

Abstract

Complex shapes can be constructed hierarchically as a combination of smaller primitive shapes meeting certain geometric constraints. However, in order to construct higher level shapes, it is imperative to accurately recognize the lower-level primitives. Gesture features like Rubine features require extensive training. More significantly, results from feature subset selection indicate that geometric features aid the recognition process more than gesture-based features when given naturally sketched data.

What are Rubine's Features?

They are the following listed gesture based features for sketch recognition:

- Cosine of initial angle
- Sine of initial angle
- Size of bounding box
- Angle of bounding box
- Distance between first and last points
- Cosine of angle between first and last points
- Sine of angle between first and last points
- Total length
- Total angle
- Total absolute angle
- Sharpness
- Total Time
- Maximum Speed

Why Rubine's Features Fail?

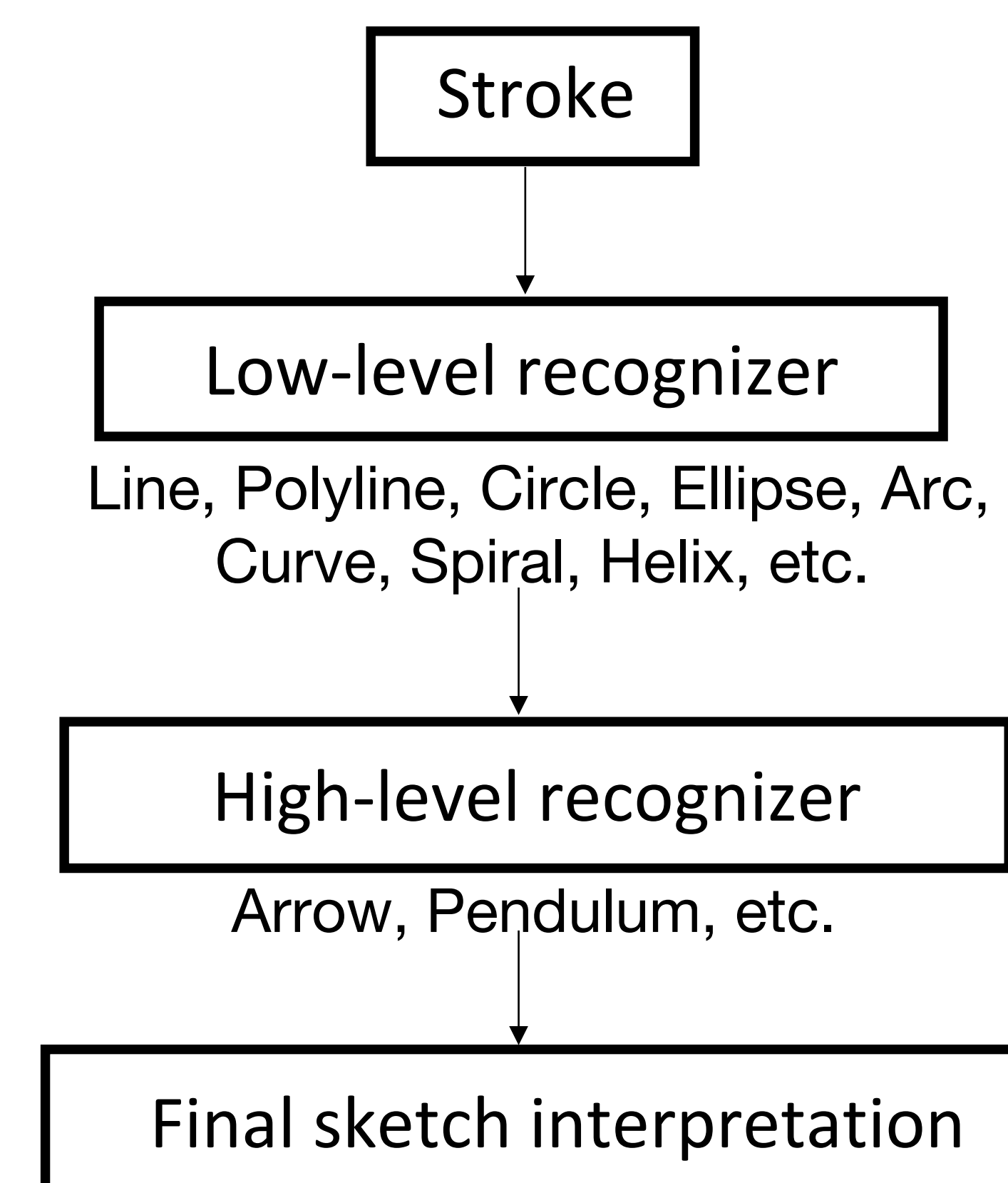
- Gesture features require extensive training
- Strokes has to be drawn in the same manner each time.
- Rubin features are proved to be helpful in recognizing two-dimensional gestures, but not for natural sketch recognition problems. The accuracy of these approaches is not optimal.

Non-Rubine Features

Complex shapes can be constructed hierarchically as a combination of smaller primitive shapes meeting certain geometric constraints. It is imperative to accurately recognize the lower-level primitives. Geometric features aid the recognition process more when given naturally sketched data, like following:

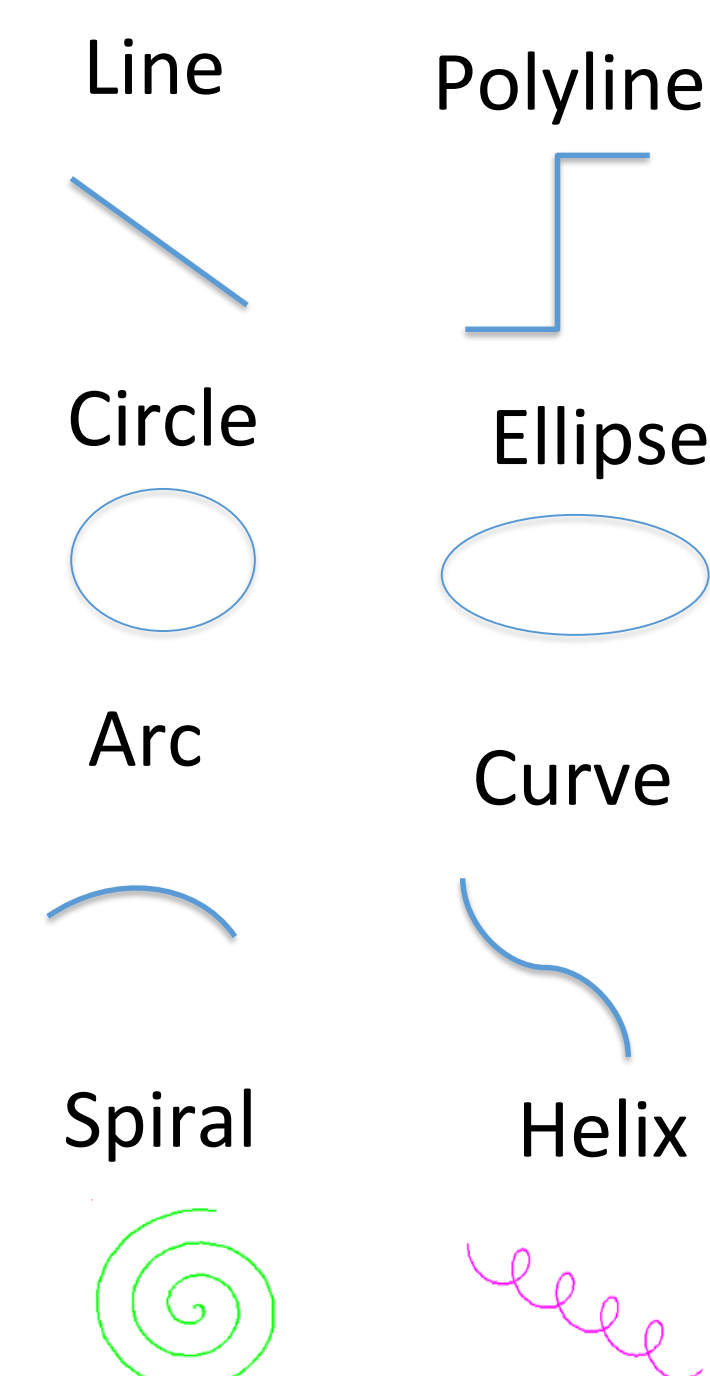


Complex Shapes Recognition:



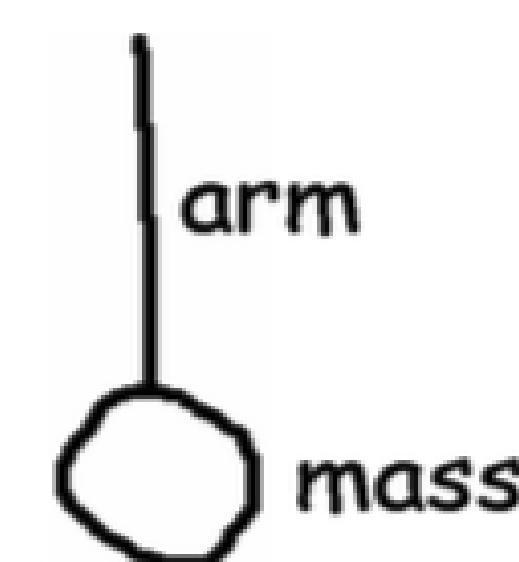
Low-level Recognizer:

1. Support primitive shapes
2. Accurate
3. Natural drawn
4. Handle noise and orientations



High-level Recognizer:

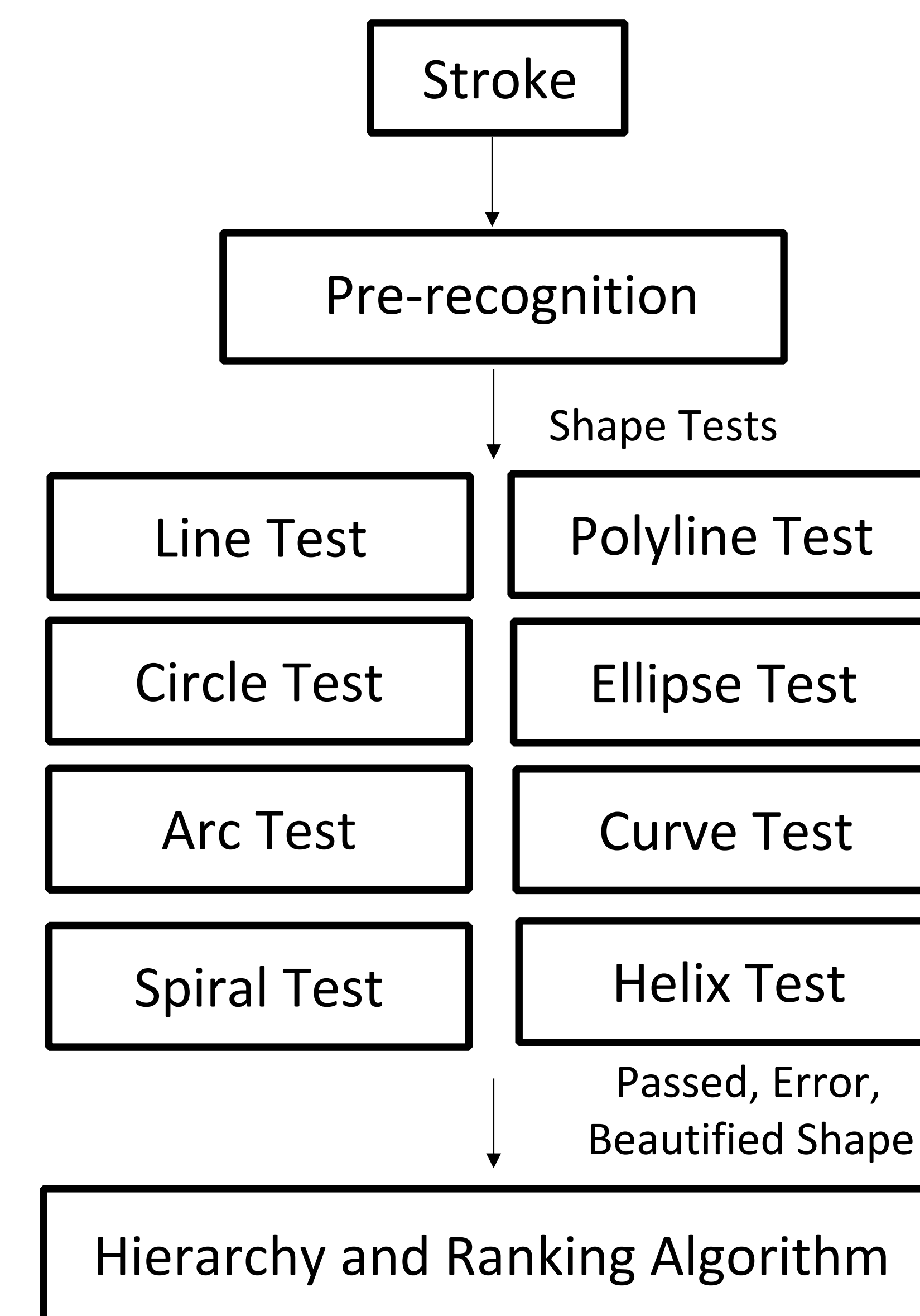
1. Shapes drawn in any order
2. Any number of strokes
3. Interspersed



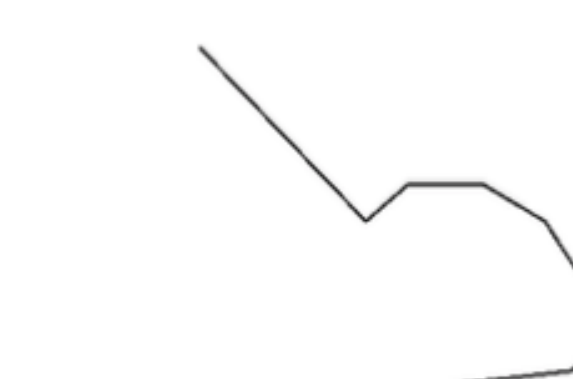
Pendulum constructed from lower level primitives (line, circle)

Geometric Features:

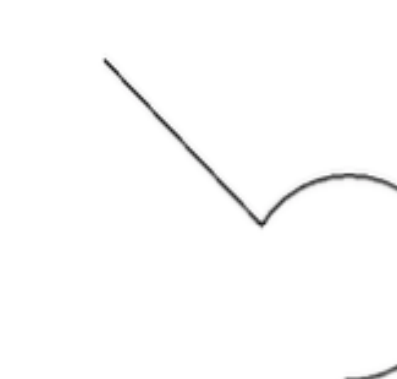
31 features are geometric-based (44 features in total [1]) 14 optimal geometric features selected based on Polyline and Complex test in PaleoSketch system



Line (1), Arc (3), Curve (5), Circle (5), Ellipse (5), Helix (5), Spiral (5)



Polyline Interpretation
8 lines
Score: 8



Polyline Interpretation
1 line and 1 arc
Score: 4

Implementation

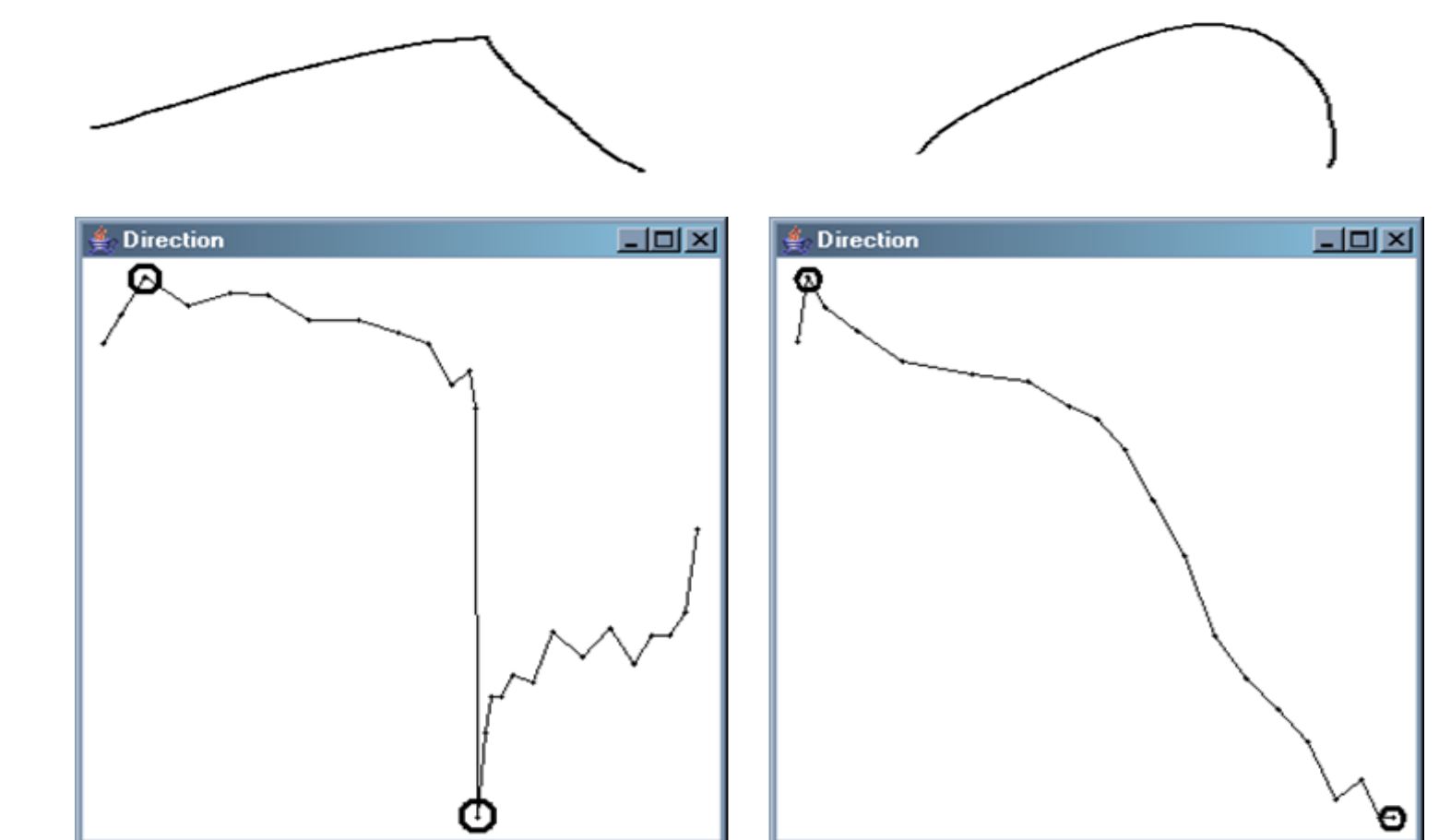
Pre-Recognition:

Remove duplicates, Compute Graphs, Remove Tails, Overtraced Test, Closed shape Test, Corner Dection

NDDE and DCR

NDDE: Normalized distance between direction extremes

DCR: Direction change ratio



NDDE = 0.551

NDDE = 0.995 [2]

Polylines

Sub-strokes pass line test
Area error less than threshold
High **DCR** value

Ellipses

Pass closed shape test
Area error less than threshold
High **NDDE** value

Results

	Without Geometric Features	With Geometric Features
Accuracy (Correct Interpretation)	93.33 %	99.89 %
Accuracy (Top Correct Interpretation)	67.56 %	98.56 %

References

- [1] Paulson, B., Hammond T., PaleoSketch: accurate primitive sketch recognition and beautification, Proceedings of the 13th international conference on Intelligent user interfaces, January 13-16, 2008, Gran Canaria, Spain.
- [2] Paulson, B., Rajan, B., Davalos, P., Hammond, T., Gutierrez-Osuna, R., What!?! No Rubine Features?: Using Geometric-based Features to Produce Normalized Confidence Values for Sketch Recognition.