

New Scalable Algorithms for

- Image Analysis and Pattern Recognition
 - Robust Statistics for background modeling, parametric model fitting
 - Spectral Graph Theory for Image Segmentation/Clustering
 - Perceptual distance normalization for pattern detection and classification
- Correlated Network Analysis
 - Use higher-order statistics to find heterogeneous sub-populations
 - Exploit long-tail distributions
- Time-series Modeling
 - High-order auto-regressive models

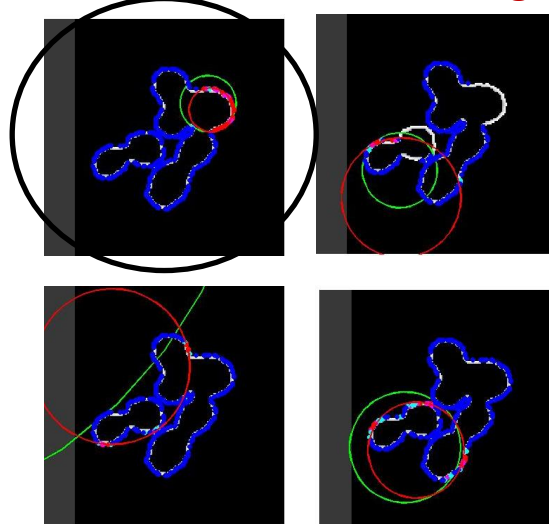
1. Robust Statistics for Image Analysis

- (i) Single-cell segmentation ; background modeling
- (ii) Automated pattern characterization across cells and cell types
- (iii) Identify and track individual cells and cell sub-populations
- (iv) *Efficient large-scale implementation*

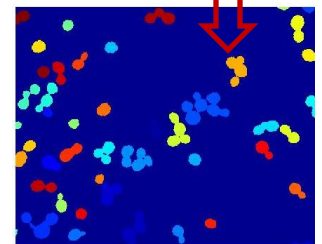
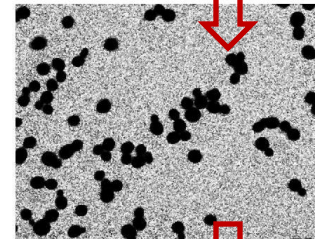
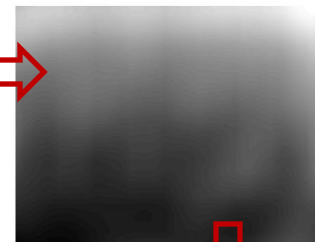
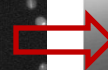
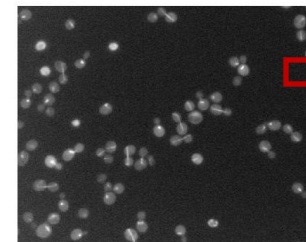
Segmentation



Parametric Model Fitting

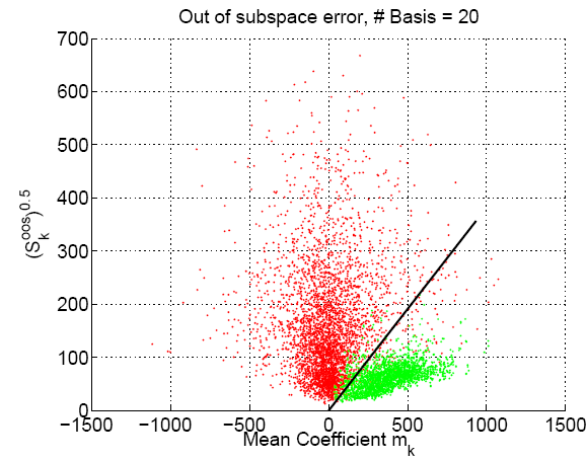


Background Modeling

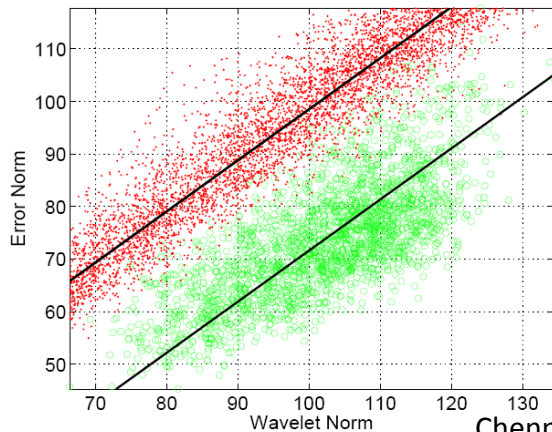


Chennubhotla & Jepson ICCV (2001)
Estrada, Jepson & Chennubhotla BMVC (2004)

2. Pattern Recognition



M = 50



Chennubhotla & Jepson ICPR(2002, 2004)

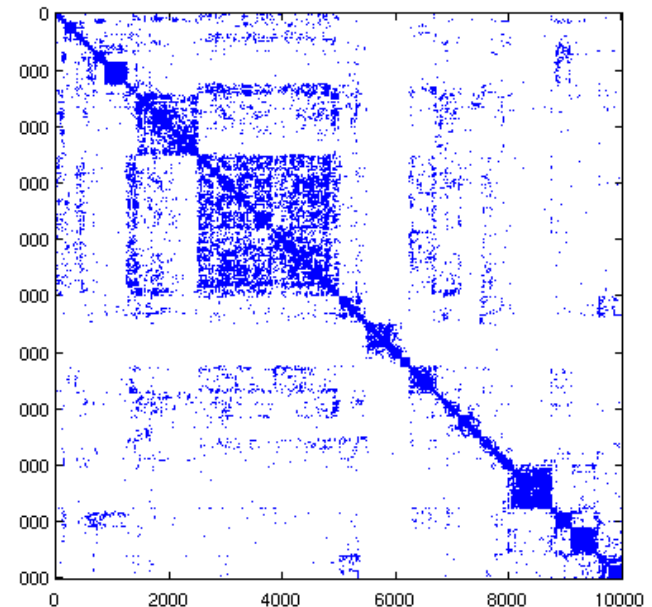
How to beat
a Support
Vector
Machine?

- Be smart on contrast normalization
- Use linear model and small amounts of non-linearity
- Model: Perceptual Distance Normalization

3. Clustering

- Use similarity mapping to find bottlenecks and other properties
- EigenCuts

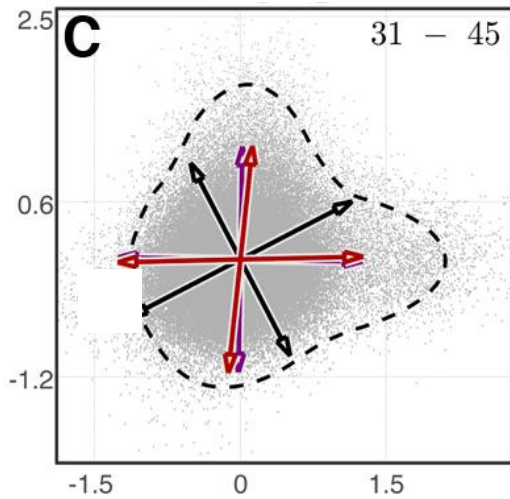
↓ Find Bottlenecks



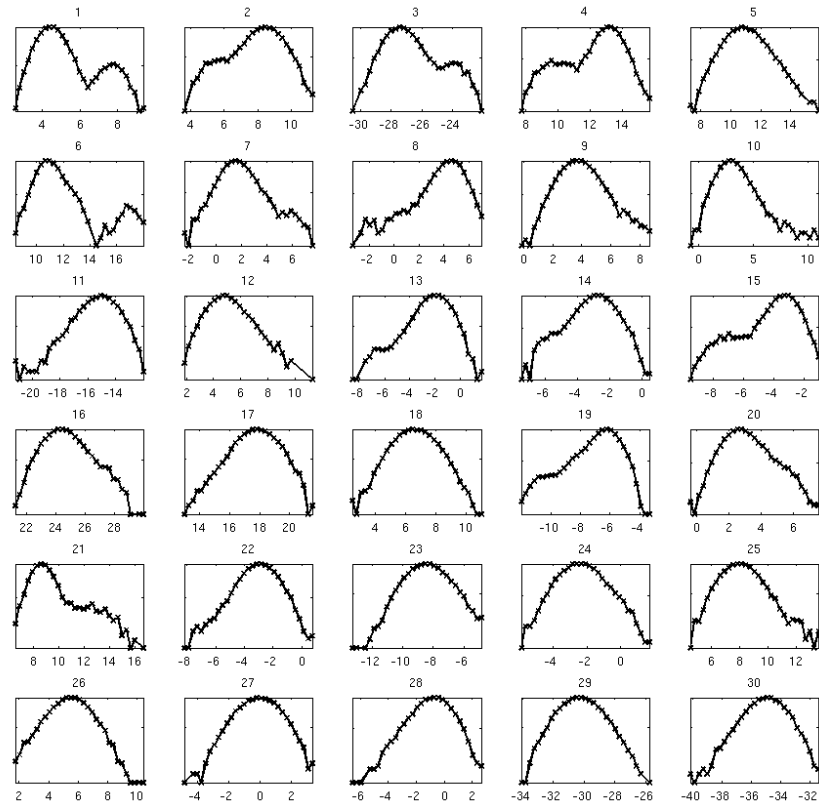
Chennubhotla & Jepson NIPS (2005, 2003)

4. Correlation Analysis

1. Find heterogeneous sub-populations
2. Exploit long-tailed distributions



Find sub-populations in low-dimensional spaces



References

- Ramanathan, A., Savol, A., Langmead, C., **Agarwal, P. & Chennubhotla, C.** (2011) Discovering conformational sub-states relevant to protein function. PLoS One Accepted.
- **Chennubhotla, C.** & Jepson, A. (2005) "Hierarchical Eigensolver for Transition Matrices in Spectral Methods" *Advances in Neural Information Processing Systems (NIPS)* **17**, L. Saul, Y. Weiss and L. Bottou eds, MIT Press, Cambridge, MA, 273-280.
- Estrada, F., Jepson, A. & **Chennubhotla, C.** (2004) "Spectral Embedding and Min-Cut for Image Segmentation" *British Machine Vision Conference (BMVC)*, London, U.K.
- **Chennubhotla, C.** & Jepson, A. (2004) "Perceptual Distance Normalization for Appearance Detection" *International Conference on Pattern Recognition (ICPR)*, Cambridge, U.K. Vol 2: 23-27.
- **Chennubhotla, C.** & Jepson, A. (2003) "Half-Lives of Eigenflows for Spectral Clustering" *Advances in Neural Information Processing Systems (NIPS)* **15**, S. Becker, S. Thrun and K. Obermayer eds, MIT Press, Cambridge, MA, 689-696.
- **Chennubhotla, C.**, Jepson, A. & Midgley, J. (2002) "Robust Contrast-Invariant EigenDetection" *International Conference on Pattern Recognition (ICPR)*, Quebec City, Canada Vol 2: 745-748.
- **Chennubhotla, C.** & Jepson, A. (2001) "Sparse PCA: Extracting Multi-Scale Structure from Data" *Proc. Intl. Conf. on Computer Vision (ICCV)*, 641-647.