Covid19 Germany Deutschland (RKI data)

October 6, 2020

[1]:
```
# This Python 3 environment comes with many helpful analytics libraries␣
↪installed
# It is defined by the kaggle/python docker image: https://github.com/kaggle/
↪docker-python
# For example, here's several helpful packages to load in

import os
import urllib
from bs4 import BeautifulSoup
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import matplotlib as mpl
import matplotlib.pyplot as plt
import seaborn as sns

# Input data files are available in the "../input/" directory.
# For example, running this (by clicking run or pressing Shift+Enter) will list␣
↪all files under the input directory

# import os
# for dirname, _, filenames in os.walk('/kaggle/input'):
#     for filename in filenames:
#         print(os.path.join(dirname, filename))

# # Any results you write to the current directory are saved as output.

sns.set()
%matplotlib inline

# This checks if the notebook is executed on Kaggle or on your local machine and
# acts accordingly with filenames. On Kaggle the dataset is already managed by␣
↪a managed
# and downloaded to (URLs are linked) a dataset there.
try:
    os.environ['KAGGLE_DATA_PROXY_TOKEN']
except KeyError:
    # daily infections in Germany
    url_daily_corona = "https://opendata.arcgis.com/datasets/
↪dd4580c810204019a7b8eb3e0b329dd6_0.csv"

    # infections per 100k residents in German states
    url_corona_bl_100k = "https://opendata.arcgis.com/datasets/
↪ef4b445a53c1406892257fe63129a8ea_0.csv"

    # infections per 100k residents in German provinces
    url_corona_provinces = "https://opendata.arcgis.com/datasets/
↪917fc37a709542548cc3be077a786c17_0.csv"

    fname1 = "./RKI_covid19_daily_de.csv"
    fname2 = "./RKI_covid19_states_100k.csv"
    fname3 = "./RKI_covid19_provinces_100k.csv"

    urllib.request.urlretrieve(url_daily_corona, fname1)
    urllib.request.urlretrieve(url_daily_corona, fname2)
    urllib.request.urlretrieve(url_daily_corona, fname3)

    fname4 = "./additional_data/covid19_events_measures.csv"

else:
    dirname = "/kaggle/input/covid19-data-germany-robert-koch-institute/"
    dirname_additional = "/kaggle/input/additional-covid19-data/additional_data/
↪"
    # daily infections in Germany
    fname1 = dirname + "dd4580c810204019a7b8eb3e0b329dd6_0.csv"

    # infections per 100k residents in German states
    fname2 = dirname + "ef4b445a53c1406892257fe63129a8ea_0.csv"

    # infections per 100k residents in German provinces
    fname3 = dirname + "917fc37a709542548cc3be077a786c17_0.csv"

    fname4 = dirname_additional + "covid19_events_measures.csv"


df_daily_data = pd.read_csv(fname1, parse_dates=["Meldedatum"],␣
↪date_parser=lambda ts: pd.Timestamp(ts).strftime('%Y-%m-%d'))
df_measures_events = pd.read_csv(fname4, parse_dates=["Date"])

df_daily_data.sort_values(['Meldedatum'], inplace=True)
df_measures_events.sort_values(['Date'], inplace=True)
```

[2]:
```
df_daily_data
```

```
[2]:         ObjectId  IdBundesland           Bundesland            Landkreis  \
173097  41264065             9               Bayern         LK Starnberg
167335  41258303             9               Bayern  LK Landsberg a.Lech
155684  41246652             9               Bayern           SK München
165893  41256861             9               Bayern  LK Fürstenfeldbruck
173456  41264424             9               Bayern        LK Traunstein
…            …           …                    …                    …
35925   41126893             5  Nordrhein-Westfalen   SK Mönchengladbach
104765  41195733             7      Rheinland-Pfalz   LK Westerwaldkreis
104707  41195675             7      Rheinland-Pfalz   LK Westerwaldkreis
35719   41126687             5  Nordrhein-Westfalen   SK Mönchengladbach
201354  41292322             9               Bayern         SK Augsburg

       Altersgruppe Geschlecht  AnzahlFall  AnzahlTodesfall Meldedatum  \
173097      A35-A59          M           1                0 2020-01-28
167335      A15-A34          M           1                0 2020-01-28
155684      A15-A34          W           1                0 2020-01-29
165893      A15-A34          M           1                0 2020-01-29
173456      A00-A04          W           1                0 2020-01-31
…                …         …          …                …         …
35925          A80+          M           1                0 2020-10-05
104765      A15-A34          W           1                0 2020-10-05
104707      A15-A34          M           1                0 2020-10-05
35719       A35-A59          W           1                0 2020-10-05
201354      A15-A34          W           2                0 2020-10-05

        IdLandkreis             Datenstand  NeuerFall  NeuerTodesfall  \
173097         9188  06.10.2020, 00:00 Uhr          0              -9
167335         9181  06.10.2020, 00:00 Uhr          0              -9
155684         9162  06.10.2020, 00:00 Uhr          0              -9
165893         9179  06.10.2020, 00:00 Uhr          0              -9
173456         9189  06.10.2020, 00:00 Uhr          0              -9
…                …                      …        …             …
35925          5116  06.10.2020, 00:00 Uhr          1              -9
104765         7143  06.10.2020, 00:00 Uhr          1              -9
104707         7143  06.10.2020, 00:00 Uhr          1              -9
35719          5116  06.10.2020, 00:00 Uhr          1              -9
201354         9761  06.10.2020, 00:00 Uhr          1              -9

                   Refdatum  NeuGenesen  AnzahlGenesen  IstErkrankungsbeginn  \
173097  2020/01/27 00:00:00           0              1                     1
167335  2020/01/23 00:00:00           0              1                     1
155684  2020/01/23 00:00:00           0              1                     1
165893  2020/01/25 00:00:00           0              1                     1
173456  2020/01/29 00:00:00           0              1                     1
…                         …         …            …                   …
35925   2020/10/05 00:00:00          -9              0                     0
```

```
104765  2020/10/01 00:00:00          -9            0                      1
104707  2020/09/27 00:00:00          -9            0                      1
35719   2020/09/24 00:00:00          -9            0                      1
201354  2020/10/05 00:00:00          -9            0                      0

            Altersgruppe2
173097  Nicht übermittelt
167335  Nicht übermittelt
155684  Nicht übermittelt
165893  Nicht übermittelt
173456  Nicht übermittelt
…                     …
35925   Nicht übermittelt
104765  Nicht übermittelt
104707  Nicht übermittelt
35719   Nicht übermittelt
201354  Nicht übermittelt

[241001 rows x 18 columns]
```

[3]:
```
print("Measures taken and events/incidents concerning Covid19."
      + "These might show a connection to the falling or rising of the curves:")
df_measures_events
```

```
Measures taken and events/incidents concerning Covid19.These might show a
connection to the falling or rising of the curves:
```

[3]:
```
        Date                                        In_Short   State  \
0 2020-03-16                 Schools, day care centers closed.    Alle
1 2020-03-16            Entry bans and strict border controls.    Alle
2 2020-03-20     Quarantine Bavaria, only vital locations open.  Bayern
3 2020-03-22  Quarantine country-wide, only vital locations …   Alle

                                     Description
0                  Schools, day care centers closed.
1  Germany has decided on entry bans and strict c…
2  Only vital location, like supermarkets, doctor…
3  Only vital location, like supermarkets, doctor…
```

[4]:
```
print("Total sum of cases in Germany:")
df_daily_data["AnzahlFall"].sum()
```

```
Total sum of cases in Germany:
```

[4]:
```
303230
```

[5]:
```
print("Describe number of cases per day in Germany:")
df_daily_data.groupby("Meldedatum").sum()["AnzahlFall"].describe()
```

```
Describe number of cases per day in Germany:
```

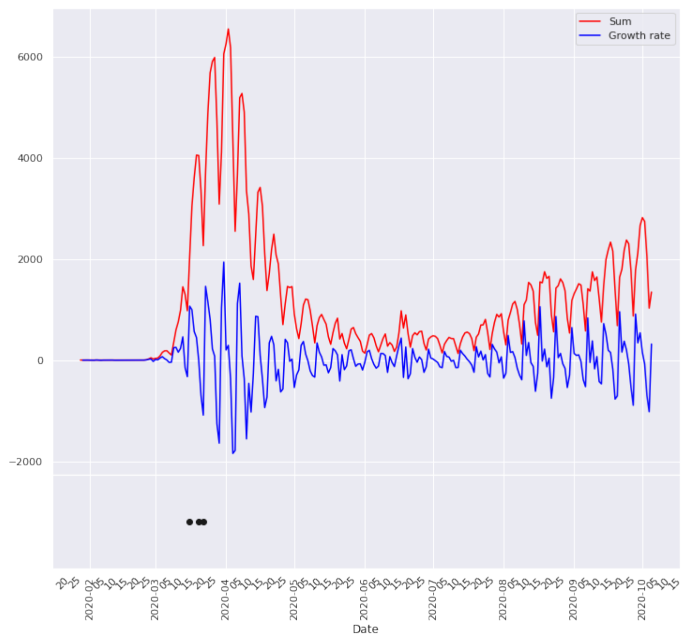
[5]:
```
count     235.000000
mean     1290.340426
std      1374.087269
min         1.000000
25%       425.500000
50%       805.000000
75%      1613.000000
max      6555.000000
Name: AnzahlFall, dtype: float64
```

[6]:
```
# def annotationsForDate(df, date):
#     """
#     Takes the measures df and a time index and returns all the short
#     measure descriptions as a string for the annotations below
#     """
#     query = df_measures_events.query("Date == '{}'".format(date))
#     ann = ""
#     for i in query.index:
#         state = ""
#         if query["State"].iloc[i]:
#             state = query["State"].iloc[i] + ": "
#         s = query["In_Short"].iloc[i]
#         ann += s + '\n'
#     return ann.rstrip()
```

[7]:
```
gr_day_reported = df_daily_data.groupby('Meldedatum')

# TODO: make these relative to screen size somehow
figsize = (12,11)
fig, ax = plt.subplots(2, 1, figsize=figsize, sharex=True,␣
 ↪gridspec_kw={'height_ratios': [5, 1]})
fig.subplots_adjust(hspace=0.0)
suptitel_attr = {"fontsize" : 16, "fontweight" : "bold", "ha" : "center", "va" :
 ↪ "bottom", "y" : 0.94}

# set plot stuff
fig.suptitle("Sum of confirmed cases per day and growth rate thereof for␣
 ↪Germany. Below are points "
             + "for political measures or events/incidents.", **suptitel_attr)

for axis in ax.flat:
    axis.set_xlabel('Date')
    rule = mpl.dates.rrulewrapper(mpl.dates.MONTHLY,  bymonthday=(5, 10, 15,␣
↪20, 25))
    axis.xaxis.set_minor_locator(mpl.dates.RRuleLocator(rule))
    axis.xaxis.set_minor_formatter(mpl.dates.DateFormatter("%d"))
    axis.xaxis.set_major_locator(mpl.dates.MonthLocator(bymonthday=1))
    axis.xaxis.set_major_formatter(mpl.dates.DateFormatter('%Y-%m'))

ax[1].yaxis.set_minor_locator(mpl.ticker.NullLocator())
ax[1].yaxis.set_major_locator(mpl.ticker.NullLocator())

sum_cases_per_day = gr_day_reported['AnzahlFall'].sum()
growth_rate = sum_cases_per_day.diff()

ax[0].plot(sum_cases_per_day, color='red', label='Sum')
ax[0].plot(growth_rate, color='blue', label='Growth rate')

plt.setp(ax[0].xaxis.get_majorticklabels(), rotation=90)
plt.setp(ax[0].xaxis.get_minorticklabels(), rotation=45)


for d in df_measures_events["Date"].unique():
    #s = annotationsForDate(df_measures_events, d)
    #axs[1].annotate(s = "bla", xy=(d, sum_cases_per_day[d]), xytext=(-50,-10),␣
↪xycoords="data")
    pass

ax[1].scatter(df_measures_events["Date"].unique(),␣
↪len(df_measures_events["Date"].unique()) * [100], c='k')

for axis in ax.flat:
    plt.setp(axis.xaxis.get_majorticklabels(), rotation=90)
    plt.setp(axis.xaxis.get_minorticklabels(), rotation=45)

ax[0].legend()
```

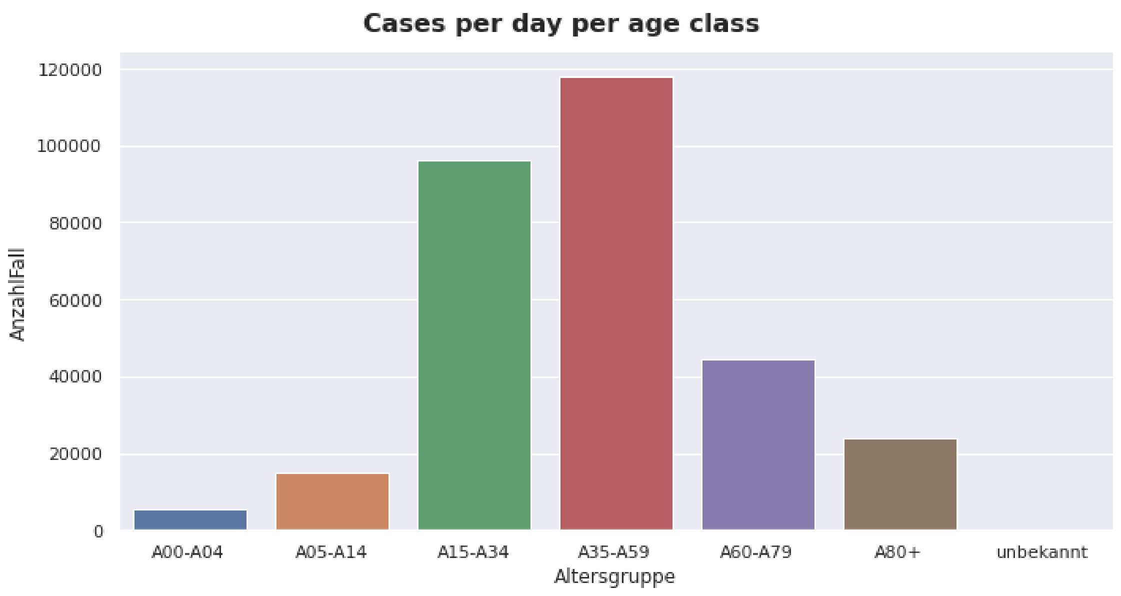
```
[7]: <matplotlib.legend.Legend at 0x7faa40570890>
```

Sum of confirmed cases per day and growth rate thereof for Germany. Below are points for political measures or events/incidents.



```
[8]: g_ages = df_daily_data.groupby("Altersgruppe")
     ages_cases = g_ages["AnzahlFall"].sum().reset_index()
     cp = sns.catplot("Altersgruppe", "AnzahlFall", data=ages_cases, kind="bar",␣
      ↪aspect = 2)
     suptitel_attr = {"fontsize" : 16, "fontweight" : "bold", "ha" : "center", "va" :
      ↪ "bottom", "y" : 1}
     cp.fig.suptitle("Cases per day per age class", **suptitel_attr)
```

```
[8]: Text(0.5, 1, 'Cases per day per age class')
```



```
[9]: print("Total sum of cases per German state")
     df_daily_data.groupby(['Bundesland'])["AnzahlFall"].sum()
```

```
Total sum of cases per German state
```

```
[9]: Bundesland
     Baden-Württemberg         51180
     Bayern                    70005
     Berlin                    15943
     Brandenburg                4447
     Bremen                     2631
     Hamburg                    8339
     Hessen                    20109
     Mecklenburg-Vorpommern     1293
     Niedersachsen             21281
     Nordrhein-Westfalen       73840
     Rheinland-Pfalz           11215
     Saarland                   3449
     Sachsen                    7533
     Sachsen-Anhalt             2764
     Schleswig-Holstein         4978
     Thüringen                  4223
     Name: AnzahlFall, dtype: int64
```

```
[10]: print("Describe sum of daily cases per day per German state.")
      df_daily_data.groupby(['Bundesland', "Meldedatum"])['AnzahlFall'].sum().
       ↪unstack().T.fillna(0).describe().round(decimals=0)
```

Describe sum of daily cases per day per German state.

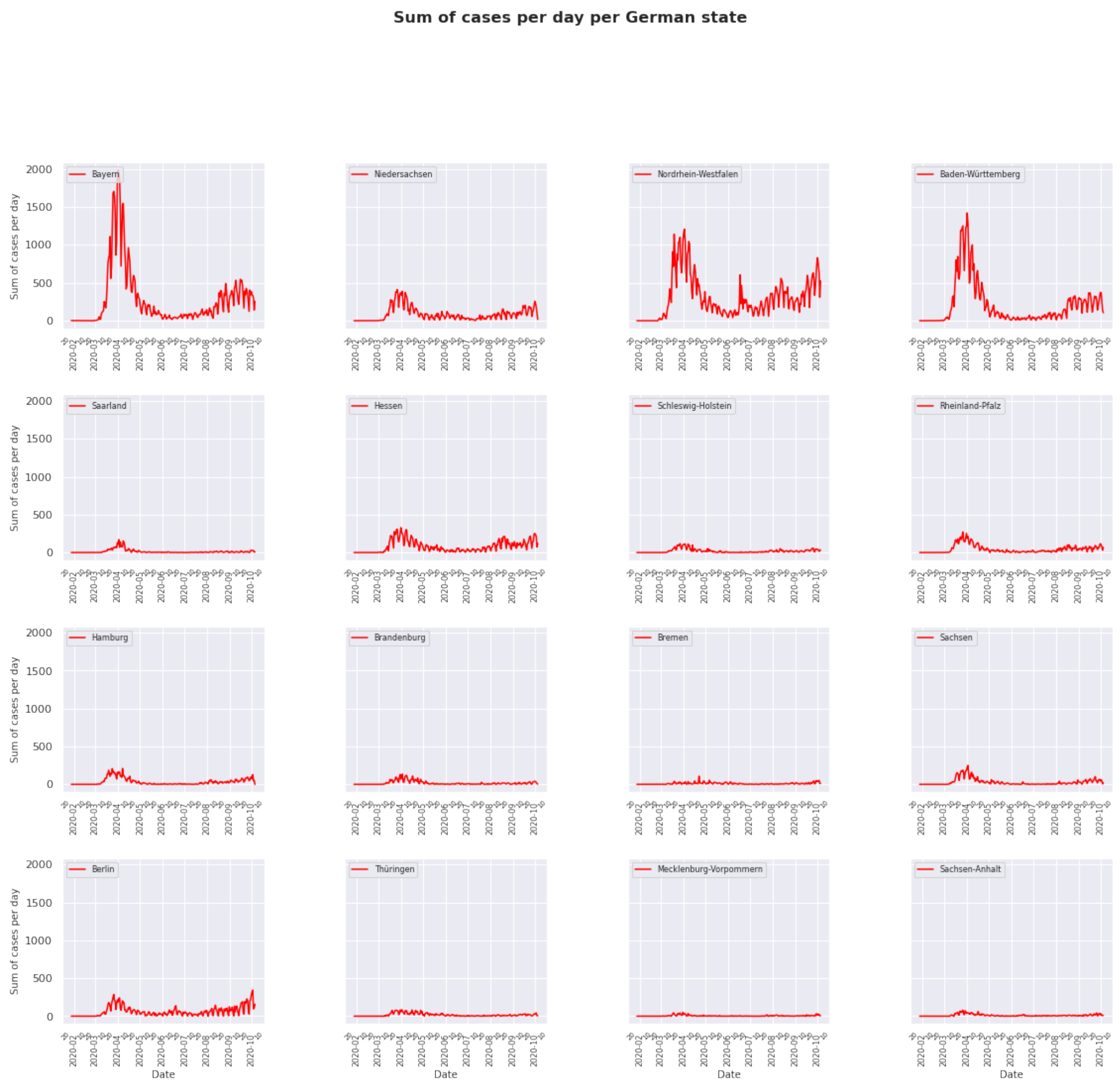
[10]:
```
Bundesland  Baden-Württemberg  Bayern  Berlin  Brandenburg  Bremen  Hamburg  \
count                   235.0   235.0   235.0        235.0   235.0    235.0
mean                    218.0   298.0    68.0         19.0    11.0     35.0
std                     287.0   398.0    66.0         26.0    13.0     45.0
min                       0.0     0.0     0.0          0.0     0.0      0.0
25%                      36.0    60.0    22.0          3.0     3.0      3.0
50%                     101.0   137.0    50.0          8.0     8.0     17.0
75%                     288.0   371.0    88.0         22.0    15.0     48.0
max                    1421.0  1985.0   343.0        136.0   108.0    210.0

Bundesland  Hessen  Mecklenburg-Vorpommern  Niedersachsen  \
count        235.0                   235.0          235.0
mean          86.0                     6.0           91.0
std           76.0                     8.0           89.0
min            0.0                     0.0            0.0
25%           27.0                     0.0           28.0
50%           64.0                     2.0           67.0
75%          128.0                     6.0          114.0
max          329.0                    50.0          410.0

Bundesland  Nordrhein-Westfalen  Rheinland-Pfalz  Saarland  Sachsen  \
count                     235.0            235.0     235.0    235.0
mean                      314.0             48.0      15.0     32.0
std                       265.0             53.0      27.0     46.0
min                         0.0              0.0       0.0      0.0
25%                       128.0             11.0       1.0      3.0
50%                       231.0             29.0       5.0     14.0
75%                       424.0             62.0      14.0     43.0
max                      1207.0            271.0     171.0    250.0

Bundesland  Sachsen-Anhalt  Schleswig-Holstein  Thüringen
count                235.0               235.0      235.0
mean                  12.0                21.0       18.0
std                   15.0                26.0       20.0
min                    0.0                 0.0        0.0
25%                    2.0                 3.0        3.0
50%                    7.0                14.0       10.0
75%                   14.0                28.0       25.0
max                   78.0               117.0       85.0
```

[11]:
```
# Get daily cases and growth rate per German state

loc_unknown_col = "-nicht erhoben-"
state_names = df_daily_data['Bundesland'].unique()
# remove column name for unknown location of the case
```

```
index = np.where(state_names == loc_unknown_col)
state_names = np.delete(state_names, index)

states_daily = df_daily_data.groupby(['Meldedatum',␣
↪'Bundesland'])['AnzahlFall'].sum()
df_per_state_daily = pd.DataFrame()
for state in state_names:
    df_per_state_daily[state] = states_daily.unstack()[state].fillna(0)
```

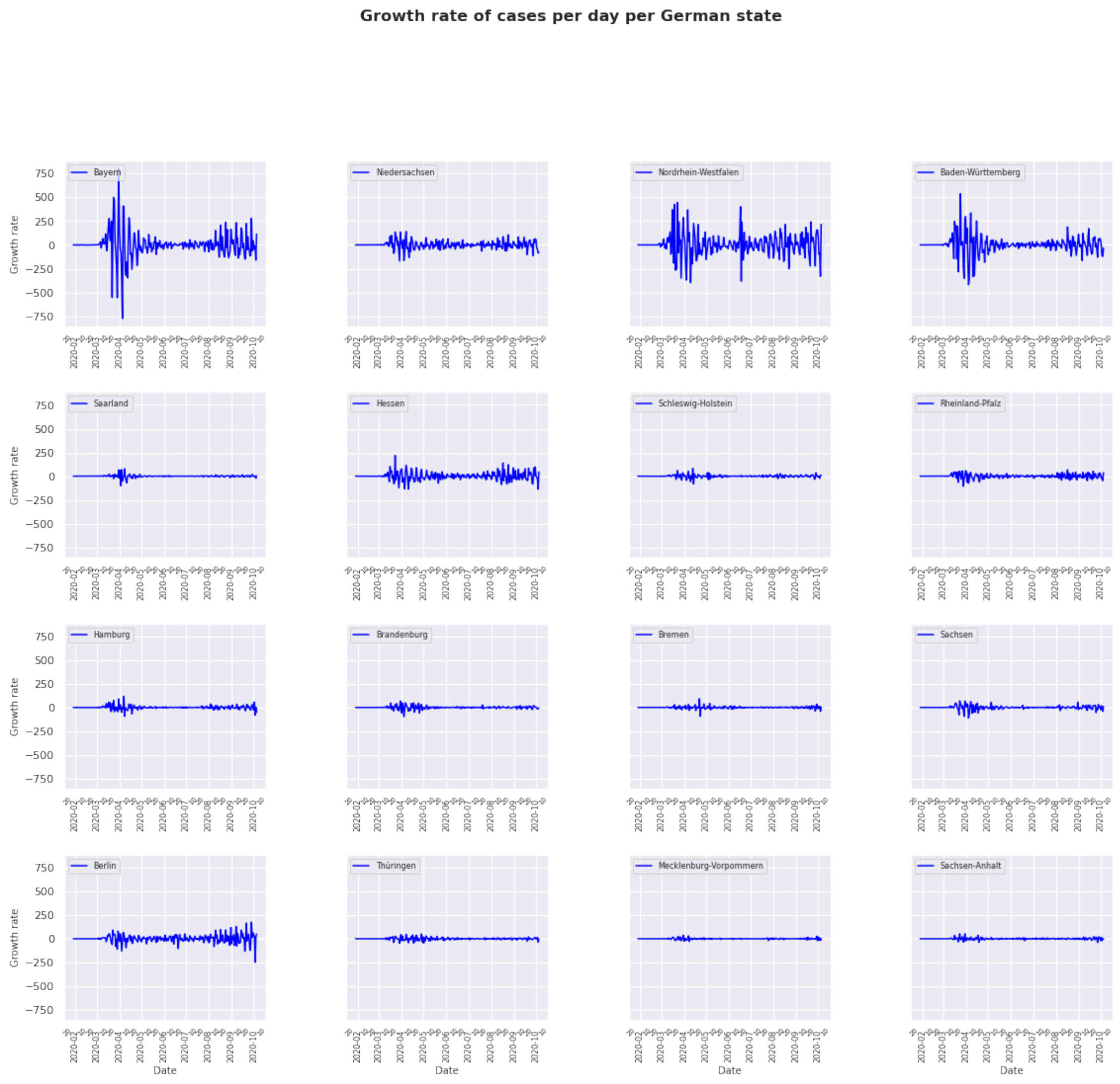
[12]:
```
# TODO: make these relative to screen size somehow
figsize = (19,16)
ax_label_fontsize = 10.0
legend_fontsize = 8.0
major_tick_fontsize = 8.0
minor_tick_fontsize = 7.0
tick_monthdays = (10, 20)
```

[13]:
```
# Plot sum of confirmed cases per day per German state

fig, ax = plt.subplots(4, 4, sharey=True, figsize=figsize)
fig.subplots_adjust(hspace = 0.4, wspace = 0.4)

fig.suptitle("Sum of cases per day per German state", **suptitel_attr)

for axis in ax.flat:
    rule = mpl.dates.rrulewrapper(mpl.dates.MONTHLY,  bymonthday=tick_monthdays)
    axis.xaxis.set_minor_locator(mpl.dates.RRuleLocator(rule))
    axis.xaxis.set_minor_formatter(mpl.dates.DateFormatter("%d"))
    axis.xaxis.set_major_locator(mpl.dates.MonthLocator(bymonthday=1))
    axis.xaxis.set_major_formatter(mpl.dates.DateFormatter('%Y-%m'))

    for tick in axis.xaxis.get_major_ticks():
            tick.label.set_fontsize(tick_fontsize)

for plt_row in ax:
    plt_row[0].set_ylabel('Sum of cases per day', fontsize=ax_label_fontsize)

for column_plots in ax.T:
    column_plots[-1].set_xlabel('Date', fontsize=ax_label_fontsize)

ix = 0
for subp in ax.flat:
    state = state_names[ix]
    subp.plot(df_per_state_daily[state], color='red', label = "{}".
↪format(state))
    subp.legend(fontsize=legend_fontsize, loc="upper left")
    plt.setp(subp.xaxis.get_majorticklabels(), rotation=90)
    plt.setp(subp.xaxis.get_minorticklabels(), rotation=45)
    for tick in subp.xaxis.get_major_ticks():
            tick.label.set_fontsize(major_tick_fontsize)
    for tick in subp.xaxis.get_minor_ticks():
            tick.label.set_fontsize(minor_tick_fontsize)
    ix += 1
```



[14]:
```
# Plot growth rate of daily confirmed cases per German state

fig, ax = plt.subplots(4, 4, sharey=True, figsize=figsize)
fig.subplots_adjust(hspace = 0.4, wspace = 0.4)

fig.suptitle("Growth rate of cases per day per German state", **suptitel_attr)
```

```python
for axis in ax.flat:
    rule = mpl.dates.rrulewrapper(mpl.dates.MONTHLY,  bymonthday=tick_monthdays)
    axis.xaxis.set_minor_locator(mpl.dates.RRuleLocator(rule))
    axis.xaxis.set_minor_formatter(mpl.dates.DateFormatter("%d"))
    axis.xaxis.set_major_locator(mpl.dates.MonthLocator(bymonthday=1))
    axis.xaxis.set_major_formatter(mpl.dates.DateFormatter('%Y-%m'))

    for tick in axis.xaxis.get_major_ticks():
            tick.label.set_fontsize(tick_fontsize)

for plt_row in ax:
    plt_row[0].set_ylabel('Growth rate', fontsize=ax_label_fontsize)

for column_plots in ax.T:
    column_plots[-1].set_xlabel('Date', fontsize=ax_label_fontsize)

ix = 0
for subp in ax.flat:
    state = state_names[ix]
    subp.plot(df_per_state_daily[state].diff(), color='blue', label = "{}".
 ↪format(state))
    subp.legend(fontsize=legend_fontsize, loc="upper left")
    plt.setp(subp.xaxis.get_majorticklabels(), rotation=90)
    plt.setp(subp.xaxis.get_minorticklabels(), rotation=45)
    for tick in subp.xaxis.get_major_ticks():
            tick.label.set_fontsize(major_tick_fontsize)
    for tick in subp.xaxis.get_minor_ticks():
            tick.label.set_fontsize(minor_tick_fontsize)
    ix += 1
```



0.1 Test reports: Visualize number of tests positive / negative results

0.1.1 Download reports

[15]:
```python
def download_pdf(link, fname, dl_dir = "test_reports/"):
    urllib.request.urlretrieve(link, dl_dir + fname)

link_reports = "https://ars.rki.de/Content/COVID19/Main.aspx"
```