

# Algoritmi e Strutture Dati

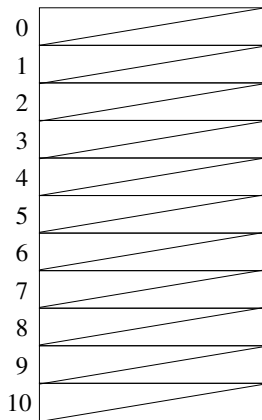
## Hash (esempi)

P. Massazza<sup>1</sup>

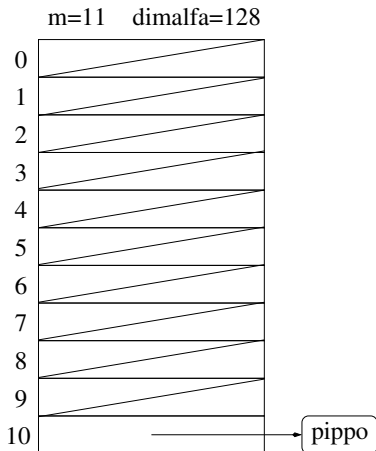
<sup>1</sup>Dipartimento di Scienze Teoriche e Applicate  
Università degli Studi dell'Insubria  
Varese Italy

# Hash statico: concatenazioni separate

$m=11$     $\text{dim}(\alpha)=128$



# Hash statico: concatenazioni separate

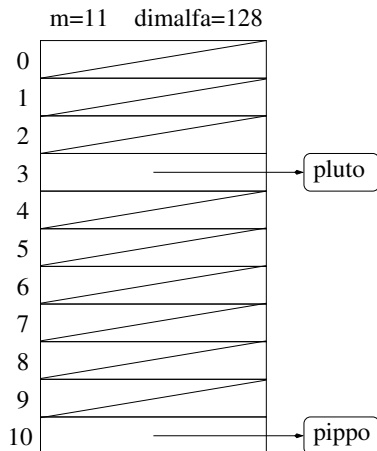


Insert(pippo)



$H(\text{pippo})=10$

# Hash statico: concatenazioni separate

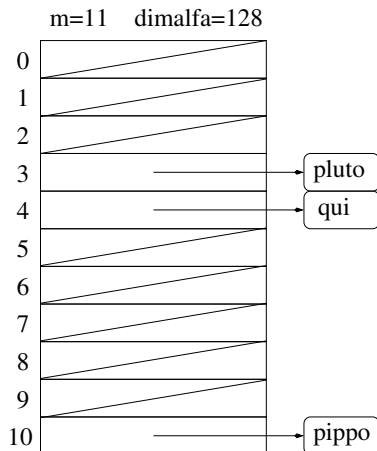


Insert(pluto)



$H(\text{pluto})=3$

# Hash statico: concatenazioni separate



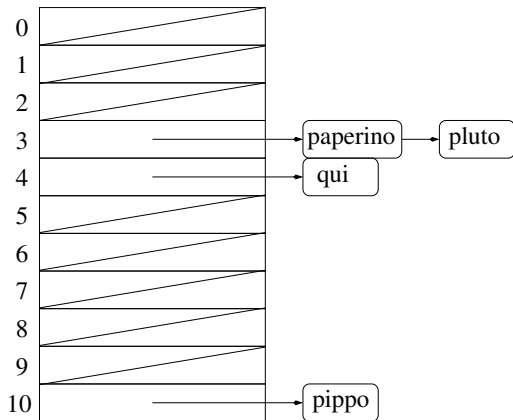
Insert(qui)



$H(\text{qui})=4$

# Hash statico: concatenazioni separate

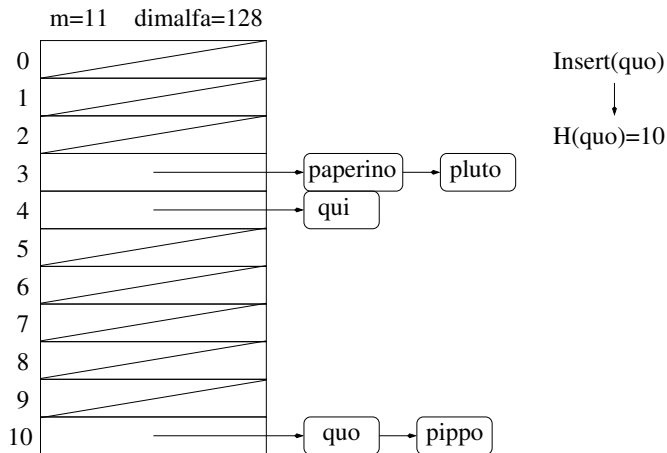
$m=11$     $dimalfa=128$



Insert(paperino)

↓  
 $H(\text{paperino})=3$

# Hash statico: concatenazioni separate



# Hash statico: indirizzamento aperto

0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

$m=11$

$\text{dim}(\text{alfa})=128$



# Hash statico: indirizzamento aperto

0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	pippo

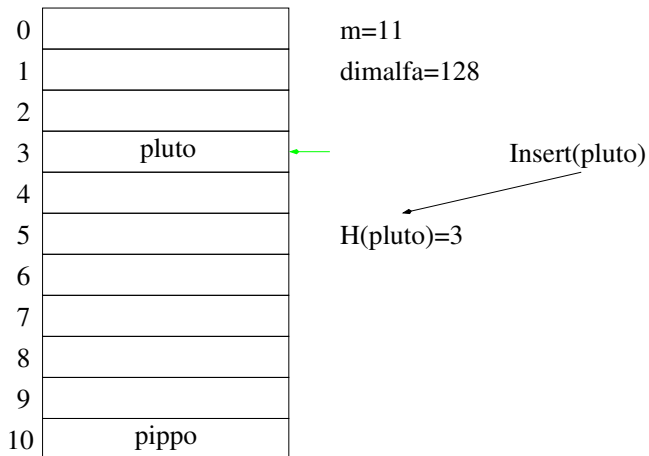
$m=11$

$dimalfa=128$

Insert(pippo)

$H(\text{pippo})=10$

# Hash statico: indirizzamento aperto



# Hash statico: indirizzamento aperto

0	
1	
2	
3	pluto
4	qui
5	
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\alpha)=128$

Insert(qui)

$H(\text{qui})=4$

# Hash statico: indirizzamento aperto

0	
1	
2	
3	pluto
4	qui
5	
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\alpha)=128$

Insert(paperino)

$H(\text{paperino})=3$

# Hash statico: indirizzamento aperto

0	
1	
2	
3	pluto
4	qui
5	
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dimalfa}=128$

Insert(paperino)

$H(\text{paperino})=3$

# Hash statico: indirizzamento aperto

0	
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\text{alfa})=128$

Insert(paperino)

$H(\text{paperino})=3$

# Hash statico: indirizzamento aperto

0	
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dimalfa}=128$

Insert(quo)

$H(\text{quo})=10$

# Hash statico: indirizzamento aperto

0	quo	← $m=11$ $dimalfa=128$
1		
2		
3	pluto	
4	qui	
5	paperino	
6		
7		
8		
9		
10	pippo	

Insert(quo)

←  
 $H(\text{quo})=10$



# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\text{alfa})=128$

$\text{Member}(\text{paperino})$

$H(\text{paperino})=3$

# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\alpha)=128$

$\text{Member}(\text{paperino})$

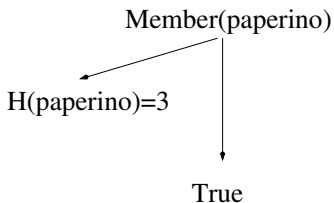
$H(\text{paperino})=3$

# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dimalfa}=128$



# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dimalfa}=128$

$\text{Member}(\text{bassotti})$

$H(\text{bassotti})=10$



# Hash statico: indirizzamento aperto

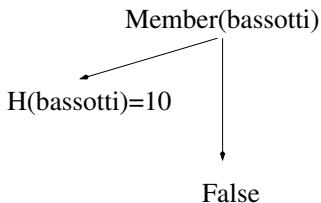
0	quo	← m=11
1		dimalfa=128
2		
3	pluto	
4	qui	Member(bassotti)
5	paperino	↙
6		H(bassotti)=10
7		
8		
9		
10	pippo	

# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$dimalfa=128$



# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	pluto
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\alpha)=128$

Delete(pluto)

$H(\text{pluto})=3$

# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\text{alfa})=128$

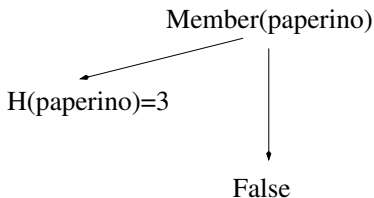


# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$dimalfa=128$



# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	*
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\alpha)=128$

Delete(pluto)

$H(\text{pluto})=3$

\*  $\begin{cases} \text{posizione libera ( inserimento)} \\ \text{posizione occupata (ricerca/cancellazione)} \end{cases}$

# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	*
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\text{alfa})=128$

$\text{Member}(\text{paperino})$

$H(\text{paperino})=3$

# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	*
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

$\text{dim}(\text{alfa})=128$

$\text{Member}(\text{paperino})$

$H(\text{paperino})=3$

# Hash statico: indirizzamento aperto

0	quo
1	
2	
3	*
4	qui
5	paperino
6	
7	
8	
9	
10	pippo

$m=11$

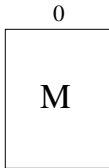
$\text{dim} \text{alfa}=128$

$H(\text{paperino})=3$

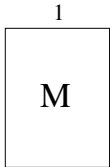
$\text{Member}(\text{paperino})$

True

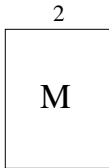
# Hash dinamico



# Hash dinamico



# Hash dinamico

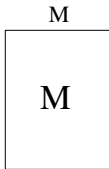




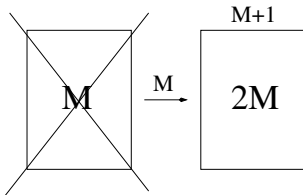
# Hash dinamico



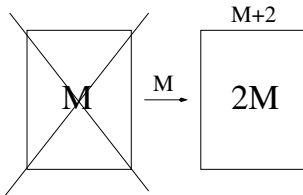
# Hash dinamico



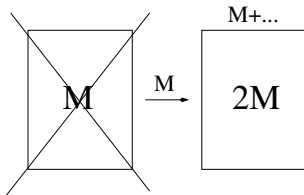
# Hash dinamico



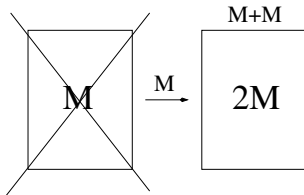
# Hash dinamico



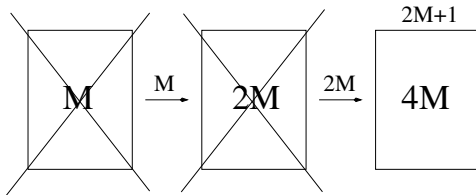
# Hash dinamico



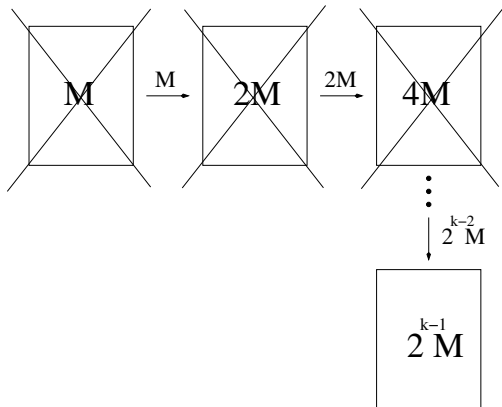
# Hash dinamico



# Hash dinamico

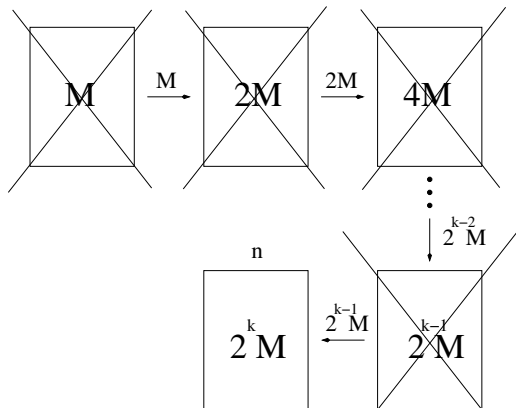


# Hash dinamico

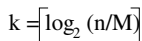




# Hash dinamico



# Hash dinamico



Il costo complessivo di  $n$  inserimenti è quindi

$$\begin{aligned} M + M \sum_{i=0}^{k-1} 2^i + M \sum_{j=0}^{k-1} 2^j &= M + 2M(2^k - 1) \\ &= M(2^{k+1} - 1) \quad (\text{nota: } k = \lceil \log_2(n/M) \rceil) \\ &\leq M(2 \cdot 2^{\log_2 n} - 1) = M(2n - 1) = \Theta(n) \end{aligned}$$

Il costo ammortizzato di un inserimento (costo totale diviso  $n$ ) è  $O(1)$