PythonTutorial

December 9, 2021

[1]:
```
import urllib
import pandas as pd
import numpy as np
from astropy import coordinates as coord
from astropy import units as u
```

[2]:
```
#loading as a pandas dataframe:
sweetCat_table_url = "http://sweetcat.iastro.pt/catalog/SWEETCAT_Dataframe.csv"
dtype_SW = dtype={'gaia_dr2':'int64','gaia_dr3':'int64'}
SC = pd.read_csv(urllib.request.urlopen(sweetCat_table_url), dtype=dtype_SW)
print(SC.columns)
```

```
Index(['Name', 'hd', 'RA', 'DEC', 'Vmag', 'eVmag', 'PlxFlag', 'Teff', 'eTeff',
       'Logg', 'eLogg', 'Vt', 'eVt', '[Fe/H]', 'e[Fe/H]', 'Reference', 'Link',
       'SWFlag', 'Update', 'Comment', 'Database', 'gaia_dr2', 'gaia_dr3',
       'Plx', 'ePlx', 'Gmag', 'eGmag', 'RPmag', 'eRPmag', 'BPmag', 'eBPmag',
       'FG', 'eFG', 'G_flux_std_n', 'Logg_gaia', 'eLogg_gaia', 'Mass_t',
       'eMass_t', 'Radius_t', 'eRadius_t', 'spec_base', 'Distance', 'RA_EU',
       'DEC_EU', 'RA_NASA', 'DEC_NASA', 'Distance_b', 'eDistance_b'],
      dtype='object')
```

[3]:
```
#loading as a astropy Table:
from astropy.table import Table
from astropy.io.ascii import convert_numpy
sweetCat_table_url = "https://sweetcat.iastro.pt/catalog/SWEETCAT_Dataframe.csv"
converters={'gaia_dr2': [convert_numpy(np.int64)],
            'gaia_dr3': [convert_numpy(np.int64)] }
T = Table.read(sweetCat_table_url, encoding='UTF-8',
           format='csv', converters=converters)
print(T.colnames)
```

```
['col0', 'Name', 'hd', 'RA', 'DEC', 'Vmag', 'eVmag', 'PlxFlag', 'Teff', 'eTeff',
'Logg', 'eLogg', 'Vt', 'eVt', '[Fe/H]', 'e[Fe/H]', 'Reference', 'Link',
'SWFlag', 'Update', 'Comment', 'Database', 'gaia_dr2', 'gaia_dr3', 'Plx',
'ePlx', 'Gmag', 'eGmag', 'RPmag', 'eRPmag', 'BPmag', 'eBPmag', 'FG', 'eFG',
'G_flux_std_n', 'Logg_gaia', 'eLogg_gaia', 'Mass_t', 'eMass_t', 'Radius_t',
'eRadius_t', 'spec_base', 'Distance', 'RA_EU', 'DEC_EU', 'RA_NASA', 'DEC_NASA',
'Distance_b', 'eDistance_b']
```

[4]:
```
SC[["Name", "RA", "DEC", "Gmag", "Teff"]]
```

[4]:

	Name	RA	DEC	Gmag	Teff
0	11 Com	12 20 43.02	+17 47 34.33	4.437300	4824.0
1	11 UMi	15 17 05.88	+71 49 26.04	4.556700	4314.0
2	14 And	23 31 17.41	+39 14 10.30	4.922200	4745.0
3	14 Her	16 10 24.31	+43 49 03.52	6.395200	5360.0
4	16 Cyg B	19 41 51.97	+50 31 03.08	6.073400	5785.0
…	…	…	…	…	…
3231	HD 96992	11 10 23.24	+43 55 08.32	8.284226	4725.0
3232	TOI-519	08 18 25.66	-19 39 46.50	15.677020	3350.0
3233	TOI-837	10 28 08.99	-64 30 18.93	10.359779	6047.0
3234	TYC 0434-04538-1	18 05 21.55	+02 03 44.60	9.927217	4679.0
3235	V830 Tau	04 33 10.02	+24 33 43.25	11.667231	4250.0

[3236 rows x 5 columns]

[5]:
```
SC[SC["Name"] == "51 Peg"]
```

[5]:

	Name	hd	RA	DEC	Vmag	eVmag	PlxFlag	Teff	\
13	51 Peg	217014	22 57 27.98	+20 46 07.79	5.46	0.05	GAIAeDR3	5810.0	

	eTeff	Logg	…	Radius_t	eRadius_t	spec_base	\
13	21.0	4.33	…	1.155875	0.037868	51Peg_HARPSS_115000_378_691_2020	

	Distance	RA_EU	DEC_EU	RA_NASA	DEC_NASA	Distance_b	\
13	15.526793	344.3625	20.768611	344.36754	20.769096	15.514698	

	eDistance_b
13	0.019995

[1 rows x 48 columns]

0.1 Get planet propreties from exoplanet.eu

[6]:
```
import urllib.request
from astropy.io import votable
import warnings
def downloadExoplanet(file_exo = "exo.csv"):
    """
    Download the table of Confirmed planets from exoplanetEU and save it to a␣
 ↪file (exo.csv).
    Return a pandas DataFrame sorted in 'update'.
    """
    response = urllib.request.urlopen("http://exoplanet.eu/catalog/votable")
    table = response.read()
    with open('exo.xml', 'wb') as f:
```

```
        f.write(table)
    """Convert the saved xml file to csv and read with pandas"""
    with warnings.catch_warnings():
        warnings.simplefilter("ignore")
        vo = votable.parse('exo.xml', invalid='mask', pedantic=False)
        vo = vo.get_first_table().to_table(use_names_over_ids=True)
        df = vo.to_pandas()

    # Divide the data in Confirmed and not.
    df[df.planet_status == 'Confirmed'].to_csv(file_exo, index=False)
```

[7]:
```
## We also provide teh exo.csv file taken from the last SWEET-Cat update
#
download = True
if download:
    downloadExoplanet()
exo = pd.read_csv("exo.csv")
```

[8]:
```
exo.columns
```

[8]:
```
Index(['name', 'planet_status', 'mass', 'mass_error_min', 'mass_error_max',
       'mass_sini', 'mass_sini_error_min', 'mass_sini_error_max', 'radius',
       'radius_error_min', 'radius_error_max', 'orbital_period',
       'orbital_period_error_min', 'orbital_period_error_max',
       'semi_major_axis', 'semi_major_axis_error_min',
       'semi_major_axis_error_max', 'eccentricity', 'eccentricity_error_min',
       'eccentricity_error_max', 'inclination', 'inclination_error_min',
       'inclination_error_max', 'angular_distance', 'discovered', 'updated',
       'omega', 'omega_error_min', 'omega_error_max', 'tperi',
       'tperi_error_min', 'tperi_error_max', 'tconj', 'tconj_error_min',
       'tconj_error_max', 'tzero_tr', 'tzero_tr_error_min',
       'tzero_tr_error_max', 'tzero_tr_sec', 'tzero_tr_sec_error_min',
       'tzero_tr_sec_error_max', 'lambda_angle', 'lambda_angle_error_min',
       'lambda_angle_error_max', 'impact_parameter',
       'impact_parameter_error_min', 'impact_parameter_error_max', 'tzero_vr',
       'tzero_vr_error_min', 'tzero_vr_error_max', 'k', 'k_error_min',
       'k_error_max', 'temp_calculated', 'temp_calculated_error_min',
       'temp_calculated_error_max', 'temp_measured', 'hot_point_lon',
       'geometric_albedo', 'geometric_albedo_error_min',
       'geometric_albedo_error_max', 'log_g', 'publication', 'detection_type',
       'mass_detection_type', 'radius_detection_type', 'alternate_names',
       'molecules', 'star_name', 'ra', 'dec', 'mag_v', 'mag_i', 'mag_j',
       'mag_h', 'mag_k', 'star_distance', 'star_distance_error_min',
       'star_distance_error_max', 'star_metallicity',
       'star_metallicity_error_min', 'star_metallicity_error_max', 'star_mass',
       'star_mass_error_min', 'star_mass_error_max', 'star_radius',
       'star_radius_error_min', 'star_radius_error_max', 'star_sp_type',
```

```
       'star_age', 'star_age_error_min', 'star_age_error_max', 'star_teff',
       'star_teff_error_min', 'star_teff_error_max', 'star_detected_disc',
       'star_magnetic_field', 'star_alternate_names'],
      dtype='object')
```

[10]:
```
#Getting coordinates matching
coordSCEU   = coord.SkyCoord(ra=SC['RA_EU'].values,
                             dec=SC['DEC_EU'].values,
                             unit=(u.deg, u.deg),
                             frame='icrs')
coordExo    = coord.SkyCoord(ra=exo['ra'].values,
                             dec=exo['dec'].values,
                             unit=(u.deg, u.deg),
                             frame='icrs')
```

[11]:
```
SCind = np.where(SC.Name == "mu Ara")[0][0]
print(SCind)
#SCind = 3001
def get_planets_for_SC_star(SCind):
    outres = []
    if "EU" in SC.Database[SCind]:
        sep = coordSCEU[SCind].separation(coordExo).arcsecond
        ind = np.where(sep <= np.nanmin(sep))[0]
        if len(ind) > 0:
            outres = exo.loc[ind].reset_index()
    else:
        print ("No EU planets in Database")
    return outres
planets = get_planets_for_SC_star(SCind)[["name", "mass", "mass_sini",␣
↪"radius", "semi_major_axis", "eccentricity"]]
planets
```

```
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```

[11]:

	name	mass	mass_sini	radius	semi_major_axis	eccentricity
0	mu Ara b	NaN	1.67600	NaN	1.50000	0.1280
1	mu Ara c	NaN	0.03321	NaN	0.09094	0.1720
2	mu Ara d	NaN	0.52190	NaN	0.92100	0.0666
3	mu Ara e	NaN	1.81400	NaN	5.23500	0.0985

[12]:
```
planets.columns
```

[12]:
```
Index(['name', 'mass', 'mass_sini', 'radius', 'semi_major_axis',
       'eccentricity'],
      dtype='object')
```

0.2 Get planet propreties from NASA Exoplanets Archive

[13]:
```
def downloadNasaExoplanetNew():
    """
    Download the table from NASA exoplanet archive
    and save it to a file (nasaexo.csv).
    """
    nasa_url = "https://exoplanetarchive.ipac.caltech.edu/TAP/sync?
↪query=select+*+from+ps+where+default_flag=1&format=csv"
    # Download the data
    response = urllib.request.urlopen(nasa_url)
    table = response.read()

    # Write the NASA exoplanet archive
    with open('nasaexo.csv', 'wb') as f:
        f.write(table)
```

[14]:
```
## We also provide teh exo.csv file taken from the last SWEET-Cat update
#
download = True
if download:
    downloadNasaExoplanetNew()
nasa = pd.read_csv("nasaexo.csv", low_memory=False)
```

[16]:
```
[print(c) for c in nasa.columns[0:10]];
```

```
pl_name
pl_letter
hostname
hd_name
hip_name
tic_id
gaia_id
default_flag
pl_refname
sy_refname
```

[18]:
```
#Getting coordinates matching
coordSCNASA = coord.SkyCoord(ra=SC['RA_NASA'].values,
                             dec=SC['DEC_NASA'].values,
                             unit=(u.deg, u.deg),
                             frame='icrs')
coordNasa   = coord.SkyCoord(ra=nasa['ra'].values,
                             dec=nasa['dec'].values,
                             unit=(u.deg, u.deg),
                             frame='icrs')
```

[19]:
```
SCind = np.where(SC.Name == "mu Ara")[0][0]
print(SCind)
#SCind = 3001
def get_planets_for_SC_star_NASA(SCind):
    outres = []
    if "NASA" in SC.Database[SCind]:
        sep = coordSCNASA[SCind].separation(coordNasa).arcsecond
        ind = np.where(sep <= np.nanmin(sep))[0]
        if len(ind) > 0:
            outres = nasa.loc[ind].reset_index()
    else:
        print ("No EU planets in Database")
    return outres
planets_nasa = get_planets_for_SC_star_NASA(SCind)[["pl_name", "pl_massj",␣
↪"pl_msinij", "pl_radj", "pl_orbsmax", "pl_orbeccen"]]
planets_nasa
```

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[19]:

	pl_name	pl_massj	pl_msinij	pl_radj	pl_orbsmax	pl_orbeccen
0	HD 160691 c	NaN	1.81400	NaN	5.23500	0.0985
1	HD 160691 e	NaN	0.52190	NaN	0.92100	0.0666
2	HD 160691 b	NaN	1.67600	NaN	1.49700	0.1280
3	HD 160691 d	NaN	0.03321	NaN	0.09094	0.1720

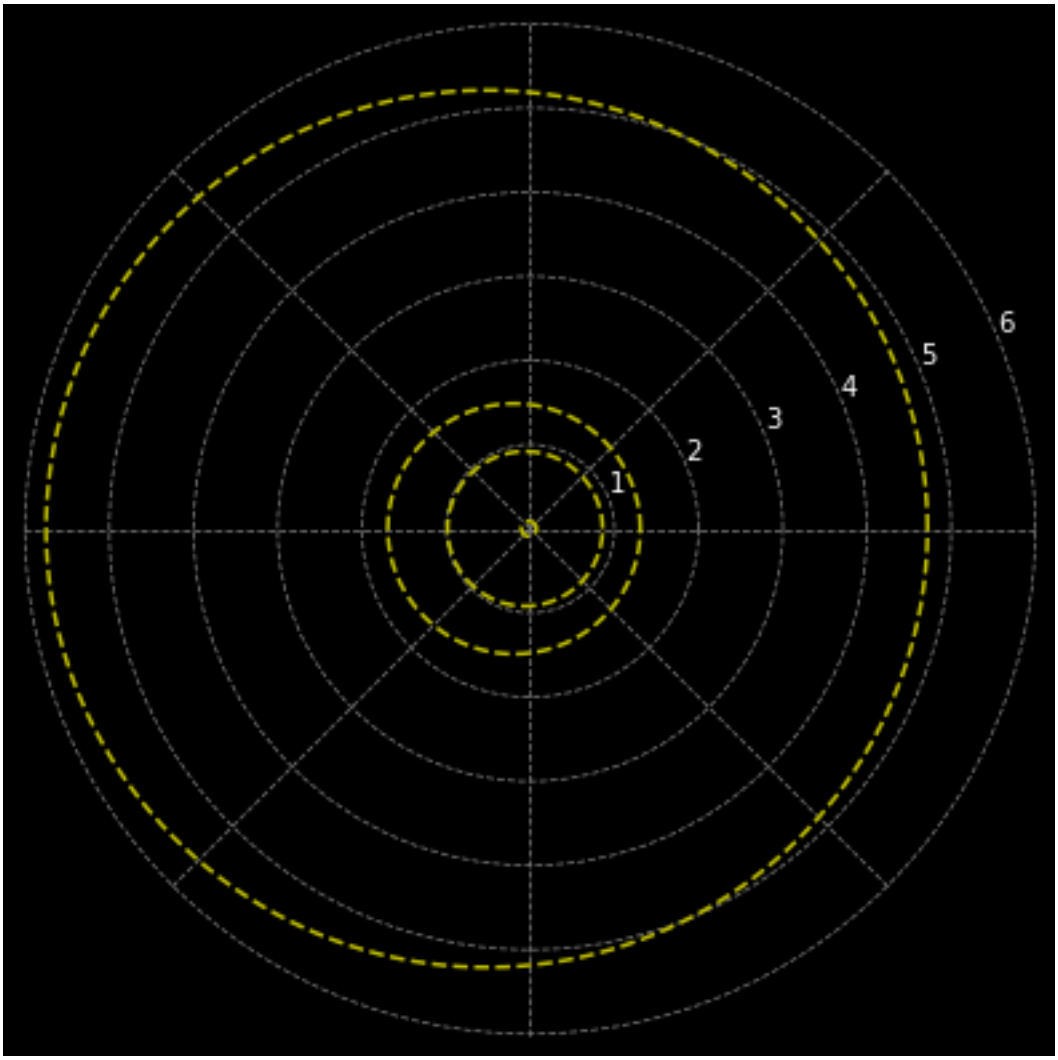
0.2.1 Plot Planetary System

[20]:
```
import matplotlib.pyplot as plt #Imports plot library
cos = np.cos
pi = np.pi


fig = plt.figure(1, figsize=(12, 7),facecolor='black')
ax = fig.add_subplot(111, projection='polar')
#ax.set_rorigin(-1)

for p in range(len(planets)):
  a = planets.semi_major_axis[p]
  e = planets.eccentricity[p]
  theta = np.linspace(0,2*pi, 360)
  r = (a*(1-e**2))/(1+e*cos(theta))
  plt.polar(theta, r, c='y', linestyle="--")
#ax.yaxis.grid(False)
ax.xaxis.grid(False)
ax.set_xticklabels([])
ax.set_facecolor('k')
ax.grid(color='gray', linestyle='--', linewidth=0.75)
```

```
ax.spines['polar'].set_visible(False)
[t.set_color('white') for t in ax.yaxis.get_ticklabels()]
#ax.set_rlim(0)
#ax.set_rscale('symlog')
#print(np.c_[r,theta])
#ax.plot(0, 0, 'y', markersize=10000, markerfacecolor='m', markeredgecolor='k')
plt.show()
```



[22]:
```
%%bash
jupyter nbconvert --to html PythonTutorial.ipynb
mv PythonTutorial.html ../
```

```
[NbConvertApp] Converting notebook PythonTutorial.ipynb to html
[NbConvertApp] Writing 320522 bytes to PythonTutorial.html
```