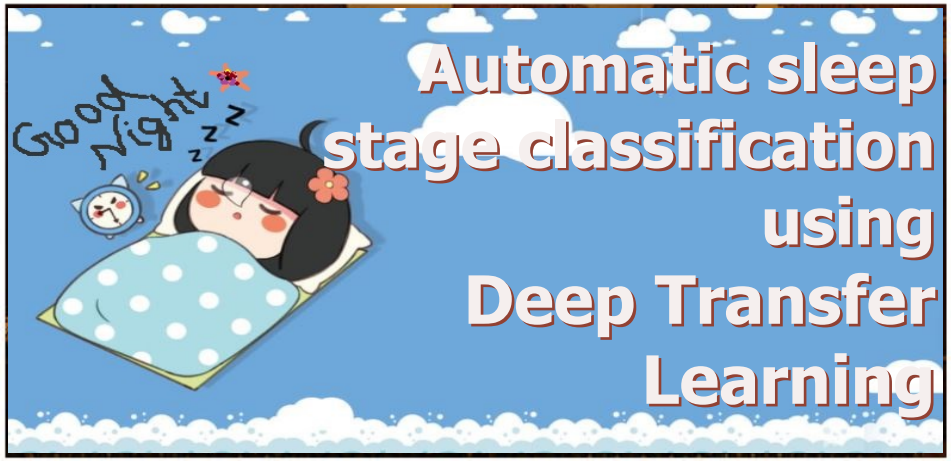


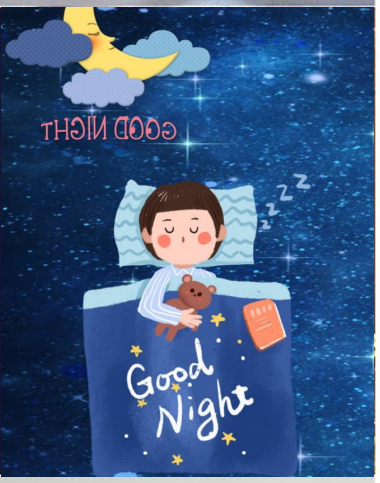
Automatic sleep stage classification using Deep Transfer Learning

Denver

Presented By: Rumana Sultana

Introduction

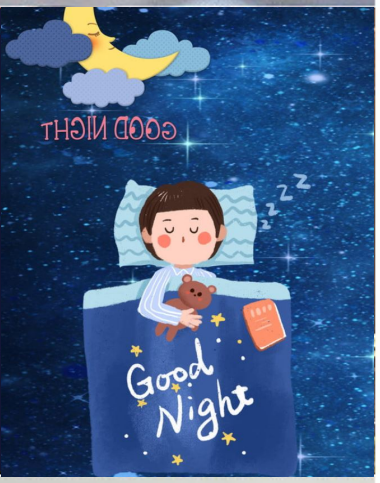
- Problem Statement and Background
- Analysis and Exploration of Dataset
- Previous Research Works
- Methodology and Implementation
- Testing and Result Analysis
- Challenges and Future plan
- Conclusion
- Git Link: https://github.com/RumanaCU/Sleep-Staging



Problem Statement and Background

Why Sleep Stage Classification?

- Depression is a long-term disorder of human life.
- Hundreds of thousands of people are suffering from sleep disorder caused by depression
- That can consequence to heart attack and even death.
- Current pandemic situation increased this situation.
- There is a need to improve human lifestyle and healthiness
- It has significant importance in clinical science to diagnose the symptoms and diseases



Problem Statement and Background

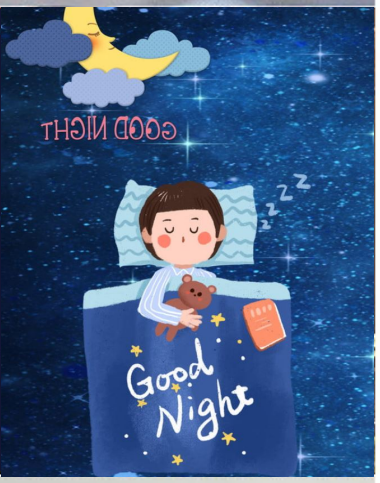
Why does data science solution need?

- Labeling of sleep stages from polysomnography (PSD) is highly time consuming with clinicians and cost involvement.
- Currently machine and deep learning techniques are widely using for every sectors, but big dataset is needed to achieve expected performance.
- Home based sleep monitoring edge devices is not reliable due to data insufficiency.
- Edge devices are dependable to cloud server for data driven decision making.
- Latency and failure of service is an overhead.
- Need to develop a data-efficient model for sleep staging from raw data for edge devices that can perform overall accuracy and macro F1 score above 87%-83.



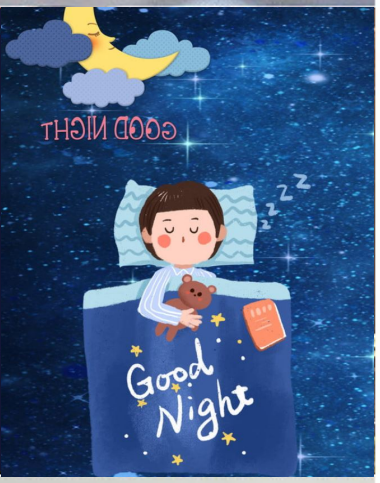
Previous Research works

- DeepSleepNet [3] – A sleep stage scoring model based on single channel EEG (F4-EOG (left), Fpz-Cz, and Pz-Oz) from two publicly available sleep dataset MASS and Sleep-EDF. A combine model of representation learning and sequence residual learning. The overall accuracy and macro F1 score achieved: MASS: 86.2%-81.7, Sleep-EDF: 82.0%-76.9.
- The Survey paper [4] described the applications scenario for edge intelligence and intelligent edge, practical implementation methods and enabling technologies and future challenges of edge computing.
- The Survey paper [5] described about model compression techniques for DNN models including parameter pruning and quantization, low-rank factorization, transferred/compact convolutional filters, and knowledge distillation.
- The research paper [6] initiated a model for automatic sleep staging using deep transfer learning. They used MASS sleep database for source domain and the Sleep-EDF Expanded database, and the Surrey-cEEGrid database as target domain. Their proposed DTL model outperformed over all previous work including accuracies 84:3% and 85:2% for the target domain database.



Analysis and Exploration of Dataset

- **Sleep-EDF Expanded Database**- 197 whole-night Polysomnographic sleep recordings, including EEG, EOG, Chin EMG, and event markers of around 20 subjects.
  - **Downloaded from-**https://www.physionet.org/static/published-projects/sleep-edfx/sleep-edf-database-expanded-1.0.0.zip.
  - **Data and Annotation Files:**
    - *PSG.edf files- whole night recordings of EEG, EOG, submental chin EMG and even marker.
      - SC*PSG.edf- contain oro-nasal respiration and rectal body temperature.
    - *Hypnogram.edf- annotation of sleep pattern correspond to PSGs consist of sleep stages W, R,1,2,3,4,M and ?(not scored)
    - Unrecorded signals removed from ST*PSG.edf
    - Stages: W=wakefulness, R- rapid eye movement, N1-light sleep,N2-deeper sleep, N3&4-deep sleep.



Analysis and Exploration of Dataset

- **Sleep Cassette Study and Data:**
  - 153 SC*files of healthy Caucasians aged 25-101, with no medication.
  - **Variables**: Files are named in the form of SC4ssNE0-PSG.edf.

    Where, ss=subject number, N=night.
  - **Missing Values**: The first night of subjects 36 and 52, and the second night of subject 13, were lost due to failing cassette or laserdisk.
  - EEG and EOG signals were sampled at 100Hz.
  - EMG signal was high-pass filtered, rectified and low-pass filtered and resulted EMG, expressed in uV(root-mean=square) was sampled at 1 HZ.
  - Oro-nasal airflow, body temperature and event marker sampled at 1 HZ.
- **Sleep Telemetry Study and Data:**
  - 44 ST*files of temazepam effects on sleep in 22 Caucasians males and females, difficulty with falling asleep.
  - Variables: Files are named in the form of ST7ssNJ0-PSG.edf

    where, ss=subject number, N=night
  - EOG, EMG, and EEG signals sampled at 100Hz.

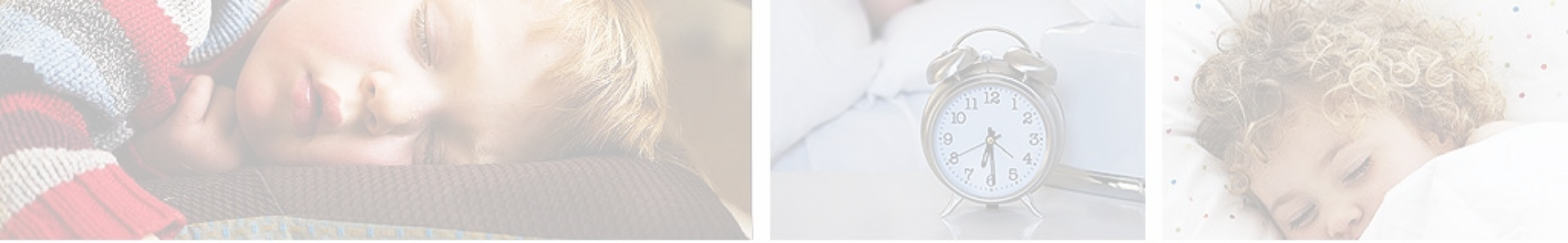


Methodology and Implementation

- Train a DeepSleepNet using DNN on source domain.
- Finetune source model into a small sub-model on target domain.
- Filter data from user-end with a threshold.
- If confidence below threshold, data sent to source domain.

Technology

- Deep Transfer Learning
  - ➢DL models are data hungry. Training is very expensive in resource and time.
  - ➢With DTL, part of one big model can use to predict another small model.
  - ➢Able to perform with lack of data, reduce training speed, and increase efficient use of resources.



Methodology and Implementation (Cont.)

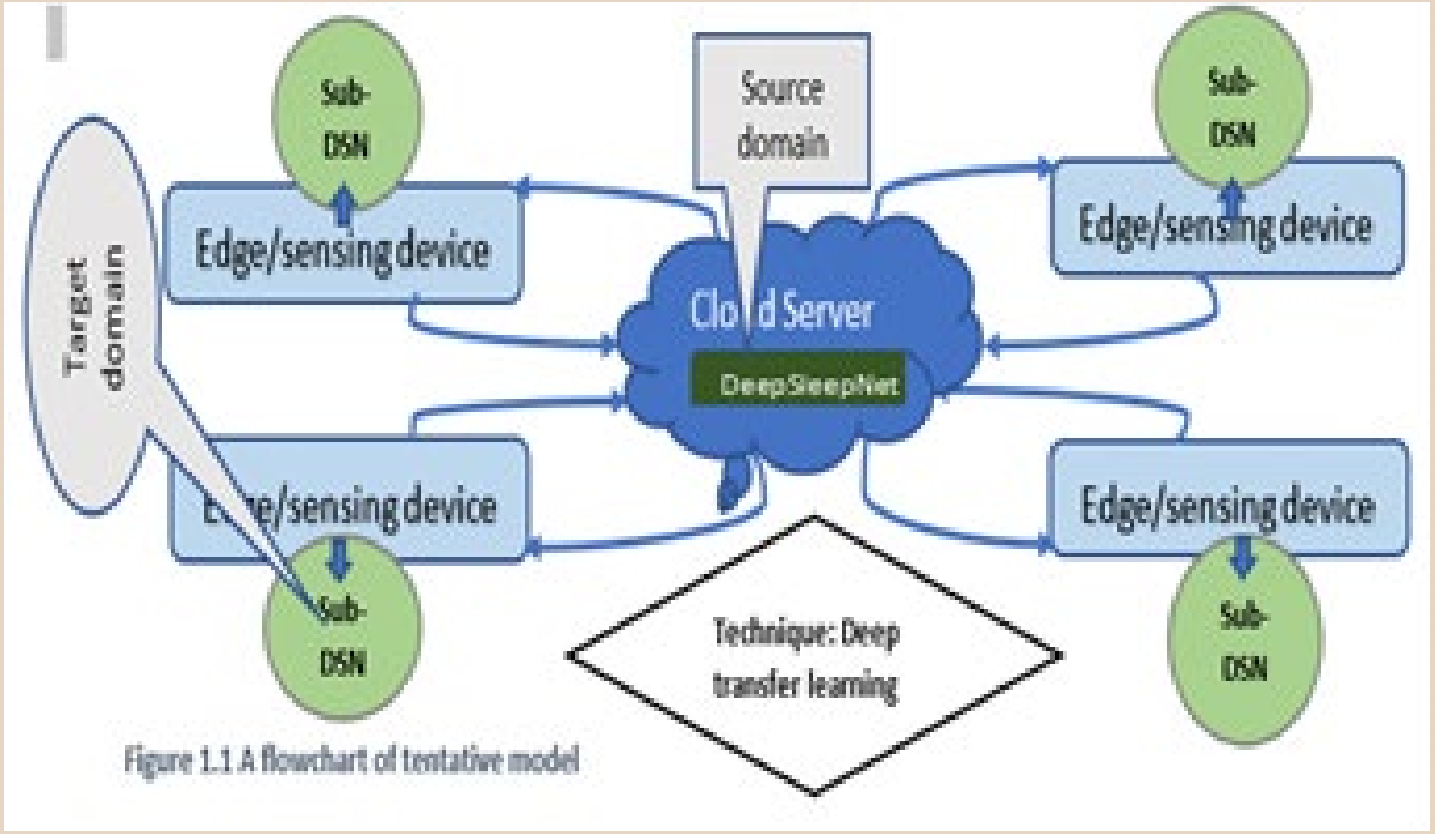


Figure 1: Flowchart



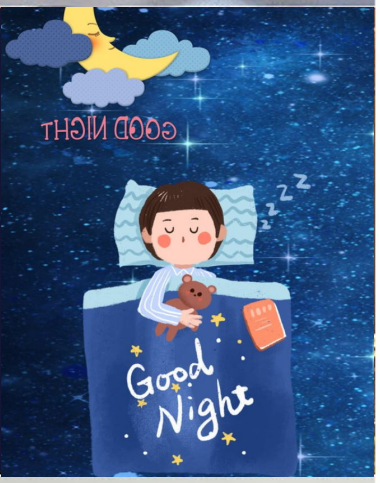
Methodology and Implementation(cont.)

PLATFORMS (could be choose as per necessity)

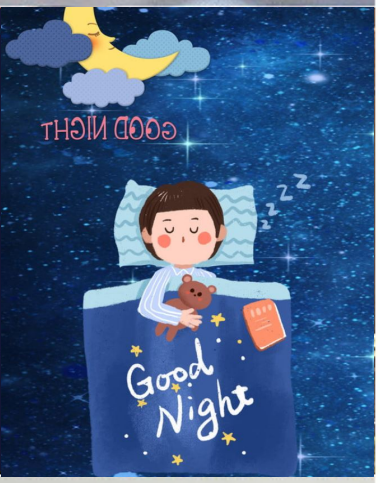
- MATLAB (for data preparation)
- Python3, TensorFlow 2 (for network training and evaluation)
- NumPy, SciPy, Sklearn, H5py.

REASONS OF CHOOSING PLATFORMS:

- **MATLAB** has user-friendly EEGLAB toolbox to process the EEG data with applying necessary high pass and low pass filter.
- **Python3** and **TensorFlow 2** is very enriched with machine and deep learning libraries.
- NumPy makes easy complex machine and deep learning numerical operations with large dataset.
- **SciPy** contains different modules for optimization, linear algebra, integration and statistics that is very helpful for data analysis.
- **Scikit-learn**, a machine learning library for Python has various algorithms like support vector machine, random forests, and k-neighbours, and it supports Python numerical and scientific libraries like NumPy and SciPy.
- **H5py** is helpful for viewing datasets of different formats in a tabular way or as an image.



Testing and Result Analysis



Testing and Result Analysis

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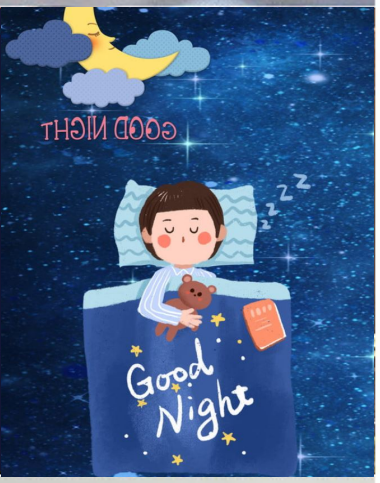

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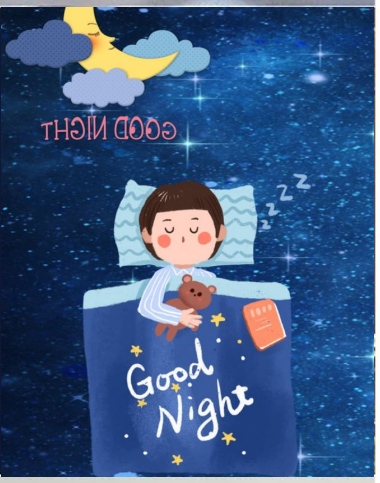

Testing and Result Analysis

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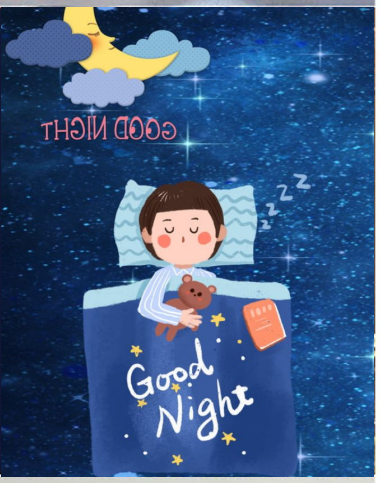

Testing and Result Analysis

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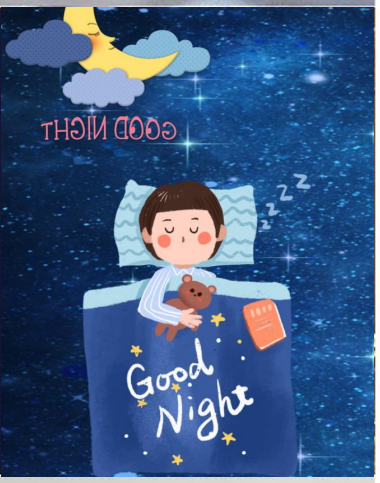

Testing and Result Analysis

(Cont...)



Challenges and Future plan



Challenges and Future plan (Cont…)

Conclusion

- Ensure sound sleep, ensure healthy life.
- Enrich sleep analysis with mobile computing.
- Increase reliable home-based sleep monitoring.

Thank you

Questions

???



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