Title Slide

Bridging the Gap: Leveraging Machine Learning for Improved Data Interpretation and Decision Making Under Uncertainty

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Date of Defense

Introduction

- Machine learning has shown tremendous potential in tackling complex real-world problems. However, challenges persist due to uncertainty and noise in data.
- This dissertation aims to develop robust machine learning techniques to improve data interpretation and decision-making under uncertainty.
- The key research objectives are:
  - Enhance label aggregation for crowdsourcing using uncertainty measures.
  - Leverage label taxonomy to boost classification accuracy in medical imaging.
  - Develop accurate and efficient networks for medical image analysis.
  - Apply deep learning for driver distraction and biological image classification.

Methodology

- Proposed methods utilize techniques including:
  - Weighted label aggregation with uncertainty scoring
  - Hierarchical multi-label classification
  - Multi-planar cascaded convolutional neural networks
  - Convolutional neural random forests
- These methods selected for their ability to:
  - Handle noise and uncertainty in data
  - Exploit relationships between classes/labels
  - Enable accuracy, efficiency and adaptability

Key Findings
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Crowdsourcing:

- Crowd-Certain improved accuracy by 14% vs benchmarks
- Robust to varying crowd sizes and datasets

Medical Imaging:

- Hierarchical classification boosted AUC by 0.2 vs baseline
- Cascaded CNNs improved Dice by 0.18 vs state-of-the-art

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Conclusions

- Developed innovative machine learning techniques that:
  - Enhance reliability of crowdsourced/ensemble learning
  - Leverage label relationships to improve medical diagnosis
  - Demonstrate clinical utility for understanding neurological diseases
  - Enable accurate driver monitoring and microscopy image analysis
- Limitations include dataset constraints and model interpretability
- Future work involves expanding evaluations and model optimizations

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