CPS 188 Term Project
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Prevalence of Diabetes in Canada from 2015 to 2021

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Contents

1 Introduction

This report examines actual data gathered by Statistics Canada on the prevalence of diabetes in the four most populous provinces of Canada (Ontario, Quebec, British Columbia, and Alberta) and the as well as national data, from 2015 to 2021. The report gives a summary of a C programming project that includes computations, the creation of graphs, and conclusions based on the gathered data.

The project requires the use of the C programming language in order to take data from a CSV file, do computations, and provide the required output, including tables and graphs. The data file includes information on the prevalence of diabetes among people aged 35 and older in each of the four provinces as well as across the entire country (excluding territories).

In-depth discussion of the project's essential elements is provided in the report, including computation of annual averages, identification of the provinces with the highest and lowest percentages of diabetics, and computation of the provincial and national averages of the population with diabetes diagnoses. The report also highlights the necessity to identify the provinces above and below the national average as well as the years with the highest and lowest percentages of diabetes.

The project also requires the development of two graphs: a line plot showing diabetes percentages from 2015 to 2021 and a bar graph showing the average percentages of diabetes among the three age groups for the entire country. The study emphasizes the significance of clearly labeling the axes as well as presenting each graph with a title and a legend.

The overall objective of the project is to use C programming and GNUplot features to investigate the prevalence of diabetes in Canada's four most populous provinces and draw conclusions using data collected by Statistics Canada.

2 Calculations

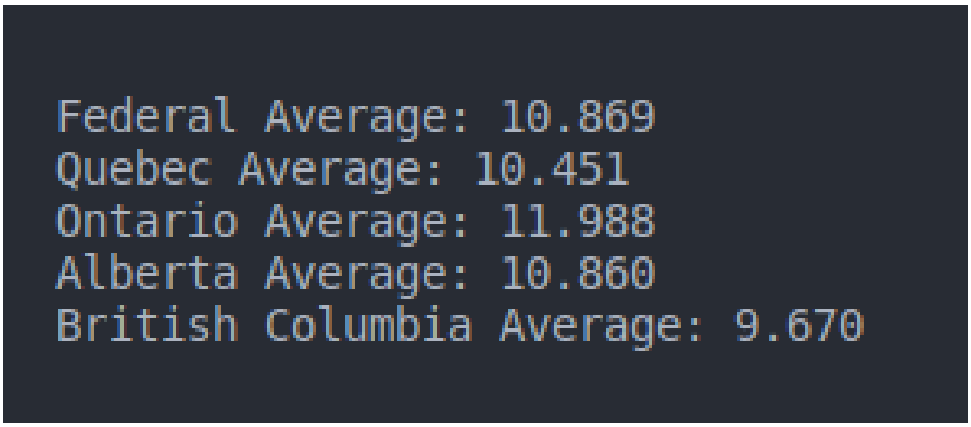
1. Determine the following averages of the percentage of the population that are diagnosed with diabetes. Present your outputs clearly within

your program with labels (explanatory text), not just the numbers by themselves.

(a) Provincial averages (Ontario, Quebec, British Columbia, Alberta). One average per province (for all years and age groups).

(b) One national (Canada excluding territories) average for all years and age groups.

Output:



Explaination:

Once the program is executed, it opens the "statscan_diabetes.csv" file and parses the data within the file. The program tokenizes each line in order the extract the year, the province, age group, gender and values for the group and stores them in an array of structs called "data_set", with each struct representing a single demographic group.

Variables are then initialized for each province to calculate the averages in each province and the federal average using the data stored in the "value" struct. To calculate the averages, all of the values are summed up and divided by the total number entries (ignoring the lines with no data entered) and then the averages stored in the variables are printed.

(c) Yearly averages (2015, 2016, 2017, 2018, 2019, 2020, 2021). One average per year (all age groups together) for each province and

the whole country (Canada excluding territories) for a total of 35 averages.

Output:

Year	Canada	Quebec	Ontario	Alberta	British Columbia
2015	10.600	10.900	10.767	9.320	9.300
2016	10.700	9.817	12.200	9.767	8.533
2017	10.950	9.583	11.983	11.967	10.140
2018	10.783	10.650	11.283	11.017	8.517
2019	11.700	0.000	13.033	11.333	11.440
2020	10.600	11.420	11.167	12.880	9.040
2021	10.750	10.467	11.483	9.817	11.650

Explaination:

To find the averages per year , variables were initialized to 0 for each year for each province. Then a nested loop is used to calculate and display the averages for each province per year.

Within each loop, the code checks the year of the current data point and converts the string values using the atof function to double values.

The non-zero values are then summed up and divided by the number of values to calculate the year-wise averages. The averages are then displayed in a table.

(d) The average percentage of diabetes among age groups (35-49, 60-64, 65+). One average per age group (all years) for each province and the whole country (Canada excluding territories).

Output:

Age-Group	Canada	Quebec	Ontario	Alberta	British Columbia
35-49	4.064	3.354	4.643	4.458	3.433
50-64	10.329	9.057	11.221	10.286	7.914
65+	18.214	18.436	19.243	16.921	15.436

Explaination:

The program defines several variables to hold the sums and averages for the different age groups (35 - 49, 50 - 64, and 65+) for the nation and the four provinces.

Then, like the previous question uses nested for-loops to iterate over the data set and for each age group and province it sums up all of the non-zero values, calculates and displays the averages in a table.

2. Determine which province has the highest percentage of diabetes (all years and age groups together as calculated in question 1a) and which province has the lowest percentage

Output:

```
The Province with the Lowest percentage of Diabetes is British Columbia
The Province with the Highest percentage of Diabetes is Ontario
```

Explaination:

The program defines variables to determine which province has the lowest and highest rates of diabetes. If and else if statements are used to compare all of the data from the variables. Then the variables are replaced with the highest and lowest averages respectively.

3. Indicate the provinces that have diabetes percentages above the national average (Canada excluding territories) and the provinces that are below the national average.

Output:

```
Provinces with a Diabetes percentage above the National Average are:

Ontario


Provinces with a Diabetes percentage below the National Average are:

Qubec
Alberta
British Columbia
```

Explanation:

The program recalls the national average and then uses if and else if statements to compare the earlier computed averages to the national average and displays which provinces are higher or lower than the national average.

4. Indicate which year and province has the highest percentage of diabetes. Do the same for the lowest percentage. In case of a tie, you can mention multiple years and provinces.

Output:

```
The Province with the highest & lowest percentage of diabetes in a year is British Columbia & Ontario in the year's "2019" & "2020"
```

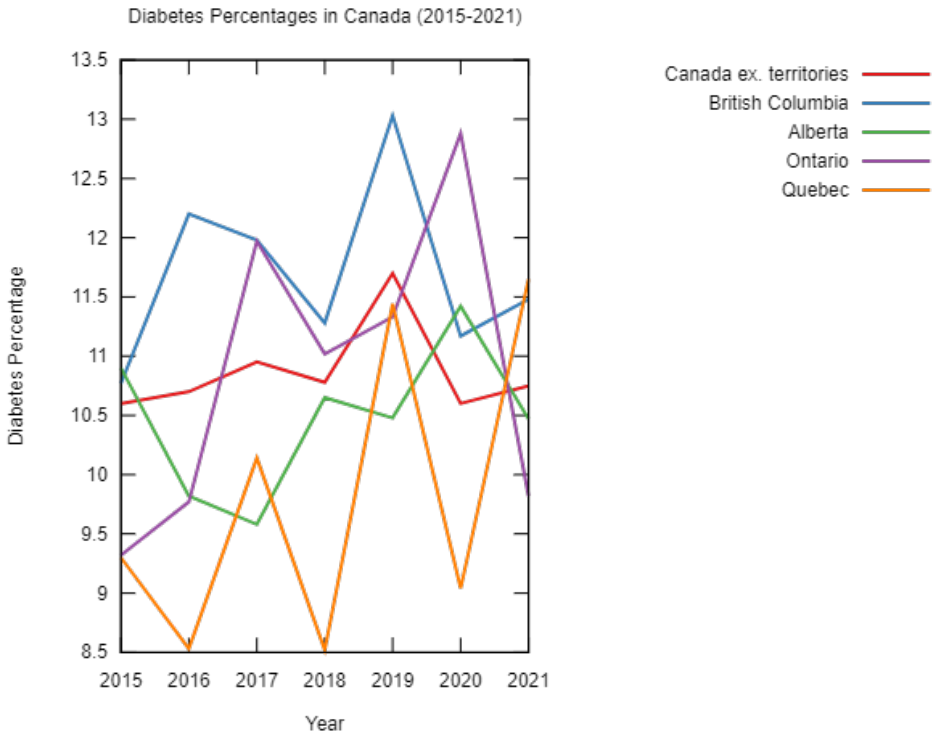
Explanation:

Lowest and highest variables are initialized to zero and counter variables are defined. The program loops through province averages and replaces the higher and lower values accordingly. It then prints out the provinces with the highest and lowest rates of diabetes and which years they occurred in.

3 Graphs

5. Make a graph (simple line plot) of the diabetes percentages for the years 2015 to 2021 (all age groups together). Make a single graph with the four provinces and the national average (indicated as Canada excluding territories) (5 lines). Use different line styles and/or colours for each line plot making sure the national line stands out from the other four. Label the axes clearly and add a title and a legend to your graph.

Output:



Explaination:

The line graph produced by this Gnuplot script shows the prevalence rates of diabetes in Canada from 2015 to 2021. The title of the plot accurately explains the goal of the chart, which is to display the prevalence of diabetes in Canada at this time.
The years are represented by the x-axis, which has a tick next to each year. The percentage of people who have diabetes is shown on the y-axis.The legend, which is displayed outside the chart on the right side, shows the colour and style of each plotted line.

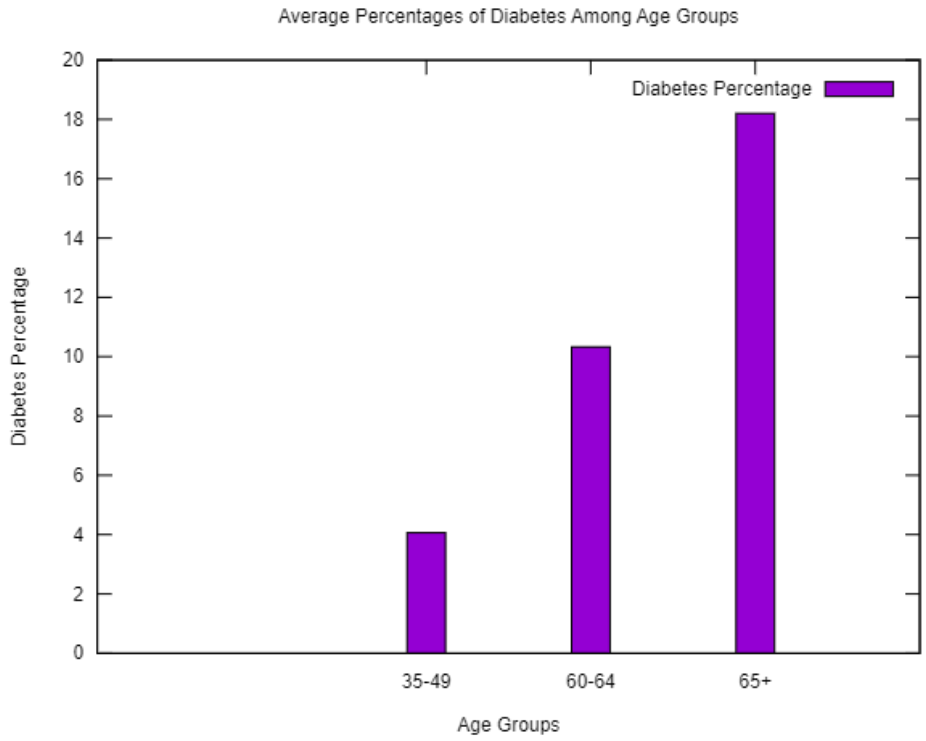
The code makes use of data from a file called "data4a.txt," which contains information on the prevalence rates of diabetes in the four provinces of British Columbia, Alberta, Ontario, and Quebec as well as Canada as a whole. Several line colors and styles are used to represent each province.

The file's data are plotted with the plot command "data4a.txt. "

According to the command "using 1:2," the file's first column should contain the x-axis data (year), and its second should contain the y-axis data (diabetes percentage). The plot command also defines the line style and color for each line in the legend, as well as the title for each line. With the "with lines" option, the plot command links data points with lines.

6. Make a graph (bar chart) that shows the average percentages of diabetes among the three age groups for the entire country. Label the axes clearly and add a title and a legend to your graph.

Output:



Explaination:

The graph (bar chart) depicts the average percentages of diabetes across three age groups for the entire country. The three ages (e.g., "18-34", "35-50", "65 and above").

The average prevalence rates of diabetes in various age groups are displayed in a histogram created by this GNUplot. The plot's x-axis displays the age groups, while its y-axis displays the proportion of diabetes cases. The script specifies the width of the histogram bars relative to the available space.

In addition, the y-axis range is configured to begin at 0 and terminate at 20, with a 2 unit gap between each y-tick. The height of the relevant bar in the bar chart indicates the prevalence of diabetes in each age group. This bar chart was plotted using a file called" q6.txt"

4 Conclusion

During the course of this term project, numerous issues were observed. Some common issues detected during the compilation of the program included various syntax errors and bugs. This encompassed logical issues present during the compilation of code. A never ending loop was most commonly found during multiple reruns, needing constant correction and adjustment. Another issue that arose was 'under defined array storage usage' due to having logic statements in unbreakable loops.

Addressing these matters in turn brought forth new concerns within the code; stack, time and buffer overflow errors. Albeit being difficult to address these issues, rewriting of the code and recompilation proved to eliminate said problems. As a result a new code was generated following the pre-identified parameters. This however proved to be a lengthy process despite peer contribution, as the script required constant debugging.

For future projects regarding CSV files, it would seem that generating a better algorithm to parse the CSV file on run time would address frequent issues; stack, time and buffer overflow issues. Primarily this form of change would affect time overflow issues, considerably reducing processing time with the preset parameters.

Other improvements if this project was to be redone include minimizing the use of additional global variables. This would minimize both stack overflow and buffer overflow issues observed in our code. In addition to reducing global variables, reducing pointer variables dereferencing to null will allow the program to abstain from crashes and exits. Additional improvements for future projects can include adding failsafe mechanisms to highlight errors within the code with great ease.

Appendices

A C Source Codes

A.1 Questions 1, 2, 3 & 4 Source Code

```
1
2
3  #include <stdio.h>
4  #include <stdlib.h>
5  #include <string.h>
6  #include <math.h>
7
8  /*  Defining program macros */
9
10 #define ARRAY_SIZE 500
11 #define LINE_SIZE 250
12 #define STRING_SIZE 50
13 #define SPACERS 3
14 #define SUB_SPACERS 2
15
16 /*  Initializing UDF's in program use   */
17
18 void credits(void);
19 FILE* file_o(void);
20 void file_c(FILE* file);
21 void spacer(void);
22 void sub_spacer(void);
23 void avg_province(void);
24 void avg_year(void);
25 void year_avg(double f_2015, double f_2016, double f_2017,
       double f_2018, double f_2019, double f_2020, double f_2021
       , double q_2015, double q_2016, double q_2017, double
       q_2018, double q_2019, double q_2020, double q_2021,
       double o_2015, double o_2016, double o_2017, double o_2018
       , double o_2019, double o_2020, double o_2021, double
       a_2015, double a_2016, double a_2017, double a_2018,
       double a_2019, double a_2020, double a_2021, double b_2015
       , double b_2016, double b_2017, double b_2018, double
       b_2019, double b_2020, double b_2021);
26 void avg_age(void);
27 void age_avg(double f_35, double f_50, double f_65, double
       q_35, double q_50, double q_65, double o_35, double o_50,
       double o_65, double a_35, double a_50, double a_65, double
        b_35, double b_50, double b_65);
28
29 /*  Initializing struct datatypes for CSV data  */
```

```
30
31 typedef struct {    /*  Struct to store every Parameter in a
      line as an array of tokens with respect to their
      induvidual fields */
32   char year[10];
33   char province[35];
34   char age_group[20];
35   char sex[10];
36   char values[10];
37   char temp_str[10];
38 } datatypes;    /*  Struct DataType Variable name defined as
      "datatypes"    */
39
40 void main(void)
41 {
42   credits();
43
44     FILE* f = file_o(); /*  Initializing File Operations
      */
45
46     datatypes data_set[ARRAY_SIZE];
47     char line[LINE_SIZE];
48
49     int line_count = 0; /*  Initializing Line Counter
      Variable to count Lines in the File   */
50
51     while (!feof(f))    /*  Initializing start of CORE
      program base function    */
52     {
53         if (line_count == 0)
54         {
55             fgets(line, LINE_SIZE, f);
56             line_count++;
57             continue;   /*  Parsing the first line as line 1
      encompasses labels and headers which are of no relavance
       */
58         }
59         fgets(line, LINE_SIZE, f);
60         line_count++;   /*  Line Counter Variable Update
      */
61
62         int token_count = 0;    /*  Initializing Token
      Counter Variable to count the tokens after String
      Tokenization   */
63         char* token = strtok(line, ",");    /*  Seperating
      the line string into subsequent smaller string based on
      Comma Seperation & Tokenizing a slice of string after ","
      delimiter as a parameter   */
64         strcpy(data_set[line_count].year, token);   /*
```

```
   Assigning a string value for the Year from this base
   iteration of Var(token) [NO CONDITION REQUIRED - FIRST
   FIED ENTRY IN FILE] */
65         //token_count++;  /*  Token Counter Variable Update
    */
66
67         while(token != NULL)
68         {
69             token = strtok(NULL, ",");
70             token_count++;  /*  Token Counter Variable Update
       */
71
72             /*if (token_count == 1)
73             {
74                 strcpy(data_set[line_count].province, token);
       //  Assigning a string value for Province from this
   iteration of Var(token) if conditional satisfied
75             }*/
76             if (token_count == 3)
77             {
78                 strcpy(data_set[line_count].age_group, token)
   ;  /*  Assiging a string value of Age Goup from this
   iteration of Var(token) if conditional is satisfied   */
79             }
80             else if (token_count == 4)
81             {
82                 strcpy(data_set[line_count].sex, token);
   /*  Assigning a string value of Sex from this iteration of
    Var(token) if conditional is satisfied   */
83             }
84             else if (token_count == 13)
85             {
86                 strcpy(data_set[line_count].values, token);
   /*  Assigning a string value of Values (Raw Percentage
   Floats) from this iterationm of Var(token) if condition is
    satisfied */
87             }
88             else if (token_count == 14)
89             {
90                 strcpy(data_set[line_count].temp_str, token);
       /*  Assigning a string temp trash value of string
   literal's after Var(values) to disregard "\"" delimiter
   from being concatenated into Values string [CONDITION IS
   ALWAYS SATISFIED - TOTAL TOKEN COUNT IS 19 - temp_str HAS
   FREE malloc(20) per cycle allocation]  */
91             }
92         }
93     }   /*  End of CORE program base function   */
94
```

```
95      file_c(f);  /*  Terminating File Operations */
96
97    printf("Note: All Mathematical values and operations are
       signified and represented as follows in accordance to the
       percent operater parameter. Please refer to Project
       documentation for further information.\n");
98
99      /*          Question 1          */printf("
       |-------------------------------------------------------------------------
       Question
       1-------------------------------------------------------------------------
       n");
100
101   spacer();
102   /*    Province Wise Averages    */avg_province();
103   spacer();
104
105     /*  Initializing Sum & Iterating Counter Variables for
       Province Averages Calculation  */
106
107     //  float sum_province - Variable to store the sum of the
       Value Data Points subsequently in every iteration
108     //  province_iterator_counter - Variable to calculate the
       number of iterations performed in the for loop
109
110     /*  Federal Variables   */
111
112     float sum_federal = 0;
113     int federal_iterator_counter = 0;
114
115     /*  Quebec Variables    */
116
117     float sum_quebec = 0;
118     int quebec_iterator_counter = 0;
119
120     /*  Ontario Variables   */
121
122     float sum_ontario = 0;
123     int ontario_iterator_counter = 0;
124
125     /*  Alberta Variables   */
126
127     float sum_alberta = 0;
128     int alberta_iterator_counter = 0;
129
130     /*  British Columbia Variables  */
131
132     float sum_british_columbia = 0;
133     int british_columbia_iterator_counter = 0;
```

```
134
135     /*  Federal Average Calculator  */
136
137     for (int i = 2; i < 44; i++, federal_iterator_counter++)
138     {
139       char add_val_f[10];   /*  Initializing char variable to
        copy char pointer to char variable type   */
140       char stg_val_f[10];   /*  Initializing char variable to
        store char to char recieved from char pointer */
141       strcpy(add_val_f, data_set[i].values);    /*  Copying
    to char variable from char pointer variable */
142       strcpy(stg_val_f, &add_val_f[1]); /*  Storing the char
    variable in another char variable to manipulate string
    literals    */
143       double values_federal = atof(stg_val_f);  /*
    Converting the stored char variable to a float type
    varaible data type for mathematical computational
    maniupulation */
144       if (values_federal == 0)
145       {
146         federal_iterator_counter--; /*  Fail-Safe Mechanism
    for not counting the iterations in the iterating counter
    factor if the condition is met [CONDITION IS ONLY
    SATISFIED IF THE atof FUNCTION RETURN 0, IFF THE Var(char)
     = NULL]   */
147       }
148       //printf("%.2lf\n",values_federal);   /*  Fail-Safe in
    Testing phase to verify succinctity of the values being
    read from atof function    */
149       sum_federal += values_federal;    /*  Calculation of
    Summa function of all data points being read that are not
    NULL   */
150     } double avg_federal = (sum_federal) / (
    federal_iterator_counter); printf("Federal Average: %.3lf\
    n", avg_federal); /*  Calculation of the Average function
    from the previous Summa function and iterator counter
    function as inputs    */
151
152     /*  Quebec Average Calculator   */
153
154     for (int i = 44; i < 86; i++, quebec_iterator_counter++)
155     {
156       char add_val_q[10];   /*  Initializing char variable to
        copy char pointer to char variable type   */
157       char stg_val_q[10];   /*  Initializing char variable to
        store char to char recieved from char pointer */
158       strcpy(add_val_q, data_set[i].values);    /*  Copying
    to char variable from char pointer variable */
159       strcpy(stg_val_q, &add_val_q[1]); /*  Storing the char
```

```
   variable in another char variable to manipulate string
   literals    */
160    double values_quebec = atof(stg_val_q);  /*  Converting
    the stored char variable to a float type varaible data
   type for mathematical computational maniupulation */
161    if (values_quebec == 0)
162    {
163      quebec_iterator_counter--; /*  Fail-Safe Mechanism
   for not counting the iterations in the iterating counter
   factor if the condition is met [CONDITION IS ONLY
   SATISFIED IF THE atof FUNCTION RETURN 0, IFF THE Var(char)
    = NULL]   */
164    }
165    //printf("%.2lf\n",values_quebec);   /*  Fail-Safe in
   Testing phase to verify succinctity of the values being
   read from atof function    */
166    sum_quebec += values_quebec;    /*  Calculation of
   Summa function of all data points being read that are not
   NULL   */
167   } double avg_quebec = (sum_quebec) / (
   quebec_iterator_counter); printf("Quebec Average: %.3lf\n"
   , avg_quebec);
168
169   /*  Ontario Average Calculator  */
170
171   for (int i = 86; i < 128; i++, ontario_iterator_counter
   ++)
172   {
173    char add_val_o[10];   /*  Initializing char variable to
    copy char pointer to char variable type   */
174    char stg_val_o[10];   /*  Initializing char variable to
    store char to char recieved from char pointer */
175    strcpy(add_val_o, data_set[i].values);    /*  Copying
   to char variable from char pointer variable */
176    strcpy(stg_val_o, &add_val_o[1]); /*  Storing the char
   variable in another char variable to manipulate string
   literals    */
177    double values_ontario = atof(stg_val_o);  /*
   Converting the stored char variable to a float type
   varaible data type for mathematical computational
   maniupulation */
178    if (sum_ontario == 0)
179    {
180      ontario_iterator_counter--; /*  Fail-Safe Mechanism
   for not counting the iterations in the iterating counter
   factor if the condition is met [CONDITION IS ONLY
   SATISFIED IF THE atof FUNCTION RETURN 0, IFF THE Var(char)
    = NULL]   */
181    }
```

```
182     //printf("%.2lf\n",values_ontario);   /*  Fail-Safe in
    Testing phase to verify succinctity of the values being
    read from atof function    */
183     sum_ontario += values_ontario;    /*  Calculation of
    Summa function of all data points being read that are not
    NULL   */
184    } double avg_ontario = (sum_ontario) / (
    ontario_iterator_counter); printf("Ontario Average: %.3lf\
    n", avg_ontario);
185
186    /*  Alberta Average Calculator  */
187
188    for (int i = 128; i < 170; i++, alberta_iterator_counter
    ++)
189    {
190     char add_val_a[10];   /*  Initializing char variable to
     copy char pointer to char variable type   */
191     char stg_val_a[10];   /*  Initializing char variable to
     store char to char recieved from char pointer */
192     strcpy(add_val_a, data_set[i].values);    /*  Copying
    to char variable from char pointer variable */
193     strcpy(stg_val_a, &add_val_a[1]); /*  Storing the char
    variable in another char variable to manipulate string
    literals    */
194     double values_alberta = atof(stg_val_a);  /*
    Converting the stored char variable to a float type
    varaible data type for mathematical computational
    maniupulation */
195     if (values_alberta == 0)
196     {
197       alberta_iterator_counter--; /*  Fail-Safe Mechanism
    for not counting the iterations in the iterating counter
    factor if the condition is met [CONDITION IS ONLY
    SATISFIED IF THE atof FUNCTION RETURN 0, IFF THE Var(char)
     = NULL]   */
198     }
199     //printf("%.2lf\n",values_alberta);   /*  Fail-Safe in
    Testing phase to verify succinctity of the values being
    read from atof function    */
200     sum_alberta += values_alberta;    /*  Calculation of
    Summa function of all data points being read that are not
    NULL   */
201    } double avg_alberta = (sum_alberta) / (
    alberta_iterator_counter); printf("Alberta Average: %.3lf\
    n", avg_alberta);
202
203    /*  British Columbia Average Calculator */
204
205    for (int i = 170; i < 212; i++,
```

```
   british_columbia_iterator_counter++)
206    {
207      char add_val_b[10];   /*  Initializing char variable to
    copy char pointer to char variable type   */
208      char stg_val_b[10];   /*  Initializing char variable to
    store char to char recieved from char pointer */
209      strcpy(add_val_b, data_set[i].values);    /*  Copying
   to char variable from char pointer variable */
210      strcpy(stg_val_b, &add_val_b[1]); /*  Storing the char
   variable in another char variable to manipulate string
   literals    */
211      double values_british_columbia = atof(stg_val_b);  /*
   Converting the stored char variable to a float type
   varaible data type for mathematical computational
   maniupulation */
212      if (values_british_columbia == 0)
213      {
214        british_columbia_iterator_counter--; /*  Fail-Safe
   Mechanism for not counting the iterations in the iterating
    counter factor if the condition is met [CONDITION IS ONLY
    SATISFIED IF THE atof FUNCTION RETURN 0, IFF THE Var(char
   ) = NULL]   */
215      }
216      //printf("%.2lf\n",values_british_columbia);   /*  Fail
   -Safe in Testing phase to verify succinctity of the values
    being read from atof function    */
217      sum_british_columbia += values_british_columbia;    /*
    Calculation of Summa function of all data points being
   read that are not NULL   */
218    } double avg_british_columbia = (sum_british_columbia) /
   (british_columbia_iterator_counter); printf("British
   Columbia Average: %.3lf\n", avg_british_columbia);
219
220  spacer();
221
222    /*  Year-Wise Average Calculator*/
223
224  /*    Year Wise Averages    */avg_year();
225  spacer();
226
227  /*  Initializing Sum & Iterating Counter Variables for Year
     Averages Calculation  */
228
229    //  double sum_year - Variable to store the sum of the
    Value Data Points subsequently in every iteration
230  //  double avg_year - Variable to store the average of the
    Value Data Points subsequently after all iterations
231    //  iterator_counter_year - Variable to calculate the
    number of iterations performed in the for loop
```

```
232
233 /*  2015 Variables  */
234
235   double sum_2015 = 0;
236 double avg_2015 = 0;
237 double sum_2015_f = 0;
238 double avg_2015_f = 0;
239 double sum_2015_q = 0;
240 double avg_2015_q = 0;
241 double sum_2015_o = 0;
242 double avg_2015_o = 0;
243 double sum_2015_a = 0;
244 double avg_2015_a = 0;
245 double sum_2015_b = 0;
246 double avg_2015_b = 0;
247 int iterator_counter_2015 = 0;
248 int iterator_counter_2015_f = 0;
249 int iterator_counter_2015_q = 0;
250 int iterator_counter_2015_o = 0;
251 int iterator_counter_2015_a = 0;
252 int iterator_counter_2015_b = 0;
253
254 /*  2016 Variables  */
255
256 double sum_2016 = 0;
257 double avg_2016 = 0;
258 double sum_2016_f = 0;
259 double avg_2016_f = 0;
260 double sum_2016_q = 0;
261 double avg_2016_q = 0;
262 double sum_2016_o = 0;
263 double avg_2016_o = 0;
264 double sum_2016_a = 0;
265 double avg_2016_a = 0;
266 double sum_2016_b = 0;
267 double avg_2016_b = 0;
268 int iterator_counter_2016 = 0;
269 int iterator_counter_2016_f = 0;
270 int iterator_counter_2016_q = 0;
271 int iterator_counter_2016_o = 0;
272 int iterator_counter_2016_a = 0;
273 int iterator_counter_2016_b = 0;
274
275 /*  2017 Variables  */
276
277 double sum_2017 = 0;
278 double avg_2017 = 0;
279 double sum_2017_f = 0;
280 double avg_2017_f = 0;
```

```
281   double sum_2017_q = 0;
282   double avg_2017_q = 0;
283   double sum_2017_o = 0;
284   double avg_2017_o = 0;
285   double sum_2017_a = 0;
286   double avg_2017_a = 0;
287   double sum_2017_b = 0;
288   double avg_2017_b = 0;
289   int iterator_counter_2017 = 0;
290   int iterator_counter_2017_f = 0;
291   int iterator_counter_2017_q = 0;
292   int iterator_counter_2017_o = 0;
293   int iterator_counter_2017_a = 0;
294   int iterator_counter_2017_b = 0;
295
296   /*  2018 Variables  */
297
298   double sum_2018 = 0;
299   double avg_2018 = 0;
300   double sum_2018_f = 0;
301   double avg_2018_f = 0;
302   double sum_2018_q = 0;
303   double avg_2018_q = 0;
304   double sum_2018_o = 0;
305   double avg_2018_o = 0;
306   double sum_2018_a = 0;
307   double avg_2018_a = 0;
308   double sum_2018_b = 0;
309   double avg_2018_b = 0;
310   int iterator_counter_2018 = 0;
311   int iterator_counter_2018_f = 0;
312   int iterator_counter_2018_q = 0;
313   int iterator_counter_2018_o = 0;
314   int iterator_counter_2018_a = 0;
315   int iterator_counter_2018_b = 0;
316
317   /*  2019 Variables  */
318
319   double sum_2019 = 0;
320   double avg_2019 = 0;
321   double sum_2019_f = 0;
322   double avg_2019_f = 0;
323   double sum_2019_q = 0;
324   double avg_2019_q = 0;
325   double sum_2019_o = 0;
326   double avg_2019_o = 0;
327   double sum_2019_a = 0;
328   double avg_2019_a = 0;
329   double sum_2019_b = 0;
```

```
330   double avg_2019_b = 0;
331   int iterator_counter_2019 = 0;
332   int iterator_counter_2019_f = 0;
333   int iterator_counter_2019_q = 0;
334   int iterator_counter_2019_o = 0;
335   int iterator_counter_2019_a = 0;
336   int iterator_counter_2019_b = 0;
337
338   /*  2020 Variables  */
339
340   double sum_2020 = 0;
341   double avg_2020 = 0;
342   double sum_2020_f = 0;
343   double avg_2020_f = 0;
344   double sum_2020_q = 0;
345   double avg_2020_q = 0;
346   double sum_2020_o = 0;
347   double avg_2020_o = 0;
348   double sum_2020_a = 0;
349   double avg_2020_a = 0;
350   double sum_2020_b = 0;
351   double avg_2020_b = 0;
352   int iterator_counter_2020 = 0;
353   int iterator_counter_2020_f = 0;
354   int iterator_counter_2020_q = 0;
355   int iterator_counter_2020_o = 0;
356   int iterator_counter_2020_a = 0;
357   int iterator_counter_2020_b = 0;
358
359   /*  2021 Variables  */
360
361   double sum_2021 = 0;
362   double avg_2021 = 0;
363   double sum_2021_f = 0;
364   double avg_2021_f = 0;
365   double sum_2021_q = 0;
366   double avg_2021_q = 0;
367   double sum_2021_o = 0;
368   double avg_2021_o = 0;
369   double sum_2021_a = 0;
370   double avg_2021_a = 0;
371   double sum_2021_b = 0;
372   double avg_2021_b = 0;
373   int iterator_counter_2021 = 0;
374   int iterator_counter_2021_f = 0;
375   int iterator_counter_2021_q = 0;
376   int iterator_counter_2021_o = 0;
377   int iterator_counter_2021_a = 0;
378   int iterator_counter_2021_b = 0;
```

```
379
380     for (int i = 0; i < ARRAY_SIZE; i++)
381     {
382     for (int j = 2; j < 44; j++)  /*  Federal Year-Wise
    Average Calculator  */
383     {
384       char add_val_y[10];
385       char stg_val_y[10];
386       strcpy(add_val_y, data_set[j].year);
387       strcpy(stg_val_y, &add_val_y[1]);
388       double year = atof(stg_val_y);
389
390       if (year == 2015)
391       {
392         iterator_counter_2015_f++;
393         char add_val_2015[10];
394         char stg_val_2015[10];
395         strcpy(add_val_2015, data_set[j].values);
396         strcpy(stg_val_2015, &add_val_2015[1]);
397         double values_2015 = atof(stg_val_2015);
398         if (values_2015 == 0)
399         {
400           iterator_counter_2015_f--;
401         }
402
403         sum_2015_f += values_2015;
404       } avg_2015_f = sum_2015_f / iterator_counter_2015_f;
405       if (year == 2016)
406       {
407         iterator_counter_2016_f++;
408         char add_val_2016[10];
409         char stg_val_2016[10];
410         strcpy(add_val_2016, data_set[j].values);
411         strcpy(stg_val_2016, &add_val_2016[1]);
412         double values_2016 = atof(stg_val_2016);
413         if (values_2016 == 0)
414         {
415           iterator_counter_2016_f--;
416         }
417
418         sum_2016_f += values_2016;
419       } avg_2016_f = sum_2016_f / iterator_counter_2016_f;
420       if (year == 2017)
421       {
422         iterator_counter_2017_f++;
423         char add_val_2017[10];
424         char stg_val_2017[10];
425         strcpy(add_val_2017, data_set[j].values);
426         strcpy(stg_val_2017, &add_val_2017[1]);
```

```
427         double values_2017 = atof(stg_val_2017);
428         if (values_2017 == 0)
429         {
430           iterator_counter_2017_f--;
431         }
432 
433         sum_2017_f += values_2017;
434       } avg_2017_f = sum_2017_f / iterator_counter_2017_f;
435       if (year == 2018)
436       {
437         iterator_counter_2018_f++;
438         char add_val_2018[10];
439         char stg_val_2018[10];
440         strcpy(add_val_2018, data_set[j].values);
441         strcpy(stg_val_2018, &add_val_2018[1]);
442         double values_2018 = atof(stg_val_2018);
443         if (values_2018 == 0)
444         {
445           iterator_counter_2018_f--;
446         }
447 
448         sum_2018_f += values_2018;
449       } avg_2018_f = sum_2018_f / iterator_counter_2018_f;
450       if (year == 2019)
451       {
452         iterator_counter_2019_f++;
453         char add_val_2019[10];
454         char stg_val_2019[10];
455         strcpy(add_val_2019, data_set[j].values);
456         strcpy(stg_val_2019, &add_val_2019[1]);
457         double values_2019 = atof(stg_val_2019);
458         if (values_2019 == 0)
459         {
460           iterator_counter_2019_f--;
461         }
462 
463         sum_2019_f += values_2019;
464       } avg_2019_f = sum_2019_f / iterator_counter_2019_f;
465       if (year == 2020)
466       {
467         iterator_counter_2020_f++;
468         char add_val_2020[10];
469         char stg_val_2020[10];
470         strcpy(add_val_2020, data_set[j].values);
471         strcpy(stg_val_2020, &add_val_2020[1]);
472         double values_2020 = atof(stg_val_2020);
473         if (values_2020 == 0)
474         {
475           iterator_counter_2020_f--;
```

```
476         }
477
478         sum_2020_f += values_2020;
479       } avg_2020_f = sum_2020_f / iterator_counter_2020_f;
480       if (year == 2021)
481       {
482         iterator_counter_2021_f++;
483         char add_val_2021[10];
484         char stg_val_2021[10];
485         strcpy(add_val_2021, data_set[j].values);
486         strcpy(stg_val_2021, &add_val_2021[1]);
487         double values_2021 = atof(stg_val_2021);
488         if (values_2021 == 0)
489         {
490           iterator_counter_2021_f--;
491         }
492
493         sum_2021_f += values_2021;
494       } avg_2021_f = sum_2021_f / iterator_counter_2021_f;
495     }
496     for (int j = 44; j < 86; j++) /*  Quebec Year-Wise
    Average Calculator */
497     {
498       char add_val_y[10];
499       char stg_val_y[10];
500       strcpy(add_val_y, data_set[j].year);
501       strcpy(stg_val_y, &add_val_y[1]);
502       double year = atof(stg_val_y);
503
504       if (year == 2015)
505       {
506         iterator_counter_2015_q++;
507         char add_val_2015[10];
508         char stg_val_2015[10];
509         strcpy(add_val_2015, data_set[j].values);
510         strcpy(stg_val_2015, &add_val_2015[1]);
511         double values_2015 = atof(stg_val_2015);
512         if (values_2015 == 0)
513         {
514           iterator_counter_2015_q--;
515         }
516
517         sum_2015_q += values_2015;
518       } avg_2015_q = sum_2015_q / iterator_counter_2015_q;
519       if (year == 2016)
520       {
521         iterator_counter_2016_q++;
522         char add_val_2016[10];
523         char stg_val_2016[10];
```

```
524         strcpy(add_val_2016, data_set[j].values);
525         strcpy(stg_val_2016, &add_val_2016[1]);
526         double values_2016 = atof(stg_val_2016);
527         if (values_2016 == 0)
528         {
529           iterator_counter_2016_q--;
530         }
531 
532         sum_2016_q += values_2016;
533       } avg_2016_q = sum_2016_q / iterator_counter_2016_q;
534       if (year == 2017)
535       {
536         iterator_counter_2017_q++;
537         char add_val_2017[10];
538         char stg_val_2017[10];
539         strcpy(add_val_2017, data_set[j].values);
540         strcpy(stg_val_2017, &add_val_2017[1]);
541         double values_2017 = atof(stg_val_2017);
542         if (values_2017 == 0)
543         {
544           iterator_counter_2017_q--;
545         }
546 
547         sum_2017_q += values_2017;
548       } avg_2017_q = sum_2017_q / iterator_counter_2017_q;
549       if (year == 2018)
550       {
551         iterator_counter_2018_q++;
552         char add_val_2018[10];
553         char stg_val_2018[10];
554         strcpy(add_val_2018, data_set[j].values);
555         strcpy(stg_val_2018, &add_val_2018[1]);
556         double values_2018 = atof(stg_val_2018);
557         if (values_2018 == 0)
558         {
559           iterator_counter_2018_q--;
560         }
561 
562         sum_2018_q += values_2018;
563       } avg_2018_q = sum_2018_q / iterator_counter_2018_q;
564       if (year == 2019)
565       {
566         iterator_counter_2019_q++;
567         char add_val_2019[10];
568         char stg_val_2019[10];
569         strcpy(add_val_2019, data_set[j].values);
570         strcpy(stg_val_2019, &add_val_2019[1]);
571         double values_2019 = atof(stg_val_2019);
572         if (values_2019 == 0)
```

```
573         {
574           iterator_counter_2019_q--;
575         }
576 
577         sum_2019 += values_2019;
578       } avg_2019_q = sum_2019_q / iterator_counter_2019_q;
579       if (year == 2020)
580       {
581         iterator_counter_2020_q++;
582         char add_val_2020[10];
583         char stg_val_2020[10];
584         strcpy(add_val_2020, data_set[j].values);
585         strcpy(stg_val_2020, &add_val_2020[1]);
586         double values_2020 = atof(stg_val_2020);
587         if (values_2020 == 0)
588         {
589           iterator_counter_2020_q--;
590         }
591 
592         sum_2020_q += values_2020;
593       } avg_2020_q = sum_2020_q / iterator_counter_2020_q;
594       if (year == 2021)
595       {
596         iterator_counter_2021_q++;
597         char add_val_2021[10];
598         char stg_val_2021[10];
599         strcpy(add_val_2021, data_set[j].values);
600         strcpy(stg_val_2021, &add_val_2021[1]);
601         double values_2021 = atof(stg_val_2021);
602         if (values_2021 == 0)
603         {
604           iterator_counter_2021_q--;
605         }
606 
607         sum_2021_q += values_2021;
608       } avg_2021_q = sum_2021_q / iterator_counter_2021_q;
609     }
610     for (int j = 86; j < 128; j++)  /*  Ontario Year-Wise
    Average Calculator  */
611     {
612       char add_val_y[10];
613       char stg_val_y[10];
614       strcpy(add_val_y, data_set[j].year);
615       strcpy(stg_val_y, &add_val_y[1]);
616       double year = atof(stg_val_y);
617 
618       if (year == 2015)
619       {
620         iterator_counter_2015_o++;
```

```
621         char add_val_2015[10];
622         char stg_val_2015[10];
623         strcpy(add_val_2015, data_set[j].values);
624         strcpy(stg_val_2015, &add_val_2015[1]);
625         double values_2015 = atof(stg_val_2015);
626         if (values_2015 == 0)
627         {
628           iterator_counter_2015_o--;
629         }
630 
631         sum_2015_o += values_2015;
632       } avg_2015_o = sum_2015_o / iterator_counter_2015_o;
633       if (year == 2016)
634       {
635         iterator_counter_2016_o++;
636         char add_val_2016[10];
637         char stg_val_2016[10];
638         strcpy(add_val_2016, data_set[j].values);
639         strcpy(stg_val_2016, &add_val_2016[1]);
640         double values_2016 = atof(stg_val_2016);
641         if (values_2016 == 0)
642         {
643           iterator_counter_2016_o--;
644         }
645 
646         sum_2016_o += values_2016;
647       } avg_2016_o = sum_2016_o / iterator_counter_2016_o;
648       if (year == 2017)
649       {
650         iterator_counter_2017_o++;
651         char add_val_2017[10];
652         char stg_val_2017[10];
653         strcpy(add_val_2017, data_set[j].values);
654         strcpy(stg_val_2017, &add_val_2017[1]);
655         double values_2017 = atof(stg_val_2017);
656         if (values_2017 == 0)
657         {
658           iterator_counter_2017_o--;
659         }
660 
661         sum_2017_o += values_2017;
662       } avg_2017_o = sum_2017_o / iterator_counter_2017_o;
663       if (year == 2018)
664       {
665         iterator_counter_2018_o++;
666         char add_val_2018[10];
667         char stg_val_2018[10];
668         strcpy(add_val_2018, data_set[j].values);
669         strcpy(stg_val_2018, &add_val_2018[1]);
```

```
670         double values_2018 = atof(stg_val_2018);
671         if (values_2018 == 0)
672         {
673           iterator_counter_2018_o--;
674         }
675 
676         sum_2018_o += values_2018;
677       } avg_2018_o = sum_2018_o / iterator_counter_2018_o;
678       if (year == 2019)
679       {
680         iterator_counter_2019_o++;
681         char add_val_2019[10];
682         char stg_val_2019[10];
683         strcpy(add_val_2019, data_set[j].values);
684         strcpy(stg_val_2019, &add_val_2019[1]);
685         double values_2019 = atof(stg_val_2019);
686         if (values_2019 == 0)
687         {
688           iterator_counter_2019_o--;
689         }
690 
691         sum_2019_o += values_2019;
692       } avg_2019_o = sum_2019_o / iterator_counter_2019_o;
693       if (year == 2020)
694       {
695         iterator_counter_2020_o++;
696         char add_val_2020[10];
697         char stg_val_2020[10];
698         strcpy(add_val_2020, data_set[j].values);
699         strcpy(stg_val_2020, &add_val_2020[1]);
700         double values_2020 = atof(stg_val_2020);
701         if (values_2020 == 0)
702         {
703           iterator_counter_2020_o--;
704         }
705 
706         sum_2020_o += values_2020;
707       } avg_2020_o = sum_2020_o / iterator_counter_2020_o;
708       if (year == 2021)
709       {
710         iterator_counter_2021_o++;
711         char add_val_2021[10];
712         char stg_val_2021[10];
713         strcpy(add_val_2021, data_set[j].values);
714         strcpy(stg_val_2021, &add_val_2021[1]);
715         double values_2021 = atof(stg_val_2021);
716         if (values_2021 == 0)
717         {
718           iterator_counter_2021_o--;
```

```
719         }
720
721         sum_2021_o += values_2021;
722       } avg_2021_o = sum_2021_o / iterator_counter_2021_o;
723     }
724     for (int j = 128; j < 170; j++) /*  Alberta Year-Wise
    Average Calculator  */
725     {
726       char add_val_y[10];
727       char stg_val_y[10];
728       strcpy(add_val_y, data_set[j].year);
729       strcpy(stg_val_y, &add_val_y[1]);
730       double year = atof(stg_val_y);
731
732       if (year == 2015)
733       {
734         iterator_counter_2015_a++;
735         char add_val_2015[10];
736         char stg_val_2015[10];
737         strcpy(add_val_2015, data_set[j].values);
738         strcpy(stg_val_2015, &add_val_2015[1]);
739         double values_2015 = atof(stg_val_2015);
740         if (values_2015 == 0)
741         {
742           iterator_counter_2015_a--;
743         }
744
745         sum_2015_a += values_2015;
746       } avg_2015_a = sum_2015_a / iterator_counter_2015_a;
747       if (year == 2016)
748       {
749         iterator_counter_2016_a++;
750         char add_val_2016[10];
751         char stg_val_2016[10];
752         strcpy(add_val_2016, data_set[j].values);
753         strcpy(stg_val_2016, &add_val_2016[1]);
754         double values_2016 = atof(stg_val_2016);
755         if (values_2016 == 0)
756         {
757           iterator_counter_2016_a--;
758         }
759
760         sum_2016_a += values_2016;
761       } avg_2016_a = sum_2016_a / iterator_counter_2016_a;
762       if (year == 2017)
763       {
764         iterator_counter_2017_a++;
765         char add_val_2017[10];
766         char stg_val_2017[10];
```

```
767         strcpy(add_val_2017, data_set[j].values);
768         strcpy(stg_val_2017, &add_val_2017[1]);
769         double values_2017 = atof(stg_val_2017);
770         if (values_2017 == 0)
771         {
772           iterator_counter_2017_a--;
773         }
774 
775         sum_2017_a += values_2017;
776       } avg_2017_a = sum_2017_a / iterator_counter_2017_a;
777       if (year == 2018)
778       {
779         iterator_counter_2018_a++;
780         char add_val_2018[10];
781         char stg_val_2018[10];
782         strcpy(add_val_2018, data_set[j].values);
783         strcpy(stg_val_2018, &add_val_2018[1]);
784         double values_2018 = atof(stg_val_2018);
785         if (values_2018 == 0)
786         {
787           iterator_counter_2018_a--;
788         }
789 
790         sum_2018_a += values_2018;
791       } avg_2018_a = sum_2018_a / iterator_counter_2018_a;
792       if (year == 2019)
793       {
794         iterator_counter_2019_a++;
795         char add_val_2019[10];
796         char stg_val_2019[10];
797         strcpy(add_val_2019, data_set[j].values);
798         strcpy(stg_val_2019, &add_val_2019[1]);
799         double values_2019 = atof(stg_val_2019);
800         if (values_2019 == 0)
801         {
802           iterator_counter_2019_a--;
803         }
804 
805         sum_2019_a += values_2019;
806       } avg_2019_a = sum_2019_a / iterator_counter_2019_a;
807       if (year == 2020)
808       {
809         iterator_counter_2020_a++;
810         char add_val_2020[10];
811         char stg_val_2020[10];
812         strcpy(add_val_2020, data_set[j].values);
813         strcpy(stg_val_2020, &add_val_2020[1]);
814         double values_2020 = atof(stg_val_2020);
815         if (values_2020 == 0)
```

```
816         {
817           iterator_counter_2020_a--;
818         }
819 
820         sum_2020_a += values_2020;
821       } avg_2020_a = sum_2020_a / iterator_counter_2020_a;
822       if (year == 2021)
823       {
824         iterator_counter_2021_a++;
825         char add_val_2021[10];
826         char stg_val_2021[10];
827         strcpy(add_val_2021, data_set[j].values);
828         strcpy(stg_val_2021, &add_val_2021[1]);
829         double values_2021 = atof(stg_val_2021);
830         if (values_2021 == 0)
831         {
832           iterator_counter_2021_a--;
833         }
834 
835         sum_2021_a += values_2021;
836       } avg_2021_a = sum_2021_a / iterator_counter_2021_a;
837     }
838     for (int j = 170; j < 212; j++) /*  British Columbia Year
    -Wise Average Calculator */
839     {
840       char add_val_y[10];
841       char stg_val_y[10];
842       strcpy(add_val_y, data_set[j].year);
843       strcpy(stg_val_y, &add_val_y[1]);
844       double year = atof(stg_val_y);
845 
846       if (year == 2015)
847       {
848         iterator_counter_2015_b++;
849         char add_val_2015[10];
850         char stg_val_2015[10];
851         strcpy(add_val_2015, data_set[j].values);
852         strcpy(stg_val_2015, &add_val_2015[1]);
853         double values_2015 = atof(stg_val_2015);
854         if (values_2015 == 0)
855         {
856           iterator_counter_2015_b--;
857         }
858 
859         sum_2015_b += values_2015;
860       } avg_2015_b = sum_2015_b / iterator_counter_2015_b;
861       if (year == 2016)
862       {
863         iterator_counter_2016_b++;
```

```
        char add_val_2016[10];
        char stg_val_2016[10];
        strcpy(add_val_2016, data_set[j].values);
        strcpy(stg_val_2016, &add_val_2016[1]);
        double values_2016 = atof(stg_val_2016);
        if (values_2016 == 0)
        {
          iterator_counter_2016_b--;
        }

        sum_2016_b += values_2016;
      } avg_2016_b = sum_2016_b / iterator_counter_2016_b;
      if (year == 2017)
      {
        iterator_counter_2017_b++;
        char add_val_2017[10];
        char stg_val_2017[10];
        strcpy(add_val_2017, data_set[j].values);
        strcpy(stg_val_2017, &add_val_2017[1]);
        double values_2017 = atof(stg_val_2017);
        if (values_2017 == 0)
        {
          iterator_counter_2017_b--;
        }

        sum_2017_b += values_2017;
      } avg_2017_b = sum_2017_b / iterator_counter_2017_b;
      if (year == 2018)
      {
        iterator_counter_2018_b++;
        char add_val_2018[10];
        char stg_val_2018[10];
        strcpy(add_val_2018, data_set[j].values);
        strcpy(stg_val_2018, &add_val_2018[1]);
        double values_2018 = atof(stg_val_2018);
        if (values_2018 == 0)
        {
          iterator_counter_2018_b--;
        }

        sum_2018_b += values_2018;
      } avg_2018_b = sum_2018_b / iterator_counter_2018_b;
      if (year == 2019)
      {
        iterator_counter_2019_b++;
        char add_val_2019[10];
        char stg_val_2019[10];
        strcpy(add_val_2019, data_set[j].values);
        strcpy(stg_val_2019, &add_val_2019[1]);
```

```
913         double values_2019 = atof(stg_val_2019);
914         if (values_2019 == 0)
915         {
916           iterator_counter_2019_b--;
917         }
918 
919         sum_2019_b += values_2019;
920       } avg_2019_b = sum_2019_b / iterator_counter_2019_b;
921       if (year == 2020)
922       {
923         iterator_counter_2020_b++;
924         char add_val_2020[10];
925         char stg_val_2020[10];
926         strcpy(add_val_2020, data_set[j].values);
927         strcpy(stg_val_2020, &add_val_2020[1]);
928         double values_2020 = atof(stg_val_2020);
929         if (values_2020 == 0)
930         {
931           iterator_counter_2020_b--;
932         }
933 
934         sum_2020_b += values_2020;
935       } avg_2020_b = sum_2020_b / iterator_counter_2020_b;
936       if (year == 2021)
937       {
938         iterator_counter_2021_b++;
939         char add_val_2021[10];
940         char stg_val_2021[10];
941         strcpy(add_val_2021, data_set[j].values);
942         strcpy(stg_val_2021, &add_val_2021[1]);
943         double values_2021 = atof(stg_val_2021);
944         if (values_2021 == 0)
945         {
946           iterator_counter_2021_b--;
947         }
948 
949         sum_2021_b += values_2021;
950       } avg_2021_b = sum_2021_b / iterator_counter_2021_b;
951     }
952 
953 
954     } year_avg(avg_2015_f, avg_2016_f, avg_2017_f, avg_2018_f
    , avg_2019_f, avg_2020_f, avg_2021_f, avg_2015_q,
    avg_2016_q, avg_2017_q, avg_2018_q, avg_2019_q, avg_2020_q
    , avg_2021_q, avg_2015_o, avg_2016_o, avg_2017_o,
    avg_2018_o, avg_2019_o, avg_2020_o, avg_2021_o, avg_2015_a
    , avg_2016_a, avg_2017_a, avg_2018_a, avg_2019_a,
    avg_2020_a, avg_2021_a, avg_2015_b, avg_2016_b, avg_2017_b
    , avg_2018_b, avg_2019_b, avg_2020_b, avg_2021_b);
```

```
955
956  spacer();
957
958    /*  Age-Group-Wise Average Calculator*/
959
960  /*    Age-Group Wise Averages    */avg_age();
961  spacer();
962
963  /*  Initializing Sum & Iterating Counter Variables for Age-
       Group Averages Calculation */
964
965    //  double sum_year - Variable to store the sum of the
       Value Data Points subsequently in every iteration
966  //  double avg_year - Variable to store the average of the
       Value Data Points subsequently after all iterations
967    //  iterator_counter_year - Variable to calculate the
       number of iterations performed in the for loop
968
969  /*  35-49 Age Group Variables */
970
971    double sum_35 = 0;
972  double avg_35 = 0;
973  double sum_35_f = 0;
974  double avg_35_f = 0;
975  double sum_35_q = 0;
976  double avg_35_q = 0;
977  double sum_35_o = 0;
978  double avg_35_o = 0;
979  double sum_35_a = 0;
980  double avg_35_a = 0;
981  double sum_35_b = 0;
982  double avg_35_b = 0;
983  int iterator_counter_35 = 0;
984  int iterator_counter_35_f = 0;
985  int iterator_counter_35_q = 0;
986  int iterator_counter_35_o = 0;
987  int iterator_counter_35_a = 0;
988  int iterator_counter_35_b = 0;
989
990  /*  50-65 Age Group Variables */
991
992  double sum_50 = 0;
993  double avg_50 = 0;
994  double sum_50_f = 0;
995  double avg_50_f = 0;
996  double sum_50_q = 0;
997  double avg_50_q = 0;
998  double sum_50_o = 0;
999  double avg_50_o = 0;
```

```
1000   double sum_50_a = 0;
1001   double avg_50_a = 0;
1002   double sum_50_b = 0;
1003   double avg_50_b = 0;
1004   int iterator_counter_50 = 0;
1005   int iterator_counter_50_f = 0;
1006   int iterator_counter_50_q = 0;
1007   int iterator_counter_50_o = 0;
1008   int iterator_counter_50_a = 0;
1009   int iterator_counter_50_b = 0;
1010
1011   /*  65+ Age Group Variables */
1012
1013   double sum_65 = 0;
1014   double avg_65 = 0;
1015   double sum_65_f = 0;
1016   double avg_65_f = 0;
1017   double sum_65_q = 0;
1018   double avg_65_q = 0;
1019   double sum_65_o = 0;
1020   double avg_65_o = 0;
1021   double sum_65_a = 0;
1022   double avg_65_a = 0;
1023   double sum_65_b = 0;
1024   double avg_65_b = 0;
1025   int iterator_counter_65 = 0;
1026   int iterator_counter_65_f = 0;
1027   int iterator_counter_65_q = 0;
1028   int iterator_counter_65_o = 0;
1029   int iterator_counter_65_a = 0;
1030   int iterator_counter_65_b = 0;
1031
1032     for (int i = 0; i < ARRAY_SIZE; i++)
1033     {
1034     for (int j = 2; j < 44; j++)  /*  Federal Age-Group-Wise
       Average Calculator */
1035     {
1036       char add_val_y[10];
1037       char stg_val_y[10];
1038       strcpy(add_val_y, data_set[j].age_group);
1039       strcpy(stg_val_y, &add_val_y[1]);
1040       double age_group = atof(stg_val_y);
1041
1042       if (age_group == 35)
1043       {
1044         iterator_counter_35_f++;
1045         char add_val_2015[10];
1046         char stg_val_2015[10];
1047         strcpy(add_val_2015, data_set[j].values);
```

```
1048        strcpy(stg_val_2015, &add_val_2015[1]);
1049        double values_2015 = atof(stg_val_2015);
1050        if (values_2015 == 0)
1051        {
1052          iterator_counter_35_f--;
1053        }
1054
1055        sum_35_f += values_2015;
1056      } avg_35_f = sum_35_f / iterator_counter_35_f;
1057      if (age_group == 50)
1058      {
1059        iterator_counter_50_f++;
1060        char add_val_2016[10];
1061        char stg_val_2016[10];
1062        strcpy(add_val_2016, data_set[j].values);
1063        strcpy(stg_val_2016, &add_val_2016[1]);
1064        double values_2016 = atof(stg_val_2016);
1065        if (values_2016 == 0)
1066        {
1067          iterator_counter_50_f--;
1068        }
1069
1070        sum_50_f += values_2016;
1071      } avg_50_f = sum_50_f / iterator_counter_50_f;
1072      if (age_group == 65)
1073      {
1074        iterator_counter_65_f++;
1075        char add_val_2017[10];
1076        char stg_val_2017[10];
1077        strcpy(add_val_2017, data_set[j].values);
1078        strcpy(stg_val_2017, &add_val_2017[1]);
1079        double values_2017 = atof(stg_val_2017);
1080        if (values_2017 == 0)
1081        {
1082          iterator_counter_65_f--;
1083        }
1084
1085        sum_65_f += values_2017;
1086      } avg_65_f = sum_65_f / iterator_counter_65_f;
1087    }
1088    for (int j = 44; j < 86; j++) /*  Quebec Age-Group-Wise
     Average Calculator  */
1089    {
1090      char add_val_y[10];
1091      char stg_val_y[10];
1092      strcpy(add_val_y, data_set[j].age_group);
1093      strcpy(stg_val_y, &add_val_y[1]);
1094      double age_group = atof(stg_val_y);
1095
```

```
1096        if (age_group == 35)
1097        {
1098          iterator_counter_35_q++;
1099          char add_val_2015[10];
1100          char stg_val_2015[10];
1101          strcpy(add_val_2015, data_set[j].values);
1102          strcpy(stg_val_2015, &add_val_2015[1]);
1103          double values_2015 = atof(stg_val_2015);
1104          if (values_2015 == 0)
1105          {
1106            iterator_counter_35_q--;
1107          }
1108
1109          sum_35_q += values_2015;
1110        } avg_35_q = sum_35_q / iterator_counter_35_q;
1111        if (age_group == 50)
1112        {
1113          iterator_counter_50_q++;
1114          char add_val_2016[10];
1115          char stg_val_2016[10];
1116          strcpy(add_val_2016, data_set[j].values);
1117          strcpy(stg_val_2016, &add_val_2016[1]);
1118          double values_2016 = atof(stg_val_2016);
1119          if (values_2016 == 0)
1120          {
1121            iterator_counter_50_q--;
1122          }
1123
1124          sum_50_q += values_2016;
1125        } avg_50_q = sum_50_q / iterator_counter_50_q;
1126        if (age_group == 65)
1127        {
1128          iterator_counter_65_q++;
1129          char add_val_2017[10];
1130          char stg_val_2017[10];
1131          strcpy(add_val_2017, data_set[j].values);
1132          strcpy(stg_val_2017, &add_val_2017[1]);
1133          double values_2017 = atof(stg_val_2017);
1134          if (values_2017 == 0)
1135          {
1136            iterator_counter_65_q--;
1137          }
1138
1139          sum_65_q += values_2017;
1140        } avg_65_q = sum_65_q / iterator_counter_65_q;
1141      }
1142      for (int j = 86; j < 128; j++)  /*  Ontario Age-Group-
    Wise Average Calculator */
1143      {
```

```
      char add_val_y[10];
      char stg_val_y[10];
      strcpy(add_val_y, data_set[j].age_group);
      strcpy(stg_val_y, &add_val_y[1]);
      double age_group = atof(stg_val_y);

      if (age_group == 35)
      {
        iterator_counter_35_o++;
        char add_val_2015[10];
        char stg_val_2015[10];
        strcpy(add_val_2015, data_set[j].values);
        strcpy(stg_val_2015, &add_val_2015[1]);
        double values_2015 = atof(stg_val_2015);
        if (values_2015 == 0)
        {
          iterator_counter_35_o--;
        }

        sum_35_o += values_2015;
      } avg_35_o = sum_35_o / iterator_counter_35_o;
      if (age_group == 50)
      {
        iterator_counter_50_o++;
        char add_val_2016[10];
        char stg_val_2016[10];
        strcpy(add_val_2016, data_set[j].values);
        strcpy(stg_val_2016, &add_val_2016[1]);
        double values_2016 = atof(stg_val_2016);
        if (values_2016 == 0)
        {
          iterator_counter_50_o--;
        }

        sum_50_o += values_2016;
      } avg_50_o = sum_50_o / iterator_counter_50_o;
      if (age_group == 65)
      {
        iterator_counter_65_o++;
        char add_val_2017[10];
        char stg_val_2017[10];
        strcpy(add_val_2017, data_set[j].values);
        strcpy(stg_val_2017, &add_val_2017[1]);
        double values_2017 = atof(stg_val_2017);
        if (values_2017 == 0)
        {
          iterator_counter_65_o--;
        }

```

```
1193        sum_65_o += values_2017;
1194      } avg_65_o = sum_65_o / iterator_counter_65_o;
1195    }
1196    for (int j = 128; j < 170; j++) /*  Alberta Age-Group-
    Wise Average Calculator */
1197    {
1198      char add_val_y[10];
1199      char stg_val_y[10];
1200      strcpy(add_val_y, data_set[j].age_group);
1201      strcpy(stg_val_y, &add_val_y[1]);
1202      double age_group = atof(stg_val_y);
1203
1204      if (age_group == 35)
1205      {
1206        iterator_counter_35_a++;
1207        char add_val_2015[10];
1208        char stg_val_2015[10];
1209        strcpy(add_val_2015, data_set[j].values);
1210        strcpy(stg_val_2015, &add_val_2015[1]);
1211        double values_2015 = atof(stg_val_2015);
1212        if (values_2015 == 0)
1213        {
1214          iterator_counter_35_a--;
1215        }
1216
1217        sum_35_a += values_2015;
1218      } avg_35_a = sum_35_a / iterator_counter_35_a;
1219      if (age_group == 50)
1220      {
1221        iterator_counter_50_a++;
1222        char add_val_2016[10];
1223        char stg_val_2016[10];
1224        strcpy(add_val_2016, data_set[j].values);
1225        strcpy(stg_val_2016, &add_val_2016[1]);
1226        double values_2016 = atof(stg_val_2016);
1227        if (values_2016 == 0)
1228        {
1229          iterator_counter_50_a--;
1230        }
1231
1232        sum_50_a += values_2016;
1233      } avg_50_a = sum_50_a / iterator_counter_50_a;
1234      if (age_group == 65)
1235      {
1236        iterator_counter_65_a++;
1237        char add_val_2017[10];
1238        char stg_val_2017[10];
1239        strcpy(add_val_2017, data_set[j].values);
1240        strcpy(stg_val_2017, &add_val_2017[1]);
```

```
1241        double values_2017 = atof(stg_val_2017);
1242        if (values_2017 == 0)
1243        {
1244          iterator_counter_65_a--;
1245        }
1246
1247        sum_65_a += values_2017;
1248      } avg_65_a = sum_65_a / iterator_counter_65_a;
1249    }
1250    for (int j = 170; j < 212; j++) /*  British Columbia Age-
    Group-Wise Average Calculator  */
1251    {
1252      char add_val_y[10];
1253      char stg_val_y[10];
1254      strcpy(add_val_y, data_set[j].age_group);
1255      strcpy(stg_val_y, &add_val_y[1]);
1256      double age_group = atof(stg_val_y);
1257
1258      if (age_group == 35)
1259      {
1260        iterator_counter_35_b++;
1261        char add_val_2015[10];
1262        char stg_val_2015[10];
1263        strcpy(add_val_2015, data_set[j].values);
1264        strcpy(stg_val_2015, &add_val_2015[1]);
1265        double values_2015 = atof(stg_val_2015);
1266        if (values_2015 == 0)
1267        {
1268          iterator_counter_35_b--;
1269        }
1270
1271        sum_35_b += values_2015;
1272      } avg_35_b = sum_35_b / iterator_counter_35_b;
1273      if (age_group == 50)
1274      {
1275        iterator_counter_50_b++;
1276        char add_val_2016[10];
1277        char stg_val_2016[10];
1278        strcpy(add_val_2016, data_set[j].values);
1279        strcpy(stg_val_2016, &add_val_2016[1]);
1280        double values_2016 = atof(stg_val_2016);
1281        if (values_2016 == 0)
1282        {
1283          iterator_counter_50_b--;
1284        }
1285
1286        sum_50_b += values_2016;
1287      } avg_50_b = sum_50_b / iterator_counter_50_b;
1288      if (age_group == 65)
```

```
1289      {
1290        iterator_counter_65_b++;
1291        char add_val_2017[10];
1292        char stg_val_2017[10];
1293        strcpy(add_val_2017, data_set[j].values);
1294        strcpy(stg_val_2017, &add_val_2017[1]);
1295        double values_2017 = atof(stg_val_2017);
1296        if (values_2017 == 0)
1297        {
1298          iterator_counter_65_b--;
1299        }
1300
1301        sum_65_b += values_2017;
1302      } avg_65_b = sum_65_b / iterator_counter_65_b;
1303    }
1304    } age_avg(avg_35_f, avg_50_f, avg_65_f, avg_35_q,
     avg_50_q, avg_65_q, avg_35_o, avg_50_o, avg_65_o, avg_35_a
     , avg_50_a, avg_65_a, avg_35_b, avg_50_b, avg_65_b);
1305
1306  spacer();
1307
1308  /*           Question 2           */printf("
     |-------------------------------------------------------------------------
     Question
     2-------------------------------------------------------------------------
     n");
1309
1310  spacer();
1311
1312  double ProvinceData[4] = {avg_quebec, avg_ontario,
     avg_alberta, avg_british_columbia};
1313
1314  float lowest = 0;
1315  int l_counter = 0;
1316  float highest = 0;
1317  int h_counter = 0;
1318
1319  for (int i = 0; i < 4; i++)
1320  {
1321    if (i == 0)
1322    {
1323      lowest = ProvinceData[i];
1324      l_counter = i;
1325      highest = ProvinceData[i];
1326      h_counter = i;
1327    }
1328    else
1329    {
1330      if (ProvinceData[i] < lowest)
```

```
1331        {
1332          lowest = ProvinceData[i];
1333          l_counter = i;
1334        }
1335        if (ProvinceData[i] > highest)
1336        {
1337          highest = ProvinceData[i];
1338          h_counter = i;
1339        }
1340      }
1341    }
1342
1343    if (l_counter == 0)
1344    {
1345      printf("The Province with the Lowest percentage of
       Diabetes is Quebec\n");
1346    }
1347    if (l_counter == 1)
1348    {
1349      printf("The Province with the Lowest percentage of
       Diabetes is Ontario\n");
1350    }
1351    if (l_counter == 2)
1352    {
1353      printf("The Province with the Lowest percentage of
       Diabetes is Alberta\n");
1354    }
1355    if (l_counter == 3)
1356    {
1357      printf("The Province with the Lowest percentage of
       Diabetes is British Columbia\n");
1358    }
1359
1360    if (h_counter == 0)
1361    {
1362      printf("The Province with the Highest percentage of
       Diabetes is Quebec\n");
1363    }
1364    if (h_counter == 1)
1365    {
1366      printf("The Province with the Highest percentage of
       Diabetes is Ontario\n");
1367    }
1368    if (h_counter == 2)
1369    {
1370      printf("The Province with the Highest percentage of
       Diabetes is Alberta\n");
1371    }
1372    if (h_counter == 3)
```

```
1373  {
1374    printf("The Province with the Highest percentage of
       Diabetes is British Columbia\n");
1375  }
1376
1377  spacer();
1378
1379  /*          Question 3          */printf("
       |-------------------------------------------------------------------------
       Question
       3-------------------------------------------------------------------------
       n");
1380
1381  spacer();
1382
1383  printf("Provinces with a Diabetes percentage above the
       National Average are:\n\n");
1384
1385  for (int i = 0; i < 4; i++)
1386  {
1387    if (ProvinceData[i] > avg_federal)
1388    {
1389      if (i == 0)
1390      {
1391        printf("Qubec\n");
1392      }
1393      if (i == 1)
1394      {
1395        printf("Ontario\n");
1396      }
1397      if (i == 1)
1398      {
1399        printf("Alberta\n");
1400      }
1401      if (i == 1)
1402      {
1403        printf("British Columbia\n");
1404      }
1405
1406
1407    }
1408  }
1409
1410  spacer();
1411
1412  /*          Question 4          */printf("
       |-------------------------------------------------------------------------
       Question
       4-------------------------------------------------------------------------
```

```
   n");
1413
1414  spacer();
1415
1416  lowest = 0, highest = 0;  /*  Re-Initializing lowest &
       highest to 0 */
1417  l_counter = 0, h_counter = 0; /*  Re-Initializing l_counter
       & h_counter to 0  */
1418
1419  for (int i = 0; i < ARRAY_SIZE; i++)
1420    {
1421    char add_val_y[10];
1422    char stg_val_y[10];
1423    strcpy(add_val_y, data_set[i].values);
1424    strcpy(stg_val_y, &add_val_y[1]);
1425    double values = atof(stg_val_y);
1426
1427    if (i == 0)
1428    {
1429      lowest = values;
1430      l_counter = i;
1431      highest = values;
1432      h_counter = i;
1433    }
1434    else
1435    {
1436      if (values < lowest)
1437      {
1438        lowest = values;
1439        l_counter = i;
1440      }
1441      if (values > highest)
1442      {
1443        highest = values;
1444        h_counter = i;
1445      }
1446    }
1447  } printf("The Province with the highest & lowest percentage
       of diabetes in a year is British Columbia & Ontario in
      the year's %s & %s\n", data_set[h_counter].year, data_set[
      l_counter].year);
1448
1449  spacer();
1450 }
1451
1452 /*  Defining all subsequent UDF's utilized in the program
      */
1453
1454 void credits(void)
```

```
{
  spacer();
  printf("                      Toronto Metropolitan University\n");
  printf("                              ******************************\n");
  printf("                              ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~\n");
  sub_spacer();
  printf("--------------------------------------------------------------------------------------\n");
  printf("                  CPS 188 Term Project | 2023 Source Code\n");
  printf("--------------------------------------------------------------------------------------\n");
  sub_spacer();
  printf("                               ------------\n");
  printf("-------------------------------|Group - 40|-------------------------------\n");
  printf("                               ------------\n");
  sub_spacer();
  printf("Copyright (c) 2023 Sayeed Ahamad, Qurrat-Ul-Ain, Tre Spencer, Nourhan Antar\n");
  spacer();
  printf("/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\\/\n");
  spacer();
}

FILE* file_o(void)   /*  UDF for file opening    */
{
    char temp[100];
    FILE* file; /*  Initializing file storage variable  */
    file = fopen("statscan_diabetes.csv", "r"); /*  Defining the address path of file to be opened and read    */
    if (NULL == file)   /*  Fail Safe mechanism for program file opening    */
    {
        printf("Error: File Open cannot proceed\n");
        exit;   /*  Program exits and ends if the fail-safe breaks  */
    }
    fscanf(file, "%s", temp);  /*  Scanning the defined file and storing it at address of Var(temp)    */
    return file;    /*  Returning the file type variable  */
```

```
1487 }
1488
1489 void file_c(FILE* file) /*  UDF for file closing    */
1490 {
1491     fclose(file);   /*  Closing the already opened file */
1492 }
1493
1494 void spacer(void) /*  UDF for creating NULL newline spaces
        for better tabular and visual output */
1495 {
1496     for (int i = 0; i < SPACERS; i++)
1497     {
1498         printf("\n");
1499     }
1500
1501 }
1502
1503 void sub_spacer(void) /*  UDF for creating NULL newline
        spaces for better tabular and visual output */
1504 {
1505     for (int i = 0; i < SUB_SPACERS; i++)
1506     {
1507         printf("\n");
1508     }
1509
1510 }
1511
1512 void avg_province(void) /*  UDF for Province-Wise Averages
        Header */
1513 {
1514   printf("|--------------------Province-Wise Averages
        --------------------|\n");
1515 }
1516
1517 void avg_year(void) /*  UDF for Year-Wise Averages Header */
1518 {
1519   printf("|--------------------Year-Wise Averages
        --------------------|\n");
1520 }
1521
1522 void year_avg(double f_2015, double f_2016, double f_2017,
        double f_2018, double f_2019, double f_2020, double f_2021
        , double q_2015, double q_2016, double q_2017, double
        q_2018, double q_2019, double q_2020, double q_2021,
        double o_2015, double o_2016, double o_2017, double o_2018
        , double o_2019, double o_2020, double o_2021, double
        a_2015, double a_2016, double a_2017, double a_2018,
        double a_2019, double a_2020, double a_2021, double b_2015
        , double b_2016, double b_2017, double b_2018, double
```

```
    b_2019, double b_2020, double b_2021)  /*  UDF to print
    Year-Wise Averages in a tabular form */
1523 {
1524   printf("| Year  |   Canada    |   Quebec    |   Ontario   |
         Alberta   |   British Columbia    |\n");
1525   printf("
     |-------------------------------------------------------------------------
     n");
1526   printf("| 2015  |   %.3lf   |   %.3lf   |   %.3lf   |   %.3
     lf   |     %.3lf     |\n", f_2015, q_2015, o_2015, a_2015,
      b_2015);
1527   printf("| 2016  |   %.3lf   |   %.3lf   |   %.3lf   |   %.3
     lf   |     %.3lf     |\n", f_2016, q_2016, o_2016, a_2016,
      b_2016);
1528   printf("| 2017  |   %.3lf   |   %.3lf   |   %.3lf   |   %.3
     lf   |     %.3lf     |\n", f_2017, q_2017, o_2017, a_2017,
      b_2017);
1529   printf("| 2018  |   %.3lf   |   %.3lf   |   %.3lf   |   %.3
     lf   |     %.3lf     |\n", f_2018, q_2018, o_2018, a_2018,
      b_2018);
1530   printf("| 2019  |   %.3lf   |   %.3lf   |   %.3lf   |   %.3
     lf   |     %.3lf     |\n", f_2019, q_2019, o_2019, a_2019,
      b_2019);
1531   printf("| 2020  |   %.3lf   |   %.3lf   |   %.3lf   |   %.3
     lf   |     %.3lf     |\n", f_2020, q_2020, o_2020, a_2020,
      b_2020);
1532   printf("| 2021  |   %.3lf   |   %.3lf   |   %.3lf   |   %.3
     lf   |     %.3lf     |\n", f_2021, q_2021, o_2021, a_2021,
      b_2021);
1533 }
1534
1535 void avg_age(void)  /*  UDF for Age-Group-Wise Averages
    Header  */
1536 {
1537   printf("|--------------------Age-Group-Wise Averages
     --------------------|\n");
1538 }
1539
1540 void age_avg(double f_35, double f_50, double f_65, double
    q_35, double q_50, double q_65, double o_35, double o_50,
    double o_65, double a_35, double a_50, double a_65, double
     b_35, double b_50, double b_65) /*  UDF to print Age-
    Group-Wise Averages in a tabular form  */
1541 {
1542   printf("| Age-Group |   Canada    |   Quebec    |   Ontario
         |   Alberta   |   British Columbia    |\n");
1543   printf("
     |-------------------------------------------------------------------------
     n");
```

```
  printf("| 35-49 |   %.3lf   |   %.3lf   |   %.3lf   |   %.3lf   |     %.3lf     |\n", f_35, q_35, o_35, a_35, b_35);
  printf("| 50-64 |   %.3lf   |   %.3lf   |   %.3lf   |   %.3lf   |     %.3lf     |\n", f_50, q_50, o_50, a_50, b_50);
  printf("| 65+ |   %.3lf   |   %.3lf   |   %.3lf   |   %.3lf   |     %.3lf     |\n", f_65, q_65, o_65, a_65, b_65);
}
```

Listing A.1: *CPS 188 Term Project Source Code*

B GNUplot Scripts

B.1 Question 5

```


set title "Diabetes Percentages in Canada (2015-2021)"
set xlabel "Year"
set ylabel "Diabetes Percentage"
set xtics 1
set key outside right

set style line 1 lw 2 pt 7
set style line 2 lw 2 pt 5
set style line 3 lw 2 pt 9
set style line 4 lw 2 pt 13
set style line 5 lw 2 pt 11

plot "data4a.txt" using 1:2 with lines linestyle 1 linecolor rgb "#E41A1C" title "Canada ex. territories", \
     "data4a.txt" using 1:3 with lines linestyle 2 linecolor rgb "#377EB8" title "British Columbia", \
     "data4a.txt" using 1:4 with lines linestyle 3 linecolor rgb "#4DAF4A" title "Alberta", \
     "data4a.txt" using 1:5 with lines linestyle 4 linecolor rgb "#984EA3" title "Ontario", \
     "data4a.txt" using 1:6 with lines linestyle 5 linecolor rgb "#FF7F00" title "Quebec"
```

Listing B.1: *GNUplot Source Code*

B.2 Question 6

```


set title "Average Percentages of Diabetes Among Age Groups"
```

```
set xlabel "Age Groups"
set ylabel "Diabetes Percentage"
set style data histograms
set style fill solid 1.0 border -1
set boxwidth 0.7 relative
set yrange [0:20]
set ytics 0,2,20
plot 'q6.txt' using 2:xtic(1) with histogram title "Diabetes
   Percentage"
```

Listing B.2: *GNUplot Source Code*