

Training Set for non- Invasive and minimally- Intrusive (*nImI*) Blood Pressure estimates.

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Version 1.1. Minimally documented Training Set, 2nd version

The acronym *nImI* was created to characterize non- Invasive and minimally- Intrusive technologies that could be used in Medical Applications to estimate Blood Pressure *BP*.

Estimations should be performed using supervised Machine Learning (*ML*) algorithms that require “big data” Training Sets (*TS*).

The following document is aimed at users of the platform <http://nimi.uv.cl>, who are interested in the contained cardiovascular data.

The Base includes information on approximately 1.188.000 heartbeats. Data was collected between May 19, 2015 and September 30, 2016, during the execution of Fondef Grant IT13/20060 from Conicyt, Chile [Conicyt, 2013], at the premises of the School of Biomedical Engineering, Valparaíso University, and of the Public Hospitals Dr. Carlos van Buren or Dr. Eduardo Pereira, at the city of Valparaíso, Chile.

Jaime Plaza, Matías Salinas and Gonzalo Tapia, at the Biomedical Engineering School, University of Valparaíso, Chile, formed the Engineering research team. Clinical research team was formed by Medical Doctors Juan Idiáquez, René Quilodrán, from the Medical School, University of Valparaíso, and Julio Riquelme from Neurological Department, at the Carlos van Buren Hospital and Teresa Veas from the Senior Service at the Dr. Eduardo Pereira Hospital. Both teams worked under the supervision of MSc BME Antonio Glaría, Research Director.

The accompanied file, “*Training_Set_nImI_estimates*”, is organized in eight primary sub-files containing nearly 250 dissimilar secondary sub- files with non-structured, non- invasive Cardio Vascular Data (*CVD*) obtained from Healthy subjects, and from Patients affected by Parkinson Disease (*PK*) or Diabetic Neuropathies (*DN*) and their controls.

The eight primary sub-files are named and contain:

24H, with *CVD* recorded in 24 hours sessions of healthy subjects

DNC, with *CVD* recorded in Diabetic Neuropathic Control sessions of healthy subjects

DNP, with *CVD* recorded in Diabetic Neuropathic Patient sessions of ill subjects

HGP, with *CVD* recorded in Handgrip sessions of healthy subjects

HMH, with *CVD* recorded in Handgrip/Movie/Handgrip sessions of healthy subjects

PKC with *CVD* recorded in Parkinson Control sessions of healthy subjects

PKP with *CVD* recorded in Parkinson Disease sessions of ill subjects

TOC with *CVD* recorded in right/left Toc occlusion sessions of healthy subjects

CVD has been recorded mainly using Finapres NOVA and Biopac System medical devices.

A preliminar description of the methodology for a very specific cases can be found in:

G. Tapia, M. Salinas, J. Plaza, D. Mellado, R. Salas, C. Saavedra, A. Veloz, A., J. Idiáquez, A. Glaría (2017) **“Photoplethysmogram Fits Finger Blood Pressure Waveform for non-Invasive and minimally-Intrusive Technologies Evaluation of Derivative Approaches”** Annals 10th Int. Joint Conf. Biomed. Eng. Syst. & Technol. Vol 4, pp 155-162.

Salinas M Plaza J Tapia G Salas R Saavedra C Veloz A Arriola J Idiáquez J Riquelme J Glaría A (2017). **“Proposal to innovate arterial pressure evaluation using a non-invasive an minimally-intrusive (nlml) methods based upon photoplethysmography and machine learning”**. In Proc. 5th BME IDEA EU Conf. Biomedical Eng. IDEA. Otto-von-Guericke-University, Magdeburg pp:139–141.

Similar signals to those referred in this paper can be found in:

<https://physionet.org/works/Noninvasiveandminimallyintrusivebloodpressureestimates>

CVD in each final file are in TXT and ACQ format. ACQ[®] is the extension of BIOPAC System proprietary software Acknowledge provided to visualize and analyze data.

The structure of the data is a table of twelve columns and “n” rows, where each row corresponds to the value at instant “i”, (with $0 \leq i \leq n$), of a Cardiovascular waveform or trend. Trends are evaluated within each heartbeat.

Cardiovascular waveforms are two Photoplethysmograms (PPG_1 and PPG_2) recorded at two external body locations, a single ECG channel, at Einthoven triangle leads, as well as the recorded finger pressure (*fiAP*) and/or reconstructed Brachial Pressure waveform, *reBP*.

PPGs are continually recorded using BIOPAC System whereas *fiAP* is continually recorded using the “volume clamp technique” developed by J. Penaz in 1973, and improved by Finapres Medical System using their NOVA device.

Details of different column templates for each specific session, as well as subject characteristics, are expected to be published by the end of 2018, in a completely documented version of the Training Sets for non- Invasive and minimally- Intrusive (nlml) Blood Pressure estimates.

The Training Set was conceived to estimate *BP* from PPG or its deviations. Input Vectors are expected to be PPG_1 and/or PPG_2 , coded in different forms, whereas the Target Vectors should be the ordered pair Systolic/Diastolic Blood Pressure estimated as a trend within a heartbeat, or the BP waveforms measured in *fiAP* or *reBP*.

Recording templates for the 12 columns used are shown in the following Table:

Template	BW Filter	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
T1	0.3/10	Sample	PPG _h ND	PPG _f ND	reBP	CO	BSA	LVET	ZAo	Cwk	ECG	Rp	HR
T2	0/10	Sample	PPG _h ND	PPG _f ND	reBP	CO	BSA	LVET	ZAo	Cwk	ECG	Rp	HR
T3	0/10	Sample	PPG _f D	PPG _f ND	reBP	CO	BSA	LVET	ZAo	Cwk	ECG	Rp	HR
T4	0/10	PPG _h ND	PPG _f ND	reBP	Resp	CO	BSA	LVET	ZAo	ECG	Cwk	Rp	HR
T5	0/10	PPG _f D	PPG _f ND	reBP	Resp	CO	BSA	LVET	ZAo	ECG	Cwk	Rp	HR
T6	0/10	PPG _h ND	PPG _f ND	reBP	Resp	CO	fiAP	LVET	ZAo	ECG	Cwk	Rp	HR
T7	0/10	PPG _f D	PPG _f ND	reBP	Resp	CO	fiAP	LVET	ZAo	ECG	Cwk	Rp	HR

Where:

BW is the Band Wide Pass filter used for the corresponding signals
BSA is the Body Surface Area estimated as a trend by FINAPRES
CO is the Cardiac Output estimated as a trend by FINAPRES
Cwk is the Windkessel Compliance estimated as a trend by FINAPRES
D applies for the deft hand or foot
ECG is lead I Einthoven electrocardiogram recorded by Bionomadix
fiaBP is the finger arterial Blood Pressure waveform measured by FINAPRES in the main finger
HR is the Heart Rate @ ppm estimated as a trend by FINAPRES.
LVET is the Left Ventricular Ejection Time estimated as a trend by FINAPRES
ND applies for the Non Deft hand or foot
PPG_h is the PPG recorded in the hand, using BIONOMADIX
PPG_f is the PPG recorded in the foot, using BIONOMADIX
reBP is the reconstructed Brachial Blood Pressure waveform calculated by FINAPRES
R_p is the Peripheral Resistance estimated as a trend by FINAPRES
Resp is the Respiratory Signal recorded using BIONOMADIX
Sample is the sampling number
Z_{Ao} is the Aortic Impedance estimated as a trend by FINAPRES

Templates (T) are used per session and subject: T1 is for 24H session, only for subject 00
T2 is for 24H session, for subjects 01 to 07 and PKP and PKC sessions, all subjects
T3 is for TOC session, all subjects
T4 is for Handgrip session, subjects 00 to 02 and for HMM session subject 00
T5 and DNC session, subject XX to YY
T6 is for Handgrip session, subjects 03 to 10 and is for HMM session subjects 01 to 09
T7 is for DNP session, all subjects and DNC sessions, subjects YY+1 to ZZ

Valparaíso (Chile), 13th November 2018.