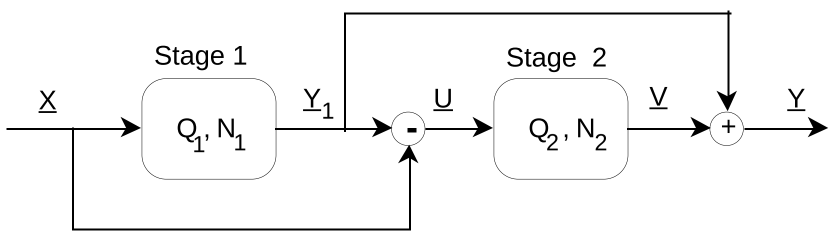
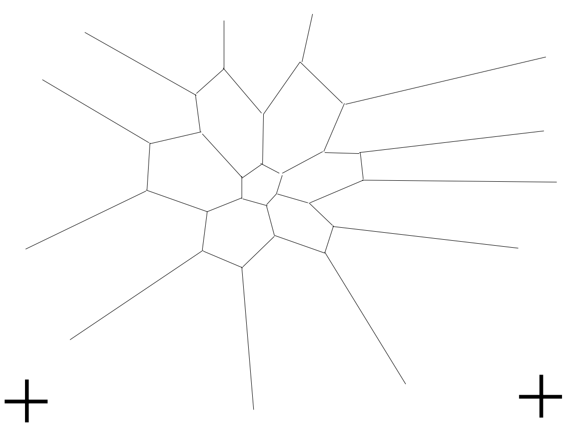
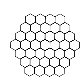
WHAT'S WRONG WITH 2VQ? & HOW TO FIX IT?

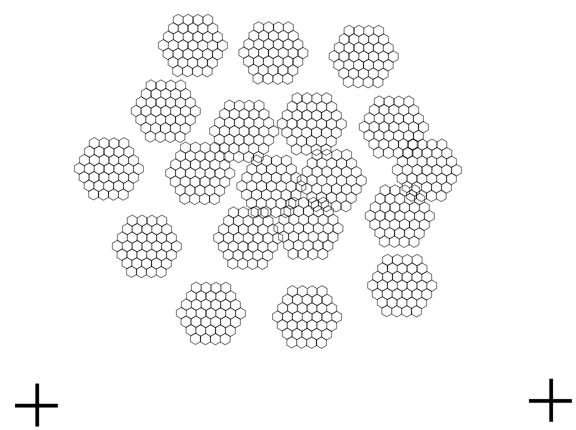




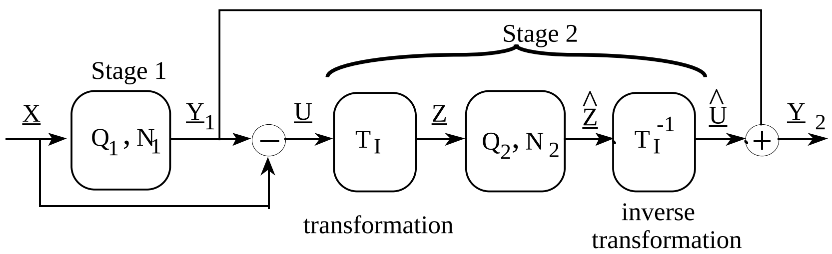
First-stage Partition



Second-stage Partition



Cell-Conditioned Two-Stage VQ (CC2VQ)

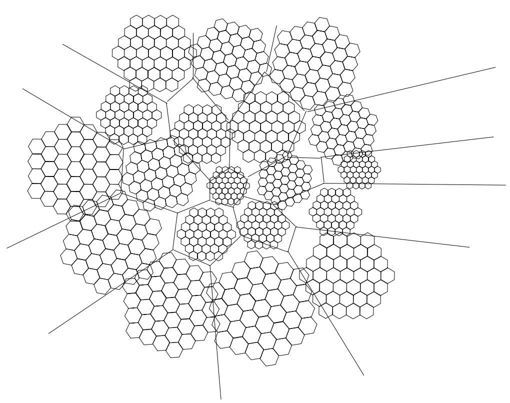


- CC2VQ
  + Q_1 = optimal, N_1 pt., k-dimensional VQ for source
  + Q_2 = N_2 pt., k-dim'l lattice VQ with cells & support region having shape of optimal k-dim'l tessel'ng polytope.
  + For $I = 1,\ldots,N_1$, T_I is rotating/scaling transformation such that $T_I S_{1,I}$ matches support region of Q_2.
  + Operation

    $\underline{X}$ quantized by Q_1 and found to be in I-th cell of S_1;

    $\underline{U}$ transformed by T_I; $\underline{Z} = T_I \underline{U}$ quantized by Q_2; then inverse transformed

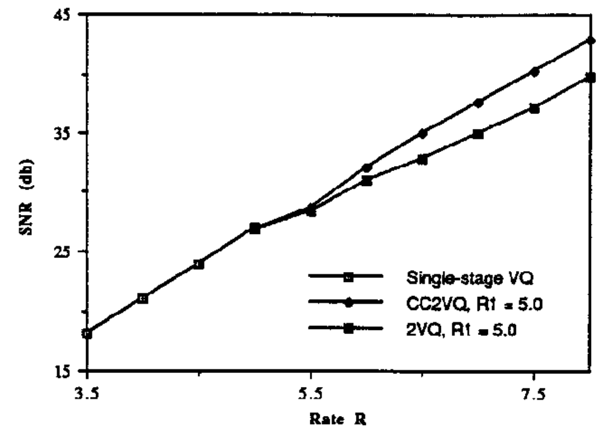
    $\underline{Y}_2 = \underline{Y}_1 + \hat{\underline{U}}$



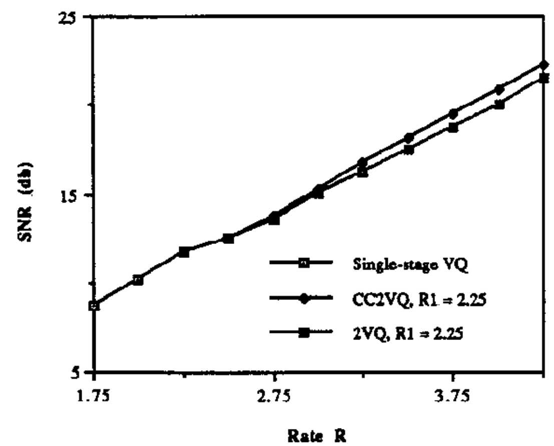
CC2VQ vs. Greedy 2VQ

IID Gaussian Source

k = 2



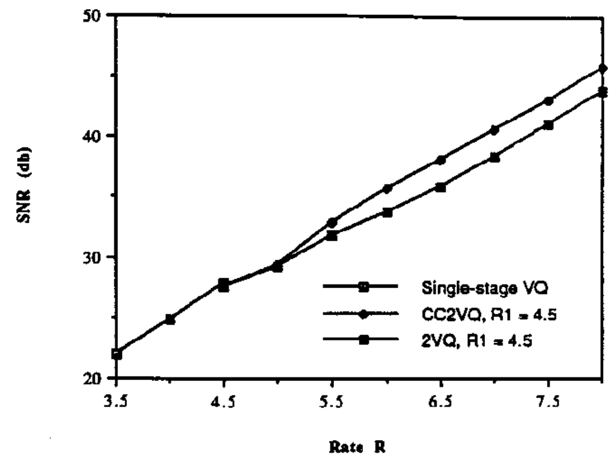
k = 4



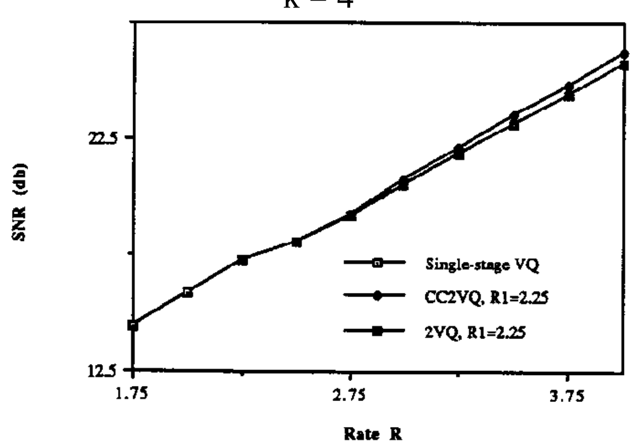
CC2VQ VS. GREEDY 2VQ

Gaussian Markov Source, $\rho = .9$

k = 2



k = 4



ASYMPTOTIC PERFORMANCE OF CC2VQ

- Point density is that of the optimal first stage
- Cells have shape of the optimal lattice quantizer

⇒ Performance is asymptotically equal to $D_k^*(R)$, which is the best possible performance of k-dimensional VQ's with rate R.

In other words 2VQ has been "fixed".

Implementation Notes

- In practice, cells of optimal first stage are so nearly spherical that rotation isn't needed, only scaling.
- CC2VQ has lower complexity than ordinary 2VQ, because second stage is simpler.
- CC2VQ is faster to design than ordinary 2VQ.

General 2VQ Principles

- The role of the first stage is to determine the point density.
- The role of the second stage is to determine the cell shape and preserve the point density of the first stage by uniformly refining the first stage cells with a good cell shape.

References [LeeN90b, Lee90, PaFi95, JeGi94, KuBu88,]