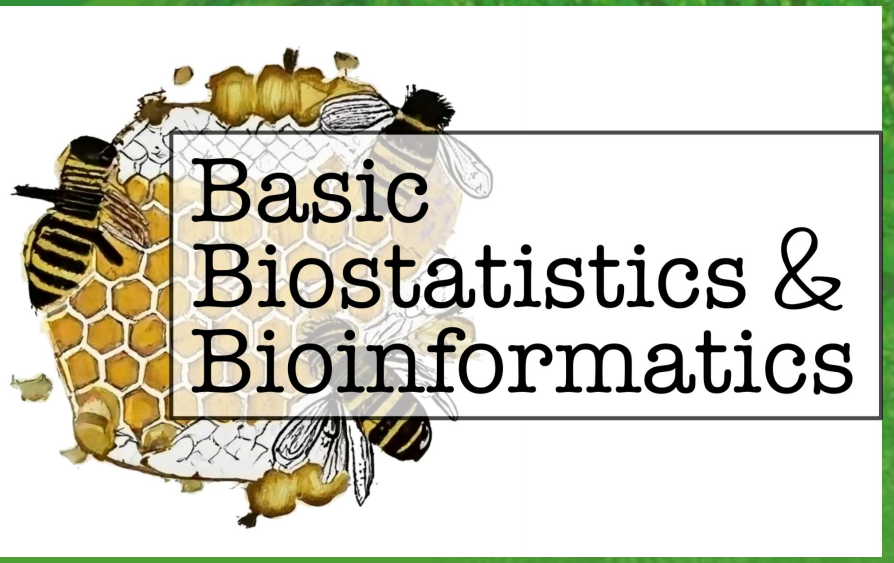
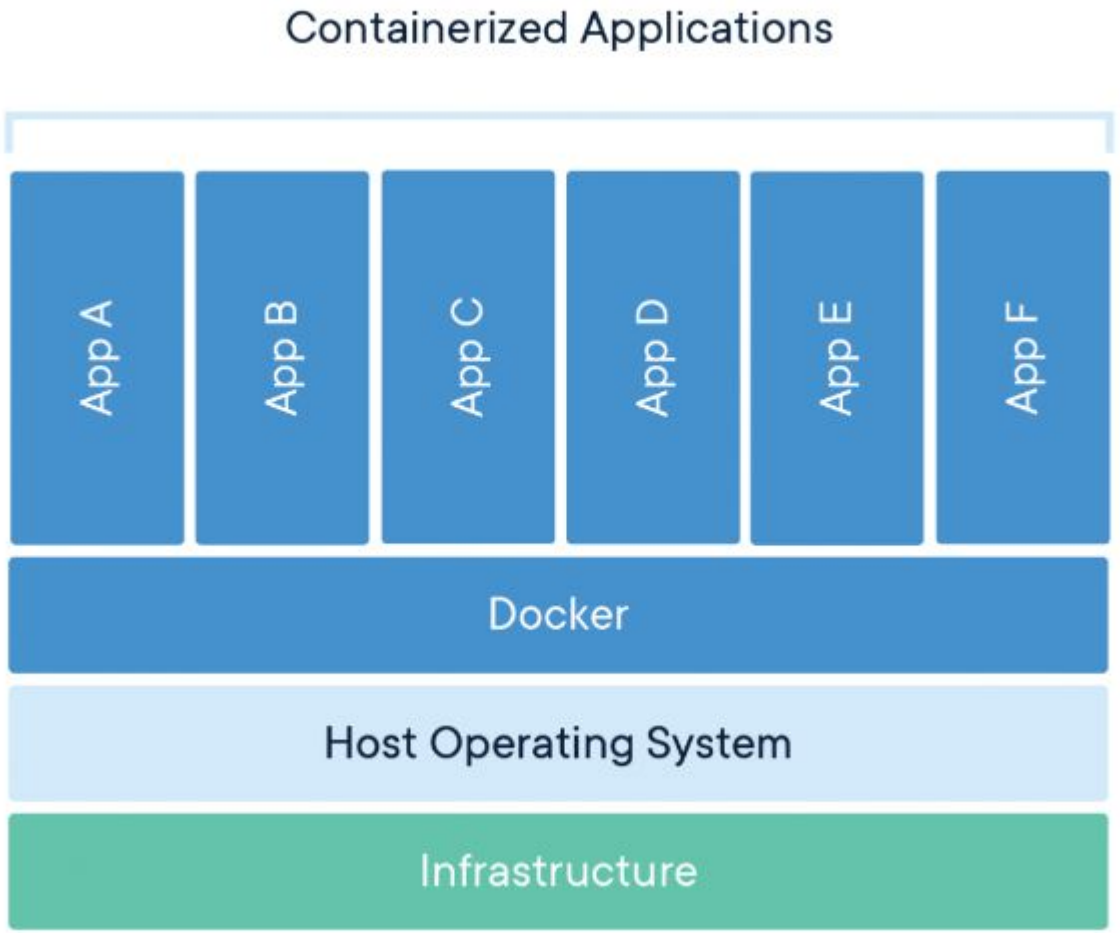


Introduction to Containers

Lizel Potgieter
lizel.potgieter@slu.se
Department of Plant Breeding, SLU Alnarp

What is a container?

- **Technical description**: A container is an object that contains an operating-system-level virtualisation
- **Practical description**: A container is a piece of software that contains an operating system, all of the libraries and dependencies, and a program (or several programs) that you want to run



https://www.docker.com/resources/what-container/

What are the advantages of containers?

- **Standardised**
  - Containers will run the same way on any operating system
  - Configuration profiles are consistent
- **Secure**
  - Programs in containers are isolated from other programs
  - Once your container is built or downloaded, it is immutable
  - All containers are verifiable
- **Lightweight**
  - You can stack operating systems on top of each other
  - You don’t need to install thousands of different dependencies (that might clash with each other)

Containers are the best way to ensure reproducible research

Apptainer

We usually use Apptainer to run containers:

https://apptainer.org/docs/user/main/index.html

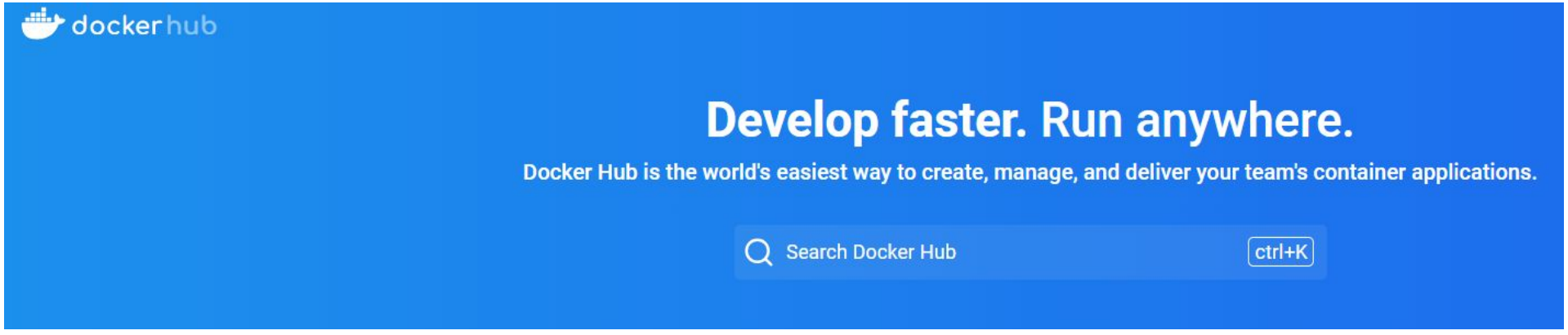
Apptainer is more secure than Docker (and is free to use!)

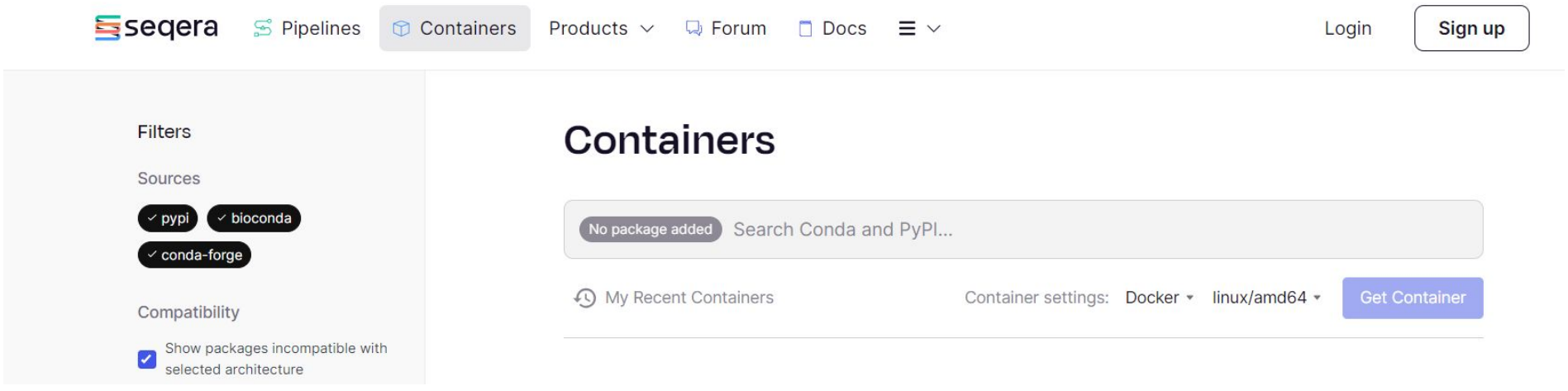
Basic commands we'll use

- `pull`: downloads containers from online registries
- `run`: runs containers
- `build`: build your own containers

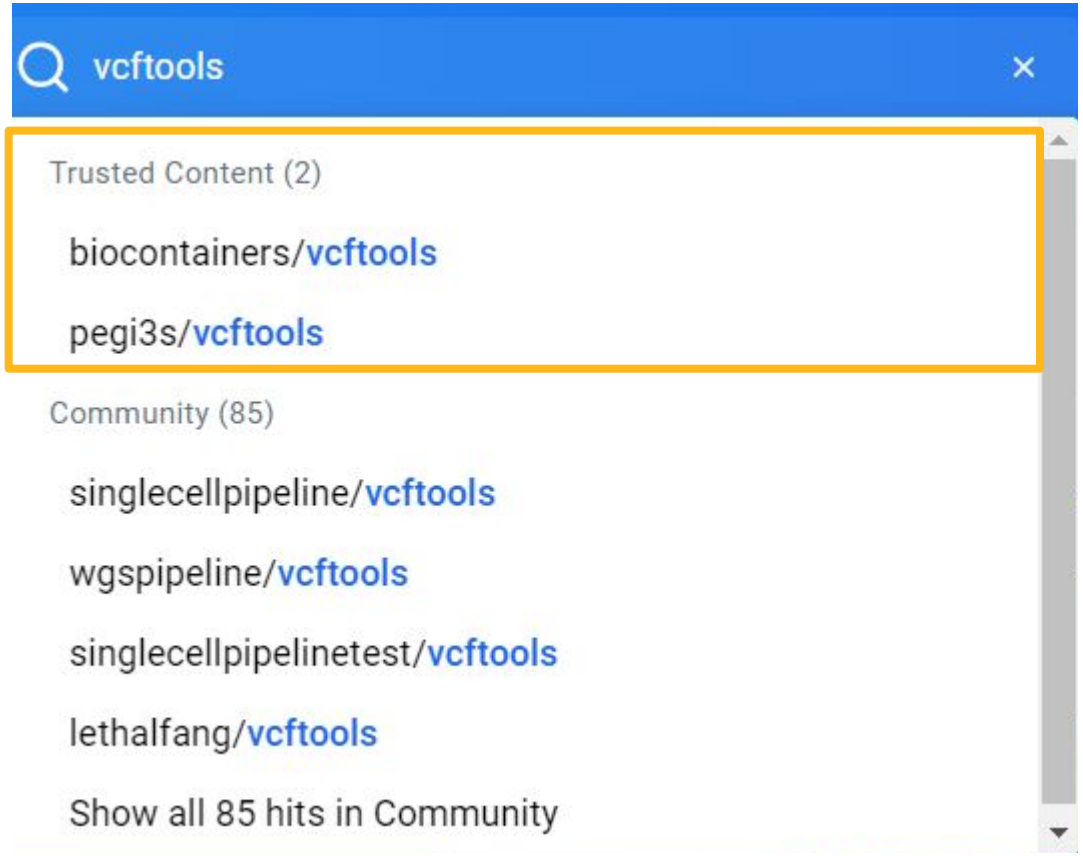
Where do we get containers?

- Several container registries exist
  - https://hub.docker.com/
  - https://seqera.io/containers/
- Build your own





Downloading from Docker Hub: VCFtools example

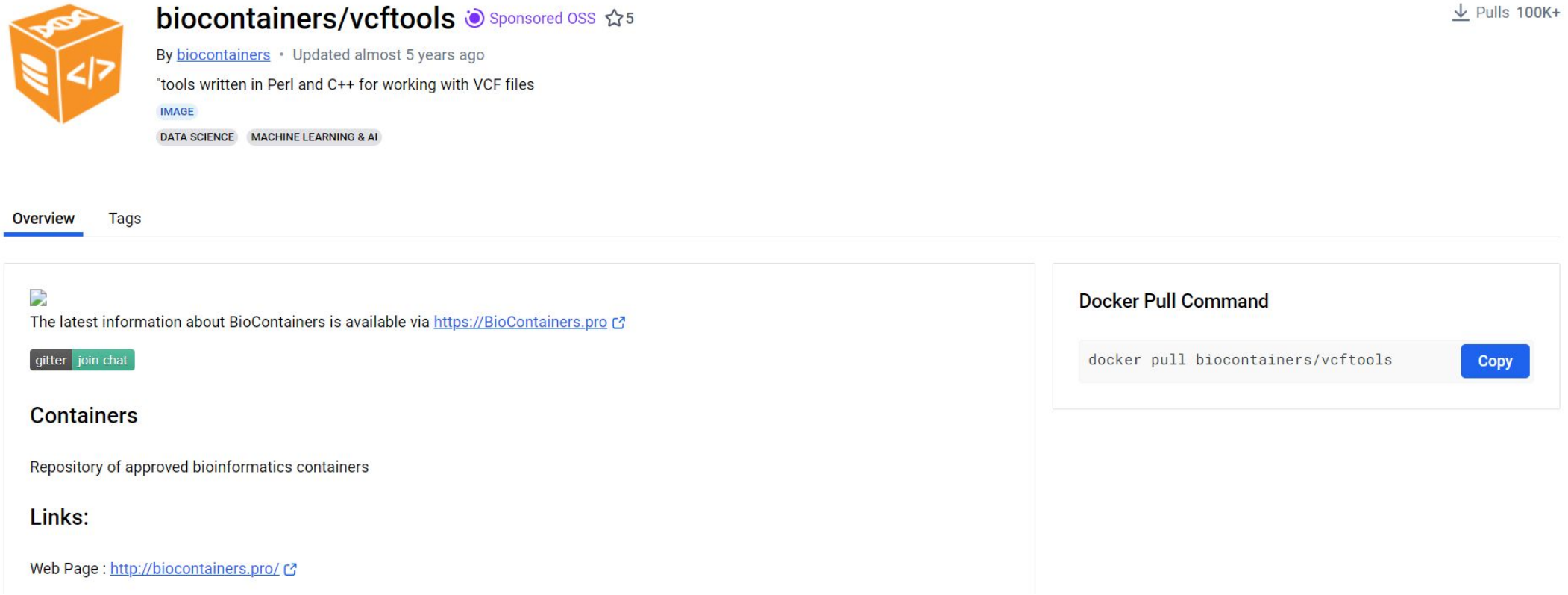


The main software we use are often built and verified (if possible, try to use the trusted content contributions)

biocontainers and pegi3s are the authors in this case

We will look at the version uploaded by biocontainers

Downloading from Docker Hub: VCFtools example



pull command: `apptainer pull vcftools.sif docker://biocontainers/vcftools`

Downloading from Docker Hub: VCFtools example

Overview Tags

Sort by Newest Filter Tags

TAG
v0.1.16-1-deb_cv1
Last pushed 5 years ago by biocontainersci

```
docker pull biocontainers/vcftools:v0.1.16-1-deb_cv1
```
Copy

Digest	OS/ARCH	Compressed Size
caa02f1a00f1	linux/amd64	67.1 MB

TAG
v0.1.14_cv2
Last pushed 6 years ago by biocontainersci

```
docker pull biocontainers/vcftools:v0.1.14_cv2
```
Copy

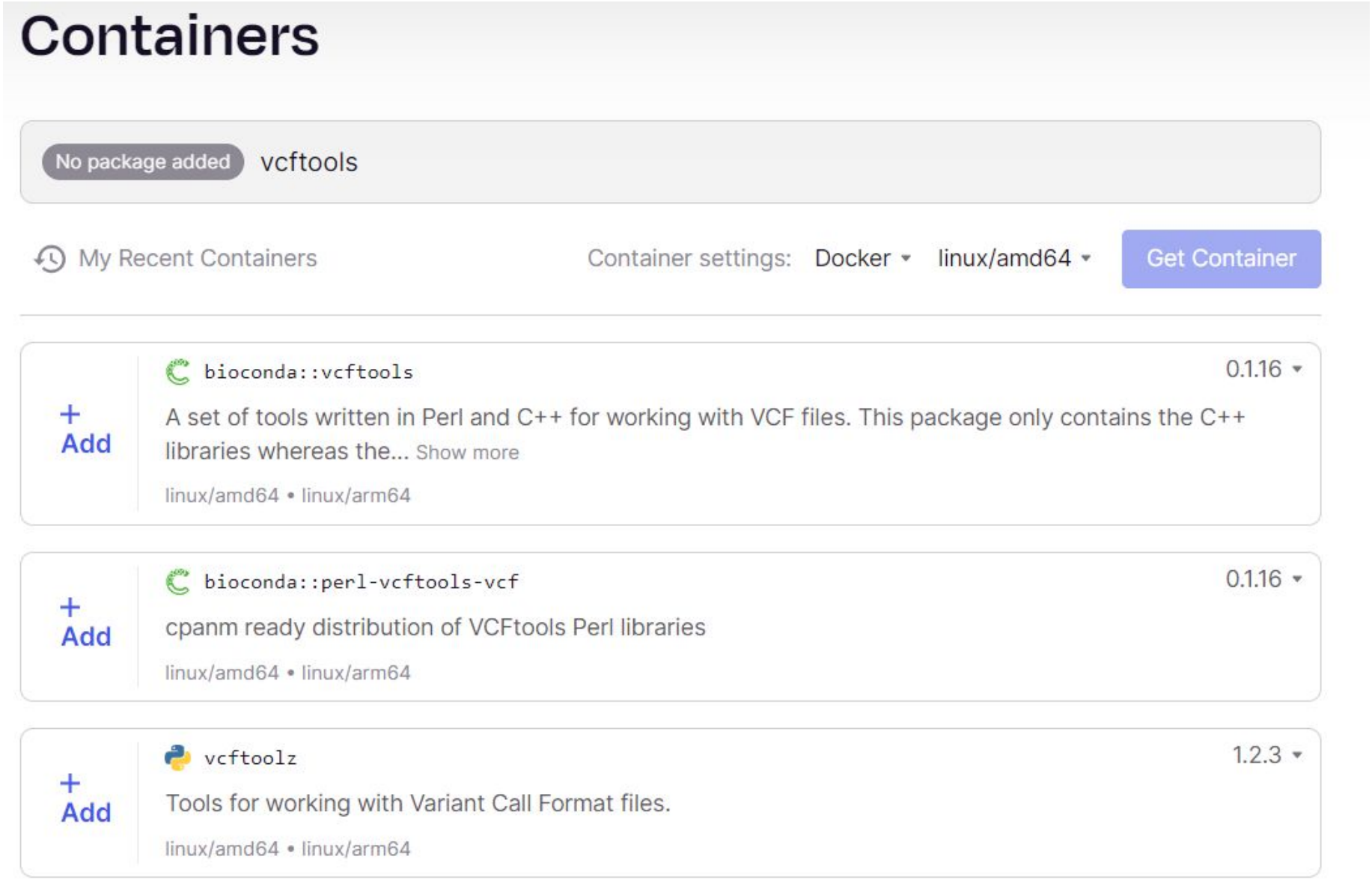
Digest	OS/ARCH	Compressed Size
d533d59a2032	linux/amd64	403.93 MB

TAG
v0.1.15_cv2
Last pushed 6 years ago by biocontainersci

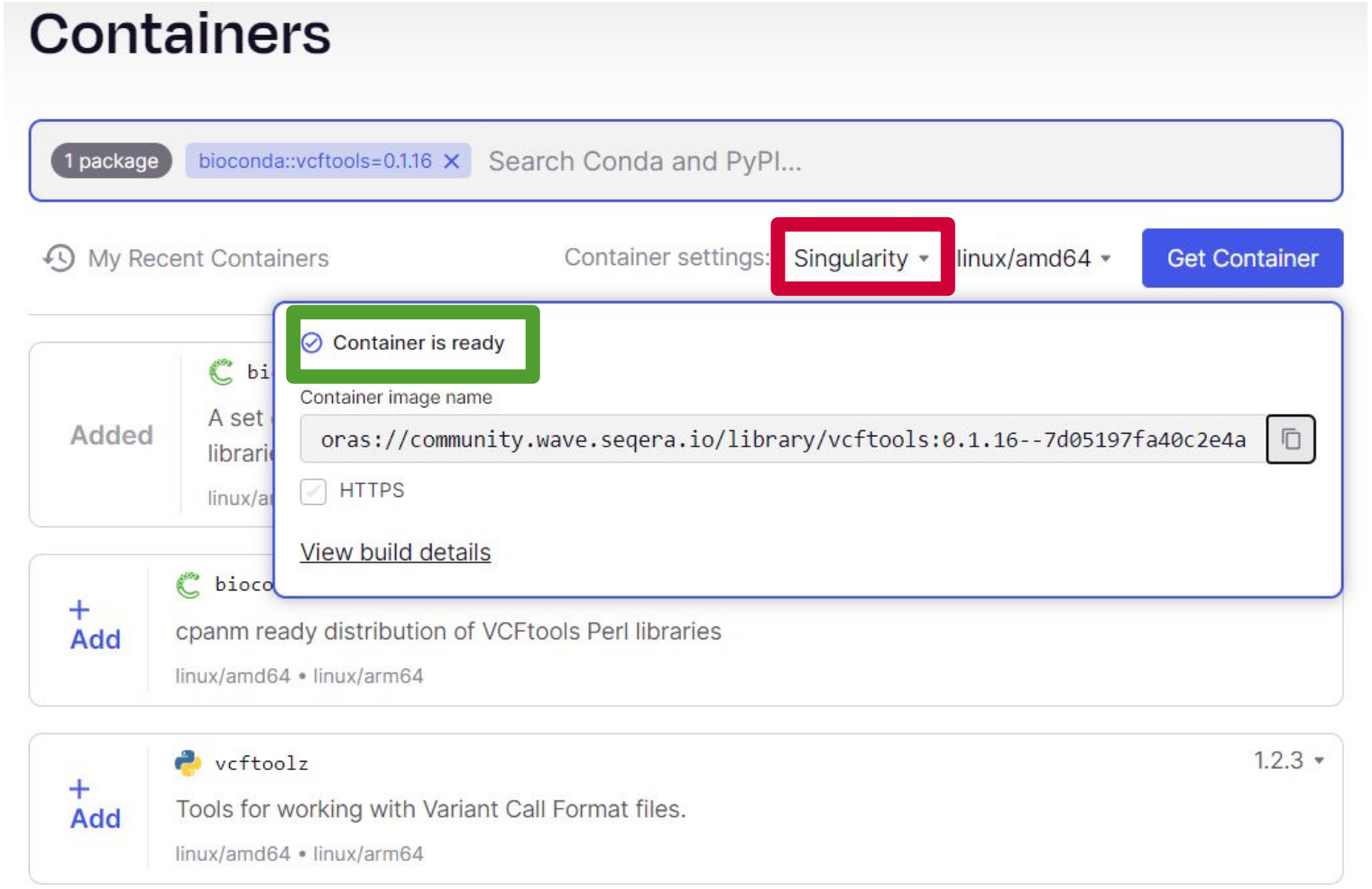
```
docker pull biocontainers/vcftools:v0.1.15_cv2
```
Copy

Digest	OS/ARCH	Compressed Size
498473972dd3	linux/amd64	449.09 MB

Downloading from Seqera: VCFtools example



Downloading from Seqera: VCFtools example



Change Docker to Singularity

Wait until the container is ready

pull command:

```
apptainer pull vcftools.sif oras://community.wave.seqera.io/library/vcftools:0.1.16--7d05197fa40c2e4a
```

How do we run our VCFtools container?

With the `apptainer pull vcftools.sif registry://author/tool` command we pulled an SIF image called vcftools.sif

To run it we use `apptainer run vcftools.sif vcftools --version` as we would if it was installed on our local system

You can run your software as you normally would!

```
containers$ apptainer run vcftools.sif vcftools --version
VCFtools (0.1.16)
```

Building your own containers

To build your own containers, you need a definition file

To build your definition file you will use

```
apptainer build container.sif library://definition_file
```

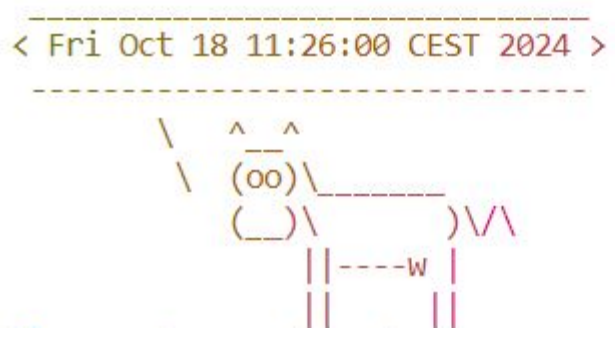
For more details: https://apptainer.org/docs/user/main/cli/apptainer_build.html

Lolcow example: Building from scratch!

```
Bootstrap: docker
From: ubuntu:20.04

%post
    apt-get -y update
    apt-get -y install cowsay lolcat

%environment
    export LC_ALL=C
    export PATH=/usr/games:$PATH

%runscript
     date | cowsay | lolcat
```

Paste this text into a file called lolcow.def

Then run: `apptainer build lolcow.sif lolcow.def`



Lolcow: Let's make it philosophical!

```
Bootstrap: docker
From: ubuntu:20.04

%post
    apt-get -y update
    apt-get -y install cowsay lolcat fortune

%environment
    export LC_ALL=C
    export PATH=/usr/games:$PATH

%runscript
    fortune | cowsay  | lolcat
```

```
 _____________________________
/ You will engage in a profitable \
\ business activity.              /
 -----------------------------
        \   ^__^
         \  (oo)\_______
            (__)\       )\/\
                ||----w |
                ||     ||
```

```
 _____________________________________
/ You will have domestic happiness and \
\ faithful friends.                    /
 -------------------------------------
        \   ^__^
         \  (oo)\_______
            (__)\       )\/\
                ||----w |
                ||     ||
```

```
 _____________________________________
< Excellent day to have a rotten day. >
 -------------------------------------
        \   ^__^
         \  (oo)\_______
            (__)\       )\/\
                ||----w |
                ||     ||
```

```
 ______________________________________
/ Q: How many supply-siders does it take \
| to change a light bulb? A: None. The   |
| darkness will cause the light bulb to  |
\ change by itself.                      /
 --------------------------------------
        \   ^__^
         \  (oo)\_______
            (__)\       )\/\
                ||----w |
                ||     ||
```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