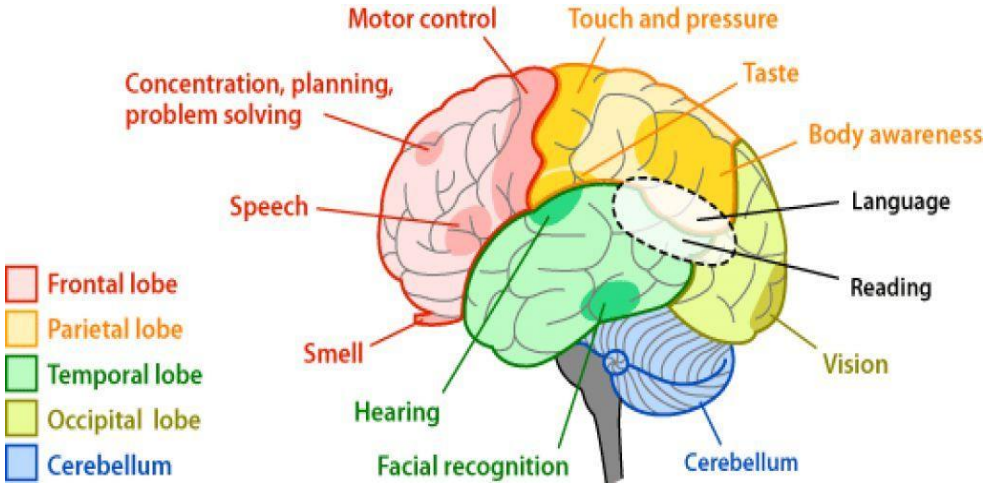
Cognitive Rehabilitation based Personalized Solution for Dementia Patients using Reinforcement Learning

2020-017

Introduction

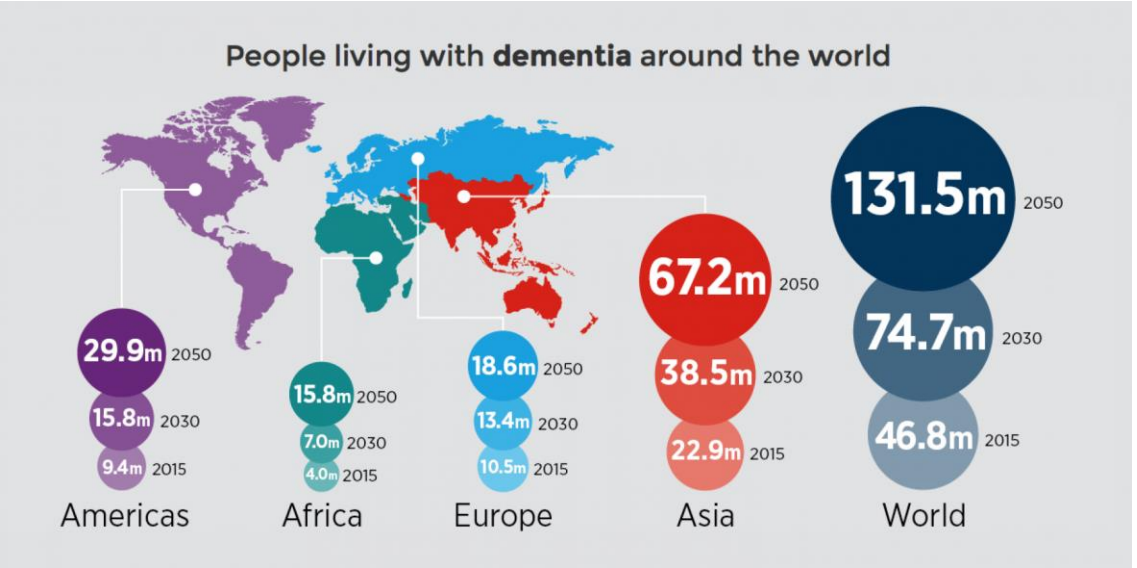
- Dementia is a type of a brain disorder which damages to cognitive functionalities of human brain. Attention and concentration, executive function, language skills, memory skills are those cognitive functionalities.
- There is no any medication for Dementia.

- Rehabilitating the cognitive functions using non-pharmaceutical therapy.
- Develop mobile application which contains games and activities to give the therapy.
- Implemented using Reinforcement Learning in a personalized way.



Research Problem

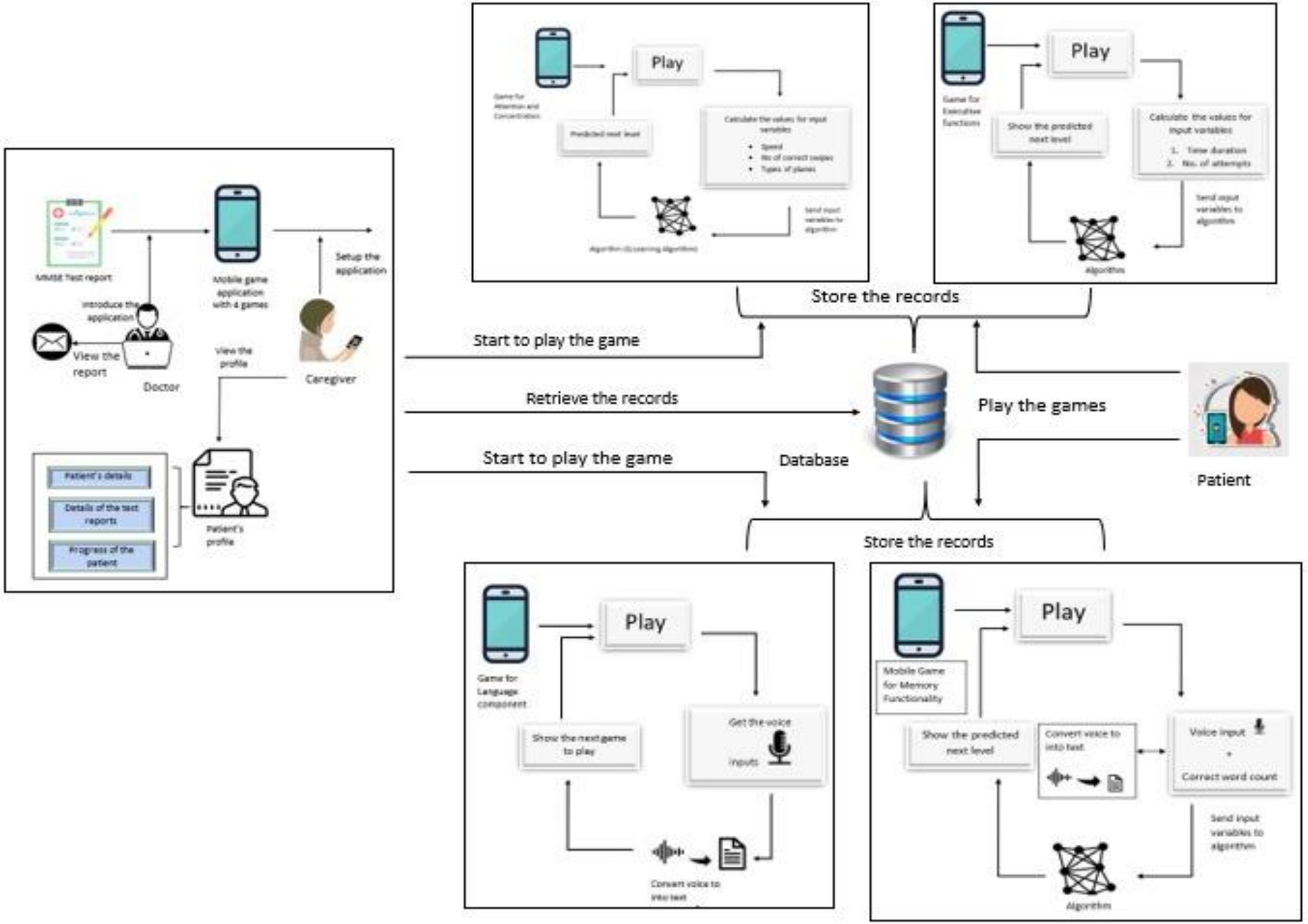
- The current prevalence of Dementia in Sri Lanka and all around the world.
- There are not customized software solutions for Dementia based on user behaviour.
- Dementia cannot be cured by medications.



Research Objectives

- Help the Dementia patients by giving rehabilitation in a cognitive way using different kinds of games or activities by learning from the user aspects which will be implemented in this application
- Decrease the mild and moderate stages of Dementia patients
- Both patients and caregivers to make their life easier because there is not a special or exact medication for Dementia

System Diagram



IT16067370 | RATHNAYAKA M.H.K.R

Software Engineering

Introduction

- Background
- Attention is a complex mental process where, one concrete anatomical structure, and that cannot be assessed by one single test as it encompasses diverse processes.[1]
- The brain training and rehabilitation for attention and concentration can be done by playing games that can be play from almost any mobile device. [2]
- The activities in the concentration programs combine different therapeutic exercises, and rehabilitation and learning techniques designed to re-train and improve the attention skills that each person needs most.

Research Gap

Features	Lumosity	Brain Games	Elevate	Proposed System
Improve both Attention and Concentration	✓		✓	✓
Personalized game				✓
Separate progress indicators for Attention and Concentration		✓	✓	✓
Suitable colours and fonts for interfaces	✓		✓	✓
Sent reports to doctor and caregiver				✓

Click to add text

Introduction Cont.

Research Question

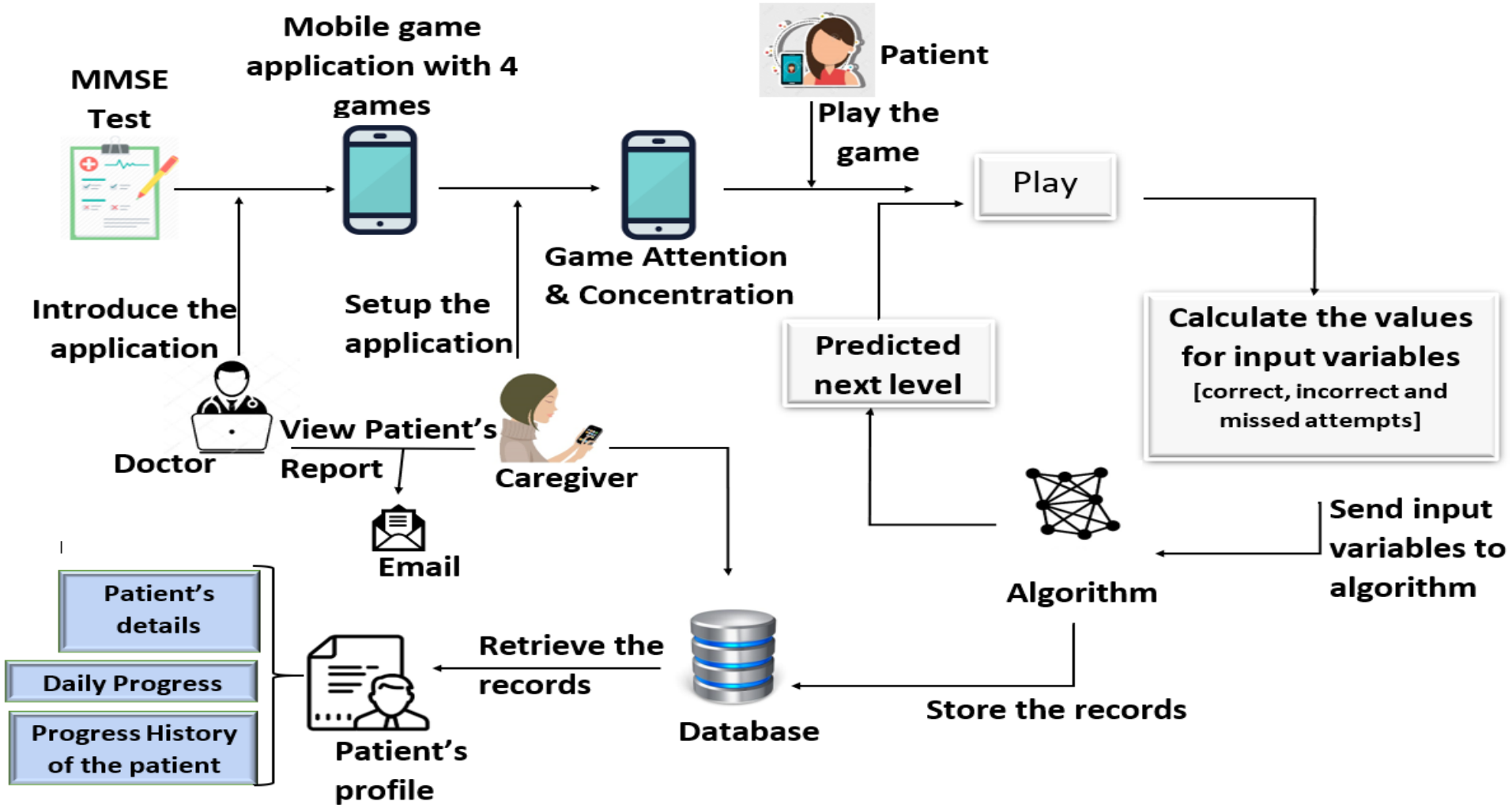
- How to help Dementia patients to improve the attention and concentration by developing a mobile game with reinforcement learning?

Specific and Sub Objectives

- Develop a mobile game for Dementia patients to improve Attention and Concentration and make their life little easier.
  - ➢ Improve the ability to Focus on one thing at a time.
  - ➢ Controlling the focus of attention.

Methodology

- System Diagram



Methodology Cont.

Technologies

- C#, PlayFab, SMTP server

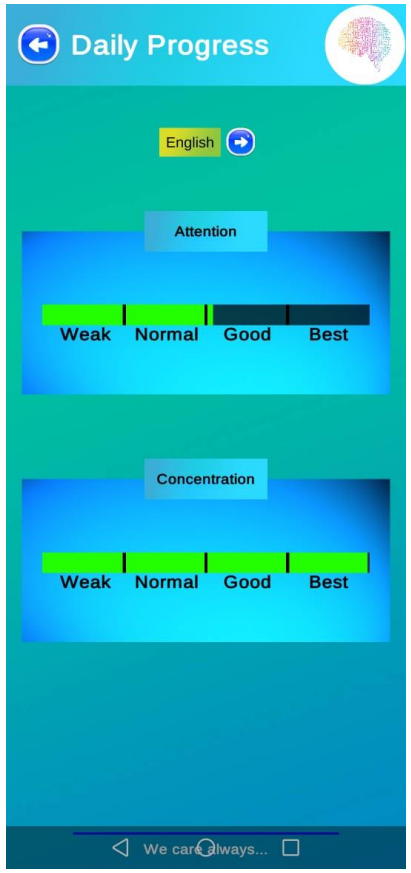
Techniques

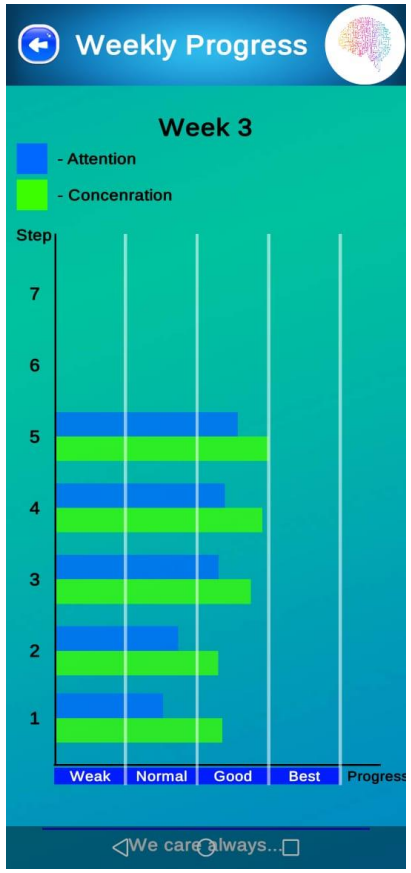
- PlayFab - Remove the challenges of building, managing, and running servers at scale with a complete back-end solution.
- Set goals and have understanding how to achieve them.
- Write short lists of tasks and rank them by importance and priority.

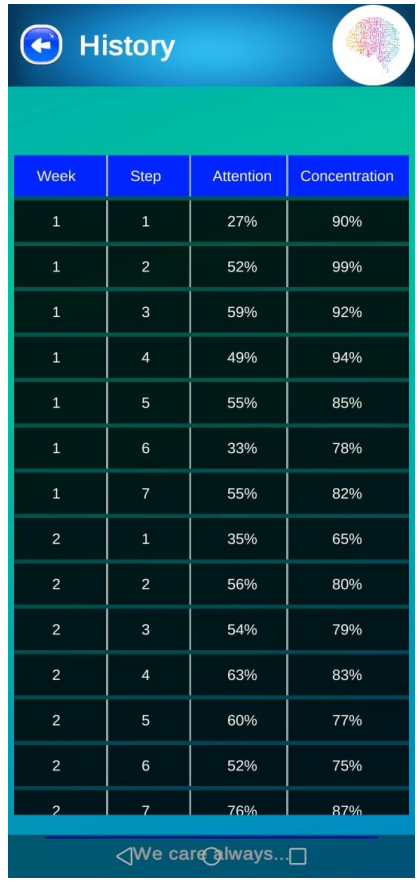
Algorithms

- Reinforcement Learning Algorithm

Achievement







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[2] Szita I. (2012) Reinforcement Learning in Games. In: Wiering M., van Otterlo M. (eds) Reinforcement Learning. Adaptation, Learning, and Optimization, vol 12. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-27645-3_17

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Information Technology

Introduction

- Background

  - ❑Executive functions include the ability to organize, use of proper judgement, plan and do a set of tasks in an effective way [1].
  - ❑The use of brain, memory, and dealing with issue games help strengthen the mind and reduce the symptoms of Dementia [2].

Introduction Cont.

- Research Gap

Feature	Lumosity	Elevate	Brain Games	Proposed System
Game in Sinhala language	✗	✗	✗	✓
View the weekly progress	✓	✓	✓	✓
Based on the performance of user predict the next step	✗	✗	✗	✓
Weekly progress report send to patient's doctor via an email	✗	✗	✗	✓

Introduction Cont.

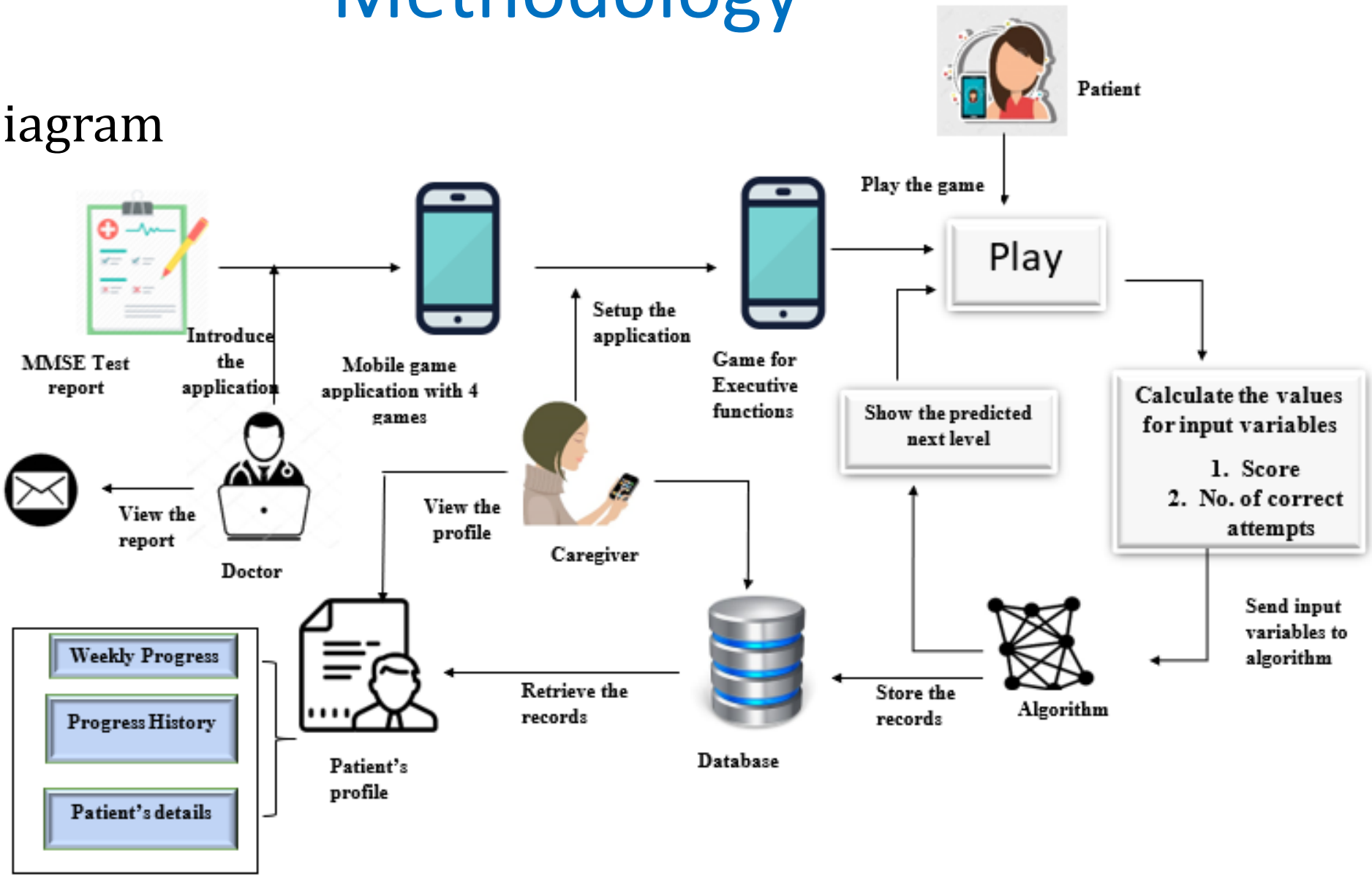
- Research Question

How to implement a game to improve executive functioning skills of Dementia patient using reinforcement learning in personalized way?

- Specific and Sub Objectives
  - ❑ Help dementia patients to improve (aspects of executive functions) :
    - Small calculations skills
    - Time management skills
    - Ability of problem solving
  - ❑ Giving rehabilitation with continuous monitoring.

Methodology

- System Diagram

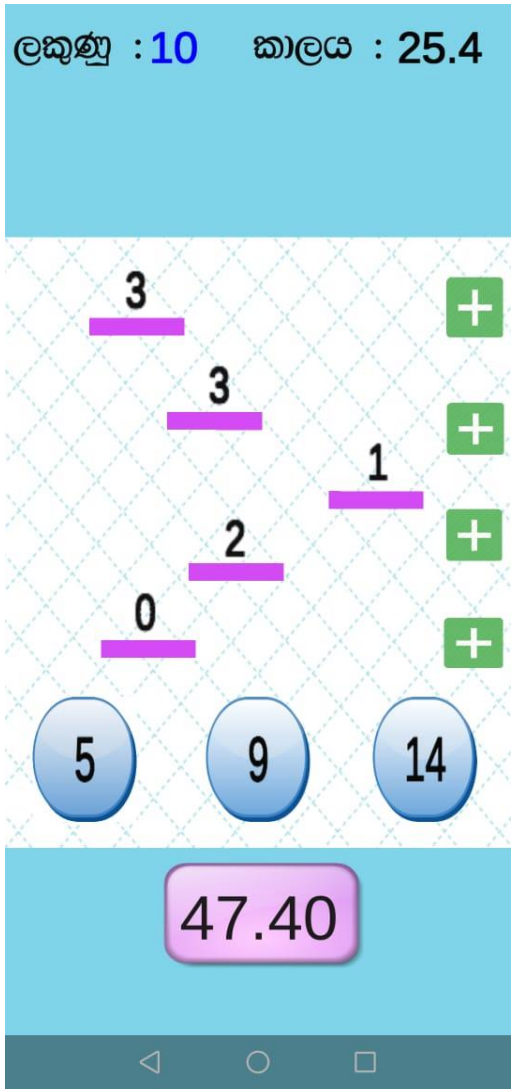


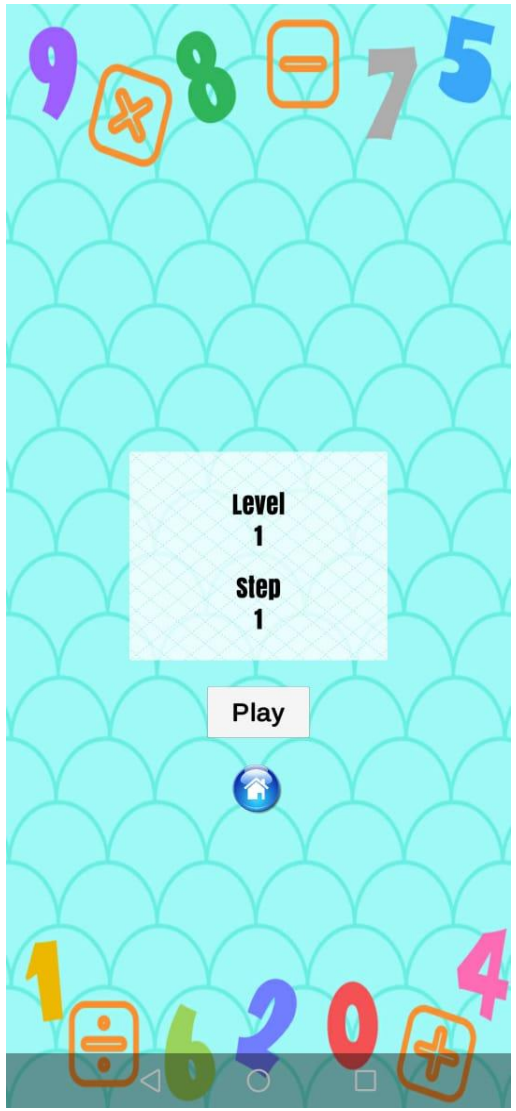
Methodology Cont.

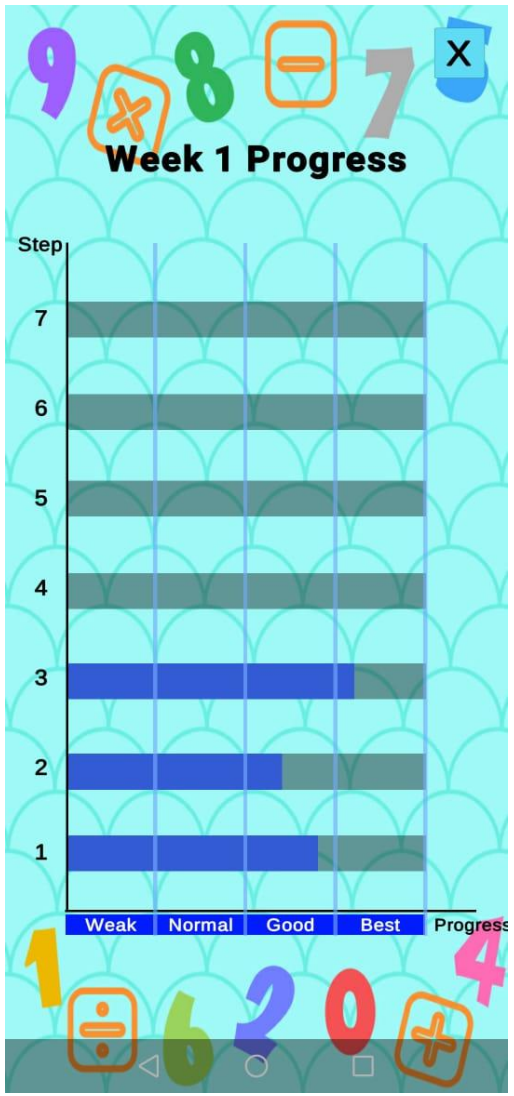
- Technologies
  - ❑C# - used as a technology in Visual Studio
  - ❑PlayFab – Cloud service, to store data
  - ❑SMTP Server – used to Email sending process

- Techniques
  - ❑PlayFab – Backend As A Service platform. User can access to the system using any device by creating an account in Playfab.
- Algorithms
  - ❑Renforcement Learning Algorithm

Achievement







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IT17119504 | MANAMENDRA M.G

Software Engineering

Introduction

- Background

- ❑ Language disorder is a communication disorder in which a person has persistent difficulties in learning and using various forms of language (i.e., spoken, written, sign language) [1].
- ❑ Among Dementia patients, comprehension and speaking disabilities are the most difficult on language cognitive functionality of Dementia.

Introduction

- Research Gap

Features	Lumosity	Brain Games	Elevate	Proposed System
Games on Sinhala language	✗	✗	✗	✓
Speaking practice activities	✗	✗	✓	✓
View weekly progress	✓	✓	✓	✓
Send progress report to caregiver and doctor via email	✗	✗	✗	✓

Introduction Cont.

- Research Question

❑ How to give a solution for the impairment of the language skills of Dementia patients using activities to make their day-to-day life easier with the rehabilitation?

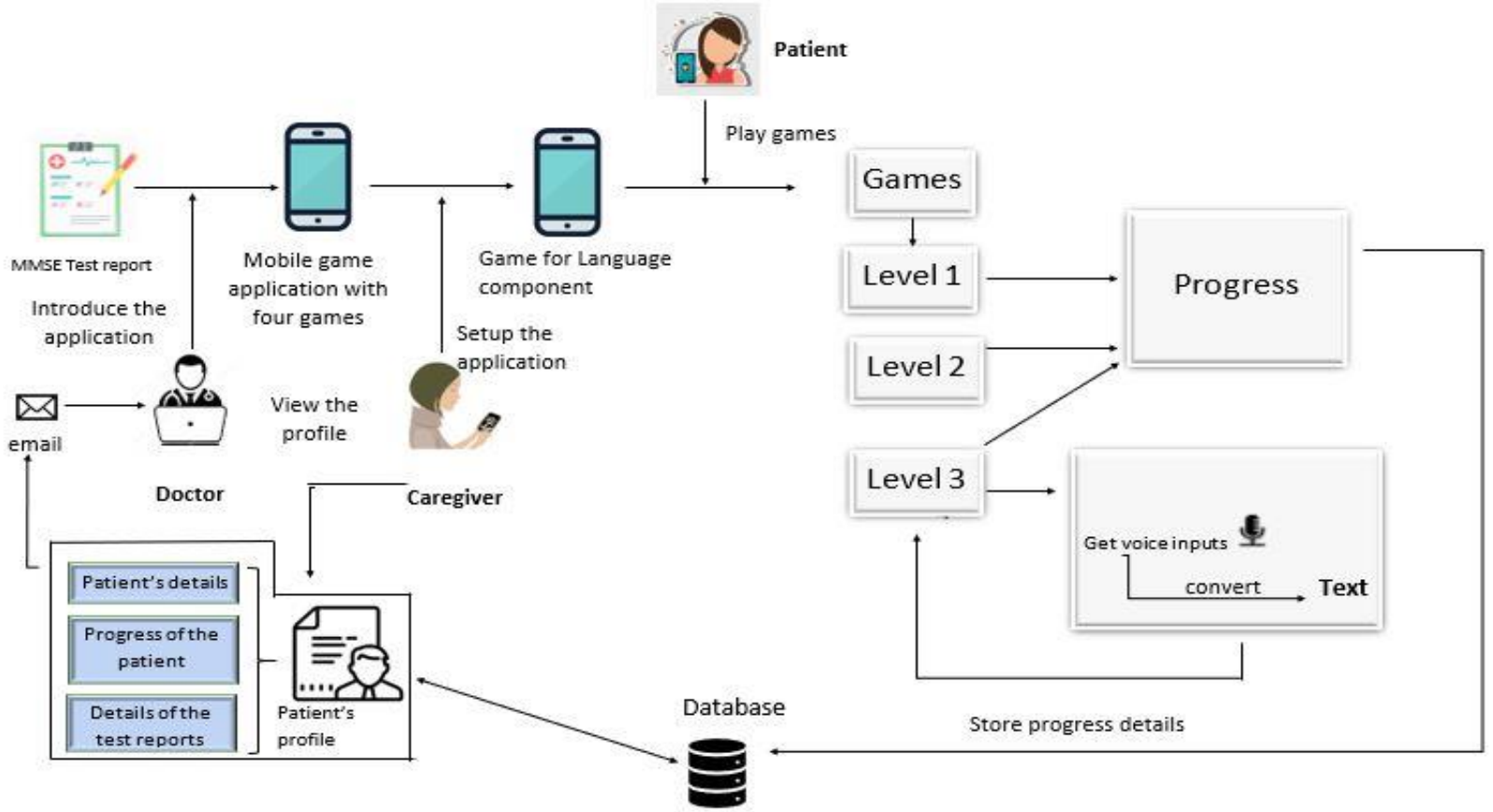
- Specific and Sub Objectives

❑ Improve the Language skills of Dementia patients through mobile games.

- Identify the given pictures correctly.
- Improve the ability of building up words using given jumbled letters .
- Improve the comprehension skills.
- Improve the speaking ability.

Methodology

- System Diagram



Methodology Cont.

- Technologies

❑ C# - Visual Studio

❑ Python (CMUSphinx library)

- Techniques

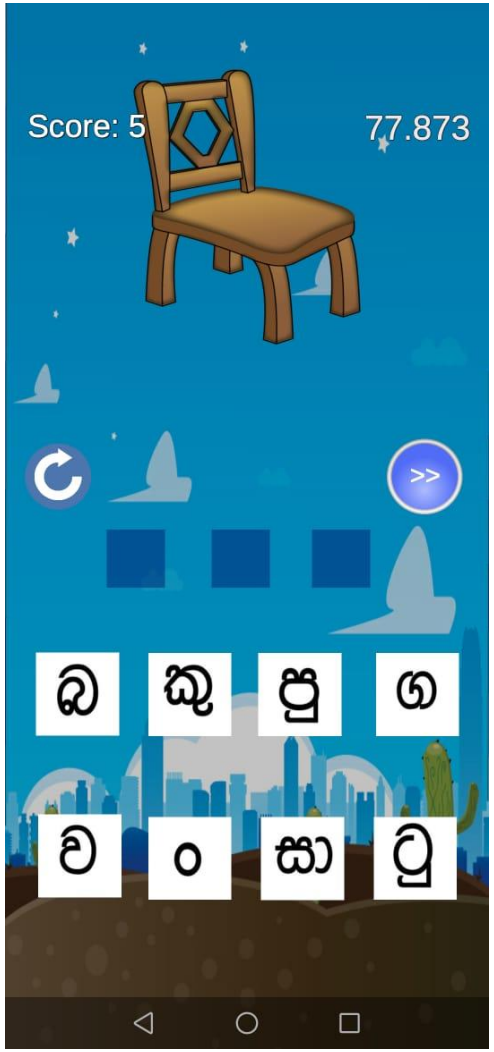
❑ PlayFab (Microsoft Azure) - complete backend platform for live games with managed game services

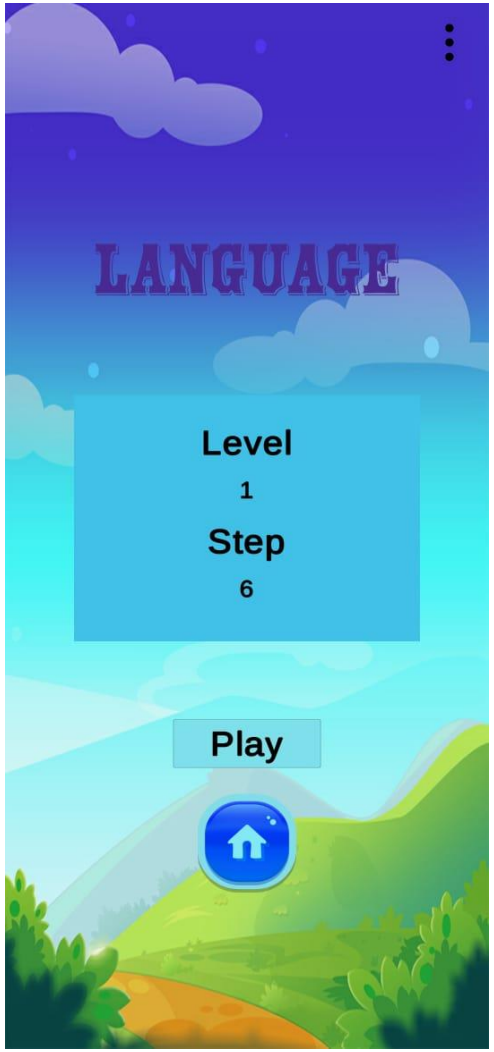
❑ Acoustic Model – Automatic Speech Recognition

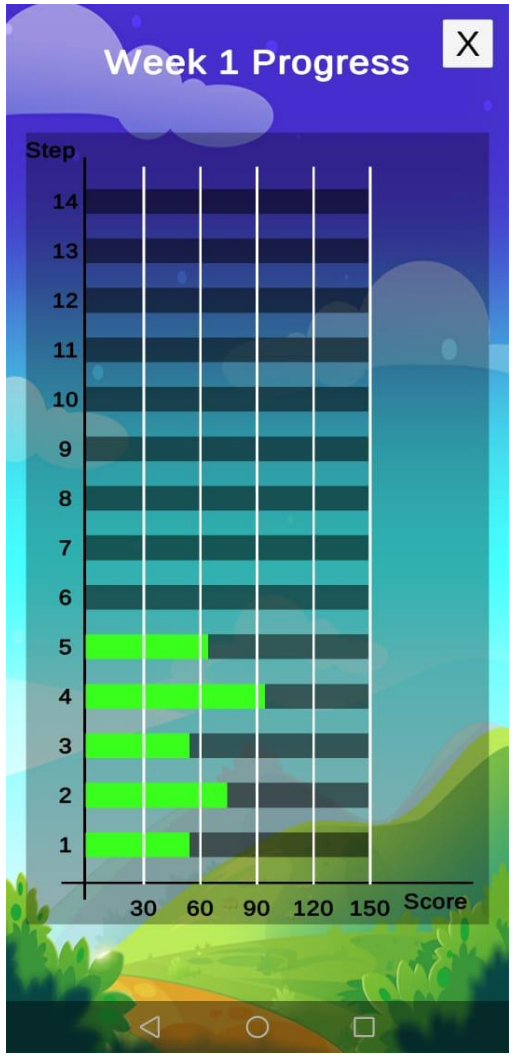
- Algorithms

❑ Deep Learning - Hidden Markov Models (Deep Neural Network)

Achievement







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IT17100076 | SILVA S.R.R.M

Software Engineering

Introduction

- Background

  - Dementia is collective term for assemblage of diseases which mainly focuses on frontal lobe and temporal lobe from the cerebral cortex of the human brain and which can be affected to on human's memory.

  - In year of **2017, Gill Livingston et al.** have demonstrated that Dementia is the greatest global challenge for health and social care in 21st century and also, they have argued that occurred people who are older than 65 years [1].

Introduction Cont.

- Research Gap

Features	Lumosity	Brain Games	Elevate	Eidetic	Proposed System
Personalized for user or patient	No	No	No	No	Yes
Support with Sinhala Language	No	No	No	No	Yes
Suitable for elderly people	Yes	No	Yes	No	Yes
Separate game for human's memory function	Yes	No	Yes	Yes	No

Introduction Cont.

- Research Question

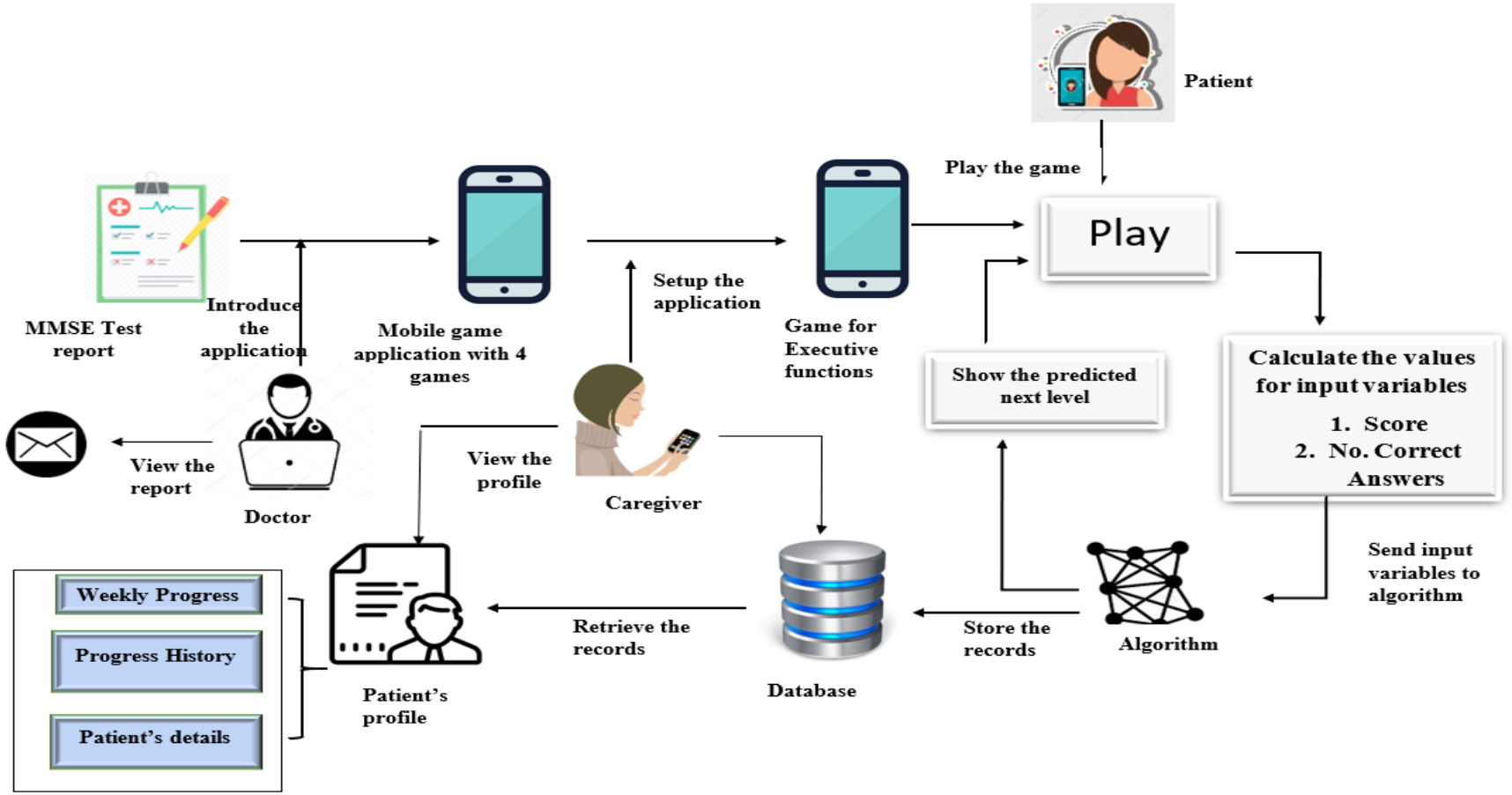
  - How to introduce a personalized gaming application for Sri Lankan Dementia patients which will be mainly based on human memory using reinforcement Learning ?

- Specific and Sub Objectives

- Develop a mobile game for Dementia patients to improve the memory skills.
  - Time Management
  - Ability to improve human's memory

Methodology

- System Diagram



Methodology Cont.

- Technologies

  C# - Visual Studio

  PlayFab

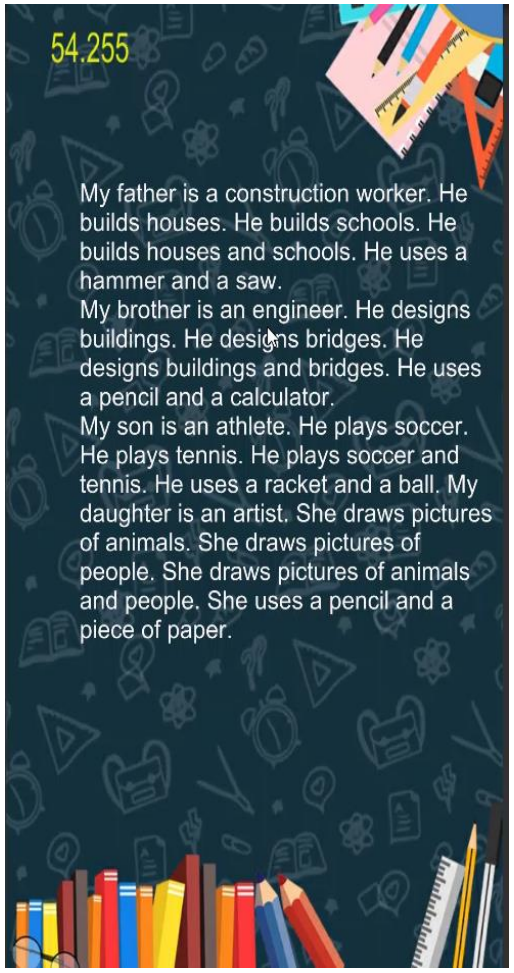
- Techniques

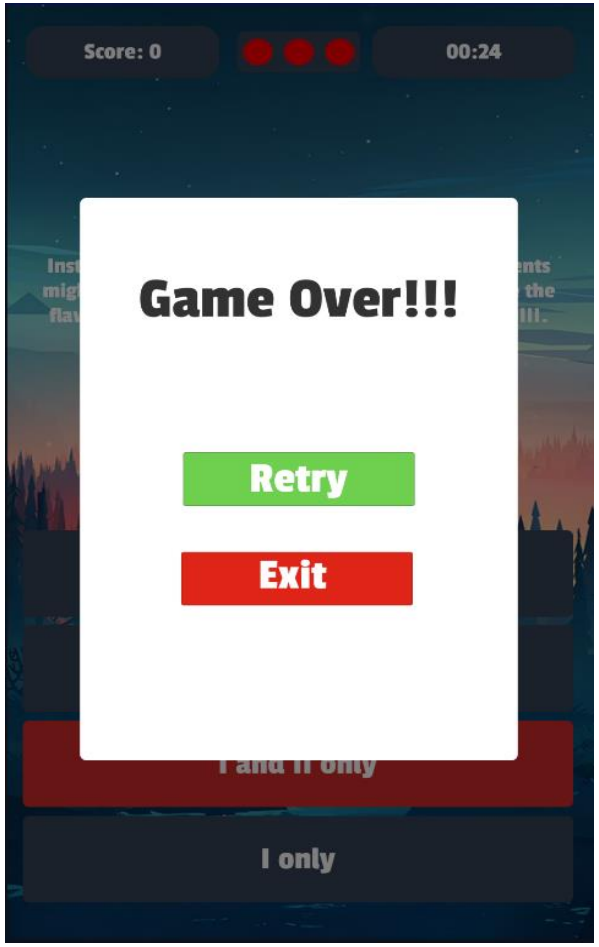
  PlayFab

- Algorithms

  Reinforcement Learning Algorithm

Achievement





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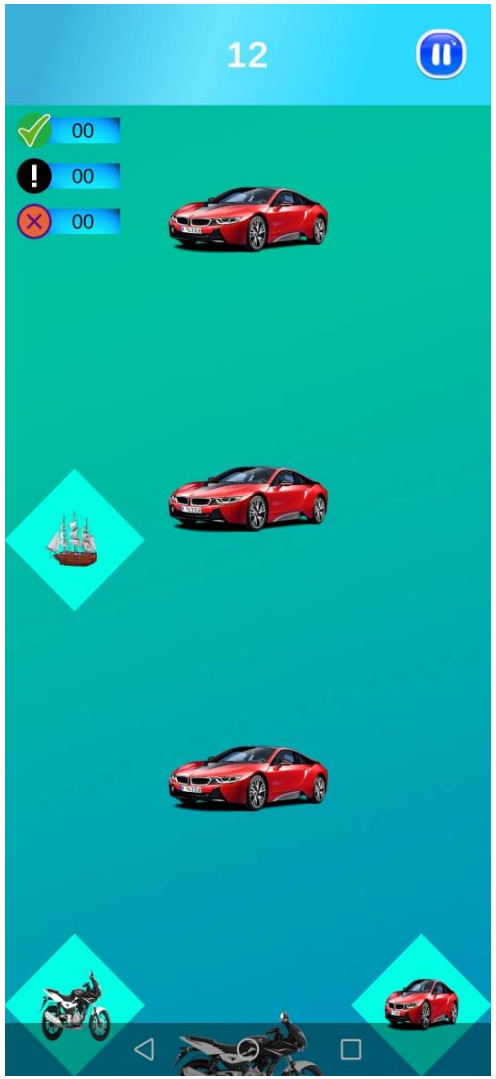
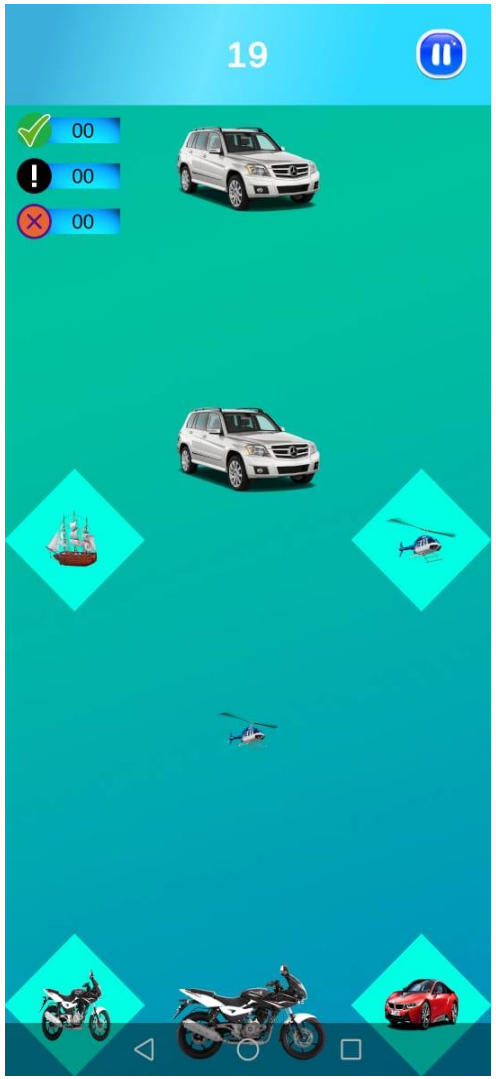
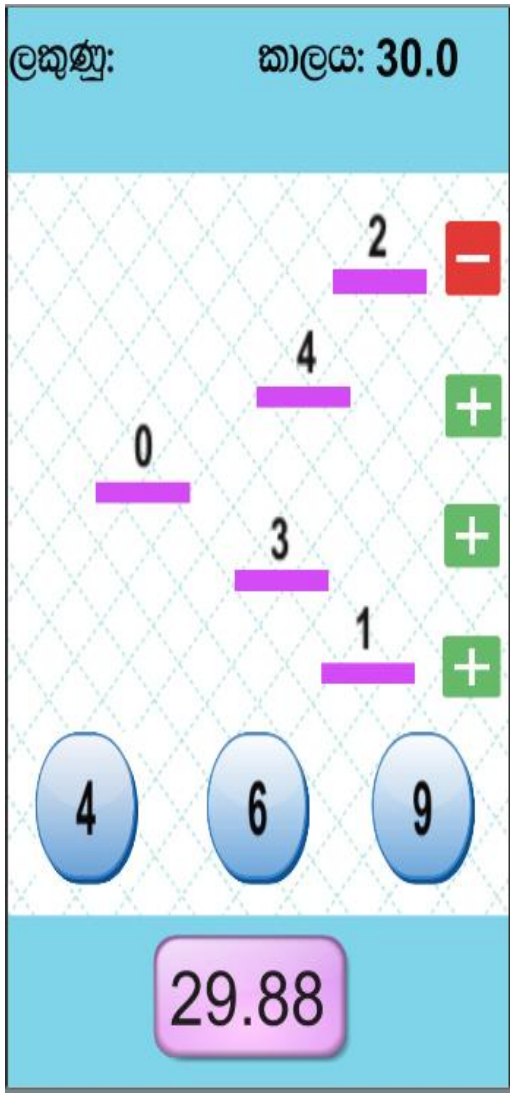
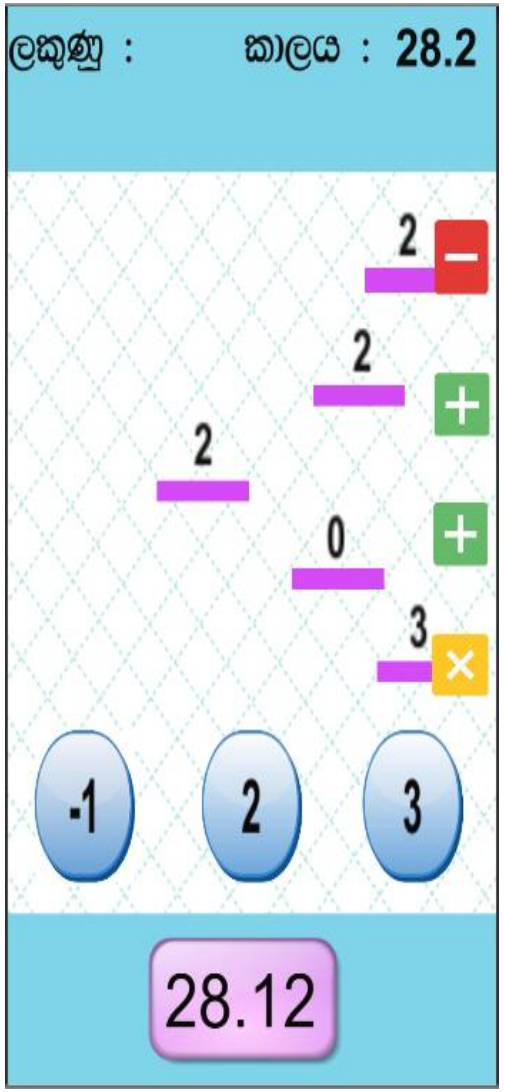
Other interfaces

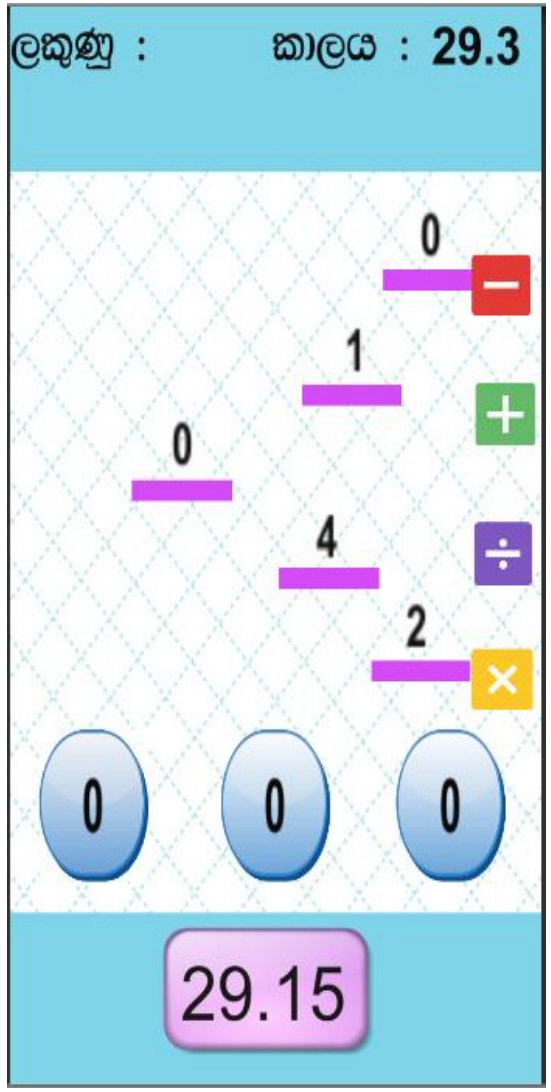




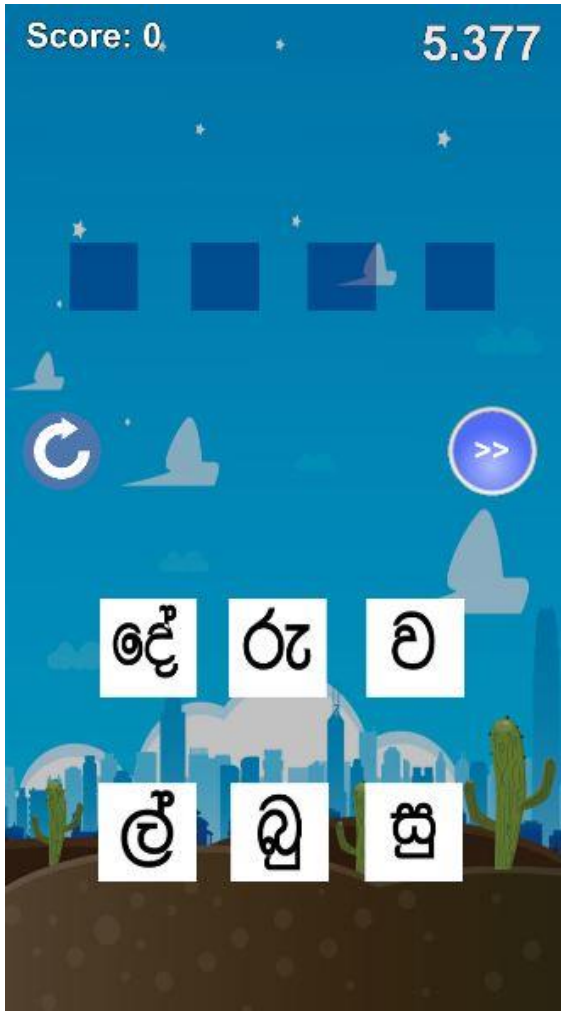
Other interfaces

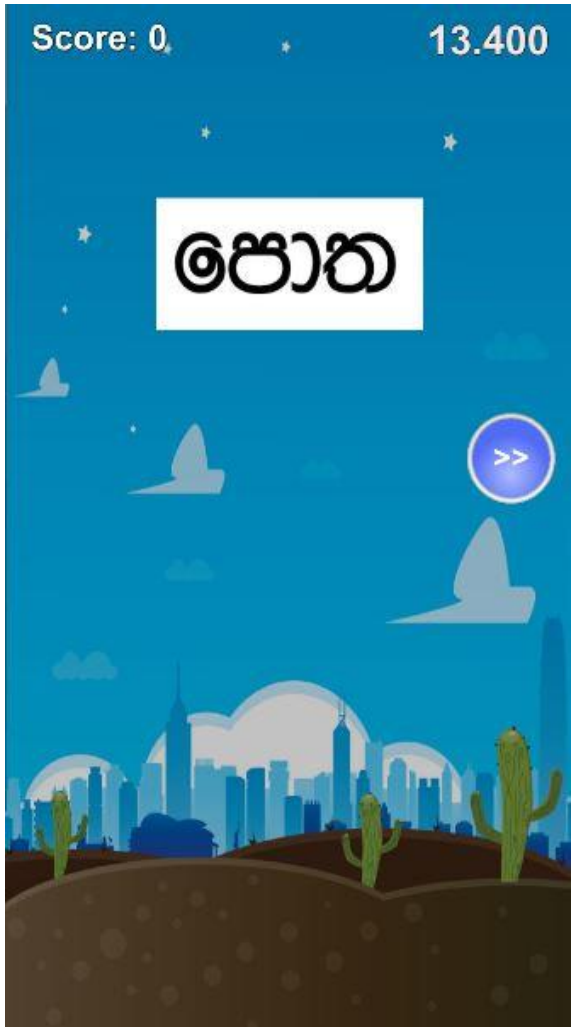




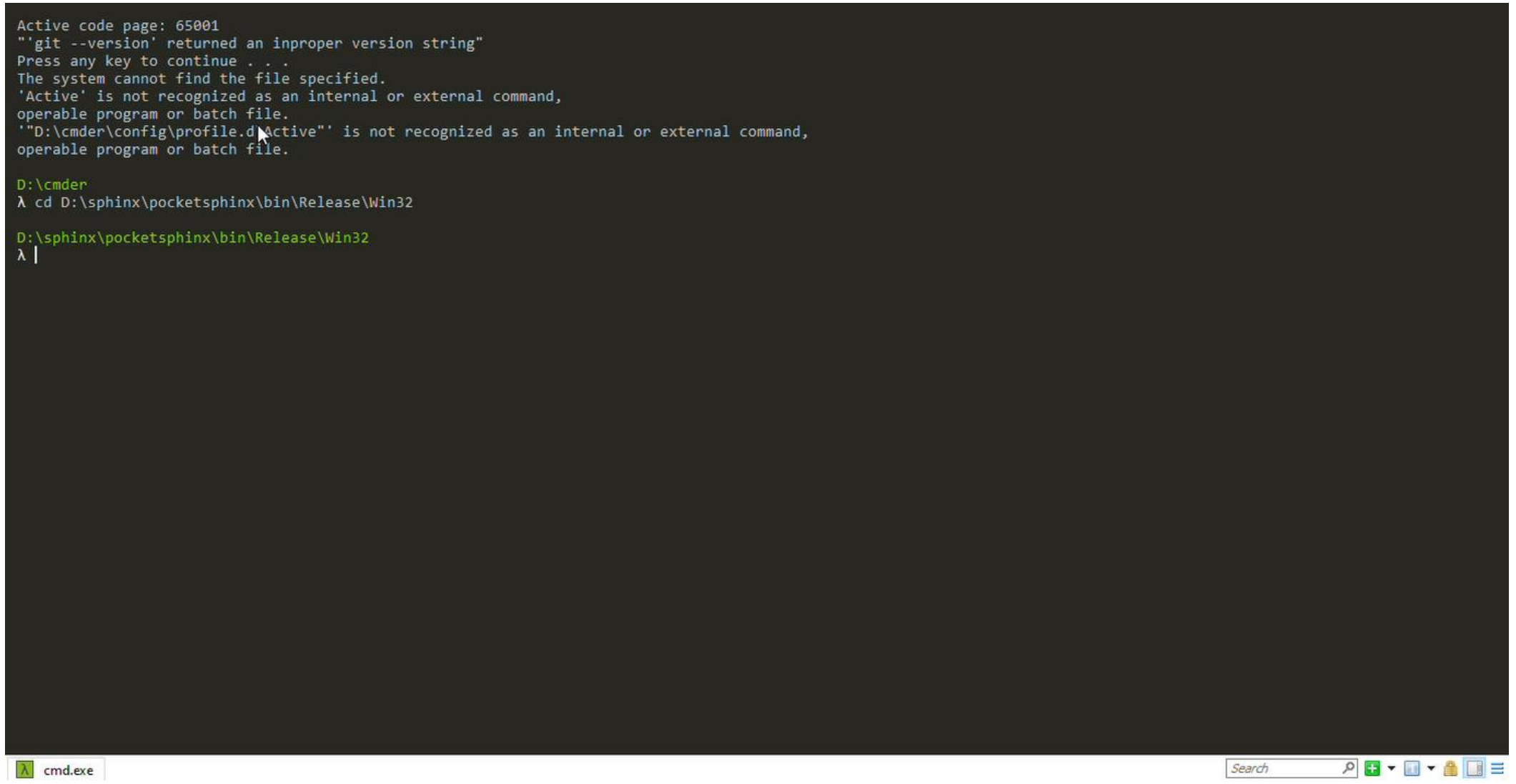


Other Interfaces of Language Component





Demo for Acoustic Model



- Thank you …

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