

THE LIFELINES PROGRAMMING SUBSYSTEM AND REPORT GENERATOR

LifeLines Version 3.0.7

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Table of Contents

1. Report Programming Manual	1
1.1. INTRODUCTION.....	1
2. LIFELINES PROGRAMMING REFERENCE	6
2.1. Procedures and Functions	6
2.2. Comments	6
2.3. Statements	7
2.4. Expressions	8
2.5. Include Feature.....	9
2.6. Built-in Functions	9
2.7. Value Types	9
2.8. Arithmetic and Logic Functions	11
2.9. Person Functions	15
2.10. Family Functions.....	24
2.11. List Functions.....	27
2.12. Table Functions	30
2.13. GEDCOM Node Functions	31
2.14. Event and Date Functions	34
2.15. Value Extraction Functions	38
2.16. User Interaction Functions	40
2.17. String Functions	42
2.18. Output Mode Functions	48
2.19. Person Set Functions and GEDCOM Extraction	52
2.20. Record Update Functions	57
2.21. Record Linking Functions.....	58
2.22. Miscellaneous Functions.....	59

List of Examples

1-1. Example of ahnentafel report	1
1-2. Example of ahnentafel report script	2

Chapter 1. Report Programming Manual

1.1. INTRODUCTION

The LifeLines programming subsystem lets you produce reports in any style or layout. You may generate files in troff, Postscript, TeX, SGML or any other ASCII-based format, for further text processing and printing. You access the report generator by choosing the `r` command from the main menu. You may also use the programming subsystem to create query and other processing programs that write their results directly upon the screen. For example, there is a LifeLines program that computes the relationship between any two persons in a database.

Each LifeLines program is written in the LifeLines programming language, and the programs are stored in normal files. When you direct LifeLines to run a program, it asks you for the name of the program file, asks you where you want the program's output written, and then runs the program.

For example, say you want LifeLines to generate an ahnentafel. Such a report might look like:

Example 1-1. Example of ahnentafel report

1. Thomas Trask WETMORE IV
b. 18 December 1949, New London, Connecticut
2. Thomas Trask WETMORE III
b. 15 October 1925, New London, Connecticut
3. Joan Marie HANCOCK
b. 6 June 1928, New London, Connecticut
4. Thomas Trask WETMORE Jr
b. 5 May 1896, New London, Connecticut
d. 8 November 1970, New London, Connecticut
5. Vivian Genevieve BROWN
b. 5 April 1896, Mondovi, Wisconsin
6. Richard James HANCOCK
b. 18 August 1904, New London, Connecticut
d. 24 December 1976, Waterford, Connecticut
7. Muriel Armstrong SMITH
b. 28 October 1905, New Haven, Connecticut
8. Thomas Trask WETMORE Sr
b. 13 March 1866, St. Mary's Bay, Nova Scotia
d. 17 February 1947, New London, Connecticut
9. Margaret Ellen KANEEN
b. 27 October 1859, Liverpool, England
d. 10 May 1900, New London, Connecticut
- ... lots more

Here is a LifeLines program that generates this report:

Example 1-2. Example of ahnentafel report script

```
proc main ()
{
  getindi(indi)
  list(ilest)
  list(alist)
  enqueue(ilest, indi)
  enqueue(alist, 1)
  while(indi, dequeue(ilest)) {
    set(ahnen, dequeue(alist))
    d(ahnen) ". " name(indi) nl()
    if (e, birth(indi)) { " b. " long(e) nl() }
    if (e, death(indi)) { " d. " long(e) nl() }
    if (par, father(indi)) {
      enqueue(ilest, par)
      enqueue(alist, mul(2, ahnen))
    }
    if (par, mother(indi)) {
      enqueue(ilest, par)
      enqueue(alist, add(1, mul(2, ahnen)))
    }
  }
}
```

Say this program is in the file `ahnen`. When you choose the **r** option from the main menu, LifeLines asks:

```
What is the name of the report program?
enter string:
```

You enter **ahnen**. Since the program generates a report, LifeLines asks where to write that report:

```
What is the name of the output file?
enter file name:
```

You enter a file name, say **my. ahnen**. LifeLines reads the program `ahnen`, executes the program, and writes the report output to `my. ahnen`. LifeLines reports any syntax or run-time errors found while trying to run the program.

A LifeLines program is made up of procedures and functions; every program must contain at least one procedure named `main`. The `main` procedure runs first; it may call other procedures, functions and built-in functions. In the `ahnentafel` example there is only one procedure.

A procedure body is a sequence of statements. In the example program the first five statements are:

```
getindi(indi)
list(ilist)
list(alist)
enqueue(ilist, indi)
enqueue(alist, 1)
```

The first statement calls the `getindi` (get individual) built-in function, which causes LifeLines to ask you to identify a person using the zip browse style of identification:

```
Identify person for interpreted report
enter name:
```

After you identify a person, he or she is assigned to the variable `indi`. The next two statements declare two list variables, `ilist` and `alist`. Lists hold sequences of things; there are operations for placing things on lists, taking things off, and iterating through the list elements. In the example, `ilist` holds a list of ancestors, in `ahnentafel` order, who have not yet been reported on, and `alist` holds their respective `ahnentafel` numbers.

The next two statements call the `enqueue` function, adding the first members to both lists. The person identified by the `getindi` function is made the first member of `ilist`, and the number one, this person's `ahnentafel` number, is made the first member of `alist`.

The rest of the program is:

```
while(indi, dequeue(ilist)) {
  set(ahmen, dequeue(alist))
  d(ahmen) ". " name(indi) nl()
  if (e, birth(indi)) { " b. " long(e) nl() }
  if (e, death(indi)) { " d. " long(e) nl() }
  if (par, father(indi)) {
    enqueue(ilist, par)
    enqueue(alist, mul(2, ahnen))
  }
  if (par, mother(indi)) {
    enqueue(ilist, par)
    enqueue(alist, add(1, mul(2, ahnen)))
  }
}
```

This is a loop that iteratively removes persons and their ahnentafel numbers from the two lists, and then prints their names and birth and death information. If the persons have parents in the database, their parents and their parents' ahnentafel numbers are then put at the ends of the lists. The loop iterates until the list is empty.

The loop is a while loop statement. The line:

```
while(indi, dequeue(ilist)) {
```

removes (via `dequeue`) a person from `ilist`, and assigns the person to variable `indi`. As long as there are persons on `ilist`, another iteration of the loop follows.

The statement:

```
set(ahnen, dequeue(alist))
```

is an assignment statement. The second argument is evaluated; its value is assigned to the first argument, which must be a variable. Here the next number in `alist` is removed and assigned to variable `ahnen`. This is the ahnentafel number of the person just removed from `ilist`.

The line:

```
d(ahnen) ". " name(indi) nl()
```

contains four expression statements; when expressions are used as statements, their values, if any, are treated as strings and written directly to the report output file. The `d` function converts its integer argument to a numeric string. The `". "` is a literal (constant) string value. The `name` function returns the default form of a person's name. The `nl` function returns a string containing the newline character.

The next two lines:

```
if(e, birth(indi)) { " b. " long(e) nl() }
if(e, death(indi)) { " d. " long(e) nl() }
```

write out basic birth and death information about a person. These lines are if statements. The second argument in the conditional is evaluated and assigned to the first argument, which must be a variable. The first if statement calls the `birth` function, returning the first birth event in a person's record. If the event exists it is assigned to variable `e`, and the body (the items between the curly brackets) of the if statement is executed. The body consists of three expression statements: a literal, and calls to the `long` and `nl` functions. `Long` takes an *event* and returns the values of the first *DATE* and *PLAC* lines in the event.

Finally in the program is:


```
if (par, father(indi)) {  
  enqueue(ilist,par)  
  enqueue(alist,mul(2,ahnen))  
}  
if (par,mother(indi)) {  
  enqueue(ilist,par)  
  enqueue(alist,add(1,mul(2,ahnen)))  
}
```

These lines add the father and mother of the current person, if either or both are in the database, to `ilist`. They also compute and add the parents' ahnentafel numbers to `alist`. A father's ahnentafel number is twice that of his child. A mother's ahnentafel number is twice that of her child plus one. These values are computed with the `mul` and `add` functions.

Chapter 2. LIFELINES PROGRAMMING REFERENCE

LifeLines programs are stored in files you edit with a screen editor. Programs are not edited from within the LifeLines program; edit them as you would any text file. The programs may be stored in any directories; they do not have to be kept in or associated with LifeLines databases. You may set the LLPROGRAMS shell variable to hold a list of directories that LifeLines will use to automatically search for programs when you request program execution.

2.1. Procedures and Functions

A LifeLines program is made up of one or more procedures and functions. A procedure has format:

```
proc name ( params ) { statements }
```

Name is the name of the procedure, params is an optional list of parameters separated by commas, and statements is a list of statements that make up the procedure body. Report generation begins with the first statement in the procedure named `main`. Procedures may call other procedures and functions. Procedures are called with the call statement described below. When a procedure is called, the statements making up its body are executed.

A function has format:

```
func name ( params ) { statements }
```

Name, params and statements are defined as in procedures. Functions may call other procedures and functions. When a function is called the statements that make it up are executed. A function differs from a procedure by returning a value to the procedure or function that calls it. Values are returned by the return statement, described below. Recursive functions are allowed. A function is called by invoking it in an expression.

2.2. Comments

You may comment your LifeLines programs using the following notation:

```
/*...comment text including any characters except */... */
```

Comments begin with a `/*` and end with a `*/`. Comments may appear on lines of their own or on lines that have program constructs. Comments may span many lines. Comments may not be nested.

2.3. Statements

There are a number of statement types. The simplest is an expression statement, an expression that is not part of any other statement or expression. Expressions are defined more fully below. An expression statement is evaluated, and if its value is non-null (non-zero), it is assumed to be a string, and written to the program output file. If its value is null, nothing is written to the output file. For example, the expression

```
name(indi)
```

, where `indi` is a person, returns the person's name and writes it to the output file. On the other hand, the expression

```
set(n, nspouses(indi))
```

assigns the variable `n` the number of spouses that person `indi` has, but since `set` returns null, nothing is written to the output file.

The programming language includes if statements, while statements and procedure call statements, with the following formats:

```
if ([varb,] expr) { statements }
    [ elseif ([varb], expr) { statements } ]*
    [ else { statements } ]
```

```
while ([varb,] expr ) { statements }
```

```
call name ( args )
```

Square brackets indicate optional parts of the statement syntax. An if statement is executed by first evaluating the conditional expression in the if clause. If non-zero, the statements in the if clause are evaluated, and the rest of the if statement, if any, is ignored. If the value is zero, and there is an elseif clause following, the conditional in the elseif clause is evaluated, and if non-zero, the statements in that clause are executed. Conditionals are evaluated until one of them is non-zero, or until there are no more. If no conditional is non-zero, and if the if statement ends with an else clause, the statements in the else clause are executed. There are two forms of conditional expressions. If the conditional is a single expression, it is simply evaluated. If the conditional is a variable followed by an expression, the expression is evaluated and its value is assigned to the variable.

Note that `if` treats null strings as false, but empty strings as true. This has the benefit that

```
if(birth(indi))
```

will return true if there is a BIRT record, even if it is empty, but will return false if there is no BIRT record at all.

The `while` statement provides a looping mechanism. The conditional is evaluated, and if non-zero, the body of the loop is executed. After each iteration the expression is reevaluated; as long as it remains non-zero, the loop is repeated.

The `call` statement provides procedure calls. Name must match one of the procedures defined in the report program. Args is a list of argument expressions separated by commas. Recursion is allowed. When a call is executed, the values of its arguments are evaluated and used to initialize the procedure's parameters. The procedure is then executed. When the procedure completes, execution resumes with the first item after the call.

The report language also includes the following statement types:

```
include(string)
```

```
global(varb)
```

```
set(varb, expr)
```

```
continue()
```

```
break()
```

```
return([expr])
```

The `include` statement includes the contents of another file into the current file; its *string* expression is the name of another LifeLines program file. It is described in more detail below. The `global` statement must be used outside the scope of any procedure or function; it declares a *variable* to have global scope. The `set` statement is the assignment statement; the *expression* is evaluated, and its value is assigned to the *variable*. The `continue` statement jumps to the bottom of the current loop, but does not leave the loop. The `break` statement breaks out of the most closely nested loop. The `return` statement returns from the current procedure or function. Procedures have return statements without expressions; functions have return statements with expressions. None of these statements return a value, so none has a direct effect on program output.

In addition to these conventional statements, the report generator provides other iterator statements for looping through genealogical and other types of data. For example, the `children` statement iterates through the children of a family, the `spouses` statement iterates through the spouses of a person, and the `families` statement iterates through the families that a person is a spouse or parent in. These iterators and others are described in more detail later under the appropriate data types.

2.4. Expressions

There are four types of expressions: literals, integers, variables and built-in or user defined function calls.

A literal is any string enclosed in double quotes; its value is itself. An integer is any integer constant; its value is itself. A variable is a named location that can be assigned different values during program execution. The value of a variable is the last value assigned to it. Variables do not have fixed type; at different times in a program, the same variable may be assigned data of completely different types. An identifier followed by comma-separated list of expressions enclosed in parentheses, is either a call to a built-in function or a call to a user-defined function.

2.5. Include Feature

The LifeLines programming language provides an include feature. Using this feature one LifeLines program can refer to other LifeLines programs. This feature is provided by the include statement:

```
include(string)
```

where string is a quoted string that is the name of another LifeLines program file. When an include statement is encountered, the program that it refers to is read at that point, exactly as if the contents of included file had been in the body of the original file at that point. This allows you to create LifeLines program library files that can be used by many programs. Included files may in turn contain include statements, and so on to any depth. LifeLines will use the LLPROGRAMS shell variable, if set, to search for the include files.

2.6. Built-in Functions

There is a long list of built-in functions, and this list will continue to grow for some time. The first subsection below describes the value types used in LifeLines programs; these are the types of variables, function parameters and function return values. In the remaining sections the built-in functions are separated into logical categories and described.

2.7. Value Types

ANY

union of all types

INT

integer (on most systems a 32-bit signed value)

BOOL

boolean (0 represents false; anything else represents true)

STRING

text string

LIST

arbitrary length list of any values

TABLE

keyed look-up table

INDI

person; reference to a GEDCOM INDI record

FAM

family; reference to a GEDCOM FAM record

SET

arbitrary length set of persons

NODE

GEDCOM node; reference to a line in a GEDCOM tree/record

EVENT

event; reference to substructure of nodes in a GEDCOM record

VOID

type with no values

In the summaries of built-in functions below, each function is shown with its argument types and its return type. The types are from the preceding list. Sometimes an argument to a built-in function must be a variable; when this is so its type is given as `xxx_v`, where `xxx` is one of the types above. The built-ins do not check the types of their arguments. Variables can hold values of any type, though at any one time they will hold values of only one type. Note that `EVENT` is a subtype of `NODE`, and `BOOL` is a subtype of `INT`. Built-ins with type `VOID` actually return null (zero) values.

2.8. Arithmetic and Logic Functions

```
INT add ( INT INT ... );
```

addition - two to 32 arguments

```
INT sub( INT , INT );
```

subtraction

```
INT mul( INT, INT, ... );
```

multiplication - two to 32 arguments

```
INT div( INT, INT );
```

division

```
INT mod( INT, INT );
```

modulus (remainder)

```
INT exp( INT, INT );
```

exponentiation

```
INT neg( INT );
```

integer negation


```
VOID incr( INT_V );
```

increment variable by one

```
VOID decr( INT_V );
```

decrement variable by one

```
BOOL and( BOOL, BOOL, ... );
```

logical and - two to 32 arguments

```
BOOL or( BOOL, BOOL, ... );
```

logical or - two to 32 arguments

```
BOOL not( BOOL );
```

logical not

BOOL **eq**(ANY , ANY) ;

equality (not strings)

BOOL **ne**(ANY , ANY) ;

non-equality

BOOL **lt**(ANY , ANY) ;

less than

BOOL **gt**(ANY , ANY) ;

greater than

BOOL **le**(ANY , ANY) ;

less than or equal

```
BOOL ge( ANY , ANY ) ;
```

greater than or equal

Add, sub, mul and div do integer arithmetic. Functions add and mul can have two to 32 arguments; the sum or product of the full set of arguments is computed. Functions sub and div have two arguments each; sub subtracts its second argument from its first, and div divides its first argument by its second. The mod function returns the remainder after dividing the first parameter by the second. If the second argument to div or mod is zero, these functions return 0 and generate a run time error. Exp performs integer exponentiation. Neg negates its argument.

Incr and decr increment by one and decrement by one, respectively, the value of a variable. The argument to both functions must be a variable.

And and or do logical operations. Both functions take two to 32 arguments. All arguments are and'ed or or'ed together, respectively. The arguments are evaluated from left to right, but only up to the point where the final value of the function becomes known. Not does the logical not operation.

Eq, ne, lt, le, gt and ge evaluate the six ordering relationships between two integers.

2.9. Person Functions

```
STRING name ( INDI BOOL ) ;
```

default name of

```
STRING fullname( INDI , BOOL , BOOL , INT ) ;
```

many name forms of

```
STRING surname(INDI) ;
```

surname of

```
STRING givens(INDI) ;
```

given names of

```
STRING trimname(INDI, INT) ;
```

trimmed name of

```
EVENT birth(INDI) ;
```

first birth event of

```
EVENT death(INDI) ;
```

first death event of

EVENT **baptism**(*INDI*);

first baptism event of

EVENT **burial**(*INDI*);

first burial event of

INDI **father**(*INDI*);

first father of

INDI **mother**(*INDI*);

first mother of

INDI **nextsib**(*INDI*);

next (younger) sibling of

```
INDI prevsib( INDI );
```

previous (older) sibling of

```
STRING sex( INDI );
```

sex of

```
BOOL male( INDI );
```

male predicate

```
BOOL female( INDI );
```

female predicate

```
STRING pn( INDI, INT );
```

pronoun referring to

```
INT nspouses( INDI );
```

number of spouses of

```
INT nfamilies( INDI );
```

number of families (as spouse/parent) of

```
FAM parents( INDI );
```

first parents' family of

```
STRING title( INDI );
```

first title of

```
STRING key( INDI / FAM , BOOL );
```

internal key of (work for families also)

```
STRING soundex( INDI );
```

SOUNDEX code of

```
NODE inode( INDI );
```

root GEDCOM node of

```
NODE root( INDI );
```

root GEDCOM node of

```
INDI indi( STRING );
```

find person with key value

```
INDI firstindi(void);
```

first person in database in key order


```
INDI lastindi(void);
```

last person in database in key order

```
INDI nextindi(INDI);
```

next person in database in key order

```
INDI previndi(INDI);
```

previous person in database in key order

```
spouses (INDI, INDI, FAM, INT) { commands }
```

loop through all spouses of

```
families (INDI, FAM, INDI, INT) { commands }
```

loop through all families (as spouse) of

```
forindi (INDI, INT) { commands }
```

loop through all persons in database

These functions take a person as a parameter and return information about him or her.

`Name` returns the default name of a person; this is the name found on the first `1 NAME` line in the person's record; the slashes are removed and the surname is made all capitals; `name` can take an optional second parameter - if it is true the function acts as described above; if false, the surname is kept exactly as it is in the record.

`Fullname` returns the name of a person in a variety of formats. If the second parameter is true the surname is shown in upper case; otherwise the surname is as in the record. If the third parameter is true the parts of the name are shown in the order as found in the record; otherwise the surname is given first, followed by a comma, followed by the other name parts. The fourth parameter specifies the maximum length field that can be used to show the name; various conversions occur if it is necessary to shorten the name to fit this length.

`Surname` returns the surname of the person, as found in the first `1 NAME` line; the slashes are removed. `Givens` returns the given names of the person in the same order and format as found in the first `1 NAME` line of the record. `Trimname` returns the default name of the person trimmed to the maximum character length given in the second variable.

`Birth`, `death`, `baptism` and `burial` return the first birth, death, baptism and burial event in the person's record, respectively. An event is a level `1 GEDCOM` node. If there is no matching event these functions return null.

`Father`, `mother`, `nextsib` and `prevsib` return the father, mother, next younger sibling and next older sibling of the person, respectively. If the person has more than one father (mother) the `father` (`mother`) function returns the first one. These functions return null if there is no person in the role.

`Sex` returns the person's sex as the string M if the person is male, F if the person is female, or U if the sex of the person is not known. `Male` and `female` return true if the person is male or female, respectively, or false if not.

`Pn` generates pronouns, useful when generating English text; the second parameter selects the type of pronoun:

0

He/She

1

he/she

2

His/Her

3

his/her

4

him/her

`Nspouses` returns the number of spouses the person has in the database, and `nfamilies` returns the number of families the person is a parent/spouse in; these two values are not necessarily the same.

`Parents` returns the first family that the person is a child in.

`Title` returns the value of the first `1 TITL` line in the record. `Key` returns the key value of a person or family; if there is a second parameter and it is non-null, the leading `I` or `F` will be stripped. `Soundex` returns the Soundex code of the person.

`Root` and `Inode` return the root node of the person's GEDCOM node tree. Note that an `INDI` value is not a `NODE` value. If you want to process the nodes within a person node tree, you must first use the `root` or `inode` function to get the root of the person node tree. `Root` and `inode` are synonyms.

`Indi` returns the person who's key is passed as an argument; if no person has the key `indi` returns null.

`Firstindi`, `nextindi` and `previndi` allow you to iterate through all persons in the database.

`Firstindi` returns the first person in the database in key order. `Nextindi` returns the next person after the argument person in key order. `Previndi` returns the previous person before the argument person in key order.

Spouses is an iterator that loops through each spouse a person has. The first argument is a person. The second argument is a person variable that iterates through the first person's spouses. The third argument is a family variable that iterates through the families the person and each spouse are in. The fourth argument is an integer variable that counts the iterations.

Families is an iterator that loops through the families a person was a spouse/parent in. The first argument is a person. The second argument is a family variable that iterates through the families the first person was a spouse/parent in. The third argument iterates through the spouses from the families; if there is no spouse in a particular family, the variable is set to null for that iteration. The fourth argument is an integer variable that counts the iterations.

Forindi is an iterator that loops through every person in the database in ascending key order. Its first parameter is a variable that iterates through the persons; its second parameter is an integer counter

variable that counts the persons starting at one.

2.10. Family Functions

EVENT **marriage**(*FAM*) ;

first marriage event of

INDI **husband**(*FAM*) ;

first husband/father of

INDI **wife**(*FAM*) ;

first wife/mother of

INT **nchildren**(*FAM*) ;

number of children in

INDI **firstchild**(*FAM*) ;

first child of

```
INDI lastchild(FAM) ;
```

last child of

```
STRING key(FAM/INDI, BOOL) ;
```

internal key of (works for persons also)

```
NODE fnode(FAM) ;
```

root GEDCOM node of

```
NODE root(FAM) ;
```

root GEDCOM node of

```
FAM fam(STRING) ;
```

find family from key

```
FAM firstfam(void);
```

first family in database in key order

```
FAM lastfam(void);
```

last family in database in key order

```
FAM nextfam(FAM);
```

next family in database in key order

```
FAM prevfam(FAM);
```

previous family in database in key order

```
children (FAM, INDI_V, INT_V) { commands }
```

loop through children of family

```
forfam (FAM_V, INT_V) { commands }
```

loop through all families in database

These functions take a family as an argument and return information about it.

`Marriage` returns the first marriage event found in the family record, if any; it returns null if there is no marriage event.

`Husband` returns the first husband/father of the family, if any; and `wife` returns the first wife/mother of the family, if any. Each returns null if the requested person is not in the family.

`Nchildren` returns the number of children in the family.

`Firstchild` and `lastchild` return the first child and last child in a family, respectively.

`Key` was described in the section on person functions.

`Root` and `fnode` return the root node of a family GEDCOM node tree. Note that a `FAM` value is not a `NODE` value. If you want to process the nodes within a family node tree, you must first use `root` or `fnode` function to get the root of the family node tree. `Root` and `fnode` are synonyms.

`Fam` returns the family who's key is passed as an argument; if no family has the key `fam` returns null.

`Firstfam`, `nextfam` and `prevfam` allow you to iterate through all families in the database. `Firstfam` returns the first family in the database in key order. `Nextfam` returns the next family after the argument family in key order. `Prevfam` returns the previous family before the argument family in key order.

Children is an iterator that loops through the children in a family. Its first parameter is a family expression; its second parameter is a variable that iterates through each child; its third parameter is an integer counter variable that counts the children starting at one. These two variables may be used within the loop body.

Forfam is an iterator that loops through every family in the database in ascending key order. Its first parameter is a variable that iterates through the families; its second parameter is an integer counter variable that counts the families starting at one.

2.11. List Functions

```
VOID list(LIST_V);
```

declare a list

```
BOOL empty(LIST);
```

check if list is empty

```
VOID list(LIST_V);
```

declare a list

```
VOID enqueue(LIST, ANY);
```

enqueue element on list

```
ANY dequeue(LIST);
```

dequeue and return element from list


```
VOID requeue(LIST, ANY);
```

requeue an element on list

```
VOID push(LIST, ANY);
```

push element on list

```
ANY pop(LIST);
```

pop and return element from list

```
VOID setel(LIST, INT, ANY);
```

array element assignment

```
ANY getel(LIST, INT);
```

array element selection

```
forlist (LIST, ANY_V, INT_V) { commands }
```

loop through all elements of list

LifeLines provides general purpose lists that can be accessed as queues, stacks or arrays. A list must be declared with the `list` function before it can be used.

A list can have any number of elements. `Empty` returns true if the list has no elements and false otherwise. `Length` returns the length of the list. The only parameter to both is a list.

`Enqueue`, `dequeue` and `requeue` provide queue access to a list. `Enqueue` adds an element to the back of a queue, `dequeue` removes and returns the element from the front of a queue, and `requeue` adds an element to the front of a queue. The first parameter to all three is a list, and the second parameter to `enqueue` and `requeue` is the value to be added to the queue and can be any value.

`Push` and `pop` provide stack access to a list. `Push` pushes an element on the stack, and `pop` removes and returns the most recently pushed element from the stack. The first parameter to both is a list, and the second parameter to `push` is the value to be pushed on the stack and can be of any type.

`Setel` and `getel` provide array access to a list. `Setel` sets a value of an array element, and `getel` returns the value of an array element. The first parameter to both is a list; the second parameter to both is an integer index into the array; and the third parameter to `setel` is the value to assign to the array element and can be of any type. Array elements are indexed starting at one. Unassigned elements are assumed to be null (0). Arrays automatically grow in size to accommodate the largest index value that is used.

Forlist is an iterator that loops through the element in a list. Its first parameter is a LIST expression; its second parameter is a variable that iterates through the list elements; and its third parameter is an integer counter variable that counts the list elements starting at one.

2.12. Table Functions

```
VOID table(TABLE_V);
```

declare a table

```
VOID insert(TABLE, STRING, ANY);
```

insert entry in table

```
ANY lookup(TABLE, STRING);
```

lookup and return entry from table

These functions provide general purpose, keyed tables. A table must be declared with the `table` function before it can be used.

`Insert` adds an object and its key to a table. Its first parameter is a table; the second parameter is the object's key; and the third parameter is the object itself. The key must be a string and the object can be any value. If there already is an object in the table with that key, the old object is replaced with the new.

`Lookup` retrieves an object from a table. Its first parameter is a table, and the second parameter is the object's key. The function returns the object with that key from the table; if there is no such object, null is returned.

2.13. GEDCOM Node Functions

```
STRING xref(NODE) ;
```

cross reference index of

```
STRING tag(NODE) ;
```

tag of

```
STRING value(NODE) ;
```

value of

```
NODE parent(NODE) ;
```

parent node of

```
NODE child(NODE) ;
```

first child of

```
NODE sibling(NODE);
```

next sibling of

```
NODE savenode(NODE);
```

copy a node structure

```
fornodes (NODE, NODE_V) { commands }
```

loop through child nodes

```
traverse (NODE, NODE_V, INT_V) { commands }
```

loop through all descendent nodes

These functions provide access to the components of a GEDCOM node. All take a GEDCOM node as their only parameter, and each returns a different value associated with the node.

`Xref` returns the cross reference index of the node, if any; `tag` returns the tag of the node; and `value` returns the value of the node, if any. If there is no cross reference, `xref` returns null; if there is no value, `value` returns null.

`Parent` returns the parent node of the node, if any; `child` returns the first child node of the node, if any; and `sibling` returns the next sibling node of the node, if any. Whenever there is no such related node, these functions return null. These three functions allow simple navigation through a GEDCOM node tree.

`Savenode` makes a copy of the node, and the substructure of nodes below the node, that is passed to it. Beware: the memory used to make the copy is never returned to the system.

Fornodes is an iterator that loops through the child nodes of a GEDCOM node. Its first argument is a node expression, and its second parameter is a variable that iterates through each direct child node of the first node.

Traverse is an iterator providing a general method for traversing GEDCOM trees. Its first parameter is a node expression; its second parameter is a variable that iterates over every node under the first node in a top down, left to right manner; and its third parameter is a variable that is set to the level of the current node in the iteration.

2.14. Event and Date Functions

```
STRING date(EVENT) ;
```

date of, value of first *DATE* line

```
STRING place(EVENT) ;
```

place of, value of first *PLAC* line

```
STRING year(EVENT) ;
```

year or, 1st string of 3-4 digits in 1st *DATE* line

```
STRING long(EVENT);
```

date and place, values of 1st *DATE* and *PLAC* lines

```
STRING short(EVENT);
```

date and place of, abbreviated from

```
EVENT gettoday(void);
```

returns the ‘event’ of the current date

```
VOID dayformat(INT);
```

set day format for stddate calls

```
VOID monthformat(INT);
```

set month format for stddate calls

```
VOID dateformat( INT );
```

set date format for stddate calls

```
STRING stddate( EVENT );
```

date of, in current format

These functions extract information about the dates and places of events.

`Date` returns the value of the first *DATE* line in an event, a node in a GEDCOM record tree. `Date` finds the first *DATE* line one level deeper than the event node. `Place` returns the value of the first *PLAC* line in an event. `Year` returns the first three or four digit number in the value of the first *DATE* line in an event; this number is assumed to be the year of the event.

`Long` returns the verbatim values of the first *DATE* and *PLAC* lines in an event, catenated together and separated by a comma. `Short` abbreviates information from the first *DATE* and *PLAC* lines, catenates the shortened information together with a comma separator and returns it. An abbreviated date is its year; an abbreviated place is the last component in the value, further abbreviated if the component has an entry in the place abbreviation table.

`Gettoday` creates an event that has today's date in the *DATE* line.

The last four functions are used to format dates in a variety of ways. `Dayformat`, `monthformat`, and `dateformat` select style options for formatting the day, month, and overall date structure; `stddate` returns dates in the selected style. The day format codes passed to `dayformat` are:

0

leave space before single digit days

1

use leading 0 before single digit days

2

no space or leading 0 before single digit days

The month format codes passed to `monthformat` are:

0

number with space before single digit months

1

number with leading zero before single digit months

2

number with no space or zero before single digit months

3

upper case abbreviation (eg, JAN, FEB)

4

capitalized abbreviation (eg, Jan, Feb)

5

upper case full word (eg, JANUARY, FEBRUARY)

6

capitalized full word (eg, January, February)

The full date formats passed to `stddate` are:

0

da mo yr

1

mo da, yr

2

mo/da/yr

3

da/mo/yr

4	mo-da-yr
5	da-mo-yr
6	modayr
7	damoyr
8	yr mo da
9	yr/mo/da
10	yr-mo-da
11	yrmoda
12	yr (year only, omitting all else)
13	da/mo yr
14	(As in GEDCOM)

2.15. Value Extraction Functions

```
VOID extractdate(NODE, INT_V, INT_V, INT_V);
```

extract a date

```
VOID extractnames(NODE, LIST_V, INT_V, INT_V);
```

extract a name

```
VOID extractplaces(NODE, LIST_V, INT_V);
```

extract a place

```
VOID extracttokens(STRING, LIST_V, INT_V, STRING);
```

extract tokens

Value extraction functions read the values of certain lines and return those values in extracted form.

Extractdate extracts date values from either an event node or *DATE* node. The first parameter must be a node; if its tag is *DATE*, the date is extracted from the value of that node; if its tag is not *DATE*, the date is extracted from the first *DATE* line one level below the argument node. The remaining three arguments are variables. The first is assigned the integer value of the extracted day; the second is assigned the integer value of the extracted month; and the third is assigned the integer value of the extracted year.

Extractnames extracts name components from a *NAME* line. Its first argument is either an *INDI* or a *NAME* node. If it is a *NAME* line, the components are extracted from the value of that node; if it is an *INDI* line, the components are extracted from the value of the first *NAME* line in the person record. The second argument is a list that will hold the extracted components. The third argument is an integer variable that is set to the number of extracted components. The fourth argument is a variable that is set to the index (starting at one) of the surname component; the / characters are removed from around the surname component. If there is no surname this argument variable is set to zero.

Extractplaces extracts place components from a *PLAC* node. The first argument is a node; if its tag is *PLAC*, the places are extracted from the value of the node; if its tag is not *PLAC*, places are extracted from the first *PLAC* line one level below the argument node. The second parameter is a list that will hold

the extracted components. The third argument is an integer variable that is set to the number of extracted components. Place components are defined by the comma-separated portions of the *PLAC* value; leading and trailing white space is removed from the components, while all internal white space is retained.

`Extracttokens` extracts tokens from a string and places them in a list. The first argument is the string to extract tokens from. The second argument is the list to hold the tokens. The third argument is an integer variable that is set to the number of tokens extracted. The fourth parameter is the string of delimiter characters that `extracttokens` uses to break the input string into tokens.

2.16. User Interaction Functions

```
VOID getindi(INDI_V , STRING);
```

identify person through user interface

```
VOID getindiset(SET_V , STRING);
```

identify set of persons through user interface

```
VOID getfam(FAM_V);
```

identify family through user interface

```
VOID getint(INT_V , STRING);
```

get integer through user interface

```
VOID getstr(STRING_V , STRING) ;
```

get string through user interface

```
INDI choosechild(INDI / FAM) ;
```

select child of person/family thru user interface

```
FAM choosefam(INDI) ;
```

select family person is in as spouse

```
INDI chooseindi(SET) ;
```

select person from set of persons

```
INDI choosespouse(INDI) ;
```

select spouse of person

```
SET choosesubset(SET) ;
```

select a subset of persons from set of persons

```
INT menuchoose(LIST, STRING) ;
```

select from a list of options

These functions interact with the user to get information needed by the program.

`Getindi` asks the user to identify a person. The first argument is a variable that is set to the person. The second is an optional string to use as a prompt. `Getindiset` asks the user to identify a set of persons. `Getfam` asks the user identify a family. `Getint` and `getstr` ask the user enter an integer and string, respectively.

`Choosechild` asks the user select a child of a family or person; its single argument is a person or family; it return the child. `Choosefam` has the user select a family that a person is in as a spouse; its argument is a person; it returns the family. `Chooseindi` has the user select one person from a set of persons; its argument in a set of persons; it returns the chosen person. `Choosespouse` has the user select a spouse of a person; its argument is a person; it returns the chosen spouse. `Choosesubset` has the user select a subset of persons from a set of persons; its argument is the chosen subset.

`Menuchoose` allows the user to select from an arbitrary menu. The first argument is a list of strings making up the items in the menu; the second, optional argument is a prompt string for the menu; `menuchoose` returns the integer index of the item selected by the user; if the user doesn't select an item, zero is return.

2.17. String Functions

```
STRING lower(STRING);
```

convert to lower case

```
STRING upper(STRING);
```

convert to upper case

```
STRING capitalize(STRING);
```

capitalize first letter

```
STRING trim(STRING, INT);
```

trim to length

```
STRING rjustify(STRING, INT);
```

right justify in field

```
STRING save(STRING);
```

save and return copy of string

```
STRING strsave(STRING);
```

same as save function

```
STRING concat(STRING, STRING, ...);
```

catenate two strings

```
STRING strconcat(STRING, STRING, ...);
```

catenate two strings

```
INT strlen(STRING);
```

number of characters in string


```
STRING substring( (STRING, INT, INT) );
```

substring function

```
INT index(STRING, STRING, INT);
```

index function

```
STRING d(INT);
```

number as decimal string

```
STRING card(INT);
```

number in cardinal form (one, two, ...)

```
STRING ord(INT);
```

number in ordinal form (first, second, ...)

STRING **alpha**(INT);

convert number to Latin letter (a, b, ...)

STRING **roman**(INT);

number in Roman numeral form (i, ii, ...)

STRING **strsoundex**(STRING);

find SOUNDEX value of arbitrary string

INT **strtoint**(STRING);

convert numeric string to integer

INT **atoi**(STRING);

convert numeric string to integer

```
INT strcmp(STRING, STRING);
```

general string compare

```
BOOL eqstr(STRING, STRING);
```

compare strings for equality

```
BOOL nestr(STRING, STRING);
```

compare strings for inequality

These functions provide string handling. Prior to version 3.0.6, many of them used an approach to memory management chosen for absolute minimal memory footprint. A function using this approach constructed its output string in its own string buffer, reusing that buffer each time it was called. When a function using this approach returned a string value it returned its buffer. In consequence the strings returned by these functions were to be either used or saved before the function was called again.

By the release of version 3.0.6, all string values are local copies, and the `save` and `strsave` functions should be entirely unnecessary.

`Lower` and `upper` convert the letters in their arguments to lower or upper case, respectively. `Capitalize` converts the first character of the argument, if it is a letter, to upper case. `Lower` and `upper` historically used the buffer return method; `capitalize` operates on and returns its argument.

`Trim` shortens a string to the length specified by the second parameter. If the string is already of that length or shorter the string is not changed. `Rjustify` right justifies a string into another string of the length specified by the second parameter. If the original string is shorter than the justified string, blanks are inserted to the left of the original string; if the string is longer than the justified string, the original string is truncated on the right. `Trim` historically used the buffer return method; `rjustify` creates and returns a new string.

`Save` creates a copy of the argument string and returns it. This function is required because built-in functions that return strings use the buffer return method; if a string is to be used repeatedly or long after it is returned from a function, it should first be saved by using the `save` function. `Strsave` is the same function as `save`. With version 3.0.6 or later, this should be unnecessary.

`Concat` and `strconcat` concatenate strings and return the result. They are identical functions. They may take two to 32 string arguments; null arguments are allowed. The arguments are concatenated together into a single, newly allocated string, which is returned.

`Strlen` returns the length of the string argument.

`Substring` returns a substring of the first argument string. The second and third arguments are the indices of the first and last characters in the argument string to use to form the substring. The indexes are relative one. `Substring` historically used the buffer return method.

`Index` returns the character index of the *n*th occurrence of a substring within a string. The index is the relative one character offset to the beginning of the substring. The first argument is the string; the second argument is the substring; and the third argument is the occurrence number.

`D`, `card`, `ord`, `alpha` and `roman` convert integers to strings. `D` converts an integer to a numeric string; `card` converts an integer to a cardinal number string (eg, `one`, `two`, `three`); `ord` converts an integer to an ordinal number (eg, `first`, `second`, `third`); `alpha` converts an integer to a letter (eg, `a`, `b`, `c`); and `roman` converts an integer to a Roman numeral (eg, `i`, `ii`, `iii`).

`Strsoundex` converts an arbitrary string to a SOUNDEX value. Non-ASCII text characters are ignored in the string.

`Strtoint` converts a numeric string to an integer. `Atoi` is identical to `strtoint`.

`Strcmp` compares two strings and returns an integer that is less than zero, equal to zero, or greater than zero, if, respectively, the first string is lexicographically less than, equal to, or greater than the second string. `Eqstr` and `nestr` return whether two strings are equal or not equal, respectively. `Strcmp`, `Eqstr`, and `nestr` all treat null strings as empty strings, which is to say they pretend that a null string is actually `""`. This means that all null and empty strings compare as equal.

2.18. Output Mode Functions

```
VOID linemode(void);
```

use line output mode

```
VOID pagemode(INT, INT);
```

use page output mode with given page size

```
VOID col(INT);
```

position to column in output

```
VOID row(INT);
```

position to row in output

```
VOID pos(INT, INT);
```

position to (row, col) coordinate in output

VOID **pageout**(void);

output page buffer

STRING **nl**(void);

newline character

STRING **sp**(void);

space character

STRING **qt**(void);

double quote character

VOID **newfile**(STRING, BOOL);

send program output to this file

```
STRING outfile(void);
```

return name of current program output file

```
VOID copyfile(STRING);
```

copy file contents to program output file

```
VOID print(STRING, STRING, ...);
```

print string to standard output window

Reports can be generated in two modes, line mode and page mode. `Linemode` selects line mode and `pagemode` selects page mode; line mode is the default. The first parameter to `pagemode` is the number of rows per page; the second parameter is the number of columns per page. When in the line mode report output is written directly to the output file as the program runs, line by line. When in page mode output is buffered into pages which are written to the output file when `pageout` is called. Page mode is useful for generating charts (eg, pedigree charts or box charts) where it is convenient to compute the two-dimensional location of output.

`Col` positions output to the given column. If the current column is greater than the argument, `col` positions output to the given column on the next line. `Col` works in both modes.

`Row` positions output to the first character in the given row; `row` can only be used in page mode.

`Pos` positions output to a specified row and column coordinate; the first argument specifies the row, and the second specifies the column. `Pos` can only be used in page mode.

`Nl` write a new line character to the output file; `sp` writes a space character to the output file; and `qt` writes a quote character to the output file. Note that `\n` and `\'` can be used within string values to represent the newline and double quote characters.

`Newfile` specifies the name of the report output file. Its first argument is the file's name; its second argument is an append flag - if its value is non-zero the report appends to this file; if its value is zero the report overwrites the contents of the file. `Newfile` can be called many times; this allows a single report program to generate many report output files during one execution. Programs are not required to use `newfile`; if it is not used then LifeLines automatically asks for the name of the report output file.

`Outfile` returns the name of the current report output file.

`Copyfile` copies the contents of a file to the report output file; its argument is a string whose value is the name of a file; if the file name is not absolute nor relative, then the `LLPROGRAMS` environment variable, if set, will be used to search for the file; the file is opened and its contents copied to the report output file.

`Print` prints its argument string to the standard output window; `print` may have one to 32 arguments.

2.19. Person Set Functions and GEDCOM Extraction

```
VOID indiset(SET_V);
```

declare a set variable

```
SET addtoset(SET, INDI, ANY);
```

add a person to a set


```
SET deletefromset(SET, INDI, BOOL);
```

remove a person from a set

```
INT lengthset(SET);
```

size of a set

```
SET union(SET, SET);
```

union of two sets

```
SET intersect(SET, SET);
```

intersection of two sets

```
SET difference(SET, SET);
```

difference of two sets

SET **parentset**(*SET*) ;

set of all parents

SET **childset**(*SET*) ;

set of all children

SET **spouseset**(*SET*) ;

set of all spouses

SET **siblingset**(*SET*) ;

set of all siblings

SET **ancestorset**(*SET*) ;

set of all ancestors

SET **descendentset** (SET) ;

set of all descendents

SET **descendantset** (SET) ;

same as descendentset; spelling

SET **uniqueset** (SET) ;

remove duplicates from set

VOID **namesort** (SET) ;

sort indiset by name

VOID **keysort** (SET) ;

sort indiset by key values

```
VOID valuesort(SET) ;
```

sort indiset by auxiliary values

```
VOID genindiset(STRING, SET) ;
```

generate indiset from GEDCOM name string

```
VOID gengedcom(SET) ;
```

generate GEDCOM file from person set

```
forindiset (SET, INDI_V, ANY_V, INT_V) { commands }
```

loop through all persons in person set

These functions allow you to manipulate person sets. A person set is a potentially large set of persons; each person may have an arbitrary value associated with him/her. A person set must be declared with the `indiset` function before it can be used.

`Addto`set adds a person to a set. The first argument is the set; the second argument is the person; and the third argument may be any value. The same person may be added to a set more than once, each time with a different value. `Deletefrom`set removes a person from a set. The first argument is the set; the second argument is the person; if the third parameter is true all of the person's entries are removed from the set; if false only the first entry is removed. `Length`set returns the number of persons in a person set.

`Union`, `intersect` and `difference` return the set union, set intersection and set difference, respectively, of two person sets. Each functions takes two person sets as arguments and returns a third person set. The functions do not affect the values of their two argument sets.

`Parentset`, `childset`, `spouseset` and `siblingset` return the set of all parents, set of all children, set of all spouses and set of all siblings, respectively, of the set of persons in their argument. In all cases there is no change to the argument person set.

`Ancestorset` returns the set all ancestors of all persons in the argument set. `Descendentset` returns the set of all descendents of all persons in the argument set. `Descendantset` is the same as `descendentset`; it allows an alternate spelling.

`Uniqueset` sorts a person set by key value and then removes all entries with duplicate keys; the input set is modified and returned.

`Namesort`, `keysort` and `valuesort` sort a set of persons by name, by key and by associated value, respectively.

Each person in a person set has an associated value. When a person is added to a set with `addto`set, the value is explicitly assigned. When new sets are created by other functions, a number of rules are used to associate values with persons as they are added to the new sets. For `parentset`, `childset` and `spouseset` the values are copied from the first input set person that causes the new person to be added to the set. For `union`, `intersect` and `difference`, the values are copied from the values in the first input set, except in the case of `union`, when persons are taken from the second set alone, in which case the values come from there. For `ancestorset` and `descendantset` the value is set to the number of generations the new person is away from the *first* person in the input set that the new person is related to. If the new person is related to more than one person in the input set, the value is set for the nearest relationship; that is, the value is as low as possible. `Valuesort` sorts a person set by the values of these auxiliary values.

`Genindiset` generates the set of persons that match a string whose value is a name in GEDCOM format. `Genindiset` uses the same algorithm that matches names entered at the browse prompt or by the user interaction `getindiset` function.

`Gengedcom` generates GEDCOM format output, to the report output file, of all persons in the argument person set. The output contains a person record for each person in the set, and all the family records that link at least two of the persons in the set together.

`Forindiset` is an iterator that loops through each person in an `indiset`. The first parameter is an `indiset`. The second parameter is a variable that iterates through each person in the set. The third parameter iterates through the values associated with the persons. The fourth parameter is an integer variable that counts the iterations.

2.20. Record Update Functions

```
NODE createnode(STRING, STRING);
```

create a GEDCOM node

```
VOID addnode(NODE, NODE, NODE);
```

add a node to a GEDCOM tree

```
VOID deletenode(NODE);
```

delete a node from a GEDCOM tree

These functions allow you to modify an internal GEDCOM node tree.

`Createnode` creates a GEDCOM node; the two arguments are tag and value strings, respectively; the value string can be null. `Addnode` adds a node to a node tree. The first argument is the new node; the second is the node in the tree that becomes the parent of the new node; the third is the node in the tree that becomes the previous sibling of the new node; this argument is null if the new node is to become the first child of the parent. `Deletenode` removes a node from a node tree.

These functions change the internal form of a node tree; they *do not* modify original records in the database. These functions may be changed or extended in the future to allow database changes. Note: `deletenode` has a memory leak.

2.21. Record Linking Functions

```
BOOL reference(STRING) ;
```

determine if string is a cross reference

```
NODE dereference(STRING) ;
```

reference cross reference or key to node tree

```
NODE getrecord(STRING) ;
```

same as dereference

These functions allow you to recognize values that are cross references and to read the records they refer to. `Reference` returns true if its string argument is a cross reference value, that is, the internal key of one of the records in the database. `Dereference` returns the node tree of the record referred to by its cross reference string argument. `Getrecord` is a synonym for `dereference`.

2.22. Miscellaneous Functions

```
VOID lock(INDI / FAM) ;
```

lock a person or family in memory

```
VOID unlock(INDI/FAM) ;
```

unlock a person or family from memory

```
STRING database(void) ;
```

return name of current database

```
STRING version(void) ;
```

return version of LifeLines program

```
VOID system(STRING) ;
```

execute string as a UNIX shell command

```
STRING getproperty(STRING) ;
```

extract system or user property. Function available after v3.0.5.

`Lock` and `unlock` are used to lock a person or family into RAM memory, and to unlock a person or family from RAM memory, respectively.

`Database` returns the name of the current database, useful in titling reports. `Version` returns the version of the running LifeLines program, eg, 3.0.7.

`System` executes its string argument as a UNIX (or MS-Windows as appropriate) shell command, by invoking the system shell. This will not occur if the user has chosen to disallow report system calls (via the `DenySystemCalls` user option).

The `getproperty` function extracts system or user properties. Properties are named `group.subgroup.property` or `group.property`. The following keys are available at the moment:

`user.fullname`

The full name of the current user. This is fetched from the system when possible.

`user.email`

The email address of the current user. This is fetched from the system when possible.

`user.address`

Postal address of the current user.

`user.url`

URL to the users home page.

These values can be changed by adding values to user options. [Miscellaneous utilities->Edit the user options file]