In [1]:
```
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [2]:
```
df = catalog.load("MICRODADOS_ENEM")
```

```
[01/14/23 18:27:39] INFO     Loading data from 'MICRODADOS_ENEM' (ParquetDa
```

In [3]:
```
df.head()
```

Out[3]:

	NU_INSCRICAO	NU_ANO	TP_ST_CONCLUSAO	IN_TREINEIRO	CO_MUNICIPIO_ESC	TP_PRESE
0	210053865474	2021	1	0	NaN	
1	210052384164	2021	1	0	NaN	
2	210052589243	2021	1	0	NaN	
3	210052128335	2021	2	0	2304202.0	
4	210051353021	2021	2	0	2311603.0	

In [4]:
```
id_cols = ["NU_INSCRICAO", "NU_ANO"]
```

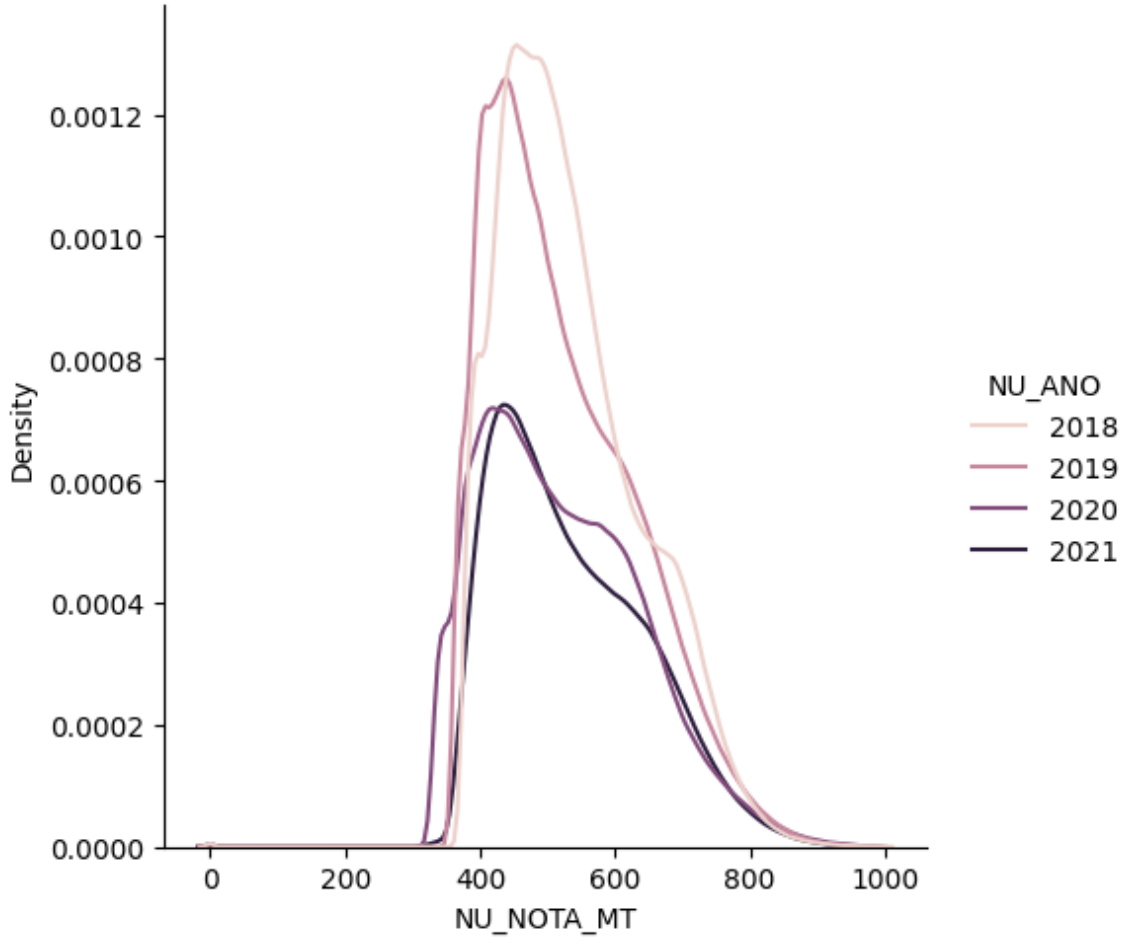
In [5]:
```
flag_cols = ["TP_ST_CONCLUSAO", "IN_TREINEIRO", "CO_MUNICIPIO_ESC", "TP_PRESENCA
```

In [6]:
```
calc_cols = ["NU_NOTA_MT"]
```

In [7]:
```
filtered_df = df.query("TP_PRESENCA_MT == 1")
```

Distribuição populacional

In [8]:
```
sns.displot(data=filtered_df, x="NU_NOTA_MT", kind="kde", hue="NU_ANO");
```

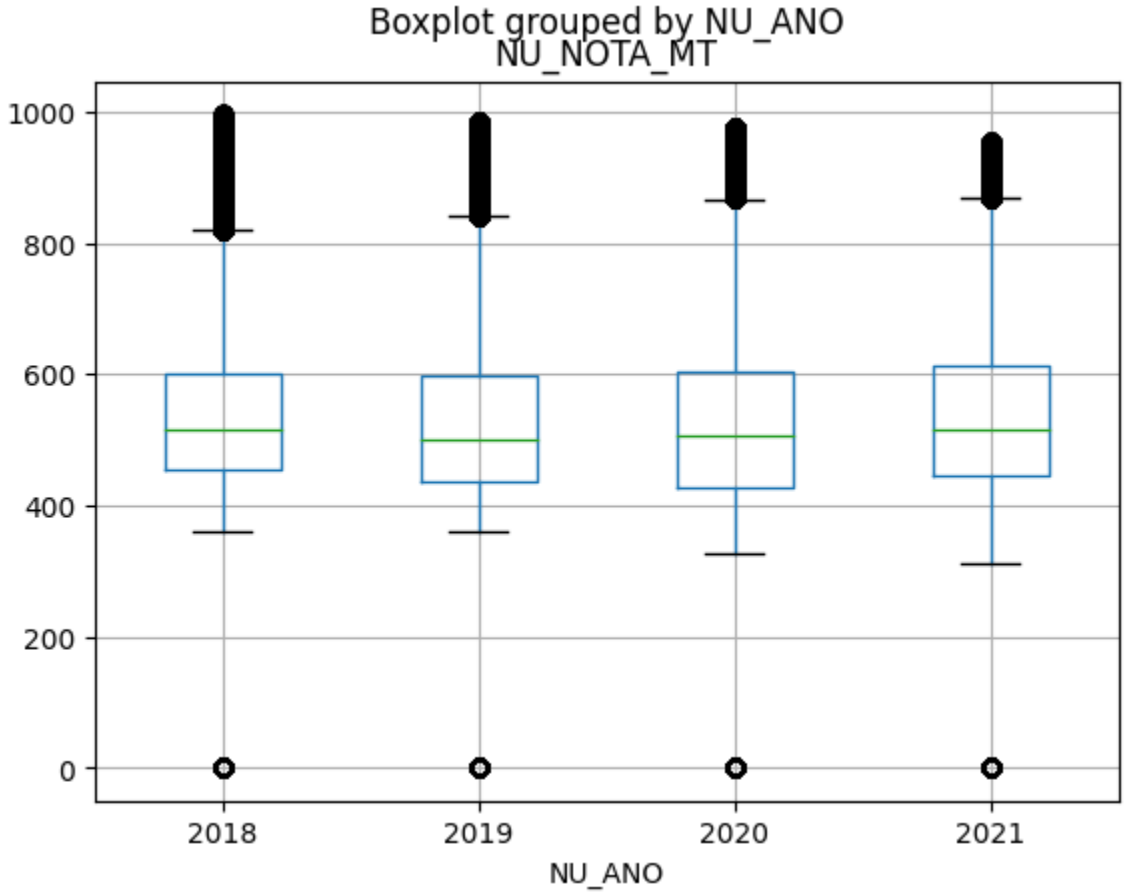


In [9]:
```
filtered_df.groupby("NU_ANO")["NU_NOTA_MT"].describe()
```

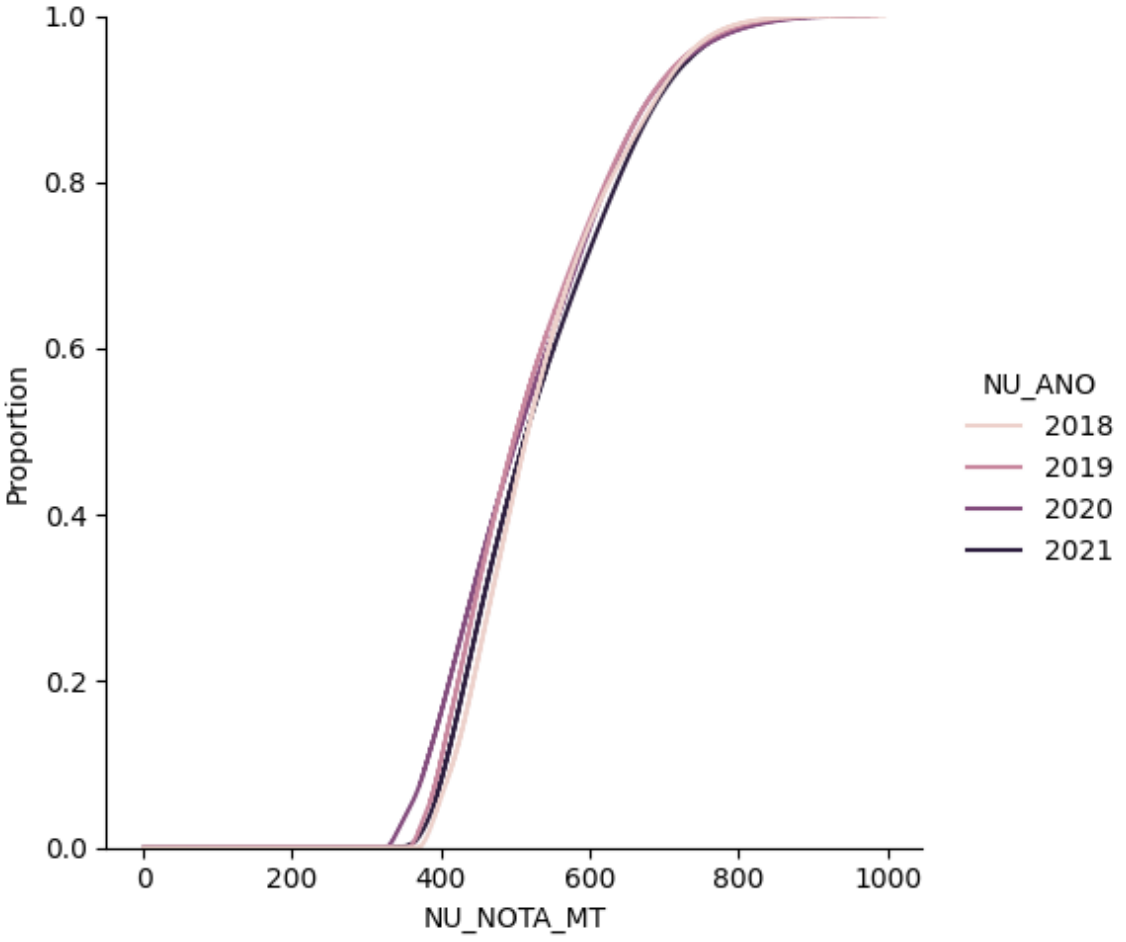
Out[9]:

NU_ANO	count	mean	std	min	25%	50%	75%	max
2018	3905085.0	535.405276	103.150900	0.0	455.3	516.6	600.7	996.1
2019	3710335.0	523.124060	109.062957	0.0	435.1	501.1	597.8	985.5
2020	2597440.0	520.578335	117.305453	0.0	425.8	505.1	602.3	975.0
2021	2245844.0	535.080186	110.626652	0.0	444.7	515.4	613.9	953.1

In [10]:
```
filtered_df.boxplot(column="NU_NOTA_MT", by="NU_ANO")
```



In [11]:
```
sns.displot(data=filtered_df, x="NU_NOTA_MT", kind="ecdf", hue="NU_ANO");
```



Distribuição amostral de 2021 a 2018

In [12]:
```
from scipy.stats import ttest_ind
```

In [13]:
```
sample_2021 = np.random.choice(filtered_df.query("NU_ANO == 2021")["NU_NOTA_MT"]
sample_2020 = np.random.choice(filtered_df.query("NU_ANO == 2020")["NU_NOTA_MT"]
sample_2019 = np.random.choice(filtered_df.query("NU_ANO == 2019")["NU_NOTA_MT"]
sample_2018 = np.random.choice(filtered_df.query("NU_ANO == 2018")["NU_NOTA_MT"]
```

In [14]:
```
mean_sample_2021 = sample_2021.mean(axis=1)
```

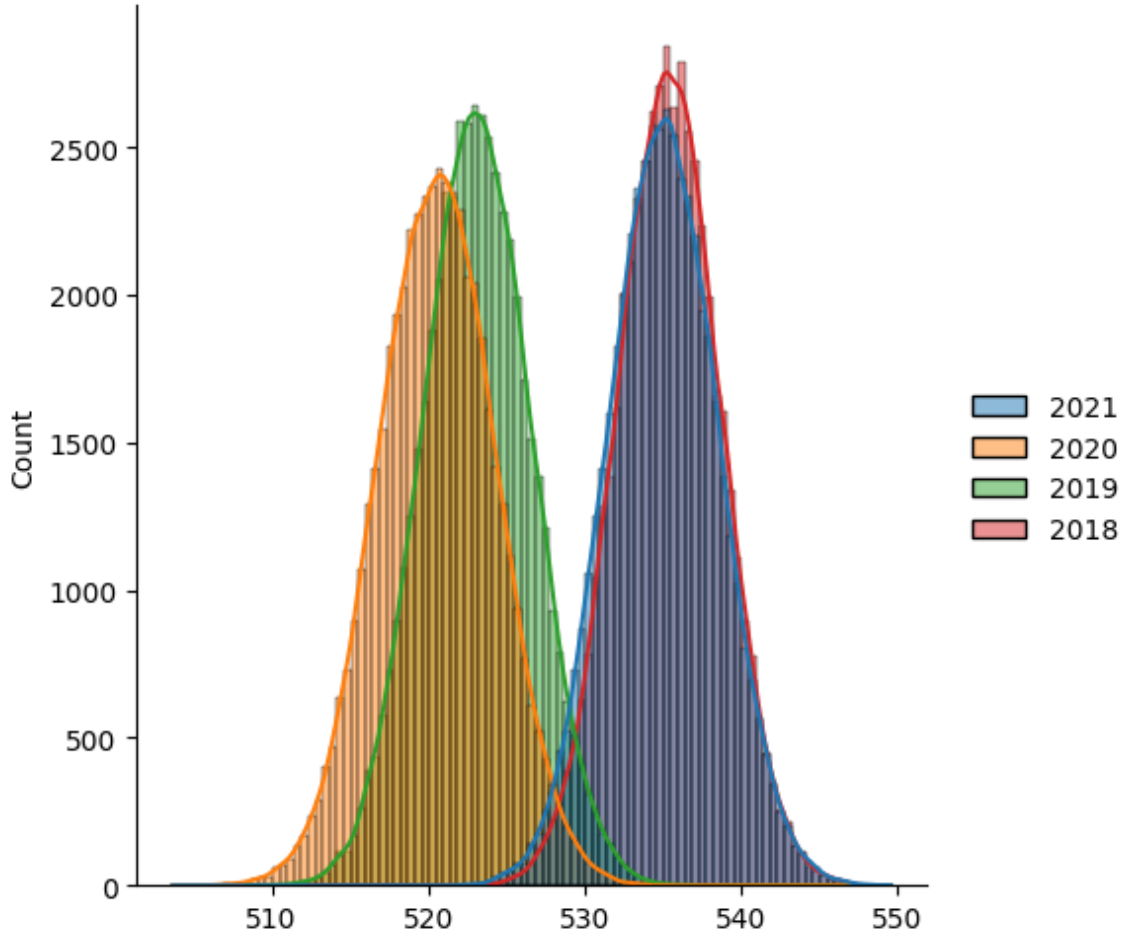
In [15]:
```
mean_sample_2020 = sample_2020.mean(axis=1)
```

In [16]:
```
mean_sample_2019 = sample_2019.mean(axis=1)
```

In [17]:
```
mean_sample_2018 = sample_2018.mean(axis=1)
```

In [18]:
```
mean_samples = pd.DataFrame({
        '2021': mean_sample_2021,
        '2020': mean_sample_2020,
        '2019': mean_sample_2019,
        '2018': mean_sample_2018
})

sns.displot(
    data=mean_samples,
    kde=True
);
```

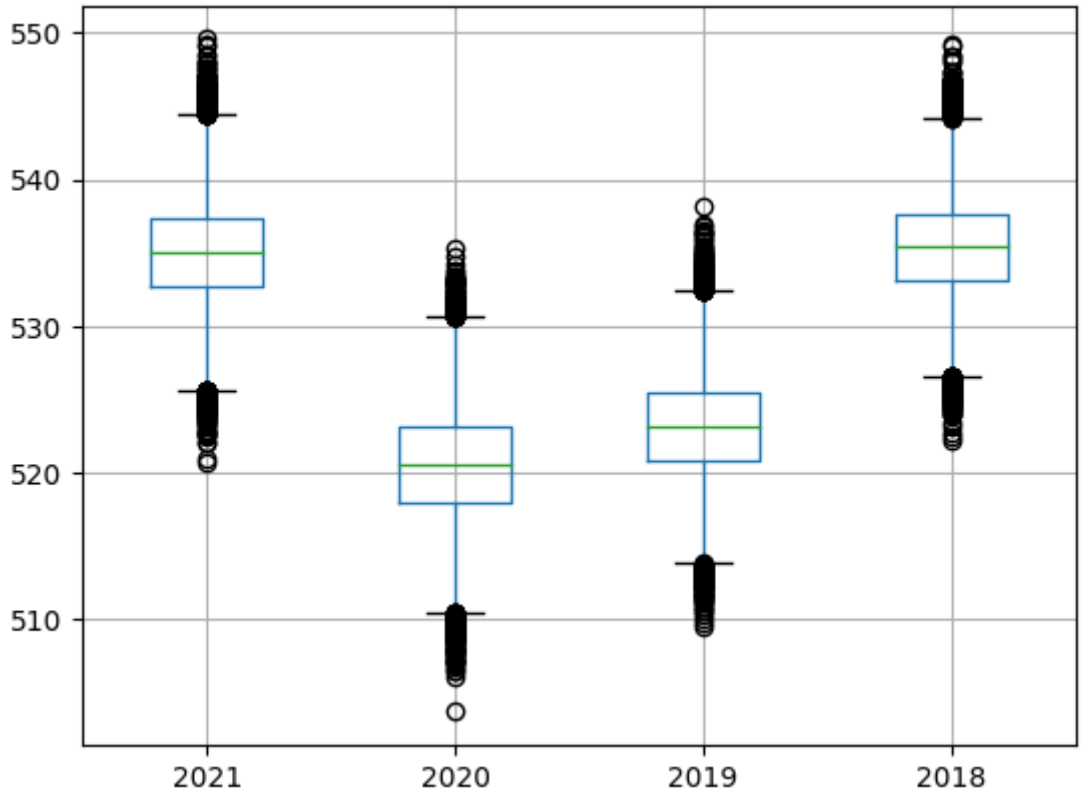


In [19]:
```
mean_samples.describe()
```

Out[19]:

	2021	2020	2019	2018
count	50000.000000	50000.000000	50000.000000	50000.000000
mean	535.041765	520.551910	523.117227	535.408385
std	3.489767	3.714303	3.444114	3.284534
min	520.704000	503.677500	509.472500	522.137300
25%	532.680050	518.015200	520.786825	533.179175
50%	535.030500	520.567850	523.098150	535.392000
75%	537.395575	523.082025	525.437350	537.603050
max	549.585100	535.332200	538.202200	549.249100

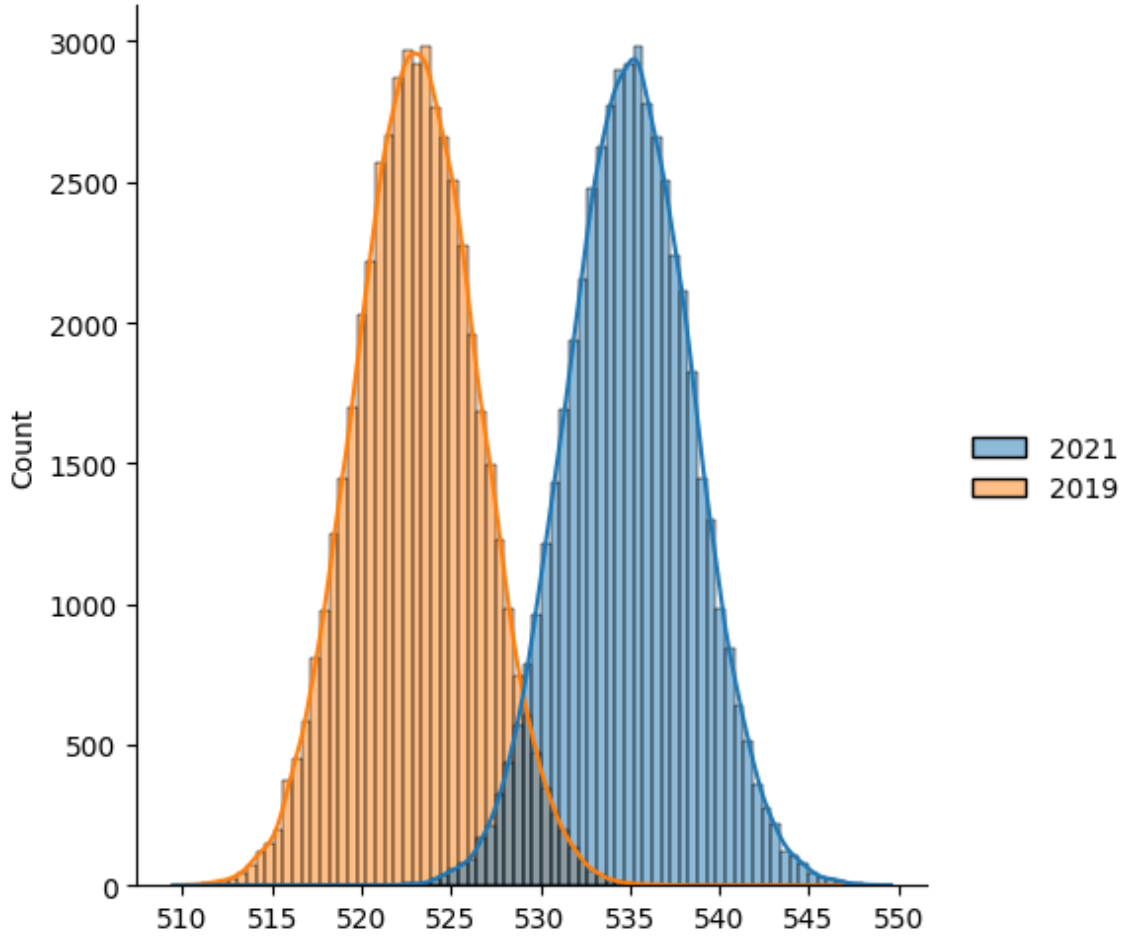
In [20]:
```
mean_samples.boxplot()
```



Testes de hipóteses

2021 vs. 2019

In [21]:
```
sns.displot(
    data=pd.DataFrame({'2021': mean_sample_2021, '2019': mean_sample_2019}),
    kde=True
);
```



In [22]:
```
ttest_ind(mean_sample_2021, mean_sample_2019, equal_var=False, alternative='grea
```

```
Ttest_indResult(statistic=543.8207437152116, pvalue=0.0)
```

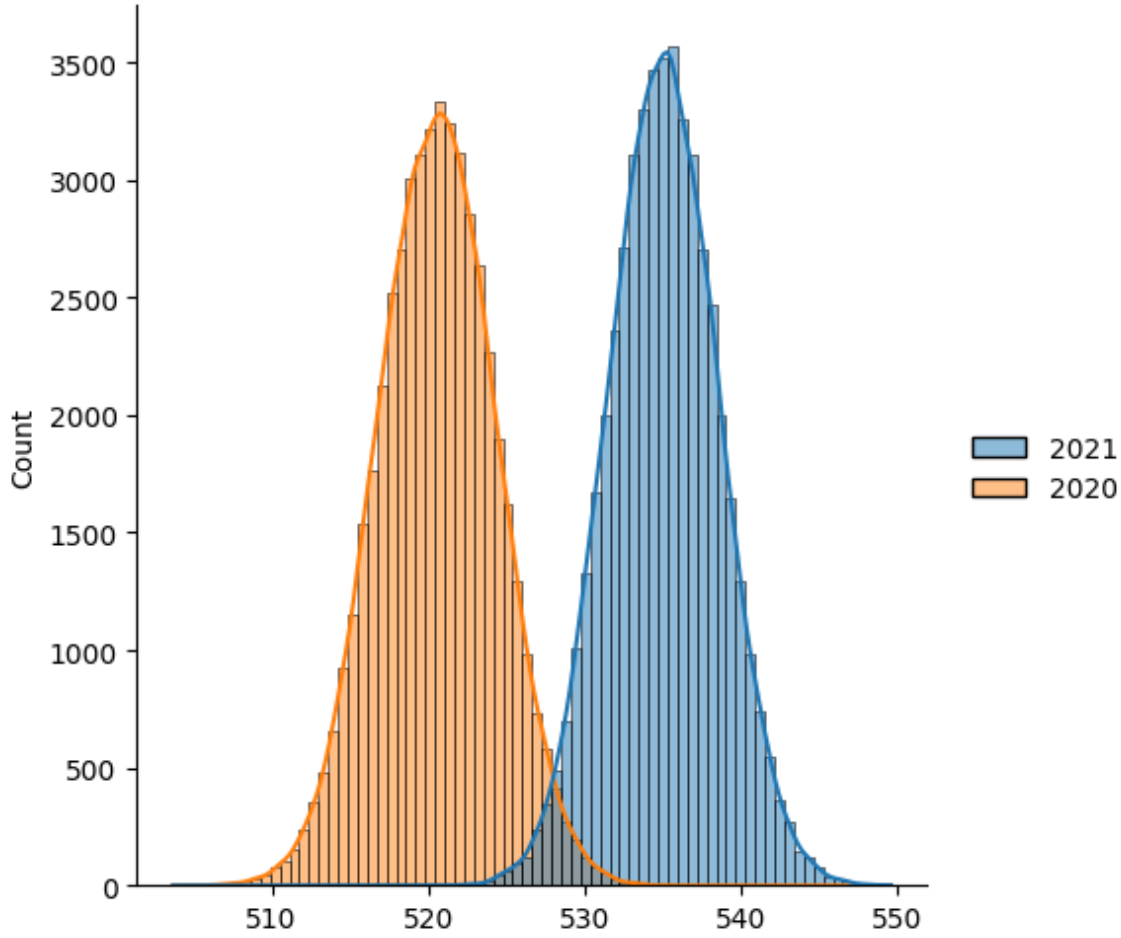
H_0: $\mu_{2021} \leq \mu_{2019}$

H_1: $\mu_{2021} > \mu_{2019}$

$pvalue = 0.0 \leq 0.05$ portanto, rejeita-se H_0

2021 vs. 2020

In [23]:
```
sns.displot(
    data=pd.DataFrame({'2021': mean_sample_2021, '2020': mean_sample_2020}),
    kde=True
);
```



In [24]:
```
ttest_ind(mean_sample_2021, mean_sample_2020, equal_var=False, alternative='grea
```

```
Ttest_indResult(statistic=635.733801986235, pvalue=0.0)
```

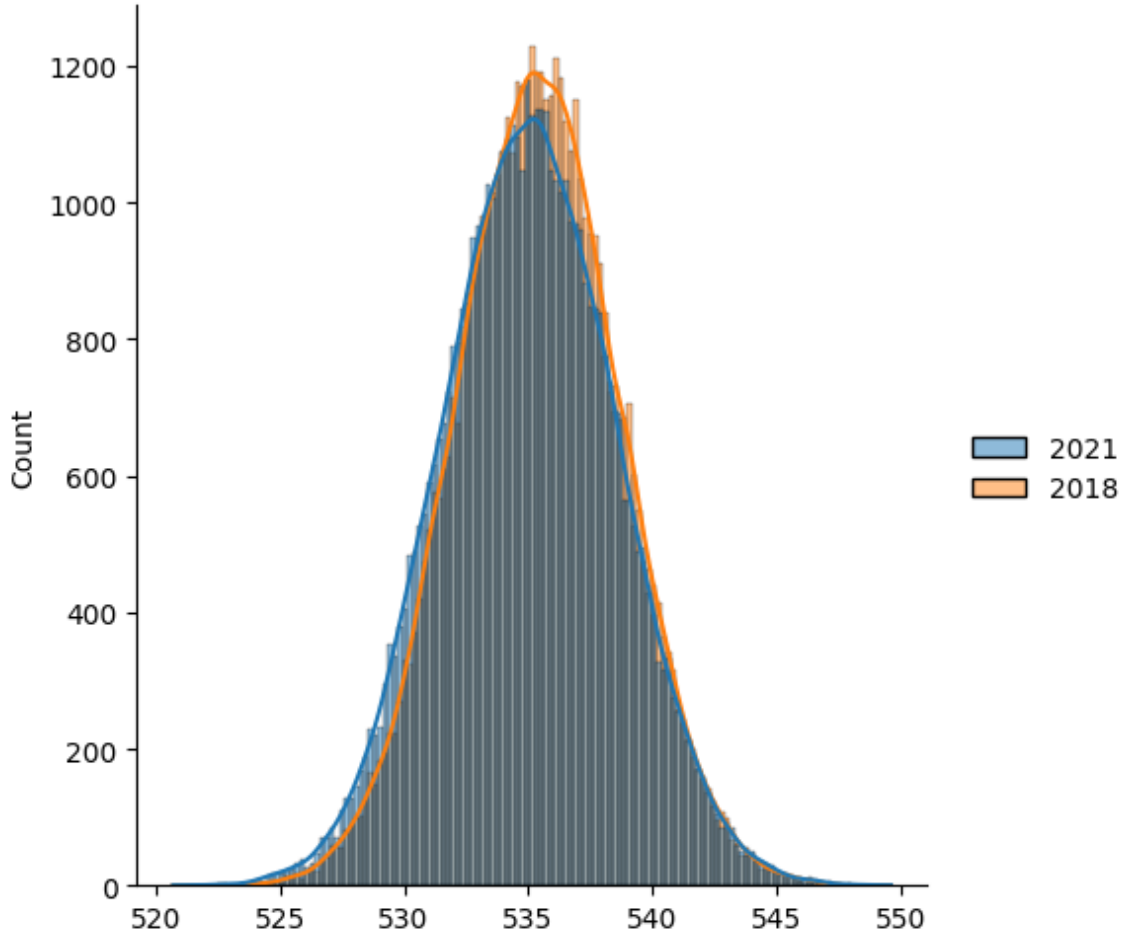
H_0: $\mu_{2021} \leq \mu_{2020}$

H_1: $\mu_{2021} > \mu_{2020}$

$pvalue = 0.0 \leq 0.05$ portanto, rejeita-se H_0

2021 vs. 2018

In [25]:
```
sns.displot(
    data=pd.DataFrame({'2021': mean_sample_2021, '2018': mean_sample_2018}),
    kde=True
);
```



In [26]:
```
ttest_ind(mean_sample_2021, mean_sample_2018, equal_var=False, alternative='grea
```

```
Ttest_indResult(statistic=-17.106181519378392, pvalue=1.0)
```

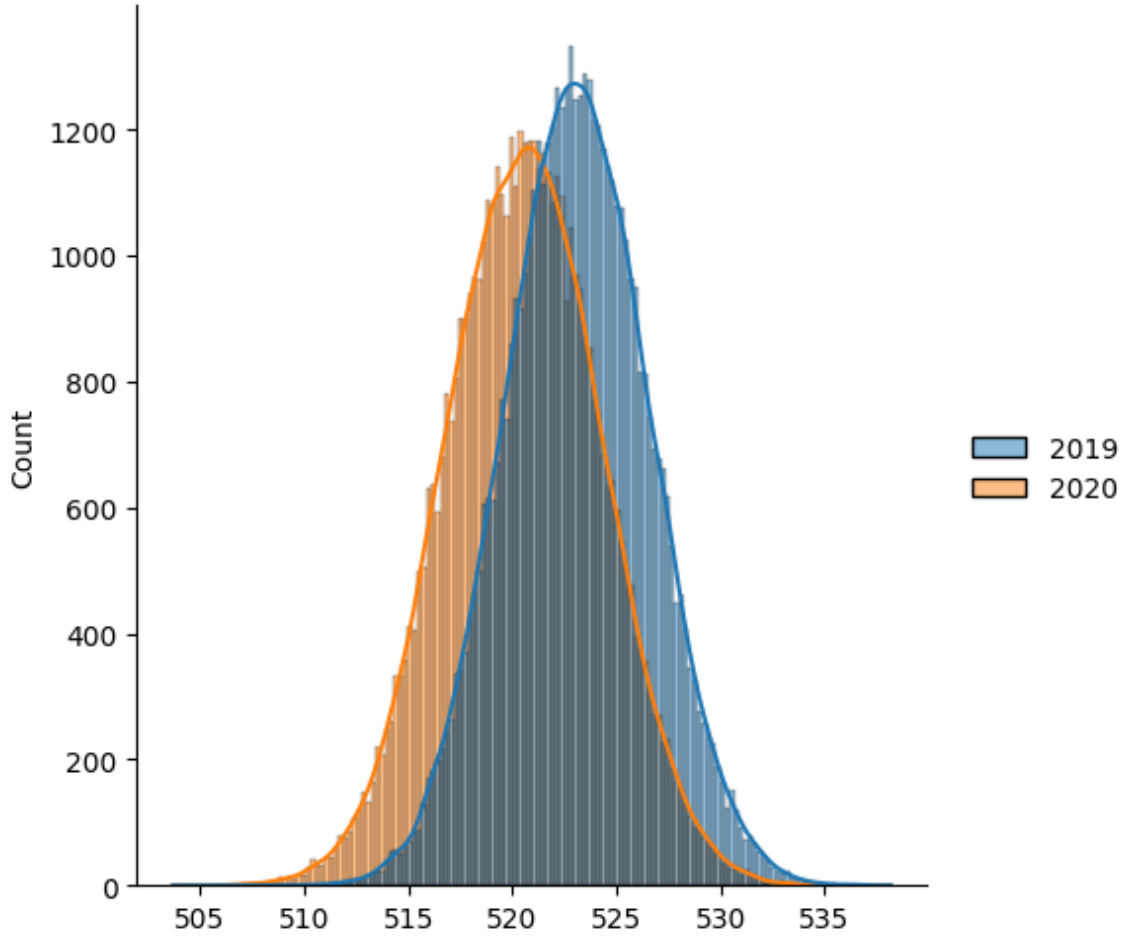
H_0: $\mu_{2021} \leq \mu_{2018}$

H_1: $\mu_{2021} > \mu_{2018}$

$pvalue = 0.99 \geq 0.05$ portanto, não se rejeita H_0

2019 vs. 2020

In [27]:
```
sns.displot(
    data=pd.DataFrame({'2019': mean_sample_2019, '2020': mean_sample_2020}),
    kde=True
);
```



In [28]:
```
ttest_ind(mean_sample_2019, mean_sample_2020, equal_var=False, alternative='grea
```

```
Ttest_indResult(statistic=113.24393358566942, pvalue=0.0)
```

H_0: $\mu_{2019} \leq \mu_{2020}$

H_1: $\mu_{2019} > \mu_{2020}$

$pvalue = 0.0 \leq 0.05$ portanto, rejeita-se H_0

In [ ]: