Syntax highlighting for SD modeling

Abstract:

When working with SD models, the equation for even a single variable can get very long and convoluted, making them difficult to grasp. This issue is neither new nor unique to SD: programmers face a similar challenge with code in every programming language. To help manage this, programming has long since come up with an approach aiding programmers in reading complex code: Syntax highlighting (a.k.a. code coloring). Text editors that have been specifically built for coding typically recognize the programming language by means of file extensions and then automatically colorize / emphasize different parts in the code syntax, (e.g. comments, key words or math operators) in different colors or font styles. This can also be of help for SD modelers, because such text editors can be taught to custom-colorize / -emphasize syntax of equations in SD models by treating them as custom programming languages. SD modelers can use this to view single equations or a whole SD model as colored text in such text editors, making it easier to read and grasp. In the medium term, it would also be desirable if developers of SD software would add syntax highlighting capabilities into the equation editors of their modeling software packages.

Let's start with a simple example from the famous world3 model that is available freely with any installation of the Vensim software. This is what the equation for the variable resource technology change rate multiplier

```
resource technology change rate  =
      IF THEN ELSE ( Time >= POLICY YEAR ,
          Resource Conservation Technology
          * resource technology change rate multiplier , 0)
  ~      1/year
  ~        RESOURCE TECHNOLOGY IMPROVEMENT RATE (NRATE-##).
  |
```

looks like when opening the model in text format (suffix.mdl)[1]:

If instead of opening an .mdl-file one copy-pasted from the equation editor into a text editor with syntax coloring, only the top part before the "~" would appear of course.

When using a prototype of a user defined language definition in Notepad++ (developed at M-Five[2]), the same equation looks like
this:

```
resource technology change rate  =
      IF THEN ELSE ( Time >= POLICY YEAR ,
          Resource Conservation Technology
          * resource technology change rate multiplier , 0)
  ~      1/year
  ~        RESOURCE TECHNOLOGY IMPROVEMENT RATE (NRATE-##).
  |
```

As can be seen, the units of the equation as well as the comment have been colored green, here.

The built-in Vensim function *IF THEN ELSE* has been colored blue, the mathematical operators "*", "=" and ">=" have been colored orange and everything within the parentheses following the key word IF THEN ELSE has been set to italic font. This makes it easier to differentiate the different parts of the equation.

Moreover, when opening a Vensim .mdl model, the sketch information —which outlines where variables are placed on the canvas, their sizes, and other spatial details— is displayed in light grey to make it less prominent, since it is not to be edited.

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[1] The world3 model actually comes with the Vensim-documentation in .vmf format. This can be converted by opening it in Vensim and saving as text format model (.mdl)

[2] https://www.m-five.de/

Note that the concept of syntax highlighting extends beyond just code coloring: Other text formats such as *italic*, **bold** or <u>underlined</u> may also be used and `different fonts` as well as <mark>background color</mark> can also be used to visually emphasize different parts of the syntax.

Potential for improvement

Improvement of existing Notepad++ prototypes for Vensim models

This is a prototype language definition only. It is shared under a GNU public license and is available here: (https://github.com/julianM5/vensim_syntax_highlighting). Any reader should feel free to improve the definition and fork the GitHub repository or create a pull request.

Potential improvement could include:

- applying a different color for units and comments to distinguish them better within the code,

- formatting the name of the equation (text to the left of the first "=" sign) differently, e.g. bold, to make it stand out,

- introducing color coding for commas to enhance readability and organizations within the equations.

Additionally, it could be desirable to color the parentheses in nested equations differently, e.g.:

```
((syntax)+(syntax(syntax))/(more syntax))
```

Having a language definitions, one with and without coloring of nested parentheses would allow for turning this feature off, whenever needed.

Vensim uses other files besides the .mdl model files for other purposes that can also be opened, read and edited in text editors. Therefore, Notepad++ prototype user language definitions have also been developed for:

• Vensim .vgd: Graph Definition files to create and modify custom graphs.

• Vensim .cin: Constant Input files to define altered exogenous input of model parameters, e.g. for running a scenario.

• Vensim .cmd: Command files to automate the operation of Vensim functionalities and also to remote-control Vensim DSS from other software applications (e.g. Excel, Python…)

Development of language definitions for other SD modeling softwares

In iThink Stella for example, "save as text" allows for exporting the equation layer of the model. This opens up the possibility to define a language definition for Notepad++ also for iThink/Stella syntax.

Development of language definitions for other text editors including other operating systems

While Notepad++ is certainly a widely used text editor and is free of charge, there may be other preferences for various reasons including other operating systems incl. macOS (for which notepad++ is not available), so that defining syntax coloring definitions for other text editors is highly desirable as well.

Development of text highlighting functionality within SD software packages

It would be desirable if SD modeling software applications such as Vensim, iThink/Stella, AnyLogic, Powersim, Smia etc. implemented syntax highlighting capabilities within their equation editors.