Related work

Adversarial Label Flips

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1 Notation

We denote neural network classifiers with $f_\theta \colon \mathcal{X} \to \mathcal{Y}, x \mapsto y$ with trainable parameter θ, where $\mathcal{X}$ are a set of images with corresponding labels (classes) $\mathcal{Y}$. The parameter θ are optimized by minimizing a training objective $(\theta, x, y) \mapsto J(\theta, x, y)$ with respect to θ.

2 On neural networks

Convolutional neural networks are the de-facto standard in computer vision related tasks. They were first introduced in [1] to classify hand-written digits. In [2] demonstrated the effectiveness of deep convolutional neural networks on ImageNet dataset [3], winning the ImageNet Large Scale Visual Recognition Challenge 2012 [4]. The architecture of convolutional neural networks has since been further optimized. Residual neural networks [5] and their variants are state-of-the-art for image recognition tasks and dominate the leaderboard on websites such as `https://paperswithcode.com/task/image-classification`.

Experiments For our experiments we will consider the MNIST [6], Fashion-MNIST [7] and CIFAR-10 [8] dataset. For MNIST and Fashion-MNIST we use the convolutional neural network described in [9], Table 1. For CIFAR-10 we may use a ResNet-18 architecture [5] with the "pre-activation" optimization [10].

3 On adversarial attacks

Deep neural networks have been shown to be vulnerable to tiny, maliciously crafted perturbations applied to otherwise benign inputs. These so-called "adversarial examples" were first introduced in [11]. Further research showed that these adversarial examples generalize over multiple dataset and architectures [12]. Even very inexpensive attacks like the Fast Gradient Sign Method (FGSM) [12] can be used to fool neural networks. FGSM requires white-box access to the targeted neural networks architecture and its weights. Adversarial examples are computed by performing a gradient ascent step with respect to the sign of the gradient

$$\mathrm{FGSM}_\epsilon(x) = x + \epsilon \,\mathrm{sign}(\nabla_x J(\theta, x, y))$$

given a step size $\epsilon > 0$. FGSM is an L^∞-bounded attack[1], i.e. $\|x - \mathrm{FGSM}_\epsilon(x)\|_\infty \leq \epsilon$, meaning that each pixel value of a benign image x may only be perturbed by up to ϵ. Stronger attacks can be computed by repeatedly applying FGSM with smaller step sizes. This type of attack is known as Projected Gradient Descent (PGD) and was first introduced [14]. Their experiments demonstrated

[1] While bounds with respect to an L^p norm are commonly used in the machine learning literature, we are aware that they are "[...] neither necessary nor sufficient for perceptual similarity [...]" [13].

the effectiveness of such attacks and showed that convergence is achieved after only a few hundred iterations.

Foolbox For our experiments we will use a suit of different attacks using the FoolBox library [15]. The documentation is available at `https://foolbox.readthedocs.io/en/stable/`.

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