
Supporting Julia Users at MIT LL Supercomputing Center

Albert Reuther and LLSC Team

July 26, 2022



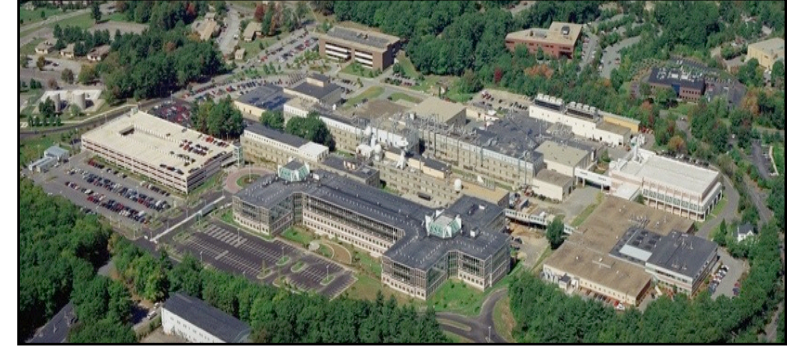


MIT/MIT Lincoln Laboratory



Massachusetts Institute of Technology

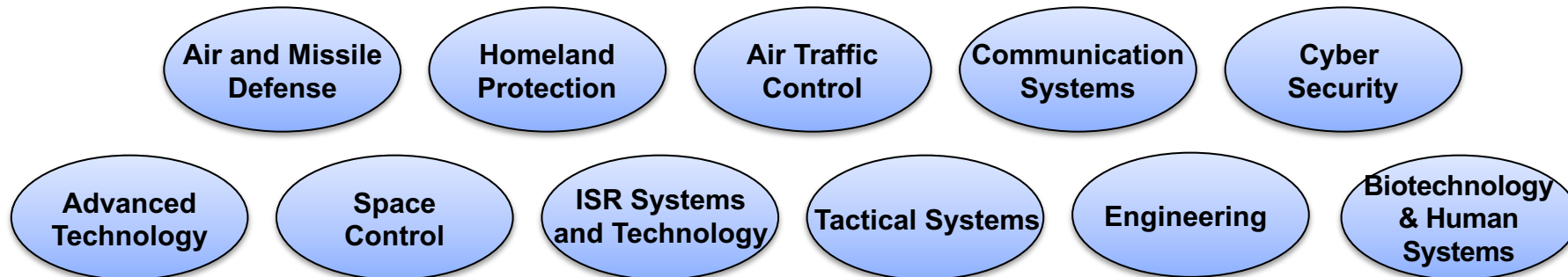
- Leading Science and Engineering Research University
- Motto: Mens et Manus (Mind and Hand)
- Thousands of companies (11th largest world economy)



MIT Lincoln Laboratory

Mission: Technology in Support of National Security
Key Roles: System architecture engineering
Long-term technology development
System prototyping and demonstration

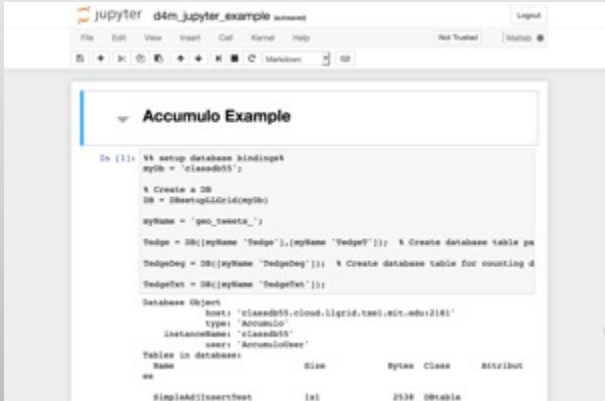
MIT Lincoln Laboratory Mission Areas:





LLSC Advantage: Interactive Supercomputing

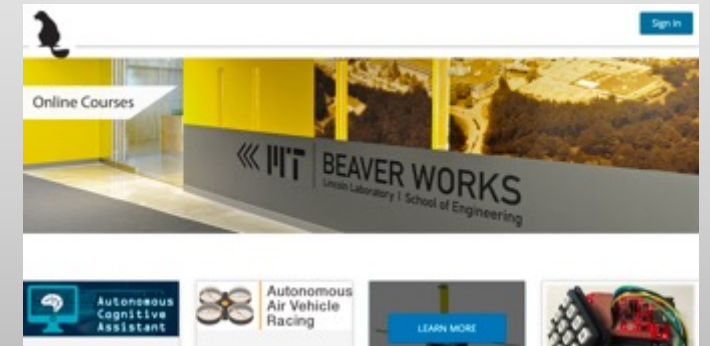
Jupyter Notebook: web-based IDE & more



Dynamic Databases: manage world's most powerful databases from a GUI

Folder Name	Type	Status	Actions	
afbrains-scldb01	SciDB v14.12	stopped	Start	Checkpoint
afbrains-scldb02	SciDB v14.12	stopped	Start	Checkpoint
afbrains01	PostgreSQL	stopped	Start	Checkpoint
afbrains02	PostgreSQL	stopped	Start	Checkpoint
bigdawg01	PostgreSQL	started	Stop	
bigdawg02	PostgreSQL	stop_requested		
class-db01	Accumulo v1.8.0	stopped	View Info	Start Checkpoint

Online Education: Learn on the same systems you are going to use



Interactive Hardware: get a processor core or a whole node

```
[vijay@login-0 ~]$ LLsub -i
salloc --immediate -p normal --constraint=xeon-e5 --qos=high sru
n --pty bash -i
salloc: Granted job allocation 441123
[vijay@node-046 ~]$
```

LLMapReduce: parallel data analysis in any language with one line of code

```
[vijay@node-046 ~]$ LLMapReduce --mapper myCode --input inputDire
ctory --output outputDirectory --np 512
```

Dynamic Web Services: start an authenticated web-service

```
[vijay@node-046 ~]$ LLWebServStartHTTPD --group myGroup myGroupWe
bService
```



High Performance Software and Tools

High Productivity Languages



High Performance Languages



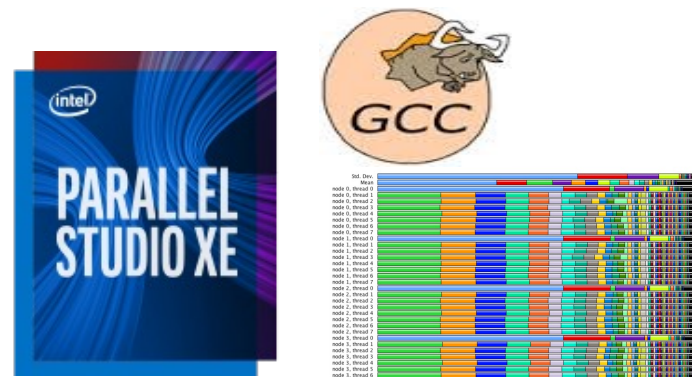
Machine Learning Frameworks



3rd Party / Commercial Software



Compilers, Debuggers, Performance Analysis



High Performance Databases





Julia Installations

- Installed locally on nodes
 - Faster launch times
 - More responsive
 - Less load on central file systems
- Accessible using Linux environment modules
 - Multiple versions available
- Utilize ~/.julia directory for user-specific packages
 - Enables customization of environment

```
al17856 — ssh reuther@txe1-login.mit.edu — 80x31
[reuther@login-3:~$ module avail
----- /etc/environment-modules/modules -----
anaconda/2020a  graphblas/4.0.3      mpi/openmpi-4.1.0      R/2020a
anaconda/2020b  graphblas/5.0.5      mpi/openmpi-4.1.1
anaconda/2021a  graphblas/6.1.3      mpi/openmpi-4.1.3
anaconda/2021b  gurobi/gurobi-801    ncc1/2.5.6-cuda10.0
anaconda/2022a  gurobi/gurobi-811    ncc1/2.5.6-cuda10.1
anaconda/2022b  gurobi/gurobi-903    ncc1/2.5.6-cuda10.2
cuda/10.0       gurobi/gurobi-951    ncc1/2.8.3-cuda11.0
cuda/10.1       icc/2019.5           ncc1/2.8.3-cuda11.1
cuda/10.2       julia/1.1.1          ncc1/2.8.3-cuda11.2
cuda/11.0       julia/1.3.0          ncc1/2.9.8-cuda11.3
cuda/11.1       julia/1.4.2          ncc1/2.10.3-cuda11.4
cuda/11.2       julia/1.5.2          ncc1/2.11.6-cuda11.6
cuda/11.3       julia/1.6.1          octave/octave-6.3.0-mkl
cuda/11.4       mpi/openmpi-4.0      octave/octave-repo-mkl
cuda/11.6       mpi/openmpi-4.0.5    R/2019b
[reuther@login-3:~$ module load julia/1.6.1
[reuther@login-3:~$ which julia
/state/partition1/llgrid/pkg/julia/julia-1.6.1/bin/julia
[reuther@login-3:~$ julia

      _
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Documentation: https://docs.julialang.org

Type "?" for help, "]"? for Pkg help.

Version 1.6.1 (2021-04-23)
Official https://julialang.org/ release

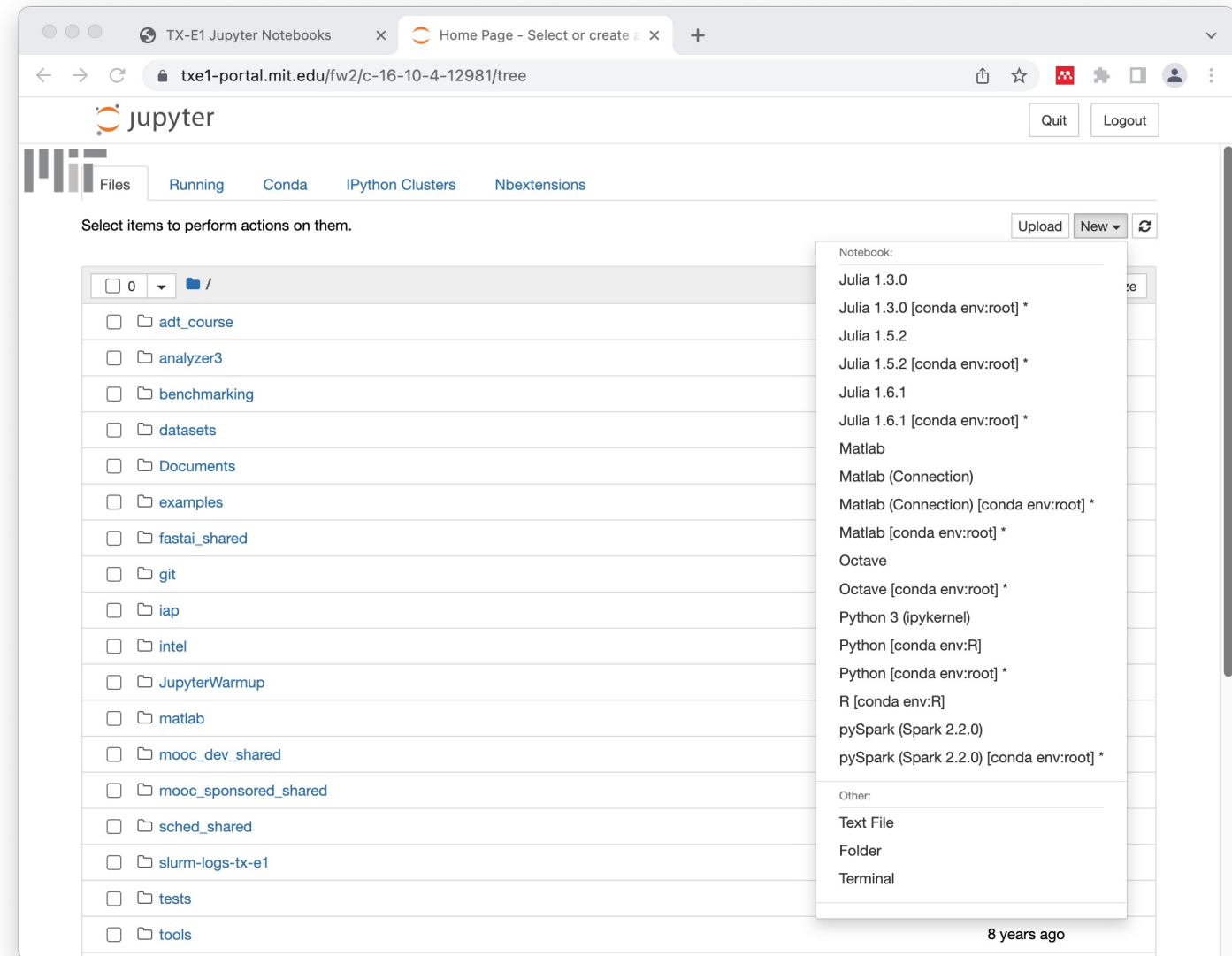
julia> 
```



Using Julia on LLSC Systems

Available through

- Interactive session command line
- Jupyter Notebooks
 - Runs on compute nodes
 - Uses web portal to connect compute node to external web interface
- VS Code via remote ssh

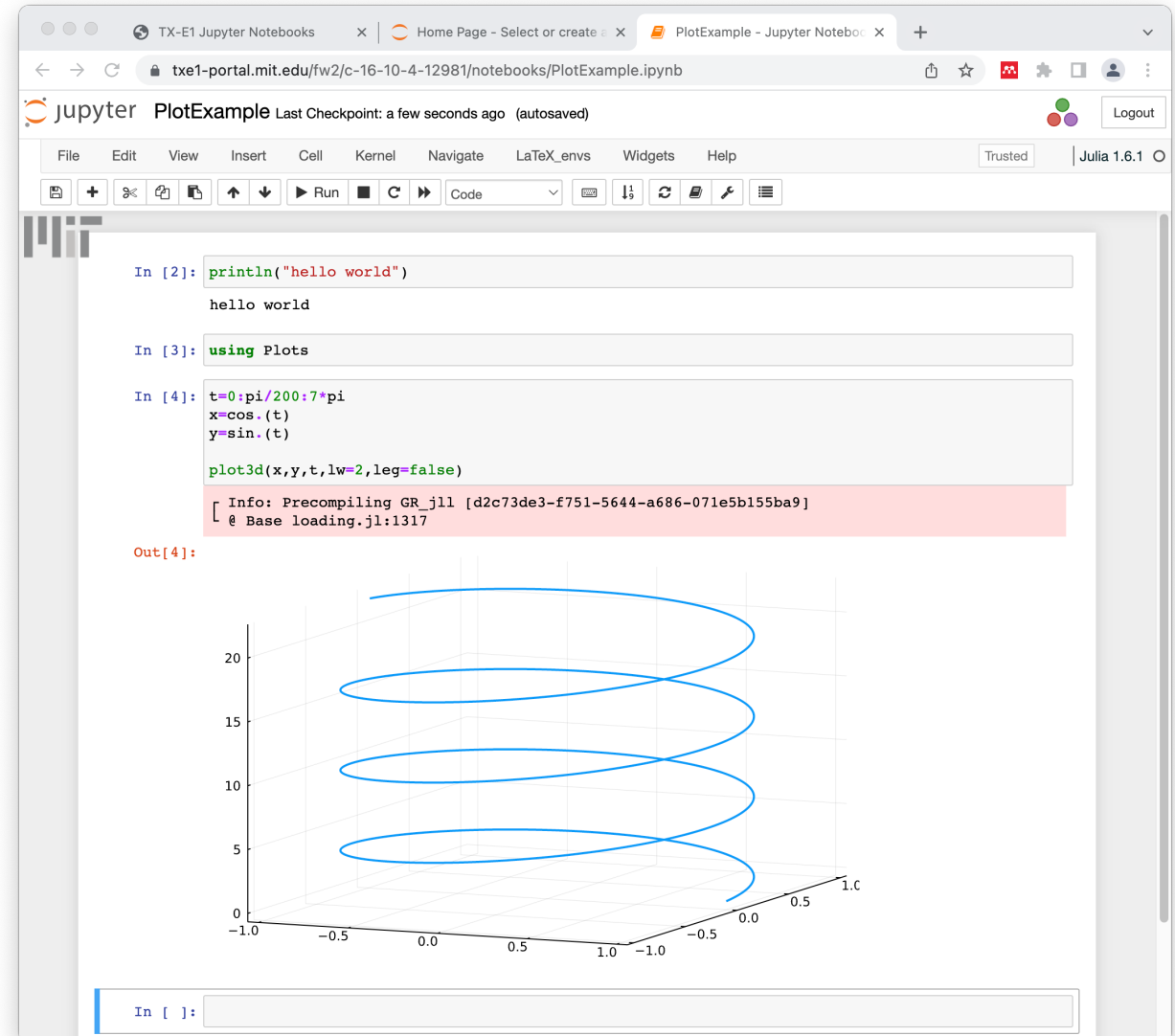




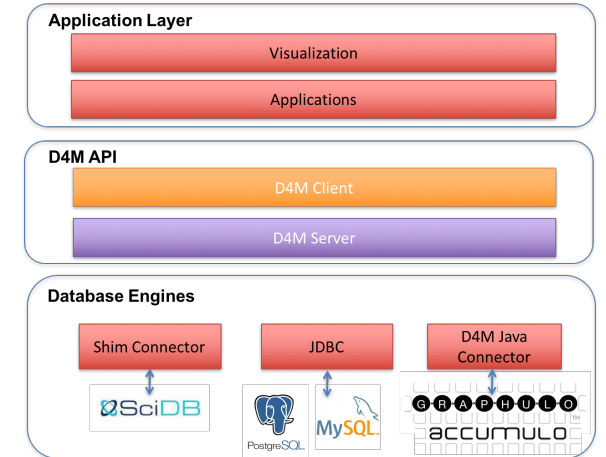
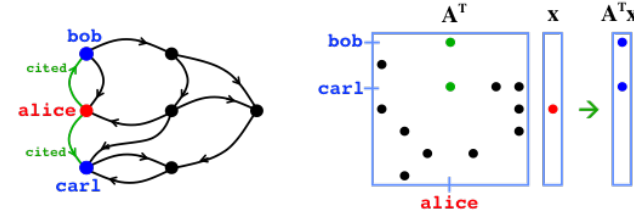
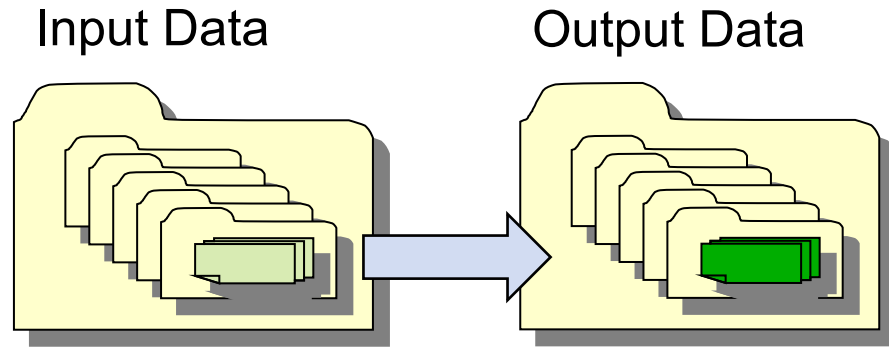
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Other LLSC Tools for Julia



LLMapReduce

- Simple scheduler interface for two-level job arrays
- Bulk synchronous parallel and Monte Carlo simulations

D4M.jl with Database Integration

- D4M = Dynamic Distributed Dimensional Data Model – <https://d4m.mit.edu/>
- Graph and data analysis via sparse linear algebra