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# **DMOG docs**

*Release 1.0*

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## GENERAL REMARKS

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Welcome to the documentation page for DMOG, the new high-performance computing (HPC) facility at Heriot-Watt University. DMOG is a state-of-the-art cluster that aligns with the University Strategy 2025, which aims to support and enable world-leading research.

The cluster is named after Dame Maria Ogilvie Gordona pioneering geologist who began her scientific career at Heriot-Watt College in 1888. She was the first woman to receive a Doctor of Science from UCL and a PhD from Munich University. Maria combined academic research with married life and work for the Liberal Party and women's action groups. She won the Geological Society Lyell medal for research on plate tectonics and became a Dame of the British Empire for her work for women's rights.

This documentation page serves as a comprehensive guide to using the DMOG cluster, including information on accessing the system, submitting jobs, and utilizing the various software packages and tools available. We hope you find this resource helpful in your research endeavors.

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**Note:** This project is under active development. If you wish to provide feedback, please contact the support team at [ishelp@hw.ac.uk](mailto:ishelp@hw.ac.uk).

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## CONTENTS

### 1.1 Access and Priorization

Access to the HPC cluster is granted to research staff and research students by default, and is free at the point of use. To gain access, users are required to fill out a [TopDesk](#) form providing basic information about their research and the expected resource requirements. The HPC team will review each application and grant access in a timely manner.

For those with specific and/or time-sensitive research requirements, a paid priority access service is available. This provides access to higher priority in the job queues. Please contact us for more information on this service.

### 1.2 Introduction

Welcome to the DMOG High-Performance Computing (HPC) facility!

This guide is designed to help users access and utilize the system effectively. Whether you're a researcher, student, or staff member, the DMOG HPC facility can provide significant computing resources to support your work. This guide covers essential topics for using the facility, including system access, data storage, job submission, program compilation, and environment management. By following these guidelines, you can make the most of the DMOG HPC facility and achieve optimal performance for your computing needs.

#### 1.2.1 Acknowledging DMOG

We would appreciate it if you could acknowledge the use of the HWU high-performance computing facility (DMOG) and associated support services in the completion of this work by including the following statement in your publications:

*"The authors acknowledge the use of the HWU high-performance computing facility (DMOG) and associated support services in the completion of this work."*

### 1.3 Job Quotas

To ensure fair share of resources among the HPC user community, we have implemented job quotas. These quotas are subject to review and may be adjusted as required. The current job quotas for standard users are as follows:

1. maximum of 10 jobs running per user
2. maximum of 60 jobs submitted per user (allowing up to 50 jobs to be held in a queued/pending state)
3. Maximum of 128 CPU cores
4. Maximum of 1006G RAM

5. Maximum of 2 GPUs per user (minimum of 1 GPU per job)
6. Maximum runtime 7 days

These quotas are designed to ensure that all users have a fair opportunity to access the cluster resources. Users who require additional resources are encouraged to contact the HPC team to discuss their requirements.

There are also groups which have different quotas. Membership of these groups is based on various factors, including early testers, financial contribution to DMOG, etc.

Currently there are no differences in job priority between groups.

Details of these groups are:

Group Name	CPUs	GPUs	Mem	Active Jobs	Total Jobs
COMSEL	768*	20*	2.51TB*	20	65
highlimits	384	6	3TB	15	65
prilimits	256	4	2TB	15	65

(\*): resource is shared between members of the group

## 1.4 Info Scripts

We have created a number of informational scripts to allow users to see more information about their jobs, as well as the cluster itself.

These scripts are located in `/opt/site/hwscripts/`

**hwNodes:** This script will show you information on each node in the cluster, how many CPU cores, GPUs, and how much memory they have. It also displays the current usage information, how many CPU cores, GPUs, or memory are currently in use on each node.

**hwStatus:** This small script shows a very high level overview of the cluster, how many CPU cores and GPUs are in use in total, how many active jobs there are, and how many are waiting in the queue.

**hwEfficiency:** This script will show you various information about a given users jobs that have run over a given time-frame. Total Number of jobs, average CPU efficiency of those jobs, average memory efficiency, average wait time (time in the queue before starting), and average runtime.

This script is intended to help users efficiently request resources. Requesting more resources (CPU cores, memory, GPUs) than needed can cause a job to wait longer in the queue than needed while waiting for those resources to be freed up, and also prevents other users' jobs from running as there are fewer resources left available while said job is running. A low average CPU efficiency metric shows that too many CPU cores are being requested on average. For example, if you always request 32 CPU cores for your jobs, and your CPU efficiency is <50% you should be able to request only 16 CPU cores for your jobs with no impact on performance, while helping keeping the queue clear. The same applies to the average memory efficiency metric.

## 1.5 Storage Quotas

Similar to the job quotas previously detailed, there are two separate quotas relating to data storage on DMOG:

1. A quota of 150GB of data capacity
2. A quota of 250k total files

If you exceed either of these quotas you will no longer be able to create new files on DMOG until you remove files and no longer exceed either quota.

You can check your current quota usage with the following command:

```
quota -s
```

This will display an output similar to the following:

```
[gp27@login1 [dmog] ~]$ quota -s
Disk quotas for user gp27 (uid 433400227):
Filesystem space quota limit grace files quota limit grace
storage:/export/users
                22111M    150G    200G                10299    250k    300k
```

Should you exceed either of these quotas an asterisk (\*) will appear next to the value in the Files column.

These quotas are designed to ensure that all users have a fair opportunity to access the cluster resources. Users who require additional resources are encouraged to contact the HPC team to discuss their requirements.

### 1.5.1 Conda

Using Conda frequently causes the total number of files quota to be exceeded.

Our recommended workaround for this is to move your .local folder (where Conda stores your environments) to the archive folder and create a symbolic link to the new location.

You can do this by using the following commands:

```
mv $HOME/.local $HOME/archive/
ln -s $HOME/archive/.local $HOME/.local
```

You can confirm that this has worked by using the `ls -la` command. You should see an output similar to this:

```
[gp27@login1 [dmog] ~]$ ls -la
total 212
drwx----- 32 gp27 clusterusers 4096 May  1 08:46 .
drwxr-xr-x 214 root root          4096 Apr 30 12:54 ..
drwx-----  2 gp27 clusterusers 4096 Feb 13 12:25 .apptainer
lrwxrwxrwx  1 gp27 clusterusers   22 Dec  5 09:59 archive -> /mnt/data/shared/gp27/
-rw-----  1 gp27 clusterusers 22927 May  1 08:52 .bash_history
-rw-----  1 gp27 clusterusers   18 Dec  5 09:59 .bash_logout
-rw-----  1 gp27 clusterusers  193 Dec  5 09:59 .bash_profile
-rw-----  1 gp27 clusterusers  231 Dec  5 09:59 .bashrc
drwxr-xr-x 16 gp27 clusterusers 4096 Apr 25 10:21 .cache
drwxr-xr-x  2 gp27 clusterusers 4096 Apr  3 08:48 .conda
drwxr-xr-x 11 gp27 clusterusers 4096 Mar  7 16:17 .config
drwx-----  3 gp27 clusterusers 4096 Jan  9 13:18 .dbus
drwxr-xr-x  2 gp27 clusterusers 4096 Jan  9 13:19 Desktop
```

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```
drwxr-xr-x  3 gp27 clusterusers 4096 Feb  9 10:42 Documents
drwxr-xr-x  2 gp27 clusterusers 4096 Jan  9 13:19 Downloads
-rw-----  1 gp27 clusterusers  334 Dec  5 09:59 .emacs
lrwxrwxrwx  1 gp27 clusterusers   15 Apr 16 15:23 .local -> archive/.local/
...
```

This line `lrwxrwxrwx 1 gp27 clusterusers 15 Apr 16 15:23 .local -> archive/.local/` shows that my `.local` folder is actually located in `archive/.local`

## 1.6 General Use Policy

The DMOG HPC cluster is a shared resource that has been set up to support research. It is a powerful and valuable resource that can be used to undertake computationally intensive tasks that would otherwise not be possible. It is important to remember that this resource is shared by all users and must, therefore, be used responsibly. Each user has a responsibility to ensure that their use of the resource does not negatively impact other users, and that they do not misuse the resource in any way.

The facility is to be used only for research purposes. This means that it should not be used for any other purposes, such as commercial or personal activities. Any misuse of the facility will not be tolerated, and users who violate the usage policy will be subject to disciplinary action, which may include suspension or termination of their access to the facility.

As a user of DMOG, you will be associated with a group that will have a designated line manager. The line manager is responsible for managing the group's accounts and ensuring that the group's usage of the HPC facility follows our guidelines. This includes deciding on the data stored in the user accounts, as well as managing access to the accounts. If a user leaves the group, their account will remain under the management of the line manager, who will ultimately decide what to do with the account. This ensures that access to our HPC facility is managed appropriately and that users are held accountable for their usage.

It is essential that all users of the facility adhere to the guidelines outlined in the documentation. The facility staff is available to provide support and assistance to users, and they can be contacted if any issues or concerns arise. By working together and using the facility responsibly, we can ensure that the facility remains a valuable resource for the research community.

## 1.7 Connecting to DMOG

Before following the process below, this guide assumes you have an account on the cluster. If that is not the case, you can request one by contacting [ISHelp@hw.ac.uk](mailto:ISHelp@hw.ac.uk)

Interaction with DMOG is done remotely via SSH (Secure Shell). To connect to another machine using SSH you need to have a SSH client program installed on your machine. macOS, Linux, and newer versions of Windows come with a command-line (text-only) SSH client pre-installed. On older Windows versions there are various graphical SSH clients you can use like PuTTY or MobaXterm.

Using your favorite SSH client, just type:

```
ssh <username>@dmog.hw.ac.uk
```

Note: the cluster is accessible within the University network. For remote access you need to log on to the [University VPN](#), or request access to the SSH gateway via the self-service portal first.

### 1.7.1 VSCode via Slurm

To create a job on DMOG and have VSCode connect to the job to debug code etc:

1. You will need to have an SSH keypair set up for connecting to DMOG, so that you can connect without entering your password.
2. Within VSCode, install the 'Remote - SSH' extension.
3. Next, follow the steps shown here to create your SSH config file, start a slurm job, and connect to it via VS Code:  
[hwVSCode](#)

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**Note:** If your connection to DMOG using VSCode suddenly stops working, this is usually due to exceeding your file storage quota. You can check this with:

[hwQuota](#)

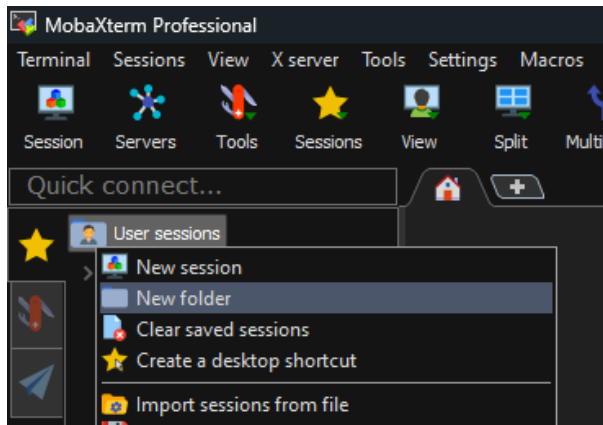
---

### 1.7.2 Configure MobaXTerm for DMOG

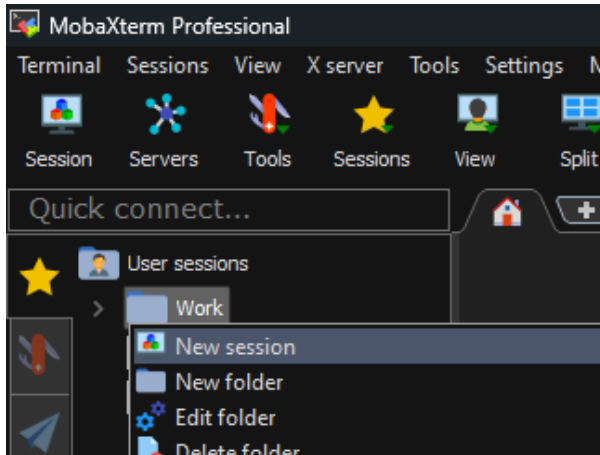
MobaXTerm is an SSH/SCP/SFTP client available for Windows. As it has SCP/SFTP functionality built-in it simplifies copying files to/from DMOG.

It is available from here: [MobaXTerm](#)

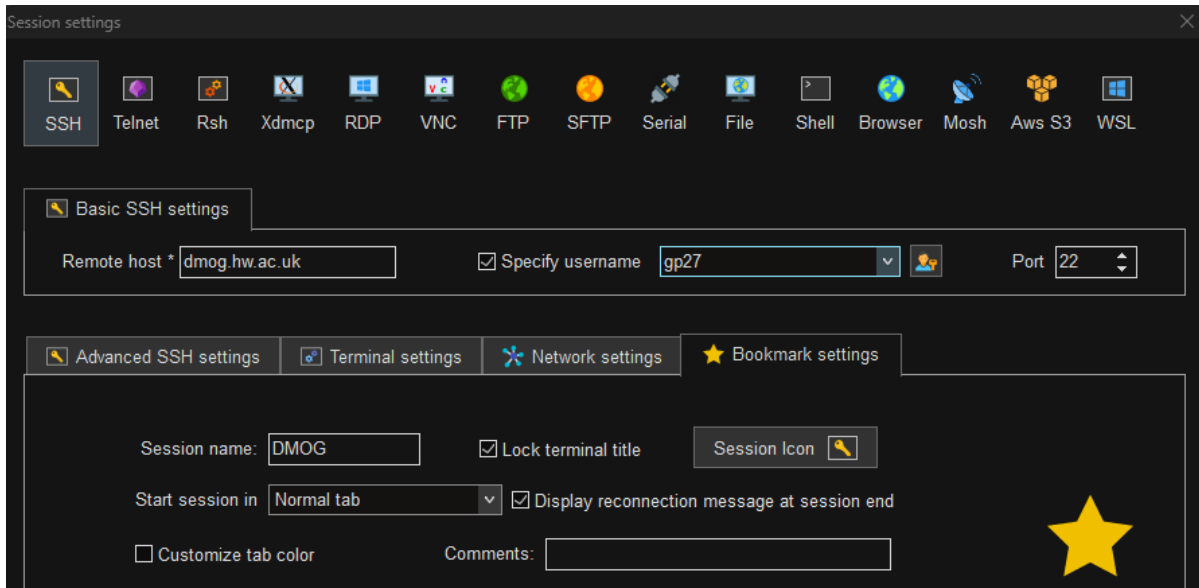
Create a Work folder on the left by right-clicking User Sessions and selecting new folder:



Right-click the work folder and select New session:

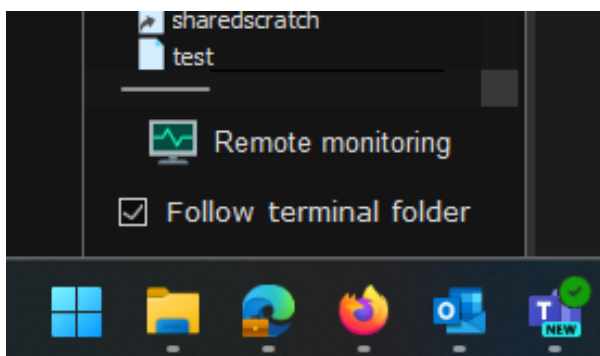


In the new session window select SSH. In the Remote Host field enter dmog.hw.ac.uk  
Check the box next to Specify Username and enter your DMOG username into the field  
Bookmark Settings and enter DMOG into the Session Name field then click OK:



Double-click the DMOG session on the left of the window, you will be prompted for your DMOG password to log in.  
Note that whenever you are prompted for a password you will not be able to see what you are typing, not even \*s.

Once logged in, at the bottom left of the window check the box next to Follow Terminal Folder:



The area to the left of the Window will allow you to see the files in the folder you are currently inside, as well as create new folders, and upload files/folders to the folder you are currently in.

To upload files from your Windows PC to DMOG, you can either drag and drop files onto this panel on the left to, or use the Up arrow to select files to upload. You can also download files from DMOG to your computer by selecting them on the left panel and clicking the Down arrow.

## 1.8 Connecting while off-campus

If you are looking to connect to DMOG from off-campus you will need to use the SSH gateway (SSHGW) as a proxy/jump host.

If you have not already been given access to the SSHGW please create a ticket with the helpdesk to request this.

Set your client to use sshw.hw.ac.uk as a proxy/jump host, and to connect to it on port 44788

If you are looking to use VSCode or MobaXterm (see above) in this way, you'll need to make some adjustments:

### 1.8.1 VSCode

In your SSH config file, change the host DMOG section to match the following (changing the values in the [ ] to your own):

```
Host dmog
  User [username]
  IdentityFile [PATH TO YOUR DMOG SSH PRIV KEY]
  HostName dmog.hw.ac.uk
  Port 22
  ProxyJump [username]@sshgw.hw.ac.uk:44788
  ConnectTimeout 60
  ServerAliveInterval 30
  ServerAliveCountMax 120
```

### 1.8.2 MobaXTerm

Right-click the session on the left, then select Edit Session.

In the window that appears, change "Remote Host" from dmog.hw.ac.uk to 137.195.249.10

Then, select Network Settings, then click 'SSH gateway (jump host)'

In the new window that appears enter the following:

Gateway host: sshgw.hw.ac.uk

Username: your HWU username

Port: 44788

Click OK, then OK again.

You should now be able to connect to DMOG via the SSHGW

## 1.9 Connecting to DMOG using VNC

Before following the process below, this guide assumes you have an account on the cluster. If that is not the case, you can request one by contacting [ISHelp@hw.ac.uk](mailto:ISHelp@hw.ac.uk)

You will first need to connect to DMOG via SSH as you normally would.

There are a few desktop environments available to use, you can see these with the following command:

```
flight desktop avail
```

You should see an output similar to this:

Name	Summary
gnome	GNOME v3, a free and open-source desktop environment for Unix-like operating systems. > <a href="https://www.gnome.org/">https://www.gnome.org/</a>
kde	KDE Plasma Desktop (KDE 4). Simple by default, powerful when needed. > <a href="https://kde.org/">https://kde.org/</a>
xfce	Xfce is a lightweight desktop environment. It aims to be fast and user friendly. > <a href="https://xfce.org/">https://xfce.org/</a>

To start a session with your chosen desktop environment:

```
flight desktop start gnome
```

You should see an output similar to this:

```
== Session details ==
Name:
Identity: dda965c2-500d-4469-9eee-e51da4b26104
Type: gnome
Host IP: 137.195.249.10
Hostname: login1
Port: 5903
Display: :3
Password: Ghodd0v4
Geometry: 1024x768
```

This desktop session is not directly accessible from outside of your cluster as it is running on a machine that only provides internal cluster access. In order to access your desktop session you will need to perform port forwarding using 'ssh'.

Refer to 'flight desktop show dda965c2' for more details.

On the last line, run the command shown. In my example this would be

```
flight desktop show dda965c2
```

This will print the same information again, but with some key info added. Specifically, this will show the command you will need to use to connect to the VNC session:

```
This desktop session is not directly accessible from outside of your
cluster as it is running on a machine that only provides internal
cluster access. In order to access your desktop session you will need
to perform port forwarding using 'ssh':
```

```
ssh -L 5903:137.195.249.10:5903 gp27@dmog.hw.ac.uk
```

(please note that this command assumes you are connecting to DMOG from on-campus or via the VPN. If you can't connect to DMOG using just simple 'ssh dmog.hw.ac.uk' the above command won't work. You will need to adjust your normal SSH command, for example:

```
ssh -tt -L 5903:localhost:5903 gp27@sshgw.hw.ac.uk -p 44788 ssh -L 5903:localhost:5903_
↪137.195.249.10
```

Run this command on your local machine. Then switch over to your VNC client and connect to, in my example, localhost:5903. You will be prompted to enter a password, enter the password shown on DMOG.

## 1.10 Data Management

There are several data storage types available to users. Each of which has different characteristics and policies, and it is suitable for different types of use. Please note that the cluster is intended to store data for as long as it is being processed and so none of the storage options are backed up.

The following table shows the different storage options that are currently available to users:

Storage	Use	Exported to nodes	Total Capacity	Notes
/users/	Home dir	Yes	12TB	Quota: 150GB, No backup
/mnt/data/	Local data	Yes	30TB	No backup
/mnt/scratch/	Compute	Yes	93TB	No backup
/tmp/users/	Compute	No	up to 1TB	No backup

## 1.11 File Transfer

The easiest way to transfer data from/to the cluster is to use one of the standard programs based on the SSH protocol such as scp or rsync.

### 1.11.1 The scp command

The `scp` command creates a copy of a file, or a directory (if the `-r` flag is called) on a remote machine.

To copy data to the cluster:

```
scp [options] /source/path/to/object <user>@dmog.hw.ac.uk:/path/to/destination
```

To copy data from the cluster:

```
scp [options] <user>@dmog.hw.ac.uk:/source/path/to/object /path/to/destination
```

For a complete list of options available: `man scp`

### 1.11.2 The rsync command

`rsync` uses the same underlying protocol as `scp`, but it employs a special delta transfer algorithm. It compares if there is any differences in the files and only transfer those differences. Also, while copying if the connection drops, it can pick up the transfer where it was left off.

The syntax to copy files to/from the cluster:

```
rsync [options] /source/path/to/object <user>@dmog.hw.ac.uk:/path/to/destination  
rsync [options] <user>@dmog.hw.ac.uk:/source/path/to/object /path/to/destination
```

For a list of options: `man rsync`

## 1.12 Job Management

DMOG uses the Slurm job scheduler to manage resources and ensure fair access for all users. To submit jobs to the scheduler, users write a submission script specifying the required resources (such as the number of CPUs, amount of memory, etc.) and input/output files. After submitting a job, Slurm will try to allocate the requested resources and start the job. If the requested resources are not immediately available, the job will be queued until enough resources become available.

In addition to batch mode jobs, Slurm also supports interactive jobs which can be useful for testing code or troubleshooting problems. To start an interactive session, users can request an allocation of resources and then start a shell session on a compute node.

Slurm is not only used to submit and monitor jobs, but also to describe the resources required for the jobs. To ensure that your job runs efficiently, it is important to specify the correct resources in your submission script.

### 1.12.1 Basic Slurm commands

- **sinfo**: This command is used to display information about the nodes available on the cluster, such as their state (idle, down, etc.), partition, number of CPUs, and amount of available memory. It can help users choose appropriate resources for their jobs.
- **squeue**: This command is used to display the current queue of jobs on the cluster, including their status, user, and estimated start time. It can help users track the progress of their jobs and estimate when they will start running.
- **sbatch**: This command is used to submit a batch job to the Slurm scheduler. Users specify the required resources and the commands to run in a script, and then submit the script using the `sbatch` command. The job is then scheduled by the Slurm scheduler and run on the requested resources.

- `scancel`: This command is used to cancel a running or pending job on the cluster. Users can specify the job ID or job name to be cancelled.
- `scontrol`: This command is used to view and modify Slurm configuration and status information. It can be used to monitor the status of Slurm components.
- `squeue`: use this command to get a high-level overview of all active (running and pending) jobs in the cluster.

Further information about these commands is available in the online manual: `man <command>`

### 1.12.2 Job queue states and reasons

The `squeue` command allows users to view information about the state of a job. The default output format of the command is as follows:

JOBID	PARTITION	NAME	USER	ST	TIME	NODES	NODELIST(REASON)
JOBID		Row 1, column 3	pp	00	jlkj	jhkh	hjhkj

Where

JOBID	Job or step ID. For array jobs, the job ID format will be of the form <code>&lt;job_id&gt;_&lt;index&gt;</code>
PARTITION	Partition of the job/step
NAME	Name of the job/step
USER	Owner of the job/step
ST	State of the job/step. See below for a description of the most common states
TIME	Time used by the job/step. Format is days-hours:minutes:seconds (days, hours only printed as needed)
NODES	Number of nodes allocated to the job or the minimum number of nodes required by a pending job
NODELIST(REASON)	For pending jobs: Reason why pending. For failed jobs: Reason why failed. For all other job states: List of allocated nodes. See below for a list of the most common reason codes.

During its lifetime, a job passes through several states. The most common states are PENDING, RUNNING, SUSPENDED, COMPLETING, and COMPLETED. Some other states are shown in the table below:

PD	Pending. Job is waiting for resource allocation
R	Running. Job has an allocation and is running
S	Suspended. Execution has been suspended and resources have been released for other jobs
CA	Cancelled. Job was explicitly cancelled by the user or the system administrator
CG	Completing. Job is in the process of completing. Some processes on some nodes may still be active
CD	Completed. Job has terminated all processes on all nodes with an exit code of zero
F	Failed. Job has terminated with non-zero exit code or other failure condition

If the job has failed or it is pending, a reason for its current state is given in the last column of the `squeue` output. Some of the most common reasons are:

(Resources)	The job is waiting for resources to become available so that the jobs resource request can be fulfilled
(Priority)	The job is not allowed to run because at least one higher prioritized job is waiting for resources
(Dependency)	The job is waiting for another job to finish first ( <code>-dependency=...</code> option)
(TimeLimit)	The job exhausted its time limit.
(ReqNodeNotAvail)	Some node required by the job is currently not available. The node may currently be in use, reserved for another job, in an advanced reservation, DOWN, DRAINED, or not responding
JobLaunchFailure	The job could not be launched. This may be due to a file system problem, invalid program name, etc.

For a complete list of job states codes and reasons, see [Job State Codes](#) and [Job Reasons](#)

## 1.13 Job Submission

### 1.13.1 Batch Jobs

To submit a batch job to the cluster, you need a submission script that contains two parts. The first part, located at the top of the script, describes the resources that the job requires using `#SBATCH` directives. These directives are treated as Slurm options and specify the necessary resources for the job. The second part of the submission script contains the job-specific shell commands.

Slurm options can also be added to the `sbatch` command directly as command line arguments, which will override the ones embedded in the job script.

Batch jobs are submitted to the cluster via `sbatch`.

For example: `sbatch ./myJob.sh`

Here are some examples of job submission scripts:

#### Serial job

```
#!/bin/bash -l

##### Part-1 Slurm directives #####
## Working dir
## SBATCH -D /users/abc123/example/path
## Environment variables
#SBATCH --export=ALL
## Output and Error Files
#SBATCH -o job-%j.output
#SBATCH -e job-%j.error
## Job name
#SBATCH -J serial-test
## Run time: "hours:minutes:seconds", "days-hours"
#SBATCH --time=00:05:00
## Memory limit (in megabytes)
#SBATCH --mem=1024
## Specify partition
#SBATCH -p nodes
```

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```
##### Part-2 Shell script #####
#=====
# Activate Flight Environment
#-----
source "${flight_ROOT:-/opt/flight}"/etc/setup.sh

#=====
# Create results directory
#-----
RESULTS_DIR="$(pwd)/${SLURM_JOB_NAME}-outputs/${SLURM_JOB_ID}"
echo "Your results will be stored in: $RESULTS_DIR"
mkdir -p "$RESULTS_DIR"

#=====
# Application launch commands
#-----
# Customize this section to suit your needs.

echo "Executing job commands, current working directory is $(pwd)"

# REPLACE THE FOLLOWING WITH YOUR APPLICATION COMMANDS

echo "Hello, dmog" > $RESULTS_DIR/test.output
echo "This is an example job. It ran on `hostname -s` (as `whoami`)." >> $RESULTS_DIR/
↪test.output
echo "Output file has been generated, please check $RESULTS_DIR/test.output"
```

### Shared memory job

```
#!/bin/bash -l

##### Part-1 Slurm directives #####
## Working dir
## SBATCH -D /users/abc123/example/path
## Environment variables
#SBATCH --export=ALL
## Output and Error Files
#SBATCH -o job-%j.output
#SBATCH -e job-%j.error
## Job name
#SBATCH -J shared-mem-test
## Run time: "hours:minutes:seconds", "days-hours"
#SBATCH --time=00:05:00
## Memory limit (in megabytes). Total --mem or amount per cpu --mem-per-cpu
#SBATCH --mem-per-cpu=1024
## Processing slots
#SBATCH --nodes=1
#SBATCH --ntasks=32
## Specify partition
```

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```

#SBATCH -p nodes

##### Part-2 Shell script #####
#=====
# Activate Flight Environment
#-----
source "${flight_ROOT:-/opt/flight}"/etc/setup.sh

#=====
# Create results directory
#-----
RESULTS_DIR="$(pwd)/${SLURM_JOB_NAME}-outputs/${SLURM_JOB_ID}"
echo "Your results will be stored in: $RESULTS_DIR"
mkdir -p "$RESULTS_DIR"

#=====
# Application launch commands
#-----
# Customize this section to suit your needs.

echo "Executing job commands, current working directory is $(pwd)"

# REPLACE THE FOLLOWING WITH YOUR APPLICATION COMMANDS

echo "Hello, dmog" > $RESULTS_DIR/test.output
echo "This is an example job. It ran on `hostname -s` (as `whoami`)." >> $RESULTS_DIR/
↪test.output
echo "Output file has been generated, please check $RESULTS_DIR/test.output"

```

## Parallel (mpi) job

```

#!/bin/bash -l

##### Part-1 Slurm directives #####
## Working dir
## SBATCH -D /users/abc123/example/path
## Environment variables
#SBATCH --export=ALL
## Output and Error Files
#SBATCH -o job-%j.output
#SBATCH -e job-%j.error
## Job name
#SBATCH -J parallel-mpi-test
## Run time: "hours:minutes:seconds", "days-hours"
#SBATCH --time=00:05:00
## Memory limit (in megabytes). Total --mem or amount per cpu --mem-per-cpu
#SBATCH --mem-per-cpu=1024
## Processing slots
#SBATCH --nodes=2
#SBATCH --ntasks=32

```

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```

## Specify partition
#SBATCH -p nodes

##### Part-2 Shell script #####
#=====
# Activate Flight Environment
#-----
source "${flight_ROOT:-/opt/flight}"/etc/setup.sh

#=====
# Activate Package Ecosystem
#-----
# e.g.:
# Load the OpenMPI module for access to `mpirun` command
flight env activate gridware
module load mpi/openmpi

if ! command -v mpirun &>/dev/null; then
    echo "No mpirun command found, ensure that a version of MPI is installed and
↪available in PATH" >&2
    exit 1
fi

#=====
# Create results directory
#-----
RESULTS_DIR="$(pwd)/${SLURM_JOB_NAME}-outputs/${SLURM_JOB_ID}"
echo "Your results will be stored in: $RESULTS_DIR"
mkdir -p "$RESULTS_DIR"

#=====
# Application launch commands
#-----
# Customize this section to suit your needs.

echo "Executing job commands, current working directory is $(pwd)"

# REPLACE THE FOLLOWING WITH YOUR APPLICATION COMMANDS

echo "Hello, dmog" > $RESULTS_DIR/test.output
echo "This is an example job. It was allocated $SLURM_NTASKS slot(s) across $SLURM_JOB_
↪NUM_NODES node(s). The master process ran on `hostname -s` (as `whoami`)." >>
↪$RESULTS_DIR/test.output
mpirun -np $SLURM_NTASKS \
    /bin/bash -c \
    'echo "This process was executed on `hostname -s` with rank $OMPI_COMM_WORLD_RANK."' >>
↪
>> $RESULTS_DIR/test.output

echo "Output file has been generated, please check $RESULTS_DIR/test.output"

```

## GPU job

```
#!/bin/bash -l

##### Part-1 Slurm directives #####
## Working dir
## SBATCH -D /users/abc123/example/path
## Environment variables
#SBATCH --export=ALL
## Output and Error Files
#SBATCH -o job-%j.output
#SBATCH -e job-%j.error
## Job name
#SBATCH -J gpu-test
## Run time: "hours:minutes:seconds", "days-hours"
#SBATCH --time=00:05:00
## Memory limit (in megabytes). Total --mem or amount per cpu --mem-per-cpu
#SBATCH --mem-per-cpu=1024
## GPU requirements
#SBATCH --gres gpu:1
## Specify partition
#SBATCH -p gpu

##### Part-2 Shell script #####
#=====
# Activate Flight Environment
#-----
source "${flight_ROOT:-/opt/flight}/etc/setup.sh

#=====
# Activate Package Ecosystem
#-----
# e.g.:
# Load the OpenMPI module for access to `mpirun` command
flight env activate gridware
module load mpi/openmpi

if ! command -v mpirun &>/dev/null; then
    echo "No mpirun command found, ensure that a version of MPI is installed and
    ↪available in PATH" >&2
    exit 1
fi

#=====
# Create results directory
#-----
RESULTS_DIR="$(pwd)/${SLURM_JOB_NAME}-outputs/${SLURM_JOB_ID}"
echo "Your results will be stored in: $RESULTS_DIR"
mkdir -p "$RESULTS_DIR"

#=====
# Application launch commands
#-----
```

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```
# Customize this section to suit your needs.

echo "Executing job commands, current working directory is $(pwd)"

# REPLACE THE FOLLOWING WITH YOUR APPLICATION COMMANDS

echo "Hello, dmog" > $RESULTS_DIR/test.output
echo "This is an example job. It ran on `hostname -s` (as `whoami`)." >> $RESULTS_DIR/
↪test.output
echo "I was allocated the following GPU devices: $CUDA_VISIBLE_DEVICES" >> $RESULTS_DIR/
↪test.output
echo "Output file has been generated, please check $RESULTS_DIR/test.output"
```

## 1.14 Interactive Jobs

When debugging or developing code, interactive testing is often necessary. However, running interactive jobs directly on the login node can cause overloading. It is recommended to run interactive jobs on the compute nodes instead. This allows you to debug your code in the same environment that it will run in.

Resource allocation for interactive jobs is done through the command line.

To start an interactive session on CPU node:

```
srun --nodes=1 --ntasks-per-node=32 --mem=1024 --time=00:05:00 --partition=nodes --pty /
↪usr/bin/bash
```

On a GPU enabled node, the command is very similar:

```
srun --nodes=1 --ntasks-per-node=32 --mem=1024 --time=00:05:00 --partition=gpu --
↪gres=gpu:1 --pty /usr/bin/bash
```

## 1.15 Making dynamic jobs scripts

Slurm provides several environment variables at runtime that can be used to create more dynamic submission scripts. These variables can be used to specify the job name, set the number of nodes or tasks, and much more. Here are some of the main environment variables that Slurm creates at runtime:

- `SLURM_JOB_NAME`: The name of the job
- `SLURM_JOB_ID`: The job ID number
- `SLURM_JOB_CPUS_PER_NODE`: The number of CPUs per node
- `SLURM_JOB_NODELIST`: The list of nodes allocated to the job
- `SLURM_ARRAY_TASK_ID`: The index of the job within an array job

In addition, Slurm also supports using format characters in submission scripts to define directives. These format characters can be used to dynamically specify options such as the output file name or the number of nodes to use. Here are some of the most common format characters:

- `%j`: Job ID
- `%N`: Node name

- %u: User name
- %a: Array job ID
- %A: Array job ID range

By using these environment variables and format characters, you can create more dynamic and flexible submission scripts that can adapt to different job requirements. For example, you can use the %j format character to dynamically specify the output file name based on the job ID, or use the SLURM\_JOB\_CPUS\_PER\_NODE variable to dynamically set the number of CPUs to use.

## 1.16 A word on OpenFlightHPC

We have installed OpenFlightHPC on our cluster to provide a robust and scalable HPC management solution for our users. With OpenFlightHPC, users have access to a suite of tools that can help them manage their jobs and resources more effectively, improving the overall efficiency and productivity of the cluster. Additionally, the modular nature of OpenFlightHPC allows us to easily add new functionality and adapt the system to meet evolving needs.

### 1.16.1 HPC User environments (flight env)

User environments (i.e flight environments) are software environments that have been pre-configured to support specific applications or workflows on an HPC cluster. They typically include a specific combination of software libraries, compilers, and tools that are required to run the application or workflow effectively.

On DMOG, there are several flight environments available to users, including Gridware, Conda, and Singularity. Gridware is a package manager that provides access to a range of pre-built software packages that have been compiled for use on the cluster, including the Modules package that allows you to load and manage software modules on the cluster. Conda is an open-source package management system and environment management system that makes it easy to install and manage multiple software packages on the cluster. Singularity is a containerization tool that allows you to create and run containers that encapsulate specific software environments and dependencies.

By providing these flight environments on the cluster, we aim to make it easier for users to access the software and tools they need to complete their work. Each flight environment has its own unique features and benefits. You can easily explore and manage the flight environments available on the cluster by using these commands:

- `flight env avail`: This command will display a list of all the available flight environments on the cluster. It will show you the name of each environment, as well as a brief description of its purpose and contents.
- `flight env activate <env_name>`: This command is used to activate a specific flight environment on the cluster. Replace <env\_name> with the name of the environment you want to activate. Once activated, any commands you run will be executed within the selected environment.
- `flight env info`: This command will display detailed information about the currently active flight environment, including the environment's name, description, and location on the cluster.
- `flight env deactivate`: This command is used to deactivate the currently active flight environment. Once deactivated, any commands you run will be executed outside of the selected environment.

## 1.16.2 Remote desktop (flight desktop)

When working on interactive applications on an HPC cluster, it can often be difficult to test and fine-tune your workflows, especially when you're working remotely. That's where Flight desktop comes in. By providing a desktop environment that you can access remotely, Flight desktop gives you the flexibility to work on your applications from your desktop or laptop computer as if they were running locally.

Now, let's look at the pre-requisites for Windows, Mac, and Linux:

- **Windows:**
- **VNC viewer:** You will need to install a VNC viewer, such as TightVNC or RealVNC, to connect to your Flight Desktop session.
- **SSH client:** You will need to install an SSH client, such as PuTTY, to connect to your HPC cluster account and launch Flight Desktop.
- **Mac:**
  - **VNC viewer:** You can use the built-in Screen Sharing app on Mac to connect to your Flight Desktop session, or you can install a third-party VNC viewer such as RealVNC.
  - **SSH client:** The built-in Terminal app on Mac can be used as an SSH client to connect to your HPC cluster account and launch Flight Desktop.
- **Linux:**
  - **VNC viewer:** You can install a VNC viewer, such as Remmina or TigerVNC, to connect to your Flight Desktop session.
  - **SSH client:** Most Linux distributions come with an SSH client pre-installed, so you should be able to use your system's built-in SSH client to connect to your HPC cluster account and launch Flight Desktop.

To launch a flight desktop environment, follow these steps:

1. Log in to your HPC cluster account.
2. Open a terminal window and type `flight desktop start <desktop-name>` to launch Flight Desktop. If you're unsure what name to use, you can find the list of available desktop sessions by typing `flight desktop avail`.
3. Wait for the desktop environment to start up. Be patient, this may take a few minutes.
4. Once the desktop environment has started, you can connect to it using a VNC viewer. The specific details for connecting to Flight Desktop will be shown on the screen once the desktop session is created and can be retrieved by using this command: `flight desktop show <sessionid>`, where `sessionid` is the ID for the specific session.
5. Note that the desktop sessions are created on the login node, and they must be terminated manually by the user when they are no longer needed. To do so, you can use the `flight desktop kill <sessionid>` command.

For further information on using Flight Desktop, you can consult the online manual available through `flight help desktop`.

### 1.16.3 Disabling OpenFlightHPC

OpenFlightHPC is a powerful tool for HPC users, but there may be situations where users want to disable it. Some reasons for disabling OpenFlightHPC could include avoiding potential conflicts with other software installed on the cluster, or simply not needing any of the features provided by OpenFlightHPC.

To disable OpenFlightHPC, users can issue the `flight stop` command, which will stop any currently running Flight services. Additionally, users can use the `flight set always off` command to disable Flight services from starting up automatically in the future. It's important to note that these commands only affect the user who issues them and not the entire cluster.

## 1.17 Software Management

### 1.17.1 System software

HPC clusters typically have many users with varying software requirements and installing software for each user can be time-consuming and may lead to conflicts between different versions of the same software.

Modules provide a way to manage software installations and make different versions of the same software available to users on demand. With modules, users can load and unload different versions of software into their environment without interfering with other users or the system's default settings. This makes it easy for users to work with different versions of the same software or to use different software packages for different projects or workflows.

---

**Note:** Please note that the easiest way to use modules is by activating the gridware user HPC environment (`flight env activate gridware`).

Some of the most useful commands for interacting with modules include:

---

- `module avail`: This command lists all the available modules on the system, showing the name, version, and any dependencies.
- `module load`: This command loads a specific module into the user's environment, making its executable and library files available for use.
- `module unload`: This command unloads a previously loaded module, removing its executable and library files from the user's environment.
- `module list`: This command lists all the currently loaded modules, showing their name and version.
- `module show`: This command displays detailed information about a specific module, including its version, dependencies, and any available module options.

### 1.17.2 Installing new software

In general, installing software on DMOG may require root access, as it often involves making changes to the system's configuration and installing packages in system directories that are only accessible to the root user.

However, there are alternative ways to install and manage software that do not require root access. For example, users may be able to install software in their home directories or in a designated software directory that's writable by users.

If you're not sure whether you need root access to install software on your cluster, it's a good idea to contact the cluster's system administrators for guidance.

### 1.17.3 Requesting new software

If you require software that is not currently available on the cluster and could benefit the broader user community, please contact the cluster support team at [ISHelp@hw.ac.uk](mailto:ISHelp@hw.ac.uk). They can assist you in installing the software or evaluating its suitability for the cluster. This will also help other users who may require the same software. Please note that the support team will evaluate the software for security and compatibility issues before installing it on the cluster.

## 1.18 Hardware

The DMOG HPC cluster consists of 25 compute nodes connected by a high-speed Ethernet network. Of these, 10 nodes are equipped with GPU cards, while the remaining nodes are CPU-only. A Lustre parallel filesystem serves shared scratch space across the cluster, maximizing the performance of the underlying hardware. Home directories are shared via NFS.

### 1.18.1 CPU compute nodes

There are three types of CPU compute node available on the DMOG HPC cluster:

#### Low Core Count Nodes

There are ten low core count nodes. Each node contains two 2.6 GHz, 32-core AMD EPYC 7513 processors and 1TB of RAM. Hyperthreading is disabled by default, but the processors support it if needed. A local SSD disk of 1TB is available on the nodes.

#### Medium Core Count Nodes

There are five medium core count nodes. Each node is equipped with two 2.3GHz, 48-core AMD EPYC 7643 processors and 1TB of RAM. Hyperthreading is disabled on these nodes. A local SSD disk is available for high throughput. These nodes are well-suited for CPU-intensive workloads.

#### High Core Count Nodes

There are six high core count nodes available. Each node is equipped with two 2.45GHz, 64-core AMD EPYC 7763 processors and 1TB of RAM. Hyperthreading is disabled on these nodes. A local SSD disk is available for high throughput. These nodes are well-suited for highly parallelised, CPU-intensive workloads.

### 1.18.2 GPU compute nodes

The DMOG HPC cluster includes 22 compute nodes equipped with GPU cards. Each node is equipped with 2 Nvidia A40 (48GB) cards, 2 32-core AMD EPYC 7543 32-Core Processor, and 512GB of RAM. These nodes are well-suited for workloads that require significant GPU computing resources, such as deep learning, or artificial intelligence.

### 1.18.3 Storage

The DMOG HPC cluster provides a Lustre parallel file system that serves the shared scratch directory. This file system has a total capacity of 93TB and is the primary storage location for processing data. In addition to the Lustre file system, there are also several other volumes available on the cluster that are presented as NFS exports. These volumes are intended for specific use cases, such as software installations or backups, and are not part of the Lustre file system:

- /mnt/data/: 30TB
- /users/: 12TB of shared space for home directories
- /mnt/scratch/: 93TB of high read/write bandwidth for parallel calculations
- /tmp/: 1TB SSD locally attached to the node

### 1.18.4 Networking

The nodes on the cluster are connected through high-speed Ethernet switches, enabling fast and efficient communication between nodes.

## 1.19 hwEfficiency

hwEfficiency allows you to check the CPU and memory efficiency of your successfully completed jobs. It will also provide information about number of successful jobs, waittime, runtime, and power usage.

It is intended to assist you with ensuring you are only requesting the resources you require, as requesting too much memory, for example, may cause your job(s) to wait in the queue for much longer than needed.

The tool will ask you which username you'd like to check the jobs for (defaulting to your own), and how many days back you'd like to check for jobs.

An example output:

```
[gp27@login1 [dmog] scripts]$ hwEfficiency
Enter username to check [gp27]:
Enter duration to check in days [30]:

Total number of valid jobs: 2
Average CPU efficiency: 1.05%
Average maximum memory efficiency: 2.67%
Average waittime: 00:00:00
Average runtime: 00:16:15
Average power usage: .1571kWh
Total power usage: .3142kWh
```

To assist with testing resource requests for jobs, it is also possible to check the efficiency of a single job by providing a job ID when you run the command, like so:

```
[gp27@login1 [dmog] scripts]$ hwEfficiency 189624

Total number of valid jobs: 1
Average CPU efficiency: 94.86%
Average maximum memory efficiency: 8.85%
Average waittime: 00:00:02
```

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```
Average runtime: 21:41:07
Average power usage: 13.6070kWh
Total power usage: 13.6070kWh
```

## 1.20 hwInteractive

There are currently 2 hwInteractive tools available, hwCPUInteractive, and hwGPUInteractive.

These tools allows you to create an interactive job to connect to one of the compute nodes, CPU or GPU node respectively. Useful for testing things out as running code on the login node, or on a compute node outside of a job is not allowed and the processes will be terminated.

An example output:

```
[gp27@login1 [dmog] scripts]$ hwCPUInteractive
flight start: Flight Direct environment is already active.
[gp27@node06 [dmog] scripts]$
```

The resources requested using these tools are quite limited, but if you'd like to adjust this you can just make a copy of the tool in your home directory and edit the values. The current tools look like this:

```
hwCPUInteractive:
srun --job-name "interactiveCPU" --cpus-per-task 16 --mem-per-cpu 1000 --time 00:30:00 --
↳pty /usr/bin/bash

hwGPUInteractive:
srun --job-name "interactiveGPU" --cpus-per-task 8 --mem-per-cpu 1024 --partition=gpu --
↳gres=gpu:1 --time 00:30:00 --pty /usr/bin/bash
```

## 1.21 hwNodes

hwNodes will provide you with a high level overview of the status of all DMOG compute nodes.

An example output:

```
[gp27@login1 [dmog] scripts]$ hwNodes
NODELIST          CPUS S:C:T  MEMORY  ALLOCMEM  FREE_MEM  GRES  GRES_USED  ↵
↳ CPUS(A/I/O/T)  CPU_LOAD  STATE   REASON
=====
gpu01             64  2:32:1  256000  0          39990    gpu:2  gpu:0      ↵
↳ 0/64/0/64      0.00     idle   none
gpu02             64  2:32:1  256000  0          142873  gpu:2  gpu:0      ↵
↳ 0/64/0/64      0.00     idle   none
gpu03             64  2:32:1  256000  102400    72185   gpu:2  gpu:1      ↵
↳ 1/63/0/64      0.68     mixed  none
gpu04             64  2:32:1  256000  0          85584   gpu:2  gpu:0      ↵
↳ 0/64/0/64      0.00     idle   none
gpu05             64  2:32:1  256000  0          102740  gpu:2  gpu:0      ↵
↳ 0/64/0/64      0.00     idle   none
node01           64  2:32:1  514048  185168    484965  (null)  gpu:0      ↵
↳ 64/0/0/64     14.47    allocated  none
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```

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node02	64	2:32:1	514048	131072	248131	(null)	gpu:0	↳
↳	32/0/32/64	33.00	draining	Kill task failed				
node03	64	2:32:1	514048	54520	410692	(null)	gpu:0	↳
↳	64/0/0/64	61.06	allocated	none				
node04	64	2:32:1	514048	59040	302075	(null)	gpu:0	↳
↳	64/0/0/64	52.00	allocated	none				
node05	64	2:32:1	514048	262144	407828	(null)	gpu:0	↳
↳	64/0/0/64	65.00	allocated	none				

## 1.22 hwPending

hwPending will display all of your currently pending jobs, including the reason for the job being in the pending state.

An example output:

```
[gp27@login1 [dmog] scripts]$ hwPending
```

JOBID	USER	PARTIT	SUBMIT_TIME	START_TIME	REASON	PRIORITY	TIME_LIMIT	↳
↳	SCHEDNODES	QOS	TRES_ALLOC					
189262	gp27	gpu	2025-02-20T17:38:04	N/A	Dependency	1071	6-00:00:00	↳
↳	(null)	highlimits	cpu=2,mem=450G,node=1,billing=2,gres/gpu=1					
189260	gp27	gpu	2025-02-20T17:38:04	N/A	Dependency	1071	6-00:00:00	↳
↳	(null)	highlimits	cpu=2,mem=450G,node=1,billing=2,gres/gpu=1					
189258	gp27	gpu	2025-02-20T17:38:04	N/A	Dependency	1071	6-00:00:00	↳
↳	(null)	highlimits	cpu=2,mem=450G,node=1,billing=2,gres/gpu=1					
189256	gp27	gpu	2025-02-20T17:38:04	N/A	Dependency	1071	6-00:00:00	↳
↳	(null)	highlimits	cpu=2,mem=450G,node=1,billing=2,gres/gpu=1					
189254	gp27	gpu	2025-02-20T17:38:04	N/A	Dependency	1071	6-00:00:00	↳
↳	(null)	highlimits	cpu=2,mem=450G,node=1,billing=2,gres/gpu=1					

For collaborative purposes, it's possible to check the pending state of another user's jobs by entering their username when running the command:

```
[gp27@login1 [dmog] scripts]$ hwPending jm130
```

JOBID	USER	PARTIT	SUBMIT_TIME	START_TIME	REASON	PRIORITY	TIME_LIMIT	↳
↳	SCHEDNODES	QOS	TRES_ALLOC					
181992	jm130	nodes	2025-02-06T11:57:44	N/A	QOSMaxCpuPerUserLimit	2030	3-00:00:00	↳
↳	(null)	userlimits	cpu=48,mem=16G,node=1,billing=48					
181991	jm130	nodes	2025-02-06T11:57:03	N/A	QOSMaxCpuPerUserLimit	2030	3-00:00:00	↳
↳	(null)	userlimits	cpu=48,mem=16G,node=1,billing=48					
181990	jm130	nodes	2025-02-06T11:56:32	N/A	QOSMaxCpuPerUserLimit	2030	3-00:00:00	↳
↳	(null)	userlimits	cpu=48,mem=16G,node=1,billing=48					
181989	jm130	nodes	2025-02-06T11:55:49	N/A	QOSMaxCpuPerUserLimit	2030	3-00:00:00	↳
↳	(null)	userlimits	cpu=48,mem=16G,node=1,billing=48					
181988	jm130	nodes	2025-02-06T11:55:16	N/A	QOSMaxCpuPerUserLimit	2030	3-00:00:00	↳
↳	(null)	userlimits	cpu=48,mem=16G,node=1,billing=48					

## 1.23 hwQuota

The hwQuota utility will display your current storage space and file count utilization across a number of directories.

An example output would be:

```
[gp27@login1 [dmog] scripts]$ hwQuota
/export/users/gp27 | 39.09GiB | 26.06% of your quota
  Number of files used: 218k | 43.60% of your quota
/mnt/scratch/gp27 | 0GiB | 0.00% of used space
/mnt/data/shared/gp27 | 7.93GiB | 0.03% of used space
```

The top line will show you how much space the files in your home directory (excluding the other folders shown), and the percentage of your quota you have used.

The second line shows how many files you have in your home directory, and what percentage of your number of files quota you're using.

The next lines will show you how much space the files in the listed directories take up. Because there is no quota for these folders, it shows you a percentage of all used space in that location you are using (your share of the space used).

## 1.24 hwStatus

hwStatus provides a very high level view of the current status of the DMOG queue

An example output:

```
..code-block:: bash [gp27@login1 [dmog] scripts]$ hwStatus CPU cores in use: 520/1120 GPUs in use: 17/40 Total
jobs running: 33 Total jobs in queue: 33
```

## 1.25 hwVSCode

This tool is used to create a job in the system which you can connect to via VS Code for development or testing purposes.

There is also a version if a GPU is required: hwVSCodeGPU

To use this tool, please first modify/create your SSH config file (Windows: C:\users\[username]\.ssh\config Mac/Linux: ~/.ssh/config) to include the following:

---

**Note:** You may need to create the '.ssh' folder and the 'config' config file if they are not already there.

---

```
Host dmog
  User [YOUR USERNAME]
  IdentityFile [PATH TO YOUR DMOG SSH PRIV KEY]
  ControlMaster auto
  HostName dmog.hw.ac.uk

Host hpc-job
  User [YOUR USERNAME]
  IdentityFile [PATH TO YOUR DMOG SSH PRIV KEY]
```

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```
ProxyCommand ssh dmog 'nc $(squeue --me --name=vsCode --states=R -h -O NodeList) $(< ~/
↪hwTunnelPort)'
```

```
StrictHostKeyChecking no
```

**Note:** If your computer is using Windows 10 you will need to use double quotes (“”), instead of the single quotes (‘’) as shown above.

When hwVSCode is run, it creates a small file in your home directory called hwTunnelPort. This file contains the port number used by the job, which your SSH config above tells VS Code to use to connect to the compute node.

An example output:

```
[gp27@login1 [dmog] ~]$ hwVSCode

Submitting VSCode CPU job...done.
VSCode job started.
JobID: 195659
Port used: 2222
End time: Wed 5 Mar 18:02:59 GMT 2025

To cancel job early: scancel 195659
```

Once you have run the tool, you can connect to DMOG using VS Code by clicking Remote Explorer on the left, then clicking the arrow next to hpc-job on the list of remotes.

Please note that depending on how busy the cluster is, your job may not start immediately and be put in the queue. Should this happen you’ll see an output like this:

```
[gp27@login1 [dmog] scripts]$ ./hwVSCode

Submitting VSCode CPU job...done.
VSCode job queued.
Job ID: 195655
Port Used: 2361

Job waiting to start. Please monitor job using 'squeue -j 195655' to see when it starts.
```

## 1.26 ABAQUS

To use Abaqus on DMOG, first you need to create an input file from the model you are looking to submit. You can do this in Abaqus CAE on your PC by right-clicking on the job you want to run on DMOG and select Write Input. This will create a file with the same name as the job’s name.

Next, copy your input file from earlier to DMOG. Then, to submit a job to DMOG create a script file (or using one you already have) similar to this (replacing the info in the [ ]):

```
#!/bin/bash
#Settings for Slurm
#SBATCH --job-name=[name for your job]
#SBATCH --ntasks-per-node=[number of CPU threads]
```

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```

#SBATCH --mem-per-cpu=[how much member (in MB) per CPU thread]
#SBATCH --time=[estimate of how long your job will take. eg. 05:00:00]

#Activate Abaqus software
flight start
flight env activate gridware
module load apps/abaqus/2024+e19fix

#Run Abaqus using input file
abaqus job=[nameForYourJob] input=[yourInputFile].inp cpus=$SLURM_JOB_CPUS_PER_NODE_
↪interactive

```

The values next to `-cpus-per-task`, `-mem-per-cpu`, and `-time` can be adjusted as needed to suit your job. Please note that higher values next to `-cpus-per-task` and `-mem` may mean that your job has to wait for a while before these resources are available.

More info on the SBATCH values can be found here: [Job Submission](#)

Once you have created the script file you can submit the job by running this command:

```
sbatch yourscrip.sh
```

Note that this will need to be run from within the folder where the `.inp` file is, or specify the full path to it in your script.

Once your job is submitted, you can monitor it either via the `sacct` command, or by using:

```
tail -f [yourJobName].sta
```

or

```
tail -f [yourJobName].msg
```

### 1.26.1 Abaqus Python

Abaqus has it's own Python interpreter, to use this you will need to use a specific version of Abaqus on DMOG.

You can load this with the following commands:

```

flight start
flight env activate gridware
module load apps/abaqus/2024

```

## 1.27 AMBER

AMBER (Assisted Model Building with Energy Refinement) is a widely used software package for molecular dynamics simulations of biomolecules. It allows users to simulate the motion and behaviour of molecules in a variety of conditions, such as in different solvents or under different temperatures.

On DMOG, users can access AMBER by activating the gridware `flight` environment using the command `flight env activate gridware`. Once activated, the AMBER package module can be loaded using the command `module load apps/amber/22/gcc-12.2.0`. This will make the AMBER tools and executables available for use on the cluster.

AMBER includes several executables that are commonly used for molecular dynamics simulations. Some of the most frequently used executables include:

- **sander**: The main molecular dynamics engine used in AMBER, which can perform energy minimization, equilibrium simulations, and production runs.
- **pmemd**: An optimized version of sander that can run on GPUs, which can significantly accelerate molecular dynamics simulations.
- **cpptraj**: A utility that can perform a variety of tasks related to analyzing and processing the output from AMBER simulations, such as calculating RMSDs, extracting specific frames from a trajectory, and generating input files for other programs.

### 1.27.1 Running AMBER jobs

An example job script for AMBER would be:

```
#!/bin/bash
#SBATCH --job-name=amber
#SBATCH --nodes=1
#SBATCH --ntasks-per-node=32
#SBATCH --cpus-per-task=1
#SBATCH --time=1:00:00
#SBATCH --mem=128G
#SBATCH --partition=nodes

# Load required modules
flight env activate gridware
module load apps/amber/22/gcc-12.2.0

# Change to the directory where input files are located
cd /path/to/input/files

# Run the Amber simulation
srun --mpi=pmi2 $AMBERHOME/bin/pmemd.MPI -O -i input.in -o output.out -p prmtop -c_
↳ inpcrd -r output.rst
```

In this script, the job is named “amber” and will run on a single node with 32 tasks (processes) per node, using 1 CPU per task. The requested memory is 128GB and the job has a maximum runtime of 1 hour. The “nodes” partition is specified.

The required modules for Amber and Gridware are loaded, and the script changes to the directory where the input files for the simulation are located. Finally, the Amber simulation is run using the *srun* command with the appropriate arguments.

## 1.28 Ansys

Ansys can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/ansys
```

Here is an example of a full submission script for Ansys Fluent (provided by Assistant Professor Fabio Malizia):

```
#!/bin/bash -l
##### Part-1 Slurm directives #####
```

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```

# Working dir
##SBATCH -D /users/USERNAME/SimFolder ## Deactivated because the batch file is in the_
↳ same folder
## Job name
#SBATCH -J JobName
## Environment variables
#SBATCH --export=ALL
## Output and Error Files
#SBATCH -o job-%j.output
#SBATCH -e job-%j.error
## Run time: "hours:minutes:seconds", "days-hours"
#SBATCH --time=144:05:00
## Memory limit (in megabytes). Total --mem or amount per cpu --mem-per-cpu
##SBATCH --mem-per-cpu=1024
#SBATCH --mem=464000
## Processing slots
#SBATCH --nodes=1
#SBATCH --ntasks=64
## Specify partition
#SBATCH -p nodes

##### Part-2 Shell script #####
#=====
# Activate Flight Environment for Ansys Fluent
#-----
source "${flight_ROOT:-/opt/flight}/etc/setup.sh
# Load modules
flight start
flight env activate gridware
#Load required Ansys version
module load apps/ansys/2024.2
#module load apps/ansys/2025.2

#=====
# Create results directory
#-----
#RESULTS_DIR="$(pwd)/${SLURM_JOB_NAME}-outputs/${SLURM_JOB_ID}"
RESULTS_DIR="$(pwd)/${SLURM_JOB_ID}"
echo "Your results will be stored in: $RESULTS_DIR"
mkdir -p "$RESULTS_DIR"

#=====
# Application launch commands
#-----
# Customize this section to suit your needs.

echo "Executing job commands, current working directory is $(pwd)"

# Command time used to measure the time of the following command
# Add -meshing after 3ddp if you want to start fluent in meshing mode
time fluent 3ddp -t${SLURM_NPROCS} -ssh -gu -driver null -i journalFile.jou > $RESULTS_DIR/
↳ outputFile.out 2> $RESULTS_DIR/errorFile.err

```

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```
date ## echo the date at the end
echo end of job
```

## 1.29 Ansyssem

Ansyssem can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/ansyssem/2023.1
```

## 1.30 CMG

CMG can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/cmg/2024.104
```

## 1.31 CP2K

CP2k can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/cp2k/2023.2/gcc-12.2.0
```

## 1.32 CREST

CREST can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/crest
```

## 1.33 Delft3D

Delft3D can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/delft3d/4.65936/gcc-7.5.0
```

## 1.34 GeoChemFoam

GeoChemFoam can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/openfoamplus
module load apps/anaconda3
conda activate gcfoam
source /opt/gridware/depots/761a7df9/e19/share/openfoamplus/22.06/applications/utilities/
↳GeoChemFoam-5.1/etc/bashrc
```

**Note:** The above assumes you have created a GeoChemFoam conda environment as outlined in the GeoChemFoam Github repo [HERE](#)

## 1.35 Gromacs

Gromacs can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/gromacs_cuda/2023.2/gcc-11.4.1+nvidia-cuda-11.8.0+openmpi-4.1.5+python3-
↳3.10.5+fftw3_float-3.3.10+openblas-0.3.21
```

## 1.36 JAGS

JAGS can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/jags/4.3.1/gcc-11.4.1+lapack-3.10.0+blas-3.10.0
```

## 1.37 Julia

Julia is a high-level, high-performance programming language designed for numerical and scientific computing. It combines the ease of use and expressive power of high-level languages like Python with the performance of low-level languages like C.

To utilize Julia on the DMOG HPC cluster, follow the instructions below:

```
flight env activate gridware
module load apps/julia
```

Note that Julia runs alongside Python. Therefore, any additional dependencies required for your Julia programs need to be installed in your user workspace using Conda or Anaconda (see [Python](#) for further details). Make sure you have the necessary packages installed to fulfill your requirements.

By default, Julia packages are stored in the `.julia` directory located within your home directory. If you want to use a different path to store local packages, you can modify the `JULIA_DEPOT_PATH` environment variable:

```
export JULIA_DEPOT_PATH=/path/to/myjulia
```

This would only work in the current active session. To make it permanent, add that line in your `.bashrc` file.

## 1.38 LAMMPS

LAMMPS can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/lammps/20230802/gcc-11.4.1+fftw3_double-3.3.10+openblas-0.3.21+openmpi-
↪4.1.5+python3-3.10.5+ffmpeg-6.0.0
```

## 1.39 MAPLE

Maple can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/maple
```

## 1.40 Mathematica

Mathematica can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/mathematica/14.0
```

## 1.41 MATLAB

MATLAB is a high-level programming language and interactive environment widely used for numerical computation, visualization, and programming. It provides an extensive collection of mathematical functions, algorithms, and toolboxes for various areas of engineering, science, and finance. MATLAB is designed to make numerical analysis and data processing easier, faster, and more accurate. It is widely used in academia, research, and industry for a range of applications, from data analysis and visualization to control systems design and image processing.

MATLAB is available for use under the university's licenses for teaching and academic research purposes. If you need to use MATLAB for other purposes, please contact [ISHelp@hw.ac.uk](mailto:ISHelp@hw.ac.uk) for further guidance.

### 1.41.1 Running MATLAB jobs

To use MATLAB on the cluster, you need to load the MATLAB module first. You can do this by running the following commands in your terminal:

```
flight env activate gridware
module load apps/matlab/r2022b
```

To run MATLAB jobs on the cluster, you need to create a job script that contains the MATLAB commands that you want to run. Here is an example job script (`my_matlab_job.sh`):

```
#!/bin/bash
#SBATCH --job-name=my-matlab-job
#SBATCH --output=my-matlab-job.out
#SBATCH --error=my-matlab-job.err
#SBATCH --nodes=1
#SBATCH --cpus-per-task=4
#SBATCH --time=00:30:00

flight env activate gridware
module load apps/matlab/r2022b

matlab -nodesktop -nosplash -r "my_matlab_script"
```

This job script requests one node with four CPUs and a maximum run time of 30 minutes. It loads the MATLAB module and runs a MATLAB script called `my_matlab_script`. The output and error messages are written to `my-matlab-job.out` and `my-matlab-job.err` respectively.

Here is an example MATLAB script that calculates the sum of two numbers (`my_matlab_script.m`):

```
a = 5;
b = 10;
c = a + b;
disp(['The sum of a and b is ', num2str(c)]);
```

Save this script as `my_matlab_script.m` and put it in the same directory as your job script. To submit the job script to the cluster, run the following command in the terminal:

```
sbatch my_matlab_job.sh
```

This will submit the job script to the cluster, and you can monitor the job status using the `squeue` command.

Here is an example job script that requests a GPU node and uses the “gpu” queue (`my_matlab_gpu_job.sh`):

```
#!/bin/bash
#SBATCH --job-name=my-matlab-gpu-job
#SBATCH --output=my-matlab-gpu-job.out
#SBATCH --error=my-matlab-gpu-job.err
#SBATCH --nodes=1
#SBATCH --cpus-per-task=4
#SBATCH --gres=1
#SBATCH --partition=gpu
#SBATCH --time=00:30:00

flight env activate gridware
```

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```
module load apps/matlab/r2022b
module load apps/nvidia-cuda/11.2.2

matlab -nodesktop -nosplash -r "my_matlab_gpu_script"
```

This job script is like the previous one, but it requests a GPU node with one GPU and uses the “gpu” queue. It also loads the CUDA toolkit module to enable GPU acceleration in MATLAB.

Here is an example MATLAB script that uses the GPU to perform matrix multiplication (`my_matlab_gpu_script.m`):

```
a = gpuArray.rand(1000);
b = gpuArray.rand(1000);
c = a * b;
d = gather(c);
disp(d);
```

Save this script as `my_matlab_gpu_script.m` and put it in the same directory as your job script.

To submit the job script to the cluster, run the following command in the terminal:

```
sbatch my_matlab_gpu_job.sh
```

This will submit the job script to the “gpu” queue, and the cluster will allocate a GPU node for your job to run.

## 1.42 OpenFoam

OpenFOAM is a popular open-source computational fluid dynamics (CFD) software package used for simulating complex fluid flow problems. It provides a comprehensive range of tools for solving problems involving flow of fluids, including heat and mass transfer.

### 1.42.1 Running OpenFoam jobs

To run OpenFOAM on the cluster, you first need to load the appropriate module. On the DMOG cluster, the OpenFOAM module can be loaded using the following commands:

```
flight env activate gridware
module load apps/openfoamplus
```

**Note:** The default version of OpenFOAM is 22.06, but we also have 24.12 available. This can be loaded instead with:

```
module load apps/openfoamplus/24.12
```

Once you have loaded the module, you can run OpenFOAM applications using the standard OpenFOAM command line interface. Here are a couple of example jobscripts to get you started:

#### Example 1: Running an OpenFOAM job on the “nodes” queue

```
#!/bin/bash
#SBATCH --job-name=myOpenFOAMJob
#SBATCH --nodes=2
```

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```
#SBATCH --ntasks-per-node=16
#SBATCH --time=1:00:00
#SBATCH --partition=nodes

flight env activate gridware
module load apps/openfoamplus

mpirun -np $SLURM_NTASKS --hostfile $SLURM_JOB_NODELIST interFoam -parallel
```

### Example 2: Running an OpenFOAM job on the “gpu” queue (using GPUs)

```
#!/bin/bash
#SBATCH --job-name=myOpenFOAMJob
#SBATCH --nodes=1
#SBATCH --ntasks-per-node=8
#SBATCH --gres=gpu:1
#SBATCH --time=1:00:00
#SBATCH --partition=gpu

flight env activate gridware
module load apps/openfoamplus

mpirun -np $SLURM_NTASKS --hostfile $SLURM_JOB_NODELIST interFoam -parallel
```

In the above examples, we use the `mpirun` command to run the OpenFOAM application in parallel. The `-np` option specifies the number of processes to be run, and `--hostfile` specifies the file that contains the list of hosts to be used for the job.

## 1.43 OpenMolcas

OpenMolcas is a state-of-the-art quantum chemistry software package developed by scientists for scientists. It offers a comprehensive suite of programs for applying various electronic structure methods to chemical systems. One of its standout features is the multiconfigurational approach, incorporating advanced methods like CASSCF (Complete Active Space Self-Consistent Field) and CASPT2 (Complete Active Space Perturbation Theory). Unlike being a fork or reimplement, OpenMolcas is a substantial part of the Molcas codebase released as free and open-source software (FOSS) under the Lesser General Public License (LGPL). However, some portions of Molcas remain under a different license due to the decisions of their original authors or accessibility issues.

We have installed two versions of OpenMolcas on our HPC cluster: version 23.10 and version 24.02. Users can access these versions by enabling the gridware flight environment and loading the respective modules. Each version of OpenMolcas includes both serial and parallel executable files, facilitating efficient calculations on both single-core and multi-core processor systems.

For further reading and to understand the capabilities and advancements of OpenMolcas, we recommend the following references:

- “OpenMolcas: From Source Code to Insight.” *J. Chem. Theory Comput.* 15 (2019) 5925-5964. doi:10.1021/acs.jctc.9b00532
- “Modern quantum chemistry with [Open]Molcas.” *J. Chem. Phys.* 152 (2020) 214117. doi:10.1063/5.0004835
- “The OpenMolcas Web: A Community-Driven Approach to Advancing Computational Chemistry.” *J. Chem. Theory Comput.* 19 (2023) 6933-6991. doi:10.1021/acs.jctc.3c00182

**Note:** We are aware of an issue with the parallel build of OpenMolcas version 23.10, whereby some jobs may hang. If you encounter this issue, we recommend using OpenMolcas version 24.02 as an alternative.

### 1.43.1 Running OpenMolcas jobs

An example job script for OpenMolcas would be:

```
#!/bin/bash

#SBATCH --job-name=molcas-test
#SBATCH --nodes=1
#SBATCH --tasks-per-node=4
#SBATCH --time=100:00:00
#SBATCH --partition=nodes
#SBATCH --mem=50000MB
#SBATCH --output=molcas.%j.o
#SBATCH --error=molcas.%j.e

flight env activate gridware
module load apps/openmolcas_mpi/24.02
export MOLCAS_NPROCS=$SLURM_TASKS_PER_NODE

pymolcas molcas.input > MOLCAS.out
```

Where molcas.input is:

```
&GATEWAY
COORD
5

N      0.000000000    15.566997820    0.000000000
O      0.000000000    14.503597820    0.000000000
C      0.000000000     0.000000000    0.000000000
O      0.000000000    -1.160000000    0.000000000
O      0.000000000     1.160000000    0.000000000

GROUP = nosym
TITLE = Molcas-Test
BASIS = STO-3G

&SEWARD

&RASSCF
SPIN= 2
RAS2= 10
NACTEL = 13
INACTIVE = 12
CIROOT = 20 20 1
```

To submit a job using the provided Slurm script, you can use the following command:

```
sbatch submit_molcas.sh
```

## 1.44 OPM

OPM can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/opm/2023.10
```

## 1.45 ORCA

ORCA is a general-purpose quantum chemistry program package that features virtually all modern electronic structure methods (density functional theory, many-body perturbation and coupled cluster theories, and multireference and semiempirical methods). It is designed with the aim of generality, extendibility, efficiency, and user friendliness. Its main field of application is larger molecules, transition metal complexes, and their spectroscopic properties

Please note that ORCA does not currently support GPU acceleration. Therefore, when utilizing ORCA on our HPC cluster, it is essential to optimize job scripts and resource allocation for CPU-based calculations to achieve optimal performance.

### 1.45.1 Running ORCA jobs

To run ORCA on the HPC cluster, you need to load the appropriate software module:

```
flight env activate gridware
module load apps/ORCA
module load mpi/openmpi
```

Below is an example of a job script and input file for running a basic ORCA calculation:

```
#!/bin/bash

#SBATCH --job-name=orca-test
#SBATCH --nodes=1
#SBATCH --tasks-per-node=4
#SBATCH --time=1:00:00
#SBATCH --partition=nodes

export UCS_LOG_LEVEL=error

flight env activate gridware
module load apps/orca
module load mpi/openmpi

input=input.inp

$ORCADIR/orca ${input} > ${input}.out 2>&1
```

In the example, the job is submitted to the CPU queue (`--partition=nodes`). It reserves 4 cores for 1 hour.

The input file (`input.inp`):

```
! DLPNO-CCSD(T) cc-pVTZ cc-pVTZ/C cc-pVTZ/jk rijk verytightscf TightPNO LED
# Specify number of processors
%pal
nprocs 4
end
# Specify memory
%maxcore 12000
%mdci
printlevel 3
end
* xyz 0 1
O 1.327706 0.106852 0.000000
H 1.612645 -0.413154 0.767232
H 1.612645 -0.413154 -0.767232
O -1.550676 -0.120030 -0.000000
H -0.587091 0.053367 -0.000000
H -1.954502 0.759303 -0.000000
*
%geom
Fragments
2 {3:5} end
end
end
```

## 1.46 PHCpack

PHCpack can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/phcpack
```

## 1.47 Proj

Proj (formerly Proj4) can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/proj4/4.9.3/gcc-7.5.0
```

## 1.48 PSI4

PSI4 can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/psi4
```

## 1.49 Python

In shared facilities, Python is commonly managed using tools like Conda and Anaconda to ensure efficient and reliable environment management. On DMOG, the flight environment Conda and the Anaconda modules, offer a comprehensive solution for creating isolated and reproducible Python environments. These environments allow multiple users to work on the same system without conflicts, as each user can have their own customized Python environment with specific package versions and dependencies.

This approach ensures that Python-based projects on DMOG can be executed reliably and with minimal compatibility issues, enabling collaborative research and streamlined workflows.

### 1.49.1 Conda

Conda is an open-source package management system and environment management system. It allows you to create and manage isolated environments for different projects, ensuring that each project has its own set of dependencies and packages. Conda simplifies package installation, updating, and removal, making it easier to maintain a consistent and reproducible development environment.

To use conda you need to activate the relevant flight environment (replace <name> with the name of your environment):

```
flight env activate conda@<name>
```

The above command will fail if you haven't created Conda environment yet. To do so, just use the `flight env create` command as follows (replace <name> with a friendly name for your environment):

```
flight env create conda@<name>
```

Conda itself supports multiple user environments. The default environment is called `base`. You can use it to build your own custom workspace. The `conda` command enables you to list the currently installed packages, and also search and install new ones.

```
conda list
conda search <packagename>
conda install <packagename>
```

Alternatively, you can create new environment to suit your needs. For example to create a new environment called "myenv" with a specific version of Python:

```
conda create --name myenv python=3.9
```

To navigate across the different Conda environment you can use:

```
conda info --env
conda activate <name>
conda deactivate
```

If you prefer to search and install packages using `pip`, you can also use

```
pip list
pip search <packagename>
pip install <packagename>
```

## 1.49.2 Anaconda

Anaconda is a widely-used distribution of Python that comes bundled with a comprehensive collection of packages and tools for scientific computing and data analysis. On DMOG, Anaconda is available through the `flight env gridware` modules, which offer two separate modules—one for Python 2 and the other for Python 3. These modules provide users with a convenient way to access and utilize Anaconda for their research and data analysis tasks.

To use anaconda:

```
flight env activate gridware
module load apps/<anaconda/anaconda3>
```

Once the module is loaded, the same commands as for Conda apply to Anaconda.

The default environment is called `base`. You can use it to build your own custom workspace. The `conda` command enables you to list the currently installed packages, and also search and install new ones.

```
conda list
conda search <packagename>
conda install <packagename>
```

Alternatively, you can create new environment to suit your needs. For example to create a new environment called “myenv” with a specific version of Python:

```
conda create --name myenv python=3.9
```

To navigate across the different Conda environment you can use:

```
conda info --env
conda activate <name>
conda deactivate
```

If you prefer to search and install packages using `pip`, you can also use

```
pip list
pip search <packagename>
pip install <packagename>
```

## 1.50 Quantum Espresso

Quantum Espresso can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/quantumespresso/7.2/gcc-12.2.0+openmpi-4.1.5+fftw3_double-3.3.10+lapack-
↪3.10.0+blas-3.10.0
```

## 1.51 R

R is a programming language and software environment used for statistical computing and graphics. It provides a wide variety of statistical and graphical techniques, and is highly extensible. R is popular among researchers and data analysts in many fields, and is widely used in the academic and business communities.

### 1.51.1 Running R jobs

To run R on the HPC cluster, you need to load the appropriate software module:

```
flight env activate gridware
module load apps/R/4.2.3
```

To run R on the CPU queue, you need to create a job script that specifies the resources required for your job. Here is an example job script:

```
#!/bin/bash
#SBATCH --job-name=my_R_job
#SBATCH --output=output.log
#SBATCH --error=error.log
#SBATCH --partition=nodes
#SBATCH --nodes=1
#SBATCH --ntasks-per-node=1
#SBATCH --cpus-per-task=8
#SBATCH --time=01:00:00

# Load the R module
flight env activate gridware
module load R/4.2.3

# Run the R script
Rscript my_R_script.R
```

In this example, the job is submitted to the nodes partition, which is the default partition for CPU jobs. The job requests one node with 8 CPU cores (`--nodes=1` and `--cpus-per-task=8`). The job also requests a runtime of 1 hour (`--time=01:00:00`). The `my_R_script.R` file is the R script that you want to run.

To run R on the GPU queue, you need to use a different partition and request the appropriate resources.

```
#!/bin/bash
#SBATCH --job-name=my_R_job
#SBATCH --output=output.log
#SBATCH --error=error.log
#SBATCH --partition=gpu
#SBATCH --gres=gpu:1
#SBATCH --nodes=1
#SBATCH --ntasks-per-node=1
#SBATCH --cpus-per-task=4
#SBATCH --time=01:00:00

# Load the R module
flight env activate gridware
module load R/4.2.3
```

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```
# Run the R script
Rscript my_R_script.R
```

In this example, the job is submitted to the `gpu` partition, which is the partition for GPU jobs. The job requests one node with 1 GPU (`--gres=gpu:1`), 4 CPU cores (`--cpus-per-task=4`), and a runtime of 1 hour (`--time=01:00:00`). The `my_R_script.R` file is the R script that you want to run.

Here are a couple of simple R scripts that you can use to test your setup:

**Example 1: Hello World**

```
# Print "Hello, world!" to the console
cat("Hello, world!\n")
```

**Example 2: Basic Data Analysis**

```
# Load the built-in iris dataset
data(iris)

# Print the dimensions of the dataset
cat("Number of rows: ", nrow(iris), "\n")
cat("Number of columns: ", ncol(iris), "\n")

# Compute the mean of the Sepal.Length variable
mean_sepal_length <- mean(iris$Sepal.Length)
cat("Mean Sepal.Length: ", mean_sepal_length, "\n")
```

## 1.52 Stata

Stata can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/stata
```

## 1.53 Swan

Swan can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/swan/41.45/gcc-11.4.1+openmpi-4.1.5
```

## 1.54 Swash

Swash can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/swash/9.01/gcc-11.4.1+openmpi-4.1.5
```

## 1.55 VSCode

VSCode via Slurm

## 1.56 WarpX

WarpX can be enabled for use within your submission script (or interactively) with the following commands:

```
flight env activate gridware
module load apps/warpx/23.06/gcc-12.2.0+openmpi-4.1.5+hdf5_mpi-1.12.2
```