Abstract:

We prove a dichotomy theorem for two-party protocols, and show that for every poly-time two-party protocol with single-bit output, at least one of the following holds:

- The protocol can be used to construct a key-agreement protocol.
- For every constant \( \rho > 0 \) the parties' output is \( \rho \)-uncorrelated: let \((X; Y; T)\) denote the parties' outputs and the protocol's transcript respectively. A protocol is \( \rho \)-uncorrelated if there exists an efficient "decorralizer" algorithm Decor, that when given a random transcript \( T \), produces two numbers \( P^A \) and \( P^B \) such that no efficient algorithm can distinguish \((U^A; U^B; T)\) (where \( U^A \) denotes a biased coin with bias \( \rho \) from \((X; Y; T)\)), with distinguishing advantage larger than \( \rho \).

Namely, if the protocol cannot be used to construct key-agreement, then its output distribution \((X; Y; T)\) is trivial: it can be simulated non-interactively by the parties given public randomness (used to sample \( T \)). (The precise statement also has qualifiers of the form: "on infinitely many choices of the security parameter").

We use the above characterization to prove that \( (\alpha = 24\varepsilon^2) \)-correct differentially private symmetric protocol for computing XOR, implies the existence of key-agreement protocol. The above dependency between \( \alpha \) and \( \varepsilon \) is tight since an \( \varepsilon \)-correct \( \rho \)-differentially private protocol for computing XOR is known to exists unconditionally. It also improves, in the \( (\mu, \varepsilon) \) dependency aspect, upon Goyal et al. [ICALP '16] who showed that, for some constant \( c > 0 \), a \( c \)-correct \( \varepsilon \)-differentially private protocol for computing XOR implies oblivious transfer. Our result extends to a weaker notion of differential privacy in which the privacy only requires to hold against external observer. Interestingly, the reductions used for proving the above results are non black box.

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