

How to Use the Programs

Corresponding to the two models for binary items and items with more than two categories, two programs are prepared; EstDistriR2forBinaryMT_2 for binary items and EstDistriR2NCatGT2MT_2 for items with more than two categories. Each program can be opened by Visual Studio 2017, or its executable file (*.exe) can be run on a PC on which Visual Studio 2017 is installed.

The free version of Visual Studio 2017 (Visual Studio Community) is available at the Microsoft website

<https://www.visualstudio.com/downloads/download-visual-studio-vs>

and some information to use Visual Studio 2017 is available at website

http://y-okamoto-psy1949.la.coocan.jp/booksetc/introvcpp/On_vs2015/en/

This website explains some error messages, which can be ignored.

1. Program for Binary Items

Start the EstDistriR2forBinaryMT_2 program, then a form shown in Figure 1.1 will appear.

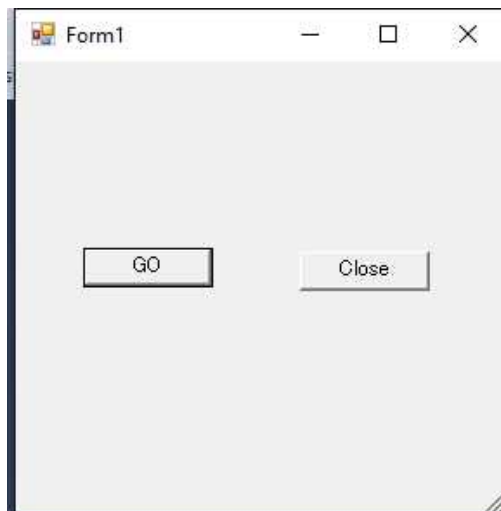


Figure 1.1

Click on the GO button, then the Input Data File dialogue window appears (Figure 1.2).

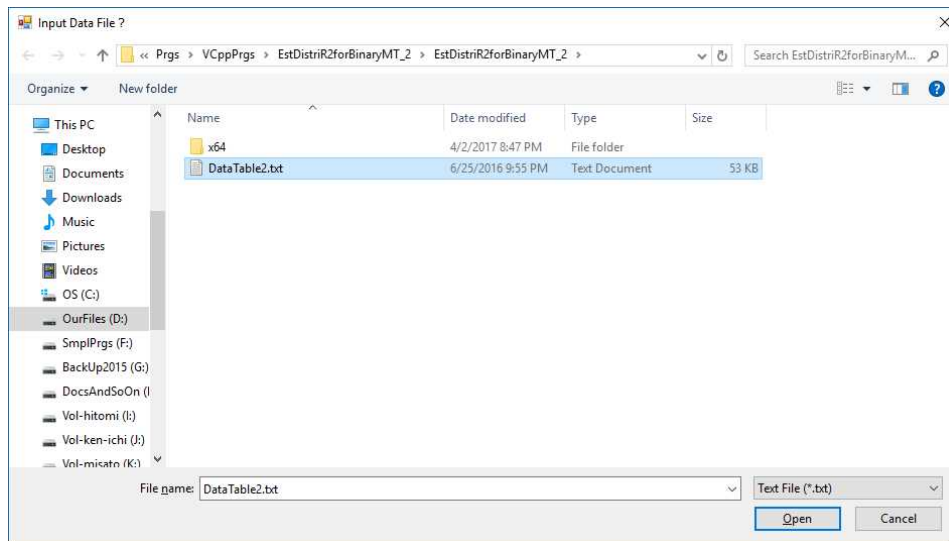


Figure 1.2

Set the input data file name. The format of the input data file is shown in Figures 1.3 and 1.4. The data file is composed of four parts, and each part begins with the line, which starts with slash / (See lines 15, 18, 22, and 25 in Figure 1.3).

```

1 m = 10 n = 500
2
3 mu Lmabda Psy
4 0.10000 0.60000 0.80000
5 0.10000 0.67500 0.73782
6 0.10000 0.75000 0.66144
7 0.10000 0.82500 0.56513
8 0.10000 0.90000 0.43589
9 -0.10000 0.60000 0.80000
10 -0.10000 0.67500 0.73782
11 -0.10000 0.75000 0.66144
12 -0.10000 0.82500 0.56513
13 -0.10000 0.90000 0.43589
14
15 /
16 2
17
18 /
19 10
20 ID Item-1 Item-2 Item-3 Item-4 Item-5 Item-6 Item-7 Item-8 Item-9 Item-10
21
22 /
23 1 1 1 1 1 1 1 1 1 1
24
25 /
26 1 1 2 2 1 1 2 2 1 1 1
27 2 1 2 1 1 1 1 1 1 2 1
28 3 2 2 1 1 1 2 2 1 1 1
29 4 1 1 1 1 1 1 1 1 1 1
30 5 2 2 2 2 2 2 2 2 2 2
31 6 1 1 1 1 1 1 1 2 1 1
32 7 2 1 1 1 1 1 1 1 1 1

```

Figure 1.3

The next line of the first line with slash / at the head (line 15) contains the number of categories (2 categories in Figure 1.3, Line 16). In the next line (Line 19) of the second line

with slash / at the head (Line 18), the number of categorical variables is written, 10 in Line 19. In the line after this line, variable names are written (Line 20). The first name is for the case identification variable, e.g. ID in Figure 1.3. The case identification variable has a string value. In Figure 1.3, as string values, strings of digits are used. After the name of the case identification variable, those of categorical variables are lined.

After the third line with slash / at the head (Line 22), integers 0 or 1 are lined (Line 23), each digit corresponds to categorical variables in the order. 1 means that the corresponding variable is included in the analysis, and 0 means that the corresponding variable is excluded from the analysis. In the case of Figure 1.3, all variables are included in the analysis (cf. Figure 2.3).

After the fourth line with slash / at the head (Line 25), responses by persons are written in the format, in which the first is the case identification value, and the second to the last ones are responses by the person, and they are put in one line (Lines 26 ~).

517	492	1	2	1	1	1	2	2	1	1	1
518	493	2	2	2	2	2	2	2	2	2	2
519	494	2	2	2	2	1	1	1	2	1	2
520	495	2	1	2	1	1	2	1	2	1	1
521	496	1	1	1	1	1	1	1	1	1	1
522	497	1	2	1	1	1	2	1	1	1	1
523	498	1	1	1	1	1	1	1	1	1	1
524	499	2	1	1	1	1	1	2	1	1	1
525	500	2	1	1	1	1	1	1	1	1	1
526	/										
527											
528											

Figure 1.4

After the last data (Line 525), a line with slash / at the head is put to indicate the end of the data.

Set the input data file name, then click on the Open button (Figure 1.2). The Input Data File dialogue window is closed. Then an Output File dialogue window appears (Figure 1.5).

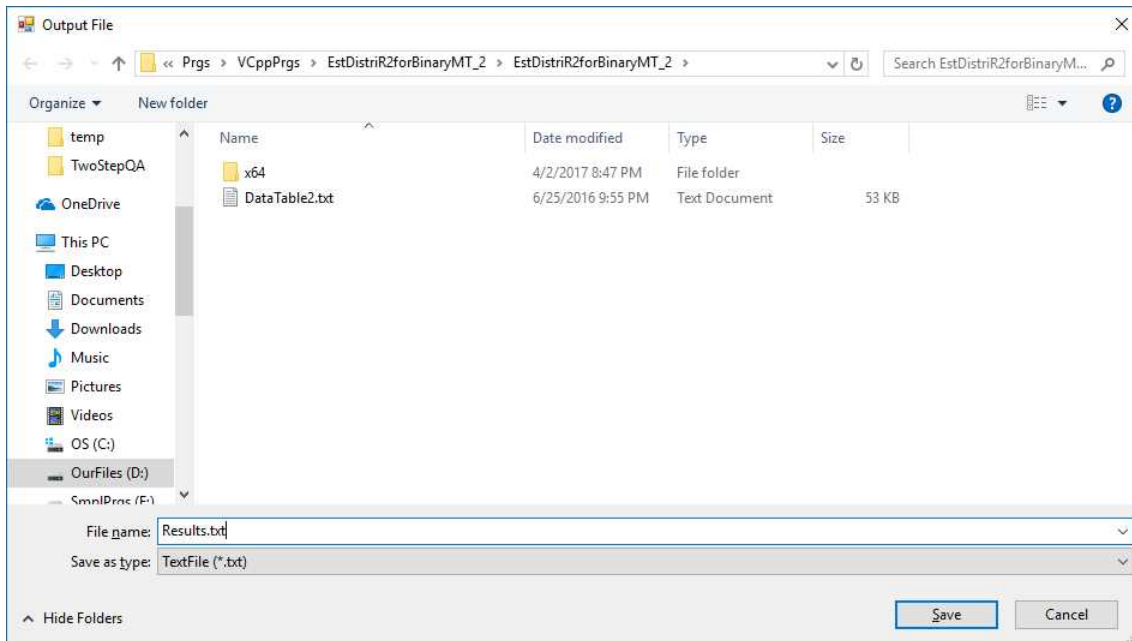


Figure 1.5

Results of analysis by the program will be written on this output text file. Set a text file name, then click on the Save button (Figure 1.5). The window is closed, then the adapting stage of MCMC will start. During executing a MCMC at an adapting stage, the DispMessage form appears, which shows information about adapting MCMC (Figure 1.6). J in “Adapting-J” indicates the sequential number of the adaptation, 0 showing that the stage is the first one. K in “Prev_n_adap_para = K” shows the number of parameters, which were adjusted in the previous stage, but is set at -1 for the first one.

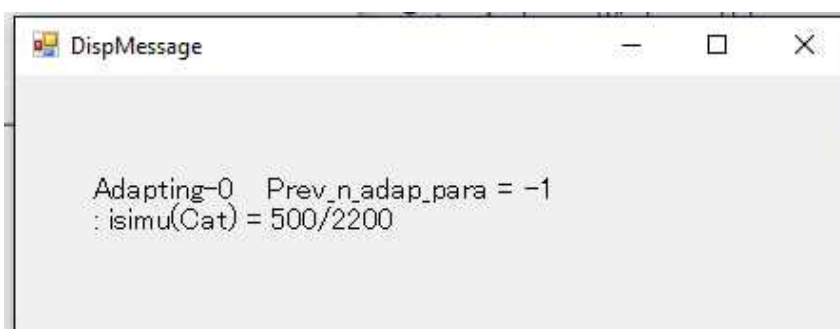


Figure 1.6

Figure 1.7 shows that it represents the adapting stage 2, and the number of parameters adjusted in the previous stage 1 is 97.

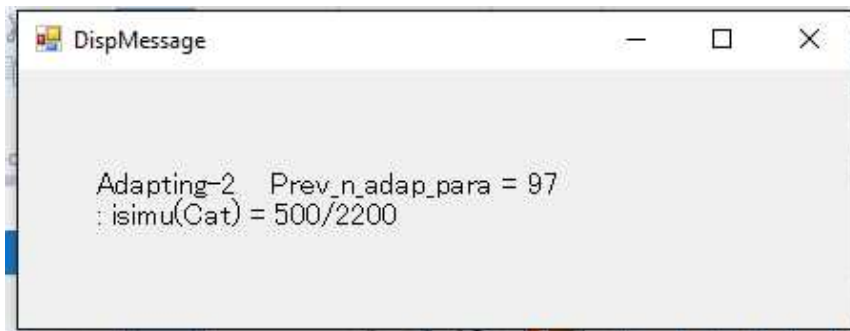


Figure 1.7

Adapting stages continue until the number of adjusted parameters becomes zero. After the adaptation, the main MCMCs will start (Figure 1.8).

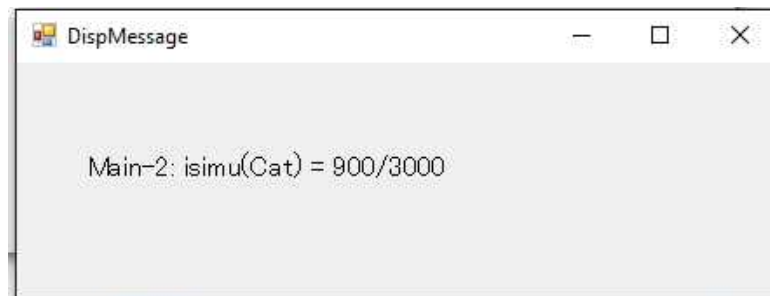


Figure 1.8

The main MCMCs are composed of four MCMCs, each of which is run by a thread independent of the others. After all of the threads for the main MCMCs are finished, the dialogue form shown in Figure 1.9 will appear.

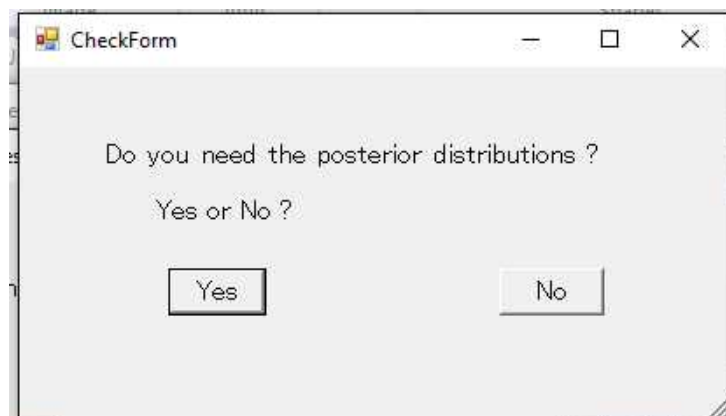


Figure 1.9

If you do not want estimates of the posterior distributions of reliability coefficients, click on

the No button. The program will end at this point. Otherwise, click on the Yes button to get estimates of the posterior distributions, then calculation of samples from the posterior distributions begins. The number of samples of sets of parameters from the posterior distributions are 1,000, and are divided into 8 subgroups. For each subgroup, a thread is created, and runs simultaneously with its associated form like that in Figure 1.10.



Figure 1.10

“1/125” in Figure 1.10 means that the 1st one from the 125 samples, which are assigned to this thread, is being calculated. After all eight threads finish their calculations, the form shown in Figure 1.11 will be shown.

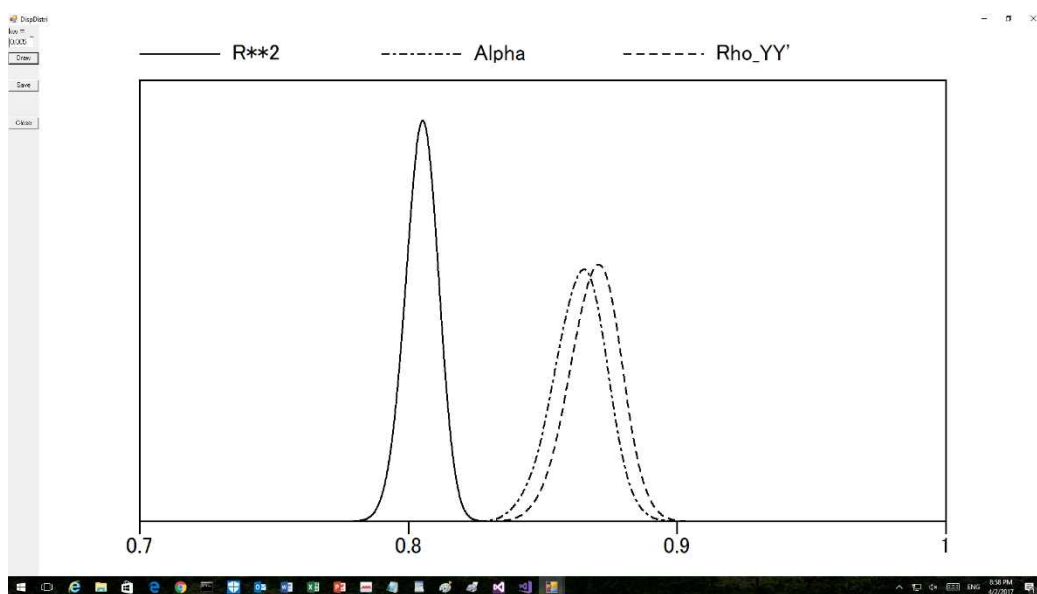


Figure 1.11

R^{**2} , Alpha, and Rho_YY' denote R^2 , α , and $\rho_{YY'}$, respectively. The upper left corner of the form is shown in Figure 1.12. “kw = 0.005” is the value used in kernel smoothing as the width parameter. A too small value produces a zigzag curve.

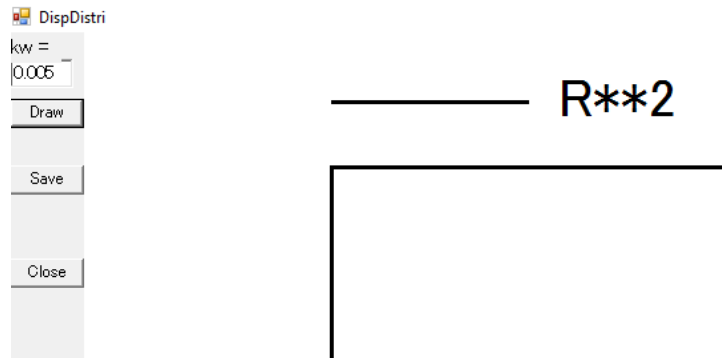


Figure 1.12

For example, set 0.0005 as the value (Figure 1.13).

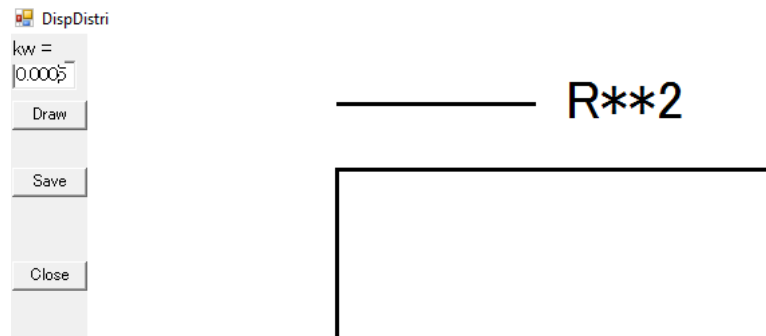


Figure 1.13

Then, click on the Draw button. The produced curves are not smooth (Figure 1.14).

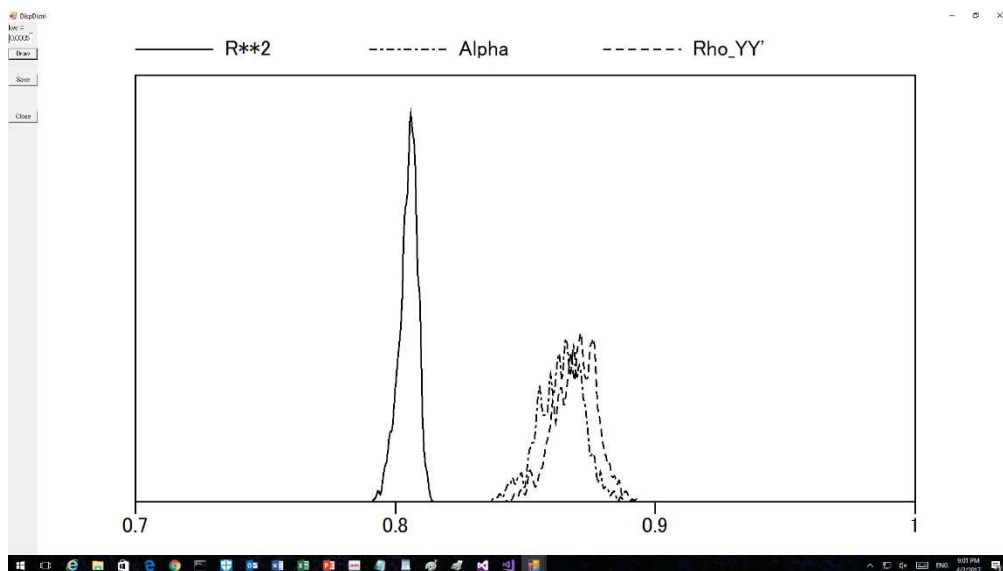


Figure 1.14

The picture displayed can be saved in a bitmap file. Click the Save button (Figure 1.12), then

the File name dialogue window will be presented (Figure 1.15).

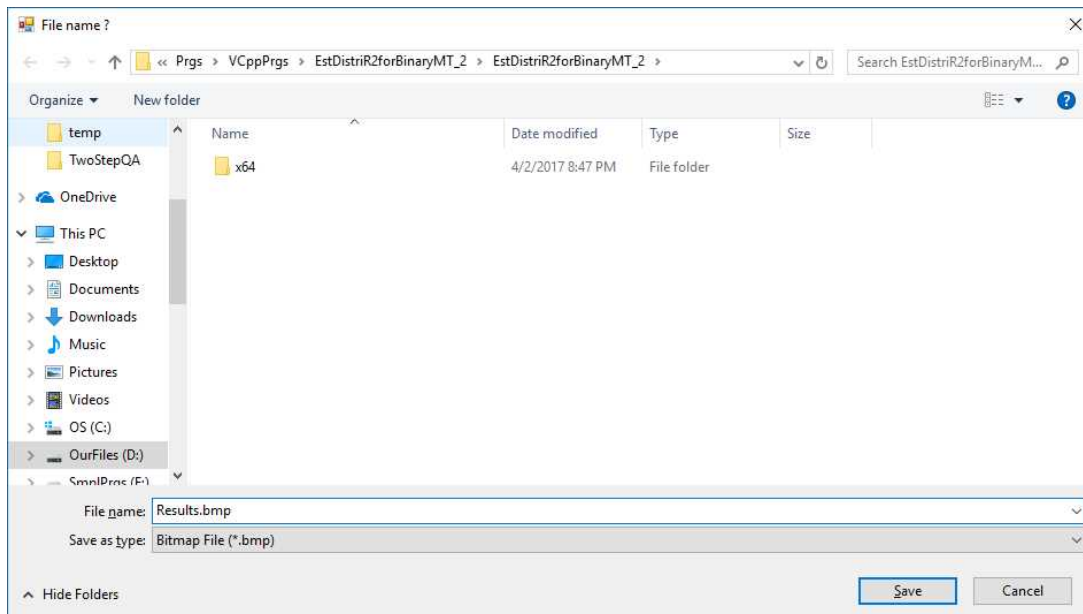


Figure 1.15

Set a name for the bitmap file, then click on the Save button (Figure 1.15). If the file is successfully saved, the MessageBox like that in Figure 1.16 will be shown.

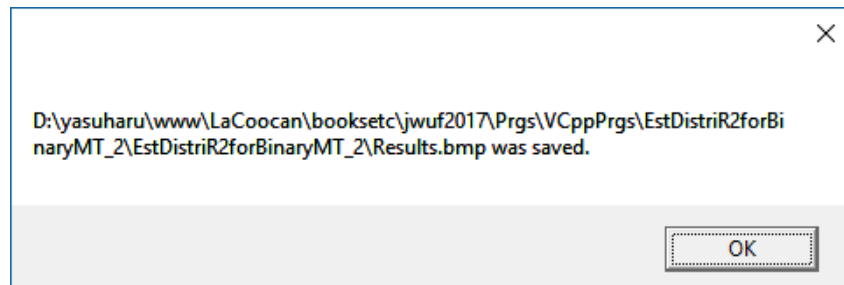


Figure 1.16

Click the OK button.

When the Close button is clicked (Figure 1.12), the MessageBox like that in Figure 1.17 will be presented, which says that the output file, whose name was set at the beginning of the execution of the program (Figure 1.5), was saved successfully.

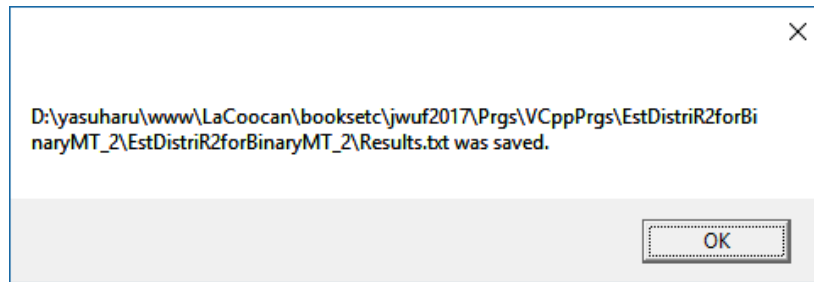


Figure 1.17

Click the OK button, then the box is closed and the program is finished.

Listing 1 shows the output file, whose name is shown in Figure 1.17.

Listing 1. Example of an output data file.

Input data

file...D:\yasuharu\www\LaCoocan\booksetc\jwuf2017\Prgs\VCppPrgs\EstDistriR2forBinaryMT_2\EstDistriR2forBinaryMT_2\DataTable2.txt

Number of categories = 2

Vars...

VarSelect...	Item-1	Item-2	Item-3	Item-4	Item-5	Item-6	Item-7	Item-8	Item-9	Item-10
--------------	--------	--------	--------	--------	--------	--------	--------	--------	--------	---------

Data (All)...	1	1	1	1	1	1	1	1	1	1
1:	1	2	2	1	1	2	2	1	1	1
2:	1	2	1	1	1	1	1	1	2	1
3:	2	2	1	1	1	2	2	1	1	1
4:	1	1	1	1	1	1	1	1	1	1
5:	2	2	2	2	2	2	2	2	2	2
6:	1	1	1	1	1	1	1	2	1	1
7:	2	1	1	1	1	1	1	1	1	1
8:	2	1	1	2	2	1	2	2	2	2
9:	2	2	2	2	2	2	2	1	2	2
10:	1	2	1	1	1	1	1	1	1	1
491:	1	1	2	1	1	1	2	2	1	1
492:	1	2	1	1	1	2	2	1	1	1
493:	2	2	2	2	2	2	2	2	2	2
494:	2	2	2	2	1	1	1	2	1	2
495:	2	1	2	1	1	2	1	2	1	1
496:	1	1	1	1	1	1	1	1	1	1
497:	1	2	1	1	1	2	1	1	1	1
498:	1	1	1	1	1	1	1	1	1	1
499:	2	1	1	1	1	1	2	1	1	1
500:	2	1	1	1	1	1	1	1	1	1

Data (Selected)...

1:	1	2	2	1	1	2	2	1	1	1
2:	1	2	1	1	1	1	1	1	2	1
3:	2	2	1	1	1	2	2	1	1	1
4:	1	1	1	1	1	1	1	1	1	1
5:	2	2	2	2	2	2	2	2	2	2
6:	1	1	1	1	1	1	1	2	1	1
7:	2	1	1	1	1	1	1	1	1	1
8:	2	1	1	2	2	1	2	2	2	2

9:	2	2	2	2	2	2	2	1	2	2
10:	1	2	1	1	1	1	1	1	1	1
491:	1	1	2	1	1	1	2	2	1	1
492:	1	2	1	1	1	2	2	1	1	1
493:	2	2	2	2	2	2	2	2	2	2
494:	2	2	2	2	1	1	1	2	1	2
495:	2	1	2	1	1	2	1	2	1	1
496:	1	1	1	1	1	1	1	1	1	1
497:	1	2	1	1	1	2	1	1	1	1
498:	1	1	1	1	1	1	1	1	1	1
499:	2	1	1	1	1	1	2	1	1	1
500:	2	1	1	1	1	1	1	1	1	1

alpha (sample) = 0.85933

The sample value of α

Adapting MCMC started: 4/2/2017 8:55:14 PM

The time at which the adapting stage started.

Main MCMC started: 4/2/2017 8:57:01 PM

The time at which the adapting stage ended, and the main MCMC started.

Main MCMC ended: 4/2/2017 8:57:36 PM

The time at which the main MCMC ended.

Item-1:	$\mu[0]/\psi[0] = 0.059$	$\Lambda[0]/\psi[0] = 0.806$
Item-2:	$\mu[1]/\psi[1] = 0.147$	$\Lambda[1]/\psi[1] = 1.112$
Item-3:	$\mu[2]/\psi[2] = 0.130$	$\Lambda[2]/\psi[2] = 1.092$
Item-4:	$\mu[3]/\psi[3] = 0.125$	$\Lambda[3]/\psi[3] = 1.363$
Item-5:	$\mu[4]/\psi[4] = 0.230$	$\Lambda[4]/\psi[4] = 3.273$
Item-6:	$\mu[5]/\psi[5] = -0.224$	$\Lambda[5]/\psi[5] = 0.886$
Item-7:	$\mu[6]/\psi[6] = -0.180$	$\Lambda[6]/\psi[6] = 0.721$
Item-8:	$\mu[7]/\psi[7] = -0.172$	$\Lambda[7]/\psi[7] = 1.018$
Item-9:	$\mu[8]/\psi[8] = -0.197$	$\Lambda[8]/\psi[8] = 1.589$
Item-10:	$\mu[9]/\psi[9] = -0.449$	$\Lambda[9]/\psi[9] = 2.212$

Point estimates of μ_j/ψ_j s and λ_j/ψ_j s.

Rho_YY = 0.87094
alpha (param) = 0.86561
R**2 = 0.80624

Point estimates of $\rho_{YY'}$, α , and R^2 calculated from the point estimates of the parameters.

Estimation of the posterior distributions started: 4/2/2017 8:57:43 PM

The time at which calculation of the posterior distributions started.

The 95% central posterior interval for Rho_YY = [0.85178, 0.88443] Median = 0.87000
The 95% central posterior interval for alpha = [0.84515, 0.87915] Median = 0.86442
The 95% central posterior interval for R**2 = [0.79674, 0.81069] Median = 0.80544

95% CIs and medians of the posterior distributions.

Estimation of the posterior distributions ended: 4/2/2017 8:58:19 PM

The time at which calculation of the posterior distributions ended.

kw = 0.005
Mode for Rho_YY = 0.87070
Mode for alpha = 0.86530
Mode for R**2 = 0.80530

Modes derived from the curves estimated by kernel smoothing with width parameter kw = 0.005.

kw = 0.0005
Mode for Rho_YY = 0.87130
Mode for alpha = 0.86560
Mode for R**2 = 0.80590

Modes derived from the curves estimated by kernel smoothing with width parameter kw = 0.0005.

kw = 0.005
Mode for Rho_YY = 0.87070
Mode for alpha = 0.86530
Mode for Rho_c = 0.80530

Modes derived from the curves estimated by kernel smoothing with width parameter kw = 0.005.

2. Program for items with more than two categories

Start the EstDistriR2NCatGT2MT_2 program, then a form shown in Figure 2.1 will appear.

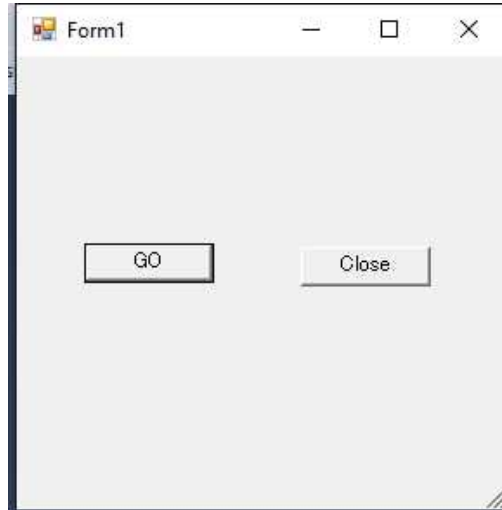


Figure 2.1

Click on the GO button, then the Input Data File dialogue window appears (Figure 2.2).

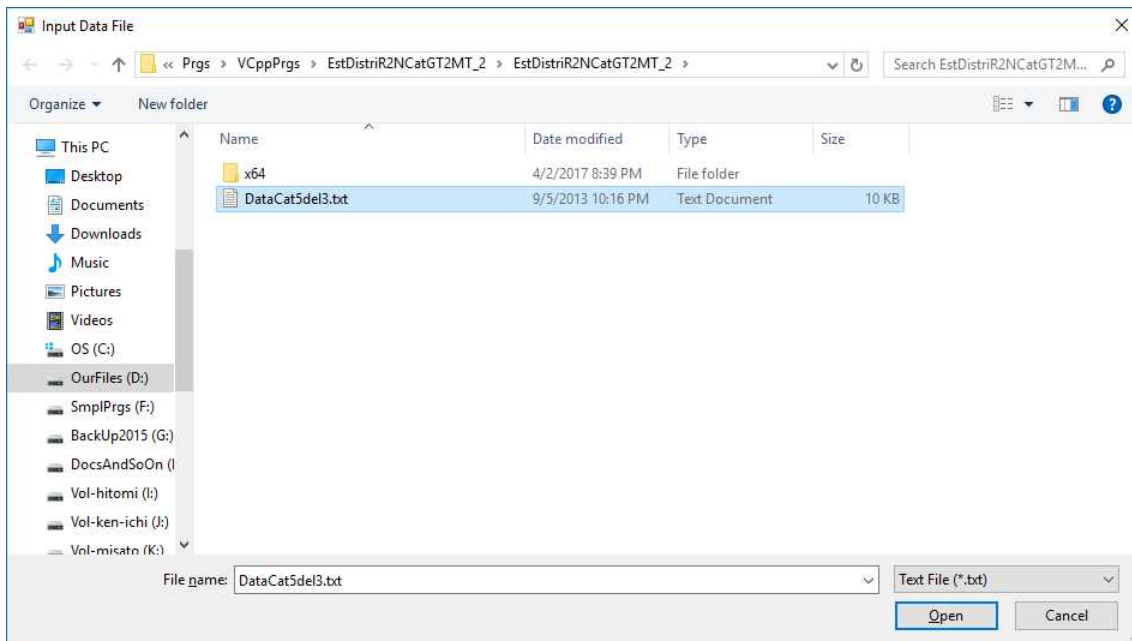


Figure 2.2

Set the input data file name. The format of the input data file is shown in Figures 2.3 and 2.4. The data file is composed of four parts, and each part begins with the line, which starts with

slash / (See lines 2, 5, 9, and 12 in Figure 2.3).

```

1
2 /
3 5
4 /
5 /
6 5
7 ID Item-1 Item-2 Item-3 Item-4 Item-5
8 /
9 /
10 1 1 0 1 1
11 /
12 /
13 1 2 3 3 2 2
14 2 5 2 5 5 4
15 3 3 1 1 1 1
16 4 1 2 1 1 4
17 5 3 2 1 5 4

```

Figure 2.3

The next line of the first line with slash / at the head (line 2) contains the number of categories (5 categories in Figure 2.3, Line 3). In the next line (Line 6) of the second line with slash / at the head (Line 5), the number of categorical variables is written, 5 in Line 6. In the line after this line, variable names are written (Line 7). The first name is for the case identification variable, e.g. ID in Figure 2.3. The case identification variable has a string value. In Figure 2.3, as string values, strings of digits are used. After the name of the case identification variable, those of categorical variables are lined.

After the third line with slash / at the head (Line 9), integers 0 or 1 are lined (Line 10), each digit corresponds to categorical variables in the order. 1 means that the corresponding variable is included in the analysis, and 0 means that the corresponding variable is excluded from the analysis. In the case of Figure 2.3, Item-1, Item-2, Item-4, and Item-5 are included in the analysis. Item-3 is excluded from the analysis.

After the fourth line with slash / at the head (Line 12), responses by persons are written in the format, in that the first is the case identification value, and the second to the last one are responses by the person, and they are put in one line (Lines 13 ~).

DataCat5del3.txt		Form1.h	Form1.h [Design]	DataNCat6GradLmbd_1.txt		
198	186	1	4	1	3	2
199	187	3	1	1	1	2
200	188	2	3	3	1	3
201	189	4	3	4	2	4
202	190	4	4	5	4	5
203	191	2	4	4	2	5
204	192	5	2	3	5	4
205	193	2	1	2	2	1
206	194	2	2	4	5	3
207	195	4	3	3	4	4
208	196	4	4	3	3	5
209	197	3	3	3	4	5
210	198	3	2	1	2	2
211	199	1	4	4	2	4
212	200	4	3	2	2	5
213	/					
214						

Figure 2.4

After the last data (Line 212), a line with slash / at the head is put to indicate the end of the data.

Set the input data file name, then click on the Open button (Figure 2.2). The Input Data File dialogue window is closed, then an Output File dialogue window appears (Figure 2.5).

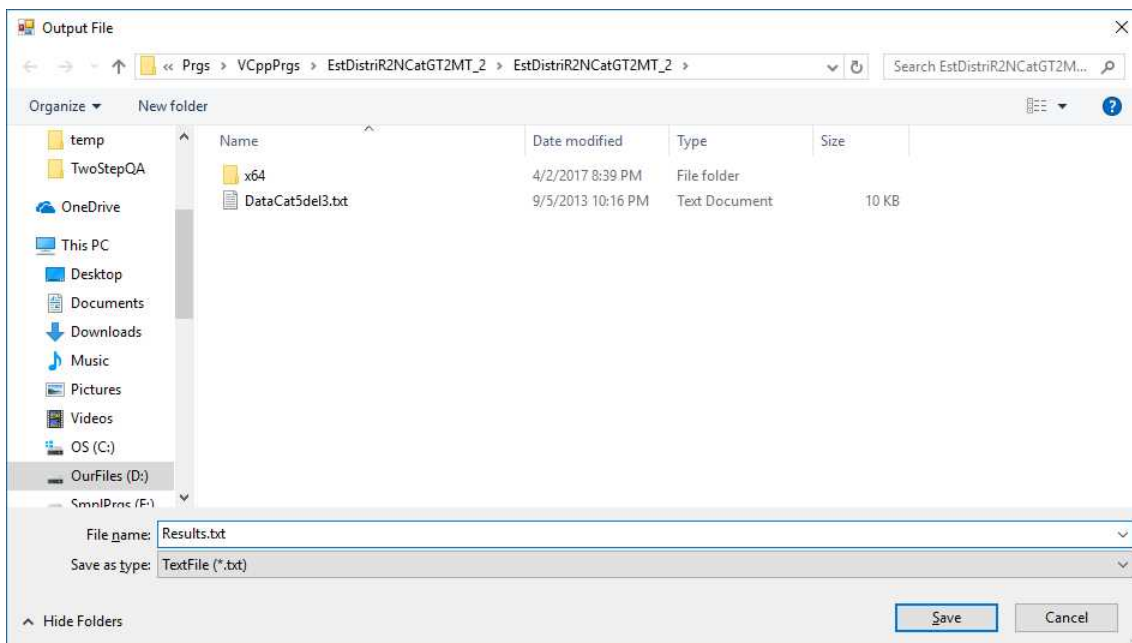


Figure 2.5

Results of analysis by the program will be written on this output text file. Set a text file name, then click on the Save button (Figure 2.5). The adapting stage of MCMC will start.

During executing an MCMC for the adapting stage, the DispMessage form appears, which shows information about adapting MCMC (Figure 2.6). J in “Adapting-J” indicates the sequential number of the adaptation, 0 showing that the stage is the first one. K in “Prev_n_adap_para = K” shows the number of parameters, which were adjusted in the previous stage, but is set at -1 for the first one.

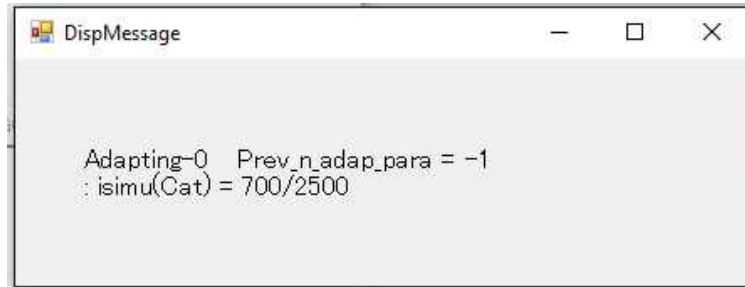


Figure 2.6

Figure 2.7 shows that it represents the adapting stage 2, and the number of parameters adjusted in the previous stage 1 is 12

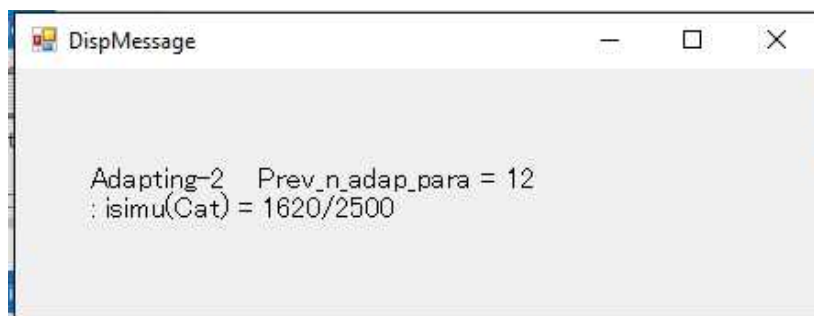


Figure 2.7

Adapting stages continue until the number of adjusted parameters becomes zero. After the adaptation, the main MCMCs will start (Figure 2.8).

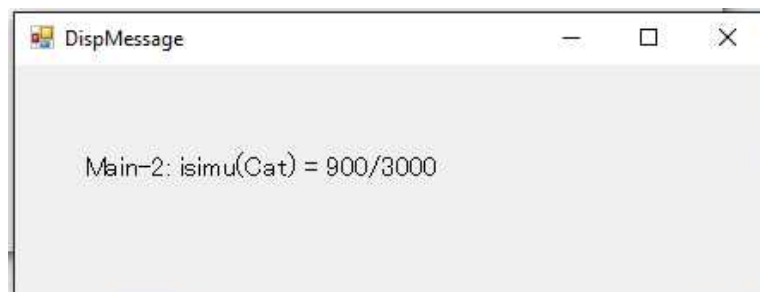


Figure 2.8

The main MCMCs are composed of four MCMCs, each of which is run by a thread

independent of the others. After all of the threads for the main MCMCs are finished, the dialogue form shown in Figure 2.9 will appear.

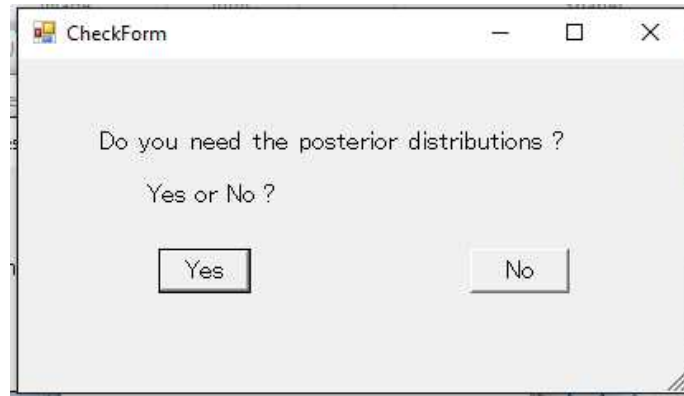


Figure 2.9

If you do not want estimates of the posterior distributions of reliability coefficients, click on the No button. The program will end at this point. Otherwise, click on the Yes button to get estimates of the posterior distributions, then calculation of samples from the posterior distributions begins. The number of samples of sets of parameters from the posterior distributions are 1,000, and are divided into 8 subgroups. For each subgroup, a thread is created, and runs simultaneously with its associated form like that in Figure 2.10.

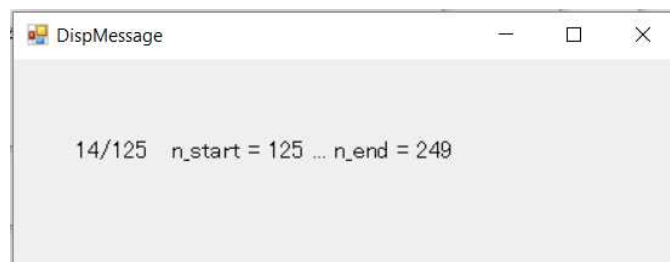


Figure 2.10

"14/125" in Figure 2.10 means that the 14th one from the 125 samples, which are assigned to this thread, is being calculated. After all eight threads finish their calculations, the form shown in Figure 2.11 will be shown.

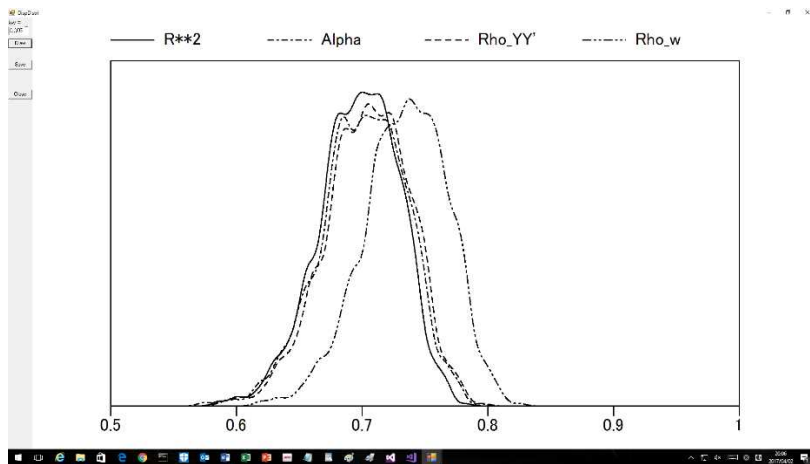


Figure 2.11

R^{**2} , Alpha, $Rho_{YY'}$, and Rho_w denote R^2 , α , $\rho_{YY'}$, and ρ_w respectively. The upper left corner of the form is shown in Figure 2.12. “kw = 0.005” is the value used in kernel smoothing as the width parameter. A too small value produces zigzag curves.

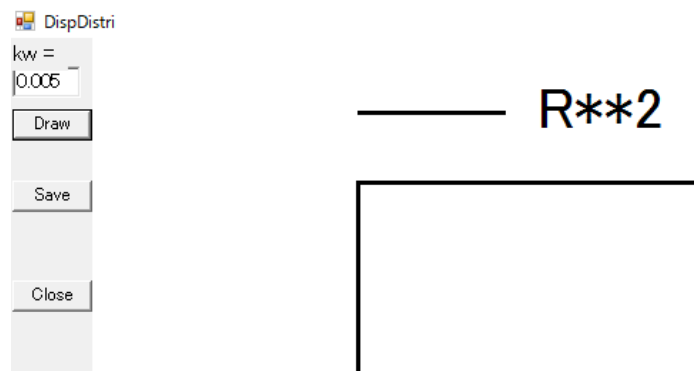


Figure 2.12

For example, as the value, set 0.01 larger than 0.005 (Figure 2.13) to make the curves smoother.

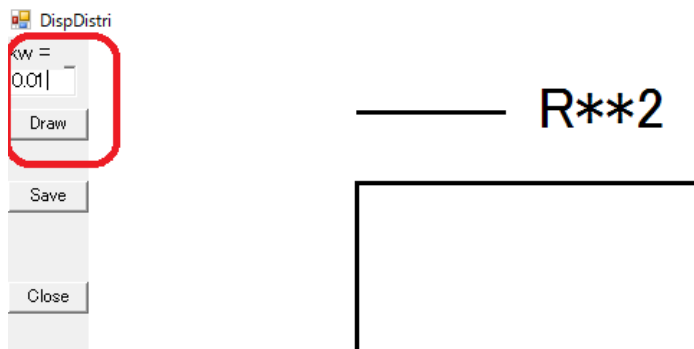


Figure 2.13

Then, click on the Draw button. Smooth curves are obtained (Figure 2.14).

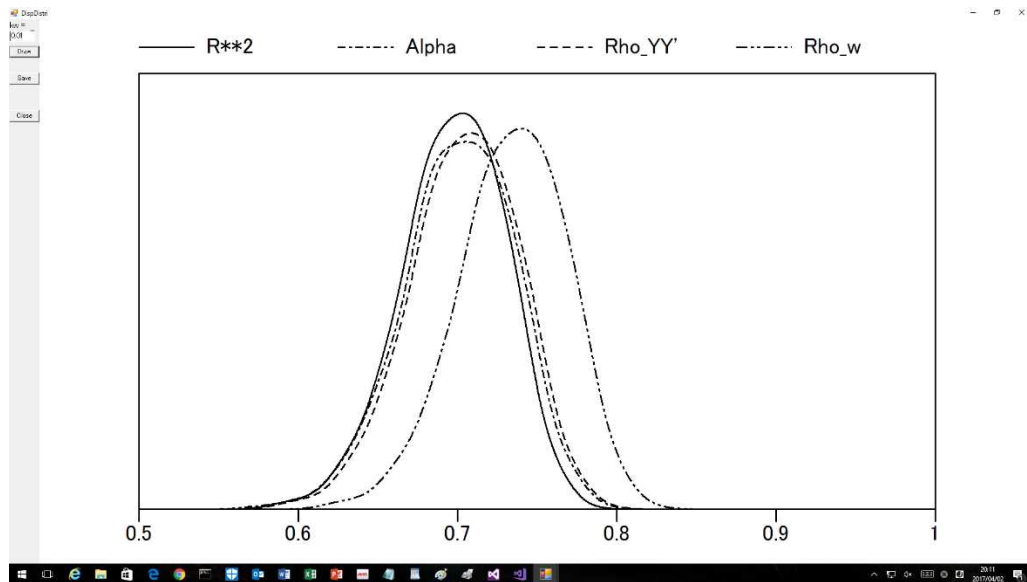


Figure 2.14

The picture displayed can be saved in a bitmap file. Click the Save button (Figure 2.12), then the File name dialogue window will be presented (Figure 2.15).

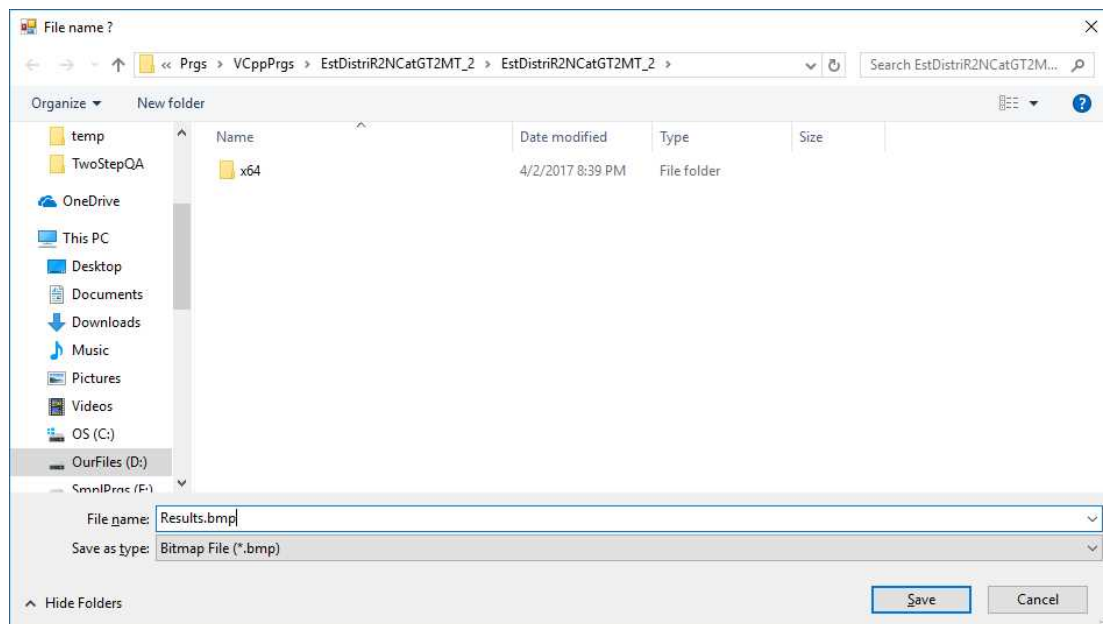


Figure 2.15

Set a name for the bitmap file, then click on the Save button (Figure 2.15). If the file is successfully saved, the MessageBox like that in Figure 2.16 will be shown.

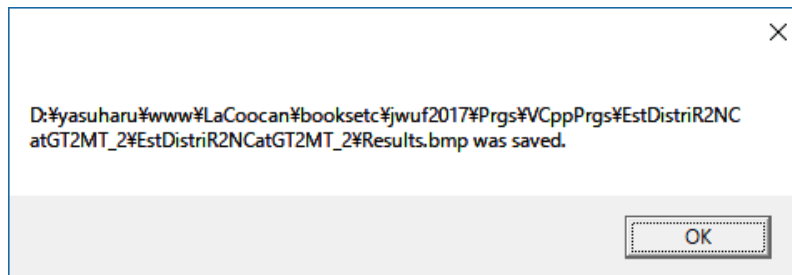


Figure 2.16

Click the OK button. If the Close button is clicked (Figure 2.12), the MessageBox like that in Figure 2.17 will be presented, which says that the output file, whose name was set at the beginning the execution of the program (Figure 2.5), was saved successfully.

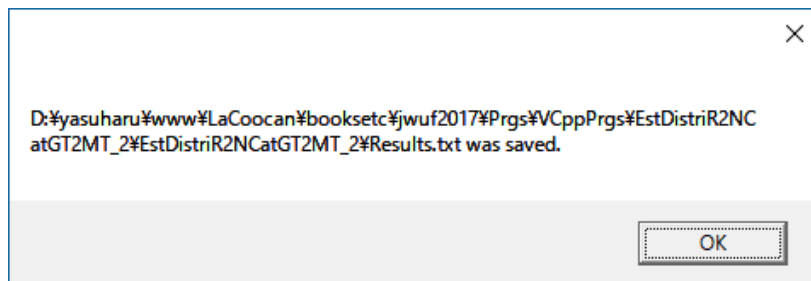


Figure 2.17

Click the OK button, then the box is closed and the program is finished.

Listing 2 shows the output file, whose name is shown in Figure 2.17.

Listing 2. Example of an output data file.

Input data
file. . . D:\yasuharu\www\LaCoocan\booksetc\jwuf2017\Prgs\VCppPrgs\EstDistriR2NCatGT2MT_2\EstDistriR2NCatGT2MT_2\DataCat5del3.txt

Number of categories = 5

Vars. . .

	Item-1	Item-2	Item-3	Item-4	Item-5
--	--------	--------	--------	--------	--------

VarSelect. . .

	1	1	0	1	1
--	---	---	---	---	---

Data (All) . . .

1:	2	3	3	2	2
2:	5	2	5	5	4
3:	3	1	1	1	1
4:	1	2	1	1	4
5:	3	2	1	5	4
6:	1	3	2	3	3

7:	4	3	1	2	4
8:	3	4	2	3	1
9:	4	2	2	1	3
10:	3	5	3	4	5
191:	2	4	4	2	5
192:	5	2	3	5	4
193:	2	1	2	2	1
194:	2	2	4	5	3
195:	4	3	3	4	4
196:	4	4	3	3	5
197:	3	3	3	4	5
198:	3	2	1	2	2
199:	1	4	4	2	4
200:	4	3	2	2	5

Data (Selected)...

1:	2	3	2	2
2:	5	2	5	4
3:	3	1	1	1
4:	1	2	1	4
5:	3	2	5	4
6:	1	3	3	3
7:	4	3	2	4
8:	3	4	3	1
9:	4	2	1	3
10:	3	5	4	5
191:	2	4	2	5
192:	5	2	5	4
193:	2	1	2	1
194:	2	2	5	3
195:	4	3	4	4
196:	4	4	3	5
197:	3	3	4	5
198:	3	2	2	2
199:	1	4	2	4
200:	4	3	2	5

alpha (sample) = 0.71231

The sample value of α

NSimuncmc/Adaptive = 2500

Adapting MCMC started: 2017/04/02 20:03:18

The time at which the adapting stage started.

Main MCMC started: 2017/04/02 20:04:25

The time at which the adapting stage ended, and the main MCMC started.

Main MCMC ended: 2017/04/02 20:04:42

The time at which the main MCMC ended.

Item-1:	mu[0] = 0.048	Lambda[0] = 0.706	SgmE[0] = 0.738
Item-2:	mu[1] = -0.049	Lambda[1] = 0.604	SgmE[1] = 0.765
Item-4:	mu[2] = -0.016	Lambda[2] = 0.671	SgmE[2] = 0.756

Point estimates of $\mu_j S$, $\lambda_j S$, and $\psi_j S$.

Item-5: mu[3] = -0.011 Lambda[3] = 0.620 SgmE[3] = 0.818

CBndry[0] = -1.00000
 CBndry[1] = -0.32775
 CBndry[2] = 0.32125
 CBndry[3] = 1.00000

Point estimates of C_k s.

Rho_w = 0.74054
 Rho_YY = 0.71087
 alpha (param) = 0.71003
 R**2 = 0.70449

Point estimates of ρ_ω , $\rho_{YY'}$, α , and R^2 calculated from the point estimates of the parameters.

Estimation of the posterior distributions started: 2017/04/02 20:04:46

The time at which calculation of the posterior distributions started.

The 95% central posterior interval for Rho_w = [0.66437, 0.79416] Median = 0.73591
 The 95% central posterior interval for Rho_YY = [0.63363, 0.76583] Median = 0.70562
 The 95% central posterior interval for alpha = [0.63124, 0.76463] Median = 0.70245
 The 95% central posterior interval for R**2 = [0.63009, 0.75478] Median = 0.69894

95% CIs and medians of the posterior distributions.

Estimation of the posterior distributions ended: 2017/04/02 20:05:38

The time at which calculation of the posterior distributions ended.

kw = 0.005
 Mode for Rho_w = 0.73750
 Mode for Rho_YY = 0.70550
 Mode for alpha = 0.70350
 Mode for R**2 = 0.70050

Modes derived from the curves estimated by kernel smoothing with width kw = 0.005.

kw = 0.01
 Mode for Rho_w = 0.73950
 Mode for Rho_YY = 0.70850
 Mode for alpha = 0.70550
 Mode for R**2 = 0.70350

Modes derived from the curves estimated by kernel smoothing with width kw = 0.01.