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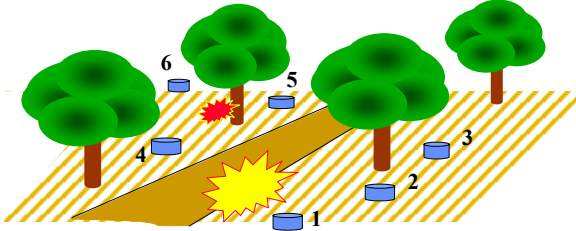
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Collaborative Data Compression in Sensor Networks

Ameesh Pandya, Aman Kansal, Gregory J Pottie and Mani Srivastava
<http://nesl.ee.ucla.edu>

Introduction: Multiple Sensor Data Compression

Multiple Sensors Detect a Phenomenon



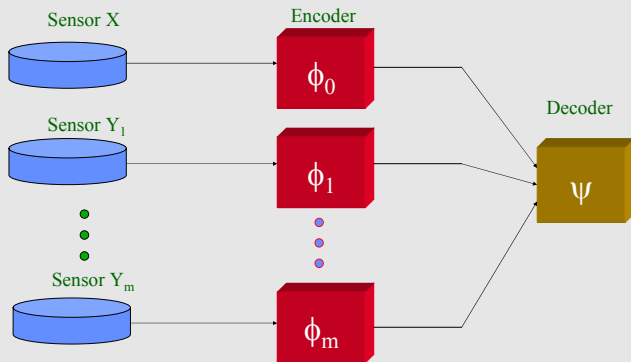
m - helpers

- Maximum data from closest sensor
- Data from other sensors helps reduce distortion in the data from closest sensor

Separate Coding

- Multiple sensors have equally useful readings
 - Distributed phenomenon, target close to several sensors
- All readings to be reproduced with given distortions

Problem Description: Rate Distortion Region for Multiple Gaussian Sources



Key Insights

- Rather than considering the m helpers together, consider each additional helper incrementally to the existing helpers.
- Define a new virtual helper in terms of the second helper conditioned on the first helper
 - takes care of the correlation among helpers
- The third insight comes into play for calculating the rate constraints for these new conditional variables from the raw rates.

Proposed Solution: One line with the main idea of the proposed solution

Results

Partial Coding Rate:

$$R_X(D_X) \geq \frac{1}{2} \log \left[\frac{\sigma_X^2}{D_X} \prod_{i=1}^m (1 - \rho_{X P_i}^2 + \rho_{X P_i}^2 2^{-2R_i}) \right]$$

where event P_i is denoted by $Y_i | Y_{-i}, \dots, Y_1$

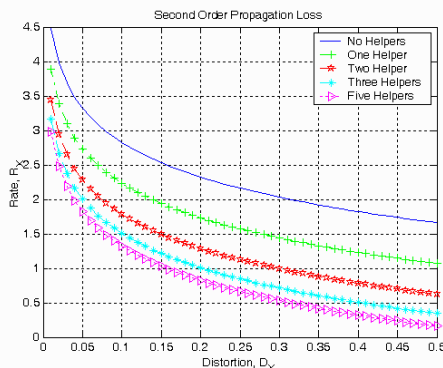
Separate Coding Rate:

$$R(D_0, D_1, \dots, D_m) \subseteq R_{\text{out}}(D_0, D_1, \dots, D_m)$$

where,

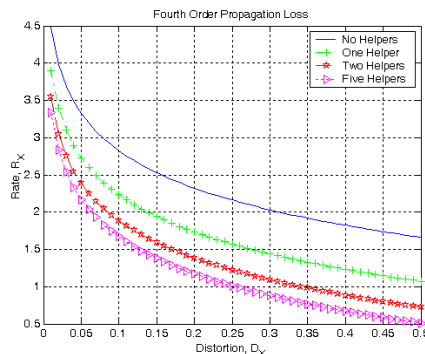
$$R_{\text{out}}(D_0, D_1, \dots, D_m) = R_{[1]}(D) \cap R_{[2]}(D) \cap \dots \cap R_{[m]}(D)$$

$R_{[k]}$ is the intersection of all possible combinations of rate-distortion bounds of k sensors.



Practical Implications

- The propagation loss in the sensing environment affects the quality of measurement at different sensors and depends on the distance of the sensors from the phenomenon.
- The helpers will certainly help in decreasing the original rate for the information transmission but returns rapidly diminish.



Conclusions

- An essential building block required for a complete information theory of the sensing coverage and communication performance of sensor networks.
- Useful for the choice of correlated sources to be encoded and transmitted in a real implementation.