

Password decryption with Java Thread

Giulio Bazzanti Niccolò Biondi

Parallel Computing, April 2020

Table of Contents

- 1 Password Decryption
- 2 Sequential approach
- 3 Parallel approach
- 4 Experiments
- 5 Conclusions

Password Decryption

DES and brute-force attack

Data Encryption Standard (DES)

- is a block cipher algorithm
- is composed by sixteen phases
- adopts a secret key for both crypt and decrypt phase

DES and brute-force attack

Data Encryption Standard (DES)

- is a block cipher algorithm
- is composed by sixteen phases
- adopts a secret key for both crypt and decrypt phase

A brute-force attack

- is used to decrypt any encrypted passwords
- leverages all possible combinations inside the set [a-zA-Z0-9]
- wants to find a secret password

DES and brute-force attack

Data Encryption Standard (DES)

- is a block cipher algorithm
- is composed by sixteen phases
- adopts a secret key for both crypt and decrypt phase

A brute-force attack

- is used to decrypt any encrypted passwords
- leverages all possible combinations inside the set [a-zA-Z0-9]
- wants to find a secret password

A lot of combinations to analyze (with 8-characters passwords are 68^8)

Dictionary attack and Java Thread

Brute-force attack \Rightarrow **Dictionary Attack**

- use dictionary
 - less password to analyze
 - pre-computed 8-characters passwords

Dictionary attack and Java Thread

Brute-force attack \Rightarrow **Dictionary Attack**

- use dictionary
 - less password to analyze
 - pre-computed 8-characters passwords
- use Java Threads parallelism
 - different threads analyze different dictionary chunks
 - speed up the password analysis process

Need threads synchronization \Rightarrow three approaches

Sequential approach

Sequential approach

- The hacker knows the DES SecretKey
- Passwords analyzed sequentially

Sequential approach

- The hacker knows the DES SecretKey
- Passwords analyzed sequentially

Algorithm 1 Dictionary finder

```
1: Read the dictionary
2: for password in dictionary do
3:   Encrypt password p to obtain ep
4:   Compare ep with the target password
5:   if ep is equal to target password then
6:     exit and return password
7:   end if
8: end for
```

Sequential approach

Very **expensive** task

- A single process checks all passwords in the dictionary
- Total computational time $\Rightarrow O(I)$

Typically the dictionary size is 10 GB

Parallel approach

Java Thread

Assumptions

- Multiple threads check different dictionary chunks
- **Callable** vs **Runnable**

Java Thread

Assumptions

- Multiple threads check different dictionary chunks
- **Callable** vs **Runnable**

Synchronization methods

- Threads Synchronization
- ReadWriteLock
- Atomic

Threads Synchronization

- Control access of multiple threads to shared resources
- Solve consistency problem and prevent race conditions
- The keyword *synchronized* leverages the lock built in Java Object

Threads Synchronization

- Control access of multiple threads to shared resources
- Solve consistency problem and prevent race conditions
- The keyword *synchronized* leverages the lock built in Java Object

State class

Two different functions to access to the shared variable

- *getState()*: read the boolean variable
- *setState()*: set the boolean state

ReadWriteLock

- Gives an advanced thread lock mechanism
- **ReentrantReadWriteLock** allows multiple readings but single writing
- Two different lock, one for reading and one for writing

ReadWriteLock

- Gives an advanced thread lock mechanism
- **ReentrantReadWriteLock** allows multiple readings but single writing
- Two different lock, one for reading and one for writing

State class

Two different functions to access to the shared variable

- *getState()*: read the boolean variable
- *setState()*: set the boolean state

Atomic

- Allows atomic access and updates without synchronization or locks
- Can implement non-blocking, lock-free algorithms solving race conditions
- No need a *State* class, only an Atomic boolean

Atomic

- Allows atomic access and updates without synchronization or locks
- Can implement non-blocking, lock-free algorithms solving race conditions
- No need a *State* class, only an Atomic boolean

AtomicBoolean

Two functions to interact with shared resources

- `get()`: return the value from the memory
- `set()`: write the value to memory

Callable vs Runnable

- Callable return a value, Runnable no
- Callable uses **Future** to store the return value

Callable vs Runnable

- Callable return a value, Runnable no
- Callable uses **Future** to store the return value
- Both leverage an **Executor**
 - Creates threads from a pool
 - Does not create extra threads
 - Separates threads creation and management

Callable vs Runnable

- Callable return a value, Runnable no
- Callable uses **Future** to store the return value
- Both leverage an **Executor**
 - Creates threads from a pool
 - Does not create extra threads
 - Separates threads creation and management

T.B.N.

Callable and Runnable performances are completely comparable in our experiments

Experiments

Testing Hypothesis

- The hacker uses two preset dictionaries
 - *Dictionary_words* contains 19958400 8 letter English words.
 - *Dictionary_data* contains 461313 data from 1600 to 2020
- Two different experiments:
 - The hacker has to find different passwords
 - The hacker can use different threads number
- 10 runs for each testing configuration

Evaluation Metrics

Speedup

- Measures two approaches performance
- Use sequential and parallel time
- Depend on the CPU processor number

$$S_p = t_s / t_p$$

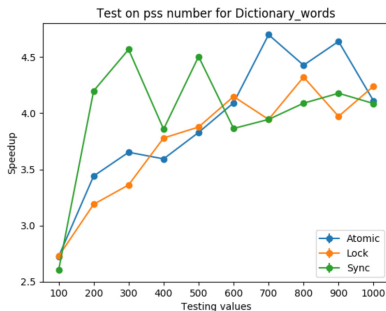
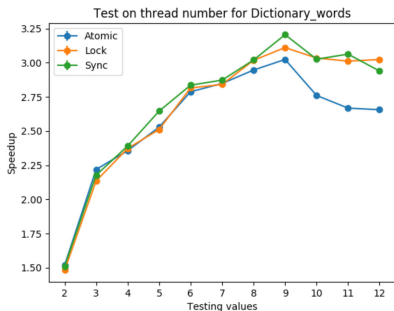
Efficiency

- Measures how well-utilized the processors
- Use the Speedup values
- Depend on the CPU processor number

$$E_p = S_p / p.$$

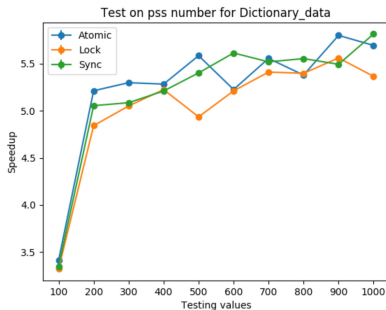
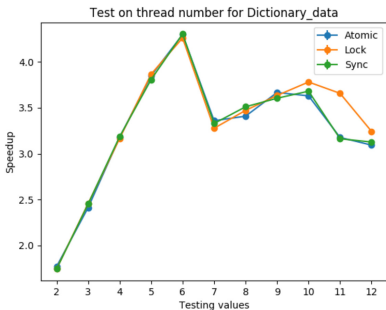
Dictionary_words

- More threads means more (smaller) dictionary chunks
- More passwords to retrieve increasing Speedup



Dictionary_data

- Similar trend but higher performances
- Smaller dictionary \Rightarrow higher Speedup

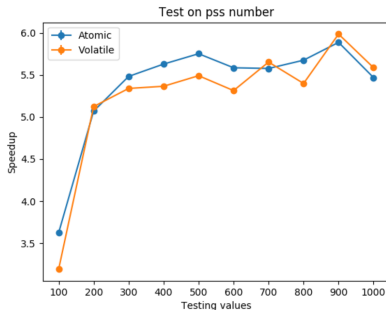
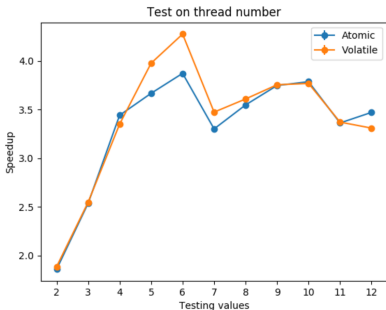


Atomic vs Volatile

- Volatile variable has atomic reading/writing operations
- One thread updates the shared variable \Rightarrow few synchronizations

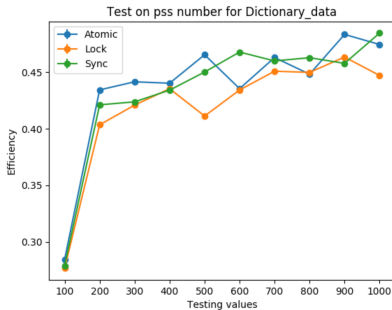
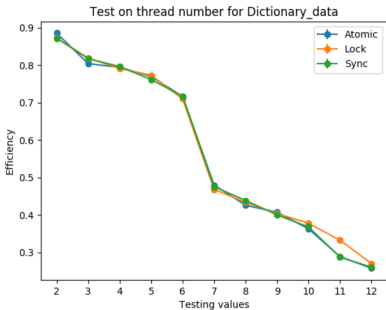
Atomic vs Volatile

- Volatile variable has atomic reading/writing operations
- One thread updates the shared variable \Rightarrow few synchronizations
- Similar Speedup values w.r.t. Atomic ones



Efficiency

- Fixed passwords number and more thread \Rightarrow less thread work
- More passwords to retrieve \Rightarrow more passwords in each chunk



Conclusions

Conclusions

- Parallel approaches improves the computational time
- Bigger dictionary size implies more computational time
- The password position in dictionary affects the results
- Different synchronization methods not change Speedup
- No race conditions, few synchronization \Rightarrow *Volatile*

Thanks for the attention