SGProtoNet: Semantic-Guided Prototypical Networks for Multi-Label Few-Shot Medical Image Classification

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Automated analysis of medical images offers transformative potential for clinical diagnostics, yet two persistent obstacles limit practical adoption: the high cost of expert annotation and the inherent multi-label nature of radiological findings. Acquiring sufficient labeled data for deep learning remains especially difficult when pathological categories are rare or previously unencountered. To tackle these issues, we introduce SGProtoNet, a Semantic-Guided Prototypical Network that unifies few-shot learning with multi-label chest X-ray classification using the IU-CXR dataset. Rather than relying solely on visual supervision, SGProtoNet grounds its prototype representations in paired radiological reports, exploiting the descriptive power of clinical language to compensate for visual data scarcity. Concretely, frozen ViT-B/16 and PubMedBERT encoders first bring image patches and report tokens into a common embedding space through contrastive pre-training; a Semantic-Guided Attention Module (SGAM) then cross-attends over patch features with report embeddings as queries, yielding semantically enriched visual representations that are fused via a learnable gating mechanism. The resulting prototypes are subsequently employed within a 5-way K-shot episodic meta-learning scheme, enabling the network to recognize unseen findings from as few as one to five annotated examples. Comprehensive experiments yield a Macro AUC of 90.6% and a Macro F1-Score of 0.75, surpassing prior baselines and establishing semantically guided prototypical learning as a compelling strategy for data-scarce, multi-label medical image recognition.

Awards Won:
King Abdulaziz &amp
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