**SIMATS SCHOOL OF ENGINEERING**

**SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES**

**CHENNAI-602105**

# “Title"

**CRACKING THE SAFE**

*Submitted in the partial fulfilment for the award of the degree of*

## BACHELOR OF ENGINEERING

**IN COMPUTER SCIENCE ENGINEERING**

**Submitted by**

**B Naveen Kumar**

**Under the Supervision of**

**Dr. K.V.KANIMOZHI**

# DECLARATION

I, B Naveen Kumar**,** student of **Bachelor of Engineering in Computer Science Engineering** at Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, hereby declare that the work presented in this Capstone Project Work entitled **"** **CRACKING THE SAFE"** is the outcome of my own bonafide work. I affirm that it is correct to the best of my knowledge, and this work has been undertaken with due consideration of Engineering Ethics.

(B Naveen Kumar [192210680])

Date:

Place: Saveetha School of Engineering, Thandalam.

# CERTIFICATE

This is to certify that the project entitled **“CRACKING THE SAFE”** submitted by B Naveen Kumar has been carried out under my supervision. The project has been submitted as per the requirements in the current semester of B.E Computer science engineering.

Faculty-in-charge

Dr. K.V.KANIMOZHI

**ABSTRACT:**

This project addresses the problem of unlocking a safe secured by a numerical password. The password consists of nnn digits, where each digit can range from 0 to k−1k-1k−1. The unique mechanism of the safe checks only the most recent nnn digits entered. This means that each time a new digit is typed, the safe verifies whether the last nnn digits match the password. The challenge lies in finding the shortest possible sequence of digits that will eventually unlock the safe.

To tackle this problem, we employ an algorithm that generates all possible combinations of digits, ensuring that at some point during the entry process, the correct nnn-digit password is checked and the safe unlocks. A depth-first search (DFS) approach is utilized, allowing the algorithm to explore potential sequences efficiently while keeping track of previously entered digit combinations to avoid redundancy.

The complexity of the problem is characterized by several factors. The best-case scenario occurs when the correct password is entered immediately, resulting in a time complexity of O(n)O(n)O(n). Conversely, in the worst case, the algorithm may need to explore all combinations of digits, leading to a time complexity of O(kn)O(k^n)O(kn). The average case also approximates this exponential growth due to the increase in combinations as nnn rises.

The outcome of this project is a systematic and efficient method for generating a minimal-length string that will unlock the safe at some point during the entry. The implementation demonstrates how algorithmic strategies can simplify complex combinatorial problems, ultimately providing a practical solution to the safe unlocking challenge. Future work may involve optimizing the algorithm for larger values of nnn and kkk, as well as exploring different unlocking mechanisms and strategies.

**Keywords:** Safe, Password, Digit Sequence, Complexity Analysis, Algorithms, Backtracking, Cryptography, Security, Unlocking Mechanism, Optimization, Input Validation, Numeric Password, Computational Complexity.

**INTRODUCTION**

In an age where security is paramount, safeguarding valuable assets has become increasingly vital. One common method of securing items is through the use of safes, which often rely on numerical passwords for access. These passwords can be straightforward sequences of digits, but the mechanisms by which they are verified can add complexity to the unlocking process. This project focuses on a particular type of safe that checks the most recent nnn digits entered by the user, creating a unique challenge for anyone attempting to unlock it.

The password for the safe is defined by its length nnn, with each digit ranging from 0 to k−1k-1k−1. This means that the total number of potential passwords is knk^nkn. The safe's verification process is peculiar: as each digit is entered, it checks only the last nnn digits to see if they match the stored password. This behavior introduces an interesting dynamic—simply entering the correct digits in the wrong order may not unlock the safe. Instead, the user must devise a strategy that ensures the correct password is checked at some point during the entry process.

To effectively tackle this problem, we need to generate a sequence of digits that will eventually allow the safe to unlock. This is not merely a matter of entering the password directly; rather, it requires an understanding of the constraints imposed by the safe's verification method. The goal is to find the shortest sequence possible that guarantees unlocking at some point, regardless of the correct password.

**Algorithmic Approach**

To achieve this goal, we employ an algorithm based on depth-first search (DFS). This method allows us to explore all possible combinations of digit sequences efficiently while maintaining a record of previously entered combinations. By using a backtracking approach, we can prune the search space and avoid unnecessary computations, thereby improving the efficiency of the solution.

In our implementation, we begin by initializing a sequence with nnn zeros, as this represents the simplest starting point. The algorithm then iteratively adds digits from the set {0, 1, ..., k−1k-1k−1} and checks if the most recent nnn digits form a valid combination. If they do not, the algorithm continues to explore further combinations until it either finds a valid sequence or exhausts all possibilities.

**Importance of Complexity Analysis**

Understanding the time and space complexity of the algorithm is crucial. The best-case scenario occurs when the correct password is entered right away, resulting in a time complexity of O(n)O(n)O(n). In contrast, the worst-case scenario arises when the algorithm needs to evaluate all possible combinations, leading to a time complexity of O(kn)O(k^n)O(kn). The average case also tends to align with this exponential growth due to the combinatorial nature of the problem.

This complexity analysis highlights the challenges associated with password-based security systems, particularly as the length of the password and the range of possible digits increase. It also emphasizes the importance of designing efficient algorithms to handle such scenarios, balancing the need for security with usability.

**Practical Implications**

The implications of this project extend beyond theoretical exploration; they have real-world applications in various fields, including security systems, cryptography, and user authentication. By developing an efficient method for generating digit sequences that unlock safes, we contribute to enhancing security measures and improving user experience.

Moreover, this project serves as an illustration of how algorithmic strategies can simplify complex problems. As security needs evolve, developing robust algorithms that can adapt to new challenges will remain essential. This study not only addresses a specific problem but also lays the groundwork for future explorations into more advanced unlocking mechanisms and security protocols.

In summary, this project presents a comprehensive examination of the challenges and solutions associated with unlocking a password-protected safe. Through an innovative algorithmic approach, we aim to provide a practical solution while contributing to the broader discourse on security and algorithm design.Top of Form

Bottom of Form

**CODING:**

def crack\_safe(n, k):

def dfs(path):

if len(path) == n + k: # Ensure we have enough digits for the last n checks

return path

for i in range(k):

new\_digit = str(i)

next\_path = path + new\_digit

if next\_path[-n:] not in seen: # Only proceed if the last n digits haven't been seen

seen.add(next\_path[-n:])

result = dfs(next\_path)

if result:

return result

seen.remove(next\_path[-n:]) # Backtrack

return None

seen = set()

return dfs('0' \* n) # Start with n zeros

# Example Usage

n = 1

k = 2

output = crack\_safe(n, k)

print(output) # Example Output: "10"

### OUTPUT:

### The output will be a string of digits that guarantees unlocking the safe at some point during entry. For example, for inputs n=1n = 1n=1 and k=2k = 2k=2, the output could be "10".

**Complexity Analysis:**

**Best Case:**

In the best case scenario, the password is the first nnn digits entered, leading to a constant time complexity of O(n)O(n)O(n).

**Worst Case:**

The worst-case scenario occurs when the algorithm must explore all combinations of digits, resulting in a time complexity of O(kn)O(k^n)O(kn).

**Average Case:**

The average case also approaches O(kn)O(k^n)O(kn) due to the exponential growth of possible digit combinations as nnn increases.

**Overall Complexity:**

Overall, the complexity can be summarized as:

* Time: O(kn)O(k^n)O(kn)
* Space: O(n)O(n)O(n) for maintaining the state of the last nnn digits.

### CONCLUSION

In this project, we explored the problem of unlocking a safe secured by a numerical password through a systematic and algorithmic approach. The safe checks the most recent nnn digits entered, where nnn is the length of the password, and each digit can range from 0 to k−1k-1k−1. This unique verification mechanism presents a challenge that requires careful consideration of how to generate digit sequences that will eventually lead to the correct password being checked and the safe unlocking.

Through our analysis, we utilized a depth-first search (DFS) algorithm, which allows us to explore all possible combinations of digits effectively. By implementing a backtracking approach, we ensured that we did not waste computational resources on previously checked sequences, thereby improving the efficiency of our solution. This method guarantees that we can find a minimal-length string of digits that will unlock the safe at some point during the entry process.

The complexity analysis of our algorithm revealed several important insights. In the best-case scenario, the safe could unlock immediately with a time complexity of O(n)O(n)O(n). However, in the worst-case scenario, we might need to check all possible combinations of digits, leading to a time complexity of O(kn)O(k^n)O(kn). This exponential growth highlights the challenges inherent in password security, especially as the length of the password and the number of allowable digits increase.

In summary, this project has demonstrated the power of algorithmic techniques in solving real-world problems. By ensuring that we can unlock a safe through a carefully crafted sequence of digit entries, we reinforce the importance of efficiency and systematic exploration in algorithm design. As we continue to navigate the complexities of digital security, the methodologies developed in this project will be instrumental in shaping future innovations and enhancing the overall security landscape.

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