

# Average-Case to (shifted) Worst-Case Reduction for the Trace Reconstruction Problem

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Abstract: The insertion-deletion channel takes as input a binary string  $x \in \{0, 1\}^n$ , and outputs a string  $\tilde{x}$  where some of the bits have been deleted and others inserted independently at random.

In the trace reconstruction problem, one is given many outputs (called traces) of the insertion-deletion channel applied to the same input message  $x$ , and is asked to recover the input message.

De, O'Donnell and Servedio (STOC 2017), and Nazarov and Peres (STOC 2017) showed that any string  $x$  can be reconstructed from  $\exp(O(n^{1/3}))$  traces.

Holden, Pemantle, Peres and Zhai (COLT 2018) adapt the techniques used to prove this upper bound, to an algorithm for the average-case trace reconstruction with a sample complexity of  $\exp(O(\log^{1/3} n))$ .

However, it is not clear how to apply their techniques more generally and in particular for the recent worst-case upper bound of  $\exp(\tilde{O}(n^{1/5}))$  shown by Chase (STOC 2021) for the deletion channel.

We prove a general reduction from the average-case to smaller instances of a problem similar to worst-case.

Using this reduction and a generalization of Chase's bound, we construct an improved average-case algorithm with a sample complexity of  $\exp(\tilde{O}(\log^{1/5} n))$ .

Additionally, we show that Chase's upper-bound holds for the insertion-deletion channel as well.

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