Final Demo

Development of a Non-invasive Intracranial Pressure (ICP) Predictive ML Model
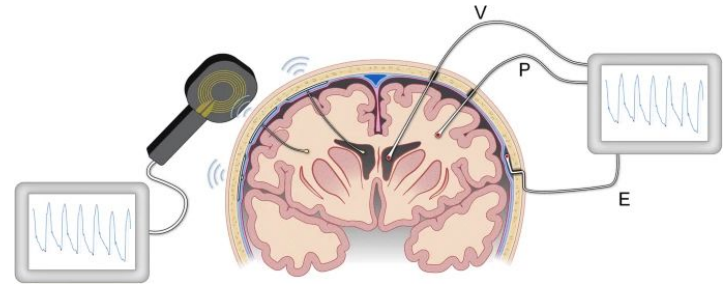
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The Problem

Currently, invasive ICP measurement is often used in clinical practice.

The problem of **invasive** intracranial pressure (ICP) monitoring in children

- The risk of Complication

- Discomfort and Pain

- Scarring

Non-Invasive Methods

Why?

- Early Detection and Monitoring
- Cost-Effectiveness
- Safety
- Facilitates Repeat Measurements

Current Situation

No consensus on a single non-invasive method that can match the precision and reliability of invasive monitoring methods.

Our project

Development of a Non-invasive ICP Predictive ML Model

Dataset

1. **Neurocritical care waveform recordings in pediatric patients 1.0.0**

- 12 pediatric and young adult patients (aged 2–25 years)

2. **MIMIC-III Waveform Database Matched Dataset**

- contains 22,317 waveform records, and 22,247 numerics records, for 10,282 distinct ICU patients.

Google Cloud Storage

MIMIC-III Waveform Database Matched Dataset
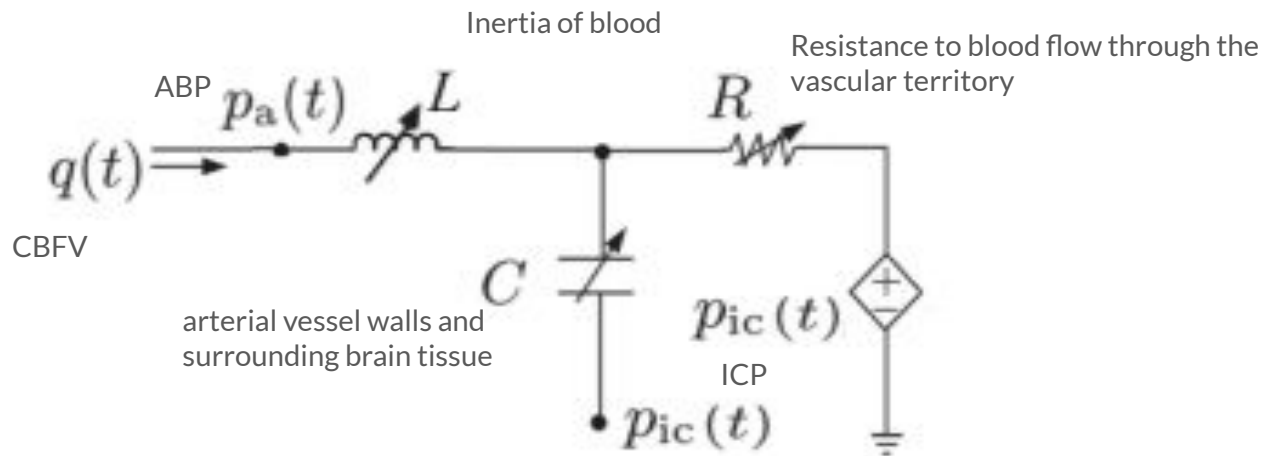
More than 2.4 TB

1. **Segments with ICP & CPP recording**

2. **The length of the recording >= 24 hours**

3. **Handling segments w/ missing value > 25%**

⇒ **About 66 segments with 50 unique patients.**

Feature Engineering

ABP + CBFV → **CPP**

Inertia of blood

Resistance to blood flow through the vascular territory

ABP $p_{\mathrm{a}}(t)$ L

R

$q(t) \rightarrow$

CBFV

arterial vessel walls and surrounding brain tissue

C

$p_{\mathrm{ic}}(t)$

ICP
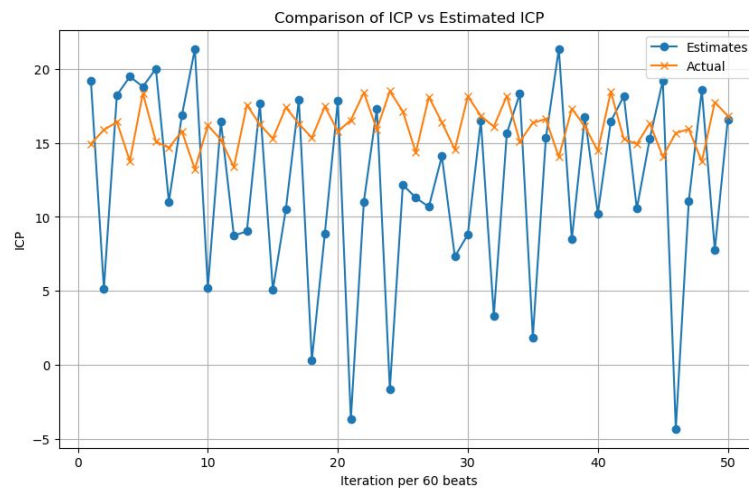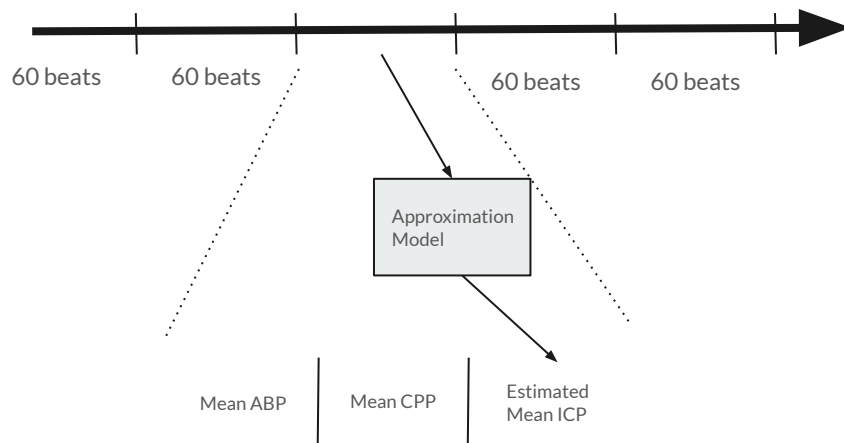
$p_{\mathrm{ic}}(t)$

Feature Engineering

ICP

- Mean ICP Approximation Algorithm based on Circuit Model
  - Inspired by mean-ICP algorithm proposed by Rohan et al.
  - Calibration of R and C values dependent on ABP, hICP, hct, hABP
    - Linear Regression model trained on random sub-segments from the the train dataset.
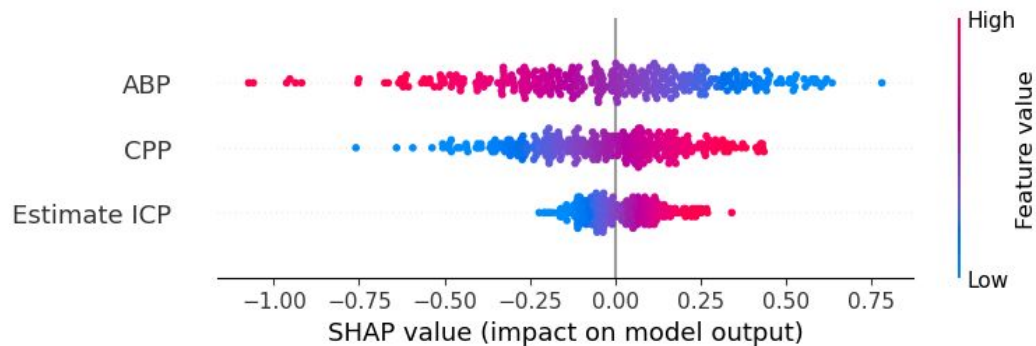
Block Preprocessing

60 beats   60 beats   60 beats   60 beats

Approximation Model

Mean ABP | Mean CPP | Estimated Mean ICP

Comparison of ICP vs Estimated ICP

Results

Demo 1

Model	MSE	R^2
Linear Regression	19.09	0.18
Ridge Regression	19.03	0.17
Random Forest Regression	12.41	0.465

	MeanAE	RMSE	R2	MedianAE	Exp. Var.
Linear Regression	0.451	0.682	0.945	0.261	0.945
Random Forest Regression	0.383	0.611	0.955	0.21	0.955
Ridge Regression	0.460	0.752	0.933	0.263	0.933

QnA