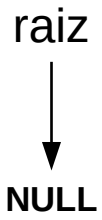
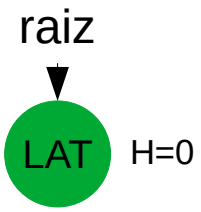
Questão 10 – AVL

cria árvore em que
raiz → NULL

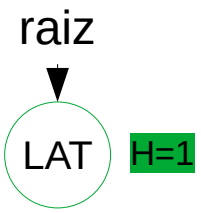


Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



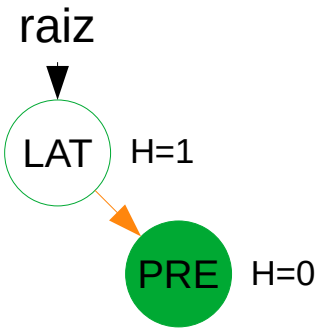
como raiz → NULL insere normalmente como árvore binária

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



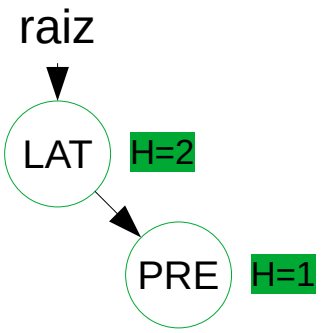
atualiza a altura
não é necessário nenhum balanceamento

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



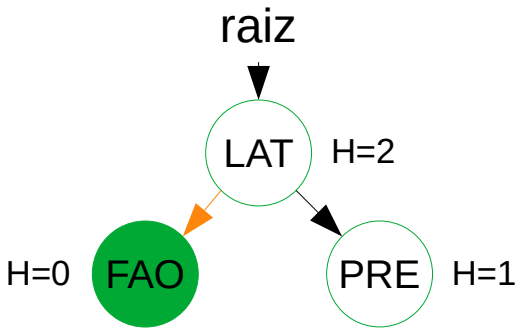
PRE > LAT, então é inserido na direita

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



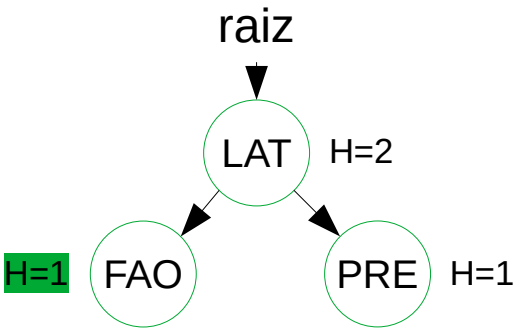
atualiza a altura
não é necessário nenhum balanceamento

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



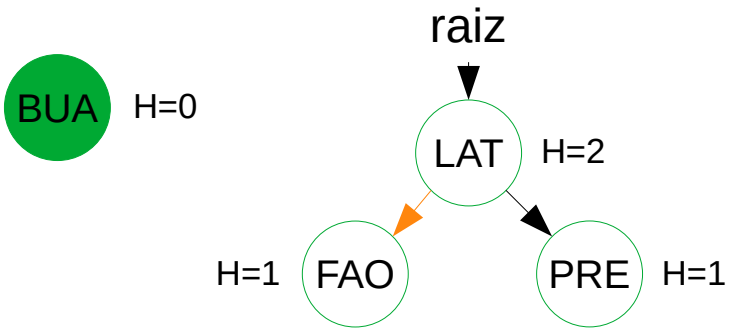
FAO < LAT, então é inserido na esquerda

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



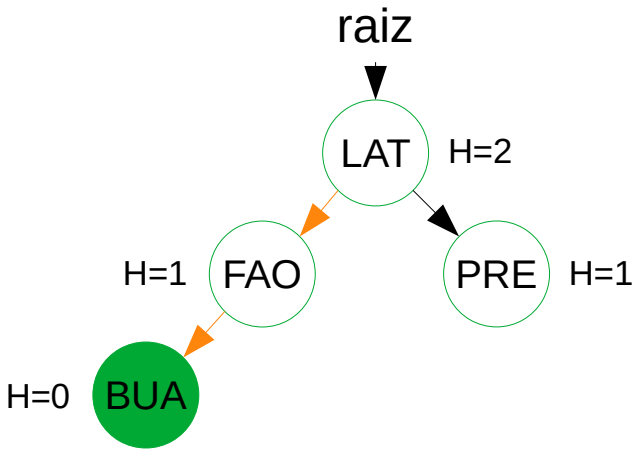
atualiza a altura
não é necessário nenhum balanceamento

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



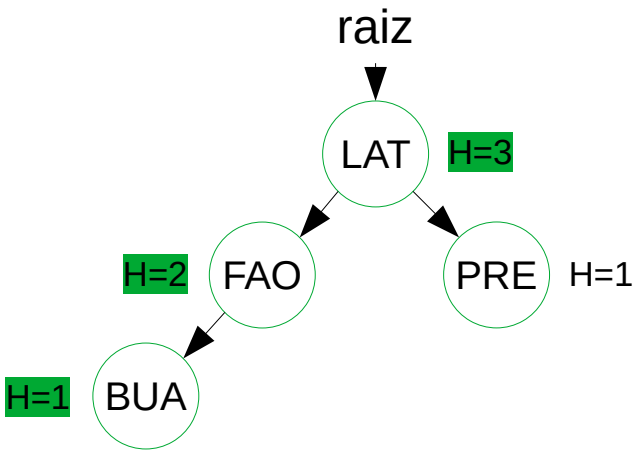
BUA < LAT, então vai pelo caminho esquerdo

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



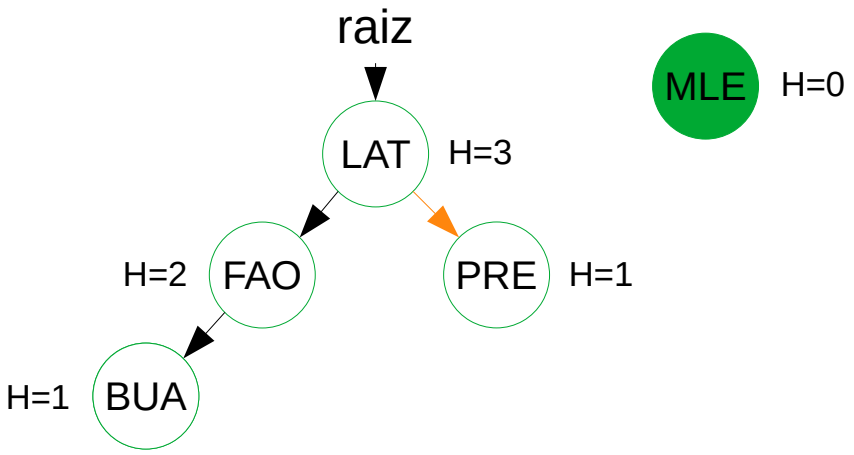
BUA < FUA, então é inserido no filho a esquerda

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



atualiza a altura
não é necessário nenhum balanceamento

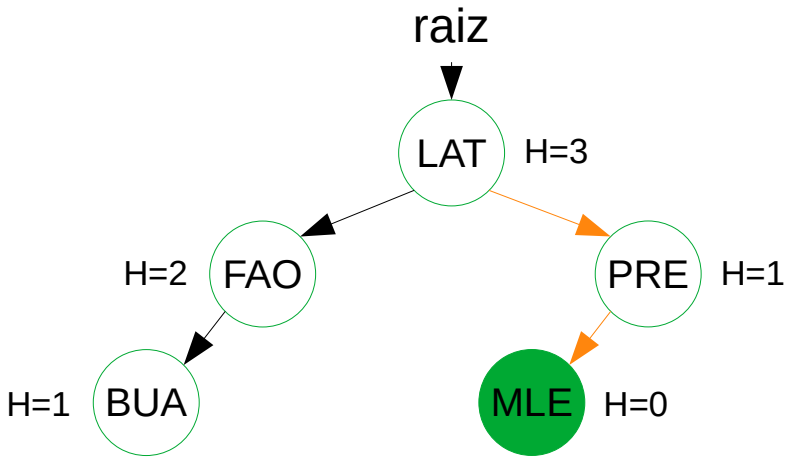
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



MLE H=0

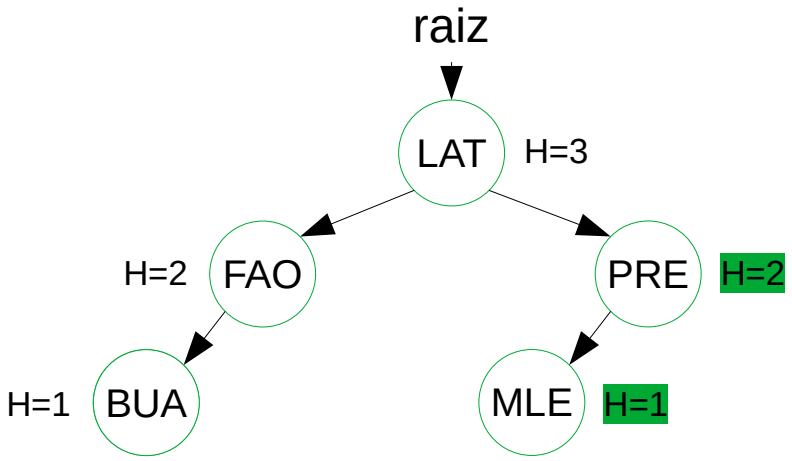
MLE > LAT, então vai pelo caminho direito

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



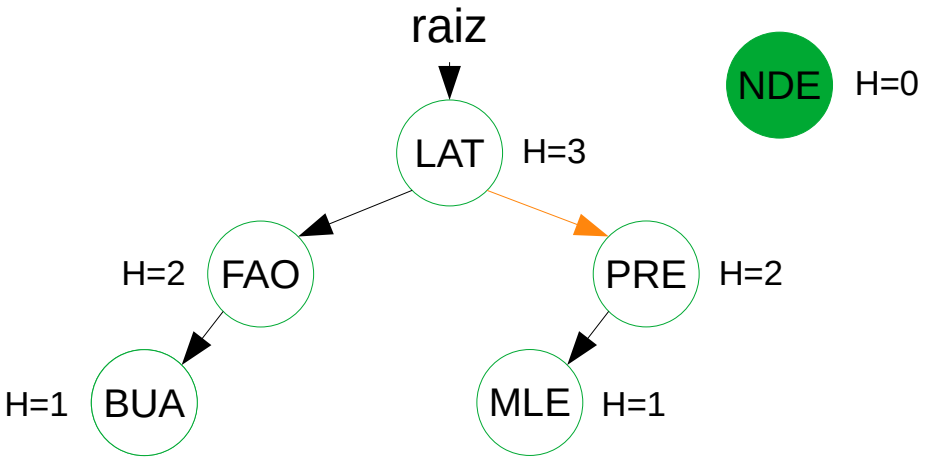
MLE < PRE, então é inserido no filho a esquerda

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



atualiza a altura
não é necessário nenhum balanceamento

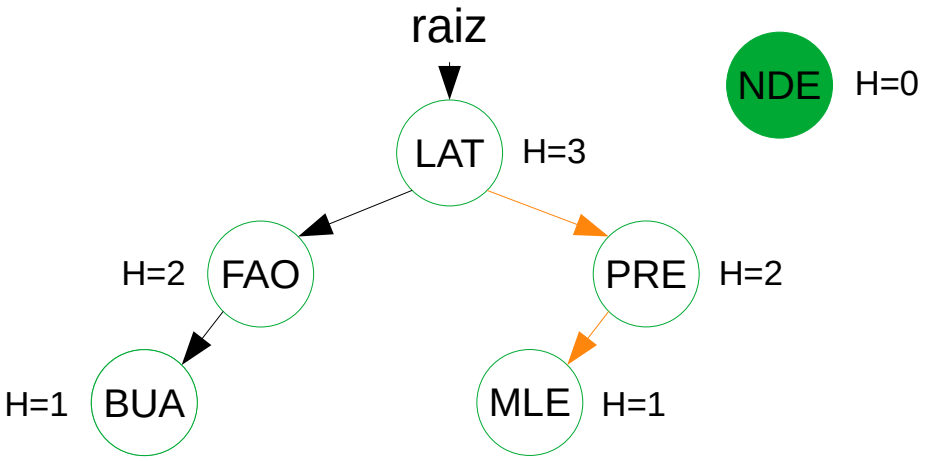
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



NDE H=0

NDE > LAT, então vai pelo caminho direito

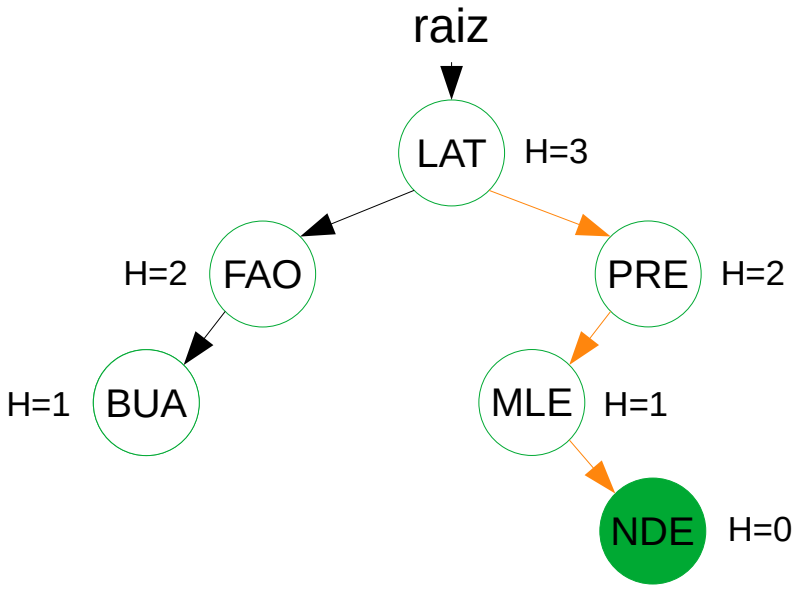
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



NDE H=0

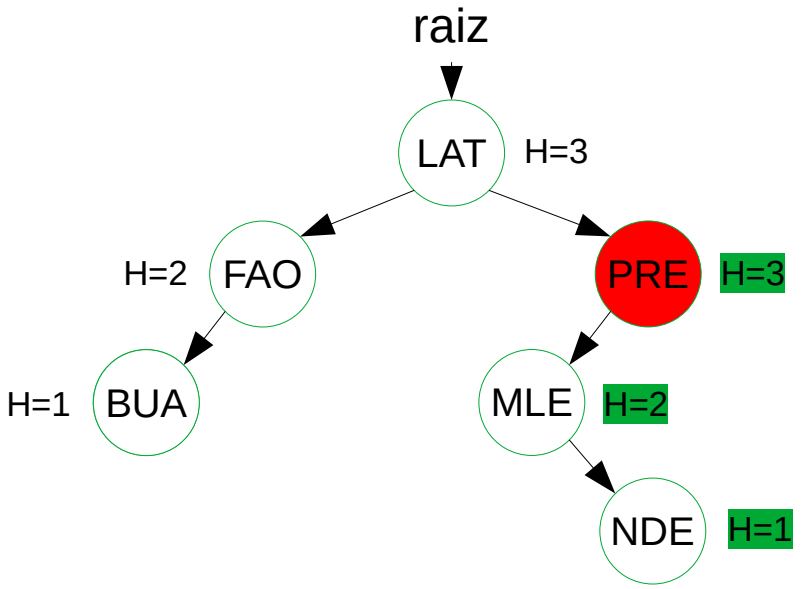
NDE < PRE, então vai pelo caminho esquerdo

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



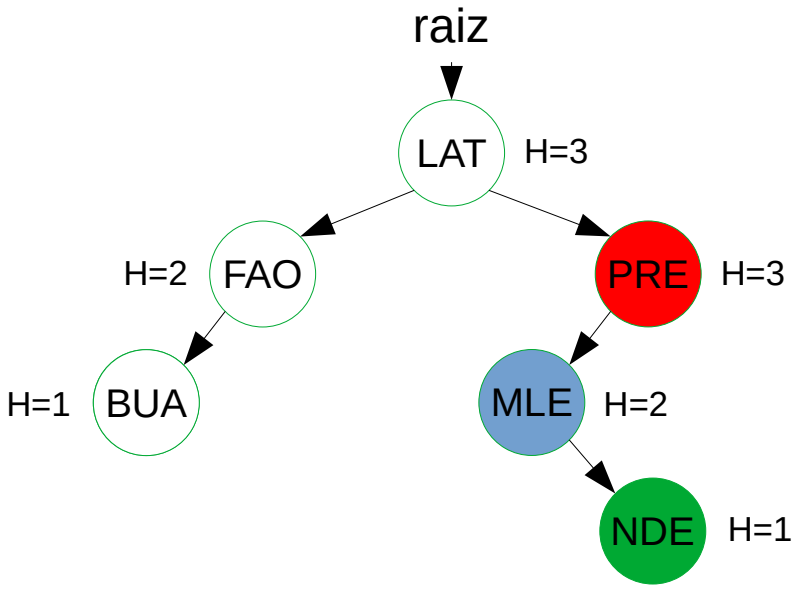
NDE > MLE, então é inserido no filho a direita

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



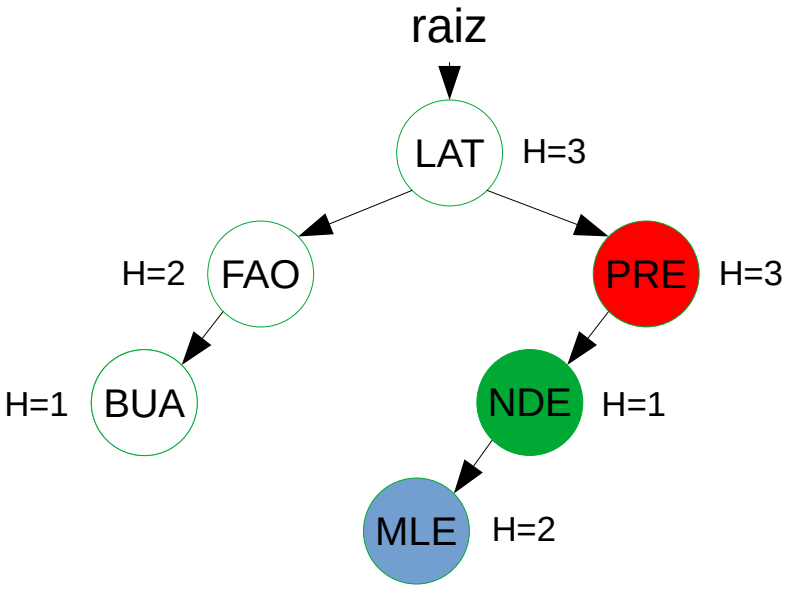
atualiza a altura
árvore desbalanceada
em PRE

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA

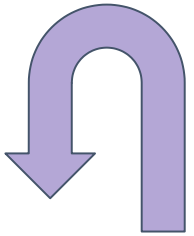


O FB em PRE é +2 e MLE é -1, devemos fazer uma rotação dupla: uma esquerda e uma direita

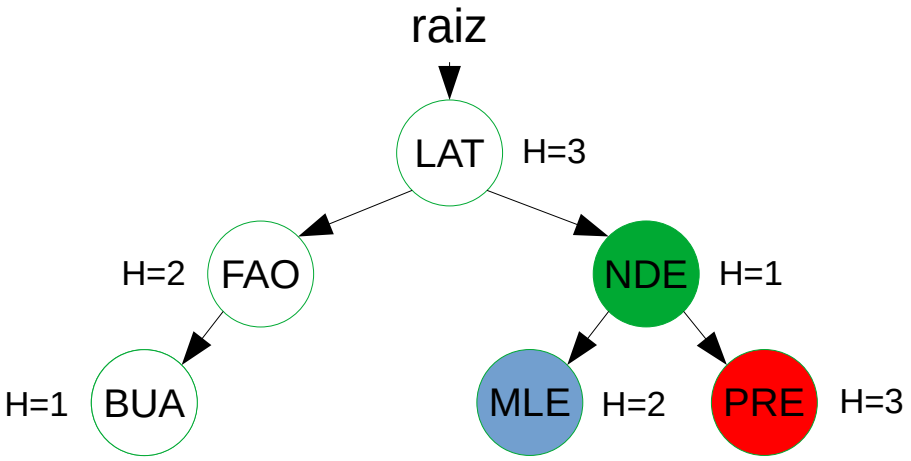
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



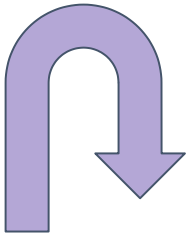
rotação esquerda em MLE



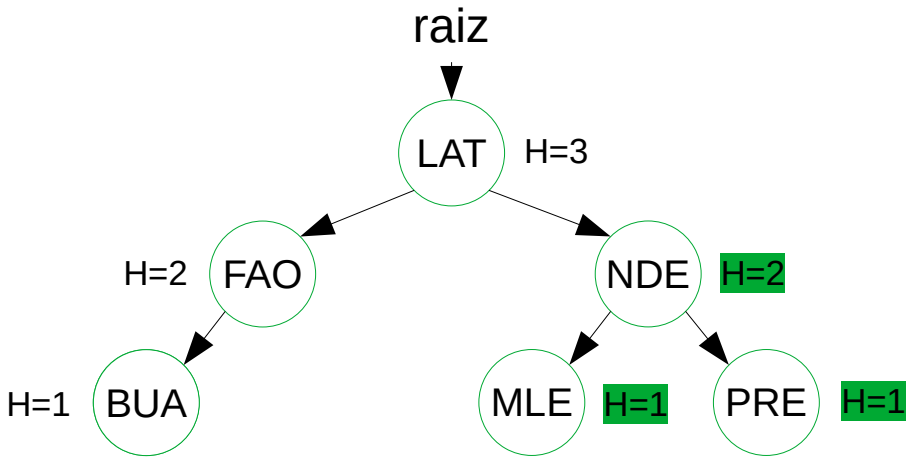
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



rotação direita em NDE

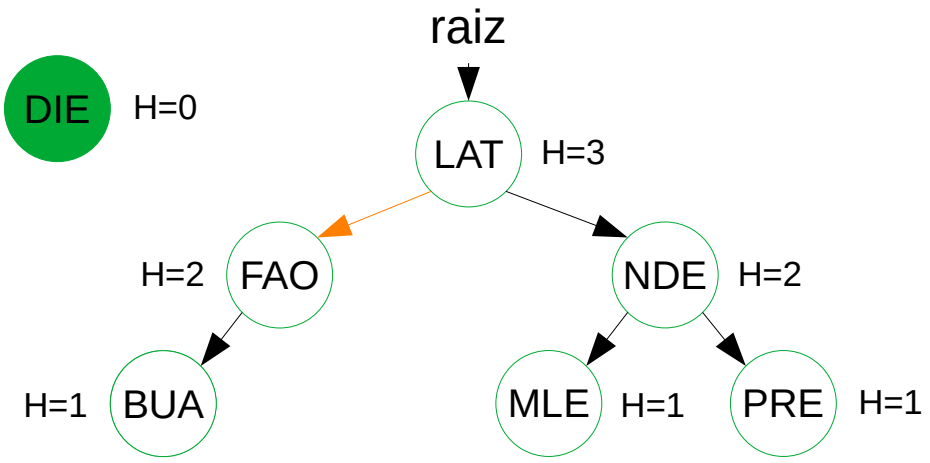


Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



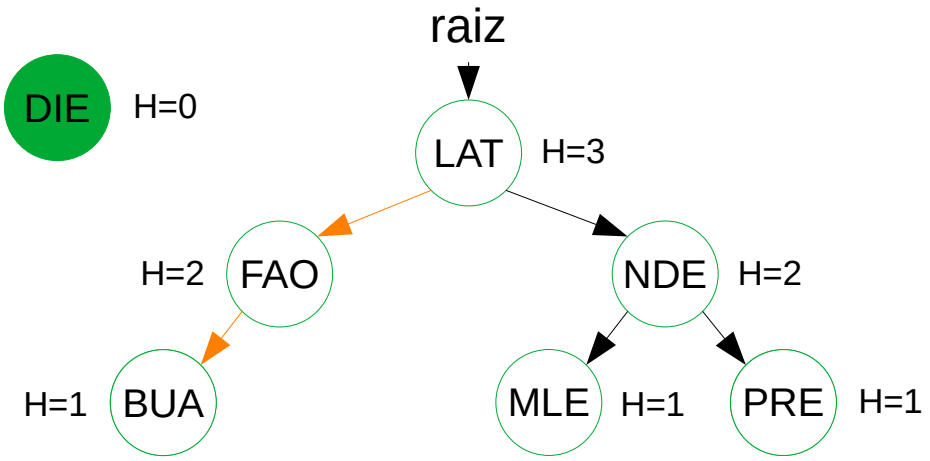
atualiza a altura

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



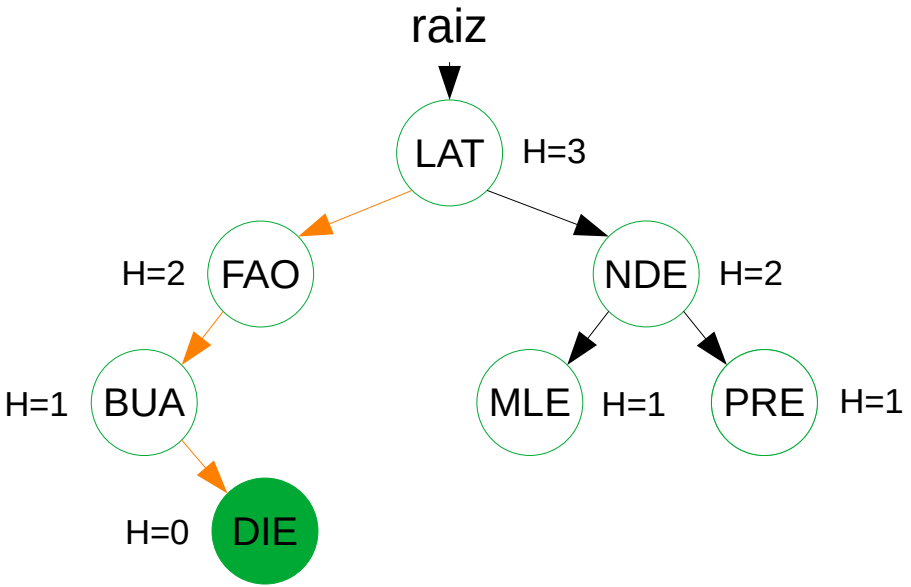
DIE < LAT, então vai pelo caminho esquerdo

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



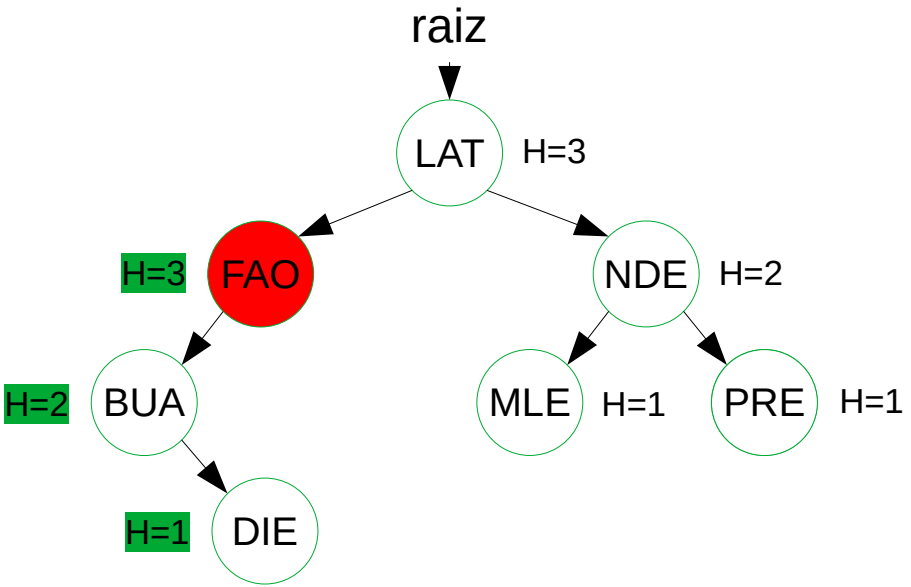
DIE < FAO, então vai pelo caminho esquerdo

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



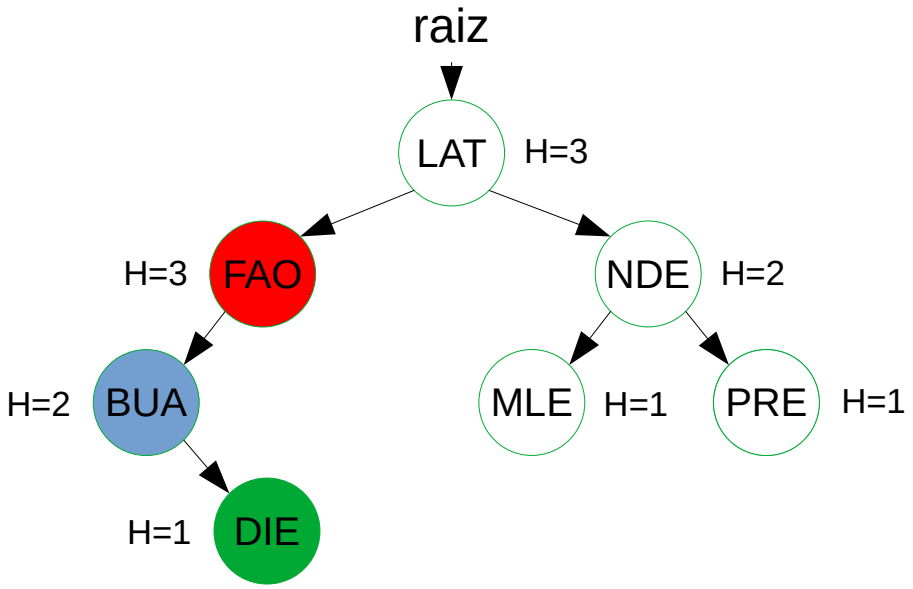
DIE > BUA, então é inserido no filho a direita

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



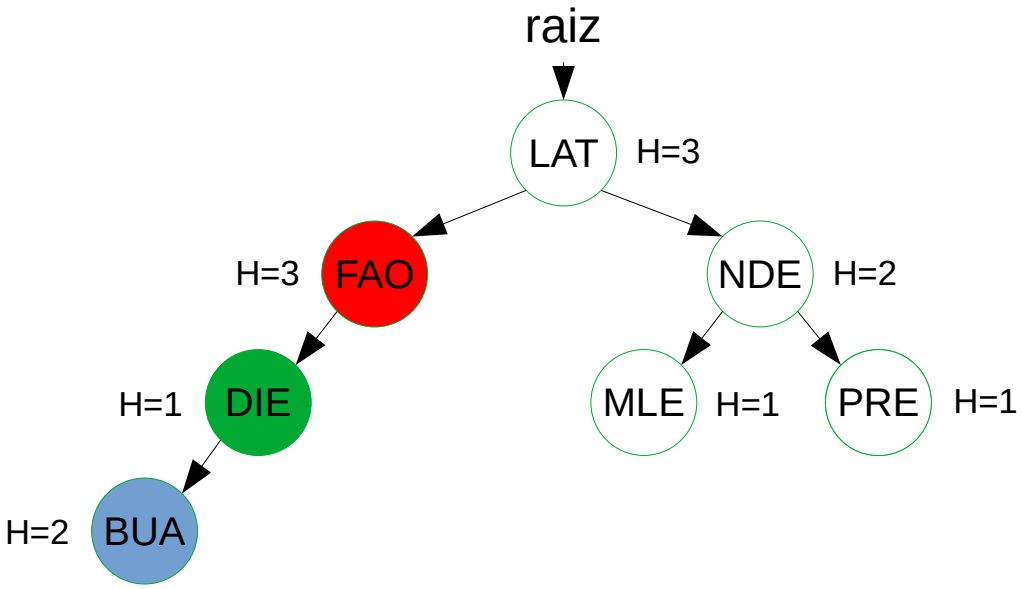
atualiza a altura
árvore desbalanceada
em FAO

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA

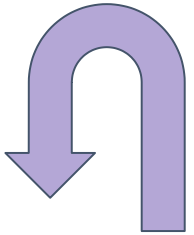


O FB em FAO é +2 e BUA é -1, devemos fazer uma rotação dupla: uma esquerda e uma direita

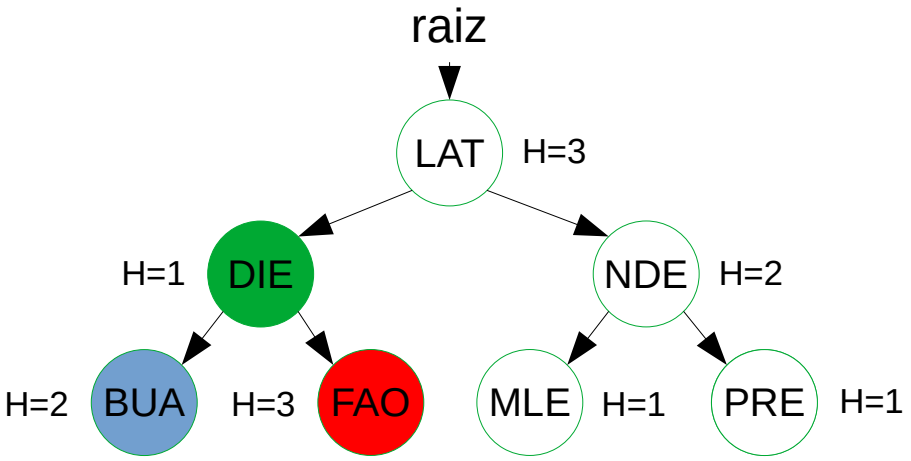
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



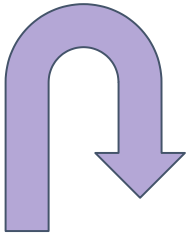
rotação esquerda em BUA



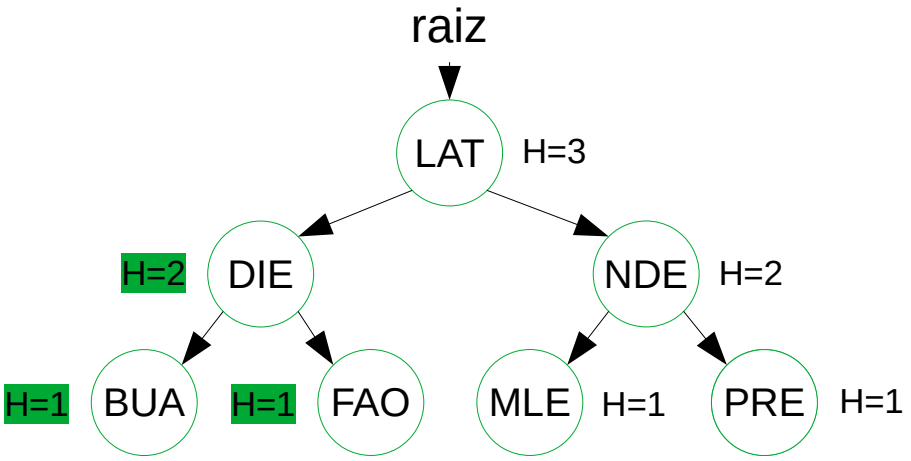
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



rotação direita em DIE

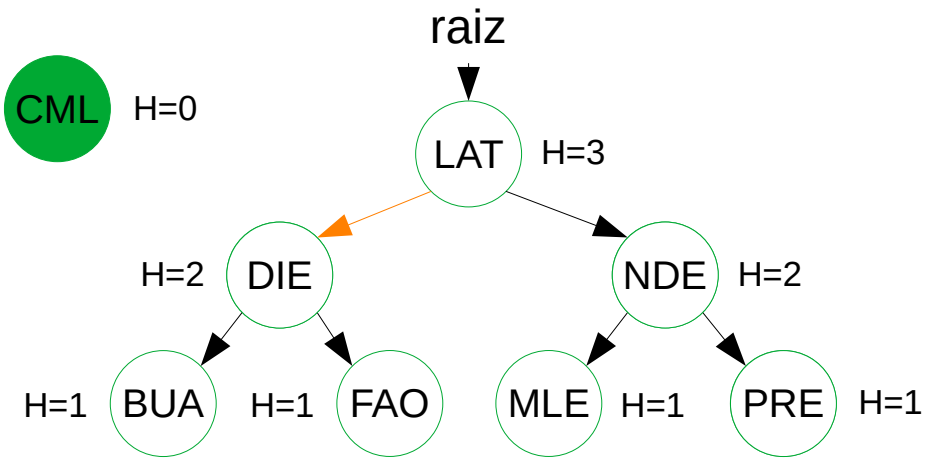


Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



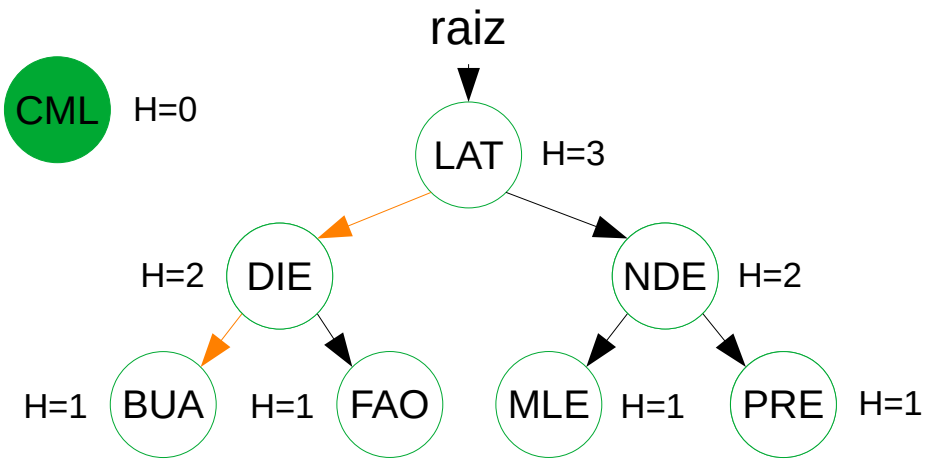
atualiza a altura

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



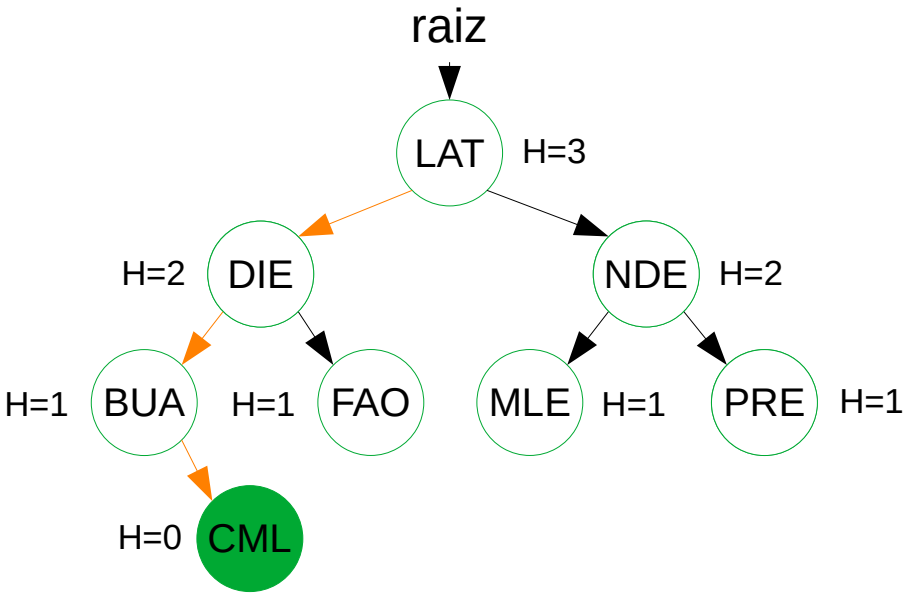
CML < LAT, então vai pelo caminho esquerdo

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



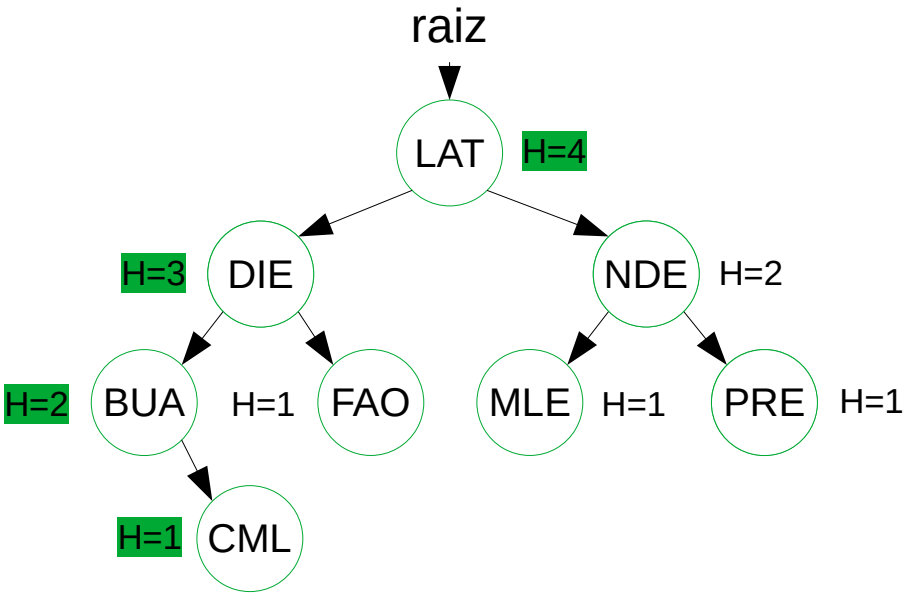
CML < DIE, então vai pelo caminho esquerdo

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



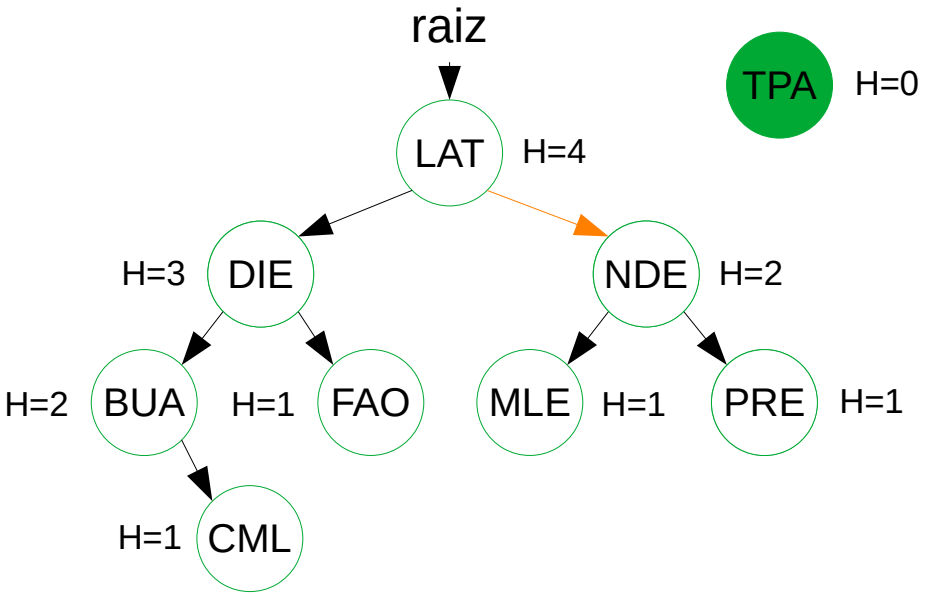
CML > BUA, então é inserido no filho a direita

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



atualiza a altura
não é necessário nenhum balanceamento

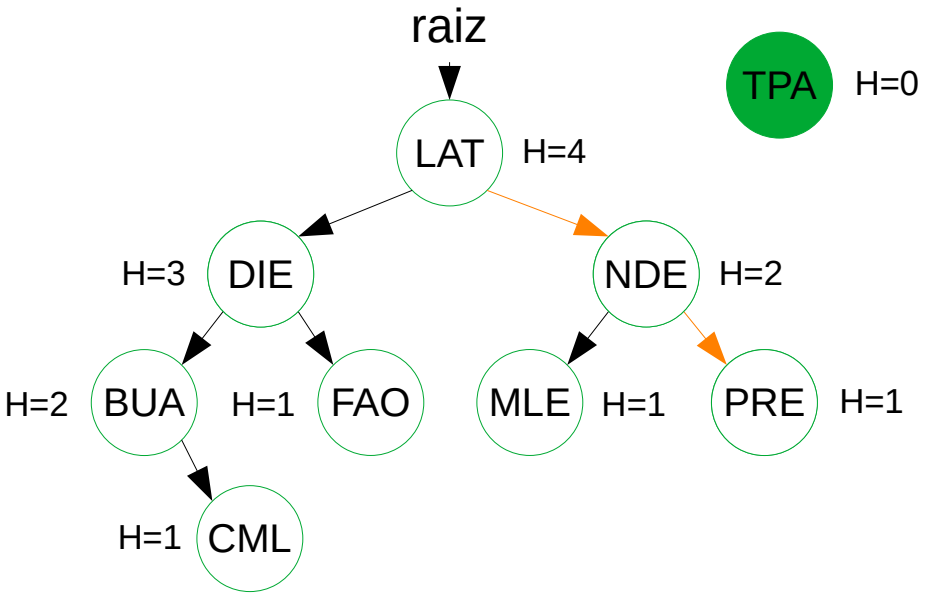
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



TPA H=0

TPA > LAT, então vai pelo caminho direito

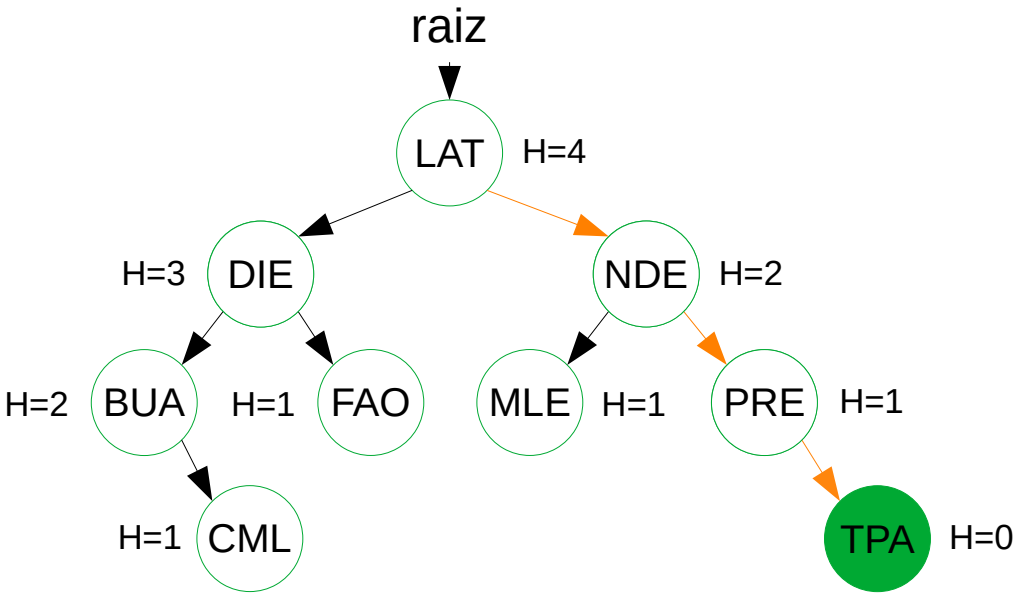
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



TPA H=0

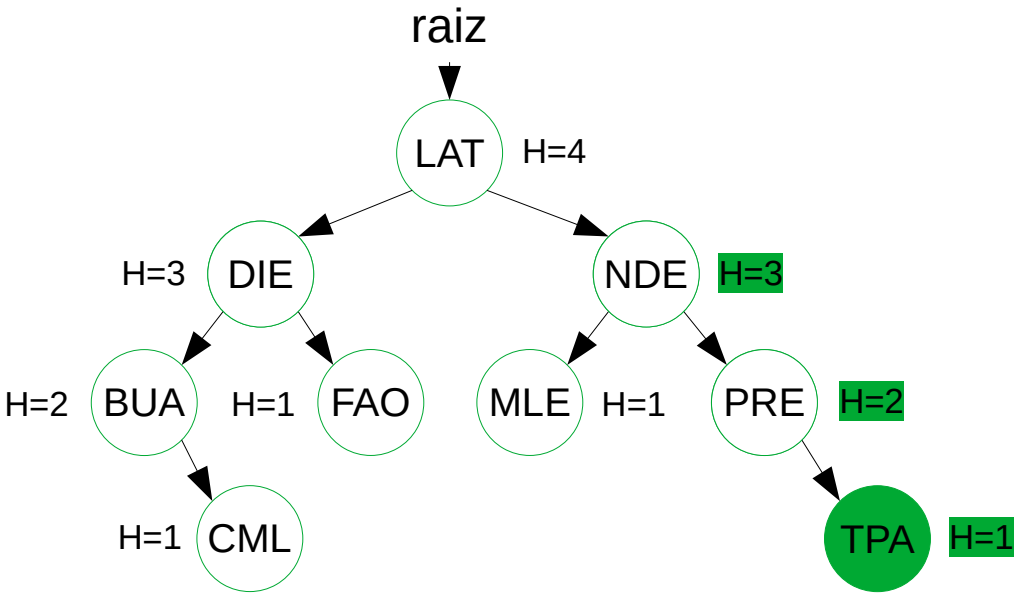
TPA > NDE, então vai pelo caminho direito

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



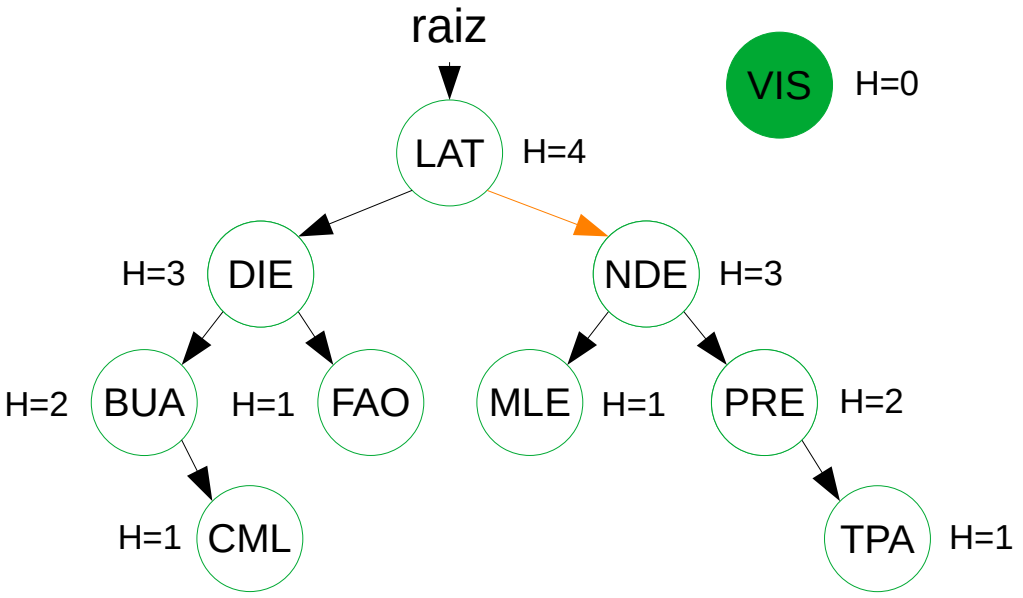
TPA > PRE, então é inserido no filho a direita

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



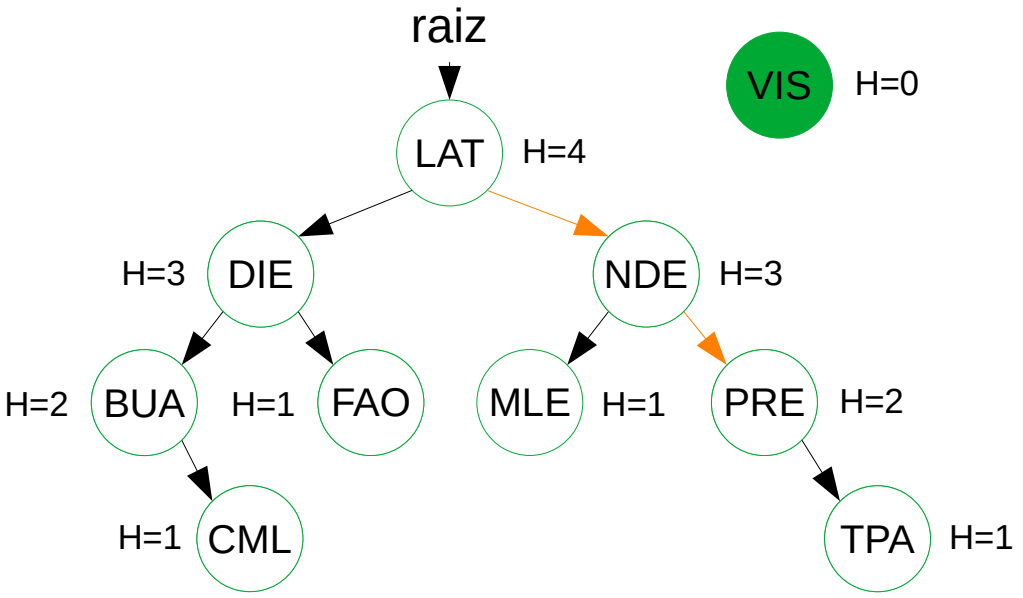
atualiza a altura
não é necessário nenhum balanceamento

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



VIS > LAT, então vai pelo caminho direito

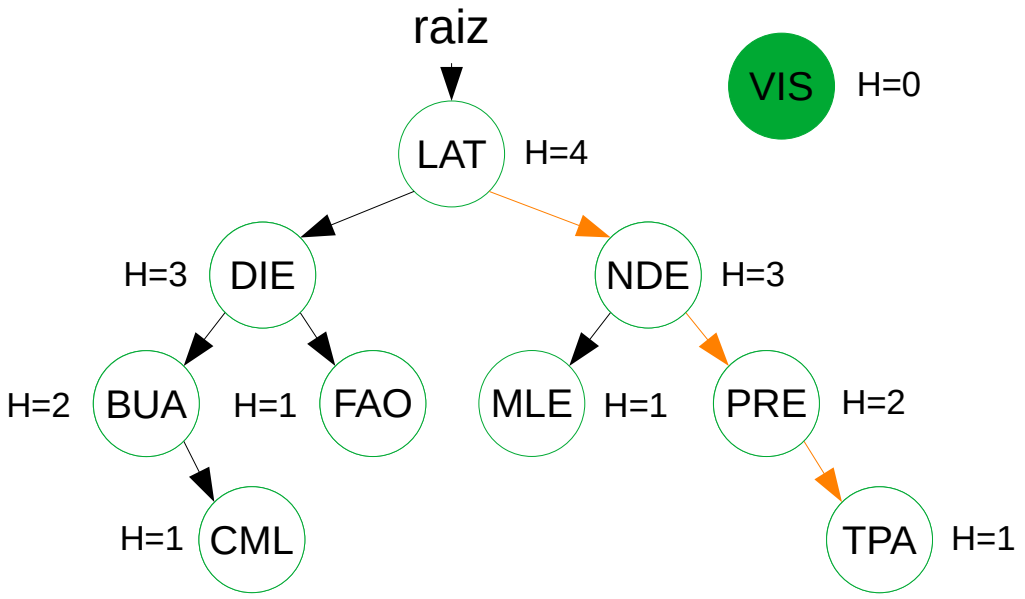
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



VIS H=0

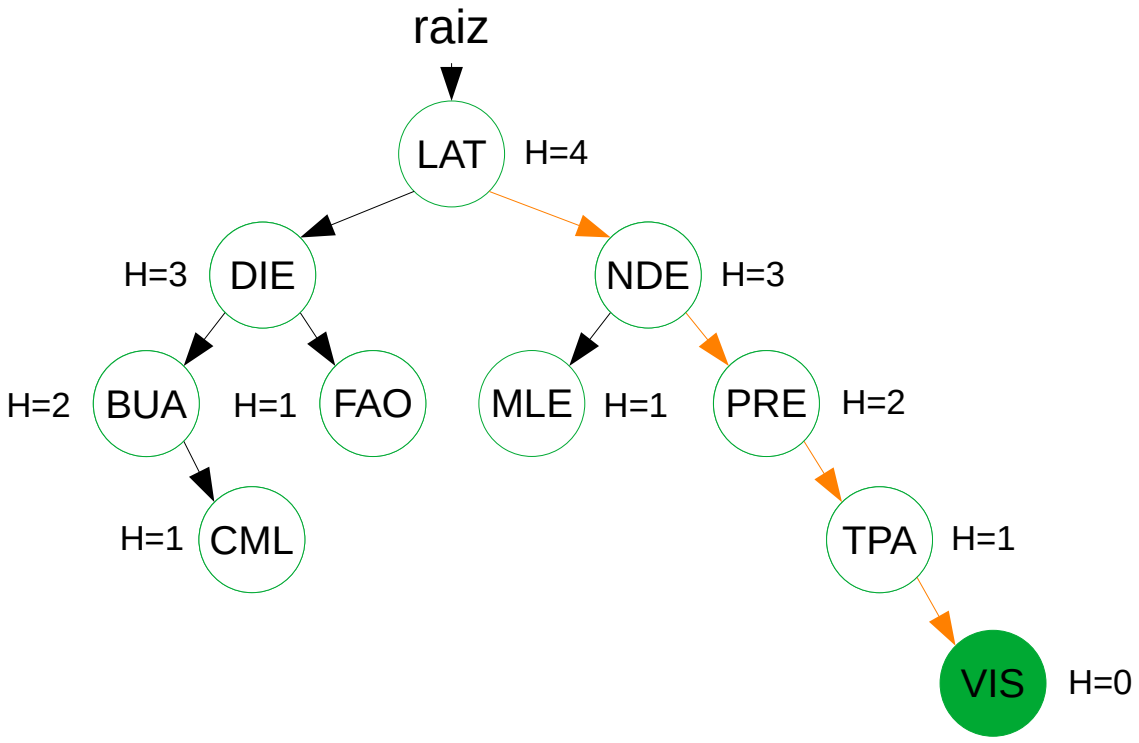
VIS > NDE, então vai pelo caminho direito

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



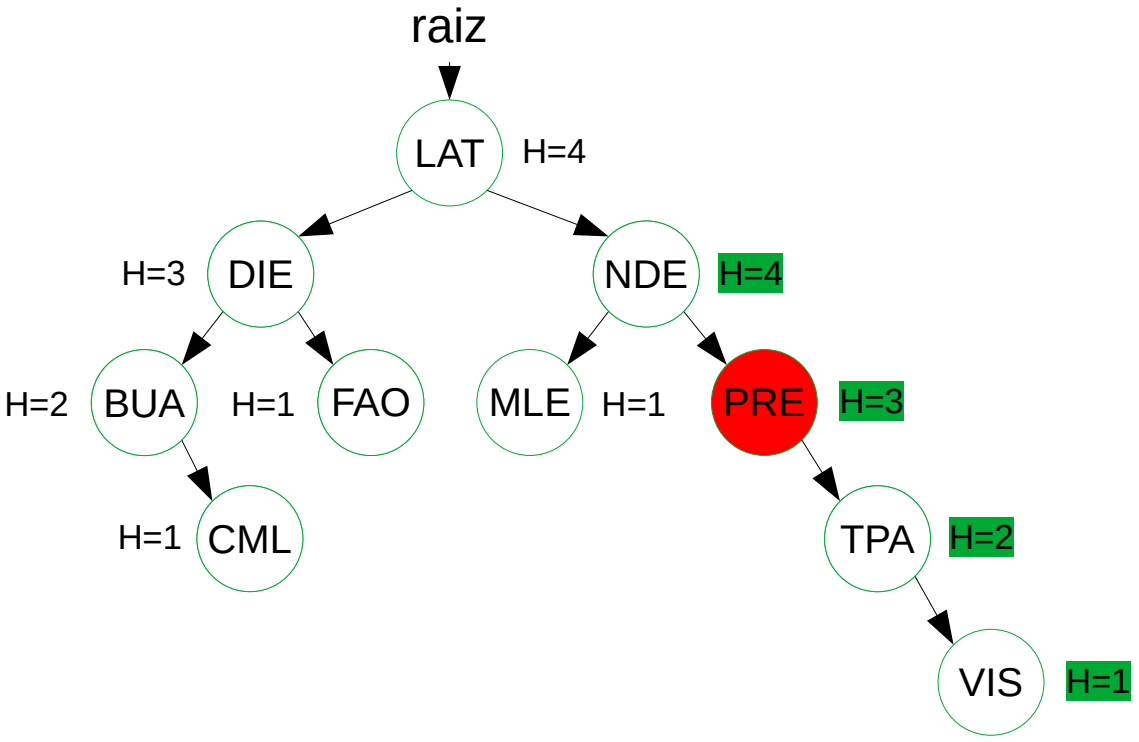
VIS > PRE, então vai pelo caminho direito

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



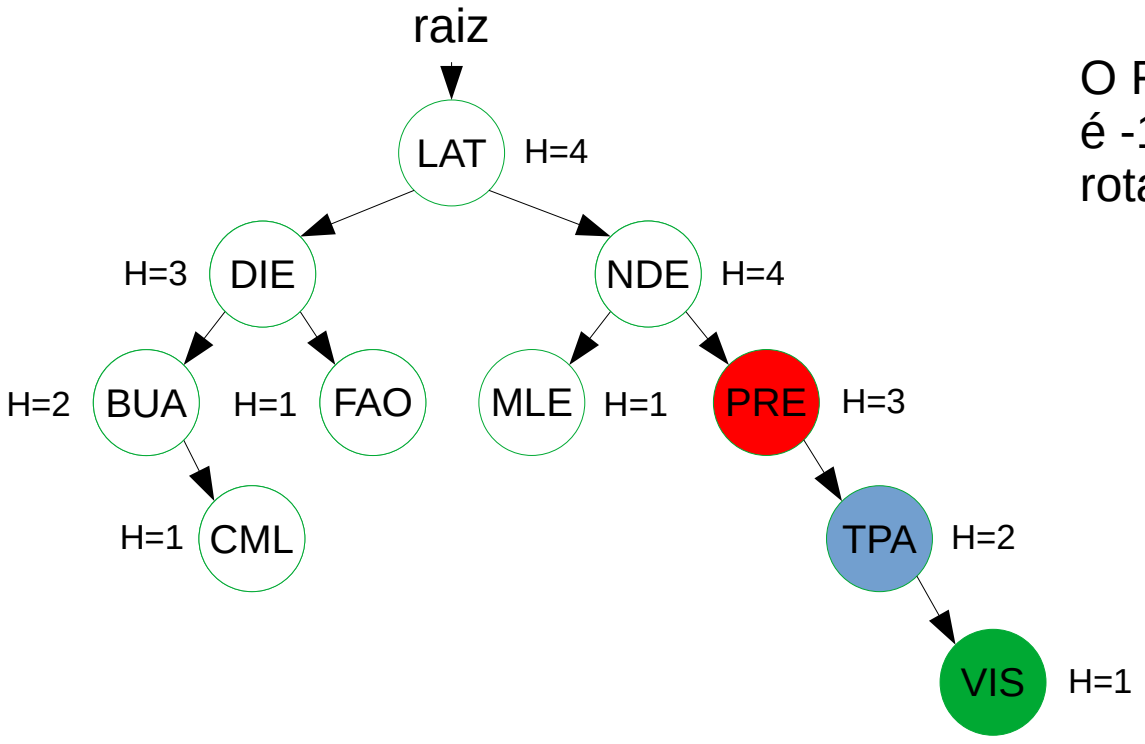
VIS > TPA, então é inserido no filho a direita

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



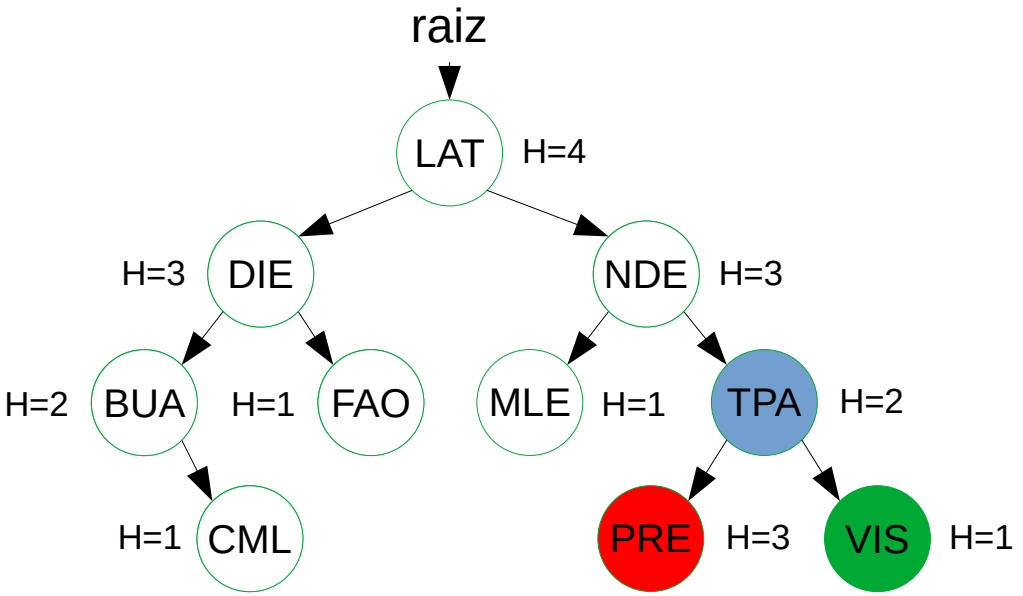
atualiza a altura
árvore desbalanceada
em PRE

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA

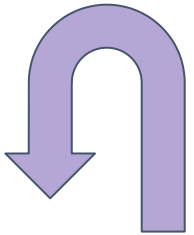


O FB em PRE é +2 e TPA é -1, devemos fazer uma rotação a esquerda

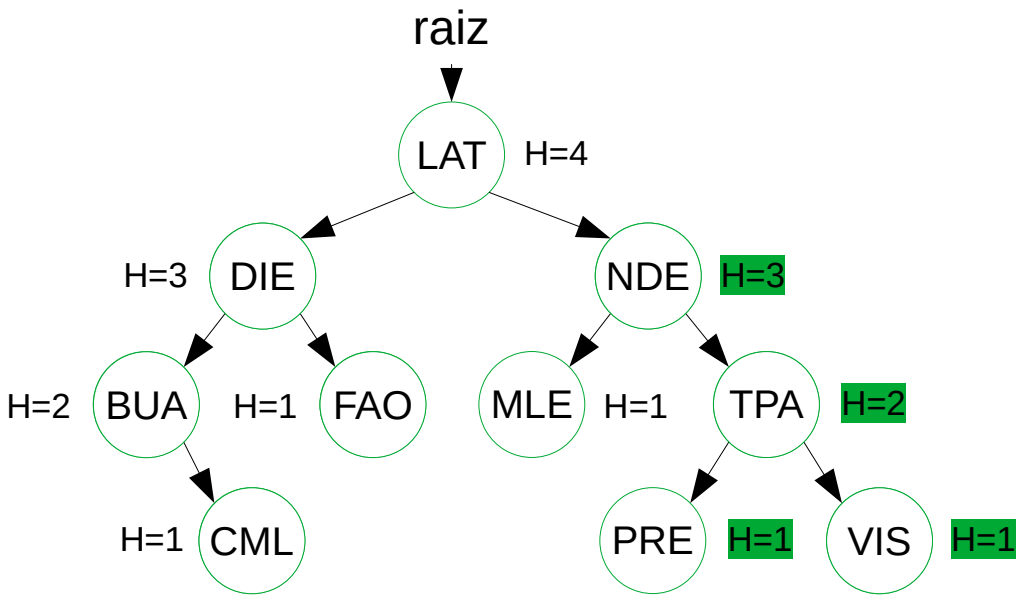
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



rotação esquerda em TPA

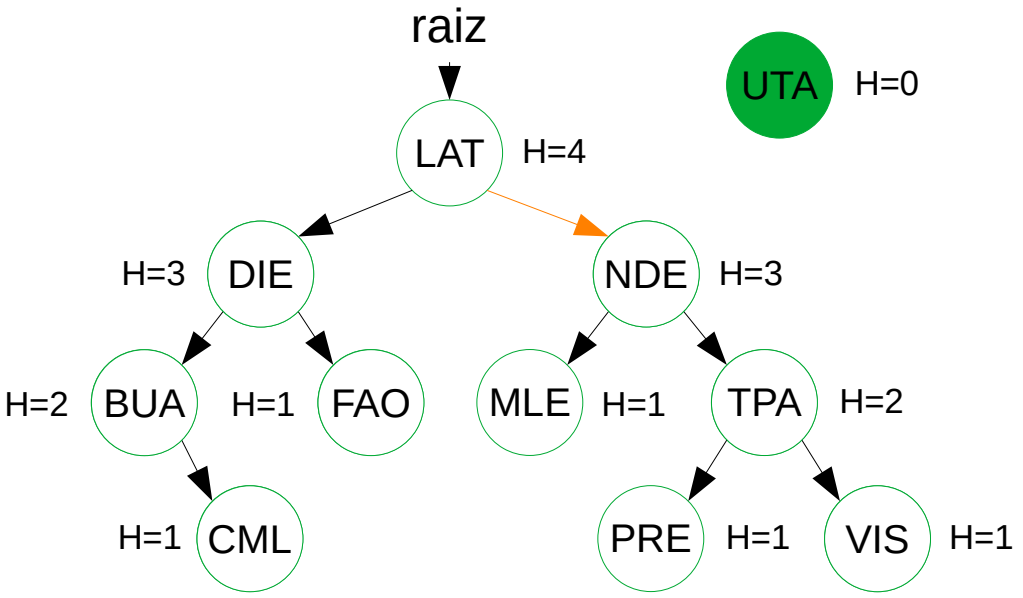


Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



atualiza a altura

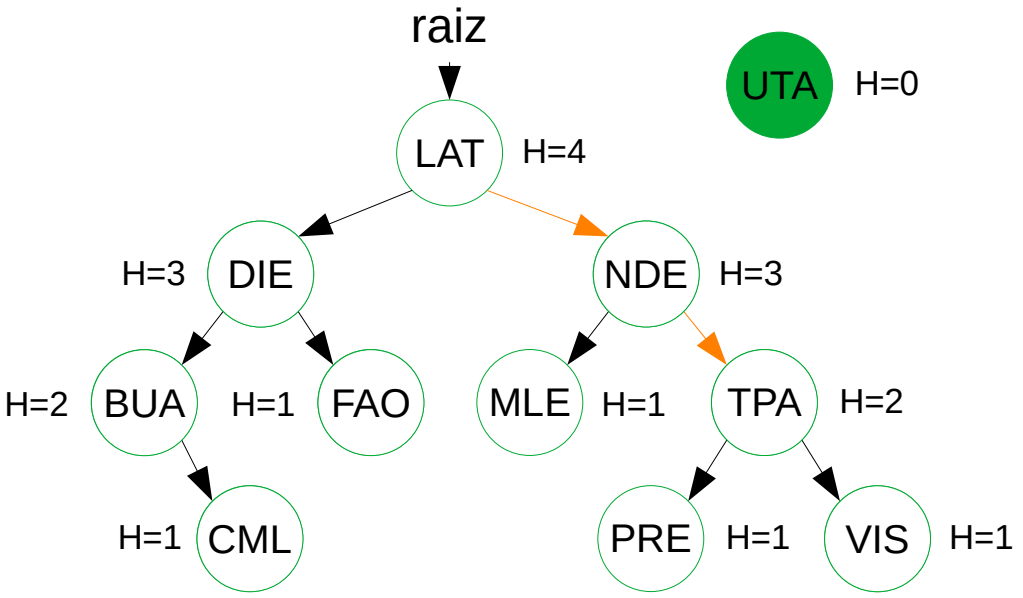
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



UTA H=0

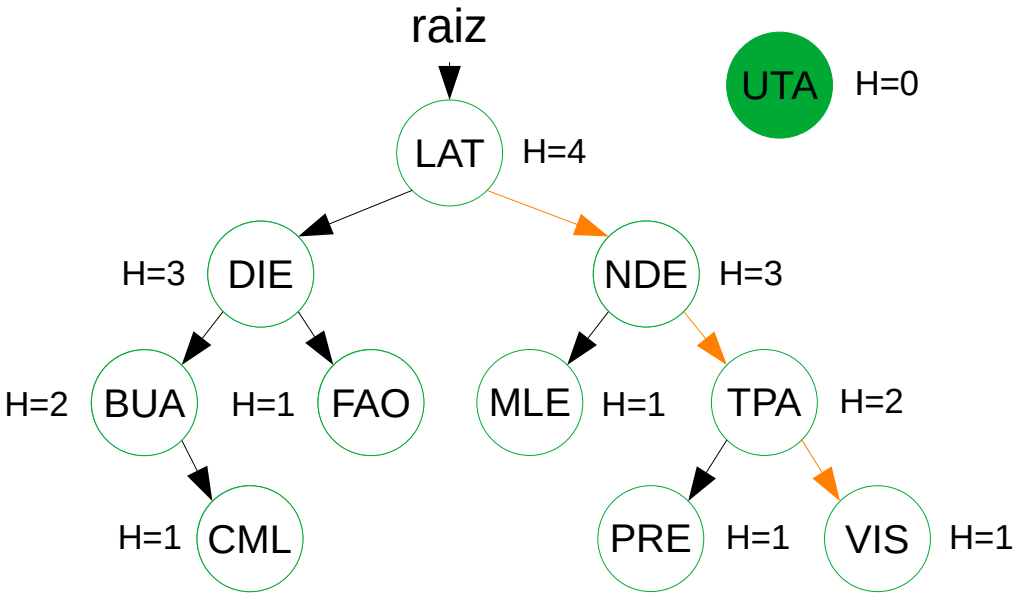
UTA > LAT, então vai pelo caminho direito

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



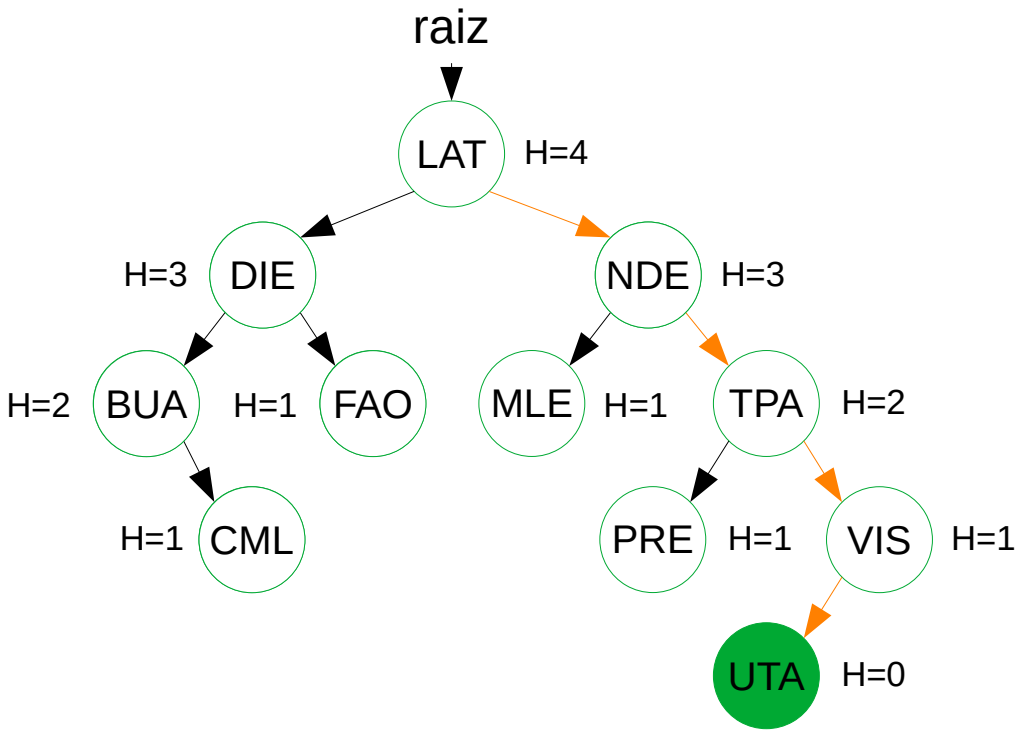
UTA > NDE, então vai pelo caminho direito

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



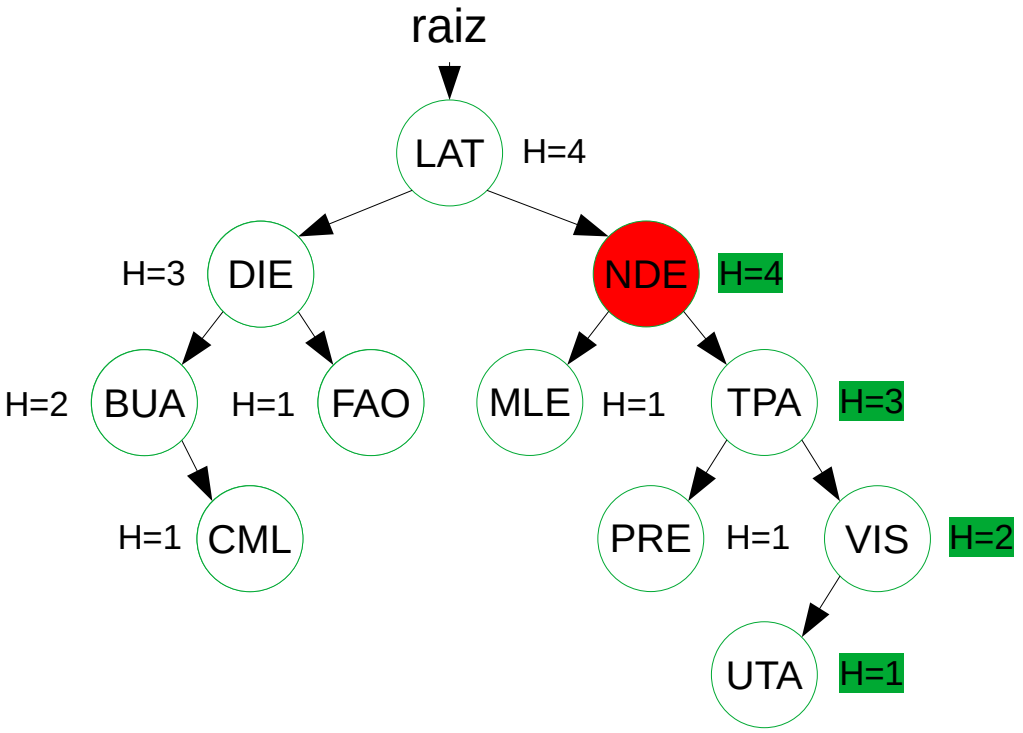
UTA > TPA, então vai pelo caminho direito

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



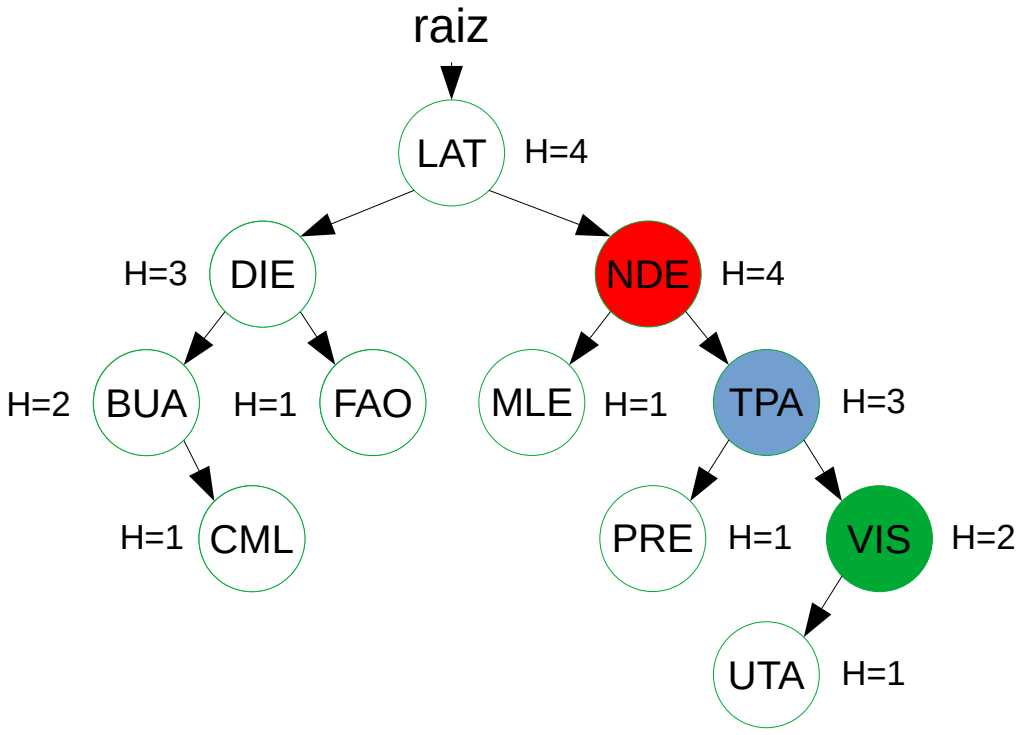
UTA < VIS, então é inserido no filho a esquerda

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



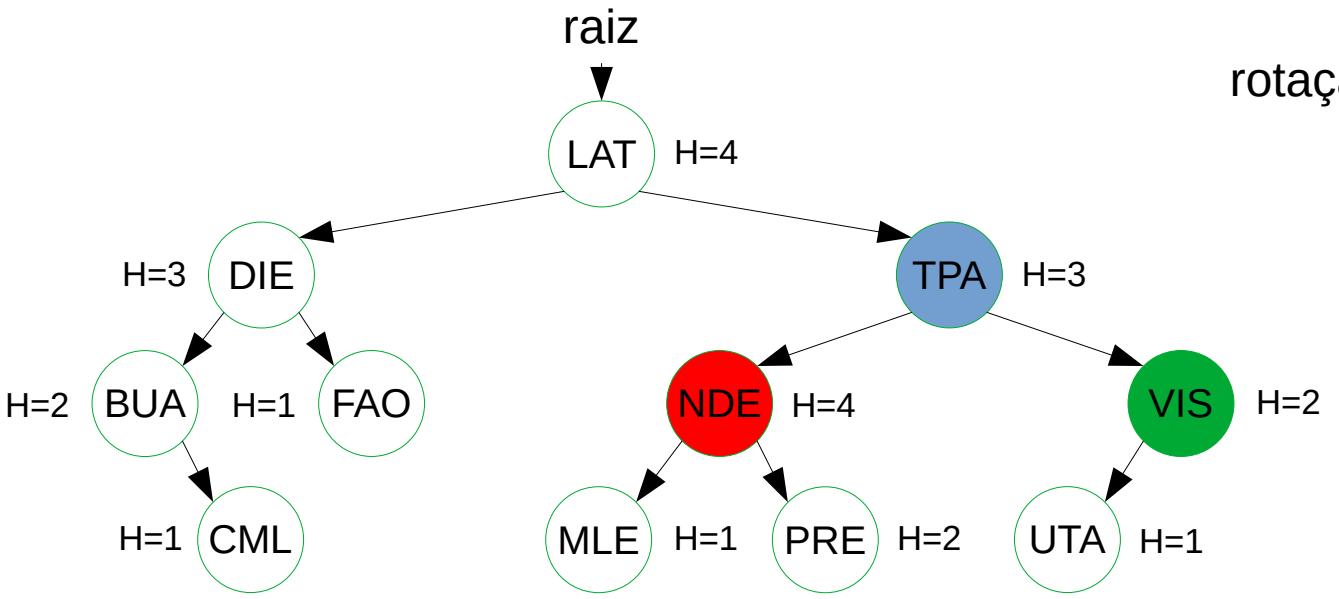
atualiza a altura
árvore desbalanceada
em NDE

Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA

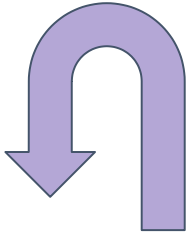


O filho a direita de NDE
é 3 e o esquerdo é 1, devemos
fazer uma rotação a esquerda

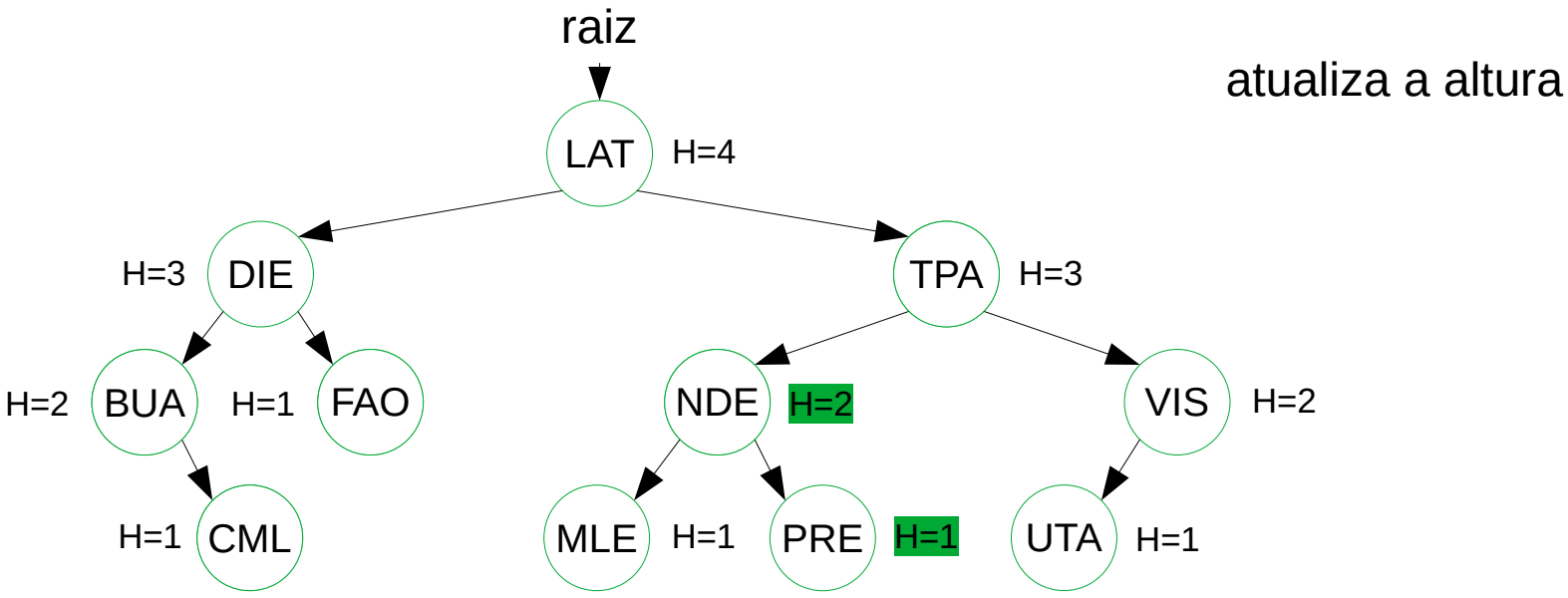
Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



rotação esquerda em TPA

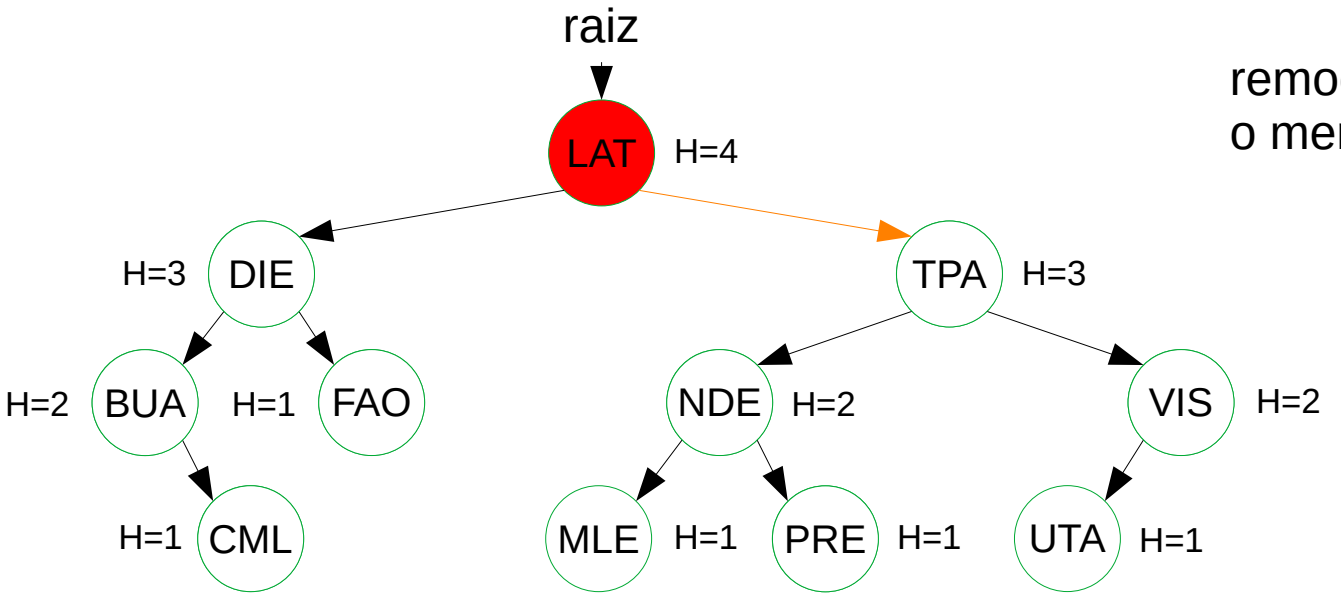


Inserir: LAT PRE FAO BUA MLE NDE DIE CML TPA VIS UTA



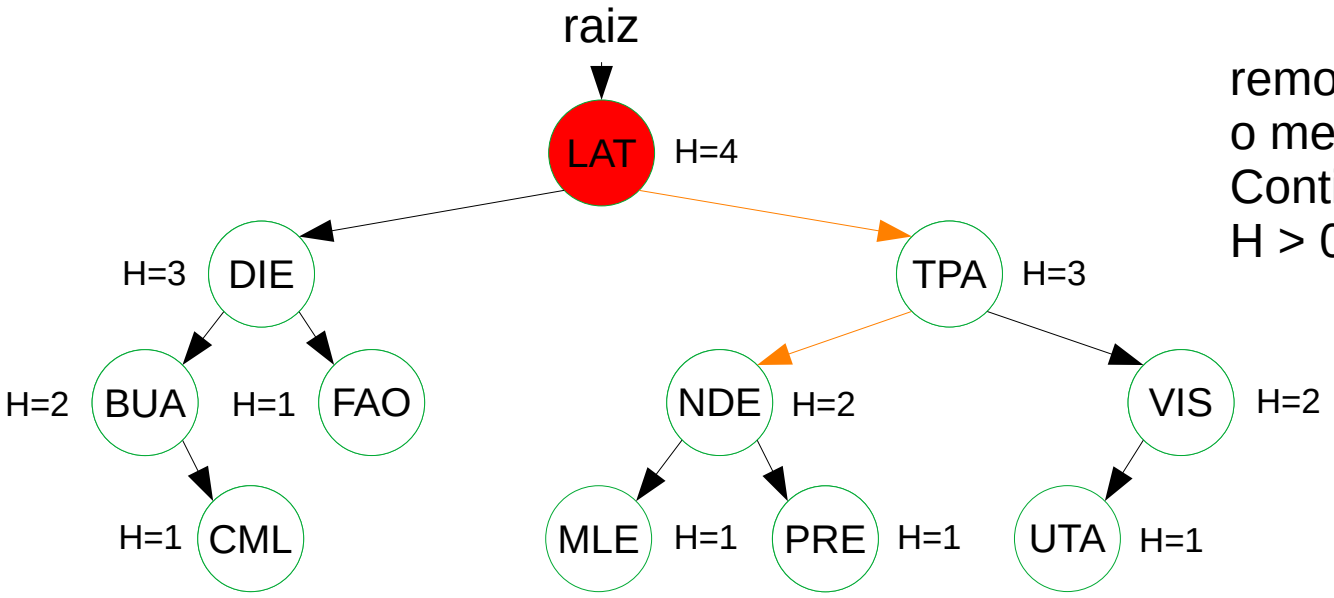
atualiza a altura

Remover: LAT PRE FAO



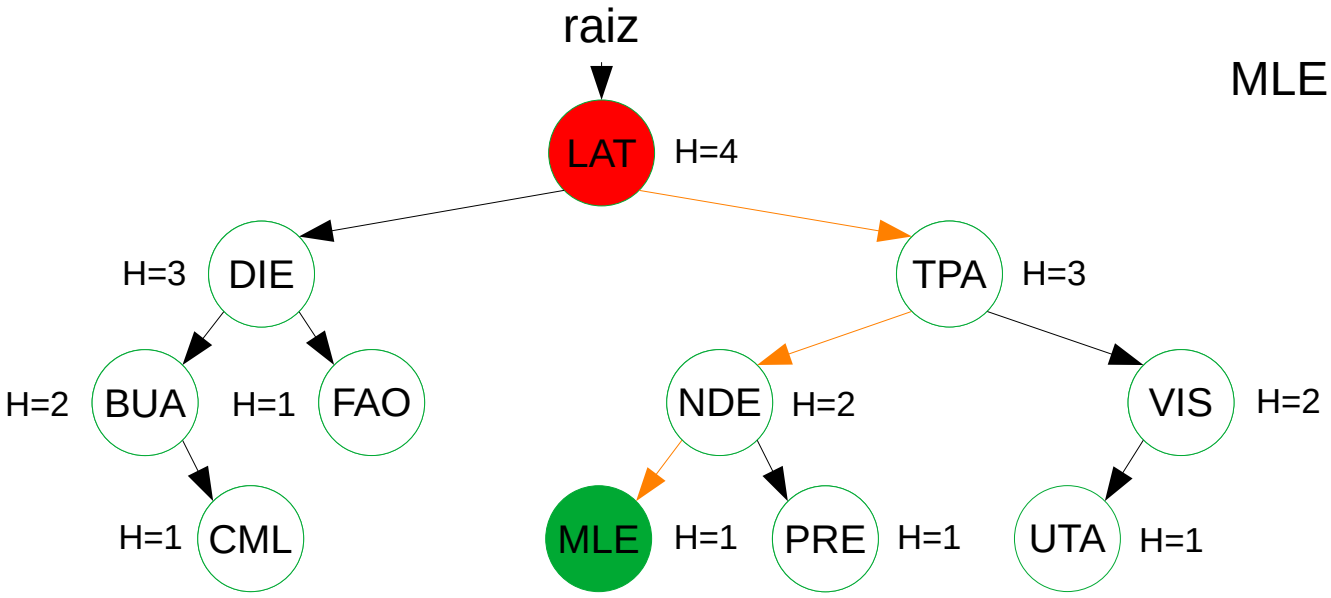
remoção de raiz, procura o
o menor do filho da direita

Remover: LAT PRE FAO



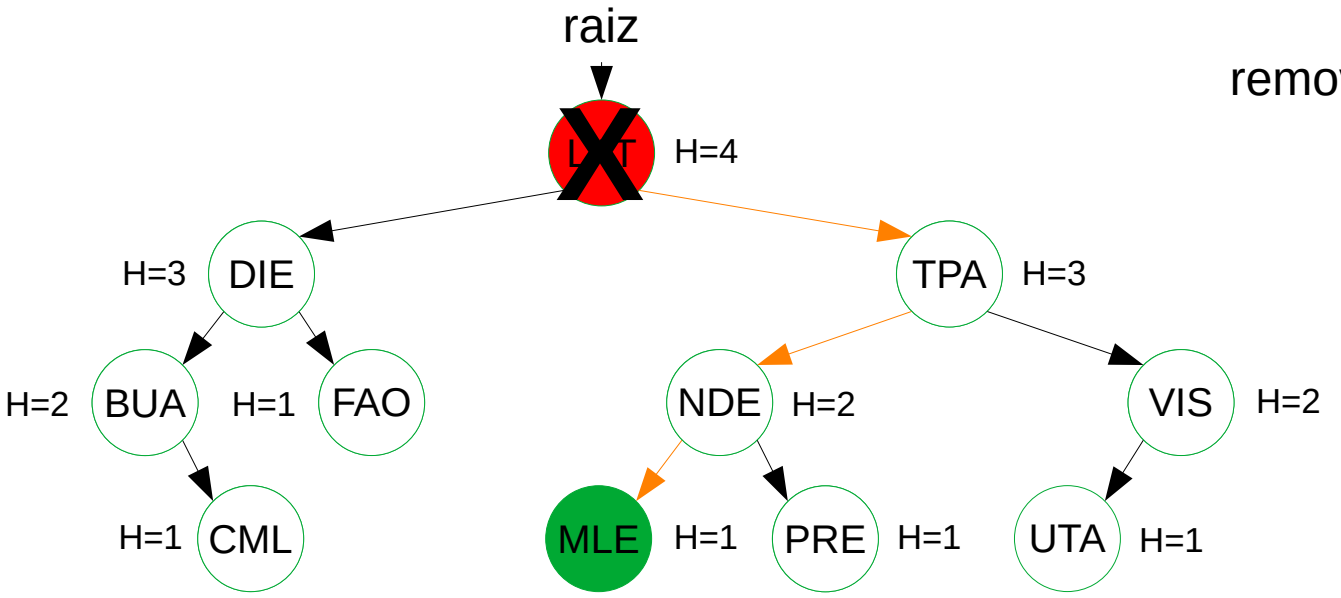
remoção de raiz, procura o
o menor do filho da direita
Continua descendo porque
H > 0

Remover: LAT PRE FAO



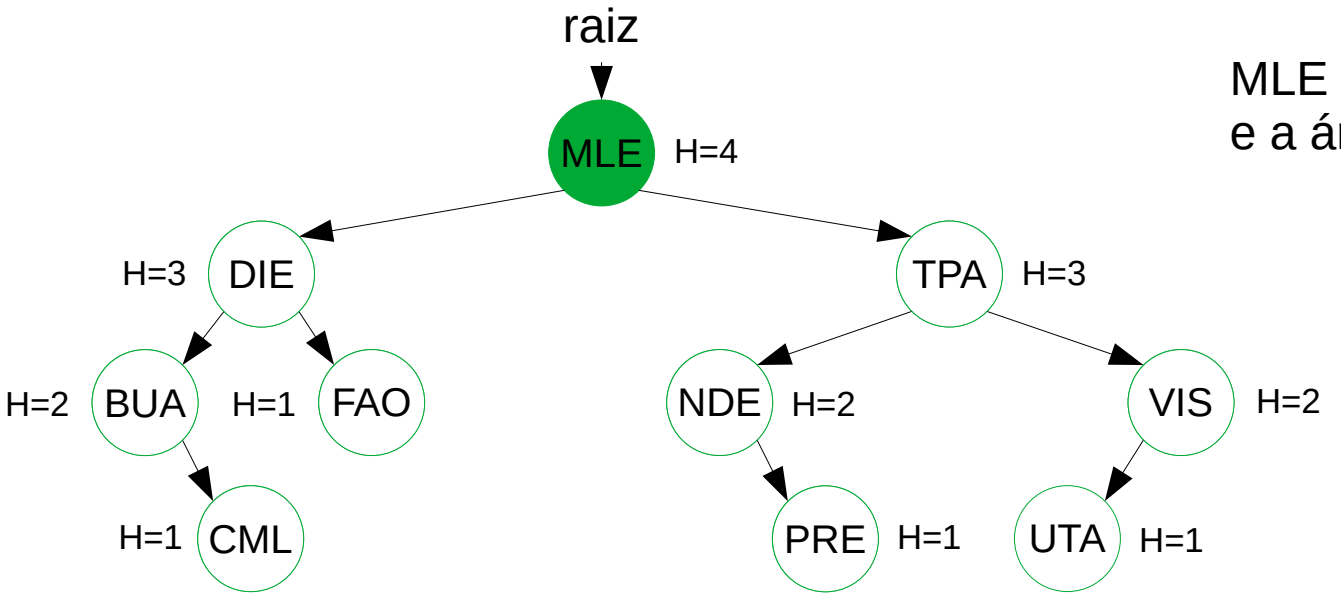
MLE é o menor filho da direita

Remover: LAT PRE FAO



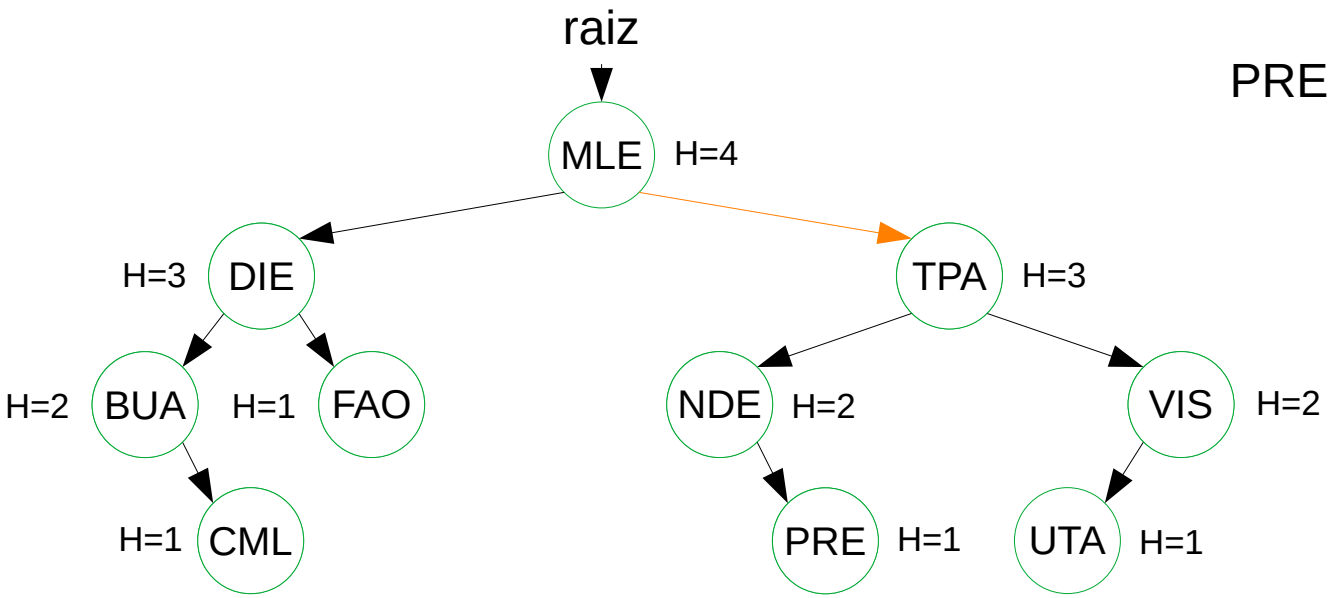
remove LAT

Remover: LAT PRE FAO



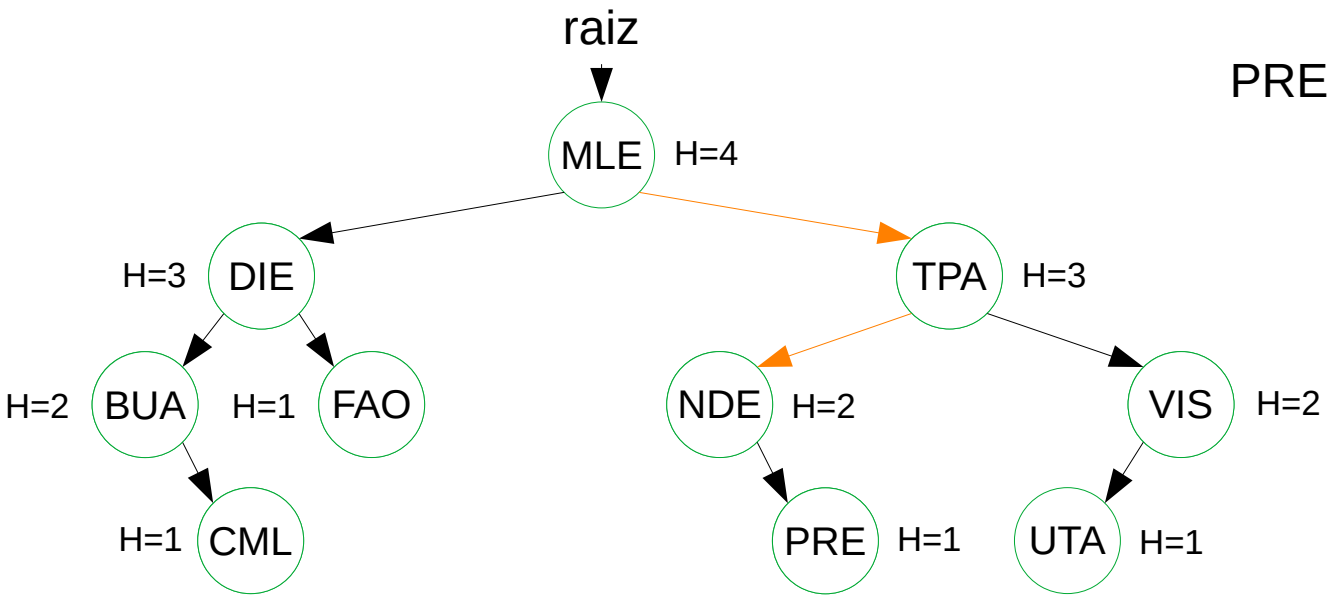
MLE sobe para a raiz
e a árvore continua balanceada

Remover: LAT PRE FAO



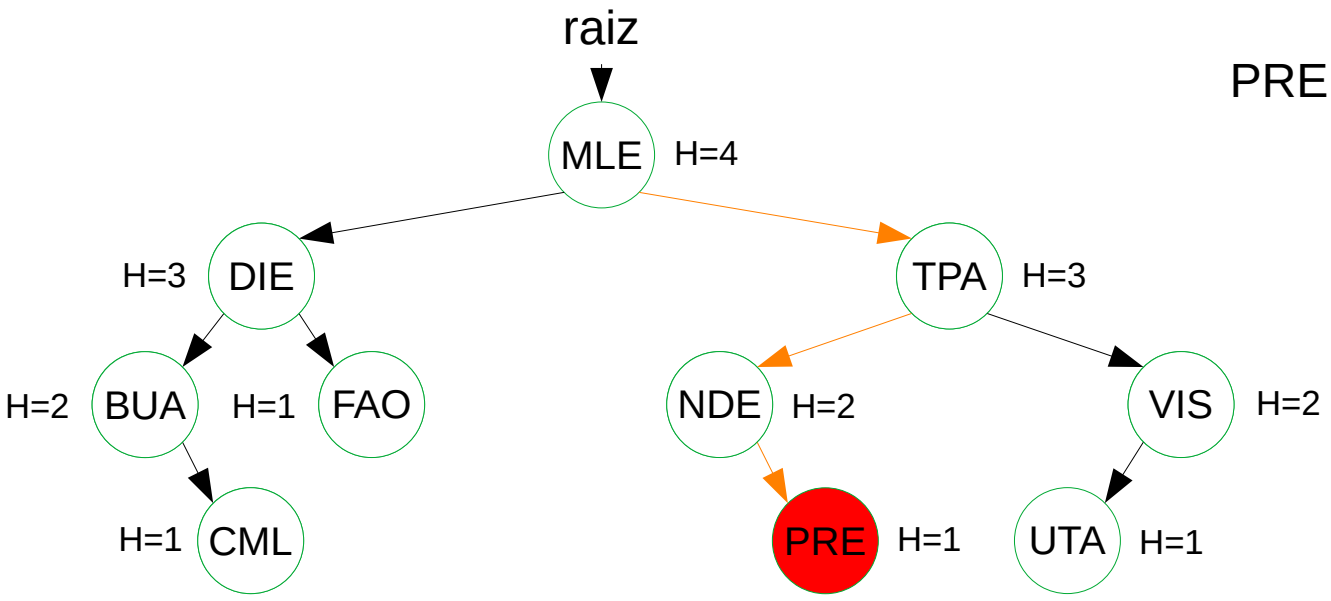
PRE > MLE vai a direita

Remover: LAT PRE FAO



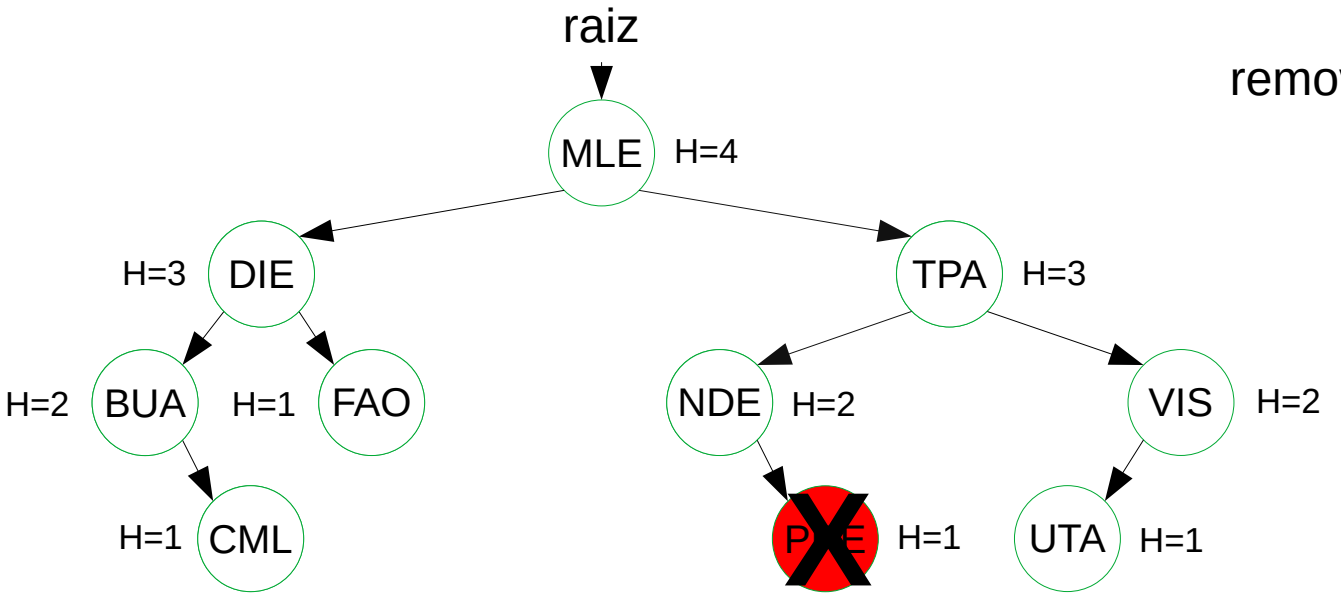
PRE < TPA vai a esquerda

Remover: LAT PRE FAO



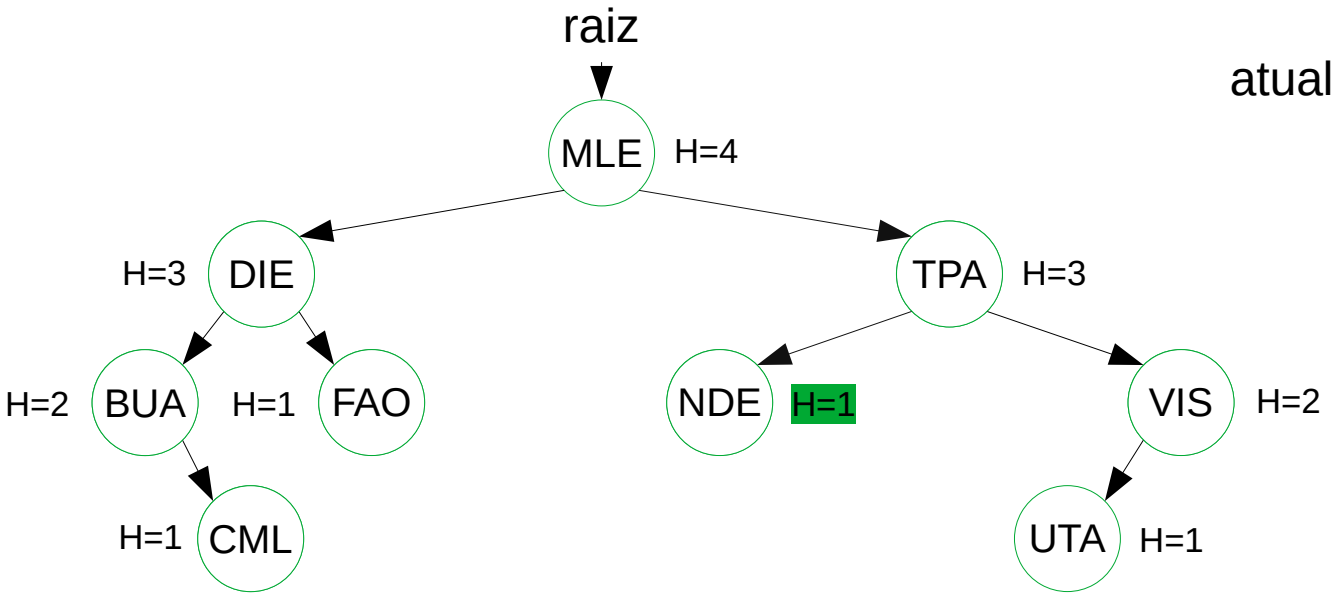
PRE > NDE vai a direita

Remover: LAT PRE FAO



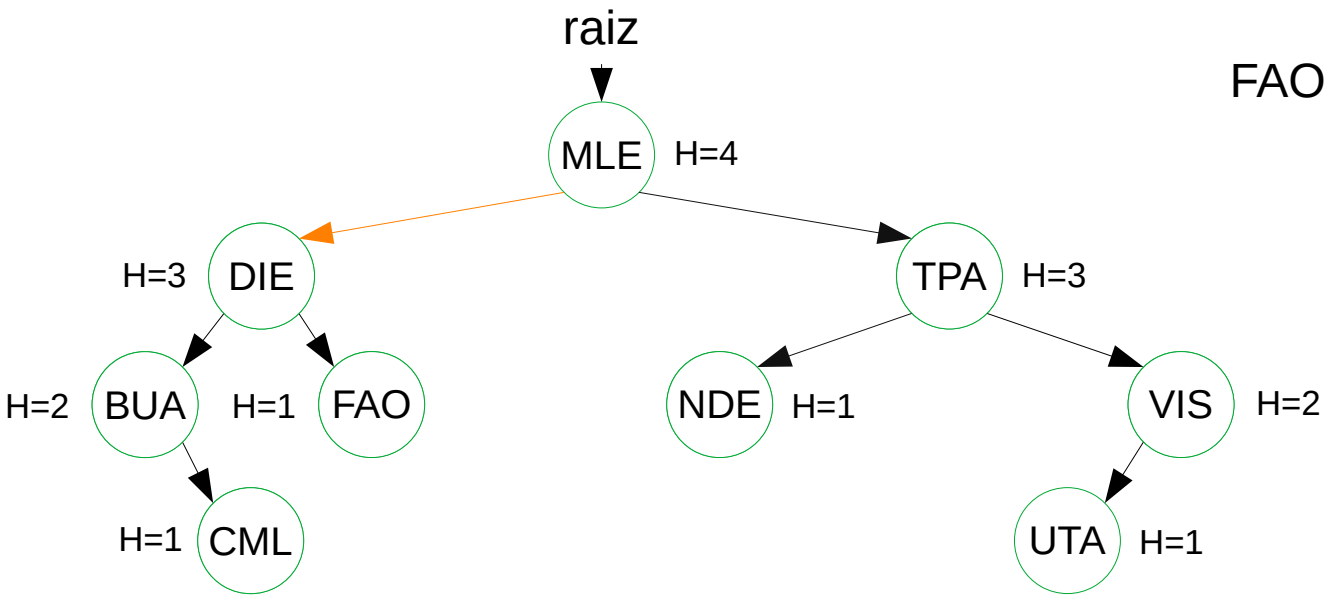
remove PRE

Remover: LAT PRE FAO



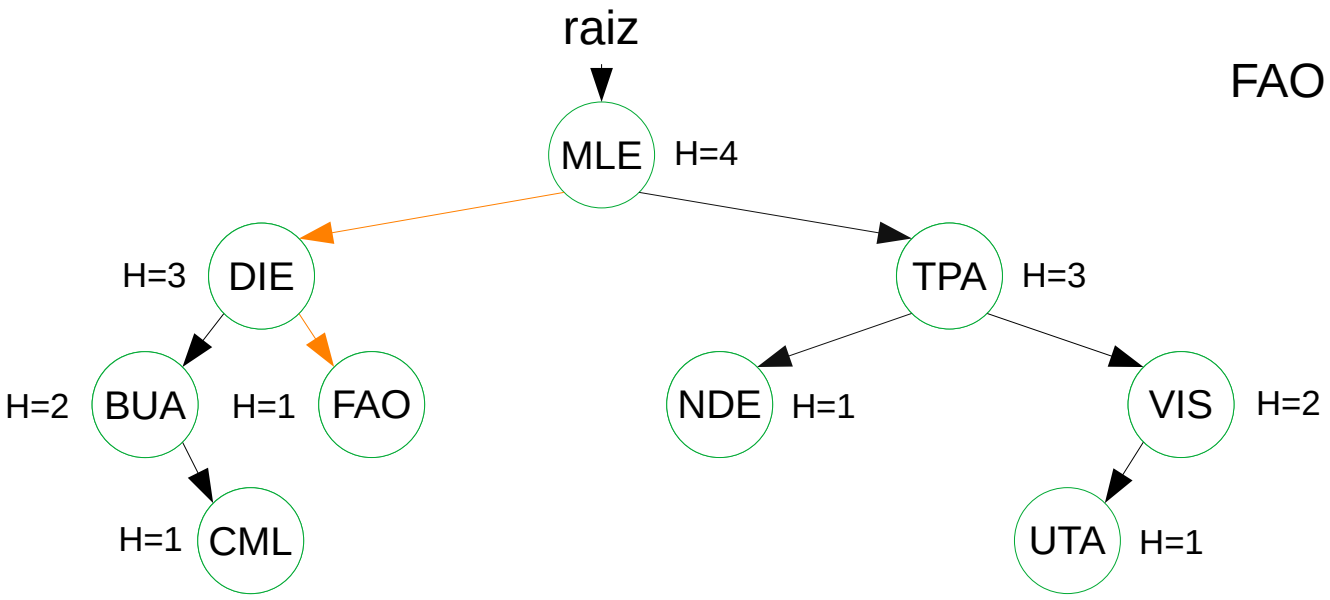
atualiza altura

Remover: LAT PRE FAO



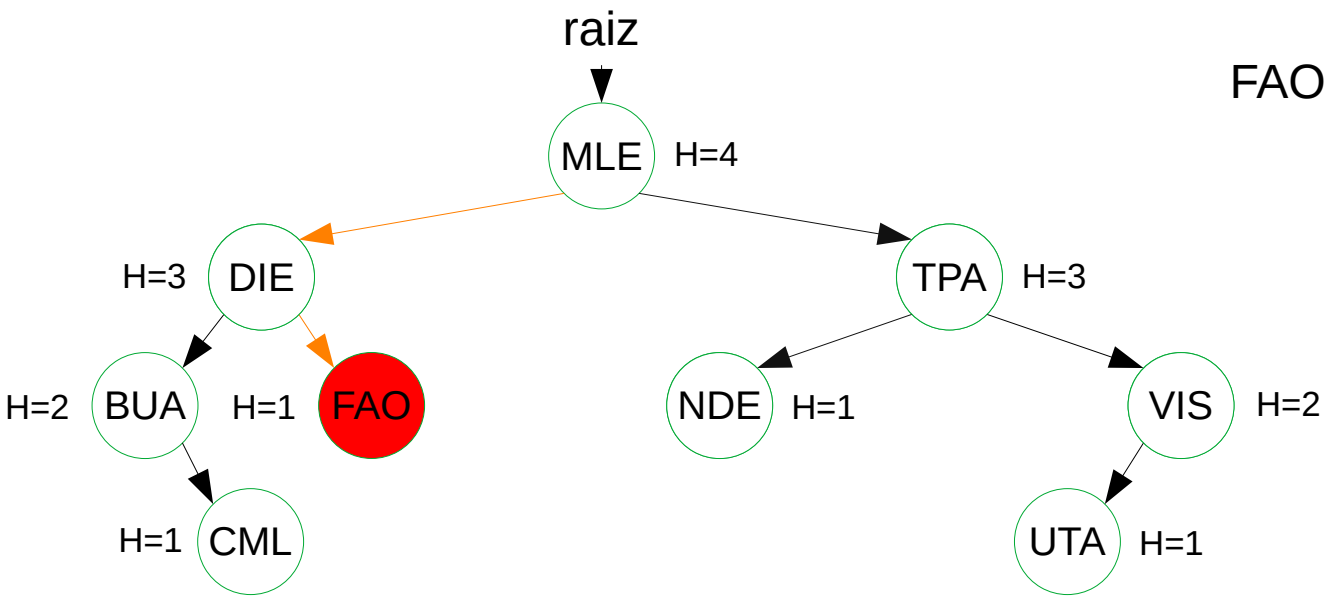
FAO < MLE vai a esquerda

Remover: LAT PRE FAO



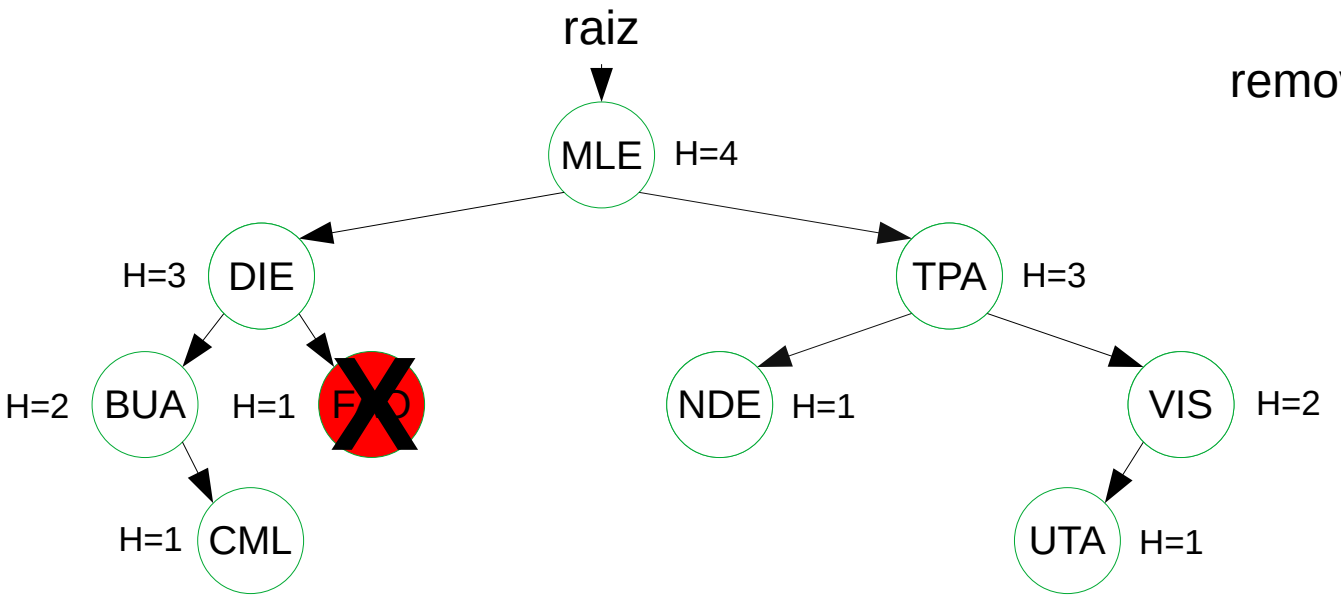
FAO > DIE vai a direita

Remover: LAT PRE FAO



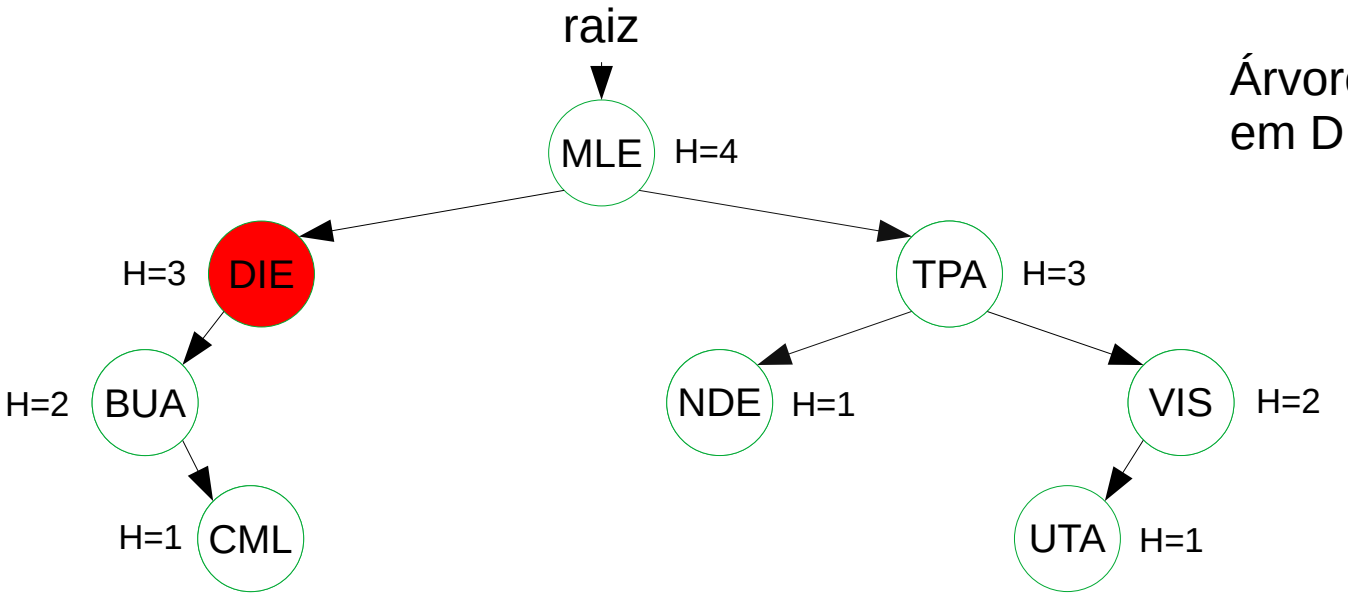
FAO > DIE vai a direita

Remover: LAT PRE FAO



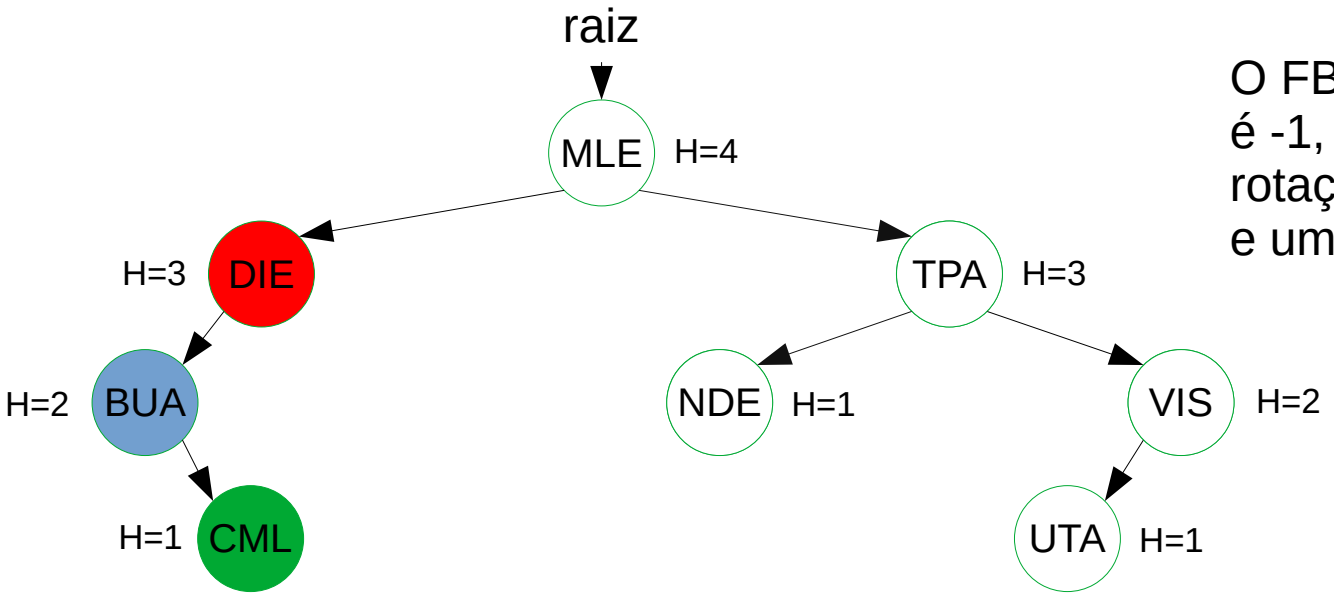
remove FAO

Remover: LAT PRE FAO



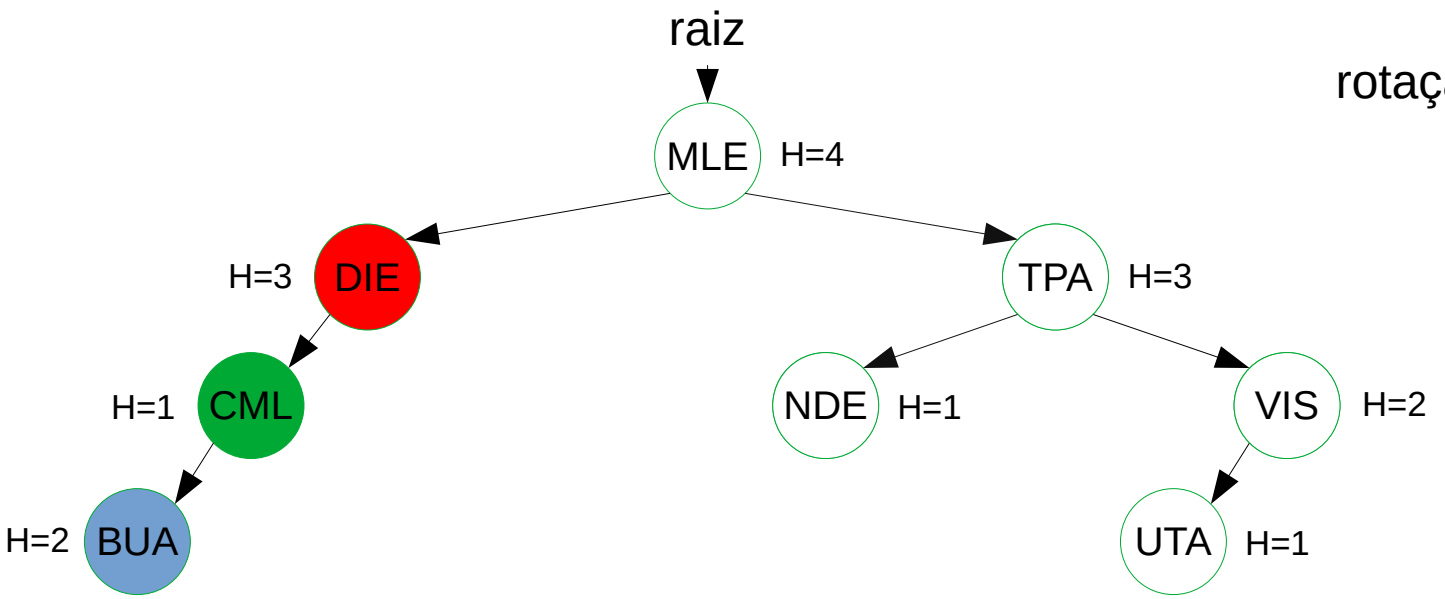
Árvore ficou desbalanceada em DIE

Remover: LAT PRE FAO

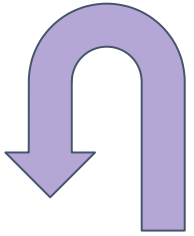


O FB em DIE é +2 e BUA é -1, devemos fazer uma rotação dupla: uma esquerda e uma direita

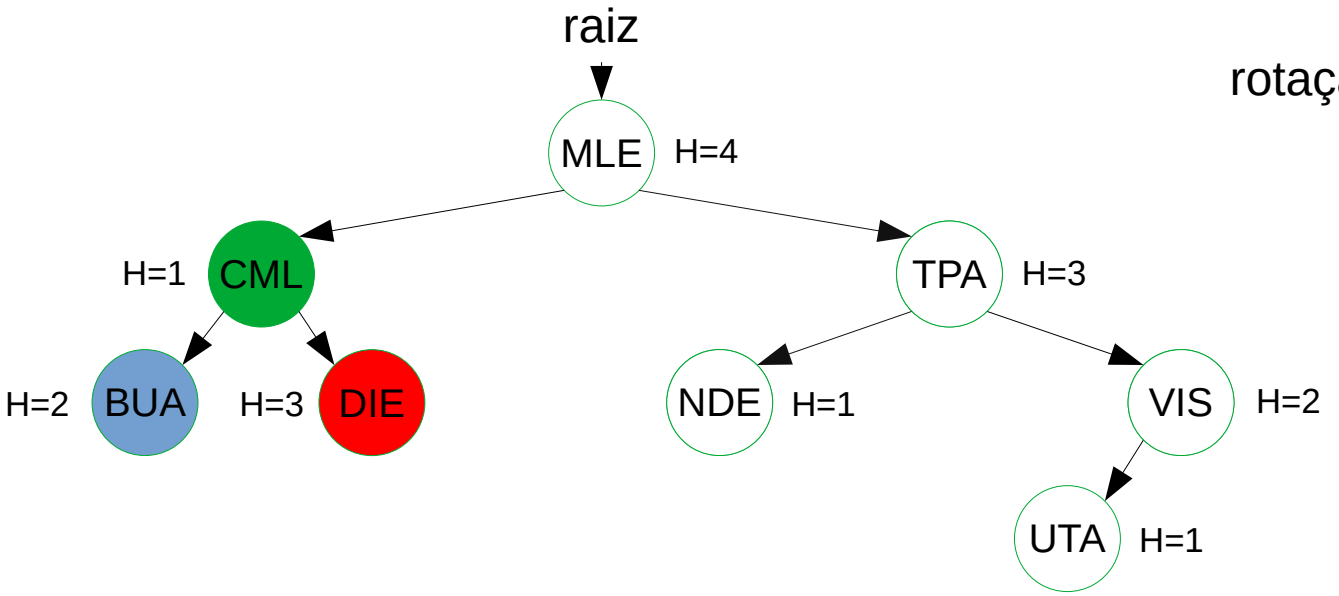
Remover: LAT PRE FAO



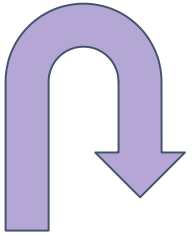
rotação esquerda em BUA



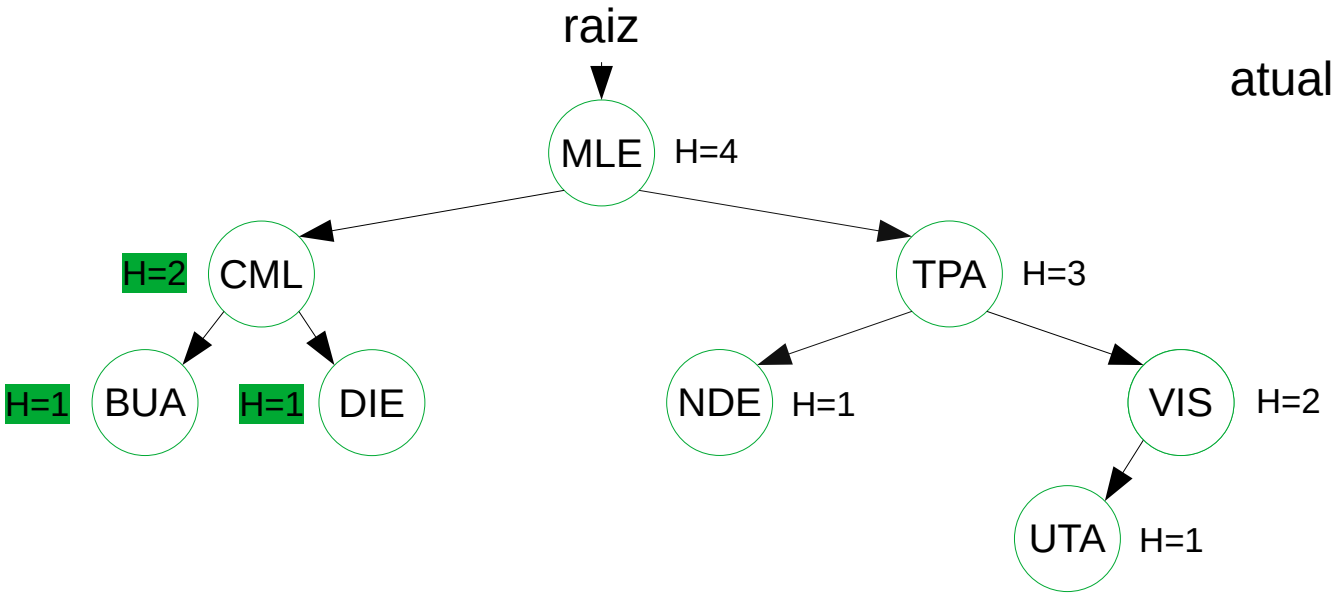
Remover: LAT PRE FAO



rotação direita em CML



Remover: LAT PRE FAO



atualiza a altura

Resultado: