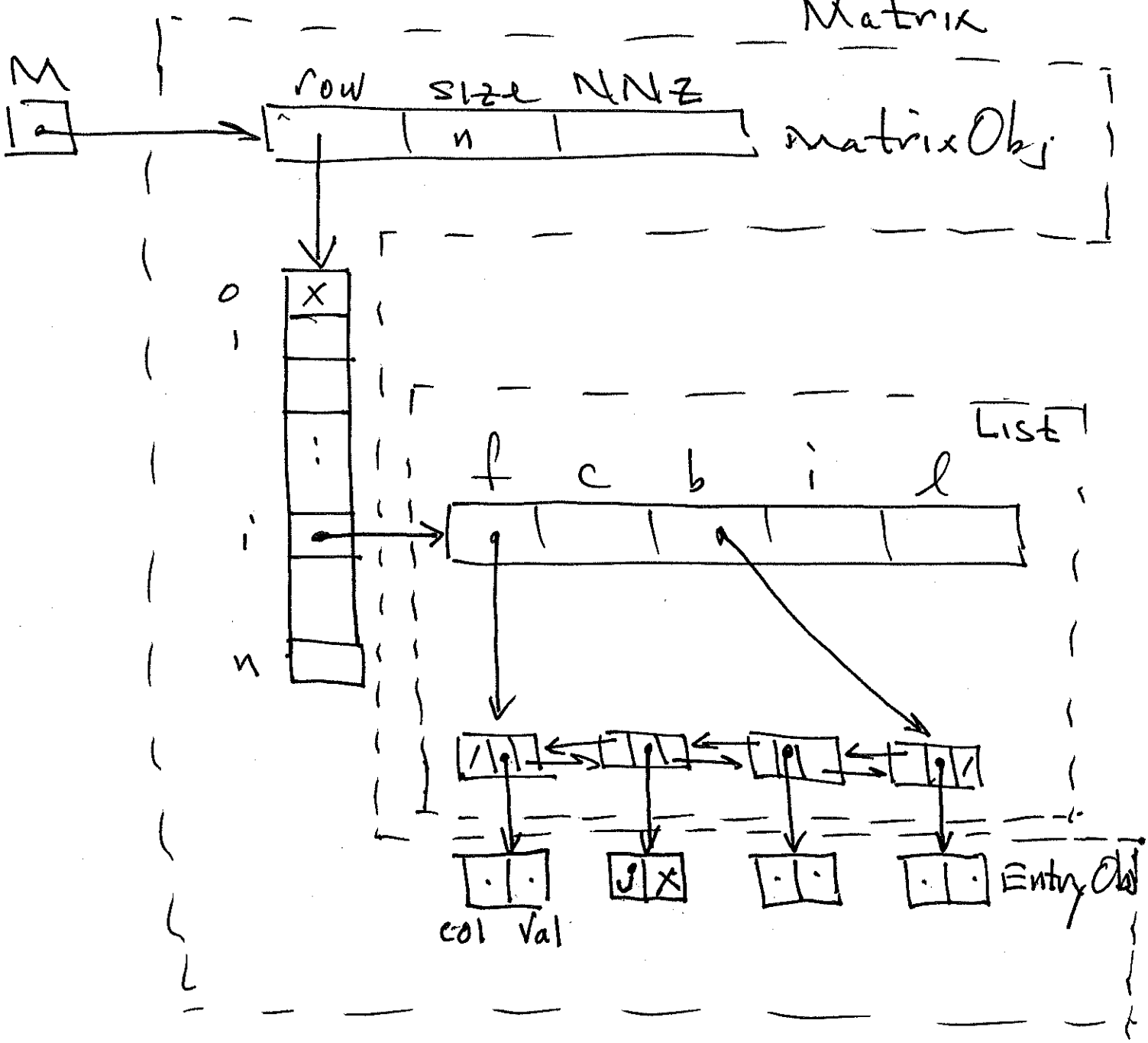
CSE 101 2-8-24

Pad Picture



Build order for Matrix OPS:

- constructor
- makeZero
- destructor
- printMatrix
- changeEntry ⟵ ***
- copy
- transpose
- scalar_Mult
- helper functions
  - dot prod. of 2 lists **
  - add / ~~sum~~ / ~~diff~~ / sub of 2 lists ***
- Product
- sum
- diff

ChangeEntry(i, j, x) **set $M_{ij} = x$**

Cases

1. $M_{ij} = 0$, $x = 0$: do nothing
2. $M_{ij} \neq 0$, $x = 0$: delete
3. $M_{ij} = 0$, $x \neq 0$: insert
4. $M_{ij} \neq 0$, $x \neq 0$: overwrite

dot (L_1 , L_2) helper_fcn.

L_1 : (10, ·) (30, ·) (50, x) ·· (90, ·) __

L_2 : (20, ·) (40, ·) (50, y) ··· (100, ·) (110, ·)

↓

sum = - - ·· + x · y +

return sum

add(L_1, L_2, S): helper fcn.

L_1: (10, x) (30, z) (50, a) ...

L_2: (20, y) (40, w) (50, b) ..

S: (10, x) (20, y) (30, z) (40, w) (50, a+b) ...

Handout on Asymptotic Runtime

Recall

Defn

$f(n) = o(g(n))$ iff $\lim_{n\to\infty}\left(\frac{f(n)}{g(n)}\right) = 0$

Ex. $\ln(n) = o(n)$ ✓

$$\lim_{n\to\infty}\left(\frac{\ln(n)}{n}\right) = \lim_{n\to\infty}\frac{1/n}{1} = 0$$

Generalize:

$\ln(n) = o(n^K)$ for any $K > 0$ ✓

$$\lim_{n\to\infty}\left(\frac{\ln(n)}{n^K}\right) = \lim_{n\to\infty}\left(\frac{1/n}{Kn^{K-1}}\right) = \lim_{n\to\infty}\left(\frac{1}{Kn^K}\right) = 0$$

further: $\log_b(n) = o(n^K)$ (exercise).

note: $\log_b(n) = \frac{\ln(n)}{\ln(b)}$

Ex $f(n) = n^k$, $g(n) = e^n$ $(k > 0)$

claim: $n^k = o(e^n)$

$$\lim_{n\to\infty}\left(\frac{n^k}{e^n}\right) = \lim_{n\to\infty}\left(\frac{k n^{k-1}}{e^n}\right)$$

$$= \lim_{n\to\infty}\left(\frac{k(k-1)n^{k-2}}{e^n}\right)$$

$$\vdots$$

$$= 0$$

note: # applications of l'Hop. $= \lceil k \rceil$

Generalize: $n^k = o(b^n)$ any $k > 0$, $b > 1$

Ex $f(n) = n^\alpha$, $g(n) = n^\beta$ where $\alpha > 0$, $\beta > 0$

$$n^\alpha = \begin{cases} o(n^\beta) & \alpha < \beta \\ \Theta(n^\beta) & \alpha = \beta \\ \omega(n^\beta) & \alpha > \beta \end{cases}$$

$$\frac{n^\alpha}{n^\beta} = n^{\alpha-\beta} \xrightarrow[n\to\infty]{\text{as}} \begin{cases} 0 & \alpha < \beta \\ 1 & \\ \infty & \alpha > \beta \end{cases}$$

Ex. $f(n) = a^n$, $g(n) = b^n$ where $a > 1$, $b > 1$

$$a^n = \begin{cases} o(b^n) & a < b \\ \Theta(b^n) & a = b \\ \omega(b^n) & a > b \end{cases}$$

$$\frac{a^n}{b^n} = \left(\frac{a}{b}\right)^n \xrightarrow{n\to\infty} \begin{cases} 0 & a < b \\ 1 & \\ \infty & a > b \end{cases}.$$

Defn

$f(n) = \omega(g(n))$ iff $\lim_{n \to \infty} \left(\frac{f(n)}{g(n)} \right) = \infty$