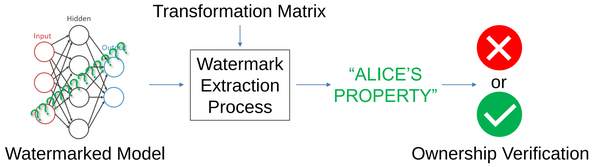
Rethinking Deep Neural Network Ownership Verification: Embedding Passports to Defeat Ambiguity Attacks

Lixin Fan[1], Kam Woh Ng[1,2], Chee Seng Chan[2]
WeBank AI Lab[1], University of Malaya[2]

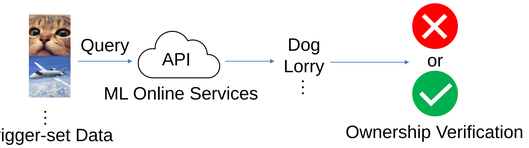
Problem Definition

Conventional DNN Watermarking methods

- **White-box Ownership Verification (Uchida et al. [1])**



- **Black-box Ownership Verification (Adi et al. [2])**



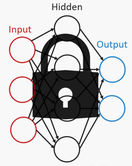
Problem Statements

1. Protection on DNN is urgently needed
2. Existing watermarking approaches are vulnerable to ambiguity attack

Watermark Approach	**Real** Watermark	**Fake** Watermark
White-box (Uchida et al. [1])	100% watermark detected	100% watermark detected
Black-box (Adi et al. [2])	100% watermark detected	100% watermark detected

Watermark detection rate for both **real** and **fake** watermarks

Protect your DNN model from theft !

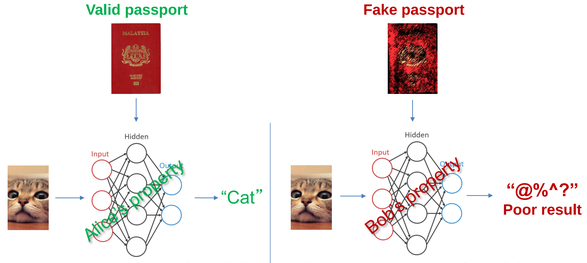


Protected Model

Code & More Details

Our Solution

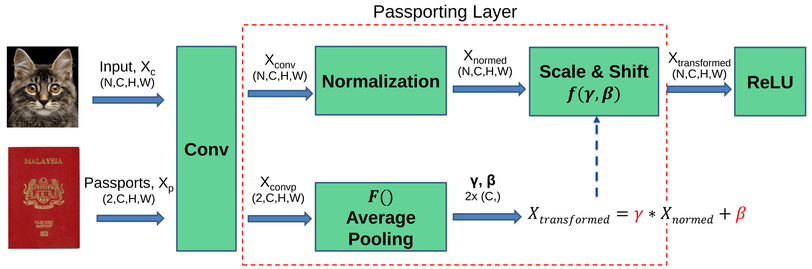
Embedding Passports



Passport-protected Model with **valid passport**

Passport-protected Model with **fake passport**

Passporting Layer



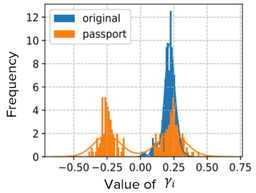
Discussion

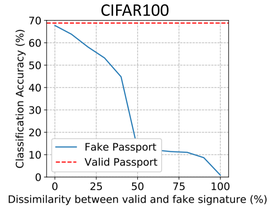
Embedding Binary Signatures into γ of Passporting Layer

$$\text{Sign Loss} = \sum_{i=1}^{C} \max(\gamma_0 - \gamma_i b_i,\ 0)$$

$\gamma_0 = 0.1$
$b: [-1\ 1\ \ldots]$

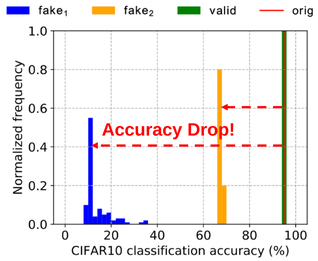
64 channels can embed 8 bytes signature





Experimental Results

Ambiguity attack	Inference Phase	Verification Phase
$Fake_1$ (random passport)	**Random guessing**	**Useless Infringement**
$Fake_2$ (reverse-engineered passport)	**Performance deteriorated** (at best 70% on CIFAR10)	**Useless Infringement**
$Fake_3$ (copied passport)	**Performance Detained Signature Detected**	**Ownership Verified**



Ownership Verification Schemes

	Scheme 1	Scheme 2	Scheme 3
Need to distribute passport	**Yes**	**No**	**No**
Inference time	Up to 10%** more time	**No extra time**	**No extra time**
Training time	Up to 30%** more time	Up to 150%** more time	Up to 150%** more time
Black or **White** box Verification	**White**	**White**	**Black** & **White**

Time increases **are linearly depending on complexity of the network architecture

Contributions

1. Novel passport-based verification schemes to defeat ambiguity attack
2. One passport-protected DNN model will only have one unique signature
3. Fake passport or modified signature will paralyze the DNN model