Improving css-KNN Classification Performance by Shifts in Training Data

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1st International KEYSTONE Conference, Coimbra Portugal, 8-9 September 2015

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Agenda

1. Classification
2. Shifts in Training Data
   - Common form
   - Shifts towards globally defined destinations
   - Shifts towards locally defined destinations
3. Results

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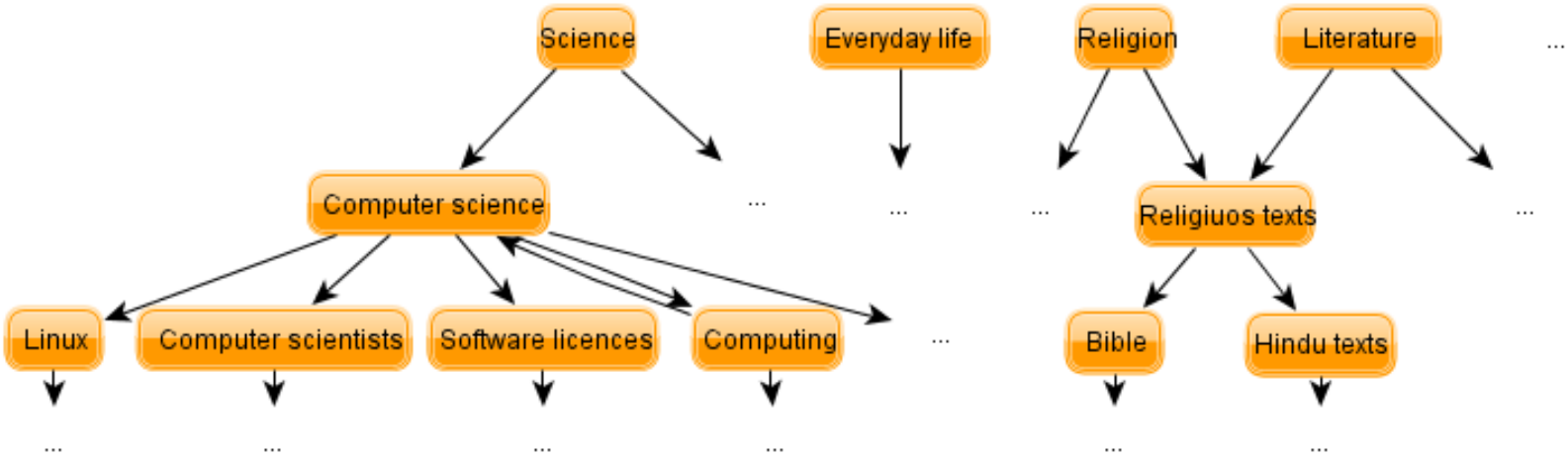
Problem description

- The need: structured, well organized information
- The problem: *Text Classification*
  - Large Scale (thousands of categories)
  - Multi-Label
  - (pseudo)Hierarchical



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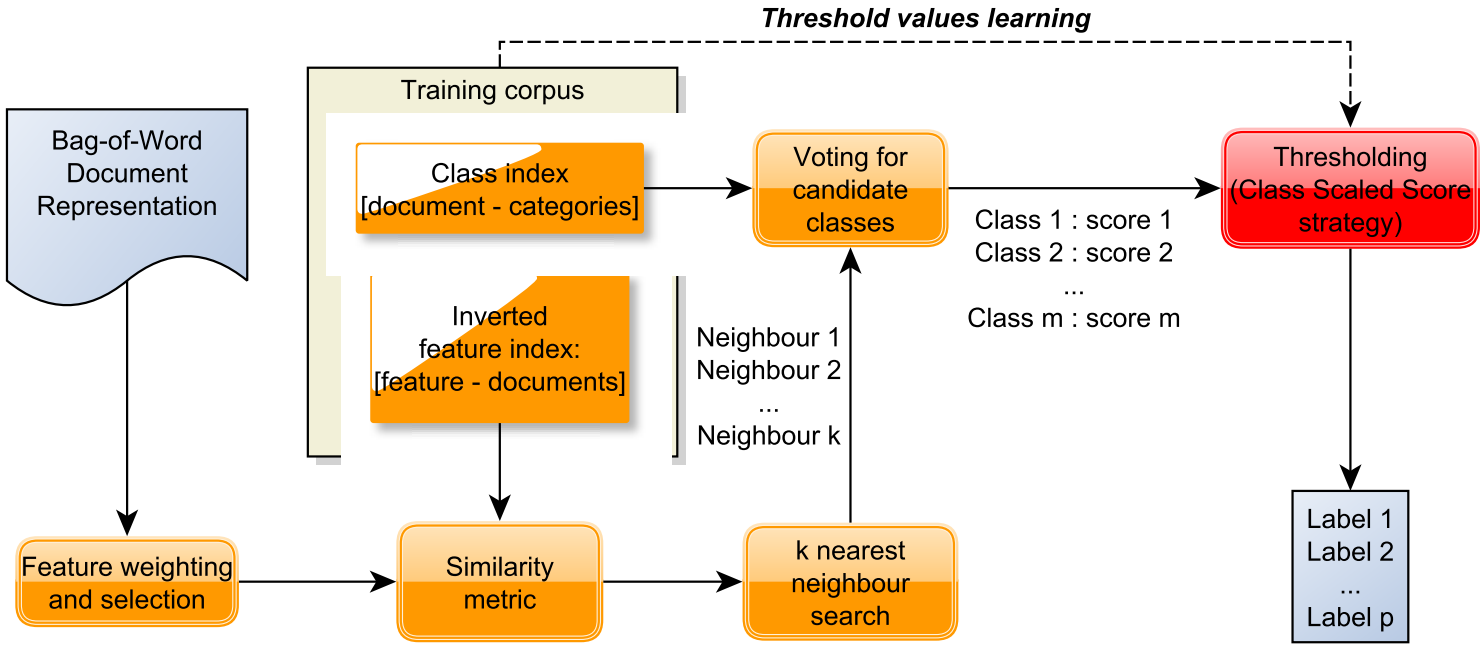
A small snippet of Wikipedia "hierarchy" of categories.

Classifier architecture



This is our version of the classifier proposed by Xiao-Lin Wang et al., the winner of *The Second Pascal Challenge on Large Scale Hierarchical Text classification*.

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Thresholding strategies

- *S-cut* – (Score-cut) returns a set of labels which scores exceed or equal some constant threshold value t:

$$h(\boldsymbol{x}) = \{l : \text{score}(l) >= t\}, \quad \forall_{l \in \boldsymbol{L}}$$

- *DS-cut* – (Distinctive Score-cut) uses a few threshold values t_i, each one corresponding to the position that a label occupies according to its score in the list of sorted scores:

$$h(\boldsymbol{x}) = \{l : \text{score}(l) >= t_{\text{rank}(l)}\}, \quad \forall_{l \in \boldsymbol{L}}$$

- *CS-cut* – (Class-specific Score-cut) instead of one global constant t needs one threshold value per each class:

$$h(\boldsymbol{x}) = \{l : \text{score}(l) >= t_l\}, \quad \forall_{l \in \boldsymbol{L}}$$

- *CDS-cut* – (Class-specific Distinctive Score-cut) accordingly:

$$h(\boldsymbol{x}) = \{l : \text{score}(l) >= t_{l,\text{rank}(l)}\}, \quad \forall_{l \in \boldsymbol{L}},$$

- we use scaled versions of these strategies: *DSS-cut* (original EKNN) and our *CSS-cut*.

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Training Data Amendments

- feature reweighting (choosing proper weighting scheme)
- outlier detection & removal
- re-labeling of training examples
- shifting/moving/translating examples

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- Data points are modified using vector translation (shift):

$$\boldsymbol{x}'^{(i)} = \boldsymbol{x}^{(i)} + \alpha \cdot \left(\boldsymbol{d}^{(i)} - \boldsymbol{x}^{(i)} \right) = (1 - \alpha) \cdot \boldsymbol{x}^{(i)} + \alpha \cdot \boldsymbol{d}^{(i)}$$

- i-th data point $\boldsymbol{x}^{(i)}$ is translated towards some destination point $\boldsymbol{d}^{(i)}$ by some *step size* $\alpha \in [0, 1]$
- the knowledge of $\mathcal{Y}^{(i)}$ as well as the rest of D_{train} is necessary to compute $\boldsymbol{d}^{(i)}$

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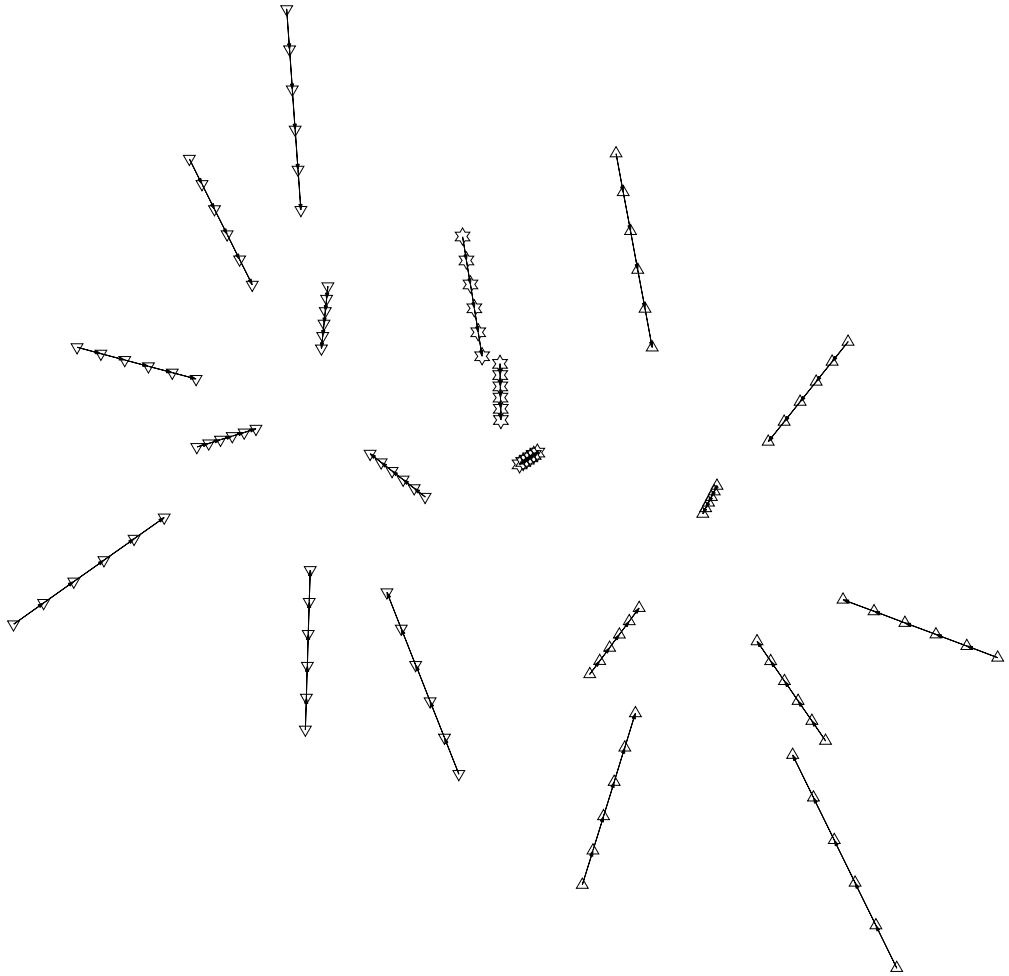
T2CC – shift to centroid of centroids



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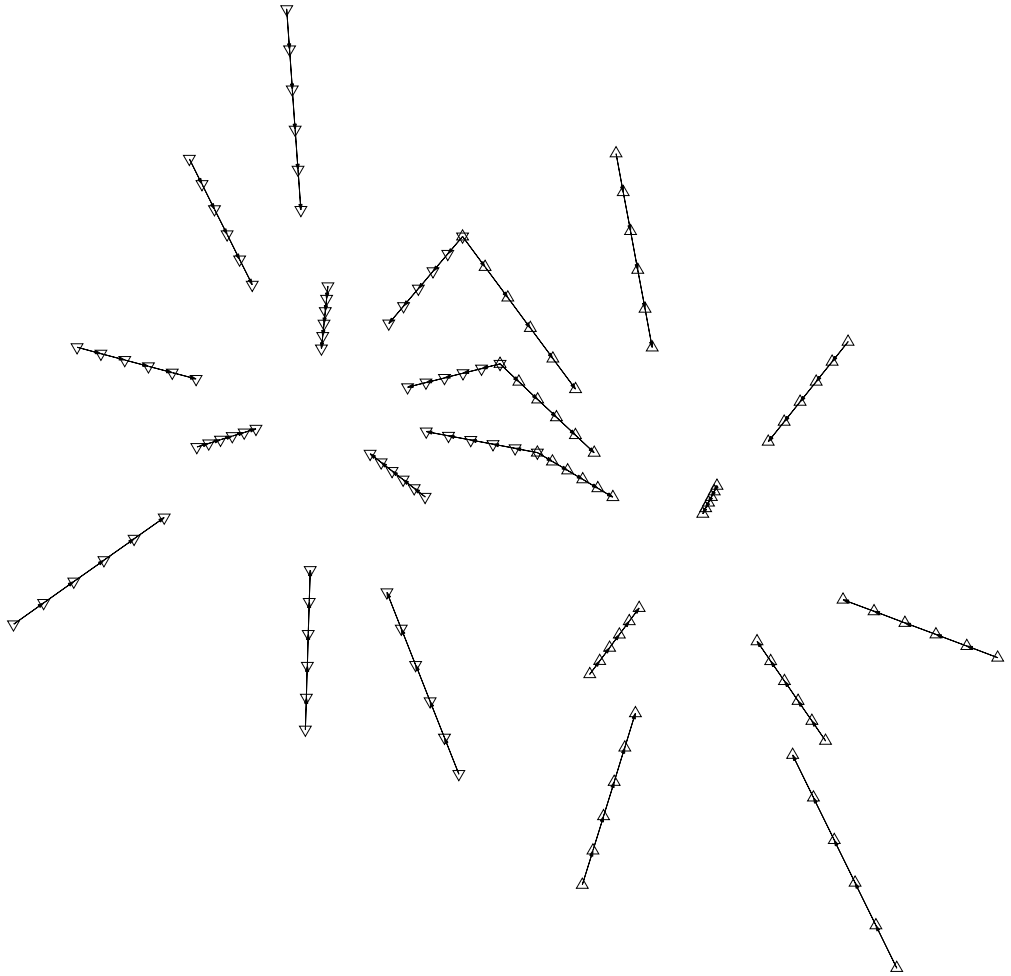
C&T2C – copy & shift to centroid



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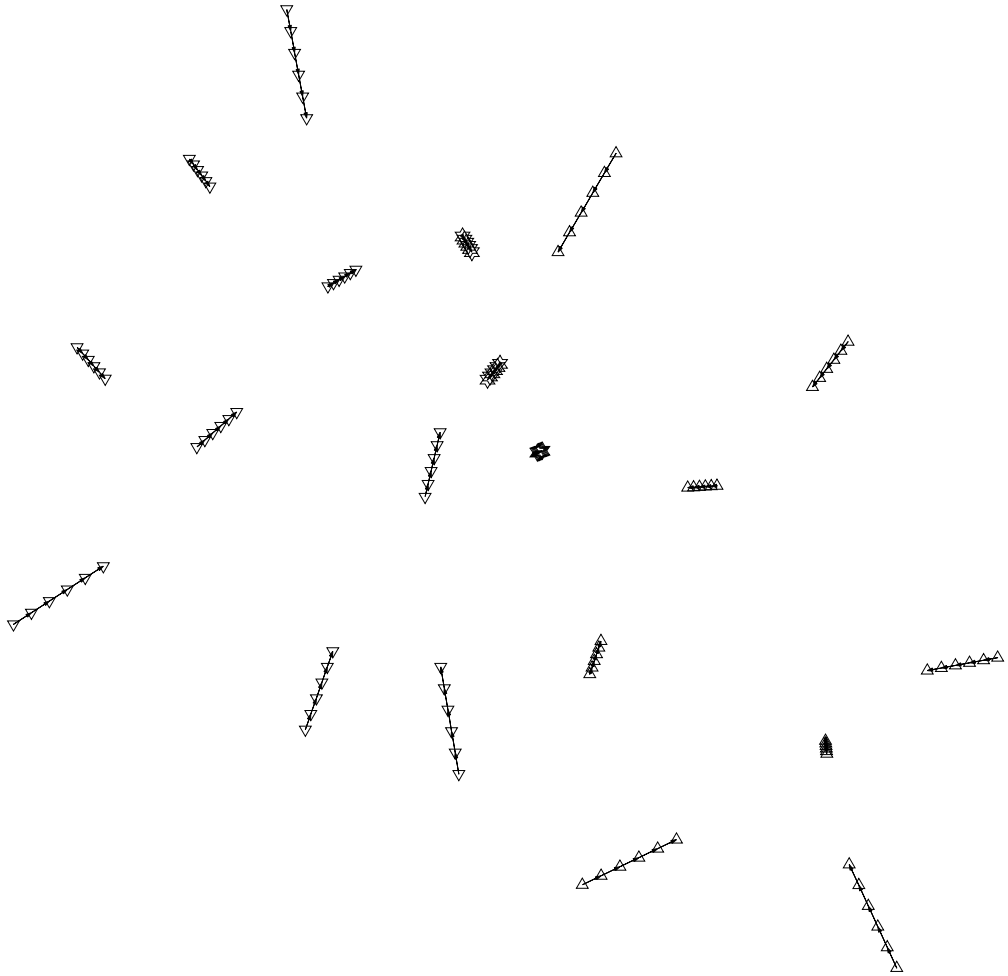
T2CNIN – shift to centroid of nearest in-classes neighbors



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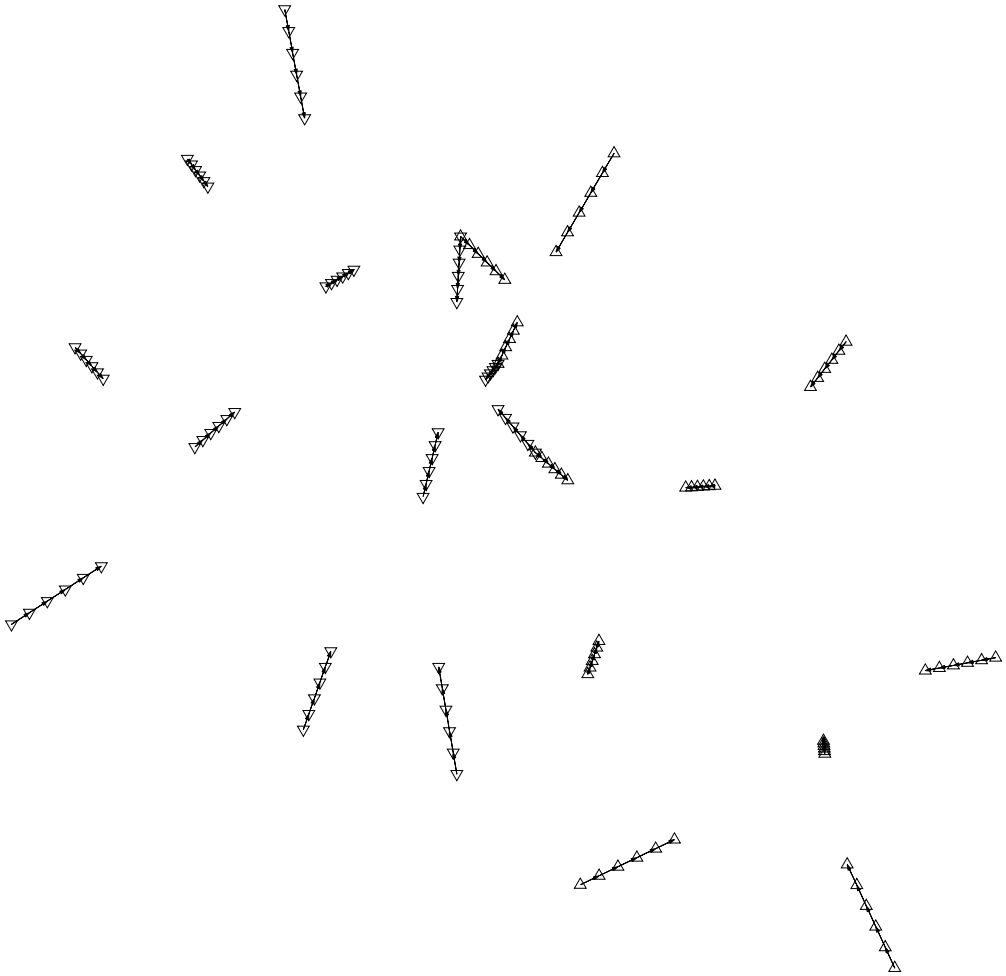
C&T2NIN – copy&shift to centroids of n. in-class neighbors



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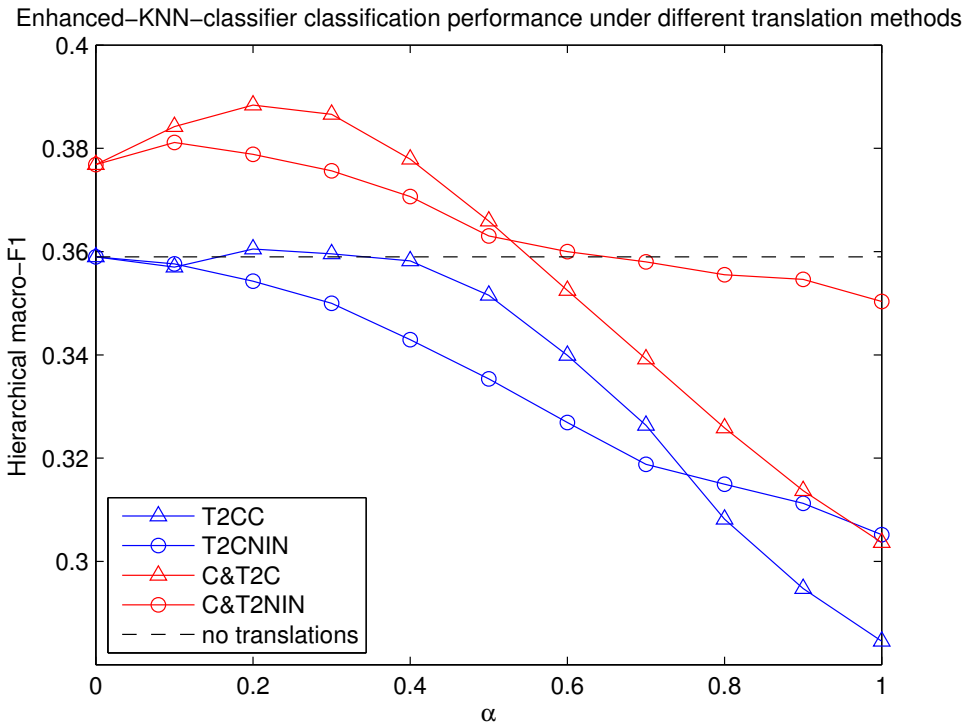
Results



The results of Enhanced-KNN classifier performance on a held out test set under train data translations using proposed methods. Simple English Wikipedia dataset, centroid pruning $th_{rel} = 0.05$, shifted data pruning $th_{rel} = 0.05$, neighborhood size for local methods: $m = 3$.

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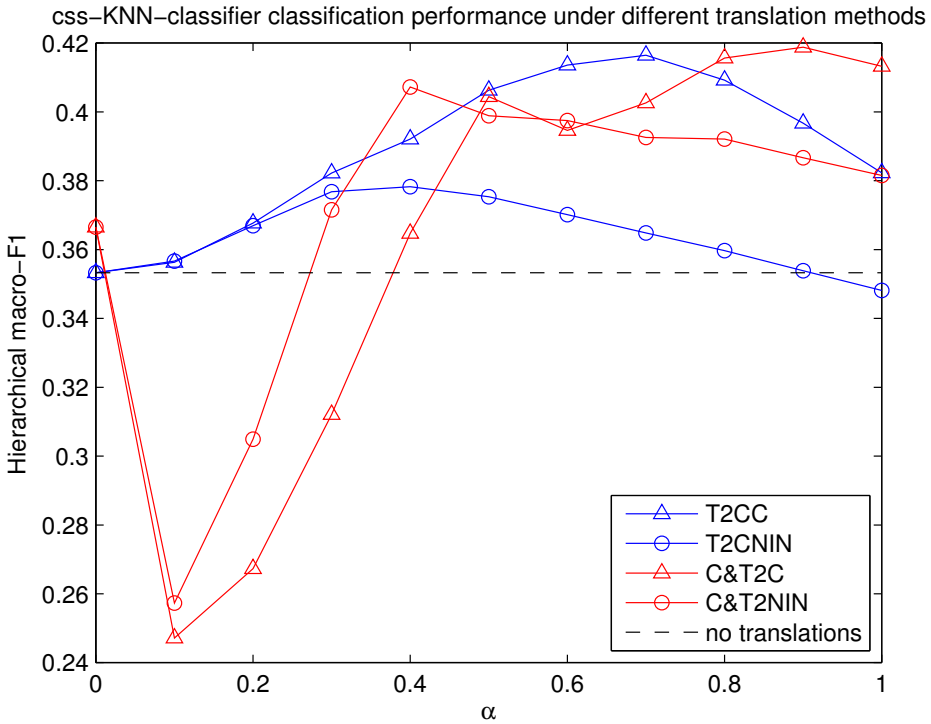
Results



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Importance of pruning

Table: The impact of pre- and post-translation data pruning on the size of the modified training dataset (in MB). Simple English Wikipedia train data. Original train data size is 25.

		post-shift pruning				
		no pruning	relative 0.01	absolute 0.01	relative 0.05	absolute 0.05
pre-shift	no pruning	-	-	-	-	34
	relative 0.01	1060	149	78	40	34
	absolute 0.01	430	143	78	40	34
	relative 0.05	304	127	75	40	34
	absolute 0.05	90	74	60	40	34

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Conclusions

- We proposed four variants of shifts in the training data that can improve classification performance of kNN-based classifiers, if the variant and step-factor chosen carefully
- This can be seen as a form of data smoothing or missing value imputation
- In the future we plan to *learn* a transformation in the feature space, so that testing examples can undergo the same processing as training ones

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