assignment_data_analysis_Elvern Neylmav T

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[48]:
```
import os
import subprocess

import joblib
import zipfile

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

from scipy.stats import skew, kurtosis
from sklearn.preprocessing import StandardScaler
```

0.1 Data Preprocessing

[17]:
```
def impute_df(df, bg_cols, insulin_cols, carbs_cols, hr_cols, steps_cols,␣
 ↪cals_cols):

    df = df.copy()

    # Blood Glucose & Heart Rate: Linear Interpolation & Mean
    df[bg_cols] = df[bg_cols].apply(
        lambda row: row.interpolate(method='linear', limit_direction='both'),␣
 ↪axis=1)
    df[bg_cols] = df[bg_cols].fillna(df[bg_cols].mean(axis=1))

    df[hr_cols] = df[hr_cols].apply(
        lambda row: row.interpolate(method='linear', limit_direction='both'),␣
 ↪axis=1)
    df[hr_cols] = df[hr_cols].fillna(df[hr_cols].mean(axis=1))

    # Insulin and Carbs: Fill NaN w/ 0
    df[insulin_cols + carbs_cols] = df[insulin_cols + carbs_cols].fillna(0)

    # Steps & Calories: Fill NaN w/ 0
    df[steps_cols + cals_cols] = df[steps_cols + cals_cols].fillna(0)
```

```
    # Residual: Forward Fill
    df = df.fillna(method='ffill').fillna(method='bfill')

    return df
```

[18]:
```
def augment_df(df):

    df = df.copy()

    noise_factor = 0.01
    exclude_cols = ['id', 'p_num', 'time', 'bg+1:00']
    numeric_aug_cols = df.select_dtypes(include=[np.number]).columns.tolist()
    numeric_aug_cols = [col for col in numeric_aug_cols if col not in␣
 ↪exclude_cols]

    for col in numeric_aug_cols:
        std_val = df[col].std()
        df[col] = df[col] + np.random.normal(0, noise_factor * std_val,␣
 ↪size=len(df))

    return pd.concat([df, df], ignore_index=True)
```

[19]:
```
def select_df(df, bg_cols, insulin_cols, carbs_cols, hr_cols, steps_cols,␣
 ↪cals_cols):

    df = df.copy()

    latest_bg_cols     = bg_cols[-24:]
    latest_insulin_cols = insulin_cols[-24:]
    latest_carbs_cols   = carbs_cols[-24:]
    latest_hr_cols      = hr_cols[-24:]
    latest_steps_cols   = steps_cols[-24:]
    latest_cals_cols    = cals_cols[-24:]

    latest_ts_cols = (
        latest_bg_cols +
        latest_insulin_cols +
        latest_carbs_cols +
        latest_hr_cols +
        latest_steps_cols +
        latest_cals_cols
    )

    selected_cols = ["id"] + latest_ts_cols
    if "bg+1:00" in df.columns:
        selected_cols += ["bg+1:00"]
```

```
    return df[selected_cols]
```

[20]:
```
def scale_df(df):

    df = df.copy()

    target_col = 'bg+1:00'
    numeric_columns = [col for col in df.select_dtypes(include=[np.number]).
 ↪columns if col != target_col]

    feature_scaler = StandardScaler()
    df[numeric_columns] = feature_scaler.fit_transform(df[numeric_columns])

    target_scaler = StandardScaler()
    if target_col in df.columns:
        df[[target_col]] = target_scaler.fit_transform(df[[target_col]])

    return df, target_scaler
```

[30]:
```
def preprocess_df(df):

    df = df.copy()

    bg_cols      = [col for col in df.columns if col.startswith("bg-")]
    insulin_cols = [col for col in df.columns if col.startswith("insulin-")]
    carbs_cols   = [col for col in df.columns if col.startswith("carbs-")]
    hr_cols      = [col for col in df.columns if col.startswith("hr-")]
    steps_cols   = [col for col in df.columns if col.startswith("steps-")]
    cals_cols    = [col for col in df.columns if col.startswith("cals-")]
    activity_cols= [col for col in df.columns if col.startswith("activity-")]

    df.drop(columns=activity_cols, inplace=True)



    # ================================
    # Data Imputation
    # ================================

    df_imputed = impute_df(df, bg_cols, insulin_cols, carbs_cols, hr_cols,␣
 ↪steps_cols, cals_cols)

    print("NaN Values (Data Imputation):")
    print(df_imputed.isna().any().any())
    print("\n")
```

```
    # ================================
    # Data Augmentation
    # ================================

    df_augmented = augment_df(df_imputed)

    print("NaN Values (Data Augmentation):")
    print(df_augmented.isna().any().any())
    print("\n")



    # ================================
    # Data Selection
    # ================================

    df_selected = select_df(df_augmented, bg_cols, insulin_cols, carbs_cols,␣
↪hr_cols, steps_cols, cals_cols)

    print("NaN Values (Data Selection):")
    print(df_selected.isna().any().any())
    print("\n")

    print("Columns:")
    for i in df_selected.columns:
        print(i)
    print("\n")



    # ================================
    # Data Scaling
    # ================================

    df_scaled, target_scalar = scale_df(df_selected)

    print("NaN Values (Data Scaling):")
    print(df_scaled.isna().any().any())
    print("\n")

    return df_scaled, target_scalar
```

0.1.1 Data Importing

[49]:
```
train_path = "./.data/train.csv.zip"
test_path = "./.data/test.csv"

if not os.path.exists(train_path):
    os.makedirs("./.data", exist_ok=True)
    print("Downloading BrisT1D ...")
    subprocess.run(["kaggle", "competitions", "download", "-c", "brist1d",␣
 ↪"-p", "./.data"], check=True)

with zipfile.ZipFile(train_path) as z:
    with z.open("train.csv") as f:
        df_train = pd.read_csv(f)

df_test = pd.read_csv("./.data/test.csv")
```

```
C:\Users\ASUS\AppData\Local\Temp\ipykernel_39300\2261742640.py:11: DtypeWarning:
Columns (435,436,437,438,439,440,441,442,443,444,445,446,447,448,449,450,451,452
,453,454,455,456,457,458,459,460,461,462,463,464,465,466,467,468,469,470,471,472
,473,474,475,476,477,478,479,480,481,482,483,484,485,486,487,488,489,490,491,492
,493,494,495,496,497,498,499,500,501,502,503,504,505,506) have mixed types.
Specify dtype option on import or set low_memory=False.
  df_train = pd.read_csv(f)
```

0.1.2 Data Transformation

[25]:
```
print(df_train)
```

```
                id p_num      time  bg-5:55  bg-5:50  bg-5:45  bg-5:40  \
0           p01_0   p01  06:10:00      NaN      NaN      9.6      NaN
1           p01_1   p01  06:25:00      NaN      NaN      9.7      NaN
2           p01_2   p01  06:40:00      NaN      NaN      9.2      NaN
3           p01_3   p01  06:55:00      NaN      NaN      8.7      NaN
4           p01_4   p01  07:10:00      NaN      NaN      8.4      NaN
…             …   …        …        …        …        …        …
177019  p12_25294   p12  23:35:00      8.8      9.1      9.2      9.4
177020  p12_25295   p12  23:40:00      9.1      9.2      9.4      9.8
177021  p12_25296   p12  23:45:00      9.2      9.4      9.8     10.2
177022  p12_25297   p12  23:50:00      9.4      9.8     10.2     10.4
177023  p12_25298   p12  23:55:00      9.8     10.2     10.4     10.3

        bg-5:35  bg-5:30  bg-5:25  …  activity-0:40  activity-0:35  \
0           NaN      9.7      NaN  …            NaN            NaN
1           NaN      9.2      NaN  …            NaN            NaN
2           NaN      8.7      NaN  …            NaN            NaN
3           NaN      8.4      NaN  …            NaN            NaN
4           NaN      8.1      NaN  …            NaN            NaN
…           …        …        …  …              …              …
```

```
177019      9.8     10.2     10.4  …            NaN            NaN
177020     10.2     10.4     10.3  …            NaN            NaN
177021     10.4     10.3     10.1  …            NaN            NaN
177022     10.3     10.1     10.0  …            NaN            NaN
177023     10.1     10.0      9.8  …            NaN            NaN

        activity-0:30  activity-0:25  activity-0:20  activity-0:15  \
0                 NaN            NaN            NaN            NaN
1                 NaN            NaN            NaN            NaN
2                 NaN            NaN            NaN            NaN
3                 NaN            NaN            NaN            NaN
4                 NaN            NaN            NaN            NaN
…                 …              …              …              …
177019            NaN            NaN            NaN            NaN
177020            NaN            NaN            NaN            NaN
177021            NaN            NaN            NaN            NaN
177022            NaN            NaN            NaN            NaN
177023            NaN            NaN            NaN            NaN

        activity-0:10  activity-0:05  activity-0:00  bg+1:00
0                 NaN            NaN            NaN     13.4
1                 NaN            NaN            NaN     12.8
2                 NaN            NaN            NaN     15.5
3                 NaN            NaN            NaN     14.8
4                 NaN            NaN            NaN     12.7
…                 …              …              …       …
177019            NaN            NaN            NaN     11.1
177020            NaN            NaN            NaN     10.9
177021            NaN            NaN            NaN     10.7
177022            NaN            NaN            NaN     10.5
177023            NaN            NaN            NaN     10.2

[177024 rows x 508 columns]
```

[23]:
```
df_train_preprocessed, df_train_preprocessed_scaler = preprocess_df(df_train)
```

```
NaN Values (Data Imputation):
False


NaN Values (Data Augmentation):
False


NaN Values (Data Selection):
False
```

```
Columns:
id
bg-1:55
bg-1:50
bg-1:45
bg-1:40
bg-1:35
bg-1:30
bg-1:25
bg-1:20
bg-1:15
bg-1:10
bg-1:05
bg-1:00
bg-0:55
bg-0:50
bg-0:45
bg-0:40
bg-0:35
bg-0:30
bg-0:25
bg-0:20
bg-0:15
bg-0:10
bg-0:05
bg-0:00
insulin-1:55
insulin-1:50
insulin-1:45
insulin-1:40
insulin-1:35
insulin-1:30
insulin-1:25
insulin-1:20
insulin-1:15
insulin-1:10
insulin-1:05
insulin-1:00
insulin-0:55
insulin-0:50
insulin-0:45
insulin-0:40
insulin-0:35
insulin-0:30
insulin-0:25
insulin-0:20
insulin-0:15
insulin-0:10
```

insulin-0:05
insulin-0:00
carbs-1:55
carbs-1:50
carbs-1:45
carbs-1:40
carbs-1:35
carbs-1:30
carbs-1:25
carbs-1:20
carbs-1:15
carbs-1:10
carbs-1:05
carbs-1:00
carbs-0:55
carbs-0:50
carbs-0:45
carbs-0:40
carbs-0:35
carbs-0:30
carbs-0:25
carbs-0:20
carbs-0:15
carbs-0:10
carbs-0:05
carbs-0:00
hr-1:55
hr-1:50
hr-1:45
hr-1:40
hr-1:35
hr-1:30
hr-1:25
hr-1:20
hr-1:15
hr-1:10
hr-1:05
hr-1:00
hr-0:55
hr-0:50
hr-0:45
hr-0:40
hr-0:35
hr-0:30
hr-0:25
hr-0:20
hr-0:15
hr-0:10

hr-0:05
hr-0:00
steps-1:55
steps-1:50
steps-1:45
steps-1:40
steps-1:35
steps-1:30
steps-1:25
steps-1:20
steps-1:15
steps-1:10
steps-1:05
steps-1:00
steps-0:55
steps-0:50
steps-0:45
steps-0:40
steps-0:35
steps-0:30
steps-0:25
steps-0:20
steps-0:15
steps-0:10
steps-0:05
steps-0:00
cals-1:55
cals-1:50
cals-1:45
cals-1:40
cals-1:35
cals-1:30
cals-1:25
cals-1:20
cals-1:15
cals-1:10
cals-1:05
cals-1:00
cals-0:55
cals-0:50
cals-0:45
cals-0:40
cals-0:35
cals-0:30
cals-0:25
cals-0:20
cals-0:15
cals-0:10

```
cals-0:05
cals-0:00
bg+1:00


NaN Values (Data Scaling):
False
```

[24]:
```
print(df_train_preprocessed)
```

```
                id   bg-1:55   bg-1:50   bg-1:45   bg-1:40   bg-1:35   bg-1:30  \
0           p01_0  3.103256  3.207739  3.306019  3.338826  3.354246  3.385527
1           p01_1  3.334344  3.368640  3.382463  3.342868  3.303760  3.241867
2           p01_2  3.351738  3.290329  3.235490  3.198546  3.087441  2.998913
3           p01_3  3.164014  3.096026  3.013504  3.049034  3.062024  3.092045
4           p01_4  3.036686  3.041001  3.069754  3.055564  3.022660  2.999762
…             …       …         …         …         …         …         …
354043  p12_25294 -0.143842 -0.166453 -0.178820 -0.190547 -0.300671 -0.393663
354044  p12_25295 -0.173634 -0.161785 -0.186081 -0.298534 -0.412794 -0.461140
354045  p12_25296 -0.205563 -0.200199 -0.298250 -0.389232 -0.461662 -0.512562
354046  p12_25297 -0.188150 -0.278181 -0.400960 -0.453957 -0.532632 -0.628098
354047  p12_25298 -0.291531 -0.394955 -0.461099 -0.537074 -0.637675 -0.692059

         bg-1:25   bg-1:20   bg-1:15  …  cals-0:40  cals-0:35  cals-0:30  \
0       3.361706  3.298674  3.236702  …  -0.913334  -0.939909  -0.923877
1       3.162056  3.084194  3.005685  …  -0.921258  -0.912809  -0.922427
2       3.029130  3.064470  3.076823  …  -0.911402  -0.908383  -0.925616
3       3.066319  3.040599  3.029240  …  -0.900110  -0.929330  -0.946666
4       2.904749  2.758129  2.637884  …  -0.928657  -0.948994  -0.934639
…            …         …         …  …          …          …          …
354043 -0.452012 -0.519864 -0.620355  …  -0.097427  -0.067986  -0.080565
354044 -0.526748 -0.631787 -0.685853  …  -0.094065  -0.099810  -0.095277
354045 -0.626099 -0.697553 -0.712969  …  -0.095215  -0.087183  -0.114142
354046 -0.680554 -0.686067 -0.745997  …  -0.094187  -0.094680  -0.068524
354047 -0.699258 -0.739261 -0.656470  …  -0.087557  -0.077106  -0.073078

        cals-0:25  cals-0:20  cals-0:15  cals-0:10  cals-0:05  cals-0:00  \
0       -0.917633  -0.913139  -0.923363  -0.921961  -0.930864  -0.940412
1       -0.943300  -0.940209  -0.920075  -0.924766  -0.914329  -0.937086
2       -0.915785  -0.934806  -0.925020  -0.906080  -0.951040  -0.940085
3       -0.917361  -0.915793  -0.941611  -0.902305  -0.938688  -0.933104
4       -0.931787  -0.910059  -0.938554  -0.929727  -0.924324  -0.927819
…            …          …          …          …          …          …
354043  -0.090742  -0.101766  -0.091164  -0.095464  -0.078162  -0.082150
354044  -0.091585  -0.090004  -0.098021  -0.101480  -0.101494  -0.083628
354045  -0.086690  -0.091760  -0.108207  -0.096454  -0.119230  -0.093000
```

```
354046  -0.113386  -0.098223  -0.086097  -0.097309  -0.105313  -0.085124
354047  -0.087422  -0.089201  -0.086692  -0.087245  -0.105076  -0.089916

         bg+1:00
0       1.709709
1       1.509468
2       2.410552
3       2.176938
4       1.476095
…          …
354043  0.942119
354044  0.875372
354045  0.808625
354046  0.741878
354047  0.641757

[354048 rows x 146 columns]
```

[31]:
```
print(df_test)
```

```
             id p_num      time  bg-5:55  bg-5:50  bg-5:45  bg-5:40  bg-5:35  \
0     p01_8459   p01  06:45:00      NaN      9.2      NaN      NaN     10.2
1     p01_8460   p01  11:25:00      NaN      NaN      9.9      NaN      NaN
2     p01_8461   p01  14:45:00      NaN      5.5      NaN      NaN      5.5
3     p01_8462   p01  04:30:00      NaN      3.4      NaN      NaN      3.9
4     p01_8463   p01  04:20:00      NaN      NaN      8.3      NaN      NaN
…        …   …        …      …       …       …       …       …
3639   p24_256   p24  06:40:00      7.3      7.3      7.1      6.7      6.8
3640   p24_257   p24  12:30:00      6.0      6.2      6.2      6.2      5.8
3641   p24_258   p24  03:45:00     12.4     12.5     12.7     13.1     13.2
3642   p24_259   p24  06:10:00      8.3      8.3      8.2      8.2      7.8
3643   p24_260   p24  03:10:00      9.9     10.1     10.0      9.9     10.0

      bg-5:30  bg-5:25  …  activity-0:45  activity-0:40  activity-0:35  \
0         NaN      NaN  …            NaN            NaN            NaN
1         9.4      NaN  …            NaN            NaN            NaN
2         NaN      NaN  …            NaN            NaN            NaN
3         NaN      NaN  …            NaN            NaN            NaN
4        10.0      NaN  …            NaN            NaN            NaN
…         …       …   …              …              …              …
3639      6.8      6.9  …            NaN            NaN            NaN
3640      5.5      5.7  …            NaN            NaN            NaN
3641     13.3     13.0  …            NaN            NaN            NaN
3642      7.4      6.9  …            NaN            NaN            NaN
3643      9.7      9.7  …            NaN            NaN            NaN

      activity-0:30  activity-0:25  activity-0:20  activity-0:15  \
0               NaN            NaN            NaN            NaN
```

```
1               NaN            NaN            NaN            NaN
2               NaN            NaN            NaN            NaN
3               NaN            NaN            NaN            NaN
4               NaN            NaN            NaN            NaN
…               …              …              …              …
3639            NaN            NaN            NaN            NaN
3640            NaN            NaN            NaN            NaN
3641            NaN            NaN            NaN            NaN
3642            NaN            NaN            NaN            NaN
3643            NaN            NaN            NaN            NaN

      activity-0:10  activity-0:05  activity-0:00
0               NaN            NaN            NaN
1              Walk           Walk           Walk
2               NaN            NaN            NaN
3               NaN            NaN            NaN
4               NaN            NaN            NaN
…               …              …              …
3639            NaN            NaN            NaN
3640            NaN            NaN            NaN
3641            NaN            NaN            NaN
3642            NaN            NaN            NaN
3643            NaN            NaN            NaN

[3644 rows x 507 columns]
```

[32]:
```
df_test_preprocessed, df_test_scaler = preprocess_df(df_test)
```

```
NaN Values (Data Imputation):
False


NaN Values (Data Augmentation):
False


NaN Values (Data Selection):
False


Columns:
id
bg-1:55
bg-1:50
bg-1:45
bg-1:40
bg-1:35
bg-1:30
```

bg-1:25
bg-1:20
bg-1:15
bg-1:10
bg-1:05
bg-1:00
bg-0:55
bg-0:50
bg-0:45
bg-0:40
bg-0:35
bg-0:30
bg-0:25
bg-0:20
bg-0:15
bg-0:10
bg-0:05
bg-0:00
insulin-1:55
insulin-1:50
insulin-1:45
insulin-1:40
insulin-1:35
insulin-1:30
insulin-1:25
insulin-1:20
insulin-1:15
insulin-1:10
insulin-1:05
insulin-1:00
insulin-0:55
insulin-0:50
insulin-0:45
insulin-0:40
insulin-0:35
insulin-0:30
insulin-0:25
insulin-0:20
insulin-0:15
insulin-0:10
insulin-0:05
insulin-0:00
carbs-1:55
carbs-1:50
carbs-1:45
carbs-1:40
carbs-1:35
carbs-1:30

carbs-1:25
carbs-1:20
carbs-1:15
carbs-1:10
carbs-1:05
carbs-1:00
carbs-0:55
carbs-0:50
carbs-0:45
carbs-0:40
carbs-0:35
carbs-0:30
carbs-0:25
carbs-0:20
carbs-0:15
carbs-0:10
carbs-0:05
carbs-0:00
hr-1:55
hr-1:50
hr-1:45
hr-1:40
hr-1:35
hr-1:30
hr-1:25
hr-1:20
hr-1:15
hr-1:10
hr-1:05
hr-1:00
hr-0:55
hr-0:50
hr-0:45
hr-0:40
hr-0:35
hr-0:30
hr-0:25
hr-0:20
hr-0:15
hr-0:10
hr-0:05
hr-0:00
steps-1:55
steps-1:50
steps-1:45
steps-1:40
steps-1:35
steps-1:30

```
steps-1:25
steps-1:20
steps-1:15
steps-1:10
steps-1:05
steps-1:00
steps-0:55
steps-0:50
steps-0:45
steps-0:40
steps-0:35
steps-0:30
steps-0:25
steps-0:20
steps-0:15
steps-0:10
steps-0:05
steps-0:00
cals-1:55
cals-1:50
cals-1:45
cals-1:40
cals-1:35
cals-1:30
cals-1:25
cals-1:20
cals-1:15
cals-1:10
cals-1:05
cals-1:00
cals-0:55
cals-0:50
cals-0:45
cals-0:40
cals-0:35
cals-0:30
cals-0:25
cals-0:20
cals-0:15
cals-0:10
cals-0:05
cals-0:00


NaN Values (Data Scaling):
False
```

[33]:
```
print(df_test_preprocessed)
```

```
            id   bg-1:55   bg-1:50   bg-1:45   bg-1:40   bg-1:35   bg-1:30  \
0     p01_8459  1.490083  1.493991  1.487914  1.536848  1.543252  1.609489
1     p01_8460 -0.484494 -0.640907 -0.822489 -0.931031 -1.038671 -1.145885
2     p01_8461 -1.100145 -1.072103 -1.085097 -1.078083 -1.079982 -1.054271
3     p01_8462 -1.550306 -1.599876 -1.667817 -1.612185 -1.573266 -1.524316
4     p01_8463 -1.452215 -1.530704 -1.639879 -1.653449 -1.693813 -1.709896
…        …        …         …         …         …         …
7283   p24_256 -0.755966 -0.598032 -0.511680 -0.485289 -0.589582 -0.516143
7284   p24_257 -0.867098 -0.597732 -0.391667 -0.329957 -0.298055 -0.364247
7285   p24_258  0.341528  0.324581  0.305170  0.260892  0.215751  0.230552
7286   p24_259 -0.475408 -0.482376 -0.462070 -0.460022 -0.407464 -0.336393
7287   p24_260 -0.934047 -0.964720 -0.875623 -0.866758 -0.816449 -0.743403

       bg-1:25   bg-1:20   bg-1:15  …  cals-0:45  cals-0:40  cals-0:35  \
0     1.690658  1.776662  1.738622  …  -0.244751  -0.259731  -0.249346
1    -1.200609 -1.274696 -1.322552  …   0.741684  -0.114562   0.398151
2    -1.112394 -1.168733 -1.233264  …   1.732667   1.523707   0.445110
3    -1.400897 -1.249383 -1.100477  …  -0.248987  -0.255125  -0.273329
4    -1.747814 -1.755256 -1.769902  …   0.489137  -0.269059  -0.247479
…        …         …         …  …         …          …          …
7283 -0.563874 -0.528208 -0.624754  …  -0.334748  -0.360433  -0.360608
7284 -0.409848 -0.463419 -0.460499  …  -0.355905  -0.368517  -0.357096
7285  0.228517  0.188118  0.164848  …  -0.357705  -0.335482  -0.365985
7286 -0.324502 -0.265292 -0.295673  …  -0.372843  -0.371043  -0.347932
7287 -0.687686 -0.571831 -0.524404  …  -0.358324  -0.355513  -0.351461

      cals-0:30  cals-0:25  cals-0:20  cals-0:15  cals-0:10  cals-0:05  \
0     -0.262492  -0.277501  -0.263626  -0.255156  -0.262386  -0.256275
1      1.017345   1.357706   1.458101   2.347735   3.321693   2.501757
2      2.595627   0.819149   0.034890  -0.038203   0.195514   1.827800
3     -0.258970  -0.241126  -0.243463  -0.260906  -0.268766  -0.239401
4     -0.256333  -0.252435  -0.269862  -0.266028  -0.282441  -0.276638
…        …          …          …          …          …          …
7283  -0.346651  -0.375909  -0.348453  -0.184442  -0.332153  -0.344670
7284  -0.330180  -0.296886  -0.327326   0.110410  -0.097930  -0.312238
7285  -0.370594  -0.364342  -0.352841  -0.373423  -0.341733  -0.333142
7286  -0.362418  -0.352212  -0.353939  -0.351694  -0.338654  -0.353384
7287  -0.364291  -0.343368  -0.343902  -0.353451  -0.342638  -0.329303

      cals-0:00
0     -0.066699
1      3.531198
2      0.489946
3     -0.247043
4     -0.249303
…          …
```

```
7283  -0.315109
7284  -0.176642
7285  -0.333617
7286  -0.341865
7287  -0.325843

[7288 rows x 145 columns]
```

0.1.3 Data Exporting

[34]:
```
df_train_preprocessed.to_csv("./.data/train_aug.csv", index=False)
df_test_preprocessed.to_csv("./.data/test_aug.csv", index=False)
```

[35]:
```
joblib.dump(df_train_preprocessed_scaler, './.data/target_scaler_aug.pkl')
```

[35]:
```
['./.data/target_scaler_aug.pkl']
```

0.2 Exploratory Data Analysis (EDA)

[68]:
```
import joblib

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

from scipy.stats import skew, kurtosis
from statsmodels.tsa.seasonal import STL
```

[69]:
```
df_train_preprocessed = pd.read_csv("./.data/train_aug.csv")
df_test_preprocessed = pd.read_csv("./.data/test_aug.csv")
target_scaler = joblib.load('./.data/target_scaler_aug.pkl')
```

[70]:
```
# df_train_preprocessed["bg+1:00"] = target_scaler.inverse_transform(
#     df_train_preprocessed["bg+1:00"].values.reshape(-1, 1)
# ).ravel()
```

[71]:
```
df_train_preprocessed['p_num'] = df_train_preprocessed['id'].str.
↪extract(r"(p\d{2})")
```

0.2.1 Descriptive Analysis

[72]:
```
bg_1 = df_train_preprocessed["bg+1:00"]
```

[73]:
```
global_stats = {
    "mean": bg_1.mean(),
    "median": bg_1.median(),
    "std_dev": bg_1.std(),
```

```
    "min": bg_1.min(),
    "max": bg_1.max(),
    "sum": bg_1.sum(),
    "count": bg_1.count(),
    "q1": bg_1.quantile(0.25),
    "q3": bg_1.quantile(0.75),
}

global_stats["IQR"] = global_stats["q3"] - global_stats["q1"]
global_stats["skewness"] = skew(bg_1, bias=False)
global_stats["kurtosis"] = kurtosis(bg_1, bias=False)
```

[74]:
```
pd.set_option("display.max_rows", None)
pd.set_option("display.max_columns", None)
pd.set_option("display.max_colwidth", None)
pd.set_option("display.width", 1000)

print("Global Summary:")
display(pd.DataFrame([global_stats]).style.hide(axis="index"))

pd.reset_option("display.max_rows")
pd.reset_option("display.max_columns")
pd.reset_option("display.max_colwidth")
pd.reset_option("display.width")
```

```
Global Summary:
```

```
<pandas.io.formats.style.Styler at 0x1a1f998f190>
```

[75]:
```
group_stats = df_train_preprocessed.groupby("p_num")["bg+1:00"].agg([
    ("mean", "mean"),
    ("median", "median"),
    ("std_dev", "std"),
    ("min", "min"),
    ("max", "max"),
    ("sum", "sum"),
    ("count", "count"),
    ("q1", lambda x: x.quantile(0.25, interpolation='nearest')),
    ("q3", lambda x: x.quantile(0.75, interpolation='nearest')),
])
group_stats["IQR"] = group_stats["q3"] - group_stats["q1"]
```

[76]:
```
def compute_skew_kurt(group):
    return pd.Series({
        "skewness": skew(group["bg+1:00"], bias=False),
        "kurtosis": kurtosis(group["bg+1:00"], bias=False)
    })
```

```
skew_kurt = df_train_preprocessed.groupby("p_num").apply(compute_skew_kurt).
 ↪reset_index()
```

[77]:
```
final_stats = group_stats.reset_index().merge(skew_kurt, on="p_num")
final_stats = final_stats.sort_values("p_num")
```

[78]:
```
pd.set_option("display.max_rows", None)
pd.set_option("display.max_columns", None)
pd.set_option("display.max_colwidth", None)
pd.set_option("display.width", 1000)

print("P_NUM Summary:")
display(final_stats.style.hide(axis="index"))

pd.reset_option("display.max_rows")
pd.reset_option("display.max_columns")
pd.reset_option("display.max_colwidth")
pd.reset_option("display.width")
```

```
P_NUM Summary:
```

```
<pandas.io.formats.style.Styler at 0x1a1f998e680>
```

0.2.2 Visual Analysis

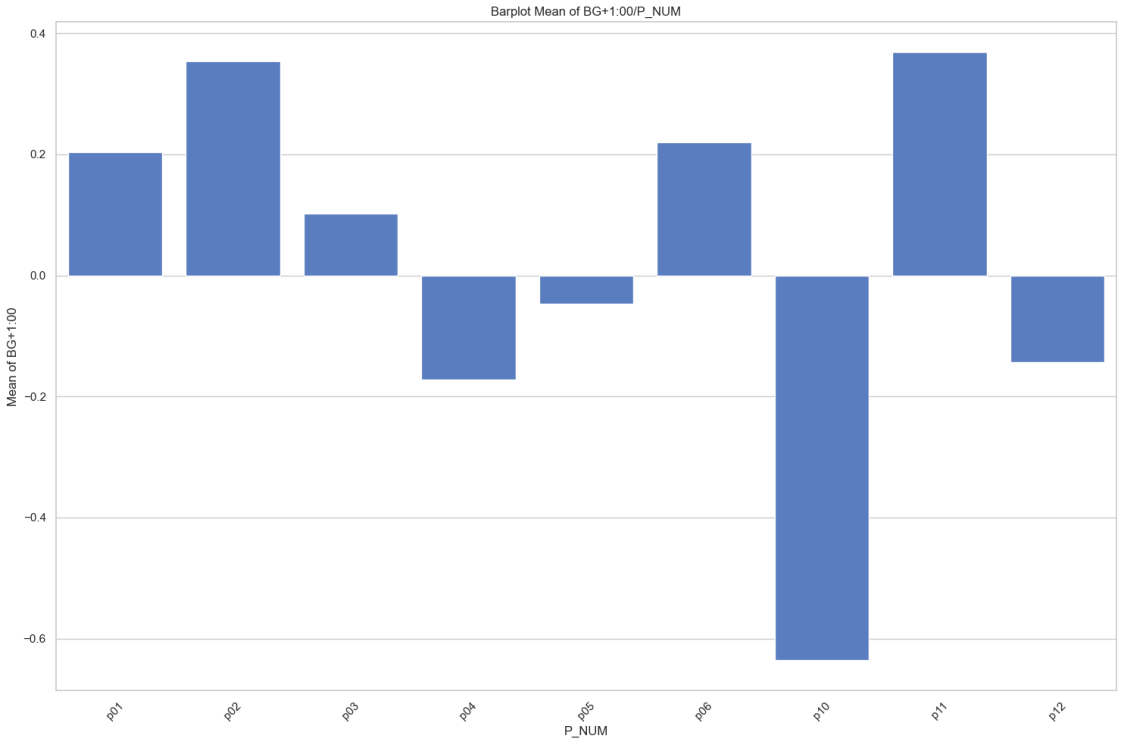
[79]:
```
df_train_preprocessed_pd = df_train_preprocessed[["p_num", "bg+1:00"]]
stats_pd = final_stats

participants = sorted(df_train_preprocessed_pd["p_num"].unique())
n = len(participants)

sns.set(style="whitegrid", palette="muted")
```

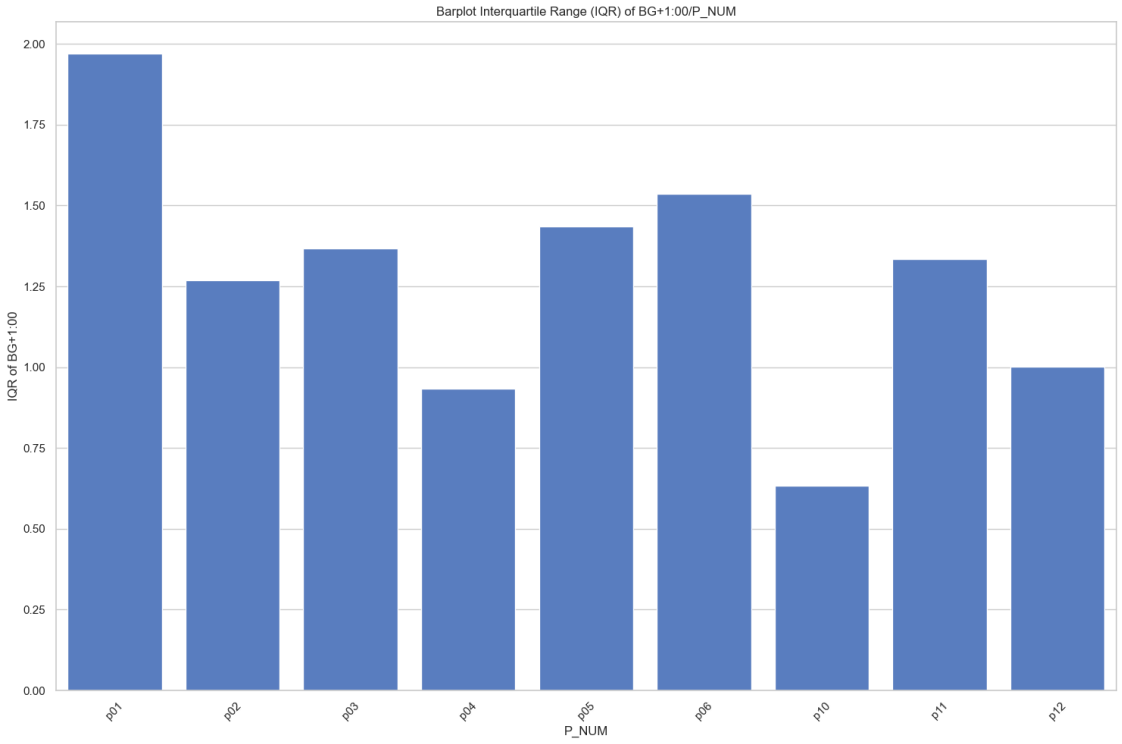
Barplot: Mean of BG+1:00/P_NUM

[80]:
```
plt.figure(figsize=(15, 10))
sns.barplot(data=stats_pd, x="p_num", y="mean")
plt.title("Barplot Mean of BG+1:00/P_NUM")
plt.xlabel("P_NUM")
plt.ylabel("Mean of BG+1:00")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



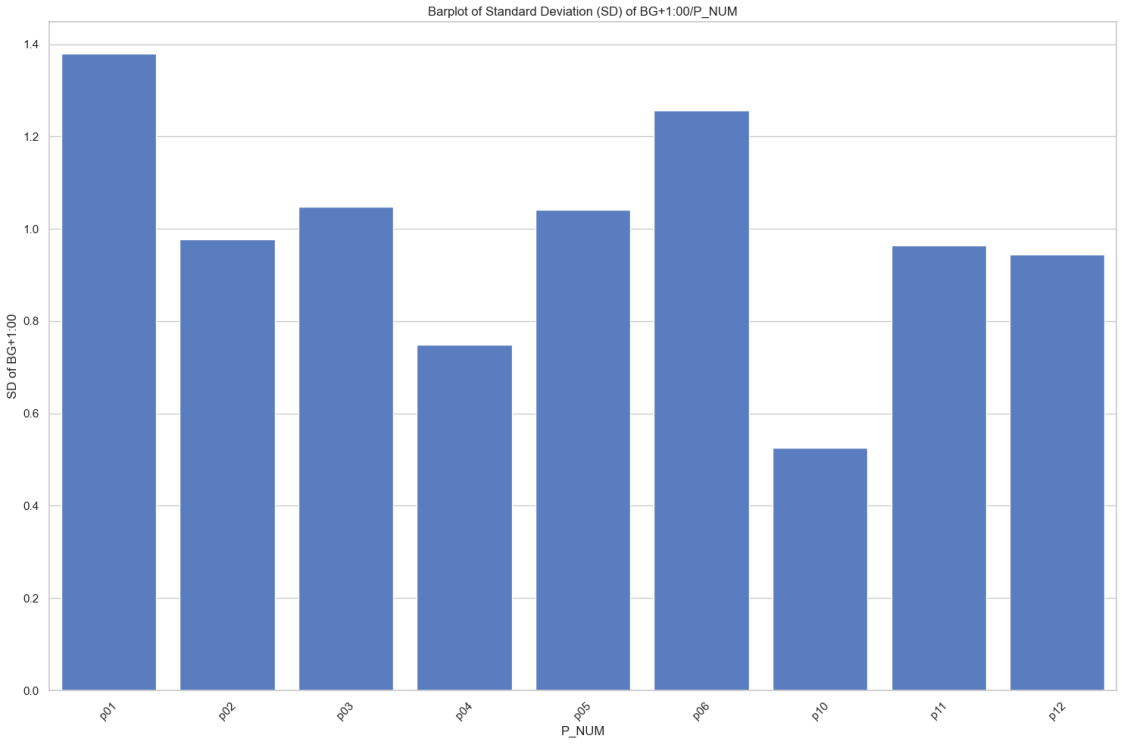
Barplot: Interquartile Range (IQR) of BG+1:00/P_NUM

[81]:
```
plt.figure(figsize=(15, 10))
sns.barplot(data=stats_pd, x="p_num", y="IQR")
plt.title("Barplot Interquartile Range (IQR) of BG+1:00/P_NUM")
plt.xlabel("P_NUM")
plt.ylabel("IQR of BG+1:00")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



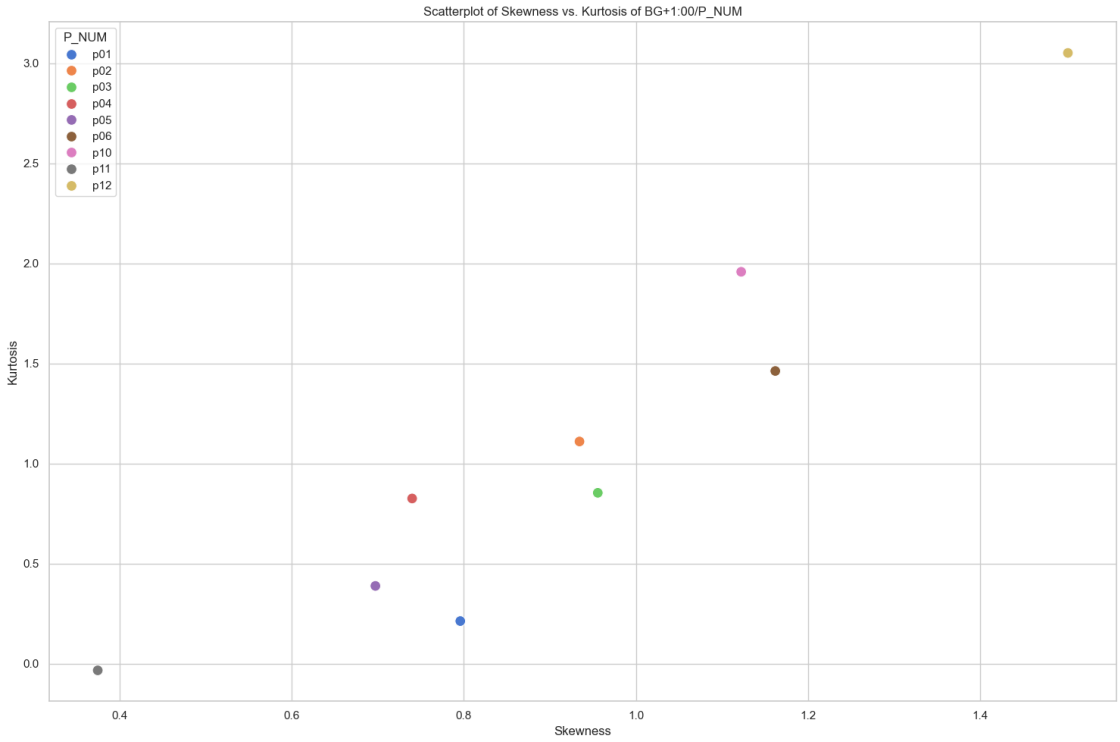
Barplot: Standard Deviation (SD) of BG+1:00/P_NUM

[82]:
```
plt.figure(figsize=(15, 10))
sns.barplot(data=stats_pd, x="p_num", y="std_dev")
plt.title("Barplot of Standard Deviation (SD) of BG+1:00/P_NUM")
plt.xlabel("P_NUM")
plt.ylabel("SD of BG+1:00")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



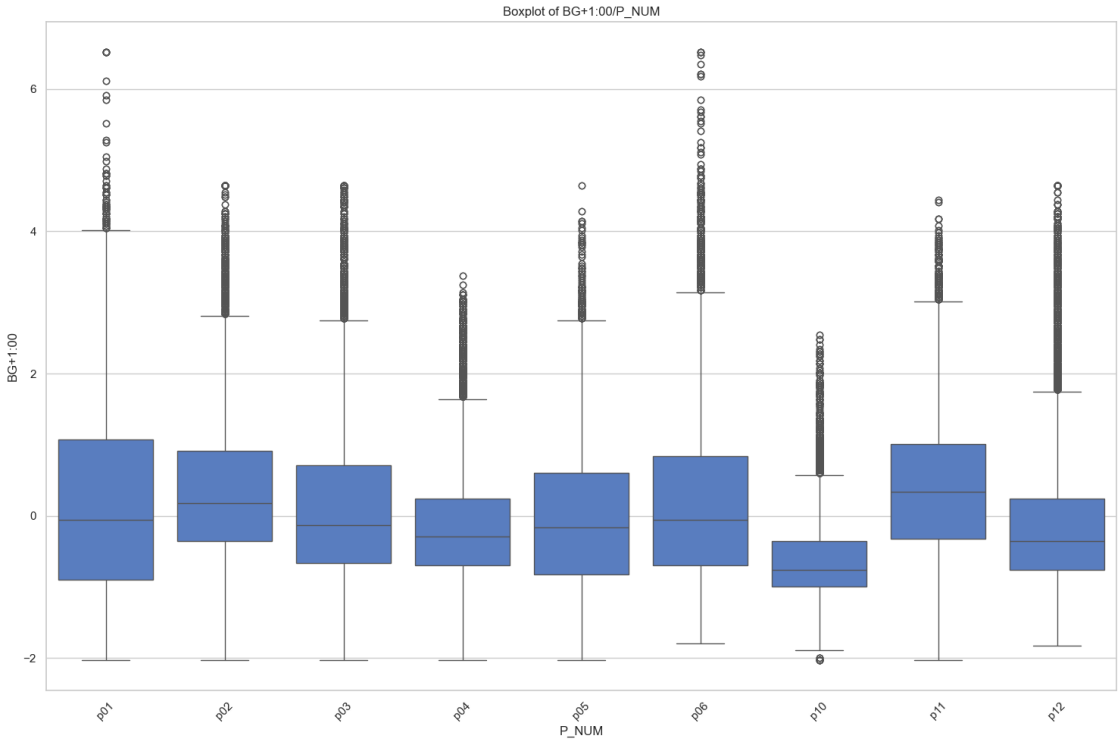
Scatterplot: Skewness vs. Kurtosis of BG+1:00/P_NUM

[83]:
```
plt.figure(figsize=(15, 10))
sns.scatterplot(data=stats_pd, x="skewness", y="kurtosis", hue="p_num", s=100)
plt.title("Scatterplot of Skewness vs. Kurtosis of BG+1:00/P_NUM")
plt.xlabel("Skewness")
plt.ylabel("Kurtosis")
plt.legend(title="P_NUM")
plt.tight_layout()
plt.show()
```



Boxplot: BG+1:00/P_NUM

[84]:
```
plt.figure(figsize=(15, 10))
sns.boxplot(data=df_train_preprocessed_pd, x="p_num", y="bg+1:00")
plt.title("Boxplot of BG+1:00/P_NUM")
plt.ylabel("BG+1:00")
plt.xlabel("P_NUM")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



Histogram: BG+1:00/P_NUM

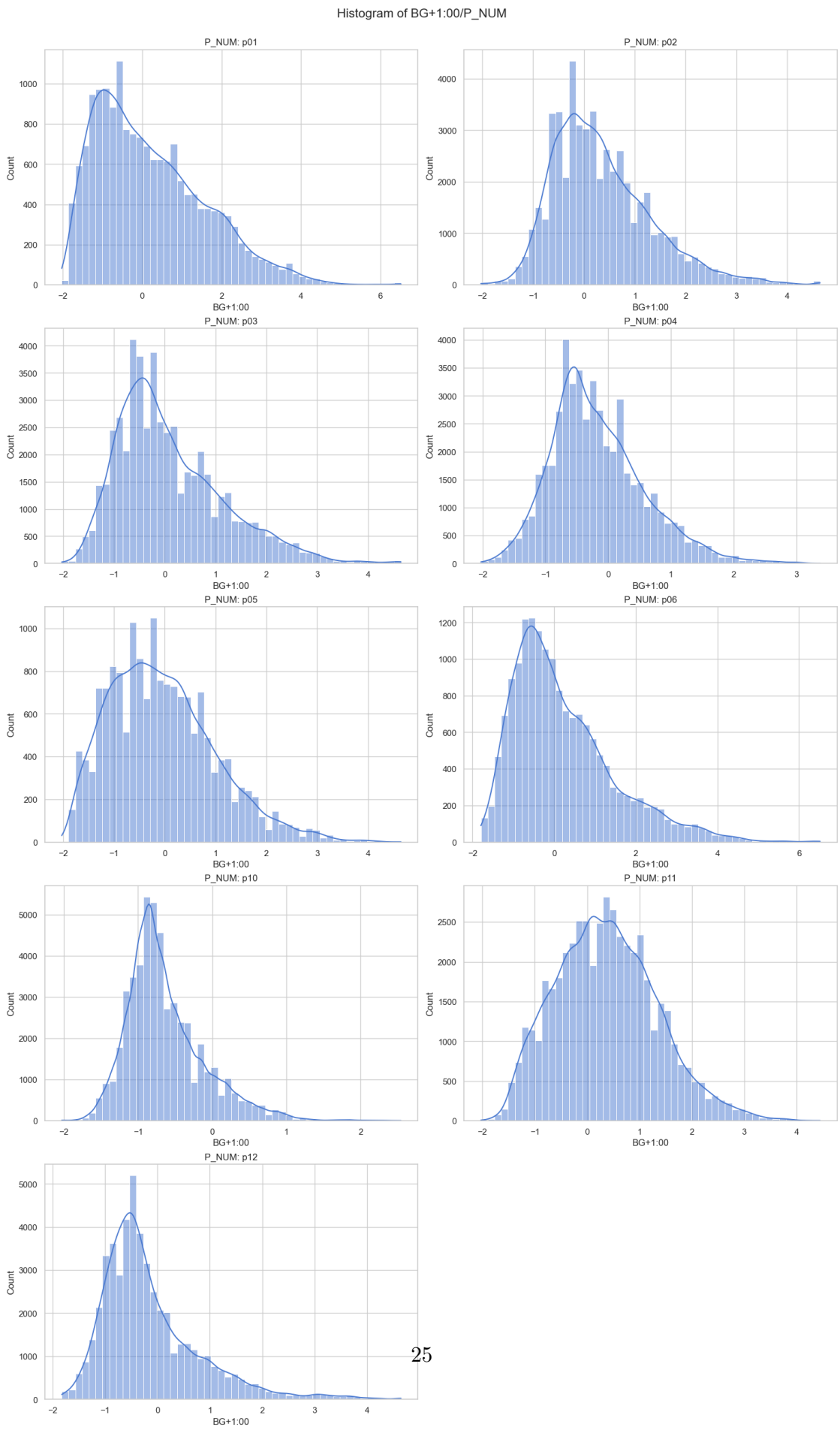
[85]:
```
ncols = 2
nrows = (n + ncols - 1) // ncols
fig, axes = plt.subplots(nrows=nrows, ncols=ncols, figsize=(15, nrows * 5),␣
 ↪constrained_layout=True)

axes = axes.flatten()

for idx, pid in enumerate(participants):
    subset = df_train_preprocessed_pd[df_train_preprocessed_pd["p_num"] == pid]
    ax = axes[idx]
    sns.histplot(subset["bg+1:00"], bins=50, kde=True, ax=ax)
    ax.set_title(f"P_NUM: {pid}")
    ax.set_xlabel("BG+1:00")
    ax.set_ylabel("Count")

for ax in axes[len(participants):]:
    ax.set_visible(False)

plt.suptitle("Histogram of BG+1:00/P_NUM", fontsize=16, y=1.02)
plt.show()
```


Histogram of BG+1:00/P_NUM
P_NUM: p01
P_NUM: p02
P_NUM: p03
P_NUM: p04
P_NUM: p05
P_NUM: p06
P_NUM: p10
P_NUM: p11
P_NUM: p12
Count
BG+1:00