

HADES (High end, Advanced, Data driven, Enterprise grade Sock sorting algorithm) - An algorithm for faster sock sorting

CelloClemens^{1,2}, Henri ¹,

September 22, 2023

¹Department for theoretical laundry science, Karlsruhe institute of suffering and sorrow (KISS), Karlsruhe, Germany

²Institute of laundry sorting, Department for socks, Karlsruhe institute of suffering and sorrow (KISS), Karlsruhe, Germany

Abstract Sorting socks can often be a time consuming task. This paper introduces the fastest method known in the scientific community to tackle this challenging task. To be able to implement this new algorithm a new datastructure will be introduced and discussed. Abundant application of this novel algorithm may be able to reduce the time required for sorting socks considerably.

1 Introduction

While sorting algorithms are one of the most discussed algorithms in the computer science community, application of this field to laundry is still quite new. In fact no research is known to the authors connecting the fields of computer science and laundry sorting. A few definitions are required in order to establish a baseline for the algorithm discussed in the following paper.

1.1 Definitions

In this section a few definitions, common in the field of theoretical laundry science shall be introduced. These are required to understand the algorithm and its advantages.

1.1.1 Sock

Let Λ_a be the Set of laundry. The set of socks, $\Sigma \subset \Lambda_a$ is defined as $\Sigma := \{s \in \Lambda_a | \chi(s) = 1\}$ ¹, where $\chi(s)$ is the Euler characteristic of s . For every sock s there is an equal counterpart s^{-1} giving rise to the identity $s \cong s^{-1}$. The task commonly known as "sock sorting" is in fact the search for this isomorphism η and matching every sock s to its inverse s^{-1} .

1.1.2 Laundry basket

Let $\Lambda \subseteq \Lambda_a$ be a set of laundry items. Then a laundry basket is a triplet $(\Lambda, +, -)$ representing a datastructure that implements the following functions:



Fig. 1: A pair of blue socks and a single orange sock.

- **get:** $\mathcal{L} \in \Lambda_a$, returns a uniformly random laundry item from the basket or $\mathcal{L}_0$, the Zero element of laundry, iff There are no items left.
- **put** ($\mathcal{L} \in \Lambda_a$), deposits the given laundry item into the basket.

Note that both operations run in $\mathcal{O}(1)$. Because of the nature of a laundry basket finding a unique item requires transferring the content of the whole basket to a new basket thus requiring $\mathcal{O}(n)$ operations, n being the number of items currently inside the basket.

¹Yes, some socks have holes. So what?!

1.2 Ongoing and latest research

To fully appreciate the gravity of HADES it has to first be discussed how most recent research tackles the problem of sock sorting. The following code describes the most recently developed sock sorting algorithm from the paper by my colleague which is the current industry standard. Notice the code has a runtime complexity of $\mathcal{O}(n^2)$.

Algorithm 1 Conventional sock sorting

```

1:  ▷ initialize a new laundry basket with a given
    set of laundry
2:   $A \leftarrow \Lambda$   ▷ WLOG assume  $\forall \mathcal{L} \in \Lambda | \mathcal{L}$  is a sock
3:  matches  $\leftarrow []$ 
4:  repeat
5:     $\mathcal{L} \leftarrow A.get$ 
6:    repeat  ▷ find the inverse Sock by checking
    all other socks
7:       $\mathcal{L}' \leftarrow A.get$ 
8:    until  $\mathcal{L}' = \mathcal{L}^{-1}$ 
9:    matches.append( $(\mathcal{L}, \mathcal{L}')$ )
10: until  $\mathcal{L} \neq \mathcal{L}_0$ 

```

2 Concepts

The basis for every fast algorithm are simple yet equally fast datastructures. To enable the low runtime achieved by HADES, the introduction of a new datastructure, the "laundry rack" is integral.

2.1 Laundry rack

Let $\Lambda \subseteq \Lambda_a$ be a set of laundry. A laundry rack (See figure 2) is a triplet $(\Lambda, +, -)$ representing a datastructure that implements the following methods:

- $get(\mathcal{L} \in \Lambda)$: $\mathcal{L} \in \Lambda$, gets a specific laundry item from the laundry rack.
- $put(\mathcal{L} \in \Lambda)$, deposits a laundry item onto the laundry rack.
- $match(\mathcal{L} \in \Lambda)$: $(\mathcal{P} \in \Lambda \times \Lambda) | \mathcal{L}_0$, returns a tuple $(\mathcal{L}, \mathcal{L}^{-1})$ representing a pair of socks iff $\mathcal{L}^{-1}$ is already on the laundry rack, $\mathcal{L}_0$ otherwise.

All these operations (especially $match$) run in $\mathcal{O}(1)$, making iteration over all n laundry items to find a pair $(\mathcal{L}, \mathcal{L}^{-1})$ obsolete.

3 Algorithm

Making use of the novel advanced features of a "drying rack" we are able to implement the following algorithm in $\mathcal{O}(n)$:

As evident from the algorithm above, only one



Fig. 2: A blue drying rack, found in many households.

Algorithm 2 HADES

```

1:  ▷ initialize a new laundry basket with a given
    set of laundry
2:   $A \leftarrow \Lambda$   ▷ WLOG assume  $\forall \mathcal{L} \in \Lambda | \mathcal{L}$  is a sock
3:  matches  $\leftarrow []$ 
4:   $\mathcal{L} \leftarrow []$   ▷ Create a new empty drying rack
5:  repeat
6:     $\mathcal{L} \leftarrow A.get$ 
7:    result  $\leftarrow \mathcal{L}.match(\mathcal{L})$ 
8:    if result  $\neq \mathcal{L}_0$  then
9:      matches.append(result)
10:   else
11:      $\mathcal{L}.put(\mathcal{L})$ 
12:   end if
13: until  $\mathcal{L} \neq \mathcal{L}_0$ 

```

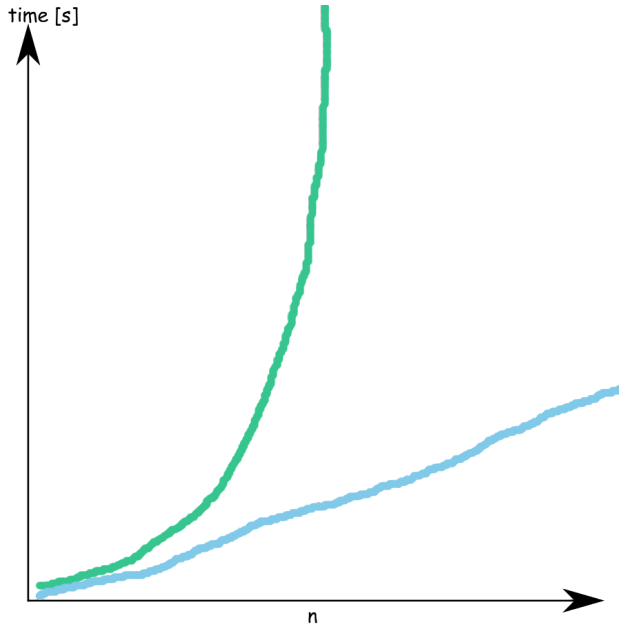
loop performing operations which are all in $\mathcal{O}(1)$ is required thus putting the algorithm in a $\mathcal{O}(n)$ runtime complexity class. Assuming that $\forall \mathcal{L} \in \Lambda \exists \mathcal{L}^{-1} | \mathcal{L} \cong \mathcal{L}^{-1}$ the algorithm always yields a correct solution for the problem (proof is left as an exercise to the reader).

4 Discussion and Results

To evaluate the algorithms performance it has been executed on different platforms consisting of diverse hardware:

Hardware	Algorithm	Runtime [s]
Myself	Conventional (n=20)	352.7
Myself	HADES (n=20)	92.3
Myself	Conventional (n=100)	42069
Myself	HADES (n=100)	420.69
My roommate	Conventional (n=10)	91.7
My roommate	HADES (n=10)	-2
Girlfriend	n.a.	n.a.

From the above data it is evident that HADES bears a clear advantage in comparison to the



written this paper.

Fig. 3: Comparative statistical time analysis of both algorithms. The graph depicts algorithm runtime (y-axis) and graphs it against input size (x-axis). Data for HADES in blue, for conventional sock sorting in green.

conventional algorithm when it comes to sock sorting. Utilizing advanced statistical modelling we calculated a speedup factor of about $3.1415926535897932384626433 \cdot n$. The data also illustrates the scalability of the algorithm and its adaptability to different hardware.

5 Conclusion

It can be concluded that the algorithm presented in this paper is greatly superior to the conventional method of sorting socks. It will probably revolutionize not only the field of laundry science but also have great impact in the industry.

The datastructures outlined above may become abundantly used and be the future industry standard. Although the field of laundry science is still rather new there are still a lot of open questions to be answered. However it is unlikely that a faster sock sorting algorithm than HADES can be developed.

6 Acknowledgements

We shall use this historic opportunity to thank the Journal of immaterial science for publishing great ~~memes~~ research. We also want to thank our university for giving us this great opportunity for ~~depression and self-loathing~~ research and personal advancement.

It is also only appropriate to thank the air. Without it no laundry would be dry and we would not have