Classifying Polarized Satellite Images of Iceberg and Ship

A Combination of Transfer Learning with Traditional Approaches

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MCM (Data Analytics) Module - CA640

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Outline

- Introduction
- Previous Work
- Purpose
- Data Collected
- Discussion
- Implications
- Conclusion
- Appendix

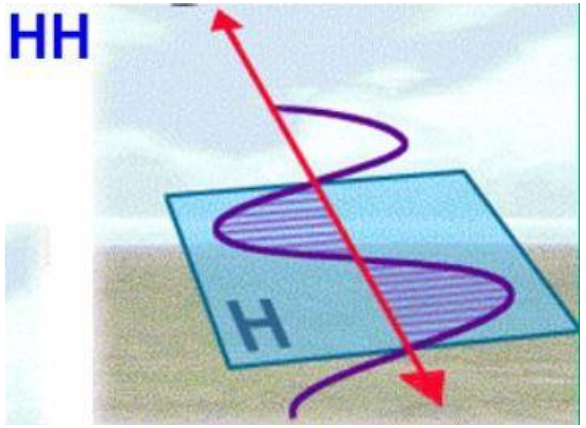
Introduction

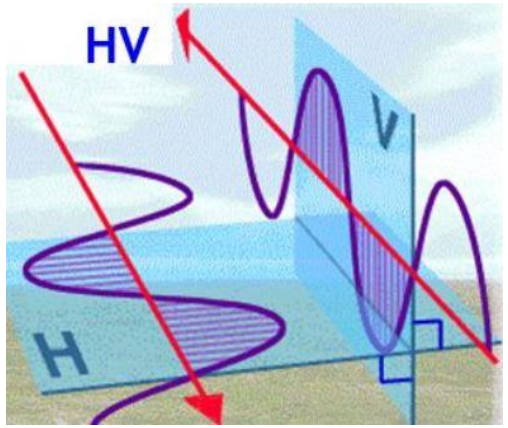
- Drifting icebergs
- Titanic and Hans Hedtoft disaster
- International Ice Patrol and Greenland Ice Service
- Synthetic Aperture Radar(SAR)
- Integration of data analytics
- Reduce the risk, cost and carbon footprint

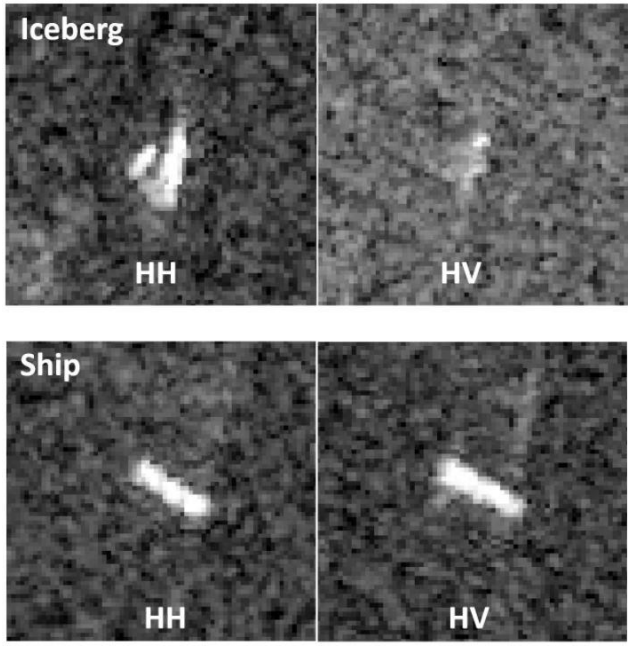
https://commons.wikimedia.org/wiki/File:Ice_patrol_DVIDS1113964.jpg

Data

- C-band dual-polarization images
- Two channels:
  - HH (transmit and receive horizontally)
  - HV (transmit horizontally and receive vertically)
- Can See through cloud, fog, rain and even darkness.

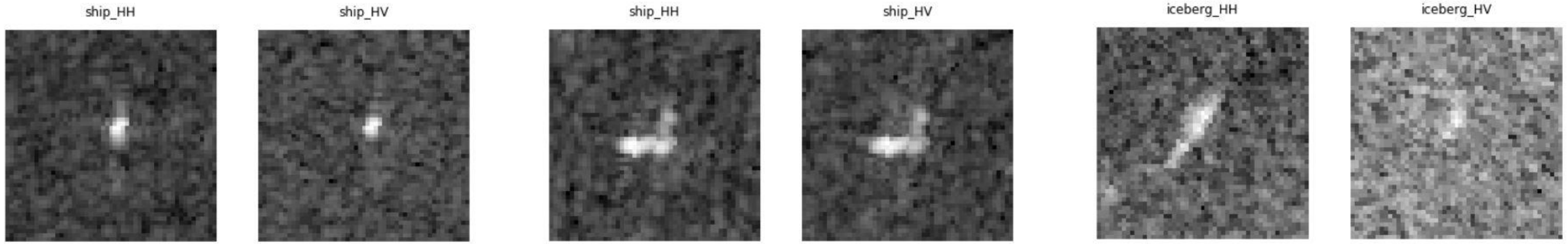


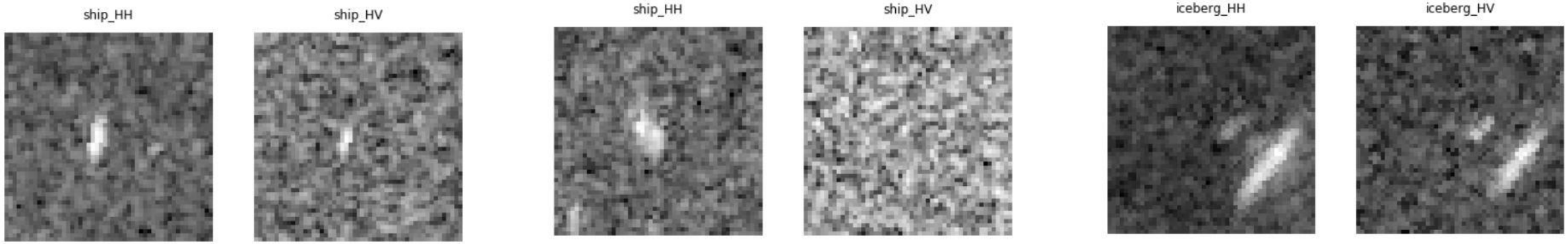




https://www.kaggle.com/c/statoil-iceberg-classifier-challenge#Background

The Challenge!





Previous work

- Data
  - ENVISAT
  - RADARSAT-2
  - TerraSAR-X
  - Urban Atlas
- Methods
  - Traditional
  - ANN, CNN
- Evaluation
  - Accuracy, F1

Purpose

Hypothesis

- Transfer Learning + Traditional Features Improves performance

Object Detection - noisy images

Applications

- Atmospheric observation
- Earth remote sensing
- Medical diagnosis
- Surveillance and reconnaissance
- Image de-hazing and 3D reconstruction

Data Collected

Statoil/C-CORE on Kaggle

1604 Samples

- Iceberg – 753
- Ship - 851
- json

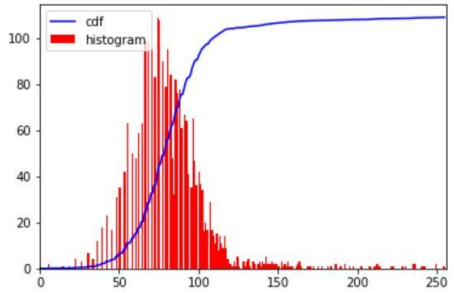
Each Sample

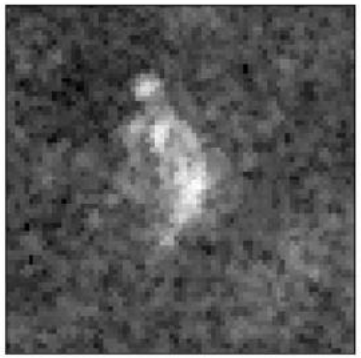
- HH & HV
- 75 X 75 pixels
- decibels (-45, 34)
- hand label

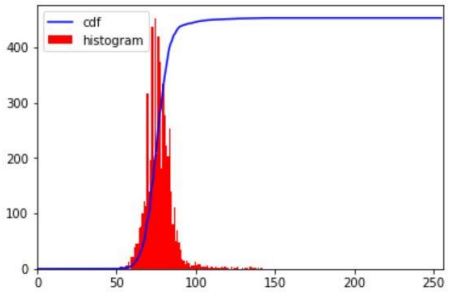
Proposed Methods

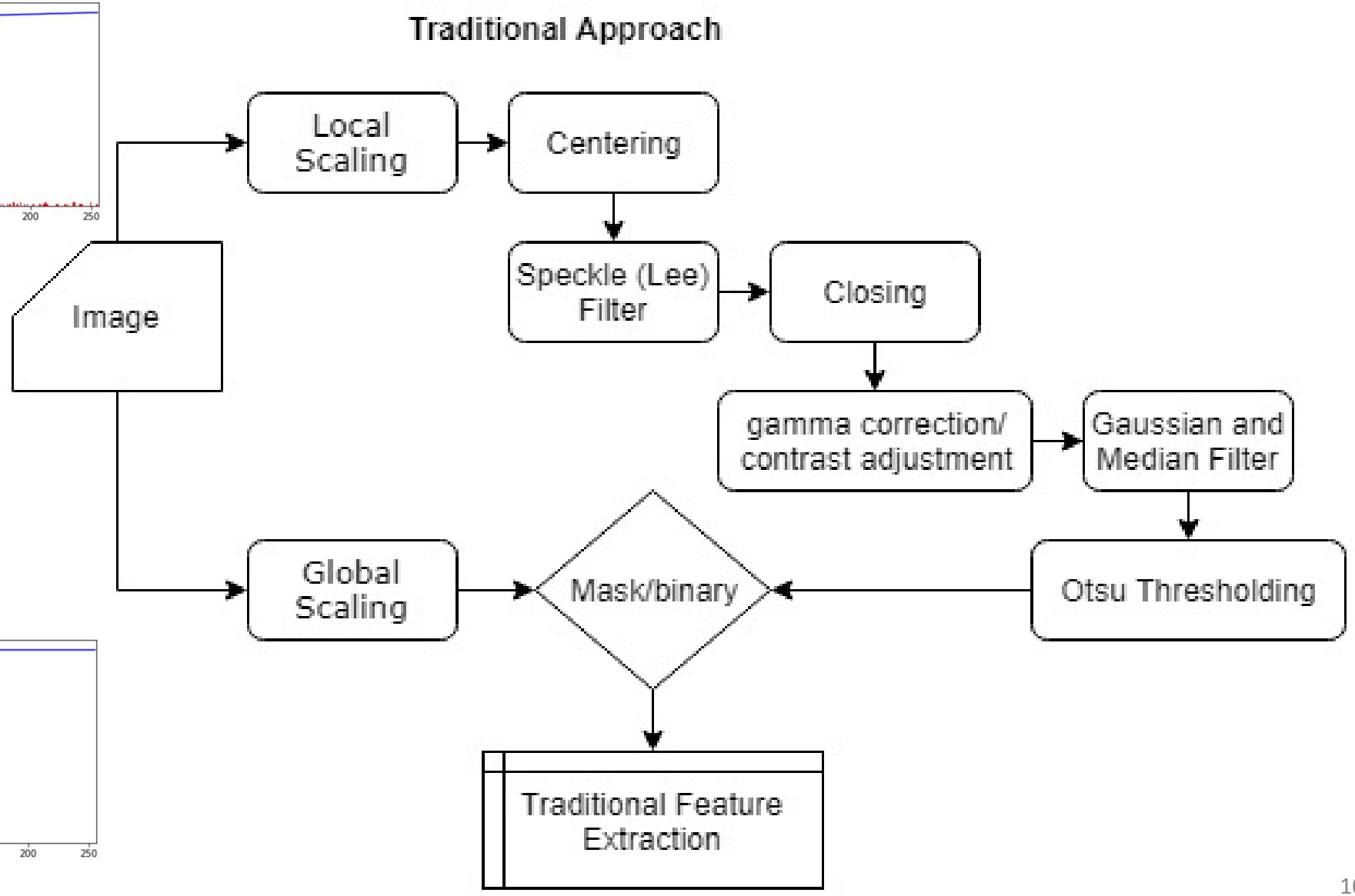
- Object Detection
  - Center
  - Enhance
  - Thresholding
- Traditional Features
  - Shape
  - Statistical
  - Texture
- Transfer Learning Features + PCA
  - Resnet
  - VGG16
  - VGG19
  - InceptionV3
- Classifier
  - Traditional
  - Transfer Learning
  - Traditional + Transfer Learning

Object Detection - Overview



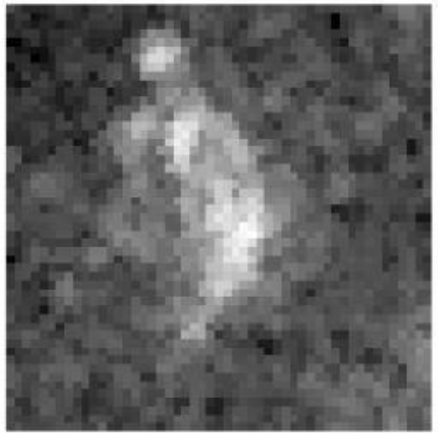




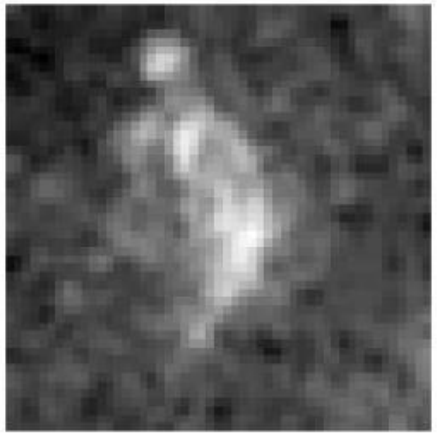


Object Detection - Sample

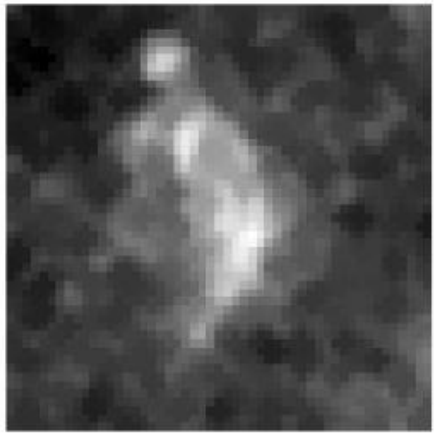
Original Image



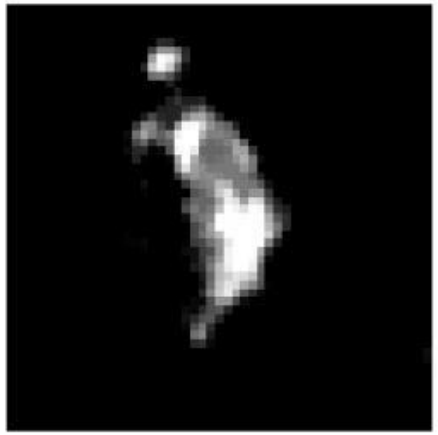
Lee Filtered



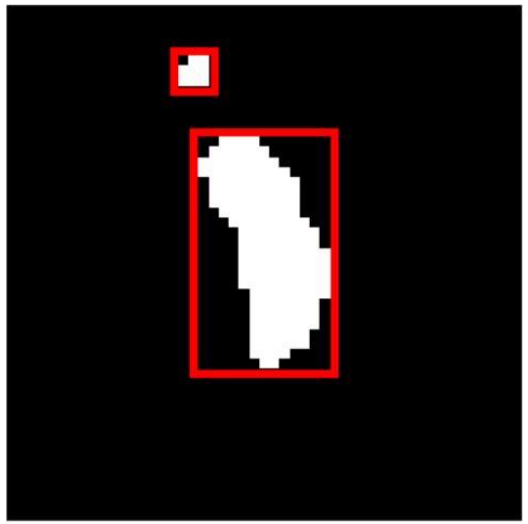
Closing

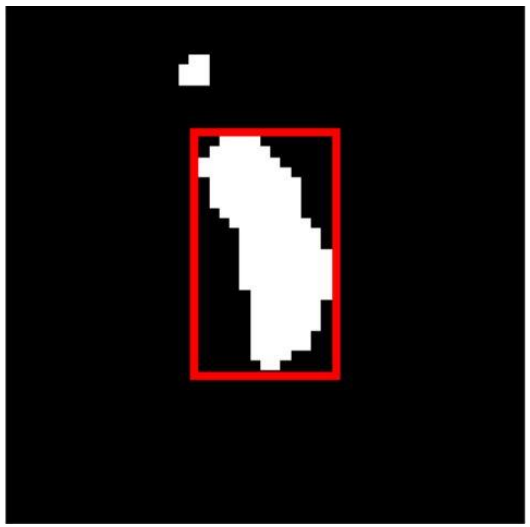


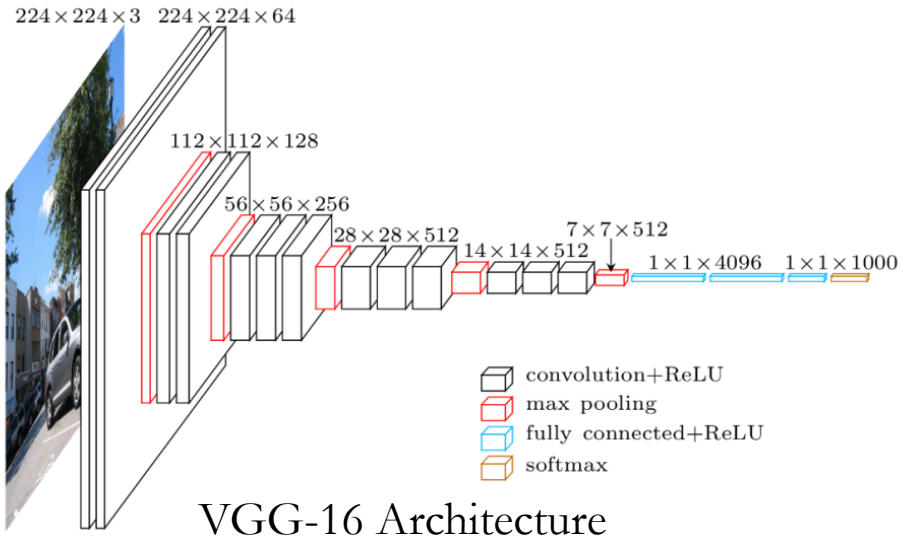
Contrast Ajusted



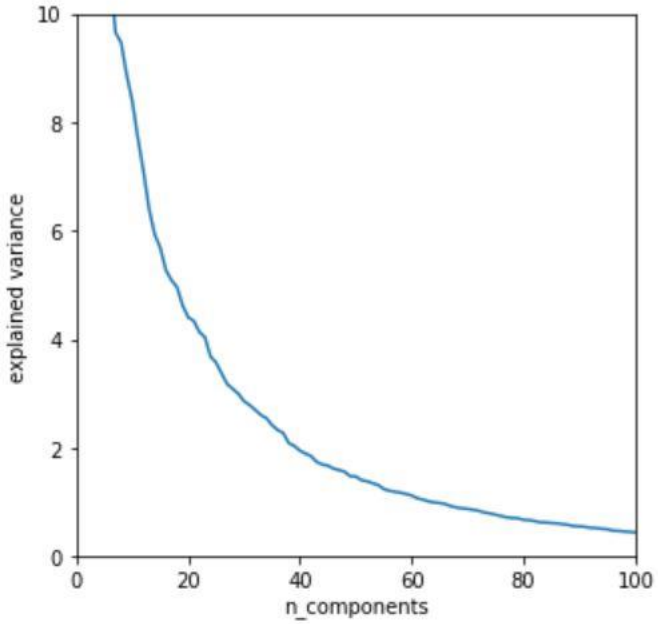
Otsu Threshold







VGG-16 Architecture



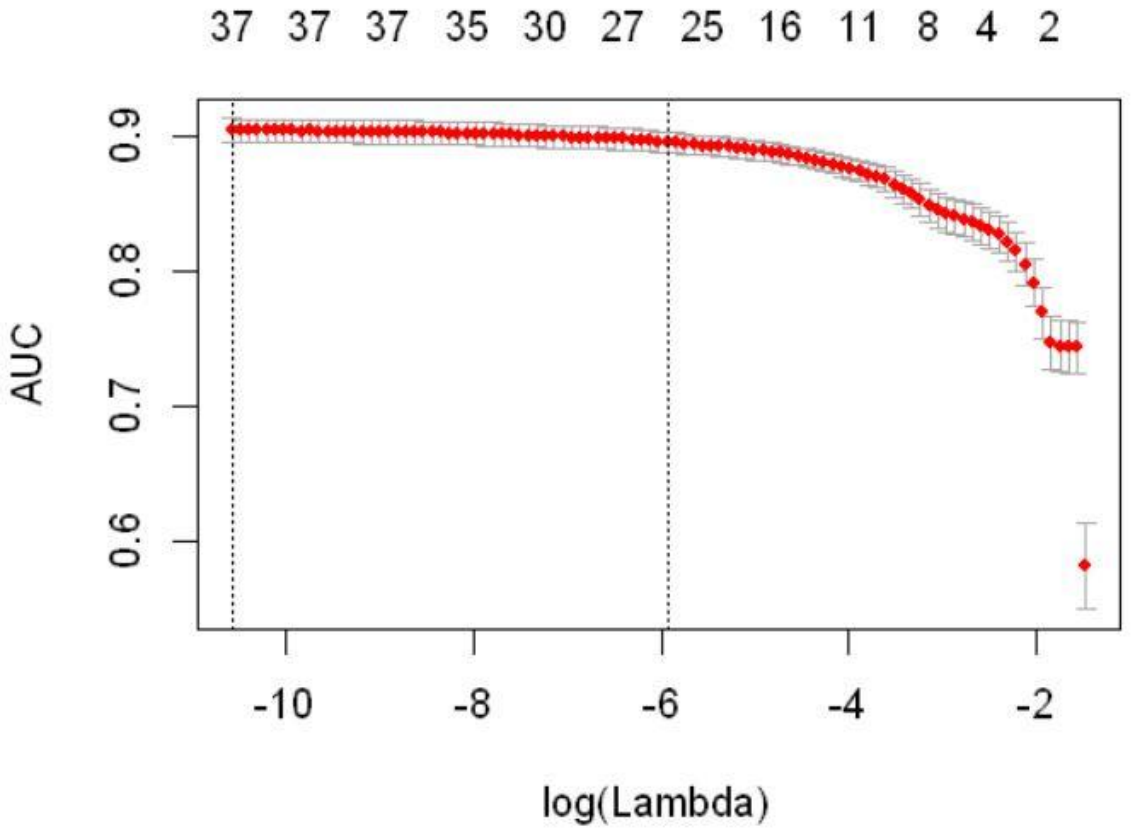
Transfer Leaning – PCA

- Architectures
  - Resnet
  - VGG16
  - VGG19
  - InceptionV3
- Embeddings > 25,000
- 50 comp > 97% variance explained

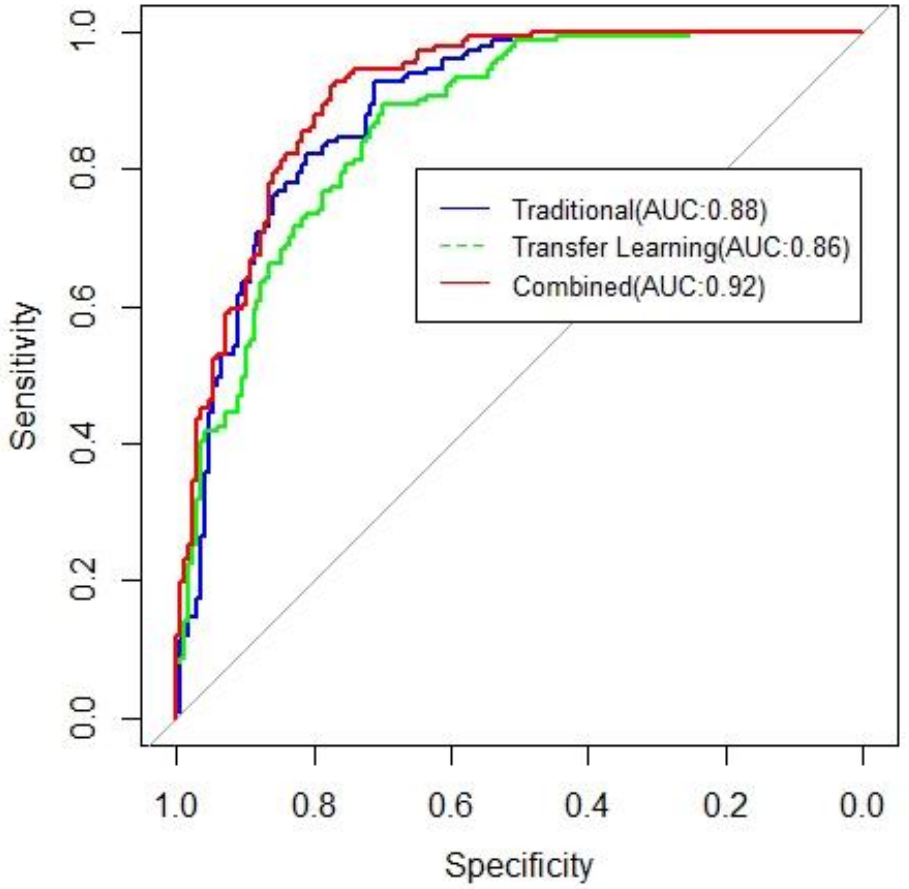
https://www.jeremyjordan.me/content/images/2018/04/vgg16.png

Classifier

- Logistic Regression
  - Regularization(Lasso)
- Train - 80%
  - 10-fold validation
- Test - 20%
- Evaluation - AUC



Features	Count	Train AUC	Test AUC
Traditional	38	0.9	0.88
Resnet	50	0.84	0.76
VGG16	50	0.84	0.79
VGG19	50	0.77	0.72
InceptionNet	50	0.88	0.86
Traditional + Resnet	88	0.92	0.89
Traditional + VGG16	88	0.92	0.89
Traditional + VGG19	88	0.9	0.89
Traditional + InceptionNet	88	0.94	0.92



Results

Discussion

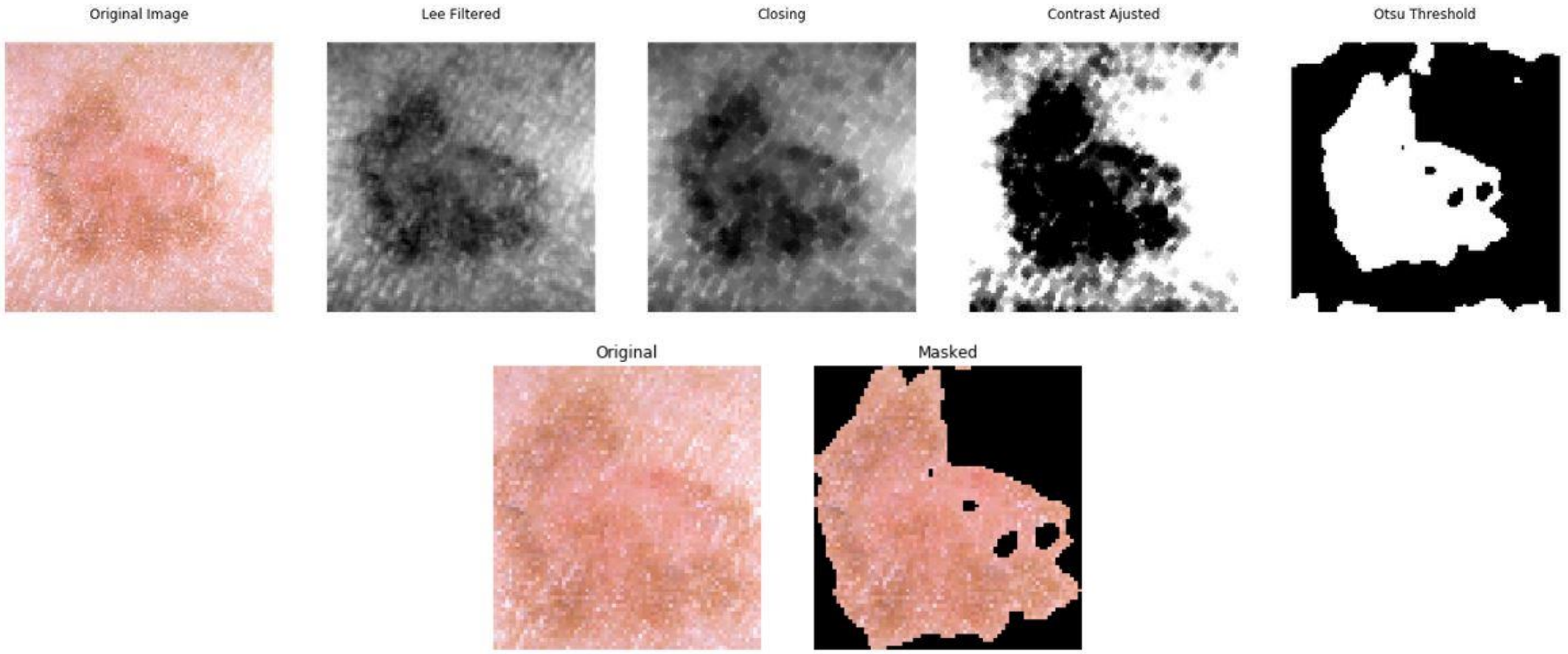
- Generalized Object Detection – Noisy Image
- InceptionV3 - better feature representation
- Feature not problem-independent
- Logistic regression with L1 regularization
  - Handles Multicollinearity
  - Feature Selection

Limitations

- Traditional Features – Specific to domain
- Identify Right Features
- Transfer Learning
  - Assumption
  - More data to fine-tune network
  - Trial/Error - layers

Implications

- Object Detection for Medical Imaging



https://www.amazon.com/Atlas-Colonoscopy-Examination-Techniques-Diagnosis-ebook/dp/B005WSQ3PG

Conclusion

Reliable Object Detection

Traditional methods

Transfer Learning (InceptionV3)

Combined - Improve Predictability (AUC – 4%)

Safe navigation & serve maritime security

Questions?

Thank You