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SI

LABORATORY WORK # 1

Title

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1 Introduction

1.1 Objective

Understand the purpose of hashing algorithms and create a tool that solves a problem using one of them.

1.2 Generic requirements

1.2.1 Directory integrity checker

This program keeps an eye on the contents of a directory, notifying you when something inside it has changed. It is ran at regular intervals by a scheduler, comparing the current state of the system with a previous snapshot, reporting differences it found. Thus, if your system was hacked and malware was planted into the file system, or if the existing files were modified to include malicious code - you'll know right away.

1.2.2 Dedupe

A duplicate finder, which analyzes a given directory and prints a list of identical files that have different names or paths.

2 Implementation

The following code implements all the requirements and also some bonus features.

2.1 Main program

```
#!/usr/bin/env ruby
require 'gli'
begin # XXX: Remove this begin/rescue before distributing your app
require 'lab1'
require 'digest'
require "sqlite3"
require 'rufus-scheduler'
PATH = "/home/peter/test"
MEGABYTE = 1024*1024
MAXSIZE = 50*MEGABYTE

include GLI::App

program_desc 'First laboratory work at the information security'

version Lab1::VERSION

subcommand_option_handling :normal
arguments :strict

# Global options
desc 'skip files above a certain size given in bytes'
default_value MAXSIZE
flag [:max_size]

desc 'skip paths that match a pattern'
default_value ""
flag [:exclude]

desc 'this command line argument ensures that nothing is printed on the screen if no differences
were found'
default_value true
switch [:silent]

# dircheck command
desc 'This program keeps an eye on the contents of a directory, notifying you when something
inside it has changed.'
arg_name 'path name'
```

```

command :dircheck do |c|
  c.action do |global_options,options,args|
    path = args.first || PATH
    @scheduler.every("10s") do
      checker = DirCheck.new path: path , max_size: global_options[:max_size], exclude:
        global_options[:exclude], db: @db
      puts checker.show_result
    end

    @scheduler.join
  end
end

# dedupe command
desc 'A duplicate finder, which analyzes a given directory and prints a list of identical files
      that have different names or paths.'
arg_name 'path name'
command :dedupe do |c|
  c.action do |global_options,options,args|
    path = args.first || PATH
    checker = DupFile.new path: path , max_size: global_options[:max_size], exclude:
      global_options[:exclude]
    puts checker.list_same_files
  end
end

pre do |global,command,options,args|
  # create a scheduler
  @scheduler = Rufus::Scheduler.new
  # Open a database
  @db = SQLite3::Database.new "check.db"
  begin
    rows = @db.execute <<-SQL
      create table hash_table (
        path varchar(30),
        hash varchar(30),
        size int
      );
    SQL
  rescue SQLite3::SQLException => e
    "Table already exists"
  end
end

post do |global,command,options,args|
end

on_error do |exception|
  true
end

exit run(ARGV)

```

```

peter@lab1 ~$ bundle exec bin/lab1 --help
NAME
  lab1 - First laboratory work at the information security

SYNOPSIS
  lab1 [global options] command [command options] [arguments...]

VERSION
  0.0.1

GLOBAL OPTIONS
  --exclude=arg - skip paths that match a pattern (default: )
  --help        - Show this message
  --max_size=arg - skip files above a certain size given in bytes (default: 52428800)
  --[no-]silent - this command line argument ensures that nothing is printed on the screen if no differences were found (default: enabled)
  --version     - Display the program version

COMMANDS
  dedupe - A duplicate finder, which analyzes a given directory and prints a list of identical files that have different names or paths.
  dircheck - This program keeps an eye on the contents of a directory, notifying you when something inside it has changed.
  help - Shows a list of commands or help for one command

```

2.2 Duplication example

```
# Reopen File Class
class File
  def each_chunk(chunk_size=MEGABYTE)
    yield read(chunk_size) until eof?
  end
end

class DupFile
  attr_reader :hash

  def initialize args
    @path = args[:path]
    @max_size = args[:max_size]
    @exclude = args[:exclude]
    @hash = {}

    calculate_size
  end

  def list_all_files
    hash.inject([]) do |res, (path, info)|
      res << "#{path} : [{info[:size]} bytes] [{info[:hash]}]"
    end.join "\n"
  end

  def list_same_files
    same_files.inject([]) do |res, (hash, paths)|
      res << "#{hash}"
      paths.each {|path| res << path }
    end.join "\n"
  end

  def same_files
    hash_contents.group_by{|_, info| info[:hash] }
      .each {|_, v| v.map! {|h| h.first } }
      .select {|_, v| v.size > 1 }
  end

  private

  def calculate_size
    Dir.glob("#{@path}/**/*")
      .reject { |file| File.directory? file }
      .reject { |file| unwanted_patterns(file) }
      .each { |file| @hash[file] = {size: File.size?(file) } }
  end

  def filter_size
    hash.select {|key, value| value[:size] < @max_size }
  end

  def hash_contents
    filter_size.each { |path, info| @hash[path][:hash] = digest_file path }
  end

  def unwanted_patterns str
    @exclude.gsub(".*", "\w*").split(" ").any? { |regx| str =~ /#{regx}/ }
  end

  def digest_file filename
    # Digest::SHA256.file(filename).hexdigest
    open(filename, "rb") do |f|
      sha256 = Digest::SHA256.new
      f.each_chunk() {|chunk| sha256 << chunk }
    end
    sha256.hexdigest
  end
end
```

```
end

end
```

```
peter lab1 p master bundle exec bin/lab1 dedupe
8b5b9db0c13db24256c829aa364aa90c6d2eba318b9232a4ab9313b954d3555f
/home/peter/test/3.txt
/home/peter/test/nest/3.txt
7692c3ad3540bb803c020b3aee66cd8887123234ea0c6e7143c0add73ff431ed
/home/peter/test/nest/1.txt
/home/peter/test/nest/4.txt
/home/peter/test/1.txt
/home/peter/test/4.txt
```

2.3 Modified in system

```
class DirCheck
  attr_reader :hash

  def initialize args
    @path = args[:path]
    @max_size = args[:max_size]
    @exclude = args[:exclude]
    @db = args[:db]
    @rows = @db.execute( "select * from hash_table" )
    @hash = {}
    @result = {created: [], deleted: [], modified: [] }
    initiate_hash
  end

  # initiate hash form {path => size}
  def initiate_hash
    Dir.glob("#{@path}/**/*")
      .reject { |file| File.directory? file }
      .reject { |file| unwanted_patterns(file) }
      .each { |file| @hash[file] = {size: File.size?(file) } }
  end

  def check_contents
    @rows.size > 1 ? search_change : fill_table
  end

  def show_result
    check_contents
    result = @result.inject([]) do |res, (status, paths)|
      paths.each { |path| res << "#{path} (#{status})" }
      res
    end.join "\n"
    refresh_table
    result
  end

  def refresh_table
    @db.execute('DELETE FROM hash_table')
    fill_table
  end

  def search_change
    check_new_files
    check_modified_files
  end

  def check_new_files
    current, old = @hash.keys, @rows.map(&:first)
    @result[:deleted] = old - current
    @result[:created] = current - old
  end

  def check_modified_files
```

```

@rows.each do |db_path, db_hash, db_size|
  if @hash.has_key?(db_path)
    @result[:modified] << db_path if digest_file(db_path) != db_hash
  end
end
end

# generate new content table
def fill_table
  hash_contents.each do |path, info|
    @db.execute("insert into hash_table values ( ?, ?, ?)", [path, info[:hash], info[:size]])
  end
end

def filter_size
  hash.select {|key, value| value[:size] < @max_size }
end

# hash all files
def hash_contents
  filter_size.each { |path, info| @hash[path][:hash] = digest_file(path) }
end

def unwanted_patterns str
  @exclude.gsub("?", "\w*").split(" ").any? { |regx| str =~ /#{regx}/ }
end

def digest_file filename
  # Digest::SHA256.file(filename).hexdigest
  open(filename, "rb") do |f|
    sha256 = Digest::SHA256.new
    f.each_chunk() {|chunk| sha256 << chunk }
    sha256.hexdigest
  end
end

end

```

```

peter@lab1 ~$ bundle exec bin/lab1 dircheck
/home/peter/test/4.txt (created)
/home/peter/test/5.txt (deleted)
/home/peter/test/1.txt (modified)

```

- Start the scheduler
- Create the class responsible for logic
- Initiate a dictionary with path and size of file
- Filter by given options
- Check the database if it is empty introduce the data to it
- If database is not empty check each file with current state.
- And create a result based on hash comparison of them.

3 Conclusion

After making this laboratory work I learn about different purposes of hashing algorithms. Hash functions are related to (and often confused with) checksums, check digits, fingerprints, randomization functions, error-correcting codes, and ciphers, usually applied to detect duplicated records in a large files (similar DNA sequence) and allows one to easily verify that some input data matches a stored hash value. If we compare some of hash algorithms like MD5, SHA1 or SHA512 they will not improve the security of the construction so much. Computing a SHA256 or SHA512 hash is very fast. An attacker with common hardware could still try tens of millions of hashes per second. Good password hashing functions include a work factor to slow down attackers.