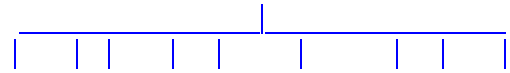
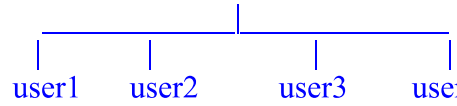
/* 6. Write a C program to simulate the following file organization techniques:
a) Single level directory b) Two level directory c) Hierarchical */

// Single level directory - All files contained in same directory
// Easy to support and understand, large number of names requirend,
// But how to support different user?
// When represented as tree structure, tree height = 1
// Tree height = max (number of edges encountered when traversing from root to leaf/last
// file/directory)

// Two level directory-one Master File Directory(MFD), supports separate directory for
// each user, User has own User File Directory(UFD), MFD has User name pointing to UFD
// When represented as tree structure, tree height = 2
// Root = MFD , direct descendants / sub directories = UFD

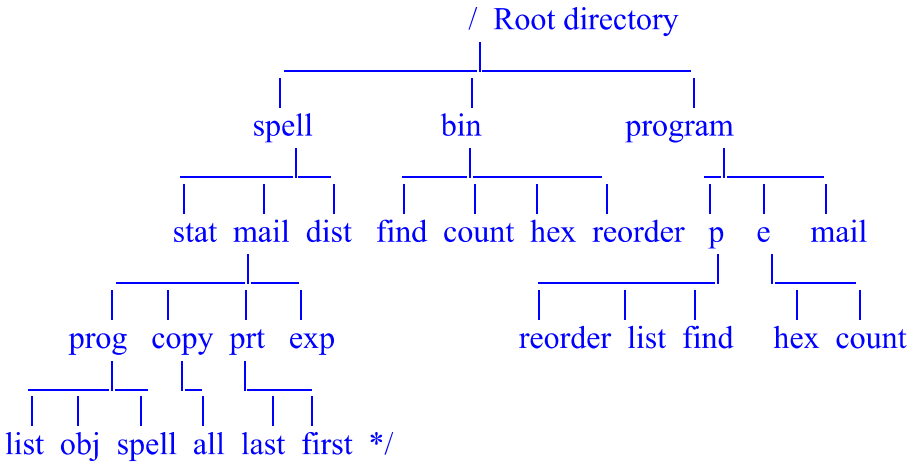
// Hierarchical, Tree Structure - Directory / Tree structure with arbitary height
// Single and Two level directory are specific case of Hierarchical directory with
// height 1 and 2 respectively; Users may create their own subdirectories
// One bit in each directory entry defines the entry as a file (0) or as a subdirectory (1)
// Path to a file in a tree-strucured directory can be longer than in a two-level directory

// Single level : All files have have parent as root directory, inode 0
// sub directory can not be created, only regular files, file with same names not allowed
// / Root directory , the only directory

// cat bo a test data mail cont hex records ; all are regular files

// Two level : Root directory with indoe 0 , can have file or sub directory, not sub directories
// / Root directory , can have sub directory

// user1 user2 user3 user4 Directories, they can have files, but no subdir

// cat bo a test a data a test x data a ; all are regular files

/* Hierarchical, Tree Structure - Directory / Tree , will have Root directory, no restrictions on files or sub directories



// Generic program that can maintain details of file organization of arbitary height.

```c
#include <stdio.h>
#include <string.h>
#define numberOfINodes 256  // Consider following data structures for file organisation
int  iNode[numberOfINodes];// Assume only 256 inodes available, inode from 0 to 255
int  freeInode[numberOfINodes];//list informing used/unused inode numbers, 1=free, 0=used
struct metadataOfFile  {
   int  parent; // Parent directory inode, -1 if no parent, example root node
   int  type; // 0 for regular, 1 for directory
   int  level; // level of file, root directory level is 0
   char name[9]; // File name, maximum 8 characters
 } fileMetadata[numberOfINodes];
// iNode + metadataOfFile structure rougly implementing Inode table structure and directory
// file structure with details inode number , type of file , level the file is on and name of file
int level;
int displayQueue[numberOfINodes + 1]; // Queue to hold list of directories to display

void displayFileOrganisation( )  { // Function to display file organisation
   printf("\n\n File organisation\n");
   int qFront=0;    int qRear=0; // Initialize queue front and rear
   int frontDirInDisplayQueue; // Variable to save inode of first directory in display queue

   displayQueue[qRear++] = 0;   // Enqueue Root directory , inode 0 added to queue
   while( qFront < qRear  ) {   // queue front not equal to queue rear
     frontDirInDisplayQueue = displayQueue[qFront++]; // Select from queue front
     for(int k=0; k<fileMetadata[frontDirInDisplayQueue].level ; k++ ) printf(" ");
     printf(" Dir = \"%s\", inode = %d\n",fileMetadata[frontDirInDisplayQueue].name, frontD
irInDisplayQueue);
     for(int k=0; k<fileMetadata[frontDirInDisplayQueue].level ; k++ ) printf(" ");
     printf(" Contains = ");
     for(int i=0; i<numberOfINodes; i++) { // print all file, and dir name along with inode
       if( fileMetadata[i].parent == frontDirInDisplayQueue ) { // If the parent of file is same a
s the directory
         if( fileMetadata[i].type == 1 ) { // if a sub directory
           printf("  subdir=%s with inode=%d;", fileMetadata[i].name, i);
           displayQueue[qRear++] = i; // Add directory in Queue
          }
         else
           printf("  %s", fileMetadata[i].name); // Print name of file
       }
     } printf("\n\n");
   }
 }

int firstFreeInode()   { // function returns first free/unused inode number
   for( int i=0; i<numberOfINodes; i++ )  if ( freeInode[i] == 1 )  return i;
 }

// Function to update file metadata with parameters as address of new file fileMetadata
void updateFileMetadata( struct metadataOfFile *ptr, int parent,
                         int type, int level, const char *fileName )
 { // which is to be updated, parent dir inode, file type, file level and name
   ptr -> parent = parent; ptr -> type = type;   ptr -> level = level;
   strcpy( ptr -> name, fileName );
 }
```

```
void  create( int fileType )// Function reads file name, parent directory
  { // gets first free inode number, update inode as used, update file metadata
    char name[9]; // variable to read new file name
    int parentDirInode; // variable to save parent directory inode number
    printf("\n For the following file organisation : \n ");
    displayFileOrganisation();
    printf("\n Please enter inode number of directory where you want to create file or (sub)direc
tory= ");
    scanf("%d",&parentDirInode); // Lets assume valid inode of directory is entered
    if(  fileType == 1 && level == 1 ) { // Creating new directory not allowed in Sinlge level
       printf("\n Creating sub directory not possible in Single Level");      return;
      }
    else if( fileType == 1 && fileMetadata[parentDirInode].level == 1 && level == 2 )
      {// In two level, further sub directory not allowed in sub directory of root
       printf("\n Creating further sub directories not possible under this directory");       return;
      }

    printf("\n Enter file or (sub) directory name = "); // How would you check if file name alrea
dy exists
    scanf("%s", name);//Assume non existing name of eight characters is entered

    int free = firstFreeInode(); // Check for first free inode
    freeInode[free] = 0; // inode number used, free = 0
    // address of fileMetadata , parent dir inode, file type, parent level + 1 and name
    updateFileMetadata( &fileMetadata[free], parentDirInode, fileType, fileMetadata[parentDir
Inode].level+1, name );
    printf("\n File or (sub) Directory %s added", name);
  }

 int main()
  { int i, operation;
    for( i=0; i<numberOfINodes; i++ ) { // Initialize
      iNode[i] = i;       freeInode[i] = 1;       fileMetadata[i].parent = -1;
     }
    freeInode[0] = 0; // inode number 0 will be used for Root Directory, hence free = 0
    // address of fileMetadata , parent dir inode, file type, level and name
    updateFileMetadata( &fileMetadata[0], -1, 1, 0, "rootDir" );
    printf("\n\n Root directory \"rootDir\" , with inode = 0 created\n");

    printf("\n Enter\n 1 to simulate Single level directory,\n 2 for Two level directory, or\n 3 fo
r Hierarchical\n ");  scanf("%d",&level);
    while(1) {
      printf("\n\n Enter: 1 to Create file\t 2 for Directory\t 3 to Display\t 4 to Exit\n");
      scanf("%d",&operation);
      switch( operation ) { // create( fileType ) 0 for file, 1 for directory
        case 1: create( 0 ); break;
        case 2: create( 1 ); break;
        case 3: displayFileOrganisation(); break;
        case 4: return 0;
       }
     }
    return(0);//Can data structure design be improved, what is the run time for file add, display
  } // With above data structure : How will you implement delete file and directory
```