DISCIPLINA

Métodos para análise de grande volume de dados e Astroinformática - 2021/2

Professor: Clécio de Bom

Análise dos dados Sísmicos

(Projeto 12)

Aluno: Eldues Martins – Doutorando (Computação Quântica)
Orientador: Prof. Ivan Santos Oliveira - COMAN

Data:
20/dezembro/2021

Centro Brasileiro de Pesquisas Físicas
CBPF
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÕES

Clécio R. De Bom está apresentando

What we did ?

1. Introdução à Python e bibliotecas de manipulação de dados (PANDAS);
2. Estatística descritiva e distribuições de probabilidades em catálogos;
3. Acesso a base de dados Astronômicas; queries
4. Estrutura de dados; fits; hdf; npy, json
5. Análise e visualização Catálogos e imagens
6. Introdução a análise e processamento de imagens
7. Matching de dados astronômicos
8. O método da máxima verossimilhança;
9. Inferência Bayesiana;
10. Simulações de Monte Carlo e MCMC;
11. Introdução ao Aprendizado de Máquina (ML);
12. Regressão e Classificação com ML;

1 . Métodos específicos sobre series temporais temporais (LSTM)

2. Gaussian Process;

3. Data Lakes;

4.Hadoop;

5. Data Lakes

6. + SQL

7. Deep Learning (curso de 1 semestre, espaço para dois)

8. Missing data inputation

9. Processamento de Sinais e Imagens (cu

Você

10:24 | 01 -Métodos para análise de grande volu...

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Seismic facies analysis using machine learning

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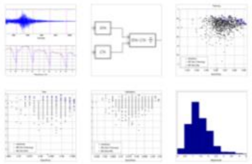
Outline

Abstract
Keywords
1. Introduction
2. Data and training methods
3. Training results
4. Continuous operation
5. Detection time
6. Conclusions
References
Vitae
Show full outline

Figures (15)



Show all figures

Tables (5)

Table 1
Table 2
Table 3
Table 4
Table 5

ELSEVIER

Neurocomputing
Volume 135, 5 July 2014, Pages 273-283

Seismic detection using support vector machines

A.E. Ruano [a, b], G. Madureira [c], O. Barros [b], H.R. Khosravani [b], M.G. Ruano [b, d], P.M. Ferreira [e]

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Abstract

This study describes research to design a seismic detection system to act at the level of a seismic station, providing a similar role to that of STA/LTA ratio-based detection algorithms.

In a first step, Multi-Layer Perceptrons (MLPs) and Support Vector Machines (SVMs), trained in supervised mode, were tested. The sample data consisted of 2903 patterns extracted from records of the PVAQ station, one of the seismographic network's stations of the Institute of Meteorology of Portugal (IM). Records' spectral variations in time and characteristics were reflected in the input ANN patterns, as a set of values of power spectral density at selected frequencies. To ensure that all patterns of the sample data were within the range of variation of the training set, we used an algorithm to separate the universe of data by hyper-convex polyhedrons, determining in this manner a set of patterns that have a mandatory part of the training set. Additionally, an active learning strategy was conducted, by iteratively incorporating poorly classified cases in the training set. The proposed system best results, in terms of sensitivity and selectivity in the whole data ranged between 98% and 100%. These results compare very favourably with the ones obtained by the existing detection system, 50%, and with other approaches found in the literature.

Subsequently, the system was tested in continuous operation for unseen (out of sample) data, and the SVM detector obtained 97.7% and 98.7% of sensitivity and selectivity, respectively. The classifier presented 88.4% and 99.4% of sensitivity and selectivity when applied to data of a different seismic station of IM.

Due to the input features used, the average time taken for detection with this

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Seismic-facies classification using random forest algorithm

Authors:
Yuji Kim,

SEG Technical Program Expanded Abstracts 2018

ISSN (print): 1052-3812

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SEISMIC DATA COMPRESSION METHODS

Authors:
Lawrence C. Wood

https://doi.org/10.1190/1.1440443

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This paper discusses two ways of compressing seismic data prior to long-distance transmission for display. A Walsh transform technique and an analogous time-domain method eliminate redundant seismic information allowing data sets to be compressed with little visual degradation. The basic approach consists of using an average 3-bit code to describe data in such a way as to minimize information loss; the method also uses the Walsh transform to achieve further compaction through sequency bandlimiting. A second technique is entirely a time-domain operation and does not use transforms. The Walsh method, however, produces larger compression ratios than the time technique before serious image degradation occurs. Both schemes have six basic parts: bandlimiting, quantization, encoding, decoding, interpolation, and band-pass filtering; they differ only in band limiting and interpolation. Band limiting sequencies in the Walsh domain is very similar to, but not the same as, alias filtering and resampling in time. Reducing Walsh bandwidths by some power of two has a time-domain implementation consisting of an averaging procedure with subsequent resampling, while the inverse Walsh transform step can be viewed as a means of interpolating in the time domain. The convergence properties of three Rademacher derived transforms—Hadamard, Paley, and Walsh—are studied with regard to exploration seismic data. Hadamard energy has been found to be uniformly distributed over its entire spectrum, whereas Walsh and Paley transforms concentrate about 80 percent of the total energy into a major lobe occupying about 15 percent of the total bandwidth (2 msec sampling). Smaller minor lobes containing the remaining 20 percent are discarded while bandlimiting. The major lobe energy suffices for many

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ISSN (print): 0016-8033
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Published: 07 Feb 2012
Published in print: 01 Aug 1974

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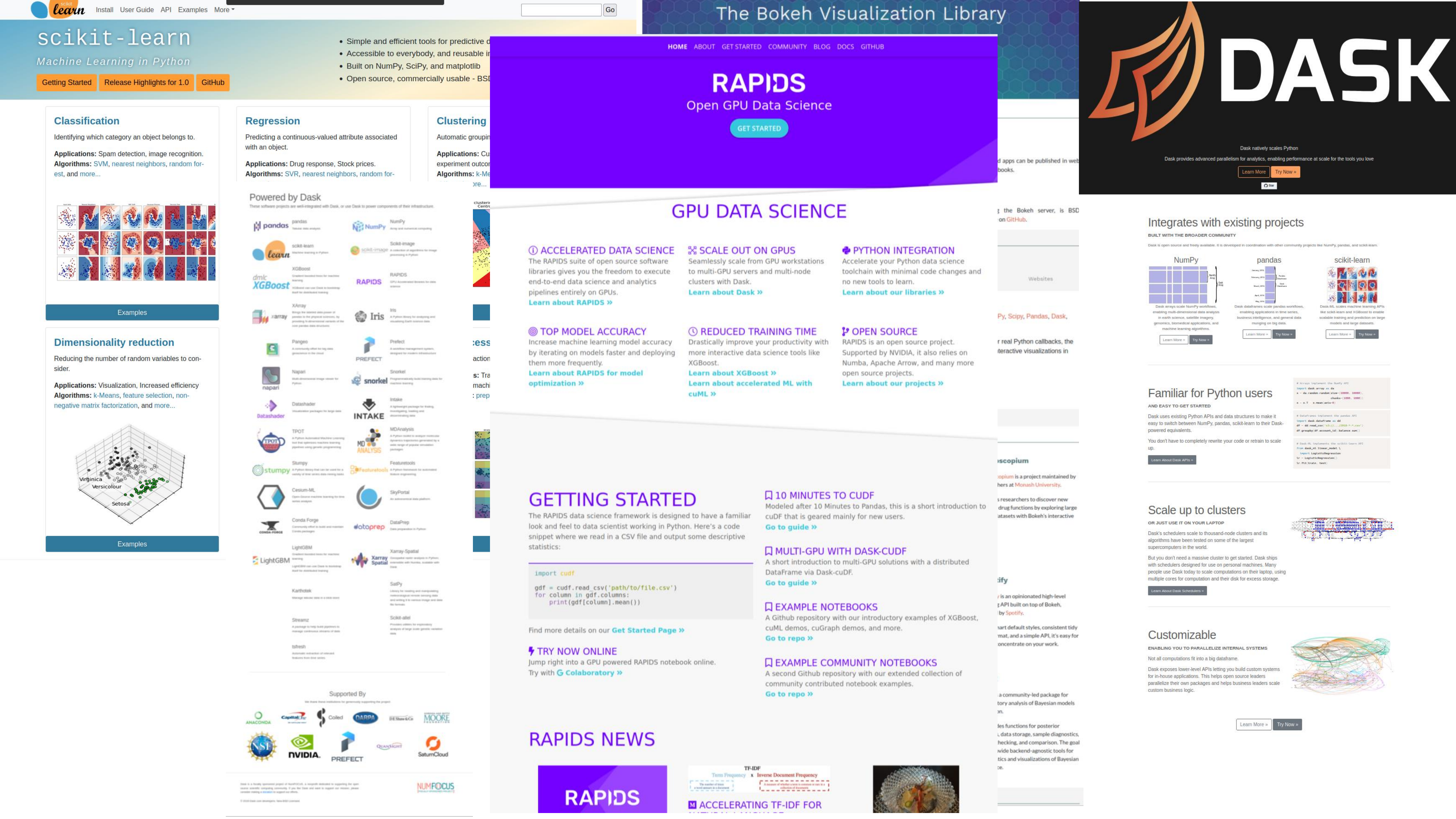
https://doi.org/10.1190/1.1440443

PLAIN-LANGUAGE SUMMARY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Machine Learning in Python
Getting Started
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GitHub
Simple and efficient tools for predictive d
Accessible to everybody, and reusable in
Built on NumPy, SciPy, and matplotlib
Open source, commercially usable - BSD
Classification
Identifying which category an object belongs to.
Applications: Spam detection, image recognition.
Algorithms: SVM, nearest neighbors, random forest, and more...
Examples
Regression
Predicting a continuous-valued attribute associated with an object.
Applications: Drug response, Stock prices.
Algorithms: SVR, nearest neighbors, random for-
Clustering
Dimensionality reduction
Reducing the number of random variables to consider.
Applications: Visualization, Increased efficiency
Algorithms: k-Means, feature selection, non-negative matrix factorization, and more...
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GETTING STARTED
The RAPIDS data science framework is designed to have a familiar look and feel to data scientist working in Python. Here's a code snippet where we read in a CSV file and output some descriptive statistics:
import cudf
gdf = cudf.read_csv('path/to/file.csv')
for column in gdf.columns:
print(gdf[column].mean())
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Modeled after 10 Minutes to Pandas, this is a short introduction to cuDF that is geared mainly for new users.
Go to guide »
MULTI-GPU WITH DASK-CUDF
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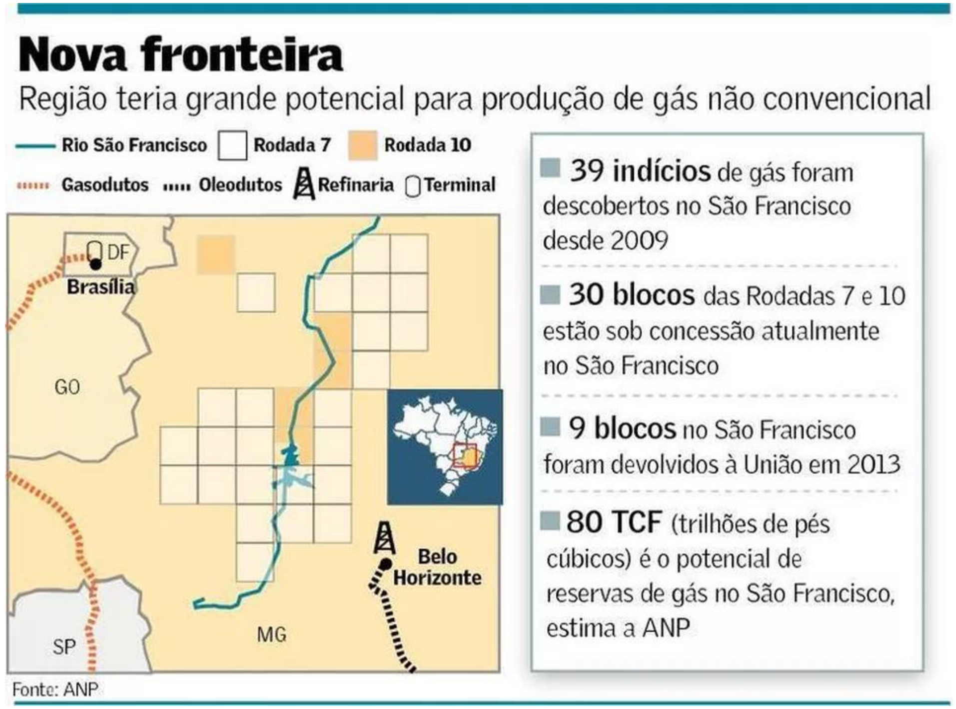
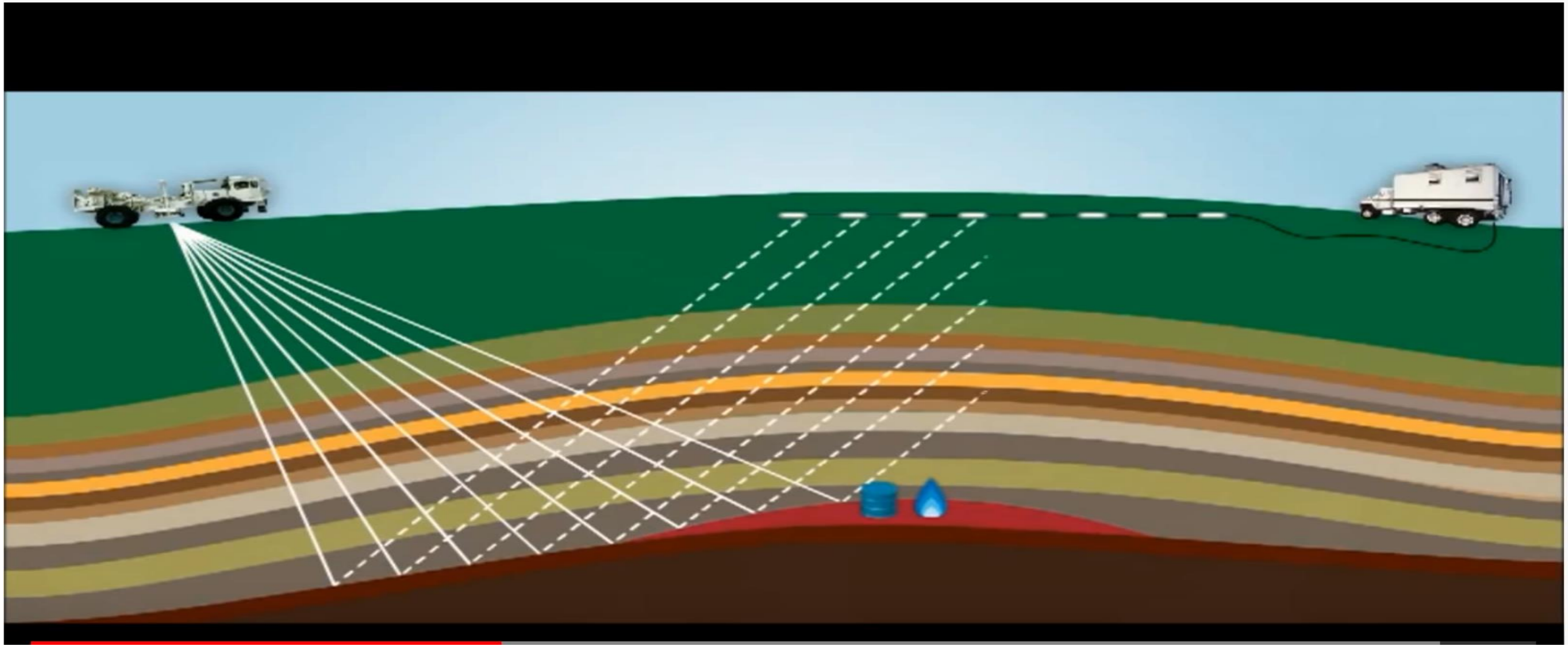
Característica do dado Sísmico

- Dedicado
- Privado
- Especificidade da área
- Volume e inespecífico dependendo da relevância da cobertura e densidade do dado





https://www.youtube.com/watch?v=wy68B476XVU

C 1 Client: SEAM Corp. Vendor: AGT Date: 14 Oct 2014
C 2 Project Description: SEAM Phase I Interpretation Challenge
C 3 SEGY Data Format: IBM Real XY Units: Meters
C 4 Data Description: 2793 Full Azimuth Shot Records with Free Surface
C 5 Data Type: RTM Migration with Perturbed Vp and Noise in depth Units: m
C 6 Sparse collection of 2D offset gathers in depth
C 7
C 8 Projection: UTM Zone 16 Spheroid: WGS84
C 9 Geodetic Datum: WGS84 Central Meridian: 87 degrees W
C10 Grid Origin XY: 401,674.66E 3,097,605.23N Scale Factor: .9996
C11 Grid Origin Lat Long: 28:00:00N 88:00:00W
C12
C13 Corner X Y Iline Xline Given in Local Coordinates K
C14 1 2940 24000 1589 5801
C15 2 31740 24000 7349 5801 Number of gathers: 33
C16
C17 Distance between gather X locations: 900 meters
C18
C19 Inline bin size: 5 m Max depth: 15000 m
C20 Crossline bin size: 5 m Sample interval: 20 m

C21 First Sample: 0 ms Samples/trace: 751
C22 Offsets: 0 - 11600 m Increment: 400 m Number of offsets:
C23
C24 Polarity: +RC peak Phase: Zero
C25 Datum: Sea Level
C26
C27 HEADER NAME POSITION LENGTH
C28 CDPX 181 4I
C29 CDPY 185 4I
C30 INLINE 189 4I
C31 CROSSLINE 193 4I
C32
C33 PROCESSING FLOW:
C34 Designature
C35 RTM with perturbed Vp
C36
C37
C38
C39 SEGY REV1
C40 END TEXTUAL HEADER

Seismic_Analysis_upload4.ipynb

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Seismic Analysis with Python

1) Importing Libraries

```
# Importing Libraries
import numpy as np
from scipy import ndimage as ndi
from shutil import copyfile
from skimage import exposure
!pip install segyio
import segyio
import matplotlib
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib.offsetbox import AnchoredText
```

```
Collecting segyio
  Downloading segyio-1.9.7-cp37-cp37m-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (83 kB)
     |████████████████████████████████| 83 kB 2.0 MB/s
Requirement already satisfied: numpy>=1.10 in /usr/local/lib/python3.7/dist-packages (from segyio) (1.19.5)
Installing collected packages: segyio
Successfully installed segyio-1.9.7
```

```
#Data no Google Drive
#from google.colab import drive
#drive.mount('/content/drive')
```

```
#import segyio ## JA FORAM IMPORTADOS NO INICIO
#import numpy as np ## JA FORAM IMPORTADOS NO INICIO
#Data uploaded
with segyio.open('SEAM_Interpretation_Challenge_1_2DSparseGathers_Depth.sgy','r+') as f:
    for trace in f.trace:
        filtered = trace[np.where(trace < 1e-2)]
```

2) Loading Data

```
import sys
```

2) Loading Data

```
import sys
import os
```

```
# Set the default plot size for matplotlib figures
matplotlib.rcParams['figure.figsize'] = (11.75,8.5)
```

```
base_segy = 'SEAM_Interpretation_Challenge_1_2DSparseGathers_Depth.sgy'
```

```
f = segyio.open(base_segy,ignore_geometry=True)
segyio.tools.wrap(f.text[0])
```

```
'C 1  Client: SEAM Corp.     Vendor: AGT                    Date: 14 Oct 2014\nC 2  Project Description: SEAM Phase I Interpretation Challenge\nC 3  SEGY Data Format: IBM Real                    XY Un
its: Meters\nC 4  Data Description: 2793 Full Azimuth Shot Records with Free Surface\nC 5  Data Type: RTM Migration with Perturbed Vp and Noise in depth   Units: m\nC 6           Sparse collection of 2D offs
et gathers in depth\nC 7\nC 8  Projection: UTM Zone 16              Spheroid: WGS84\nC 9  Geodetic Datum: WGS84                 Central Meridian: 87 degrees W\nC10  Grid Origin XY: 401,674.66E 3,097,605.23N
Scale Factor: .9996\nC11  Grid Origin Lat Long: 28:00:00N  88:00:00W\nC12\nC13  Corner     X        Y     Iline  Xline   Given in Local Coordinates     K\nC14    1       2940     24000    1589    5801\nC15    2
31740    24000    7349    5801    Number of gathers: 33\nC16\nC17  Distance between gather X locations:  900 meters\nC18\nC19  Inline bin size:      5 m        ...'
```

```
f.trace[10]
f.trace[-2]
```

```
array([-2.01366043e+00, -6.05375385e+00, -3.78104305e+00, -8.63110006e-01,
        6.11716866e-01, -1.63687706e+00, -2.72039413e+00, -1.14763451e+00,
        3.35989475e+00,  4.76012993e+00,  3.01636696e+00,  1.83521557e+00,
        2.65846252e+00, -1.27267742e+00, -3.69801140e+00,  8.05239201e-01,
        4.53335667e+00, -1.65886497e+00, -6.33541203e+00,  8.70620906e-01,
        7.55232525e+00,  4.12557602e+00,  5.89431465e-01,  5.17095290e-02,
       -4.96521854e+00, -1.07247038e+01, -7.67143345e+00,  2.50645256e+00,
        1.10698195e+01,  1.00203018e+01,  9.17518139e-01, -8.90377998e+00,
       -9.49874973e+00,  1.43924522e+00,  8.84746647e+00,  2.81741047e+00,
       -8.42773628e+00, -6.76858616e+00,  3.82758808e+00,  1.22012606e+01,
        9.46120262e+00, -8.98574948e-01, -7.73301506e+00, -7.93793106e+00,
       -1.43096924e+00,  4.90565586e+00,  3.15968513e+00,  9.93162572e-01,
        1.53293324e+00,  2.92832184e+00,  2.60410786e+00, -7.50936151e-01,
       -4.47587109e+00, -6.36281204e+00, -7.13270426e-01,  4.24686813e+00,
       -6.18524432e-01, -7.36450863e+00, -2.28927326e+00,  6.71272373e+00,
        3.75258255e+00, -9.49347782e+00, -8.34703350e+00,  7.37300205e+00,
        1.78732300e+01,  1.31640291e+01, -5.32160282e-01, -8.42532444e+00,
       -1.10773792e+01, -6.01653004e+00,  1.80954838e+00,  7.43215275e+00,
        3.20165825e+00, -6.73680019e+00, -6.42342377e+00,  8.22889090e-01,
        6.02881241e+00,  2.97925282e+00, -7.87215412e-01, -5.12140691e-01,
        2.53087616e+00,  9.92177129e-02, -3.70834732e+00,  2.38673878e+00,
        2.21116352e+00,  2.37938023e+00,  2.30319118e+00, -1.29623127e+00,
```

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```
        -8.96327496e+00, -6.63597775e+00, -5.75602341e+00, -5.19660282e+00,
        -5.01639080e+00, -4.17887974e+00, -2.04370785e+00,  9.70532596e-01,
         4.06124210e+00.  5.93174458e+00.  5.84596157e+00.  4.41881561e+00.
```

```
f.samples[:5]
```

```
array([ 0., 20., 40., 60., 80.])
```

```
with segyio.open(base_segy) as segyf:
    n_traces = segyf.tracecount
    sample_rate = segyio.tools.dt(segyf)
    n_samples = segyf.samples.size
    n_il = len(segyf.iline)
```

```
f = segyio.open(base_segy, ignore_geometry = True)
ntraces    = len(f.trace)
inlines    = []
crosslines = []

for i in range(ntraces):
    headeri = f.header[i]
    inlines.append(headeri[segyio.su.iline])
    crosslines.append(headeri[segyio.su.xline])

print(f'{ntraces} traces')
print(f'first 10 inlines: {inlines[:10]}')
print(f'first 10 crosslines: {crosslines[:10]}')
```

```
990 traces
first 10 inlines: [1589, 1589, 1589, 1589, 1589, 1589, 1589, 1589, 1589, 1589]
first 10 crosslines: [5801, 5801, 5801, 5801, 5801, 5801, 5801, 5801, 5801, 5801]
```

```
# loading the seismic data as cube
seismic_data = segyio.tools.cube(base_segy)
```

```
# lets check the inline, xline spread of the seismic data
print('Survey IL/XL shape:' +str(np.shape(seismic_data)[0])+ ' / ' +str(np.shape(seismic_data)[1]))
```

```
Survey IL/XL shape:1 / 33
```

```
#Check the inline e cross line range for the seismic data directly from segy file is below
print('Inline Range:' +str(np.amin(segyf.ilines))+'-'+str(np.amax(segyf.ilines)))
print('Xnline Range:' +str(np.amin(segyf.xlines))+'-'+str(np.amax(segyf.xlines)))
```

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```python
print('Xnline Range:' +str(np.amin(segyf.xlines))+'-'+str(np.amax(segyf.xlines)))
```

```
Inline Range:1589-7349
Xnline Range:5801-5801
```

```python
# Plot the inline and crossline as a scatter plot
#plt.scatter(crosslines, inlines, marker="s", s=1)
```

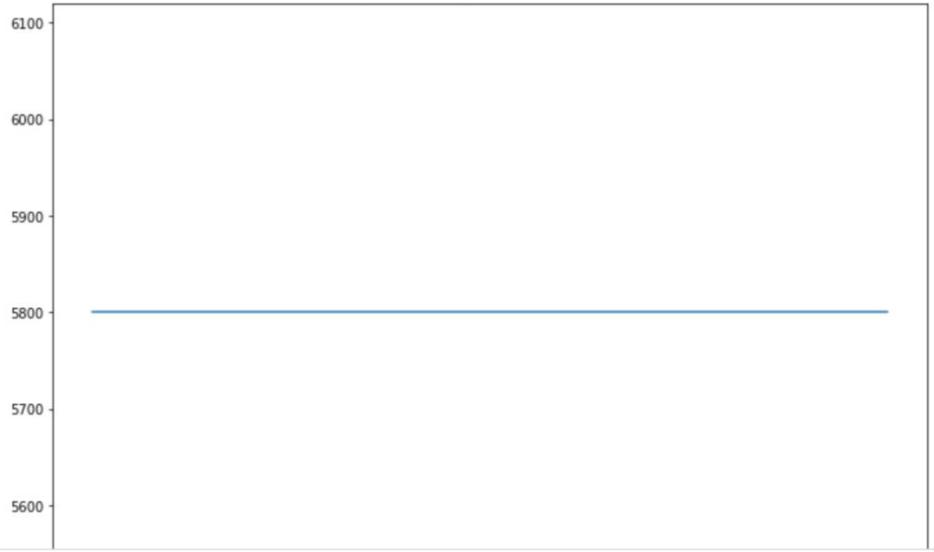
```python
import itertools
uniqil = set(inlines)
uniqxl = set(crosslines)
real = set(zip(inlines, crosslines))
grid = set(itertools.product(uniqil, uniqxl))
missing = grid - real
missing
```

```
set()
```

```python
#plt.plot(inlines)
```

```python
plt.plot(crosslines[:5000])
```

```
[<matplotlib.lines.Line2D at 0x7f82f7df7210>]
```



Seismic_Analysis_upload4.ipynb

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```
#import numpy as np
ils = np.unique(inlines)
xls = np.unique(crosslines)
inline_interval    = ils[1:] - ils[:-1]
crossline_interval = xls[1:] - xls[:-1]
print(inline_interval)
print(crossline_interval)
```

```
[180 180 180 180 180 180 180 180 180 180 180 180 180 180 180 180 180 180
 180 180 180 180 180 180 180 180 180 180 180 180 180 180]
[]
```

```
ils = sorted(uniqil)
xls = sorted(uniqxl)
lineindex = {
    (il, xl): i
    for i, (il, xl) in enumerate(sorted(grid))

}
lineindex
```

```
{(1589, 5801): 0,
 (1769, 5801): 1,
 (1949, 5801): 2,
 (2129, 5801): 3,
 (2309, 5801): 4,
 (2489, 5801): 5,
 (2669, 5801): 6,
 (2849, 5801): 7,
 (3029, 5801): 8,
 (3209, 5801): 9,
 (3389, 5801): 10,
 (3569, 5801): 11,
 (3749, 5801): 12,
 (3929, 5801): 13,
 (4109, 5801): 14,
 (4289, 5801): 15,
 (4469, 5801): 16,
 (4649, 5801): 17,
 (4829, 5801): 18,
 (5009, 5801): 19,
 (5189, 5801): 20,
 (5369, 5801): 21,
 (5549, 5801): 22,
 (5729, 5801): 23,
 (5909, 5801): 24,
 (6089, 5801): 25,
 (6269, 5801): 26,
 (6449, 5801): 27,
```

Seismic_Analysis_upload4.ipynb

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```
[ ] d = np.zeros((len(ils), len(xls), len(f.samples)))
    lineard = d.reshape(d.shape[0] * d.shape[1], d.shape[2])
    for il, xl, trace in zip(inlines, crosslines, f.trace[:]):
        lineard[lineindex[il, xl]][:] = trace[:]
```

```
[ ] d.shape
```

```
(33, 1, 751)
```

```
[ ] # Set up some aliases
    ilines = np.array(sorted(uniqil))
    xlines = np.array(sorted(uniqxl))
    t = np.array(f.samples)

    # Estimate the amplitude range to use for the plots by taking the 95th percentile

    vm = np.percentile(d, 95)
    print(vm)

    # Define the central line
    central = len(ilines) // 2
```

```
19.057722473144516
```

```
[ ] # Plot

    plt.imshow(d[central,:,:].T, cmap='gray', aspect='auto', vmin=-vm, vmax=vm)
    plt.show()
```

Activities   Firefox Web Browser   dez 16 09:26

Seismic_Analysis_upload4.ipynb

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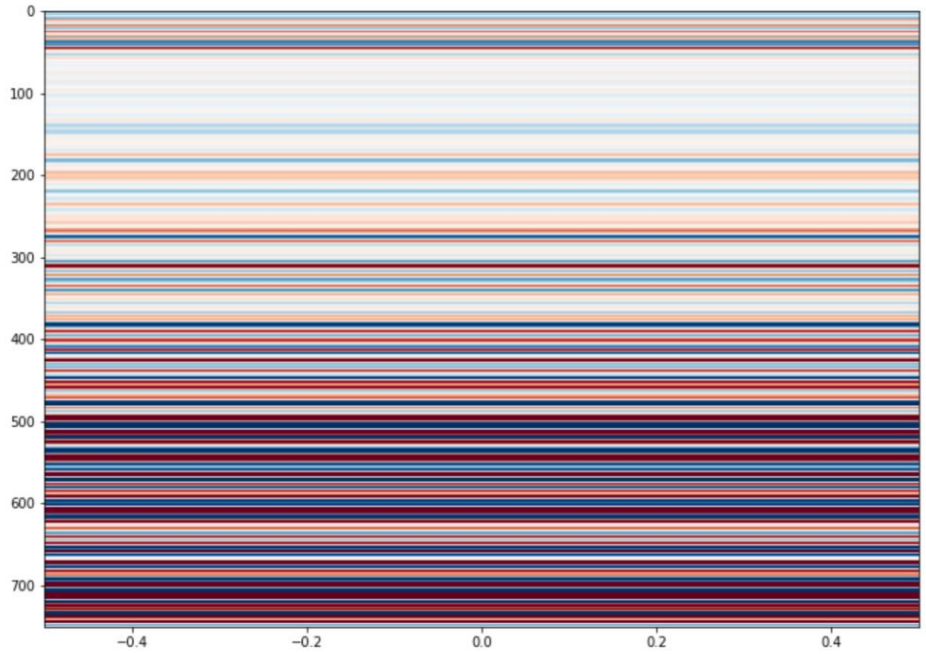
```
#plt.imshow(d[central,:,:].T, cmap='RdBu',aspect='auto',vmin=-vm, vmax=vm)
plt.imshow(d[central,:,:].T, cmap='RdBu',aspect='auto', vmin=-10, vmax=10)
plt.show()
```




```
fig,ax = plt.subplots()

# Some example data
y = np.linspace(700.,900.,401)
offset = 94.
x = offset+10*(np.sin(y/2.)*
        1/(10. * np.sqrt(2 * np.pi)) *
        np.exp( - (y - 800)**2 / (2 * 10.**2))
        ) # This function just gives a wave that looks something like a seismic arrival

ax.plot(x,y,'k-')
ax.fill_betweenx(y,offset,x,where=(x>offset),color='k')

ax.set_xlim(93,95)

plt.show()
```

Seismic_Analysis_upload4.ipynb

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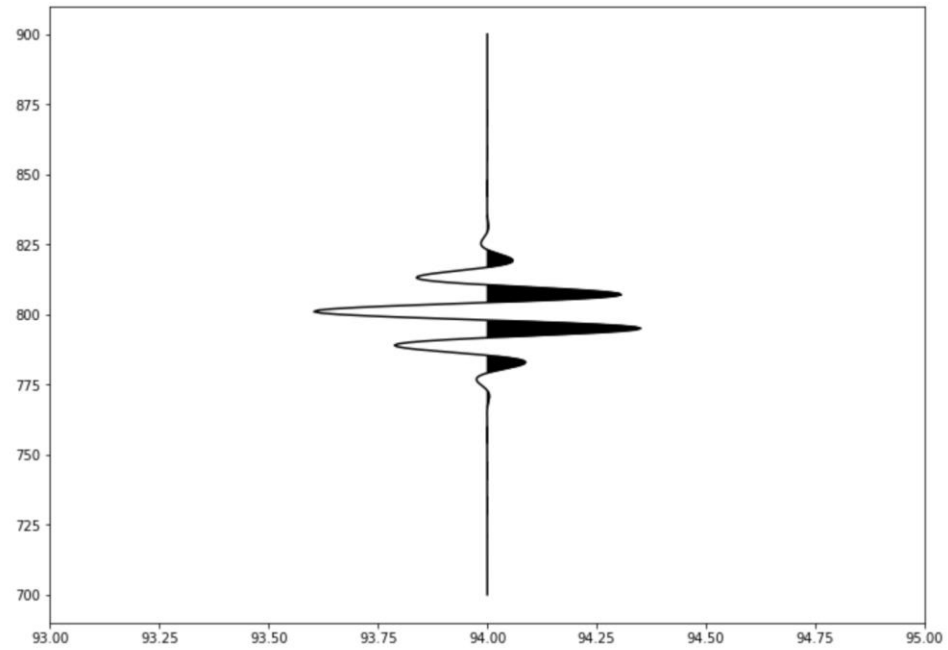
```
plt.show()
```




```
fig,ax = plt.subplots()

# Some example data
y = np.linspace(700.,900.,401)
offsets = [94., 95., 96., 97.]
times = [800., 790., 780., 770.]

for offset, time in zip(offsets,times):
    x = offset+10*(np.sin(y/2.)*
        1/(10. * np.sqrt(2 * np.pi)) *
        np.exp( - (y - time)**2 / (2 * 10.**2))
        )

    ax.plot(x,y,'k-')
    ax.fill_betweenx(y,offset,x,where=(x>offset),color='k')

ax.set_xlim(93,98)
```

Seismic_Analysis_upload4.ipynb

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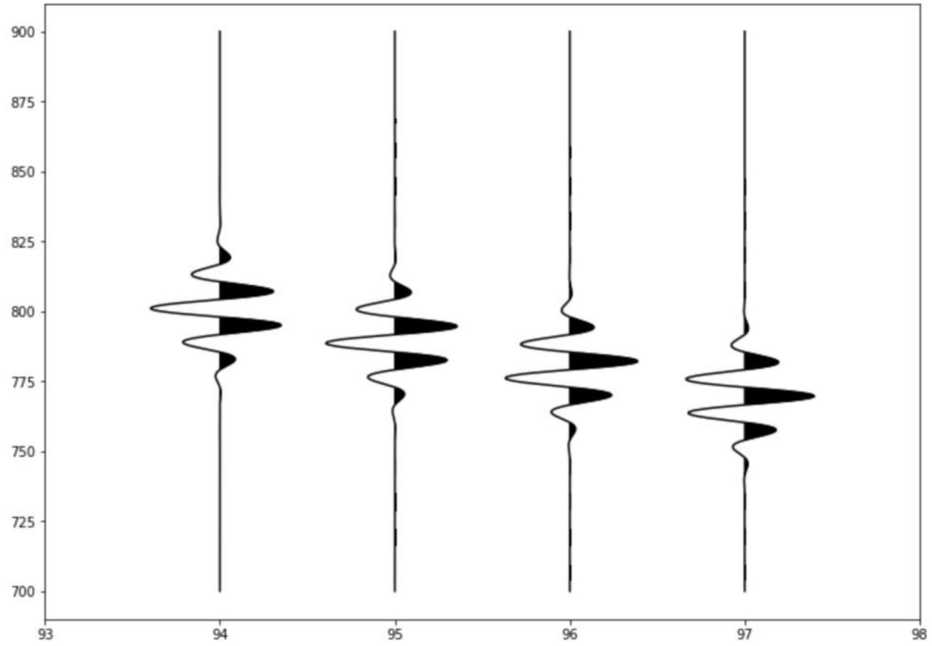
```
plt.show()
```



```
extent = [xlines[0], xlines[-1], t[-1], t[0]]

# Plot the central inline in the usual orientation by transposing the data

plt.imshow(d[central,:,:].T, cmap='gray', aspect='auto', vmin=-vm, vmax=vm, extent=extent)

plt.xlabel('Xline')
plt.ylabel('TWT (ms)')
plt.title('SEAM Phase I Interpretation Challenge'+ str(ilines[central]))
plt.show()
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:5: UserWarning: Attempting to set identical left == right == 5801 results in singular transformations; automatically expanding.
  """
```

Seismic_Analysis_upload4.ipynb

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```
import xarray as xr
!pip install hvplot
import panel as pn
```

```
Collecting hvplot
  Downloading hvplot-0.7.3-py2.py3-none-any.whl (3.1 MB)
     |████████████████████████████████| 3.1 MB 8.6 MB/s
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (from hvplot) (1.1.5)
Requirement already satisfied: holoviews>=1.11.0 in /usr/local/lib/python3.7/dist-packages (from hvplot) (1.14.6)
Requirement already satisfied: bokeh>=1.0.0 in /usr/local/lib/python3.7/dist-packages (from hvplot) (2.3.3)
Requirement already satisfied: numpy>=1.15 in /usr/local/lib/python3.7/dist-packages (from hvplot) (1.19.5)
Requirement already satisfied: colorcet>=2 in /usr/local/lib/python3.7/dist-packages (from hvplot) (2.0.6)
Requirement already satisfied: packaging>=16.8 in /usr/local/lib/python3.7/dist-packages (from bokeh>=1.0.0->hvplot) (21.3)
Requirement already satisfied: tornado>=5.1 in /usr/local/lib/python3.7/dist-packages (from bokeh>=1.0.0->hvplot) (5.1.1)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.7/dist-packages (from bokeh>=1.0.0->hvplot) (2.8.2)
Requirement already satisfied: pillow>=7.1.0 in /usr/local/lib/python3.7/dist-packages (from bokeh>=1.0.0->hvplot) (7.1.2)
Requirement already satisfied: typing-extensions>=3.7.4 in /usr/local/lib/python3.7/dist-packages (from bokeh>=1.0.0->hvplot) (3.10.0.2)
Requirement already satisfied: Jinja2>=2.9 in /usr/local/lib/python3.7/dist-packages (from bokeh>=1.0.0->hvplot) (2.11.3)
Requirement already satisfied: PyYAML>=3.10 in /usr/local/lib/python3.7/dist-packages (from bokeh>=1.0.0->hvplot) (3.13)
Requirement already satisfied: param>=1.7.0 in /usr/local/lib/python3.7/dist-packages (from colorcet>=2->hvplot) (1.12.0)
Requirement already satisfied: pyct>=0.4.4 in /usr/local/lib/python3.7/dist-packages (from colorcet>=2->hvplot) (0.4.8)
Requirement already satisfied: panel>=0.8.0 in /usr/local/lib/python3.7/dist-packages (from holoviews>=1.11.0->hvplot) (0.12.1)
Requirement already satisfied: pyviz-comms>=0.7.4 in /usr/local/lib/python3.7/dist-packages (from holoviews>=1.11.0->hvplot) (2.1.0)
Requirement already satisfied: MarkupSafe>=0.23 in /usr/local/lib/python3.7/dist-packages (from Jinja2>=2.9->bokeh>=1.0.0->hvplot) (2.0.1)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/python3.7/dist-packages (from packaging>=16.8->bokeh>=1.0.0->hvplot) (3.0.6)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/dist-packages (from pandas->hvplot) (2018.9)
Requirement already satisfied: tqdm>=4.48.0 in /usr/local/lib/python3.7/dist-packages (from panel>=0.8.0->holoviews>=1.11.0->hvplot) (4.62.3)
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packages (from panel>=0.8.0->holoviews>=1.11.0->hvplot) (2.23.0)
Requirement already satisfied: bleach in /usr/local/lib/python3.7/dist-packages (from panel>=0.8.0->holoviews>=1.11.0->hvplot) (4.1.0)
Requirement already satisfied: markdown in /usr/local/lib/python3.7/dist-packages (from panel>=0.8.0->holoviews>=1.11.0->hvplot) (3.3.6)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (from python-dateutil>=2.1->bokeh>=1.0.0->hvplot) (1.15.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.7/dist-packages (from bleach->panel>=0.8.0->holoviews>=1.11.0->hvplot) (0.5.1)
Requirement already satisfied: importlib-metadata>=4.4 in /usr/local/lib/python3.7/dist-packages (from markdown->panel>=0.8.0->holoviews>=1.11.0->hvplot) (4.8.2)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata>=4.4->markdown->panel>=0.8.0->holoviews>=1.11.0->hvplot) (3.6.0)
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-packages (from requests->panel>=0.8.0->holoviews>=1.11.0->hvplot) (3.0.4)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-packages (from requests->panel>=0.8.0->holoviews>=1.11.0->hvplot) (2.10)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist-packages (from requests->panel>=0.8.0->holoviews>=1.11.0->hvplot) (2021.10.8)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local/lib/python3.7/dist-packages (from requests->panel>=0.8.0->holoviews>=1.11.0->hvplot) (1.24.3)
Installing collected packages: hvplot
Successfully installed hvplot-0.7.3
```

```
# Define a plotting function, the input will be the inline

def plot_inl(inl):
    """
    Plot a single inline using hvplot
    """
```

Seismic_Analysis_upload4.ipynb

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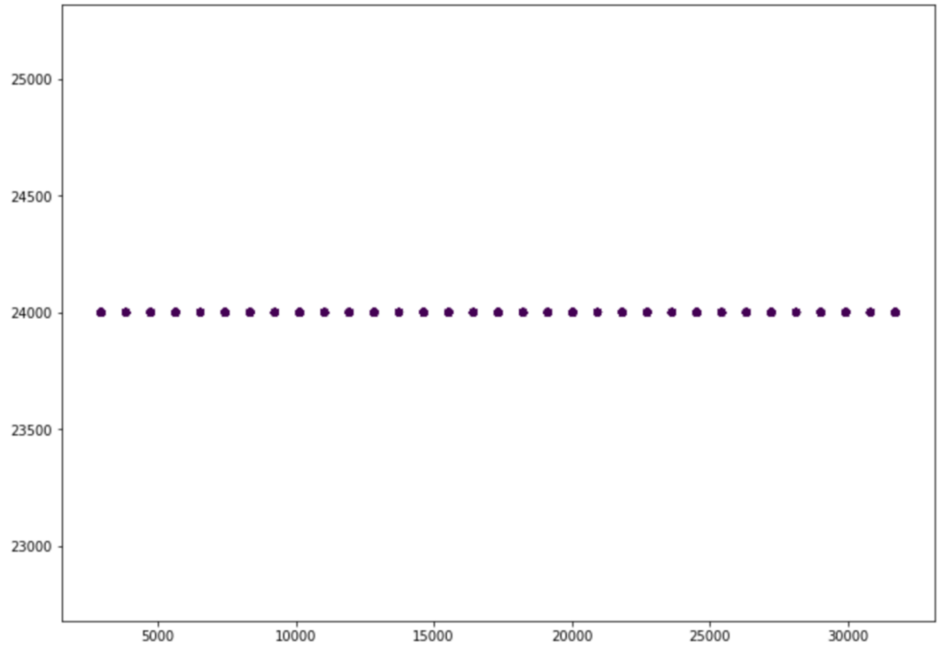
```python
filename = 'SEAM_Interpretation_Challenge_1_2DSparseGathers_Depth.sgy'
with segyio.open(filename, ignore_geometry=True) as segyfile:
    segyfile.mmap()

    # Extract header word for all traces
    sourceX = segyfile.attributes(segyio.TraceField.SourceX)[:]

    # Scatter plot sources and receivers color-coded on their number
    plt.figure()
    sourceY = segyfile.attributes(segyio.TraceField.SourceY)[:]
    nsum = segyfile.attributes(segyio.TraceField.NSummedTraces)[:]
    plt.scatter(sourceX, sourceY, c=nsum, edgecolor='none')

    groupX = segyfile.attributes(segyio.TraceField.GroupX)[:]
    groupY = segyfile.attributes(segyio.TraceField.GroupY)[:]
    nstack = segyfile.attributes(segyio.TraceField.NStackedTraces)[:]
    plt.scatter(groupX, groupY, c=nstack, edgecolor='none')
```



Seismic_Analysis_upload4.ipynb

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2) Data Preprocessing

```
def main():
    filename = 'SEAM_Interpretation_Challenge_1_2DSparseGathers_Depth.sgy'

    # Open file
    with segyio.open(filename, ignore_geometry=True) as f:
    # Get all header keys:
        header_keys = segyio.tracefield.keys
        # Initialize df with trace id as index and headers as columns
        trace_headers = pd.DataFrame(index=range(1, f.tracecount+1),
                              columns=header_keys.keys())
        # Fill dataframe with all trace headers values
        for k, v in header_keys.items():
            trace_headers[k] = f.attributes(v)[:]
    print(trace_headers.head())
    trace_headers.to_csv('out.csv')
if __name__ == '__main__':
    main()
```

```
   TRACE_SEQUENCE_LINE  TRACE_SEQUENCE_FILE  ...  UnassignedInt1  UnassignedInt2
1                    0                    0  ...               0               0
2                    0                    0  ...               0               0
3                    0                    0  ...               0               0
4                    0                    0  ...               0               0
5                    0                    0  ...               0               0

[5 rows x 91 columns]
```

```
pd.read_csv('out.csv')
```

	Unnamed: 0	TRACE_SEQUENCE_LINE	TRACE_SEQUENCE_FILE	FieldRecord	TraceNumber	EnergySourcePoint	CDP	CDP_TRACE	TraceIdentificationCode	NSummedTraces	NStackedTraces	DataUse	offset	ReceiverGroupElevatio
0	1	0	0	0	0	1589	5801	0	1	0	0	0	0	
1	2	0	0	0	0	1589	5801	0	1	0	0	0	400	
2	3	0	0	0	0	1589	5801	0	1	0	0	0	800	
3	4	0	0	0	0	1589	5801	0	1	0	0	0	1200	
4	5	0	0	0	0	1589	5801	0	1	0	0	0	1600	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	.
985	986	0	0	0	0	7349	5801	0	1	0	0	0	10000	

rapids-colab-0.8.ipynb

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RAPIDS Examples

Now you can run code!

What follows are basic examples where all processing takes place on the GPU.

cuDF

Load a dataset into a GPU memory resident DataFrame and perform a basic calculation.

Everything from CSV parsing to calculating tip percentage and computing a grouped average is done on the GPU.

```
import cudf
import io, requests

# download CSV file from GitHub
url="https://github.com/plotly/datasets/raw/master/tips.csv"
content = requests.get(url).content.decode('utf-8')

# read CSV from memory
tips_df = cudf.read_csv(io.StringIO(content))
tips_df['tip_percentage'] = tips_df['tip']/tips_df['total_bill']*100

# display average tip by dining party size
print(tips_df.groupby('size').tip_percentage.mean())
```

```
size
1     21.72920154872781
2    16.571919173482886
3    15.215685473711835
4    14.594900639351332
5    14.149548965142023
6    15.622920072028379
Name: tip_percentage, dtype: float64
```

cuML

This snippet does label and one-hot encoding of the tips dataset's categorical features and applies standard scaling to all columns. All operations run on the GPU.

Conclusão

1. Desenvolvemos um *notebook* para dado sísmico utilizando como base o *notebook* da empresa petrolífera Equinor;
2. Adaptamos outras rotinas para o nosso problema;
3. Rotina para converter dados .sgy em .csv. Permitindo realizar novas implementações com o ferramental apresentado em sala;
4. Metodologia de QC do dado sísmico através do acesso a várias chaves do *header*;
5. Adquirirmos o conhecimento de novas formas de utilizar e manipular o dado sísmico em open *source*, ou seja, não utilizamos *software* de geofísica;
6. Temos como passos futuros a implementação das bibliotecas: Bokeh, Dask e Rapids;
7. Este notebook será ferramental para o desenvolvimento do doutorado.

Conclusão

Muito Obrigado pela oportunidade!
Saio do curso um profissional mais completo