Data Science for Digital Forensics & Incident Response

ODSC EAST

BOSTON I APRIL 19-21

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Jess Garcia

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Founder and CEO of One eSecurity
25 years of experience

Global DFIR company
15 years

Leader of the DS4N6 project
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Senior Instructor at the SANS Institute
~ 20 years

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David Contreras

Senior Forensic Analyst
~ 7 years of experience

Product Owner at One eSecurity

DS4N6 Project Forensicator
www.ds4n6.io

DFIR


SANS DFIR
DIGITAL FORENSICS & INCIDENT RESPONSE
SANSForensics
dfir.to/DFIRCast
@SANSForensics
OPERATING SYSTEM & DEVICE IN-DEPTH
FOR308 Digital Forensics Essentials
FOR498 Battlefield Forensics & Data Acquisition GBFA
FOR500 Windows Forensic Analysis GCFE
FOR518 Mac and iOS Forensic Analysis & Incident Response
FOR585 Smartphone Forensic Analysis In-Depth GASF
INCIDENT RESPONSE & THREAT HUNTING
FOR508 Advanced Incident Response, Threat Hunting, & Digital Forensics GCFA
FOR572 Advanced Network Forensics: Threat Hunting, Analysis, & Incident Response GNFA
FOR578 Cyber Threat Intelligence GCTI
FOR610 REM: Malware Analysis Tools & Techniques GREM
SEC504 Hacker Tools, Techniques, Exploits, & Incident Handling GCIH
DFIR

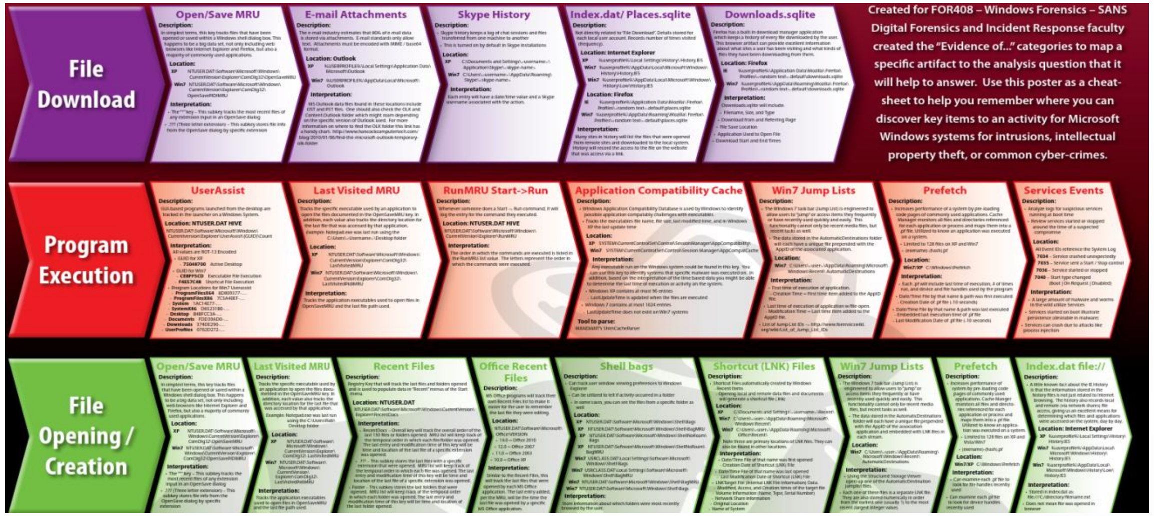
Forensic Investigation

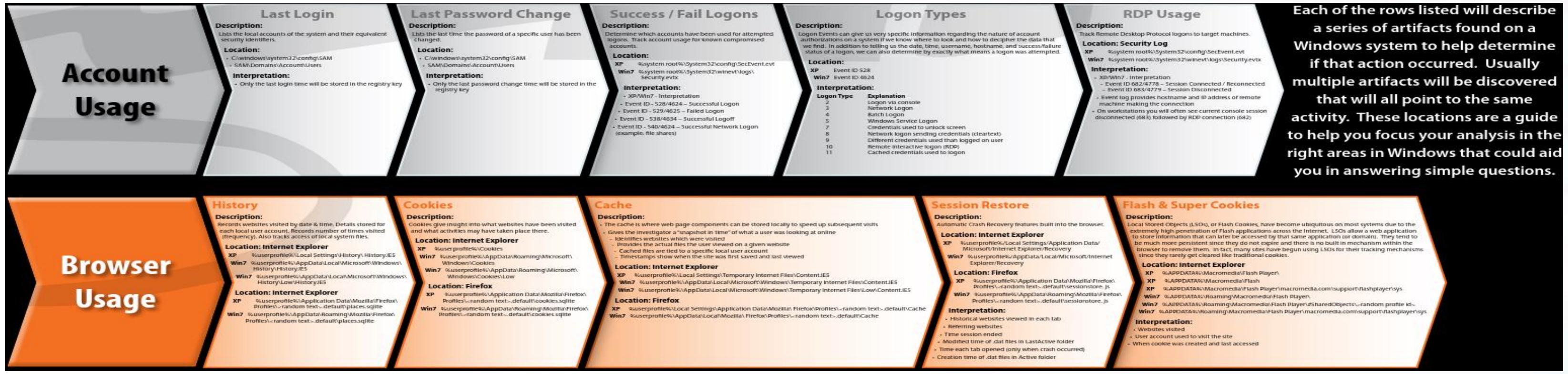
Answer the 5Ws

Who
What
When
Where
Why

Hypothesis → Investigation Lines → Evidence Acquisition → Artifacts Analysis → Check the Most Probable Hypothesis → Reports

Windows Artifacts Categories





SANS

Download the SANS poster here: **https://www.sans.org/posters/windows-forensic-analysis/**

Windows Forensic Tools

plaso

- Parse logs and artifacts
- Correlated supertimeline

https://github.com/log2timeline/plaso

fls & mactime

- FLS: lists files and directories
- Mactime: timeline based on FLS

https://github.com/sleuthkit/sleuthkit

SANS Faculty DFIR Tools

SIFT WORKSTATION

Eric Zimmerman's TOOLS

DS4N6

Find more free SANS tools:
https://www.sans.org/img/free-faculty-tools.pdf

Other Open Source Tools

Velociraptor

GRR RAPID RESPONSE

timesketch Digital Forensics Timeline Analysis

VOLATILITY

Comercial Tools

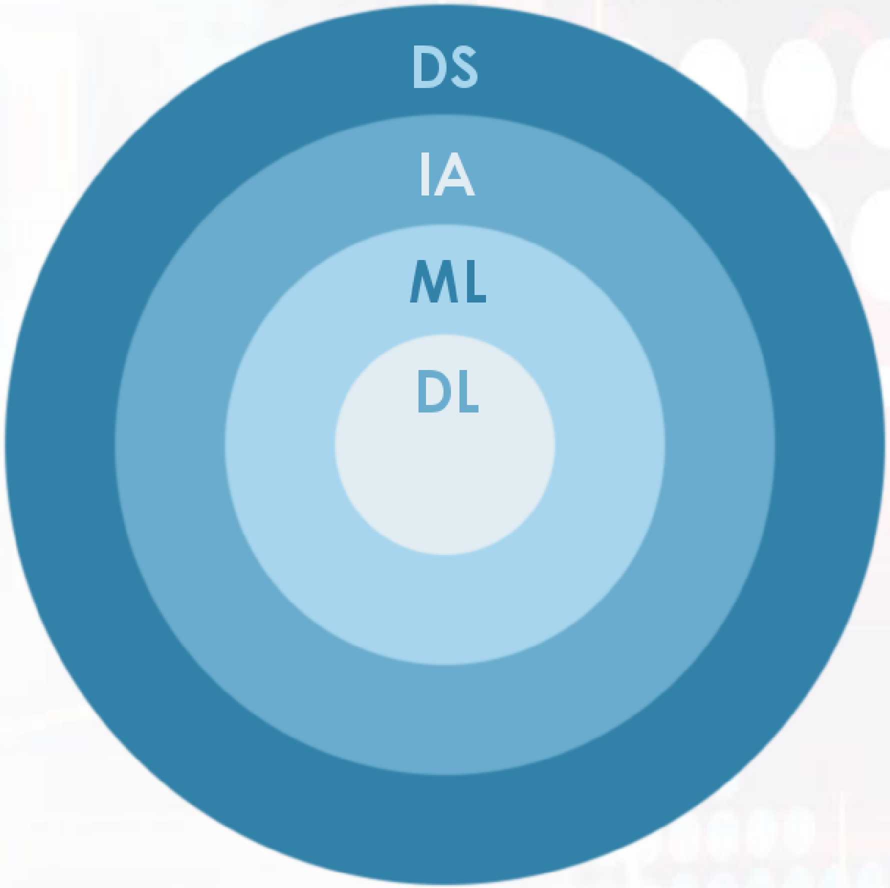
MAGNET FORENSICS

EnCase Forensic

ACCESSDATA ForensicToolkit (FTK)

Intro to Data Science

- Analyze faster
- Scalable
- Flexible
- Visualization

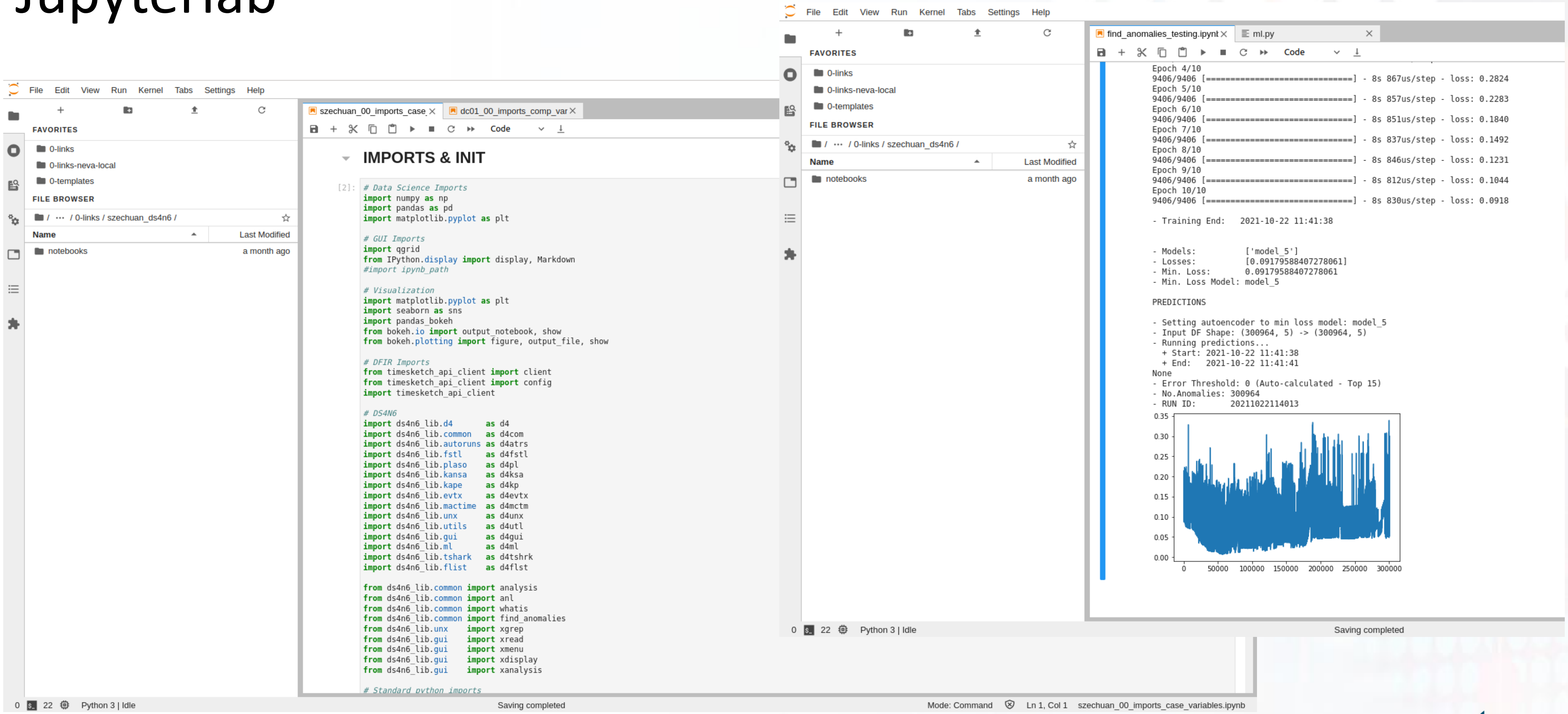


Used in Finance, Medicine, Marketing, Retail...

And many more!

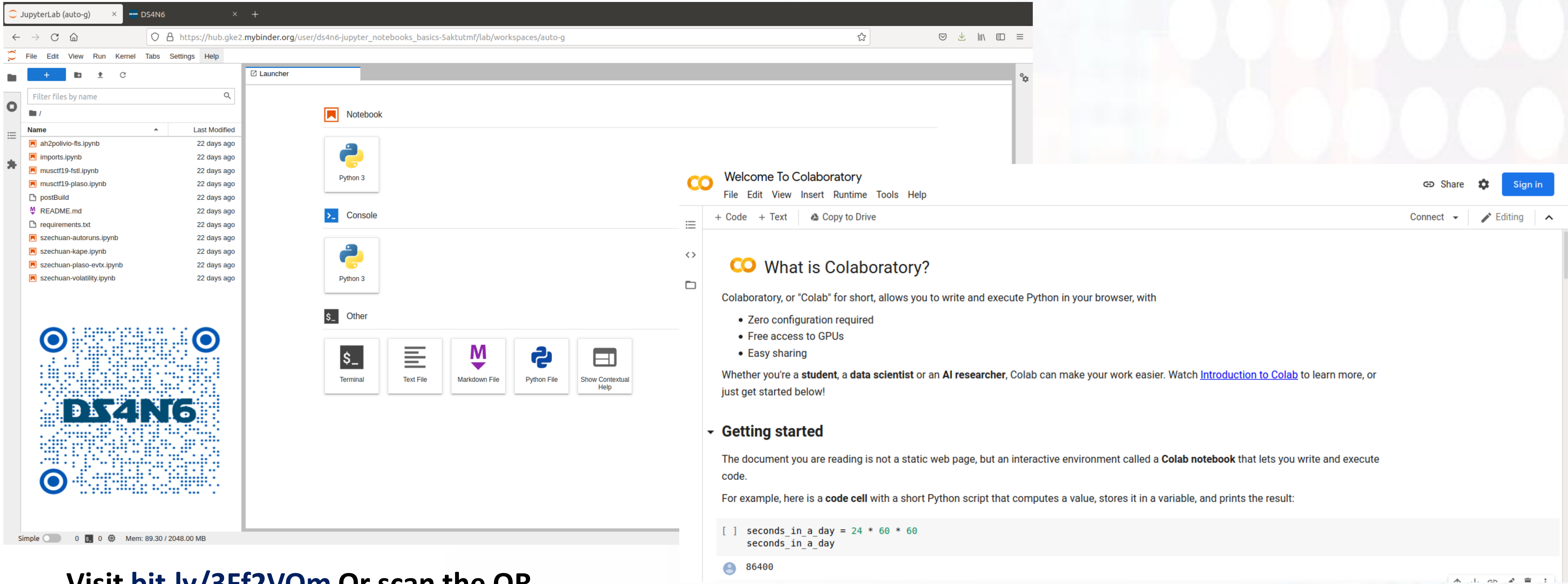
So... What about using it on DFIR?

Jupyterlab



File Edit View Run Kernel Tabs Settings Help
FAVORITES
0-links
0-links-neva-local
0-templates
FILE BROWSER
/ ··· / 0-links / szechuan_ds4n6 /
Name
Last Modified
notebooks
a month ago
szechuan_00_imports_case
dc01_00_imports_comp_var
Code
IMPORTS & INIT
[2]:
# Data Science Imports
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
# GUI Imports
import qgrid
from IPython.display import display, Markdown
#import ipynb_path
# Visualization
import matplotlib.pyplot as plt
import seaborn as sns
import pandas_bokeh
from bokeh.io import output_notebook, show
from bokeh.plotting import figure, output_file, show
# DFIR Imports
from timesketch_api_client import client
from timesketch_api_client import config
import timesketch_api_client
# DS4N6
import ds4n6_lib.d4 as d4
import ds4n6_lib.common as d4com
import ds4n6_lib.autoruns as d4atrs
import ds4n6_lib.fstl as d4fstl
import ds4n6_lib.plaso as d4pl
import ds4n6_lib.kansa as d4ksa
import ds4n6_lib.kape as d4kp
import ds4n6_lib.evtx as d4evtx
import ds4n6_lib.mactime as d4mctm
import ds4n6_lib.unx as d4unx
import ds4n6_lib.utils as d4utl
import ds4n6_lib.gui as d4gui
import ds4n6_lib.ml as d4ml
import ds4n6_lib.tshark as d4tshrk
import ds4n6_lib.flist as d4flst
from ds4n6_lib.common import analysis
from ds4n6_lib.common import anl
from ds4n6_lib.common import whatis
from ds4n6_lib.common import find_anomalies
from ds4n6_lib.unx import xgrep
from ds4n6_lib.gui import xread
from ds4n6_lib.gui import xmenu
from ds4n6_lib.gui import xdisplay
from ds4n6_lib.gui import xanalysis
# Standard python imports
0 22 Python 3 | Idle
Saving completed
Mode: Command
Ln 1, Col 1
szechuan_00_imports_case_variables.ipynb
find_anomalies_testing.ipynb
ml.py
Epoch 4/10
9406/9406 [==============================] - 8s 867us/step - loss: 0.2824
Epoch 5/10
9406/9406 [==============================] - 8s 857us/step - loss: 0.2283
Epoch 6/10
9406/9406 [==============================] - 8s 851us/step - loss: 0.1840
Epoch 7/10
9406/9406 [==============================] - 8s 837us/step - loss: 0.1492
Epoch 8/10
9406/9406 [==============================] - 8s 846us/step - loss: 0.1231
Epoch 9/10
9406/9406 [==============================] - 8s 812us/step - loss: 0.1044
Epoch 10/10
9406/9406 [==============================] - 8s 830us/step - loss: 0.0918
- Training End: 2021-10-22 11:41:38
- Models: ['model_5']
- Losses: [0.09179588407278061]
- Min. Loss: 0.09179588407278061
- Min. Loss Model: model_5
PREDICTIONS
- Setting autoencoder to min loss model: model_5
- Input DF Shape: (300964, 5) -> (300964, 5)
- Running predictions...
+ Start: 2021-10-22 11:41:38
+ End: 2021-10-22 11:41:41
None
- Error Threshold: 0 (Auto-calculated - Top 15)
- No.Anomalies: 300964
- RUN ID: 20211022114013
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50000
100000
150000
200000
250000
300000

Doing DS on the Cloud: binder & colab



Visit bit.ly/3Ff2VOm Or scan the QR code to test the DS4N6 repository

Data Structures: Dataframes

```
df.head()
```

Timestamp	D4_DataType_	D4_Orchestrator_	D4_Tool_	D4_Plugin_	D4_Hostname_	EventRecordID	EventID_	evtxFileName_	ProviderName	ProviderGuid	System > EventID	Version	Level	Task	Opcode	Keywords	ProcessID	Threa
2020-09-18 05:41:16	evtx	NaN	plaso	windows_evtx_record	NaT	16	4624	Security.evtx	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4624	2	0	12544	0	0x8020000000000000	660	6
2020-09-18 05:41:17	evtx	NaN	plaso	windows_evtx_record	NaT	47	4624	Security.evtx	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4624	2	0	12544	0	0x8020000000000000	660	7
2020-09-18 05:41:17	evtx	NaN	plaso	windows_evtx_record	NaT	50	4624	Security.evtx	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4624	2	0	12544	0	0x8020000000000000	660	7
2020-09-18 05:41:18	evtx	NaN	plaso	windows_evtx_record	NaT	51	4624	Security.evtx	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4624	2	0	12544	0	0x8020000000000000	660	7
2020-09-18 05:41:18	evtx	NaN	plaso	windows_evtx_record	NaT	54	4624	Security.evtx	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4624	2	0	12544	0	0x8020000000000000	660	7

Data Structures: Dictionaries

```
pldfs_srv.keys()
```

```
dict_keys(['windows_registry_installation', 'windows_registry_userassist', 'windows_lnk_link', 'fs_stat', 'olecf_item', 'pe_compilation_compilation_time', 'windows_registry_key_value',
'windows_shell_item_file_entry', 'windows_distributed_link_tracking_creation', 'task_scheduler_task_cache_entry', 'windows_evtx_record', 'windows_registry_network', 'fs_ntfs_usn_change
', 'setupapi_log_line', 'windows_registry_run', 'windows_registry_msie_zone_settings', 'windows_registry_mount_points2', 'windows_registry_bagmru', 'windows_registry_boot_execute', 'win
dows_registry_timezone', 'windows_registry_service', 'windows_registry_winlogon', 'windows_registry_sam_users', 'olecf_dest_list_entry', 'msie_webcache_container', 'windows_registry_mru
list', 'msie_webcache_containers', 'windows_registry_shutdown', 'windows_registry_usb', 'windows_registry_typedurls', 'windows_registry_mrulistex', 'windows_metadata_deleted_item', 'win
dows_registry_mstsc_connection', 'windows_registry_mstsc_mru', 'pe_import_import_time'])
```

```
pldfs_srv['task_scheduler_task_cache_entry']['Timestamp_'].iloc[0]
```

```
Timestamp('2013-08-10 14:48:44.446487')
```

```
pldfs_srv['task_scheduler_task_cache_entry'][['Timestamp_','task_name']].iloc[0:10]
```

	Timestamp_	task_name
0	2013-08-10 14:48:44.446487	Plug and Play Cleanup
1	2013-08-16 14:48:44.477735	Sqm-Tasks
2	2013-08-16 14:48:44.649610	SynchronizeTimeZone
3	2013-08-17 14:48:44.758985	KernelCeipTask
4	2013-08-18 14:48:43.837110	SmartScreenSpecific
5	2013-08-18 14:48:44.743361	AnalyzeSystem
6	2013-08-18 14:48:44.758985	UsbCeip
7	2013-08-19 14:48:44.087110	SQM data sender
8	2013-08-19 14:48:44.149611	SynchronizeTime
9	2013-08-19 14:48:44.321488	Metadata Refresh

```
[113]: xmenu(pldfs_srv)
```

DataFrame visualization menu:

Select DataFrame: Select DataFrame

Selected dataframe

[113]: <ds4n6_lib.gui.

- Select DataFrame
- fs_ntfs_usn_change
- fs_stat
- msie_webcache_container
- msie_webcache_containers
- olecf_dest_list_entry
- olecf_item
- pe_compilation_compilation_time
- pe_import_import_time
- setupapi_log_line
- task_scheduler_task_cache_entry
- windows_distributed_link_tracking_creation
- windows_evtx_record
- windows_lnk_link
- windows_metadata_deleted_item
- windows_registry_bagmru
- windows_registry_boot_execute
- windows_registry_installation
- windows_registry_key_value
- windows_registry_mount_points2

Pandas

- Most used DS library in Python
- Other commonly used are:
  - Numpy
  - SciPy
  - Scikit-Learn
  - Keras
  - Matplotlib

```
df.loc["2020-09-18 05:41:16":"2020-09-18 05:41:18", ["TargetUserSid", "Computer"]]
```

Timestamp	TargetUserSid	Computer
2020-09-18 05:41:16	S-1-5-18	WIN-2IH1TBB9I4Q
2020-09-18 05:41:17	S-1-5-18	WIN-2IH1TBB9I4Q
2020-09-18 05:41:17	S-1-5-96-0-0	WIN-2IH1TBB9I4Q
2020-09-18 05:41:18	S-1-5-20	WIN-2IH1TBB9I4Q
2020-09-18 05:41:18	S-1-5-96-0-1	WIN-2IH1TBB9I4Q

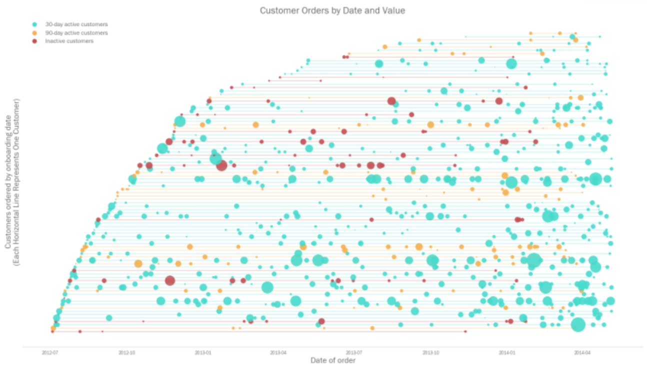
```
df['Computer'].iloc[0]
```

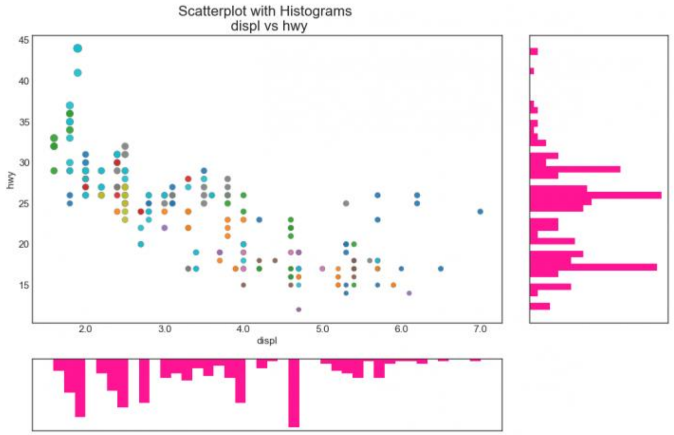
```
'WIN-2IH1TBB9I4Q'
```

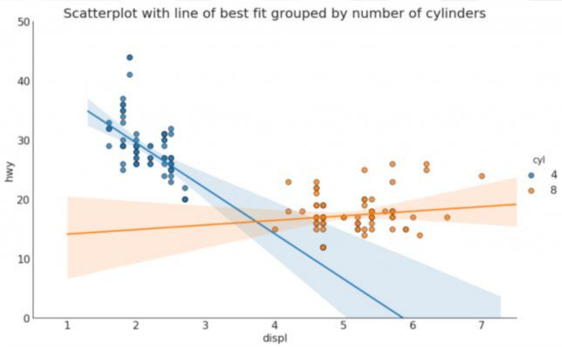
```
df.query('TargetUserSid == "S-1-5-18"').head()
```

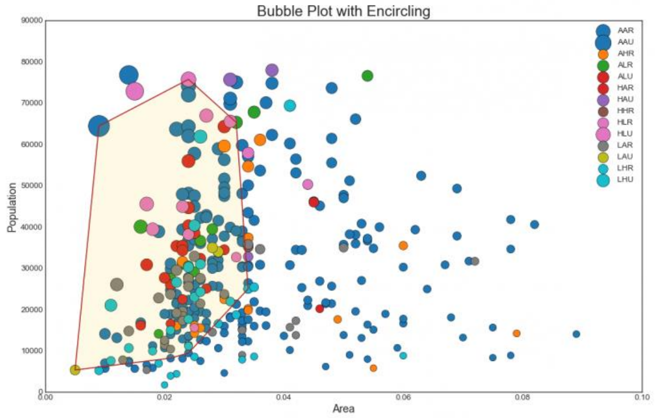
SubjectUserName	SubjectDomainName	SubjectLogonId	TargetUserSid	TargetUserName	TargetDomainName	TargetLogonId	@CorrelationActivityID	LogonType	LogonProcessName
-	-	0x0000000000000000	S-1-5-18	SYSTEM	NT AUTHORITY	0x00000000000003e7	<NA>	0	-
MINWINPC$	<NA>	0x00000000000003e7	S-1-5-18	SYSTEM	NT AUTHORITY	0x00000000000003e7	{4B73C7C8-8D7E-0001-15CA-734B7E8DD601}	5	Advapi
MINWINPC$	<NA>	0x00000000000003e7	S-1-5-18	SYSTEM	NT AUTHORITY	0x00000000000003e7	{4B73C7C8-8D7E-0001-15CA-734B7E8DD601}	5	Advapi
MINWINPC$	<NA>	0x00000000000003e7	S-1-5-18	SYSTEM	NT AUTHORITY	0x00000000000003e7	{4B73C7C8-8D7E-0001-15CA-734B7E8DD601}	5	Advapi
MINWINPC$	<NA>	0x00000000000003e7	S-1-5-18	SYSTEM	NT AUTHORITY	0x00000000000003e7	{4B73C7C8-8D7E-0001-15CA-734B7E8DD601}	5	Advapi

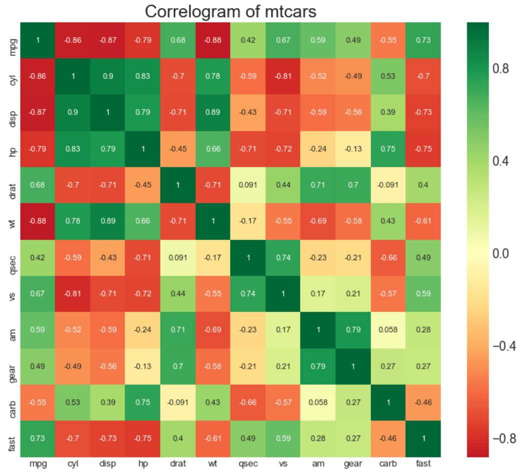
Matplotlib











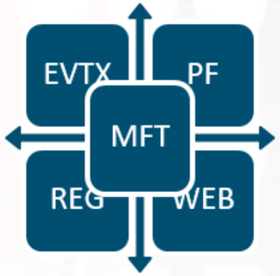
Other visualization libraries:
- seaborn
- plotly
- bokeh
- NetworkX
- altair

DS4N6. The Road So Far

DS4N6

CHRYSALIS

D4ML



HAM

ADAM

ADversAry eMulator

DAISY

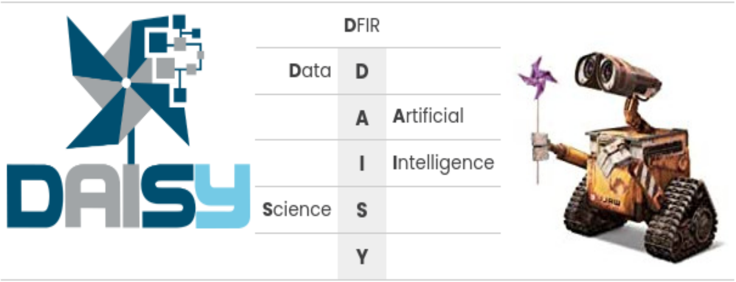
DAISY VM

CHRYSALIS

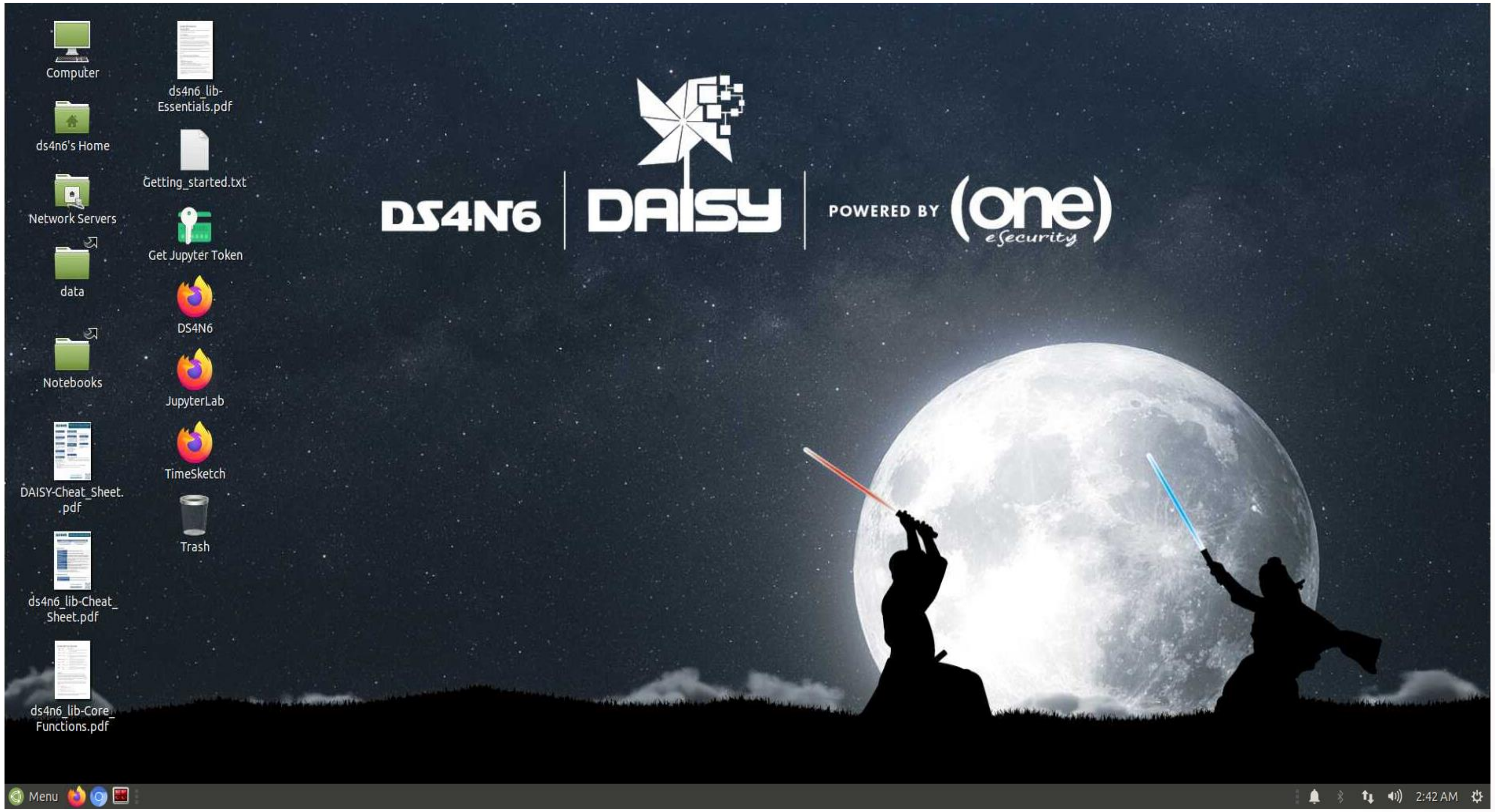
Function	Usage	Type	Description
whatis()	whatis(obj)	CLI	Identifies the forensic data type of an object (DataFrame -df- or DataFrame Collection -dfs-)
xread()	xread(options)	GUI	Reads tool output data (e.g. plaso output) and stores it in a df/dfs
xmenu()	xmenu(obj)	GUI	Used to easily select a dataframe from dfs, or a column from a df, displaying the selected data and allowing manual (Excel-like) analysis on it
xanalysis()	xanalysis(obj, options)	GUI	Displays a menu with the advanced analysis functions available for the data type (i.e. forensic artifact) given
xdisplay()	xdisplay()	GUI	Used to select the display settings for the dataframes that will be displayed (max. rows, max. columns, etc.)
simple()	df.simple(options)	CLI	Simplifies forensic output (df) showing only the most interesting columns for analysis.
xgrep()	xgrep(obj, options)	CLI	UNIX-like grep for the DataFrame world. Allows the user to search for a regular expression in a DF column or full DF

For more information, visit https://www.ds4n6.io/tools/chrysalis.html

DAISY



www.ds4n6.io/daisy



The Case: The Stolen Szechuan Sauce

Read the whole case here:
https://dfirmadness.com/the-stolen-szechuan-sauce/

- The FBI contacts us: our secret Szechuan Sauce recipe is on the Dark Web
- The recipe was on the Domain Controller. There are more interesting files in the share
- We receive the Domain Controller disk, an affected desktop computer disk and memory and a pcap with the network traffic of the attack date
- The computers were in Colorado (UTC -6)

We need to find out WHO, WHEN and HOW did it!

The Case: The Stolen Szechuan Sauce Case

Devices

Desktop

DC

Desktop

Network

Tools

Parsed Artifacts

EVTX

MFT

010101
011010
011100

DS4N6

CHRYSALIS

Other Libraries

Read Data

- xread()

- pd.read_json()
- pd.read_csv()

Analyze Data

- xmenu()
- xanalysis()
- xgrep ()

- Pandas
- Numpy
- Matplotlib

DS4N6

All the details about this Workshop:

ds4n6.io/odsceast22

HANDS
ON

DS4N6

ds4n6.io

@ds4n6_io

DS4N6

(one) eSecurity

one-esecurity.com

One_eSecurity