داستان اول:

بسم الله الرحمن الرحیم

$$M_{n \times n}$$

$$S = 0$$

```
for i in range(n):
        for j in range(n):
                if i == j:
                        S += M[i][j]
```

$$T(n) = n^2$$

$$\sim \overline{G}$$

```
S = 0
for i in range(n):
        S += M[i][i]
```

$T(n) = n$

e^2

اندازه ورودی ، تعداد گام‌ار عمل اصلی به ازای اندازه ورودی

$$T(n)$$

$$L = [\quad , \quad , \quad , \quad - - - - -)_n$$

key

```
def search(L):
    for i in range(n):
        if L[i] == key:     حالة : عادي
            return i
    return -1
```

$B(n) = 1$

$W(n) = n$

~~$T(n)$~~

$T(n)$ $W(n)$ $B(n)$ $A(n)$

$T(n)$ ✓ $T(n) = W(n) = B(n) = A(n)$

```
def    fib1(n):

    L[0] = 1
    L[1] = 1
    for  i in range(2,n):

            L[i] = L[i-1] + L[i-2]

    return  L[n-1]
```

علم الحمل ع:

$$T(n) = n - 2$$

```python
def fib2(n):
    if n < 3:
        return 1
    else:
        return fib2(n-1) + fib2(n-2)
```

$$T(n) \sim 2^n$$

$f(6)$

$5\ f(5)$ $f(4)$

$3\ f(4) + f(3)\ 2$ $f(3) + f(2)$

$2\ f(3) + f(2)\ 1$ $f(2) + f(1)$ $f(2) + f(1)$

$f(2) + f(1)$ 1 1

1 1

$$T(n) = n - 2$$
$$n - 5$$

$$an + b \longrightarrow \Sigma ?$$

$$T(n) = 2^n$$

$n = 5 \longrightarrow 7s$
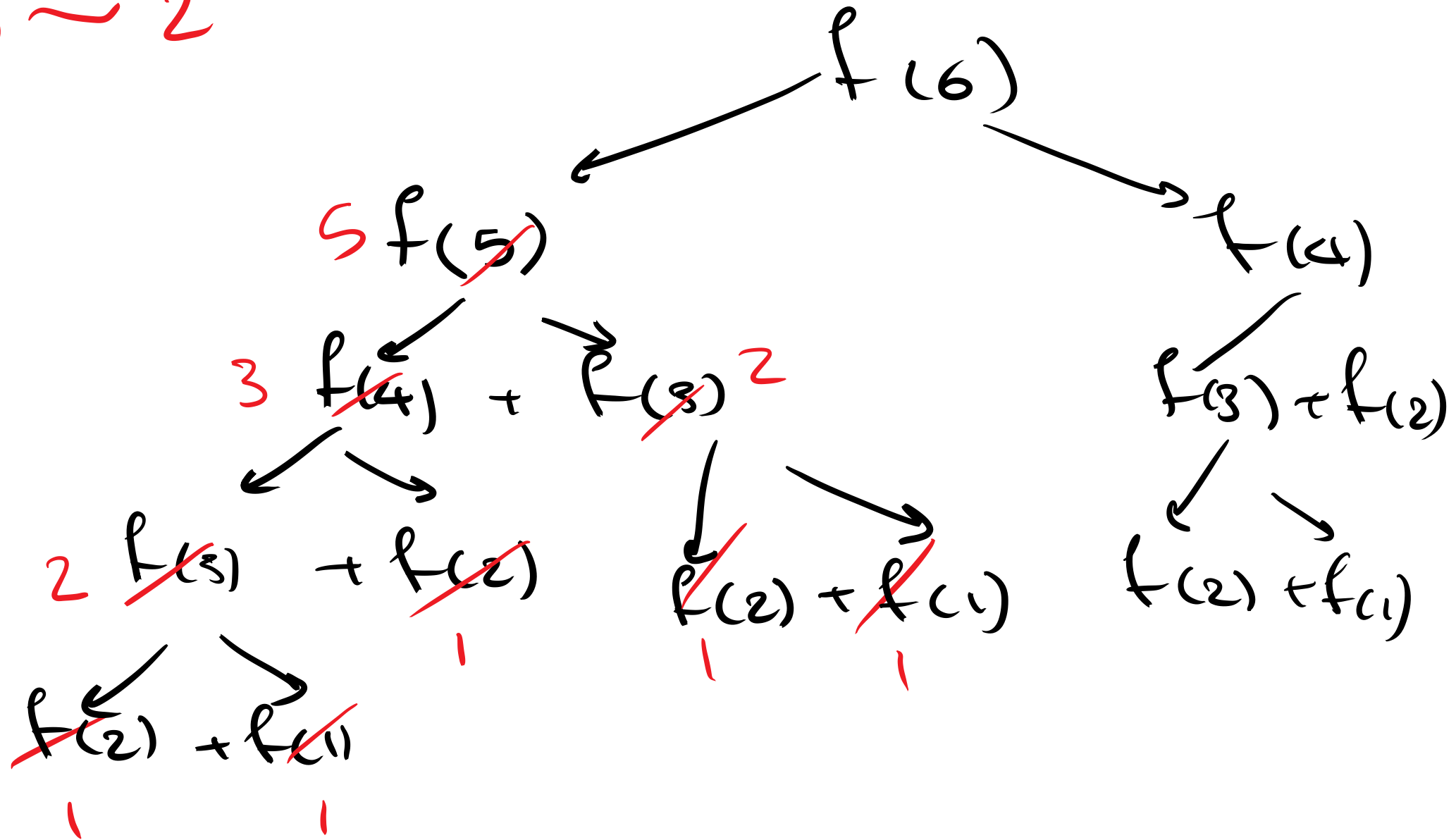
$n = 10 \longrightarrow 2s$

$T(n) = 40 \longrightarrow 1m$

$41 \longrightarrow 2$

$42 \longrightarrow 4$

$43 \longrightarrow 8$

$44 \longrightarrow 16$

$45 \longrightarrow .5h$

$46 \longrightarrow 1h$

$47 \longrightarrow 2$

$48 \longrightarrow 4$

$50 \longrightarrow 16h$ $49 \longrightarrow 8$

$$T(n) = T(n-1) + T(n-2)$$

$$T(n) - T(n-1) - T(n-2) = 0$$

$$r^2 - r - 1 = 0$$

$$T(n) \sim \left(\frac{1+\sqrt{5}}{2}\right)^n$$

$$\text{sol. } r < \begin{cases} \dfrac{1+\sqrt{5}}{2} \\[3mm] \dfrac{1-\sqrt{5}}{2} \end{cases}$$

$$T(n) = \alpha_1 \left(\frac{1+\sqrt{5}}{2}\right)^n + \alpha_2 \left(\frac{1-\sqrt{5}}{2}\right)^n$$

Golden Ratio

$$T(n) = 2T(n-1) + 3T(n-2)$$

$$r^2 - 2r - 3 = 0$$

$$Ar^2 + Br + C = 0 \qquad \boxed{f(n)}$$

$$\underset{\substack{\to r_1 \\ \to r_2}}{} \quad T(n) = \alpha_1 r_1^n + \alpha_2 r_2^n \quad \Big|\quad \begin{array}{l} r_1 = r_2 \\[6pt] T(n) = \alpha_1 r_1^n + \alpha_2 n r_1^n \end{array}$$

Binary Search (L, key) :

$l = 0$

$h = n - 1$

while ($L <= h$) :

$m = \dfrac{(L + h)}{2}$

if key $== L[m]$

return m

$B(n) = 1$

$W(n) = 2 * (\lfloor \log n \rfloor + 1)$

```
elif key > L[m]:
    l = m + 1

else:
    h = m - 1
```

```
BubbleSort ( L ) :
    for i in range ( n ) :
        for j in range ( n - i ) :
            if L[j] > L[j+1]:
                swap(L[j],
                     L[j+1])
```

$T(n) = n + n-1 + n-2$
$ \cdots + 1$

$T(n) = \dfrac{n(n+1)}{2} \sim n^2$

$\theta \quad \Omega \quad O \quad o \quad \omega$

$f(n) \in \theta(g(n)) \iff \{ \exists_{n_0}, c_1, c_2$

$\forall n > n_0 \quad c_1 g(n) \leq f(n) \leq c_2 g(n) \}$

$$f(n) \in \theta(g(n)) \iff \begin{cases} \exists n_0, c_1, c_2 \end{cases}$$

$$\forall n > n_0 \quad c_1 g(n) \leq f(n) \leq c_2 g(n)$$

$$f(n) = 5n^2 - 20 \in \theta(n^2)$$

$$c_1 n^2 \leq 5n^2 - 20 \leq c_2 n^2$$

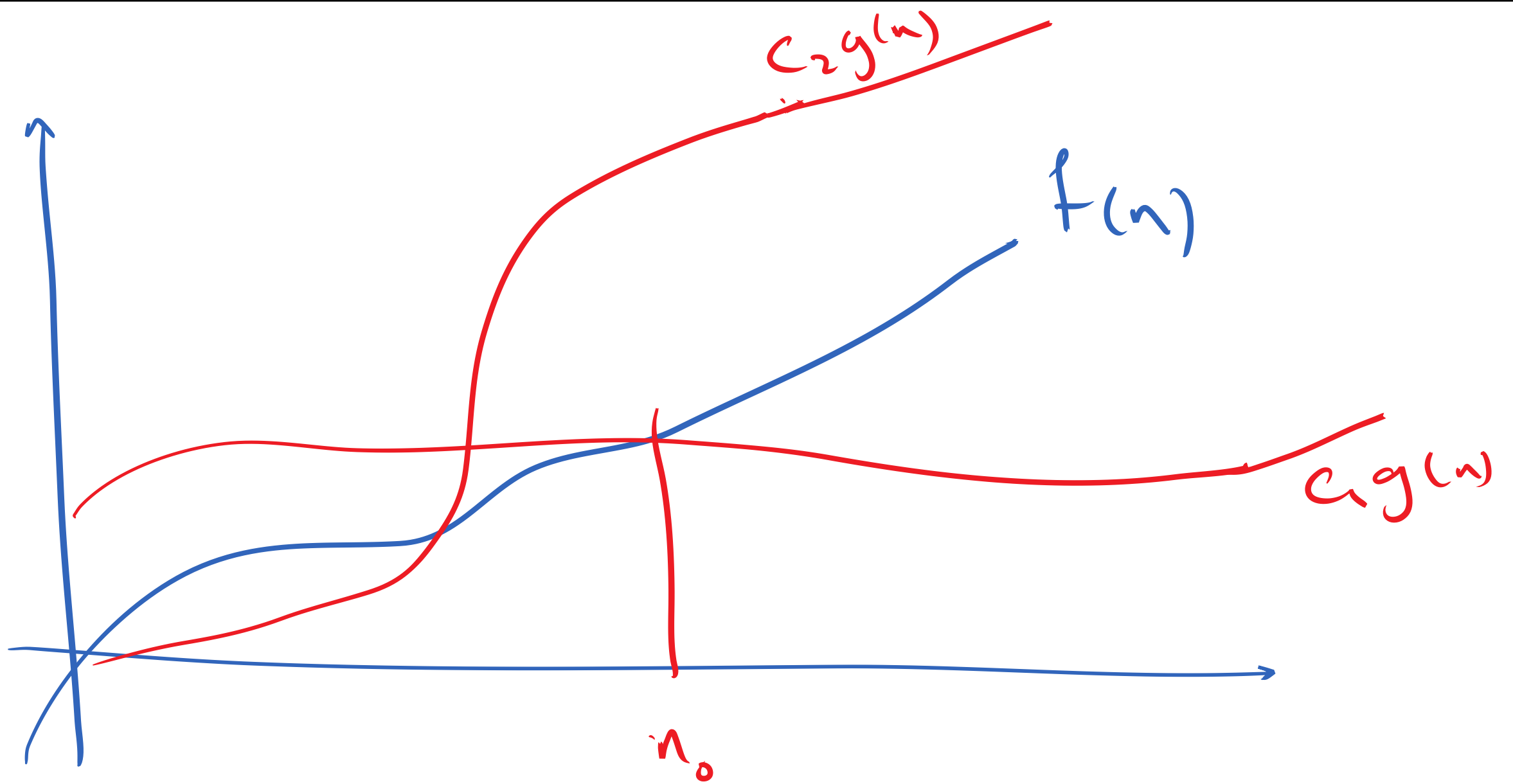$$c_1 n^2 \leq 5n^2 - 20$$

$$c_1 \leq 5 - \frac{20}{n^2}$$

$$5 - \frac{20}{n^2} \leq c_2$$

$$c_1 \leq 5 - \frac{20}{n^2}$$

$$n_0 = \sqrt{20}$$

$$c_1 = 4$$

$$c_2 = 5$$

$c_2 g(n)$

$f(n)$

$c_1 g(n)$

n_0

$$f(n) \in O(g(n)): \{ \exists n_0, c$$

$$\forall n > n_0 \ . \ f(n) \leq c g(n) \}$$

$$f(n) \in \Omega(g(n)): \{ \exists n_0, c$$

$$\forall n > n_0 \ . \ c g(n) \leq f(n) \}$$

$f(n)$

$(g(n))$

n_0

Ω