Web-based Breathing Exercise System for Assisting the Treatment of Chronic Obstructive Pulmonary Disease (COPD)

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Outline

- Motivation
- Research Questions
- Results
- Discussion
- Conclusion

Outline

Motivation

Research Questions

Results

Discussion

Conclusion

Motivation

Chronic Obstructive Pulmonary Disease (COPD)

65 Million

People suffer from moderate or severe COPD

3 Million

People die each year

Global Leading Causes of Death*

1- Ischaemic heart disease

2- Stroke

3- COPD

- Muscle weakness
- Shortness of breath
- Physical inactivity in daily life

FIRS. (2017). The Global Impact of Respiratory Disease - Second Edition

*WHO. (2019)

Motivation

Respiratory Physiotherapy

Physical Body Exercises

Breathing Exercises

- Strengthen the respiratory muscles
- Reduce shortness of breath
- Improve quality of life

Lack of a guidance mechanism

Lack of supervision over the patient

Motivation

Solution

Digital Breathing Exercise Assistant

Performance Monitoring Module

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Research Goals - Research Questions

RQ1: What are the **relevant** and **measurable metrics** of an effective breathing exercise for the treatment of COPD?

RQ2: How can an **algorithm** be developed from the relevant metrics to **accurately evaluate** the breathing exercise?

RQ3: From the perspective of physiotherapists, how does this approach **improve** the **efficiency** of the COPD treatment?

RQ4: How **usable** is this approach in the treatment of COPD from the perspectives of patients and physiotherapists?

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Research

RQ1: What are the **relevant** and **measurable metrics** of an effective breathing exercise for the treatment of COPD?

Method: Structured and semi-structured interviews with physiotherapists

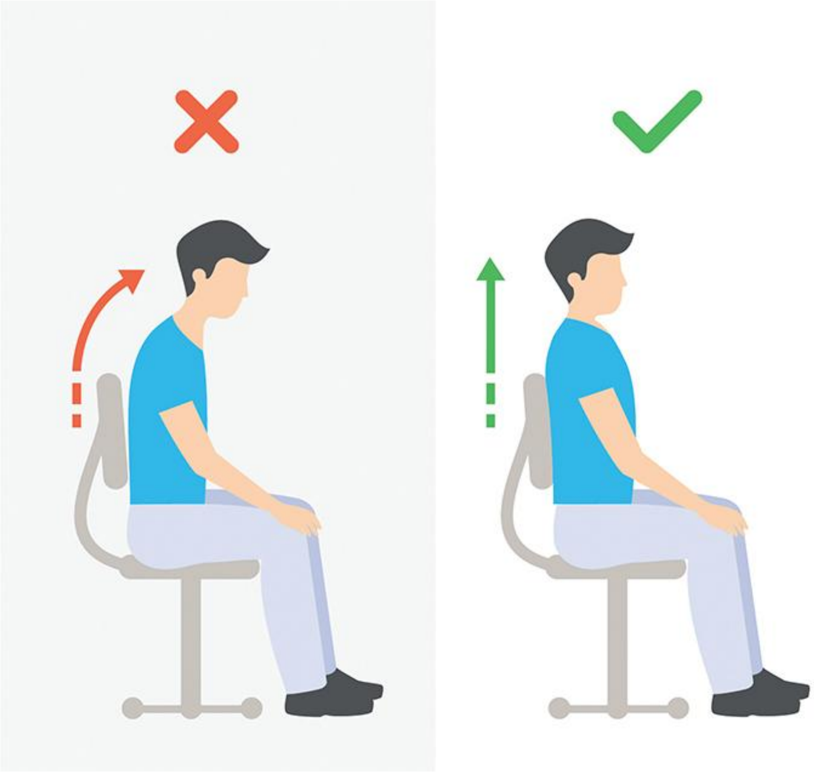
RQ1 - Metrics of the Proper Breathing Pattern

Expansion and Contraction Movements on Patient Belly

https://www.hopkinsmedicine.org/

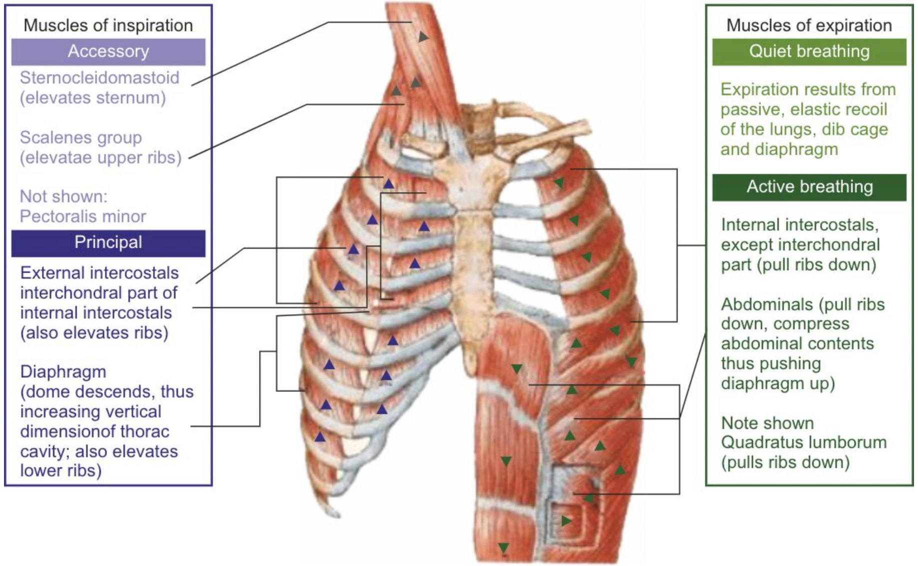
RQ1 - Metrics of the Proper Breathing Pattern

Body Posture



https://www.hopkinsmedicine.org/

Shoulder Movement



https://www.hopkinsmedicine.org/

Research

RQ2: How can an **algorithm** be developed from the relevant metrics to **accurately evaluate** the breathing exercise?

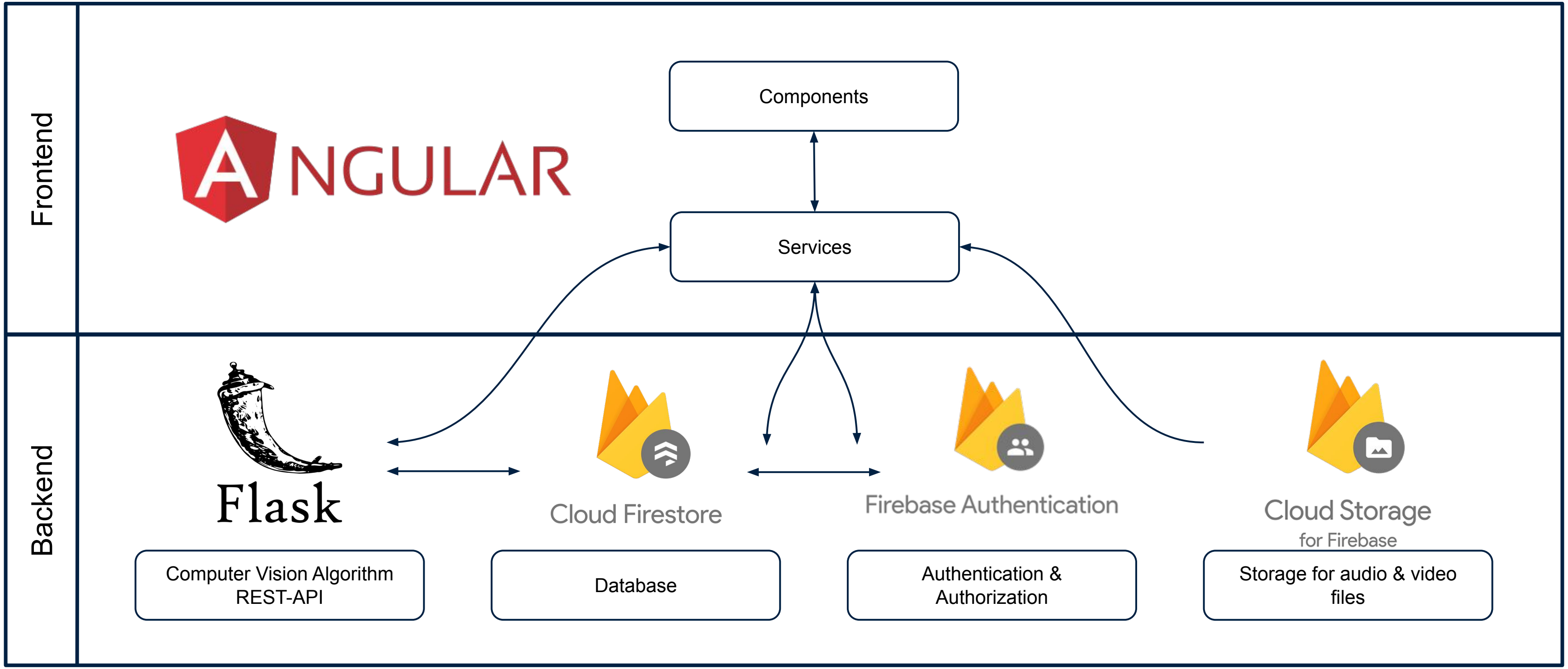
Method: Iterative development; interview with physiotherapist and on-site experiment

RQ2 - System Components

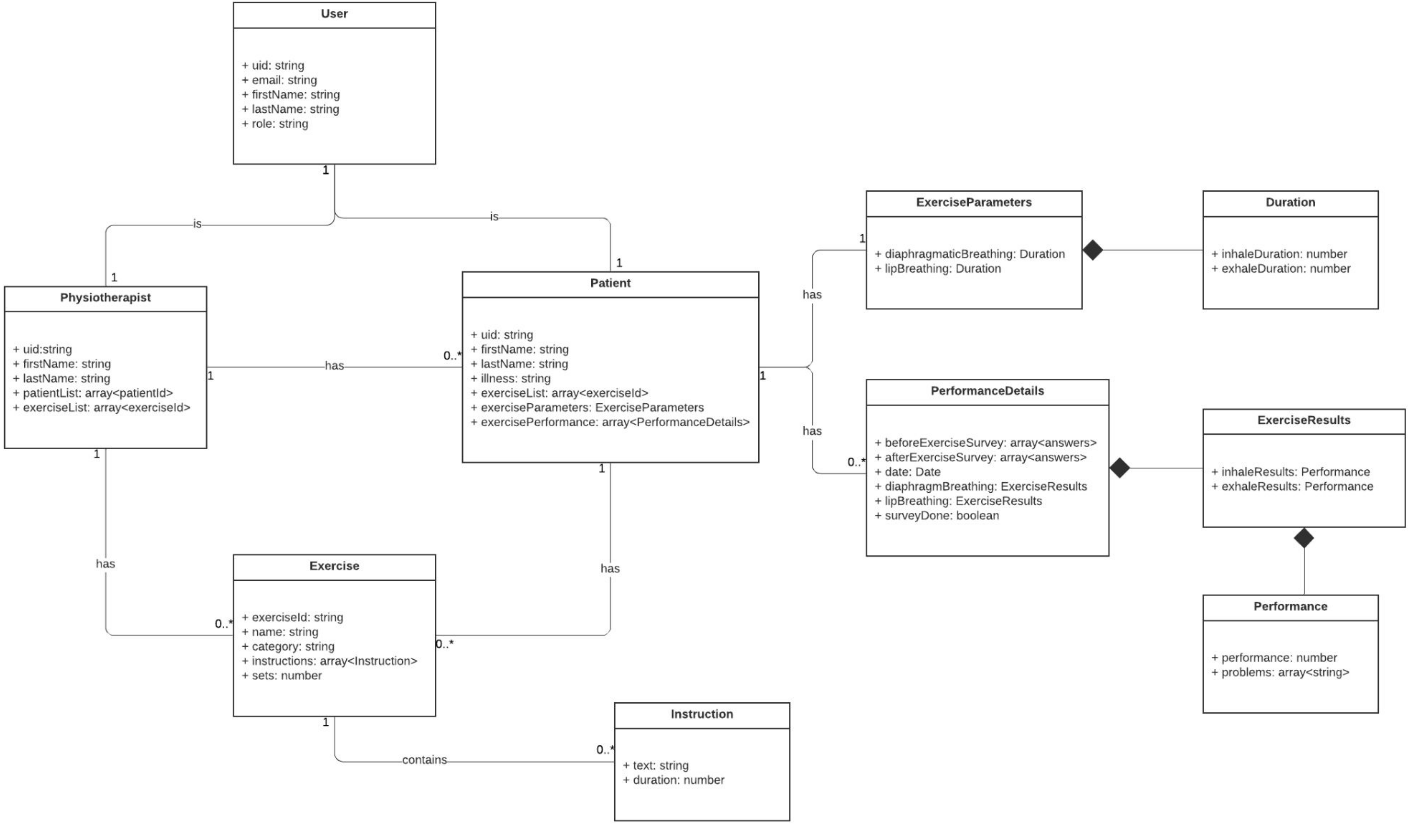
Digital Breathing Exercise Assistant

Performance Monitoring Module

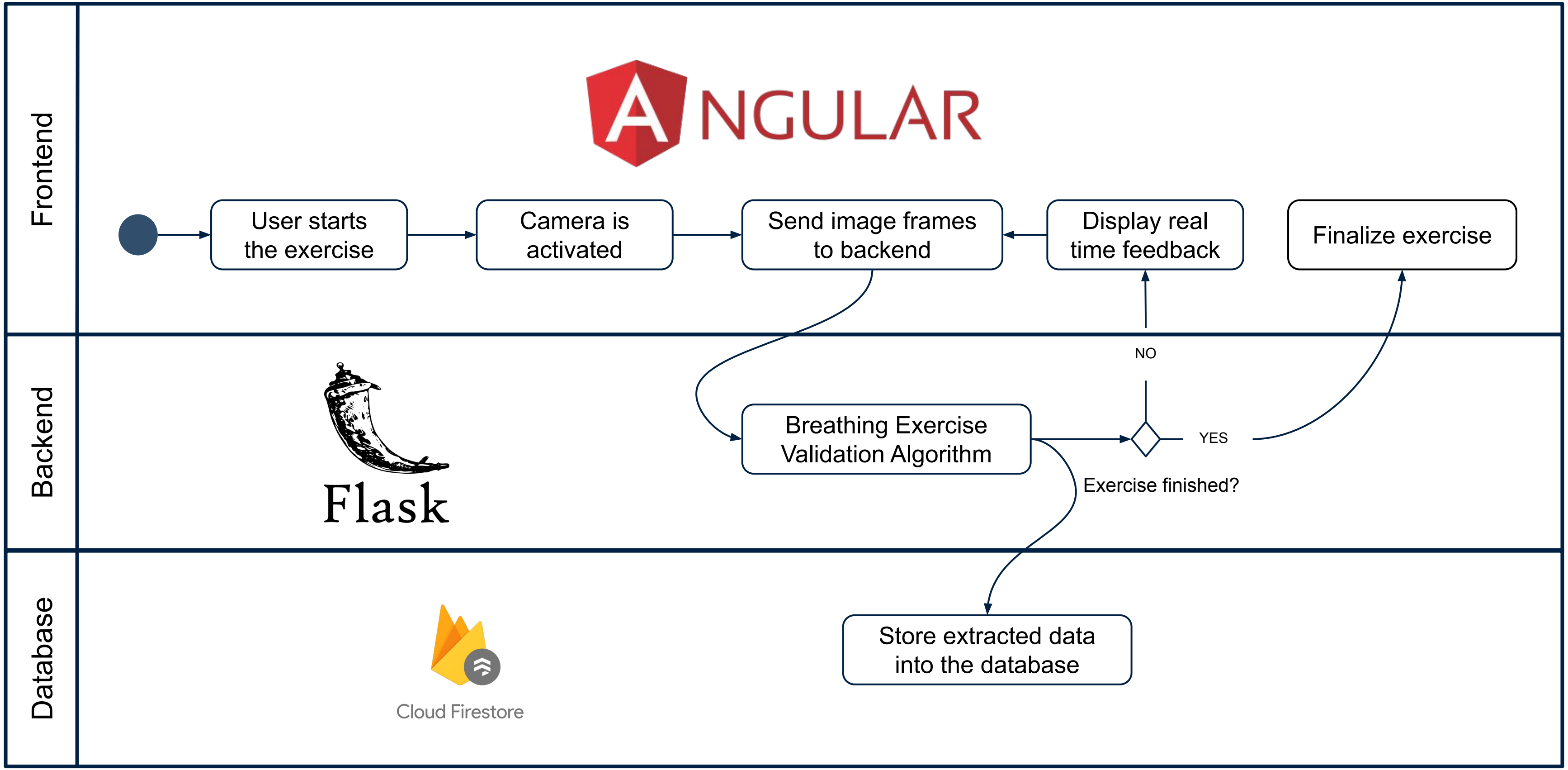
RQ2 - System Architecture



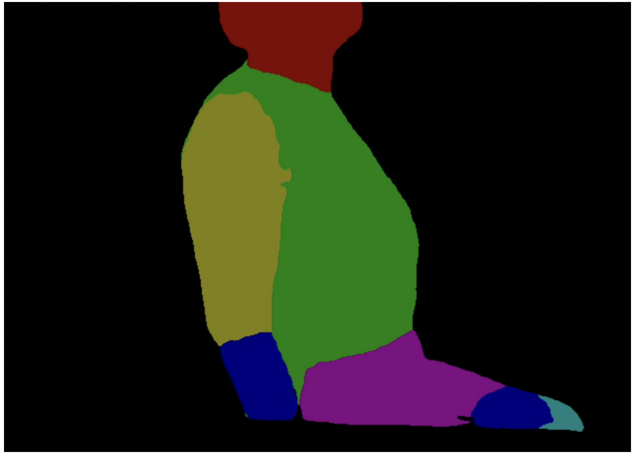
RQ2 - Data Model



RQ2 - Digital Breathing Exercise Assistant Workflow



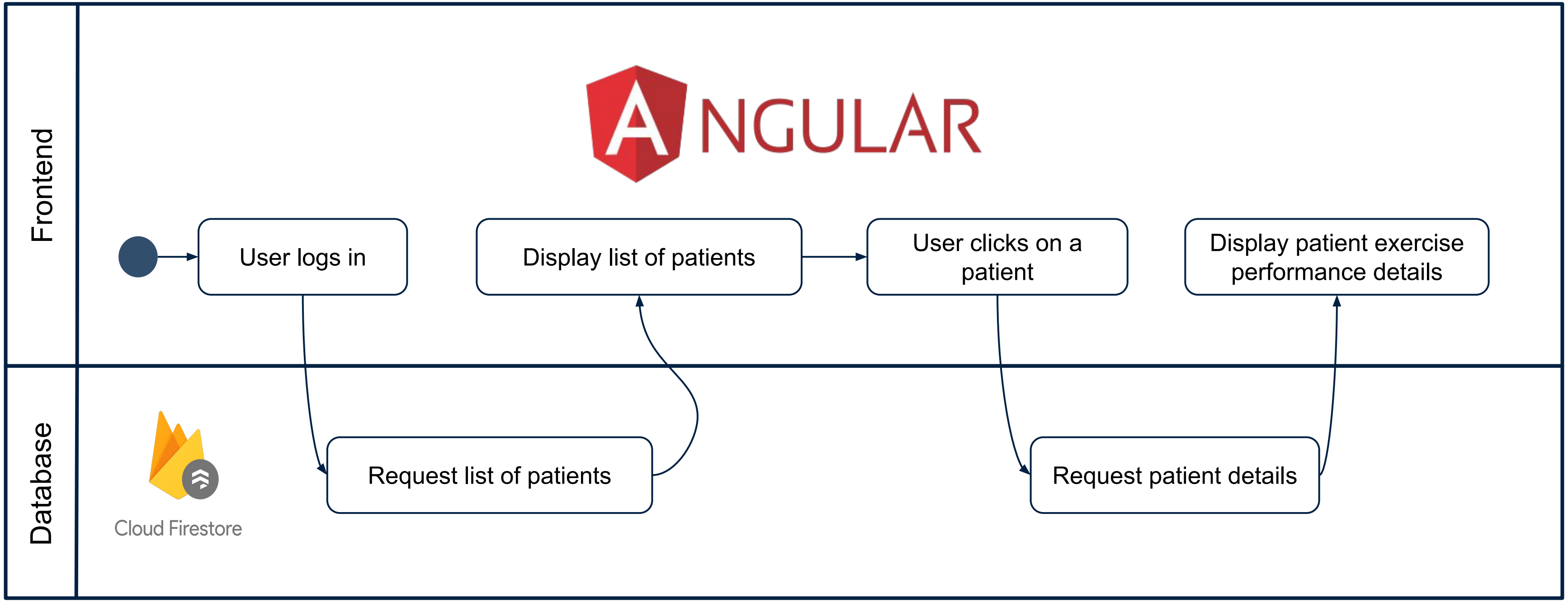
RQ2 - Digital Breathing Exercise Assistant



Self Correction Human Parsing - Pascal Person Part

Machine Learning model for body parts segmentation

RQ2 - Performance Monitoring Module Workflow



Demo

Evaluation

Accuracy

Efficiency & Usability

4 Physiotherapists (Germany & Turkey)

5 COPD patients (Germany & Turkey)

Evaluation - Breathing Pattern Detection Accuracy

Efficiency & Usability

Accuracy

- On-site experiment

Evaluation - Breathing Pattern Detection Accuracy

2 Physiotherapists

3 COPD patients

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Evaluation - Breathing Pattern Detection Accuracy

Exercise / *Detection*	**Diaphragmatic Breathing Exercise**	**Pursed Lip Breathing Exercise**
Belly Expansion & Contraction	83%	80%
Shoulder Increase	92%	95%
Body Posture	97%	92%
Overall	90.6%	85.6%

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Evaluation - Efficiency & Usability

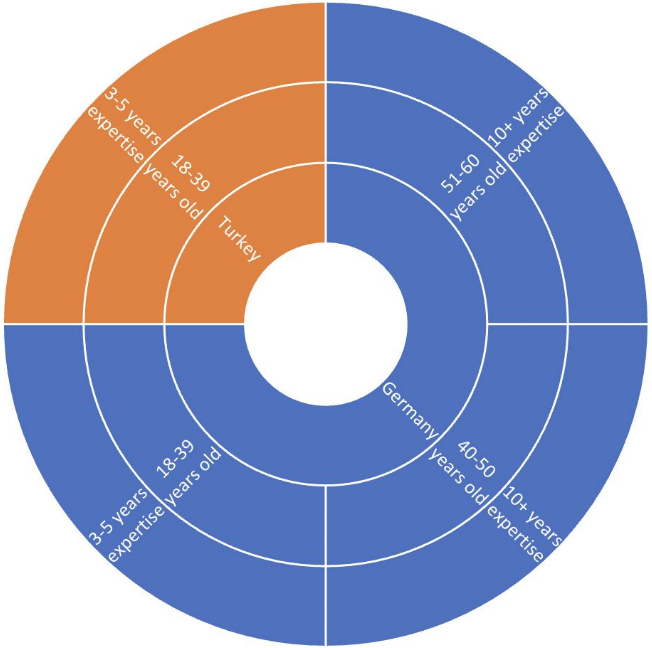
Accuracy

Efficiency & Usability

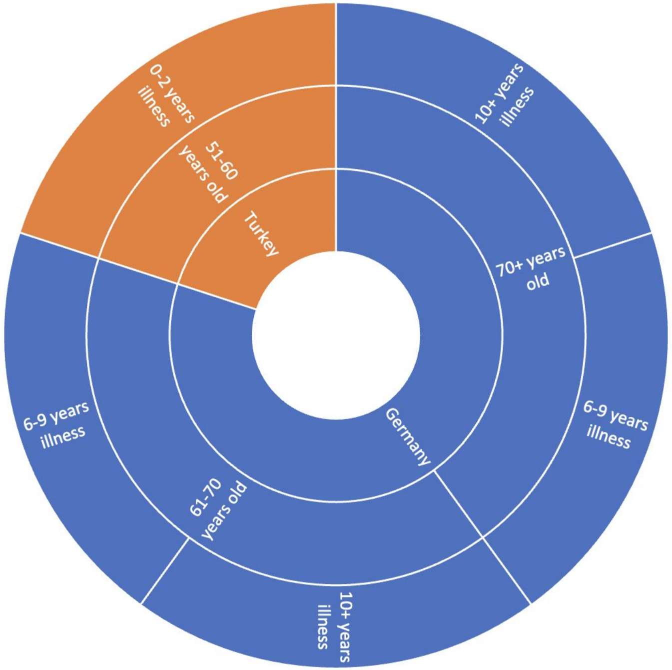
- Efficiency: User study
- Usability: System Usability Scale

Evaluation - Efficiency and Usability

4 Physiotherapists (Germany & Turkey)



5 Patients (Germany & Turkey)



Research

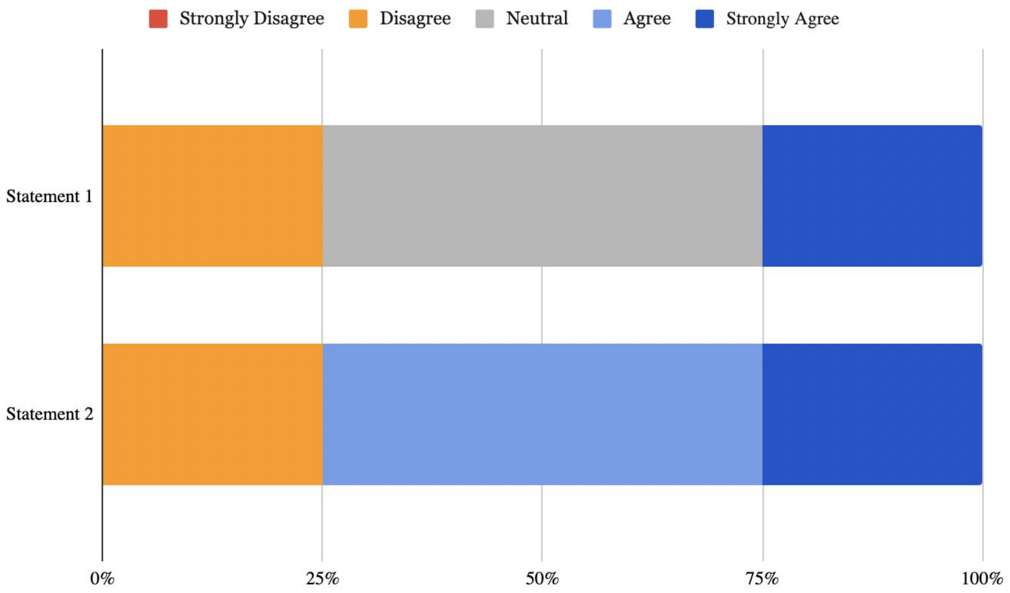
RQ3: From the perspective of physiotherapists, how does this approach **improve** the **efficiency** of the COPD treatment?

Method: Conduct user study on physiotherapists and patients

RQ3 - Evaluation - Efficiency

Physiotherapists

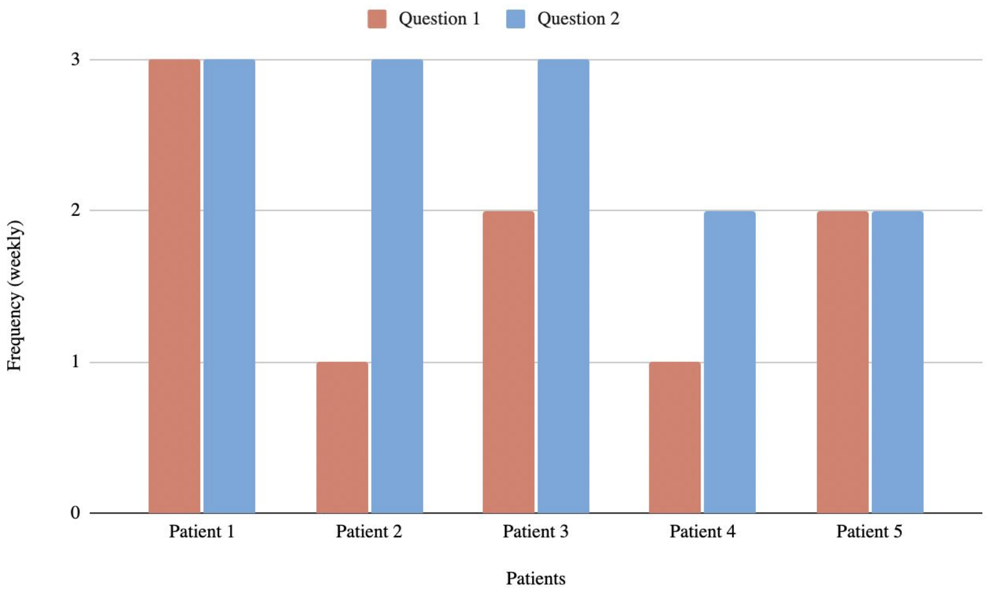
- Statement 1: This system increased the efficiency of the COPD treatment.
- Statement 2: I would like to use this system for the COPD treatment process.



RQ3 - Evaluation - Efficiency

Patients

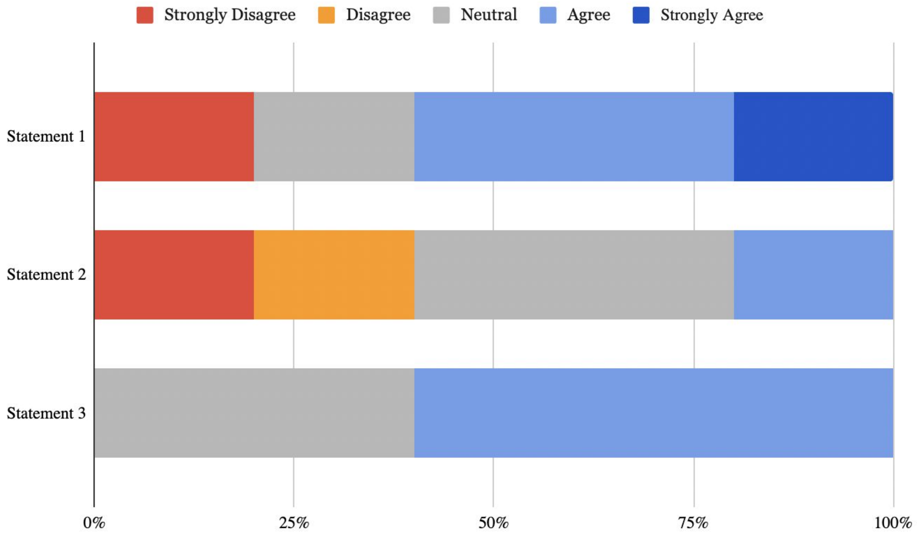
- Question 1: How often did you do your home exercises before this system?
- Question 2: How often did you do your home exercises using this system?



RQ3 - Evaluation - Efficiency

Patients

- Statement 1: This system increased my motivation for doing my home exercises.
- Statement 2: This system helped to improve my health condition.
- Statement 3: I would like to use this system in my treatment.



Research

RQ4: How **usable** is this approach in the treatment of COPD from the perspectives of patients and physiotherapists?

Method: User study

Evaluation - Usability

Patients	System Usability Score
Patient 1	77.5
Patient 2	60
Patient 3	67.5
Patient 4	90
Patient 5	77.5

Physiotherapists	System Usability Score
Physiotherapist 1	85
Physiotherapist 2	87.5
Physiotherapist 3	85
Physiotherapist 4	95

Average	**74.5**

Average	**88.12**

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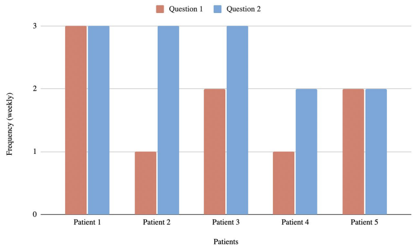
Discussion

Observations

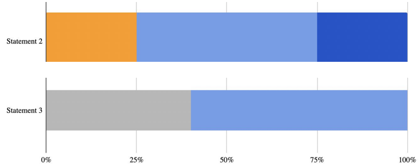
Relatively good accuracy (> 85%)

Uncertain efficiency

Increase in weekly exercise frequency of patients



Willingness to use by patients and physiotherapists



Discussion

Limitations

Dependency on the ML model

Instructions and performance alignment for real-time analysis

Treatment process and regulations in different countries

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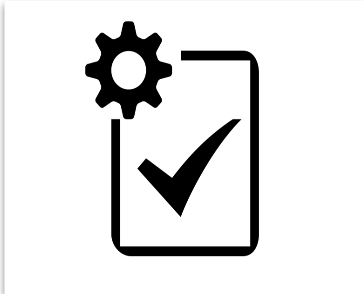
Conclusion

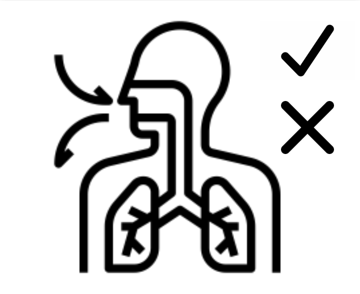
Summary

RQ2



RQ4: Usability

RQ1:
- Belly expansion & contraction
- Body posture
- Shoulder movement



RQ3: Efficiency

Conclusion

Future Work

Enhancements on CV algorithm

Mobile app

Informative content for patients to increase awareness

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