String a = "Kunal"
(n)

String b = "Apoorv Kunal Rahul"
(m)

Quad time complexity.

Linear time ? O(n+m) O(n * m)

Karp - Rabin algorithm

a = K U N A L
0 1 2 3 4

b = A P O O R V K U N A L R
0 1 2 3 4 5 6 7 8 9 10 11

$$h(a) = hb[i : i + len(a)]$$

① If $h(a) = hb[i : i + len(a)]$

* maybe → found a match

** check every character $O(a)$

if all char = , answer ✓✓

→ ** not all chars are equal

$h(a) = h(\text{substring})$

but $a \mathrel{!}= \text{substring}$

$$p = \frac{1}{len(a)}$$ → (Universal hashing prev lecture)

$\Rightarrow$ expected cost per i (index) = $O(1)$

Time = $O\left(\text{len}(a) + \text{len}(b) * \text{cost of hash function}\right)$

$\hookrightarrow$ $O(\text{len}(a) * \text{len}(b))$ a lot of collisions.

Extra:

- Monte Carlo variant
- Las Vegas variant