BED

A Blood Pressure Event Detector

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Orientador - Dr. João Paulo Cunha

Introduction

RTAB – Hgaia association:

- **12** Acquisitions
  - **4** Useful (Good PTT, HR and invasive SBP signals)
  - **8** Not Useful (At least one signal not usable). **Causes:** frequent intermittences or long periods of unavailable data.

So far, Matlab simulations have been conducted using data extracted from MIMIC Physionet 2.

Two datasets:

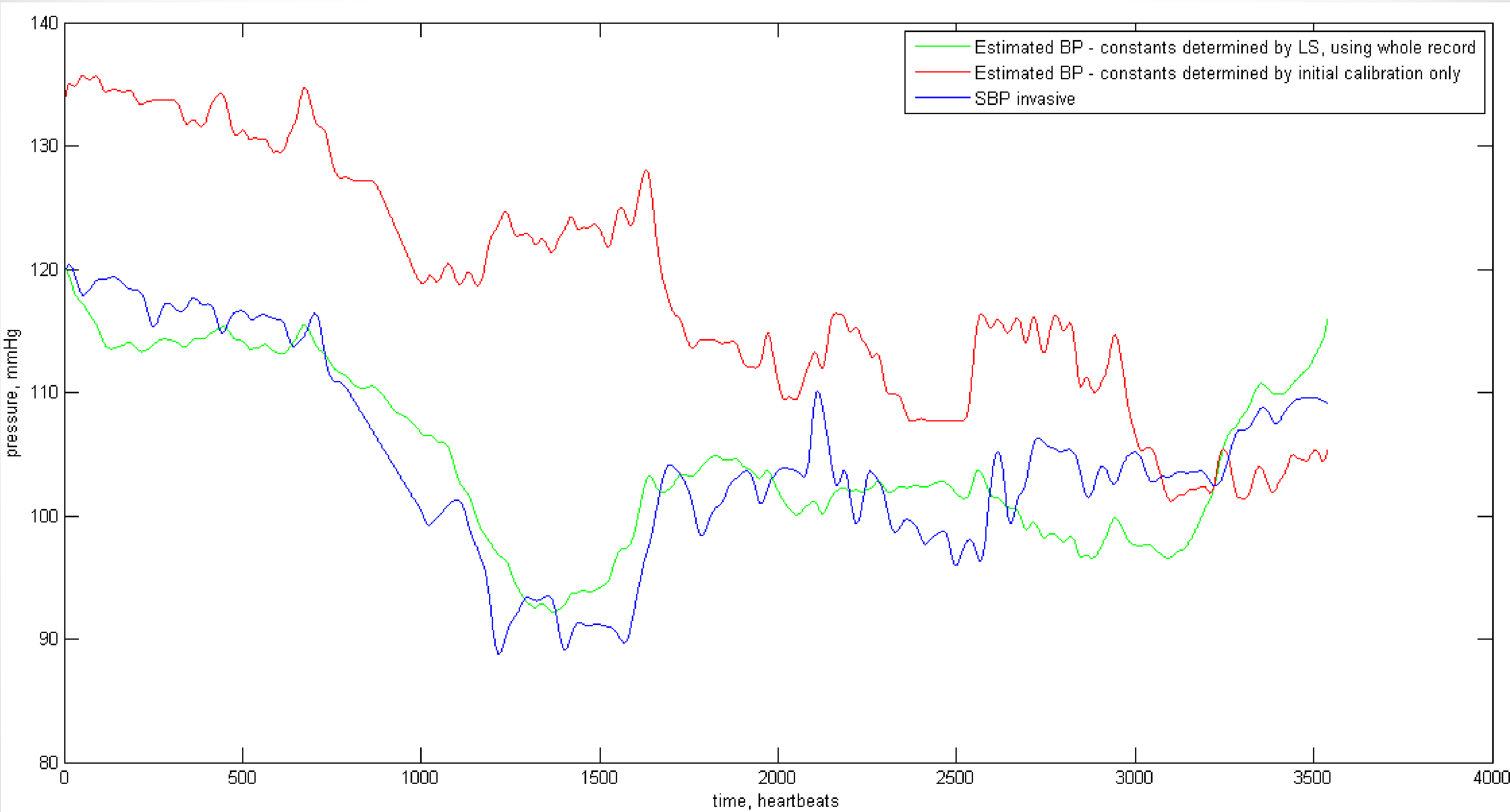
- Records from people **between 60 and 65 years old** with tendency to show **high** blood pressure levels.
- Records from people **under 40 years old**, represented by **sudden** blood pressure **changes**.

The Problem

$$BP = a \cdot PTT + b \cdot HR + c \qquad (1)$$

- Blood Pressure **can be estimated** using the model represented in (1).
- **Calibration constants (a,b,c)** are determined by Least Squares Fitting and using 10-40 initially observed values of SBP.
- **However**, the study of these constants have shown that these **evolve considerably** over time, and the **ones calculated initially grow obsolete with time** if re-calibration isn't performed within a short period of time.

The Problem



Estimated BP - constants determined by LS, using whole record
Estimated BP - constants determined by initial calibration only
SBP invasive
pressure, mmHg
time, heartbeats
140
130
120
110
100
90
80
0
500
1000
1500
2000
2500
3000
3500
4000

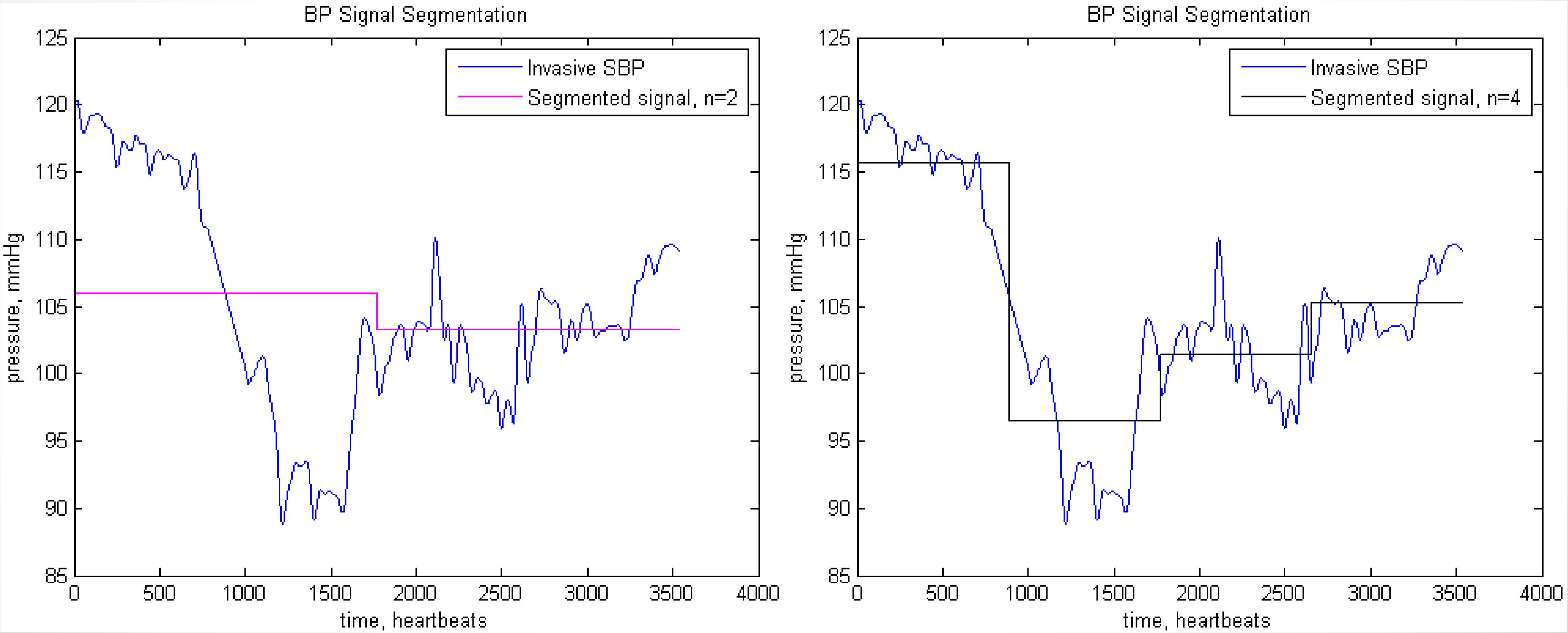
Motivation

- Yet, in most cases, with a well fixed *a* and *b*, we find the invasive and estimated SBP curves to be **similar** in shape.
- Furthermore, many estimated signals have proven to be a **good indicator of large variations** in SBP.

Can a **system** be developed to **detect blood pressure events** based on considerable **large variations** of **systolic blood pressure**?

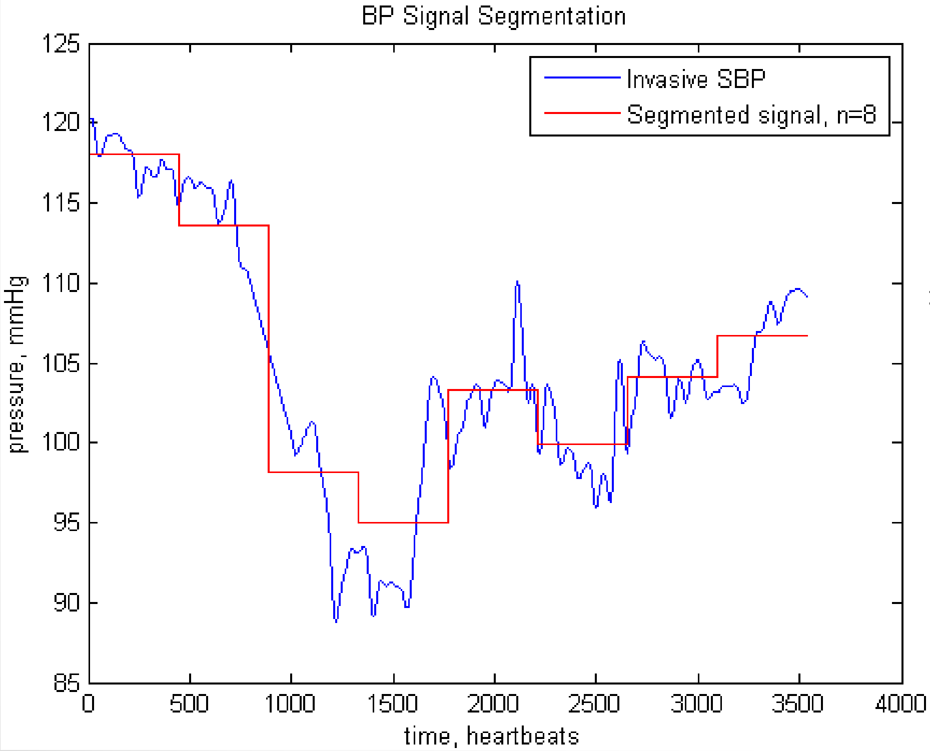
Signal Segmentation

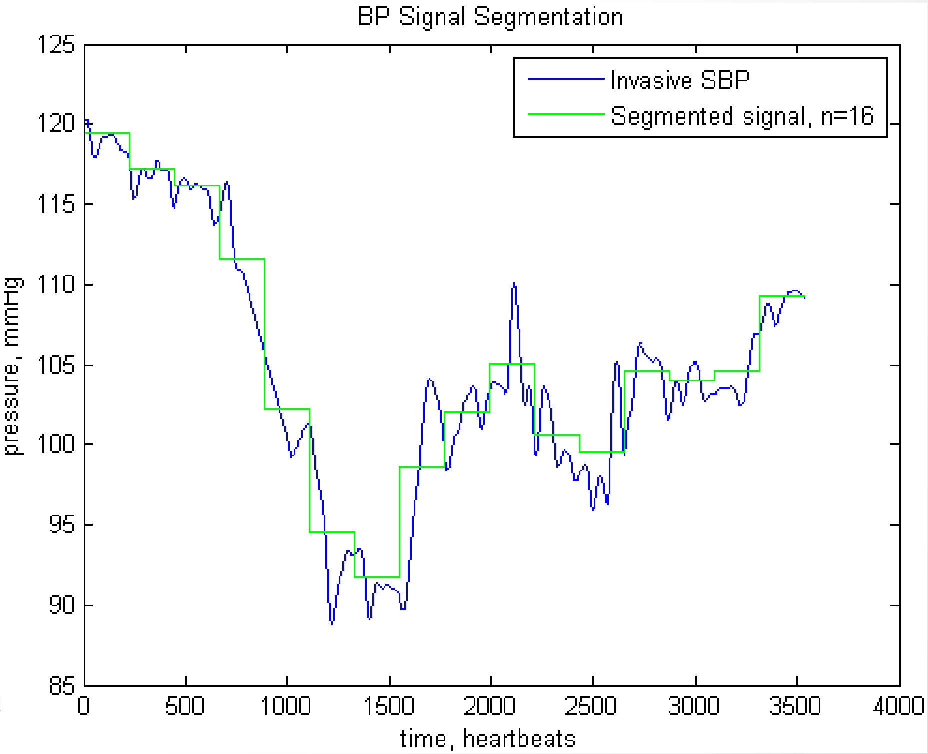
Break the signal into n equal segments, which represent the mean value of the samples in that segment. Vary $n = 2^p$, with $p = 1,2,3,4...$



Signal Segmentation

Which segmentation represents best the signal and enables the detetection of BP events, with the highest rate of true positives and the lowest rate of false positives?





AIC –Akaike Information Criterion

Size = Number of samples that the signal contains

n = Number of segments in which the signal is divided in. It is equal to 2^p $where\ p = 1,2,3,4$.

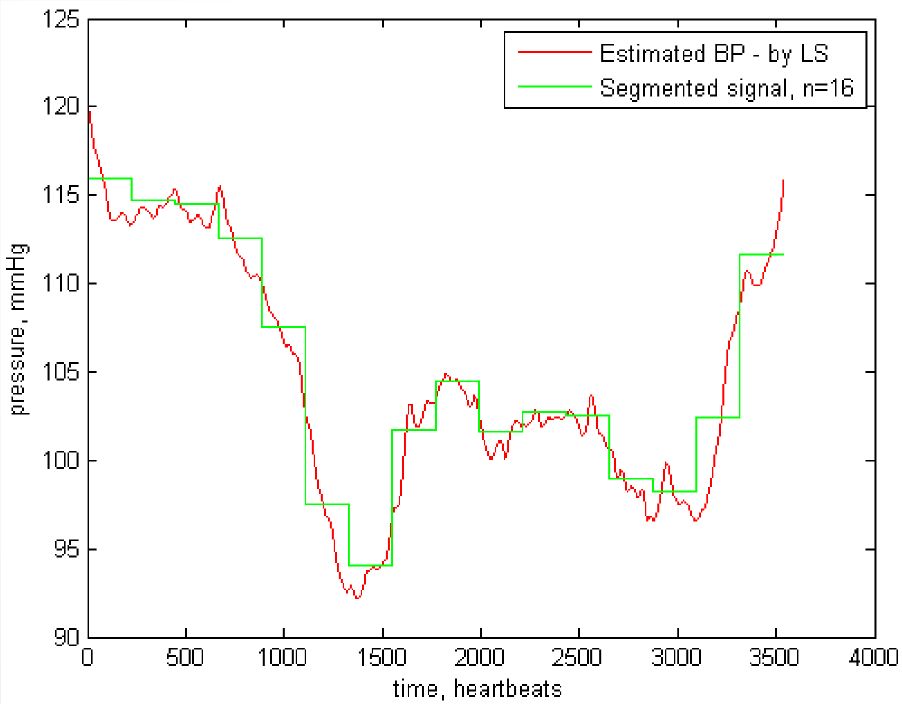
$$AIC = \log\left(\sum_{i=1}^{size}(x_i - \bar{x})^2\right) + \frac{size + 2n}{size}$$

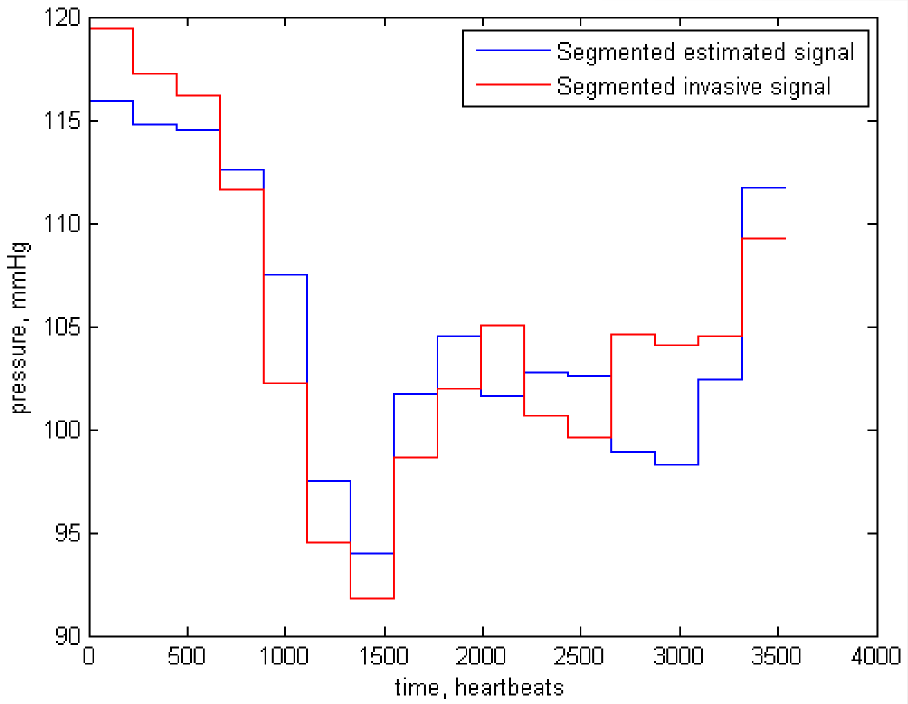
$and\ \bar{x}\ changes\ according\ to\ the\ segment\ in\ which\ x_i\ \ is\ currently\ being\ evaluated\ on.$

The value of n that **minimizes AIC**, corresponds to the segmented signal which **approximates best** the non-segmented signal.

Signal Segmentation

Comparing the estimated and invasive SBP signals, after segmentation:





Detection criteria

AIC values of previous graphs:

- $AIC_{n=2} = 5.1178$
- $AIC_{n=4} = 3.5893$
- $AIC_{n=8} = 3.3429$
- $AIC_{n=16} = 2.6953$

AIC is minimum for n = 16, which indicates that this segmentation might be the one that allows for more information on the signal's structural changes.

Given the **mean values** of the segments, of the chosen segmentation type (n=16, in this case), how to use these to **test** if a BP **event occured**, or not?

Detection criteria

A segment may be eligible as a BP event if:

- **First Requirement:**

  The previous segments have shown a clear tendency of BP to increase or decrease, in the last 15/20 min.

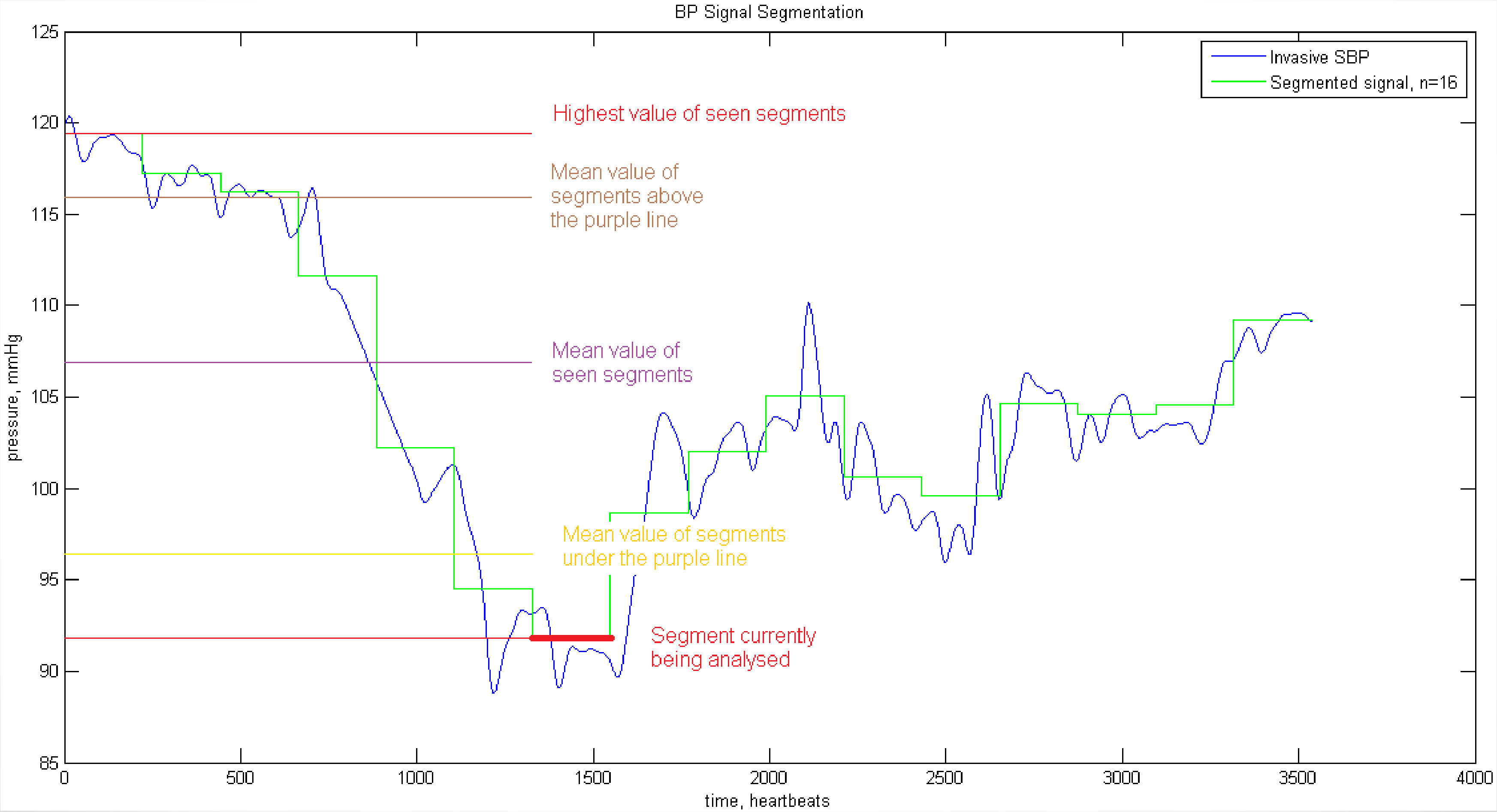
- **Second Requirement:**

  This difference is large enough to be considered as significant or even dangerous (20 mmHg ?).

- **Clinical Requirements?**

Detection algorithm

- In order to detect events using the correct criteria, non-parametric tests based on analysis of segments and 'past' segments, and their mean values, might prove promising:



Future Work

- Choose a **good criteria** for detecting a BP event.
- Develop a **quality test** on segmented signals that enable a high rate of 'true positive' detections.
- Perform the tests on **segmented estimated sbp signals** and build the resulting **ROC curves**, considering a **TPR**(true positive rate) and **FPR** (false positive rate) relative to the ones found in segmented invasive SBP signals available.