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MISAS: Probabilistic Medical Image Segmentation Neural Architecture Search

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Introduction

Designing efficient Deep Neural Architectures for medical image segmentation is error prone and trial-evaluate based method. What architecture will perform best for a given input dataset requires expensive hand tuning, requires deep domain knowledge and days and months to train.

Recent advancements in Neural Architecture Search techniques have been focused on image classification tasks using techniques such as weight sharing but for medical image segmentation, there has been limited progress. Most of the NAS techniques have been designed using non-medical datasets for training. In this work, we propose a novel method to search for best neural architecture based on probabilistic approach that tries to optimize for finding local optima versus expensive global optima. The proposed method speeds up search procedure and performance on validation dataset.

Hypothesis

Using Probabilistic approach to search for local optima versus global optima significantly reduces time it takes to find better neural architecture with good performance as opposed to searching for months and even years to achieve single digit performance gain over optimal architectures with acceptable performance.

Methods

MISAS architecture starts neural architecture search by designing cell block which is represented as a DAG (directed acyclic graph) with Nodes and Edges. A node is represented by an input image or feature map and edge is denoted by operation between the nodes. An edge operator can be conv 3x3 operation, or Max/Average pooling or a skip connection. Once optimized, we sample over the distribution to find the best possible architecture with best mIOU value (mean intersection of units). After this, we stack sequence of these individual cell-based blocks connected via skip connections to optimize the end to end architecture.

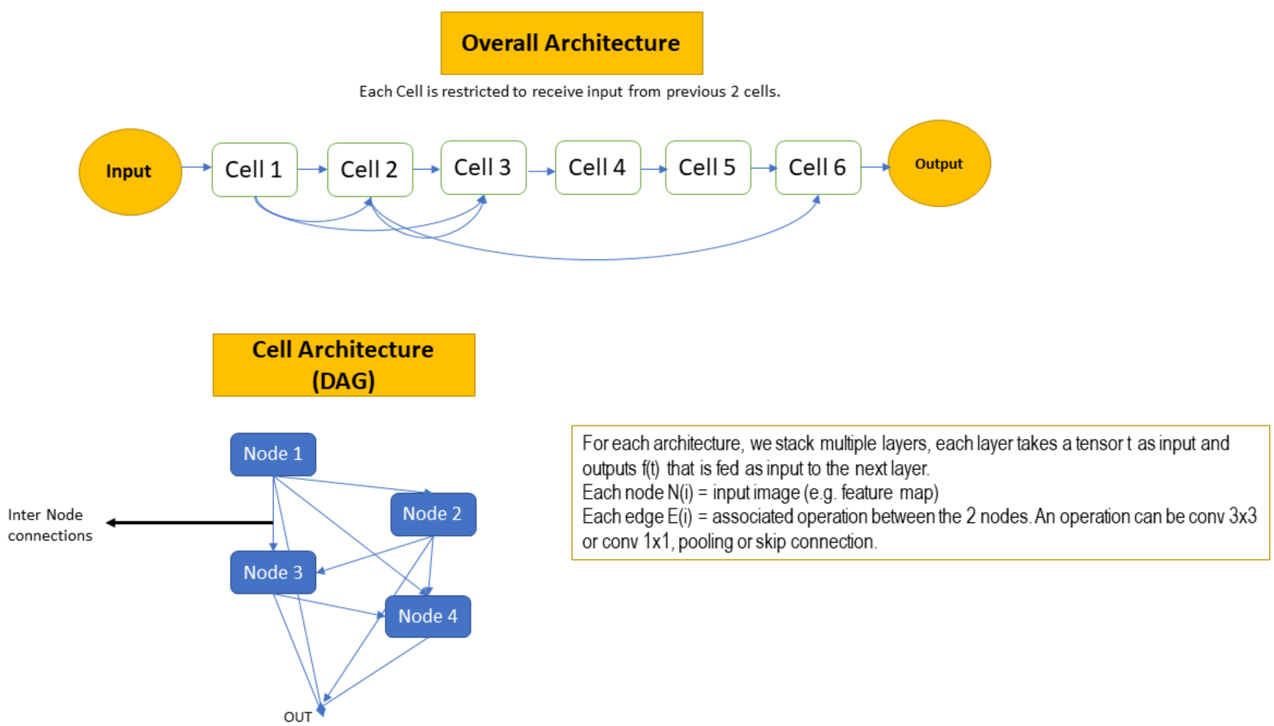
Results

We used CHAOS dataset (abdominal CT) of 40 different patients to test our hypothesis. Approximation based method to search for best possible neural architecture performs better than other expensive neural architecture-based methods that try to search for global minima. Our approach also allows the user to set a given threshold which when reached will stop search, yield an architecture that has acceptable validation accuracy.

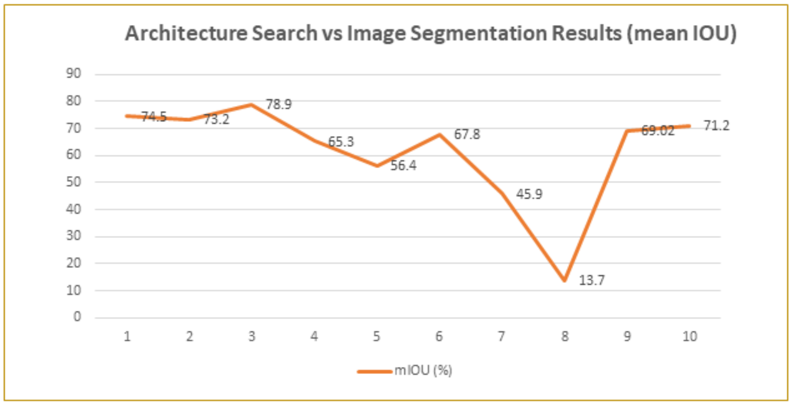
Conclusion

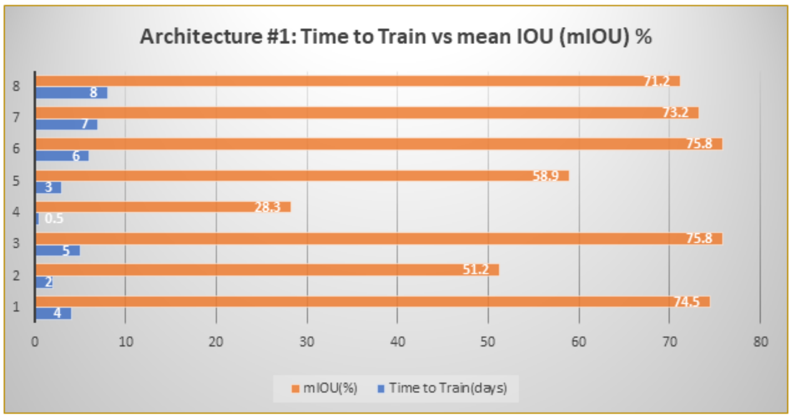
In this paper, we present a novel way to find Neural Architecture by approximation thereby compressing the search space and reducing the time to find best possible architecture with comparably better mIOU. The results of the search are evaluated on CHAOS dataset by calculating mean Intersection of Units (mIOU) that takes 3 GPU days to achieve single digit performance gain without probabilistic approximation.

Figures



Overall Architecture: For each architecture, we stack multiple layers, each layer takes a tensor t as input and outputs f(t) that is fed as input to the next layer.





Results: Architecture search vs. Image Segmentation results and Time to train vs. Mean IOU

Keywords

Artificial Intelligence; Emerging Technologies; Enterprise Imaging; Imaging Research

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