Compression of Correlated Sources 
Using LDPC Codes

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We consider the problem of compressing correlated binary sources when the correlation between sources is defined by a Hidden Markov Model (HMM). Specifically, the HMM describes the correlation pattern, i.e. the modulo-2 addition of the two sources. In this framework, we develop a density evolution analysis of a compression system using irregular LDPC codes as source codes. In order to achieve this goal, we modify the standard density evolution approach to incorporate the HMM. The proposed scheme is applied to the design of irregular LDPC codes that optimize the system performance. Theoretical results agree with simulations, and show that it is possible to achieve a performance close to the theoretical Slepian-Wolf limit.

The key to incorporate the HMM in density evolution is to find the input-output characteristic of the Forward-Backward (F-B) decoding algorithm. Since in order to facilitate decoding it is sometimes necessary to add synchronization bits to the compressed sequences, we obtain the F-B characteristic function of sources with different synchronization bit rates. In the proposed density evolution optimization algorithm, the output of the F-B block substitutes the \textit{a priori} message in the traditional density evolution case.

Tab. 1 lists the parameters and compression results for three test HMMs with two states. Model 1 is highly oscillatory, while models 2 and 3 are highly persistent. $R_1$ and $\alpha$ represents the compression rate and the synchronization bit rate, respectively. In most cases, the optimized irregular LDPC codes outperform the best regular LDPC codes proposed in the literature.

<table>
<thead>
<tr>
<th>model</th>
<th>$(R_1, \alpha)_{\text{reg}}^{\text{SIMU}}$</th>
<th>$(R_1, \alpha)_{\text{ THEO}}^{\text{inreg}}$</th>
<th>$(R_1, \alpha)_{\text{SIMU}}^{\text{inreg}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(0.666, 0.20)</td>
<td>(0.599, 0.05)</td>
<td>(0.634, 0.15)</td>
</tr>
<tr>
<td>2</td>
<td>(0.582, 0.20)</td>
<td>(0.544, 0.05)</td>
<td>(0.577, 0.13)</td>
</tr>
<tr>
<td>3</td>
<td>(0.423, 0.08)</td>
<td>(0.413, 0.02)</td>
<td>(0.434, 0.06)</td>
</tr>
</tbody>
</table>

Table 1: Results for the test models.