

Robust Neural Networks

Part 5: Conclusions and Future Directions

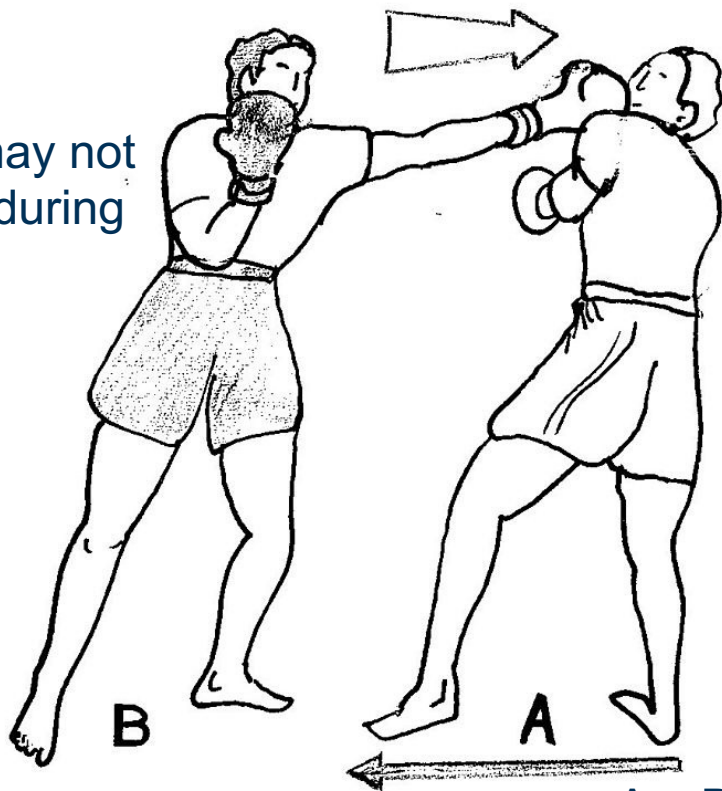


Mememes to Wrap it Up

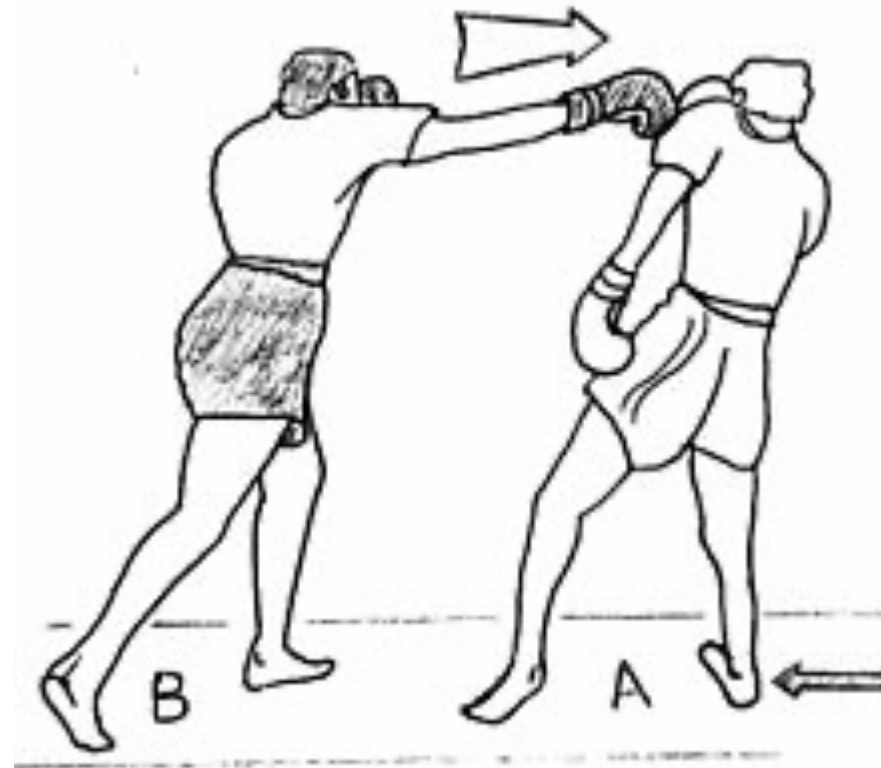
Overcoming Challenges at Training

Novel data packs a 1-2 punch!

Novel data may not be available during training



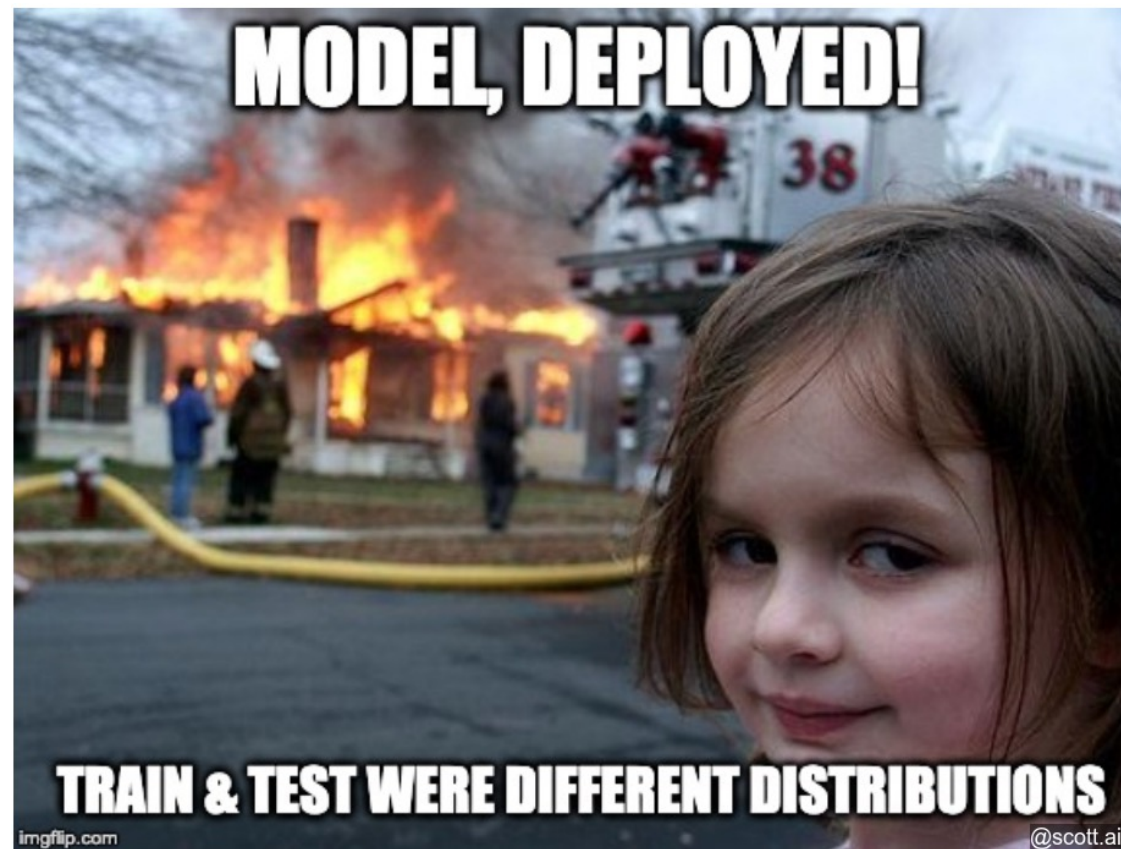
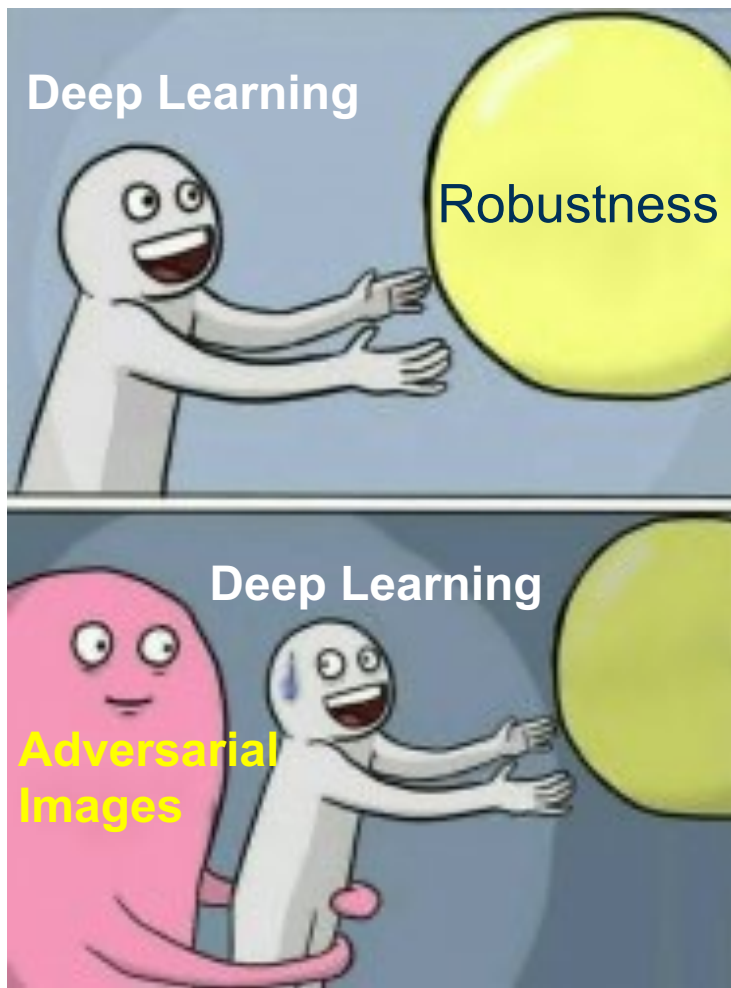
A = Deep Neural Networks
B = Novel data



Even if available, novel data does not easily fit into either the earlier or later stages of training

Mememes to Wrap it Up

Robustness at Inference

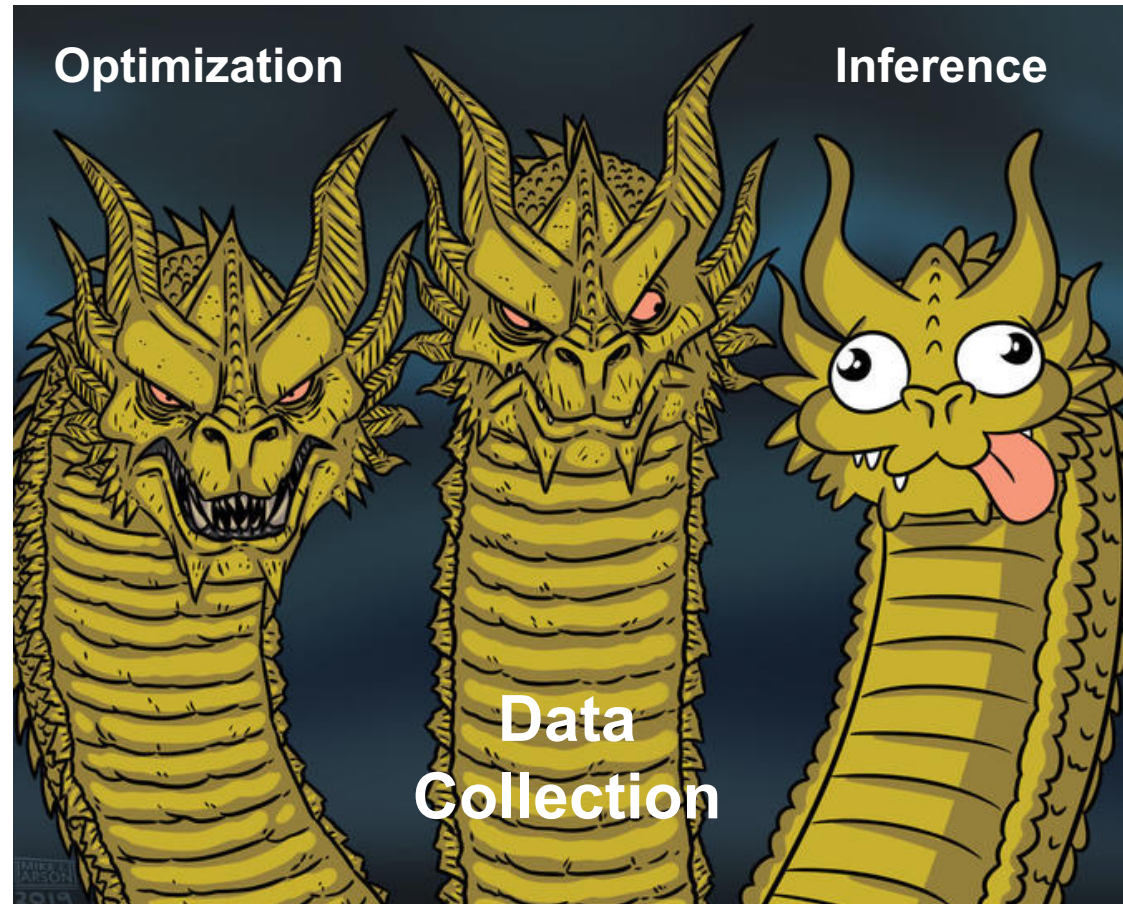


Cannot depend on training to construct robust models

Mememes to Wrap it Up

Robustness Research in the Inferential Stage of Neural Networks

Existing research on robustness focuses on data collection and optimization

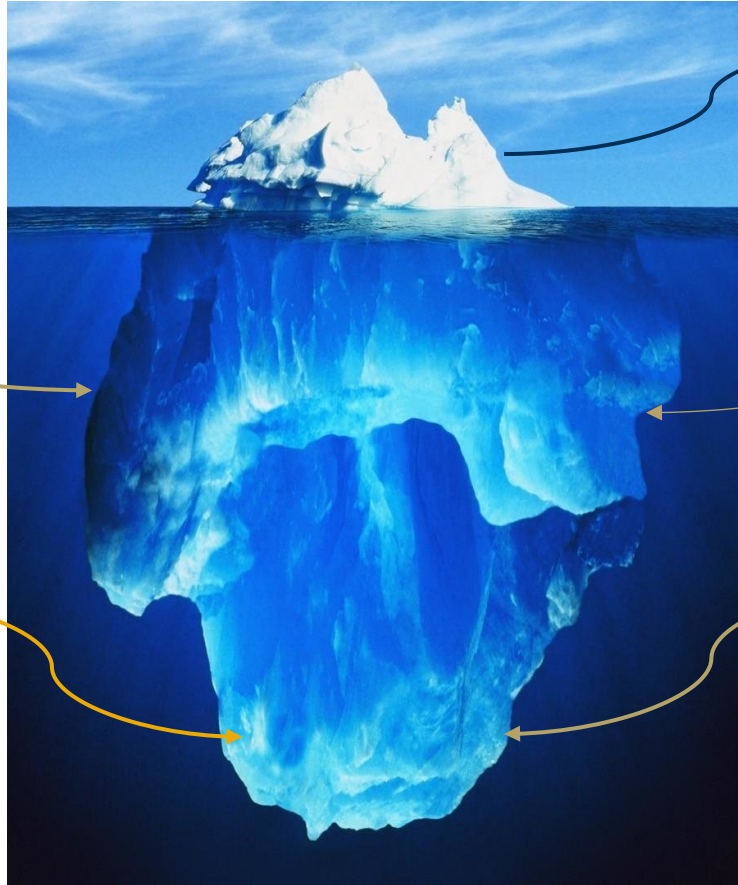
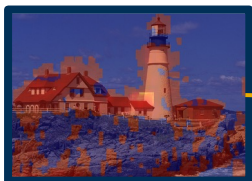
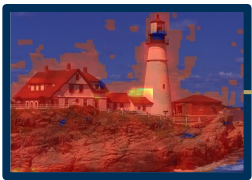


Mememes to Wrap it Up

Implicit Knowledge in Neural Networks

Trained Neural Networks have a wealth of implicit stored knowledge, waiting to be extracted at inference

Why P, rather than Q?



Traditional Why P?

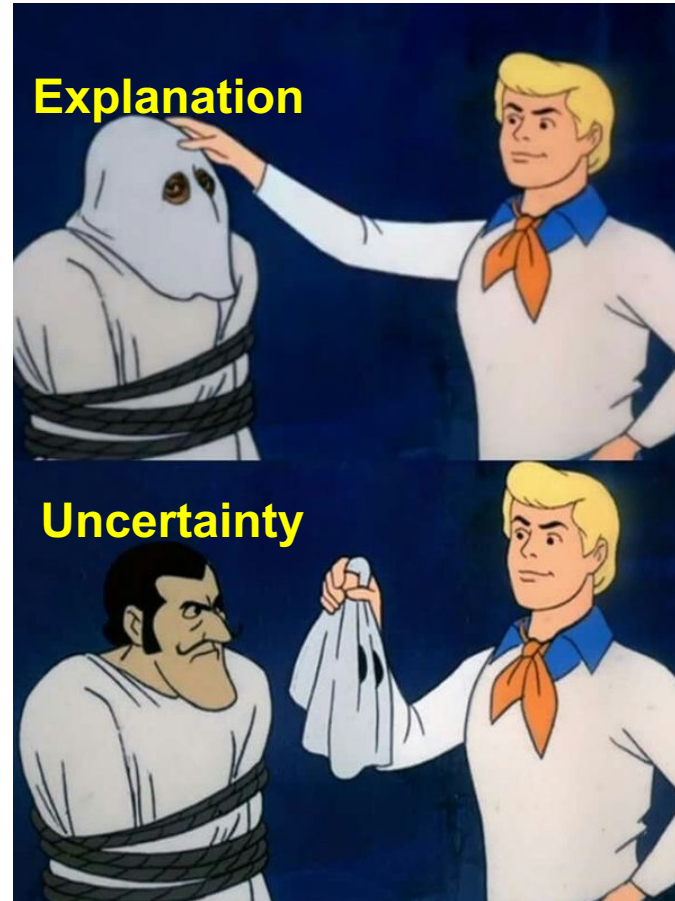


What if?

Mememes to Wrap it Up

Explainability Research is Just Uncertainty Research

Explanatory Evaluation reduces Uncertainty



Key Takeaways

Role of Gradients

- **Robustness** under distributional shift in domains, environments, and adversaries are **challenges** for neural networks
 - **Gradients at Inference** provide a **holistic solution** to the above challenges
- **Gradients** can help **traverse** through a trained and unknown **manifold**
 - They approximate **Fisher Information** on the projection
 - They can be **manipulated** by providing **contrast** classes
 - They can be used to construct **localized contrastive** manifolds
 - They provide **implicit knowledge** about **all classes**, when only **one data** point is available at inference
- Gradients are useful in a number of **Image Understanding** applications
 - Highlighting features of the current prediction as well as **counterfactual** data and **contrastive** classes
 - Providing **directional information** in anomaly detection
 - **Quantifying uncertainty** for out-of-distribution, corruption, and adversarial detection
 - Providing **expectancy mismatch** for human vision related applications



Future Directions

Research at Inference Stage

- **Test Time Augmentation (TTA) Research**
 - Multiple augmentations of data are passed through the network at inference
 - Research is in designing the best augmentations
- **Active Inference**
 - Utilize the knowledge in Neural Networks to *ask it to ask us*
 - Neural networks ask for the best augmentation of the data point given that one data point at inference
- **Uncertainty in Explainability, Label Interpretation, and Trust quantification**
 - Uncertainty research has to expand beyond model and data uncertainty
 - In some applications within medical and seismic communities, there is no agreed upon label for data. Uncertainty in label interpretation is its own research
- **Test-time Interventions for AI alignment**
 - Human interventions at test time to alter the decision-making process is essential trustworthy AI
 - Further research in intelligently involving experts in a non end-to-end framework is required



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Tutorial Materials

Accessible Online



<https://alregib.ece.gatech.edu/aaai-2024-tutorial/>
{alregib, mohit.p}@gatech.edu

AAAI 2024 Tutorial



Presented by: *Ghassan AlRegib, and Mohit Prabhushankar*
Georgia Institute of Technology

www.ghassanalregib.info

Duration: Half Day (3 hours, 30 mins)

Title: Formalizing Robustness in Neural Networks: Explainability, Uncertainty, and Intervenability

