# Not all Failure Modes are Created Equal: Training Deep Neural Networks for Explicable (Mis)Classification

## Motivation



• Accuracy  $\neq$  explicability.

• How do Failures Look? Egregious Errors can result in

- 1. Loss of Trust
- 2. Safety issues
- 3. Uphold societal biases

• Predictive parity / error rate balance / demographic parity does not consider the egregiousness of a mistake.

## **Representing Magnitude of** Explicability

• Pairwise similarity between classes can be used to represent egregiousness of misclassifications.

- ♦ Classification to classes semantically far away = Egregious mistakes
- ♦ Classification to semantically close classes = Explicable mistakes



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#### **Obtaining Semantic Similarity** Representation

- Instance Based Human Labelling (IHL)
  - ♦ Very expensive
  - $\diamond$  Does not scale
  - ♦ Finest Granularity
- Pairwise Class-level Human Labelling (CHL)
  - $\diamond$  Less expensive
  - ♦ Scales decently
  - ♦ Coarser Granularity
- Existing Knowledge for Labelling (EKL)
  - ♦ Not expensive
  - $\diamond$  Scales easily
  - ♦ May not represent context-specific Explicability

#### **Discouraging egregious mistakes**

• Weight the loss values in accordance with the semantic similarity distance.

- ♦ Explicable mistakes should not make the loss infinity.
- ♦ Inexplicable or egregious mistakes should make the loss infinity.

 $W\mathcal{L}F(y_i, p) = \mathcal{L}(W_i, p)$ 

	Functionality	Explicability			Robustness		Cost
Model	Top-1 Accuracy ↑	$\mathcal{L}_{IHL}\downarrow$	$\mathcal{L}_{CHL}\downarrow$	$\mathcal{L}_{EKL}\downarrow$	Gaussian Noise $\uparrow$	Adversarial (FGSM) ↑	Additional Human Labels ↓
$ResNet-v2$ $(W = \mathbf{I})$	91.85%	14.761	5.044	16.047	17.03%	9.98%	0
ResNet-v2 ( $W = IHL$ )	83.61%	2.258	1.889	2.311	17.08%	12.14%	+511,400
ResNet-v2 ( $W = CHL$ )	91.17%	3.054	1.305	3.274	21.45%	11.73%	+460
ResNet-v2 ( $W = EKL$ )	86.03%	2.353	1.567	2.461	28.76%	12.63%	0

#### Table 1: ResNet-v2 on CIFAR-10.





Figure 2: Vanilla VGG vs VGG fine-tuned with EKL.

