Problem sheet _03

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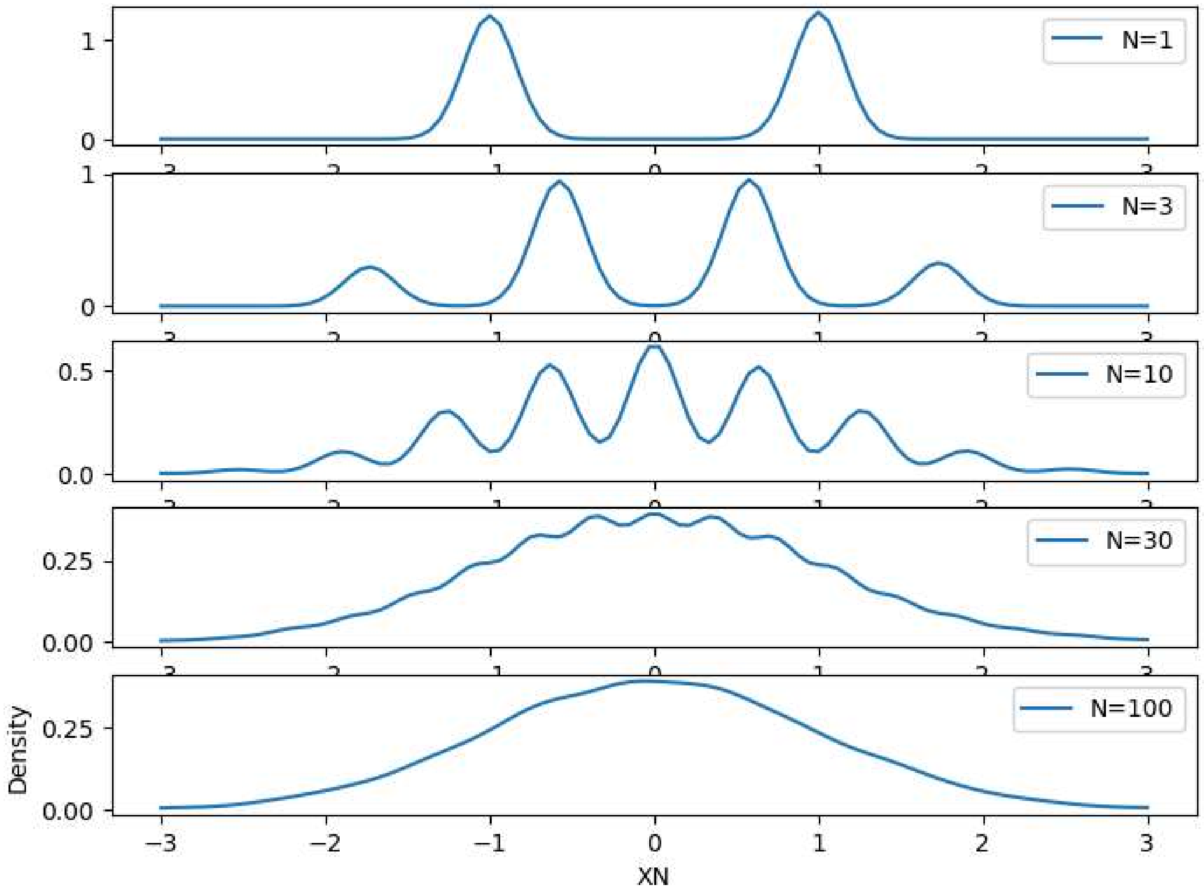
Ex.: 3.1

In [ ]:

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import gaussian_kde
import seaborn as sns
```

In [ ]:

```
def draw_samples(M, N):
    samples = np.zeros(M)
    for i in range(M):
        xi = np.random.choice([-1, 1], size=N)
        XN = np.sum(xi) / np.sqrt(N)
        samples[i] = XN
    return samples

def plot_distribution(M, N_values):
    fig, axes = plt.subplots(len(N_values), 1, figsize=(8, 6))
    for i, N in enumerate(N_values):
        samples = draw_samples(M, N)
        density = gaussian_kde(samples)
        x = np.linspace(-3, 3, 100)
        axes[i].plot(x, density(x), label=f'N={N}')
        axes[i].legend()
    plt.xlabel('XN')
    plt.ylabel('Density')
    plt.show()

M = 10000
N_values = [1, 3, 10, 30, 100]
plot_distribution(M, N_values)
```

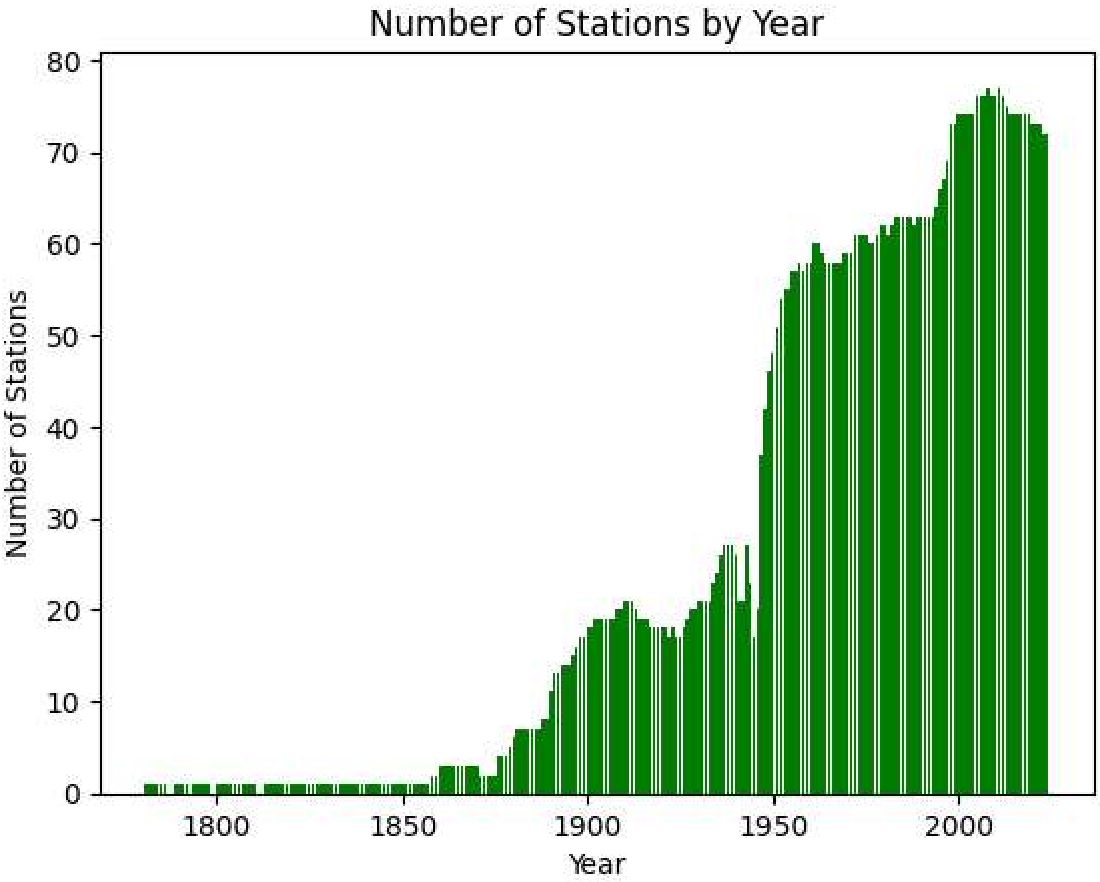


Ex.: 3.2

In [ ]:
```python
import pandas as pd

# Read the dataframe
df = pd.read_csv('temperature_data_processed.csv')

# Parse the date column into year, month and day
df['date'] = pd.to_datetime(df['date'], format='%Y%m%d')
df['year'] = df['date'].dt.year
df['month'] = df['date'].dt.month
df['day'] = df['date'].dt.day

# Filter out missing data
df = df[df['temp'] != -999]
print(df.head())
```

```
   stationid  temp       date  time  year  month  day
0          3  -5.6 1891-01-01     7  1891      1    1
1          3  -0.7 1891-01-01    14  1891      1    1
2          3  -4.0 1891-01-01    21  1891      1    1
3          3  -5.2 1891-01-02     7  1891      1    2
4          3  -1.0 1891-01-02    14  1891      1    2
```

In [ ]:
```python
stations_by_year = df.groupby('year')['stationid'].nunique()
plt.bar(stations_by_year.index, stations_by_year.values, color='green')
plt.xlabel('Year')
plt.ylabel('Number of Stations')
plt.title('Number of Stations by Year')

plt.show()
```



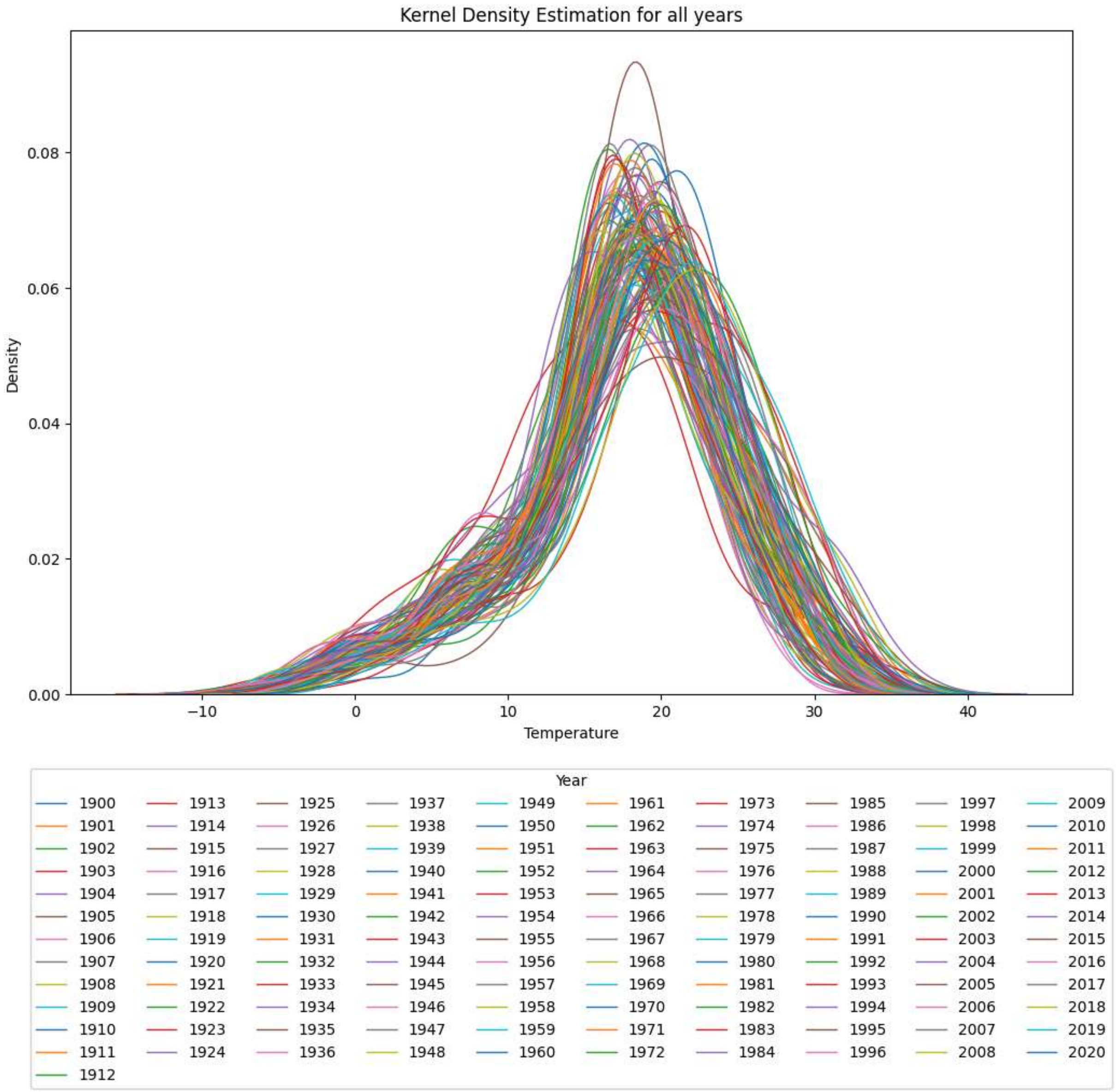
In [ ]:

```
active_stations_1900 = set(df[df['year'] == 1900]['stationid'])
active_stations_2020 = set(df[df['year'] == 2020]['stationid'])
reference_stations = active_stations_1900 & active_stations_2020  # Intersection of

filtered_data = df[(df['stationid'].isin(reference_stations))
                   & (df['year'].between(1900, 2020))
                   & (df['month'].isin([6, 7, 8]))
                   & (df['time'].isin([12, 14]))]
grouped_data = filtered_data.groupby('year')
```

Another approach is below:

In [ ]:

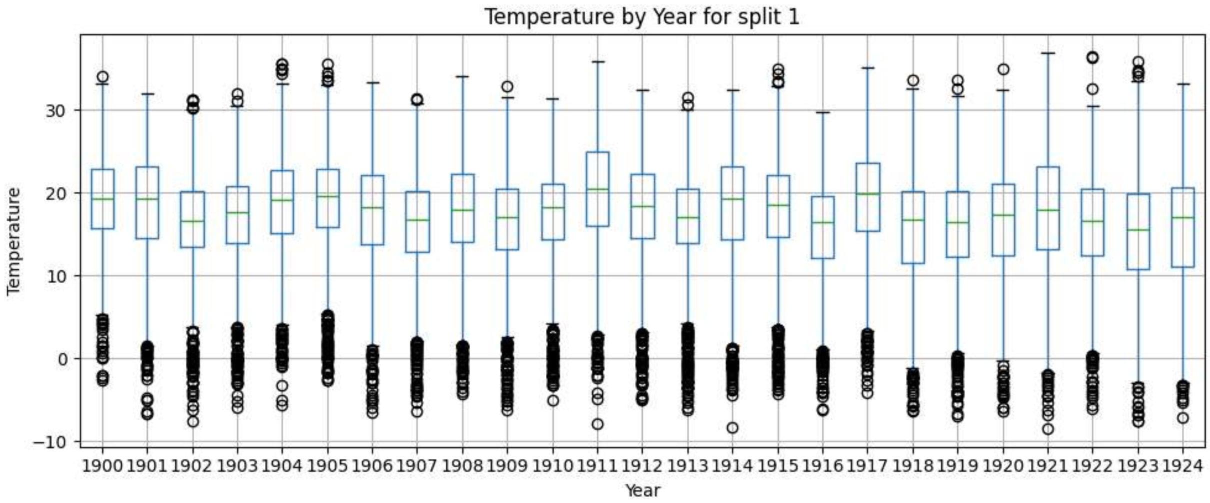
```
unique_years = np.sort(filtered_data['year'].unique())
plt.figure(figsize=(12, 8)) # Adjust the figure size as per your preference

for year in unique_years:
    data_for_year = filtered_data[filtered_data['year'] == year]['temp']
    sns.kdeplot(data_for_year, lw=1, label=f'{year}')

plt.xlabel('Temperature')
plt.ylabel('Density')
plt.title('Kernel Density Estimation for all years')
plt.legend(loc='upper center', bbox_to_anchor=(0.5, -0.10), ncol=10, title="Year")
plt.show()
```

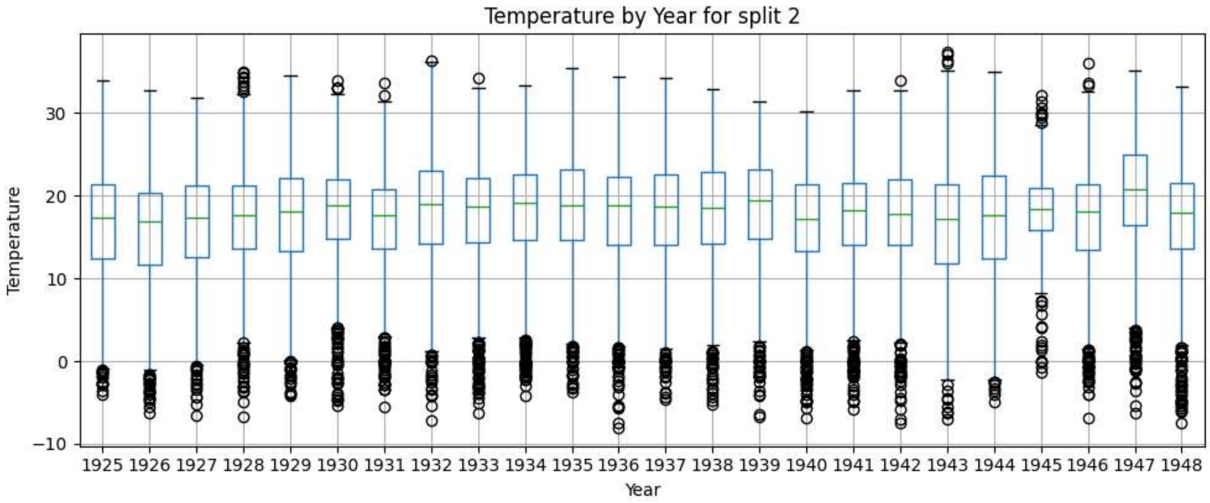


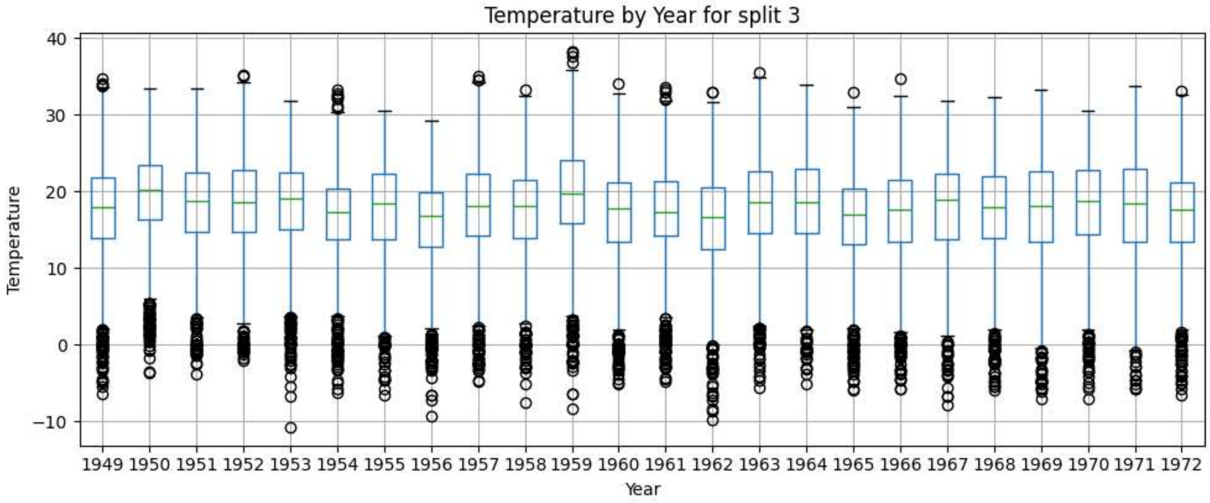
In [ ]:

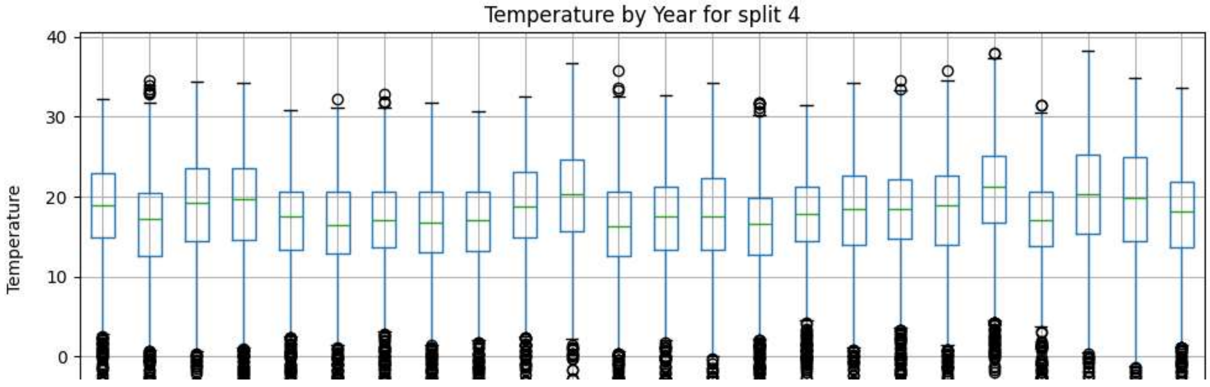
```
splits = np.array_split(unique_years, 5)

for i, split in enumerate(splits, 1):
    print(f'Split {i}: {split}')

dataframes = []

for split in splits:
    split_df = filtered_data[filtered_data['year'].isin(split)]
    dataframes.append(split_df)


fig, axes = plt.subplots(5, 1, figsize=(10, 21)) # Creates a layout with 5 rows and

for i in range(5):
    dataframes[i].boxplot(column='temp', by='year', ax=axes[i])
    fig.suptitle('') # Removes the default title
    axes[i].set_title(f'Temperature by Year for split {i+1}')
    axes[i].set_xlabel('Year')
    axes[i].set_ylabel('Temperature')

plt.tight_layout()
plt.show()
```

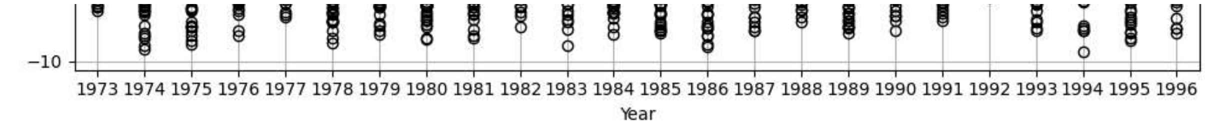
```
Split 1: [1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913
 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924]
Split 2: [1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938
 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948]
Split 3: [1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962
 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972]
Split 4: [1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986
 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996]
Split 5: [1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020]
```


Temperature by Year for split 1
Temperature
30
20
10
0
−10
1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924
Year

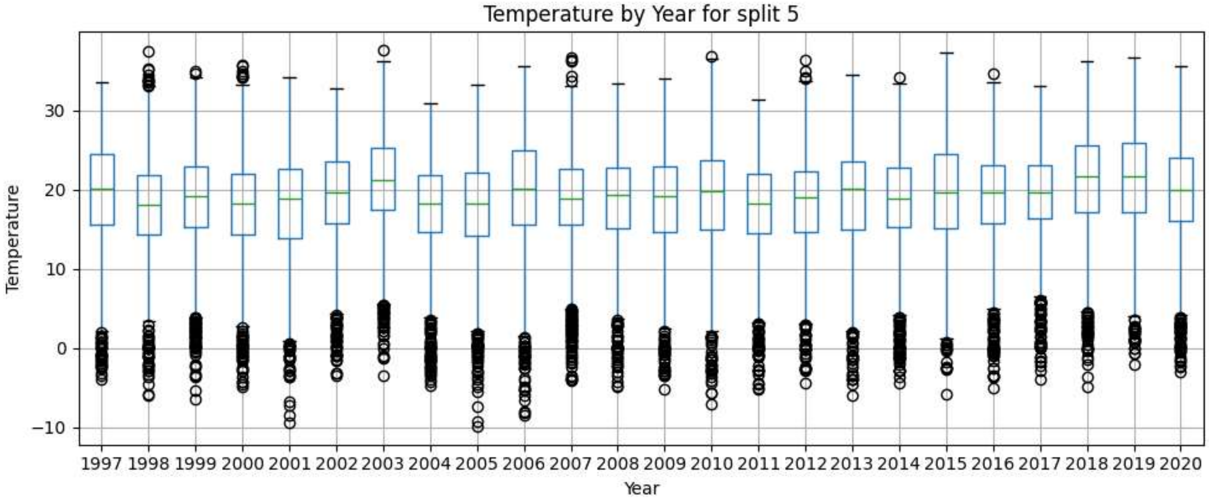

Temperature by Year for split 2
Temperature
30
20
10
0
−10
1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948
Year


Temperature by Year for split 3
Temperature
40
30
20
10
0
−10
1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972
Year


Temperature by Year for split 4
Temperature
40
30
20
10
0



−10
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
Year



Temperature by Year for split 5
Temperature
30
20
10
0
−10
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year

In [ ]: