Operator Precedence in Arithmetic[1]:

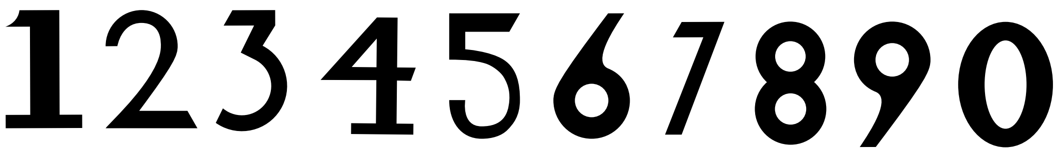

Figure 1: ‘Arithmetic,’ can be defined as ‘[the science of] numbers, and the operations performed on numbers.’

[2]

Introduction:

Conventional Arithmetic possesses rules for the order of operations. Which operations ought we to evaluate first? In what order ought we to evaluate operations? This is the topic that this chapter wishes to address. ‘Precedence,’ is also sometimes referred to as ‘the order of operations.’

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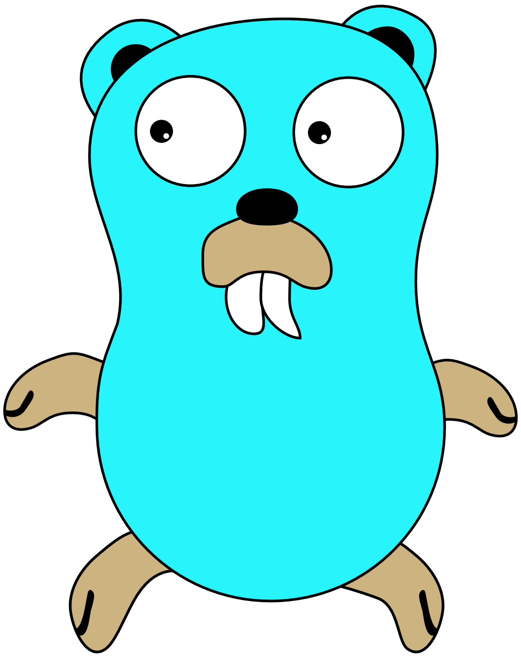
[1] The Etymology of the English mathematical term, ‘arithmetic,’ is as follows. The English adjective, ‘arithmetic,’ is derived from the Latin 1st-and-2nd-declension adjective, ‘arithmētica, arithmēticus, arithmēticum.’ Further, the Latin adjective, ‘arithmēticus,’ is derived from the Ancient-Greek phrase, ἀριθμητικὴ τέξνη or, when transliterated, ‘arithmētikḕ téchne,’ which means ‘the art of counting;’ ‘the skill of counting;’ ‘the science of counting.’ ὁ ἀριθμός *genitive:* τοῦ ἀριθμοῦ, or–when transliterated: ‘ho arithmós,’ *genitive:* ‘toũ arithmoũ,’–is a 2nd-declension Ancient-Greek noun that means ‘number,’ ‘numeral,’ Cf. ‘ἀριθμός#Ancient_Greek,’ Wiktionary (last modified: 7th September 2018, at 17:57.), https://en.wiktionary.org/wiki/ἀριθμός#Ancient_Greek , accessed 29th April 2019.

[2] Cf. ‘arithmetic,’ Wiktionary (last modified: 25th April 2019, at 04:45.), https://en.wiktionary.org/wiki/arithmetic , accessed 29th April 2019.

Body:

The Etymological Definition of 'Precedence:'

Our English noun, 'precedence,' is derived from the Latin substantive participle, 'praecēdentia.[3]'
'Praecēdentia,' in Latin, means 'the abstract concept of which things go before [other things].'



Go

[3] 'praecedēntia' is the nominative neuter plural of the participle, 'praecedēns,' which means 'going before.' The form, 'praecedēntia,' means 'those things going before;' 'the concept of things going before.' We shall metamorphose 'praecedēntia' into a 1st-declension feminine noun that means 'precedence.' 'praecedēntia' genitive singular: 'praecēdentiae,' is a 1st-declension feminine noun that means 'precedence.' 'praecēdentiae,' can be further broken down into the preposition, 'prae,' which means 'before;' and the 3rd-conjugation verb, 'cēdō, cēdere, cessī, cessum,' which means 'to go,' and the Latin 1st-declension feminine nominative nominal suffix, '-ia,' genitive: '-iae,' which, in this instance, denotes 'a noun formed from a present-participle stem.' Hence, the etymological definition of 'precedence' is 'the concept of things going before [other things].' Within the context of arithmetic, the etymological definition of 'precedence is 'the concept of operations being evaluated before other operations.' Cf. 'praecedentia,' Wiktionary (last modified on 9th September 2013, at 02:28.), accessed on 1st May 2019. Cf. 'praecedens,' Wiktionary (last modified on 11th November 2016, at 16:40.) https://en.wiktionary.org/wiki/praecedens#Latin, accessed on 1st May 2019.

Figure 1: The English arithmetical term, 'precendence,' is derived from a compund of the Latin verb 'cēdēre,' which means 'to go.' Go, or Golang, as a language, is - syntactically - very like the C Programming Language.

Within the context of Arithmetic, 'precedence,' etymologically, means 'the science of determining which operations *go before* [other operations];' 'the science of determining which operations should be evaluated *before* [other operations].

The Acronym, 'P.E.M.D.A.S:'

The acronym, 'P.E.M.D.A.S.,' stands for:

1. Parenthesis;
2. Exponentiation;
3. Multiplication and Division;
4. Addition and Subtraction.

The Acronym, 'P.E.M.D.A.S.,' can be easily remembered with the Mnemonic phrase:

'Please Excuse My Dear Aunt Sally.'[4]

Levels of Precedence:

As we can observe from the above ordered list, some operations share *the same level of precedence*. For example, the operation, *multiplication*, and the operation, *division,* have the same level of precedence. Multiplication and Division share the third level of precedence, in the above list. When we are confronted with an expression or an equation that contains operations at the same level of precedence, seeing that in Anglophone countries, we read from left to right, then we evaluate operations that possess the same level of precedence from left to right. Hence, when two or more operations – within an equation or an expression – share the same level of precedence, then we evaluate them from left to right. Concerning operations at the same level of precedence, we evaluate from beginning at the leftmost operation, and work our way rightwards.

An Example of Precedence:

In the expression:

$$2 \div 1 + 3 \times 4^2 - 5 + (3 - 2)$$

, we first evaluate the operation in parenthesis, i.e.:

$$(3 - 2)$$

. When we evaluate:

$$(3 - 2)$$

, then we obtain the difference:

$$1$$

.

This renders the original expression as:

$$2 \div 1 + 3 \times 4^2 - 5 + (1)$$

[4] Stapel, Elizabeth, 'The Order of Operations: PEMDAS,' Purple Math (2019), http://www.purplemath.com/modules/orderops.htm, accessed on the 1st May 2019.

or as:

$$2 \div 1 + 3 \times 4^2 - 5 + 1$$

.

Second, we evaluate the exponentiation operation i.e.:

$$4^2$$

. When we evaluate:

$$4^2$$

, then this obtains for us the power:

$$16$$

. This renders our original expression as:

$$2 \div 1 + 3 \times 16 - 5 + 1$$

.

The operations, *Multiplication* and *Division*, share the same level of precedence. However, given that the division operation is further to the left, on the page, than the multiplication operation, then we evaluate the division operation *before* we evaluate the multiplication operation.

Given that the division operation:

$$2 \div 1$$

is further to the left, on our page than the multiplication operation:

$$3 \times 16$$

, then we evaluate:

$$2 \div 1$$

before we evaluate:

$$3 \times 16$$

.

When we evaluate:

$$2 \div 1$$

, then we obtain the quotient:

$$2$$

. This renders our original expression as:

$$2 + 3 \times 16 - 5 + 1$$

. Then we proceed to evaluate:

$$3 \times 16$$

, and this obtains for us the product:

$$48$$

. This renders our original expression as:

$$2 + 48 - 5 + 1$$

.

The operations; addition, and subtraction; share the same level of precedence. In the above ordered list, they are at the 4th level of precedence. We evaluate these operations as we should find them, beginning at the leftmost, and working our way rightward. Hence, we evaluate:

$$2 + 48$$

first. This obtains for us the sum:

$$50$$

. This renders our original expression as:

$$50 - 5 \ + 1$$

. We then proceed to evaluate the operation:

$$50 - 5$$

, which obtains for us the difference:

$$45$$

. This renders our original expression as:

$$45 + 1$$

. We then proceed to evaluate the expression:

$$45 + 1$$

. This obtains for us the sum:

$$46$$

.

This renders our original expression as:

$$46$$

. We have thus simplified the expression:

$$2 \div 1 + 3 \times 4^2 - 5 + (3 - 2)$$

to:

$$46$$

. We have observed *mathematical precedence* or *the order of operations* in our simplification of the expression:

$$2 \div 1 + 3 \times 4^2 - 5 + (3 - 2)$$

to:

46

.

<u>Conclusion:</u>

In this chapter, we have endeavoured to gain for ourselves an implicit understanding of *precedence* as it pertains to basic or conventional arithmetic. Boolean arithmetic, an arithmetic of logic employed in Computer Science, also possesses *precedence* or *an order of operations*, which we shall examine in a subsequent chapter. In the next chapter, we shall examine *precedence* or *the order of operations* as it specifically applies to the C programming language.