Similar Image Retrieval from X-Ray Database

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Motivation

- Automated content based similar image retrieval techniques not only serve as an efficient management tool for handling large amount of data but also works as an useful tool in the clinical decision making process
- In content-based retrieval systems the images are first represented in terms of high dimensional features, and similarity between images are measured from distances between these features
- The selection of feature space is very important in medical image retrieval systems since the performance of the whole system depends on the extracted features
  - Deep learning framework can eliminate the need for manual feature selection
- While retrieving similar images, the literature-based methods compare every image in the database to extract the closest matches, which is computationally expensive when there are a large number of images in the database.
  - A prior clustering technique that can extract similar image subspace beforehand can be highly beneficial for image retrieval techniques since a query image can then be only compared with its most similar subset of images.

Method

- Dataset : ChestXray14 dataset from NIH[1]
- Framework consists of three parts – deep learning based feature extraction, image network generation and similar image clustering

Deep learning based feature extraction:

- Convolutional Neural Network (CNN)-based Inception-v3[2] framework is fine-tuned on 112,120 frontal-view X-ray images
- The last fully-connected layer of the trained network was then used to extract features from the dataset
- The 2048-dimensional feature vector was further reduced by eliminating the neurons that were not activated for any of the X-ray image samples

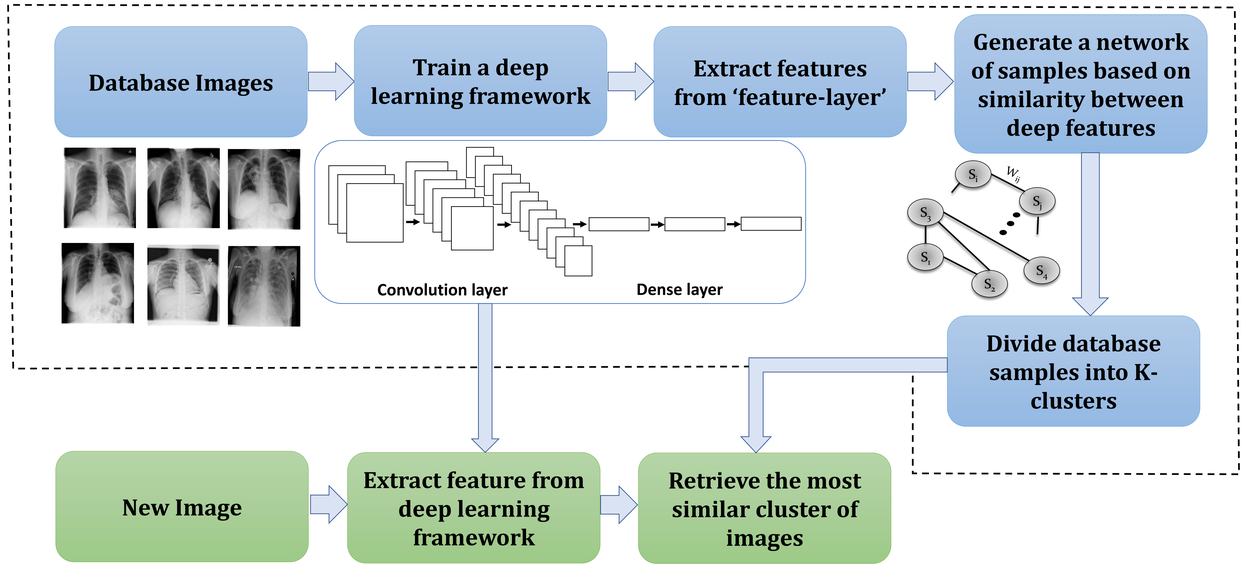
Image network generation:

- A network of images was generated where each image is represented by a node in the network and similar images share edges between them
- Edges were calculated from image-similarity and the similarity between samples was measured by: $w_{ij} = 1/(1 + d_{ij})$, where d_{ij} is the Euclidean distance between the features of samples i and j
- Edge-weights ensure more similar images are strongly connected than images that are different

Similar image clustering:

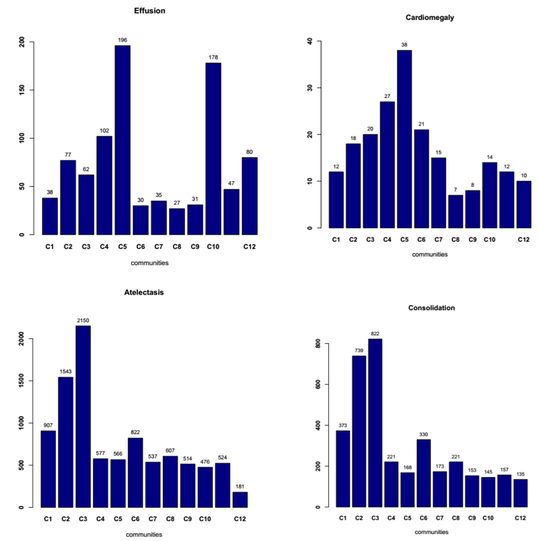
- From the network, similar image clusters were extracted by applying a new graph-based clustering method, named *weighted-modularity based clustering*[3]
- It was able to find clusters from networks without any prior knowledge regarding the number and sizes of clusters

Proposed Framework



Preliminary Results

- As an initial implementation, we trained the deep-learning framework to differentiate Effusion disease samples from other samples
- Extracted the features from test samples and generated graph networks
- Although the deep learning network was trained to distinguish effusion-vs-all, after the clustering we can see few other diseases are also distributed into separate clusters
- The framework generated clusters with similar images which indicates its potential as a large-scale medical image retrieval tool



Future Works

- Compare different combinations of deep-learning and graph-generation frameworks
- Explore more ways to measure similarity between samples from features
- Extend the framework for multiple disease datasets

References

[1]Wang *et al.*, CVPR 2017, pp. 3462–3471.[2]Szegedy *et al.*, CVPR 2016, pp. 2818–2826.[3]Haq *et al.*, submitted to Pattern Recognition Letters 2018