A Deep Learning Approach for Network Intrusion Detection System

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A Deep Learning Approach for Network Intrusion Detection System

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Outline

- Introduction
  - Self-taught Learning (STL)
  - NSL-KDD
- Implementation of NIDS
- Results
- Conclusion

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- **Introduction**
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Introduction

- NIDS can be categorized as:
  - Signature based NIDS (SNIDS)
    - Attacks signatures are pre-installed
  - Anomaly detection based NIDS (ADNIDS)
    - Deviation from normal traffic pattern is attack
    - Most common among research community

Introduction

- Challenges arise for developing an efficient ADNIDS
  - Proper feature selection
  - Organization's reluctance to report any intrusion
    - To maintain privacy of various users
- Deep Learning can help to overcome the challenges of developing an efficient NIDS

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Self-taught Learning (STL)

- A deep learning approach consists of two stages for classification
  - Feature representation learnt from large unlabeled data, i.e., Unsupervised Feature Learning (UFL)
  - Learnt representation is applied on labeled data
- Sparse auto-encoder used for UFL

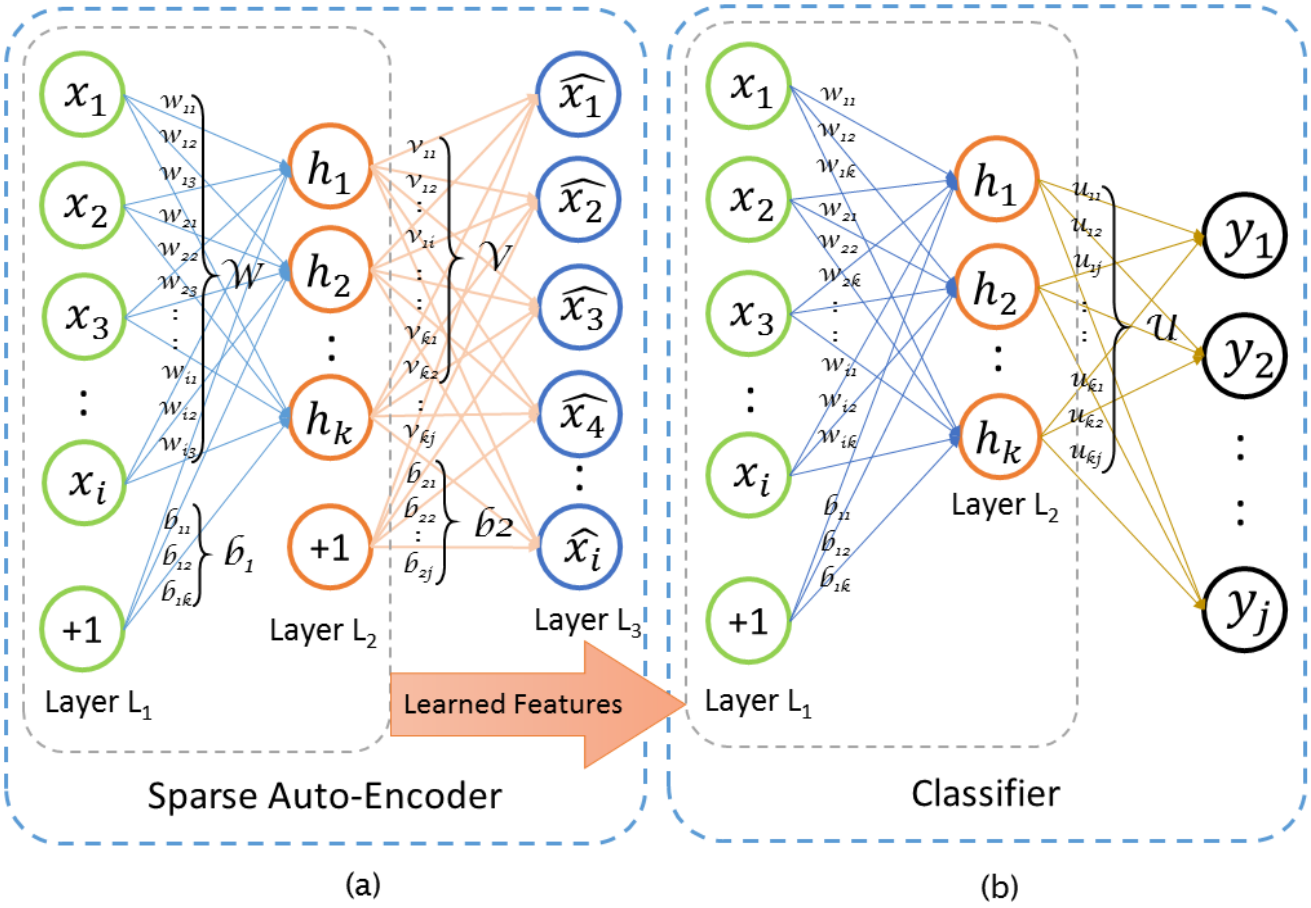

Figure 1: Two stages of Self-taught Learning (STL)

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NSL-KDD Dataset

- An improved version of KDD Cup 99 intrusion dataset
  - Eliminated redundant records in KDD Cup 99
- Dataset records consist of 41 features labeled with normal or a particular attack traffic
  - Includes basic features, traffic features accumulated in a window interval, and content features

NSL-KDD Dataset

- Out of 41 features:
  - 3 nominal, 4 binary, and 34 continuous
- Training and test data contains 23 and 38 traffic classes including normal and attack traffic
  - Attacks grouped into 4 categories: DoS, Probing, U2R, and R2L

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NIDS Implementation

- Implemented using MATLAB/Octave
- Pre-processed the dataset before applying STL
  - 1-to-N encoding to convert nominal attributes to discrete attributes
  - Max-min normalization of the attributes
- Evaluated for both the training and test data

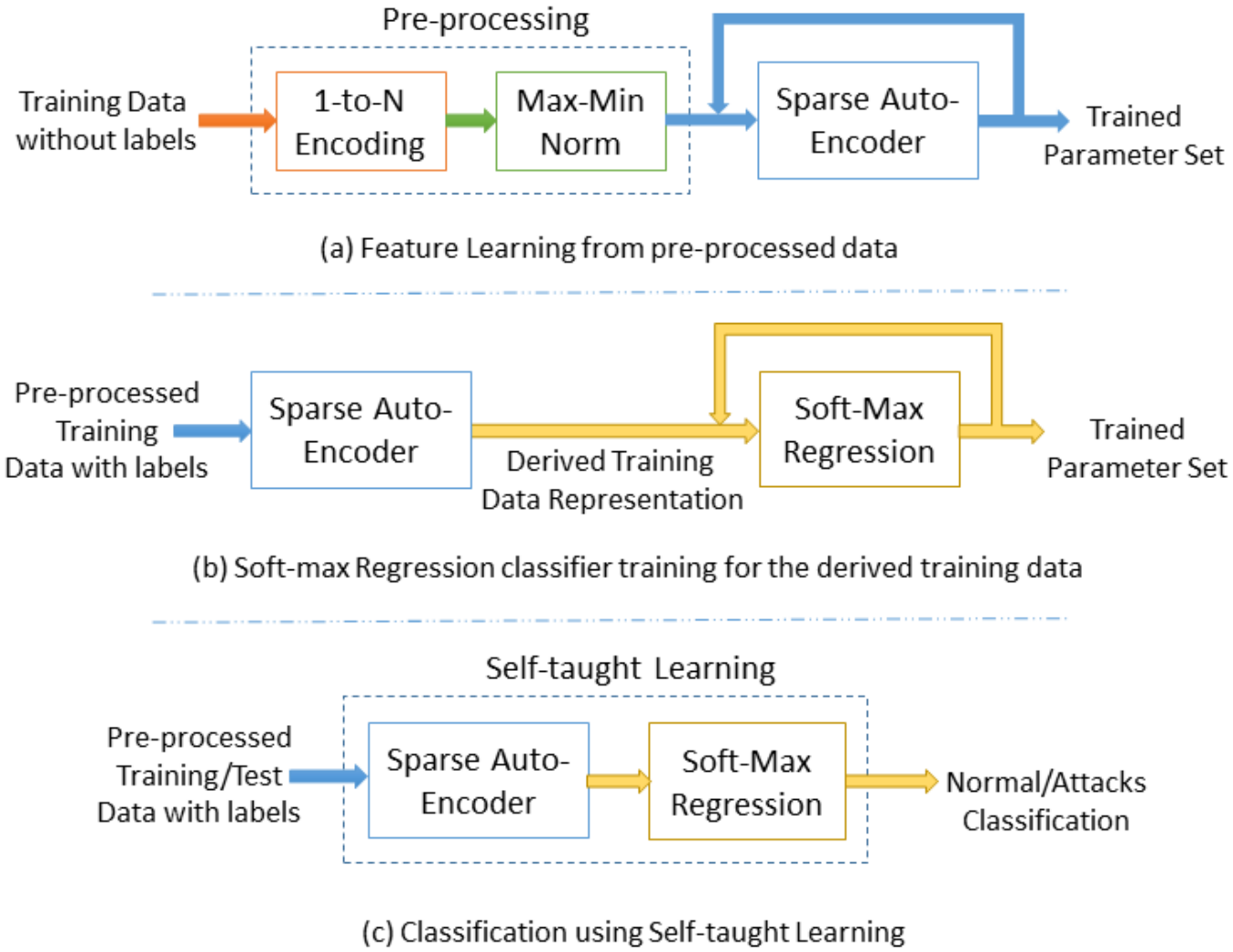

Figure 2: Steps involved in NIDS Implementation

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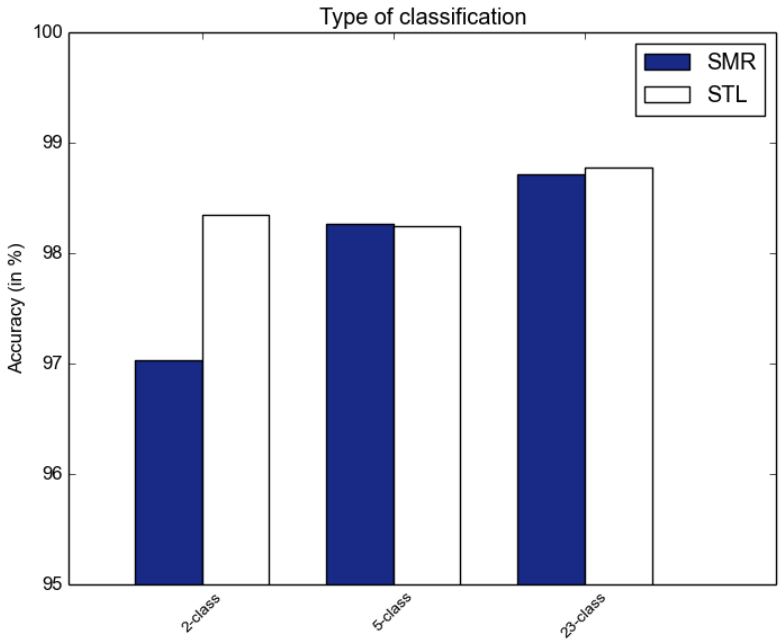
Accuracy Metrics

- **Accuracy** %age of correctly classified records
- **Precision** $P = TP/(TP + FP)*100\%$
- **Recall** $R = TP/(TP + FN)*100\%$
- **F-measure** $F = 2*P*R/(P + R)*100\%$

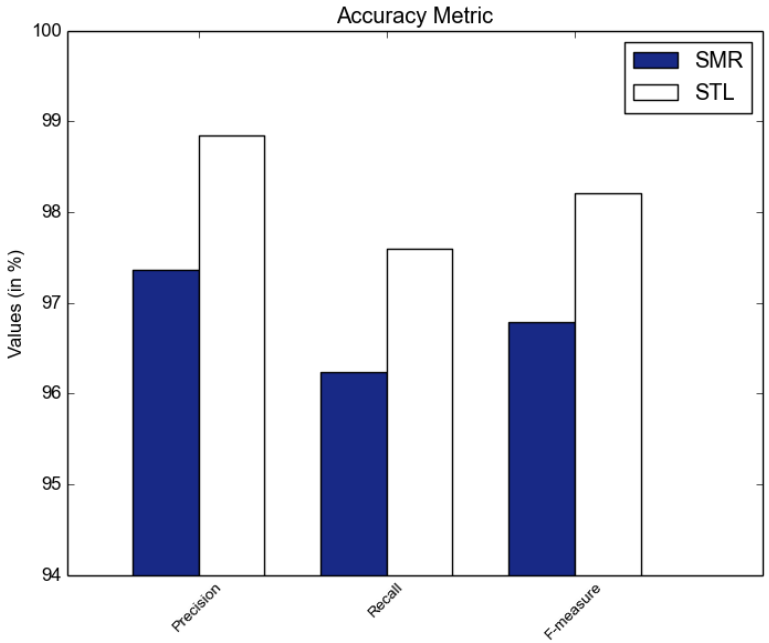
Performance Evaluation

- Implemented the NIDS for 3-types
  - Normal and Anomaly (2-class)
  - Normal and four attack categories (5-class)
  - Normal and 22 attacks (23-class)
    - For training data only
- Precision, Recall, and F-measures evaluated for 2-class and 5-class

Evaluation based on Training data



- Accuracy evaluated for 2, 5, and 23-classes
- STL achieved >98% accuracy for all types



- Precision, recall, and f-measure evaluated for 2-class
- STL achieved f-measure value ~99%

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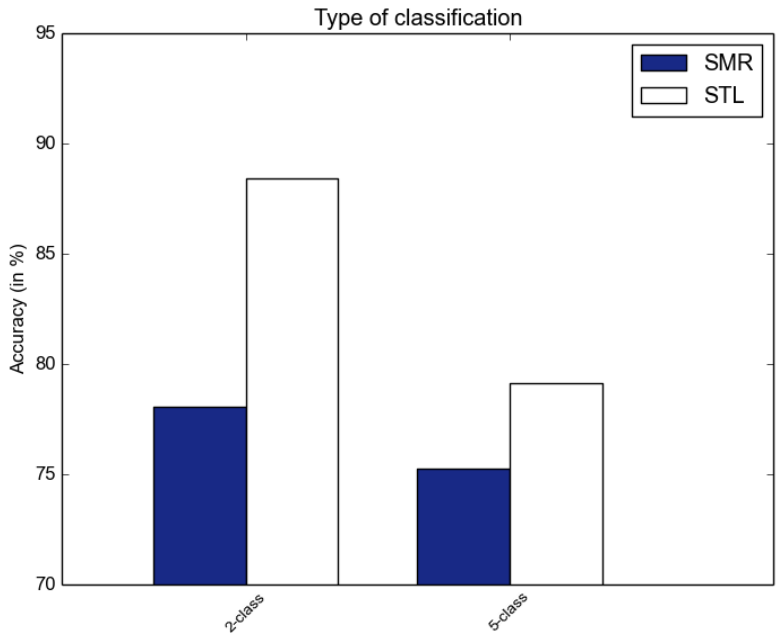
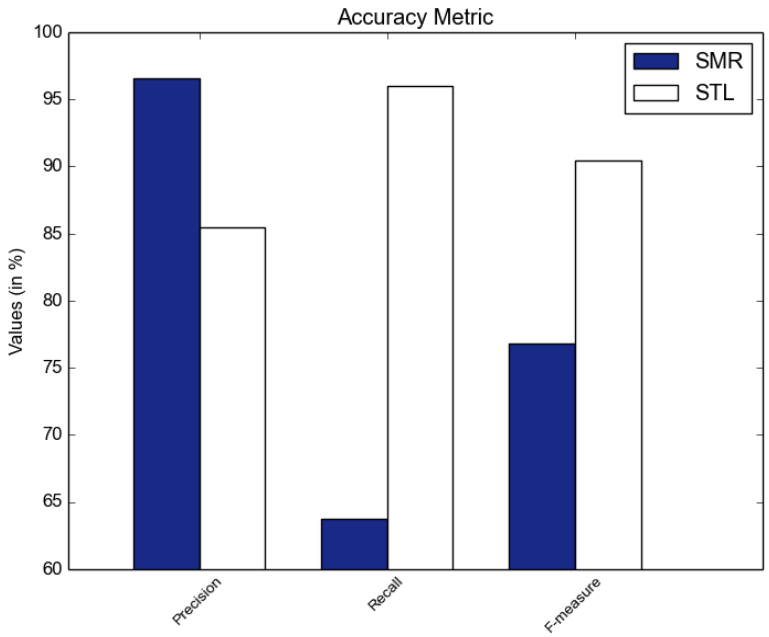
Evaluation based on Test data



- STL achieved accuracy of ~88% for 2-class
- Better than various previous methods



- STL achieved ~90% f-measure value
- SMR achieved only ~77%

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Conclusion

- STL based NIDS showcased good performance compared to other methods on NSL-KDD dataset
- Future work
  - Performance enhancement using other DL methods
  - To be implemented for real-time network operation

Thanks!

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