Data Driven Feature Extraction for Gender Classification using Multi-script Handwritten Texts

Momina Moetesum[a], Imran Siddiqi[a], Chawki Djeddi[b], Yaacoub Hannad[c], Somaya Al-Maadeed[d]

[a]Bahria University, Islamabad, Pakistan, [b]Larbi Tebessi University, Tebessa, Algeria, [c]Ibn Tofail University, Morocco, [d]Qatar University, Qatar

Contact: imran.Siddiqi@bahria.edu.pk

1 • INTRODUCTION

- Handwriting is indicative of rich information about the writer and can be employed as an effective biometric modality.
- A widely established correlation is between handwriting and writer demographics especially the gender of writer.
- Popular computerized methods for gender prediction include extraction and classification of hand crafted global or local features from given set of handwriting samples (Figure 1).

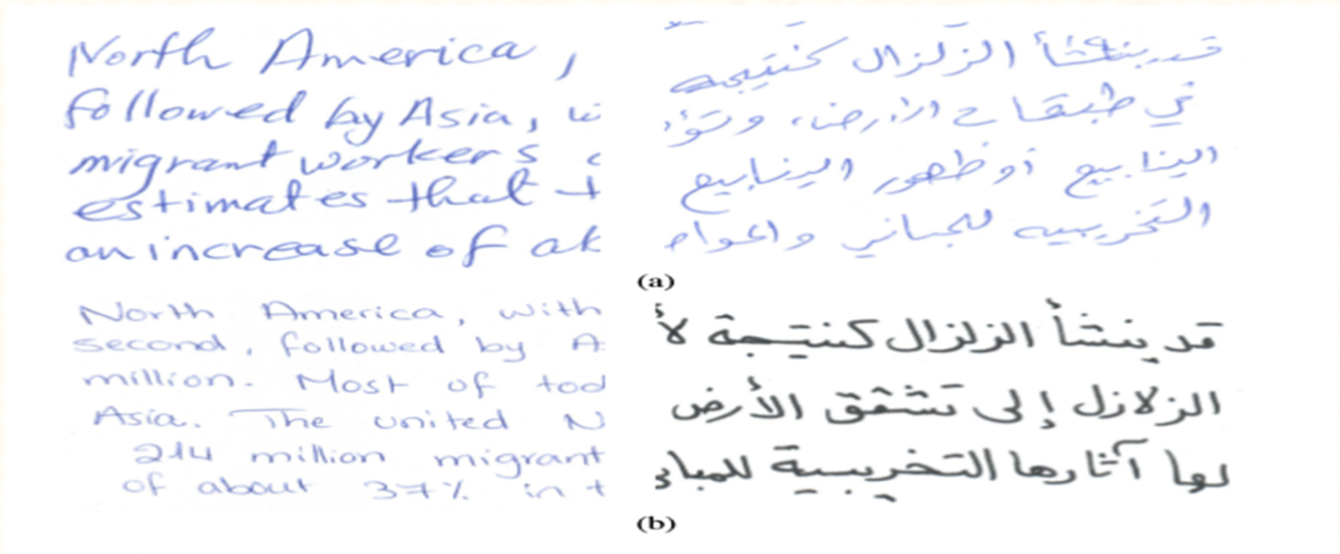

Fig 1: Sample images of (a): Male and (b): Female writings in the QUWI database

Objectives:

- To assess effectiveness of machine learned visual attributes from handwriting samples of males and females for gender prediction.
- To study the impact of scale of observation (e.g. word, patch & page level) on the classification outcome.

2 • METHODOLOGY

Handwriting Sample Images (Word, Patch and Page Level)

Feature Extraction (using Pre-Trained Convolutional Neural Networks)

Classification

Prediction Decision

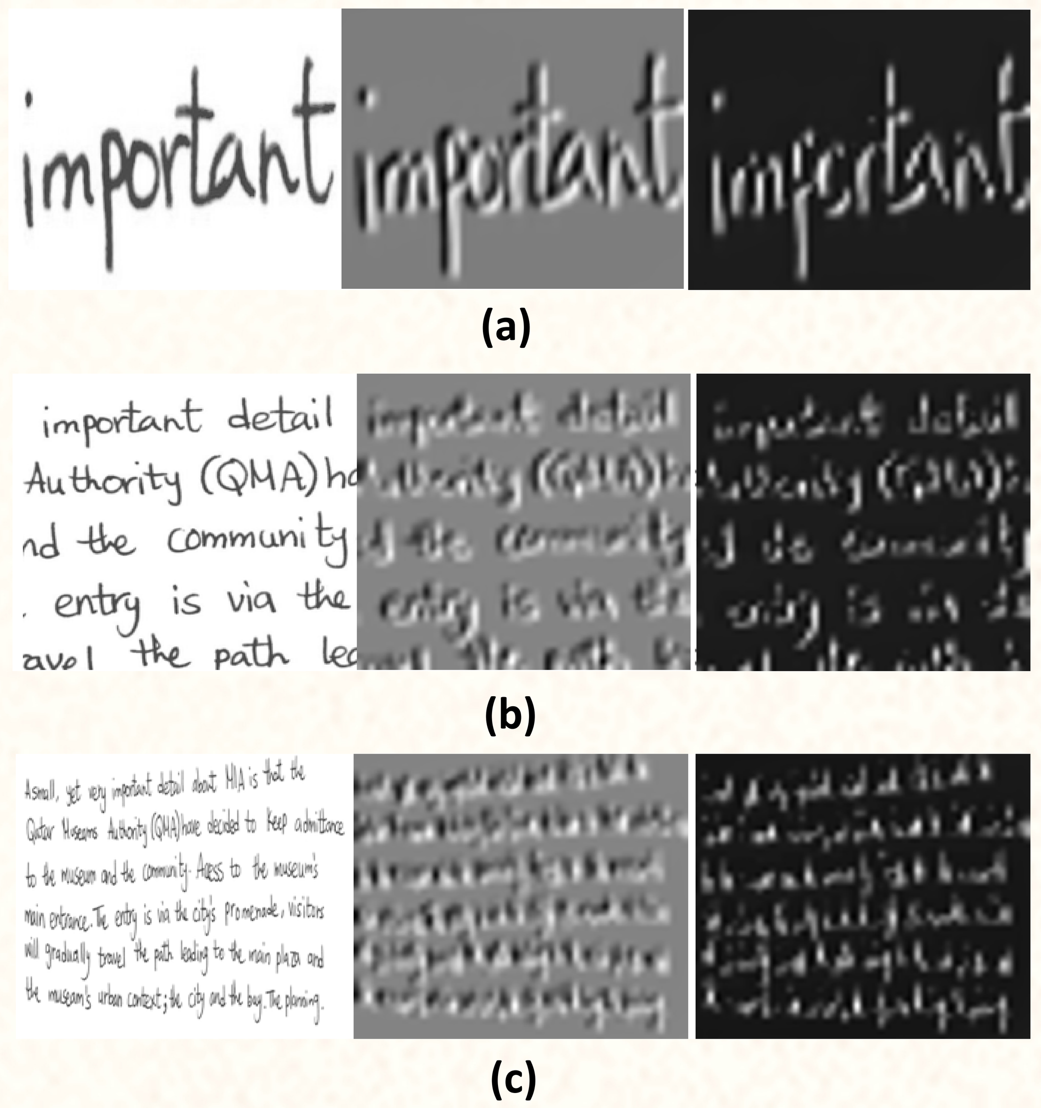

Fig 2: Samples and Activations at (a): Word Level (b): Patch Level (c): Page Level

3 • EXPERIMENTAL PROTOCOL

Dataset	QUWI-English QUWI-Arabic
Training : Testing	700 Writers : 300 Writers
Pre-Trained ConvNet	AlexNet
Classifiers	SVM, LDA, NB, DT
Evaluation Scenario 1	Text Dependent vs. Text Independent
Evaluation Scenario 2	Script Dependent vs. Script Independent

4 • RESULTS & ANALYSIS

Image Scale Level	Classifiers			
	LDA	NB	SVM	DT
Word	**67.75%**	65.41%	63.66%	64.33%
Patch	**70.08%**	**67.16%**	**65.03%**	**65.58%**
Page	**68.50%**	66.75%	64.66%	64.33%

Dataset	Text Dependent			Text Independent		
	Word	Patch	Page	Word	Patch	Page
English	68.33%	**73.33%**	70.33%	67.33%	**72.00%**	69.33%
Arabic	64.66%	**71.66%**	69.66%	65.33%	**70.66%**	66.33%

	Training Set	Testing Set	Word	Patch	Page
Script Dependent	English	English	68.50%	71.50%	70.83%
	Arabic	Arabic	63.66%	69.83%	68.83%
Script Independent	English	Arabic	67.50%	65.16%	64.50%
	Arabic	English	60.83%	64.83%	63.83%

- Highest accuracy achieved with **CNN-LDA** combination at **patch level**
- **Comparative performance** with state-of-the-art:
  - Using ICDAR 2015 gender classification competition protocol
  - Using larger datasets

5 • CONCLUSION & FUTURE DIRECTIONS

An experimental study is presented to evaluate the performance of state-of-the-art deep convolutional neural network based feature extraction to classify gender from offline handwriting. Features were extracted from writing samples by changing the scale of observation and comprehensive series of experiments were carried out. Work can be extended in following directions:

A comprehensive series of experiments can be carried out using other pre-trained models.

Fine tuning of pre-trained models can be done by continued back propagation on the images.

Training a network from scratch at word, patch or image levels to allow deeper insights into what writing features contribute to characterize gender can be considered.