Spring 2017

HASH-BASED DISK INDEXING

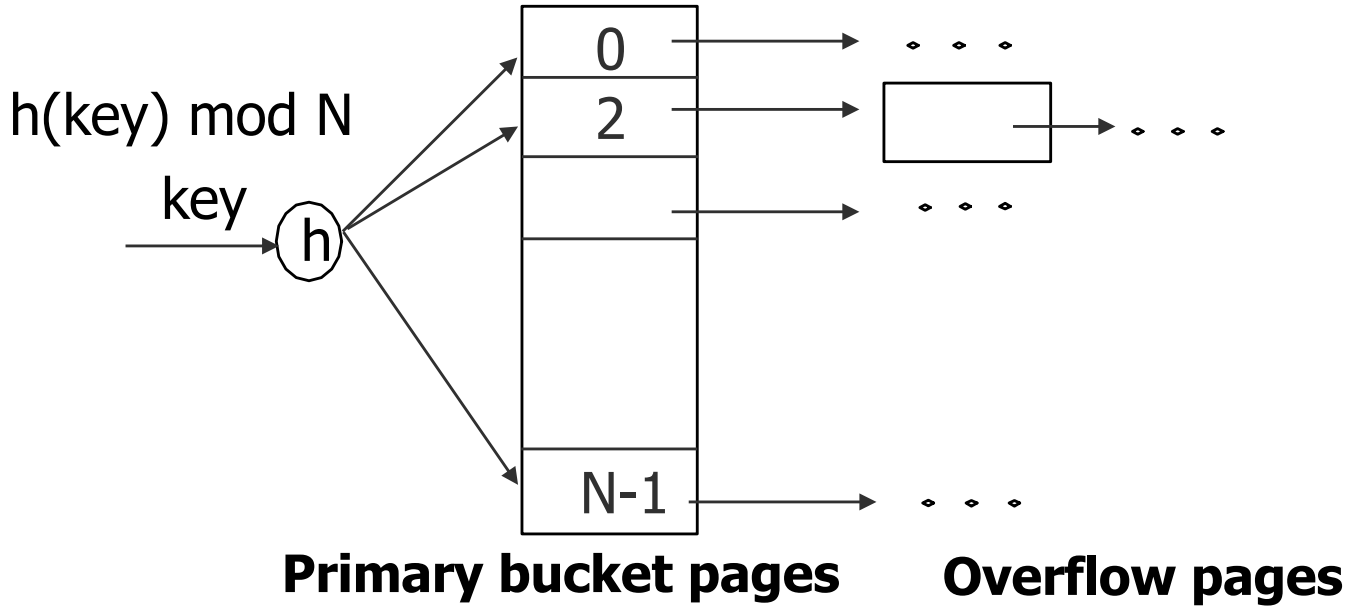
(BASED ON THE COW BOOK: 11.1 AND 11.2)

Introduction

- Hash-based indexes are best for equality selections. Cannot support range searches.
  - Static hashing
  - Extendible hashing (dynamic)
  - Linear hashing (dynamic) – not covered in the course, see 11.3 in the cow book

Static Hashing

- # primary bucket pages fixed, allocated sequentially, never de-allocated; overflow pages if needed.
- h(*k*) mod M = bucket to which data entry with key *k* belongs. (M = # of buckets)



Static Hashing (Contd.)

- Buckets contain data entries.
- Hash function works on *search key* field of record *r.* Must distribute values over range 0 ... M-1.
  - What is a good hash function?
  - **h**(*key*) = (a * *key* + b) usually works well.
  - a and b are constants; lots known about how to tune **h**.
- Long overflow chains can develop and degrade performance.
  - Reorganization is expensive and may block queries
  - *Extendible* and *Linear Hashing*: Dynamic techniques to fix this problem.

Extendible Hashing

- Why not re-organize file by doubling the number of buckets?
  - Note that reading and writing all pages is expensive!
- *Idea*:
  - Use directory of pointers to buckets
  - On overflow, double the directory (not the # of buckets)
  - Why does this help?
    - Directory is much smaller than the entire index file
    - Only one page of data entries is split.
    - *No overflow page! (caveat: duplicates w.r.t. the hash function)*
  - Trick lies in how the hash function is adjusted!

Example

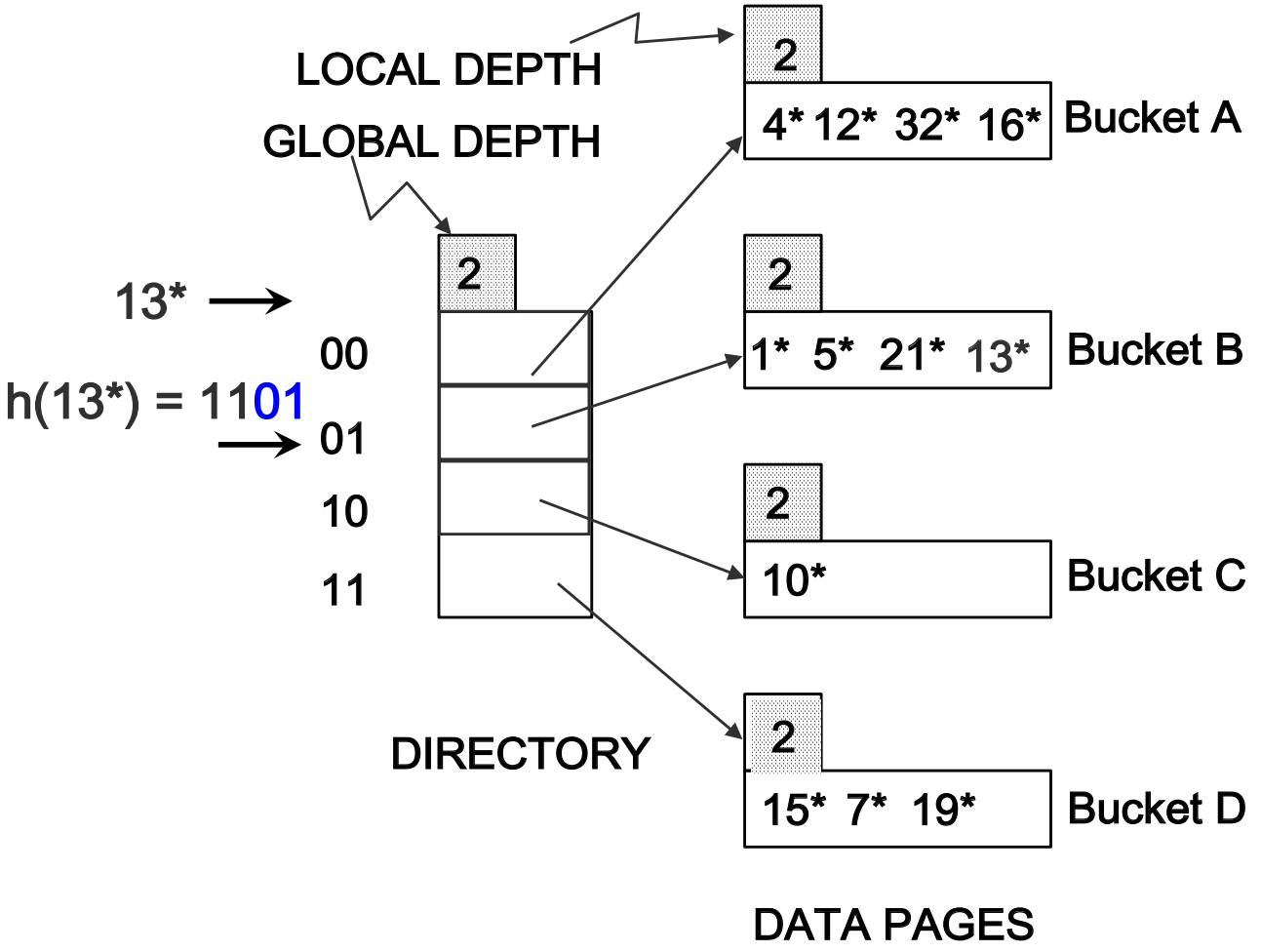
- Directory an array
- Search for k:
  - Apply hash function h(k)
  - Take last **global depth**

    # bits of **h**(*k*)
- Insert:
  - If the bucket has space, insert, done
  - If the bucket if full, **split** it, re-distribute
  - If necessary, double the directory

DATA PAGES

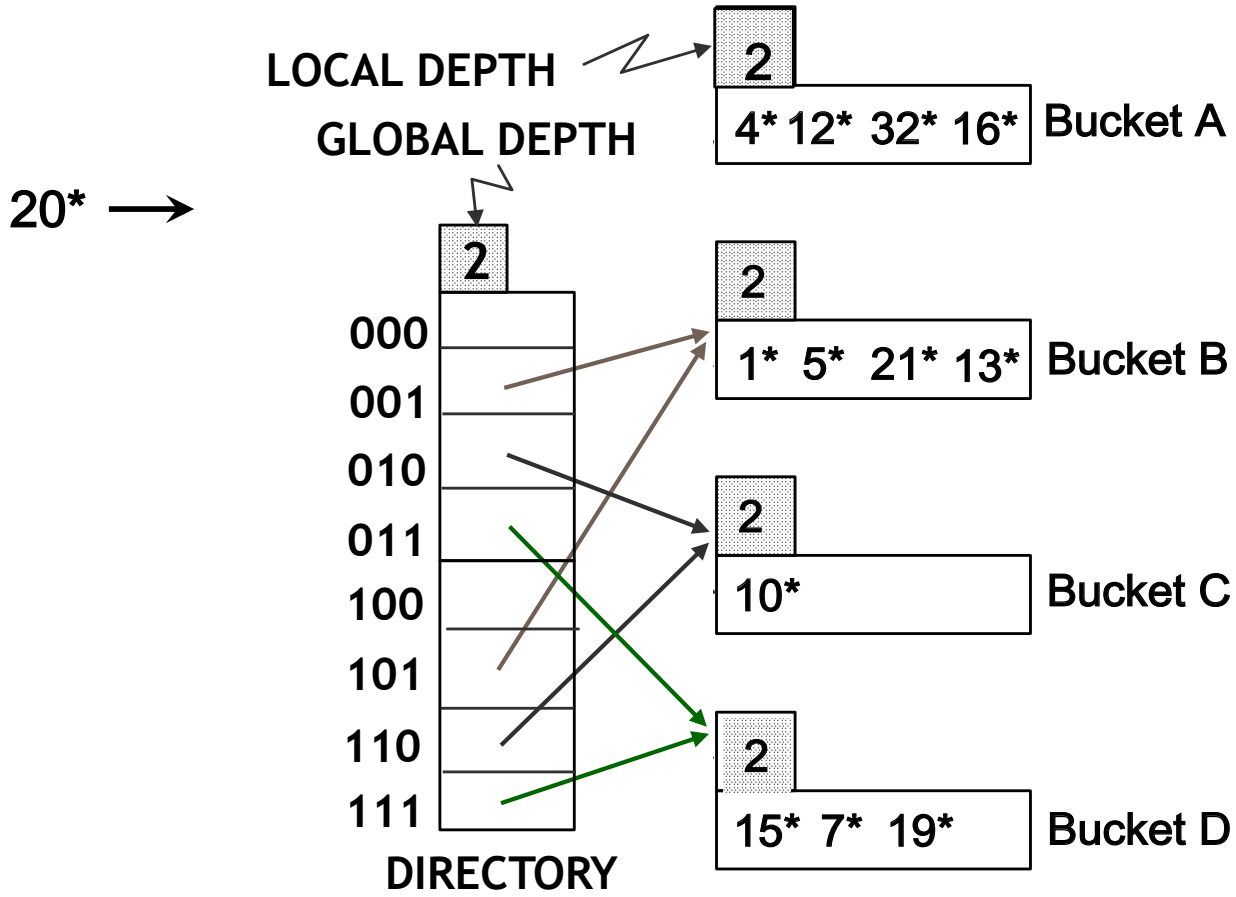
Can you identify this hash function?

Example



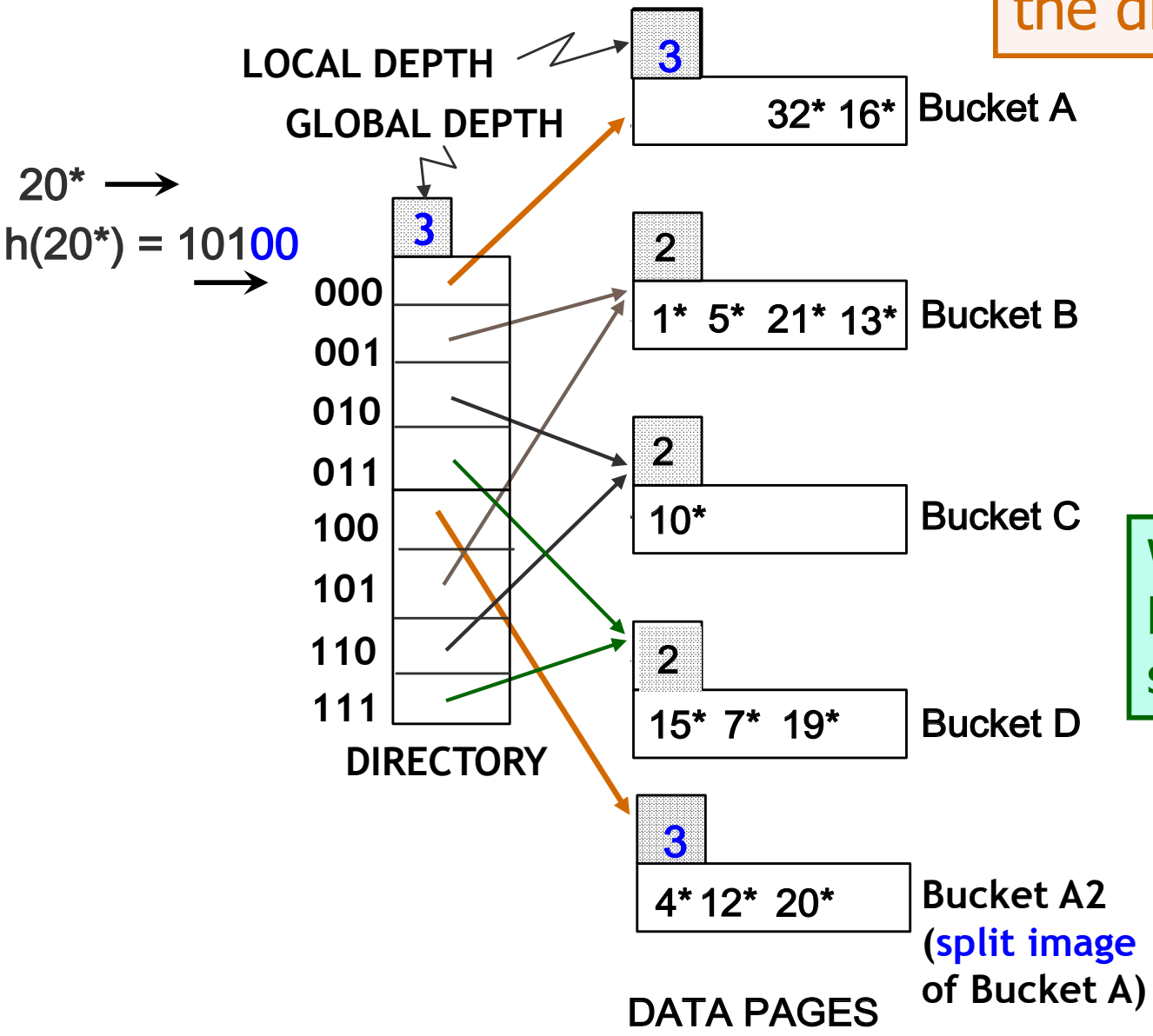
Can you identify this hash function?

Insert 20


LOCAL DEPTH
GLOBAL DEPTH
20*
2
4* 12* 32* 16*
Bucket A
2
000
001
010
011
100
101
110
111
DIRECTORY
2
1* 5* 21* 13*
Bucket B
2
10*
Bucket C
2
15* 7* 19*
Bucket D
DATA PAGES

Insert 20

Does splitting a bucket always require doubling the directory?



What happens if we had used most-significant bits?

Comments on Extendible Hashing

- How many disk accesses for equality search?
  - One if directory fits in memory, else two.
- Directory grows in spurts, and, if the distribution *of hash values* is skewed, directory can grow large.
- Do we ever need overflow pages?
  - Multiple entries with same hash value cause problems!
- **Delete**: Reverse of inserts
  - Can merge with split image.
  - Can shrink the directory by half. When?
    - Each directory element points to same bucket as its split image
  - Is shrinking/merging a good idea?