impl TopKMeasure for ZeroConcentratedDivergence

Michael Shoemate

October 8, 2025

1 Hoare Triple

Precondition

Compiler-verified

- Associated Const `REPLACEMENT = true`
- Method `privacy_map` *Types consistent with pseudocode.*

Caller-verified

- Method `privacy_map`
  - `d_in` is non-null and positive.
  - `scale` is non-null and positive.

Pseudocode

```python
# ZeroConcentratedDivergence
REPLACEMENT = True

def privacy_map(d_in: f64, scale: f64) -> f64:
    return d_in.inf_div(scale).inf_powi(ibig(2)).inf_div(8.0)
```

Postcondition

Theorem 1.1. The implementation is consistent with all associated items in the `TopKMeasure` trait.

1. Method `privacy_map`: For any x, x' where $d_{\text{in}} \geq d_{\text{Range}}(x, x')$, return $d_{\text{out}} \geq D_{\text{self}}(f(x), f(x'))$, where $f(x) = \text{noisy\_top\_k}(x = x, k = 1, \text{scale} = \text{scale}, \text{replacement} = \text{Self} :: \text{REPLACEMENT})$.

Proof of postcondition: ***privacy_map****.* [2] Proposition 2 shows that the exponential mechanism satisfies Bounded Range. [1] Lemma 3.2 shows that Bounded Range satisfies . □

References

[1] Mark Cesar and Ryan Rogers. Bounding, concentrating, and truncating: Unifying privacy loss composition for data analytics, 2020.

[2] Jinshuo Dong, David Durfee, and Ryan Rogers. Optimal differential privacy composition for exponential mechanisms and the cost of adaptivity. *CoRR*, abs/1909.13830, 2019.