

# Class 34

Shortest Palindrome → longest Palindromic Prefix

## Repeated String Match

= longest Duplicate Substring

String S = " banana "

ban  
ana  
han  
nana

at least 2 times

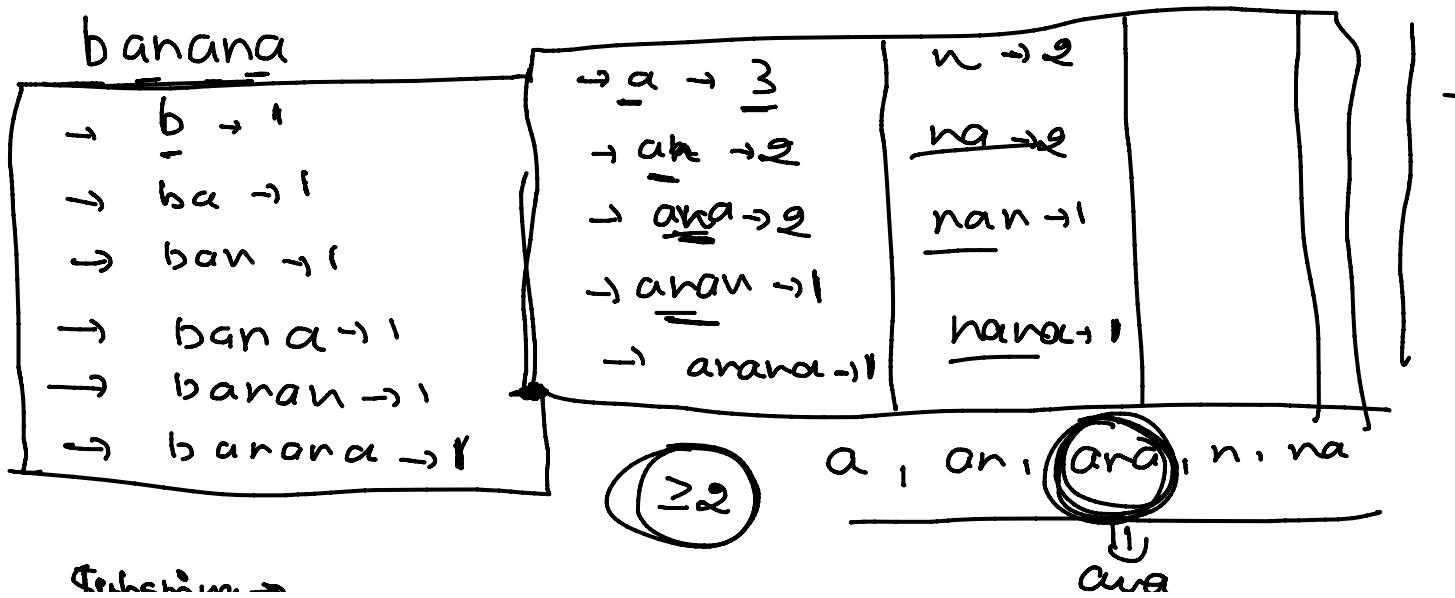
abcd       $\Rightarrow$  " "

## Brute Force

K M<sub>1</sub> D

map<String, int> m;

32



## Substring →

```

for (int i=0; i<n; i++) {
    string str = " "
    for (int j=i; j<n; j++) {
        if (str.push_back(s[j])) {
            cout << str;
        }
    }
}
    
```

For (auto i : ma )  
 { if (i.second ≥ 2)

a b c d

Str = 'a'  
 'ab'  
 'abc'  
 'abcd'

b  
b c  
b c d

c

c d

$O(n^2 \log n)$   $t = "$   
 $O(n^2)$   $O(n^3)$

T.C =  $O(n^2 \log n)$   
 $O(n^3)$

S + = S i h

String str = "a b c"

char ch = 'a'

str += ch;

cout << str;

"a"  
"a"

## Optimized

banana

S.C

binary search

Rabin Karp

longest length ans

sorted array / rotated  
element find

banana

longest

Duplicate answer

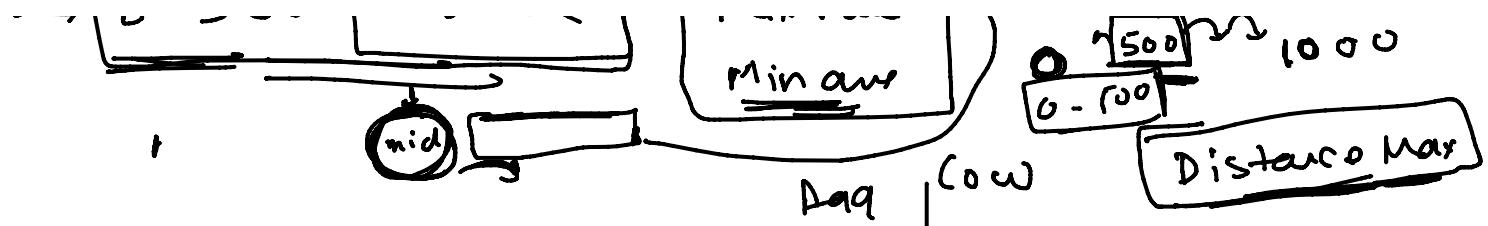
max nof page

B.S on

answer

Max value  
Min ans

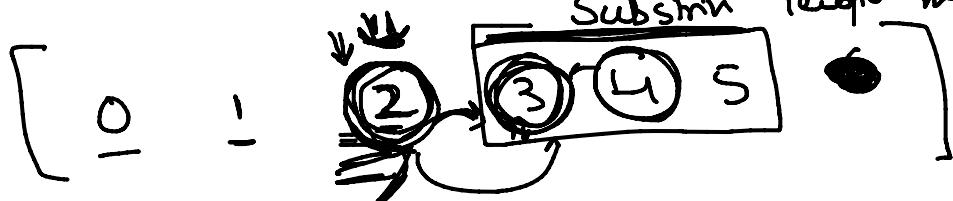
500  
1000  
1 - root



banana

Substring length in = 3

Substring length now = 3



ans = 2

longest Duplicate Substring

b anana

⇒ an ⇒ 'a'

now

an an

Pattern ≈ 3

How to decide length of cue using R-S

banana → ? length Substring Duplicate ?  
2 length?

t1

Rabin Karp

b anana ana ana

How window value

S.erase(i)

S.insert(i)

Rabin Karp

window → value (hash)

str = "abcabc"

ptr = b c ab

b anana a → ur

u1

u2 u3 u4

```

graph TD
    u1((u1)) --> u2((u2))
    u2 --> u3((u3))
    u3 --> u4((u4))

```

$$u_2 = -u$$

$$u_3 = \underline{\underline{u}}^e$$

map<int,int> ma

$$u_1 \rightarrow 1$$

$$v_2 \rightarrow \underline{2} \quad y$$

$$u_3 \rightarrow 2$$

T.C  $\downarrow$   
 $O(n^2) \text{ogn}$ )

## Practice

10

3

longest length

Rabin-Karp  $\Rightarrow$  Din 3

## B.5 on Answer

Max Distance, Min Pugel

$$10 \cdot 10^3 = 10^4$$

$$S = 1000 \Rightarrow \log_2 1000 =$$

$$\log_2 50^{\circ} = 3 - 4$$

banana

Fig. 1. A 2D schematic

$10^4$

$\rightarrow O(n^2)X$

DYNAMIC

## longest Duplicate Substring

"ab cd"

SubString

"d c h a"

lengths

$10^4$

1

$O(n^2)X$

Ornlogn  
 $O(n)$

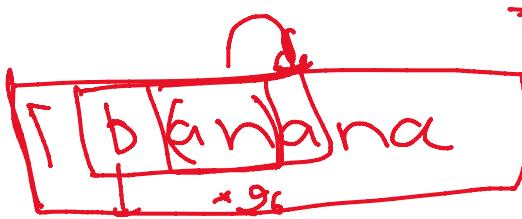
Sort, B.S



Rabin Karp =

abcd

$$\Rightarrow a * \underline{26}^3 + b * \underline{26}^2 + c * \underline{26}^1 + \underline{d}$$



$$- (b * 26^2) + a$$

j - 1c

j = window ending

Hash value

store in

Map

Hashvalue repeat

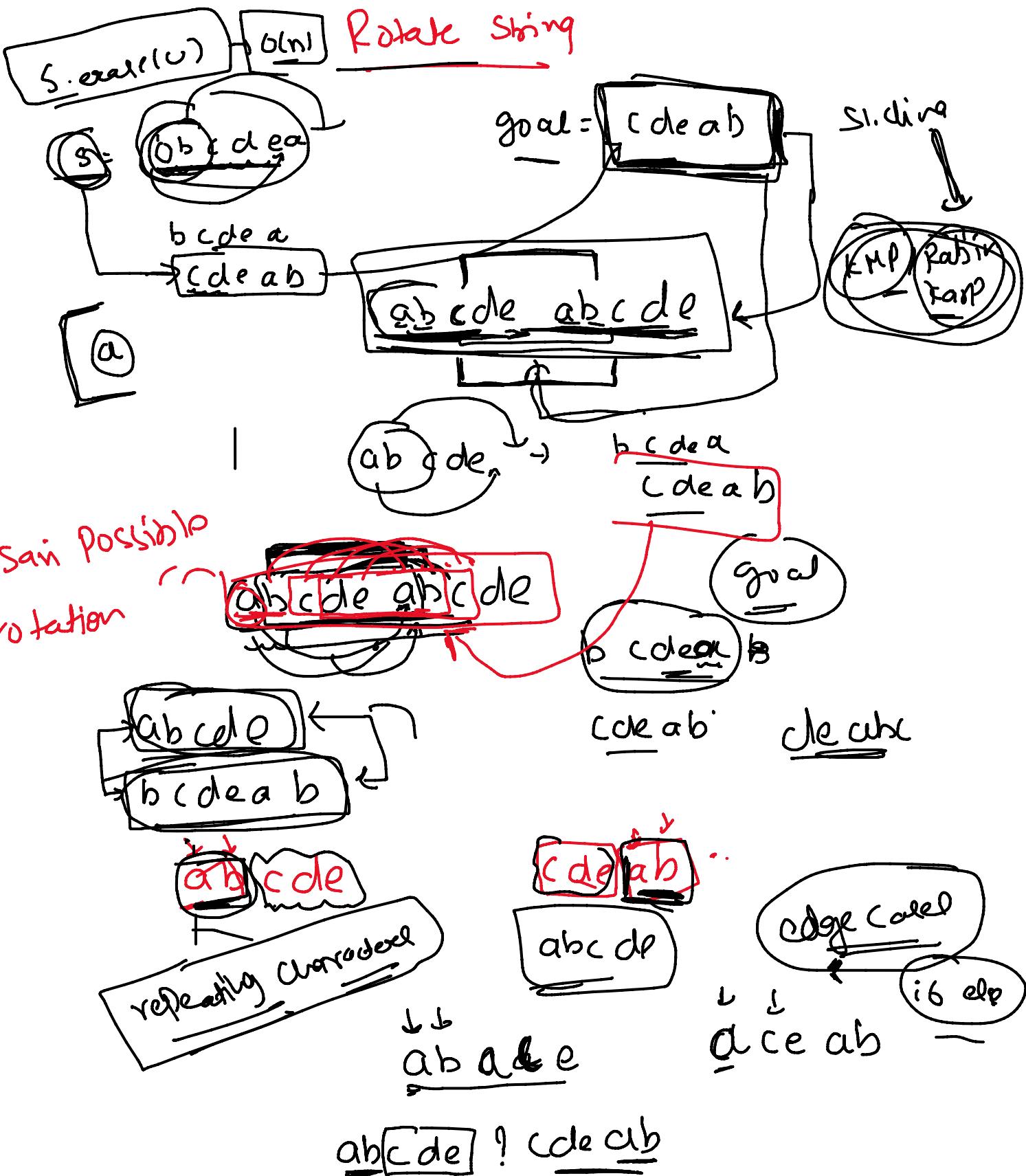
Collisions

String

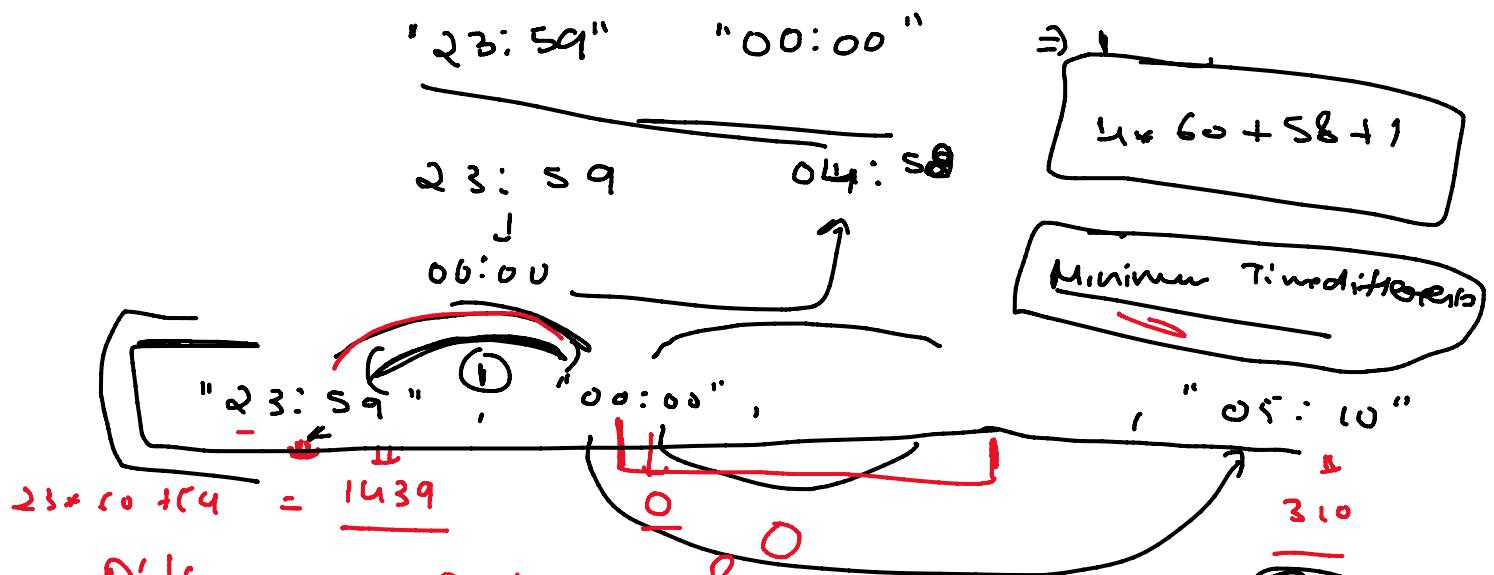
a

b

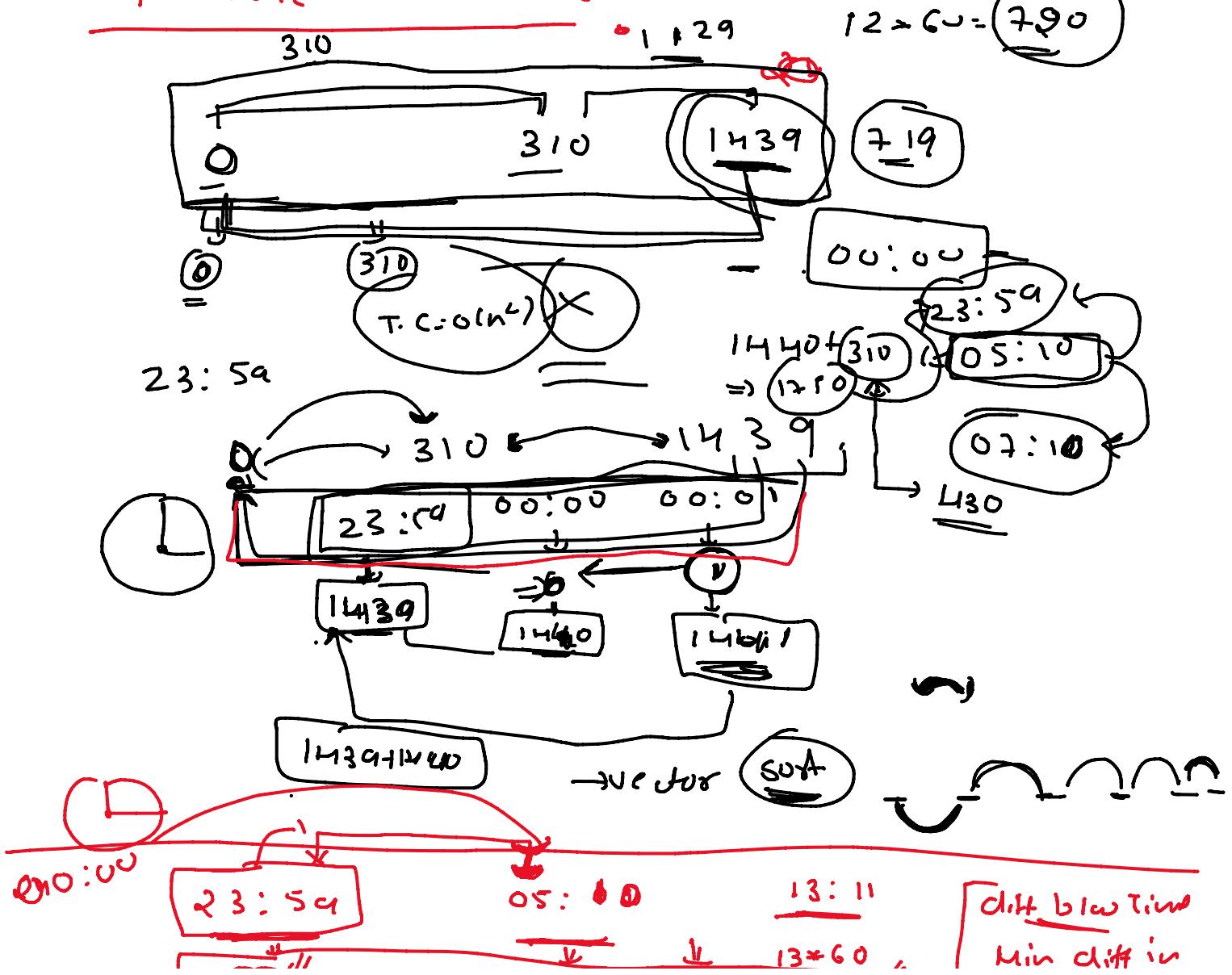
a ≠ b

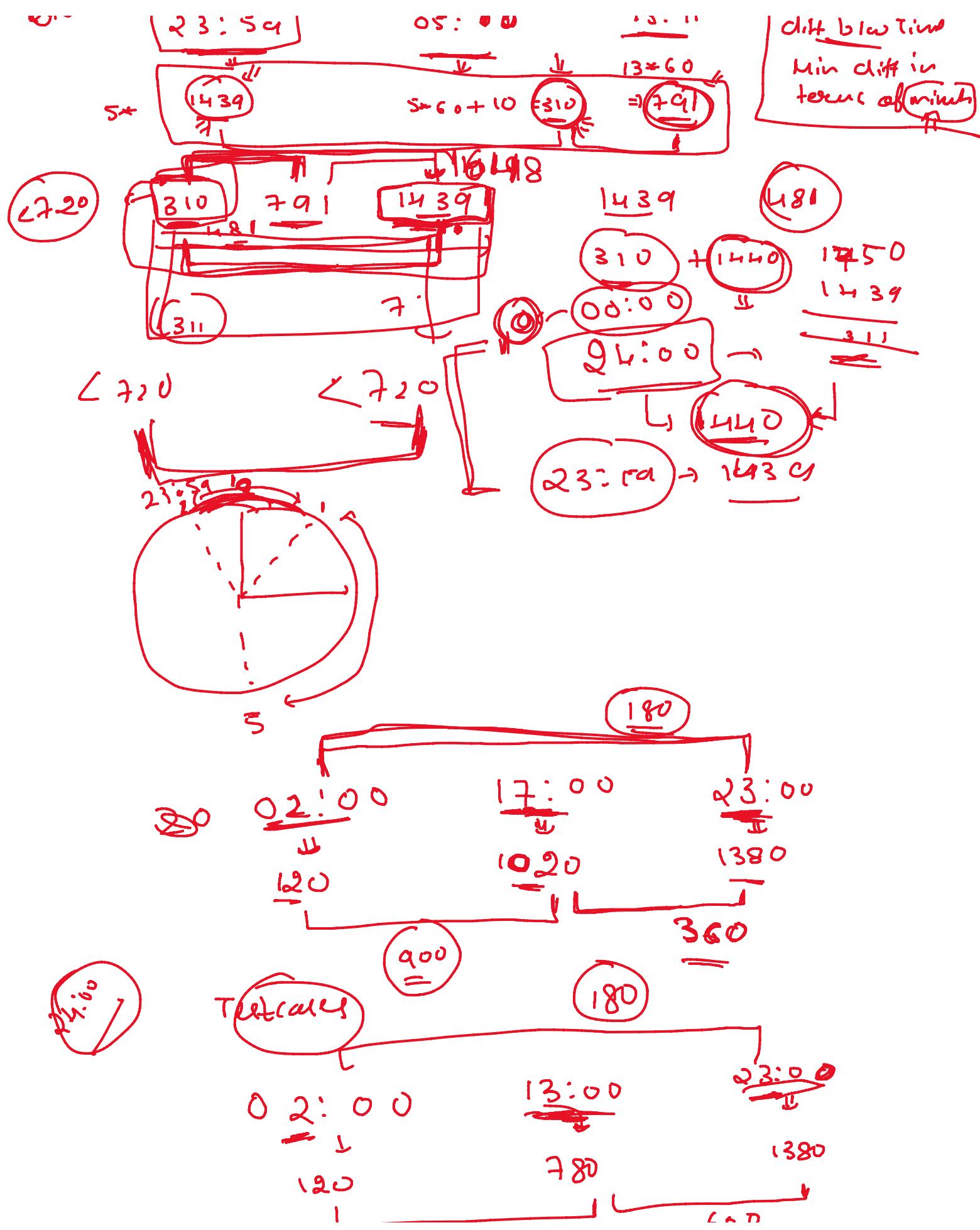


## Minimum Time Difference



Difference calculate?





120                  +80  
660                  600