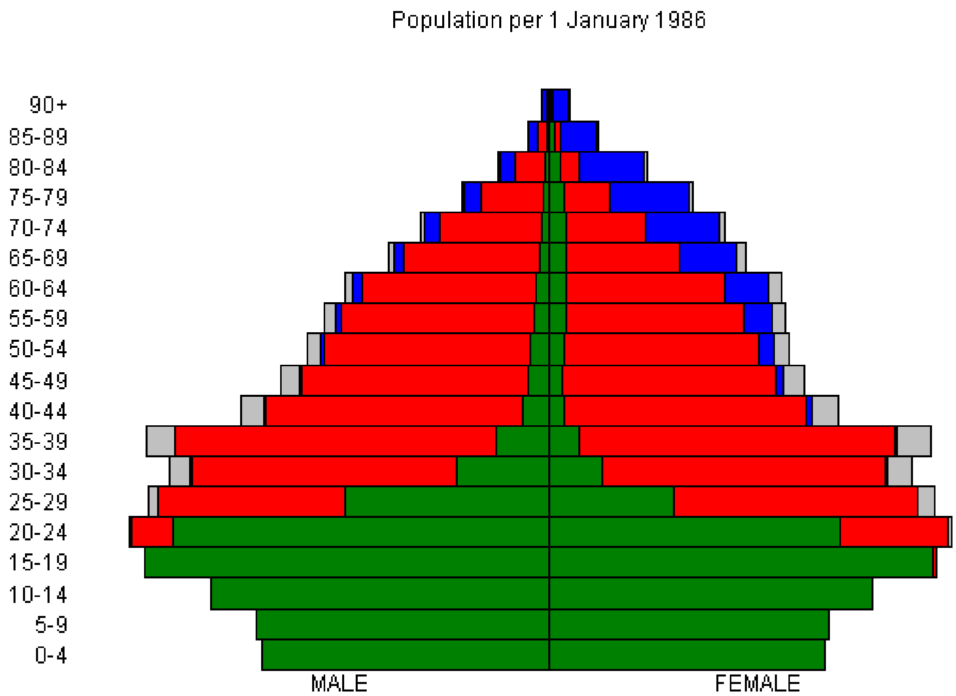
LIPRO 4.0

Tutorial



The projection to be prepared in this tutorial concerns the population of the Netherlands by marital status

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Contents

Tutorial 1: Definition file

This tutorial presents a step-by-step application of the LIPRO computer program. It is intended to serve as an illustration of how to prepare a multi-dimensional demographic projection with LIPRO. In addition, a number of issues in the compilation and manipulation of input data are discussed.

The projection to be prepared in this tutorial concerns the population of the Netherlands by marital status. The input data for this projection have been taken from the Netherlands population register as published by Statistics Netherlands (SN).

It is assumed that users are familiar with Windows and with Microsoft Excel.

Most of the computer files that are used in this tutorial are also located on the distribution diskette. In this way, the user can work his or her own way through the tutorial, by carefully repeating the various commands described in this Help file.

Creating a Definition File

The steps described in this section can be skipped by giving the command FILE / OPEN and selecting the definition file tutorial.ldf in the Tutorial folder.

In the sample model, the population is classified by sex (males, females), age (5-year age groups, up to 90+), and marital status. There are four marital states:

1. single (i.e. never married)
2. married
3. widowed
4. divorced

Newly born children always enter the state 'single'. Obviously, individuals can die from each of the four marital states. In addition, the model allows for international migration. This international migration is specified in terms of absolute numbers of net migrants (including so-called 'administrative corrections').

These basic characteristics of the model are stored in a LIPRO definition file, which has to be created. A new definition file can be created with the command FILE / NEW. The program now asks for the name of the definition file to be created. If you just enter a file name, e.g. marital, the program will automatically add the correct file extension .LDF. In addition, the new definition file will be stored into the current directory. Since this is correct, we can close the dialog window by clicking the Save button. Note that, after entering this file name, the main window's title bar includes the name of the currently active definition file marital.ldf.

After having specified the definition file's name, we are automatically entering the DEFINE window. This window contains several tabbed pages. On the first page, the state space must be specified:

- Under 'Internal positions', type labels for the four marital states, one label per line: enter nevr (for 'never married'), marr (for 'married'), wido (for 'widowed'), divo (for 'divorved'). These labels serve two purposes in LIPRO: they are used in tables to distinguish internal positions, and they are used in several input files (e.g. consistency algorithm, flexible tables). For this reason, it is important that the labels are simultaneously short and descriptive.
- Under 'Exit destinations', type labels for destinations of the exit events. We have only one, viz. 'dead'. Thus, we simply type dead.
- Under 'Entry origins', type labels for the origins of the entry events. We have only one, viz. 'rest of the world', which captures the net effect of emigration, immigration and administrative corrections. Thus, simply type rest.
- Using the radio button, specify 2 sexes.
- Using the spin edits, specify 5-year age groups up to 90 years and over.

Now click on the second tabbed page, named Parameters. In the example to be developed in this tutorial, the population projection is made with the exponential model specification. The length of the projection interval is necessarily equal to the width of the age groups, i.e. 5 years, and the projection period is from 1 January 1991 to 31 December 2020 or, equivalently, 1 January 2021. However, the data to be used for estimating the initial rates refer to 1 January 1986 - 1 January 1991. When applying these rates to the population per 1 January 1986, the observed events during the period 1986-1990 will be exactly replicated by the projection model. Thus, we might as well make the projection period start from 1 January 1986.

Ultimately, we are going to specify demographic rates separately for each projection interval, which means that we are going to use a 'variable' scenario. Because we have a marital-status model, it is natural to impose two-sex conditions via LIPRO's consistency algorithm. The consistency algorithm will use the generalized harmonic mean function, and it will calculate consistent rates once consistent events have been computed.

The 'Parameters' page will also have to specify the names of the data files. All data files have extension .BIN and will, by default, be stored in the current directory. If each application uses the same data directory, it is recommended that the file names are chosen in such a way that the application to which they belong is easily recognized. Thus, in our case we might start each file name with 'MAR_', to indicate that the files belong to our marital-status model.

We now enter the following information:

- Population file name: mar_pop.bin
- Person years file name: mar_year.bin
- Rates file name: mar_rat.bin
- Events file name: mar_evt.bin
- Using the radio buttons, specify the exponential model, and a variablescenario
- Using the spin edits, specify the projection period as being from (1 January of) 1986 to (31 December of) 2020.
- In the edit fields, enter 1e-10 for the 'assumed zero' and 1e-10 for the 'convergence criterion for matrix exponentiation.
- Using the check box, specify that consistency is required.

After checking the 'consistency' check box, the tabbed page named 'Consistency' becomes visible. Click on this tab. Now specify the following parameters for the consistency algorithm:

- Using the radio buttons, specify the harmonic mean function, that consistent rates are required, and linear starting values.
- Name of file containing the consistency requirements: two_sex.con
- File name for consistent events: mar_evtc.bin
- File name for consistent rates: mar_ratc.bin
- In the edit fields, enter 1 for the 'convergence criterion for person years' and 25 for the 'maximum number of iterations'.

We have now finished specifying the model definition. Click the OK button to return to the main window.

Tutorial 2: General data issues

For the marital-status model specified in the previous section, two types of input data are needed:

1. an initial population per 1 January 1991, by age (0-4, 5-9, ..., 90+), sex, and marital status;
2. intensities (rates) and absolute numbers on net migration, by age at the beginning of the 5-year projection interval (negative, 0-4, ..., 90+) and by sex, for each possible event, and for each of the six 5-year projection intervals.

Several points need special emphasis. These will be discussed below.

The events matrix

From: / To:	NEVR	MARR	WIDO	DIVO	DEAD
	Internal events (from/to)				Exits
NEVR	-	+	-	-	+
MARR	-	-	+	+	+
WIDO	-	+	-	-	+
DIVO	-	+	-	-	+
	Births (state mother/to)				
NEVR	+	-	-	-	
MARR	+	-	-	-	
WIDO	-	-	-	-	
DIVO	-	-	-	-	
	Net Migration				
REST	+	+	+	+	

+ = possible event - = impossible event

The first remark concerns the list of possible events. As can be ascertained from the events matrix above, the following events can be distinguished in this marital-status model:

1. Internal events:
   first marriage: from NEVR to MARR
   entry into widowhood: from MARR to WIDO
   divorce: from MARR to DIVO
   remarriage after widowhood: from WIDO to MARR
   remarriage after divorce: from DIVO to MARR
2. Exits:
   mortality: from either marital status to DEAD
3. Entries (absolute numbers):
   net migration: from REST to either marital status
4. Births (endogenous entries):
   legitimate fertility: births into NEVR from mother's marital status MARR

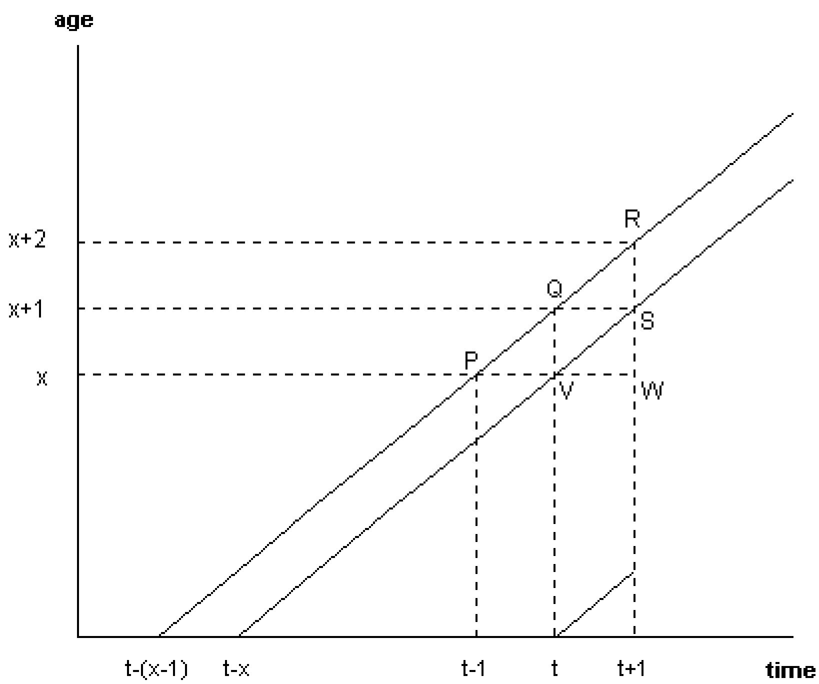
illegitimate fertility: births into NEVR from mother's marital status NEVR. For the sake of simplicity, it is assumed that women in state WIDO or DIVO do not bear children.

The age classification of the flow data

Second, the data on events (either rates or absolute numbers) should be of the period-cohort type: the data apply to a group of persons that is followed over time. This means that the events data should not be classified by the age at the occurrence of the event, but by year of birth of the individual involved. Alternatively, events data may be classified by age at the beginning of the time interval, or at the end of the time interval.

The reason for this is as follows. Demographic rates measure the risk of experiencing a particular event, say death. This implies that observations on events (deaths) should be related to the size of the population exposed to the risk of experiencing such deaths. This is not possible if deaths are classified by age at event (death), e.g. all deaths in 1986 at age 65 (i.e. after 65th but before 66th birthday): persons dying at age 65 in 1986 belong to either the population aged 65 on 1 January 1986 (dying before their 66th birthday) or the population aged 64 on 1 January 1986 (dying after their 65th birthday). On the other hand, if we are interested in the mortality risk of persons aged 65 on 1 January 1986, we should look at those deaths occurring in 1986 that are experienced by persons aged 65 on 1 January 1986; equivalently, we may look at deaths experienced by persons born in 1921, or by persons aged 66 on 31 December 1986 (including those persons who would have been 66, had they not died during 1986).

In short, the period-cohort criterion requires that demographic flow data be classified by year of birth or age per January 1 or age per December 31. Thus, the observation plan for the flow data should be of the period-cohort type, represented by the parallellogram QRSV in the Lexis diagram below.



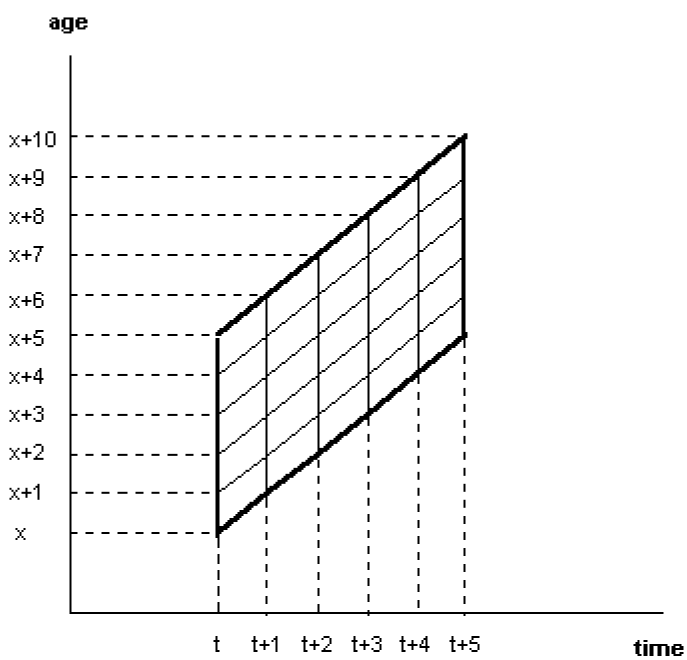
The number of age groups
Third, the number of age groups in the classification of events should equal the number of age groups in the classification of the population plus one. For each age group in the initial population, we require observations on events. In addition, we require observations on events experienced by the newly borns, i.e. the persons who are not yet alive at the beginning of the interval but who started their life during the interval. Thus, if the initial population is classified in 19 age groups (0-4, 5-9, ..., 90+), the data on events should be classified in 20 age groups. If events are classified by age on January 1 of the first year of the 5-year interval, the additional age group can be labelled 'births' or '-5..-1'; if events are classified by age on December 31 of the last year of the 5-year interval, the age groups are ...., 90-94, 95+.

From this last point it also follows that it is the degree of detail in the age classification of the flow data (events) that determines the maximum age classification that can be used in the model. Thus, in the case of the Statistics Netherlands data to be discussed in the next section, the flow data are classified in 1-year age groups per 31 December with highest age group 99+. For a 5-year model this implies that the classification of the initial population cannot go beyond 90+, even though the stock (population) data are available until 99+.

Aggregation of 1-year data into 5-year data
The final remark concerns the aggregation of flow data for 1-year age groups and 1-year observation intervals into flow data for 5-year age groups and 5-year observation intervals. When performing such an aggregation, it has to be taken

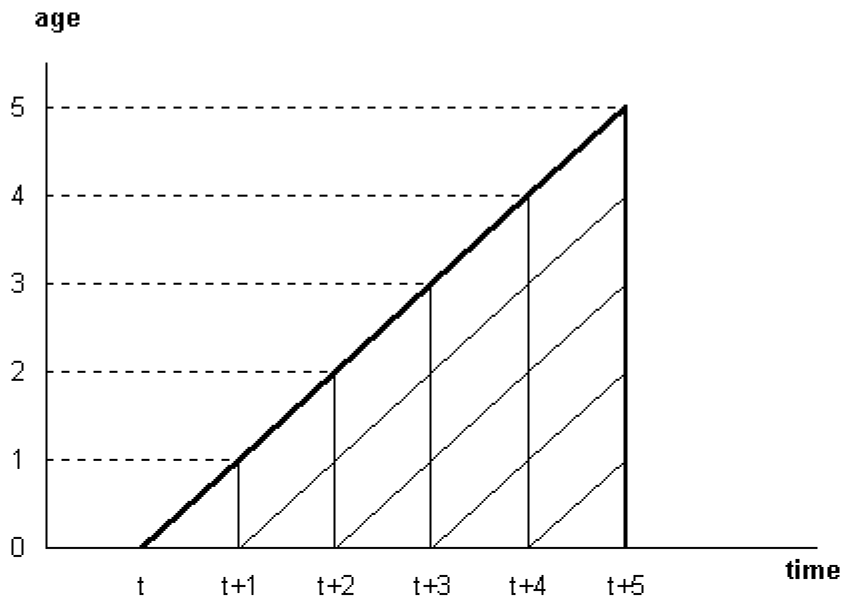
into account that individuals within a 1-year age group grow older within that 5-year interval. If events experienced during one year by persons aged x at the beginning of the year are denoted by E(x), then individuals of a certain age x at the beginning of the 5-year interval experience events E(x) during the first year, E(x+1) during the second year, E(x+2) during the third year, E(x+3) during the fourth year, and E(x+4) during the fifth year. Aggregation of all events for individuals in the five-year age group (x..x+4) should thus be calculated as follows (cf. the Lexis diagram below):

E(x..x+4) = 1×E(x) + 2×E(x+1) + 3×E(x+2) + 4×E(x+3) + 5×E(x+4) + 4×E(x+5) + 3×E(x+6) + 2×E(x+7) + 1×E(x+8)



For children born during the 5-year interval (i.e. aged -5..-1 at the beginning of the interval, or 0-4 at the end of the interval), the corresponding aggregation formula is (cf. the Lexis diagram below):

E(-5..-1) = 5×E(-1) + 4×E(0) + 3×E(1) + 2×E(2) + 1×E(3)


age
5
4
3
2
1
0
t
t+1
t+2
t+3
t+4
t+5
time

Tutorial 3: Statistics Netherlands sample data

The first step in estimating intensities for the marital-status model consists of collecting observed flow data and a corresponding initial population. For the purpose of the present tutorial, the intensities will be estimated from observations on the 5-year interval immediately preceding the projection period, i.e. the period from 1 January 1986 to 31 December 1990.

The observed stock and flow data stem from the population register in the Netherlands. The data have been made available by the Statistics Netherlands (SN), in the form of an 'electronic publication'. From this electronic publication, we have created a text file called TUT_1YR.TXT which, by kind permission of SN, can be found on the LIPRO distribution diskette.

The text file TUT_1YR.TXT consists of 500 lines of text. It contains numbers, arranged in 500 rows and 40 columns. The 500 rows refer to 5 years of observation (1986-1990) and 100 age groups (0,1,...,99+). For flow data, the age variable refers to age per 31 December, i.e. the flow data are of the period-cohort type, as they should be.

The colums contain the following variables:

1. observation year (86 stands for 1986)
2. age (99 stands for 99+)
3. population per 1 January, never married, males
4. population per 1 January, never married, females
5. population per 1 January, married, males
6. population per 1 January, married, females
7. population per 1 January, widowed, males
8. population per 1 January, widowed, females
9. population per 1 January, divorced, males
10. population per 1 January, divorced, females
11. legitimate live births (by age of mother)
12. illegitimate live births (by age of mother)
13. deaths, never married, males
14. deaths, never married, females
15. deaths, married, males
16. deaths, married, females
17. deaths, widowed, males
18. deaths, widowed, females
19. deaths, divorced, males
20. deaths, divorced, females
21. (first) marriages, never married, males
22. (first) marriages, never married, females
23. (re)marriages, widowed, males
24. (re)marriages, widowed, females
25. (re)marriages, divorced, males

26. (re)marriages, divorced, females
27. total marriages, males (sum of 21, 23, and 25)
28. total marriages, females (sum of 22, 24, and 26)
29. entries into widowhood, males
30. entries into widowhood, females
31. divorces, males
32. divorces, females
33. population per 31 December, never married, males
34. population per 31 December, never married, females
35. population per 31 December, married, males
36. population per 31 December, married, females
37. population per 31 December, widowed, males
38. population per 31 December, widowed, females
39. population per 31 December, divorced, males
40. population per 31 December, divorced, females

Even for these extremely comprehensive data, three things are still missing:

1. Births are not completely broken down by marital status of the mother. Within the category of illegitimate births, no distinction can be made between 'never married', 'widowed', and 'divorced' women. For this reason, we will make the simplifying but probably harmless assumption that all illegitimate children are born from 'never married' women. That is, fertility rates for 'widowed' and 'divorced' are zero by assumption.
2. Births are not broken down by sex. However, from other SN publications we know that in the Netherlands, recently about 0.5118 of all live births were boys and 0.4882 were girls. We will assume this ratio to be constant and independent of age of the mother.
3. Net migration data are not included. However, net migration by age, sex, and marital status can be obtained from the flow data in combination with the initial and final population.

Manipulating the SN sample data
Several data manipulations have to be performed before the data can be entered into LIPRO for rates estimation and scenario setting. The following things have to be done:

- aggregation into 5-year age group and 5-year period flow data;
- aggregation into 5-year population data;
- calculation of net migration data;
- breakdown of births data by sex.

There are numerous way in which these data manipulations can be performed. In this tutorial, we use the well-known spreadsheet program Microsoft Excel, also because LIPRO contains the powerful features of direct data exchange with

Excel. It is assumed that you have Excel at your disposal, and that you know how to work with it.

Start the Excel program. Issue the command FILE / OPEN. Set 'File of type' to Text files. Select file TUT_1YR.TXT and click the Open button. Excel will now ask some questions as to how the text file should be converted. Just click Finish to complete importing the text file.

The data are now ready for manipulation. This requires entering large numbers of formulas, explanatory text labels, 'move' and 'copy' commands. In order to save you all this trouble, a worksheet file TUTORIAL.XLS has been prepared that contains the data as well as all additional labels and formulas. This worksheet is also on your distribution diskette. Thus, you may discard your current worksheet and retrieve the prepared worksheet with Excel's FILE / OPEN command.

The original data from the text file are contained in the cells A2:AN501 (check that this corresponds to 500 rows and 40 columns). The cells A1:AN1 contain labels (right justified) that describe the contents of the columns in a short-hand fashion. For example:

- 'PMd' for 'Population, males, divorced';
- 'Bleg' for 'Births, legitimate';
- 'DFm' for 'Deaths, female, married';
- 'IMsm' for 'Internal events, males, from single to married';
- 'PeMs' for 'Final population, males, single';
- 'NMt' for 'Net migration, males, total'.

Aggegation into 5-year age groups
Now scroll to the range of cells B505:B527. In this area of the worksheet (stretching all the way to cell AX527), the aggregation into 5-year age groups is performed, as well as the calculation of the net migration data. Row 505 contains column labels, and column B contains labels for the age groups. The age labels refer to the 5-year age range at the start of the 5-year observation period, ranging from 'births' to '90+'; these age groups correspond to ages '0-4'..'95+' at the end of the 5-year observation period. In addition, two additional rows have been added: 'Total' and 'Check'. These rows are used for checking the calculations. It is frustratingly easy to make mistakes in calculations such as these, and you are therefore strongly urged to check and double-check everything that you do.

Columns C:J contain the initial population (per 1 January 1986) by sex and marital status, in 5-year age groups. They have been calculated from the original 1-year data in rows 2:101. The initial population for the age group 'births' (row 506) is zero by definition. Cell C507 contains the formula =SUM(C2:C6), i.e. the male, never married population aged 0-4, measured per 1 January 1986. Cell C525 equals =SUM(C92:C101), the sum of the population data for ages 90, 91,

..., 98, 99+, i.e. age group 90+. Cell C526 contains the sum of the 20 cells C506:C525 with 5-year age group population data, i.e. the total never married male population per 1 January 1986. This should equal the sum of the 100 cells C2:C101 with 1-year population data, which is evaluated in cell C527. Fortunately this happens to be the case. Similar calculations are made in the columns D:J.

The columns K:AF contain the events experienced during the 5-year period 1986-1990. These events are aggregated from the 1-year flow data in accordance with the aggregation formulas explained in the previous section. For example, look at the contents of cell M507, which contains the deaths of never married males from the cohort aged 0-4 on 1 January 1986. In terms of age per 31 December, this cohort is aged 1-5 in 1986, 2-6 in 1987, 3-7 in 1988, 4-8 in 1989, and 5-9 in 1990. Therefore, cell M507 contains the following formula:

=SUM(M3:M7) + SUM(M104:M108) + SUM(M205:M209) + SUM(M306:M310) + SUM(M407:M411)

The cells in rows 508:524 contain similar expressions, with the row indices in the formulas being incremented by 5 for each subsequent row containing the formula.

Slightly different formulas appear in row 506, for the youngest age group, and row 525, for the oldest age group. The youngest age group only starts experiencing events from the time of birth; thus, e.g. cell M506 contains:

=SUM(M2) + SUM(M102:M103) + SUM(M202:M204) + SUM(M302:M305) + SUM(M402:M406)

In the formulas for the oldest age group 90+, the summations of the 1-year data are for ages at 31 December 91..99+ in 1986, 92..99+ in 1987, ..., 95..99+ in 1990. Thus, cell M525 contains:

=SUM(M93:M101) + SUM(M194:M201) + SUM(M295:M301) + SUM(M396:M401) + SUM(M497:M501)

Cell M526 again contains the sum of the 20 cells M506:M525 with 5-year age group 5-year period flow data, i.e. the total number of never married males dying in the years 1986-1990. This should equal the sum of the 500 cells M2:M501 with 1-year mortality data, which is evaluated in cell M527. Similar calculations are made in the columns K:L and N:AF.

Columns AG:AN contain the final population (per 31 December 1990) by sex and marital status, in 5-year age groups as per 1 January 1986. For example, cell AG507 contains the number of never married males on 31 December 1990 in the cohort aged 0-4 on 1 January 1986, i.e. aged 5-9 on 31 December 1990. These final population data have been calculated from the original 1-year data in rows 402:501. The final population for the age group 'births' (row 506) is calculated from the formula =SUM(AG402:AG406), i.e. the male, never married population aged 0-4, measured per 31 December 1990. Cell AG525 equals =SUM(AG497:C501), the sum of the population data for ages 95, ..., 98, 99+, i.e. age group 95+ per 31 December 1990 and age group 90+ per 1 January 1986. The rows 526 and 527 contain the totals over all age groups, as before. Note the similarities and the differences between the range C506:C525 for the initial population and the range AG506:AN525 for the final population.

Calculating net migration data

The columns AO:AV calculate the net migration by sex, marital status, and 5-year cohort. These calculations start from the following identity:

Final pop = Initial pop + Net migration + Other entries - Other exits

from which

Net migration = Final pop - Initial pop - Other entries + Other exits

The final and initial population numbers are directly obtained from the corresponding elements in rows AG:AN and C:J. The 'other entries' depend on the marital status:

- Never married (columns AO and AP, for males and females, respectively): the only possible entry into 'never married' is through birth, and then only for the youngest age group (row 506). The total number of births equals =SUM(K506:L525). This total number has to be disaggregated by sex, using fixed proportions for boys and girls. These proportions are contained in cells AO503 and AP503, respectively.
- Married (columns AQ and AR): entry can occur through marriage, from each of the three other marital states. The total number of entries into marriage is already part of the worksheet (columns AA and AB).
- Widowed (columns AS and AT): entry can occur through widowhood (columns AC and AD).
- Divorced (columns AU and AV): entry can occur through divorce (columns AE and AF).

The 'other exits' are either death or change of marital status:

Never married: first marriage (columns U/V) or death (columns M/N). Marriage: widowhood (columns AC/AD), divorce (AE/AF), or death (columns O/P). Widowed: remarriage (columns W/X) or death (columns Q/R). Divorced: remarriage (columns Y/Z) or death (columns S/T).

With these points in mind, we can now calculate the net migration numbers. Inspect the formulas in the range AO506:AV525 and verify that they are indeed valid expressions.

As usual, row 526 contains the summation of the rows 506:525, i.e. net migration aggregated over all age groups. Row 527 is again a verification row, containing similar formulas as rows 506:525. However, note that cells AO527 and AP527 also contain a term for live births, similar to cells AO506 and AP506 but contrary to cells AO507:AP525.

In order to check these calculations from another perspective, the columns AW and AX have been added. Column AW simply gives the sum of the columns AO:AV. For example, cell AW506 contains the formula =SUM(AO506:AV506). Thus, column AW contains net migration by 5-year age group, but irrespective of sex and marital status. These values should equal the identity given above aggregated over marital status and sex. Thus:

Net migration = Final pop - Initial pop - Births + Deaths

where the 'Births' term only applies to the youngest age group (rows 506 and 527). For example, cell AX507 contains:

=SUM(AG507:AN507) - SUM(C507:J507) + SUM(M507:T507)

Fortunately, the columns AW and AX produce identical results.

Rearranging the flow data
Because eventually all flow data are to be imported into LIPRO for further processing, it is convenient to collect all flow data together in a separate section of the worksheet. This section consists of the range B531:AF551. Row 531 again contains the column labels, and column B contains the labels for the age groups.

The following flow variables are being collected here:

- Births, by marital status of mother and by sex of child: columns C:F.
- Deaths, by marital status and sex: columns G:N.
- Marriages, by previous marital status and sex: columns O:T.
- Entries into widowhood, by sex: columns U and V.
- Divorce, by sex: columns W and X.
- Net migration, by marital status and sex: columns Y:AF.

With the exception of the four births variables, all these variables are directly copied from the previous section of the worksheet. For example, cell G551 (male deaths, never married, cohort 90+) contains the formula +M525, indicating that the appropriate number has already been calculated in cell M525.

The four birth variables (cells C532:F551) are obtained by combining the data on legitimate and illegitimate live births (K506:L525) with the proportions for boys and girls in cells AO503 and AP503. For example, cell C536 (boys born from never married mothers, aged 15-19 on 1 January 1986) contains the formula =AO$503*L510, which stands for the proportion of boys multiplied by the number of illegitimate births from women aged 15-19 on 1 January 1986.

Tutorial 4: Importing Excel data into LIPRO

In the Excel file prepared in the previous section, note that the column labels in row 531 (as well as those in range C505:J505) are in the LIPRO shorthand format, using the labels defined earlier in the definition file. This is done in order to be able to use LIPRO's 'automatic import from Excel' feature to which we will now turn.

While keeping Excel open, return to LIPRO. From the main menu, select the command TOOLS / IMPORT/EXPORT. A dialog window appears.

We will start with importing the population data for (1 January) 1986. 'Importing' means that the population numbers prepared earlier in Excel, are to be stored in the LIPRO binary file for population data, at the position in the file corresponding to the year 1986. Verify that in the dialog window, the radio group 'Type of data' is set to Population, and the list box 'Year' to 1986. The data in Excel are arranged so that age groups correspond to rows; thus, the radio group 'Sorting' can be kept in its default position 'Ages as rows'.

We are going to import from Excel, thus, set the radio group 'Mode' to Import from Excel. A set of controls headed 'Excel setting' appears. Here we have to specify from which Excel sheet we are going to import the data, and from which cell (row and column) import should start. The population data are stored in file TUTORIAL.XLS, sheet SampleData, range C507:J525. Thus, we should specify 'Sheet name' as [tutorial.xls]SampleData and 'Starting column' as 3 (i.e. column C). For the 'Starting row' we have two options, depending on how LIPRO is going to know which variables are located where:

- We could put the list of variable in a description file. In that case, 'Starting row' should be set to 507, which is where the data for the first population age group can be found (remember, age group 1 corresponds to those born during the obervation interval and thus is not present in the starting population). We should also check the check box 'Use description file', and create a description file using the controls in the panel headed 'Text settings'.
- However, far easier is to identify the variables in the Excel sheet itself. This is why, when preparing the Excel file, we put the LIPRO-type labels like P(M,NEVR) in the range C505:J505. Now, 'Starting row' should be set to 505, since this is the row where LIPRO will be able to find the variable names. 'Use description file' must be left unchecked. Note that, when using this method for population data, the Excel file should leave one empty row between the labels and the data for age group 0-4.

The easiest way to proceed is as follows: switch to Excel; put the cursor in cell C505, i.e. the cell containing the label 'P(M,NEVR)'; switch to LIPRO; click the button Copy from current. Now all three controls 'Excel sheet', 'Starting column' and 'Starting row' have their correct values.

Now click Start Import into LIPRO to import the data from Excel. LIPRO parses row 505 (starting in C505) for valid population variable labels. Row 505 contains many labels that do not correspond to valid population variables (e.g. cell K505 contains 'Bleg'). A warning of such invalid labels is given; simply click OK and ignore. After succesful import, a message 'Import from Excel completed, 8 variables read' appears. This is at it should be, since we have imported data for 2 sexes and 4 internal states; again click OK.

Importing the events data for the period 1986-1990 should now be easy. To summarize the steps:

- Set the radio button 'Type of data' to Events. Note that the list box 'Year' now changes into a list box 'Period'.
- Switch to Excel, put the cursor in cell C531 (containing 'B(M,nevr,nevr)'), switch back to LIPRO, click the button Copy from current.
- Click the button Start Import into LIPRO.
- After succesful import, a message 'Import from Excel completed, 30 variables read' appears. Click OK.
- Click Close to return to the main window.

Tutorial 5: Estimating and analysing rates
From an initial population and observed events we can now estimate the rates. For a comprehensive discussion of the various formulas involved, see chapter 4 of Van Imhoff and Keilman (1991) and the references cited there.

Estimating rates is done with the command TOOLS / CALCULATE RATES. A dialog window appears. The CALCULATE RATES command can estimate rates from two types of observations: events and transitions. Since our data refer to events, the 'Type of input ' should be 'Events', which it is by default.

Given an initial population and observed events, the CALCULATE RATES command calculates the corresponding rates and person years. Population and events data are read from binary files; rates and person years are written to binary files. By default, these binary files are the ones specified in the definition file, as can be verified from the dialog window.

Thus, we can immediately proceed with the actual estimation, which is started by clicking the button Compute rates. A progress bar keeps you informed about the progress of the calculations. After completion, click the Close button to return to the main window.

Investigating the rates
Whenever LIPRO makes a projection or a calculation, the output is immediately written to one of the binary files defined in the definition file. Thus, on entering other commands, the output is already there, although not in a very accessible form. Inspecting the rates means to produce some form of readable output from the non-readable binary files.

There are several ways in which rates can be inspected:

- Export all rates to Excel, with the TOOLS / IMPORT/EXPORT command.
- With the EDIT command. Set 'Type' to Rates, then click Load. A tabbed worksheet-like control appears. As an exercise, you could verify that the instantaneous divorce rate for married females aged 20-24 at the start of the 5-year period 1986-1990 was 0.015379 (page 'I>divo', column 'Females, marr', row '20-24'). Right-click on the control to activate font and clipboard options.
- With the OUTPUT / TABLES command. Activate the tabbed page 'Transition matrices' (first scroll right using the navigation arrows in the top-right corner). As an exercise, click Create table to verify the same 20-24 rate I(F,marr,divo), as follows. In the newly created 'Intensity matrices' window, click 'Options' and select 6 decimal digits. Once more click 'Options' and select Fixed headers. Then scroll to age group 20-24 in the tabbed page 'FEMALES', to find that it is still 0.015379 (row '20-24 marr', column 'divo'). Give FILE / EXIT to return to the Tables window. Now set 'Type of output' to Transition probabilities and click Create table once

more. Verify that an instantaneous divorce rate of 0.015379 implies that, given that one is married at the start of the 5-year period, the probability of being divorced at the end of the 5-year period equals 0.056176. Note: this is not the same as saying that the probability of having a divorce within 5 years equals 0.056176; if one has a divorce, one could remarry within the same 5-year period which would not count as a transition from married to divorced.

Life table analysis

What do these estimated rates imply for the life course of a representative individual? If someone were subjected to these rates from the moment of birth until the moment of death, how would he or she change status over time?

In order to investigate these issues, we will now create a marital-status life table. From the main menu, select the command OUTPUT / LIFE TABLE ANALYSIS. A dialog window appears. Verify that, by default, the rates in file MAR_RAT.BIN are analysed for the period 1986-1990. We also see the default radix of the life table for females, which is 100,000 for 'never married' (the first internal state) and zero for the other marital statuses. Now click the button Calculate Life Table. After some progress indicators, a window with output tables appears. The top page contains the life table for females in absolute numbers. Note that the first row corresponds to the default radix.

Scroll down to the start of the sub-table with life table person years. At the bottom of this sub-table we find the line labeled 'Total'. From this line, we see that the total life expectancy at birth for females equals 79.5 years (divide the rightmost number 7,947,205 by the size of the radix 100,000); of these 79.5 years, 36.8 years are lived in the state 'never married', 30.4 in 'married', 7.7 in 'widowed', and 4.6 in 'divorced'. The 36.8 years lived in state 'never married' should not be confused with the average age at first marriage; the latter is the average number of years lived in 'never married' by women who marry at least once, while the former refers to all women, irrespective of whether they ever marry.

Click on tabbed page 'Males, Abs' and scroll down to find the corresponding numbers for men: 39.1 NEVR, 28.9 MARR, 1.7 WIDO, 2.9 DIVO, total life expectancy 72.6 years.

Now click on tabbed page 'Total, Abs'. Scroll down to the sub-table 'Births/mother' which gives the births (boys+girls) from the life table cohort of women, by age and by marital status. Apparently, the 100,000 women of the life table radix have 138,723 children during their lifetime, of which 23,477 (16.9%) are born out of wedlock.

Drag the 'Life Table' window to a corner of the screen to restore visibility of the previous 'Life Table Analysis' window. For analysing fertility, click the button Fertility indicators. In the output window 'Fertility indicators', we see that the average number of children equals 1.387233, which is in agreement with the 138,723 births from the life table cohort found earlier. Since only 48.82% of all births are girls, the average number of daughters is 0.677237 which equals the net reproduction rate. The average age at birth, or the mean length of generations, is 29.205531 years. In combination with an NRR of 0.677237, this implies an annual growth rate in the stable population of -1.3344%.

With the command FILE / EXIT, close the two output windows 'Fertility indicators' and 'Life table'.

Suppose now that we want to investigate the proportion ever married, as well as the proportion of marriages ending in divorce. For this purpose, we create so-called experience tables. For the proportion ever married, this is done as follows:

- Click on the tabbed page 'Experience table'.
- In the table, click in the cell formed by row 'nevr (1)' and column '2'. This means that we are going to create an experience table for the event 'First marriage', i.e. the jump from internal position 'never married' to 'married'. It is experiencing this event that distinguishes the 'ever married' from the 'never married'.
- Click the button Calculate Experience Table.

Two output windows appear, with titles 'Average ages at event' and 'Experience Table', respectively. Scrolling one page down in the latter, we see that, out of 100,000 women, 79,230 are 'ever married'. In table 'Female, Perc', we find the proportions 'ever married' by age and by marital status. Of course, these proportions are 100% for states MARR, WIDO, and DIVO, and 0% for 'never married'. For the oldest age group, 90+, 80.71% of the living is 'ever married', which is slightly higher than the 79.23% for the proportion 'ever married' after the whole synthetic cohort has died; this small difference reflects the fact that married women have a lower death rate than the non-married.

Drag this window away to restore the window 'Average ages at event'. (Another way of navigating between windows is, to drag the main window to the top of the screen, and use its 'Window' menu command to move the focus between sub-windows). Surprisingly, the lines 'Average age at first event' and 'Average age at any event' give slightly different ages, namely 27.06 versus 27.09 for women, and 29.39 versus 29.42 for men. This can only be due to rounding/approximation errors (see p.54 of Van Imhoff and Keilman, 1991), since obviously 'becoming ever married' can occur only once during one's lifetime.

Return to the 'Life Table Analysis' window. If we now want to find out how many marriages end in divorce we create a new experience table and compare it to the previous one. We might proceed as follows:

- In the table, check the cell formed by row 'marr (2)' and column '4'. You could also uncheck the cell nevr/2, but it is basically irrelevant whether or not this event is counted, because anyone going from 'married' to 'divorced' did necessarily experience the event from 'never married' to 'married' earlier in life.
- Click the button Calculate Experience Table.

Again two output windows appear, with titles 'Average ages at event' and 'Experience Table'. In the latter, scroll down to verify that 19,944 women die after experiencing at least one divorce. This is 19.94% of the total cohort (divide by 100,000), and 25.17% of the women ever married (divide by 79,230). The average age at 'becoming ever divorced' for the first time equals 38.20 years for women, while the average age at divorce in general equals 38.63 years; the latter is somewhat higher than the former, because it is possible to have a divorce more than once during one's lifetime.

We can also see, in the table 'Female, Perc' that, of those women alive at ages 90+, 17.17% have experienced at least one divorce. This proportion is slightly lower than the 19.94% for the full cohort, which reflects the fact that mortality among divorced women is above average.

Close all output windows and the 'Life Table Analysis' window to return to the main window.

Tutorial 6: Projection
At this stage, we have prepared the following data:

- an initial population per 1 January 1986;
- rates for fertility, mortality, and marriage formation and dissolution, estimated from observed demographic behaviour during the years 1986-1990;
- absolute numbers for net migration, by sex, age, and marital status, as observed during the years 1986-1990.

Although the rates and migration data refer to one 5-year interval only, we already can make a population projection if we are prepared to assume that the rates and migration numbers are going to remain constant over time. Such a projection is sometimes called a 'status-quo projection' or, in LIPRO terms, a constant scenario.

As a first exercise, we will make such a status-quo projection. We should tell the program that it should keep its input parameters (rates and migration numbers) constant thoughout the projection period. This is done as follows:

- From the main window, issue the menu command Define.
- Click on the tabbed page 'Parameters'.
- Set the radio group 'Scenario type' to Constant.
- Click the OK button.

Creating the input file for the consistency algorithm
In the definition file, we earlier specified that our marital-status projection is going to be subject to consistency conditions of the two-sex type. In particular, we want the following two-sex requirements to be satisfied:

- the number of males entering marriage should equal the number of females entering marriage;
- the number of divorcing males should equal the number of divorcing females;
- the number of married males who die should equal the number of females entering widowhood;
- the number of males who become widowers should equal the number of married females who die.

A slight complication is caused by the fact that our model allows for international migration. International marriages exist and can occur in different ways. Also, it is perfectly possible for a married foreign couple to immigrate separately, e.g. first the husband and several years later the wife (family reunification). Indeed, such cases explain why in our demographic data net migration for married males does not exactly equal net migration of married females. However, for simplicity we assume that these slight deviations from exact fulfillment of the two-sex conditions cancel out and we simply impose as an additional condition:

- net migration of married males should equal net migration of married females.

If such consistency relations are imposed, the initially projected number of events (aggregated over all age groups) are subsequently adjusted in such a way that the consistency requirements are satisfied. For example, if initially 10,000 males are projected to divorce and 12,000 females, the LIPRO program adjusts male divorce upwards and female divorce downwards (specifically, the adjusted number of divorces will be 10,909, namely the harmonic mean of 10,000 and 12,000).

In the case of marriage and divorce this type of adjustment can be justified with a 'market-mechanism' argument: if females are more willing to divorce than males, a bargaining process will start in which some unwilling males will give in, and in which other unwilling males will convince their wife that they should stay married. However, in the case of mortality and entry into widowhood, such an argument is less convincing: it is generally not possible to bargain over death. Rather, entries into widowhood should completely follow the projected number of deaths, i.e. widowhood is mortality dominant. This can be achieved in LIPRO by using the feature of passive consistency relations.

The consistency relations to be imposed in the marital-status projection will, as specified in the definition file, be stored in the input file TWO_SEX.CON. However, this file does not yet exist. We therefore issue the following commands:

From the main window, once more issue the menu command Define.
Click on the tabbed page 'Consistency'.
Click the Edit button to the right of the 'Input file' edit field.

On entering the editor, type the following lines of text (also available on the distribution diskette as file TWO_SEX.TUT):

```
i(m,nevr..divo,marr) = i(f,nevr..divo,marr) ;
i(m,marr,divo) = i(f,marr,divo) ;
n(m,rest,marr) = n(f,rest,marr) ;
passive i(f,marr,wido) = x(m,marr,dead) ;
passive i(m,marr,wido) = x(f,marr,dead) ;
```

The first line contains the two-sex requirement for marriage, the second for divorce, the third for net migration of married couples, the fourth for new widows, and the fifth for new widowers.

Save the input file by pressing the [F2] key, which is equivalent to the command FILE / SAVE AND EXIT. Click the OK button to return to the main window.

Making the projection
With all preparations completed, we may now start the projection by issuing the menu command RUN. The computer now starts doing the calculations. While these calculations are in progress, you will note virtually continuous activitity of your harddisk. The program does its reading from and writing to the binary files separately for each combination of age group and sex, which explains why the program is rather I/O intensive.

During the calculations, the computer keeps you informed of its activities via progress bars:

1. The top bar indicates which projection interval is currently being handled;
2. The second bar gives the progress of the initial projection phase (from rates, calculate events);
3. The third bar stands for the consistency algorithm: calculating adjusted events, and saving adjusted events after imposing consistency relations;
4. The fourth bar gives the progress of the (iterative) final projection phase (from consistent events, recalculate rates and recalculate events not involved in the consistency relations).

After finishing the projection computations, the program displays a log file, which contains a summary report of the projection phase. This output file starts with a systematic overview of the model specification. In addition, it contains, for each projection interval, the results of the consistency algorithm: for each event affected by the consistency algorithm, the file gives the aggregate number of events before and after imposing consistency. As an exercise, you may verify that during the last projection interval, the total adjusted number of divorces equals 120563 which equals the harmonic mean of the initial numbers 120491 and 120635 for males and females, respectively.

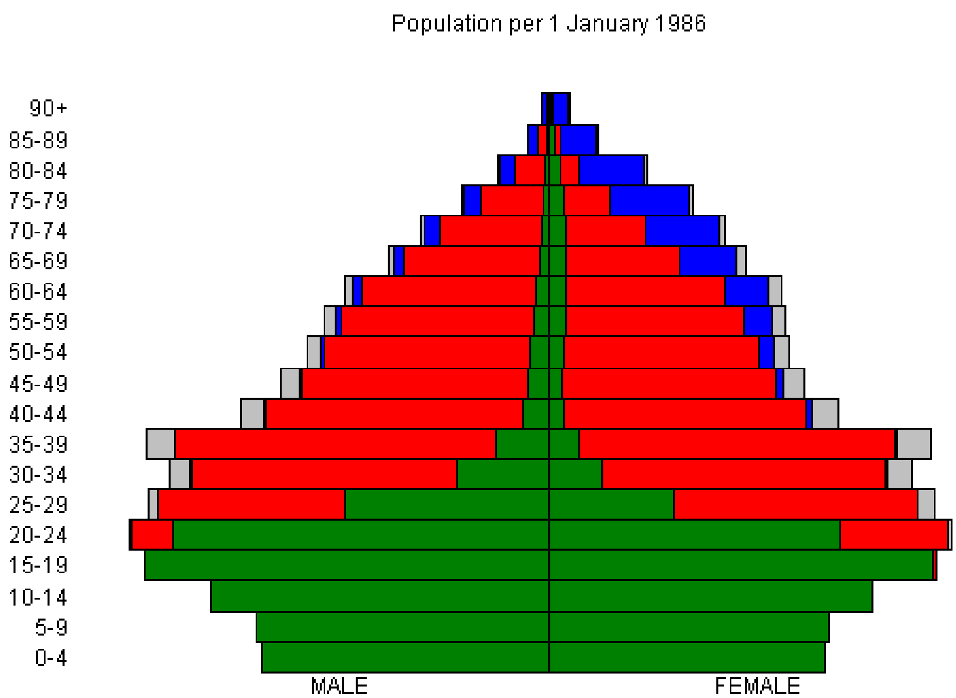
Return to the main window by pressing the [F10] key, which is equivalent to FILE / EXIT.

The size of the binary files
The files with events and rates consist of records that are 320 bytes long, namely 8 bytes per number times 40 types of events (cf. the 40 cells in the events matrix displayed in the second section of this tutorial). For each projection interval there are 40 records, namely 2 sexes times 20 age groups. The rates file MAR_RAT.BIN contains rates for one projection interval only (remember that we have just created a status-quo projection) and thus is 40*320=12800 bytes large. The files MAR_RATC.BIN (adjusted rates), MAR_EVT.BIN (unadjusted events) and MAR_EVTC.BIN (adjusted events) contain data for 7 projection intervals and thus are 7*40*320=89600 bytes large.

The files with person years and population data consist of records that are 32 bytes long, namely 4 marital states times 8 bytes per number. The file of person years MAR_YEAR.BIN contains 7 intervals times 2 sexes times 20 age groups = 280 records, or 8960 bytes. The file of population data MAR_POP.BIN contains data for 304 records, namely 2 sexes times 19 age groups (excluding "births") times 8 periods (1986, 1991, ..., 2021); thus, the population file occupies 304*32=9728 bytes.

Graphics: Population pyramid

Let us now have a look at the projection results. For the present projection, we concentrate on the graphical representation of the projected demographic changes, in the form of a population pyramid. Issue the menu command OUTPUT / PYRAMID. The currently defined graph refers to the population data in file MAR_POP.BIN for the first year, which is 1986 (1 January). If all goes well, you screen will now display the figure below.



We now want to see how this population structure by sex, age, and marital status develops over time. To this purpose, we click the Up button (or click somewhere in the upper-left quadrant of the pyramid). Now the pyramid for 1 January 1991 appears. Note that the previous pyramid, for 1986, leaves a kind of 'shadow' on the screen. This shadow is intended to make it easier to follow the changes over time. We could repeat the process by scrolling to the next projection interval. However, we can also click Up Auto: this command scrolls to subsequent intervals, continuing automatically until the end of the full projection period has been reached.

It is possible to open two pyramid windows simultaneously. The current one is for 1 January of the year 2021. By dragging the window aside and issuing once mode OUTPUT / PYRAMID from the main window, we see another pyramid for 1 January of the year 1986. By moving both pyramid windows around on the screen, we can visually compare the two population structures.

Right-click on a pyramid and select View Data to obtain quick access to the age-specific population data underlying the pyramid.

Tutorial 7: Scenario setting

In the final section of this Tutorial, we will create a very simple scenario. Contrary to the status-quo projection of the previous section, we will now allow the input rates and net migration numbers to vary between projection intervals. The following steps will be taken:

- create a new binary file with input rates and net migration numbers;
- modify the definition file;
- copy the initial population data to a new population binary r/a file;
- compute the new projection.

In addition, we will create a user-defined table with projection results.

Creating a scenario

In the status-quo projection we used as our input rates file the file named MAR_RAT.BIN. This file contains the demographic rates as observed during the period 1986-1990. In the new projection, we will use rates that are based on these 1986-1990, but modified in line with the hypotheses that we are prepared to make with respect to future changes in demographic behaviour. These rates will be stored in file MAR2_RAT.BIN.

For the sake of this Tutorial, suppose that we agree on the following assumptions:

- Mortality rates will decline by 10% over the period 1986-2010 and remain constant thereafter. The decline is uniform over age groups and for both sexes, and it will occur linearly over time. Thus, in 1986-1990 the mortality rates are 100% of their 1986-1990 levels, in 1991-1995 97.5%, in 1996-2000 95%, in 2001-2005 92.5% and from 2006 onwards 90%.
- Fertility rates will slightly increase over time. We keep the age pattern of fertility constant, but we specify values for the period TFR: 1.50 for 1986-1990, 1.60 for 1991-1995, 1.65 for 1996-2000, 1.70 for 2001-2005, 1.75 for 2006-2010, and 1.80 for 2011-2020.
- Net migration numbers will remain constant for all marital states, except for the 'never married'. For this latter category, we specify the net migration numbers as in the table below.

The other rates will be kept constant at their 1986-1990 levels.

	MALES		FEMALES	
	1986-1990 (observed)	1991-1995 And beyond	1986-1990 (obeserved)	1991-1995 And beyond
Births	4623	6000	5312	6000
0-4	8363	12000	7675	12000
5-9	7580	12000	6808	12000
10-14	11203	16000	8298	12000
15-19	13155	20000	6812	16000
20-24	6038	15000	748	10000
25-29	781	5000	816	2000
30-34	-867	1000	314	400
35-39	-1138	0	217	0
40-44	-954	0	269	0
45-49	-776	0	174	0
50-54	-409	0	161	0
55-59	-152	0	213	0
60-64	6	0	194	0
65-69	44	0	223	0
70-74	55	0	78	0
75-79	28	0	84	0
80-84	-19	0	-3	0
85-89	-24	0	24	0
90+	-64	0	-28	0

The rates in the file MAR2_RAT.BIN can be interpreted as transformations of the observed 1986-1990 rates, which are in file MAR_RAT.BIN. In order to create MAR2_RAT.BIN from MAR_RAT.BIN according to these hypotheses, we proceed as follows.

From the main window, give the menu command TOOLS / SCENARIOS. A dialog window appears. Click on the button [...] to the right of the 'Rates file (output)' edit field. If necessary, navigate to the directory containing the binary files. In the 'Open' dialog window, behind 'File name' type mar2_rat, then click the Open button. The output rates file will be named MAR2_RAT.BIN, located in the same directory as where the other binary files reside (this is not strictly necessary, but it is good practice).

In order to save you some typing, the file that specifies how the scenario should be constructed is included on the distribution diskette. The file is named TUTORIAL.SCN. Click on the button [...] to the right of the 'Scenario description file' edit field, and open TUTORIAL.SCN. The contents of this file can be inspected/modified by clicking the 'Edit scenario file' button. For easy reference the file is reproduced below.

```
{mortality rates go down by 10% over period 1986-2010}
Y(1..5) d1 = 1.00 > 0.90 ;
```

```
repeat (1,L,nevr..divo) ;
X(M,/1/,dead) = c1 * X(M,/1/,dead) ;
X(F,/1/,dead) = c1 * X(F,/1/,dead) ;
end repeat ;

{fertility: period TFR goes up, starting at 1.50 in 1986-1990}
d2 = file () 1.50 1.60 1.65 1.70 1.75 1.80 1.80 ;
d3 = c2 / 1.50 ;
B(M,nevr,nevr) = c3 * B(M,nevr,nevr) ;
B(F,nevr,nevr) = c3 * B(F,nevr,nevr) ;
B(M,marr,nevr) = c3 * B(M,marr,nevr) ;
B(F,marr,nevr) = c3 * B(F,marr,nevr) ;

{net migration: constant for MARR / WIDO / DIVO ; file for NEVR}
Y(1..2) d4 = file ([net_nevr.xls]Data!B10:C29,columnwise) A ;
Y(1..2) d5 = file ([net_nevr.xls]Data!D10:E29,columnwise) A ;
N(M,rest,nevr) = c4 ;
N(F,rest,nevr) = c5 ;
```

The first set of statements sets the scenario for the mortality rates. An endogenous constant (D1) is defined for the first five projection intervals, declining linearly from 1.00 in the first interval to 0.90 in the fifth interval. For the later projection intervals, the constant D1 remains at its last level of 0.90. The constant is used as a multiplicative factor for all mortality rates. Note the use of the REPEAT feature, which compresses statements for 8 groups of mortality rates into only 4 lines of text.

The second set of statements sets the fertility rates. This block illustrates the use of file constants. An endogenous constant (D2) is defined with TFR values for the seven projection intervals that are read from the input file itself (thus, the filename in brackets after the FILE keyword remains blank). These TFR values are then converted into multiplicative factors for the age-specific fertility rates, dividing the TFRs by 1.50 which is the TFR for the first projection interval 1986-1990.

The third set of statements sets the net migration numbers for marital status NEVR. This block illustrates the use of age-specific file constants, stored in an Excel file. The Excel file NET_NEVR.XLS, which is included on the distribution diskette, contains the net migration numbers we hypothesized above. Since these numbers refer to the first two projection intervals only, the endogenous constants D4 and D5 are preceded by a 'year indicator' Y(1..2). The values for subsequent projection intervals are the same as for the second interval. You can load this file into Excel to verify that the ranges (filename, sheetname, topleft cell, bottomright cell) indeed correspond to the location of the numbers required. Since age-specific file constants are read first by year and then by age, we should specify that reading the data from Excel should be done 'columnwise'.

In the 'Scenario setting' dialog window, we now should define the size of the file MAR2_RAT.BIN to be created, i.e. we should indicate that we want to create a scenario for 7 projection intervals. Finally, note that the 'Type of Modification' is by default set to 'Fixed'. This is all right for us, since the rates file from which the scenario is to be created contains data for one projection interval only; thus, for each projection interval, the rates in MAR2_RAT.BIN are transformations of the rates in MAR_RAT.BIN for the same fixed interval 1986-1990.

We can now start creating the new rates file by clicking the Run scenario button. After completion, a summary report is shown. Close it with FILE / EXIT, then also close the 'Scenario setting' window to return to the main window.

Modifying the definition file
There are three reasons why we want to modify the definition file before making the new projection:

1. the new projection uses rates file MAR2_RAT.BIN rather than MAR_RAT.BIN;
2. the new projection has input rates that vary over time ('variable scenario') rather than being constant ('constant scenario');
3. if we want to keep the results of the status-quo projection, we need to create new binary files for the projection results.

For these reasons, enter the following:

- Give the menu command DEFINE.
- Go to the tabbed sheet 'Parameters'.
- Change the names of the binary files into mar2_pop.bin, mar2_year.bin, mar2_rat.bin, and mar2_evt.bin, respectively.
- Change the 'Scenario type' into Variable.
- Go to the tabbed sheet 'Consistency'.
- Change the names of the binary files into mar2_evtc.bin, and mar2_ratc.bin, respectively.
- Click the OK button to save the modified definition file.

Copying the initial population data
The new projection will use file MAR2_POP.BIN for its population data, including the initial population. However, this binary file does not yet exist. The initial population is contained in file MAR_POP.BIN and needs to be copied into file MAR2_POP.BIN. There are several ways in which this can be achieved:

- repeat the process of section 4 of this Tutorial, converting the Excel population data to binary file MAR2_POP.BIN;
- copy the complete file MAR_POP.BIN to file MAR2_POP.BIN, using a tool like the Windows Navigator;

- use LIPRO's EDIT command.

For illustrative purposes, we will use this third method. From the main window, issue the command EDIT. A dialog window appears. By default, the controls are set to data of 'Type' population for the 'Year' 1986, which is what we should have. The corresponding numbers are displayed in a worksheet-like control. Since file MAR2_POP.BIN does not exist, all numbers are equal to zero. To remedy this, change the 'File name' edit field into MAR_POP.BIN and click Load. To store these data into file MAR2_POP.BIN, change the 'File name' edit field into MAR2_POP.BIN and click Store. Then click Close to return to the main window.

Making the projection
In order to make the actual projection, issue the Run command. After completion, the summary report is shown. Press the [F10] key to return to the main window.

Producing a table
As a final illustration, let us create a table with the 'Flexible tables' command. Suppose that we want to investigate the development over time in the number of married people, by age and sex. For each projection interval, and for males and females separately, we want to know: the number of married at the start of the interval; the number of new marriages during the interval; the number of marriage dissolutions, distinguished by cause (divorce, widowhood); net migration; and the number of married at the end of the interval.

Issue the command OUTPUT / TABLES. Click on the tabbed page 'Flexible'. In order to save you some typing, the table description file that specifies how the table should be constructed is included on the distribution diskette. The file is named MARRIED.FLX, so we click the [...] button to the right of the 'Description file' edit field and open this file. The table description file can be inspected with the Edit button. However, for easy reference the file is reproduced below.

```
MALES = P(M,marr) ;
MARR = i(M,nevr..divo,marr) ;
DEAD = x(M,marr,dead) ;
WIDO = i(M,marr,wido) ;
DIVO = i(M,marr,divo) ;
NET_MIG = n(M,rest,marr) ;
END = "MALES"+"MARR"-"DEAD"-"WIDO"-"DIVO"+"NET_MIG" ;
FEMALES = P(F,marr) ;
MARR = i(F,nevr..divo,marr) ;
DEAD = x(F,marr,dead) ;
WIDO = i(F,marr,wido) ;
DIVO = i(F,marr,divo) ;
NET_MIG = n(F,rest,marr) ;
END = "FEMALES"+"MARR"-"DEAD"-"WIDO"-"DIVO"+"NET_MIG" ;
TOTAL = P(T,marr) ;
```

```
MARR = i(T,nevr..divo,marr) ;
DEAD = x(T,marr,dead) ;
WIDO = i(T,marr,wido) ;
DIVO = i(T,marr,divo) ;
NET_MIG = n(T,rest,marr) ;
END = "TOTAL"+"MARR"-"DEAD"-"WIDO"-"DIVO"+"NET_MIG" ;
```

In order to create the table, click the Create table button.

Epilogue
Our tour of LIPRO has come to an end. Hopefully, this Tutorial has succeeded in enabling you to explore other features of the program all by yourself. If you start using LIPRO for your own applications, do not hesitate to write if you find particular aspects of the program inconvenient, or, worse still, simply wrong. However, if you find LIPRO useful, so much the better.