# 캡스톤 프로젝트

## - NN(RR) interval

:심전도에서 인접한 QRS 복합체 사이에서 R과 연속된 다음 R 사이의 간격을 말하고,

NN간격으로 그 순간의 심박동수가 결정됨

🔗 <30312E20C1BEBCB320B9DAB1E2C1BE2E687770> (e-acn.org)

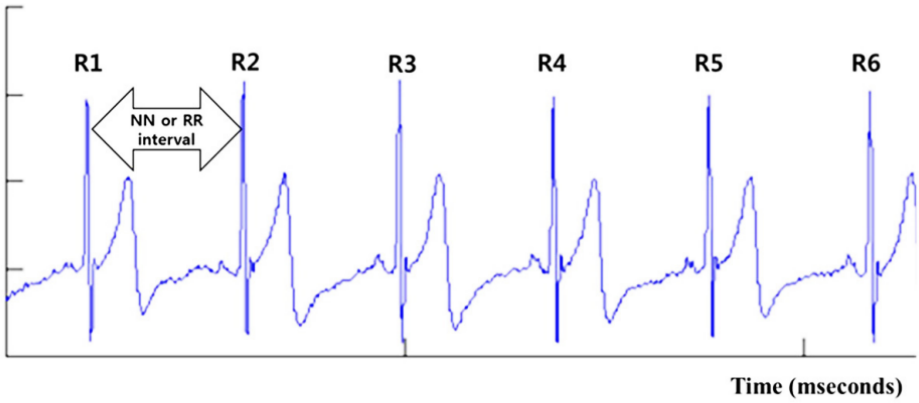


**Figure 1.** NN or RR interval in ECG.

### → NN interval과 HR(Heart Rate)의 관계

$$HR = 60,000/NNinterval(ms)$$

참고) 심박 변이도 지표

**Table 1.** Time domain variables of heart rate variability[1]

| Variable | Description | Units |
|---|---|---|
| Statistical measures | | |
| SDNN | Standard deviation of all NN intervals | ms |
| SDANN | Standard deviation of the averages of NN intervals in all 5 min segments of the entire recording | ms |
| RMSSD | The square root of the mean of the sum of the squares of differences between adjacent NN intervals | ms |
| SDNN index | Mean of the standard deviations of all NN intervals for all 5 min segments of the entire recording | ms |
| SDSD | Standard deviation of differences between adjacent NN intervals | ms |
| NN50 count | Number of pairs of adjacent NN intervals differing by more than 50 ms in the entire recording | |
| pNN50 | PNN50 count divided by the total number of all NN intervals | % |
| Geometric measures | | |
| HRV triangular index | Total number of all NN intervals divided by the maximum number of all NN intervals in the distribution histogram (height of the histogram) of all NN intervals | |

**Table 2.** Frequency domain measures of HRV[1]

| Variables | Description | Frequency range | Units |
|---|---|---|---|
| Analysis of short-term recordings (5 min) | | | |
| Total power | The variance of NN intervals over the temporal segment | Approximately ≤0.4 Hz | $ms^2$ |
| VLF | Power in very low frequency range | ≤0.04 Hz | $ms^2$ |
| LF | Power in low frequency range | 0.04-0.15 Hz | $ms^2$ |
| LF norm or LFn | LF power in normalized units (LF/(total power-VLF)) × 100 | | |
| HF | Power in high frequency range | 0.15-0.4 Hz | $ms^2$ |
| HF norm or LFn | HF power in normalized units (HF/(total power-VLF)) × 100 | | |
| LF/HF | Sympathovagal balance | | |
| Analysis of entire 24 h | | | |
| Total power | Variance of all NN intervals | Approximately ≤0.4 Hz | |
| ULF | Power in the ultra low frequency range | ≤0.003 Hz | $ms^2$ |
| VLF | Power in the very low frequency range | ≤0.04 Hz | $ms^2$ |
| LF | Power in the low frequency range | 0.04-0.15 Hz | $ms^2$ |
| HF | Power in the high frequency range | 0.15-0.4 Hz | $ms^2$ |

HRV; heart rate variability, VLF; very low frequency, LF; low frequency, HF; high frequency, ULF; ultra low frequency.

# - hrvanalysis 모듈 소개

: SciPy, AstroPy, Nolds 및 NumPy를 기반으로 구축되고 GPLv3 라이선스에 따라 배포되는 RR(NN) 간격의 심박수 변동성 분석을 위한 Python 모듈

🔗 https://github.com/Aura-healthcare/hrv-analysis

## → NN간격에서 얻을 수 있는 4가지 기능

① Time domain features : **Mean_NNI, SDNN, SDSD, NN50, pNN50, NN20, pNN20, RMSSD, Median_NN, Range_NN, CVSD, CV_NNI, Mean_HR, Max_HR, Min_HR, STD_HR**

② Geometrical domain features : **Triangular_index, TINN**

③ Frequency domain features : **LF, HF, VLF, LH/HF ratio, LFnu 등**

④ Non Linear domain features : **CSI, CVI, Modified_CSI, SD1, SD2, 등**

## - 예시 코드

```
#fitbit데이터 불러오기
import pandas as pd
fp = pd.read_csv('/content/drive/MyDrive/캡스톤/all_intradata_1.csv')
fp
```

| | time | value | date |
|---|---|---|---|
| **0** | 00:00:04 | 72 | 2022-04-06 |
| **1** | 00:00:14 | 68 | 2022-04-06 |
| **2** | 00:00:19 | 65 | 2022-04-06 |
| **3** | 00:00:24 | 63 | 2022-04-06 |
| **4** | 00:00:29 | 62 | 2022-04-06 |
| **...** | ... | ... | ... |
| **67664** | 22:49:08 | 86 | 2022-04-11 |
| **67665** | 22:49:13 | 85 | 2022-04-11 |
| **67666** | 22:49:18 | 83 | 2022-04-11 |
| **67667** | 22:49:23 | 84 | 2022-04-11 |
| **67668** | 22:49:28 | 83 | 2022-04-11 |

67669 rows × 3 columns

```
#nn_intervals 계산
nn_intervals = 60000/ fp['value']
nn_intervals
```

```
0        833.333333
1        882.352941
2        923.076923
3        952.380952
4        967.741935
            ...
67664    697.674419
67665    705.882353
67666    722.891566
67667    714.285714
67668    722.891566
Name: value, Length: 67669, dtype: float64
```

```
#hrvanalysis 모듈 설치하고 필요한 기능 불러오기
!pip install hrv-analysis
from hrvanalysis import get_time_domain_features
from hrvanalysis import get_geometrical_features
from hrvanalysis import get_frequency_domain_features
```

```
time_domain_features = get_time_domain_features(nn_intervals)
time_domain_features
```

```
{'cvnni': 0.23935136270349497,
 'cvsd': 0.024107473224207726,
 'max_hr': 172.0,
 'mean_hr': 86.44736880994252,
 'mean_nni': 734.568199326023,
 'median_nni': 697.6744186046511,
 'min_hr': 50.0,
 'nni_20': 8192,
 'nni_50': 1264,
 'pnni_20': 12.106165395755749,
 'pnni_50': 1.8679434887982502,
 'range_nni': 851.1627906976744,
 'rmssd': 17.708583196606583,
 'sdnn': 175.81989950733612,
 'sdsd': 17.708583121394746,
 'std_hr': 20.673928934755985}
```

```
geometrical_features = get_geometrical_features(nn_intervals)
geometrical_features
```

```
{'tinn': None, 'triangular_index': 29.03003003003003}
```

```
frequency_domain_features = get_frequency_domain_features(nn_intervals)
frequency_domain_features
```

```
{'hf': 108.80890063131919,
 'hfnu': 19.128644870339762,
 'lf': 460.0181196247505,
 'lf_hf_ratio': 4.227761855470309,
 'lfnu': 80.87135512966024,
 'total_power': 1249.0986783326118,
 'vlf': 680.2716580765422}
```

## -스트레스지수 산출

🔗 KR100745972B1 - 심박간격변이도를 이용한 표준지표 산출 방법 - Google Patents

$$\text{급성스트레스지수} = \frac{T_{LF/HF} + T_{HR}}{2}$$

여기서, $T_{LF/HF}$ = 자율신경 균형도(LF/HF)의 표준지표($T_i$),

$T_{HR}$ = 신체각성도(HR)의 표준지표($T_i$).

$$\text{만성스트레스지수} = 2M - \frac{T_{SDNN} + T_{HRV\text{-}Idx}}{2}$$

여기서, 2M의 M = 각각의 평균($m_i$)의 기준이 되는 평균,

$T_{SDNN}$ = 스트레스 저항도(SDNN)의 표준지표($T_i$),

$T_{HRV\text{-}Idx}$ = 심기능 활성도(HRV-Index)의 표준지표($T_i$).