Functional Hash Maps in a Data Parallel Language

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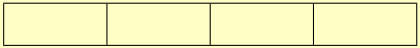
Open Adressing Example

- Keys $k_0, k_1 \in K$.
- Hash function $h : K \to \{0, 1, 2, 3\}$.
- $h(k_0) = h(k_1) = 1$.



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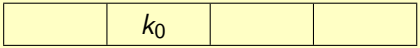

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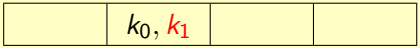

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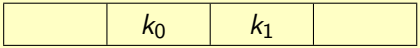

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- Concurrency.

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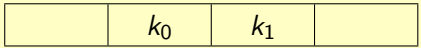
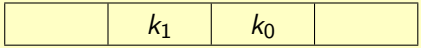
- Collision resolution.

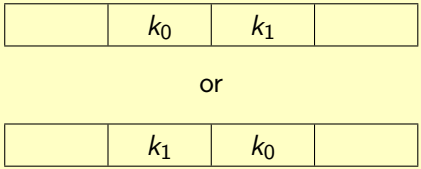


or



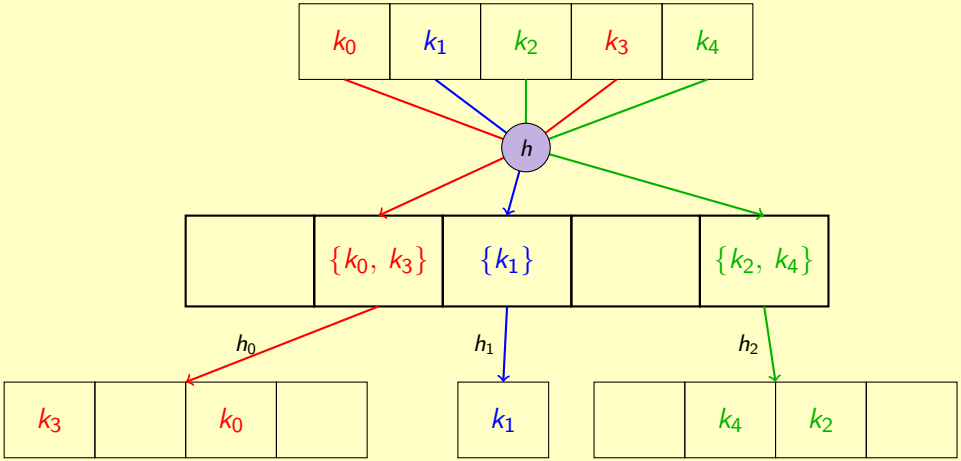
Core Ideas

- Concurrency.
- Collision resolution.
- Functional Array Languages.



$$\texttt{map} : (\alpha \to \beta) \to [n]\alpha \to [n]\beta$$

Perfect Hashing with FKS



Finding collision-free hash functions

- Pick hash functions h_i for every bin.
- Compute $o_i + h_i(k)$ for every k.
- Compute a histogram to count the number of collisions.
- Using a segmented scan, check if any subhash map has a collision.
- Partition subhash maps by if they had collision.
- Continue on subhash maps with collisions.

Benchmarks

	64-bit integer keys ($n = 10^7$)		
	Construction	*Lookup*	*Membership*
Futhark (hash maps)	18.3	3.3	1.6
Futhark (binary search)	40.9	6.2	5.8
Futhark (Eytzinger)	42.3	4.3	2.4
cuCollections	2.7	1.1	0.9

All times in milliseconds.

The End

Towards Efficient Hash Maps in Functional Array Languages

https://arxiv.org/abs/2508.11443

Code

https://github.com/diku-dk/containers

https://github.com/diku-dk/futhark-hashmap-experiments