ECE COLLOQUIUM

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Thursday August 9, 2018 @ 1PM
Photonics Center, Room 339

Light refreshments will be available outside of 339 at 12:45PM

Sparse NOMA: A Closed-Form Characterization

Understanding fundamental limits of the various technologies suggested for future 5G and beyond cellular systems is crucial for developing efficient state-of-the-art designs. A leading technology of major interest is non-orthogonal multiple-access (NOMA). In particular, sparse, or low-density code-domain (LDCD) NOMA is a prominent sub-category, which conceptually relies on multiplexing low-density signatures (LDS). The main attractiveness of this class of NOMA schemes is in its inherent receiver complexity reduction, achieved by utilizing message-passing algorithms, and different variants of sparse NOMA have recently gained much attention in 5G standardization. Relying on recent results from the spectral theory of large random graphs, we derive an explicit closed-form analytical expression for the optimum spectral efficiency in the large-system limit of regular sparse NOMA. The latter setting corresponds to the case where only a fixed and finite number of orthogonal resources is allocated to any designated user, and vice versa.

The basic Verdu-Shamai (1999) formula for (dense) randomly-spread code-division multiple-access (RS-CDMA) turns out to coincide with the limit of the derived expression, when the number of orthogonal resources occupied by each user grows large. Furthermore, regular sparse NOMA is shown to be spectrally more efficient than RS-CDMA across the entire system load range. It may therefore serve as an efficient means for reducing the throughput gap to orthogonal transmission in the underloaded regime, and to the ultimate Cover-Wyner multiple-access channel bound in overloaded systems. The results analytically reinforce preliminary conclusions for the regular sparse NOMA setting, which mostly relied on the non-rigorous cavity method of statistical physics and numerical integration.

The spectral efficiency is also derived in closed form for the sub-optimal linear minimum-mean-square-error (LMMSE) receiver, which again extends the corresponding Verdu-Shamai (1999) formula to regular sparse NOMA. An extreme-SNR analysis is also provided, leading to useful insights.

The talk is based on a joint work with Dr. Benjamin Zaidel (Bar-Ilan University) and Dr. Ori Shental (Nokia Bell Labs). This research is supported by the Heron consortium via the Israel Innovation Authority.

Faculty Host: Bobak Nazer
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