Center for Embedded Networked Sensing

# Collaborative Data Compression in Sensor Networks

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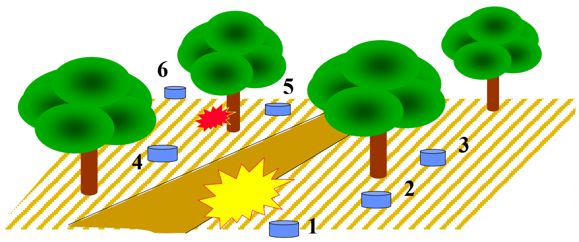
## Introduction: Multiple Sensor Data Compression

### Multiple Sensors Detect a Phenomenon



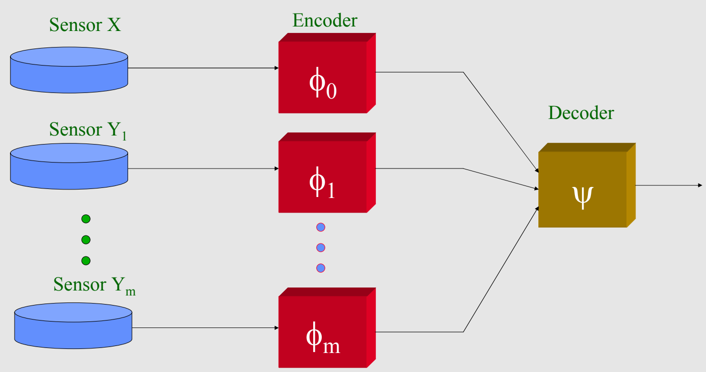

### m - helpers

- 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




1. Only **X** (m-helper problem)
2. **X** and **Y's** (separate coding problem)

### 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:

$$R_X(D_X) \ge \frac{1}{2}\log[\frac{\sigma_X^2}{D_X}\prod_{i=1}^{m}(1-\rho_{XP_i}^2+\rho_{XP_i}^2 2^{-2R_i})]$$

where event $P_i$ is denoted by $Y_i|Y_{i-1},\ldots,Y_1$

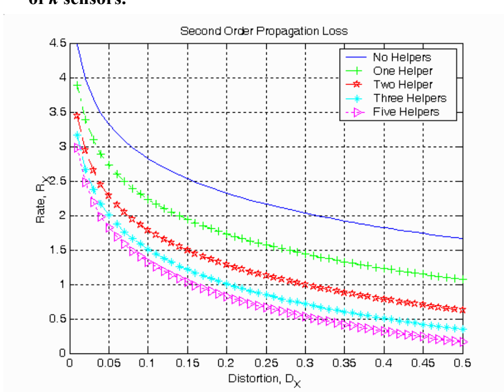
- Separate Coding Rate:

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

where,

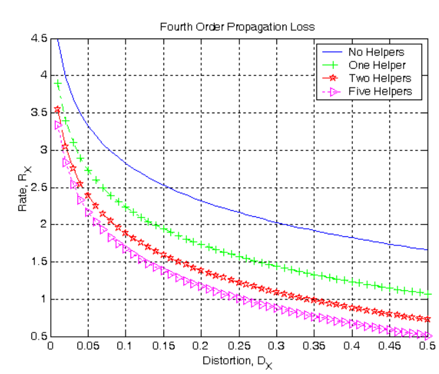
$$R_{\text{out}}(D_0,D_1,\ldots,D_m) = R_{[1]}(D) \cap R_{[2]}(D) \cap \ldots \cap R_{[m]}(D)$$

$R_{[k]}$ 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.