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COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE

Hash Tables: Linear Probing

Linear probing

Earlier, we saw our first collision resolution policy, separate chaining.

Linear probing is another approach to resolving hash collisions.

Unlike separate chaining, we only allow a single object at a given index.

Linear probing

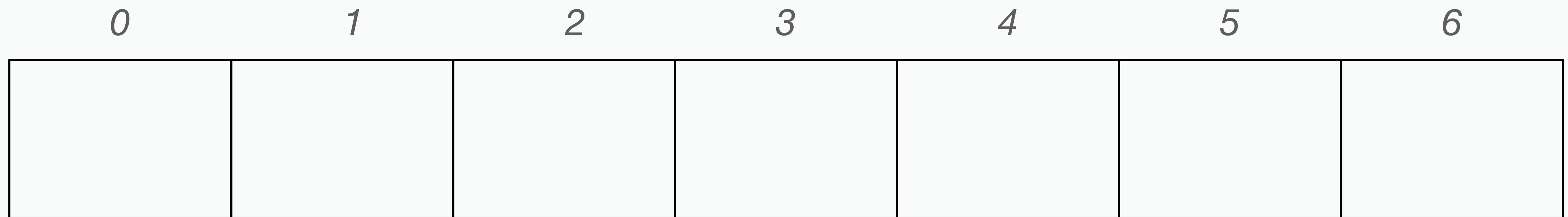
Earlier, we saw our first collision resolution policy, separate chaining.

Linear probing is another approach to resolving hash collisions.

Unlike separate chaining, we only allow a single object at a given index.

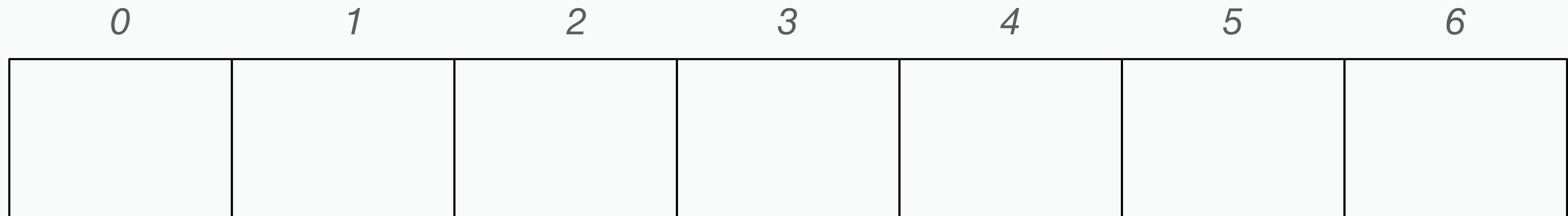
The idea behind linear probing is simple: if a collision occurs, we probe our hash table taking one step at a time until we find an empty spot for the object we wish to insert.

Linear probing



Linear probing

Hash function:
 $f(x) = x \bmod 7$



Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 12 : $12 \bmod 7 = 5$

<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
					12	

Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 9 : $9 \bmod 7 = 2$

<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
					12	

Linear probing

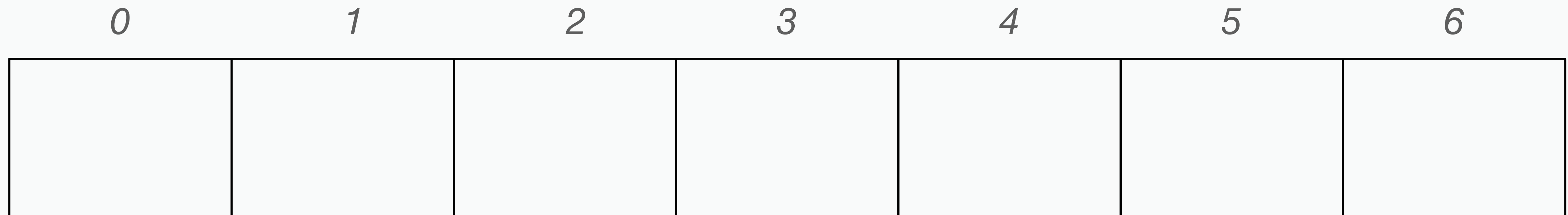
Hash function:
 $f(x) = x \bmod 7$

Insert 9 : $9 \bmod 7 = 2$

<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
		9			12	

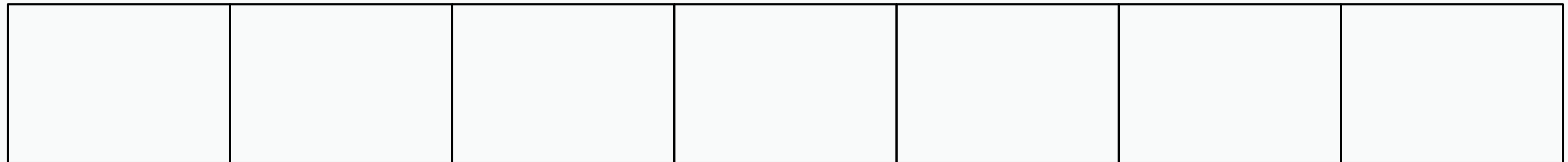
Linear probing

Hash function:



Linear probing

0

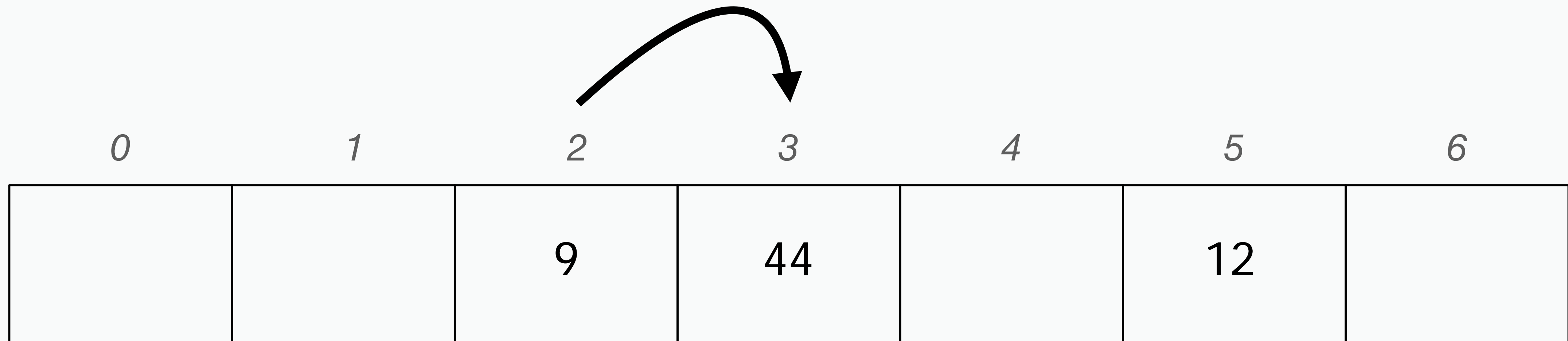


Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 44 : $44 \bmod 7 = 2$

collision!



Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 30 : $30 \bmod 7 = 2$

collision!

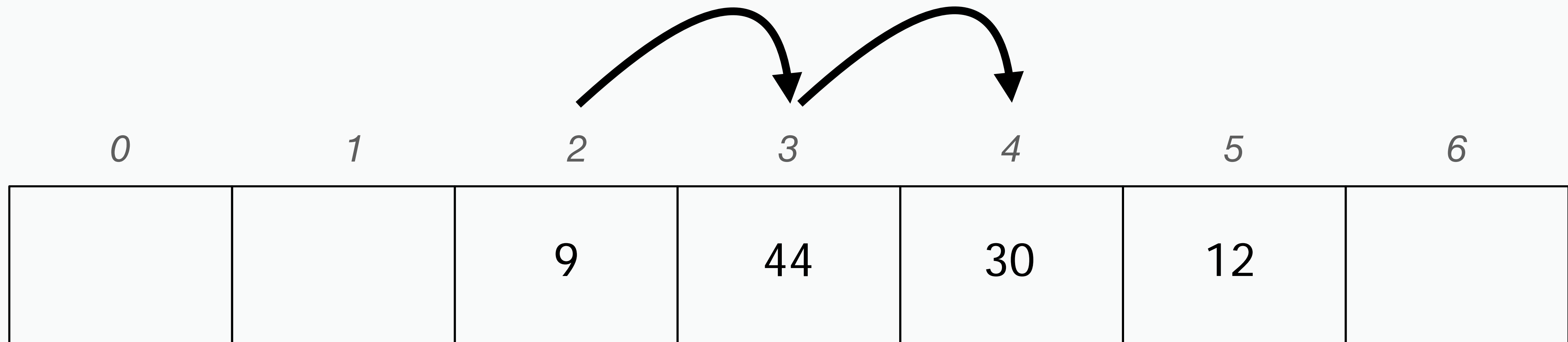
<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
		9	44		12	

Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 30 : $30 \bmod 7 = 2$

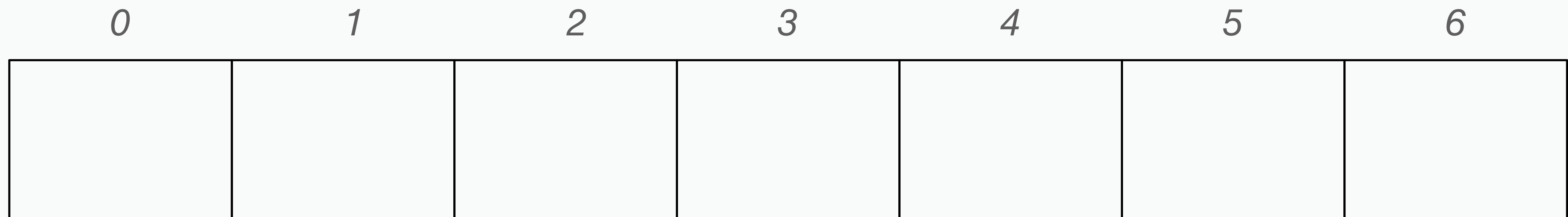
collision!



Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 2 : $2 \bmod 7 = 2$

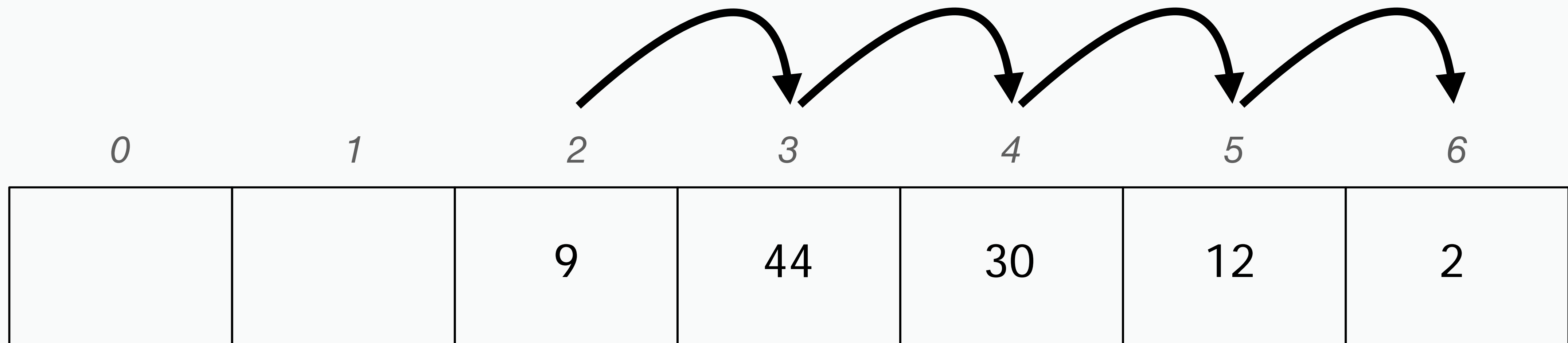


Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 2 : $2 \bmod 7 = 2$

collision!



Linear probing

Hash function:
 $f(x) = x \bmod 7$

Insert 16 : $16 \bmod 7 = 2$

collision!

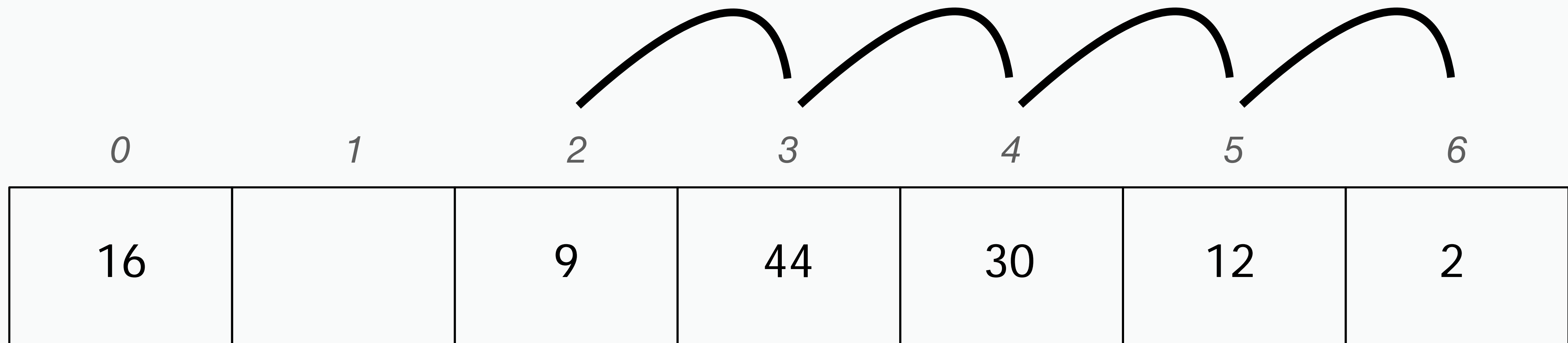
0	1	2	3	4	5	6
		9	44	30	12	2

Linear probing

Hash function:
 $f(x) = x \bmod 7$

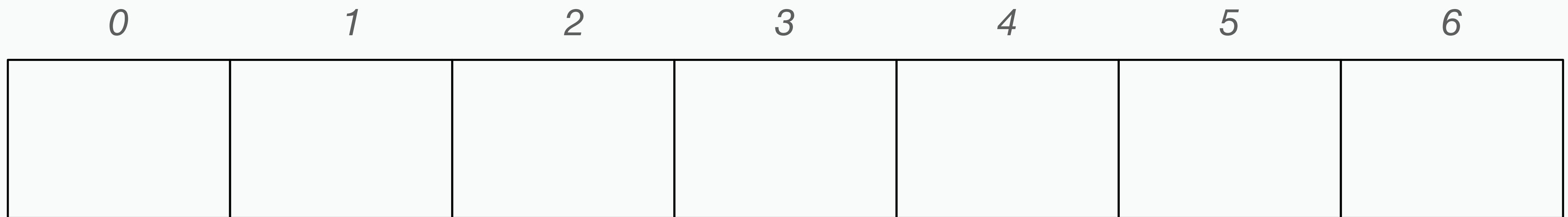
Insert 16 : $16 \bmod 7 = 2$

collision!



Linear probing

Linear probing



Linear probing

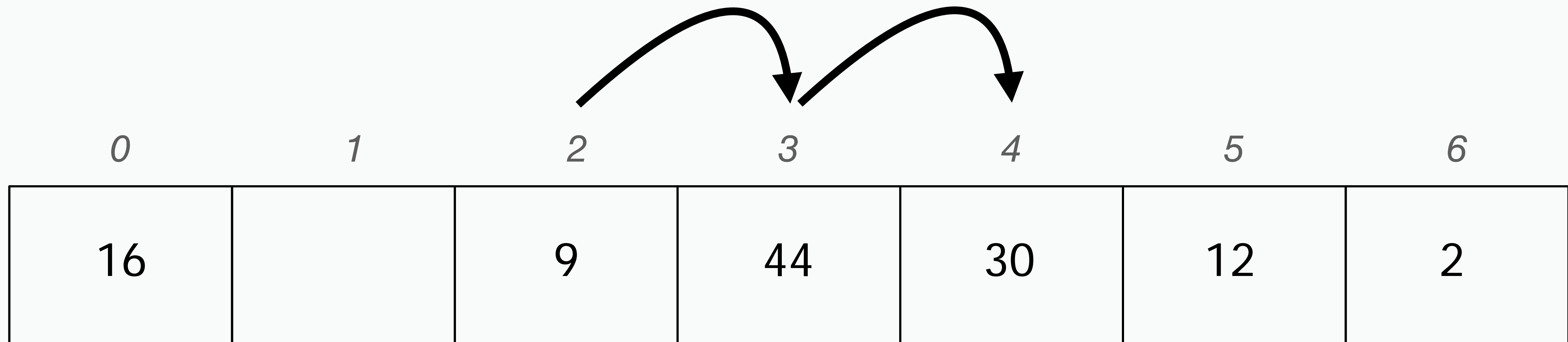
Hash function:
 $f(x) = x \bmod 7$

<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
16		9	44	30	12	2

Linear probing

Hash function:
 $f(x) = x \bmod 7$

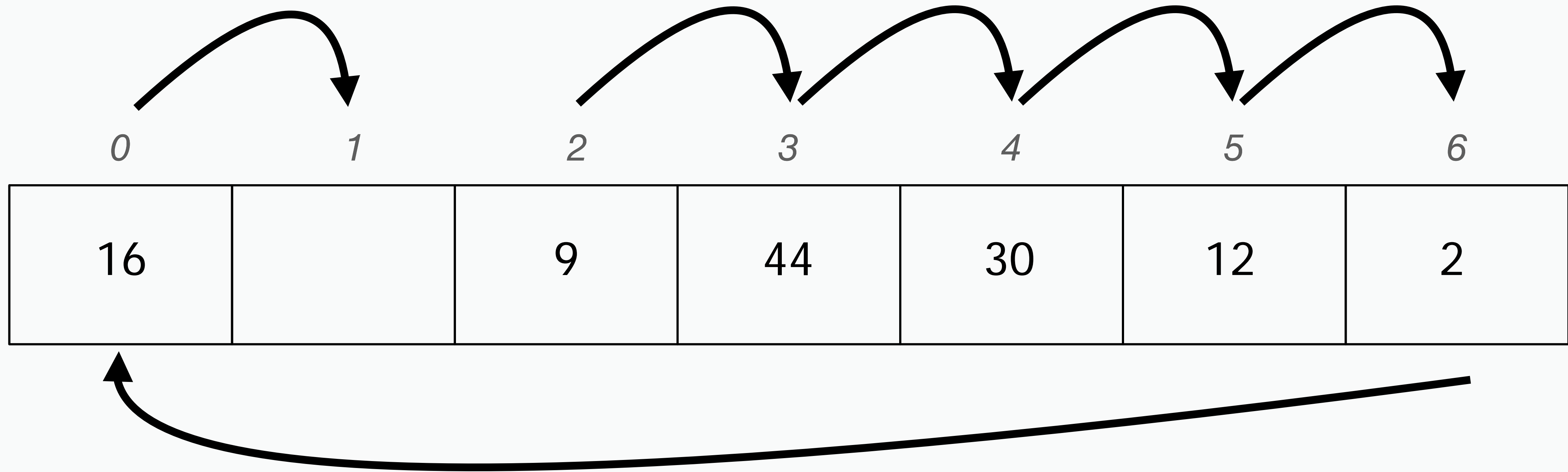
Find 30 : $30 \bmod 7 = 2$



Linear probing

Hash function:
 $f(x) = x \bmod 7$

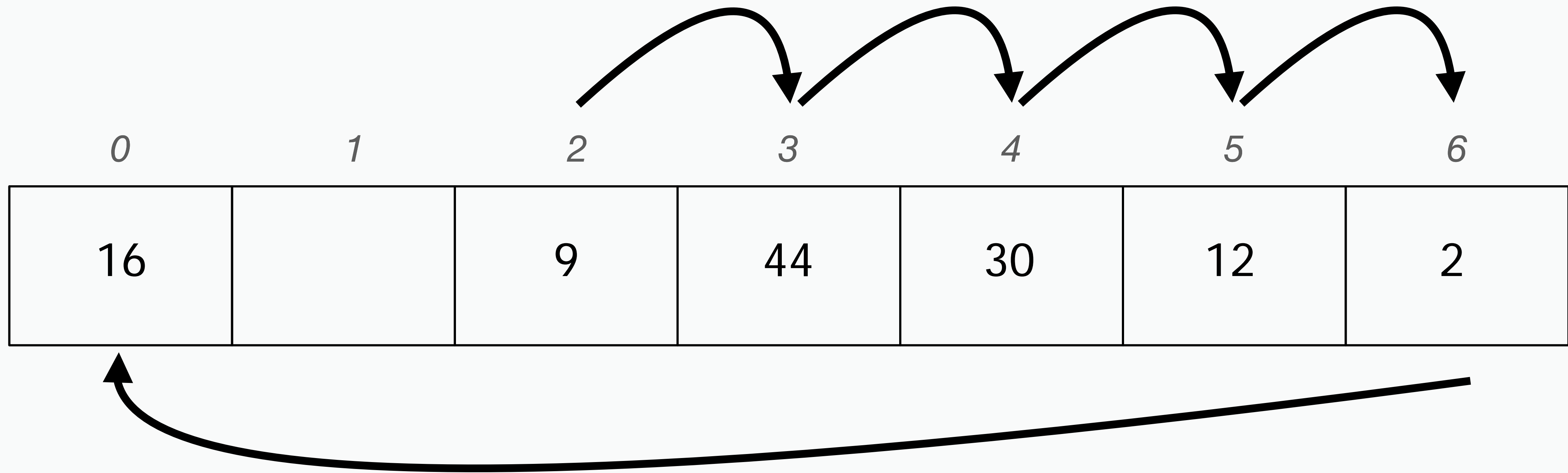
Find 72 : $72 \bmod 7 = 2$



Linear probing

Hash function:
 $f(x) = x \bmod 7$

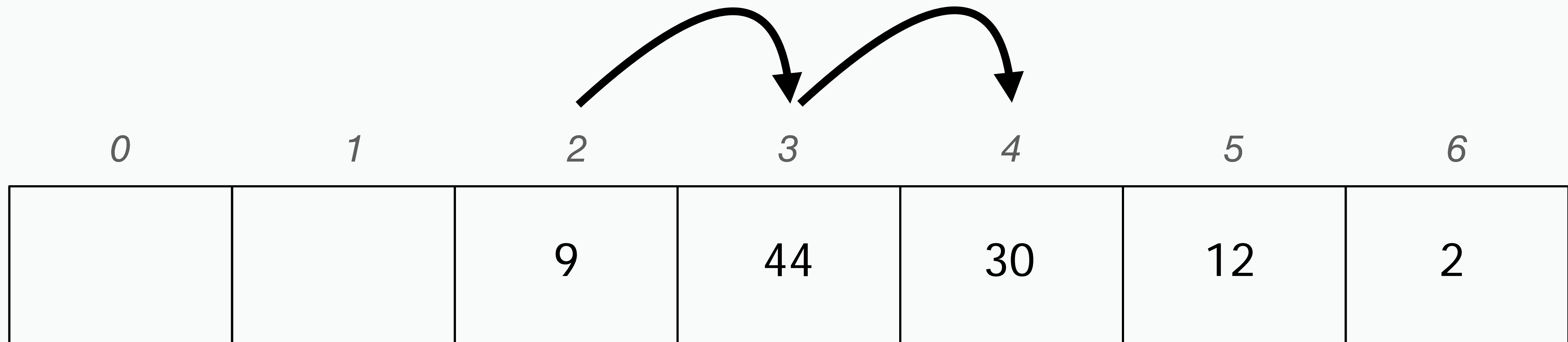
Remove 16 : $16 \bmod 7 = 2$



Linear probing

Hash function:
 $f(x) = x \bmod 7$

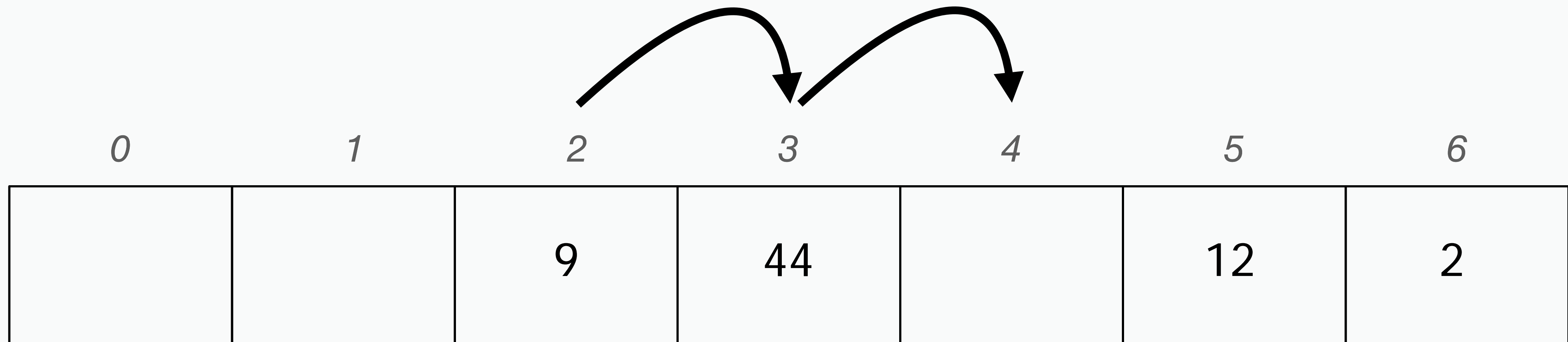
Remove 30 : $30 \bmod 7 = 2$



Linear probing

Hash function:
 $f(x) = x \bmod 7$

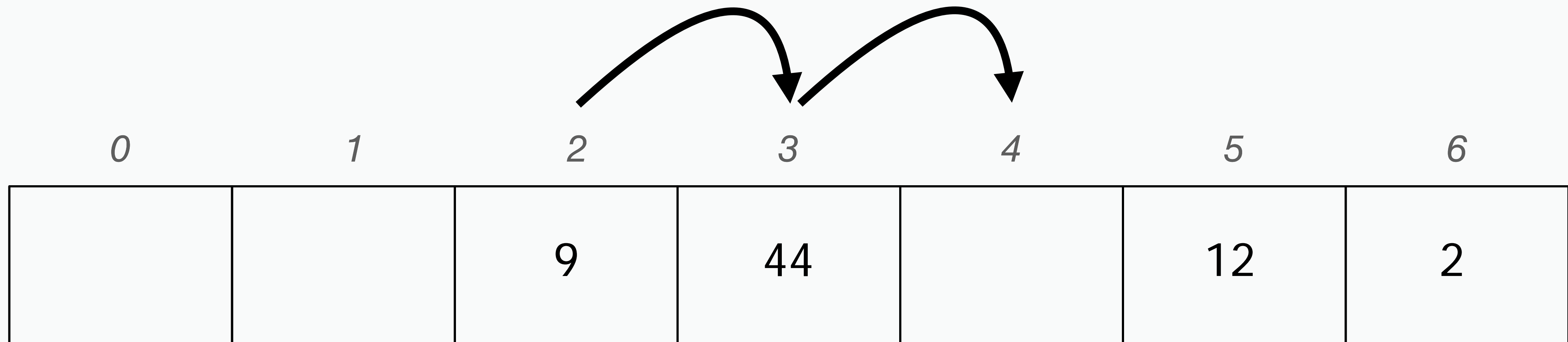
Remove 30 : $30 \bmod 7 = 2$



Linear probing

Hash function:
 $f(x) = x \bmod 7$

Find 2 : $2 \bmod 7 = 2$



Linear probing

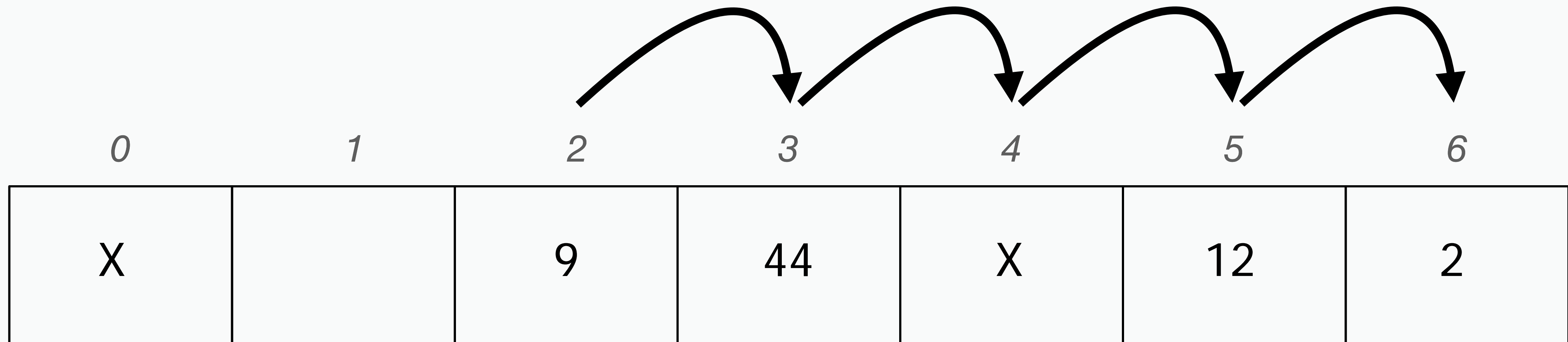
Hash function:
 $f(x) = x \bmod 7$

<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
X		9	44	X	12	2

Linear probing

Hash function:
 $f(x) = x \bmod 7$

Find 2 : $2 \bmod 7 = 2$



Linear probing: primary clustering

<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
		9	44	30	12	2

Linear probing vs separate chaining

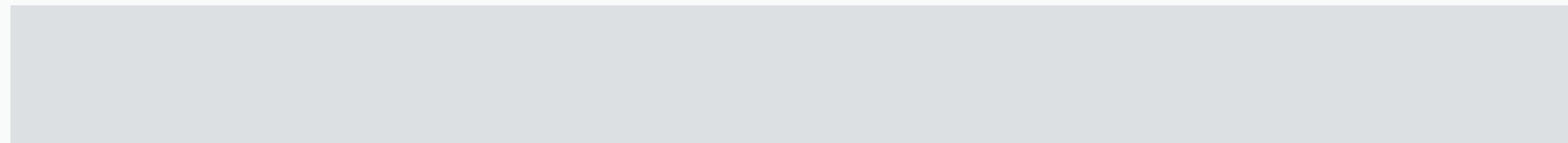
Linear probing

On collisions we probe

Fixed upper limit on number of

Separate chaining

On collisions we extend the chain



Linear probing: summary

- We only allow a single object at a given index.
- Upon hash collisions, we probe our hash table, one step at a time, until we find an empty position in which we may insert our object.
- Unlike separate chaining, where we can extend chains, linear probing has a fixed limit on the number of objects we can insert into our hash table.

Questions

- What can we do when we run out of space in our hash table?
- If we set our stride to some value greater than one, why is it a good idea to have a hash table size that's a prime number?