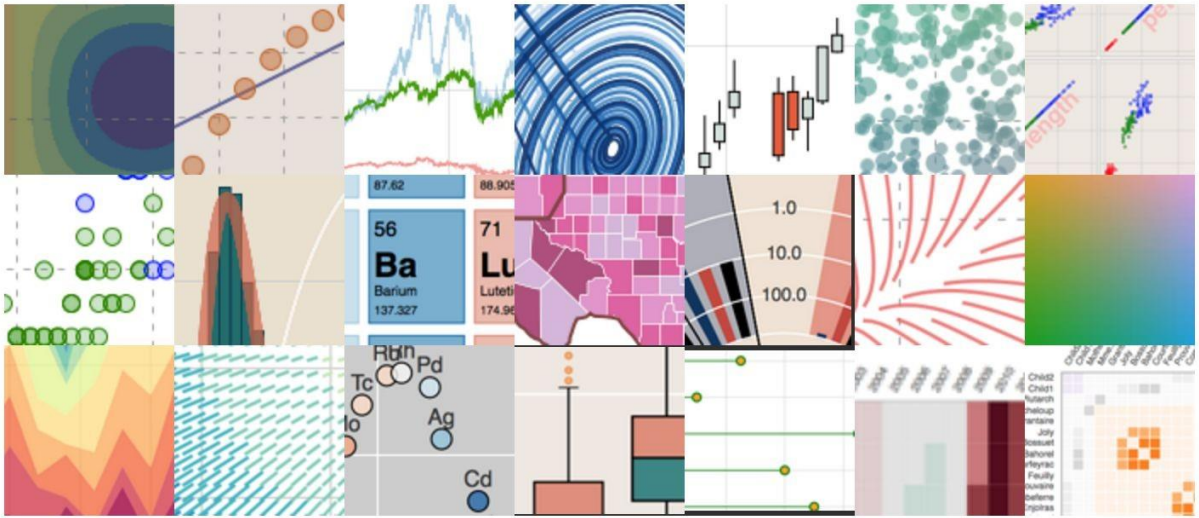
Introduction to plotting in python™

Python for Data Science Workshop
2016-01-07



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@bzamecnik

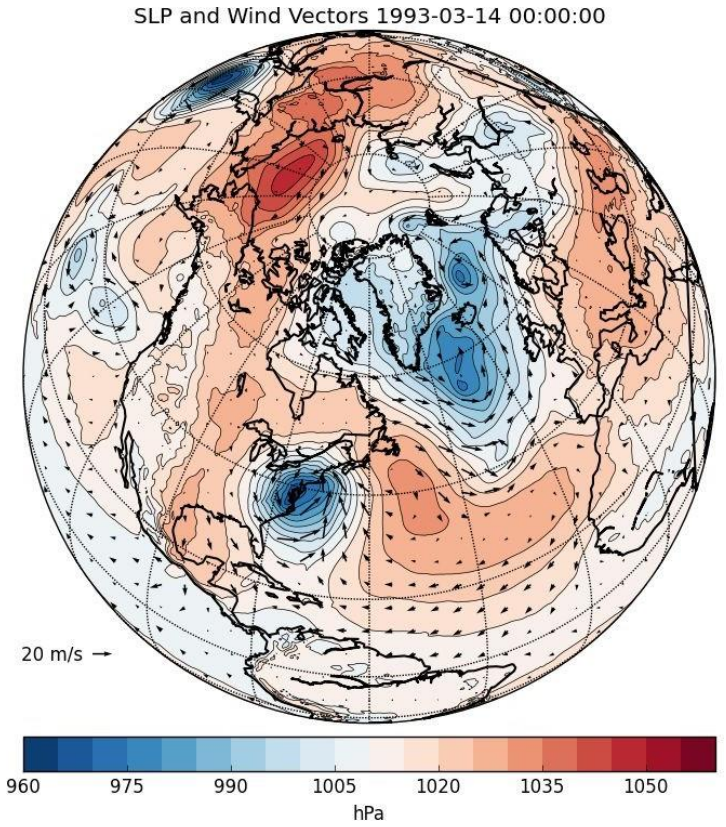
jumpshot

Agenda

- mostly how to plot with

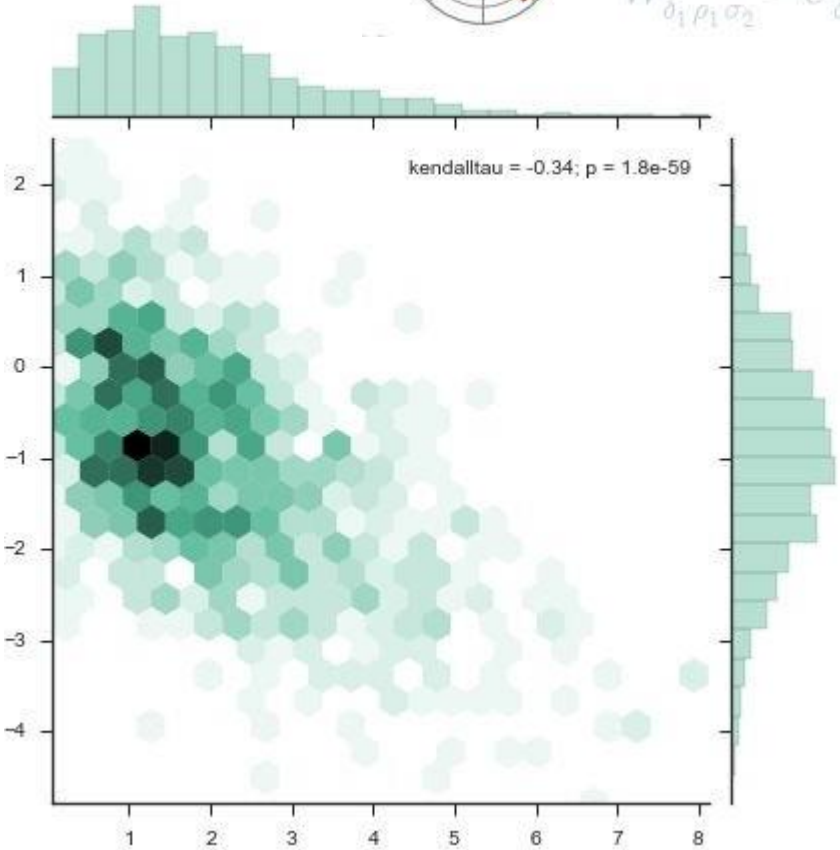
matplotlib

- practical examples
- tips for other packages



http://matplotlib.org/basemap/users/examples.html

What is matplotlib ?



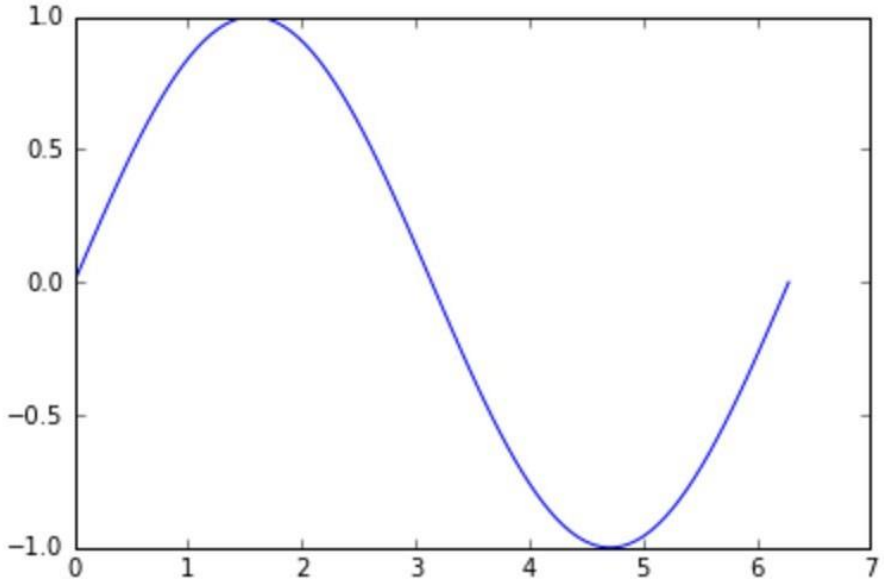
http://stanford.edu/~mwaskom/software/seaborn/examples/hexbin_marginals.html

- Python package
- for 2D plotting
- publication quality
- & interactive plots
- very powerful
- very popular
- many extensions

Hello, world!

in matplotlib

In [3]:
```
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np

x = np.linspace(0, 2 * np.pi, 100)
y = np.sin(x)
plt.plot(x, y);
```

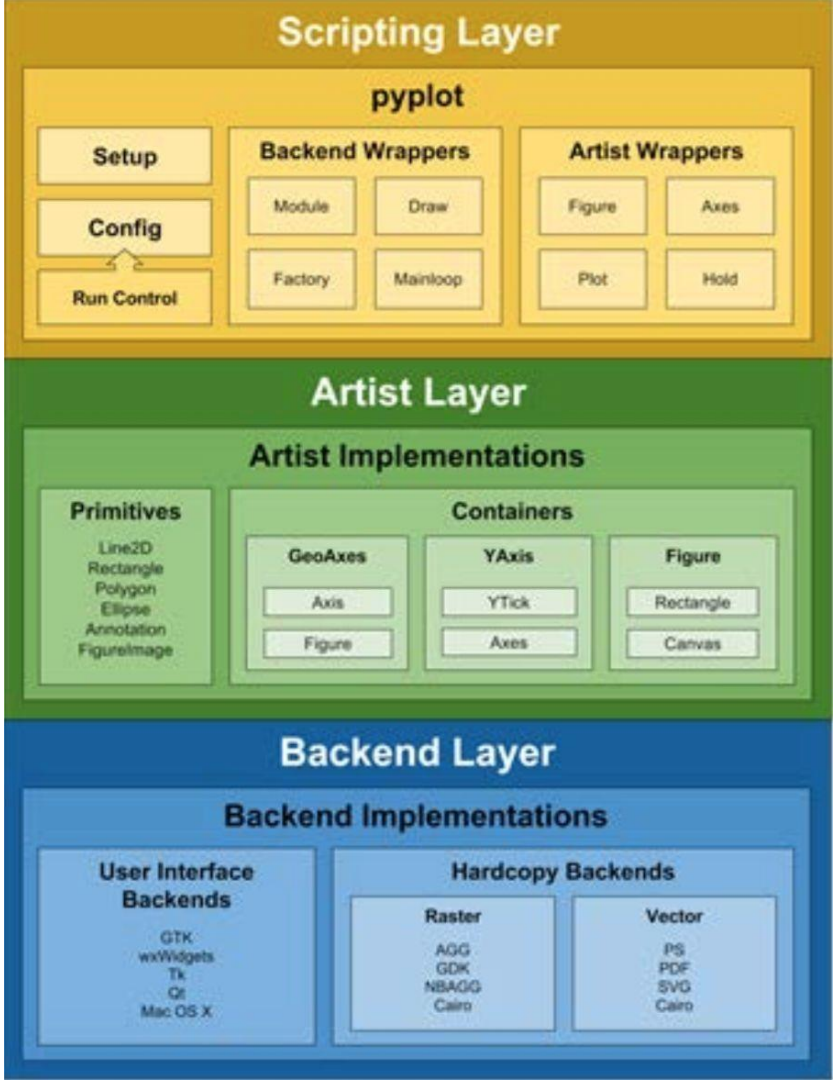


Motto:

"Make easy things easy and hard things possible."

Architecture

- scripting layer
- artist layer
- backend layer



from book:
Mastering matplotlib
by Duncan M. McGreggor
Packt Publishing, 2015

Scripting layer

- pyplot
  - syntax sugar
  - stateful API
  - high-level object API
  - you typically use this
- pylab
  - compatibility with MATLAB
  - deprecated

Artist layer

- what should be rendered?
- parts of the plot
- object-oriented API
- primitives - Line2D, Rectangle, Text, Image
- containers
  - Figure - full plot
  - **Axes** - single subplot
  - Axis - one axis

Backend layer

- how it should be rendered?
- interactive
  - Tk, GTK, Qt, OS X, WX
- hardcopy
  - raster – AGG, GDK, NBAGG, Cairo
  - vector – PS, PDF, SVG, Cairo
- FigureCanvas - area where Figure is drawn
- Renderer - knows how to draw

Matplotlib - basics

https://gist.github.com/bzamecnik/b58579e319287abcb3ca

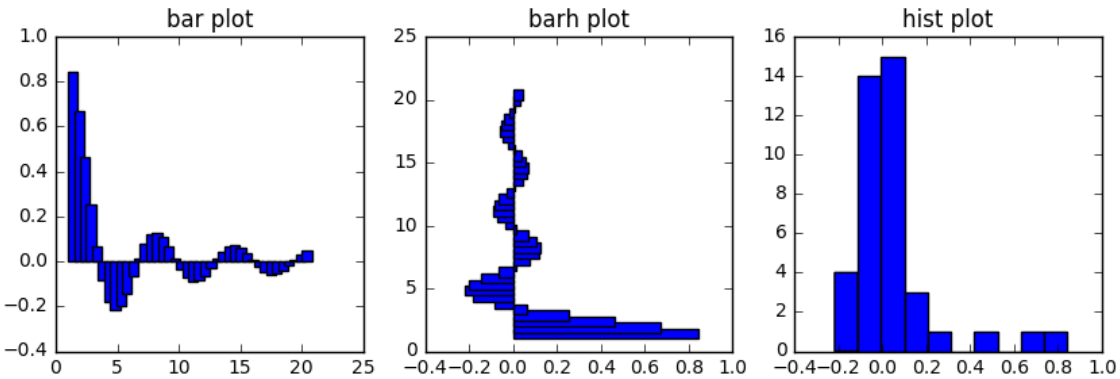
```
# show the plots in Jupyter output
%matplotlib inline
# import the object-oriented API, 'plt' is a conventional alias
import matplotlib.pyplot as plt
import numpy as np
fig, axes = plt.subplots(2, 2, figsize=(10, 5))
# subplots(nrows, ncols), axes[0,0] = top-left subplot
```

Matplotlib – plot types

Bar, barh, errorbar, hist
Boxplot, violinplot
Coherence
Csd (cross spectral density), psd, Specgram
Hist2d, matshow, xcorr
Pie,
plot, stem, fill, Scatter, plot_date
quiver (arrows)
Specgram
streamplot

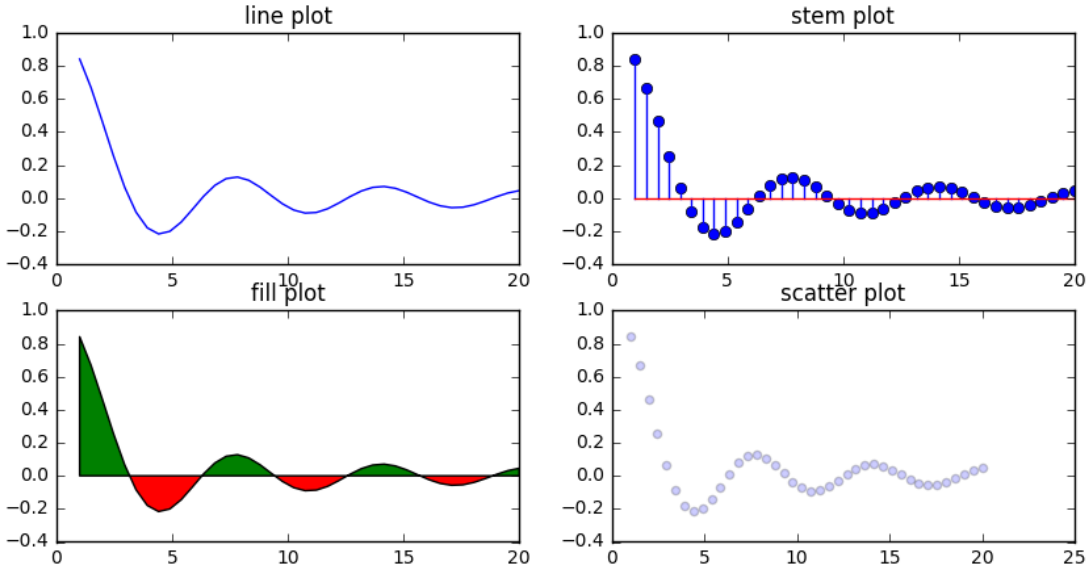
Matplotlib – plot types

```
fig, axes = plt.subplots(1, 3, figsize=(10, 3))

x = np.linspace(1,20, 40)
y = np.sin(x) / x
axes[0].bar(x, y)
axes[0].set_title("bar plot")
axes[1].barh(x, y)
axes[1].set_title("barh plot")
axes[2].hist(y)
axes[2].set_title("hist plot")
plt.savefig("f1.png")
```



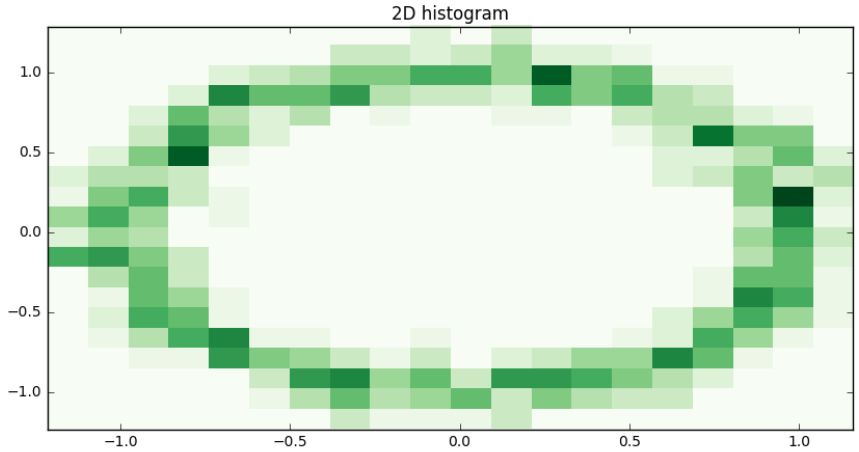
Matplotlib – plot types

```
fig, axes = plt.subplots(2, 2)

axes[0,0].plot(x, y)
axes[0,0].set_title("line plot")
axes[0,1].stem(x, y)
axes[0,1].set_title("stem plot");

axes[1,0].fill_between(x, 0, y, where=y >= 0,
  facecolor='green', interpolate=True)
axes[1,0].fill_between(x, 0, y, where=y < 0,
  facecolor='red', interpolate=True)
axes[1,0].set_title("fill plot");

axes[1,1].scatter(x, y, alpha=0.2)
axes[1,1].set_title("scatter plot")
```



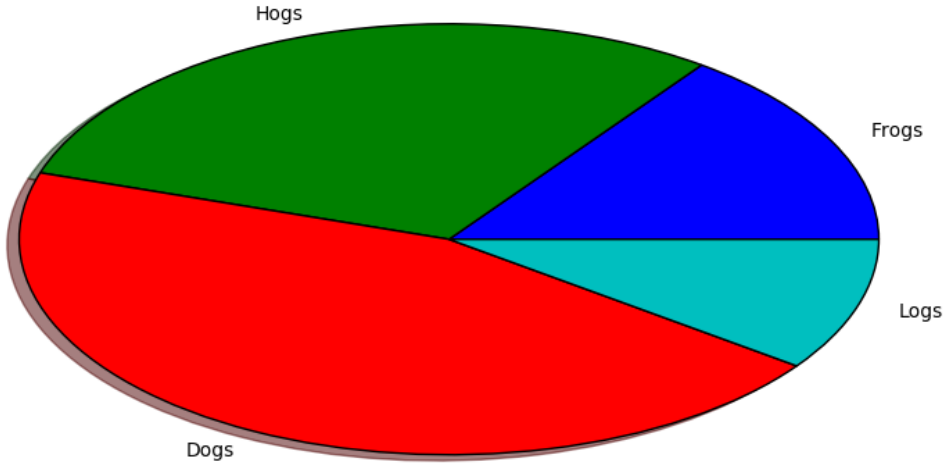
Matplotlib – plot types

```
x = np.linspace(-4 * np.pi, 4 * np.pi, 800)
y1 = np.sin(x)
   + np.random.normal(scale=0.1, size=len(x))
y2 = np.cos(x)
   + np.random.normal(scale=0.1, size=len(x))

plt.hist2d(y1, y2, bins=20, cmap=plt.cm.Greens)
#cmap = color map
plt.gca().set_title("2D histogram")
#get current axes
```



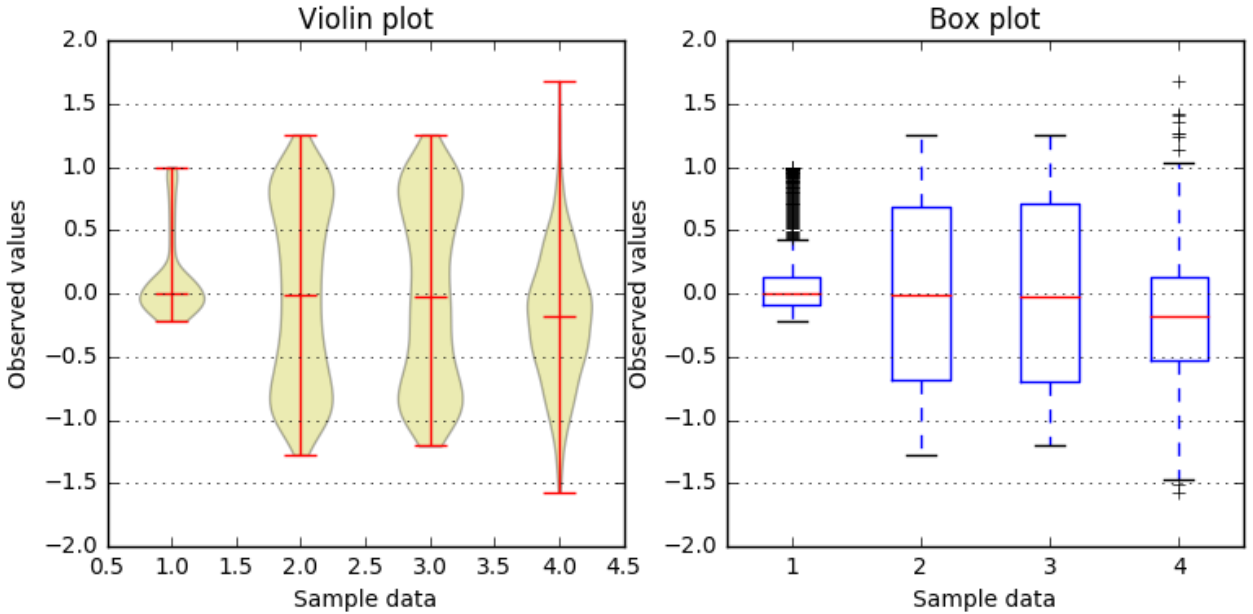
Matplotlib – plot types

```
labels = 'Frogs', 'Hogs', 'Dogs', 'Logs'
fracs = [15, 30, 45, 10]
plt.pie(fracs, labels=labels, shadow=True)
```



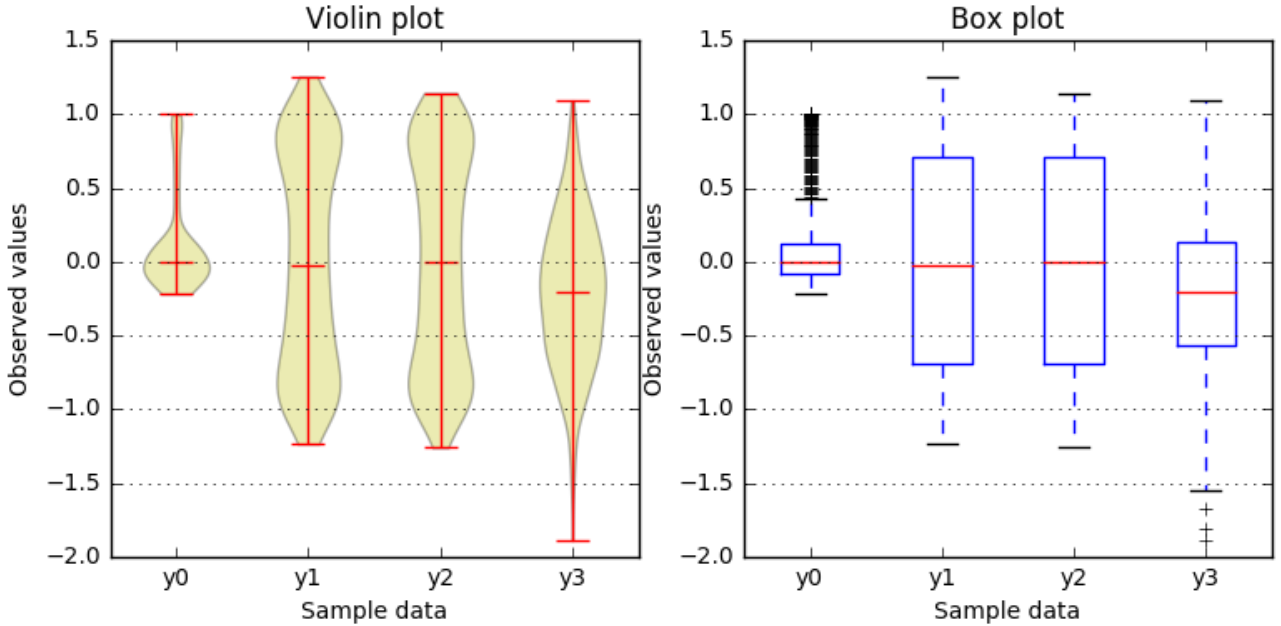
Matplotlib – plot types

```
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(9, 4))
y0 = np.sin(x) / x
y1 = np.sin(x) + np.random.normal(scale=0.1, size=len(x))
y2 = np.cos(x) + np.random.normal(scale=0.1, size=len(x))
y3 =  np.random.normal(loc=-0.2, scale=0.5, size=len(x))
# plot violin plot
axes[0].violinplot([y0,y1,y2,y3],
                   showmeans=False,
                   showmedians=True)
axes[0].set_title('Violin plot')
# plot box plot
axes[1].boxplot([y0,y1,y2,y3])
axes[1].set_title('Box plot')
# adding horizontal grid lines
for ax in axes:
    ax.yaxis.grid(True)
    ax.set_xlabel('Sample data')
    ax.set_ylabel('Observed values')
```



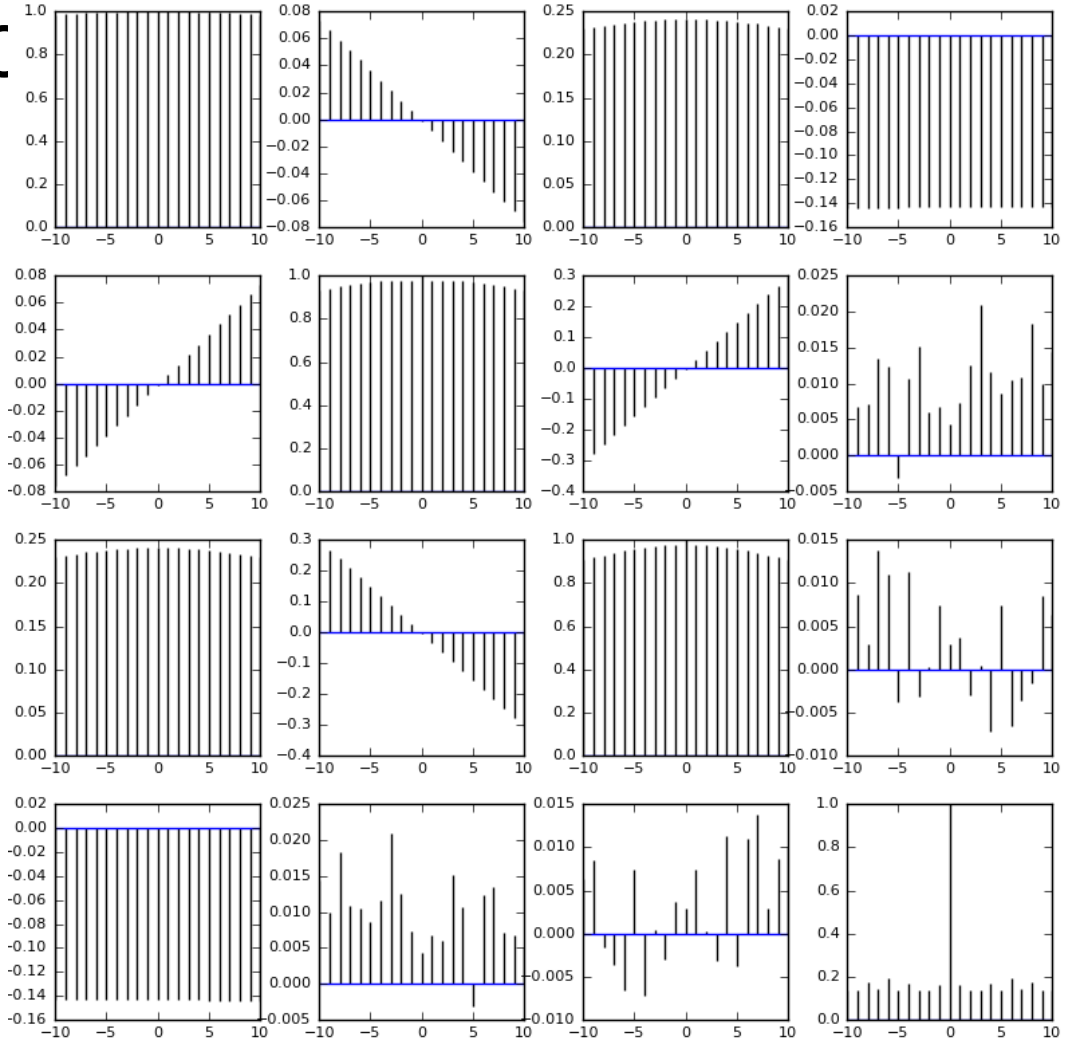
Matplotlib – plot types

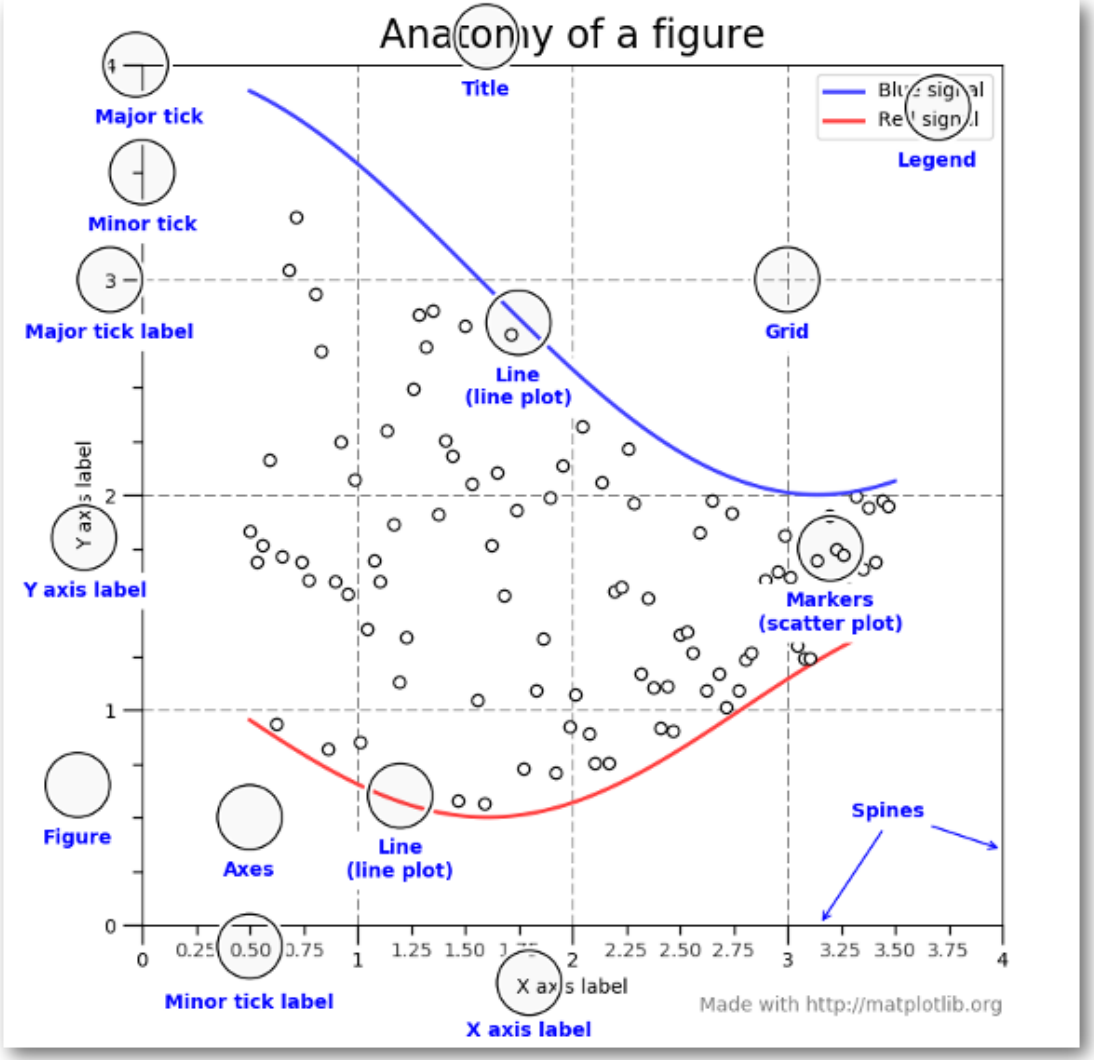
```
for ax in axes:
    ax.yaxis.grid(True)
    ax.set_xlabel('Sample data')
    ax.set_ylabel('Observed values')
    ax.set_xticks(range(1,5))#num of features
    ax.set_xticklabels(['y0', 'y1', 'y2', 'y3', 'y4'])
```



Matplo

```
import matplotlib
matplotlib.rcParams.update({'font.size': 8})
f = [y0,y1,y2,y3]
fig, axes = plt.subplots(4, 4, figsize=(8, 8))
fig.tight_layout()

for i in range(4):
    for j in range(4):
        axes[i,j].xcorr(f[i], f[j])
```




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

```
fig, (ax0, ax1) = plt.subplots(nrows=1,ncols=2, sharey=True, figsize=(7, 4))

fig.suptitle('2014 Sales Analysis', fontsize=14, fontweight='bold')

top_10.plot(kind='barh', y="Sales",
            x="Name", ax=ax0)

top_10.plot(kind='barh', y="Purchases",
            x="Name", ax=ax1)

ax1.axvline(x=avg, color='b',
            label='Average',
            linestyle='--',
            linewidth=1)

ax0.set_xlim([-10000, 140000])

ax0.set(title='Revenue', xlabel='Total
        Revenue', ylabel='Customers')

ax1.set(title='Units',
        xlabel='Total Units', ylabel='')

fig.savefig('sales.png', transparent=False, dpi=80, bbox_inches="tight")
```

Extensions & other packages

seaborn

ggplot

bokeh

plot.ly

https://dsaber.com/2016/10/02/a-dramatic-tour-through-pythons-data-visualization-landscape-including-ggplot-and-altair/

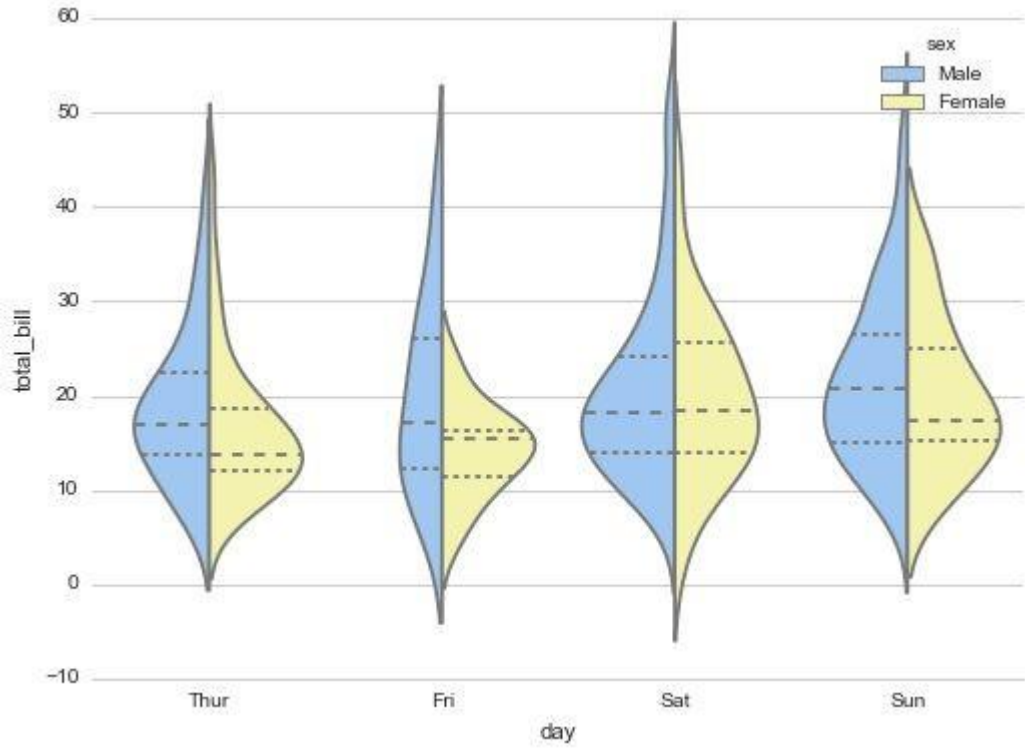
http://pbpython.com/effective-matplotlib.html

matplotlib drawbacks

- quite old
- too focused on server-side
- too cross-platform
- not awesomely beautiful by default

Seaborn: statistical data visualization

- matplotlib extension
- beautiful theme
- statistical plots
  - distribution
    - hexbin, violin plot, etc.
  - scatterplot
  - pairwise correlations

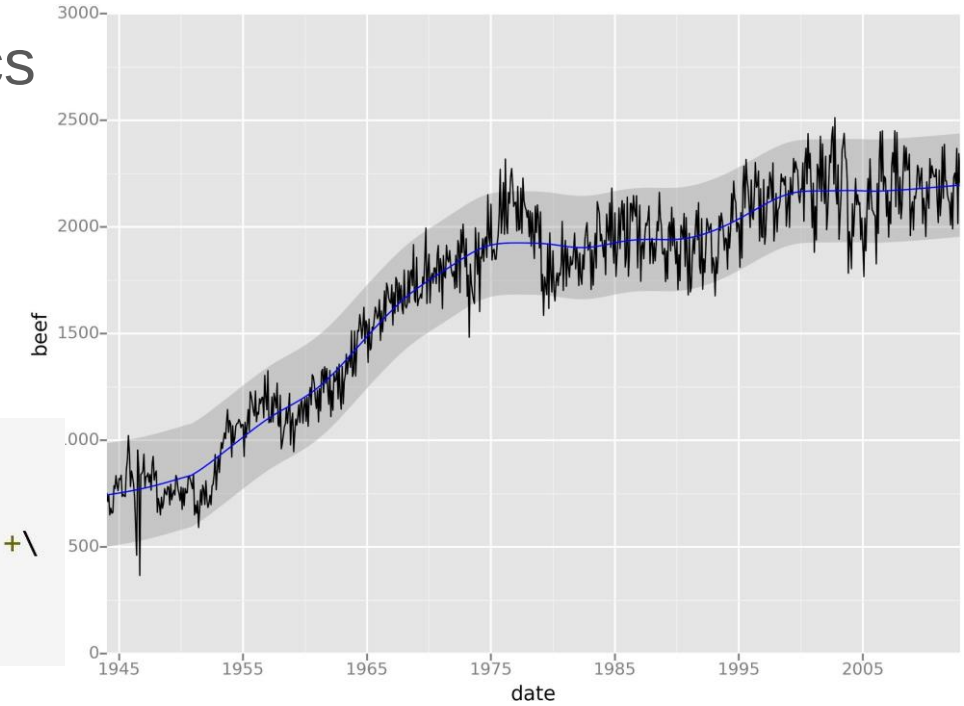


http://stanford.edu/~mwaskom/software/seaborn/examples/grouped_violinplots.html

ggplot from ŷhat

- based on
  - Grammar of Graphics
  - ggplot2 from R

```
from ggplot import *

ggplot(aes(x='date', y='beef'), data=meat) +\
    geom_line() +\
    stat_smooth(colour='blue', span=0.2)
```

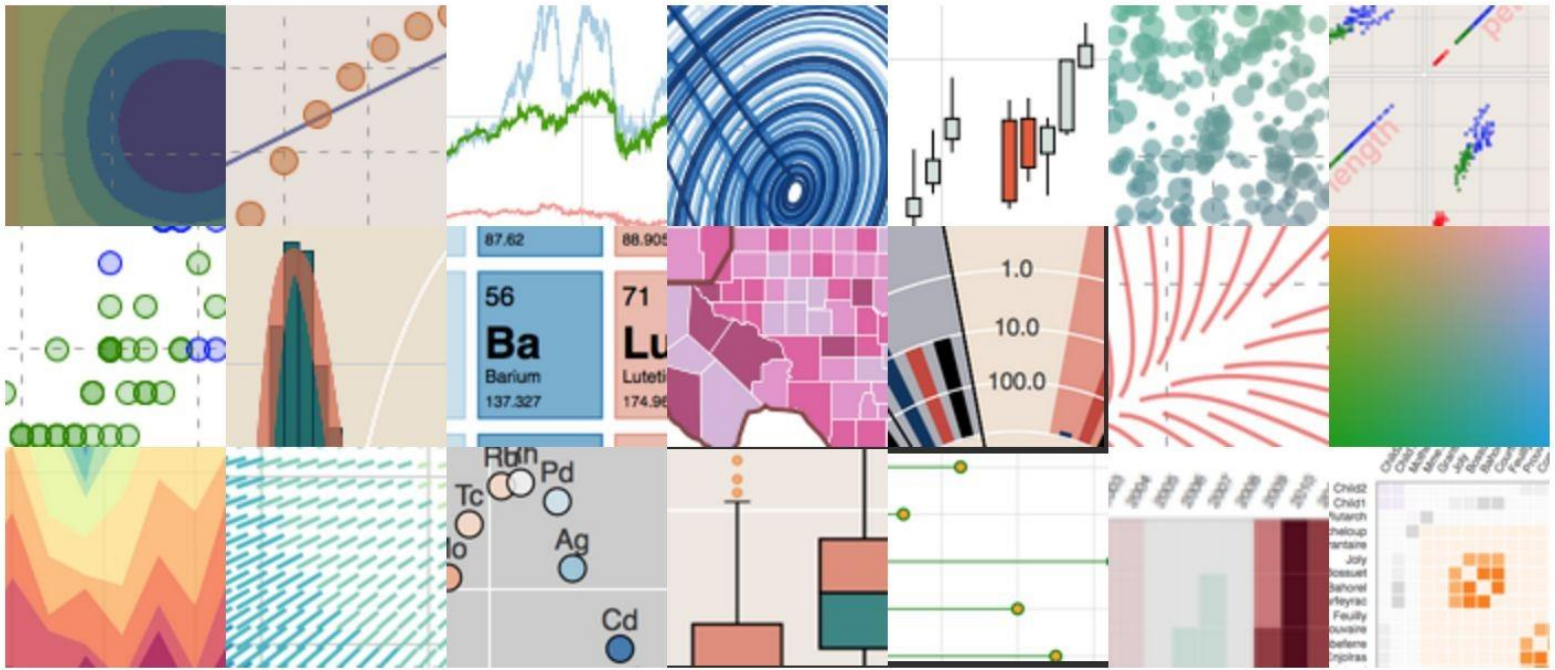


http://ggplot.yhathq.com/

Bokeh

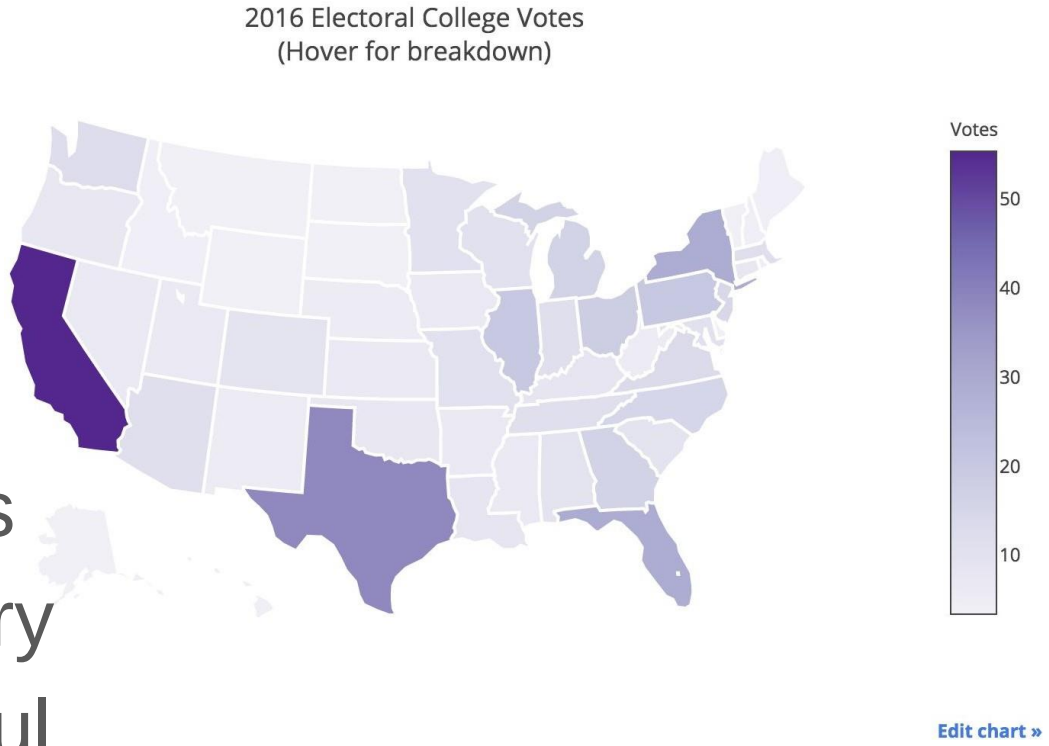
- based on D3.js
- client-side
- interactive
- beautiful
- high-performance

http://bokeh.pydata.org/



Plot.ly

- cloud service
- can publish plots
- free for public plots
- API & Python library
- interactive, beautiful
- good for dashboards



https://plot.ly/python/choropleth-maps/

Summary

- plotting in Python is nice & powerful
- sometimes a bit overwhelming
- it is worth learning it!

Wish you nice plots!

Semestrální projekt – varianta 4

- Klasifikace objektů ve filmech na bázi snímků
  - Vyhledávání známé scény v kolekci videa (100+ hodin)
    - http://www.videobrowsershowdown.org/
  - Filtry pro vyhledávání známé scény (osoby, comix, titulky, …)
  - Vstupní data:
    - kolekce náhodně vybraných keyframes + deskriptory z DCNN
    - Cca 10 000 instancí / 1024 features (GoogLeNet)
  - Task:
    - Vytvořit ground truth vzhledem k vybranému/vybraným filtrům
    - Vybrat a natrénovat vhodný klasifikátor pro dané deskriptory (features vektor)
    - Alternativně: přetrénovat DCNN pro daný task
  - Evaluace:
    - Pomocí hidden test setu
    - Precision-Recall curve, Area under precision-recall
    - Cílem je tedy ranking prediction (seřazení objektů od nejpravděpodobnějších)
  - Typické algoritmy:
    - Random forrest / Gradient boosting trees / jiné varianty ensamble metod
    - FC neuronové sítě
    - Transfer learning (částečné přetrénování původní DCNN pro nový task)
  - Bonus:
    - Algoritmy schopné iterativních updatů pomocí nových trénovacích příkladů?
  - Kontakt: Jakub Lokoč, lokoc[at]ksi.mff.cuni.cz