Thesis Proposal

Study of Artificial Neural Networks and application of ANN in the field of Medical Imaging

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Introduction

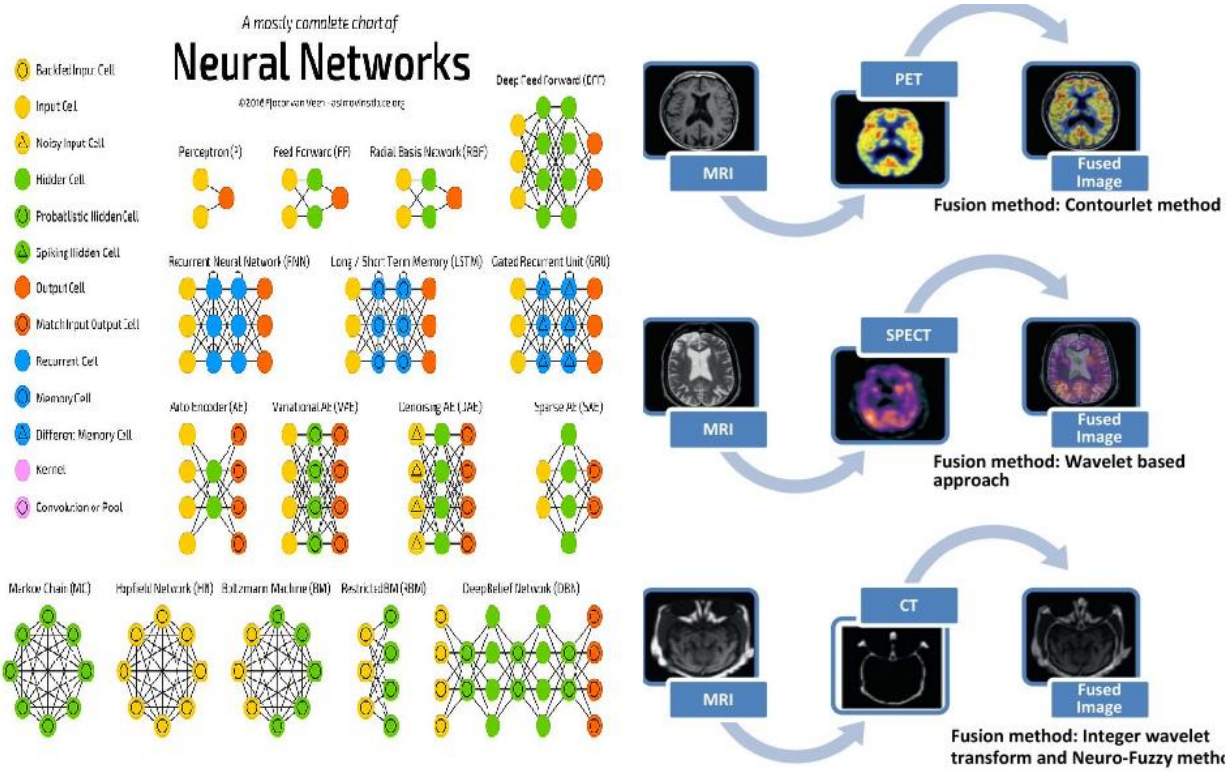

Figure 1: ANNs and image fusion

Artificial neural networks (**ANNs**) or **connectionist systems** are computing systems vaguely inspired by the biological neural networks that constitute animal brains. Such systems "learn" (i.e. progressively improve performance on) tasks by considering examples, generally without task-specific programming. For example, in image recognition, they might learn to identify images that contain cats by analyzing example images that have been manually labeled as "cat" or "no cat" and using the results to identify cats in other images. They do this without any a priori knowledge about cats, e.g., that they have fur, tails, whiskers and cat-like faces. Instead, they evolve their own set of relevant characteristics from the learning material that they process.

An ANN is based on a collection of connected units or nodes called artificial neurons (a simplified version of biological neurons in an animal brain). Each connection (a simplified version of a synapse) between artificial neurons can transmit a signal from one to another. The artificial neuron that receives the signal can process it and then signal artificial neurons connected to it.

There are lots of variants of ANN such as Group method of data handling, Convolutional neural networks, long short-term memory, Deep reservoir computing, Deep belief networks and so on.

The principal method of obtaining physical information about the biological human body is called medical imaging. It is accomplished by creation of specialized images of human body or its parts for clinical purposes. In broader definition it is part of biological imaging and assimilates many specialized fields like nuclear medicine, radiological sciences, thermography and microscopy. From the early invention of X-RAYS by Wilhelm Röntgen back in 1895, the research and development in medical imaging continued throughout the century which resulted in highly technological medical imaging applications of the current era like ultrasound, lungs monitoring applications etc. Over the past twenty to thirty years clinical applications are habitually utilizing medical imaging in different forms and helping in better disease diagnostic and treatment. In last decade or so the usage of Neural Networks in applications of Medical Imaging and Computer Vision opened new doors for researchers, stirring them to excel in this domain.

Research Context

- ANNs are the state of the art machine learning models.
- Deep ANNs are like black boxes, hard to decipher how they reach to the results.
- ANNs have been applied to different medical imaging and computer vision applications and showed good performance.
- Unorthodox networks based on Neural Networks such as Generative adversarial network (2014) is yet to see application in the field of medical imaging.
- Ensemble Neural Networks can be used to boost performance in different existing research works.
- Medical Image Fusion can be introduced to further improve overall performance.

Research Approach/Timeline

Phase 1 (Background study):

- Duration: (March - May)
  - Reading classic papers, books on ANNs.
  - Building up mathematical backbone.
  - Focusing on theoretical understanding.
  - From black box to modular understanding, developing intuition.
  - Visualization of intermediate layers of Neural Nets, meaningful representation of hidden nodes, Can we make ANNs explain how did they reach a solution?
- Duration: (April - May)
  - Studying medical image fusion techniques
  - Reading classic papers, novel methods
  - Introducing novel approaches for fusion or comparing performances

Phase 2 (Research groundwork):

- Duration: (June)
  - Coming up with an interesting research problem
  - Data acquisition/Dataset collection
  - Organizing research methodologies, selecting paradigms, schemes and models

Phase 3 (Primary Submission):

- Duration: (July-October)
  - *Probable contribution:*
    - Using unorthodox NN models
    - Developing new NN heuristics
    - Using ensemble methods for improving performance
    - Medical image fusion, novel approach/comparison with conventional techniques
    - Medical image classification, disease diagnosis