

# impl TopKMeasure for MaxDivergence

Tudor Cebere

Michael Shoemate

November 22, 2025

This proof resides in “**contrib**” because it has not completed the vetting process.

This document proves soundness of **TopKMeasure** for **MaxDivergence** in **mod.rs** at commit **e62b0aa2** (outdated<sup>1</sup>).

## 1 Hoare Triple

### Precondition

#### Compiler-verified

- Associated Const `REPLACEMENT = false`
- 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

```
1 # MaxDivergence
2 REPLACEMENT = False
3
4 def privacy_map(d_in: f64, scale: f64) -> f64:
5     return d_in.inf_div(scale)
```

### Postcondition

**Theorem 1.1.** The implementation is consistent with the 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.* Since `Self::REPLACEMENT` is false, then by the postcondition of `noisy_top_k`, `noisy_top_k` returns a sample from  $\mathcal{M}_{PF}$ . In the case that scores are not monotonic, by [1] Theorem 1,  $\mathcal{M}_{PF}$  satisfies  $\epsilon$ -DP, because the range distance is equal to  $2 \cdot \Delta$ . Otherwise in the case that scores are monotonic, by [1] Remark 1,  $\mathcal{M}_{PF}$  satisfies  $\epsilon/2$ -DP, but the range distance is equal to  $\Delta$ , thus satisfying  $\epsilon$ -DP.  $\square$

<sup>1</sup>See new changes with `git diff e62b0aa2..efc94d1 rust/src/measurements/noisy_top_k/mod.rs`

## References

- [1] Ryan McKenna and Daniel Sheldon. Permute-and-flip: A new mechanism for differentially private selection, 2020.