Differential Image Classification by Means of Probability

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INTRODUCTION:

Multiresolution analysis is widely used in image classification by generating random series of numbers and combining outcomes. This improves images by accurately reflecting the complex probability of distributions as sequences of the Markov chain.

BACKGROUND:

•A multiresolution images correspond to a probability vectors in a stochastic matrix.

•The outcome depends only on current conditions, and not on past situations.

•A Markov chain is a series of probability vectors

$x_0, x_1, x_2, \ldots,$ a stochastic matrix, A

$$x_1 = Ax_0,\ x_2 = Ax_1,\ x_3 = Ax_2, \ldots$$

The first order difference equation:

$$x_{k+1} = Ax_k \text{ for } k = 0, 1, 2, \ldots$$

APPLICATION:

•Statistical sequences using Markov Chain Monte Carlo

•Macroeconomics use in equilibrium price

•Biological population process

•Physics use of Hidden Markov Model (HMM)

•Algorithmic music composition in CSound and Max

•Impartial game theory in games and gambling

•De-noising/de-blurring by HMM

METHOD:

•The intended plan of action would be to use images in place of the mathematical figures through the Markov Model

•The Hidden Markov Model will use the Bayesian network (definition is given below).

•Image analysis through the Markov model, will have Multi-Resolution characteristics forming an MR tree.

DEFINITION:

The Bayesian Network (like a stochastic matrix) is a probability model that represents a set of random variables and their conditional independence via a graph.

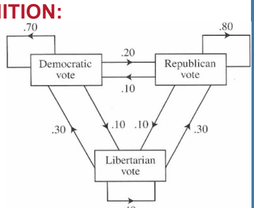


FIGURE 1: Voting changes from one election to the next.

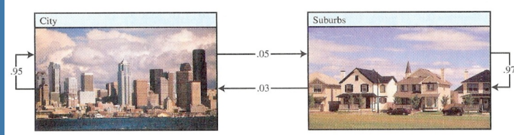
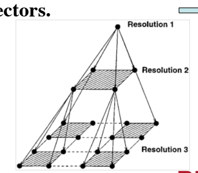


FIGURE 2 Annual percentage migration between city and suburbs.

From Fig. 2, we can generate a stochastic matrix by using the percent migration as probability vectors.

From: City, Suburbs; To: City, Suburbs

$$M = \begin{bmatrix} .95 & .03 \\ .05 & .97 \end{bmatrix}$$



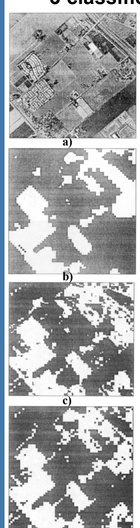
The multiresolution model enables multiscale context information to be incorporated into classification decisions.

RESULTS:

Classification and Regression Tress, CART® (Breiman et al., 1984).

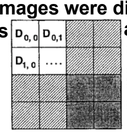
Learning Vector Quantization Algorithm, version 1, LVQ1 (Kohonen, 1989).

3 classifications, 3 resolutions, 24 trials



•(left) are 512 x 512 pixel images of the San Francisco Bay, image a) is the original, b) is its hand-labeled classification, c) is a singular HMM, and d) is a MHMM.

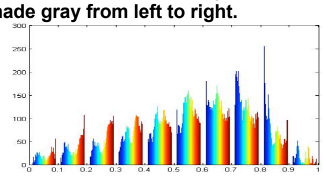
•The images were divided into six 4 x 4 blocks



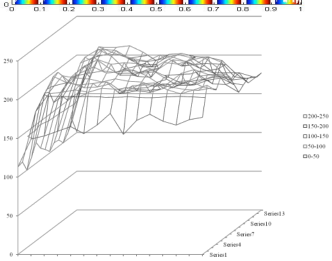
and were defined as:

1) $f_1 = D_{0,0}; f_2 = D_{1,0}|; f_3 = D_{0,1}|;$
2) $f_4 = \sum_{i=2}^{3} \sum_{j=0}^{1} D_{i,j}/4;$
3) $f_5 = \sum_{i=0}^{1} \sum_{j=2}^{3} D_{i,j}/4;$
4) $f_6 = \sum_{i=2}^{3} \sum_{j=2}^{3} |D_{i,j}|/4.$

By using the random data points in a), MATLAB was used to create the histogram below. The y-axis represents the degree of intensity of gray and the x-axis shows the frequency of the multi-shade gray from left to right.



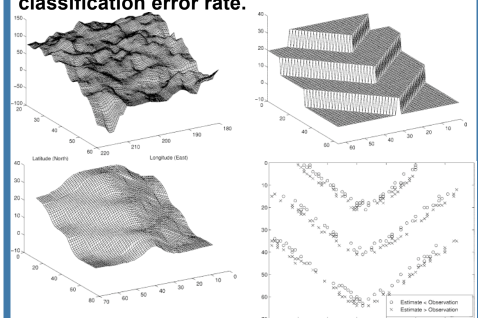
(Right) This is a wire-framed 3-D surface graph generated by Excel using a cross-section of image a)



Iteration	CART	LVQ1	HMM	MHMM
1	0.2263	0.2161	0.1904	0.1733
2	0.1803	0.1918	0.1765	0.1636
3	0.2899	0.2846	0.2034	0.1782
4	0.2529	0.2492	0.2405	0.2051
5	0.1425	0.1868	0.1834	0.1255
6	0.2029	0.1813	0.1339	0.1157
Ave.	0.2158	0.2183	0.1880	0.1602

Table 1: illustrates the classification error rate returned through analysis

*Multiresolution Hidden Markov Model out performed all others by yielding the lowest classification error rate.



Landsides can also be determined through means of probability. In the lower right image, we can see the area in need of reconstruction.

Each move in Chutes and Ladders is fixated and are independent to any previous games which exemplifies the Markov Chain.

SUMMARY:

•A multiresolution hidden Markov model is proposed for image classification.

•Any random point on the model represents a statistically dependent vector through the fundamental Markov process.

•Each application, such as Ariel maps and landsides correspond to variables within a matrix

CONCLUSIONS:

•At a given image point, the Markovian properties take on the conditional independence of its position and points alongside it.

•The MR tree model is a framework describing image processing.

•Image processing problems are acceptable to MR approximation which produces optimal performance.

•Stochastic variance form a paradigm unitary among variables.

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