LEARN MATE

"Empowering Autism, Unlocking Potential"

Team

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Supervisor

Ms. Thisara Shyamalee
Co-Supervisor

Prof. Hemamali Perera
External Supervisor

Title: Former Child and Adolescent Psychiatric

Hospital : Lady Ridgeway Hospital for Children

Expertise : Specializes in working with children with special needs. (ASD, Dyslexia, Hyper-activity)

Research Publications :

- The ability of adolescents to recognize common indicators of mental health problems, and their sources of mental health knowledge
- Stigma related to mental health issues – a study among adolescents in Sri Lanka
- Prevalence of attention deficit hyperactivity disorder and other psychiatric morbidity in children with burn injuries
- Culturally adapted pictorial screening tool for autism spectrum disorder: A new approach

Background

ASD (Autism Spectrum Disorder) - A neuro-developmental condition of variable severity with lifelong effects that can be recognized from early childhood,

Affects communication, learning, and behavior of a person

Statistics according to Neuro-Development Centre in Northern Sri Lanka

1 in 93

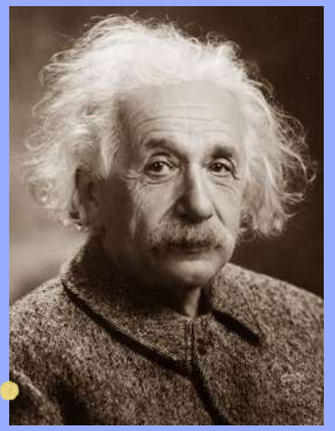
aged 18 to 24 months has ASD

91.9%
Behavioural Issues

96.7%
Poor Social Interaction

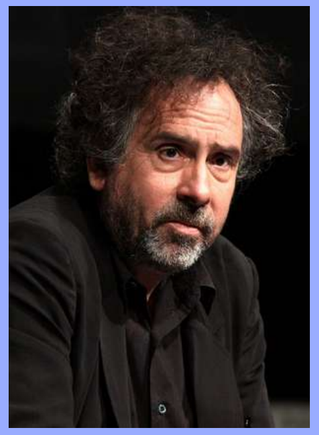
78%
Sensory Issues

Famous People with Autism



Albert Einstein
German Theoretical physicist

Elon Musk
CEO of Tesla Motors



Tim Burton
American director and film producer

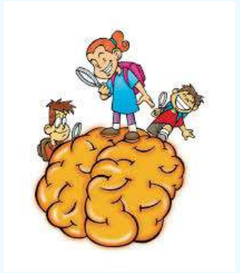
Research Problem

How to enhance autistic children's abilities using machine learning techniques based on domains of learning?

INTRODUCTION

- Enhance learning skills of autistic children using machine learning techniques.
- Provide personalized recommendations on a weekly basis.
- Capture detailed progress of each child.
- Visualize the child's progress through intuitive graphs and charts using color theory.
- Enable parents and teachers to monitor and review the child's development.

Cognitive Domain : Focus on intellectual skills such as critical thinking, problem solving, and creating a knowledge base



Affective Domain : Involves feelings, attitudes, and emotions

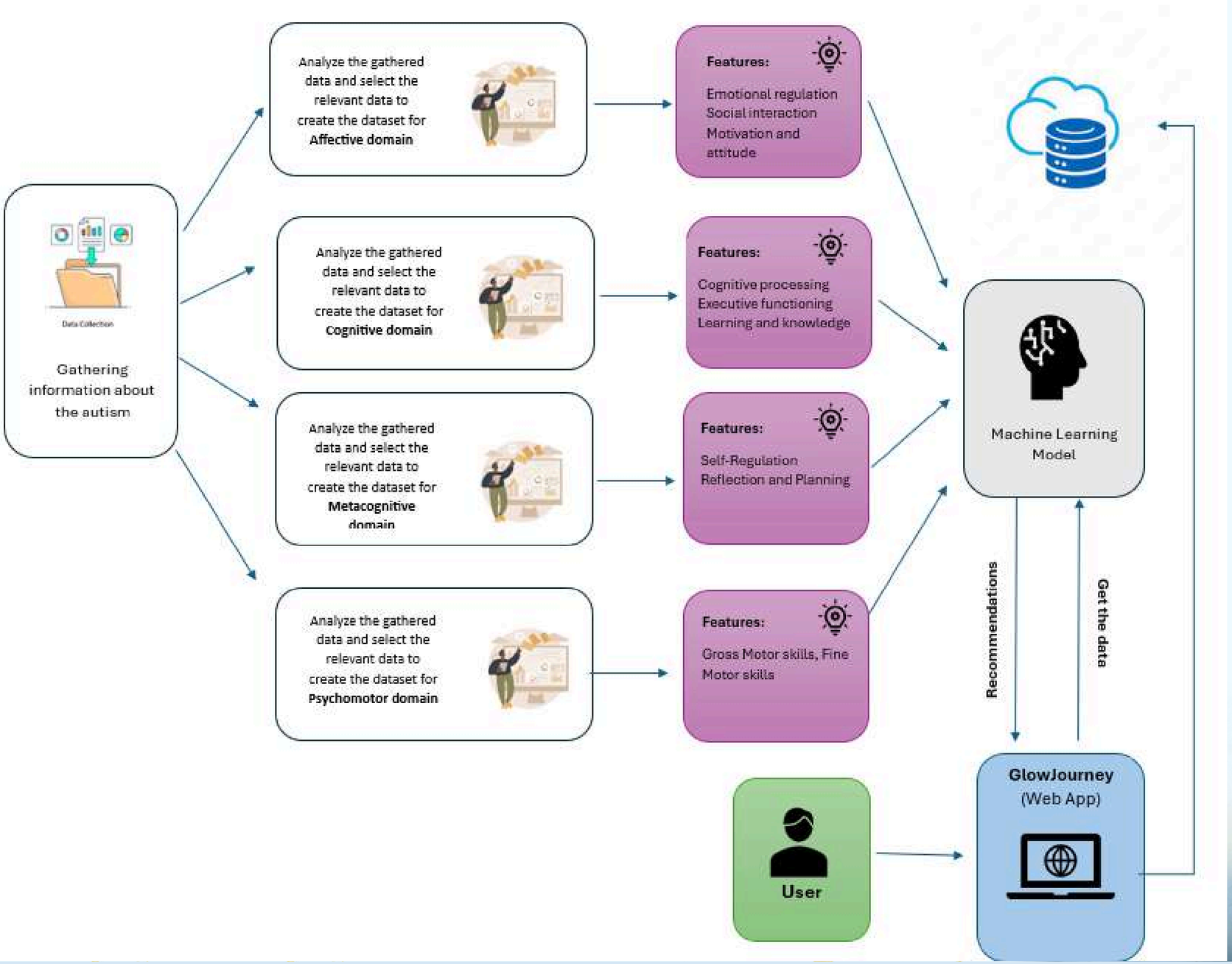
Psychomotor Domain : Includes physical movement, coordination, and use of the motor-skill areas

Meta Cognitive Domain : Awareness of one's thought processes and an understanding of the patterns behind them

Objectives

- Understand How Autistic Children Learn
- Create customized Learning Plans
- Test Plans in Small Studies
- Improve Teaching Tools and Support
- Make sure Plans Work Everywhere
- Protect Autistic Children's Rights

Overall System Diagram



Cognitive Domain

Rupasinghe Y. S.

Introduction

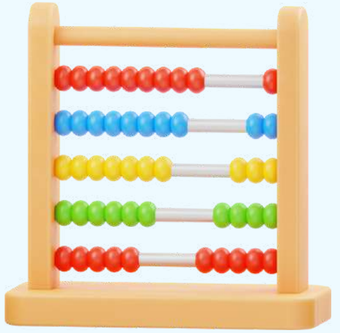
- Development of intellectual skills such as critical thinking, problem solving and creating a knowledge base.

- 6 levels in cognitive domain:
  - Knowledge
  - Comprehension
  - Application
  - Analysis
  - Synthesis
  - Evaluation

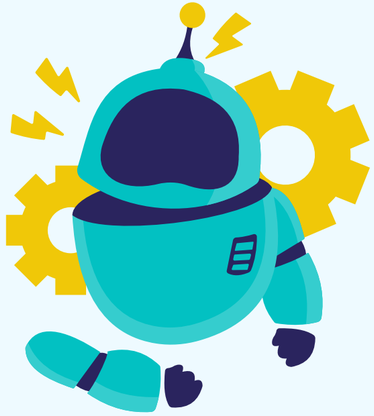
Cognitive Skills

Problem-solving Skills

Mathematical Skills



Error Monitoring Skills



Research Gap

[1] A technological intervention for improving cognitive abilities based on the preferences of Autistic children

[2] AI-powered backup robot designed to enhance cognitive abilities in children with Down syndrome

[3] Detection of Autism Spectrum Disorder in Children Using Machine Learning Techniques

[4] A Machine Learning and Integration Based Architecture for Cognitive Disorder Detection Used for Early Autism Screening

[5] Cognitive and Affective Brain–Computer Interfaces for Improving Learning Strategies and Enhancing Student Capabilities

Feature	[1]	[2]	[3]	[4]	[5]	Learn Mate
Specialized for Autistic Children	✓	X	✓	✓	X	✓
Personalized Recommendations	X	✓	X	X	X	✓
Enhanced Cognitive Skills	X	✓	X	X	✓	✓
Error Monitoring Skills	X	X	X	X	X	✓
Progress Monitoring	✓	X	X	X	X	✓
Machine Learning	X	X	✓	✓	X	✓

Research Problem

How can machine learning techniques be used to enhance the cognitive domain of autistic children through personalized and adaptive learning strategies?

Novelty

Personalized recommendations while adapting to the child's responses :

Reinforcement Learning

The child will be given with small tasks to improve his cognitive skills. Based on the responses of the child, the system will adapt the difficulty level

Objectives

Develop a web application to help children with ASD to reach their full potential in education by improving cognitive abilities.

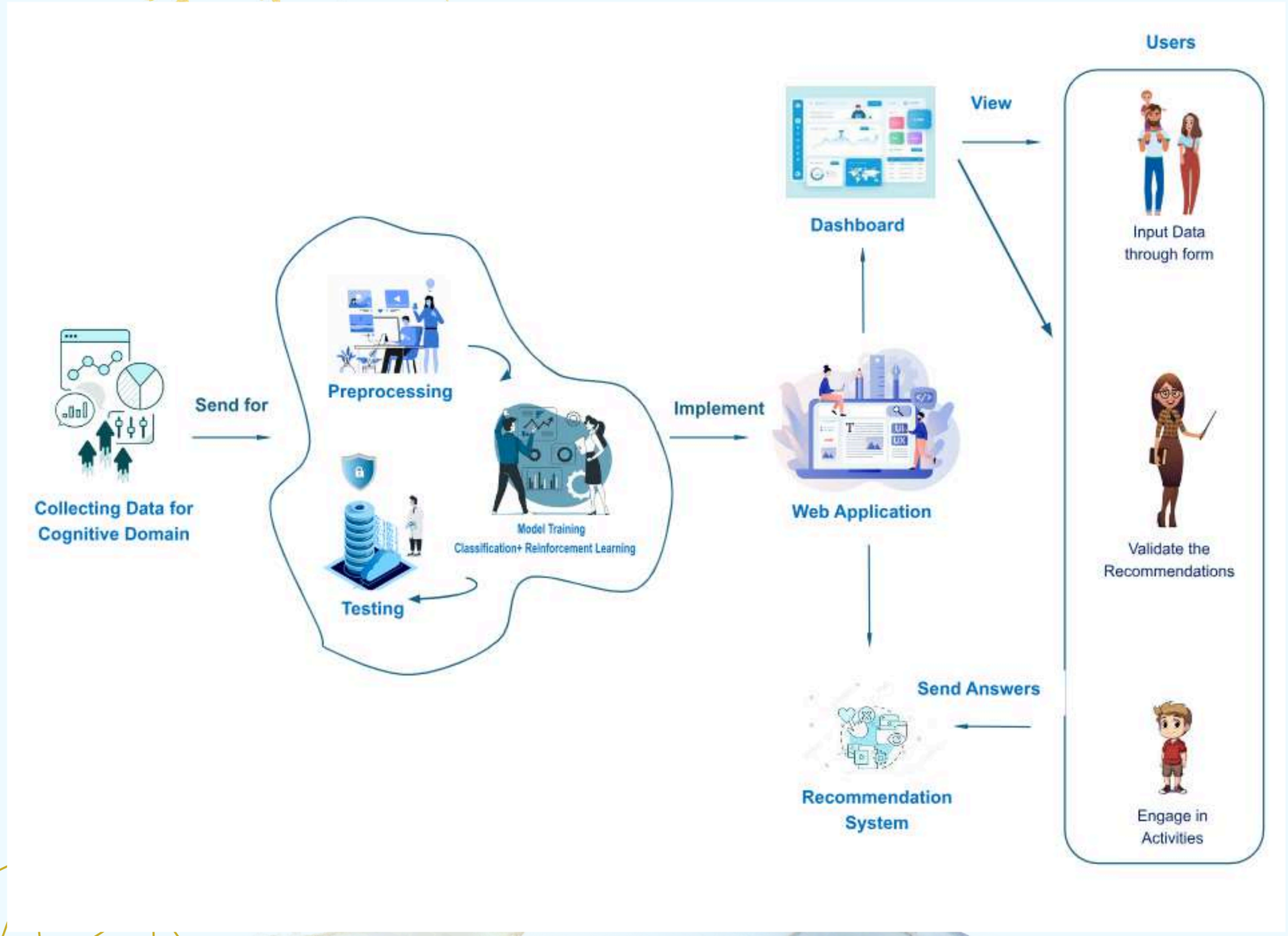
To provide an easily accessible platform for autistic children.

To adapt child's responses and provide personalized recommendations.

To connect with experts and educational programs.

To receive feedback on the application for future maintenance.

System Diagram



References

[1] Gunathilake Y. A. G. U. T. , Fasliya R. F., Premarathne R. D. A. R. , Pasan Kalhara D., Anuradha Karunasena and Pradeepa Senani Bandara, "A technological intervention for improving cognitive abilities based on the preferences of Autistic children," Proc. of the 7th International Conference on Engineering and Emerging Technologies (ICEET), 2021.

[2] Francys Zabdiel Oyuela and Óscar Ariel Paz, "AI-powered backup robot designed to enhance cognitive abilities in children with Down syndrome," IEEE Central America and Panama Student Conference (CONESCAPAN), 2023.

[3] Kaushik Vakadkar, · Diya Purkayastha and Deepa Krishnan, "Detection of Autism Spectrum Disorder in Children Using Machine Learning Techniques," Springer Nature Singapore Pte Ltd, 2021.

[4] Jesús Peral, David Gil, Sayna Rotbei, Sandra Amador, Marga Guerrero and Hadi Moradi, "A Machine Learning and Integration Based Architecture for Cognitive Disorder Detection Used for Early Autism Screening," Electronics, 2020.

[5] Nuraini Jamil, Abdelkader Nasreddine Belkacem, Spfia Ouhbi and Christoph Guger, "Cognitive and Affective Brain–Computer Interfaces for Improving Learning Strategies and Enhancing Student Capabilities: A Systematic Literature Review," IEEE Access, 2021.

Affective Domain

Ruhunage R.S.D.P

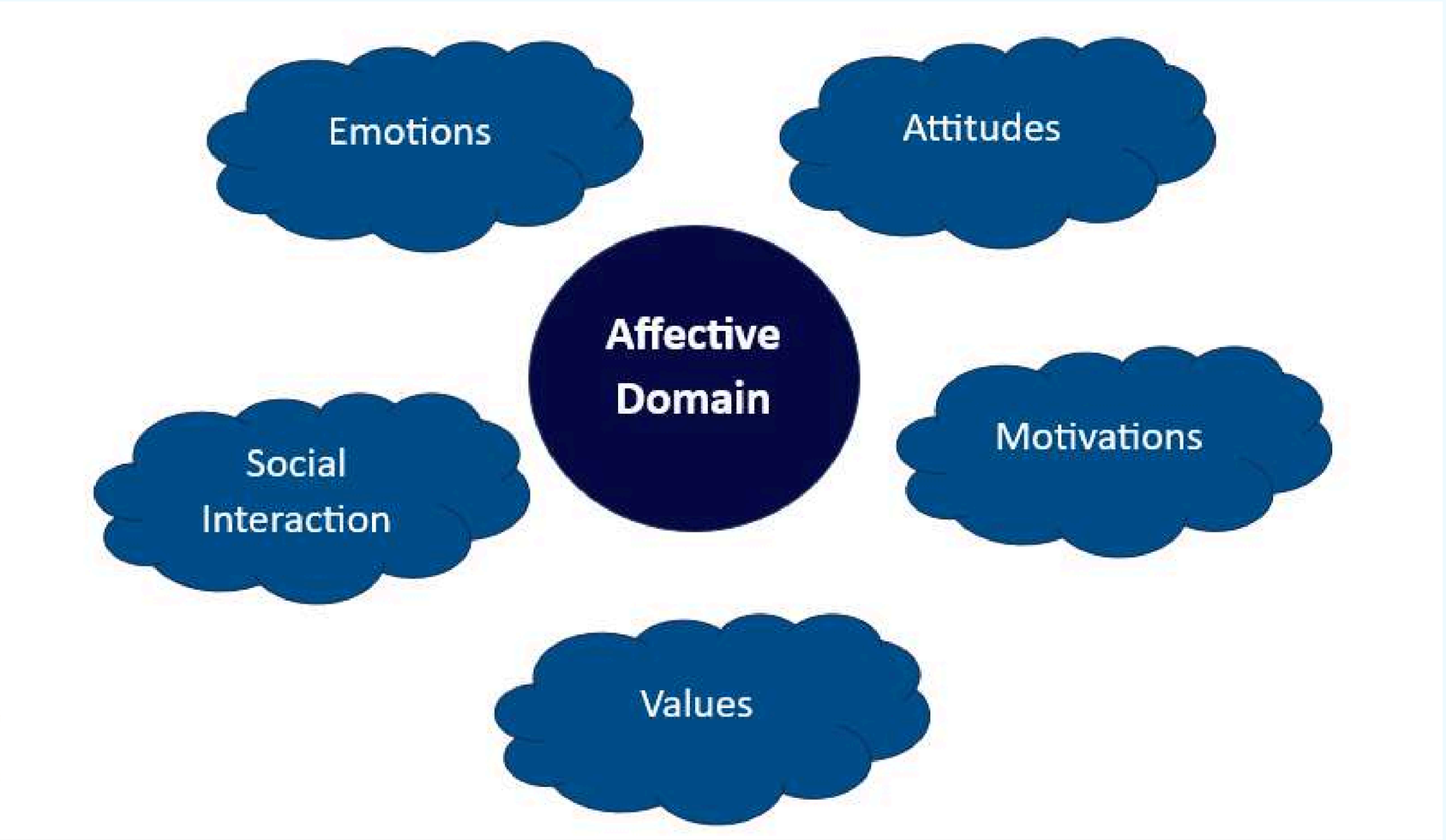
Introduction

- Emotional and social skills are crucial for helping autistic children learn effectively and interact well.

- Using machine learning and emotional recognition to predict each child's skill levels and create personalized strategies to meet their specific goals.

- Developing personalized tools and recommendations to enhance emotional regulation and social interaction, aiming to improve overall learning outcomes and quality of life.

Affective Domain Skills



Research Gap

[1] Affective Computing of Children with Autism Based on Feature Transfer

[2] An Application of Neural Networks to Predicting Mastery of Learning Outcomes in the Treatment of Autism Spectrum Disorder

[3] Towards Developing a Learning Tool for Children with Autism

[4] Avatarizing Children with Autism Spectrum Disorder into Serious Games for Social Communication Skill Intervention

Feature	[1]	[2]	[3]	[4]	Learn Mate
Emotional Regulation	✓	✓	X	X	✓
Social Interaction	X	X	X	X	✓
Behavioral and Emotional Factors	✓	✓	✓	✓	✓
Motivation and Attitude	X	X	X	X	✓
Machine learning	✓	✓	X	X	✓

Research Problem

Research on helping autistic children learn using emotions and social skills is insufficient. Existing studies focus on recognizing emotions and creating tools but don't directly improve learning. Better methods are needed to enhance learning through emotional and social interaction.

Novelty

Using the Transfer Learning ML technique that helps enhance learning through emotional and social interaction more quickly and accurately, even with less data.

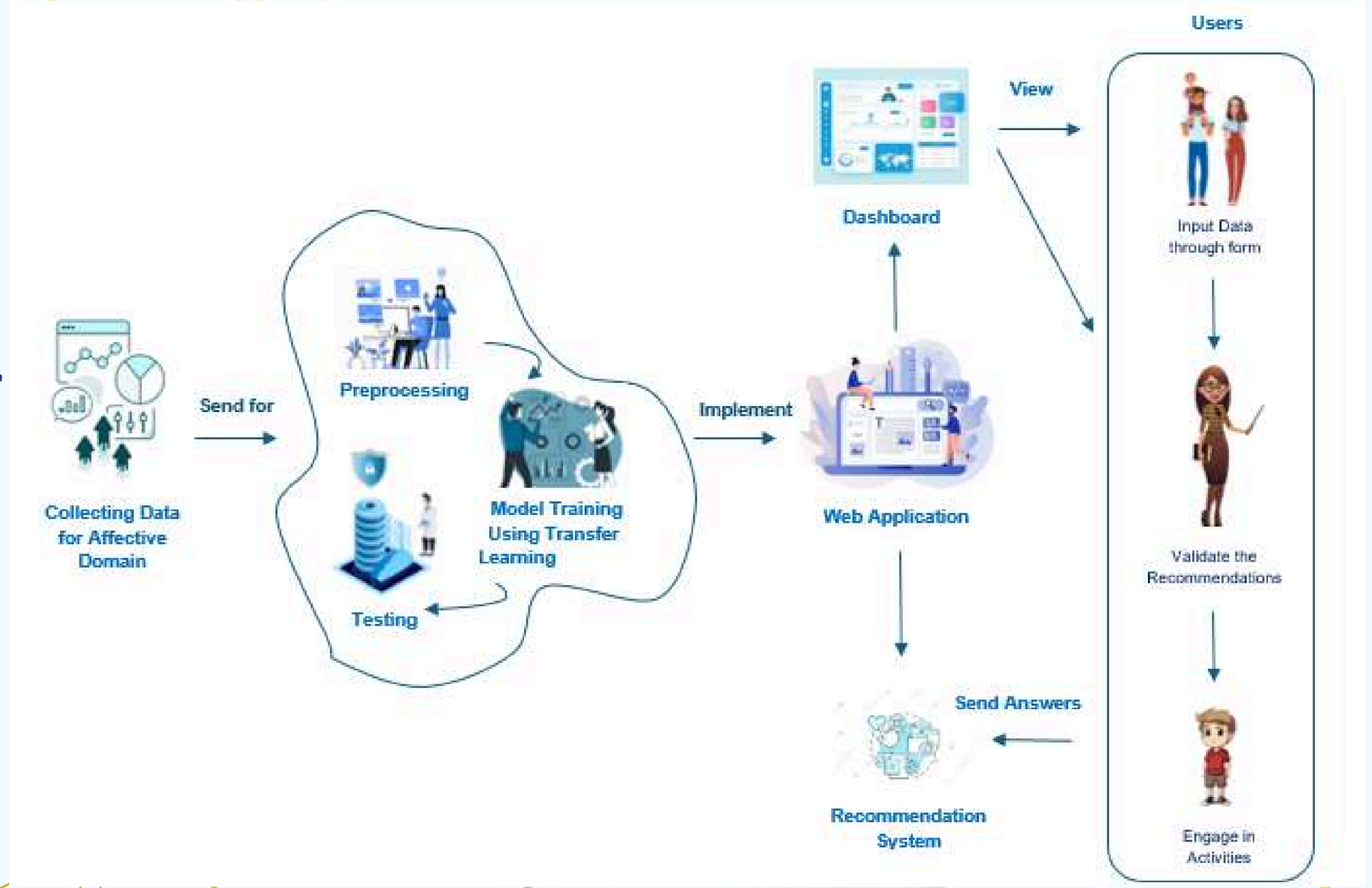
- Select a pre-trained model [VGG,ResNet]
- Modify the model [adjust last layers to match new dataset]
- Fine-tune the model
  ** Freeze Earlier layers - train only the new layers
  ** Fine tune all layers - training the entire model with a lower learning rate.
- Validate the model's performance and adjust as necessary.

Objectives

Aiming to build tools to help autistic children learn better by improving their emotions and social skills, and test their effectiveness.

- To adapt learning tools for each child's unique needs.
- Enhance engagement by making learning activities more interesting and interactive.
- Measure the progress of children and assess their impact on learning.
- Gather feedback from users.

System Diagram



References

[1] J. Han, X. Liu, L. Qiu, J. Liu, F. Wang, and Z. Wang, "Affective Computing of Children with Autism Based on Feature Transfer," School of Computer and Communication Engineering, University of Science and Technology Beijing, Beijing, China, 2024.

[2] E. Linstead, R. German, D. Dixon, D. Granpeesheh, M. Novack, and A. Powell, "An Application of Neural Networks to Predicting Mastery of Learning Outcomes in the Treatment of Autism Spectrum Disorder," Schmid College of Science and Technology, Chapman University, Orange, CA, USA; Center for Autism and Related Disorders, Woodland Hills, CA, USA, 2024.

[3] T. Zaki, M. N. Islam, M. S. Uddin, S. N. Tumpa, M. J. Hossain, M. R. Anti, and M. M. Hasan, "Towards Developing a Learning Tool for Children with Autism," Department of Computer Science and Engineering, Military Institute and Science and Technology, Dhaka, Bangladesh, 2024.

[4] L. Liu, X. Wu, J. Meng, and J. Chen, "Avatarizing Children with Autism Spectrum Disorder into Serious Games for Social Communication Skill Intervention," Faculty of Artificial Intelligence in Education, Central China Normal University, Wuhan, China, 2024.

Psychomtor Domain

Pehesarani W.K.A

Introduction

- Develop a model to predict the autistic child psychomotor level and recommend strategies to improve psychomotor domain in autistic children.

- Psychomotor skills involve the coordinated function of the brain and muscles, enabling movements and physical activities.

Gross Motor Skills

Fine Motor Skills

Psychomotor Skills

Gross motor skills

Walking
Running
Jumping
Swimming
Climbing
Throwing and Catching

Fine motor skills

Writing
Drawing
Coloring
Buttoning Clothes
Typing

Research Gap

[1] Consensus on the Best Practice Guidelines for Psychomotor Intervention in Preschool Children with Autism Spectrum Disorder.

[2] Developing Psychomotor Skills in the Case of Autistic Students

[3] Effects of Motor Intervention Program on Academic Skills, Motor Skills and Social Skills in Children with Autism Spectrum Disorder

[4] Enhancement of psychomotor skills in children with autism spectrum disorder by employing a mechatronic training kit

Feature	[1]	[2]	[3]	[4]	Learn Mate
Fine motor	✓	✓	X	✓	✓
Gross motor	✓	✓	✓	✓	✓
Psychomotor Level	X	X	X	X	✓
Recommendations to improve the psychomotor skills	✓	✓	✓	✓	✓
Machine learning	X	X	X	X	✓

Research Problem

How can machine learning techniques be used to enhance the psychomotor domain of autistic children?

Novelty

Personalized recommendations with the use of **Ensemble methods.**

- Utilize ensemble methods (e.g., Boosting, Bagging, Stacking) to combine multiple models, improving the accuracy of psychomotor level predictions for autistic children.
- Generate personalized recommendations based on precise psychomotor level predictions, addressing each child's unique developmental needs.

Novelty

Develop an algorithm to **calculate the activeness** of autistic children

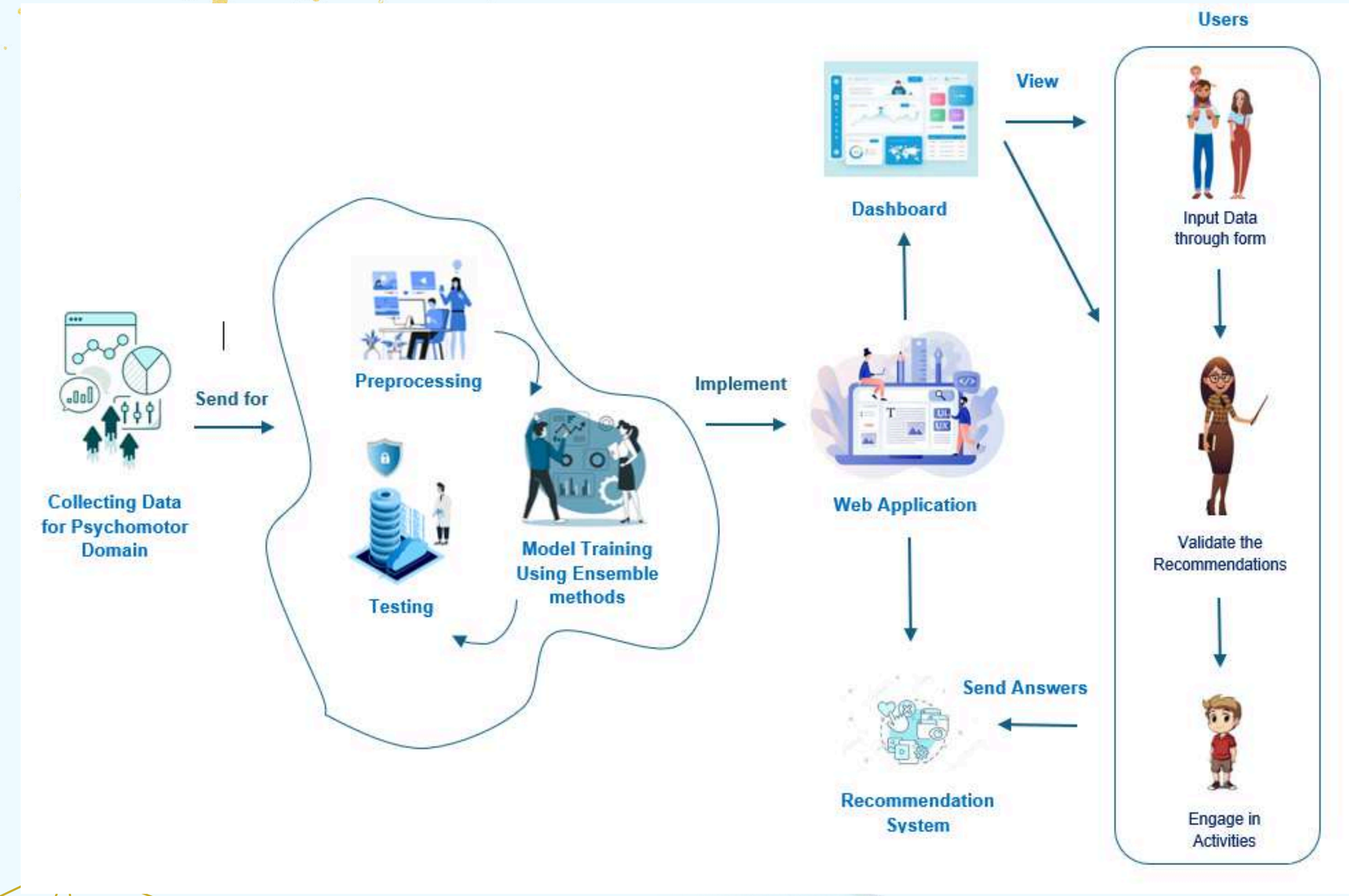
- Assigns different importance levels to various activities (e.g., therapy vs. play).
- Measures both the duration and engagement in each activity, providing a detailed view of overall activeness.

Objectives

Develop a web application utilizing machine learning techniques to predict the psychomotor level of autistic children and recommend personalized strategies for improving their psychomotor skills

- Enhance Personalization of Recommendations
- Ensure Application Scalability and Performance
- Build a user-friendly web application to users.
- User Testing and Feedback

System Diagram



References

1. A. Frazão, S. Santos, A. Rodrigues, T. Brandão, C. Simões, and P. Lebre, "Consensus on the best practice guidelines for psychomotor intervention in preschool children with autism spectrum disorder," Children, vol. 9, no. 11, pp. 1778, Nov. 2022. doi: 10.3390/children9111778.

2. Barna, "Developing psychomotor skills in the case of autistic students," in Proc. 7th Int. Conf. Edu World 2016, Galati, Romania, 2016.

3. Hatipoğlu Özcan, D. F. Özer, and S. Pınar, "Effects of motor intervention program on academic skills, motor skills, and social skills in children with autism spectrum disorder," J. Autism Dev. Disord., Apr. 2024.

4. R. S. Moorthy, K. Iyer, R. H. Krishnan, and S. Pugazhenthi, "Enhancement of psychomotor skills in children with autism spectrum disorder by employing a mechatronic training kit," Pacific J. Biomed. Res., 2019.

Meta-Cognitive Domain

Tharaki D.H.D

Introduction

- Awareness and comprehension of one's own thought and learning processes.
- Critical for problem-solving and academic success.
- Increased Independence and Self-assurance and enhances daily activities.
- Supports social and personal development, aiding in overcoming obstacles.

Knowledge

Regulations

Meta Cognitive Skills

Planning
Goal Setting
Strategizing
Resource Allocation

Monitoring
Self-Assessment
Comprehension Monitoring
Error Detection

Regulating
Adjusting Strategies
Time Management
Seeking Help

Self-Reflection
Reviewing Processes
Learning from Experience
Continuous Improvement

Research Gap

[1] Supporting Children's Metacognition with a Facial Emotion Recognition based Intelligent Tutor System

[2] Metacognition in Autism Spectrum Disorder: Digital Technologies in Metacognitive Skills Training

[3] Visual Strategies for Students with Autism Spectrum Disorders

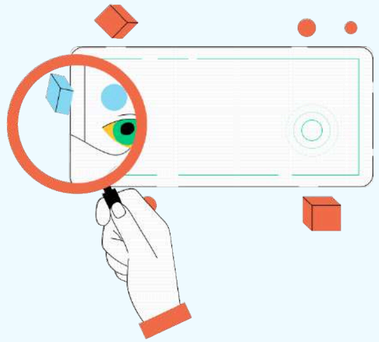
[4] Metacognition, Mindfulness, and Robots for Autism Inclusion

[5] A meta-analysis and critical review of metacognitive accuracy in autism

Feature	[1]	[2]	[3]	[4]	[5]	Learn Mate
Real-time feedback	X	✓	X	✓	X	✓
Use of Machine learning	X	X	X	X	X	✓
Personalized Recommendations	X	✓	X	✓	X	✓
Improve metacognition	✓	✓	✓	✓	✓	✓
Classifying the Level of the Child	X	X	X	X	X	✓
Adaptation Based on User Input	X	✓	X	✓	X	✓

Research Problem

How can machine learning techniques be used to enhance the metacognitive domain of autistic children through personalised and adaptive learning strategies?



Novelty

Provide recommendations with the use of Hybrid Model :

Behavioral Classification & NLP

- With a suitable classification algorithm (e.g., Decision Trees, Random Forest, SVM) to categorize the child's level (severe, average, mild)
- Use sentiment analysis on text data to gauge the emotional state and preferences of the child
- Use a method (e.g., stacking, blending) to integrate predictions from both models for more accurate recommendations

Objectives

To create an application that offers autistic kids personalized exercises to enhance their meta-cognitive skills.

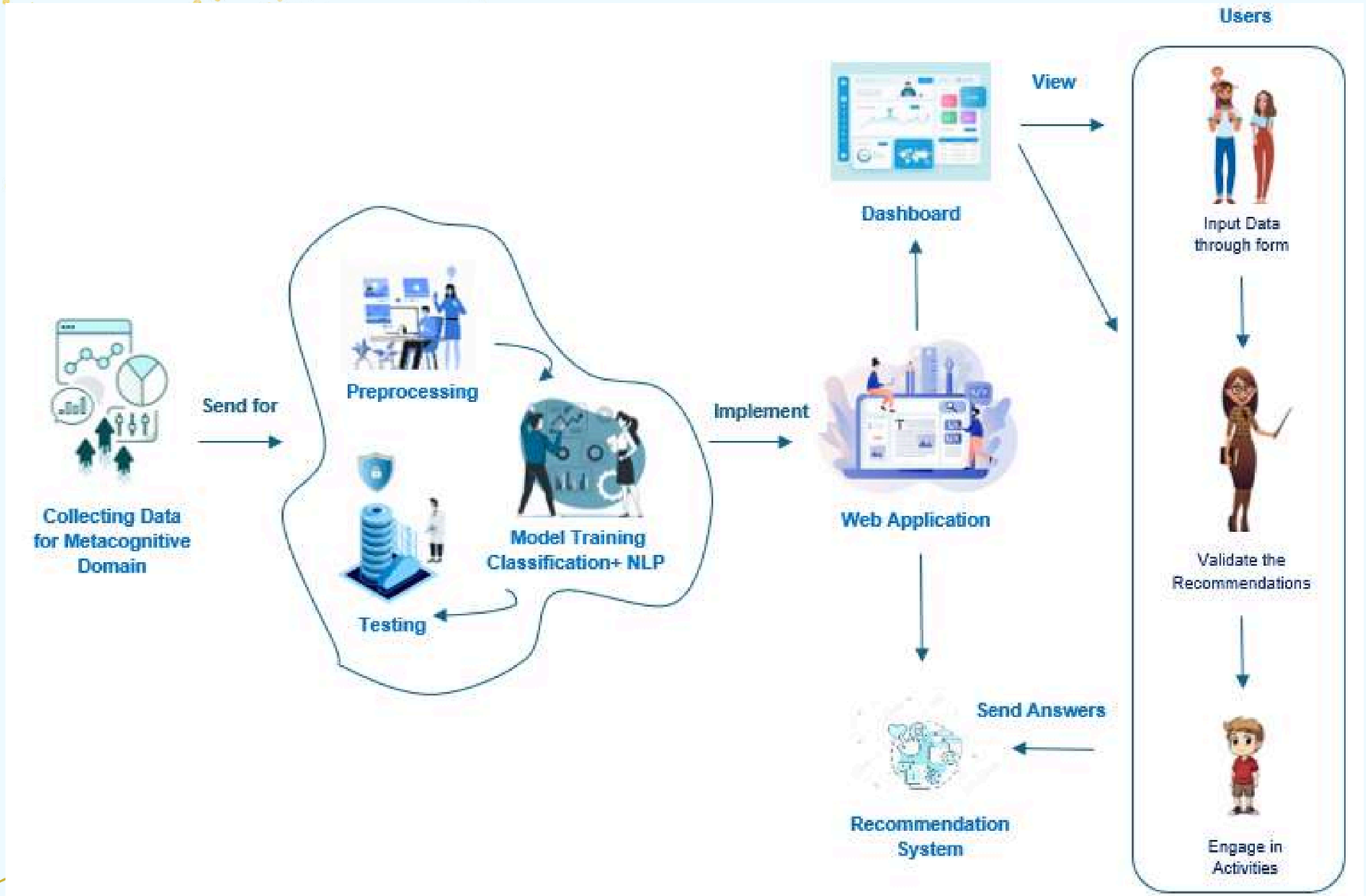
To assess how well the application helps with self-regulation, planning, and reflection

To build a easily accessible tool to assist responsible parties

To guarantee data privacy and security

To connect with current therapeutic and educational programs

System Diagram



References

1. H. Price, E. Caldwell, E. G. Hughes-Roberts, R. Beale, and R. S. Roper (2020), "Supporting Children's Metacognition with a Facial Emotion Recognition based Intelligent Tutor System," *TU Delft Repository*.

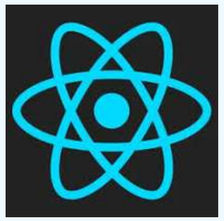
2.A. Thomas and C. Smith (2022), "Metacognition in Autism Spectrum Disorder: Digital Technologies in Metacognitive Skills Training," ResearchGate,

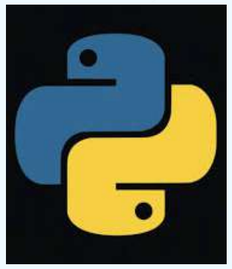
3. McCorkle, Susan L. (2012), "Visual Strategies for Students with Autism Spectrum Disorders," LC Journal of Special Education: Vol. 6, Article 4.

4. Mitsea, E., Lytra, N., Akrivopoulou, A., & Drigas, A. (2020). "Metacognition, Mindfulness and Robots for Autism Inclusion", International Journal of Recent Contributions from Engineering, Science & IT (iJES), 8(2), pp. 4–20.

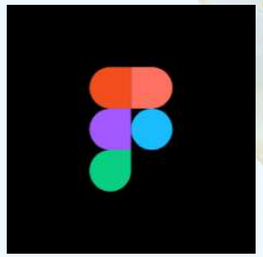
5.E. K. Schuck, D. J. H. de Bruin, and M. T. Lee, "A meta-analysis and critical review of metacognitive accuracy in autism," Front. Psychol., vol. 13, pp. 1-21

Technologies





Tools



Requirements

Functional Requirements

- User Registration and Login
- Personalized Exercise Recommendations
- Progress Tracking
- Real-time Feedback
- Data Analysis and Reporting

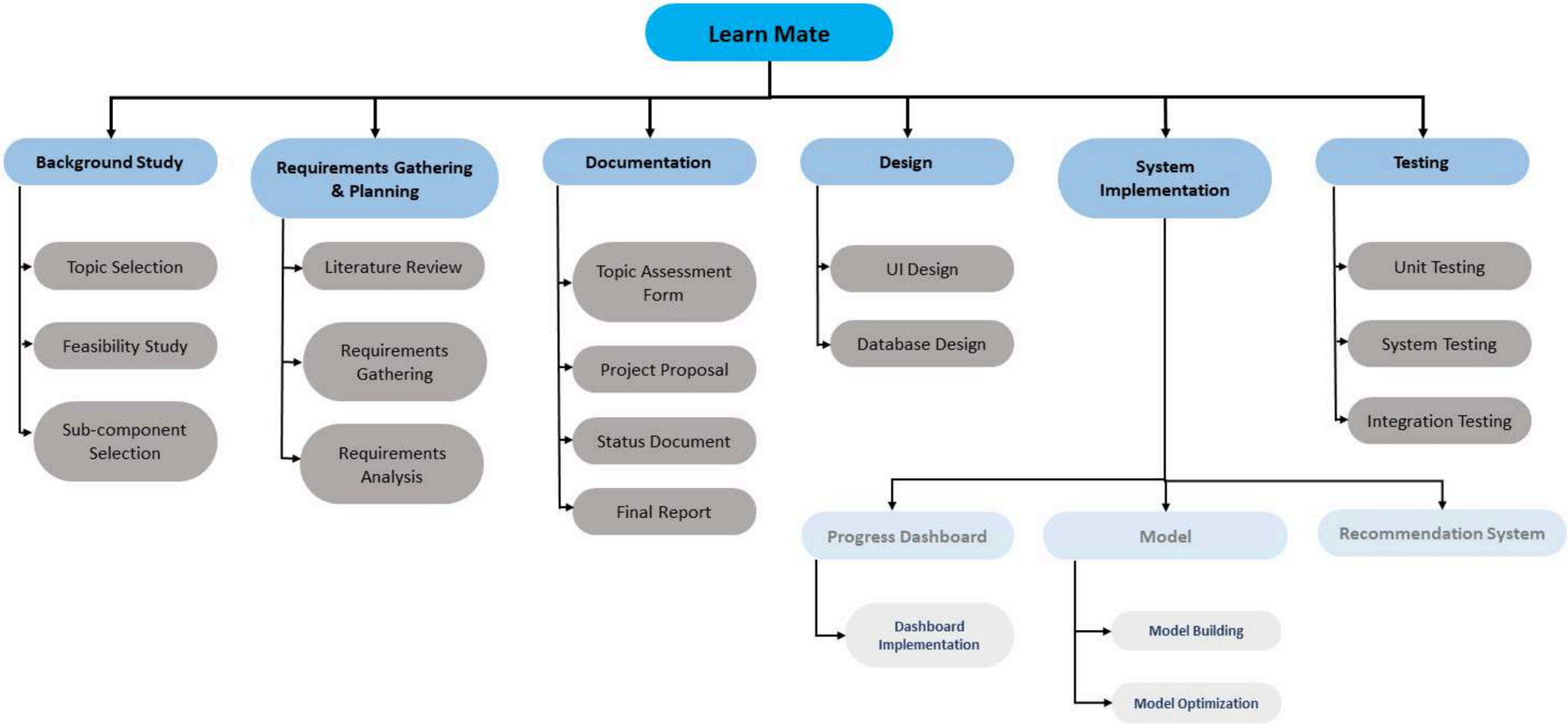
Non-Functional Requirements

- Usability
- Scalability
- Security
- Reliability
- Accessibility
- Performance

Personal Requirements

- Data related to different domains of autistic children
- Expertise in machine learning and autism
- Experience with UI/UX

Workflow Breakdown



Gantt Chart

No	Assessment / Milestione	Start Date	End Date	2024- 2025													
				April	May	June	July	August	September	October	November	December	January	February	March	April	May
1	Research group formation	10/04/2024	17/04/2024														
2	Supervisor selection	18/04/2024	18/04/2024														
3	Brainstorming workshop 1	20/04/2024	25/04/2024														
4	Selection of research topic	26/04/2024	30/04/2024														
5	Co-supervisor selection	20/04/2024	20/04/2024														
6	Brainstorming workshop 2	01/05/2024	07/05/2024														
7	Feasibility and background study	01/05/2024	30/05/2024														
8	Topic registration from submission	22/04/2024	22/04/2024														
9	In-depth feasibility and background study 1	01/06/2024	30/06/2024														
10	External supervisor selection	14/06/2024	13/07/2024														
11	Topic assessment form submission	24/05/2024	24/05/2024														
12	Topic assessment from evaluation	25/05/2024	30/05/2024														
13	In-depth feasibility and background study 2	01/07/2024	30/07/2024														
14	Data Gathering	23/07/2024	30/09/2024														
15	Proposal presentation	04/08/2024	07/08/2024														
16	Individual proposal report submission	15/08/2024	15/08/2024														
17	Implementation of research work(upto 50%)	01/10/2024	04/12/2024														
18	Progress presentation 1	05/12/2024	12/12/2024														
19	Prepare and submit research paper	20/10/2024	20/04/2025														
20	Implementation of research work(upto 90%)	05/01/2025	05/03/2025														
21	Progress presentation 2	05/04/2025	10/04/2025														
22	Integration of the research work	10/04/2025	15/04/2025														
23	Project completion	15/04/2025	20/04/2025														
24	System testing	20/04/2025	30/04/2025														
25	Website and final report preparation	01/05/2025	15/05/2025														
26	Final presentation	15/05/2025	25/05/2025														
27	Final report submission	26/05/2025	30/05/2025														

Commercialization

- Release pilot version to data-providing centers.
- Collect feedback from these centers.
- Develop the application further with advanced features based on feedback.
- Release the improved application to the public.

Q & A

THANK YOU!