

Interactive Graphs

Kriss Harris, SAS Specialists Limited
Richann Watson, DataRich Consulting

ABSTRACT

This paper demonstrates how you can use interactive graphics in SAS® 9.4 to assess and report your safety data. The interactive visualizations that you will be shown include the adverse event and laboratory results. In addition, you will be shown how to display "details-on-demand" when you hover over a point.

Adding interactivity to your graphs will bring your data to life and help improve lives!

INTRODUCTION

Being able to drill-down on your graphs enables you to interrogate your graphs and understand your data better. That is the beauty of having interactive visualizations.

To create graphs, which can be drilled-down on requires HTML. Based on the assumption that you already know how to create graphs with the SG Procedures or using the Graph Template Language (GTL), then the only additional things you need to produce drill-down graphs in SAS 9.4 are the following:

- Using ODS OUTPUT HTML statements around your SG procedures or your GTL statements;
- Using the URL= *<CHARACTER-VARIABLE>* option in your plot statements;
- Using the IMAGEMAP = ON option within ODS GRAPHICS.

Being able to filter graphs by selecting items from a drop-down box is very useful too. This can be achieved in SAS by using the same methods, which the drill-down uses, and in addition using a few lines of HTML code, to create your drop-down menu. JavaScript and Cascading Style Sheets (CSS) are also needed, however the JavaScript and CSS that you need are provided with these examples, and therefore, you do not need to learn how to write JavaScript or CSS, to be able to use filtering.

For more details on creating graphs using GTL then please see (Harris & Watson, Great Time to Learn GTL, 2018), (Harris, Hands-On Graph Template Language (GTL): Part A, 2017) or (Watson, 2019)

The adverse event and laboratory data sets used in this paper are from the CDISC SDTM / ADaM Pilot Project and they were obtained from the CDISC website (CDISC, 2013).

ADVERSE EVENT DRILL-DOWN EXAMPLE

The following link shows an Adverse Event (AE) plot, which you are able to drill-down on - <https://www.krishharris.co.uk/sgf/2019/3261/output/aes.html>.

When incorporating a drill-down feature, it is important to know what you want to display after you have drilled-down. When you hover over the graph, you can display the active link that can take you to another graph or a table or it can display basic information pertaining to that specific item in the graph. In the AE example in the above link, when you click on (or drill-down on) the bar which shows the percentage of subjects with at least one **Application Site Dermatitis** event in the **Placebo** treatment group, you are then shown the number of subjects which had that AE by each severity group. In this example, all the Application Site Dermatitis events were mild, and so if you click on that bar, you are then shown the results table of the five subjects, which had that event.

Using the AE example, drill-down capability was achieved by:

1. Producing subject level listings of each AE, for each treatment, and severity group.

1

2

2. Producing graph of counts of AE's, for each treatment, and severity group.
 - Linking these bars to the subject level listings in “1”.
3. Producing a graph of percentage of subjects with the AE's by each treatment group. 3
 - Linking these bars to the counts of AE's in “2”.

In order to achieve the drill-down affect, an output for each combination specified in bullet points 1 and 2 above needs to be created. Because an output for all combinations needs to be created, it is recommended to use a macro.

PRODUCING SUBJECT LEVEL LISTING OF EACH AE, TREATMENT AND SEVERITY GROUP

Output 1 below shows an example of the listings, which are created for each AE, treatment and severity group. This is the final level of the drill-down.

Click back arrow on navigation bar to return to severity bar chart

Body System or Organ Class=GENERAL DISORDERS AND ADMINISTRATION SITE CONDITIONS Dictionary-Derived Term=APPLICATION SITE DERMATITIS Severity/Intensity=MILD Actual Treatment=Placebo

Unique Subject Identifier	Reported Term for the Adverse Event	Analysis Start Date	Analysis End Date	AE Duration (N)	Serious Event	Causality	AREL	Outcome of Adverse Event
01-709-1088	APPLICATION SITE DERMATITIS	08MAY2014	.	.	N	PROBABLE	RELATED	NOT RECOVERED/NOT RESOLVED
01-709-1312	APPLICATION SITE DERMATITIS	17MAY2014	.	.	N	PROBABLE	RELATED	NOT RECOVERED/NOT RESOLVED
01-710-1077	APPLICATION SITE DERMATITIS	12DEC2013	12DEC2013	1	N	POSSIBLE	RELATED	RECOVERED/RESOLVED
01-713-1256	APPLICATION SITE DERMATITIS	30OCT2012	31OCT2012	2	N	PROBABLE	RELATED	NOT RECOVERED/NOT RESOLVED
	APPLICATION SITE DERMATITIS	30OCT2012	31OCT2012	2	N	PROBABLE	RELATED	RECOVERED/RESOLVED
01-718-1355	APPLICATION SITE DERMATITIS	27APR2013	27APR2013	1	N	PROBABLE	RELATED	RECOVERED/RESOLVED
	APPLICATION SITE DERMATITIS	12MAY2013	12MAY2013	1	N	PROBABLE	RELATED	RECOVERED/RESOLVED
	APPLICATION SITE DERMATITIS	16MAY2013	16MAY2013	1	N	PROBABLE	RELATED	RECOVERED/RESOLVED
	APPLICATION SITE DERMATITIS	20MAY2013	20MAY2013	1	N	PROBABLE	RELATED	RECOVERED/RESOLVED

Output 1: Subject Level Listing

Program 1 below shows how to produce the subject level listings illustrated in Output 1.

```
/* Generate the supporting listing for each preferred term by treatment */
%macro genlist;
  %let x = 1;
  %let upttrt = %scan(&allpttrt, &x, '#'); 1

  %do %while (&upttrt ne );
    proc sort data = adae
      out = adae_&x; 2
      where pttrtsev = "&upttrt";
      by AEBODSYS AEDECOD AESEV TRTA USUBJID ASTDT AENDT;
    run;

    ods html path = outp file = "&upttrt..html"; 3
    title color=red "Click back arrow on navigation bar to return to severity bar chart";
    proc report data = adae_&x;
      by AEBODSYS AEDECOD AESEV TRTA;
      columns USUBJID AETERM ASTDT AENDT ADURN AESER AEREL AREL AEOUT;
      define USUBJID / group;
      break after USUBJID / skip;
    run;
    ods html close;

    %let x = %eval(&x + 1); 4
    %let upttrt = %scan(&allpttrt, &x, '#');
  %end;
%mend genlist;
```

Program 1: Code to Produce Subject Level Listings

- 1 For this example, the **allpttrt** macro variable contains the 53 combinations of the AE name, treatment group, and AE severity. Here the **upttrt** macro variable value consists of the first **allpttrt** combination, which is the value **application_site_dermatitis_MILD_0**. Where **application_site_dermatitis** is the name of the AE, **MILD** is the severity, and **0** means the Placebo treatment group.
- 2 Filters the ADAE data set to only the combination of interest, and then outputs that filtered data set.
- 3 Produces HTML file of the subject level listing for the combination of interest.
- 4 Increments the value of **x** so that the scan function can extract each of the 53 combinations during the do loop process, and therefore 53 subject level listings can be outputted.

PRODUCING GRAPHS OF AE COUNTS, FOR EACH TREATMENT AND SEVERITY GROUP

Figure 1 below is an example of a graph showing the number of subjects with at least one AE for each treatment and severity group. This particular graph shows the Number of Placebo Subjects for the Application Site Dermatitis AE.

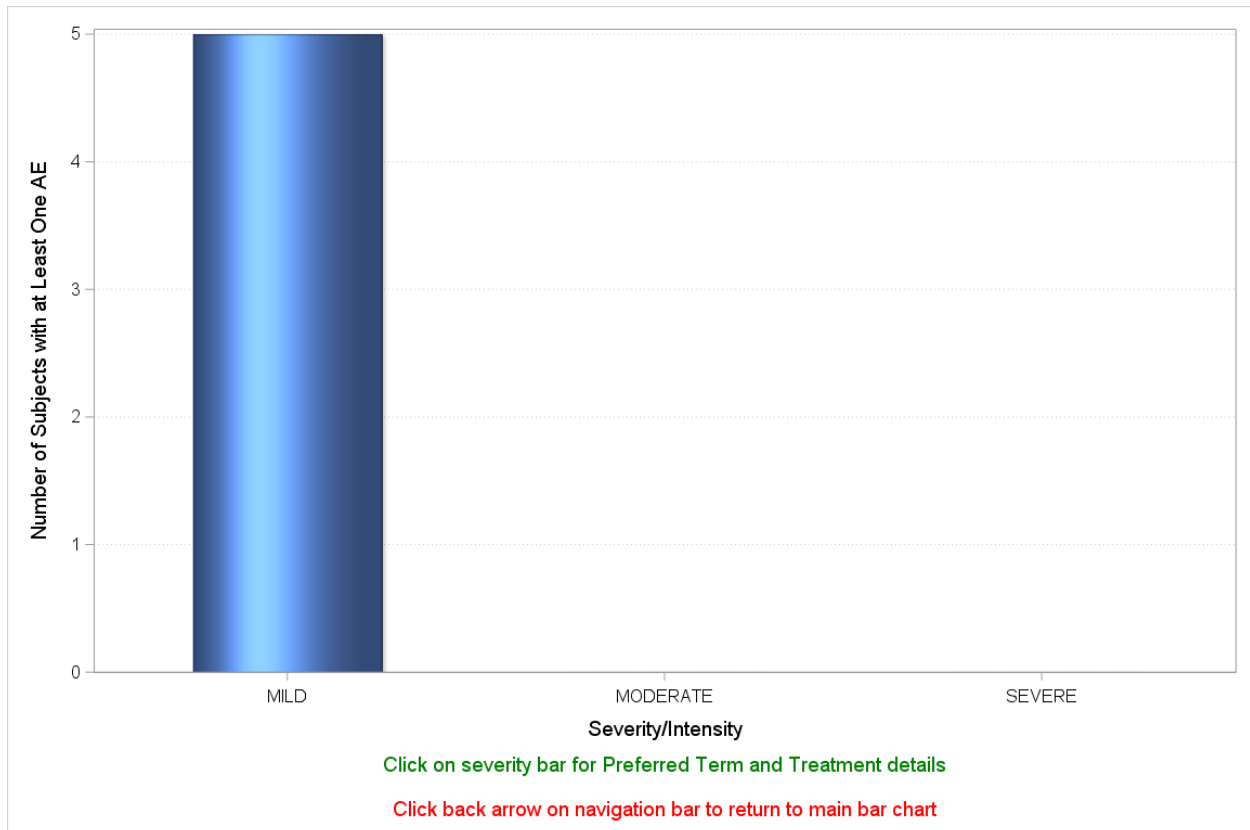


Figure 1: Number of Placebo Subjects with at Least One Application Site Dermatitis by Severity

Program 2 below shows how to produce graphs of the AE counts, for each AE, treatment and severity group illustrated in Figure 1.

```

/* generate a supporting graph for each preferred term */
%macro genchart(trt = , color =);
  /* create a template for the supporting AE graph - within in macro so bar colors
  can align with main graph */
  proc template;
    define statgraph sevfreq&trt;
      begingraph;
        entryfootnote textattrs = (size = 12 pt color = green) "<Text1>";
        entryfootnote " ";
        entryfootnote textattrs = (size = 12 pt color = red) "<Text2>";
        layout overlay / yaxisopts = (label = "<Label1>"
                                     griddisplay = on
                                     gridattrs = (color = lightgray
                                                  pattern = dot));
        barchart category = AESEV response = COUNT / barwidth = 0.5
                 fillattrs =
                 (color = &color)
                 dataskin = sheen
                 url = url1;
      endlayout;
    endgraph;
  end;
run;

%let y = 1;
%let upt = %scan(&allprefterm, &y, '#');

%do %while (&upt ne );

  %if %sysfunc(find(&upt, &trt)) > 0 %then %do;
    /* Specify the image output filename. */
    ods graphics / reset imagemap = on imagename = "&upt"
    drilltarget = "_self" height = 8in width = 12in;

    /* Generate the graph using ODS HTML. */
    ods html path = outp file = "&upt..html";
    proc sgrender data = adaesev template = sevfreq&trt;
      where pttrt = "&upt";
      by AEDECOD TRTA;
    run;
    ods html close;
  %end;

  %let y = %eval(&y + 1);
  %let upt = %scan(&allprefterm, &y, '#');
%end;
%mend genchart;

options mprint mlogic;

%genchart(trt = 0, color = cornflowerblue)
%genchart(trt = 54, color = indianred)
%genchart(trt = 81, color = cadetblue)

```

Program 2: Code to Produce Graphs of AE Counts

- 1 Creates the GTL needed to produce the bar charts. Due to space limitations in the above code, the details regarding the text in <Text1>, and <Text2> can be seen in the Appendix.
- 2 The URL option indicates that each bar on the bar chart has an active link, and the hyperlink is the value in the **URL1** variable. When the bar is clicked you will then be navigated to the respective subject level listing.

- 3 The IMAGEMAP = ON option enables the data tips and drill-down options to work.
- 4 Creates the HTML file of the bar chart of AE counts, for each of the 53 combinations of AE, treatment and severity group in this example.
- 5 Since an output needs to be produced for each of the AE and severity level combinations, then when associating the AE data with the template, we need to ensure we are referencing the correct template and subsetting the data for the appropriate set of records.

PRODUCING MAIN BAR CHART

Figure 2 shows the main bar chart of the percentages of subjects with at least one AE, by AE and treatment group.

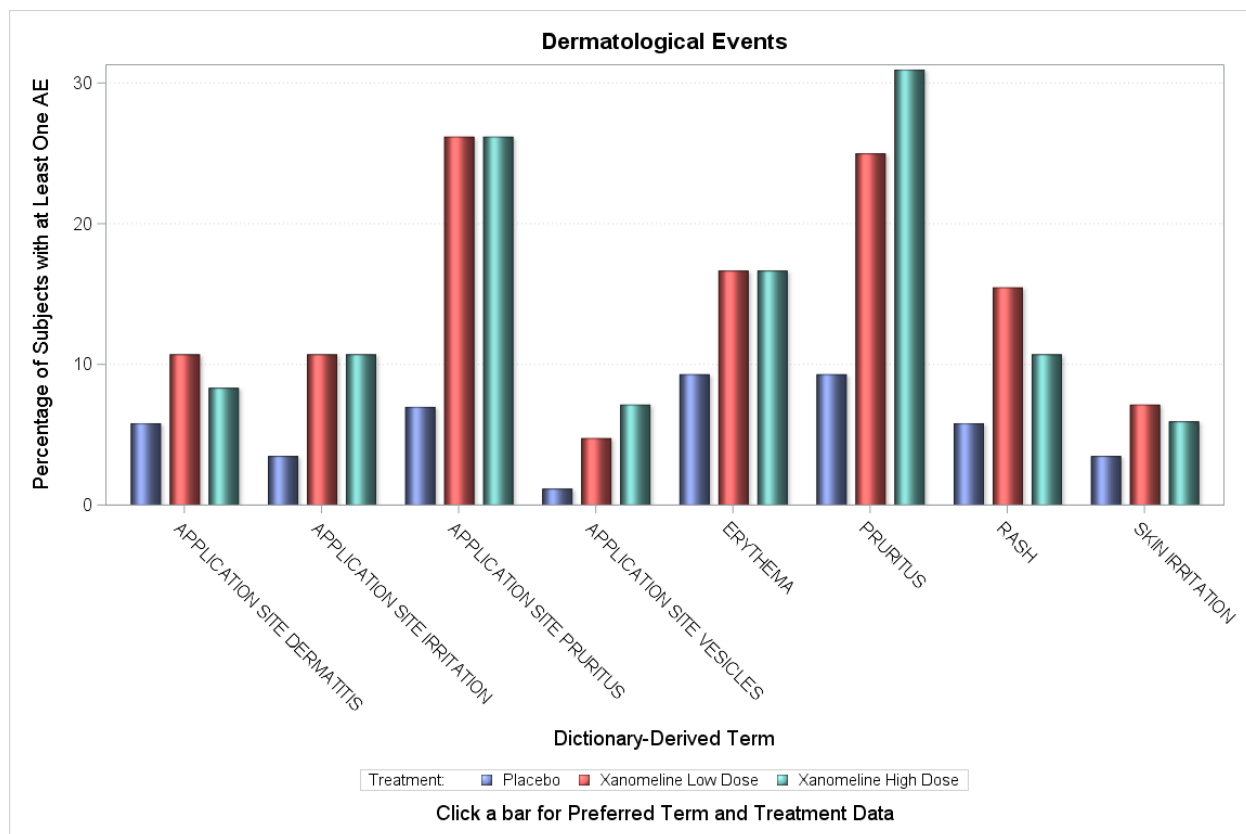


Figure 2: Main Bar Chart

Program 3 creates the main bar chart of the percentages of subjects with at least one AE, by AE and treatment group shown in Figure 2.

```

proc template;
  define statgraph ptfreq;
    begingraph;
      entrytitle "Dermatological Events";
      entryfootnote textattrs = (size = 12 pt) "<Text1>";
      layout overlay / yaxisopts = (label = "<Text2>"
                                   griddisplay = on
                                   gridattrs = (color = lightgray pattern
                                                = dot));
      barchart category = AEDECOD response = PERCENT / name =
                                   "dermevent"
                                   group = TRTA
                                   groupdisplay =
                                   cluster
                                   barwidth = 0.75
                                   dataskin = sheen
                                   url = url0;
      discretelegend "dermevent" / title = "Treatment:";
    endlayout;
  endgraph;
end;
run;

/* Enable image mapping in the HTML output and specify a base image name */
ods graphics / reset imagemap = on imagename = "aes" drilltarget = "_top" height =
8in width = 12in;

/* Generate the drill-down graph using ODS HTML */
ods html path = outp file = "aes.html";
proc sgrender data = ptcnt2 template = ptfreq;
run;
ods html close;

```

Program 3: Code for Producing Main Bar Chart of Percentages of Subjects with at least one AE, by AE and Treatment.

- 1 The variable URL0 is used in the URL option. This variable contains the values of the URL name associated with each AE and treatment group by severity bar charts, and when you click on the associated bar you are then navigated to the appropriate severity bar charts, which are created in Program 2.
- 2 This template is different from the template in Program 2, because this template produces a bar chart of the percentage of subjects with at least one AE, by AE and treatment. Therefore, we need to make sure we are using the correct template and that we are not subsetting the data since this is the main bar chart.

CREATING THE INPUT DATA SET

Now that the templates and macros have been created to produce the necessary output, we have an idea of how many URLs are needed and how these URLs will look. We can then make sure that our input data set has the correct variables that will hold these URLs that are needed so that we can build our supporting listings and graphs and have our drill-down effect. Refer to **Error! Reference source not found.** for illustration of how the URL values were created and stored in the input data set.

```

/* add a URL column for the drill-down links to the Adverse Event data set */
data adae;
  length url0 url1 pttrt pttrtsev $500;
  set ADAM.ADAE;

  /* need to change the spaces to underscores to build URLs */
  PREFTERM = lowercase(tranwrd(tranwrd(strip(AEDECOD), ' ', '_'), '-', '_'));

  /* build URLs for each preferred term */
  pttrt = catx('_', PREFTERM, TRTAN);
  url0 = cats(pttrt, '.html');

  /* build URLs for each preferred term by relation */
  pttrtsev = catx('_', PREFTERM, AESEV, TRTAN);
  url1 = cats(pttrtsev, '.html');
run;

```

Output 2: Selection Menu

DROP-DOWN SELECTION MENU

There is an example on the SAS Website (SAS Institute Inc, 2019), which shows how to create a drill-down graph. The example was modified to allow for the drop-down selection menu. An example of using a drop-down selection can be seen here -

https://www.krissharris.co.uk/sqf/2019/3261/output/filter/SOFA_all.html. You will notice that as you select a different region, the plot changes. This is achieved by also using HTML, JavaScript and CSS.

In order to use the selection menu on your graphs, you need to output all possible graphs first similar to what was done for the AE and Lab examples. For the sofa sales graphs, three graphs are outputted based on three regions: east and west combined, east, and west. Program 4 shows how to output the graphs for each region.

```

%macro genchart(product=, region=, regioncls=, outname=);
  /* Specify the image output filename. */
  ods graphics / reset=all imagemap=on imagename="&product._&outname"; 1

  /* Generate the graph using ODS HTML. */
  ods _all_ close;
  ods html path=outp file="&product._&outname..html" text="&filterlink." 2
    headtext='<script src="myScript.js"></script> <link rel="stylesheet"
      type="text/css" href="myScript.css">';
  proc sgrender data=sales template=drilldown; 3
    where product = "&product" and &regioncls.;
    dynamic product="&product" region="&region";
  run;
  ods html close;
%mend genchart;

/* Use the macro to generate the supporting graphs. */
%genchart(product=SOFA, region=%str(West and East), regioncls=%str(region in
('EAST', 'WEST')), outname=all);
%genchart(product=SOFA, region=%str(West), regioncls=%str(region in
('WEST')), outname=west);
%genchart(product=SOFA, region=%str(East), regioncls=%str(region in
('EAST')), outname=east);

```

Program 4: Creating outputs for Each Region

- 1 Using the standard ODS GRAPHICS statement, we can output the graph.
- 2 Using custom HTML code to help build the selection box and to reference the JavaScript and Cascading Style Sheet (CSS). The FILTERLINK macro variable contains the code which is used for the selection box, which shown in Program 5.
- 3 Within SGRENDER procedure we can have a where clause that will allow us to select the region for the outputs.

The HTML code to create the selection box is in Program 5. Admittedly, being familiar with HTML code is useful when creating these types of interactive graphics.

```

%let filterlink=<center><div class='dropdown'>
  <button onclick='myFunction()' class='dropbtn'>Select Region</button>
  <div id='myDropdown' class='dropdown-content'>
    <a href='SOFA_all.html'>Regions=All</a>
    <a href='SOFA_west.html'>Regions=West</a>
    <a href='SOFA_east.html'>Regions=East</a>
  </div>
</div>
</center>;

```

Program 5: HTML Needed to Create the Selection Box.

It is not necessary to explain the JavaScript code and CSS that was for the selection box example. The main point of those files is just to be referenced in the HTML code, because they control the appearance of the selection box and the function. The JavaScript code and CSS can be found at the links below and in the Appendix:

- JavaScript - <https://www.krissharris.co.uk/sgf/2019/3261/output/filter/myScript.js>
- CSS - <https://www.krissharris.co.uk/sgf/2019/3261/output/filter/myScript.css>

CONCLUSION

SAS can produce interactive graphics when it is combined with HTML. Interactive graphics allow you to drill-down or filter you graphs, and allows you to understand the data better.

REFERENCES

- CDISC. (2013). *CDISC*. Retrieved from SDTM/ADaM Pilot Project:
http://www.cdisc.org/system/files/members/article/application/zip/updated_pilot_submission_package.zip
- Harris, K. (2017). Hands-On Graph Template Language (GTL): Part A. *SAS Global Forum*. Denver: SAS Global Forum.
- Harris, K., & Watson, R. (2018). Great Time to Learn GTL. *PharmaSUG*. Seattle: PharmaSUG.
- SAS Institute Inc. (2019, 02 25). *Create a Drill-Down Graph*. Retrieved from SAS® 9.4 Graph Template Language: User's Guide, Fifth Edition:
<https://documentation.sas.com/?docsetId=grstatug&docsetTarget=p1vl3qpgkcj6stn1okehgp0nbqvg.htm&docsetVersion=9.4&locale=en>
- Watson, R. (2019). Great Time to Learn GTL: A Step-by-Step Approach to Creating the Impossible. *SAS Global Forum*. Dallas: SAS Global Forum.

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the authors at:

Kriss Harris
SAS Specialists Limited
italjet125@yahoo.com
<http://www.krissharris.co.uk>

Richann Watson
DataRich Consulting
richann.watson@datarichconsulting.com
<http://www.datarichconsulting.com>

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APPENDIX

PROGRAM 2

<Text1>

Click on severity bar for Preferred Term and Treatment details

<Text2>

Click back arrow on navigation bar to return to main bar chart

PROGRAM 3

<Text1>

Click a bar for Preferred Term and Treatment Data

<Text2>

Percentage of Subjects with at Least One AE

JAVASCRIPT

```
function myFunction() {
    document.getElementById("myDropdown").classList.toggle("show");
}

// Close the dropdown menu if the user clicks outside of it
window.onclick = function(event) {
    if (!event.target.matches('.dropbtn')) {
        var dropdowns = document.getElementsByClassName("dropdown-content");
        var i;
        for (i = 0; i < dropdowns.length; i++) {
            var openDropdown = dropdowns[i];
            if (openDropdown.classList.contains('show')) {
                openDropdown.classList.remove('show');
            }
        }
    }
}
```

CSS

```
/* Dropdown Button */
.dropbtn {
    background-color: #3498DB;
    color: white;
    padding: 16px;
    font-size: 16px;
    border: none;
    cursor: pointer;
}

/* Dropdown button on hover & focus */
.dropbtn:hover, .dropbtn:focus {
    background-color: #2980B9;
}

/* The container <div> - needed to position the dropdown content */
.dropdown {
    position: relative;
    display: inline-block;
}

/* Dropdown Content (Hidden by Default) */
.dropdown-content {
    display: none;
    position: absolute;
```

```

    background-color: #f1f1f1;
    min-width: 160px;
    box-shadow: 0px 8px 16px 0px rgba(0,0,0,0.2);
    z-index: 1;
}

/* Links inside the dropdown */
.dropdown-content a {
    color: black;
    padding: 12px 16px;
    text-decoration: none;
    display: block;
}

/* Change color of dropdown links on hover */
.dropdown-content a:hover {background-color: #ddd}

/* Show the dropdown menu (use JS to add this class to the .dropdown-content
container when the user clicks on the dropdown button) */
.show {display:block;}

```