

## Appendix E

### The Selection Tree in the Equation Writer

The expression tree is a diagram showing how the Equation Writer interprets an expression. The form of the expression tree is determined by a number of rules known as the hierarchy of operation. The rules are as follows:

1. Operations in parentheses are executed first, from the innermost to the outermost parentheses, and from left to right in the expression.
2. Arguments of functions are executed next, from left to right.
3. Functions are executed next, from left to right.
4. Powers of numbers are executed next, from left to right.
5. Multiplications and divisions are executed next, from left to right.
6. Additions and subtraction are executed last, from left to right.

Execution from left to right means that, if two operations of the same hierarchy, say two multiplications, exist in an expression, the first multiplication to the left will be executed before the second, and so on.

Consider, for example, the expression shown below in the equation writer:

$$\frac{((y-3).x+5).(x^2+4)}{\text{SIN}(4x-2)}$$

EDIT CURS BIG EVAL FACTO SIMP

The insertion cursor (◀) at this point is located to the right of the 2 in the argument of the SIN function in the denominator. Press the down arrow key (▼) to trigger the clear, editing cursor (□) around the 2 in the denominator. Next, press the left arrow key (◀), continuously, until the clear, editing cursor is around the y in the first factor in the denominator. Then, press the upper-arrow key to activate the selection cursor (■) around the y. By pressing the upper arrow key (▲), continuously, we can follow the expression tree that will take use from the y to the completion of the expression. Here is the sequence of operations highlighted by the upper arrow key (▲):

Step A1

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT | CURS | BIG = | EVAL | FACTO | SIMP

Step A2

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT | CURS | BIG = | EVAL | FACTO | SIMP

Step A3

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT | CURS | BIG = | EVAL | FACTO | SIMP

Step A4

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT | CURS | BIG = | EVAL | FACTO | SIMP

Step A5


$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT | CURS | BIG = | EVAL | FACTO | SIMP

Step A6

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT | CURS | BIG = | EVAL | FACTO | SIMP

We notice the application of the hierarchy-of-operation rules in this selection. First the y (Step A1). Then, y-3 (Step A2, parentheses). Then, (y-3)x (Step A3, multiplication). Then (y-3)x+5, (Step A4, addition). Then, ((y-3)x+5)(x<sup>2</sup>+4) (Step A5, multiplication), and finally, ((y-3)x+5)(x<sup>2</sup>+4)/SIN(4x-2) (Step A6, division). It is important to point out that the multiplication in Step A5 includes the first term, ((y-3)x+5) with a second term (x<sup>2</sup>+4), which is already calculated. To see the steps in calculating these second term, press the down arrow key , continuously, until the clear, editing cursor is triggered around the y, once more. Then, press the right arrow key until these cursor is over the x in the second term in the numerator. Then, press the upper-arrow key to select this x. The steps in the evaluation of the expression, starting from this point, are shown below:

Step B1

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

Step B2

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

Step B3

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

Step B4 = Step A5

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

Step B5 = Step A6

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

We can also follow the evaluation of the expression starting from the 4 in the argument of the SIN function in the denominator. Press the down arrow key  $\nabla$ , continuously, until the clear, editing cursor is triggered around the y, once more. Then, press the right arrow key until this cursor is over the 4 in the denominator. Then, press the upper-arrow key  $\triangle$  to select this 4. The steps in the evaluation of the expression, starting from this point, are shown below:

Step C1

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

Step C2

$$\frac{((y-3)x+5)(x^2+4)}{\sin(4x-2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

Step C3

$$\frac{((y-3) \cdot x + 5) \cdot (x^2 + 4)}{\text{SIN}(4 \cdot x - 2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

Step C4

$$\frac{((y-3) \cdot x + 5) \cdot (x^2 + 4)}{\text{SIN}(4 \cdot x - 2)}$$

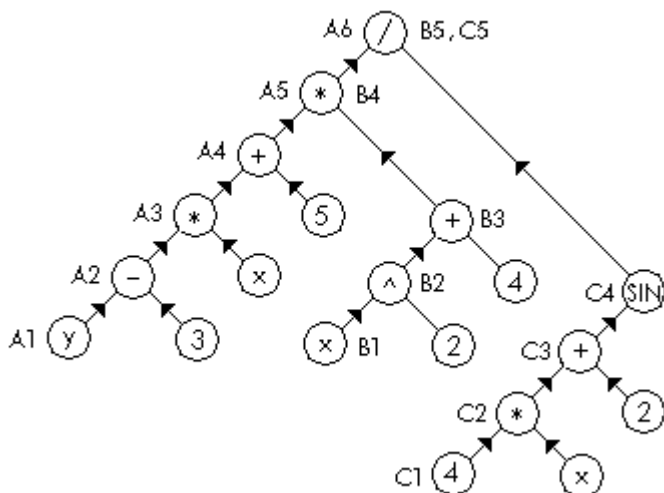
EDIT CURS BIG = EVAL FACTO SIMP

Step C5 = Step B5 = Step A6

$$\frac{((y-3) \cdot x + 5) \cdot (x^2 + 4)}{\text{SIN}(4 \cdot x - 2)}$$

EDIT CURS BIG = EVAL FACTO SIMP

The expression tree for the expression presented above is shown next:



The steps in the evaluation of the three terms (A1 through A6, B1 through B5, and C1 through C5) are shown next to the circle containing numbers, variables, or operators.