Operating Systems
Lecture 31: Filesystems 2

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Deleting Files

There is no system call for deleting files!

Inode (and associated file) is garbage collected when there are no references (from paths or fds).

Paths are deleted when: `unlink()` is called.

Let's Learn About Link Before Unlink
Hard Link

```
prompt> echo hello > file
prompt> cat file
hello
prompt> ln file file2  // create a hard link, link file to file2
prompt> cat file2
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- Create another way to refer to the same file
- The command-line link program : ln

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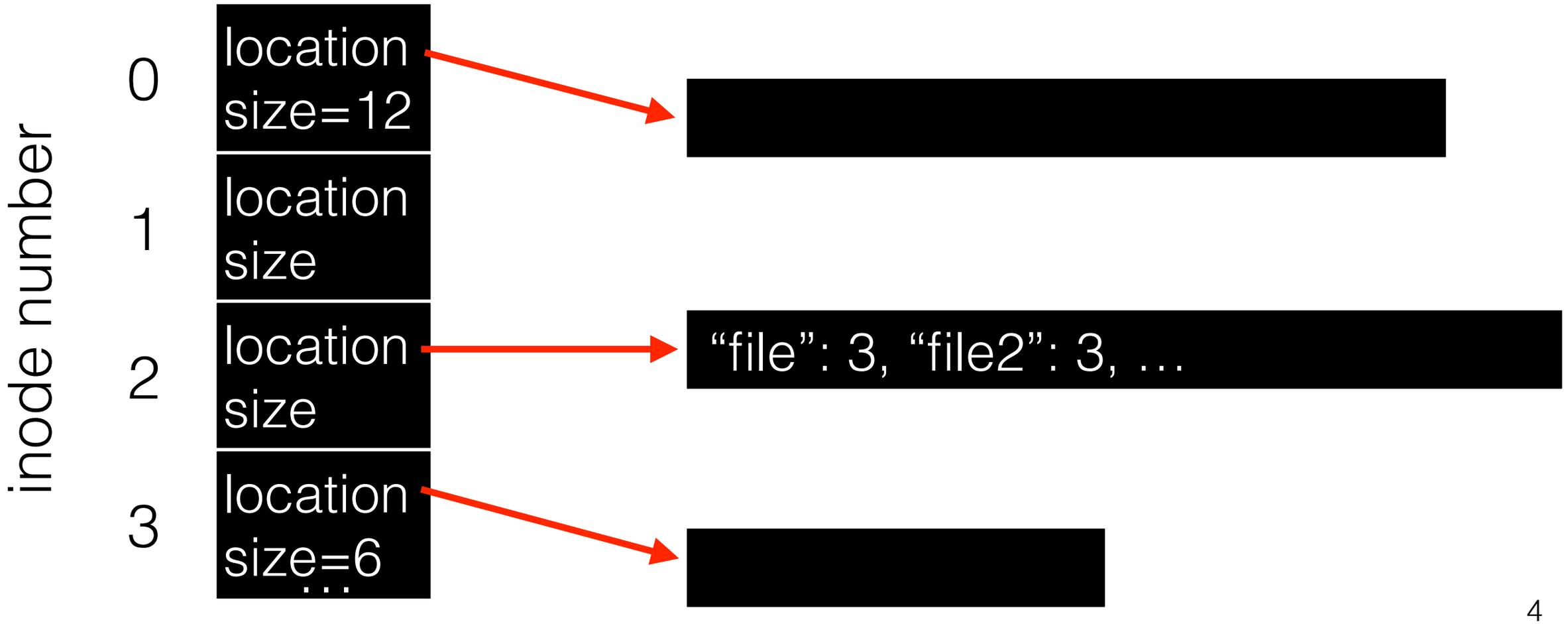

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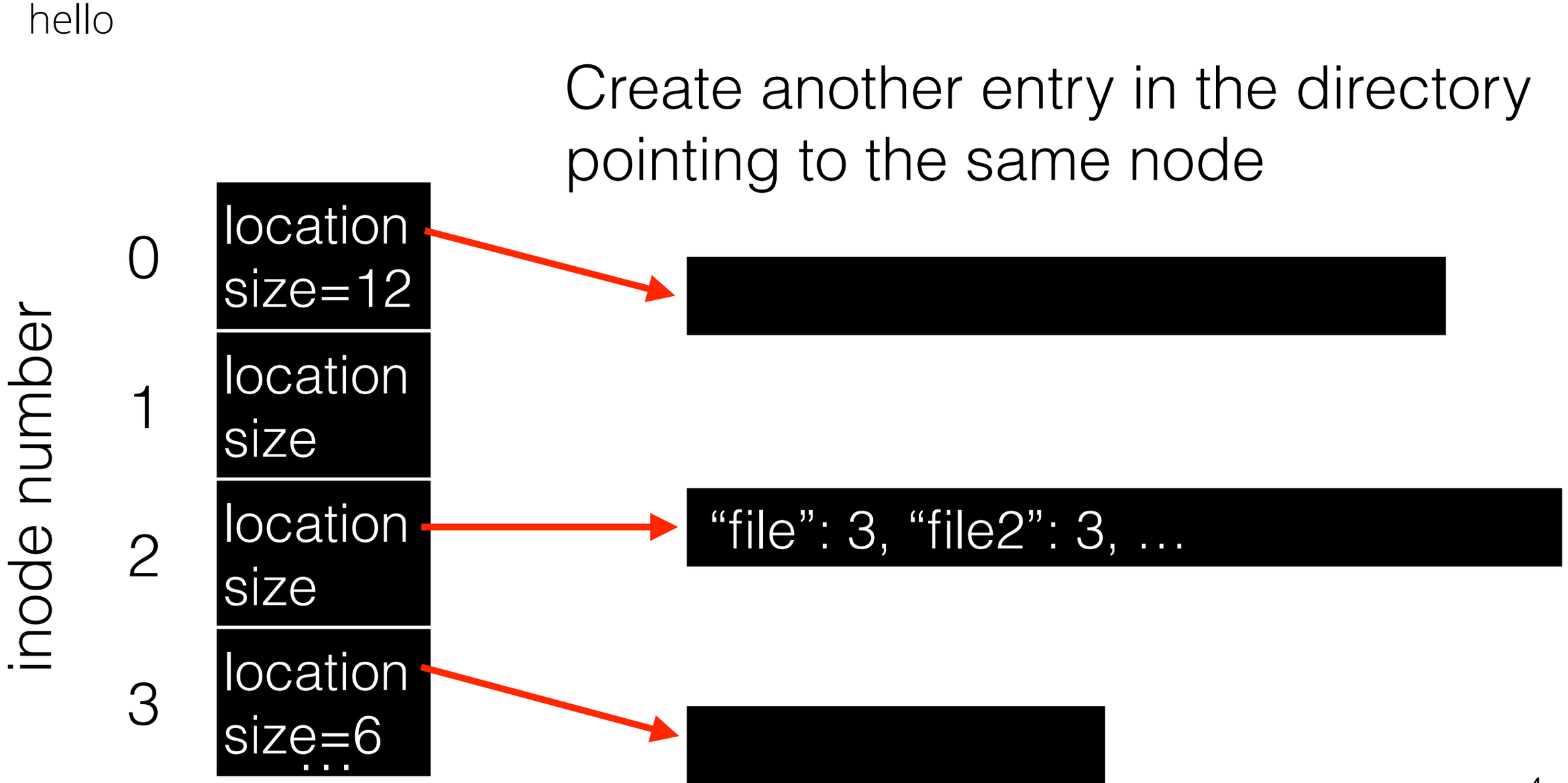
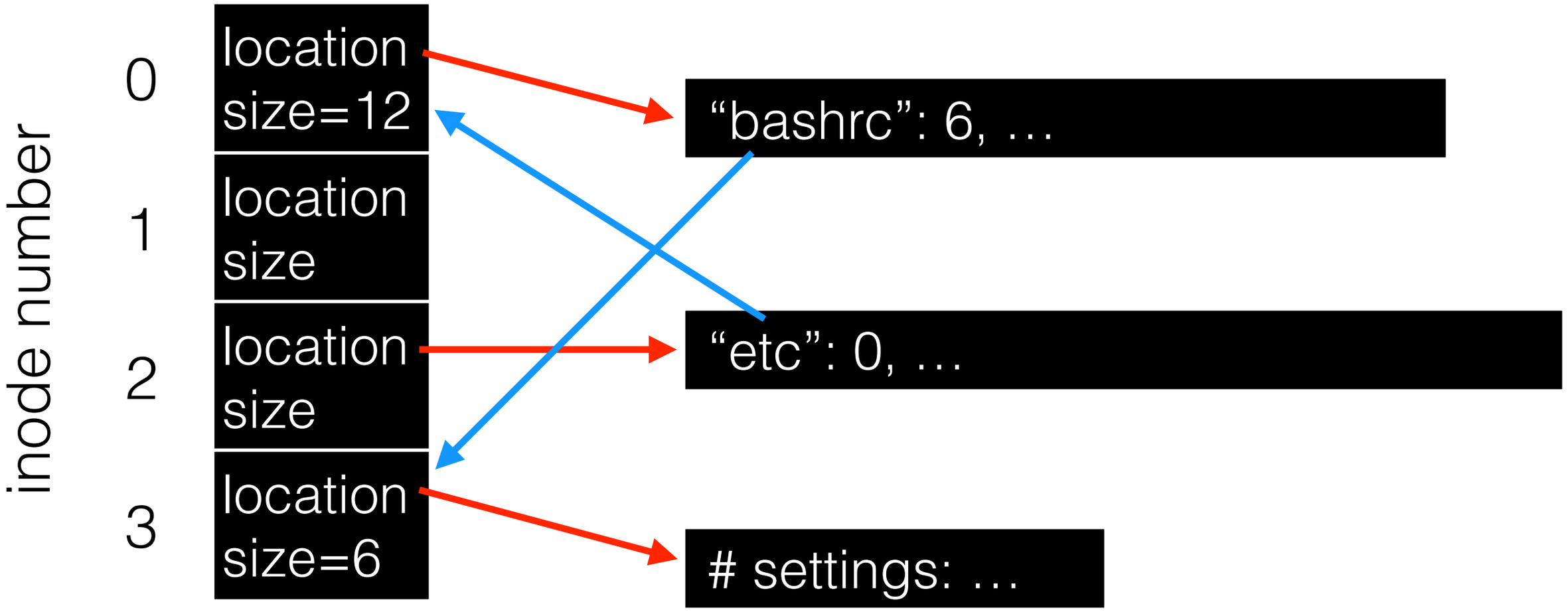
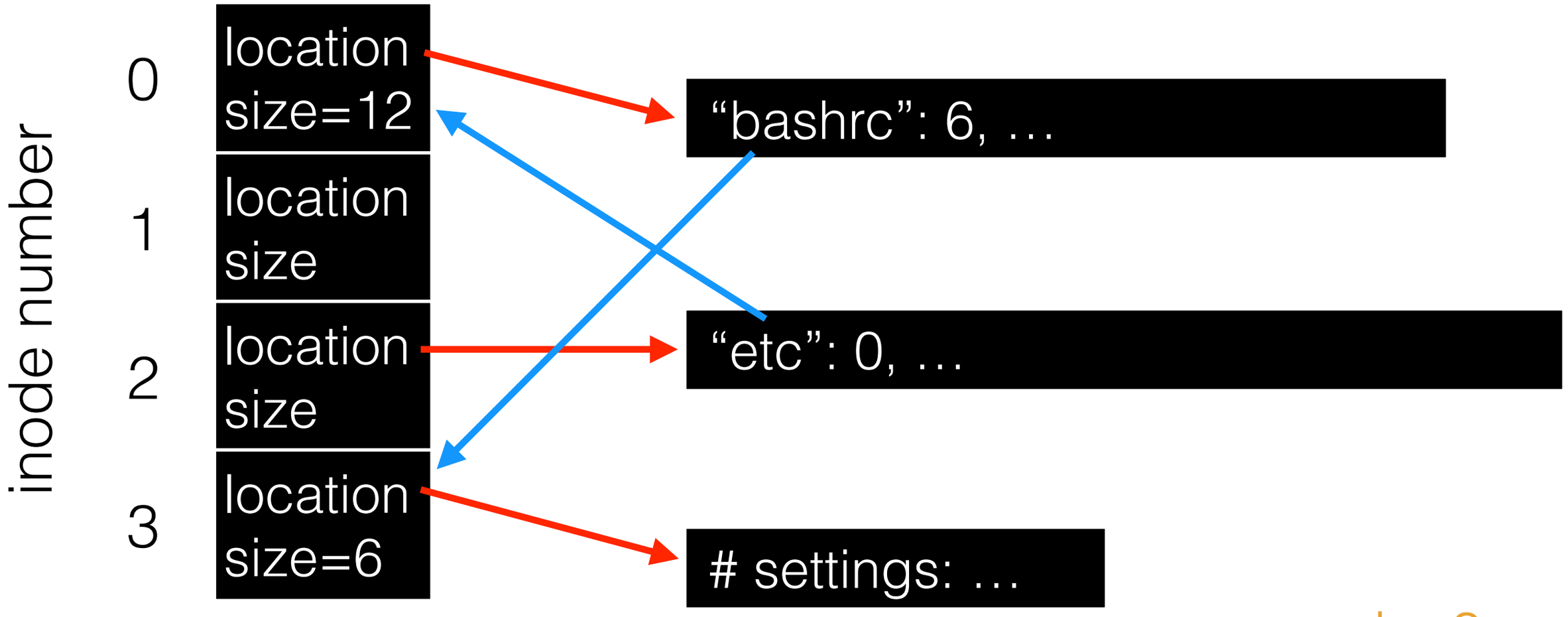


Directories and Files



Directories and Files

read **/etc/bashrc**



reads: 0

Directories and Files

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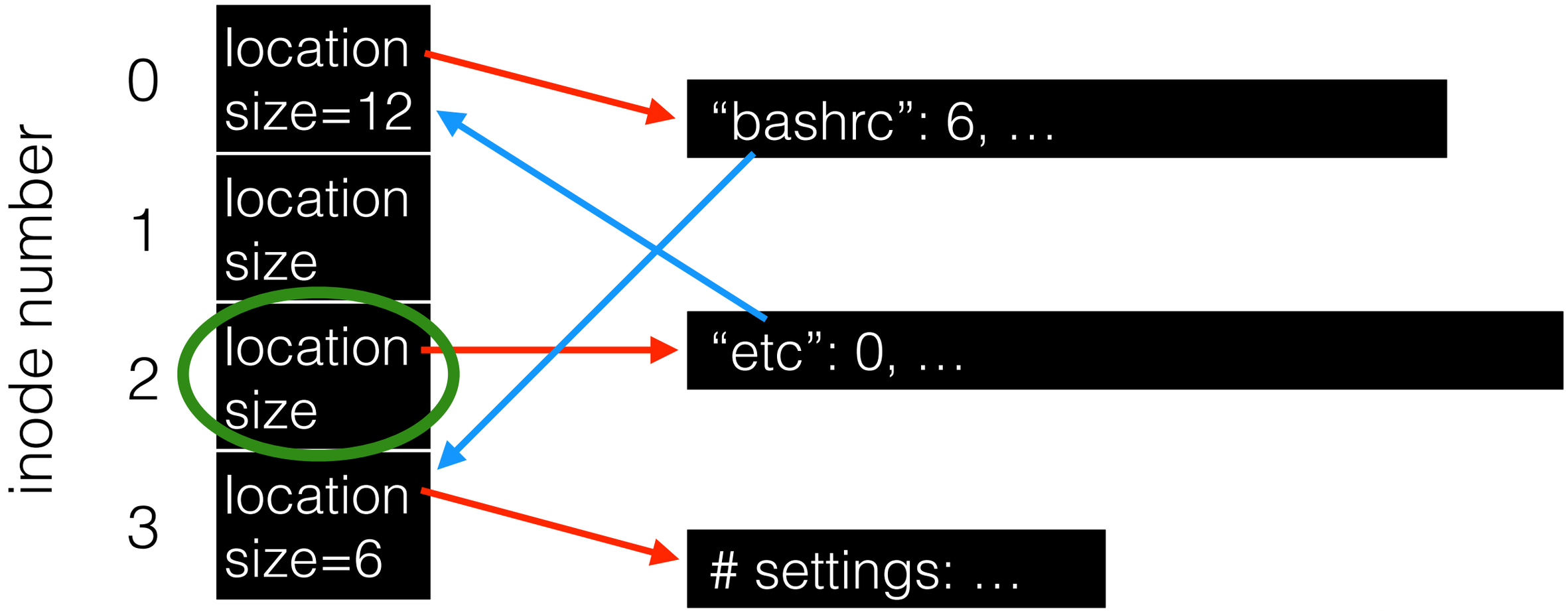

reads: 1

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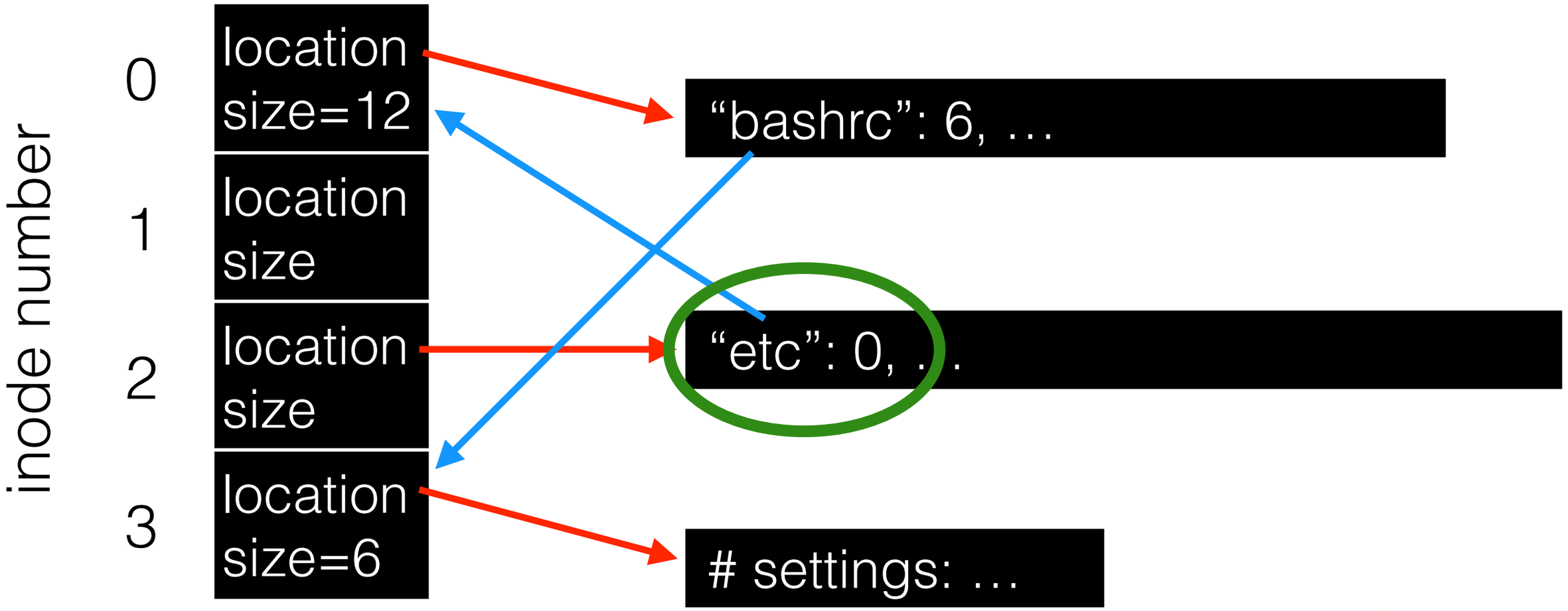

reads: 2

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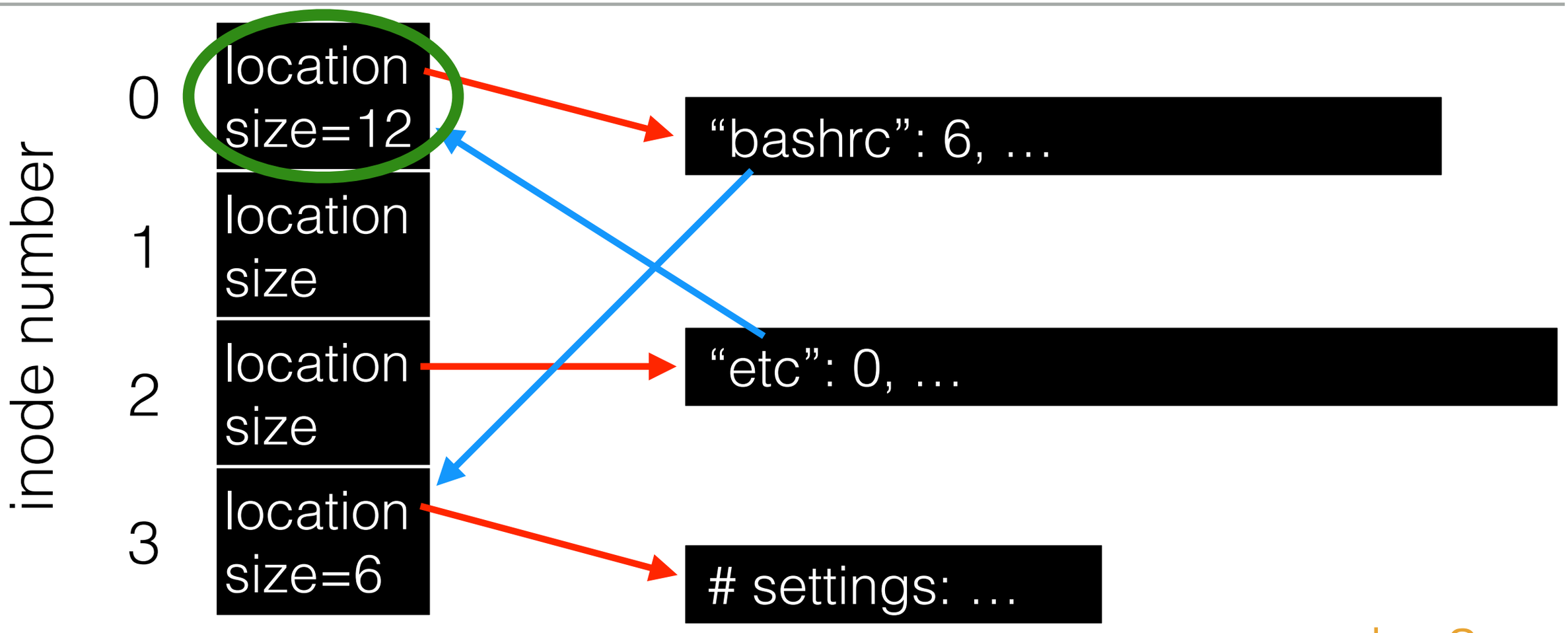

reads: 3

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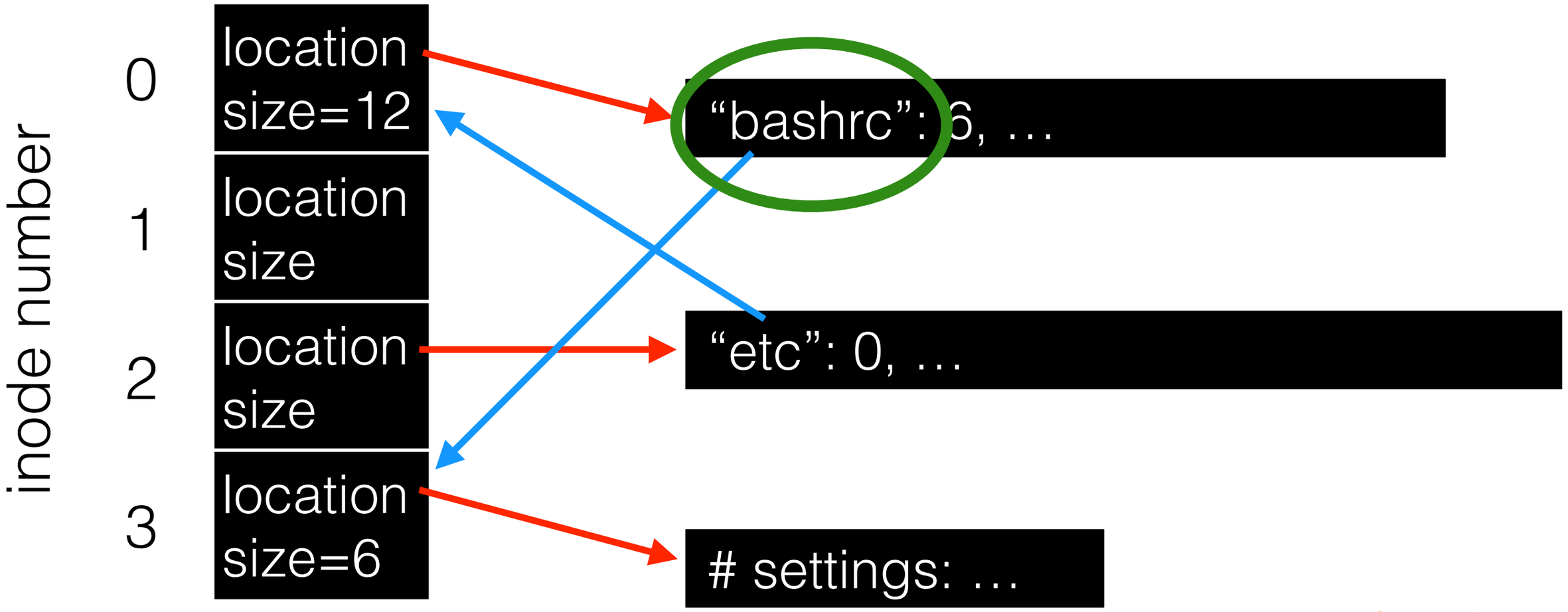

reads: 4

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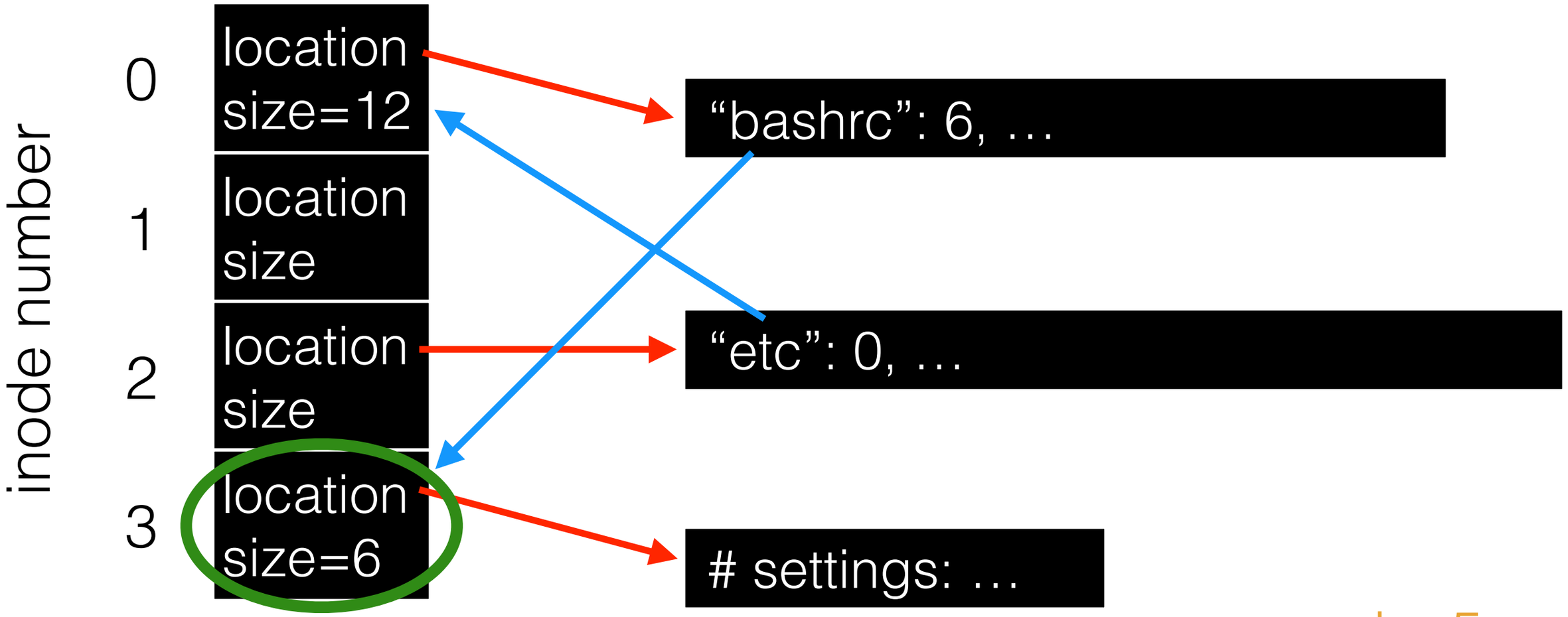

reads: 5

Directories and Files

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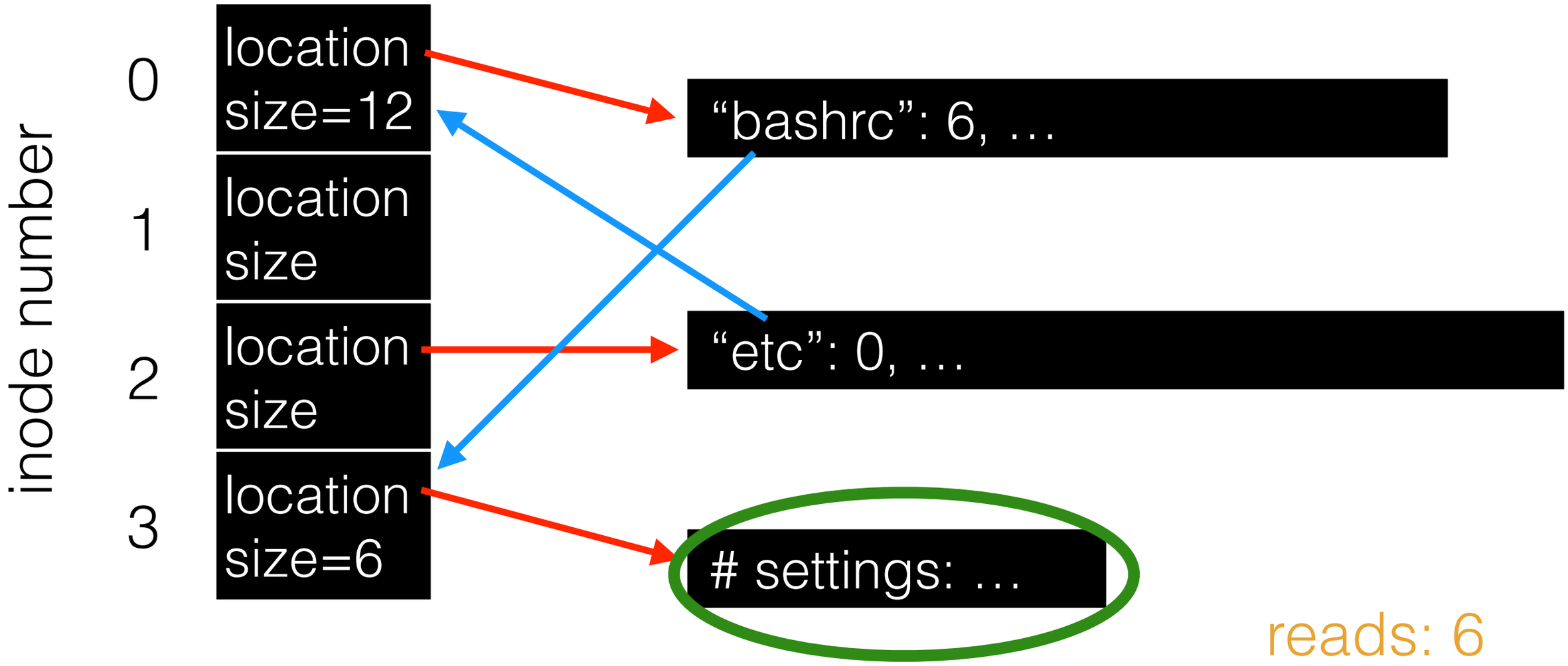

reads: 6

Creating Directories

prompt> strace mkdir foo

…

mkdir(“foo”, 0777) = 0

prompt>

```
▶ ls -la
total 9033248
drwxr-xr-x+  90 nipun  staff        2880 Nov 15 05:28 .
drwxr-xr-x    6 root   admin         192 Sep 25 06:35 ..
-r--------    1 nipun  staff           7 Nov 30  2017 .CFUserTextEncoding
-rw-r--r--@   1 nipun  staff       34820 Nov 14 16:56 .DS_Store
drwx------    3 nipun  staff          96 Oct 29 19:17 .Trash
drwxr-xr-x    3 nipun  staff          96 Nov 30  2017 .astropy
drwxr-xr-x   15 nipun  staff         480 Sep 17 10:07 .atom
-rw-------    1 nipun  staff         191 Nov 30  2017 .bash_history
-rw-r--r--    1 nipun  staff         172 Jun 25 17:01 .bash_profile
-rw-r--r--    1 nipun  staff          87 Nov 30  2017 .bash_profile-anaconda3.bak
drwx------    5 nipun  staff         160 Nov 30  2017 .bash_sessions
drwxr-xr-x    3 nipun  staff          96 Jun 26 09:46 .cache
drwxr-xr-x    4 nipun  staff         128 Nov 30  2017 .conda
-rw-r--r--    1 nipun  staff          39 Jun 25 17:21 .condarc
drwxr-xr-x    3 nipun  staff          96 Jan 27  2018 .config
drwx------    3 nipun  staff          96 Dec  1  2017 .cups
drwx------   14 nipun  staff         448 Mar 30  2018 .dropbox
-rw-r--r--    1 nipun  staff         322 Feb 10  2018 .floydconfig
drwxr-xr-x    5 nipun  staff         160 Dec  9  2017 .fxhome-helper
```

Directory Entry

```
struct dirent {
    char  d_name[256];   /* filename */
    ino_t      d_ino;  /* inode number */
    off_t      d_off;  /* offset to the next direct */
    unsigned short  d_reclen;  /* length of this record */
    unsigned char  d_type;  /* type of file */
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`unsigned char d_type`

This is the type of the file, possibly unknown. The following constants are defined for its value:

`DT_UNKNOWN`

The type is unknown. Only some filesystems have full support to return the type of the file, others might always return this value.

`DT_REG`

A regular file.

`DT_DIR`

A directory.

`DT_FIFO`

A named pipe, or FIFO. See FIFO Special Files.

How would **ls** work on a Directory?

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```
int main(int argc, char *argv[]) {
    DIR *dp = opendir(".");   // open current directory
    assert(dp != NULL);
    struct dirent *d;
    while ((d = readdir(dp)) != NULL)  // read one directory entry
    {
        // print outthe name and inode number of each file
        printf("%d %s\n", (int) d->d_ino, d->d_name);
    }
    closedir(dp);   // close current directory
    return 0;
}
```

Removing a Directory

Removing a Directory

- rmdir(): Delete a directory.
  - Require that the directory be empty.
  - If you call rmdir() to a non-empty directory, it will fail.
  - I.e., Only has “.” and “..” entries.

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```
nipun@nipun-VirtualBox:~/demo$ mkdir test
nipun@nipun-VirtualBox:~/demo$ touch test/1.txt
nipun@nipun-VirtualBox:~/demo$ touch test/2.txt
nipun@nipun-VirtualBox:~/demo$ strace rm -rf test
```

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```

```
unlinkat(4, "2.txt", 0)                 = 0
unlinkat(4, "1.txt", 0)                 = 0
close(4)                                = 0
unlinkat(AT_FDCWD, "test", AT_REMOVEDIR) = 0
```

Permission Bits

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- demo_permission.sh

Many File Systems

Users often want to use many file systems.

For example:
- main disk
- backup disk
- NFS
- thumb drives

What is the most elegant way to support this?

Many File Systems

Idea: stitch all the file systems together into a super file system!

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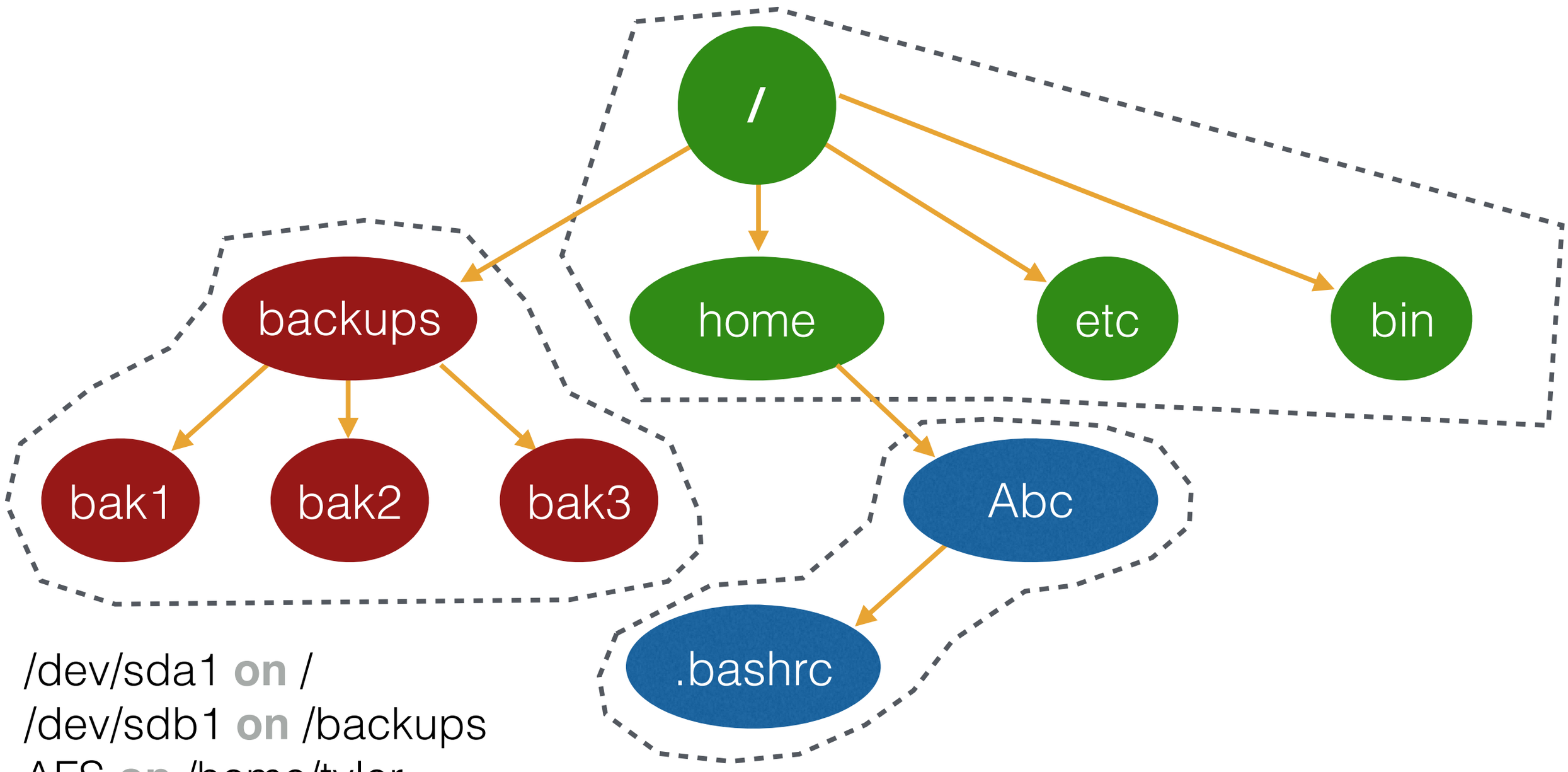
sh> **mount**
/dev/sda1 on / type ext4 (rw)
/dev/sdb1 on /backups type ext4 (rw)
NFS on /home/abc type nfs

Many File Systems



/dev/sda1 **on** /
/dev/sdb1 **on** /backups
AFS **on** /home/tyler
harter@galap-1:… **on** /home/tyler/537

Mounting Video

https://www.youtube.com/watch?v=A8lTr5ZpzvA

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