

Open Problems in Network Information Theory

There are many well-known open problems in network information theory.

Open Problem 0.1 (P)

What is the capacity region of the 2-receiver DM-BC?

Open Problem 0.2 (P)

What is the capacity region of the 2-user-pair DM-IC?

Open Problem 0.3 (P)

What is the optimal rate region for distributed lossless compression with two helpers?

Open Problem 0.4 (P)

What is the rate–distortion region for distributed lossy compression?

Open Problem 0.5 (P)

What is the rate–distortion region for multiple description coding?

Open Problem 0.6 (P)

What is the sufficient and necessary condition for communicating a 2-DMS over a DM-MAC?

Open Problem 0.7 (P)

What is the capacity region of the graphical multimessage network?

Open Problem 0.8 (P)

What is the capacity region of the DM-RC?

Open Problem 0.9 (P)

What is the capacity region of the 2-sender DM-MAC with feedback?

Open Problem 0.10 (P)

What is the capacity region of the DM-TWC?

Open Problem 0.11 (P)

What is the optimal rate region for distributed lossless computing?

Open Problem 0.12 (P)

What is the secret key capacity for the 3-DMS (X_1, X_2, Z) ?

In addition to these (platinum) problems, a collection of less well-known and potentially less formidable (gold and silver) problems appear in the Network Information Theory book, which are listed below.

Open Problem 5.1 (S)

What is the capacity region of less noisy BCs with four or more receivers?

Open Problem 5.2 (S)

What is the capacity region of more capable BCs with three or more receivers?

Open Problem 6.1 (G)

What is the capacity region of the Gaussian IC with weak interference?

Open Problem 6.2 (S)

What is the generalization of strong interference to three or more user pairs?

Open Problem 6.3 (G)

What is the capacity region of the 3-user-pair injective deterministic IC?

Open Problem 6.4 (G)

Is the Han–Kobayashi inner bound tight in general? solved

Open Problem 7.1 (S)

What is the capacity region of the DM-MAC with DM state when the state information is available causally or noncausally at the encoders?

Open Problem 7.2 (S)

What is the common-message capacity of the DM-BC with DM state when the state information is available noncausally at the encoder?

Open Problem 8.1 (G)

What is the capacity region of the general 3-receiver DM-BC with one common message to all three receivers and one private message to one receiver?

Open Problem 8.2 (S)

Is superposition coding optimal for the general 3-receiver DM-BC with one message to all three receivers and another message to two receivers? solved (almost surely)

Open Problem 8.3 (G)

What is the sum-capacity of the binary skew-symmetric broadcast channel?

Open Problem 8.4 (G)

Is Marton's inner bound tight in general?

Open Problem 9.1 (G)

What is the capacity region of the Gaussian product BC with more than 2 receivers?

Open Problem 9.2 (S)

Can the converse for the Gaussian vector BC be proved directly by optimizing the Nair–El Gamal outer bound? solved

Open Problem 9.3 (G)

What is the capacity region of the 2-receiver Gaussian vector BC with common message? solved

Open Problem 13.1 (G)

Is the Zhang–Berger inner bound tight?

Open Problem 13.2 (S)

What is the multiple description rate–distortion region for a Bern($1/2$) source and Hamming distortion measures?

Open Problem 15.1 (G)

What is the capacity region of the general graphical 2-unicast network?

Open Problem 15.2 (G)

Does linear network coding achieve the capacity region of graphical multiple-unicast networks?

Open Problem 15.3 (S)

Is the average probability of error capacity region of the general graphical multmessage network equal to its maximal probability of error capacity region?

Open Problem 16.1 (S)

Is decode–forward or compress–forward optimal for the Gaussian RC with any nonzero channel gains?

Open Problem 16.2 (S)

What joint distribution maximizes the compress–forward lower bound for the Gaussian RC?

Open Problem 16.3 (S)

What is the linear relaying capacity of the Gaussian RC?

Open Problem 16.4 (S)

Can linear relaying outperform compress–forward?

Open Problem 17.1 (S)

What is the sum-capacity of the 3-sender symmetric Gaussian MAC with feedback?

Open Problem 17.2 (G)

What is the sum-capacity of the 2-receiver symmetric Gaussian BC with feedback?

Open Problem 17.3 (G)

What is the symmetric capacity of the binary multiplier channel?

Open Problem 18.1 (G)

What is the common-message capacity of a general DM network (that is, multicast with $\mathcal{D} = [2 : N]$)?

Open Problem 18.2 (G)

What is the capacity of a general deterministic multicast network?

Open Problem 18.3 (S)

How can partial decode–forward be extended to noisy networks?

Open Problem 18.4 (S)

How can noisy network coding and interference alignment be combined?

Open Problem 19.1 (G)

What is the capacity region of the Gaussian two-way relay channel with no direct links?

Open Problem 19.2 (G)

What is the symmetric capacity scaling law for the random network model?

Open Problem 20.1 (G)

What is the optimal rate region for distributed lossless computing of $X_1 \cdot X_2$, where (X_1, X_2) is a DSBS?

Open Problem 20.2 (S)

What is the rate-distortion region of cascade coding for computing the sum of independent WGN sources?

Open Problem 22.1 (G)

What is the secrecy capacity of the 2-receiver 1-eavesdropper DM-WTC?

Open Problem 22.2 (G)

What is the secrecy capacity of the 1-receiver 2-eavesdropper DM-WTC?

Open Problem 22.3 (S)

What is the 2-round secret key capacity for the 3-DMS (X_1, X_2, Z) ?

Open Problem 23.1 (G)

What is the ergodic capacity region of the Gaussian fading BC under fast fading when the channel gain information is available only at the decoders?

Open Problem 24.1 (S)

What is the capacity region of the asynchronous MAC when $d = \alpha n$ for $\alpha \in (0, 1)$?

If you have suggestions for other open problems or found solutions to any of these problems please contact Abbas El Gamal or Young-Han Kim.

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