

CSC 4400/5400 Fall 2009 Programming Assignment

Assigned: November 9, 2009

Due: December 11, 2009

NO LATE ASSIGNMENTS ACCEPTED!!!

You will be writing a program to practice with the **backtracking** programming paradigm. In this assignment, you will be determine all valid ways to construct an arithmetic expression in postfix notation (sometimes known as Reverse Polish Notation, or RPN) with n distinct integer operands and the four standard binary arithmetic operations of addition, subtraction, multiplication, and division. Your program will ask the user for the number of operands and then for the user to enter those operands. You should do error checking on your input data (such as making sure that the number of operands is an integer that is at least 2 and that your operands are all distinct integers). Then you will be generating and displaying all valid arithmetic expressions from your operands, along with the values. Display the expression both in postfix and infix form, with parentheses as needed. For example, the infix for $3\ 5\ *\ 7\ -$ is $((3 * 5) - 7)$. For division, you will be performing integer division. If you encounter a division by zero, you can display the symbol for infinity or negative infinity, depending on whether the numerator was positive or negative. Remember that you will need $(n-1)$ operations if you have n operands. All operands must be used exactly once. Operations can be repeated, as necessary. Remember that a stack can be used to evaluate an expression that is in postfix notation. The non-infinite values of evaluation will need to be collected in a list and sorted in ascending order. Determine and show the number of occurrences of each value. You will also need to inform the user about how many infinite values were obtained.

A brute force approach could be used to generate all expressions with n operands and $n-1$ operations, and then invalid expressions (either with repeated operands or invalid according to postfix notations) could be eliminated. We would have for our example, 7^5 , or 16807 expressions to check. Backtracking can cause a lot of expressions to be eliminated early.

I have shown sample results for operands 3, 5, and 7. There are 192 valid postfix expressions, with respect to using the stack. There are three infinite results, all positive.

I will be giving you test cases with more than 3 operands, so make your code be general.

| Expression | Value |
|-----------------|-------|
| $3\ 5\ +\ 7\ +$ | 15 |
| $3\ 5\ +\ 7\ -$ | 1 |
| $3\ 5\ +\ 7\ *$ | 56 |
| $3\ 5\ +\ 7\ /$ | 1 |
| $3\ 5\ -\ 7\ +$ | 5 |
| $3\ 5\ -\ 7\ -$ | -9 |
| $3\ 5\ -\ 7\ *$ | -14 |
| $3\ 5\ -\ 7\ /$ | 0 |

| | |
|------------|-----|
| $35 * 7 +$ | 22 |
| $35 * 7 -$ | 8 |
| $35 * 7 *$ | 105 |
| $35 * 7 /$ | 2 |
| $35 / 7 +$ | 7 |
| $35 / 7 -$ | -7 |
| $35 / 7 *$ | 0 |
| $35 / 7 /$ | 0 |
| $37 + 5 +$ | 15 |
| $37 + 5 -$ | 5 |
| $37 + 5 *$ | 50 |
| $37 + 5 /$ | 2 |
| $37 - 5 +$ | 1 |
| $37 - 5 -$ | -9 |
| $37 - 5 *$ | -20 |
| $37 - 5 /$ | 0 |
| $37 * 5 +$ | 26 |
| $37 * 5 -$ | 16 |
| $37 * 5 *$ | 105 |
| $37 * 5 /$ | 4 |
| $37 / 5 +$ | 5 |
| $37 / 5 -$ | -5 |
| $37 / 5 *$ | 0 |
| $37 / 5 /$ | 0 |
| $53 + 7 +$ | 15 |
| $53 + 7 -$ | 1 |
| $53 + 7 *$ | 56 |
| $53 + 7 /$ | 1 |
| $53 - 7 +$ | 9 |
| $53 - 7 -$ | -5 |
| $53 - 7 *$ | 14 |
| $53 - 7 /$ | 0 |
| $53 * 7 +$ | 22 |
| $53 * 7 -$ | 8 |
| $53 * 7 *$ | 105 |
| $53 * 7 /$ | 2 |
| $53 / 7 +$ | 8 |
| $53 / 7 -$ | -6 |
| $53 / 7 *$ | 7 |
| $53 / 7 /$ | 0 |
| $57 + 3 +$ | 15 |
| $57 + 3 -$ | 9 |
| $57 + 3 *$ | 36 |
| $57 + 3 /$ | 4 |
| $57 - 3 +$ | 1 |
| $57 - 3 -$ | -5 |

| | |
|----------|-----|
| $57-3^*$ | -6 |
| $57-3/$ | 0 |
| $57*3+$ | 38 |
| $57*3-$ | 32 |
| $57*3^*$ | 105 |
| $57*3/$ | 11 |
| $57/3+$ | 3 |
| $57/3-$ | -3 |
| $57/3^*$ | 0 |
| $57/3/$ | 0 |
| $73+5+$ | 15 |
| $73+5-$ | 5 |
| $73+5^*$ | 50 |
| $73+5/$ | 2 |
| $73-5+$ | 9 |
| $73-5-$ | -1 |
| $73-5^*$ | 20 |
| $73-5/$ | 0 |
| $73*5+$ | 26 |
| $73*5-$ | 16 |
| $73*5^*$ | 105 |
| $73*5/$ | 4 |
| $73/5+$ | 7 |
| $73/5-$ | -3 |
| $73/5^*$ | 10 |
| $73/5/$ | 0 |
| $75+3+$ | 15 |
| $75+3-$ | 9 |
| $75+3^*$ | 36 |
| $75+3/$ | 4 |
| $75-3+$ | 5 |
| $75-3-$ | -1 |
| $75-3^*$ | 6 |
| $75-3/$ | 0 |
| $75*3+$ | 38 |
| $75*3-$ | 32 |
| $75*3^*$ | 105 |
| $75*3/$ | 11 |
| $75/3+$ | 4 |
| $75/3-$ | -2 |
| $75/3^*$ | 3 |
| $75/3/$ | 0 |
| $357++$ | 15 |
| $357+-$ | -9 |
| $357+^*$ | 36 |
| $357+ /$ | 0 |

| | |
|--------|----------|
| 357-+ | 1 |
| 357-- | 5 |
| 357-* | -6 |
| 357-/ | -1 |
| 357*+ | 38 |
| 357*- | -32 |
| 357** | 105 |
| 357*/ | 0 |
| 357/+ | 3 |
| 357/- | 3 |
| 357/* | 0 |
| 357// | ∞ |
| 375++ | 15 |
| 375+- | -9 |
| 375+* | 36 |
| 375+// | 0 |
| 375-+ | 5 |
| 375-- | 1 |
| 375-* | 6 |
| 375-/ | 1 |
| 375*+ | 38 |
| 375*- | -32 |
| 375** | 105 |
| 375*/ | 0 |
| 375/+ | 4 |
| 375/- | 2 |
| 375/* | 3 |
| 375// | 3 |
| 537++ | 15 |
| 537+- | -5 |
| 537+* | 50 |
| 537+// | 0 |
| 537-+ | 1 |
| 537-- | 9 |
| 537-* | -20 |
| 537-/ | -1 |
| 537*+ | 26 |
| 537*- | -16 |
| 537** | 105 |
| 537*/ | 0 |
| 537/+ | 5 |
| 537/- | 5 |
| 537/* | 0 |
| 537// | ∞ |
| 573++ | 15 |
| 573+- | -5 |

| | |
|------------------------------------|----------|
| 573+* | 50 |
| 573+/ <td>0</td> | 0 |
| 573-+ <td>9</td> | 9 |
| 573-- <td>1</td> | 1 |
| 573-* <td>20</td> | 20 |
| 573-/ <td>1</td> | 1 |
| 573*+ <td>26</td> | 26 |
| 573*- <td>-16</td> | -16 |
| 573** <td>105</td> | 105 |
| 573*/ <td>0</td> | 0 |
| 573/+ <td>7</td> | 7 |
| 573/- <td>3</td> | 3 |
| 573/* <td>10</td> | 10 |
| 573// <td>2</td> | 2 |
| 735++ <td>15</td> | 15 |
| 735+- <td>-1</td> | -1 |
| 735+* <td>56</td> | 56 |
| 735+/ <td>0</td> | 0 |
| 735-+ <td>5</td> | 5 |
| 735-- <td>9</td> | 9 |
| 735-* <td>-14</td> | -14 |
| 735-/ <td>-3</td> | -3 |
| 735*+ <td>22</td> | 22 |
| 735*- <td>-8</td> | -8 |
| 735** <td>105</td> | 105 |
| 735*/ <td>0</td> | 0 |
| 735/+ <td>7</td> | 7 |
| 735/- <td>7</td> | 7 |
| 735/* <td>0</td> | 0 |
| 735// <td>∞</td> | ∞ |
| 753++ <td>15</td> | 15 |
| 753+- <td>-1</td> | -1 |
| 753+* <td>56</td> | 56 |
| 753+/ <td>0</td> | 0 |
| 753-+ <td>9</td> | 9 |
| 753-- <td>5</td> | 5 |
| 753-* <td>14</td> | 14 |
| 753-/ <td>3</td> | 3 |
| 753*+ <td>22</td> | 22 |
| 753*- <td>-8</td> | -8 |
| 753** <td>105</td> | 105 |
| 753*/ <td>0</td> | 0 |
| 753/+ <td>8</td> | 8 |
| 753/- <td>6</td> | 6 |
| 753/* <td>7</td> | 7 |
| 753// <td>7</td> | 7 |

The sorted values, along with their counts, are shown below.

| Value | Count |
|-------|-------|
| -32 | 2 |
| -20 | 2 |
| -16 | 2 |
| -14 | 2 |
| -9 | 4 |
| -8 | 2 |
| -7 | 1 |
| -6 | 3 |
| -5 | 5 |
| -3 | 3 |
| -2 | 1 |
| -1 | 6 |
| 0 | 30 |
| 1 | 12 |
| 2 | 6 |
| 3 | 8 |
| 4 | 6 |
| 5 | 11 |
| 6 | 3 |
| 7 | 8 |
| 8 | 4 |
| 9 | 8 |
| 10 | 2 |
| 11 | 2 |
| 14 | 2 |
| 15 | 12 |
| 16 | 2 |
| 20 | 2 |
| 22 | 4 |
| 26 | 4 |
| 32 | 2 |
| 36 | 4 |
| 38 | 4 |
| 50 | 4 |
| 56 | 4 |
| 105 | 12 |