University of St Andrews | FOUNDED 1413

An introduction to Docker

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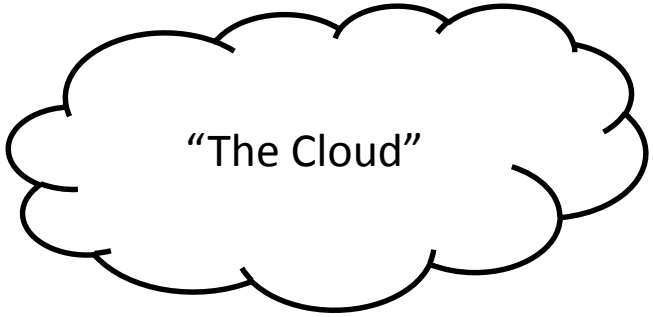
Problem introduction

Where does your application run?



Problem introduction

Different systems have:

- different operating systems
- different hardware
- different compilers/libraries...

How do you make sure that an application/workflow that runs on your computer will run on another computer?

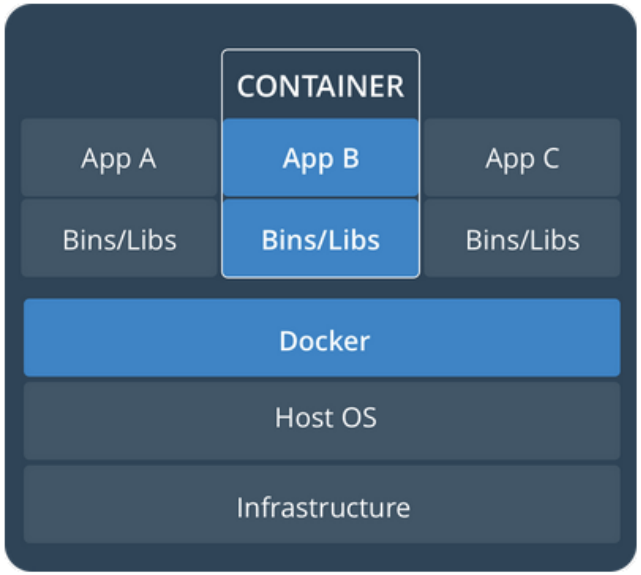
Traditional solution

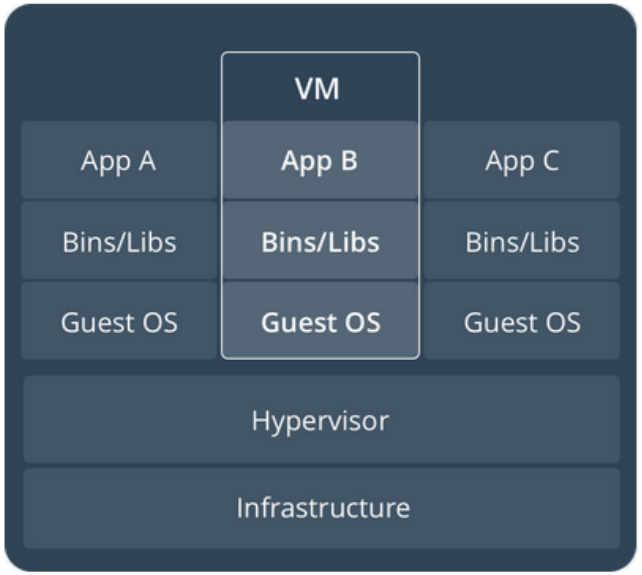
Test on other systems:

- install a dual boot system, buy a new laptop...
- run another system in VirtualBox (system emulation)
- manually install different compilers, libraries... and figure out how to use/link them correctly

New solution

Container: isolated environment that runs within your operating system





docker

Containers: advantages

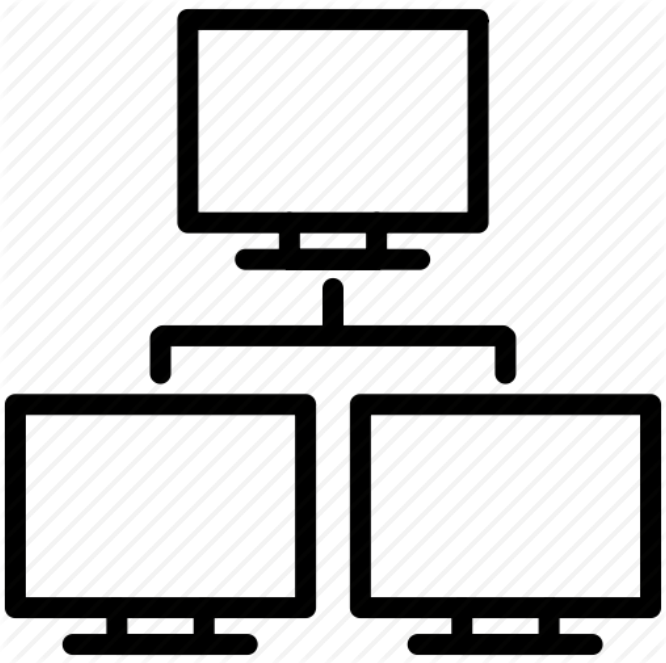
- Lightweight: only relevant libraries and applications, no complete OS
- Portable: can be saved (image) and loaded on another system
- Isolated from host OS

- Large number of images (100,000+) in online container registries on hub.docker.com

Use case 1: remote analysis

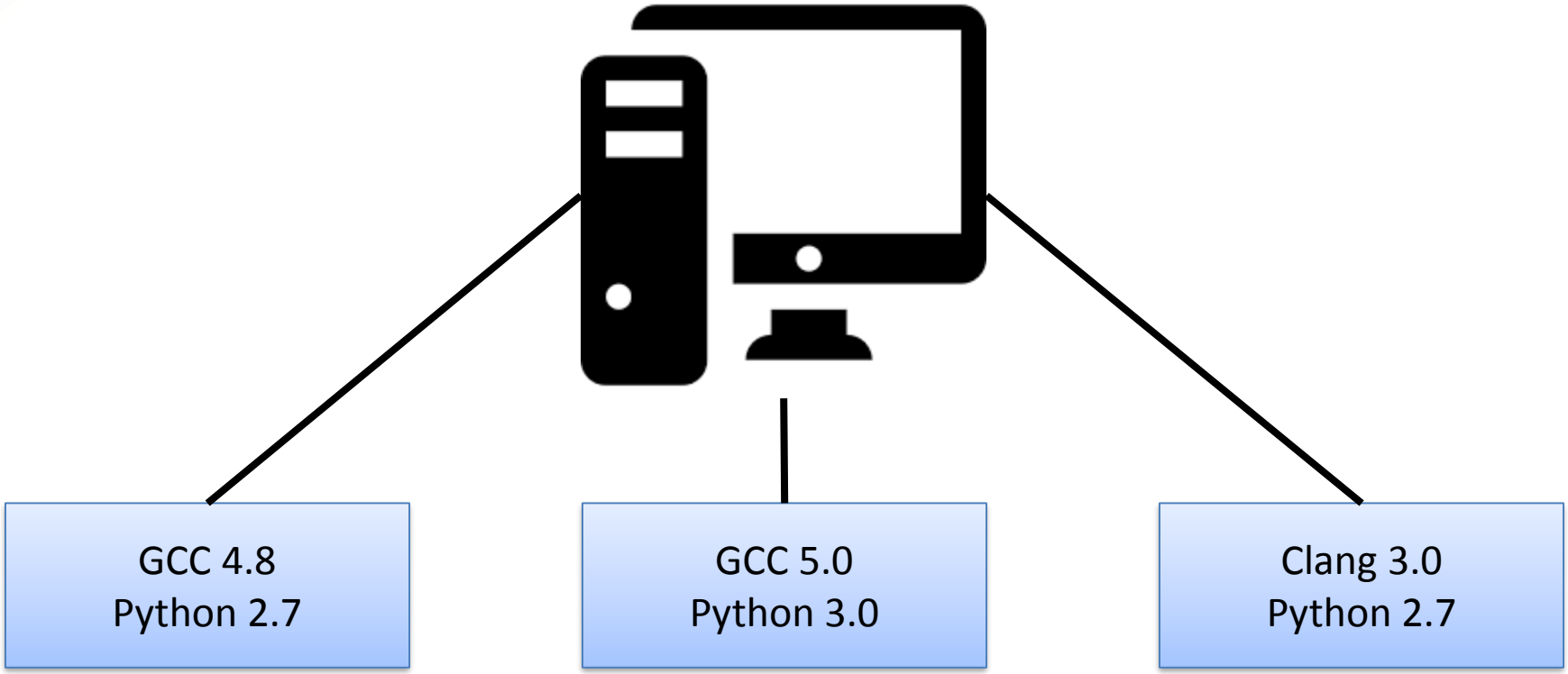
Create analysis scripts and pipeline on your own computer

Run the actual analysis in the same environment on a large cluster



Use case 2: code testing

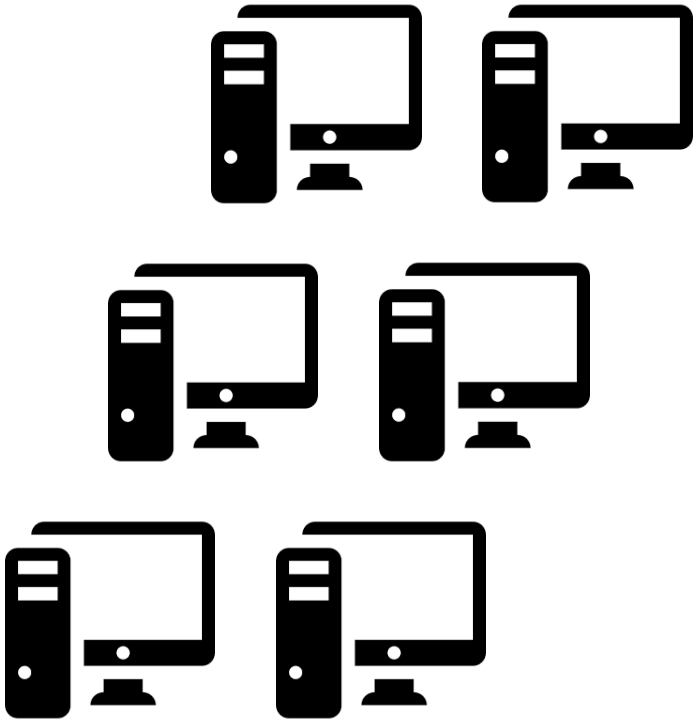
Check that code works with different compilers and libraries on the same computer



Use case 3: student labs

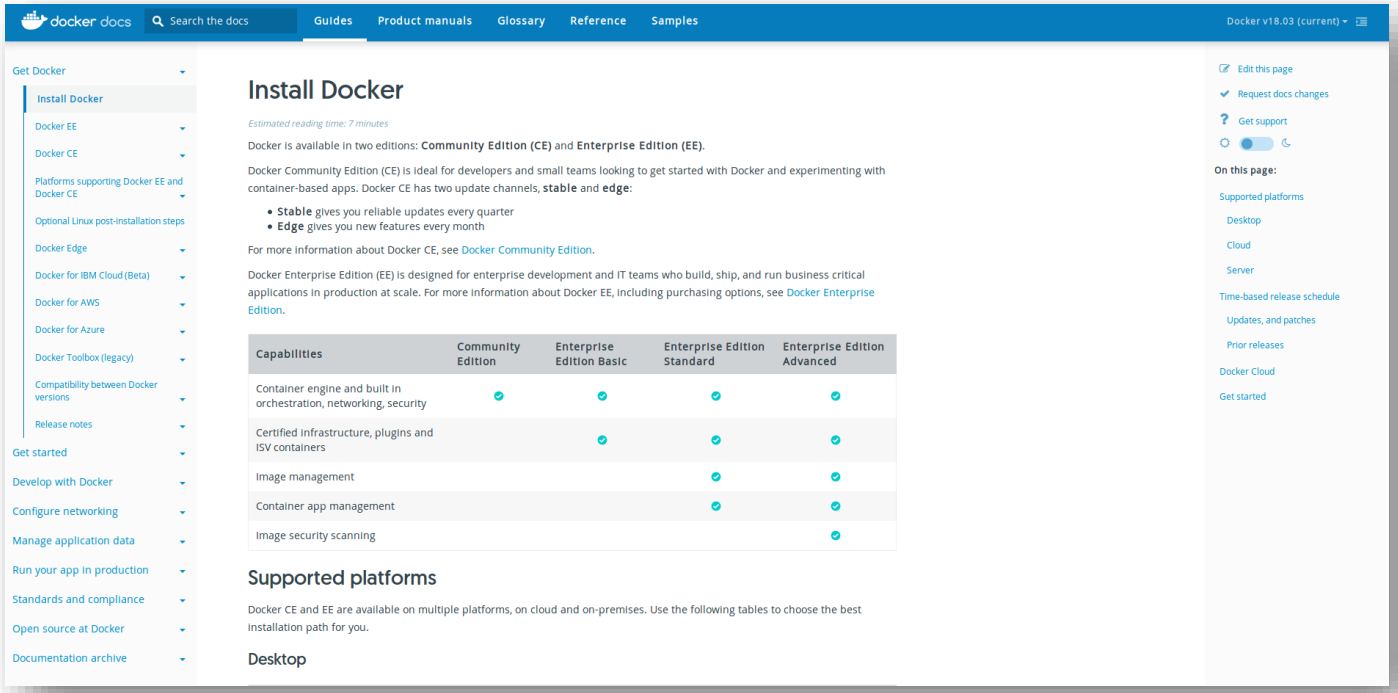
Create lab scripts on your own computer

Students do the lab in the same environment



Docker setup

Detailed instructions for various platforms available: https://docs.docker.com/install/



docker docs | Search the docs | Guides | Product manuals | Glossary | Reference | Samples | Docker v18.03 (current)

- Get Docker
  - Install Docker
  - Docker EE
  - Docker CE
  - Platforms supporting Docker EE and Docker CE
  - Optional Linux post-installation steps
  - Docker Edge
  - Docker for IBM Cloud (Beta)
  - Docker for AWS
  - Docker for Azure
  - Docker Toolbox (legacy)
  - Compatibility between Docker versions
  - Release notes
- Get started
- Develop with Docker
- Configure networking
- Manage application data
- Run your app in production
- Standards and compliance
- Open source at Docker
- Documentation archive

Install Docker

Estimated reading time: 7 minutes

Docker is available in two editions: **Community Edition (CE)** and **Enterprise Edition (EE)**.

Docker Community Edition (CE) is ideal for developers and small teams looking to get started with Docker and experimenting with container-based apps. Docker CE has two update channels, **stable** and **edge**:

- **Stable** gives you reliable updates every quarter
- **Edge** gives you new features every month

For more information about Docker CE, see Docker Community Edition.

Docker Enterprise Edition (EE) is designed for enterprise development and IT teams who build, ship, and run business critical applications in production at scale. For more information about Docker EE, including purchasing options, see Docker Enterprise Edition.

Capabilities	Community Edition	Enterprise Edition Basic	Enterprise Edition Standard	Enterprise Edition Advanced
Container engine and built in orchestration, networking, security	✓	✓	✓	✓
Certified infrastructure, plugins and ISV containers		✓	✓	✓
Image management			✓	✓
Container app management			✓	✓
Image security scanning				✓

Supported platforms

Docker CE and EE are available on multiple platforms, on cloud and on-premises. Use the following tables to choose the best installation path for you.

Desktop

- Edit this page
- Request docs changes
- Get support

On this page:

- Supported platforms
  - Desktop
  - Cloud
  - Server
- Time-based release schedule
  - Updates, and patches
  - Prior releases
- Docker Cloud
- Get started

Docker overview

Creating a container

Loading and running a container

Saving a container

Docker overview

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Creating a container

A new container is always based on an existing *base container*:

- contains basic OS binaries
- contains basic libraries
- can contain specific libraries (e.g. specific Python version)
- should be available from an online *registry*

Creating a container

Basic command: `docker build`

Requires a `Dockerfile` to be present:

- specifies a base container
- sets up new libraries and applications
- creates custom folders and files
- copies files from the host to the container

Creating a container

Example `Dockerfile` that sets up a default code development environment based on Ubuntu

```
FROM ubuntu

RUN apt-get update && \
    apt-get install gcc git -y
```

base container

install GCC and git

automatically answer "yes" when apt-get asks for permission to install new packages

Creating a container

```
Terminal
bv7@apsient:/data/bv7/docker_test/demo$ docker build .
Sending build context to Docker daemon  2.048kB
Step 1/2 : FROM ubuntu
 ---> f975c5035748
Step 2/2 : RUN apt-get update && apt-get install gcc git -y
 ---> Using cache
 ---> 26c860824c1a
Successfully built 26c860824c1a
bv7@apsient:/data/bv7/docker_test/demo$
```

*first run of command will produce more output

Creating a container

Check that image was created

```
Terminal

bv7@apsient:/data/bv7/docker_test/demo$ docker images
REPOSITORY          TAG                 IMAGE ID            CREATED
SIZE
<none>              <none>              26c860824c1a        3 minutes ago
340MB
ubuntu              latest              f975c5035748        3 weeks ago
112MB
swift_exec          latest              8fe40c8179ba        6 weeks ago
505MB
<none>              <none>              e4662b15e1af        6 weeks ago
503MB
swift_repo          latest              861eecad1e26        6 weeks ago
450MB
swift_base          latest              cb21474c8a62        6 weeks ago
383MB
<none>              <none>              1c43bda62963        6 weeks ago
525MB
<none>              <none>              85273bc884fc        6 weeks ago
489MB
<none>              <none>              801b2d307b6e        6 weeks ago
472MB
<none>              <none>              f318a68eee96        6 weeks ago
472MB
```

Docker overview

Creating a container

Loading and running a container

Saving a container

Loading and running a container

Host system: old GCC version

Run an interactive docker container based on the image we created

```
root@c6386563f8ac: /
bv7@apsient:/data/bv7/docker_test/demo$ gcc --version
gcc (Ubuntu 4.8.4-2ubuntu1~14.04.4) 4.8.4
Copyright (C) 2013 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

bv7@apsient:/data/bv7/docker_test/demo$ docker run -t -i --rm 26c860824c1a bash
root@c6386563f8ac:/# gcc --version
gcc (Ubuntu 5.4.0-6ubuntu1~16.04.9) 5.4.0 20160609
Copyright (C) 2015 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

root@c6386563f8ac:/#
```

Attach a pseudo-shell to the container

Container: new GCC version

Clean up when we're done

Loading and running a container

List running containers

```
root@c6386563f8ac: /
bv7@apsient:/data/bv7/docker_test/demo$ docker container ls
CONTAINER ID        IMAGE               COMMAND             CREATED
STATUS              PORTS               NAMES
c6386563f8ac        26c860824c1a        "bash"              5 minutes ago
Up 5 minutes                            xenodochial_ramanujan
bv7@apsient:/data/bv7/docker_test/demo$ docker exec -it c6386563f8ac bash
root@c6386563f8ac:/#
```

Connect a second shell to the running container in another terminal window

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Saving a container

You can create a new image from any *running* container using `docker commit`

This creates a new image that contains all changes made in the container since it was started (and overwrites the existing image)

If you don't save, all changes are lost!

Saving a container

```
root@c6386563f8ac: /
bv7@apsient:/data/bv7/docker_test/demo$ docker commit cc5a903ddead
sha256:ce68c24f665392ff6b895f4edbe15d63bf1c6ec025d4605833cc82d0827049cc
bv7@apsient:/data/bv7/docker_test/demo$ docker images
REPOSITORY          TAG                 IMAGE ID            CREATED
SIZE
<none>              <none>              ce68c24f6653        3 seconds ago
341MB
<none>              <none>              664cc5456023        2 minutes ago
341MB
ubuntu              latest              f975c5035748        3 weeks ago
112MB
swift_exec          latest              8fe40c8179ba        6 weeks ago
505MB
<none>              <none>              e4662b15e1af        6 weeks ago
503MB
swift_repo          latest              861eecad1e26        6 weeks ago
450MB
swift_base          latest              cb21474c8a62        6 weeks ago
383MB
<none>              <none>              1c43bda62963        6 weeks ago
525MB
<none>              <none>              85273bc884fc        6 weeks ago
489MB
<none>              <none>              801b2d307b6e        6 weeks ago
```

Saving a container

Images can be converted into tar files using `docker save`

These tar files can be copied to other systems to run remote containers (using `docker load`)

Alternatively, you can publish your container in an online registry using `docker push`

Summary

- Containers are a lightweight alternative for system emulation
- Easy to use
- Container images can be ported to other systems/hardware...

- EXTRA: container support in workflow management systems (see previous talk)

More information

A huge body of documentation can be found on https://docs.docker.com/

But the easiest way to learn Docker is using it!