

# axiom™



## The 30 Year Horizon

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Volume 6: Axiom Command

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## New Foreword

On October 1, 2001 Axiom was withdrawn from the market and ended life as a commercial product. On September 3, 2002 Axiom was released under the Modified BSD license, including this document. On August 27, 2003 Axiom was released as free and open source software available for download from the Free Software Foundation's website, Savannah.

Work on Axiom has had the generous support of the Center for Algorithms and Interactive Scientific Computation (CAISS) at City College of New York. Special thanks go to Dr. Gilbert Baumslag for his support of the long term goal.

The online version of this documentation is roughly 1000 pages. In order to make printed versions we've broken it up into three volumes. The first volume is tutorial in nature. The second volume is for programmers. The third volume is reference material. We've also added a fourth volume for developers. All of these changes represent an experiment in print-on-demand delivery of documentation. Time will tell whether the experiment succeeded.

Axiom has been in existence for over thirty years. It is estimated to contain about three hundred man-years of research and has, as of September 3, 2003, 143 people listed in the credits. All of these people have contributed directly or indirectly to making Axiom available. Axiom is being passed to the next generation. I'm looking forward to future milestones.

With that in mind I've introduced the theme of the "30 year horizon". We must invent the tools that support the Computational Mathematician working 30 years from now. How will research be done when every bit of mathematical knowledge is online and instantly available? What happens when we scale Axiom by a factor of 100, giving us 1.1 million domains? How can we integrate theory with code? How will we integrate theorems and proofs of the mathematics with space-time complexity proofs and running code? What visualization tools are needed? How do we support the conceptual structures and semantics of mathematics in effective ways? How do we support results from the sciences? How do we teach the next generation to be effective Computational Mathematicians?

The "30 year horizon" is much nearer than it appears.

Tim Daly  
CAISS, City College of New York  
November 10, 2003 ((iHy))

# Chapter 1

## Overview

The axiom system consists of a set of processes managed by the superman process. The superman process, called sman, is normally invoked from the axiom shell script in order to start a tree of subprocesses.

The `axiom` command is a shell script that collects the command line options for the `sman` process, sets some shell variables, and then invokes `sman`.

The `sman` process starts the following tree of processes:

```
--xterm---bash---sman-|-AXIOMsys
                        |-clef---spadclient
                        |-hypertex
                        |-session
                        |-sman
                        |-viewman
```



## Chapter 2

# The axiom Command

The `axiom` command starts everything for Axiom. The options for the `axiom` command are:

```
axiom
[-ht    |-noht]    whether to use HyperDoc
[-gr    |-nogr]    whether to use Graphics
[-clef  |-noclef]  whether to use Clef
[-noiw  |-iw]      start in interpreter in a separate window
[-ihere |-noihere] start an interpreter in this window
[-nox]              don't use X Windows
[-go    |-nogo]    whether to start system
[-ws wsname]        use named workspace
[-list]              list workspaces only
[-grprog fname]     use named program for Graphics
[-htprog fname]     use named program for HyperDoc
[-clefprog fname]   use named program for Clef
[-sessionprog fname] use named program for session
[-clientprog fname] use named program for spadclient
[-h]                show usage
```

In detail, the command options are:

### 2.0.1 [-ht | -noht]

```
[-ht    |-noht]    whether to use HyperDoc
```

Hyperdoc is the documentation tool for Axiom. The `-ht` option, enabled by default, will start this tool. See Jenks[Jenk92] Chapter 3 for further information on the `hyperdoc` subsystem.

### 2.0.2 [-gr | -nogr]

```
[-gr    |-nogr]    whether to use Graphics
```

The `graphics` subsystem is enabled using the `-gr` option, enabled by default. Graphics will appear as a result of a `draw` command, such as

```
draw(sin(x),x=0..1)
```

Note that attempting to use `draw` commands when the `graphics` is disabled will simply hang

the interpreter waiting for a response. See Jenks[Jenk92] Chapter 7 for further information on the `graphics` subsystem.

### 2.0.3 [-clef | -noclef]

`[-clef | -noclef]`      *whether to use Clef*

The `clef` (Command Line Edit Facility) allows for command completion. The list of command completion strings is in the last chapter of this document. If `clef`, enabled by default, is running then you can type:

```
x:Dena<tab>
```

and this will automatically be expanded to:

```
x:DenavitHartenbergMatrix
```

The `clef` program also allows command line editing. The commands are special keyboard keys.

- HOME move to beginning of the line
- END move to the end of the line
- CTRL-END delete to end of the line
- TAB command completion (multiple tabs give new choices)
- UPARROW move back thru commands
- DOWNARROW move forward thru commands
- LEFTARROW move left on the line
- RIGHTARROW move right on the line
- INSERT toggle insert/overstrike

See Jenks[Jenk92] page 21 for further information on the `clef` command.

### 2.0.4 [-noiw | -iw]

`[-noiw | -iw]`      *start in interpreter in a separate window*

The `iw` option, disabled by default, will start a second interpreter in its own window with its own frame. The fact that the second interpreter is in its own frame can be seen using the `)frame` command. For instance, if you type

```
axiom -iw
```

there will be two interpreter windows available, one in the current window and one in a new window. In the current window if you type:

```
)frame names
```

you will see:

```
The names of the existing frames are:
```

```
frame0
```

```
frame1
```

```
initial
```

```
The current frame is the first one listed.
```

In the second window, if you type

```
)frame names
```

you will see:

```
The names of the existing frames are:
```

```
frame1
```

```
frame0
```

```
initial
```

```
The current frame is the first one listed.
```

Setting

```
x:=3
```

in the second window will set the variable  $x$  in the frame `frame1`. Switching to the first window and typing:

```
x
```

gives:

```
(1) x
```

```
Type: Variable x
```

since the first window is in `frame0` and the variable  $x$  is defined in `frame1`. But we can switch frames in the first window using

```
)frame next
```

and then

```
x
```

gives:

```
(2) 3
```

```
Type: PositiveInteger
```

and now the two windows share the same frame space. See Jenks[Jenk92] page 579 for further information on the `frame` command.

## 2.0.5 [-ihere | -noihere]

```
[-ihere | -noihere] start an interpreter in this window
```

This option determines whether Axiom will start in the current window. Using this option alone is not particularly useful and it is generally used in combination with the `-iw` option:

```
axiom -noihere -iw &
```

However, used alone, as in:

```
axiom -noihere &
```

it will start Axiom and show the Hyperdoc window. Graphics will also work from the Hyperdoc pages.

## 2.0.6 [-nox]

```
[-nox] don't use X Windows
```

allows Axiom to start the interpreter without Hyperdoc or the graphics subsystem. This is

useful for starting Axiom in an emacs buffer.

### 2.0.7 [-go | -nogo]

`[-go | -nogo]`            `whether to start system`

uses the `-go` option, enabled by default, controls whether the system starts from the command line. If the `-nogo` option is chosen the system prints the command line that would have been issued. This is useful for finding out what the command line options to `sman` will be. For instance:

```
axiom -nogo -iw
```

does not start Axiom but types out:

```
Would now start the processes.
```

```
exec ~/mnt/linux/bin/sman -iw -ws ~/mnt/linux/bin/AXIOMsys
```

### 2.0.8 [-ws wsname]

`[-ws wsname]`            `use named workspace`

In the `-nogo` command above you can see that the default workspace name is

```
-ws ~/mnt/linux/bin/AXIOMsys
```

This option allows you to change that. This is useful for debugging new system builds. During build a debugging version of Axiom is created in the `obj/linux/bin` directory. The `debugsys` image uses interpreted lisp code rather than compiled code. This makes it possible to do deep debugging. To use this workspace you would incant:

```
cd youraxiombuild
export AXIOM='pwd'/mnt/linux
export PATH=$AXIOM/bin:$PATH
axiom -ws obj/linux/bin/debugsys
```

### 2.0.9 [-list]

`[-list]`                `list workspaces only`

shows you the executable workspaces. Generally in a built system there is only one, called `$AXIOM/bin/AXIOMsys`.

### 2.0.10 [-grprog fname]

`[-grprog fname]`        `use named program for Graphics`

allows you to specify which program to use for the graphics. By default this is `$AXIOM/lib/viewman`.

### 2.0.11 [-htprog fname]

`[-htprog fname]`        `use named program for Hyperdoc`



allows you to specify which program to use for Hyperdoc. By default it is `$AXIOM/bin/hypertext -s`.

### 2.0.12 [-clefprog fname]

`[-clefprog fname]` use named program for Clef

allows you to specify which program to use for clef. By default it is `$AXIOM/bin/clef -f $AXIOM/lib/command.list -e`.

### 2.0.13 [-sessionprog fname]

`[-sessionprog fname]` use named program for session

allows you to specify the session manager program. By default it is `$AXIOM/lib/session`.

### 2.0.14 [-clientprog fname]

`[-clientprog fname]` use named program for spadclient

allows you to specify the spadclient program. By default it is `$AXIOM/lib/spadclient`.

### 2.0.15 [-h]

`[-h]` show usage

— axiomcmd —

`#!/bin/sh`

\_\_\_\_\_

The `MALLOCTYPE` shell variable is an IBM AIX shell variable that controls buckets based extensions in the default memory allocator which may enhance performance. AIX uses a new memory management routine that does not zero `malloc` memory and does not round up to the nearest power of 2, unlike most non-AIX systems. This can cause failures so we protect against that here. See the AIX Performance Tuning Guide[\[Haya05\]](#) for details.

— axiomcmd —

```
MALLOCTYPE=3.1
export MALLOCTYPE
```

\_\_\_\_\_

— axiomcmd —

```
HOST='hostname'
export HOST
```

---

There are 4 basic utilities used by this script. The `ciao` script for immediate exit:

— **axiomcmd** —

```
ciao() {
echo "Goodbye."
exit 1
}
```

---

The `needsupt` script which is used to issue an error message when one of the command line options requires an option:

— **axiomcmd** —

```
needsupt () {
echo "The $1 option requires an argument."
ciao
}
```

---

The `showuse` script which gives basic command line help:

— **axiomcmd** —

```
showuse() {
echo "axiom"
echo " [-ht    |-noht]    whether to use HyperDoc"
echo " [-gr    |-nogr]    whether to use Graphics"
echo " [-clef   |-noclef]   whether to use Clef"
echo " [-noiw   |-iw]       start in interpreter in a separate window"
echo " [-ihere  |-noihere]  start an interpreter in this window"
echo " [-nox]                don't use X Windows"
echo " [-go    |-nogo]     whether to start system"
echo " [-ws wsname]         use named workspace"
echo " [-list]              list workspaces only"
echo " [-grprog fname]     use named program for Graphics"
echo " [-htprog fname]     use named program for HyperDoc"
echo " [-clefprog fname]   use named program for Clef"
echo " [-sessionprog fname] use named program for session"
echo " [-clientprog fname] use named program for spadclient"
echo " [-h]                show usage"
}
```

---

List the various workspaces if asked.

— **axiomcmd** —

```
listwsaces()
{
    echo "$1"
    ls -l $2 | grep "sys$"
    echo ""
}
```

---

Step 1. Ensure the environment is set.

Just process “-h”. If it exists in the command line then we print out the simple command line help menu.

```

— axiomcmd —
if [ "$*" = "-h" ] ; then
    showuse
fi

```

---

We assume that Axiom is installed in the standard place on a linux system. We will modify this assumption as we process the environment and command line. The term `spad` is an historical shortened version of the name `scratchpad`, the original name of the Axiom system.

```

— axiomcmd —
SPADDEFAULT=/usr/local/axiom/mnt/linux

```

---

If the `$AXIOM` shell variable is set then we use it.  
 If not, then if the `$SPAD` shell variable is set then we use it.  
 If not, then we try to use the default value above.  
 If not, we simply fail.

```

— axiomcmd —
if [ "$SPAD" = "" ] ; then
    if [ "$AXIOM" = "" ] ; then
        SPAD=$SPADDEFAULT
        echo "AXIOM variable is not set"
        echo "assuming AXIOM = $SPAD"
        AXIOM=$SPAD
        export AXIOM
    else
        SPAD=$AXIOM
    fi
    export SPAD
else
    if [ "$AXIOM" = "" ] ; then
        echo "AXIOM variable is not set"
        echo "but SPAD = $SPAD"
        echo "Using AXIOM = $SPAD"
        AXIOM=$SPAD
        export AXIOM
    else
        if [ ! "$SPAD" = "$AXIOM" ] ; then
            echo "ignoring SPAD variable"
            SPAD=$AXIOM
        fi
    fi
fi

```

---

If we get here then all attempts to find axiom have failed so we complain and exit.

```

— axiomcmd —
if [ ! -d "$SPAD" ] ; then
  echo "The directory for Axiom, $SPAD, does not exist."
  ciao
fi

```

Step 2. Process command line arguments.

Name the workspace directories

```

— axiomcmd —
rootwsdir=$SPAD/bin

```

We set up the defaults for command-line arguments. We don't want just a list by default

```

— axiomcmd —
list=no

```

We default to actually executing the workspace.

```

— axiomcmd —
go=yes

```

We default to the AXIOMsys workspace.

```

— axiomcmd —
wsname=AXIOMsys

```

And all other options are unset.

```

— axiomcmd —
otheropts=""

```

For each option on the command line do

```

— axiomcmd —
while [ "$*" != "" ] ; do
— axiomcmd —
case $1 in

```

If the user specified list anywhere then we give the workspace list and exit.

```
— axiomcmd —
-list) list=yes
      go=no;;
_____
```

If the user specified go or nogo we handle that case

```
— axiomcmd —
-go) go=yes ;;
-nogo) go=no ;;
_____
```

The workspace option requires an argument which follows immediately. If the argument is missing we complain and exit.

```
— axiomcmd —
-ws)
if [ "$2" = "" ] ; then needsubopt "$1" ; fi
shift
wsname="$1"
;;
_____
```

We can specify the various subprograms to use.

```
— axiomcmd —
-grprog|-htprog|-clefprog|-sessionprog|-clientprog)
if [ "$2" = "" ] ; then needsubopt "$1" ; fi
otheropts="$otheropts $1 $2"
shift
;;
_____
```

These options were not explained earlier and are only for developer use.

```
— axiomcmd —
-paste|-rm|-rv)
if [ "$2" = "" ] ; then needsubopt "$1" ; fi
otheropts="$otheropts $1 $2"
shift
;;
_____
```

We handle the various [-option | -nooption] cases

```
— axiomcmd —
-clef|-noclef|-gr|-nogr|-ht|-noht|-iw|-noiw)
otheropts="$otheropts $1"
;;
-ihere|-noihere|-nox)
otheropts="$otheropts $1"
;;
_____
```

The user wanted help so we will not execute.

— **axiomcmd** —

```
-h)
go=no
;;
```

\_\_\_\_\_

The user is confused. Complain and exit.

— **axiomcmd** —

```
*) echo "Unknown option: $1"
echo "To use a specific workspace use, e.g.: spad -ws $1"
ciao
;;
esac
```

\_\_\_\_\_

Move to the next option and loop.

— **axiomcmd** —

```
shift
done
```

\_\_\_\_\_

Step 3. Handle options that require special case handling.

The user just wanted to know what workspaces are available.

— **axiomcmd** —

```
if [ $list = yes ] ; then
  listwspace "AXIOM workspaces in \${AXIOM}/bin = $rootwsdir: " $rootwsdir
fi
```

\_\_\_\_\_

Try to ensure a suitable workspace on this host.

— **axiomcmd** —

```
if [ 'expr $wsname : '.*/*.*' = 0 ] ; then
  serverws=$rootwsdir/$wsname
else
  serverws=$wsname
fi
```

\_\_\_\_\_

If we can't find the executable then we complain and exit.

— **axiomcmd** —

```
if [ ! -x $serverws ] ; then
  echo "Cannot find the executable $serverws"
showuse
ciao
fi
```

\_\_\_\_\_

The user just wanted to see what would happen so we output the command line and exit.

— axiomcmd —

```
if [ $go = no ] ; then
echo "Would now start the processes."
echo exec $SPAD/bin/sman $otheropts -ws $serverws
exit 0
fi
```

—————

All of the options have been processed so we start sman

— axiomcmd —

```
exec $SPAD/bin/sman $otheropts -ws $serverws
```

—————





## Chapter 3

# The sman program

### 3.1 include files

```
— include/sockio-c.h1 —  
/* from bookvol6 chunk include/sockio-c.h1 */  
extern int get_int(Sock * );  
extern char * get_string(Sock * );  
extern double get_float(Sock * );  
extern Sock * connect_to_local_server(char * , int , int );  
extern int sread(Sock * , char * , int , char * );  
extern double plus_infinity(void );  
extern double minus_infinity(void );  
extern double NANQ(void );  
extern void sigpipe_handler(int );  
extern int wait_for_client_read(Sock * , char * , int , char * );  
extern int wait_for_client_write(Sock * , char * , int , char * );  
extern int swrite(Sock * , char * , int , char * );  
extern int sselect(int , fd_set * , fd_set * , fd_set * , void * );  
extern int fill_buf(Sock * , char * , int , char * );  
extern int sock_get_int(int );  
extern int get_ints(Sock * , int * , int );  
extern int sock_get_ints(int , int * , int );  
extern int send_int(Sock * , int );  
extern int sock_send_int(int , int );  
extern int send_ints(Sock * , int * , int );  
extern int sock_send_ints(int , int * , int );  
extern int send_string(Sock * , char * );  
extern int send_string_len(Sock * , char * , int );  
extern int sock_send_string(int , char * );  
extern int sock_send_string_len(int , char * , int );  
extern int send_strings(Sock * , char * * , int );  
extern int sock_send_strings(int , char * * , int );  
extern char * sock_get_string(int );  
extern char * get_string_buf(Sock * , char * , int );  
extern char * sock_get_string_buf(int , char * , int );
```

```

extern int get_strings(Sock * , char * * , int );
extern int sock_get_strings(int , char * * , int );
extern int send_float(Sock * , double );
extern int sock_send_float(int , double );
extern int send_sfloats(Sock * , float * , int );
extern int sock_send_sfloats(int , float * , int );
extern int send_floats(Sock * , double * , int );
extern int sock_send_floats(int , double * , int );
extern double sock_get_float(int );
extern int get_sfloats(Sock * , float * , int );
extern int sock_get_sfloats(int , float * , int );
extern int get_floats(Sock * , double * , int );
extern int sock_get_floats(int , double * , int );
extern int wait_for_client_kill(Sock * , int );
extern int sock_get_remote_fd(int );
extern int send_signal(Sock * , int );
extern int sock_send_signal(int , int );
extern int send_wakeup(Sock * );
extern int sock_send_wakeup(int );
extern Sock * connect_to_local_server_new(char * , int , int );
extern void remote_stdio(Sock * );
extern void init_purpose_table(void );
extern int make_server_number(void );
extern void close_socket(int , char * );
extern int make_server_name(char * , char * );
extern int open_server(char * );
extern int accept_connection(Sock * );
extern void get_socket_type(Sock * );
extern int sock_accept_connection(int );
extern void redirect_stdio(Sock * );
extern void init_socks(void );
extern int server_switch(void );
extern void flush_stdout(void );
extern void print_line(char * );

```

—————

### 3.1.1 include/sman.h

The `spad_proc` structure holds information about the process id of a child process, what to do when it dies, and the shell command line necessary to restart the process. There is a linked list of these structures which maintains the process list for axiom.

— `include/sman.h` —

```

/* from bookvol6 chunk include/sman.h */
/* Process control definitions. Used by fork_you and spawn_of_hell */

/* When a process dies it kills off everything else */
#define Die 1
/* When a process dies, do nothing */
#define NadaDelShitsky 2
/* When a process dies start it up again */
#define DoItAgain 3
/* When hypertext dies, clean its socket */

```

```
#define CleanHypertextSocket 4

typedef struct spad_proc {
    int proc_id; /* process id of child */
    int death_action; /* one of the above constants */
    char *command; /* sh command line to restart the process */
    struct spad_proc *next;
} SpadProcess;
```

### 3.1.2 include/com.h

```
— include/com.h —

/* from bookvol6 chunk include/com.h */
#ifndef _COM_H_
#define _COM_H_

#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#if defined(RIOSplatform)
#include <sys/select.h>
#endif

typedef struct {
    int socket;          /* socket number returned by "socket" call */
    int type;            /* socket type (AF_UNIX or AF_INET) */
    int purpose;        /* can be SessionManager, GraphicsServer, etc. */
    int pid;            /* process ID of connected socket */
    int frame;          /* spad interpreter frame (for interpreter windows) */
    int remote_fd;      /* file descriptor of remote socket */
    union {
        struct sockaddr u_addr;
        struct sockaddr_in i_addr;
    } addr;
    char *host_name;    /* name of foreign host if type == AF_INET */
} Sock;

#define MaxClients      150

/* possible socket types (purpose) */

#define SessionManager  1
#define ViewportServer  2
#define MenuServer      3
#define SessionIO       4
#define BalloonServer   5
#define InterpWindow    6
#define KillSpad        7
#define DebugWindow     8
```

```

#define Forker          9
#define AV              10 /*Simon's algebraic viewer */

#define Acknowledge     255

/* Timeout value for connection to remote socket */

#define Forever 0

/* Socket name for local AXIOM server and session manager */

#define SpadServer      "/tmp/.d"
#define SessionServer   "/tmp/.s"
#define SessionIOName   "/tmp/.i"
#define MenuServerName  "/tmp/.h"
#define ForkServerName  "/tmp/.f"

#define MASK_SIZE      (NBBY*sizeof(fd_set))

/* table of dedicated socket types */

extern Sock *purpose_table[];
extern Sock server[];
extern Sock clients[];
extern fd_set socket_mask;
extern fd_set server_mask;

/* Commands sent over the AXIOM session manager or menu socket */

#define CreateFrame      1
#define SwitchFrames    2
#define EndOfOutput     3
#define CallInterp      4
#define EndSession      5
#define LispCommand     6
#define SpadCommand     7
#define SendXEventToHyperTeX 8
#define QuietSpadCommand 9
#define CloseClient     10
#define QueryClients    11
#define QuerySpad       12
#define NonSmanSession  13
#define KillLispSystem  14

#define CreateFrameAnswer 50

/* Commands from AXIOM menu server to interpreter windows */

#define ReceiveInputLine 100
#define TestLine         101

#endif

```

### 3.1.3 include/bsdsignal.h

```

— include/bsdsignal.h —
/* from bookvol6 chunk include/bsdsignal.h */
#ifndef _BSDSIGNAL_H_
#define _BSDSIGNAL_H_

#define RestartSystemCalls 1
#define DontRestartSystemCalls 0

typedef void (* SignalHandlerFunc)(int);

#endif /* _BSDSIGNAL */

```

### 3.1.4 include/bsdsignal.h1

```

— include/bsdsignal.h1 —
/* from bookvol6 chunk include/bsdsignal.h1 */
extern SignalHandlerFunc bsdSignal(int , SignalHandlerFunc , int );

```

### 3.1.5 include/openpty.h1

```

— include/openpty.h1 —
/* from bookvol6 chunk include/openpty.h1 */
extern void makeNextPtyNames(char * , char * );
extern int ptyopen(int * , int * , char * , char * );

```

### 3.1.6 include/sman.h1

```

— include/sman.h1 —
/* from bookvol6 chunk include/sman.h1 */
extern int main(int argc , char * argv[] , char * envp[]);
#ifdef _SMAN_C
static void process_arguments(int argc , char * * argv);
static int should_I_clef(void);
static int in_X(void);
static void set_up_defaults(void);
static void process_options(int argc , char * * argv);

```

```

static void death_handler(int sig);
static void sman_catch_signals(void);
static void fix_env(char * * envp , int spadnum);
static void init_term_io(void);
static char * strPrefix(char * prefix , char * s);
static void check_spad_proc(char * file , char * prefix);
static void clean_up_old_sockets(void);
static SpadProcess * fork_you(int death_action);
static void exec_command_env(char * command , char * * env);
static SpadProcess * spawn_of_hell(char * command , int death_action);
static void start_the_spadclient(void);
static void start_the_local_spadclient(void);
static void start_the_session_manager(void);
static void start_the_hypertext(void);
static void start_the_graphics(void);
static void fork_Axiom(void);
static void start_the_Axiom(char * * envp);
static void clean_up_sockets(void);
static void clean_hypertext_socket(void);
static void read_from_spad_io(int ptcNum);
static void read_from_manager(int ptcNum);
static void manage_spad_io(int ptcNum);
static void init_spad_process_list(void);
static SpadProcess * find_child(int proc_id);
static void kill_all_children(void);
static void clean_up_terminal(void);
static void monitor_children(void);
#endif

```

---

### 3.1.7 include/session.h1

```

— include/session.h1 —

/* from bookvol6 chunk include/session.h1 */
extern int main(void);
#ifdef _SESSION_C
static void usr1_handler(int sig);
static void usr2_handler(int sig);
static void term_handler(int sig);
static void close_client(int frame);
static void read_SpadServer_command(void);
static int test_sock_for_process(Sock * sock);
static void read_menu_client_command(void);
static void read_from_spad_io(void);
static void kill_spad(void);
static int accept_session_connection(Sock * server_sock);
static void read_from_session(Sock * sock);
static void manage_sessions(void);
#endif

```

---

— include/spadclient.h1 —

```
/* from bookvol6 chunk include/spadclient.h1 */
extern int main(void);
#ifdef _SPADCLIENT_C
static void inter_handler(int sig);
#endif
```

—————

## 3.2 sman.c

### 3.2.1 includes

— sman.includes —

```
#include <stdlib.h>
#include <unistd.h>
#include <string.h>
#include <stdio.h>
#include <pwd.h>
#include <fcntl.h>
#include <termios.h>
#include <errno.h>
#include <sys/time.h>
#include <sys/wait.h>
#include <signal.h>

#if defined(SUN40S5platform) || defined(HP10platform)
#include <sys/stropts.h>
#endif

\getchunk{include/com.h}
\getchunk{include/bsdsignal.h}
\getchunk{include/sman.h}
\getchunk{include/bsdsignal.h1}
\getchunk{include/sockio-c.h1}
\getchunk{include/openpty.h1}
\getchunk{include/sman.h1}
```

—————

### 3.2.2 variables

— sman.variables —

```
char *ws_path; /* location of the AXIOM executable */
int start_clef; /* start clef under spad */
int start_graphics; /* start the viewman */
int start_ht; /* start hypertext */
```

```

int start_spadclient; /* Start the client spad buffer */
int start_local_spadclient; /* Start the client spad buffer */
int use_X; /* Use the X windows environment */
int server_num; /* AXIOM server number */

```

We add a debug flag so we can print information about what sman is trying to do. This change is pervasive as it touches nearly every routine.

— sman.variables —

```

int tpd=0; /* to-print-debug information */

/*****
/* definitions of programs which sman can start */
*****/

\getchunk{the viewman command line}
\getchunk{the hypertext command line}
\getchunk{the clef command line}
\getchunk{the session manager command line}
\getchunk{the spadclient command line}
char *PasteFile = NULL;
char *MakeRecordFile = NULL;
char *VerifyRecordFile = NULL;

SpadProcess *spad_process_list = NULL;
/*****
/* sman defaults file name */
*****/

#define SpadDefaultFile "spadprof.input"

char ClefCommandLine[256];

#define BufSize 4096 /* size of communication buffer */
char big_bad_buf[BufSize]; /* big I/O buffer */

Sock *session_io = NULL; /* socket connecting to session manager */

/*****
/* Some characters used and externally defined in edible.h */
*****/

unsigned char _INTR, _QUIT, _ERASE, _KILL, _EOF, _EOL, _RES1, _RES2;

/*****
/* Stuff for opening pseudo-terminal */
*****/

int ptsNum, ptcNum;
char ptsPath[20], ptcPath[20];

char **new_envp; /* new environment for AXIOM */
int child_pid; /* child's process id */

```



```

struct termios oldbuf;          /* the original settings */
struct termios childbuf;       /* terminal structure for user i/o */

int death_signal = 0;

```

—————

### 3.2.3 process\_arguments

— sman.processarguments —

```

static void
process_arguments(int argc, char ** argv)
{
    int arg;
    if (tpd == 1) fprintf(stderr, "sman:process_arguments entered\n");
    for (arg = 1; arg < argc; arg++) {
        if (strcmp(argv[arg], "-debug") == 0)
            tpd = 1;
        else if (strcmp(argv[arg], "-noclef") == 0)
            start_clef = 0;
        else if (strcmp(argv[arg], "-clef") == 0)
            start_clef = 1;
        else if (strcmp(argv[arg], "-gr") == 0)
            start_graphics = 1;
        else if (strcmp(argv[arg], "-nogr") == 0)
            start_graphics = 0;
        else if (strcmp(argv[arg], "-ht") == 0)
            start_ht = 1;
        else if (strcmp(argv[arg], "-noht") == 0)
            start_ht = 0;
        else if (strcmp(argv[arg], "-iw") == 0)
            start_spadclient = 1;
        else if (strcmp(argv[arg], "-ihere") == 0)
            start_local_spadclient = 1;
        else if (strcmp(argv[arg], "-noihere") == 0)
            start_local_spadclient = 0;
        else if (strcmp(argv[arg], "-noiw") == 0)
            start_spadclient = 0;
        else if (strcmp(argv[arg], "-ws") == 0)
            ws_path = argv[++arg];
        else if (strcmp(argv[arg], "-comp") == 0)
            ws_path = "$AXIOM/etc/images/comp";
        else if (strcmp(argv[arg], "-nox") == 0)
            {
                use_X = 0;
                start_local_spadclient = 1;
                start_spadclient = 0;
                start_ht = 0;
                start_graphics = 0;
            }
        else if (strcmp(argv[arg], "-grprog") == 0)

```

```

    GraphicsProgram = argv[++arg];
else if (strcmp(argv[arg], "-htprog") == 0)
    HypertextProgram = argv[++arg];
else if (strcmp(argv[arg], "-clefprog") == 0) {
    strcpy(ClefCommandLine, argv[++arg]);
ClefProgram =
    strcat(ClefCommandLine, " -f $AXIOM/lib/command.list -e ");
}
else if (strcmp(argv[arg], "-sessionprog") == 0)
    SessionManagerProgram = argv[++arg];
else if (strcmp(argv[arg], "-clientprog") == 0)
    SpadClientProgram = argv[++arg];
else if (strcmp(argv[arg], "-rm") == 0)
    MakeRecordFile = argv[++arg];
else if (strcmp(argv[arg], "-rv") == 0)
    VerifyRecordFile = argv[++arg];
else if (strcmp(argv[arg], "-paste") == 0)
    PasteFile = argv[++arg];
else {
    fprintf(stderr, "Usage: sman <-clef|-noclef> <-gr|-nogr> <-ht|-noht>");
    fprintf(stderr, " <-iw|-noiw> <-nox> <-comp>");
    fprintf(stderr, " <-ws spad_workspace> <-grprog path> <-htprog path>");
    fprintf(stderr, " <-clefprog path> <-sessionprog path>");
    fprintf(stderr, " <-clientprog path>\n");
    exit(-1);
}
}
if (tpd == 1)
{ fprintf(stderr, " sman ");
  if (start_clef == 0)
    fprintf(stderr, "-noclef ");
  else
    fprintf(stderr, "-clef ");
  if (start_graphics == 0)
    fprintf(stderr, "-nogr ");
  else
    fprintf(stderr, "-gr ");
  if (start_ht == 0)
    fprintf(stderr, "-noht ");
  else
    fprintf(stderr, "-ht ");
  if (start_spadclient == 0)
    fprintf(stderr, "-noiw ");
  else
    fprintf(stderr, "-iw ");
  if (start_local_spadclient == 0)
    fprintf(stderr, "-noihere ");
  else
    fprintf(stderr, "-ihere ");
  if (start_local_spadclient == 0)
    fprintf(stderr, "-noihere ");
  else
    fprintf(stderr, "-ihere ");
  if (use_X == 0)

```

```

    fprintf(stderr, "-nox ");
    fprintf(stderr, "-ws ");
    fprintf(stderr, "'%s' ", ws_path);
    fprintf(stderr, "-grprog ");
    fprintf(stderr, "'%s' ", GraphicsProgram);
    fprintf(stderr, "-htprog ");
    fprintf(stderr, "'%s' ", HypertextProgram);
    fprintf(stderr, "-clefprog ");
    fprintf(stderr, "'%s' ", ClefCommandLine);
    fprintf(stderr, "-sessionprog ");
    fprintf(stderr, "'%s' ", SessionManagerProgram);
    fprintf(stderr, "-clientprog ");
    fprintf(stderr, "'%s' ", SpadClientProgram);
    fprintf(stderr, "-rm ");
    fprintf(stderr, "'%s' ", MakeRecordFile);
    fprintf(stderr, "-rv ");
    fprintf(stderr, "'%s' ", VerifyRecordFile);
    fprintf(stderr, "-paste ");
    fprintf(stderr, "'%s' ", PasteFile);
    fprintf(stderr, "\n");
}
if (tpd == 1) fprintf(stderr, "sman:process_arguments exit\n");
}

```

### 3.2.4 should\_I\_clef

— sman.shouldIclef —

```

static int
should_I_clef(void)
{
    return(1);
}

```

### 3.2.5 in\_X

— sman.inX —

```

static int
in_X(void)
{
    if (getenv("DISPLAY")) return 1;
    return 0;
}

```

### 3.2.6 set\_up\_defaults

These are the default values for sman. A '1' value means that sman will try to start the given process, a '0' value means not starting the process.

```

— sman.setupdefaults —

static void
set_up_defaults(void)
{
    if (tpd == 1) fprintf(stderr,"sman:set_up_defaults entered\n");
    start_clef = should_I_clef();
    start_graphics = 1;
    start_ht = 1;
    start_spadclient = 0;
    start_local_spadclient = 1;
    use_X = isatty(0) && in_X();
    ws_path = "$AXIOM/bin/AXIOMsys";
    if (tpd == 1) fprintf(stderr,"sman:set_up_defaults exit\n");
}

```

### 3.2.7 process\_options

```

— sman.processoptions —

static void
process_options(int argc, char **argv)
{
    if (tpd == 1) fprintf(stderr,"sman:process_options entered\n");
    set_up_defaults();
    process_arguments(argc, argv);
    if (tpd == 1) fprintf(stderr,"sman:process_options exit\n");
}

```

### 3.2.8 death\_handler

```

— sman.deathhandler —

static void
death_handler(int sig)
{
    death_signal = 1;
}

```

### 3.2.9 sman\_catch\_signals

— sman.smancatchsignals —

```
static void
sman_catch_signals(void)
{
    /* Set up the signal handlers for sman */
    bsdSignal(SIGINT,  SIG_IGN,RestartSystemCalls);
    bsdSignal(SIGTERM, death_handler,RestartSystemCalls);
    bsdSignal(SIGQUIT, death_handler,RestartSystemCalls);
    bsdSignal(SIGHUP,  death_handler,RestartSystemCalls);
    bsdSignal(SIGILL,  death_handler,RestartSystemCalls);
    bsdSignal(SIGTRAP, death_handler,RestartSystemCalls);
    bsdSignal(SIGIOT,  death_handler,RestartSystemCalls);
    bsdSignal(SIGBUS,  death_handler,RestartSystemCalls);
    bsdSignal(SIGSEGV, death_handler,RestartSystemCalls);
    bsdSignal(SIGUSR1, death_handler,RestartSystemCalls);
}

```

—————

### 3.2.10 fix\_env

insert SPADSERVER and SPADNUM variables into the environemnt

— sman.fixenv —

```
static void
fix_env(char **envp, int spadnum)
{
    int len, i;
    char *sn;
    for(len = 0; envp[len] != NULL; len++);
    new_envp = (char **) malloc((len + 3) * sizeof(char *));
    new_envp[0] = "SPADSERVER=TRUE";
    sn = (char *) malloc(20 * sizeof(char));
    sprintf(sn, "SPADNUM=%d", spadnum);
    new_envp[1] = sn;
    for(i=0; i<=len; i++)
        new_envp[i+2] = envp[i];
}

```

—————

### 3.2.11 init\_term\_io

— sman.inittermio —

```
static void

```

```

init_term_io(void)
{
    if(!isatty(0)) return;
    if( tcgetattr(0, &oldbuf) == -1) {
        perror("getting termios");
        return ; /* exit(-1); */
    }
    if( tcgetattr(0, &childbuf) == -1) {
        perror("getting termios");
        return ; /* exit(-1); */
    }
    _INTR = oldbuf.c_cc[VINTR];
    _QUIT = oldbuf.c_cc[VQUIT];
    _ERASE = oldbuf.c_cc[VERASE];
    _KILL = oldbuf.c_cc[VKILL];
    _EOF = oldbuf.c_cc[VEOF];
    _EOL = oldbuf.c_cc[VEOL];
}

```

—————

### 3.2.12 strPrefix

— sman.strPrefix —

```

static char *
strPrefix(char *prefix, char * s)
{
    while (*prefix != '\0' && *prefix == *s) {
        prefix++;
        s++;
    }
    if (*prefix == '\0') return s;
    return NULL;
}

```

—————

### 3.2.13 check\_spad\_proc

— sman.checkspadproc —

```

static void
check_spad_proc(char *file, char *prefix)
{
    char *num;
    int pid;
    if ((num = strPrefix(prefix, file))) {
        pid = atoi(num);
        if (pid > 2) {

```

```

        kill(pid, 0);
        if (kill(pid, 0) == -1 && errno == ESRCH) {
unlink(file);
        }
    }
}
}

```

---

### 3.2.14 clean\_up\_old\_sockets

— sman.cleanupoldsockets —

```

static void
clean_up_old_sockets(void)
{
    char com[512], tmp_file[128];
    FILE *file;
    int len;
    sprintf(tmp_file, "/tmp/socks.%d", server_num);
    sprintf(com, "ls /tmp/.d* /tmp/.s* /tmp/.i* /tmp/.h* 2> %s > %s",
tmp_file, tmp_file);
    system(com);
    file = fopen(tmp_file, "r");
    if (file == NULL) {
        fprintf(stderr, "Can't open socket listing file\n");
        return;
    }
    while(fgets(com, 512, file) != NULL) {
        len = strlen(com);
        if (len) com[len-1] = '\0';
        else break;
        check_spad_proc(com, "/tmp/.d");
        check_spad_proc(com, "/tmp/.s");
        check_spad_proc(com, "/tmp/.i");
        check_spad_proc(com, "/tmp/.h");
    }
    fclose(file);
    unlink(tmp_file);
}

```

---

### 3.2.15 fork\_you

— sman.forkyou —

```

static SpadProcess *
fork_you(int death_action)

```

```

{
  /* fork a new process, giving it a default death action */
  /* return NULL in child, SpadProcess in parent          */
  int child_pid = fork();
  SpadProcess *proc;
  if (!child_pid) return NULL;
  proc = (SpadProcess *) malloc(sizeof(SpadProcess));
  proc->proc_id = child_pid;
  proc->death_action = death_action;
  proc->command = NULL;
  proc->next = spad_process_list;
  spad_process_list = proc;
  return proc;
}

```

---

### 3.2.16 exec\_command\_env

Note that the next-to-last argument of `execle` must be an explicit NULL pointer. The previous naked 0 value was not correct.

— `sman.execcommandenv` —

```

static void
exec_command_env(char *command, char ** env)
{
  char new_command[512];
  sprintf(new_command, "exec %s", command);
  execle("/bin/sh", "/bin/sh", "-c", new_command, (char *)0, env);
}

```

---

### 3.2.17 spawn\_of\_hell

— `sman.spawnofhell` —

```

static SpadProcess *
spawn_of_hell(char *command, int death_action)
{
  SpadProcess *proc = fork_you(death_action);
  if (proc != NULL) {
    proc->command = command;
    return proc;
  }
  exec_command_env(command, new_envp);
  return NULL;
}

```

---



### 3.2.18 start\_the\_spadclient

run a AXIOM client in the main process

— sman.startthespadclient —

```
static void
start_the_spadclient(void)
{
    char command[256];
    if (start_clef)
#ifdef RIOSplatform
        sprintf(command,
            "aixterm -sb -sl 500 -name axiomclient -n AXIOM -T AXIOM -e %s %s",
            ClefProgram, SpadClientProgram);
    #else
        sprintf(command,
            "xterm -sb -sl 500 -name axiomclient -n AXIOM -T AXIOM -e %s %s",
            ClefProgram, SpadClientProgram);
    #endif
    else
#ifdef RIOSplatform
        sprintf(command,
            "aixterm -sb -sl 500 -name axiomclient -n AXIOM -T AXIOM -e %s",
            SpadClientProgram);
    #else
        sprintf(command,
            "xterm -sb -sl 500 -name axiomclient -n AXIOM -T AXIOM -e %s",
            SpadClientProgram);
    #endif
    if (tpd == 1)
        fprintf(stderr, "sman:start_the_spadclient: %s\n", command);
    spawn_of_hell(command, NadaDelShitsky);
}
```

—————

### 3.2.19 start\_the\_local\_spadclient

— sman.startthelocalspadclient —

```
static void
start_the_local_spadclient(void)
{
    char command[256];
    if (start_clef)
        sprintf(command, "%s %s", ClefProgram, SpadClientProgram);
    else
        sprintf(command, "%s", SpadClientProgram);
    if (tpd == 1)
        fprintf(stderr, "sman:start_the_local_spadclient: %s\n", command);
    spawn_of_hell(command, NadaDelShitsky);
}
```

---

### 3.2.20 start\_the\_session\_manager

— sman.startthesessionmanager —

```
static void
start_the_session_manager(void)
{
    spawn_of_hell(SessionManagerProgram, Die);
}
```

---

### 3.2.21 start\_the\_hypertext

— sman.startthehypertext —

```
static void
start_the_hypertext(void)
{
    char prog[512];

    if (PasteFile){
        sprintf(prog, "%s -k -ip %s", HypertextProgram, PasteFile);
        spawn_of_hell(prog, NadaDelShitsky);
    }
    else if (MakeRecordFile){
        sprintf(prog, "%s -k -rm %s", HypertextProgram, MakeRecordFile );
        spawn_of_hell(prog, NadaDelShitsky);
    }
    else if (VerifyRecordFile){
        sprintf(prog, "%s -k -rv %s", HypertextProgram, VerifyRecordFile);
        spawn_of_hell(prog, NadaDelShitsky);
    }
    /* If we restart hyperdoc from the axiom command prompt */
    else spawn_of_hell(HypertextProgram, CleanHypertextSocket);
}
```

---

### 3.2.22 start\_the\_graphics

— sman.startthegraphics —

```
static void
start_the_graphics(void)
```

```

{
  spawn_of_hell(GraphicsProgram, DoItAgain);
}

```

### 3.2.23 fork\_Axiom

— sman.forkAxiom —

```

/* Start the AXIOM session in a separate process, */
/* using a pseudo-terminal to catch all input and output */
static void
fork_Axiom(void)
{
  char augmented_ws_path[256]; /* will append directory path */
  char *tmp_pointer;
  SpadProcess *proc;

  proc = fork_you(Die);
  child_pid = (proc == NULL ? 0 : proc->proc_id);
  switch(child_pid) {
  case -1 :
    fprintf(stderr, "Can't create a new process \n");
    exit(0);
  case 0:
    /* Dissasociate from my parents group so all my child processes */
    /* look at my terminal as the controlling terminal for the      */
    /* group                                                         */

    if(setsid() < 0) {
      perror("Dissassociating from parents group");
      exit(-1);
    }

    close(ptsNum);
    /* Now reopen the server side, so that pg, su, etc. work properly */

    if ((ptsNum = open(ptsPath, O_RDWR)) < 0 ) {
      perror("fork_Axiom: Failed to reopen server");
      exit(-1);
    }
    #if defined(SUN40S5platform) || defined(HP10platform)
      ioctl(ptsNum, I_PUSH, "ptem");
      ioctl(ptsNum, I_PUSH, "ldterm");
    #endif

    /* since I am the child, I can close ptc, and dup pts for all its */
    /* standard descriptors                                           */

    if( (dup2(ptsNum, 0) == -1) ||
        (dup2(ptsNum, 1) == -1) ||

```

```

        (dup2(ptsNum, 2) == -1) ) {
    perror("trying to dupe the child");
    exit(-1);
}
close(ptyNum);
close(ptsNum);

/* I also have to turn off echoing, since I am echoing all the */
/* input myself */

childbuf.c_lflag &= ~ECHO;
if( tcsetattr(0, TCSAFLUSH, &childbuf) == -1) {
    perror("setting the term buffer");
    exit(-1);
}
strcpy(augmented_ws_path,ws_path);          /* write the name */
strcat(augmented_ws_path," ");             /* space */
strcat(augmented_ws_path,ws_path);        /* name again */
tmp_pointer = (char *)
    strchr(augmented_ws_path,'/');         /*pointer to last / */
*(++tmp_pointer) = '\0';
exec_command_env(augmented_ws_path, new_envp);

/*    fprintf(stderr, "Cannot execute the %s system.\n", ws_path); */

exit(0);
}
}

```

### 3.2.24 start\_the\_Axiom

— sman.starttheAxiom —

```

static void
start_the_Axiom(char **envp)
{
    server_num = make_server_number();
    clean_up_old_sockets();
    if (server_num == -1) {
        fprintf(stderr, "could not get an AXIOM server number\n");
        exit(-1);
    }
    if (ptyopen(&ptyNum, &ptsNum, ptyPath, ptsPath) == -1) {
        perror("start_the_Axiom: ptyopen failed");
        exit(-1);
    }
    fix_env(envp, server_num);
    fork_Axiom();
    close(ptsNum);
}

```

```
}

```

---

### 3.2.25 clean\_up\_sockets

In order to be able to restart hyperdoc from the axiom command prompt we need to remove the socket for this server.

— sman.cleanupsockets —

```
static void
clean_hypertext_socket(void)
{
    char name[256];
    sprintf(name, "%s%d", MenuServerName, server_num);
    unlink(name);
}

static void
clean_up_sockets(void)
{
    char name[256];
    sprintf(name, "%s%d", SpadServer, server_num);
    unlink(name);
    sprintf(name, "%s%d", SessionServer, server_num);
    unlink(name);
    sprintf(name, "%s%d", SessionIOName, server_num);
    unlink(name);
    clean_hypertext_socket();
}
```

---

### 3.2.26 read\_from\_spad\_io

— sman.readfromspadio —

```
static void
read_from_spad_io(int ptcNum)
{
    int ret_code = 0, i=0;
    static int mes_len =0;
    ret_code = read(ptcNum, big_bad_buf, BufSize);
    if (ret_code == -1) {
        clean_up_sockets();
        exit(-1);
    }
    if (session_io == NULL) {
        if (ret_code < mes_len)
            mes_len -= ret_code;
        else {
```

```

        if (mes_len > 0) {
i = mes_len;
mes_len = 0;
    }
    else
i = 0;
    ret_code = write(1, big_bad_buf+i, ret_code-i);
    }
}
else
    ret_code = swrite(session_io, big_bad_buf, ret_code,
        "writing to session man");
if (ret_code == -1) {
    perror("writing output to session manager");
    clean_up_sockets();
    exit(-1);
}
}
}

```

---

### 3.2.27 read\_from\_manager

— sman.readfrommanager —

```

static void
read_from_manager(int ptcNum)
{
    int ret_code;
    ret_code = sread(session_io, big_bad_buf, BufSize, "reading session io");
    if (ret_code == -1) {
        return;
    }
    ret_code = write(ptcNum, big_bad_buf, ret_code);
    if (ret_code == -1) {
        return;
    }
}
}

```

---

### 3.2.28 manage\_spad\_io

— sman.managespadio —

```

static void
manage_spad_io(int ptcNum)
{
    int ret_code, i, p;
    fd_set rd;

```

```

while (1) {
    rd = socket_mask;
    FD_SET(pteNum, &rd);
    if (session_io != NULL)
        FD_SET(session_io->socket, &rd);
    ret_code = sselect(FD_SETSIZE, &rd, 0, 0, NULL);
    if (ret_code == -1) {
        perror("Session manager select");
        clean_up_sockets();
        exit(-1);
    }
    if (FD_ISSET(pteNum, &rd)) {
        read_from_spad_io(pteNum);
    }
    for(i=0; i<2; i++) {
        if (server[i].socket > 0 && FD_ISSET(server[i].socket, &rd)) {
p = accept_connection(server+i);
switch(p) {
case SessionIO:
    session_io = purpose_table[SessionIO];
    /* printf("connected session manager\n\r");*/
    printf("\n");
    break;
default:
    printf("sman: Unkown connection request type: %d\n", p);
    break;
}
        }
    }
    if (session_io != NULL && FD_ISSET(session_io->socket, &rd)) {
        read_from_manager(pteNum);
    }
}
}

```

\_\_\_\_\_

### 3.2.29 init\_spad\_process\_list

— sman.initspadprocesslist —

```

static void
init_spad_process_list(void)
{
    spad_process_list = NULL;
}

```

\_\_\_\_\_

### 3.2.30 print\_spad\_process\_list

— sman.printspadprocesslist —

```
#if 0
static void
print_spad_process_list()
{
    SpadProcess *proc;
    for(proc = spad_process_list; proc != NULL; proc = proc->next)
        fprintf(stderr, "proc_id = %d, death_action = %d\n", proc->proc_id,
            proc->death_action);
}
#endif
```

### 3.2.31 find\_child

— sman.findchild —

```
static SpadProcess *
find_child(int proc_id)
{
    SpadProcess *proc;
    for(proc = spad_process_list; proc != NULL; proc = proc->next)
        if (proc->proc_id == proc_id) return proc;
    return NULL;
}
```

### 3.2.32 kill\_all\_children

— sman.killallchildren —

```
static void
kill_all_children(void)
{
    char name[256];
    SpadProcess *proc;

    for(proc = spad_process_list; proc != NULL; proc = proc->next) {
        kill(proc->proc_id, SIGTERM);
    }
    sprintf(name, "/tmp/hyper%d.input", server_num);
    unlink(name);
}
```



---

### 3.2.33 clean\_up\_terminal

— sman.cleantupterminal —

```
static void
clean_up_terminal(void)
{
    tcsetattr(0, TCSAFLUSH, &oldbuf);
}
```

---

### 3.2.34 monitor\_children

— sman.monitorchildren —

```
static void
monitor_children(void)
{
    int dead_baby, stat;
    SpadProcess *proc;
    while (1) {
        stat = 0;
        dead_baby = wait(&stat);
        /* Check the value of dead_baby, since wait may have returned
           a pid but subsequently we have received a signal. Yeuch!
           In order to restart hyperdoc from the axiom command prompt
           we no longer call clean_up_terminal */
        if (dead_baby == -1 && death_signal) {
            kill_all_children();
            clean_up_sockets();
            sleep(2);
            exit(0);
        }
        if (dead_baby == -1) {
            fprintf(stderr, "sman: wait returned -1\n");
            continue;
        }
        proc = find_child(dead_baby);
        if (proc == NULL) {
            /*      fprintf(stderr, "sman: %d is not known to be a child process\n",
               dead_baby);
            */
            continue;
        }
        switch(proc->death_action) {
            /* In order to restart hyperdoc from the axiom command prompt
```

```

    we no longer call clean_up_terminal. Instead we've added a
    case to just clean up the socket. */
case Die:
    kill_all_children();
    clean_up_sockets();
    sleep(2);
    exit(0);
case NadaDelShitsky:
    break;
case DoItAgain:
    spawn_of_hell(proc->command, DoItAgain);
    break;
case CleanHypertextSocket:
    clean_hypertext_socket();
    break;
}
}
}

```

### 3.2.35 main sman

The main procedure should return an int. We change the return value here and in src/include/sman.h1.

```

    — sman.result —
return(0);
    —————

    — sman.main —

int
main(int argc, char *argv[],char *envp[])
{
    if (tpd == 1) fprintf(stderr,"sman:main entered\n");
    bsdSignal(SIGINT, SIG_IGN,RestartSystemCalls);
    process_options(argc, argv);

    init_term_io();
    init_spad_process_list();
    start_the_Axiom(envp);
    if (open_server(SessionIOName) == -2) {
        fprintf(stderr, "Fatal error opening I/O socket\n");
        clean_up_sockets();
        exit(-1);
    }
    start_the_session_manager();
    if (start_spadclient) start_the_spadclient();
    if (start_local_spadclient) start_the_local_spadclient();
    if (start_ht) start_the_hypertext();
    if (start_graphics) start_the_graphics();
}

```

```

sleep(1);

if (fork_you(Die) != NULL) {
    sman_catch_signals();
    monitor_children();
    exit(0);
}
manage_spad_io(putcNum);
if (tpd == 1) fprintf(stderr,"sman:main exit\n");
\getchunk{sman.result}
}

```

### 3.2.36 sman.c

— sman.c —

```

#define _SMAN_C

\getchunk{sman.includes}
\getchunk{sman.variables}
\getchunk{sman.processarguments}
\getchunk{sman.shouldIclef}
\getchunk{sman.inX}
\getchunk{sman.setupdefaults}
\getchunk{sman.processoptions}
\getchunk{sman.deathhandler}
\getchunk{sman.smancatchsignals}
\getchunk{sman.fixenv}
\getchunk{sman.inittermio}
\getchunk{sman.strPrefix}
\getchunk{sman.checkspadproc}
\getchunk{sman.cleanupoldsockets}
\getchunk{sman.forkyou}
\getchunk{sman.execcommandenv}
\getchunk{sman.spawnofhell}
\getchunk{sman.startthespadclient}
\getchunk{sman.startthelocalspadclient}
\getchunk{sman.startthesessionmanager}
\getchunk{sman.startthehypertex}
\getchunk{sman.startthegraphics}
\getchunk{sman.forkAxiom}
\getchunk{sman.starttheAxiom}
\getchunk{sman.cleanupsockets}
\getchunk{sman.readfromspadio}
\getchunk{sman.readfrommanager}
\getchunk{sman.managespadio}
\getchunk{sman.initspadprocesslist}
\getchunk{sman.printspadprocesslist}
\getchunk{sman.findchild}
\getchunk{sman.killallchildren}

```

```
\getchunk{sman.cleanupterminal}  
\getchunk{sman.monitorchildren}  
\getchunk{sman.main}
```

---

## Chapter 4

# Support Routines

### 4.1 Command Completion

Hyperdoc has the ability to do command completion. The known commands are listed, one entry per line, in a file called `command.list`.



## Chapter 5

# The viewman program

— the viewman command line —

```
char *GraphicsProgram = "$AXIOM/lib/viewman";
```

—————





## Chapter 6

# The hypertext program

— the hypertext command line —

```
char *HypertextProgram = "$AXIOM/bin/hypertext -s";
```

—————



## Chapter 7

# The clef program

— the clef command line —

```
char *ClefProgram = "$AXIOM/bin/clef -f $AXIOM/lib/command.list -e ";
```

—————



# Chapter 8

## The session program

— the session manager command line —

```
char *SessionManagerProgram = "$AXIOM/lib/session";
```

—————

### 8.1 session

#### 8.1.1 includes

— ses.includes —

```
#include <stdlib.h>
#include <sys/time.h>
#include <stdio.h>
#include <string.h>
#include <signal.h>
#ifdef SGIplatform
#include <bstring.h>
#endif
\getchunk{include/com.h}
\getchunk{include/bsdsignal.h}
\getchunk{include/sockio-c.h1}
\getchunk{include/bsdsignal.h1}
\getchunk{include/session.h1}
```

—————

#### 8.1.2 variables

— ses.variables —

```

#define BufSize 4096 /* size of communication buffer */

typedef struct sock_list {      /* linked list of Sock */
    Sock Socket;
    struct sock_list *next;
} Sock_List;

Sock *spad_io = (Sock *) 0;    /* to_server socket for SessionIO */
Sock *spad_server = (Sock *) 0; /* to_server socket for SpadServer */
Sock *menu_client = (Sock *) 0; /* to_client socket for MenuServerName */
Sock *active_session = (Sock *) 0; /* pointer to currently active session */

Sock_List *plSock = (Sock_List *) 0;

char big_bad_buf[BufSize]; /* big I/O buffer */
int num_active_clients = 0; /* number of InterpWindows attached */
int reading_output = 0;
fd_set session_socket_mask;

```

---

### 8.1.3 usr1\_handler

```

— ses.usr1handler —

static void
usr1_handler(int sig)
{
    return;
}

```

---

### 8.1.4 usr2\_handler

SIGUSR2 is generated by spadclients. We interpret it as an interrupt for the Lisp.

```

— ses.usr2handler —

static void
usr2_handler(int sig)
{
    send_signal(spad_server, SIGINT);
    return;
}

```

---

### 8.1.5 term\_handler

— ses.termhandler —

```
static void
term_handler(int sig)
{
    exit(1);
}
```

---

### 8.1.6 pr

— ses.pr —

```
static void
pr()
{
    Sock_List *pSock;

    fprintf(stderr, "The socket list:\n");
    for(pSock=plSock; pSock!=(Sock_List *)0; pSock=pSock->next){
        fprintf(stderr, "(%d,%d,%d)\t",
            pSock->Socket.pid, 2<<(pSock->Socket.socket), pSock->Socket.frame);
    }
    fprintf(stderr, "\n");
}
```

---

### 8.1.7 close\_client

— ses.closeclient —

```
static void
close_client(int frame)
{
    Sock_List *pSock,*locSock;
    int socket_fd;

    /* we will check for frame equality,
       kill with send_signal,
       notify HyperTex so that it updates its list (if it's a spadbuf),
       repair the list,
       unset the active_session,
       update num_active_clients
       */
}
```

```

    /* first check head */
#ifdef DEBUG
fprintf(stderr,"close_client(%d)\n",frame);
#endif

    if ( (plSock) && (plSock->Socket.frame == frame) ){
        socket_fd = plSock->Socket.socket;
        send_signal((Sock *)plSock, SIGTERM);
        if ( menu_client != (Sock *) 0){
            send_int(menu_client,CloseClient);
            send_int(menu_client,(*plSock).Socket.pid);
        }
#ifdef DEBUG
fprintf(stderr,"trying to clear %u\n",socket_fd);
#endif
        FD_CLR(socket_fd,&session_socket_mask);
        locSock = plSock;
        if ((*plSock).next == (Sock_List *) 0)
            {plSock = (Sock_List *) 0;}
        else
            {plSock = plSock->next;}
        active_session = (Sock *) 0;
        num_active_clients--;
        free(locSock);
    }

    /* now check the rest */

    else {
        for (pSock=plSock; pSock->next != (Sock_List *) 0 ; pSock=pSock->next)
            if (pSock->next->Socket.frame == frame){
                socket_fd = pSock->next->Socket.socket;
                send_signal((Sock *)pSock->next, SIGTERM);
                if ( menu_client != (Sock *) 0){
                    send_int(menu_client,CloseClient);
                    send_int(menu_client,(*plSock).Socket.pid);
                }
#ifdef DEBUG
fprintf(stderr,"trying to clear %u\n",socket_fd);
#endif
                FD_CLR(socket_fd,&session_socket_mask);
                locSock = pSock->next;
                if ( pSock->next->next == (Sock_List *) 0 )
                    { pSock->next= (Sock_List *) 0;}
                else
                    { pSock->next = pSock->next->next;}
                num_active_clients--;
                active_session = (Sock *) 0;
                free(locSock);
                break;
            }
    }
#ifdef DEBUG
pr();

```



```
#endif
}
```

---

### 8.1.8 read\_SpadServer\_command

— ses.readSpadServercommand —

```
static void
read_SpadServer_command(void)
{
    int cmd, frame, num;
    cmd = get_int(spada_server);
    switch (cmd) {
    case EndOfOutput:
        if (menu_client != (Sock *) 0) send_signal(menu_client, SIGUSR2);
        if (reading_output != 0) reading_output = 0;
        break;
    case QueryClients:
        /* don't count MenuServer */
        num = num_active_clients;
        send_int(spada_server, num);
        break;
    case CloseClient:
        frame = get_int(spada_server);
        if (frame != -1) close_client(frame);
        break;
    case SendXEventToHyperTeX:
        break;
    default:
        fprintf(stderr, "session : unknown command from SpadServer %d\n", cmd);
        break;
    }
}
```

---

### 8.1.9 test\_sock\_for\_process

— ses.testsockforprocess —

```
static int
test_sock_for_process(Sock *sock)
{
    if (sock == (Sock *)0) return -1;
    return kill(sock->pid, 0);
}
```

---

## 8.1.10 read\_menu\_client\_command

— ses.readmenuclientcommand —

```

static void
read_menu_client_command(void)
{
    int cmd,frame, i,socket_fd;
    Sock_List *pSock;

    /* save it for possible clearing */
    socket_fd = menu_client->socket;

    if (test_sock_for_process(menu_client) == -1) {
        FD_CLR(socket_fd,&session_socket_mask);
        menu_client = (Sock *) 0;
        reading_output = 0;
        return;
    }
    cmd = get_int(menu_client);
    switch(cmd) {
    case -1: /* socket closed */
        FD_CLR(socket_fd,&session_socket_mask);
        menu_client = (Sock *) 0;
        reading_output = 0;
        break;
    case SwitchFrames:
#ifdef DEBUG
        fprintf(stderr,"menu:SwitchFrames\n");
#endif
        frame = get_int(menu_client);
        send_int(spada_server, SwitchFrames);
        send_int(spada_server, frame);
        for(i=0,pSock=plSock; pSock != (Sock_List *) 0 ; i++,pSock=pSock->next)
            if ((pSock->Socket.frame == frame)) {
                active_session = (Sock *)pSock;
                reading_output = 1;
                break;
            }
        if (i == num_active_clients) {
            /* fprintf(stderr, "Couldn't find socket for frame %d\n", frame); */
        }
        break;
    case QuerySpad:
#ifdef DEBUG
        fprintf(stderr,"menu:QuerySpad\n");
#endif
        send_int(menu_client, reading_output);
        break;
    default:
        fprintf(stderr, "session : unknown command from MenuServer: %d\n", cmd);
        menu_client = (Sock *) 0;
        break;
    }
}

```

```

    }
}

```

---

### 8.1.11 read\_from\_spad\_io

— ses.readfromspadio —

```

static void
read_from_spad_io(void)
{
    int ret_code;
    ret_code = sread(spadi_io, big_bad_buf, BufSize, "session: stdout socket");
    if (ret_code == -1) return;
    if (active_session != (Sock *) 0) {
        ret_code = swrite(active_session, big_bad_buf, ret_code,
            NULL);
    }
}

```

---

### 8.1.12 kill\_spad

— ses.killspad —

```

static void
kill_spad(void)
{
    int i;
    Sock_List *pSock;

    send_signal(spadi_server, SIGTERM);
    for (pSock=plSock,i=0;
        (i<num_active_clients) && (pSock != (Sock_List *) 0);
        i++,pSock=pSock->next) {
        if ((pSock->Socket).socket != 0)
            send_signal((Sock *)pSock, SIGTERM);
    }
    if (menu_client != (Sock *) 0) send_signal(menu_client, SIGTERM);
    exit(0);
}

```

---

8.1.13 `accept_session_connection`— `ses.acceptsessionconnection` —

```

static int
accept_session_connection(Sock *server_sock)
{
    int sock_fd, ret_code;
    Sock_List *pls;

    /* Could be three things : KillSpad MenuServer InterpWindow */

    pls = (Sock_List *) malloc(sizeof (Sock_List));
    sock_fd = accept(server_sock->socket, 0, 0);
    if (sock_fd == -1) {
        perror("session : accepting connection");
        return -1;
    }
    (pls->Socket).socket = sock_fd;
    get_socket_type((Sock *)pls);

    switch((pls->Socket).purpose) {
    case KillSpad:
        kill_spad();
        return KillSpad;
        free(pls);
    case MenuServer:
#ifdef DEBUG
        fprintf(stderr,"session: accepted MenuServer , fd = %d\n",sock_fd);
#endif
        menu_client = &(pls->Socket);
        FD_SET(menu_client->socket, &session_socket_mask);
        return MenuServer;
    case InterpWindow:
#ifdef DEBUG
        fprintf(stderr,"session: accepted InterpWindow , fd = %d\n",sock_fd);
#endif
        /* new Sock is put at the head of the list */
        if (plSock == (Sock_List *)0 ) {
            plSock = pls;
            plSock->next = (Sock_List *)0 ;
        }
        else{
            pls->next = plSock;
            plSock = pls;
        }

        /* we need to maintain session_socket_mask here
           since we roll our own accept */

        FD_SET(plSock->Socket.socket, &session_socket_mask);
        send_int(spad_server, CreateFrame);

```

```

    {
        int command = get_int(spad_server);
        /* XXX hack -- the whole protocol looks broken, we just
        try to detect losage */
        if (command != CreateFrameAnswer) {
            fprintf(stderr, "session: non-fatal, got out of sync "
                "with Spad server\n (lost race)\n");
            /* exit(1); */
        }
    }
    plSock->Socket.frame = get_int(spad_server);
    active_session = (Sock *)plSock;
    get_string_buf(spad_server, big_bad_buf, BufSize);
    ret_code = swrite((Sock *)plSock, big_bad_buf, strlen(big_bad_buf)+1,
"session: writing to InterpWindow");
    if (ret_code == -1)
return -1;
    num_active_clients++;
#ifdef DEBUG
pr();
#endif
    return plSock->Socket.purpose;
}
return (-1);
}

```

### 8.1.14 read\_from\_session

— ses.readfromsession —

```

static void
read_from_session(Sock *sock)
{
    int ret_code;
    if (sock != active_session) {
        send_int(spad_server, SwitchFrames);
        send_int(spad_server, sock->frame);
    }
    active_session = sock;
    ret_code = sread(sock, big_bad_buf, BufSize,
"session: reading InterpWindow");
    if (ret_code == -1) {
        active_session = (Sock *) 0;
        reading_output = 0;
        return;
    }
    ret_code = swrite(spad_io, big_bad_buf, ret_code,
"session: writing SessionIO");
    if (ret_code == -1) {
        active_session = (Sock *)0 ;
    }
}

```

```

    reading_output = 0;
    return;
}
reading_output = 1;
}

```

—————

### 8.1.15 manage\_sessions

— ses.managesessions —

```

static void
manage_sessions(void)
{
    int ret_code;
    fd_set rd, wr, ex;
    Sock_List *pSock;

    reading_output = 0;
    while (1) {
        FD_ZERO(&rd);
        FD_ZERO(&wr);
        FD_ZERO(&ex);

        /* Allow server socket and all connections if not waiting for output
           socket_mask is maintained by libspad.a */
#ifdef DEBUG
        fprintf(stderr, "session_socket_mask=%u ", *((long *)session_socket_mask.fds_bits));
#endif
        rd = session_socket_mask;
        if (!reading_output) {
            rd = session_socket_mask;
        }

        /* Allow the active_session if set */
        if (active_session) FD_SET(active_session->socket, &rd);
#ifdef DEBUG
        fprintf(stderr, "[rd=%u ", *((long *)rd.fds_bits));
#endif

        ret_code = sselect(FD_SETSIZE, &rd, &wr, &ex, NULL);
        if (ret_code == -1) {
            break;
        }
#ifdef DEBUG
        fprintf(stderr, "rd=%u]\n", *((long *)rd.fds_bits));
#endif

        if ((menu_client != (Sock *) 0) && FD_ISSET(menu_client->socket, &rd)) {
            /* MenuServer wants to talk */
            read_menu_client_command(); }
    }
}

```

```

if (FD_ISSET(spad_io->socket, &rd)) {
    /* Lisp has output */
    read_from_spad_io(); }

if (FD_ISSET(server[1].socket, &rd)) {
    /* Someone wants to connect to our server socket */
    accept_session_connection(server+1); }

for(pSock=plSock; pSock != (Sock_List *) 0 ; pSock=pSock->next) {
    if ((active_session == (Sock *)pSock || !reading_output) &&
        (pSock->Socket).socket>0 && FD_ISSET(pSock->Socket.socket, &rd)) {
/* An InterpWindow */
read_from_session((Sock *)pSock); }
    }

if (FD_ISSET(spad_server->socket, &rd)) {
    /* The Lisp socket */
    read_SpadServer_command(); }
}
}

```

—————

### 8.1.16 main sessionmanager

— ses.main —

```

int
main(void)
{
#ifdef DEBUG2
    /* delay for attaching with debugger before interesting things happen */
    sleep(30);
#endif

    /* spad_server connects to Lisp server socket
       read_SpadServer_command handles requests */
    spad_server = connect_to_local_server(SpadServer, SessionManager, Forever);
    if (spad_server == (Sock *) 0) {
        fprintf(stderr, "session: Cannot connect to AXIOM server!\n");
        exit(0);
    }
    else {
#ifdef DEBUG
        fprintf(stderr, "session: connected SpadServer , fd = %d\n",
            spad_server->socket);

```

```

#endif
    FD_SET(spada_server->socket, &session_socket_mask);
}

/* spada_io connects to SessionIOName server socket
   this is Lisp std IO read_from_spada_io handles requests */
spada_io = connect_to_local_server(SessionIOName, SessionIO, Forever);
if (spada_io == (Sock *) 0) {
    fprintf(stderr, "session: Cannot connect to AXIOM IO!\n");
    exit(0);
}
else {
#ifdef DEBUG
    fprintf(stderr, "session: connected SessionIOName , fd = %d\n",
            spada_io->socket);
#endif
    FD_SET(spada_io->socket, &session_socket_mask);
}
bsdSignal(SIGUSR2, usr2_handler, DontRestartSystemCalls);
bsdSignal(SIGUSR1, usr1_handler, RestartSystemCalls);
bsdSignal(SIGINT, SIG_IGN, RestartSystemCalls);
bsdSignal(SIGTERM, term_handler, RestartSystemCalls);

/* open_server opens the server socket so that we can accept connections
   we expect connections from spadbuf/spadclient(purpose:InterpWindow)
   and hypertex (MenuServer) */

if (open_server(SessionServer) == -2) {
    fprintf(stderr, "session: Cannot make server socket!\n");
    exit(-1);
}
else {
#ifdef DEBUG
    fprintf(stderr, "session: opened SessionServer , fd = %d\n",
            server[1].socket);
#endif
    FD_SET(server[1].socket, &session_socket_mask);
}
manage_sessions();
return(0);
}

```

### 8.1.17 session

— session.c —

```

/* #define DEBUG */
#define _SESSION_C

```



```
\getchunk{ses.includes}  
\getchunk{ses.variables}  
\getchunk{ses.usr1handler}  
\getchunk{ses.usr2handler}  
\getchunk{ses.termhandler}  
\getchunk{ses.pr}  
\getchunk{ses.closeclient}  
\getchunk{ses.readSpadServercommand}  
\getchunk{ses.testsockforprocess}  
\getchunk{ses.readmenuclientcommand}  
\getchunk{ses.readfromspadio}  
\getchunk{ses.killspad}  
\getchunk{ses.acceptsessionconnection}  
\getchunk{ses.readfromsession}  
\getchunk{ses.managesessions}  
\getchunk{ses.main}
```

---



## Chapter 9

# The spadclient program

— the spadclient command line —

```
char *SpadClientProgram = "$AXIOM/lib/spadclient";
```

—————

### 9.1 spadclient

— spadclient.c —

```
#define _SPADCLIENT_C

#include <stdio.h>
#include <signal.h>

\getchunk{include/com.h}
\getchunk{include/bsdsignal.h}
\getchunk{include/bsdsignal.h1}
\getchunk{include/sockio-c.h1}
\getchunk{include/spadclient.h1}

Sock *sock;

static void
inter_handler(int sig)
{
    send_signal(sock, SIGUSR2);
    fflush(stderr);
}

int
main(void)
{
```

```
sock = connect_to_local_server(SessionServer, InterpWindow, Forever);
bsdSignal(SIGINT, inter_handler, RestartSystemCalls);
remote_stdio(sock);
return(0);
}
```

---

## Chapter 10

# The Command Completion List

— command.list —

```
-  
/  
/\n^  
~=  
~  
~=  
*  
**  
\  
#  
+  
<  
<=  
=  
>  
>=  
0  
1  
abelianGroup  
abs  
absolutelyIrreducible?  
accuracyIF  
acos  
acosh  
acoshIfCan  
acosIfCan  
acot  
acoth  
acothIfCan  
acotIfCan  
acsc  
acsch  
acschIfCan
```

acscIfCan  
aCubic  
adaptive  
adaptive?  
adaptive3D?  
addBadValue  
addChild!  
addData!  
addField!  
addiag  
addMatch  
addMatchRestricted  
addmod  
addPoint  
addPoint2  
addPointLast  
adjoint  
airyAi  
airyBi  
Aleph  
algDsolve  
algebraic?  
algebraicCoefficients?  
algebraicDecompose  
algebraicOf  
algebraicSort  
algebraicVariables  
algint  
algintegrate  
algSplitSimple  
aLinear  
allRootsOf  
alphabetic  
alphabetic?  
alphanumeric  
alphanumeric?  
alternating  
alternatingGroup  
alternative?  
An  
AND  
And  
and  
anfactor  
antiAssociative?  
antiCommutative?  
antiCommutator  
anticoord  
antisymmetric?  
antisymmetricTensors  
any  
any?  
append  
appendPoint

apply  
applyQuote  
applyRules  
approximants  
approximate  
approxNthRoot  
approxSqrt  
aQuadratic  
aQuartic  
areEquivalent?  
arg1  
arg2  
argscript  
argument  
argumentList!  
argumentListOf  
arity  
aromberg  
arrayStack  
asec  
asech  
asechIfCan  
asecIfCan  
asimpson  
asin  
asinh  
asinhIfCan  
asinIfCan  
aspFilename  
assert  
assign  
assoc  
associatedEquations  
associatedSystem  
associates?  
associative?  
associator  
associatorDependence  
atan  
atanh  
atanhIfCan  
atanIfCan  
atom?  
atoms  
atrapezoidal  
att2Result  
augment  
autoReduced?  
axes  
axesColorDefault  
Bisolve  
back  
backOldPos  
badNum

badValues  
bag  
balancedBinaryTree  
balancedFactorisation  
bandedHessian  
bandedJacobian  
base  
baseRDE  
baseRDEsys  
BasicMethod  
basicSet  
basis  
basisOfCenter  
basisOfCentroid  
basisOfCommutingElements  
basisOfLeftAnnihilator  
basisOfLeftNucleus  
basisOfLeftNucloid  
basisOfMiddleNucleus  
basisOfNucleus  
basisOfRightAnnihilator  
basisOfRightNucleus  
basisOfRightNucloid  
bat  
bat1  
beauzamyBound  
belong?  
bernoulli  
bernoulliB  
bessell  
besselJ  
besselK  
bessely  
Beta  
bezoutDiscriminant  
bezoutMatrix  
bezoutResultant  
bfEntry  
bfKeys  
binary  
binaryFunction  
binarySearchTree  
binaryTournament  
binaryTree  
binomial  
binomThmExpt  
bipolar  
bipolarCylindrical  
biRank  
birth  
bit?  
bitCoef  
bitLength  
bits



bitTruth  
bivariate?  
bivariatePolynomials  
bivariateSLPEBR  
blankSeparate  
block  
blue  
bombieriNorm  
bool  
bool?  
bottom!  
boundOfCauchy  
box  
brace  
bracket  
branchIfCan  
branchPoint?  
branchPointAtInfinity?  
bright  
brillhartIrreducible?  
brillhartTrials  
bringDown  
bsolve  
btwFact  
bubbleSort!  
build  
BumInSepFFE  
bumprow  
bumptab  
bumptab1  
BY  
c02aff  
c02agf  
c05adf  
c05nbf  
c05pbf  
c06eaf  
c06ebf  
c06ecf  
c06ekf  
c06fpf  
c06fqf  
c06frf  
c06fuf  
c06gbf  
c06gcf  
c06ggf  
c06gsf  
cache  
cAcos  
cAcosh  
cAcot  
cAcoth  
cAcsc

cAcsch  
calcRanges  
call  
cap  
car  
cardinality  
cartesian  
cAsec  
cAsech  
cAsin  
cAsinh  
cAtan  
cAtanh  
cCos  
cCosh  
cCot  
cCoth  
cCsc  
cCsch  
cdr  
ceiling  
center  
central?  
certainlySubVariety?  
cExp  
cfirst  
chainSubResultants  
changeBase  
changeMeasure  
changeName  
changeNameToObjf  
changeThreshold  
changeVar  
changeWeightLevel  
char  
character?  
characteristic  
characteristicPolynomial  
characteristicSerie  
characteristicSet  
charClass  
charpol  
charthRoot  
chebyshevT  
chebyshevU  
check  
checkCxResult  
checkForZero  
checkMxCDF  
checkMxDF  
checkPrecision  
checkResult  
checkRur  
child

child?  
children  
chineseRemainder  
chiSquare  
chiSquare1  
choosemon  
chvar  
Ci  
className  
clearCache  
clearDenominator  
clearFortranOutputStack  
clearTable!  
clearTheFTable  
clearTheIFTable  
clearTheSymbolTable  
clikeUniv  
clip  
clipBoolean  
clipParametric  
clipPointsDefault  
clipSurface  
clipWithRanges  
cLog  
close  
close!  
closeComponent  
closed?  
closedCurve  
closedCurve?  
cn  
code  
coef  
coefChoose  
coefficient  
coefficients  
coerce  
coerceImages  
coerceListOfPairs  
coerceP  
coercePreimagesImages  
coHeight  
coleman  
collect  
collectQuasiMonic  
collectUnder  
collectUpper  
color  
colorDef  
colorFunction  
column  
combineFeatureCompatibility  
commaSeparate  
comment

common  
commonDenominator  
commutative?  
commutativeEquality  
commutator  
comp  
compactFraction  
companionBlocks  
comparison  
compBound  
compdegd  
compile  
compiledFunction  
complement  
complementaryBasis  
complete  
completeEchelonBasis  
completeEval  
completeHensel  
completeHermite  
completeSmith  
complex  
complex?  
complexEigenvalues  
complexEigenvectors  
complexElementary  
complexExpand  
complexForm  
complexIntegrate  
complexLimit  
complexNormalize  
complexNumeric  
complexNumericIfCan  
complexRoots  
complexSolve  
complexZeros  
component  
components  
compose  
composite  
composites  
computeBasis  
computeCycleEntry  
computeCycleLength  
computeInt  
computePowers  
concat  
concat!  
cond  
condition  
conditionP  
conditions  
conditionsForIdempotents  
conical

conjHerm  
conjug  
conjugate  
conjugates  
connect  
connect?  
cons  
consnewpol  
const  
constant  
constant?  
constantCoefficientRicDE  
constantIfCan  
constantKernel  
constantLeft  
constantOperator  
constantOpIfCan  
constantRight  
constantToUnaryFunction  
constDsolve  
construct  
contains?  
content  
continue  
continuedFraction  
contract  
contractSolve  
controlPanel  
convergents  
convert  
coord  
coordinate  
coordinates  
copies  
copy  
copy!  
copyInto!  
corrPoly  
cos  
cos2sec  
cosh  
cosh2sech  
coshIfCan  
cosIfCan  
cosSinInfo  
cot  
cot2tan  
cot2trig  
coth  
coth2tanh  
coth2trigh  
cothIfCan  
cotIfCan  
count

countable?  
countRealRoots  
countRealRootsMultiple  
cPower  
cRationalPower  
create  
create3Space  
createGenericMatrix  
createIrreduciblePoly  
createLowComplexityNormalBasis  
createLowComplexityTable  
createMultiplicationMatrix  
createMultiplicationTable  
createNormalElement  
createNormalPoly  
createNormalPrimitivePoly  
createPrimitiveElement  
createPrimitiveNormalPoly  
createPrimitivePoly  
createRandomElement  
createThreeSpace  
createZechTable  
credPol  
crest  
critB  
critBonD  
critM  
critMonD1  
critMTonD1  
critpOrder  
critT  
cross  
crushedSet  
csc  
csc2sin  
csch  
csch2sinh  
cschIfCan  
cscIfCan  
cSec  
cSech  
cSin  
cSinh  
csubst  
cTan  
cTanh  
cubic  
cup  
currentSubProgram  
curry  
curryLeft  
curryRight  
curve  
curve?

curveColor  
curveColorPalette  
cycle  
cycleElt  
cycleEntry  
cycleLength  
cyclePartition  
cycleRagits  
cycles  
cycleSplit!  
cycleTail  
cyclic  
cyclic?  
cyclicCopy  
cyclicEntries  
cyclicEqual?  
cyclicGroup  
cyclicParents  
cyclicSubmodule  
cyclotomic  
cyclotomicDecomposition  
cyclotomicFactorization  
cylindrical  
D  
d01ajf  
d01akf  
d01alf  
d01amf  
d01anf  
d01apf  
d01aqf  
d01asf  
d01bbf  
d01fcf  
d01gaf  
d01gbf  
d02bbf  
d02bhf  
d02cjf  
d02ejf  
d02gaf  
d02gbf  
d02kef  
d02raf  
d03edf  
d03eef  
d03faf  
dAndcExp  
dark  
datalist  
ddFact  
debug  
debug3D  
dec

decimal  
declare  
declare!  
decompose  
decomposeFunc  
decrease  
decreasePrecision  
deepCopy  
deepestInitial  
deepestTail  
deepExpand  
defineProperty  
definingEquations  
definingInequation  
definingPolynomial  
degree  
degreePartition  
degreeSubResultant  
degreeSubResultantEuclidean  
delay  
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# Chapter 11

## Research Topics

These are included here as ideas that may get expanded in more detail later.

### 11.1 Proofs

The goal would be to prove that Axiom's algorithms are correct.

For instance, show that the GCD algorithm is correct. This involves several levels of proof. At one level we need to prove that the GCD algorithm is mathematically correct and that it terminates. This can be picked up from the literature.

A second level of correctness involves proving that the implementation of the algorithm is correct. This involves using something like ACL2 [KMJ00] and proof of the common lisp implementation.

A third level is to show that the binary implementation conforms to the semantics of the common lisp implementation. This involves using something like Function Extraction (FX) [LMW79] to extract the machine-level behavior of the program and comparing it to the specification.

### 11.2 Indefinites

There are times when it would be convenient to write algorithms in terms of indefinite values. For instance, we would like to be able to declare that X and Y are matrices and compute X\*Y symbolically. We would like to be able to do the same with arbitrary integers, I and J. In general, for a given domain we would like to create domain elements that are not fully specified but have the computation proceed with these "indefinite" values.

### 11.3 Provisos

We would like to create "provisos" on statements such as:

$$\frac{1}{x} \text{ provided } x \neq 0$$

We would then like to rewrite this in terms of intervals to create three “continuations” where each continuation is a separate domain of computation (and could thus be computed in parallel). So for the above example we would generate:

$$\frac{1}{x} \text{ such that } x \in [-\infty, 0)$$

$$\frac{1}{x} \text{ such that } x \in (0, 0)$$

$$\frac{1}{x} \text{ such that } x \in (0, \infty]$$

When a new proviso is added, for instance, when we divide by  $y$  then there would be further subdivision of the computation, forming a tree:

$$\frac{1}{xy} \text{ such that } x \in [-\infty, 0) \text{ and } y \in [-\infty, 0)$$

$$\frac{1}{xy} \text{ such that } x \in (0, 0) \text{ and } y \in [-\infty, 0)$$

$$\frac{1}{xy} \text{ such that } x \in (0, \infty] \text{ and } y \in [-\infty, 0)$$

$$\frac{1}{xy} \text{ such that } x \in [-\infty, 0) \text{ and } y \in (0, 0)$$

$$\frac{1}{xy} \text{ such that } x \in (0, 0) \text{ and } y \in (0, 0)$$

$$\frac{1}{xy} \text{ such that } x \in (0, \infty] \text{ and } y \in (0, 0)$$

$$\frac{1}{xy} \text{ such that } x \in [-\infty, 0) \text{ and } y \in (0, \infty]$$

$$\frac{1}{xy} \text{ such that } x \in (0, 0) \text{ and } y \in (0, \infty]$$

$$\frac{1}{xy} \text{ such that } x \in (0, \infty] \text{ and } y \in (0, \infty]$$

Interesting questions arise, such as how to recover the function over the real line. Of course, the domain and range are not restricted to the real line in general but could, for instance, range over the complex plane.

Note that the provisos need not be an interval. They could be anything such as a polynomial or a property like “ $f(x)$  is entire”.

# Chapter 12

## Makefile

```
— * —

BOOK=${SPD}/books/bookvol6.pamphlet

# this is where to put the various commands
OUT= ${MNT}/${SYS}/bin
OUTLIB= ${MNT}/${SYS}/lib

# this is where we hid the libspad library
LIB= ${OBJ}/${SYS}/lib

# this is where the documentation ends up
LDFFLAGS= -L${LIB} -lspad ${LDF}

all: announce ${OUTLIB}/session ${OUTLIB}/spadclient ${OUT}/sman \
      ${OUT}/axiom finish

announce:
@ echo =====
@ echo Making sman, session, spadclient, axiom bookvol6
@ echo =====

finish:
@ echo =====
@ echo Finished sman, session, spadclient, axiom bookvol6
@ echo =====

${OUTLIB}/session: ${LIB}/libspad.a
@ echo 1 making ${OUTLIB}/session from ${BOOK}
@ (cd ${LIB} ; \
    ${BOOKS}/tanglec ${BOOK} session.c >session.c ; \
    ${CC} ${CCF} -o ${OUTLIB}/session session.c libspad.a )

${OUTLIB}/spadclient: ${LIB}/libspad.a
@ echo 2 making ${OUTLIB}/spadclient from ${BOOK}
@ (cd ${LIB} ; \
```

```
    ${BOOKS}/tanglec ${BOOK} spadclient.c >spadclient.c ; \  
    ${CC} ${CCF} -o ${OUTLIB}/spadclient spadclient.c libspad.a )  
  
${OUT}/axiom: ${BOOK}  
@ echo 3 making ${OUT}/axiom from ${BOOK}  
@ (cd ${OUT} ; ${BOOKS}/tanglec ${BOOK} axiomcmd >axiom )  
@ chmod +x ${OUT}/axiom  
  
${OUT}/sman: ${LIB}/libspad.a  
@ echo 4 making ${OUT}/sman from ${BOOK}  
@ (cd ${LIB} ; \  
    ${BOOKS}/tanglec ${BOOK} sman.c >sman.c ; \  
    ${CC} ${CCF} -o ${OUT}/sman sman.c libspad.a )
```

---

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