

A Users Guide for the
Doubly Linked List API
Version 2.0.0

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Preface

Writing an API for a link list came about after many years of struggling with data storage problems. I would often write link list code embedded in my application, exposing all of its innards to the application. This was a nightmare to weed through as the application grew in functionality and complexity. Often much of the functionality that I would have liked in my application would be too difficult to implement or would be kludged in. If more than one link list was needed my beard would thin.

This manual documents the implementation and use of the Doubly Linked List API. A brief overview of the design philosophy and how the data is abstracted will be discussed followed by a thorough explanation of the calling and return mechanism of each function.

I hope it is as useful for you as it has been for me.

Carl J. Nobile
April 1999

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This Doubly Linked List can be downloaded from the following sites. The first site below has a web page dedicated to the API. All current releases will become available here first.

`http://tetrasys.homelinux.org`

You will also find the API at the following site and its mirrors.

`ftp://ibiblio.org/pub/linux/lib`

Bug reports should go to me at `carl.nobile@gmail.com`.

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3 Introduction

There are many goals to achieve when deciding to write an API. The functions in the library should be reenterable, easy to include in an application, platform independent, and reasonably flexible with enough functionality to be usable. These goals can often be contradictory; however, they are achievable with enough forethought and planning.

This package is sufficiently abstracted so that the programmer will neither need to know or care how it is implemented; at least that is the goal I have striven to achieve while writing it.

Within this package is found the: source files written in C; make files for various platforms and compilers; a text script which sets the environment correctly when it runs the demo program created by the make utility; README and INSTALL text files; Artistic and Eclipse Licenses; documentation in L^AT_EX 2_ε form; and Python epydoc API documentation; however, most of this document is dedicated to the C API.

A short overview will follow, discussing the philosophy of how the package works including a rationale of the structure and type definition used in the package.

Then the library itself is broken into six groups: **initialization**, **status and state**, **pointer manipulation**, **list update**, **search**, and **input/output**. The Python version has a seventh **miscellaneous helper methods**.

- (a) The **initialization** group handles the creation, initializing, and destruction of the link list.
- (b) The **status and state** group returns various kinds of information about the status of the link list during its operation.
- (c) The **pointer manipulation** group allows the positioning of the current pointer to the head, the tail, or an arbitrary node within the list.
- (d) The **list update** group adds and deletes nodes.
- (e) The **search** group returns the record information based on key data or on the absolute record position.
- (f) The **input/output** group saves or retrieves record data to or from a disk file.
- (g) The Python **miscellaneous helper methods** group adds some functionality for comparison and testing the Info object.

At this writing there are 29 functions in the C library, each one of which is thoroughly explained and examples given when needed.

4 Python epydoc Overview

It is best to read the epydoc HTML documentation to get a better ideas of how the Python API is used and operates. It has the exact same functionality as the C API, but is in a class which takes care of most of the low level work that needs to be done. The Python API uses ctypes to thinly wrap the C API, so it will be fast.

5 C API Overview

When writing tools such as this, one needs to be concerned with how it affects the entire programming environment. One of the most important aspects of this environment is the problem concerning *namespace* pollution. To minimize this problem I have used `DLL_` as a prefix to all function names and enumerated *typedefs*.

It is often the case that search criteria will remain the same between queries. As such, a state table is implemented that passes the current state to the search functions. There are two functions: one to set and the other to read the state table.

6 Structures

Most implementations of link lists allocate a single node per record and these nodes are what are linked to each other. This type of algorithm works well when the link list is embedded in the application code, but not when implementing a link list within an API, because it cannot be made reentrant.

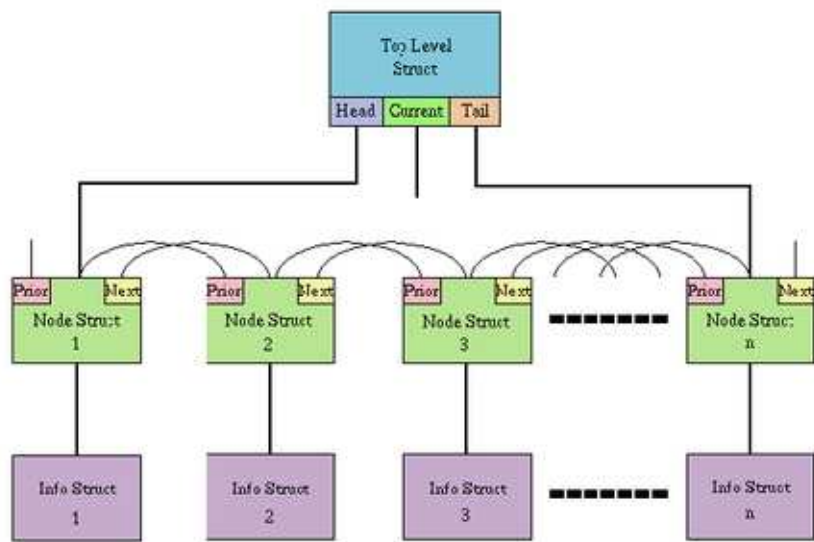
A well written Application Programming Interface (API) requires that the functions contained within it be reentrant and also creates an environment in which the code can be abstracted. In order to take advantage of these two ideas the Doubly Linked List (hereafter referred to as the DLL) has a three level hierarchy as pictured in the figure.

The first level we will refer to as the “Top Level Struct”. All the global data is held by one of these structures and it is allocated once for each incident of the link list.

```
typedef struct list
{
    Node          *head;          /* pointer to head record */
    Node          *tail;          /* pointer to tail record */
    Node          *current;       /* pointer to current record */
    Node          *saved;         /* pointer to stored record */
    size_t        infosize;       /* size of record incident */
    unsigned long listsize;       /* number of records in list */
    unsigned long current_index;  /* index value of current record */
    unsigned long save_index;     /* index value of stored record */
    DLL_Boolean   modified;       /* modified flag (TRUE or FALSE) */
    DLL_SrchOrigin search_origin; /* location a search originates from */
    DLL_SrchDir   search_dir;     /* direction the search proceeds from */
} List;
```

At the next level is the “Node Struct”. This structure holds the pointer to the actual record data plus the pointers to the next and prior nodes. It is allocated once for each record structure.

```
typedef struct node
{
    Info          *info;          /* pointer to record data */
    struct node *next;            /* pointer to next node */
    struct node *prior;          /* pointer to prior node */
} Node;
```



Hierarchical Structure of the Doubly Linked List

The third and final level is the “Info Struct”, which holds the actual data inserted by the application. The Info Struct is defined by the developer and is only restricted by the environment in which the application runs or is compiled in.

```
typedef struct your_info
{
    type your_data;           /* Your data goes here */
} YourInfo;
```

There is one more structure which is not part of this hierarchy. It is only used to return the current state of the search criteria.

```
typedef struct search_modes
{
    DLL_SrchOrigin search_origin; /* Search from head, tail, or current */
    DLL_SrchDir     search_dir;   /* Search up or down */
} DLL_SearchModes;
```


7 Enumerations

I'm a firm believer that the return values of functions should be predefined *typedef* enumerations. There are two reasons for this. The first is that many compilers will complain when a switch statement is used to test the return values of functions with one or more of the enumerated values missing, thus alerting the developer to use the *default* statement. The second reason is that the *typedef* name can be used as the return type of the function, disallowing anything other than the enumerated values to be returned. These are good things and should be taken advantage of.

Since at the time of this writing Booleans are not part of the C specifications, I've created my own.

```
typedef enum
{
    DLL_FALSE,
    DLL_TRUE
} DLL_Boolean;
```

Many functions return the *typedef* enumerated type **DLL_Return** as shown below.

```
typedef enum
{
    DLL_NORMAL,           /* normal operation */
    DLL_MEM_ERROR,        /* malloc error */
    DLL_ZERO_INFO,        /* sizeof(Info) is zero */
    DLL_NULL_LIST,        /* List is NULL */
    DLL_NOT_FOUND,        /* Record not found */
    DLL_OPEN_ERROR,       /* Cannot open file */
    DLL_WRITE_ERROR,      /* File write error */
    DLL_READ_ERROR,       /* File read error */
    DLL_NOT_MODIFIED,     /* Unmodified list */
    DLL_NULL_FUNCTION     /* NULL function pointer */
} DLL_Return;
```

The next two enumerations are used to determine the state of search inquiries: one is used to determine the origin and the other for the direction. These values are passed as arguments to the *DLL_SetSearchModes* function.

```
typedef enum
{
    DLL_ORIGIN_DEFAULT,   /* Use current origin setting */
    DLL_HEAD,             /* Set origin to head pointer */
    DLL_CURRENT,          /* Set origin to current pointer */
    DLL_TAIL              /* Set origin to tail pointer */
} DLL_SrchOrigin;
```

```
typedef enum
{
    DLL_DIRECTION_DEFAULT, /* Use current direction setting */
    DLL_DOWN,              /* Set direction to down */
    DLL_UP                  /* Set direction to up */
} DLL_SrchDir;
```

The last enumerated type is used to determine the direction of insertion or the swapping of a record. This structure is passed as an argument to two functions, *DLL_InsertRecord* and *DLL_SwapRecord*.

```
typedef enum
{
    DLL_INSERT_DEFAULT, /* Does nothing legacy value--don't use it */
    DLL_ABOVE,          /* Insert new record ABOVE current record toward head */
    DLL_BELOW           /* Insert new record BELOW current record toward tail */
} DLL_InsertDir;
```

8 Functions

The following function calls are grouped by their general functionality, as described above. They are written in manpage style so that I only have to document the API once.

8.1 Initialization

NAME

DLL_CreateList, DLL_InitializeList, DLL_DestroyList

SYNOPSIS

```
#include <linklist.h>

List *DLL_CreateList(List **list);
DLL_Return DLL_InitializeList(List *list, size_t infosize);
void DLL_DestroyList(List **list);
```

DESCRIPTION

The initialization group of functions must be used in the allocation and freeing of memory used by the link list.

DLL_CreateList

This function is called first to create the environment of the link list package. It is passed **list**, a pointer to a pointer, of the *Top Level Struct* type *List*. This pointer is returned both as the return value of the function and in the argument **list**.

DLL_InitializeList

After defining the *Info* structure this function is called to initialize the environment. Its first argument, **list**, is the value returned from *DLL_CreateList* and the second argument, **infosize**, is the size in bytes of the *Info* structure. The value **DLL_ZERO_INFO** is returned if **infosize** is zero; **DLL_NULL_LIST** if the pointer **list** is NULL; and **DLL_NORMAL** if the initialization was successful.

DLL_DestroyList

Upon exiting the application this function when called will free all memory allocated during this instance of the list. It is passed **list**, the value returned from *DLL_CreateList*, and has no return value of its own; however, the argument **list** is set to NULL.

EXAMPLE

```
#include <stdio.h>
#include <stdlib.h>
#include <linklist.h>

typedef struct name_addr    /* Sample data structure */
```

```

{
char name[30];
char street[40];
char city[22];
char state[3];
char zip[11];
} NameAddr;

void main(void)
{
List *NAList = NULL;
DLL_Return DLL_Exit;

if(DLL_CreateList(&NAList) == NULL)
{
fputs("Fatal Memory error", stderr);
exit(EXIT_FAILURE);
}

if((DLL_Exit = DLL_InitializeList(NAList, sizeof(NameAddr)))
!= DLL_NORMAL)
{
(void)(DLL_Exit == DLL_ZERO_INFO
&& fputs("Size of address record is zero.\n\n", stderr));
(void)(DLL_Exit == DLL_NULL_LIST
&& fputs("NAList points to a NULL address.\n\n", stderr));
exit(EXIT_FAILURE);
}

DoYourThingHere(NAList);

DLL_DestroyList(&NAList);
exit(EXIT_SUCCESS);
}

```

8.2 Status and State

NAME

DLL_Version, DLL_IsListEmpty, DLL_IsListFull,
DLL_GetNumberOfRecords, DLL_SetSearchModes,
DLL_GetSearchModes, DLL_GetCurrentIndex

SYNOPSIS

```
#include <linklist.h>

char *DLL_Version(void);
DLL_Boolean DLL_IsListEmpty(List *list);
DLL_Boolean DLL_IsListFull(List *list);
unsigned long DLL_GetNumberOfRecords(List *list);
DLL_Return DLL_SetSearchModes(List *list, DLL_SrchOrigin origin,
                              DLL_SrchDir dir);
DLL_SearchModes *DLL_GetSearchModes(List *list,
                                     DLL_SearchModes *ssp);
unsigned long DLL_GetCurrentIndex(List *list);
```

DESCRIPTION

All the functions below except *DLL_Version* take as their first argument **list** the pointer returned by *DLL_CreateList*. These functions either return or set the status or state of some aspect of the link list.

DLL_Version

This function has no arguments and returns a string in the following format:

```
Ver: 2.0.0  December 30 2011
-----
Developed by: Carl J. Nobile
Contributions: Charlie Buckheit
               Graham Inchley
               Wai-Sun Chia
               Mark M. Feenstra
               Lianqi Qiu
```

DLL_IsListEmpty

This function determines if the link list has any nodes defined by testing if the head and tail pointers are NULL. It returns **DLL_TRUE** if the list is empty and **DLL_FALSE** if the list has valid nodes.

DLL_IsListFull

This function determines if there is enough memory to create new *Node* and *Info* structures by creating and then deleting them. It returns **DLL_TRUE** if either of the two structures could not be allocated and **DLL_FALSE** if the memory allocations were successful.

DLL_GetNumberOfRecords

This function returns the number of records currently in the link

list by retrieving a counter value. It returns the number of nodes allocated where a return value of zero is an empty list.

DLL_SetSearchModes

This function sets the search mode state table which is used by various function in the API. Its second and third arguments are **origin** and **dir**. The **origin** argument can take one of four values:

DLL_HEAD The origin of the search starts from the node which is at the head of the list. This is the default value if none have been set beforehand.

DLL_CURRENT The origin of the search starts from the currently selected node.

DLL_TAIL The origin of the search starts from the node which is at the tail of the list.

DLL_ORIGIN_DEFAULT The origin of the search defaults to the last set value.

The **dir** argument can take one of three values:

DLL_DOWN The direction of the search is from the head to the tail nodes. This is the default value if none have been set beforehand.

DLL_UP The direction of the search is from the tail to the head nodes.

DLL_DIRECTION_DEFAULT The direction of the search defaults to the last set value.

It returns **DLL_NOT_MODIFIED** if an invalid value was passed in either **origin** or **dir**. **DLL_NORMAL** is returned if the state table was set.

DLL_GetSearchModes

This function gets the state of the search criteria, which can either be the default values or those set by *DLL_SetSearchModes*. Its second argument is **ssp**, a pointer to the structure below. It returns a pointer to this same instance of the structure.

```
typedef struct search_modes
{
    DLL_SrchOrigin search_origin;
    DLL_SrchDir    search_dir;
} DLL_SearchModes;
```

NOTE: This function has a different argument list starting with release linkist-1.1.0. The original function allocated the structure internally to the function, which was not thread safe. This WILL break old code that used this function.

DLL_GetCurrentIndex

This function returns the index of the current record by retrieving a counter value. A return value of zero is an empty list.

EXAMPLE

Examples of most of these functions can be seen in the source file *dll_test.c* used in the testing of the link list API.

8.3 Pointer Manipulation

NAME

DLL_CurrentPointerToHead, DLL_CurrentPointerToTail,
DLL_IncrementCurrentPointer, DLL_DecrementCurrentPointer,
DLL_StoreCurrentPointer, DLL_RestoreCurrentPointer

SYNOPSIS

```
#include <linklist.h>

DLL_Return DLL_CurrentPointerToHead(List *list);
DLL_Return DLL_CurrentPointerToTail(List *list);
DLL_Return DLL_IncrementCurrentPointer(List *list);
DLL_Return DLL_DecrementCurrentPointer(List *list);
DLL_Return DLL_StoreCurrentPointer(List *list);
DLL_Return DLL_RestoreCurrentPointer(List *list);
```

DESCRIPTION

The *current* pointer in the link list keeps track of the last used node. In order for this to be of benefit there needs to be a way of controlling where this pointer is located within the list. These functions allow the repositioning and storing of this pointer during program execution.

All of these functions return the enumerated type *DLL_Return* and take only one argument **list** the pointer returned by *DLL_CreateList*.

DLL_CurrentPointerToHead

This function sets the *current* pointer to the head of the list and sets the *index* counter to 1. A return value of **DLL_NULL_LIST** indicates that the list has no nodes allocated and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_CurrentPointerToTail

This function sets the *current* pointer to the tail of the list and sets the index counter to the **listsize** counter. A return value of **DLL_NULL_LIST** indicates that the list has no allocated nodes and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_IncrementCurrentPointer

This function increments the *current* pointer and the *index* counter each by 1. A return value of **DLL_NULL_LIST** indicates that the list has no allocated nodes, **DLL_NOT_FOUND** indicates that the end of the list has been reached, and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_DecrementCurrentPointer

This function decrements the *current* pointer and the *index* counter each by 1. A return value of **DLL_NULL_LIST** indicates that

the list has no allocated nodes, **DLL_NOT_FOUND** indicates that the beginning of the list has been reached, and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_StoreCurrentPointer

This function stores the *current* pointer and the *index* counter in the *Top Level Struct* for later retrieval. Only one value can be stored at a time so calling this function again will destroy the first stored pointer and index values. A return value of **DLL_NOT_FOUND** indicates that the list is empty and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_RestoreCurrentPointer

This function restores the *current* pointer and the *index* counter from the *Top Level Struct*. Since only one value can be stored at a time, calling this function again will return the last pointer and index values. A return value of **DLL_NOT_FOUND** indicates that the list is empty and **DLL_NORMAL** indicates that the function succeeded in its task.

EXAMPLE

Examples of most of these functions can be seen in the source file *dll_test.c* used in the testing of the link list API.

8.4 List Update

NAME

DLL_AddRecord, DLL_InsertRecord, DLL_SwapRecord,
DLL_UpdateCurrentRecord, DLL_DeleteCurrentRecord,
DLL_DeleteEntireList

SYNOPSIS

```
#include <linklist.h>

DLL_Return DLL_AddRecord(List *list, Info *info,
                        int (*pFun)(Info *, Info *));
DLL_Return DLL_InsertRecord(List *list, Info *info,
                        DLL_InsertDir dir);
DLL_Return DLL_SwapRecord(List *list, DLL_InsertDir dir);
DLL_Return DLL_UpdateCurrentRecord(List *list,
                        Info *record);
DLL_Return DLL_DeleteCurrentRecord(List *list);
DLL_Return DLL_DeleteEntireList(List *list);
```

DESCRIPTION

These functions manipulate the data in the link list. They all return the enumerated type *DLL_Return* and take as their first argument, **list**, the pointer returned by *DLL_CreateList*.

DLL_AddRecord

This function adds a new node and record to the link list. The second argument is a pointer to the *Info* structure where the new data is stored. The third argument is a pointer to a function used to sort the insertion of the new data. The return value of this function is identical to the return value of the *strcmp* function of the standard C library.

Where the return value is

```
less than zero:    arg1 < arg2,

zero:              arg1 == arg2, or

greater than zero: arg1 > arg2.
```

Below is an example of this function:

```
int sort_foo(Info *record, Info *compare)
{
    return(strcmp(record->info_element,
                  compare->info_element));
}
```

If a *NULL* is passed instead of the function pointer no sorting will take place causing the next new node and record to be added to the tail of the list. A return value of **DLL_MEM_ERROR** indicates that memory could not be allocated and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_InsertRecord

This function adds a new node and record to the link list above or below current record. The new record will be current after completion. The second argument is a pointer to the *Info* structure where the new data is stored. The third argument is passed an enumerated define of type *DLL_InsertDir*.

```
typedef enum
{
    DLL_INSERT_DEFAULT, /* Use current insert setting */
    DLL_ABOVE,          /* Insert new record ABOVE current record */
    DLL_BELOW           /* Insert new record BELOW current record */
} DLL_InsertDir;
```

In the current version the value **DLL_INSERT_DEFAULT** is not used; it has been included for conformity to other like definitions and possible future expansion.

The value **DLL_NOT_MODIFIED**, if returned, indicates that a wrong value was passed in the argument *dir*; **DLL_MEM_ERROR** indicates that memory could not be allocated; and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_SwapRecord

This function swaps the current record up or down one place in the list. The swapped record will remain current after completion. The second argument is passed the same enumerated define of type *DLL_InsertDir* as the function **DLL_InsertRecord** above. The value **DLL_NOT_MODIFIED**, if returned, indicates that a value other than the type *DLL_InsertDir* was passed in the argument *dir*; **DLL_NULL_LIST** indicates that the list is empty and there are no nodes to swap; **DLL_NOT_FOUND** indicates that the current node is either at the head and cannot be swapped above or is at the tail and cannot be swapped below; and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_UpdateCurrentRecord

This function replaces the current data in an *Info* structure with updated data from the application. The entire structure gets overwritten so all elements in the updating structure will need to be present whether or not they have been changed. The second argument of this function is passed a pointer to an *Info* structure which contains the updated information. The value **DLL_NULL_LIST**,

if returned, indicates that the list is empty and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_DeleteCurrentRecord

This function deletes the current *Node* and its *Info* structures from the list. The value **DLL_NULL_LIST**, if returned, indicates that the list is empty and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_DeleteEntireList

This function deletes all the *Node* and *Info* structures from the list. It does not delete the *Top Level Struct* allowing the application to add new records without having to reinitialize the list again. The value **DLL_NULL_LIST**, if returned, indicates that the list is empty and **DLL_NORMAL** indicates that the function succeeded in its task.

EXAMPLE

Examples of most of these functions can be seen in the source file *dll_test.c* used in the testing of the link list API.

8.5 Search

NAME

DLL_FindRecord, DLL_FindNthRecord, DLL_GetCurrentRecord,
DLL_GetPriorRecord, DLL_GetNextRecord

SYNOPSIS

```
#include <linklist.h>

DLL_Return DLL_FindRecord(List *list, Info *record,
                          Info *match, int (*pFun)(Info *, Info *));
DLL_Return DLL_FindNthRecord(List *list, Info *record,
                             unsigned long skip);
DLL_Return DLL_GetCurrentRecord(List *list, Info *record);
DLL_Return DLL_GetPriorRecord(List *list, Info *record);
DLL_Return DLL_GetNextRecord(List *list, Info *record);
```

DESCRIPTION

These functions retrieve data from the list. They all return the enumerated type *DLL_Return* and take as their first argument **list** the pointer returned by *DLL_CreateList*.

DLL_FindRecord

This function returns in its second argument a record found using the criteria passed in its third argument based on the logic of a function passed as its fourth argument. See **DLL_SetSearchModes** for setting the search direction and origin. The form of the passed in function containing the search criteria is the same as that used by the **DLL_AddRecord**, but in this case a *NULL* function pointer cannot be passed. It is shown below for convenience.

Where the return value is

```
less than zero:    arg1 < arg2,

zero:              arg1 == arg2, or

greater than zero: arg1 > arg2.
```

Below is an example of this function:

```
int sort_foo(Info *record, Info *compare)
{
    return(strcmp(rcrd->info_element,
                 cmp->info_element));
}
```

The value **DLL_NULL_FUNCTION**, if returned, indicates that a **NULL** was passed as the fourth argument; **DLL_NULL_LIST**

indicates that the list is empty; **DLL_NOT_FOUND** indicates that a record could not be found; and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_FindNthRecord

This function returns in its second argument the record found by adding the skip value passed in the third argument to the index value of the current record. The skip value is an *unsigned long* integer and should always be a positive number. See **DLL_SetSearchModes** for setting the search direction and origin. The value **DLL_NULL_LIST**, if returned, indicates that the list is empty; **DLL_NOT_FOUND** indicates that a record could not be found in the list or that the *skip* value was out of range; and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_GetCurrentRecord

This function returns in its second argument the current record. The value **DLL_NULL_LIST**, if returned, indicates that the list is empty and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_GetPriorRecord

This function returns in its second argument the record just prior to the current record. The value **DLL_NULL_LIST**, if returned, indicates that the list is empty; **DLL_NOT_FOUND** indicates that the current record is at the head of the list and there is no prior record; and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_GetNextRecord

This function returns in its second argument the record just after the current record. The value **DLL_NULL_LIST**, if returned, indicates that the list is empty; **DLL_NOT_FOUND** indicates that the current record is at the tail of the list and there is no next record; and **DLL_NORMAL** indicates that the function succeeded in its task.

EXAMPLE

Examples of most of these functions can be seen in the source file *dll_test.c* used in the testing of the link list API.

8.6 Input/Output

NAME

DLL_SaveList, DLL_LoadList

SYNOPSIS

```
#include <linklist.h>
```

```
DLL_Return DLL_SaveList(List *list, const char *path);
DLL_Return DLL_LoadList(List *list, const char *path,
                        int (*pFun)(Info *, Info *))
```

DESCRIPTION

These functions are designed to easily write and read the link list data to a disk. They take advantage of their ability to access the *Top Level Struct* for saving and loading data quickly; however, this will only be useful in limited cases as most implementations will need application specific file formats. Both return the enumerated type *DLL_Return* and take as their first argument, **list**, the pointer returned by *DLL_CreateList*, and as their second argument, **path**, a pointer to the file name.

DLL_SaveList

This function saves all the *Info* structures including any *NULL* characters in the elements. The record size is equal to, **infosize**, the second argument of the *DLL_InitializeList* function.

The value **DLL_NULL_LIST**, if returned, indicates that the list is empty; **DLL_OPEN_ERROR** indicates that the file could not be opened for writing; **DLL_WRITE_ERROR** indicates that there was an error while writing to the file meaning that the data in the list should not be trusted; **DLL_NOT_MODIFIED** indicates that the list has not been modified since the last save and no updating to the file was done; and **DLL_NORMAL** indicates that the function succeeded in its task.

DLL_LoadList

This function retrieves from a file data based on the same criteria that it was saved with. See *DLL_SaveList* above. The third argument **pFun** is a pointer to a sorting function the same as can be found in **DLL_AddRecord**. A *NULL* function pointer can be passed if no sorting is needed. The **list->current_index** will have an arbitrary value it depending on the sort algorithm used. Use one of the **DLL_CurrentPointerToHead** or **DLL_CurrentPointerToTail** functions to get the known location.

Where the return value is

less than zero: **arg1 < arg2**,

zero: arg1 == arg2, or

greater than zero: arg1 > arg2.

Below is an example of this function:

```
int sort_foo(Info *record, Info *compare)
{
    return(strcmp(rcrd->info_element,
                  cmp->info_element));
}
```

EXAMPLE

Examples of most of these functions can be seen in the source file *dll_test.c* used in the testing of the link list API.