# Short Contents

1. Copying Conditions .......................................................... 1
2. Introduction to GNU dbm ................................................. 2
3. List of functions .............................................................. 3
4. Opening the database ....................................................... 4
5. Closing the database ........................................................ 6
6. Number of Records .......................................................... 7
7. Inserting and replacing records in the database .................... 8
8. Searching for records in the database ................................... 9
9. Removing records from the database .................................... 10
10. Sequential access to records ............................................. 11
11. Database reorganization ................................................... 13
12. Database Synchronization ................................................. 14
13. Export and Import ........................................................... 15
14. Error handling ............................................................... 19
15. Recovery ................................................................. 21
16. Setting options .............................................................. 23
17. File Locking ................................................................. 26
18. Useful global variables ..................................................... 27
19. Error codes ........................................................ .......... 29
20. Compatibility with standard dbm and ndbm ......................... 32
21. Examine and modify a GDBM database ................................ 36
22. The gdbm_dump utility ...................................................... 47
23. The gdbm_load utility ....................................................... 48
24. Exit codes ................................................................. 49
25. Problems and bugs ........................................................ 50
26. Additional resources ....................................................... 51
A. GNU Free Documentation License ...................................... 52
Index .......................................................... 60
# Table of Contents

1. Copying Conditions ........................................ 1
2. Introduction to GNU dbm .............................. 2
3. List of functions ......................................... 3
4. Opening the database ................................. 4
5. Closing the database .................................. 6
6. Number of Records .................................... 7
7. Inserting and replacing records in the database .......... 8
8. Searching for records in the database ............... 9
9. Removing records from the database ............. 10
10. Sequential access to records ....................... 11
11. Database reorganization ........................... 13
12. Database Synchronization ......................... 14
13. Export and Import .................................. 15
14. Error handling .................................... 19
15. Recovery ........................................ 21
16. Setting options .................................. 23
17. File Locking ....................................... 26
18. Useful global variables ................................ 27
Chapter 1: Copying Conditions.

1 Copying Conditions.

This library is free; this means that everyone is free to use it and free to redistribute it on a free basis. GNU dbm (gdbm) is not in the public domain; it is copyrighted and there are restrictions on its distribution, but these restrictions are designed to permit everything that a good cooperating citizen would want to do. What is not allowed is to try to prevent others from further sharing any version of gdbm that they might get from you.

Specifically, we want to make sure that you have the right to give away copies gdbm, that you receive source code or else can get it if you want it, that you can change these functions or use pieces of them in new free programs, and that you know you can do these things.

To make sure that everyone has such rights, we have to forbid you to deprive anyone else of these rights. For example, if you distribute copies gdbm, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must tell them their rights.

Also, for our own protection, we must make certain that everyone finds out that there is no warranty for anything in the gdbm distribution. If these functions are modified by someone else and passed on, we want their recipients to know that what they have is not what we distributed, so that any problems introduced by others will not reflect on our reputation.

Gdbm is currently distributed under the terms of the GNU General Public License, Version 3. (NOT under the GNU General Library Public License.) A copy the GNU General Public License is included with the distribution of gdbm.
Chapter 2: Introduction to GNU dbm.

2 Introduction to GNU dbm.

GNU dbm (gdbm) is a library of database functions that use extensible hashing and works similar to the standard UNIX dbm functions. These routines are provided to a programmer needing to create and manipulate a hashed database. (gdbm is NOT a complete database package for an end user.)

The basic use of gdbm is to store key/data pairs in a data file. Each key must be unique and each key is paired with only one data item. The keys can not be directly accessed in sorted order. The basic unit of data in gdbm is the structure:

```c
typedef struct {
    char *dptr;
    int dsize;
} datum;
```

This structure allows for arbitrary sized keys and data items.

The key/data pairs are stored in a gdbm disk file, called a gdbm database. An application must open a gdbm database to be able manipulate the keys and data contained in the database. gdbm allows an application to have multiple databases open at the same time. When an application opens a gdbm database, it is designated as a reader or a writer. A gdbm database can be opened by at most one writer at a time. However, many readers may open the database simultaneously. Readers and writers can not open the gdbm database at the same time.
3 List of functions.

The following is a quick list of the functions contained in the gdbm library. The include file gdbm.h, that can be included by the user, contains a definition of these functions.

```c
#include <gdbm.h>

GDBM_FILE gdbm_open(name, block_size, flags, mode, fatal_func);
int gdbm_close(dbf);
int gdbm_store(dbf, key, content, flag);
datum gdbm_fetch(dbf, key);
int gdbm_delete(dbf, key);
datum gdbm_firstkey(dbf);
datum gdbm_nextkey(dbf, key);
int gdbm_reorganize(dbf);
int gdbm_sync(dbf);
int gdbm_exists(dbf, key);
char *gdbm_strerror(errno);
int gdbm_setopt(dbf, option, value, size);
int gdbm_fdesc(dbf);
int gdbm_export (GDBM_FILE, const char *, int, int);
int gdbm_export_to_file (GDBM_FILE dbf, FILE *fp);
int gdbm_import (GDBM_FILE, const char *, int);
int gdbm_import_from_file (GDBM_FILE dbf, FILE *fp, int flag);
int gdbm_count (GDBM_FILE dbf, gdbm_count_t *pcount);
int gdbm_version_cmp (int const a[], int const b[]);
```

The gdbm.h include file is often in the /usr/include directory. (The actual location of gdbm.h depends on your local installation of gdbm.)
Chapter 4: Opening the database.

4 Opening the database.

GDBM_FILE gdbm_open (const char *name, int block_size, int flags, int mode, void (*)(const char *))

Initializes gdbm system. If the file has a size of zero bytes, a file initialization procedure is performed, setting up the initial structure in the file.

The arguments are:

name The name of the file (the complete name, gdbm does not append any characters to this name).

block_size It is used during initialization to determine the size of various constructs. It is the size of a single transfer from disk to memory. This parameter is ignored if the file has been previously initialized. If the value is less than 512, the file system block size is used instead. The size is adjusted so that the block can hold exact number of directory entries, so that the effective block size can be slightly greater than requested. However, if the ‘GDBM_BSEXACT’ flag is set and the size needs to be adjusted, the function will return with error status, setting the ‘gdbm_errno’ variable to ‘GDBM_BLOCK_SIZE_ERROR’.

flags If flags is set to ‘GDBM_READER’, the user wants to just read the database and any call to gdbm_store or gdbm_delete will fail. Many readers can access the database at the same time. If flags is set to ‘GDBM_WRITER’, the user wants both read and write access to the database and requires exclusive access. If flags is set to ‘GDBM_WRCREAT’, the user wants both read and write access to the database and wants it created if it does not already exist. If flags is set to ‘GDBM_NEWDB’, the user want a new database created, regardless of whether one existed, and wants read and write access to the new database.

The following may also be logically or’d into the database flags: ‘GDBM_SYNC’, which causes all database operations to be synchronized to the disk, ‘GDBM_NOLOCK’, which prevents the library from performing any locking on the database file, and ‘GDBM_NOMMAP’, which disables the memory mapping mechanism. The option ‘GDBM_FAST’ is now obsolete, since gdbm defaults to no-sync mode.

If this flag is set and the requested block_size cannot be used without adjustment, gdbm_open will refuse to create the databases. In this case it will set the ‘gdbm_errno’ variable to ‘GDBM_BLOCK_SIZE_ERROR’ and return ‘NULL’.

If the host ‘open’ call (see Section “open” in open(2) man page) supports the ‘O_CLOEXEC’ flag, the ‘GDBM_CLOEXEC’ can be or’d into the flags, to enable the close-on-exec flag for the database file descriptor.

mode File mode (see Section “change permissions of a file” in chmod(2) man page, and see Section “open a file” in open(2) man page), which is used if the file is created).
**fatal_func**  A function for `gdbm` to call if it detects a fatal error. The only parameter of this function is a string. If the value of ‘NULL’ is provided, `gdbm` will use a default function.

The return value, is the pointer needed by all other functions to access that `gdbm` file. If the return is the ‘NULL’ pointer, `gdbm_open` was not successful. The errors can be found in `gdbm_errno` variable (see Chapter 18 [Variables], page 27). Available error codes are discussed in Chapter 19 [Error codes], page 29.

In all of the following calls, the parameter `dbf` refers to the pointer returned from `gdbm_open`.

```c
GDBM_FILE gdbm_fd_open (int fd, const char *name, int block_size, int flags, int mode, void (*fatal_func)(const char *))
```

Alternative function for opening a GDBM database. The `fd` argument is the file descriptor of the database file obtained by a call to `open(2)`, `creat(2)` or similar functions. The descriptor is not dup’ed, and will be closed when the returned `GDBM_FILE` is closed. Use `dup(2)` if that is not desirable.

```c
int gdbm_copy_meta (GDBM_FILE dst, GDBM_FILE src)
```

Copy file ownership and mode from `src` to `dst`.
5 Closing the database.

It is important that every file opened is also closed. This is needed to update the reader/writer count on the file:

```c
int gdbm_close (GDBM_FILE dbf) [gdbm interface]

This function closes the gdbm file and frees all memory associated with it. The parameter is:

dbf The pointer returned by gdbm_open.

Gdbm_close returns 0 on success. On error, it sets gdbm_errno and system errno variables to the codes describing the error and returns -1.
```
6 Number of Records

```c
int gdbm_count (GDBM_FILE dbf, gdbm_count_t *pcount)  [gdbm interface]
Counts number of records in the database dbf. On success, stores it in the memory
location pointed to by pcount and return 0. On error, sets gdbm_errno (if relevant,
also errno) and returns -1.
```
Chapter 7: Inserting and replacing records in the database.

7 Inserting and replacing records in the database.

```c
int gdbm_store (GDBM_FILE dbf, datum key, datum content, int flag) {
    The function gdbm_store inserts or replaces records in the database.

    The parameters are:
    
    dbf: The pointer returned by gdbm_open.
    key: The search key.
    content: The data to be associated with the key.
    flag: Defines the action to take when the key is already in the database. The value ‘GDBM_REPLACE’ (defined in gdbm.h) asks that the old data be replaced by the new content. The value ‘GDBM_INSERT’ asks that an error be returned and no action taken if the key already exists.

    This function can return the following values:
    
    -1: The item was not stored in the database because the caller was not an official writer or either key or content have a ‘NULL’ ‘dptr’ field.
    
    Both key and content must have the ‘dptr’ field be a non-‘NULL’ value. Since a ‘NULL’ ‘dptr’ field is used by other functions to indicate an error, it cannot be valid data.
    
    +1: The item was not stored because the argument flag was ‘GDBM_INSERT’ and the key was already in the database.
    
    0: No error. The value of content is keyed by key. The file on disk is updated to reflect the structure of the new database before returning from this function.

    If you store data for a key that is already in the data base, gdbm replaces the old data with the new data if called with ‘GDBM_REPLACE’. You do not get two data items for the same key and you do not get an error from gdbm_store.

    The size in gdbm is not restricted like dbm or ndbm. Your data can be as large as you want.
```
8 Searching for records in the database.

datum gdbm_fetch (GDBM_FILE dbf, datum key) [gdbm interface]
Looks up a given key and returns the information associated with it. The ‘dptr’ field in the structure that is returned points to a memory block allocated by malloc. It is the caller’s responsibility to free it when no longer needed.

If the ‘dptr’ is ‘NULL’, inspect the value of the gdbm_errno variable (see Chapter 18 [Variables], page 27). If it is ‘GDBM_ITEM_NOT_FOUND’, no data was found. Any other value means an error occurred. Use gdbm_strerror function to convert gdbm_errno to a human-readable string.

The parameters are:
dbf The pointer returned by gdbm_open.
key The search key.

An example of using this function:
content = gdbm_fetch (dbf, key);
if (content.dptr == NULL)
{
    fprintf(stderr, "key not found\n");
}
else
{
    /* do something with content.dptr */
}

You may also search for a particular key without retrieving it:

int gdbm_exists (GDBM_FILE dbf, datum key) [gdbm interface]
Checks whether the key exists in the database dbf.

If key is found, returns ‘true’ (‘1’). If it is not found, returns ‘false’ (‘0’) and sets gdbm_errno to ‘GDBM_NO_ERROR’ (‘0’).

On error, returns ‘0’ and sets gdbm_errno to a non-‘0’ error code.

The parameters are:
dbf The pointer returned by gdbm_open.
key The search key.
9 Removing records from the database.

To remove some data from the database, use the `gdbm_delete` function.

```c
int gdbm_delete (GDBM_FILE dbf, datum key)          [gdbm interface]
               Deletes the data associated with the given key, if it exists in the database dbf. The
               file on disk is updated to reflect the structure of the new database before returning
               from this function.
               The parameters are:
               dbf         The pointer returned by `gdbm_open`.
               datum key   The search key.
               The function returns ‘-1’ if the item is not present or the requester is a reader. The
               return of ‘0’ marks a successful delete.
10 Sequential access to records.

The next two functions allow for accessing all items in the database. This access is not key sequential, but it is guaranteed to visit every key in the database once. The order has to do with the hash values. `gdbm_firstkey` starts the visit of all keys in the database. `gdbm_nextkey` finds and reads the next entry in the hash structure for `dbf`.

```c
// [gdbm interface]
datum gdbm_firstkey (GDBM_FILE dbf)
    Initiate sequential access to the database dbf. The returned value is the first key accessed in the database. If the 'dptr' field in the returned datum is 'NULL', inspect the gdbm_errno variable (see Chapter 18 [Variables], page 27). The value of GDBM_ITEM_NOT_FOUND means that the database contains no data. Other value means an error occurred.
```

Otherwise, 'dptr' points to a memory block obtained from malloc, which holds the key value. The caller is responsible for freeing this memory block when no longer needed.

```c
// [gdbm interface]
datum gdbm_nextkey (GDBM_FILE dbf, datum prev)
    This function continues the iteration over the keys in dbf, initiated by gdbm_firstkey. The parameter prev holds the value returned from a previous call to gdbm_nextkey or gdbm_firstkey.
```

The function returns next key from the database. If the 'dptr' field in the returned datum is 'NULL' inspect the gdbm_errno variable (see Chapter 18 [Variables], page 27). The value of GDBM_ITEM_NOT_FOUND means that all keys in the database has been visited. Any other value means an error occurred.

Otherwise, 'dptr' points to a memory block obtained from malloc, which holds the key value. The caller is responsible for freeing this memory block when no longer needed.

These functions were intended to visit the database in read-only algorithms, for instance, to validate the database or similar operations. The usual algorithm for sequential access is:

```c
key = gdbm_firstkey (dbf);
while (key.dptr)
{
    datum nextkey;

    /* do something with the key */
    ...

    /* Obtain the next key */
    nextkey = gdbm_nextkey (dbf, key);
    /* Reclaim the memory used by the key */
    free (key.dptr);
    /* Use nextkey in the next iteration. */
    key = nextkey;
}
```
Care should be taken when the `gdbm_delete` function is used in such a loop. File visiting is based on a hash table. The `gdbm_delete` function re-arranges the hash table to make sure that any collisions in the table do not leave some item un-findable. The original key order is not guaranteed to remain unchanged in all instances. So it is possible that some key will not be visited if a loop like the following is executed:

```c
key = gdbm_firstkey (dbf);
while (key.dptr)
{
    datum nextkey;
    if (some condition)
    {
        gdbm_delete (dbf, key);
    }
    nextkey = gdbm_nextkey (dbf, key);
    free (key.dptr);
    key = nextkey;
}
```
11 Database reorganization.

The following function should be used very seldom.

```
int gdbm_reorganize (GDBM_FILE dbf)  [gdbm interface]
    Reorganizes the database.
    The parameter is:
    dbf        The pointer returned by gdbm_open.
```

If you have had a lot of deletions and would like to shrink the space used by the gdbm file, this function will reorganize the database. This results, in particular, in shortening the length of a gdbm file by removing the space occupied by deleted records.

This reorganization requires creating a new file and inserting all the elements in the old file dbf into the new file. The new file is then renamed to the same name as the old file and dbf is updated to contain all the correct information about the new file. If an error is detected, the return value is negative. The value zero is returned after a successful reorganization.
Chapter 12: Database Synchronization

12 Database Synchronization

Unless your database was opened with the ‘GDBM_SYNC’ flag, gdbm does not wait for writes to be flushed to the disk before continuing. This allows for faster writing of databases at the risk of having a corrupted database if the application terminates in an abnormal fashion. The following function allows the programmer to make sure the disk version of the database has been completely updated with all changes to the current time.

```
int gdbm_sync (GDBM_FILE dbf)                [gdbm interface]
Synchronizes the changes in dbf with its disk file. The parameter is a pointer returned by gdbm_open.

This function would usually be called after a complete set of changes have been made to the database and before some long waiting time. The gdbm_close function automatically calls the equivalent of gdbm_sync so no call is needed if the database is to be closed immediately after the set of changes have been made.

Gdbm_sync returns 0 on success. On error, it sets gdbm_errno and system errno variables to the codes describing the error and returns -1.
```
13 Export and Import

Gdbm databases can be converted into so-called flat format files. Such files cannot be used for searching, their sole purpose is to keep the data from the database for restoring it when the need arrives. There are two flat file formats, which differ in the way they represent the data and in the amount of meta-information stored. Both formats can be used, for example, to migrate between the different versions of gdbm databases. Generally speaking, flat files are safe to send over the network, and can be used to recreate the database on another machine. The recreated database is guaranteed to be a byte-to-byte equivalent of the database from which the flat file was created. This does not necessarily mean, however, that this file can be used in the same way as the original one. For example, if the original database contained non-ASCII data (e.g. C structures, integers etc.), the recreated database can be of any use only if the target machine has the same integer size and byte ordering as the source one and if its C compiler uses the same packing conventions as the one which generated C which populated the original database. In general, such binary databases are not portable between machines, unless you follow some stringent rules on what data is written to them and how it is interpreted.

The GDBM version 1.18 supports two flat file formats. The binary flat file format was first implemented in GDBM version 1.9.1. This format stores only key/data pairs, it does not keep information about the database file itself. As its name implies, files in this format are binary files.

The ascii flat file format encodes all data in base64 and stores not only key/data pairs, but also the original database file metadata, such as file name, mode and ownership. Files in this format can be sent without additional encapsulation over transmission channels that normally allow only ASCII data, such as, e.g. SMTP. Due to additional metadata they allow for restoring an exact copy of the database, including file ownership and privileges, which is especially important if the database in question contained some security-related data.

We call a process of creating a flat file from a database exporting or dumping this database. The reverse process, creating the database from a flat file is called importing or loading the database.

```c
int gdbm_dump (GDBM_FILE dbf, const char *filename, int format, int open_flags, int mode) {
    Dumps the database file to the named file in requested format. Arguments are:
    
    dbf A pointer to the source database, returned by a prior call to gdbm_open.
    filename Name of the dump file.
    format Output file format. Allowed values are: ‘GDBM_DUMP_FMT_BINARY’ to create a binary dump and ‘GDBM_DUMP_FMT_ASCII’ to create an ASCII dump file.
    open_flags How to create the output file. If flag is ‘GDBM_WRCREAT’ the file will be created if it does not exist. If it does exist, the gdbm_dump will fail.
    If flag is ‘GDBM_NEWDB’, the function will create a new output file, replacing it if it already exists.
    mode The permissions to use when creating the output file. See Section “open a file” in open(2) man page, for a detailed discussion.
}
```

[gdbm interface]
Chapter 13: Export and Import

int gdbm_load (GDBM_FILE *pdbf, const char *filename, int flag, int meta_mask, unsigned long *errline)
Loads data from the dump file filename into the database pointed to by pdbf. The latter can point to 'NULL', in which case the function will try to create a new database. If it succeeds, the function will return, in the memory location pointed to by pdbf, a pointer to the newly created database. If the dump file carries no information about the original database file name, the function will set gdbm_errno to 'GDBM_NO_DBNAME' and return '-1', indicating failure.

The flag has the same meaning as the flag argument to the gdbm_store function (see Chapter 7 [Store], page 8).

The meta_mask argument can be used to disable restoring certain bits of file’s metadata from the information in the input dump file. It is a binary OR of zero or more of the following:

GDBM_META_MASK_MODE
   Do not restore file mode.

GDBM_META_MASK_OWNER
   Do not restore file owner.

The function returns 0 upon successful completion or -1 on fatal errors and 1 on mild (non-fatal) errors.

If a fatal error occurs, gdbm_errno will be set to one of the following values:

GDBM_FILE_OPEN_ERROR
   Input file (filename) cannot be opened. The errno variable can be used to get more detail about the failure.

GDBM_MALLOC_ERROR
   Not enough memory to load data.

GDBM_FILE_READ_ERROR
   Reading from filename failed. The errno variable can be used to get more detail about the failure.

GDBM_ILLEGAL_DATA
   Input contained some illegal data.

GDBM_ITEM_NOT_FOUND
   This error can occur only when the input file is in ASCII format. It indicates that the data part of the record about to be read lacked length specification. Application developers are advised to treat this error equally as 'GDBM_ILLEGAL_DATA'.

Mild errors mean that the function was able to successfully load and restore the data, but was unable to change database file metadata afterward. The table below lists possible values for gdbm_errno in this case. To get more detail, inspect the system errno variable.

GDBM_ERR_FILE_OWNER
   The function was unable to restore database file owner.
GDBM_ERR_FILE_MODE

The function was unable to restore database file mode (permission bits).

If an error occurs while loading data from an input file in ASCII format, the number of line in which the error occurred will be stored in the location pointed to by the errline parameter, unless it is 'NULL'.

If the line information is not available or applicable, errline will be set to '0'.

int gdbm_dump_to_file (GDBM.FILE dbf, FILE *fp, int format)   [gdbm interface]

This is an alternative entry point to gdbm_dump (which see). Arguments are:

dbf A pointer to the source database, returned by a call to gdbm_open.
fp File to write the data to.
format Format of the dump file. See the format argument to the gdbm_dump function.

int gdbm_load_from_file (GDBM.FILE *pdbf, FILE *fp, int replace, int meta_mask, unsigned long *line)   [gdbm interface]

This is an alternative entry point to gdbm_dump. It writes the output to fp which must be a file open for writing. The rest of arguments is the same as for gdbm_load (excepting of course flag, which is not needed in this case).

int gdbm_export (GDBM.FILE dbf, const char *exportfile, int flag, int mode)   [gdbm interface]

This function is retained for compatibility with GDBM 1.10 and earlier. It dumps the database to a file in binary dump format and is entirely equivalent to

gdbm_dump(dbf, exportfile, GDBM_DUMP_FMT_BINARY, flag, mode)

int gdbm_export_to_file (GDBM.FILE dbf, FILE *fp)   [gdbm interface]

This is an alternative entry point to gdbm_export. This function writes to file fp a binary dump of the database dbf.

int gdbm_import (GDBM.FILE dbf, const char *importfile, int flag)   [gdbm interface]

This function is retained for compatibility with GDBM 1.10 and earlier. It loads the file importfile, which must be a binary flat file, into the database dbf and is equivalent to the following construct:

dbf = gdbm_open (importfile, 0,
   flag == GDBM_REPLACE ?
   GDBM_WRCREAT : GDBM_NEWDB,
   0600, NULL);

gdbm_load (&dbf, exportfile, 0, flag, NULL)

int gdbm_import_from_file (GDBM.FILE dbf, FILE *fp, int flag)   [gdbm interface]

An alternative entry point to gdbm_import. Reads the binary dump from the file fp and stores the key/value pairs to dbf. See Chapter 7 [Store], page 8, for a description of flag.
This function is equivalent to:

```c
    dbf = gdbm_open (importfile, 0,
        flag == GDBM_REPLACE ?
            GDBM_WRCREAT : GDBM_NEWDB,
        0600, NULL);

gdbm_load_from_file (dbf, fp, flag, 0, NULL);
```
Chapter 14: Error handling.

The global variable `gdbm_errno` (see Chapter 18 [Variables], page 27) keeps the error code of the most recent error encountered by GDBM functions.

To convert this code to human-readable string, use the following function:

```c
const char * gdbm_strerror (gdbm_error errno)  // [gdbm interface]
Converts errno (which is an integer value) into a human-readable descriptive text.
Returns a pointer to a static string. The caller must not alter or free the returned pointer.
```

Detailed information about the most recent error that occurred while operating on a GDBM file is stored in the `GDBM_FILE` object itself. To retrieve it, the following functions are provided:

```c
gdbm_error gdbm_last_errno (GDBM_FILE dbf)  // [gdbm interface]
Returns the code of the most recent error encountered when operating on `dbf`.
```

```c
int gdbm_last_syserr (GDBM_FILE dbf)  // [gdbm interface]
Returns the value of the system `errno` variable associated with the most recent error.
Notice, that not all GDBM errors have an associated system error code. The following are the ones that have:
- GDBM_FILE_OPEN_ERROR
- GDBM_FILE_WRITE_ERROR
- GDBM_FILESEEK_ERROR
- GDBM_FILE_READ_ERROR
- GDBM_FILE_STAT_ERROR
- GDBM_BACKUP_FAILED
For other errors, `gdbm_last_syserr` will return 0.
```

```c
int gdbm_check_syserr (gdbm_errno err)  // [gdbm interface]
Returns 1, if system `errno` value should be checked to get more info on the error
described by GDBM code `err`.
```

To get a human-readable description of the recent error for a particular database file, use the `gdbm_db_strerror` function:

```c
const char * gdbm_db_strerror (GDBM_FILE dbf)  // [gdbm interface]
Returns textual description of the most recent error encountered when operating on
the database `dbf`. The resulting string is often more informative than what would be
returned by `gdbm_strerror(gdbm_last_errno(dbf))`. In particular, if there is a
system error associated with the recent failure, it will be described as well.
```

```c
void gdbm_clear_error (GDBM_FILE dbf)  // [gdbm interface]
Clears the error state for the database `dbf`. Normally, this function is called upon the
entry to any GDBM function.
```
Certain errors (such as write error when saving stored key) can leave database file in inconsistent state. When such a critical error occurs, the database file is marked as needing recovery. Subsequent calls to any GDBM functions for that database file (except `gdbm_recover`), will return immediately with GDBM error value `GDBM_NEED_RECOVERY`. Additionally, the following function can be used to check the state of the database file:

```c
int gdbm_needs_recovery (GDBM_FILE dbf) [gdbm interface]

Returns 1 if the database file `dbf` is in inconsistent state and needs recovery.
```

The only way to bring the database back to operational state is to call the `gdbm_recover` function (see Chapter 15 [Recovery], page 21).
15 Recovery

Certain errors (such as write error when saving stored key) can leave database file in inconsistent state. When such a critical error occurs, the database file is marked as needing recovery. Subsequent calls to any GDBM functions for that database file (except `gdbm_recover`), will return immediately with GDBM error value `GDBM_NEED_RECOVERY`.

To escape from this state and bring the database back to operational state, use the following function:

```c
int gdbm_recover (GDBM_FILE dbf, gdbm_recovery *rcvr, int flags)
```

Check the database file `dbf` and fix eventual errors. The `rcvr` argument points to a structure that has input members, providing additional information to alter the behavior of `gdbm_recover`, and output members, used to return additional statistics about the recovery process (rcvr can be NULL if no such information is needed).

Each input member has a corresponding flag bit, which must be set in the `flags` in order to instruct the function to use it.

The `gdbm_recover` type is defined as:

```c
typedef struct gdbm_recovery_s
{
    /* Input members. These are initialized before call to gdbm_recover. The flags argument specifies which of them are initialized. */
    void (*errfun) (void *data, char const *fmt, ...);
    void *data;
    size_t max_failed_keys;
    size_t max_failed_buckets;
    size_t max_failures;

    /* Output members. The gdbm_recover function fills these before returning. */
    size_t recovered_keys;
    size_t recovered_buckets;
    size_t failed_keys;
    size_t failed_buckets;
    char *backup_name;
} gdbm_recovery;
```

The input members modify the behavior of `gdbm_recover`:

```c
void (*errfun) (void *data, char const *fmt, ...)
```

If the `GDBM_RCVR_ERRFUN` flag bit is set, `errfun` points to a function that will be called upon each recoverable or non-fatal error that occurred during the recovery.

```c
void * data
```

Supplies first argument for the `errfun` invocations.
size_t max_failed_keys  
If GDBM_RCVR_MAX_FAILED_KEYS is set, this member sets the limit on the number of keys that cannot be retrieved. If the number of failed keys grows bigger than max_failed_keys, recovery is aborted and error is returned.

size_t max_failed_buckets  
If GDBM_RCVR_MAX_FAILED_BUCKETS is set, this member sets the limit on the number of buckets that cannot be retrieved or that contain bogus information. If the number of failed buckets grows bigger than max_failed_buckets, recovery is aborted and error is returned.

size_t max_failures  
If GDBM_RCVR_MAX_FAILURES is set, this member sets the limit of failures that are tolerated during recovery. If the number of errors grows bigger than max_failures, recovery is aborted and error is returned.

The following members are filled on output, upon successful return from the function:

size_t recovered_keys  
Number of recovered keys.

size_t recovered_buckets  
Number of recovered buckets.

size_t failed_keys  
Number of key/data pairs that cannot be retrieved.

size_t failed_buckets  
Number of buckets that cannot be retrieved.

char * backup_name  
Name of the file keeping the copy of the original database, in the state prior to recovery. It is filled if the GDBM_RCVR_BACKUP flag is set. The string is allocated using the malloc call. The caller is responsible for freeing that memory when no longer needed.

By default, gdbm_recovery first checks the database for inconsistencies and attempts recovery only if some were found. The special flag bit GDBM_RCVR_FORCE instructs gdbm_recovery to omit this check and to force recovery unconditionally.
16 Setting options

`Gdbm` supports the ability to set certain options on an already open database.

```c
int gdbm_setopt (GDBM_FILE dbf, int option, void *value, int size)
```

Sets an option on the database or returns the value of an option.

The parameters are:
- `dbf` The pointer returned by `gdbm_open`.
- `option` The option to be set or retrieved.
- `value` A pointer to the value to which `option` will be set or where to place the option value (depending on the option).
- `size` The length of the data pointed to by `value`.

The valid options are:

**GDBM_SETCACHESIZE**

Set the size of the internal bucket cache. This option may only be set once on each `GDBM_FILE` descriptor, and is set automatically to 100 upon the first access to the database. The `value` should point to a `size_t` holding the desired cache size.

The `GDBM_CACHESIZE` option is provided for compatibility with earlier versions.

**GDBM_GETCACHESIZE**

Return the size of the internal bucket cache. The `value` should point to a `size_t` variable, where the size will be stored.

**GDBM_GETFLAGS**

Return the flags describing the state of the database. The `value` should point to an `int` variable where to store the flags. The return is the same as the flags used when opening the database (see Chapter 4 [Open], page 4), except that it reflects the current state (which may have been altered by another calls to `gdbm_setopt`.

**GDBM_FASTMODE**

Enable or disable the `fast writes mode`, i.e. writes without subsequent synchronization. The `value` should point to an integer: `TRUE` to enable fast mode, and `FALSE` to disable it.

This option is retained for compatibility with previous versions of `gdbm`. Its effect is the reverse of `GDBM_SETSYNCMODE` (see below).

**GDBM_SETSYNCMODE**

Turn on or off file system synchronization operations. This setting defaults to off. The `value` should point to an integer: `TRUE` to turn synchronization on, and `FALSE` to turn it off.
Note, that this option is a reverse of GDBM_FASTMODE, i.e. calling GDBM_SETSYNCMODE with ‘TRUE’ has the same effect as calling GDBM_FASTMODE with ‘FALSE’.

The ‘GDBM_SYNCMODE’ option is provided for compatibility with earlier versions.

GDBM_GETSYNCMODE
Return the current synchronization status. The value should point to an int where the status will be stored.

GDBM_SETCENTFREE
GDBM_CENTFREE
 NOTICE: This feature is still under study.
Set central free block pool to either on or off. The default is off, which is how previous versions of gdbm handled free blocks. If set, this option causes all subsequent free blocks to be placed in the global pool, allowing (in theory) more file space to be reused more quickly. The value should point to an integer: ‘TRUE’ to turn central block pool on, and ‘FALSE’ to turn it off.

The ‘GDBM_CENTFREE’ option is provided for compatibility with earlier versions.

GDBM_SETCOALESCEBLKS
GDBM_COALESCEBLKS
 NOTICE: This feature is still under study.
Set free block merging to either on or off. The default is off, which is how previous versions of gdbm handled free blocks. If set, this option causes adjacent free blocks to be merged. This can become a CPU expensive process with time, though, especially if used in conjunction with GDBM_CENTFREE. The value should point to an integer: ‘TRUE’ to turn free block merging on, and ‘FALSE’ to turn it off.

GDBM_GETCOALESCEBLKS
Return the current status of free block merging. The value should point to an int where the status will be stored.

GDBM_SETMAXMAPSIZE
Sets maximum size of a memory mapped region. The value should point to a value of type size_t, unsigned long or unsigned. The actual value is rounded to the nearest page boundary (the page size is obtained from sysconf(_SC_PAGESIZE)).

GDBM_GETMAXMAPSIZE
Return the maximum size of a memory mapped region. The value should point to a value of type size_t where to return the data.

GDBM_SETMMAP
Enable or disable memory mapping mode. The value should point to an integer: ‘TRUE’ to enable memory mapping or ‘FALSE’ to disable it.

GDBM_GETMMAP
Check whether memory mapping is enabled. The value should point to an integer where to return the status.
GDBM_GETDBNAME

Return the name of the database disk file. The value should point to a variable of type char**. A pointer to the newly allocated copy of the file name will be placed there. The caller is responsible for freeing this memory when no longer needed. For example:

```c
char *name;

if (gdbm_setopt (dbf, GDBM_GETDBNAME, &name, sizeof (name)))
{
    fprintf (stderr, "gdbm_setopt failed: %s\n", gdbm_strerror (gdbm_errno));
}
else
{
    printf ("database name: %s\n", name);
    free (name);
}
```

GDBM_GETBLOCKSIZE

Return the block size in bytes. The value should point to int.

The return value will be ‘-1’ upon failure, or ‘0’ upon success. The global variable gdbm_errno will be set upon failure.

For instance, to set a database to use a cache of 10, after opening it with gdbm_open, but prior to accessing it in any way, the following code could be used:

```c
int value = 10;
ret = gdbm_setopt (dbf, GDBM_CACHESIZE, &value, sizeof (int));
```
17 File Locking.

With locking disabled (if `gdbm_open` was called with ‘GDBM_NOLOCK’), the user may want to perform their own file locking on the database file in order to prevent multiple writers operating on the same file simultaneously.

In order to support this, the `gdbm_fdesc` routine is provided.

```c
int gdbm_fdesc (GDBM_FILE dbf) [gdbm interface]
    Returns the file descriptor of the database `dbf`. This value can be used as an argument to `flock`, `lockf` or similar calls.
```
18 Useful global variables.

The following global variables and constants are available:

```
gdbm_error gdbm_errno
```
This variable contains error code from the last failed `gdbm` call. See Chapter 19 [Error codes], page 29, for a list of available error codes and their descriptions. Use `gdbm_strerror` (see Chapter 14 [Errors], page 19) to convert it to a descriptive text.

```
const char * gdbm_errlist[]
```
This variable is an array of error descriptions, which is used by `gdbm_strerror` to convert error codes to human-readable text (see Chapter 14 [Errors], page 19). You can access it directly, if you wish so. It contains `_GDBM_MAX_ERRNO + 1` elements and can be directly indexed by the error code to obtain a corresponding descriptive text.

```
int const gdbm_syserr[]
```
Array of boolean values indicating, for each GDBM error code, whether the value of `errno(3)` variable is meaningful for this error code. See [gdbm_check_syserr], page 19.

```
_GDBM_MIN_ERRNO
```
The minimum error code used by `gdbm`.

```
_GDBM_MAX_ERRNO
```
The maximum error code used by `gdbm`.

```
const char * gdbm_version
```
A string containing the version information.

```
int const gdbm_version_number[3]
```
This variable contains the `gdbm` version numbers:

<table>
<thead>
<tr>
<th>Index</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Major number</td>
</tr>
<tr>
<td>1</td>
<td>Minor number</td>
</tr>
<tr>
<td>2</td>
<td>Patchlevel number</td>
</tr>
</tbody>
</table>

Additionally, the following constants are defined in the `gdbm.h` file:

```
GDBM_VERSION_MAJOR
```
Major number.

```
GDBM_VERSION_MINOR
```
Minor number.

```
GDBM_VERSION_PATCH
```
Patchlevel number.

These can be used to verify whether the header file matches the library.

To compare two split-out version numbers, use the following function:
int gdbm_version_cmp (int const a[3], int const b[3])  [gdbm interface]

Compare two version numbers. Return ‘-1’ if a is less than b, ‘1’ if a is greater than b and ‘0’ if they are equal.

Comparison is done from left to right, so that:

a = { 1, 8, 3 };  
b = { 1, 8, 3 };  
gdbm_version_cmp (a, b) ⇒ 0

a = { 1, 8, 3 };  
b = { 1, 8, 2 };  
gdbm_version_cmp (a, b) ⇒ 1

a = { 1, 8, 3 };  
b = { 1, 9. 0 };  
gdbm_version_cmp (a, b) ⇒ -1
Chapter 19: Error codes

19 Error codes

This chapter summarizes error codes which can be set by the functions in gdbm library.

GDBM_NO_ERROR
No error occurred.

GDBM_MALLOC_ERROR
Memory allocation failed. Not enough memory.

GDBM_BLOCK_SIZE_ERROR
This error is set by the gdbm_open function (see Chapter 4 [Open], page 4), if the value of its block_size argument is incorrect and the ‘GDBM_BSEXACT’ flag is set.

GDBM_FILE_OPEN_ERROR
The library was not able to open a disk file. This can be set by gdbm_open (see Chapter 4 [Open], page 4), gdbm_export and gdbm_import functions (see Chapter 13 [Flat files], page 15).
Inspect the value of the system errno variable to get more detailed diagnostics.

GDBM_FILE_WRITE_ERROR
Writing to a disk file failed. This can be set by gdbm_open (see Chapter 4 [Open], page 4), gdbm_export and gdbm_import functions.
Inspect the value of the system errno variable to get more detailed diagnostics.

GDBM_FILESEEK_ERROR
Positioning in a disk file failed. This can be set by gdbm_open (see Chapter 4 [Open], page 4) function.
Inspect the value of the system errno variable to get a more detailed diagnostics.

GDBM_FILE_READ_ERROR
Reading from a disk file failed. This can be set by gdbm_open (see Chapter 4 [Open], page 4), gdbm_export and gdbm_import functions.
Inspect the value of the system errno variable to get a more detailed diagnostics.

GDBM_BAD_MAGIC_NUMBER
The file given as argument to gdbm_open function is not a valid gdbm file: it has a wrong magic number.

GDBM_EMPTY_DATABASE
The file given as argument to gdbm_open function is not a valid gdbm file: it has zero length.

GDBM_CANT_BE_READER
This error code is set by the gdbm_open function if it is not able to lock file when called in ‘GDBM_READER’ mode (see Chapter 4 [Open], page 4).

GDBM_CANT_BE_WRITER
This error code is set by the gdbm_open function if it is not able to lock file when called in writer mode (see Chapter 4 [Open], page 4).
Chapter 19: Error codes

GDBM.Reader.Cant.Delete
Set by the gdbm_delete (see Chapter 9 [Delete], page 10) if it attempted to operate on a database that is open in read-only mode (see Chapter 4 [Open], page 4).

GDBM.Reader.Cant.Store
Set by the gdbm_store (see Chapter 7 [Store], page 8) if it attempted to operate on a database that is open in read-only mode (see Chapter 4 [Open], page 4).

GDBM.Reader.Cant.Reorganize
Set by the gdbm_reorganize (see Chapter 11 [Reorganization], page 13) if it attempted to operate on a database that is open in read-only mode (see Chapter 4 [Open], page 4).

GDBM.Item.Not.Found
Requested item was not found. This error is set by gdbm_delete (see Chapter 9 [Delete], page 10) and gdbm_fetch (see Chapter 8 [Fetch], page 9) when the requested key value is not found in the database.

GDBM.Reorganize.Failed
The gdbm_reorganize function is not able to create a temporary database. See Chapter 11 [Reorganization], page 13.

GDBM.Cannot.Replace
Cannot replace existing item. This error is set by the gdbm_store if the requested key value is found in the database and the flag parameter is not ‘GDBM_REPLACE’. See Chapter 7 [Store], page 8, for a detailed discussion.

GDBM.Illegal.Data
Either key or content parameter was wrong in a call to to gdbm_store (see Chapter 7 [Store], page 8).

GDBM.Opt.Already.Set
Requested option can be set only once and was already set. This error is returned by the gdbm_setopt function. See Chapter 16 [Options], page 23.

GDBM.Opt.Illegal
The option argument is not valid or the value argument points to an invalid value in a call to gdbm_setopt function. See Chapter 16 [Options], page 23.

GDBM.Byte.Swapped
The gdbm_open function (see Chapter 4 [Open], page 4) attempts to open a database which is created on a machine with different byte ordering.

GDBM.Bad.File.Offset
The gdbm_open function (see Chapter 4 [Open], page 4) sets this error code if the file it tries to open has a wrong magic number.

GDBM.Bad.Open.Flags
Set by the gdbm_export function if supplied an invalid flags argument. See Chapter 13 [Flat files], page 15.

GDBM.File.Stat.Error
Getting information about a disk file failed. The system errno will give more details about the error.
Chapter 19: Error codes

This error can be set by the following functions: `gdbm_open, gdbm_reorganize`.

**GDBM_FILE_EOF**
End of file was encountered where more data was expected to be present. This error can occur when fetching data from the database and usually means that the database is truncated or otherwise corrupted.

This error can be set by any GDBM function that does I/O. Some of these functions are: `gdbm_delete, gdbm_exists, gdbm_fetch, gdbm_export, gdbm_import, gdbm_reorganize, gdbm_firstkey, gdbm_nextkey, gdbm_store`.

**GDBM_NO_DBNAME**
Output database name is not specified. This error code is set by `gdbm_load` (see [gdbm_load], page 16) if the first argument points to ‘NULL’ and the input file does not specify the database name.

**GDBM_ERR_FILE_OWNER**
This error code is set by `gdbm_load` if it is unable to restore database file owner. It is a mild error condition, meaning that the data have been restored successfully, only changing the target file owner failed. Inspect the system `errno` variable to get a more detailed diagnostics.

**GDBM_ERR_FILE_MODE**
This error code is set by `gdbm_load` if it is unable to restore database file mode. It is a mild error condition, meaning that the data have been restored successfully, only changing the target file owner failed. Inspect the system `errno` variable to get a more detailed diagnostics.

**GDBM_NEED_RECOVERY**
Database is in inconsistent state and needs recovery. Call `gdbm_recover` if you get this error. See Chapter 15 [Recovery], page 21, for a detailed description of recovery functions.

**GDBM_BACKUP_FAILED**
The GDBM engine is unable to create backup copy of the file.

**GDBM_DIR_OVERFLOW**
Bucket directory would overflow the size limit during an attempt to split hash bucket. This error can occur while storing a new key.
20 Compatibility with standard dbm and ndbm.

Gdbm includes a compatibility layer, which provides traditional ‘ndbm’ and older ‘dbm’ functions. The layer is compiled and installed if the `--enable-libgdbm-compat` option is used when configuring the package. The compatibility layer consists of two header files: `ndbm.h` and `dbm.h` and the `libgdbm_compat` library.

Older programs using `ndbm` or `dbm` interfaces can use `libgdbm_compat` without any changes. To link a program with the compatibility library, add the following two options to the `cc` invocation: `-lgdbm -lgdbm_compat`. The `-L` option may also be required, depending on where `gdbm` is installed, e.g.:

```
cc ... -lgdbm -lgdbm_compat
```

Databases created and manipulated by the compatibility interfaces consist of two different files: `file.dir` and `file.pag`. This is required by the POSIX specification and corresponds to the traditional usage. Note, however, that despite the similarity of the naming convention, actual data stored in these files has not the same format as in the databases created by other `dbm` or `ndbm` libraries. In other words, you cannot access a standard UNIX `dbm` file with GNU `dbm`!

GNU `dbm` files are not sparse. You can copy them with the usual `cp` command and they will not expand in the copying process.

20.1 NDBM interface functions.

The functions below implement the POSIX ‘ndbm’ interface:

```
DBM * dbm_open (char *file, int flags, int mode) [ndbm]
```

Opens a database. The `file` argument is the full name of the database file to be opened. The function opens two files: `file.pag` and `file.dir`. The `flags` and `mode` arguments have the same meaning as the second and third arguments of `open` (see Section “open a file” in `open(2)` man page), except that a database opened for write-only access opens the files for read and write access and the behavior of the `O_APPEND` flag is unspecified.

The function returns a pointer to the `DBM` structure describing the database. This pointer is used to refer to this database in all operations described below.

Any error detected will cause a return value of ‘NULL’ and an appropriate value will be stored in `gdbm_errno` (see Chapter 18 [Variables], page 27).

```
void dbm_close (DBM *dbf) [ndbm]
```

Closes the database. The `dbf` argument must be a pointer returned by an earlier call to `dbm_open`.

```
datum dbm_fetch (DBM *dbf, datum key) [ndbm]
```

Reads a record from the database with the matching key. The `key` argument supplies the key that is being looked for.

If no matching record is found, the `dptr` member of the returned datum is ‘NULL’. Otherwise, the `dptr` member of the returned datum points to the memory managed by the compatibility library. The application should never free it.
int dbm_store (DBM *dbf, datum key, datum content, int mode)  [ndbm]
Writes a key/value pair to the database. The argument dbf is a pointer to the DBM structure returned from a call to dbm_open. The key and content provide the values for the record key and content. The mode argument controls the behavior of dbm_store in case a matching record already exists in the database. It can have one of the following two values:

DBM_REPLACE
Replace existing record with the new one.

DBM_INSERT
The existing record is left unchanged, and the function returns ‘1’.

If no matching record exists in the database, new record will be inserted no matter what the value of the mode is.

int dbm_delete (DBM *dbf, datum key)  [ndbm]
Deletes the record with the matching key from the database. If the function succeeds, ‘0’ is returned. Otherwise, if no matching record is found or if an error occurs, ‘-1’ is returned.

datum dbm_firstkey (DBM *dbf)  [ndbm]
Initializes iteration over the keys from the database and returns the first key. Note, that the word ‘first’ does not imply any specific ordering of the keys.

If there are no records in the database, the dptr member of the returned datum is ‘NULL’. Otherwise, the dptr member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

datum dbm_nextkey (DBM *dbf)  [ndbm]
Continues the iteration started by dbm_firstkey. Returns the next key in the database. If the iteration covered all keys in the database, the dptr member of the returned datum is ‘NULL’. Otherwise, the dptr member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

The usual way of iterating over all the records in the database is:

```c
for (key = dbm_firstkey (dbf);
    key.ptr;
    key = dbm_nextkey (dbf))
{
    /* do something with the key */
}
```

The loop above should not try to delete any records from the database, otherwise the iteration is not guaranteed to cover all the keys. See Chapter 10 [Sequential], page 11, for a detailed discussion of this.

int dbm_error (DBM *dbf)  [ndbm]
Returns the error condition of the database: ‘0’ if no errors occurred so far while manipulating the database, and a non-zero value otherwise.
void dbm_clearerr (DBM *dbf)  
Clears the error condition of the database.

int dbm_dirfno (DBM *dbf)  
Returns the file descriptor of the ‘dir’ file of the database. It is guaranteed to be different from the descriptor returned by the dbm_pagfno function (see below).

The application can lock this descriptor to serialize accesses to the database.

int dbm_pagfno (DBM *dbf)  
Returns the file descriptor of the ‘pag’ file of the database. See also dbm_dirfno.

int dbm_rdonly (DBM *dbf)  
Returns ‘1’ if the database dbf is open in a read-only mode and ‘0’ otherwise.

20.2 DBM interface functions.
The functions below are provided for compatibility with the old UNIX ‘DBM’ interface. Only one database at a time can be manipulated using them.

int dbminit (char *file)  
Opens a database. The file argument is the full name of the database file to be opened. The function opens two files: file.pag and file.dir. If any of them does not exist, the function fails. It never attempts to create the files.

The database is opened in the read-write mode, if its disk permissions permit.

The application must ensure that the functions described below in this section are called only after a successful call to dbminit.

int dbmclose (void)  
Closes the database opened by an earlier call to dbminit.

datum fetch (datum key)  
Reads a record from the database with the matching key. The key argument supplies the key that is being looked for.

If no matching record is found, the dptr member of the returned datum is ‘NULL’. Otherwise, the dptr member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

int store (datum key, datum content)  
Stores the key/value pair in the database. If a record with the matching key already exists, its content will be replaced with the new one.

Returns ‘0’ on success and ‘-1’ on error.

int delete (datum key)  
Deletes a record with the matching key.

If the function succeeds, ‘0’ is returned. Otherwise, if no matching record is found or if an error occurs, ‘-1’ is returned.
**datum firstkey (void)**

Initializes iteration over the keys from the database and returns the first key. Note, that the word ‘first’ does not imply any specific ordering of the keys.

If there are no records in the database, the dptr member of the returned datum is ‘NULL’. Otherwise, the dptr member of the returned datum points to the memory managed by the compatibility library. The application should never free it.

**datum nextkey (datum key)**

Continues the iteration started by a call to firstkey. Returns the next key in the database. If the iteration covered all keys in the database, the dptr member of the returned datum is ‘NULL’. Otherwise, the dptr member of the returned datum points to the memory managed by the compatibility library. The application should never free it.
Chapter 21: Examine and modify a GDBM database.

21 Examine and modify a GDBM database.

The gdbmtool utility allows you to view and modify an existing GDBM database or to create a new one.

When invoked without arguments, it tries to open a database file called junk.gdbm, located in the current working directory. You can change this default by supplying the name of the database as argument to the program, e.g.:

$ gdbmtool file.db

The database will be opened in read-write mode, unless the -r (--read-only) option is specified, in which case it will be opened only for reading.

If the database does not exist, gdbmtool will create it. There is a special option -n (--newdb), which instructs the utility to create a new database. If it is used and if the database already exists, it will be deleted, so use it sparingly.

21.1 gdbmtool invocation

When started without additional arguments, gdbmtool operates on the default database junk.gdbm. Otherwise, the first argument supplies the name of the database to operate upon. If neither any additional arguments nor the -f (--file) option are given, gdbmtool opens starts interactive shell and receives commands directly from the human operator.

If more than one arguments are given, all arguments past the database name are parsed as gdbmtool commands (see Section 21.2 [shell], page 37, for a description of available commands) and executed in turn. All commands, except the last one, should be terminated with semicolons. Semicolon after the last command is optional. Note, that semicolons should be escaped in order to prevent them from being interpreted by the shell.

Finally, if the -f (--file) option is supplied, its argument specifies the name of the disk file with gdbmtool script. The program will open that file and read commands from it.

The following table summarizes all gdbmtool command line options:

- b size
  --block-size=size
  Set block size.

- c size
  --cache-size=size
  Set cache size.

- f file
  --file file
  Read commands from file, instead of the standard input.

- h
  --help
  Print a concise help summary.

- N
  --norc
  Don’t read startup files (see Section 21.2.4 [startup files], page 46).

- n
  --newdb
  Create the database.
-l
--no-lock
Disable file locking.

-m
--no-mmap
Disable mmap.

-q
--quiet
Don't print the usual welcome banner at startup. This is the same as setting the variable 'quiet' in the startup file. See [quiet], page 39.

-r
--read-only
Open the database in read-only mode.

-s
--synchronize
Synchronize to the disk after each write.

-V
--version
Print program version and licensing information and exit.

--usage
Print a terse invocation syntax summary along with a list of available command line options.

21.2 gdbmtool interactive mode
After successful startup, gdbmtool starts a loop, in which it reads commands from the standard input, executes them and prints results on the standard output. If the standard input is attached to a console, gdbmtool runs in interactive mode, which is indicated by its prompt:

    gdbmtool> _

The utility finishes when it reads the 'quit' command (see below) or detects end-of-file on its standard input, whichever occurs first.

A gdbmtool command consists of a command verb, optionally followed by arguments, separated by any amount of white space and terminated with a newline or semicolon. A command verb can be entered either in full or in an abbreviated form, as long as that abbreviation does not match any other verb. For example, ‘co’ can be used instead of ‘count’ and ‘ca’ instead of ‘cache’.

Any sequence of non-whitespace characters appearing after the command verb forms an argument. If the argument contains whitespace or unprintable characters it must be enclosed in double quotes. Within double quotes the usual escape sequences are understood, as shown in the table below:
Sequence | Replaced with
---|---
\a | Audible bell character (ASCII 7)
\b | Backspace character (ASCII 8)
\f | Form-feed character (ASCII 12)
\n | Newline character (ASCII 10)
\r | Carriage return character (ASCII 13)
\t | Horizontal tabulation character (ASCII 9)
\v | Vertical tabulation character (ASCII 11)
\| | Single slash
\" | Double quote

Table 21.1: Backslash escapes

In addition, a backslash immediately followed by the end-of-line character effectively removes that character, allowing to split long arguments over several input lines.

Command parameters may be optional or mandatory. If the number of actual arguments is less than the number of mandatory parameters, gdbmtool will prompt you to supply missing arguments. For example, the 'store' command takes two mandatory parameters, so if you invoked it with no arguments, you would be prompted twice to supply the necessary data, as shown in example below:

```
gdbmtool> store
key? three
data? 3
```

However, such prompting is possible only in interactive mode. In non-interactive mode (e.g. when running a script), all arguments must be supplied with each command, otherwise gdbmtool will report an error and exit immediately.

If the package is compiled with GNU Readline, the input line can be edited (see Section “Command Line Editing” in GNU Readline Library).

## 21.2.1 Shell Variables

A number of gdbmtool parameters is kept in its internal variables.

**bool confirm**

[ gdbmtool variable ]

Whether to ask for confirmation before certain destructive operations, such as truncating the existing database.

Default is ‘true’.

**string ps1**

[ gdbmtool variable ]

Primary prompt string. Its value can contain conversion specifiers, consisting of the ‘%’ character followed by another character. These specifiers are expanded in the resulting prompt as follows:

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>%f</td>
<td>name of the current database file</td>
</tr>
<tr>
<td>%p</td>
<td>program invocation name</td>
</tr>
<tr>
<td>%P</td>
<td>package name (‘GDBM’)</td>
</tr>
</tbody>
</table>
Chapter 21: Examine and modify a GDBM database.

The default value is ‘%p>%_’, i.e. the program name, followed by a “greater than” sign, followed by a single space.

**string ps2**

Secondary prompt. See ‘ps1’ for a description of its value. This prompt is displayed before reading the second and subsequent lines of a multi-line command.

The default value is ‘%_>%_’.

**string delim1**

A string used to delimit fields of a structured datum on output (see Section 21.2.3 [definitions], page 44).

Default is ‘,’ (a comma). This variable cannot be unset.

**string delim2**

A string used to delimit array items when printing a structured datum (see Section 21.2.3 [definitions], page 44).

Default is ‘,’ (a comma). This variable cannot be unset.

**string pager**

The name and command line of the pager program to pipe output to. This program is used in interactive mode when the estimated number of output lines is greater than the number of lines on your screen.

The default value is inherited from the environment variable PAGER. Unsetting this variable disables paging.

**bool quiet**

Whether to display a welcome banner at startup. This variable should be set in a startup script file (see Section 21.2.4 [startup files], page 46). See [-q option], page 37.

The following variables control how the database is opened:

**numeric blocksize**

Sets the block size. See Chapter 4 [Open], page 4. Unset by default.

**numeric cachesize**

Sets the cache size. See Chapter 16 [Options], page 23. By default this variable is not set.

**string open**

Open mode. The following values are allowed:

- newdb Truncate the database if it exists or create a new one. Open it in read-write mode.

  Technically, this sets the ‘GDBM_NEWDB’ flag in call to ‘gdbm_open’. See Chapter 4 [Open], page 4.
wrcreat
rw
Open the database in read-write mode. Create it if it does not exist. This is the default.
Technically speaking, it sets the ‘GDBM_WRCREAT’ flag in call to gdbm_open. See Chapter 4 [Open], page 4.

reader
readonly
Open the database in read-only mode. Signal an error if it does not exist. This sets the ‘GDBM_READER’ flag (see Chapter 4 [Open], page 4).

Attempting to set any other value or to unset this variable produces an error.

---

**number filemode**  
[gdbmtool variable]
File mode (in octal) for creating new database files and database dumps.

**bool lock**  
[gdbmtool variable]
Lock the database. This is the default.
Setting this variable to false or unsetting it results in passing ‘GDBM_NOLOCK’ flag to gdbm_open (see Chapter 4 [Open], page 4).

**bool mmap**  
[gdbmtool variable]
Use memory mapping. This is the default.
Setting this variable to false or unsetting it results in passing ‘GDBM_NOMMAP’ flag to gdbm_open (see Chapter 4 [Open], page 4).

**bool sync**  
[gdbmtool variable]
Flush all database writes on disk immediately. Default is false. See Chapter 4 [Open], page 4.

**bool coalesce**  
[gdbmtool variable]
Enables the coalesce mode, i.e. merging of the freed blocks of GDBM files with entries in available block lists. This provides for effective memory management at the cost of slight increase in execution time when calling gdbm_delete. See Chapter 16 [Options], page 23.
This variable affects the open command and should be set before invoking it.

**bool centfree**  
[gdbmtool variable]
Set to ‘true’, enables the use of central free block pool in newly opened databases. See Chapter 16 [Options], page 23.
This variable affects the open command and should be set before invoking it.

The following commands are used to list or modify the variables:

**set [assignments]**
[command verb]
When used without arguments, lists all variables and their values. Unset variables are shown after a comment sign (‘#’). For string and numeric variables, values are shown after an equals sign. For boolean variables, only the variable name is displayed if the variable is ‘true’. If it is ‘false’, its name is prefixed with ‘no’.
For example:

---

**Example:**

```bash
$ gdbmtool set
```

---

**Example:**

```bash
$ gdbmtool set number=0644
```

---

**Example:**

```bash
$ gdbmtool set bool=False
```

---

**Example:**

```bash
$ gdbmtool set bool=true
```
ps1=\%_\%p>\%_\%
ps2=\%_\%p>\%_
delim1=","
delim2=","
confirm
# cachesize is unset
# blocksize is unset
open="wrcreate"
lock
mmap
nosync
pager="less"
# quiet is unset

If used with arguments, the set command alters the specified variables. In this case, arguments are variable assignments in the form ‘name=value’. For boolean variables, the value is interpreted as follows: if it is numeric, ‘0’ stands for ‘false’, any non-zero value stands for ‘true’. Otherwise, the values ‘on’, ‘true’, and ‘yes’ denote ‘true’, and ‘off’, ‘false’, ‘no’ stand for ‘false’. Alternatively, only the name of a boolean variable can be supplied to set it to ‘true’, and its name prefixed with ‘no’ can be used to set it to false. For example, the following command sets the ‘delim2’ variable to ‘;’ and the ‘confirm’ variable to ‘false’:

set delim2=";" noconfirm

unset variables

Unsets the listed variables. The effect of unsetting depends on the variable. Unless explicitly described in the discussion of the variables above, unsetting a boolean variable is equivalent to setting it to ‘false’. Unsetting a string variable is equivalent to assigning it an empty string.

21.2.2 Gdbmtool Commands

avail

Print the avail list.

bucket num

Print the bucket number num and set it as the current one.

cache

Print the bucket cache.

close

Close the currently open database.

count

Print the number of entries in the database.

current

Print the current bucket.
debug \([+\cdot]^{\ldots}\) \[command verb\]
If \texttt{GDBM} is configured with additional debugging, this statement queries or sets \texttt{GDBM}
internal debugging level. This is intended for debugging and testing purposes and
requires good knowledge of \texttt{GDBM} internals. The use of this command is not recom-
manded.

delete key \[command verb\]
Delete record with the given key

dir \[command verb\]
Print hash directory.

export file-name \([\text{truncate}]\) \([\text{binary}|\text{ascii}]\) \[command verb\]
Export the database to the flat file \textit{file-name}. See Chapter 13 [Flat files], page 15, for a
description of the flat file format and its purposes. This command will not overwritte
an existing file, unless the \texttt{trunc}ate\ parameter is also given. Another optional
argument determines the type of the dump (see Chapter 13 [Flat files], page 15). By
default, ASCII dump is created.

The global variable \texttt{filemode} specifies the permissions to use for the created output
file.

fetch key \[command verb\]
Fetch and display the record with the given key.

first \[command verb\]
Fetch and display the first record in the database. Subsequent records can be fetched
using the \textit{next} command (see below). See Chapter 10 [Sequential], page 11, for more
information on sequential access.

hash key \[command verb\]
Compute and display the hash value for the given key.

header \[command verb\]
Print file header.

help \[command verb\]
Print a concise command summary, showing each command verb with its parameters
and a short description of what it does. Optional arguments are enclosed in square
brackets.

import file-name \([\text{replace}]\) \([\text{nometa}]\) \[command verb\]
Import data from a flat dump file \textit{file-name} (see Chapter 13 [Flat files], page 15).
If the word \texttt{replace} is given as an argument, any records with the same keys as
the already existing ones will replace them. The word \texttt{nometa} turns off restoring
meta-information from the dump file.

history \[command verb\]

history count \[command verb\]
Chapter 21: Examine and modify a GDBM database.

history \texttt{n count} [command verb]

Shows the command history list with line numbers. When used without arguments, shows entire history. When used with one argument, displays \textit{count} last commands from the history. With two arguments, displays \textit{count} commands starting from \textit{n}th command. Command numbering starts with 1.

This command is available only if GDBM was compiled with GNU Readline. The history is saved in file \texttt{.gdbmtool_history} in the user’s home directory. If this file exists upon startup, it is read to populate the history. Thus, command history is preserved between \texttt{gdbmtool} invocations.

list [command verb]

List the contents of the database.

next \texttt{[key]} [command verb]

Sequential access: fetch and display the next record. If the \texttt{key} is given, the record following the one with this key will be fetched.

Issuing several \texttt{next} commands in row is rather common. A shortcut is provided to facilitate such use: if the last entered command was \texttt{next}, hitting the \texttt{Enter} key repeats it without arguments.

See also \texttt{first}, above.

See Chapter 10 [Sequential], page 11, for more information on sequential access.

open \texttt{filename} [command verb]

Open the database file \texttt{filename}. If successful, any previously open database is closed. Otherwise, if the operation fails, the currently opened database remains unchanged.

This command takes additional information from the following variables:

\begin{itemize}
  \item \texttt{open} The database access mode. See [The \texttt{open} variable], page 39, for a list of its values.
  \item \texttt{lock} Whether or not to lock the database. Default is \texttt{on}.
  \item \texttt{mmap} Use the memory mapping. Default is \texttt{on}.
  \item \texttt{sync} Synchronize after each write. Default is \texttt{off}.
  \item \texttt{filemode} Specifies the permissions to use in case a new file is created.
\end{itemize}

See [open parameters], page 39, for a detailed description of these variables.

quit [command verb]

Close the database and quit the utility.

recover \texttt{[options]} [command verb]

Run database recovery. The following \texttt{options} are understood:

\begin{itemize}
  \item \texttt{backup} Create a backup copy of the original database.
  \item \texttt{max-failed-buckets=n} Abort recovery process if \textit{n} buckets could not be recovered.
\end{itemize}
Chapter 21: Examine and modify a GDBM database.

max-failed-keys=n
Abort recovery process if n keys could not be recovered.

max-failures=n
Abort recovery process after n failures. A failure in this context is either a key or a bucket that failed to be recovered.

summary
Print the recovery statistics at the end of the run. The statistics includes number of successfully recovered, failed and duplicate keys and the number of recovered and failed buckets.

verbose
Verbosely list each error encountered.

reorganize
Reorganize the database (see Chapter 11 [Reorganization], page 13).

source filename
Read gdbmtool commands from the file filename.

status
Print current program status. The following example shows the information displayed:

   Database file: junk.gdbm
   Database is open
   define key string
   define content string

The two ‘define’ strings show the defined formats for key and content data. See Section 21.2.3 [definitions], page 44, for a detailed discussion of their meaning.

store key data
Store the data with key in the database. If key already exists, its data will be replaced.

version
Print the version of gdbm.

21.2.3 Data Definitions
GDBM databases are able to keep data of any type, both in the key and in the content part of a record. Quite often these data are structured, i.e. they consist of several fields of various types. Gdbmtool provides a mechanism for handling such kind of records.

The define command defines a record structure. The general syntax is:

   define what definition

where what is ‘key’ to defining the structure of key data and ‘content’ to define the structure of the content records.

The definition can be of two distinct formats. In the simplest case it is a single data type. For example,

   define content int

defines content records consisting of a single integer field. Supported data types are:

char      Single byte (signed).
short     Signed short integer.
Chapter 21: Examine and modify a GDBM database.

ushort Unsigned short integer.
int Signed integer.
unsigned uint Unsigned integer.
long Signed long integer.
ulong Unsigned long integer.
llong Signed long long integer.
ullong Unsigned long long integer.
float A floating point number.
double Double-precision floating point number.
string Array of bytes.
stringz Null-terminated string, trailing null being part of the string.

All numeric data types (integer as well as floating point) have the same respective widths as in C language on the host where the database file resides.

The ‘string’ and ‘stringz’ are special. Both define a string of bytes, similar to ‘char x[]’ in C. The former defines an array of bytes, the latter - a null-terminated string. This makes a difference, in particular, when the string is the only part of datum. Consider the following two definitions:

1. define key string
2. define key stringz

Now, suppose we want to store the string "ab" in the key. Using the definition (1), the dptr member of GDBM datum will contain two bytes: ‘a’, and ‘b’. Consequently, the dsize member will have the value 2. Using the definition (2), the dptr member will contain three bytes: ‘a’, ‘b’, and ASCII 0. The dsize member will have the value 3.

The definition (1) is the default for both key and content.

The second form of the define statement is similar to the C struct statement and allows for defining structural data. In this form, the definition part is a comma-separated list of data types and variables enclosed in curly braces. In contrast to the rest of gdbm commands, this command is inherently multiline and is terminated with the closing curly brace. For example:

```c
define content {
    int status,
    pad 8,
    char id[3],
    string name
}
```

This defines a structure consisting of three members: an integer status, an array of 8 bytes id, and a null-terminated string name. Notice the pad statement: it allows to introduce padding between structure members. Another useful statement is offset: it specifies that the member following it begins at the given offset in the structure. Assuming the size of int is 8 bytes, the above definition can also be written as
define content {
    int status,
    offset 16,
    char id[3],
    string name
}

NOTE: The ‘string’ type can reasonably be used only if it is the last or the only member of the data structure. That’s because it provides no information about the number of elements in the array, so it is interpreted to contain all bytes up to the end of the datum.

When displaying the structured data, gdbmtool precedes each value with the corresponding field name and delimits parts of the structure with the string defined in the ‘delim1’ variable (see Section 21.2.1 [variables], page 38). Array elements are delimited using the string from ‘delim2’. For example:

    gdbmtool> fetch foo
    status=2, id={ a, u, x }, name="quux"

To supply a structured datum as an argument to a gdbmtool command, use the same notation, but without field names, e.g.:

    gdbmtool> hash { 2, {a,u,x}, "quux" }
    hash value = 13089969.

21.2.4 Startup Files

Upon startup gdbmtool looks for a file named ‘.gdbmtoolrc’ first in the current working directory and, if not found, in the home directory of the user who started the command.

If found, this file is read and interpreted as a list of gdbmtool commands. This allows you to customize the program behavior.

Following is an example startup file which disables the welcome banner, sets command line prompt to contain the name of the database file in parentheses and defines the structure of the database content records:

    set quiet
    set ps1= "(%f) "
    define key stringz
    define content {
        int time,
        pad 4,
        int status
    }
22 The gdbm_dump utility

The gdbm_dump utility creates a flat file dump of a GDBM database (see Chapter 13 [Flat files], page 15). It takes one mandatory argument: the name of the source database file. The second argument, if given, specifies the name of the output file. If not given, gdbm_dump will produce the dump on the standard output.

For example, the following invocation creates a dump of the database file.db in the file file.dump:

    $ gdbm_dump file.db file.dump

By default the utility creates dumps in ASCII format (see Chapter 13 [Flat files], page 15). Another format can be requested using the --format (-H) option.

The gdbm_dump utility understands the following command line options:

- `-H fmt`
  `--format=fmt`
  Select output format. Valid values for `fmt` are: `binary` or `0` to select binary dump format, and `ascii` or `1` to select ASCII format.

- `-h`
  `--help`
  Print a concise help summary.

- `-V`
  `--version`
  Print program version and licensing information and exit.

- `--usage`
  Print a terse invocation syntax summary along with a list of available command line options.
23 The `gdbm_load` utility

The `gdbm_load` utility restores a GDBM database from a flat file. The utility requires at least one argument: the name of the input flat file. If it is `-`, the standard input will be read. The format of the input file is detected automatically.

By default the utility attempts to restore the database under its original name, as stored in the input file. It will fail to do so if the input is in binary format. In that case, the name of the database must be given as the second argument.

In general, if two arguments are given the second one is treated as the name of the database to create, overriding the file name specified in the flat file.

The utility understands the following command line arguments:

```
-b num
   --block-size=num
       Sets block size. See Chapter 4 [Open], page 4.

-c num
   --cache-size=num
       Sets cache size. See Chapter 16 [Options], page 23.

-M
   --mmap
       Use memory mapping.

-m mode
   --mode=mode
       Sets the file mode. The argument is the desired file mode in octal.

-n
   --no-meta
       Do not restore file meta-data (ownership and mode) from the flat file.

-r
   --replace
       Replace existing keys.

-u user[:group]
   --user=user[:group]
       Set file owner. The `user` can be either a valid user name or UID. Similarly, the `group` is either a valid group name or GID. If `group` is not given, the main group of `user` is used.

       User and group parts can be separated by a dot, instead of the colon.

-h
   --help
       Print a concise help summary.

-V
   --version
       Print program version and licensing information and exit.

--usage
       Print a terse invocation syntax summary along with a list of available command line options.
```
24 Exit codes

All GDBM utilities return uniform exit codes. These are summarized in the table below:

<table>
<thead>
<tr>
<th>Code</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Successful termination.</td>
</tr>
<tr>
<td>1</td>
<td>A fatal error occurred.</td>
</tr>
<tr>
<td>2</td>
<td>Program was unable to restore file ownership or mode.</td>
</tr>
<tr>
<td>3</td>
<td>Command line usage error.</td>
</tr>
</tbody>
</table>
Chapter 25: Problems and bugs.

If you have problems with GNU dbm or think you’ve found a bug, please report it. Before reporting a bug, make sure you’ve actually found a real bug. Carefully reread the documentation and see if it really says you can do what you’re trying to do. If it’s not clear whether you should be able to do something or not, report that too; it’s a bug in the documentation!

Before reporting a bug or trying to fix it yourself, try to isolate it to the smallest possible input file that reproduces the problem. Then send us the input file and the exact results gdbm gave you. Also say what you expected to occur; this will help us decide whether the problem was really in the documentation.

Once you’ve got a precise problem, send e-mail to bug-gdbm@gnu.org.

Please include the version number of GNU dbm you are using. You can get this information by printing the variable gdbm_version (see Chapter 18 [Variables], page 27).

Non-bug suggestions are always welcome as well. If you have questions about things that are unclear in the documentation or are just obscure features, please report them too.

You may contact the authors and maintainers by e-mail:

phil@cs.wwu.edu, downsj@downsj.com, gray@gnu.org.ua
26 Additional resources

For the latest updates and pointers to additional resources, visit http://www.gnu.org/software/gdbm.


To track gdbm development, visit http://puszcza.gnu.org.ua/projects/gdbm.
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Index

(  
(*errfun) on gdbm_recovery .................... 21
-  
--newdb. gdbmtool option .................... 36
--read-only. gdbmtool option ............... 36
-n. gdbmtool option ........................ 36
-r. gdbmtool option ........................ 36
  
.  
gdbmtoolrc .................................. 46
?
?................................................ 42
  
/chat  
_GDBM_MAX_ERRNO ................................ 27
_GDBM_MIN_ERRNO ................................ 27

A
avail .......................................... 41
B
backup_name of gdbm_recovery ............... 22
blocksize ..................................... 39
bucket ......................................... 41
C
cache .......................................... 41
   
cachesize .................................... 39
centfree ...................................... 40
close .......................................... 41
close-on-exec ................................. 4
closing database ................................ 6
coalesce ...................................... 40
command line options, gdbmtool ............ 36
compatibility layer ......................... 32
confirm ....................................... 38
count .......................................... 41
creating a database, gdbmtool ............. 36
current ........................................ 41
data of gdbm_recovery ....................... 21
database options ............................. 23
database reorganization ..................... 13
database synchronization .................... 14
database, closing ............................ 6
database, opening or creating .............. 4
dbm .............................................. 32
dbm_clearerr .................................. 34
dbm_close ...................................... 32
dbm_delete ..................................... 33
dbm_dirfno ..................................... 34
dbm_error ....................................... 33
dbm_fetch ....................................... 32
dbm_firstkey ................................... 33
dbm_nextkey ..................................... 33
dbm_open ........................................ 32
dbm_recov ....................................... 34
dbm_store ....................................... 33
DBM functions .................................. 34
DBM_INSERT ...................................... 33
DBM_REPLACE .................................... 33
debug ............................................ 42
default database, gdbmtool .................. 36
delete ............................................ 34, 42
deleting records .............................. 10
deletion in iteration loops .................. 11
delim ............................................ 39
delim2 .......................................... 39
dir ............................................... 42
   
'dir' file ...................................... 32

E
error code, most recent ...................... 19
error codes ..................................... 29
error strings ................................... 19
exit code ....................................... 49
export .......................................... 15, 42

F
failed_buckets of gdbm_recovery ............. 22
failed_keys of gdbm_recovery ............... 22
fetch ............................................ 34, 42
fetching records ............................. 9
filename ....................................... 40
first ............................................ 42
firstkey ........................................ 35
Flat file format ................................ 15

G
gdbm_check_syserr ............................ 19
gdbm_clear_error .............................. 19
gdbm_close .................................... 6
<table>
<thead>
<tr>
<th>Function</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>gdbm_copy_meta</td>
<td>5</td>
</tr>
<tr>
<td>gdbm_count</td>
<td>7</td>
</tr>
<tr>
<td>gdbm_db_strerror</td>
<td>19</td>
</tr>
<tr>
<td>gdbm_delete</td>
<td>10</td>
</tr>
<tr>
<td>gdbm_delete and sequential access</td>
<td>11</td>
</tr>
<tr>
<td>gdbm_dump</td>
<td>15, 47</td>
</tr>
<tr>
<td>gdbm_dump_to_file</td>
<td>17</td>
</tr>
<tr>
<td>gdbm_errlist[]</td>
<td>27</td>
</tr>
<tr>
<td>gdbm_errno</td>
<td>19, 27</td>
</tr>
<tr>
<td>gdbm_exists</td>
<td>9</td>
</tr>
<tr>
<td>gdbm_export</td>
<td>17</td>
</tr>
<tr>
<td>gdbm_export_to_file</td>
<td>17</td>
</tr>
<tr>
<td>gdbm_fd_open</td>
<td>5</td>
</tr>
<tr>
<td>gdbm_fdesc</td>
<td>26</td>
</tr>
<tr>
<td>gdbm_fetch</td>
<td>9</td>
</tr>
<tr>
<td>gdbm_firstkey</td>
<td>11</td>
</tr>
<tr>
<td>gdbm_import</td>
<td>17</td>
</tr>
<tr>
<td>gdbm_import_from_file</td>
<td>17</td>
</tr>
<tr>
<td>gdbm_last_errno</td>
<td>19</td>
</tr>
<tr>
<td>gdbm_last_syserr</td>
<td>19</td>
</tr>
<tr>
<td>gdbm_load</td>
<td>16, 48</td>
</tr>
<tr>
<td>gdbm_load_from_file</td>
<td>17</td>
</tr>
<tr>
<td>gdbm_needs_recovery</td>
<td>20</td>
</tr>
<tr>
<td>gdbm_nextkey</td>
<td>11</td>
</tr>
<tr>
<td>gdbm_open</td>
<td>4</td>
</tr>
<tr>
<td>gdbm_recover</td>
<td>21</td>
</tr>
<tr>
<td>gdbm_reorganize</td>
<td>13</td>
</tr>
<tr>
<td>gdbm_setopt</td>
<td>23</td>
</tr>
<tr>
<td>gdbm_store</td>
<td>8</td>
</tr>
<tr>
<td>gdbm_strerror</td>
<td>19</td>
</tr>
<tr>
<td>gdbm_sync</td>
<td>14</td>
</tr>
<tr>
<td>gdbm_syserr[]</td>
<td>27</td>
</tr>
<tr>
<td>gdbm_version</td>
<td>27</td>
</tr>
<tr>
<td>gdbm_version_number[3]</td>
<td>27</td>
</tr>
<tr>
<td>GDBM_BACKUP_FAILED</td>
<td>31</td>
</tr>
<tr>
<td>GDBM_BAD_FILE_OFFSET</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_BAD_MAGIC_NUMBER</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_BAD_OPEN_FLAGS</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_BLOCK_SIZE_ERROR</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_BSEXACT</td>
<td>4, 29</td>
</tr>
<tr>
<td>GDBM_BYTE_SWAPPED</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_CACHESIZE</td>
<td>23</td>
</tr>
<tr>
<td>GDBM_CANNOT_REPLACE</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_CANT_BE_READER</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_CANT_BE_WRITER</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_CENTFREE</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_CLOEXEC</td>
<td>4</td>
</tr>
<tr>
<td>GDBM_COALESCEBLKS</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_DIR_OVERFLOW</td>
<td>31</td>
</tr>
<tr>
<td>GDBM_EMPTY_DATABASE</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_ERR_FILE_MODE</td>
<td>16, 31</td>
</tr>
<tr>
<td>GDBM_ERR_FILE_OWNER</td>
<td>16, 31</td>
</tr>
<tr>
<td>GDBM_FASTMODE</td>
<td>23</td>
</tr>
<tr>
<td>GDBM_FILE_EOF</td>
<td>31</td>
</tr>
<tr>
<td>GDBM_FILE_OPEN_ERROR</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_FILE_READ_ERROR</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_FILESEEK_ERROR</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_FILE_STAT_ERROR</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_FILE_WRITE_ERROR</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_GETBLOCKSIZE</td>
<td>25</td>
</tr>
<tr>
<td>GDBM_GETCACHESIZE</td>
<td>23</td>
</tr>
<tr>
<td>GDBM_GETCOALESCEBLKS</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_GETDBNAME</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_GETFLAGS</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_GETMAXMAPSIZE</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_GETMMAP</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_GETSYNCMODE</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_ILLEGAL_DATA</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_INSERT</td>
<td>8</td>
</tr>
<tr>
<td>GDBM_ITEM_NOT_FOUND</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_MALLOC_ERROR</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_NEED_RECOVERY</td>
<td>31</td>
</tr>
<tr>
<td>GDBM_NEWDB</td>
<td>4</td>
</tr>
<tr>
<td>GDBM_NO_DBNAME</td>
<td>31</td>
</tr>
<tr>
<td>GDBM_NO_ERROR</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_NOLOCK</td>
<td>4, 26</td>
</tr>
<tr>
<td>GDBM_NOMMAP</td>
<td>4</td>
</tr>
<tr>
<td>GDBM_OPT_ALREADY_SET</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_OPT_ILLEGAL</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_RCVR_BACKUP</td>
<td>22</td>
</tr>
<tr>
<td>GDBM_RCVR_ERRFUN</td>
<td>21</td>
</tr>
<tr>
<td>GDBM_RCVR_FORCE</td>
<td>22</td>
</tr>
<tr>
<td>GDBM_RCVR_MAX_FAILED_BUCKETS</td>
<td>22</td>
</tr>
<tr>
<td>GDBM_RCVR_MAX_FAILED_KEYS</td>
<td>22</td>
</tr>
<tr>
<td>GDBM_RCVR_MAX_FAILURES</td>
<td>22</td>
</tr>
<tr>
<td>GDBM_READER</td>
<td>4</td>
</tr>
<tr>
<td>GDBM_READER_CANT_DELETE</td>
<td>29</td>
</tr>
<tr>
<td>GDBM_READER_CANT_REORGANIZE</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_READER_CANT_STORE</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_REORGANIZE_FAILED</td>
<td>30</td>
</tr>
<tr>
<td>GDBM_REPLACE</td>
<td>8</td>
</tr>
<tr>
<td>GDBM_SETCACHESIZE</td>
<td>23</td>
</tr>
<tr>
<td>GDBM_SETCENTFREE</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_SETCOALESCEBLKS</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_SETMAXMAPSIZE</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_SETMMAP</td>
<td>24</td>
</tr>
<tr>
<td>GDBM_SETSYNCMODE</td>
<td>23</td>
</tr>
<tr>
<td>GDBM_SYNC</td>
<td>4, 14</td>
</tr>
<tr>
<td>gdbtool</td>
<td>36</td>
</tr>
</tbody>
</table>
global error state       | 19   |
GNU Readline             | 38   |

**H**

- hash .......................... 42
- header ........................ 42
- help .......................... 42
- history ......................... 42
<table>
<thead>
<tr>
<th>Index</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>import</td>
<td>15,42</td>
</tr>
<tr>
<td>init file, gdbmtool</td>
<td>46</td>
</tr>
<tr>
<td>interactive mode, gdbmtool</td>
<td>37</td>
</tr>
<tr>
<td>iterating over records</td>
<td>11</td>
</tr>
<tr>
<td>iteration and gdbm_delete</td>
<td>11</td>
</tr>
<tr>
<td>iteration loop</td>
<td>11</td>
</tr>
<tr>
<td>iteration loop, using 'NDBM'</td>
<td>33</td>
</tr>
<tr>
<td>junk.gdbm</td>
<td>36</td>
</tr>
<tr>
<td>libgdbm_compat</td>
<td>32</td>
</tr>
<tr>
<td>list</td>
<td>43</td>
</tr>
<tr>
<td>lock</td>
<td>40</td>
</tr>
<tr>
<td>locking</td>
<td>26</td>
</tr>
<tr>
<td>looking up records</td>
<td>9</td>
</tr>
<tr>
<td>max_failed_buckets of gdbm_recovery</td>
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</tr>
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<td>max_failed_keys of gdbm_recovery</td>
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<td>mmap</td>
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<td>most recent error code</td>
<td>19</td>
</tr>
<tr>
<td>ndbm.h</td>
<td>32</td>
</tr>
<tr>
<td>NDBM functions</td>
<td>32</td>
</tr>
<tr>
<td>next</td>
<td>43</td>
</tr>
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<td>nextkey</td>
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</tr>
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<td>number of records</td>
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<td>open</td>
<td>39,43</td>
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<td>opening the database</td>
<td>4</td>
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<tr>
<td>options, database</td>
<td>23</td>
</tr>
<tr>
<td>'pag' file</td>
<td>32</td>
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<tr>
<td>pager</td>
<td>39</td>
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<td>ps1</td>
<td>38</td>
</tr>
<tr>
<td>ps2</td>
<td>39</td>
</tr>
<tr>
<td>quiet</td>
<td>39</td>
</tr>
<tr>
<td>quit</td>
<td>43</td>
</tr>
<tr>
<td>read-only mode, gdbmtool</td>
<td>36</td>
</tr>
<tr>
<td>readline</td>
<td>38</td>
</tr>
<tr>
<td>record, deleting</td>
<td>10</td>
</tr>
<tr>
<td>record, fetching</td>
<td>9</td>
</tr>
<tr>
<td>records, iterating over</td>
<td>11</td>
</tr>
<tr>
<td>records, storing</td>
<td>8</td>
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<td>records, testing existence</td>
<td>9</td>
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<td>recover</td>
<td>43</td>
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<td>recovered_buckets of gdbm_recovery</td>
<td>22</td>
</tr>
<tr>
<td>recovered_keys of gdbm_recovery</td>
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<tr>
<td>reorganization, database</td>
<td>13</td>
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<td>reorganize</td>
<td>44</td>
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<td>sequential access</td>
<td>11</td>
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<td>sequential access, using 'NDBM'</td>
<td>33</td>
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<td>set</td>
<td>40</td>
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<tr>
<td>source</td>
<td>44</td>
</tr>
<tr>
<td>startup file, gdbmtool</td>
<td>46</td>
</tr>
<tr>
<td>status</td>
<td>44</td>
</tr>
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<td>store</td>
<td>34,44</td>
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<td>sync</td>
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<td>synchronization, database</td>
<td>14</td>
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<td>unset</td>
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<td>variables, gdbmtool</td>
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<td>version</td>
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