

#### Computational Linguistics

**KS-DFT** 



#### spread broadcast (1850s) seed sows circulated scatter broadcast (1900s) newspapers television radio bbc broadcast (1900s)

C solemn awful (1850s) majestic dread gloomy horrible appalling terrible awful (1990s) awful (1990s) awful Weird

**HPC Workshop** 

October 21 or 25, 2022

11:30 - 12:30 pm (followed by lunch)

Location: Elings Hall 1601

Register @ https://csc.cnsi.ucsb.edu



- What is HPC?
- Quickly get Started to Use HPC
- Basic Linux Commands
- Basic Slurm Commands
- National HPC & Commercial cloud computing Resources





The total energy in Kohn-Sham Density Functional Theory (KS-DFT) is expressed as







UC SANTA BARBARA

# Introduction to High-Performance Computing (HPC) Resources and Linux

#### Paul Weakliem, Fuzzy Rogers, and Jay Chi

October 21, 2022

### **Speaker Introductions**





Fuzzy Rogers



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#### Letters & Science INFORMATION TECHNOLOGY

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### Agenda

- What is the Center for Scientific Computing (CSC) at UCSB?
- Introduction to High-Performance Computing (HPC) at UCSB
- Goals of this workshop
  - Quickly get started to use cluster
  - Learn the basic of Linux Commands
  - Learn the basic of Slurm (Simple Linux Utility for Resource Management) commands to submit jobs to the cluster
  - File Transfer
  - Introduction to national and commercial HPC resources

## What is Center for Scientific Computing (CSC)

What we are:

• A home for HPC and expertise with national supercomputing centers leveraging CNSI, MRL, and ETS resources to enable researchers to focus on the research project/education and not the infrastructure.

Support Capabilities

- We provide the computational infrastructure.
- We provide a large amount of data to store and/or process.
- We provide some expertise/assistance.
- We work with your local IT staff to provide help.
- Regular working hours, realistically, 8:30 am 5 pm Monday through Friday. But we try to make sure the clusters are running near 24/7 (I'd say 365, but it's UCSB and we're a small group)

## Scenario (Distributed Computing)

#### Professor



Exam: 15 Questions 300 Students



#### Scenario

#### **Teaching Assistants**



TA #1 TA #2 TA #3

#### Data Parallelism



TA #1

100 Exams per TA





TA #2

TA #3



#### Task Parallelism



Ē Question 6-10 Question 10-15 Question 1-5 h

## Overview

- Most research now involve some form of computing
  - Often you're solving equations, or analyzing data/doing statistics ('data science'). Engineers often will model a device.
  - Some specific examples:
    - Protein Folding
    - Structure of crystal
    - Search for patterns in DNA
    - Predicting the spread of wildfire
    - Weather prediction
    - Natural Language Processing
- Like many parts of research, you often start a small, with a simple idea, but it grows beyond what you (or your computer) can do yourself!
- Solution:
  - Better Computer
  - High-Performance Computing (HPC)
  - Cloud (Can be both of above, with arbitrary size) somebody else's computer!

## What is High-Performance Computing (HPC)?

- High-Performance Computing (HPC) allows scientists and engineers to solve complex science, engineering, and business problem using applications that require high bandwidth, enhanced networking, and very high compute capabilities. Ref: <u>https://aws.amazon.com/hpc/</u>
- Multiple computer nodes connected by a very fast interconnect.
- Each node contains many CPU cores (around 12-40 cores) and 4-6G RAM.
- Allows many users to run calculations simultaneously on nodes.
- Allows a single user to use many CPU caress incorporating multiple nodes.
- Often has high end (64 bit/high memory) GPUs

#### UCSB provides access and support for multiple HPC resources and educational/training/research support.

#### HPC is not always the only one solution!!!

- Sometimes you need a faster desktop workstation
- Sometimes 'Cloud' is the right solution (need 1000 nodes, but only once every 3 months)
- Sometimes you might even need your own cluster ......



## **HPC Infrastructure**





#### **Terminologies Definitions**

- Core: The smallest compute unit that can process logic and floating point (run a program).
- CPU: The chip that processes the basic instructions that drive a computer. The term *processor* is used interchangeably with the term central processing unit (CPU). CPUs have many cores.
  Socket: A physical processor which includes multiple cores with sharing memory. Most of our stuff has 2 sockets, for 2 CPUs.
  Node: An individual computer that includes one or more sockets, memory, storages, etc. The fast network connects other nodes.

#### **General HPC Workflow**



## HPC system at CSC

#### • Campus available cluster Knot (CentOS/RH 7):

- 110 nodes with ~ 1400 cores system
- 4 "fat" nodes with 1TB memory RAM
- GPU nodes (12 M2050's) (too old now)

#### Campus available cluster Pod (CentOS/RH7)

- 70 nodes with ~ 2600 cores system
- 4 "fat" nodes with 1TB memory RAM
- 15 GPU nodes (Quad NVIDIA V100/32GB with NVLINK)
- GPU Development node (P100, T4)
- Published papers should acknowledge CSC https://csc.cnsi.ucsb.edu/publications

Request access: https://csc.cnsi.ucsb.edu/forms/user-account

- Condo Clusters
  - Guild (70 nodes) EOL
  - Braid (120 nodes, also has GPUs) fairly old now
  - Braid2 (20 nodes with some GPUs)

#### PIs buy nodes in the clusters, CSC handles infrastructure.

### What Computational Resources are available

- UCSB Center for Scientific Computing (CSC) HPC clusters
  - Access to all UCSB staff, Pod (free) and condo (PI) clusters.
- Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support (ACCESS)
  - National HPC resources funded by NSF. Free\*
- NRP Nautilus Cluster (Consumer GPUs)
  - National cloud computing resource for accelerating machine learning on the GPUs. Free\*
- Aristotle Cloud (LSIT)
  - UCSB local cloud resource, e.g. Jupyter hub
- Secure Compute Research Environment (SCRE)
- Other discipline specific UCSB resources
  - NCEAS, ERI, ECI, your local department
- Commercial Cloud Computing Resources:
  - AWS, Microsoft Azure, google Cloud Platform

## **HPC Resources of Useful Information**

- CSC Software Documentation
  - https://csc.cnsi.ucsb.edu/docs
- National HPC resources
  - ACCESS: <u>https://access-ci.org/</u>
  - San Diego Supercomputer Center: <u>https://www.sdsc.edu/</u>
  - NRP Nautilus: https://portal.nrp-nautilus.io/
- Transitioning from XSEDE to ACCESS by using Globus
  - <u>https://www.globus.org/advance-to-access</u>
- UCSB Aristotle Cloud (LSIT):
  - <u>https://www.aristotle.ucsb.edu/</u> and

https://help.lsit.ucsb.edu/hc/en-us/categories/360005255312-Jupyter

- UCSB Campus Cloud Information:
  - <u>https://www.it.ucsb.edu/explore-services/ucsb-campus-cloud</u>
  - https://docs.cloud.ucsb.edu/
- More information, go to <u>https://csc.cnsi.ucsb.edu/resources</u>

### Connecting to the POD

- For the Windows system, you can use PuTTY ssh client
  - Download the PuTTY (<u>https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html</u>)



### Connecting to the POD

• For the Mac or Linux system, you can open the terminal

ssh your_user_name@pod-login1.cnsi.ucsb	.edu
---	------

	🛅 jaychi — jay@pod-login1:~ — ssh jay@pod-login1.cnsi.ucsb.edu — 90×30
(base) EEU	C-YT61Y2PL:~ jaychi\$ ssh jay@pod-login1.cnsi.ucsb.edu
jay@pod-lo	gin1.cnsi.ucsb.edu's password:
Last login	: Mon Aug 29 09:28:40 2022 from 169-231-103-70.wireless.ucsb.edu
Welcome to	 Pod
For basic	documentation to get started please see
http://csc	.cnsi.ucsb.edu/docs/pod-cluster
March 2022	
We are exp	eriencing some slow /home performance because the
filesystem	is fairly full - please, please, please, take a
look at wh	at you can move off the system!!
Apr 4, 202	2
login node	crashed - all jobs are fine. Please be careful
with runni	ng anything large directly on the login node!
[iav0pod−1	ogin1 ~1\$

	Connect	ions	
>	UCSB Remote Access Connected	<ul> <li>Sector</li> </ul>	Disconnect

#### Important: Remote (non UCSB) login via VPN client:

https://www.ets.ucsb.edu/pulse-secure-campus-vpn/get-connected-campus-vpn

## File Transfer

- How do I uploaded data & download my files?
  - Graphical User Interface (GUI)
    - Filezilla: <u>https://filezilla-project.org/</u>
    - Cyberduck: <u>https://cyberduck.io/</u>
  - Command-Line Interface (CLI)
    - "scp" command
- FileZilla
  - Host: pod-login1.cnsi.ucsb.edu
  - Username: your\_user\_name
  - Password: your\_password
  - Port: 22
- Globus (for larger files transfers)
  - <u>https://csc.cnsi.ucsb.edu/docs/globus-v5-new</u>

11 🖹 🖬 🗂 📲			1						
lost:	Username:	Password:	Port:		Quickconnect				
ocal site: // leare/iavchi/									
				tomoto otto					
Volumes									
bin									
cores									
> 📒 dev									
> 📒 etc			- H.						
home			- H.						
> 🦲 opt			- H.						
> 🦰 private			- H.						
sbin									
> tmp									
ilename 🔨	Filesize Filetype	Last modified	E E	ilename 🔨		Filesize Filetype	Last modified	Permissions	Owner/
.Trash	Directory	08/30/2022 12:3	- H.						
.anaconda	Directory	08/10/2022 17:0	- H.			Not connected	d to any server		
.aws	Directory	08/25/2022 17:2	- H.						
.bash_sessions	Directory	08/29/2022 16:5	- H.						
.cache	Directory	08/10/2022 11:4	- H.						
.conda	Directory	08/10/2022 17:1							
.contig	Directory	08/30/2022 12:3							
.continuum	Directory	08/10/2022 17:0							
.cups	Directory	0//25/2022 16:2							
.giobusoniine	Directory	08/09/2022 13:2							
.iucal	Directory	06/27/2022 17-3							
	Directory	07/07/2022 17:3							
outty	Directory	0/12/12022 15-3							
ronin-link	Directory	08/30/2022 12:3							
retudio-deekton	Directory	08/10/2022 00:							
.istudio-desktop	Directory	00/10/2022 17:1							
eeb	Directory								

Queued files Failed transfers Successful transfers

## **Basic Linux Commands**

- Is
- pwd
- cd
- mkdir
- ср
- mv
- rm
- scp
- nano, vim, or emacs to edit your file.

## Basic Linux Commands (Is)

- The Is (list) command files and directories in a directory.
  - General syntax:

Is [OPTIONS] [FILENAME]

• OPTIONS include:

-l long listing, includes file date and size

- -a displays all files
- -t show the newest files first

## Basic Linux Commands (pwd & cd)

- pwd stands for print working directory.
   pwd
- The cd (change directory) command is used to change one directory to another.
   General syntax:
  - cd [DIRECTORY]
  - Change your present directory to the parent directory:
    - \$ cd ..
  - Change your present directory to the home directory:
    - \$ cd ~

## Basic Linux Commands (mkdir & cp)

- The mkdir (make directory) command creates a new directory.
   General syntax:
  - General Syntax.

mkdir [OPTIONS] Folder\_name

- The touch command creates a new file.
  - General syntax:

touch file\_name

The cp (copy) command is used to copy a file or directory.
 General syntax:

cp [OPTIONS] Source Destination

• OPTIONS include:

-r recursively copy a directory, all files and subdirectories inside it.

### Basic Linux Commands (mv & rm)

- The mv (move) command is used to move or rename a file or directory.
  - General syntax:

mv Source Destination

- The rm (remove) command is used to delete a file or directory.
  - General syntax:

rm [OPTIONS] file\_name

- OPTIONS include:
  - -r recursively delete a directory, all files and subdirectories inside it.
- Important: After rm or rm -r command is executed, all files are gone and can't find in recycle bin.

#### File Transfer

- The scp (secure copy) command is used to transfer files between two locations.
  - General syntax:

SCP [OPTIONS] LOCAL REMOTE

scp [OPTIONS] REMOTE LOCAL

scp [OPTIONS] REMOTE REMOTE

• OPTIONS include:

-r recursively copy a directory, all files and subdirectories inside it.

#### More Linux Resource Information

- UCSB Software Carpentries
  - Introduction to the Unix Shell and Version Control with Git

(https://ucsbcarpentry.github.io/2022-10-18-ucsb-bash-git/)

- Module system provides for the dynamics modification of a user's environment.
- Module commands allow the user to add applications and libraries to your environment.
- This allows us to simultaneously and safely provides several versions of the same softwares.
- All clusters have a default programming environment loaded for you when you login.
- There are some functional software are not modularized in /sw directory. Please take a look if you need.

- 1. List available modules
- 2. Search available modules for MatLab
- 3. Load the MatLab module
- 4. Unload the MatLab module
- 5. Purge all modules
- 6. List currently loaded modules

. . .

- 1. List available modules
  - \$ module avail
- 2. Search available modules for MatLab

\$ module avail MatLab

------/sw/modulefiles ------

MatLab/R2016b MatLab/R2018a MatLab/R2018b MatLab/R2019a MatLab/R2019b MatLab/R2021b

3. Load the MatLab module

\$ module load MatLab/R2021b

4. Unload the MatLab module

\$ module unload MatLab/R2021b

5. Purge all modules

\$ module purge

6. List currently loaded modules

\$ module listCurrently Loaded Modulefiles:1) autotools 2) prun/1.2 3) gnu/5.4.0 4) ohpc

### Job Submission Script

- When you login to the Cluster, you are on the login node. This node is <u>NOT</u> for running calculations!
- All jobs must be submitted to the queue it just allocate nodes.
- Submission to the queue requires a job script to be written.
- Job script need to specify the resource that you need. There are three basic units:
  - Number of Nodes
  - Number of Cores
  - Time (Optional)
- Other resource you might need to add such as: job name, memory, reminder email, etc.

### Example Slurm Job Submission script

#### Slurm job script file: job.s

#!/bin/bash	
#SBATCH -J 'testJob'	### Job Name
#SBATCHnodes=1	### No. of Nodes
#SBATCHntasks=1	### No. of Tasks
#SBATCH -p short	### Submit the job to Partition (Optional)
#SBATCH -o outLog	### Output Log File (Optional)
#SBATCH -e errLog	### Error Log File (Optional but suggest to have it)
#SBATCH -t 00:10:00	### Job Execution Time
#SBATCHmail-user=usernam@ucsb.edu	### Mail to you (Optional)
#SBATCHmail-type ALL	### Mail send you when the job starts and end (Optional)

module purge module load openmpi/2.1.0-opt

cd \$SLURM\_SUBMIT\_DIR/

### Absolute path of the current working directory when you submit the job

mpirun ./hello

#### How to Submit and Monitor Your Job

 Once you have a job script, you may submit this script to SLURM using the sbatch command. SLURM will find an available compute node or set of compute nodes and run your job there, or leave your job in a queue until some resources become available.

\$ sbatch job.s Submitted batch job 1234567

• List all current jobs from the user.

\$ squeue -u your\_user\_name
\$ showq your\_user\_name

• Stop and delete the Job

\$ scancel 1234567

#### How to Submit and Monitor Your Job

#### • List all partitions on the cluster

\$ sinfo

PARTITION	AVAIL	TIMELIMIT	NODES	STATE	NODELIST
batch*	up	32-00:00:0	1	down*	node1
batch*	up	32-00:00:0	1	drng	node20
batch*	up	32-00:00:0	1	drain	node4
batch*	up	32-00:00:0	30	mix	node[6,8-9,11,13-16,19,22-23,26-28,32,36-39,42-44,49,52-56,58,60]
batch*	up	32-00:00:0	29	alloc	node[3,5,7,10,12,17-18,21,24-25,29-31,33-35,40-41,45-48,50-51,57,59,61-63]
batch*	up	32-00:00:0	1	idle	node2
short	up	2:00:00	1	mix	node64
largemem	up	37-12:00:0	4	mix	node[101-104]
gpu	up	7-00:00:00	1	down*	node117
gpu	up	7-00:00:00	13	mix	node[111-113,115-116,118-125]

- List the partition who are using \$ squeue -p short
- Report the job expected start time \$ squeue -start -job job\_ID

## Running Jobs on Pod (Slurm)

- Start a job:
- Check status of the running jobs:
- \$ sbatch job.s
  \$ squeue -u user\_name
- \$ showq user\_name

• Delete a running job:

\$ scancel job\_id

- Available partition:
  - Short partition: running under 2 hrs
    - #SBATCH -p short
  - Large memory partition: running the longest 37 days
    - #SBATCH -p largemem
  - GPU partition: running the longest 7 days
    - #SBATCH -p gpu

#### **Other Computing Options**

• National HPC Resource: ACCESS

• Cloud Computing: Amazon Web Services

## National HPC Resources: ACCESS

Four Allocation Opportunities to suit a variety of needs (credit thresholds):

- Explore (400,000)
  - Best-suited for endeavors with light resource requirements
    - Grad students can be PIs
- Discover (1,500,000)
  - Minimal effort to start production research activities
    - Potential best-fit for Campus Champion Allocations
- Accelerate (3,000,000)
  - More substantial resource requirements
    - Multi-grand research, Gateways, etc.
- Maximize (No upper limit)
  - For large-scale research project with extreme resource needs
    - Will largely resemble XRAC process



#### **ACCESS Credits and Thresholds**

Researchers have opportunities to request ACCESS allocations at four levels, which are described at the links in the table.

Allocation	Credit Threshold
Explore ACCESS	400,000
Discover ACCESS	1,500,000
Accelerate ACCESS	3,000,000
Maximize ACCESS	Not awarded in credits.

## National HPC Resources: ACCESS



Get started	Manage allocations	Prepare requests Use c	redits Updates Polic	ies FAQs		
Researchers and educators can gain access to advanced Resource providers are at the center of the ACCESS Alloc	Overview Submit a request	, and data resources to accom ng research possible for the div	plish their research or classroo verse community that ACCESS	m objectives S serves		
Reviewers provide a valuable service to ACCESS, the NSF Manage my projects Manage users We hope you'll get involved! Let's get started. Allocations Usage			Explore	Discover	Accelerate	Maximize
		Possible purposes	Evaluation, courses, development, exploration	Small-scale research, Campus Champions, growing gateways	Mid-scale needs, consolidating related grants, collaborations	Largest-scale research activities
		Credit threshold	400,000 Credits	1,500,000 Credits	3,000,000 Credits	No upper limit
CREATE SELECT REQUE ACCOUNT OPPORTUNITY ALLOCA		Duration	Grant duration or 12 months	Grant duration or 12 months	Grant duration or 12 months	12 months
If you have questions, please use the ACCESS Help Request	Number per PI	Multiple	Multiple	One (some exceptions)	One (limited exceptions)	
		Accepted	Continuously	Continuously	Continuously	Semi-annually
		<b>Proposal length</b>	Abstract	1 page	3 pages	10 pages

Eligibility

Review

Advisory review

requestable

Rolling panel review

Panel review

### National HPC Resources: ACCESS



Purdue Anvil CPU	$\sim$	allocations Prepare req	uests	Use credits	Updates	Policies	FAQs
Purdue Anvil GPU	$\sim$	1 visualization and data res	Oven	- view	r research or ol	assroom obio	otivos
SDSC Expanse CPU	$\sim$	ketplace, making research p	Availa	able resources	nmunity that AC	CESS serve	S
SDSC Expanse GPU	$\sim$	tional research community	Exch	ange calculator	views of the larg	gest allocatior	n requests.

REQUEST ALLOCATION

#### Resource Type: Compute

Resource Description:	Expanse GPU will be a Dell integrated cluster, NVIDIA V100 GPUs with NVLINK, interconnected with Mellanox HDR InfiniBand in a hybrid fat-tree topology. There are a total of 52 nodes with four V100 SMX2 GPUs per node. (with NVLINK connectivity). There are two 20-core Xeon 6248 CPUs per node. Full bisection bandwidth will be available at rack level (52 CPU nodes, 4 GPU nodes) with HDR100 connectivity to each node. HDR200 switches are used at the rack level and there will be 3:1 oversubscription cross-rack. In addition, Expanse also has four 2 TB large memory nodes. The system will also feature 12PB of Lustre based performance storage (140GB/s aggregate), and 7PB of Ceph based object storage.
Recommended Use:	GPUs are a specialized resource that performs well for certain classes of algorithms and applications. Recommend to be used for accelerating simulation codes optimized to take advantage of GPUs (using CUDA, OpenACC). There is a large and growing base of community codes that have been optimized for GPUs including those in molecular dynamics, and machine learning. GPU-enabled applications on Expanse will include: AMBER, Gromacs, BEAST, OpenMM, NAMD, TensorFlow, and PyTorch.

Organization:	San Diego Supercomputer Center			
Units: GPU Hours				
Description:				

#### **Exchange Calculator**

Number of units on this resource:

10,000	ACCESS Credits
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#### Equals this many units on this resource:

186	SDSC Expanse GPU
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RESET

## Cloud Computing: Amazon Web Services (AWS) (will delete)

#### Sign in to AWS Management Console

Amazon EC2 Virtual servers in the cloud Types Of Offers Explore more than 100 products and start building on AWS using the Free Tier. Three different types of free offers are available Root User: Creates the AWS account depending on the product used. Click icon below to explore our offers. Amazon Simple Storage Service (S3) and has unrestricted account access. Scalable storage in the cloud 12 months free Always free Amazon Aurora Free trials Enjoy these offers for 12-months following your initial short-term free trial offers start from the date you These free tier offers do not expire and are available to High performance managed relational database with full MySQL sign-up date to AWS all AWS customer activate a particular service Root user and PostgreSQL compatibility Account owner that performs tasks requiring Explore Top Product Categories unrestricted access. Learn more Amazon DynamoDB 8 Ľ, B Managed NoSQL database Comput Database Storage Container Web & Mobile Apps Serverless Free Tier details O IAM user Amazon RDS Filter by: Managed relational database service for MySQL, PostgreSQL, Q. Search free tier products User within an account that performs daily tasks. lear all filter Oracle, SOL Server, and MariaDB Tier Type COMPUTE STORAGE DATARASE Learn more Featured Free Tier Free Tier 12 MONTHS FREE Free Tier 12 Months Free AWS Lambda Amazon EC2 Amazon S3 Amazon RDS Always Free Trials **750** Hours **5** GB **750** Hours Run code without thinking about servers Product Categorie IAM User: Created by the root Resizable compute capacity in the Serure durable and scalable object Analytics storage infrastructure. Managed Relational Database Service Cloud. Amazon VPC Application Integration user or IAM administrator. for MySQL, PostgreSQL, MariaDB, or **Business Productivity** Isolated cloud resources Compute

Container Customer Engagement \$

12 MONTHS ERF

Machine Learnin

Amazon Lightsail Launch and manage virtual private servers

Amazon SageMaker Build, train, and deploy machine learning models at scale

### Cloud Computing: Amazon Web Services (AWS)

If you choose to use AWS, it is recommended to take advantage of the Campus Cloud Landing Zone (LZ) for AWS. A UCSB purchases order is required to request an Campus Cloud account (<u>https://ucsb.github.io/campus-cloud-docs/getting-started/#procurement</u>).



*Important:* You may need the help of a PI or Department Purchasing person to create a Purchase Order which is necessary to request an account in the Campus Cloud.

## Amazon Elastic Compute Cloud (Amazon EC2)

- Use Case:
  - Run cloud-native and enterprise applications
  - Scale for HPC applications
  - Train and deploy ML applications
- EC2 Instance Types
  - General Purpose
  - Compute Optimized
  - Memory Optimization
  - Accelerated Computing
  - Storage Optimized
- More Information
  - Amazon EC2: <u>https://aws.amazon.com/ec2/</u>
  - Amazon EC2 Pricing Estimation: <u>https://aws.amazon.com/ec2/pricing/on-demand/</u>

https://instances.vantage.sh/

#### **On-Demand Plans for Amazon EC2**

Location Type		Region		
AWS Region	•	US West (Oregon)		
Select an operating system, instanc	e type, and vCPU to vi	ew rates		
Select an operating system, instanc Operating system	e type, and vCPU to vi	ew rates		
Select an operating system, instanc Operating system Linux	e type, and vCPU to vi	ew rates		
Select an operating system, instanc Operating system Linux Instance type	e type, and vCPU to vi	vCPU		

Viewing 4 of 525 available instances						
Instance name 🔺	On-Demand hourly rate ⊽	vCPU ⊽	Memory 🛛	Storage $\bigtriangledown$	Network performance $\bigtriangledown$	
c5.9xlarge	\$1.53	36	72 GIB	EBS Only	10 Gigabit	
c5d.9xlarge	\$1.728	36	72 GIB	1 x 900 NVMe SSD	10 Gigabit	
c5n.9xlarge	\$1.944	36	96 GIB	EBS Only	50 Gigabit	
c4.8xlarge	\$1.591	36	60 GiB	EBS Only	10 Gigabit	

# Ronin Platform **RONIN**

#### ronin.ucsb.edu/login.php

#### View site information

If you like to use AWS to be your cloud computing platform, RONIN removes the enormous complexity of AWS offerings and provides an easy-to-use self-service platform.
UCSB provides RONIN information support if you like to use AWS to do your computing research via the RONIN platform.

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LET'S GO!



**RESEARCH IT BUILDERS** 

Contact with Bill Doering: billd@ucsb.edu

#### **Ronin Platform: Control Your AWS Cost**



### **Questions and Thought**

- What else content should we cover?
- Other ideas for a workshop?
  - Running Parallel Python / Matlab / R on the Cluster, Mathematica, Lumerical, Singularity/Docker Container, etc.

• More Information:

https://csc.cnsi.ucsb.edu/