

Introduction How to Use the Computer Clusters Within the Department of Mathematics and Informatics

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C o m p u t e r I n t r o d u c t i o n

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1 Introduction

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1.1 Cluster Overview

cluster name	room	number of machines	machine names	processor	RAM	OS
CIP	G.14.11	22	l01, ..., l05, l07, ..., l23	Intel Core2 Quad, 3 GHz ¹ ; Intel Core i7, 2.8 GHz ²	8 GB	openSUSE Leap 15.6
IT	G.16.15	15	l101, ..., l115	Intel Core i7, 3.6 GHz	16 GB	openSUSE Leap 15.6

All machines belong to the domain **studs.math.uni-wuppertal.de**—i. e. the complete name to access one of the machines from outside is e. g. **l111.studs.math.uni-wuppertal.de**.

¹l08, ..., l14

²l01, ..., l05, l07, l15, ..., l23

1.2 Contact Persons

name	room	phone	email
Dr. Peter Feuerstein	G.14.18	2818	fpf@math.uni-wuppertal.de
Dr. Martin Galgon	G.14.05	3777	galgon@math.uni-wuppertal.de
Dr. Holger Arndt	G.14.16	2033	arndt@math.uni-wuppertal.de

In case of problems, you can always send an email to **root@math.uni-wuppertal.de**.

1.3 Accounts

- You can log in using your ZIM account—i. e. username = matriculation number plus ZIM password.
- To enable your account, you have to log in at one of the machines inside the computer rooms—not from remote.
- Afterwards logging in is also possible remotely via ssh, cf. Section 3.2.
- prerequisite: attending this course (or attending the German equivalent or carefully reading these slides on your own)

1.4 Getting Access to the Rooms

- The doors have a locking system.
- For courses (e. g. exercises), the lecturer will open the door and let you in.
- Besides that remote access from private or other machines is available at any time.
- If you really need physical access (e. g. because you have no private computer to log in from), you can apply for a card for the locking system.
 - Cards are handed out by Peter Feuerstein in his office.
 - You will have to pay a deposit of 10€.
 - If possible, fill out the application form at <https://www-app.math.uni-wuppertal.de/CIPITPI/>, print the pdf file, and bring it with you.

- translation table for the online form:

German	English
Vor- und Nachname	given name and family name
Straße und Hausnummer	street and number
PLZ Ort	postal code (zip code) and town
Matrikelnummer	matriculation number
Studiengang	course of studies
PDF-Datei erstellen	create pdf file

1.5 Dos and Don'ts

- Never switch off the computers!
- Keep your password secret. You are responsible for all actions from within your account.
- Read your emails regularly (to receive news from the administration).
- Don't fill paper into the printers by yourself, especially no recycled paper or paper already printed on.
- Remove pending print jobs when you leave.
- Respect the "Netiquette" (cf. <https://datatracker.ietf.org/doc/html/rfc1855>).
- Leave adjustments of the air conditioning to our staff. Keep doors and windows shut if air conditioning is active.
- If you are the last to leave the room, close the door and windows and switch off the light.
- Don't switch on the heating.
- Don't eat or drink anything in the computer rooms.
- Don't plug your private computers (notebooks) into our network sockets.

1.5.1 Reasonable Usage of Resources

- Long running computing jobs should only be started after consulting one of the contact persons (see [1.2](#)).
- Don't print more than necessary. Printing of private data, scripts, and online handbooks is generally forbidden. Consult one of the contact persons for needed larger prints.
- Don't waste hard disk space, clean up your home directory from time to time.
- Don't use more than one computer at a time.
- Lock the screen only if you leave the room for a few minutes, otherwise log out.

1.5.2 Even If You Could ...

- Don't observe what passwords other users enter.
- Don't read other users' files even if they forgot to prevent you from.
- If some user is logged in but not present in the room, log him/her out (maybe send an email-reminder to the user).

2 Some Basics about Linux

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Linux is a:

- **multi-user** operating system

It can be used by multiple users, all having their own password and directory for personal files.

Several users can work on the same machine at the same time.

- **multi-tasking** operating system

Multiple programs can be run in parallel (by one or more users).

2.1 Users

Each user

- has a unique **user name** (in our case the matriculation number or ZIM name),
- a **user ID**,
- belongs to (at least) one **user group**,
- has his/her own **password**, which must be kept secret,
- has his/her own **home directory** inside the file system to store personal files.

2.1.1 Path to the Home Directories on Our Clusters

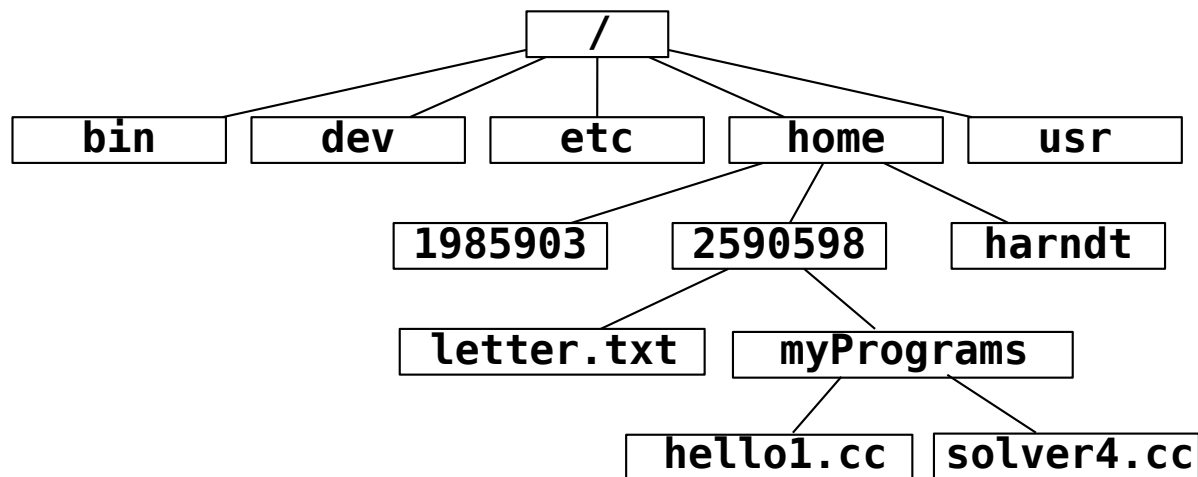
/home/username (shared for CIP and IT)

The home directories have a snapshot mechanism. Backups of older revisions of your files or deleted files are located in **/home/.snapshot**.

2.2 File System

The file system

- has a tree structure,
- consists of **directories** (folders) and **files**.
- The top directory is called **root**-directory, its name is `/`.
- There are no drive letters, instead subtrees might be physically located on different partitions or even different servers.
- Each file is owned by a user and a group.



2.2.1 File Permissions

For each file and directory there are three sets of **permissions**:

u	user	the owner of the file/directory
g	group	all users belonging to the group owning the file
o	other	all other users

example:

output of the command `ls -l`:

The diagram illustrates the output of the `ls -l` command with the following fields and their meanings:

- Permissions:** The first ten characters of the first column are grouped into three sets:
 - The first character (e.g., 'd') indicates if it's a directory.
 - The next three characters (e.g., 'rw-r--r--') represent permissions for the owner.
 - The next three characters (e.g., 'r--r--') represent permissions for users of the owning group.
 - The last three characters (e.g., '--r--') represent permissions for other users.
- File Size:** The number in the fourth column (e.g., 643, 4096, 19888, 827).
- Date/Time:** The date and time in the fifth and sixth columns (e.g., Sep 7 12:31).
- File Name:** The name of the file or directory in the seventh column (e.g., output.txt, pictures, primes1, primes1.cc).
- Owning User and Group:** The user and group names in the second and third columns (e.g., harndt, ldapusers).

meaning of the permission letters:

		for files:	for directories:
r	read	read the file (its content)	read the directory (file listing)
w	write	modify the file	make changes in the directory (create/rename/delete files)
x	execute	execute file as program	change into the directory

2.3 Processes

Each running program is managed as a **process**.

For each process the following information (among others) is available:

UID	user ID of the user who started and owns the process
PID	process ID
PPID	parent process ID
CMD	command by which the process was started

example:

partial output of the command `ps -ef`:

```
UID      PID  PPID  C  STIME TTY          TIME CMD
root          1    0  0  Sep05 ?          00:00:19 /usr/lib/systemd/systemd showopt
root          2    0  0  Sep05 ?          00:00:00 [kthreadd]
...
root      9684  1545  0  12:20 ?          00:00:00 sshd: harndt [priv]
harndt    9686  9684  0  12:20 ?          00:00:01 sshd: harndt@pts/1
harndt    9687  9686  0  12:20 pts/1     00:00:00 -bash
...
harndt   12848  9687  37  13:41 pts/1     00:00:01 /usr/bin/emacs
...
harndt   12889  9687  0  13:41 pts/1     00:00:00 ps -ef
...
```

3 Login

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To log in on one of the computers, you have to enter your user name and your password.

Normally this is done via a graphical dialog window.

3.1 Switching to a Text Console

You can also switch to a text console via *Strg-Alt-F1*, *Strg-Alt-F3*, ..., *Strg-Alt-F6*.

switching back to graphics mode: *Alt-F2*

3.2 Remote Login

You can log in from other computers via the network using an SSH (secure shell) connection:

```
ssh username@hostname
```

Please do not always choose the machine having the first number like **101** or **1101**!

For an SSH login from outside of the university's network you have to setup a VPN connection. For instructions (at the moment only in German) see

<https://zim.uni-wuppertal.de/de/unsere-dienste/netzzugang/vpn-aussenzugang/>
or (instructions in English after logging in) <https://vpn.uni-wuppertal.de/>.

Instead of Cisco AnyConnect you could also use OpenConnect VPN for Windows:

<https://gui.openconnect-vpn.net/>

Under Linux, OpenConnect is available as a plugin for NetworkManager.

Use **vpn.uni-wuppertal.de** as server for OpenConnect under both systems.

3.3 Logout

Commands for leaving a command line / remote login:

exit, *logout*, or *Strg-D (Ctrl-D)*

Graphical desktop environments like KDE have a logout button in their main menu or desktop menu.

3.4 Some Useful Software to Work Remotely from Windows

- PuTTY: login via SSH (text mode only), <https://www.putty.org/>
- WinSCP: copy files to/from remote via graphical scp, <https://winscp.net/eng/index.php>
- Bitvise SSH Client: SSH login and file transfer, <https://bitvise.com/ssh-client-download>
- SmarTTY: SSH connection, includes scp and X server for graphical applications, <https://sysprogs.com/SmarTTY/>

3.5 Changing Your Password

Use the webpage <https://zim.uni-wuppertal.de/en/my-account/account-activation/>

(also affects all other ZIM based services, e. g. StudiLöwe, Moodle, Webmail, ...)

4 Graphical Desktop Environments

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default environment on our clusters: KDE Plasma

alternatives: Gnome (maybe others)

4.1 Switching to an English Environment


If you get a German KDE Plasma desktop when you log in for the first time, follow these steps for switching to English:

1. Click on the menu in the lower left corner.
2. In menu **Einstellungen** choose **Systemeinstellungen**.
3. In area **Persönliche Informationen** choose **Regionaleinstellungen**.
4. In **Region & Sprache** click on button **Ändern . . .** next to **Sprache**.
5. Click on **Weitere hinzufügen . . .**
6. Click on **Hinzufügen**, choose e. g. **American English**, make sure that American English is the first or only entry in the list.
7. Click on the button **Anwenden**.
8. Close the window.
9. Log out:
 - a) Click on the menu in the lower left corner.
 - b) Click on the symbol < (**Verlassen**).
 - c) Choose **Abmelden**, then **OK**.
10. Log in again.

5 Shells (Working with the Command Line)

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Under KDE Plasma, a command line window (**konsole**) is started via the icon  or the entry **Konsole** in the main menu or in the menu **System**.

Under Linux systems, the command interpreter running inside is called **shell**.

A shell displays a command prompt, reads user commands, and executes these commands.

The default shell is the **Bash** (Bourne-Again-Shell).

How to Get English Messages in a Shell

1. Open the file `.bashrc` in your home directory with a text editor.
2. Append the lines:

```
export LANG=en_US.UTF-8
export LANGUAGE=en
```

3. Log out and in again.

5.1 How Commands are Found

Commands are

- either built-in commands of the shell
- or external programs inside a directory which is contained in the environment variable **\$PATH**.

example:

<code>test</code>	starts the built-in command doing nothing by default
<code>./test</code>	starts the program test from the current working directory (.) if it exists

5.2 Quoting

The **meta characters**

><; & () [] { } | \ \$? * ~ ' " ` !

have a special meaning and (sometimes) have to be **quoted** to be used as a normal character.

There are three different quoting mechanisms:

- `\`: Quote next character.
- `'...'`: Quote all included characters except `'` itself.
- `"..."`: Quote all included characters except `$`, `\`, ``` and `"` itself.

Via **command substitution** (``some command``) the result of a command can be used directly, e. g.

```
cat `find . -name "*.tex"`
```

5.2.1 Input/Output Redirection

<code>myprog < ifile</code>	redirecting standard input
<code>myprog > ofile</code>	redirecting standard output (overwrites ofile)
<code>myprog >> ofile</code>	redirecting standard output (append output at the end of ofile)
<code>myprog 2> efile</code>	redirecting standard error output
<code>myprog > ofile 2>&1</code>	redirecting standard and error output
<code>myprog &> ofile</code>	redirecting standard and error output (short form)

Pipes

<code>firstprog secondprog</code>	use output of firstprog as input for secondprog
-------------------------------------	---

e. g.: `ls -l | less` to show a long directory listing page by page

5.3 Background Processes

After entering a command, the shell waits until the program has finished.

For programs running in their own window (e. g. a text editor) this is inconvenient.

solution: Starting the program as a **background process** by appending **&**.

```
l115 ~/CompIntr/sampleDir > emacs primes1.cc &  
[1] 15334  
l115 ~/CompIntr/sampleDir > g++ -Wall primes1.cc -o primes1  
l115 ~/CompIntr/sampleDir >  
[1]+  Done                  emacs primes1.cc  
l115 ~/CompIntr/sampleDir >
```

6 Some Basic Linux Commands

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Although most of the following tasks can be handled by a file manager as well, working on a command line can be faster or even necessary (for remote logins).

6.1 Handling Files and Directories

6.1.1 Wildcards

File and directory names can be abbreviated by **wildcards**:

*	any character sequence (can also be empty)
?	one arbitrary character
~	the name of your home directory
.	the current working directory
..	the parent directory

6.1.2 Getting and Changing the Current Working Directory

<i>pwd</i>	print working directory
<i>cd /some/absolute/path</i>	change directory to a directory given by its complete path starting at root
<i>cd subdirectory</i>	change directory to a subdirectory
<i>cd</i>	change to home directory

6.1.3 Listing Directory Contents

<code>ls</code>	list current directory
<code>ls name(s)</code>	list specified files/directories
<code>ls -a ...</code>	show also hidden files (starting with a dot, e. g. .bashrc)
<code>ls -d ...</code>	with directories: show their names instead of content
<code>ls -F ...</code>	append / for directories, @ for links, * for executables
<code>ls -l ...</code>	long version, showing permissions, size, owner, group, date
<code>ls -R ...</code>	list all subdirectories recursively

Usually the options can be combined, e. g. `ls -alF`.

6.1.4 Copying, Moving, and Renaming

<code>cp file newname</code>	copy a file giving it a new name
<code>cp file(s) directory</code>	copy file(s) to a different directory
<code>cp -R directory otherdirectory</code>	recursively copy a whole directory to a different directory
<code>mv oldname newname</code>	rename a file or directory
<code>mv name(s) directory</code>	move files/directories to a different directory
<code>cp -i .../mv -i ...</code>	interactive, i. e. overwriting existing files has to be confirmed

6.1.5 Creating and Removing Directories and Files

<code>mkdir directory</code>	make (create) directory
<code>rmdir directory</code>	remove (an empty) directory
<code>rm file(s)</code>	remove files
<code>rm -i ...</code>	ask for confirmation before removing
<code>rm -r directory/ies</code>	remove complete directories (use with care!)
<code>touch file(s)</code>	create empty files

6.1.6 Links

A **(symbolic) link** is a pointer to an already existing file or directory.

<code>ln -s oldname newname</code>	create link under new name
<code>ln -s name directory</code>	create link in directory

example:

```
l115 ~/CompIntr/sampleDir2 > touch letter.txt
l115 ~/CompIntr/sampleDir2 > ln -s letter.txt sameletter.txt
l115 ~/CompIntr/sampleDir2 > mkdir ../sampleDir1
l115 ~/CompIntr/sampleDir2 > ln -s ../sampleDir1 .
l115 ~/CompIntr/sampleDir2 > ls -l
total 0
-rw-r--r-- 1 harndt ldapusers  0 Sep  7 13:54 letter.txt
lrwxrwxrwx 1 harndt ldapusers 10 Sep  7 13:54 sameletter.txt -> letter.txt
lrwxrwxrwx 1 harndt ldapusers 13 Sep  7 13:58 sampleDir1 -> ../sampleDir1
l115 ~/CompIntr/sampleDir2 > cd sampleDir1
l115 ~/CompIntr/sampleDir2/sampleDir1 >
```

6.1.7 Showing Text Files

<code>cat file(s)</code>	show the complete file(s) in the terminal
<code>more file(s), less file(s)</code>	show files page by page

commands within **more** and **less**:

space	next page
return	next line
b	one page back
:n	next file
/text	search for text
q	quit

6.1.8 Changing File Permissions

<code>chmod mode file(s)/directory/ies</code>	change file mode
---	------------------

format of the file mode (without spaces): *who operator rights [, ...]*

<i>who</i>		<i>operator</i>		<i>rights</i>	
u	user	+	grant right	r	read
g	group	-	withdraw right	w	write
o	others			x	execute
a	all				

example:

```
l115 ~/CompIntr/sampleDir > ls -l doit
-rw-r--r-- 1 harndt ldapusers 3 Sep  7 14:02 doit
l115 ~/CompIntr/sampleDir > chmod ug+x,o-r doit
l115 ~/CompIntr/sampleDir > ls -l doit
-rwxr-x--- 1 harndt ldapusers 3 Sep  7 14:02 doit
```

6.1.9 Disk Usage

<code>du</code>	disk usage of current directory
<code>du name(s)</code>	disk usage of specified files/directories
<code>du -s ...</code>	print only sum, not information of each subdirectory

6.2 Copying Files Over the Network Between Different Computers

<code>scp file(s) username@hostname:directory</code>	copy to remote host
<code>scp username@hostname:directory/files localdir</code>	copy from remote host

7 Where to Get Help

Manual Pages

<i>man name</i>	show manual page for a command or function
<i>whatis name</i>	show one-line description

Help Option of Commands

Many Linux commands have an option *--help*.

e. g.: *cp --help*

CIP help system (local information in German)

accessible with any browser at

<https://www.math.uni-wuppertal.de/de/information/it-dienste/dienste-fuer-studierende/cip-hilfesystem.html>

8 Common Problems

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8.1 Killing Processes

problem: How can you terminate a “hanging” program?

solution 1: If the program was started from a shell and not in the background, type *Strg-C*.

solution 2: Kill the process:

1. Find out the ID of the process with *ps -ef*.

You can restrict the output list to a certain process name with *ps -ef | grep procname*.

2. Terminate the process with *kill pid*.
3. If that didn't help, try *kill -9 pid*.

example 1: We assume the text editor **kwrite** is hanging:

```

l115 ~ > kwrite &
[1] 15522
l115 ~ > ps -ef
UID          PID  PPID  C  STIME TTY          TIME CMD
harndt      15522  9687  1  14:47 pts/1        00:00:00 kwrite
harndt      15531  9687  0  14:47 pts/1        00:00:00 ps -ef

l115 ~ > kill 15522
l115 ~ >
[1]+  Terminated                  kwrite

```

example 2: using **kill -9** now:

```

l115 ~ > kwrite &
[1] 27403
l115 ~ > ps -ef | grep kwrite
harndt      15544  9687  1  14:48 pts/1        00:00:00 kwrite
harndt      15556  9687  0  14:49 pts/1        00:00:00 grep --colour kwrite
l115 ~ > kill 15544
l115 ~ > ps -ef | grep kwrite
harndt      15544  9687  0  14:48 pts/1        00:00:00 kwrite
harndt      15558  9687  0  14:49 pts/1        00:00:00 grep --colour kwrite
l115 ~ > kill -9 15544
l115 ~ >
[1]+  Killed                          kwrite

```

solution 3: killing all processes with a certain name with **killall**

example: **killall kwrite** or **killall -9 kwrite**

8.2 Remote Kill

problem: The complete window system is blocked by some process.

solution 1: Change to a text console (cf. Section 3.1), log in, determine and kill the hanging process.

solution 2: If even the keys for switching to a text console don't work: Log in on some other computer, use **ssh** to log in on the hanging machine (cf. Section 3.2), proceed as above.

solution 3: If killing a certain process does not help, try killing the complete window manager.

- For KDE Plasma the window manager is called **kwin_x11**.
- Try pressing **Strg-Alt-Backspace** twice on the hanging machine itself.

8.3 If Nothing Else Helps

- Don't hesitate to ask other students in the room.
- Ask one of the administrators (personally or by email).
- but: Never switch off or power-cycle the computers yourself!

9 Printing

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In both rooms there is a laser printer.

Remember: You should use our resources economically—including paper and toner.

printing restriction: at most 20 pages per 24 hours

9.1 What Can Be Printed?

The printers themselves can only handle postscript files (suffix **.ps**).

Most graphical programs have a print function that automatically generates the correct output format.

9.2 Printing from the Command Line

Printing Postscript Files

<code>lp file(s)</code>	print file(s)
<code>lpr file(s)</code>	print file(s)

Printing Text Files

<code>a2ps file(s)</code>	convert file(s) to postscript (including syntax highlighting) and print
---------------------------	---

9.3 Cancelling Print Jobs

To **cancel** an already submitted but queued print job,

1. find out the job ID using `lpq` or `lpstat`,
2. cancel the job with `lprm` or `cancel`.

example 1:

```
wmai20 .../ModProg/CompIntr > lpr CompIntr.ps
wmai20 .../ModProg/CompIntr > lpq
wmailj03 is ready and printing
Rank   Owner   Job     File(s)                Total Size
active holger  830     CompIntr.ps           2084864 bytes
wmai20 .../ModProg/CompIntr > lprm 830
wmai20 .../ModProg/CompIntr > lpq
wmailj03 is ready
no entries
```

example 2:

```
wmai20 .../ModProg/CompIntr > lp CompIntr.ps
request id is wmailj03-831 (1 file(s))
wmai20 .../ModProg/CompIntr > lpstat
wmailj03-831      holger      2084864    Mi 02 Okt 2013 11:07:03 CEST
wmai20 .../ModProg/CompIntr > cancel 831
wmai20 .../ModProg/CompIntr > lpstat
```

If printing has already started,

1. switch the printer offline by pressing the button “Start”,
2. cancel the job as explained above,
3. press the cancel button (“Job abbrechen”) on the printer.

9.4 In Case of Problems

possible problems: out of paper, paper jam

solution: consult one of the administrators

another problem: wrong paper format (i. e. US-Letter)

solution: remove the print job; choose A4 in the print dialog if possible

important: Remove pending print jobs before you leave the room.

10 Email

Programs for Reading and Writing Email

- **thunderbird**
- **seamonkey**
- **kmail** (especially for KDE users)
- **evolution** (especially for Gnome users)
- any web browser using the web frontend <https://webmail.uni-wuppertal.de/S0Go/>

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