ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

WEEK 11
2021 SPRING

Contents

- What are deep belief networks?
- What are the most important properties of deep belief networks?
- What are the application areas of deep belief networks?

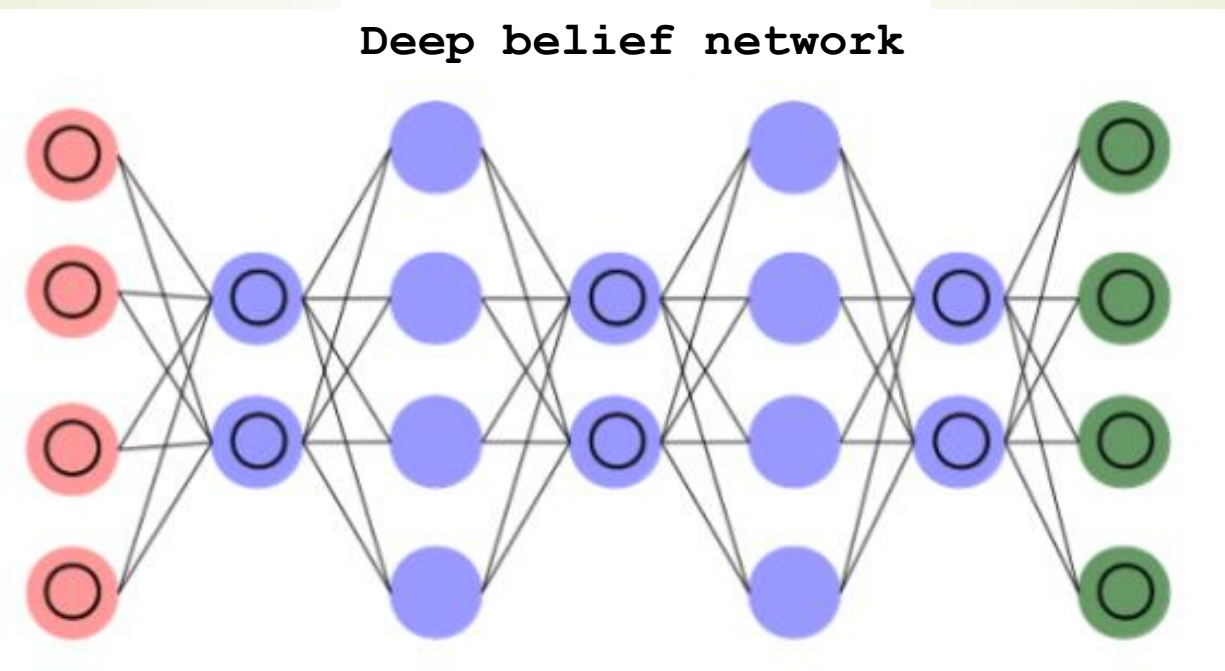
Deep belief networks

- Deep belief networks (DBN) are one of the first non-convolutional models that allow deep architectures to be trained successfully.
- Before DBNs, the optimization of deep models were considered to be very difficult.
- DBNs have shown that deep architectures can be successful by performing better than support vector machines.
- DBNs are generative models that consists of multiple hidden variable layers.

Deep belief networks

- In machine learning DBN is a generative graphical model.
- DBN is a deep neural network class which consists of multiple layers of hidden nodes with connection between layers but not between nodes.
- When trained over a set of unsupervised samples, DBN can learn to restructure its inputs probabilistically.
- Layers later behave as feature detectors. After this training stage, a DBN may be trained with more supervision to perform classification.

Deep belief networks



Deep belief networks

- DBNs are deep neural networks consisting of a multi-layered graphical model with both directed and unverified edges.
- It consists of multiple hidden unit layers in which each layer is connected with each other while units aren’t.
- Generally, DBNs have very distinctive application and usages in real life applications.

Deep belief networks

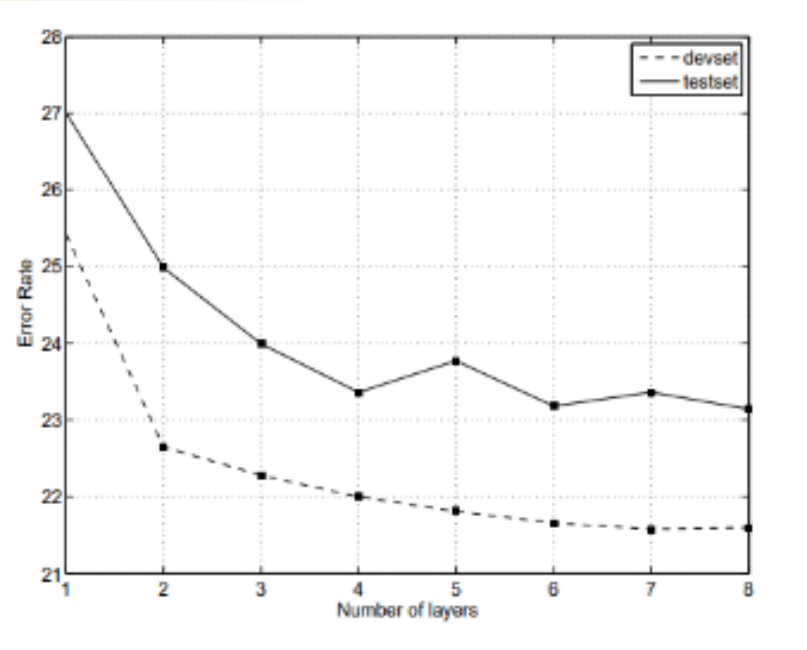
- Two most important properties of DBNs are presented below.
- 1) It has a layer-layer procedure for learning the productivity weights from top to bottom that determine how the variables in a layer depends on the variables in upper layers.
- 2) After learning, the values of hidden variables at each layer can be deducted with a single, from-bottom to-top pass that starts with a data vector at bottom layer and utilizes generative weights on reverse direction.

Deep belief networks

- DBN are used today in the following fields.
- Clustering: Is grouping a set of objects so that the ones similar to each other end up in the same cluster. Simply put, the aim is to seperate the objects with similar properties and assign them to same clusters.
- Classification: Is the supervised learning approach in which the computer program learns the data from its input and later uses this learning to classify new observations.
- Dimensionality reduction: What is done with this process is the meaningful expression of higher dimensional data in a lower dimensional space.
- Anomality Detection: It is the detection of that significantly differs / deviates from other observations in the same sample.
- Natural language processing: It aims the understanding of natural languages' canonical structure or reproducing them.

Deep belief networks

- In DBNs, initially the error rate drops rapidly as the number of layers increases.



Deep belief networks

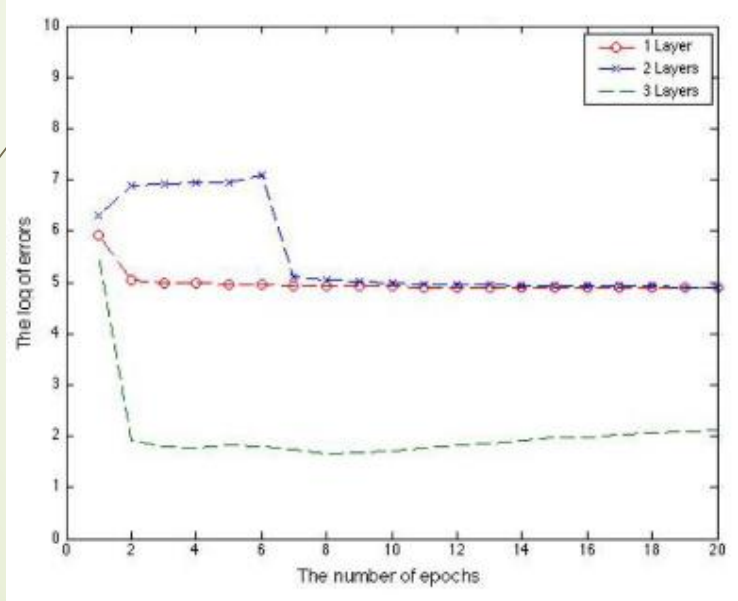
- The number of neurans at each hidden layer change the error rate.
- Increasing number of neurons does not continiously increase or decrease the error rate.
- If the table below associated with a DBN study is analyzed;

Model	devset	testset
1024 units	21.94%	23.46%
2048 units	22.00%	23.36%
3072 units	21.74%	23.54%

- In the table, even if the number of neurons change considerably, the error rate changes very little.
- In the table, the lowest error rate on test set is obtained with 2048 neurons.

Deep belief networks

- The learning rate changes in a DBN depending on the number of hidden layers.



Deep belief networks

- The learning rate changes in a DBN depending on the number of neurons in hidden layers.
- In the figure below, the change in a 3 layer DBN is demonstrated.