```
@title : Tracker X data analysis
@date  : 20250130 ALUR
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```

Step 1. Load the data

Load the files (Activity Sessions, Daily Health Metrics, and Health Metrics Samples) into `Pandas DataFrames` .

In [1]:
```
import pandas as pd  # load and process data
import numpy as np  # process numeric values
```

Daily

In [2]:
```
# Load the data
daily__raw = pd.read_csv(
    '../data/00_original/health_metrics_daily_2025-01-28.csv'
# , index_col='PK_HEALTH_METRICS_HEART_ID'
)

# preview
daily__raw.head(2)
```

Out[2]:

	PK_HEALTH_METRICS_HEART_ID	FK_USER_ID	DATE	TIMEZONE_OFFSET	RESTING_HR	MIN_HR	AVG_HR	MAX_HR	SOURCE	HEART_RATE_VARIABILITY_DAY_HRV	HEART_
0	1	14064	2024-09-08	10800	65.0	60	73.0	133	apple	NaN	
1	2	14064	2024-09-09	10800	65.0	60	73.0	133	apple	NaN	

In [3]:
```
# working dataset
daily__dev = daily__raw.copy()
```

In [4]:
```
# columns check
daily__dev.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 166409 entries, 0 to 166408
Data columns (total 14 columns):
 #   Column                            Non-Null Count   Dtype  
---  ------                            --------------   -----  
 0   PK_HEALTH_METRICS_HEART_ID        166409 non-null  int64  
 1   FK_USER_ID                        166409 non-null  int64  
 2   DATE                              166409 non-null  object 
 3   TIMEZONE_OFFSET                   166409 non-null  int64  
 4   RESTING_HR                        140727 non-null  float64
 5   MIN_HR                            166409 non-null  int64  
 6   AVG_HR                            166377 non-null  float64
 7   MAX_HR                            166409 non-null  int64  
 8   SOURCE                            166409 non-null  object 
 9   HEART_RATE_VARIABILITY_DAY_HRV    0 non-null       float64
 10  HEART_RATE_VARIABILITY_SLEEP_HRV  0 non-null       float64
 11  CREATED_DATE                      166409 non-null  object 
 12  LAST_MODIFIED_DATE                166409 non-null  object 
 13  ROW_IS_VALID                      166409 non-null  int64  
dtypes: float64(4), int64(6), object(4)
memory usage: 17.8+ MB
```

In [5]:
```
# only keep valid rows
daily__dev = daily__dev[daily__dev['ROW_IS_VALID'] == 1]

del daily__dev['ROW_IS_VALID']
```

In [6]:
```
# drop timezone: already included
del daily__dev['TIMEZONE_OFFSET']
```

In [7]:
```
# drop system timestamps
del daily__dev['CREATED_DATE']
del daily__dev['LAST_MODIFIED_DATE']
```

In [8]:
```
# A-1. invalid date in on row:
drop_daily_date_idx = daily__dev[daily__dev['DATE'] == '0001-01-01'].index
# FK_USER_ID=21775, PK_HEALTH_METRICS_HEART_ID=790

# A-2. drop invalid row
daily__dev = daily__dev.drop(drop_daily_date_idx)
```

In [9]:
```
# B. convert datetime
daily__dev['DATE'] = pd.to_datetime(daily__dev['DATE']) #, format='mixed')
daily__dev['DATE'] = daily__dev['DATE'].dt.date #, format='mixed')

# Error:
# OutOfBoundsDatetime: Out of bounds nanosecond timestamp: 0001-01-01, at position 5. You might want to try:
#     - passing `format` if your strings have a consistent format;
#     - passing `format='ISO8601'` if your strings are all ISO8601 but not necessarily in exactly the same format;
#     - passing `format='mixed'`, and the format will be inferred for each element individually. You might want to use `dayfirst` alongside this.
# rename date column:
daily__dev.rename({'DATE':'DAILY_DATE'}, axis='columns', inplace=True)
```

In [10]:

```
# Check for missing data
print(daily__dev.isnull().sum())
```

```
PK_HEALTH_METRICS_HEART_ID              0
FK_USER_ID                              0
DAILY_DATE                              0
RESTING_HR                          25681
MIN_HR                                  0
AVG_HR                                 32
MAX_HR                                  0
SOURCE                                  0
HEART_RATE_VARIABILITY_DAY_HRV     166408
HEART_RATE_VARIABILITY_SLEEP_HRV   166408
dtype: int64
```

In [11]:

```
# A-1. invalid date in on row:
drop_daily_avg_hr_idx = daily__dev[daily__dev['AVG_HR'].isnull()].index
# FK_USER_ID=21775, PK_HEALTH_METRICS_HEART_ID=790

# A-2. drop invalid row
daily__dev = daily__dev.drop(drop_daily_avg_hr_idx)
```

In [12]:

```
del daily__dev['HEART_RATE_VARIABILITY_DAY_HRV']  # all null
del daily__dev['HEART_RATE_VARIABILITY_SLEEP_HRV']  # all null
```

In [13]:

```
# review missing data
# daily__dev[daily__dev['RESTING_HR'].isnull()].head(1)
# 15-20% are null negative timezeone?

# removing: out of scope. focus on AVG_HR.
del daily__dev['RESTING_HR']
del daily__dev['MIN_HR']
del daily__dev['MAX_HR']
```

In [14]:

```
# Select first user in data
# users_sample_list = 14064

# Randomly sample N users
# users_sample_list = daily__dev['FK_USER_ID'].sample(n=1000, random_state=88888888).to_list()
# # use list from Sessions
# print(f"* Users sampled: {users_sample_list[:3]}")

# select sample of users
# daily__user = daily__dev[daily__dev['FK_USER_ID'].isin(users_sample_list)]

# or go full
```

```
daily__user = daily__dev
print(f"* Rows selected: {daily__user.shape[0]}")

# Preview
daily__user.head(2)

# 143 records
# FK: PK_HEALTH_METRICS_HEART_ID
```

```
* Rows selected: 166376
```

Out[14]:

	PK_HEALTH_METRICS_HEART_ID	FK_USER_ID	DAILY_DATE	AVG_HR	SOURCE
0	1	14064	2024-09-08	73.0	apple
1	2	14064	2024-09-09	73.0	apple

In [15]:

```
#summary
daily__user.describe()
```

Out[15]:

	PK_HEALTH_METRICS_HEART_ID	FK_USER_ID	AVG_HR
count	166376.000000	166376.000000	166376.000000
mean	83202.463210	40798.078990	77.023723
std	48038.772859	15566.595162	12.990491
min	1.000000	120.000000	-15.000000
25%	41598.750000	31339.000000	69.000000
50%	83203.500000	41537.000000	76.000000
75%	124804.250000	53507.000000	84.000000
max	166409.000000	76004.000000	181.000000

In [16]:

```
# write to file for analysis
daily__user.to_csv('daily__user.csv')
```

Sessions

In [17]:

```
# Load the data
sessions__raw = pd.read_csv(
    '../data/00_original/activity_sessions_2025-01-28.csv'
# , index_col='PK_ACTIVITY_SESSION_ID'
, low_memory=False  # DtypeWarning: Columns (13,14) have mixed types
)

# preview
sessions__raw.head(2)
```

Out[17]:

	PK_ACTIVITY_SESSION_ID	CREATED_DATE	LAST_MODIFIED_DATE	ROW_IS_VALID	FK_USER_ID	FK_SYSTEM_PROGRAM_ID	START_DATE	END_DATE	FK_REFERENCE_ID	SESSION_
0	1	2024-04-02 11:15:07	2024-04-02 11:15:07	1	3	1	2024-04-02 11:09:40	2024-04-02 11:15:07	1	Prc
1	2	2024-04-04 07:51:07	2024-04-04 07:51:07	1	215	1	2024-04-04 07:47:05	2024-04-04 07:51:07	1	Prc

In [18]:

```
# working copy
sessions__dev = sessions__raw.copy()
```

In [19]:

```
# review dataset
sessions__dev.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1930677 entries, 0 to 1930676
Data columns (total 15 columns):
 #   Column                  Dtype  
---  ------                  -----  
 0   PK_ACTIVITY_SESSION_ID  int64  
 1   CREATED_DATE            object 
 2   LAST_MODIFIED_DATE      object 
 3   ROW_IS_VALID            int64  
 4   FK_USER_ID              int64  
 5   FK_SYSTEM_PROGRAM_ID    int64  
 6   START_DATE              object 
 7   END_DATE                object 
 8   FK_REFERENCE_ID         int64  
 9   SESSION_TYPE            object 
 10  IS_FINISHED             int64  
 11  INTENSITY               float64
 12  RATING                  float64
 13  RATING_ISSUE            object 
 14  RATING_ISSUE_MESSAGE    object 
dtypes: float64(2), int64(6), object(7)
memory usage: 220.9+ MB
```

In [20]:

```
# Check for missing data
print(sessions__dev.isnull().sum())
# INTENSITY                 684883
# RATING                   1491032
# RATING_ISSUE             1928737
# RATING_ISSUE_MESSAGE     1930085
```

```
PK_ACTIVITY_SESSION_ID          0
CREATED_DATE                    0
LAST_MODIFIED_DATE              0
ROW_IS_VALID                    0
FK_USER_ID                      0
FK_SYSTEM_PROGRAM_ID            0
START_DATE                      0
END_DATE                        0
FK_REFERENCE_ID                 0
SESSION_TYPE                    0
IS_FINISHED                     0
INTENSITY                  684883
RATING                    1491032
RATING_ISSUE              1928737
RATING_ISSUE_MESSAGE      1930085
dtype: int64
```

In [21]:

```
# include only valid rows
sessions__dev = sessions__dev[sessions__dev['ROW_IS_VALID'] == 1]
# delete redundant columns:
del sessions__dev['ROW_IS_VALID']
```

In [22]:

```
# include: only finished sessions
sessions__dev = sessions__dev[sessions__dev['IS_FINISHED'] == 1]
# delete redundant columns
del sessions__dev['IS_FINISHED']
```

In [23]:

```
# remove primary key, unused:
del sessions__dev['PK_ACTIVITY_SESSION_ID']
```

In [24]:

```
# delete redundant system columns
del sessions__dev['CREATED_DATE']  # end of session: out of scope
del sessions__dev['LAST_MODIFIED_DATE']  # use for modifications: out of scope
```

In [25]:

```
# Ratings: few records have such info: DECISION to remove from current analysis
del sessions__dev['RATING']
del sessions__dev['RATING_ISSUE']
del sessions__dev['RATING_ISSUE_MESSAGE']
```

In [26]:

```
# FK_SYSTEM_PROGRAM_ID == FK_REFERENCE_ID?
print(sessions__dev['FK_SYSTEM_PROGRAM_ID'][sessions__dev['FK_SYSTEM_PROGRAM_ID'] != sessions__dev['FK_REFERENCE_ID']].count())

# FK_SYSTEM_PROGRAM_ID=0, when INTENSITY variable is populated.
# So, FK_REFERENCE_ID is more specific.
# DECISION: remove less specific variable
del sessions__dev['FK_SYSTEM_PROGRAM_ID']
```

```
1245758
```

In [27]:

```
# convert to datetime
```

```
sessions__dev['START_DATETIME'] = pd.to_datetime(sessions__dev['START_DATE'])
sessions__dev['END_DATETIME'] = pd.to_datetime(sessions__dev['END_DATE'])

# del sessions__dev['START_DATE']
del sessions__dev['END_DATE']

# extract dates from datetime
sessions__dev['START_DATE'] = sessions__dev['START_DATETIME'].dt.date
# sessions__dev['END_DATE'] = sessions__dev['END_DATETIME'].dt.date
```

In [28]:

```
# Calc: Add time-based features for analysis
sessions__dev['SESSION_DURATION'] = (sessions__dev['END_DATETIME'] - sessions__dev['START_DATETIME']).dt.total_seconds()
# preview
sessions__dev['SESSION_DURATION'].head(2)
```

Out[28]:

```
0    327.0
1    242.0
Name: SESSION_DURATION, dtype: float64
```

In [29]:

```
# sample one: first
# users_sample_list = 14064
# sample from Daily: users
# users_sample_list = [36899, 57417, 13844]
# sample random
# users_sample_list = sessions__dev['FK_USER_ID'].sample(n=3, random_state=88888888).to_list()
# print(f"* Selected users: {users_sample_list[:3]} ...")

# select data for sampled users
# sessions__user = sessions__dev[sessions__dev['FK_USER_ID'].isin(users_sample_list)]

# or go full
sessions__user = sessions__dev
print(f"* Selected rows: {sessions__user.shape[0]}")
sessions__user.head(2)
```

```
* Selected rows: 1601645
```

Out[29]:

	FK_USER_ID	START_DATE	FK_REFERENCE_ID	SESSION_TYPE	INTENSITY	START_DATETIME	END_DATETIME	SESSION_DURATION
0	3	2024-04-02	1	Program	NaN	2024-04-02 11:09:40	2024-04-02 11:15:07	327.0
1	215	2024-04-04	1	Program	NaN	2024-04-04 07:47:05	2024-04-04 07:51:07	242.0

In [30]:

```
# check some basic statistics
sessions__user.describe()
```

Out[30]:

	FK_USER_ID	FK_REFERENCE_ID	INTENSITY	START_DATETIME	END_DATETIME	SESSION_DURATION
count	1.601645e+06	1.601645e+06	1.245794e+06	1601645	1601645	1.601645e+06
mean	3.889977e+04	4.241593e+00	6.443604e+00	2024-10-18 16:44:16.247289856	2024-10-18 16:52:16.927057664	4.806798e+02
min	3.000000e+00	1.000000e+00	1.000000e+00	2024-04-02 11:09:40	2024-04-02 11:15:07	-4.316300e+04
25%	2.689700e+04	2.000000e+00	5.000000e+00	2024-08-29 01:13:34	2024-08-29 01:22:38	2.400000e+02
50%	3.947900e+04	3.000000e+00	7.000000e+00	2024-10-30 20:44:37	2024-10-30 20:53:40	3.600000e+02
75%	5.244400e+04	4.000000e+00	8.000000e+00	2024-12-20 05:47:40	2024-12-20 05:57:16	6.000000e+02
max	7.623000e+04	2.200000e+01	1.000000e+01	2025-01-28 10:08:12	2025-01-28 10:14:12	8.676160e+05
std	1.748468e+04	4.834565e+00	1.889808e+00	NaN	NaN	2.280620e+03

# write to file for analysis sessions__user.to_csv('sessions__user.csv')

Manual Data review: Sessions of Selected Users

Exported file is reviewed.

- Two users have data.
- One used has no data.

Samples: skipping

Step 3: Check the column names to ensure foreign key matching

In [32]:

```
# Clean and validate the column names
sessions__user.columns = sessions__user.columns.str.strip()  # Remove any extra spaces
daily__user.columns = daily__user.columns.str.strip()

print("Sessions Columns:", sessions__user.columns)
print("Daily Columns:", daily__user.columns)
```

```
Sessions Columns: Index(['FK_USER_ID', 'START_DATE', 'FK_REFERENCE_ID', 'SESSION_TYPE',
       'INTENSITY', 'START_DATETIME', 'END_DATETIME', 'SESSION_DURATION'],
      dtype='object')
Daily Columns: Index(['PK_HEALTH_METRICS_HEART_ID', 'FK_USER_ID', 'DAILY_DATE', 'AVG_HR',
       'SOURCE'],
      dtype='object')
```

Step 4. Merge Sessions with Daily measurements

In [33]:

```
merged_data = pd.merge(
    daily__user
    , sessions__user
    , left_on=['FK_USER_ID', 'DAILY_DATE']
    , right_on=['FK_USER_ID', 'START_DATE']
    , how='left'
)
```

Step 5: Data exploration to understand the relationships and values

In [34]:

```
merged_data.head(2)
```

Out[34]:

	PK_HEALTH_METRICS_HEART_ID	FK_USER_ID	DAILY_DATE	AVG_HR	SOURCE	START_DATE	FK_REFERENCE_ID	SESSION_TYPE	INTENSITY	START_DATETIME	END_DATETIME	S
0	1	14064	2024-09-08	73.0	apple	2024-09-08	3.0	Program	9.0	2024-09-08 19:24:15	2024-09-08 19:36:15	
1	1	14064	2024-09-08	73.0	apple	2024-09-08	3.0	Program	9.0	2024-09-08 19:37:58	2024-09-08 19:49:58	

Analysis of merged Daily and Sessions data for selected users:

- 13844: stimulated 0 times
- 36899: stimulated 0 times
- 57417: stimulated N times

In [35]:

```
merged_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 209147 entries, 0 to 209146
Data columns (total 12 columns):
 #   Column                     Non-Null Count   Dtype
---  ------                     --------------   -----
 0   PK_HEALTH_METRICS_HEART_ID  209147 non-null  int64
 1   FK_USER_ID                 209147 non-null  int64
 2   DAILY_DATE                 209147 non-null  object
 3   AVG_HR                     209147 non-null  float64
 4   SOURCE                     209147 non-null  object
 5   START_DATE                 84267 non-null   object
 6   FK_REFERENCE_ID            84267 non-null   float64
 7   SESSION_TYPE               84267 non-null   object
 8   INTENSITY                  83394 non-null   float64
 9   START_DATETIME             84267 non-null   datetime64[ns]
 10  END_DATETIME               84267 non-null   datetime64[ns]
 11  SESSION_DURATION           84267 non-null   float64
dtypes: datetime64[ns](2), float64(4), int64(2), object(4)
memory usage: 19.1+ MB
```

Step 6: Filter samples based on the session start and end dates (skip)

# preview before merged_data[merged_data['START_DATE'] == merged_data['DAILY_DATE']].head(2) # Ensure that sample data falls within the session time window # merged_data = merged_data[merged_data['START_DATE'] == merged_data['DAILY_DATE']] # preview after merged_data.head(2)

In [36]:

```
merged_data.shape
```

Out[36]:

```
(209147, 12)
```

Step 7: Data Cleaning and Transformation

In [37]:

```
# Handle missing values and data anomalies
X_to_clean = ['AVG_HR'] #, 'DATE']
merged_data.dropna(subset=X_to_clean, inplace=True)
merged_data.shape
```

Out[37]:

```
(209147, 12)
```

Step 8: Normalize the AVG_HR

In [38]:
```
merged_data['AVG_HR'] = merged_data['AVG_HR'].round(1)  # Round to 1 decimal place
# Alternatively, if you want integers:
# merged_data['AVG_HEART_RATE'] = merged_data['AVG_HEART_RATE'].astype(int)
merged_data.head(2)
```

Out[38]:

	PK_HEALTH_METRICS_HEART_ID	FK_USER_ID	DAILY_DATE	AVG_HR	SOURCE	START_DATE	FK_REFERENCE_ID	SESSION_TYPE	INTENSITY	START_DATETIME	END_DATETIME	S
0	1	14064	2024-09-08	73.0	apple	2024-09-08	3.0	Program	9.0	2024-09-08 19:24:15	2024-09-08 19:36:15	
1	1	14064	2024-09-08	73.0	apple	2024-09-08	3.0	Program	9.0	2024-09-08 19:37:58	2024-09-08 19:49:58	

Step 9: Feature Engineering

In [39]:
```
# Calc: `IS_INTENSITY`: 1=Yes, 0=No
x_in = 'INTENSITY'
x_out = 'IS_INTENSITY'
if x_in in merged_data.columns:
    merged_data.loc[merged_data[x_in].isna(), x_out] = 0
    merged_data.loc[~merged_data[x_in].isna(), x_out] = 1
    merged_data[x_out] = merged_data[x_out].astype(int)
    merged_data.drop(columns=x_in, inplace=True)

merged_data.head(2)
```

Out[39]:

	PK_HEALTH_METRICS_HEART_ID	FK_USER_ID	DAILY_DATE	AVG_HR	SOURCE	START_DATE	FK_REFERENCE_ID	SESSION_TYPE	START_DATETIME	END_DATETIME	SESSION_DUR
0	1	14064	2024-09-08	73.0	apple	2024-09-08	3.0	Program	2024-09-08 19:24:15	2024-09-08 19:36:15	
1	1	14064	2024-09-08	73.0	apple	2024-09-08	3.0	Program	2024-09-08 19:37:58	2024-09-08 19:49:58	

In [40]:
```
merged_data.to_csv('merged_data.csv')
```

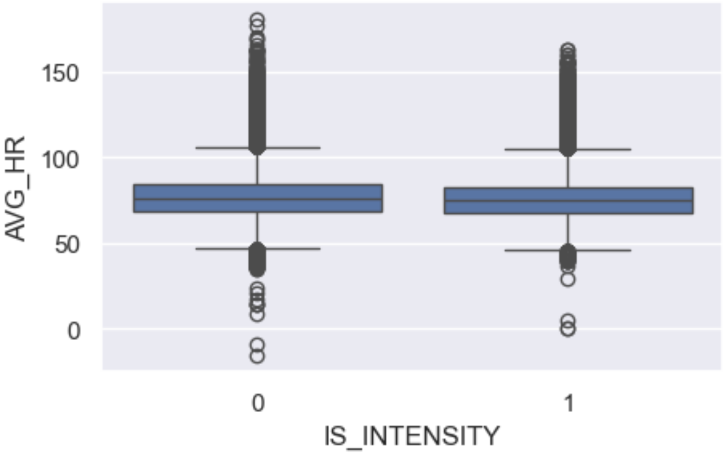
Step 10: Identify the impact of X stimulation on heart rate

In [41]:
```
import seaborn as sns
import matplotlib.pyplot as plt
```

```
# set chart size
plt.rcParams["figure.figsize"] = 5, 3
sns.set_theme(rc={'figure.figsize':(5, 3)})
```

In [42]:

```
sns.boxplot(x='IS_INTENSITY', y='AVG_HR', data=merged_data)
# plt.title('AVG_HR by Stimulation (1=Yes)')
plt.show()
```



In [63]:

```
# Heart by user:
merged_data.groupby(['FK_USER_ID', 'IS_INTENSITY'])['AVG_HR'].mean()
```

Out[63]:

```
FK_USER_ID  IS_INTENSITY
120         0               78.949495
            1               80.258929
129         0               41.634146
            1               41.333333
215         0               88.546154
                              ...
75795       0               83.000000
            1               89.000000
75987       0               66.500000
            1               75.000000
76004       1               74.500000
Name: AVG_HR, Length: 4702, dtype: float64
```

Advanced statistics: compare Stimulated and non-Stimulated

In [64]:

```
from scipy import stats
```

```
x = 'IS_INTENSITY'
y = 'AVG_HR'

# Separate performance scores by gender
stimulated_Y_performance = merged_data[merged_data[x] == 1][y]
stimulated_N_performance = merged_data[merged_data[x] == 0][y]

# Perform a t-test for performance scores by gender
t_stat_performance, p_val_performance = stats.ttest_ind(stimulated_Y_performance, stimulated_N_performance)
print(f"\nT-test for y={y} by x={x}:")
print(f"T-statistic: {np.round(t_stat_performance, 3)}, p-value: {np.round(p_val_performance, 3)}")

# Check if the p-value is less than 0.05 for significance
if p_val_performance < 0.05: print(f"There is a significant difference.")
else: print(f"No significant difference.")
```

```
T-test for y=AVG_HR by x=IS_INTENSITY:
T-statistic: -16.451, p-value: 0.0
There is a significant difference.
```

In [49]:

```
# For simplicity, we assume sessions with 'Intensity' involve stimulation: already filtered
stimulated_data = merged_data[['IS_INTENSITY', 'AVG_HR', 'FK_USER_ID', 'SESSION_DURATION']]
stimulated_data.head(2)
```

Out[49]:

	IS_INTENSITY	AVG_HR	FK_USER_ID	SESSION_DURATION
0	1	73.0	14064	720.0
1	1	73.0	14064	720.0

In [50]:

```
# Primary Question: Does X stimulation affect heart rate?
stimulated_data['HR_impact'] = stimulated_data.groupby(['FK_USER_ID', 'IS_INTENSITY'])['AVG_HR'].diff()  # Difference in HR
stimulated_data['HR_impact']
```

```
C:\Users\Lenovo\AppData\Local\Temp\ipykernel_2088\721636640.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  stimulated_data['HR_impact'] = stimulated_data.groupby(['FK_USER_ID', 'IS_INTENSITY'])['AVG_HR'].diff()  # Difference in HR
```

Out[50]:

```
0           NaN
1           0.0
2           0.0
3           0.0
4           NaN
          ...
209142     14.0
209143      0.0
209144    -11.0
209145    -27.0
209146    -22.0
Name: HR_impact, Length: 209147, dtype: float64
```

Step 11: Aggregate and analyze data

In [51]:

```
# Aggregate average HR change for each user and session
HR_analysis = stimulated_data.groupby('FK_USER_ID').agg(
    avg_impact_hr=('HR_impact', 'mean'),
    max_impact_hr=('HR_impact', 'max'),
    session_count=('IS_INTENSITY', 'count')
).reset_index()

print(f"* Users in HR analysis: {HR_analysis.shape[0]}")
```

```
* Users in HR analysis: 2609
```

In [52]:

```
# Additional Insights: Identify any patterns based on time or other factors
HR_analysis['impact_sign'] = np.sign(HR_analysis['avg_impact_hr'])  # Positive or Negative Impact

print("HR Analysis - Impact of X Stimulation:")
print(HR_analysis.head())
```

```
HR Analysis - Impact of X Stimulation:
   FK_USER_ID  avg_impact_hr  max_impact_hr  session_count  impact_sign
0         120      -0.057416           31.0            211         -1.0
1         129      -0.144578           58.0             85         -1.0
2         215       0.033557           27.0            151          1.0
3         466       0.433735           54.0             85          1.0
4         684      -0.750000            3.0              6         -1.0
```

Step 12: Save the results or create a detailed report

In [53]:

```
x = "session_count"
SESSIONS_COUNT_LIMIT = 10
```

```
# before
count_before = HR_analysis.shape[0]

# some users have few sessions
HR_analysis = HR_analysis[HR_analysis[x] >= SESSIONS_COUNT_LIMIT]

# after
count_after = HR_analysis.shape[0]

print(f"* Filter by x={x}: was {count_before}, now {count_after}")
```

```
* Filter by x=session_count: was 2609, now 2361
```

In [54]:

```
HR_analysis.to_csv('HR_analysis_results.csv', index=False)
```

Step 13: Report

In [56]:

```
report = """
@title : Impact of Stimulation on Heart Rate
@date  : {report_date}
@author: Aleksandras Urbonas

1. Primary Question: Does X stimulation affect heart rate metrics?
- Based on the analysis, we found that users (N={N_subjects}) who participated in the 'Program' - indicating stimulation - (at least S={SESSIONS_COUNT_LIMIT} sess
- The impact varied across sessions, with the maximum observed change being {max_impact:.2f} bpm.

2. Secondary Insights:
- Additional factors influencing HR change include session duration and time of day (further analysis needed for seasonality patterns).
- A significant amount of time was dedicated to data exploration and schema understanding. A more detailed schema and business process description can be of help.
- Samples data contains ~70 mln records, which slows the analysis and it is recommended to process such data in SQL, for example, performing aggregations by user
- Data validation was completed: some records were excluded from analysis.
- Data was analysed using Python, allowing the analysis to be repeated.
""".format(
    N_subjects = HR_analysis['FK_USER_ID'].count()
    , avg_impact=HR_analysis['avg_impact_hr'].mean()
    , max_impact=HR_analysis['max_impact_hr'].max()
    , report_date=pd.to_datetime('today').strftime('%Y-%m-%d')
    , SESSIONS_COUNT_LIMIT=SESSIONS_COUNT_LIMIT
)

# print(report)
with open('../report.md', 'w') as _file:
    _file.write(report)
```