Learning Robust Representations of Text

A Discussion

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Summary

- Deep nets are sensitive to noise, adversarial attacks
- Present regularization method to limit network sensitivity to inputs
  - Models become more robust
  - Ideas are inspired by computer vision
- Achieve superior performance on noisy inputs, out-of-domain data on sentiment datasets

Introduction

- Primary cause of neural nets' vulnerability is linear nature[1]
  - LSTMs, ReLUs, maxout designed linearly to facilitate optimization
- Fawzi et al.[2]showed linear models not robust to adversarial noise
- Present a regularization method to make neural nets more robust to noise
  - Inspired by Rifai et al [3]

[1]Goodfellow et al. , Explaining and harnessing adversarial examples, ICLR 2014
[2]Analysis of classifiers' robustness to adversarial perturbations
[3]Contractive autoencoders: Explicit invariance during feature extraction, ICML 2011

Approach

- **Intuition**: Minimize ability of features to perturb predictions
  - to stabilize predictions
- **Idea**: Train models using first-order derivatives of training loss as part of regularization term
  - Necessitates second-order derivatives for computing gradient

Training for Robustness

- **Training**: SGD to min L (measures $y_{pred} - y_{true}$)
  - w: Input, a sequence of (discrete) words
  - h: fixed-size vector of continuous values representing w
  - $y_{pred} = f(h)$
- **Goal**: Learn models that are more robust to strange/invalid inputs
  - y_{pred} remains stable on perturbations on w (or h)
- **Application**: Transfer learning scenarios such as domain adaptation
  - Inputs in distinct domains drawn from different distributions
  - Highly variable but convey same information
  - Different word choice, different syntactic structures, typographical errors, stylistic changes, etc

Robust Regularization

- Minimize variation of output when noise applied to input
  - $\Delta_y = f(x + \Delta_x) - f(x)$
  - $$\lim_{\Delta_x \to 0} \Delta_y = \lim_{\Delta_x \to 0} \big(f(x + \Delta_x) - f(x)\big) = \frac{\partial y}{\partial x} \cdot \Delta_x$$
  - Minimising noise sensitivity $\equiv$ minimising $\left\| \frac{\partial y}{\partial x} \right\|_F$
- $\mathcal{L} = L + \lambda \cdot \left\| \frac{\partial L}{\partial h} \right\|_2$
  - Supports gradient optimization
  - Need to compute second-order derivatives of L during back-propagation

Experiments and Datasets

- Model f is CNN proposed by Yoon Kim[4]
  - MR: Sentence polarity dataset
  - Subj: Subjectivity dataset
  - CR: Customer review dataset
  - SST: Stanford Sentiment Treebank, using the 3-class configuration
- **Noise**: Apply world-level dropout noise to each document
  - Randomly replace words by a unique sentinel symbol
  - Apply this to each word with probability $\alpha \in \{0, 0.1, 0.2, 0.3\}$
- Cross-domain evaluation
  - Train on one dataset, apply it to another
  - Pair MR (movie reviews) and CR (product reviews) that use same label set

[1] Convolutional neural networks for sentence classification, EMNLP 2014