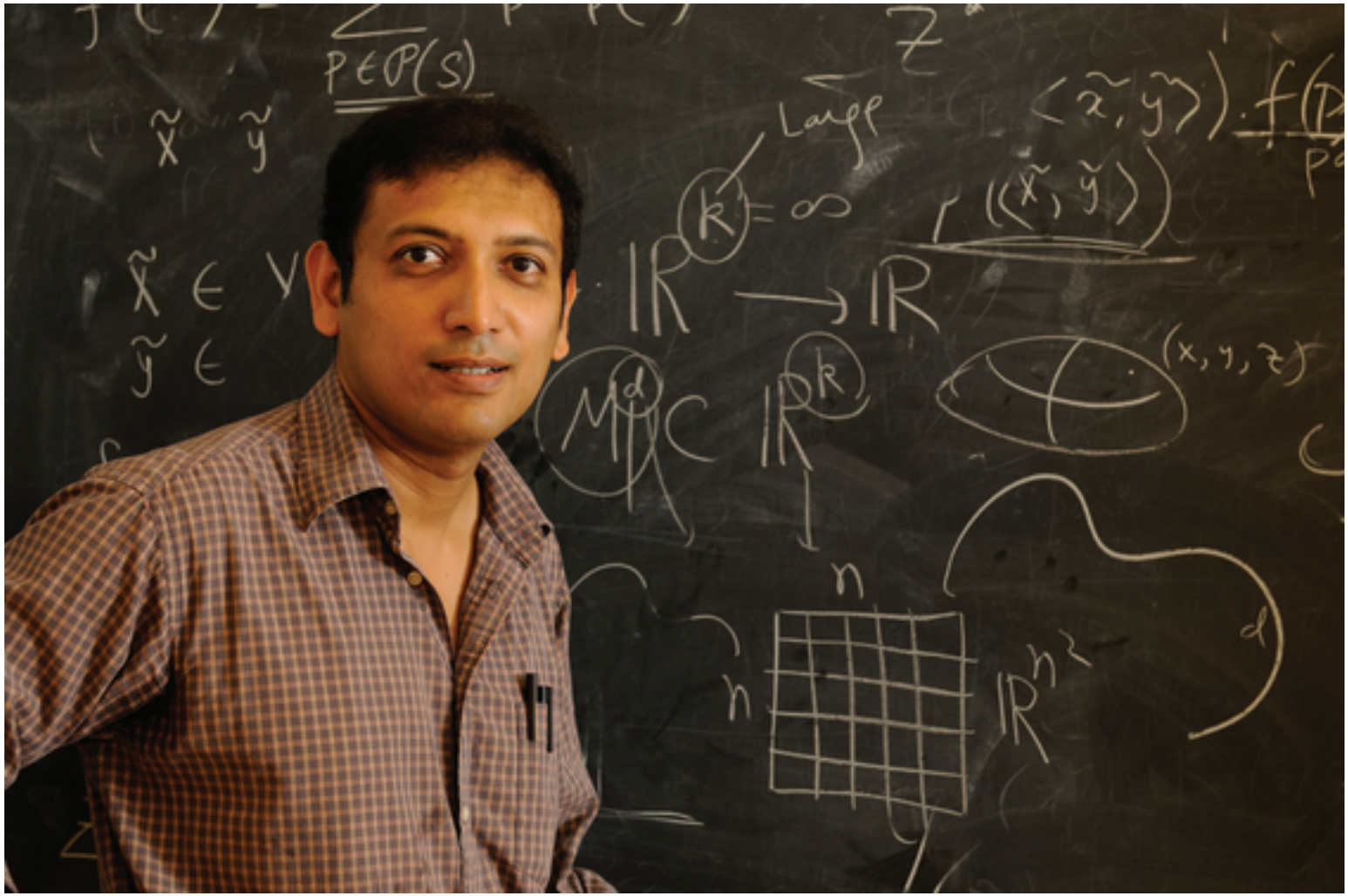


Partha Niyogi July 31, 1967 — Oct 1, 2010

Laplacian Eigenmaps and Locality Preserving Projections

Laplacian Eigenmaps for Dimensionality Reduction
and Data Representation

Mikhail Belkin and Partha Niyogi
Neural Computation 2003
revised from NIPS 2002

Locality Preserving Projections

Xiaofei He and Partha Niyogi
NIPS 2003

Locality Preserving Projections (LPP): A PCA Alternative

Input: A set of points $x_1, \ldots, x_n$ in $\mathbb{R}^d$ and a kernel function K.

Compute a vector $w \in \mathbb{R}^d$ minimizing

$$\sum_{i,j} K(x_i, x_j) \left(w^\top x_i - w^\top x_j\right)^2$$

subject to

$$\sum_{i,j} K(x_i, x_j) \left((w^\top x_i)^2 + (w^\top x_j)^2\right) = 1$$

The KKT Conditions Yield an Eigenvector Problem

$$XLX^\top w = \lambda XDX^\top w$$

$$\begin{aligned} X_{j,i} &= (x_i)_j \\ L &= D - K \\ K_{i,j} &= K(x_i, x_j) \\ D_{i,i} &= \sum_j K_{i,j} \end{aligned}$$

Taking the k principal eigenvectors gives a map $\mathbb{R}^d \to \mathbb{R}^k$.

Speech Science

Towards a Computational Model of Human Speech Perception

Partha Niyogi

Conference on Sound to Sense, MIT, 2004

(In Honor of Ken Stevens' 80th birthday)

Distinctive Feature Detection using Support Vector Machines

P. Niyogi, C. Burges, P. Ramesh

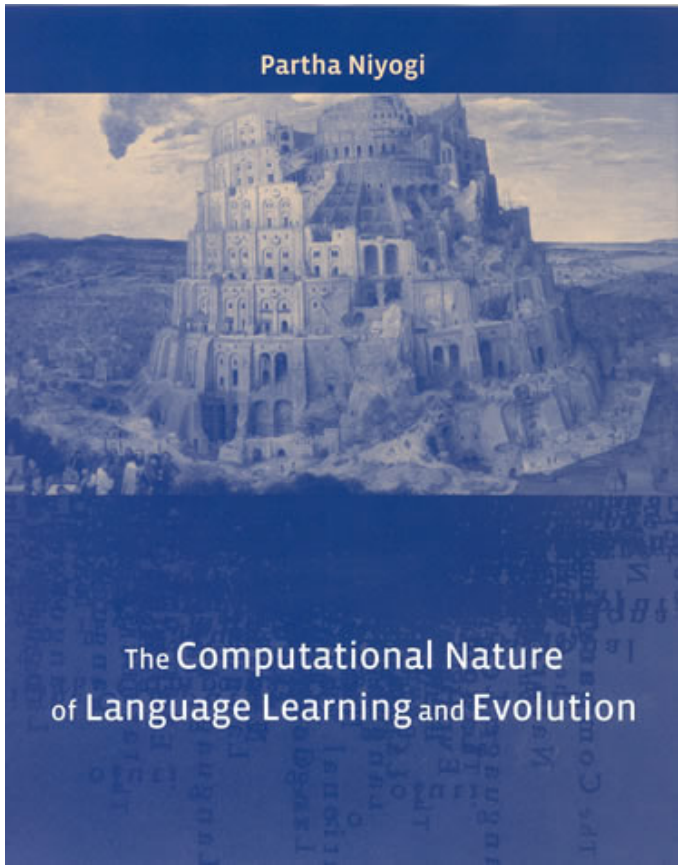
ICASP, 1999

Pure Speech Recognition

We will concern ourselves here with the problem of *pure speech recognition*. ... the problem of obtaining a complete (adequate) phonological representation of the speech signal based purely on the acoustics and ... phonological (phonetic) aspects of language.

Language learning would be impossible without the ability of pure speech recognition.

Language Evolution



MIT Press 2006 (paperback 2009)

Differential Equations for Language Dynamics

$$\frac{dx_i}{dt} = \sum_j x_j f_j Q_{i,j} - \phi x_i$$

where

$$x_i = \text{The fraction of the population having grammar } i$$

$$f_i = \text{the fitness of grammar } i$$

$$Q_{i,j} = \text{the probability that a child of an } i\text{-speaker learns } j$$

$$\phi = \sum_i x_i f_i \quad (\text{this preserves } \textstyle\sum_i x_i = 1)$$

Lost Dialogues

- Is universal grammar information-theoretically required for language learning?
- Should we talk about grammaticality as a hard or soft concept?
- Should we talk about the entropy of English?
- Should we talk about natural images?
- Should a CS department hire engineers or scientists?
- Do we really need Hilbert space or does shallow mathematics ($\mathbb{R}^d$) suffice?
- ...

A Great Loss