Jlp22
Users' Guide

Version 2022/11/28

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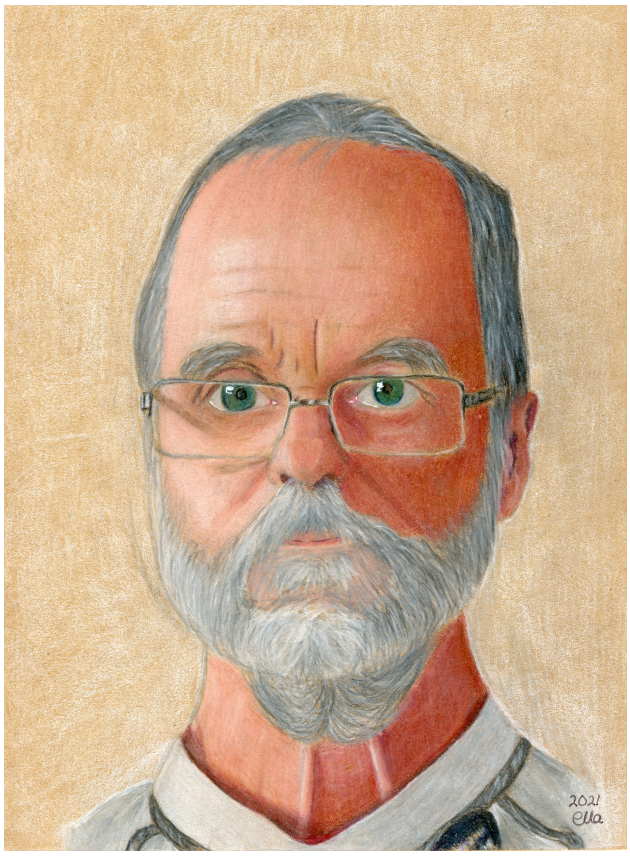

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Preface

The **Jlp22** software is the newest version of **J** software. Don Shepard told via Fortran Discourse that that there is already **J** programming language. In order to avoid confusion, the name of **J** is now changed into **Jlp22**, the name which shows the inheritance from JLP. The name **J** was used in everything which happened to the software before this point. In the current version **Jlp22**, the beef if still the linear programming in forest management planning. But **Jlp22** has so many tools for data management and numeric computations, that also vegetarians can use it. Perhaps these tools will be first used for preprocessing data and postprocessing the results in conjuction of linear programming. The random number generators provide possiblities to do risk computations related to linear programming within **Jlp22**.

History of J before Luke

JLP is the linear programming (LP) software I made for the forest planning system Mela which was created by Markku Siitonen in Finnish Forest Researc Institute (Metla). In Mela, a simulator generates a large number of treatment schedules for each stand in a group of stands. In an optimization problem a linear combination of sums of variables (e.g. amount of harvested sawlogs dutring a period) produced in treatments is maximized or minimized subject to constraints which are also linear combinations of variables. JLP was published 1992 and Finnish Forest Research Institute (Metla) started to distribute it. I wrote most part of it when payed by Academy of Finland. I reinvented the generalized upper bound technique of Dantzik and Van Slyke. The key idea is to remove with algebraic tricks the area constraints which tell that areas of different schedules add to the total area of the stand. In a typical problem the data can consist of 10000 stands, and and optimization problem can consist of 10 contraints for the sums ofe variables. Using an ordinary LP software in one iterative optimization step, a matrix consisting of 100200100 elements is updated. In JLP the equivalent step is computed by updating a matrix consisting 100 elements. NMBU started to use JLP from the beginning in its GAYA software which was then called GAYA-JLP. JLP allowed to compute new variables from the simulated variables. It allowed also to add nicely constraints for domains, i.e. subsets of stands. JLP was programmed in Fortran77, which did not have dynamic allocation, pointers or own data types.

I wrote **J** as a successor for JLP. First version of **J**, version 0.9.3 was published in August 2004. The beef in **J** was the same linear programming

algorithm as in JLP. **J** was written in Fortran90 and now it probably contains properties of newer Fortrans. **J** uses in linear programming matrix suboutines of Roger Fletcher which I changed to double precision. **J** provided many new possibilities for preprocessing of data and postprocessing of results, and these computations can be uased also without LP problems. Even Bergseng from NMBU started to use **J** in a premature face and thus he had to tolerate quite much mix-up. The GAYA started to use **J** in the planning system called thereafter GAYA-**J**. Mela has not included **J** as as the optimizer, but it is possible to pull out simulated schedules from Mela and then define and solve linear programming problems using **J**.

Simosol started to use **J** as an optimizer from the beginning. Simosol has privately admitted, that they using much **J**. For some reason Simosol wants to keep this hidden from the users of their sofware and from the public. It would be important for an open source software that the users would rise a flag when they use the sofware. This would give feedback to the developers and would allow communication between users.

J version 2.0. published in 2013 made it possible optimize simultatenously forestry and transportations to factories and factory production. I extended the generalized upper bound tehcnique for constraints which tell that all harvested timber volume in a stand is transported somewhere. Reetta Lempinen started to work with me in the factory optimization. Reetta has professional training in programming, while I'm a self-learning amateur. Reetta had a clear head to keep complicated data structures I had created in order. She also maintained the spirit during the black moments.

J in Luke

When working with Reetta, I noticed how terribly dirty the code was. I started to clean the code. In 2015 Metla and two other institutes were merged into Institute of Natural Resources Finland (Luke). When my retirement was approaching, I suggested Luke that **J** would be published as an open source software so that I could continue its development after my retirement. The leaders of Luke told that it is a good idea to open the software, and this is so important that Luke cannot let me take care of the publication but the leaders wanted to publish **J** themselves. This started a frustrating and humillating process which lasted until 7.10. 2021. None of the involved eleven leaders thought that the software had been even so important that he/she had taken care that it had been eventually published.

The following leading persons were involved in process before my retirement in 2017: Päivi Eskelinen, Olli Salminen, Kari T. Korhonen, Kimmo Kukkavuori, Tuula Packalen, Sirpa Thessler, Sari Forsman-Hugg, Emilia Kata-

jajuuri and Johanna Buchert. Iikka Sainio was an outside legal consult. After my retirement prof. Packalen and after she left Luke in 2020 research director Antti Asikainen, head of adiministration Ilkka P. Laurila, and the director general Johanna Buchert took the control of the publication.

In the previous version of this manual I wrote a detailed description of the process, e.g. of the farce related to the subroutines of Roger Fletcher. Now I present only some key points. The process can be described as a hostile take over. The leading lawyer Emilia Katajajuuri stated it explicitly: 'Listen Juha, you do not decide anything in this matter'. Päivi Eskelinen told that I should wait patiently because the leaders want to prepare the publication carefully.

At the time when I retired in March 2017 I was told that the decision was ready to be signed by Sari Forsman-Hugg. She was not able to decide, similarly as as she was not able to decide whether Luke could take me as an outside researcher.

Research director Johanna Buchert signed the opening decision 30. 8. 2017. Buchert nominated prof Packalen to take care of the launch. I was not informed of the decision. When I heard that such decision has been made, I asked prof. Packalen what it contained. She did not remember. The software was used in a tiny research project utilizing factory optimization. I had sent to Luke a bug correction beleaving that the publication was approaching as prof Packalen had promised. She suggested a high-level launch with oversees attendees. I did not like such launch because the software was not yet ripe for that. I would be ashamed if the prominent guests would look at the code. Prof Packalen then prevented without any notice the publication altogether by not allowing Reetta Lempinen to do necessary preparations. Research director Buchert did not follow how prof Packalen was doing the launch.

Prof Packalen left Luke in June 2020 and could thus no more prevent the publication. In February 2021 Hannu Salminen started to discuss with me of the development and utilization of **J**. He was the first person in Luke's history wanting to discuss such things with me. A cooperation plan was made. I had made significant improvements and corrected a bug in the factory optimization. I had difficulties to obey the six year's old request of Päivi Eskelinen to wait patiently, so I tried to get **J** published during my life time. I told the leaders of Luke in March 2021 that I will not send improved codes to Luke without an explicit co-operation agreement. The research director Antti Asikainen answered 'According to my understanding the IPR rights of **J** software belong to Luke'. The head of admininistration, Ilkka P Laurila wrote: 'Luke has started preparations for the publication'. Laurila was not on my e-mail list, so evidently he answered on behalf of director

general Johanna Buchert, who was. After getting such a rejection to my co-operation offer, it was clear that I would not send any codes to Luke. The highest leaders of Luke did evidently not care of research needs of Hannu Salminen and others included in the planned project.

I decided to continue my co-operation only with the GAYA group. It had new interest in co-operation as they were making a new simulator.

The situation changed when Lauri Mehtätalo was invited to become a professor of Luke. He started to mediate negotiations between me and Luke. Earlier Luke did not acknowledge that I did exist in legal sense in this matter. Lauri was able to persuade the research director Asikainen to make an U-turn. As some months earlier he did not see any co-operation with me possible, he was now interested to become a co-author in a forthcoming publication. The negotiations started well, but finally I had to make an ultimatum to brake conclusively all conncetions to Luke before the co-operation agreement was signed 7.10. 2021 in the 100 years celebration of NFI in Kings Hall in the medieval Olavinlinna castle in Savonlinna.

I got a permission to publish the software, and Luke agreed to provide treatment schedules simulated with Mela using NFI data from whole Finland and data from pulp mills and saw mills. Luke should provide me access to CSC supercomputers. Luke should distribute **Jlp22** via Github. This point was not necessary as Reetta adviced me how to use Github.

During the hostile take over, the leaders knew nothing of the code and the optimization algoritm, and were not willing to learn these things. Packalen Salminen and Korhonen had some idea what the software can do. Thus the leaders did not know that the code contained so much dirty code that it could not be maintained and developed without my assistance. For instance, the linear programming, the most important part of the software, was coded into one 7000-line subroutine having 135 goto statements (do not tell anyone!). The new factory optimization was very immature, the data structures were too complicated, the algorithm was inefficient, and import and export were not included. The software was a 32-bit software with single precision data vectors. To allow large optimization problems, the software must be in 64-bit and in double precision. Reetta could do some minor local maintenance work. But for real improvements she should start from clean table. The code without my support provided only slightly better perspectives than a one-time exe- file. Anyhow, it would be interesting to know how the leaders planned to publish tens of thousand code and manual lines I had written indicating that they had produced these lines.

Markku Siitonen, the developer of the Mela software, used to say 'You shall not steal more that you can carry'. The leaders were stealing (legally as all big robberies are done) more than they could carry as they did not

understand that their capture contained a large amount of dirty, heavy-to-carry code.

Rewriting the software

Open **Jlp22** was published 22.4.2022 in a web-seminar, and it has been distributed in Github since then. It contained many errors, but I wanted to get it out of the control of Luke as soon as possible. After my retirement I have rewritten completely the software, the most part after the agreement in 7.10.2021. Only the sceleton and innermost loops in the optimization come from the time I worked for Metla and Luke. The following manual tells what **Jlp22** can do now. The factory optmization is under development, and I will be published it later. Reetta has participated in testing, in addition to teaching the use of Github.

Acknowledgements

I acknowledge the positive contribution of Even Bergseng and Victor Strimbu from NMBU for co-operation in the development of **J**, Kyle Eyvindson from NMBU/Luke for providing me access to CSC supercomputer, Hannu Salminen for co-operation. Hannu Hirvelä provided me Mela data, and Pekka Hyvönen factory data. Lauri Mehtätalo was building with me the links between **J** and R. Ron Shepard adviced in Fortran Discourse to make expansion of allocated vectors faster, in addition to advicing to chance the name of **J** software. I thank Reetta Lempinen from Luke for being a loyal colleague for a long time. I also ackowledge that Antti Asikainen was willing to listen to Lauri Mehtätalo and that he finally changed the six and half year's consistent policy of Luke to prevent me to take care of or even participate in the publication of the software I had created.

I thank my grand daughter Ella for the permission to use the portrait she drawed for my 70 yr birthday in 2021.

Suonenjoki 8.11.2022 Juha Lappi

1 Recent changes

After renaming the software to **Jlp22**, this chapter starts to describe changes in new versions. The corrections of errors are not described in detail. The first version of **Jlp22** contains so many new properties that also old users

should look at the manual. All the examples of the manual should now go through using ALL in running jexamples.inc.

I (in this manual 'I' refers to the first author) found recently a bug in Fletchers code. When after some pivot steps only residual variables are in the basis, the code computed wrong shadow prices, and the objective was getting worse. This situation will not happen in ordinary linear programming problems. When hunting the bug, I developed new debugging tools, so I hope that all users would now send problematic runs to me.

2 Introduction

Jlp22 can be used as is, i.e. using exe files. The User guide concentrates on using binary files, but some reference is also made to additional possibilities offered by the open **Jlp22** code.

2.1 Using Jlp22 exe files

Jlp22 is a general program for many different tasks. In one end, **Jlp22** is a programming language which can be used to program several kind of applications and tasks, starting from computing 1+1, either at sit> promt or inside a trasformation object. In the other end, it contains many functions which can do several tasks in statistics, plotting figures, deterministic and stochastic simulation and linear optimization. Forest planning with factories using jlp() function can take several hours. The general **Jlp22** functions and **Jlp22** trasformations can be combined in many ways.

There are several alternatives for doing general mathematical and statistical computations available in **Jlp22**, most prominent being R. For users of R, the most interesting functions in **Jlp22** are evidently the linear programming functions which utilize the the structure of typical forest managment planning problems. The forest management planning can now in principle be combined with factories. Just now a completely new version of factory optimization is under development, and thus it is not usable. R users can do general data management in R and use **Jlp22** only for linear programming. But after learning basics of **Jlp22**, it may be more straightforward to do also data management in Jjlp22.

Jlp22 can now be used for general matrix computations. I have included in **Jlp22** all matrix functions of Matlab which I found useful in a consulting project. **Jlp22** uses Gnuplot for making figures. It is straigtforward to extend these graphics functions. **Jlp22** can be used an interface to Gnuplot graphics. **Jlp22** contains many tools to deal with classified data.

2.2 Developing own Jlp22 functions in Fortran

The user's of **Jlp22** can utilize the open source of **Jlp22** in principally two different ways. Either the user can develop new versions of existing **Jlp22** functions or the user can can make new functions. It both cases the user should make new developments using so called own functions, which can be independently of the main **Jlp22** functions. When modifying an existing **Jlp22** function, the user should make a copy of the function under a different name. Then the old and new versions can exist simultaneously in the function space of **J**. It is very easy to add new functions in **Jlp22** and even more easy to add new options.

When deloping a new methods in **Jlp22**, it is possible to first use the **Jlp22** script language to make developments. Then the user can make an own function where the method is written in Fortran to make the method faster. When writing new methods in Fortran, the user can concentrate on essential parts of the method, and utilize the standard data management services provided by **Jlp22**.

3 Installing Jlp22 from Github

The Github ditribution was made under the guidance of Reetta Lempinen. This section describes the folders of the Github distribution and also how to install **Jlp22** and Gnuplot.

3.1 Git package

The **Jlp22** package can be loaded by pressing load zip button under the green code button in the right side of the page github.com/juhalappi/jlp22. The package contains the following files.

- LICENSE the license file
- README.m readme file

The package contains following folders:

- **J_R** using **Jlp22** from R, courtesy of Lauri Mehtätalo.
    - j.par default include file for starting **Jlp22**
    - JR_0.0.tar.gz File needed to use Fortran subroutines in R
    - testr.cda

    - test.xda
    - testr.inc include file for an jlp-example
    - testr.inc

- **Jbin** binary .exe files and dll files
    - jlp22.exe Debug version of **Jlp22**.
    - jlp22r.exe Release version of **Jlp22**. If the release version crashes use the debug version to get more information of the cause.
    - jmanual.exe makes the latex code file jmanual.tex and the example file jexamples.inc.
    - jpre.exe the precompiler which generates the code for accessing variables in module, makes indentations and gives better error messages for mixed do-loops and if-then structures than Gfortran.
    - dll: libgcc_s_seh-1.dll, libgfortran-5.dll, libquadmath-0.dll and libwinpthread-1.dll which must be available in the path. e.g., in the same folder as the exe

- **Jdoc_demo** documents and include file for running examples from User's guide
    - hyvonenetal2019.pdf A paper utilizing the factory optimization.
    - **Jlp22**.pdf This users guide made with Latex.
    - **Jlp22**_setup_development.docx not up-to-date manual for developers
    - jexamples.inc include file which can be used to run all examples in the manual and which is generated with jmanual.exe
    - cdat.txt example unit data file for small jlp() example in jexample.inc.
    - xdat.txt example schedule file for small jlp() example
    - jlp92.pdf Manual of old JLP which explains the theory behind the jlp algorithm
    - lappilempinen.pdf Paper explaining the theory behing factory optimization.

- **Jmanual** Source files for making Latex code for the manual and the include file for running examples
  - jmanual.f90 source for making the Latex code and jexamples.inc
  - jmanual.tex Latex code generated with jmanual.exe
  - jsections.txt describes manual sections not in source files
  - jsections2.txt tells in what order sections found in jsections.txt and source files are put into the manual and what is the level of the sections
  - main.tex Preample code containing Latex definitions
  - Makefile_debug Makefile for making jmanual.exe
- **Source** source code before precompilation
  - fletcherd.for Fletchers subroutines turned into double precision
  - j.f90 code for **Jlp22** functions
  - jlp.f90 code for linear programming
  - j.main main prorgam for calling **Jlp22** when used as is, if **Jlp22** is used as a subroutine then this must be made a subroutine
  - jmodules.f90 data structure definitions
  - jutilities.f90 subroutines for handling objects etc.
  - jsysdep_gfortran.f90 system dependent routines
  - matsub.f subroutines obtained from other sources, e.g. from Netlib
  - other subroutines for setting up users own functions
- **Source2** source code files after precompilation in addition to files in Source (such files which are not precompiled are put in both folders)
  - makefile_debug makefile for making debug- version
  - makefile_release makefile for making release- version

3.2 Loading the package

The installation is here described from the viewpoint of an user who just want to use **Jlp22**, not develop it (yet).

The load zip button loads file **Jlp22**-master.zip. Copy this file into a proper folder. Let it be Jgit. Clicking the **Jlp22**-master.zip icon shows folder **Jlp22**-master in 7Zip (if this is installed). Clicking unpack 7zip unpacks it to the folder Jgit. Too many folder levels are avoided, if everyhing in folder **Jlp22**-master is copied directly in folder Jgit.

The jlp22.exe is the debug version of **Jlp22** and **Jlp22**r is the release version. The debug version should be used still used to set up a project. When everythings seems to work, the user can try the release version in production runs where the time is of some concern. Let us assume that the working folder is jtest.

4 Typographical conventions

In this manual function names are written in red, option names in blue, object types in capital letters, object names within the text are written in this color: Object. Coloring of objects is not ready. Objects of a certain type are written using just the type. Thus a DATA means a DATA object. Names like ob1 are used as generic names for object and names like var1 are generic names for REAL variables. An object with a special type is written using the first letter in upper case and others in the lower case. Thus Matrix is a generic name for a MATRIX object.

For functions that return real values or matrices which can be used directly in arithmetic or matrix operations, the existence of output is not indicated.

5 Subroutines from other sources

The following subroutines are obtained from other sources.

- subroutine tautsp used in j_function tautspline from Carl de Boor (1978) A practical guide to splines. Springer, New York, p.310-314 No licence restrictions known distribution: http://pages.cs.wisc.edu/∼deboor/pgs/tautsp.f
- real function ppvalu used in **Jlp22** function value from Carl de Boor (1978) A practical guide to splines. Springer, New York, p.310-314

No licence restrictions known distribution: http://pages.cs.wisc.edu/ ∼deboor/pgs/tautsp.f

- subroutine interv , used in function ppvalue from Carl de Boor (1978) A practical guide to splines. Springer, New York, p.310-314 No licence restrictions known obtained from: http://pages.cs.wisc.edu/ ∼deboor/pgs/tautsp.f Lapack matrix routines
- Several subroutines from www.netlib.org/lapack with licence : http://www.netlib.org/lapack/LICENSE.txt

6 Using Jlp22, and Gnuplot and Rscript from Jlp22

This section tells how to install **Jlp22**, Gnuplot and Rscript from **Jlp22** so that the user can start running the examples in file jexamples.inc.

6.1 Installing Jlp22, Gnuplot and Rscript

After loading **Jlp22** from the Github, the folders of the exe files must be put into the environmental variable PATH. In my computer the PATH contains line C:\jlp22 An ordinary user may use **Jlp22** ans **Jlp22**r from the folder Jgit**Jlp22**bin.

Let us then install Gnuplot. Go to page gnuplot.info, and select there download, and in the download page select green 'download latest version', which loads 'gp543-min64-mingw.exe' (or similar), and if you let it install with usual yes-next procedures gnuplot is installed in folder c:\program files\gnuplot which should be placed into the environmental variable Path.

When adding new lines to the path, it is necessary to accept changes with two 'OK'. After editing PATH have effect only after restarting the computer.

If you plan to run R scripts from **Jlp22**, Rscript program mus be installed and the folder must be put into the PATH. In my computer the folder is C:\Program Files\R\R-4.1.2\bin

6.2 Running examples

If you plan to edit the example file, copy jexamples.inc and jlp22.pdf from jdocdemo folder into the Jtest folder. It is not wise to start working in the Jdocdemo folder, because if you load a new version of **Jlp22** in a similar

way into Jgit folder and allow the computer replace existing folders with the same name, you would loose the work done in Jgit folder.

Open the command prompt and move to the directory 'jtest' by 'cd' commands. It is possible to use **Jlp22** also directly, but its necessary to use **Jlp22** through the command prompt at this testing phase, because then, if **Jlp22** crashes, the error messages do not disappear. In first time, you may want to change the colors etc of the commant prompt (color may take effect only after closing command prompt and reopening it). It may be reasonable to tick all editing properties under the properties button of the command prompt.

If you would like that when starting **Jlp22** in this folder, **Jlp22** immediately starts with examples, make file j.par to folder jtest and write to it

;incl(jexamples.inc)

It is possible to write to the first line of j.par

*3000

which would mean that **Jlp22** would generate intially 3000 named objects.

Then start **Jlp22** by giving command **Jlp22** at the command prompt. If you have not done j.par file, write at the sit> prompt: ;incl(jexamples.inc). Alternatively you can diretly start in the jexamples.inc by launching **Jlp22** by

Jlp22 jexamples.inc

Jlp22 will then print all shortcuts available. You can run examples one by one by giving example shortcuts individually, or you can run all examples by shortcut ALL. If you give shortcut ALL, **Jlp22** asks whether a ;pause is generated after each example ('pause after each example(1/0)>'). Even if pause() is not generated after each example, it is generated after each plot. This can be prevented by pressing <return> when **Jlp22** asks value for fpause. Examples in the ALL section can anyhow be started at any point by putting label ';current:' to any point after label ;ALL: and giving shortcut 'current'. This is also handy when examples have errors which break the execution. If the errors are made intentionally to demonstrate error situations, the interruption of excution after these intentional errors are prevented so that the jexamples.inc have command Continue=1 before the intentional error. Theafter the normal error handling is put on by command Continue=0.

It is useful to keep the manual open and follow simultaneously the manual and the execution of examples.

7 Command input and output

Jlp22 has two programming levels. First level, called input programming, generates text lines which are then transmitted to the parser which generates code which is the put into transformations sets or excuted directly. Input programming loops make it possible to generate large number of command lines in a compact and short form. This chapter describes input programming concepts and commands.

7.1 Input record and input line

Jlp22 reads input records from the current input channel which may be terminal, file or a text object. When **Jlp22** interprets input lines, spaces between limiters and function or object names are not significant. In input programming, functions start with ';' which is part of the function name (and there can thus be no space immediately after ';'). If a line (record) ends with ',' ,'+', '*´, '-', '(', '=' or with '>', then the next record is interpreted as a continuation record and the continuation character is kept as a part of the input line. Tf a record ends with ',' and the next record starts also with ',, only one ',' is obtained. If a line ends with '>>', then the nex line is also continuation line, and '>>' is ignored. All continuation records together form one input line. In previous version input programming functions operated on input lines but now they operate on recors. One input record can contain 4096 characters, and an input line can contain also 4096 characters (this can be increased if needed). There can be comment lines within a command line.

When entering input lines from the keyboard, the previous lines given from the keyboard can no more be accessed and edited using the arrow keys owing to MSYS2 MSYS environment used to build the exe-file. To copy text from the **Jlp22** window into the clipboard right-click the upper left icon, select Edit, and then select Mark. Next click and drag the cursor to select the text you want to copy and finally press Enter (or right-click the title bar, select Edit, and in the context menu click Copy). To paste text from the clipboard into the **Jlp22** command line right-click the title bar, select Edit, and in the context menu click Paste. Console applications of Intel Fortran do not provide copy and paste using <cntrl>c and <cntrl>v. An annoying feature of the current command window is that it is possible All input lines starting with '*' will be comments, and in each line text starting with '!' will also be interpreted as comment (!debug will put a debugging mode on for interpretation of the line, but this debug information can be understood only by the author). If a comment line starts with '*!', it will be printed.

7.2 Input Paragraph

Many **Jlp22** functions parsed and executed (interpreted) at the command level need or can use a group of text lines as input. In these cases the additional input lines are immediately after the function. This group of lines is called input paragraph. The input paragraph ends with '/', except the input paragraph of text function ends with '//' as a text object can contain ordinary input paragraphs. It may be default for the function that there is input paragraph following. When it is not a default, then the existence of the input paragraph is indicated with option in-> without any value. An input paragraph can contain input programming commands; the resulting text lines are transmitted to the **Jlp22** function which interprets the input paragraph

Example 7.1 (inpuparag)**.** Example of inputparagraph

```
 transa=trans()
a=log(b)
write($,'(~sinlog is=~,f4.0)',sin(a))
/
b=matrix(2,3,in->)
1,2,3
5,6,7
/
```

7.3 Shortcuts

Command shortcuts are defined by defining character variables. When entering the name of a character variable at sit> prompt or from an include file, **Jlp22** excutes the command. The command can be either input programming command or ??? command. The file jexamples.inc shows an useful way to organize shortcuts and include files.

Example 7.2 (shortex)**.** Example of using shortcuts and include files

```
 short1='sin(Pi)+cos(Pi);'
short1
te=text()
this=thisfile()
ju1=';incl(this,from->a1)'
ju2=';incl(this,from->a2)'
;return
;a1:
;return
```

```
;a2:
** here, jump to a1
ju1
*! back here, return to sit> or next example in ALL
;return
//
write('shortex.txt',$,te)
close('shortex.txt')
;incl(shortex.txt)
ju1
ju2
delete_f('shortex.txt')
te=0 !delete also text object te
```

7.4 Input programming

The purpose of the input programming is to read or generate **Jlp22** commands or input lines needed by **Jlp22** functions. The names of input programming commands start with semicolon ';'. There can be no space between ';' and the following input programming function. The syntax of input programming commands is the same as in **Jlp22** functions, but the input programming functions cannot have an output. There are also controls structures in the input programming. An input paragraph can contain input programming structures.

7.5 Labels in input programming

The included text files can contain labels. Labels define possible starting points for the inclusion or jump labels within an include file. A label starts with semicolon (;) and ends with colon (:). There can be text after the label and the text is printed but otherwise ignored.

```
;ad1: At this point we are doing thit and that
```

Note 7.1. The definition of a transformations object can also contain labels. These labels start with a letter and end also with colon (:). When defining a transformation object with trans() function, the input paragraph can contain input programming addresses and code labels. It is up to input programming what code alabels become part of the transformation object.

7.6 Changing "i" sequences

If an original input line contains text within quotation marks, then the sequence will be replaced as follows. If a character variable is enclosed, then the value of the character variable is substituted: E.g. directory='D: \j/ńame='area1' extension='svs' then in->'"directory""name"."extension"' is equivalent to in->'D: \j \area1.svs' If the "-expression is not a character variable then **Jlp22** interprets the sequence as an arithmetic expression and computes its value. Then the value is converted to character string and substituted into the place. E.g. if nper is variable having value 10, then lines

```
x\#"nper+1"\#"nper" = 56
chv = 'code"nper"'
```

are translated into

```
x\#11\#10 = 56
chv = 'code10'
```

With " " substitution one can define general macros which will get specific interpretation by giving values for character and numeric parameters, and numeric parameters can be utilized in variable names or other character strings. In transformation sets one can shorten computation time by calculating values of expressions in the interpretation time instead of doing computations repeatedly. E.g. if there is in a data set transformation x3 = "sin(Pi/4)"*x5 Then evaluation of sin(Pi/4) is done immediately, and the value is transmitted to the transformation set as a real constant. If value of the expression within a "" sequence is an integer then the value is dropped in the place without the decimal point and without any spaces, otherwise its value is presented in form which is dependent on magnitude of the value. After J3.0 the format can be explicitly specified within [] before the numeric value. Eg. text can be put into a figure as fig = drawline(5,5,mark->'y="[f5.2]coef(reg,x1)"*x1+"[f5.2]coef(reg,1)"") See file jex.txt and Chapter 8 for an ex

7.7 ;incl() lines from a file

Includes lines from a file or from a text object. Using the from-> option the include file can contain sections which start with adresses like ;ad:
and end with
;return

Args	0|1	Ch|Tx

	file name. Default: the same file is used as in the previous ;incl().
from	N|1 Ch gives the starting label for the inclusion, label is given without starting ';' and ending ':'.
wait	N|0 **Jlp22** waits until the include file can be opened. Useful in client server applications. See chapter **Jlp22** as a server.

Note 7.2. Include files can be nested up to 4 levels.

Note 7.3. In the current version of **Jlp22**, the file name and the adress can be without apostrophes ' ', but the previous names with apostrophes are allowed.

Note 7.4. It is possible to start reading the script from the same file. In that case ;return returns the reading of the script after the ;incl- line.

Note 7.5. ;goto(adr) and ;incl(from->adr) go to the same line in the include file but after ;goto the ;return-command closes the include file but after ;incl() the ;return-command returns the control to the calling point.

Note 7.6. See Chapter Defining a text object with text function and using it in ;incl how to include commands from a text object.

Note 7.7. When editing the include file with Notepad ++, it is reasonable to set the language as Fortran (free form).

Example 7.3 (inpuincl)**.** Example of ;incl()

```
 file=text()
** File start
i=1;
;goto(ad1)
** Never here
i=2;
;ad1:i=66;
**After ad1
;goto(ad2,ad3,2) !select label from a label list
;ad2:
** After ad2
i=3;
;ad3:
```

```
** After ad3
i=4;
;ad4:
** After ad4
i=5;
;ad5:
** After ad5
i=6;
//
file;
;if(exist_f('file.txt'))delete_f('file.txt')
write('file.txt',$,file)
close('file.txt')
;incl(file.txt)
;incl(file.txt,from->ad2)
```

Note 7.8. The adress line can contain comment starting with '!'.

7.8 ;goto()

Go to different adress in ;incl() file.

Args	1	CHAR
	The label from which the reading continues. With ;goto(adr1) the adress line starts ;adr1:	

Example 7.4 (inpugotoex)**.** Example of ;goto() and ;incl()

```
 gototxt=text()
;goto(ad2)
;ad1:
;return
;ad2:
;goto(ad1)
//
print(gototxt)
if(exist_f('goto.txt'))delete_f('goto.txt')
write('goto.txt',gototxt)
close('goto.txt')
print('goto.txt')
;incl(goto.txt)
;incl(goto.txt,from->ad1)
delete_f('goto.txt')
```

Note 7.9. In the previous versions the adress had to be withing apostrophes ’ ’, but now tis is not necessatry even if it is possible.

7.9 ;do() input records in a loop.

Args	3|4	Var,Num..
	Arguments are: iteration index, starting limit, final limit and step. First argument must be a variable name and others can be REAL variables or numeric constants.	

Example 7.5 (inpudoex)**.** Examples of ;do()

```
 ;do(i,1,2)
x"i"="i"*10
print(’Greetings from iteration "i"’)
;enddo
print(x1,x2)
varlist=list(x0,y0,
;do(i,1,3)
x"i",y"i",
;enddo
x4,y4);
```

```
<print(’Greetings from iteration 1’)
’Greetings from iteration 1’
<print(’Greetings from iteration 2’)
’Greetings from iteration 2’
sit< print(x1,x2)
<print(x1,x2)
x1=   10.000000000000000
x2=   20.000000000000000
```

7.10 ;sum() sums into input

Jlp22 an generate text of form part1+part2+...partn into input line using input programming function ;isum(). The syntax of the function is as follows:
;sum(i,low,up,step)(text)
or
;sum(i,low,up)

Arguments low, up and step must be integers (actually from nonintger values, the integer part is used) or REAL variables. Thus te valuse cannot be obtained from arithmetic operations. Sum is useful at least in problem() function.

Example 7.6 (inpusumex)**.** Example of ;sum()

```
 prob=problem()
;sum(i,1,5)(a"i"*x"i")==max
;sum(i,1,3)(a"i"*x"i")<8
/
```

Note 7.10. ;dif()() works similarly for minus

7.11 ;dif() differences into input

Jlp22 can generate text of form part1-part2-...partn into input line using input programming function ;dif(). The syntax of the function is as follows:
;dif(i,low,up,step)(text)
or
;dif(i,low,up)
Arguments low, up and step must be integers (actually from nonintger values, the integer part is used) or REAL variables. Thus te valuse cannot be obtained from arithmetic operations. ;dif() is useful at least in problem() function.

Note 7.11. ;sum()() works similarly for plus. See ;sum() for examples.

7.12 ;pause in script processing

Including input from an include file can be interrupted using an input programming command ;pause promt or the **Jlp22** function pause('<prompt>'). In both cases the user can give **Jlp22** commands, e.g., print objects, change the value of Printdebug etc. The difference is that pause('<prompt>') goes first through the interpreted and the interptreted code is transmitted to the **Jlp22** function driver. In the ;pause- pause it is possible to use input programming commands while in pause()- pause it is not possible. In both cases, when an error occurs, the control remains at the pause prompt. If the user is pressing <return> **Jlp22** continues in the include file. If pause() is part of a transformation object, pressing <return>, the function driver continues in the transformation object. If the user gives command 'e' or 'end', then **Jlp22** procees similarly as if an error had occured, i.e. print error messages and returns control to sit> -promt.

7.13 ;return from ;incl

;return in an input file means that the control returns to the point where a jumpt to an label was found. Two different cases need to be separated:

- The conrol came to the starting address or to the beginning of the include file from outside the current include file using a ;incl command. Then ;return returns the control to upper level include file or to the sit> prompt.
- The control came to the starting label from within the same include file using an explicit ;incl or ;incl is generated with command shortcut.

7.14 ;where the current lines in ;incl -files

7.15 Access using part of the name

The subobjects generated with a function can be seen according to the following example. The second example shows how objects having a common part in the name can be printed.

Example 7.7 (subobjex). Seeing subobjects

```
 dat=data(in->,read->(x,y))
1,2
3,4
/
dat%?; !prints subobjects
subob=;list(dat%?) ! makes the list of subobjects and prints it
@subob; ! prints the subobjects
```

Example 7.8 (relativesex). Seeing relatives

```
 x1a...x3a=3...5
x?a;
rel=;list(x?a);
@rel;
```

7.16 @List(index) Gets a name from a LIST

The name of an object in a LIST can be obtained into the input using the following example.

Example 7.9 (inpulistelem). Getting name from list

```
 lis=list(c2...c5);
```

```
@lis=2...5;
@lis(2)=6;
@lis(4)=@lis(1);
@lis(2)%@lis(4)=66;
```

7.17 @List expands a LIST

If a LIST is generated explicitly with list() function or as a byproduct of an other function, then all elements of the list can put into the code using @-sign in the front of the name of the list. The code then works similarly as if all the object names had been written consecutively and separated with commas.

Note 7.12. A function or an option can have several parts in the arguments generated with @

Note 7.13. In the earlier versions of the software,expanding lists with @ was implemented during the generation of the input line similarly as in the input programming proper. This was stupid. It is more simple and more efficient to to implement the expanding of lists during the code parsing stage. This is presented here because, @-sign works as if it were part of input programming.

Example 7.10 (expandex)**.** Example of expanding lists with @

```
 list0=list(site,altitude)
list1=list(
;do(i,1,3)
vol"i",ba"i",
;enddo
vol4,ba4);
dat=data(in->,read->(@list0,@list1))
1,2,3,4,5,6,7,8,9,10
2,3,4,5,6,7,8,9,10,11
/
stat()
```

7.18 ... sequences

It is often natural to index object names, and often we need to refer object names having consecutive index numbers or index letters. In **Jlp22** versions before version 3.0 it was possible to generate object lists using

... -construct which replaced part of the input line with the names of objects being between the the object name before ... and after ... . Now the dots construct is no more done as part of the input programming but in the interpret subroutine which interprets the input line and generates the integer vector for function and argument indices. But as dots work as if it would be part of the input programming, it is presented in this section. Currently also sequences of integer constants can be generated with dots and sequences can be from larger to smaller.

Example 7.11 (dotsex)**.** Example of dots construct

```
 dat=data(read->(x4...x7),in->)
1,2,3,4
11,12,13,14
/
stat(min->,max->,mean->)
x3%mean...x7%mean;
A...D=4...1;
Continue=1 !demo of error in data()
dat=data(read->(x3...x7),in->)
1,2,3,4
11,12,13,14
/
Continue=0
```

8 Jlp22 objects

Jlp22 objects have a simple yet efficient structure. Each object is associatd with two integer vectors, one single precision vector, one double precision vector, one vector of characters and one vector of text lines. All vectors are allocated dynamically. There are several object types which store data differently in these vectors. Object can be either simple or compound objects. Compound objects are linked to other objects which can be used also directly utilizing the standard naming conventions. All objects are global, i.e. also users can acces all objects. Some predefined objects are locked so that users cannot change them.

There are three types of objects

- Named objects. The number of named objects is specified at the initilaization, and it cannot be changed later. Deleting an object means deallocating all the allocated vectors associated with the objects.
- Temporary objects used to store intermediate results.

- Temporary objects used to store the partial derivatives when computing the derivatives using the derivations rules.

Alongside the objects there is a vector of double precision values, call j_v-vector. When an object is called a REAL object or variable, this vector is referenced. After the parts corresponding to named objects and those two sets of temporary objects, there is an area used to store numeric constants. If a REAL variable a has object number of 100 and constan 7 is in the position 7000 in the v-vector, then a+7 can be presented as j_v(100)+j_v(7000). Thus after parsing, all arithmetic computations can be done wihtou reference to whether a variable is in the named part or constant part of the j_v-vector. Because the numeric contants are at the end section of the j_v-vector, new space can be added for the numeric constants without mixing up parsed transformations.

8.1 Object names

Object names start with letter or with $#. Object names can contain any of symbols #%§ \_ **Jlp22** is using '%' to name objects related to some other objects. E.g. function stat(x1,x2,mean->) will store means of variables x1 and x2 into variables x1%mean and x2%mean. Objects with name starting with '$' are not stored in the automatically created lists of input and output variables when defining transformation objects. The variable Result which is the output variable, if no output is given, is not put into these lists. Object names can contain special characters (e.g. +-*=()) if these are closed within '[' and ']', e.g. a[2+3]. This possibility to include additional information is borrowed from Markku Siitonen, the developer of Mela software. If an transformation object is created with trans() function, and the intended global arguments are given in the list of arguments, then a local object ob created e.g. with transformation object tr have prefix tr \ yelding tr \ob. Actually also these objects are global, but their prefix protects them so that they do not intervene with objects having the same name in the calling transformation object. There are many objects intialized automatically. Some of these are locked so that the users cannot change them. In transformation objects there can be objects which are intended to be used only locally. These are protected by putting an unvisible prefix to the object names, but these can be anyhow accessed by writing the the prefix. Names of objects having a predefined interpretation start with capital letter. The user can freely use lower or upper case letters. **Jlp22** is case sensitive. All objects known at a given point of a **Jlp22** session can be listed by command: print(Names)

8.2 Object types

The following description describes shortly different object types available in **J**. More detailed descriptions are given in connection of **Jlp22** functions which create the objects and in Developers' guide.

8.2.1 Real variables and constants

A REAL variable is a named object associated with a single double precision value. Before version J3.0 the values were in single precision, and thus this objecttype is still called REAL. The value can be directly defined at the command level, or the variable can get the value from data structures. E.g. stat(D,H,min->,max->) ! Here arguments must be variable names a = sin(2.4) ! argument is in radians sind() is for degrees h = data(read->(x1...x4)) ! x1, x2 ,x3, x4 are variables in the data set, and get their values when doing operations for the data.

Note 8.1. All objects have also an associated REAL value. In order to make arithmetic operations fast, the argument types in simple arithmetic functions are not checked. If a general object is used as an argument in an arithmetic operation, then the REAL value associated with the object is used. This will usually prevent the program to stop due to Fortran errors, but will produce unintended results.

Note 8.2. In this manual 'variable' refers to a **Jlp22** object whose type is REAL.

8.2.2 Character constants and variables

Character constants are generated by closing text within apostrophe signs ('). Apostrophe character (') within a character constant is indicated with (∼) (if the character ∼ is not present in the keyboard, it can be produced by <Alt >126, where numbers are entered from the numeric keyboard) Character constants are used e.g. in I/O functions for file names, formats and to define text to be written. , e.g a = data(in->'file1.dat', read->(x1,x2))

write('output.txt', '(∼kukkuu=∼,4f7.0)', sqrt(a)) Character variables are pointers to character constants. An example of a character variable definition:

cvar='file1.dat' After defining a character variable, it can be used exactly as the character constants.

Note 8.3. The quotation mark (") has special meaning in the input programming. See Input programming how to use character constants within character constants.

8.2.3 Logical values

There is no special object type for logical variables. Results of logical operations are stored into temporary or named real variables so that 0 means False and 1 means True. In logical tests all non-zero values will mean True. Thus e.g. if(6)b=7 is legal statement, and variable b will get value 7. E.g. sit>h=a.lt.b.and.b.le.8 sit>print(h) h= 1.00000

8.3 Predefined objects

The following objects are generated during the initilaization.

Names	Text	Text object containg the names of named objects
Pi	REAL	The value of Pi (=3.1415926535897931)
$Cursor$	TRANS	The transformation object used to run sit> prompt
$Cursor2$	TRANS	Another transformation object used to run sit> prompt
Val	TRANS	Transformation object used to extract values of mathematical statements, used,
Round	REAL	jlp(): The current round through treatment units in jlp() function.
Change	REAL	jlp(): The change of objective in jlp() in one round before finding feasible and thereafter
Imp	REAL	jlp(): The number of improvements obtained from schedules outside the current active
$Data$	List	Default data set name for a new data set created by data()-function.
Obs	REAL	The default name of variable obtaining the the number of
Maxnamed	REAL	The maximum number of named objects. Determined via j.par in
Record	REAL	The name of variable obtaining the the number of
Subecord	REAL	The name of variable obtaining the the number of
Duplicate	REAL	A special variable used in data() function when duplicating observations
LastaData	List	A list object referring to the last data set made, used as default data set.
$Buffer	Char	A special character object used by the write() function.
$Input$	Text	Text object used for original input line.
1$Input1$	Text	Text object for input line after removing blanks and comments.

Data	List	List object used to indicate current data setsDat
$		
textcolortealtabto25mm	REAL	
		Object name used to indicate console and '*' format in reading and writing
x#	REAL	Variable used when drawing functions.
Selected	REAL	Variable used to indicate the simulator selected in simulations
Printinput	REAL	Variable used to specify how input lines are printed. Not properly used.
Prinoutpu	REAL	Variable used to indicate how much output is printed. Not properly used.
$Debug	REAL	Variable used to put debugging mode on.
Accepted	REAL	The number of accepted observations in functions using data sets.
Arg	REAL	The default argument name when using transformation object as a function.
Continue	REAL	If Continue has nonzero value then the control does not return to the
Err	REAL	If Continue prevents the control from returning to sit> prompt
Result	?	The default name of output object.

9 Jlp22 functions

The structure of **Jlp22** functions is easiest to explain using an example. For instance a data object can be created with
data2=newdata(matrx,matrz,read->(x1...x3,z1...z4),maketrans->mt)
Here data2 is the output, matrx and matrz are matrices having equal number of rows. Matrix matrx has 3 columns, matrz 4. read-> is an option which tells what are the variable names in the data. x1...x3 is equivalent to x1,x2,x3. Option maketrans->mt tells that for each observation the trasformations defined in the trasformation object mt are computed from variables x1...x3 and z1...z4. The output variables whose names do not start with $ are included in the DATA object.

A function call obtained from the input programming can have the following components separed with commas.

9.1 Output of a function

There are the the following cases with respect to the output of the function

- The function appears in a code line looking like
  Output=func()
  Then the function produces an object Output. The type of the Output depends on the function. Several functions produce additional objects whose name start with]Output%[. The object Output may or may not store links to these object. If such links are stored then the output is a compound object. An objects to which there is a link, is called a subobject. Objects without such links are called side objects. For instance linear programming function jlp() does not produce any object with name Output just several side objects.

- The expression
  func()
  is equivalent to
  Result=func()

- If code line is Output=func(); or func(); the Output or Result are printed if variable Printvalue has value 1 or 3. If code line is Output=func();; or func();; if variable Printvalue has value 2 or 3.

- Output is a temporal object. If a function is part of arithmetic computations, then the intermediate results are stored into temporary objects according to the parse tree. Thus in the expression y=sin(x)+cos(x), sin(x) produses first a temporary object and cos(x) another temporary object.

- Output is a submatrix of a MATRIX object. If A is a 4x4 matrix, and B is a3x3 MATRIX,then expression
  A(2,-4,1,-3)=B
  puts MATRIX B into A.

9.2 Function names

Function name can be be any of the four cases.

- A standard **Jlp22** function,

- An arithmetic or logical function obtained when translating the code into the polish notation.nslated first into Thus
  if(region.eq.savo)c=2*3+4;

is translated into
if(EQ(region,savo))c=PLUS(MULT(2,3),4);
The user can try directly the above translated form

- An own-function of the user included in the function space.
- Implicit function generated with the parser. For instance, options are implemented using setoption() function.
- **Jlp22** object which can be used as if it were a function. Currently there are four such cases

9.2.1 MATRIX as a function

If matrixa is a MATRIX then expression matrixa() can be both in the input side or output side to indicate a submatrix or element of the matrix. See matrix chapter.

9.2.2 REAL as a MATRIX

Often in matrix computations, a REAL is a limiting value of a sequence of matrices. To facilitate such computations, matrixa(1) and matrixa(1,1) are legal ways to refer to matrixa even if it is REAL. If matrixa is REAL, then expression matrixa(3) is causing error:
matrixa is REAL, ranges 5 are illegal, only (1) or (1,1) are allowed

9.2.3 DATA as a function

If Data is DATA then Data(var1,..,varn) indicates a matrix obtained by picking the columns of the data matrix corresponding the argument variables.

9.2.4 Using a transformation object as a function

It is now possible to use a transformation object as a function which computes new objects when generating arguments for functions or options, or values of code options, or in any place within a transformation object. If tr is a transformation and the transformation computes an object A then tr(A) is first calling transformation tr and provides then object A into this place. As the transformation computes also other objects which are computed within it, also thes objects are available. At this point it is important to note that arguments of a transformation line are computed from right to left, because options must be computed before entering into a function.

Example 9.1 (transfunc)**.** Transformation as a function

```
 delete_o(a,c)
transa=trans()
a=8;
c=2;
/
transb=trans()
a=5;
c=1;
/
c=2
a=c+transb(a)+c+transa(a);
```

9.2.5 REGR as a function

If Regr is a regression object produced with regr, then Regr() produces the value of the regression function as explained for regr(). The values of arguments can be given in the calling code or the existing values can be used.

9.2.6 Cannot produce -error

If the code looks like a function, the control goes to j_getelem function which computes the results for the above mentioned object types. But if the object cannot produce anything, there will be an error message:
produce but it is not a function or object which can provide something then there will be an error message:
* (object name) cannot produce anything
But if the object is REAL then the error message can be
matrixa is REAL, ranges 5 are illegal, only (1) or (1,1) are allowed
because a REAL can be treated as a 1x1 MATRIX.

9.3 Arguments of a function

Arguments separated with commas. Arguments can be a combination of the following types

- object name
- numeric constant
- A code which produces a temporary object generated with any **Jlp22** functions

- a sequence of object names generated with ... as x1...x3 above.
- @List where List is a LIST. If List is obtainedwit List=list(x1...x3), then @List is equivalent to x1...x3 which is equivalnet to x1,x2,x3.

a = sin(cos(c)+b) ! Usual arithmetic functions have numeric values as arguments. here the value of the argument of cos is obtained by 'computing' the value of real variable c. stat(D,H,min->,max->) ! Here arguments must be variable names plotyx(H,D,xrange->(int(D%min,5), ceiling(D%max,5))) !arguments of the function are variables, arguments of option xrange-> are numeric values c = inverse(h+t(g)) ! The argument can be intermediate result from matrix computations. If it is evident if a function or option should have object names or values as their arguments, it is not indicated with a special notation. If the difference is emphasized, then the values are indicated by val1,...,valn, and objects by obj1,...,objn, or the names of real variables are indicated by var1,...,varn. There are some special options which do not refer to object names or values. Some options define a small one-statement transformation to be used to compute something repeatedly.

9.4 Options of a function

Options give additional arguments to the function.

9.4.1 Option structure

An option starts with the option name followed with '->' after which there can be

- Nothing. In this case the option indicated that the option is put 'on'. E.g. continue-> in a graphics function indicates that no pause() is generated after plotting the figure.
- Numeric value, e.g. continue->fcont in a graphics function indicates that no pause() is generated if a REAL object fcont has a nonzero value.
- Object name.
- Function name followed by the arguments within parenthesis, e.g., xrange->(0,ask('xmax')) where ask() is the function which asks a numeric value from the user.
- Arguments of the option expressed in the same way as the arguments of the function, i.e., using acode which is producing a temporary object.

9.4.2 Codeoptions

Options are grouped into two groups: code options and regular options. Code options define a small one-statement transformation to be used to compute something repeatedly. As these one-statement can use transformation objects as functions, the code option can actually execute long computations. For instance
stat(D,H,filter->(region.eq.savo))
only those observations are accepted which pass the filter.
draw(func->(sin($x)+1),x->$x,xrange->(0,10,1),continue->fcont)
func-> option transmits the function to be drawn not a single value.

10 Arithmetic and logical functions and operations

Jlp has all the standard arithmetic and logical opertaions and functions. The arithmetic and logical functions return single REAL value or a MATRIX.

10.1 Functions sqrt(), sqrt2(), exp(), log(), log10(), abs()

!

- sqrt(x) square root, sqrt(0) is defined to be 0, negative argument produce error. If x is matrix, then an error occurs if any elemet is negative.
- sqrt2(x) If x or an element of x is negative then $sqrt2()=-sqrt()$. Actually sqrt2() might be a useful sigmoidal function in modeling context.
- exp(x) e to power x. If x>88, then **Jlp22** produces error in order to avoid system crash.
- log(x) natural logarithm
- log10(x) base 10 logarithm
- abs(x) absolute value

10.2 Conversion to integer

- nint(x) nearest integer value

- nint(x,modulo) returns modulo*nint(x/modulo) ,e.g.nint(48,5)=50; nint(47,5)=45;
- int(x) integer value obtained by truncation
- int(x,modulo) returns modulo*int(x/modulo), e.g. int(48,5)=45
- ceiling(x) smallest integer greater than or equal to x.
- ceiling(x,modulo) returns modulo*ceiling(x/modulo), e.g. ceiling(47,5)=50.
- floor(x) greatest integer smaller than or equal to x.
- floor(x,modulo) returns modulo*floor(x/modulo), e.g. floor(47,5)=45.

10.3 min() and max()

Functions min() and max () behave in a special way, max() behaves similarly as min() here:

- min(x1,x2):: minimum of two REAL
- min(MATRIX,REAL):: each element is min(elem,REAL)
- min(MATRIX):: row vector having minimums of all columns
- min(MATRIX,any->):: minimum over the whole amtrix

10.4 sign(A,B)

sign(A,B) returns the value of A with the sign of B.

10.5 Numeric operations

An arithmetic expression consisting of ordinary arithmetic operations is formed in the standard way. The operations are in the order of their precedence.

- - unary minus
- *** integer power
- ** or r̂eal power
- * multiplication

- / division
- + addition
- - subtraction

The reason for having a different integer power is that it is faster to compute and a negative value can have an integer power but not a real power.

In matrix computations there are two additional opertations.

- *. elementwise product (Hadamard product)
- /. elementwise division

The matrix operations are explained in section ?. Their operation rules extent the standard rules.

10.6 Logical and relational expressions

There are following relational and logical operations. The first alternatives follow Fortan style:

- .eq. == equal to
- .ne. <> not equal
- .gt. > greater than
- .ge. >= greater or equal
- .lt. < less than
- .le. <= less or equal
- .not. $\sim$ negation
- .and. conjunction
- .or. disjunction
- .eqv. equivalent.
- .neqv. not equivalent

The relational and logical expressions produce value 1 for True and value 0 for False. Note: Testing equivalence can be done also using 'equal to' and 'not equal', as the same truth value is expressed with the same numeric value.

Note 10.1. when the truth value of an expression is tested with if(), then all nonzero real values means that the expression is true.

11 Operation of Jlp22

In this section the main structure of the operation of **Jlp22** and tools in code development in a project are presented. The two operation modes are interactive operation and batch operation.

11.1 Looping between j_getinput, j_parser and dotrans

The are three key subroutines in **Jlp22** operation.

- j_getinput gets a new command line from the console, an include file. j_getinput can read several records to make one command line, and it can edit or duplicate the input with special **input programming** tools. Jlp prints sit> prompt when reading form the console. Input programming lines are indicated with initila %.
- If the obtained input line is not an input programming command or if it is not captured by some function which is utilizing j_getinput, the line goes to j_parser which generates an integer vector.
- The integer vector produced by the j_parser is interpred ('executed' in this manual) with dotrans subroutine.
- trans() function packs several lines generated in j_getinput - j _parser loops into a tranformation (TRANS) object, which can be called from different functions.
- dotrans subroutine executes a single line command which is not part of an TRANS object. **Jlp22** writes '#' in te front of the line.

11.2 Printing of Jlp22

Jlp22 prints information of the proceeding of the control. There are different ways to control the output. Finetuning is needed in the output. There

are three logical stages in the flow of the control. The output indicates these as follows.

11.2.1 % -lines are printed from input programming

The input programming lines are printed starting with %. The amount of printing is controlled with Printinput variable. the dafault is Printinput=1. A problem in printing the input is how much should be printed when many input lines are produced with ;do()

11.2.2 # -lines are printed in one-line commands.

The input lines which go directly to execution are printed starting with #.

11.2.3 Printoutput guides printing of functions.

The amount of printing in functions is guided with with variable [Printoutput[. The default is

In the interactive operation, the processing of sripts can be interrupted with ;pause, and execution of TRANS can be intterrupted with pause(). Even if they are described in 'Command input and output' and '**Jlp22** transformations' chapters, descriptions are repeated here as they are useful in the interactive operation of **Jlp22**.

11.2.4 ;pause in script processing

Including input from an include file can be interrupted using an input programming command ;pause promt or the **Jlp22** function pause('<prompt>'). In both cases the user can give **Jlp22** commands, e.g., print objects, change the value of Printdebug etc. The difference is that pause('<prompt>') goes first through the interpreted and the interptreted code is transmitted to the **Jlp22** function driver. In the ;pause- pause it is possible to use input programming commands while in pause()- pause it is not possible. In both cases, when an error occurs, the control remains at the pause prompt. If the user is pressing <return> **Jlp22** continues in the include file. If pause() is part of a transformation object, pressing <return>, the function driver continues in the transformation object. If the user gives command 'e' or 'end', then **Jlp22** procees similarly as if an error had occured, i.e. print error messages and returns control to sit> -promt.

11.2.5 pause() in a TRANS or in command input

Function pause() stops the execution of **Jlp22** commands which are either in an include file or in TRANS object. The user can give any commands during the pause() except input programming commands. If the user presses <return> the excution continues. If the user gives 'e', then an error condition is generated, and **Jlp22** comes to the sit> promt, except if Continue has values 1, in which case the control returns one level above the sit> promt. If pause() has a CHAR argument, then that character constant is used as the prompt.

Note 11.1. When reading commands from an include file, the a pause can be generated also with ;pause, which works similarly as pause(), but during ;pause also input programming commands can be given.

11.3 Batch mode

If the default main program is replaced with a program which tells that Jlp is operated in the batch mode, or if the initial ;incl -file containscommand batch(), the **Jlp22** is operated in the batch mode. In the batch mode, the control never starts to read commands from the console at sit> prompt. Using **Jlp22** from R, developed with Lauri Mehtätalo is using **Jlp22** in the batch mode.

11.4 Using shortcuts and sections in ;incl files

It is useful to organize the project sript into one script file, which conatians swections starting with a lable and ending with ;return. I think that it is more difficult to have several script files. The example file jexamples.inc is a good example of a script file. different versions of the same script file are stored in different names, it is useful to have as first line something like this=thisfile()
Then it is not necessary to change anything if the file is stored in a different name. Thereafter comes the shortcut definitions for different sections. the same For instance, if the the section label is
;thistask:
then the shortcut definition could be thistaskh=';incl(this,from->thistask)'

The section should end with
;return
After defining shortcuts for all sections, it is useful to have a shortcut as:
again=;incl(this)

If new sections are added, then one needs to give just shortcut
again
and then the new shortcuts will be defined. It does not matter if the earlier shortcuts are redefined.

The last shortcut could be
current=';incl(this,from->current) The label 'current' can be a floating label which is put into the section which is under developed in place the problems started.

If a **Jlp22** code line, either in the input paragraph defining a transformation object or outside it, ends with ';' or ';;', the the output object of the code line may be printed. The output of ';'-line is printed if the variable Printoutput has value 1 or 3 at the time when the the code line is computed. The output of ';;'-line is printed if the variable Printoutput has value 2 or 3 at the time when the the code line is computed.

If a code line within a tranformation has function pause('text'), then a pause is generated during which the user can give any commands except input programming commands. If the user will press <return> then the exceution continues. If the user presses 'e' and <return>, the control comes to the sit> promt similarly as during an error.

If the line outside the transformation definition paragraph is ';pause', then a similar pause is generated except also input programming commands can be give.

If the variable Debugtrans has value 1, them a pause() is genertated before each line within a tranformation object is executed. If variable Debugconsole has value 1, a ';pause' is generated before the line is excuted. In bot cases the user can give new values for Debugtrans and Debugconsole.

What happens when an error is encountered is dependent on the value of variable Continue. If Continue has value 0 (the default case), the control comes into sit> prompt when an real error occurs or if an atrficial error condition is generated with errexit(). If Continue has value 1 then the computation continues in the same script file where the error occured. This property is used in file jexaples.inc to demonstrate possible error conditions so that the computation continues as if no error had occured.

11.5 end ends Jlp22

To exit **Jlp22** program and close console window, just give end command:

```
sit>end
```

12 Functions for handling objects

The following functions can handle objects.

12.1 Copying object: a=b

A copy of object can be made by the assignment statement a=b.

12.2 type() Type of an object or all available types

The type of any object can be access by type(object). If the argument is a character variable or character constant referring to a character constant, and there is content-> option, and the character is the name of an object , the type() returns the type of the object having the name given in the argument. If there is no object having that name, then type() returns -1 and no error is generated.

Example 12.1 (typeex)**.** Example of type

```
 ttt=8; !REAL
type(ttt);
type('ttt'); !type is CHAR
type('ttt',content->);
cttt='ttt'
type(cttt);
type(cttt,content->);
```

12.3 delete_o() Deletes objects

The function delete_o() deletes all the argument objects, which means that the associated allocated vectors are deallocated, and the object will be REAL.

Note 12.1. Note that delete_o() is actually needed only for matrices, because objects can be deleted with Object=0. When Object is a matrix, then Object=0 puts all elements into zero.

Example 12.2 (deleteoex)**.** Delete object

```
 a=matrix(2,3,do->);
b=t(a);
delete_o(a,b)
a,b;
```

12.4 exist_o(): does an object exist

looks whether an object with the name given in the character constant argument exists.

Note 12.2. In the previous versions of **Jlp22** same function was used for files and objects.

12.5 name(): writes the name of an object

The argument gives the index of the object. This function may useful if **J** prints in problem cases the object indices.

13 System requirement

The current binary versions of **Jlp22** are developed using Gfortran Fortran 90 compiler in MSYS2 MINGW 64-bit environment under Windows 10. Binary versions are ordinary console applications. It is recommended that **Jlp22** is used in command prompt window, so that if execution of **Jlp22** terminates unexpectedly, the error debugging information, remains visible. With the debug version the problematic line is indicated. See chapter ? for more information of error handling.

See **Jlp22**.0 Development Guide to start develop the software or to add own functions. The development package contains, in addition to source code for the standard **Jlp22** software, program Jmanual which can be used to generate Latex code for the manualand the the include file for examples. The precompiler Jpre writes necessary Fortran statements to access all global **Jlp22** data structures, makes indentations and checks if-the and do strutures and gives better error messages for them than Gfortran.

Figures are made with Gnoplot. Gnuplot is freely available at
https://sourceforge.net/projects/gnuplot/files/gnuplot/5.4.2/

Download download gp542-win64-mingw.exe. This will install gnuplot on your windows system under C::\Program Files˙Jlp22 will strat Gnuplot automatically when plotting figures if Gnuplot is on the PATH (see section Installing Gnuplot and **Jlp22**). Dcomentation is found also in **??**

14 Jlp22 transformations

Most operation commands affecting **Jlp22** objects can be entered directly at the command level or packed into transformation object. In both cases

the syntax and working is the same. A command line can define arithmetic operations for real variables or matrices, or they can include functions which operate on other **Jlp22** objects. General **Jlp22** functions can have arithmetic statements in their arguments or in the option values. In some cases the arguments must be object names. In principle it is possible to combine several general **Jlp22** functions in the same operation command line, but there may not be any useful applications yet, and possibly some error conditions would be generated. Definition: A numeric function is a **Jlp22** function which returns a single real value. These functions can be used within other transformations similarly as ordinary arithmetic functions. E.g. weights() is a numeric function returning the number of schedules having nonzero weight in a JLP-solution. Then print(sqrt(weights())+Pi) is a legal transformation.

14.1 Transformation object

A transformation object groups several operation commands together so that they can be used for different purposes by **Jlp22** functions and **Jlp22** objects. A transformation object contains the interpreted transformations. For more details see **Jlp22** function for defining transformation objects: trans(). Transformation objects can be called using call() function, so that all transformations defined in the object are done once. Function result() also calls transformations but is also returning a value. When transformation objects are linked to data objects, then the transformations defined in trans-formation object are done separately for each observation. There is an implicit transformation object $Cursor$ which is used to run the command level. The name $Cursor$ may appear in error messages when doing commands at command level. An-other transformation object Val which is used to take care of the substitutions of "-sequences in the input programming. Some **Jlp22** functions use also implicitly transformations object $Cursor2$.

14.2 trans() Creates a TRANS (transformation) object

trans() function interprets lines from input paragraph following the trans() command and puts the interpreted code into an integer vector, which can be excuted in several places. If there are no arguments in the function, the all objected used within the transforamations are global. This may cause conflicts if there are several recursive functions operating at the same time with same objects. **Jlp22** checks some of these conflict situations, but not all. These conflicts can be avoided by giving intended global arguments

in the list of arguments. Then an object 'ob' created e.g. with transformation object tr have prefix]tr \[yelding]tr \ob[. Actually also these objects are global, but their prefix protects them so that they do not intervene with objects having the same name in the calling transformation objec.

Each line in the input paragraph is read and interpreted and packed into a transformation object, and associated tr%input and tr%output lists are created for input and output variables. Objects can be in both lists. Objects having names starting with '$' are not put into the input or output lists. The source code is saved in a text object tr%source. List tr%arg contains all arguments. ! If a semicolon ';' is at the end of an input line, then the output is printed if REAL variable Prindebug has value 1 or value>2 at the execution time. If the double semicolon ';;' is at the end then the output is printed if Printresult>1. If there is no output, but just list of objects, then these objects will be printed with semicolns.

!

Output	1	Data
	The TRANS object generated.	
Args	N|1-	
	Global objects.	

Note 14.1. Options input->, local->, matrix->, arg->, result->, source-> of previous versions are obsolte.

Note 14.2. The user can intervene the execution from console if the code calls read($,), ask(), askc() or pause() functions. During the pause one can give any command excepts such input programming command as ;incl.

Note 14.3. The value of Printresult can be changed in other parts of the transformation, or in other transforamations called or during execution of pause().

Note 14.4. Output variables in maketrans-> transformations whose name start with $ are not put into the new data object.

Example 14.1 (transex)**.** Demonstrates also error handling

```
 transa=trans()
$x3=x1+3
x2=2/$x3;
/
transa%input,transa%output,transa%source;
x1=8
```

```
call(transa)
transb=trans(x1,x2)
$x3=x1+3
x2=2/$x3;
x3=x1+x2+$x3;
/
transb%input,transb%output,transb%source;
call(transb)
transb|x3; !x3 is now local
transc=trans()
x1=-3
call(transb) !this is causing division by zero
/
Continue=1 ! continue after error
call(transc)


sit>transex
<;incl(exfile,from->transex)


<transa=trans()
<\$x3=x1+3
<x2=2|\$x3;
</
<transa\%input,transa\%output,transa\%source;
transa\%input is list with            2  elements:
x1 \$x3
transa\%output is list with            1  elements:
x2
transa\%source is text object:
1 \$x3=x1+3
2 x2=2/\$x3;
3 /
///end of text object

<x1=8


<call(transa)
x2=0.18181818
```

```
<transb=trans(x1,x2)
<\$x3=x1+3
<x2=2/\$x3;
<x3=x1+x2+\$x3;
</
<transb\%?;


<call(transb)


<transc=trans()
<x1=-3
<call(transb)
</
<Continue=1
<call(transc)
*division by zero
*****error on row            2  in tr\%source
x2=2/\$x3;
recursion level set to    3.0000000000000000

*****error on row            2  in transc\%source
call(transa)
recursion level set to    2.0000000000000000

*err* transformation set=\$Cursor\$
recursion level set to    1.0000000000000000
****cleaned input
call(transc)
*Continue even if error has occured
<;return
```

14.3 call() executes TRANS object

Parsed transformations in a TRANSobject can be automatically executed by other **Jlp22** functions or they can be executed explicitly using call() function.

Arg	1	TRANS
	The transformation object executed.	

Note 14.5. A transformation objects can be used recursively, i.e. a transformation can be called from itself. The depth of recursion is not controlled by **J**, so going too deep in recursion will eventually lead to a system error.

Note 14.6. Professional programmers would probably say that the integer vector produced with the parser is interpreted and not executed. An amateur programmer can be more flexible with terms.

Example 14.2 (recursion)**.** Recursion produces system crash.

```
 transa=trans() !level will be initialized as zero
level;
level=level+1
call(transa)
/
Continue=1 !error is produced
call(transa)
Continue=0
```

14.4 pause() in a TRANS or in command input

Function pause() stops the execution of **Jlp22** commands which are either in an include file or in TRANS object. The user can give any commands during the pause() except input programming commands. If the user presses <return> the excution continues. If the user gives 'e', then an error condition is generated, and **Jlp22** comes to the sit> promt, except if Continue has values 1, in which case the control returns one level above the sit> promt. If pause() has a CHAR argument, then that character constant is used as the prompt.

Note 14.7. When reading commands from an include file, the a pause can be generated also with ;pause, which works similarly as pause(), but during ;pause also input programming commands can be given.

15 Special implicit functions

The special functions are such that the parser uses these functions for special operations. Only list2() is function which also the user can use, but the parser is is using it implicitly.

15.1 setoption(): set option on

When a function has an option then the parser generates first code setoption(...) where the arguments of the option are interpred in the similar way as arguments of all functions. Then the parser genarates the code for setoption() function in a special way.

15.2 Get or set a matrix element or submatrices

Matrix elements or submatrices can be accessed using the same syntax as accesing **Jlp22** functions.

One can get or set matrix elements and submatrices as follows. If the expression is on the right side of '=' then **Jlp22** gets a REAL value or submatrix, if the expression is on the left side of '=', the **Jlp22** sets new values for a matrix element or a submatrix. In the following formulas C is a column vector, R a row vector, and M is a general matrix with m rows and n columns. If C is actually REAL it can be used as if it would 1 x 1 MATRIX. This can be useful when working with matrices whose dimensions can vary starting from 1 x 1. Symbol r refers to row index, r1 to first row in a row range, r2 to the last row. The rows and columns can be specifiel using ILIST objects il1 and il2 to specify noncontiguous ranges. It is currently not possible to mix ILIST range and contiguous range, so if ILIST is needed for rows (columns), it must be used also for columns (rows). ILIST can be specified using explicitly ilist() function or using construction. Similarly columns are indicated with c. It is always legal to refer to vectors by using the M formulation and giving c with value 1 for column vectors and and r with value 1 for row vectors.

Args	0-4	REAL | ILIST row and column range as explained below.
diag	N| Get or set diagonal elements	
sum	N|0|1 When setting elements, the right side is added to the current elements. If the sum-> option has argument, the right side is multiplied with the argument when adding to the curretn elements.	

Row and column ranges can be spcidie as follows.

- M(r,c) Get or set single element.
- C(r) Get or set single element in column vector.
- R(c) Get or set single element in column vector.
- M(RANGES) Get or set a submatrix, where RANGES can be. For a column vector, the column range need not to specified.
  - r1,-r2,c1,-c2
  - r,c1,-c2 part of row r
  - r1,-r2,c part of column c
  - r1,-r2,All All columns of the row range
  - All,c1,-c2 All rows of the column range
  - r1,....rm,c1,...,cn Given rows and columns
  - r1,....rm Given rows for column vector
  - il1,il2 for matrix with several columns
  - il1 for column vector
- When r2= m, then -r2 can be replaced with Tolast.
- When c2= n, then -c2 can be replaced with Tolast.

If option diag-> is present then

- M(diag->) Get or set the diagonal. If M is not square matrix, and error occurs.
- M(r1,-r2,diag->) (Again -r2 can be Tolast.

Note 15.1. Note When setting values to a submatrix the the the values given in input matrix are put into the outputmatrix in row order, and the shape of the input and output matrices need not be the same. An error occurs only if input and output contain different number of elements.

Example 15.1 (getset)**.** Get or set submatrices

```
 A=matrix(3,4,do->);
B=A(1,-2,3,-4);
A(1,-2,3,-4)=B+3;
A(1,-2,3,-4,sum->)=-5;
```

```
A(1,-2,3,-4,sum->2)=A(2,-3,1,-2);
C=A(1,3,4...2);
H=matrix(4,4,diag->,do->3);
H(3,-4,diag->)=matrix(2,values->(4,7));
```

Note 15.2. When giving range, the lower and upper limit can be equal.

15.3 getelem(): extracting information from an object

The origin of this function is the function which was used in previous versions to take an matrix element, which explains the name. Now it is used to extract also submatrices (e.g. a(1,-3,All)) , or to get value of an regression function or to compute a transformation and then take argument object as the result. E.g. if tr is a transformation then the result of tr(a) is object a after calling tr.

Note 15.3. If someone starts to use the own function property of the open source **J**, she/he probably would like to get the possiblity to extract information from her/his object types also. To implement this property requires some co-operation from my side.

15.4 setelem(): Putting something into an object.

The origin of this function is the function which was used in previous versions to set an matrix element, which explains the name. Now it is used to replace values of submatrices when submatrix expression is on the output side (e.g. a(1,-3,All)=..).

Note 15.4. If someone starts to use the own function property of the open source **J**, she/he probably would like to get the possiblity to put information into from her/his object types also. To implement this property requires some co-operation from my side.

Note 15.5. In effect the getelem() and setelem() functions are excuted in the same getelem() subroutine, because bot functions can utilize the same code.

15.5 list2()

The interpreted utilizes this to separate when spearating output and input objects. See Section **??** hw user can use this function

15.6 setcodeopt(): Initialization of a code option

This function initializes an code option for a function which has the option.

15.7 o1_funcs(), o2_funcs() and o3_funcs() calls own functions

The users of open **Jlp22** can define their own functions using three available own-function sets. In addition to own functions open **Jlp22** is ready to recognize also own object types and options which are defined in the source files controlled by the users. The main **Jlp22** does not know what to do with these own object types and options, they are just transmitted to the own-functions. In the main **Jlp22** the control is transmitted to the own functions using implicit **Jlp22** functions o1_funcs(), o2_funcs() and o3_funcs().

16 Transformation objects

The code lines generated by the input programming can be either executed directly after interpretation, or the interpreted code lines are packed into a transformation object, which can be excuted with call() which is either in the code generated with the input programming or inside the same or other transformation object. Recursive calling a transformation is thus also possible. Different functions related to transformation object are described in this section.

17 Loops and control strucures

This section describes nonstadard functions.

17.1 do() loops

The loop construction in **Jlp22** looks as follows: do(i,start,end[,step]) enddo

Note 17.1. cycle and exit are implemented in the current **Jlp22** version with goto() Within a do–loop there can be cycleand exitdostatements

Note 17.2. There can be 8 nested loops. do-loop is not allowed at command level.

Example 17.1 (doex). do-loop

```
 transa=trans()
do(i,1,5)
i;
ad1: if(i.eq.3)goto(cycle)
i;
if(i.eq.4)goto(jump)
cycle:enddo
jump:i;
/
call(transa)
```

17.2 if()

if()j_statement...
The one line if-statement.

17.3 if() elseif() else endif

There can be 4 nested if()then structures. If-then-structures are not allowed at command level.

if()then .... elseif()then ... else .... endif

17.4 output=input

There are two assignment functions generated by '=', when the line is of form output=func[]input[], then the output is directly put to the output position of the function without explicitly generating assignment. When the codeline is in form output=input then the following cases can occur

- output is MATRIX and input is scalar, then each element of MATRIX is replaced with the input in assone() function.
- output is submatrix expression, then the elements of the submatrix are asigned in setelem() funtion whether input is MATRIX or submatrix expression, scalar or LIST.
- output is MATRIX and on input side is a random number generation function, the random numbers are put to all elements of the matrix.
- If on output side are many object names, and input side is one REAL value, this is put to all variables.

- If on output side are many object names, and input there are several variables then both sides should have equal numbers of object names, then then copies of the input objects are put into output objects.

Example 17.2 (assignex). Examples of assignments

```
 a=matrix(2,3);
a=4;
a=rann();
v1...v5=2...6;
v1...v5=77;
Continue=1 ! ERROR
v1..v3=1,5;
v1..3=1...3 ! v is missing from the front of 3
Continue=0
```

17.5 which() Value based on conditions

Usage://

output=which(condition1,value1,...,conditionn,valuen) // or// output=which(condition1,value

Where conditionx is a REAL value, nonzero value indicating TRUE. Output will get first value for which the condition is TRUE. When the number of arguments is not even, the the last value is the default value.

Example 17.3 (whichex). Example of which()

```
 c=9
which(a.eq.3.or.c.gt.8,5,a.eq.7,55);
a=7
which(a.eq.3.or.c.gt.8,5,a.eq.7,55);
a=5
which(a.eq.3.or.c.gt.8,5,a.eq.7,55);
which(a.eq.3.or.c.gt.8,5,a.eq.7,55,108);
```

17.6 errexit() returns to sit>

Function errexit() returns the control to sit> prompt with a message similarly as when an error occurs.

Example 17.4 (errexitex). itex

```
 transa=trans()
if(a.eq.0)errexit('illegal value ',a)
s=3/a; ! division with zero is teste automatically
```

```
/
a=3.7
call(transa)
transa(s); !tr can also be used as a function
a=0
Continue=1 !Do not stop in thsi seflmade error
call(transa)
Continue=0
```

17.7 goto() goto a different place in TRANS

Control can be transfered to a line in a transformation set with goto(). There are two types of goto's, unconditional goto to a given address and goto to an address from a group af adresses based on a condition (Computed goto in Fortran). These are decribed in separate subsections. Notes common to both are presented here.

Note 17.3. It is not recommended to use goto() according to modern computation practices. However, it was easier to implement cycle and exitdo with goto().

Note 17.4. It is not allowed to jump in to a loop or into if -then structure. This is checked already in in the parser.

Note 17.5. Even if the labels are logically character arguments, they are not treated using CHARs. The parser handles them otherwise.

Note 17.6. The label lines can contain code but the labels can stand on the line also alone.

17.8 goto(label) Unconditional goto

An unconditional goto() has only one address argument.

Example 17.5 (gotoex)**.** Example of unconditional goto

```
 transa=trans()
i=0
if(i.eq.0)goto(koe)
out=99;
koe:out=88;
/
call(transa)
out;
```

17.9 goto(index,lable1...labeln) Conditional goto

An conditional goto() selects the label from a group of labels.

Example 17.6 (congotoex)**.** transa=trans()

```
out=999
goto(ad1)
77;
ad1:
1;
goto(2,ad1,ad3)
88;
ad2:
2;
goto(go,ad1,ad3)
out=0;
return
ad3:
3;
goto(3,ad3,ad1,ad2)
/
go=0 ! This determines the last goto
call(transa)
out;
go=4
** Now error occurs
Continue=1
call(transa)
Continue=0
;return
```

Note 17.7. A simulator for generating treatment schedules for forest stands can be nicely defined using the conditional goto, as will shortly be described.

18 Arithmetic and logical operations

The logical operations follow the same ruels as addition +. The following rules, extending the standard matrix computaion rules apply. The same rules aplly if the order of arguments is changed,

- MATRIX + REAL : REAL is added to each element

- MATRIX1+MATRIX2 :: elementwise addition, if matrices hav comptaible dimensions
- MATRIX+ column vector: column vector is added to each column of MATRIX if the numbers of rows agrees.
- MATRIX+ row vector: row vector is added to each row of MATRIX if the numbers of columns agree.

The same rules apply for the lelmentwise multiplication *. and elementwise division /. as for addition +.

18.1 min() and max()

Functions min() and max () behave in a special way, max() behaves similarly as min() here:

- min(x1,x2):: minimum of two REAL
- min(MATRIX,REAL):: each element is min(elem,REAL)
- min(MATRIX):: row vector having minimums of all columns
- min(MATRIX,any->):: minimum over the whole amtrix

19 Statistical functions for matrices

Functions mean(), sd(), var(), sum(), min() and max() can be used used to compute stastics from a matrix. Let mean() here present any of thes functions. The following rules apply:

> mean(VECTOR) computes the mean of the vector, output is REAL mean(MATRIX) computes the mean of the each column. Result is row vector. mean(VECTOR,weight->wvector) computes the weigted mean of the vector,weights being in vector wvector. mean(MATRIX,weight->wvector) computes the weighted mean of each column, weights being in vector wvector, result is row vector.

19.1 mean() Means or weighted means

See section matrixstat for details

19.2 sd() Sd's or weighted sd's

See section matrixstat for details

19.3 var() Sample variances or weighted variances

See section matrixstat for details

19.4 sum() Sums or weighted sums

See section matrixstat for details

20 Special arithmetic functions

Jlp22 has the following arithmetic functions producing REAL values.These functions cannot yet have matrix arguments.

20.1 der() Derivatives

Derivates of a function with respect to any of its arguments can be computed using the derivation rules by using der() function in the previous line. The funcion must be expressed with one-line statement. The function can call other functions using the standard way to obtain objects from transformations, but these functions cannot contain variables for which derivatives are obtained. Nonlinear regression needs the derivatives with respect to the parameters.

Output	The der() function does not have an explicit output, but der() accompanied with the function produces REAL]d[[] variable for each of the argument variables.
Args	1- REAL]d[[Argi] variable will get the value of the derivative wiht respect to the argument Argi.

Example 20.1 (derex). Derivatives with der()

```
 transa=trans()
der(x)
f=(1+x)*cos(x)
```

```
/
fi=draw(func->transa(f),x->x,xrange->(0,10),color->Blue,continue->)
fi=draw(func->transa(f),x->x,xrange->(0,10),color->Cyan,append->,continue-
>fcont)
```

Example 20.2 (derex2)**.** 2

```
 X=matrix(do->(0,1000,10))
e=matrix(nrows(X))
e=rann(0,2);
A,Pmax,Res=0.1,20,2
A*Pmax*1000/(A*1000+Pmax);
Y=A*Pmax*X/.(A*X+Pmax)-Res+e !rectangular hyperbola used often for pho-
tosynthesis transa=trans()
der(A,Pmax,Res)
f=A*Pmax*I/(A*I+Pmax)-Res
/ fi=draw(func->(transa(f)),x->I,xrange->(0,1000),color->Orange,width->2,continue-
>,show->0)
da=newdata(X,Y,e,extra->(Regf,Resid),read->(I,P,er))
stat()
fi=plotyx(P,I,append->,show->0,continue->fcont) A,Pmax,Res=0.07,17,3 !ini-
tial values fi=draw(func->(transa(f)),x->I,xrange->(0,1000),color->Green,width-
>2,append->,show->0,continue->)
reg=nonlin(P,f,par->(A,Pmax,Res),var->,corr->,data->da,trans->transa)
reg%var;
reg%corr;
corrmatrix(reg%var);
fi=draw(func->(transa(f)),x->I,xrange->(0,1000),color->Violet,append->,continue-
>fcont)
```

20.2 gamma() Gamma function

Function gamma() produses the value of gamma funtion for a positive argument. The function utilises gamma subroutine from library dcdflib in Netlib. For computing gamma function for a product, loggamma() is often needed. loggamma() Log of gamma function Function gamma() produces the value of loggamma funtion for a positive argument. ! The function utilises gamma subroutine from library dcdflib in Netlib. Loggamma is used in statistics in many cases where gamma function gets a too large value to be presented in double precision.

20.3 logistic() Logistic function

Returns the value of the logistic function 1/(1+exp(-x)). This can in principle computed by the transformation, but the transformation will produce an error condition when the argument -x of the exp-function is large. Because the logistic function is symmetric, these cases are computed as exp(x)/(1+exp(x)). Because the logistic function can be needed in the nonlinear regression, also the derivatives are implemented. Note, to utilize derivatives the function needs to be in a TRANS object. Eg when f=logistic(a*(x-x0)), then the derivatives can be obtained with respect to the parameters a and x0 by

Example 20.3 (logisticex)**.** Example of logistic function

```
 transa=trans()
der(a,x0)
f=logistic(a*(x-x0));
/ x,x0,a=10,5,0.1
call(transa)
```

Note 20.1. In the previous example tr(d[x0] ahs the effect that TRANS tr is first called, which makes that also d[a] and d[x] have been computed. Remember that the parse tree is computed from right to left.

20.4 npv() Net present value

npv(]interest,income1,. . . ,incomen,time1,. . . ,timen[)// Returns net present value for income sequence income1,...,incomen, occurring at times time1,. . . ,timen when the interest percentage is interest.

21 Probality distributions

There are currently the following functions relate to probability distributions.

Note 21.1. function density() can be used define density or probability function for any continuous or discrete distribution which can then be used to generate random numbers with random() function.

21.1 pdf() Normal density

Output	1	REAL

	the value of the density.
Args	0-2 REAL Arg1 is the mean (default 0), Arg2 is the standard deviation (default 1). If sd is given, the mean must be given explicitly as teh first argument.

Note 21.2. See example drawclassex for an utilization of pdf()

21.2 cdf() Cumulative distribution for normal and chi2

Output	1 REAL The value of the cdf.
Args	1-3 REAL Arg1 the upper limit of the integral. When chi2-> is not present, then Arg2, if present is the mean of the normal distribution (defaul 0), and Arg3, if present, is the sd of the ditribution. If chi2-> is present, then oblicatory Arg2 is ifs the number of degrees of freedom for chi2-distribution.
chi2	N |0 chi2 N |0

21.3 bin() Binomial probability

bin(k,n,p)// The binomial probability that there will be k successes in n independent trials when in a single trial the probability of success is p.

21.4 negbin() Negative binomial

negbin(k,myy,theta)// The probability that a negative binomial random variable has value k when the variable has mean myy and variance myy+]theta[*]myy[**2.

Note 21.3. negbin(k,n*p,0)= bin(k,n*p).

Note 21.4. Sorry for the parameter inconsistency with rannegbin().

21.5 density() for any discrete or continues distribution

Make density for for random numbers either with a function or histogram generated with classify.

Args	0-1 MATRIX MATRIX generated with classify()
func	N|1 codeoption defining the density. The x-varaible is $.
xrange	0|2 REAL Range of x-values
discrete	-1|0 Presence implies the the distribution is discrete

Note 21.5. Actually the function generates a matrix having towo rows which has values for the cumulative distribution function.

Note 21.6. When defining the density function, the user need not care about the scaling constant which makes the integral to integrate up to 1.

Example 21.1 (densityex)**.** Example of distributions

```
 ber=density(func->(1-p+(2*p-1)*$),xrange->(0,1),discrete->); Bernoully
bim=matrix(100)
bim=random(ber)
mean(bim);
p*(1-p); !theoretical variance
var(bim);
pd=density(func->exp(-0.5*$*$),xrange->(-3,3)) !Normal distribution ra=random(pd);
f=matrix(1000)
f=random(pd)
da=newdata(f,read->x)
stat(min->,max->)
cl=classify(x->x,xrange->);
fi=drawclass(cl,continue->fcont)
fi=drawclass(cl,area->,continue->fcont)
    fi=draw(func->pdf(x),x->x,xrange->,append->,continue->fcont)
f=matrix(1000)
f=rann()
da=newdata(f,read->x)
stat(min->,max->)
```

```
cl=classify(x->x,xrange->)
fi=drawclass(cl,histogram->,classes->20,continue->fcont)
den=density(cl);
fi=drawline(den,continue->fcont)
```

22 Random number generators

Random number generators are taken from Ranlib library of Netlib. They can produce single REAL variables or random MATRIX objects. Random matrices are produced by defining first a matrix with matrix() funtion and putting that as the output.

22.1 ran() Uniform

Uniform random numbers between 0 and 1 are generating usig Netlib function ranf.

Output	1	REAL |MATRIX
		The generated REAL value or MATRIX. Random matrix cab generated by defining first the matrix with matrix().

Example 22.1 (ranex). ran();

```
ran();
cpu0=cpu()
A=matrix(10000,5)
A=ran()
mean(A);
mean(A,any->) !mean over all elements
mean(A(All,2));
sd(A);
sd(A,any->);
min(A);
min(A,any->);
max(A);
cpu()-cpu0;
```

22.2 rann() Normal

Computes normally distributed pseudo random numbers into a REAL variable or into MATRIX.

Output	1	REAL|MATRIX The matrix to be generated must be defined earlier with matrix().
Args	0-2	num rannn() produces N(0,1) variables, rann(mean) will produce N(mean,1) variables and rann(mean,sd) procuses N(mean,sd) variables.

Example 22.2 (rannex). Random normal variates, illustrating also find

```
 rx=rann(); !Output is REAL
rm=matrix(1000)
rm=rann()
rm(1,-5);
print(mean(rm),sd(rm),min(rm),max(rm))
Continue=1 !an error
large=find(rm,filter->($.ge.2),any)
Continue=0
large=find(rm,filter->($.ge.2),any->)
100*nrows(large)/nrows(rm);
cpu0=cpu()
rm2=matrix(1000000)
rm2=rann(10,2) !there cannot be arithmetix opreations in the right side
cpu()-cpu0;
mean(rm2),sd(rm2),min(rm2),max(rm2);
large=find(rm2,filter->($.ge.14),any->)
100*nrows(large)/nrows(rm2);
!
```

Note 22.1. When generating a matrix with random numbers, there cannot be arithmetic operations on the right side.That means that code:

```
rm=matrix(100)
rm=2*rann()
```

would produce a REAL value rm.

22.3 ranpoi() Poisson

ranpoi(myy// returns a random Poisson variable with expected value and variance myy

22.4 ranbin() Binomial

Binomial random numbers between 0 and n are generating usig Netlib ignbin(n,p).Random matrix can generated by defining first the matrix with matrix().

Output	1	REAL |MATRIX The generated REAL value or MATRIX with number of successes. (**Jlp22** does not have explicit integer type object).
Args	2	REAL Arg1 is the number of trials (n) and Arg2 is the probability of succes in one trial. !

Example 22.3 (ranbinex). x
```
 ranbin(10,0.1); ranbin(10,0.1);
A=matrix(1000,2)
Continue=1
A(All,1)=ranbin(20,0.2)
Continue=0
A=matrix(1000)
A=ranbin(20,0.2)
B=matrix(1000)
B=ranbin(20,0.2)
da=newdata(A,B,read->(s1,s2))
stat(min->,max->)
cl=classify(1,x->s1,xrange->)
fi=drawclass(cl,histogram->,color->Blue,continue->fcont)
cl=classify(1,x->s2,xrange->)
fi=drawclass(cl,histogram->,color->Red,append->,continue->fcont)
```

22.5 rannegbin() Negative binomial

The function returns random number distributed according to the negative binomial distribution.

Output	1	REAL | MATRIX
	the number of successes in independent Bernoul trials before r'th failure when p is the probability of success. ranbin(r,1)returns 1.7e37 and ranbin(r,0)returns 0.	

Note 22.2. there are different ways to define the negative binomial distribution. In this definition a Poisson random variable with mean $$ is obtained by letting r go to infinity and defining p= $$/($$+r) The mean E(x) of this definition is p*r/(1-p) and the variance is V=p*r/(1-p)2. Thus given E(x) and V, r and p can be obtained as follows: p=1- E(x) /V and r= E(x)**2/(V- E(x)) . This is useful when simulating 'overdispersed Poisson' variables. Sorry for the (temporary) inconsistency of parameters with function negbin().

Note 22.3. can also have a noninteger values. This is not in accordance with the above interpretation of the distribution, but it is compatible with interpreting negative binomial distribution as a compound gamma-Poisson distribution and it is useful when simulating overdispersed Poisson distributions.

22.6 select() Random selection

Output	1	MATRIX
	column vector with n elements indicating random selection of k elements out of n elements. The selection is without replacement, thus elements of the output are 1 or 0..	
Args	2	REAL
	k=Arg1 and n=Arg2.	

Example 22.4 (selectex)**.** Random selection

```
 ** select 500 numbers without replacement from 10000
** output is vector of 10000 rows containing 0 or 1
S=select(500,10000)
nrows(S),mean(S),sum(S),500/10000;
```

22.7 random() Any distribution

usage random(dist) where dist is the density defined in density(). See density() for examples.

23 Interpolation

The following functions can be used for interpolation

23.1 interpolate() Linear interpolation

Usage:// interpolate(x0,x1[,x2],y0,y1[,y2],x]// If arguments x2 and y2 are given then computes the value of the quadratic function at value x going through the three points, otherwise computes the value of the linear function at value x going through the two points.

Note 23.1. The argument x need not be within the interval of given x values (thus the function also extrapolates).

23.2 plane() Interpolates an a plane

Usage:// plane(x1,x2,x3,y1,y2,y3,z1,z2,z3,x,y]// The function computes the equation of plane going through the three points (x1,y1,z1), etc and computes the value of the z-coordinate in point (x,y). The three points defining the plane cannot be on single line.

23.3 bilin() Bilinear interpolation

Usage:// bilin(x1,x2,y1,y2,z1,z2,z3,z4,x,y]// z1 is the value of function at point (x1,y1), z2 is the value at point (x1,y2), z3 is the value at (x2,y1) and z4 is the value at (x2,y2): the function is using bilinear interpolation to compute the value of the z-coordinate in point (x,y). The point (x,y) needs not be within the square defined by the corner points, but it is good if it is. See Press et al. ? (or Google) for the principle of bilinear interpolation

24 List functions

The following list functions are available

24.1 Object lists

An object list is a list of named **Jlp22** object. See Shortcuts for implicit object lists and List functions for more details. Object lists can be used also as pointers to objects, see e.g. the selector option of the simulate() function.

24.2 list() Creates LIST

Output	1	LIST The generated LIST object.
Args	0-	 named objects. If an argument is LIST it is ex+panded
mask	N|1-	REAl Which object are picked from the list of arguments. value 0 indicates that he object is dropped, positive value indicates how many variables are taken, negative value how many objects are dropped (thus 0 is equivalent to -1). mask-option is useful for creating sublists of long lists.

Note 24.1. The same object may appear several times in the list. (see merge())

Note 24.2. There may be zero arguments, which result in an empty list which can be updated later.

Note 24.3. The index of object in a LIST can be obtained using index().

li=list(x1...x3); index(x2,li); Continue=1 index(x4,li); ! error Continue=0

Example 24.1 (list2ex). x

```
 all=list(); ! empty list
sub=list();
nper=3
;do(i,1,nper)
period#"i"=list(ba#"i",vol#"i",age#"i",harv#"i")
sub#"i"=list(@period#"i",mask->(-2,1,-1))
all=list(@all,@period#"i") !note that all is on both sides
sub=list(@sub,@sub#"i")
;end do
```

24.3 merge() Merges LISTs

merge() will produce of list consisting of separate objects in argument lists and argument objects.

Output	1	LIST

		A list which is produced by first putting all elements of argument lists and non-list arguments into a vector, and then duplicate objects are dropped.
Args	2-	LIST|OBJ LIST and separate non-list objects.

Example 24.2 (mergex). Merging list

```
 x1...x3=1,2,3
mat=matrix(3,values->(4,5,6))
lis0=list(x2,x1)
lis2=merge(x1,mat,lis0)
print(lis2)
```

```
<print(lis2)
lis2 is list with            3  elements:
x1 mat x2
```

24.4 difference() Difference of LISTs

difference() removes elements from a LIST

Output	1	LIST the generated LIST.
Args	2	LIST|OBJ The first argument is the LIST from which the elements of of the are removed If second argument is LIST then all of its eleemts are remove, other wise it is assumed that the second argument is an object which is remode from the lisrt.

Example 24.3 (diffex). fex

```
 lis=list(x1...x3,z3..z5);
lis2=list(x1,z5);
liso=difference(lis,lis2);
liso2=difference(liso,z3);
Continue=1
lisoer=difference(lis,z6); ! error occurs
liser=difference(Lis,x3); !error occurs
Continue=0
```

24.5 index() Index in a LIST

To be documented later

24.6 len() Length of LIST, ILIST or MATRIX

len(arg) Lenghts for the following argument types

- arg is MATRIX => len=the size of the matrix, i.e. nrows(arg)*ncols(arg)
- arg is TEXT => len=the number of chracter in TEXT object
- arg is LIST => len=the number of elements in LIST
- arg is ILIST => len=the number of elements in ILIST

If arg does not have a legal type for len(), then len(arg)=-1 if len() has option any->, otherwise an error is produced.

24.7 ilist() ILIST of integers

Generates a list of integers which can be used as indexes. This function is used implicitly with .

Output	1	ILIST The generated ILIST.
Args	0-	REAL Values to be put into ILIST, or the dimesion of the ILIST when values are given in values->, or variables whose indeces in in the data are put into the ILIST.
data	N|1	DATA The DATA from whose variable indeces are obtained.
extra	1	REAL Extra space reserved for later updates of the ILIST.
values	N|1-	REAL Values to be put into ILIST when dimesnion is determined as the only argument

Note 24.4. ILIST is a new object whose all utilization possiblities are not yet explored. It will be used e.g. when developing factory optimization.

Note 24.5. eote Using ilist() by giving the dimension as argument and values with values-> option imitates the definition of a matrix (column vector). The structure of ILIST object is the same as LIST object which can be used in matrix computations.

Example 24.4 (ilistex)**.** ILIST examples

```
 1,4,5;
4...1;
A=matrix(4,4)
A(1,5,3=
```

24.8 putlist() puts into LIST an object

Usage:// putlist(LIST,OBJ)// put OBJ into LIST

24.9 table() Crossses two LISTs

Usage:// Output=table(rowlist,collist)// This can be used in factory optimizations

25 TEXT and TXT text objects

The are now two object types for text.

25.1 text() Creates TEXT

Text objects are created as a side product by many **Jlp22** functions. Text objects can be created directly by the text() function which works in a non-standard way. The syntax is: output=text()// . . . //

The input paragraph ends exceptionally with '//' and not with '/'. The lines within the input paragraph of text are put literally into the text object (i.e. even if there would be input programming functions or structures included)

25.2 txt() Creates TXT

Works as text(), to be documented later. The new TXT object is used to implement ;incl and Gnuplot -figures.

26 File handling

The following functions can handle files.

26.1 exist_f(): does a file exist

looks whether a file with the name given in the character constant argument exists.

Note 26.1. In the previous versions of **Jlp22** same function was used for files and objects.

26.2 delete_o() Deletes files

The function delete_f() deletes all files having the names given in the arguments. The arguments can be character constants or character variables associated with character constants. After deleting a file whose name is given in character variable, the variable still refers to the same chracter constant.

Example 26.1 (deletfex). Deletef file

```
 write('delete_fex.txt',$,'a=matrix(2,4,do->);')
write('delete_fex.txt',$,'delete_o(a)')
write('delete_fex.txt',$,'a;')
close('delete_fex.txt')
;incl(delete_fex.txt)
delete_f('delete_fex.txt')
```

26.3 close() Closes a file

close(file) closes an open file where file is either a character constant or character variable associated with a file.

Note 26.2. No open(9)function is needed. An file is opened when it is first time in write() or print(file->).

26.4 showdir() shows the current directory

Note 26.3. showdir is defined in the system dependent file jsysdep_gfortran.f90. Using other compliers it may be neccessary to change the definition

26.5 setdir() sets the current directory

Note 26.4. setdir is defined in the system dependent file jsysdep_gfortran.f90. Using other complilers it may be neccessary to change the definition

26.6 thisfile() Name of the current ;incl -file

The name of the current include file is returned as a character variable by: out=thisfile() This is useful when defining shortcuts for commands that include sections from an include file. Using this function the shortcuts work even if the name of the include file is changed. See file jexamples.inc for an application

26.7 filestat() Information of a file

Function filestat(filename) prints the size of the file in bytes (if available) and the time the file was last accessed

27 Io-functions

Theree are following io functions

27.1 read() Reads from file

read(file,format[,obj1,...,objn][,eof->var] [,wait->])// Reads real variables or matrices from a file. If there are no objects to be read, then a record is bypassed.// Arguments: file the file name as a character variable or a character constant// format// b' unformatted (binary) data // 'bn' unformatted, but for each record there is integer for the size of the record. Does not work when reading matrices. 'bis' binary data consisting of bytes, each value is converted to real value (the only numeric data type in J). This works only when reading matrices.// '(....)' a Fortran format. Does not work when reading matrices. $ the * format of Fortran// obj1,...,objn **Jlp22** objects// Options:// eof Defines the variable which indicates the end of file condition of the file. If the end of the file is not reached the variable gets the value 0, and when the end of file is reached then the variable gets value 1 and the file is closed without extra notice.

When eof-> option is not present and the file ends then an error condition occurs and the file is closed.// wait **Jlp22** is waiting until the file can be

opened. Useful in client-server applications. See chapter **Jlp22** as a server.

Note 27.1. Use ask() or askc() to read values from the terminal when reading lines from an include file.

Note 27.2. When reading matrices, their shapes need to be defined earlier with matrix() hfunction.

27.2 write() Writes to console or to file

write(file,format,val1,...,valn[,tab->][,rows->])! case[1/6] Writes real values to a file or to the console. If val1 is a matrix then this matrix (or usually vector) is written or at most as many values as given in the values-> option. Arguments: file variable $ (indicating the console), or the name of the file as a character variable or a character constant, or variable $Buffer format $ indicates the '*' format of Fortran, works only for numeric values. A character expression, with the following possibilities: A format starting with 'b' will indicate binary file. Now 'b' indicates ordinary unformatted write, later there will be other binary formats A Fortran format statement, e.g. (∼the values were ∼,4f6.0), with this format pure text can be written by having no object to write (e.g. write('out.txt','(∼kukuu∼)')). For these formats, other arguments are supposed to be real variables or numeric expressions or there is a matrix argument. If they are not, then just the real value which is anyhow associated with each **Jlp22** object is printed (usually it will be zero). If the val1 argument is a matrix, then all values are printed. val1,...,valn real values Options: tab if format is a Fortran format then, tab-> option indicates that sequences of spaces are replaced by tab character so that written text can be easily converted to Ms Word tables. If there are no decimals after the decimal point also the decimal point is dropped. rows If val1 is a matrix or a vector and rows-> has one argument then at most as many values are written as given in this option, if there are two arguments then the option gives the range of written rows in the form rows->(row1,-row2). If the upper limit is greater than the number of rows, no error is produced, all available rows are just written. write(file,'t',t1,val1,t2,val2,...,tn,valn[,tab->]) ! case[2/6] Tabulation format. positive tab position values indicate that the value is written starting from that position, negative tab positions indicate that the value is written up to that position. The values can be either numeric expressions or character variables or character constants. Tab positions can be in any order. Arguments: file variable $ (indicating the console), or the name of the file as a character variable or a character constant, or variable $Buffer 't' tabulation format t1,val1,t2,val2,...,tn,valn KU-

VAUS Options: tab option indicates that sequences of spaces are replaced by tab character so that writ-ten text can be easily converted to Ms Word tables.

27.3 print() Prints objects to file or console

print(arg1,. . . ,argn[,maxlines->][,data->][,row->] [,file->][,func->][,debug->])// Print values of variables or information about objects.// Arguments: arg1,. . . ,argn arguments can be any **Jlp22** objects or values of arithmetic or logical expressions or the only argument can be name of a text file. Options: maxlines-1|1REAL the maximum number of lines printed for matrices, default 100. any -1|0 if the argument is the name of a text file, then any-> indicates that the file is read to the end and the number of lines is put into variable Accepted. data-1|1 DATA data sets. If data-> option is given then arguments must be ordinary real variables obtained from data. row if a text object is printed, then the first value given in the row-> option gives the first line to be printed. If a range of lines is printed, then the second argument must be the negative of the last line to be printed (e.q. row->(10,-15)).Note that nrows() function can be used to get the number of rows. file the file name as a character variable or a character constant. Redirects the output of the print() function to given file. After printing to the file, the file remains open and must be explicitly closed (close('file')) if it should be opened in a different application. form when a matrix is printed, the format for a row can be given as a Fortran format, e.g. form '(15f6.2)' may be useful when printing a correlation matrix. debug the associated real variable part is first printed, and thereafter the tow associated two integer vectors, the real vector and the double precision vector func all functions available are printed

Note 27.3. For simple objects, all the object content is printed, for complicates objects only summary information is printed. print(Names) will list the names, types and sizes of all named **Jlp22** objects. The printing format is dependent on the object type.

Note 27.4. print() function can be executed for the output of a **Jlp22** command by writing ';' or ';;' at the end of the line. The excution of implied print() is dependent on the value of Printoutput. If printoutput =0, then the output is not printed, If printoutput =1, then ';' is causing printing, if Printoutput =2 then only ';;'-outputs are printed, and if Printoutput =3, then both ';' and ';;' outputs are printed.

27.4 ask() Asks REAL

ask([var][,default->][,q->][,exit->])// Ask values for a variable while reading commands from an include file.// Argument:// var 0 or one real variable (need not exist before) Options: default default values for the asked variables q text used in asking exit if the value given in this option is read, then the control returns to command level similarly as if an error would occur. If there is no value given in this option, then the exit takes place if the text given as answer is not a number.

Note 27.5. If there are no arguments, then the value is asked for the output variable, otherwise for the argument. The value is interpreted, so it can be defined using transformations. Response with carriage return indicates that the variables get the default values. If there is no default-> option, then the previous value of the variable is maintained (which is also printed as the default-> value in asking)

Example 27.1 (askex)**.** Examples for ask()

```
 a=ask(default->8)
ask(a,default->8)
print(ask()+ask()) ! ask without argument is a numeric function
ask(v,q->'Give v>')
```

27.5 askc() Asks CHAR

Usage :// askc(chvar1[,default->][,q->][,exit->]) Asks values for character variables when reading commands from an include file.

Args	0-4	REAL | ILIST row and column range as explained below.
Args	0|1	CHAR character variable (need not exist before)
default	0|1	CHAR default character stings
q	0|1	CHAR text used in asking
exit	-1|0	

	if the character constant or variable given in this option is read, then the control return to command level similarly as if an error would occur.

Note 27.6. Note Response with carriage return indicates that the variable gets the default value. If there is no default-> option, then the variable will be unchanged (i.e. it may remain also as another object type than character variable).

Note 27.7. If there are no arguments, then the value is asked for the output variable, otherwise for the arguments.

27.6 printresult() and printresult2() for ending ; and ;;

The **Jlp22** interpreter translates ';' at the end of the line to a call to printresult() function and ';;' to a call to printresult2() The output of a function is printed by writing ';' or ';;' at the end of the line. The excution of implied print() is dependent on the value of Printoutput. If printoutput =0, then the output is not printed, If printoutput =1, then ';' is causing printing, if Printoutput =2 then only ';;'-outputs are printed, and if Printoutput =3, then both ';' and ';;' outputs are printed.

Note 27.8. printresult() and printresult2() are simple functions which just test the value of Printoutput and then call the printing subroutine, if needed.

28 Matrix functions

Jlp22 contains now the following matrix functions.

28.1 Matrices and vectors

Matrices and vectors are generated with the matrix() function or they are produced by matrix operations, matrix functions or by other **Jlp22** functions. E.g. the data() function is producing a data matrix as a part of the compound data object. Matrix elements can be used in arithmetic operations as input or output in similar way as real variables. See Matrix computations.

28.2 matrix() Creates MATRIX

Function matrix() creates a matrix and puts REAL values to the elements. Element values can be read from the input paragraph, file, or the values can be generated using values-> option, or sequential values can be generated using do-> option. Function matrix() can generate a diagonal and block diagonal matrix. A matrix can be generated from submatrices by using matrices as arguments of the values-> option. It should be noted that matrices are stored in row order.

Output	1	MATRIX | REAL
		If a 1x1 matrix is defined, the output will be REAL. The output can be a temporary matrix without name, if matrix() is an argument of an arithmetic function or matrix function. If no element values are given in values-> or obtained from in-> input, all elemets get value zero.
Args	0-2	REAL The dimension of the matrix. The first argument is the number of rows, the second argument, if present, the number of columns. If the matrix is generated from submatrices given in values->, then the dimensions refer to the submatrix rows and submatrix columns. If there are no arguments, then the it should be possible to infer the dimensions from values-> option. If the first argument is Inf, the the number of rows is determined by the number number of lines in source determined by in->.
in	N|0|1	CHAR The input for values. in-> means that values are read in from the following input paragraps, in->file means that the values are read from file. in both cases a record must contain one row for the matrix. If there is reading error and values are read from the terminal, **Jlp22** gives possibility to continue with better luck, otherwise an error occurs.
values	N|1-	REAL values or MATRIX objects put to the matrix. The argumenst of values-> option go in the regular way through the interpreter, so the values can be obtained by computations. If only one REAL value is given then all diagonal elements

	are put equal to the value (ohers will be zero), if diag-> option is present, otherwise all elements are put equal to this value. If matrix dimensions are given, and there are fewer values than is the size the matrix, matrix is filled row by row using all values given in values->. If there are more values as is the size, an error occurs unless there is any-> option present. Thus matrix(N,N,values->1) generates the identity matrix. If value-> refers to one MATRIX,and diag-> is present then a block diagonal matrix is generated. Without diag->, a partitioned matrix is generated having all submatrices equal
do	N|0-3 REAL A matrix of number sequences is generated, as followsws: do-> Values 1,2,...,arg1 x arg2 are put into the matrix in the row order. do->5 Values 5,6,...,arg1 x arg2+4 are put into the matrix do->

Example 28.1 (matrixex)**.** Example of generating matrices
A=matrix(3,

28.3 nrows() Number of rows in MATRIX, TEXT or BITMATRIX

can be used as:

- nrows(MATRIX)
- nrows(TEXT)
- nrows(BITMATRIX)

Note 28.1. If the argument has another object type, and error occurs

28.4 ncols() Number of columns in MATRIX or BITMATRIX

can be used as:

- nrows(MATRIX)
- nrows(BITMATRIX)

Note 28.2. If the argument has another object type, and error occurs

28.5 t() Transpose of a MATRIX or a LIST

t(MATRIX) is the transpose of a MATRIX. As LIST objects can now be used in matrix computations, t(LIST) is also available.

Note 28.3. Multiplying a matrix by the transpose of a matrix can be made by making new operation '*.

Note 28.4. The argument matrix can also be a submatrix expression.

28.6 inverse() Inverse and condition number of MATRIX

inverse(matrixa) computes the inverse of a square MATRIX matrixa. The function utilized dgesv funtion of netlib. If the argument has type REAL, then the reciprocal is computed, and the output will also have type REAL. An error occurs, if matrixa is not a square matrix or REAL, or matrixa is singular according to dgesv. The condition number is stored in REAL with name Output%condition.

Example 28.2 (inverseex)**.** inverse() and condition number

```
 matrixa=matrix(4,4)
matrixa=1
*** well conditoned matrix
matrixa(diag->)=10
matrixa;
matrixb=inverse(matrixa);
matrixb%condition;
** almost singular matrix
matrixa(diag->)=1.05
matrixb=inverse(matrixa);
matrixb%condition;
** figure of condition number
transa=trans()
matrixa(diag->)=diag
matrixb=inverse(matrixa)
/
** Note that the lower bound is equal to the dimension
figa=draw(x->diag,xrange->(1.05,50),func->transa(matrixb%condition),
color->Blue,continue->fcont)
```

Note 28.5. instead of writing c=inverse(a)*b, it is faster and more accurate to write c=solve(a,b)

28.7 solve() Solves a linear equation A*x=b

A linear matrix eqaution A*x=b can be solved for x with code
x=solve(A,b)

Note 28.6. x=solve(A,b) is faster and more accurate than x=inverse(A)*b

Note 28.7. solve works also if A and b are scalars. This is useful when working with linear systems which start to grow from scalars.

28.8 qr() QR decomposition of MATRIX

Makes QR decomposition of a MATRIX This can be used to study if columns of a are linearly dependent. **Jlp22** prints a matrix which indicates the structure of the upper diagonal matrix R in the qr decomposition. If column k is linearly dependent on previous columns the k'th diagonal element is zero. If output is given, then it will be the r matrix. Due to rounding errors diagonal elements which are interpreted to be zero are not exactly zero. Explicit r matrix is useful if user thinks that **Jlp22** has not properly interpreted which diagonal elements are zero. In **Jlp22** qr() may be useful when it is studied why a matrix which shoudl be nonsingular turns out to be singular in inverse() or solve(). qr() is using the subroutine dgeqrf from Netlib. An error occurs if the argument is not MATRIX or if dgeqrf produces error code, which is just printed. Now the function just shows the linear dependencies, as sho in the examples.

Args	1	MATRIX
	A m-by-n MATRIX.	

28.9 eigen() Eigenvector and eigenmatrix from MATRIX

Computes eigenvectors and eigenvalues of a square matrix. The eigenvectors are stored as columns in matrix output%matrix and the eigenvalues are stored as a row vector output%values. The eigenvalues and eigenvectors are sorted from smallest to larges eigenvalue. Netlib subroutines DLASCL, DORGTR, DSCAL, DSTEQR, DSTERF, DSYTRD, XERBLA, DLANSY and DLASCL are used.

Args	1	MAT
	A square MATRIX.	

28.10 sort() Sorts MATRIX

Usage:// sort(a,key->(key1[,key2]))// Makes a new matrix obtained by sorting all matrix columns of MATRIX a according to one or two columns. Absolute value of key1 and the value of key2 must be legal column numbers. If key1 is positive then the columns are sorted in ascending order, if key1 is negative then the columns are sorted in descending order. If two keys are given, then first key dominates.

Note 28.8. It is currently assumed that if there are two keys then the values in first key column have integer values.

Note 28.9. If key2 is not given and key1 is positive, then the syntax is: sort(a,key->key1).

Note 28.10. If there is no output, then the argument matrix is sorted in place.

Note 28.11. The argument can be the data matrix of a data object. The data object will remain a valid data object.

28.11 envelope() Convex hull of point

Output	1	MATRIX
	(nvertex+1, 2) matrix of the coordinates of the convex hull, where nvertex is the number of verteces. The last point is the same as the first point	
arg	1	MATRIX
	(n,2) matrix of point coordinates	
nobs	-1|1	REAL
	The number of points if not all points of the input matrix are used	

Note 28.12. The transpose of the output can be directly used in frawline() function to draw the envelope

Note 28.13. The function is using a subroutine made by Alan Miller and found in Netlib

28.12 find() Finds from a MATRIX

Function find() can be used to find the first matrix element satisfying a given condition, or all matrix elements satifying the conditon, and in that case the found elements can be put to a vector containg element numbers or to a vector which has equal size as the input matrix and where 1 indicates that the element satifies the condition.. Remember that matrices are stored in row order. If a given column or row of matrix A should be seaeched, use A(All,column) or A(row,ALL) to extract that row or column.

Output	1	REAL|MATRIX Without any-> or expand-> the first element found in row order. With any->, the vector of element numbers satisfying the conditon. If nothing found the output will be REAL with value zero. With expand->, the matrix of the same dimensions as the input matrix where hits are marked with 1.
Args	1	Matrix The matrix searched.
filter	1	Code The condition which the matrix element should be satisfied. The values of the matrix elements are put to the variable $.
any	-1|0	The filtered element numbers are put to the output vector.
expand	-1|0	The filtered elements are put the output matrix

Example 28.3 (findex)**.** Finding something from matrix

```
 ** Example of find, illustrating also rann() (line 6426 file c:/j3/j.f90)
** Repeating the example, different results will be obtained
rm=matrix(500)
m,s=2,3
rm=rann(m,s)
mean(rm),sd(rm),min(rm),max(rm);
m+1.96*s;
** index of first row satisfying the condition:
first=find(rm,filter->($.ge.m+1.96*s));
```

```
** indeces of all rows satisfying the condition
large=find(rm,filter->($.ge.m+1.96*s),any->);
nrows(large),nrows(large)/nrows(rm),mean(large),sd(large),min(large),max(large);
** vector of equal size as rm containing 1 or 0
large2=find(rm,filter->($.ge.m+1.96*s),expand->)
mean(large2),min(large2),max(large2);
```

28.13 mean() Means or weighted means

See section matrixstat for details

28.14 sum() Sums or weighted sums

See section matrixstat for details

28.15 var() Sample variances or weighted variances

See section matrixstat for details

28.16 sd() Sd's or weighted sd's

See section matrixstat for details

28.17 minloc() Locations of the minimum values

minloc(MATRIX) generates a row vector containing the locations of the minimum values in each column. minloc(VECTOR) is the REAL scalar telling the location of the minimum value. Thus the VECTOR can also be a row vector.

28.18 maxloc() Locations of the minimum values

maxloc(MATRIX) generates a row vector containing the locations of the minimum values in each column. maxloc(VECTOR) is the REAL scalar telling the location of the maxim value whether VECTOR is a row vector or column vector.

28.19 cumsum() Cumulative sums

cumsum(MATRIX) generates a MATRIX with the same dimesnions as the argument, and puts the cumulative sums of the columsn into the output matrix.

Note 28.14. If the argument is vector, the cumsum makes a vector having the same form as the argument.

28.20 corrmatrix() Correlation matrix from variance-covariance matrix

This simple function is sometimes needed. The function does not test wether the input matrix is symmetric. Negative diagonal eleemnt produces error, value zero correaltion 9,99.

Output	1	MATRIX matrix having nondiagonal values Out(i,j)=arg(i,j)= arg(i,j)/sqrt(arg(i,i)*]arg[(j,j)).
Args	1	MATRIX symmetric matrix
sd	N|0	If sd-> is given, then diagonal elements will be equal to sqrt(arg(i,i)

29 Working with DATAs

Data can be analyzed and processed either using matrix computations or using DATAs. A DATA is compound object linked to a data MATRIX and LIST containing variable (column) names, some other information. When data ere used via DATA in statistical or linear programming functions, the data are processed observarion by observation. It is possible to work using DATA or using directly the data matrix, wharever is more convenient. It is posible make new data objects or new matrices by to extracting columns of data matrix, computing matrices with matrix computations. It is possible to use data in hierarcchila way, This property is inherited fro JLP. There are two **Jlp22** functions which create DATAs from files, data() and exceldta(). data() can create hierarchical data objects. Function newdata() creates a DATA from matrices, which temselfs can be picked from data objects. Function linkdata() can link two data sets to make a hierarchical data.

Note 29.1. If a data file contains columns which are referred with variable names and some vectors, the it is practical to read data first into a matrix using matrix() function and then use matrix operations and newdata() to make DATA with variable names and matrices. See Simulator section for an example.

Note 29.2. transdata() function goes through a DATA similarly as statitical functions, but does not serve a specific purpose, just transformations defined in the TRANS object refreed with trans-> option are computed. See again the simulator section.

Note 29.3. In earlier versions it was possible to give several data sets as arguments for data-> option. This festure is now deleted as it is possible to stack several data matrices and then use newdata() function to create a single data set.

29.1 data() Making a DATA

Data objects are created with the data() function. Two linked data objects can be created with the same function call (using option subdata-> and options thereafter in the following description). It is recommended that two linked data objects are created with one data() function call only in case the data is read from a single file where subdata observations are stored immediately after the upper data observation. Data objects can be linked also afterwards with the linkdata() function. A data object can created by a data() function when data are read from files or data are created using transformation objects. New data objects can be created with newdata() function from previous data objects and/or matrices. If data objects can created using transformation objects either with data() function or by creating first data matrix by transformation and then using newdata() to create data object.

Output 1 Data
Output 1 Data Data object to be created. It is recommended that this default is used only when only one data object is used in the analysis. !

---

read 0|1- REAL|List
Variables read from the input files. If no arguments are given and there is no readfirst-> option then the variables to read in are stored in the first line of the data file separated with commas.?? Also the ... -shortcut can be used

to define the varaible list. If no arguments are given and there is readfirst-> option then the variable names are read from the second line.

---

in 0- Char
input file or list of input files. If no files are given, data is read from the following input paragraph. If either of read-> or in-> option is given, then both options must be present.

---

form -1|1 Char
Format of the data as follows
$ Fortran format '*', the default
b Single precison binary
bs Single precison binary opened with access='stream' Needed for Pascal files in Windows.
B Double precison binary.
Char giving a Fortran format, e.g. '(4f4.1,1x,f4.3)'
d4 Single precison direct access for Gfortran files.
d1 Single precison direct acces for Intel Fortran files.

---

maketrans -1|1 TRANS
Transformations computed for each observation when reading the data

---

keep -1|1- REAL
variables kept in the data object, default: all read-> variables plus the output variables of maketrans-> transformations.

---

obs -1|1 REAL
Variable which gets automatically the observation number when working with the data, variable is not stored in the data matrix, default: Obs. When working with hierarchical data it is reasonable to give obs variable for each data object.

---

filter -1|1 Code
logical or arithmetic statement (nonzero value indicating True) describing which observations will be accepted to the data object. maketrans->-transformations are computed before using filter. Option filter-> can utilize automatically created variable Record which tells which input record has

been just read. If observations are rejected, then the Obsvariable has as its value number of already accepted observations+1.

---

reject -1|1 Code
Logical or arithmetic statement (nonzero value indicating True) describing which observations will be rejected from the data object. If filter-> option is given then reject statement is checked for observations which have passed the filter. Option reject-> can utilize automatically created variable Record which tells which input record has been just read. If observations are rejected, then the Obsvariable has as its value number of already accepted observations+1. subdata the name of the lower level data object to be created. This option is not allowed, if there are multiple input files defined in option in->.

subread,. . . ,subobs sub data options similar as read->. . . obs-> for the upper level data. (subform->'bgaya' is the format for the Gaya system). The following options can be used only if subdata-> is present

---

nobsw -1|1 REAL
A variable in the upper data telling how many subdata observations there is under each upper level observation, necessary if subdata-> option is present.

---

nobswcum -1|1 REAL
A variable telling the cumulative number of subdata observations up to the current upper data observation but not including it. This is useful when accessing the data matrix one upper level unit by time, i.e., the observation numbers within upper level observation are nobswcum+1,. . . ,nobswcum+nobsw

---

obsw -1|1 REAL
A variable in the subdata which automatically will get the number of observation within the current upper level observation, i.e. obsw variable gets values from 1 to the value of nobsw-variable, default is 'obs_variable%obsw'.

---

duplicate -1|2 TRANS
duplicate -1|2 TRANS The two transforma-

tion object arguments describe how observations in the subdata will be duplicated. The first transformation object should have Duplicates as an output variable so that the value of Duplicates tells how many duplicates ar made (0= no duplication). The second transformation object defines how the values of subdata variables are determined for each duplicate. The number of duplicate is transmitted to the variable Duplicate. These transformations are called also when Duplicate=0. This means that when there is the duplicate-> option, then all transformations for the subdata can be defined in the duplicate transformation object, and submaketrans-> is not necessary.

---

oldsubobs -1|1 REAL

If there are duplications of sub-observations, then this option gives the variable into which the original observation number is put. This can be stored in the subdata by putting it into subkeep-> list, or, if subkeep-> option is not given then this variable is automatically put into the keep-> list of the subdata.

---

oldobsw -1|1 REAL

This works similarly with respect to the initial obsw variable as oldsubobs-> works for initial obs variable.

---

nobs -1|1 Real

There are two uses of this option. First, a data object can be created without reading from a file or from the following input paragraph by using nobs-> option and maketrans-> transformation, which can use Obs variable as argument. Creation of data object this way is indicated by the presence of nobs-> option and absence of in-> and read-> options. Second, if read-> option is present nobs-> option can be used to indicate how many records are read from a file and what will be the number of observations. Currently reject-> or filter-> can not be used to reject records (consult authors if this would be needed). If there are fewer records in file as given in nobs-> option, an error occurs. There are three reasons for using nobs-> option this way. First, one can read a small sample from a large file for testing purposes. Second, the reading is slightly faster as the data can be read directly into proper memory area without

using linked buffers. Third, if the data file is so large that a virtual memory overflow occurs, then it may be possible to read data in as linked buffers are not needed. In case nobs-> option is present and read-> option is absent either maketrans-> or keep-> option (or both) is required.

---

buffersize

-1|1 Real
buffersize -1|1 Real The number of observations put into one temporary working buffer. The default is 10000. Experimentation with different values of buffersize-> in huge data objects may result in more efficient buffersize-> than is the default (or perhaps not). Note that the buffers are not needed if number of observations is given in nobs->.

---

par

-1|1- Real
additional parameters for reading. If subform-> option is 'bgaya' then par option can be given in form par->(ngvar,npvar) where ngvar is the number of nonperiodic x-variables and npvar is the number of period specific x-variables for each period. Default values are par->(8,93).

---

rfhead

-1|0
When reading data from a text file, the first line can contain a header which is printed but othewise ignored

---

rfcode

-1|0
The data file can contain also **Jlp22**-code which is first executed. Note the code can be like var1,var,x1...x5=1,2,3,4,5,6,7, which give the possibility to define variables which describe the in-> file.

rfsubhead-> works for subdata similarly as rfhead-> for data. rfsubcode works for subdata similarly as rfcode-> for data

If there are both rfhead-> and rfcode-> then rfhead-> is excuted first. rfhead-> and rfcode-> replace readfirst-> option of previous versions which was too complicated.

---

time

-1|0
If time-> is present, the cpu-time and total time in function are printed

---

Note 29.4. data() function will create a data object object, which is a compound object consisting of links to data matrix, etc. see Data object object. If Data is the output of the function, the function creates the list Data%keep telling the variables in the data and Data%matrix containg the data as a single precision matrix. The number of observations can be obtained by nobs(Data) or by nrows(Data%matrix).

Note 29.5. See common options section for how data objects used in other **Jlp22** functions will be defined.

Note 29.6. The in-> and subin-> can refer to the same file, or if both are without arguments then data are in the following input paragraph. In this case data() function read first one upper level record and then nobsw-> lower level records.

Note 29.7. When reading the data the obs->variable (default Obs) can be used in maketrans- > transformation and in reject-> option and filter-> option, and the variable refers to the number of observation in resulting data object. The variable Record gets the number of the read record in the input file, and can be used in maketrans-> transformations and in reject-> and filter-> options. If subdata-> option is given, variable Subreject gets the number of record in the sub file, and it can be used in submaketrans-> transformations and in subreject-> option and in subfilter-> option.

Note 29.8. Options nobs->100, reject->(Record.gt.100) and filter-> (Record.le.100) result in the same data object, but when reading a large file, the nobs-> option is faster as the whole input file is not read.

Note 29.9. If no observations are rejected, obs variable and Record variable get the same values.

Note 29.10. If virtual memory overflow occurs, see nobs-> optio. This should not happen easily with the currrent 64-bit application.

Note 29.11. Earlier versions contained trans-> and subtrans->options which associated a permanent transformation object with the data object. This feature is now deleted because it may confuse and is not really needed. If tranformations are needed in functions they can always be included using trans-> .

Example 29.1 (dataex)**.** data() generates a new data object by reading data.

```
 data1=data(read->(x1...x3),in->)
1,2,3
4,5,6
7,8,9
/
```

29.2 newdata() Making a DATA from MATRIXs and/or DATAs

Function newdata() generates a new data object from existing data objects and/or matrices possibly using transformations to generate new variables.

Output	1	Data
	The data object generated.	
Args	1-	Data|Matrix
	Input matrices and data objects.	
read	N|1-	REAL
	Variable names for columns of matrices in the order of matrices.	
maketrans	N|1	TRANS
	A predefined ransformation object computed for each observation.	
time	-1|0	
	If time-> is present, the cpu-time and total time in function are printed	

Note 29.12. It is not yet possible to drop variables.

Note 29.13. An error occurs if the same variable is several times in the variable list obtained by combining variables in data sets and read-> variables.

Note 29.14. An error occurs if the numbers of rows of matrices and observations in data sets are not compatible.

Note 29.15. Output variables in maketrans-> transformations whose name start with $ are not put into the new data object.

Example 29.2 (newdataex)**.** newdata() generates a new data object.

```
 data1=data(read->(x1...x3),in->)
1,2,3
4,5,6
7,8,9
/
matrix1=matrix(3,2,in->)
```

```
10,20
30,40
50,60
/
transa=trans()
;do(i,1,3)
;do(j,1,2)
x"i"#z"j"=x"i"*z"j"
;enddo
;enddo
/
new=newdata(data1,matrix1,read->(z1,z2),maketrans->transa)
print(new)
```

29.3 datawcase() DATA with case names

This function will replace the properties function in factory optimizations. The function creates subobjects Output%matrix,Output%keep, and Output%case, which is a list of case names. !

Output	0|1 Output created.	Data	0|1	Data	Data object to be cre-
read	0|1- Variables read from the following input paragraph.	REAL|List			
maketrans	0|1 Transformations made. Output variables whose names do not start with $ are put into the data.	TRANS			

Example 29.3 (datawcaseex)**.** Example of datawcase

```
 sawmills=datawcase(read->(capacity1...capacity4))
Kotka,110,120,130,140
Oulu,210,220,230,240
/
sawsub=;list(sawmills%?);
@sawsub;
sawmills%?;
stat()
```

29.4 exceldata() DATA from an excel file

Generates data object from csv data generated with excel. It is assumed that ';' is used as column separator, and first is the header line generated with excel and containing column names. The second line contains information for **Jlp22** how to read the data. First the first line is copied and pasted as the second line. To the beginning of the second line is put '@#'. Then each entry separated by ';' is edited as follows. If the column is just ignored, then put '!' to the beginning of the entry. If all characters in the column are read in as a numeric variable, change the name to accpetable variable name in **J**. If the column is read in but it is just used as an input variable fot maketrans-> trasformations, then start the name with '$' so the variable is not put to the list of keep-> variables. If a contains only character values then it must be ignored using '!'. If the contains numeric values surrounded by characters, the the numeric value can be picked as follows. Put '?' to the end of entry. Put the variable name to the beginning of the entry. then put the the number of characters to be ignored by two digits, inserting aleading zero if needed. The given the length of the numeric field to be read in as a numeric value. For instance, if the header line in the excel file is

```
Block;Contract;Starting time;Name of municipality;Number of stem;Species c
```

and the first data line could be

```
MG\_H100097362501;20111001;7.5.2021 9:37;Akaa;20;103;1;FI2\_Spruce
```

then the second line before the first data line could be

```
\#\#block0808?;!Contract;!Starting time;!Name of municipality;stem;specie
```

therafter the first observation would get values block=97362501,stem=1, and species=2.

If there are several input files, the header line of later input lines is ignored, and also if the second line of later files starts with '##', then it is ignored. if any later lines in any input files start with 'jcode:', then the code is computed. This way variables decribing the whole input file can be transmitted to the data. Currently jcode-output variables can be transmitted to data matrix only by using the as pseudo outputvariables in maketrans-transformations, e.g., filevar1=filevar1, if filevar1 is generated in jcode transformation. If there are several input files the file number is put into variable In before computing maketrans transformations and this variable is automatically stored in the data matrix.

Output	1	Data

	Data object generated	
in	1-	Char
	Files to read in.	
maketrans	N|1	trans
	Transformations used to compute new variables to be stored in the data.	

29.5 linkdata() Links or combines hierarchical DATAs

linkdata(data->,subdata->,nobsw->[,obsw->]) links hierarchical data sets. Currently linkdata can create also one falt file whicg can be used in jlp()

data	1	DATA
	the upper level data set object	
subdata	1	DATA
	the lower data set object	
nobsw	1	REAL
	the name of variable telling the number of lower level observations for each	
obsw	0|1	REALV
	variable which will automatically get the number of lower level observation within each upper level observation. If not given, then this variable will be Obs%obsw where Obs is the obs-variable of the upper level DATA.	

Note 29.16. In most cases links between data sets can be either made using sub-options of data() function or linkdata() function. If there is need to duplicate lower level observations, then this can be currently made only in data() function. Also when the data for both the upper level and lower level data are read from the same file, then data() function must be used.

Note 29.17. When using linked data in other functions, the values of the upper level variables are automatically obtained when accessing lower level observations. Which is the observational unit in each function is determined which data set is given in data-> option or defined using Data list.

Note 29.18. In the current version of **Jlp22** it is no more necassary to use linked data sets in jlp() function, as the treatment unit index in data containing both stand and schedule data can be given in unit-> option

Note 29.19. When making a file which can be used in jlp() there must be a variable which is the indicator for the unit. If the upper level data has obs-variable which is different than the obs-variable of the lower level data, the this is put into the DATA. But if the obs-variablers are the same, e.g., the default Obs-variable, then the unit-> variable is named as Unit.

Example 29.4 (linkdataex)**.** Example for linkdata.

```
 ** make upper level DATA
dataa=data(read->(ns,site),in->)
2,4
3,5
/
dataa%matrix; ** make subdata as an ordinary DATA
datab=data(read->(x1,y),in->)
1,2
3,4
5,6
7,8
6,9
/
datab%matrix;
datab%keep;
**link now DATAs
linkdata(data->dataa,subdata->datab,nobsw->ns)
listb=;list(datab%?);
@listb;
** when working with subdata the upper level data is feeded in for all observations
** even if they are not part of the data matrix as seen from datab%keep.
stat() **
** Note stat() and all functions assume that the last DATA created is used
** Thus when there are several DATAs around it is safer all use data-> option
** i.e. the above could/should be stat(data->datab)
**
**If linkdata() has output, then a new flat DATA is created
** where upper level variables are put to the DATA.
datac=linkdata(data->dataa,subdata->datab,nobsw->ns)
```

```
stat()
datac%matrix;
**
** The flat file can be created also as follows:
** when dealing with the subdata the upper level data is automatically used
transa=trans()
Unit=Unit !adds Unit and site variables from up-data to sub-data
site=site
Unit%obsw=Unit%obsw
/
** In TRANS transa, the input variables come from the upper level data, and
** outputvariables go to the new data based on DATA datab.
datac=newdata(datab,maketrans->transa)
stat()
datac%matrix;
```

29.6 getobs() Obsevarion from DATA

Getting an observation from a data set: // getobs(dataset,obs[,trans->])// Get the values of all variables associated with observation obs in data object dataset. First all the variables stored in row obs in the data matrix are put into the corresponding real variables. If a transformation set is permanently associated with the data object, these transformations are executed.

dataset	1 the DATA	DATA
obs	1 row number in the data matrix of the dataset	REAL
trans	-1|1 these transformations are also executed.	TRANS

29.7 nobs() number of observations in DATA or REGR

nobs(DATA) returns the number of rows in the data matrix of DATA// nobs(REGR) returns the number of observations used to compute the regression with regr().

29.8 classvector() Vectors from grouped DATA

Function classvector computes vectors from data which extract information from grouped data. These vectors can be used to generate new data object using newdata() function or new matrices from submatrices using matrix() function with matrix-> option or they can be used in transformation objects to compute class related things. There is no explicit output for the function, but several output vectors can be generated depending on the arguments and first->, last-> and expand-> options. The function prints the names of the output vectors generated.

Args

0- REAL
The variables whose class information is computed. Arguments are not necessary if first-> and/or last-> are present. Let §Arg be the generic name for arguments.

---

class

1 REAL
.oindent class 1 REAL

---

class

1 REAL
The variable indicating the class. The class variable which must be present in the data object or which is an output variable of the trans-> transformations. When the class-> variable, denoted as as §Class changes, the class changes.

---

data

0|1 Data
Data object used. Only one data object used; extra data-> objects just ignored. The default is the last data object generated.

---

expand

-1|0
If expand-> is present then the lengths output vectors are equal to the number of observations in the data object and the values of the class variables are repeated as many times as there are observations in each class. If expand-> is not present, the lengths of the output vectors are. equal to the number of classes.

---

first

0
The the number of first observation in class is stored in vector §Class%%first if expand-> is present and §Class%first if expand-> is not present.

last	0 The the number of lastt observation in class is stored in vector §Class%%last if expand-> is present and §Class%lastobject if expand-> is not present.
obsw	0 If there axpnad-> option then vector Class%%obsw
ext	-1|1 Char The extension to the names of vectors generated for arguments. Let Ext be denote the extension.
mean	-1|0 The class means are stored in the vectors §Arg#Class%%mean with expand-> and without ext-> §Arg#Class%%meanExt with expand-> and with ext-> are §Arg#Class%mean without expand-> and without ext-> §Arg#Class%meanExt without expand-> and with ext->
sd	-1|0 Class standard deviations are computed to sd vectors
var	-1|0 Class variances are computed to var vectors
min	-1|0 Class minimums are computed to min vectors
max	-1|0 Class maximums are computed to max vectors.

Note 29.20. Numbers of observations in each class can be obtained by Class%nobs=Class%%last-Class%%first+1 when expand-> is present, and Class%nobs=Class%%last-Class%%first+1

Example 29.5 (classdata)**.** Hierarchical data

```
 nstand=10
xm=matrix(nstand)
xm=rann(3)
ym=0.7*xm+0.1*xm
xm;
ym;
```

```
standdata=newdata(xm,ym,read->(X,Y))
stat()
ntree=6
xt=matrix(ntree*nstand)
yt=matrix(ntree*nstand)
standv=matrix(ntree*nstand)
ex=matrix(ntree*nstand)
ey=matrix(ntree*nstand)
transa=trans()
jj=0
do(i,1,nstand)
do(j,1,ntree) jj=jj+1
standv(jj)=i
ex(jj)=rann()
ey(jj)=0.3*ex(jj)+0.3*rann()
xt(jj)=xm(i)+ex(jj)
yt(jj)=ym(i)+0.3*ex(jj)+0.3*rann()
enddo
enddo
/
call(transa)
treedata=newdata(standv,xt,yt,read->(stand,x,y))
stat() classvector(x,y,class->stand,data->treedata,mean->,min->)
standdata2=newdata(x[stand]%mean,y[stand]%mean,x[stand]%min,y[stand]%min,
read->(x,y,xmin,ymin))
stat()
classvector(x,y,class->stand,data->treedata,mean->,expand->)
ex2=treedata(x)-x
```

29.9 values() Different values of variables in DATA

Extracting values of class variables: values( ).

Output	1	VECTOR the vector getting differen values
arg	1	REALV variables whose values obtained
data	1	DATA The data set.

Note 29.21. The values found will be sorted in an increasing order.

Note 29.22. After getting the values into a vector, the number of different values can be obtained using nrows() function.

Note 29.23. values() function can be utilized e.g. in generating domains for all different owners or regions found in data.

29.10 transdata() Own computations for DATA

transdata() is useful when all necassy computions are put into a TRANS , and a DATA is gone throug obsevation by observation. This is useful e.g. when simulating harvesting schdules using a simulator which is defined as an ordinary TRANS. The whole function is written below to indicate how users' own functions dealing with data could be developped. @@data

```
subroutine transdata(iob,io)
call j\_getdataobject(iob,io)
if(j\_err)return
call j\_clearoption(iob,io)  ! subroutine

do iobs=j\_dfrom,j\_duntil
call j\_getobs(iobs)
if(j\_err)return
end do !do iobs=j\_dfrom,j\_duntil

if(j\_depilog.gt.0)call dotrans(j\_depilog,1)

return
```

30 Statistical functions

There are several statistical functions which can be used to compute basic statistics linear and and nonlinear regression, class means, standard deviations and standard errors in one or two dimensional tables using data sets. There are also functions which can be used to compute statistics from matrices, but these are described in Section 28.2

30.1 stat() Basic statistics in DATA

Computes and prints basic statistics from data objects.

Output	0-1 kokopo	REAL
Args	0-99 variables for which the statistics are computed, the default is all variables in the data (all variables in the data matrix plus the output variables of the associated transformation object) and all output @@data	REAL
data	-1,99 data objects , see section Common options for default! weight gives the weight of each observations if weighted means and variances ar transformation or it can be a variable in the data object @@seecom	Data
min	-1,99 defines to which variables the minima are stored. If the value is character constant or character variable, then the name is formed by concatenating the character with the name of the argument variable. E.g. stat(x1,x2,min->'%pien') stores minimums into variables x1%pien and x2%pien. The default value for min is '%min'. If the values of the min-> option are variables, then the minima are stored into these variables.	REAL
max	-1,99 maxima are stored, works as min->	REAL
mean	-1,99 means are stored	REAL
var	-1,99 variances are stored	REAL
sd	-1,99 standard deviations are stored	REAL
sum	-1,99	REAL

	sums are stored, (note that sums are not printed automatically)
nobs	-1 | 1 REAL gives variable which will get the number of accepted observations, default is variable 'Nnobs'. If all observations are rejected due to fi
trans	-1 | 1 TRANS transformation object which is executed for each observation. If there is a transformation object associated with the data object, those
filter	-1 | 1 Code logical or arithmetic statement (nonzero value indicating True) describing which observations will be accepted. trans-> transformations
reject	-1 | 1 Code reject -1 | 1 Code
transafter	-1 | 1 TRANS transformation object which is executed for each observation which has passed the filter and is not rejected by the reject->-optio

Note 30.1. 1: stat() function prints min, max, means, sd and sd of the mean computed as sd/sqrt(number of observations)

Note 30.2. 2: If the value of a variable is greater than or equal to 1.7e19, then that observation is rejected when computing statistics for that variable.

Example 30.1 (statex)**.** stat() computes minimums, maximums, means and std deviatons

```
 ;if(type(data1).ne.DATA)dataex
;if(type(data1).ne.DATA)dataex
stat()
stat(data->data1,sum->x2,mean->,filter->(x3.le.18.5))
li=;list(x2%?);
@li;
stat(x1,data->data1,weight->x2)
stat(x1,weight->(x2**1.2))
```

30.2 cov() Covariance MATRIX

cov() computes the covariance matrix of variables in DATA.

output	1	MATRIX symmetric aoutput matrix.
arg	1-N	LIST or REALV variables for which covarianes are computed, listing individually or given as a LIST. @@data
weight	-1|1	CODE Codeoption for weight of each observation.

Note 30.3. the output is not automaticall printed, but it can be printed using ';' at the end of line.

Note 30.4. The covariance matrix can changed into correaltion matrix with corrmatrix() function.

Note 30.5. If variable w in the data is used as the weigth, this can be expressed as weight->w

Example 30.2 (covex)**.** Example of covariance

```
 X1=matrix(200)
X1=rann()
;do(i,2,6)
ad=matrix(200)
ad=rann()
X"i"=X"i-1"+0.6*ad
;enddo
Continue=1 !error
dat=newdata(X1...X6,read->(x1...x5))
Continue=0
dat=newdata(X1...X6,read->(x1...x6))
co=cov(x1...x5);
co=cov(dat%keep);
```

30.3 corr() Correlation MATRIX

corr(1) works similarly as cov()

30.4 regr() Linear regression

Ordinary or stepwise linear regrwession can be computed using regr().

output	1 sRegression object..	REGR
arg	1-N	LIST or REALV y-variable and x-variables variables listing them individually or given as a LIST. @@data
noint	-1|0 noint-> implies that the model does not include intercept	
step	-1|1 t-value limit for stepwise regression. Regression variables are droped one-by-one until the absolute value of t-value is at least as large as the limit given. intercept is not considered.	REAL
var	-1|0 if var-> is present regr() generated matrix]output%var[for the variance-covariance matrix of the coeffcient estimates.	
corr	-1|0 if vcorr-> is present regr() generated matrix]output%corr[for the correlation matrix of the coeffcient estimates. Standard deviations are put to the diagonal.	
variance	-1|1 The variance of the residual error is proportional to the function given in this codeoption.	CODE

Note 30.6. If the DATA contains variables Regr and Resid, then the values of the regression function and resduals are put into these columns. Space for these e coluns cab reserved with extra-> option in data() or in newdata()

Note 30.7. If re is the output of the regr() then function re() can be used to compute the value of the regression function. re() can contain from zero arguments up to the total number of arguments as arguments. The rest of arguments get the value they happen to have at the moment when teh function is called.

Information from the REGR object can be obtained with the following functions. let re be the name of the REGR object.

- coef(re,xvar) = coefficient of variable xvar
- coef(re,xvar,any) = returns zero if the variable is dropped from the equation in the setwise procsedure of due to linear dependencies.
- coef(re,1) or coef(]re(,$1) returns the intercept
- se(re,xvar) standard error of a coeffcient
- mse(re) MSE of the regression
- rmse(re) RMSE of the regression
- r2(re) adjusted R2. If the intercept is not present this can be negative.
- nobs(re) number of observations used
- len(re) number of independent variables (including intercept) used

30.5 nonlin() Nonlinear regression

To be raported later, see old manual

30.6 varcomp() Variance and covariance components

TO BE RAPORTED LATER, see old manual

30.7 classify() Group means, variaances and standard deviations

Classifies data with respect to one or two variables, get class frequencies, means and standard deviations of argument variables.

Output	1	Matrix	
	Output	1	Matrix A matrix containing class information (details given below)
Args	1-	REAL	
	Args	1-	REAL Variables for which class means are computed.
	@@data		

x	1 REAL The first variable defining classes.
minobs	-1|1 REAL minimum number of observation in a class, obtained by merging classes. Does not work if z-> is given
xrange	-1|0|2 Real Defines the range of x variable. If xrange-> is given without arguments and **Jlp22** variables x%min and x%max exist, they are used, and if they do not exist an error occurs. Note that these variables can be generate with stat(min->,max->). Either xtrange-> or any-> must be presente.
any	-1|0 Indicates that each value of the x-variables foms a separate class. either xrange-> or nay-> must be present.
tailtofirst	-1|0 If the x-variable is less than the lower xrange, the observation is put to the first class
tailtolast	-1|0 If the x-variable is greater than the upper xrange, the observation is put to the first class
classes	-1|1 Real Number of classes, If dx-> is not given, the default is that range is divided into 7 classes. minobs-> minimum number of observations in one class. Classes are merged so that this can be obtained. Does not work if z-> is present. !
z	-1|1 REAL The second variable (z variable) defining classes in two dimensional classification.
zrange	-1|0|2 Real Defines the range and class width for a continuous z variable. If **Jlp22** variables x%min and x%max exist, provided by stat(min->,max->), they are used.

dz	-1|1	Real
	Defines the class width for a continuous z variable. mean if z variable is given, class means are stored in a matrix given in the mean-> option classes number of classes, has effect if dx is not defined in xrangedx->. The default is classes->7. If z is given then, there can be a second argument, which gives the number of classes for z, the default being 7. @@trans @@filter @@reject	
print	-1|1	Real
	By setting print->0, the classification matrix is not printed. The matrix can be utilized directly in drawclass() function.	

Note 30.8. If z variable is not given then first column in printed output and the first row in the output matrix (if given) contains class means of the x variable. In the output matrix the last element is zero. Second column an TARKASTA VOISIKO VAIHTAArow shows number of observations in class, and the last element is the total number of observations. Third row shows the class means of the argument variable. The fourth row in the output matrix shows the class standard deviations, and the last element is the overall standard deviation

Note 30.9. Variable Accepted gets the number of accepted obsevations.

30.8 class() Class of a given value

Function class() computes the class of given value when classifying values similarly as done in classify().

Output	1	REAL
	The class number.	
Args	1	Real
	The value whose class is determined.	
xrange	2	Real
	The range of values.	
dx	N|1	Real
	The class width.	
classes	N|1	Real

The number of classes.

Note 30.10. Either dx-> or classes-> must be given. If both are given, dx-> dominates.

Note 30.11. If stat() is used earlier for variables including Var1 and options min-> and max-> are present, then xrange->(Var1%min,Var1%max) is assumed.

31 Linear programming theory

This chapter will later describe more closely the theoretical aspects of the linear programming functions. Now only some key concepts are listed. Now the reader is referred to the old JLP manual (Lappi 1992) and Hyvönen et al

The concepts in the JLP algorithm

- In a optimization problem with schedules generated for each stand, there must be a area constraint for each stand telling that shares of schedules add up to one in each stand.
- In the generalized upper bound (GUB) technique of Dantzik and van Slyke, the area contraints can be dropped with slight overhead cost.
- The heuristic algorithm of Hoganson and Rose (1984) and Hoganson and Kapple (1991) lead to similar computations where a schedule in a stand is selected using shadow prices. Their shadow prices are updated heuritically but JLP algorith updates the prices using the linear programming theory.
- The key concept in GUB is the key variable, in our case the key schedule, which is any of the schedules which has nonzero weight.
- JLP algorithm is also using the ordinary upper bound technique. If there is both lower and upper bound in a contraint, the standard theory assumes that the lower bound and upper bound constraints are presented as different constraints. In the ordinary upper bound technique there is only one constraint, and the algorithm keeps either of the bounds as the active bound.
- JLP of Lappi (1992) introduced domains, i.e.. subsets of stands into the problem defition. They decrease the memory needs and help to formulate more reasonable problems. Their utility to define spatial constraints is not fully utilized.

- When a constraint is not binding, standard algorithms, a residual variable tells the difference between the contraint row and the active bound. Algorithm of Lappi (1992) reduced the dimension of the basis matrix.
- Lappi (1992) used own matrix subroutines which computed all the time the explicit inverse of the basis matrix. **Jlp22** is using matrix routines of Fletcher based on Flethcer (1996)
- In Lappi and Lempinen (2014) the GUB technique is extended to deal with constraints telling that all harvested logs are transported to somewhere. Hyvönen et al (2019) applied the algorithm in a small project in North-Carelia. Note that the DTRAN algoritm can deal with factories also.
- In optimization with factories, there is for any log type harvested in a given time a key factory to which something is transported.

32 Linear programming (JLP) functions

There are linear programming functions for defining and solving ordinary LP-problems or LP problems found in forest management planning.

32.1 Problem definition object

Problem definition object is a compound object produced by the problem() function, and it is described in Linear programming.

32.2 problem() PROB for jlp() and jlpz()

An LP-problem is defined in similar way as a TEXT object. The following rules apply for problem rows:

- On the left there is any number of terms separated with + or -.
- Each term is either a variable name or coefficient*variable.
- A coefficient can be
  - a number
  - Computation code inside parenthesis. These coefficients are computed within problem().

    - computation code within apostrophes. These coefficients are computed in jlp(), jlpz() or jlpcoef() functions.
    - A legal name for an object.
- The variable must be a legal object name. The optimization variable can either be a z-variable or x-variable. A x-variable is an variable in schedules data set. In jlpz() all variables are z variables. Function jlpz() unpacks lists to z-variables.
- The right side of the first row ends either by ==min or ==max.
- On the right side for other rows there is a number or code for computing a numeric value within parnthesis or within apostrophes or a variable name. Numbers within parenthesis are computed within problem() but numbers within apostrophes are computed in jlp(), jlpz() or jlpcoef() functions. Between the left side and the right side there is

    - >Low <Up
    - >Low
    - = Value

Sign < means less or equal, and > means greater or equal. Pure less or greater would be meaningless in this context.
If there two different identical rows the other having '<' and the other '>', an error occurs, because the solution is obtained faster that way. If all rows have both lower limit and upper limit, the solution is obtained in half time when merging the lines.

In problems with x-data, there can be domain rows, which tell for what subset of the treament units the following constraints apply. Domains are defined using c-variables, i.e. variables in the unit data, or in nonhierarchical, flat data set, the value of the c-variable is obtained from the first observation where the variable given in unit-> gets a different value than in the previous observation. The variables in the flat data file having the same value for all observations in the same unit are called also c-variables. Later there will be variables related to factory problems. A domain definition ends with ':'. In a domain row there can be any number of domain definitions. There are three diffent kinds of domain definitions
All indicates all units. This domain is assumed to all rows before the first domain row.
c-variable, a nonzero value tells that the unit belongs to the domain.

A piece of code which tells how the indicator is computed from the c-variables. A nonzero value indicates that the unit belongs to the domain. Recall tha logical operations produce 1 for True and 0 for false. The code is parsed at this point, so syntax errors are detected at this point, but other errors (e.g. division by zero) are detected in jlp().

Output	1	PROB
	the PROB object created	
print	0|1	REAL
	If print-> gives a value, then values >2 tell that the problem is printed (default)	

Note 32.1. Examples are give in connection of jlpz() and jlp().

Note 32.2. the cofficients in a PROB can be interpreted also using jlpcoef() function, which is used also by jlp() and jlpz() functions.

Note 32.3. Note Problems without x-variables can be solved also without problem() function by feeding in the necessary matrices.

32.3 jlp() for schedules DATA

jlp() solves linear programming problems. The function now assumes that there is schedules data. Without schedules jlpz() must be used.

Output	1
	Output tells how objects created by jlp() are named. There is no JLP object type, but the output indicates that e.g. the following objects are created. Many other objects are created but they are currently used for debuggging purposes and they will be described later. They can be used also to teach how the algorithm proceeds. beginitemize
	Output%weights The weights of the schedules, see teh example below.
	Output%objective= value of the objective function
	Output%rows= the vector the valuef of the constraint rows.
	Output%shprice = vector of shadow prices of the rows
	Output%xvars= LIST of xvariables in the schedules data Output%xvarsproblem= LIST of x-variables in the PROB

Output%xsum= Vector of sums of variables in Output%xvarsproblem

Output%xprice Shadow prices of the variables in Output%xvarsproblem

Output%xsumint The sums of x-variables in the integer approximation, generated if integer-> is present

---

problem — 1 PROB
Problem object produced with problem()

---

data — 1 DATA
Unit data when schedules data is linked to it with linkdata() or schedules data when unit-> gives the unit variable which changes when unit changes.

---

z — -1|0
This option must be present when there are z-variables in the problem.

---

print — -1:1 REAL
print-> set printing level to 2, print->value set the printling level to value, where zero indicates no printing. Default level is 1.

---

debug — -1|0|1 REAl
debug-> sets debugging on at start debug->value sets debugging on when pivot=value, After the debugging pivot, **Jlp22** generates pause() and during the pause the user can do any computations. Before the pause some additional matrices are generated in addition to matrices which are used the computations. default is stop->(Change%.lt.0.01.and.Round.ge.30).

---

report — -1|1 CHAR
the results are written to the file spesified.

---

echo|-1|0

When results are printed to a file, echo-> implies that they are written alo to the terminal.

---

refac — -1|1| REAL
refac->value tells that the factors of the basis matrix are recomputed after value pivot operations. The default is

	refac->1000.
tole	-1|1 REAL tole->value tells that the default tolerances are multiplied with the value.

Note 32.4. In small problems dCPU, i.e. increase of used CPU time is not very accurate.

Example 32.1 (jlpex)**.** jlp() solves linear programming problem

```
 cdata=data(in->'cdat.txt',read->(ns,site))
stat()
xdata=data(in->'xdat.txt',read->(npv#0,npv#5,income1...income5))
stat()
linkdata(data->cdata,subdata->xdata,nobsw->ns) proba=problem();
** In this problem the 4% net present value at the beginning is maximixe
** subject to the constraints telling that net incomes are nondecreasing
npv#0==max
;do(i,2,5)
income"i"-income"i-1"=0
;enddo
npv#5-npv#0>0
/
plist=;list(proba%?);
@plist; jlpa=jlp(problem->proba,data->cdata)
jlist=;list(jlpa%?);
@jlist; ** jlpa%weights gets the weights of schdedules
** combain the weights with the data
xdataw=newdata(xdata,jlpa%weights,read->w)
stat(sum->)
**sum of weights is equal to the number of stands
w%sum;
** weighted statistics
** thesw agree with the jlp solution
stat(weight->w,sum->)
;do(i,1,len(xdataw%keep))
@xdataw%keep(i)%sum;
;enddo
***Problem with domains
probb=problem();
npv#0==max
**Domain definitions:
```

```
**there can be several domain definitions on a row
** one domain definition is:
** a logical statement in terms of stand variable
** a stand variable whose nonzero value implies that the domain applies
** All indicates all stands.
** before first domain definition row the default Domain is All
site.le.3: site.gt.3:
;do(i,2,5)
income"i"-income"i-1"=0
;enddo
npv#5-npv#0>0
/
plistb=;list(probb%?);
@plistb; jlpb=jlp(problem->probb,data->cdata)
** Note problem with domains produces more subobjects
jlistb=;list(jlpb%?);
@jlistb;
** How to work without hierarchical data objects.
stat(data->xdata) !original xdata
xdata2=linkdata(data->cdata,subdata->xdata,nobsw->ns)
stat(data->xdata2)
jlpb=jlp(problem->probb,data->xdata2,unit->Unit)
```

32.4 jlpz() for an ordinary Lp-problem.

The problem defined in the problem() function can be given in problem-> or by giving values for max-> or min->, and zmatriz->, rhs-> and rhs2-> options.

Output	1 Theres is no jlpz -object, but the output is used to name several objects created with the function. The list of created objects can be seen with // outlist=;list(Output%?);// The objects can then be be seen with // @outlist;// The objects created can be used in debugging the algorithm and also in teaching how the alogorithm proceeds. This will demonstrated later.
problem	-1|1 PROB Problem defined in problem(). If problem-> is not present the following 3 options must be present and either min->

	or max->.
zmatrix	-1|1 MATRIX Constraint matrix.
rhs	-1|1 MATRIX Lower bounds as row or column vector having as many elements as there are rows in the matrix given in zmatrix->.
rhs2	-1|1 MATRIX Upper bounds as row or column vector having as many elements as there are rows in the matrix given in zmatrix->.
max	-1|1 MATRIX The objective vector for a maximization problem. It must have as many elements as the constraint matrix has columns.
min	-1|1 MATRIX The objective vector for a minimization problem.
dpivot	-1|1 REAL The objective function etc are printed after dpivot pivots.
debug	-1|0|1 REAL Gives the value of Pivot at which a pause is generated. During the pause all essential matrices can be studied. Pure debug-> is the same as debug->0, which implies that pause is generated before pivoting. If variable Debug is given a new value, the the next pause is generated when Pivot.eq.Debug. The default is that the next pause is generated after the next pivot. The pause() function can now use also // lis=;list(Output%?); // even if ;list is input programming function which are not otherwise allowed during pause(). !

Note 32.5. The ordinary Lp-algorithm can be taught using matrices generated in pause to show how the algorithm proceeds.

Example 32.2 (jlpzex)**.** Problem with only z-variables.

```
 probz=problem()
2*x1+x2+3*x3-2*x4+10*x5==min
```

```
x1+x3-x4+2*x5=5
x2+2*x3+2*x4+x5=9
x1<7
x2<10
x3<1
x4<5
x5<3
/
probzs=;list(probz%?); !subobject created
@probzs; !printing the subobjects jz=jlpz(problem->probz,dpivot->1)
jzs=;list(jz%?);
@jzs;
** The same problem is defined using different tools available.
!
probz2=problem()
2*x1+x2+x34c*x34+10*x5==min
x1+x3-x4+(2+0)*x5=5
x2+2*x3+2*x4+x5=9
x1<7
x2<i10
x3<'1+zero'
x4<5
x5<3
/
x34=list(x3,x4)
x34c=matrix(2,values->(3,-2))
i10=10
zero=0
jz2=jlpz(problem->probz2,dpivot->1)
**Now different problem is obtained
x34c=matrix(2,values->(3,-3))
zero=1
z23=jlpz(problem->probz2,dpivot->1)
**
**The matrices needed to use jlpz without problem-> can be obtained from
a problem as follows
jzc=jlpcoef(probz)
jzclist=;list(jzc%?);
jzb=jlpz(zmatrix->jzc%matrix,rhs->jzc%rhs,rhs2->jzc%rhs2,min->jzc%objective)
```

32.5 jlpcoef() PROB into numeric form

This function is used at the beginning of jlp() and jlpz().

Note 32.6. see jlpz() for how jlpcoef() can be used to demonstate problem defintion using matrices only.

32.6 weights() weights of schedules

TO BE RAPORTED LATER

32.7 partweight() weights of split schedules

TO BE RAPORTED LATER

33 Plotting figures

The graphiscs of the current version of **Jlp22** is produced Gnuplot. **Jlp22** offers nowan alternative interface to Gnuplot, and it is quite easy to add more plotinng routines later.

33.1 Figures inp Jlp22

Figures are made using Gnuplot. **Jlp22** transmits information into Gnuplot using text files. **Jlp22** generates the files using .jfig extension. Necessary files are generated by deleting old files without asking permission. If fig is the output of a figure function, then **Jlp22** creates always, except in 3D, file with name fig.jfig and possibly other files with .jfi0, jfi1 etc extensions. All figure functions use the following options.

Output	1	FIGURE
	The FIGURE object created or updated @@figure	

Note 33.1. is possible to show a figure using show() function. It can have either the fig object as the argument or the file name of fig.jfig -file. Thus it is possible to edit the file using Gnuplot capabilites.

Note 33.2. It is possible to change the terminal type used by Gnuplot by giving the name of the terminal to the predefine CHAR variable Terminal. The default is
Terminal='qt'.

Note 33.3. The default writte by Gnuplot does not look nice and is not implemented. The user can write own legends using label-> option in drawline().

Note 33.4. Easiest way to delete an nonmatrix object fi is fi=0, which makes it possible to use append-> also for an fi wihtout the need to construct if then- structures.

Note 33.5. Graphic functions produce FIGURE objects. Each FIGURE object can consist of several subfigures. Each FIGURE object stores information of x- and y axes, the range of all x- and y-values, and for each sub-figure information of the ranges of x and y in the subfigure plus the subfigure type and the needed data values. Currently, when Gnuplot is used for graphics, most data values are stored in text files which Gnuplot reads. Function plot3d() is plotting 3-d figures without making a FIGURE object.

33.2 plotyx() Scatterplot

plotyx() makes scatterplot.

Output	1	FIGURE The FIGURE object created or updated.
Args	1 | 2	REAL y and x-variable, if func-> is not present. In case y-variable is given with func->only, x-variable is given as argument.
data	N | 1	DATA Data object used, default the last data object created or the dta given with data=list(). @@figu
mark	N | 1	REAL | CHAR The mark used in the plot. Numeric values refer to mark types of Gnuplot. The mark can be given also as CHAR varible or constant.
func	N | 1	Code Code option telling how the y-variable is computed.

Example 33.1 (plotyxex)**.** plotyx()

```
xmat=matrix(do->(0,10,0.001))
```

```
transa=trans()
y=2+3*x+0.4*x*x+4*rann()
/
datyx=newdata(xmat,read->x,maketrans->transa,extra->(Regf,Resid))
fi=plotyx(y,x,continue->fcont)
fi=plotyx(x,func->transa(y),mark->3,color->Orange,continue->fcont)
reg=regr(y,x)
figyx=plotyx(y,x,show->0)
fi=plotyx(Regf,x,append->,continue->fcont)
fir=plotyx(Resid,x,continue->fcont)
```

Note 33.6. With data with integer values, the default ranges of Gnuplot may be hide point at borderlines.

Note 33.7. fi=plotyx() produces or updates file fi.jfig] which contains Gnuplot commands and file fi.jfi0 containg data.

33.3 draw() Draws a function

draw() draws a function.

Output	1	FIGURE The FIGURE object created or updated.
func	N | 1	Code Code option telling how the y-variable is computed. @@draw
mark	N | 1	REAL | CHAR The mark used in the plot. Numeric values refer to. mark types of Gnuplot. The mark can be given also as CHAR varible or constant.
width	0 | 1	REAL the width of the line

Example 33.2 (drawex)**.** Example of draw()

```
 fi=draw(func->sin(x),x->x,xrange->(0,2*Pi),color->Blue,continue->fcont)
fi=draw(func->cos(x),x->x,xrange->(0,2*Pi),color->Red,append->,continue->fcont)
;if(type(figyx).ne.FIGURE)plotyxex
show(figyx,continue->fcont)
reg0=regr(y,x)
```

```
stat(data->datyx,min->,max->)
figyx=draw(func->reg0(),x->x,xrange->,color->Violet,append->,continue->fcont)
transa=trans()
x2=x*x
/
reg2=regr(y,x,x2,data->datyx,trans->transa)
transa=trans()
x2=x*x
fu=reg2()
/
Continue=1 !Error
figyx=draw(func->transa(fu),xrange->,color->Orange,append->,continue->fcont)
continue=0
figyx=draw(func->transa(fu),x-x,xrange->,color->Orange,append->,continue-
>fcont)
Continue=1 !Errors
fi=draw(func->sin(x),x->x)
fi=draw(xrange->(1,100),func->Sin(x),x->x)
Continue=0
```

Note 33.8. fi=draw() produces or updates file fi.jfig] which contains Gnuplot commands and file fi.jfi0 containg data.

33.4 drawclass() Draws results of classify()

drawclass() can plot class means and/or lines connecting class means, with or without standard errors of class means, within class standard deviations, within class variances, frequency histograms, which can be scaled so that density funtions can be drawn in the same figure.

Output	1	FIGURE FIGURE object updated or generated.
Arg	1	MATRIX A MATRIX generated with classify().
se	N | 0	Presence of option tells to include that error bars showing standard errors of class means computed as sqrt(sample_within-class_variance)/number_of_obs)
sd	N | 0	

	Within-calss standard deviations are drawn.
var	N | 0 Within-class sample variances are drawn.
histogram	N | 0 Within-class sample variances are drawn.
freq	N | 0 Absolute frequences are drawn in histogram. Default percentage if area-> is not present
area	N |0 the histogram is scaled so that that it can be overlayed to density function
cumulative	N|0 cumulativer histogram is drawn. If freq-> is presented then absolute cumulative frequences are drawn, otherwise cumulative percentages are draw, except if also area-> is presenet then then cumulative realtive freaquences are drawn.

Example 33.3 (drawclassex)**.** Examples of drawclass()

```
 X=matrix(do->(1,100,0.1))
e=matrix(nrows(X))
e=rann()
X2=0.01*X*.X !elementwise product
Y=2*X+0.01*X2+(1+0.3*X)*.e !nonequal error variance,quadratic function
dat=newdata(X,Y,X2,read->(x,y,x2),extra->(Regf,Resid))
stat(min->,max->)
reg=regr(y,x) ! Regf and resid are put into the data
fi=plotyx(y,x,continue->fcont)
fi=drawline(x%min,x%max,reg(x%min),reg(x%max),width->3,color->Cyan,append->,continue->fcont)
cl=classify(Resid,x->x,xrange->,classes->5)
fi=drawclass(cl,color->Blue,continue->fcont)
fi=drawclass(cl,se->,continue->fcont)
fi=drawclass(cl,sd->,continue->fcont)
fi=drawclass(cl,var->,continue->fcont)
fi=drawclass(cl,histogram->,area->,continue->fcont)
fi=draw(func->pdf(0,rmse(reg)),x->x,xrange->,append->,continue->fcont) ! xrange comes from stat()
```

Note 33.9. In previous versions of **Jlp22** if se-> and sd-> were both present, the error both bars were plotted. This possibility will be included later.

33.5 drawline() Draws a polygon through points.

Output	1	FIGURE The FIGURE object created or updated.
Args	1-	REAL | MATRIX The points which are connected: • x1,...,xn,y1,...,yn The x-coordinates and y-coordinates, $n \geq 1$*$Ifthereisonlyoneargumentwhichisamatrixobjecthavingtworows, th*

- If there are two matrix (vector) arguments, then the first matrix gives the x-values and the second matrix gives the y-values. It does not matter if arguments are row or column vectors.

@@figure

label	N | 1	CHAR Label written to the end of line. If arguments define only one point, then with label-> option one can write text to any point.
mark	N | 1	REAL | CHAR The mark used in the plot.
break	N | 0	The line is broken when a x-value is smaller than the previous one.
set	N|1	REAL<6 Set to which lines are put. If the option is not present, then a separate Gnuplot plot command with possible color and width information is generated for each drawline() and data points are stored in file fi.jfi0, i.e. the same file used by plotyx(). If set is given e.g as set->3, then it is possible to plot a large number of lines with the same width and color.

	The data points are stored into file fi.jfi3. This is useful e.g. when drawing figures showing transportation of timber to factories for huge number of sample plots. Numeric values refer to Gnuplot mar types. The mark can be given also as CHAR varible or constant.
width	0 | 1 REAL the width of the line. Default: width->1
label	N |1 CHAR Text plotted to the end of line.

Example 33.4 (drawlineex). Example of drawline()

```
 ;drawlineex:
** Example of drawline() (line 13761 file c:/j3/j.f90)
fi=draw(func->sin(x),x->x,xrange->(0,2*Pi),color->Blue,continue->fcont)
fi=drawline(Pi,sin(Pi)+0.1,label->'sin()',append->,continue->fcont)
xval=matrix(do->(1,10));
mat=matrix(values->(xval,xval+1,xval,xval+2,xval,xval+3))
fi=drawline(mat,color->Red,continue->fcont)
fi=drawline(mat,color->Orange,break->,continue->fcont)
xm=matrix(do->(0,100,1))
e=matrix(101)
e=rann(0,3)
ym=2*x+0.3*xm*.xm+0.4+e
dat=newdata(xm,ym,read->(x,y),extra->(Regf,Resid))
reg=regr(y,x)
figyx=plotyx(y,x,continue->fcont)
figr=plotyx(Resid,x,continue->fcont)
reg0=regr(y,x)
stat(min->,max->)
figyx=draw(func->reg0(),x->x,xrange->,color->Violet,append->,continue->fcont)
transa=trans()
x2=x*x
if(type(reg2).eq.REGR)fu=reg2()
/
reg2=regr(y,x,x2,trans->transa)
figyx=draw(func->transa(fu),x->x,xrange->,color->Orange,append->,continue-
>fcont)
Continue=1 !Errors
fi=draw(func->sin(x),x->x)
fi=draw(xrange->(1,100),func->Sin(x),x->x)
```

```
Continue=0
;if(wait);pause
;return
```

Note 33.10. if a line is not visible, this may be caused by the fact that the starting or ending point is outside the range specified by xrange-> or yrange->.

33.6 show() Plots FIGURE

An figure stored in a figure object or in Gnuplot file can be plotted. If the argument is FIGURE, the parameters of the figure can be changed. If the argument is the name of Gnuplot file, the file must be edited.

Args	1	FIGURE | CHAR
		The figure object or the name of the file containg Gnuplot commans, @@figure

Note 33.11. If the argument is the file name with .jfig extension, and you edit the file, its is safe to change the name, becase if an figure with teh same name is generated, the edited fike is autimatically deleted. If the file refers other files, it is wise to rename also these files and change the names in the beginning of the .jfig file.

Note 33.12. You may wish to use show also if you cnange the window size

Example 33.5 (showex). Example of show()

```
 fi=draw(func->sqrt2(x),x->x,xrange->(-50,50),continue->fcont)
show(fi,xrange->(-60,60),xlabel->'NEWX',ylabel->'NEWY',continue->fcont)
show(fi,axes->10,continue->fcont)
show(fi,axes->01,continue->fcont)
show(fi,axes->00,continue->fcont)
Window='400,800'
show(fi,continue->fcont)
Window='700,700'
fi=drawline(1,10,3,1,color->Red,continue->fcont)
show(fi,xrange->(1.1,11),continue->fcont) !the line is not visible
dat=data(read->(x,y),in->)
1,4
2,6
3,2
```

```
5,1
/
stat()
fi=plotyx(y,x,continue->fcont) ! Gnuplot hides points at border
show(fi,xrange->(0,6),yrange->(0,7),continue->fcont)
```

33.7 plot3d() 3d-figure.

Plot 3d-figure with indicater contours with colours.

Output	1 fi=plot3d() generates Gnuplot file fi.jfig. No figure object is produced.
Args	1 MATRIX The argument is a matrix having 3 columns for x,y and z.
sorted	N | 1 plot3d() uses the Gnuplot function splot, which requires that the data is sorted withe respect to the x-variable. sorted-> indicates that the argument matrix is sorted either natrurally or with sort() function. If sort-> is not presented, plot3 sorts the data.

Example 33.6 (plot3dex). plot3d() example see p. 328 in Mehtatalo Lappi 2020

```
 mat=matrix(1000000,3)
mat2=matrix(1000000,3)
transa=trans() !second order response surface
x=0
x2=0
xy=0
irow=1
do(ix,1,1000)
y=0
y2=0
xy=0
do(iy,1,1000)
mat(irow,1)=x
mat(irow,2)=y
mat(irow,3)=12+8*x-7*x2+124*y+8*xy-13*y2
```

```
mat2(irow,1)=x
mat2(irow,2)=y
mat2(irow,3)=50+160*x-5*x2-40*y-20*xy+10*y2
irow=irow+1
y=y+0.01
y2=y*y
xy=x*y
enddo
x=x+0.01
x2=x*x
enddo
/
call(transa)
fi=plot3d(mat,sorted->,continue->fcont)
fi=plot3d(mat2,sorted->,continue->fcont)
```

34 Splines, stem splines, and volume functions

There are several spline functions.

34.1 tautspline() Creates a more regular TAUTSPLINE

tautspline(x1,...,xn,y1,...,yn[,par->][,sort->][,print->])// Output:// An interpolating cubic spline, which is more robust than an ordinary cubic spline. To prevent oscillation (which can happen with splines) the function adds automatically additional knots where needed.// Arguments:// x1,...,xn the x values// d1,...,dn the y values.// There must be at least 3 knot point, i.e. 6 arguments.// Options:// par Parameter determining the smoothness of the curve. The default is zero, which produces ordinary cubic spline. A typical value may 2.5. Larger values mean that the spline is more closely linear between knot points.// sort the default is that the x's are increasing, if not then sort-> option must be given// print if print-> option is given, the knot points are printed (after possible sorting). The resulting spline can be utilized using value() function. The taut spline algorithm is published by de Boor (1978) on pages 310-314. The source code was loaded from Netlib.

34.2 stemspline() Creates STEMSPLINE

To be reported later.

34.3 stempolar() Puts a stem into polar coordinates

To be reported later

34.4 laasvol() Volume equations of Laasasenaho

To be reported later.

34.5 laaspoly() Polynomial stem curves of Laasasenaho

To be reported later.

34.6 integrate() Integrates volume from STEMSPLINE

To be reported later.

35 Bit functions

bit functions help to store large amound of binary variables in small space. These functions are used in domain calcualtions

35.1 Bitmatrix

A BITMATRIX is an object which can store in small memory space large matrices used to indicate logical values. A BITMATRIX object is produced by bitmatrix() function or by closures() function from an existing bitmatrix. Bitmatrix values can be read from the input stream or file or set by setvalue() function. The values of bitmatrix elements can be accessed with value() function.

Note 35.1. Also ordinary real variable can be used to store bits. See bit functions.

35.2 setbits() Sets bits

To be reported alter

35.3 clearbits() Clears bits

To be reported later

35.4 getbit() : Gets bit

To be reported later, see old manual

35.5 bitmatrix() Creates BITMATRIX

To be reported later, see old manual

35.6 setvalue() Set value for a BITMATRIX

To be reported later, see old manual

35.7 closures() Convex closure

To be desrribed later, see old manual

36 Misc. functions

There are some functions which do not belong to previous classes.

36.1 properties() Properties of subjects

This function has been used to define properties of factories. It will replaced with othe means in later versions.

36.2 cpu() Cpu time

Example 36.1 (cpuex). Example of cpu-timing

```
 cpu0=cpu()
a=matrix(100000)
a=ran() !uniform
mean(a),sd(a),min(a),max(a);
cpu1=cpu()
elapsed=cpu1-cpu0;
```

36.3 secnds() Clock time

Example 36.2 (secondsex). Example of elapsed time

```
 cpu0=cpu()
```

```
sec0=secnds()
a=matrix(100000)
a=ran() !uniform
mean(a),sd(a),min(a),max(a);
cpu1=cpu()
sec1=secnds()
elapsed=cpu1-cpu0;
selapsed=sec1-sec0;
```

37 Co-operation between Jlp22 and R

Is is possible to run R scripst from **Jlp22** and **Jlp22** scripts from R.

37.1 R() Executes an R-script

An R script can be executed with R(script) where script is CHAR object defining the script text file. The function is calling // call execute_command_line('Rscript.lnk '//j_filename(1:le), wait=.false.)// Thus a shortcut for the Rscript program needs to be available.

Example 37.1 (Rex)**.** Example of Rscript

```
 rscript=text()
# A simple R-script that generates a small data to file mydat.txt
wd<-"C:/jlp22/jmanual"
x<-runif(10,0,10)
y<-cbind(1,x)%*%c(1,2)+rnorm(10)
mydat<-data.frame(y,x)
write.table(mydat,file=paste(wd,"/mydat.txt",sep=""))
//
write('miniscript.r',rscript)
close('miniscript.r')
R('miniscript.r')
print('mydat.txt')
delete_f('mydat.txt','miniscript.r')
```

37.2 Calling Jlp22-scripts from R

File JR_0.0.tar.gz in the folder J_R contains R tarball for taking **Jlp22** subroutines into R. With R command JR("testr.inc") the example jp problem can

be solved from R. Later lauri Mehtatälo will develop this co-operation further so that R can directly access also matrices in the **Jlp22** memory. For further information contact lauri.mehtatalo@luke.fi THIS DOES NOT WORK NOW We will reconsider it soon with Lauri

38 Future development

The previous version contained possiblities to include factories into the optimization. Factory optimization is not available in the current version, because I'm now building a completely new version. I have already cleaned the data structures of linear programming and put the algorithm into reasonable subroutines. This makes it possible to follow and optimized the the flow of control. This made it already possible to put ordinary linear programming into a separate jlpz() function.

I think that the current version of **Jlp22** provides many possibilities for future developments. For instance:

-
- The current version does not have any special functions for making simulators. The new goto() commands, possibility to work with submatrices, and the new transdata() function provide much more efficient ways to develop simulators. Examples will be provided shortly.
- Using the possibility to compute derivatives using the analytic derivates makes it quite straightforward to make it possible to have a nonlinear objective function and nonlinear constraints. These things are under design.
- It would be quite easy to inclued tools for piecewise linear constraints and objectives.
- It would be quite easy to develop **Jlp22** so that integer solution is produced with respect to the schedule weight.
- It would be interesting to see how **Jlp22** can put to work with Heureka.
- The possiblity to run R scripts from **Jlp22** and **Jlp22** scripts from R provide new possiblities.
- **Jlp22** can now be used as an interface to Gnuplot. Google search show how many possiblities Gnuplot provides. It is quite straightforward to implement these graphs if it is not currently possible.

- The possibility to generate random numbers from any discrete or continuous distribution provide new possibilities to study the effects of random errors in the optimization.
- The new tools for analyzing grouped data are useful when studying the grouped data. it would be straightforward to implement mixed model methods based on expected means squares.

References

[1] Dantzig, G.B. and VanSlyke, R.M. (1967) *Generalized upper bounding techniques* **J** Compt Sys Sci 1(10),213-226

[2] Fletcher,R. 1996. Dense factors of Sparse matrices. Dundee Numerical Analysis Report NA/170.

[3] Hoganson, H.M. and Rose, D.W. (1984), *A simulation approach for optimal timber management scheduling* Forest Science, 30:220-238

[4] Hoganson, H.M. and Kapple, D.C. (1991), *DTRAN version 1.0. A multimarket timber supply model. Users' guide* Minneapolis: University of Minnesota Department of Forest Resources Staff Series Paper 82,

[5] Hyvönen, Pekka, Lempinen, Reetta, Lappi, Juha, Laitila, Juha and Packalen, Tuula (2019) *Joining up optimisation of wood supply chains with forest*, Forestry an international journal of forestry, 93(1):163–177, DOI = https://doi.org/10.1093/forestry/cpz058

[6] Lappi, Juha (1992) *JLP – a linear programming package for management planning* Finnish Forest Research Institute Research papers; 414, 134 p.

[7] , Lappi, Juha and Lempinen, Reetta (2014) *A linear programming algorithm and software for forest-level planning problems including factories* Scandinavian Journal of Forest Research,29 Supplement 178–184", DOI = http://dx.doi.org/10.1080/02827581.2014.886714