User's Guide
for the *Varimin* program
(PCA, Varimin, and Varimax factor rotations)

	Prior to starting varimin.exe **A paper printout of this guide may be helpful for Varimin users,**
01	Set up some **new folder** for an intended factor analysis. Place the **input file** (raw data or a correlation matrix) in this folder. Varimin.exe will save all **output files** of your factor analysis in this folder.
02	The **format** of input files is ASCII. Use a deliberate file extension like *.dat`* or *.txt,*. Don't use for input files the following extensions: *.ini, *.cor,*.eig, *.vec, *.fmi, *.fma, *.min, *.max, *.pca which are reserved for output files. Non-ASCII files with input data must be converted into ASCII. All output file types generated by varimin.exe are ASCII except one graphic file type (*.png).
03	**Decimal numbers**: Only decimal points are recognized. Do not use decimal commas. **Delete** in your input file **non-numerical characters**, if present (e.g. column headings)
04	Correlations as input are **accepted** as **square** or **triangular** tables (upper or lower triangle). In correlation matrices PCA requires 1s as diagonal entries. Triangular correlation tables, if available as input, need not have 1_s in the diagonal. If 1_s are missing in the diagonal of a triangular matrix, the program inserts them without extra command.
05	You might have obtained your data (raw data or correlations) as clipboard content, e.g., after downloading an ASCII-table from some **Usages** entry of the **Varimin** program.
06	Mark and copy this data into the clipboard, call the **Windows editor** and paste the data from the clipboard pn the editor plane.
07	**Save the data from the editor, e.g. as *.txt file,** into the folder that you reserve for this factorial project.

01	**Start** the *Varimin* program by clicking the Varimin icon on your desktop.	
02	In the upper left corner of an otherwise empty screen you see three buttons: ***File*** ***Settings*** ***Help*** . ***Help**** calls this User's Guide.	
03	Click ***Settings*** . **Three** options are displayed: ***Precision*, *Show welcome screen*** and ***Open file explorer when closing Varimin session*.**	
04	Click ***Precision*.** The default is "2" meanig that two decimal numbers will be used in this analysis. The number of decimals may be changed.	
05	Mark ***Show welcome screen*** if you do not like to see a yawningly empty screen after calling varimin.exe next time. The welcome screen, its brief colorful exposure, is not shown during the present session.	
06	Mark ***Open file explorer when closing the Varimin session***. This is recommended since viewing output files of varimin.exe might otherwise be cumbersome.	
07	Press ***File*,** the button left of *Settings*. *Read data* and *Read correlations* are the effected next options.	
08	Press ***Read data**** or ***Read correlations*,** depending on the intended input. Calling the data and correlations, respectively, can, but need not be shortened by pressing CTRL+ D (for data) and A for ASCII) or CTRL+ C (for correlations) and CTRL + A (for ASCII). This handling wiill become easier with practice.	
09	When you click one of the two ***Read*** buttons, two windows are shown providing, on the left, an overview of your directories and, to the right of this, detailed folders and file names. The **view format** of the files should not be ***image***. If necessary, click the right mouse button and select the view ***Detail***. **Search the folder** where you saved your ASCII data file and double-click this file. Later on, the program will store all output into this directory.	
10	If you entered raw data	The options ***Raw data*, *Correlations*** and ***PCA*** are displayed. Click ***Raw data***
11		The **type of the raw data matrix** needs to be indicated:
12		Mark ***Each column one variable*** if the columns in your file contain variables. Mark ***Each row one variable*** if rows contain the variables.
13		The raw data matrix may be saved by clicking ***Save***.

14		The default extension of saved raw data files is ***.dat** irrespective of the file extension used for your raw data input.
15	If you entered correlations	The options ***Correlations* *PCA*** are displayed. Click ***Correlations*** The correlation matrix is shown
16 17	Henceforth, the User's Guide info is valid for analyses of raw data as well as correlations.	Click ***edit names of variables***, and fill in the blanks of ***Names of variables*.** The length of names is not limited, however short designations, say 15-20 characters, are recommended. Names of variables may be re-edited any time. Click ***Save*** to save the raw data or correlation matrix. Once your raw data and/or your correlation matrix has been supplemented with names of variables, saved files will also keep the variable names (attached to the last numerical row of respective files). On entering such files as input of varimin.exe the variable names are further considered.
18		Click ***PCA***. ***Eigenvalues* * Eigenvectors* * Initial factor matrix*** are displayed as options.
19 20 21		Click ***Eigenvalues*.** Check how many Eigenvalues are larger than 1 (the Kaiser criterion). Click ***Save*** to save Eigenvalues. The file extension is ***.eig.** Click ***Eigenvectors*** Click***Save*** to save Eigenvectors. The file extension is ***.vec.** Click***initial factor matrix***. Click ***Save*** to save the initial factor matrix. The file extension is ***.ini**.
22 23 24 25 26		Make selections for ***Settings for factor rotation*.** ***Number of factors***. The default number (>1 Eigenvalues) may be deliberately changed. ***Types of rotation*** You may mark ***Varimin***or ***Varimax*** or both rotations. Marking ***Initial*** yields an nrotated factor matrix. Click ***Start processing* for** actually performing the marked rotations and/or to produce an unrotated factor matrix **Visualized results** are provided by clicking the buttons

27 28		*__Varimin[X]*__ and/or __*Varimax[X]**__ and/or __*Initial[X]**__ as shown in the right section of the __*PCA**__ line. __[X]__ = number of factors to be rotated (in case of Varimax and Varimin rotation) or merely shown without rotation (in case of initial solutions). Inadvertently duplicated rotations may be deleted by clicking pertinent **small white-on-red crosses** on the respective rotation labels.	
29		Factor loadings are visualized by circles of varying size and color: The color of **positive loadings** is dark grey, of **negative loadings** light grey. The **area of the circles** (not diameters) indicates **the size of factor loadings**.	
30		By moving a long size-adjusting **horizontal slider**, the visualization of results for large numbers of variables is improved.	
31 32		You may save the rotation results by clicking __*Save**__ or __*Image**__. The effect of __*Save**__ is storing tables of rotated (or unrotated) factor weights on ASCII files with extensions __*.min,* *.max*__, or __*.ini*.__ The effect of __*Image**__ is storing the visualized results as **png-files** with __*.min*, *.max*,__ or __*.ini**__.-syllables, respectively, as part of the file names.	
33		The number of rotated factors is also included in the file names, e.g., *_2.* is included in case of 2 rotated factors e.g. **dataname_2_min.png**	
34		In case your input was **raw data**, you may want to get **factor scores** for further statistical use (for validation, e.g.). Go back to __*PCA*.__ Compute __*Start processing**__ for Varimin rotation. Click the __*Varimin**__button which will in turn offer three buttons: __*Visualization**__, __*Minimal pairs**__, and __*Factor scores**__. Click __*Factor scores**__ and then __*Save*.__ The file extension is __*.fmi__ for Varimin factor scores. If you want to get Varimax factor scores or scores of unrotated factors, use corresponding buttons. The File extension for Varimax factor scores is __*.fma__, for initial factors __*.fin.__	
35		You may want to have a look at all output files of the project. Click the white-on-red cross of the project window. If the files do not yet have the detail view format press the right mouse button and select from the displayed menu the view *detail*.	

	Interpreting Varimin factors
01	The following information is useful, but not indispensable for interpreting Varimin factors.
02	It is advisable for Varimin factor interpretations to first inspect the **visualized factor loadings**. Variables loading **positively** on a Varimin factor and variables loading **negatively** on that factor have generally, quite different, opposite or even bipolar factorial meanings. Factor weights are not conceivable as representing ratio scale values, positive and negative factor weights may occur with a median of 0 similar to Z-values.
03	Factors obtained by **Varimin** rotation represent **components of complex structures** of the analyzed variables. Components of full meanings of variables of the analyzed sample of variables may be **more or less** manifest (transparent). They need not be latent (unrecognizable).
04	Factors obtained by **simple structure rotation** like **Varimax** are generally not elementary "dimensions", but clusters of Varimin components. Varimin components of Varimax factors are not easily recognized as such; they are often hardly intelligible. An example: One Big-5 Varimax factor of personality was called by different authors, ambiguously, "intellect" or "culture" and "openness to experience," while the underlying Varimin components of this Varimax cluster remained undiscovered (more about Varimin discoveries in the personality domain has been reported in "Factor analysis. Healing an ailing model)."
05	The meanings of Varimin factors are generally **more abstract** than the meanings of Varimax factors just as fundamental constructs in physics that are also more abstract (applicable on a wider range of phenomena) than concepts specified for physical subdomains).
06	The meanings of Varimin factors are found by **comparing the meaning of pairs of seemingly different variables** as long as they differ by only one component. For example, a comparison of the word pairs "uncle" vs. "aunt" and "nephew" vs. "niece" as variables suggests the existence of the bipolarity cslled gender.

07 08	Comparisons of pairs of different variables contrasting by only one common component are called **"minimal pair comparisons,"** a term and technique borrowed from linguistics. (See pp. 48-49 in Factor analysis. Healing an ailing model, Ertel ,2013)..
	This technique is applied as **an aid for interpreting Varimin factors**. It is inapplicable for interpreting Varimax factors because "simple structure" meanings are actually complex, not simple. .
09	Click the button for Varimin rotation. Click button ***Minimal pairs*** adjacent to the button ***Visualisation*.**
10 11	Assuming, for example, you rotated two Varimin factors. Below ***minimal pairs*** you find ***Focal factor No. 1***and ***Focal factor No. 2***. The minimal pair technique is applied in succession to rotated factors individually. The factor whose meaning is searched is called **"focal" factor**. Additional factors whose meanings are ignored when a focal factor is searched are called **"non-focal factors"**.
12	Click ***focal factor 1*.** The window on the right displays loadings of focal factor (F1) for a first, a second, and a third minimal pair of variables as well as their absolute loading differences.
13	The absolute loading difference for the focal factor of the **first minimal pair** of variables is the largest difference for this focal factor among paired variables of the sample. See ***|difference|:** *.
14	The absolute loading difference for the focal factor of the **second minimal pair** is the second largest among paired variables when the two variables used for the first minimal pair are ignored. See ***|difference|:** *
15	The absolute loading difference for the focal factor of the **third minimal pair** is the next largest among paired variables when the two variables used for the first pair and the two for the second pair are ignored. See ***|difference:|*** Restricting this analysis to three minimal pairs is an arbitrary decision.
16	Pull the slider down on the right: You see the **loadings of the non-focal factors** of the first, the second, and the third minimal pairs, and on the bottom, you see the **average of absolute differences** across non-focal factors.
17 18	On the left of this window, you find the (non-absolute) **DIFFERENCE** between (1) the |difference| for the focal factor minus (2) the avg. |difference| for the non-focal factors. DIFFERENCES are obtained for the first, the second, and the third minimal pair.

	The larger the DIFFERENCE, the larger the focal factor loading of the first variable of a pair of variables compared with the focal factor loading of the second variable of the same pair.
19	**In practice, you merely take a look at the three pairs of variables written on the left and try to find out how their paired meanings differ**. If, for example, the three minimal pairs with relatively large positive DIFFERENCE values for a focal factor are “grandmother-mother,” “father-son,” and “child-grandchild,” then the meaning of this factor is apparently “generation,” suggesting the contrasting polarity “older” vs.“younger”.
20	**To repeat: It is advisable for factor interpretations to** always **check the visualized factor loadings first**. Differences between variables loading positively on a factor and variables loading negatively on that factor generally reveal very different or even contrasting (bipolar) factoriameanings.
21	**An exception:** The minimal pair technique may yield **minimal or even sometimes negative** DIFFERENCE values for focal factors if the variance of loadings across variables for a focal factor is low, i.e., for “**g-factors**” above all. The meaning of g-factors is rarely manifested, if at all, by only slightly varying factor loadings across variables. .
22	Applying the minimal pair technique on **Varimax**-rotated factor loadings (or for initial factors) would not make any sense. Hence the Varimin program does not provide this technique for Varimax and initial results.