Context-based Virtual Adversarial Training for Text Classification with Noisy Labels

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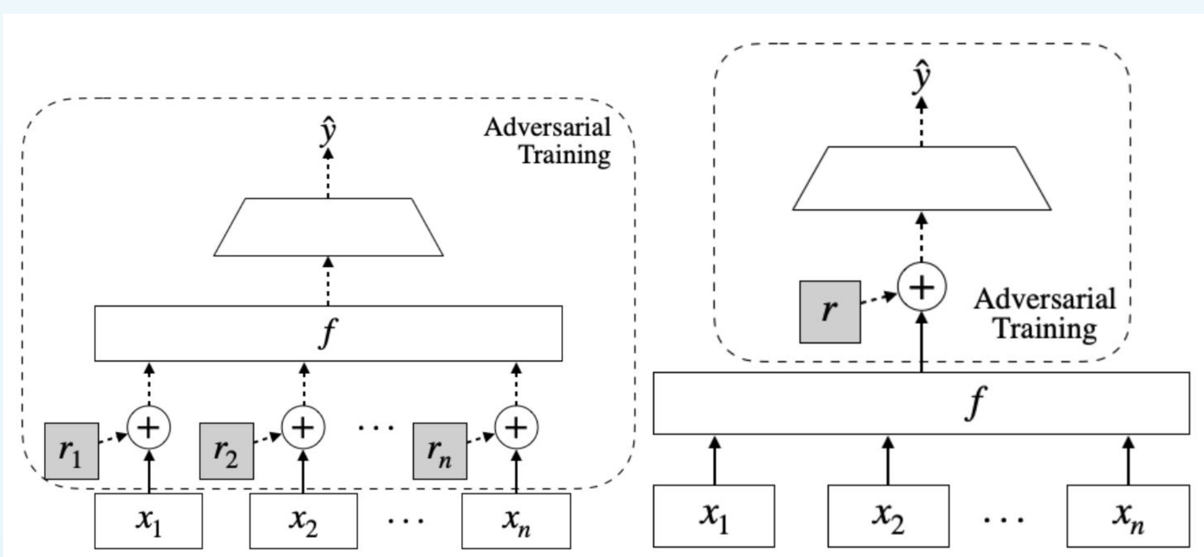
Introduction

Real World Datasets made by Human annotators or Users suffer from Label Noise. Furthermore, improving the quality of the datasets takes additional costs.

For that reason, we propose a simple but effective method *Context-based Virtual Adversarial Training (ConVAT)* which is robust to Noisy Label Datasets. Our approach is inspired by *Virtual Adversarial Training (VAT).*

The driving force behind *ConVAT* is to prevent the models from overfitting data points by enforcing consistency between the inputs and the perturbed inputs

This strategy allows us to train a robust classifier against Label Noise without placing any burden to Computational Cost.



A) VAT B) ConVAT

Methodology

Training Step

1) **Formulating Perturbation** : Using context vector, we create a worst-case perturbation (adversarial example) for each data point to have a direction which maximize the classification loss. The adversarial example is obtained by computing the gradient of the context vector and is used to add an additional term to the given loss function.

2) **Label Smoothing** : Our additional term plays a important role in coping with Label Noise. Minimizing the distributional distance (KL-Divergence) between a normal sample and a perturbed sample enables the model to have an effect of Label Smoothing.

Dataset

Uniform label noise : In generating Noise from clean dataset, we flip the label from one category to another with the same probability across all the labels.

62.50%	12.50%	12.50%	12.50%
12.50%	62.50%	12.50%	12.50%
12.50%	12.50%	62.50%	12.50%
12.50%	12.50%	12.50%	62.50%

C) Label Transition Matrix with 4 different types of Labels (Uniform)

Random label noise : In generating Noise from clean dataset, labels are flipped from one labels to another based on a certain random distribution across all the labels.

58.33%	18.75%	10.41%	12.50%
12.50%	58.92%	14.28%	14.28%
21.05%	21.05%	50%	7.89%
15%	17.50%	17.50%	50%

D) Label Transition Matrix with 4 different types of Labels (Random)

Results

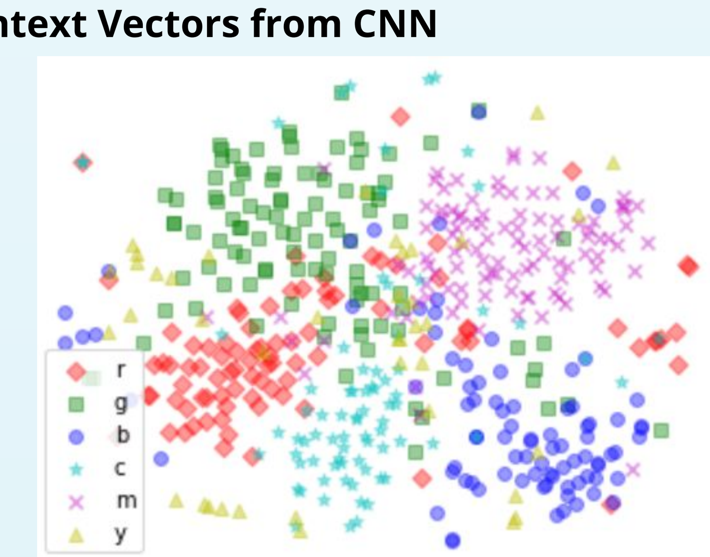
Denoising Effect of ConVAT

To analyze the denoising effects of ***ConVAT***, we train our model and a baseline CNN model on the noisy dataset.

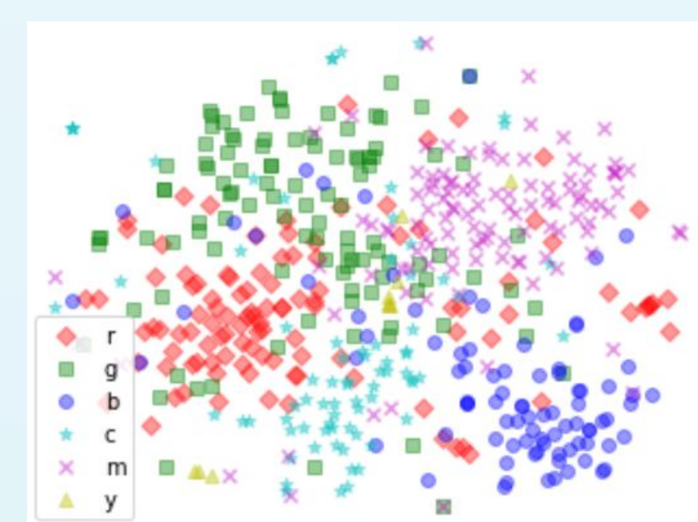
We visualize the context vectors of each sample from TREC datasets with 50% uniform noises through t-SNE (Van Der Maaten, 2014) and it is shown below in Figure E) , F).

In Figure E), the context vector are clustered with ambiguous decision boundaries. Moreover, data points labeled as 'y' aren't clustered . On the Contrary, context vectors in Figure F) are clearly clustered together with same labels. the scatter plot with overlayed clean labels shows our denoising effect of ***ConVAT*** on Label Noise**.**

E) Context Vectors from CNN

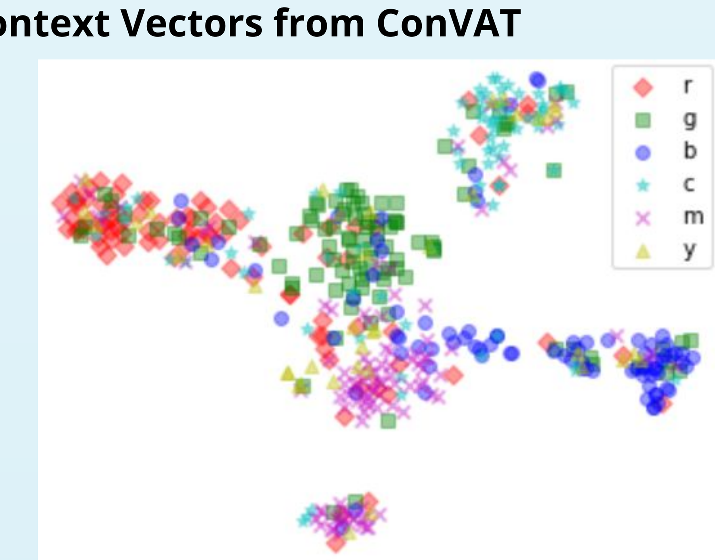


With Noisy Labels

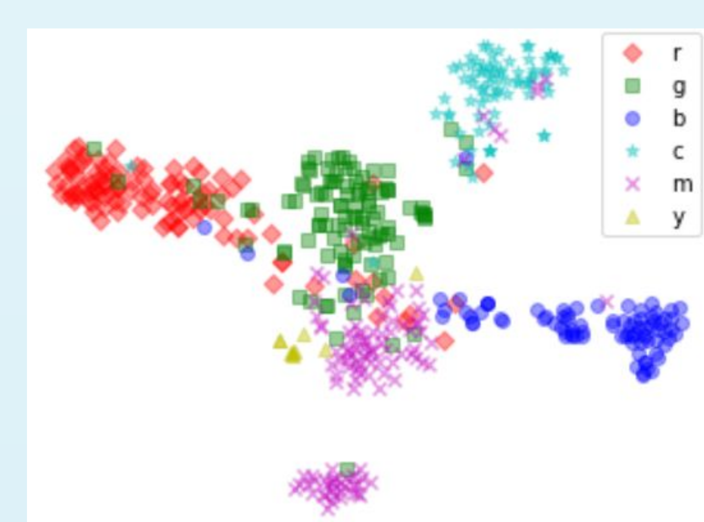


With Overlayed Clean Labels

F) Context Vectors from ConVAT



With Noisy Labels



With Overlayed Clean Labels

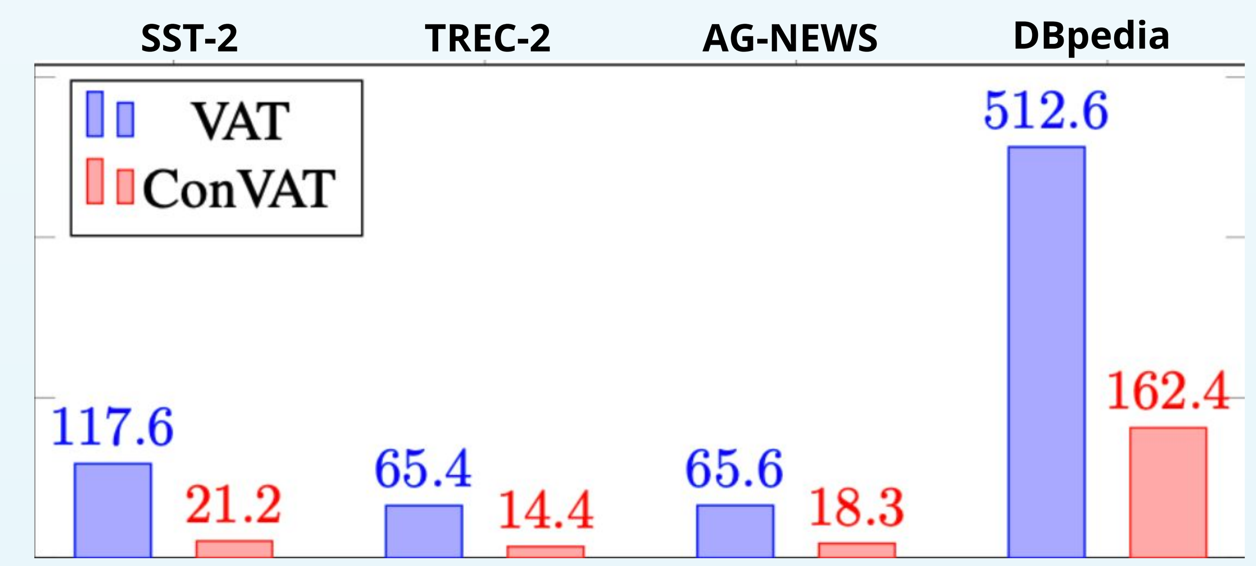
Time and Memory usage Analysis of ConVAT

Convat has significant advantages on both time and memory efficiency compared to the normal *VAT* (Miayto et al., 2016).

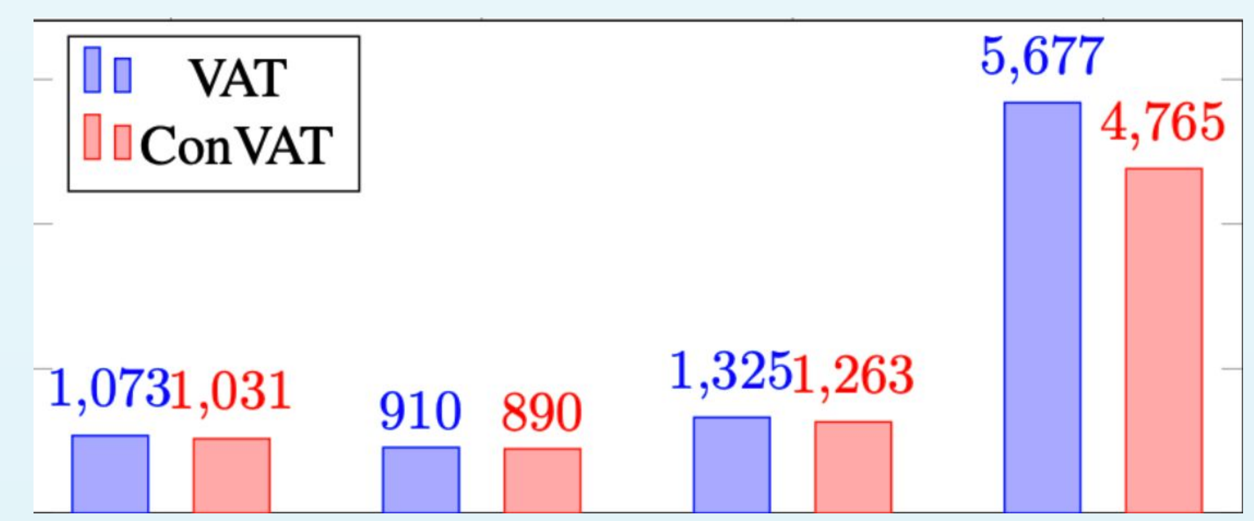
VAT performs a forward and backward propagation **twice** to obtain a perturbation whereas ***ConVAT*** propagates the whole network **once** with an additional one layer back propagation.
It indicates that the computational efficiency of ConVAT is superior to VAT.

We prove our Model efficiency by comparing time and memory footage of VAT and ConVAT with 4 different text datasets. **SST-2, TREC, AG-NEWS, DBpedia**

The Time and Memory efficiency of our proposed model is shown below in Bar plot G), H). Those plots demonstrate we benefit from ConVAT more than VAT as the size of the Training Dataset increases.



G) Time usage of VAT and ConVAT



H) Memory usage of VAT and ConVAT

Conclusion

We have proposed context-based virtual adversarial training, coined ConVAT, a robust training method that prevents networks from overfitting to label noises.

Furthermore, ConVAT is designed as a network-agnostic manner and has strong advantages in terms of the time complexity.

Comprehensive evaluation results have clearly shown that ConVAT is superior to previous works on Text Classification with Noisy Labels.