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Astana IT University
Research Methods and Tools

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Using deep learning and sensory technologies for early detection and management of learning disabilities and health conditions

Outline

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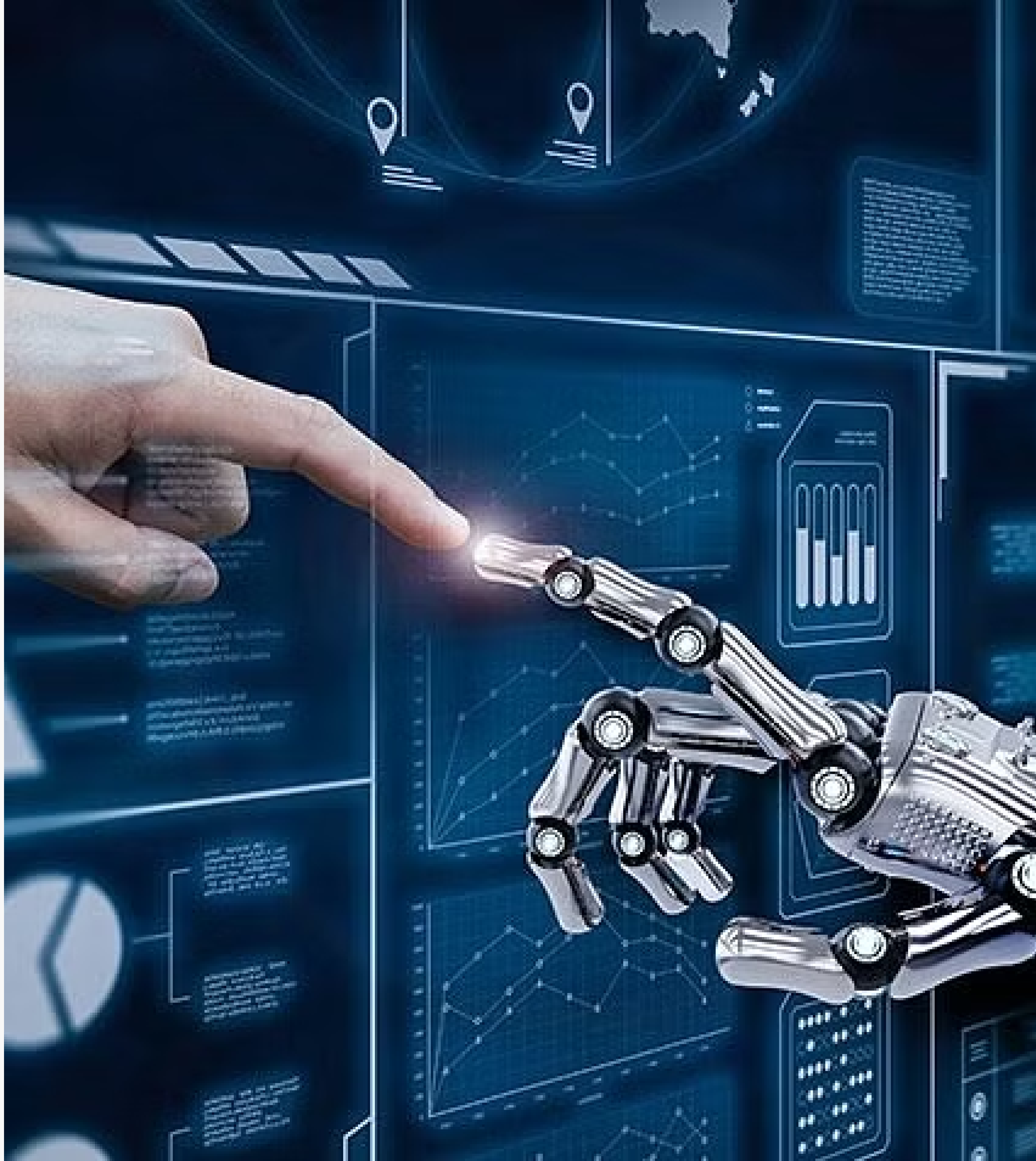


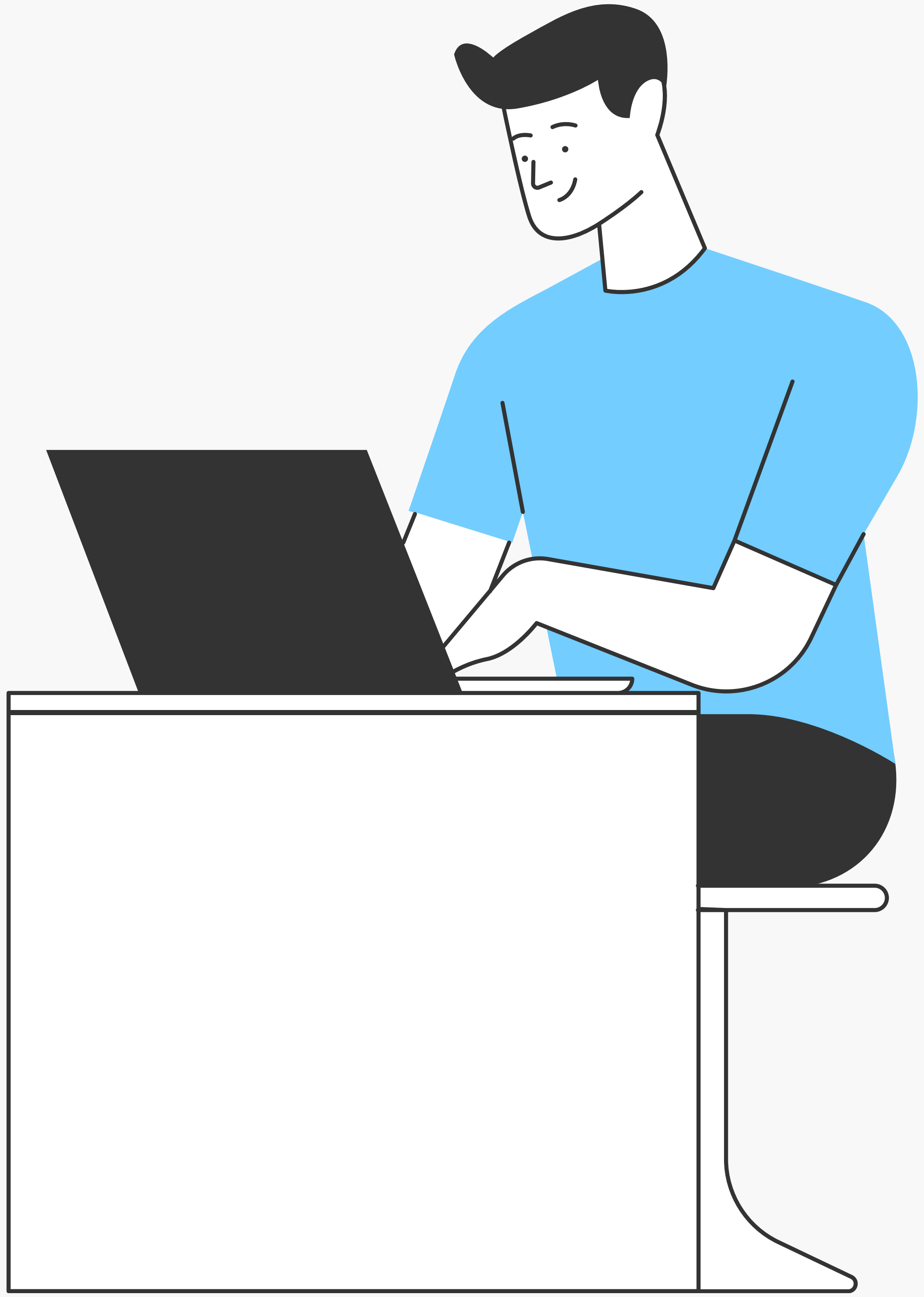
Introduction

This research explores information technology and medicine, focusing on the application of deep learning and sensor technologies for the early detection and treatment of learning disabilities and health conditions.

Aims and objectives

Research objectives:

1. **Identify Tech for Healthcare:**
- Find convenient and accessible technologies.
2. **Understand Impact:**
- Explore how these technologies enhance healthcare.
3. **Accessibility and Applicability:**
- Determine tech beneficial for patients and healthcare professionals.
4. **"Why" of Research:**
- Solve healthcare challenges with user-friendly technologies.
5. **Social Significance:**
- Improve healthcare, reduce costs, contribute to progress.



PROBLEM STATEMENT

- Our study tackles a significant challenge in healthcare:
- Objective: Focus on early identification and management of dysgraphia and related learning disabilities.
- Approach: Employ modern technology for swift detection and intervention strategies.
- Impact: Enhance overall quality of life by implementing timely and effective measures.

Research Questions:

- How well can computer models perform at recognizing diseases using photographs of people's drawings?

- If we set up a model to recognize drawings, could we detect dysgraphia?

- What computer models are best suited for disease recognition purposes?

- How can this model be used in the medical field?

- Using what indicators can we determine the reliability of the model?

- AI & Cognitive Exams: Neural networks perspective of pattern classification of cognitive tests in telemedicine platforms [2].
- ML in Stroke Treatment: Machine learning shifts stroke treatment paradigms [3].
- AI in Oncology: Automation and data integration enhance cancer understanding [4].
- Parkinson's & Epilepsy: Automated methods aid Parkinson's prediction, IoT enhances epilepsy monitoring [5][6].
- Wearable Diabetes Tech: LSTM-based wearables predict blood glucose for diabetes management [7].
- Deep Learning for Dysgraphia: Deep learning identifies dysgraphia, "SensoGrip" aids real-world detection [8][9].
- Determination of Parkinson's stage using composite index and pen pressure (CISP) in drawing clocks and spirals[10].
- Automated Dysgraphia Diagnosis: Studies ropose nuanced methodologies for automated dysgraphia diagnosis [11].

Gaps & Current Research:

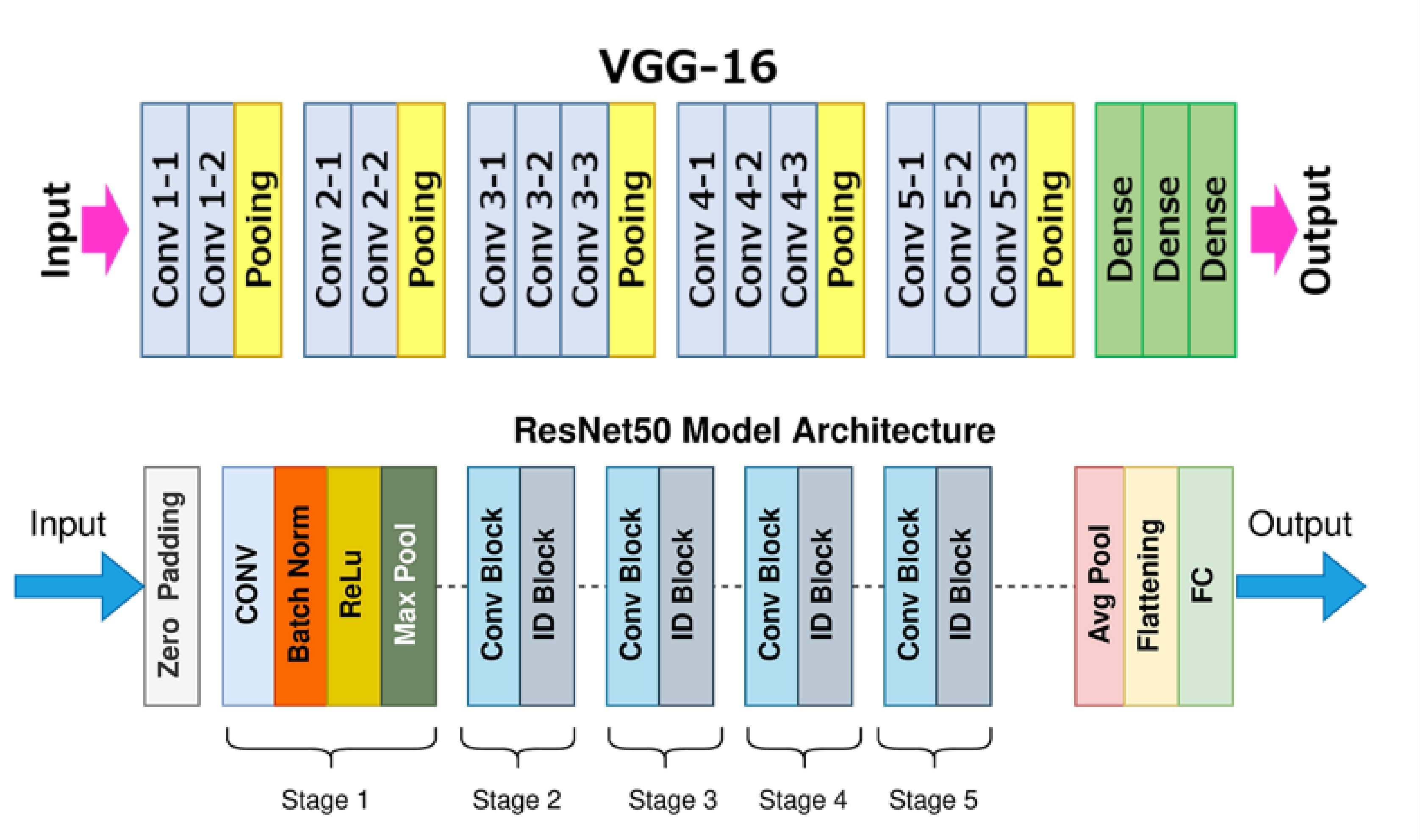
- Limited real-world testing and data in existing studies.
- Untapped potential of machine learning for diverse healthcare issues.
- Need for more comprehensive and accessible healthcare technologies.

Mixed Methodology:
Quantitative analysis for numerical insights.
Qualitative data for human aspects and expert opinions.

Dataset:
Specialized dataset capturing dysgraphia patterns, pioneered by Drotár & Dobeš [11].
Collected from Wacom tablets, including various handwriting features.

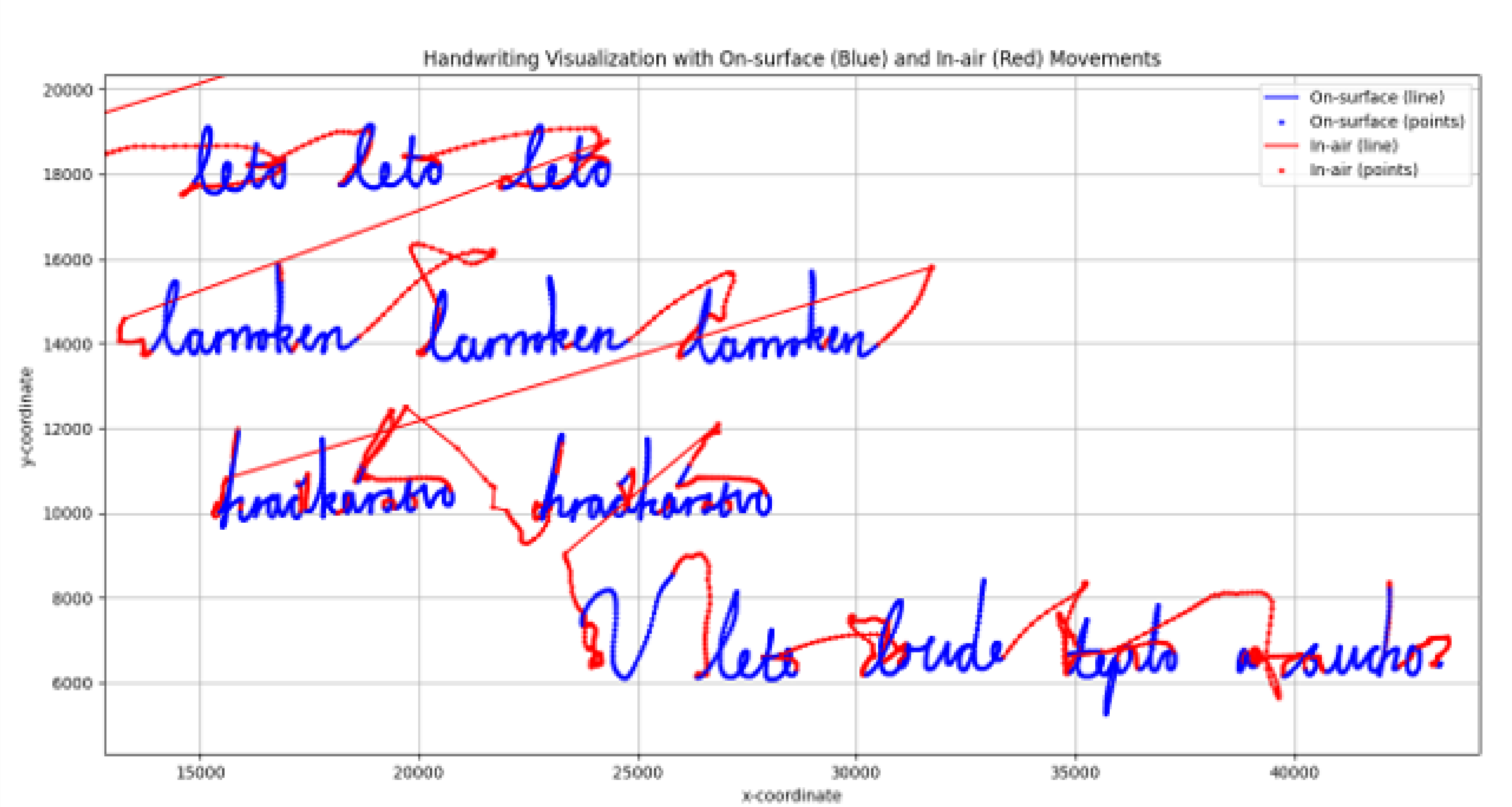
Data Preprocessing:
Normalize, segment, and clean handwriting samples.
Transform pen data into structured image format for advanced analysis.
Augmentation techniques to avoid overtraining.

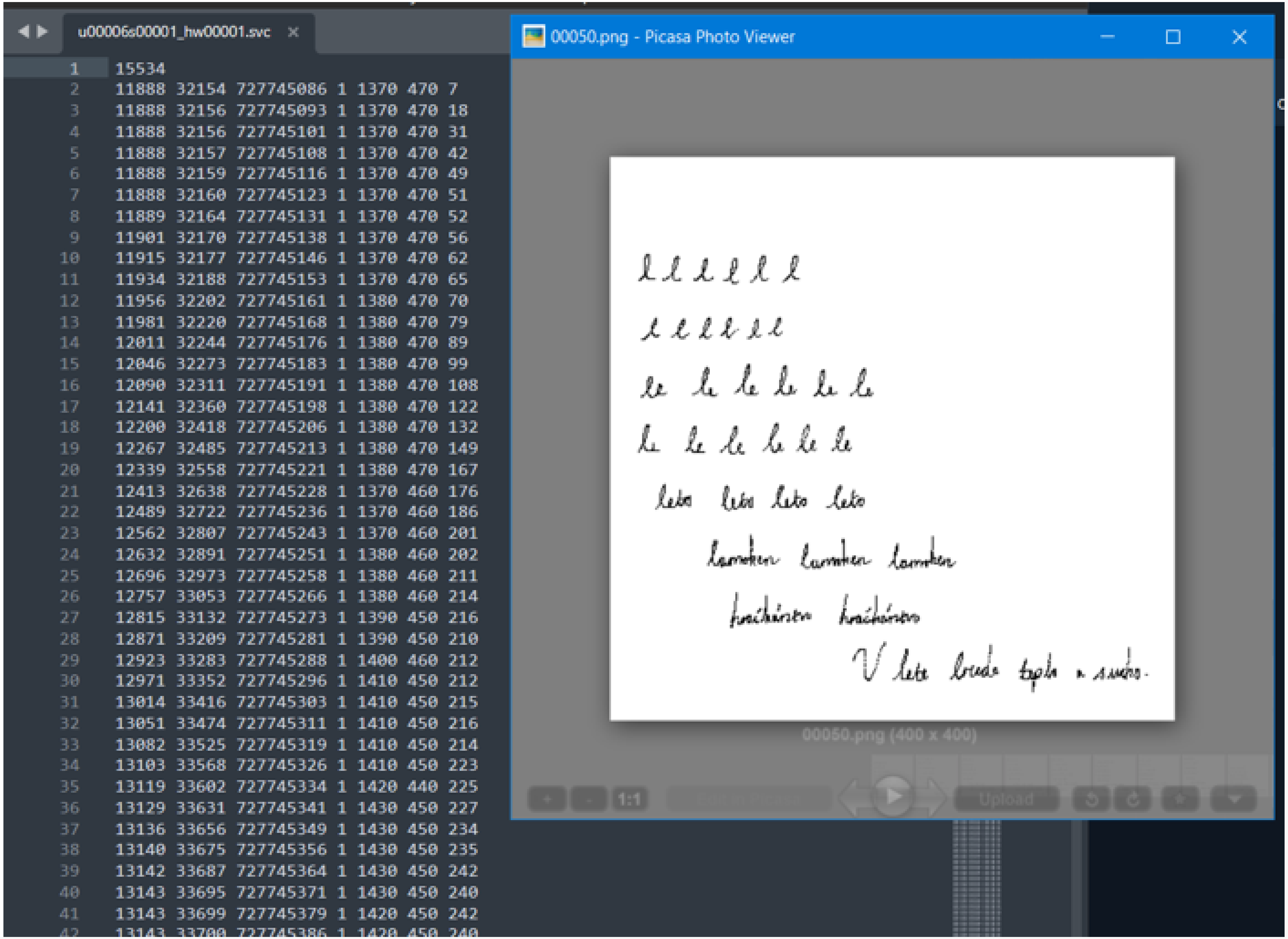
Model Architecture:
VGG16 and ResNet50 CNNs for binary classification.
Pre-trained models enhance dysgraphia detection.



METHODS

	A	B	C	D	E
1	**ID**	**diag**	**sex**	**hand**	**age**
2	00006	DYSGR	F	R	15
3	00007	DYSGR	M	R	15
4	00049	DYSGR	F	R	12
5	00050	0	M	R	13
6	00051	0	F	R	11
7	00052	0	F	R	10
8	00054	0	M	L	11
9	00056	0	M	R	11
10	00057	0	M	R	12





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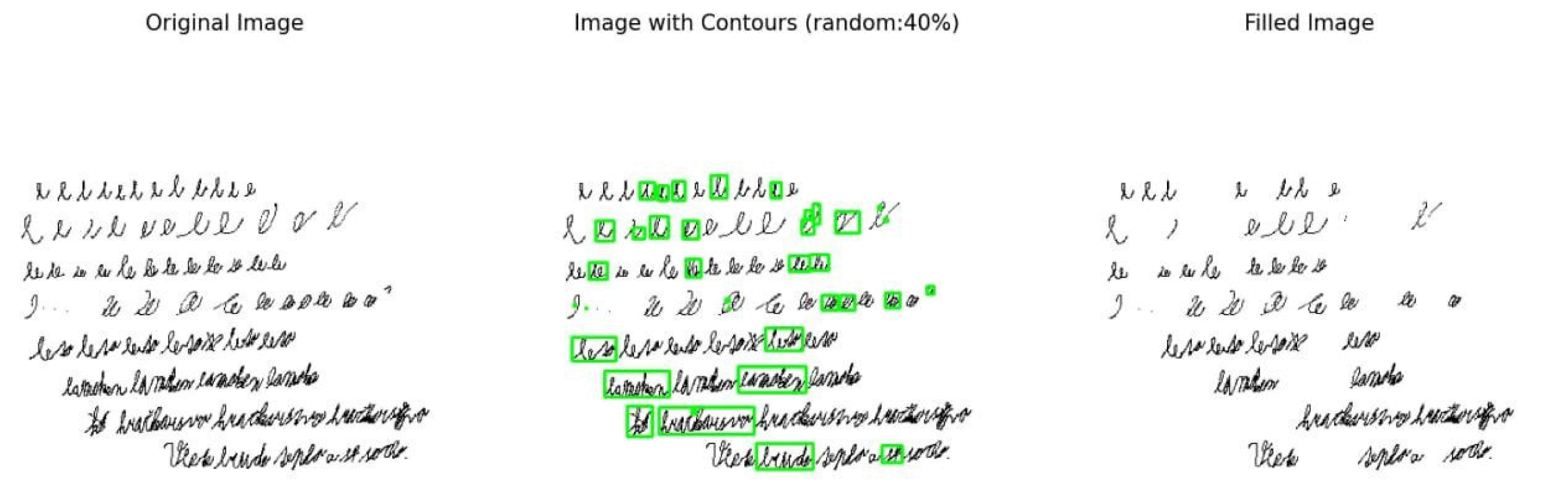
METHODS


Original Image
Image with Contours (random:40%)
Filled Image

Training and Validation:

Dataset divided for fairness; 5-fold cross-validation applied.

Strategic model training to distinguish dysgraphia and normal handwriting.

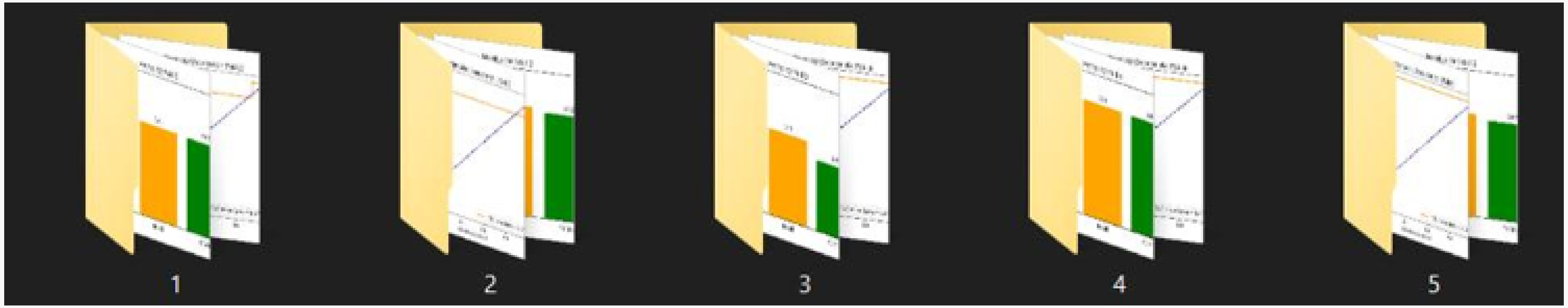
Evaluation:

Utilize accuracy metrics and F1 score for comprehensive model assessment.

Stratified Random Sampling:

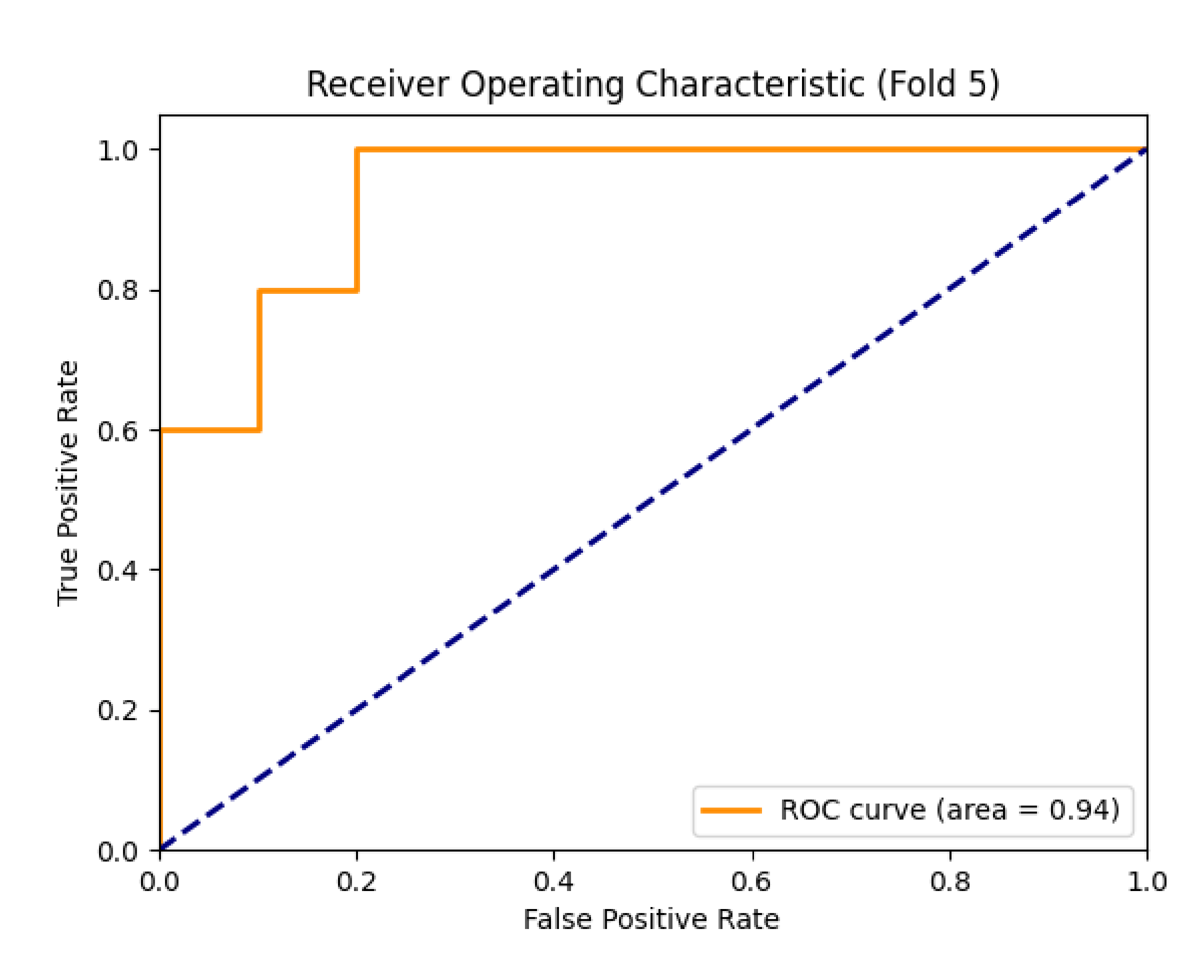
Chosen for diverse disease detection.

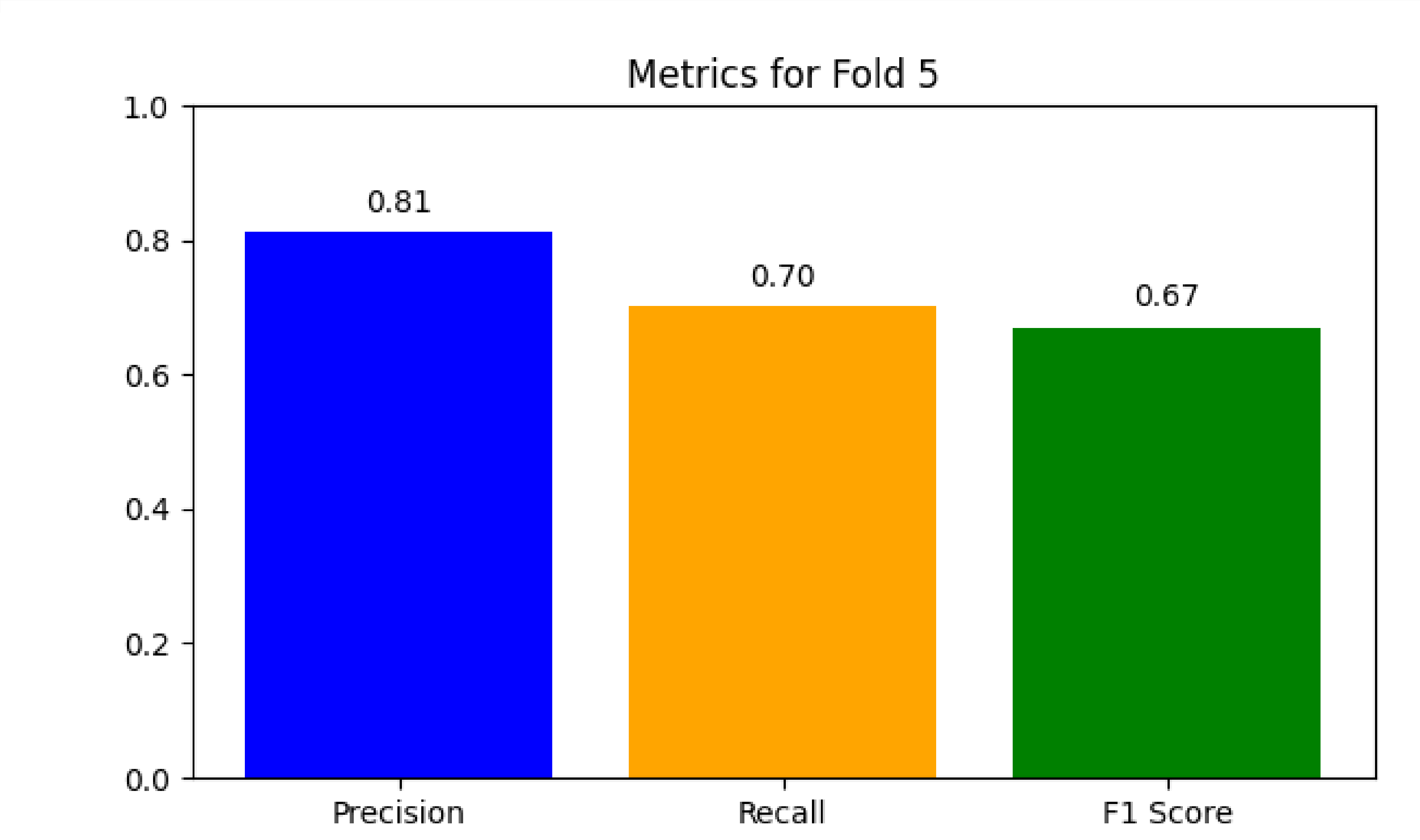
Ensures representation from various subgroups in the sample.



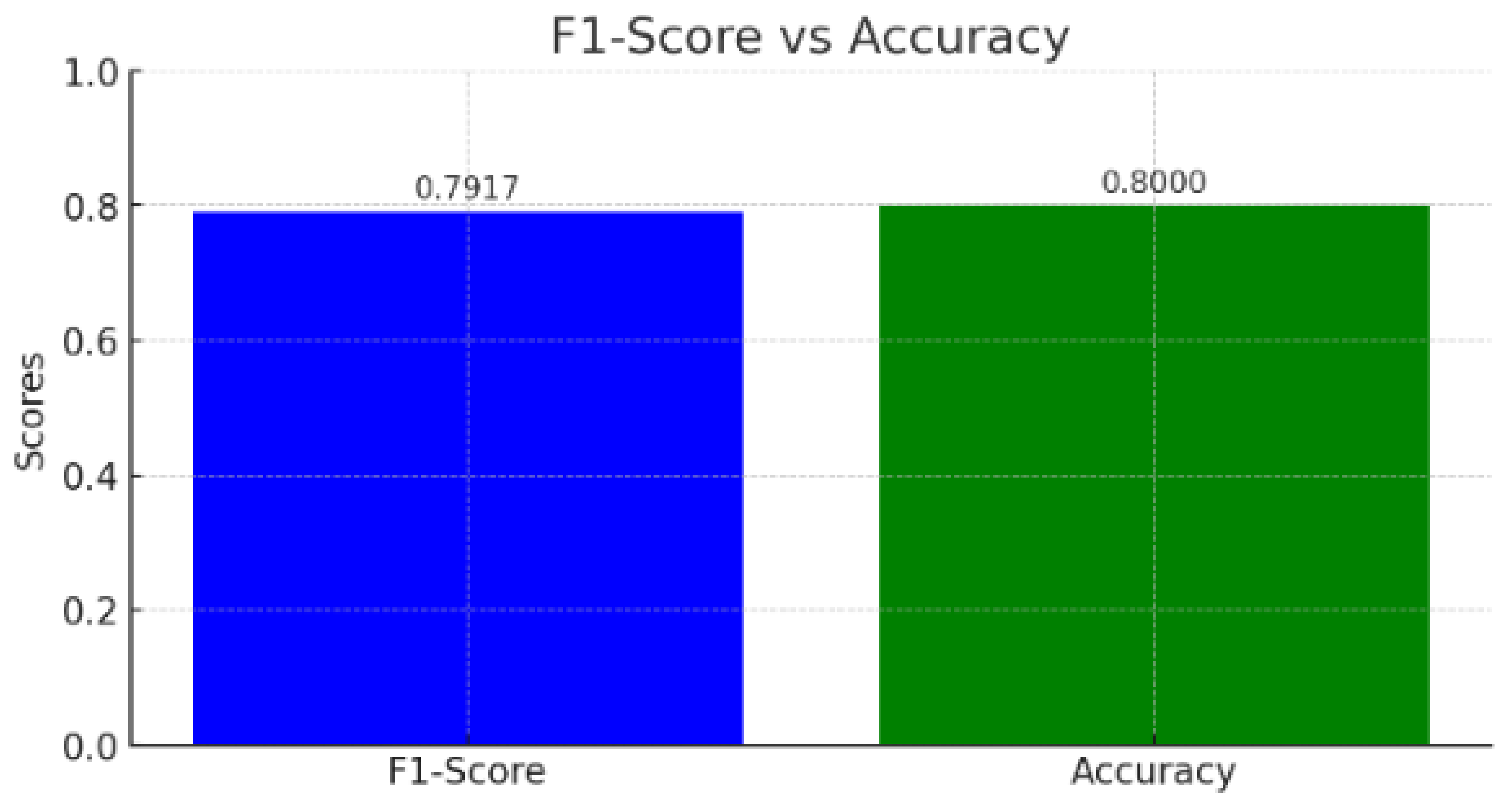
IMPLEMENTATION

VGG16 EVALUATION

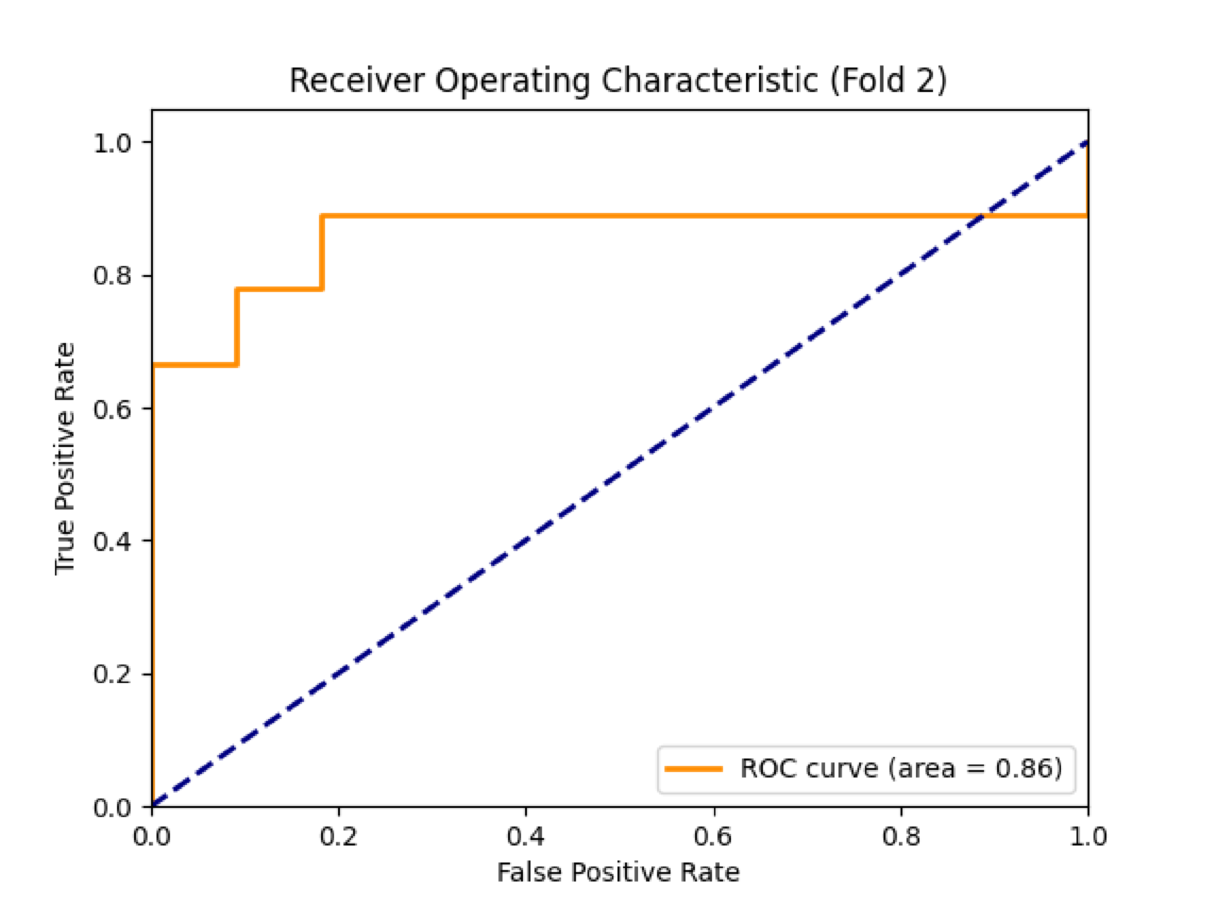


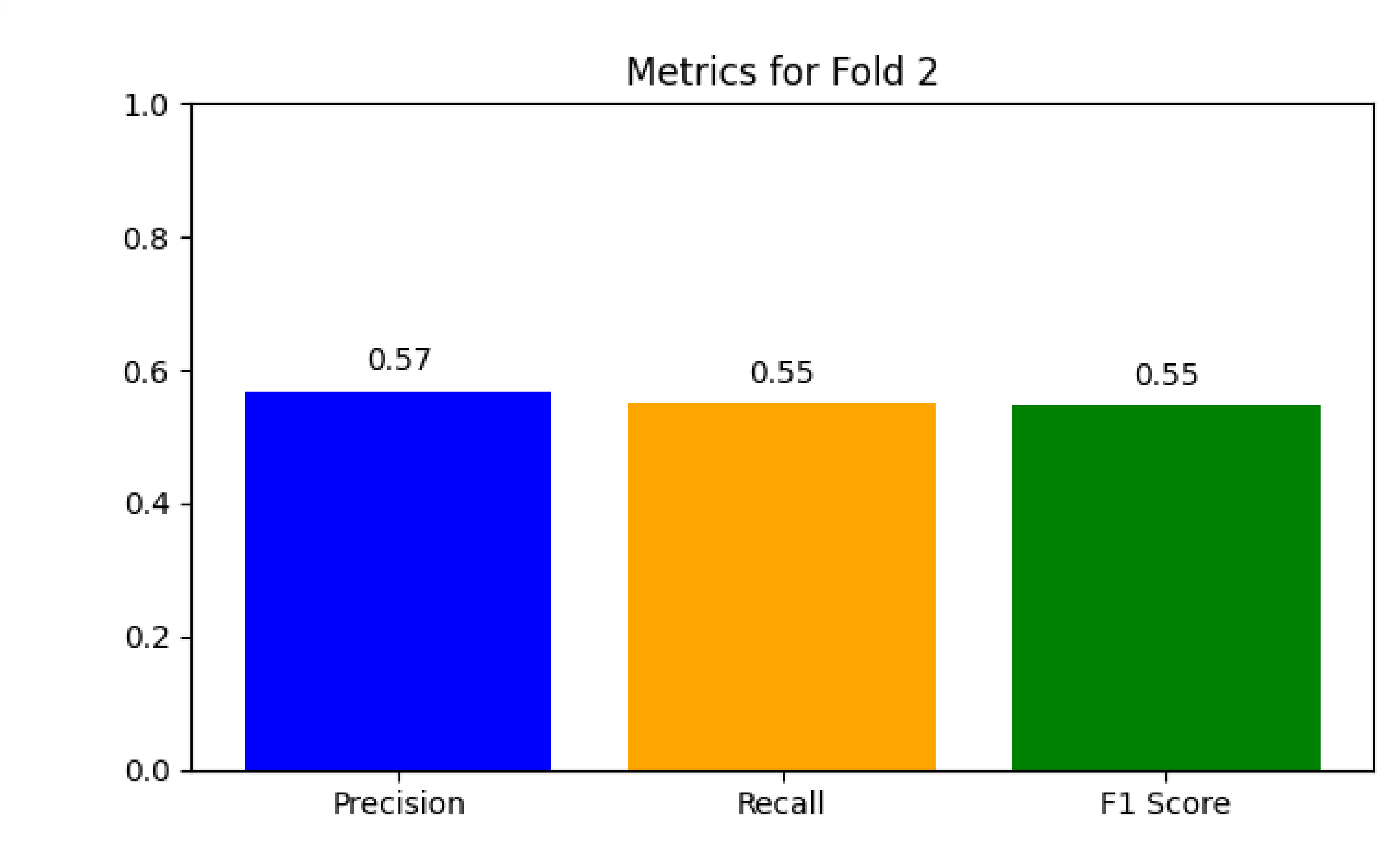


The best fold was fifth with an area under the ROC curve of 0.94. We were able to achieve an F-Score accuracy of 79.17% on a test sample that did not participate in model training.



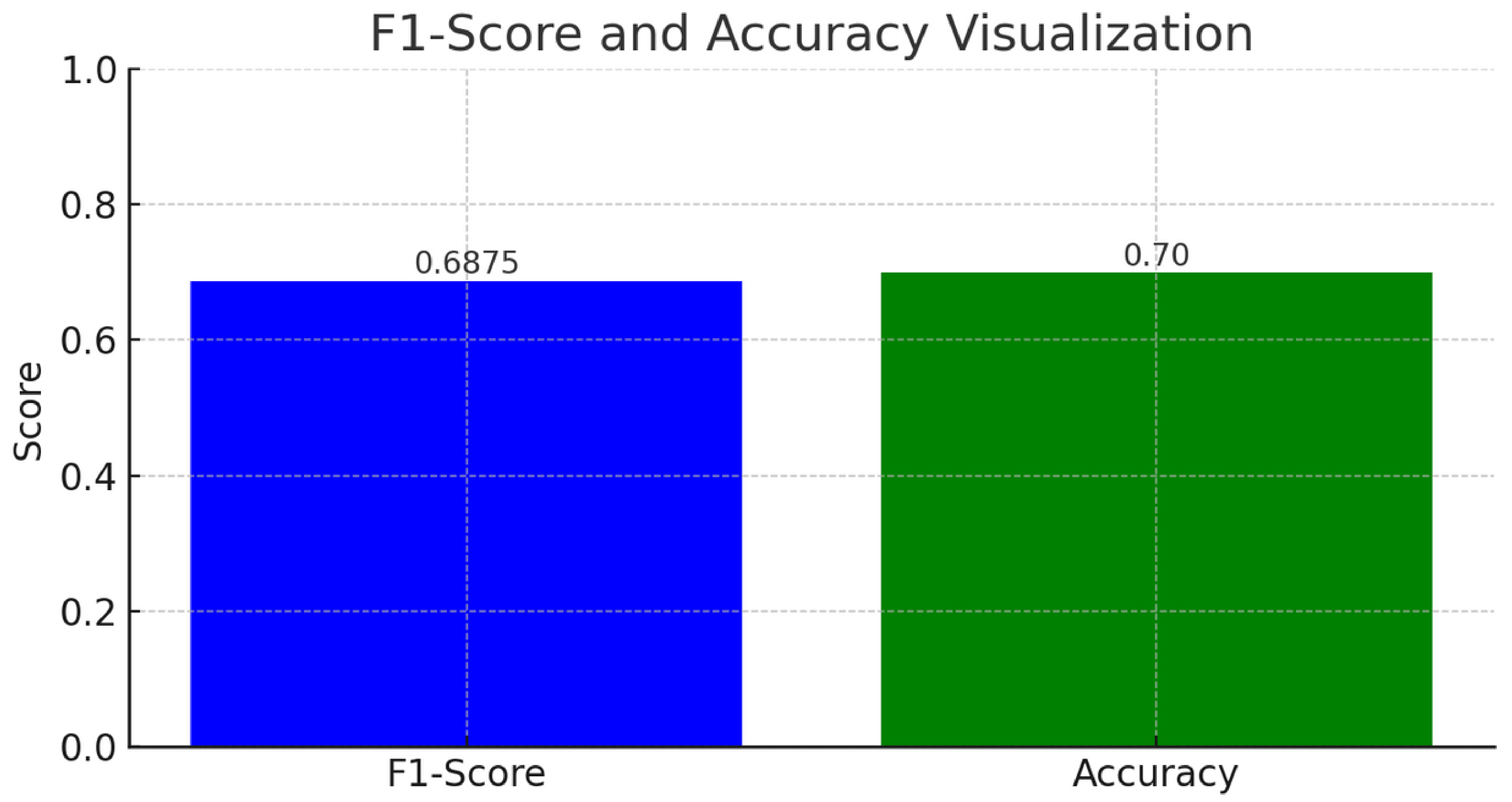
IMPLEMENTATION



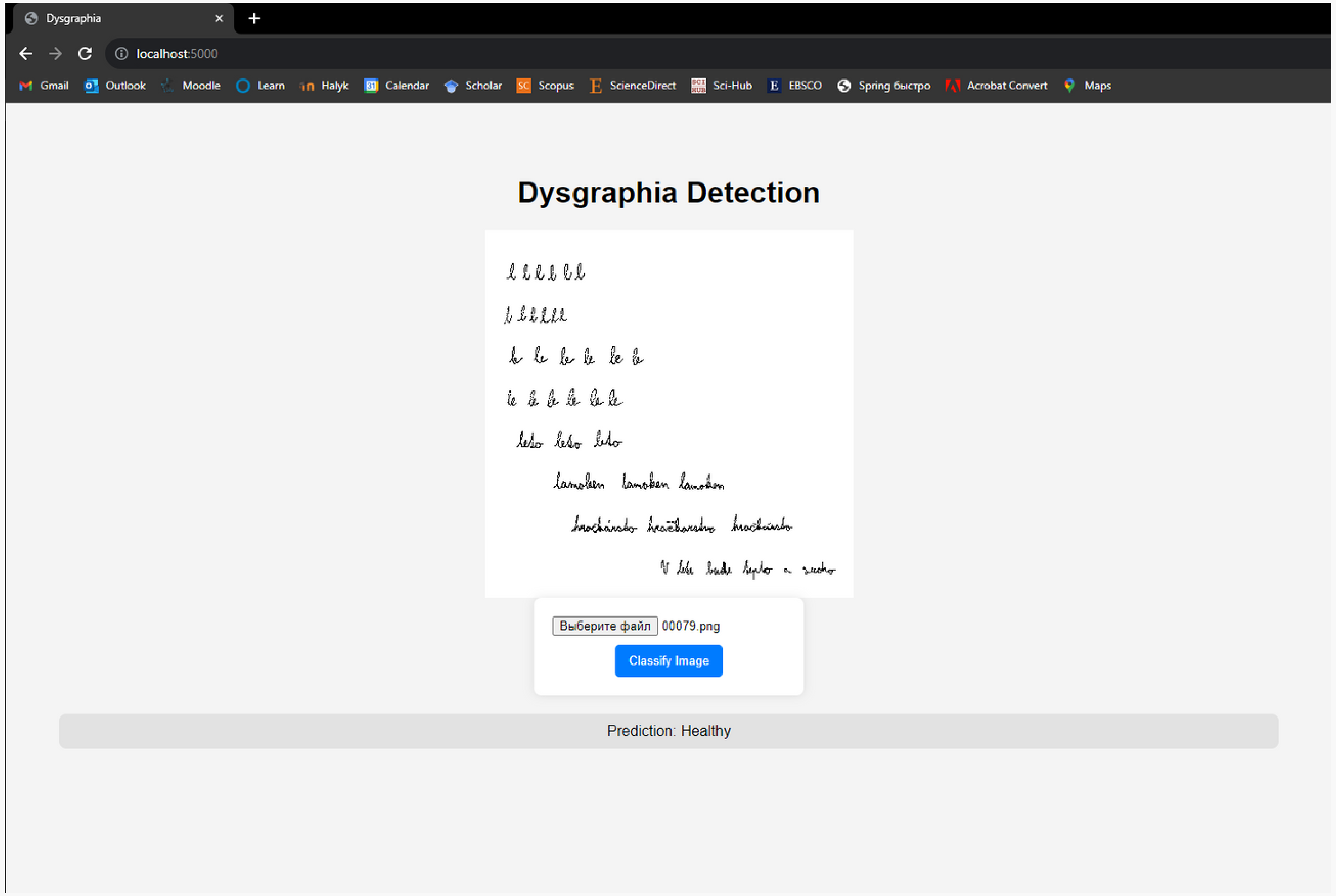


RESNET EVALUATION

ResNet showed an accuracy of 68.75%. These results reflect a fair evaluation of our trained models.



IMPLEMENTATION



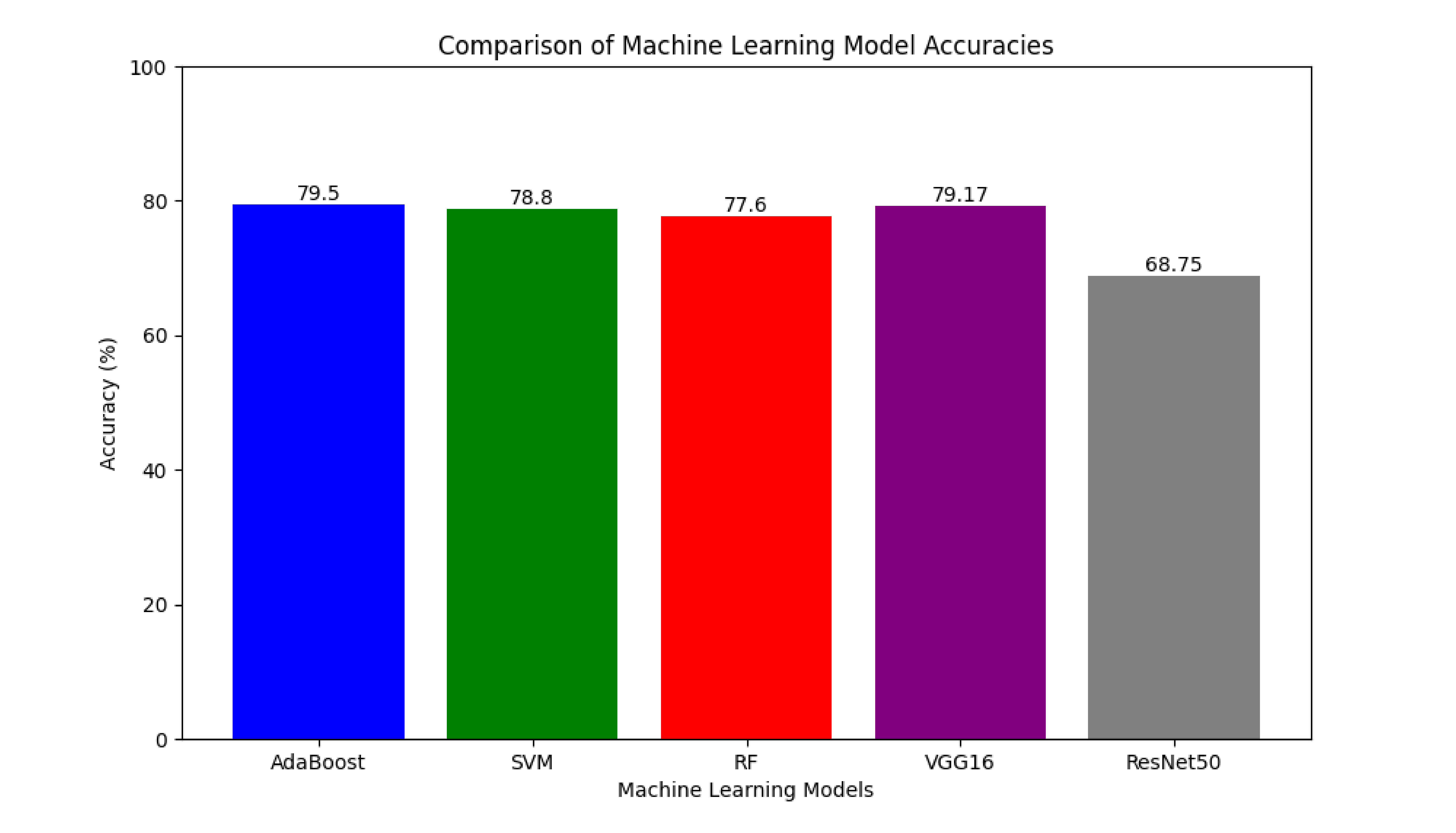
As part of our dysgraphia detection project, we developed a web application using Flask, a flexible and lightweight Python web framework. This allowed us to easily integrate machine learning into the web interface.

RESULT AND DISCUSSION

Research Outcomes:

1. Effectiveness of Image-Based Analysis:
    - Deep learning on handwriting images identified dysgraphia patterns.
    - Models offer a step forward in early dysgraphia detection.
2. Model Performance Metrics:
    - Comparable accuracy with traditional algorithms (AdaBoost, SVM, RF).
    - Deep learning's higher complexity, but efficient classification after training.
3. Accessibility and Scalability:
    - Image-based approach removes dependence on specialized equipment.
    - Scalable for wider applications due to the use of images.

RESULT AND DISCUSSION

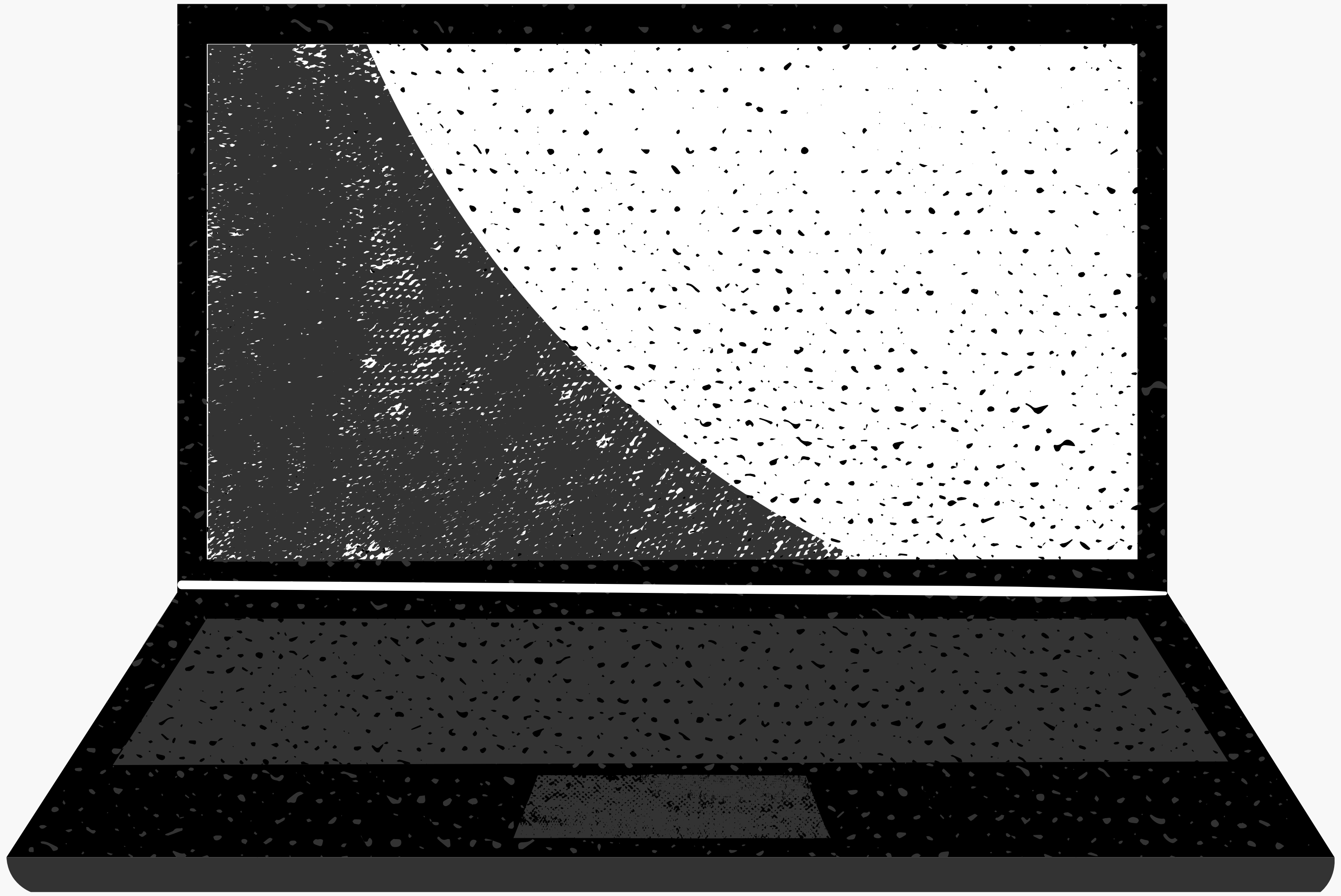


Future Work:

1. Model Enhancement:
   - Integrate more deep learning architectures and data augmentation techniques.
   - Expand dataset for Cyrillic dysgraphia, testing for diverse age groups and styles.
2. Application Development:
   - Explore real-time analyses.
   - Develop user-friendly application for dysgraphia detection, monitoring, and support.

CONCLUSION

- Advances made in dysgraphia detection through deep learning and image-based analysis.
- Self-learning model offers flexibility and scalability beyond dysgraphia.
- Potential applications extend to neurological diseases like Parkinson's.
- Recognized limitations in sample size and feature inconsistency, paving the way for future research.
- Study showcases the transformative impact of AI in healthcare for improved patient outcomes.



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Thank you for listening!