

00000000	7F 45 4C 46	02 01 01 00	00 00 00 00	00 00 00 00	03 00 3E 00	01 00 00 00	90 08 55 00	00 00 00 00
00000028	F8 99 56 03	00 00 00 00	00 00 00 00	40 00 38 00	0A 00 40 00	20 00 1F 00	06 00 00 00	05 00 00 00
00000050	40 00 00 00	00 00 00 00	40 00 00 00	00 00 00 00	30 02 00 00	00 00 00 00	30 02 00 00	00 00 00 00
00000078	03 00 00 00	04 00 00 00	70 02 00 00	00 00 00 00	70 02 00 00	00 00 00 00	70 02 00 00	00 00 00 00
000000A0	1C 00 00 00	00 00 00 00	01 00 00 00	00 00 00 00	01 00 00 00	05 00 00 00	00 00 00 00	00 00 00 00
000000C8	00 00 00 00	00 00 00 00	88 52 30 03	00 00 00 00	88 52 30 03	00 00 00 00	00 00 20 00	00 00 00 00
000000F0	28 58 30 03	00 00 00 00	28 58 50 03	00 00 00 00	28 58 50 03	00 00 00 00	98 40 26 00	00 00 00 00
00000118	00 00 20 00	00 00 00 00	02 00 00 00	06 00 00 00	88 39 52 03	00 00 00 00	88 39 72 03	00 00 00 00
00000140	60 04 00 00	00 00 00 00	60 04 00 00	00 00 00 00	08 00 00 00	00 00 00 00	04 00 00 00	04 00 00 00
00000168	8C 02 00 00	00 00 00 00	8C 02 00 00	00 00 00 00	24 00 00 00	00 00 00 00	24 00 00 00	00 00 00 00
00000190	07 00 00 00	04 00 00 00	08 58 50 03	00 00 00 00	08 58 50 03	00 00 00 00	28 58 50 03	00 00 00 00
000001B8	0C 00 00 00	00 00 00 00	08 58 50 03	00 00 00 00	08 58 50 03	00 00 00 00	14 51 E9 02	00 00 00 00
000001E0	14 51 E9 02	00 00 00 00	74 4D 0E 00	00 00 00 00	74 4D 0E 00	00 00 00 00	04 00 00 00	00 00 00 00
00000208	00 00 00 00	00 00 00 00	00 00 00 00	00 00 00 00	00 00 00 00	00 00 00 00	00 00 00 00	00 00 00 00
00000230	08 00 00 00	00 00 00 00	52 E5 74 64	04 00 00 00	28 58 30 03	00 00 00 00	28 58 50 03	00 00 00 00
00000258	D8 C7 22 00	00 00 00 00	D8 C7 22 00	00 00 00 00	01 00 00 00	00 00 00 00	2F 6C 69 62	36 34 2F 6C
00000280	78 38 36 2D	36 34 2E 73	6F 2E 32 00	04 00 00 00	14 00 00 00	03 00 00 00	47 4E 55 00	96 C3 87 E9
000002A8	D8 98 A2 45	C0 1F B0 D0	E9 03 00 00	65 09 00 00	7E 08 00 00	47 08 00 00	CB 06 00 00	4E 02 00 00
000002D0	F5 07 00 00	82 05 00 00	00 06 00 00	45 07 00 00	9B 03 00 00	A5 06 00 00	C1 04 00 00	A9 07 00 00
000002F8	62 04 00 00	77 08 00 00	53 03 00 00	2C 03 00 00	B5 07 00 00	34 05 00 00	5A 05 00 00	94 03 00 00
00000320	B7 04 00 00	D9 04 00 00	00 00 00 00	EE 07 00 00	0C 09 00 00	C4 07 00 00	C8 01 00 00	CA 08 00 00
00000348	89 05 00 00	39 03 00 00	E2 05 00 00	03 06 00 00	84 04 00 00	14 04 00 00	83 07 00 00	B5 08 00 00
00000370	90 07 00 00	2C 07 00 00	8F 06 00 00	00 00 00 00	66 06 00 00	01 04 00 00	26 09 00 00	B2 07 00 00
00000398	AC 06 00 00	A8 06 00 00	08 06 00 00	82 06 00 00	DE 04 00 00	78 06 00 00	23 07 00 00	81 04 00 00
000003C0	36 02 00 00	EA 08 00 00	36 08 00 00	04 05 00 00	00 00 00 00	B0 07 00 00	68 04 00 00	71 05 00 00
000003E8	60 08 00 00	82 07 00 00	CE 07 00 00	F5 03 00 00	F2 02 00 00	14 07 00 00	00 00 00 00	9A 05 00 00
00000410	00 00 00 00	6A 08 00 00	2C 06 00 00	B7 03 00 00	B4 03 00 00	BA 08 00 00	90 08 00 00	00 00 00 00
00000438	1B 02 00 00	FF 03 00 00	76 08 00 00	E4 06 00 00	B4 08 00 00	4F 09 00 00	CE 05 00 00	DF 07 00 00
00000460	10 06 00 00	09 08 00 00	D4 05 00 00	4F 08 00 00	00 00 00 00	1D 08 00 00	AB 08 00 00	8B 08 00 00
00000488	A0 06 00 00	D9 01 00 00	81 08 00 00	D4 04 00 00	42 09 00 00	C0 07 00 00	E7 04 00 00	2F 03 00 00
000004B0	9E 07 00 00	00 00 00 00	78 07 00 00	22 02 00 00	2A 08 00 00	9B 07 00 00	00 00 00 00	58 05 00 00
000004D8	D7 08 00 00	00 09 00 00	6C 03 00 00	08 08 00 00	43 07 00 00	9A 08 00 00	C5 08 00 00	46 08 00 00
00000500	9D 07 00 00	2B 07 00 00	CC 06 00 00	DC 04 00 00	0D 06 00 00	06 07 00 00	77 06 00 00	E0 04 00 00
00000528	1C 07 00 00	60 07 00 00	A1 07 00 00	1C 06 00 00	5A 03 00 00	00 07 00 00	E7 05 00 00	9F 03 00 00
00000550	BD 07 00 00	8E 05 00 00	84 02 00 00	A3 04 00 00	00 00 00 00	60 00 00 00	57 08 00 00	ED 02 00 00
00000578	98 01 00 00	5D 06 00 00	D2 05 00 00	98 00 00 00	D3 00 00 00	B9 07 00 00	B2 04 00 00	5C 08 00 00
000005A0	00 00 00 00	43 08 00 00	17 05 00 00	2F 05 00 00	80 01 00 00	64 08 00 00	CC 07 00 00	DA 06 00 00
000005C8	17 07 00 00	FD 04 00 00	30 05 00 00	DA 04 00 00	12 06 00 00	A1 05 00 00	2F 07 00 00	42 08 00 00
000005F0	00 00 00 00	FD 01 00 00	7A 07 00 00	E1 08 00 00	6E 02 00 00	B6 08 00 00	38 08 00 00	78 00 00 00

DEEP LEARNING DRONES

DEV Tools

Patrick Christ

CDTM DEV Tools

- Anaconda
- Spyder
- Git
- Numpy
- Opencv
- Libardrone
- FFMPEG
- Docker

Python Distribution with 195 Packages such as Numpy and Spyder

Download from <http://continuum.io/downloads>

Install

Package Manager from Terminal (Mac OS) or CMD (Windows):

- conda install “package-name” to install a new package
- conda run “package-name” to start an package (e.g. conda run spyder or spyder)
- conda remove “package-name” to deinstall a package

Task:

→ Open Spyder

Editor for Scientific Development

Spyder is a Matlab like Editor for Python.

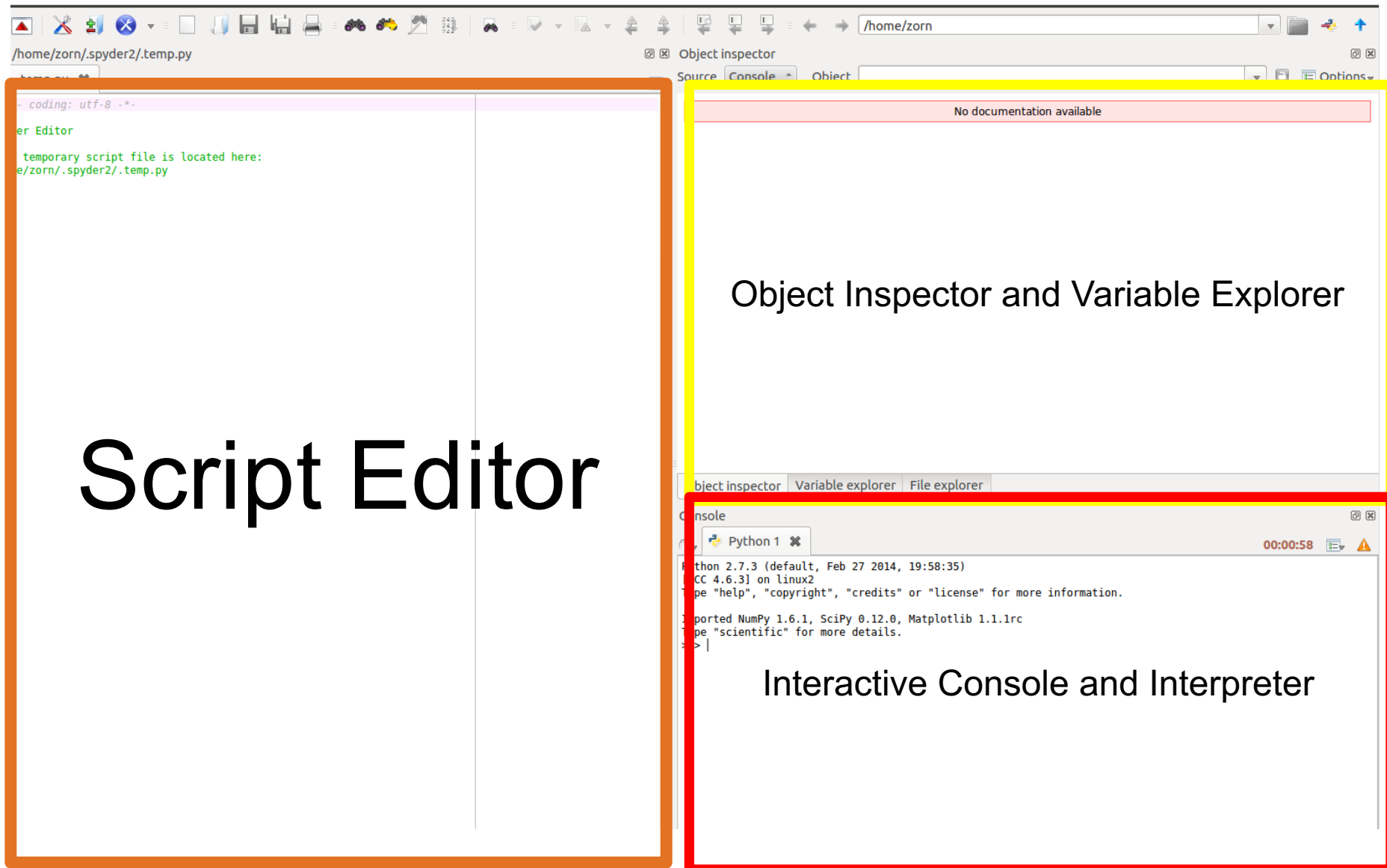
Main Feature: Variable Explorer, Interactive Console and Debugging Editor

Interactive Console: Test and run your code in real time

For Windows: Open Programs/Anaconda Launcher and than Spyder

For Mac: Open Home/Anaconda/Launcher and than Spyder

Or in Terminal/CMD conda run spyder



Installing new libraries with Anaconda

Library for manipulating Images and Videos

For installing new libraries and frameworks use the conda package manager.

Open Terminal or CMD and type:

`conda info #` to show the current conda info

`conda list #` to show all installed packages

`conda install „packagename“ #` to install a new package

Task: install OpenCV

`conda install opencv`

Collaboration Tool for Programmers

Share code and work together in Teams on your Drone Project.

Installation:

<https://git-scm.com/>

Usage:

Explain your team partner how to use git.

Task: Register on Github, Clone and Star

<https://github.com/PatrickChrist/CDTM-Deep-Learning-Drones>

- Lists ok for storing small amounts of one-dimensional data

```
>>> a = [1,3,5,7,9]
>>> print(a[2:4])
[5, 7]
>>> b = [[1, 3, 5, 7, 9], [2, 4, 6, 8, 10]]
>>> print(b[0])
[1, 3, 5, 7, 9]
>>> print(b[1][2:4])
[6, 8]
```

```
>>> a = [1,3,5,7,9]
>>> b = [3,5,6,7,9]
>>> c = a + b
>>> print c
[1, 3, 5, 7, 9, 3, 5, 6, 7, 9]
```

- But, can't use directly with arithmetical operators (+, -, *, /, ...)
- Need efficient arrays with arithmetic and better multidimensional tools

Important: Images and Videos are multidimensional lists/arrays

Changing from Python Array to Numpy Array

Numpy Array are computational more efficient and capable

```
>>> import numpy
>>> l = [[1, 2, 3], [3, 6, 9], [2, 4, 6]] # create a list
>>> a = numpy.array(l) # convert a list to an array
>>> print(a)
[[1 2 3]
 [3 6 9]
 [2 4 6]]
>>> a.shape
(3, 3)
>>> print(a.dtype) # get type of an array
int32
>>> print(a[0]) # this is just like a list of lists
[1 2 3]
>>> print(a[1, 2]) # arrays can be given comma separated indices
9
>>> print(a[1, 1:3]) # and slices
[6 9]
>>> print(a[:,1])
[2 6 4]
```

OpenCV is the most popular library for Image Processing and Computer Vision. You can manipulate, process and show Images and Videos with OpenCV

Usage:

```
import cv2
# Creates a numpy.ndarray object
img = cv2.imread("path to your file", cv2.IMREAD_COLOR)

# Creates a window (title = 'Your Image!') and displays img in it.
cv2.imshow('Your Image', img)

# Waits for any key to be pressed.
cv2.waitKey(0)
# Destroys all windows.
cv2.destroyAllWindows()
```

Example get the stream of your webcam

```
import cv2
cam = cv2.VideoCapture(0) # Get the stream of your webcam
running = True
while running: # get current frame of video
    running, frame = cam.read()
    if running:
        # cv2.rectangle(frame, (x1, y1), (x2, y2), (255,0,0), 2)
        cv2.imshow('frame', frame)
    if cv2.waitKey(1) & 0xFF == 27: # escape key pressed
        running = False
    else: # error reading frame
        print 'error reading video feed'

cam.release()
cv2.destroyAllWindows()
```

Modify or process your Frame with OpenCV.

```
import cv2
cam = cv2.VideoCapture(0) # Get the stream of your webcam
running = True
while running: # get current frame of video
    running, frame = cam.read()
    if running:
        # Paste here your modification
        cv2.rectangle(frame, (100, 100), (200, 200), (255,0,0), 2)
        font = cv2.FONT_HERSHEY_SIMPLEX
        cv2.putText(frame, 'Finally Done', (10, 500), font, 4, (255, 255, 255), 2, cv2.LINE_AA)
        cv2.imshow('frame', frame)
    if cv2.waitKey(1) & 0xFF == 27: # escape key pressed
        running = False
    else: # error reading frame
        print 'error reading video feed'

cam.release()
cv2.destroyAllWindows()
```

Installing Libardrone and PSdrone

For installing external libraries such as the libardrone open Terminal or CMD.
Change the folder:

e.g.

```
cd /home/patrickchrist/Downloads/python-ardrone
```

Execute the Setup.py with the following command
`python setup.py install`

Script will install the library to you Anaconda Python Distribution

You can access the library with

```
import libardrone.libardrone as libardrone
```

You can use psdrone directly.

Installing ffmpeg

Install ffmpeg to stream the camera stream

Conda install ffmpeg

```
PatrickMBA:~ patrickchrist$ conda install ffmpeg
Fetching package metadata: ....
Error: No packages found in current osx-64 channels matching: ffmpeg

You can search for this package on Binstar with

    binstar search -t conda ffmpeg
PatrickMBA:~ patrickchrist$ binstar search -t conda ffmpeg
Using binstar api site https://api.anaconda.org
Run 'binstar show <USER/PACKAGE>' to get more details:
Packages:
```

Name	Version	Package Types	Platforms
asmeurer/ffmpeg	2.1.0	conda	linux-64
		: None	
auto/easy-thumbnails-ffmpeg	0.1.1	conda	linux-32
		: Video thumbnails source generator.	
bgreen-litl/ffmpeg	2.5.3	conda	linux-64
community/ffmpeg	2.2.4	conda	linux-64, osx-64
		: http://www.ffmpeg.org/	
derickl/ffmpeg	2.5.3	conda	osx-64
erik/ffmpeg	2.2.4	conda	osx-64
		: None	
joemarct/ffmpeg	2.2.4	conda	linux-64
		: ffmpeg with libmp3lame enabled for use in audio file conversions to mp3	
litl-rnd/ffmpeg	2.5.3	conda	linux-64, osx-64
mutirri/ffmpeg	2.1.0	conda	linux-64
		: http://www.ffmpeg.org/	
ver228/ffmpeg	2.2.4	conda	osx-64

```
Found 10 packages
PatrickMBA:~ patrickchrist$
```


Configurable Enviroments for Development und Production

Every machine and environment is different. Code may not run on your teams computer.

Solution: Sharing the same environment using Docker. Even share environment and configurations among others.

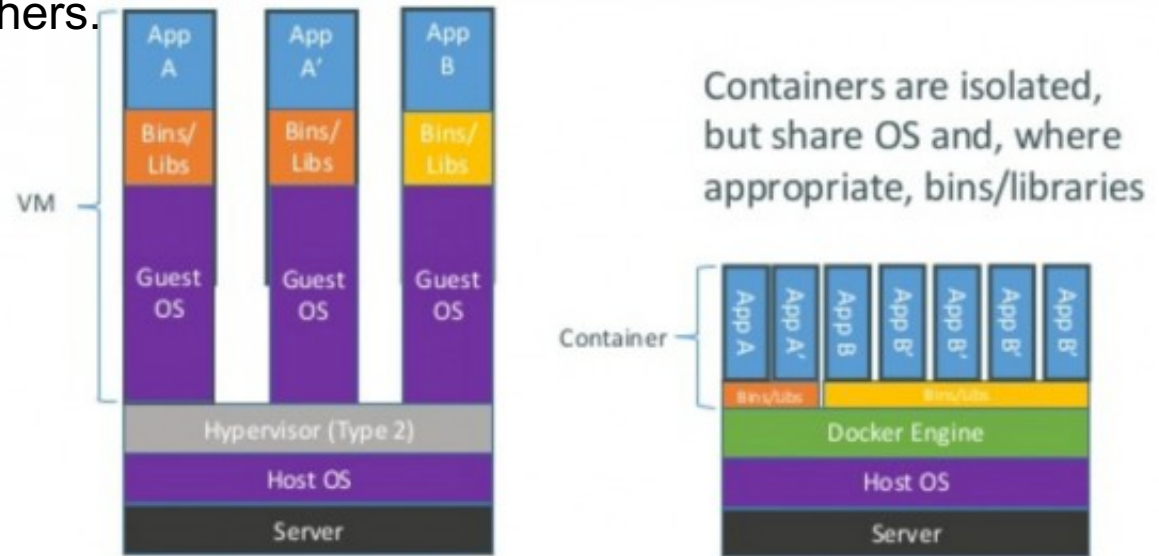
Installation:

<https://www.docker.com/>

Usage:

For building a Docker container
from a Dockerfile
docker build
Running a container
docker run

Look into <https://github.com/PatrickChrist/CDTM-Deep-Learning-Drones> for more infos



Start with Coding Challenge 1

Troubleshooting



No connection to the drone

`lsof -i :5555`

Kill pid

Restart drone