

# Apropos Replacement (Initial Outline)

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# 1 Abstract

Unix like operating systems have withstood the test of time for 40 odd years for several technical and philosophical reasons. One of those reasons is the quality documentation they ship in the form of man pages. They are a single point source of consultation for most of our routine work. But there has been a lack of good search tool to accompany this documentation which would increase their usefulness manifolds.

Traditionally *apropos* [1] has been there to act as a search interface but to a large extent it hasn't really lived up to it's expectation. *apropos* was developed in the early days of Unix when computing resources were scarce and which is the primary reason that it's design was kept so minimal and simple.

In this paper the limitations of the traditional implementation of *apropos* are discussed along with brief details of how those limitations have been solved in the implementation developed as part of this project and also what other modern implementations are available out there.

# 2 Introduction

The classical version of *apropos* has been implemented by simply indexing the keywords in the NAME section of the man pages in a plain text file (whatis.db) [2] and performing searches on it. The reason for this simple design was most probably lack of computing resources in the early days. The plain text file consisting of keywords hardly takes few hundreds of kilo bytes of disk space and performing search on a plain text file is also not very hard.

This simplified design of *apropos(1)* resulted in limited utility and usability. The searches are limited to the keywords in the NAME section of the keywords. If only a user knows the exact keywords he gets the right results otherwise most of the times the searches are full of bogus results or a dead end. In the modern computing world where hard problems like searching the World Wide Web have been solved [3] to sufficient degree, then it makes perfect sense that we leverage the advancement in technology to solve the problem of an effective man page search tool, considering the fact that the man pages consist of structured data, making the problem somewhat less complex.

In present times the machines are powerful and capable of running the search algorithms efficiently. Disk space is also cheap enough that indexing of additional metadata from man pages can be easily afforded. These are necessary prerequisites for building an effective search tool.

## 3 Limitations of Conventional *apropos*(1)

In this section results of some sample query searches from the classical version of *apropos* are shown and their shortcomings are analyzed.

### 3.1 Lack of support for free form queries

The conventional *apropos* is limited to the keywords used in the NAME section of the man pages. If the user specifies keywords relevant to the page which he is looking but probably those keywords are not used in the NAME section, then *apropos* would not return anything relevant. So in essence the user cannot use free form queries like those supported by modern search applications.

```
$ apropos ‘‘add new user’’
add new user: nothing appropriate

$ apropos ‘‘get process status’’
get process status: nothing appropriate

$ apropos ‘‘termcap database’’
termcap database: nothing appropriate

$ apropos ‘‘signal number to string’’
signal number to string: nothing appropriate
```

Listing 1: No results for free form queries

### 3.2 Lack of basic language support

Another major limitation of the classical version of *apropos* is that it has no natural language support. For example in the following listing it can be seen that while *apropos* returns the correct result for the query “*make directories*” but it fails when the keyword “*directory*” is used in place of “*directories*”, although the two words are based on same root word.

```
$ apropos ‘‘make directories’’
mkdir (1) – make directories
$ apropos ‘‘make directory’’
make directory: nothing appropriate

$ apropos “upgrading software package”
pkg-add (1) – a utility for installing and upgrading software
package
distributions
$ apropos “upgrading software packages”
```

```
upgrading software packages: nothing appropriate
```

Listing 2: No support for stems or word with same roots

Similarly, it is very common for users to misspell keywords in a query and *apropos* has no support for it either.

```
$ apropos 'copy strings'
stpcpy, stpncpy, strcpy, strncpy (3) - copy strings
$ apropos 'copy strings'
copy strings: nothing appropriate
```

Listing 3: No spelling correction

### 3.3 Unintelligible Output

Because of the way *apropos* works, sometimes it's output can be unintelligible and it can be very hard for the user to identify the results which are relevant to him.

```
$ \textit{apropos(1)} power
PCI, pci_activate, pci_bus_devorder, pci_chipset_tag_create,
pci_chipset_tag_destroy, pci_conf_read, pci_conf_write,
pci_conf_print, pci_conf_capture, pci_conf_restore,
pci_find_device,
pci_get_capability, pci_mapreg_type, pci_mapreg_map,
pci_mapreg_info,
pci_intr_map, pci_intr_string, pci_intr_event,
pci_intr_establish,
pci_intr_disestablish, pci_get_powerstate, pci_set_powerstate,
pci_vpd_read, pci_vpd_write, pci_make_tag, pci_decompose_tag,
pci_findvendor, pci_devinfo, PCLVENDOR, PCLPRODUCT,
PCLREVISION (9)
- Peripheral Component Interconnect
PMF, pmf_device_register, pmf_device_unregister1,
pmf_device_deregister,
pmf_device_suspend, pmf_device_resume,
pmf_device_recursive_suspend,
pmf_device_recursive_resume, pmf_device_resume_subtree,
pmf_class_network_register, pmf_class_input_register,
pmf_class_display_register, pmf_system_suspend,
pmf_system_resume,
pmf_system_shutdown, pmf_event_register, pmf_event_deregister,
pmf_event_inject, pmf_set_platform, pmf_get_platform (9) - power
management and inter-driver messaging framework
acpi (4) - Advanced Configuration and Power Interface
acpimtr (4) - ACPI Power Meter
amdpm (4) - AMD768 Power Management Controller and AMD8111
System
```

```
Management Controller
...
.
.
.
```

Listing 4: Unintelligible output of *apropos(1)*

### 3.4 Other Problems

Apart from the search related problems there are a few issues related to the way man pages are handled in NetBSD. The different aliases of the man pages are stored on the filesystem in the form of hard (or soft) links and these have to be mentioned in the makefiles explicitly using the MLINKS mechanism. This approach works fine but it is a mess from maintenance point of view. It should be possible to fix this by utilizing the index already built and maintained by *apropos* and related tools, but yet again, the simplistic implementation of *apropos* does not leave any room for improvement.

## 4 Proposed Solution

A very simple and straightforward solution is proposed to solve these problems as part of this project. The idea is to parse and index the complete content (or at least most of the content) in the form of an inverted index [4] and use it to build a full text search interface. Having an index based on the complete content of the man pages solves many of the search related problems associated with the conventional *apropos(1)* as noted before and discussed as follows:

### Free Form Queries

The users can express their queries in more natural language form as the searches are no longer limited to the keywords defined in the NAME section of the man pages, the keywords used throughout the body of the page also play a role. For example queries like “*installing new software package*” will now get results.

### Basic Natural Language Processing Support

When parsing the man pages and building the index, it is also possible to pre-process the tokens extracted from the man pages to support some of the very basic natural language processing functionalities. In this implementation the Porter stemming algorithm [5] has been used to

reduce the individual tokens extracted from the man pages to their root words. This enables support for more flexible searches. For example both “*Installing new packages*” and “*install new package*” will return same results.

Similarly along with the inverted index, a dictionary of the keywords frequently occurring in the corpus of man pages can also be built and used to support spelling suggestion.

In this implementation, both word stemming and spelling correction in our implementation are used to make the search experience more smooth.

### **Bookkeeping of man page metadata**

In this implementation additional metadata related to the man pages, for example an md5 hash, the device id, inode number and modification time of the man page files are indexed and stored so as to support fast and hassle free update of the index as new man pages are installed or the old ones are modified/updated.

Similarly a separate index of all the man page aliases is stored and maintained. This provides an option to get rid of all the hard or symbolic links of the man pages scattered throughout the filesystem, and also for clean up of the MLINKS mess in the makefiles.

## **4.1 Tools Used**

The two main tasks that are needed to be performed to implement this project are parsing of the man pages and building an index of the data. *libmandoc* [6] and *sqlite* [7] have been used for the two tasks respectively in this implementation.

### ***libmandoc***

*libmandoc* is a library interface to a validating compiler. It provides interface to parse and build an AST (Abstract Syntax Tree) of the man page, and interface for traversing that tree in order to extract the data from nodes which are of our interest.

### ***sqlite***

*sqlite* is an embedded relational database management system providing a relatively small and easy to use C library interface. One of the main reason for choosing it over the myriad of other possible options is that it provides in built support for full text search through it's FTS

virtual table module [8]. The FTS module can be accessed using pretty much standard SQL syntax, and it is still flexible enough to accept user supplied ranking function to suit the needs of the application. Besides that another advantage of *sqlite* is the RDBMS support which makes it very easy to store additional metadata in the form of normal database tables without any hassles.

## 5 Implementation Details

Due to space constraints it is not possible to go into enough implementation details but in this section some important components of this project are discussed in brief.

### **makemandb**

*makemandb* [9] is the key component of this implementation. It is a command line tool which traverses the filesystem, reads the raw man page source files, feeds them to the *libmandoc* parser and then stores the extracted data in the database using *sqlite*.

### **apropos**

This is the version of *apropos* written from scratch utilizing the full text search functionality of *sqlite*. Unlike the classical version of *apropos*, it only displays the top 10 results relevant to the user query and most of the times this is sufficient as will be seen later. Also, it shows a brief snippet for each of the search results, making it more easy to identify the relevant documents.

### **apropos-utils**

*apropos-utils* [10] is a small library interface provided with this implementation. It provides functions for querying the FTS index and for processing the results in a user supplied callback function. It's main purpose is to develop different interfaces on top of this implementation for different use cases. For example a small CGI application was built using it for doing the searches from a web browser, similarly an IRC bot was also developed utilizing this interface.

## 6 Results

This section shows results of some of the sample queries on the version of developed as part of this project *apropos* to demonstrate how it solves many

of the problems cited earlier with the classical version of *apropos*.<sup>1</sup>

```
$ apropos ‘‘add new user’’
ssh-add(1)      adds private key identities to the
                 authentication agent
...on the command line. If any file requires a passphrase, ssh-
add
asks for the passphrase from the user. The passphrase is read
from the
user’s tty. ssh-add retries the last passphrase if multiple
identity
files are given...

chpass(1)      add or change user database information
add or change user database information

useradd(8)     add a user to the system
The useradd utility adds a user to the system, creating and
populating
a home directory if necessary. Any skeleton files will be
provided for
the new user if they exist in the skel-dir directory (see the k
option). Default...
.
.
.
```

Listing 5: Add new user

```
$ apropos ‘‘make directory’’
make(1) maintain program dependencies
...CURDIR A path to the directory where make was executed. Refer
to
the description of PWD for more details. MAKE The name that make
was
executed with argv[0] . For compatibility make also sets .MAKE
with
the same value. The...

mkdir(1)      make directories
make directories

ln(1) make links
...a directory in which to place the link; otherwise it is
placed in
the current directory. If only the directory is specified, the
link
```

---

<sup>1</sup>Although this implementation of *apropos(1)* returns 10 results in normal case for a query but in the following listings the output has been snipped to save space



```

will be made to the last component of source_file . Given more
than
two arguments, ln makes...

mkfifo(1)          make fifos
make fifos...of a=rw mkfifo requires write permission in the
parent
directory. mkfifo exits 0 if successful, and >0 if an...

mkdir(2)           make a directory file
...will contain the directory has been exhausted. EDQUOT The
user's
quota of inodes on the file system on which the directory is
being
created has been exhausted. EIO An I/O error occurred while
making the
directory entry or...

```

Listing 6: make directory

```

$ apropos ‘‘signal number to string’’
psignal(3)         system signal messages
...the signal number is not recognized sigaction(2) , the string
Unknown signal is produced. The psiginfo function produces the
same
output as the psignal function, only it uses the signal number
information from the si argument. The message strings can...

intro(2)           introduction to system calls and error numbers
...undefined signal to a signal(3) or kill(2) function). 23
ENFILE Too
many open files in system . Maximum number...shell. Pathname A
path
name is a NUL -terminated character string starting with an
optional
slash \&/ , followed by zero or...

groff_mdoc(7)      reference for groff's mdoc implementation
...Qq .Qq string ) , string ) , .Qq string Ns ), string ), .Sq .
Sq
string string .Em or...UNTITLED is used. The section number may
be a
number in the range 1...2, 3 and 9 error \&.\e” and signal
handling only. \&.\e” .Sh ERRORS \&.\e...

```

Listing 7: signal number to string

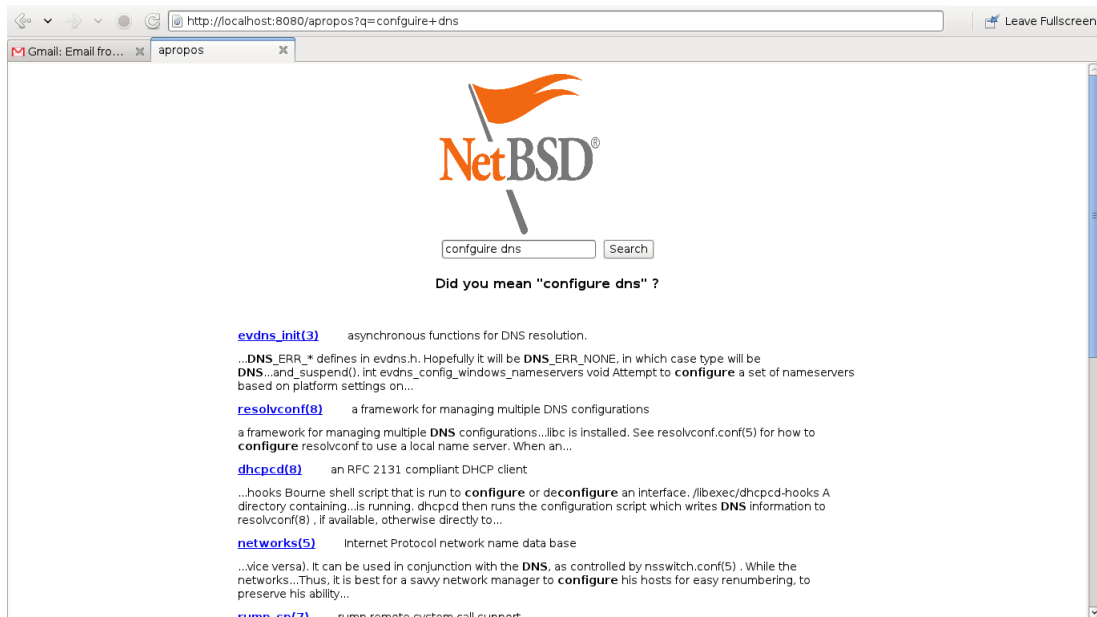


Figure 1: The spell corrector and the web interface in action

## 7 Related Work

There are at least two projects which are related to this in some way.

### man-db

*man-db* [11] is a complete implementation of the man page documentation system and it is used on a number of GNU/Linux distributions. *man-db* takes an interesting approach for indexing the man page data. Unlike the classical *apropos*, it uses a Berkley DB database but still its index is limited to the NAME section only. It adds an option ‘K’ to *man(1)* to allow a crude full text search but it is not very efficient nor effective.

### mandocdb

*mandocdb* [12] is more in line with the goals of our project but it takes a novel approach. It indexes the keywords extracted from the man pages in a key-value store using *btree(3)* [13]. It also comes with its own implementation of *apropos* which performs search using this key-value store. The main key point of this implementation is that it exploits the semantic structure of the man pages.

## 8 Future Work

### Work on Ranking Algorithm

A ranking algorithm based on probabilistic model [14] of information retrieval has been implemented to filter out the most relevant results and show them at the top. It is essentially based on the Okapi BM25F algorithm [15] and uses certain parameters whose values are usually dependent on the corpus and the search application. For example certain weight parameters are assigned to different sections of man pages. At the moment these values have been determined manually but one goal is to use some machine learning techniques in the coming days to automate this.

### Fix Some Loose Ends In Parsing of man pages

Although the parsing routine is working fine for most purposes on the man pages supplied with NetBSD and also on most of the man pages found in Pkgsrc. But there are perhaps a few corner cases still to be fixed. Besides that another issue that is to be addressed is the parsing of the escape sequences which are used extensively in the *man(7)* [16] based man pages. These issues are to be addressed in the coming days.

## 9 Acknowledgement

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## References

- [1] *NetBSD manual page for apropos(1)*  
<http://netbsd.gw.com/cgi-bin/man-cgi?apropos++NetBSD-5.1>
- [2] *NetBSD manual page for makewhatis(1)*  
<http://netbsd.gw.com/cgi-bin/man-cgi?makewhatis++NetBSD-5.1>

- [3] Brin, S.; Page L. *The Anatomy of a Large-Scale Hypertextual Web Search Engine* Computer Networks and ISDN Systems 30:107-117, 1998
- [4] Manning; Raghwan; Schutze *Introduction to information retrieval*, 3-9, 2008
- [5] Porter, M. F. *An algorithm for suffix stripping*, Program, 14(3): 130-137, 1980
- [6] *mdocml online manual page for libmandoc*  
<http://mdocml.bsd.lv/mandoc.3.html>
- [7] *Sqlite home page*  
<http://sqlite.org>
- [8] *Sqlite FTS3 and FTS4 Extensions*  
<http://sqlite.org/fts3.html>
- [9] *Online manual page for makemandb(1)*  
[http://netbsd-soc.sourceforge.net/projects/apropos\\_replacement/makemandb.html1](http://netbsd-soc.sourceforge.net/projects/apropos_replacement/makemandb.html1)
- [10] *Online manual page for apropos-utils(3)*  
[http://netbsd-soc.sourceforge.net/projects/apropos\\_replacement/apropos-utils.html3](http://netbsd-soc.sourceforge.net/projects/apropos_replacement/apropos-utils.html3)
- [11] *man-db, the on-line manual database*  
<http://man-db.nongnu.org/>
- [12] *Online manual page for mandocdb(1)*  
<http://mdocml.bsd.lv/mandocdb.8.html>
- [13] *NetBSD online manual page for btree(3)*  
<http://netbsd.gw.com/cgi-bin/man-cgi?btree+3+NetBSD-5.1>
- [14] Fuhr, Norbert *Probabilistic models in information retrieval* The Computer Journal 1992
- [15] Zaragoza H.; Craswell N.; Taylor M.; Saria S.; Robertson S. *Microsoft Cambridge at TREC13: Web and HARD tracks* In proceedings of TREC-2004
- [16] *Online manual page for man(7)*  
<http://mdocml.bsd.lv/man.7.html>
- [17] *Google Summer of Code home page*  
<http://code.google.com/soc/>

- [18] *The mdocml project home page*  
<http://mdocml.bsd.lv>