01_QuickStart

May 8, 2020

1 asammdf Quick Start & Reference.

A one page introduction to `asammdf` for Measurement Data Format (MDF) data analysis.

For engineers wanting to drink from a fire hose or already experienced with Python data analysis.

Replaces some or all of the functionality of these tools with a fullly opensource, free, analysis stack:

- AVL CONCERTO 5™
- MathWorks® Vehicle Network Toolbox™
- ETAS Measure Data Analyzer (MDA V8)
- National Instruments DIAdem
- Vector CANape & vSignalyzer

[1]:
```
%matplotlib inline
import asammdf
import seaborn as sns
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl
```

2 Create MDF File

- Create a [0, 10)s time vector with 100Hz sampling rate (10 ms raster)
- Create a simple MDF file with two channels:
  - "EngineSpeedCmd" 0.5 Hz sinewave with amplitude=10, & dc offset=600.
  - "EngineSpeed" 0.5 Hz sinewave with amplitude=5, phi=pi/8, & dc offset=600.

2.0.1 Generate Engine Speed signals

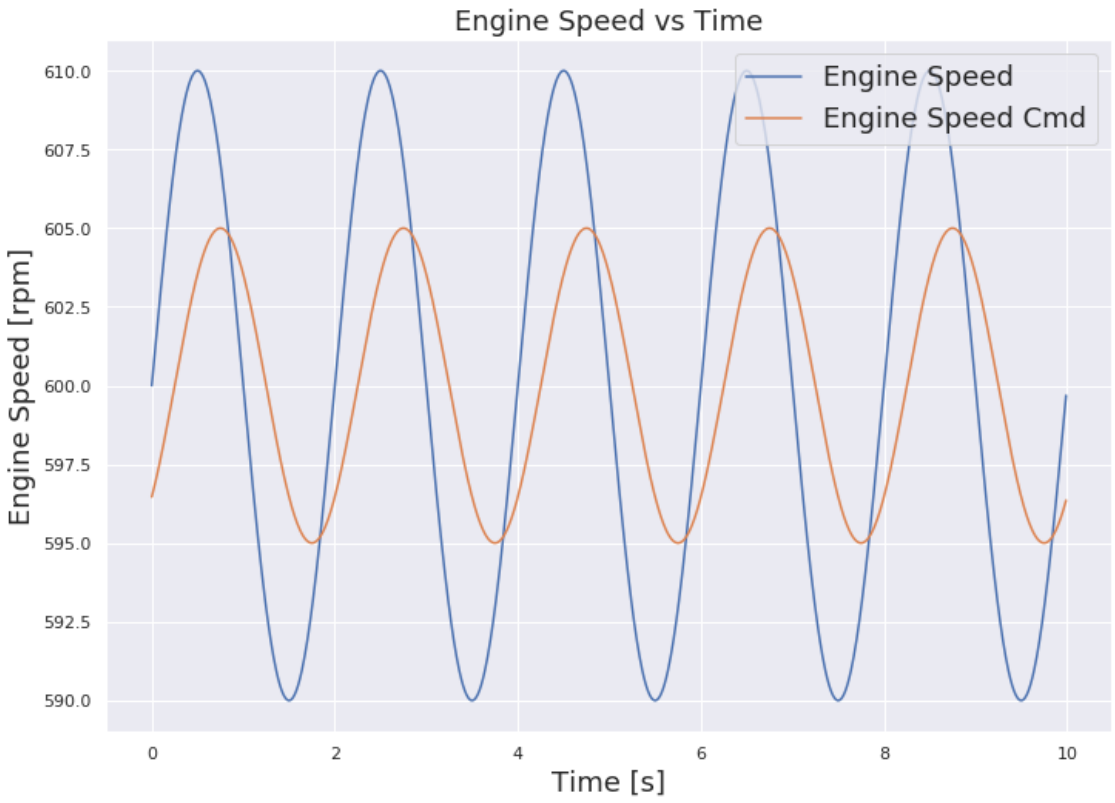
[2]:
```
# Time Vector
t0=0  # [s]
tf=10 # [s]
f_sample = 100 # [Hz]
dT = 1/f_sample # [s]
```

```
timestamps = np.arange(t0, tf, dT)
# Engine Speed
A = 10
f_signal = 0.5
dc_offset = 600
engine_speed_cmd = A*np.sin(2*np.pi*f_signal*timestamps)+dc_offset
engine_speed = A*0.5*np.sin(2*np.pi*f_signal*(timestamps-0.25))+dc_offset
```

2.0.2 Plot engine speed signal.

Direct plotting with matplotlib & seaborn.

[3]:
```
sns.set(
    rc={
        "figure.figsize": (11.69, 8.27), # A4 paper size.
        "figure.facecolor": "w",
        "figure.edgecolor": "k",
        "axes.labelsize": 18,
        "axes.titlesize": 18,
        "legend.fontsize": 18,
    }
)
plt.plot(timestamps, engine_speed_cmd, timestamps, engine_speed)
plt.xlabel("Time [s]")
plt.ylabel("Engine Speed [rpm]")
plt.title("Engine Speed vs Time")
plt.legend(
    {"Engine Speed Cmd", "Engine Speed"},
    loc='upper right'
);
plt.savefig(
    "EngineSpeedPlot.png",
    transparent=False,
    bbox_inches='tight'
);
```



2.1 Generate `asammdf.Signal` & save `MDF` file.

Convert the `numpy` arrays into `asammdf.Signals` & save.

2.1.1 `Signal` Object

[4]:
```
asammdf.Signal?
```

[5]:
```
engine_speed_cmd_sig = asammdf.Signal(
    samples=engine_speed_cmd,
    timestamps=timestamps,
    unit='rpm',
    name='EngineSpeedCmd',
    conversion=None,
    comment='Swept sine plant identification, X(t)',
    raw=True,
    master_metadata=None,
    display_name='Engine Speed Command',
    attachment=(),
    source=None,
```

```
    bit_count=None,
    stream_sync=False,
    invalidation_bits=None,
    encoding=None,
)
engine_speed_sig = asammdf.Signal(
    samples=engine_speed,
    timestamps=timestamps,
    unit='rpm',
    name='EngineSpeed',
    conversion=None,
    comment='Swept sine plant identification, Y(t)',
    raw=True,
    master_metadata=None,
    display_name='Engine Speed',
    attachment=(),
    source=None,
    bit_count=None,
    stream_sync=False,
    invalidation_bits=None,
    encoding=None,
)
signals = [
    engine_speed_cmd_sig,
    engine_speed_sig,
]
```

2.1.2 `MDF` Object

[6]:
```
asammdf.MDF?
```

Write the file directly in and out of a context manager.

[7]:
```
with asammdf.MDF(version="4.10") as mdf:
    mdf.append(signals, "Created by Python")
    # save new file
    mdf.save("quickstart_example.mf4", overwrite=True)
```

[8]:
```
mdf = asammdf.MDF(version="4.10")
mdf.append(signals, "Created by Python")
    # save new file
mdf.save("quickstart_example.mf4", overwrite=True)
mdf.close()
```

`fsspec` example.

> Filesystem Spec is a project to unify various projects and classes to work with remote filesystems and file-system-like abstractions using a standard pythonic interface. - https://filesystem-spec.readthedocs.io/en/latest/

This allows reading & writing directly from S3, Azure Datalakes, Google Storage, and others.

[9]:
```
import fsspec
with fsspec.open("quickstart_example_fs.mf4", "wb") as fid:
    with asammdf.MDF(version="4.10") as mdf:
        mdf.append(signals, "Created by Python")
        # save new file
        mdf.save(fid, overwrite=True)
```

3 Read & Analyze MDF

[10]:
```
%matplotlib inline
import asammdf
import seaborn as sns
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl
```

Open a file with and without `fsspec`.

[11]:
```
with fsspec.open("quickstart_example_fs.mf4", "rb") as fid:
    mdf = asammdf.MDF(fid)
```

[12]:
```
mdf = asammdf.MDF("quickstart_example.mf4")
```

List the channels in the database.

[13]:
```
mdf.channels_db
```

[13]:
```
{'time': ((0, 0),), 'EngineSpeedCmd': ((0, 1),), 'EngineSpeed': ((0, 2),)}
```

[14]:
```
mdf.get_channel_unit("EngineSpeedCmd")
```

[14]:
```
'rpm'
```

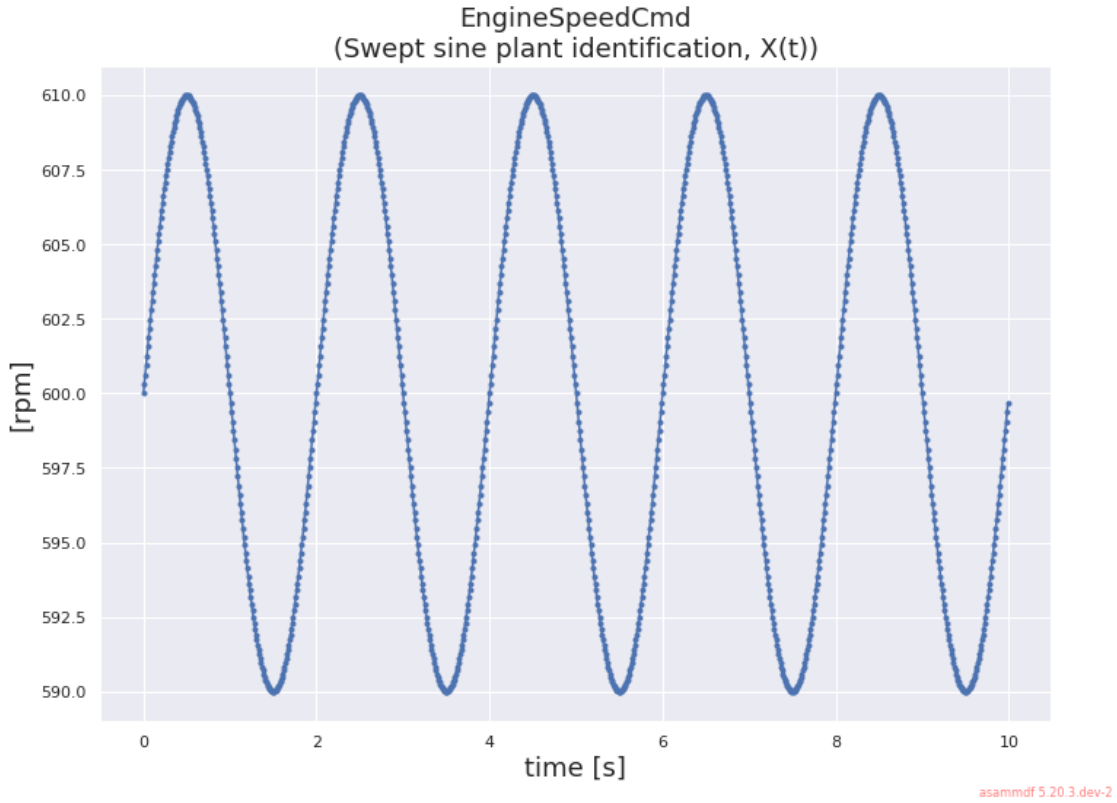
[15]:
```
mdf.get_channel_comment("EngineSpeedCmd")
```

[15]:
```
'Swept sine plant identification, X(t)'
```

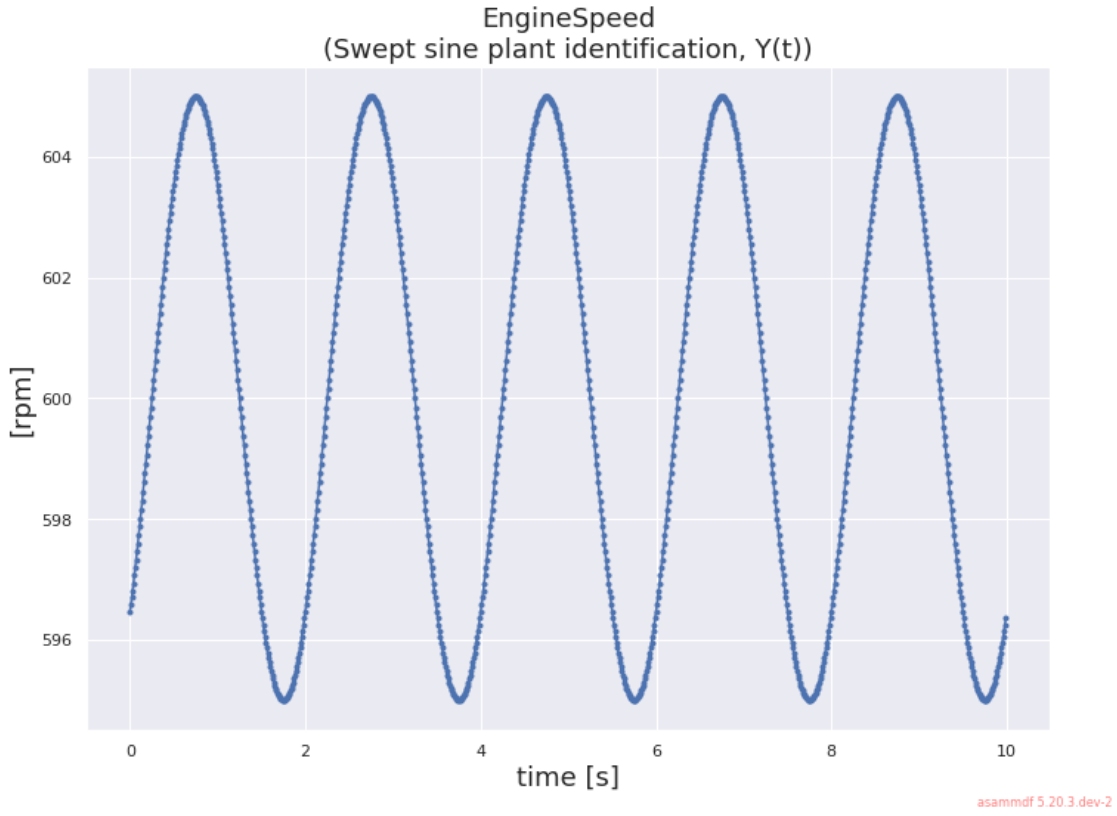
[16]:
```
sns.set(
    rc={
        "figure.figsize": (11.69, 8.27), # A4 paper size.
```

```
        "figure.facecolor": "w",
        "figure.edgecolor": "k",
        "axes.labelsize": 18,
        "axes.titlesize": 18,
        "legend.fontsize": 18,
    }
)
for channel in mdf.iter_channels():
    channel.plot()
```

```
WARNING:root:Signal plotting requires pyqtgraph or matplotlib
```




```
WARNING:root:Signal plotting requires pyqtgraph or matplotlib
```



3.0.1 Export to pandas.DataFrame:

[17]:
```
df = mdf.to_dataframe()
```

[18]:
```
df.describe()
```

[18]:

	EngineSpeedCmd	EngineSpeed
count	1000.000000	1000.000000
mean	600.000000	600.000000
std	7.074606	3.537303
min	590.000000	595.000000
25%	592.928932	596.464466
50%	600.000000	600.000000
75%	607.071068	603.535534
max	610.000000	605.000000

[19]:
```
df
```

[19]:

timestamps	EngineSpeedCmd	EngineSpeed

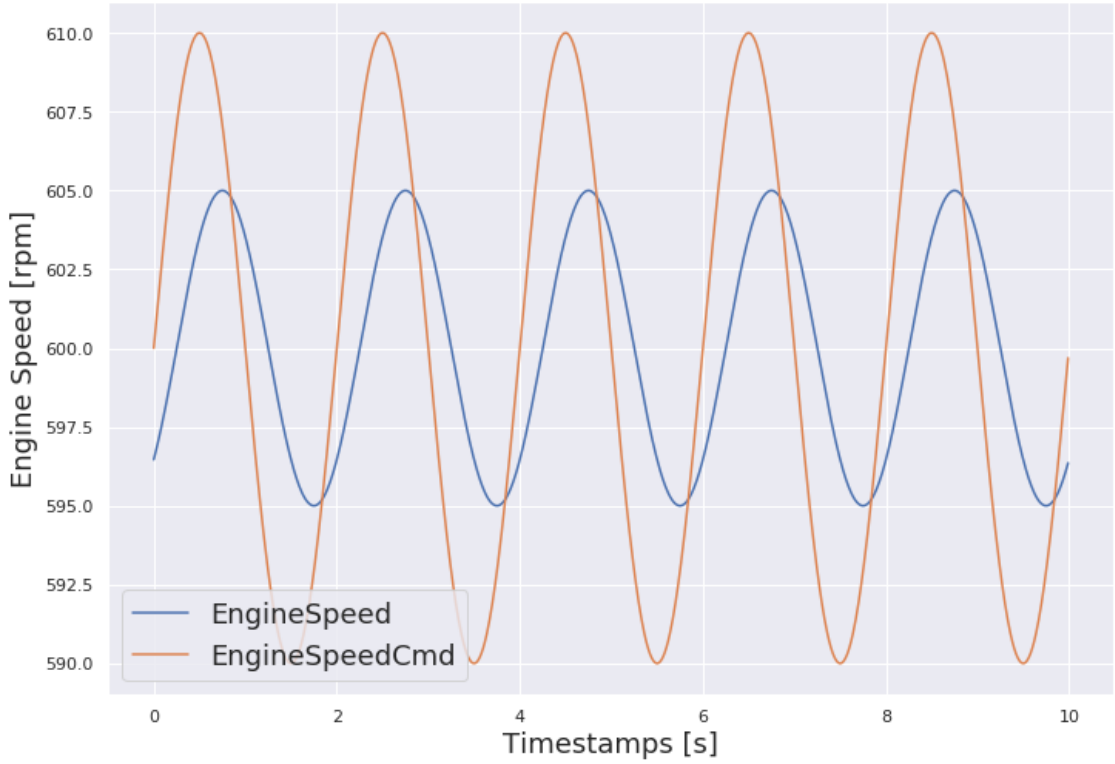
```
0.00            600.000000   596.464466
0.01            600.314108   596.577264
0.02            600.627905   596.693441
0.03            600.941083   596.812880
0.04            601.253332   596.935465
...                    ...          ...
9.95            598.435655   595.954915
9.96            598.746668   596.049225
9.97            599.058917   596.147434
9.98            599.372095   596.249445
9.99            599.685892   596.355157

[1000 rows x 2 columns]
```

Reset Index

Convert the 'timestamps' index back into a column for direct plotting from `pandas`.

[20]:
```
# Convert the
df.reset_index(inplace=True)
```

[21]:
```
df.plot(x="timestamps", y={"EngineSpeed", "EngineSpeedCmd"})
plt.ylabel("Engine Speed [rpm]")
plt.xlabel("Timestamps [s]");
```



4 Export

asammdf natively supports:

- csv
- hdf5
- mat
- parquet

[22]:
```
mdf.export?
```

[23]:
```
mdf.export(fmt="csv")
!ls *.csv
```

```
quickstart_example.ChannelGroup_0.csv
```

[24]:
```
pd.read_csv("quickstart_example.ChannelGroup_0.csv")
```

[24]:

	timestamps	EngineSpeedCmd	EngineSpeed
0	0.00	600.000000	596.464466
1	0.01	600.314108	596.577264
2	0.02	600.627905	596.693441
3	0.03	600.941083	596.812880
4	0.04	601.253332	596.935465
..	…	…	…
995	9.95	598.435655	595.954915
996	9.96	598.746668	596.049225
997	9.97	599.058917	596.147434
998	9.98	599.372095	596.249445
999	9.99	599.685892	596.355157

[1000 rows x 3 columns]

[25]:
```
mdf.export(fmt="hdf5")
!ls *.hdf
```

```
quickstart_example.hdf
```

[26]:
```
mdf.export(fmt="mat")
!ls *.mat
```

```
quickstart_example.mat
```