

Handwriting

Saki Sakakihara (Moderator)
Masaki Nakagawa
Clement Chatelain
Yoshinobu Hotta (Scribe)

Past Result

- US Post Office address, state, and zip code recognition (~60% recognition with ~90% after redundancy check)
- Commercial OCR (Arabic similar to cursive)
- Microsoft tablet PC
- PDAs : Online training on individual cooperative user (poor result, market is small)
- CedarFox : Forensic handwriting analysis
- Signature Matching
 - popular (US), minor (Japan) -> difference of culture
- Automated scoring of handwritten essays (limited lexicon)
- Numeric values on bank checks
- Machine print versus handwriting classifier

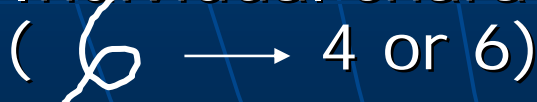
Data

Easy	Difficult
Online	Offline
Limited or small character/word set (e.g. Latin, Katakana, Hiragana)	Unlimited or large character/word set (e.g. Kanji 4000+)
Clean	Noisy
Segmented (form boxes)	Unsegmented
Unconnected characters	Connected or semi-connected characters
From cooperative user	from unknowing user
Good ink	Carbon copy ink, old ink
Good paper	historical paper

Challenges

- Variety of writing (font, style, size, etc. not discrete)
- Segmentation
- Inconsistent skew
- Inconsistent connectivity
- Historical document (bad ink, paper)
- Background lines, figures, graphs, tables
- HUGE training set needed to accommodate variability

How handwriting is different from traditional OCR

- Traditional
 - Filter
 - Deskew
 - Segment
 - Training models
 - Recognize
 - Evaluate
- How should handwriting steps differ ?
 - Possibly combine segmentation and recognition
 - Segmentation at word and/or character level
 - Line model to find ordering of words on line
 - Individual character consistency
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Algorithms

- For handwritten recognition and speech modeling and/or classification
 - SVM (accurate)
 - Neural Network (MLP) (accurate and fast)
 - cross correlation
 - Bayesian Net
 - HMM seems best option : modeling & classifier
 - Conditional random field
 - Classifier ensemble method

Future Work

- Handwritten lecture whiteboard notes searchable by students combined with handwriting & spoken words
- Recognition of handwritten figures, tables
- Memos extraction and recognition
- Degraded / photographed handwriting recognition
- Ultimate goal is accurate, fast, offline recognition in unconstrained environment by unknowing/uncooperative user
- Timeline and budget unknown