

# STRAT

**A Program for Analyzing Statistical Strategic Models**

**Version 1.4**

**Curtis S. Signorino**  
Department of Political Science  
University of Rochester

© Copyright, 2001–2003, Curtis S. Signorino  
All rights reserved

Email: [sign@troi.cc.rochester.edu](mailto:sign@troi.cc.rochester.edu)  
Please check the following web site for updates:  
<http://www.rochester.edu/college/psc/signorino>

# Contents

<b>1</b>	<b>OVERVIEW</b>	<b>2</b>
<b>2</b>	<b>DATA</b>	<b>2</b>
2.1	IMPORT . . . . .	2
2.2	CREATE . . . . .	2
2.3	RECODE . . . . .	3
<b>3</b>	<b>DESCRIPT</b>	<b>4</b>
3.1	STATS . . . . .	4
3.2	SERIES . . . . .	4
3.3	SCATTER . . . . .	4
3.4	HISTOGRM . . . . .	4
3.5	DENSITY . . . . .	4
<b>4</b>	<b>MODEL</b>	<b>5</b>
4.1	UNCERTNT . . . . .	5
4.2	MODEL 1-2 . . . . .	5
4.3	MODEL 1-2-2 . . . . .	7
4.4	MODEL 1-2-1 . . . . .	7
4.5	MODEL 1-2-3 . . . . .	8
4.6	MODEL 1-2-1-2 . . . . .	8
4.7	MODEL 1-2-2-1 . . . . .	9
4.8	MODEL 1-2-2-3-3 . . . . .	10
4.9	RE-RUN . . . . .	10
<b>5</b>	<b>INTERPRET</b>	<b>10</b>
5.1	PROB . . . . .	10
5.2	PLOTFIT . . . . .	10
5.3	FITVAL . . . . .	11
5.4	1STDIFF . . . . .	11
5.5	%CORRECT . . . . .	12
<b>6</b>	<b>UTILITIES</b>	<b>12</b>
6.1	SYSINFO . . . . .	12
6.2	OUTPUT . . . . .	12
6.3	STVAL . . . . .	13
6.4	FORMAT . . . . .	13
6.5	HEADER . . . . .	13
6.6	RESET . . . . .	13
<b>7</b>	<b>MISC</b>	<b>13</b>
7.1	DOS . . . . .	13
7.2	HELP . . . . .	13
7.3	BIBLIO . . . . .	13
7.4	ABOUT . . . . .	14
<b>8</b>	<b>NOTES ON CONVERGENCE</b>	<b>14</b>

# 1 OVERVIEW

The core of STRAT's instructions are in the DATA, DESCRIPT, MODEL, and INTERPRET menu columns. The ordering of these options reflects the general flow of a typical analysis with STRAT. You are required first to import or create a data set (DATA column). If you would like to examine descriptive statistics or plots of the data, you may do so using the various options in the DESCRIPT column. To specify and estimate a strategic model, you then select options in the MODEL column — first choosing a form of uncertainty (UNCERTNT) and then choosing the strategic model you would like to estimate (see models 1-2 through 1-2-2-1 below). When a model has been estimated, you are presented with the parameter estimates and likelihood value. You may then also interpret the results of your estimated model more using options in the INTERPRET column. To do so, you first select the action or outcome probability of interest in the model (PROB), and then calculate fitted values (FITVAL) or plot that probability as a function of one of the regressors (PLOTFIT). Finally, the percent correctly predicted (%CORRECT) is provided for assessing model fit.

## 2 DATA

Before running any model, a dataset has to be specified. STRAT requires that all your independent and dependent variables be in a single Gauss format dataset. This dataset can either be imported or created.

### 2.1 IMPORT

If your data are already in Gauss format, you may use it by choosing the IMPORT option from the main menu. After selecting IMPORT, STRAT will display all \*.dat files in the current directory. To select a file, use the arrow keys to move to the file and then press <ENTER>. To change directories, press “D” (or “d”) and specify the name of the directory when prompted. If there are no Gauss data files in that directory, STRAT will print an error message at the bottom of the screen and will return to the previous directory. To quit without selecting a dataset, simply press “Q” (or “q”).

### 2.2 CREATE

If your data are not in a Gauss dataset, STRAT will create one from an ASCII dataset you provide. [You can tell if you have data in an ASCII file by typing it to the screen from DOS (type filename.asc); if the file is readable, then it is probably in ASCII. A sample ASCII dataset with six variables is included on the program disk; it is called sample.asc.] The ASCII data file must conform to the following:

- Your ASCII file must have the extension “.ASC” (for example, wardata.asc, sample.asc, etc).
- The columns in this ASCII dataset must be variables, and rows must be observations.
- All columns (and numbers) must have blanks between them.
- Zeros must be written out as 0 or 0.00 and not left blank.
- Rows may be greater than 80 columns, and each observation may take up more than a single row in the data matrix (as long as each observation has the same number of elements).

- All data must be numbers; letters and most special symbols are not permitted.
- Each missing value, if any, must appear as a period (“ . ”) with blanks on either side (the program uses listwise deletion prior to each run).
- You may have up to 8190 variables and any number of observations.

To translate an ASCII file to a Gauss dataset, choose the CREATE option from the main menu. STRAT will display all the \*.asc files in the current directory. To select an ASCII data file, use the arrow keys to move to the file and then press <ENTER>. To change directories, press “D” (or “d”) and specify the name of the directory when prompted. If there are no \*.asc data files in that directory, STRAT will print an error message at the bottom of the screen and will return to the previous directory. To quit without selecting an ASCII dataset, simply press “Q” (or “q”).

Once you have selected an ASCII dataset, STRAT will print a warning that the Gauss header and data files will be saved with the same filename prefix as the \*.asc file you selected. You will then be prompted for the variable names corresponding to the columns in your dataset. If you already have header and data files with that prefix and don’t want them overwritten or if you simply want to exit, press <ENTER> and you will be returned to the main menu. (If you want, you can then escape to DOS, rename the ASCII file, and then select CREATE to translate the renamed ASCII file to Gauss format.) If you do not have header and data files with the same prefix or if you don’t care if they are overwritten, enter the variable names corresponding to the columns in your dataset. Press <ENTER> twice when you are finished.

If Gauss was able to translate the ASCII dataset successfully, a message will be printed to that effect, along with the names of the header and data files. Gauss data files come in pairs, \*.DAT files contain the data and \*.DHT files contain the “header“ information, including variable names and locations (both in non-readable, binary format).

Note: It is possible to enter the wrong number of variables and still have Gauss create a dataset without flagging an error. Therefore, you should check to make sure your data has been transferred properly into Gauss format. An easy way of doing this is to calculate descriptive statistics (menu item STATS) and verify that the number of observations for each variable is correct. If they are not correct, re-CREATE the dataset and make sure you’ve entered a variable name for each column in your dataset. If that does not work, check your dataset for missing entries (which are different from missing values [see the above format requirements for missing values notation]).

If you successfully create a Gauss data file during one use of STRAT, you may import the same file the next time using IMPORT. That way, you only need to specify all the variable names and columns once.

## 2.3 RECODE

The RECODE option allows you to recode a variable into a new variable in the current dataset. After you choose RECODE, STRAT will display all the variables in the dataset. You can use the arrow keys to move the “>” sign to the name of the variable that you want to recode. Press <ENTER> to select that variable. However, if that variable has more than 20 unique values, (which normally means that variable is continuous), STRAT will take you back to the “Select one variable:” menu and let you choose another variable. Next, STRAT will ask for a name of the new variable that you want to recode into. The name of the new variable has to be different from that of any existing variable in the dataset, otherwise STRAT will ask for a name again. Type in a name for the new variable and then press <ENTER>. If you want to quit and return to the main menu, just press <ENTER>. After you enter a valid new variable name, STRAT will let you input

a new value for each of the unique values in the variable that you want to recode from. If you want to retain the old value, just press <ENTER>. If you want to quit and return to the main menu, type in “q” or “Q” and then press <ENTER>. After you enter all the new values, STRAT will recode the old variable into a new variable and append that variable at the end of the dataset you are using. You can view the descriptive statistics of that new variable, together with all the other variables, through the STATS option in the DESCRPT menu group.

### **3 DESCRIPT**

The DESCRIPT menu options provides general descriptive statistics and use Gauss’ publication-quality graphics routines to generate various plots of the data for the currently active dataset.

#### **3.1 STATS**

The STATS option provides general descriptive statistics for the currently active dataset, including the number of observations, variable names, minimums, means, medians, maximums, variances, and the number of missing values.

#### **3.2 SERIES**

Produces a series (or time series) plot of a user-selected variable. Two options are available: AUTO or SPECIFY. In AUTO, only the Y-axis variable is input by the user — STRAT automatically provides a sequence along the X-axis. In SPECIFY, you are prompted for both the Y-axis variable and for a variable denoting the sequence or series (such as a sequence of years). In both, use the arrow keys to move the “>” sign in front of a variable name and press <ENTER> to select that variable. In SPECIFY, STRAT tests whether the X-axis sequence variable is in fact an increasing sequence of numbers. If it is not, the user must select another variable.

#### **3.3 SCATTER**

Produces a scatter plot of X and Y data. You will be prompted for the X and Y variables. For both, use the arrow keys to move the “>” sign in front of a variable name and press <ENTER> to select that variable. After inputting the Y-axis variable, the scatter plot is produced.

#### **3.4 HISTOGRM**

Produces a histogram or density plot of a variable’s data. After selecting HISTOGRM, use the arrow keys to move to a variable and then press <ENTER> to select that variable. After inputting the variable, STRAT tests whether the variable data contains only integer values. If it does, a histogram is plotted; otherwise, a density plot is made.

#### **3.5 DENSITY**

Produces a density plot of a variable’s data. After selecting DENSITY, use the arrow keys to move to a variable and then press <ENTER> to select that variable. After inputting the variable, a density plot is made.

## 4 MODEL

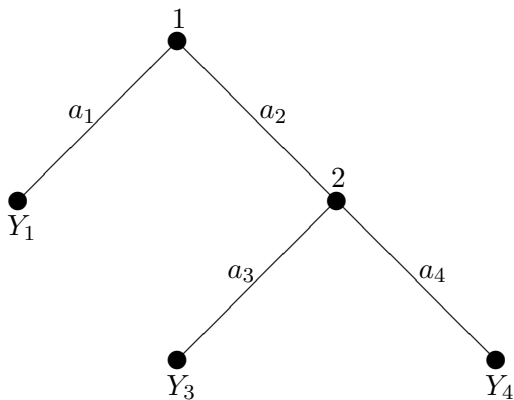
Assuming you have chosen a dataset, you can choose from this set of commands the appropriate model to run. Note that before running a model, you need to specify the source of uncertainty first, using UNCERTNT command.

### 4.1 UNCERTNT

UNCERTNT provides you with two options: Agent Error and Private Information. These are the two source of uncertainty. Agent Error assumes the uncertainty enters through the player's action at information sets; Private Information assumes the uncertainty is in the player's outcome payoffs. Before running a model, you need to make a choice here, depending on your belief about the source of uncertainty in your data.

### 4.2 MODEL 1-2

The following is a simple graphical depiction of MODEL 1-2:



Model 1-2 has two players and each player has two options. Player 1 makes the first move. Player 1 must choose between actions  $a_1$  and  $a_2$ . If  $a_1$  is chosen, then the outcome is  $Y_1$ . If  $a_2$  is selected, then player 2 must choose between actions  $a_3$  and  $a_4$ , leading to outcomes  $Y_3$  and  $Y_4$ , respectively. If player 1 chooses action 2, then player 2 chooses between actions 3 and 4. This interaction produces three outcomes:  $Y_1$ ,  $Y_3$  and  $Y_4$ .

Depending on the data available, users can choose between two types of Dependent variables:

- (1) The dependent variable represents outcomes:  $Y_1$ ,  $Y_3$ ,  $Y_4$ .
- (2) The dependent variable represents actions:  $a_1$ ,  $a_2$ .

The data for each of these should be coded as above — e.g., outcomes  $Y_1$ ,  $Y_3$ , and  $Y_4$  should be coded in the data set as 1, 3, 4, respectively. Similarly data for the actions  $a_1$  and  $a_2$  should be coded as 1 and 2, respectively.

When choosing dependent variables, use the arrow keys to move to that variable and press <ENTER>.

For model 1-2, there are five utilities for which regressors can be specified:

$U_1(Y_1)$  player 1's utility for outcome  $Y_1$ ;

$U_1(Y_3)$  player 1's utility for outcome  $Y_3$ ;

$U_1(Y_4)$  player 1's utility for outcome  $Y_4$ ;

$U_2(Y_3)$  player 2's utility for outcome  $Y_3$ ;

$U_2(Y_4)$  player 2's utility for outcome  $Y_4$ .

When choosing the independent variables, use the arrow keys to move to that variable and press <SPACE> to mark the variable with an asterisk (\*). When all of the variables have been marked for a given utility, press <ENTER> to move to the next utility specification. When all of the utilities have been specified, STRAT will attempt to estimate the specified strategic model.

### Example 1.

Suppose you have done the following:

- choose a data file named example.dat
- specify the source of uncertainty — Agent Error
- choose MODEL 1-2 to run
- specify the dependent variable as Y134 — outcomes  $Y_1, Y_3, Y_4$
- specify regressors for utilities as  $X_{11}$  (for  $U_1(Y_1)$ ),  $X_{13}$  (for  $U_1(Y_3)$ ),  $X_{14}$  (for  $U_1(Y_4)$ ),  $X_{23}$  (for  $U_2(Y_3)$ ) and  $X_{24}$  (for  $U_2(Y_4)$ ).

STRAT will produce an output similar to the following:

```
=====
MAXLIK Version 4.0.24                               2/10/01  11:03 am
=====
                        Data Set:  EXAMPLE.DAT
-----

return code =      0
normal convergence

Mean log-likelihood      -0.420714
Number of cases         5000

Covariance matrix of the parameters computed by the following method:
Inverse of computed Hessian

Parameters      Estimates      Std. err.  Est./s.e.  Prob.      Gradient
-----
X11              0.9933          0.0307    32.314    0.0000     0.0000
X13              1.0174          0.0378    26.886    0.0000    -0.0000
X14              1.0064          0.0384    26.226    0.0000     0.0000
X23              0.9590          0.0386    24.866    0.0000    -0.0000
X24              0.9465          0.0385    24.613    0.0000     0.0000
```

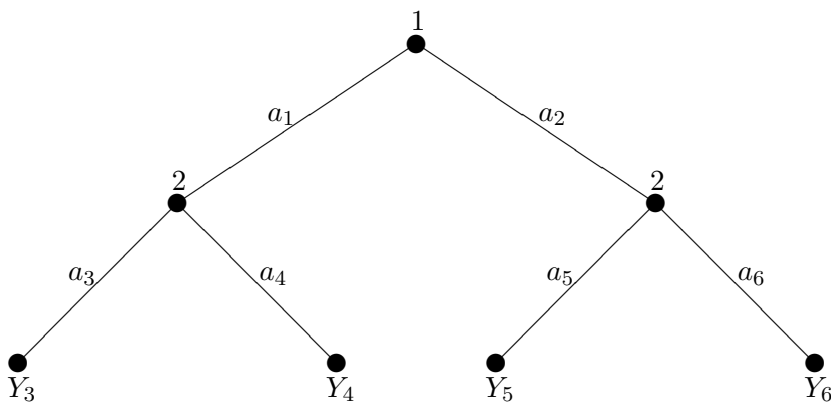
Correlation matrix of the parameters

1.000	0.692	0.676	0.012	0.007
0.692	1.000	0.488	-0.102	-0.097
0.676	0.488	1.000	-0.085	-0.098
0.012	-0.102	-0.085	1.000	0.852
0.007	-0.097	-0.098	0.852	1.000

Number of iterations      17  
 Minutes to convergence      1.14117

### 4.3 MODEL 1-2-2

The following is a simple graphical depiction of MODEL 1-2-2:

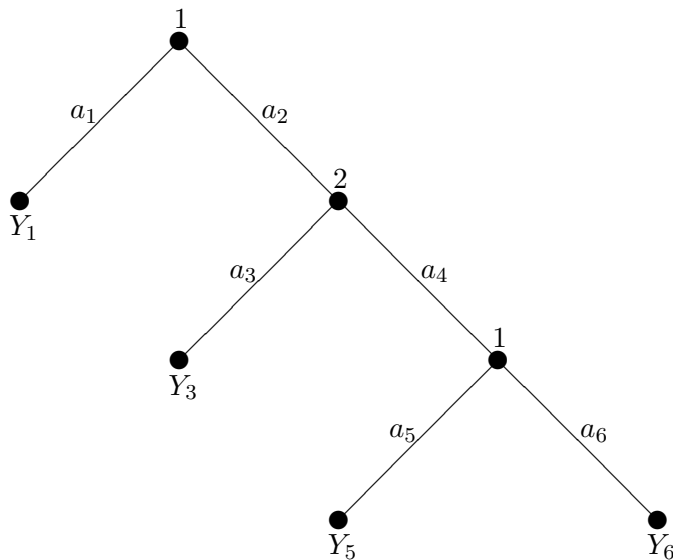


Player 1 chooses between options  $a_1$  and  $a_2$ . If  $a_1$  is chosen, the player 2 chooses between options  $a_3$  and  $a_4$ , leading to outcomes  $Y_3$  and  $Y_4$ , respectively. If player 1 chooses  $a_2$ , then player 2 must choose between options  $a_5$  and  $a_6$ , leading to outcomes  $Y_5$  and  $Y_6$ , respectively. The steps for estimating this are similar to those for Model 1-2.

### 4.4 MODEL 1-2-1

The following is a simple graphical depiction of MODEL 1-2-1:

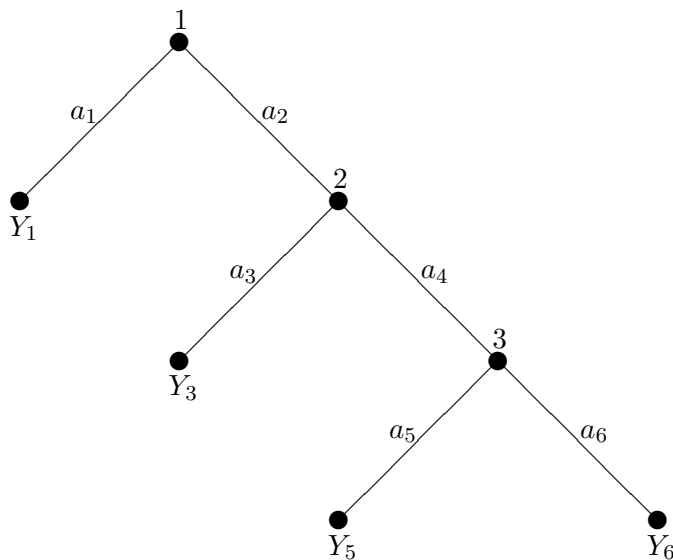




Player 1 chooses between actions  $a_1$  and  $a_2$ . If  $a_1$  is chosen, the outcome is  $Y_1$ . If  $a_2$  is chosen, then player 2 chooses between actions  $a_3$  and  $a_4$ . If  $a_3$  is chosen, the outcome is  $Y_3$ . If  $a_4$  is chosen, then player 1 chooses between actions  $a_5$  and  $a_6$ , resulting in outcomes  $Y_5$  and  $Y_6$ , respectively.

#### 4.5 MODEL 1-2-3

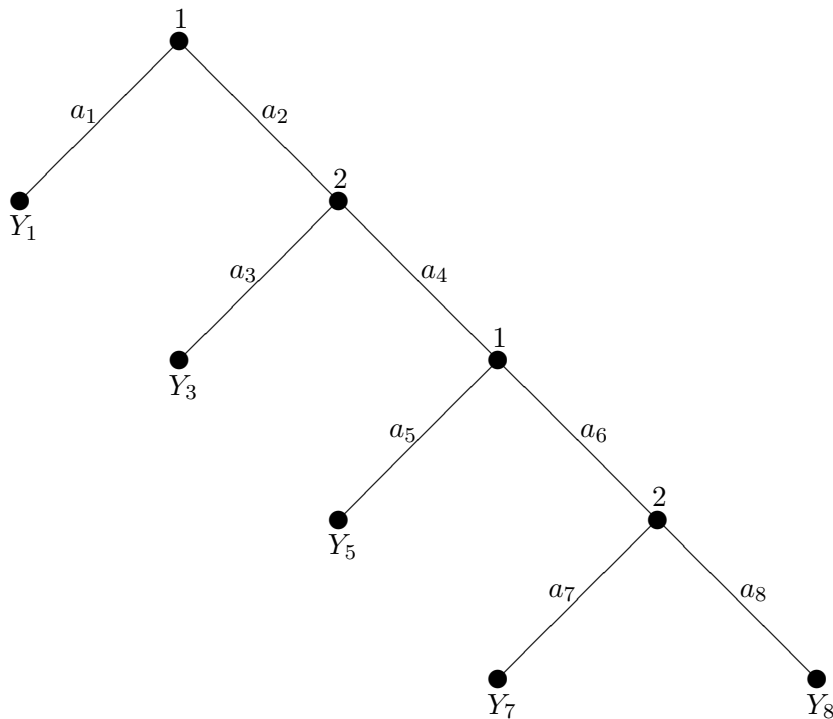
The following is a simple graphical depiction of MODEL 1-2-3:



Player 1 chooses between actions  $a_1$  and  $a_2$ . If  $a_1$  is chosen, the outcome is  $Y_1$ . If  $a_2$  is chosen, then player 2 chooses between actions  $a_3$  and  $a_4$ . If  $a_3$  is chosen, the outcome is  $Y_3$ . If  $a_4$  is chosen, then player 3 chooses between actions  $a_5$  and  $a_6$ , resulting in outcomes  $Y_5$  and  $Y_6$ , respectively.

#### 4.6 MODEL 1-2-1-2

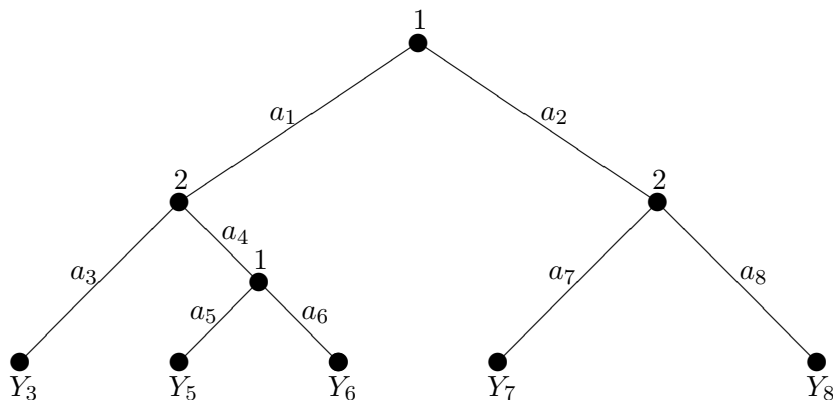
The following is a simple graphical depiction of MODEL 1-2-1-2:



Model 1-2-1-2 has two players. Player 1 makes the first move. Player 1 must choose between actions  $a_1$  and  $a_2$ . If  $a_1$  is chosen, then the outcome is  $Y_1$ . If  $a_2$  is selected, then player 2 must choose between actions  $a_3$  and  $a_4$ . If player 2 chooses  $a_3$ , then the outcome is  $Y_3$ . If  $a_4$  is selected, then player 1 must choose between actions  $a_5$  and  $a_6$ . If  $a_5$  is chosen, then the outcome is  $Y_5$ . If  $a_6$  is chosen, then player 2 must choose between actions  $a_7$  and  $a_8$ , leading to outcomes  $Y_7$  and  $Y_8$ , respectively.

#### 4.7 MODEL 1-2-2-1

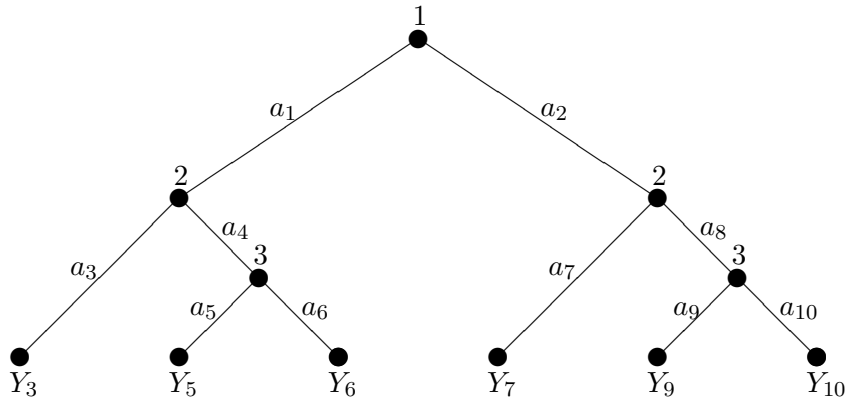
The following is a simple graphical depiction of MODEL 1-2-2-1:



Player 1 chooses between options  $a_1$  and  $a_2$ . If  $a_1$  is chosen, player 2 chooses between options  $a_3$  and  $a_4$ . If  $a_3$  is selected, the outcome is  $Y_3$ . If  $a_4$  is chosen, player 1 chooses between actions  $a_5$  and  $a_6$ , leading to outcomes  $Y_5$  and  $Y_6$ , respectively. If at the first node player 1 chooses  $a_2$ , then player 2 must choose between options  $a_7$  and  $a_8$ , leading to outcomes  $Y_7$  and  $Y_8$ , respectively.

## 4.8 MODEL 1-2-2-3-3

The following is a simple graphical depiction of MODEL 1-2-2-3-3:



Player 1 chooses between options  $a_1$  and  $a_2$ . If  $a_1$  is chosen, player 2 chooses between options  $a_3$  and  $a_4$ . If  $a_3$  is selected, the outcome is  $Y_3$ . If  $a_4$  is chosen, player 3 chooses between actions  $a_5$  and  $a_6$ , leading to outcomes  $Y_5$  and  $Y_6$ , respectively. If at the first node player 1 chooses  $a_2$ , then player 2 must choose between options  $a_7$  and  $a_8$ . If  $a_7$  is selected, the outcome is  $Y_7$ . If  $a_8$  is chosen, player 3 chooses between actions  $a_9$  and  $a_{10}$ , leading to outcomes  $Y_9$  and  $Y_{10}$ , respectively.

## 4.9 RE-RUN

This option allows you to re-run the model last run with the same set of explanatory variables, but with different random starting values on the interval (0, 0.5).

## 5 INTERPRET

The INTERPRET options assume you have both chosen a dataset and run a model. All results are specific to the dataset, the model last run, and, subsequently, to the parameter estimates generated by the last run. The two options allow you to calculate fitted value and first differences for probabilities of each action and each outcome. Each is addressed in the following:

### 5.1 PROB

Before calculating fitted value or first difference, you need to choose an action or outcome probability that you are interested in. For example, if the model you just ran is model 1-2, you will choose among  $\text{Prob}(a_1)$ ,  $\text{Prob}(a_2)$ ,  $\text{Prob}(Y_3)$ ,  $\text{Prob}(Y_4)$ ,  $\text{Prob}(Y_1 \text{ or } Y_3)$ , and  $\text{Prob}(Y_1 \text{ or } Y_4)$ .

### 5.2 PLOTFIT

This option allows you to plot the action or outcome probability as a function of one explanatory variable while holding all other variables constant at their minimum, mean, median, or maximum values. After choosing this option, you will be first asked to select an explanatory variable, and then you have to specify whether you want all the other explanatory variables to be held at their minimum, mean, median, or maximum values. Before generating the plot, STRAT asks you for a file name so that you can export the plot data in both ASCII (.asc) and GAUSS (.dat) formats. If no file name is entered, the data will be plotted but not exported.

### 5.3 FITVAL

Assuming an action or outcome probability is chosen for analysis, you have two options:

**DEFAULT** This option gives you all types of default probabilities of the dependent variable you have chosen for the model last run;

**USER** This option allows you to input a new set of values for independent variables and calculate the probability of the dependent variable you have chosen, using the parameter estimates generated by the last run.

#### Example 2.

Suppose after running a model, you are interested in the default probabilities of outcome  $Y_3$ . The following is an example of DEFAULT output:

Holding all other variables constant at:

		min	mean	median	max
X11	min	0.23038406	0.50515761	0.48494220	0.51677352
.	mean	0.00284508	0.24069961	0.22979896	0.51328679
.	median	0.00276412	0.23701985	0.22626856	0.51318411
.	max	0.00002159	0.00342342	0.00325237	0.27111129
.	.	.	.	.	.
X13	min	0.23038406	0.03288190	0.03415003	0.00295604
.	mean	0.44148569	0.24069961	0.22887402	0.03731266
.	median	0.44065725	0.23786964	0.22626856	0.03653520
.	max	0.48002926	0.47032971	0.44713625	0.27111129
.	.	.	.	.	.
X14	min	0.23038406	0.03626639	0.03021812	0.00437838
.	mean	0.44678554	0.24069961	0.22500520	0.04528250
.	median	0.44714353	0.24196727	0.22626856	0.04569026
.	max	0.48093551	0.46547701	0.44884604	0.27111129
.	.	.	.	.	.
X23	min	0.23038406	0.00395355	0.00369355	0.00003789
.	mean	0.46503941	0.24069961	0.22825822	0.00464472
.	median	0.46497091	0.23863196	0.22626856	0.00456442
.	max	0.46889830	0.46648596	0.44841553	0.27111129
.	.	.	.	.	.
X24	min	0.23038406	0.46627956	0.44838714	0.53126610
.	mean	0.00401038	0.24069961	0.23347187	0.52688688
.	median	0.00376481	0.23320970	0.22626856	0.52659872
.	max	0.00003536	0.00427108	0.00417689	0.27111129

### 5.4 1STDIF

Assuming an action or outcome probability is chosen for analysis, this option calculates the sensitivity of the probability of chosen dependent variable for changes in each explanatory variable, using first differences. When running, the names of the explanatory variables will be given on the screen. Enter the set of values for independent variables following the instructions on the screen.

Once you have entered values for all the variables, press <ENTER> to calculate the first differences of probabilities for the dependent variable you are interested in.

## 5.5 %CORRECT

This option provides information on the percentage of the dependent variable cases that are correctly predicted by the strategic model you just ran. You have the option of specify a file name so that the predicted probabilities for each observation can be exported in both ASCII (.asc) and GAUSS (.dat) formats. If no file name is entered, the predicted probabilities will be summarized to the screen, but not exported.

### Example 3.

Suppose you just ran a 1-2 model, the following information will be shown on the screen. A graph of the game tree for model 1-2 will also appear in a separate window for your reference.

```
Dependent Variable:          Y134

Empirical Frequency:
Y1          50.080%
Y3          24.520%
Y4          25.400%

Model Fit:

                Predicted:
                Y1      Y3      Y4      Total
Observed      Y1      2281    100     123    2504
              Y3      144     968     114    1226
              Y4      145     114    1011    1270
              Total   2570    1182    1248    5000

Percent Correctly Predicted:      85.200000%
```

Press any key to continue.

## 6 UTILITIES

### 6.1 SYSINFO

Provides a summary of system information: dataset, last model, output, starting values, decimal formatting, header, etc.

### 6.2 OUTPUT

The OUTPUT option allows you to control where output is sent and how it is formatted. There are two options for output direction: output can be sent only to the screen or it can be sent to both the screen and a file. If you direct output to both the screen and a file, you will also be prompted for an output filename. Either press <ENTER> to accept the default filename (in parentheses) or enter another filename.

The OUTPUT option also controls the format of the maximum likelihood estimation output. The two format options control whether output is formatted using STRAT's STRATPRT routine or using Gauss's MAXPRT routine. The two are similar; however, you may prefer one or the other, depending on your analysis requirements.

### 6.3 STVAL

STVAL controls the method of calculating starting values for the parameter estimates. The choices are as follows:

- (Default) use a vector of random numbers on the interval (0, 0.5);
- Prompt user for a vector of numbers;
- Use a vector of random numbers on the interval (0, 1);
- Use a vector of random numbers distributed Normal with a mean of 0 and standard deviation of 1.

### 6.4 FORMAT

This option controls the number of digits printed to the right of the decimal point. The default is 4.

### 6.5 HEADER

The HEADER option allows you to change the title message that is printed at the top of each regression's output.

### 6.6 RESET

The RESET option resets the system parameters to their initial settings.

## 7 MISC

### 7.1 DOS

Selecting DOS from the main menu causes STRAT to escape to a DOS Shell. The DOS shell provides enough environment memory to issue common DOS commands (COPY, DEL, DIR, etc.) and to run small-to-medium programs. To return to STRAT, type EXIT.

### 7.2 HELP

Provides information on all menu options. You are currently in HELP!

### 7.3 BIBLIO

Select BIBLIO for an annotated bibliography on all models and methods used in STRAT. (Or, review bibliography at end of HELP file.)

## 7.4 ABOUT

This option displays the program's intro screen and provides the warranty and acknowledgement clauses.

## 8 NOTES ON CONVERGENCE

You should keep in mind two issues when estimating strategic models using STRAT. First, STRAT does not constrain you to specify regressors in such a way that the model is guaranteed to be identified, nor does it perform any sort of error checking at this point for identification. If the same regressor (including the constant) never appears more than once in any given player's set of utilities, then the model will be identified. However, there may be situations where you would like to include a particular regressor in two or more utilities of a given player. Depending on where those utilities are in the game, the associated parameters may not be identified. No general results yet exist for determining when parameters will be identified in these models. My advice is to start by specifying utilities as simply as possible, and with eye towards \*differences\* in utilities, since that is what really matters in the estimation.

If you notice during the estimation that all of the estimates increase each iteration until they "blow up," then your model is likely unidentified. Similarly, if STRAT reaches a point where it just bounces around each iteration and never converges (especially if you notice that "backsteps" is -1), you may have an identification problem. However, in that last case, it may be that your parameters are technically identified, but that your data in combination with your model have created a likelihood function that is "weakly identified," meaning that there are areas of the likelihood function that are flatter than the computer can detect at its level of precision. This may also result in STRAT telling you that it cannot calculate the standard errors by inverting the hessian.

If your model is unidentified, then the only course of action is to figure out a way to specify the utilities such that all parameters are identified. If your model is weakly identified, then you should consider rerunning the model with the same specification but from different starting values (RERUN may be useful for this). Indeed, even when you do not suspect a weak identification problem, it is actually a good idea to rerun your model a number of times from different starting values to ensure STRAT is finding the global maximum.

The second convergence issue is that STRAT (via Gauss' Maxlik library) provides a number of options you may access during estimation. If you press "h" while STRAT is iterating, a list of options will appear on the screen (you may have to click on the screen first to select that window). One of the most useful of these is the ability to change the search algorithm. If you press "a" while STRAT is iterating, you will be presented with eight different search algorithms. I have found that BFGS (2), BHHH (5), and Newton-Raphson (4) tend to be the most useful. BFGS is actually the default. If you find STRAT "getting lost" during estimation (e.g., backsteps equal to 20 or, worse, -1), try switching to one of these other search algorithms. Sometimes one search algorithm performs better than another for a given combination of model and data. This, of course, assumes your model is not technically unidentified, as mentioned above.

## References

- [1] Signorino, Curtis S. 1999. "Strategic Interaction and the Statistical Analysis of International Conflict." *American Political Science Review* 93(2)
- [2] Signorino, Curtis S. 2002. "Strategy and Selection in International Relations." *International Interactions*. 28(1).
- [3] Signorino, Curtis S. and Kuzey Yilmaz. 2003. "Strategic Misspecification in Discrete Choice Models." *American Journal of Political Science*. 47(3).
- [4] Signorino, Curtis S. 2003. "Structure and Uncertainty in Discrete Choice Models." *Political Analysis*. 11(4).
- [5] Signorino, Curtis S. and Ahmer Tarar. 2001. "A Unified Theory and Test of Extended Immediate Deterrence." Working paper. University of Rochester.
- [6] Signorino, Curtis S., Robert W. Walker, and Muhammet Ali Bas. 2003. "Picking a Fight: Disputes, Deterrence, and War-Time Alliances." Working paper. University of Rochester.
- [7] Clarke, Kevin A. and Curtis S. Signorino 2003. "Discriminating Methods: Tests for Nonnested Discrete Choice Models." Working paper. University of Rochester.
- [8] Signorino, Curtis S. and Kristopher W. Ramsay. 2003. "A Statistical Model of the Divide-the-Dollar Game." Working paper. University of Rochester.

### See also

- [9 ] McKelvey, Richard and Tom Palfrey. 1996. "A Statistical Theory of Equilibrium in Games." *Japanese Economic Review*. 47(2).
- [10 ] McKelvey, Richard and Tom Palfrey. 1998. "Quantal Response Equilibria for Extensive Form Games." *Experimental Economics*. 1.