Deep Learning in Storage

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Deep Learning Applications in IT

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Deep Learning Applications

IT - General

Image Processing Example (CNN)

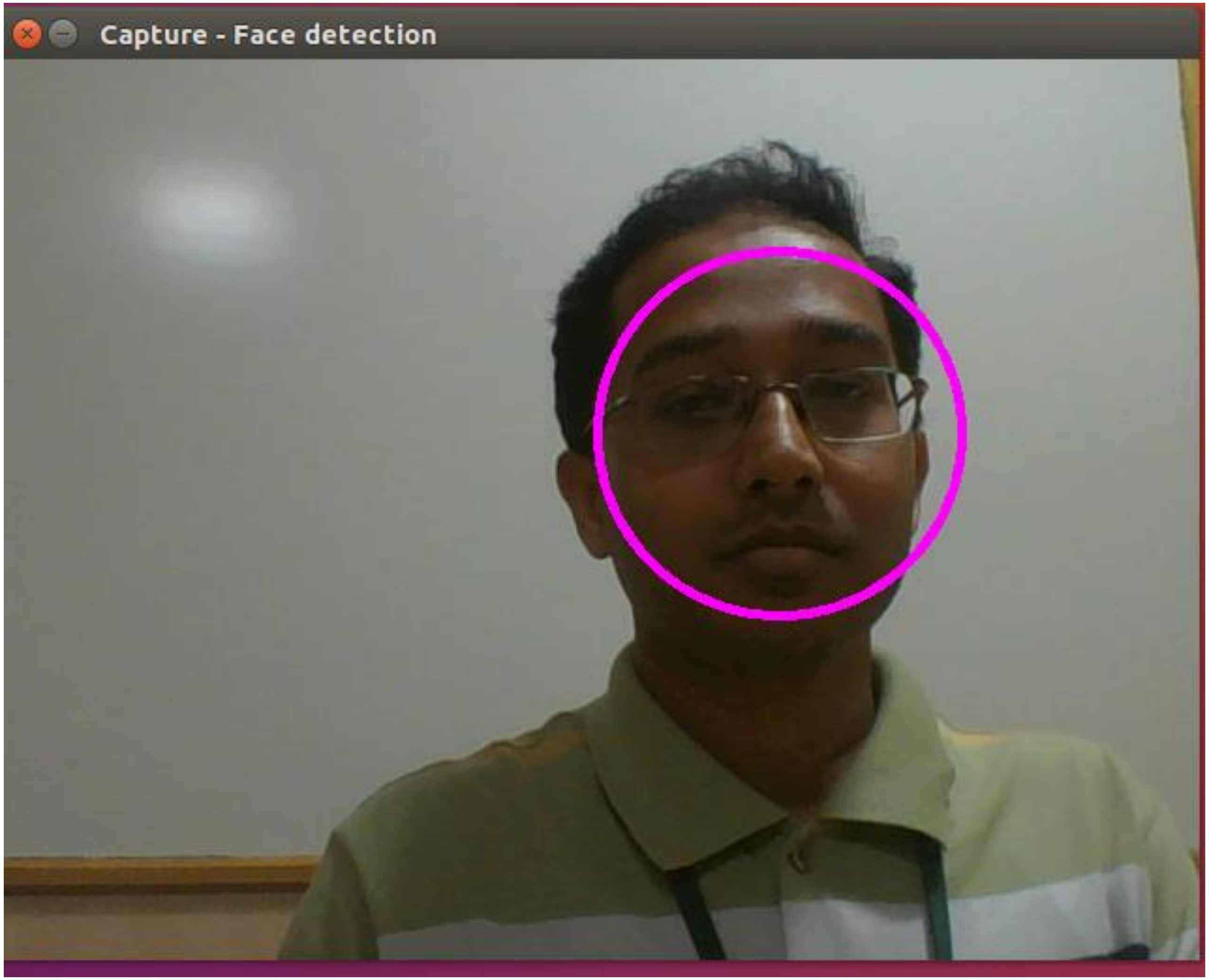
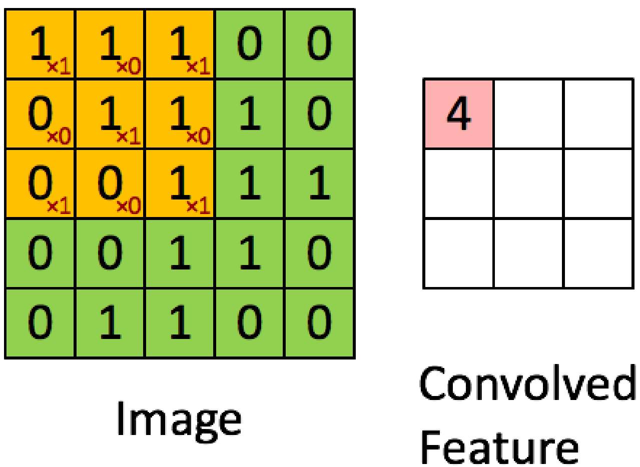


Image Processing – Overview I

- The easiest way to understand a *convolution* is by thinking of it as a sliding window function applied to a matrix. It becomes quite clear looking at a visualization:

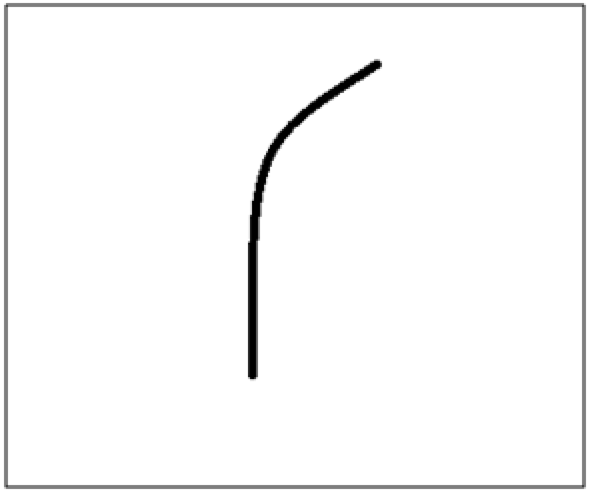


- The sliding window is called a *kernel, filter,* or *feature detector.* Here we use a 3×3 filter, multiply its values element-wise with the original matrix, then sum them up.

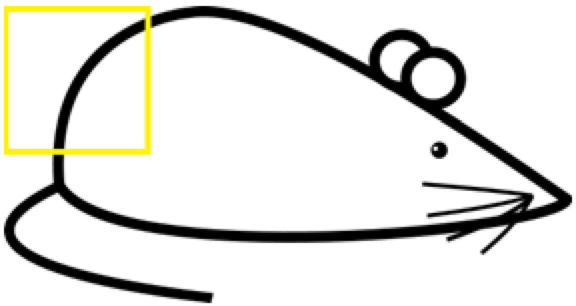
Image Processing – Overview II

0	0	0	0	0	30	0
0	0	0	0	30	0	0
0	0	0	30	0	0	0
0	0	0	30	0	0	0
0	0	0	30	0	0	0
0	0	0	30	0	0	0
0	0	0	0	0	0	0

Pixel representation of filter

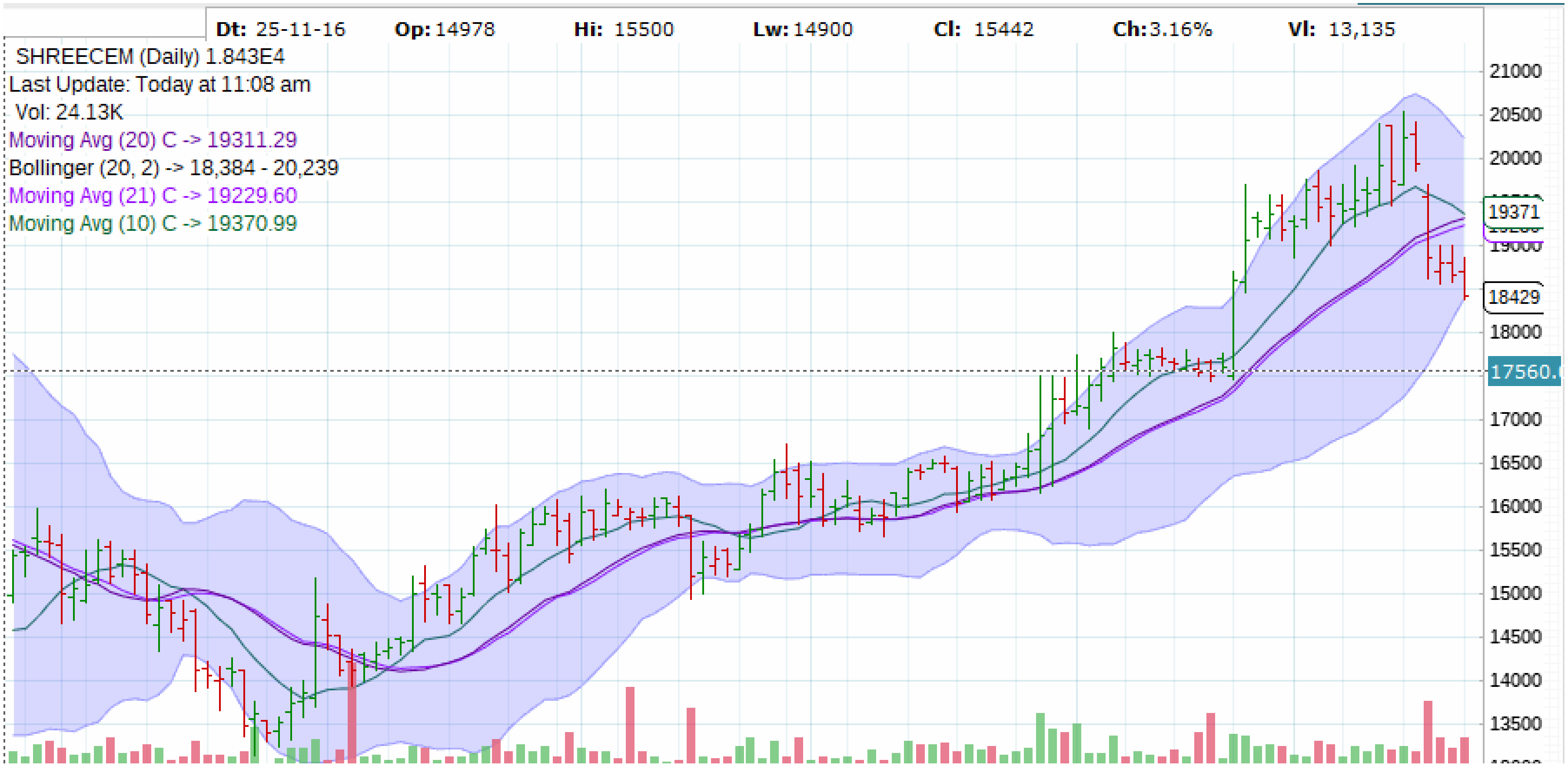


Visualization of a curve detector filter

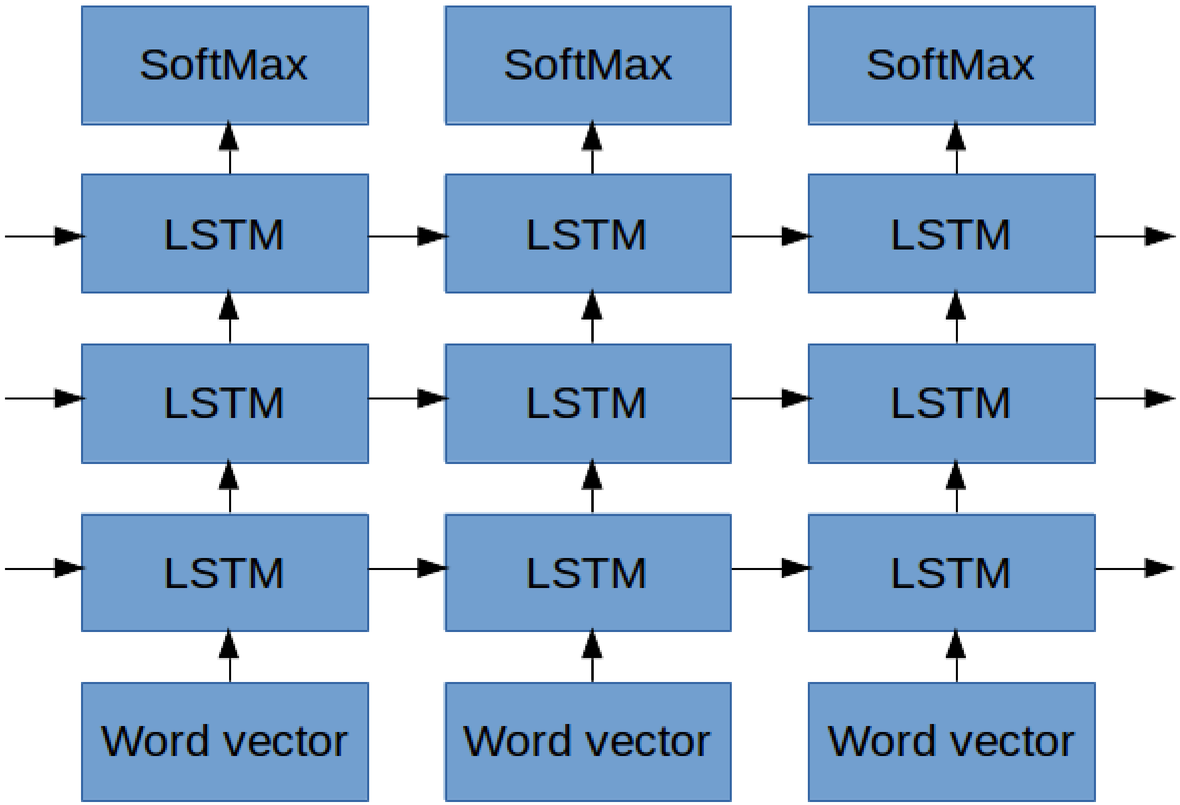


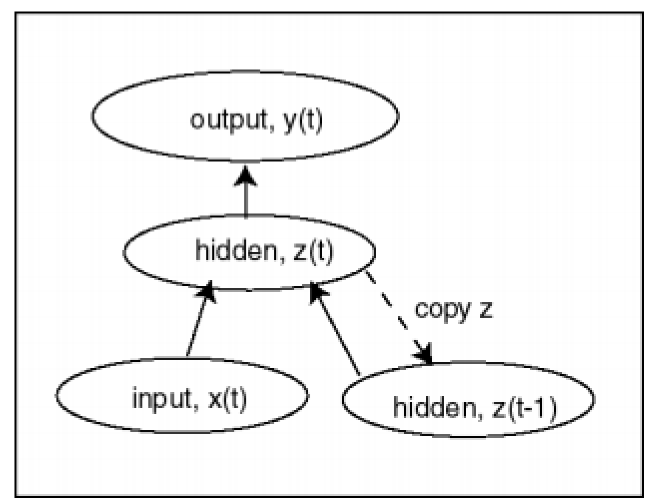
https://adeshpande3.github.io/adeshpande3.github.io/A-Beginner's-Guide-To-Understanding-Convolutional-Neural-Networks/

Stock Prediction Example (RNN and LSTM)



Stock Market Example - Process





Person-Movie Relationship – RBM/Autoenc

	M1	M2	M3	M4	M5	M6	M7	M8
P1	1	1	1					
P2		1						
P3			1					
P4				1	1			
P5						1		
P6							1	

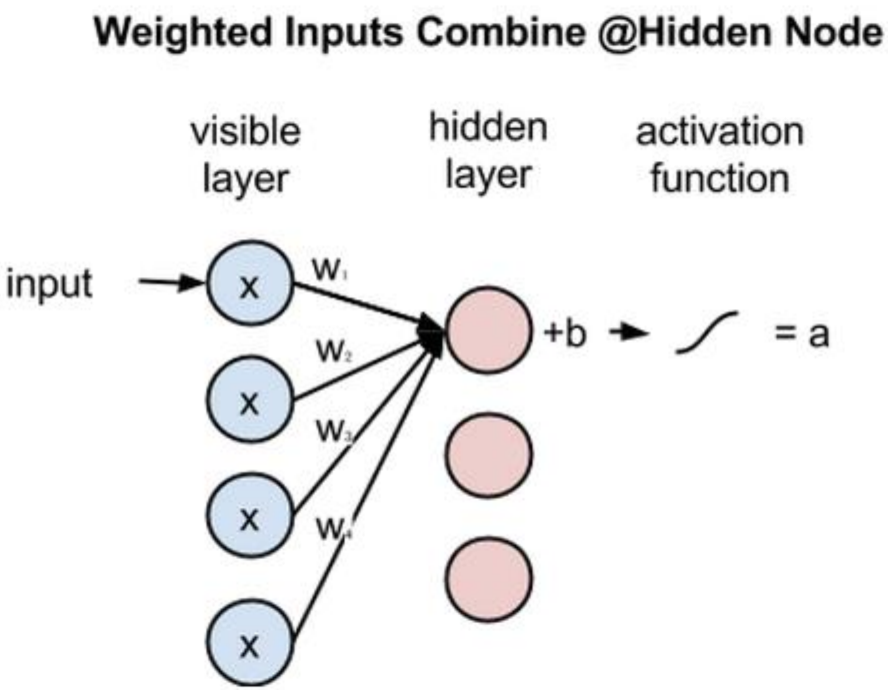
Person to Model, Model to Person, Model Strength
SVD (Matrix representation)

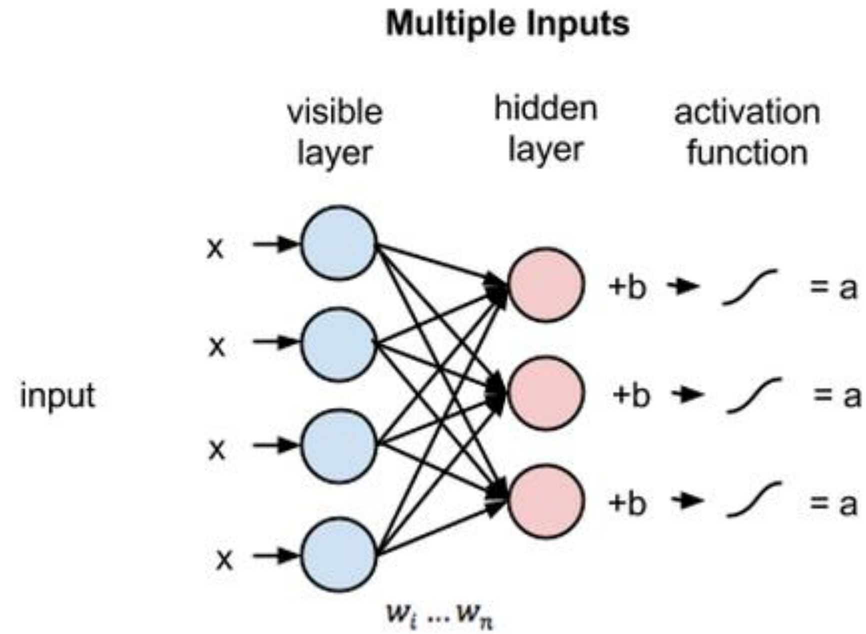
$$A = U\Sigma V^T$$

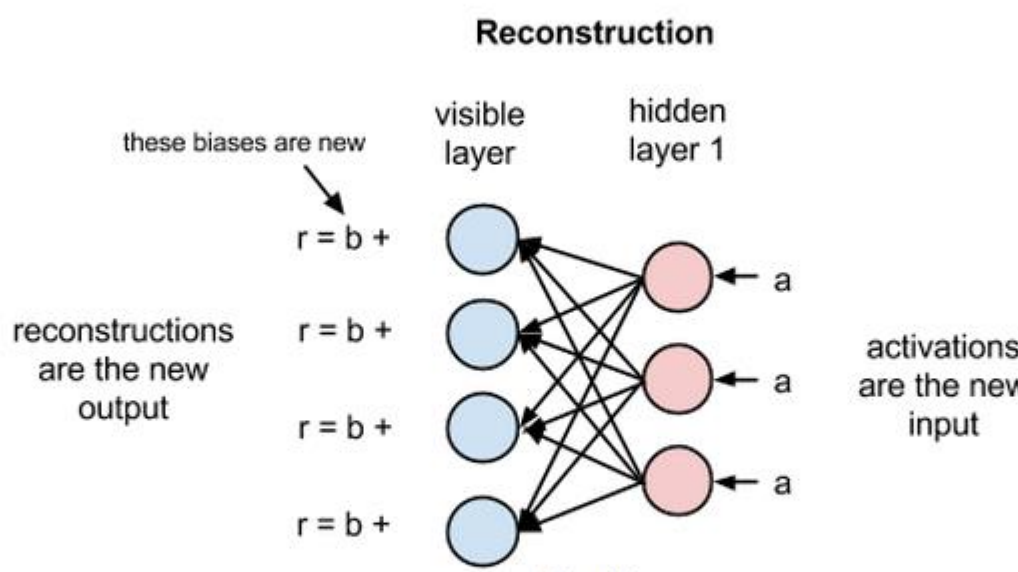
where U is an $m \times m$ orthogonal matrix[1] whose columns are the eigenvectors of AA^T, V is an $n \times n$ orthogonal matrix whose columns are the eigenvectors of A^TA, and Σ is an $m \times n$ diagonal matrix of the form

$$\Sigma = \begin{pmatrix} \sigma_1 & & & & & \\ & \ddots & & & \mathbf{0} & \\ & & \sigma_r & & & \\ & & & 0 & & \\ & \mathbf{0} & & & \ddots & \\ & & & & & 0 \end{pmatrix}$$

RBM







https://deeplearning4j.org/restrictedboltzmannmachine

NLP Example

- Term Frequency, Inverse Document Frequency - tfidf
- Word Representation
  - One hot: [1,0,0,0], [0,1,0,0], [0,0,1,0], [0,0,0,1]
  - Vector Representation and Cosine Similarity

	King	Queen	Man	Woman
Familiarity	0.90	0.9	0.02	0.02
Wealth	0.90	0.99	0.5	0.5
Gender	….			
Other Attr				

  - Word2Vec

$$P(w_t|h) = \text{softmax}(\text{score}(w_t, h)) = \frac{\exp\{\text{score}(w_t, h)\}}{\sum_{\text{Word w' in Vocab}} \exp\{\text{score}(w', h)\}}$$

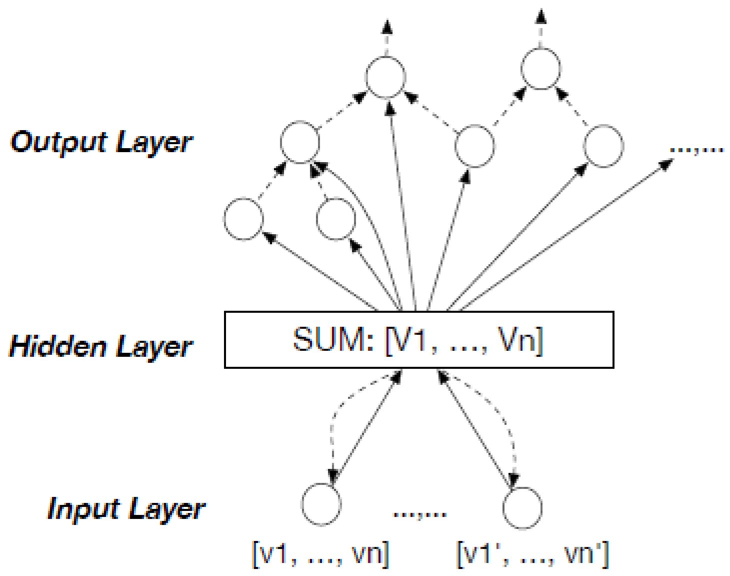
Deep Learning Applications

IT - Storage

Prefetching

Vector Representation example

- Physical location of block
- File it belongs to
- User who owns the file
- Creation time
- Access time



Use Cases

- VM Migration
  - PreCopy and Post Copy
  - PostCopy results in network fault and copies faulted data. Also prefetches pages
  - Vector representation – Pages belonging to schedulable processes
- Tiering
  - Block movement between Tiers
  - Predicting blocks to be accessed in near future
- NFS - 4.2 has application hint for caching
  - Cache or no cache
  - No application intelligence

  Local FS – Read ahead size

Capacity/Performance

Use cases

- Power Consumption in Data Center – Historical Power consumption Data, CPU Memory Utilization, IO/Network Workload

- Performance Modelling and Prediction inter-arrival time, and sequential-scan run-length, queue time, seek and rotational latency, transfer time, sequential/random, read/write ratio – CART (Classification and Regression Tree) model
  - Parameter selection – additive and subtractive
    - CART model - CUT points are chosen
    - RBM to get latent features - subsequent regression can find the metric

Predictive Failure

Use cases

“Recently, LSTM autoencoders and encoder-decoder frameworks have been used as **reconstruction models** where some form of reconstruction error is used as a measure of anomaly. The idea behind such models is: autoencoder is trained to reconstruct the normal time-series and it is assumed that such a model would do badly to reconstruct the anomalous time-series having not seen them during training.”

Miscellaneous

Parameters

- Load Balancing – some of the parameters
  - Latency
  - Response Time
  - Reject connection count

- Generalized Resource Management
  - Protocol Detection

References

http://web.cs.iastate.edu/~cs577/handouts/svd.pdf

https://www.slideshare.net/ananth/word-representation-svd-lsa-word2vec

http://ieeexplore.ieee.org/document/7576472/

https://www.quora.com/How-do-I-use-LSTM-Networks-for-time-series-anomaly-detection

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