COVID19_30_04

April 30, 2020

0.1 Dados COVID19 em .ipynb 30/04/2020

Estou tentando importar e utilizar os dados do Ministério da Saúde em https://covid.saude.org.br para avaliar a situação divulgada oficialmente pelo MS; A url muda diariamente, há uma série de caracteres em primeira vista aleatórios que é atualizada também todo dia... como puxar o arquivo csv automaticamente?

O site não disponibiliza dados de SRAG, apenas uma tabela repetida e desatualizada do COVID19.

Nova tabela com dados do Brasil (população)

Dados de SRAG da fiocruz estão no padrão brasileiro (109,0009) como transformar o arquivo em padrão americano/internacional (109.0009) automaticamente pela URL?

0.2 Gráficos dos Dados

Mostrar infectados e mortes confirmados diariamente
Mostrar infectados e mortes confirmados acumulados
Mostrar dados separados por região e por estado

Mostrar dados de SRAG e comparar com o aumento dos números confirmados de COVID

Dados em semana epidemiológica

0.3 Estimativas (Regressão)

Estimar próximos números (até 7 dias?) utilizando 3 dias anteriores e regressão não linear

Estimar curvas com ajuda dos dados de SRAG inconclusivos (qual a porcentagem de testes incompletos espera-se que serão confirmados)

0.4 Modelo de Contágio

Utilizar dados adquiridos para rodar um modelo epidemiológico que utiliza valores de reprodução base e evolução da COVID-19, causada pelo vírus SARS-COV-2

[1]:
```
import pandas as pd
import numpy as np
from datetime import datetime,timedelta
from sklearn.metrics import mean_squared_error
from scipy.stats import norm
from scipy.optimize import curve_fit
from scipy.optimize import fsolve
import matplotlib.pyplot as plt
%matplotlib inline

url_B = "https://raw.githubusercontent.com/Yannngn/COVID19-04-20/master/brasil.
 ↪csv"
url_C = "https://mobileapps.saude.gov.br/esus-vepi/files/
 ↪unAFkcaNDeXajurGB7LChj8SgQYS2ptm/
 ↪1d2b944e065c7304b2754cc386635e38_Download_COVID19_20200430.csv"
```

[2]:
```
brasil = pd.read_csv(url_B, sep = ';')
df = pd.read_csv(url_C, sep = ";")
```

[3]:
```
FMT = '%Y-%m-%d'

date = df['data']
regi = df['regiao']

df['data'] = date.map(lambda x : (datetime.strptime(x, FMT) - datetime.
 ↪strptime("2020-01-30", FMT)).days)
```

[4]:
```
df = df.sort_values('estado')

df1 = df.loc[:, ['data', 'casosAcumulados', 'casosNovos', 'obitosAcumulados',␣
 ↪'obitosNovos']]
dfs = df.loc[:, ['regiao', 'data', 'casosAcumulados', 'casosNovos',␣
 ↪'obitosAcumulados', 'obitosNovos', 'estado']]
df_UF = df.loc[:, ['estado', 'data', 'casosAcumulados', 'casosNovos',␣
 ↪'obitosAcumulados', 'obitosNovos']]
```

[5]:
```
df1 = df1.groupby("data").sum()

# total of days since 2020-01-30 - x
days = list(df1.index)
x = days
```

[6]:
```
def exponential_model (x, a, b, c) :
    return a * np.exp (b * (x - c))
```

```
#curve_fit(f, xdata, ydata, p0=None, sigma=None, absolute_sigma=False,␣
↪check_finite=True, bounds=(-inf, inf), method=None, jac=None,␣
↪**kwargs)[source]

def exp_param (R, X) :
    a = np.exp(X[2] * (((np.log(R[2]))/X[2]) - ((np.log(R[1]) - np.log(R[0]))/
↪(X[1] - X[0]))))
    b = (np.log(R[2])/X[2]) - (1/X[2])*(((np.log(R[0])/X[0]) - (np.log(R[1])/
↪X[1]))/((X[0])**(-1) - (X[1])**(-1)))
    return [a, b]

def exp_est (R, X) :
    np.random.seed(max(x))
    a = np.exp(X[2] * (((np.log(R[2]))/X[2]) - ((np.log(R[1]) - np.log(R[0]))/
↪(X[1] - X[0]))))
    b = (np.log(R[2])/X[2]) - (1/X[2])*(((np.log(R[0])/X[0]) - (np.log(R[1])/
↪X[1]))/((X[0])**(-1) - (X[1])**(-1)))
    return a * np.exp(b * (max(x) + 1)) + norm.rvs(size = 1,scale = 0.05 *␣
↪(max(x) + 1))
```

```
[7]: desc = ["total cases", "new cases", "total deaths", "new deaths"]
print("The errors of the exponential model parameters of: \n")

for i in range(4) :
    y = list(df1.iloc[:, i])
    exp_p = exp_param([y[-5], y[-3], y[-1]], [x[-5], x[-3], x[-1]])
    exponential_fit = curve_fit(exponential_model, x, y, p0 = [exp_p[0] * np.
↪exp(-1), exp_p[1], 1])
    exponential_sol = int(fsolve(lambda x : exponential_model(x,␣
↪exponential_fit[0][0], exponential_fit[0][1],
                                                    exponential_fit[0][2])␣
↪- int(exponential_fit[0][2]), exponential_fit[0][1]))

    exponential_errors = [np.sqrt(exponential_fit[1][j][j]) for j in [0, 1, 2]]

    print(desc[i] + " numbers are: " + str(exponential_errors) + "\n")
```

```
The errors of the exponential model parameters of:

total cases numbers are: [21515361.93652721, 0.0010839215065679285,
2005232.8931679511]

new cases numbers are: [75.92428610372065, 0.003388576099651459,
15895915.079091322]

total deaths numbers are: [128302.60091768738, 0.0014400377809052531,
1107337.7550645925]
```

```
new deaths numbers are: [2.2254853499881426e-08, 0.004532921646098262,
37303677.61218945]
```

```
C:\Users\calad\anaconda3\lib\site-packages\ipykernel_launcher.py:2:
RuntimeWarning: overflow encountered in exp

C:\Users\calad\anaconda3\lib\site-packages\scipy\optimize\minpack.py:162:
RuntimeWarning: The iteration is not making good progress, as measured by the
  improvement from the last ten iterations.
  warnings.warn(msg, RuntimeWarning)
```

0.5 logistic model

a refers to the infection speed b is the day with the maximum infections occurred c is the total number of recorded infected people at the infection's end

velocidade da infecção: 2

dia de máximo de infecções: daqui a 2 semanas dia de máximo de mortes: daqui a 4 semanas

população do Brasil: 209.500.000 população máxima infectada: 60% população máxima infectada num dia: 2% população máxima morta: 0.6% população máxima morta num dia: 0.02%

[8]:
```
# logistic model of the evolution of the contamination in Brazil

def logistic_model (x, a, b, c) :
    return c / (1 + np.exp ( - (x - b) / a))

# curve_fit(f, xdata, ydata, p0=None, sigma=None, absolute_sigma=False,␣
 ↪check_finite=True, bounds=(-inf, inf), method=None, jac=None,␣
 ↪**kwargs)[source]

a0 = 2.7

lb = [df1.index.size + 31, df1.index.size + 86, df1.index.size + 45, df1.index.
 ↪size + 45]

pBrasil = brasil.at[brasil['UF'].eq('BR').idxmax(),'População']
lc = [0.2 * pBrasil, 0.001 * pBrasil, 0.008 * pBrasil, 0.00016 * pBrasil]
```

[9]:
```
print("The errors of the logistic model parameters of: \n")

for i in range(4) :
    y = list(df1.iloc[:, i])

    logistic_fit = curve_fit(logistic_model, x, y, p0 = [a0, lb[i], lc[i]])
    logistic_sol = int(fsolve(lambda x : logistic_model(x, logistic_fit[0][0],␣
 ↪logistic_fit[0][1],
                                                       logistic_fit[0][2]) -␣
↪int(logistic_fit[0][2]), logistic_fit[0][1]))

    logistic_errors = [np.sqrt(logistic_fit[1][j][j]) for j in [0, 1, 2]]

    print(desc[i] + " numbers are: " + str(logistic_errors) + "\n")
```

```
The errors of the logistic model parameters of:

total cases numbers are: [0.26467492251351343, 1.5455758805429491,
17820.59130006587]

new cases numbers are: [1.6833481044579233e+21, 2.4152703479144707e+29,
1.8971253557985927e+34]

total deaths numbers are: [0.22946140931809317, 1.164335361999356,
933.9937086776018]

new deaths numbers are: [2.006813747614292, 28.9108666655004, 5059.995262779091]
```

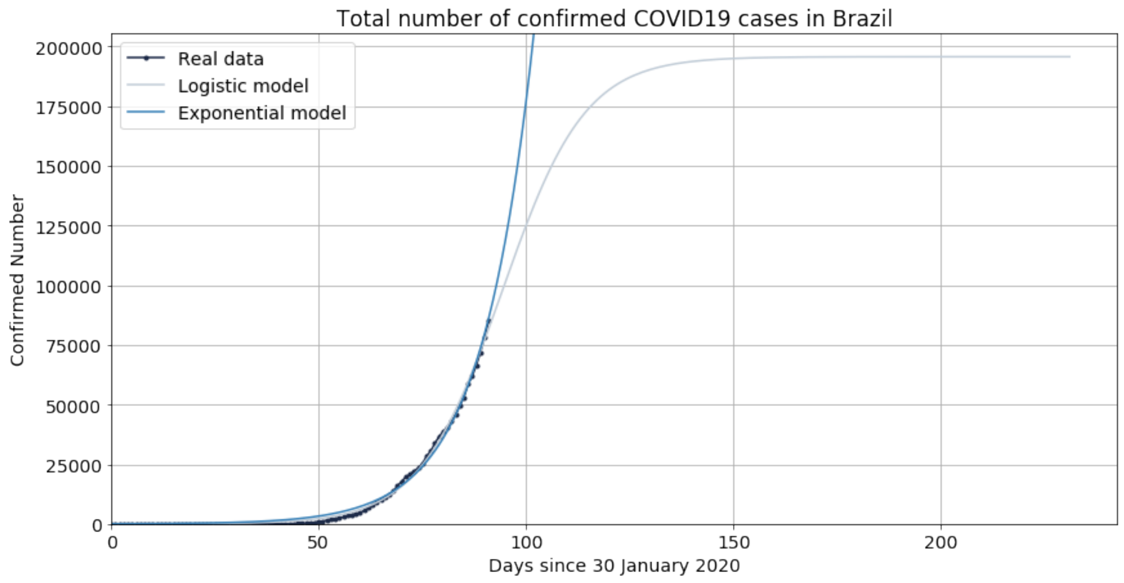
1 Gráficos

1.1 Cores

```
branco --> #c2cdd8
cinza --> #a1a9b4
azul --> #3881b8
azul --> #235174
preto --> #1d2b49
```

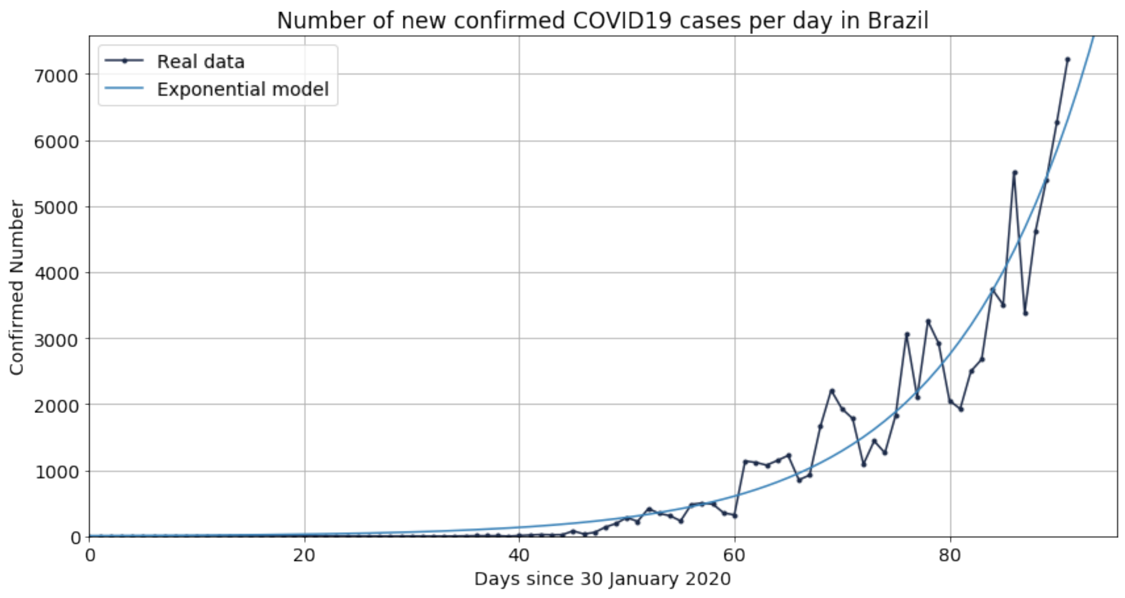
[10]:
```
plt.rc('font', size=14)
plt.rcParams['figure.figsize'] = [14, 7]
ttl = ["Total number of confirmed COVID19 cases in Brazil",
       "Number of new confirmed COVID19 cases per day in Brazil",
       "Total number of deceased in Brazil",
       "Number of new confirmed deceased per day in Brazil"]

expo = []
for f in range(4) :
    x = days
    plt.grid(True)
    plt.rc('font', size=14)
    plt.rcParams['figure.figsize'] = [14, 7]

    y = list(df1.iloc[:, f])
    logistic_fit = curve_fit(logistic_model, x, y, p0 = [a0, lb[f], lc[f]])
    logistic_sol = int(fsolve(lambda x : logistic_model(x, logistic_fit[0][0],␣
↪logistic_fit[0][1],
                                                                   logistic_fit[0][2]) -␣
↪int(logistic_fit[0][2]),
                             logistic_fit[0][1]))

    exp_p = exp_param([y[-5], y[-3], y[-1]], [x[-5], x[-3], x[-1]])
    exponential_fit = curve_fit(exponential_model, x, y, p0 = [exp_p[0] * np.
↪exp(-1), exp_p[1], 1])
    exponential_sol = int(fsolve(lambda x : exponential_model(x,␣
↪exponential_fit[0][0], exponential_fit[0][1],
                                                                ␣
↪exponential_fit[0][2]) - int(exponential_fit[0][2]),
                                exponential_fit[0][1]))

    pred_x = list(range(max(x), logistic_sol))

    # Real data
    plt.plot(x, y, marker = '.', label = "Real data", color = "#1d2b49")

    # Predicted logistic curve for the total data
    if (f == 0 or f == 2) :

        plt.plot(x + pred_x, [logistic_model(i, logistic_fit[0][0],␣
↪logistic_fit[0][1], logistic_fit[0][2])
                             for i in x + pred_x], label = "Logistic model",␣
↪color = "#c2cdd8")
        print("Expected final values: end of spread in " + str(max(pred_x) -␣
↪max(x))
              + " days, with " + str(round(logistic_fit[0][2], 3)) + "␣
↪confirmed numbers in Brazil")

    # Predicted exponential curve
    plt.plot(x + pred_x, [exponential_model(i, exponential_fit[0][0],␣
↪exponential_fit[0][1], exponential_fit[0][2])
                         for i in x + pred_x], label = "Exponential model",␣
↪color = "#3881b8")

    expo.append(exponential_fit)

    plt.title(ttl[f])
    plt.legend()
    plt.xlabel("Days since 30 January 2020")
    plt.ylabel("Confirmed Number")
    if (f == 0 or f == 2) :
        plt.xlim(0, max(pred_x) * 1.05)
        plt.ylim(0, logistic_fit[0][2] * 1.05)
    else :
        plt.ylim(0, max(y) * 1.05)
        plt.xlim(0, max(x) * 1.05)
    plt.show()
    print("Next estimated number of confirmed cases is " +
          str(round(exponential_model(max(x) + 1, exponential_fit[0][0],␣
↪exponential_fit[0][1], exponential_fit[0][2]), 3)))
```

```
Expected final values: end of spread in 140 days, with 195703.183 confirmed
numbers in Brazil
```

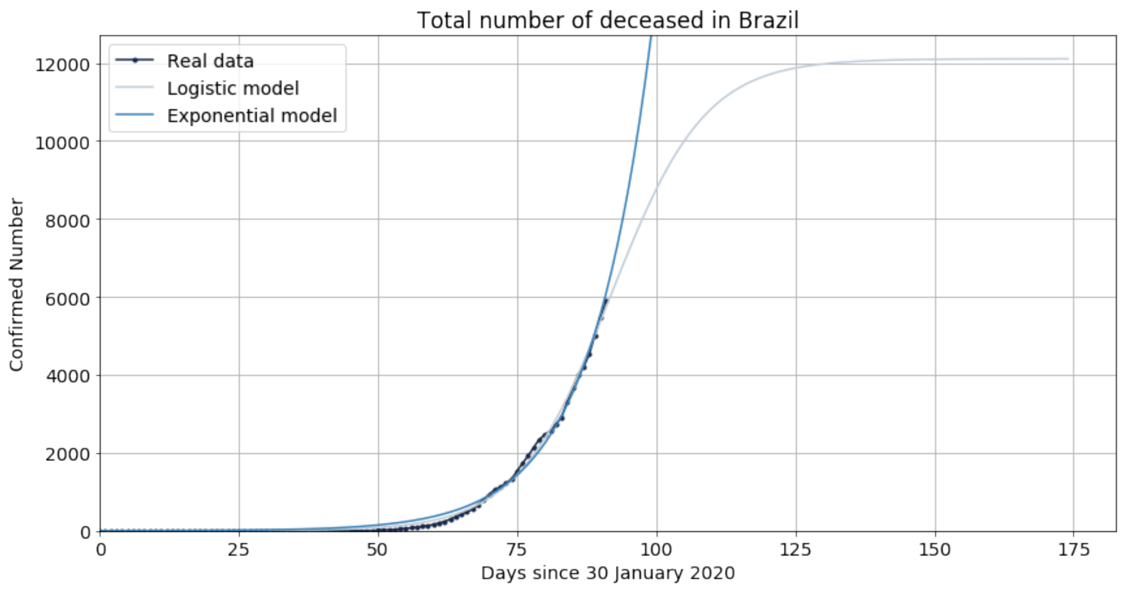


```
Next estimated number of confirmed cases is 93531.559
```

```
C:\Users\calad\anaconda3\lib\site-packages\ipykernel_launcher.py:2:
RuntimeWarning: overflow encountered in exp

C:\Users\calad\anaconda3\lib\site-packages\scipy\optimize\minpack.py:162:
RuntimeWarning: The iteration is not making good progress, as measured by the
  improvement from the last ten iterations.
  warnings.warn(msg, RuntimeWarning)
```

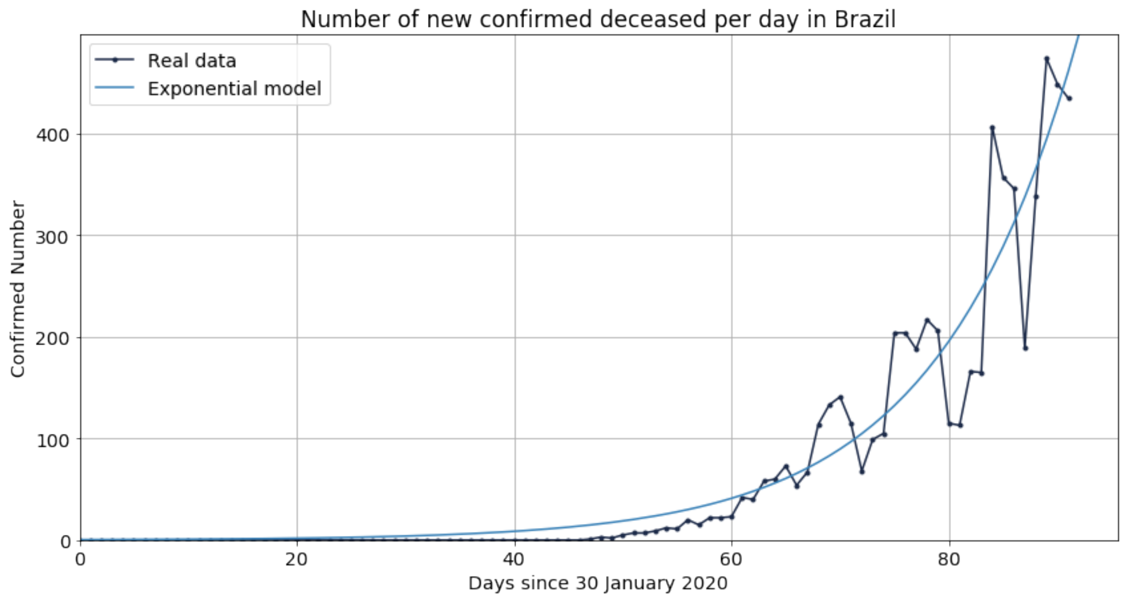


```
Next estimated number of confirmed cases is 6803.063
Expected final values: end of spread in 83 days, with 12105.625 confirmed
numbers in Brazil

C:\Users\calad\anaconda3\lib\site-packages\scipy\optimize\minpack.py:162:
RuntimeWarning: The iteration is not making good progress, as measured by the
  improvement from the last ten iterations.
  warnings.warn(msg, RuntimeWarning)
```



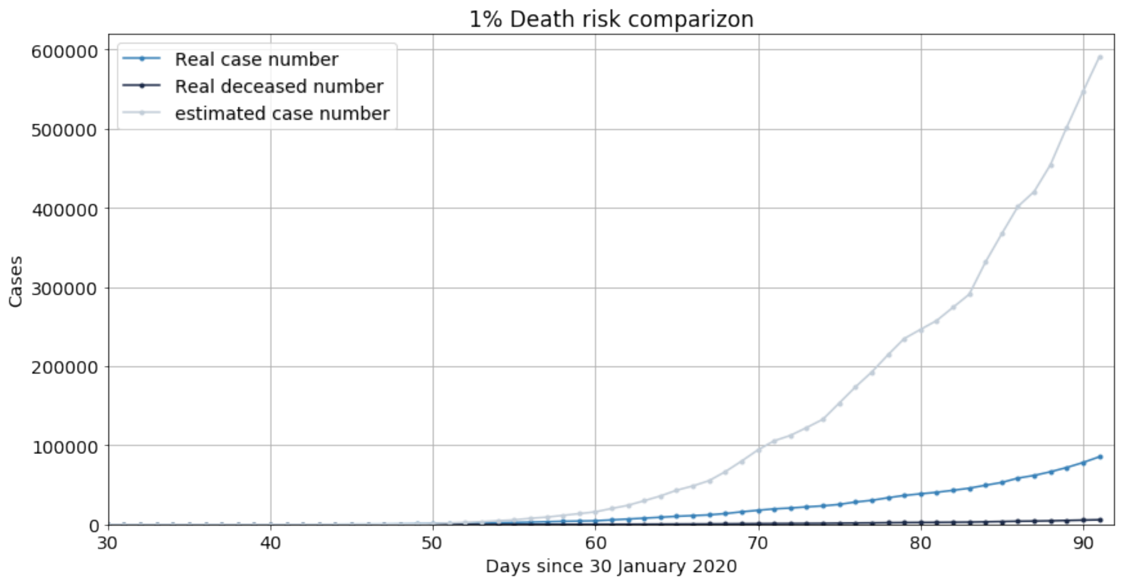
```
Next estimated number of confirmed cases is 6675.448
```

```
C:\Users\calad\anaconda3\lib\site-packages\ipykernel_launcher.py:2:
RuntimeWarning: overflow encountered in exp

C:\Users\calad\anaconda3\lib\site-packages\scipy\optimize\minpack.py:162:
RuntimeWarning: The iteration is not making good progress, as measured by the
  improvement from the last ten iterations.
  warnings.warn(msg, RuntimeWarning)
```



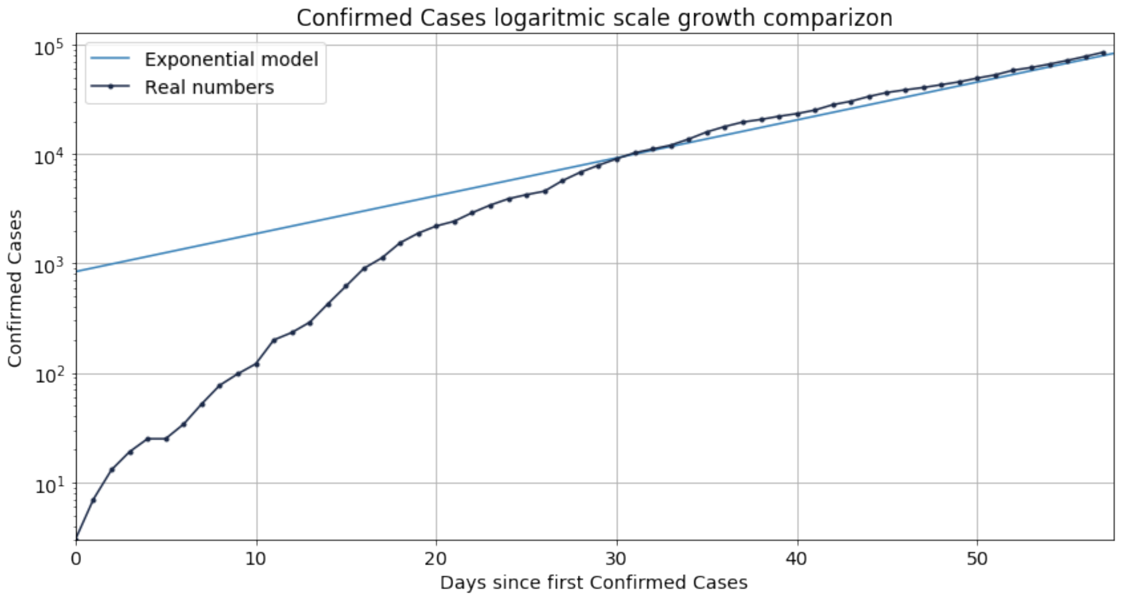
```
Next estimated number of confirmed cases is 498.688
```

[11]:
```python
plt.grid(True)
plt.rc('font', size=14)
plt.rcParams['figure.figsize'] = [14, 7]

# Real data

y = list(df1.iloc[:, 0])
plt.plot(x, y, marker = '.', label = "Real case number", color = "#3881b8")

y = list(df1.iloc[:, 2])

plt.plot(x, y, marker = '.', label = "Real deceased number", color = "#1d2b49")

y = list(df1.iloc[:, 2].multiply(100))

plt.plot(x, y, marker = '.', label = "estimated case number", color = "#c2cdd8")
plt.title("1% Death risk comparizon")
plt.legend()
plt.xlabel("Days since 30 January 2020")
plt.ylabel("Cases")
plt.xlim(30, max(x) * 1.01)
plt.ylim(0, max(y) * 1.05)
plt.show()
print("Expected actual value is: " + str(max(y)) + " in day " + str(max(x)))
```

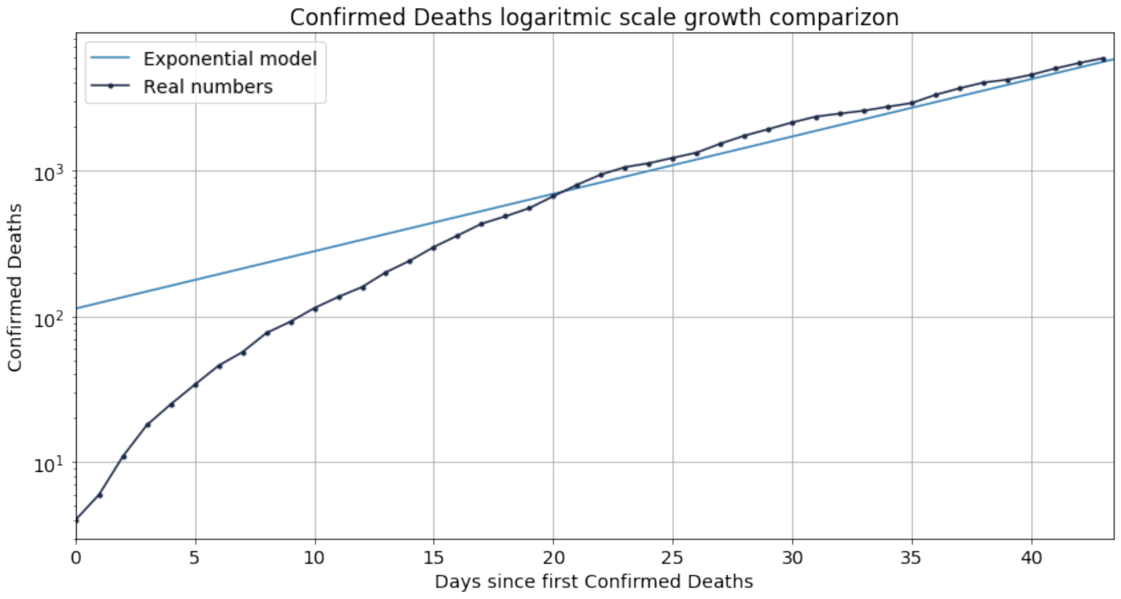


```
Expected actual value is: 590100 in day 91
```

[12]:
```
inicio = [33, 47]
ttl = ["Confirmed Cases", "Confirmed Deaths"]
for f in range(2) :
    plt.grid(True)
    plt.rc('font', size=14)
    plt.rcParams['figure.figsize'] = [14, 7]

    # Lines
    x = days
    y = list(df1.iloc[:, 2 * f])

    logistic_fit = curve_fit(logistic_model, x, y, p0 = [a0, lb[2 * f], lc[2 *␣
↪f]])
    logistic_sol = int(fsolve(lambda x : logistic_model(x, logistic_fit[0][0],␣
↪logistic_fit[0][1],
                                                        logistic_fit[0][2]) -␣
        ↪int(logistic_fit[0][2]),
                              logistic_fit[0][1]))

    exp_p = exp_param([y[-4], y[-2], y[-1]], [x[-4], x[-2], x[-1]])
    exponential_fit = curve_fit(exponential_model, x, y, p0 = [exp_p[0] - 1,␣
        ↪exp_p[1], 1])

    pred_x = list(range(max(x), logistic_sol))

    plt.plot(x + pred_x, [exponential_model(i + inicio[f],␣
        ↪exponential_fit[0][0], exponential_fit[0][1], exponential_fit[0][2])
                              for i in x + pred_x], label = "Exponential␣
        ↪model", color = "#3881b8")

    # Real data

    x = list(df1.head(max(days) - inicio[f]).index)

    y = list(df1.iloc[:, 2 * f].tail(max(days) - inicio[f]))
    plt.plot(x, y, marker = '.', label = "Real numbers", color = "#1d2b49")

    plt.title(ttl[f] + " logaritmic scale growth comparizon")
    plt.legend()
    plt.yscale('log')
    plt.xlabel("Days since first " + ttl[f])
    plt.ylabel(ttl[f])
    plt.xlim(0, max(x) * 1.01)
    plt.ylim(3, max(y) * 1.5)
    plt.show()

    print("The growth rate of " + ttl[f] + " is: doubling every " +␣
        ↪str(round(np.log(2) / exponential_fit[0][1], 3)) + " days")
```



```
The growth rate of Confirmed Cases is: doubling every 8.684 days
```



```
The growth rate of Confirmed Deaths is: doubling every 7.648 days
```