About me (Luoluo Liu, Ph.D 19 from Hopkins)

Philips Research North America (PRNA) 2020- present

Detection and early warning algorithms from wearables, bedside monitors, and lab results

- chronic respiratory diseases: asthma, COPD
- infectious respiratory diseases: pneumonia, COVID,
- opioid usage

Hospital Operational improvement

- Interpretable method on Recurrent patients identification summary
- Improvements of 30-day readmission risk predictions summary
- predict unit level next day median Length of Stay summary

Pre-graduate industrial works

simulation of motion-corrupted MRI images and automatic deep-learning scoring of those images. summary

algorithmic approaches to tackle **data imbalance** in minimum inhibitory concentration detection project

Current work @ Philips Research

The Department of Defense's Defense Innovation Unit and Philips are studying the ability of Garmin watches and Oura rings to collect data that can offer an early warning of COVID-19 infection. [Photo courtesy of the DOD Defense Innovation Unit]

Full press release

diseases early-warning prediction and threat detection

- respiratory diseases:

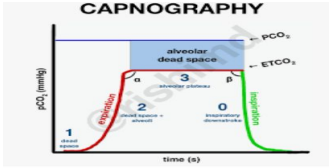
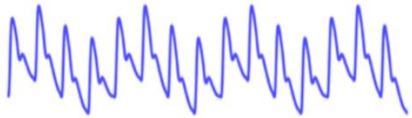
  chronic: asthma, COPD, ARDS;

  infectious: pneumonia, COVID

- Opioid usage

link

Different modalities that I have worked with

Modality	Sample waveform	Clinical usage	Wearable info
Capnography (Co2)		Clinical gold standard for respiratory rates, Rich features indicating various diseases	Portable Capnography product exits
Photoplethysmography (PPG)		measure Oxygen saturation	Popular wearables such as watches, rings Flexible wearables (clothing)
Electrocardiogram (ECG or EKG)		measure pulse rate	Patches
ECG impedance waveform		measure breath rate	Chest bands
Audio	 sound examples	Limited use (breath sound tests, heart sound tests)	Easily accessible thru phones, and other devices

Times-series and operational research

Hospital Operational improvement

Interpretable method on Recurrent patients identification summary

Interpretable framework to identify **top-X factors** associated with ED & in-patient recurrent visits.

Algorithms for **selecting Top-X factors**	AR (Association rules)	XGBoost + Shap values	**MSAR (Ours)**
Interpretability	Yes	Medium	**Yes**
Balance confidence support trade-off	No	No	**Yes**
Ability to select high-confidence, low-support factors	Limited	Limited	**Yes**
Consistency	High	medium	**High**
Ability to distinguish across factors	Limited	Limited	**Yes**

Times-series and operational research

predict unit level next day median Length of Stay using LSTM neural network [summary]

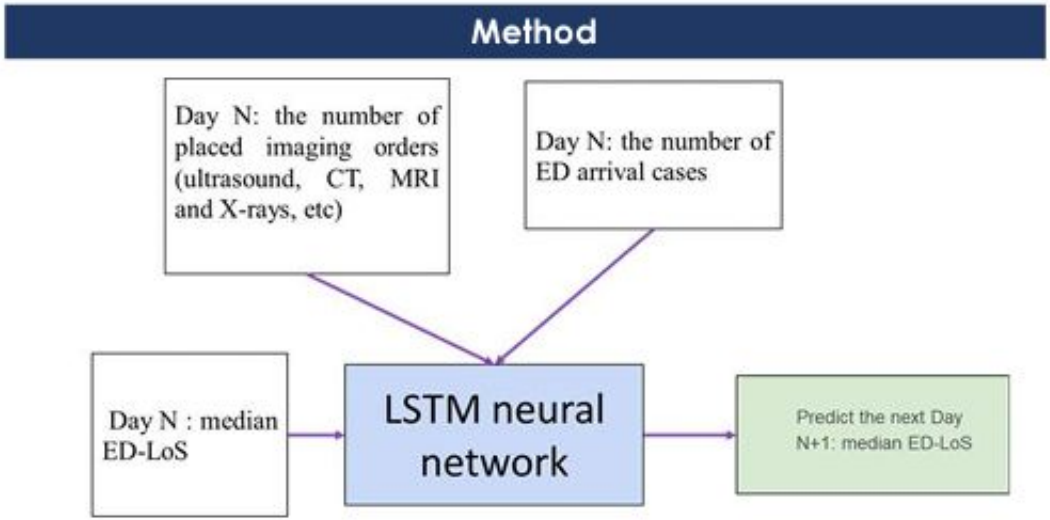


Figure 1. Diagram of the proposed method

Times-series and operational research

Improvements of 30-day readmission risk predictions [summary]

17% AUC improvement of the original LACE+ readmission risk score

the improved LACE+ algorithm:

Here is an illuatration of the improved LACE+ algorithm:

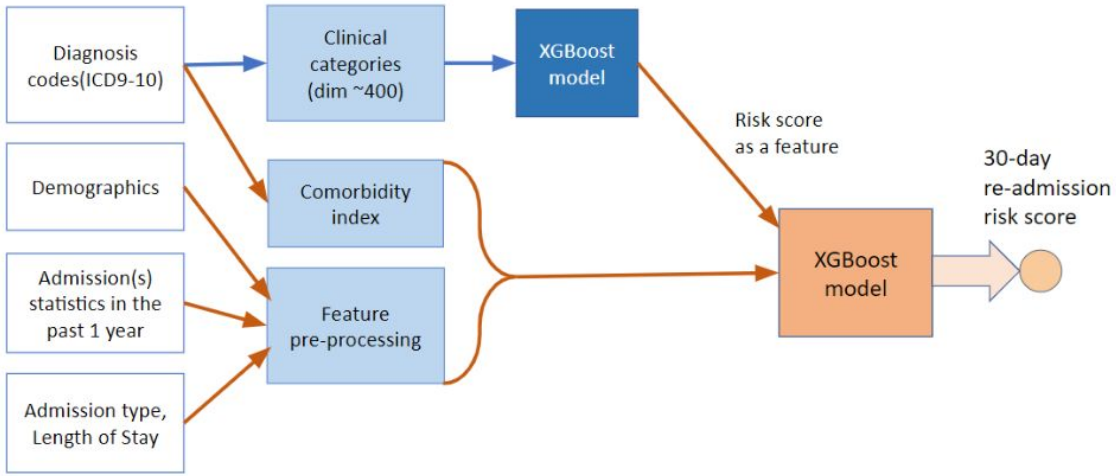
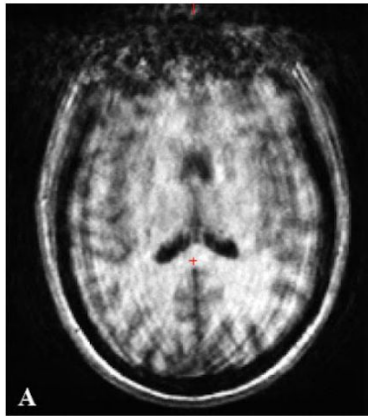


Image Processing and computer vision:
Deep learning scoring motion-corrupted MRI images

Step 1: Simulate and score volumetric MRI image motion using deep neural networks



picture from here

Step 2: Scoring using deep neural nets
Two approaches:: 3D and 2D multi-channel network

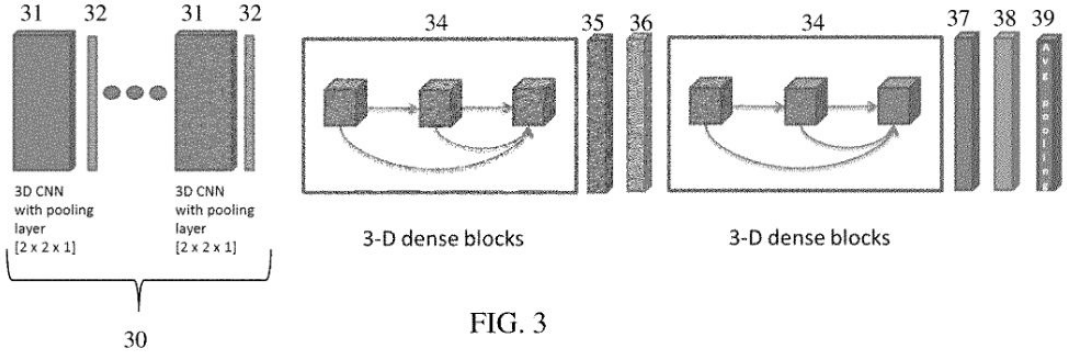


FIG. 3

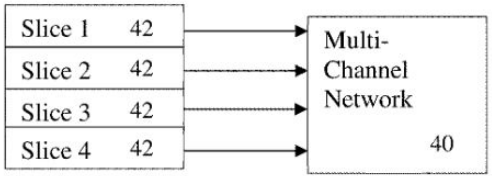


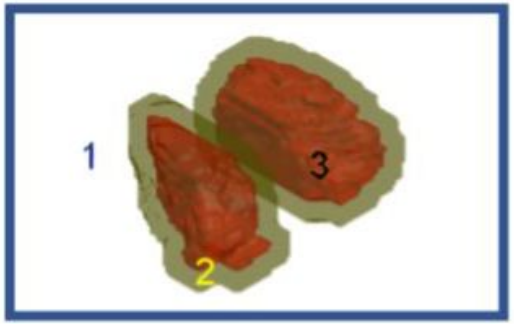
FIG. 4

summary of this work

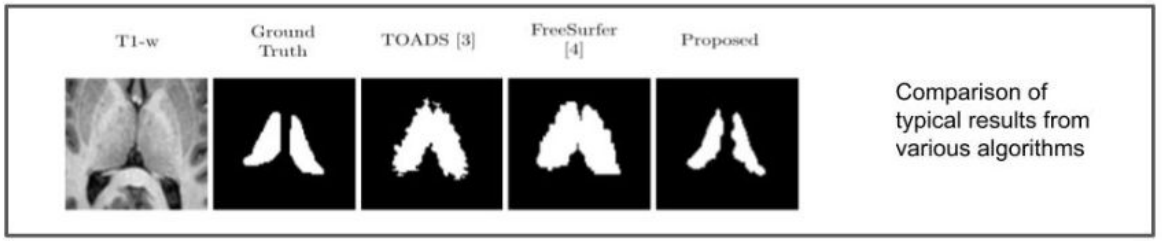
Medical image classification

Thalamus segmentation

Perspective view of an atlas thalamus



Sample 5000 voxels from region 1, 2,3 at fixed ratios



Comparison of typical results from various algorithms

summary of this work

Robust Classification methods with missing data

1. Structured missing data

Application area: detect facial images with masks without alignments
(automatic **face detection**)

[summary of this work]

Problem Statement

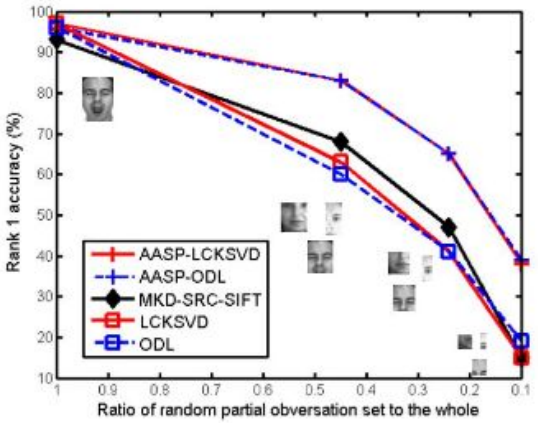
(a) Training: **holistic** data

(b) Testing: **partial** data w.o. alignment info

Example results on AR dataset

Comparisons: MKD-SRC (feature based [4]); SDL with the same initialization.

Metric: Rank 1 accuracy on 3 random partial patterns

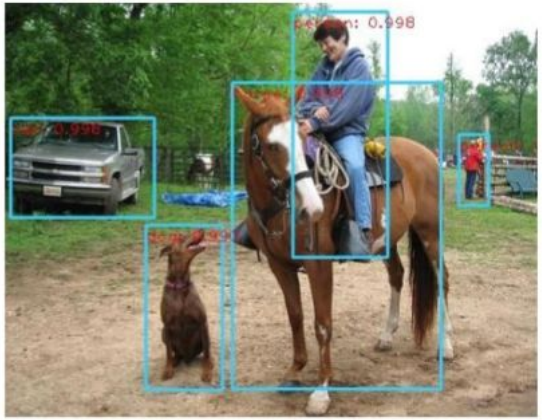


Robust Classification methods with missing data

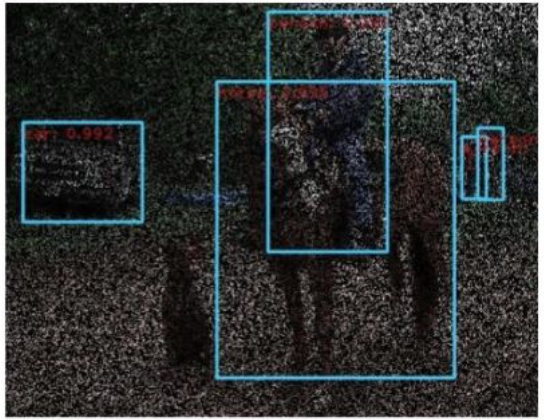
2. Extremely large missing data observation ratios on object detection and classification

summary of this work

Reconstruction-free (imputation-free) object detection on any observed patterns

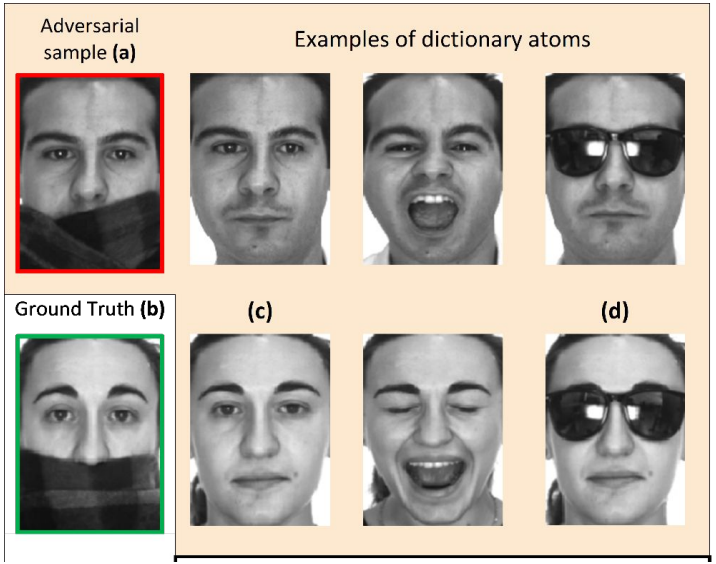


Detection on the original image

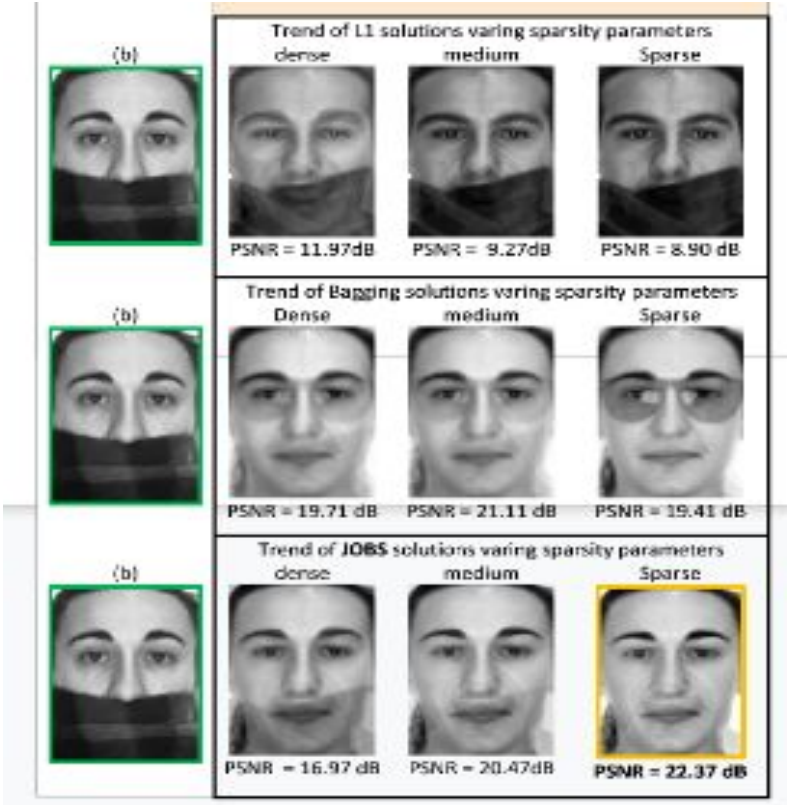


Detection on observation ratio: 25%

3. Robust collaborative bootstrapping method against the presence of adversarial example



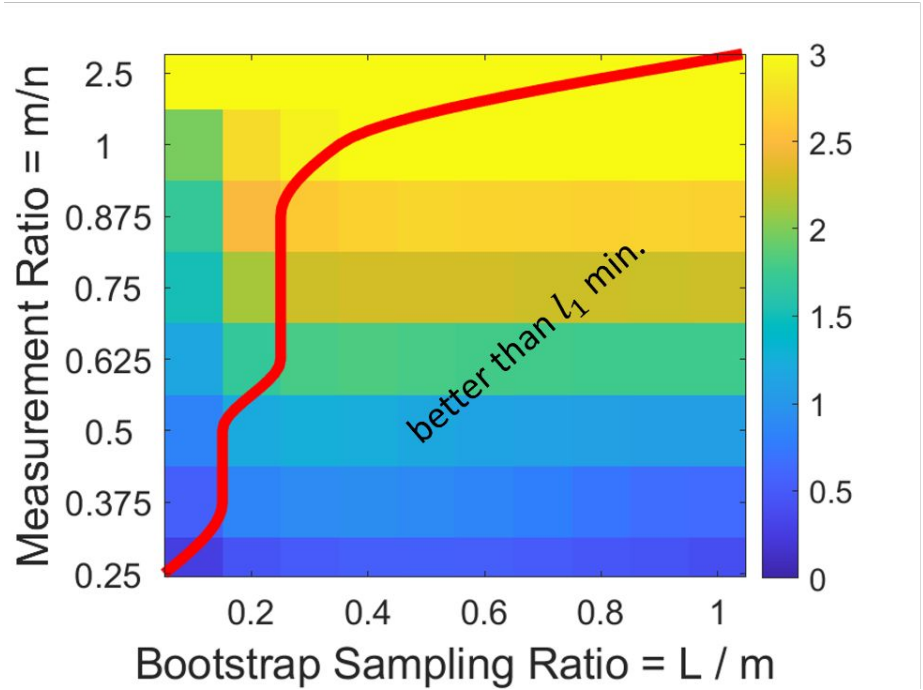
[details of the proposal]



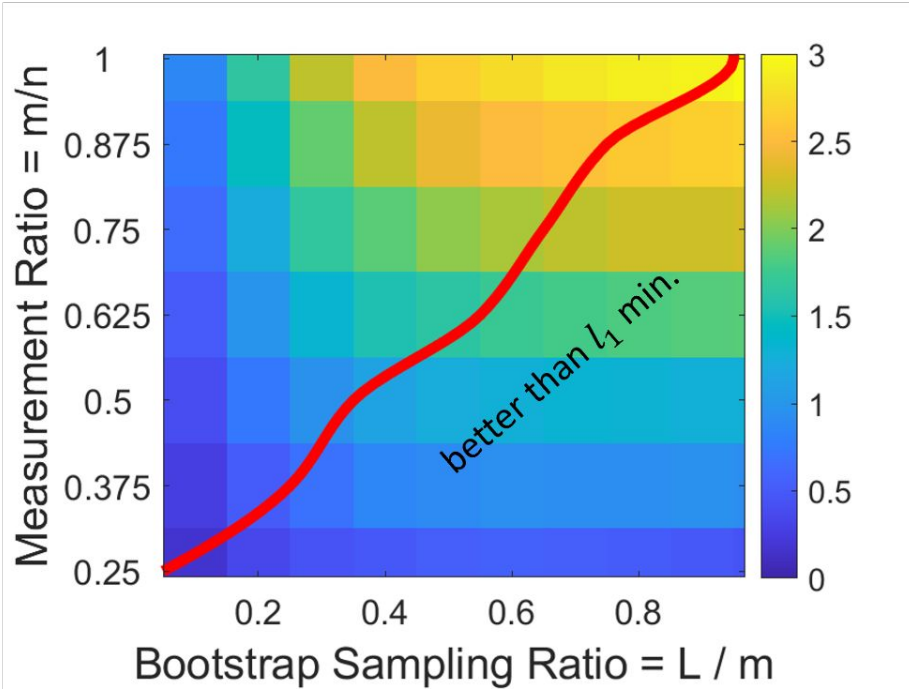
Proposed

Theoretical understanding sparsity optimization problem

JOBS

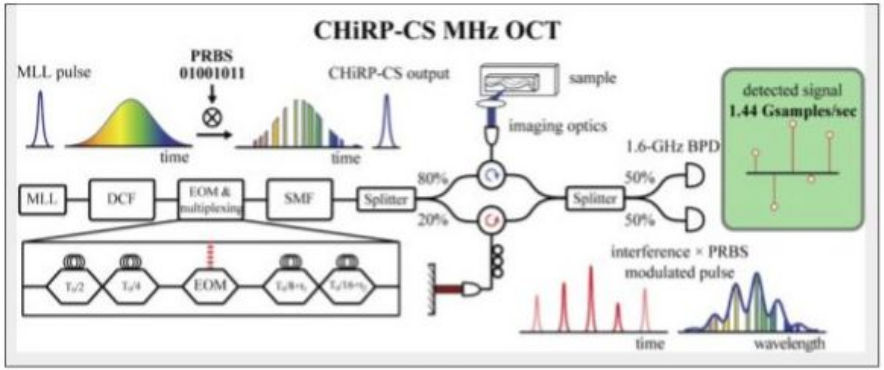


Bagging

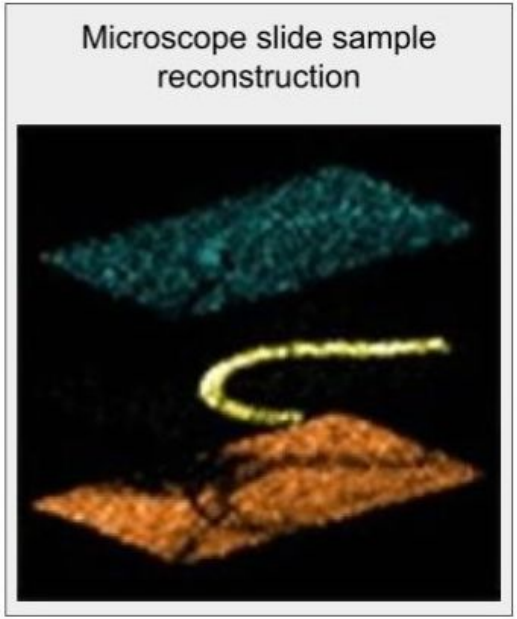


Heatmaps are signal to noise ratios

Image reconstruction from OCT system



Proposed algorithm: Fine-tuned weighted l1 minimization



https://opg.optica.org/oe/fulltext.cfm?uri=oe-27-25-36329

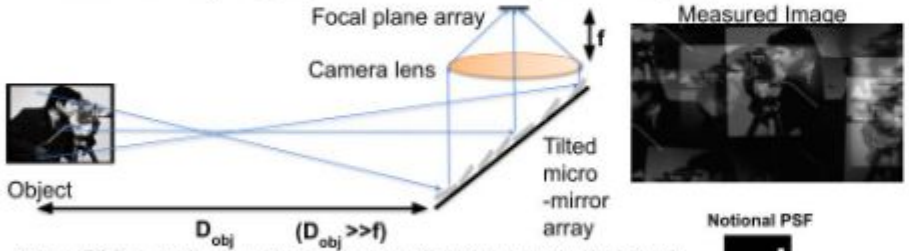
Image reconstruction from CS imaging system

System calibration and image reconstruction of compressed sensing imaging system

Hardware to create quasi-random Bernoulli sensing matrix

- Replacing conventional mirror with tilted-mirror array

Intensities of multiple object points are encoded together in a single pixel.



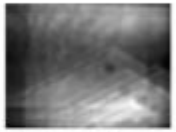
Note: PSF is similar for all object points (not independent/random)

Mathematically similar to Coded Aperture Imaging, with additional capability of having rotations in subimage replicates

1

Experimental Results – large noise

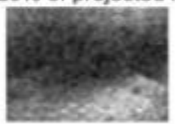
Original image



Projected image

Measurements
(20% of projected image)

Result of sparse calibration of transfer function



Sparse Recovery Result

2

https://ieeexplore.ieee.org/abstract/document/7905821
paper link

Highlights of my Ph.D work at Hopkins

- novel robust collaborative sparsity methods with applications in sparse regression, difficult image classification problems with large missing ratios, challenging structured missing, the presence of adversarial examples,

- theoretical understanding of collaborative vs independent approach (bagging)
  - determine optimal parameters for both
  - understand performance limits for both

- image classifications, regression
- Image reconstructions from hardware systems

Audio Signal Processing

Speaker sound removal

Audio denoising

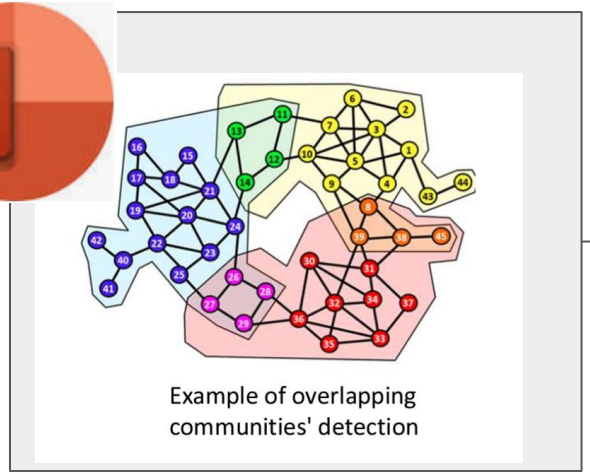
Physionet challenge on heart sound classification

Classification on lung sounds

Natural Language Processing/ text

Rule-based keywords matching from powerpoint slides

Keywords and phrase extraction from powerpoint slides



Key words and key phrases extractor

Example outputs

keywords	confidence
networks	0.44
communities	0.41
clustering	0.40
graphs	0.40
adjacency	0.37

Key phrases	confidence
graph community detection problem	0.65
example diabetes heart disease	0.35
activation use GNN	0.26

Natural Language Processing/ text

ChatCPT assists programing demo [link]