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 following holds:

1. The protocol can be used to construct a key-agreement protocol.
2. For every constant $\lambda \geq 24\epsilon^2$, the parties' output $I\&\#129; > 0$ the parties' output is $I\&\#129; -uncorrelated: let (X; Y; T)$ denote the parties' outputs and the protocol's transcript respectively. A protocol is $\lambda$ -uncorrelated if there exists an efficient "decorralizer" algorithm $D$, that when given a random transcript $T$, produces two numbers $P_A; P_B$, such that no efficient algorithm can distinguish $(U_A; U_B; T)$ (where $U$ denotes a biased coin with bias $\lambda\&\#129; from (X; Y; T)$, with distinguishing advantage larger than $\lambda\&\#129;$.)

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 $(\lambda \geq 24\epsilon^2)$-correct differentially private symmetric protocol for computing XOR, implies the existence of key-agreement protocol. The above dependency between $\lambda$ and $\epsilon$ is tight since an $\epsilon$ -correct "-differentially private protocol for computing XOR is known to exists unconditionally. It also improves, in the $(\lambda, \epsilon)$ dependency aspect, upon Goyal et al. [ICALP '16] who showed that, for some constant $c > 0$, a $c$-correct "-differentially private protocol for computing XOR implies oblivious transfer. Our result extends to a weaker notion of di erential 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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