

# Docker to Singularity Conversion

Peter Z. Vaillancourt  
Computational Scientist,  
Center for Advanced Computing (CAC)  
Cornell University  
XCRI Engineer, XSEDE





# Docker to Singularity Conversion

## Different Philosophies

### Docker

- Focus on flexibility and cloud usability
- Daemon runs as root
- Isolated from host filesystem
- Not originally designed for interoperability with Singularity or HPC systems

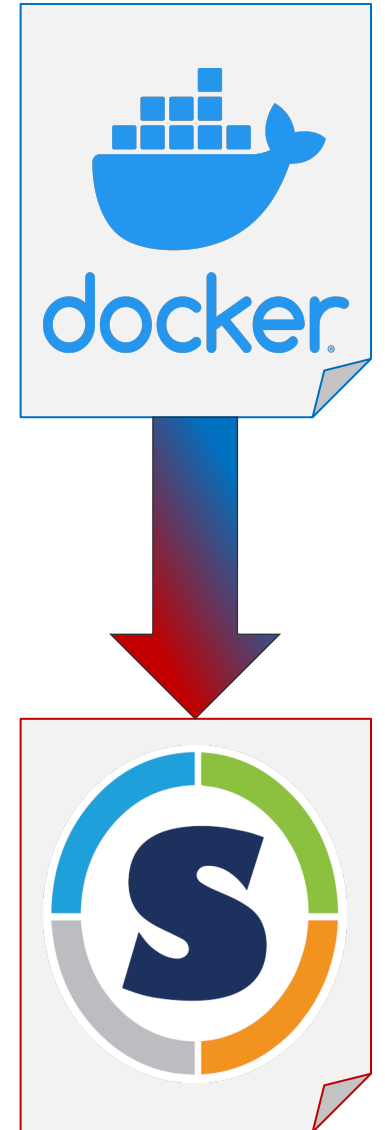
### Singularity

- Focus on security and HPC usability
- Runs in userspace
- Direct Filesystem access
- Designed for interoperability with Docker

# Docker to Singularity Conversion

## Overview of the Process

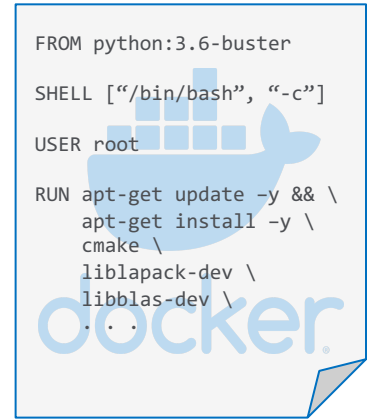
1. Create & Build the **Dockerfile**
2. Test the **Docker** container
3. Tag the **Docker** image and push to a **DTR**
4. Create the **Singularity** Definition file
5. Build & Test the **Singularity** container
6. (Optional) Push **Singularity** image to a registry





# Docker to Singularity Conversion

## Where to Start?



- Focus here is on the composition of the Dockerfile
  - For public images, find the Dockerfile where possible
    - Often available through Docker Hub links to GitHub repositories
    - Without the Dockerfile, you're taking a risk (security and conversion)
  - Keep these ideas in mind when building a Dockerfile
- Refer to Singularity Best Practices for Docker Images docs when attempting a conversion: [https://sylabs.io/guides/3.5/user-guide/singularity\\_and\\_docker.html#best-practices](https://sylabs.io/guides/3.5/user-guide/singularity_and_docker.html#best-practices)

# Docker to Singularity Conversion

## Best Practices

### 1. Account for differences in the trust model of Docker vs. Singularity

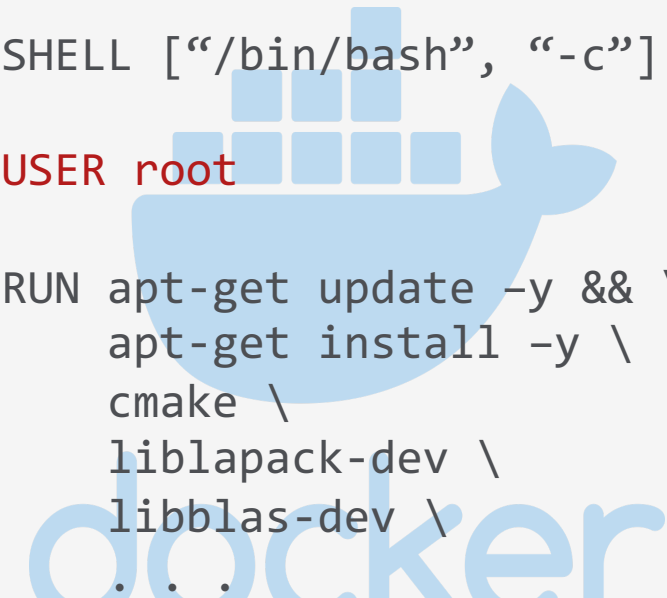
- Do not create a user
- Do not use the USER command unless it's to specify "USER root"

```
FROM python:3.6-buster

SHELL ["/bin/bash", "-c"]

USER root

RUN apt-get update -y && \
    apt-get install -y \
    cmake \
    liblapack-dev \
    libblas-dev \
    . . .
```



# Docker to Singularity Conversion

## Best Practices

### 1. Account for differences in the trust model of Docker vs. Singularity

- Do not create a user
- Do not use the USER command unless it's to specify "USER root"

### 2. Account for potential changes in the underlying Docker image

- Use a Singularity definition file to pull and convert
- Version pinning of Docker image can mitigate this, but not alleviate it entirely
- Do a "diff" before "pull"
- Also see: <https://singularityhub.github.io/container-diff/>



```
FROM python:3.6-buster

SHELL ["/bin/bash", "-c"]

USER root

RUN apt-get update -y && \
    apt-get install -y \
    cmake \
    liblapack-dev \
    libblas-dev \
    . . .
```


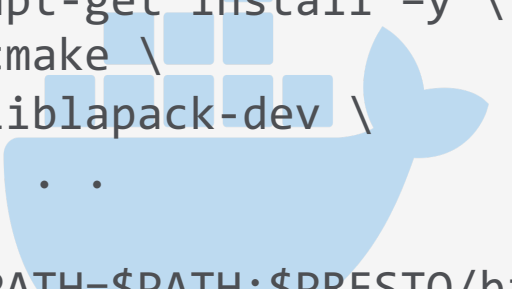
# Docker to Singularity Conversion

## Best Practices

### 3. Declare environment Variables in the Dockerfile

- Do not declare them in other files (i.e. .bashrc or .profile)
- Understand Singularity definition files:  
[https://sylabs.io/guides/3.5/user-guide/definition\\_files.html#definitionfiles](https://sylabs.io/guides/3.5/user-guide/definition_files.html#definitionfiles)

```
. . .  
  
RUN apt-get update -y && \  
    apt-get install -y \  
    cmake \  
    liblapack-dev \  
    . . .  
  
ENV PATH=$PATH:$PRESTO/bin  
  
COPY file.py /root  
.  
.  
.
```



# Docker to Singularity Conversion

## Best Practices

### 3. Declare environment Variables in the Dockerfile

- Do not declare them in other files (i.e. .bashrc or .profile)
- Understand Singularity definition files:  
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### 4. Avoid installing to “/root”

- Not a blanket ban, but can sometimes cause issues
- User access remains the same as on host
- Cannot make changes to the read-only filesystem

```
...  
RUN apt-get update -y && \  
    apt-get install -y \  
    cmake \  
    liblapack-dev \  
...  
ENV PATH=$PATH:$PRESTO/bin  
COPY file.py /root  
...  
docker
```



# Docker to Singularity Conversion

## Best Practices

### 5. Prepare for “/” to be read-only

- Overlay FS can allow changes, but not allowed on some HPC systems: [https://sylabs.io/guides/3.5/user-guide/persistent\\_overlays.html](https://sylabs.io/guides/3.5/user-guide/persistent_overlays.html)
- The default install locations of most trusted/maintained software will just work
- A good place to install may be a subdirectory of /opt or /usr/local

```
...  
COPY file.py /root  
  
ENV PATH=$PATH:$PRESTO/bin  
  
COPY file.py $HOME  
COPY file2.py $TMP  
  
...  
  
RUN ldconfig
```

  
docker®

# Docker to Singularity Conversion

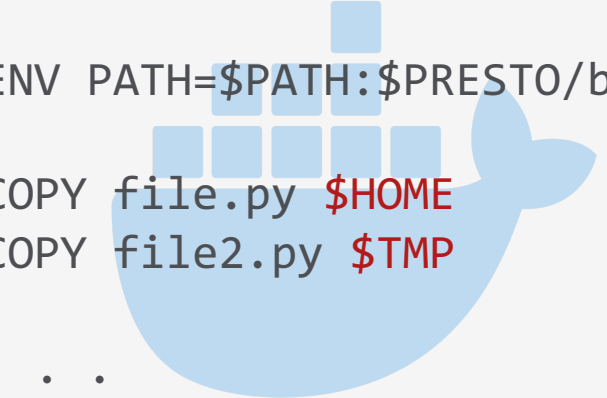
## Best Practices

### 5. Prepare for “/” to be read-only

- Overlay FS can allow changes, but not allowed on some HPC systems: [https://sylabs.io/guides/3.5/user-guide/persistent\\_overlays.html](https://sylabs.io/guides/3.5/user-guide/persistent_overlays.html)
- The default install locations of most trusted/maintained software will just work
- A good place to install may be a subdirectory of /opt or /usr/local

### 6. Avoid placing files in “\$HOME” or “\$TMP”

```
...  
COPY file.py /root  
  
ENV PATH=$PATH:$PRESTO/bin  
  
COPY file.py $HOME  
COPY file2.py $TMP  
  
...  
  
RUN ldconfig
```



# Docker to Singularity Conversion

## Best Practices

### 5. Prepare for “/” to be read-only


- Overlay FS can allow changes, but not allowed on some HPC systems: [https://sylabs.io/guides/3.5/user-guide/persistent\\_overlays.html](https://sylabs.io/guides/3.5/user-guide/persistent_overlays.html)
- The default install locations of most trusted/maintained software will just work
- A good place to install may be a subdirectory of /opt or /usr/local

### 6. Avoid placing files in “\$HOME” or “\$TMP”

### 7. Ensure symbolically linked libraries are cached

- Can run “ldconfig” at or near the end of the Dockerfile

```
...  
COPY file.py /root  
  
ENV PATH=$PATH:$PRESTO/bin  
  
COPY file.py $HOME  
COPY file2.py $TMP  
  
...  
  
RUN ldconfig
```

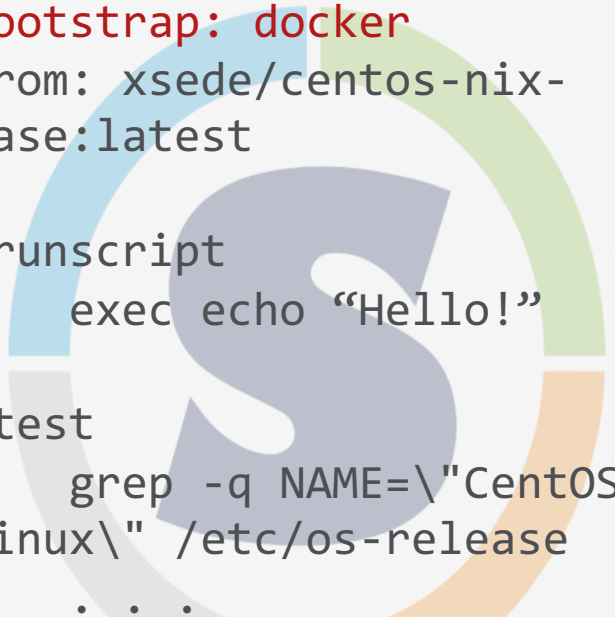


# Docker to Singularity Conversion

## Best Practices

### 8. Do not use plain text passwords

- Can use the “--docker-login” option for Singularity “pull” and “build” commands



```
Bootstrap: docker
From: xsede/centos-nix-
base:latest

%runscript
    exec echo "Hello!"

%test
    grep -q NAME=\"CentOS\
Linux\" /etc/os-release
    . . .
```

# Docker to Singularity Conversion

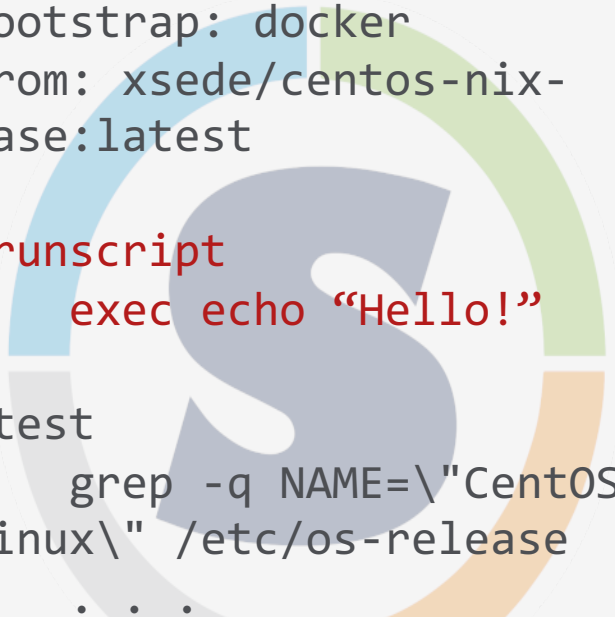
## Best Practices

### 8. Do not use plain text passwords

- Can use the “--docker-login” option for Singularity “pull” and “build” commands

### 9. Use the “%runscript” environment to execute commands in the container

- Removes ambiguity



```
Bootstrap: docker
From: xsede/centos-nix-
base:latest

%runscript
exec echo "Hello!"

%test
grep -q NAME=\"CentOS\
Linux\" /etc/os-release
. . .
```



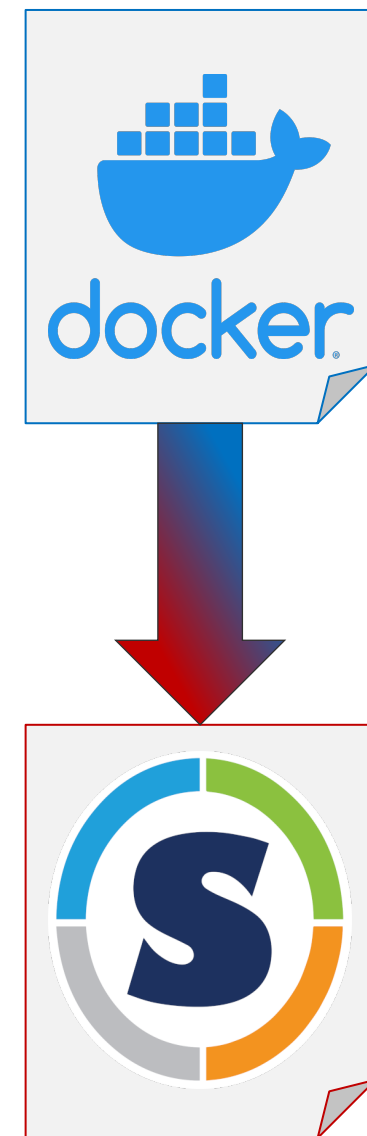
# Docker to Singularity Conversion Summary

- DO run commands entirely as the root user in your Dockerfile
- DO a diff on the base image before building a new image of your container
- DO use the ENV directive for environment variables
- DO install to a subdirectory of /opt or /usr/local (recommended)
- DO run "ldconfig" near the end of your Dockerfile
- DO protect secure information

# Docker to Singularity Conversion

## Example Completed Conversion

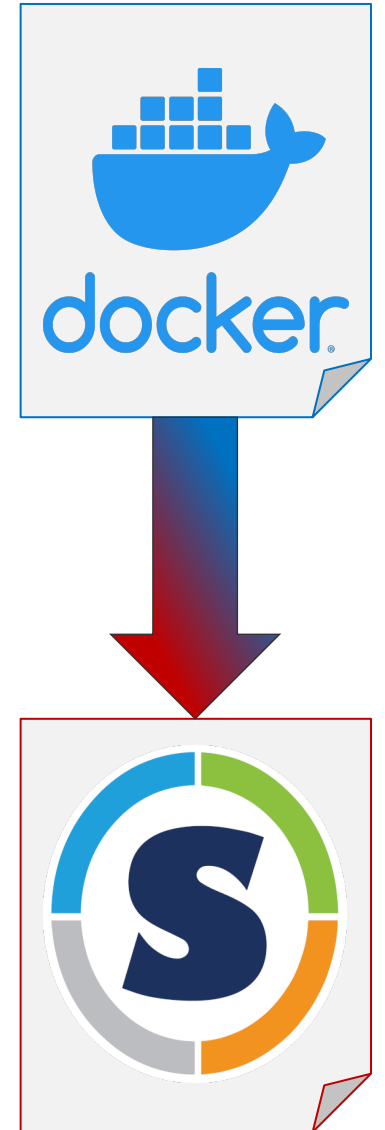
1. **Dockerfile:** <https://github.com/federatedcloud/docker-PRESTO/blob/master/Dockerfile>
  - `docker build ...`



# Docker to Singularity Conversion

## Example Completed Conversion

1. **Dockerfile:** <https://github.com/federatedcloud/docker-PRESTO/blob/master/Dockerfile>
  - `docker build ...`
2. Test the **Docker** container
  - `docker image`
  - `docker run <image> <command>`
  - Or `docker run --name=<name> <image> sleep 1000000 &`  
`docker exec --it <name> /bin/bash`

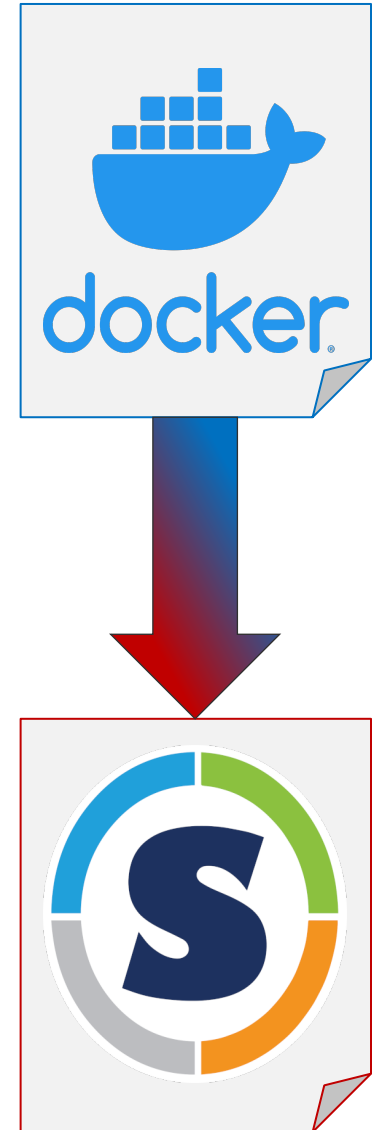




## Docker to Singularity Conversion

### Example Completed Conversion

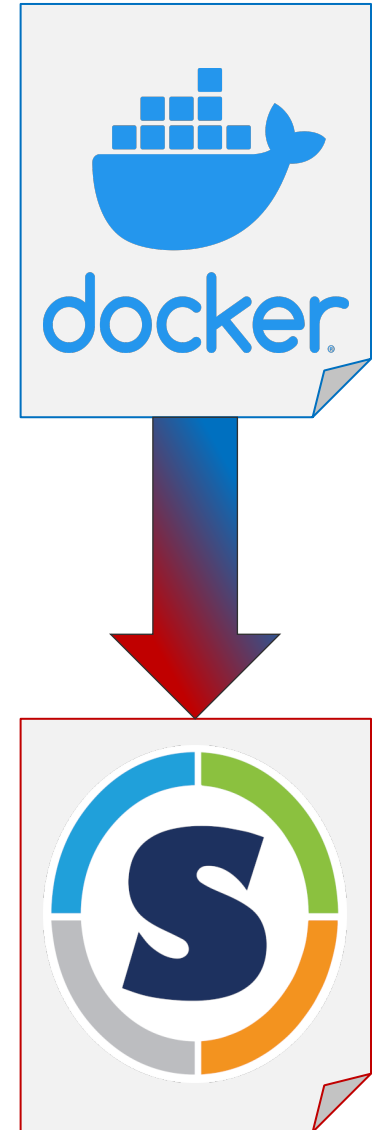
3. Tag the **Docker** image and push to a **DTR**
  - `docker tag <image> <org/repo:tag>`
  - `docker push <org/repo:tag>`



# Docker to Singularity Conversion

## Example Completed Conversion

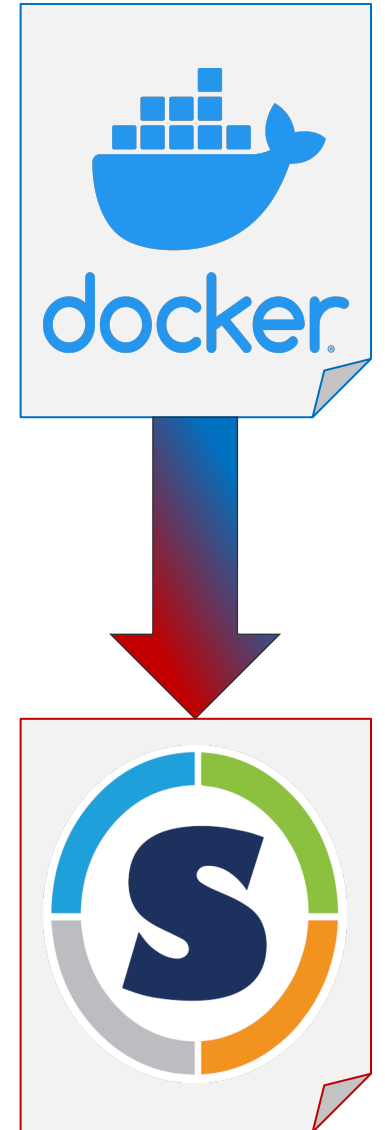
3. Tag the **Docker** image and push to a **DTR**
  - `docker tag <image> <org/repo:tag>`
  - `docker push <org/repo:tag>`
4. **Singularity** Definition file:  
<https://github.com/federatedcloud/singularity-PRESTO/blob/master/Singularity>



# Docker to Singularity Conversion

## Example Completed Conversion

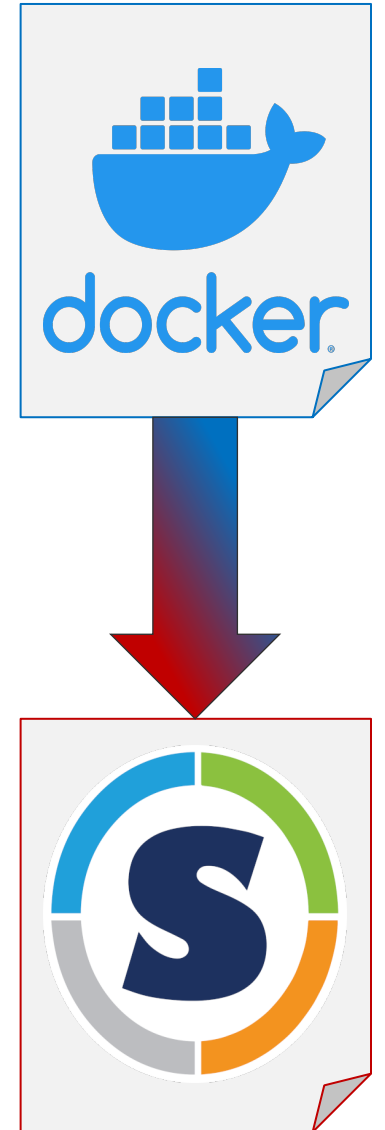
5. Build & Test the **Singularity** container
  - **singularity build ...**



# Docker to Singularity Conversion

## Example Completed Conversion

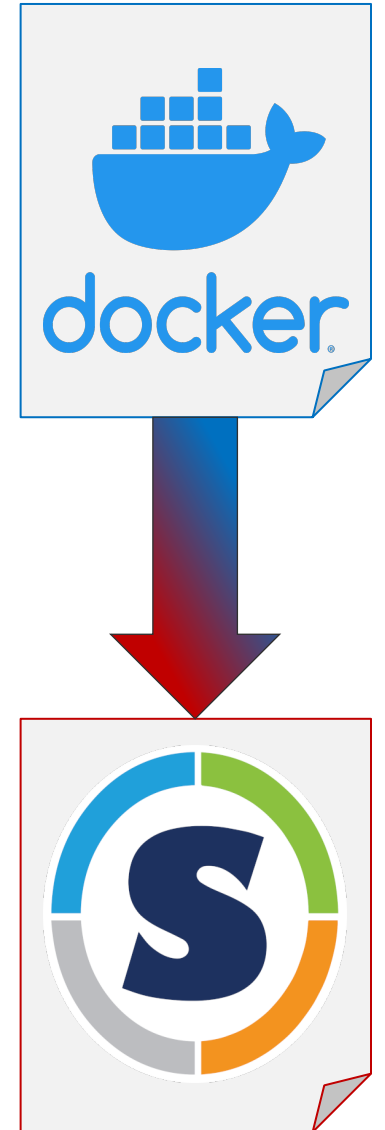
5. Build & Test the **Singularity** container
  - **singularity build ...**
6. (Optional) Push **Singularity** image to a registry



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## Overview of the Process

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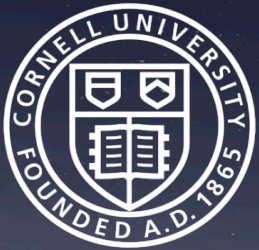
# Docker to Singularity Conversion

## Also See

- All Tier 1 XSEDE systems have Singularity, for versions see: <https://portal.xsede.org/software#/>
- If you need to troubleshoot the conversion, see: [https://sylabs.io/guides/3.5/user-guide/singularity\\_and\\_docker.html#troubleshooting](https://sylabs.io/guides/3.5/user-guide/singularity_and_docker.html#troubleshooting)
- For other conversion tools, especially for non-Linux users, see: <https://github.com/singularityhub/docker2singularity>







# XSEDE

Extreme Science and Engineering  
Discovery Environment

## Now try it out for yourself!

[https://github.com/XSEDE/Container\\_Tutorial](https://github.com/XSEDE/Container_Tutorial)



Peter Vaillancourt  
Computational Scientist  
Center for Advanced Computing (CAC)  
Cornell University

