

on Software Design, Big Data and DevOps

April 2, 2016

Docker RUN vs CMD vs ENTRYPOINT

Some Docker instructions look similar and cause confusion among developers who just started using Docker or do it irregularly. In this post I will explain the difference between CMD, RUN, and ENTRYPOINT on examples.

In a nutshell

• RUN executes command(s) in a new layer and creates a new image. E.g., it is often used for installing software packages.

- CMD sets default command and/or parameters, which can be overwritten from command line when docker container runs.
- ENTRYPOINT configures a container that will run as an executable.

If it doesn't make much sense or you after details, then read on.

Docker images and layers

When Docker runs a container, it runs an *image* inside it. This image is usually built by executing Docker instructions, which add *layers* on top of existing image or *OS distribution*. *OS distribution* is the initial image and every added layer creates a new image.

Final Docker *image* reminds an onion with OS distribution inside and a number of layers on top of it. For example, your image can be built by installing a number of deb packages and your application on top of Ubuntu 14.04 distribution.

Shell and Exec forms

All three instructions (RUN, CMD and ENTRYPOINT) can be specified in *shell* form or *exec* form. Let's get familiar with these forms first, because the forms usually cause more confusion than instructions themselves.

Shell form

<instruction> <command>

Examples:

```
RUN apt-get install python3
CMD echo "Hello world"
ENTRYPOINT echo "Hello world"
```

When instruction is executed in *shell* form it calls /bin/sh -c <command> under the hood and normal shell processing happens. For example, the following snippet in Dockerfile

```
ENV name John Dow
ENTRYPOINT echo "Hello, $name"
```

when container runs as docker run -it <image> will produce output

```
Hello, John Dow
```

Note that variable *name* is replaced with its value.

Exec form

This is the preferred form for CMD and ENTRYPOINT instructions.

```
<instruction> ["executable", "param1", "param2", ...]
```

Examples:

```
RUN ["apt-get", "install", "python3"]
CMD ["/bin/echo", "Hello world"]
ENTRYPOINT ["/bin/echo", "Hello world"]
```

When instruction is executed in *exec* form it calls executable directly, and shell processing does not happen. For example, the following snippet in Dockerfile

```
ENV name John Dow
ENTRYPOINT ["/bin/echo", "Hello, $name"]
```

when container runs as docker run -it <image> will produce output

```
Hello, $name
```

Note that variable *name* is not substituted.

How to run bash?

If you need to run *bash* (or any other interpreter but sh), use *exec* form with /bin/bash as executable. In this case, normal shell processing will take place. For example, the following snippet in Dockerfile

```
ENV name John Dow
ENTRYPOINT ["/bin/bash", "-c", "echo Hello, $name"]
```

when container runs as docker run -it <image> will produce output

```
Hello, John Dow
```

RUN

RUN instruction allows you to install your application and packages requited for it. It executes any commands on top of the current image and creates a new layer by committing the results. Often you will find multiple RUN instructions in a Dockerfile.

RUN has two forms:

- RUN <command> (shell form)
- RUN ["executable", "param1", "param2"] (exec form)

(The forms are described in detail in *Shell and Exec forms* section above.)

A good illustration of RUN instruction would be to install multiple version control systems packages:

```
RUN apt-get update && apt-get install -y \
bzr \
cvs \
git \
mercurial \
subversion
```

Note that apt-get update and apt-get install are executed in a single RUN instruction. This is done to make sure that the latest packages will be installed. If apt-get install were in a separate RUN instruction, then it would reuse a layer added by apt-get update, which could had been created a long time ago.

CMD

CMD instruction allows you to set a *default* command, which will be executed only when you run container without specifying a command. If Docker container runs with a command, the default command will be ignored. If Dockerfile has more than one CMD instruction, all but last CMD instructions are ignored.

CMD has three forms:

- CMD ["executable", "param1", "param2"] (exec form, preferred)
- CMD ["param1", "param2"] (sets additional default parameters for ENTRYPOINT in *exec* form)
- CMD command param1 param2 (shell form)

Again, the first and third forms were explained in *Shell and Exec forms* section. The second one is used together with ENTRYPOINT instruction in *exec* form. It sets default parameters that will be added after ENTRYPOINT parameters if

container runs without command line arguments. See ENTRYPOINT for example.

Let's have a look how CMD instruction works. The following snippet in Dockerfile

CMD echo "Hello world"

when container runs as docker run -it <image> will produce output

Hello world

but when container runs with a command, e.g.,

docker run -it <image> /bin/bash, CMD is ignored and bash interpreter runs instead:

root@7de4bed89922:/#

ENTRYPOINT

ENTRYPOINT instruction allows you to configure a container that will run as an executable. It looks similar to CMD, because it also allows you to specify a command with parameters. The difference is ENTRYPOINT command and

parameters are not ignored when Docker container runs with command line parameters. (There is a way to ignore ENTTRYPOINT, but it is unlikely that you will do it.)

ENTRYPOINT has two forms:

- ENTRYPOINT ["executable", "param1", "param2"] (exec form, preferred)
- ENTRYPOINT command param1 param2 (shell form)

Be very careful when choosing ENTRYPOINT form, because forms behaviour differs significantly.

Exec form

Exec form of ENTRYPOINT allows you to set commands and parameters and then use either form of CMD to set additional parameters that are more likely to be changed. ENTRYPOINT arguments are always used, while CMD ones can be overwritten by command line arguments provided when Docker container runs. For example, the following snippet in Dockerfile

```
ENTRYPOINT ["/bin/echo", "Hello"]
CMD ["world"]
```

when container runs as docker run -it <image> will produce output

Hello world

but when container runs as docker run -it <image> John will result in

Hello John

Shell form

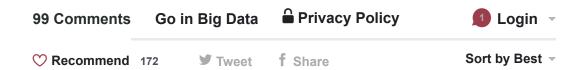
Shell form of ENTRYPOINT ignores any CMD or docker run command line arguments.

The bottom line

Use RUN instructions to build your image by adding layers on top of initial image.

Prefer ENTRYPOINT to CMD when building executable Docker image and you need a command always to be executed. Additionally use CMD if you need to provide extra default arguments that could be overwritten from command line when docker container runs.

Choose CMD if you need to provide a default command and/or arguments that can be overwritten from command line when docker container runs.





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Name



Nitin Bansal • 2 years ago

Wow!!! So beautifully explained.....thanks so much:)



Haritha Srinivas • a year ago

Such a great teacher you are .Awesome explanation in a simple way



Serguei Cambour • 2 years ago

Reaally great explained nuances I've never seen before! Thanks a lot, спасибо огромное, Юра!



Pepito Fernandez • a year ago

Yury! Killed it. Added it to my bookmarks bar... then I realized... I won't need it.



alikemaltasci • a year ago

thanks



LE Xuan Hung • 5 months ago

Greet job, Thank you.



Samuel Costa • a year ago

Thank you



Luís • a year ago

Thank wan



mank you



Majid ahmadi • a month ago

(2) Persian comment



Hongliang Wang • 2 years ago

Thanks. It's helpful!



Dr. Γιάννης Γουάτ δε φάκ • 9 days ago

Let's say I have a dockerfile specifying an ENTRYPOINT to an executable.

How do I run a command BEFORE the entrypoint in a docker-compose script?



vasim vahora • 12 days ago

Awesome !!!



vasim vahora • 12 days ago

Awesome!



Jose Gustavson • 12 days ago

Thanks. most of it is very understable



Rajesh Thokala • a month ago

Its very clear information. Thanks for writing this article . Writing style is impressive



Tayyab • a month ago

Great article, thanks a lot!



Жора Смирнов • a month ago

Still GREAT!!!



tometchy • a month ago

Nice description;)



Manish Kumar • 2 months ago

This simple tutorial saved my lots of time



Sudara • 2 months ago

Well written and carefully explained. Thanks a lot!



test • 3 months ago

Thank you



Faruk Onder • 3 months ago

dude, perfect!



Ostap • 3 months ago

Thanks!



Николай Симкин • 4 months ago

Best article about RUN vs CMD vs ENTRYPOINT. Thanks a lot!



Marta J. • 5 months ago

thank you:)



채수정 • 5 months ago

Thank you. It's great article. I want to share this post in Korean. I will link your article url!

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A | V . Ranky . Share .
```

TOPIN TOTALE



Louis Mamakos • 5 months ago

Thanks so very much for this explanation! I don't know why this isn't clearly documented in the obvious places, so thanks for taking up the slack.



Alan Machado Corrêa • 5 months ago

Excellent explanation! Very useful



Han Mai • 6 months ago • edited

The executing docker run -it <image> /bin/bash is less common in used than

docker run -it <image>, that's reason why I was only aware the shell form of CMD. Now I know other forms and the differences between CMD and ENTRYPOINT. Thank you very much. Very helpful article.



Arnar Leifsson • 6 months ago

Very nice article! Takes the confusion out of these ones!



Laurence Nyein • 7 months ago

all my confusion with those three commands are now demystified. thanks.



Malachi • 7 months ago

Thank you for this



moreirapontocom • 8 months ago

Very awesome article! Thank you for sharing.



Daniel Marques • 8 months ago

Wonderful:D



Brady Wunsch • 8 months ago

Really appreciate the thorough and clear explanation.



Alexander K • 8 months ago

One more thanks here



Arup J Thakuria • 9 months ago

Excellent, it clears my doubt regarding difference between CMD & ENTRYPOINT



Mamadou Oury Bah • 9 months ago

thank you for your explanations, it is clear with good examples.



lucas almeida • 9 months ago

Thank you! Very elucidating and well detailed explanation!



Rj Sharma • 9 months ago

Great job...



Hino • 10 months ago

thank mate for the awesome explanation:D



Jheison Rodriguez • 10 months ago

Nice explanation, thanks



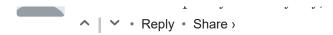
VB • 10 months ago

Great article



Leo Lin • a year ago

This article completely saved my day, thanks!





Wellspring • a year ago

This was fabulously helpful to me. Thank you. I've found myself reading this post several times over the past few weeks.



Amara Bargougui • a year ago

Awesome explanation..thank you



林峻同•a year ago

I just started learning docker. This information is very helpful to me.

Thank you!



YuhaoFeng • a year ago

Thanks for sharing!



algore87 • a year ago

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