand panel, you can browse libraries like you would in a file system. When you select a library, it expands to show you all of the datasets. When you expand the dataset, you see all of the variables.

Once you double click to open a dataset, a new tab will appear showing the Column information and the data table. In the column information panel, you can uncheck columns to remove them from the dataset view, and you can view the column metadata for a selected column (label, name, length, type, format, and informat). If you prefer, you can collapse the column information panel to give yourself more viewing area for the data.

When the dataset is open, the first 100 rows will be visible on the screen, and you will be able to page through the rest of the data in pages of 100 records. This is done to speed up the loading of data if you are accessing a server. The total number of rows and columns is always displayed. You can also easily apply filters to the data view, either by clicking the filter funnel and writing valid SAS expressions or by right-clicking a column name and adding it to the filter. You can filter multiple columns very easily. The number of filtered rows will be displayed, as well as information about the filter. Studio will keep this filter on the data until you clear it, even if you exit the Studio session. You can also view the SQL query that was used to create the filtered view, in case you want to save the code to apply to a program.

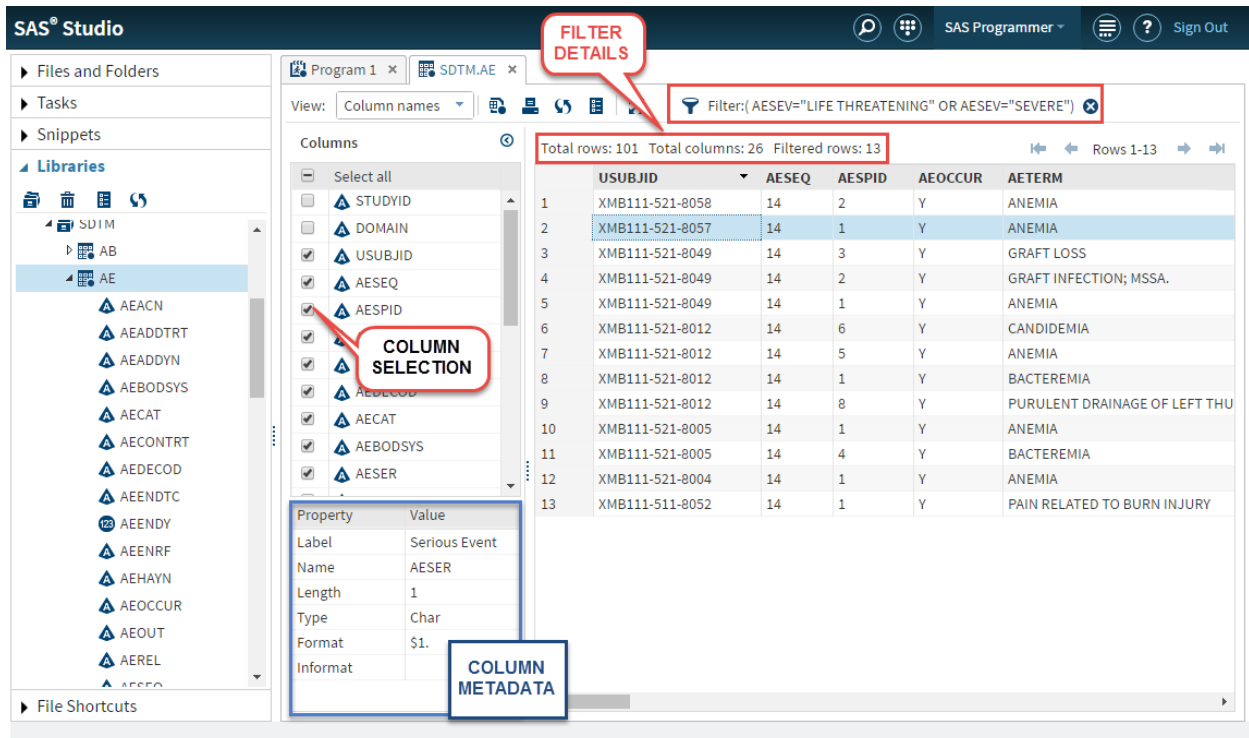


Figure 1. Library and Dataset Browser

## CODE EDITOR

The code editor is where you will spend most of your time, and there are some very nice features in Studio to make programming easier. Figure 2 shows the code editor. Note that the code, log and results windows are part of a tabbed display system, making it very easy to switch between them. If you have the screen real estate, you can also separate the tabs and view two in the same window. The code uses the same syntax highlighting as the Windows Display Manager. In Figure 2, I've called out one of my favorite features – the code formatting button. As programmers, we know that properly formatted code is much easier to read and understand, but being busy means we don't always take the time to properly format the code. SAS Studio will do that for you at the press of a button, as you can see in Figure 3.

The screenshot shows the SAS Code Editor interface. At the top, there are tabs for '\*Program 1' and '\*Program 2'. Below the tabs are three buttons: 'CODE', 'LOG', and 'RESULTS'. A toolbar contains various icons for file operations and execution. A red callout box with the text 'FORMAT CODE' points to the 'TABBED CODE & OUTPUT' button in the toolbar. The main editor area displays SAS code from line 16 to 43. The code is unformatted, with no indentation or color coding. The code includes comments, variable assignments, conditional logic, and a PROC SGplot statement.

```

16
17
18 ** Computing crossing points **;
19 ** Skip for class presentation **;
20 ** Set two normal density functions equal then solve for X **;
21
22 data _null_;
23 file print;
24 mu1=3; mu2=2; s1=1*1; s2=&sigma2*&sigma2; ** (macro has sigma, need variance here) **;
25 c=mu1*mu1/s1-mu2*mu2/s2 + log(s1/s2);
26 b=2*mu2/s2-2*mu1/s1; a=1/s1 - 1/s2;
27 det=b*b-4*a*c; put a b c det;
28 if s1=s2 then do; root1=(mu1+mu2)/2; root2 = root1; root2A=.; end;
29 else do;
30 root1=(-b+sqrt(det))/(2*a);
31 root2 = (-b-sqrt(det))/(2*a); root2A = root2; end;
32 put "Roots: " root1 root2;
33 call symput("root1",root1);
34 call symput("root2",root2);
35 call symput("root2A",root2A);
36 run; quit;
37
38
39 proc sgplot;
40 series X=X Y=Y / group=color lineattrs=(thickness=2);
41 refline &root1 &root2/axis=X;
42 Title "Crossing point(s) &root1 &root2A";
43 run; quit;

```

Line 43, Column 12

Figure 2. Code Editor with Unformatted Code

The screenshot shows the same SAS Code Editor interface as Figure 2, but the code is now auto-formatted. The code is indented, and keywords and comments are color-coded. The 'TABBED CODE & OUTPUT' button in the toolbar is now highlighted in blue. The status bar at the bottom right indicates 'Line 65, Column 6'.

```

26 data _null_;
27   file print;
28   mu1=3;
29   mu2=2;
30   s1=1*1;
31   s2=&sigma2*&sigma2;
32   ** (macro has sigma, need variance here) **;
33   c=mu1*mu1/s1-mu2*mu2/s2 + log(s1/s2);
34   b=2*mu2/s2-2*mu1/s1;
35   a=1/s1 - 1/s2;
36   det=b*b-4*a*c;
37   put a b c det;
38
39   if s1=s2 then
40     do;
41       root1=(mu1+mu2)/2;
42       root2=root1;
43       root2A=.;
44     end;
45   else
46     do;
47       root1=(-b+sqrt(det))/(2*a);
48       root2=(-b-sqrt(det))/(2*a);
49       root2A=root2;
50     end;
51   put "Roots: " root1 root2;
52   call symput("root1", root1);
53   call symput("root2", root2);

```

Line 65, Column 6

Figure 3. Code Editor with Auto-Formatted Code

Figure 4 shows some code that has been submitted and has returned an error. Before we get to checking the log, I wanted to point out that when writing the code, I can drag variable names from the library panel directly into the code editor, so I don't have to worry about spelling the variables correctly. As you'll see with the error message, I should have done that with the dataset name, too. Note that the red x in the program tab tells me that I have an error. To investigate, I just need to click on the Log tab.

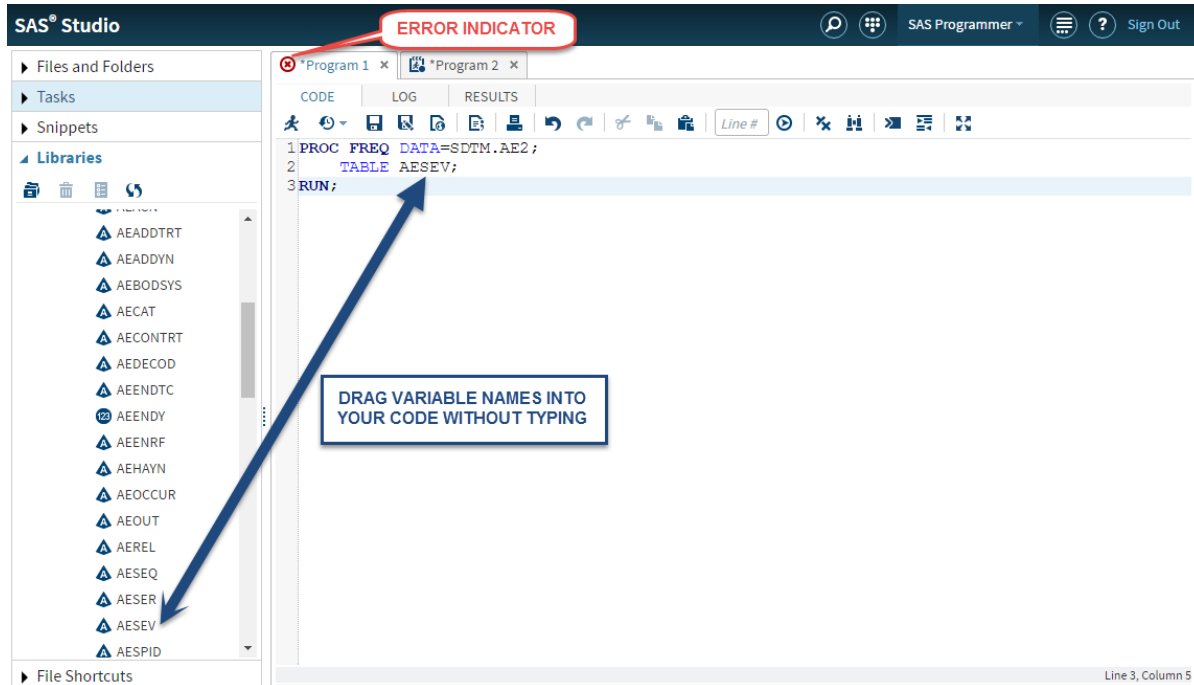


Figure 4. Code Editor with Error

Figure 5 shows what happens when I view the log. The top part of the display, in the grey box, gives me a count of errors, warnings and notes. When I expand the errors section, I see a list of all of the error messages. When I click on the error message in that section, I am linked directly to the part of the log where the error shows up. No more CTRL-F to find the Errors!

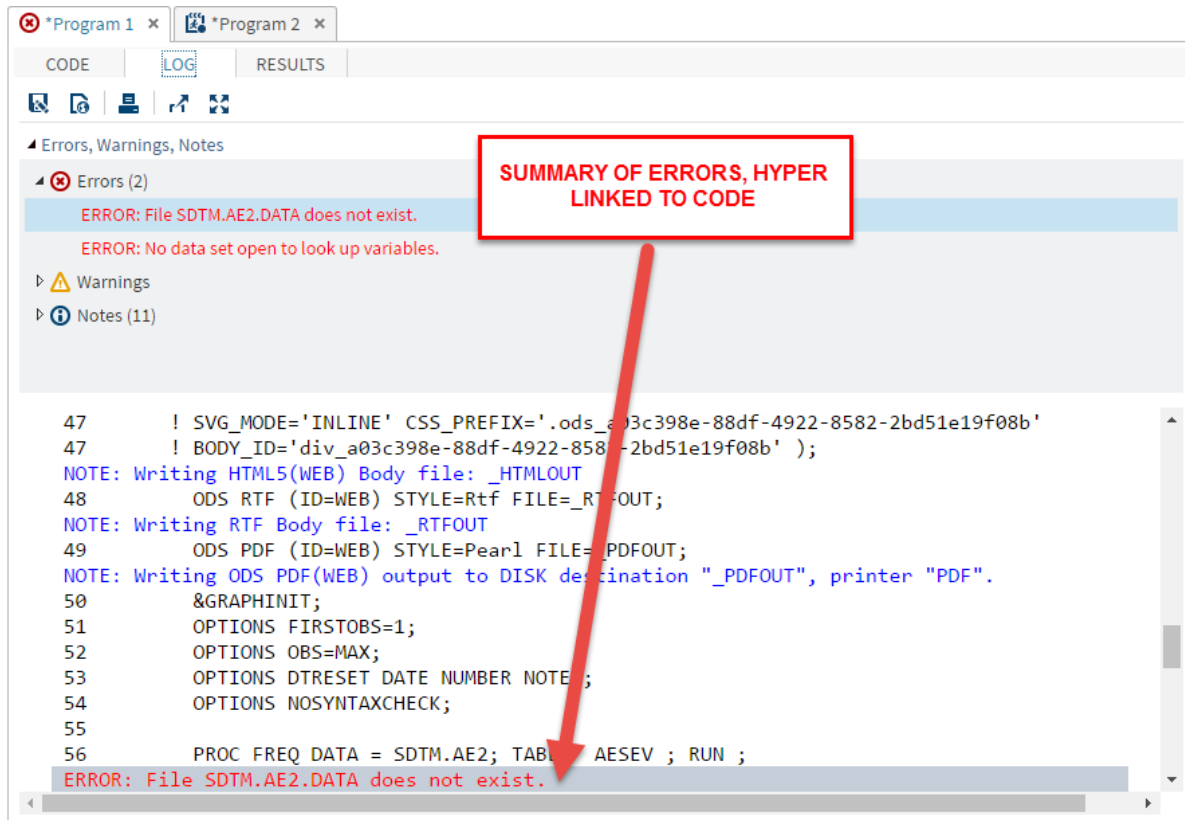


Figure 5. Log Viewer

Another handy feature is the submission history button (Figure 6). Studio keeps a record of every time you submit code during a session, and you can call up the previous sessions. Make some changes to the code and realize you liked it better on the previous submission? Go to the submission history and call up a previous run. It will open in a new program tab as a read-only file and you can cut and paste the changes you want into your current program. Note that this history will clear out when you close the Studio session.

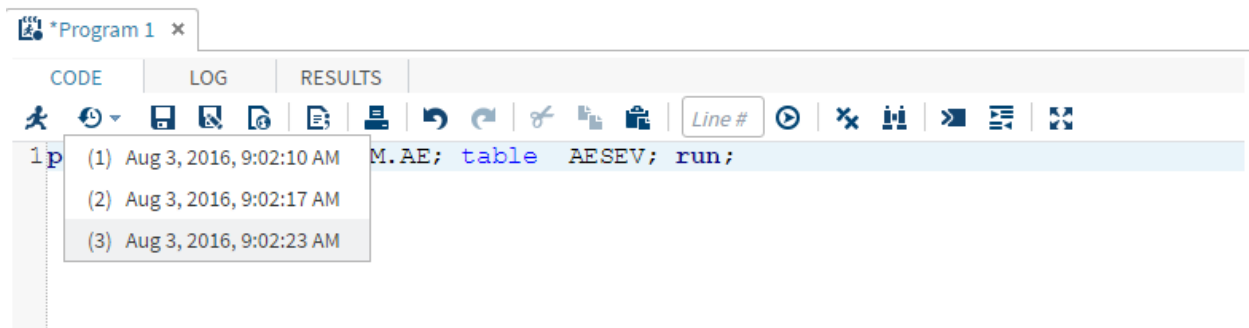


Figure 6. Submission History

## CODE SNIPPETS

If you are like me, somewhere (or maybe several places) you have a document with some examples of cool or really useful code you have written and want to be able to go back to and use again. Once you get more than just a few of these code blocks, it can get really hard to manage them. SAS Studio has a built in way to manage these code snippets. It comes with several well documented snippets that cover things like importing and exporting files, creating graphs, writing macros and even IML functions. As Figure 7 shows, all you have to do is drag a snippet over to your programming window, and you add the code to your existing program. In the Import CSV example, all you have to do is put in the file name, change the output dataset, and remove the section about the Unix filename, and you are all set.

In addition to the included snippets, you can create your own collection, so you always have your coding toolset with you no matter where you are accessing the server from. You can also set up shared locations for snippets for study specific ones to share across the team (like the program header, for example).

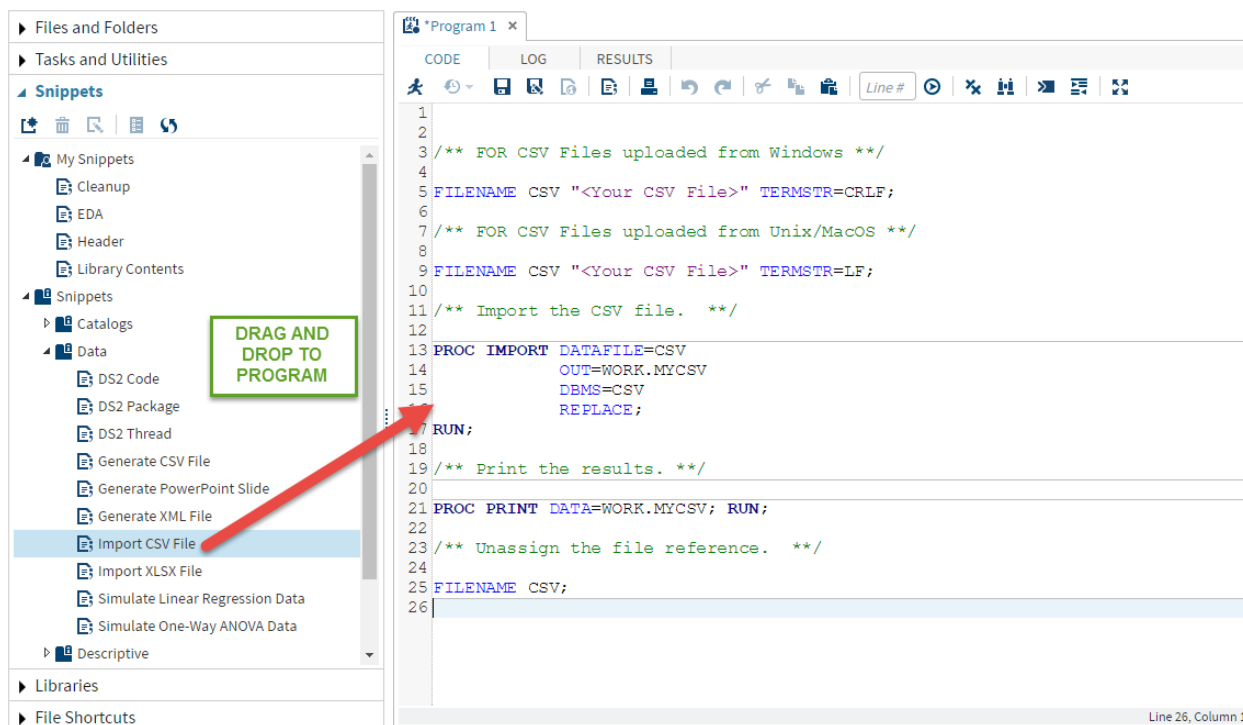


Figure 7. Code Snippets

## TASKS

SAS Studio also comes equipped with pre-defined tasks to help you generate code. These are very helpful when it comes to using procedures and methods you are unfamiliar with. The included tasks cover areas such as data summarization, graphing, probability, statistics, high-performance statistics, power and sample size, multivariate analysis, econometrics, forecasting, statistical process control, and data mining. Let's look at a graphing one as an example.

Figure 8 shows the task for building a bar chart. In the settings panel, you select the dataset to use from a drop down, and this allows you to select the different variables. In the Options tab, you can set the headers and footers, and specify data labels. While you are making your selections, code is generated in the code window. When you submit the code, the results are presented as in Figure 9. Note that once you have the graphical output, you can easily save it out in one of several formats.

Tasks are an excellent way to learn new procedures or options. Once you have the output working the way you want, you can just cut and paste the automatically generated code into your own program.

**Tasks**

- Characterize Data
- Describe Missing Data
- List Data
- Transpose Data
- Stack/Split Columns
- Filter Data
- Select Random Sample
- Partition Data
- Sort Data
- Rank Data
- Transform Data
- Standardize Data
- Graph
  - Bar Chart**
  - Bar-Line Chart
  - Box Plot
  - Bubble Plot
  - Histogram
  - Line Chart
- Snippets
- Libraries
- File Shortcuts

**Program 1 x | \*Bar Chart x**

Settings Code/Results Split

DATA OPTIONS INFORMATION

DATA: SDTM.AE

WHERE CLAUSE FILTER

ROLES

- Category variable: (1 item)
  - AESEV
- Response variable: (1 item)
  - Column
- Group variable: (1 item)
  - Column
- URL variable: (1 item)
  - Column
- BY variable: (1 item)
  - Column

DIRECTION

GROUP LAYOUT

STATISTICS

**SPECIFY VALUES AND DETAILS**

```

1 /*
2 *
3 * Task code generated by SAS Studio 3.4
4 *
5 * Generated on '8/2/16, 2:28 PM'
6 * Generated by 'jimbox'
7 * Generated on server 'L7A368.NA.SAS.COM'
8 * Generated on SAS platform 'X64_7PRO WIN'
9 * Generated on SAS version '9.04.01M3P06242'
10 * Generated on browser 'Mozilla/5.0 (Windows NT 6.1; WOW64; rv:44.0) like Firefox/44.0'
11 *
12 *
13 */
14
15 /*--Set output size--*/
16 ods graphics / reset imagemap;
17
18 /*--SGPLOT proc statement--*/
19 proc sgplot data=SDTM.AE;
20 /*--Bar chart settings--*/
21 vbar AESEV / datalabel name='Bar';
22
23 /*--Response Axis--*/
24 yaxis grid;
25 run;
26
27 ods graphics / reset;
    
```

CODE AUTOMATICALLY GENERATED

Line 1, Column 1

Figure 8. Using Built-In Tasks

**Tasks**

- Characterize Data
- Describe Missing Data
- List Data
- Transpose Data
- Stack/Split Columns
- Filter Data
- Select Random Sample
- Partition Data
- Sort Data
- Rank Data
- Transform Data
- Standardize Data
- Graph
  - Bar Chart**
  - Bar-Line Chart
  - Box Plot
  - Bubble Plot
  - Histogram
  - Line Chart
- Snippets
- Libraries
- File Shortcuts

**Program 1 x | \*Bar Chart x**

Settings Code/Results Split

CODE LOG RESULTS

SEND OUTPUT TO HTML, PDF OR RTF

Frequency

AE Severity

AE Severity	Frequency
LIFE THREATENING	3
MILD	40
MODERATE	40
SEVERE	10

Figure 9. Task Results

You can also create your own tasks to do just about anything. You just have to set up the options panel using code that is very much like XML to capture the inputs you want. You can then treat those input as essentially macro variables to pass into your code for execution. Studio comes equipped with simple and advanced task templates for you to see how to edit the options.

```

19
20     <Options>
21     <Option inputType="string" name="OptionsTab">OPTIONS</Option>
22     <Option inputType="string" name="observationsGroup">Odds Ratio</Option>
23     <Option inputType="string" name="infoText">Provide an Odds Ratio to see a Prob.
24     <Option decimalPlaces="0,15" defaultValues="1.5" inputType="numbertext" minVal:
25     </Options>
26
27 </Metadata>
28
29 <UI>
30
31     <Container option="OptionsTab">
32     <Group open="true" option="observationsGroup">
33     <OptionItem option="infoText"/>
34     <OptionItem option="OddsRatio"/>
35     </Group>
36
37     </Container>
38 </UI>
39
40 <CodeTemplate>
41     <![CDATA[
42
43
44 %macro odds_prob(orat);
45 data probs;
46 do i = 0.001 to .999 by .001;
47   p_A = I;
48   odds_A = p_A / (1 - p_A);
49   odds_B = odds_A / &orat;
50

```

My Tasks/Example Tasks/Odds Ratios and Probability.ctm Line 1, Column 1

Figure 20. Task Editor

## CONCLUSION

SAS Studio is a tool designed specifically to make writing programs easier. Manage your snippets, use tasks to help generate code, and access your SAS environment from any computer. Once you try it out and see how easy it is to write and format your code, you'll wonder how you programmed without it.



## RECOMMENDED READING

- SAS® Studio Video Library: <http://support.sas.com/training/tutorial/studio/index.html>
- Teach Them to Fish—How to Use Tasks in SAS® Studio to Enable Coworkers to Run Your Reports Themselves  
<http://support.sas.com/resources/papers/proceedings15/SAS1831-2015.pdf>
- SAS® Studio Knowledge Base: <http://support.sas.com/software/products/sasstudio/#s1=2>

## CONTACT INFORMATION

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