Deep KNN for Medical Image Classification

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Review

1. **Recommendation**
   Strong accept
2. **Summary of the paper**
   In this research, the author improved the Knn by incorporating it with the feature extraction process and named it as deep KNN. It is applicable to small class prediction, where deep learning models do not generalize well. The author enforced the idea that the training sample and its K-nearest neighbors belong to the same class during learning the feature extractor. Finally, results declared that deep KNN outperformed strong classifiers on medical image datasets where classes are small or imbalanced.
3. **Strengths**
   - Description of the problem is very clear.
   - The researcher unified the feature extraction and the kNN classification procedure, that tlead to become the better feature extractor which can be learned specifically for the kNN classifier and the task of interest
   - Faster in convergence regardless of model structures and datasets - Flexibility with architecture (can be integrated with any deep learning network)
4. **Shortcomings**
   Overall, the paper is well written and proposed solution to addresses the challenges are highly related but I could not find any time complexity parameter which compare that its time efficient as well. Additionally, future work or its applicability on other should also be discussed. Does it perform state-of-the-art in the era of few-shot learning is the question mark.
5. **Justification of rating**
   - Comprehensive evaluations on multiple medical image datasets showed that the proposed approach, outperforms various kNNs and even CNN classifiers particularly for small class prediction the proposed novel loss function can help train the feature extractor much faster.
   - It was observed that the proposed triplet loss takes much fewer epochs than the traditional loss to reach the same level of training accuracy.
6. **Confidence of your assessment**
   Highly confident
7. **How many years have been reviewing for MIUA? (or other medical imaging conferences e.g. CVPR, ICCV, MICCAI, ISBI)**
   Never
8. **Should this paper be considered for the best paper award?**
   No

Rebuttal

Firstly, I'd like to thank you for the constructive criticism and comments

Below we would like to address your concerns

(1) Time Complexity for time efficiency

The time efficiency is consisting of two parts, one the time to extract features and two to classify them using kNN algorithm. As far as the first to calculate extracted features it is a design choice as to whether you use VGG-16 or ResNet50 to extract your features. And would be determined by the number of training examples and the number of iterations which again is problem specific and a design choice. As for the second part the time complexity for kNN is standard $O(k*n*d)$ where k is the k closest neighbors, n is # of testing examples and d is the dimension size. Here again k and d are specific to your design choice on how many K closest neighbors you want and what dimension is extracted from the feature extracted and n is problem specific as to how many testing examples you want to do prediction.

(2) Future work

Although we didn't add a separate section in the paper, we did add the comment "Therefore, deep kNN provides a new approach to intelligent diagnosis of diseases with limited training data." However, to elaborate more on this sort of classification can be used for other image classification tasks where there is an imbalance for classes. It also opens up the idea for using learned feature extractors with other non-parametric models.

(3) State of the art in Few-Shot Learning Era

We agree that our idea for medical image classification does not fall into the category of few shot learners but we never claimed our proposed idea did. Our motivation and goal for the paper was a model that due to class imbalance in diseases could generalize well through unifying kNN classification and learning of feature extraction. We wanted to predict better for those small classes of diseases which state of the art CNN models miss due to lack of generalizability and few classes for training. This was also showed by our experiments on multiple small-class and class-imbalanced medical image datasets where our proposed deep kNN out-performed both kNN and other strong classifiers.

Thank you again for your suggestions, we hope that our clarifications and new supportive answers may help the reviewer in reassessing the paper.