## Automatic Numbering

**NUMBERS function**

In the following box, which it is a Mathcad Picture Tool (inserted by pressing Ctrl-T) there are a function named NUMBERS, but because the arguments are hidden, it's visible only as a picture


Picture Tool containing the function NUMBERS

You can see the code righting click over it and choosing "Show arguments" from the contextual menu, or looking at the end of this worksheet. It write numbers into another Picture Tool like

$N := 456789$

NUMBERS(456789)

Eventually, instead of define only a variable, consider to define a nested array, initializing it first, and making the assignation value a function of the rows of the array. This hold in the following

$A_{ORIGIN} := 0$

$A_{rows(A)+ORIGIN} := 1$

NUMBERS(rows(A))

Now, if you copy and paste the above region, see what's happen ...

$A_{rows(A)+ORIGIN} := 2$

NUMBERS(rows(A))

... and again ...

$A_{rows(A)+ORIGIN} := 3$

NUMBERS(rows(A))

**Equation numbering**

That's an *automatic counter*. Using a variable name like EQUATION highlighting the region and hiding arguments in the Picture Tool, can have a lot of always consecutive numbers

Initialize $EQUATION_{ORIGIN} := 0$

1 2 3 4 5 6 7 8 9 10

$last(EQUATION) = 11$ ...

11 12 13 14 15 16 17 18 19 20

$last(EQUATION) = 21$

You can play moving the a box, it know always where are respect the others, and take the correct value, forcing the others to change too.

**New counter Setup**

With the same method, can have independents counters: using another variable name, SECTION for example

```
SECTION[last(SECTION)+1] :=

                          NUMBERS(rows(SECTION))
```

Enabling, highlighting and hiding arguments we have the counter starting at one

$SECTION_{ORIGIN} := 0$

1 2 3 ... $last(SECTION) = 4$

Following shows that if this worksheet is referenced into an usual book structure, the section number is preserved

$SECTION_{20+ORIGIN} := 0$

21 22 23 ... $last(SECTION) = 24$

**Numbering in another worksheet**

To setup this counters into another worksheet three steps are necessary:

1. Copy and paste into it the Picture tool at the top with the function NUMBERS
2. Initialize the variable name inside the Picture tool with the counters

3 Copy and paste the Picture Tool with the counter and edit it to change the variable name inside.

For starting a new worksheet with the numeration correlative to another, you can reference the new with the previous inserting a *Reference*. But with this you also carry all the variables in the previous worksheet. If you don't want this effect can initialize manually the row of the counter variable, or save it with WRITEPRN from the previous work and recover it with READPRN in the new.

Notice that there are not components or scripting in this technique, so it is always available like any other Mathcad function.

**ORIGIN**

This worksheet uses my usual ORIGIN

$$ORIGIN \equiv 1$$

but function and boxes with numbers are implemented in such way that for any valid ORIGIN starts with **one** each counter if it are initialized with ORIGIN in the row of the variable name.

**The function code**

Because it is hide, the code for the function NUMBERS is listed here, but suppressing the font definition.

$$\begin{aligned}
&NUMBERS(n) := \\
&\quad O \leftarrow ORIGIN \\
&\quad Z_{3+O,\,7+O} \leftarrow S_{17+O,\,3+O} \leftarrow 0 \\
&\quad \text{if } n < 0 \\
&\quad\quad \Delta \leftarrow \text{"Define the font here as a 10x80 matrix"} \\
&\quad\quad M \leftarrow submatrix[\,\Delta, O, 9+O, 8\cdot(-1-n)+O, 8\cdot(-1-n)+7+O\,] \\
&\quad\quad \text{return } stack(Z, M, Z) \\
&\quad M \leftarrow NUMBERS(-1-n) \quad \text{if } 0 \le n < 10 \\
&\quad \text{otherwise} \\
&\quad\quad \nu \leftarrow floor(\log(n)) + O \\
&\quad\quad \text{for } k \in \nu .. O \\
&\quad\quad\quad a \leftarrow \mathrm{mod}\left(floor\left(n\cdot 10^{-k+O}\right), 10\right) \\
&\quad\quad\quad M \leftarrow \begin{cases} NUMBERS(-1-a) & \text{if } k = \nu \\ augment(M, NUMBERS(-1-a)) & \text{otherwise} \end{cases} \\
&\quad M \leftarrow 255 - augment(S, M, S)
\end{aligned}$$

Font used in this example is $Mathcad\ UniMath$ font.

**To Do**

Finally, you can improve the function NUMBERS adding parenthesis, mixing equation numbers with the chapter, separate it with dots, drawing your own numbers or what you discover to improve.

**References**

How to insert a Picture Tool can be read in the Mathcad Resources with Help / QuickSheets under *GRAPHING AND VISUALIZATION / Image Processing / Reading a Grayscale Image into a Matrix*.

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