

Cambridge Pathology

Introduction to High-Performance Computing

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Outline

We will cover:

- ① how to create an account,
- ② logging in,
- ③ types of data storage,
- ④ types of compute nodes,
- ⑤ running jobs,
- ⑥ how to check on the status of jobs,
- ⑦ how to set up environments.

Account Creation

Link for account creation:

www.hpc.cam.ac.uk/applications-access-research-computing-services

Workflow:

- 1 Have your PI create an account first (if they haven't already).
- 2 Students/postdocs/staff apply for their own account.
- 3 PI gets an Email to approve student/postdoc/staff account creation, linking to lab's account.
- 4 Set up multifactor authentication.

Resources Available Per Account

Computing Resources Per Lab Account

- 200,000 CPU hours per PI per quarter.
- 3,000 GPU hours per PI per quarter.
- Refreshes on first of: Nov, Feb, May, Aug.

Data Storage Per User Account

1 TB in rds/hpc-work (hot storage; not backed up).

Setting up Multifactor Authentication

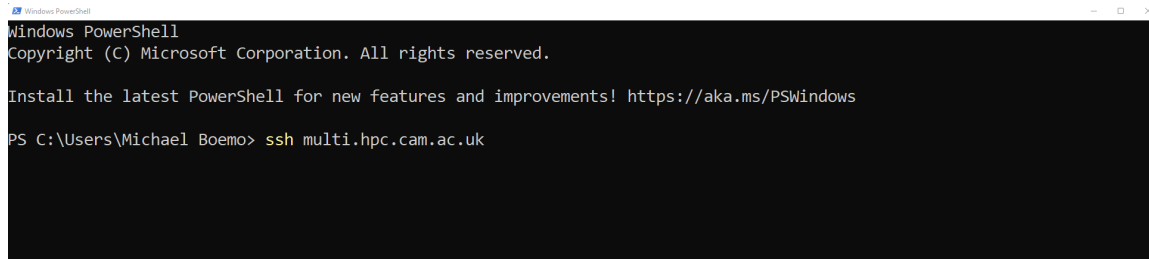
Download and install Microsoft Authenticator app on your phone:

<https://www.microsoft.com/en-us/security/mobile-authenticator-app>

(You probably already have this for Outlook login.)

Open PowerShell (Windows) or a terminal (OSX or Linux).

Type: `ssh multi.hpc.cam.ac.uk`



```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\Michael Boemo> ssh multi.hpc.cam.ac.uk
```

Setting up Multifactor Authentication

Enter your username and password.

Username: CRSid

Password: Raven password

From phone app: tap “+” in the right corner.

Scan the QR code that appears in the terminal.

Phone app will show a 6-digit TOTP code.

(Code changes every 30 seconds.)

Enter TOTP code in terminal.

Connection should terminate.



Ways to Log In

Command Line

- submit jobs,
- move files around,
- ftp files between servers,
- PowerShell or PuTTY (Windows) or terminal (OSX or Linux).

FTP Client

- move files between your computer and the server,
- graphical user interface,
- FileZilla (Windows, OSX), CyberDuck (Windows, OSX), Nautilus (Ubuntu).

Logging In (Command Line)

Windows PowerShell

Windows PowerShell

Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! <https://aka.ms/PSWindows>PS C:\Users\Michael Boemo> `ssh mb915@login-cpu.hpc.cam.ac.uk`

[illegible]

Password:

Logging In (Command Line)

[illegible]

Logging In (Command Line)

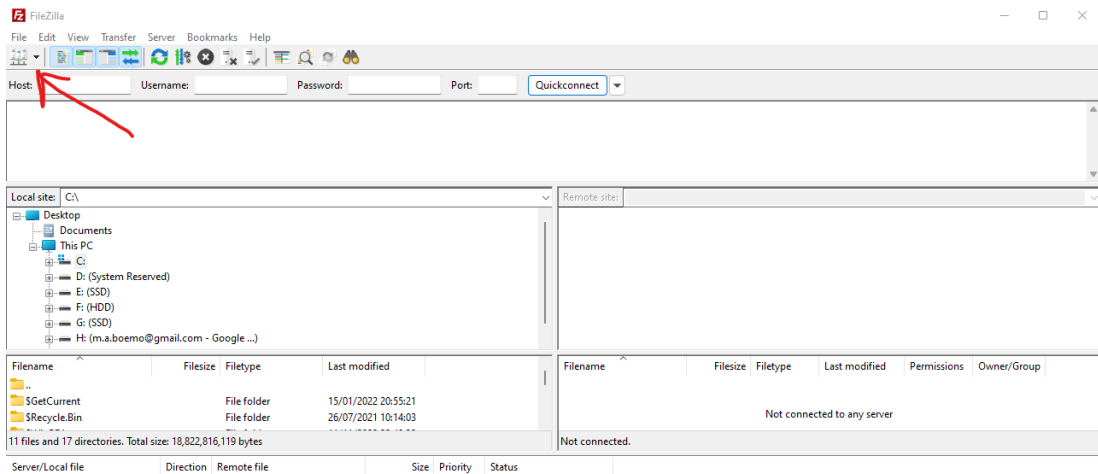
```
PS C:\Users\Michael Boemo> ssh mb915@login-cpu.hpc.cam.ac.uk
The authenticity of host 'login-cpu.hpc.cam.ac.uk (128.232.224.46)' can't be established.
ED25519 key fingerprint is SHA256:nFV5XK+VRGCaUupQEhXzO6kp01m2fzzmbgPr0sc2so.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'login-cpu.hpc.cam.ac.uk,128.232.224.46' (ED25519) to the list of known hosts.
```

[illegible]

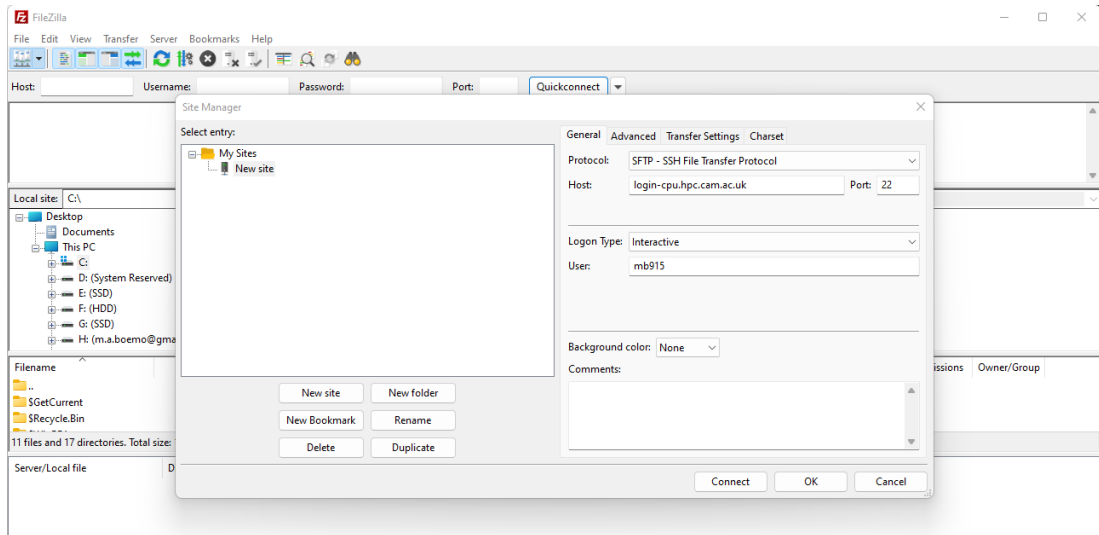
PLEASE NOTE: From 1st November 2022, SSH login to CSD3 will require TOTP MFA. For more information, please see <https://docs.hpc.cam.ac.uk/hpc/user-guide/mfa.html>.

```
Password:
TOTP Verification Code: 055513
Last login: Fri Nov  4 17:39:33 2022 from 10.249.26.95
(base) [mb915@login-e-9 ~]$
```

Logging In (FTP Client)



Logging In (FTP Client)



Logging In (FTP Client)

New site - sftp://mb915@login-cpu.hpc.cam.ac.uk - FileZilla

File Edit View Transfer Server Bookmarks Help

Host: Username: Password: Port: Quickconnect

Status: Retrieving directory listing of "/home/mb915/rds"...

Status: Listing directory /home/mb915/rds

Status: Directory listing of "/home/mb915/rds" successful

Status: Retrieving directory listing of "/home/mb915/rds/hpc-work"...

Status: Listing directory /rds/user/mb915/hpc-work

Status: Directory listing of "/rds/user/mb915/hpc-work" successful

Local site: C:\

Remote site: /rds/user/mb915/hpc-work

Desktop

Documents

This PC

C:

D: (System Reserved)

E: (SSD)

F: (HDD)

G: (SSD)

H: (m.a.boemo@gmail.com - Google ...)

home

mb915

rds

user

mb915

hpc-work

Filename	Filesize	Filetype	Last modified	Permissions	Owner/Group
..					
\$GetCurrent		File folder	15/01/2022 20:55:21		
\$Recycle.Bin		File folder	26/07/2021 10:14:03		

11 files and 17 directories. Total size: 18,822,816,119 bytes

Filename	Filesize	Filetype	Last modified	Permissions	Owner/Group
..					
analysis		File folder	12/10/2022 15:...	drwxrwxr-x	mb915 mb9...
archive		File folder	19/02/2020 16:...	drwxrwxr-x	mb915 mb9...

1 file and 15 directories. Total size: 43,704,069 bytes

Server/Local file	Direction	Remote file	Size	Priority	Status
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Data Services

Research Data Storage (RDS)

- high-performance, hot storage mounted on HPC platforms,
- not redundant,
- £54 per TB per year.

Research Cold Storage (RCS)

- slow, redundant cold storage on two tape libraries,
- £30.72 per TB per year.

Research File Share (RFS)

- not mounted on HPC platforms, but resilient with frequent snapshots for backups,
- £116.10 per TB per year.

Accessing Data Services (Command Line)

```
mb915@login-e-10:~/rds
```

```
PS C:\Users\Michael Boemo> ssh mb915@login-cpu.hpc.cam.ac.uk
Warning: Permanently added the ED25519 host key for IP address '128.232.224.47' to the list of known hosts.
```

[illegible]

PLEASE NOTE: From 1st November 2022, SSH login to CSD3 will require TOTP MFA. For more information, please see <https://docs.hpc.cam.ac.uk/hpc/user-guide/mfa.html>.

```

Password:
TOTP Verification Code: 016191
Last login: Fri Nov 11 12:18:20 2022 from 10.249.26.95
(base) [mb915@login-e-10 ~]$ ls
berl5  rcs  rds  slurm_submit.peta4-cclake  slurm_submit.peta4-knl  slurm_submit.peta4-skylake  slurm_submit.wilkes2

```


Accessing Data Services (FTP Client)

New site - sftp://mb915@login-cpu.hpc.cam.ac.uk - FileZilla

File Edit View Transfer Server Bookmarks Help

Host: Username: Password: Port: Quickconnect

Status: Retrieving directory listing of "/home/mb915/rcs"...

Status: Listing directory /rcs/user/mb915

Status: Directory listing of "/rcs/user/mb915" successful

Status: Retrieving directory listing of "/home/mb915/rds"...

Status: Listing directory /home/mb915/rds

Status: Directory listing of "/home/mb915/rds" successful

Local site: C:\Users\Michael Boemo\Desktop\

Remote site: /home/mb915

Desktop Documents This PC C: \$GetCurrent \$Recycle.Bin \$WinREAgent AMD Config.Msi

home mb915 .aws .cache .conda .config .gnome2 .keras

Filename	Filesize	Filetype	Last modified
..			
calendar		File folder	04/12/2021 22:56:51
New folder		File folder	05/11/2022 15:15:53

14 files and 3 directories. Total size: 1,128,609 bytes

Filename	Filesize	Filetype	Last modified	Permissions	Owner/Group
rcs		File folder	27/01/2020 12:...	lrwxrwxrwx	root root
rds		File folder	19/10/2022 12:...	drwxr-xr-x	mb915 mb9...
slurm_submit.peta4-c...		File folder	21/09/2020 17:...	lrwxrwxrwx	mb915 mb9...

10 files and 21 directories. Total size: 90,375 bytes

Server/Local file	Direction	Remote file	Size	Priority	Status
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Data Services Working Together

Consider the following lab:

- protocols, spreadsheets, and documents shared and edited between a number of people (Research File Share),
- data and files from lab members that have left (Research Cold Storage),
- backups of all raw sequencing datasets (Research Cold Storage),
- sequencing datasets actively being used for omics analyses (Research Data Storage).

Backup and Data Handling Practices

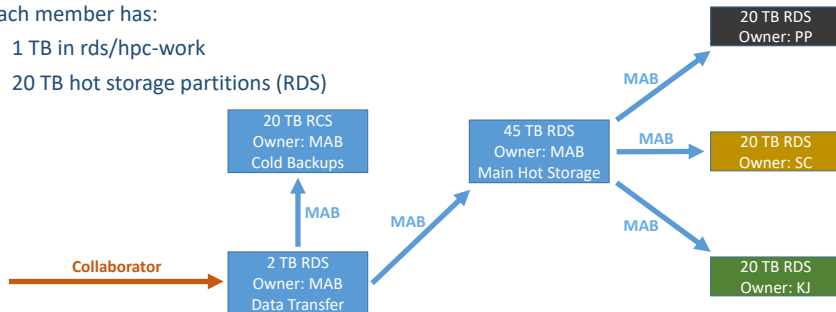
- at least one data copy should be completely raw,
- good naming conventions and record keeping for datasets,
 - 2021_08_12_VM_ONT_EdU_HU_BrdU_ULR_fast5
- think through how data is moving and any weak points,
- accidents should never cause permanent damage,
- clear and agreed upon backup strategies.

Backup Strategies

Data Storage

Each member has:

- 1 TB in rds/hpc-work
- 20 TB hot storage partitions (RDS)



Tracking the Flow of Data

	A	B	C	D	E	F	G	H	I	J	K
1	Collaborator	Institution	Date Received	Cold Storage c/o	Cold Storage Location	Hot Storage c/o	Hot Storage Location	Sequencing Platform	Organism	Cell Line	Protocol/Description
2	XXXXX	XXXXX	26/10/2022	MAB	rds/rcs-mb915-rawdataaar	PLP	rds/rds-pfuderer-G2yvlii	MinION (R9.4.1)	XXXXX	XXXXX	XXXXX
3	XXXXX	XXXXX	26/10/2022	MAB	rds/rcs-mb915-rawdataaar	PLP	rds/rds-pfuderer-G2yvlii	MinION (R9.4.1)	XXXXX	XXXXX	XXXXX
4	XXXXX	XXXXX	26/10/2022	MAB	rds/rcs-mb915-rawdataaar	PLP	rds/rds-pfuderer-G2yvlii	MinION (R9.4.1)	XXXXX	XXXXX	XXXXX
5	XXXXX	XXXXX	24/10/2022	MAB	rds/rcs-mb915-rawdataaar	SY	rds/rds-ye_shutong-xcyv	MinION (R9.4.1)	XXXXX	XXXXX	XXXXX
6	XXXXX	XXXXX	24/10/2022	MAB	rds/rcs-mb915-rawdataaar	SY	rds/rds-ye_shutong-xcyv	MinION (R9.4.1)	XXXXX	XXXXX	XXXXX

CPU Compute Nodes Available

Cascade Lake Nodes

- 56 CPUs (112 threads) per node,
- 192 GB of RAM per node,
- high memory nodes with 384 GB of RAM.

Ice Lake Nodes

- 76 CPUs (152 threads) per node,
- 192 GB of RAM per node,
- high memory nodes with 384 GB of RAM.

GPU Compute Nodes Available

A100 Nodes

- four NVIDIA Ampere A100 80 GB GPUs per node,
- 128 AMD CPUs per node.

At-Once Usage Caps

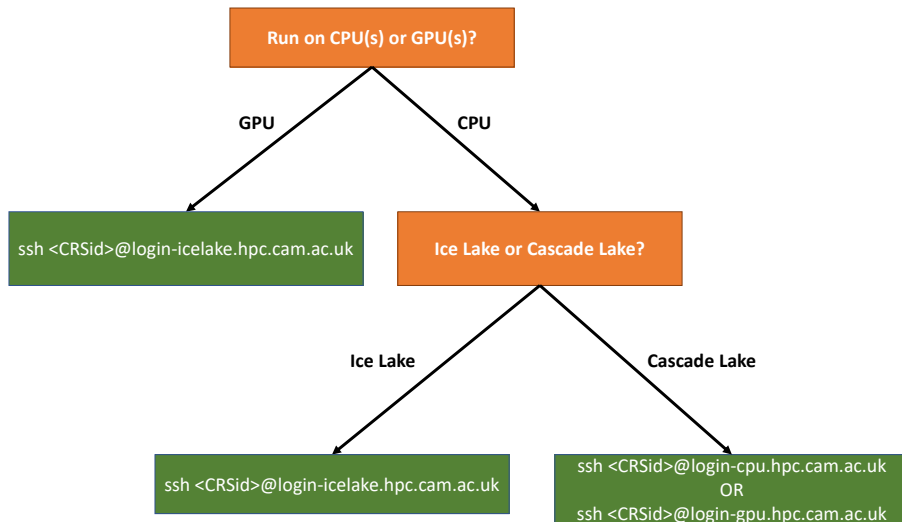
SL3

- 320 CPUs,
- 32 GPUs,
- 12-hour maximum job time.

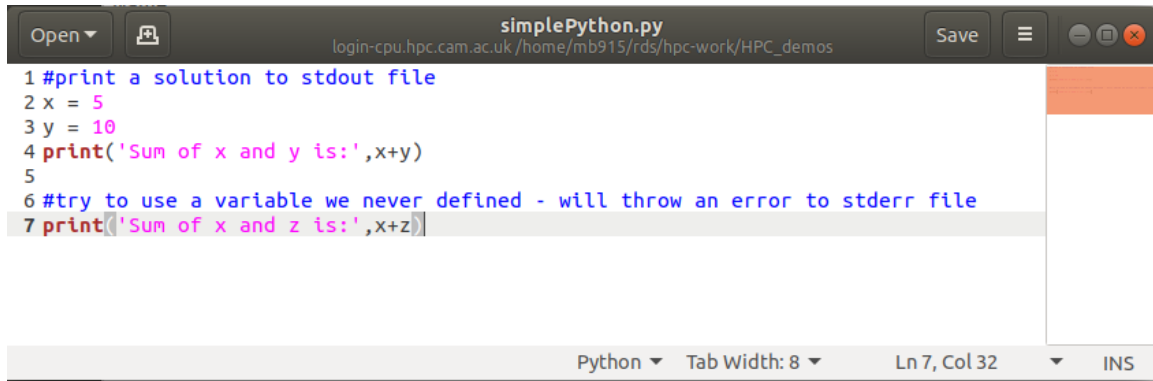
SL1/2

- 1280 CPUs,
- 64 GPUs,
- 36-hour maximum job time.

Which Login Node to Use?



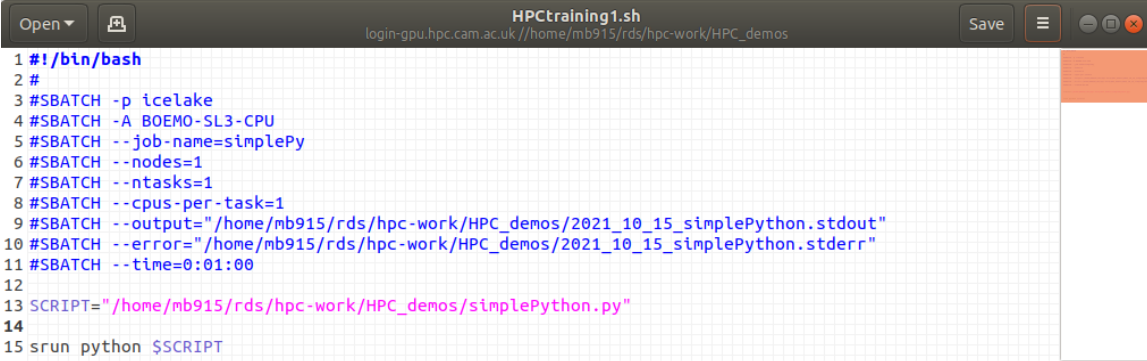
Create a Simple Python Script



```
1 #print a solution to stdout file
2 x = 5
3 y = 10
4 print('Sum of x and y is:',x+y)
5
6 #try to use a variable we never defined - will throw an error to stderr file
7 print('Sum of x and z is:',x+z)
```

Python ▾ Tab Width: 8 ▾ Ln 7, Col 32 ▾ INS

Creating an sbatch Script



```
1 #!/bin/bash
2 #
3 #SBATCH -p icelake
4 #SBATCH -A BOEMO-SL3-CPU
5 #SBATCH --job-name=simplePy
6 #SBATCH --nodes=1
7 #SBATCH --ntasks=1
8 #SBATCH --cpus-per-task=1
9 #SBATCH --output="/home/mb915/rds/hpc-work/HPC_demos/2021_10_15_simplePython.stdout"
10 #SBATCH --error="/home/mb915/rds/hpc-work/HPC_demos/2021_10_15_simplePython.stderr"
11 #SBATCH --time=0:01:00
12
13 SCRIPT="/home/mb915/rds/hpc-work/HPC_demos/simplePython.py"
14
15 srun python $SCRIPT
```

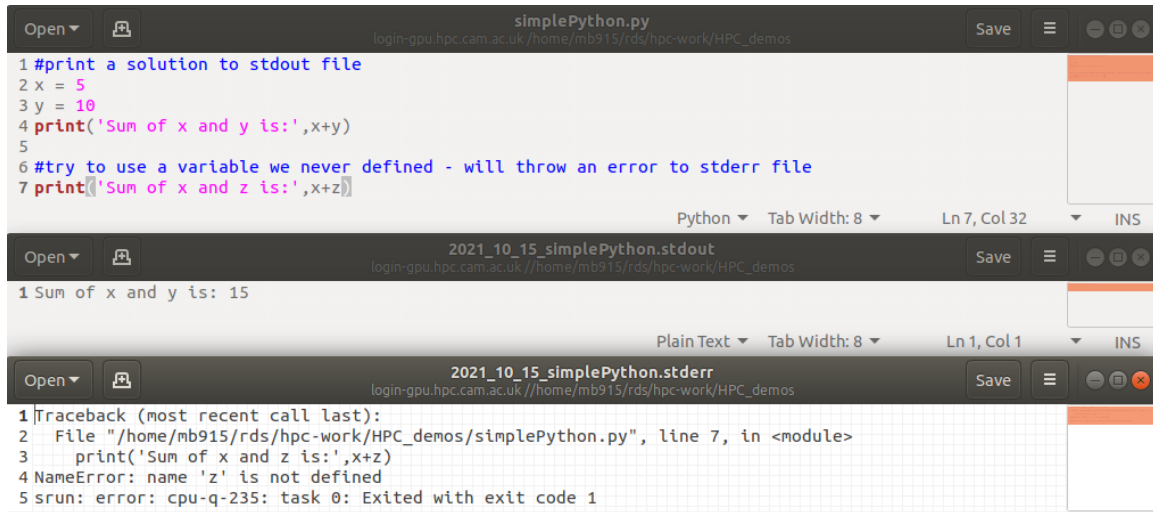
Submitting Jobs to Compute Nodes

```
(base) [mb915@login-e-8 HPC_demos]$ sbatch HPCtraining1.sh
Submitted batch job 47460048
(base) [mb915@login-e-8 HPC_demos]$ squeue -u mb915
```

JOBID	PARTITION	NAME	USER	ST	TIME	NODES	NODELIST (REASON)
47455220	cclake	bcs	mb915	PD	0:00	1	(Priority)
47455255	cclake	bcs	mb915	PD	0:00	1	(Priority)
47460048	cclake	simplePy	mb915	PD	0:00	1	(Priority)

```
(base) [mb915@login-e-8 HPC_demos]$
```

Submitting Jobs to Compute Nodes



The screenshot displays a terminal window with three stacked panes. The top pane shows a Python script named `simplePython.py` with the following code:

```
1 #print a solution to stdout file
2 x = 5
3 y = 10
4 print('Sum of x and y is:',x+y)
5
6 #try to use a variable we never defined - will throw an error to stderr file
7 print('Sum of x and z is:',x+z)
```

The middle pane shows the standard output (stdout) of the script:

```
1 Sum of x and y is: 15
```

The bottom pane shows the standard error (stderr) output, indicating a `NameError` because the variable `z` is not defined:

```
1 Traceback (most recent call last):
2   File "/home/mb915/rds/hpc-work/HPC_demos/simplePython.py", line 7, in <module>
3     print('Sum of x and z is:',x+z)
4 NameError: name 'z' is not defined
5 srun: error: cpu-q-235: task 0: Exited with exit code 1
```

Multicore Processing



```
1 #!/bin/bash
2 #
3 #SBATCH -p icelake
4 #SBATCH -A BOEMO-SL3-CPU
5 #SBATCH --job-name=align
6 #SBATCH --nodes=1
7 #SBATCH --ntasks=1
8 #SBATCH --cpus-per-task=76
9 #SBATCH --output="/home/mb915/rds/hpc-work/HPC_demos/alignment.stdout"
10 #SBATCH --error="/home/mb915/rds/hpc-work/HPC_demos/alignment.stderr"
11 #SBATCH --time=6:00:00
12
13 MINIMAP2="/home/mb915/rds/hpc-work/software/minimap2-2.17_x64-linux/minimap2"
14 OUTSAM="/home/mb915/rds/hpc-work/HPC_demos/alignments.sam"
15 GENOME="/home/mb915/rds/hpc-work/reference.fasta"
16 QUERY="/home/mb915/rds/hpc-work/HPC_demos/reads.fastq"
17
18 srun $MINIMAP2 -ax map-ont -t 76 -a -o $OUTSAM $GENOME $QUERY
```

Job Arrays

We have:

- one Python script that will do some analysis,
- lots of data files (called `input0`, `input1`, ..., `input6`) that we want to run this same script on.



The screenshot shows a code editor window with a dark theme. The title bar at the top reads "simplePythonArray.py" and the address bar shows the file path "login-cpu.hpc.cam.ac.uk/home/mb915/rds/hpc-work/HPC_demos". The editor contains three lines of Python code: "1 import sys", "2", and "3 print('I was passed:', sys.argv[1])". The third line is highlighted. The status bar at the bottom indicates "Python", "Tab Width: 8", "Ln 3, Col 12", and "INS".

```
1 import sys
2
3 print('I was passed:', sys.argv[1])
```

Job Arrays



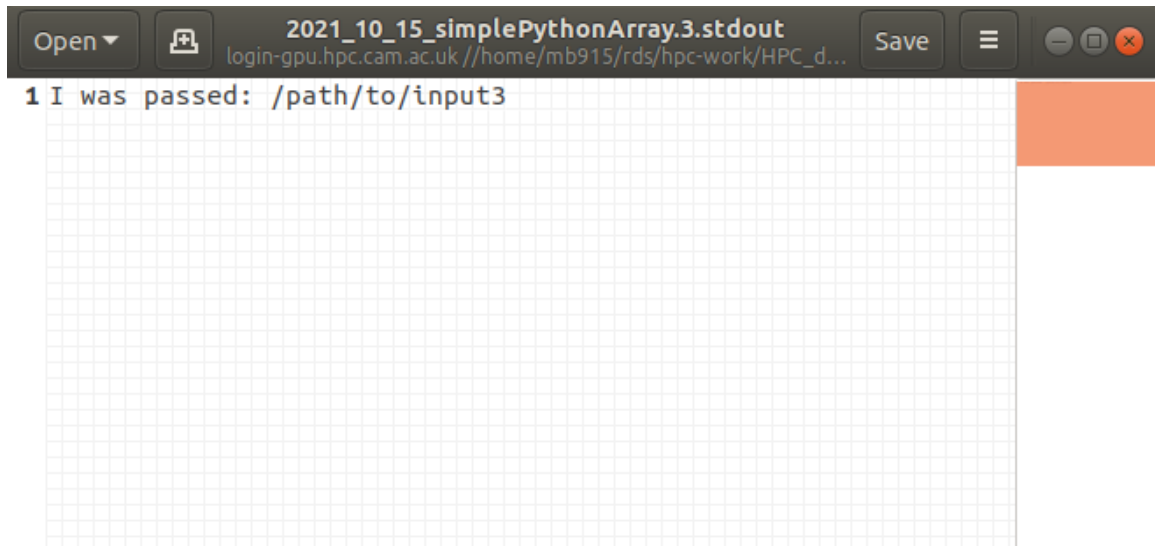
```
1 #!/bin/bash
2 #
3 #SBATCH -p cclake
4 #SBATCH -A BOEMO-SL3-CPU
5 #SBATCH --job-name=simplePyArr
6 #SBATCH --nodes=1
7 #SBATCH --ntasks=1
8 #SBATCH --cpus-per-task=1
9 #SBATCH --output="/home/mb915/rds/hpc-work/HPC_demos/2021_10_15_simplePythonArray.%a.stdout"
10 #SBATCH --error="/home/mb915/rds/hpc-work/HPC_demos/2021_10_15_simplePythonArray.%a.stderr"
11 #SBATCH --time=0:01:00
12 #SBATCH --array=0-6
13
14 SCRIPT="/home/mb915/rds/hpc-work/HPC_demos/simplePythonArray.py"
15 INPUTDATA="/path/to/input${SLURM_ARRAY_TASK_ID}"
16
17 srun python $SCRIPT $INPUTDATA
```


Job Arrays

The screenshot shows a file manager window with the address bar set to `login-gpu.hpc.cam.ac.uk`. The left sidebar shows navigation options like Recent, Home, Desktop, Documents, Downloads, Music, Pictures, Videos, Rubbish Bin, `sf_VM_shared`, `login-gpu.h...`, and Other Locations. The main pane displays a list of files with columns for Name, Size, Type, and Modified.

Name	Size	Type	Modified
2021_10_15_simplePython.stderr	181 bytes	Binary	Mon
2021_10_15_simplePython.stdout	22 bytes	Binary	Mon
2021_10_15_simplePythonArray.0.stderr	0 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.0.stdout	30 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.1.stderr	0 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.1.stdout	30 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.2.stderr	0 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.2.stdout	30 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.3.stderr	0 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.3.stdout	30 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.4.stderr	0 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.4.stdout	30 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.5.stderr	0 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.5.stdout	30 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.6.stderr	0 bytes	Binary	Yesterday
2021_10_15_simplePythonArray.6.stdout	30 bytes	Binary	Yesterday

Job Arrays



The screenshot shows a terminal window with a dark title bar. The title bar contains the text "2021_10_15_simplePythonArray.3.stdout" and a URL "login-gpu.hpc.cam.ac.uk //home/mb915/rds/hpc-work/HPC_d...". There are buttons for "Open", "Save", and window control icons. The terminal content shows a single line of output: "1 I was passed: /path/to/input3". The background of the terminal is a light gray grid.

```
2021_10_15_simplePythonArray.3.stdout
login-gpu.hpc.cam.ac.uk //home/mb915/rds/hpc-work/HPC_d...
1 I was passed: /path/to/input3
```

Modules

All modules currently loaded:

```
module list
```

List all modules available to load:

```
module avail
```

Search for an available module (samtools, for example):

```
module avail samtools
```

Virtual Environments

We have:

- at least one Python package we want to install.

We could do:

- `pip3 install --user tensorflow=2.4.1`

Better:

- use virtual environments!

Virtual Environments

Making a new virtual environment:

- `virtualenv HPC_TRAINING`

Activate it:

- `source /path/to/HPC_TRAINING/bin/activate`

Deactivate it:

- `deactivate`

Putting It All Together: Run on GPUs



```
1 #!/bin/bash
2 #
3 #SBATCH -p ampere
4 #SBATCH -A BOEMO-SL3-GPU
5 #SBATCH --job-name=gpuJob
6 #SBATCH --gres=gpu:1
7 #SBATCH --ntasks=1
8 #SBATCH --nodes=1
9 #SBATCH --cpus-per-task=3
10 #SBATCH --output="/home/mb915/rds/hpc-work/output/2021_10_15_gpuJob.stdout"
11 #SBATCH --error="/home/mb915/rds/hpc-work/output/2021_10_15_gpuJob.stderr"
12 #SBATCH --time=4:00:00
13
14 module purge
15 module load rhel7/default-gpu
16 module unload cuda/8.0
17 module load cuda/11.0 cuda/11.1 cudnn/8.0_cuda-11.1
18
19 source /home/mb915/rds/hpc-work/tensorflow-env/bin/activate
20
21 SCRIPT="/home/mb915/rds/hpc-work/trainLargeDNN.py"
22
23 srun python $SCRIPT
```

Seeing Past Jobs and Statuses

```
(base) [mb915@login-e-5 HPC_demos]$ sacct --starttime 2021-10-14
```

JobID	JobName	Partition	Account	AllocCPUS	State	ExitCode
47654390_0	simplePyA+	cclake	boemo-sl3+	1	COMPLETED	0:0
47654390_0.+	batch		boemo-sl3+	1	COMPLETED	0:0
47654390_0.+	extern		boemo-sl3+	1	COMPLETED	0:0
47654390_1	simplePyA+	cclake	boemo-sl3+	1	COMPLETED	0:0
47654390_1.+	batch		boemo-sl3+	1	COMPLETED	0:0
47654390_1.+	extern		boemo-sl3+	1	COMPLETED	0:0
47654390_2	simplePyA+	cclake	boemo-sl3+	1	COMPLETED	0:0
47654390_2.+	batch		boemo-sl3+	1	COMPLETED	0:0
47654390_2.+	extern		boemo-sl3+	1	COMPLETED	0:0
47654390_3	simplePyA+	cclake	boemo-sl3+	1	COMPLETED	0:0
47654390_3.+	batch		boemo-sl3+	1	COMPLETED	0:0
47654390_3.+	extern		boemo-sl3+	1	COMPLETED	0:0
47654390_4	simplePyA+	cclake	boemo-sl3+	1	COMPLETED	0:0
47654390_4.+	batch		boemo-sl3+	1	COMPLETED	0:0
47654390_4.+	extern		boemo-sl3+	1	COMPLETED	0:0
47654390_5	simplePyA+	cclake	boemo-sl3+	1	COMPLETED	0:0
47654390_5.+	batch		boemo-sl3+	1	COMPLETED	0:0
47654390_5.+	extern		boemo-sl3+	1	COMPLETED	0:0

Checking Used Diskspace

```
mb915@login-q-3:~
(base) [mb915@login-q-3 ~]$ quota
Filesystem/Project  GB      quota      limit      grace      files      quota      limit
ser/Grp/Proj
/home              16.4      50.0      55.0      -      ----- No File Quotas
:mb915
/rds-d4            754.5     1099.5    1209.5    -      715031    1048576    1048576
:mb915
/rds2              6152.7    21990.2   21990.2   -      588937    2000000    2000000
rds-6m653hlCD3A    13.3      1000.0    1000.0    -        35      512000     512000
/rds-d2             0.0        0.0        0.0      -         1         0         0
/rds-d4            1114.8     2199.0    2199.0    -       5082     1048576    1048576
/rds-d4            48311.7    48378.5   48378.5   -    15564252    23068672    23068672
/rds-d5             0.0        0.0        0.0      -         1         0         0
rds-e89MpZIIFKg    6000.3     6000.0    6000.0    -     198691    3072000    3072000
rds-G2yvliM05O4    3174.8     20000.0   20000.0   -     387968    10240000   10240000
rds-KxAwp6sTNTA    11795.3    20000.0   20000.0   -     41396     10240000   10240000
rds-lbo2YIBtMG4    223.0      1000.0    1000.0    -       2580     512000     512000
rds-llQYKINinB8    877.8      20000.0   20000.0   -       9592     10240000   10240000
rds-povrOiKbCCA    0.0        1000.0    1000.0    -         1     512000     512000
rds-PwZwSmUxXag    570.5      10000.0   10000.0   -     112705     5120000    5120000
rds-X7FJV3IVi1A    91.2       1000.0    1000.0    -        799     512000     512000
rds-xcywAxU6Kd0    384.3      20000.0   20000.0   -     22586     10240000   10240000
(base) [mb915@login-q-3 ~]$
```


Checking Number of CPU/GPU Hours Remaining



mb915@login-q-3:~



```
(base) [mb915@login-q-3 ~]$ mybalance
```

User	Usage		Account	Usage		Account Limit	Available (hours)
-----	-----	+	-----	-----	+	-----	-----
mb915	10,749		BOEMO-SL2-CPU	10,749		385,000	374,251
mb915	1,694		BOEMO-SL2-GPU	1,694		11,035	9,341
mb915	294,418		BOEMO-SL3-CPU	344,289		543,375	199,086
mb915	8,644		BOEMO-SL3-GPU	8,946		11,831	2,885

```
(base) [mb915@login-q-3 ~]$
```

Where to Find Resources

- These slides and Slurm scripts: <https://github.com/MBoemo/HPC-resources>
- HPC computing documentation: <https://docs.hpc.cam.ac.uk/hpc/>
- HPC storage documentation: <https://docs.hpc.cam.ac.uk/storage/>
- Purchasing storage: <https://selfservice.uis.cam.ac.uk/>
- SBS bioinformatics Slack channel:
<https://www.bio.cam.ac.uk/facilities/bioinformatics-computing>