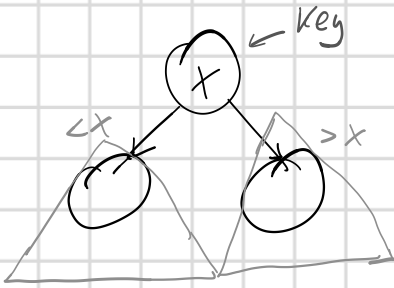


# Дерево поиска

## Двоичное дерево поиска



Node { val

- L = \*Node

ссылка

R = \*Node

par = \*Node

y

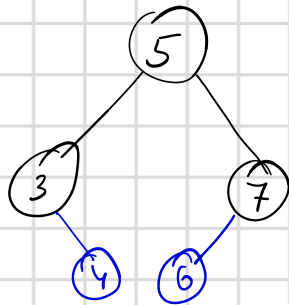
add

remove

find  $O(h)$ , h - высота

Пр.:

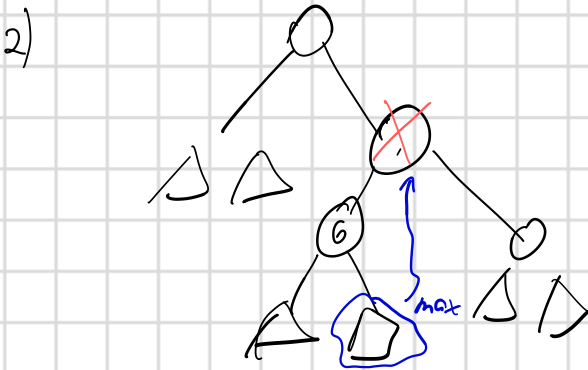
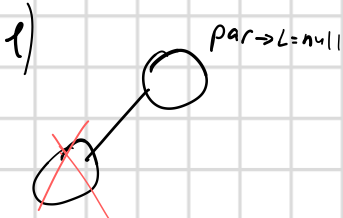
add:



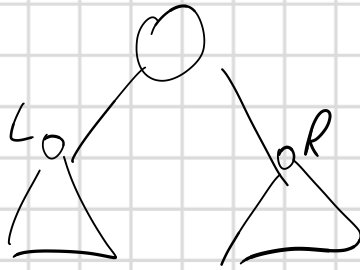
add(6)

add(4)

remove



# AVL



$h(v)$  - height of node  $v$  or number of edges

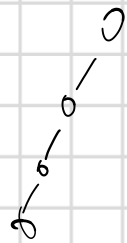
$h(v) = \text{dist to leaf node}$

$$|h(L) - h(R)| \leq 1$$



$$h(\text{leaf}) = 1$$

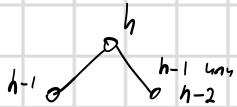
$$h = 4$$



▷  $n \approx h \log n$

$\Rightarrow f(h) = \min \# \text{ nodes in a tree of height } h$

$$h(v) = \max(h(L), h(R)) + 1$$



$$\text{size}(v) = \text{size}(L) + \text{size}(R) + 1$$

$$f(h) = f(h-1) + f(h-2) + 1 \geq \varphi^h \approx \left(\frac{1+\sqrt{5}}{2}\right)^h$$

$$h \approx \log n \Rightarrow h \approx \log n$$

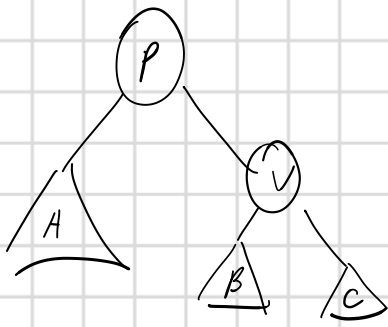
$$n \leq h(v) \leq \varphi^h$$

$$h(v) \geq n$$

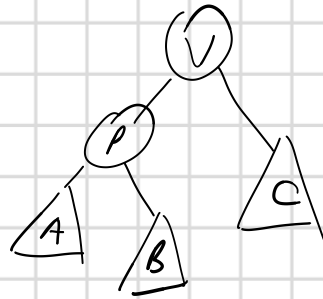
$$? n \rightarrow \max h, \quad h \geq f(h) \geq \varphi^h$$

$$h \leq \log_{\varphi} n \quad O(\log n)$$





Поворот направо ( $r \rightarrow v$ )



$rotateR(p, v)$

$B = v \rightarrow L$

$parent = p \rightarrow parent$

$p \rightarrow R = B$

$B \rightarrow par = p$

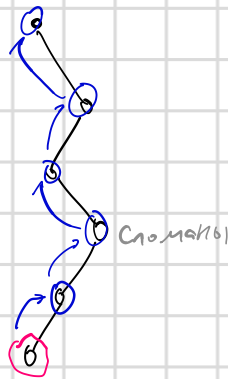
$v \rightarrow par = parent$

if ( $parent.L = p$ ):  $parent \rightarrow L = v$

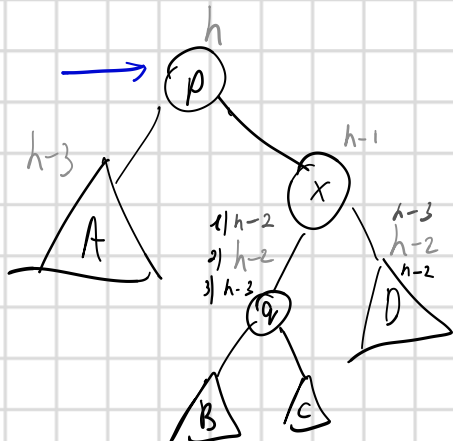
else:  $parent \rightarrow R = v$

$v \rightarrow L = p$

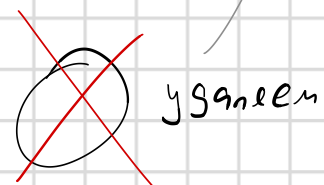
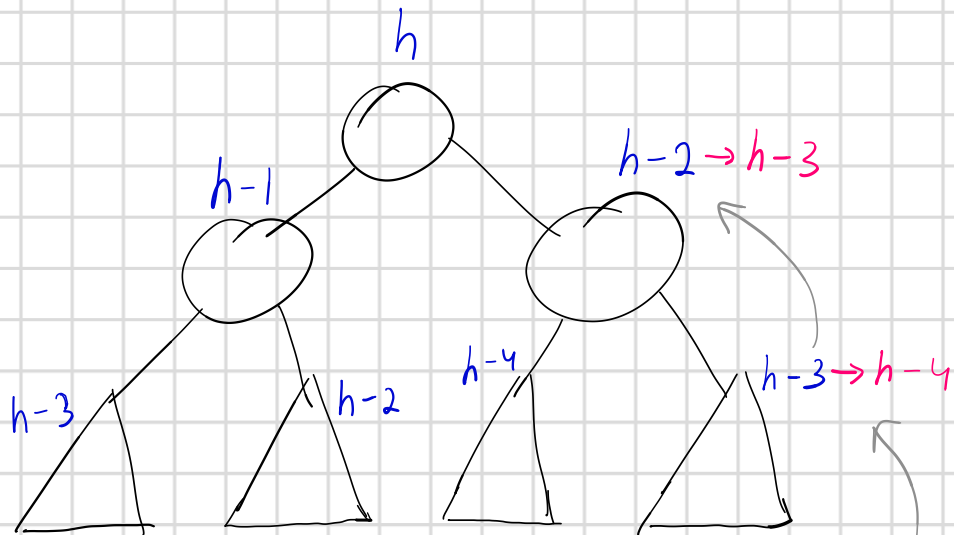
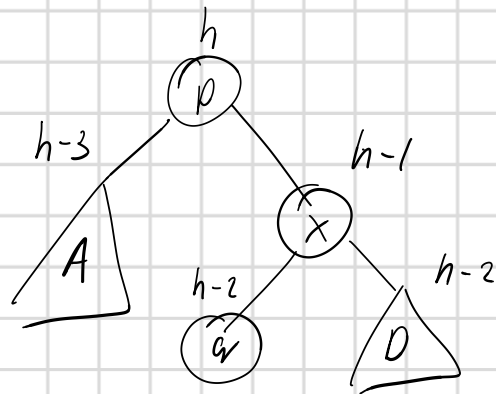
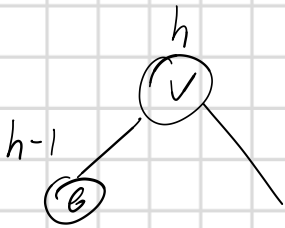
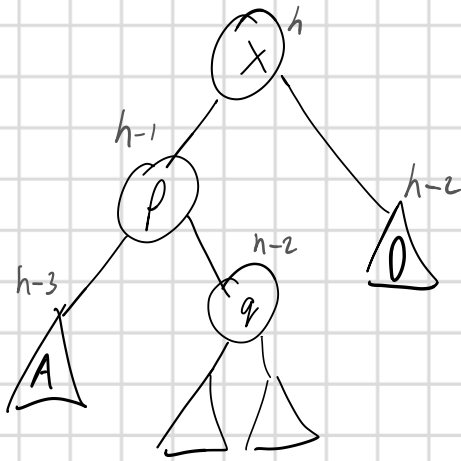
$p \rightarrow par = v$

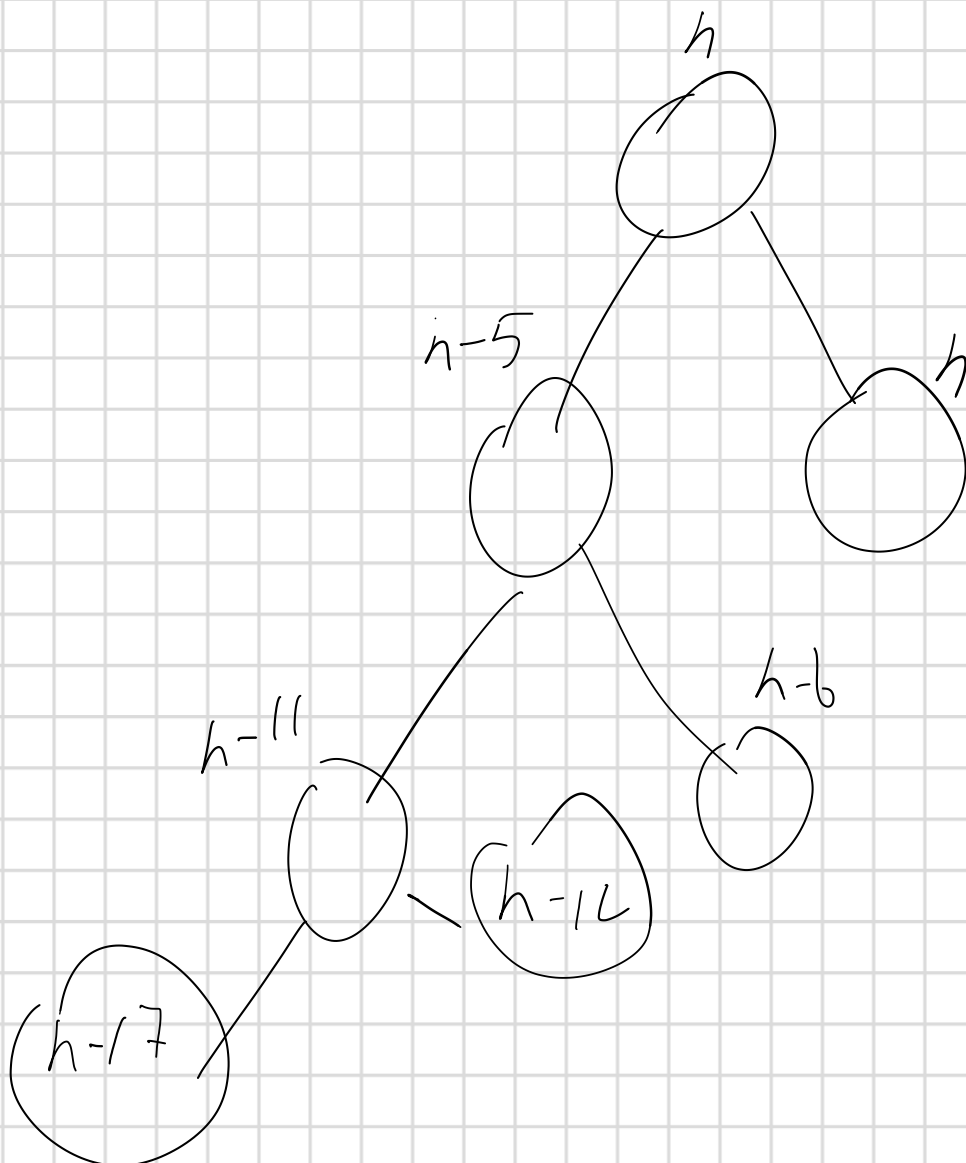
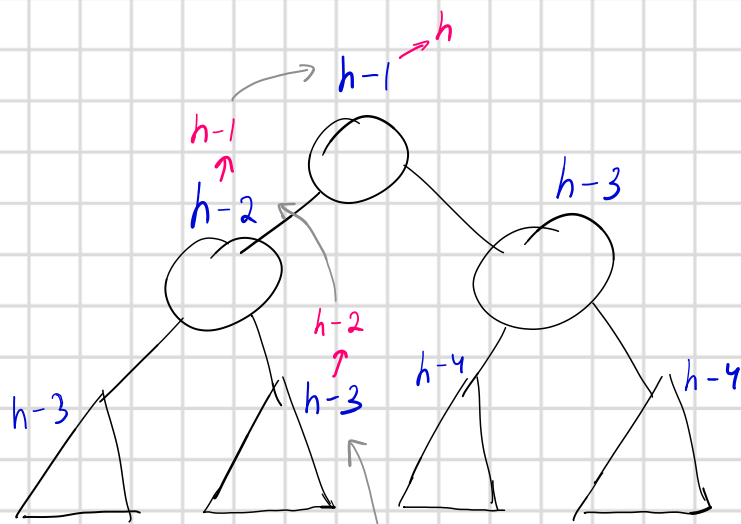


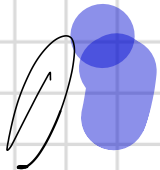
Пр.:



2)







6-1

