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Non-Uniform Slant Correction for Handwritten Text Line Recognition

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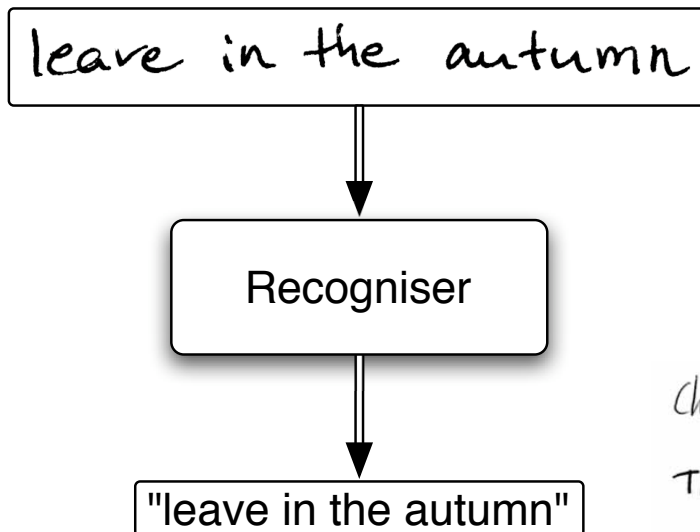
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Handwritten Text Line Recognition



Main challenges:

- > Large vocabulary
- > Segmentation problem
- > Many different writing styles

Charles obliged with "April Serenade". This week it appears, The Government should settle this argument with two words to on new techniques - and on the universities to think hard and long before his next jump into the I don't think he will storm the charts with this one, but it's a good start.

Slanted Handwriting

One of the greatest steps forward that has been

and I was interested some little while

Outline

- > Introduction
- > Image normalisation
- > Offline handwritten text line recognition
- > Experiments and results
- > Conclusions and future work

Image Normalisation

- > Skew correction

Maemillan. ⇒ Maemillan.

- > Slant correction

Maemillan. ⇒ Maemillan.

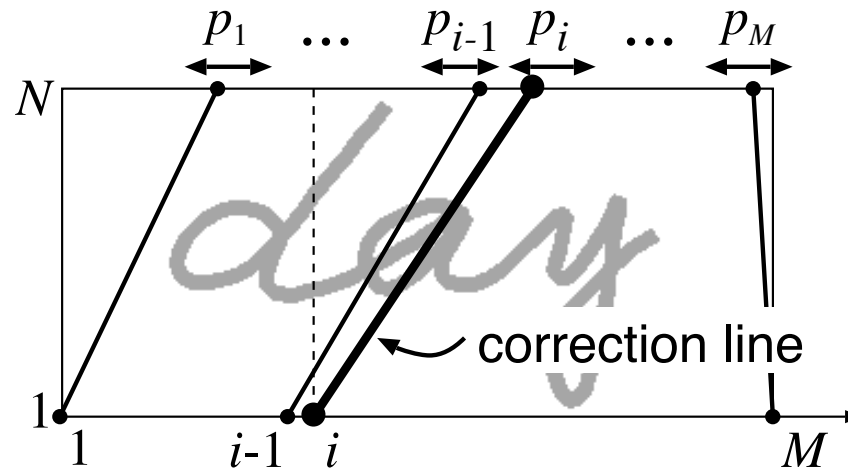
- > Position of upper and lower baseline

Maemillan. ⇒ Maemillan.

- > All parameters are estimated globally (e.g. average slant angle of a text line)

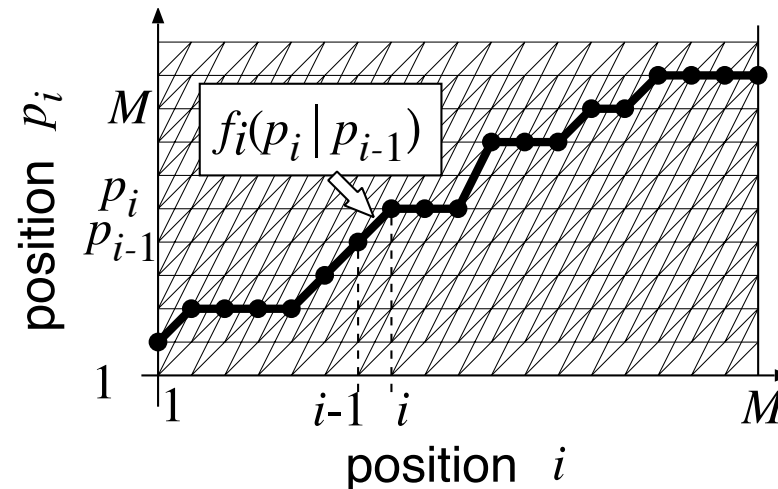
Non-Uniform Slant Correction

- > Non-uniform slant correction by estimating the local slant angle at each horizontal position $i = 1, \dots, M$.



- > Properties:
 - long near vertical strokes exhibit local slant angles.
 - left-to-right transition of the local slant angle is smooth.

Optimising the Slant Correction Path



- > Where $f_i(p_i | p_{i-1})$ expresses the goodness the i -th correction line and is a weighted sum of $s_i(p_i)$, $\gamma(p_i | p_{i-1})$, and $c_i(p_i)$:
- $s_i(p_i)$ increases if a longer stroke is on the correction line
 - $\gamma(p_i | p_{i-1})$ evaluates the similarity to the preceding correction line
 - $c_i(p_i)$ suppresses over-corrections by comparing to an average slant angle in the neighbourhood

Slant Corrected Handwriting

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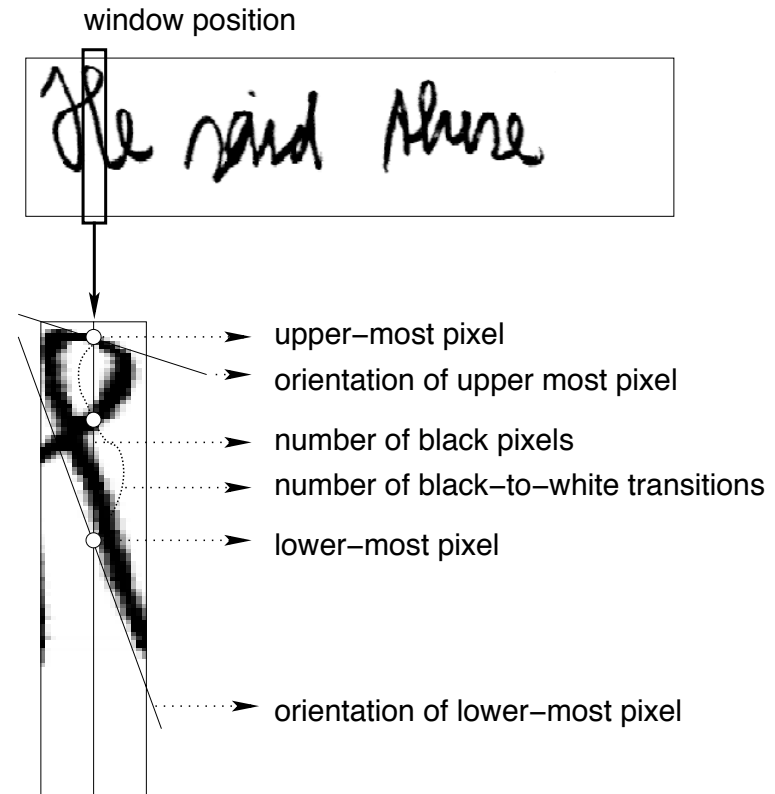
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Offline Handwritten Text Line Recogniser

- > Based on Hidden Markov Models (HMMs)
- > A sliding window approach extracts nine geometrical features.
- > Sliding window is moved from left to right, one pixel at each step.



Offline Handwritten Text Line Recogniser

- > Characters are modelled with linear HMMs of individual length. Twelve Gaussian mixture components model the output distribution in each state.
- > Based on a lexicon word models are built by concatenating character models.
- > A statistical bigram language model supports the recognition.

Experimental Setup

- > Writer independent task
- > Training set: 6,161 text lines (283 writers), validation set: 920 text lines (56 writers), test set 2, 781 text lines (161 writers)
- > Language model trained on three corpora
- > Optimisation of the language model integration on the validation set
- > 20,000 word lexicon (OOV-rate 6.5%)

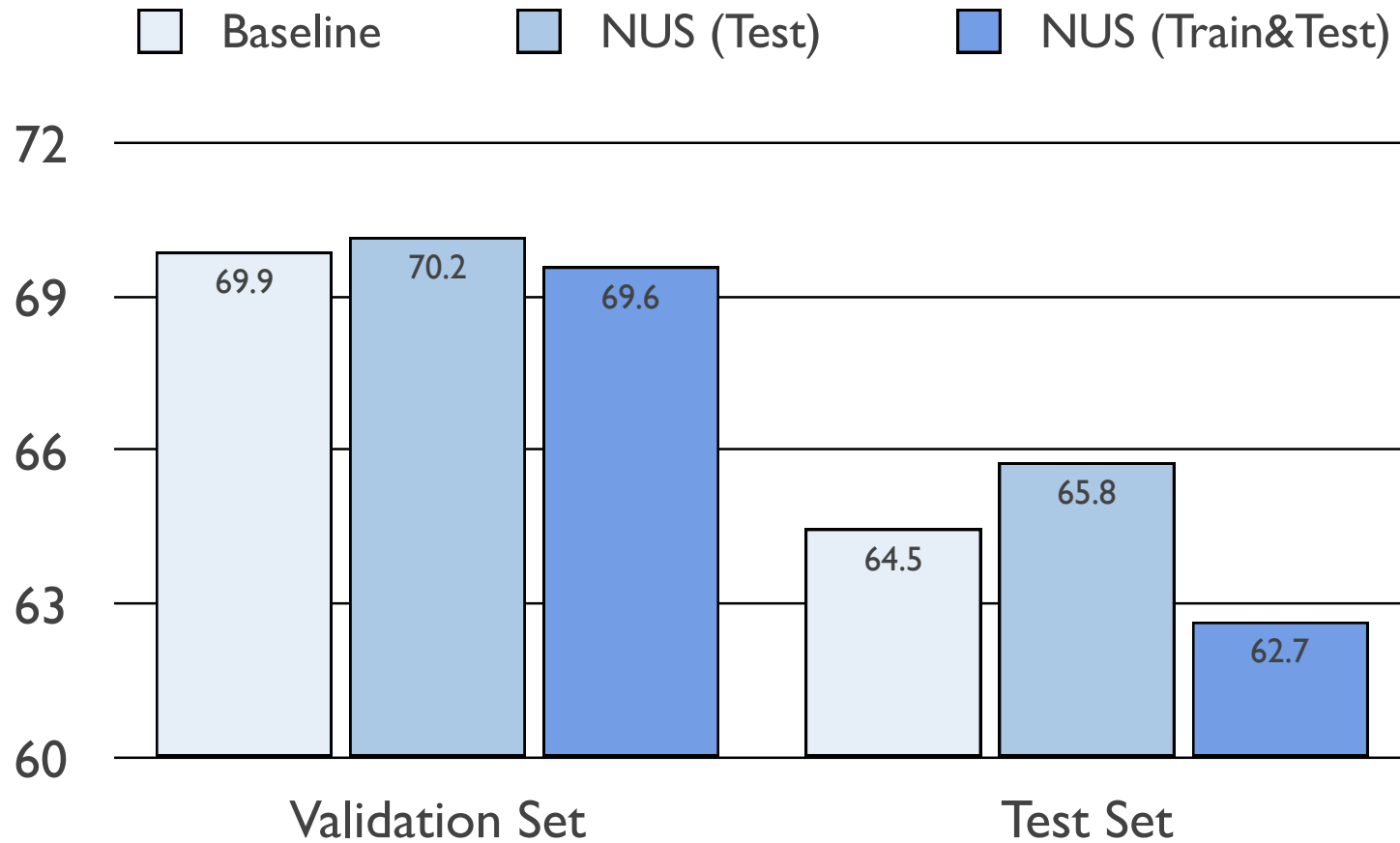
Experimental Setup

> Three Experiments

	Training set normalisation	Test set normalisation
Baseline	uniform slant correction	uniform slant correction
NUS (Test)	uniform slant correction	non-uniform slant correction
NUS (Train&Test)	non-uniform slant correction	non-uniform slant correction

> Motivation for NUS (Test): diversity among character instances in the training set is higher with uniform slant correction.

Results (Word Level Accuracy)



Conclusions

- > Many handwriting styles exhibit a variety of different slant angles within a single line of text.
- > Non-uniform slant correction locally corrects slant angles. It is formulated as a optimisation problem where local slant angles represent the variables to be optimised.
- > Experiments on a large number of text lines confirm the usefulness of the proposed pre-processing method.

Future Work

- > Writer dependent setup
- > Generalisation of the concept of local corrections to skew correction or base line normalisation