$f: \mathbb{N} \to \mathbb{R}$

$f \in O(g) . \exists M > 0 . \exists N \in \mathbb{N} . \forall n > N . \; f(n) \leq M g(n)$

množenje $n^3 \rightsquigarrow n^{\log_2 7} \rightsquigarrow n$

$$\boxed{\lim_{x \to \infty} \frac{f(x)}{g(x)} = 0 \Rightarrow f \in O(g)}$$

$\forall \varepsilon > 0 . \exists N > 0 . \; x > N . \Rightarrow \left| \frac{f(x)}{g(x)} \right| < \varepsilon$

$\Rightarrow |f(x)| < \varepsilon |g(x)|$

potem je

$\exists \underset{\overset{\shortparallel}{1}}{\varepsilon} > 0 . \exists N > 0 . \forall n > N . \; f(n) \leq \varepsilon g(n) \Rightarrow f \in O(g)$

$O(1) \subset O(\ln(\ln(n)))$

$O(\log_2(n)) = O(\log_{10}(n))$

$\log_2(n) = \frac{\log_{10} n}{\log_{10} 2} \in O(\log_{10}(n))$

$\log_{10}(n) = \frac{\log_2 n}{\log_2 10} \in O(\log_2(n))$

kolena

- že celo pdjelje (predvsem po kolesarjenju)
- zdaj že po kolesu jemlje na fakst
- sestrična ima obrabljen hrustanec

$$O(1) \subset O(\log(\log n)) \subset O(\log_2(n)) = O(\log_{10}(n))$$

$$\subset O(\sqrt{n}) \subseteq O(\log(n!)) \subseteq O(n\log n) \subseteq O(3^{\ln n})$$

$$\boxed{O(\log_a(n)) \subset O(n^{\varepsilon})}$$

$$\subseteq O(n^2) \subseteq O(2^n)$$

$$\subseteq (2^{2\log n})$$

$$\log(n!) \leq \log(n^n) = n\log n$$

$$O(\log(\log(n))) \subseteq O(\log n)$$

$\log(n) < n$ in log inj naraščajoča

$$\log(\log(n)) \leq \log(n)$$

$$\log(n) \in O(\sqrt{n})$$

$$\lim_{n \to \infty} \frac{\log n}{\sqrt{n}} \overset{LH}{=} \frac{\frac{1}{n}}{\frac{1}{2\sqrt{n}}} = \ln 2 \frac{1}{2\sqrt{n^3}} = 0 \implies \log(n) \in O(\sqrt{n})$$

$$3^{\ln(n)} = 3^{\frac{\log_3(n)}{\log_3 e}} = = n^{\frac{1}{\log_3 e}} = n^{\varepsilon > 1}$$

$$\sqrt{n} < n < n\log n$$

$$O(n \log n) = O(\log n!)$$

$$\log n! = \sum_{i=1}^{n} \log i$$

$$\log n! > \log \left(\frac{n}{2}\right)^{\frac{n}{2}} = \frac{n}{2}(\log n - \log 2) \cong n\,($$

$$n \log n < n^2$$

$$n \log n \leq n \cdot n \leq n^2$$

$$O(n^2) \subseteq O(2^n) \subseteq O(2^{n \log n} \subsetneq O(n!)$$

$$2^{\log n^n} = 2^{\frac{\log_2 n^n}{\log_2 10}} = n^{\log_2 10}\, n$$

seznam: n

append: $O(1)^*$

delite(i) $O(n)$ $(n-i)$

copy : $O(n)$

uppdate(i) : $O(1)$

get(i) : $O(1)$

find(a) : $O(n)$

add : $O(n)$

le nes
tipična zenim

add(i)	$O(n)$
add(0,n)	$O(n)$ $O(1)$
delete(i)	$O(n)$
delet(0,1)	$O(n)$, $O(1)$
get(i)	$O(1)$
search(x)	$O(n)$

le nes
tipična zenim

	čas	prostor
add(i)	$O(n)$	$O(1)$
add(0,n)	$O(n)$ $O(1)$	$O(1)$
delete(i)	$O(n)$	$O(1)$
delet(0,1)	$O(n)$, $O(1)$	$O(1)$
get(i)	$O(1)$	$O(1)$
search(x)	$O(n)$	$O(1)$

Slovar

$O(1)$ vse

algoritem za iskanje maximuma

```
m= seznam[0]
for c in seznam[1:]
    if c>m => m=c
return m
```

$O(n), O(1)$

---

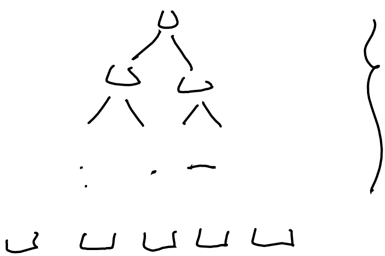
seznam n

seznam.sort $\quad O(n \log n) \quad O(1)$

seznam[-1]

$$\sum_{i \in \mathbb{N}}^{n} i = O(n^2)$$

Rekurzivno: seznam na dva dela



log n globina

čas je lahko $O(\log n)$ z prostorom n (procesorjev)

lahko pa je tudi $O(\frac{n}{\log n})$ prostora in je

še vedno hitreje

Bitne operacije

- bitand &
- bitor |
- bitxor ^
- bitnot !, ~
- bitshiftleft <<
- bitshift right >>

v jezikih
&&
||
!=
not

z: 1 1 1
g: 1 0 0 1

$$\begin{array}{r} 111 \\ 1001 \\ \hline 1 \end{array} \;\&$$

$$\begin{array}{r} 0111 \\ 1001 \\ \hline 1111 \end{array} \;|$$

$$\wedge \begin{array}{r} 111 \\ 1001 \\ \hline 1110 \end{array}$$

$$! \begin{array}{r} 111 \\ \hline 0 \end{array} \qquad ! \begin{array}{r} 1001 \\ \hline 110 \end{array}$$

$$<< \begin{array}{r} 111 \\ \hline 1110 \end{array} \qquad << \begin{array}{r} 1001 \\ \hline 10010 \end{array} \qquad g >> 2 \begin{array}{r} 1001 \\ \hline 10 \end{array}$$

$a \oplus b \oplus b = a$

a\b	0	1
0	$0 \oplus 0 = 0$	$1 \oplus 1 = 0$
1	$1 \oplus 0 = 1$	$0 \oplus 1 = 1$

a...bit

$$
\begin{array}{rl}
 & a_n \ldots\ldots a_2 a_1 a_0 \\
\& & [0 \ldots 0 1 0 \ldots 0 . 0 . 0] \leftarrow \text{maske} \\
\hline
 & 0 \ldots\ldots a_i \ldots\ldots 0
\end{array}
$$

if $(\underbrace{a \& \text{mask}}_{>0 \text{ zero True}})$

$\text{maske} = 1 \ll i$

$$
\begin{array}{rl}
1.) & [0 \ldots\ldots 0] \\
\hline
\sim & [1 \ldots\ldots 1] \\
\hline
>> n-i & [0 \ldots\ldots 1 \ldots 1]
\end{array}
$$

$\sim((\sim 0) << i)$

$(1 \sim i) - 1$

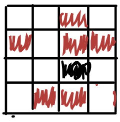
funkcija sprejme a, i

$a_n \dots a_1 0 \to a_n \dots 1 \dots a_1 a_0$

```
def f(a,i):
    mask := 1<<i
    return a | mask

def f'(a,i)
    mask := ~(1<<i)
    return a & mask
```

10 mesta



n: 0010 : 1011 : 0 00 0 : 0110 : 1010

levo: n-1
desno: n+1
gor: n-4
dol: n+4

```
def levopogoj(a)
    maskp = (1 << 4)-1
    p = a & maskp
    mask = ~(1 << 20 - p_10 + 1)
    return (a & mask) - 1
```

```
a = a & mask
a = (a>>4)<<4
return a | p
```

```
def fib(n):
   prv = 1
   drv = 1
   for i in range(n)
        drv = drv'
        drv += prv
        prv = drv'
   return drv
```

$O(drv) = 1{,}6^{i} = 1{,}6^{n}$

← velikost

št bitov za drv $= \log_2 1{,}6^{i}$

$= O(i)$

assign $= O(n)$

$$\sum v_1 + v_2 + v_3 = \sum_{i=1}^{n} 3O(i) = O(n^2)$$

TRIE – prefix tree