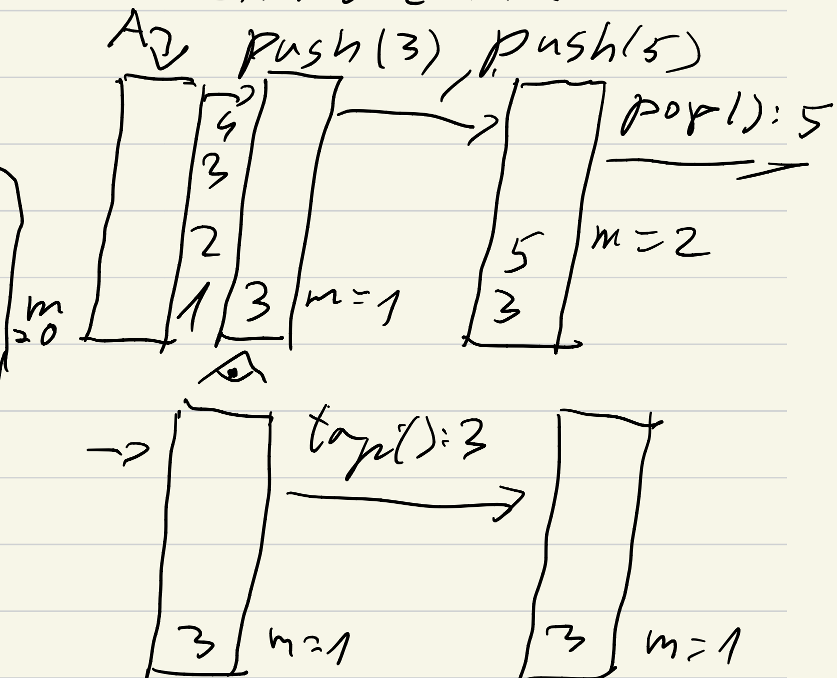
ELEMI ADATSZERKEZETEK & ADATTÍPUSOK

Stack
$-A/1 : \mathcal{T}[]$
$-n : \mathbb{N}$
$-$ constant $m_0 : \mathbb{N}_+ := 16$
$+$ Stack$(max : \mathbb{N}_+ := m_0)$ $\{A := \underline{new}\ \mathcal{T}[max];\ n := 0\}$
$+$ push$(x : \mathcal{T})$
$+$ pop$() : \mathcal{T}$
$+$ top$() : \mathcal{T}$
$+$ isEmpty$() : \mathbb{B}\{\underline{return}\ n = 0\}$
$+$ setEmpty$()\{n := 0\}$
$+ \sim$Stack$()\ \{\underline{delete}\ A\}$

UML leírás (Verem)

LIFO tároló



$\{S : Stack;\ \ldots\ \ldots\}$ | $AT_{push}(n) \in \Theta(1)$ | $\Theta(1)$ || kiv. push() $\{mT \in \Theta(1),\ MT(n) \in \Theta(n)\}$

read(&x:T):B

fordít()

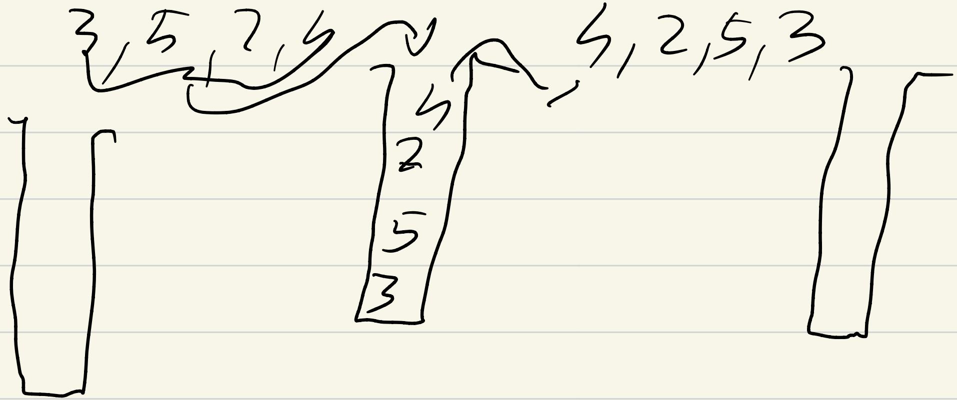
S:Stack

read(x)

S.push(x)

¬S.isEmpty()

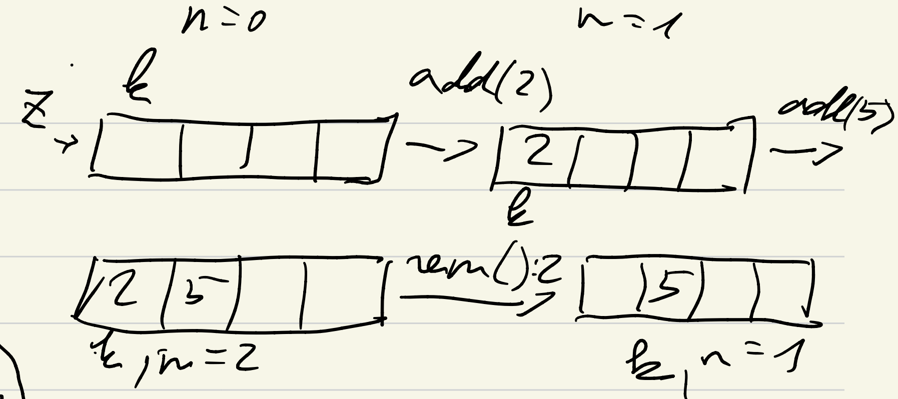
write(S.pop())

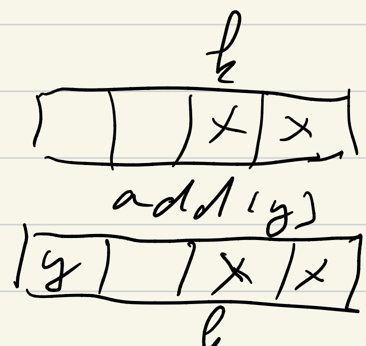


Queue

- constant $m_0 : \mathbb{N}_+ := 16$
- $Z : \mathcal{T}[\,]$
- $k, n : \mathbb{N}$

+ $Queue(m : \mathbb{N}_+ := m_0)$
  $\{Z := new\ \mathcal{T}[m];\ k := n := 0\}$
+ $add(x : \mathcal{T})$
+ $rem() : \mathcal{T}$
+ $first() : \mathcal{T}$
+ $length() : \mathbb{N}\{\underline{return}\ n\}$
+ $setEmpty()\{k := n := 0\}$
+ $\sim Queue()\{\underline{delete}\ Z\}$





$\Theta(1)$

Műveletigény: $\Theta(1)$, kiv. $add(x)$ $\begin{cases} MT(n) \in \Theta(n) \\ AT(n) \in \Theta(1) \\ mT(n) \in \Theta(1) \end{cases}$ AMORTIZÁLT műv. igény számítás

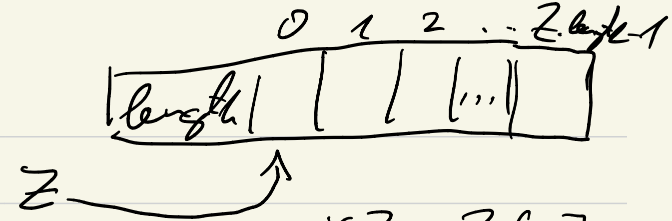
Queue::add(x : T)

n = Z.length

DoubleQueueArray(Z, k) | X

Z[(k+n) mod Z.length] := x

n++



$*Z = Z[0]$

$*(Z+1) = Z[1]$

$\vdots$

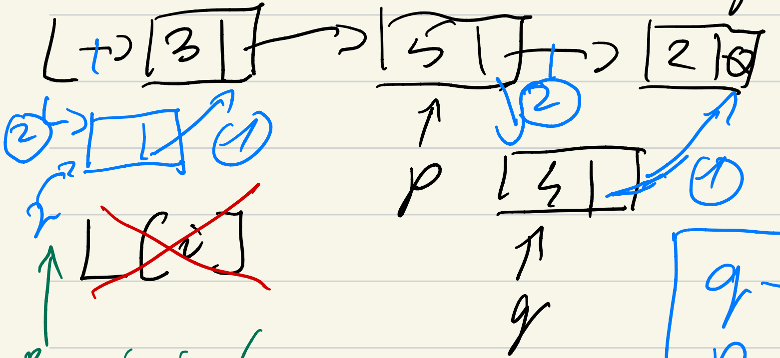
Queue::rem() : T

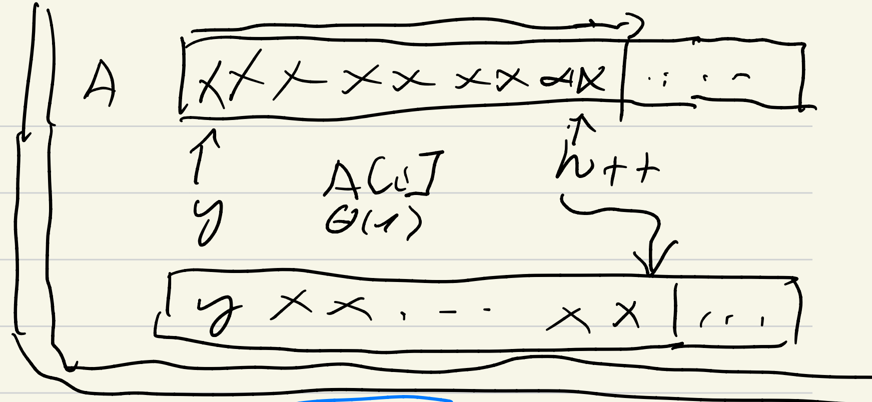
n > 0

i := k ; n-- k := (k+1) mod Z.length return Z[i]	throw EMPTY_Queue_ERROR

LÁNCOLT LISTÁK

⟨3,5,2⟩ reprezentációja





Beszúrás a lista elején

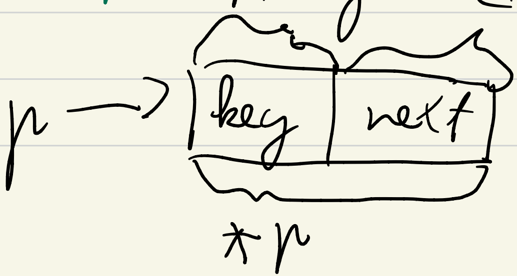
$$q \to next := p \to next$$
$$p \to next := q$$

Beszúrás(*p) után

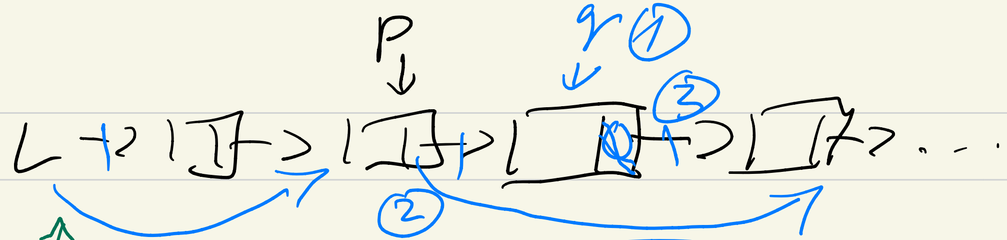
E1
+key : T
+next : E1* := ⊘

$\underbrace{p \to key}_{(*p).key}$

$\underbrace{p \to next}_{(*p).next}$



$p \to next \neq \emptyset$



"első" elem kifűzése

$q := p \to next$

$p \to next := q \to next$

$q \to next := \emptyset$

$(*p)$ utáni elem kifűzése

S1L-ek (üres: $L = \emptyset$)

Láncolt listák

egyirányú — kétirányú

egyszerű (S1L)

$L = \emptyset$

$L \to [5|\,] \to [2|\,] \to [3|\emptyset]$

fejelemes (H1L)

$H \to [\,|\emptyset]$

$H \to [\,|\,] \to [5|\,] \to [2|\,] \to [3|\emptyset]$

végelemes (1LT)

$[\,|\,]$ ← ℓ, t

$[5|\,] \to [2|\,] \to [3|\,] \to [\,|\,]$ ← ℓ (first), t (last)

ciklikus (C1L)

$L \to [\,|\,]$

$[5|\,] \to [2|\,] \to [3|\,] \to [\,|\,]$ ← H

SOK reprezentációjához

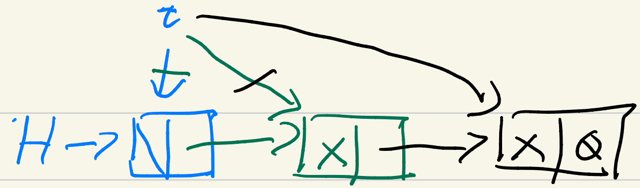
$p := \underline{\text{new}}\ E1$

$p \to [\,|\emptyset]$

$\emptyset = q \to \cancel{[\,|\,]}$ ← r

$\underline{\text{delete}}\ q; \ldots ; r \to next := s$???

```
read_H1L() : E1*
-----------------------------
t := H := new E1
read(x)
  t := t->next := new E1
  t->key := x
```



rett   rlen

$\langle 5 \mid 2, 7, 2' \rangle \to \langle 2, 5, 7 \mid 2' \rangle \to \langle 2, 2', 5, 7 \rangle$

Insertion_sort (IS)

IS_H1L(H : E1*)

$r := H \to next$

$r \neq \emptyset$

$s := r \to next$

$s \neq \emptyset$

$r \to key \leq s \to key$

$r := s$

$r \to next := s \to next$

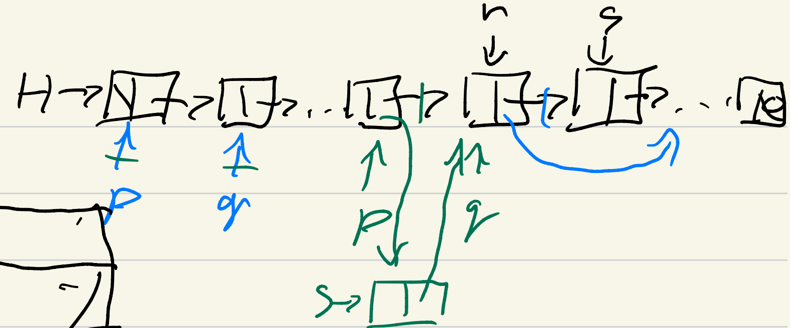
$q \to key \geq s \to key$

$p := q \,;\, q := q \to next$

$s \to next := q$

$p \to next := s$

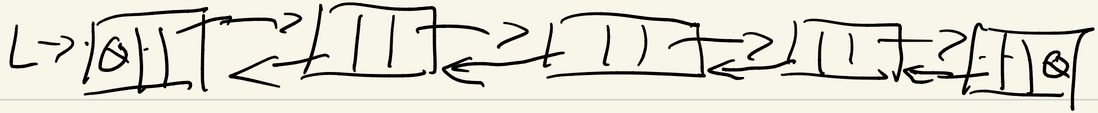
$s := r \to next$



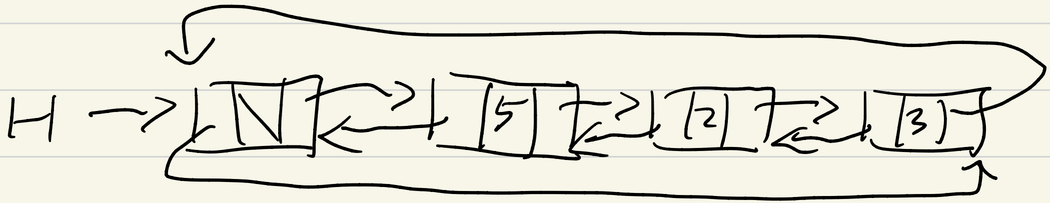
$mT(n) \in \Theta(n)$

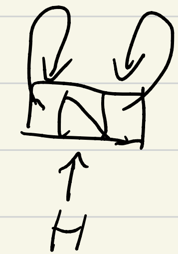
$\left.\begin{array}{l} MT(n) \\ AT(n) \end{array}\right\} \in \Theta(n^2)$

S2L



C2L





read_C2L() : E2*

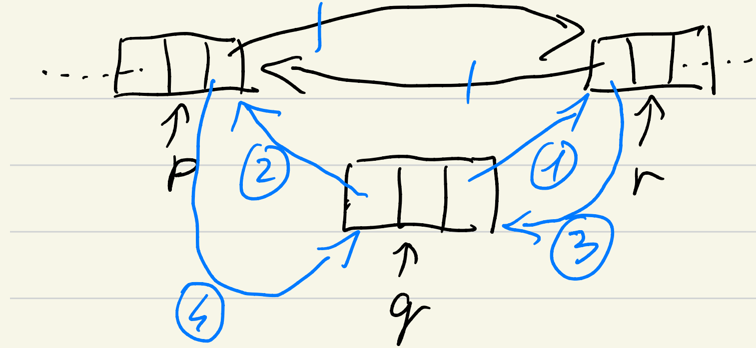
```
H := new E2
read(x)
    p := new E2
    p→key := x
    precede(p, H)
```

precede(q, r : E2*)

```
p := r→prev
insert(p, q, r)
```

E2

```
+ key : T
+ next, prev : E2*
---
+ E2() {
    next := prev := this
}
```

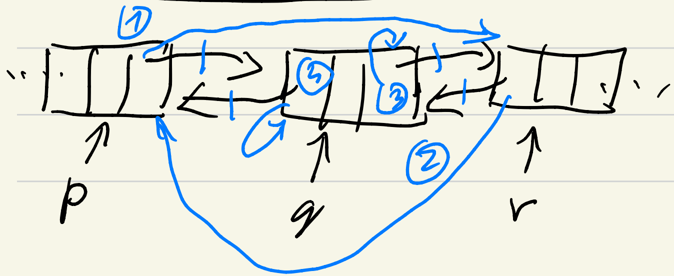


insert(p, q, r : E2*)

- q->next := r
- q->prev := p
- r->prev := q
- p->next := q

follow(p, q : E2*)

- r := p->next
- insert(p, q, r)

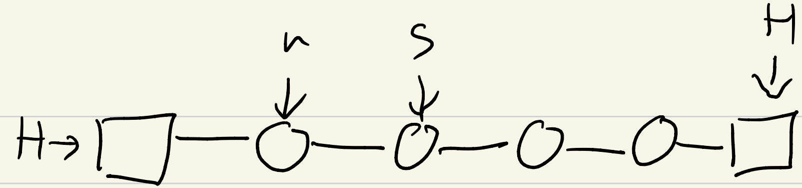


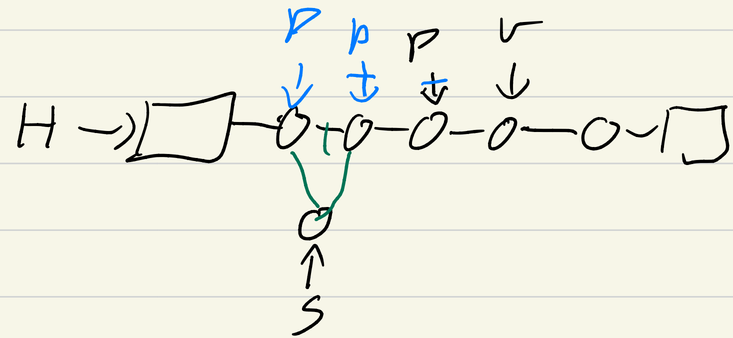
unlink(q : E2*)

- p := q->prev ; r := q->next
- p->next := r
- r->prev := p
- q->prev := q->next := q

IS_C2L(H : E2*)

```
r := H->next; s := r->next
s ≠ H
    r->key ≤ s->key
    | r := s
    \ unlink(s)
      p := r->prev
      p ≠ H ∧ p->key > s->key
          p := p->prev
      follow(p, s)
    s := r->next
```





$mT(n) \in \Theta(n)$

$$\left.\begin{array}{l} MT(n) \\ AT(n) \end{array}\right\} \in \Theta(n^2)$$

QUICKSORT(QS)

QuickSort(A:T[n])

QS(A, 0, n−1)

tengely (pivot)

$\langle 5, 2, 9, 7, 4, 8, 1, 3, 6 \rangle$ QS

$\langle 2, 1, 3, 4, 5, 9, 7, 8, 6 \rangle$

$\underbrace{\langle 2, 1, 3 \rangle}_{QS}\ 4\ \underbrace{\langle 5, 9, 7, 8, 6 \rangle}_{QS}$

PARTICIONÁLÁS

QS(A:T[]; p, r:N)

// A[p..r] rendezése

p < r	
q := partition(A, p, r)	SKIP
// $A[p..q-1] \le A[q] \le A[q+1..r]$	
QS(A, p, q−1)	
QS(A, q+1, r)	

$l := r - p + 1$

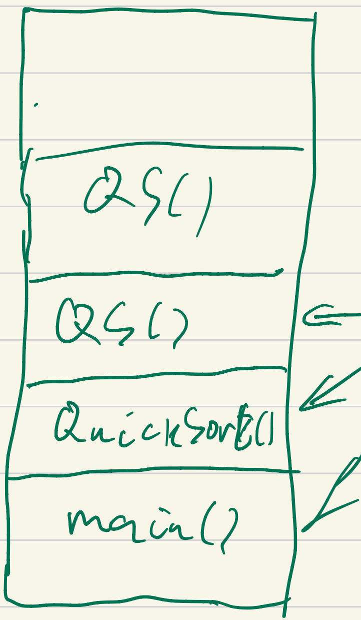
$MT_{Part}(l),\ mT_{Part}(l) \approx l$

$mT_{QS}(n) \le n \cdot \log n$

$MT_{QS}(n) \ge n + (n-1) + (n-2) + \ldots + 1$

$= \frac{n(n+1)}{2} = \frac{1}{2}n^2 + \frac{1}{2}n$

CALL STACK



← CALL FRAME

Biz. ható

$$\left.\begin{array}{l} mT_{QS}(n) \\ AT_{QS}(n) \end{array}\right\} \in \Theta(n \cdot \log n)$$

$$MT_{QS}(n) \in \Theta(n^2)$$

$$mS_{QS}(n) \in \Theta(\log n)$$

$$MS_{QS}(n) \in \Theta(n)$$

$$mS_{MS}(n) = MS_{MS}(n) \in \Theta(n)$$

$$mS_{IS}(n) = MS_{IS}(n) \in \Theta(1)$$ HELYBEN-RENDEZŐ

```
partition(A : T[]; p, r : N) : N
  i := random(p, r)
  swap(A[i], A[r])
  i := p
  while i < r ∧ A[i] ≤ A[r]
    i++
  if i < r
    j := i+1
    while j < r
      if A[j] < A[r]
        swap(A[i++], A[j])
      j++
  swap(A[i], A[r])
  return i
```

$\langle 2, 4, 8, 3, 4, 5, 1, 6, 9, 2 \rangle$

p $\qquad\qquad\qquad\qquad\qquad r$

$\langle 2, 4, 8, 3, 2, 5, 1, 6, 9, 4 \rangle$

$\cancel{i}\ \cancel{i}\ i\ j$

$p \leq i < j \qquad r$

$\leq t$	$\geq t$	?	t

$\langle 2, 4, 3, 8, 2, 5, 1, 6, 9, 4 \rangle$

$i\ j \qquad r$

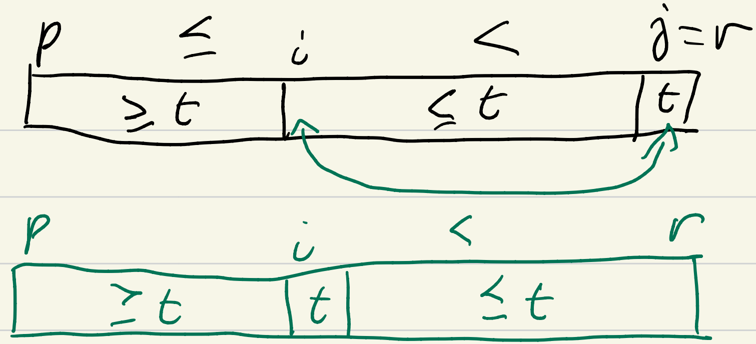
$\langle 2, 4, 3, 2, 8, 5, 1, 6, 9, 4 \rangle$

$i\ \cancel{j}\ j \qquad r$

$\langle 2, 4, 3, 2, 1, 5, 8, 6, 9, 4 \rangle$

$i \qquad \cancel{j}\ \cancel{j}\ j$

$\langle 2, 4, 3, 2, 1, 4, 8, 6, 9, 5 \rangle$


p
≤
i
<
j=r
≥ t
≤ t
t
p
i
<
r
≥ t
t
≤ t

ASZIMPTOTIKA

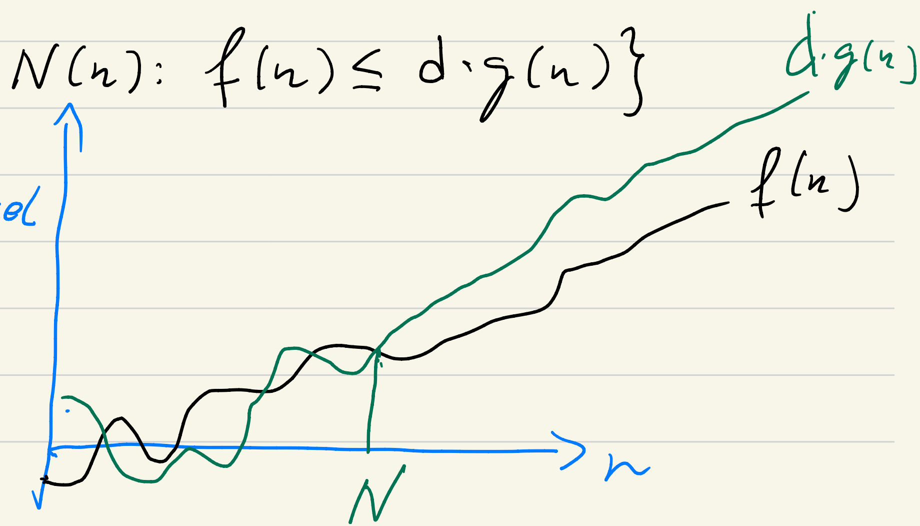
D $\mathcal{E}N(n): P(n) \overset{def}{\iff} \exists N \in \mathbb{N}_+ : \forall n \geq N : P(n)$

D $f : \mathbb{N} \to \mathbb{R}$ AP $\overset{def}{\iff} \mathcal{E}N(n) : f(n) > 0$

f, g, h : AP fv-ek ; $\varphi, \psi : \mathbb{N} \to \mathbb{R}$

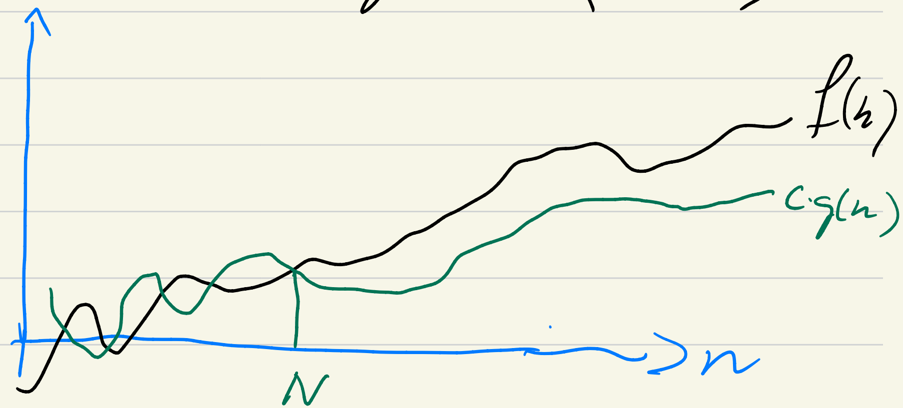
D $O(g) := \{ f \mid \exists d > 0 : \mathcal{E}N(n) : f(n) \leq d \cdot g(n) \}$

$f \in O(g)$: (f legfeljebb g-vel arányos; f aszimptotikus felső korlátja g)



D, $\Omega(g) = \{ f \mid \exists c>0 : EN(n) : c \cdot g(n) \leq f(n) \}$

$f \in \Omega(g)$: (f legalább g-vel arányos; f aszimptotikus alsó korlátja g)



T, $f \in \Omega(g) \Leftrightarrow g \in O(f)$

D, $\Theta(g) \overset{\text{def}}{=} O(g) \cap \Omega(g)$

T, $f \in \Theta(g) \Leftrightarrow g \in \Theta(f)$ (f és g aszimptotikusan ekvivalens)