Just Breathe: A Breathing Control App to Manage Well-Being

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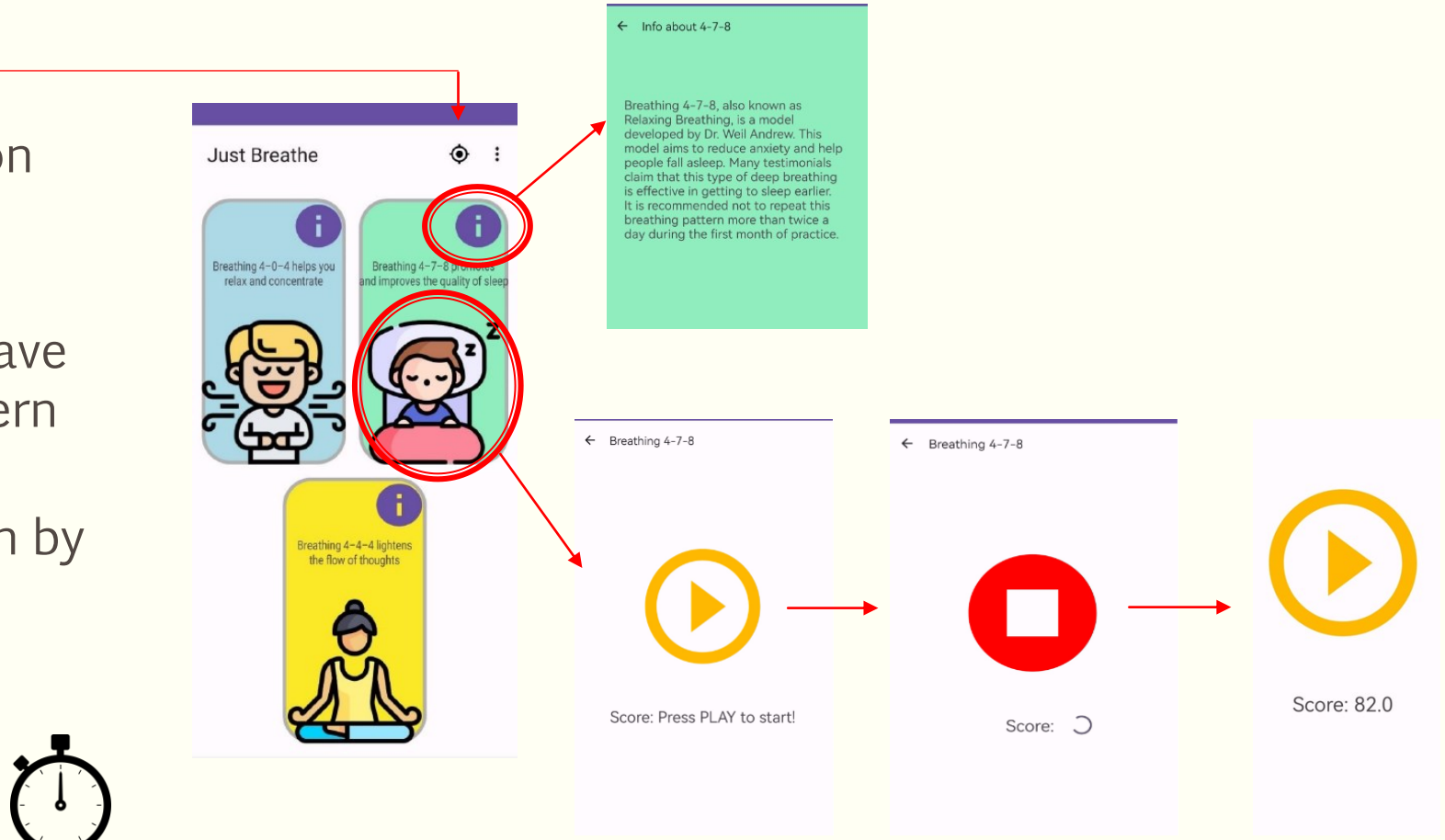
INTRODUCTION

- Breathing is an automatic function of the body that is controlled by the respiratory centre of the brain
- Breathing control is a fundamental operation to manage emotions or states of confusion.
- Just Breathe is an intuitive application to follow a breathing pattern

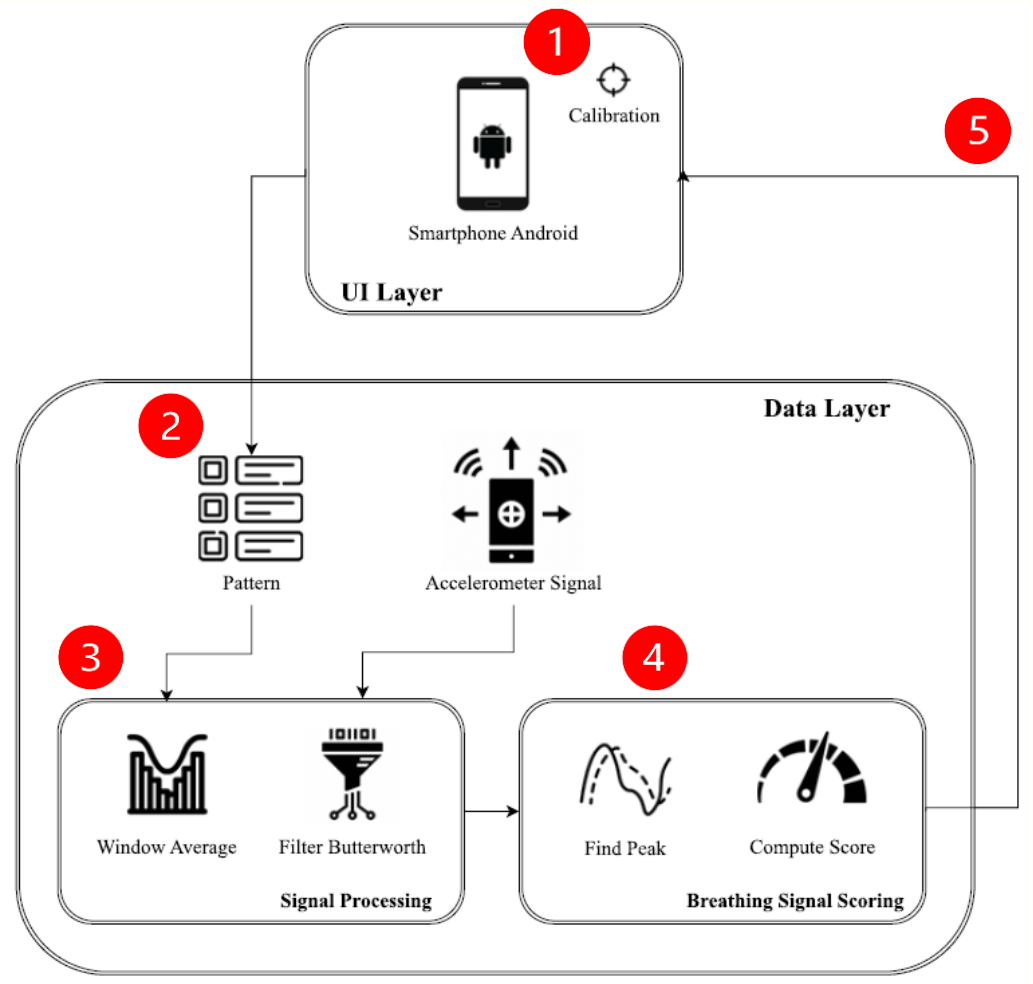
- Just Breathe Objective: help a user to improve its breathing control

JUST BREATHE – GUI DESCRIPTION

- We recommend Calibration
- Click con info button to have more info about that pattern
- Chose one of three pattern by clicking on one picture
- We suggest to use a watch to take the time of breathing.



ARCHITECTURE



1. **Recommended calibration**

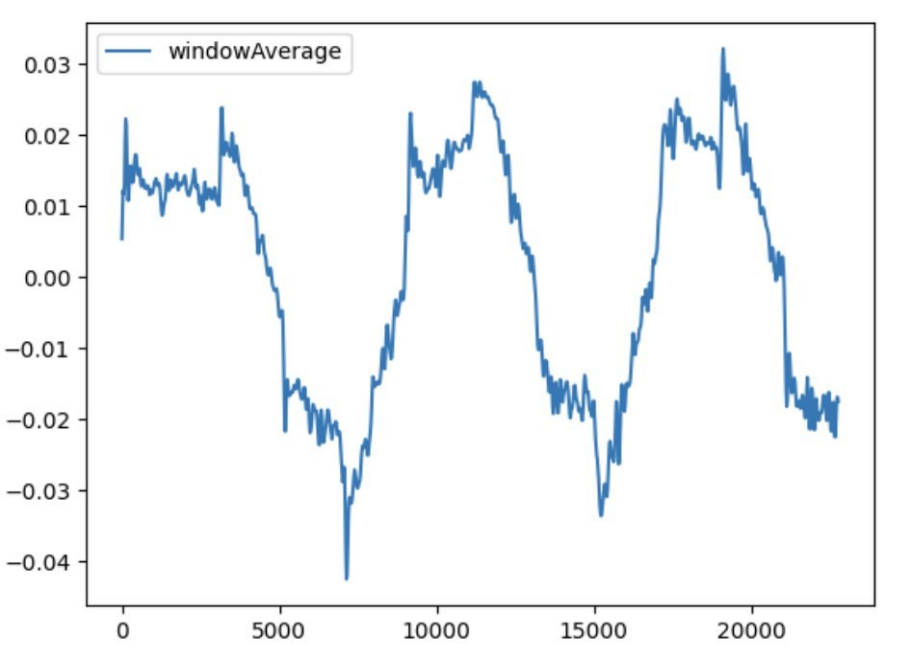
2. **Pattern choice by graphical interface**

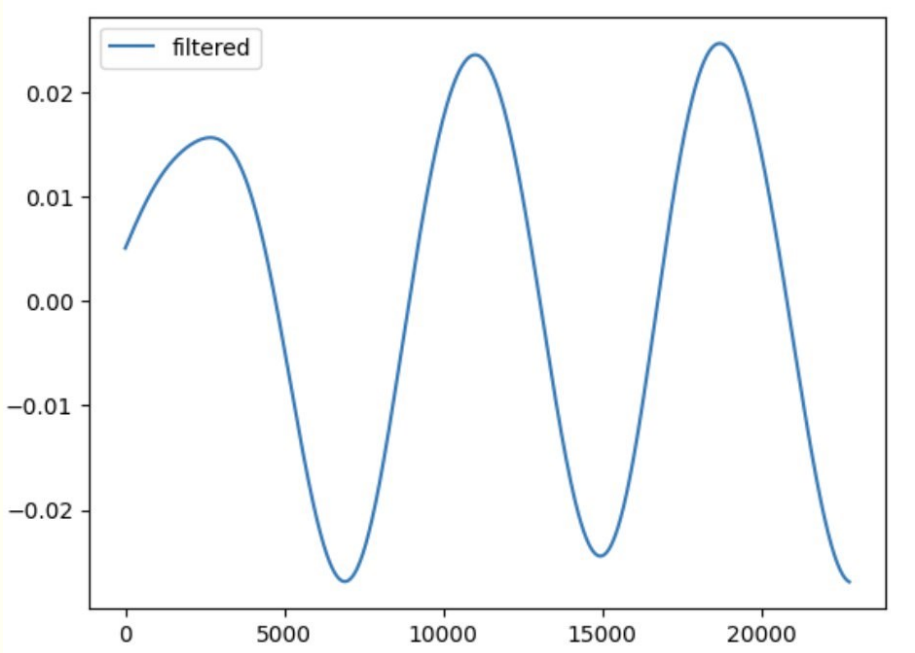
3. **Accelerometer signals processing:**
   1. Calculation of the window average
   2. Signal filtering through the Butterworth filter

4. **Computation of the respiratory signal score in according to the pattern**
   1. Finding of peak function
   2. Application of the formula for scorin

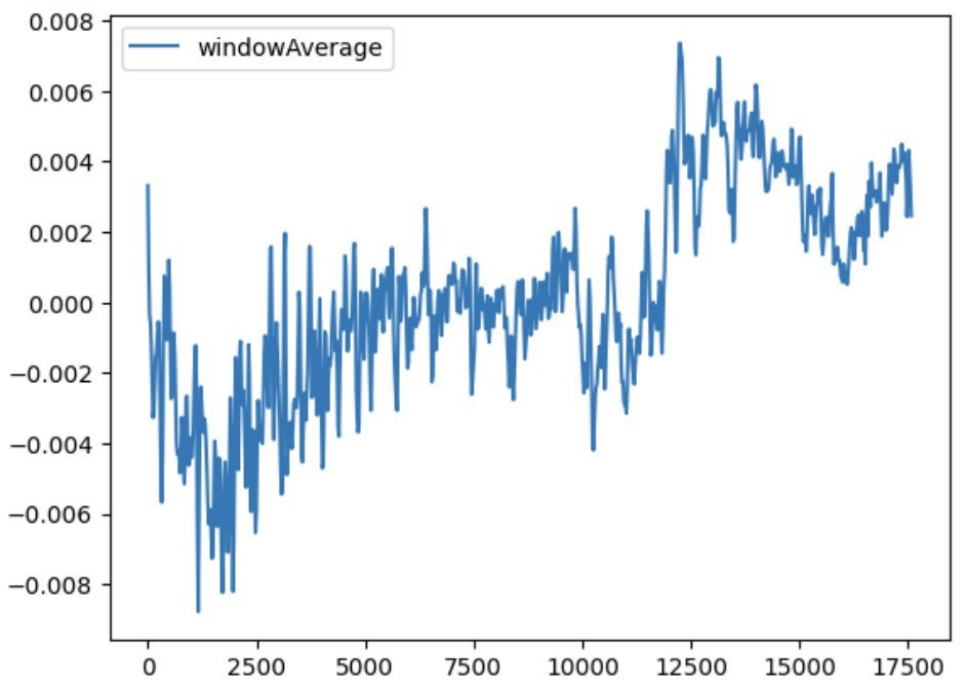
5. **Return of the score to the GUI**

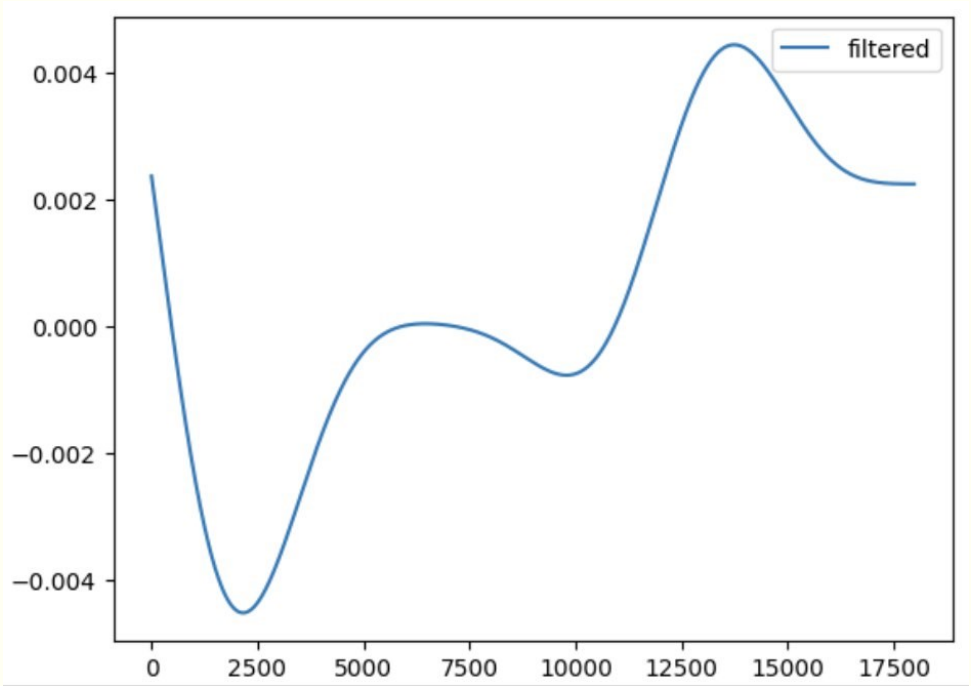
PATTERN 4-0-4 – SIGNAL PROCESSING





PATTERN 4-7-8 - SIGNAL PROCESSING





BREATHING SIGNAL SCORE – DESCRIPTION

To measure the **goodness** of a user's breathing, a heuristic algorithm has been developed, **breathingScore()**.

- It takes as input the processed breath signal and the pattern to follow.
- Returns a value between 0 and 1 which will be multiplied by 100 before showing it on the smartphone screen.

$$S = \alpha_1 q_{max} + \alpha_2 q_{min} + \alpha_3 q_{int} + \alpha_4 q_{hold}$$

- ***qmax***: is the index that measures how close the local maximum peaks are to their average
- ***qmin***: is the index that measures how close the local minimum peaks are to their average
- ***qint***: is the index that measures how much the period of inhalation and exhalation corresponds
- ***qhold***: is the index that measures the general goodness of the apnea periods of the entire session

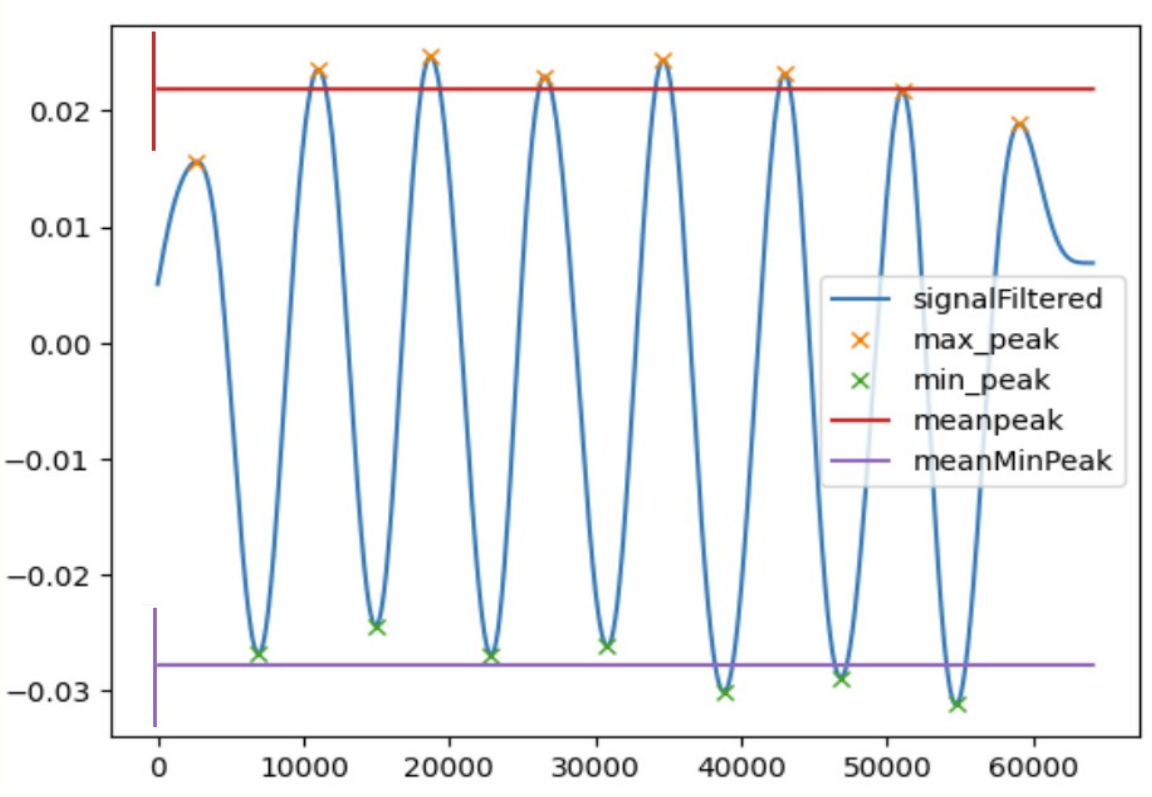
BREATHING SIGNAL SCORE – EXAMPLE

An example of breathingScore() that takes as input the signal in the figure with following parameters:

- **peak_max_tollerance** = 0.005 m/s^2
- **peak_min_tollerance** = 0.005 m/s^2
- **breath_period_tollerance** = 500ms
- $\alpha 1 = \alpha 2 = 0.25$, $\alpha 3 = 0.50$

Computing:

- **q_min** = 8/8 = 1
- **q_max** = 7/8 = 0.875
- **q_int** = 15/15 = 1
- **S** = 0.25 q_min + 0.25 q_max + 0.50 q_int
  = 0.954 -> **95.4**



EXPERIMENT RESULTS – CHOICE OF HYPERPARAMETERS

Peak Tolerance	Breath Period Tolerance	$\alpha_1 = \alpha_2$	α_3
0.15	1000	0.3	0.4
0.005	500	0.25	0.5

Useful Considerations:

- Each user reported difficulties in respecting the chosen breathing pattern for over 40 seconds.
- Each user has a different abdominal extensibility and sensitivity
- Two users stated that keeping the breathing rhythm accurate to the ideal one was difficult.

EXPERIMENT RESULTS – TEST-SET

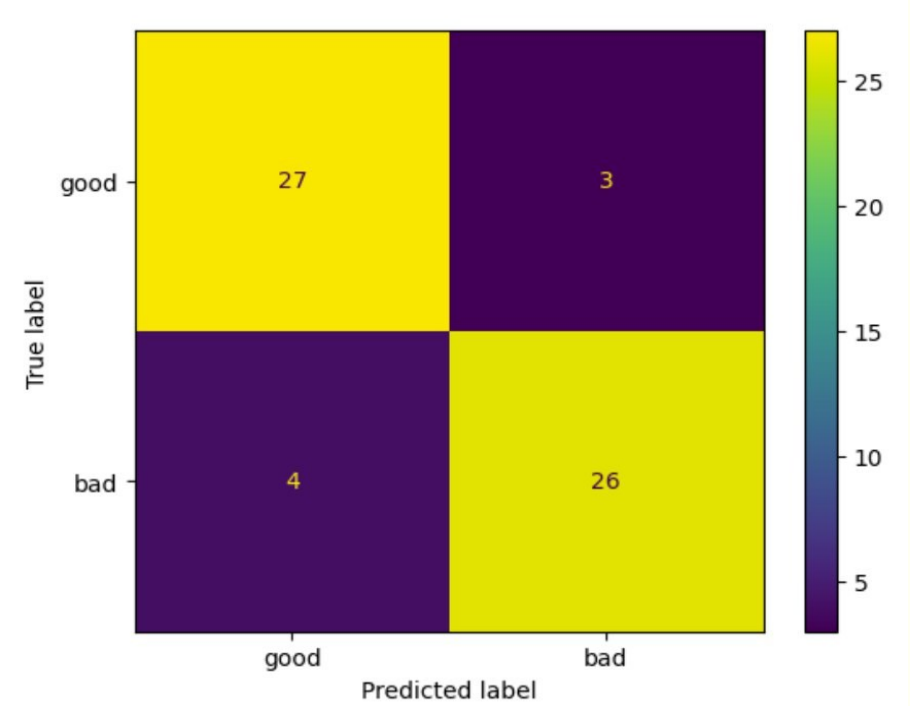
The test-set created to conduct the experiments was defined as follows:

- **Breathing Pattern**: 4-0-4 for all registration sessions
- **Environment Set**: User lying on bed with smartphone resting on abdomen
- **Breathing Session Duration**: At least 45s
- **Session Type**: 50% Correct - 50% Incorrect (compared to the chosen pattern)
- **Beta-Version** of the JustBreathe App to sperimentation
- 60 breathing sessions were collected on a sample of 4 male persons, same build and breathing capacity who installed the **JustBreathe** app on their Android Smartphone

EXPERIMENT RESULTS – MEASUREMENT OF SCORE RELIABILITY

Sessions Labels:

- "Good": When the user breathed in the manner closest to the chosen breathing pattern
- "Bad": When the user did not breathe in the manner close to the chosen breathing pattern



	Precision	Recall	F1-Score	Support
"Good"	0.90	0.87	0.88	30
"Bad"	0.87	0.90	0.89	30
Accuracy			0.88	60

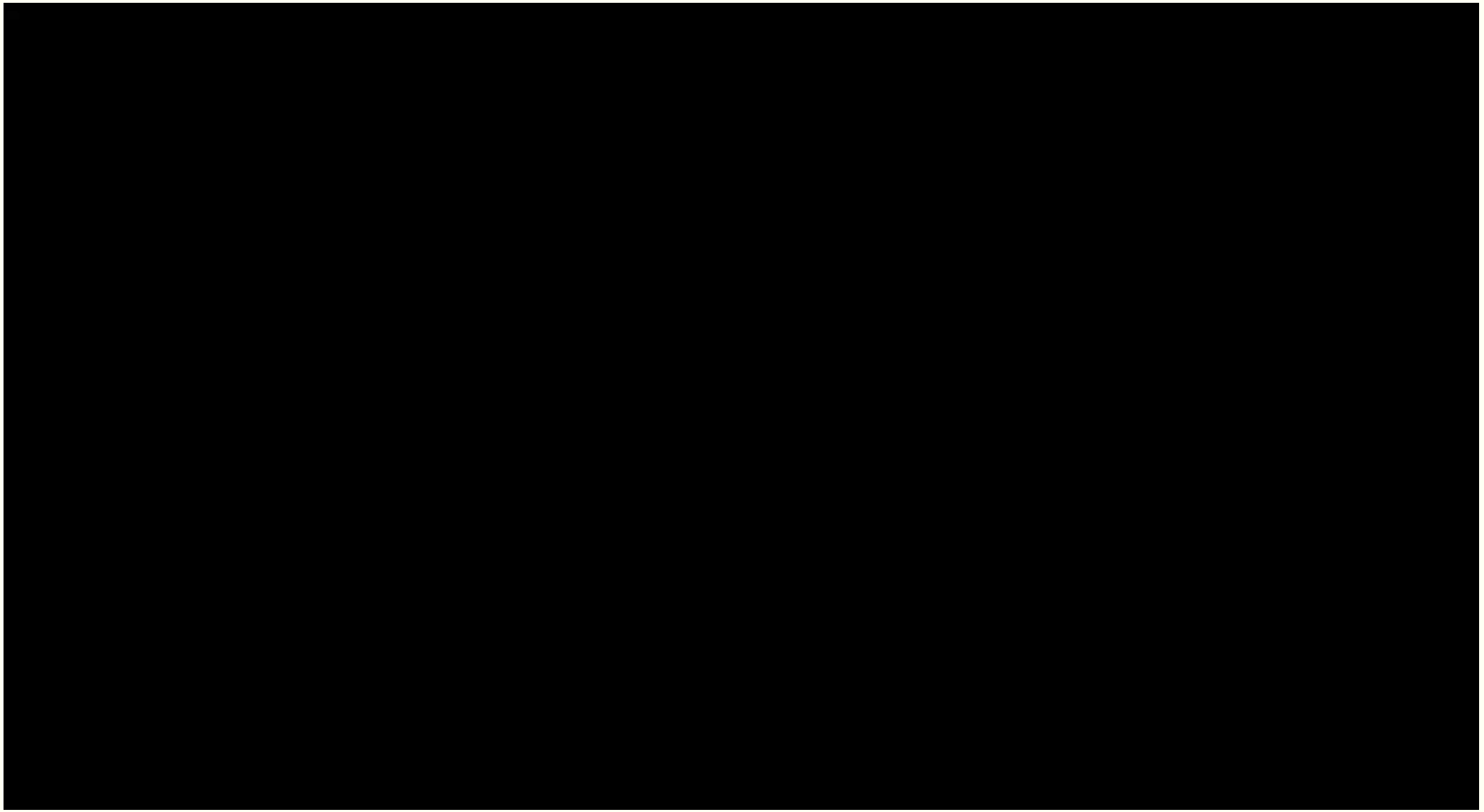
Table: Metrics Results

CONCLUSION

- **Advantages**:
  - Original and innovative solution in the mobile app industry dedicated to supporting user breathing
  - Reduced complexity due to the fact that no AI technique is required
  - Easy to use and based on an unobtrusive approach for the monitoring phase

- **Limitations**:
  - JustBreathe App is not yet ready for large-scale use
  - Choice of Hyperparameters based on a too small sample of users
  - Physiological characteristics of the users
  - Noise in the raw signal obtained from the accelerometer

VIDEO DEMONSTRATION




THANKS FOR YOUR ATTENTION!
ANDROID FOUNDRY
ANDROID-FOUNDRY.COM

REFERENCES

[1]. Francesco Bruno; Gaetano Sferrazza; Lorenzo Tonelli; Nicolò Picchi, Manage Well-Being Through a Breathing Control App https://github.com/francescoB1997/Just_Breathe