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# A Study of Teager-Kaiser Energy Operator Pertinence for R Peak Detection in ECG Recordings

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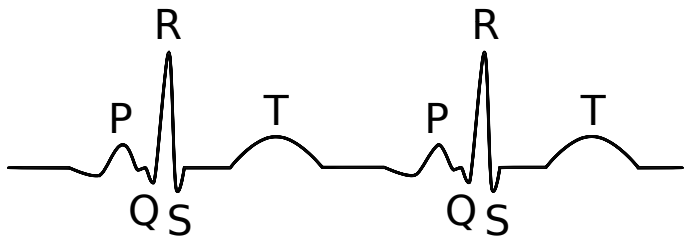
# Motivation

- Number 1 cause of death globally (31% of all global deaths in 2012)[1]
- Contribution of CVDs to mortality in CIS (percents)

| | |
|---|---|
| Georgia | 67 |
| Ukraine | 64 |
| Azerbaijan | 60 |
| Russia | 57 |
| Moldova | 56 |
| Belorussia | 53 |
| Kazakhstan | 50 |
| Armenia | 50 |
| Kyrgyzstan | 49 |
| Tajikistan | 39 |

- Can be prevented by addressing behavioural risk factors (tobacco use, unhealthy diet, obesity, physical inactivity, etc.)
- Need early detection and management
- Can be done based on ECG analysis




[1]Source: WHO

# Significance of confident R peak detection

- Normal sinus rhythm

- Sinus tachycardia

- Sinus bradycardia

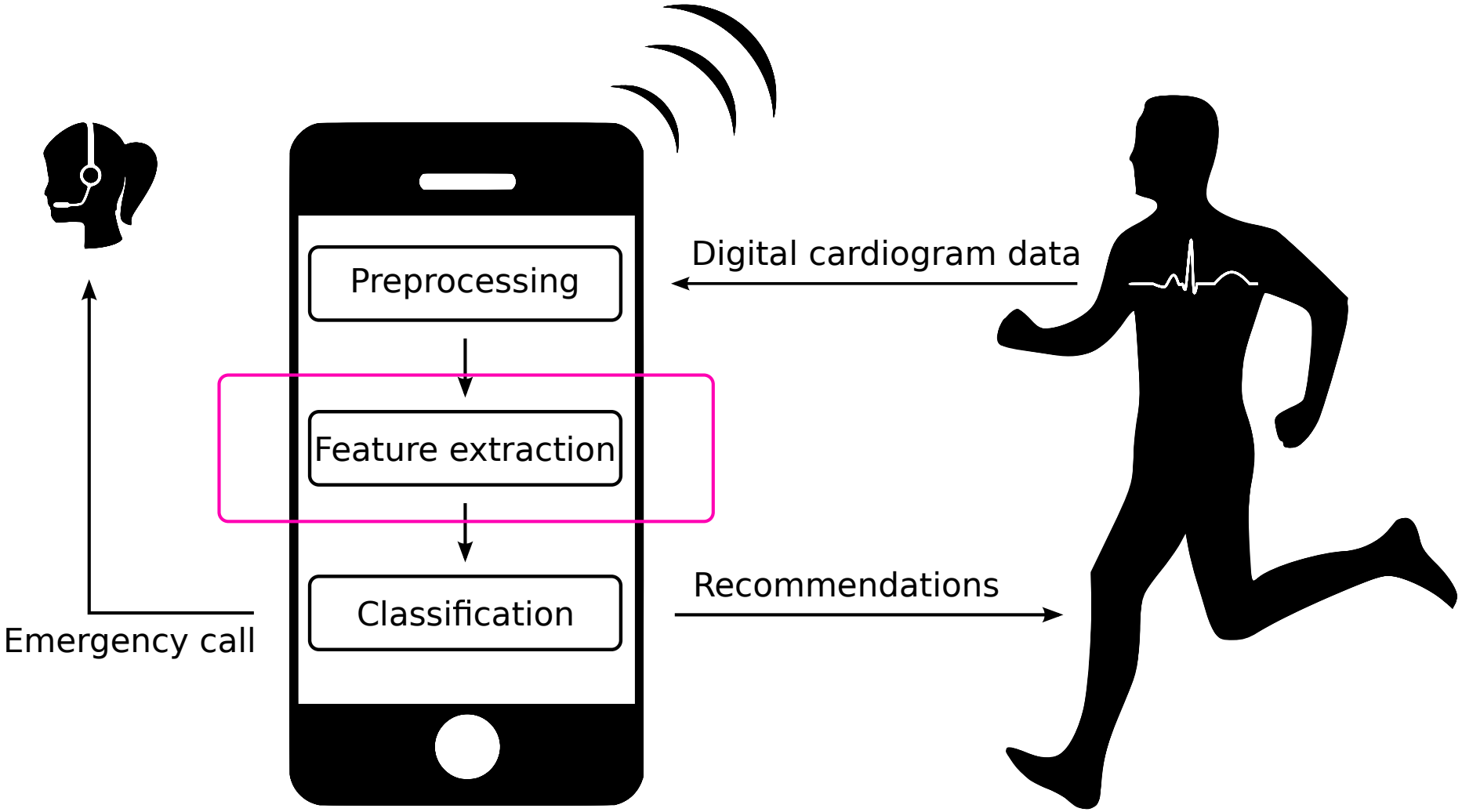
- Sinoatrial block

- Atrial flutter

- Wolff-Parkinson-White syndrome

Source: Medical Training and Simulation LLC
http://www.practicalclinicalskills.com

# Arrhythmia detection based on continuous monitoring



# Teager-Kaiser energy operator based approach

Consider the digital ECG recording represented by discrete signal $x_n$

1. Estimate the instantaneous energy of a signal

$$\Psi_d[x_n] = x_n^2 - x_{n-1}x_{n+1}$$

2. Emphasize the pulses

$$y_n = \Psi_d[x_n]^3$$

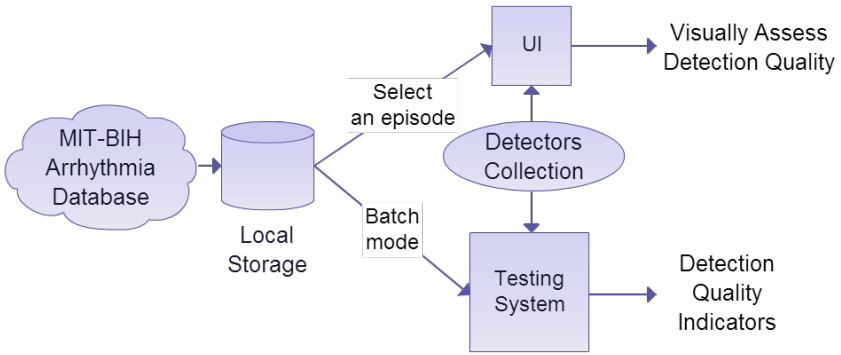
3. Choosing parameters $N$, $\alpha$ and $\beta$, apply the adaptive threshold

$$z_n = \alpha \frac{1}{N+1} \sum_{k=-N}^{N} y_k + \beta\sigma_y$$

Source: Yamamoto and Yoshida, 2013

# Contribution, experiments and results

- An one-pass algorithm of R Peak detection have been constructed based on the approach.
- The algorithm have been implemented as a C / C++ library
- The verification tool have been built.




- Set of experiments with signal from MIT_BIH Arrhythmia Database
- Good sensitivity on the signals with sinus where a sinus rhythm is identified.
- More chaotic signals reported to be too hard for well-known precise methods as well.