



MFCF APPLIED MATH GRAD SESSION FALL 2023

AGENDA

- ▶ Introduction, Help Centre
- ▶ Getting online
- ▶ Using your desktop machine
 - ▶ desktops, accessing your files, central file service, printing, applications
- ▶ Academic resources
 - ▶ personal web pages using Scholar
 - ▶ library journals
- ▶ Computing resources
 - ▶ Linux environment - servers (fast, big, GPU, HPC), managing jobs and priorities
 - ▶ Windows environment - MS Remote Desktop
- ▶ Mathematical applications
- ▶ Questions

HELP CENTRE

- ▶ MC 3017, ext. 46323 (hMFCF) mfcfhelp@uwaterloo.ca
- ▶ desktops - re-imaging, downloading software
- ▶ personal laptop wired connections - submit RT ticket
- ▶ accounts, printing
- ▶ Request Tracker - <https://rt.uwaterloo.ca/SelfService/Forms/MFCF/>
- ▶ please feel free to ask us for help!

GETTING CONNECTED

- ▶ two-factor authentication - for campus wide services
- ▶ on-campus: wireless and wired connections
 - ▶ Wired connection -
 - ▶ submit [request](#) with MAC address, OS, supervisor, room number, expiry date
- ▶ off-campus: VPN
 - ▶ use <https://checkvpn.uwaterloo.ca/> to verify things work
- ▶ Microsoft 365 suite - including Teams

VIRTUAL PRIVATE NETWORK

- ▶ Allows remote access to all campus network resources
 - ▶ e.g. files, remote desktop services
 - ▶ all data transferred are encrypted and secure
- ▶ Install VPN from IST. This is a one-time install.
 - ▶ <https://uwaterloo.ca/information-systems-technology/services/virtual-private-network-vpn>
 - ▶ includes Windows and Mac instructions
 - ▶ the client is called Cisco AnyConnect
 - ▶ WatIAM credentials to login
 - ▶ use <https://checkvpn.uwaterloo.ca/> to verify things work

WIRELESS

- ▶ Select eduroam from the list of available Wi-Fi networks
- ▶ authentication
 - ▶ [userid@uwaterloo.ca](mailto:user@uwaterloo.ca)
 - ▶ WatIAM password
- ▶ Do NOT run your own wifi service. It just interferes with eduroam and makes it worse for everyone!

WIRED

- ▶ submit a request in the MFCF RT queue with the following information:
 - ▶ operating system
 - ▶ room
 - ▶ expiry date
 - ▶ MAC hardware address
 - ▶ <https://uwaterloo.ca/math-faculty-computing-facility/services/wired-connections/how-find-mac-hardware-address>
 - ▶ sponsor/supervisor

USING YOUR DESKTOP

- ▶ desktop machines
- ▶ central file service
- ▶ printing
- ▶ applications

DESKTOPS

- ▶ managed by MFCF
 - ▶ but you have admin access to install applications
- ▶ files on local machine are NOT backed up
 - ▶ use the central file server for important files (thesis!)
- ▶ Common Mathematical software - Maple, MATLAB, Office suite, R, etc., preinstalled or available via Applications > Self-Serve portal

USING YOUR DESKTOP

The image shows a screenshot of an Apple desktop environment. At the top, the menu bar includes 'Finder', 'File', 'Edit', 'View', 'Go', 'Window', and 'Help'. On the right side of the menu bar, there are icons for volume, battery, Wi-Fi, search, and a clock showing 'Fri Aug 18 10:19 AM'. The desktop background is a vibrant orange and yellow abstract pattern. Three blue callout boxes are overlaid on the desktop, each pointing to a specific icon on the right side of the screen. The first callout box points to a server icon labeled 'files.math' and contains the text 'files.math.uwaterloo.ca - your files on the central fileserver'. The second callout box points to a penguin icon labeled 'linux.math' and contains the text 'linux.math.uwaterloo.ca - opens Linux command window'. The third callout box points to a Windows logo icon labeled 'windows.math' and contains the text 'windows.math.uwaterloo.ca - connects to Windows terminal servers using Remote Desktop' and 'P: drive is your personal storage on central file server'. Below the desktop, the dock contains various application icons including Safari, Launchpad, Spotlight, Messages, Mail, Maps, Photos, Video Chat, Calendar (showing 'AUG 18'), Contacts, Reminders, Notes, a music player, Apple TV, Music, Podcasts, News, App Store, System Preferences, a folder icon, and the Trash.

files.math.uwaterloo.ca - your files on the central fileserver

linux.math.uwaterloo.ca - opens Linux command window

windows.math.uwaterloo.ca - connects to Windows terminal servers using Remote Desktop
P: drive is your personal storage on central file server

DESKTOPS

- ▶ Mac minis - icons on the desktop for:
 - ▶ `files.math.uwaterloo.ca` - your files on the central fileserver
 - ▶ `windows.math.uwaterloo.ca` - connects to Windows terminal servers using Remote Desktop
 - ▶ P: drive is your personal storage on central file server
 - ▶ `linux.math.uwaterloo.ca` - opens Linux command window
 - ▶ more about choice of Linux servers later in the presentation

CENTRAL FILE SERVICE

- ▶ central research file server "files.math.uwaterloo.ca"
- ▶ central teaching file server - coursework
"files.student.math.uwaterloo.ca"
- ▶ frequent online backups for safe reliable storage and easy retrieval of old versions
- ▶ all central Linux and Windows servers, plus your desktop machines, use the central file servers
- ▶ keep your important files there, not on your desktop!

CONNECT TO FILE SERVER FROM YOUR OWN MACHINE

- ▶ Use Virtual Private Network (VPN) when accessing campus resources remotely <https://vpn.uwaterloo.ca>
- ▶ store files on the central Math fileserver (back up your data)
 - ▶ Mac standalone: Go > Connect to Server...
 - ▶ <smb://files.math.uwaterloo.ca/UWuserid>
 - ▶ Windows standalone: Map a network drive
 - ▶ <\\files.math.uwaterloo.ca>\UWuserid
 - ▶ Windows Remote Desktop: windows.math.uwaterloo.ca
 - ▶ P: drive (files are stored automatically on the file server)
- ▶ Linux: File Manager > Connect to Server...
 - ▶ <smb://files.math.uwaterloo.ca/UWuserid>
 - ▶ ssh to linux.math.uwaterloo.ca

PRINTING

- ▶ access is automatic once registered - check with admin for location of printers
- ▶ for thesis only - do not print books
- ▶ can be added to your personal workstation
 - ▶ <https://uwaterloo.ca/math-faculty-computing-facility/services/service-catalog-printing/adding-printers-your-computer>

APPLICATIONS

▶ math software

- ▶ R, Maple, Julia, Octave (freeware version of MATLAB), Python and many more
- ▶ MATLAB - Free campus wide license. See <https://uwaterloo.atlassian.net/wiki/spaces/ISTKB/pages/284525621/Download+or+use+MATLAB+online>
- ▶ others at <https://uwaterloo.ca/information-systems-technology/services/software-faculty-and-staff/licensed-software-university-waterloo> (some free, some paid by your supervisor)

▶ typesetting

- ▶ LaTeX, including Overleaf Commons (www.overleaf.com/edu/uwaterloo)
- ▶ Zoom - Free campus wide license. <https://uwaterloo.zoom.us>

APPLICATIONS - OVERLEAF

- ▶ Overleaf is a collaborative online document editor - understands LaTeX for typesetting math
 - ▶ www.overleaf.com/edu/uwaterloo
- ▶ works in browser
- ▶ templates for UW thesis style, etc.
- ▶ UW site licence, free of charge for grad students

APPLICATIONS - ZOOM

- ▶ UW site licence free for grad students
- ▶ pro/educational level features
- ▶ <https://uwaterloo.zoom.us>
 - ▶ click Sign In, use your UWuserid@uwaterloo.ca address and WatIAM password
- ▶ <https://uwaterloo.atlassian.net/wiki/spaces/ISTSERV/pages/42583425333/Collaboration+-+Zoom>
- ▶ we use Microsoft Teams a lot here too

ACADEMIC RESOURCES

- ▶ personal web sites
 - ▶ [UW Scholar](#)
- ▶ library journals
 - ▶ start at uwaterloo.ca/library
 - ▶ find articles for your department
 - ▶ Math representative

PERSONAL WEB SITES

- ▶ UWaterloo Scholar <https://uwaterloo.ca/scholar>
 - ▶ does not require programming or coding skills
 - ▶ easy to use tools, self managed with templates/content modules
 - ▶ bio, CV, publications, events, etc....
 - ▶ publications can be imported into UWaterloo Scholar
- ▶ Documentation and guidelines:
 - ▶ <https://uwaterloo.ca/web-resources/scholar>

- ▶ how long to keep Scholar site after leaving:
 - ▶ indefinite (cannot edit after you leave though)
 - ▶ make sure to put in a link to a new site before it's read only
 - ▶ request to have it shut down/hidden

LIBRARY JOURNALS

- ▶ start at uwaterloo.ca/library
 - ▶ Quick Links -> Get Access From Anywhere to connect using your surname and barcode on back of WatCard
 - ▶ Quick Links -> Research Guides
 - ▶ scroll down, click Applied Math, then click the title
 - ▶ select the "Find Articles" tab for links to various research databases including MathSciNet (on AMS.org site)
 - ▶ check out "Links of Interest" tab
- ▶ Library support person for Math: Rebecca Hutchinson (r3hutchinson@uwaterloo.ca)
- ▶ training workshops may be available, or just email Rebecca with any questions

COMPUTING RESOURCES

- ▶ Linux environment
 - ▶ servers
 - ▶ job management
- ▶ Windows environment
 - ▶ servers
 - ▶ Remote Desktop

LINUX ENVIRONMENT

- ▶ Servers
- ▶ Job management

SERVERS

- ▶ types of Linux servers
 - ▶ aliases - ssh to one of: linux.math, biglinux.math, fastlinux.math, and linux.student.math (course work only)
 - ▶ GPU servers, Parallel clusters
 - ▶ departmental-specific servers: Fluids group, Control group (by request), Bauch Lab
- ▶ what they can be used for:
 - ▶ Math applications/IDEs
 - ▶ MATLAB, SAGE, CPLEX, Maple, R, Julia, NumPy, SciPy, etc.
 - ▶ compilers and numerical libraries (gcc, GSL)
 - ▶ parallel tools on biglinux (OpenMP) and the clusters (MPI)
 - ▶ lots more memory and processors than your supplied desktop or laptop
 - ▶ long running jobs

BIGLINUX.MATH

- ▶ for large memory or multi-process jobs
- ▶ pool of computers with 4 high-core-count CPUs, large memory

FASTLINUX.MATH

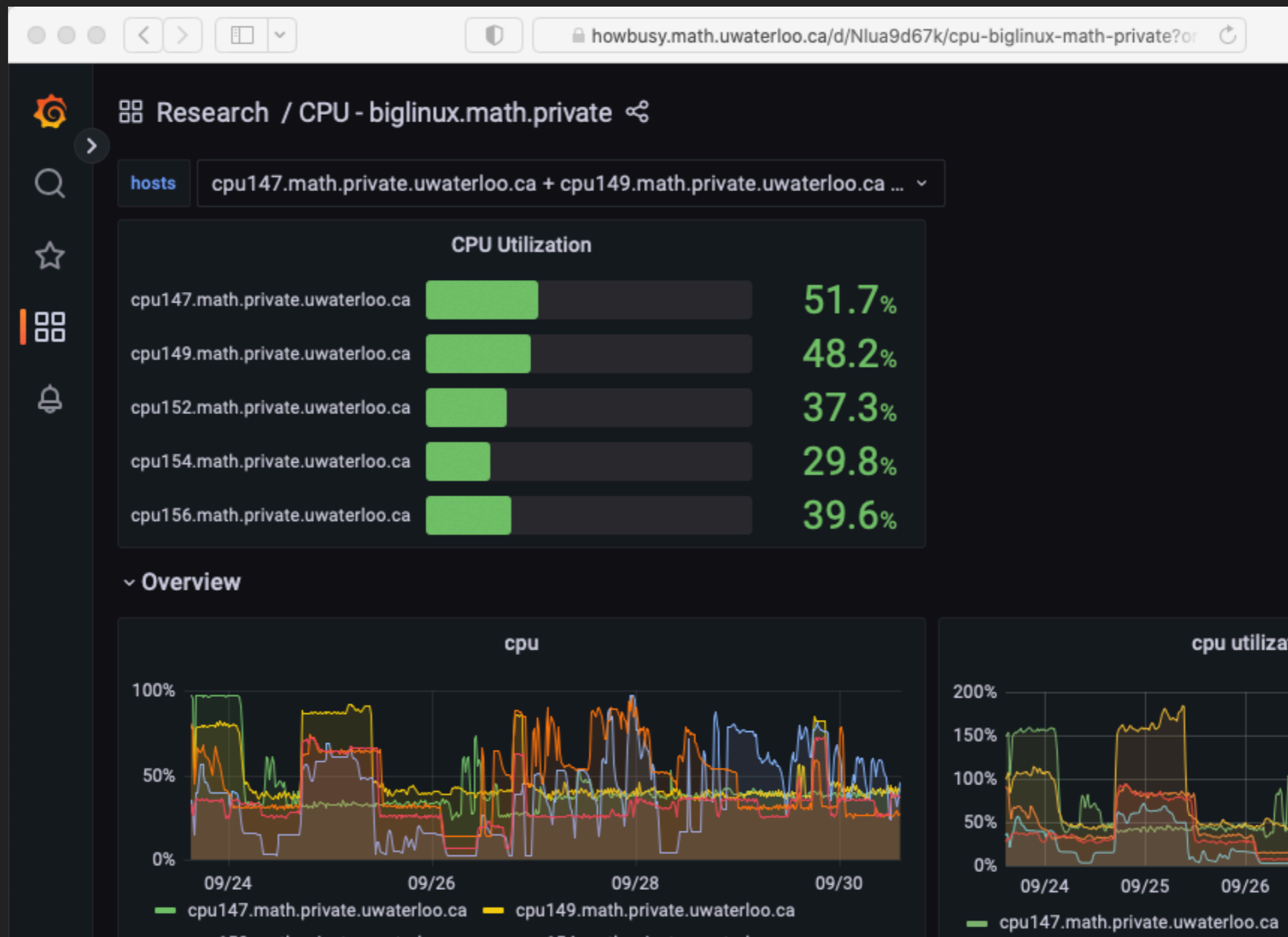
- ▶ for jobs where processor speed is most important
- ▶ pool of computers with fastest CPUs
- ▶ 2 CPUs per machine, low core count; moderate memory

LINUX.MATH

- ▶ for light-duty casual use
- ▶ pool of older computers

CHOOSING A MACHINE FROM ONE OF THE POOLS

▶ <https://howbusy.math.uwaterloo.ca/>



SOFTWARE ENVIRONMENT

- ▶ Ubuntu 22.04
- ▶ see details at
 - ▶ <https://uwaterloo.ca/mfcf/services/> -> Computing -> Research and staff Linux servers

JUPYTER

- ▶ web-based application that allows you to use or create documents that contain live code, equations, and visualizations
- ▶ use it remotely for Python, R, MATLAB, Octave, etc., or a command shell for quick work
- ▶ <https://jupyter.math.uwaterloo.ca>

GPU SERVERS

- ▶ gpu-pr1-01.math / gpu-pr1-02.math
- ▶ two 14-core CPUs, 128GB RAM / two 32-core CPUs, 1 TB RAM
- ▶ four NVIDIA Tesla P100 GPUs / eight A100 GPUs
- ▶ CUDA and other parallel GPU tools
- ▶ access via SLURM job scheduler – see our web site
 - ▶ <https://uwaterloo.ca/mfcf/services/specialty-research-linux-servers>

PARALLEL CLUSTERS

- ▶ mosaic - hybrid, with InfiniBand
 - ▶ 19 nodes with 20 cores, 256 GB RAM, and 2 Tesla K20 GPUs
 - ▶ four nodes with 32 cores, 768 GB RAM
- ▶ Hpc-pr3
 - ▶ 8 nodes with 32 cores and 128 GB per node
- ▶ access via SLURM job scheduler – see our website
 - ▶ <https://uwaterloo.ca/mfcf/services/specialty-research-linux-servers>

HIGH-PERFORMANCE COMPUTING

- ▶ Digital Research Alliance of Canada <https://alliancecan.ca/>
 - ▶ formerly Compute Canada
- ▶ graham cluster located here at UW
 - ▶ 32,000 CPUs
 - ▶ InfiniBand high-speed interconnect
 - ▶ 320 NVIDIA P100 GPUs
- ▶ sponsored by your faculty member, free of charge

JOB MANAGEMENT

- ▶ background jobs
- ▶ nice
- ▶ nohup, screen, tmux

PUT JOBS IN THE BACKGROUND

- ▶ if you do this:

- ▶ \$ firefox

you can't run another command until firefox exits

- ▶ put an ampersand on the end:

- ▶ \$ firefox &

it runs in the background and you can type more commands

- ▶ see what jobs you have in the background:

- ▶ \$ jobs

- ▶ e.g. bring the third one to the foreground again:

- ▶ \$ fg %3

- ▶ e.g. kill the second one:

- ▶ \$ kill %2

NICE

- ▶ commands started at the shell prompt run at normal interactive priority ('nice' value of zero)
- ▶ having many things competing for interactive priority can make the system feel slow
- ▶ so it is not polite (or "nice") to run big/long jobs at normal priority
- ▶ use the "nice" command to start a job at a polite background level (value higher than zero):

```
% nice 19 ./a.out &
```

- ▶ use the "renice" command to reset the priority of a running job:

```
% ./a.out &
```

```
% ps -u
```

USER	PID	%CPU	%MEM	VSZ	RSS	TTY	STAT	START	TIME	COMMAND
rblander	14142	0.8	0.0	13796	2016	pts/3	Ss	11:29	0:00	./a.out

```
% top
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
14142	rblander	20	0	269m	150m	5092	R	100.0	0.0	0:01.12	./a.out

```
% renice 19 14142
```

```
% top
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
14142	rblander	39	19	269m	150m	5092	R	100.0	0.0	0:01.23	./a.out

NOHUP

- ▶ log-out sends “hang up” (HUP) signal to child processes
- ▶ “nohup” command blocks HUP signal
- ▶ syntax: put ‘nohup’ in front of usual command line
 - ▶ % nohup ./myprog.a <infile >outfile
 - ▶ % nohup matlab -nojvm -r [a,b,c]=myarray -logfile myarray.log
 - ▶ % logout

SCREEN

- ▶ lets you disconnect from session and reconnect later
- ▶ start: screen
- ▶ disconnect: ctrl-A d
- ▶ reconnect: screen -x

TMUX

- ▶ terminal multiplexer: multiple terminal sessions in one window

LIMIT

- ▶ protects against accidental long-running jobs
- ▶ default is 1200 seconds (20 minutes) CPU time
- ▶ Increase it in your shell control file
 - ▶ open the `.cshrc` file with your favourite editor
 - ▶ e.g. change `"limit cputime unlimited"`
 - ▶ e.g. change `"limit memoryuse unlimited"`
- ▶ log out and log back in again for it to take effect
- ▶ `"man limit"`

WINDOWS ENVIRONMENT

- ▶ Servers
- ▶ Remote Desktop

SERVERS

- ▶ types of Windows servers
 - ▶ windows.math
 - ▶ pool of servers for research computing
 - ▶ P: drive is files.math
 - ▶ wingpu.math
 - ▶ GPU server with three NVIDIA T4 GPUs
 - ▶ windows.student.math
 - ▶ pool of servers for student/coursework computing, NOT for research
 - ▶ M: drive is files.student.math

REMOTE DESKTOP

- ▶ Microsoft Remote Desktop
 - ▶ icon on Mac mini desktop
 - ▶ can disconnect from a session and reconnect later
 - ▶ but on `windows.student.math`, disconnected sessions get closed after two hours
- ▶ save your work often
- ▶ write code with checkpoint methods

[Math Faculty Computing Facility \(MFCF\)](#) »

Mathematical Applications

[Maple worksheets](#) - developed for Applied Math courses

[MATLAB tutorials](#)

[Introduction to GPU computing in MATLAB, R, and C++ with CUDA](#)
(PDF)

[R and GPU computing](#)- specifically for Statisticians (PDF)

[Comparison of R and Python Data Science Applications](#)

[Scientific Blogging with R and Blogdown](#)

[Dedalus](#)

**MFCF Help Centre
Information**

EMAIL, LEARN, QUEST AND MORE
FROM
IST SERVICES

WEB RESOURCES

- ▶ MFCF Web site - uwaterloo.ca/mfcf
- ▶ LinkedIn Learning ([LiL](#))- online training
 - ▶ formerly known as Lynda.com
- ▶ Request Tracker - online reporting system
- ▶ handy one-page reference to all the main topics we covered:
 - ▶ <https://uwaterloo.ca/mfcf/mfcf-information-sheet-math-faculty>
- ▶ services for grad students:
 - ▶ <https://uwaterloo.ca/mfcf/services/audience/25>



THANK YOU

From the MFCF Team



suggestions for future topics?

<https://uwaterloo.ca/math-faculty-computing-facility/services/audience/25>