UT Southwestern Medical Center
Lyda Hill Department of Bioinformatics

BioHPC

Basics of Linux II

The Linux Command Line Interface

19 Jan 2022

Some examples about the target knowledge

- for i in $(seq -f "%02g" 1 40); do ii=$(echo "43.00+($i-1)*0.5" | bc -l) ; cp -r sampletest test-$i; sed -i 's/#2#/'$ii'/g' test-$i/check; sed -i 's/#2#/'$ii'/g' test-$i/killer; sed -i 's/#1#/'$i'/g' test-$i/check; sed -i 's/#1#/'$i'/g' test-$i/job-submit; done;

- cd /home2; for user in *; do quota 2>&1 -wp -u $user | awk -v user=$user '{if(NR == 3) {print $6,user}}' ; done | sort -n -r > ~/home2-number-of-files.txt

- for i in $(seq 70 77); do if ! ping -c1 10.100.163.$i 1>/dev/null ; then echo "NucleusC$i IB is NOT OK"; fi; done

- for i in $(seq -w 010 195); do ssh Nucleus$i 'hname=`/bin/hostname`; core=`lscpu | grep ^CPU\(| cut -f2- -d" "`; ht=`lscpu | grep ^Thread| cut -f4- -d" "`; mem=`free -g |grep ^Mem | cut -f2- -d" "`; echo $hname $mem $core $ht'; done > node-information.txt

- awk '{print $4/3600, $15}' 2020_01_15_1901.log | grep -v "e-05" | sort -n -r | head -10 | sed 's/\/home2\///g' | gnuplot -p -e 'set terminal png size 1200,800; set output "~/home2-backup-time.png"; set boxwidth 0.5; set style fill solid; plot "/dev/stdin" using 1:xtic(2) with boxes'

Shell commands and tools:

- bash scripting
  - Commands
  - Outputs
  - errors
  - forwarding
  - numerical operations
  - loops
  - conditional tools
- Shell tools
  - grep
  - sed
  - awk
  - gnuplot

Forwarding, Arrays, Numerical operations

```
python hello.py > output.txt    # stdout to (file)
python hello.py >> output.txt   # stdout to (file), append
python hello.py 2> error.log    # stderr to (file)
python hello.py 2>&1            # stderr to stdout
python hello.py 2>/dev/null     # stderr to (null)
python hello.py &>/dev/null     # stdout and stderr to (null)

python hello.py < foo.txt
```

```
Fruits=('Apple' 'Banana' 'Orange')

Fruits[0]="Apple"
Fruits[1]="Banana"
Fruits[2]="Orange"

echo ${Fruits[0]}           # Element #0
echo ${Fruits[@]}           # All elements, space-separated
echo ${#Fruits[@]}          # Number of elements
echo ${#Fruits}             # String length of the 1st element
echo ${#Fruits[3]}          # String length of the Nth element
echo ${Fruits[@]:3:2}       # Range (from position 3, length 2)
```

```
a=20
var1=$((a + 200))
echo $var1                  220

echo $(( 20 / 5 ))          4
echo $(( 20 * 5 ))          100
echo $(( 20 % 3 ))          2

x=5
echo $(( x++ ))             5
echo $(( x++ ))             6
echo $(( x-- ))             7
echo $(( x-- ))             6

x=2
y=3
echo $(( x ** y ))          8
```

Loops

Basic for loop

```
for i in /etc/rc.*; do
  echo $i
done
```

Ranges

```
for i in {1..5}; do
    echo "Welcome $i"
done

With step size

for i in {5..50..5}; do
    echo "Welcome $i"
done
```

Reading lines

```
cat file.txt | while read line; do
  echo $line
done
```

Forever

```
while true; do
  ...
done
```

```
for i in $(seq -w 001 081); do echo "Nucleus$i"; done
```

Conditional Tools

```
Conditions

[ -z STRING ]           Empty string
[ -n STRING ]           Not empty string
[ NUM -eq NUM ]         Equal
[ NUM -ne NUM ]         Not equal
[ NUM -lt NUM ]         Less than
[ NUM -le NUM ]         Less than or equal
[ NUM -gt NUM ]         Greater than
[ NUM -ge NUM ]         Greater than or equal
[[ STRING =~ STRING ]]  Regexp
(( NUM < NUM ))         Numeric conditions
[ -o noclobber ]        If OPTIONNAME is enabled
[ ! EXPR ]              Not
[ X ] && [ Y ]          And
[ X ] || [ Y ]          Or
```

```
File conditions

[ -e FILE ]             Exists
[ -r FILE ]             Readable
[ -h FILE ]             Symlink
[ -d FILE ]             Directory
[ -w FILE ]             Writable
[ -s FILE ]             Size is > 0 bytes
[ -f FILE ]             File
[ -x FILE ]             Executable
[ FILE1 -nt FILE2 ]     1 is more recent than 2
[ FILE1 -ot FILE2 ]     2 is more recent than 1
[ FILE1 -ef FILE2 ]     Same files
```

```
#!/bin/bash
if [ -r $1 ]; then
    content=$(cat $1)
elif [ -f $1 ]; then
    echo "$1 not readable"
else
    echo "$1 doesn't exist"
fi
```

```
Example

# String
if [ -z "$string" ]; then
  echo "String is empty"
elif [ -n "$string" ]; then
  echo "String is not empty"
fi

# Combinations
if [ X ] && [ Y ]; then
  ...
fi

# Regex
if [[ "A" =~ "." ]]

if (( $a < $b ))

if [ -e "file.txt" ]; then
  echo "file exists"
fi
```

Sed

Sed is a stream editor.

```
unix is great os. unix is opensource. unix is free os.
learn operating system. u
learn operating system. un
learn operating system. uni
learn operating system. unix
unix linux which one you choose.
unix is easy to learn.unix is a multiuser os.Learn unix .unix is a powerful.
```

- Syntax:
- sed OPTIONS... [SCRIPT] [INPUTFILE...]

- sed 's/unix/linux/' geekfile.txt # change first occurrence
- sed 's/unix/linux/2' geekfile.txt # change second occurrence
- sed 's/unix/linux/g' geekfile.txt # change all occurrence
- sed '3 s/unix/linux/' geekfile.txt # for line 3
- sed 's/unix/linux/p' geekfile.txt # Duplicating the replaced line
- sed -n 's/unix/linux/p' geekfile.txt # Printing only the replaced lines
- sed '1,3 s/unix/linux/' geekfile.txt # Replacing string on a range of lines
- sed '2,$ s/unix/linux/' geekfile.txt # 2 to end
- sed '5d' filename.txt # Deleting lines from file
- sed '$d' filename.txt # to delete last line
- sed '3,6d' filename.txt # delete 3-6 lines
- sed '/pattern/d' filename.txt # To Delete pattern matching line

- echo "Welcome To The Geek Stuff" | sed 's/\(\b[A-Z]\)/\(\1\)/g' # (W)elcome (T)o (T)he (G)eek (S)tuff

https://www.geeksforgeeks.org/sed-command-in-unix/

grep

- grep “linux” index.html # Search for a string
- grep -i “linux” index.html # Insensitive case search
- grep “linux” file*.* # Searching multiple files
- grep “fast.*host” index.html # Specifying the search string
- grep -n “word*” file.txt # Displaying the line numbers
- grep –color “linux” index.html # Highlighting the search
- grep -v linux /etc/passwd # Print the line excluding the pattern
- grep ^root /etc/passwd # lines that starts with specified pattern
- grep bash$ /etc/passwd # lines that ends with specified pattern
- grep -r linux /etc/ # Search the pattern recursively
- grep -c 'test' /home/example/test.txt # Counting the lines when words match

Awk

AWK is a programming language designed for text processing and typically used as a data extraction and reporting tool.

Basic Syntax : awk '/search_pattern/ { action_to_take_on_matches; another_action; }' file_to_parse

- awk '{print}' /etc/fstab
- awk '/UUID/' /etc/fstab
- awk '/^UUID/' /etc/fstab
- awk '/^UUID/ {print $1;}' /etc/fstab

- awk '/sa/' favorite_food.txt # print lines includes sa in anywhere
- awk '$2 ~ /^sa/' favorite_food.txt # print lines if its second column starts with sa
- awk '$2 !~ /^sa/' favorite_food.txt # print lines if its second column not starts with sa

- awk script files:

```
awk 'BEGIN { action; }
/search/ { action; }
END { action; }' input_file
```

- awk 'BEGIN { FS=":"; print "User\t\tUID\t\tGID\t\tHome\t\tShell\n--------------"; } {print $1,"\t\t",$3,"\t\t",$4,"\t\t",$6,"\t\t",$7;} END { print "---------\nFile Complete" }' /etc/passwd

```
# cat favorite_food.txt
1 carrot sandy
2 wasabi luke
3 sandwich brian
4 salad ryan
5 spaghetti jessica
```

1) https://www.digitalocean.com/community/tutorials/how-to-use-the-awk-language-to-manipulate-text-in-linux

```
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
proc /proc proc nodev,noexec,nosuid 0 0
# / was on /dev/vda1 during installation
UUID=b96601ba-7d51-4c5f-bfe2-63815708aabd / ext4
noatime,errors=remount-ro 0 1
```

Awk Built-in Variables – FS, OFS, RS, ORS, NR, NF, FILENAME, FNR

FS = input separator, use –F in command line
Syntax:
$ awk -F 'FS' 'commands' inputfilename
(or)
$ awk 'BEGIN{FS="FS";}'

OFS = input separator, use –F in command line
Syntax:
$ awk 'BEGIN{OFS=":";}'

RS = inpur Record separator (default line by line)
Syntax:
$ awk 'BEGIN{RS="\n\n";}'

NR = Line number at the time of processing
NF = Number of column at the line of processing
FNR = Line number for the current file
FILENAME = the name of the file being read

```
$ awk '{print FILENAME, FNR;}' student-marks bookdetails
student-marks 1
student-marks 2
student-marks 3
student-marks 4
student-marks 5
bookdetails 1
bookdetails 2
bookdetails 3
bookdetails 4
bookdetails 5
```

```
$cat student.txt
Jones
2143
78
84
77

Gondrol
2321
56
58
45

RinRao
2122
38
37
65

Edwin
2537
78
67
45

Dayan
2415
30
47
20
```

```
$ cat student.awk
BEGIN {
      RS="\n\n";
      FS="\n";
}
{
      print $1,$2;
}
```

```
$ awk -f student.awk student.txt > student.mark
Jones 2143
Gondrol 2321
RinRao 2122
Edwin 2537
Dayan 2415
```

```
$ awk 'BEGIN{FS="\n";RS="\n\n";ORS="=";} {print $1,$2;}' student.txt
Jones 2143=Gondrol 2321=RinRao 2122=Edwin 2537=Dayan 2415=
```

```
$ awk '{print FILENAME, NR, FNR;}' student.mark
student.txt
student.mark 1 1
student.mark 2 2
student.mark 3 3
student.mark 4 4
student.mark 5 5
student.txt 6 1
student.txt 7 2
student.txt 8 3
```

https://www.thegeekstuff.com/2010/01/8-powerful-awk-built-in-variables-fs-ofs-rs-ors-nr-nf-filename-fnr/

Example: script for awk

```
$ ls -l /usr/bin | head -7
total 436832
-rwxr-xr-x   1 root root      41544 Mar 15  2019 [
-rwxr-xr-x   1 root root     107904 Jan  7  2019 a2p
-rwxr-xr-x   1 root root      11336 Mar 20  2019 abrt-action-analyze-backtrace
-rwxr-xr-x   1 root root      11320 Mar 20  2019 abrt-action-analyze-c
-rwxr-xr-x   1 root root       1345 Mar 20  2019 abrt-action-analyze-ccpp-local
-rwxr-xr-x   1 root root       6821 Mar 20  2019 abrt-action-analyze-core
```

```
ls -l /usr/bin | awk '
   BEGIN {
      print "Directory Report"
      print "================"
   }
   NF > 9 {
      print $9, "is a symbolic link to", $NF
   }
   END {
      print "============="
      print "End Of Report"
   }'
```

```
Directory Report
================
apropos is a symbolic link to whatis
arecord is a symbolic link to aplay
atq is a symbolic link to at
...
ypdomainname is a symbolic link to hostname
zsoelim is a symbolic link to soelim
=============
End Of Report
```

```
$ ls -l /usr/bin | awk '{print $1}' | head -5
total
-rwxr-xr-x
-rwxr-xr-x
-rwxr-xr-x
-rwxr-xr-x
```

```
$ ls -l /usr/bin | awk '{print $9}' | head -5

[
a2p
abrt-action-analyze-backtrace
abrt-action-analyze-c
```

```
$ ls -l /usr/bin | awk 'NF > 9 {print $0}' | head -5
lrwxrwxrwx   1 root root         6 Feb 24  2020 apropos -> whatis
lrwxrwxrwx   1 root root         5 Feb 24  2020 arecord -> aplay
lrwxrwxrwx   1 root root         2 Feb 24  2020 atq -> at
lrwxrwxrwx   1 root root         2 Feb 24  2020 atrm -> at
lrwxrwxrwx   1 root root        11 Feb 24  2020 audit2why -> audit2allow
```

```
$ ls -l /usr/bin | awk 'BEGIN {OFS = ","} NF == 9 {print
$1,$2,$3,$4,$5,$6,$7,$8,$9}' | head -5
-rwxr-xr-x,1,root,root,41544,Mar,15,2019,[
-rwxr-xr-x,1,root,root,107904,Jan,7,2019,a2p
-rwxr-xr-x,1,root,root,11336,Mar,20,2019,abrt-action-analyze-backtrace
-rwxr-xr-x,1,root,root,11320,Mar,20,2019,abrt-action-analyze-c
-rwxr-xr-x,1,root,root,1345,Mar,20,2019,abrt-action-analyze-ccpp-local
```

```
$ ls -l /usr/bin | awk 'BEGIN {ORS = "\n\n"} {print}' | head -10
total 436832

-rwxr-xr-x   1 root root      41544 Mar 15  2019 [

-rwxr-xr-x   1 root root     107904 Jan  7  2019 a2p

-rwxr-xr-x   1 root root      11336 Mar 20  2019 abrt-action-analyze-backtrace

-rwxr-xr-x   1 root root      11320 Mar 20  2019 abrt-action-analyze-c
```

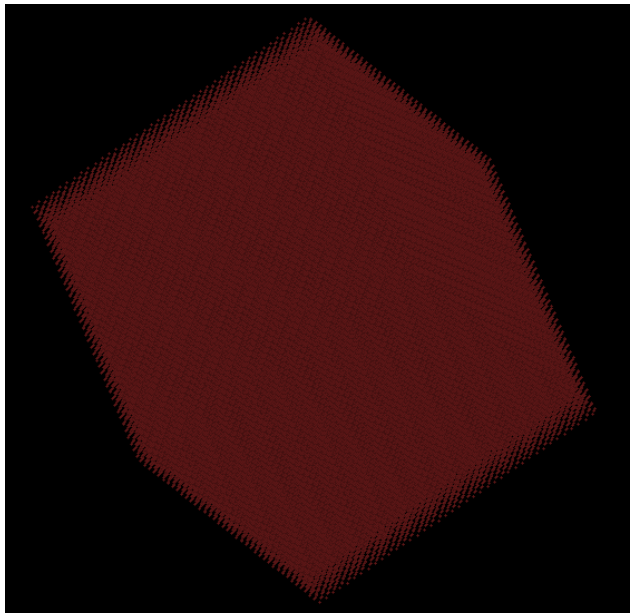
Example: script for awk

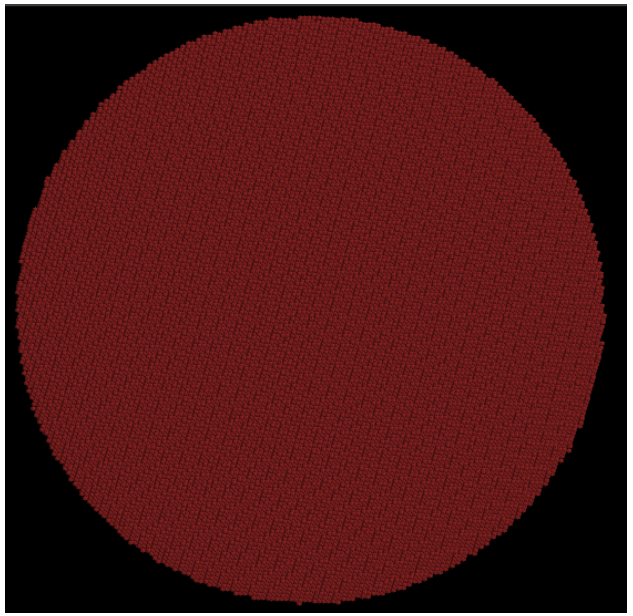
```
##!/bin/awk -f
awk '
BEGIN {
  while (getline > 0) {
  i++;
  el[i]=$1; x[i]=$2; y[i]=$3; z[i]=$4;
  if(NR == 1) {
    mx=$2; my=$3; mz=$4
    }
    if($2>mx) {mx=$2}
    if($2>my) {mx=$2}
    if($2>mz) {mx=$2}
    }
   str=i
}
END {
     for (i=1; i <= str; i++) {
     print el[i], x[i]+0.0, y[i]+26.0, z[i]+0.0
     print el[i], x[i]-0.0, y[i]-26.0, z[i]+0.0
     }
}'
```

```
# Check for file space on /tmp
space=`df | grep "/tmp" | awk '{ print $5+0.0; }'`
echo "Space on /tmp:" $space "%"
if test $space -ge 80
then
    echo "slurm script check: File space on tmp on node" `hostname`
    echo "is dangerously low. Aborting job."
    echo "Please ask an administrator to clean up /tmp on that node"
    echo `df | grep "/tmp"`
    exit
fi
```

Example: script for awk

```
    256000
Normal fcc (001) cell. Boxsize     144.8000    144.8000    144.8000
Cu   -72.399998      -72.399998      -72.399998                  1
Cu   -70.589998      -70.589998      -72.399998                  1
Cu   -70.589998      -72.399998      -70.589998                  1
Cu   -72.399998      -70.589998      -70.589998                  1
Cu   -72.399998      -72.399998      -68.779998                  1
Cu   -70.589998      -70.589998      -68.779998                  1
Cu   -70.589998      -72.399998      -66.969998                  1
Cu   -72.399998      -70.589998      -66.969998                  1
Cu   -72.399998      -72.399998      -65.159998                  1
Cu   -70.589998      -70.589998      -65.159998                  1
```

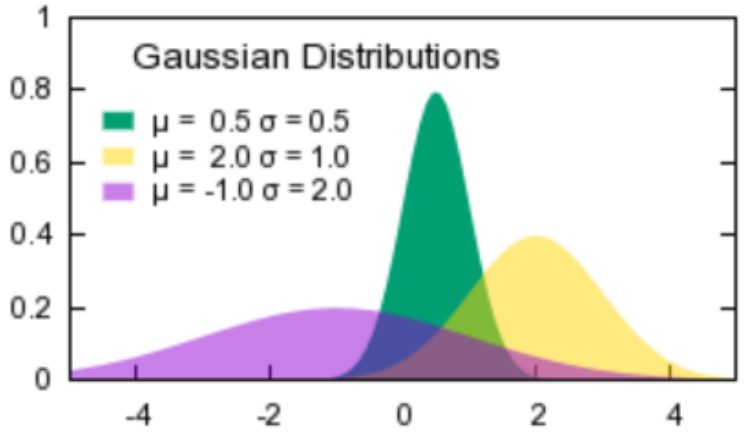




```
awk '
   BEGIN {rmax=70;
}
   {if(NR == 2) line=$0;
    if(NR > 2) {i++;
       if(NR == 3) {xmax=$2; ymax=$3; zmax=$4;
                    xmin=$2; ymin=$3; zmin=$4;}
       el[i]=$1; x[i]=$2; y[i]=$3; z[i]=$4;
       if(xmax < $2) xmax=$2;
       if(ymax < $3) ymax=$3;
       if(zmax < $4) zmax=$4;

       if(xmin > $2) xmin=$2;
       if(ymin > $3) ymin=$3;
       if(zmin > $4) zmin=$4;
    }
   str=i;

}
   END {
    xcenter=(xmax+xmin)/2;
    ycenter=(ymax+ymin)/2;
    zcenter=(zmax+zmin)/2;
    for(i=1; i<= str; i++) {
      x[i]=x[i]-xcenter;
      y[i]=y[i]-ycenter;
      z[i]=z[i]-zcenter;
      r=sqrt(x[i]*x[i] + y[i]*y[i] + z[i]*z[i]);
      if(r<rmax) {j++;}
      }
    natom=j; print natom; print line;
    for(i=1; i<= str; i++) {
             r=sqrt(x[i]*x[i] + y[i]*y[i] + z[i]*z[i]);
      if(r<rmax) {print   el[i],x[i],y[i],z[i]}
      }
}'
```



gnuplot

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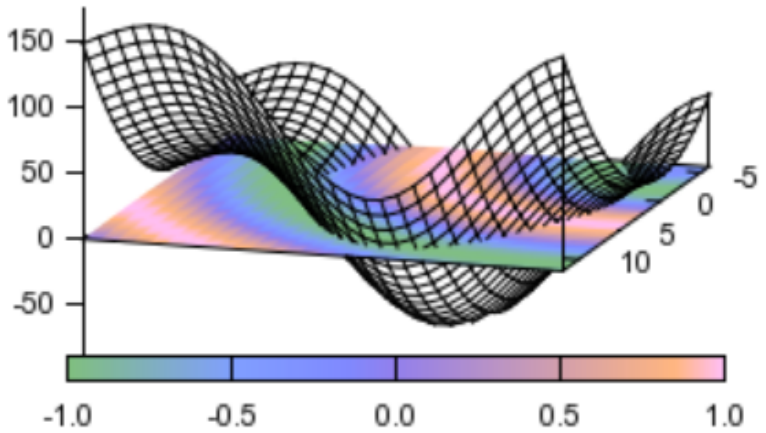


- **Gnuplot** is a portable command-line driven graphing utility for Linux, OS/2, MS Windows, OSX, VMS, and many other platforms.

Example1 script for gnuplot

```
set terminal postscript portrait
set output "d1_plot.ps"
set size .75,.75
set title "Energy vs. Time for Sample Data"
set xlabel "Time"
set ylabel "Energy"
plot "d1.dat" with lines
pause -1 "Hit any key to continue"
```

- d1.dat

```
1  10
2  20
3  30
4  25
5  40
```

Example2 script for gnuplot

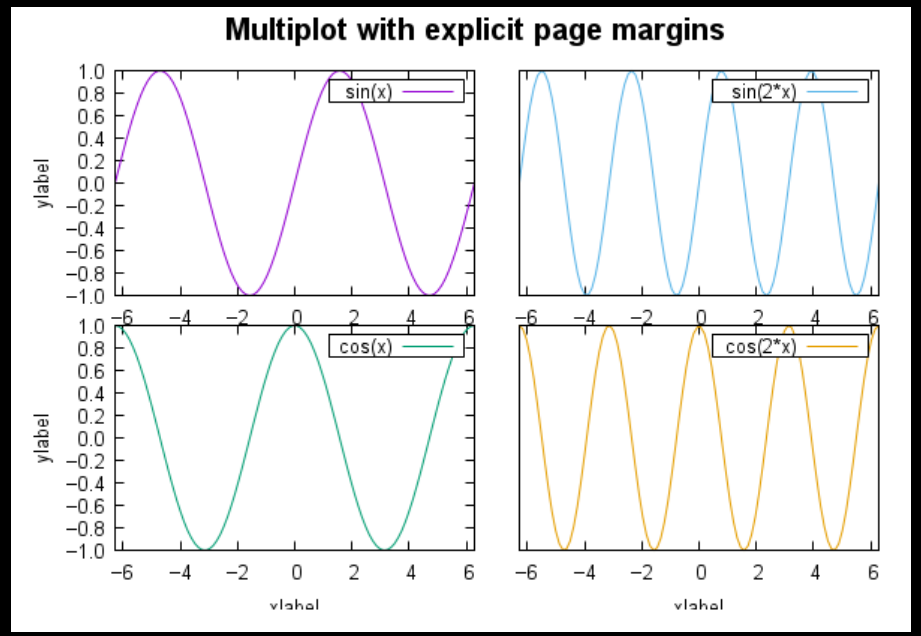
```
set term x11 enhanced font "terminal-14"
#set output "data_p.ps"
#set terminal postscript portrait
set size .75,.75
set grid
set title 'BP and Heartrate'
set yrange [50:160]
set xlabel 'time (military)'
set label 'finished walk' at 15, 140
unset label
set label 'finished walk' at 15, 105
plot 'bp-hr.dat' u 1:2 w lp t 'systolic', 'bp-hr.dat' u 1:3 w lp t 'diastolic', 'bp-hr.dat' u 1:4 w lp t 'heartrate'
pause -1 "Hit any key to continue"
replot
```

- 'bp-hr.dat

8.5	112	60	52
9	116	73	59
10.5	127	71	58
11	124	69	62
11.5	117	68	60
12	122	73	60
13	121	67	62
15	120	78	68
15.5	134	70	96
16	120	72	73
16.5	114	68	72
22	119	69	61

Example3 gnuplot multiplot

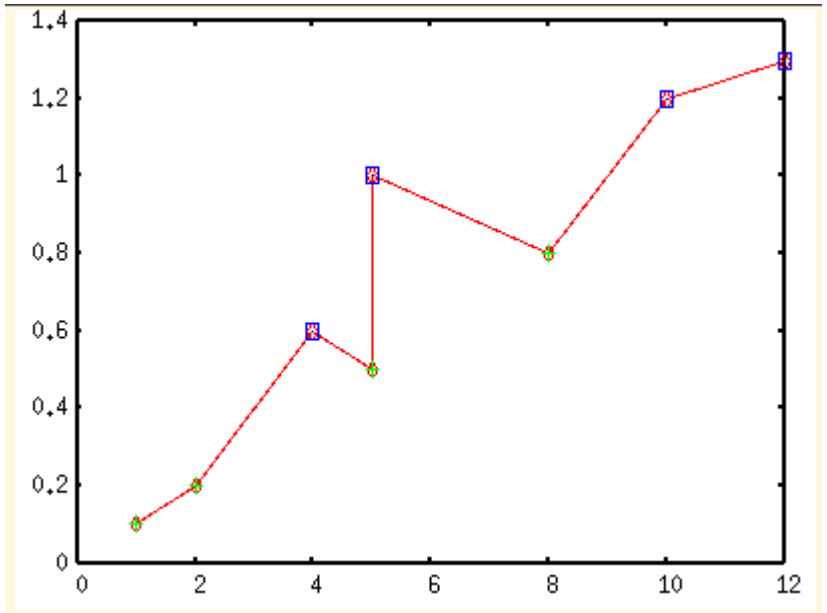
```
#
# Set overall margins for the combined set of plots and size them
# to generate a requested inter-plot spacing
#
if (!exists("MP_LEFT"))   MP_LEFT = .1
if (!exists("MP_RIGHT"))  MP_RIGHT = .95
if (!exists("MP_BOTTOM")) MP_BOTTOM = .1
if (!exists("MP_TOP"))    MP_TOP = .9
if (!exists("MP_GAP"))    MP_GAP = 0.05

set multiplot layout 2,2 columnsfirst title "{/:Bold=15 Multiplot with explicit page margins}"
              margins screen MP_LEFT, MP_RIGHT, MP_BOTTOM, MP_TOP spacing screen MP_GAP

set format y "%.1f"
set key box opaque
set ylabel 'ylabel'
set xrange [-2*pi:2*pi]

plot sin(x) lt 1
set xlabel 'xlabel'
plot cos(x) lt 2

unset ylabel
unset ytics

unset xlabel
plot sin(2*x) lt 3
set xlabel 'xlabel'
plot cos(2*x) lt 4
unset multiplot
```



Example gnuplot & bash

file1.dat		file2.dat	
1.0	0.1	4.0	0.6
2.0	0.2	5.0	1.0
5.0	0.5	10.0	1.2
8.0	0.8	12.0	1.3

```
gnuplot> plot "< cat -n file1.dat file2.dat" using 1:2  w l,\
>             "file1.dat" u 1:2 w p,\
>             "file2.dat" u 1:2 w p
```




```
gnuplot> plot  "<awk '{print $1,($1<=3 && $1>=1) ? $2*5 : $2}' file1.dat" with lines
```

Regression with gnuplot

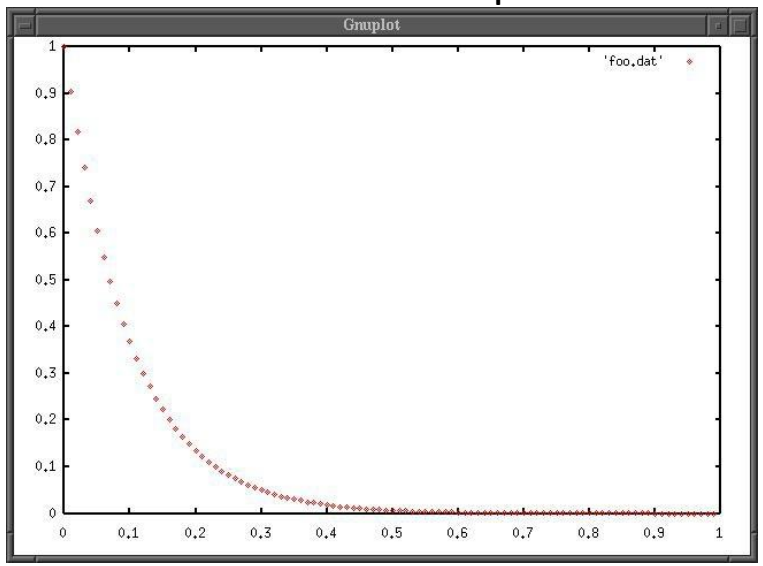
- foo.dat

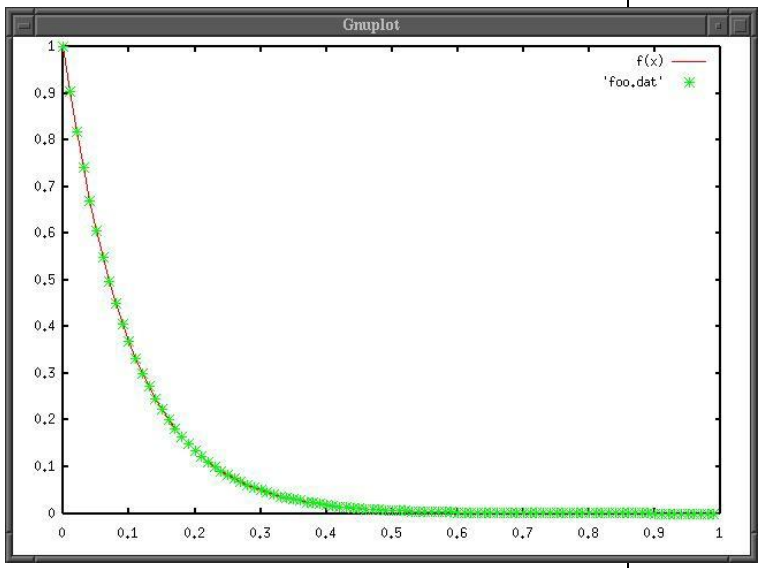
```
0.00000 1.00000
0.0100000 0.904837
0.0200000 0.818731
0.0300000 0.740818
0.0400000 0.670320
0.0500000 0.606531
0.0600000 0.548812
0.0700000 0.496585
0.0800000 0.449329
0.0900000 0.406570
0.100000 0.367879
0.110000 0.332871
0.120000 0.301194
0.130000 0.272532
0.140000 0.246597
```

- gnuplot> plot 'foo.dat'
- gnuplot> f(x) = a * exp (-x*b)
- gnuplot> fit f(x) 'foo.dat' via a,b
- gnuplot> plot f(x), 'foo.dat'

- gnuplot> set term post eps
- Options are 'eps noenhanced monochrome dashed defaultplex "Helvetica" 14'
- gnuplot> set output 'foo.eps'
- gnuplot> plot f(x), 'foo.dat'

- # reset to default
- gnuplot> set term x11
- gnuplot> set output



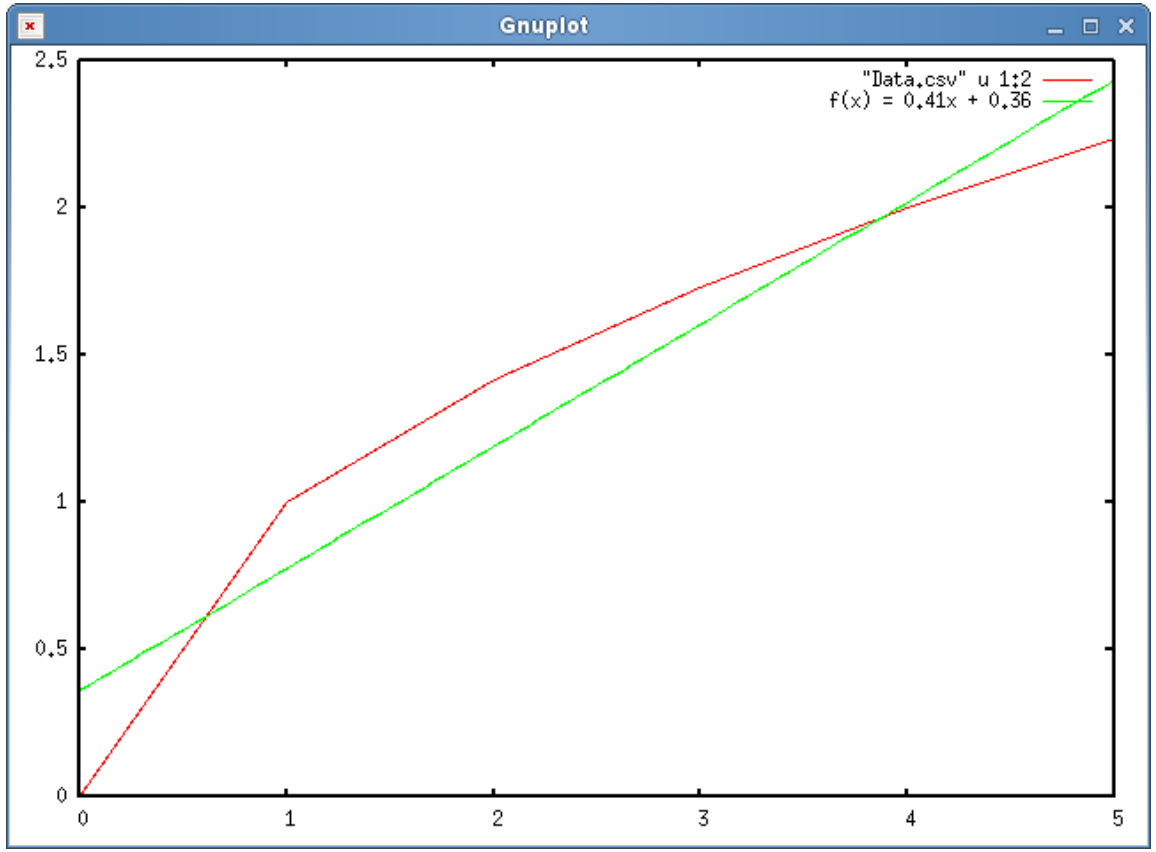


Regression with gnuplot 2

```
f(x) = a*x + b
fit f(x) 'Data.csv' u 1:2 via a, b
title_f(a,b) = sprintf('f(x) = %.2fx + %.2f', a, b)
plot "Data.csv" u 1:2 w l, f(x) t title_f(a,b)
```

- foo.dat

```
0 0.00000
1 1.00000
2 1.41421
3 1.73205
4 2.00000
5 2.23607
```



Thanks !