05-E1

二叉树

先序遍历：算法A

真君曰：“昔吕洞宾居庐山而成仙，鬼谷子居云梦而得道，今或无此吉地么？”璞曰：“有，但当遍历耳。”

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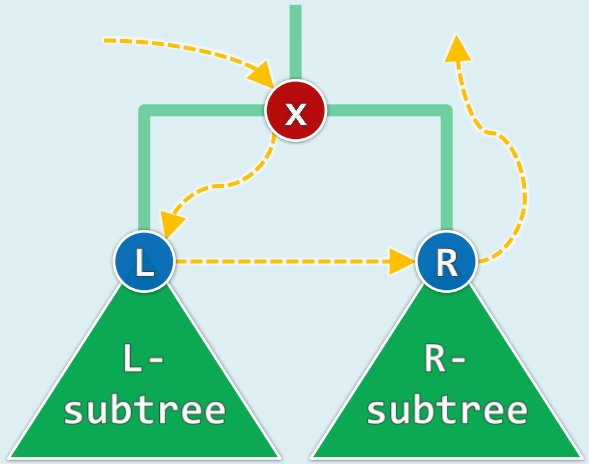
遍历

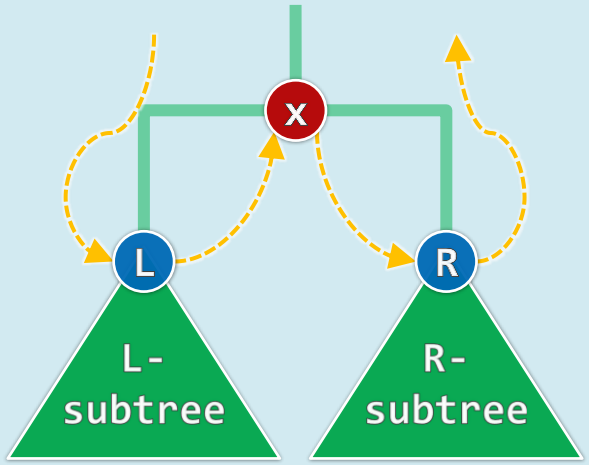
❖ 按照某种次序访问树中各节点，每个节点被访问恰好一次：T = L ∪ X ∪ R

先序
preorder



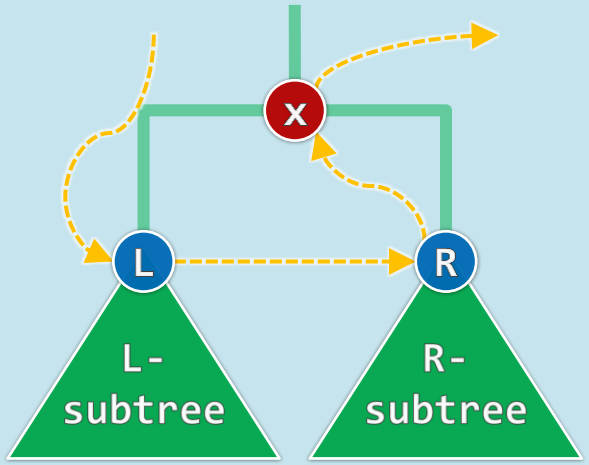
X | L | R

中序
inorder



L | X | R

后序
postorder



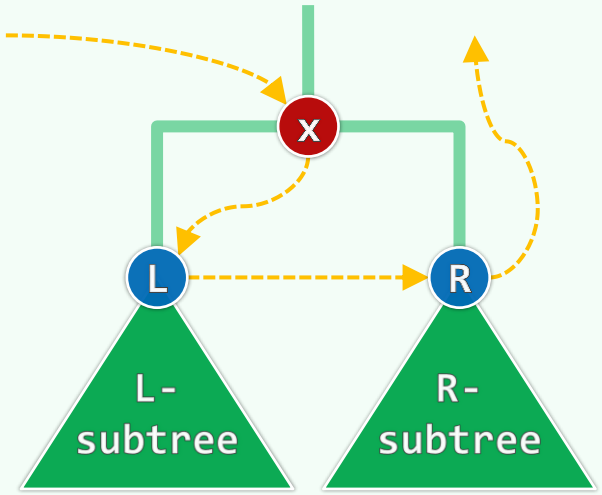
L | R | X

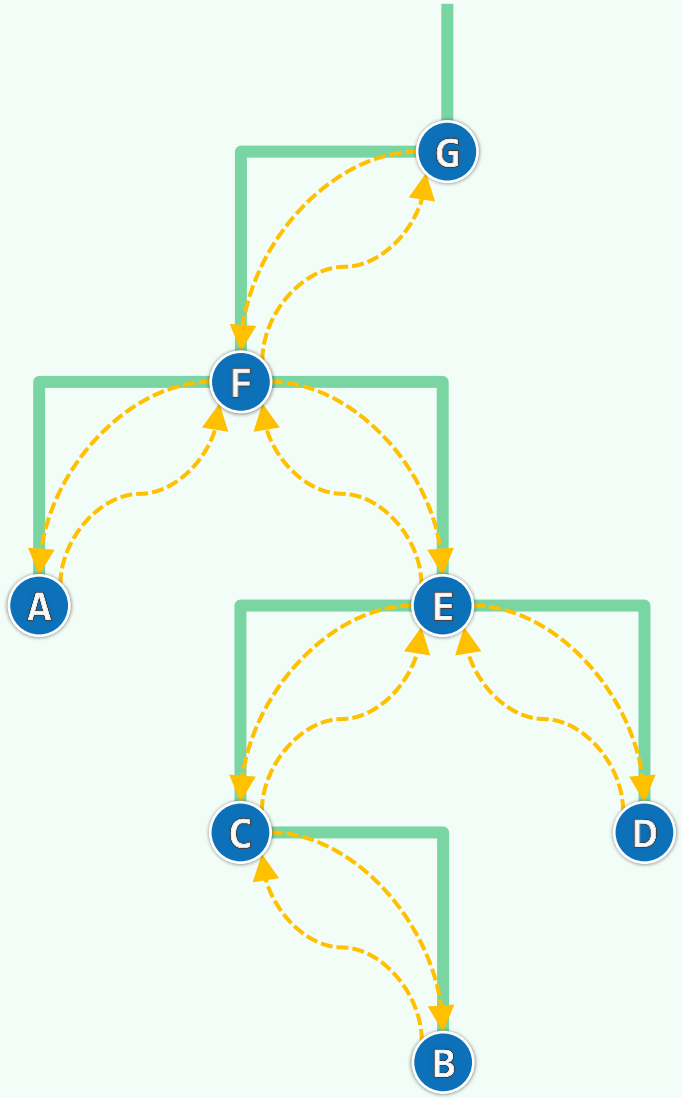
❖ 遍历结果 ~ 遍历过程 ~ 遍历次序 ~ 遍历策略

递归实现

❖ 应用：先序输出文件树结构：`c:\> tree.com c:\windows`

❖
```
template <typename T, typename VST>
void traverse( BinNodePosi<T> x, VST & visit ) {
    if ( ! x ) return;
    visit( x->data );
    traverse( x->lc, visit );
    traverse( x->rc, visit );
}
```





❖ $T(n) = \mathcal{O}(1) + T(a) + T(n - a - 1) = \mathcal{O}(n)$

❖ 挑战： 不依赖递归机制，能否实现先序遍历？如何实现？效率如何？

思路

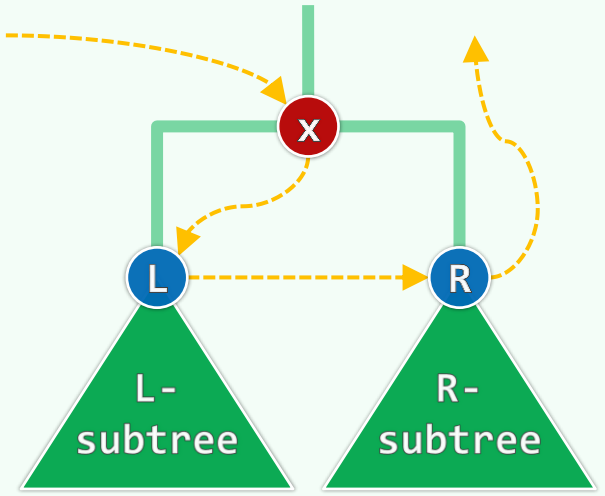
❖ 先序遍历任一二叉树T的过程，无非是

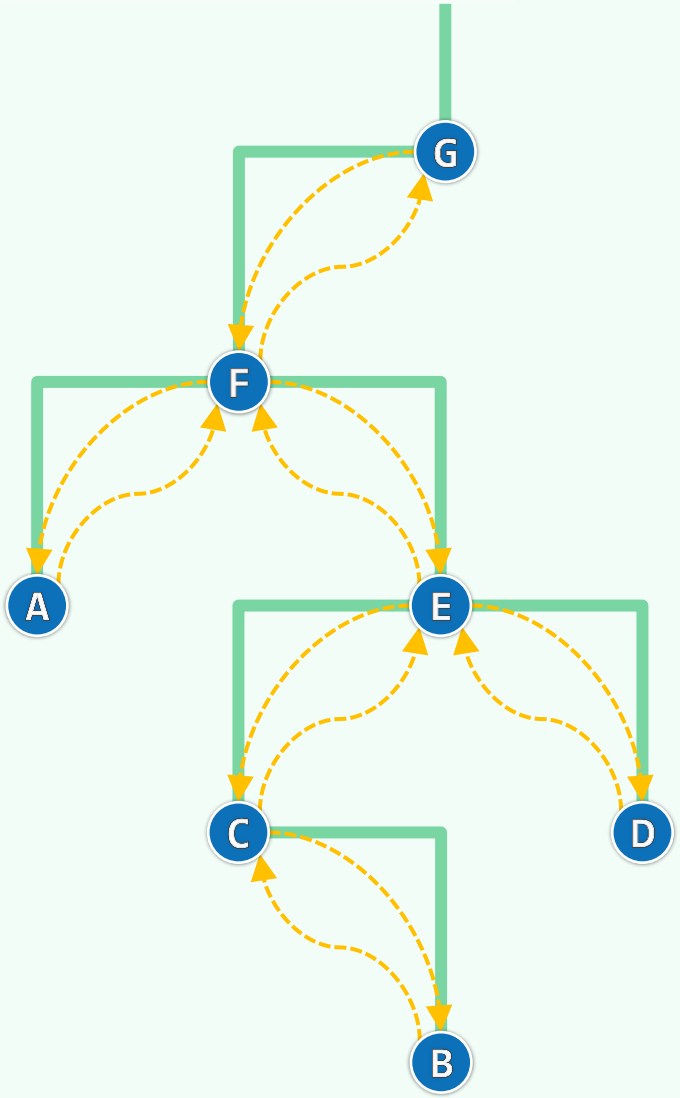
- 先访问根节点X
- 再先后递归地遍历T_L和T_R

❖ 递归实现中

对左、右子树的递归遍历

- 都类似于尾递归
- 故不难直接消除

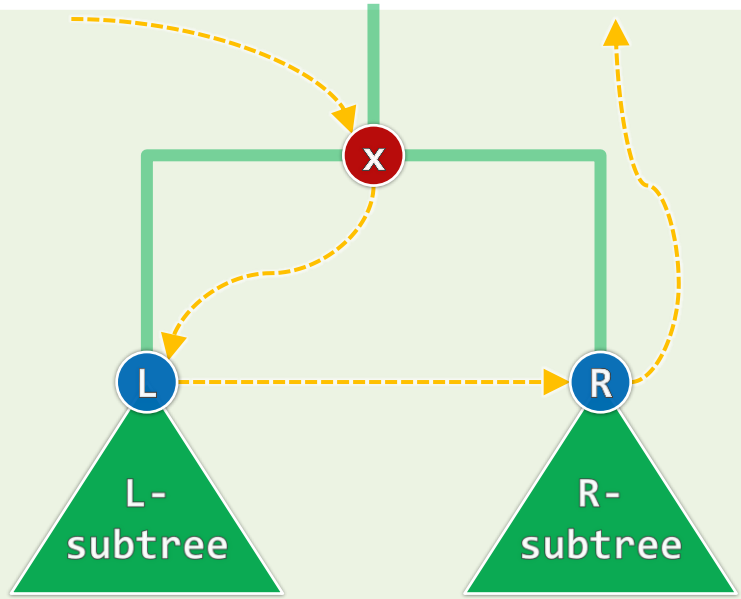




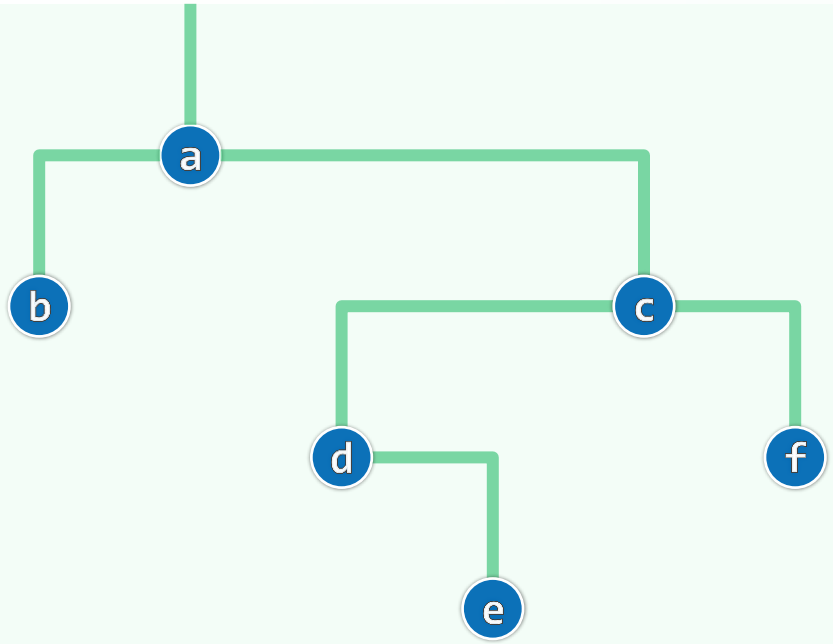
❖ 思路：二分递归 → 迭代 + 单递归 → 迭代 + 栈

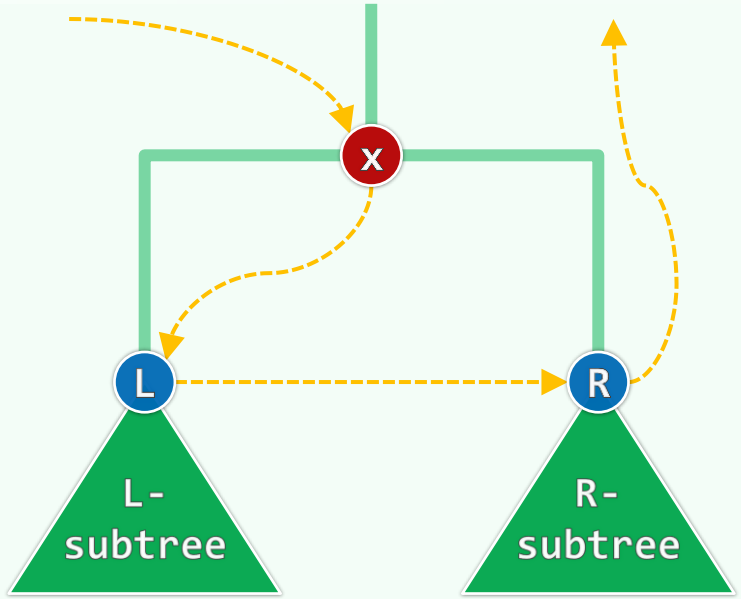
迭代算法A

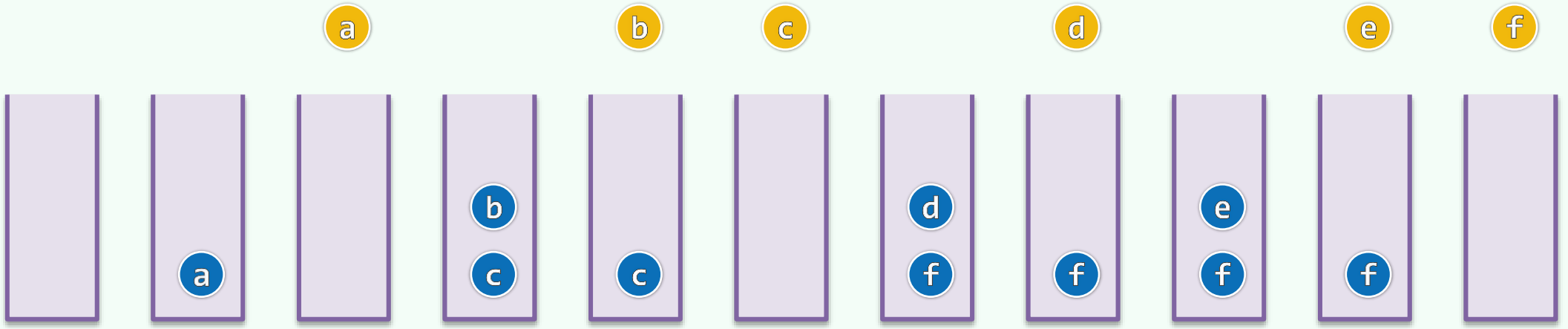
```
template <typename T, typename VST>
void travPre_I1( BinNodePosi<T> x, VST & visit ) {
   Stack < BinNodePosi<T> > S; //辅助栈
   if (x) S.push( x ); //根节点入栈
   while ( ! S.empty() ) { //在栈变空之前反复循环
      x = S.pop(); visit( x->data ); //弹出并访问当前节点
      if ( HasRChild( *x ) ) S.push( x->rc ); //右孩子先入后出
      if ( HasLChild( *x ) ) S.push( x->lc ); //左孩子后入先出
   } //体会以上两句的次序
}
```



实例







评价

- 正确性
  - 无遗漏：可按深度归纳证明，每个节点都会被访问到
  - 根优先：任一子树中，根被访问后才会访问其它节点
  - 左先右后：同一节点的左子树，先于右子树被访问
- 复杂度$O(n)$
  - 每步迭代，都有一个节点出栈并被访问
  - 每个节点入/出栈一次且仅一次
  - 每步迭代只需$O(1)$时间
- 很遗憾，以上消除递归的思路**不易推广**，需另寻他法...