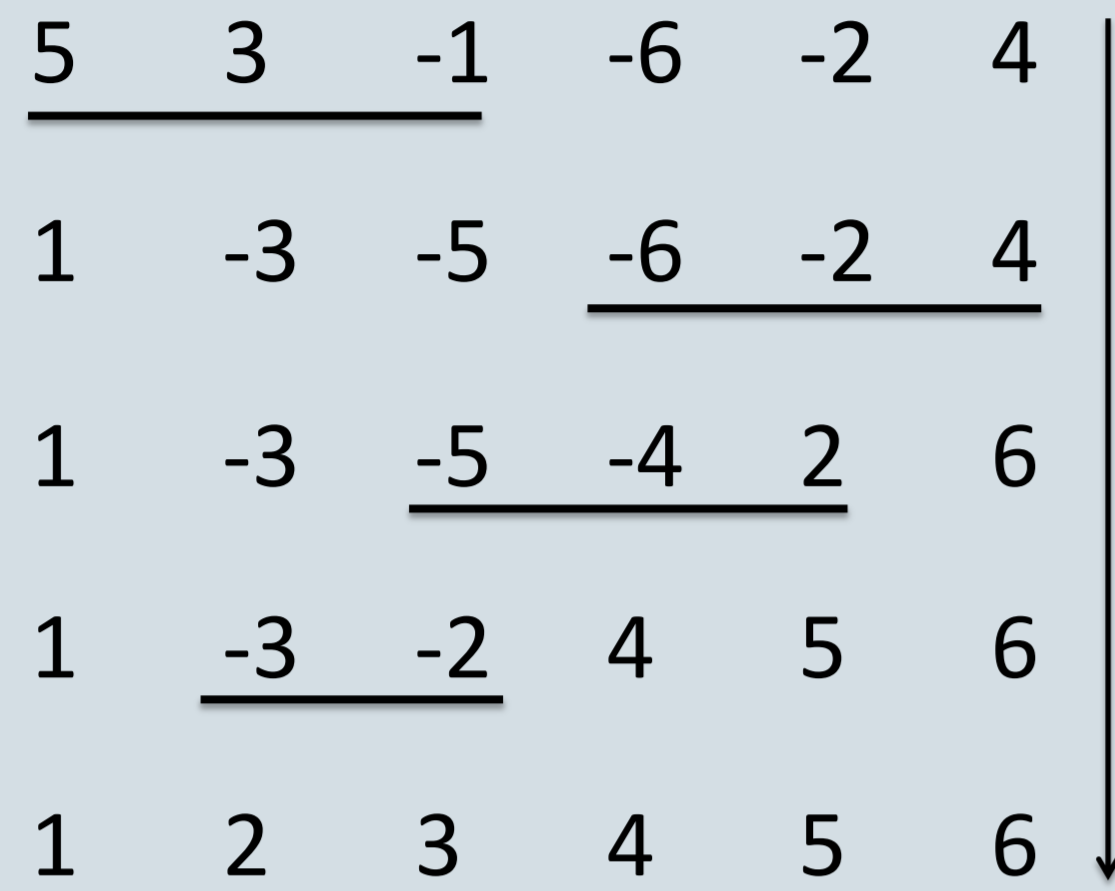


# The Streaming Complexity of Cycle Counting and Sorting by Reversals

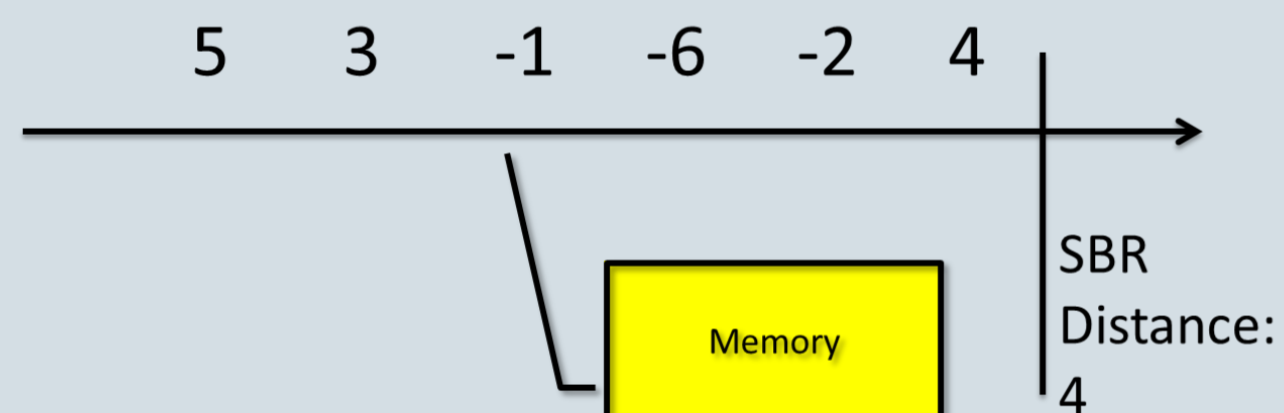
## Sorting by Reversal (SVR)



Compute number of "reversals" needed to sort the signed permutation

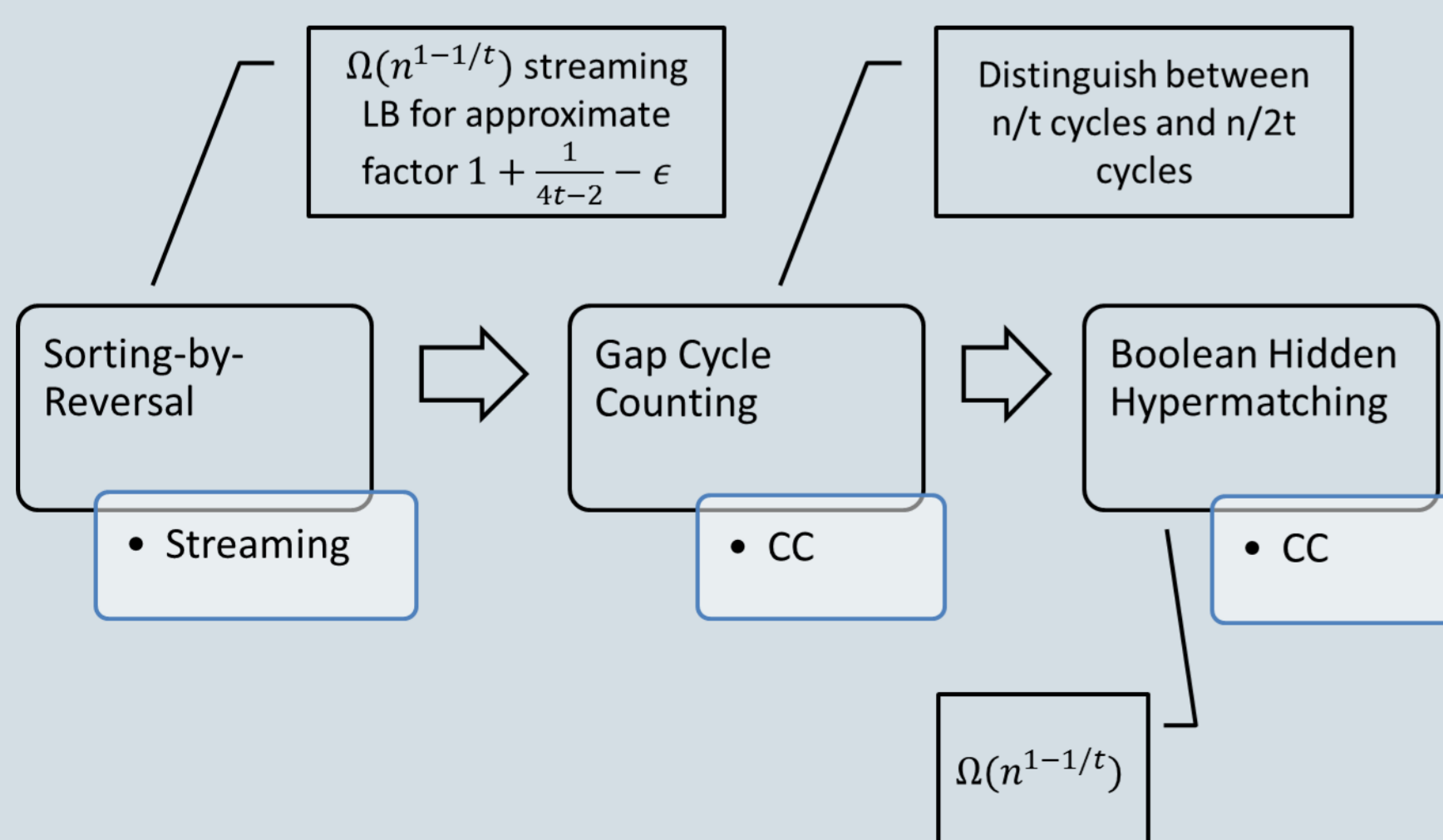
## Streaming Model

Just one scan from left to right



Streaming Complexity: Least memory used by the algorithm

## Results



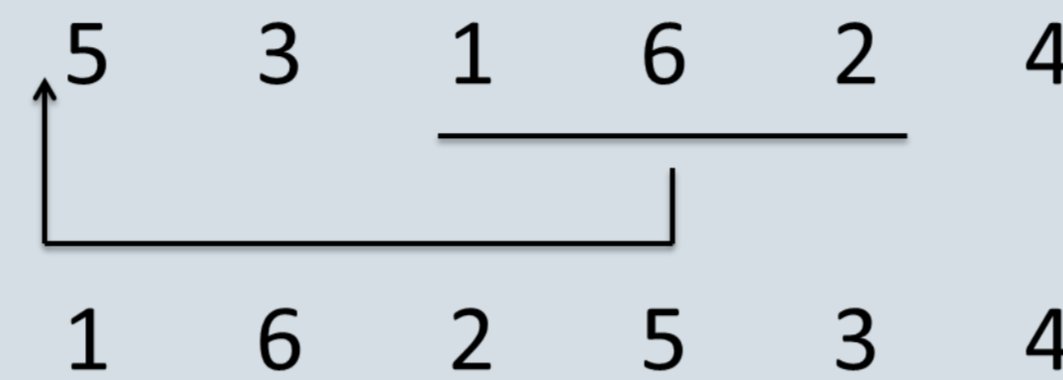
## Motivation

### Edit Distance with Block Moves

[CM02]  $O(\log n \log^* n)$ -approximation with  $O(1)$  sketch size

### Transposition Distance

[CMS01]  $(3 + \epsilon)$ -approximation with  $O(\log n)$  sketch size



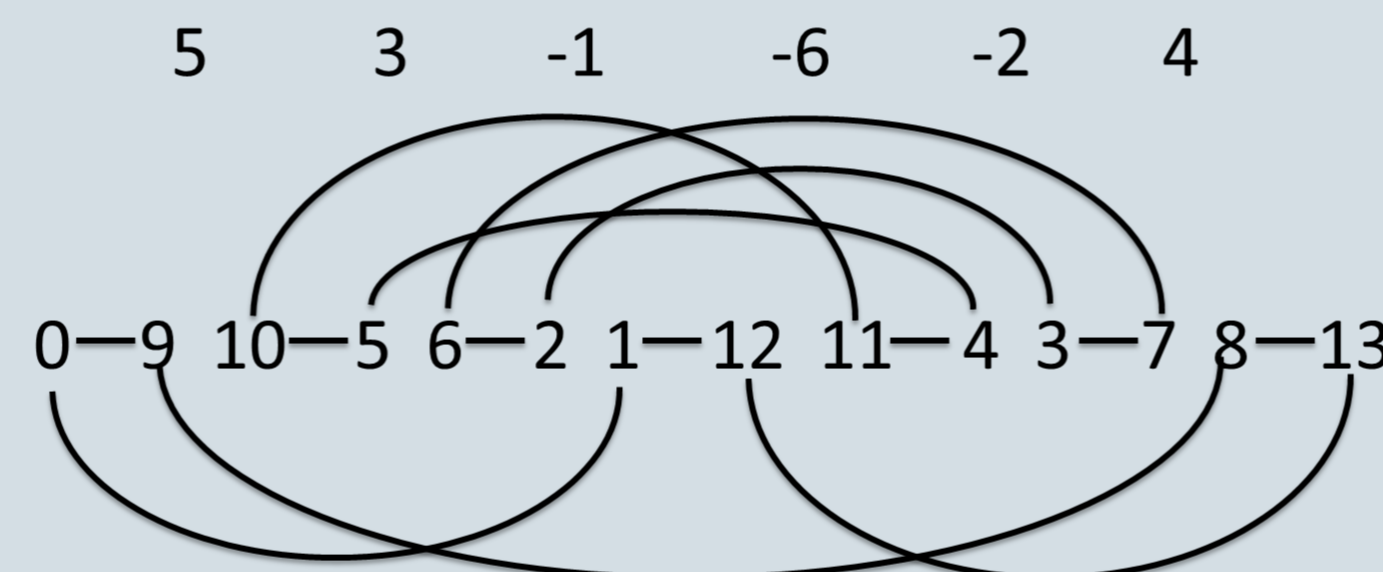
### Reversal Distance

[CMS01]  $(2 + \epsilon)$ -approximation with  $O(\log n)$  sketch size

What happens for  $1 + \epsilon$  approximation?

## Reduction Chains

Breakpoint Graph



Construction of Breakpoint Graph

- $5 \rightarrow (9\ 10)$
- $3 \rightarrow (5\ 6)$
- $-1 \rightarrow (2\ 1)$
- ...
- insert 0
- append 13

### Theorem [HP99]

- C: # of cycles;
- If all cycles are oriented,  $SBR = n + 1 - C$ .

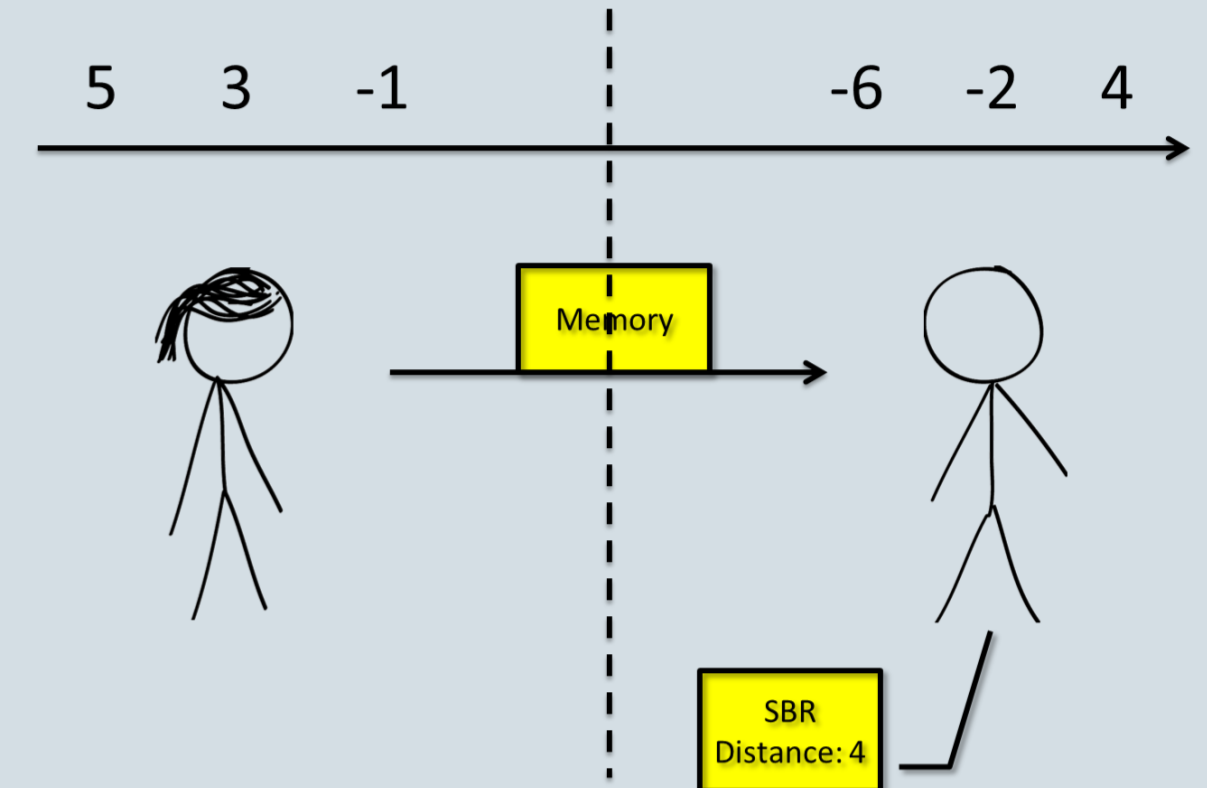
$$2 * (\# \text{ of cycles in } \begin{matrix} u_1 & u_2 & u_3 \\ \diagdown & \diagup & \diagdown \\ v_1 & v_2 & v_3 \end{matrix})$$

$$\# \text{cycles} ( \begin{matrix} 0-20 & 19-3 & 4-16 & 15-7 & 8-24 & 23-11 & 12-13 & 14-10 & 9-17 & 18-6 & 5-21 & 22-2 & 1-25 \end{matrix} )$$

$$4n - SBR ( \begin{matrix} u_2 & u_1 & u_3 & v_3 & v_2 & v_1 \\ -10 & 2 & -8 & 4 & -12 & 6 & 7 & -5 & 9 & -3 & 11 & -1 \end{matrix} )$$

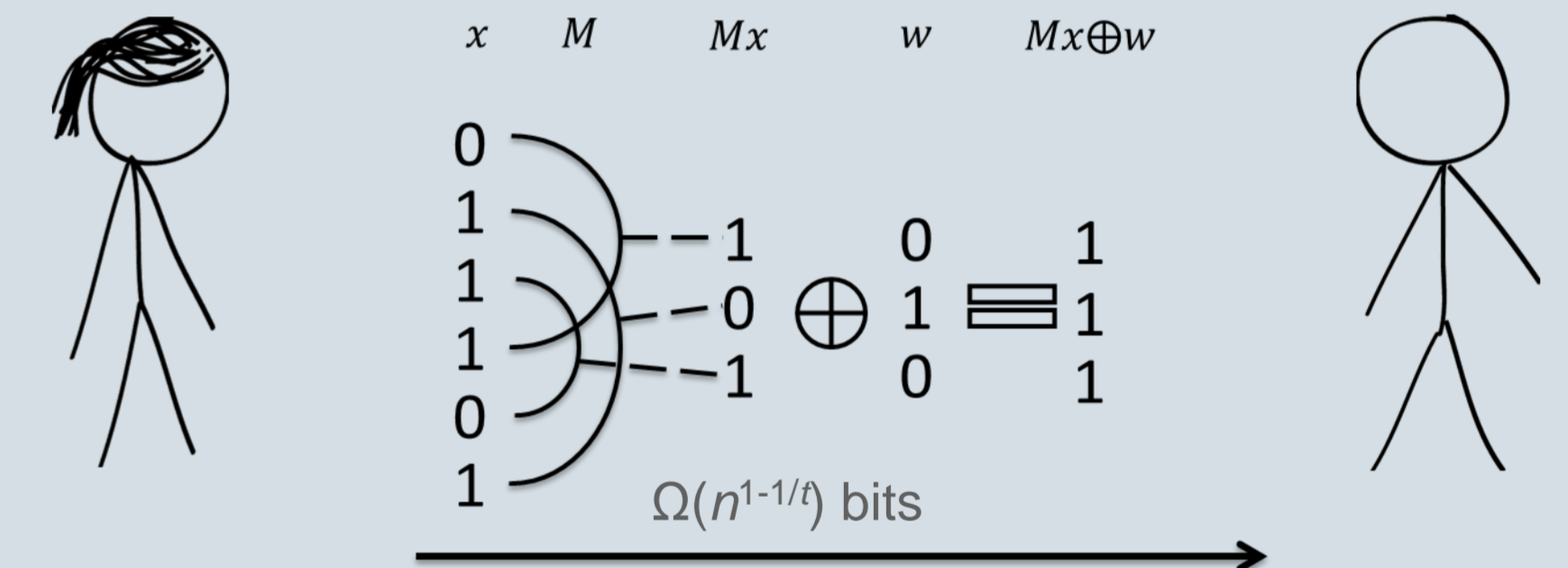
Permutations

## Communication Complexity (CC)

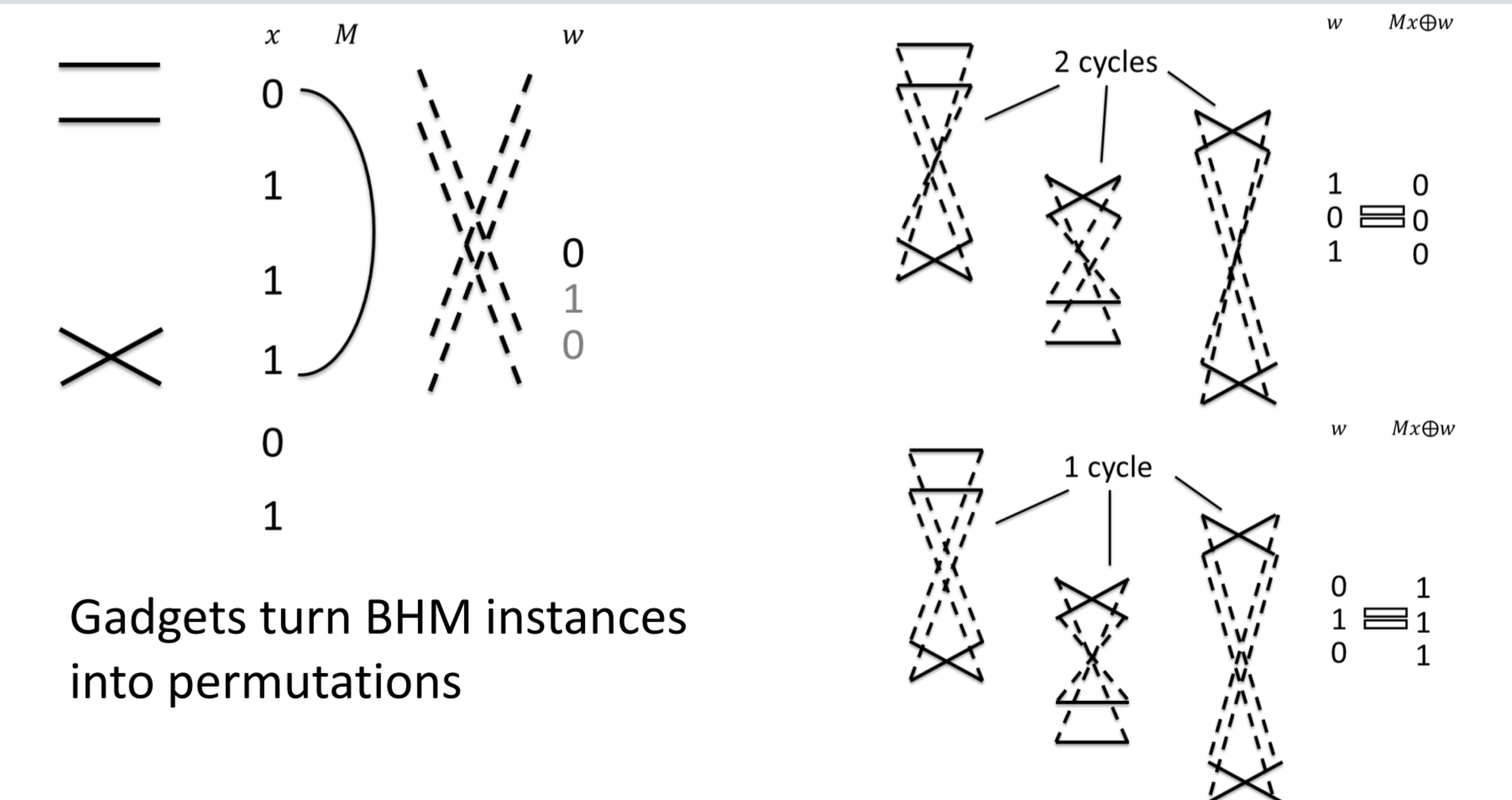


## Boolean Hidden (Hyper)Matching

$x \in \{0,1\}^n$  Promise:  $Mx \oplus w = \begin{cases} 0^{n/t} \\ 1^{n/t} \end{cases}$   $M \in \text{Perfect } t\text{-HyperMatching}_n$   $w \in \{0,1\}^{n/t}$



Which is the case?



Gadgets turn BHM instances into permutations

## References

- [CMS01] G. Cormode, S. Muthukrishnan, and C. Sahinalp. Permutation editing and matching via embeddings. ICALP 2001.
- [CM01] G. Cormode and S. Muthukrishnan. The string edit distance matching problem with moves. TALG 2007.
- [HP99] S. Hannenhalli and P.A. Pevzner. Transforming cabbage into turnip: polynomial algorithm for sorting signed permutations by reversals. JACM 1999.