Rule induction for global explanation of neural nets

Madhumita Sushil, Simon Šuster, Walter Daelemans

Computational Linguistics and Psycholinguistics Research Center, University of Antwerp, Belgium

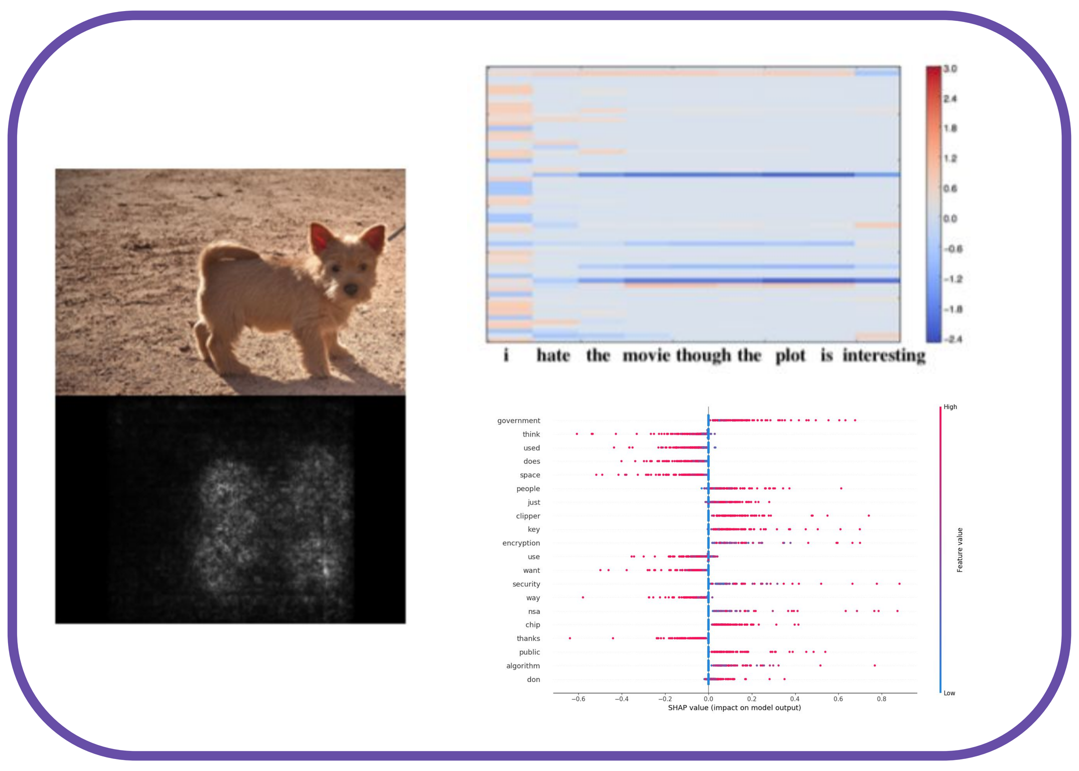
madhumita.sushil@uantwerpen.be

EXISTING APPROACHES

Existing techniques for interpreting DNN in NLP:

- Input deletion
- Gradient computation
- Layerwise relevance propagation (LRP)
- Backpropagation using reference value (DeepLIFT)
- Learning explanation models: LIME, SHAP
- Attention weights

Feature Analysis



Open question:

How do we find the feature interactions that have been learned by a model for a certain class?

PROPOSED TECHNIQUE AND RESULTS: INDUCING RULES FOR INTERPRETING NEURAL NETS

BoW/ BoEntities, TF-IDF → **Neural Classifier** → Predicted output class (o_k)

Compute feature saliency, $G = \frac{\partial o_k}{\partial I}$

Reweigh input features with their saliency scores in the network

Product of feature values and saliency scores

Select top reweighed features

Sensitivity Analysis / Mutual Information

Simplify the selected reweighed features to sign

Provides correlations b/w feature values and predicted output probabilities

- +1: positive correlation (high feature value: high prob.)
- -1: negative correlation (low feature value: high prob.)
- 0: absent feature value

Induce if-then-else rules using RIPPER-k on the correlation data to fit neural classifier predictions (one-vs-rest)

Feature-class associations that explain model predictions

Results:

- Rule fidelity score to explain neural predictions:
  - 0.8 macro F1, high precision, lower recall.
- Interdependence between features plays an important role for classification.

Learned Rules (unordered):

government = high and
launch = absent and
medical = absent and
nasa = absent
→ Cryptography (✓45/46)

Text classification: medicine vs. space vs. electronics vs. cryptography (20 newsgroups data)

Primary diagnostic category and in-hospital mortality prediction using EHR notes (MIMIC-III corpus)

Take blood pressure (treatment) = high and
Nothing by mouth = absent and
Coronary heart disease = high and
Flagyl = absent
→Diseases of the circulatory system (✓84/90)

Dilantin = high and
Thalamus, posterior lateral nucleus = high
→Diseases of the nervous system (✓5/6)

Pneumonia = high and
Lung opacity = high and
Non-specific ST-T changes by ECG = low and
CT of pelvis w/o contrast = absent
→Diseases of the respiratory system (✓7/7)

Physical examination = high and
Pregnancy with medical condition = high
→Dies within hospital (✓221/222)

Code available at: http://github.com/clips/interpret_with_rules/