



Enhancing Trust in AI-Powered Situational Awareness Systems for US Army Ground Vehicles: A Holistic Approach to Explainability and Interpretability

High-Trust AI Solutions for Defense and Federal Partners



Strategic Ai Services (SAS)

“We believe the adoption of Artificial Intelligence (AI) and Machine Learning (ML) can be agile, cost-effective, and readily deployable.”

Expertise

- Artificial Intelligence (AI) and Machine Learning (ML) Algorithms:
 - Object and Threat Detection
 - Clutter Discrimination
 - Multi-Source Data Fusion
 - Enhanced Decision Making
- DoD Engineering and Integration
- Concept and Prototype Development
- ACAT 1 Program Management
- DoD Cybersecurity Compliance

Performance

- **AFWERX Phase II SBIR** – AI-enabled Object Recognition and Threat Detection
- **Ground Vehicle Systems Center (GVSC)** – Common Autonomy and Robotic Control
 - SW Development and Testing of Warfighter Machine Interface (WMI)
 - PM UAS integration of WMI common controller into Short Range Reconnaissance (SRR)
 - HW and SW Object Detection System in Ground Vehicle Simulator
- **PM UAS** – Autonomous Science and Technology Transition Planning

Artificial Intelligence (AI) as a Force Multiplier

- If a human can **see** it, we can train AI to **detect** it
 - Multi-modal
 - High-trust
 - Explainable
 - Deployable

Object of Interest Identification for U.S. Army

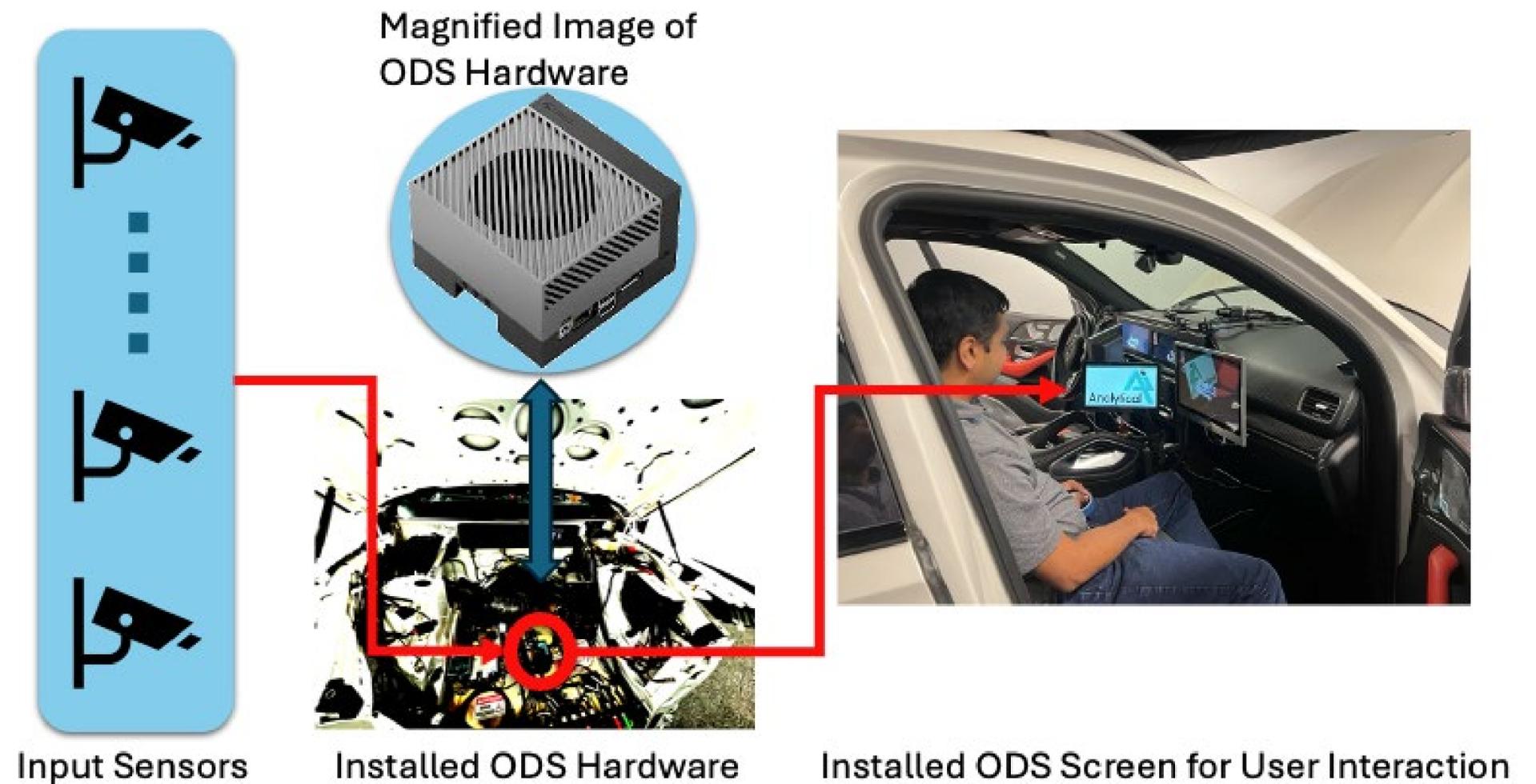


- Object detection system deployed in GVSC funded simulator at UA
 - Reduction in cognitive load
 - Event triage



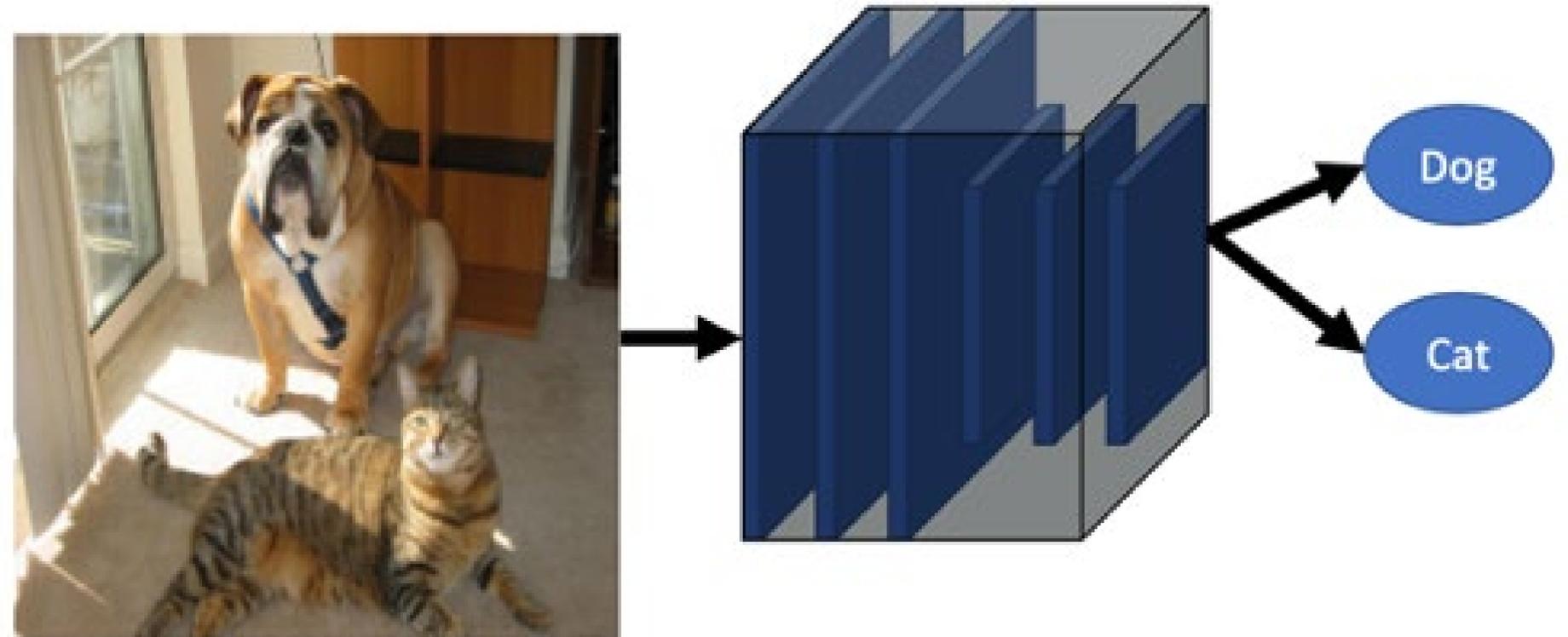
Deployed Object Identification System (ODS)

- Near real-time AI inferencing in a field deployable platform
- System runs with 60 Watts of power
- A single system can multiplex sensor inputs for at least 6 cameras/other input devices
- Does not “phone home”



Deep Learning as a Black Box

- Machine learning algorithms are often treated as black boxes.
- This is partially due to their complexity, and partially due to the difficulty with certain architectures to view intermediate results.



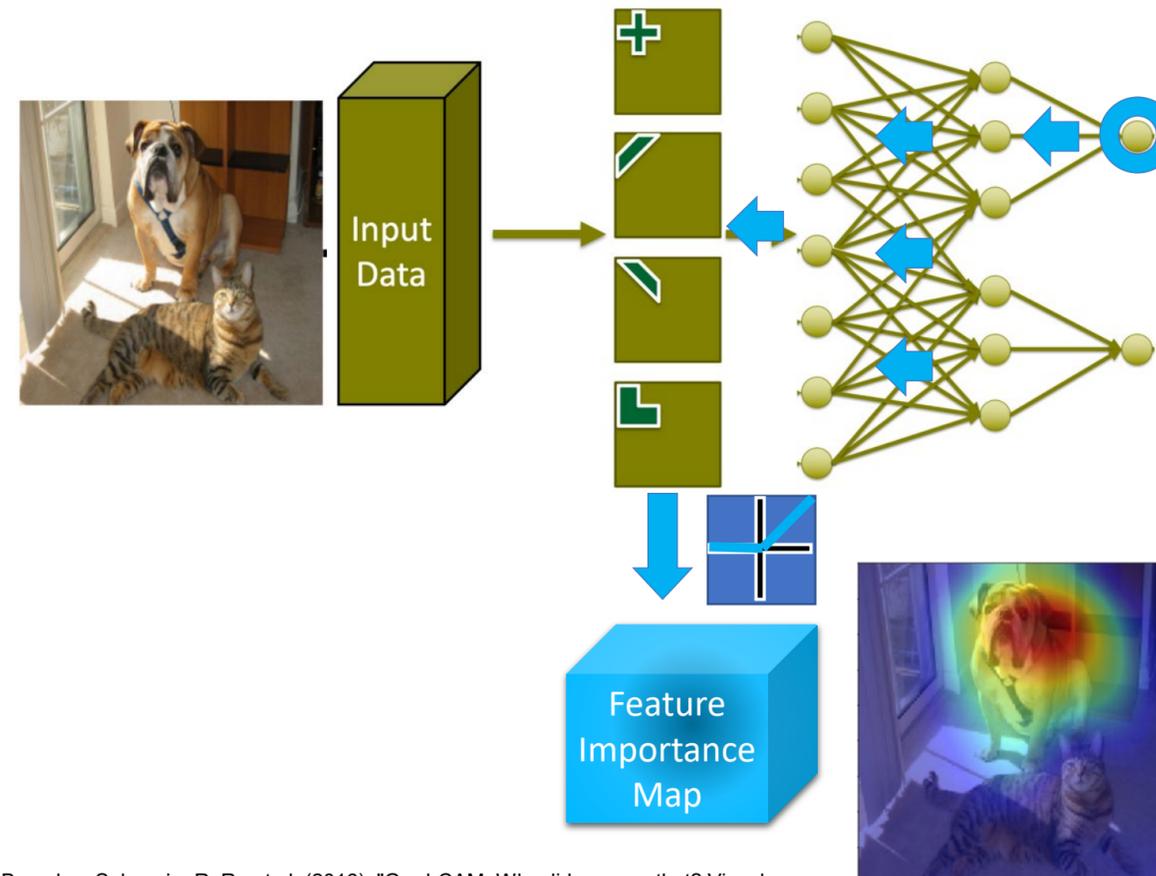


The problem with “black boxes”

- Machine Learning: The High-Interest Credit Card of Technical Debt
- “[A] study of 30 internal medicine residents showed ... a decrease in diagnostic accuracy (from 57% to 48%) when electrocardiograms were annotated with inaccurate computer- aided diagnoses.”

Gradient Class Activation Mapping

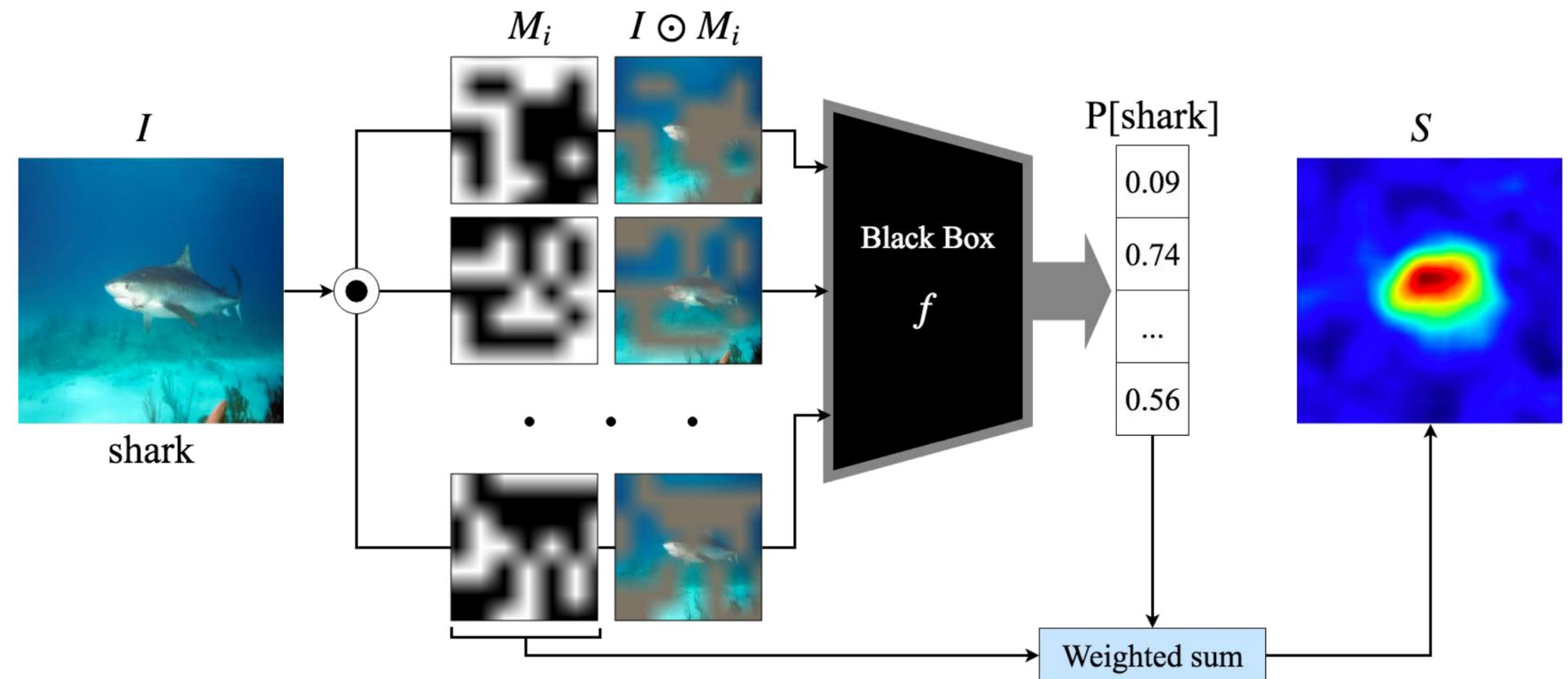
- Feature weights and activations combine to generate a feature map
- Requires access to inputs, outputs, AND model weights



Based on Selvaraju, R. R., et al. (2016). "Grad-CAM: Why did you say that? Visual Explanations from Deep Networks via Gradient-based Localization."

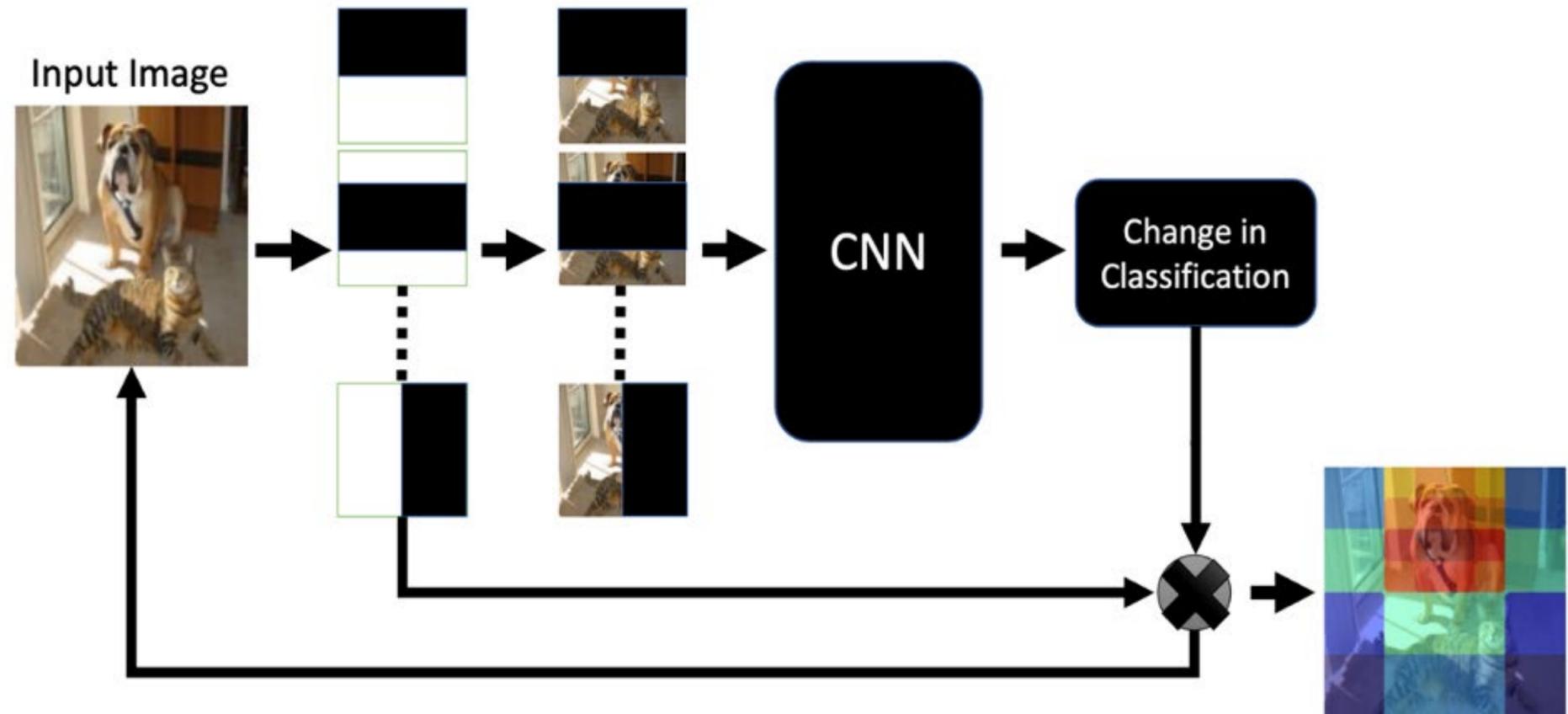
Occlusion Sensitivity: Explainability of Visual AI

- Reduction in prediction confidence due to occluded regions provide feature importance
- Only requires access to inputs and outputs
- But it's slow...

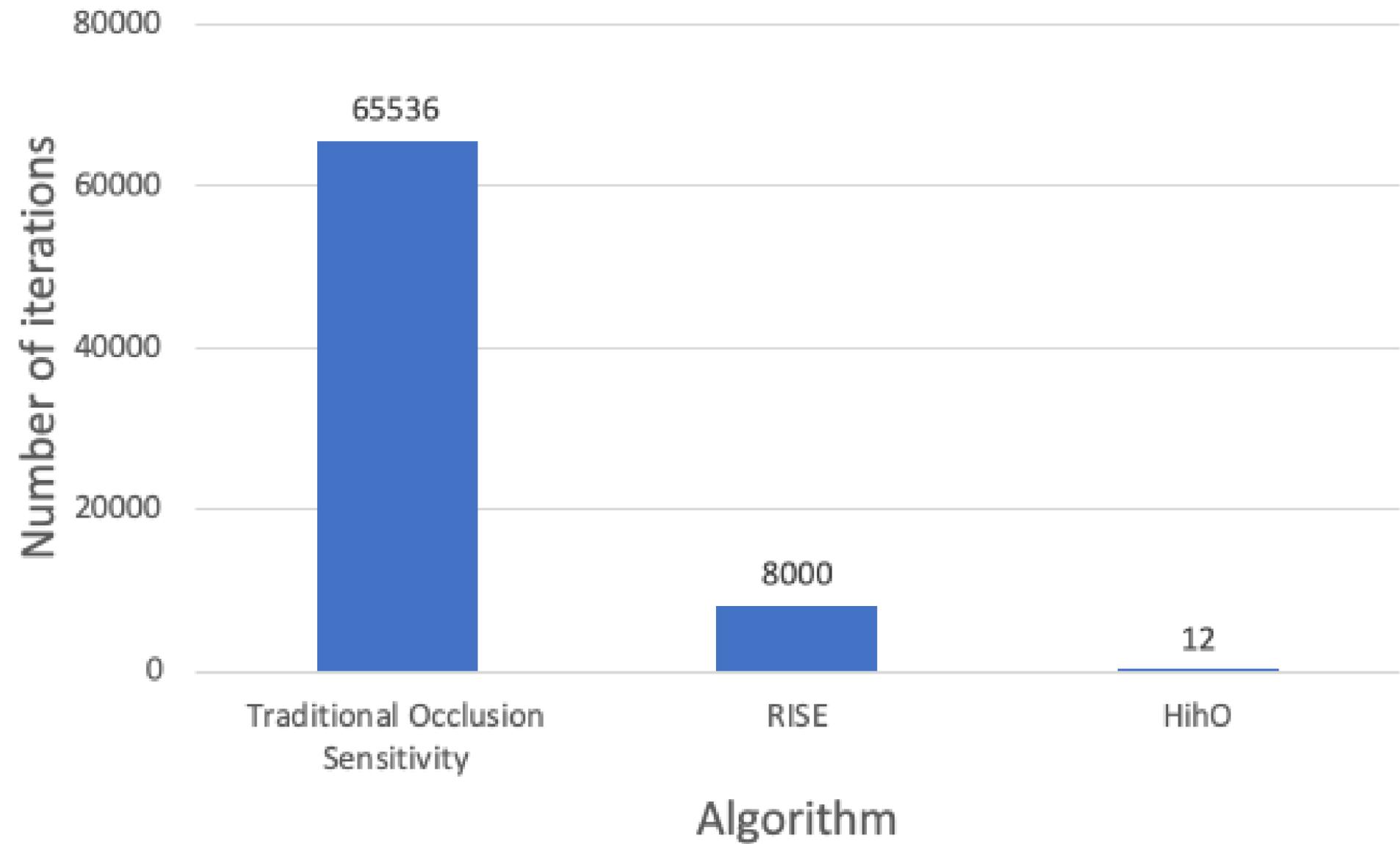


Hierarchical Occlusion (HihO): Fast Explainability of Visual AI

- Reduction in prediction confidence due to occluded regions provide feature importance
- Only requires access to inputs and outputs
- Hierarchical methodology provides similar results much faster



Visualization Efficiency (in iterations)



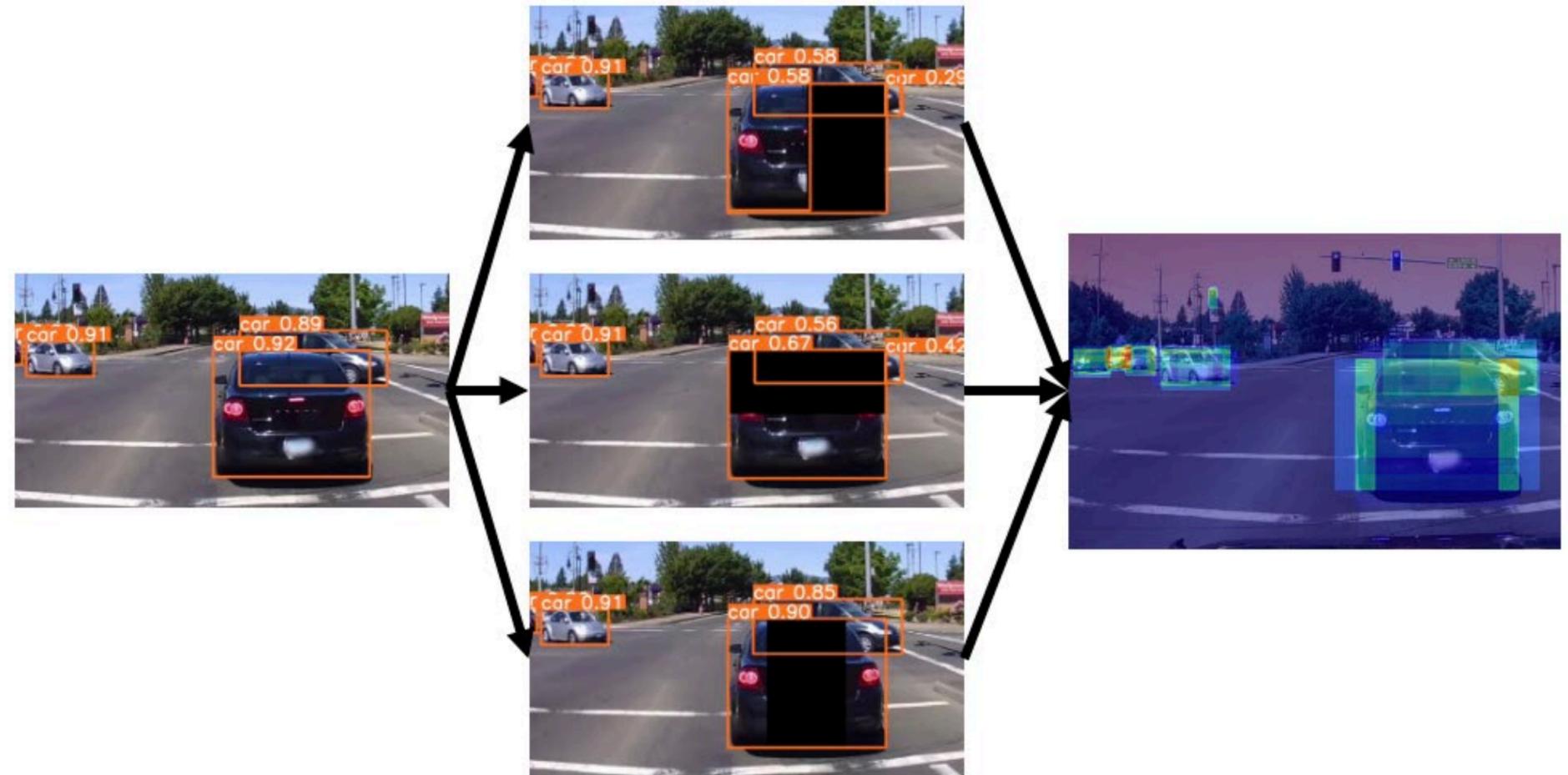
Occlusion
Algorithm
Complexity
(an example)

Region proposal networks

- Explainability built in, kind of...
- Important features within sub-regions not specified



Hierarchical Occlusion (HihO) for Sub Regions: Fast Explainability of Visual AI



Application of HihO methodology to sub-regions provides instance specific explainability

Hierarchical Occlusion (HihO) for Sub Regions: Fast Explainability of Visual AI

Application of HihO methodology to sub-regions provides instance specific explainability



Conclusions



- Sub-region explainability using truly black-box explainability can provide insight for systems, subsystems, and systems of systems

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