(whttps://eduassistpro.github.

axgopala@imperial.ac.uk

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Shar

https://eduassistpro.github.

directories and intrager entor data edu\_assist\_production and intrager edu\_assist\_production and intrager entor data edu\_assist\_production and intrager entor data edu\_assist\_production and intrager edu\_assist\_produc

File: Named collection of data of arbitrary size

File Naming
Typical file extensions

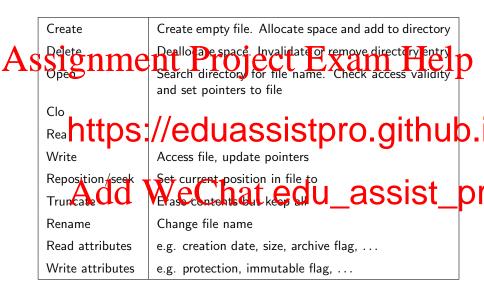
## As sile gynemetals in rojection Exam Help

executable	exe, com, bin	read to run machine-language pro-	
obj https	:://edua	assistpro.githฃ	b.
source code	c, cc, java,	sour	
batchAdd	but seCh	at edu_assist_	pr
		prete	]

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#### File User Functions



### Unix/Linux: File System calls

```
Assignment Projecto Exam Help
    open (file, how, ...)
                        Open a file for reading/writing
    c1
    re https://eduassistpro.github.
    write (fd, buf, nbytes)
                        Write
                 ceChatedu_assist_pr
                        File locking and other operations
    fnctl (fd, cmd, ...)
```

File System Support Functions

Logical name to physical disk address translation

sile. /homes/axgopala/vimrc → disk 2, block 399 sile. memorisk are project Exam Help

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Caching and buffering

Protected dans to State Chat edu\_assist\_pr

Back-up and restore

Security

Protection against unauthorised access

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### File Attributes I

Basic information

Assignment, Pintry Jeache, Lirexa, m Help

file o

file https://eduassistpro.github.

Address information

size allocated

start addresses size used

weight addresses cyl, head, sect, LBA

disk drive partition edu\_assist\_properties of the cyl, head, sect, LBA

cyl, head, sect, LBA

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### File Attributes II

Access control information

access activity counts

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per

Usaghttps://eduassistpro.github.

last read date and time last read date and time

Unix/Linux: File Attributes

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### Unix/Linux stat System Call

File attributes can be accessed using system call stat(2) (man 2 stat)

```
ssignment Project Exam Help
 struct stat {
  de
  https://eduassistpro.github.
                        /* user ID of owner */
  uid_t
           st_uid;
                        /* group ID of owner */
                           total size. <del>in</del> bytes */
  struct timespec st_atim; /* time of last access */
  struct timespec st_mtim; /* time of last modification */
  struct timespec st_ctim; /* time of last status change */
 };
```

File size naturally variable

# Assignments Project 81 Extam Help Choosing block size

- https://eduassistpro.github.
  - More memory needed for buffer space
- Block size too small wastes spa Add verve de em national assist pr
  - High file transfer time: seek time greater t

Which allocation works the best?

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Index Alodd WeChat edu\_assist\_pr

#### Contiguous File Allocation I

Place file data at contiguous addresses on storage device

## Assignment Project Exam Help Successive logical records typically physically adjacent

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- Poor performance if files grow and shrink ov
- Fix graved be will be considered that seed u\_assist\_pr
  - Must be transferred to new area of adequate size
  - Leads to additional I/O operations

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- (a) Contiguous allocation of disk space for seven files
- (b) The state of the disk after files D and F have been removed

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## Block Linkage (Chaining) I

Place file data by linking them together  $\Rightarrow$  insertion/deletion by modifying pointer in previous block

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Block Linkage (Chaining) II

Disadvantages

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Block-to-block seeks occur

wastandspWieChat edu\_assist\_pr

#### Block Allocation Table I

Store pointers to file blocks

Assignmented properties block of file

Assignmented properties block

Determines location of next block

File Anttps://eduassistpro.github.

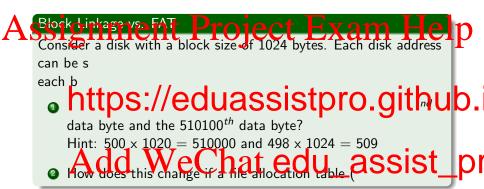
- Stored on disk but cached in memory for perf
  Add WeChat edu assist\_pr
  Reduces number of lengthy seeks to access given re
  - But files become fragmented → periodic defragmentation
  - Table can get very large

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### Example Problem



#### Answer: Block Linkage

There are 1020 data bytes per block. The 1022<sup>nd</sup> byte is resident Assing nick block Projective Exam Help

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The 510100<sup>th</sup> data byte is resident in the 501 01

reads Ac required WeChat edu\_assist\_properties.

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### **Example Problem**

#### Answer: FAT

There are 1024 data bytes per block. Each block of the FAT can series are 1024 data bytes per block. Each block of the FAT can series are 1024 data bytes per block. Each block of the FAT can series are 1024 data bytes per block. Each block of the FAT can series are 1024 data bytes per block. Each block of the FAT can series are 1024 data bytes per block. Each block of the FAT can series are 1024 data bytes per block. Each block of the FAT can series are 1024 data bytes per block.

- 1 The 1020<sup>th</sup> byte is on the 1<sup>st</sup> block and requires 1 read for the
- https://eduassistpro.github.
  - At best, all of the first 499 blocks of the file can be represented in 2 FAT blocks

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Either case requires 1 extra read for the data. H

- Best case requires 3 reads
- Worst case requires 500 reads

Answer: FAT

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Example Problem

Answer: FAT

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How can we improve?

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#### Index Blocks I

Each file has one (or more) index blocks

## Assignment of the points of the block Help

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- Searching may take place in index blocks the
  Practities blocks Generating OU\_assist\_presented
  - access to data
- Can cache index blocks in memory for faster access

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### Unix/Linux: Inodes

Index blocks called inodes (index nodes) in UNIX/Linux nodes) in UNIX/Linux Project UE Kam Help inode entry created in memory

clu https://eduassistpro.github. Direct pointer

- Disk device number
- Add we have been been edu\_assist\_
  - file
- Major/minor device number

inode

Type and access control

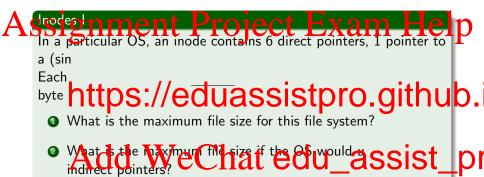
Group ID

Indirect pointer Double indirect pointer Triple indirect pointer

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### Example Problem



### Answer: Inodes I Assignment (details) is: Assignment (details) is: $+ 128 \times 1024$ (data referenced by single indirect) https://eduassistpro.github. 2 (data directly indexed) (data referenced by double in assist\_pr $128^2 \times 1024$ $+ 128^3 \times 1024$ (data referenced by triple indirect) = 2.02 GB

### Example Problem

A special to the local contact point of point of

Answer: Inodes II

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## Summary: File Allocation Examples

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Byt https://eduassistpro.github.

Byt worst case

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# How do we manage a storage device's free space? Assergation Telephore Devote D

Use fr

- https://eduassistpro.github.
- Newly-freed blocks appended to end of list

Low Add Nore Chatine Cub\_assist\_pr

Files likely to be allocated in noncontiguous blocks  $\rightarrow$  increases file access time

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## Assignment Project Exam Help Disk b Num https://eduassistpro.github. Hard drive size: 500 GB Numb Action ks We lio hat edu\_assist\_ Number of blocks required to store all addresses: 1.

### Bitmap I

# Assignment black rosect Exam Help • ith bit corresponds to ith block on disk

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# Disady Antered We Chat edu\_assist\_properties May need to search entire bitmap to find free b

 May need to search entire bitmap to find free to in execution overhead

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Assing nment Project Exam Help
Block size: 1 KB

Hard

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Number of bits required: 488 million

A possible file system layout

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### File System Layout II

Fixed disk layout (with inodes)

boot block

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- https://eduassistpro.github.
  - no of inodes
  - nA of class by eChat edu\_assist\_pressure of inode & free space bitmap
  - first data block
  - block size
  - maximum file size, . . .

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### File System Directories

### **Directory**

• Maps symbolic file names to logical disk locations (e.g.

# Assignment organization et al. (LBA)) Assignment organization et al. (LBA)) Assignment of the control of the

• Ensures uniqueness of names

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FS often performs linear search of directory to locate file

• Leads to poor performance

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Little flexibility in terms of file organisation

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### MultiLevel (Tree) Directory Structure

### Hierarchical file system

- UNIX, Linux, Windows, Mac, . . .
- Assignment on disk root directory begins

  Assignment of the declared and Help

  Each of which contains entries for its files

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### **Pathnames**

#### **Pathnames**

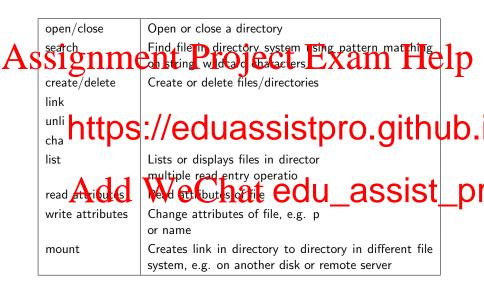
• File names usually given as path from root directory to file

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- https://eduassistpro.github.
  - Relative to working (or current) directory

    and dang dougled darka edu\_assist\_pi
    - Displayed with pwd
    - Current directory: .
    - Parent directory: ..

### **Directory Operations**



### Unix/Linux: Directory System Calls

```
System Call
                          Description
ssignment. Project Examp Help
                          Remove directory
  s = rmdir (path)
 s https://eduassistpro.github.
   = chdir (path)
 dir Addir We Chat edu_assist
   = closedir (dir)
 dirent = readdir (dir)
                          Read one entry from directory
                          Rewind directory to re-read
 rewinddir (dir)
```

Unix/Linux: Looking Up File Names

Steps in looking up /usr/ast/mbox

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### Links

Link: Reference to directory/file in another part of FS

• Allows alternative names (and different locations in tree)

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• Only supported for files in Unix

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### Problems dd We Chat edu assist pr

- Leave links and cause exception when used (symbolic links)
- Keep  $\underline{\mathsf{link}}\ \mathsf{count}\ \mathsf{with}\ \mathsf{file} \to \mathsf{delete}\ \mathsf{file}\ \mathsf{when}\ \mathsf{count} = \mathsf{0}\ \mathsf{(hard}\ \mathsf{links)}$
- Looping: directory traversal algorithms may loop

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### Mounting I

### Mount operation

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Support for soft-links to files in mounted FSs but not

## мыhttps://eduassistpro.github.

• Directory in native FS assigned to root of mou

### FSs maded www.cchat edu\_assist\_pr

- Information about location of mount poin
- When native FS encounters mount point, use mount table to determine device and type of mounted FS

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# Assignment Project Exam Help Goal: high-performance, robust F3 with support for advanced featu

Typi https://eduassistpro.github.

Safety mechanism: 5% of blocks reserved for root

• Avoid process Continue tentiler assist process consumes all FS disk space

### ext2fs Inode

Represents files and directories in ext2 FS

Stores information relevant to single file/directory ightarrow e.g. time

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- https://eduassistpro.github.
- 14<sup>th</sup> pointer is a doubly-indirect pointer

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- 15<sup>th</sup> pointer is triply-indirect pointer
  - · Locates block of doubly indirect pointers

Provides fast access to small files, while supporting very large files

### ext2fs Block Groups I

Block groups

Clusters of contiguous blocks

# Assissation accessing groups of related data in same block group Help

Bloc

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FS was mounted, ...

### ext2fs Block Groups II

Inode table: Contains entry for each inode in block group

Inode allocation bitmap: Inodes used within block group

Storigation of:

Storigation of:

Storigation of:

Storigation of:

- https://eduassistpro.github.
- block allocation bitmap
- Add WeChat edu\_assist\_properties | Properties | Propertie
  - Directory information stored in directory entries
  - Each directory entry is composed of: inode number, directory entry length, file name length, file type, file name

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# Assignment Projectex xam File Atricke WG 32 19812 edu\_assist\_te)pr