Aix*Marseille université
Socialement engagée

Statistique descriptive et visualisation

```
titanic.describe()
```

	PassengerId	Survived	Pclass	Age	SibSp	Parch	Fare
count	891.000000	891.000000	891.000000	714.000000	891.000000	891.000000	891.000000
mean	446.000000	0.383838	2.308642	29.699118	0.523008	0.381594	32.204208
std	257.353842	0.486592	0.836071	14.526497	1.102743	0.806057	49.693429
min	1.000000	0.000000	1.000000	0.420000	0.000000	0.000000	0.000000
25%	223.500000	0.000000	2.000000	20.125000	0.000000	0.000000	7.910400
50%	446.000000	0.000000	3.000000	28.000000	0.000000	0.000000	14.454200
75%	668.500000	1.000000	3.000000	38.000000	1.000000	0.000000	31.000000
max	891.000000	1.000000	3.000000	80.000000	8.000000	6.000000	512.329200

```
titanic["Age"].mean()
```

```
titanic["Age"].mean()
```

```
29.69911764705882
```

```
titanic[["Age", "Fare"]].median()
```

```
titanic[["Age", "Fare"]].median()
```

```
Age      28.0000
Fare     14.4542
dtype: float64
```

```
titanic.groupby("Sex").mean()
```

```
titanic.groupby("Sex").mean()
```

	PassengerId	Survived	Pclass	Age	SibSp	Parch	Fare
Sex							
female	431.028662	0.742038	2.159236	27.915709	0.694268	0.649682	44.479818
male	454.147314	0.188908	2.389948	30.726645	0.429809	0.235702	25.523893

```
titanic[["Sex", "Age"]].groupby("Sex").mean()
titanic.groupby("Sex")[["Sex", "Age"]].mean()
```

	Age
Sex	
female	27.915709
male	30.726645

```
titanic[["Survived","Pclass"]].groupby("Pclass").describe()
```

	Survived							
	count	mean	std	min	25%	50%	75%	max
Pclass								
1	216.0	0.629630	0.484026	0.0	0.0	1.0	1.0	1.0
2	184.0	0.472826	0.500623	0.0	0.0	0.0	1.0	1.0
3	491.0	0.242363	0.428949	0.0	0.0	0.0	0.0	1.0

```
titanic.groupby("Pclass").sum()
```

	PassengerId	Survived	Age	SibSp	Parch	Fare
Pclass						
1	99705	136	7111.42	90	77	18177.4125
2	82056	87	5168.83	74	70	3801.8417
3	215625	119	8924.92	302	193	6714.6951

```
titanic.groupby("Sex").sum()
```

	PassengerId	Survived	Pclass	Age	SibSp	Parch	Fare
Sex							
female	135343	233	678	7286.00	218	204	13966.6628
male	262043	109	1379	13919.17	248	136	14727.2865

What is the mean ticket fare price for each of the sex and cabin class combinations?

```
titanic.groupby(["Sex", "Pclass"])["Fare"].mean()
```

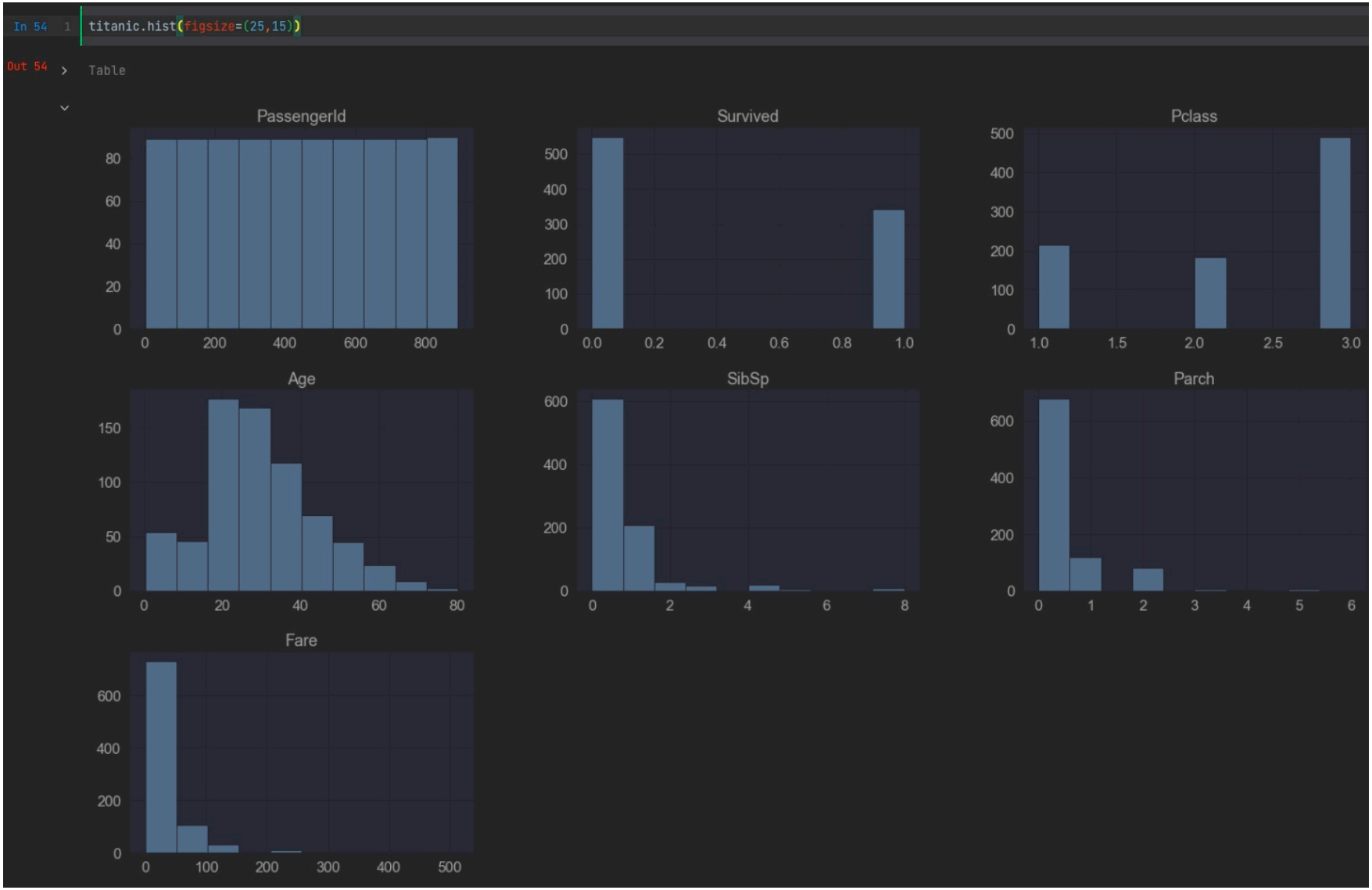
```
Sex     Pclass
female  1         106.125798
        2          21.970121
        3          16.118810
male    1          67.226127
        2          19.741782
        3          12.661633
```

```
titanic.groupby(["Pclass","Sex"])["Fare"].mean()
```

```
Pclass  Sex
1       female    106.125798
        male       67.226127
2       female     21.970121
        male       19.741782
3       female     16.118810
        male       12.661633
```

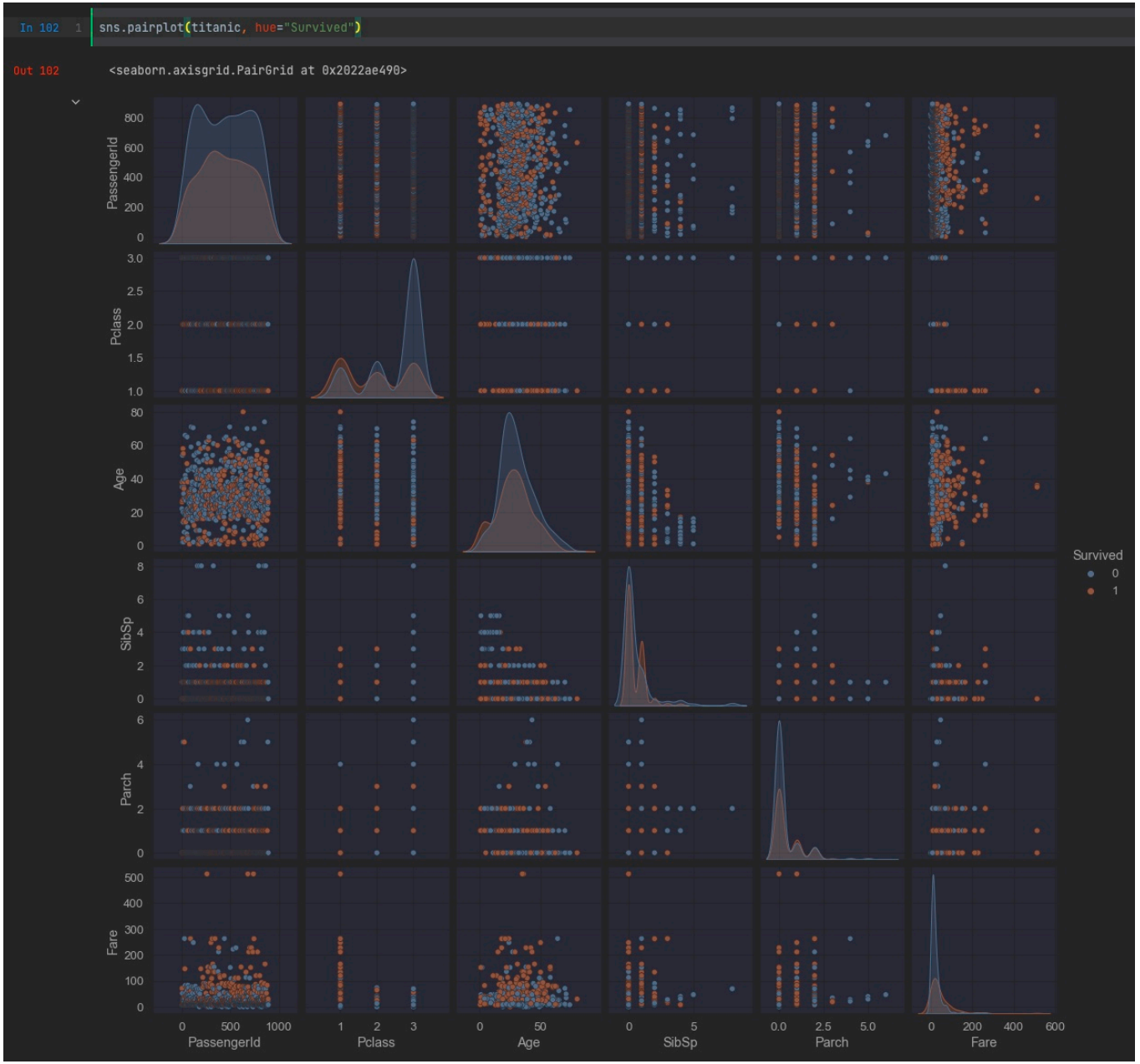
```
In 54  1  titanic.hist(figsize=(25,15))
```

Out 54 Table



```
In 102  1  sns.pairplot(titanic, hue="Survived")

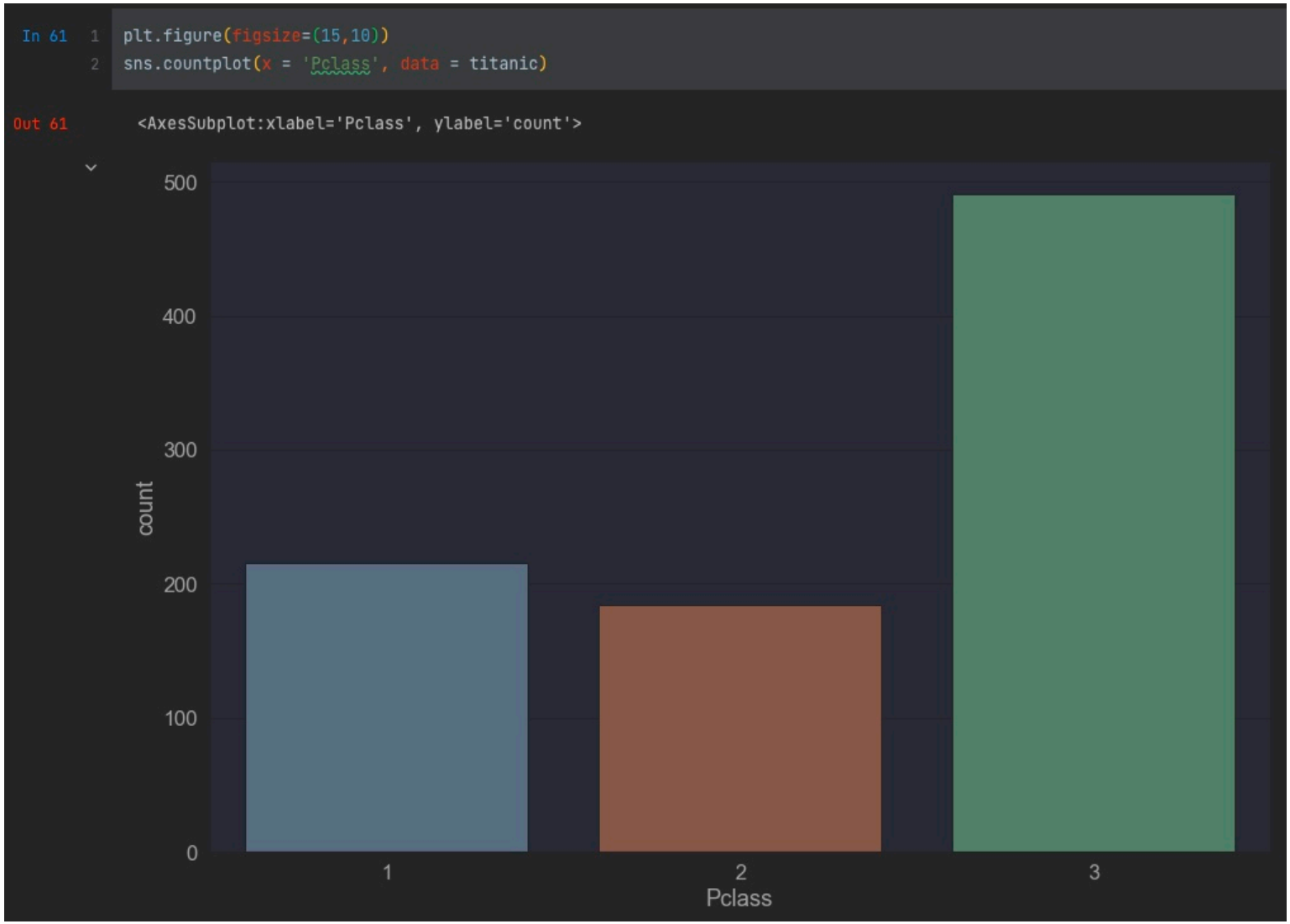
Out 102    <seaborn.axisgrid.PairGrid at 0x2022ae490>
```



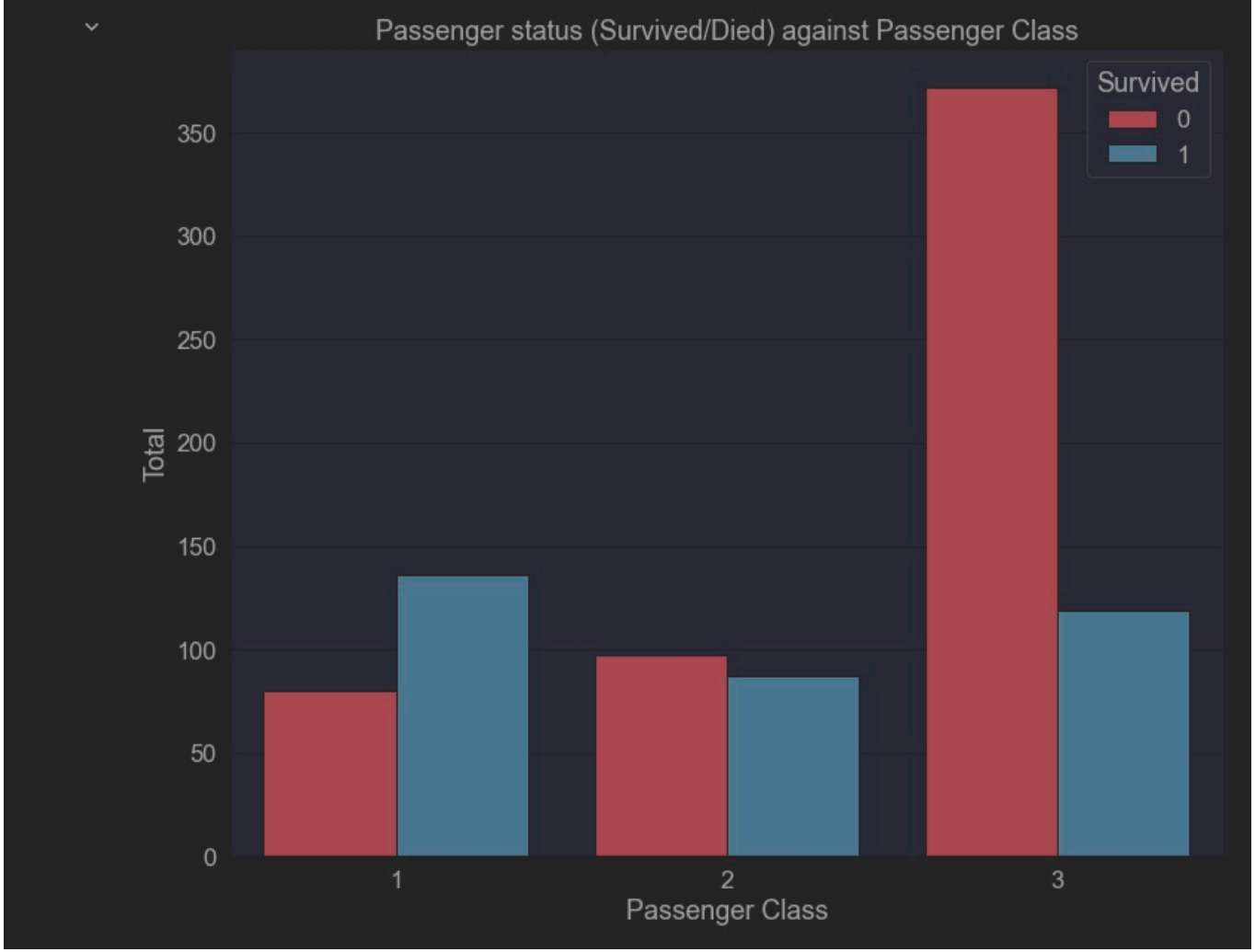
```
import matplotlib.pyplot as plt
import seaborn as sns
```

```
In 61  1  plt.figure(figsize=(15,10))
       2  sns.countplot(x = 'Pclass', data = titanic)
```

```
Out 61  <AxesSubplot:xlabel='Pclass', ylabel='count'>
```

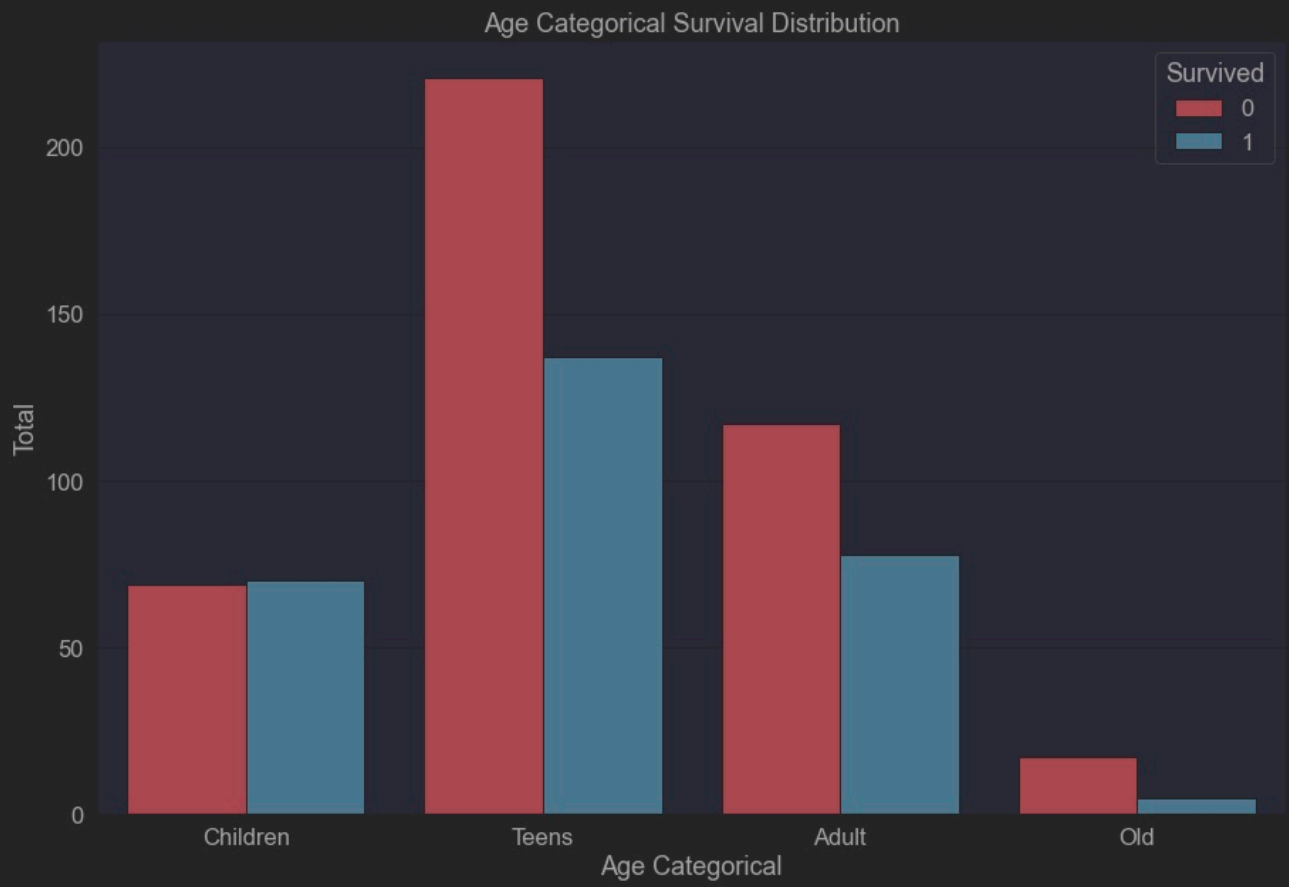


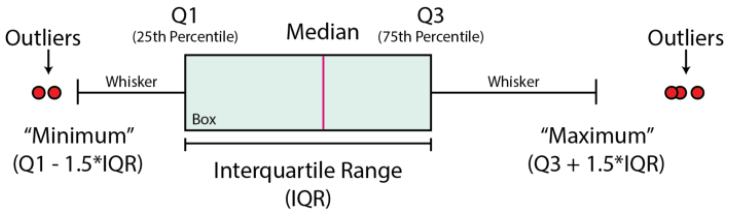
```
In 57  1  fig, ax = plt.subplots(1,1, figsize = (12,10))
       2  ax = sns.countplot(x = 'Pclass', hue = 'Survived', palette = 'Set1', data = titanic)
       3  ax.set(title = 'Passenger status (Survived/Died) against Passenger Class',
       4         xlabel = 'Passenger Class', ylabel = 'Total')
       5  plt.show()
```



In 66

```
# We look at Age column and set Intevals on the ages and the map them to their categories as
# (Children, Teen, Adult, Old)
plt.figure(figsize=(15,10))
interval = (0,18,35,60,120)
categories = ['Children','Teens','Adult', 'Old']
titanic['Age_cats'] = pd.cut(titanic.Age, interval, labels = categories)
ax = sns.countplot(x = 'Age_cats',  data = titanic, hue = 'Survived', palette = 'Set1')
ax.set(xlabel='Age Categorical', ylabel='Total',
       title="Age Categorical Survival Distribution")
plt.show()
```



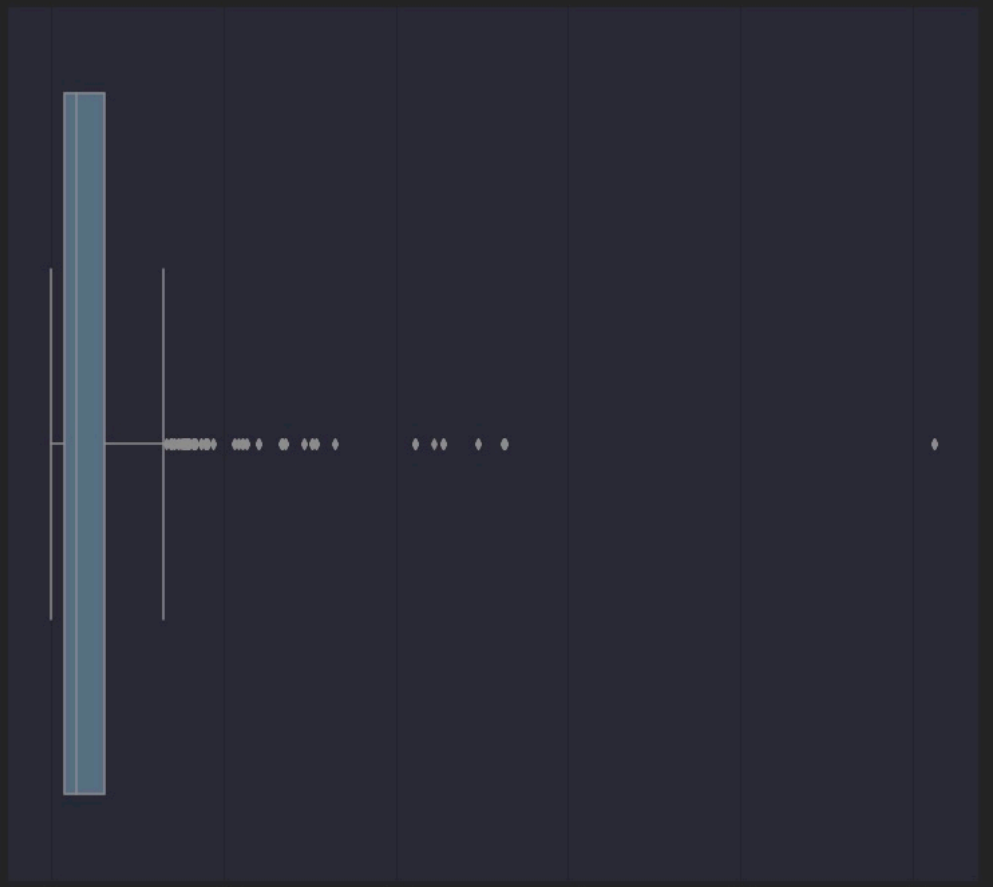


https://towardsdatascience.com/creating-boxplots-of-well-log-data-using-matplotlib-in-python-34c3816e73f4

```
In 69  1  sns.set(font_scale = 1.2)
       2  plt.figure(figsize=(10,8))
       3  ax = sns.boxplot(data=titanic, orient="v")
```

```
In 91   1  plt.figure(figsize=(13,12))
        2  sns.boxplot(data=titanic, x='Fare')

Out 91     <AxesSubplot:xlabel='Fare'>
```

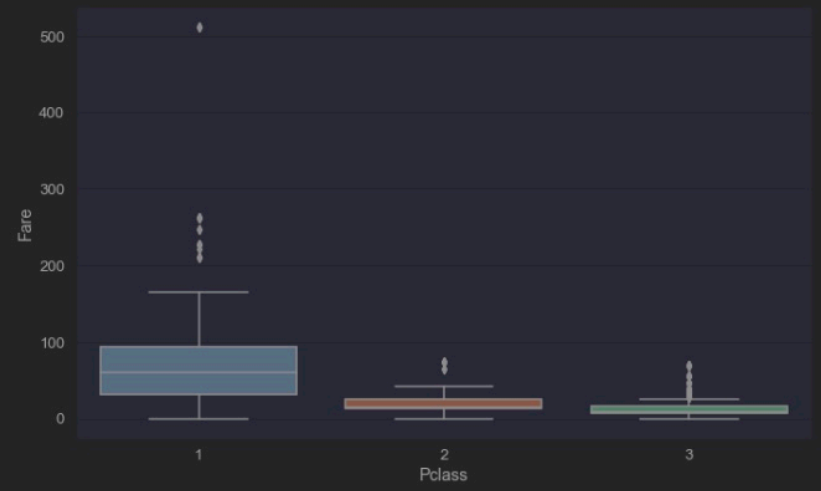


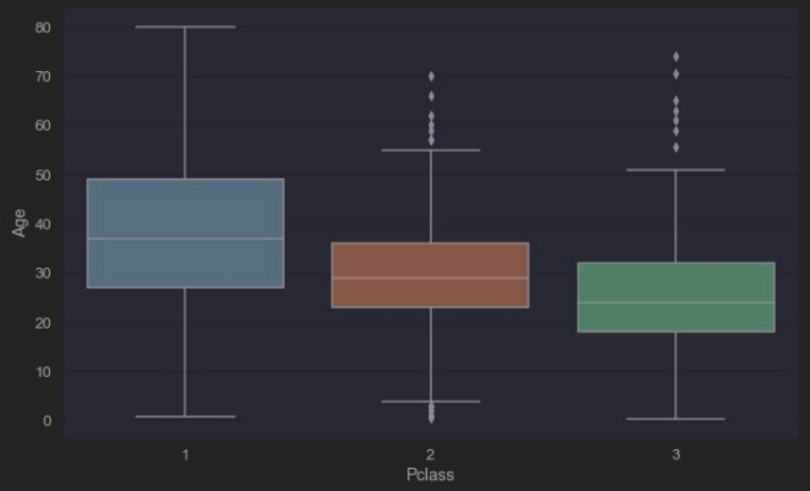
In 88

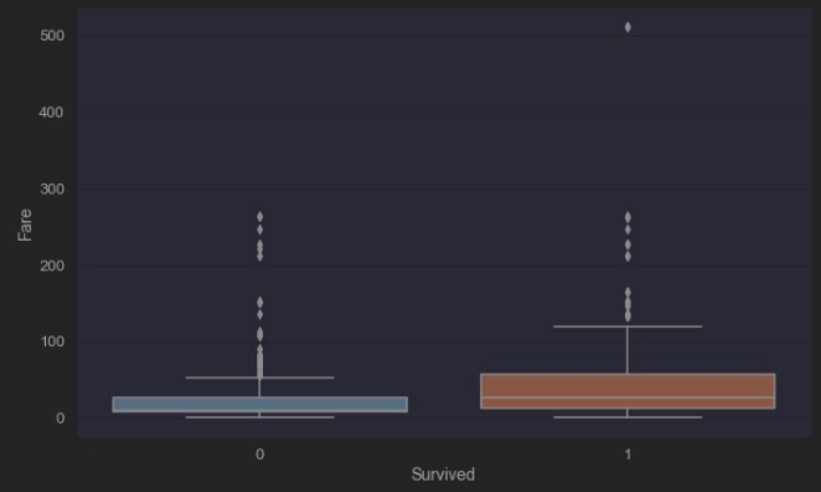
```
fig, axes = plt.subplots(2, 2, figsize=(25, 15))
sns.boxplot(ax=axes[0, 0], data=titanic, x='Pclass', y='Fare')
sns.boxplot(ax=axes[0, 1], data=titanic, x='Pclass', y='Age')
sns.boxplot(ax=axes[1, 0], data=titanic, x='Survived', y='Fare')
sns.boxplot(ax=axes[1, 1], data=titanic, x='Survived', y='Age')
```

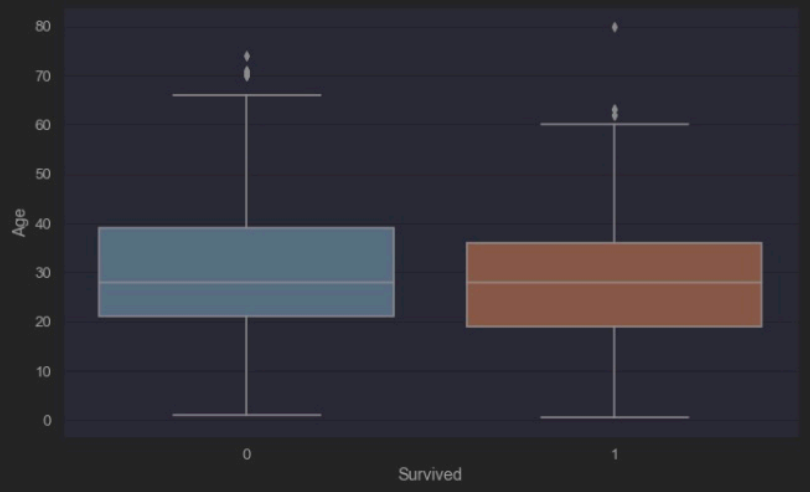
Out 88

```
<AxesSubplot:xlabel='Survived', ylabel='Age'>
```



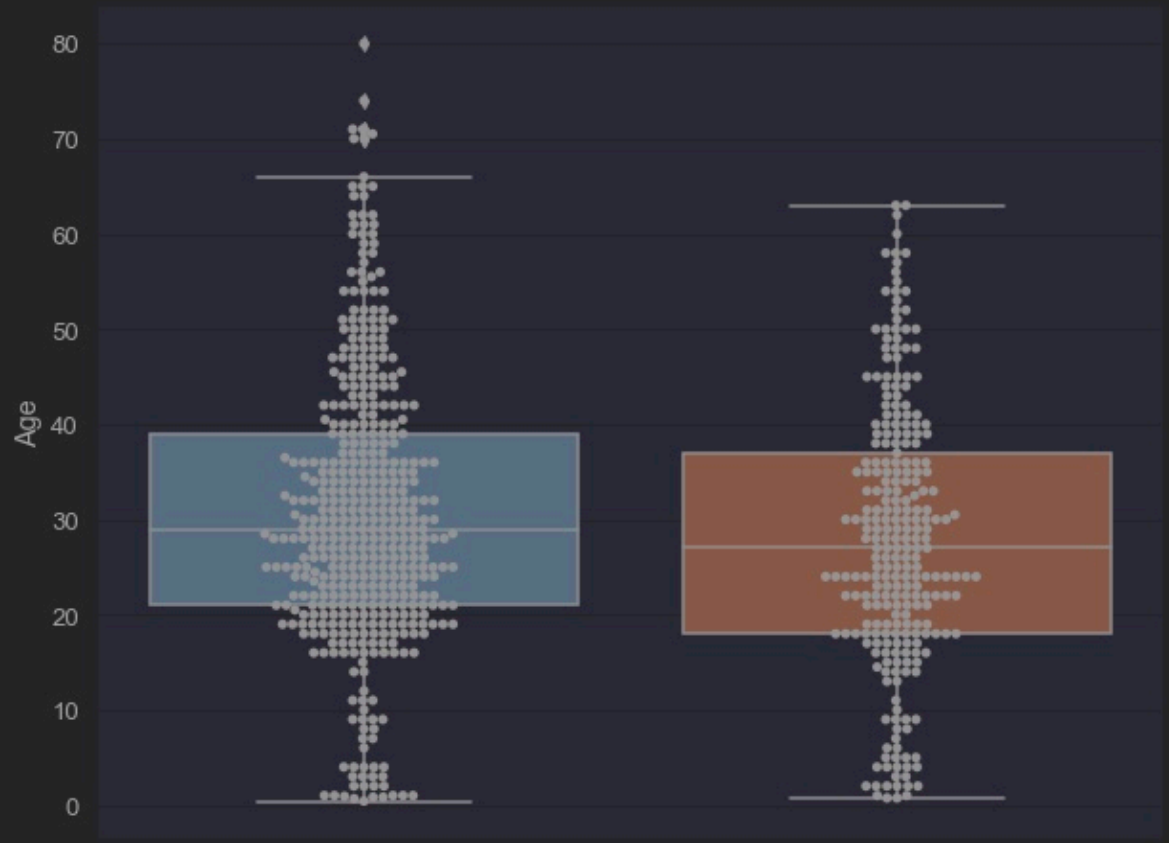






In 71

```
1  sns.set(font_scale = 1.2)
2  plt.figure(figsize=(10,8))
3  ax = sns.boxplot(x='Sex', y="Age",data=titanic, orient="v")
4  ax = sns.swarmplot(x='Sex', y="Age", data=titanic, color=".25")
```

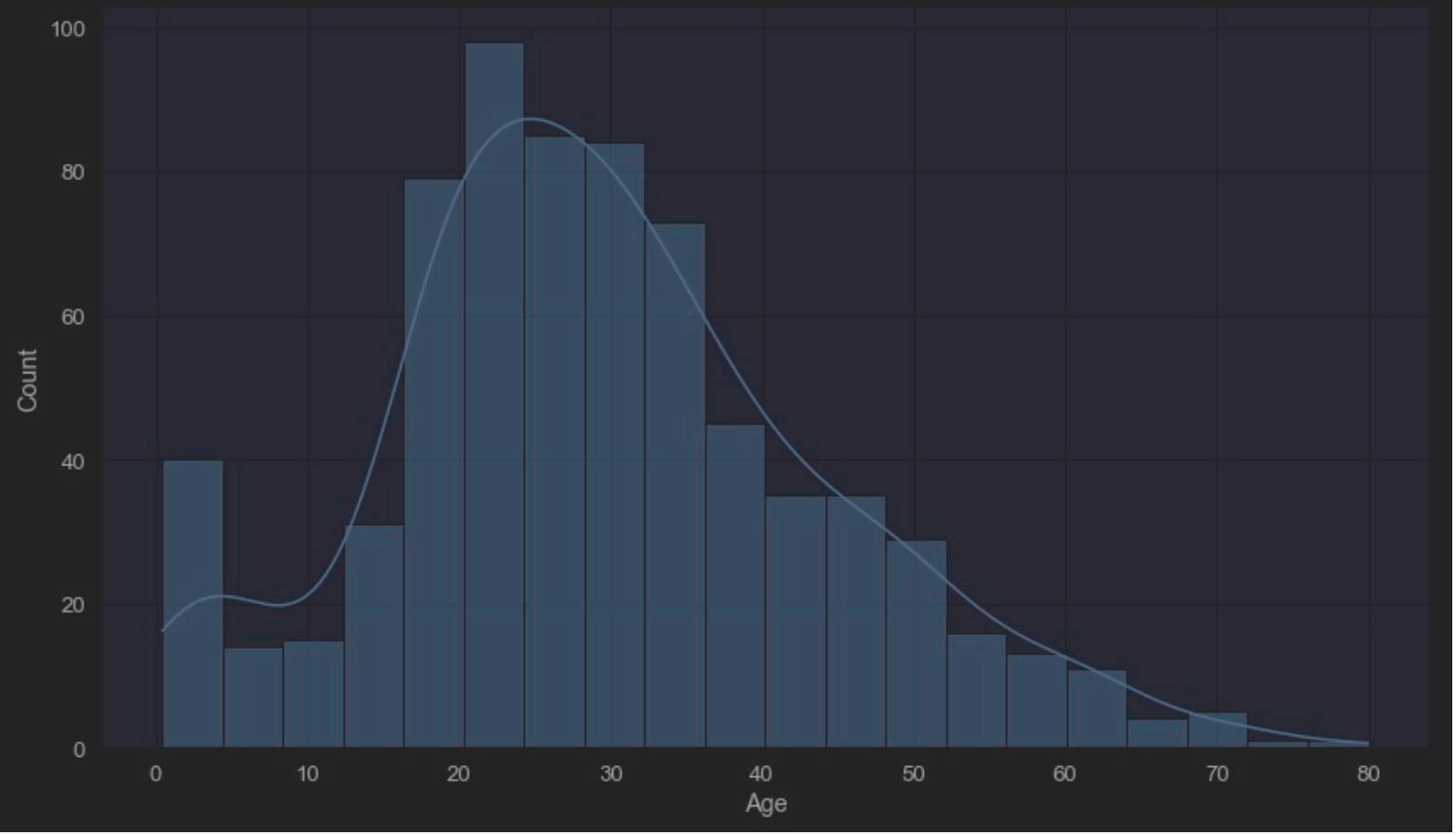


In 74
```
1 sns.set(font_scale = 1.2)
2 plt.figure(figsize=(13,12))
3 ax = sns.catplot(x='Sex', y="Age", hue="Survived", col="Pclass", data=titanic, orient="v")
```

```
<Figure size 936x864 with 0 Axes>
```

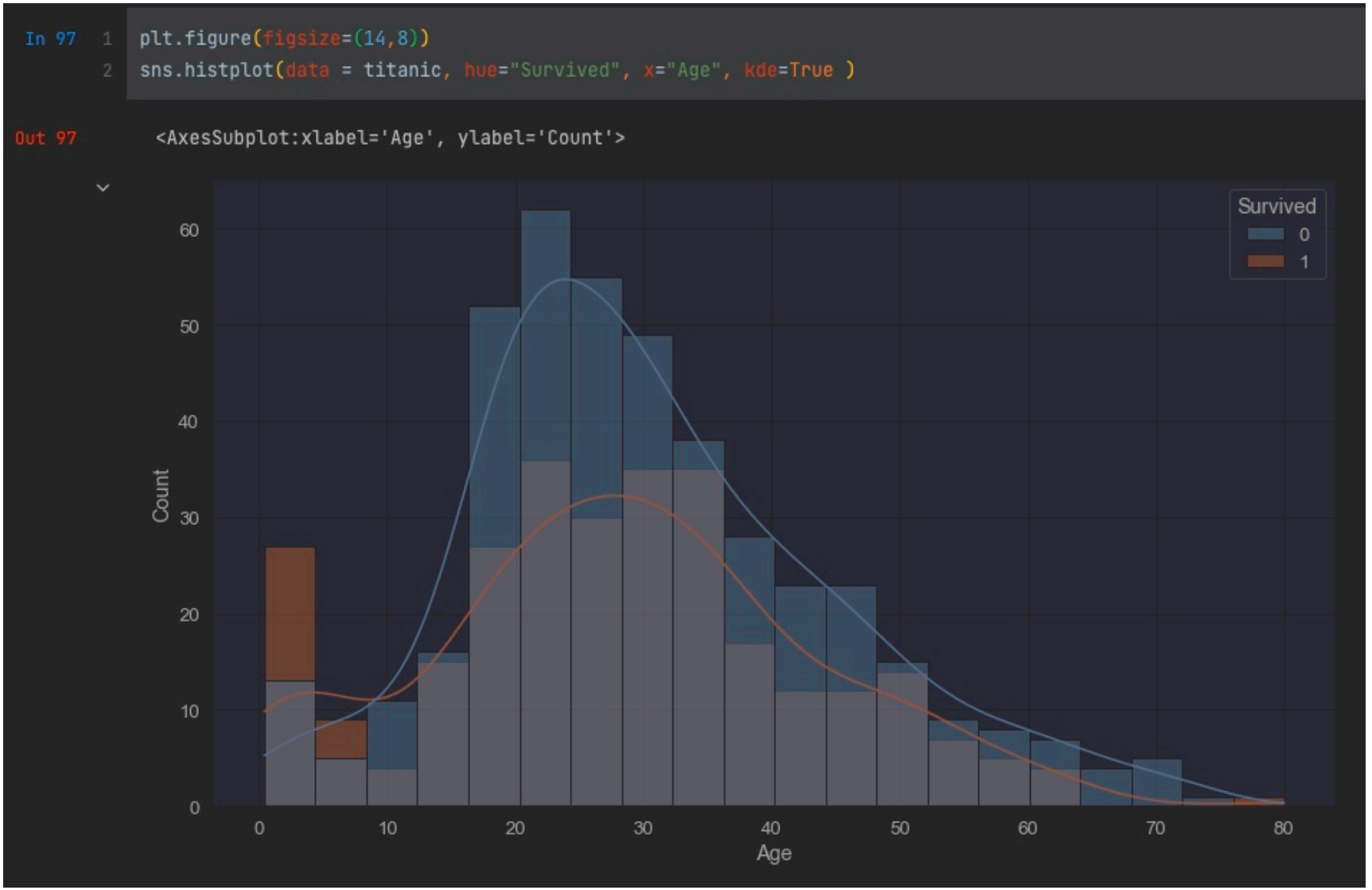
```
In 96   1  plt.figure(figsize=(14,8))
        2  sns.histplot(data = titanic, x="Age", kde=True )
```

```
Out 96  <AxesSubplot:xlabel='Age', ylabel='Count'>
```



```
In 97   1  plt.figure(figsize=(14,8))
        2  sns.histplot(data = titanic, hue="Survived", x="Age", kde=True )
```

```
Out 97   <AxesSubplot:xlabel='Age', ylabel='Count'>
```



Camemberts

```
In 177  1  titanic.Pclass.value_counts()
```

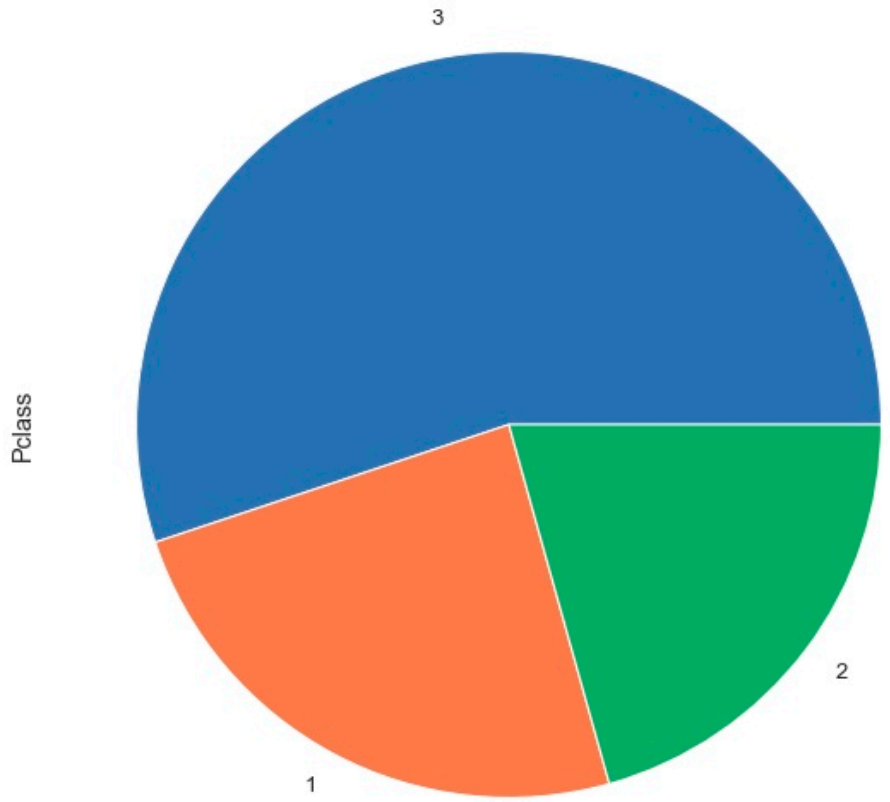
Out 177

	Pclass
3	491
1	216
2	184

Length: 3, dtype: int64 Open in new tab

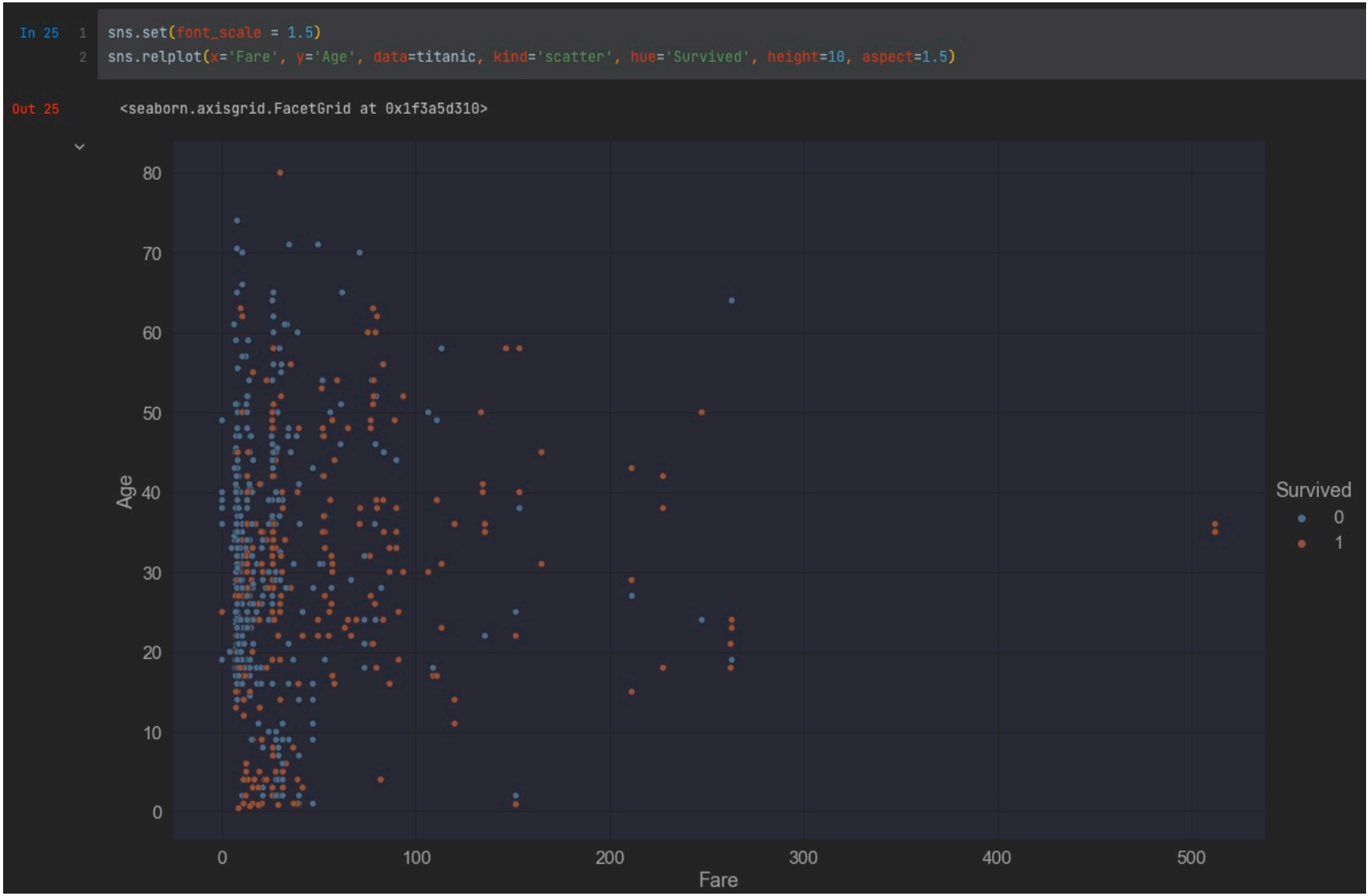
```
plt.figure(figsize=(15,10))
titanic.Pclass.value_counts().plot(kind='pie')
```

```
<AxesSubplot:ylabel='Pclass'>
```



In 25
```
sns.set(font_scale = 1.5)
sns.relplot(x='Fare', y='Age', data=titanic, kind='scatter', hue='Survived', height=10, aspect=1.5)
```

Out 25
```
<seaborn.axisgrid.FacetGrid at 0x1f3a5d310>
```



Corrélation entre variables

```
corr = titanic.corr()
corr
```

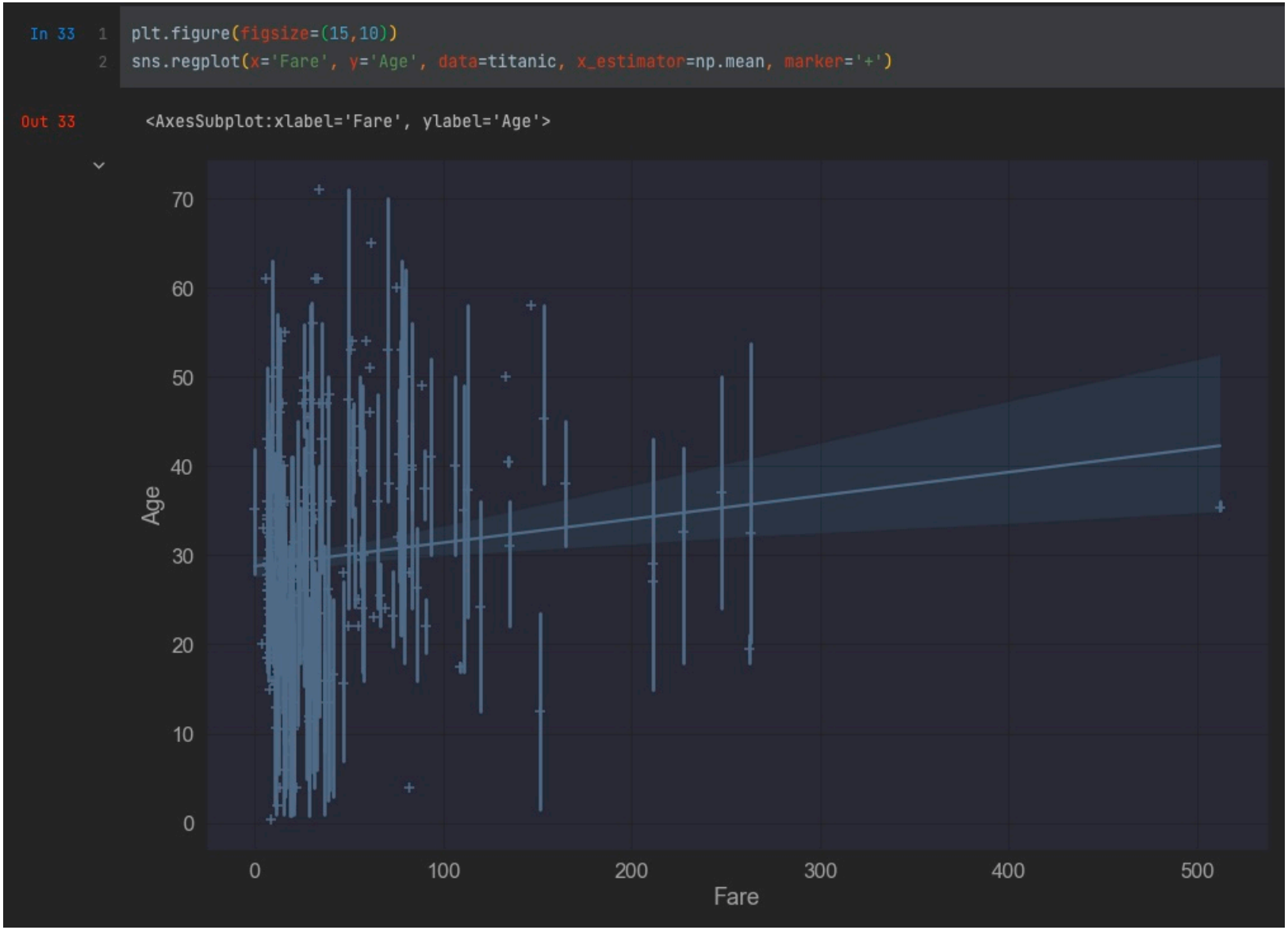
	PassengerId	Survived	Pclass	Age	SibSp	Parch	Fare	Fare_round
PassengerId	1.000000	-0.005007	-0.035144	0.036847	-0.057527	-0.001652	0.012658	0.012671
Survived	-0.005007	1.000000	-0.338481	-0.077221	-0.035322	0.081629	0.257307	0.257322
Pclass	-0.035144	-0.338481	1.000000	-0.369226	0.083081	0.018443	-0.549500	-0.549542
Age	0.036847	-0.077221	-0.369226	1.000000	-0.308247	-0.189119	0.096067	0.096076
SibSp	-0.057527	-0.035322	0.083081	-0.308247	1.000000	0.414838	0.159651	0.159736
Parch	-0.001652	0.081629	0.018443	-0.189119	0.414838	1.000000	0.216225	0.216290
Fare	0.012658	0.257307	-0.549500	0.096067	0.159651	0.216225	1.000000	1.000000
Fare_round	0.012671	0.257322	-0.549542	0.096076	0.159736	0.216290	1.000000	1.000000

```
plt.xticks(rotation=45)
sns.heatmap(corr,cmap="YlGnBu",annot = True)
```

```
<AxesSubplot:>
```

```
In 33   1  plt.figure(figsize=(15,10))
        2  sns.regplot(x='Fare', y='Age', data=titanic, x_estimator=np.mean, marker='+')
```

```
Out 33  <AxesSubplot:xlabel='Fare', ylabel='Age'>
```



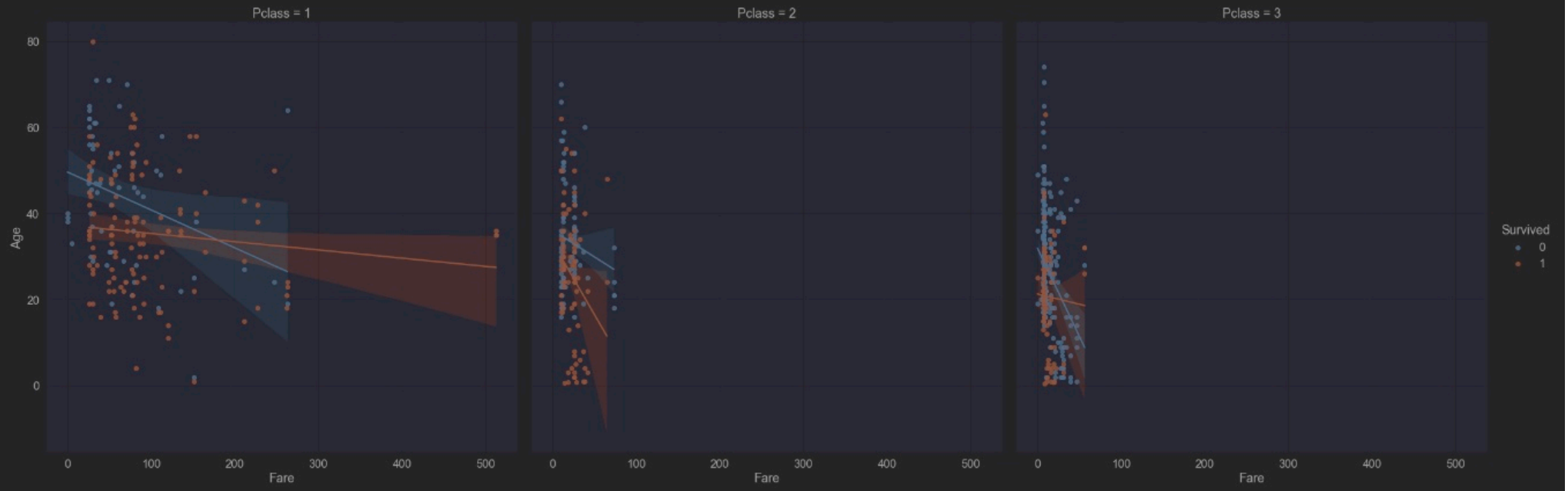
```
In 45  1  sns.lmplot(x='Fare', y='Age', hue="Survived", data=titanic, height=10)

Out 45    <seaborn.axisgrid.FacetGrid at 0x1f4a8ec40>
```

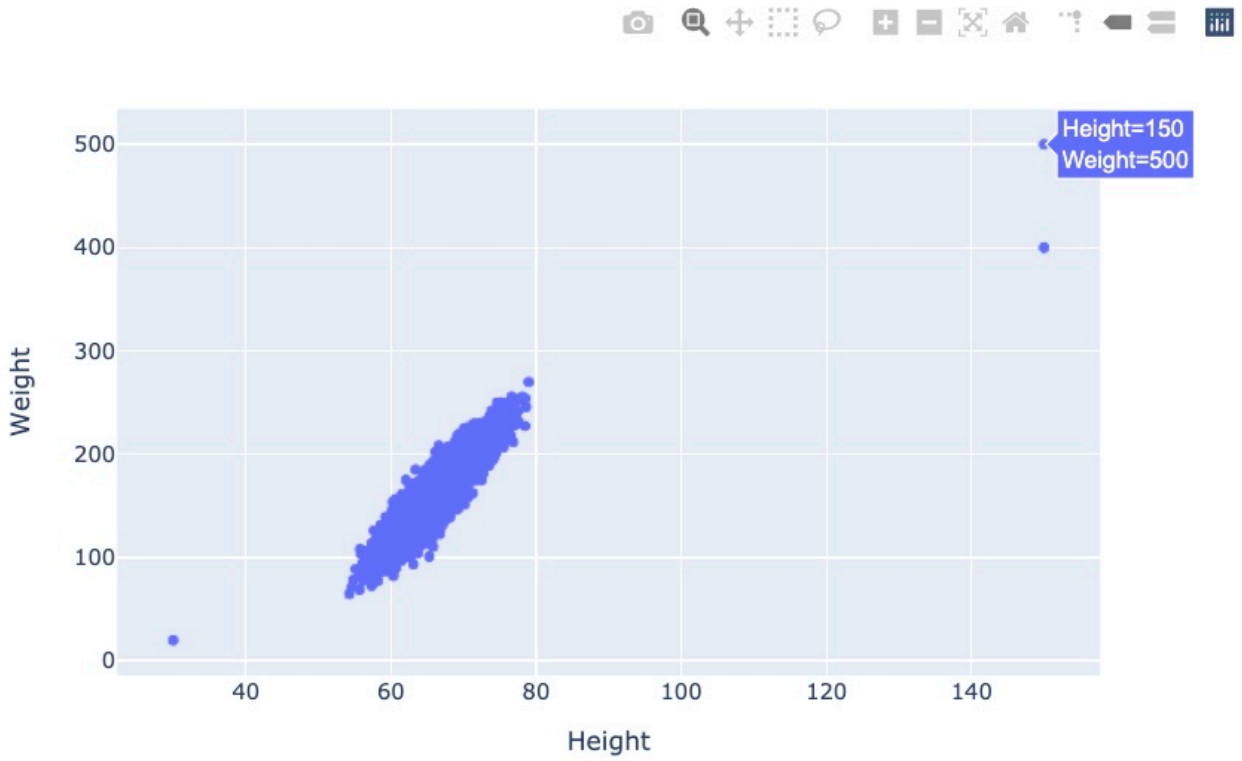
avec facettes

In 48
```
sns.set(font_scale = 1.5)
sns.lmplot(x='Fare', y='Age', hue="Survived", col='Pclass', data=titanic, height=10)
```

Out 48
```
<seaborn.axisgrid.FacetGrid at 0x1f46e7580>
```



```
import plotly.express as px
fig = px.scatter(wh, x='Height',y='Weight')
fig.show()
```



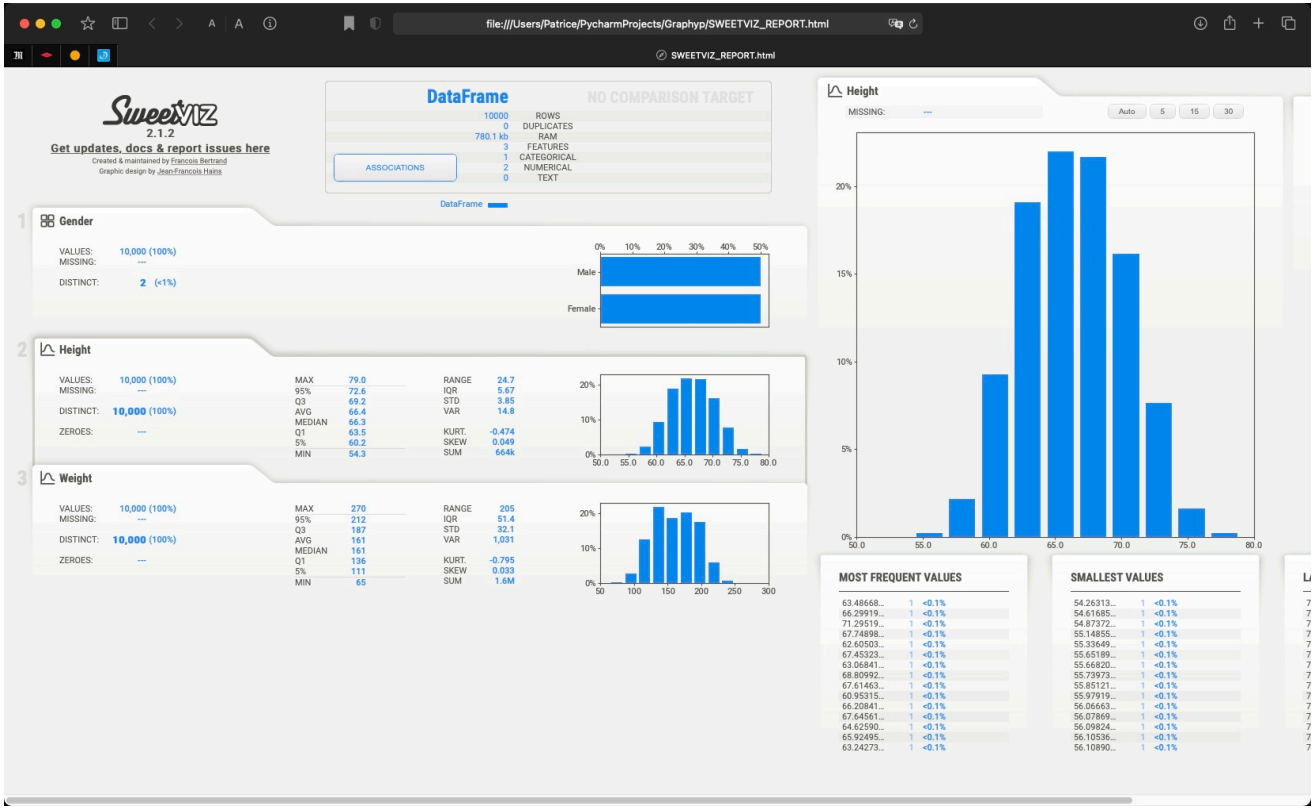
https://medium.com/spatial-data-science/4-tools-to-speed-up-exploratory-data-analysis-eda-in-python-e240ebcd18de

Des modules « tout prêts »

https://pypi.org/project/sweetviz/

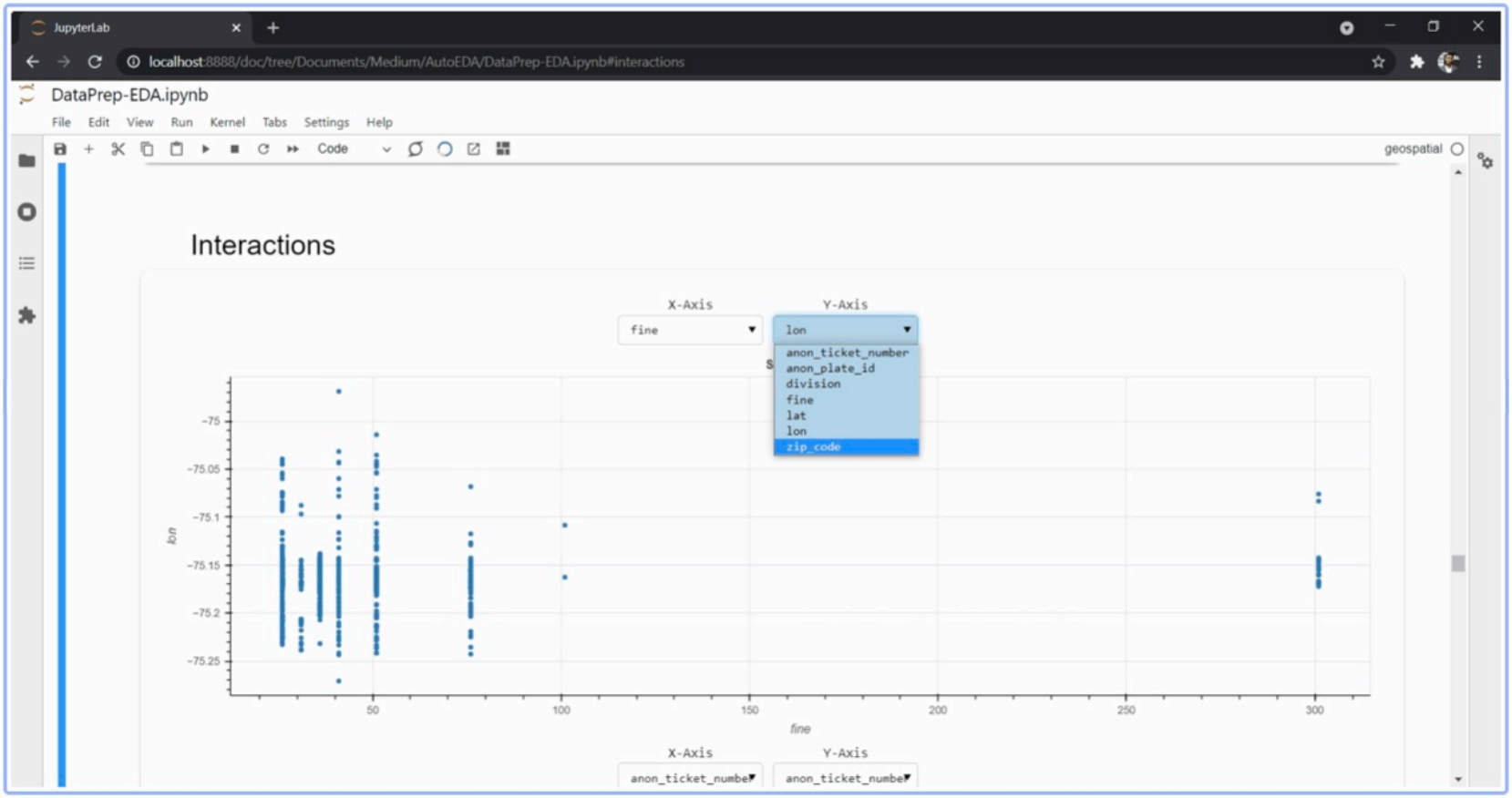
```
import sweetviz as sv

my_report = sv.analyze(df)
my_report.show_html()
```



```
from dataprep.eda import create_report

create_report(df)
```



DataPrep EDS report.

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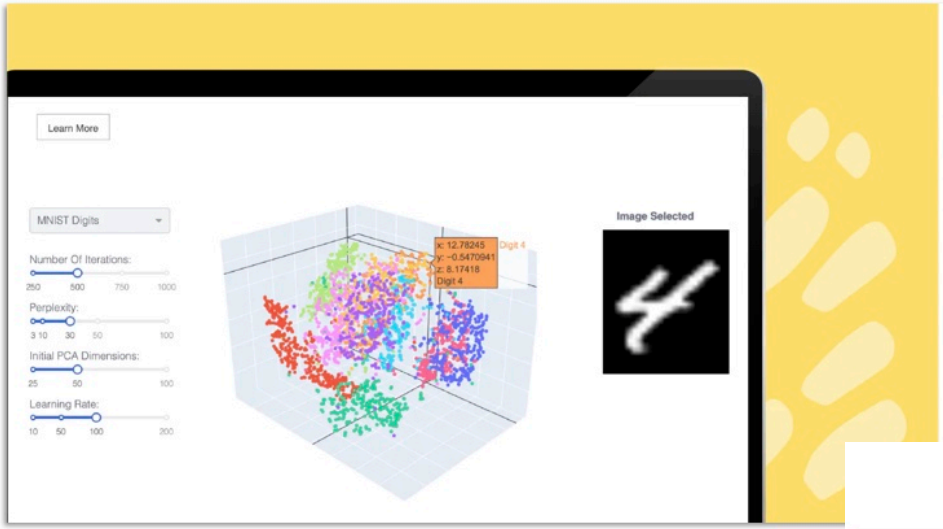
https://plotly.com

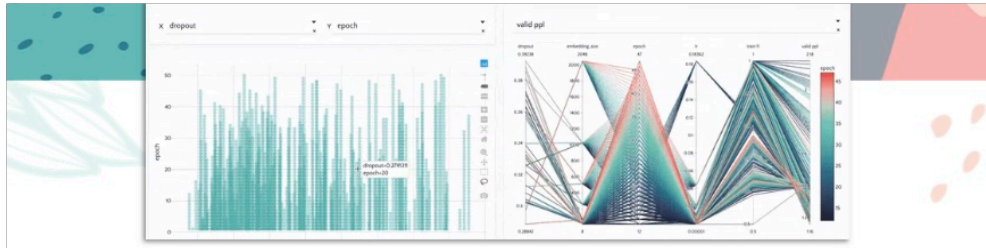
ML & AI apps made with Dash



Clustering

Dash is the fastest way to deplo
apps for dimensionality reductic

This Dash app demos TSNE clu
lines of Python code



Dash Enterprise is the low-code platform for ML & data science apps.

With Dash Enterprise, full-stack AI applications that used to require a team of front-end, back-end, and DevOps engineers can now be built, deployed, and hyperscaled by a single data scientist within hours.

plotly

Plotly Open Source Graphing Libraries

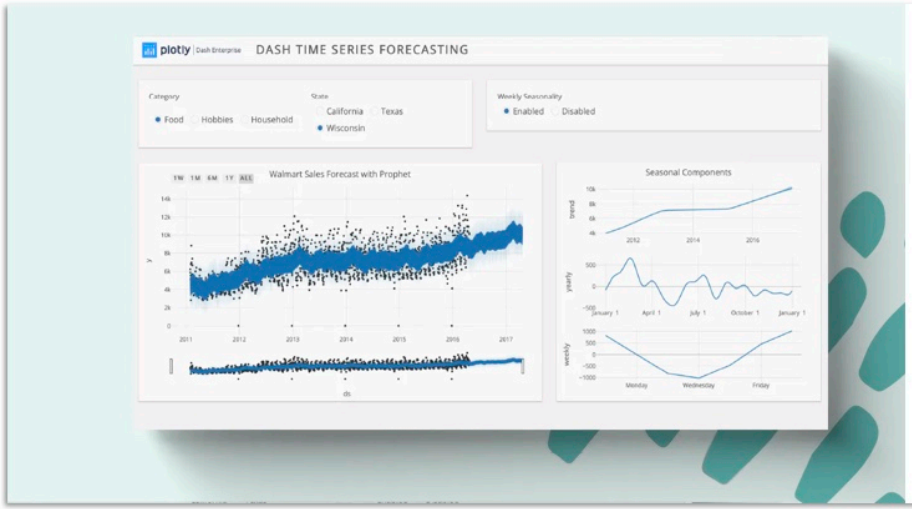
Interactive charts and maps for Python, R, and JavaScript.

Plotly Python Open Source Graphing Library

Plotly R Open Source Graphing Library

Plotly JavaScript Open Source Graphing Library

ML & AI apps made with Dash



Predictive Analytics

Dash is the fastest way to deploy Python-based apps for predictive analytics and forecasting.

Use predictive analytics + Dash to put neural networks, nonlinear regressions, decision trees, SVMs, and other forecasting methods in the hands of business users.

This Dash app demos Facebook's Prophet library in ~200 lines of Python code

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Données temporelles

Le module de base *datetime*

```
import datetime

x = datetime.datetime.now()
print(x)
```

```
2021-06-02 11:03:29.693092
```

```
print(x.year)
print(x.month)
print(x.day)
print(x.strftime("%B"))
```

```
2021
6
2
June
```

```
x = datetime.datetime(2020, 5, 17)
```

Directive	Description
%a	Weekday, short version
%A	Weekday, full version
%w	Weekday as a number 0-6, 0 is Sunday
%d	Day of month 01-31
%b	Month name, short version
%B	Month name, full version
%m	Month as a number 01-12
%y	Year, short version, without century
%Y	Year, full version
%H	Hour 00-23
%I	Hour 00-12
%p	AM/PM
%M	Minute 00-59
%S	Second 00-59
%f	Microsecond 000000-999999
%z	UTC offset
%Z	Timezone
%j	Day number of year 001-366
%U	Week number of year, Sunday as the first day of week, 00-53
%W	Week number of year, Monday as the first day of week, 00-53
%c	Local version of date and time
%x	Local version of date
%X	Local version of time
%%	A % character
%G	ISO 8601 year
%u	ISO 8601 weekday (1-7)
%V	ISO 8601 weeknumber (01-53)

Les modules NumPy *datetime64* et *timedelta*

```
import numpy as np
np.datetime64('2005-02-25')
```

Example

All the dates for one month:

```
>>> np.arange('2005-02', '2005-03', dtype='datetime64[D]')
array(['2005-02-01', '2005-02-02', '2005-02-03', '2005-02-04',
       '2005-02-05', '2005-02-06', '2005-02-07', '2005-02-08',
       '2005-02-09', '2005-02-10', '2005-02-11', '2005-02-12',
       '2005-02-13', '2005-02-14', '2005-02-15', '2005-02-16',
       '2005-02-17', '2005-02-18', '2005-02-19', '2005-02-20',
       '2005-02-21', '2005-02-22', '2005-02-23', '2005-02-24',
       '2005-02-25', '2005-02-26', '2005-02-27', '2005-02-28'],
      dtype='datetime64[D]')
```

Example

```
>>> np.datetime64('2009-01-01') - np.datetime64('2008-01-01')
numpy.timedelta64(366,'D')
```

```
>>> np.datetime64('2009') + np.timedelta64(20, 'D')
numpy.datetime64('2009-01-21')
```

```
>>> np.datetime64('2011-06-15T00:00') + np.timedelta64(12, 'h')
numpy.datetime64('2011-06-15T12:00')
```

Pandas et *datetime*

```
dti = pd.to_datetime(["1/1/2018", np.datetime64("2018-01-01"),
datetime.datetime(2018, 1, 1)])
```

pandas.to_datetime

pandas.to_datetime(*arg, errors='raise', dayfirst=False, yearfirst=False, utc=None, format=None, exact=True, unit=None, infer_datetime_format=False, origin='unix', cache=True*) [source]

Convert argument to datetime.

Parameters:

arg : *int, float, str, datetime, list, tuple, 1-d array, Series, DataFrame/dict-like*

The object to convert to a datetime.

errors : *{'ignore', 'raise', 'coerce'}, default 'raise'*

- If 'raise', then invalid parsing will raise an exception.
- If 'coerce', then invalid parsing will be set as NaT.
- If 'ignore', then invalid parsing will return the input.

dayfirst : *bool, default False*

Specify a date parse order if *arg* is str or its list-likes. If True, parses dates with the day first, eg 10/11/12 is parsed as 2012-11-10. Warning: dayfirst=True is not strict, but will prefer to parse with day first (this is a known bug, based on dateutil behavior).

yearfirst : *bool, default False*

Specify a date parse order if *arg* is str or its list-likes.

- If True parses dates with the year first, eg 10/11/12 is parsed as 2010-11-12.
- If both dayfirst and yearfirst are True, yearfirst is preceded (same as dateutil).

Warning: yearfirst=True is not strict, but will prefer to parse with year first (this is a known bug, based on dateutil behavior).

utc : *bool, default None*

Return UTC DatetimeIndex if True (converting any tz-aware datetime.datetime objects as well).

format : *str, default None*

The strftime to parse time, eg "%d/%m/%Y", note that "%f" will parse all the way up to nanoseconds. See strftime documentation for more information on choices: https://docs.python.org/3/library/datetime.html#strftime-and-strptime-behavior.

exact : *bool, True by default*

Behaves as: - If True, require an exact format match. - If False, allow the format to match anywhere in the target string.

unit : *str, default 'ns'*

The unit of the arg (D,s,ms,us,ns) denote the unit, which is an integer or float number. This will be based off the origin. Example, with unit='ms' and origin='unix' (the default), this would calculate the number of milliseconds to the unix epoch start.

infer_datetime_format : *bool, default False*

If True and no *format* is given, attempt to infer the format of the datetime strings based on the first non-NaN element, and if it can be inferred, switch to a faster method of parsing them. In some cases this can increase the parsing speed by ~5-10x.

origin : *scalar, default 'unix'*

Define the reference date. The numeric values would be parsed as number of units (defined by *unit*) since this reference date.

- If 'unix' (or POSIX) time; origin is set to 1970-01-01.
- If 'julian', unit must be 'D', and origin is set to beginning of Julian Calendar. Julian day number 0 is assigned to the day starting at noon on January 1, 4713 BC.
- If Timestamp convertible, origin is set to Timestamp identified by origin.

https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html

Lorsque la date est sur plusieurs colonnes

	year	month	day
0	2015	2	4
1	2016	3	5

```
pd.to_datetime(df)
```

```
0   2015-02-04
1   2016-03-05
```

	year	month	day	temp
0	2015	2	4	15
1	2016	3	5	20

```
pd.to_datetime(df[['year','month','day']])
```

```
df['date'] =
pd.to_datetime(df[['year', 'month', 'day']])
```

	year	month	day	temp	date
0	2015	2	4	15	2015-02-04
1	2016	3	5	20	2016-03-05

```
df.set_index('date')
```

```
df.set_index('date', inplace=True)
```

	year	month	day	temp
date				
2015-02-04	2015	2	4	15
2016-03-05	2016	3	5	20

```
df.drop(['year', 'month', 'day'],axis=1, inplace=True)
```

	temp
date	
2015-02-04	15
2016-03-05	20

Manipulating and converting date times with timezone information

```
In [6]: dti = dti.tz_localize("UTC")

In [7]: dti
Out[7]:
DatetimeIndex(['2018-01-01 00:00:00+00:00', '2018-01-01 01:00:00+00:00',
               '2018-01-01 02:00:00+00:00'],
              dtype='datetime64[ns, UTC]', freq='H')

In [8]: dti.tz_convert("US/Pacific")
Out[8]:
DatetimeIndex(['2017-12-31 16:00:00-08:00', '2017-12-31 17:00:00-08:00',
               '2017-12-31 18:00:00-08:00'],
              dtype='datetime64[ns, US/Pacific]', freq='H')
```

Resampling or converting a time series to a particular frequency

```
In [9]: idx = pd.date_range("2018-01-01", periods=5, freq="H")

In [10]: ts = pd.Series(range(len(idx)), index=idx)

In [11]: ts
Out[11]:
2018-01-01 00:00:00    0
2018-01-01 01:00:00    1
2018-01-01 02:00:00    2
2018-01-01 03:00:00    3
2018-01-01 04:00:00    4
Freq: H, dtype: int64

In [12]: ts.resample("2H").mean()
Out[12]:
2018-01-01 00:00:00    0.5
2018-01-01 02:00:00    2.5
2018-01-01 04:00:00    4.0
Freq: 2H, dtype: float64
```

If you use dates which start with the day first (i.e. European style), you can pass the `dayfirst` flag:

```
In [45]: pd.to_datetime(["04-01-2012 10:00"], dayfirst=True)
Out[45]: DatetimeIndex(['2012-01-04 10:00:00'], dtype='datetime64[ns]', freq=None)

In [46]: pd.to_datetime(["14-01-2012", "01-14-2012"], dayfirst=True)
Out[46]: DatetimeIndex(['2012-01-14', '2012-01-14'], dtype='datetime64[ns]', freq=None)
```

Warning

You see in the above example that `dayfirst` isn't strict, so if a date can't be parsed with the day being first it will be parsed as if `dayfirst` were False.

Invalid data

The default behavior, `errors='raise'`, is to raise when unparsable:

```
In [2]: pd.to_datetime(['2009/07/31', 'asd'], errors='raise')
ValueError: Unknown string format
```

Pass `errors='ignore'` to return the original input when unparsable:

```
In [56]: pd.to_datetime(["2009/07/31", "asd"], errors="ignore")
Out[56]: Index(['2009/07/31', 'asd'], dtype='object')
```

Pass `errors='coerce'` to convert unparsable data to `NaT` (not a time):

```
In [57]: pd.to_datetime(["2009/07/31", "asd"], errors="coerce")
Out[57]: DatetimeIndex(['2009-07-31', 'NaT'], dtype='datetime64[ns]', freq=None)
```

Des formats de dates spécifiques

```
df = pd.DataFrame({'date': ['2016-6-10 20:30:0',
                            '2016-7-1 19:45:30',
                            '2013-10-12 4:5:1'],
                   'value': [2, 3, 4]})

df['date'] = pd.to_datetime(df['date'], format="%Y-%d-%m %H:%M:%S")
df
```

	date	value
0	2016-10-06 20:30:00	2
1	2016-01-07 19:45:30	3
2	2013-12-10 04:05:01	4

Ajouter une colonne « âge »

5. Get the age from the date of birth

The simplest solution to get age is by subtracting year:

```
today = pd.to_datetime('today')
df['age'] = today.year - df['DoB'].dt.year

df
```

	name	DoB	year	month	day	week_of_year	day_of_week	is_leap_year	day_of_week_name	age
0	Tom	1997-08-05	1997	8	5	32	1	False	Tuesday	23
1	Andy	1996-04-28	1996	4	28	17	6	True	Sunday	24
2	Lucas	1995-12-16	1995	12	16	50	5	False	Saturday	25

https://towardsdatascience.com/working-with-datetime-in-pandas-dataframe-663f7af6c587

However, this is not accurate as people might haven't had their birthday this year. A more accurate solution would be to consider the birthday

```
# Year difference
today = pd.to_datetime('today')
diff_y = today.year - df['DoB'].dt.year
# Haven't had birthday
b_md = df['DoB'].apply(lambda x: (x.month,x.day) )
no_birthday = b_md > (today.month,today.day)

df['age'] = diff_y - no_birthday
df
```

	name	DoB	year	month	day	week_of_year	day_of_week	is_leap_year	day_of_week_name	age
0	Tom	1997-08-05	1997	8	5	32	1	False	Tuesday	23
1	Andy	1996-04-28	1996	4	28	17	6	True	Sunday	24
2	Lucas	1995-12-16	1995	12	16	50	5	False	Saturday	24

https://towardsdatascience.com/working-with-datetime-in-pandas-dataframe-663f7af6c587

Sélectionner selon l'année

```
df.loc['2018']
```

date	num	city
2018-01-01 09:00:00	2	London
2018-01-01 09:01:00	1	London
2018-01-01 09:02:00	3	London
2018-01-01 09:03:00	3	London
2018-01-01 09:04:00	3	London
...	...	...
2018-12-31 15:56:00	4	Cambridge
2018-12-31 15:57:00	2	Cambridge
2018-12-31 15:58:00	3	Cambridge
2018-12-31 15:59:00	3	Cambridge
2018-12-31 16:00:00	2	Cambridge

439524 rows × 2 columns

Get the total num in 2018

```
df.loc['2018','num'].sum()

1231190
```

Get the total num for each city in 2018

```
df['2018'].groupby('city').sum()
```

city	num
Cambridge	308428
Durham	307965
London	307431
Oxford	307366

Sélectionner une période

Select data between 2016 and 2018

```
df.loc['2016' : '2018']
```

Select data between 10 and 11 o'clock on the 2nd May 2018

```
df.loc['2018-5-2 10' : '2018-5-2 11' ]
```

Select data between 10:30 and 10:45 on the 2nd May 2018

```
df.loc['2018-5-2 10:30' : '2018-5-2 10:45' ]
```

And to select data between time, we should use `between_time()`, for example, 10:30 and 10:45

```
df.between_time('10:30','10:45')
```

https://towardsdatascience.com/working-with-datetime-in-pandas-dataframe-663f7af6c587

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Séries temporelles

DateOffsets

Alias	Description
B	business day frequency
C	custom business day frequency
D	calendar day frequency
W	weekly frequency
M	month end frequency
SM	semi-month end frequency (15th and end of month)
BM	business month end frequency
CBM	custom business month end frequency
MS	month start frequency
SMS	semi-month start frequency (1st and 15th)
BMS	business month start frequency
BQS	business quarter start frequency
A, Y	year end frequency
BA, BY	business year end frequency
AS, YS	year start frequency
BAS, BYS	business year start frequency
BH	business hour frequency
H	hourly frequency
T, min	minutely frequency
S	secondly frequency
L, ms	milliseconds
U, us	microseconds
N	nanoseconds

https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html#offset-aliases

```
In [238]: pd.date_range(start, periods=5, freq="B")
Out[238]:
DatetimeIndex(['2011-01-03', '2011-01-04', '2011-01-05', '2011-01-06',
               '2011-01-07'],
              dtype='datetime64[ns]', freq='B')

In [239]: pd.date_range(start, periods=5, freq=pd.offsets.BDay())
Out[239]:
DatetimeIndex(['2011-01-03', '2011-01-04', '2011-01-05', '2011-01-06',
               '2011-01-07'],
              dtype='datetime64[ns]', freq='B')
```

You can combine together day and intraday offsets:

```
In [240]: pd.date_range(start, periods=10, freq="2h20min")
Out[240]:
DatetimeIndex(['2011-01-01 00:00:00', '2011-01-01 02:20:00',
               '2011-01-01 04:40:00', '2011-01-01 07:00:00',
               '2011-01-01 09:20:00', '2011-01-01 11:40:00',
               '2011-01-01 14:00:00', '2011-01-01 16:20:00',
               '2011-01-01 18:40:00', '2011-01-01 21:00:00'],
              dtype='datetime64[ns]', freq='140T')

In [241]: pd.date_range(start, periods=10, freq="1D10U")
Out[241]:
DatetimeIndex([       '2011-01-01 00:00:00', '2011-01-02 00:00:00.000010',
               '2011-01-03 00:00:00.000020', '2011-01-04 00:00:00.000030',
               '2011-01-05 00:00:00.000040', '2011-01-06 00:00:00.000050',
               '2011-01-07 00:00:00.000060', '2011-01-08 00:00:00.000070',
               '2011-01-09 00:00:00.000080', '2011-01-10 00:00:00.000090'],
              dtype='datetime64[ns]', freq='86400000010U')
```

Sélectionner les lignes pour un jour (n°) donné

dataframe[‘colonne’].day n’est pas possible

AttributeError: 'Series' object has no attribute 'days'

pandas.Series.dt

```
Series.dt()
```

Accessor object for datetimelike properties of the Series values.

```
rythme[rythme['creationDate'].dt.day==27].head()
```

```
rythme.query('creationDate.dt.day==27').head()
```

	creationDate	startDate	value
24016	2020-05-27 17:59:38+01:00	2020-05-27 17:56:03+01:00	98
24017	2020-05-27 18:05:26+01:00	2020-05-27 18:02:36+01:00	85
24018	2020-05-27 18:07:07+01:00	2020-05-27 18:07:06+01:00	85
24019	2020-05-27 18:07:07+01:00	2020-05-27 18:07:07+01:00	83
24020	2020-05-27 18:07:09+01:00	2020-05-27 18:07:08+01:00	83

Sélectionner les lignes pour un jour précis

```
mask = rythme['creationDate'].between('2022-02-27 0:00','2022-02-27 23:59')
rythme.loc[mask].head()
```

	creationDate	startDate	value
65957	2022-02-27 15:49:40+01:00	2021-04-21 15:11:51+01:00	87
65958	2022-02-27 15:52:32+01:00	2022-02-27 15:52:31+01:00	91
65959	2022-02-27 15:52:32+01:00	2022-02-27 15:52:32+01:00	90
65960	2022-02-27 15:52:34+01:00	2022-02-27 15:52:33+01:00	88
65961	2022-02-27 15:52:34+01:00	2022-02-27 15:52:34+01:00	88

mieux :

```
mask = rythme['creationDate'].between('2022-02-27','2022-02-28', inclusive='left')
```

et si date dans index :

```
df_data_minute[df_data_minute.index.get_loc("2022-02-27")]
```

```
df_data_minute.loc["2022-02-27"]
```

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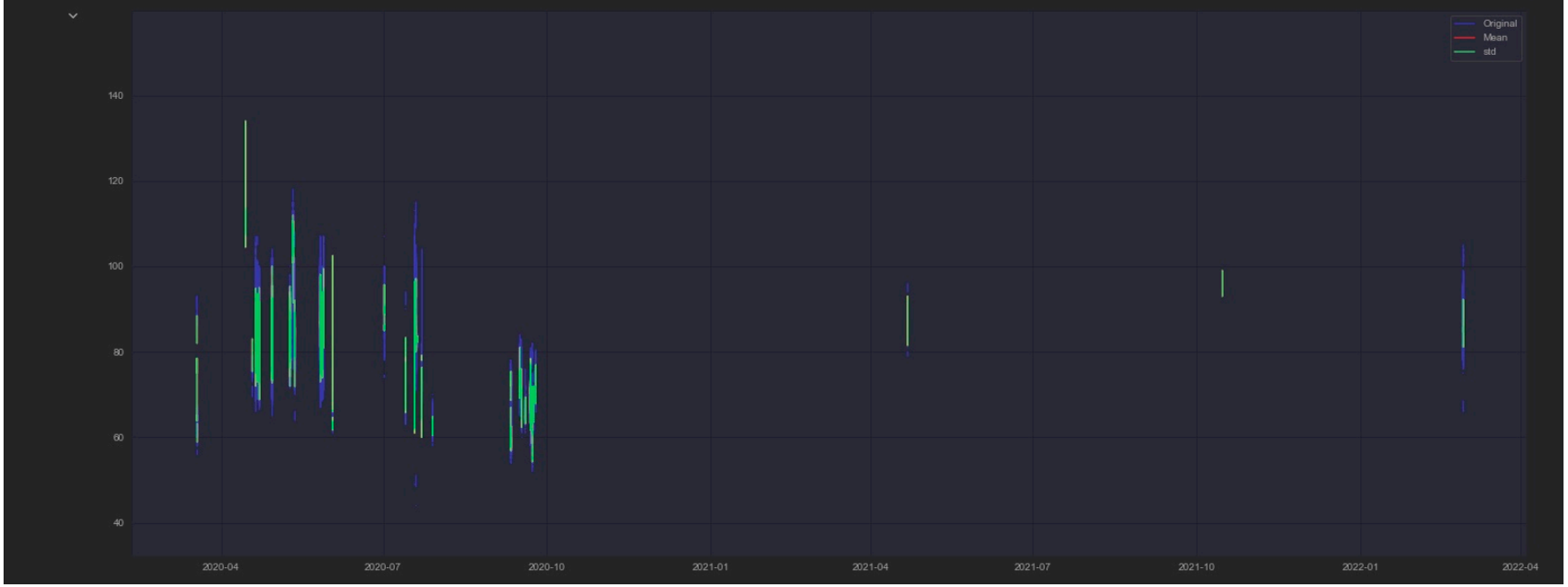
In 42
```
rythme.tail()
```

Out 42

	creationDate	startD	value
66863	2022-02-27 16:11:35+01:00	2022-...	86
66864	2022-02-27 16:11:36+01:00	2022-...	85
66865	2022-02-27 16:11:36+01:00	2022-...	85
66866	2022-02-27 16:11:38+01:00	2022-...	85
66867	2022-02-27 16:11:39+01:00	2022-...	85

5 rows × 3 columns Open in new tab

In 54
```
df_data_minute = rythme.groupby(pd.Grouper(key='creationDate', axis=0, freq='S')).mean()
df_rollmean = df_data_minute.resample(rule='T').mean()
df_rollstd = df_data_minute.resample(rule='T').std()
fig, axs = plt.subplots(1, 1, figsize=(25, 10))
axs.plot(df_data_minute['value'], color='blue', label = "Original")
axs.plot(df_rollmean['value'], color='red', label = "Mean")
axs.plot(df_rollmean['value'], color='green', label = "std")
plt.legend()
plt.show()
```



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Ré-échantillonnage

```
In 1
1 import pandas as pd
2 from datetime import datetime
3 import numpy as np
```

```
In 2
1 # création d'un intervalle temporel
2 intervalle = pd.date_range(start='2022-05-01',end='2022-05-10',freq='H')
```

```
In 5
1 intervalle
```

```
Out 5
DatetimeIndex(['2022-05-01 00:00:00', '2022-05-01 01:00:00',
               '2022-05-01 02:00:00', '2022-05-01 03:00:00',
               '2022-05-01 04:00:00', '2022-05-01 05:00:00',
               '2022-05-01 06:00:00', '2022-05-01 07:00:00',
               '2022-05-01 08:00:00', '2022-05-01 09:00:00',
               ...
               '2022-05-09 15:00:00', '2022-05-09 16:00:00',
               '2022-05-09 17:00:00', '2022-05-09 18:00:00',
               '2022-05-09 19:00:00', '2022-05-09 20:00:00',
               '2022-05-09 21:00:00', '2022-05-09 22:00:00',
               '2022-05-09 23:00:00', '2022-05-10 00:00:00'],
              dtype='datetime64[ns]', length=217, freq='H')
```

```
In 6
1 type(intervalle[0])
```

```
Out 6
pandas._libs.tslibs.timestamps.Timestamp
```

In 9
```
#création d'un dataframe avec des valeurs aléatoires
df = pd.DataFrame(np.random.randint(0,100,size=(len(intervalle))), index = intervalle, columns=["valeur"])
```

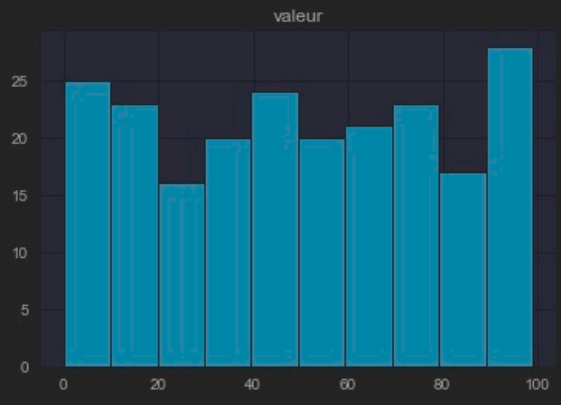
In 12
```
display(df)
```

	valeur
2022-05-01 00:00:00	7
2022-05-01 01:00:00	90
2022-05-01 02:00:00	54
2022-05-01 03:00:00	75
2022-05-01 04:00:00	22
...	...
2022-05-09 20:00:00	50
2022-05-09 21:00:00	47
2022-05-09 22:00:00	7
2022-05-09 23:00:00	7
2022-05-10 00:00:00	90

217 rows × 1 columns Open in new tab

In 13
```
df.hist()
```

Out 13
```
array([[<AxesSubplot:title={'center':'valeur'}>]], dtype=object)
```



```
df.resample('D').mean().plot()
```

```
<AxesSubplot:>
```


```
In 25   1  df.resample('D').mean()
```

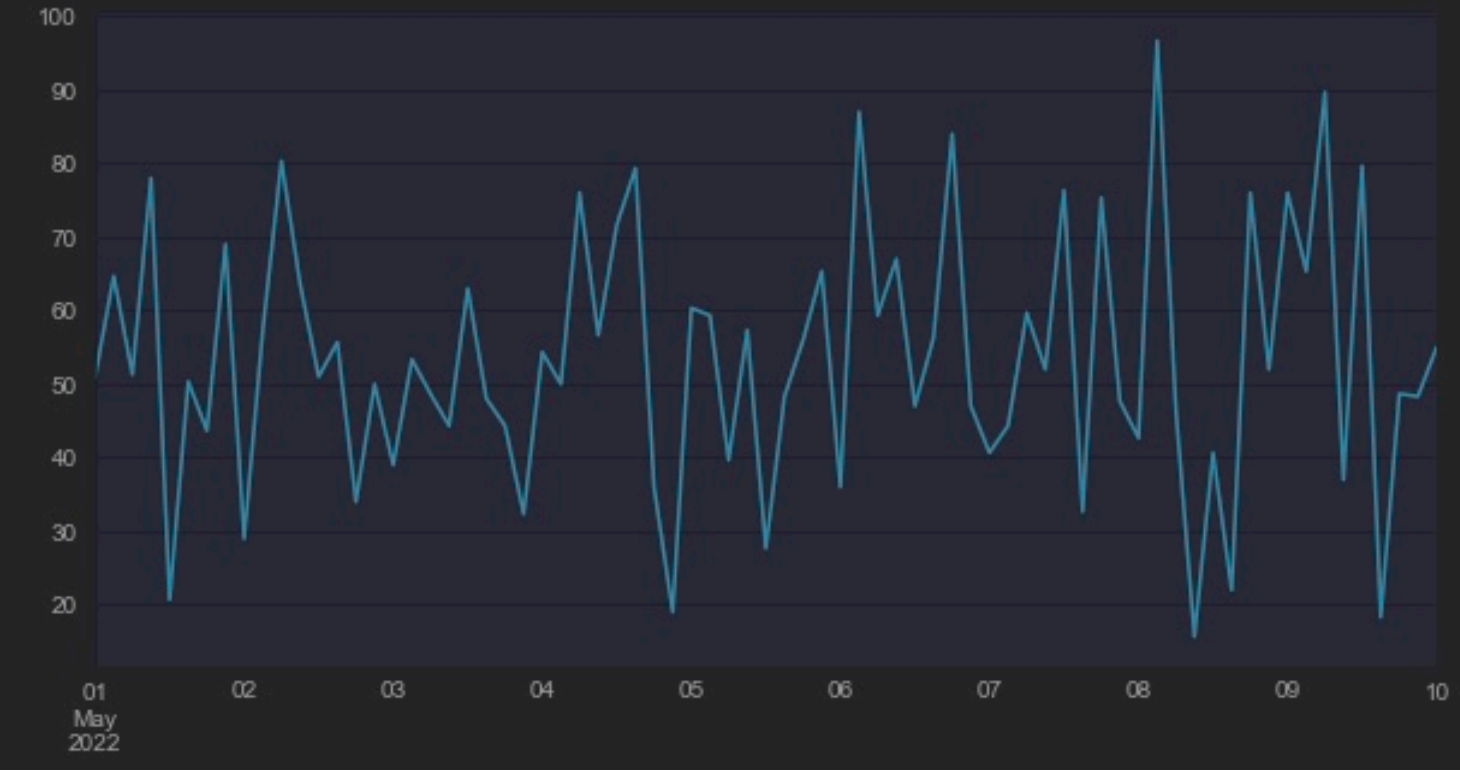
Out 25

	valeur
2022-05-01	50.625000
2022-05-02	53.375000
2022-05-03	51.875000
2022-05-04	52.708333
2022-05-05	51.208333
2022-05-06	52.541667
2022-05-07	43.375000
2022-05-08	55.125000
2022-05-09	37.000000
2022-05-10	90.000000

10 rows × 1 columns Open in new tab

```
In 52  1  df['valeur'].resample('3H').mean().plot(figsize=(10,5))

Out 52    <AxesSubplot:>
```



Somme par jour : groupby sur index

2022-05-09 20:00:00	49	146.0
2022-05-09 21:00:00	1	60.0
2022-05-09 22:00:00	77	127.0
2022-05-09 23:00:00	67	145.0
2022-05-10 00:00:00	55	199.0

```
In 48   1  df.groupby(df.index.day)['valeur'].sum()
```

Out 48

	valeur
1	1286
2	1263
3	1119
4	1329
5	1242
6	1451
7	1286
8	1177
9	1389
10	55

Synthèse par fenêtre glissante : rolling

```
df.head()
```

	valeur
2022-05-01 00:00:00	77
2022-05-01 01:00:00	60
2022-05-01 02:00:00	16
2022-05-01 03:00:00	88
2022-05-01 04:00:00	82

```
In 44   1  df['Somme par...'] = df.valeur.rolling(3).sum()
```

```
In 45   1  df
```

Out 45

	valeur	Somme par...
2022-05-01 00:00:00	77	NaN
2022-05-01 01:00:00	60	NaN
2022-05-01 02:00:00	16	153.0
2022-05-01 03:00:00	88	164.0
2022-05-01 04:00:00	82	186.0
2022-05-01 05:00:00	24	194.0
2022-05-01 06:00:00	1	107.0
2022-05-01 07:00:00	99	124.0
2022-05-01 08:00:00	54	154.0

https://pandas.pydata.org/docs/reference/api/pandas.DataFrame.rolling.html

Moyenne glissante sur 24 heures

```
In 57   1  df.valeur.rolling(24).mean().plot(figsize=(10,5))

Out 57     <AxesSubplot:>
```

Exemple de série avec tendance, cycles et saisonnalité

In 59

```
df = pd.read_csv("https://raw.githubusercontent.com/AileenNielsen/TimeSeriesAnalysisWithPython/master/data/AirPassengers.csv")
df['Month'] = pd.to_datetime(df['Month'],infer_datetime_format=True)
df = df.set_index(['Month'])
df.head(10)
```

Out 59

Month	#Passe
1949-01-01	112
1949-02-01	118
1949-03-01	132
1949-04-01	129
1949-05-01	121
1949-06-01	135
1949-07-01	148
1949-08-01	148
1949-09-01	136
1949-10-01	119

```
In 62  1  df.info()

<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 144 entries, 1949-01-01 to 1960-12-01
Data columns (total 1 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   #Passengers  144 non-null    int64
dtypes: int64(1)
memory usage: 2.2 KB

In 63  1  df.describe()
```

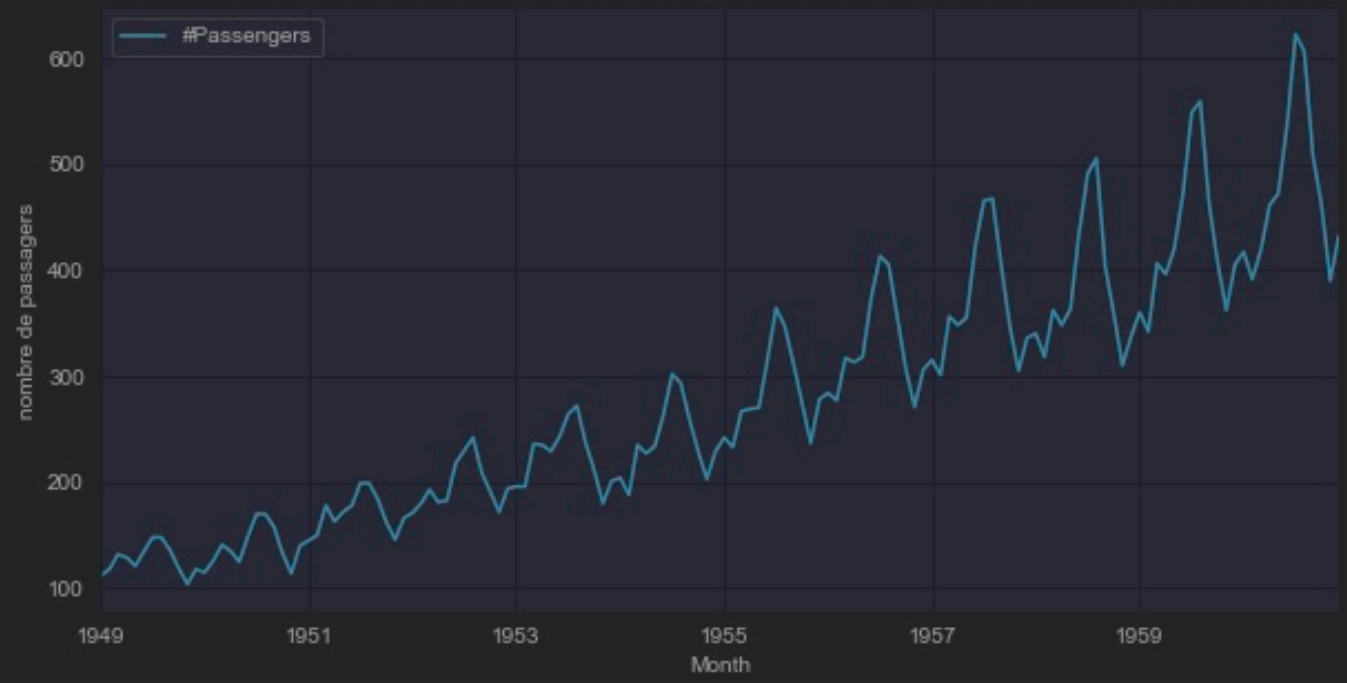
Out 63

	#Passe
count	144.0...
mean	280.2...
std	119.9...
min	104.0...
25%	180.0...
50%	265.5...
75%	360.5...
max	622.0...

8 rows × 1 columns Open in new tab

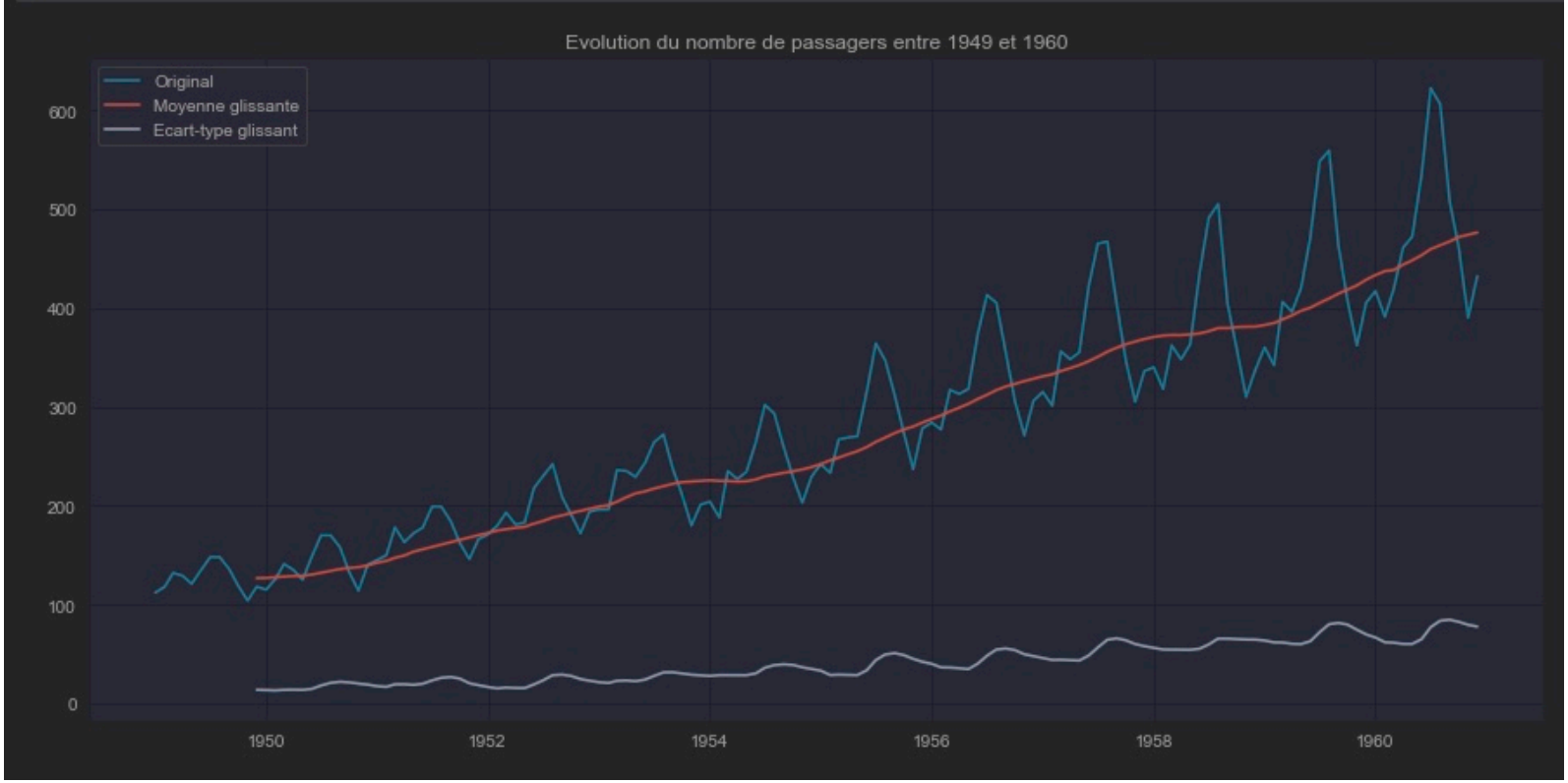
```
df.plot(figsize=(10,5), ylabel='nombre de passagers')
```

```
<AxesSubplot:xlabel='Month', ylabel='nombre de passagers'>
```



```
df["Moyenne glissante"] = df['#Passengers'].rolling(window=12).mean()
df["Ecart-type glissant"] = df['#Passengers'].rolling(window=12).std()
```

```
import matplotlib.pyplot as plt
plt.figure(figsize=(15,7))
plt.plot(df["#Passengers"], color='#379BDB', label='Original')
plt.plot(df["Moyenne glissante"], color='#D22A0D', label='Moyenne glissante')
plt.plot(df["Ecart-type glissant"], color='#142039', label='Ecart-type glissant')
plt.legend(loc='best')
plt.title('Evolution du nombre de passagers entre 1949 et 1960')
plt.show(block=False)
```



Stationnarité ? Non !

```
from statsmodels.tsa.stattools import adfuller
import pmdarima as pm
#Augmented Dickey-Fuller test:
print('Results of Dickey Fuller Test:')
dftest = adfuller(df['#Passengers'], autolag='AIC')

dfoutput = pd.Series(dftest[0:4], index=['Test Statistic','p-value','#Lags Used','Number of Observations Used'])
for key,value in dftest[4].items():
    dfoutput['Critical Value (%s)'%key] = value

print(dfoutput)
```

```
Results of Dickey Fuller Test:
Test Statistic                  0.815369
p-value                         0.991880
#Lags Used                     13.000000
Number of Observations Used    130.000000
```

Risque de se tromper en affirmant qu'elle est stationnaire > 99,1 %

Essai de modélisation avec ARIMA

Prise en compte des valeurs antérieures (auto-régressif)
+ des moyennes mobiles (lissage) avec suppression de la tendance générale

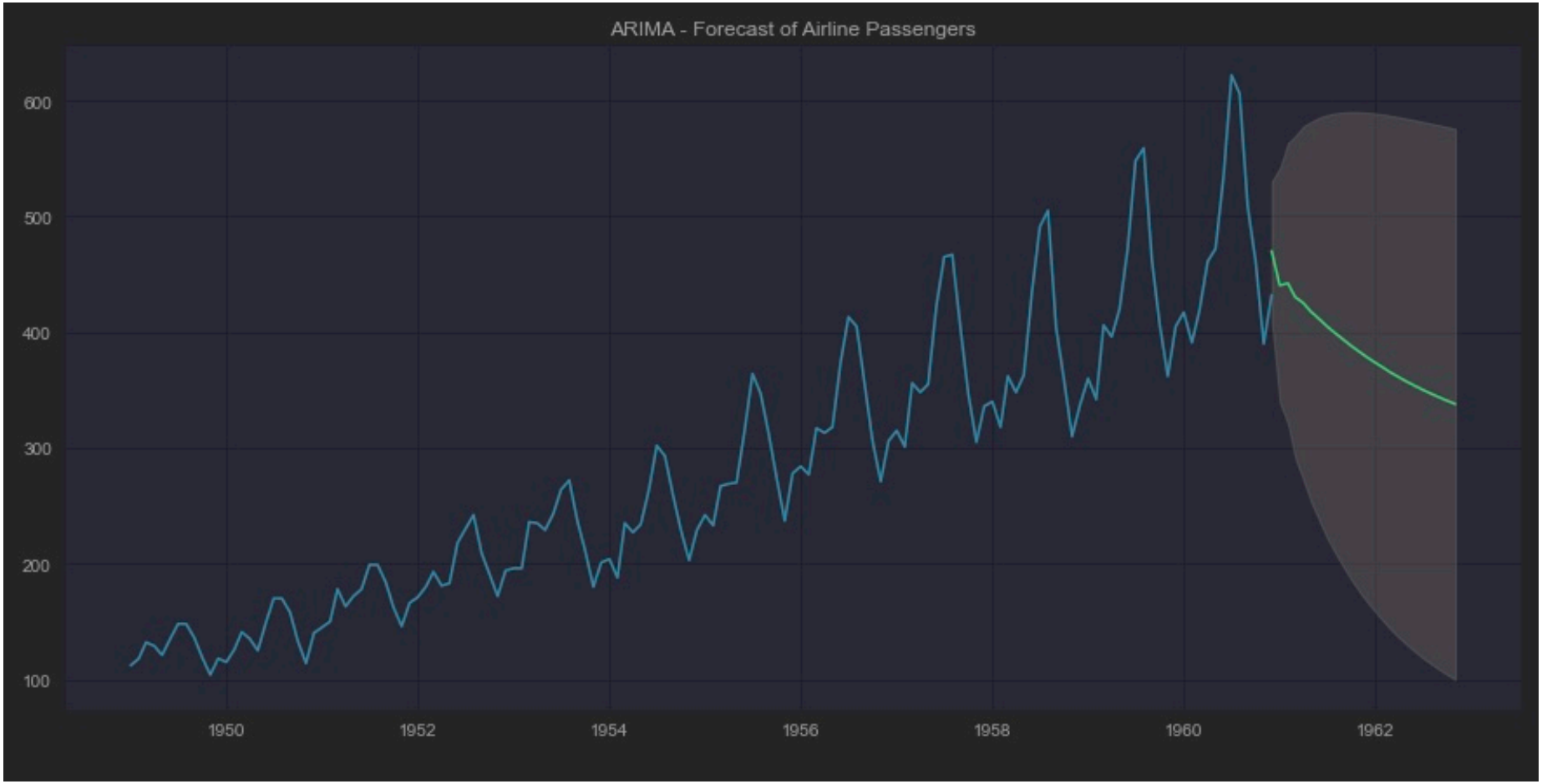
```
def forecast(ARIMA_model, periods=24):
    # Forecast
    n_periods = periods
    fitted, confint = ARIMA_model.predict(n_periods=n_periods, return_conf_int=True)
    index_of_fc = pd.date_range(df.index[-1], periods = n_periods, freq='MS')

    # make series for plotting purpose
    fitted_series = pd.Series(fitted, index=index_of_fc)
    lower_series = pd.Series(confint[:, 0], index=index_of_fc)
    upper_series = pd.Series(confint[:, 1], index=index_of_fc)

    # Plot
    plt.figure(figsize=(15,7))
    plt.plot(df["#Passengers"], color='#1f76b4')
    plt.plot(fitted_series, color='darkgreen')
    plt.fill_between(lower_series.index,
                     lower_series,
                     upper_series,
                     color='k', alpha=.15)

    plt.title("ARIMA - Forecast of Airline Passengers")
    plt.show()

forecast(ARIMA_model)
```

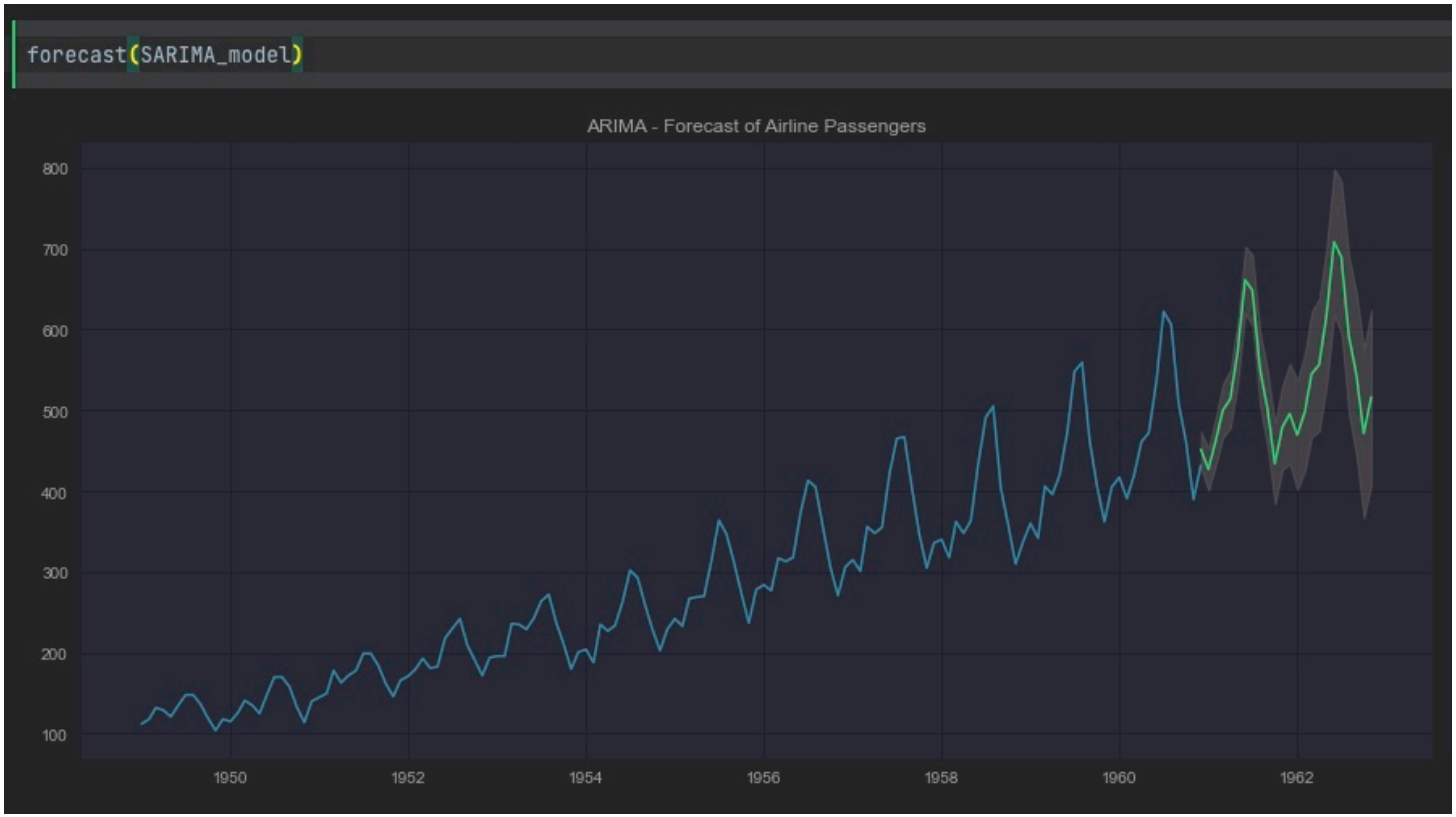

ARIMA - Forecast of Airline Passengers
600
500
400
300
200
100
1950
1952
1954
1956
1958
1960
1962

Essai avec SARIMA

Ajout d'une composante saisonnière

```
# Seasonal - fit stepwise auto-ARIMA
SARIMA_model = pm.auto_arima(df["#Passengers"], start_p=1, start_q=1,
                             test='adf',
                             max_p=3, max_q=3,
                             m=12, #12 is the freguncy of the cycle
                             start_P=0,
                             seasonal=True, #set to seasonal
                             d=None,
                             D=1, #order of the seasonal differencing
                             trace=False,
                             error_action='ignore',
                             suppress_warnings=True,
                             stepwise=True)
```

```
forecast(SARIMA_model)
```



Aix*Marseille université
Socialement engagée

Les données textuelles

Pandas, Représentations vectorielles, NLTK…

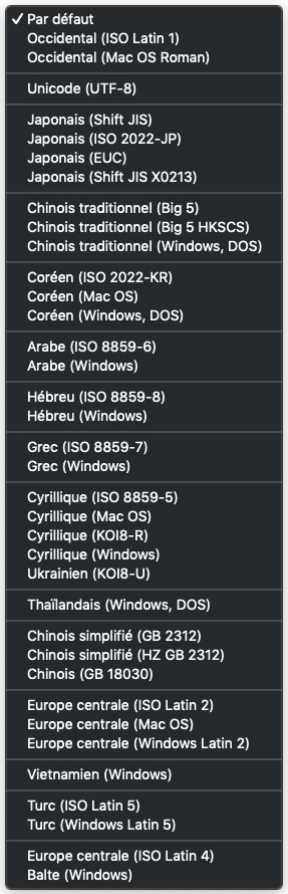
Qu’est-ce qu’un texte ?

Des caractères, des mots, des phrases, des concepts, des documents
Des références, des structures (syntaxe, discours), des rôles

Analyse lexicale, analyse syntaxique, analyse sémantique, pragmatique

Des arborescences, des sacs de mots, des représentations distribuées, des formes

L’encodage des caractères



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68	44	D	100	64	d
69	45	E	101	65	e
70	46	F	102	66	f
71	47	G	103	67	g
72	48	H	104	68	h
73	49	I	105	69	i
74	4A	J	106	6A	j
75	4B	K	107	6B	k
76	4C	L	108	6C	l
77	4D	M	109	6D	m
78	4E	N	110	6E	n
79	4F	O	111	6F	o
80	50	P	112	70	p
81	51	Q	113	71	q

7	00A8	00A9	00AA	00AB	00AC	00A
7	00B8	00B9	00BA	00BB	00BC	00B
7	00C8	00C9	00CA	00CB	00CC	00C
7	00D8	00D9	00DA	00DB	00DC	00D
7	00E8	00E9	00EA	00EB	00EC	00E
7	00F8	00F9	00FA	00FB	00FC	00F

ISO-Latin 1 sur 8 bits
(ISO/CEI 8859)

face-smiling

№	Code	Browser	Appl	Goog	FB
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940	ά	έ	ή	ί	ΰ	α	β	γ	δ	ε
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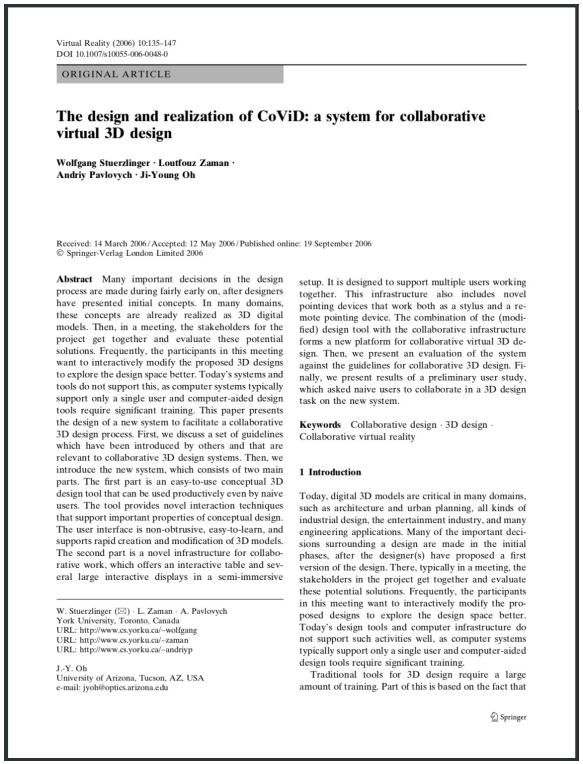
1100	ь	э	ю	я	ѐ	ё	ђ	ѓ	є	ѕ
1110	і	ї	ј	љ	њ	ћ	ќ	ѝ	ў	џ
1120	Ѡ	ѡ	Ѣ	ѣ	Ѥ	ѥ	Ѧ	ѧ	Ѩ	ѩ

Unicode (1988) dont UTF-8
plus de 100 000 caractères
(dont > 3 000 émojis)
de 1 jusqu’à 6 octets

https://unicode.org/emoji/

L'encodage des documents



Virtual Reality (2006) 10:135–147
DOI 10.1007/s10055-006-0048-0

ORIGINAL ARTICLE

The design and realization of CoViD: a system for collaborative virtual 3D design

Wolfgang Stuerzlinger · Loutfouz Zaman · Andriy Pavlovych · Ji-Young Oh

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Abstract Many important decisions in the design process are made during fairly early on, after designers have presented initial concepts. In many domains, these concepts are already realized as 3D digital models. Then, in a meeting, the stakeholders for the project get together and evaluate these potential solutions. Frequently, the participants in this meeting want to interactively modify the proposed 3D designs to explore the design space better. Today's systems and tools do not support this, as computer systems typically support only a single user and computer-aided design tools require significant training. This paper presents the design of a new system to facilitate a collaborative 3D design process. First, we discuss a set of guidelines which have been introduced by others and that are relevant to collaborative 3D design systems. Then, we introduce the new system, which consists of two main parts. The first part is an easy-to-use conceptual 3D design tool that can be used productively even by naive users. The tool provides novel interaction techniques that support important properties of conceptual design. The user interface is non-obtrusive, easy-to-learn, and supports rapid creation and modification of 3D models. The second part is a novel infrastructure for collaborative work, which offers an interactive table and several large interactive displays in a semi-immersive setup. It is designed to support multiple users working together. This infrastructure also includes novel pointing devices that work both as a stylus and a remote pointing device. The combination of the (modified) design tool with the collaborative infrastructure forms a new platform for collaborative virtual 3D design. Then, we present an evaluation of the system against the guidelines for collaborative 3D design. Finally, we present results of a preliminary user study, which asked naive users to collaborate in a 3D design task on the new system.

Keywords Collaborative design · 3D design · Collaborative virtual reality

1 Introduction

Today, digital 3D models are critical in many domains, such as architecture and urban planning, all kinds of industrial design, the entertainment industry, and many engineering applications. Many of the important decisions surrounding a design are made in the initial phases, after the designer(s) have proposed a first version of the design. There, typically in a meeting, the stakeholders in the project get together and evaluate these potential solutions. Frequently, the participants in this meeting want to interactively modify the proposed designs to explore the design space better. Today's design tools and computer infrastructure do not support such activities well, as computer systems typically support only a single user and computer-aided design tools require significant training.

Traditional tools for 3D design require a large amount of training. Part of this is based on the fact that

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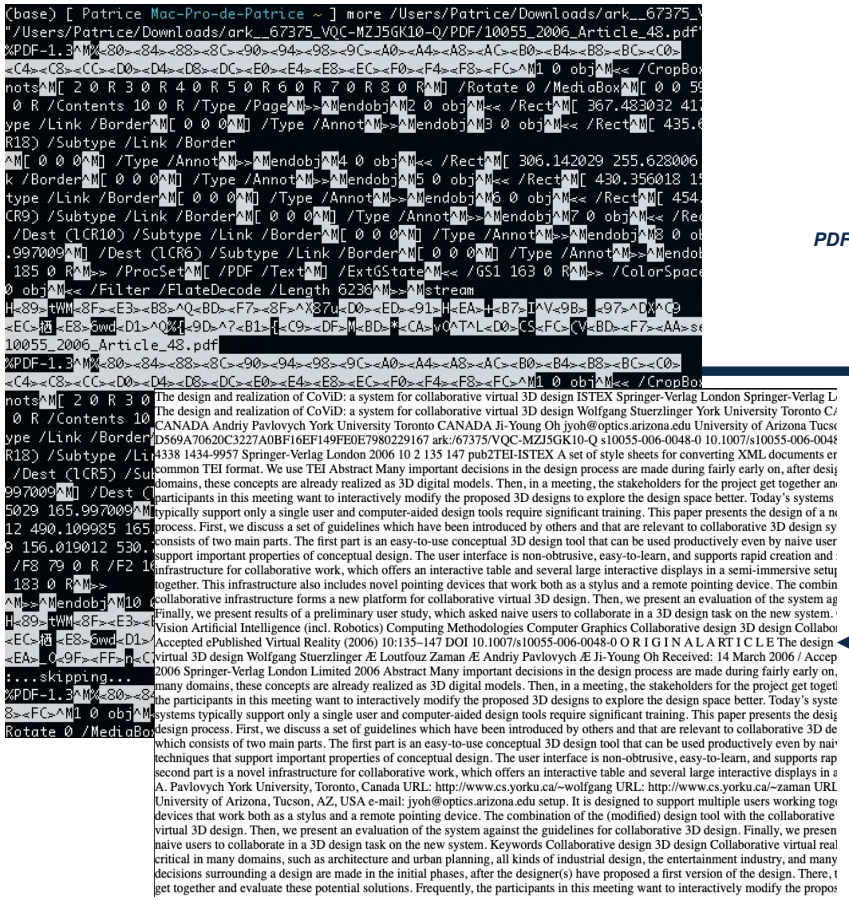
Evitons les PDF…

PDF to text



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The design and realization of CoViD: a system for collaborative virtual 3D design ISTEX Springer-Verlag London Springer-Verlag L
The design and realization of CoViD: a system for collaborative virtual 3D design Wolfgang Stuerzlinger York University Toronto C
CANADA Andriy Pavlovych York University Toronto CANADA Ji-Young Oh jyoh@optics.arizona.edu University of Arizona Tucs
D569A70620C3227A0BF16EF149FE0E7980229167 ark:/67375/VQC-MZJ5GK10-Q s10055-006-0048-0 10.1007/s10055-006-004
4338 1434-9957 Springer-Verlag London 2006 10 2 135 147 pub2TEI-ISTEX A set of style sheets for converting XML documents e
common TEI format. We use TEI Abstract Many important decisions in the design process are made during fairly early on, after desi
domains, these concepts are already realized as 3D digital models. Then, in a meeting, the stakeholders for the project get together an
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Vision Artificial Intelligence (incl. Robotics) Computing Methodologies Computer Graphics Collaborative design 3D design Collabo
Accepted ePublished Virtual Reality (2006) 10:135–147 DOI 10.1007/s10055-006-0048-0 O R I G I N A L A R T I C L E The design
virtual 3D design Wolfgang Stuerzlinger Æ Loutfouz Zaman Æ Andriy Pavlovych Æ Ji-Young Oh Received: 14 March 2006 / Accep
2006 Springer-Verlag London Limited 2006 Abstract Many important decisions in the design process are made during fairly early on,
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A. Pavlovych York University, Toronto, Canada URL: http://www.cs.yorku.ca/~wolfgang URL: http://www.cs.yorku.ca/~zaman URL
University of Arizona, Tucson, AZ, USA e-mail: jyoh@optics.arizona.edu setup. It is designed to support multiple users working tog
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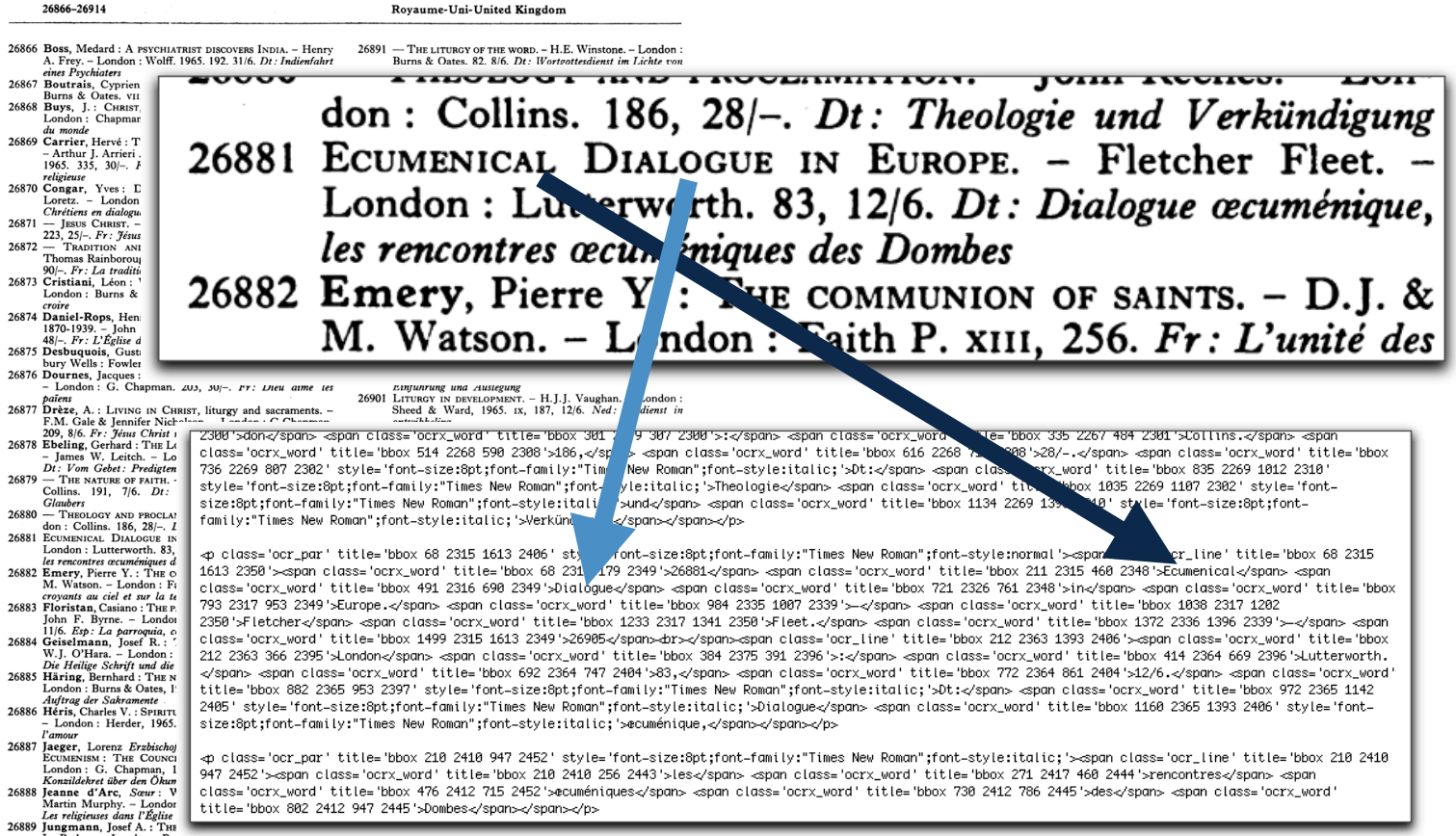
Des documents « images »



L'encodage des documents : formats ouverts et méta-données

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XML


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process are made during fairly early on, after designers
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    a semi-immersive

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URL: http://www.cs.yorku.ca/~zaman
URL: http://www.cs.yorku.ca/~andriyp
J.-Y. Oh
University of Arizona, Tucson, AZ, USA
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Keywords Collaborative design  3D design
Collaborative virtual reality
```

D'autres formats ouverts

```
"jour";"nomReg";"numReg";"incid_rea"
2020-03-19;"Auvergne-RhÙne-Alpes";84;44
2020-03-19;"Bourgogne-Franche-ComtÊ";27;33
2020-03-19;"Bretagne";53;8
2020-03-19;"Centre-Val de Loire";24;6
2020-03-19;"Corse";94;11
2020-03-19;"Grand-Est";44;69
2020-03-19;"Guadeloupe";1;0
2020-03-19;"Guyane";3;0
2020-03-19;"Hauts-de-France";32;37
2020-03-19;"Ile-de-France";11;151
2020-03-19;"La RÊunion";4;0
2020-03-19;"Martinique";2;0
2020-03-19;"Mayotte";6;0
2020-03-19;"Normandie";28;7
2020-03-19;"Nouvelle-Aquitaine";75;7
2020-03-19;"Occitanie";76;29
2020-03-19;"Pays de la Loire";52;11
2020-03-19;"Provence-Alpes-CÛte d'Azur";93;25
2020-03-20;"Auvergne-RhÙne-Alpes";84;16
2020-03-20;"Bourgogne-Franche-ComtÊ";27;9
2020-03-20;"Bretagne";53;2
2020-03-20;"Centre-Val de Loire";24;4
2020-03-20;"Corse";94;0
2020-03-20;"Grand-Est";44;45
```

CSV

https://en.wikipedia.org/wiki/Comma-separated_values

```
"header": {
  "title": "The JSON example",
  "descriptionText": "This is some title text."
},
"content": {
  "title": "The content example text",
  "elements": [
    {
      "title": "The first element",
      "mainText": "First element main text",
      "additionalText": "First element additional te
    },
    {
      "title": "The second element",
      "mainText": "Second element main text",
      "additionalText": "Second element additional
```

JSON

https://en.wikipedia.org/wiki/JSON

```
---
receipt:     Oz-Ware Purchase Invoice
date:        2012-08-06
customer:
    first_name:   Dorothy
    family_name:  Gale

items:
    - part_no:   A4786
      descrip:   Water Bucket (Filled)
      price:     1.47
      quantity:  4

    - part_no:   E1628
      descrip:   High Heeled "Ruby" Slippers
      size:      8
      price:     133.7
      quantity:  1

bill-to:  &id001
    street: |
            123 Tornado Alley
            Suite 16
    city:   East Centerville
    state:  KS

ship-to:  *id001

specialDelivery:  >
    Follow the Yellow Brick
```

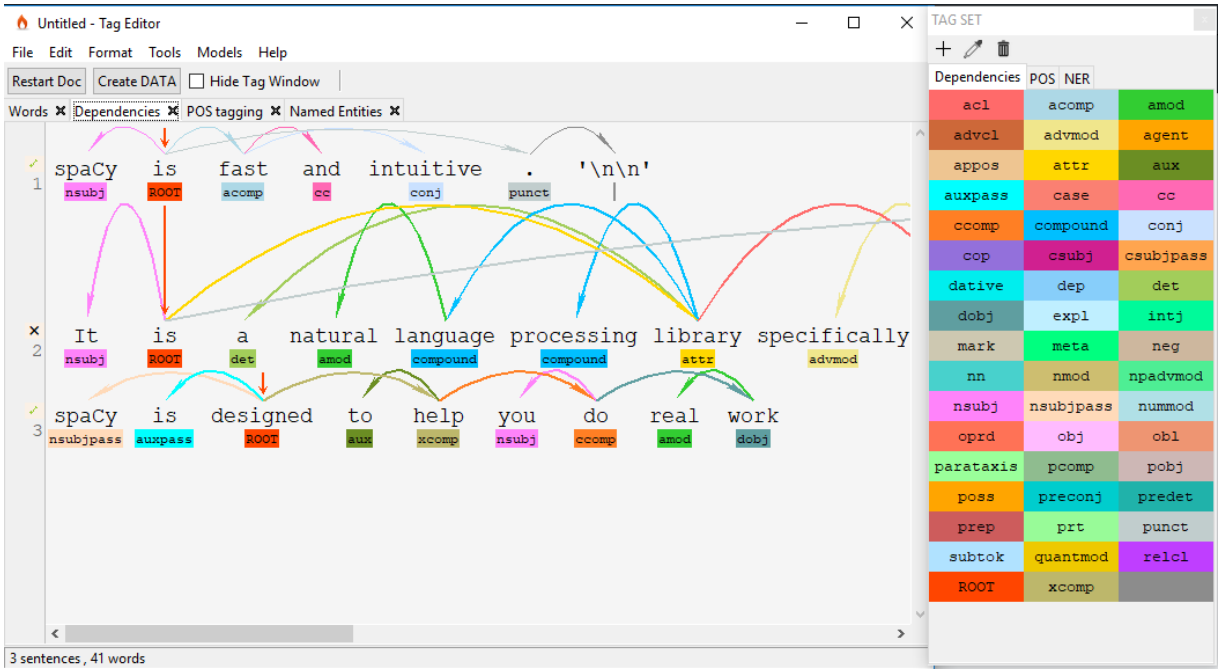
YAML

https://en.wikipedia.org/wiki/YAML

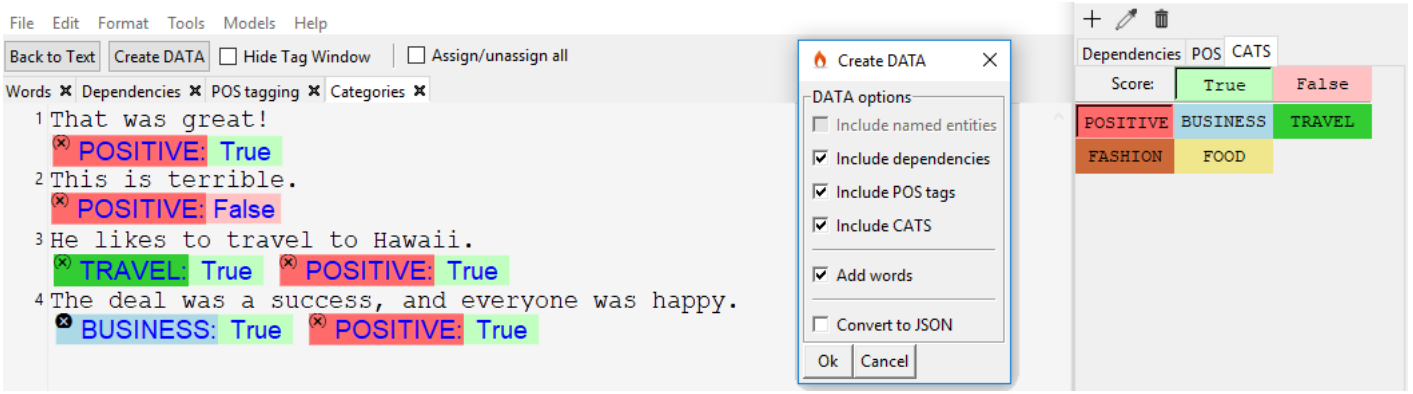
Balises orientées affichage vs. annotations sémantiques

BACHELARD, Gaston
1975 *La formation de l'esprit scientifique* (Paris, Librairie philosophique J. Vrin) [1re éd. 1938].
BARTHES, Roland
1957 *Mythologies* (Paris, Le Seuil).
BENVENISTE, Émile
1966 De la subjectivité dans le langage, *in* É. Benveniste (dir.), *Problèmes de linguistique générale*, I (Paris, Gallimard) : 258-266.
1974 La forme et le sens dans le langage, *in* É. Benveniste (dir.), *Problèmes de linguistique générale*, II (Paris, Gallimard) : 215-240.

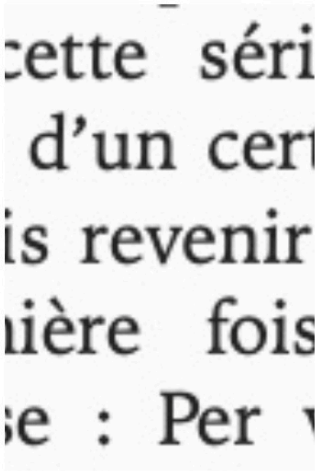
```
<bibl><hi rend="bold">C</hi><hi rend="small-caps bold">oupry</hi><hi rend="bold">, François<lb/></hi>1999 <hi r
<bibl><hi rend="bold">C</hi><hi rend="small-caps bold">ruz</hi><hi rend="bold"> S</hi><hi rend="small-caps bold
<bibl><hi rend="bold">D</hi><hi rend="small-caps bold">escola</hi><hi rend="bold">, Philippe<lb/></hi>1994 Rétr
<bibl><hi rend="bold">D</hi><hi rend="small-caps bold">ubois</hi><hi rend="bold">, Jacques<lb/></hi>1992 <hi re
<bibl>
  <hi xml:lang="en" rend="italic bold">Etnoloska sticisca</hi>
  <hi xml:lang="en" rend="italic bold">
    <lb/>
  </hi>
  <hi xml:lang="en">1997 </hi>
  <hi xml:lang="en" rend="italic">Prejudices and stereotypes in the social sciences and humanities</hi>
  <hi xml:lang="en">, 5 et 7 (Ljubljana, Jezernik, Bozidzr Ed.).</hi>
</bibl>
<bibl><hi rend="bold">F</hi><hi rend="small-caps bold">erney</hi><hi rend="bold">, Alice<lb/></hi>1997 <hi rend
<bibl><hi rend="bold">G</hi><hi rend="small-caps bold">eertz</hi><hi rend="bold">, Clifford<lb/></hi>1986 Comme
<bibl>
  <hi xml:lang="en" rend="bold">G</hi>
  <hi xml:lang="en" rend="small-caps bold">ilman</hi>
  <hi xml:lang="en" rend="bold">, Sander L.<lb/></hi>
  <hi xml:lang="en">1985 </hi>
  <hi xml:lang="en" rend="italic">Difference and pathology, stereotypes of sexuality, race and madness</hi>
  <hi xml:lang="en"> (Ithaca, Cornell University Press).</hi>
</bibl>
```



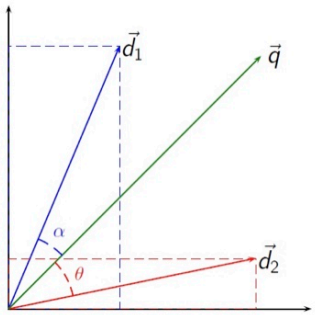
https://github.com/d5555/TagEditor



Des formes, des distributions et des vecteurs



Des formes rassemblées,
des sacs (de lettres, de mots)



Des vecteurs

Mot	Probabilité

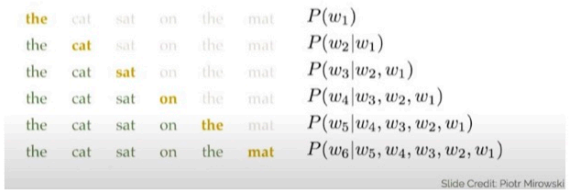
Des modèles de langues

$$P(Classe|(w_1, w_2, ..., w_{T-1}, w_T))$$

$$\text{Similarité}(d_1, d_2) \approx \vec{d_1}.\vec{d_2}$$

$$\text{Similarité}(d_1, d_2) \approx \cos(\vec{d_1}, \vec{d_2})$$

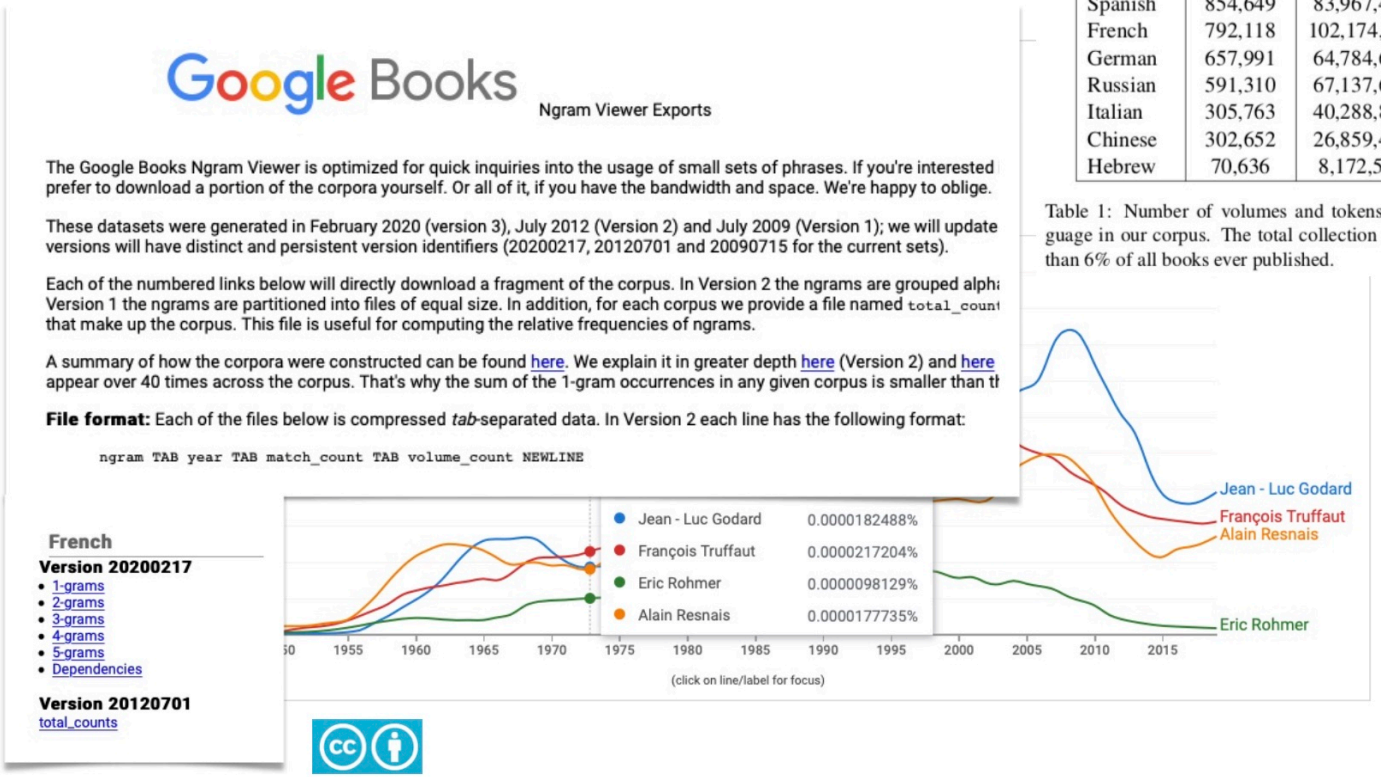
$$P(w_1, w_2, ..., w_{T-1}, w_T) = \prod_{t=1}^{T} P(w_t|w_{t-1}, w_{t-2}, ..., w_1)$$



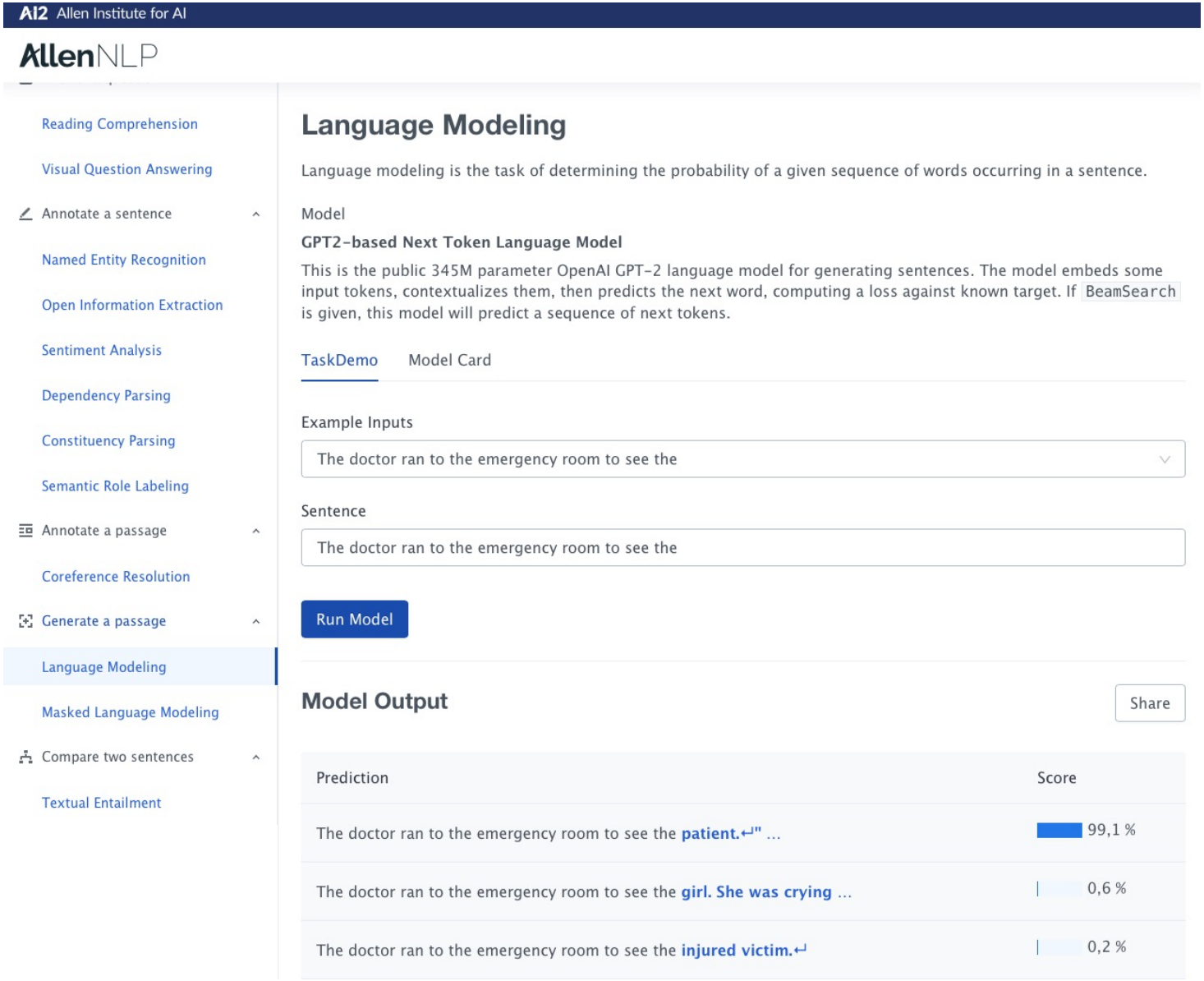
Un exemple de modèle de langue

Language	#Volumes	#Tokens
English	4,541,627	468,491,999,592
Spanish	854,649	83,967,471,303
French	792,118	102,174,681,393
German	657,991	64,784,628,286
Russian	591,310	67,137,666,353
Italian	305,763	40,288,810,817
Chinese	302,652	26,859,461,025
Hebrew	70,636	8,172,543,728

Table 1: Number of volumes and tokens for each language in our corpus. The total collection contains more than 6% of all books ever published.



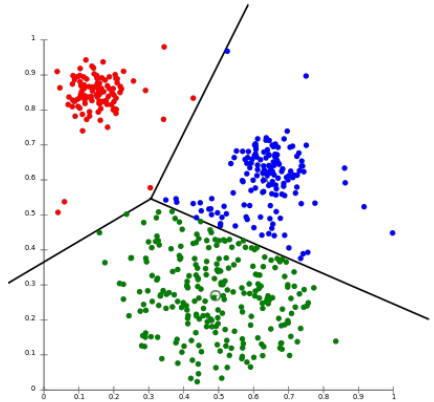
https://books.google.com/ngrams


AI2 Allen Institute for AI
AllenNLP
Reading Comprehension
Visual Question Answering
Annotate a sentence
Named Entity Recognition
Open Information Extraction
Sentiment Analysis
Dependency Parsing
Constituency Parsing
Semantic Role Labeling
Annotate a passage
Coreference Resolution
Generate a passage
Language Modeling
Masked Language Modeling
Compare two sentences
Textual Entailment
Language Modeling
Language modeling is the task of determining the probability of a given sequence of words occurring in a sentence.
Model
GPT2-based Next Token Language Model
This is the public 345M parameter OpenAI GPT-2 language model for generating sentences. The model embeds some input tokens, contextualizes them, then predicts the next word, computing a loss against known target. If BeamSearch is given, this model will predict a sequence of next tokens.
TaskDemo
Model Card
Example Inputs
The doctor ran to the emergency room to see the
Sentence
The doctor ran to the emergency room to see the
Run Model
Model Output
Share
Prediction
Score
The doctor ran to the emergency room to see the patient.↵" ...
99,1 %
The doctor ran to the emergency room to see the girl. She was crying ...
0,6 %
The doctor ran to the emergency room to see the injured victim.↵
0,2 %

Approches statistiques, probabilistes
Apprentissage automatique

Quels sont les mots caractéristiques d'un groupe de documents ?

Similarités, corrélations

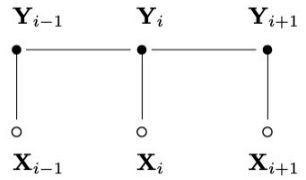


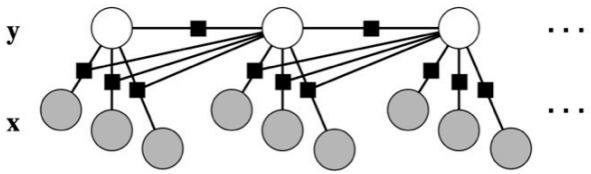
$$Z_{score(t_{ij})} = \frac{tfr_{ij} - mean_i}{sdi}$$

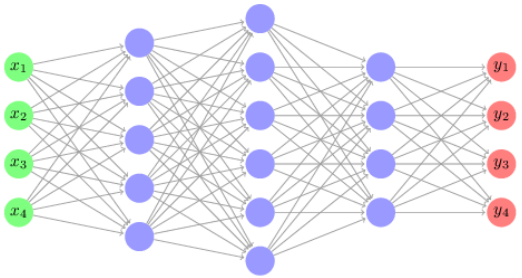
positive	Z_score	negative	Z_score	Neutral	Z_score
Love	14.31	Not	13.99	Httpbit	6.44
Good	14.01	Fuck	12.97	Httpfb	4.56
Happy	12.30	Don't	10.97	Httpbnd	3.78
Great	11.10	Shit	8.99	Intern	3.58
Excite	10.35	Bad	8.40	Nov	3.45
Best	9.24	Hate	8.29	Httpdlvr	3.40
Thank	9.21	Sad	8.28	Open	3.30
Hope	8.24	Sorry	8.11	Live	3.28
Cant	8.10	Cancel	7.53	Cloud	3.28
Wait	8.05	stupid	6.83	begin	3.17

Table1. The first ten terms having the highest Z_score in each class

Quelles relations significatives à partir des seules formes observées ?



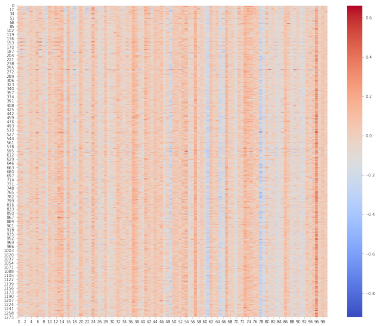




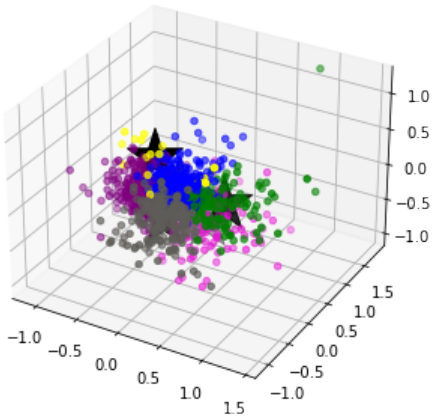
$$p(\boldsymbol{y}|\boldsymbol{x},\boldsymbol{\lambda}) = \frac{1}{Z(\boldsymbol{x})} \exp\left(\sum_j \lambda_j F_j(\boldsymbol{y},\boldsymbol{x})\right).$$

Conditional Random Fields: Probabilistic Models for Segmenting and Labeling Sequence Data
Proceedings of the 18th International Conference on Machine Learning 2001 (ICML 2001)

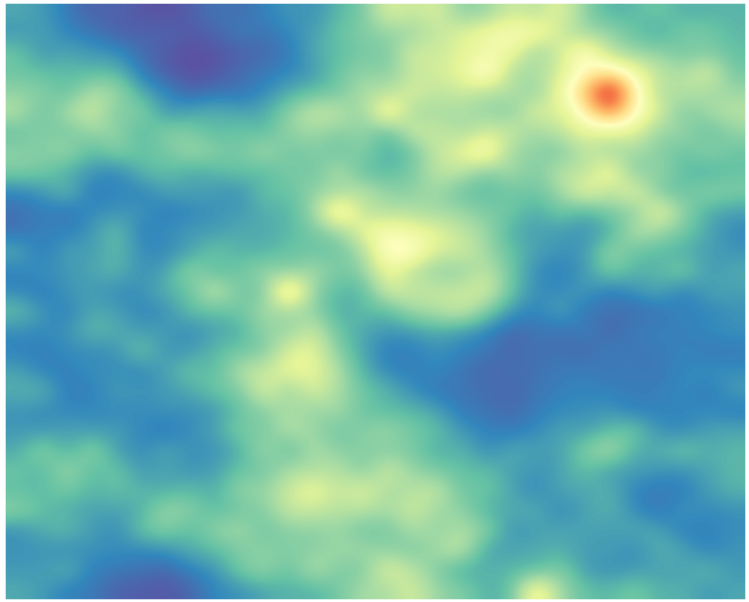
Représentation de documents par projection



Vectorisation dans des espaces continus (Doc2Vec) par plongements lexicaux

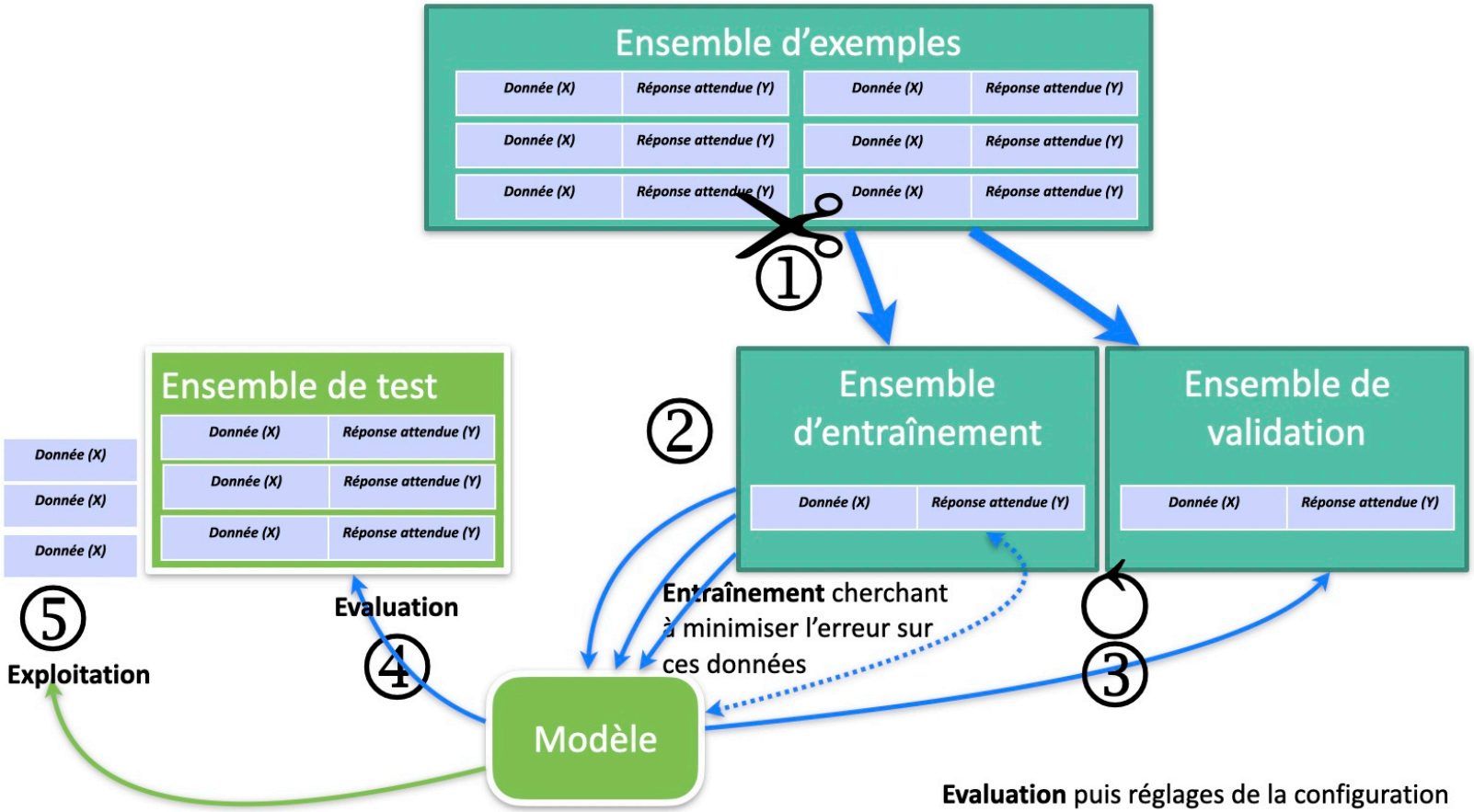


Analyse en Composantes Principales



Cartes auto-organisées (SOM)

Apprentissage automatique, modèle, évaluation



Documents, lexique et *dataframes*

	méta-donnée 1	méta-donnée 2	…
document 1			
document 2			

	mot 1	mot 2
document 1		
document 2		
document 3		

sacs de mots

	mot 1	mot 2
dimension 1		
dimension 2		
dimension 3		

espaces de représentation réduits

Le module *RegEx*

https://www.w3schools.com/python/python_regex.asp

RegEx Functions

The `re` module offers a set of functions that allows us to search a string for a match:

Function	Description
findall	Returns a list containing all matches
search	Returns a Match object if there is a match anywhere in the string
split	Returns a list where the string has been split at each match
sub	Replaces one or many matches with a string

Example

Print the part of the string where there was a match.

The regular expression looks for any words that starts with an upper case "S":

```
import re

txt = "The rain in Spain"
x = re.search(r"\bS\w+", txt)
print(x.group())
```

Example

Replace every white-space character with the number 9:

```
import re

txt = "The rain in Spain"
x = re.sub("\s", "9", txt)
print(x)
```

Example

Search the string to see if it starts with "The" and ends with "Spain":

```
import re

txt = "The rain in Spain"
x = re.search("^The.*Spain$", txt)
```

Example

Print a list of all matches:

```
import re

txt = "The rain in Spain"
x = re.findall("ai", txt)
print(x)
```

Metacharacters

Metacharacters are characters with a special meaning:

Character	Description	Example
[]	A set of characters	"[a-m]"
\	Signals a special sequence (can also be used to escape special characters)	"\d"
.	Any character (except newline character)	"he..o"
^	Starts with	"^hello"
$	Ends with	"world$"
*	Zero or more occurrences	"aix*"
+	One or more occurrences	"aix+"
{}	Exactly the specified number of occurrences	"al{2}"
|	Either or	"falls|stays"
()	Capture and group	

Special Sequences

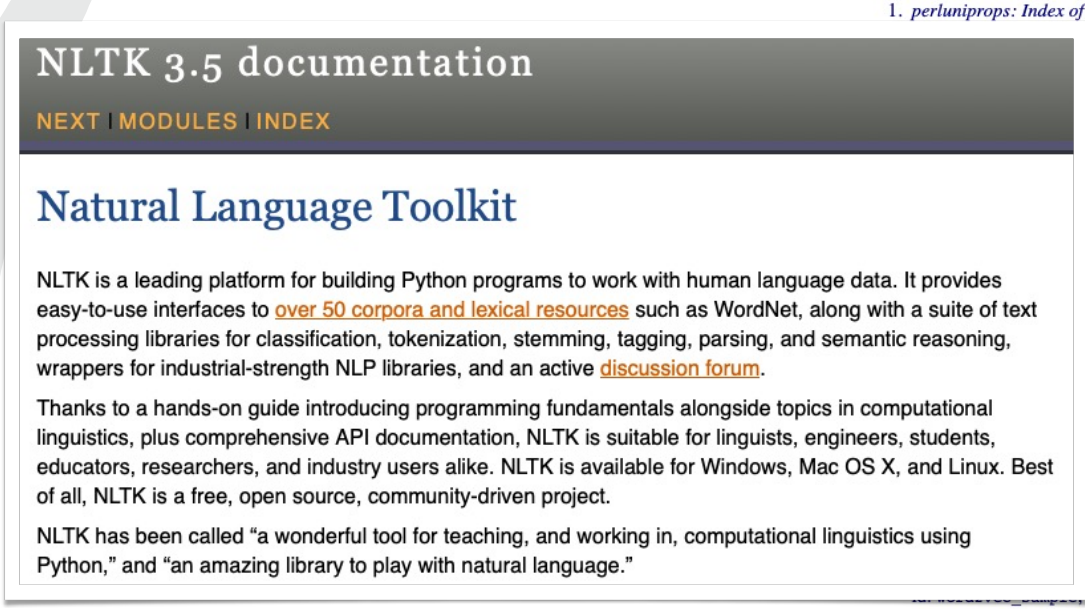
A special sequence is a `\` followed by one of the characters in the list below, and has a special meaning:

Character	Description	Example
\A	Returns a match if the specified characters are at the beginning of the string	"\AThe"
\b	Returns a match where the specified characters are at the beginning or at the end of a word (the "r" in the beginning is making sure that the string is being treated as a "raw string")	r"\bain" r"ain\b"
\B	Returns a match where the specified characters are present, but NOT at the beginning (or at the end) of a word (the "r" in the beginning is making sure that the string is being treated as a "raw string")	r"\Bain" r"ain\B"
\d	Returns a match where the string contains digits (numbers from 0-9)	"\d"
\D	Returns a match where the string DOES NOT contain digits	"\D"
\s	Returns a match where the string contains a white space character	"\s"
\S	Returns a match where the string DOES NOT contain a white space character	"\S"
\w	Returns a match where the string contains any word characters (characters from a to Z, digits from 0-9, and the underscore _ character)	"\w"
\W	Returns a match where the string DOES NOT contain any word characters	"\W"
\Z	Returns a match if the specified characters are at the end of the string	"Spain\Z"

Sets

A set is a set of characters inside a pair of square brackets `[]` with a special meaning:

Set	Description
[arn]	Returns a match where one of the specified characters (`a` , `r` , or `n`) are present
[a-n]	Returns a match for any lower case character, alphabetically between `a` and `n`
[^arn]	Returns a match for any character EXCEPT `a` , `r` , and `n`
[0123]	Returns a match where any of the specified digits (`0` , `1` , `2` , or `3`) are present
[0-9]	Returns a match for any digit between `0` and `9`
[0-5][0-9]	Returns a match for any two-digit numbers from `00` and `59`
[a-zA-Z]	Returns a match for any character alphabetically between `a` and `z` , lower case OR upper case
[+]	In sets, `+` , `*` , `.` , `|` , `()` , `$` , `{}` has no special meaning, so `[+]` means: return a match for any `+` character in the string



http://www.nltk.org

NLTK Corpora

NLTK has built-in support for dozens of corpora and trained models, as listed below. To use these within NLTK we recommend that

Please consult the README file included with each corpus for further information.

1. *perluniprops: Index of Unicode Version 7.0.0 character properties in Perl* [download | source]
   : 100266; author: ; copyright: ; license: ;

   aligner (Sultan et al. 2015) subset of the Paraphrase Database. [download | source]
   4711; author: ; copyright: ; license: Creative Commons Attribution 3.0 Unported (CC-BY);

   s [download | source]
   33; author: Jan Strunk; copyright: ; license: ;

   edor de Sufixos da Lingua Portuguesa) [download | source]
   thor: Viviane Moreira Orengo (vmorengo@inf.ufrgs.br) and Christian Huyck; copyright: ; license: ;

   iles [download | source]
   200510; author: ; copyright: ; license: ;

   oad | source]
   e: 6785405; author: ; copyright: ; license: ;

   unker (Maximum entropy) [download | source]
   r; size: 13404747; author: ; copyright: ; license: ;

   [download | source]
   : 10961490; author: ; copyright: ; license: ;

   odel [download | source]
   ; size: 24516205; author: ; copyright: ; license: ;

   wnload | source]
   size: 49396025; author: ; copyright: ; license: ;

11. *Evaluation data from WMT15* [download | source]
    id: `wmt15_eval`; size: 383096; author: ; copyright: ; license: ;

12. *Grammars for Spanish* [download | source]
    id: `spanish_grammars`; size: 4047; author: Kepa Sarasola; copyright: ; license: ;

13. *Sample Grammars* [download | source]
    id: `sample_grammars`; size: 20293; author: ; copyright: ; license: ;

14. *Large context-free and feature-based grammars for parser comparison* [download | source]
    id: `large_grammars`; size: 283747; author: ; copyright: ; license: See the individual grammar files;

15. *Grammars from NLTK Book* [download | source]
    id: `book_grammars`; size: 9103; author: Ewan Klein; copyright: ; license: ;

16. *Grammars for Basque* [download | source]
    id: `basque_grammars`; size: 4704; author: Kepa Sarasola; copyright: ; license: ;

Aix*Marseille université
Socialement engagée

http://www.nltk.org

Some simple things you can do with NLTK

Tokenize and tag some text:

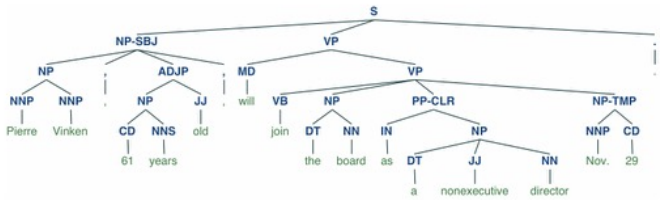
```
>>> import nltk
>>> sentence = """At eight o'clock on Thursday morning
... Arthur didn't feel very good."""
>>> tokens = nltk.word_tokenize(sentence)
>>> tokens
['At', 'eight', "o'clock", 'on', 'Thursday', 'morning',
'Arthur', 'did', "n't", 'feel', 'very', 'good', '.']
>>> tagged = nltk.pos_tag(tokens)
>>> tagged[0:6]
[('At', 'IN'), ('eight', 'CD'), ("o'clock", 'JJ'), ('on', 'IN'),
('Thursday', 'NNP'), ('morning', 'NN')]
```

Identify named entities:

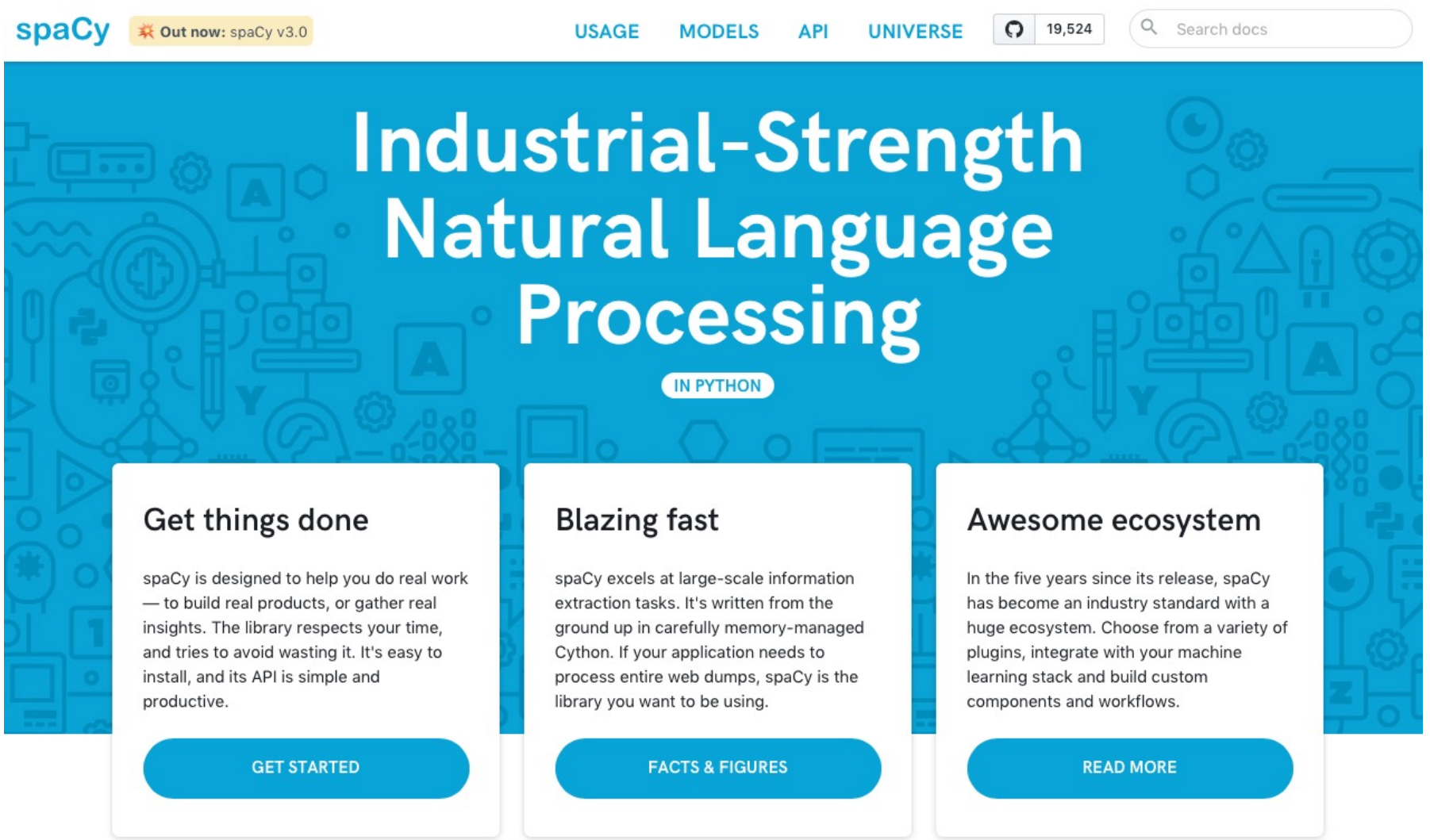
```
>>> entities = nltk.chunk.ne_chunk(tagged)
>>> entities
Tree('S', [('At', 'IN'), ('eight', 'CD'), ("o'clock", 'JJ'),
          ('on', 'IN'), ('Thursday', 'NNP'), ('morning', 'NN'),
      Tree('PERSON', [('Arthur', 'NNP')]),
          ('did', 'VBD'), ("n't", 'RB'), ('feel', 'VB'),
          ('very', 'RB'), ('good', 'JJ'), ('.', '.')])
```

Display a parse tree:

```
>>> from nltk.corpus import treebank
>>> t = treebank.parsed_sents('wsj_0001.mrg')[0]
>>> t.draw()
```



https://spacy.io/



Edit the code & try spaCy spaCy v3.0 · Python 3 · via Binder

```
# pip install -U spacy
# python -m spacy download en_core_web_sm
import spacy

# Load English tokenizer, tagger, parser and NER
nlp = spacy.load("en_core_web_sm")

# Process whole documents
text = ("When Sebastian Thrun started working on self-driving cars at "
        "Google in 2007, few people outside of the company took him "
        "seriously. “I can tell you very senior CEOs of major American "
        "car companies would shake my hand and turn away because I wasn’t "
        "worth talking to,” said Thrun, in an interview with Recode earlier "
        "this week.")
doc = nlp(text)

# Analyze syntax
print("Noun phrases:", [chunk.text for chunk in doc.noun_chunks])
print("Verbs:", [token.lemma_ for token in doc if token.pos_ == "VERB"])

# Find named entities, phrases and concepts
for entity in doc.ents:
    print(entity.text, entity.label_)
```

RUN

```
Noun phrases: ['Sebastian Thrun', 'self-driving cars', 'Google', 'few people', 'th
e company', 'him', 'I', 'you', 'very senior CEOs', 'major American car companies',
'my hand', 'I', 'Thrun', 'an interview', 'Recode']
Verbs: ['start', 'work', 'drive', 'take', 'tell', 'shake', 'turn', 'be', 'talk', '
say']
Sebastian Thrun PERSON
2007 DATE
American NORP
Thrun PERSON
Recode PERSON
earlier this week DATE
```

Features

- Support for **69+ languages**
- **58 trained pipelines** for 18 languages
- Multi-task learning with pretrained **transformers** like BERT
- Pretrained **word vectors**
- State-of-the-art speed
- Production-ready **training system**
- Linguistically-motivated **tokenization**
- Components for **named entity** recognition, part-of-speech tagging, dependency parsing, sentence segmentation, **text classification**, lemmatization, morphological analysis, entity linking and more
- Easily extensible with **custom components** and attributes
- Support for custom models in **PyTorch**, **TensorFlow** and other frameworks
- Built in **visualizers** for syntax and NER
- Easy **model packaging**, deployment and workflow management
- Robust, rigorously evaluated accuracy

https://spacy.io/

Features

In the documentation, you'll come across mentions of spaCy's features and capabilities. Some of them refer to linguistic concepts, while others are related to more general machine learning functionality.

NAME	DESCRIPTION
Tokenization	Segmenting text into words, punctuations marks etc.
Part-of-speech (POS) **Tagging**	Assigning word types to tokens, like verb or noun.
Dependency Parsing	Assigning syntactic dependency labels, describing the relations between individual tokens, like subject or object.
Lemmatization	Assigning the base forms of words. For example, the lemma of "was" is "be", and the lemma of "rats" is "rat".
Sentence Boundary Detection (SBD)	Finding and segmenting individual sentences.
Named Entity Recognition (NER)	Labelling named "real-world" objects, like persons, companies or locations.
Entity Linking (EL)	Disambiguating textual entities to unique identifiers in a knowledge base.
Similarity	Comparing words, text spans and documents and how similar they are to each other.
Text Classification	Assigning categories or labels to a whole document, or parts of a document.
Rule-based Matching	Finding sequences of tokens based on their texts and linguistic annotations, similar to regular expressions.
Training	Updating and improving a statistical model's predictions.
Serialization	Saving objects to files or byte strings.

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Annexes : pense-bêtes

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Python For Data Science *Cheat Sheet*

Python Basics

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Variables and Data Types

Variable Assignment

```
>>> x=5
>>> x
5
```

Calculations With Variables

`>>> x+2` → `7`	Sum of two variables
`>>> x-2` → `3`	Subtraction of two variables
`>>> x*2` → `10`	Multiplication of two variables
`>>> x**2` → `25`	Exponentiation of a variable
`>>> x%2` → `1`	Remainder of a variable
`>>> x/float(2)` → `2.5`	Division of a variable

Types and Type Conversion

`str()`	`'5', '3.45', 'True'`	Variables to strings
`int()`	`5, 3, 1`	Variables to integers
`float()`	`5.0, 1.0`	Variables to floats
`bool()`	`True, True, True`	Variables to booleans

Asking For Help

```
>>> help(str)
```

Lists

Also see NumPy Arrays

```
>>> a = 'is'
>>> b = 'nice'
>>> my_list = ['my', 'list', a, b]
>>> my_list2 = [[4,5,6,7], [3,4,5,6]]
```

Selecting List Elements

Index starts at 0

Subset	
`>>> my_list[1]`	Select item at index 1
`>>> my_list[-3]`	Select 3rd last item
Slice	
`>>> my_list[1:3]`	Select items at index 1 and 2
`>>> my_list[1:]`	Select items after index 0
`>>> my_list[:3]`	Select items before index 3
`>>> my_list[:]`	Copy my_list
Subset Lists of Lists	
`>>> my_list2[1][0]`	my_list[list][itemOfList]
`>>> my_list2[1][:2]`	

List Operations

```
>>> my_list + my_list
['my', 'list', 'is', 'nice', 'my', 'list', 'is', 'nice']
>>> my_list * 2
['my', 'list', 'is', 'nice', 'my', 'list', 'is', 'nice']
>>> my_list2 > 4
True
```

List Methods

`>>> my_list.index(a)`	Get the index of an item
`>>> my_list.count(a)`	Count an item
`>>> my_list.append('!')`	Append an item at a time
`>>> my_list.remove('!')`	Remove an item
`>>> del(my_list[0:1])`	Remove an item
`>>> my_list.reverse()`	Reverse the list
`>>> my_list.extend('!')`	Append an item
`>>> my_list.pop(-1)`	Remove an item
`>>> my_list.insert(0,'!')`	Insert an item
`>>> my_list.sort()`	Sort the list

Strings

```
>>> my_string = 'thisStringIsAwesome'
>>> my_string
'thisStringIsAwesome'
```

String Operations

```
>>> my_string * 2
'thisStringIsAwesomethisStringIsAwesome'
>>> my_string + 'Innit'
'thisStringIsAwesomeInnit'
>>> 'm' in my_string
True
```

String Operations

Index starts at 0

```
>>> my_string[3]
>>> my_string[4:9]
```

String Methods

`>>> my_string.upper()`	String to uppercase
`>>> my_string.lower()`	String to lowercase
`>>> my_string.count('w')`	Count String elements
`>>> my_string.replace('e', 'i')`	Replace String elements
`>>> my_string.strip()`	Strip whitespaces

Libraries

Import libraries

```
>>> import numpy
>>> import numpy as np
```

Selective import

```
>>> from math import pi
```

pandas — Data analysis
learn — Machine learning
NumPy — Scientific computing
matplotlib — 2D plotting

Install Python

ANACONDA — Leading open data science platform powered by Python

spyder — Free IDE that is included with Anaconda

jupyter — Create and share documents with live code, visualizations, text, ...

Numpy Arrays

Also see Lists

```
>>> my_list = [1, 2, 3, 4]
>>> my_array = np.array(my_list)
>>> my_2darray = np.array([[1,2,3],[4,5,6]])
```

Selecting Numpy Array Elements

Index starts at 0

Subset	
`>>> my_array[1]` → `2`	Select item at index 1
Slice	
`>>> my_array[0:2]` → `array([1, 2])`	Select items at index 0 and 1
Subset 2D Numpy arrays	
`>>> my_2darray[:,0]` → `array([1, 4])`	my_2darray[rows, columns]

Numpy Array Operations

```
>>> my_array > 3
array([False, False, False,  True], dtype=bool)
>>> my_array * 2
array([2, 4, 6, 8])
>>> my_array + np.array([5, 6, 7, 8])
array([6, 8, 10, 12])
```

Numpy Array Functions

`>>> my_array.shape`	Get the dimensions of the array
`>>> np.append(other_array)`	Append items to an array
`>>> np.insert(my_array, 1, 5)`	Insert items in an array
`>>> np.delete(my_array,[1])`	Delete items in an array
`>>> np.mean(my_array)`	Mean of the array
`>>> np.median(my_array)`	Median of the array
`>>> my_array.corrcoef()`	Correlation coefficient
`>>> np.std(my_array)`	Standard deviation

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Jupyter Notebook

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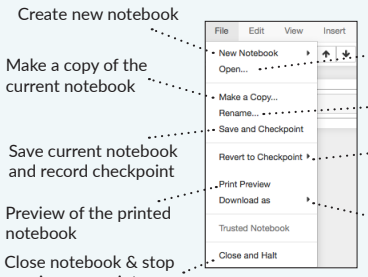
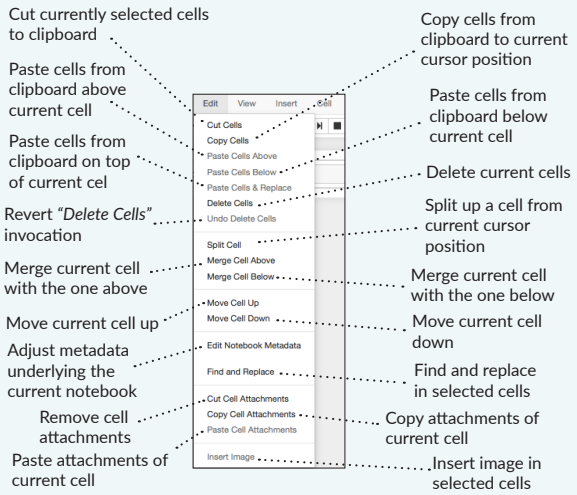
Saving/Loading Notebooks



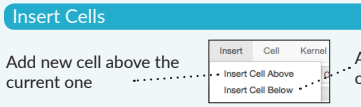
Writing Code And Text

Code and text are encapsulated by 3 basic cell types: markdown cells, code cells, and raw NBConvert cells.

Edit Cells



Insert Cells

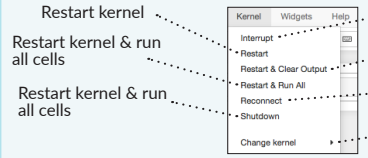


Working with Different Programming Languages

Kernels provide computation and communication with front-end interfaces like the notebooks. There are three main kernels:

IP[y]: IPython | IRkernel | IJulia

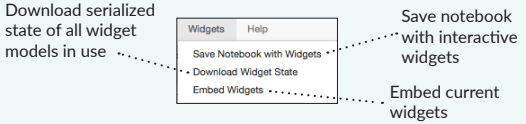
Installing Jupyter Notebook will automatically install the IPython kernel.



Widgets

Notebook widgets provide the ability to visualize and control changes in your data, often as a control like a slider, textbox, etc.

You can use them to build interactive GUIs for your notebooks or to synchronize stateful and stateless information between Python and JavaScript.

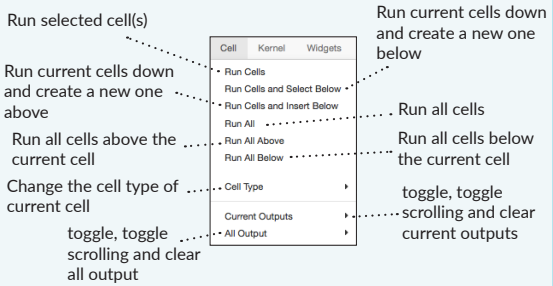


Command Mode:

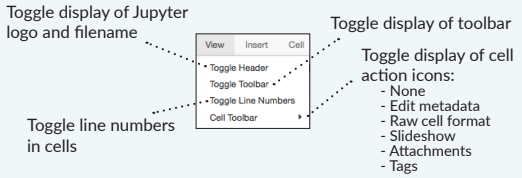
Edit Mode:

1. Save and checkpoint
2. Insert cell below
3. Cut cell
4. Copy cell(s)
5. Paste cell(s) below
6. Move cell up
7. Move cell down
8. Run current cell
9. Interrupt kernel
10. Restart kernel
11. Display characteristics
12. Open command palette
13. Current kernel
14. Kernel status
15. Log out from notebook server

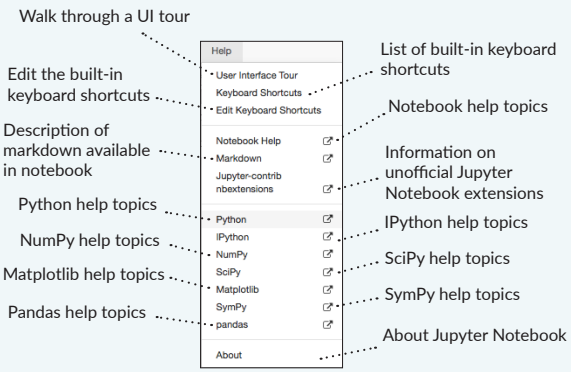
Executing Cells



View Cells



Asking For Help



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NumPy Basics

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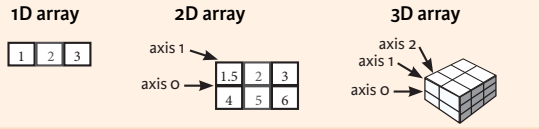
NumPy

The **NumPy** library is the core library for scientific computing in Python. It provides a high-performance multidimensional array object, and tools for working with these arrays.

Use the following import convention:

```
>>> import numpy as np
```

NumPy Arrays



Creating Arrays

```
>>> a = np.array([1,2,3])
>>> b = np.array([(1.5,2,3), (4,5,6)], dtype = float)
>>> c = np.array([[(1.5,2,3), (4,5,6)], [(3,2,1), (4,5,6)]],
                 dtype = float)
```

Initial Placeholders

```
>>> np.zeros((3,4))                  Create an array of zeros
>>> np.ones((2,3,4),dtype=np.int16)  Create an array of ones
>>> d = np.arange(10,25,5)           Create an array of evenly
                                     spaced values (step value)
>>> np.linspace(0,2,9)               Create an array of evenly
                                     spaced values (number of samples)
>>> e = np.full((2,2),7)             Create a constant array
>>> f = np.eye(2)                    Create a 2X2 identity matrix
>>> np.random.random((2,2))          Create an array with random values
>>> np.empty((3,2))                  Create an empty array
```

I/O

Saving & Loading On Disk

```
>>> np.save('my_array', a)
>>> np.savez('array.npz', a, b)
>>> np.load('my_array.npy')
```

Saving & Loading Text Files

```
>>> np.loadtxt("myfile.txt")
>>> np.genfromtxt("my_file.csv", delimiter=',')
>>> np.savetxt("myarray.txt", a, delimiter=" ")
```

Data Types

```
>>> np.int64       Signed 64-bit integer types
>>> np.float32     Standard double-precision floating point
>>> np.complex     Complex numbers represented by 128 floats
>>> np.bool        Boolean type storing TRUE and FALSE values
>>> np.object      Python object type
>>> np.string_     Fixed-length string type
>>> np.unicode_    Fixed-length unicode type
```

Inspecting Your Array

```
>>> a.shape          Array dimensions
>>> len(a)           Length of array
>>> b.ndim           Number of array dimensions
>>> e.size           Number of array elements
>>> b.dtype          Data type of array elements
>>> b.dtype.name     Name of data type
>>> b.astype(int)    Convert an array to a different type
```

Asking For Help

```
>>> np.info(np.ndarray.dtype)
```

Array Mathematics

Arithmetic Operations

```
>>> g = a - b                        Subtraction
  array([[-0.5,  0. ,  0. ],
         [-3. , -3. , -3. ]])
>>> np.subtract(a,b)                 Subtraction
>>> b + a                            Addition
  array([[ 2.5,  4. ,  6. ],
         [ 5. ,  7. ,  9. ]])
>>> np.add(b,a)                      Addition
>>> a / b                            Division
  array([[ 0.66666667,  1.        ,  1.        ],
         [ 0.25      ,  0.4       ,  0.5       ]])
>>> np.divide(a,b)                   Division
>>> a * b                            Multiplication
  array([[  1.5,   4. ,   9. ],
         [  4. ,  10. ,  18. ]])
>>> np.multiply(a,b)                 Multiplication
>>> np.exp(b)                        Exponentiation
>>> np.sqrt(b)                       Square root
>>> np.sin(a)                        Print sines of an array
>>> np.cos(b)                        Element-wise cosine
>>> np.log(a)                        Element-wise natural logarithm
>>> e.dot(f)                         Dot product
  array([[ 7.,  7.],
         [ 7.,  7.]])
```

Comparison

```
>>> a == b                           Element-wise comparison
  array([[False,  True,  True],
         [False, False, False]], dtype=bool)
>>> a < 2                            Element-wise comparison
  array([True, False, False], dtype=bool)
>>> np.array_equal(a, b)             Array-wise comparison
```

Aggregate Functions

```
>>> a.sum()                          Array-wise sum
>>> a.min()                          Array-wise minimum value
>>> b.max(axis=0)                    Maximum value of an array row
>>> b.cumsum(axis=1)                 Cumulative sum of the elements
>>> a.mean()                         Mean
>>> b.median()                       Median
>>> a.corrcoef()                     Correlation coefficient
>>> np.std(b)                        Standard deviation
```

Copying Arrays

```
>>> h = a.view()          Create a view of the array with the same data
>>> np.copy(a)            Create a copy of the array
>>> h = a.copy()          Create a deep copy of the array
```

Sorting Arrays

```
>>> a.sort()              Sort an array
>>> c.sort(axis=0)        Sort the elements of an array's axis
```

Subsetting, Slicing, Indexing

Also see Lists

Subsetting

```
>>> a[2]                             Select the element at the 2nd index
  3
>>> b[1,2]                           Select the element at row 0 column 2
  6.0                                (equivalent to b[1][2])
```

Slicing

```
>>> a[0:2]                           Select items at index 0 and 1
  array([1, 2])
>>> b[0:2,1]                         Select items at rows 0 and 1 in column 1
  array([ 2.,  5.])
>>> b[:1]                            Select all items at row 0
  array([[1.5, 2., 3.]])             (equivalent to b[0:1, :])
>>> c[1,...]                         Same as [1,:,:]
  array([[[ 3.,  2.,  1.],
          [ 4.,  5.,  6.]]])
>>> a[ : :-1]                        Reversed array a
  array([3, 2, 1])
```

Boolean Indexing

```
>>> a[a<2]                           Select elements from a less than 2
  array([1])
```

Fancy Indexing

```
>>> b[[1, 0, 1, 0],[0, 1, 2, 0]]    Select elements (1,0),(0,1),(1,2) and (0,0)
  array([ 4. , 2. , 6. , 1.5])
>>> b[[1, 0, 1, 0]][:,[0,1,2,0]]    Select a subset of the matrix's rows
  array([[ 4. ,5. , 6. , 4. ],       and columns
         [ 1.5, 2. , 3. , 1.5],
         [ 4. , 5. , 6. , 4. ],
         [ 1.5, 2. , 3. , 1.5]])
```

Array Manipulation

Transposing Array

```
>>> i = np.transpose(b)              Permute array dimensions
>>> i.T                              Permute array dimensions
```

Changing Array Shape

```
>>> b.ravel()                        Flatten the array
>>> g.reshape(3,-2)                  Reshape, but don't change data
```

Adding/Removing Elements

```
>>> h.resize((2,6))                  Return a new array with shape (2,6)
>>> np.append(h,g)                   Append items to an array
>>> np.insert(a, 1, 5)               Insert items in an array
>>> np.delete(a,[1])                 Delete items from an array
```

Combining Arrays

```
>>> np.concatenate((a,d),axis=0)     Concatenate arrays
  array([ 1,  2,  3, 10, 15, 20])
>>> np.vstack((a,b))                 Stack arrays vertically (row-wise)
  array([[ 1. ,  2. ,  3. ],
         [ 1.5,  2. ,  3. ],
         [ 4. ,  5. ,  6. ]])
>>> np.r_[e,f]                       Stack arrays vertically (row-wise)
>>> np.hstack((e,f))                 Stack arrays horizontally (column-wise)
  array([[ 7.,  7.,  1.,  0.],
         [ 7.,  7.,  0.,  1.]])
>>> np.column_stack((a,d))           Create stacked column-wise arrays
  array([[ 1, 10],
         [ 2, 15],
         [ 3, 20]])
>>> np.c_[a,d]                       Create stacked column-wise arrays
```

Splitting Arrays

```
>>> np.hsplit(a,3)                   Split the array horizontally at the 3rd
  [array([1]),array([2]),array([3])]  index
>>> np.vsplit(c,2)                   Split the array vertically at the 2nd index
[array([[[ 1.5,  2. ,  1. ],
         [ 4. ,  5. ,  6. ]]]),
 array([[[ 3. ,  2. ,  3.1],
         [ 4. ,  5. ,  6.]]])]
```

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SciPy - Linear Algebra

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SciPy

The **SciPy** library is one of the core packages for scientific computing that provides mathematical algorithms and convenience functions built on the NumPy extension of Python.

Interacting With NumPy

Also see NumPy

```
>>> import numpy as np
>>> a = np.array([1,2,3])
>>> b = np.array([(1+5j,2j,3j), (4j,5j,6j)])
>>> c = np.array([[(1.5,2,3), (4,5,6)], [(3,2,1), (4,5,6)]])
```

Index Tricks

```
>>> np.mgrid[0:5,0:5]          Create a dense meshgrid
>>> np.ogrid[0:2,0:2]          Create an open meshgrid
>>> np.r_[[3,[0]*5,-1:1:10j]   Stack arrays vertically (row-wise)
>>> np.c_[b,c]                 Create stacked column-wise arrays
```

Shape Manipulation

```
>>> np.transpose(b)            Permute array dimensions
>>> b.flatten()                Flatten the array
>>> np.hstack((b,c))           Stack arrays horizontally (column-wise)
>>> np.vstack((a,b))           Stack arrays vertically (row-wise)
>>> np.hsplit(c,2)             Split the array horizontally at the 2nd index
>>> np.vpslit(d,2)             Split the array vertically at the 2nd index
```

Polynomials

```
>>> from numpy import polyld
>>> p = polyld([3,4,5])        Create a polynomial object
```

Vectorizing Functions

```
>>> def myfunc(a):
        if a < 0:
          return a*2
        else:
          return a/2
>>> np.vectorize(myfunc)       Vectorize functions
```

Type Handling

```
>>> np.real(c)                 Return the real part of the array elements
>>> np.imag(c)                 Return the imaginary part of the array elements
>>> np.real_if_close(c,tol=1000)  Return a real array if complex parts close to 0
>>> np.cast['f'](np.pi)        Cast object to a data type
```

Other Useful Functions

```
>>> np.angle(b,deg=True)       Return the angle of the complex argument
>>> g = np.linspace(0,np.pi,num=5)  Create an array of evenly spaced values
                                    (number of samples)
>>> g [3:] += np.pi
>>> np.unwrap(g)               Unwrap
>>> np.logspace(0,10,3)        Create an array of evenly spaced values (log scale)
>>> np.select([c<4],[c*2])     Return values from a list of arrays depending on
                               conditions
>>> misc.factorial(a)          Factorial
>>> misc.comb(10,3,exact=True) Combine N things taken at k time
>>> misc.central_diff_weights(3)  Weights for Np-point central derivative
>>> misc.derivative(myfunc,1.0)   Find the n-th derivative of a function at a point
```

Linear Algebra

Also see NumPy

You'll use the `linalg` and `sparse` modules. Note that `scipy.linalg` contains and expands on `numpy.linalg`.

```
>>> from scipy import linalg, sparse
```

Creating Matrices

```
>>> A = np.matrix(np.random.random((2,2)))
>>> B = np.asmatrix(b)
>>> C = np.mat(np.random.random((10,5)))
>>> D = np.mat([[3,4], [5,6]])
```

Basic Matrix Routines

Inverse

```
>>> A.I                        Inverse
>>> linalg.inv(A)              Inverse
>>> A.T                        Tranpose matrix
>>> A.H                        Conjugate transposition
>>> np.trace(A)                Trace
```

Norm

```
>>> linalg.norm(A)             Frobenius norm
>>> linalg.norm(A,1)           L1 norm (max column sum)
>>> linalg.norm(A,np.inf)      L inf norm (max row sum)
```

Rank

```
>>> np.linalg.matrix_rank(C)   Matrix rank
```

Determinant

```
>>> linalg.det(A)              Determinant
```

Solving linear problems

```
>>> linalg.solve(A,b)          Solver for dense matrices
>>> E = np.mat(a).T            Solver for dense matrices
>>> linalg.lstsq(D,E)          Least-squares solution to linear matrix
                               equation
```

Generalized inverse

```
>>> linalg.pinv(C)             Compute the pseudo-inverse of a matrix
                               (least-squares solver)
>>> linalg.pinv2(C)            Compute the pseudo-inverse of a matrix
                               (SVD)
```

Creating Sparse Matrices

```
>>> F = np.eye(3, k=1)         Create a 2X2 identity matrix
>>> G = np.mat(np.identity(2)) Create a 2x2 identity matrix
>>> C[C > 0.5] = 0
>>> H = sparse.csr_matrix(C)   Compressed Sparse Row matrix
>>> I = sparse.csc_matrix(D)   Compressed Sparse Column matrix
>>> J = sparse.dok_matrix(A)   Dictionary Of Keys matrix
>>> E.todense()                Sparse matrix to full matrix
>>> sparse.isspmatrix_csc(A)   Identify sparse matrix
```

Sparse Matrix Routines

Inverse

```
>>> sparse.linalg.inv(I)       Inverse
```

Norm

```
>>> sparse.linalg.norm(I)      Norm
```

Solving linear problems

```
>>> sparse.linalg.spsolve(H,I) Solver for sparse matrices
```

Sparse Matrix Functions

```
>>> sparse.linalg.expm(I)      Sparse matrix exponential
```

Matrix Functions

Addition

```
>>> np.add(A,D)                Addition
```

Subtraction

```
>>> np.subtract(A,D)           Subtraction
```

Division

```
>>> np.divide(A,D)             Division
```

Multiplication

```
>>> np.multiply(D,A)           Multiplication
>>> np.dot(A,D)                Dot product
>>> np.vdot(A,D)               Vector dot product
>>> np.inner(A,D)              Inner product
>>> np.outer(A,D)              Outer product
>>> np.tensordot(A,D)          Tensor dot product
>>> np.kron(A,D)               Kronecker product
```

Exponential Functions

```
>>> linalg.expm(A)             Matrix exponential
>>> linalg.expm2(A)            Matrix exponential (Taylor Series)
>>> linalg.expm3(D)            Matrix exponential (eigenvalue
                               decomposition)
```

Logarithm Function

```
>>> linalg.logm(A)             Matrix logarithm
```

Trigonometric Tunctions

```
>>> linalg.sinm(D)             Matrix sine
>>> linalg.cosm(D)             Matrix cosine
>>> linalg.tanm(A)             Matrix tangent
```

Hyperbolic Trigonometric Functions

```
>>> linalg.sinhm(D)            Hyperbolic matrix sine
>>> linalg.coshm(D)            Hyperbolic matrix cosine
>>> linalg.tanhm(A)            Hyperbolic matrix tangent
```

Matrix Sign Function

```
>>> np.sigm(A)                 Matrix sign function
```

Matrix Square Root

```
>>> linalg.sqrtm(A)            Matrix square root
```

Arbitrary Functions

```
>>> linalg.funm(A, lambda x: x*x)  Evaluate matrix function
```

Decompositions

Eigenvalues and Eigenvectors

```
>>> la, v = linalg.eig(A)      Solve ordinary or generalized
                               eigenvalue problem for square matrix
>>> l1, l2 = la                Unpack eigenvalues
>>> v[:,0]                     First eigenvector
>>> v[:,1]                     Second eigenvector
>>> linalg.eigvals(A)          Unpack eigenvalues
```

Singular Value Decomposition

```
>>> U,s,Vh = linalg.svd(B)     Singular Value Decomposition (SVD)
>>> M,N = B.shape
>>> Sig = linalg.diagsvd(s,M,N)  Construct sigma matrix in SVD
```

LU Decomposition

```
>>> P,L,U = linalg.lu(C)       LU Decomposition
```

Sparse Matrix Decompositions

```
>>> la, v = sparse.linalg.eigs(F,1)  Eigenvalues and eigenvectors
>>> sparse.linalg.svds(H, 2)         SVD
```

Asking For Help

```
>>> help(scipy.linalg.diagsvd)
>>> np.info(np.matrix)
```

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Python For Data Science *Cheat Sheet*

Pandas Basics

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Pandas

The **Pandas** library is built on NumPy and provides easy-to-use **data structures** and **data analysis** tools for the Python programming language.

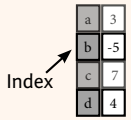
Use the following import convention:

```
>>> import pandas as pd
```

Pandas Data Structures

Series

A **one-dimensional** labeled array capable of holding any data type




```
>>> s = pd.Series([3, -5, 7, 4], index=['a', 'b', 'c', 'd'])
```

DataFrame

Columns

	Country	Capital	Population
0	Belgium	Brussels	11190846
1	India	New Delhi	1303171035
2	Brazil	Brasília	207847528

Index

A **two-dimensional** labeled data structure with columns of potentially different types

```
>>> data = {'Country': ['Belgium', 'India', 'Brazil'],
            'Capital': ['Brussels', 'New Delhi', 'Brasília'],
            'Population': [11190846, 1303171035, 207847528]}

>>> df = pd.DataFrame(data,
                      columns=['Country', 'Capital', 'Population'])
```

Asking For Help

```
>>> help(pd.Series.loc)
```

Selection

Also see NumPy Arrays

Getting

```
>>> s['b']
-5
```
Get one element

```
>>> df[1:]
   Country     Capital  Population
1   India   New Delhi  1303171035
2  Brazil    Brasília   207847528
```
Get subset of a DataFrame

Selecting, Boolean Indexing & Setting

By Position

```
>>> df.iloc[[0],[0]]
'Belgium'
```
```
>>> df.iat[[0],[0]]
'Belgium'
```
Select single value by row & column

By Label

```
>>> df.loc[[0], ['Country']]
'Belgium'
```
```
>>> df.at[[0], ['Country']]
'Belgium'
```
Select single value by row & column labels

By Label/Position

```
>>> df.ix[2]
Country      Brazil
Capital    Brasília
Population  207847528
```
Select single row of subset of rows

```
>>> df.ix[:,'Capital']
0     Brussels
1    New Delhi
2     Brasília
```
Select a single column of subset of columns

```
>>> df.ix[1,'Capital']
'New Delhi'
```
Select rows and columns

Boolean Indexing

```
>>> s[~(s > 1)]
>>> s[(s < -1)  |  (s > 2)]
```
Series `s` where value is not >1 `s` where value is <-1 or >2

```
>>> df[df['Population']>1200000000]
```
Use filter to adjust DataFrame

Setting

```
>>> s['a'] = 6
```
Set index `a` of Series `s` to 6

Dropping

```
>>> s.drop(['a', 'c'])
>>> df.drop('Country', axis=1)
```
Drop values from rows (axis=0)
Drop values from columns(axis=1)

Sort & Rank

```
>>> df.sort_index()
>>> df.sort_values(by='Country')
>>> df.rank()
```
Sort by labels along an axis
Sort by the values along an axis
Assign ranks to entries

Retrieving Series/DataFrame Information

Basic Information

```
>>> df.shape
>>> df.index
>>> df.columns
>>> df.info()
>>> df.count()
```
(rows,columns)
Describe index
Describe DataFrame columns
Info on DataFrame
Number of non-NA values

Summary

```
>>> df.sum()
>>> df.cumsum()
>>> df.min()/df.max()
>>> df.idxmin()/df.idxmax()
>>> df.describe()
>>> df.mean()
>>> df.median()
```
Sum of values
Cummulative sum of values
Minimum/maximum values
Minimum/Maximum index value
Summary statistics
Mean of values
Median of values

Applying Functions

```
>>> f = lambda x: x*2
>>> df.apply(f)
>>> df.applymap(f)
```
Apply function
Apply function element-wise

Data Alignment

Internal Data Alignment

NA values are introduced in the indices that don't overlap:

```
>>> s3 = pd.Series([7, -2, 3], index=['a', 'c', 'd'])
>>> s + s3
  a     10.0
  b      NaN
  c      5.0
  d      7.0
```

Arithmetic Operations with Fill Methods

You can also do the internal data alignment yourself with the help of the fill methods:

```
>>> s.add(s3, fill_value=0)
  a    10.0
  b    -5.0
  c     5.0
  d     7.0
>>> s.sub(s3, fill_value=2)
>>> s.div(s3, fill_value=4)
>>> s.mul(s3, fill_value=3)
```

I/O

Read and Write to CSV

```
>>> pd.read_csv('file.csv', header=None, nrows=5)
>>> df.to_csv('myDataFrame.csv')
```

Read and Write to Excel

```
>>> pd.read_excel('file.xlsx')
>>> pd.to_excel('dir/myDataFrame.xlsx', sheet_name='Sheet1')
```

Read multiple sheets from the same file

```
>>> xlsx = pd.ExcelFile('file.xls')
>>> df = pd.read_excel(xlsx, 'Sheet1')
```

Read and Write to SQL Query or Database Table

```
>>> from sqlalchemy import create_engine
>>> engine = create_engine('sqlite:///:memory:')
>>> pd.read_sql("SELECT * FROM my_table;", engine)
>>> pd.read_sql_table('my_table', engine)
>>> pd.read_sql_query("SELECT * FROM my_table;", engine)
```

`read_sql()` is a convenience wrapper around `read_sql_table()` and `read_sql_query()`

```
>>> pd.to_sql('myDf', engine)
```

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Python For Data Science *Cheat Sheet*

Scikit-Learn

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Scikit-learn

Scikit-learn is an open source Python library that implements a range of machine learning, preprocessing, cross-validation and visualization algorithms using a unified interface.

A Basic Example

```
>>> from sklearn import neighbors, datasets, preprocessing
>>> from sklearn.model_selection import train_test_split
>>> from sklearn.metrics import accuracy_score
>>> iris = datasets.load_iris()
>>> X, y = iris.data[:, :2], iris.target
>>> X_train, X_test, y_train, y_test= train_test_split(X, y, random_state=33)
>>> scaler = preprocessing.StandardScaler().fit(X_train)
>>> X_train = scaler.transform(X_train)
>>> X_test = scaler.transform(X_test)
>>> knn = neighbors.KNeighborsClassifier(n_neighbors=5)
>>> knn.fit(X_train, y_train)
>>> y_pred = knn.predict(X_test)
>>> accuracy_score(y_test, y_pred)
```

Loading The Data

Also see NumPy & Pandas

Your data needs to be numeric and stored as NumPy arrays or SciPy sparse matrices. Other types that are convertible to numeric arrays, such as Pandas DataFrame, are also acceptable.

```
>>> import numpy as np
>>> X = np.random.random((10,5))
>>> y = np.array(['M','M','F','F','M','F','M','M','F','F','F'])
>>> X[X < 0.7] = 0
```

Training And Test Data

```
>>> from sklearn.model_selection import train_test_split
>>> X_train, X_test, y_train, y_test = train_test_split(X,
                                                        y,
                                                        random_state=0)
```

Create Your Model

Supervised Learning Estimators

Linear Regression

```
>>> from sklearn.linear_model import LinearRegression
>>> lr = LinearRegression(normalize=True)
```

Support Vector Machines (SVM)

```
>>> from sklearn.svm import SVC
>>> svc = SVC(kernel='linear')
```

Naive Bayes

```
>>> from sklearn.naive_bayes import GaussianNB
>>> gnb = GaussianNB()
```

KNN

```
>>> from sklearn import neighbors
>>> knn = neighbors.KNeighborsClassifier(n_neighbors=5)
```

Unsupervised Learning Estimators

Principal Component Analysis (PCA)

```
>>> from sklearn.decomposition import PCA
>>> pca = PCA(n_components=0.95)
```

K Means

```
>>> from sklearn.cluster import KMeans
>>> k_means = KMeans(n_clusters=3, random_state=0)
```

Model Fitting

Supervised learning	
`>>> lr.fit(X, y)`	Fit the model to the data
`>>> knn.fit(X_train, y_train)`	
`>>> svc.fit(X_train, y_train)`	
Unsupervised Learning	
`>>> k_means.fit(X_train)`	Fit the model to the data
`>>> pca_model = pca.fit_transform(X_train)`	Fit to data, then transform it

Prediction

Supervised Estimators	
`>>> y_pred = svc.predict(np.random.random((2,5)))`	Predict labels
`>>> y_pred = lr.predict(X_test)`	Predict labels
`>>> y_pred = knn.predict_proba(X_test)`	Estimate probability of a label
Unsupervised Estimators	
`>>> y_pred = k_means.predict(X_test)`	Predict labels in clustering algos

Evaluate Your Model's Performance

Classification Metrics

Accuracy Score

```
>>> knn.score(X_test, y_test)
```
Estimator score method

```
>>> from sklearn.metrics import accuracy_score
>>> accuracy_score(y_test, y_pred)
```
Metric scoring functions

Classification Report

```
>>> from sklearn.metrics import classification_report
>>> print(classification_report(y_test, y_pred))
```
Precision, recall, f1-score and support

Confusion Matrix

```
>>> from sklearn.metrics import confusion_matrix
>>> print(confusion_matrix(y_test, y_pred))
```

Regression Metrics

Mean Absolute Error

```
>>> from sklearn.metrics import mean_absolute_error
>>> y_true = [3, -0.5, 2]
>>> mean_absolute_error(y_true, y_pred)
```

Mean Squared Error

```
>>> from sklearn.metrics import mean_squared_error
>>> mean_squared_error(y_test, y_pred)
```

R^2 Score

```
>>> from sklearn.metrics import r2_score
>>> r2_score(y_true, y_pred)
```

Clustering Metrics

Adjusted Rand Index

```
>>> from sklearn.metrics import adjusted_rand_score
>>> adjusted_rand_score(y_true, y_pred)
```

Homogeneity

```
>>> from sklearn.metrics import homogeneity_score
>>> homogeneity_score(y_true, y_pred)
```

V-measure

```
>>> from sklearn.metrics import v_measure_score
>>> metrics.v_measure_score(y_true, y_pred)
```

Cross-Validation

```
>>> from sklearn.cross_validation import cross_val_score
>>> print(cross_val_score(knn, X_train, y_train, cv=4))
>>> print(cross_val_score(lr, X, y, cv=2))
```

Tune Your Model

Grid Search

```
>>> from sklearn.grid_search import GridSearchCV
>>> params = {"n_neighbors": np.arange(1,3),
              "metric": ["euclidean", "cityblock"]}
>>> grid = GridSearchCV(estimator=knn,
                        param_grid=params)
>>> grid.fit(X_train, y_train)
>>> print(grid.best_score_)
>>> print(grid.best_estimator_.n_neighbors)
```

Randomized Parameter Optimization

```
>>> from sklearn.grid_search import RandomizedSearchCV
>>> params = {"n_neighbors": range(1,5),
              "weights": ["uniform", "distance"]}
>>> rsearch = RandomizedSearchCV(estimator=knn,
                                 param_distributions=params,
                                 cv=4,
                                 n_iter=8,
                                 random_state=5)
>>> rsearch.fit(X_train, y_train)
>>> print(rsearch.best_score_)
```

Preprocessing The Data

Standardization

```
>>> from sklearn.preprocessing import StandardScaler
>>> scaler = StandardScaler().fit(X_train)
>>> standardized_X = scaler.transform(X_train)
>>> standardized_X_test = scaler.transform(X_test)
```

Normalization

```
>>> from sklearn.preprocessing import Normalizer
>>> scaler = Normalizer().fit(X_train)
>>> normalized_X = scaler.transform(X_train)
>>> normalized_X_test = scaler.transform(X_test)
```

Binarization

```
>>> from sklearn.preprocessing import Binarizer
>>> binarizer = Binarizer(threshold=0.0).fit(X)
>>> binary_X = binarizer.transform(X)
```

Encoding Categorical Features

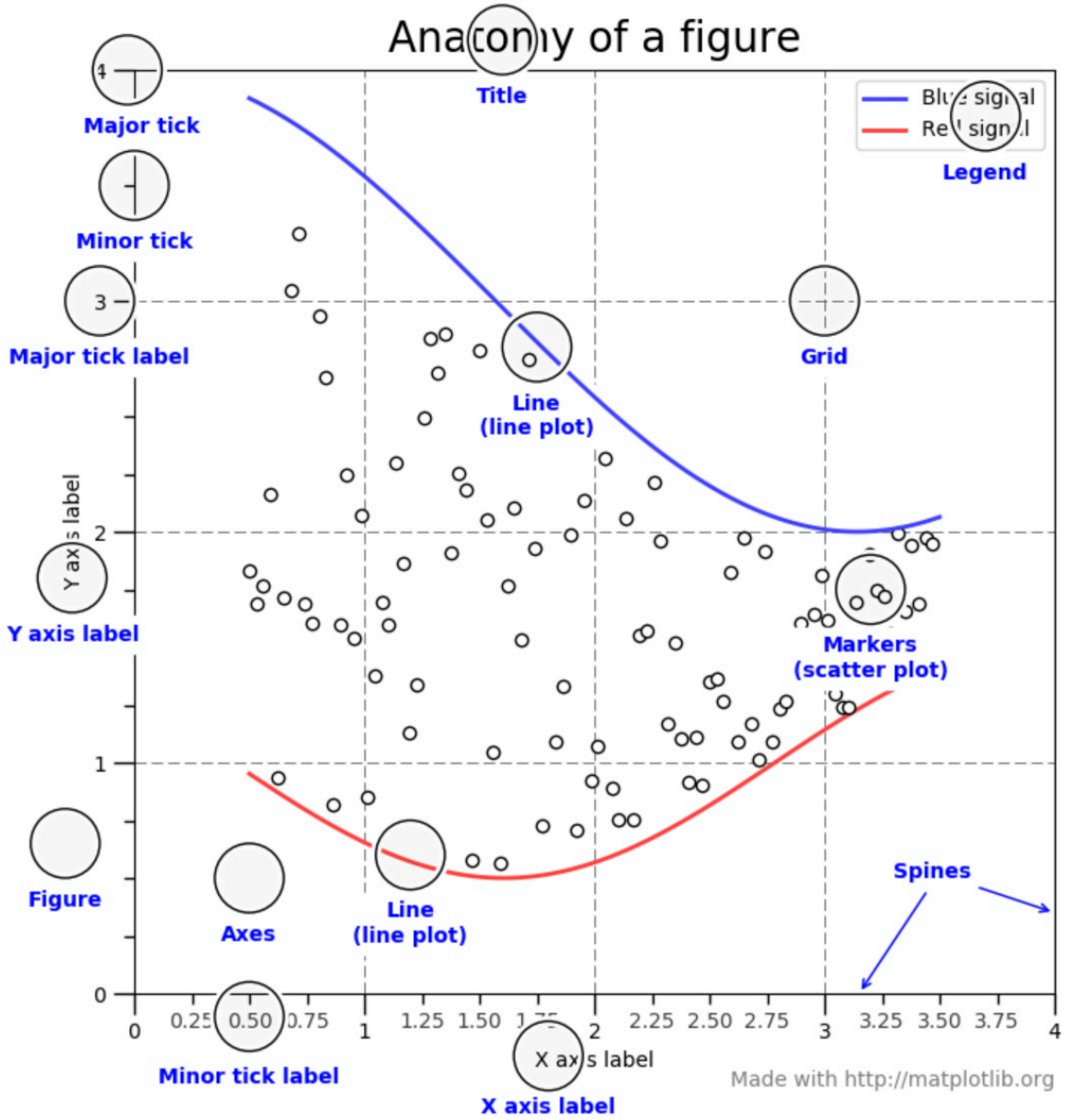
```
>>> from sklearn.preprocessing import LabelEncoder
>>> enc = LabelEncoder()
>>> y = enc.fit_transform(y)
```

Imputing Missing Values

```
>>> from sklearn.preprocessing import Imputer
>>> imp = Imputer(missing_values=0, strategy='mean', axis=0)
>>> imp.fit_transform(X_train)
```

Generating Polynomial Features

```
>>> from sklearn.preprocessing import PolynomialFeatures
>>> poly = PolynomialFeatures(5)
>>> poly.fit_transform(X)
```

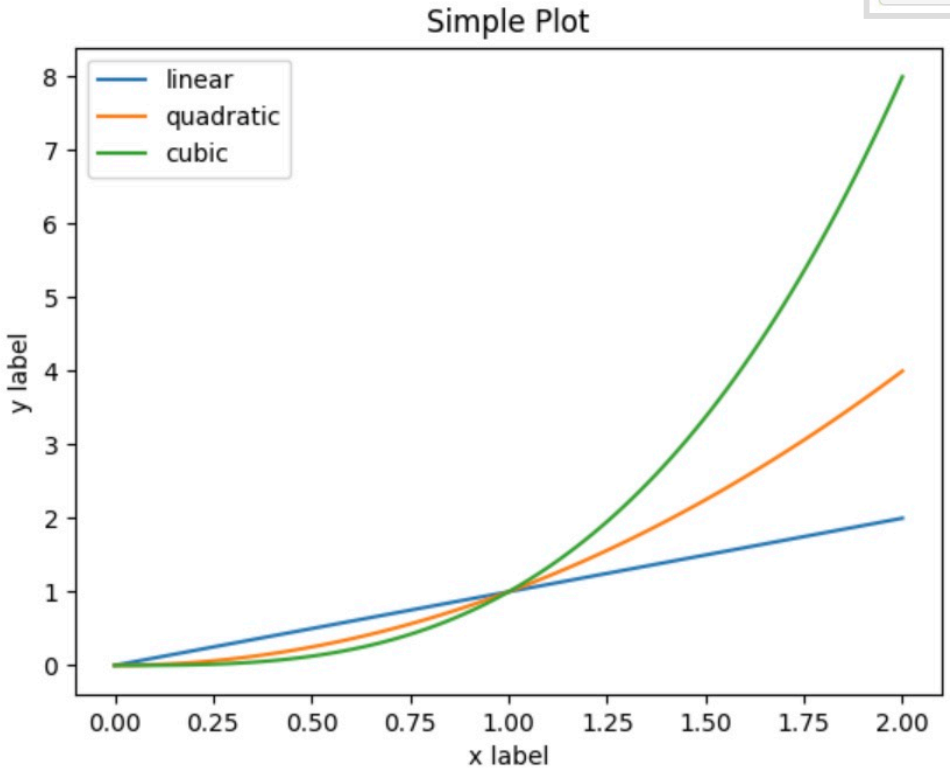

Anatomy of a figure
Title
Major tick
Minor tick
Major tick label
Legend
Grid
Line
(line plot)
Y axis label
Markers
(scatter plot)
Figure
Axes
Line
(line plot)
Spines
Minor tick label
X axis label
Made with http://matplotlib.org

```python
x = np.linspace(0, 2, 100)

# Note that even in the OO-style, we use `.pyplot.figure` to create the figure.
fig, ax = plt.subplots()  # Create a figure and an axes.
ax.plot(x, x, label='linear')  # Plot some data on the axes.
ax.plot(x, x**2, label='quadratic')  # Plot more data on the axes...
ax.plot(x, x**3, label='cubic')  # ... and some more.
ax.set_xlabel('x label')  # Add an x-label to the axes.
ax.set_ylabel('y label')  # Add a y-label to the axes.
ax.set_title("Simple Plot")  # Add a title to the axes.
ax.legend()  # Add a legend.
```

=

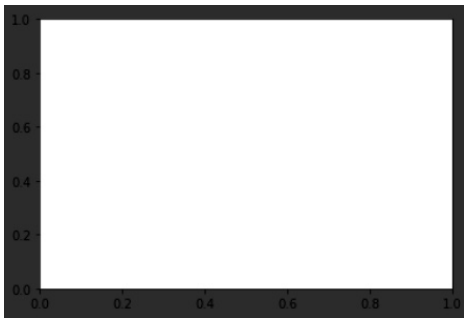
or (pyplot-style)

```python
x = np.linspace(0, 2, 100)

plt.plot(x, x, label='linear')  # Plot some data on the (implicit) axes.
plt.plot(x, x**2, label='quadratic')  # etc.
plt.plot(x, x**3, label='cubic')
plt.xlabel('x label')
plt.ylabel('y label')
plt.title("Simple Plot")
plt.legend()
```

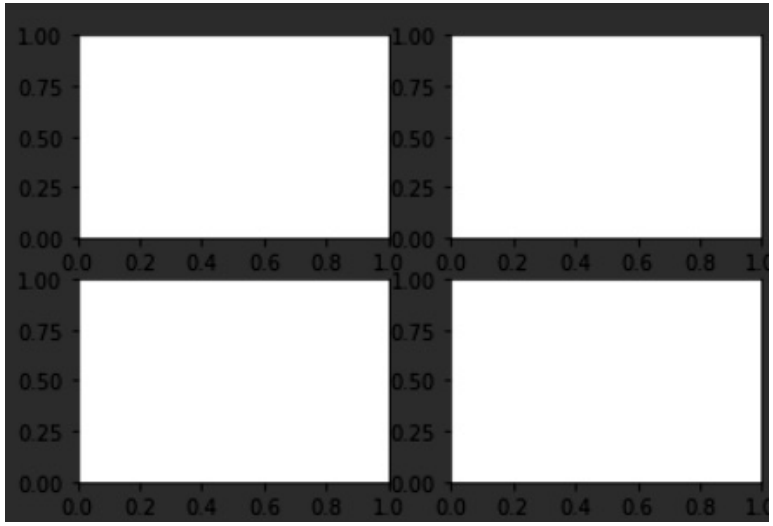


```
fig = plt.figure()  # an empty figure with no Axes
```

```
fig, ax = plt.subplots()  # a figure with a single Axes
```



```
fig, axs = plt.subplots(2, 2)  # a figure with a 2x2 grid of Axes
```



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Python For Data Science *Cheat Sheet*

Matplotlib

Learn Python Interactively at www.DataCamp.com

Matplotlib

Matplotlib is a Python 2D plotting library which produces publication-quality figures in a variety of hardcopy formats and interactive environments across platforms.

matplotlib

1 Prepare The Data

Also see Lists & NumPy

1D Data

```
>>> import numpy as np
>>> x = np.linspace(0, 10, 100)
>>> y = np.cos(x)
>>> z = np.sin(x)
```

2D Data or Images

```
>>> data = 2 * np.random.random((10, 10))
>>> data2 = 3 * np.random.random((10, 10))
>>> Y, X = np.mgrid[-3:3:100j, -3:3:100j]
>>> U = -1 - X**2 + Y
>>> V = 1 + X - Y**2
>>> from matplotlib.cbook import get_sample_data
>>> img = np.load(get_sample_data('axes_grid/bivariate_normal.npy'))
```

2 Create Plot

```
>>> import matplotlib.pyplot as plt
```

Figure

```
>>> fig = plt.figure()
>>> fig2 = plt.figure(figsize=plt.figaspect(2.0))
```

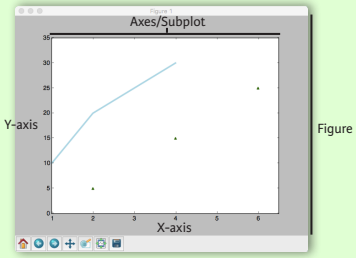
Axes

All plotting is done with respect to an `Axes`. In most cases, a subplot will fit your needs. A subplot is an axes on a grid system.

```
>>> fig.add_axes()
>>> ax1 = fig.add_subplot(221) # row-col-num
>>> ax3 = fig.add_subplot(212)
>>> fig3, axes = plt.subplots(nrows=2,ncols=2)
>>> fig4, axes2 = plt.subplots(ncols=3)
```

Plot Anatomy & Workflow

Plot Anatomy



Workflow

The basic steps to creating plots with matplotlib are:

1 Prepare data 2 Create plot 3 Plot 4 Customize plot 5 Save plot 6 Show plot

```
>>> import matplotlib.pyplot as plt
>>> x = [1,2,3,4]                          Step 1
>>> y = [10,20,25,30]
>>> fig = plt.figure()                     Step 2
>>> ax = fig.add_subplot(111)              Step 3
>>> ax.plot(x, y, color='lightblue', linewidth=3)   Step 3, 4
>>> ax.scatter([2,4,6],
               [5,15,25],
               color='darkgreen',
               marker='^')
>>> ax.set_xlim(1, 6.5)
>>> plt.savefig('foo.png')
>>> plt.show()                             Step 6
```

3 Plotting Routines

1D Data

```
>>> fig, ax = plt.subplots()
>>> lines = ax.plot(x,y)
>>> ax.scatter(x,y)
>>> axes[0,0].bar([1,2,3],[3,4,5])
>>> axes[1,0].barh([0.5,1,2.5],[0,1,2])
>>> axes[1,1].axhline(0.45)
>>> axes[0,1].axvline(0.65)
>>> ax.fill(x,y,color='blue')
>>> ax.fill_between(x,y,color='yellow')
```

Draw points with lines or markers connecting them
Draw unconnected points, scaled or colored
Plot vertical rectangles (constant width)
Plot horiontal rectangles (constant height)
Draw a horizontal line across axes
Draw a vertical line across axes
Draw filled polygons
Fill between y-values and 0

Vector Fields

```
>>> axes[0,1].arrow(0,0,0.5,0.5)
>>> axes[1,1].quiver(y,z)
>>> axes[0,1].streamplot(X,Y,U,V)
```

Add an arrow to the axes
Plot a 2D field of arrows
Plot a 2D field of arrows

Data Distributions

```
>>> ax1.hist(y)
>>> ax3.boxplot(y)
>>> ax3.violinplot(z)
```

Plot a histogram
Make a box and whisker plot
Make a violin plot

2D Data or Images

```
>>> fig, ax = plt.subplots()
>>> im = ax.imshow(img,
                   cmap='gist_earth',
                   interpolation='nearest',
                   vmin=-2,
                   vmax=2)
```

Colormapped or RGB arrays

```
>>> axes2[0].pcolor(data2)
>>> axes2[0].pcolormesh(data)
>>> CS = plt.contour(Y,X,U)
>>> axes2[2].contourf(data1)
>>> axes2[2]= ax.clabel(CS)
```

Pseudocolor plot of 2D array
Pseudocolor plot of 2D array
Plot contours
Plot filled contours
Label a contour plot

4 Customize Plot

Colors, Color Bars & Color Maps

```
>>> plt.plot(x, x, x, x**2, x, x**3)
>>> ax.plot(x, y, alpha = 0.4)
>>> ax.plot(x, y, c='k')
>>> fig.colorbar(im, orientation='horizontal')
>>> im = ax.imshow(img,
                   cmap='seismic')
```

Markers

```
>>> fig, ax = plt.subplots()
>>> ax.scatter(x,y,marker=".")
>>> ax.plot(x,y,marker="o")
```

Linestyles

```
>>> plt.plot(x,y,linewidth=4.0)
>>> plt.plot(x,y,ls='solid')
>>> plt.plot(x,y,ls='--')
>>> plt.plot(x,y,'--',x**2,y**2,'-.')
>>> plt.setp(lines,color='r',linewidth=4.0)
```

Text & Annotations

```
>>> ax.text(1,
            -2.1,
            'Example Graph',
            style='italic')
>>> ax.annotate("Sine",
                xy=(8, 0),
                xycoords='data',
                xytext=(10.5, 0),
                textcoords='data',
                arrowprops=dict(arrowstyle="->",
                                connectionstyle="arc3"),)
```

Mathtext

```
>>> plt.title(r'$sigma_i=15$', fontsize=20)
```

Limits, Legends & Layouts

Limits & Autoscaling

```
>>> ax.margins(x=0.0,y=0.1)
>>> ax.axis('equal')
>>> ax.set(xlim=[0,10.5],ylim=[-1.5,1.5])
>>> ax.set_xlim(0,10.5)
```

Add padding to a plot
Set the aspect ratio of the plot to 1
Set limits for x-and y-axis
Set limits for x-axis

Legends

```
>>> ax.set(title='An Example Axes',
           ylabel='Y-Axis',
           xlabel='X-Axis')
>>> ax.legend(loc='best')
```

Set a title and x-and y-axis labels
No overlapping plot elements

Ticks

```
>>> ax.xaxis.set(ticks=range(1,5),
                 ticklabels=[3,100,-12,"foo"])
>>> ax.tick_params(axis='y',
                   direction='inout',
                   length=10)
```

Manually set x-ticks
Make y-ticks longer and go in and out

Subplot Spacing

```
>>> fig3.subplots_adjust(wspace=0.5,
                         hspace=0.3,
                         left=0.125,
                         right=0.9,
                         top=0.9,
                         bottom=0.1)
>>> fig.tight_layout()
```

Adjust the spacing between subplots
Fit subplot(s) in to the figure area

Axis Spines

```
>>> ax1.spines['top'].set_visible(False)
>>> ax1.spines['bottom'].set_position(('outward',10))
```

Make the top axis line for a plot invisible
Move the bottom axis line outward

5 Save Plot

Save figures

```
>>> plt.savefig('foo.png')
```

Save transparent figures

```
>>> plt.savefig('foo.png', transparent=True)
```

6 Show Plot

```
>>> plt.show()
```

Close & Clear

```
>>> plt.cla()
>>> plt.clf()
>>> plt.close()
```

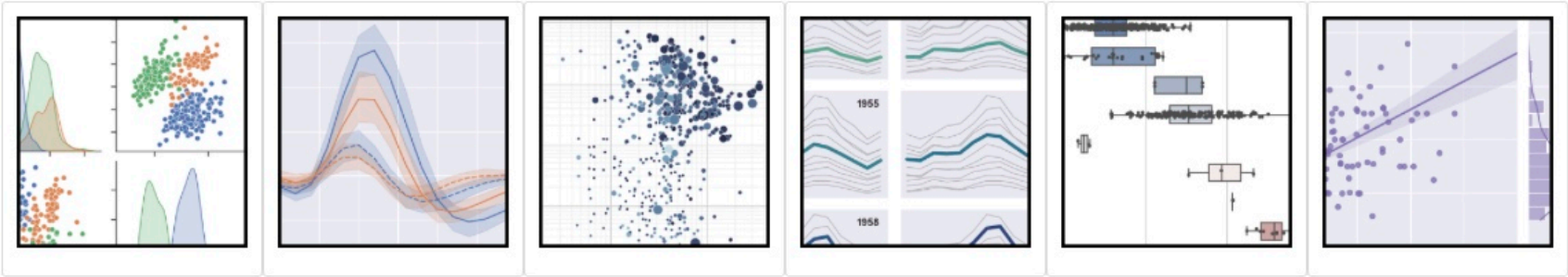
Clear an axis
Clear the entire figure
Close a window

DataCamp
Learn Python for Data Science Interactively

https://seaborn.pydata.org

seaborn 0.11.1 Gallery Tutorial API Site Page Search

seaborn: statistical data visualization



Seaborn is a Python data visualization library based on matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics.

For a brief introduction to the ideas behind the library, you can read the introductory notes. Visit the installation page to see how you can download the package and get started with it. You can browse the example gallery to see what you can do with seaborn, and then check out the tutorial and API reference to find out how.

To see the code or report a bug, please visit the GitHub repository. General support questions are most at home on stackoverflow or discourse, which have dedicated channels for seaborn.

Contents

- Introduction
- Release notes
- Installing
- Example gallery
- Tutorial
- API reference

Features

- Relational: API | Tutorial
- Distribution: API | Tutorial
- Categorical: API | Tutorial
- Regression: API | Tutorial
- Multiples: API | Tutorial
- Style: API | Tutorial
- Color: API | Tutorial

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Python For Data Science *Cheat Sheet*

Seaborn

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Statistical Data Visualization With Seaborn

The Python visualization library **Seaborn** is based on matplotlib and provides a high-level interface for drawing attractive statistical graphics.

Make use of the following aliases to import the libraries:

```
>>> import matplotlib.pyplot as plt
>>> import seaborn as sns
```

The basic steps to creating plots with Seaborn are:

1. Prepare some data
2. Control figure aesthetics
3. Plot with Seaborn
4. Further customize your plot

```
>>> import matplotlib.pyplot as plt
>>> import seaborn as sns
>>> tips = sns.load_dataset("tips")                    Step 1
>>> sns.set_style("whitegrid")                         Step 2
>>> g = sns.lmplot(x="tip",                            Step 3
                   y="total_bill",
                   data=tips,
                   aspect=2)
>>> g = (g.set_axis_labels("Tip","Total bill(USD)").
set(xlim=(0,10),ylim=(0,100)))                         Step 4
>>> plt.title("title")
>>> plt.show(g)                                        Step 5
```

1 Data

Also see Lists, NumPy & Pandas

```
>>> import pandas as pd
>>> import numpy as np
>>> uniform_data = np.random.rand(10, 12)
>>> data = pd.DataFrame({'x':np.arange(1,101),
                         'y':np.random.normal(0,4,100)})
```

Seaborn also offers built-in data sets:

```
>>> titanic = sns.load_dataset("titanic")
>>> iris = sns.load_dataset("iris")
```

2 Figure Aesthetics

Also see Matplotlib

```
>>> f, ax = plt.subplots(figsize=(5,6))
```
Create a figure and one subplot

Seaborn styles

```
>>> sns.set()
>>> sns.set_style("whitegrid")
>>> sns.set_style("ticks",
                  {"xtick.major.size":8,
                   "ytick.major.size":8})
>>> sns.axes_style("whitegrid")
```
(Re)set the seaborn default
Set the matplotlib parameters
Set the matplotlib parameters

Return a dict of params or use with `with` to temporarily set the style

Context Functions

```
>>> sns.set_context("talk")
>>> sns.set_context("notebook",
                    font_scale=1.5,
                    rc={"lines.linewidth":2.5})
```
Set context to `"talk"`
Set context to `"notebook"`, scale font elements and override param mapping

Color Palette

```
>>> sns.set_palette("husl",3)
>>> sns.color_palette("husl")
>>> flatui = ["#9b59b6","#3498db","#95a5a6","#e74c3c","#34495e","#2ecc71"]
>>> sns.set_palette(flatui)
```
Define the color palette
Use with `with` to temporarily set palette
Set your own color palette

3 Plotting With Seaborn

Axis Grids

```
>>> g = sns.FacetGrid(titanic,
                      col="survived",
                      row="sex")
>>> g = g.map(plt.hist,"age")
>>> sns.factorplot(x="pclass",
                   y="survived",
                   hue="sex",
                   data=titanic)
>>> sns.lmplot(x="sepal_width",
               y="sepal_length",
               hue="species",
               data=iris)
```
Subplot grid for plotting conditional relationships

Draw a categorical plot onto a Facetgrid

Plot data and regression model fits across a FacetGrid

```
>>> h = sns.PairGrid(iris)
>>> h = h.map(plt.scatter)
>>> sns.pairplot(iris)
>>> i = sns.JointGrid(x="x",
                      y="y",
                      data=data)
>>> i = i.plot(sns.regplot,
               sns.distplot)
>>> sns.jointplot("sepal_length",
                  "sepal_width",
                  data=iris,
                  kind='kde')
```
Subplot grid for plotting pairwise relationships
Plot pairwise bivariate distributions
Grid for bivariate plot with marginal univariate plots

Plot bivariate distribution

Categorical Plots

Scatterplot

```
>>> sns.stripplot(x="species",
                  y="petal_length",
                  data=iris)
>>> sns.swarmplot(x="species",
                  y="petal_length",
                  data=iris)
```
Scatterplot with one categorical variable

Categorical scatterplot with non-overlapping points

Bar Chart

```
>>> sns.barplot(x="sex",
                y="survived",
                hue="class",
                data=titanic)
```
Show point estimates and confidence intervals with scatterplot glyphs

Count Plot

```
>>> sns.countplot(x="deck",
                  data=titanic,
                  palette="Greens_d")
```
Show count of observations

Point Plot

```
>>> sns.pointplot(x="class",
                  y="survived",
                  hue="sex",
                  data=titanic,
                  palette={"male":"g",
                           "female":"m"},
                  markers=["^","o"],
                  linestyles=["-","--"])
```
Show point estimates and confidence intervals as rectangular bars

Boxplot

```
>>> sns.boxplot(x="alive",
                y="age",
                hue="adult_male",
                data=titanic)
>>> sns.boxplot(data=iris,orient="h")
```
Boxplot

Boxplot with wide-form data

Violinplot

```
>>> sns.violinplot(x="age",
                   y="sex",
                   hue="survived",
                   data=titanic)
```
Violin plot

Regression Plots

```
>>> sns.regplot(x="sepal_width",
                y="sepal_length",
                data=iris,
                ax=ax)
```
Plot data and a linear regression model fit

Distribution Plots

```
>>> plot = sns.distplot(data.y,
                        kde=False,
                        color="b")
```
Plot univariate distribution

Matrix Plots

```
>>> sns.heatmap(uniform_data,vmin=0,vmax=1)
```
Heatmap

4 Further Customizations

Also see Matplotlib

Axisgrid Objects

```
>>> g.despine(left=True)
>>> g.set_ylabels("Survived")
>>> g.set_xticklabels(rotation=45)
>>> g.set_axis_labels("Survived",
                      "Sex")
>>> h.set(xlim=(0,5),
          ylim=(0,5),
          xticks=[0,2.5,5],
          yticks=[0,2.5,5])
```
Remove left spine
Set the labels of the y-axis
Set the tick labels for x
Set the axis labels

Set the limit and ticks of the x-and y-axis

Plot

```
>>> plt.title("A Title")
>>> plt.ylabel("Survived")
>>> plt.xlabel("Sex")
>>> plt.ylim(0,100)
>>> plt.xlim(0,10)
>>> plt.setp(ax,yticks=[0,5])
>>> plt.tight_layout()
```
Add plot title
Adjust the label of the y-axis
Adjust the label of the x-axis
Adjust the limits of the y-axis
Adjust the limits of the x-axis
Adjust a plot property
Adjust subplot params

5 Show or Save Plot

Also see Matplotlib

```
>>> plt.show()
>>> plt.savefig("foo.png")
>>> plt.savefig("foo.png",
                transparent=True)
```
Show the plot
Save the plot as a figure
Save transparent figure

Close & Clear

Also see Matplotlib

```
>>> plt.cla()
>>> plt.clf()
>>> plt.close()
```
Clear an axis
Clear an entire figure
Close a window

https://github.com/matplotlib/cheatsheets#cheatsheets

Matplotlib for beginners

Matplotlib is a library for making 2D plots in Python. It is designed with the philosophy that you should be able to create simple plots with just a few commands:

1 Initialize

```
import numpy as np
import matplotlib.pyplot as plt
```

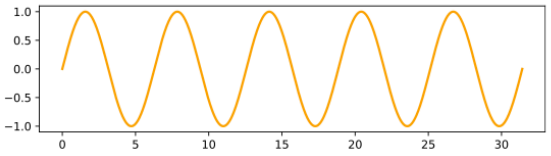
2 Prepare

```
X = np.linspace(0, 4*np.pi, 1000)
Y = np.sin(X)
```

3 Render

```
fig, ax = plt.subplots()
ax.plot(X, Y)
fig.show()
```

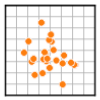
4 Observe



Choose

Matplotlib offers several kind of plots (see Gallery):

```
X = np.random.uniform(0, 1, 100)
Y = np.random.uniform(0, 1, 100)
ax.scatter(X, Y)
```

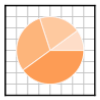


```
X = np.arange(10)
Y = np.random.uniform(1, 10, 10)
ax.bar(X, Y)
```

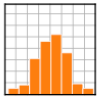
```
Z = np.random.uniform(0, 1, (8,8)

ax.imshow(Z)
```

```
Z = np.random.uniform(0, 1, (8,8)

ax.contourf(Z)
```

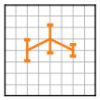
```
Z = np.random.uniform(0, 1, 4)

ax.pie(Z)
```



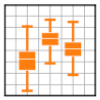
```
Z = np.random.normal(0, 1, 100)

ax.hist(Z)
```



```
X = np.arange(5)
Y = np.random.uniform(0,1,5)
ax.errorbar(X, Y, Y/4)
```



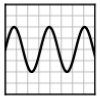
```
Z = np.random.normal(0,1,(100,3))

ax.boxplot(Z)
```



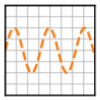
Tweak

You can modify pretty much anything in a plot, including limits, colors, markers, line width and styles, ticks and ticks labels, titles, etc.

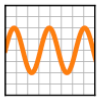
```
X = np.linspace(0,10,100)
Y = np.sin(X)
ax.plot(X, Y, color="black")
```



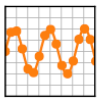
```
X = np.linspace(0,10,100)
Y = np.sin(X)
ax.plot(X, Y, linestyle="--")
```



```
X = np.linspace(0,10,100)
Y = np.sin(X)
ax.plot(X, Y, linewidth=5)
```



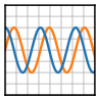
```
X = np.linspace(0,10,100)
Y = np.sin(X)
ax.plot(X, Y, marker="o")
```



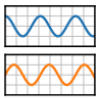
Organize

You can plot several data on the the same figure but you can also split a figure in several subplots (named *Axes*):

```
X = np.linspace(0,10,100)
Y1, Y1 = np.sin(X), np.cos(X)
ax.plot(X, Y1, Y2)
```



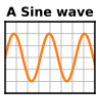
```
fig, (ax1, ax2) = plt.subplots((2,1))
ax1.plot(X, Y1, color="C1")
ax2.plot(X, Y2, color="C0")
```



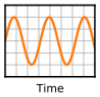
```
fig, (ax1, ax2) = plt.subplots((1,2))
ax1.plot(Y1, X, color="C1")
ax2.plot(Y2, X, color="C0")
```

Label (everything)

```
ax.plot(X, Y)
fig.suptitle(None)
ax.set_title("A Sine wave")
```




```
ax.plot(X, Y)
ax.set_ylabel(None)
ax.set_xlabel("Time")
```



Explore

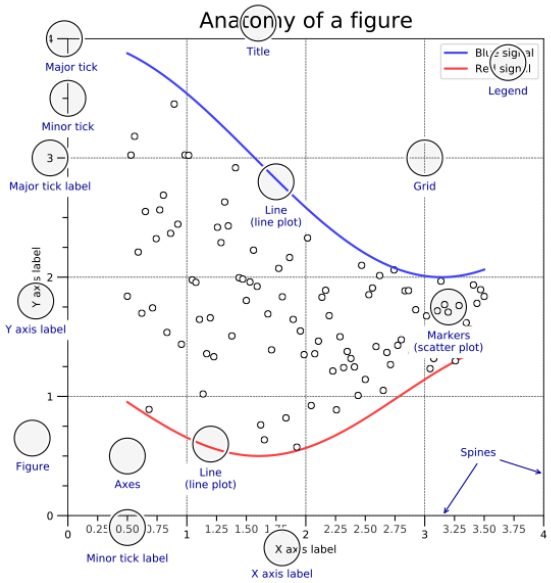
Figures are shown with a graphical user interface that allows to zoom and pan the figure, to navigate between the different views and to show the value under the mouse.

Save (bitmap or vector format)

```
fig.savefig("my-first-figure.png", dpi=300)
fig.savefig("my-first-figure.pdf")
```

Matplotlib for intermediate users

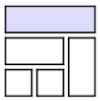
A matplotlib figure is composed of a hierarchy of elements that forms the actual figure. Each element can be modified.



Figure, axes & spines

```
fig, axs = plt.subplots((3,3))
axs[0,0].set_facecolor("#ddddff")
axs[2,2].set_facecolor("#ffffdd")
```

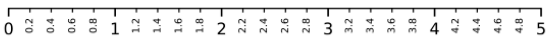
```
gs = fig.add_gridspec(3, 3)
ax = fig.add_subplot(gs[0, :])
ax.set_facecolor("#ddddff")
```



```
fig, ax = plt.subplots()
ax.spines["top"].set_color("None")
ax.spines["right"].set_color("None")
```

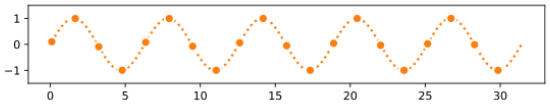
Ticks & labels

```
from mpl.ticker import MultipleLocator as ML
from mpl.ticker import ScalarFormatter as SF
ax.xaxis.set_minor_locator(ML(0.2))
ax.xaxis.set_minor_formatter(SF())
ax.tick_params(axis='x',which='minor',rotation=90)
```



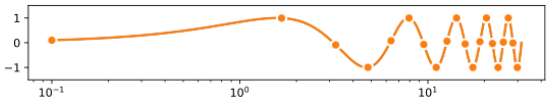
Lines & markers

```
X = np.linspace(0.1, 10*np.pi, 1000)
Y = np.sin(X)
ax.plot(X, Y, "C1o:", markevery=25, mec="1.0")
```



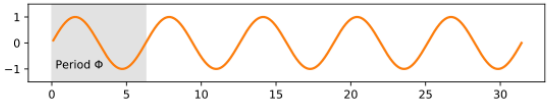
Scales & Projections

```
fig, ax = plt.subplots()
ax.set_xscale("log")
ax.plot(X, Y, "C1o-", markevery=25, mec="1.0")
```



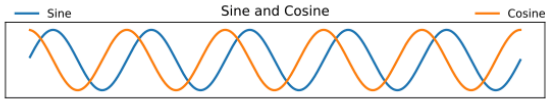
Text & Ornaments

```
ax.fill_betweenx([-1,1],[0],[2*np.pi])
ax.text(0, -1, r" Period $\Phi$")
```



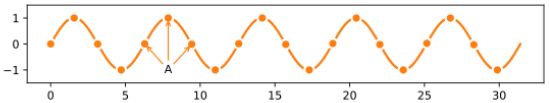
Legend

```
ax.plot(X, np.sin(X), "C0", label="Sine")
ax.plot(X, np.cos(X), "C1", label="Cosine")
ax.legend(bbox_to_anchor=(0,1,1,.1),ncol=2,
          mode="expand",  loc="lower left")
```



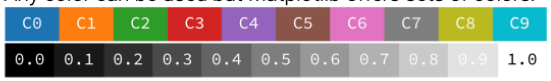
Annotation

```
ax.annotate("A", (X[250],Y[250]),(X[250],-1),
  ha="center", va="center",arrowprops =
  {"arrowstyle" : "->", "color": "C1"})
```



Colors

Any color can be used but Matplotlib offers sets of colors:



Size & DPI

Consider a square figure to be included in a two-columns A4 paper with 2cm margins on each side and a column separation of 1cm. The width of a figure is (21 - 2*2 - 1)/2 = 8cm. One inch being 2.54cm, figure size should be 3.15×3.15 in.

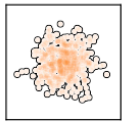
```
fig = plt.figure(figsize=(3.15,3.15), dpi=50)
plt.savefig("figure.pdf", dpi=600)
```

Matplotlib tips & tricks

Transparency

Scatter plots can be enhanced by using transparency (alpha) in order to show area with higher density and multiple scatter plots can be used to delineate a frontier.

```
X = np.random.normal(-1,1,500)
Y = np.random.normal(-1,1,500)
ax.scatter(X, Y, 50, "0.0", lw=2) # optional
ax.scatter(X, Y, 50, "1.0", lw=0) # optional
ax.scatter(X, Y, 40, "C1",  lw=0, alpha=0.1)
```



Rasterization

If your figure is made of a lot graphical elements such as a huge scatter, you can rasterize them to save memory and keep other elements in vector format.

```
X = np.random.normal(-1, 1, 10_000)
Y = np.random.normal(-1, 1, 10_000)
ax.scatter(X, Y, rasterized=True)
fig.savefig("rasterized-figure.pdf", dpi=600)
```

Offline rendering

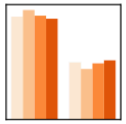
Use the Agg backend to render a figure directly in an array.

```
from matplotlib.backends.backend_agg import FigureCanvas
canvas = FigureCanvas(Figure()))
... # draw som stuff
canvas.draw()
Z = np.array(canvas.renderer.buffer_rgba())
```

Range of continuous colors

You can use colormap to pick a range of continuous colors.

```
X = np.random.randn(1000, 4)
cmap = plt.get_cmap("Blues")
colors = [cmap(i) for in in [.2,.4,.6,.8]]

ax.hist(X, 2, histtype='bar', color=colors)
```



Text outline

Use text outline to make text more visible.

```
import matplotlib.patheffects as fx
text = ax.text(0.5, 0.1, "Label")
text.set_path_effects([
  fx.Stroke(linewidth=3, foreground='1.0'),
  fx.Normal()])
```

Multiline plot

You can plot several lines at once using None as separator.

```
X,Y = [], []
for x in np.linspace(0, 10*np.pi, 100):
  X.extend([x, x, None]), Y.extend([0, sin(x), None])
ax.plot(X, Y, "black")
```

Dotted lines

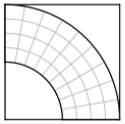
To have rounded dotted lines, use a custom `linestyle` and modify `dash_capstyle`.

```
ax.plot([0,1], [0,0], "C1",
        linestyle = (0, (0.01, 1)), dash_capstyle="round")
ax.plot([0,1], [1,1], "C1",
        linestyle = (0, (0.01, 2)), dash_capstyle="round")
```

Combining axes

You can use overlaid axes with different projections.

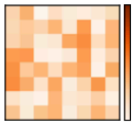
```
ax1 = fig.add_axes([0,0,1,1],
                   label="cartesian")
ax2 = fig.add_axes([0,0,1,1],
                   label="polar",
                   projection="polar")
```



Colorbar adjustment

You can adjust colorbar aspect when adding it.

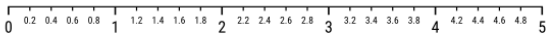
```
im = ax.imshow(Z)

cb = plt.colorbar(im,
        fraction=0.046, pad=0.04)
cb.set_ticks([])
```



Taking advantage of typography

You can use a condensed face such as Roboto Condensed to save space on tick labels.

```
for tick in ax.get_xticklabels(which='both'):
    tick.set_fontname("Roboto Condensed")
```



Getting rid of margins

Once your figure is finished, you can call `tight_layout()` to remove white margins. If there are remaining margins, you can use the `pdfcrop` utility (comes with TeX live).

Hatching

You can achieve nice visual effect with thick hatch patterns.

```
cmap = plt.get_cmap("Oranges")
plt.rcParams['hatch.color'] = cmap(0.2)
plt.rcParams['hatch.linewidth'] = 8
ax.bar(X, Y, color=cmap(0.6), hatch="/" )
```

Read the documentation

Matplotlib comes with an extensive documenation explaining every detals of each command and is generally accompanied by examples with. Together with the huge online gallery, this documentation is a gold-mine.

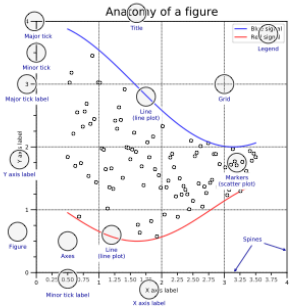
matplotlib Cheat sheet

Version 3.2

Quick start

```
import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt


X = np.linspace(0, 2*np.pi, 100)
Y = np.cos(X)

fig, ax = plt.subplots()
ax.plot(X,Y,color='C1')

fig.savefig("figure.pdf")
fig.show()
```

Anatomy of a figure



Subplots layout

```
subplot[s](cols,rows,…)
fig, axs = plt.subplots(3,3)

G = gridspec(cols,rows,…)
ax = G[0,:]

ax.inset_axes(extent)

d=make_axes_locatable(ax)
ax=d.new_horizontal('10%')
```

Getting help

- matplotlib.org
- github.com/matplotlib/matplotlib/issues
- discourse.matplotlib.org
- stackoverflow.com/matplotlib
- gitter.im/matplotlib
- twitter.com/matplotlib
- Matplotlib users mailing list

Basic plots

```
plot([X],Y,[fmt],…)
```
X, **Y**, fmt, color, marker, linestyle

```
scatter(X,Y,…)
```
X, **Y**, [s]izes, [c]olors, markers, cmap

```
bar[h](x,height,…)
```
x, **height**, width, bottom, align, color

```
imshow(Z,[cmap],…)
```
Z, cmap, interpolation, extent, origin

```
contour[f]([X],[Y],Z,…)
```
X, Y, **Z**, levels, colors, extent, origin

```
quiver([X],[Y],U,V,…)
```
X, Y, **U**, **V**, C, units, angles

```
pie(X,[explode],…)
```
Z, explode, labels, colors, radius

```
text(x,y,text,…)
```
x, **y**, **text**, va, ha, size, weight, transform

```
fill[_between][x]( … )
```
X, Y1, Y2, color, where

Advanced plots

```
step(X,Y,[fmt],…)
```
X, **Y**, fmt, color, marker, where

```
boxplot(X,…)
```
X, notch, sym, bootstrap, widths

```
errorbar(X,Y,xerr,yerr,…)
```
X, **Y**, xerr, yerr, fmt

```
hist(X, bins, …)
```
X, bins, range, density, weights

```
violinplot(D,…)
```
D, positions, widths, vert

```
barbs([X],[Y], U, V, …)
```
X, Y, **U**, **V**, C, length, pivot, sizes

```
eventplot(positions,…)
```
positions, orientation, lineoffsets

```
hexbin(X,Y,C,…)
```
X, **Y**, C, gridsize, bins

```
xcorr(X,Y,…)
```
X, **Y**, normed, detrend

Scales

```
ax.set_[xy]scale(scale,…)
```

linear any values

log values > 0

symlog any values

logit 0 < values < 1

Projections

```
subplot(…,projection=p)
```

p='polar'

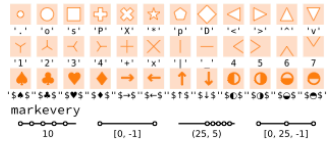
p='3d'

```
p=Orthographic()
from cartopy.crs import Cartographic
```

Lines

```
linestyle or ls
"-"  ":"  "--"  "-."  (0,(0.01,2)
capstyle or dash_capstyle
"butt"  "round"  "projecting"
```

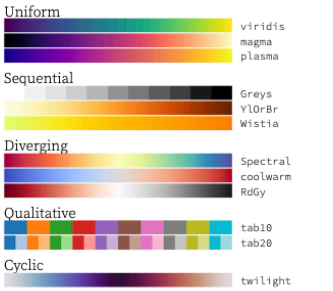
Markers



Colors

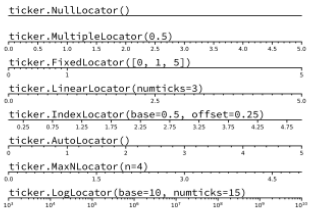
Colormaps

```
plt.get_cmap(name)
```



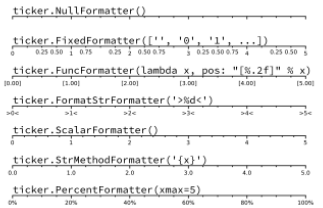
Tick locators

```
from matplotlib import ticker
ax.[xy]axis.set_[minor|major]_locator(locator)
```



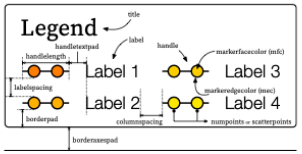
Tick formatters

```
from matplotlib import ticker
ax.[xy]axis.set_[minor|major]_formatter(formatter)
```

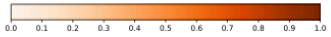


Ornaments

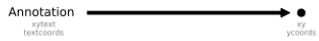
```
ax.legend(…)
```
handles, labels, loc, title, frameon




```
ax.colorbar(…)
```
mappable, ax, cax, orientation




```
ax.annotate(…)
```
text, **xy**, **xytext**, xycoords, textcoords, arrowprops



Event handling

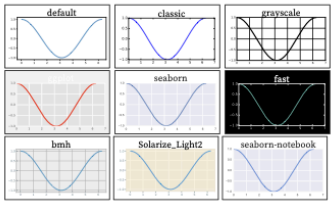
```
fig, ax = plt.subplots()
def on_click(event):
  print(event)
fig.canvas.mpl_connect(
  'button_press_event', on_click)
```

Animation

```
import matplotlib.animation as mpla

T = np.linspace(0,2*np.pi,100)
S = np.sin(T)
line, = plt.plot(T, S)
def animate(i):
  line.set_ydata(np.sin(T+i/50))
anim = mpla.FuncAnimation(
  plt.gcf(), animate, interval=5)
plt.show()
```

Styles

```
plt.style.use(style)
```



Quick reminder

```
ax.grid()
ax.patch.set_alpha(0)
ax.set_[xy]lim(vmin, vmax)
ax.set_[xy]label(label)
ax.set_[xy]ticks(list)
ax.set_[xy]ticklabels(list)
ax.set_[sup]title(title)
ax.tick_params(width=10, …)
ax.set_axis_[on|off]()

ax.tight_layout()
plt.gcf(), plt.gca()
mpl.rc('axes', linewidth=1, …)
fig.patch.set_alpha(0)
text=r'$\frac{-e^{i\pi}}{2^n}$'
```

Keyboard shortcuts

ctrl + s	Save	ctrl + w	Close plot
r	Reset view	f	Fullscreen 0/1
f	View forward	b	View back
p	Pan view	o	Zoom to rect
x	X pan/zoom	y	Y pan/zoom
g	Minor grid 0/1	G	Major grid 0/1
l	X axis log/linear	L	Y axis log/linear

Ten Simple Rules

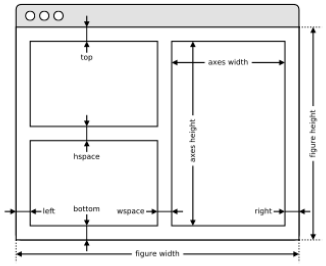
READ

1. Know Your Audience
2. Identify Your Message
3. Adapt the Figure
4. Captions Are Not Optional
5. Do Not Trust the Defaults
6. Use Color Effectively
7. Do Not Mislead the Reader
8. Avoid "Chartjunk"
9. Message Trumps Beauty
10. Get the Right Tool

Axes adjustements

API

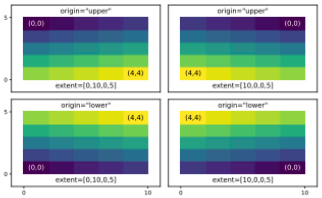
plt.**subplot_adjust**(...)



Extent & origin

API

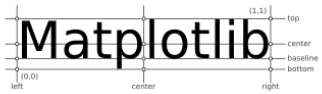
ax.**imshow**(extent=..., origin=...)



Text alignments

API

ax.**text**(..., ha=... , va=..., ...)



Text parameters

API

ax.**text**(..., family=... , size=..., weight = ...)
ax.**text**(..., fontproperties = ...)

The quick brown fox — xx-large (1.73)
The quick brown fox — x-large (1.44)
The quick brown fox — large (1.20)
The quick brown fox — medium (1.00)
The quick brown fox — small (0.83)
The quick brown fox — x-small (0.69)
The quick brown fox — xx-small (0.58)

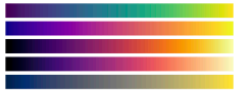
The quick brown fox jumps over the lazy dog — black (900)
The quick brown fox jumps over the lazy dog — bold (700)
The quick brown fox jumps over the lazy dog — semibold (600)
The quick brown fox jumps over the lazy dog — normal (400)
The quick brown fox jumps over the lazy dog — ultralight (100)

The quick brown fox jumps over the lazy dog — monospace
The quick brown fox jumps over the lazy dog — serif
The quick brown fox jumps over the lazy dog — sans
The quick brown fox jumps over the lazy dog — cursive

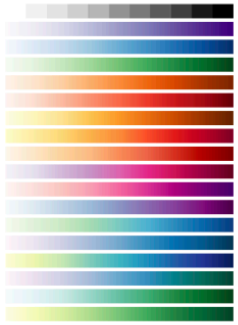
The quick brown fox jumps over the lazy dog — italic
The quick brown fox jumps over the lazy dog — normal

THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG — small-caps
The quick brown fox jumps over the lazy dog — normal

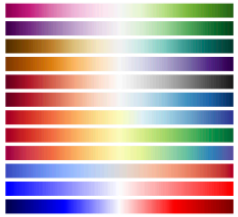
Uniform colormaps



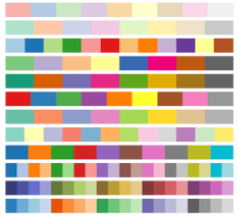
Sequential colormaps



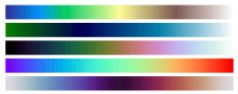
Diverging colormaps



Qualitative colormaps



Miscellaneous colormaps

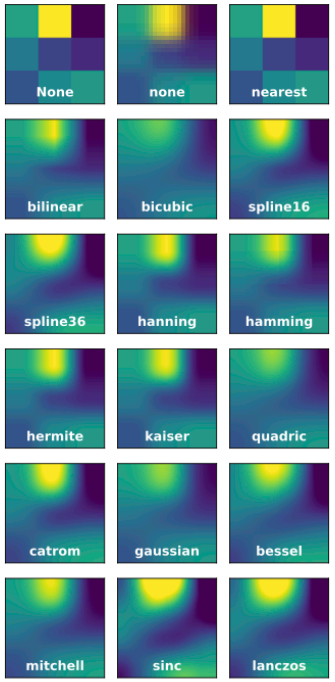


Color names

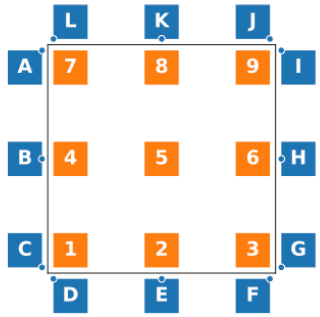
API

Image interpolation

API



Legend placement



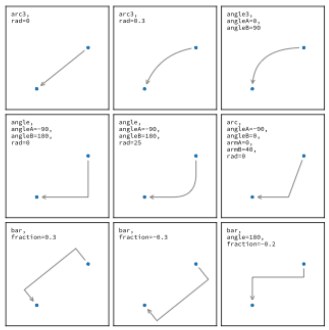
ax.**legend**(loc="string", bbox_to_anchor=(x,y))

1: lower left — 2: lower center — 3: lower right
4: left — 5: center — 6: right
7: upper left — 8: upper center — 9: upper right

A: upper right / (-.1,.9) — B: right / (-.1,.5)
C: lower right / (-.1,.1) — D: upper left / (-.1,-.1)
E: upper center / (.5,-.1) — F: upper right / (.9,-.1)
G: lower left / (1.1,.1) — H: left / (1.1,.5)
I: upper left / (1.1,.9) — J: lower right / (.9,1.1)
K: lower center / (.5,1.1) — L: lower left / (.1,1.1)

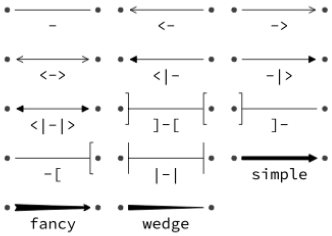
Annotation connection styles

API



Annotation arrow styles

API



How do I ...

... resize a figure?
→ fig.set_size_inches(w,h)
... save a figure?
→ fig.savefig("figure.pdf")
... save a transparent figure?
→ fig.savefig("figure.pdf", transparent=True)
... clear a figure?
→ ax.clear()
... close all figures?
→ plt.close("all")
... remove ticks?
→ ax.set_xticks([])
... remove tick labels ?
→ ax.set_[xy]ticklabels([])
... rotate tick labels ?
→ ax.set_[xy]ticks(rotation=90)
... hide top spine?
→ ax.spines['top'].set_visible(False)
... hide legend border?
→ ax.legend(frameon=False)
... show error as shaded region?
→ ax.fill_between(X, Y+error, Y-error)
... draw a rectangle?
→ ax.add_patch(plt.Rectangle((0, 0),1,1)
... draw a vertical line?
→ ax.axvline(x=0.5)
... draw outside frame?
→ ax.plot(..., clip_on=False)
... use transparency?
→ ax.plot(..., alpha=0.25)
... convert an RGB image into a gray image?
→ gray = 0.2989*R+0.5870*G+0.1140*B
... set figure background color?
→ fig.patch.set_facecolor("grey")
... get a reversed colormap?
→ plt.get_cmap("viridis_r")
... get a discrete colormap?
→ plt.get_cmap("viridis", 10)
... show a figure for one second?
→ fig.show(block=False), time.sleep(1)

Performance tips

```
scatter(X, Y)                          slow
plot(X, Y, marker="o", ls="")          fast

for i in range(n): plot(X[i])          slow
plot(sum([x+[None] for x in X],[]))    fast

cla(), imshow(…), canvas.draw()        slow
im.set_data(…), canvas.draw()          fast
```

Beyond Matplotlib

Seaborn: Statistical Data Visualization
Cartopy: Geospatial Data Processing
yt: Volumetric data Visualization
mpld3: Bringing Matplotlib to the browser
Datashader: Large data processing pipeline
plotnine: A Grammar of Graphics for Python

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