

insertions				
birthdate	name	hash	hash%9	hash%18
10/12/1815	Ada Lovelace	3,717,898	7	16
12/9/1906	Grace Hopper	3,904,265	2	11
1/1/1990	Joy Buolamwini	4,075,585	7	7
6/23/1912	Alan Turing	3,916,183	4	13
8/19/1978	Luis von Ahn	4,051,475	8	17
8/1/1943	Judy Faulkner	3,979,777	4	13
5/1/2004	Nate Mitchell	4,104,513	0	9
1/9/1959	Shafi Goldwasser	4,012,105	4	13
3/5/1964	Yoshua Bengio	4,022,469	0	9

slot	
0	
1	
2	12/9/1906
3	
4	6/23/1912
5	
6	
7	10/12/1815 ; 1/1/1990
8	

} rehash before
 → 5th
 insertion

slot	
0	
1	
2	
3	
4	
5	
6	
7	1/1/1990
8	
9	5/1/2004 ; 3/5/1964
10	
11	12/9/1906
12	
13	6/23/1912 ; 8/1/1943 ; 1/9/1959
14	
15	
16	10/12/1815
17	8/19/1978

Open Hashing

lookups			
birthdate	hash	hash%9	hash%18
6/23/1912	3,916,183	4	13
8/15/1975	4,045,327	7	7
8/1/1943	3,979,777	4	13
1/9/1959	4,012,105	4	13
8/19/1943	3,979,795	4	13
3/23/1964	4,022,487	0	9

AT
 null
 JF
 SG
 null
 null

insertions				
birthdate	name	hash	hash%9	hash%18
10/12/1815	Ada Lovelace	3,717,898	7	16
12/9/1906	Grace Hopper	3,904,265	2	11
1/1/1990	Joy Buolamwini	4,075,585	7	7
6/23/1912	Alan Turing	3,916,183	4	13
8/19/1978	Luis von Ahn	4,051,475	8	17
8/1/1943	Judy Faulkner	3,979,777	4	13
5/1/2004	Nate Mitchell	4,104,513	0	9
1/9/1959	Shafi Goldwasser	4,012,105	4	13
3/5/1964	Yoshua Bengio	4,022,469	0	9

slot	
0	
1	
2	12/9/1906
3	
4	6/23/1912
5	
6	
7	10/12/1815
8	1/1/1990

rehash before 5th insertion

$p(6) = 1^2 = 1$.
use slot $7+1=8$.

slot	
0	
1	
2	
3	
4	1/9/1959
5	
6	
7	1/1/1990
8	
9	5/1/2004
10	
11	12/9/1906
12	
13	6/23/1912
14	8/1/1943
15	
16	10/12/1815
17	8/19/1978

$p(1) = 1^2 = 1$. Collides at slot 14.
 $p(2) = 2^2 = 4$. Collides at slot 17.
 $p(3) = 3^2 = 9$. slot $13+9=22$; $22 \% 18 = 4$.
 So put in slot 4.

$p(1) = 1^2 = 1$. use slot $13+1=14$.

Closed Hashing

with quadratic probe

lookups			
birthdate	hash	hash%9	hash%18
6/23/1912	3,916,183	4	13
8/15/1975	4,045,327	7	7
8/1/1943	3,979,777	4	13
1/9/1959	4,012,105	4	13
8/19/1943	3,979,795	4	13
3/23/1964	4,022,487	0	9

AT null
JF
SC
null
NM

check 5 different slots!