

# **Advanced Programming in the UNIX Environment**

**Week 04, Segment 7:  
atime, mtime, ctime**

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`https://stevens.netmeister.org/631/`

## struct stat

---

```
struct stat {  
    dev_t    st_dev;      /* device number (filesystem) */  
    ino_t    st_ino;      /* i-node number (serial number) */  
    mod_t    st_mode;     /* file type & mode (permissions) */  
    dev_t    st_rdev;     /* device number for special files */  
    nlink_t  st_nlink;   /* number of links */  
    uid_t    st_uid;      /* user ID of owner */  
    gid_t    st_gid;      /* group ID of owner */  
    off_t    st_size;     /* size in bytes */  
    time_t   st_atime;    /* time of last access */  
    time_t   st_mtime;    /* time of last modification */  
    time_t   st_ctime;    /* time of last file status change */  
    long     st_blocks;   /* number of 512-byte blocks allocated */  
    long     st_blksize;  /* optimal I/O block size */  
}
```

Relevant ls(1) flags: '-c', '-t', '-u'

```
[apue$ ls -l
```

```
total 40
```

-rw-----	1	jschauma	users	931	Sep	21	00:25	cd.c		
-rw-r--r--	1	jschauma	users	3673	Sep	25	01:50	getpw.c		
-rw-r--r--	1	jschauma	users	3881	Sep	25	02:59	groups.c		
-rw-r--r--	1	jschauma	users	471	Sep	20	02:56	lns.c		mtime
-rw-r--r--	1	jschauma	users	460	Sep	20	02:42	rename.c		
-rw-----	1	jschauma	users	1337	Sep	3	2019	sizeof.c		
-rw-----	1	jschauma	users	2430	Sep	20	14:26	wait-unlink.c		

```
apue$
```

```
[apue$ ls -l
```

```
total 40
```

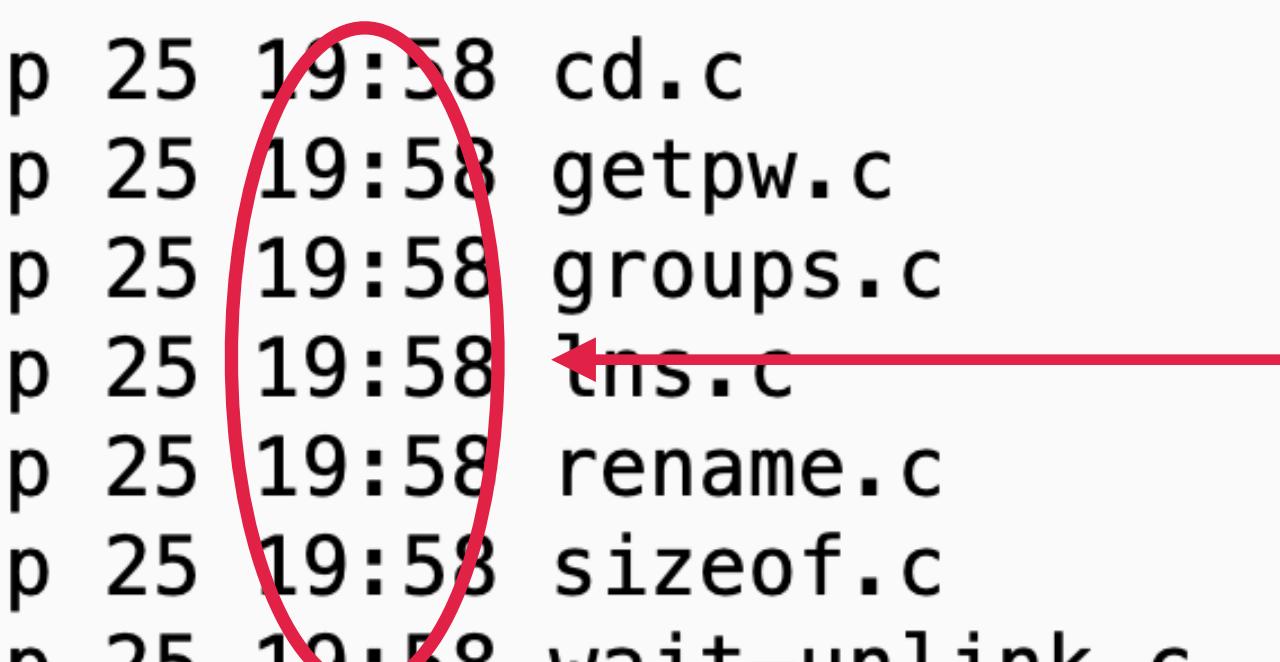
```
-rw----- 1 jschauma users 931 Sep 21 00:25 cd.c
-rw-r--r-- 1 jschauma users 3673 Sep 25 01:50 getpw.c
-rw-r--r-- 1 jschauma users 3881 Sep 25 02:59 groups.c
-rw-r--r-- 1 jschauma users 471 Sep 20 02:56 lns.c
-rw-r--r-- 1 jschauma users 460 Sep 20 02:42 rename.c
-rw----- 1 jschauma users 1337 Sep 3 2019 sizeof.c
-rw----- 1 jschauma users 2430 Sep 20 14:26 wait-unlink.c
```

```
[apue$ ls -lu
```

```
total 40
```

```
-rw----- 1 jschauma users 931 Sep 25 19:58 cd.c
-rw-r--r-- 1 jschauma users 3673 Sep 25 19:58 getpw.c
-rw-r--r-- 1 jschauma users 3881 Sep 25 19:58 groups.c
-rw-r--r-- 1 jschauma users 471 Sep 25 19:58 lns.c
-rw-r--r-- 1 jschauma users 460 Sep 25 19:58 rename.c
-rw----- 1 jschauma users 1337 Sep 25 19:58 sizeof.c
-rw----- 1 jschauma users 2430 Sep 25 19:58 wait-unlink.c
```

```
apue$
```



atime

```
[apue$ ls -l
```

```
total 40
```

-rw-----	1	jschauma	users	931	Sep 21	00:25	cd.c
-rw-r--r--	1	jschauma	users	3673	Sep 25	01:50	getpw.c
-rw-r--r--	1	jschauma	users	3881	Sep 25	02:59	groups.c
-rw-r--r--	1	jschauma	users	471	Sep 20	02:56	lns.c
-rw-r--r--	1	jschauma	users	460	Sep 20	02:42	rename.c
-rw-----	1	jschauma	users	1337	Sep 3	2019	sizeof.c
-rw-----	1	jschauma	users	2430	Sep 20	14:26	wait-unlink.c

```
[apue$ ls -lu
```

```
total 40
```

-rw-----	1	jschauma	users	931	Sep 25	19:58	cd.c
-rw-r--r--	1	jschauma	users	3673	Sep 25	19:58	getpw.c
-rw-r--r--	1	jschauma	users	3881	Sep 25	19:58	groups.c
-rw-r--r--	1	jschauma	users	471	Sep 25	19:58	lns.c
-rw-r--r--	1	jschauma	users	460	Sep 25	19:58	rename.c
-rw-----	1	jschauma	users	1337	Sep 25	19:58	sizeof.c
-rw-----	1	jschauma	users	2430	Sep 25	19:58	wait-unlink.c

```
[apue$ ls -lc
```

```
total 40
```

-rw-----	1	jschauma	users	931	Sep 26	19:31	cd.c
-rw-r--r--	1	jschauma	users	3673	Sep 25	01:50	getpw.c
-rw-r--r--	1	jschauma	users	3881	Sep 25	02:59	groups.c
-rw-r--r--	1	jschauma	users	471	Sep 20	02:56	lns.c
-rw-r--r--	1	jschauma	users	460	Sep 20	02:42	rename.c
-rw-----	1	jschauma	users	1337	Aug 26	21:38	sizeof.c
-rw-----	1	jschauma	users	2430	Sep 26	19:31	wait-unlink.c

ctime

```
apue$
```

```
[apue$ echo bananas > file
apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 8
atime: Sep 26 19:43:06 2020  inode: 1067883
mtime: Sep 26 19:43:06 2020
ctime: Sep 26 19:43:06 2020
apue$ ]
```

```
[apue$ echo bananas > file
apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 8
atime: Sep 26 19:43:06 2020  inode: 1067883
mtime: Sep 26 19:43:06 2020
ctime: Sep 26 19:43:06 2020
[apue$ cat file
bananas
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 8
atime: Sep 26 19:44:12 2020  inode: 1067883
mtime: Sep 26 19:43:06 2020
ctime: Sep 26 19:43:06 2020
apue$ ]
```

```
[apue$ echo bananas > file
apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 8
atime: Sep 26 19:43:06 2020  inode: 1067883
mtime: Sep 26 19:43:06 2020
ctime: Sep 26 19:43:06 2020
[apue$ cat file
bananas
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 8
atime: Sep 26 19:44:12 2020  inode: 1067883
mtime: Sep 26 19:43:06 2020
ctime: Sep 26 19:43:06 2020
[apue$ echo are berries. >> file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 21
atime: Sep 26 19:44:12 2020  inode: 1067883
mtime: Sep 26 19:45:05 2020
ctime: Sep 26 19:45:05 2020
apue$ ]
```

```
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file  
birth: Sep 26 19:43:06 2020  size: 21  
atime: Sep 26 19:44:12 2020  inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:45:05 2020  
[apue$ ln file file2  
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file  
birth: Sep 26 19:43:06 2020  size: 21  
atime: Sep 26 19:44:12 2020  inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:47:55 2020  
apue$ ]
```

```
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 21
atime: Sep 26 19:44:12 2020  inode: 1067883
mtime: Sep 26 19:45:05 2020
ctime: Sep 26 19:45:05 2020
[apue$ ln file file2
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 21
atime: Sep 26 19:44:12 2020  inode: 1067883
mtime: Sep 26 19:45:05 2020
ctime: Sep 26 19:47:55 2020
apue$ chmod go-r file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020  size: 21
atime: Sep 26 19:44:12 2020  inode: 1067883
mtime: Sep 26 19:45:05 2020
ctime: Sep 26 19:48:39 2020
apue$ ]
```

```
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %] Sc%n" file  
birth: Sep 26 19:43:06 2020  size: 21  
atime: Sep 26 19:44:12 2020  inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:45:05 2020  
[apue$ ln file file2  
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %] Sc%n" file  
birth: Sep 26 19:43:06 2020  size: 21  
atime: Sep 26 19:44:12 2020  inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:47:55 2020  
apue$ chmod go-r file  
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %] Sc%n" file  
birth: Sep 26 19:43:06 2020  size: 21  
atime: Sep 26 19:44:12 2020  inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:48:39 2020  
[apue$ sudo chown fred file  
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %] Sc%n" file  
birth: Sep 26 19:43:06 2020  size: 21  
atime: Sep 26 19:44:12 2020  inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:49:32 2020  
apue$
```

[apue\$ ls -l file  
-rw----- 2 fred users 21 Sep 26 19:45 file  
[apue\$ stat -f "birth: %SB size: %z%natime: %Sa inode: %i%nctime: %S%Sc%n" file  
birth: Sep 26 19:43:06 2020 size: 21  
atime: Sep 26 19:44:12 2020 inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:49:32 2020  
[apue\$ **touch file**  
touch: file: Permission denied  
[apue\$ stat -f "birth: %SB size: %z%natime: %Sa inode: %i%nctime: %S%Sc%n" file  
birth: Sep 26 19:43:06 2020 size: 21  
atime: Sep 26 19:44:12 2020 inode: 1067883  
mtime: Sep 26 19:45:05 2020  
ctime: Sep 26 19:49:32 2020  
apue\$ ]

```
[apue$ ls -l file
-rw----- 2 fred users 21 Sep 26 19:45 file
[apue$ stat -f "birth: %SB size: %z%natime: %Sa inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020 size: 21
atime: Sep 26 19:44:12 2020 inode: 1067883
mtime: Sep 26 19:45:05 2020
ctime: Sep 26 19:49:32 2020
[apue$ touch file
touch: file: Permission denied
[apue$ stat -f "birth: %SB size: %z%natime: %Sa inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020 size: 21
atime: Sep 26 19:44:12 2020 inode: 1067883
mtime: Sep 26 19:45:05 2020
ctime: Sep 26 19:49:32 2020
[apue$ sudo chmod a+rw file
[apue$ touch file
[apue$ stat -f "birth: %SB size: %z%natime: %Sa inode: %i%nctime: %S%Sc%n" file
birth: Sep 26 19:43:06 2020 size: 21
atime: Sep 26 19:53:07 2020 inode: 1067883
mtime: Sep 26 19:53:07 2020
ctime: Sep 26 19:53:07 2020
apue$
```

```
apue$ touch -t 197001010000 file  
touch: file: Operation not permitted  
apue$
```



```
apue$ touch -t 197001010000 file
touch: file: Operation not permitted
[apue$ sudo chown jschauma file
[apue$ touch -t 197001010000 file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %Sc%n" file
birth: Jan  1 00:00:00 1970  size: 21
atime: Jan  1 00:00:00 1970  inode: 1067883
mtime: Jan  1 00:00:00 1970
ctime: Sep 26 19:55:32 2020
apue$
```

Terminal — 80x28

```
apue$ touch -t 197001010000 file
touch: file: Operation not permitted
[apue$ sudo chown jschauma file
[apue$ touch -t 197001010000 file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %Sc%n" file
birth: Jan  1 00:00:00 1970  size: 21
atime: Jan  1 00:00:00 1970  inode: 1067883
mtime: Jan  1 00:00:00 1970
ctime: Sep 26 19:55:32 2020
apue$ touch -a -t 197111111111 file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %Sc%n" file
birth: Jan  1 00:00:00 1970  size: 21
atime: Nov 11 11:11:00 1971  inode: 1067883
mtime: Jan  1 00:00:00 1970
ctime: Sep 26 19:56:50 2020
apue$
```

```
apue$ touch -t 197001010000 file
touch: file: Operation not permitted
[apue$ sudo chown jschauma file
[apue$ touch -t 197001010000 file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %Sc%n" file
birth: Jan  1 00:00:00 1970  size: 21
atime: Jan  1 00:00:00 1970  inode: 1067883
mtime: Jan  1 00:00:00 1970
ctime: Sep 26 19:55:32 2020
apue$ touch -a -t 197111111111 file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %Sc%n" file
birth: Jan  1 00:00:00 1970  size: 21
atime: Nov 11 11:11:00 1971  inode: 1067883
mtime: Jan  1 00:00:00 1970
ctime: Sep 26 19:56:50 2020
apue$ touch -m -t 202002020202 file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %Sc%n" file
birth: Jan  1 00:00:00 1970  size: 21
atime: Nov 11 11:11:00 1971  inode: 1067883
mtime: Feb  2 02:02:00 2020
ctime: Sep 26 19:57:00 2020
apue$
```

[apue\$ cat file  
bananas  
are berries.  
[apue\$ stat -f "birth: %SB size: %z%natime: %Sa inode: %i%nctime: %Sm%nctime: %Sc%n" file  
birth: Jan 1 00:00:00 1970 size: 21  
atime: Sep 26 20:07:16 2020 inode: 1067883  
mtime: Feb 2 02:02:00 2020  
ctime: Sep 26 19:57:00 2020  
apue\$ ( echo 1s/b/B/; echo wq; ) | ed -s file  
apue\$ stat -f "birth: %SB size: %z%natime: %Sa inode: %i%nctime: %Sm%nctime: %Sc%n" file  
birth: Jan 1 00:00:00 1970 size: 21  
atime: Sep 26 20:07:37 2020 inode: 1067883  
mtime: Sep 26 20:07:37 2020  
ctime: Sep 26 20:07:37 2020  
apue\$

```
[apue$ cat file  
bananas  
are berries.  
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%nctime: %Sc%n" file  
birth: Jan  1 00:00:00 1970  size: 21  
atime: Sep 26 20:07:16 2020  inode: 1067883  
mtime: Feb  2 02:02:00 2020  
ctime: Sep 26 19:57:00 2020  
apue$ ( echo 1s/b/B/; echo wq; ) | ed -s file  
apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%nctime: %Sc%n" file  
birth: Jan  1 00:00:00 1970  size: 21  
atime: Sep 26 20:07:37 2020  inode: 1067883  
mtime: Sep 26 20:07:37 2020  
ctime: Sep 26 20:07:37 2020  
[apue$ cat file  
Bananas  
are berries.  
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %S%nctime: %Sc%n" file  
birth: Jan  1 00:00:00 1970  size: 21  
atime: Sep 26 20:08:47 2020  inode: 1067883  
mtime: Sep 26 20:07:37 2020  
ctime: Sep 26 20:07:37 2020  
apue$ ]
```



```
jschauma@apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%ntime: %Sm%
nctime: %Sc%n" file
birth: Jan  1 00:00:00 1970  size: 21
atime: Sep 26 20:08:47 2020  inode: 1067883
mtime: Sep 26 20:07:37 2020
ctime: Sep 26 20:07:37 2020
[jshauma@apue$ cat file
Bananas
are berries.
jschauma@apue$ ]
```

```
jschauma@apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%ntime: %Sm%  
nctime: %Sc%n" file  
birth: Jan  1 00:00:00 1970  size: 21  
atime: Sep 26 20:08:47 2020  inode: 1067883  
mtime: Sep 26 20:07:37 2020  
ctime: Sep 26 20:07:37 2020  
[jschauma@apue$ cat file  
Bananas  
are berries.  
[jschauma@apue$ sed -i -e 's/B/b/' file  
[jschauma@apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%ntime: %Sm%  
nctime: %Sc%n" file  
birth: Sep 26 20:27:44 2020  size: 21  
atime: Sep 26 20:27:44 2020  inode: 1067854  
mtime: Sep 26 20:27:44 2020  
ctime: Sep 26 20:27:44 2020  
jschauma@apue$
```



```
[apue$ sudo mount -o noatime /dev/wd1a /mnt
[apue$ cd /mnt
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%ncftime: %]
Sc%n" file
birth: Jan  1 00:00:00 1970  size: 8
atime: Sep 23 00:57:32 2020  inode: 3
mtime: Sep 26 18:44:26 2020
ctime: Sep 26 18:44:26 2020
apue$
```

```
[apue$ sudo mount -o noatime /dev/wd1a /mnt
[apue$ cd /mnt
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %]
Sc%n" file
birth: Jan  1 00:00:00 1970  size: 8
atime: Sep 23 00:57:32 2020  inode: 3
mtime: Sep 26 18:44:26 2020
ctime: Sep 26 18:44:26 2020
[apue$ cat file
foo
foo
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %]
Sc%n" file
birth: Jan  1 00:00:00 1970  size: 8
atime: Sep 23 00:57:32 2020  inode: 3
mtime: Sep 26 18:44:26 2020
ctime: Sep 26 18:44:26 2020
apue$
```

```
[apue$ sudo mount -o noatime /dev/wd1a /mnt
[apue$ cd /mnt
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %]
Sc%n" file
birth: Jan  1 00:00:00 1970  size: 8
atime: Sep 23 00:57:32 2020  inode: 3
mtime: Sep 26 18:44:26 2020
ctime: Sep 26 18:44:26 2020
[apue$ cat file
foo
foo
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %]
Sc%n" file
birth: Jan  1 00:00:00 1970  size: 8
atime: Sep 23 00:57:32 2020  inode: 3
mtime: Sep 26 18:44:26 2020
ctime: Sep 26 18:44:26 2020
[apue$ touch -a file
[apue$ stat -f "birth: %SB  size: %z%natime: %Sa  inode: %i%nctime: %Sm%nctime: %]
Sc%n" file
birth: Jan  1 00:00:00 1970  size: 8
atime: Sep 23 00:57:32 2020  inode: 3
mtime: Sep 26 18:44:26 2020
ctime: Sep 26 20:13:56 2020
apue$
```

```
[linux$ stat file
  File: 'file'
  Size: 21          Blocks: 8          IO Block: 4096   regular file
Device: fc00h/64512d  Inode: 651631      Links: 2
Access: (0600/-rw-----)  Uid: (10235/jschauma)  Gid: (10000/professor)
Access: 2020-09-26 16:20:34.152125850 -0400
Modify: 2020-09-26 14:57:02.752992657 -0400
Change: 2020-09-26 15:09:55.954608533 -0400
 Birth: -
[linux$ cat file
bananas
are berries.
[linux$ stat file
  File: 'file'
  Size: 21          Blocks: 8          IO Block: 4096   regular file
Device: fc00h/64512d  Inode: 651631      Links: 2
Access: (0600/-rw-----)  Uid: (10235/jschauma)  Gid: (10000/professor)
Access: 2020-09-26 16:20:34.152125850 -0400
Modify: 2020-09-26 14:57:02.752992657 -0400
Change: 2020-09-26 15:09:55.954608533 -0400
 Birth: -
linux$
```

```
Access: (0600/-rw-----) Uid: (10235/jschauma)  Gid: (10000/professor)
Access: 2020-09-26 16:20:34.152125850 -0400
Modify: 2020-09-26 14:57:02.752992657 -0400
Change: 2020-09-26 15:09:55.954608533 -0400
 Birth: -
[linux$ cat file
```

```
bananas
are berries.
```

```
[linux$ stat file
  File: 'file'
```

```
    Size: 21          Blocks: 8          IO Block: 4096   regular file
Device: fc00h/64512d  Inode: 651631      Links: 2
Access: (0600/-rw-----) Uid: (10235/jschauma)  Gid: (10000/professor)
Access: 2020-09-26 16:20:34.152125850 -0400
Modify: 2020-09-26 14:57:02.752992657 -0400
Change: 2020-09-26 15:09:55.954608533 -0400
 Birth: -
```

```
linux$ ( echo 1s/b/B/; echo wq; ) | ed -s file
```

```
[linux$ stat file
  File: 'file'
```

```
    Size: 21          Blocks: 8          IO Block: 4096   regular file
Device: fc00h/64512d  Inode: 651631      Links: 2
Access: (0600/-rw-----) Uid: (10235/jschauma)  Gid: (10000/professor)
Access: 2020-09-26 16:20:34.152125850 -0400
Modify: 2020-09-26 16:22:27.529542469 -0400
Change: 2020-09-26 16:22:27.529542469 -0400
 Birth: -
[linux$
```



```
Access: (0600/-rw-----) Uid: (10235/jschauma)  Gid: (10000/professor)
Access: 2020-09-26 16:20:34.152125850 -0400
Modify: 2020-09-26 14:57:02.752992657 -0400
Change: 2020-09-26 15:09:55.954608533 -0400
 Birth: -
```

```
linux$ ( echo 1s/b/B/; echo wq; ) | ed -s file
```

```
[linux$ stat file
```

```
  File: 'file'
  Size: 21          Blocks: 8          IO Block: 4096   regular file
Device: fc00h/64512d  Inode: 651631      Links: 2
```

```
Access: (0600/-rw-----) Uid: (10235/jschauma)  Gid: (10000/professor)
```

```
Access: 2020-09-26 16:20:34.152125850 -0400
```

```
Modify: 2020-09-26 16:22:27.529542469 -0400
```

```
Change: 2020-09-26 16:22:27.529542469 -0400
```

```
 Birth: -
```

```
[linux$ cat file
```

```
Bananas
```

```
are berries.
```

```
[linux$ stat file
```

```
  File: 'file'
  Size: 21          Blocks: 8          IO Block: 4096   regular file
Device: fc00h/64512d  Inode: 651631      Links: 2
```

```
Access: (0600/-rw-----) Uid: (10235/jschauma)  Gid: (10000/professor)
```

```
Access: 2020-09-26 16:23:28.086299136 -0400
```

```
Modify: 2020-09-26 16:22:27.529542469 -0400
```

```
Change: 2020-09-26 16:22:27.529542469 -0400
```

```
 Birth: -
```

```
linux$
```

## utimes(2)

```
#include <sys/time.h>
```

```
int utimes(const char *path, const struct timeval times[2]);
```

```
int lutimes(const char *path, const struct timeval times[2]);
```

```
int futimes(int fd, const struct timeval times[2]);
```

```
int utimensat(int fd, const char *path, const struct timespec times[2], int flag);
```

Returns: 0 if OK, -1 on error

- if times is NULL, set atime and mtime to current time (write permissions sufficient)
- if times is non-NULL, set atime and mtime accordingly (need to be owner)
- either way, ctime is set to current time
- timespec allows for nanosecond precision

## atime, mtime, ctime

---

- atime: time of last data access
  - may trigger frequent I/O; diminishes performance
  - remedies: mount -o noatime, nodiratime, relatime, lazytime
- mtime: time of last data modification
- ctime: time of last file status change; automatically updated by various syscalls
- utimes(2) with values requires ownership; may update non-standard time fields
- you can now implement touch(1)

Time is weird. We'll get into more on that next time.

## Links and Discussions

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- POSIX: [https://pubs.opengroup.org/onlinepubs/9699919799/basedefs/V1\\_chap04.html#tag\\_04\\_09](https://pubs.opengroup.org/onlinepubs/9699919799/basedefs/V1_chap04.html#tag_04_09)
- [https://en.wikipedia.org/wiki/Stat\\_%28system\\_call%29#Criticism\\_of\\_atime](https://en.wikipedia.org/wiki/Stat_%28system_call%29#Criticism_of_atime)
- Once upon atime: <https://lwn.net/Articles/244829/>