Ex: T = A B A B A B A B B A B A B A B

P = A B A B A Valid shifts: 0, 2, 9

π: 0 0 1 2 3

q: ~~0 1 2 3 4 5 6 7 8 9 10 11 12~~ ....

i: ~~1 2 3 4 5 6 7 8 9 10 11 12~~ ....

Computing π:

```
π[1] ← 0        k ← 0
for q ← 2 to m do
    while k > 0 and P[k+1] ≠ P[q] do
            k ← π[k]
    if P[k+1] = P[q] then
            k++
    π[q] ← k
```

RT = O(m)

Applications of KMP:

1. Given a string S, can S be rotated by and still be equal to S.

   a b a b a b $\xrightarrow{1 \text{ shift}}$ b a b a b a $\xrightarrow{2^{nd} \text{ shift}}$ a b a b a b

   A: search for S in SS =

   # valid shifts > 2 then output Yes. RT = O(|S|).

2. Q: Given S, find shortest x such that xS is a palindrome.

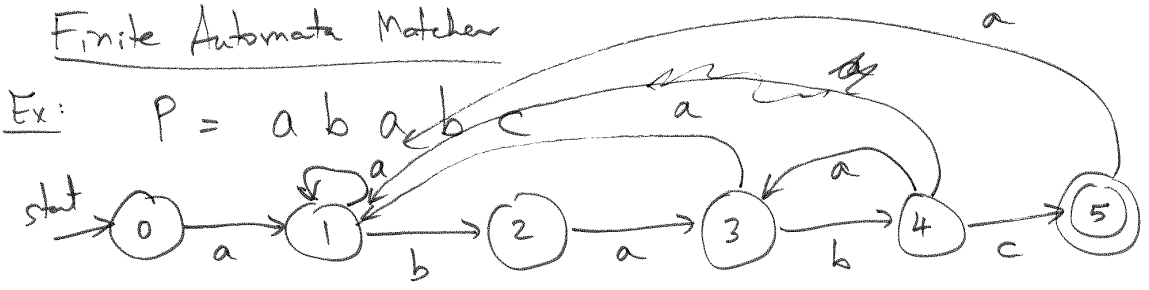
   A: SS^R Find prefix function π

   $|SS^R| = \ell$ $\pi[\ell]$ — max prefix that is a suffix of SS^R

   ?? Open: find the ~~solu~~ rest of the solution.

Finite Automata Matcher

Ex: P = a b a c b c



start from state 0: run the characters of text through the automaton.

Current state = max suffix of text = prefix of pattern

Missing transition = go back to start state.

Every visit to state 5 gives a valid shift.

$$RT = O(n) + O(m \cdot \Sigma)$$

$O(n)$ ↑ matching — $O(m \cdot \Sigma)$ ↑ Automaton construction

	a	b	c
0	1		
1	1	2	
2	3		
3	1	4	
4	3		5
5	1		

Σ = alphabet size

Boyer-Moore Algorithm

T[1..n] P[1..m] — Preprocess pattern and compute tables: - Bad character table
- Good suffix table.

scan T left to right.

Pattern is matched to text from right to left.

When there is a mismatch:

Bad character table proposes a shift
Good suffix table " " " } choose maximum of these two

+ Galil rule for not comparing characters that are already known to match.

Notes: RT of B-M is $O(n)$ if P never occurs in T

RT could be $O(nm)$ if T is periodic

With Galil rule, RT is $O(n)$ for all cases.

RT can be as good as $O(n/m)$ for some P, T.

Tries :

Input : A dictionary of words (say, 50000 words, length: 1-12, average length = 5.69)

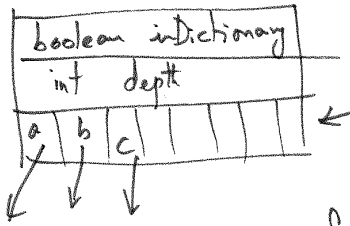
Preprocess these words :

Query (w) : Does w occur in dictionary?

Does w occur as a prefix of any word in dictionary?

Valid characters : a-z (26 possibilities)

Trie Entry :



array of pointers to TrieEntry. (of size 26)

f (a-z) ⟶ 0-25

Dictionary : if, else, end