Ming Hsieh Department of Electrical Engineering

USC Viterbi School of Engineering

Fully Automated Segmentation of Mitochondria Based on Morphological Feature Learning

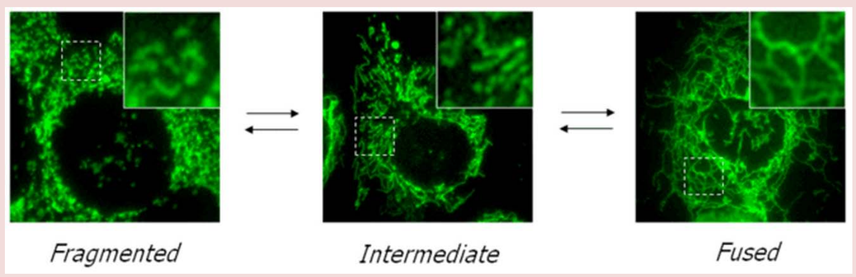
Xue Wang[1], Jing Zhang[1], Chun-Nan Hsu[2], and C. –C Jay Kuo[1]

[1] Dept. of Electrical Engineering, University of Southern California, [2] Division of Biomedical Informatics, Univ. of California, San Diego

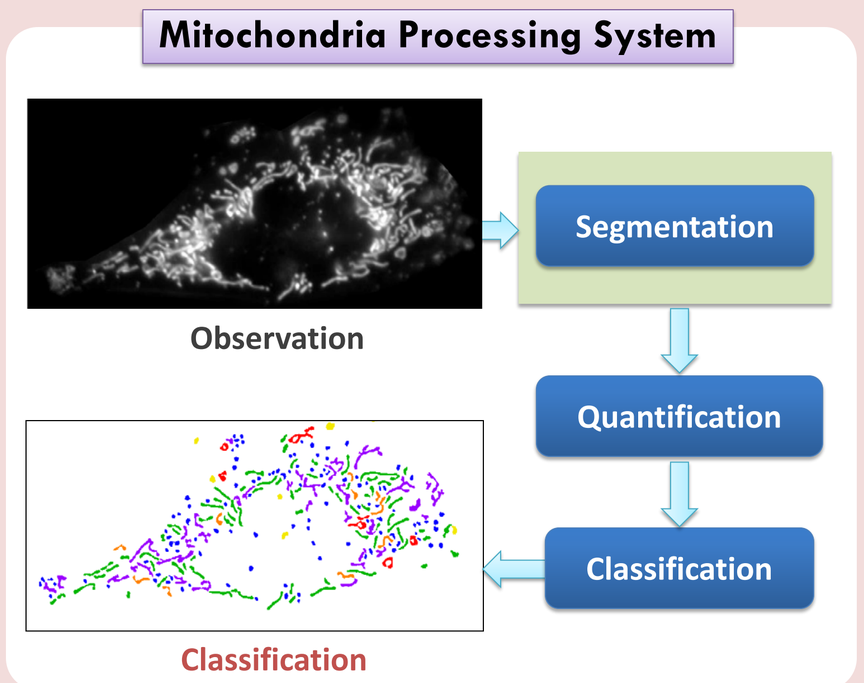
Background Review

Characteristics of Mitochondria

- Dynamic organelles
- Fusion and fission processes
- Diverse morphological structures
- Correlated with important biological functions

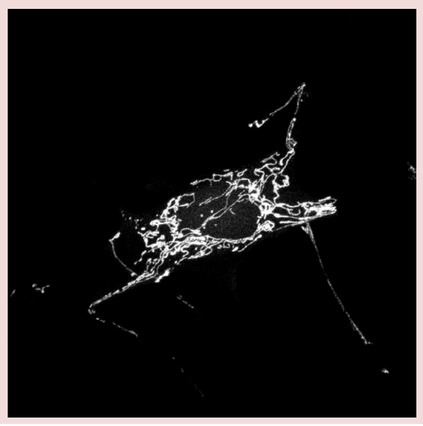


Mitochondrial morphology of MEF cells [1]



Challenges

- Inhomogeneity in background intensity, signal-to-background ratio, and SNR
- Diversity of morphological structures



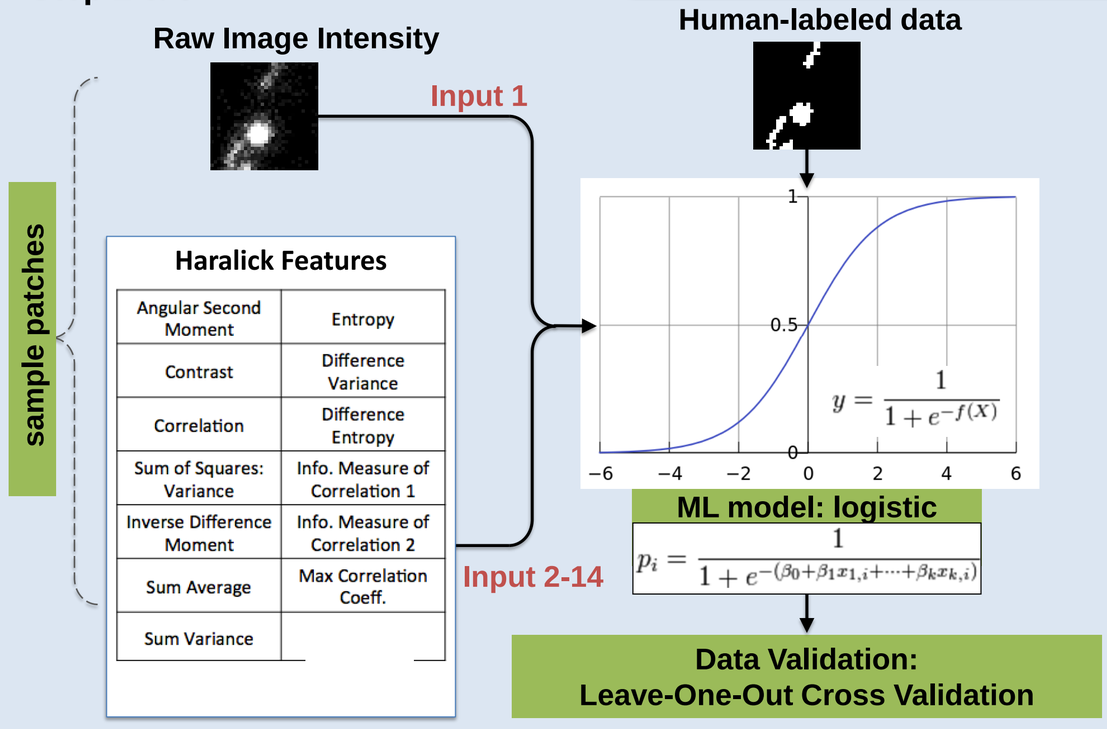
Proposed 2-stage Approach for Mitochondria Segmentation

- **Pre-Processing**
  image →non-overlapped patches
- **Step 1. Input Data Grouping**

$$R = \frac{Local\ Variance\ of\ Patch}{Global\ Variance\ of\ Image}$$

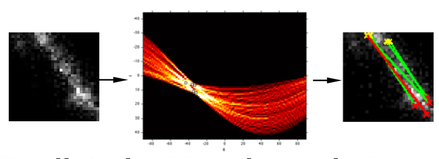
Group the patches by R $[R_{min}, 1), [1, 5]$ *and* $(1, R_{max}]$

- **Step 2 & 3**



- **Step 4. Otsu's Method** [2]

- **Step 5. Connection of Break-outs**



$$C(i,\ j) = \begin{cases} \infty\ , & i = j \\ a_1 \cdot c_1 + a_2 \cdot c_2 + a_3 \cdot c_3\ , & i \neq j \end{cases}$$

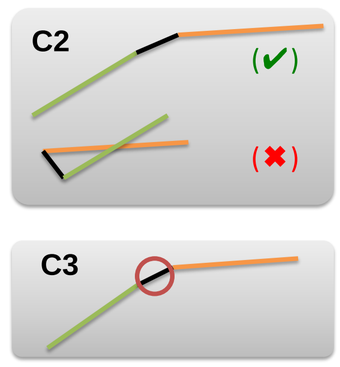
where
c_k *is* k^{th} *cost component, and*
a_k *is the importance weight of* c_k, *with* $k = 1, 2, 3.$

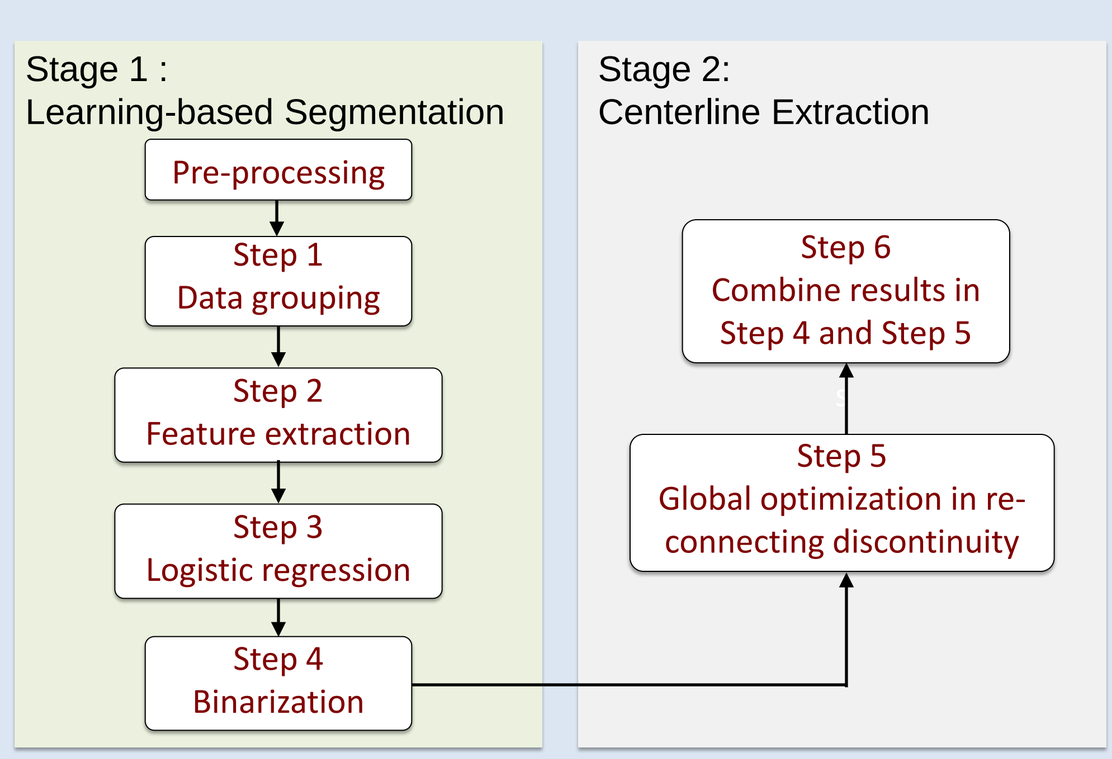
c1: cost of **distance**

c2: cost of **Angular Mismatch**

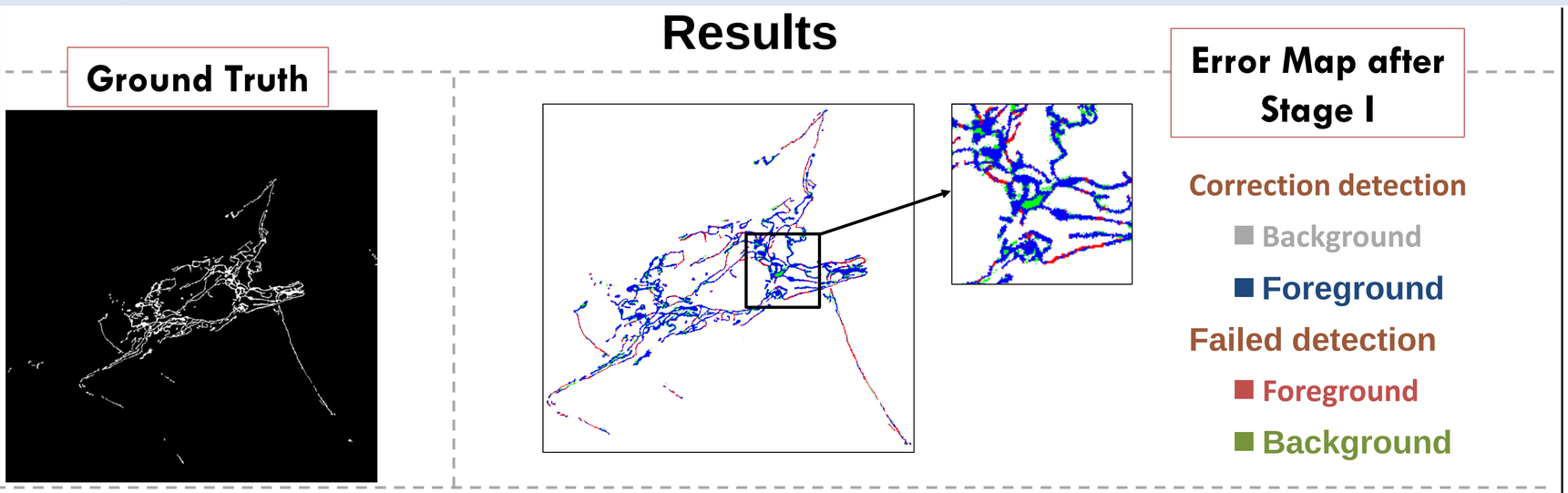
c3: cost of **Variance Contrast**

$$c_3 = \frac{\sigma_{line} + \sigma_{disk}}{\mu_{line} - \mu_{disk} + eps}$$





Results



Conclusion

- 2-stage Approach for Mitochondria Segmentation
  - Regression-based Mitochondrial Objectiveness Estimation
  - Optimal-algorithm Based Centerline Extraction
- Automatic segmentations
- Reduce morphological errors

1. http://www.unige.ch/sciences/biologie/bicel/Martinou/research.html
2. Nobuyuki Otsu, "A threshold selection method from gray-level histograms", 1979.

Ming Hsieh Institute
Ming Hsieh Department of Electrical Engineering