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 $P_A, P_B$ such that no efficient algorithm can distinguish $(U_p; U_p; T)$ (where $U_p$ 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 $(\epsilon = 2\delta, \mu)$-correct differentially private symmetric protocol for computing XOR, implies the existence of key-agreement protocol. The above dependency between $\epsilon$ and $\mu$ is tight since an $\epsilon, (\mu)$-correct $\epsilon$-differentially private protocol for computing XOR is known to exists unconditionally. It also improves, in the $(\mu, \epsilon)$dependency aspect, upon Goyal et al. [ICALP '16] who showed that, for some constant $c > 0$, a $c$-correct $\epsilon$-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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