

# Functional Hash Maps in a Data Parallel Language

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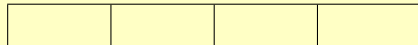
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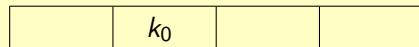
# Open Addressing Example

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



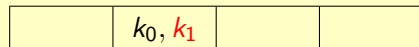
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	$k_0$	$k_1$	
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# Core Ideas

- Concurrency.
- Collision resolution.



or



# Hash Maps in Functional Array Language

- Avoid collisions.
- Bulk operations.

$$\text{map} : (\alpha \rightarrow \beta) \rightarrow [n]\alpha \rightarrow [n]\beta$$

$$\text{from\_array} : [n](\alpha, \beta) \rightarrow \mathbf{map} \ \alpha \ \beta$$

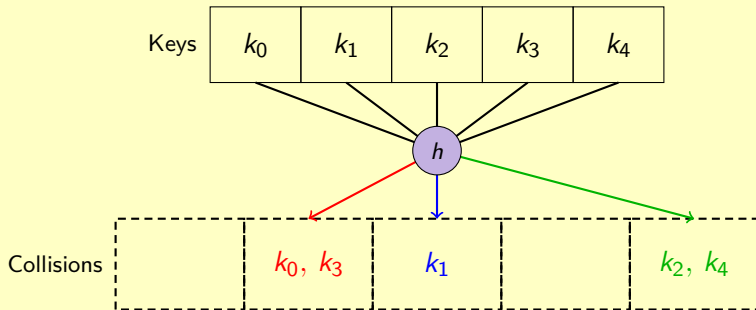
# Perfect Hashing with FKS

Keys

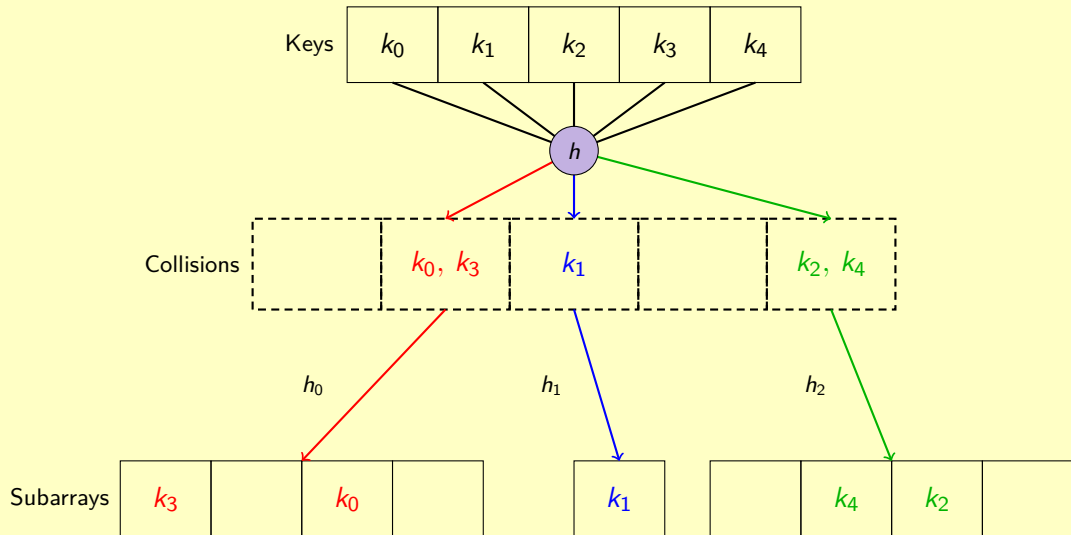
$k_0$	$k_1$	$k_2$	$k_3$	$k_4$
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# Perfect Hashing with FKS



# Perfect Hashing with FKS



# Finding collision-free hash functions

# Benchmarks

	<b>64-bit integer keys (<math>n = 10^7</math>)</b>		
	<i>Construction</i>	<i>Lookup</i>	<i>Membership</i>
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.

## **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>