Kernel: python3

Stage 2 - Johannes Kaendler

First, we define some constants. We want to look at July-December, but beacuse we wnat to look at the difference, we start at the last Sunday in June 2020. The Array of states are my choice for the comparisson. The Factor will be used for the normalisation.

In [1]:
```
FIRST_DATE = '2020-06-28'
LAST_DATE = '2020-12-27'
STATES = ['NC', 'AL', 'FL', 'CA', 'TX', 'SC']
FACTOR = 10000 # for normalisation
PICTURE_HEIGHT = 400
PICTURE_WIDTH = 600
```

Next, we import the data and normalize it.

In [2]:
```
import pandas as pd
import numpy as np
import plotly.graph_objects as go
import os

if not os.path.exists("images"):
    os.mkdir("images")

raw_cases = pd.read_csv("../Team/covid_confirmed_usafacts.csv")
raw_deaths = pd.read_csv("../Team/covid_deaths_usafacts.csv")
county_population =
pd.read_csv("../Team/covid_county_population_usafacts.csv")
```

In [3]:
```
raw_cases = raw_cases.merge(county_population[['countyFIPS','population']],
on='countyFIPS')
cases = raw_cases.drop(raw_cases[raw_cases.population == 0].index)
for col in cases.columns:
    if FIRST_DATE <= col <= LAST_DATE:
        cases[col] = cases[col] / cases['population'] * FACTOR

raw_deaths = raw_deaths.merge(county_population[['countyFIPS','population']],
on='countyFIPS')
deaths = raw_deaths.drop(raw_cases[raw_deaths.population == 0].index)
for col in deaths.columns:
    if FIRST_DATE <= col <= LAST_DATE:
        deaths[col] = deaths[col] / deaths['population'] * FACTOR
```

Now we select only the Sundays in our desired range

In [4]:
```
selected_date_columns = [col for col in cases.columns if FIRST_DATE <= col <=
LAST_DATE]
additional_columns = ["countyFIPS", "County Name", "State", "StateFIPS"]
selected_columns = additional_columns + selected_date_columns[0::7]
selected_cases = cases[selected_columns]
selected_deaths = deaths[selected_columns]

selected_cases.head()
```

Out[4]:

	countyFIPS	County Name	State	StateFIPS	2020-06-28	2020-07-05	2020-07-12	2020-07-19
2601	1001	Autauga County	AL	1	90.032039	110.078935	126.367037	150.709696
2602	1003	Baldwin County	AL	1	25.757725	39.465314	57.966080	86.769936
2603	1005	Barbour County	AL	1	128.412866	142.590942	163.250425	200.518513
2604	1007	Bibb County	AL	1	72.340806	86.183799	101.812986	120.121461
2605	1009	Blount County	AL	1	32.684260	41.330889	57.240688	83.353509

5 rows × 31 columns

Now we focus on North Carolina. For a better analysis, we want to look at the change in the numbers, not the absolut numbers

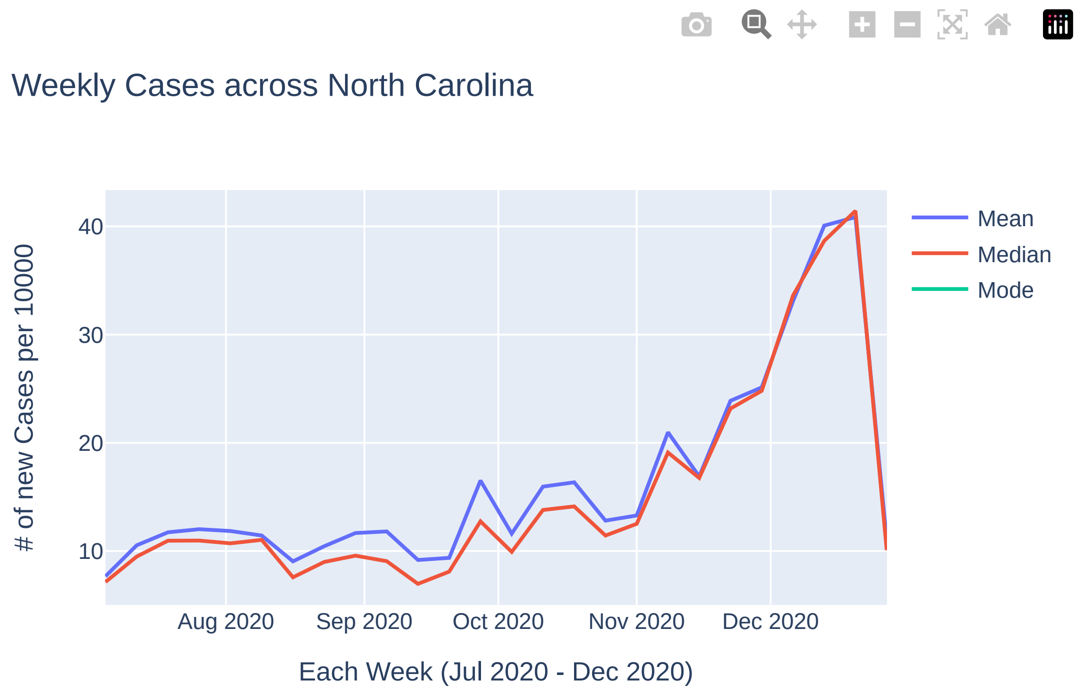
In [5]:

```
nc_cases = selected_cases.loc[selected_cases['State'] == 'NC']
nc_deaths = selected_deaths.loc[selected_deaths['State'] == 'NC']
```

In [6]:

```
nc_diff_cases =
nc_cases[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE, axis=1)
mean = nc_diff_cases.mean()
median = nc_diff_cases.median()
mode = nc_diff_cases.mode()

fig = go.Figure()

fig.add_trace(go.Scatter(x=mean.index, y=mean,
                         mode='lines', name='Mean'))

fig.add_trace(go.Scatter(x=mean.index, y=median,
                         mode='lines', name='Median'))

fig.add_trace(go.Scatter(x=mean.index, y=mode.T,
                         mode='lines', name='Mode'))

fig.update_layout(
    title='Weekly Cases across North Carolina',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Cases per {FACTOR}'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)

fig.write_image("images/weekly_case_nc.png")

fig.show()
```

Out[6]:

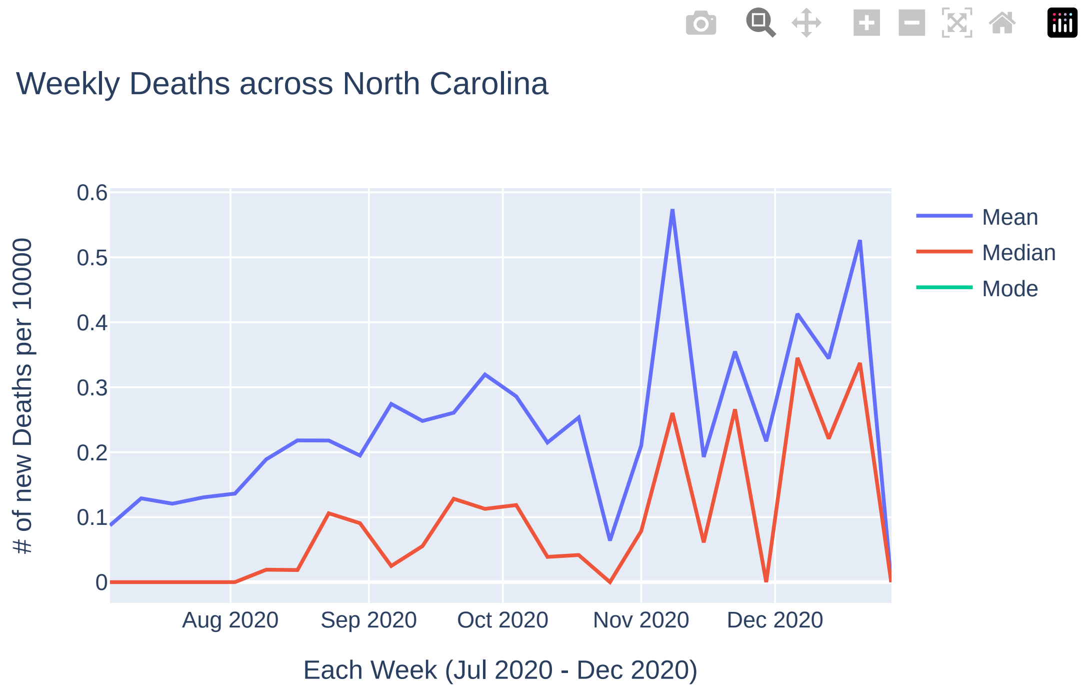


In [7]:

```
nc_diff_deaths =
nc_deaths[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE, axis=1)
mean = nc_diff_deaths.mean()
median = nc_diff_deaths.median()
mode = nc_diff_deaths.mode()

fig = go.Figure()

fig.add_trace(go.Scatter(x=mean.index, y=mean,
                         mode='lines', name='Mean'))

fig.add_trace(go.Scatter(x=mean.index, y=median,
                         mode='lines', name='Median'))

fig.add_trace(go.Scatter(x=mean.index, y=mode.T,
                         mode='lines', name='Mode'))

fig.update_layout(
    title='Weekly Deaths across North Carolina',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Deaths per {FACTOR}'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)
```

```
fig.write_image("images/weekly_death_nc.png")

fig.show()
```

Out[7]:



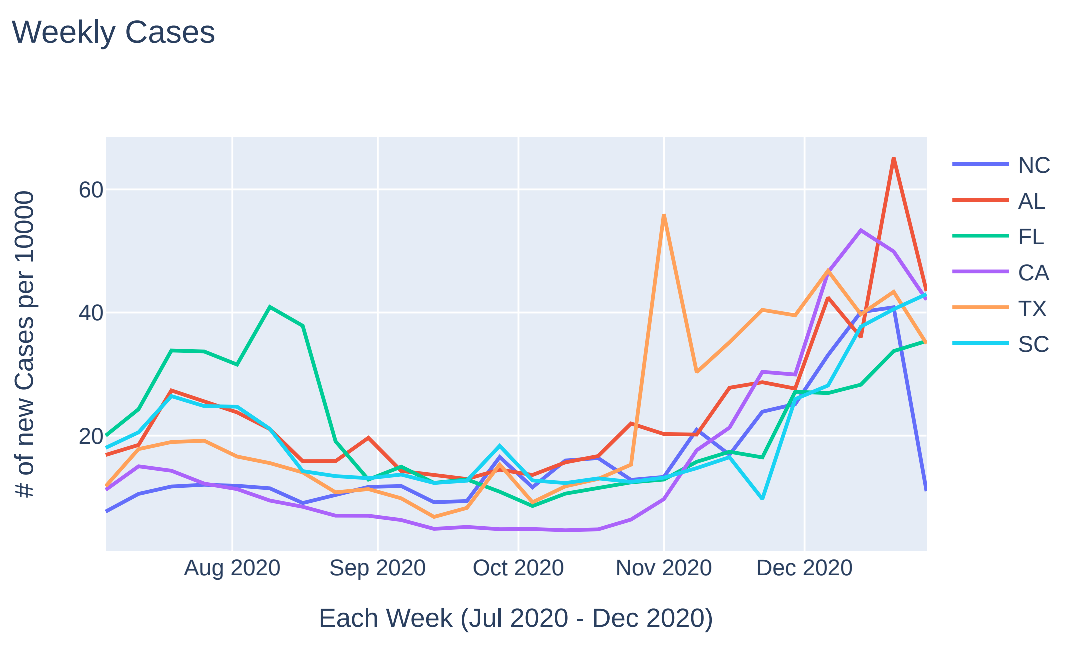
We can see, that the mode statistic is not very useful in this case, so we will be ignoring it from now. Next, we define functions that give us the mean of cases and deaths for a given state and use it, to compare the states.

In [8]:

```
def analyzeStateCases(state):
    state_cases = selected_cases.loc[selected_cases['State'] == state]
    diff_cases =
state_cases[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE,
axis=1)
    return diff_cases.mean()

def analyzeStateDeaths(state):
    state_deaths = selected_deaths.loc[selected_deaths['State'] == state]
    diff_cases =
state_cases[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE,
axis=1)
    return diff_cases.mean()


fig = go.Figure()
```

```
for state in STATES:
    temp = analyzeStateCases(state)
    fig.add_trace(go.Scatter(x=temp.index, y=temp,
                         mode='lines', name=state))



fig.update_layout(
    title='Weekly Cases',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Cases per {FACTOR}'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)
fig.write_image("images/weekly_case_states.png")

fig.show()
```

Out[8]:

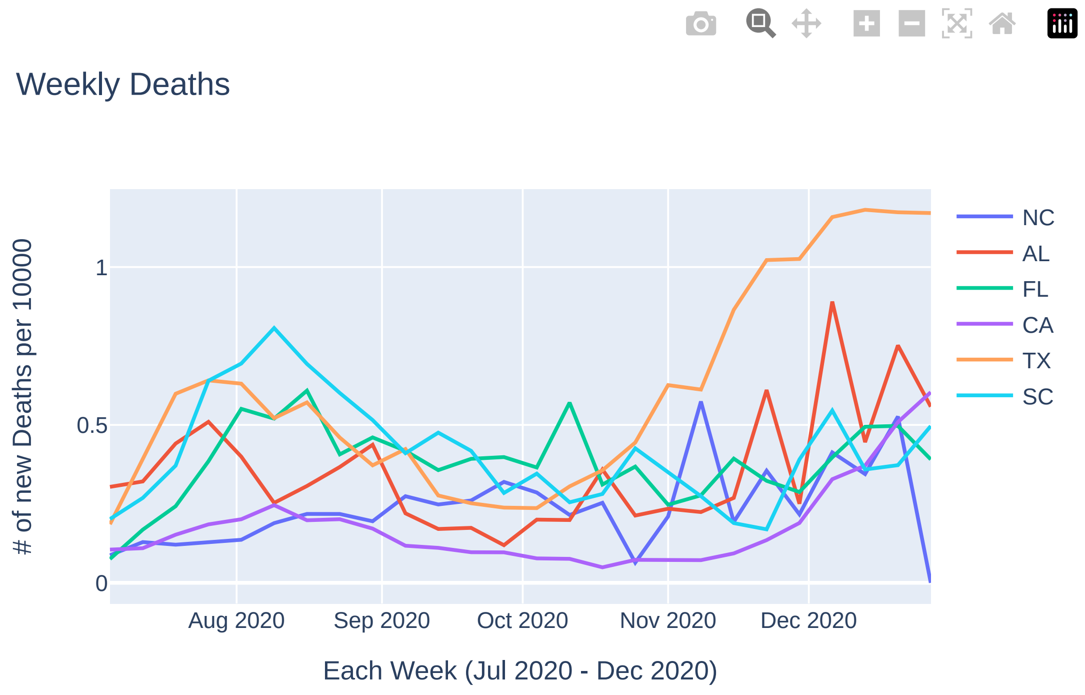


In [9]:

```
def analyzeStateDeaths(state):
    state_deaths = selected_deaths.loc[selected_deaths['State'] == state]
    diff_cases =
state_deaths[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE,
axis=1)
    return diff_cases.mean()
```

```
fig = go.Figure()

for state in STATES:
    temp = analyzeStateDeaths(state)
    fig.add_trace(go.Scatter(x=temp.index, y=temp,
                              mode='lines', name=state))



fig.update_layout(
    title='Weekly Deaths',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Deaths per {FACTOR}'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)

fig.write_image("images/weekly_death_state.png")

fig.show()
```

Out[9]:



The rates differ, since even though the pandemic was a global event, the actual spread is a local event. So certain states were introduced to the virus later than others. So we would expect that lines are slightly shifted horizontally. The states have also very different demographics and infrastructure, which will lead to different rates. However, the general trend is similar to the US trend we have seen in the team report. To find out the five counties with the strongest spread, we sort them by the max of all normalized new cases.

In [10]:
```
nc_diff_cases['max'] = nc_diff_cases[[col for col in nc_diff_cases.columns if
FIRST_DATE <= col <= LAST_DATE]].max(axis=1)
nc_diff_cases.sort_values(['max']).join(cases[additional_columns]).head()
```

Out[10]:

	2020-07-05	2020-07-12	2020-07-19	2020-07-26	2020-08-02	2020-08-09	2020-08-16	2020-08-23	2
4509	7.251242	8.325500	7.251242	9.265476	7.922653	8.862629	7.116960	9.265476	7.
4505	6.441520	3.680869	9.202172	6.441520	10.122389	8.281955	3.680869	8.281955	11
4518	7.835932	10.808182	7.565727	9.457159	6.484909	2.702045	0.810614	4.863682	3.
4500	11.693040	9.452458	11.132895	7.842039	9.522476	4.271110	4.271110	3.010783	2.
4512	1.780785	1.780785	16.027068	18.698246	5.342356	6.232749	9.794319	5.342356	5.

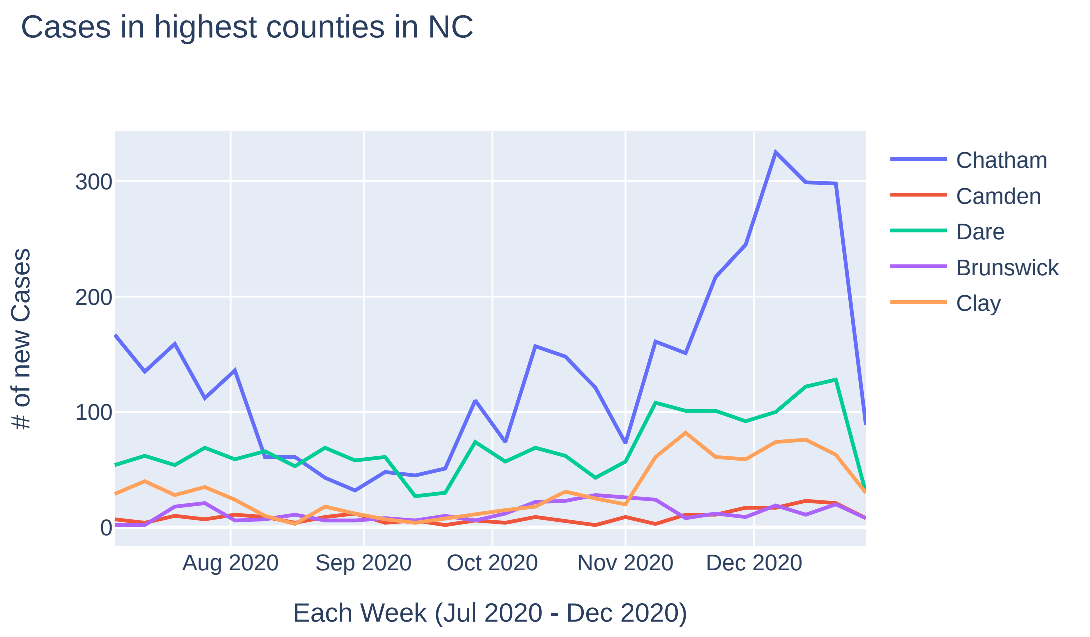
5 rows × 31 columns

Now that we have identified the five counties, we can plot the weekly trends.

In [11]:
```
high_counties = [37037, 37029, 37055, 37019, 37043]

selected_county_cases =
raw_cases[selected_columns].loc[raw_cases['countyFIPS'].isin(high_counties)]
selected_county_cases =
selected_county_cases[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE,
axis=1)




fig = go.Figure()


fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=selected_county_cases.iloc[0], mode='lines', name="Chatham"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=selected_county_cases.iloc[1], mode='lines', name="Camden"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=selected_county_cases.iloc[2], mode='lines', name="Dare"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=selected_county_cases.iloc[3], mode='lines', name="Brunswick"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=selected_county_cases.iloc[4], mode='lines', name="Clay"))



fig.update_layout(
    title='Cases in highest counties in NC',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Cases'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)
```

```
fig.write_image("images/weekly_case_counties.png")

fig.show()
```

Out[11]:

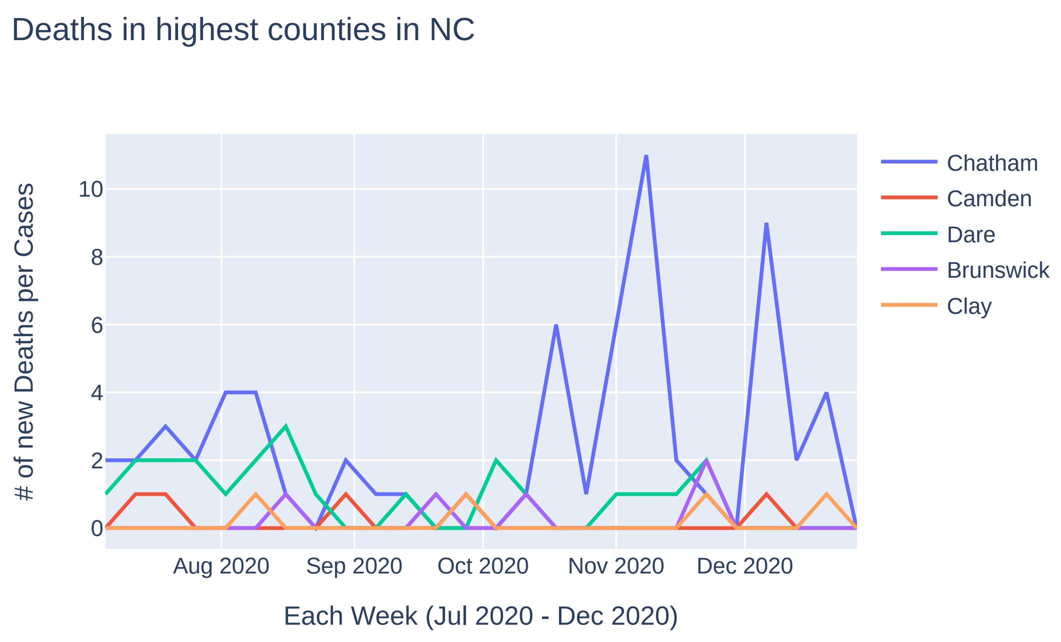


In [12]:

```
selected_county_deaths =
raw_deaths[selected_columns].loc[raw_deaths['countyFIPS'].isin(high_counties)]
selected_county_deaths =
selected_county_deaths[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE,
axis=1)




fig = go.Figure()


fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=selected_county_deaths.iloc[0], mode='lines', name="Chatham"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=selected_county_deaths.iloc[1], mode='lines', name="Camden"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=selected_county_deaths.iloc[2], mode='lines', name="Dare"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=selected_county_deaths.iloc[3], mode='lines', name="Brunswick"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=selected_county_deaths.iloc[4], mode='lines', name="Clay"))
```

```
fig.update_layout(
    title='Deaths in highest counties in NC',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Deaths per Cases'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)

fig.write_image("images/weekly_deaths_counties.png")

fig.show()
```

Out[12]:

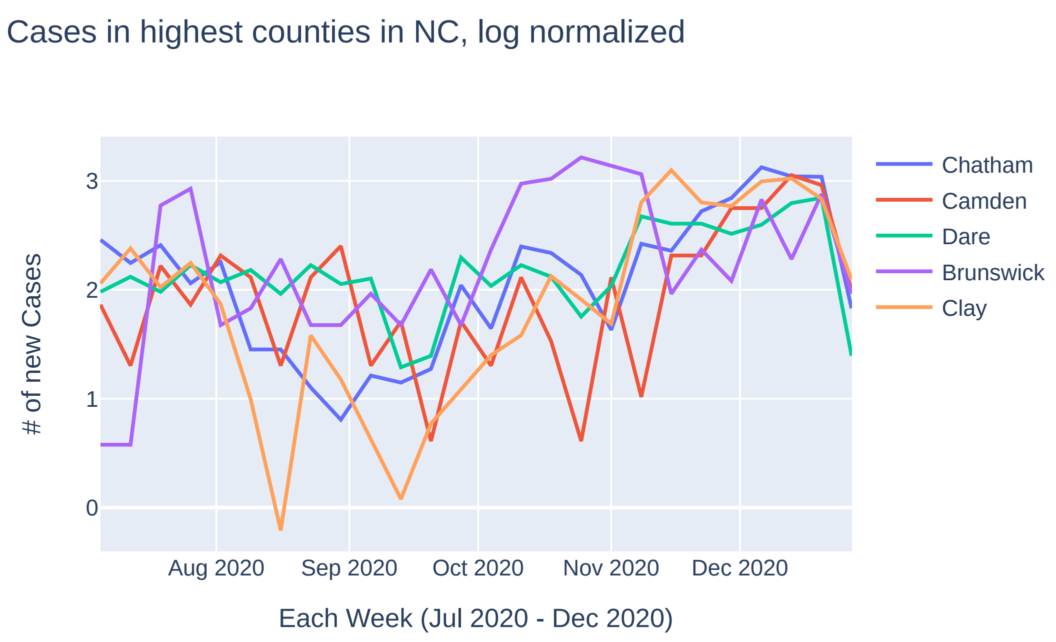


In [13]:

```
selected_county_cases =
cases[selected_columns].loc[cases['countyFIPS'].isin(high_counties)]
selected_county_cases =
selected_county_cases[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE,
axis=1)



fig = go.Figure()
```

```
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=np.log(selected_county_cases.iloc[0]), mode='lines', name="Chatham"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=np.log(selected_county_cases.iloc[1]), mode='lines', name="Camden"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=np.log(selected_county_cases.iloc[2]), mode='lines', name="Dare"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=np.log(selected_county_cases.iloc[3]), mode='lines', name="Brunswick"))
fig.add_trace(go.Scatter(x=selected_county_cases.columns,
y=np.log(selected_county_cases.iloc[4]), mode='lines', name="Clay"))



fig.update_layout(
    title='Cases in highest counties in NC, log normalized',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Cases'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)

fig.write_image("images/weekly_cases_counties_log.png")

fig.show()
```

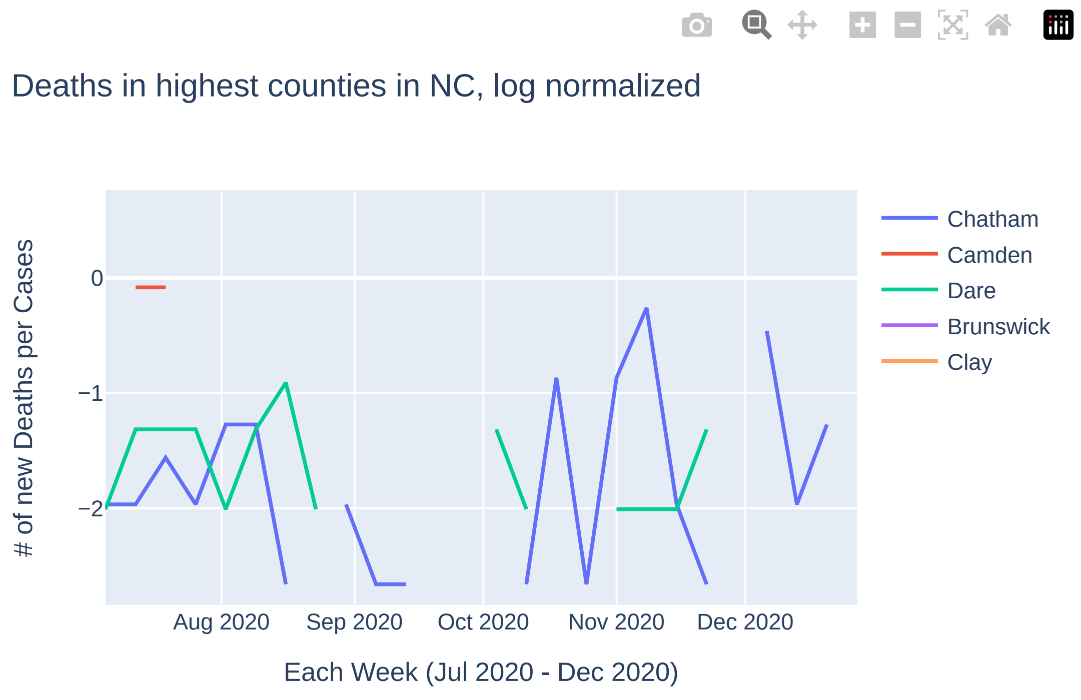
```
Out[13]:
```



In [14]:

```
selected_county_deaths =
deaths[selected_columns].loc[deaths['countyFIPS'].isin(high_counties)]
selected_county_deaths =
selected_county_deaths[selected_date_columns[0::7]].diff(axis=1).drop(FIRST_DATE,
axis=1)




fig = go.Figure()


fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=np.log(selected_county_deaths.iloc[0]), mode='lines', name="Chatham"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=np.log(selected_county_deaths.iloc[1]), mode='lines', name="Camden"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=np.log(selected_county_deaths.iloc[2]), mode='lines', name="Dare"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=np.log(selected_county_deaths.iloc[3]), mode='lines', name="Brunswick"))
fig.add_trace(go.Scatter(x=selected_county_deaths.columns,
y=np.log(selected_county_deaths.iloc[4]), mode='lines', name="Clay"))



fig.update_layout(
    title='Deaths in highest counties in NC, log normalized',
    xaxis=dict(title='Each Week (Jul 2020 - Dec 2020)'),
    yaxis=dict(title=f'# of new Deaths per Cases'),
    showlegend=True,
    width=PICTURE_WIDTH,
    height=PICTURE_HEIGHT
)

fig.write_image("images/weekly_deaths_counties_log.png")

fig.show()
```

Out[14]:
```
/usr/local/lib/python3.10/dist-packages/pandas/core/arraylike.py:402:
RuntimeWarning:

divide by zero encountered in log
```



Since we sometime have no death in a county, performing a log normalisation doesn't really work.