Password decryption with Java Thread

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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

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- leverages all possible combinations inside the set [a-zA-Z0-9]
- wants to find a secret password

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

Dictionary attack and Java Thread

Brute-force attack ⇒ **Dictionary Attack**

- use dictionary
  - less password to analyze
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Brute-force attack ⇒ **Dictionary Attack**

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- use Java Threads parallelism
  - different threads analyze different dictionary chunks
  - speed up the password analysis process

Need threads synchronization ⇒ three approaches

Sequential approach

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- Passwords analyzed sequentially

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Algorithm 1 Dictionary finder

```
Read the dictionary
for password in dictionary do
    Encrypt password $p$ to obtain $ep$
    Compare $ep$ with the target password
    if $ep$ is equal to target password then
        exit and return password
    end if
end for
```

Sequential approach

Very **expensive** task

- A single process checks all passwords in the dictionary
- Total computational time ⇒ $O(l)$

Typically the dictionary size is 10 GB

Parallel approach

Java Thread

Assumptions

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

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Synchronization methods

- Threads Synchronization
- ReadWriteLock
- Atomic

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- 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

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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

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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
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- 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

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

$$S_p = t_s / t_p$$

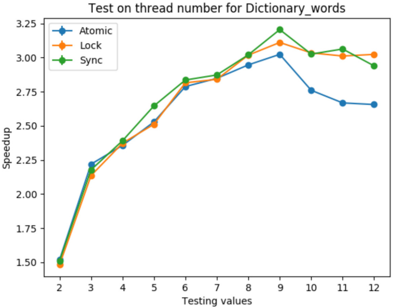
Efficiency

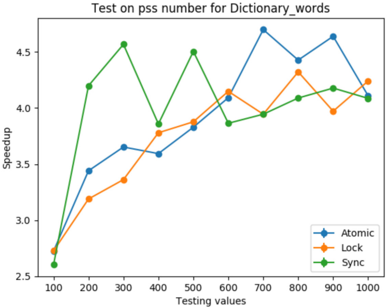
- Measures how well-utilized the processors
- Use the Speedup values
- Depend on the CPU processor number

$$E_p = S_p / p.$$

Dictionary_words

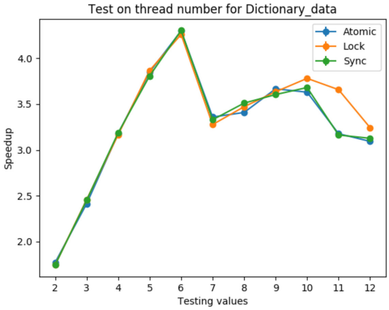
- More threads means more (smaller) dictionary chunks
- More passwords to retrieve increasing Speedup

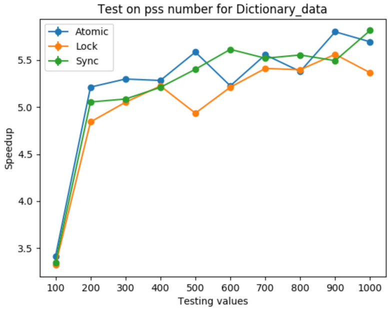

Test on thread number for Dictionary_words


Test on pss number for Dictionary_words

Dictionary_data

- Similar trend but higher performances
- Smaller dictionary ⇒ higher Speedup
- Password position in chuck affects the result





Atomic vs Volatile

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

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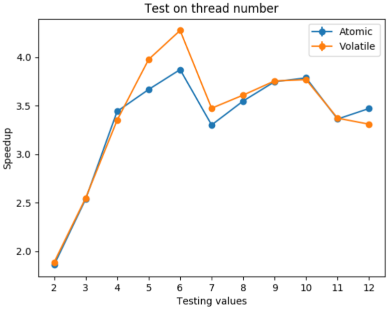
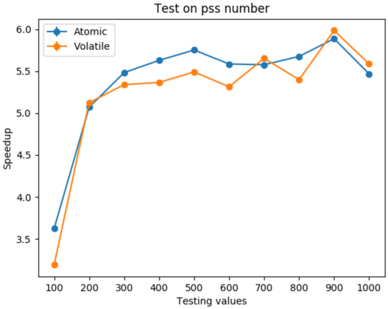
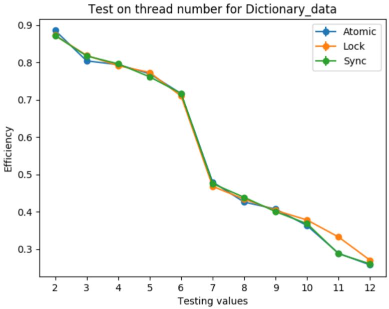
- Similar Speedup values w.r.t. Atomic ones

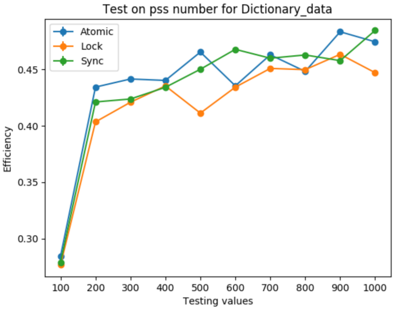




Efficiency

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


Test on thread number for Dictionary_data


Test on pss number for Dictionary_data

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