Modeling & Analyzing Development of Scripts

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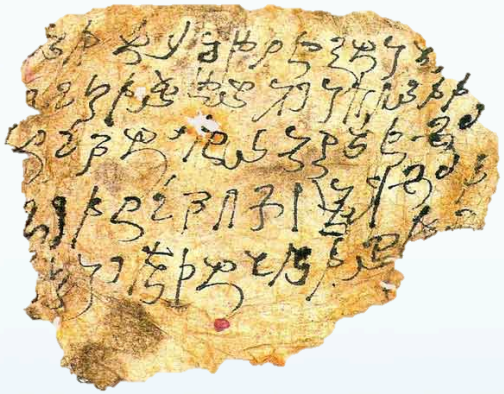
Writing !

Writing is possibly the most earliest visualization technique innovated by humans (and perhaps the most useful one as well ☺) which is still evolving



Different Interfaces but same technique !

user + Medium + Implement

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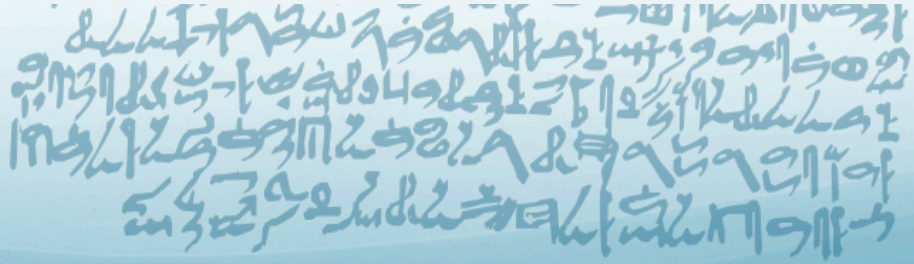
Writing System

[1]A set of visible or tactile signs used to represent units of language in a systematic way

PHONOGRAPHIC WRITING SYSTEMS, MORPHOGRAPHIC WRITING SYSTEMS ETC.

[2]System of representing a particular language (in written form) by specific rules

ENGLISH WRITING SYSTEM, JAPANESE WRITING SYSTEM ETC.



Vivian Cook et al (2007)

Script

Script is the physical representation of the writing system.

Runic

Α Β Γ Δ Ε Ζ Η Θ
Ι Κ Λ Μ Ν Ξ Ο Π
Ρ Σ Τ Υ Φ Χ Ψ Ω

Greek

Phoenician

It is comprised of a set of graphic signs having a distinct identity

Components

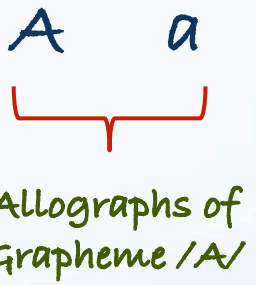
Grapheme

Contrastive unit of a Script

Analogous to Phonemes in Phonology

Allograph

Distinctive variant of a single underlying Grapheme (within a specific context)



Allographs of Grapheme /A/

Analogous to Allophones in Phonology

Graph

Visual realization of the Grapheme either Typographic or Handwritten

Graphic variants

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Structure of a Glyph

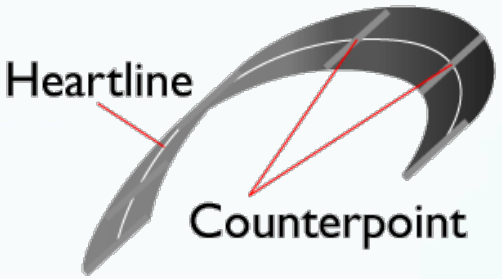
http://www.computer.org/csdl/trans/tg/2010/01/ttg2010010161-abs.html

Stroke

Stroke is the fundamental unit of handwriting. All handwritten characters are composed of strokes

Up stroke

The stroke that moves away from the person



Down stroke

It moves towards the person

Graphetics

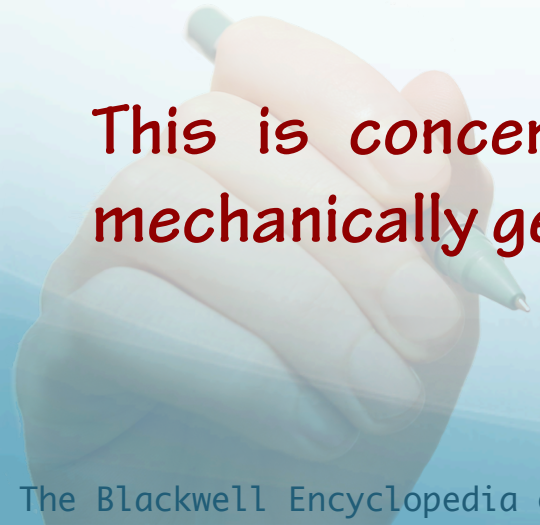
The study of physical properties of written signs

Visual Graphetics

It investigates the visual features of written signs.

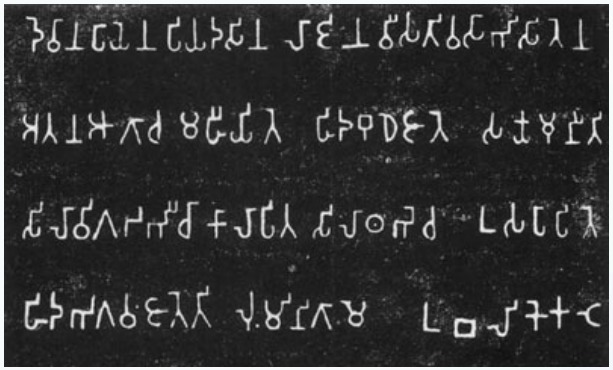
Mechanical Graphetics

This is concerned with the how written signs are mechanically generated



Brahmi

The Mother of (most) S. Asian & S.E Asian Scripts !



(Probably) Begins with Asoka circa 300 BCE

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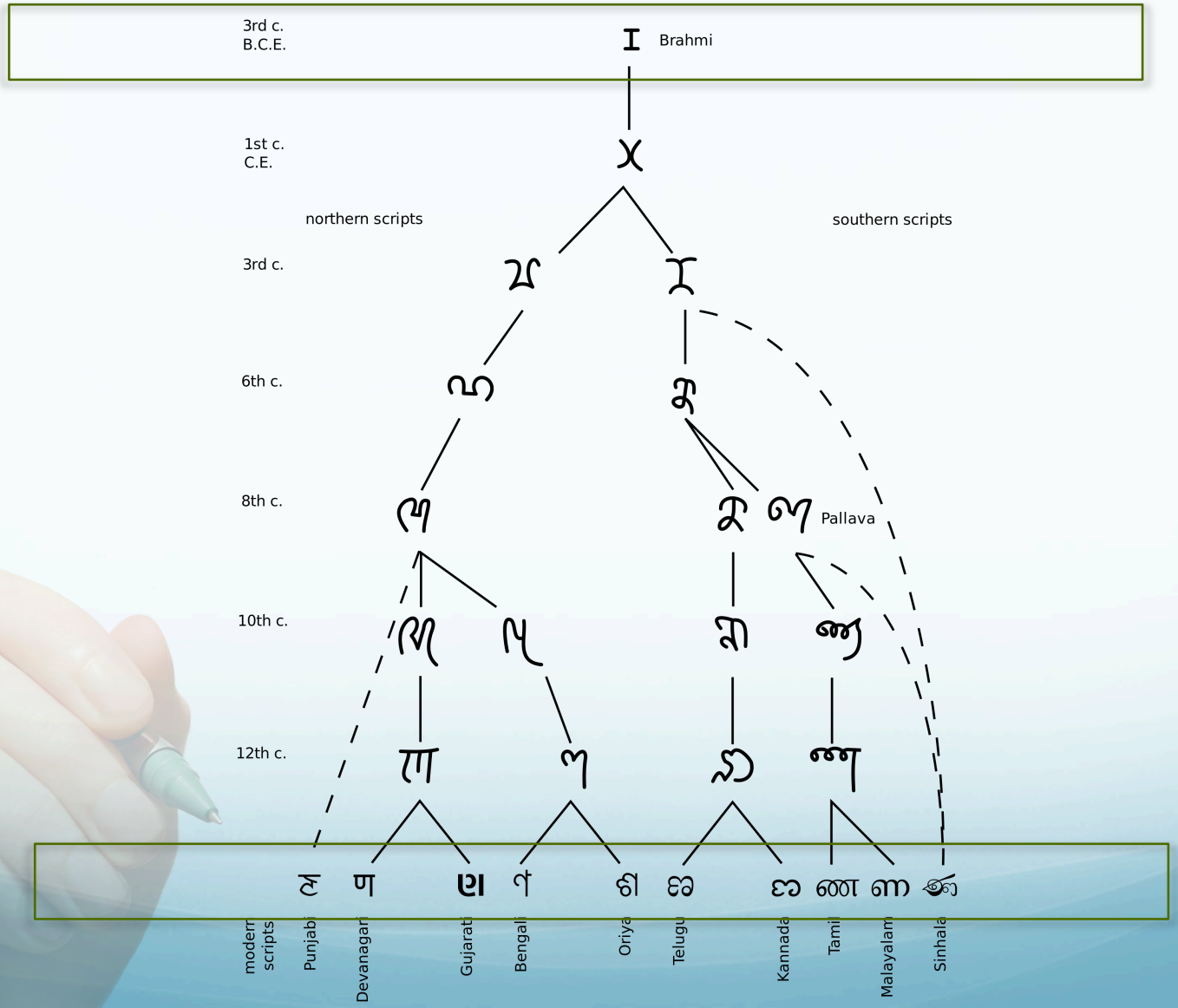
Development of Brahmic family of Scripts



Changes in Scripts

Why do scripts change in appearance ?

Devanagari Script

~300 BCE ~1600 CE

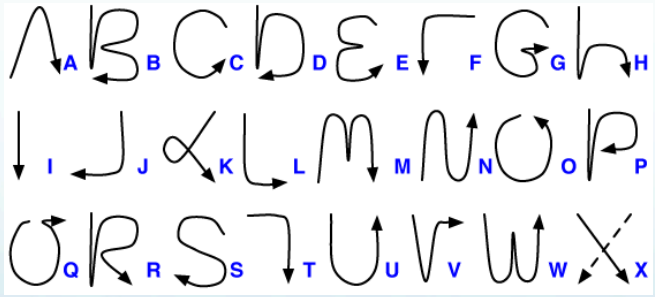
Grantha Script

Writing Medium

Kinematics of the Medium-Implement play a major role in the appearance of writing

WRITING ON A PAPYRUS WITH A REED PEN ISN'T THE SAME AS USING A TABLET AND STYLUS !

Constraint imposed by the Medium



Palm PDA Graffiti Alphabet

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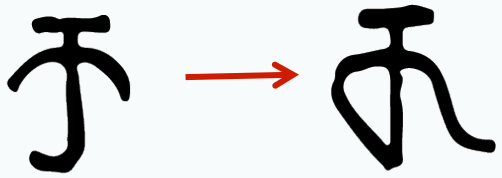
Stroke Reduction

Writing tends to evolve towards minimizing the effort required to produce a grapheme.

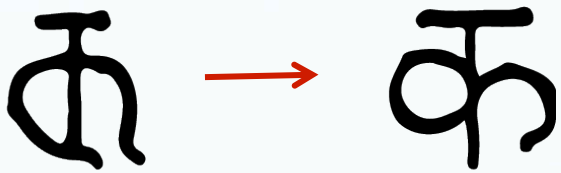
Reducing pen lift



Fusion of strokes

Stroke Re-ordering

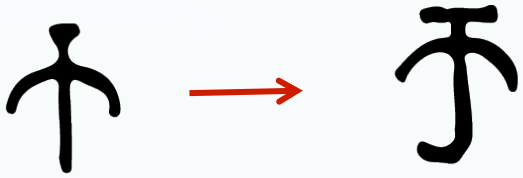
Strokes are sometimes are re-ordered and the writing procedure of a grapheme is modified



The re-ordering of the strokes generate a different stroke behavior & interaction resulting in a different shape !

Stroke Augmentation

Incorporation of incidental handwriting artifacts, glitches, onset marks into the main skeleton of the Grapheme



Retraces morphing into loops

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Aesthetics !

"Human Beings are a curious, fickle, and whimsical lot who love to fiddle and amuse themselves by change !"

RICHARD SALOMON

Some modifications made to the characters were just to make it more ornamental.

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Handwriting Modeling

The processes involved in the production of handwriting are numerous & very complex !

So How do we Model Handwriting ?

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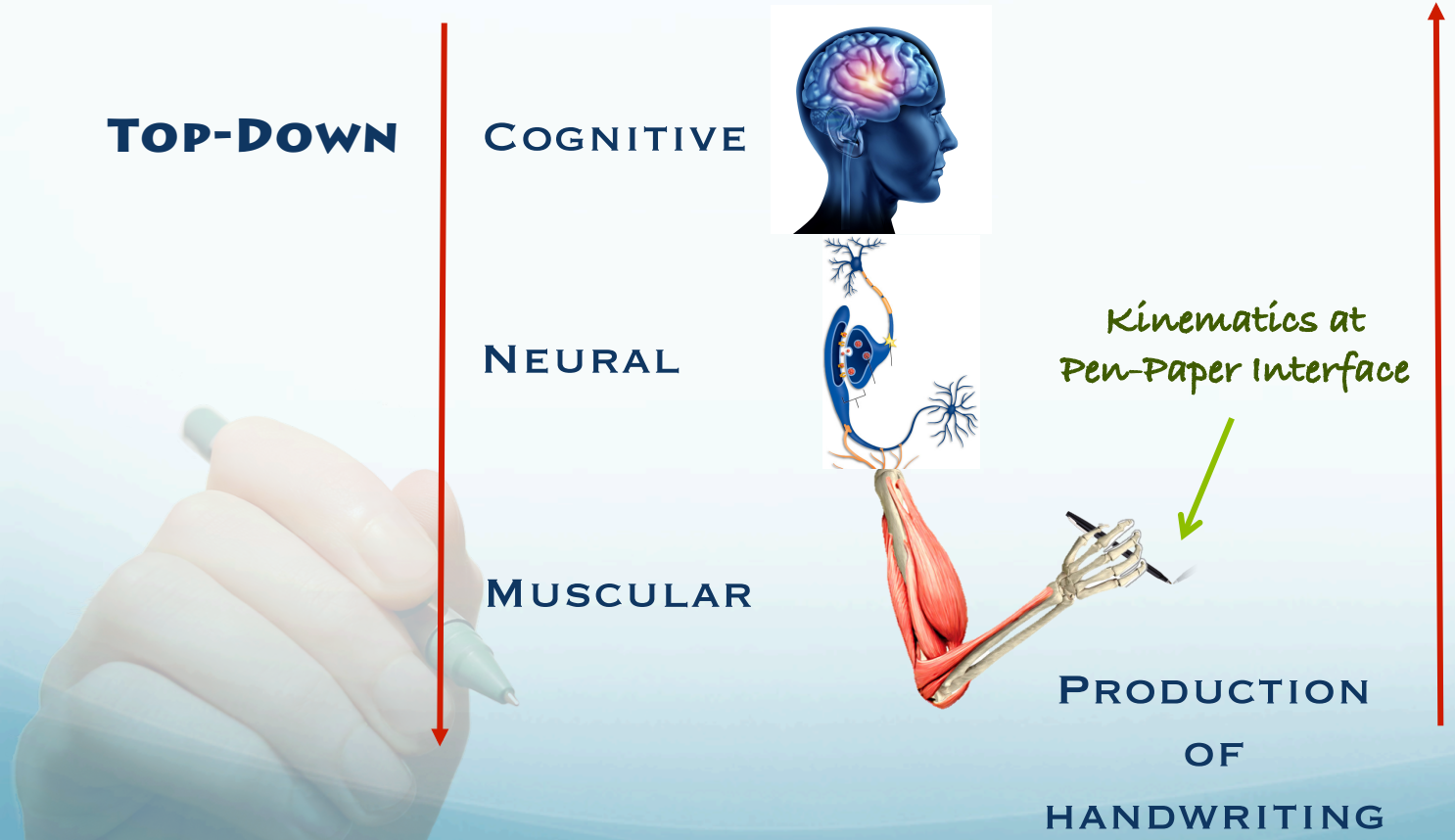
Movement Simulation

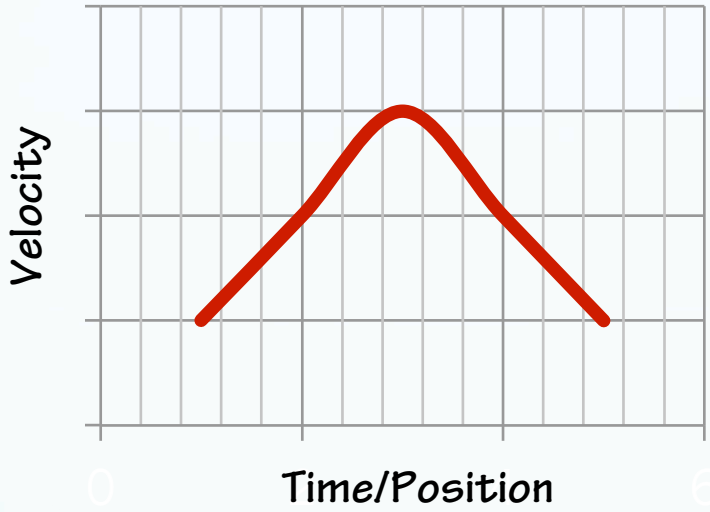
Modeling the actual Cognitive-Neural-Muscular processes involved in the production of handwriting



Réjean Plamondon (1989)

Kinematics of Handwriting

Different dynamics produce different shapes



Stroke

The shape of the stroke can be controlled via simulated Kinematic parameters

Other parameters:

- Pen pressure
- Jerk
- Angular velocity

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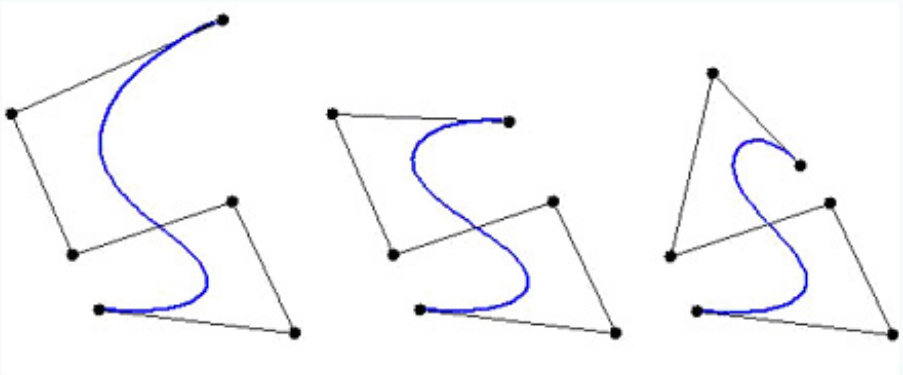
Shape Simulation

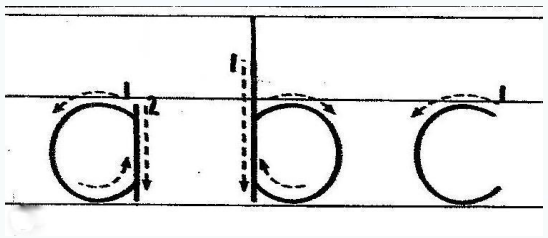
Doesn't involve any dynamics of the handwriting process. Only depends on the written trajectory of the character

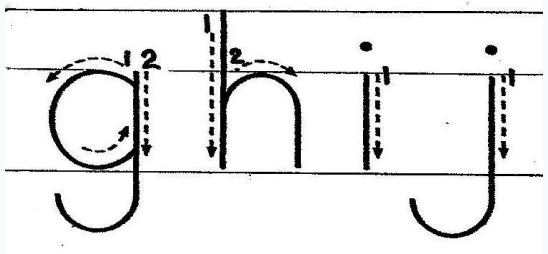


Handwriting variations are modeled in terms of shape change

Trajectory Reconstruction

Temporal information i.e written trajectory is required to simulate the kinematics of the production





The trajectory of the character also allows several additional features to be computed

David S. Doermann et al (1992)

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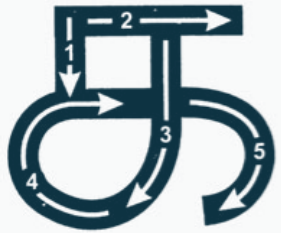
How to Reconstruct ?

By applying a set of heuristics on the static shape of the character, the trajectory can be obtained

Map → GRAPH → Generate → EULERIAN PATHS → Evaluate & Rank



GLOBAL HEURISTICS

- LENGTH MINIMIZATION
- CURVATURE MINIMIZATION
- DIRECTION OF WRITING
- STARTING AND ENDING POINTS
- AND OTHER SCRIPT LEVEL HEURISTICS...

Stefan Jäger (1996)

Stroke Segmentation

Predicting major "landmark points" in a glyph that are crucial to the shape/formation of the glyph

The character is broken down to primitive strokes.

Also, the appearance of the character can be altered by modifying their landmark points (via shape simulation)

Xiaolin Li et al (1997)

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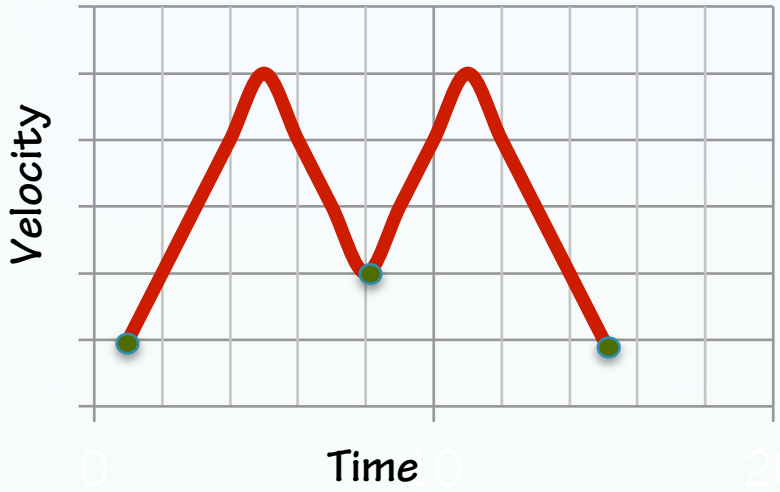
Method for Segmentation



- Extreme Curvature Points
- Pen Lift points
- Inflection Points
- Disjoint Points

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My Current Work (:

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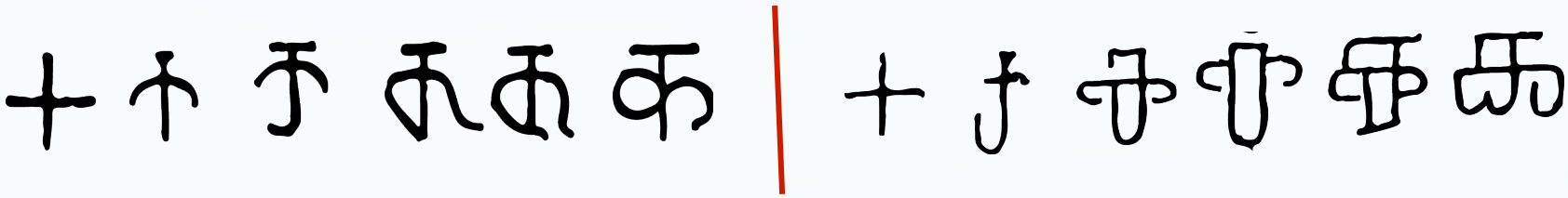
Analysis

Let's say we have two (or more) sets of written symbols how do we compare and analyze them ?



QUANTIFY THE FEATURES INTO DEFINED METRICS

PERFORM VISUAL COMPARISON

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Deriving Metrics

Based on Glyph Shape, Stroke Segmentation, and Reconstructed Trajectory various metrics of the glyph/script are derived

Static Metrics

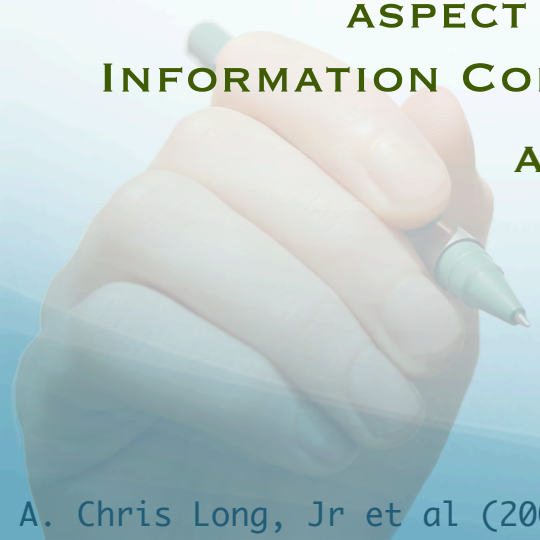
- Openness
- Compactness
- Density
- aspect
- Information Complexity

And more ...

Dynamic Metrics

- Disfluency
- Production Complexity
- Pen Lift
- Primary direction
- Direction Change

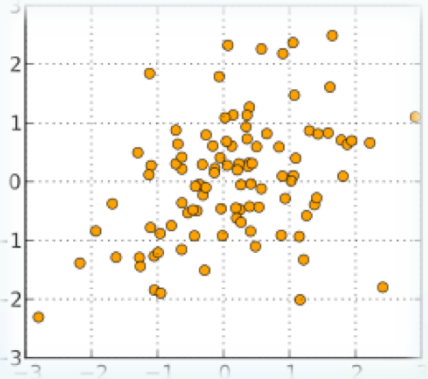
And more ...



A. Chris Long, Jr et al (2000)

Discovering Patterns & Correlations

Underneath the heap of quantified data with multitude of dimensions there should be some interesting patterns and correlations



Probably, it can throw more light on the evolution process & human handwriting behavior

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Future Work

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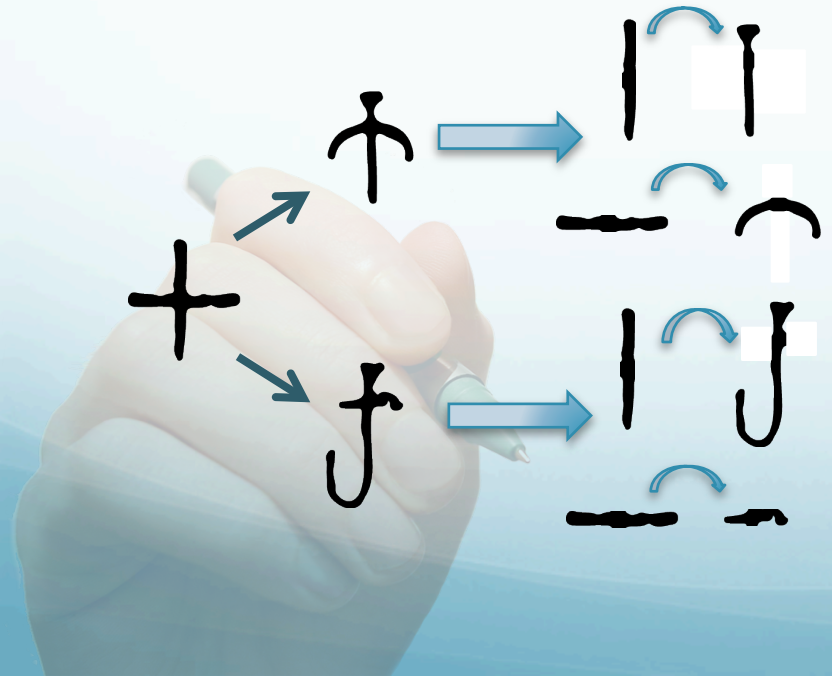
Stroke level Analysis

Apart from number crunching, any two related character can be compared at the stroke level

Stroke Correspondence



Comparing Stroke Inventory of the scripts

Comparing Stroke Patterns

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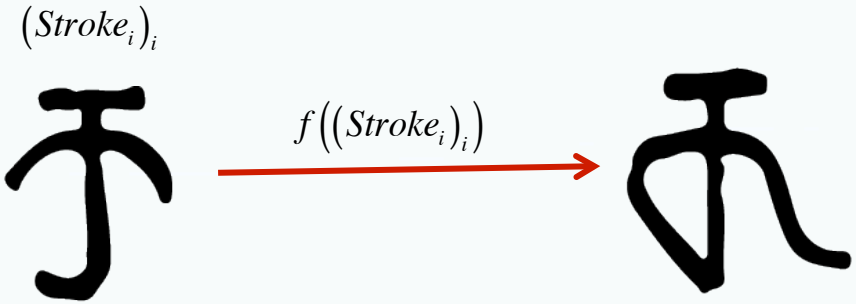
Actual Modeling !

Attempting to describe the shape changing behavior of the script via Handwriting Modeling



The change could probably be modeled by combining the Movement and Shape simulation models

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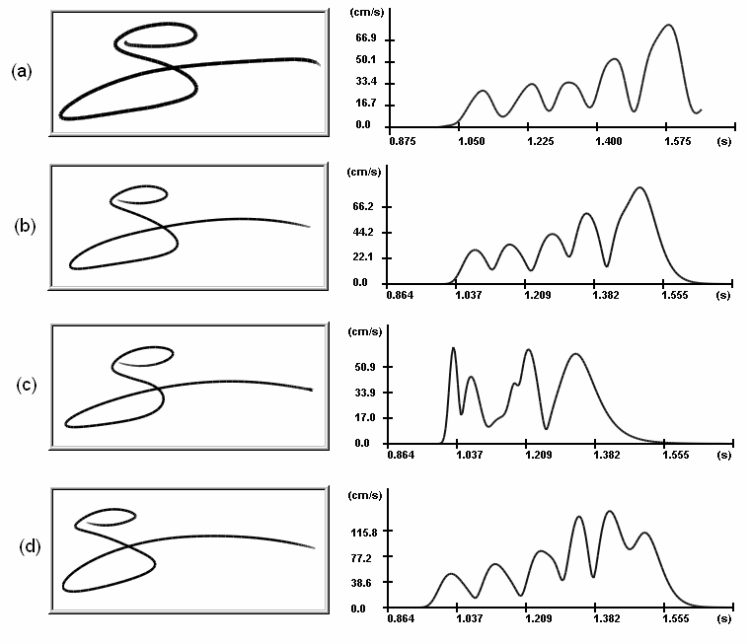
Shape Change Model

By modifying the parameters of the model, the effect of various factors on the shape change could be studied.



Moussa Djioua et al (2006)

Reconstruction of Intermediate Forms

Predicting the intermediate forms and the possible shape change path

VISUALIZE !

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THANK YOU

"Writing, oh Pharaoh, will make the Egyptians wiser [...] It is the recipe for both memory and wisdom."