

AIDEN: AI Driven Enhanced Multiple Sclerosis Lesion Segmentation and Recommendation Framework

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Introduction and Motivation

Introduction

- Multiple Sclerosis (MS) is a potentially disabling autoimmune disease of the brain and spinal cord (central nervous system).
- The disease can cause lesions, nerve damage, disability, and even death.
- Magnetic Resonance Imaging (MRI) is the gold standard for assessing MS progression, revealing brain volume loss and lesions.

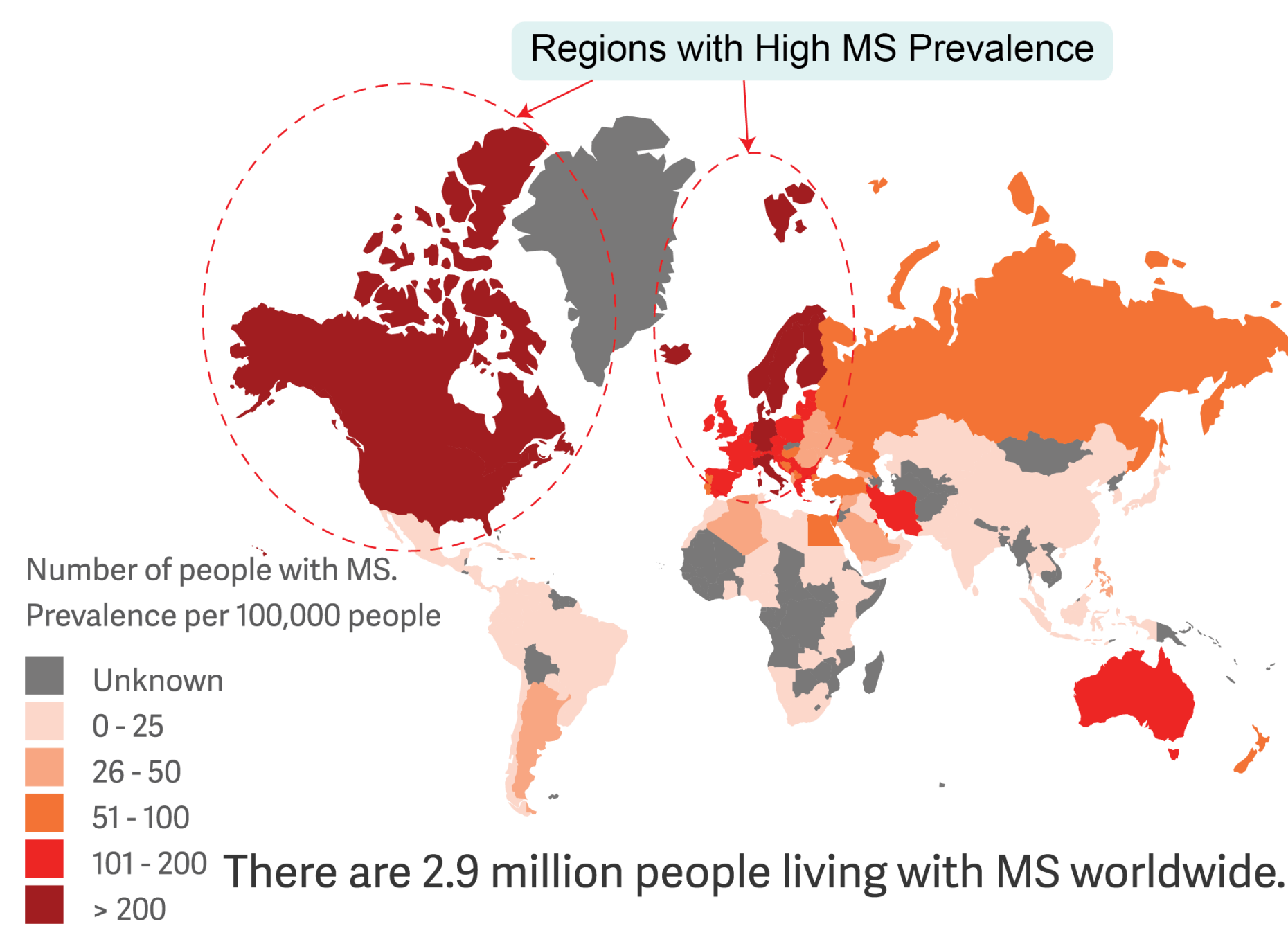
Role of AI in addressing MS Detection:

- AI enhances MS detection by analyzing MRI scans to identify lesions, track disease progression, and assess brain volume loss with greater accuracy.
- Assist in early diagnosis, predictive analysis, and personalized treatment planning for MS patients.

Motivation

- How can AI enhance early detection, and personalized treatment for MS?

Atlas of MS: Mapping multiple sclerosis around the world. Source: MS International Federation



Challenges

- State-of-the-art models like LST-AI achieve only ~0.62 Dice overlap score.
- Studies lack insights into model inaccuracies and failure conditions.
- Performance across varying lesion sizes and shapes remains unquantified.

Novel Contributions:

- AIDEN aims to develop a framework for automatic and accurate identification and segmentation of MS lesions in MRI brain scans of MS patients.
- Integration of a Multi-modal Large Language Model (MLLM) for natural language analytics and human-readable medical insights.

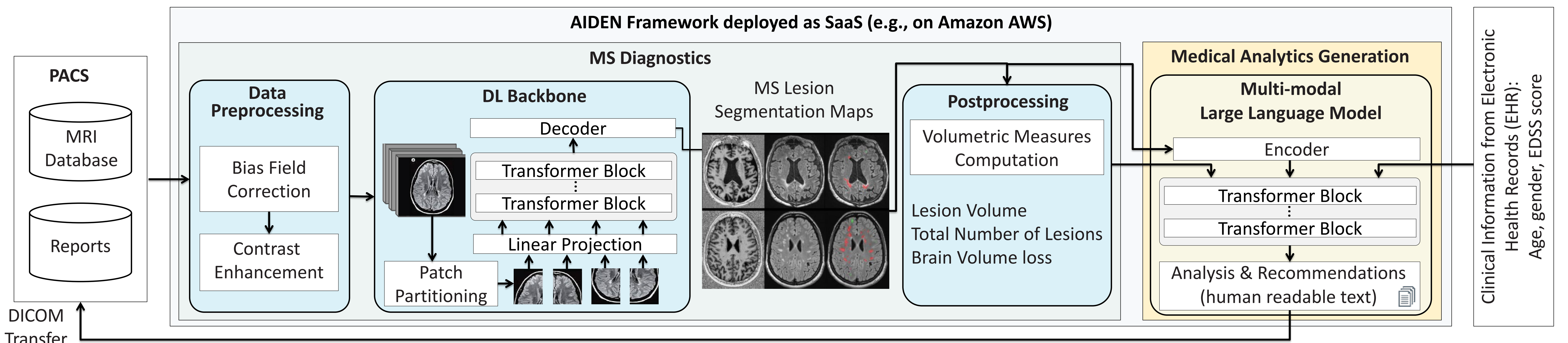
AIDEN Framework for Multimodal Brain MS Analysis and Report Generation

- Design goal-specific deep learning models to balance lesion presence detection and precise boundary segmentation.

- Integrate a MLLM for understanding analytic queries and generating human-readable reports.

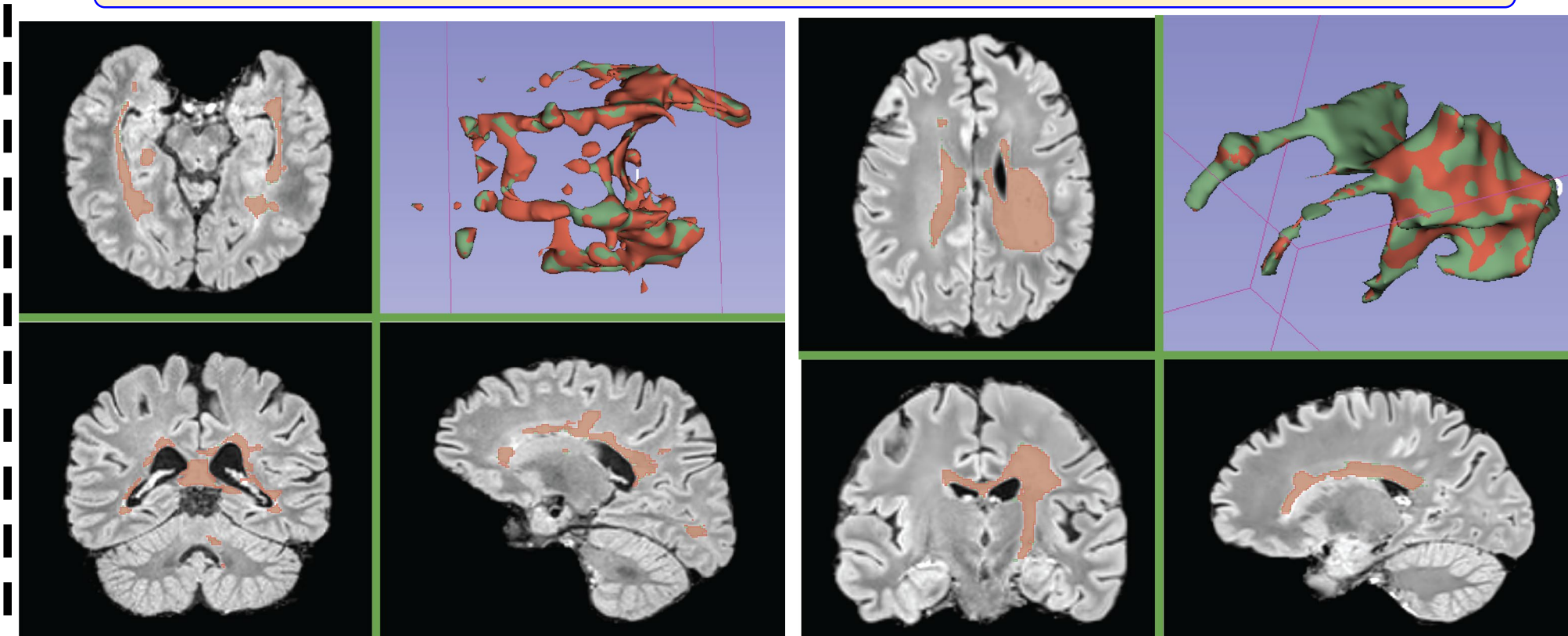
- Leverage MLLM for prognostic insights, such as MS progression risks and personalized treatment recommendations.

AIDEN Framework deployed as SaaS (e.g., on Amazon AWS)

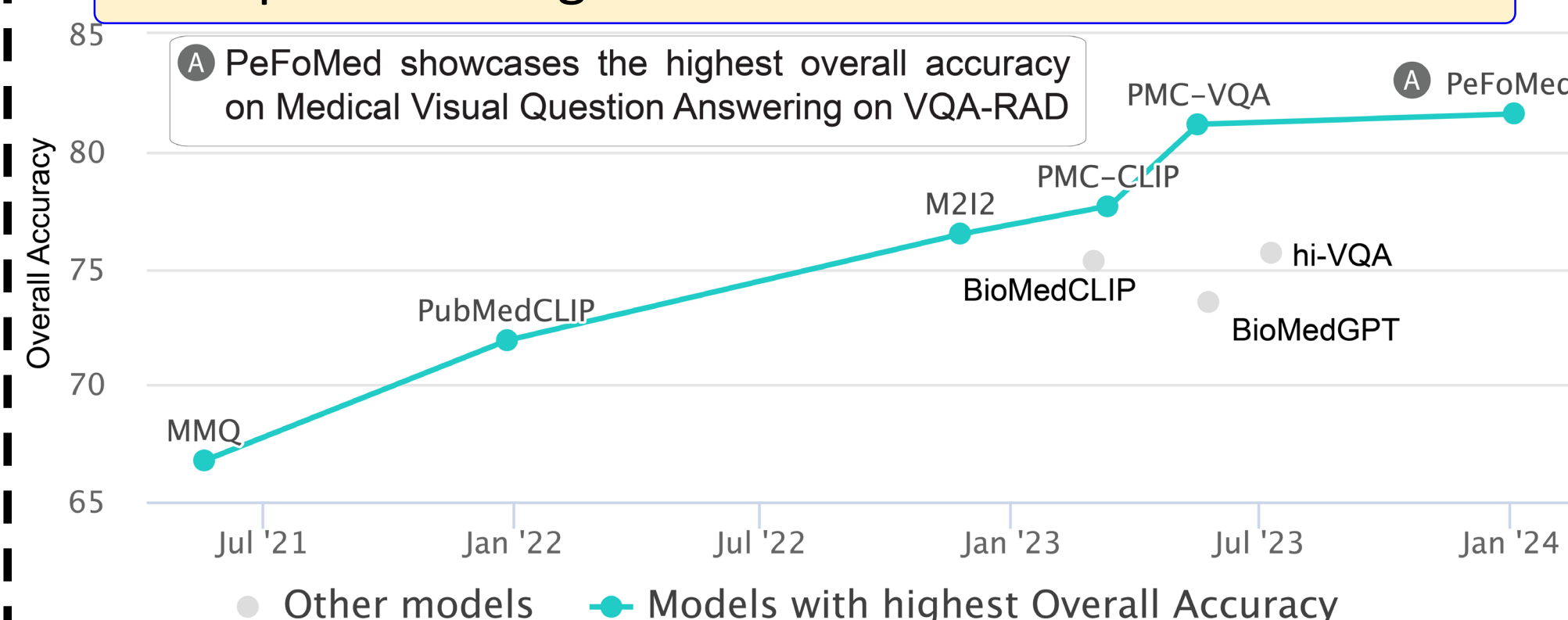


Experimental Results

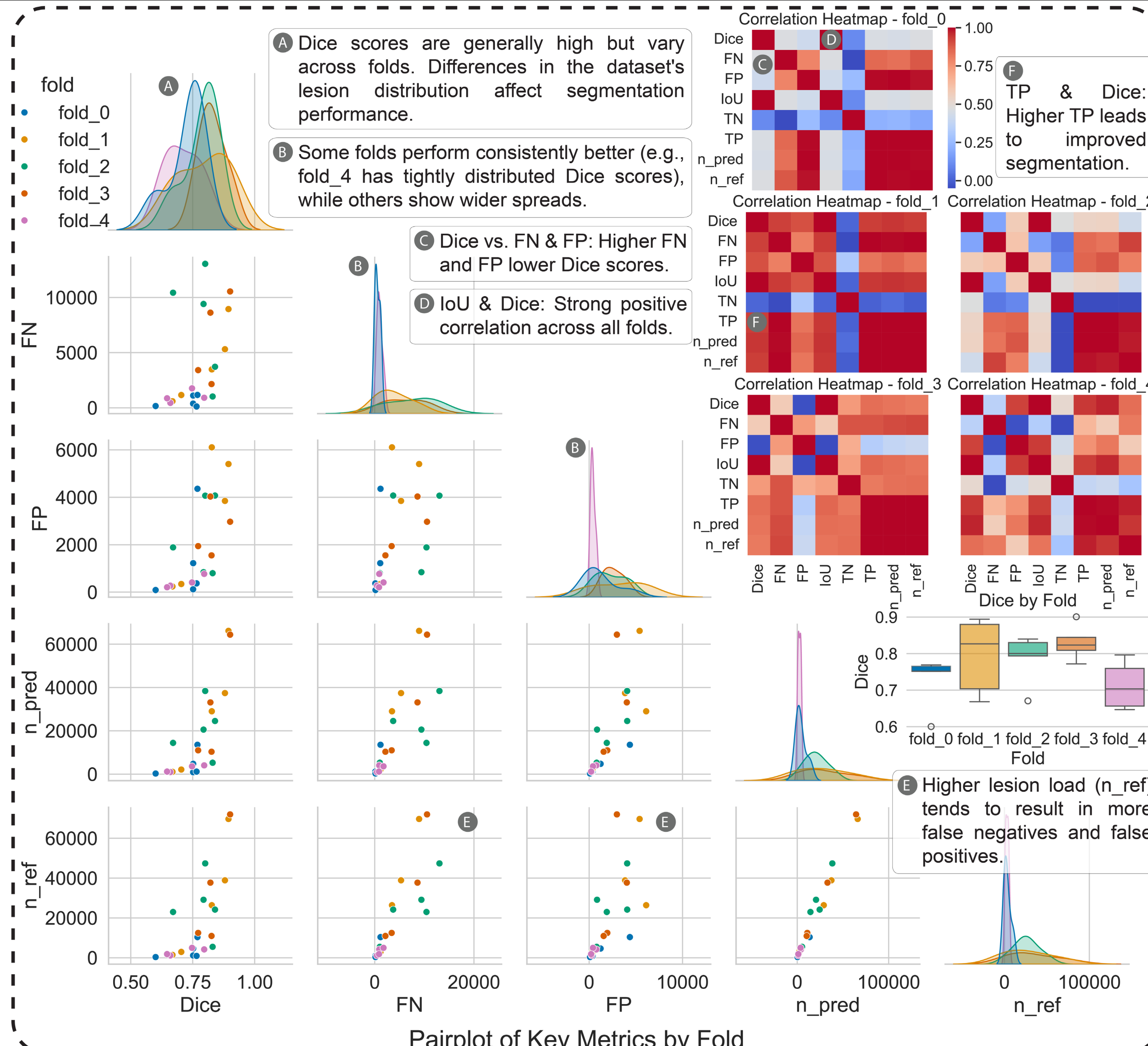
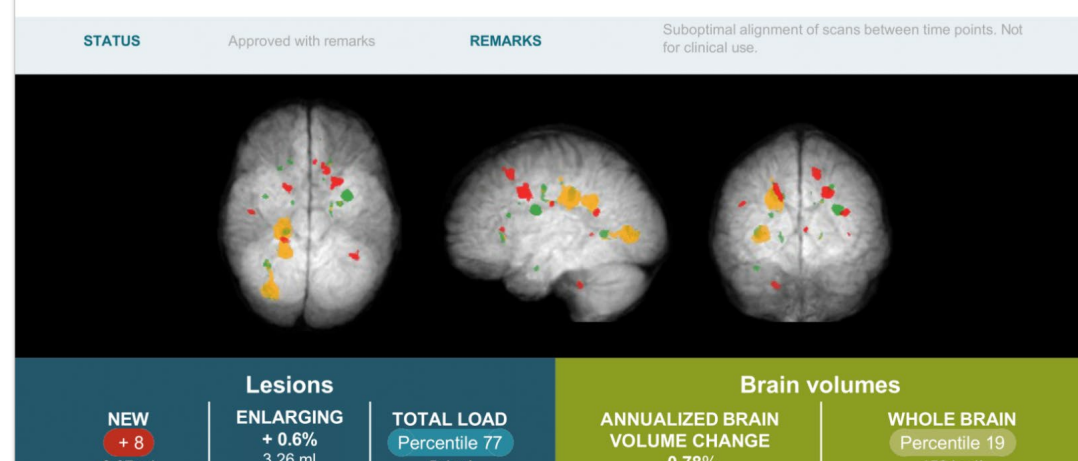
MS Lesion Segmentation Results for MSSeg Dataset



Top Performing MLLMs on Medical VQA dataset



Report Generation using MLLMs
Source: <https://icomatrix.com/>



AIDEN Functionalities

- Automated Image Preprocessing:** Accepts and standardizes brain MRI images.
- Modular Segmentation:** Uses MONAI Label with a customizable DL backbone for accurate MS lesion segmentation.
- Quantitative Scoring:** Computes brain and lesion metrics and assess based on clinical standards.
- Modular DL Backbone:** AIDEN framework is extendable to other diseases and modalities with different DL models.
- Customizable Front-End:** Provides a user interface for visualization and report generation.
- Scalable Back-End & APIs:** Ensures secure data handling and compliance with hospital requirements.

