

fn peel_permute_and_flip

Michael Shoemate

October 31, 2025

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

This document proves soundness of `peel_permute_and_flip` in `mod.rs` at commit `e62b0aa2` (outdated¹). `peel_permute_and_flip` noisily selects the index of the greatest score from a vector of input scores k times without replacement.

1 Hoare Triple

Preconditions

Types consistent with pseudocode.

Pseudocode

```
1 def peel_permute_and_flip(  
2     x: list[RBig],  
3     scale: RBig,  
4     k: usize,  
5     replacement: bool,  
6 ):  
7     natural_order = []  
8     sorted_order = BTreeSet.new()  
9  
10    for _ in range(min(k, x.len())):  
11        index = permute_and_flip(x, scale, replacement) #  
12        x.remove(index) #  
13  
14        # map index on modified x back to original x (postprocessing)  
15        for del_ in sorted_order: # |  
16            if del_ <= index:  
17                index += 1  
18            else:  
19                break  
20  
21        sorted_order.insert(index)  
22        natural_order.push(index)  
23  
24    return natural_order
```

Postcondition

Theorem 1.1. • If replacement is set, returns a sample from \mathcal{M}_{EM} (as defined in MS2023 Definition 4), otherwise returns a sample from \mathcal{M}_{PF} (as defined in MS2023 Lemma 1), k times by peeling, where $\text{scale} = \frac{2\Delta}{\epsilon}$.

¹See new changes with `git diff e62b0aa2..5c7814f rust/src/measurements/noisy_top_k/mod.rs`

- Errors are data-independent, except for exhaustion of entropy.

Proof. The pseudocode applies `permute_and_flip` on line 11 up to k times (no greater than the number of scores), each time removing the selected score on line 12.

Since the index in subsequent selections may be offset by an earlier removal, a data-independent post-processing of the index is performed on line 15.

The only source of error is due to entropy exhaustion. □