

Step 2 :-

KMP String Matching Algorithm

①

Matching Pattern with string.

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lets, say the given string is

T =

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
a	b	a	b	a	b	a	b	a	c	a	b	a	b	a	c	a

and the pattern is

P =

1	2	3	4	5	6	7
a	b	a	b	a	c	a

for this we have computed the prefix function as

q	1	2	3	4	5	6	7
P[q]	a	b	a	b	a	c	a
$\pi[q]$	0	0	1	2	3	0	1

KMP-MATCHER (T, P)

```
1 n = length (T)
2 m = length (P)
3 pi = COMPUTE-PREFIX-FUNCTION(P)
4 q = 0
5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]
```

Now using the KMP_MATCHER(T, P) Algorithm, we will match pattern with the text.

According to algorithm, $q = 0$

for $i = 1$

Here $q = 0$ \therefore while $q > 0$ and $P[q+1] \neq T[i]$ is false

Now compute $P[q+1] = P[0+1] = P[1] = a$

$T[i] = T[1] = a$

$\therefore P[q+1] == T[i]$ is true

$\therefore q = q+1$

$= 0+1$

$= 1$

for $i = 2$, $q = 1$

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$q > 0$ is True

$$P[q+1] = P[1+1] = P[2] = b$$

$$T[i] = T[2] = b$$

Here $P[q+1] == T[i]$ is true

$$\therefore q = q + 1$$

$$q = 1 + 1$$

$$q = 2$$

```
5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]
```

for $i = 3$, $q = 2$

$q > 0$ is True

$$P[q+1] = P[2+1] = P[3] = a$$

$$T[i] = T[3] = a$$

Here $P[q+1] == T[i]$ is True

$$\therefore q = q + 1$$

$$= 2 + 1$$

$$= 3$$

for $i = 4$, $q = 3$

$q > 0$ is True

$$P[q+1] = P[3+1] = P[4] = b$$

$$T[i] = T[4] = b$$

Here $P[q+1] == T[i]$ is True

$$\therefore q = q + 1$$

$$= 3 + 1$$

$$= 4$$

for $i=5$, $q=4$

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$q > 0$ is True

$$P[q+1] = P[4+1] = P[5] = a$$

$$T[i] = T[5] = a$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned}\therefore q &= q+1 \\ &= 4+1 \\ &= 5\end{aligned}$$

```
5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]
```

for $i=6$, $q=5$

$q > 0$ is True

$$P[q+1] = P[5+1] = P[6] = c$$

$$T[i] = T[6] = b$$

so $P[q+1] \neq T[i]$ is True

$$\therefore q \leftarrow \pi[q]$$

$$q = \pi[5]$$

Get the prefix function value from the table

$$q = 3$$

again, $q > 0$ is True

$$P[q+1] = P[3+1] = P[4] = b$$

$$T[i] = T[6] = b$$

Now $P[q+1] == T[i]$ is True

$$\begin{aligned}\therefore q &= q+1 \\ q &= 3+1 \\ &= 4\end{aligned}$$

for $i = 7$, $q = 4$

$q > 0$ is True

$$P[q+1] = P[4+1] = P[5] = a$$

$$T[i] = T[7] = a$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned}\therefore q &= q+1 \\ &= 4+1 \\ &= 5\end{aligned}$$

```
5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]
```

for $i = 8$, $q = 5$

$q > 0$ is True

$$P[q+1] = P[5+1] = P[6] = c$$

$$T[i] = T[8] = b$$

Here $P[q+1] \neq T[i]$ is True

$$\therefore q = \pi[q]$$

Get the value of $\pi[q]$ from prefix function table

$$q = \pi[5]$$

$$q = 3$$

again $q > 0$ is True

$$P[q+1] = P[3+1] = P[4] = b$$

$$T[i] = T[8] = b$$

Now $P[q+1] == T[i]$ is True

$$\begin{aligned}\therefore q &= q+1 \\ &= 3+1 \\ &= 4\end{aligned}$$

for $i=9$, $q=4$

$q > 0$ is True

$$P[q+1] = P[4+1] = P[5] = a$$

$$T[i] = T[9] = a$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned} \therefore q &= q+1 \\ &= 4+1 \\ &= 5 \end{aligned}$$

for $i=10$, $q=5$

$q > 0$ is True

$$P[q+1] = P[5+1] = P[6] = c$$

$$T[i] = T[10] = c$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned} \therefore q &= q+1 \\ &= 5+1 \\ &= 6 \end{aligned}$$

for $i=11$, $q=6$,

$q > 0$ is True

$$P[q+1] = P[6+1] = P[7] = a$$

$$T[i] = T[11] = a$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned} \therefore q &= q+1 \\ &= 6+1 \\ &= 7 \end{aligned}$$

Now acc. to algo. if $q == m$ then
print "Pattern occurs at shift" $i-m$
 $q = \pi[q]$

```

5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]

```

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Therefore,

Here because $q = 7$ and

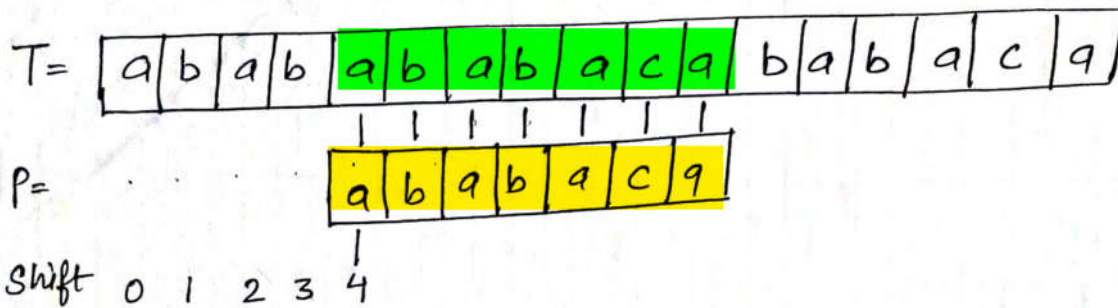
m which is length of pattern, $m = \text{len}(P) = 7$

$\therefore q == m$ is True

so, we will print

"Pattern occurs at shift" $i - m$

i.e. Pattern occurs at shift $11 - 7 = 4$



and then $q = \pi[q]$
 $q = \pi[7]$
 $= 1$

for $i = 12$, $q = 1$

$q > 0$ is True

$P[q+1] = P[1+1] = P[2] = b$

$T[i] = T[12] = b$

Here $P[q+1] == T[i]$ is True

$\therefore q = q+1$
 $= 1+1$
 $= 2$

```

5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]

```

for $i = 13$, $q = 2$

$q > 0$ is True

$$P[q+1] = P[2+1] = P[3] = a$$

$$T[i] = T[13] = a$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned}\therefore q &= q+1 \\ &= 2+1 \\ &= 3\end{aligned}$$

```
5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]
```

for $i = 14$, $q = 3$

$q > 0$ is True

$$P[q+1] = P[3+1] = P[4] = b$$

$$T[i] = T[14] = b$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned}q &= q+1 \\ &= 3+1 \\ &= 4\end{aligned}$$

for $i = 15$, $q = 4$

$q > 0$ is True

$$P[q+1] = P[4+1] = P[5] = a$$

$$T[i] = T[15] = a$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned}\therefore q &= q+1 \\ &= 4+1 \\ &= 5\end{aligned}$$

for $i = 16$, $q = 5$

$q > 0$ is True

$$P[q+1] = P[5+1] = P[6] = C$$

$$T[i] = T[16] = C$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned} \therefore q &= q+1 \\ &= 5+1 \\ &= 6 \end{aligned}$$

```

5 for i = 1 to n
6   while q > 0 and P[q+1] != T[i]
7     q = pi[q]
8   if P[q+1] == T[i]
9     q = q+1
10  if q == m
11    print "Pattern occurs with shift" i - m
12    q = pi[q]

```

for $i = 17$, $q = 6$

$q > 0$ is True

$$P[q+1] = P[6+1] = P[7] = a$$

$$T[i] = T[17] = a$$

Here $P[q+1] == T[i]$ is True

$$\begin{aligned} \therefore q &= q+1 \\ &= 6+1 \\ &= 7 \end{aligned}$$

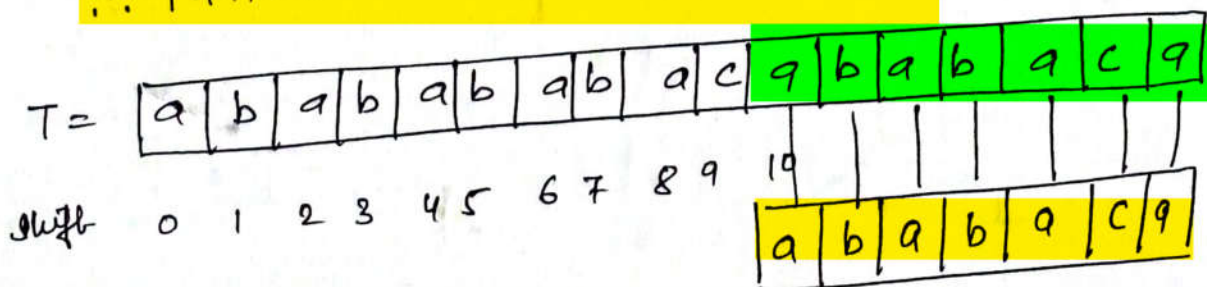
Now $q == m$ is True

i.e $q = \text{len}(P)$ \therefore we will print

"Pattern occurs at" $i - m$ shift

$$i - m = 17 - 7 = 10$$

\therefore Pattern occurs at shift = 10



so pattern occurs in Text at shift = 4 and shift = 10.