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Analysis-by-Synthesis Quantization for Compressed Sensing Measurements

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- Problem:
  - Quantizer design for compressive sensing measurements under a fixed decoder and sparse reconstruction algorithm
  - MSE is chosen as the performance criterion
- Contributions:
  - Derive necessary encoding conditions to minimize reconstruction MSE for a sparse input vector
  - Develop a new framework for scalar quantization of CS measurements with the objective of achieving a lower end-to-end reconstruction distortion rather than quantization distortion
  - Given a fixed quantizer look-up table and a fixed (generic) sparse reconstruction scheme, two-step algorithm is proposed:
    - *synthesis*: employ a sparse signal reconstruction technique for measuring the direct effect of quantization of CS measurements on the final sparse signal reconstruction quality
    - *analysis*: choose appropriate quantized values to minimize the final sparse signal reconstruction distortion
  - The algorithm is called Analysis by Synthesis (AbS)- used in multi-media coding

- Though computationally expensive, provides a significantly better reconstruction performance
- More contributions:
  - Analysis of the computational complexity of the proposed algorithm
    - Complexity depends on availability of two compression resources: quantization bit-rate and number of CS measurements
  - Propose a low complexity scheme based on quantization of estimated sparsity patterns at the quantizer encoder
    - Performs well at high quantization bit-rates
  - Develop an adaptive quantization method by combining the proposed schemes
    - Provides high-quality performance at all ranges of quantization and measurement rates

Joint Precoding and Multivariate Backhaul Compression for the Downlink of Cloud Radio Access Networks

Seok-Hwan Park, Osvaldo Simeone; *NJIT, New Jersey, USA*
Onur Sahin; *InterDigital Inc., New York, USA*
Shlomo Shamai; *Technion, Haifa, Israel*

- Existing strategies in cloud area networks:
  - Encoding/decoding functionalities of the BSs are migrated to a central unit
  - In *uplink*: *Distributed compression* schemes are used, which provide advantages over the conventional approach based on independent compression at the BSs
  - In *downlink*: Central encoder performs joint encoding, then independently compresses the produced baseband signal to be transmitted by each BS

- Contributions:
  - Propose to use joint compression (*multivariate compression*) of the signals of different BSs
    - Better control of the effect of the additive quantization noises at the MSs
  - Formulate the problem of jointly optimizing the precoding matrix and the correlation matrix of the quantization noises
    - Aims at maximizing the weighted sum-rate s.t power and backhaul constraints resulting from multivariate compression
    - Propose an iterative algorithm that achieves a stationary point
  - Proposed strategy outperforms the conventional approaches

Bayesian Simultaneous Sparse Approximation With Smooth Signals

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S. Derin Babacan; *Google, Inc., USA*
Rafael Molina; *Universidad de Granada, Spain*

- Consider a measurement system for L latent vectors:

$$Y = \phi W + \eta \tag{1}$$

  - $Y \in \mathbb{R}^{M \times L}$ is the measurement matrix
  - $\phi \in \mathbb{R}^{M \times N}$ is the fixed forward operator
  - $W \in \mathbb{R}^{N \times L}$ latent variable matrix
  - η : noise matrix
  - $M \ll N$
- Existing methods induce row-sparsity in W
  - Do not fully exploit all prior information about W
  - Coefficients in a row may be strongly correlated
- In this work: in addition to row sparsity, they assume that non-zero rows in W correspond to smooth waveforms

Contributions:

- Propose a recovery algorithm which exploits correlation in W
  - Enforce row-sparsity and penalize non-smooth solutions
- Following ideas from SBL, develop a global method which obtains an approximation to the posterior distribution of all unknowns, based on the empirical Bayes procedure
  - Computationally very demanding
- Derive a greedy(constructive) inference scheme
  - Computationally more efficient
- Show that the proposed methods result in significantly lower reconstruction error when the latent signals are smooth

Orthogonal Frequency Division Multiplexing With Index Modulation

Ertugrul Basar, Umit Aygolu; *Istanbul Technical University, Turkey*
Erdal Panayirci; *Kadir Has University, Turkey*
H. Vincent Poor; *Princeton University, USA*

- Propose a novel transmission scheme: "OFDM with index modulation (OFDM-IM)" for frequency selective fading channels
  - In addition to M-ary constellations, indices of the subcarriers also convey the information
  - Feedforward signalling from Tx to the Rx is not required to successfully detect the transmitted information bits
  - Number of active subcarriers can be adjusted, and the incoming bits can be systematically mapped to them
- Different mapping and detection techniques are proposed
  - Simple lookup table implemented to map the information bits to the subcarrier indices
    - ML decoder is employed at the Rx
  - To cope with increasing encoder/decoder complexity with increasing number of bits to be transmitted, simple and effective technique based on combinatorial number theory is used for the mapping
    - Log-likelihood decoder is employed at the Rx

- Theoretical error performance analysis based on pairwise error probability is provided for ideal channel conditions
- Proposed scheme is investigated under realistic channel conditions
  - Upper bound on the PEP under channel estimation errors is derived
- Scheme is modified to operate under conditions where mobile terminals can reach high mobility
  - MMSE Detector, Submatrix Detector, Block Cancellation Detector and Signal Power Detector are proposed

Distributed Adaptive Networks: A Graphical Evolutionary Game-Theoretic View

Chunxiao Jiang, Yan Chen, and K. J. Ray Liu;
University of Maryland, College Park, USA

Efficient Solutions for Weighted Sum Rate Maximization in Multicellular Networks With Channel Uncertainties

Muhammad Fainan Hanif, Le-Nam Tran, Antti Tolli, Umit Aygolu, Markku Juntti and Savo Glisic;
University of Oulu, Finland

A Spatio-Temporal Array Processing for Passive Localization of Radio Transmitters

Jonathan Bosse; *Delft University of Technology, The Netherlands*
Anne Ferrol, Pascal Larzabal; *SATIE Laboratory, France*