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Asano, Choichiro
Research Institute of Fundamental Information Science, Kyushu University | Department of Information Systems, Interdisciplinary Graduate School of Engineering Science, Kyushu University

Watanabe, Michiko
Research Institute of Fundamental Information Science, Kyushu University | Department of Information Systems, Interdisciplinary Graduate School of Engineering Science, Kyushu University

Hosokawa, Koji
Department of Information Systems, Interdisciplinary Graduate School of Engineering Science, Kyushu University

Kurihara, Koji
Department of Information Systems, Interdisciplinary Graduate School of Engineering Science, Kyushu University

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By

Chooichiro ASANO*,, Michiko WATANABE*,**, Koji HOSOKAWA****

and

Koji KURIHARA**

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Abstract

NISAN system has been developed by a group of Japanese statisticians, since 1978. The package is widely applicable in statistical data analyses, confirmatory and exploratory, with newly developed methods. The system is useful not only for the beginners in data analysis, but also for the senior statisticians with analytical insight, i.e. choosing adequate procedure of statistical analysis and model-building.

In the presest paper, some features in NISAN system recently developed are presented, especially concentrating on both functions of new monitor and knowledge-commands. These two functions are mainly for statistical researchers. The former is easy to cooperate and to accumulate further commands developed with respect to data-handling and analytical methods by NISAN research members, working in the respective fields of statistics and locating in several parts of Japan. The latter is to investigate and to evaluate properties of statistical methodologies by simulations in some varieties of circumstances given, and jointly may be to recognize the mathematical model previously unspecified for data.

1. Introduction

NISAN system is a New Interactive Statistical ANalysis program package, which consists mainly of the following five modules: NISAN-MONITOR module for control, STAT module for statistical methods in confirmatory and exploratory analysis of data, DATA module for data bases, HELP module for various inquiries with three levels, and DOC module for documentation. The conversational terminals are cathode ray tubes, teletypes or graphic terminals, where all the outputs in NISAN system are designed on at most eighty characters per a line.

In this way, NISAN system has been developed concretely not only on ordinarily important commands for methods of statistical data analysis, but also on some commands for statistical data-handling, e. g. stratification, graphic representation, quantification and

* Research Institute of Fundamental Information Science, Kyushu University 33, Fukuoka 812.

** Department of Information Systems, Interdisciplinary Graduate School of Engineering Science, Kyushu University 39, Fukuoka 812.

so on. Thus a relatively simple users' guide was made on this February as a trial, and the booklet obtained good evaluation for statisticians without regard to their experience of computer work. Therefore more commands of analytical methods and statistical data-handling are now reinforced.

On the other hand, two emphasized features, that is, a new NISAN monitor with effective functions and some knowledge-commands for statistical inference are recently studied and developed with the ordinary method-commands.

2. New NISAN-monitor

Generally speaking, the functions of monitor are very important for efficiency of the whole system of statistical program package. Regarding the program construction of NISAN system, the main functions of NISAN-monitor are as follows: interpretation of input commands, allocation of memories, allocation of files, control of several peripheral devices, terminals and programs.

In NISAN system, the monitor is fully written by the standard FORTRAN IV language, although only LOGON and BREAK functions depend on TSS. This assures every university computer of the portability of NISAN system, that is to say, NISAN system is independent from the kinds of computer machines, being available FORTRAN language.

The monitor interprets naturally regular commands and operands. In them, some conventions are particularly provided for users' convenience. For example,

variables X1:X5 means all variables between X1 and X5 in NISAN file,
variables X(1:5) means X1, X2, X3, X4 and X5,
values 1:5 means values between 1 and 5, i.e. [1, 5],

and so on. Also several conventions, depending on the command, are given as shown in the following example;

levels L((X1 1 (2 7 8) (3 4)) means making three levels of variable X1, where the respective levels are composed of a value 1, a set of values 2, 7, 8 and a set of values 3, 4, as elements.

For the convenience of successive replication of analysis, changing variables is considered simultaneously by arranging related variables, as shown in the following example,

SCAT(X1 X2:X5) means four scatter diagrams of X2, X3, X4 and X5 on X1, respectively.

Regarding operands, many varieties are prepared to obtain several features of outputs corresponding to users' requests. In case of omission for operands, either a prompt inquiry is presented or a standard value involved is given, depending on the semantics of the operands. In the monitor, the interactive functions are provided.

In view of statistical analysis, it makes clear in NISAN system for us to use statistical terminologies, defined by mathematical statistics, as the names of commands and operands. For example,

POP means POPulation(s).
TESTIM means statistical TESTs and ESTIMation.
REF means RElative EFficiency.
DEFTP means DEFinition of Test-Process.

The NISAN standard file is applied as a self-descriptive systematized file composed of both parts of directory and data, since there exist big varieties on types and formats in every file of users. The logical structure of data part is a set of record, being called cases. The file has parent file name, and each case consists of a set of items refered by variable names. Group names of variables are also assigned as key names, and in case of continuous type of variables, three data ranges are given as normal, warning and something unusual.

It is one of the most emphasized functions of NISAN monitor for the research members to construct easily new commands with operands on the basis of their FORTRAN programs. The arrangement is fill several definitions for commands and operands in a printed form, and to set initial values for arguments. Thus the setup is completed by a certain simple operations on TSS. As the manual, a thin booklet Commands Construction Manual for NISAN Research Members [3] is prepared to be easily to understand for statisticians, even if they are not so familiar with computer operation.

In view of further development of NISAN system, this function of the monitor is very useful, since the research members of the organization of NISAN system are widely located at several universities and institutions in Japan, and the respective members, working in various statistical fields, are able to integrate easily their authorized programs of analytical methodologies to NISAN system.

3. Analytical method-commands

It is natural in statistical program packages to have many method-commands to analyze actual data in data file. In NISAN system, analytical programs in STAT module are originally developed and are integrated under TSS operation. Although the whole method-commands involved are still not so many and such commands are soon to be added, a tentative users' guide of 43 pages was prepared as a trial in this February. Since the manner of writing and form was simple and customary, the booklet had a good reputation to apply easily those commands and operands. In order to show some illustrations, several commands are quoted from the booklet in the following manner.

The contents of the respective commands are composed of (0) Name of command, (1) Input form, (2) Functions, (3) Explanation of operands, (4) Pagination of illustrations of output.

4. Knowledge-commands

4.1. The principle

NISAN system is widely available for both statistical situations, confirmatory analysis and exploratory analysis, and is not only for senior statisticians to obtain analytical wisdom on mathematical model-building for the essence of urgent phenomenon, but also for the beginners of statistical data analysis to learn analytical methods and properties and to train their experience of data analysis. For these purposes in NISAN system, separating from analytical method-commands, so-called knowledge-commands have been developed to investigate or to learn about methodologies of statistical in-

6. Command MEAN2

Significance test between two sample mean vectors in multivariate normal population with unknown variance-cavariance.

MEAN2	[FI (file name)]*
	[VAR (variable name list)]*
	POP «identification variable name value 1 value 2»
	[ALPHA (significance level)]

8. Command HIST

Output of histograms for respective variables.

HIST	[FI (file name)]*
	[VAR (variable name list)]*
	[MINIMUM (minimum value)]
	[MAXIMUM (maximum value)]
	[SIZE (number of intervals)]
	[DENSITY (frequencies for a height scale unit)]
	[CUMULATE] [NUMERAL]

12. Command SCAT

Scatter diagrams of the second and the latter variables on the first variable respectively.

SCAT	[FI (file name)]*
	[VAR (variable name list)]*
	[MINIMUM (minimum value)]
	[MAXIMUM (maximum value)]
	[WIDTH (number of cells on horizontal axis)]
	[HEIGHT (number of cells on vertical axis)]
	[GROUP «variable name value 1 value 2… value n»]
	[MEAN] [FRAME]

11. Command STREG

Stepwise forward or backward regression analysis with a constant term.

STREG	[FI (file name)]*
	[VAR (variable name list)]*
	[{FORWARD / BACKWARD}]
	[FVALUE (F value)]
	[TOLERANCE (tolerance)]
	[FO (file name)]
	[NOPRINT] [LIMIT] [RANGE]

16. Command LEVEL

Level-making of each variable before cross-table analysis, analysis of variance, and so on.

LEVEL	FI (file name)
	L «variable name level 1 level 2… level n)…»

17. Command CROSS

Making two-way cross tables.

CROSS	[FI (file name)]*
	[VAR (variable name list)]*
	[PRINT ({[EXPECTED] [ROW] [COLUMN] [TOTAL] [NO]})]
	[ASSOC (association indices list)]
	[LIMIT] [RANGE] [MISS] [AUTO]
	[GROUP (variable name list)]

20. Command MNT

Multivariate normality test, including 1. skewness 2. kurtosis 3. Geary's test 4. Shapiro-Wilk 5. Shapiro-Francia 6. D'Agostino-Pearson

MNT	[FI (file name)]*
	[VAR (variable name list)]*

18. Command CLUST

Cluster analysis based on distance or similarlity.

CLUST	[FI (file name)]*
	[VAR (variable name list)]*
	MAT (category of data)
	SOL (analytical method)
	CL (number of clusters)
	[GRAPH] [RESULTS] [ALL]
	[CYCLE] [INTER]

Note

(1) [ ] means that operand and item involved can be omitted.

(2) [ ]* means that operand and item involved are not necessary when they are fixed previously by LOCK command.

(3) { } means that only one operand must be selected from the plural operands shown.

(4) Underline of operand means the shorten ing form.

ference, including the single method and the serial process of methods for inference.

In such simple situations, facing the statistical data analysis, one likes to obtain statistical knowledge about the properties of applied methods on the accuracies and precisions for estimates, the distributions or conditional distributions of test statistics, the powers of tests, and furthermore the relative efficiencies or the asymptotic relative efficiencies between two arbitrary tests in case of selecting statistical tests for several alternative hypotheses in varieties of circumstances to be considered. On these accounts, commands DIST, POWER, REF and AREF are available.

From the viewpoint of the process of statistical inference, generally speaking, in order to specify an adequate mathematical model for observations or to investigate the feature pattern of data, statisticians apply more or less their systematic processes, composed of several methods, to their data basing upon their logics of inference.

As a simple example of inference process, called a kind of pooling methodology by Bancroft et al., let us consider an estimation problem for two observation means with a common but unknown variance. Then it may be natural that when the distinction between two observation means is not significant by t-test, two sets of observations may be pooled and the average is given as the best estimates of both population means, because of acceptance of the null hypothesis that two population means are equal. On the other hand, if the distinction is significant, the respective observation means may be given as the respective best estimates of population means. More details are discussed in section 4.3. Ordinary processes of statistical inference may be composed of more tests, and the mathematical formulations are extremely complicated with multiple integrations on complex domain.

Even if the inference process is multiple-stage, NISAN system is able to give very quickly numerical evaluation of the properties with enough precision about inference on the basis of simulating the inference process by NISAN random numbers or by random number generation implemented and arbitrarily transformed as in Table B, keeping away from awfully complicated mathematical formulations and these numerical computations.

Such inference processes are also applied frequently in case of nonparametric inference, since the structure of observations is too complicated to know what kinds of nonparametric tests are suitable to the data feature, which may be observed from a composite population. Since every test itself has a specific aspect without a consistence in the test-statistic, and actually several nonparametric tests are tried. Then some tests indicate significant but another indicate nonsignificant. Therefore, in cases of exploratory analysis or in the situations of imcompletely specified model of data, it may be dissatisfied for us to apply merely a statistical test. It may be needed ordinarily to take a test process.

Thus at any rate, the performances and properties of such inference processes have to be theoretically evaluated and, if any, the optimality improvement should be considered as statistician's knowledge. For instance, the overall power of a test-process, the relative efficiency between arbitrary two test-processes, the accuracy and precision of estimate due to preliminary test-process should be studied.

These knowledges may be also able to prevent misapplication of statistical methods and of statistical program packages, and jointly to recognize the mathematical model of data.

For these purposes, knowledge-commands DEFTP, CONDIST, TPATTN, POWER and TESTIM are prepared in NISAN system. In the following section, more details of the commands are introduced.

4.2. Formation of each command

The manner of writing and form is, of course, similar with the method-commands but a little complicated in users' guide. In order to show concisely their functions, operands and varieties, we quote the expression of these commands in its entirety, as below.

(i) **Command DIST**

```
DIST    TEST (test name)
        POP (number of populations)
        SIZE (sample 1 sample 2…)
        [TYPE (type of R.N.)]
        [SIM (size of simulation)]
        [PARA (parameters of R.N.)]
        {UP LW BO}
        [PERC (percent point)]
        [PERT (probability level)]
        [HIST]
```

[Function]

To obtain the distribution of a test statistic in a certain environment given.

[Operands]

TEST …A test name shown in Table A.

POP …The number of populations.

SIZE …The respective sizes of samples obtained from the populations.

TYPE …A name of type of random numbers shown in Table B. In case of omittion of key-in, NOR is applied.

HIST …A histogram of test statistic is shown by the simulation. In case of omittion of PERC- and RERT-commands, the histogram of test statistic is shown, even if HIST command is omitted.

SIM …The size of simulation in a cycle. In case of omittion, the size is five thousands.

PARA …Parameters of the random numbers defined by TYPE.

UP …Output of the upper probability level, or the upper percentile of test statistic.

LW …Output of the lower probability level, or the lower percentile of test statistic.

BO …Output of either sides of the probability level, or of the both percentiles.

PERC …Output of the probability level for the percentile given.

PERT …Output of the percentile for the probability level given.

(ii) **Command POWER**

```
POWER   TEST (test name)
        POP (number of populations)
        SIZE (sample 1 sample 2…)
        [TYPE (type of R.N.)]
        [ALPHA (probability level)]
        [SIM (size of simulation)]
        [PARA (parameters of R.N.)]
        [SIG (pattern of sig.)]
```

[Function]

To obtain the power of test given.

[Operands]

TEST …The name of a test shown in Table A, or the name of a test process defined by DEFTP command.

SIG …Only if a test process si applied in TEST operand, SIG operand is needed. The manner is the same as DEFTP command.

The other operands are quite the same as those in DIST command.

(iii) Command REF

```
REF     TEST (test name 1 test name 2)
        POP (number of populations)
        SIZE (sample 1 sample 2…)
        [TYPE (type of R.N.)
        [ALPHA (probability level)]
        [SIM (size of simulation)]
        [PARA (parameters of R.N.)]
```

[Function]
To obtain the relative efficiency of test 2 to test 1 in a certain environment given.

[Operands]
TEST …The name of tests shown in Table A, or the name of test process(es) defined by DEFTP command.

The other operands are quite the same as those in DIST command.

(iv) Command AREF

```
AREF    TEST (test name 1 test name 2)
        POP (number of populations)
        SIZE (sample 1 and 2…)
        [TYPE (type of R.N.)]
        [ALPHA (probability level)]
        [SIM (size of simulation)]
```

[Function]
To obtain the asymptotic relative efficiency of test 2 to test 1 in a certain environment given, where test 1 is to be the best test in the Eeden's sense.

[Operands]
Operands involved are quite the same as those in REF command.

(v) Command DEFTP

```
DEFTP   NAME (test process name)
        TEST (test 1…test n+1)
        SIG (pattern of sig.)
        [ALPHA (lev. 1…lev. n)]
```

[Function]
To define a test process (test-series), where individual tests are in Table A.

[Operands]
NAME …The name of a test process to be defined.

TEST …The names of tests applied in a test process.

ALPHA …Significance levels for individual tests, excepting a level for the final test in a test process. The final significance level depends on the succeeding command. In case of omittion, all levels must be given at the succeeding command.

SIG …Significance pattern defined by a test process, where 1, 0 and* mean significance, non-significance and ignorance, respectively. Examples are shown as below.

SIG(111) …significance in view of a test process, when all individual tests are significant.

SIG(11*) …significance in view of a test process, where the first and the second tests are significant. The third test does not work anything.

SIG(1*0) …significance in view of a test process, when the first test is significant, the third test is non-significant.

SIG(1) …significance in view of a test process, specially when anyone of individual test is significant.

(vi) Command TPATTN

```
TPATTN  TEST (list of test name)
        POP (number of populations)
        SIZE (sample 1 sample 2…)
        [TYPE (type of R.N.)]
        [ALPHA (probability level)]
        [SIM (size of simulation)]
        [PARA (parameters of R.N.)]
```

[Function]
To obtain frequencies for the respective significance and non-siginificance patterns due to several tests involved in a test process.

[Operands]
All operands are quite the same as those

of POWER command.

(vii) **Command TESTIM**

```
TESTIM  TEST (test name)
        POP (number of populations)
        SIZE (sample 1 sample 2…)
        [TYPE (type of R.N.)]
        [ALPHA (probability level)]
        [SIM (size of simulation)]
        [PARA (parameters of R.N.)]
        [SIG (pattern of sig.)]
```

[Function]

To obtain the mean square error and value of a kind of risk function of estimating the mean of the first population after a preliminary test or a test process given.

[Operands]

TEST …The name of a test or a test process given. The name of tests involved in the process are shown in Table A, like those in POWER command.

ALPHA …A probability of significance level. In case of omittion, $\alpha = 0.05$.

The other operands are quite the same as those of POWER command.

(viii) **Command CONDIST**

```
CONDIST TEST (test process name)
        POP (number of populations)
        SIZE (sample 1 sample 2…)
        [TYPE (type of R.N.)]
        [ALPHA (list of pro. level)]
        [PAL (probability level)]
        [SIM (size of simulation)]
        [PARA (parameters of R.N.)]
        [HIST]
```

[Function]

To obtain the conditional distribution of test statistic used in the final test at a test-process (test series) defined.

[Operands]

TEST …The name of a test-process defined by DEFTP command.

ALPHA …Individual significance levels when they are not given by DEFTP command. See DEFTP command.

PAL …A significance level desired throughout the test process. Then a significant value of test statistic used in the final test at a test process is shown.

The other operands are the same as those used in POWER command.

Table A. Simple Statistical Tests Involved at Present*

One-Sample Tests	Two-Sample Tests	Multi-Sample Tests
Wilcoxon one sample test	Wilcoxon rank sum test	KRUskal-wallis test
CHI-square test	Ansari-Bradley test	CHI-square test
KOLmogorov-Smirnov test	LEPage test	FRIEdman test
	CHI-square test	MEDian test
	SIGN test	LOGrank test
	KOLmogorov-Smirnov test	
	D-test (Grove's)	
	Generalized Wilcoxon test	
	COX-Mantel test	
	MANtel-Haenzel test	
	T-test	
	WELch-aspin test	
	F-test	

(* Tests are still increased.)

Table B. Types of Random Numbers and their Input-Forms

Types (notations)		Input-Forms					
		1st Parameter		2nd Parameter		3rd Parameter	
REctangular	[a, b]	a	[0]	b	[1]	——	
BInomial	B(n, p)	n	[10]	p	[0.5]	——	
POisson	mean a	a	[5]	——		——	
NORmal	N(a, b)	a	[0]	b	[1]	——	
EXPonential	$be^{-b(X-a)}$	a	[0]	b	[1]	——	
WEIbull	$(c/b)Z^{c-1}e^{-Z^c}$ $Z \equiv (X-a)/b$	a	[0]	b	[1]	c	[3]

[ ]: Value in case of omission for key-in.

4.3. A simple illustration of the correspondence of command TESTIM with the mathematical formulation

(i) PROBLEM: The inference of population mean after one-sided t-test (Asano [6]).

Let $O_{n_1}: (x_{11}, x_{12}, \cdots, x_{1n_1})$ be a random sample of n_1 from a normal population $N(\mu_1, \sigma^2)$ and let $O_{n_2}: (x_{21}, x_{22}, \cdots, x_{2n_2})$ be another random sample of n_2 drawn from another normal population $N(\mu_2, \sigma^2)$. These two normal populations are known to have the same population variance σ^2, whose value is however unknown. Then, our rule of the statistical procedure is formulated in the following way.

(1) Let $\bar{x}_i$ and s_i^2 be the sample mean and the sample variance defined by O_{n_i} $(i=1, 2)$.

(2) Let the statistic t be defined by

$$t=(\bar{x}_1-\bar{x}_2)\Big/\left\{\left(\frac{1}{n_1}+\frac{1}{n_2}\right)^{1/2}\left(\frac{n_1 s_1^2+n_2 s_2^2}{n_1+n_2-2}\right)^{1/2}\right\}.$$

(3) Let us define the statistic $\bar{\bar{x}}$ in the following way:

(a) $\bar{\bar{x}}=\bar{x}_2$, if $t \leqq \lambda$,

(b) $\bar{\bar{x}}=(n_1\bar{x}_1+n_2\bar{x}_2)/(n_1+n_2)$, if $\lambda<t<\Lambda$,

(c) $\bar{\bar{x}}=\bar{x}_1$, if $t \geqq \Lambda$,

where the switching constants Λ and λ are prescribed constants.

THEOREM 4.1. *The distribution function of* $\bar{\bar{x}}$ *is given by*

$$(4.1)\quad Pr.\{\bar{\bar{x}}<u\}=\frac{1}{\sqrt{2\pi}}\int\!\!\int_{T\leq\lambda} e^{-p^2/2}\frac{V^{\frac{n_1+n_2}{2}-2}e^{-V}}{\Gamma\left(\frac{n_1+n_2-2}{2}\right)}\Phi\left(\frac{u-\mu_2}{\sigma}\sqrt{n_1+n_2}-\sqrt{\frac{n_1}{n_2}}p\right)dp\,dV$$

$$+\frac{1}{\sqrt{2\pi}}\Phi\left(\frac{(n_1+n_2)u-(n_1\mu_1+n_2\mu_2)}{\sigma\sqrt{n_1+n_2}}\right)\int\!\!\int_{\lambda<T<\Lambda} e^{-\mu^2/2}\frac{V^{\frac{n_1+n_2}{2}-2}e^{-V}}{\Gamma\left(\frac{n_1+n_2-2}{2}\right)}dp\,dV$$

$$+\frac{1}{\sqrt{2\pi}}\int_{T\geq\Lambda}\int e^{-p^2/2}\frac{V^{\frac{n_1+n_2}{2}-2}e^{-V}}{\Gamma\left(\frac{n_1+n_2-2}{2}\right)}\Phi\left(\frac{u-\mu_1}{\sigma}\sqrt{n_1+n_2}+\sqrt{\frac{n_2}{n_1}}p\right)dp\,dV\,,$$

where

$$T\equiv\left(\sqrt{\frac{n_1n_2}{n_1+n_2}}\frac{\mu_2-\mu_1}{\sigma}+p\right)\Big/\sqrt{\frac{2}{n_1+n_2-2}V}\,.$$

THEOREM 4.2. *The mean value* $E\{\bar{\bar{x}}\}$ *and the mean square error* $M.S.E.\{\bar{\bar{x}}\}$ *of estimate* $\bar{\bar{x}}$ *are given by*

$$(4.2)\quad E\{\bar{\bar{x}}\}=\mu_1-\frac{(\mu_1-\mu_2)}{n_1+n_2}\{n_1Pr.\{D_0\}+n_2(1-Pr.\{D_2\})\}$$

$$+\frac{\sigma}{\sqrt{n_1+n_2}}\cdot\left\{\sqrt{\frac{n_1}{n_2}}I_{D_0}(p)-\sqrt{\frac{n_2}{n_1}}I_{D_2}(p)\right\},$$

$$(4.3)\quad M.S.E.\{\bar{\bar{x}}\}=\frac{\sigma^2}{n_1+n_2}+\frac{\sigma^2}{n_1+n_2}\left\{\frac{n_2}{n_1}I_{D_2}(p^2)+\frac{n_1}{n_2}I_{D_0}(p^2)\right\}+\{1-Pr.\{D_2\}\}$$

$$\cdot\left(\frac{n_2(\mu_1-\mu_2)}{n_1+n_2}\right)^2+Pr.\{D_0\}\cdot\left\{\mu_1+\frac{n_2\mu_1+n_1\mu_2}{n_1+n_2}\right\}\left\{\mu_2+\frac{n_1\mu_1+n_2\mu_2}{n_1+n_2}\right\},$$

where

$$I_{D_i}(p^j)=\iint_{D_i}p^jf(p,V)dp\,dV\,,\qquad(j=1,2),$$

$$f(p,V)=\frac{1}{\sqrt{2\pi}}e^{-p^2/2}\frac{V^{\frac{n_1+n_2}{2}-2}e^{-V}}{\Gamma\left(\frac{n_1+n_2-2}{2}\right)}\,,$$

$$D_i:\begin{cases}T\leqq\lambda\,, & (i=0)\,,\\ T\geqq\Lambda\,, & (i=2)\,,\end{cases}$$

$$Pr.\{D_i\}=\iint_{D_i}f(p,V)dp\,dV\,.$$

(ii) SOLUTION: For a practical situation, when the estimate of μ_1 is given by a result of preliminary test of signficance between two population means, i.e. $\bar{\bar{x}}=\bar{x}_1$ for the significance and $\bar{\bar{x}}=(n_1\bar{x}_1+n_2\bar{x}_2)/(n_1+n_2)$ for the nonsignificance, where $\lambda=-\infty$ in the previous theorems, the properties of such a procedure are evaluated in the following way.

```
NISAN
TESTIM TEST(T) POP(2) SIZE(5 15) TYPE(NORMAL) -
 ALPHA(5.0) SIM(5000) PARA((0.0 0.0 1.0 1.0) -
 (0.0 -0.05 1.0 1.0) (0.0 -0.1 1.0 1.0) -
 (0.0 -0.50 1.0 1.0) (0.0 -1.0 1.0 1.0) -
 (0.0 -2.00 1.0 1.0) (0.0 -5.0 1.0 1.0)) AVE UP

TESTIMATION FOR MEAN1

 TEST NAME                                      STUDENT T
 NUMBER OF POPULATIONS                                  2
 TYPE OF RANDOM NUMBER                             NORMAL
 SIGNIFICANCE LEVEL                                 0.050
 NUMBER OF SIMULATION                                5000

  NO. 1   SAMPLE1          5        SAMPLE2        15
      1)  PARA.(1)      0.00        PARA.(1)     0.00
          PARA.(2)      1.00        PARA.(2)     1.00

          MEAN                                   0.039
          VARIANCE                               0.075
          M.S.E.                                 0.077
          RELATIVE RISK                          0.399

      2)  PARA.(1)      0.00        PARA.(1)    -0.05
          PARA.(2)      1.00        PARA.(2)     1.00

          MEAN                                   0.007
          VARIANCE                               0.089
          M.S.E.                                 0.089
          RELATIVE RISK                          0.438

      3)  PARA.(1)      0.00        PARA.(1)    -0.10
          PARA.(2)      1.00        PARA.(2)     1.00

          MEAN                                  -0.015
          VARIANCE                               0.096
          M.S.E.                                 0.097
          RELATIVE RISK                          0.476

      4)  PARA.(1)      0.00        PARA.(1)    -0.50
          PARA.(2)      1.00        PARA.(2)     1.00

          MEAN                                  -0.157
          VARIANCE                               0.202
          M.S.E.                                 0.227
          RELATIVE RISK                          1.110

      5)  PARA.(1)      0.00        PARA.(1)    -1.00
          PARA.(2)      1.00        PARA.(2)     1.00

          MEAN                                  -0.171
          VARIANCE                               0.327
          M.S.E.                                 0.356
          RELATIVE RISK                          1.761

      6)  PARA.(1)      0.00        PARA.(1)    -2.00
          PARA.(2)      1.00        PARA.(2)     1.00

          MEAN                                  -0.011
          VARIANCE                               0.226
          M.S.E.                                 0.226
          RELATIVE RISK                          1.140

      7)  PARA.(1)      0.00        PARA.(1)    -5.00
          PARA.(2)      1.00        PARA.(2)     1.00

          MEAN                                  -0.002
          VARIANCE                               0.193
          M.S.E.                                 0.193
          RELATIVE RISK                          1.000

NISAN
```

4.4. The other illustrations of outputs

(i) COMMAND DIST (jointly checking the precision)

```
NISAN
DIST TEST(T) POP(2) SIZE(20 20) TYPE(NORMAL) -
 SIM(5000) PARA(0.0 0.0 1.0 1.0) PERT(1.0 5.0 -
 10.0 20.0) BO HIST

 TEST NAME                                      STUDENT T
 NUMBER OF POPULATIONS                                  2
 TYPE OF RANDOM NUMBER                             NORMAL
 NUMBER OF SIMULATION                                5000

  NO. 1   SAMPLE1        20       SAMPLE2        20
      1)  PARA.(1)     0.00       PARA.(1)     0.00
          PARA.(2)     1.00       PARA.(2)     1.00      Theoretical
                                                           values
  NO.      SIG. LEVEL(TWO-TAILED)         PERCENT POINT       ↓
  1              0.010                       2.626          2.712
  2              0.050                       2.005          2.024
  3              0.100                       1.682          1.686
  4              0.200                       1.310          1.304

 THE DISTRIBUTION AND PROBABILITIES OF  T -TEST STATISTICS

VALUES OF               55  110  165  220  275  330  385  440  495  550  605  660
TEST-STAT  FREQ. +----+----+----+----+----+----+----+----+----+----+----+----+
  INT. 1      0  I
  INT. 2      0  I
  INT. 3      2  I*
  INT. 4      0  I
  INT. 5      1  I*
  INT. 6      1  I*
  INT. 7      5  I*
  INT. 8     14  I**
  INT. 9     33  I***
  INT.10     69  I*******
  INT.11    115  I***********
  INT.12    192  I******************
  INT.13    270  I*************************
  INT.14    360  I*********************************
  INT.15    473  I*******************************************
  INT.16    548  I**************************************************
  INT.17    616  I********************************************************
  INT.18    581  I*****************************************************
  INT.19    504  I**********************************************
  INT.20    433  I****************************************
  INT.21    287  I***************************
  INT.22    211  I********************
  INT.23    132  I************
  INT.24     76  I*******
  INT.25     40  I****
  INT.26     21  I**
  INT.27      8  I*
  INT.28      5  I*
  INT.29      3  I*
  INT.30      0  I
                 +----+----+----+----+----+----+----+----+----+----+----+----+
  WHERE
    INT. 1 =( -5.00  -4.70), CUM.FREQ.    0 CUM.PROB.   0.0  PERCENT
    INT. 2 =( -4.70+ -4.40), CUM.FREQ.    0 CUM.PROB.   0.0  PERCENT
    INT. 3 =( -4.40+ -4.10), CUM.FREQ.    2 CUM.PROB.   0.04 PERCENT
    INT. 4 =( -4.10+ -3.80), CUM.FREQ.    2 CUM.PROB.   0.04 PERCENT
    INT. 5 =( -3.80+ -3.50), CUM.FREQ.    3 CUM.PROB.   0.06 PERCENT
    INT. 6 =( -3.50+ -3.20), CUM.FREQ.    4 CUM.PROB.   0.08 PERCENT
    INT. 7 =( -3.20+ -2.90), CUM.FREQ.    9 CUM.PROB.   0.18 PERCENT
    INT. 8 =( -2.90+ -2.60), CUM.FREQ.   23 CUM.PROB.   0.46 PERCENT
    INT. 9 =( -2.60+ -2.30), CUM.FREQ.   56 CUM.PROB.   1.12 PERCENT
    INT.10 =( -2.30+ -2.00), CUM.FREQ.  125 CUM.PROB.   2.50 PERCENT
    INT.11 =( -2.00+ -1.70), CUM.FREQ.  240 CUM.PROB.   4.80 PERCENT
    INT.12 =( -1.70+ -1.40), CUM.FREQ.  432 CUM.PROB.   8.64 PERCENT
    INT.13 =( -1.40+ -1.10), CUM.FREQ.  702 CUM.PROB.  14.04 PERCENT
    INT.14 =( -1.10+ -0.80), CUM.FREQ.1062 CUM.PROB.  21.24 PERCENT
    INT.15 =( -0.80+ -0.50), CUM.FREQ.1535 CUM.PROB.  30.70 PERCENT
    INT.16 =( -0.50+ -0.20), CUM.FREQ.2083 CUM.PROB.  41.66 PERCENT
    INT.17 =( -0.20+  0.10), CUM.FREQ.2699 CUM.PROB.  53.98 PERCENT
    INT.18 =(  0.10+  0.40), CUM.FREQ.3280 CUM.PROB.  65.60 PERCENT
    INT.19 =(  0.40+  0.70), CUM.FREQ.3784 CUM.PROB.  75.68 PERCENT
    INT.20 =(  0.70+  1.00), CUM.FREQ.4217 CUM.PROB.  84.34 PERCENT
    INT.21 =(  1.00+  1.30), CUM.FREQ.4504 CUM.PROB.  90.08 PERCENT
    INT.22 =(  1.30+  1.60), CUM.FREQ.4715 CUM.PROB.  94.30 PERCENT
    INT.23 =(  1.60+  1.90), CUM.FREQ.4847 CUM.PROB.  96.94 PERCENT
    INT.24 =(  1.90+  2.20), CUM.FREQ.4923 CUM.PROB.  98.46 PERCENT
    INT.25 =(  2.20+  2.50), CUM.FREQ.4963 CUM.PROB.  99.26 PERCENT
    INT.26 =(  2.50+  2.80), CUM.FREQ.4984 CUM.PROB.  99.68 PERCENT
    INT.27 =(  2.80+  3.10), CUM.FREQ.4992 CUM.PROB.  99.84 PERCENT
    INT.28 =(  3.10+  3.40), CUM.FREQ.4997 CUM.PROB.  99.94 PERCENT
    INT.29 =(  3.40+  3.70), CUM.FREQ.5000 CUM.PROB. 100.00 PERCENT
    INT.30 =(  3.70+  4.00), CUM.FREQ.5000 CUM.PROB. 100.00 PERCENT
NISAN
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(ii) COMMAND POWER (jointly changing sampling ratio)

```
NISAN
POWER TEST(T) POP(2) SIZE((10 10) (11 9) (12 8) -        (required
 (13 7) (14 6)) TYPE(NORMAL) ALPHA(5.0) SIM(5000) -        time)
 PARA(0.0 1.0 1.0 1.0)
                                                              0
POWERS OF TEST STATISTICS

 TEST NAME                                      STUDENT T
 NUMBER OF POPULATIONS                                  2
 TYPE OF RANDOM NUMBER                             NORMAL
 SIGNIFICANCE LEVEL                                 0.050
 NUMBER OF SIMULATION                                5000

  NO. 1   SAMPLE1        10      SAMPLE2               10
      1)  PARA.(1)     0.00      PARA.(1)            1.00
          PARA.(2)     1.00      PARA.(2)            1.00

          POWER                                     0.559

  NO. 2   SAMPLE1        11      SAMPLE2                9
      1)  PARA.(1)     0.00      PARA.(1)            1.00
          PARA.(2)     1.00      PARA.(2)            1.00

          POWER                                     0.553

  NO. 3   SAMPLE1        12      SAMPLE2                8
      1)  PARA.(1)     0.00      PARA.(1)            1.00
          PARA.(2)     1.00      PARA.(2)            1.00

          POWER                                     0.548

  NO. 4   SAMPLE1        13      SAMPLE2                7
      1)  PARA.(1)     0.00      PARA.(1)            1.00
          PARA.(2)     1.00      PARA.(2)            1.00

          POWER                                     0.517

  NO. 5   SAMPLE1        14      SAMPLE2                6
      1)  PARA.(1)     0.00      PARA.(1)            1.00
          PARA.(2)     1.00      PARA.(2)            1.00

          POWER                                     0.489     4 sec.
NISAN
```

(iii) COMMAND POWER (for a process of testing)

(required time)

```
NISAN
POWER TEST(W T) POP(2) SIZE(20 20) TYPE(NORMAL) -
 ALPHA(5.0 5.0) SIM(5000) PARA((0.0 0.0 1.0 1.0) -
 (0.0 0.2 1.0 1.0) (0.0 0.4 1.0 1.0) -
 (0.0 0.6 1.0 1.0) (0.0 0.8 1.0 1.0) -
 (0.0 1.0 1.0 1.0)) SIG(1)

POWER OF TEST STATISTICS                                    0

 TEST NAME(1)                          WILCOXON RANK SUM
 TEST NAME(2)                                  STUDENT T
 NUMBER OF POPULATINS                                  2
 TYPE OF RANDOM NUMBER                            NORMAL
 SIGNIFICANCE LEVEL(1)                             0.050
 SIGNIFICANCE LEVEL(2)                             0.050
 NUMBER OF SIMULATION                               5000
 TEST(1)                                          (SIG.)
 TEST(2)                                          (SIG.)

  NO. 1   SAMPLE1        20        SAMPLE2         20
      1)  PARA.(1)     0.00        PARA.(1)      0.00
          PARA.(2)     1.00        PARA.(2)      1.00

          POWER                                 0.062

      2)  PARA.(1)     0.00        PARA.(1)      0.20
          PARA.(2)     1.00        PARA.(2)      1.00

          POWER                                 0.104

      3)  PARA.(1)     0.00        PARA.(1)      0.40
          PARA.(2)     1.00        PARA.(2)      1.00

          POWER                                 0.255

      4)  PARA.(1)     0.00        PARA.(1)      0.60
          PARA.(2)     1.00        PARA.(2)      1.00

          POWER                                 0.482

      5)  PARA.(1)     0.00        PARA.(1)      0.80
          PARA.(2)     1.00        PARA.(2)      1.00

          POWER                                 0.719

      6)  PARA.(1)     0.00        PARA.(1)      1.00
          PARA.(2)     1.00        PARA.(2)      1.00

          POWER                                 0.884      5 sec.
NISAN
```

(iv) COMMAND TPATTN

```
NISAN
TPATTN TEST(W ANS T) POP(2) SIZE(20 20) TYPE(NORMAL) -
 ALPHA(5.0 5.0 5.0) SIM(3000) PARA(0.0 0.0 1.0 1.0)

SIGNIFICANCE TABLE OF TEST

 TEST NAME1                                WILCOXON RANK SUM
 TEST NAME2                                   ANSARI BRADLEY
 TEST NAME3                                        STUDENT T
 NUMBER OF POPULATIONS                                     2
 TYPE OF RANDOM NUMBER                                NORMAL
 SIGNIFICANCE LEVEL1                                   0.050
 SIGNIFICANCE LEVEL2                                   0.050
 SIGNIFICANCE LEVEL3                                   0.050
 NUMBER OF SIMULATION                                   3000

  NO. 1    SAMPLE1        20        SAMPLE2          20
      1)   PARA.(1)     0.00        PARA.(1)       0.00
           PARA.(2)     1.00        PARA.(2)       1.00


----------------------------------------------------------------------
  FREQ.  WIL ANS  T
----------------------------------------------------------------------
   2701   0   0   0
     34   0   0   1
    128   0   1   0
      1   0   1   1
     22   1   0   0
    112   1   0   1
      1   1   1   0
      1   1   1   1
----------------------------------------------------------------------
   3000
----------------------------------------------------------------------
                WHERE  0:NON-SIG., 1:SIG.

NISAN
```

(v) COMMAND REF

```
NISAN
REF TEST(T W) POP(2) SIZE(20 20) TYPE(NORMAL) -
 ALPHA(5.0) SIM(5000) PARA((0.0 0.2 1.0 1.0) -
 (0.0 0.4 1.0 1.0) (0.0 0.6 1.0 1.0) -
 (0.0 0.8 1.0 1.0) (0.0 1.0 1.0 1.0))

 TEST1 NAME                                    STUDENT T
 TEST2 NAME                            WILCOXON RANK SUM
 NUMBER OF POPULATIONS                                 2
 TYPE OF RANDOM NUMBER                            NORMAL
 SIGNIFICANCE LEVEL                                0.050
 NUMBER OF SIMULATION                               5000

 RELATIVE EFFICIENCY OF TEST2 TO TEST1

  NO. 1    SAMPLE1        20        SAMPLE2          20
      1)   PARA.(1)     0.00        PARA.(1)       0.20
           PARA.(2)     1.00        PARA.(2)       1.00

           EFFICIENCY                             0.860

      2)   PARA.(1)     0.00        PARA.(1)       0.40
           PARA.(2)     1.00        PARA.(2)       1.00

           EFFICIENCY                             0.956

      3)   PARA.(1)     0.00        PARA.(1)       0.60
           PARA.(2)     1.00        PARA.(2)       1.00

           EFFICIENCY                             0.972

      4)   PARA.(1)     0.00        PARA.(1)       0.80
           PARA.(2)     1.00        PARA.(2)       1.00

           EFFICIENCY                             0.935

      5)   PARA.(1)     0.00        PARA.(1)       1.00
           PARA.(2)     1.00        PARA.(2)       1.00

           EFFICIENCY                             0.956

NISAN
```

(vi) COMMANDS DEFTP AND TESTIM

```
NISAN
DEFTP NAME(WILT) TEST(W T) SIG(1)
NISAN
TESTIM TEST(WILT) POP(2) SIZE(5 15) TYPE(NORMAL) -
 ALPHA(5.0 5.0) SIM(5000) PARA((0.0 0.0 1.0 1.0) -
 (0.0 -0.1 1.0 1.0) (0.0 -0.5 1.0 1.0) -
 (0.0 -1.0 1.0 1.0) (0.0 -2.0 1.0 1.0)) AVE UP

TESTIMATION FOR MEAN1

 TEST NAME                                          WILT
  TEST(1)                              WILCOXON RANK SUM
  TEST(2)                                      STUDENT T
 SIGNIFICANCE PATTERN
  TEST(1)                                         (SIG.)
  TEST(2)                                         (SIG.)
 NUMBER OF POPULATIONS                                 2
 TYPE OF RANDOM NUMBER                            NORMAL
 SIGNIFICANCE LEVEL(1)                             0.050
 SIGNIFICANCE LEVEL(2)                             0.050
 NUMBER OF SIMULATION                               5000

  NO. 1   SAMPLE1         5        SAMPLE2            15
      1)  PARA.(1)     0.00        PARA.(1)         0.00
          PARA.(2)     1.00        PARA.(2)         1.00

          MEAN                                     0.020
          VARIANCE                                 0.094
          M.S.E.                                   0.094
          RELATIVE RISK                            0.489

      2)  PARA.(1)     0.00        PARA.(1)        -0.10
          PARA.(2)     1.00        PARA.(2)         1.00

          MEAN                                    -0.030
          VARIANCE                                 0.109
          M.S.E.                                   0.109
          RELATIVE RISK                            0.536

      3)  PARA.(1)     0.00        PARA.(1)        -0.50
          PARA.(2)     1.00        PARA.(2)         1.00

          MEAN                                    -0.172
          VARIANCE                                 0.197
          M.S.E.                                   0.227
          RELATIVE RISK                            1.118

      4)  PARA.(1)     0.00        PARA.(1)        -1.00
          PARA.(2)     1.00        PARA.(2)         1.00

          MEAN                                    -0.151
          VARIANCE                                 0.339
          M.S.E.                                   0.362
          RELATIVE RISK                            1.769

      5)  PARA.(1)     0.00        PARA.(1)        -2.00
          PARA.(2)     1.00        PARA.(2)         1.00

          MEAN                                    -0.020
          VARIANCE                                 0.226
          M.S.E.                                   0.227
          RELATIVE RISK                            1.121

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(vii) COMMAND CONDIST

```
NISAN
CONDIST TEST(WILT) POP(2) SIZE(20 20) TYPE(NORMAL) -
 ALPHA(5.0) PAL(10.0) SIM(5000) PARA(0.0 0.0 1.0 1.0) -
 HIST

 TEST NAME                                          WILT
  TEST(1)                               WILCOXON RANK SUM
  TEST(2)                                       STUDENT T
 SIGNIFICANCE PATTERN
  TEST(1)                                          (SIG.)
 TYPE OF RANDOM NUMBER                             NORMAL
 SIGNIFICANCE LEVEL(1)                              0.050
 NUMBER OF SIMULATION                                5000

  NO. 1    SAMPLE1         20        SAMPLE2          20
      1)   PARA.(1)      0.00        PARA.(1)       0.00
           PARA.(2)      1.00        PARA.(2)       1.00

PERCENT POINT OF TEST(2) WITH TOTAL SIG. LEVEL FIXED

  NO.       SIG. LEVEL(TWO-TAILED)          PERCENT POINT
   1              0.100                         1.733

VALUES OF              35   70  105  140  175  210  245  280  315  350  385  420
TEST-STAT  FREQ. +----+----+----+----+----+----+----+----+----+----+----+----+
  INT. 1      0  I
  INT. 2      0  I
  INT. 3      1  I*
  INT. 4      7  I*
  INT. 5     21  I***
  INT. 6     55  I********
  INT. 7     75  I***********
  INT. 8    138  I********************
  INT. 9    179  I**************************
  INT.10    216  I*******************************
  INT.11    257  I*************************************
  INT.12    267  I***************************************
  INT.13    335  I************************************************
  INT.14    379  I*******************************************************
  INT.15    410  I***********************************************************
  INT.16    414  I************************************************************
  INT.17    382  I*******************************************************
  INT.18    353  I***************************************************
  INT.19    306  I********************************************
  INT.20    258  I*************************************
  INT.21    218  I********************************
  INT.22    159  I***********************
  INT.23    125  I******************
  INT.24     82  I************
  INT.25     74  I***********
  INT.26     27  I****
  INT.27      7  I*
  INT.28      0  I
  INT.29      0  I
  INT.30      0  I
                 +----+----+----+----+----+----+----+----+----+----+----+----+
 WHERE
   INT. 1 =( -3.00  -2.80), CUM.FREQ.    0 CUM.PROB.    0.0  PERCENT
   INT. 2 =( -2.80+ -2.60), CUM.FREQ.    0 CUM.PROB.    0.0  PERCENT
   INT. 3 =( -2.60+ -2.40), CUM.FREQ.    1 CUM.PROB.    0.02 PERCENT
   INT. 4 =( -2.40+ -2.20), CUM.FREQ.    8 CUM.PROB.    0.17 PERCENT
   INT. 5 =( -2.20+ -2.00), CUM.FREQ.   29 CUM.PROB.    0.61 PERCENT
   INT. 6 =( -2.00+ -1.80), CUM.FREQ.   84 CUM.PROB.    1.77 PERCENT
   INT. 7 =( -1.80+ -1.60), CUM.FREQ.  159 CUM.PROB.    3.35 PERCENT
   INT. 8 =( -1.60+ -1.40), CUM.FREQ.  297 CUM.PROB.    6.26 PERCENT
   INT. 9 =( -1.40+ -1.20), CUM.FREQ.  476 CUM.PROB.   10.03 PERCENT
   INT.10 =( -1.20+ -1.00), CUM.FREQ.  692 CUM.PROB.   14.58 PERCENT
   INT.11 =( -1.00+ -0.80), CUM.FREQ.  949 CUM.PROB.   20.00 PERCENT
   INT.12 =( -0.80+ -0.60), CUM.FREQ.1216 CUM.PROB.   25.63 PERCENT
   INT.13 =( -0.60+ -0.40), CUM.FREQ.1551 CUM.PROB.   32.69 PERCENT
   INT.14 =( -0.40+ -0.20), CUM.FREQ.1930 CUM.PROB.   40.67 PERCENT
   INT.15 =( -0.20+ -0.00), CUM.FREQ.2340 CUM.PROB.   49.32 PERCENT
   INT.16 =( -0.00+  0.20), CUM.FREQ.2754 CUM.PROB.   58.04 PERCENT
   INT.17 =(  0.20+  0.40), CUM.FREQ.3136 CUM.PROB.   66.09 PERCENT
   INT.18 =(  0.40+  0.60), CUM.FREQ.3489 CUM.PROB.   73.53 PERCENT
   INT.19 =(  0.60+  0.80), CUM.FREQ.3795 CUM.PROB.   79.98 PERCENT
   INT.20 =(  0.80+  1.00), CUM.FREQ.4053 CUM.PROB.   85.42 PERCENT
   INT.21 =(  1.00+  1.20), CUM.FREQ.4271 CUM.PROB.   90.01 PERCENT
   INT.22 =(  1.20+  1.40), CUM.FREQ.4430 CUM.PROB.   93.36 PERCENT
   INT.23 =(  1.40+  1.60), CUM.FREQ.4555 CUM.PROB.   96.00 PERCENT
   INT.24 =(  1.60+  1.80), CUM.FREQ.4637 CUM.PROB.   97.72 PERCENT
   INT.25 =(  1.80+  2.00), CUM.FREQ.4711 CUM.PROB.   99.28 PERCENT
   INT.26 =(  2.00+  2.20), CUM.FREQ.4738 CUM.PROB.   99.85 PERCENT
   INT.27 =(  2.20+  2.40), CUM.FREQ.4745 CUM.PROB.  100.00 PERCENT
   INT.28 =(  2.40+  2.60), CUM.FREQ.4745 CUM.PROB.  100.00 PERCENT
   INT.29 =(  2.60+  2.80), CUM.FREQ.4745 CUM.PROB.  100.00 PERCENT
   INT.30 =(  2.80+  3.00), CUM.FREQ.4745 CUM.PROB.  100.00 PERCENT

NISAN
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5. Conclusion

A new development of NISAN system is presented mainly in view of the functions of NISAN monitor, fully written by FORTRAN, and some of knowledge-commands newly-introduced, with ordinary method-commands sampled. The functions of monitor is for the benefit not only of the users, but also of the cooperation of NISAN research members. The functions of knowledge-commands are emphasized to be effective on statistical study and data analysis in practice for the senior statistician and the beginner, because of reasonable eveluation and preventing misapplication of statistical methods.

NISAN system is still developing into fullness on the ordinary usefulness and with the originality of statistical research.

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