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Graph-Based Multimodal AI for Personalized Melanoma Risk Assessment and Skin Lesion Analysis

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From isolated lesion images to patient-aware melanioma risk modelling

Clinical Context and Objective

Clinical Gap

- Image-only models usually assess lesions independently.
- Longitudinal evolution and patient-specific risk factors are often omitted

Objective

Link temporal lesion change, within-patient lesion context and between-patient similarity in one multiscale graph framework

Multimodal Cohort and Data

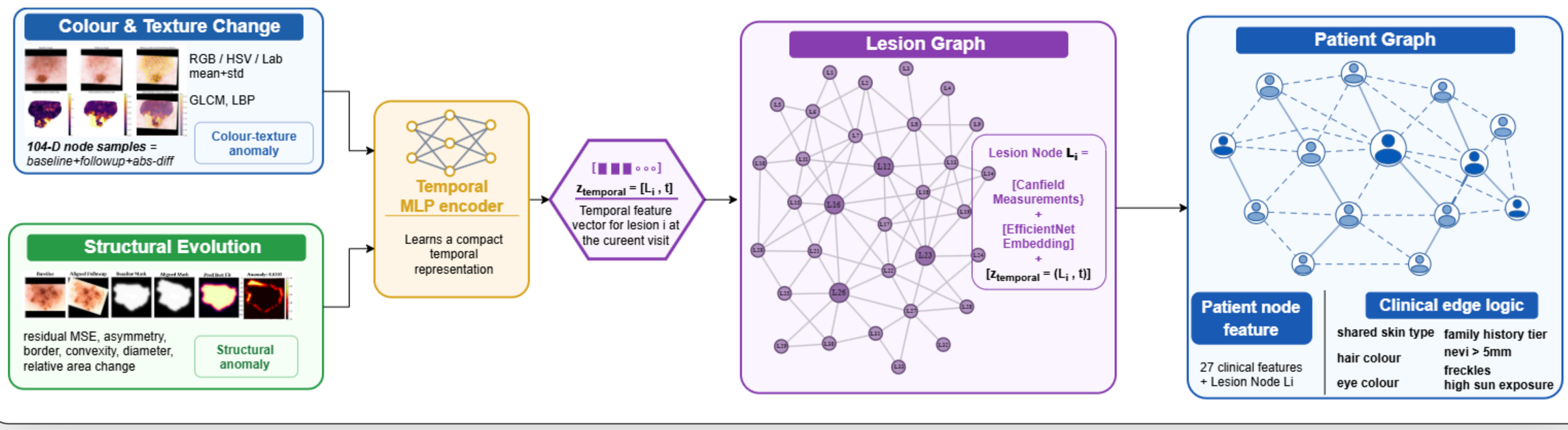
>1,000 Patients
iToBoS and HARMONY cohort

>3,000 Patients
expected with ongoing expansion

- Clinical photographs
- Dermoscopic images
- Sequential visits
- Clinical metadata

Metadata examples: age, sex, geographic background, sun exposure, melanoma history and nevus count.

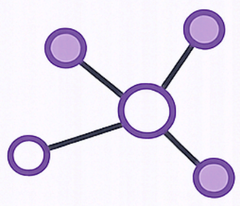
Multiscale Graph Framework



Preliminary Module-level Evidence

Lesion Graph

Graph setup



- **Node:** one lesion at one exploration
- **Features:** Canfield measurements + EfficientNet embedding
- **Edges:** top-k appearance similarity
- **Output:** lesion risk score

AUC

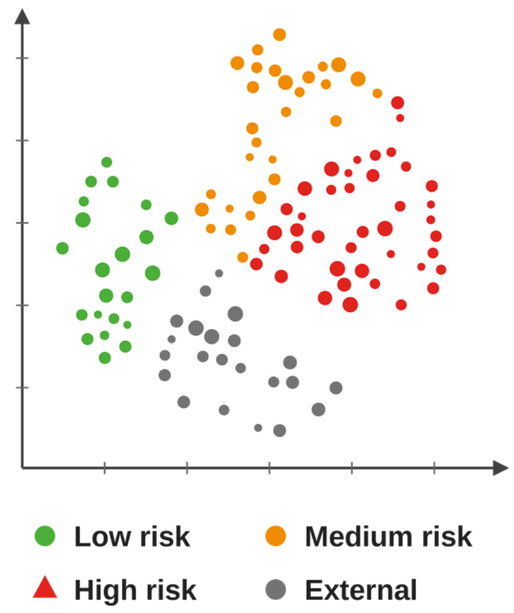
MLP	0.9265
SAGE	**0.9388**

Sensitivty at 90% Specificity

MLP	0.3649
SAGE	0.7845

Patient Embedding Space

- Lesion distribution
- Change patterns
- Risk aggregation
- Clinical context



ONE FRAMEWORK. TWO CLINICAL QUESTIONS.

Which lesion needs review?
lesion risk • ugly duckling • temporal anomaly

Which patient needs closer surveillance?
personalized risk • clinical context • graph relations

Multimodel learning | Graph neural networks | Temporal change detection | Ugly duckling sign