

FINAL PROJECT

BONUS SECTION

This document contains the bonus section, It is not mandatory.

MEDIAN & AVERAGE 5PTS

Extend SPCalculator to support the following functions:

- 1- *average*($\text{exp}_1, \text{exp}_2, \dots, \text{exp}_n$)- Calculates the average of the expressions, that is:

$$\text{average}(\text{exp}_1, \text{exp}_2, \dots, \text{exp}_n) = \frac{\sum \text{value}(\text{exp}_i)}{n}$$

- 2- *median*($\text{exp}_1, \text{exp}_2, \dots, \text{exp}_n$)- Calculates the median of the expressions:

Recall "The **median** is also the number that is halfway into the set. To find the **median**, the data should first be arranged in order from least to greatest." [Mathgoodies].

Let $S = \{a_1, \dots, a_n\}$ be a set of numbers,

and let $S^* = \{b_1, \dots, b_n\}$ be the set S ordered from least to greatest.

$$\text{Then median}(S) = \begin{cases} b_{[n/2]} & \text{if } n \text{ is odd} \\ \frac{b_{\frac{n}{2}} + b_{\frac{n}{2}+1}}{2} & \text{if } n \text{ is even} \end{cases}$$

Examples:

```
>> median(3,10/2,1);
>> res = 3.00
>> median (4,0+1,2,3$3)
>> res = 2.50
>> average(2,3,1);
>> res = 2.00
>> average(4,2,1,3);
>> res = 2.5
>> average(5$2,1);
>> Invalid Result
```

Notes:

- The rules for valid/invalid average/median expressions is as max/min expressions.
- exp_i is any valid arithmetical expression as given in the assignment document.
- The string representing each of average/median is the same as max/min
- You can assume the total number of arguments of average/median cannot exceed 10.

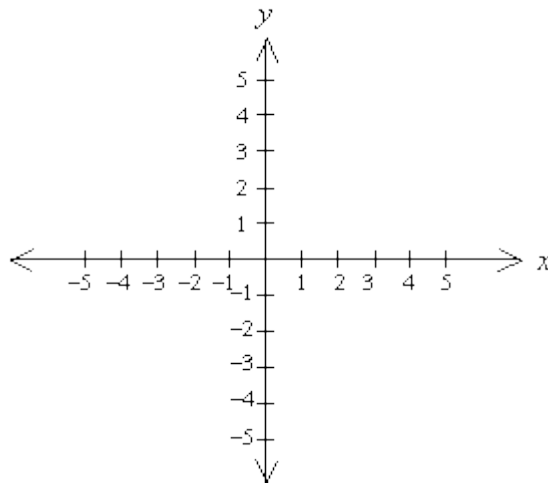
GRAPHS 10PTS

Extend SP Calculator to support the following function:

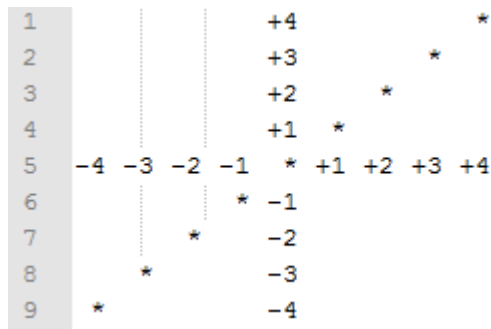
$graph(filename, N, [exp_1, c_1, d_1, ch_1], \dots, [exp_k, c_k, d_k, ch_k]);$

Where:

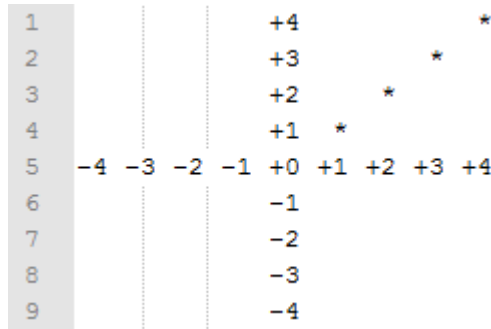
- Filename – the filename to which the graphs will be drawn. The filename must be different than the variable init file / output file (If these are given). You may assume filename contains only valid letters (Capital and small English letters).
- N – Positive integer (>0) which represents the size of the x-axis/y-axis. For example if $N=5$ then the rectangular coordinate system would be:



- $[exp_i, c_i, d_i, ch_i]$ -
 exp_i represents a function with at most one variable (You may assume it will have no more than one variable). Please note however, that an expression is not necessarily of the form $a_i x + b_i$. It could be any valid expression with one variable. For example:
 $\max(a, 5, 7)$
 $(5+2)*x+1/3+1\$x$
 $5+10$
The domain of the function is $[c_i, d_i]$, that is; if $exp_i = f(x)$ then you need to calculate the value of $f(x)$ in the point $x \in \{c_i, c_i + 1, \dots, d_i - 1, d_i\}$.
Each point in the coordinate system is represented by the char ch_i
You may assume:
 - $ch_i \in \{'\$', '\%', '\&', '*', '\sim', '\+', '\#', '@'\}$
 - c_i, d_i are all integers
 - The maximum number of function to be printed is $k=8$
- Example: The following expression creates the file graph1.out and the content of the file is given bellow:
 $graph(graph1.out, 4, [x, -4, 4, '*'])$

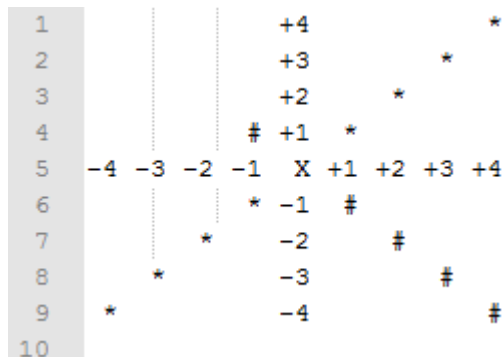


`graph(graph1.out,4,[x,1,4,'*']);`



If two lines intersect, the char printed should be 'X'

`graph(graph1.out,4,[x,-4,4,'*'],[-1*x,-1,4,'#']);`



- Messages:
 - In case filename is the same as [-o filename] or [-v filename] you should print:
"Filename should be different than cmd line argument"
 - In case file cannot be created:
"File cannot be created"
 - In case **N** is non-positive, you should print:
"N should be positive"
 - In case out of range , i.e $\exists c_i \ c_i < N$ or $\exists d \ d_i > N$
"Out of range"
 - In case two lines use the same char, i.e $\exists ch_i, ch_j \ s.t \ i \neq j \ and \ ch_i = ch_j$
"Chars should be different"

- Hints and guidelines:
 - Reminder: If two lines intersect, the char printed should be 'X'
 - In case the function in a point is a fraction, then round it to the closest integer. For example, if $f(x) = 3/2 * x + 5$, then $f(1) = 6$, $f(3) = 9$.
 - If a function is not defined on an entry, you should print the char 'O' on that entry.
 - Use a two dimensional array of size $(2n+1, 2n+1)$, the array should be initialized to zero.
 - Before drawing the lines to the file, change the array such that the entry (i,j) in the array is set to k if the k -th function (say $f(x)$) has the value j in i ($x=i$).
 - In case of collusion (Two functions have the same value in the same entry): set the entry to -1
 - After the matrix is set, run over the entries of the matrix and print to the file according to the entry values (Run over the rows, when moving to a new row print a new line):
 - Each entry takes m chars where m is the number of chars needed to represent N plus 1 (for the sign).
For example, if N is 105 then $m = 4$ (3 chars to represent 105 and 1 for the plus sign)
 - Adjacent entries (i,j) $(i+1,j)$ should be separated by one space
 - If the entry represents an axis value then you should print the sign of the entry and the value afterwards. (Note if the number of chars to represent the number plus the sign is less than m , print spaces in the beginning. For example ($N=10 \rightarrow m=3$):
 $(0,1) \rightarrow " +1"$ //Note the space in the first
 $(-1,0) \rightarrow " -1"$
 $(0,0) \rightarrow " +0"$
 $(10,0) \rightarrow "+10"$ // Note there are no spaces
 - If the entry represents a function with the char 'ch' then you should print the char of the entry (Spaces are added to fill the entry size) For example ($N=10 \rightarrow m=3$)
if $(5,1)$ represents the entry of a function given by '*' the you should print
 $" *"$ //Note two spaces are added in the first.