

Advanced (Batch) Job Scripting

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How to read the following slides

| Abbreviation/Colour code | Full meaning |
|---|--|
| <code>\$ command -opt value</code> | <code>\$</code> = prompt of the interactive shell The full prompt may look like: <code>user@machine:path \$</code> The command has been entered in the interactive shell session |
| <code><integer></code> <code><string></code> | <code><></code> = Placeholder for integer, string etc |
| <code>foo, bar</code> | Metasyntactic variables |
| <code>\${WORKSHOP}</code> | <code>@uc2:/opt/bwhpc/common/workshops/2023-03-30</code> <code>@hk:/software/all/workshops/2023-03-30</code> |

Where to get the slides/exercises/reservation?

■ https://indico.scc.kit.edu/e/hpc_course_2023-03-30 or

bwUniCluster: /opt/bwhpc/common/workshops/2023-03-30

horeka:/software/all/workshops/2023-03-30

■ exercises

■ slides

■ Workshop reservation:

single node:

```
SBATCH -p single --reservation=ws
```

■ multi node:

```
SBATCH -p multiple --reservation=ws
```

Overview
Agenda
Registration
Contact
✉ courses@bwhpc.de

Das Steinbuch Centre for Performance Computing (HPC) veranstaltet eine Fortbildung (HPC Course) für die Anwender der bwUniCluster (bwForCluster) und der Speichersysteme. Die Teilnahme ist kostenlos. Es fallen keine Teilnahmegebühren an.

The Steinbuch Centre for Performance Computing (HPC) course is aimed at (f) information about advanced and tutorials, and advanced

Starts 21 Oct 2023
Ends 21 Oct 2023
Europe/Berlin

exercises
slides

How to do exercises?

- Login to cluster & Generate workspace „bwhpc-course“

```
$ ws_allocate bwhpc-course 30
Info: creating workspace
/pfs/work7/workspace/scratch/ab1234-bwhpc-course
remaining extensions : 3
remaining time in days: 30
```

- Copy examples to your workspace

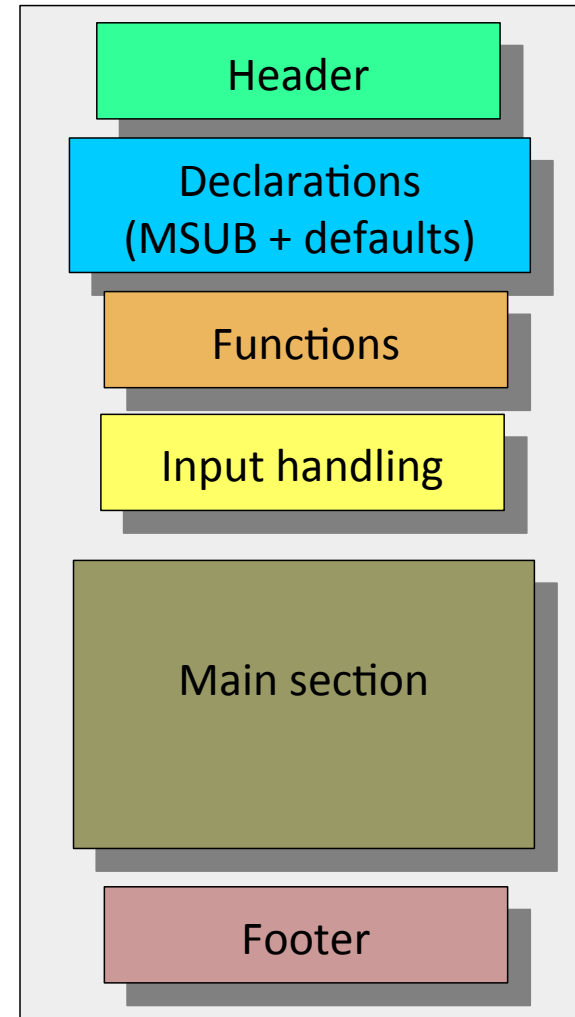
```
$ WORKSHOP=/opt/bwhpc/common/workshops/2023-03-30
$ cd $(ws_find bwhpc-course)
$ mkdir -v 2023-03-30; cd 2023-03-30
$ cp -vpr ${WORKSHOP}/exercises/02 ./
```

- Submit jobs from your workspace

```
$ cd $(ws_find bwhpc-course)/2022-04-13/02
$ sbatch -p {single|cpuonly} --res=ws <jobscript>
```

Goal

- Be descriptive!
 - Comment your code
 - e.g. via headers sections of script and functions.
 - Decipherable names for variables and functions
- Organise and structure!
 - Break complex scripts into simpler blocks e.g. use functions
 - Use exit codes
 - Use standardized parameter flags for script invocation.
- Write job script that runs **interactively**
 - Then add part for Slurm



Typical Issues & Cases (1)

■ Singlenode Issues

■ (Parallel) File System Issues

- Workflow for job on a different Filesystem (on \$TMPDIR/BEEOND, Case 1)

■ *OpenMP Jobs (cf. Afternoon – talk no. 4)*

■ Multinode Issues

■ Parallel File System Issues

■ *MPI Jobs (cf. Afternoon – talk no. 4)*

■ Walltime Issues

■ Job abortion (Case 2)

■ Task Issues

■ Bulk Jobs (Case 3)

■ Array Jobs (Case 4)

■ Chain Jobs (Case 5)

Typical Issues & Cases (2)

■ Login Node Issues

- @bwUniCluster, we have 4 Login nodes but over 2000! users
- „only want to test fast/interactively“ slows the login nodes

→ Do not Run your code, application, job on login nodes / in $\${HOME}$:

- for interactive jobs use `sacct`
- For development use `develop queue`

SLURM variables (bwUniCluster 2.0, HoreKa)

■ [bwHPC Wiki](#) , excerpt:

| Environment | Brief explanation |
|-------------------------|---|
| SLURM_JOB_CPUS_PER_NODE | Number of processes per node dedicated to the job |
| SLURM_JOB_NODELIST | List of nodes dedicated to the job |
| SLURM_JOB_NUM_NODES | Number of nodes dedicated to the job |
| SLURM_MEM_PER_NODE | Memory per node dedicated to the job |
| SLURM_NPROCS | Total number of processes dedicated to the job |
| SLURM_CLUSTER_NAME | Name of the cluster executing the job |
| SLURM_CPUS_PER_TASK | Number of CPUs requested per task |
| SLURM_JOB_ACCOUNT | Account name |
| SLURM_JOB_ID | Job ID |

■ SLURM Submit options (excerpt):

```
#!/bin/bash
#SBATCH -J test
#SBATCH -N1 -n1 --mem=50
#SBATCH -t 00:05:00
#SBATCH --mail-type=all
#SBATCH --export="my_own_variable=arguments"

if [ ! -z ${SLURM_JOB_NAME} ] ; then
  printenv 2>&1 | grep -e "(SLURM|my_own_variable)"
else
  printenv 2>&1 | grep 'TMPDIR'
fi
```

```
${WORKSHOP}/exercises/02/00_switch.sh
```


MOAB variables (bwForC. NEMO & BinAC)

■ [bwHPC Wiki](#) , excerpt:

| MOAB variables | |
|-----------------------|---------------------------------------|
| Environment variables | Description |
| MOAB_CLASS | Class name |
| MOAB_GROUP | Group name |
| MOAB_JOBID | Job ID |
| MOAB_JOBNAME | Job name |
| MOAB_NODECOUNT | Number of nodes allocated to job |
| MOAB_PARTITION | Partition name the job is running in |
| MOAB_PROCCOUNT | Number of processors allocated to job |
| MOAB_SUBMITDIR | Directory of job submission |
| MOAB_USER | User name |

■ MSUB submit options (excerpt):

```
#!/bin/bash

#MSUB -N test
#MSUB -l nodes=1:ppn=1,mem=50mb
#MSUB -l walltime=00:05:00
#MSUB -m n
#MSUB -v my_own_variable="arguments"
```

File system issues (1)

■ Multinode Job:

- For most cases

→ use *workspaces*

But: Producing Tbyte of scratch files & >10000 File?

Change your application code

Need help for that? Apply for [Tiger Team Support](#).

- A lot of I/O over all nodes

→ **opt out to local parallel file system (FS)** instead of global one

use BeeOND: but requires a „workflow“

■ Singlenode Job:

- A lot of I/O?

→ **opt out to local file system** instead of global one

use `#{TMPDIR}/BeeOND`: but requires a „workflow“

Jobs @ local/private FS (1)

- If temporary files of job > Gbyte
→ Run your job at local/private Filesystem
- Basic script recipe:
 - 1. Set “declarations”/defaults
 2. Use “private” subdirectory, assign to `${run_DIR}`
 3. Prepare `${run_DIR}` or Copy “things” to `${run_DIR}`
 4. Change to `${run_DIR}` & start your application
 5. Copy results back to DIR where job was submitted
- How?
 - Start with templates:

```
${WORKSHOP}/exercises/02/01_job_run_under_local_fs.sh  
+  
${WORKSHOP}/exercises/02/{01_gen_files,01_gen_files.inp}
```

Jobs @ local/private FS (2)

Code snip: `${WORKSHOP}/exercises/02/01_job_run_under_local_fs.sh`

```
#!/bin/bash
...
## 1.a-f) Declaration: defaults + load modules

## 2) Define your run private local filesystem
##   Interactive / NODES=1 / NODES>1:
mkdir -pv "${TMPDIR}/${USER}.${SLURM_JOB_ID:-$$}"
run_DIR=???

## 3.a) Check existence of run directory

## 3.b) Copy files from submit directory
##   to run directory
cd $SLURM_SUBMIT_DIR
cp -pv gen_files.x "${TMPDIR}/${USER}.${SLURM_JOB_ID:-$$}"
##   Check if copy succeeded
cp -pv gen_files.inp "${TMPDIR}/${USER}.${SLURM_JOB_ID:-$$}"

## 4) Change to run directory (check if succeeded) and start binary + input file
cd "${TMP}/${USER}.${SLURM_JOB_ID}"
./01_gen_files.x 01_gen_files.inp

## 5.a) Check run status

## 5.b) Transfer files to submit directory
cp -pv files_*.out "${SLURM_SUBMIT_DIR}"

## 5.c) Cleanup run_DIR
```

TASK/ToDo:

- * Generalise blue code avoiding repetition
- * Write code for 1-5
- * Redirect output of binary

Jobs @ local/private FS (3)

Part 1/3:

```
${WORKSHOP}/solutions/02/01_job_run_under_local_fs_solv.sh
```

Solution!

```
## 1.a) Define your binary
submitdir=${SLURM_SUBMIT_DIR:-${PWD}}
EXE="01_gen_files.x"

## 1.b) Define output file
##      = Name of executable w/o extension + JOBID or PID
output="$(basename ${EXE/./.*})_${SLURM_JOB_ID:-$$}.log"

## 1.c) Define full path input files
Input="01_gen_files.inp"

## 1.d) Define input files to be copied
copy_list="${EXE} ${input}"

## 1.e) Define files to be copied back after run, i.e. output file
save_list="${output} files_*.out"

## 1.f) Load modules INTEL+MKL
for mod in compiler/intel numlib/mkl ; do
    module load "${mod}"
done
```

Jobs @ local/private FS (4)

Part 2/3:

```
${WORKSHOP}/solutions/02/01_job_run_under_local_fs_solv.sh
```

Solution!

```
## 2) Define your run directory and generate via mkdir
## Nodes=1 -> TMPDIR option: run_DIR <=> tmpdir + username + JobID or PID
## Nodes>1 -> BEEOND option: run_DIR <=> path to BEEOND directories
if [ ! -z ${SLURM_JOB_NAME} ] ; then
  if [ ${SLURM_NNODES:-1} -gt 1 ] ; then
    run_DIR=/mnt/odfs/${SLURM_JOB_ID}/stripe_16/
  else
    run_DIR=${TMPDIR}
  fi
else
  run_DIR="${TMPDIR}/${USER}.${SLURM_JOB_ID:-$$}"
  mkdir -pv "${run_DIR}"
fi

## 3.a) Check existence of run directory
if [ ! -d "${run_DIR}" ] ; then
  echo "ERROR: Run DIR = ${run_DIR} does not exist"; exit 1
fi

## 3.b) Change to Submit Dir or PWD / Copy files from submit_DIR to run_DIR
cd "${submitdir}"
for X in ${copy_list} ; do
  cp -pv "${X}" "${run_DIR}"
  if [ $? -ne 0 ] ; then echo "ERROR: Copy of ${X} failed"; exit 1; fi
done
```

Jobs @ local/private FS (5)

Part 3/3:

```
`${WORKSHOP}/solutions/02/01_job_run_under_local_fs_solv.sh
```

Solution!

```
## 4) Change to runDIR and start binary
cd "${run_DIR}"
if [ $? -ne 0 ] ; then echo "ERROR: Entering ${run_DIR} failed"; exit 1; fi
./$EXE ${input} > $output 2>&1

## 5.a) Check run status
if [ $? -ne 0 ] ; then
    echo "WARNING: ${EXE} did not run properly!"
fi

## 5.b) Transfer output files to submit directory
cd "${run_DIR}"
for X in ${save_list} ; do
    cp -pv "${X}" "${submitdir}"
    if [ $? -ne 0 ] ; then echo "WARNING: Copy of ${X} failed"; fi
done

## 5.c) Cleanup run directory
rm -f ${run_DIR}/*; rmdir ${run_DIR}; exit 0
```

Walltime Issues (1)

■ Revision:

- Jobs have limited runtime (=walltime)
- Define walltime by your own, cf. `sbatch -t D-HH:MM:SS`

■ Issue:

- Executable needs more time than given walltime
→ queueing system is terminating your jobscript and its child processes

■ Solution:

- `sbatch --signal=B:<sigint>@<seconds>` , e.g. 120 before walltime send `sigterm` (15)

TASK/ToDo:

* combine "sbatch --signal" & "trap" to trigger message and "exit 1"

- template: `${WORKSHOP}/exercises/02/04_handle_aborts.sh`

Walltime Issues (2)

Solution!

- Use: „`sbatch --signal`“ and „`trap`“ to abort job on own terms

```
`${WORKSHOP}/solutions/02/04_handle_aborts_solv.sh
```

```
#!/bin/bash
## Pre-termination via Slurm
## sending signal with defined offset

#SBATCH -n 1 -t 00:01:00
#SBATCH --mem=100
#SBATCH --signal=B:15@10
#SBATCH -p ws

cleanup(){
    echo "Cleanup before walltime reached"
    exit 0
}

trap cleanup 15

echo "Repeating \"sleep 1\" loop until SIGTERM"
i=1
while true ; do
    sleep 1; echo $i; let i+=1
done
```

Slurm sends **SIGTERM** (kill -15)
10 seconds before walltime
is reached

Bulk Jobs (1)

- Many (>100) „independent“ jobs with very short runtime

- Solution:

→ Pack in one multinode/multitask job with long runtime

HowTo?

- Assign resources for „parallel“ task processing, aka „workers“
- Load balance „workers“, i.e., and assign step by step free „workers“ with jobs

Bulk Jobs: MPI based solution (1)

- Parbatch → MPI task based

Example: job script

```
${WORKSHOP}/exercises/02/03_parbatch.sh
```

```
#!/bin/bash

#SBATCH -n 4 -N 1
#SBATCH --mem=150
#SBATCH -t 00:03:00

module load system/parbatch

parbatch joblist.txt
```

+ joblist.txt

```
${WORKSHOP}/exercises/02/03_joblist.txt
```

```
echo "Subjob 01"; hostname
echo "Subjob 02"; hostname
echo "Subjob 03"; hostname
echo "Subjob 04"; hostname
echo "Subjob 05"; hostname
echo "Subjob 06"; hostname
echo "Subjob 07"; hostname
echo "Subjob 08"; hostname
```

TASK/ToDo:

- Prepare joblist with 10 jobs each running max. 15 seconds and submit it with „workers“

Bulk Jobs: MPI based solution (2)

Solution!

- Parbatch → MPI task based

Example: job script

```
#!/bin/bash

#SBATCH -n 2 -N 1
#SBATCH --mem=150
#SBATCH -t 00:03:00

module load system/parbatch

parbatch joblist.txt
```

+ joblist.txt

```
${WORKSHOP}/exercises/02/03_joblist.txt
```

```
sleep 10; echo 'Hello'; sleep 5
sleep 10; echo 'World'; sleep 5
sleep 10; echo 'today'; sleep 5
sleep 10; echo 'it is'; sleep 5
sleep 10; echo 'time'; sleep 5
sleep 10; echo 'for'; sleep 5
sleep 10; echo 'something'; sleep 5
sleep 10; echo 'new'; sleep 5
```

Job Arrays (1)

- Jobs with a „task range“

- with the same executable and resource requirements
→ but different input (files)

- Interactive setup (aka „pure“ bash script setup):

- Master script:

- Translating index setup into list, executing each index value as a job

- Slurm:

- Available as submit feature:

```
sbatch --array [<indexlist>]:<delim> job.sh
```

→ makes master script obsolete & groups Job IDs (= easier to handle)

→ `job.sh` gets index value via `$SLURM_ARRAY_TASK_ID`

Job Arrays (2)

- Simple slurm array example: `${WORKSHOP}/exercises/02/05_slurm_array.sh`

```
#!/bin/bash

#SBATCH -J ws_array
#SBATCH -N1 -n2
#SBATCH -t 00:01:00
#SBATCH --array=0-10:2
#SBATCH --output=array_%A-%2a.out

printenv | grep "SLURM_ARRAY"

## Generate real number, e.g. via exp fct.
echo ${SLURM_ARRAY_TASK_ID} | awk '{printf "%.4f\n",exp($X)}'
sleep 2
```

List from 0 to 10
with increment of 2

Default is: `slurm-%A_%a.out`,
but generates here:
`slurm-12346_0.out`
...
`slurm-123456_10.out`

`%2a` = pads one-digit
numbers with zeros

current array task ID

Bash based Job Array (3)

■ Without array submit features → approach:

a.) handle each index value as one job/task

b.) handle as one (=master) sbatch job

```
#!/bin/bash
```

```
export IARR="0-10:2"
```

```
${WORKSHOP}/exercises/02/05_master_job_array.sh
```

```
#SBATCH --export="All,IARR=2-10:2" # index setup: min-max:inc
```

```
# Define subjob script
```

```
subjob="./05_array_task.sh"
```

```
# Decipher index setup:
```

```
IARR=${IARR:-1-5:1}
```

```
if [[ ${IARR//:/} = ${IARR} ]] ; then inc=1 ; else inc=${IARR/*:} ; fi
```

```
IARR=${IARR/*:}
```

```
if [[ ${IARR/-//} = ${IARR} ]] ; then max=1 ; else max=${IARR/*-} ; fi
```

```
min=${IARR/-*}
```

```
ndm="${#max}" ## Number of digits of max
```

Automatic padding
digits with zeros

```
echo "Generate index list from ${min} to ${max} with increment ${inc}"
```

```
while [[ $min -le $max ]] ; do
```

```
    printf " Execute ${subjob} %0${ndm}d\n" "${min}"
```

```
    ##${subjob} $(printf "%0${ndm}d" "${min}")
```

```
    let min+=${inc}
```

```
done
```

Bash based Job Array (4)

TASK/ToDo:

- Modify 05_master_job_array.sh
 - To do parallel (use parbatch):
- 05_array_task.sh writes index value to indexed output

```
${WORKSHOP}/exercises/02/05_array_task.sh
```

```
#!/bin/bash

## Get index value via positional parameter
value="?"

## Define name of output file, array_<jobid>-<task-id>.out
outputfile="?"

## Write value to file
??
```


Bash based Job Array (4)

Solution!

- Modify 05_master_job_array.sh
 - To do parallel (use parbatch):
- 05_array_task.sh writes index value to indexed output

```
#{WORKSHOP}/solutions/02/05_array_task_solv.sh
```

```
## Get index value via positional parameter
value="${1:?missing_value}"
## Define name of output file
outputfile="array_${SLURM_JOB_ID:-$$}-${value}.out"
## Write value to file
echo ${value} > ${outputfile}
```

```
#{WORKSHOP}/solutions/02/05_master_job_array_solv.sh
```

```
module load system/parbatch
...
joblist=joblist_${SLURM_JOB_ID:-$$}.txt
while [[ $min -le $max ]] ; do
    printf "  Execute ${subjob} %0${ndm}d\n" "${min}"
    echo "${subjob}" $(printf "%0${ndm}d" "${min}") >> ${joblist}
    let min+=${inc}
done
# Execute parbatch
parbatch ${joblist}
```

Bonus: Chain Jobs (1)

- Idea:
 - Do N consecutive Jobs via N Batch Jobs
- Goal:
 - Do everything in one script
 - Submit only at the beginning
- „Pre-step“: generate script that runs interactively

- Result:

```
${WORKSHOP}/exercises/02/02_chain_job.sh
```

Bonus: Bash script based Chain Jobs (2)

```
#!/bin/bash
## Defaults
loop_max=10
cmd='sleep 2'

## Check if counter environment variable is set
if [ -z "${myloop_counter}" ] ; then
    echo " ERROR: myloop_counter is undefined, stop chain job"; exit 1
fi
## Only continue if below loop_max
if [ ${myloop_counter} -lt ${loop_max} ] ; then
    ## Increase counter
    let myloop_counter+=1
    ## Print current Job number
    echo " Chain job iteration = ${myloop_counter}"
    ## Execute your command
    echo " -> executing ${cmd}"
    ${cmd}

    if [ $? -eq 0 ] ; then
        ## Continue only if last command was successful
        export myloop_counter=${myloop_counter}
        ./${0}
    else
        ## Terminate chain
        echo " ERROR: ${cmd} of chain job no. ${myloop_counter} terminated unexpectedly"
        exit 1
    fi
fi
fi
```

```
${WORKSHOP}/exercises/02/02_chain_job.sh
```

```
$ export myloop_counter=0
$ ./02_chain_job.sh
```

loop

Bonus: Chain Jobs (3) → How for Slurm?

```
#!/bin/bash
#SBATCH ...
## Defaults
loop_max=10
cmd='sleep 2'
## Check if counter environment variable is set
if [ -z "${myloop_counter}" ] ; then
    echo " ERROR: myloop_counter is undefined, stop chain job"; exit 1
fi
## only continue if below loop_max
if [ ${myloop_counter} -lt ${loop_max} ] ; then
    ## increase counter
    let myloop_counter+=1
    ## print current Job number
    echo " Chain job iteration = ${myloop_counter}"
    ## Execute your command
    echo " -> executing ${cmd}"
    ${cmd}

    if [ $? -eq 0 ] ; then
        ## continue only if last command was successful
        export myloop_counter=${myloop_counter}
        ./${0}
    else
        ## Terminate chain
        echo " ERROR: ${cmd} of chain job no. ${myloop_counter} terminated unexpectedly"
        exit 1
    fi
fi
```

TASK/ToDo:

* add the parts for Slurm

loop

Bonus: Chain Jobs (4) → Solution! for Slurm

```
#!/bin/bash
#SBATCH -N1 -n1 -t 00:00:05 -mem=250 -p ws
## Defaults
loop_max=10
cmd='sleep 2'

## Check if counter environment variable is set
if [ -z "${myloop_counter}" ] ; then
    echo " ERROR: myloop_counter is undefined, stop chain job"; exit 1
fi
## only continue if below loop_max
if [ ${myloop_counter} -lt ${loop_max} ] ; then
    ## increase counter
    let myloop_counter+=1
    ## print current Job number
    echo " Chain job iteration = ${myloop_counter}"
    ## Execute your command
    echo " -> executing ${cmd}"
    ${cmd}
    if [ $? -eq 0 ] ; then
        ## continue only if last command was successful
        sbatch --export=myloop_counter=${myloop_counter} ./02_chain_job_solv.sh
    else
        ## Terminate chain
        echo " ERROR: ${cmd} of chain job no. ${myloop_counter} terminated unexpectedly"
        exit 1
    fi
fi
fi
```

loop

Bonus: Chain Jobs (5)

■ Slurm + interactive script =

```
{WORKSHOP}/solutions/02/02_gen_chain_job_solv.sh
```

```
...
if [ $? -eq 0 ] ; then
  ## continue only if last command was successful
  if [ ! -z ${MOAB_JOBNAME} ] ; then
    ## If MOAB_JOBNAME environment variable is defined
    ## -> this script is under MOAB "control"
    msub -v myloop_counter=${myloop_counter} ./02_gen_chain_job_solv.sh
  elif [ ! -z ${SLURM_JOB_NAME} ] ; then
    sbatch --export="myloop_counter=${myloop_counter}" ./02_gen_chain_job_solv.sh
  else
    export myloop_counter=${myloop_counter}
    ./${0}
  fi
else
  ## Terminate chain
  echo " ERROR: ${cmd} of chain job no. ${myloop_counter} terminated unexpectedly"
  exit 1
fi
...
```

→ USE bash programming to **generalise** and **unify** your batch job scripts

Bonus: Chain Jobs: Optimization (1)

■ Problem of `02_generalised_chain_job.sh`: **Waiting time!**

■ Solution: two scripts (master + links) + `sbatch -d afterok:<jobID>`

■ 1. script - links: `${WORKSHOP}/solutions/02/02_chain_link_job_solv.sh`

```
#!/bin/bash
#SBATCH ...

## Define your command
cmd='sleep 30'

## Execute your command
echo "  -> executing ${cmd}"
${cmd}

## Do you check if correctly terminated
if [ $? -ne 0 ] ; then
  ## Terminate chain
  echo "  ERROR: ${cmd} of chain job no. ${myloop_counter:-1} terminated unexpectedly"
  exit 1
fi
```

Bonus: Chain Jobs: Optimization (2)

■ 2. script - master: `${WORKSHOP}/solutions/02/02_submitter_f_chain_job_solv.sh`

```
#!/bin/bash
max_nojob=${1:-5}
chain_link_job=${PWD}/02_chain_link_job_solv.sh
dep_type="${2:-afterok}"

myloop_counter=1
while [ ${myloop_counter} -le ${max_nojob} ] ; do
  if [ ${myloop_counter} -eq 1 ] ; then
    slurm_opt=""
  else
    slurm_opt="-d ${dep_type}:${jobID}"
  fi

  echo "Chain job iteration = ${myloop_counter}"
  echo "  sbatch --export=myloop_counter=${myloop_counter} ${slurm_opt} ${chain_link_job}"
  ## Store job ID for next iteration by storing output of msub command with empty lines
  jobID=$(sbatch --export=myloop_counter=${myloop_counter} ${slurm_opt} ${chain_link_job}
    2>&1 | sed 's/[S,a-z]* //g')

  ## Check if ERROR occurred
  if [[ "${jobID}" =~ "ERROR" ]] ; then
    echo "  -> submission failed!" ; exit 1
  else
    echo "  -> job number = ${jobID}"
  fi
  ## Increase counter
  let myloop_counter+=1
done
```

loop

Your Workflows?

- Tell us about your typical workflow
 - Preprocessing methods
 - Input methods
 - Data staging methods
 - I/O management
 - Postprocessing methods
 -
 - If you have issue, please contact us via:

<https://www.bwhpc.de/supportportal.php>

Thank you for your attention!
Questions?