WORKSHOP

Linear Analysis
Variability of Signal

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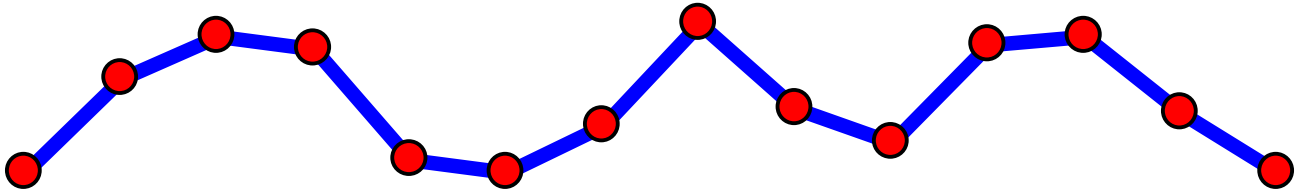
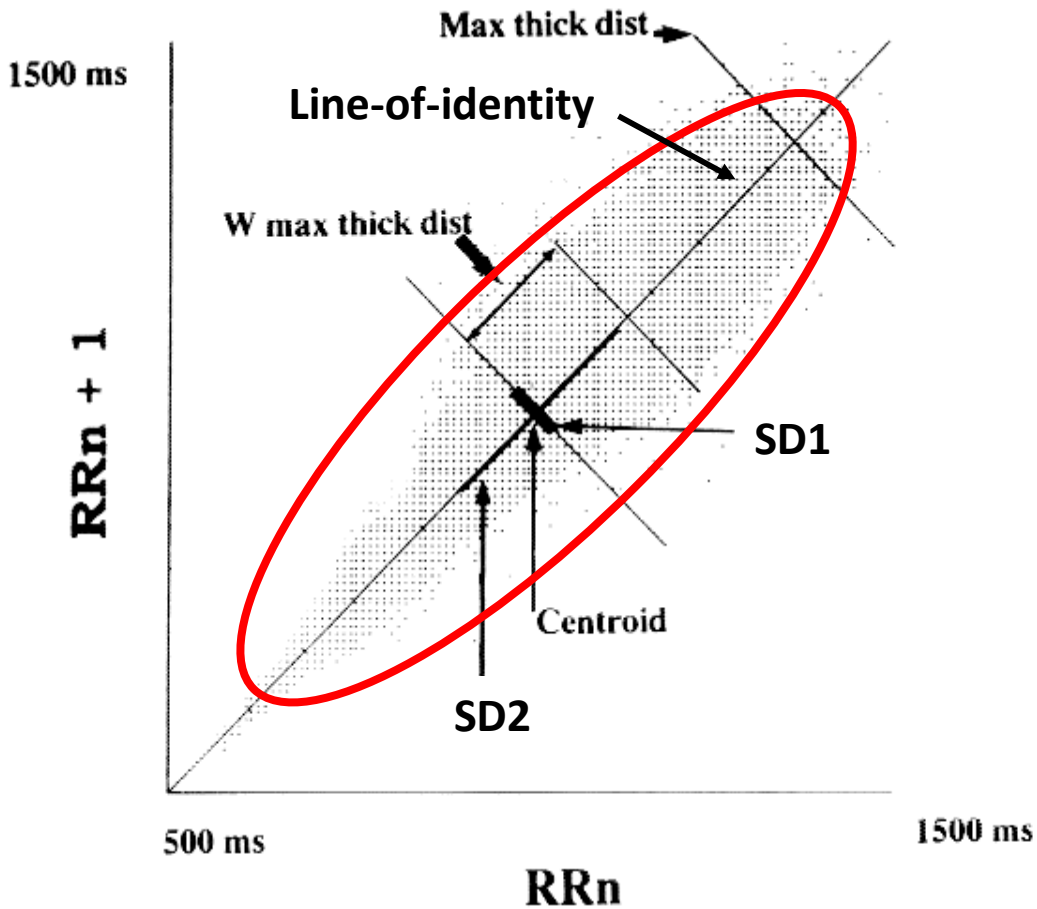
Definition of Time Domain HRV Measures



SDNN	Standard deviation of normal interbeat intervals
SDANN	standard deviation of the averages of normal interbeat intervals in all five minutes segments of the entire recording
RMSSD	Square root of the mean of the squared differences between successive interbeat intervals
pNN50	Percentage of adjacent intervals that varied by greater than 50 ms

Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology: Heart rate variability: standards of measurement, physiological interpretation and clinical use. Circulation 1996;93:1043-1065.14

Poincaré Plot



SD1: dispersion (standard deviation) of points perpendicular to the axis of line-of-identity

SD2: dispersion (standard deviation) of points along the axis of line-of-identity

Huikuri, H. V. et al. Circulation 1996;93:1836-1844

Poincaré Plot Indices

- Ellipse fitting technique

$$\mathrm{SD1}^2 = \mathrm{Var}(x_1) = \mathrm{Var}\left(\frac{1}{\sqrt{2}}\mathrm{RR}_n - \frac{1}{\sqrt{2}}\mathrm{RR}_{n+1}\right)$$
$$= \tfrac{1}{2}\mathrm{Var}(\mathrm{RR}_n - \mathrm{RR}_{n+1}) = \tfrac{1}{2}\mathrm{SDSD}^2.$$

$$\mathrm{SD2}^2 = 2SDRR^2 - \tfrac{1}{2}\mathrm{SDSD}^2.$$

SDRR : standard deviation of the RR intervals

SDSD: standard deviation of the successive differences of the RR intervals

Brennan M. et al. IEEE Trans Biomed Eng 2001;48:1342-47

Objective

- Plot histogram in Excel
- Calculate time domain indices
  - SDNN
  - RMSSD
  - pNN50
- Create Poincaré Plot
- Calculate Poincaré Plot indices
  - SD1
  - SD2
  - SD1/SD2

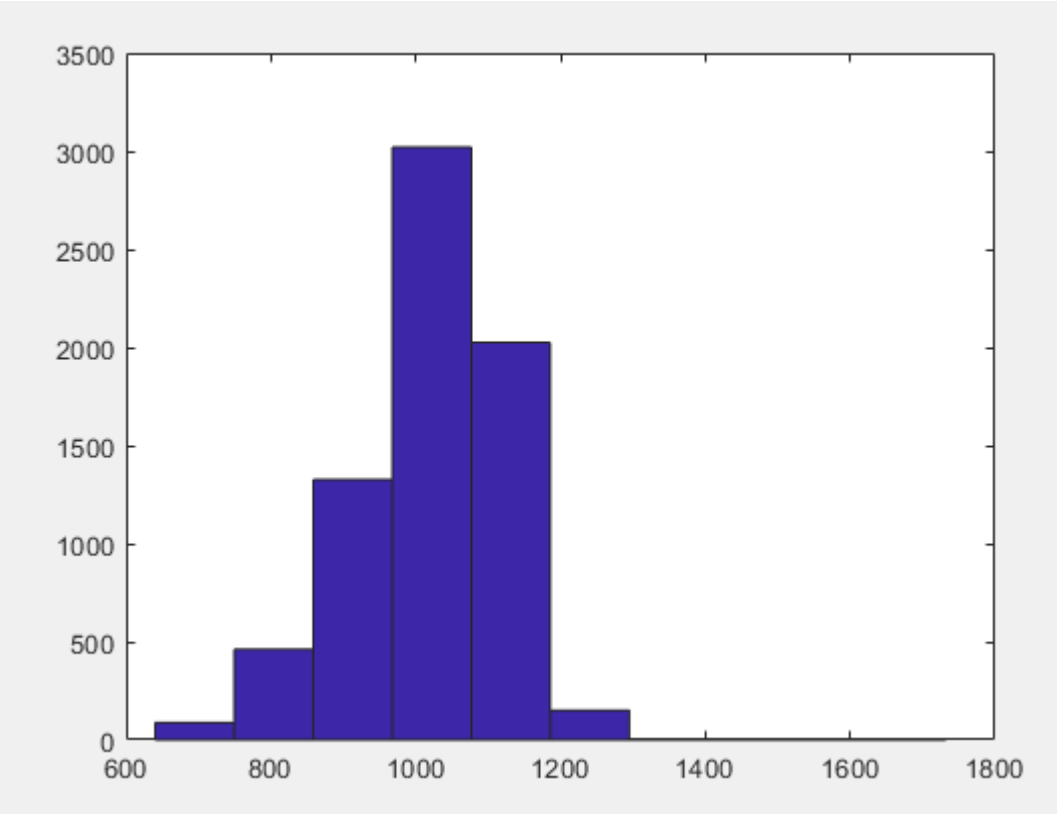
Matlab

- Repeat the objective using Matlab

- Function to be learned
  - hist
  - mean
  - Std
  - diff
  - sum
  - sqrt
  - power (^)
  - logical expression

hist

- HR01=load('HR01.txt');
- hist(HR01)



SDNN

- mean(HR01)
- sdnn=std(HR01)

RMSSD

- Square root of the mean of the squared differences between successive interbeat intervals

- diffrr=diff(HR01);
- rmssd=sqrt(mean(diffrr.^2))

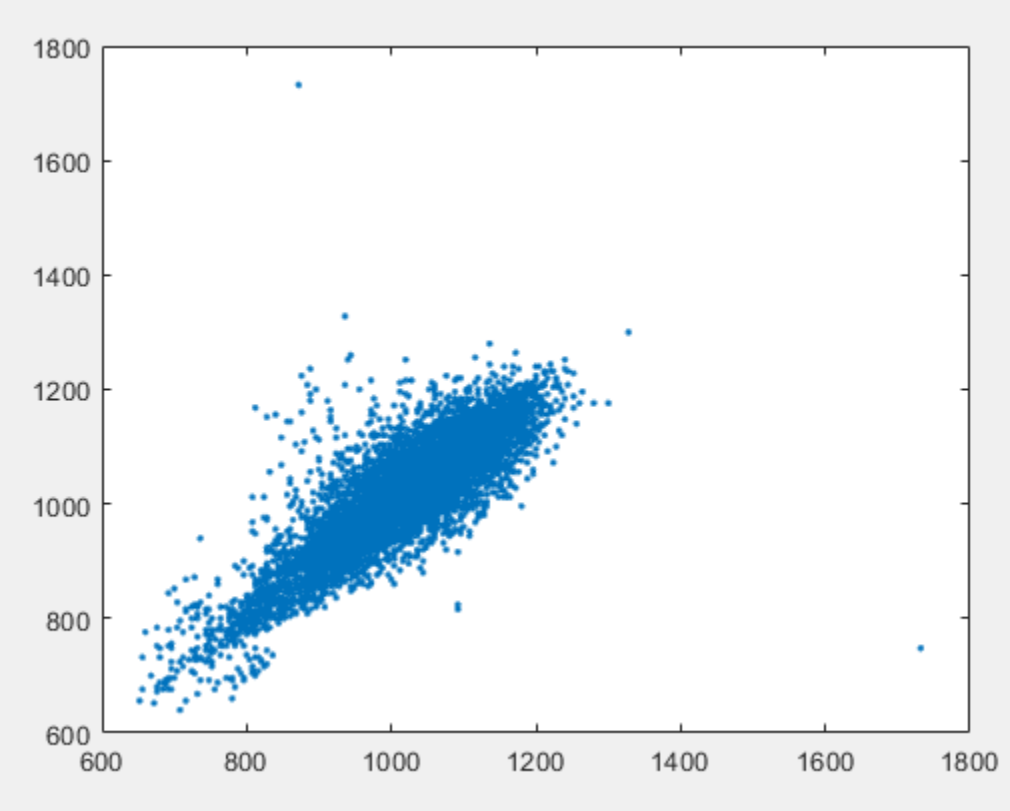
pNN50

- Percentage of adjacent intervals that varied by greater than 50 ms

- diffrr=diff(HR01);
- nn50=abs(diffrr)>50;
- pnn50=sum(nn50)/length(nn50)*100

Poincaré Plot

- plot(HR01(1:end-1),HR01(2:end),'.')



SD1 vs. SD2

$$\mathrm{SD1}^2 = \mathrm{Var}(x_1) = \mathrm{Var}\left(\frac{1}{\sqrt{2}}\mathrm{RR}_n - \frac{1}{\sqrt{2}}\mathrm{RR}_{n+1}\right)$$
$$= \tfrac{1}{2}\mathrm{Var}(\mathrm{RR}_n - \mathrm{RR}_{n+1}) = \tfrac{1}{2}\mathrm{SDSD}^2.$$

$$\mathrm{SD2}^2 = 2SDRR^2 - \tfrac{1}{2}\mathrm{SDSD}^2.$$

SDRR : standard deviation of the RR intervals

SDSD: standard deviation of the successive differences of the RR intervals

- sdsd=std(diffrr);
- sdrr=std(HR01);
- sd1=sqrt(0.5*sdsd^2)
- sd2=sqrt(2*sdrr^2-0.5*sdsd^2)