CompositionMeasure for RenyiDivergence

Michael Shoemate

> This proof resides in **"contrib"** because it has not completed the vetting process.

Proves soundness of the implementation of `CompositionMeasure` for `RenyiDivergence` in `mod.rs` at commit f5bb719 (outdated[1]).

1 Hoare Triple

Precondition

Compiler-Verified

Types matching pseudocode.

Caller-Verified

None

Pseudocode

```
1  class CompositionMeasure(RenyiDivergence):
2      def composability(  #
3          self, adaptivity: Adaptivity
4      ) -> Composability:
5          return Composability.Concurrent
6
7      def compose(self, d_mids: Vec[Self_Distance]) -> Self_Distance:
8          def curve(alpha: float) -> float: #
9              epsilons = [d_mid(alpha) for d_mid in d_mids]
10
11             d_out = 0.0
12             for d_mid in epsilons:
13                 d_out = d_out.inf_add(d_mid)
14             return d_out
15
16         return Function.new_fallible(curve)
```

Postcondition

Theorem 1.1. `composability` returns `Ok(out)` if the composition of a vector of privacy parameters `d_mids` is bounded above by `self.compose(d_mids)` under `adaptivity` adaptivity and `out`-composability. Otherwise returns an error.

Proof. The new curve constructed on line 8 composes all epsilon parameters at a given fixed `alpha`. By the postcondition of `InfAdd` we have that for any choice of `alpha`, $\sum_i$ `d_mid`$_i$`(alpha)` $\leq$ `compose(d_mids)`(α).

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[1]See new changes with `git diff f5bb719..991c3fb5 rust/src/combinators/sequential_composition/mod.rs`

Adaptivity	Sequential	Concurrent
Non-Adaptive	Proposition 1[Mir17]	Theorem 2[Lyu22]
Adaptive	-	-
Fully-Adaptive	Theorem 4.3[FZ22]	Theorem 1.21[VW21]

This table is reflected in the implementation of `composability` on line 2.

$\square$

References

[FZ22]   Vitaly Feldman and Tijana Zrnic. Individual privacy accounting via a renyi filter, 2022.

[Lyu22] Xin Lyu. Composition theorems for interactive differential privacy, 2022.

[Mir17] Ilya Mironov. Rényi differential privacy. In *2017 IEEE 30th Computer Security Foundations Symposium (CSF)*, page 263–275. IEEE, August 2017.

[VW21]   Salil Vadhan and Tianhao Wang. Concurrent composition of differential privacy, 2021.