“ALEXANDRU IOAN CUZA” UNIVERSITY OF IAȘI

FACULTY OF COMPUTER SCIENCE



THESIS

Interactive web application-based learning for the

Operating Systems course

proposed by

Dorin Haloca

Session: luna, anul

Scientific Coordinator

Lect.dr. Vidrascu Cristian

UNIVERSITATEA “ALEXANDRU IOAN CUZA” DIN IAȘI

FACULTATEA DE INFORMATICĂ

Titlu

Prenume Nume

Sesiunea: luna, anul

Coordonator științific

Titlu Prenume Nume

DECLARAŢIE PRIVIND ORIGINALITATE ŞI RESPECTAREA DREPTURILOR DE AUTOR

Prin prezenta declar că Lucrarea de licenţă cu titlul „Titlul complet al lucrării” este scrisă de mine şi nu a mai fost prezentată niciodată la o altă facultate sau instituţie de învăţământ superior din ţară sau din străinătate. De asemenea, declar că toate sursele utilizate, inclusiv cele preluate de pe Internet, sunt indicate în lucrare, cu respectarea regulilor de evitare a plagiatului:

- toate fragmentele de text reproduse exact, chiar şi în traducere proprie din altă limbă, sunt scrise între ghilimele şi deţin referinţa precisă a sursei; - reformularea în cuvinte proprii a textelor scrise de către alţi autori deţine referinţa precisă; - codul sursă, imaginile etc. preluate din proiecte open-source sau alte surse sunt utilizate cu respectarea drepturilor de autor şi deţin referinţe precise; - rezumarea ideilor altor autori precizează referinţa precisă la textul original.

Iaşi, data

Absolvent Dorin Haloca

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(semnătura în original)

DECLARAŢIE DE CONSIMŢĂMÂNT

Prin prezenta declar că sunt de acord ca Lucrarea de licență cu titlul „Titlul complet al lucrării”, codul sursă al programelor şi celelalte conţinuturi (grafice, multimedia, date de test etc.) care însoţesc această lucrare să fie utilizate în cadrul Facultăţii de Informatică.

De asemenea, sunt de acord ca Facultatea de Informatică de la Universitatea „Alexandru Ioan Cuza” din Iași, să utilizeze, modifice, reproducă şi să distribuie în scopuri necomerciale programele-calculator, format executabil şi sursă, realizate de mine în cadrul prezentei lucrări de licenţă.

Iaşi, data

Absolvent Dorin Haloca

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(semnătura în original)

ACORD PRIVIND PROPRIETATEA DREPTULUI DE AUTOR

Facultatea de Informatică este de acord ca drepturile de autor asupra programelor-calculator, în format executabil şi sursă, să aparţină autorului prezentei lucrări, Prenume Nume.

Încheierea acestui acord este necesară din următoarele motive:

[Se explică de ce este necesar un acord, se descriu originile resurselor utilizate în realizarea produsului-program (personal, tehnologii, fonduri) şi aportul adus de fiecare resursă.]

Iaşi, data

Decan Adrian Iftene Absolvent Dorin Haloca \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (semnătura în original) (semnătura în original)

INDEX

INTRODUCTION

I have chosen to create this web application for the Operating Systems course because the Databases course has one and from my point of view it aids students. Instead of solving just by yourself, you can interact with your colleagues through the application and check your knowledge or learn through trial and error. For sure, the teacher wouldn’t have the necessary time, energy or imagination to create all the interesting questions students would post there.

The Databases course was the first time I experienced an interactive web application at the faculty and I enjoyed it. Of course, it had its flaws but I tried to fix some of them in my application. Unfortunately, I don’t think it is a reliable method of grading the students due to the complexity of the Linux operating system. As far as SQL is concerned, its way of working is simple and straightforward to assess.

aceasta va conţine motivaţia alegerii temei, gradul de noutate a temei, obiectivele generale ale lucrării, metodologia folosită, descrierea sumară a soluţiei, structura lucrării (titlul capitolelor şi legătura dintre ele). Introducerea nu se numerotează ca şi capitol.

CONTRIBUTIONS

aceasta va avea cel mult o pagină şi va descrie schematic principalele contribuţii ale absolventului în realizarea lucrării.

# Configuring the Linux machines

## General description

Initially, I thought about using the faculty’s server so the application would run the code on the students’ accounts. However, on further discussion with my scientific coordinator, I realised that uploading the question’s author code on the students’ account could lead to unwanted leaks and possible exploits. The web interface limits the actions a student can perform. This is why I need to configure my own Linux machine, with its own students’ accounts, which will communicate via SSH with the Apache server.

## Configuring the Linux machine used for execution of code

First we make sure that the Linux distribution is up-to-date

$ sudo apt-get update

$ sudo apt-get upgrade

Now we install and start the SSH service to connect remotely to the Linux machine and execute code.

$ sudo apt-get install openssh-server openssh-client

$ sudo service ssh start

### 2. 1. How the Apache server will access it with php

First we make use the ssh2\_connect() method to connect to a machine using a given $host and $port, with a default value of 22. It returns a resource which we will use in the authentication process.

ssh2\_connect ( string $host [, int $port = 22 [, array $methods [, array $callbacks ]]] ) : resource

In order to authenticate a user though SSH, we use the ssh2\_auth\_password() which takes as parameters the previous resource, a username and a password. In case the process was successful, it returns true. Otherwise, it return false.

ssh2\_auth\_password ( resource $session , string $username , string $password ) : bool

The ssh2\_exec() method is used to send a bash command for execution through SSH. It takes as arguments the resource returned by the ssh2\_connect() method and the command.

ssh2\_exec ( resource $session , string $command [, string $pty [, array $env [, int $width = 80 [, int $height = 25 [, int $width\_height\_type = SSH2\_TERM\_UNIT\_CHARS ]]]]] ) : resource

In order to get the output or errors we need the ssh2\_fetch\_stream() method. The stream id can be SSH2\_STREAM\_STDIO or SSH2\_STREAM\_ERR. The stream\_get\_contents() returns the string.

ssh2\_fetch\_stream ( resource $channel , int $streamid ) : resource

stream\_get\_contents ( resource $handle [, int $maxlength = -1 [, int $offset = -1 ]] ) : string

SCRIE CEVA AICI!!!

ssh2\_scp\_send ( resource $session , string $local\_file , string $remote\_file [, int $create\_mode = 0644 ] ) : bool

### 2.2. How a student’s account is created

$ useradd -m --password <password> <password>

I tried to use the adduser command, but it would not let me create users with usernames longer than 8 chars. For example, my faculty’s webmail username is dorin.haloca and it’s too long for adduser command.

The password used for authenticating on this Linux machine will be generated randomly and its hash, created using the PHP’s default hashing algorithm which may change in the future, stored in the MySQL database server.

## Configuring the Linux environment used for hosting the application

$ sudo apt-get update

$ sudo apt-get upgrade

My web application needs to be albe to execute sudo commands without needing to input the sudo password. The reason for this decision is the fact that when you first use a sudo command, you are asked for the password, but afterwards you are not asked for the password anymore. <VERIFICAT ASTA>

In case the Apache server is on the Linux machine used for executing code, students must not have permissions over the “mvc/app/” directory of the application. However, the group “www-data” needs at least read permissions for the “mvc/app/” to read the php scripts and write permissions for the “mvc/app/questions/” and “mvc/app/scp\_cache/” in order to create and modify files. The owner of the application directory (“mvc/”) should be a sudo account. These rights adjustments can be done using the ConfigureRights.sh. It has the following syntax: ./ConfigureRights.sh <a sudo user>. Place it in the same directory with the mvc folder of the application and execute it.[[1]](#footnote-1)

* 1. Configuring the Apache server

$ sudo apt-get install apache2

$ sudo apache2ctl configtest

$ sudo ufw allow in "Apache Full"

$ sudo apt-get install mysql-server

$ sudo mysql\_secure\_installation

$ sudo apt-get install apache2 php libapache2-mod-php php-mysqli

$ sudo systemctl restart apache2

$ sudo systemctl status apache2

$ sudo apt-get install libssh2-1 php-ssh2 -y

$ sudo a2enmod rewrite

$ sudo service apache2 restart

If the apache version is 2.4 then you have to go to /etc/apache2/. There will be a file named apache2.conf. You have to edit that one (you should have root permission). Change directory text like this

<Directory /var/www/>

Options Indexes FollowSymLinks

AllowOverride All

Require all granted

</Directory>

$ service apache2 reload

## Configure a new user for the MySQL server[[2]](#endnote-1)

$ sudo mysql -u root

mysql> USE mysql;

mysql> CREATE USER 'YOUR\_SYSTEM\_USER'@’localhost’ IDENTIFIED BY 'YOUR\_PASSWORD';

mysql> GRANT ALL PRIVILEGES ON \*.\* TO 'YOUR\_SYSTEM\_USER'@'localhost';

mysql> UPDATE user SET plugin='mysql\_native\_password' WHERE User='YOUR\_SYSTEM\_USER';

mysql> FLUSH PRIVILEGES;

mysql> exit;

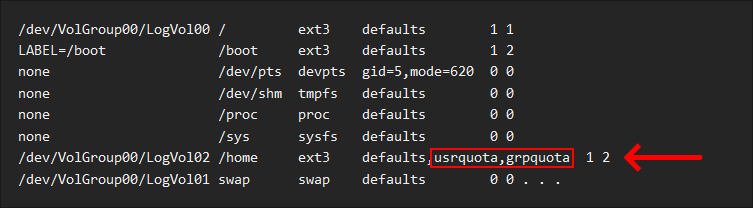
$ service mysql restart

Is may be possible that the ‘mysql’ user has a quota limit set. If it is the case, it will eventually run out of disk space and not function properly.

* 1. Configuring quotas[[3]](#endnote-2)

$ sudo apt install quota

$ sudo nano /etc/fstab



$ sudo mount -o remount /

$ quotacheck -cug /

$ sudo quotacheck -m -avug

Note: Quotas don’t work for users with only a number as username. They need at least one letter!

# Types of users in the web application

1. Gues user
   1. Can access the authentication page
   2. Can authenticate
2. Normal user (student)
   1. Can do anything the above user can do
   2. Can view announcements
   3. Can solve questions
   4. Can report question
   5. Can post questions according to set criteria
   6. Can delete his or her own questions according to set criteria
   7. Can view own posted questions in “My Questions” page
   8. Can view the message and the date of the report for those questions
   9. Can de-authenticate
3. Administrator (professor)
   1. Can do anything the above user can do
   2. Can post announcements
   3. Can delete announcements
   4. Can post questions unconditionally
   5. Can view all posted questions in “All Questions” page
   6. Can view all deleted questions in “All Questions” page

The deleted questions are not removed from the system, but marked as “Deleted”. I chose to keep the deleted questions in case of a system error, unintentional operation or a conflict (i.e. maybe the student posted an inappropriate question and he or she deleted it to hide any proof.

* 1. Can access the administrator page (url: <ip>/mvc/public/admin)
  2. Can add administrator by username
  3. Can remove administrators
  4. Can post chapters
  5. Can unpost chapters

# Deployment of the application

1. General information
2. How it will be done in the Faculty of Computer Science
   1. Database server

<https://students.info.uaic.ro/auth/?url=https://students.info.uaic.ro/db/>

# Bugs

1. PHP semaphores in combination with the sleep x instruction prevent the header() instruction from executing in another tab. The instruction header() executes when sleep finishes execution. Ex: open two tabs of chapter\_x\_solve and click ‘Execute’ on both with a delay.
2. Sometimes, when pressing ‘Execute’ or ‘Submit’ for chapters based on C, an error message like “Output cannout be empy!” or “Could not send file execution” may appear. This is because of the SSH connection. Press the button again and it should work fine.

CONCLUSIONS

în această parte a lucrării de licenţă se regăsesc cele mai importante concluzii din lucrare, opinia personală privind rezultatele obţinute în lucrare, precum şi potenţiale direcţii viitoare de cercetare legate de tema abordată. Concluziile lucrării nu se numerotează ca şi capitol.

BIBLIOGRAPHY

acesta este ultima parte a lucrării şi va conţine lista tuturor surselor de informaţie utilizate de către absolvent pentru redactarea lucrării de licenţă. Bibliografia nu se va numerota ca şi capitol al lucrării.

1. <https://www.cyberciti.biz/faq/linux-unix-running-sudo-command-without-a-password/> [↑](#footnote-ref-1)
2. <https://stackoverflow.com/questions/39281594/error-1698-28000-access-denied-for-user-rootlocalhost> [↑](#endnote-ref-1)
3. <https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/5/html/deployment_guide/ch-disk-quotas> [↑](#endnote-ref-2)