

# Unraveling the Magic Behind Buildpacks

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# Overview

- What are container images?
- How container builds typically work?
- How Buildpacks and lifecycle work?

# What are container images?

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```
--- app.py ---
from flask import Flask
app = Flask(__name__)

@app.route("/")
def hello_world():
    return "Hello, Kubecon EU!"

--- requirements.txt ---
click==8.0.3
Flask==2.0.2
itsdangerous==2.0.1
Jinja2==3.0.2
MarkupSafe==2.0.1
Werkzeug==2.0.2
--- Dockerfile ---
FROM python:3.8-slim-buster

WORKDIR /app

COPY requirements.txt requirements.txt
RUN pip3 install --no-cache-dir -r requirements.txt

COPY . .

CMD [ "python3", "-m" , "flask", "run", "--host=0.0.0.0"]
```

# What are container images?



```
FROM python:3.8-slim-buster
```

```
WORKDIR /app
```

```
COPY requirements.txt requirements.txt
```

```
RUN pip3 install --no-cache-dir -r requirements.txt
```

```
COPY . .
```

```
CMD [ "python3", "-m" , "flask", "run", "--host=0.0.0.0"]
```

# What are container images?

```
{
  "Id": "sha256:bc43796e3c8a0c247f3af164756b304cba278f2c1abdb336da8b8b387fd296f2",
  "Config": {
    "User": "",
    "Env": [
      "PATH=/usr/local/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin",
      "LANG=C.UTF-8",
      "PYTHON_VERSION=3.8.12"
    ],
    "Cmd": ["python3", "-m", "flask", "run", "--host=0.0.0.0"],
    "Image": "sha256:489a14c15b1736f39c9ae90d2f1705ce1a185adfca70388d079365507934bb72",
    "WorkingDir": "/app"
  },
  "Architecture": "amd64",
  "Os": "linux",
  "Size": 124011190,
  "RootFS": {
    "Type": "layers",
    "Layers": [
      "sha256:e81bff2725dbc0bf2003db10272fef362e882eb96353055778a66cda430cf81b",
      "sha256:9d1100648d6db485e16fa8d60c4535830bf128c9ef274a4eb884367127829a3f",
      "sha256:da27cd6210afeafcafad4cf8cedbfc187d296c7059b4ac97ad38e5db98fb2280",
      "sha256:c511542be34c785e7ae85d7e5184fb67cd55ddb23aad6825e4120ec0362de3f9",
      "sha256:1d486fa85b2686240b30037987470187f177c2d54c5f6fd0cc331da04bbbfe0e",
      "sha256:f32958cc0f4563e5b3198be5179977c280e8d1786884bb2c686cd8f6a851ddde",
      "sha256:16682f259c74c6436c5e1545dcf1ea80c908074800b44ba39313af6803a11307",
      "sha256:4c8c9b21ed6a352c64e25a6b50094cc0d48478f0c6ad120c456c03524549c95b",
      "sha256:18238e863646fe305fa14400c1a70bcae8d3f76abc7da69456f470785c73f775"
    ]
  }
}
```

# What are container images?

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      "LANG=C.UTF-8",
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    ],
    "Cmd": ["python3", "-m", "flask", "run", "--host=0.0.0.0"],
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    "WorkingDir": "/app"
  },
  "Architecture": "amd64",
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      "sha256:da27cd6210afeafcafad4cf8cedbfc187d296c7059b4ac97ad38e5db98fb2280",
      "sha256:c511542be34c785e7ae85d7e5184fb67cd55ddb23aad6825e4120ec0362de3f9",
      "sha256:1d486fa85b2686240b30037987470187f177c2d54c5f6fd0cc331da04bbbfe0e",
      "sha256:f32958cc0f4563e5b3198be5179977c280e8d1786884bb2c686cd8f6a851ddde",
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    ]
  }
}
```



# What are container images?



```
FROM python:3.8-slim-buster
```

```
WORKDIR /app
```

```
COPY requirements.txt requirements.txt
```


```
RUN pip3 install --no-cache-dir -r requirements.txt
```

```
COPY . .
```

```
CMD [ "python3", "-m" , "flask", "run", "--host=0.0.0.0"]
```

```
"Config": {  
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    "PATH=/usr/local/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin",  
    "LANG=C.UTF-8",  
    "PYTHON_VERSION=3.8.12"  
  ],  
  "Cmd": ["python3", "-m", "flask", "run", "--host=0.0.0.0"],  
  "Image": "sha256:489a14c15b1736f39c9ae90d2f1705ce1a185adfca70388d079365507934bb72",  
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FROM python:3.8-slim-buster
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RUN pip3 install --no-cache-dir -r requirements.txt
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COPY . .
```

→ 

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CMD [ "python3", "-m", "flask", "run", "--host=0.0.0.0" ]
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  "User": "",  
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    "PYTHON_VERSION=3.8.12"  
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COPY requirements.txt requirements.txt
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RUN pip3 install --no-cache-dir -r requirements.txt
```

```
COPY . .
```

```
CMD [ "python3", "-m" , "flask", "run", "--host=0.0.0.0"]
```

```
"Layers": [
```

```
  "sha256:e81bff2725dbc0bf2003db10272fef362e882eb96353055778a66cda430cf81b",  
  "sha256:9d1100648d6db485e16fa8d60c4535830bf128c9ef274a4eb884367127829a3f",  
  "sha256:da27cd6210afeafcafad4cf8cedbfc187d296c7059b4ac97ad38e5db98fb2280",  
  "sha256:c511542be34c785e7ae85d7e5184fb67cd55ddb23aad6825e4120ec0362de3f9",  
  "sha256:1d486fa85b2686240b30037987470187f177c2d54c5f6fd0ccc331da04bbbf0e",  
  "sha256:f32958cc0f4563e5b3198be5179977c280e8d1786884bb2c686cd8f6a851ddde",  
  "sha256:16682f259c74c6436c5e1545dcf1ea80c908074800b44ba39313af6803a11307",  
  "sha256:4c8c9b21ed6a352c64e25a6b50094cc0d48478f0c6ad120c456c03524549c95b",  
  "sha256:18238e863646fe305fa14400c1a70bcae8d3f76abc7da69456f470785c73f775"
```

```
]
```

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```
FROM python:3.8-slim-buster
```

```
WORKDIR /app
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```
COPY requirements.txt requirements.txt
```

```
RUN pip3 install --no-cache-dir -r requirements.txt
```

```
COPY . .
```

```
CMD [ "python3", "-m", "flask", "run", "--host=0.0.0.0"]
```

## Layers

Size	Command
69 MB	FROM 970b29bb2c78938
7.0 MB	set -eux; apt-get update; apt-get install -y --no-install-recommends ca-cer
28 MB	set -ex && savedAptMark="\$(apt-mark showmanual)" && apt-get update && apt-get i
0 B	cd /usr/local/bin && ln -s idle3 idle && ln -s pydoc3 pydoc && ln -s python3 py
9.5 MB	set -ex; savedAptMark="\$(apt-mark showmanual)"; apt-get update; apt-get ins
0 B	#!/bin/sh WORKDIR /app
94 B	#!/bin/sh COPY file:b10a0855c3dfb57177be69422acdb25833f35312143fe73fa6fd9e31f4ab0b8a in requir
9.8 MB	pip3 install --no-cache-dir -r requirements.txt
6.5 kB	#!/bin/sh COPY dir:a6249b228993dcdb127f6c96790fb8ceb5952f55aa12db5c7796c9f1a3e96c79 in .

# What are container images?



A terminal window with a dark background and three colored window control buttons (red, yellow, green) in the top left corner. It displays the steps for building a container image. Colored arrows point from the text to the corresponding lines in the terminal.

```
FROM python:3.8-slim-buster

WORKDIR /app

COPY requirements.txt requirements.txt
RUN pip3 install --no-cache-dir -r requirements.txt

COPY . .

CMD [ "python3", "-m" , "flask", "run", "--host=0.0.0.0"]
```

Layers		
Cmp	Size	Command
	69 MB	FROM 970b29bb2c78938
	7.0 MB	set -eux; apt-get update; apt-get install -y --no-install-recommends ca-cer
	28 MB	set -ex && savedAptMark="\$(apt-mark showmanual)" && apt-get update && apt-get i
	0 B	cd /usr/local/bin && ln -s idle3 idle && ln -s pydoc3 pydoc && ln -s python3 py
	9.5 MB	set -ex; savedAptMark="\$(apt-mark showmanual)"; apt-get update; apt-get ins
	0 B	#!/bin/sh WORKDIR /app
	94 B	#!/bin/sh COPY file:b10a0855c3dfb57177be69422acdb25833f35312143fe73fa6fd9e31f4ab0b8a in requir
	9.8 MB	pip3 install --no-cache-dir -r requirements.txt
	6.5 kB	#!/bin/sh COPY dir:a6249b228993dcdb127f6c96790fb8ceb5952f55aa12db5c7796c9f1a3e96c79 in .

# What are container images?

Layers			Current Layer Contents		
Cmp	Size	Command	Permission	UID:GID	Size Filetree
	69 MB	FROM 970b29bb2c78938	drwxr-xr-x	0:0	0 B app
	7.0 MB	set -eux; apt-get update; apt-get install -y			
	28 MB	set -ex && savedAptMark="\$(apt-mark showmanua			
	0 B	cd /usr/local/bin && ln -s idle3 idle && ln -			
	9.5 MB	set -ex; savedAptMark="\$(apt-mark showmanual)			
	0 B	WORKDIR /app			
	94 B	COPY file:b10a0855c3dfb57177be69422acdb25833f3			
	9.8 MB	pip3 install --no-cache-dir -r requirements.txt			
	117 B	COPY dir:22ac8978dcad3e01ddec10f59952804234234			

Layer Details	
Tags:	(unavailable)
Id:	c7d4878e02e17988732329599c099cee305175657a6ae9f37e201a391
Digest:	sha256:f32958cc0f4563e5b3198be5179977c280e8d1786884bb2c68
Command:	#(nop) WORKDIR /app

Image Details	
Image name:	demo
Total Image size:	124 MB
Potential wasted space:	6.6 MB
Image efficiency score:	96 %

Count	Total Space	Path
4	3.1 MB	/var/cache/debconf/templates.dat
3	2.3 MB	/var/cache/debconf/templates.dat-old
4	322 kB	/var/lib/dpkg/status
4	322 kB	/var/lib/dpkg/status-old

^C Quit	Tab Switch view	^F Filter	^L Show layer changes	^A Show aggregated changes
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# What are container images?

Layers

Cmp	Size	Command
	69 MB	FROM 970b29bb2c78938
	7.0 MB	set -eux; apt-get update; apt-get install -y
	28 MB	set -ex && savedAptMark="\$(apt-mark showmanua
	0 B	cd /usr/local/bin && ln -s idle3 idle && ln -
	9.5 MB	set -ex; savedAptMark="\$(apt-mark showmanual)
	0 B	\$(nop) WORKDIR /app
	94 B	\$(nop) COPY file:b10a0855c3dfb57177be69422acdb25833f3
	9.8 MB	pip3 install --no-cache-dir -r requirements.txt
	117 B	\$(nop) COPY dir:22ac8978dcad3e01ddec10f59952804234234

Current Layer Contents

Permission	UID:GID	Size	Filetree
drwxr-xr-x	0:0	94 B	app
-rw-r--r--	0:0	94 B	requirements.txt

Layer Details

Tags: (unavailable)

Id: a45dd7a769b095fd8fae50380b0e992f3350dc52482e698f5464bdee8

Digest: sha256:16682f259c74c6436c5e1545dcf1ea80c908074800b44ba393

Command: \$(nop) COPY file:b10a0855c3dfb57177be69422acdb25833f35312143fe73f

Image Details

Image name: demo

Total Image size: 124 MB

Potential wasted space: 6.6 MB

Image efficiency score: 96 %

Count	Total Space	Path
4	3.1 MB	/var/cache/debconf/templates.dat
3	2.3 MB	/var/cache/debconf/templates.dat-old
4	322 kB	/var/lib/dpkg/status
4	322 kB	/var/lib/dpkg/status-old

^C Quit

Tab Switch view

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# What are container images?

Layers		Current Layer Contents			
Cmp	Size	Command	Permission	UID:GID	Size
	69 MB	FROM 970b29bb2c78938	drwxr-xr-x	0:0	9.8 MB
	7.0 MB	set -eux; apt-get update; apt-get install -y	drwxr-xr-x	0:0	9.8 MB
	28 MB	set -ex && savedAptMark="\$(apt-mark showmanual	drwxr-xr-x	0:0	213 B
	0 B	cd /usr/local/bin && ln -s idle3 idle && ln -	-rwxr-xr-x	0:0	213 B
	9.5 MB	set -ex; savedAptMark="\$(apt-mark showmanual)	drwxr-xr-x	0:0	9.8 MB
	0 B	\$(nop) WORKDIR /app	drwxr-xr-x	0:0	9.8 MB
	94 B	\$(nop) COPY file:b10a0855c3dfb57177be69422acd25833f3	drwxr-xr-x	0:0	1.8 MB
	9.8 MB	pip3 install --no-cache-dir -r requirements.txt	-rw-r--r--	0:0	4.2 kB
	117 B	\$(nop) COPY dir:22ac8978dcad3e01ddec10f59952804234234	-rw-r--r--	0:0	1.2 kB
Layer Details			-rw-r--r--	0:0	29 kB
Tags: (unavailable)			-rw-r--r--	0:0	5.5 kB
Id: d493804b6078d7b1b95555084f98a91b7c53721b7cb1e88fe08c1a4d6			-rw-r--r--	0:0	4.2 kB
Digest: sha256:4c8c9b21ed6a352c64e25a6b50094cc0d48478f0c6ad120c45			-rw-r--r--	0:0	7.8 kB
Command:			-rw-r--r--	0:0	3.5 kB
pip3 install --no-cache-dir -r requirements.txt			-rw-r--r--	0:0	19 kB
Image Details			-rw-r--r--	0:0	7.6 kB
Image name: demo			-rw-r--r--	0:0	5.3 kB
Total Image size: 124 MB			-rw-r--r--	0:0	62 kB
Potential wasted space: 6.6 MB			-rw-r--r--	0:0	17 kB
Image efficiency score: 96 %			-rw-r--r--	0:0	2.4 kB
Count	Total Space	Path	-rw-r--r--	0:0	12 kB
4	3.1 MB	/var/cache/debconf/templates.dat	-rw-r--r--	0:0	27 kB
3	2.3 MB	/var/cache/debconf/templates.dat-old	-rw-r--r--	0:0	27 kB
4	322 kB	/var/lib/dpkg/status	-rw-r--r--	0:0	34 kB
4	322 kB	/var/lib/dpkg/status-old	-rw-r--r--	0:0	9.4 kB
			-rw-r--r--	0:0	46 kB
			-rw-r--r--	0:0	20 kB
			-rw-r--r--	0:0	249 B
			-rw-r--r--	0:0	7.0 kB
			-rw-r--r--	0:0	4.3 kB

Filetree  
usr  
local  
bin  
lib  
python3.8  
\_pycache\_  
\_futu  
\_bootl  
\_colle  
\_compa  
\_compr  
\_marku  
\_siteb  
\_sysco  
\_weakr  
abc.cp  
argpar  
base64  
bisect  
bz2.cp  
calend  
cgi.cp  
codecs  
compil  
config  
context  
context  
copy.c  
copyre

^C Quit Tab Switch view ^F Filter ^L Show layer changes ^A Show aggregated changes



# How do container builds typically work?

# How does Docker do it?

- Start a container
- Run the command to make changes
- Commit the changes in a layer
- Repeat if necessary
- Image is ready!

# Start a container

```
[1] → packaging-con-demo docker run -d --name demo-container busybox sleep infinity  
3b0f0b032623306f2d39b3b2f3520d7a2967c3bee8cd2b698449f6325347992b
```

```
█
```

# Run the command

```
[1] → packaging-con-demo docker run -d --name demo-container busybox sleep infinity
3b0f0b032623306f2d39b3b2f3520d7a2967c3bee8cd2b698449f6325347992b
[2] → packaging-con-demo docker exec demo-container /bin/sh -c "echo \"Hello World\" > /demo"
[3] → packaging-con-demo docker exec demo-container /bin/sh -c "cat /demo"
Hello World
```



# Commit the changes

```
[1] → packaging-con-demo docker run -d --name demo-container busybox sleep infinity
3b0f0b032623306f2d39b3b2f3520d7a2967c3bee8cd2b698449f6325347992b
[2] → packaging-con-demo docker exec demo-container /bin/sh -c "echo \"Hello World\" > /demo"
[3] → packaging-con-demo docker exec demo-container /bin/sh -c "cat /demo"
Hello World
[4] → packaging-con-demo docker commit -m "Add demo file" demo-container demo-image
sha256:c2a4ec1914f9897a52ce5914375bc92803b328a544d06fb01032608482c33373
```



# Image is ready!

```
[1] → packaging-con-demo docker run -d --name demo-container busybox sleep infinity
3b0f0b032623306f2d39b3b2f3520d7a2967c3bee8cd2b698449f6325347992b
[2] → packaging-con-demo docker exec demo-container /bin/sh -c "echo \"Hello World\" > /demo"
[3] → packaging-con-demo docker exec demo-container /bin/sh -c "cat /demo"
Hello World
[4] → packaging-con-demo docker commit -m "Add demo file" demo-container demo-image
sha256:c2a4ec1914f9897a52ce5914375bc92803b328a544d06fb01032608482c33373
[5] → packaging-con-demo docker run demo-image cat /demo
Hello World
```



# How docker build works?

# Docker build

```
FROM python:3.8-slim-buster
```

```
WORKDIR /app
```

```
COPY requirements.txt requirements.txt
```

```
RUN pip3 install --no-cache-dir -r requirements.txt
```

```
COPY . .
```

```
CMD [ "python3", "-m" , "flask", "run", "--host=0.0.0.0"]
```



# Docker build

## TERMINAL

```
[1] → packaging-con-demo cat Dockerfile
FROM python:3.8-slim-buster
```

```
WORKDIR /app
```

```
COPY requirements.txt requirements.txt
```

```
RUN pip3 install --no-cache-dir -r requirements.txt
```

```
COPY . .
```

```
CMD [ "python3", "-m", "flask", "run", "--host=0.0.0.0"]
```

```
[2] → packaging-con-demo docker build -t demo . --no-cache
```

Demo: tmux + - [ ] [ ]

CONTAINER ID	NAME	CPU %	MEM USAGE / LIMIT	MEM %	NET I/O	BLOCK I/O	PI
DS							

```
[6] 0: bash*
```

"ws-73b74af8-d265-4e74" 12:04 05-Nov-21

# Docker build

## TERMINAL

```
[1] → packaging-con-demo cat Dockerfile
FROM python:3.8-slim-buster
```

```
WORKDIR /app
```

```
COPY requirements.txt requirements.txt
RUN pip3 install --no-cache-dir -r requirements.txt
```

```
COPY . .
```

```
CMD ["python3", "-m", "flask", "run", "--host=0.0.0.0"]
[2] → packaging-con-demo docker build -t demo . --no-cache
Sending build context to Docker daemon 15.87kB
Step 1/6 : FROM python:3.8-slim-buster
--> 52c287c5a9a3
Step 2/6 : WORKDIR /app
--> Running in 95e8fc07a41d
```

```
[6] 0: bash*
```

Demo: tmux + - [ ] [X]

CONTAINER ID	NAME	CPU %	MEM USAGE / LIMIT	MEM %	NET I/O	BLOCK
I/O PIDS						
95e8fc07a41d	focused_burnell	0.00%	0B / 0B	0.00%	0B / 0B	0B / 0
B 0						

"ws-73b74af8-d265-4e74" 12:04 05-Nov-21

# Docker build

## TERMINAL

```
Downloading click-8.0.3-py3-none-any.whl (97 kB)
Collecting Flask==2.0.2
  Downloading Flask-2.0.2-py3-none-any.whl (95 kB)
Collecting itsdangerous==2.0.1
  Downloading itsdangerous-2.0.1-py3-none-any.whl (18 kB)
Collecting Jinja2==3.0.2
  Downloading Jinja2-3.0.2-py3-none-any.whl (133 kB)
Collecting MarkupSafe==2.0.1
  Downloading MarkupSafe-2.0.1-cp38-cp38-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_12_x86_64.manylinux2010_x86_64.whl (30 kB)
Collecting Werkzeug==2.0.2
  Downloading Werkzeug-2.0.2-py3-none-any.whl (288 kB)
Installing collected packages: MarkupSafe, Werkzeug, Jinja2, itsdangerous, click, Flask
Successfully installed Flask-2.0.2 Jinja2-3.0.2 MarkupSafe-2.0.1 Werkzeug-2.0.2 click-8.0.3 itsdangerous-2.0.1
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviour with the system package manager. It is recommended to use a virtual environment instead: https://pip.pypa.io/warnings/venv
WARNING: You are using pip version 21.2.4; however, version 21.3.1 is available.
You should consider upgrading via the '/usr/local/bin/python -m pip install --upgrade pip' command.
Removing intermediate container 44fdc7393cc4
--> 7ed01f92e67f
Step 5/6 : COPY . .
--> 0ec9dc6c3d30
Step 6/6 : CMD [ "python3", "-m", "flask", "run", "--host=0.0.0.0" ]
--> Running in 5b1b82e5f044
Removing intermediate container 5b1b82e5f044
--> 133d9b1a503d
Successfully built 133d9b1a503d
Successfully tagged demo:latest
```

Demo: tmux + - [ ] [X]

CONTAINER ID	NAME	CPU %	MEM USAGE / LIMIT	MEM %	NET I/O	BLOCK
I/O PIDS						
95e8fc07a41d	focused_burnell	--	-- / --	--	--	--
---						
44fdc7393cc4	musings_pasteur	--	-- / --	--	--	--
---						
5b1b82e5f044	modest_jepsen	--	-- / --	--	--	--
---						

[6] 0: bash\*

"ws-73b74af8-d265-4e74" 12:04 05-Nov-21

# Recap

Container images are just layers + config files

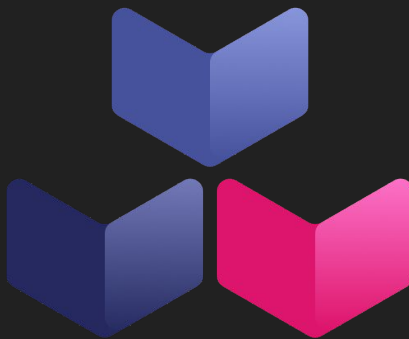
# Demo

OCI Images from first principles!

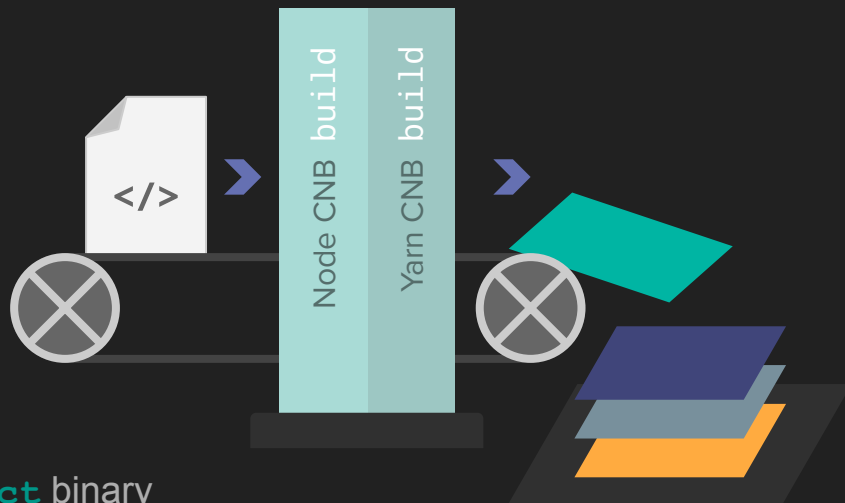
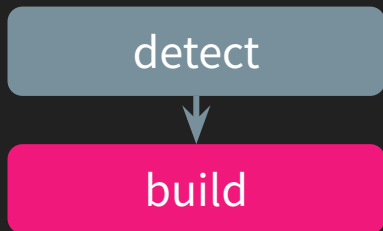
# Same principle - vastly different tools

- Buildah
- Kaniko
-  **Cloud Native Buildpacks**

# Cloud Native Buildpacks Build



# What is a buildpack?



- The lifecycle runs each buildpack's **detect** binary against the source code
- For the first buildpack group that passes detection, it executes each buildpack's **build** binary, in order
- **build** gathers dependencies, compiles app (if needed), and sets launch command



# What does a buildpack actually do?

- Install dependencies
- Run compilation if needed
- Define runtime processes
- Configure the environment
- Generate a Software Bill of Materials (SBOM) for installed dependencies

# CNB Specification - Buildpack API



# A buildpack's view of the world

```
/layers  
|-- some_buildpack_id
```

```
/workspace  
|-- ...source code...
```

```
/platform  
|-- ...platform-specific configuration...
```

# A buildpack's view of the world

```
/layers  
|-- some_buildpack_id
```

```
|   |-- some_layer
```

```
|   |-- some_layer.toml
```

```
/workspace  
|-- ...source code...
```

```
/platform  
|-- ...platform-specific configuration...
```

# A buildpack's view of the world

```
/layers
|-- some_buildpack_id
```

```
|  |-- some_layer
|  |  |-- bin
```

```
|  |  |-- include
|  |  |-- lib
|  |  |-- ...
|  |-- some_layer.toml
```

```
/workspace
|-- ...source code...
```

```
/platform
|-- ...platform-specific configuration...
```

# A buildpack's view of the world

# A buildpack's view of the world

```
/layers
|-- some_buildpack_id
```

```
|
| |-- some_layer
| | |-- bin
| | |-- env
| | | `-- SOME_VAR
| | |-- include
| | |-- lib
| | `-- ...
| |-- some_layer.toml
| |-- some_other_layer
| `-- some_other_layer.toml
```

```
/workspace
|-- ...source code...
```

```
/platform
|-- ...platform-specific configuration...
```

# A buildpack's view of the world

```
/layers
|-- some_buildpack_id
|   |-- build.toml
```

```
|   |-- some_layer
|       |-- bin
|       |-- env
|       |-- SOME_VAR
|       |-- include
|       |-- lib
|       |-- ...
|-- some_layer.toml
|-- some_other_layer
|-- some_other_layer.toml
```

```
/workspace
|-- ...source code...
```

```
/platform
|-- ...platform-specific configuration...
```



# A buildpack's view of the world

```
/layers
|-- some_buildpack_id
|   |-- build.toml
|   |-- launch.toml
|   |-- some_layer
|       |-- bin
|       |-- env
|       |-- `-- SOME_VAR
|       |-- include
|       |-- lib
|       |-- `-- ...
|-- some_layer.toml
|-- some_other_layer
|-- `-- some_other_layer.toml
```

```
/workspace
|-- ...source code...
```

```
/platform
|-- ...platform-specific configuration...
```

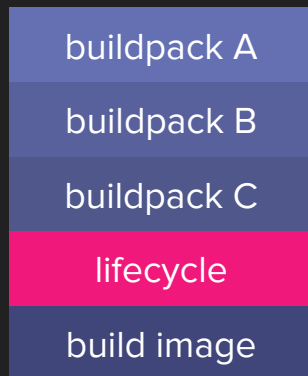
# A buildpack's view of the world

```
/layers
|-- some_buildpack_id
|   |-- build.toml
|   |-- launch.toml
|   |-- some_layer
|       |-- bin
|       |-- env
|       |-- SOME_VAR
|       |-- include
|       |-- lib
|       |-- ...
|   |-- some_layer.toml
|   |-- some_other_layer
|   |-- some_other_layer.toml
|-- some_other_buildpack_id
|-- ...
```

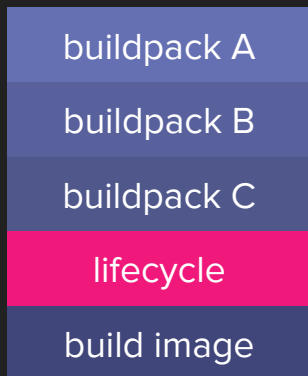
```
/workspace
|-- ...source code...
```

```
/platform
|-- ...platform-specific configuration...
```

# How do they work?



# How do they work?

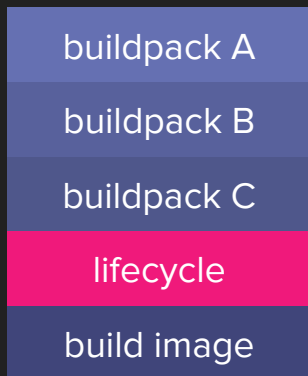


+



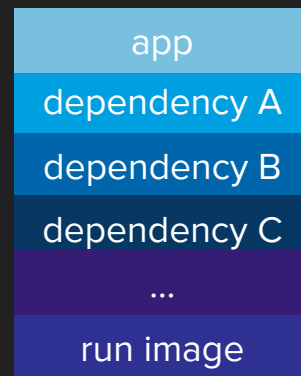
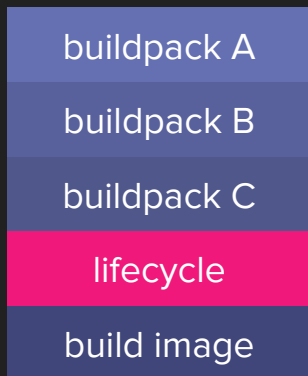
source

# How do they work?



source

# How do they work?

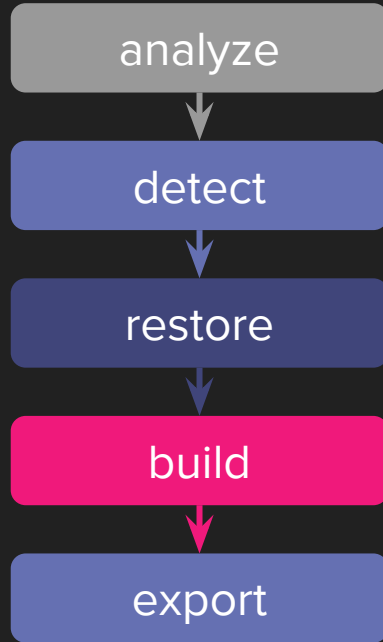


+



source

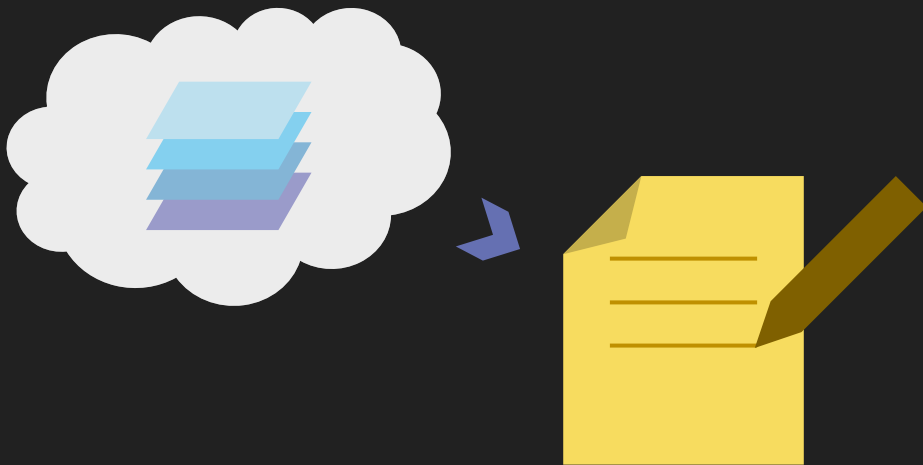
# Lifecycle phases



# Analyze

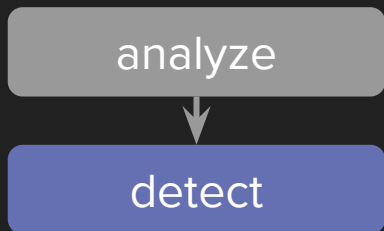
analyze

- Gathers metadata from previously-build image
- Used during export t, to avoid re-uploading unchanged layers



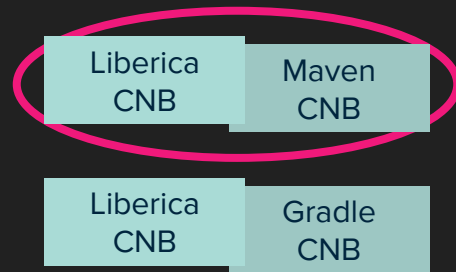


# Detect

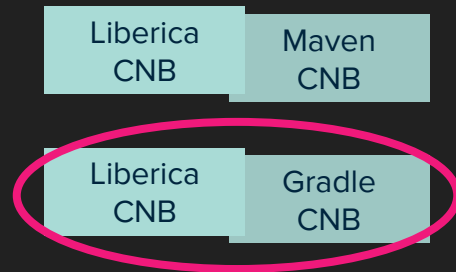


- Determines which buildpacks are needed
- Tests buildpacks against source, in order (via each buildpack's detect binary)

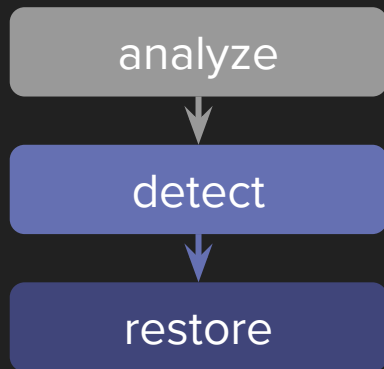
```
pom.xml  
src/  
...
```



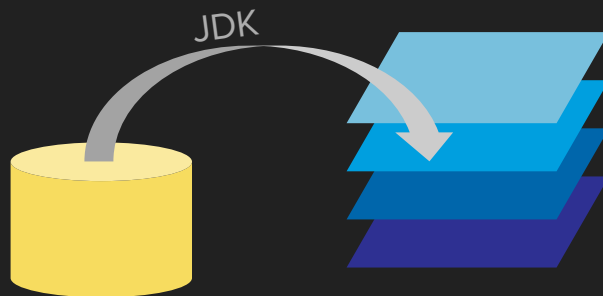
```
build.gradle  
src/  
...
```



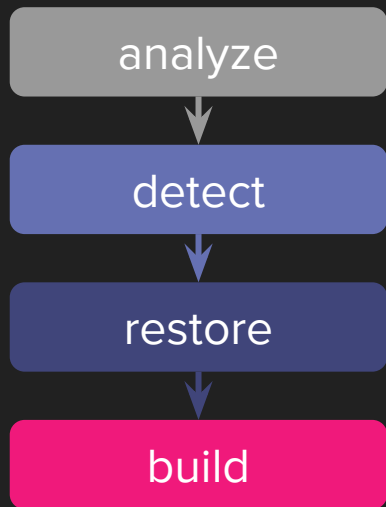
# Restore



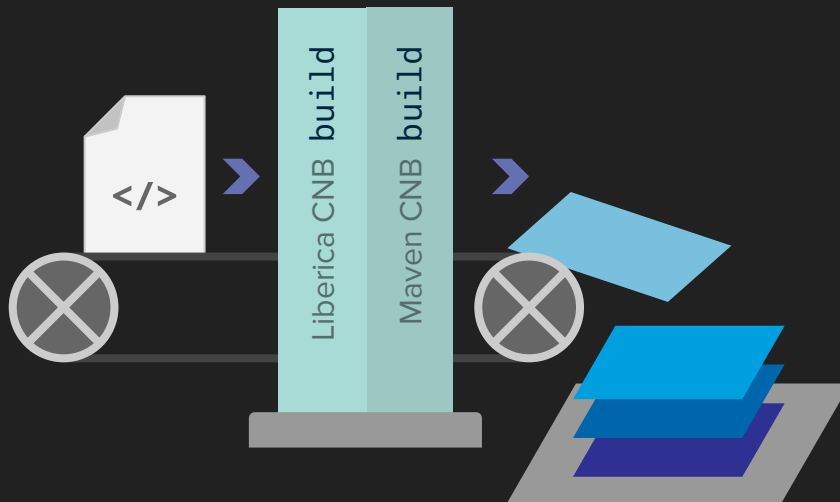
- Copies any previously-cached build-time dependencies into the build container



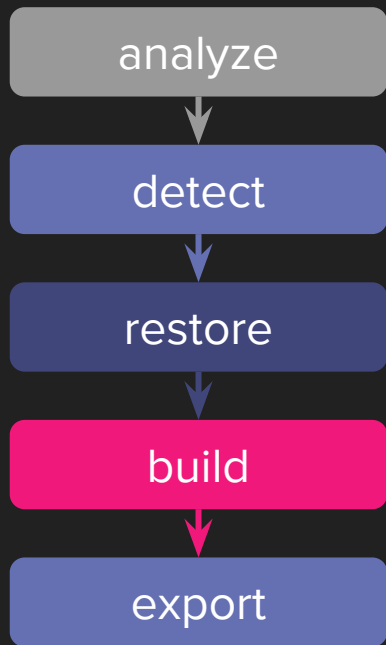
# Build



- Executes each buildpack's build binary, in order
- build downloads dependencies, compiles app (if needed), sets start command, etc.



# Export



- Assembles layers, creates final image
- Uses information from analyze phase to re-use unchanged layers
- Caches build-time dependencies

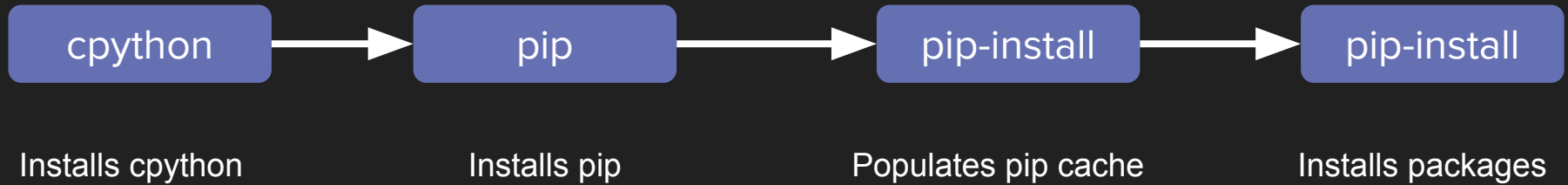


```
pack build my-app-image \  
  --path ./my-source-dir \  
  --builder my-builder-image
```

```
pack build my-app-image
```

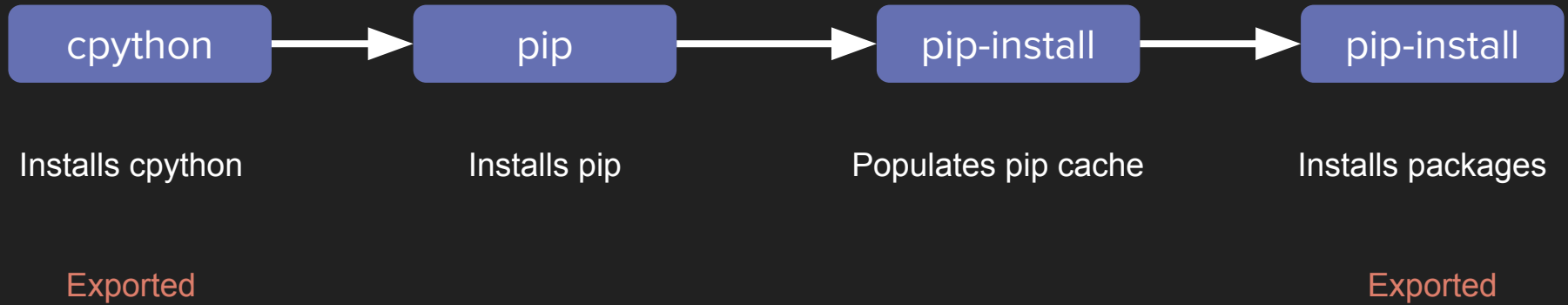
# Demo

# Returning to our Python application...

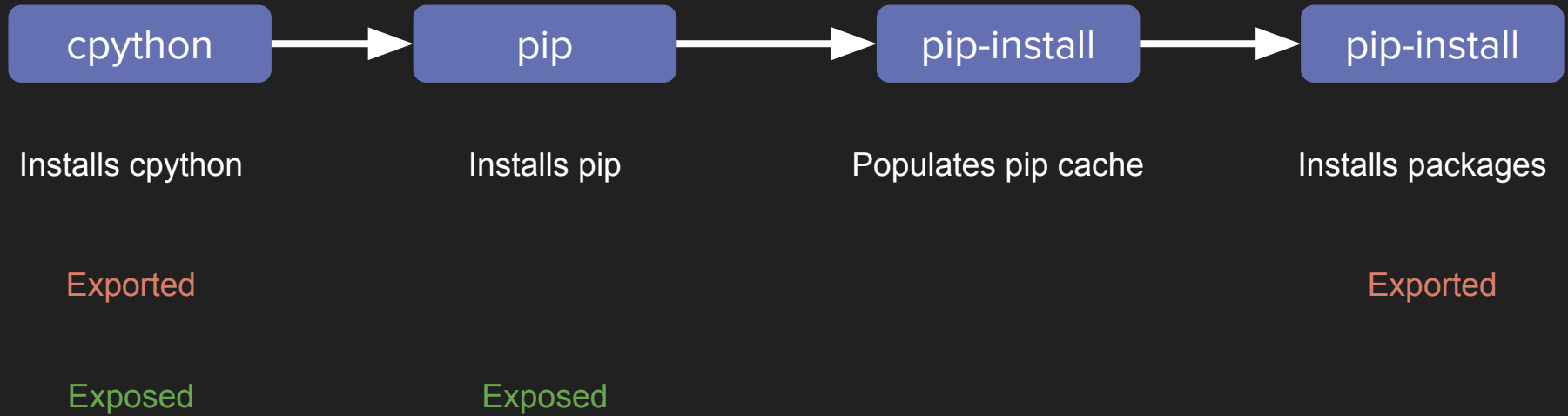




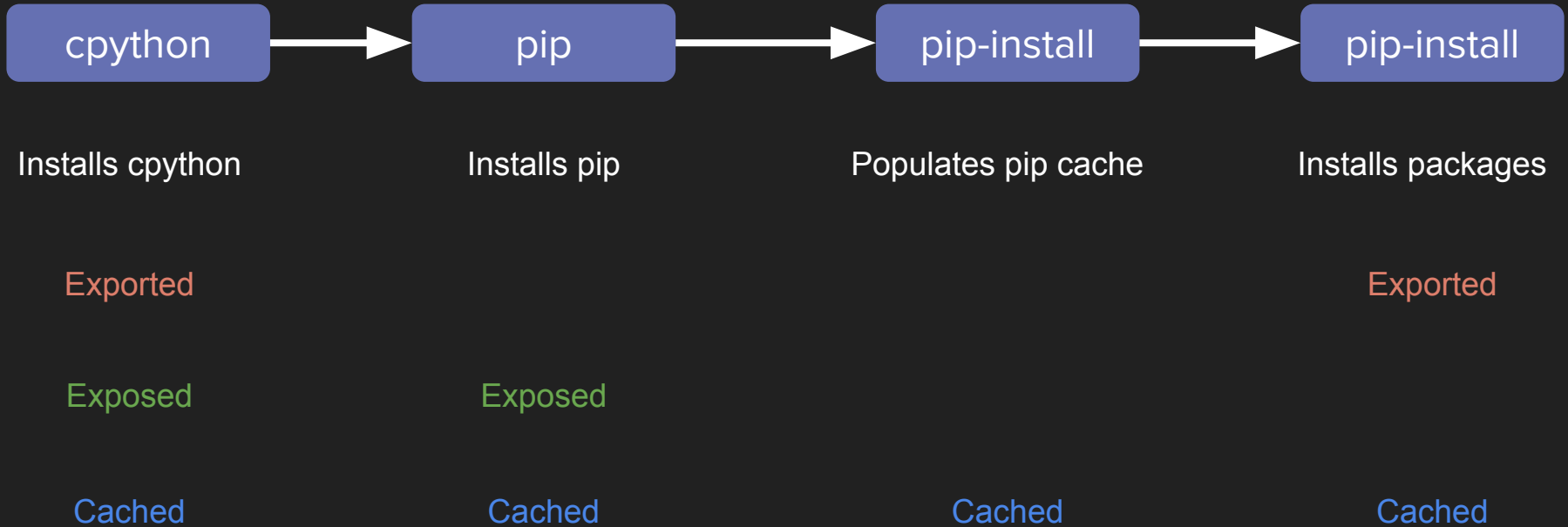
# Returning to our Python application...



# Returning to our Python application...



# Returning to our Python application...



# Directory structure - in the build container

/layers

```
/workspace  
|-- app.py  
`-- requirements.txt
```

ENV

PATH=

```
/usr/local/sbin:  
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |   |-- ...
|   |-- cpython.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |   |-- ...
|   |-- cpython.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
    /layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
    /layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
    /layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
    /layers/paketo-buildpacks_cpython/cpython

PATH=
    /layers/paketo-buildpacks_cpython/cpython/bin:
    /usr/local/sbin:
    /usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |   |-- ...
|   |-- cpython.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |   |-- ...
|   |-- cpython.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```



# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |   |-- ...
|   |-- cpython.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |   |-- ...
|   |-- cpython.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |-- ...
|   |-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.delim
|   |   |   |-- PYTHONPATH.prepend
|   |   |-- lib
|   |-- pip.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_pip/pip/lib/python3.8/site-
packages:
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_pip/pip/bin:
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |-- ...
|   |-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.delim
|   |   |   |-- PYTHONPATH.prepend
|   |   |-- lib
|   |-- pip.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_pip/pip/lib/python3.8/site-
packages:
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_pip/pip/bin:
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |-- ...
|   |-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.delim
|   |   |   |-- PYTHONPATH.prepend
|   |   |-- lib
|   |-- pip.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_pip/pip/lib/python3.8/site-
packages:
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_pip/pip/bin:
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.override
|   |   |-- include
|   |   |-- lib
|   |   |-- ...
|   |-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   |   |-- PYTHONPATH.delim
|   |   |   |-- PYTHONPATH.prepend
|   |   |-- lib
|   |-- pip.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_pip/pip/lib/python3.8/site-
packages:
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_pip/pip/bin:
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   `-- ...
|   `-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   `-- pip.toml
|-- paketo-buildpacks_pip-install
|   |-- cache
|   |   `-- http
|   |-- cache.toml
|   |-- packages
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   `-- packages.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_pip/pip/lib/python3.8/site-
packages:
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_pip/pip/bin:
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   `-- ...
|   `-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   `-- pip.toml
|-- paketo-buildpacks_pip-install
|   |-- cache
|   |   `-- http
|   |-- cache.toml
|   |-- packages
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   `-- packages.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_pip/pip/lib/python3.8/site-
packages:
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_pip/pip/bin:
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```



# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   `-- ...
|   `-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   `-- pip.toml
|-- paketo-buildpacks_pip-install
|   |-- cache
|   |   `-- http
|   |-- cache.toml
|   |-- packages
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   `-- packages.toml
```

```
/workspace
|-- app.py
`-- requirements.txt
```

```
LD_LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

LIBRARY_PATH=
/layers/paketo-buildpacks_pip/pip/lib:
/layers/paketo-buildpacks_cpython/cpython/lib

CPATH=
/layers/paketo-buildpacks_cpython/cpython/include

PYTHONPATH=
/layers/paketo-buildpacks_pip/pip/lib/python3.8/site-
packages:
/layers/paketo-buildpacks_cpython/cpython

PATH=
/layers/paketo-buildpacks_pip/pip/bin:
/layers/paketo-buildpacks_cpython/cpython/bin:
/usr/local/sbin:
/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

# Directory structure - in the build container

/layers

```
-- paketo-buildpacks_cpython
|   |-- cpython
|   |   |-- bin
|   |   |-- env
|   |   `-- ...
|   |-- cpython.toml
-- paketo-buildpacks_pip
|   |-- pip
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   |-- pip.toml
-- paketo-buildpacks_pip-install
|   |-- cache
|   |   `-- http
|   |-- cache.toml
|   |-- packages
|   |   |-- bin
|   |   |-- env
|   |   `-- lib
|   |-- packages.toml
```

/workspace

```
-- app.py
`-- requirements.txt
```

# Directory structure - in the build container

/layers

|-- paketo-buildpacks\_cpython

| |-- cpython  
| | |-- bin  
| | |-- env  
| | `-- ...

| cpython.toml

|-- paketo-buildpacks\_pip

| |-- pip  
| | |-- bin  
| | |-- env  
| | `-- lib

| pip.toml

|-- paketo-buildpacks\_pip-install

| |-- cache

| | `-- http

| cache.toml

| packages

| |-- bin  
| | |-- env  
| | `-- lib

| packages.toml

/workspace

|-- app.py

`-- requirements.txt

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
```

```
    |-- cpython
    |   |-- bin
    |   |-- env
    |   `-- ...
    `-- cpython.toml
```

```
-- paketo-buildpacks_pip
```

```
    |-- pip
    |   |-- bin
    |   |-- env
    |   |-- lib
    |   `-- pip.toml
```

```
-- paketo-buildpacks_pip-install
```

```
    |-- cache
    |   `-- http
    |-- cache.toml
    |-- packages
    |   |-- bin
    |   |-- env
    |   `-- lib
    `-- packages.toml
```

```
/workspace
```

```
|-- app.py
`-- requirements.txt
```

# Directory structure - in the build container

```
/layers  
|-- paketo-buildpacks_cpython
```

```
    |-- cpython  
    |   |-- bin  
    |   |-- env  
    |   `-- ...  
    `-- cpython.toml
```

```
-- paketo-buildpacks_pip
```

```
    |-- pip  
    |   |-- bin  
    |   |-- env  
    |   |-- lib  
    |   `-- pip.toml
```

```
-- paketo-buildpacks_pip-install
```

```
    |-- cache  
    |   |-- http  
    |   `-- cache.toml
```

```
    |-- packages
```

```
        |-- bin  
        |-- env  
        |-- lib  
        `-- packages.toml
```

```
/workspace
```

```
|-- app.py  
`-- requirements.txt
```

# Directory structure - in the build container

```
/layers
|-- paketo-buildpacks_cpython
|   |-- cpython
|   |-- cpython.cdx.json
|   |-- cpython.spdx.json
|   |-- cpython.syft.json
|   |-- ...
|   |-- cpython.toml
|-- paketo-buildpacks_pip
|   |-- pip
|   |-- pip.cdx.json
|   |-- pip.spdx.json
|   |-- pip.syft.json
|   |-- ...
|   |-- pip.toml
|-- paketo-buildpacks_pip-install
|   |-- packages
|   |-- packages.cdx.json
|   |-- packages.spdx.json
|   |-- packages.syft.json
|   |-- ...
|   |-- packages.toml

/workspace
|-- app.py
`-- requirements.txt
```

# Dive

Layers			Current Layer Contents			
Cmp	Size	Command	Permission	UID:GID	Size	Filetree
	63 MB	FROM d5e7df7d8eeae3b	drwxr-xr-x	0:0	4.8 MB	bin
	225 B		drwxr-xr-x	0:0	0 B	boot
	24 MB		drwxr-xr-x	0:0	0 B	dev
	398 kB		drwxr-xr-x	0:0	379 kB	etc
	3.4 MB		drwxr-xr-x	0:0	4.8 kB	home
	192 MB		drwxr-xr-x	1000:1000	195 MB	layers
	4.0 MB		drwxr-xr-x	1000:1000	3.4 MB	└─ paketo-buildpacks_ca-certificates
	36 kB		drwxr-xr-x	1000:1000	192 MB	└─ paketo-buildpacks_cpython
	2.5 MB		drwxr-xr-x	0:0	12 MB	lib
	1.6 kB		drwxr-xr-x	0:0	0 B	lib64
	0 B		drwxr-xr-x	0:0	0 B	media
			drwxr-xr-x	0:0	0 B	mnt
			drwxr-xr-x	0:0	0 B	opt
			drwxr-xr-x	0:0	0 B	proc
			drwx-----	0:0	3.3 kB	root
			drwxr-xr-x	0:0	7 B	run
			drwxr-xr-x	0:0	3.8 MB	sbin
			drwxr-xr-x	0:0	0 B	srv
			drwxr-xr-x	0:0	0 B	sys
			drwxrwxrwx	0:0	0 B	tmp
			drwxr-xr-x	0:0	59 MB	usr
			drwxr-xr-x	0:0	5.5 MB	var
Layer Details						
Tags: (unavailable)						
Id: 81702466cc7982fc0230253812e9431759b9da870c8454757b627bde351d882						
Digest: sha256:5c8e32c6b5606b61912c446f8b99a3cbb0ef77c56e405f1eae34acd9c88498a7						
Command:						
Image Details						
Total Image size: 289 MB						
Potential wasted space: 3.0 MB						
Image efficiency score: 99 %						
Count	Total Space	Path				
2	1.3 MB	/var/cache/debconf/templates.dat				
2	395 kB	/var/log/dpkg.log				
2	322 kB	/var/log/lastlog				
2	222 kB	/usr/share/info/coreutils.info.gz				
2	181 kB	/var/lib/dpkg/status				
2	92 kB	/usr/share/info/find.info.gz				
2	70 kB	/var/log/tallylog				
2	61 kB	/usr/share/doc/perl/changelog.Debian.gz				
2	61 kB	/usr/share/info/diffutils.info.gz				
2	52 kB	/usr/share/info/sed.info.gz				

# Dive

Layers			Current Layer Contents			
Cmp	Size	Command	Permission	UID:GID	Size	Filetree
	63 MB	FROM d5e7df7d8eeae3b	drwxr-xr-x	0:0	4.8 MB	bin
	225 B		drwxr-xr-x	0:0	0 B	boot
	24 MB		drwxr-xr-x	0:0	0 B	dev
	398 kB		drwxr-xr-x	0:0	379 kB	etc
	3.4 MB		drwxr-xr-x	0:0	4.8 kB	home
	192 MB		drwxr-xr-x	1000:1000	199 MB	layers
	4.0 MB		drwxr-xr-x	1000:1000	3.4 MB	paketo-buildpacks_ca-certificates
	36 kB		drwxr-xr-x	1000:1000	192 MB	paketo-buildpacks_cpython
	2.5 MB		drwxr-xr-x	1000:1000	4.0 MB	paketo-buildpacks_pip-install
	1.6 kB		drwxr-xr-x	0:0	12 MB	lib
	0 B		drwxr-xr-x	0:0	0 B	lib64
			drwxr-xr-x	0:0	0 B	media
			drwxr-xr-x	0:0	0 B	mnt
			drwxr-xr-x	0:0	0 B	opt
			drwxr-xr-x	0:0	0 B	proc
			drwxr-xr-x	0:0	0 B	root
			drwxr-xr-x	0:0	3.3 kB	run
			drwxr-xr-x	0:0	7 B	sbin
			drwxr-xr-x	0:0	3.8 MB	srv
			drwxr-xr-x	0:0	0 B	sys
			drwxr-xr-x	0:0	0 B	tmp
			drwxr-xr-x	0:0	59 MB	usr
			drwxr-xr-x	0:0	5.5 MB	var
Layer Details						
Tags: (unavailable)						
Id: fbc035a985e3c9871c0e12798b94a3b6d0a88fb031d2e95000a241041d708d6b						
Digest: sha256:43329a76bb805a00652728cd864463127185f284599ff4962a60a94c258f7449						
Command:						
Image Details						
Total Image size: 289 MB						
Potential wasted space: 3.0 MB						
Image efficiency score: 99 %						
Count	Total Space	Path				
2	1.3 MB	/var/cache/debconf/templates.dat				
2	395 kB	/var/log/dpkg.log				
2	322 kB	/var/log/lastlog				
2	222 kB	/usr/share/info/coreutils.info.gz				
2	181 kB	/var/lib/dpkg/status				
2	92 kB	/usr/share/info/find.info.gz				
2	70 kB	/var/log/tallylog				
2	61 kB	/usr/share/doc/perl/changelog.Debian.gz				
2	61 kB	/usr/share/info/diffutils.info.gz				
2	52 kB	/usr/share/info/sed.info.gz				



# Dive

Layers			Current Layer Contents			
Cmp	Size	Command	Permission	UID:GID	Size	Filetree
	63 MB	FROM d5e7df7d8eeae3b	drwxr-xr-x	0:0	4.8 MB	bin
	225 B		drwxr-xr-x	0:0	0 B	boot
	24 MB		drwxr-xr-x	0:0	0 B	dev
	398 kB		drwxr-xr-x	0:0	379 kB	etc
	3.4 MB		drwxr-xr-x	0:0	4.8 kB	home
	192 MB		drwxr-xr-x	1000:1000	199 MB	layers
	4.0 MB		drwxr-xr-x	1000:1000	3.4 MB	paketo-buildpacks_ca-certificates
	36 kB		drwxr-xr-x	1000:1000	192 MB	paketo-buildpacks_cpython
	2.5 MB		drwxr-xr-x	1000:1000	4.0 MB	paketo-buildpacks_pip-install
	1.6 kB		drwxr-xr-x	0:0	12 MB	lib
	0 B		drwxr-xr-x	0:0	0 B	lib64
			drwxr-xr-x	0:0	0 B	media
			drwxr-xr-x	0:0	0 B	mnt
			drwxr-xr-x	0:0	0 B	opt
			drwxr-xr-x	0:0	0 B	proc
			drwxr-xr-x	0:0	3.3 kB	root
			drwxr-xr-x	0:0	7 B	run
			drwxr-xr-x	0:0	3.8 MB	sbin
			drwxr-xr-x	0:0	0 B	srv
			drwxr-xr-x	0:0	0 B	sys
			drwxrwxrwx	0:0	0 B	tmp
			drwxr-xr-x	0:0	59 MB	usr
			drwxr-xr-x	0:0	5.5 MB	var
			drwxrwxrwx	1000:1000	36 kB	workspace
			-rw-r--r--	1000:1000	201 B	.dockerignore
			drwxr-xr-x	1000:1000	29 kB	.git
			-rw-r--r--	1000:1000	148 B	.gitpod.yml
			-rw-r--r--	1000:1000	203 B	Dockerfile
			-rw-r--r--	1000:1000	117 B	app.py
			-rwxr-xr-x	1000:1000	450 B	demo-docker-commit
			-rwxr-xr-x	1000:1000	114 B	demo-image
			-rw-r--r--	1000:1000	4.2 kB	demo-magic.sh
			-rw-r--r--	1000:1000	94 B	requirements.txt
			-rwxr-xr-x	1000:1000	1.0 kB	setup.sh

**Layer Details**

Tags: (unavailable)  
Id: c9c24f0252d44ec99ed676d15d09c61e1bbcf5b4ec1fe5cfaf5ca94b43acee8  
Digest: sha256:d522f77a74ba995c60a5bf857626eb79ae4b62ec8be20eb96134b994b054a09f  
Command:

**Image Details**

Total Image size: 289 MB  
Potential wasted space: 3.0 MB  
Image efficiency score: 99 %

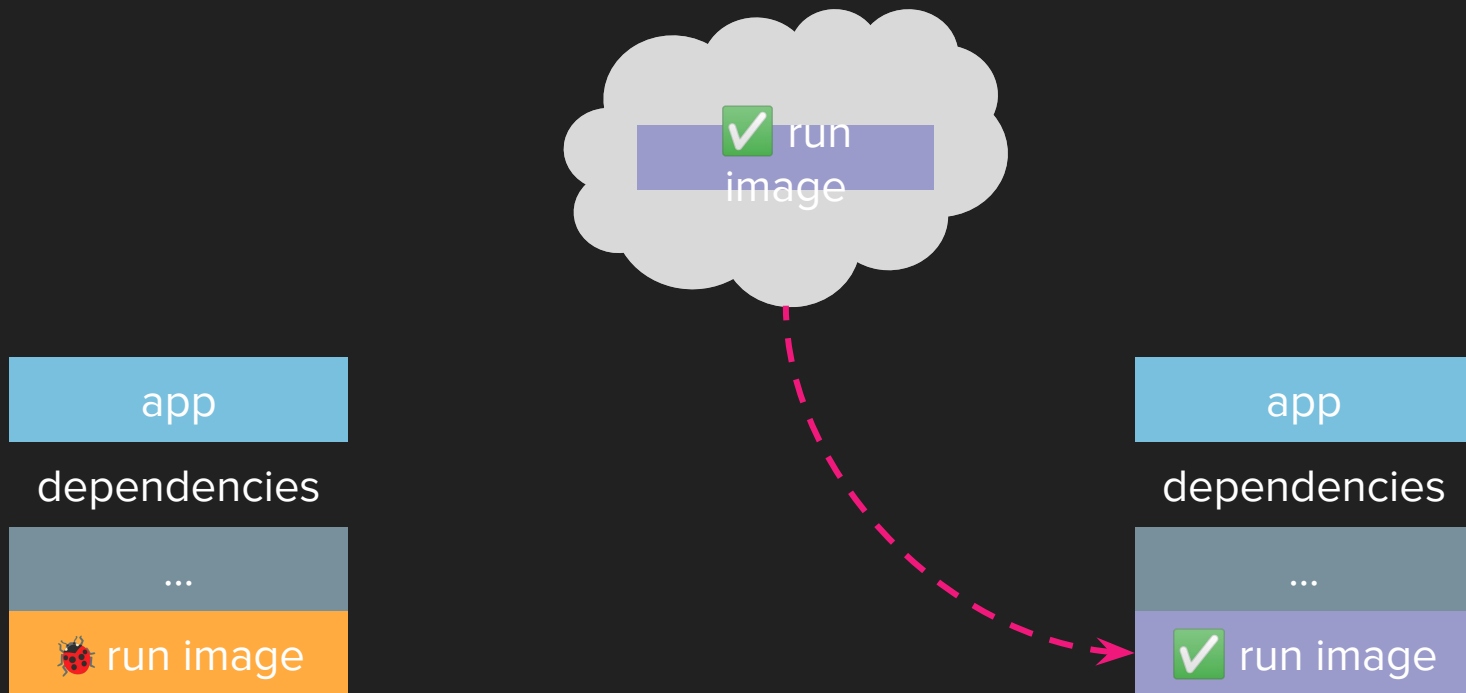
Count	Total Space	Path
2	1.3 MB	/var/cache/debconf/templates.dat
2	395 kB	/var/log/dpkg.log
2	322 kB	/var/log/lastlog
2	222 kB	/usr/share/info/coreutils.info.gz
2	181 kB	/var/lib/dpkg/status
2	92 kB	/usr/share/info/find.info.gz
2	70 kB	/var/log/tallylog
2	61 kB	/usr/share/doc/perl/changelog.Debian.gz
2	61 kB	/usr/share/info/diffutils.info.gz
2	52 kB	/usr/share/info/sed.info.gz

# Image Config

```
docker inspect demo-app | jq .[0].Config
```

```
{
  "Hostname": "",
  "Domainname": "",
  "User": "1000:1000",
  "AttachStdin": false,
  "AttachStdout": false,
  "AttachStderr": false,
  "Tty": false,
  "OpenStdin": false,
  "StdinOnce": false,
  "Env": [
    "PATH=/cnb/process:/cnb/lifecycle:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin",
    "CNB_LAYERS_DIR=/layers",
    "CNB_APP_DIR=/workspace",
    "CNB_PLATFORM_API=0.8",
    "CNB_DEPRECATION_MODE=quiet"
  ],
  "Cmd": null,
  "Image": "sha256:6c9f16a1fcc23ed7b7aff2bb9d8247c3d7e08183d9c24bf6b36ecf578df94973",
  "Volumes": null,
  "WorkingDir": "/workspace",
  "Entrypoint": [
    "/cnb/process/web"
  ],
}
```

# Rebase



# What did we see?

- Buildpacks analyze source code and determine the best way to build it
- Buildpacks follow a specification
- Logical mapping of buildpack-installed dependencies to layers
- The lifecycle orchestrates the build
- Ability to rebase

# Pros

- Concentrates understanding of container build best practices to buildpack authors - not app developers!
- Dependency updates / patches are easy and straightforward
- Layers within an image are logically mapped to the dependencies that they provide
- More accurate SBOMs
- Rebase allows fast patching at scale

# Limitations

- Does not allow arbitrary file system changes
- Must be run unprivileged

# Community



Buildpacks.io



**Slack**

[#buildpacks@cncf.slack.io](#)



**Twitter**

[@buildpacks\\_io](#)



**GitHub**

[github.com/buildpacks](#)

Thanks!