左角分析算法

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D. J. Rosenkrantz and P. M. Lewis II.,1970, Deterministic left corner parsing. In IEEE Conference Record of the 11th Annual Symposium on Switching and Automata Theory, pages 139--152, 1970.

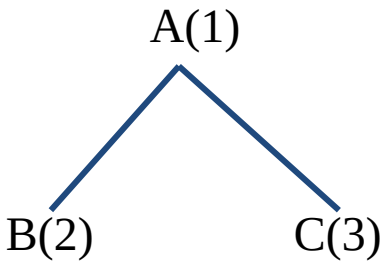
Mark-Jan Nederhof, 1993, Generalized left-corner parsing. In 6th Meeting of the European Association of Computational Linguistics (ACL), pages 305--314, Utrecht, Netherlands, 1993. 20

John Nerbonne, Computational Semantics, In The Handbook of Contemporary Semantic Theory, ed. by Shalom Lappin, Blackwell Publishers Ltd., 1996, p479.

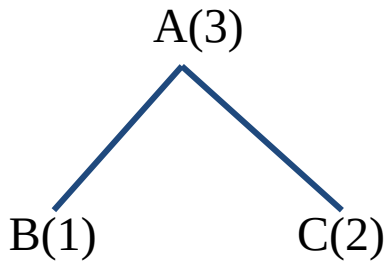
左角分析法

- 左角分析法是一种自顶向下和自底向上相结合的方法
- 所谓“左角(Left Corner)”是指任何一个句法子树中左下角的那个符号
- 比较：

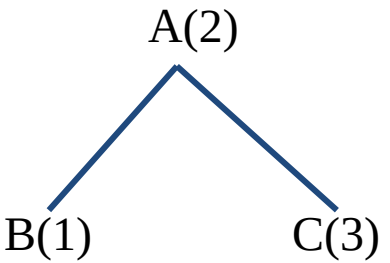
自顶向下分析法



自底向上分析法



左角分析法



左角分析法-基本思想

1 由箭头右部最左的非终结符去调用规则（自底向上，然后向下）

2 由终结符触发归约（即当碰到适合的终结符时，一条规则被满足）；

3 只有被满足的非终结符节点，才能进一步触发归约；

4 从历史上形成的离当前处理节点最近的最大的子树根节点开始回溯

5 回溯就是断开已经形成的子树的右分支（right branch），由右分支节点（非终结符或终结符）开始，重新调用规则进行预测（等待归约）

规则被满足指的是规则根节点覆盖了终结符序列中的一个子串

左角分析法-算法描述1

表示B是A的左角
比如S-> NP VP,
则 NP L^* S

la. If the element on top of the stack is the nonterminal **A** and if the first symbol of the remaining input is **t**, then we may remove **t** from the input and push an item [B $\rightarrow$ t • α] onto the stack,provided B L^* A.

lb. If the element on top of the stack is the nonterminal **A**, then we may push an item [B $\rightarrow$ •] onto the stack, provided B L^* A. (The item [B $\rightarrow$ •] is derived from an epsilon rule B $\rightarrow \varepsilon$)

2. If the element on top of the stack is the item [A$\rightarrow \alpha$• t β] and if the first symbol of the remaining input is **t**, then we may remove **t** from the input and replace the item by the item [A$\rightarrow \alpha$ t • β].

3. If the top-most two elements on the stack are B [A$\rightarrow \alpha$•], then we may replace the item by an item of the form [C $\rightarrow$ A • β], provided C L^* B.

4. If the top-most three elements on the stack are [B $\rightarrow \beta$ • Aγ] A [A $\rightarrow \alpha$ •], then we may replace these three elements by the item [B $\rightarrow \beta$ A • γ].

5. If a step according to one of the previous clauses ends with an item [A $\rightarrow \alpha$ • B β] on top of the stack, where B is a nonterminal, then we subsequently push B onto the stack.

6. If the stack consists only of the two elements S[S $\rightarrow \alpha$ •] and if the input has been completely read, then we may successfully terminate the parsing process.

左角分析法-算法描述2

```
Proc LC_Parse(α:nonterminal-category)
        begin
                read next word W;
                CAT ← CAT(W);
                if CAT = α      then SUCCESS
                else
                        if IS-LC(CAT, α)  then      expand_lc(CAT, α)
                        else FAIL
                        endif
                endif
        end LC_Parse

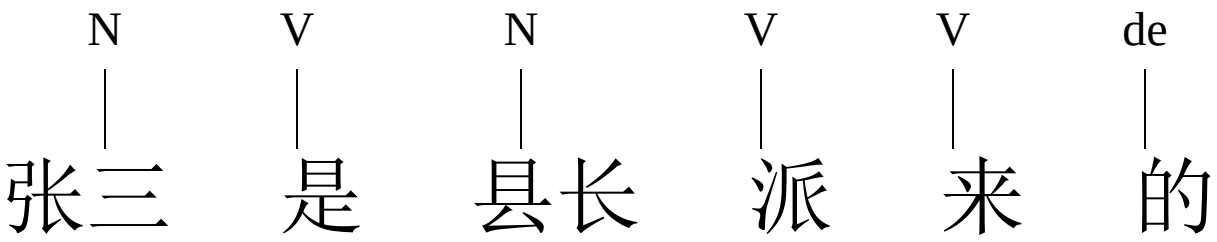
Proc expand-lc(CAT,goal)
        begin
                for-each rule  β→ CAT γ
                        if IS-LC(CAT, goal)  then
                                LC_Parse(γ);
                                if end-of-input  then       SUCCESS
                                else expand-lc(β,goal)
                                endif
                        endif
                end-for-each
        end expand-lc
```

IS-LC(A,B)函数
用来判断
A是否为B的左角

左角分析法示例-1

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

查词典

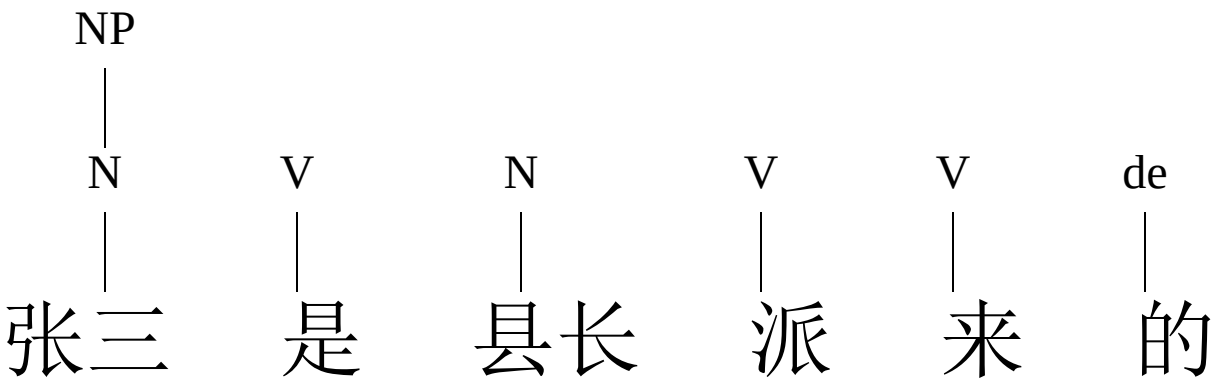


左角分析法示例-2

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

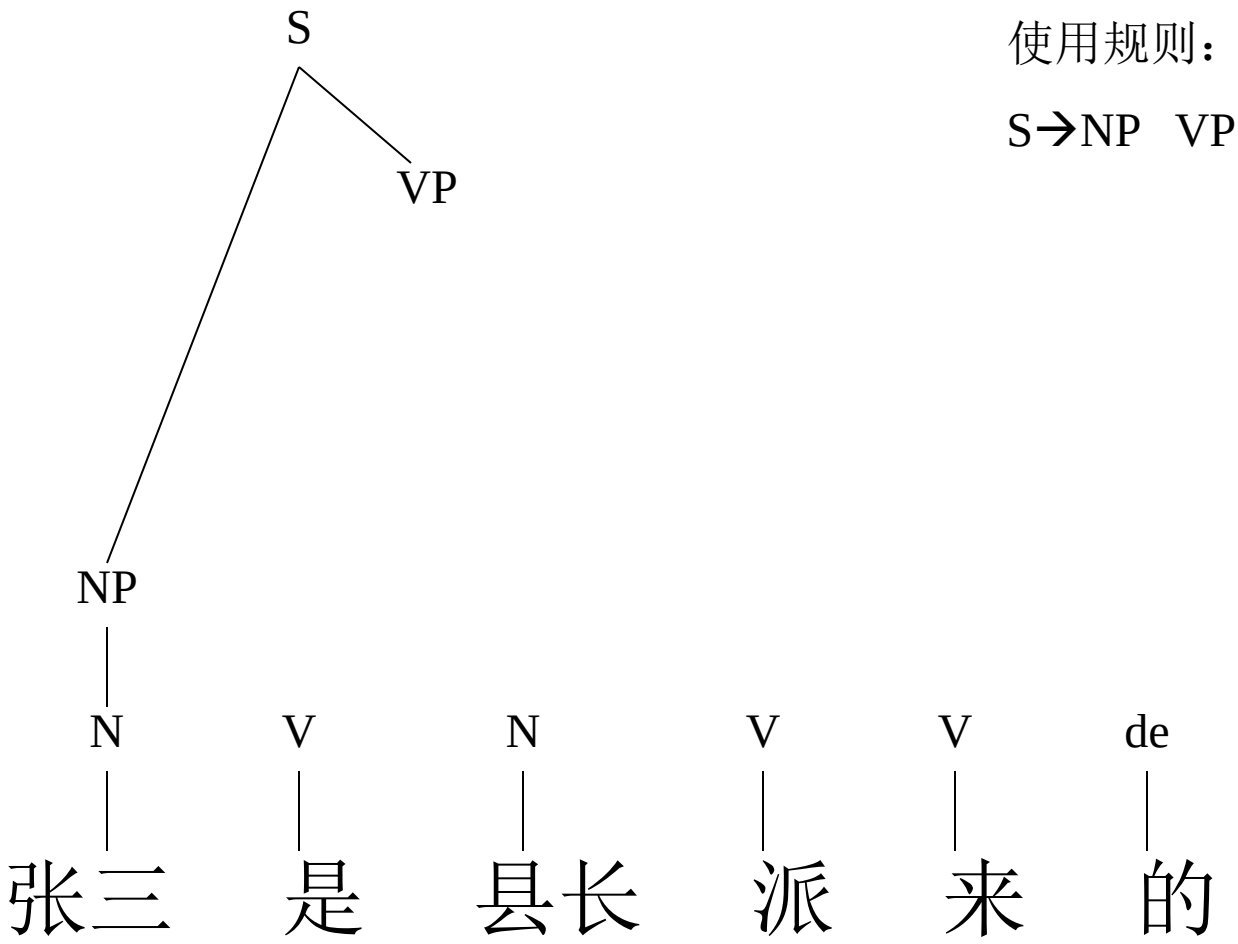
使用规则：

NP→N



左角分析法示例-3

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V



使用规则：

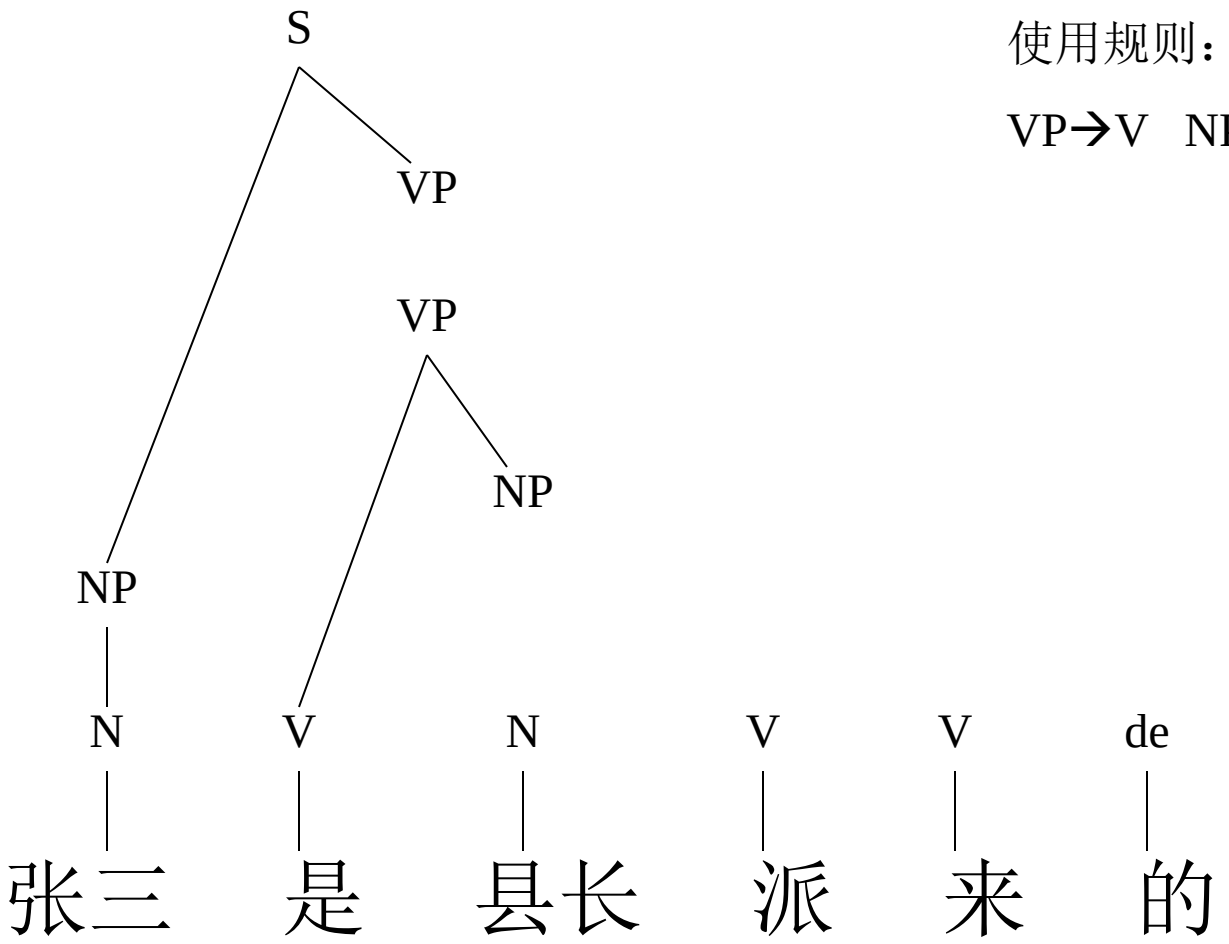
S→NP VP

左角分析法示例-4

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则：

VP→V NP

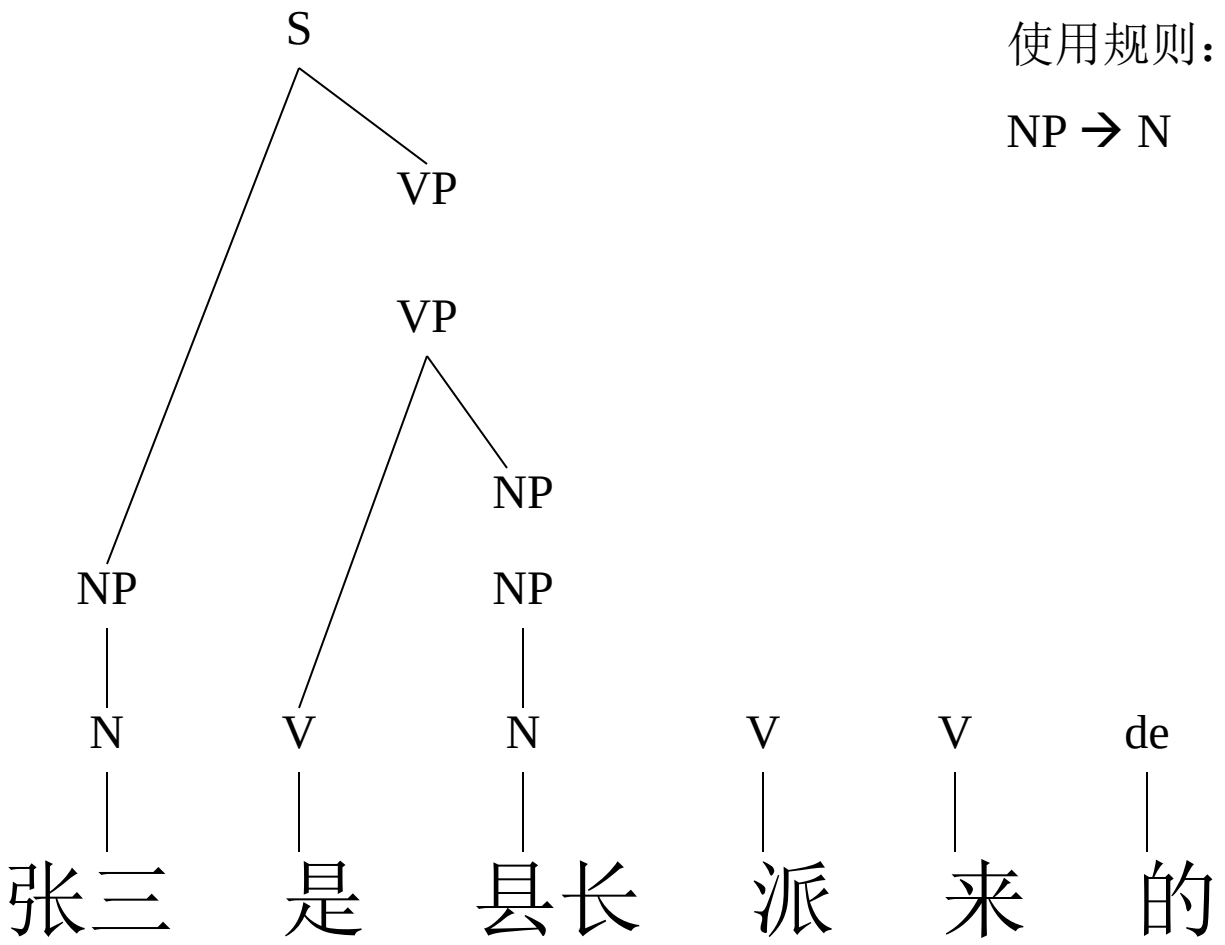


左角分析法示例-5

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

使用规则：

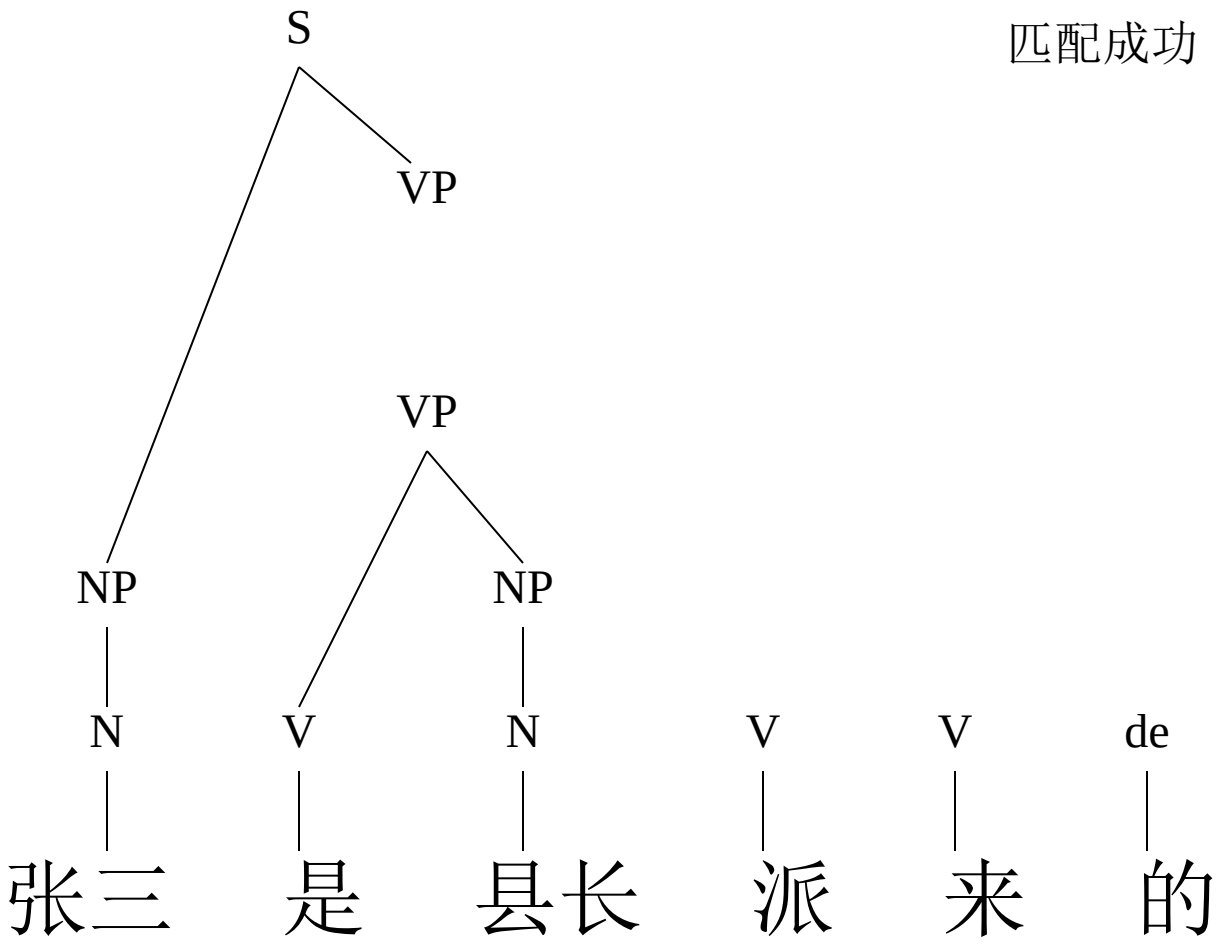
NP → N



左角分析法示例-6

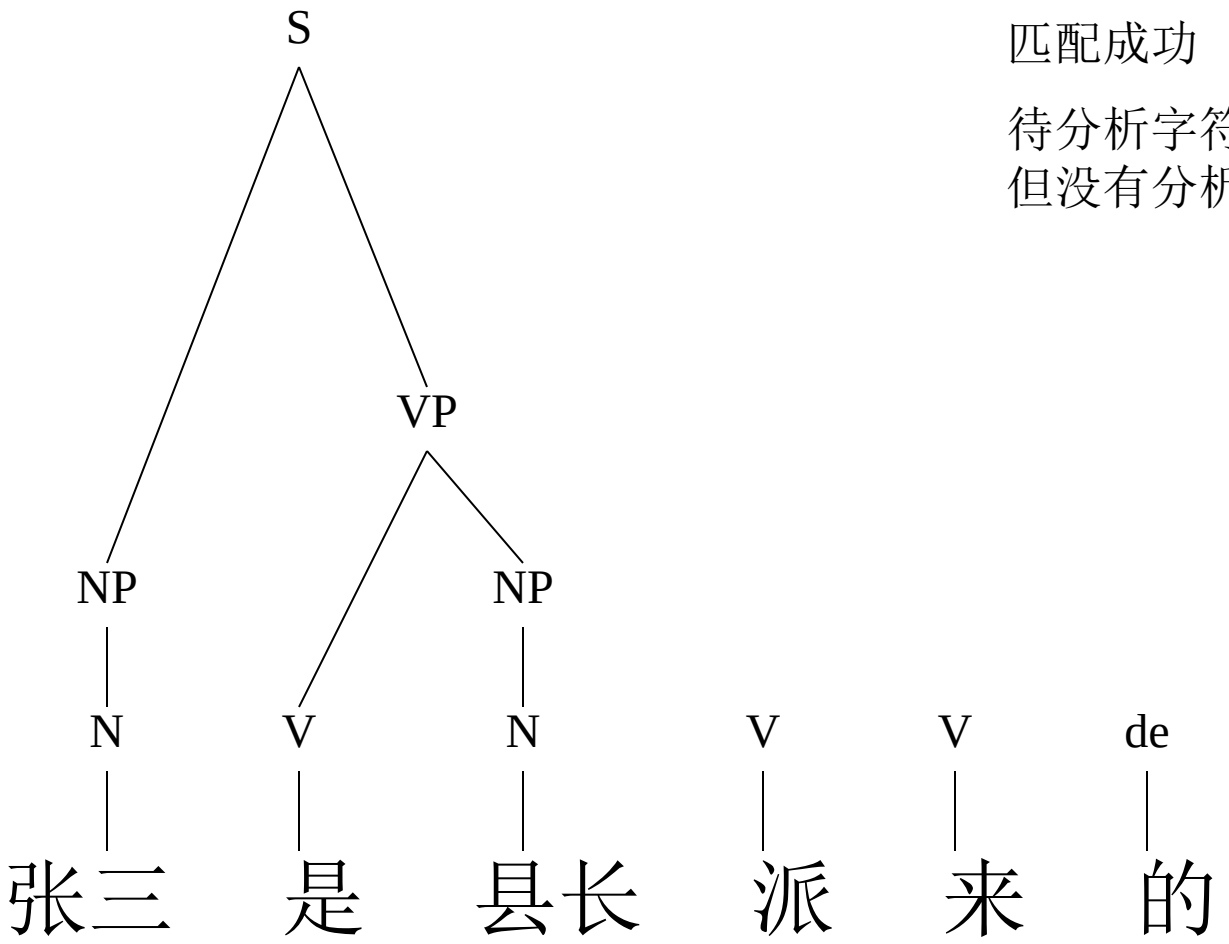
(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

匹配成功



左角分析法示例-7

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V



匹配成功

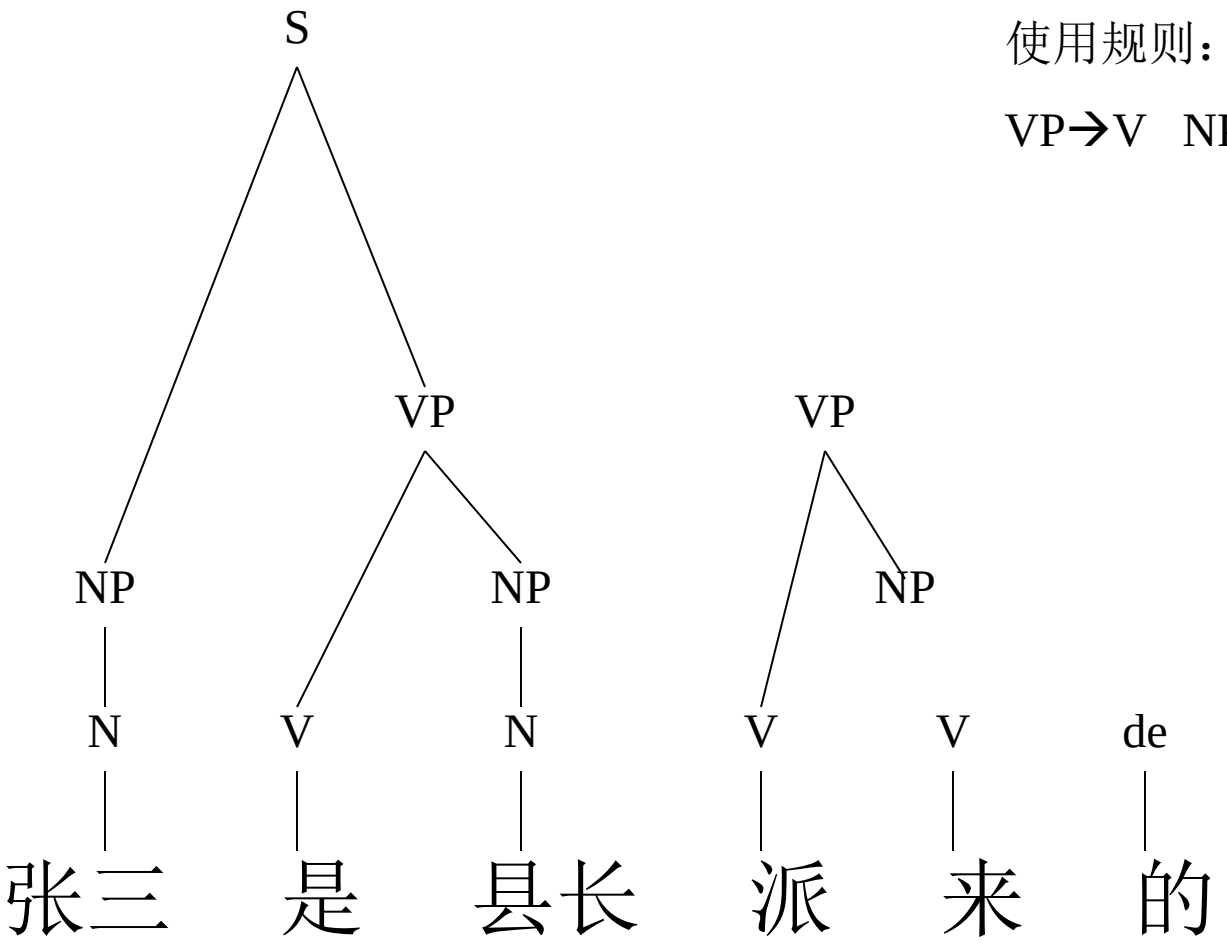
待分析字符串归结为S，
但没有分析完，继续扫描

左角分析法示例-8

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则：

VP→V NP

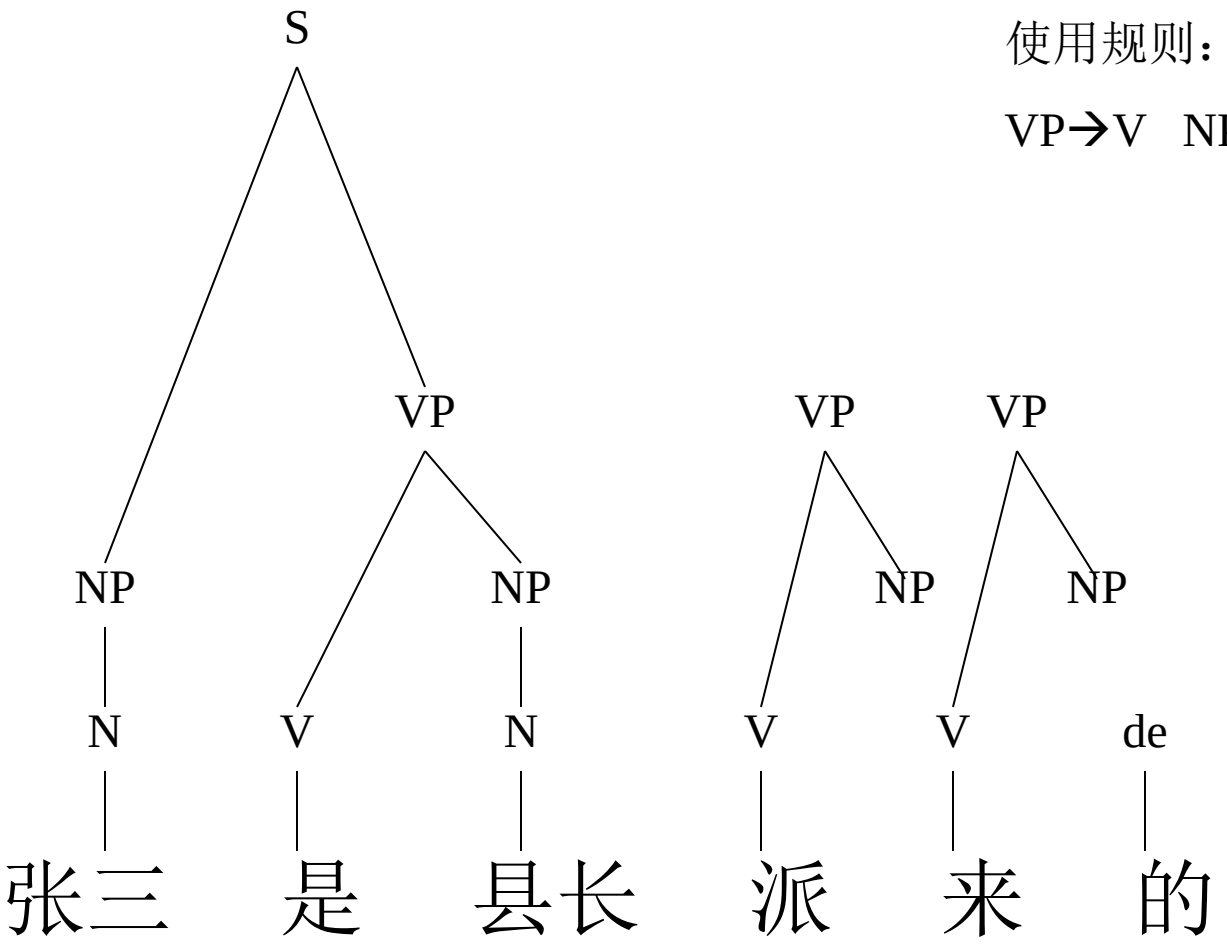


左角分析法示例-9

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则：

VP→V NP

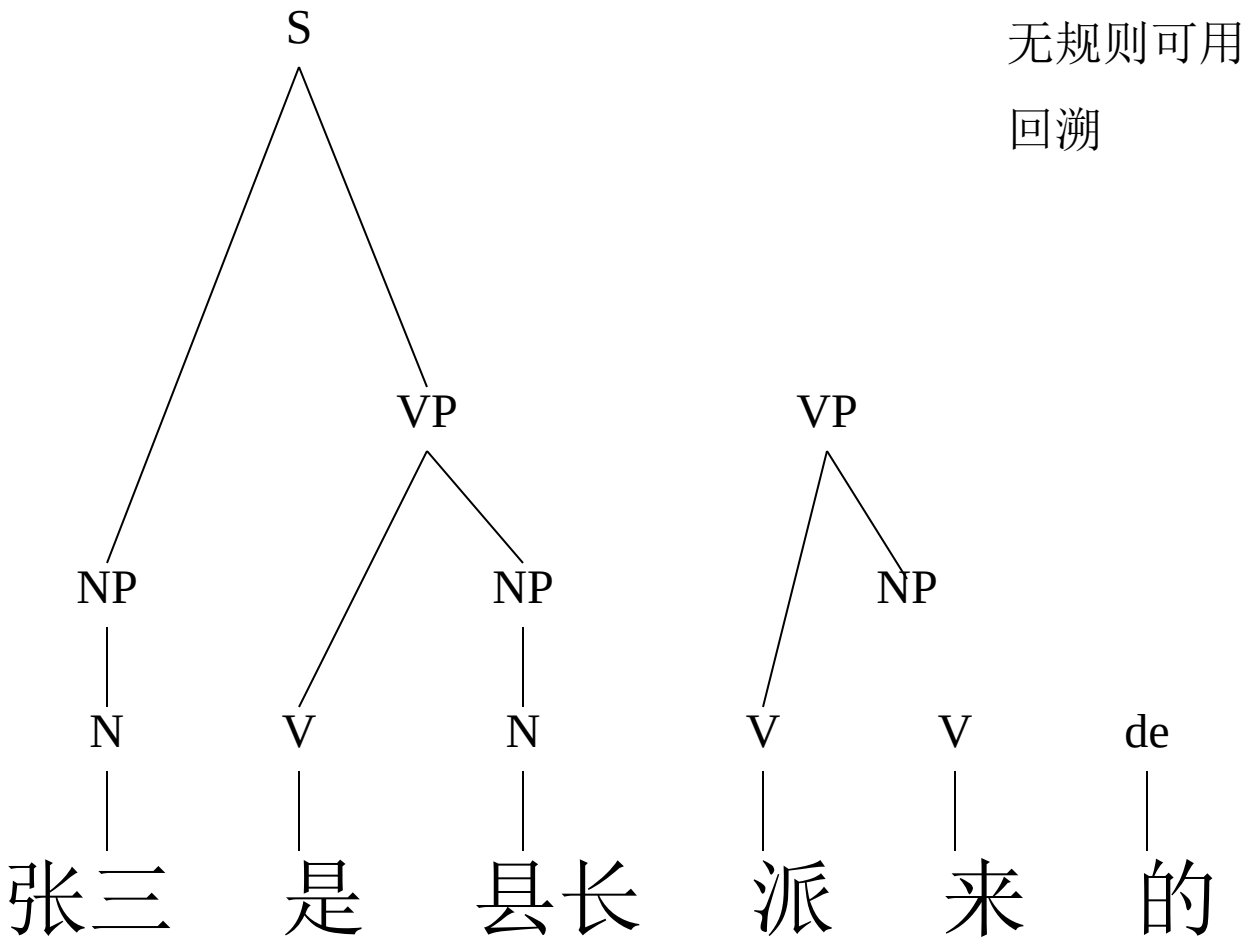


左角分析法示例-10

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

无规则可用

回溯

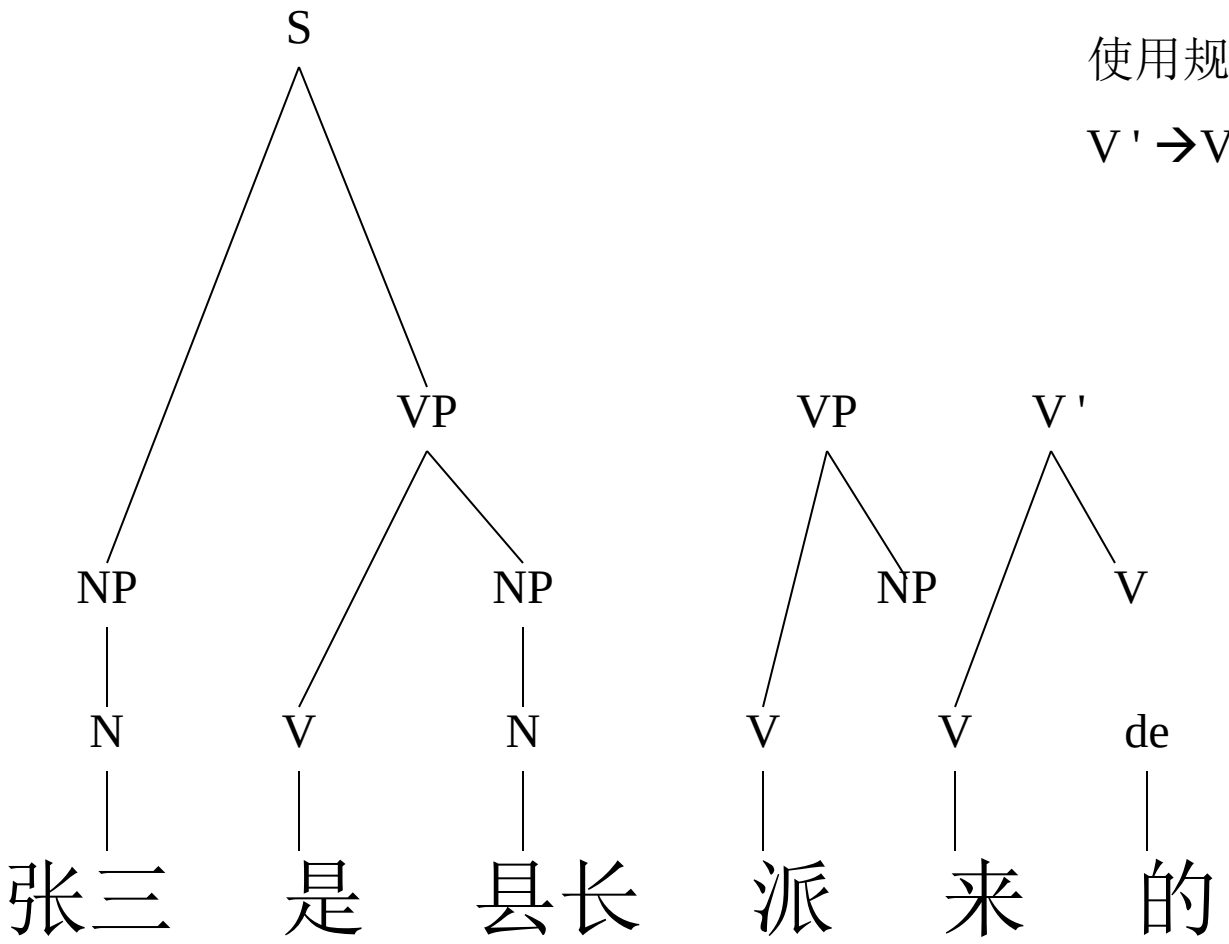


左角分析法示例-11

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

使用规则

V ' →V V

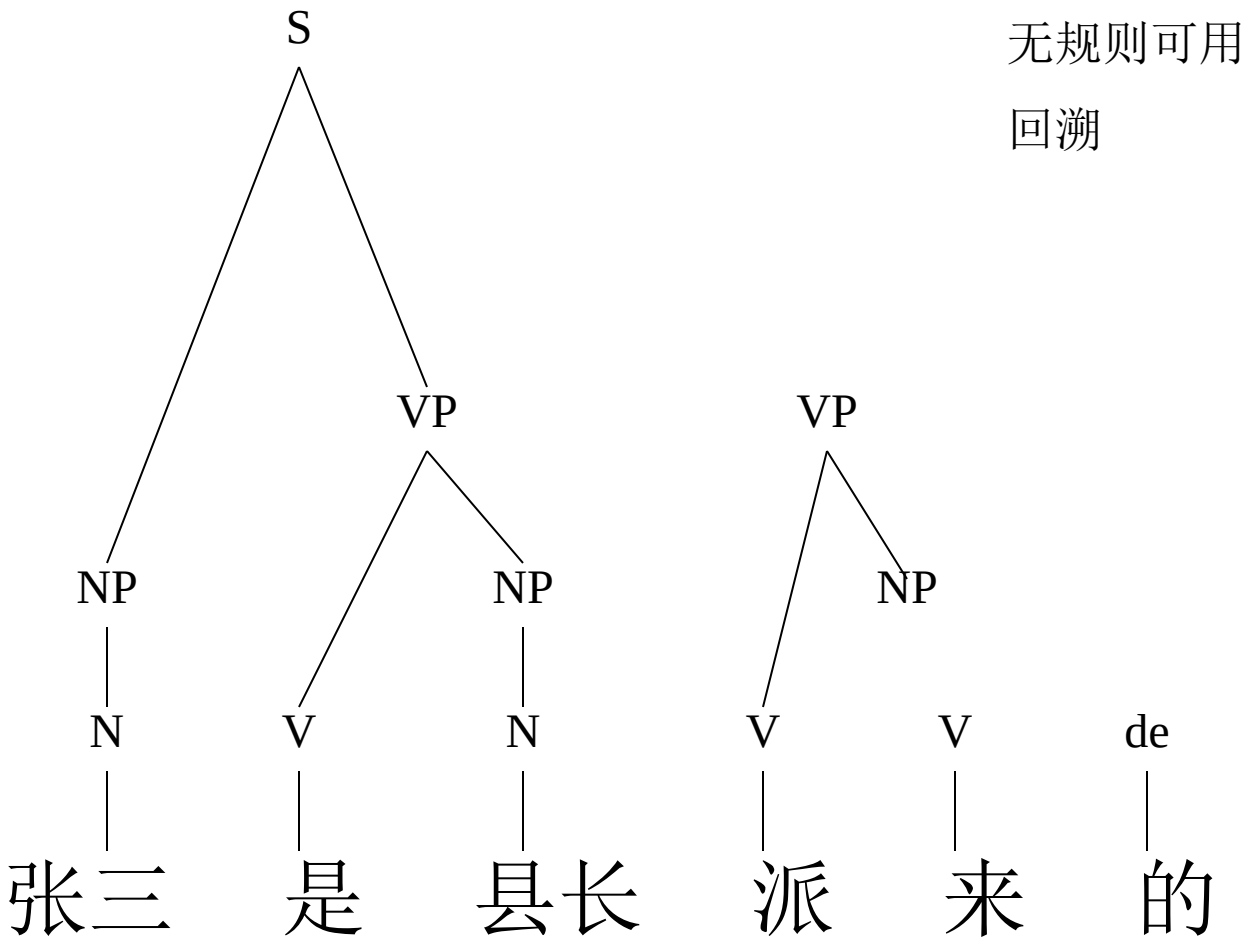


左角分析法示例-12

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

无规则可用

回溯

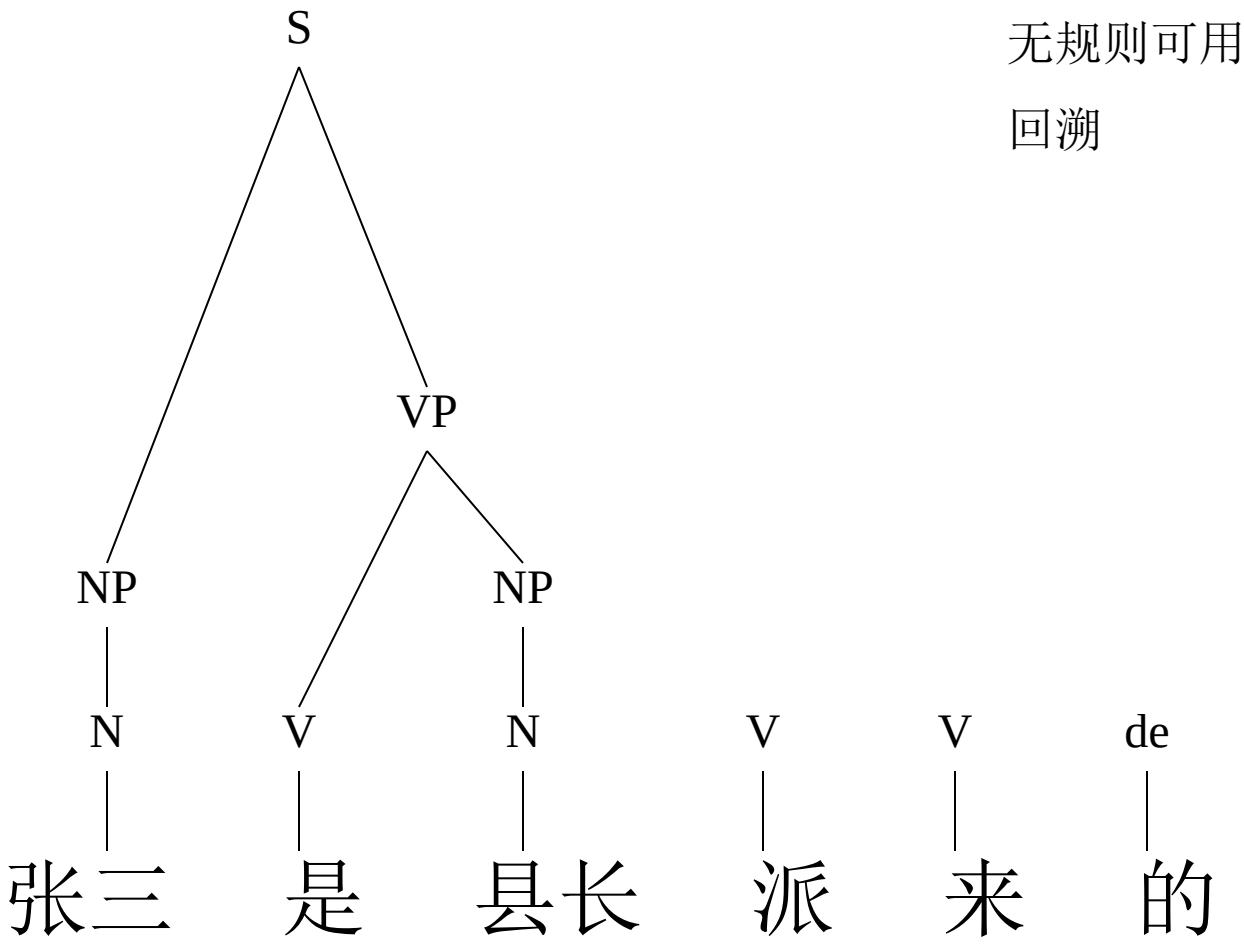


左角分析法示例-13

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

无规则可用

回溯

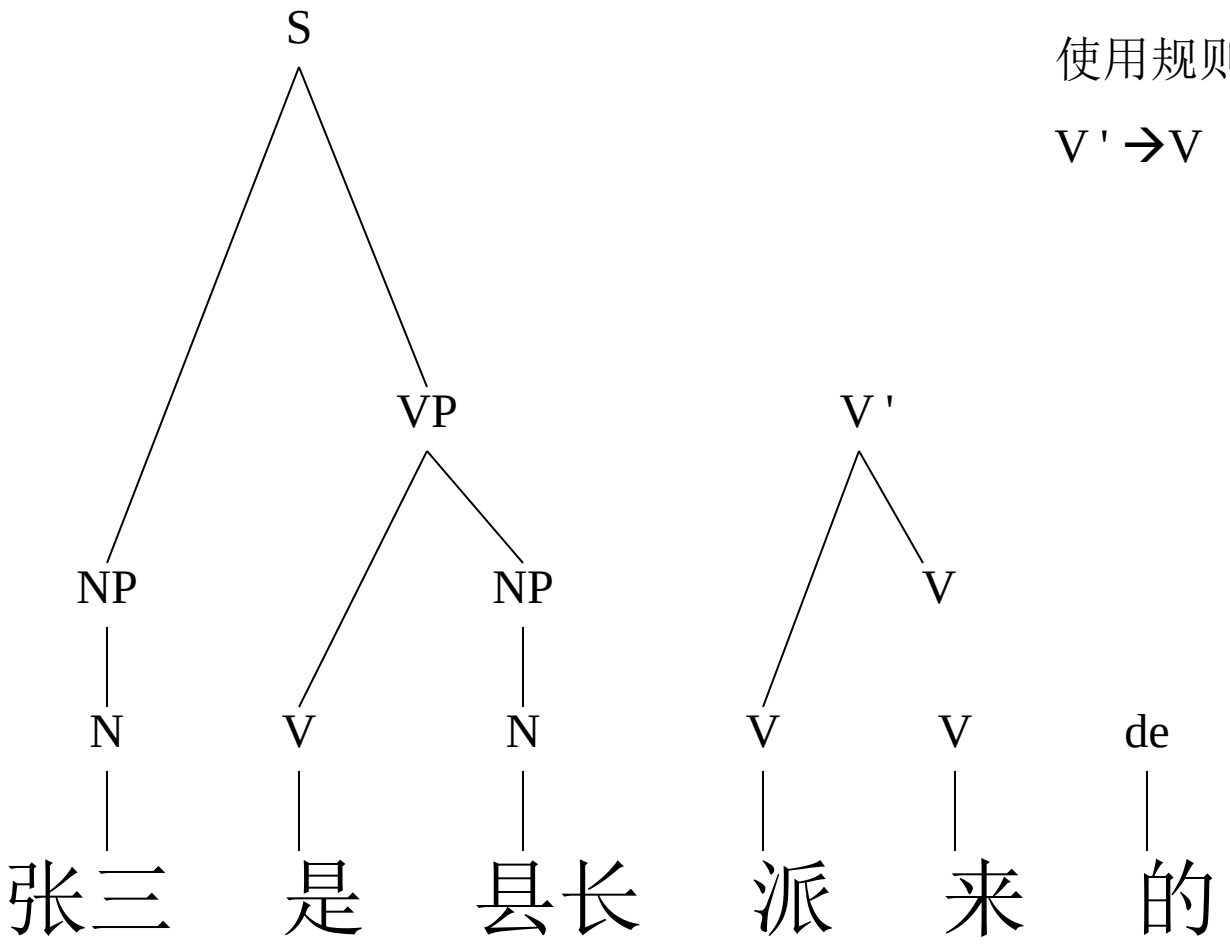


左角分析法示例-14

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则

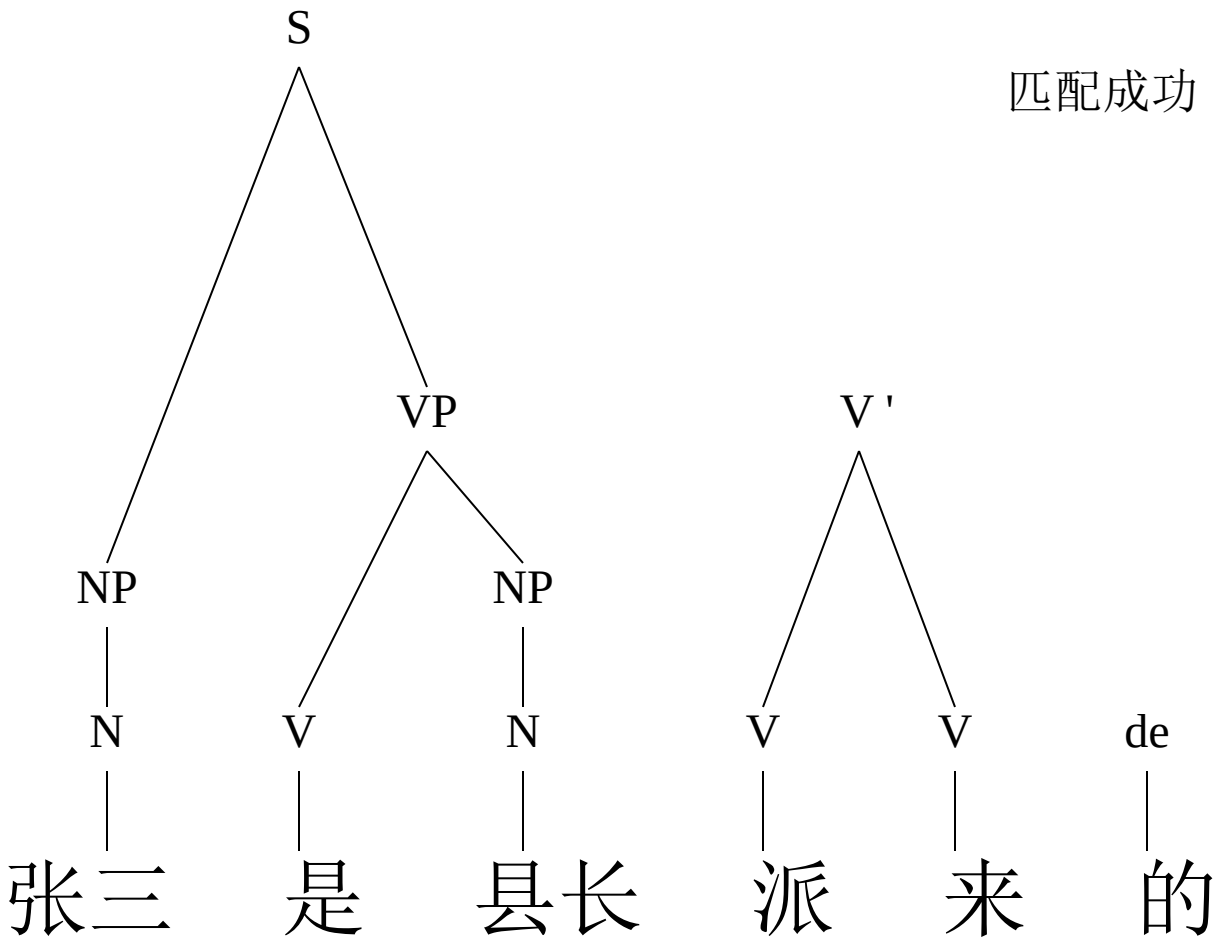
V' →V V



左角分析法示例-15

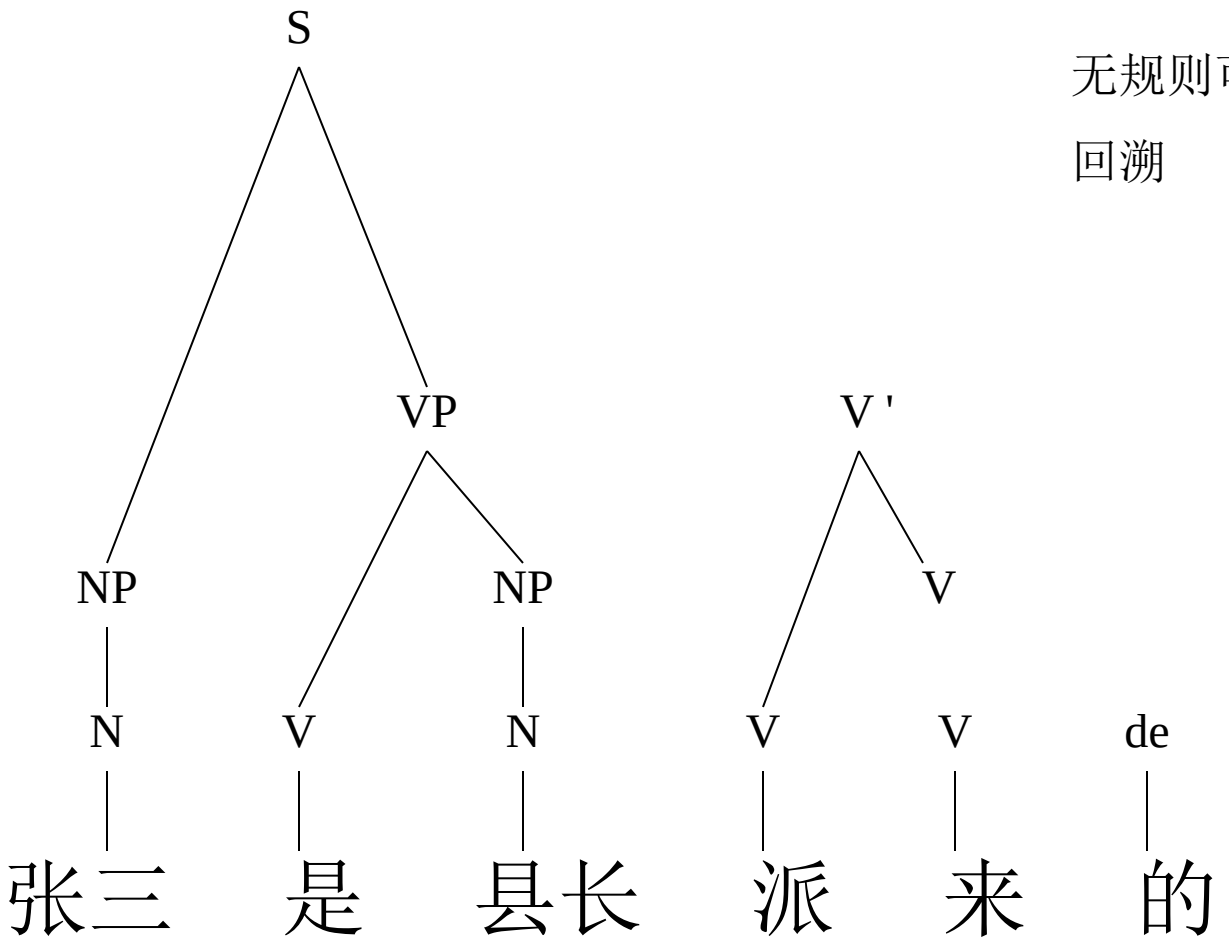
(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

匹配成功



左角分析法示例-16

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V



无规则可用

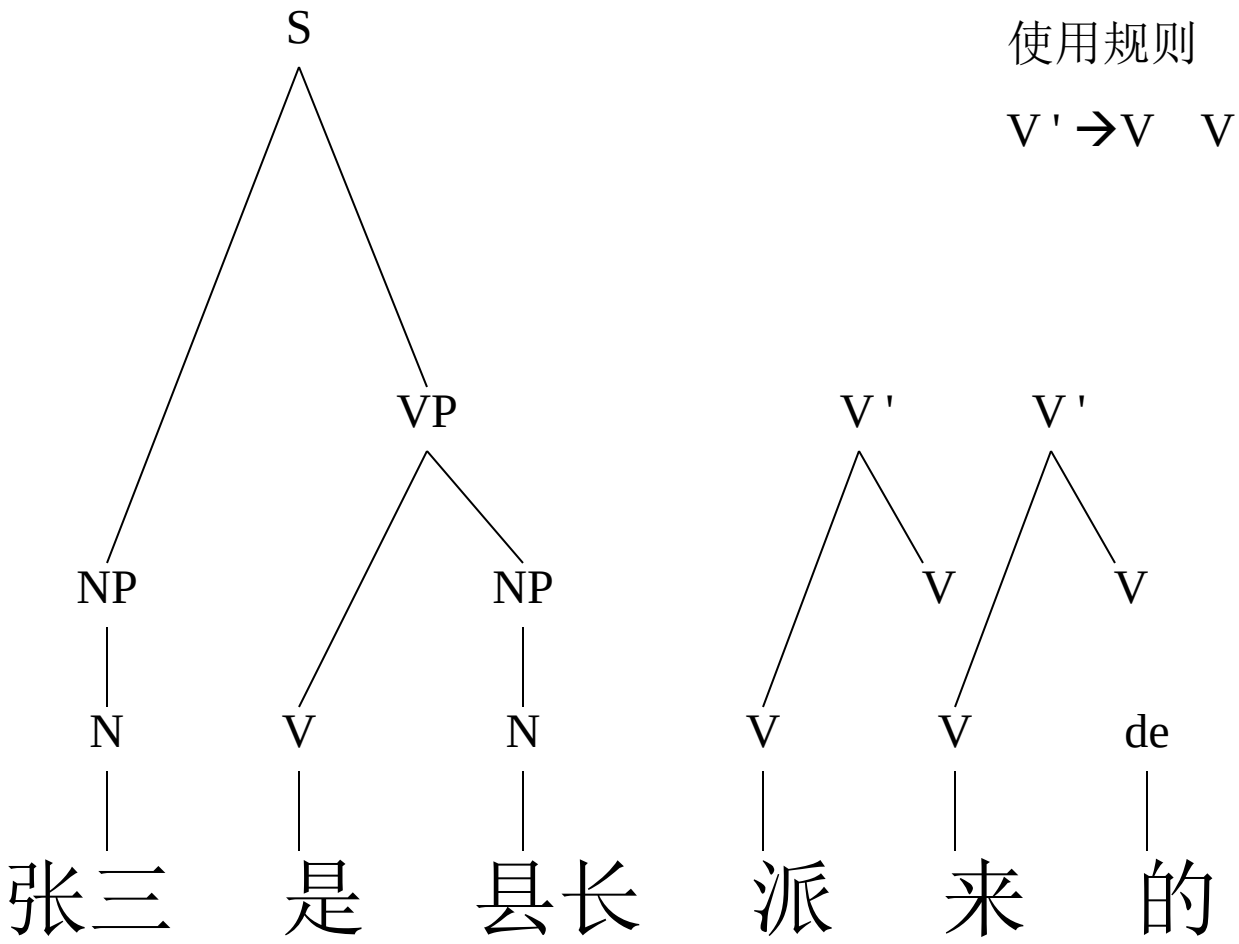
回溯

左角分析法示例-17

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则

V' →V V

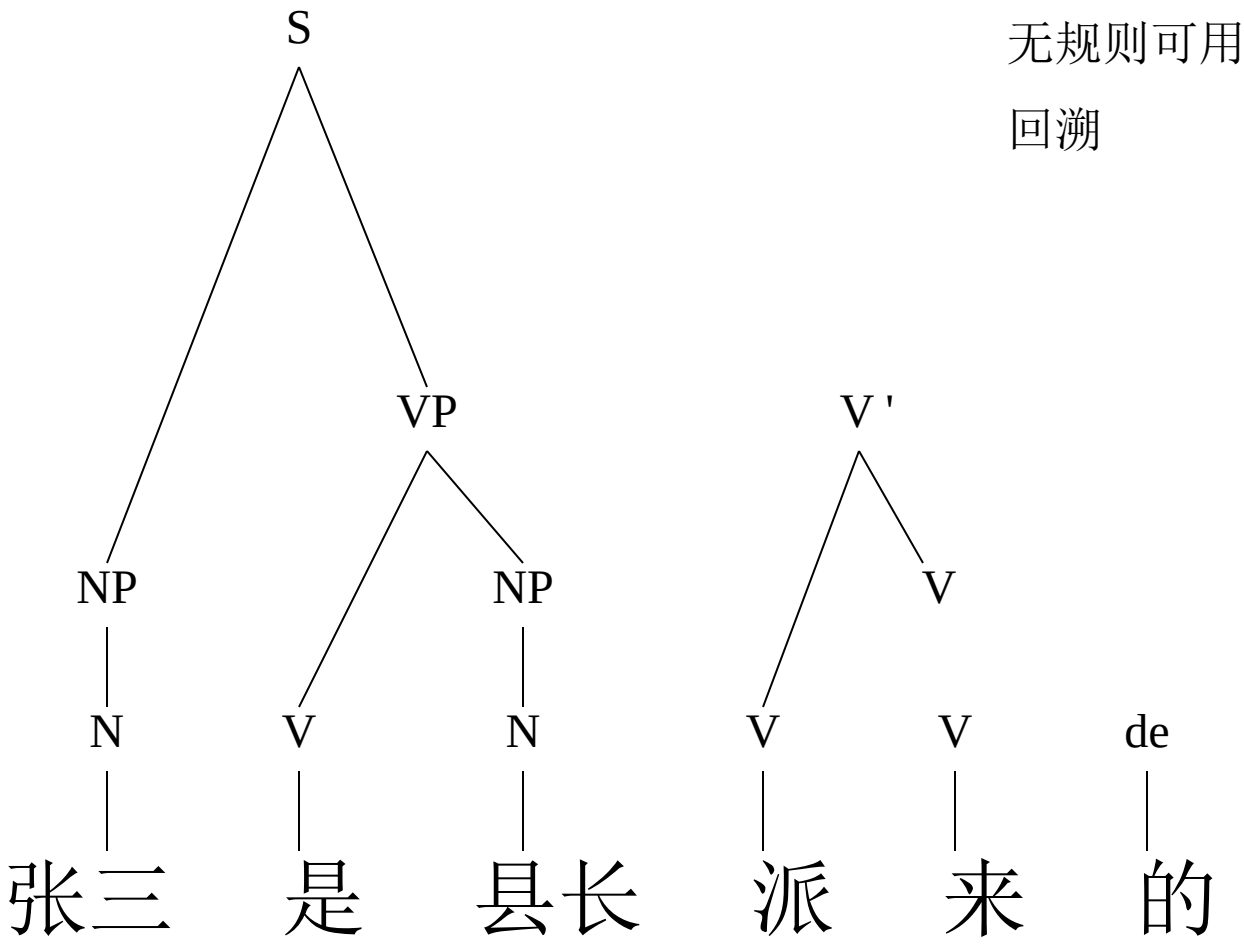


左角分析法示例-18

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

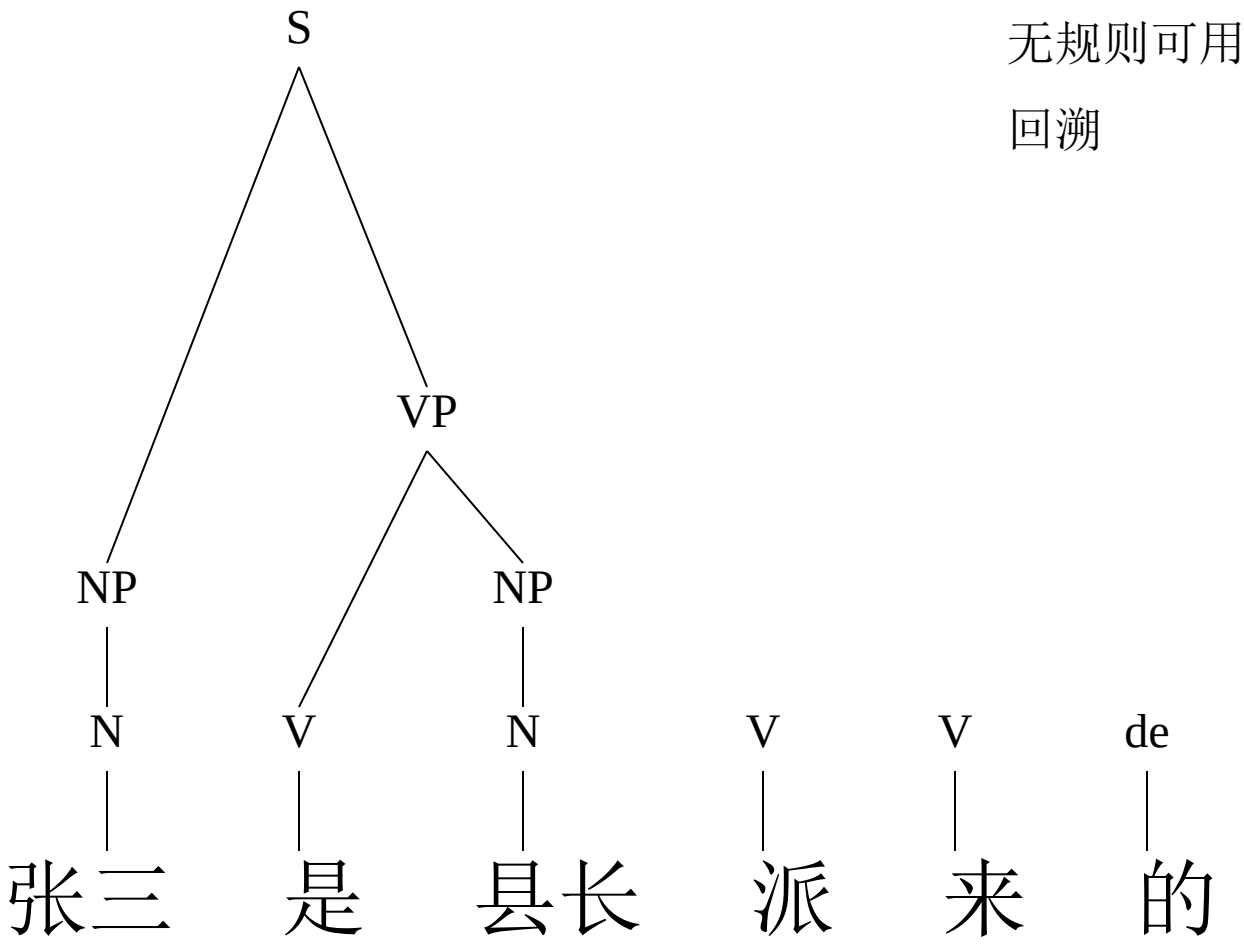
无规则可用

回溯



左角分析法示例-19

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V



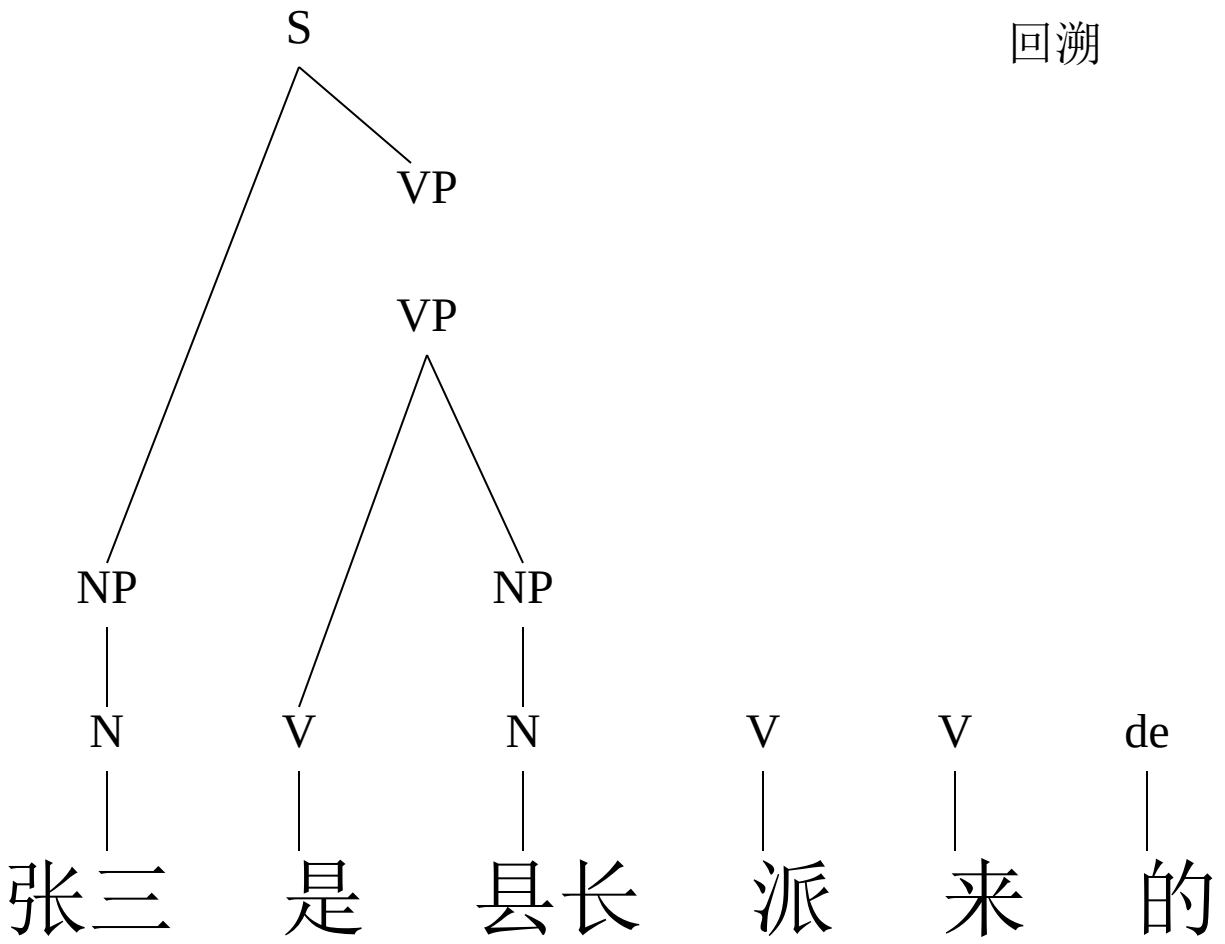
无规则可用

回溯

左角分析法示例-20

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

回溯

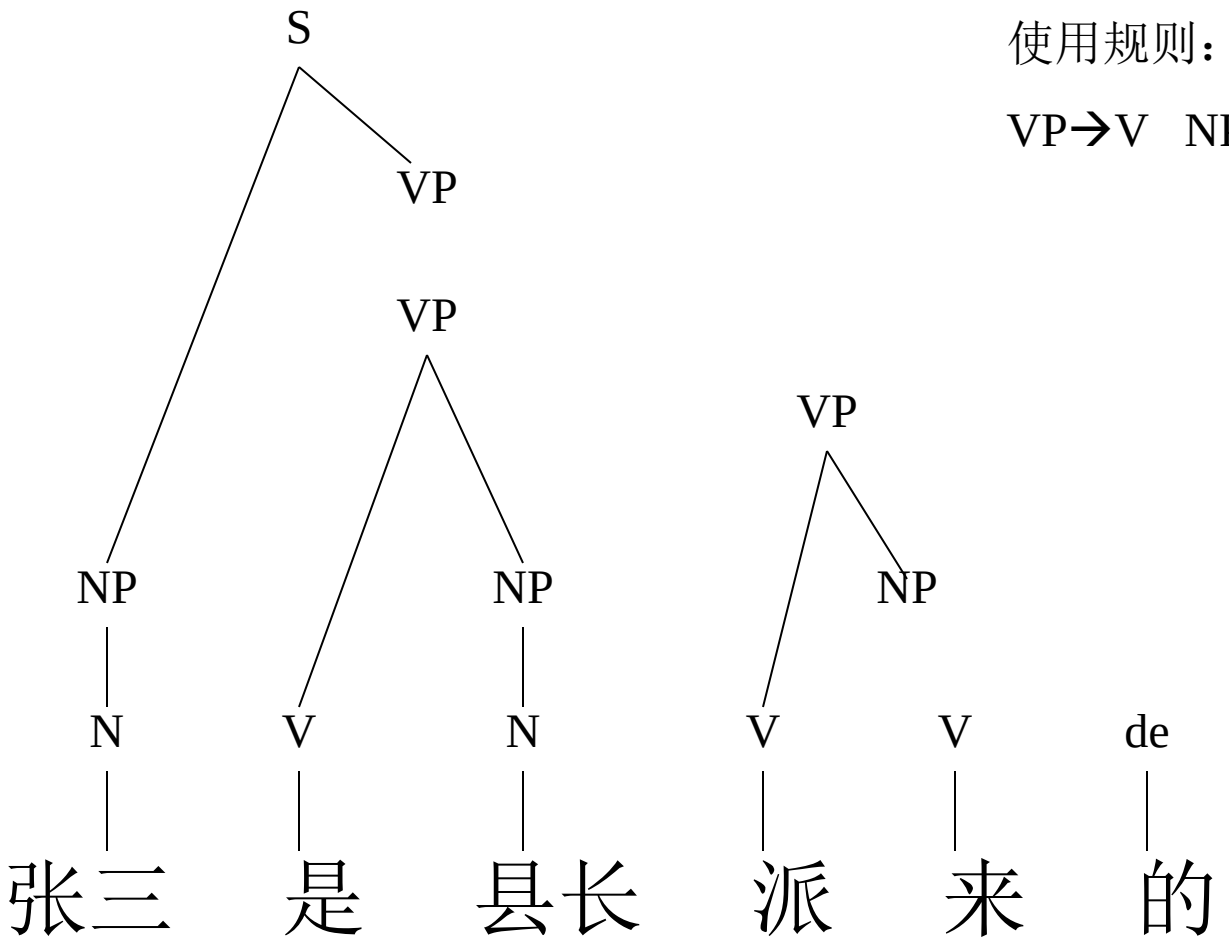


左角分析法示例-21

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则：

VP→V NP

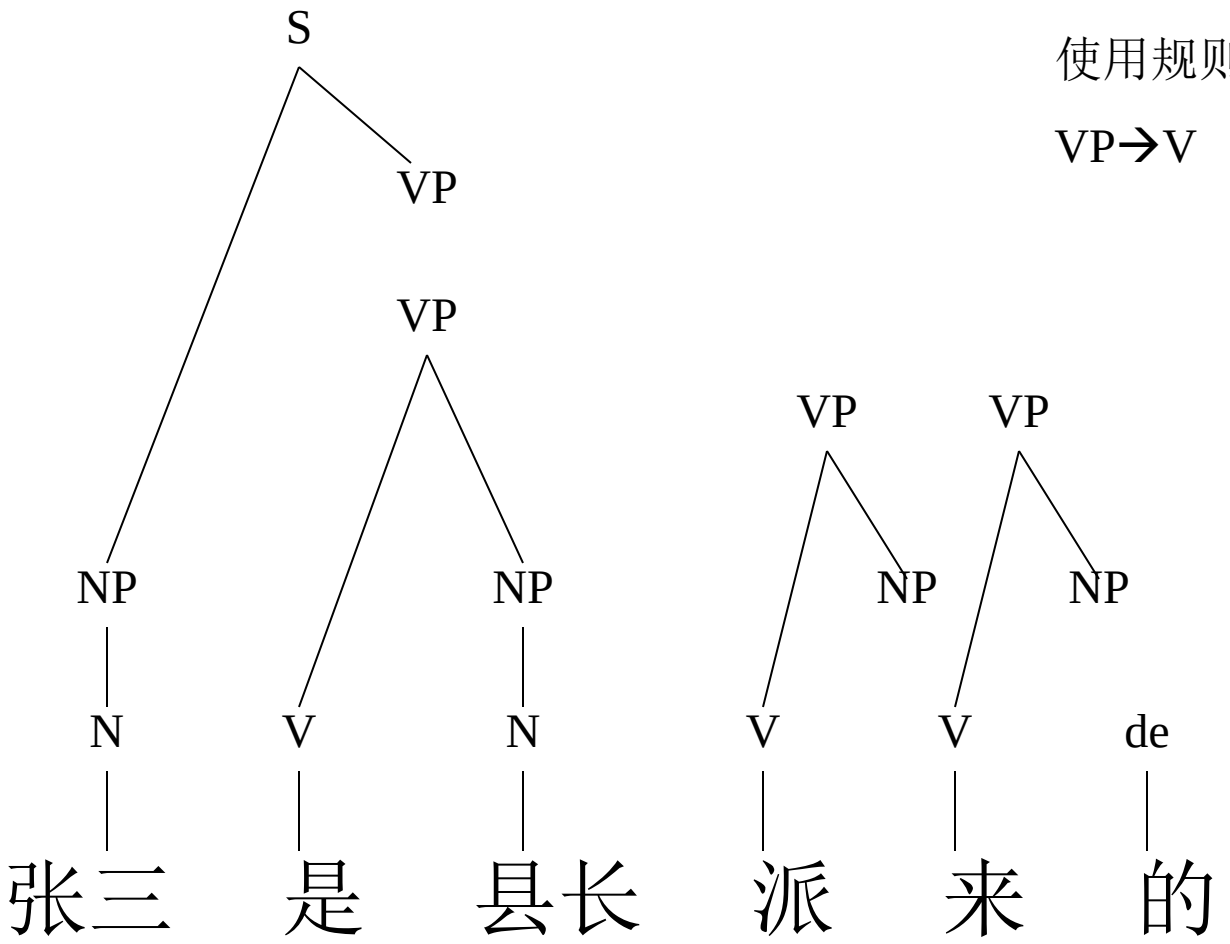


左角分析法示例-22

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则：

VP→V NP

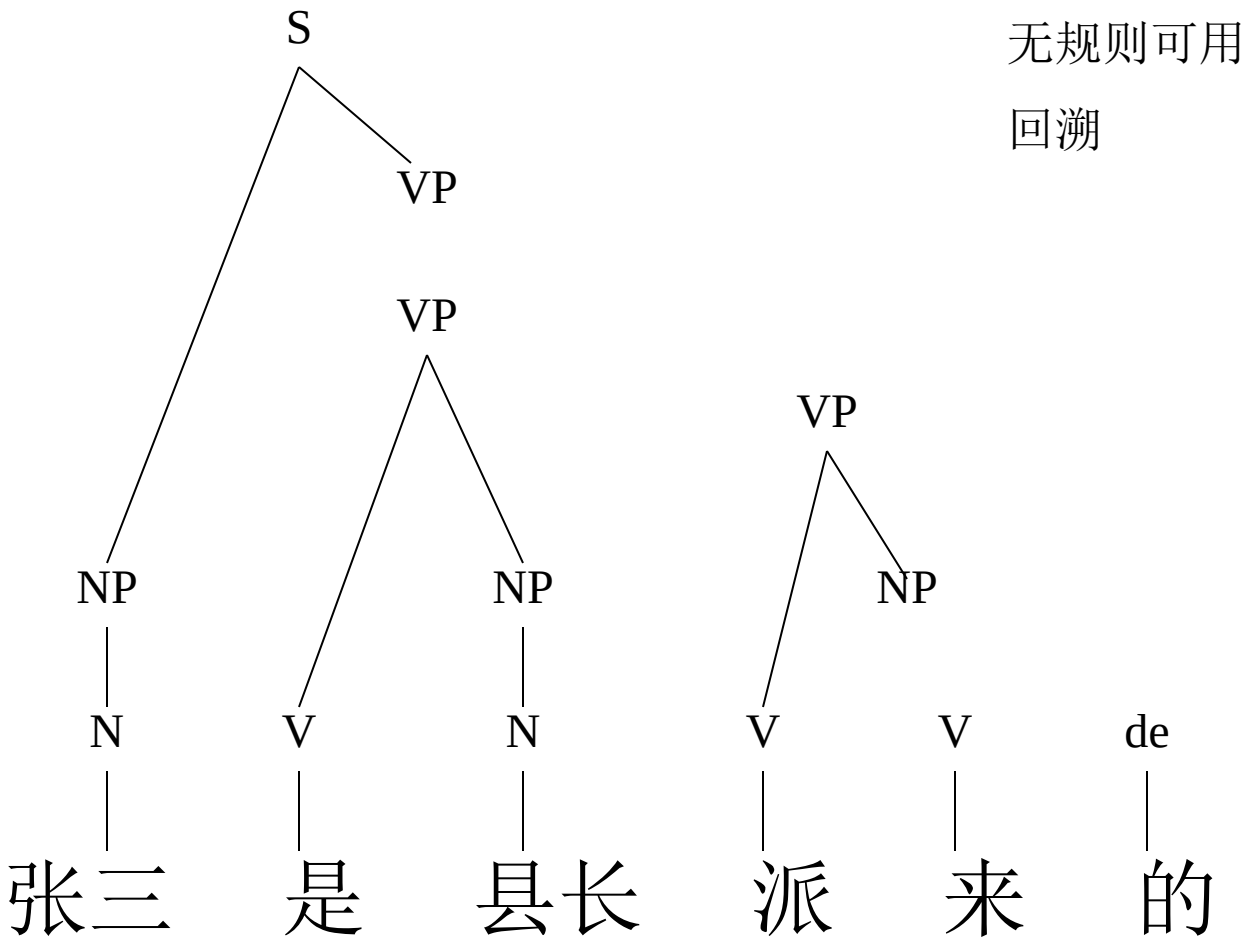


左角分析法示例-23

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

无规则可用

回溯

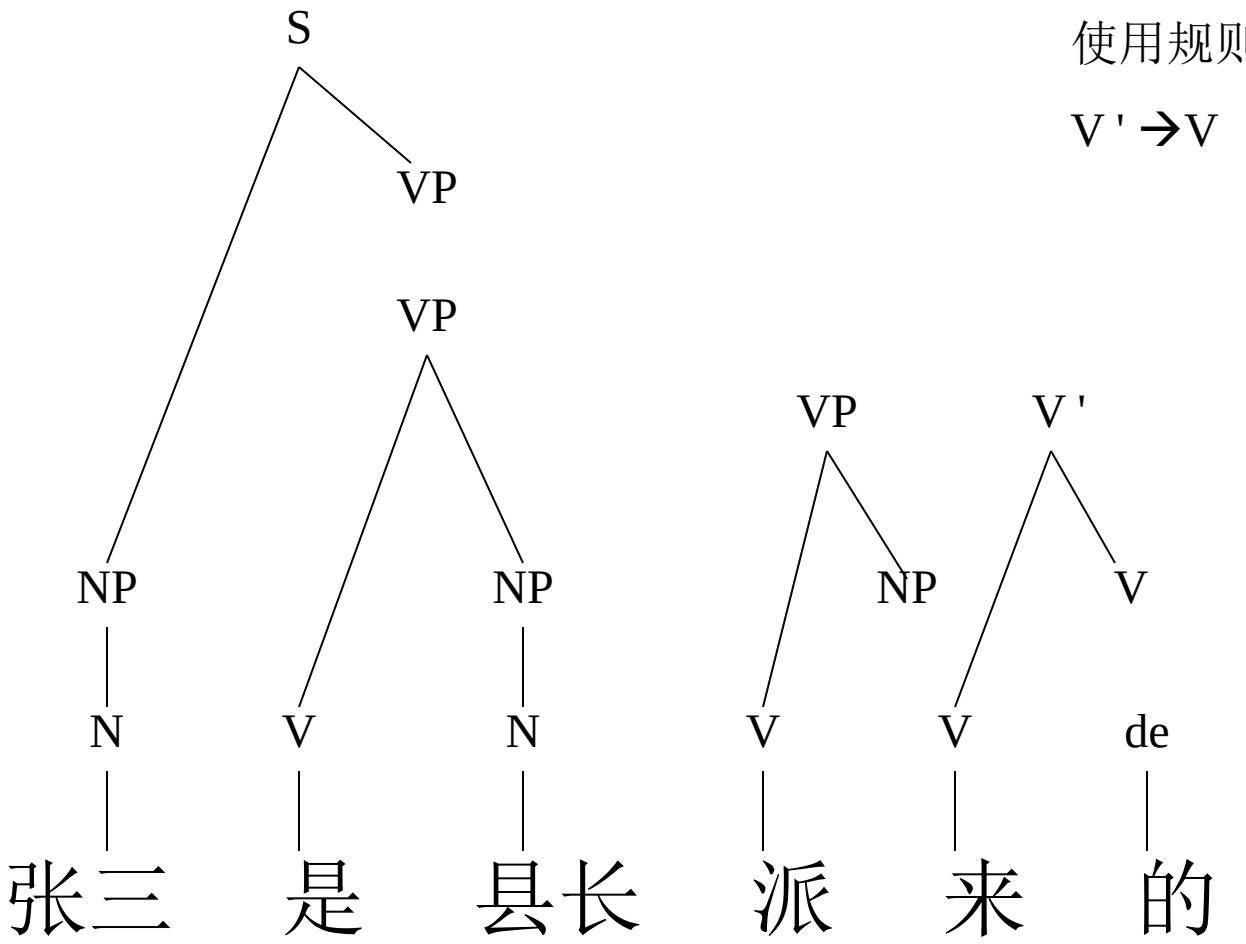


左角分析法示例-24

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则

V' → V V

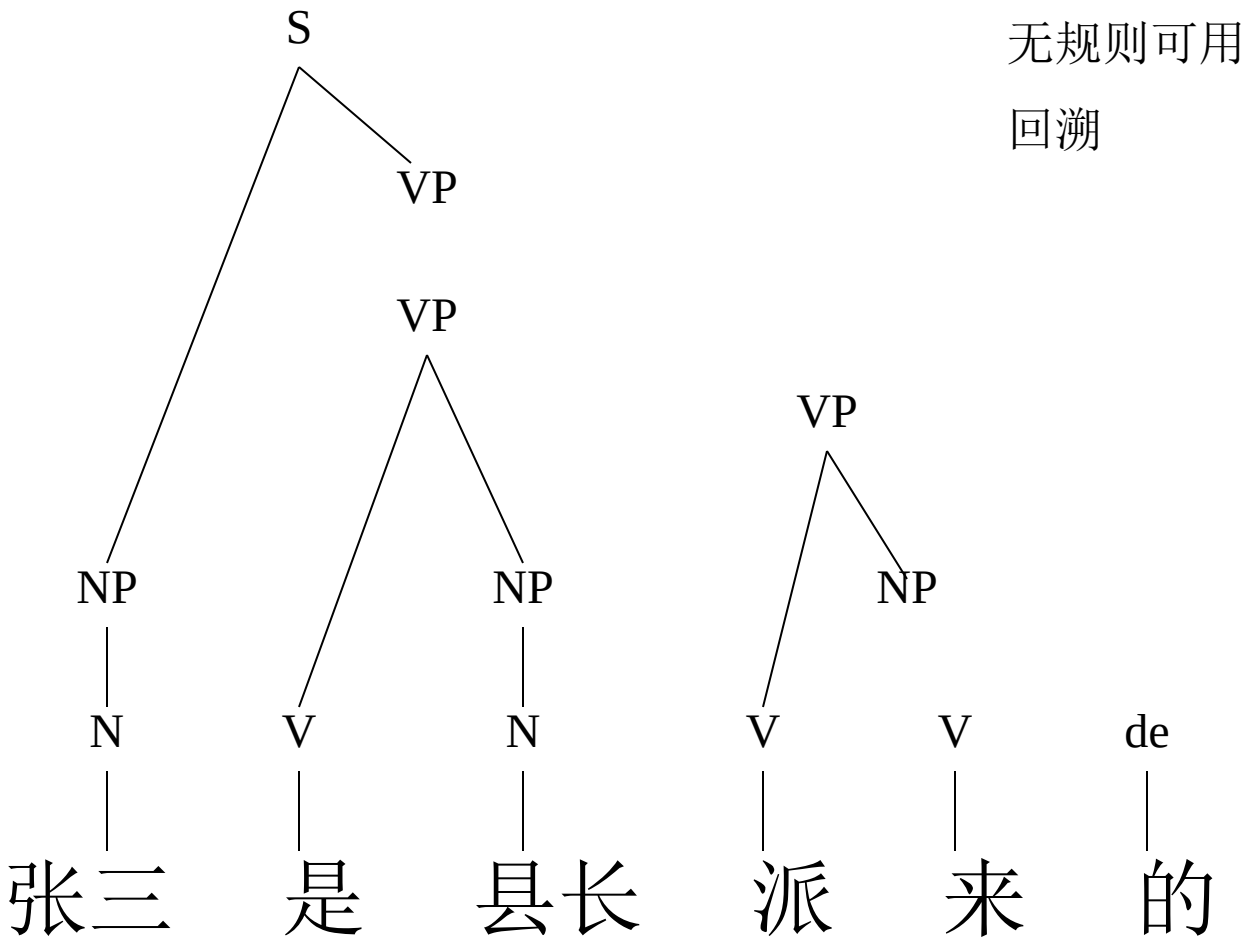


左角分析法示例-25

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

无规则可用

回溯

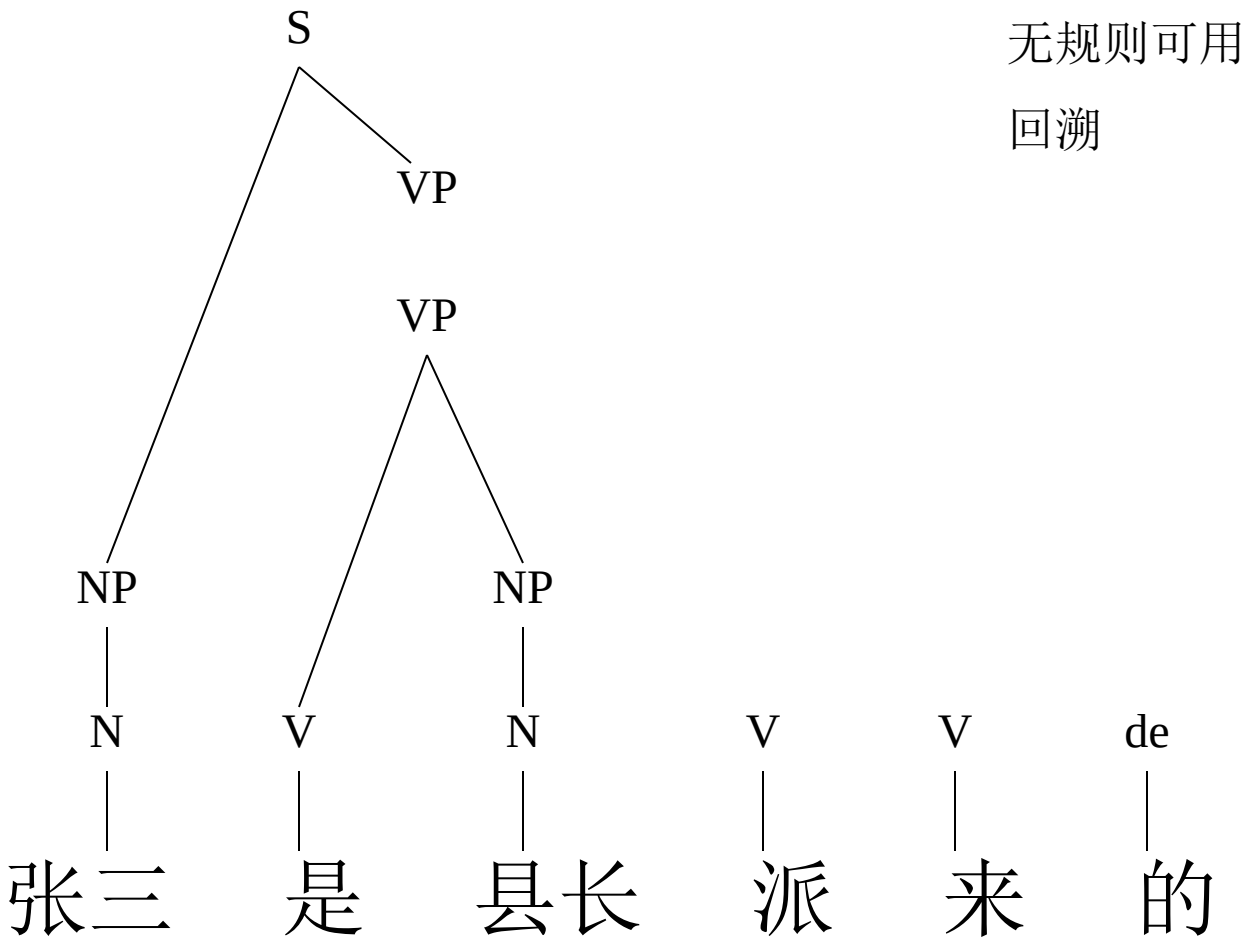


左角分析法示例-26

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

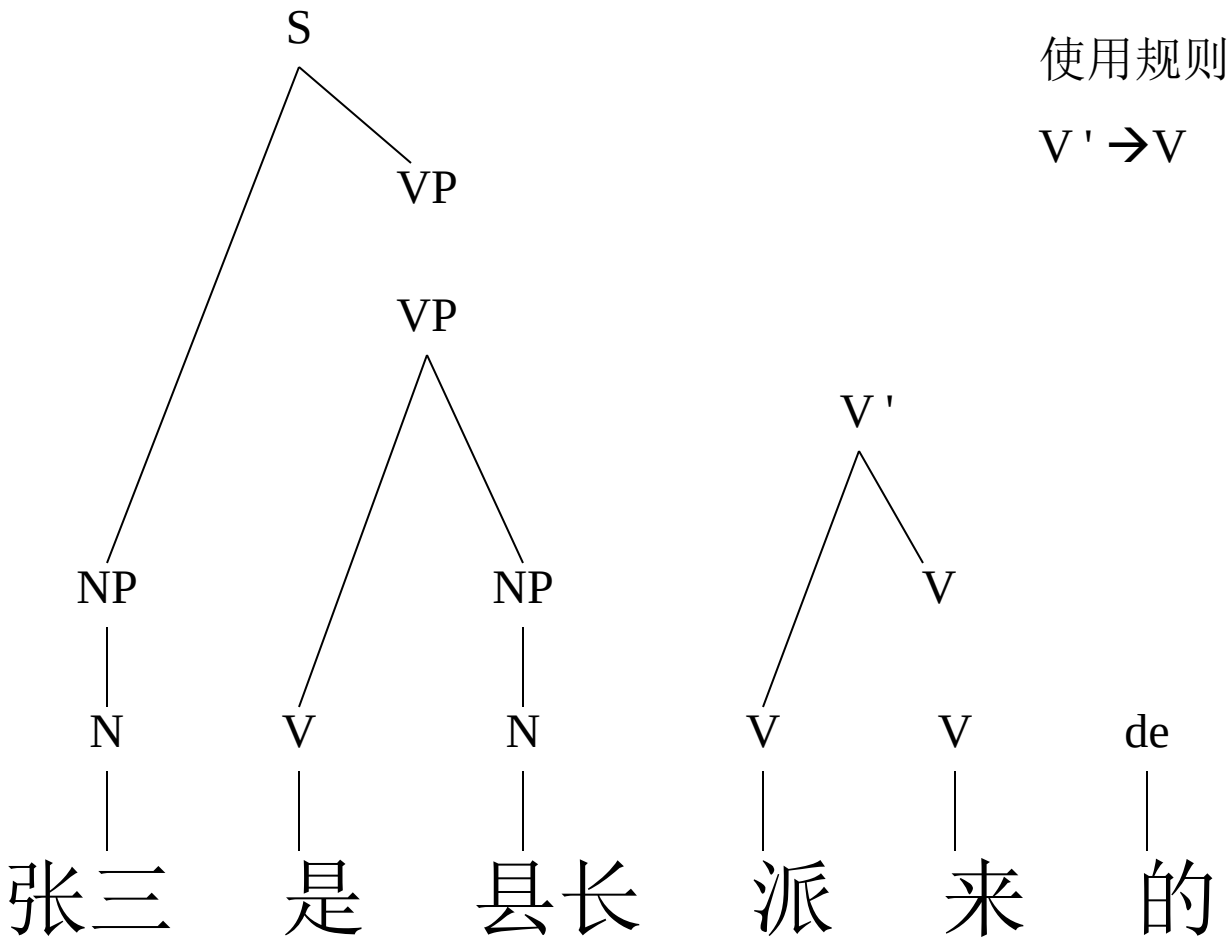
无规则可用

回溯



左角分析法示例-27

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V



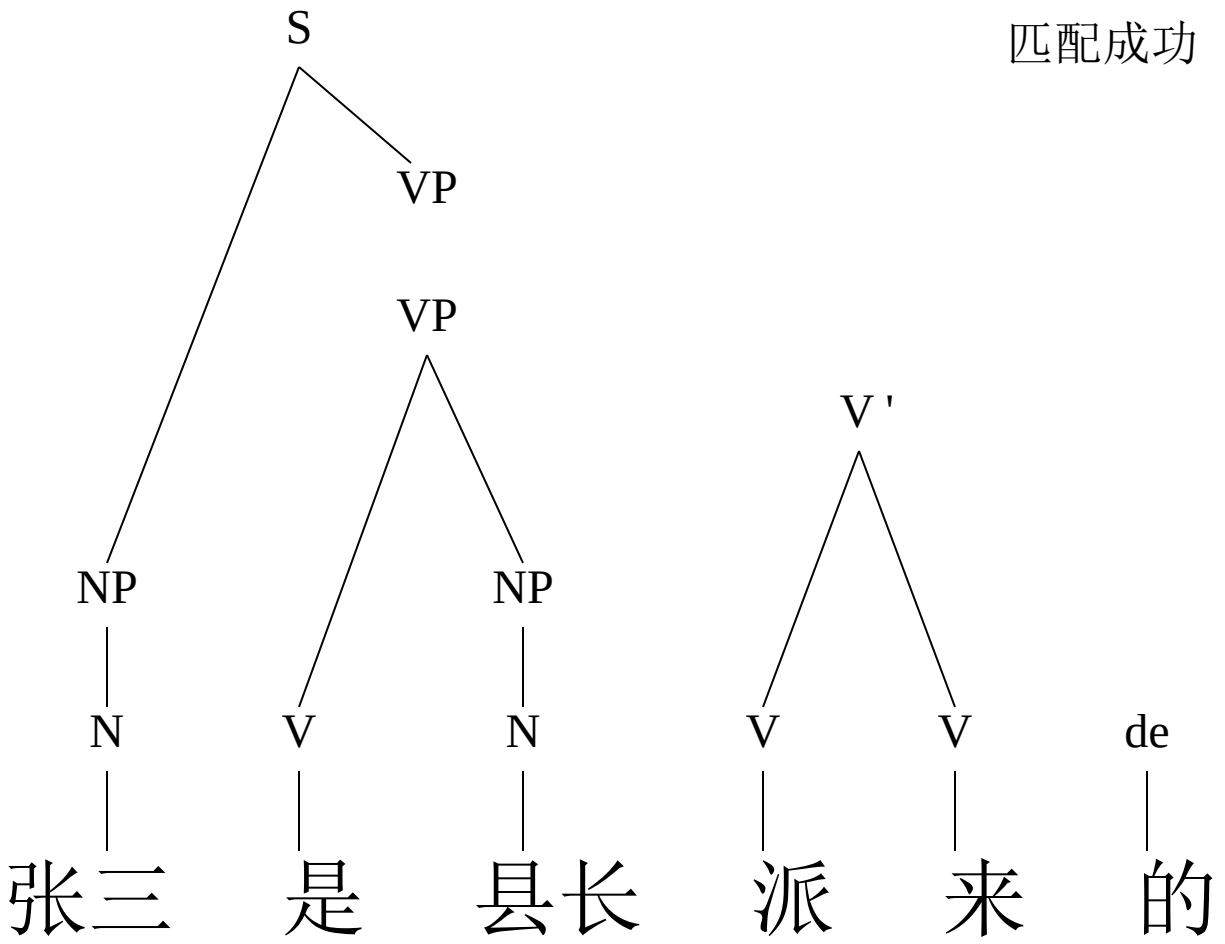
使用规则

V' →V V

左角分析法示例-28

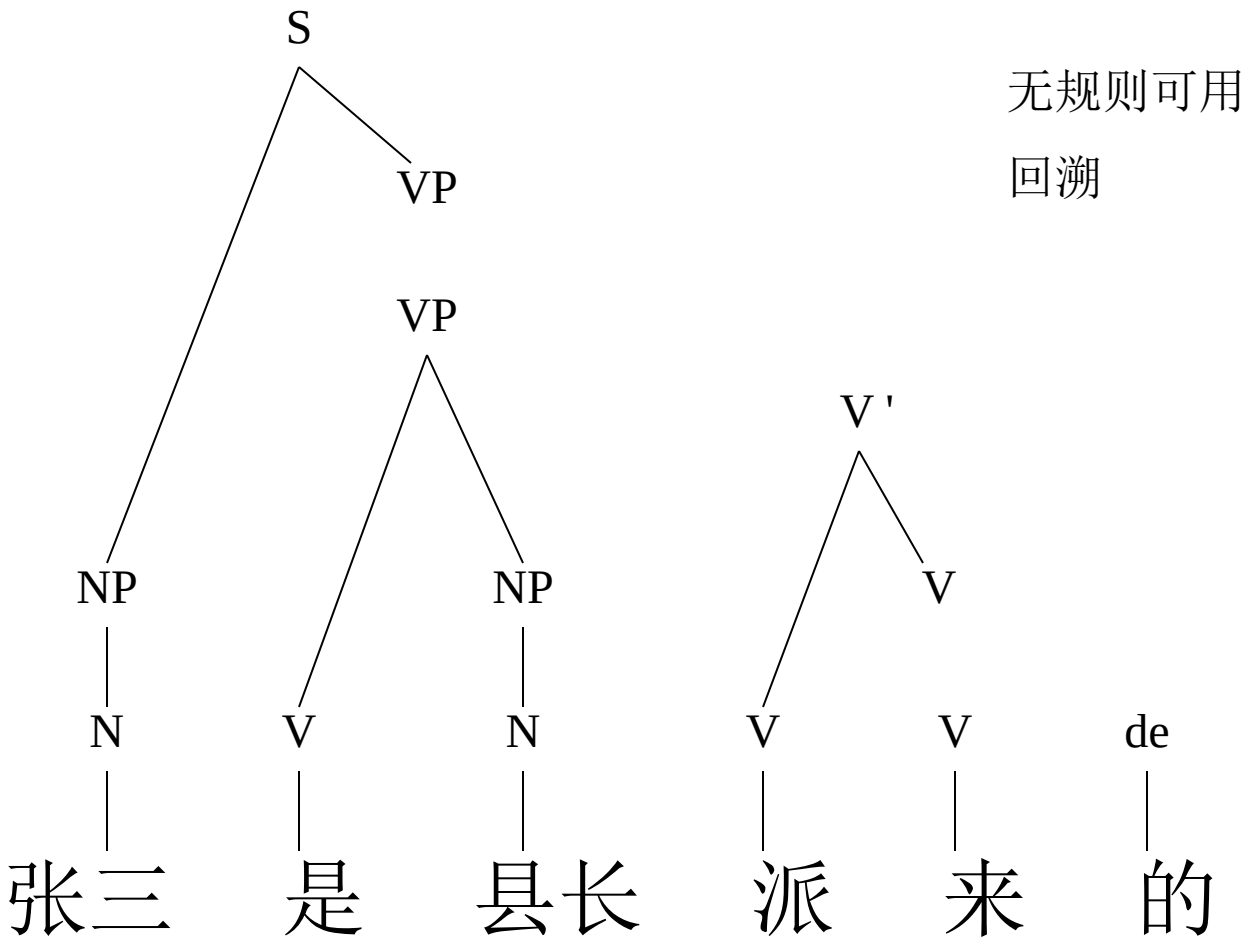
(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

匹配成功



左角分析法示例-29

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V



无规则可用

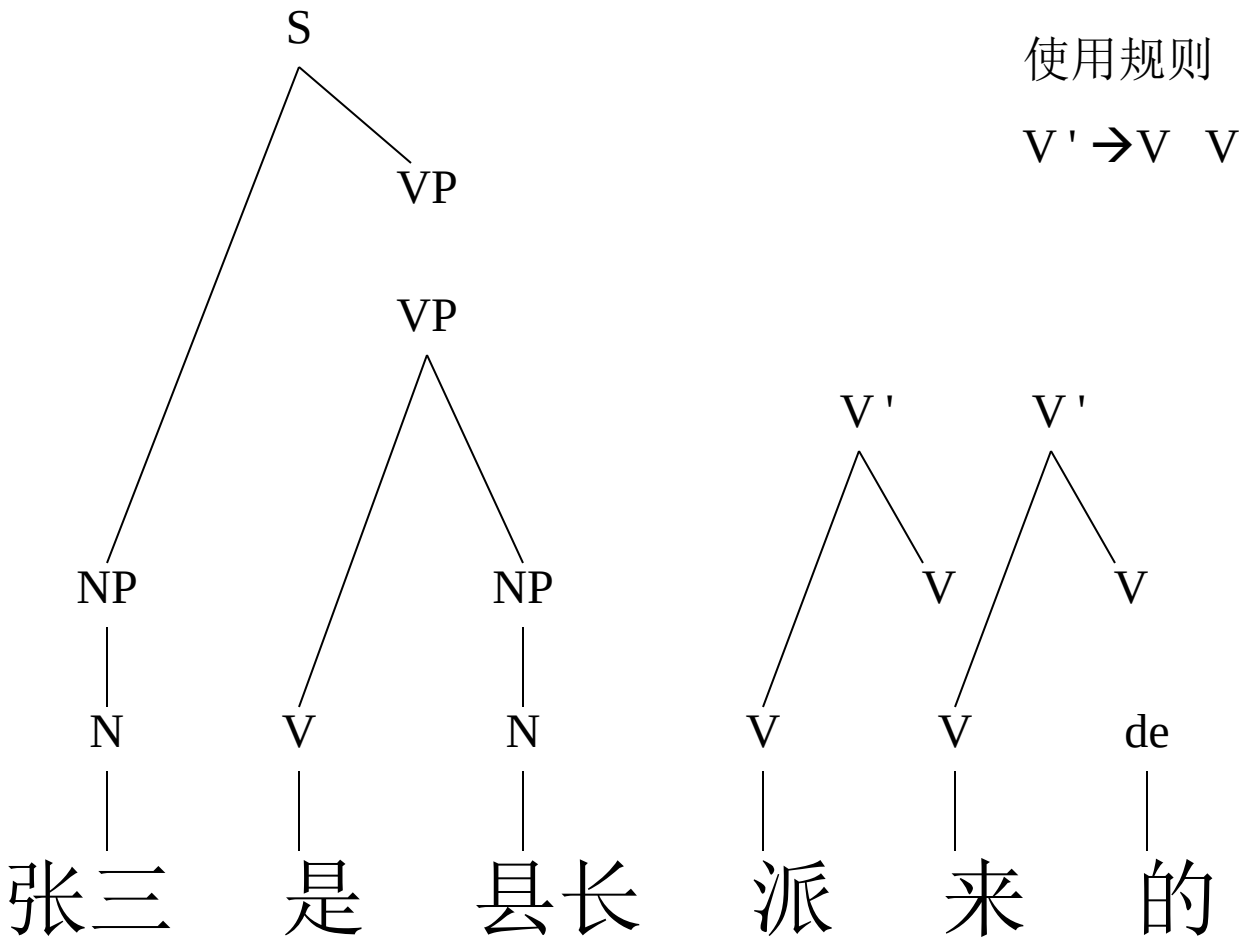
回溯

左角分析法示例-30

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则

V' →V V

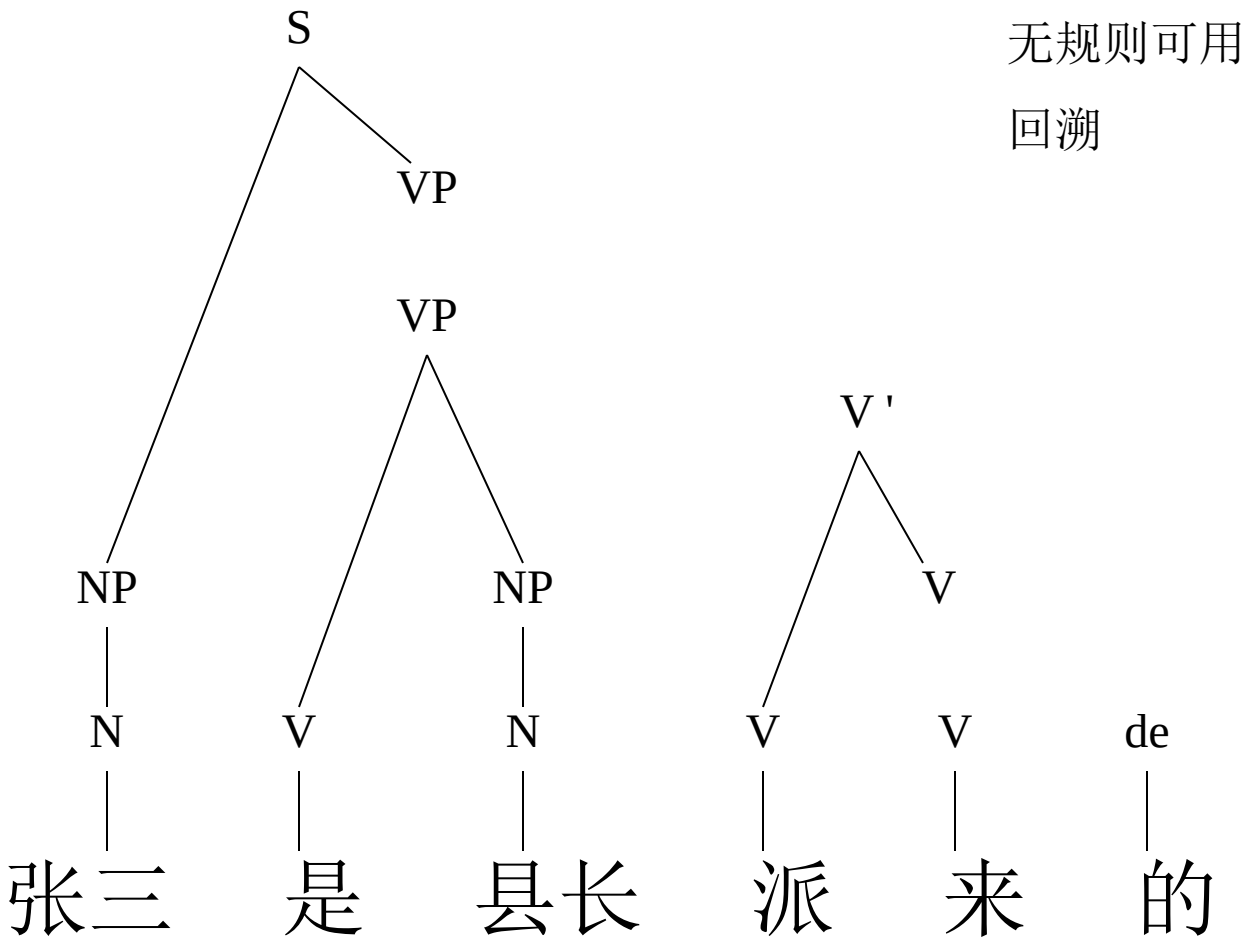


左角分析法示例-31

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

无规则可用

回溯

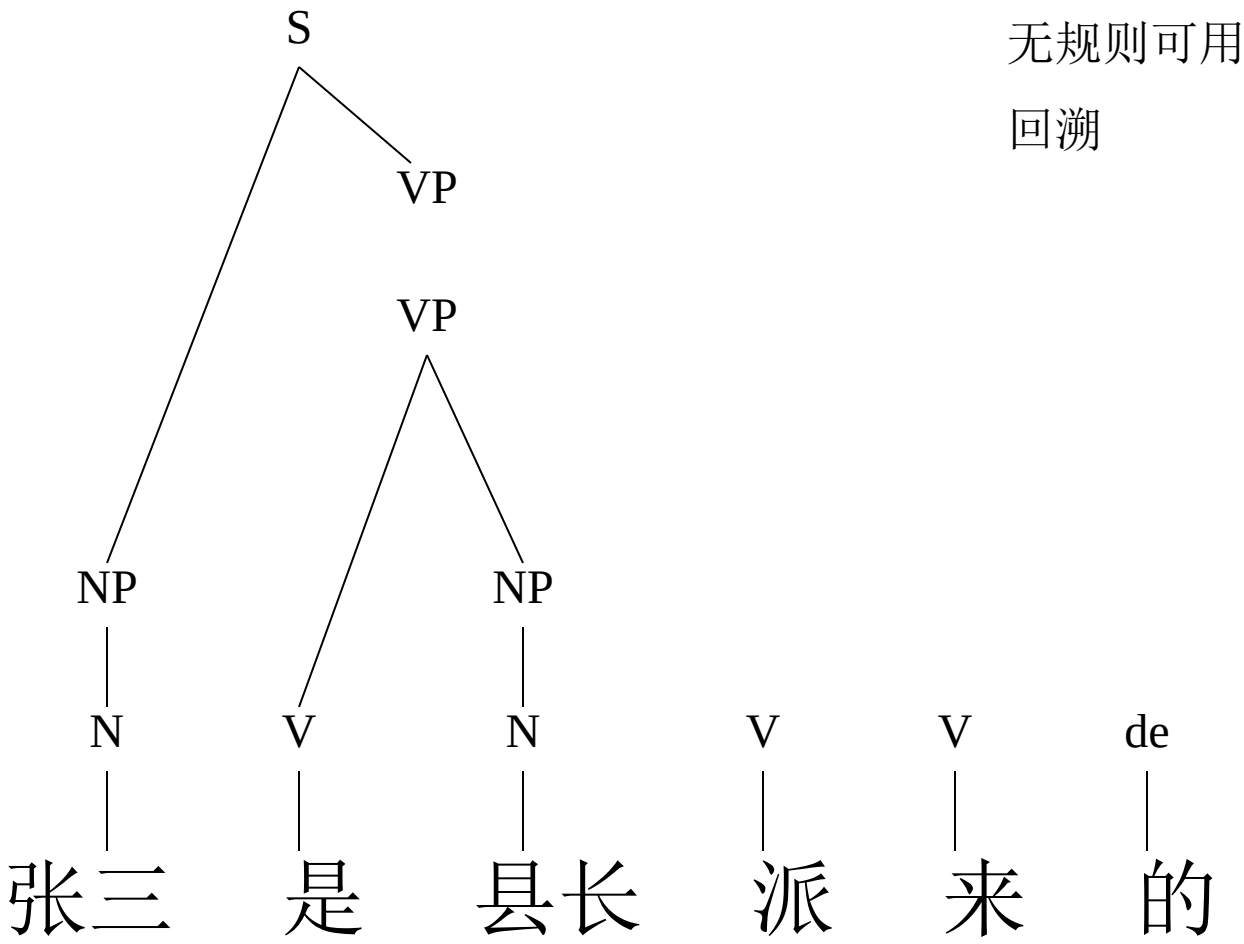


左角分析法示例-32

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

无规则可用

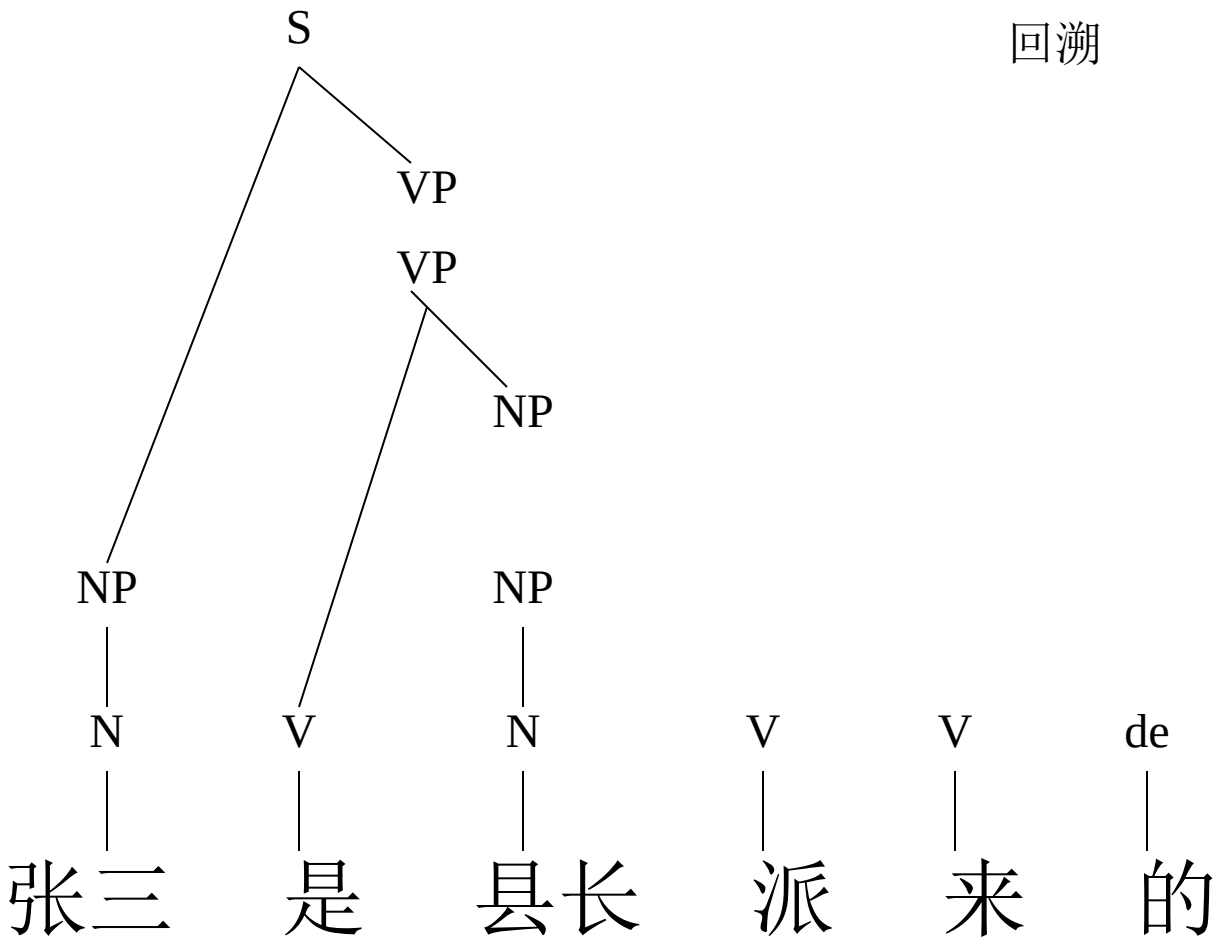
回溯



左角分析法示例-33

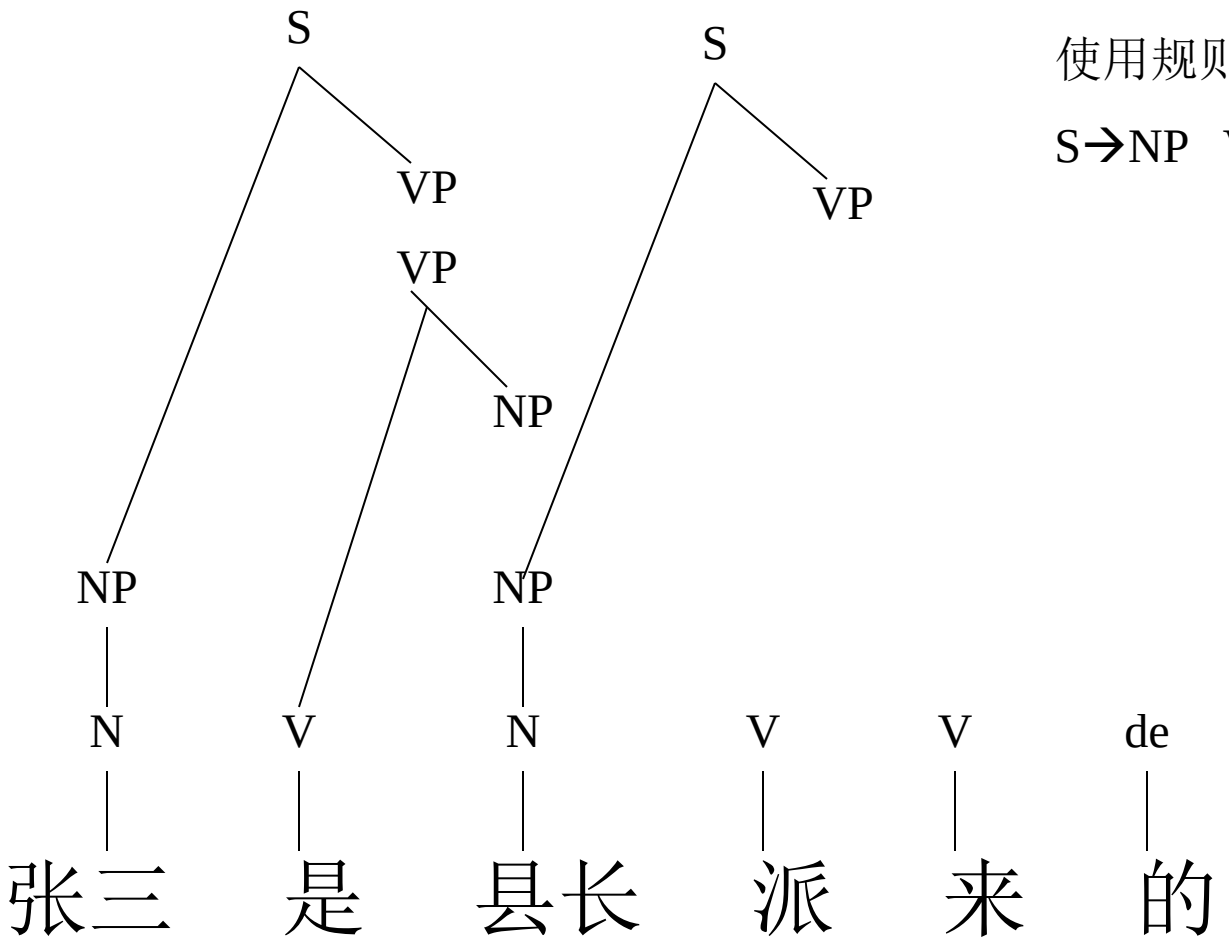
(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

回溯



(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

左角分析法示例-34

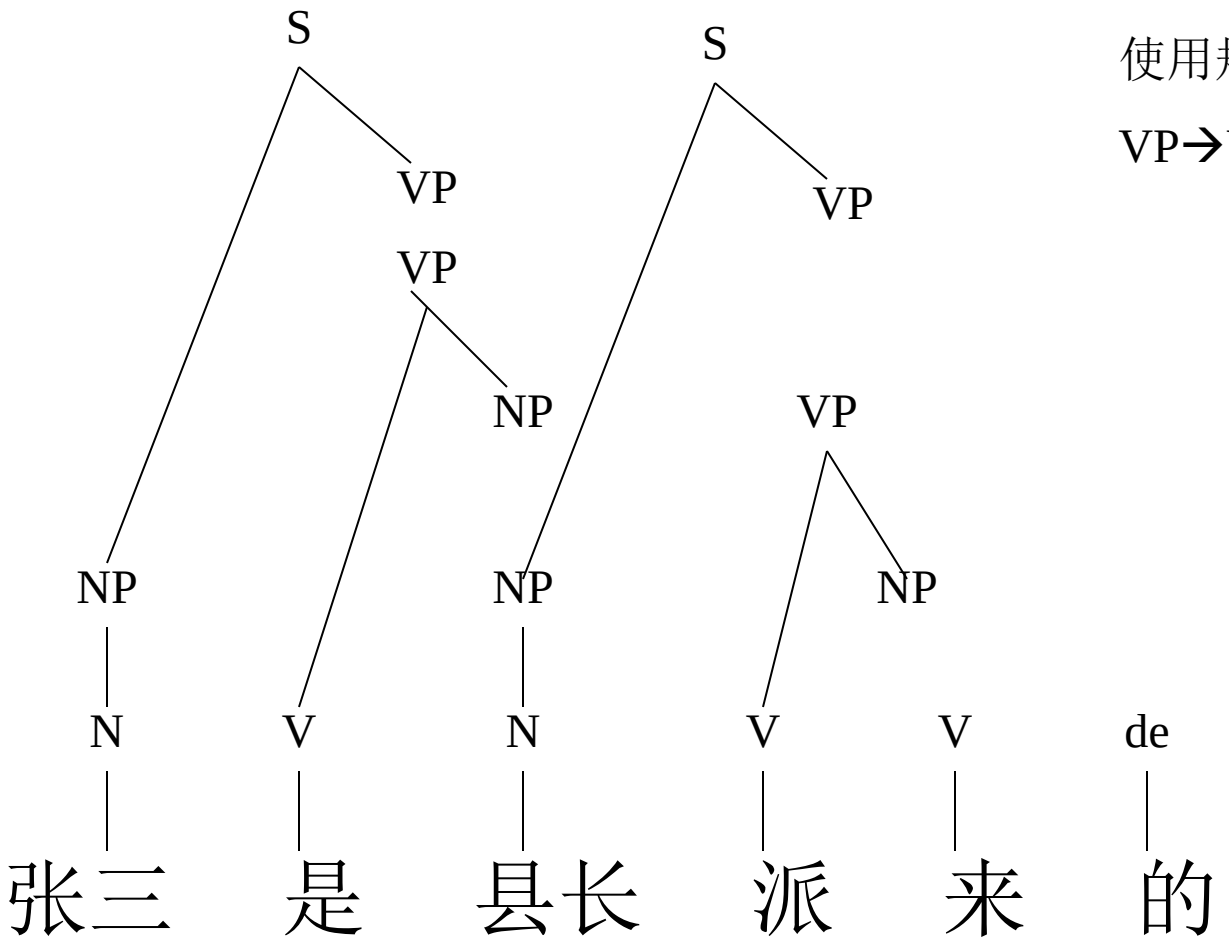


使用规则

S→NP VP

左角分析法示例-35

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

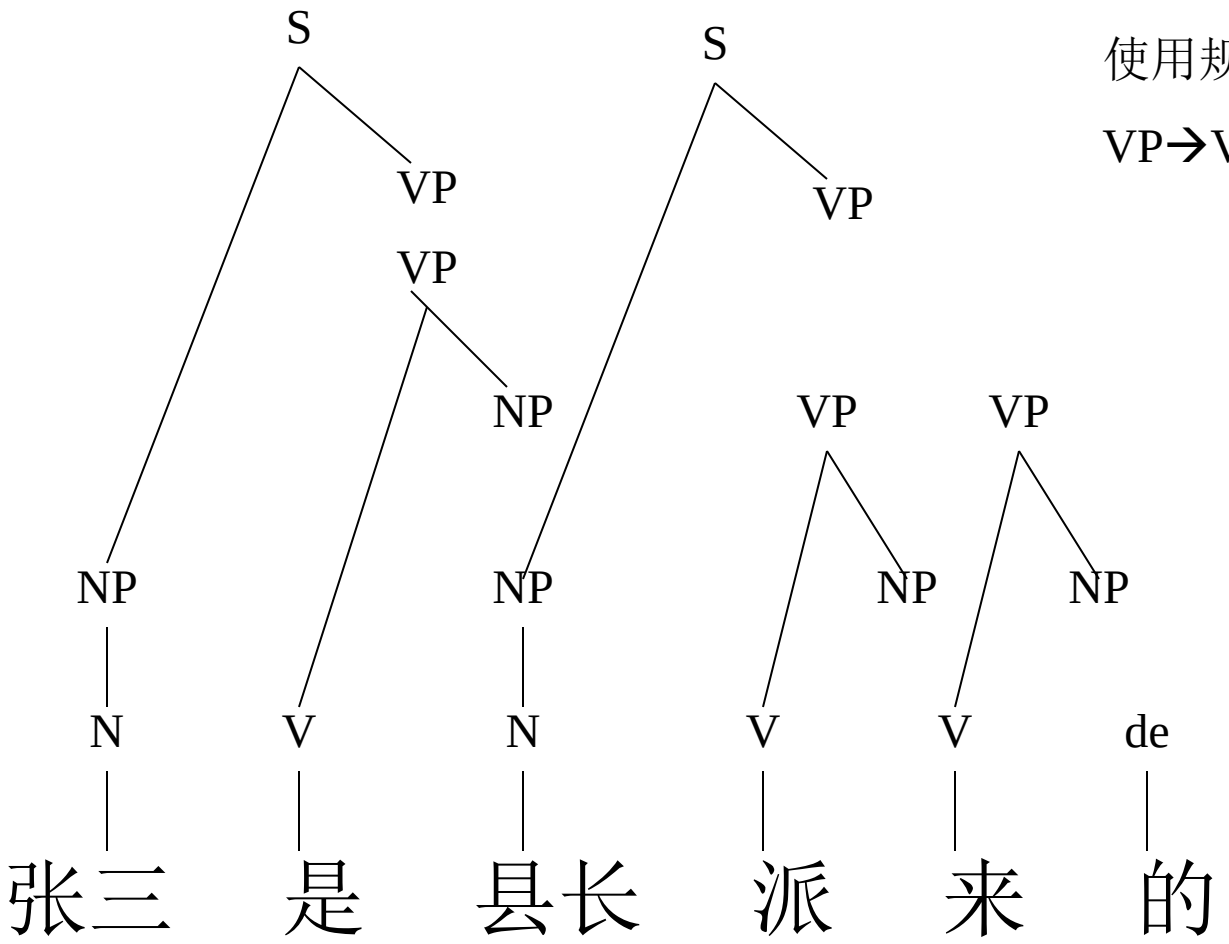


使用规则：

VP→V NP

左角分析法示例-36

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

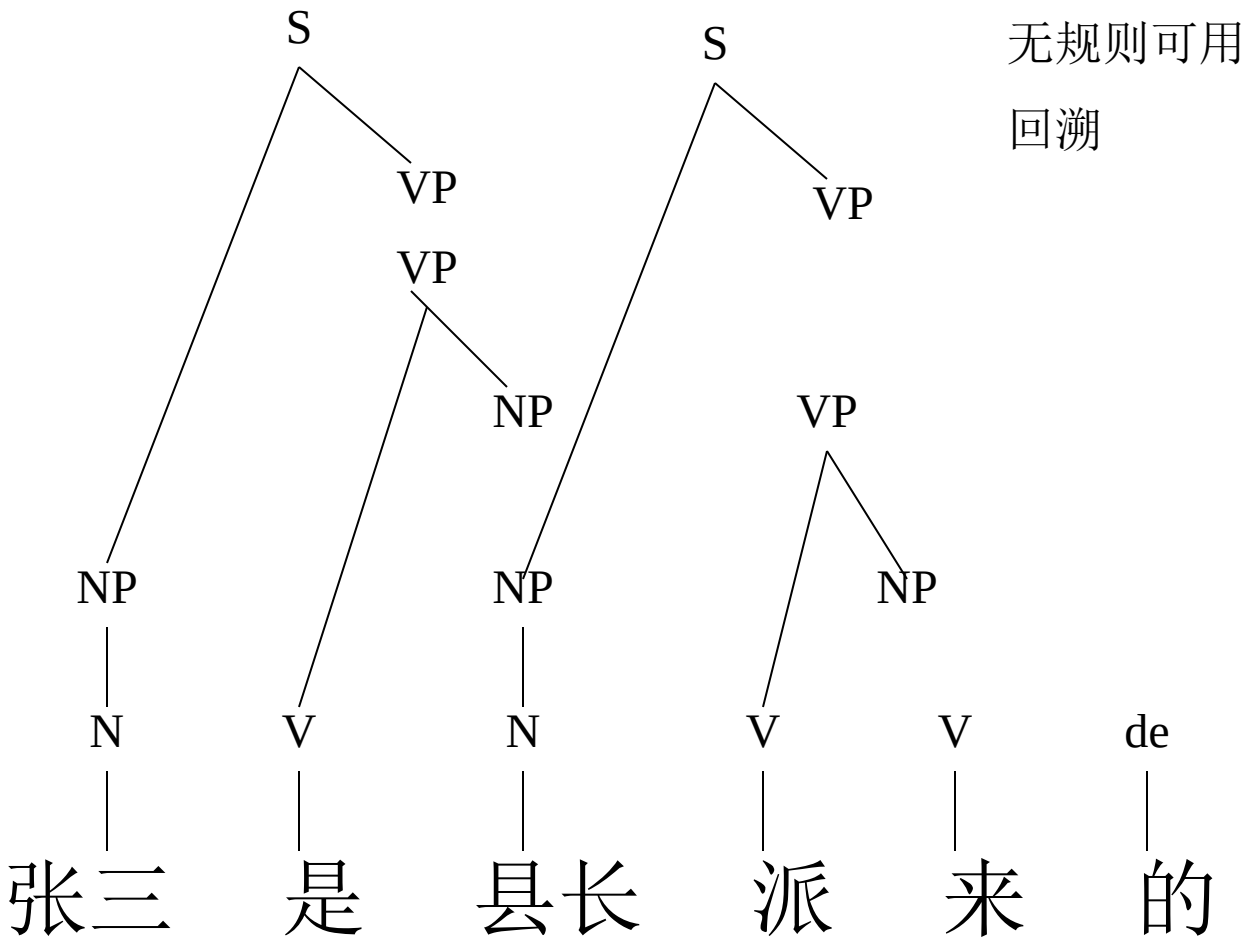


使用规则：

VP→V NP

左角分析法示例-37

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

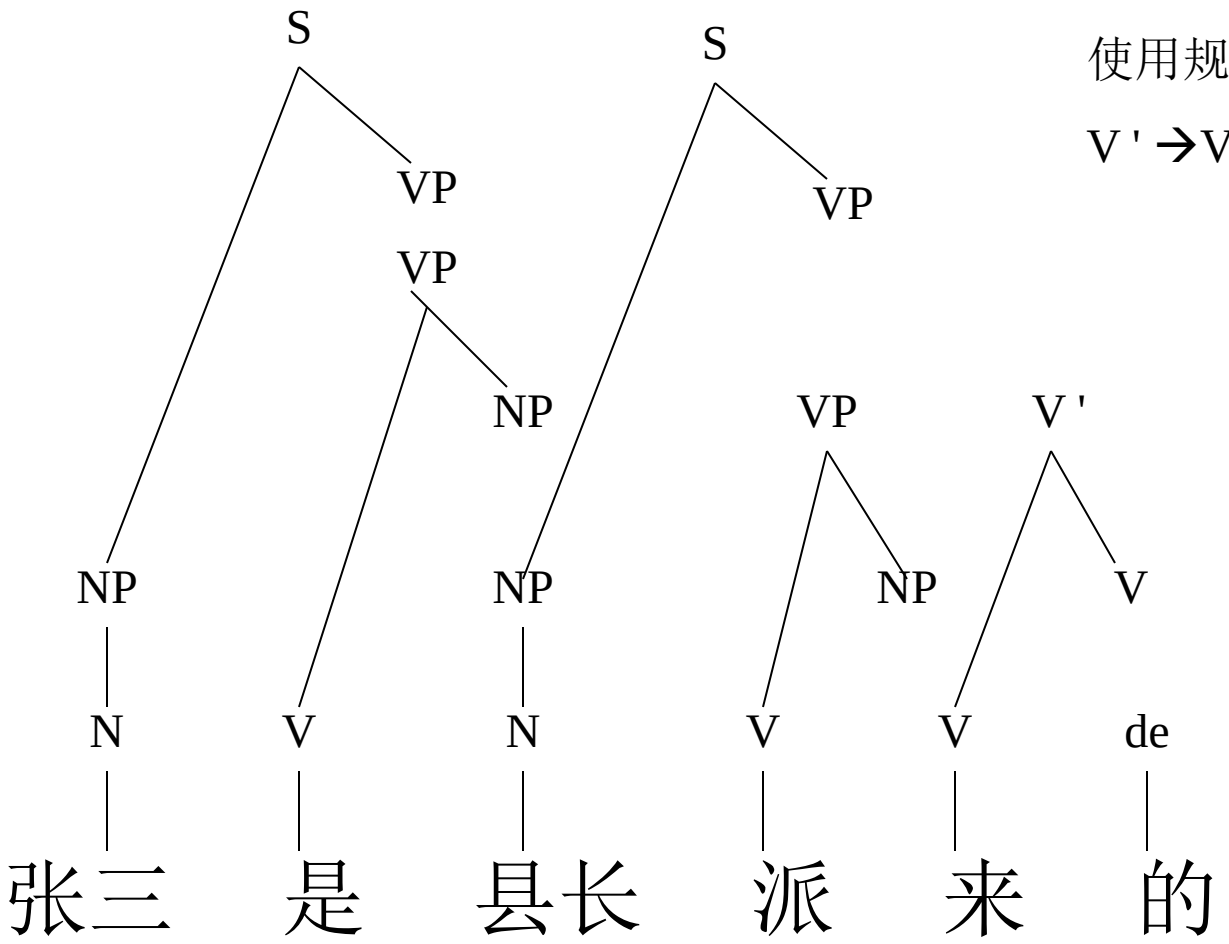


无规则可用

回溯

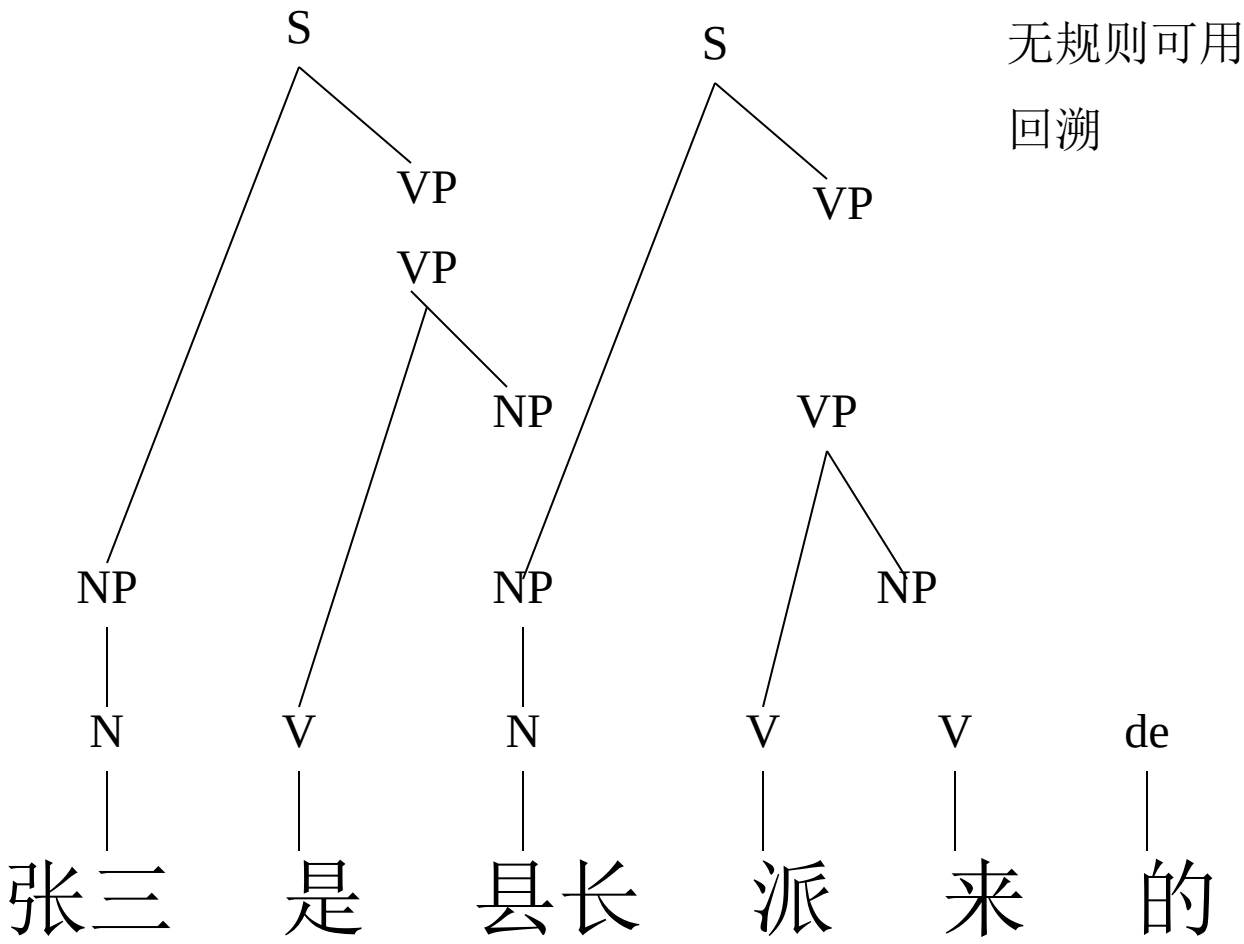
左角分析法示例-38

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V



左角分析法示例-39

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

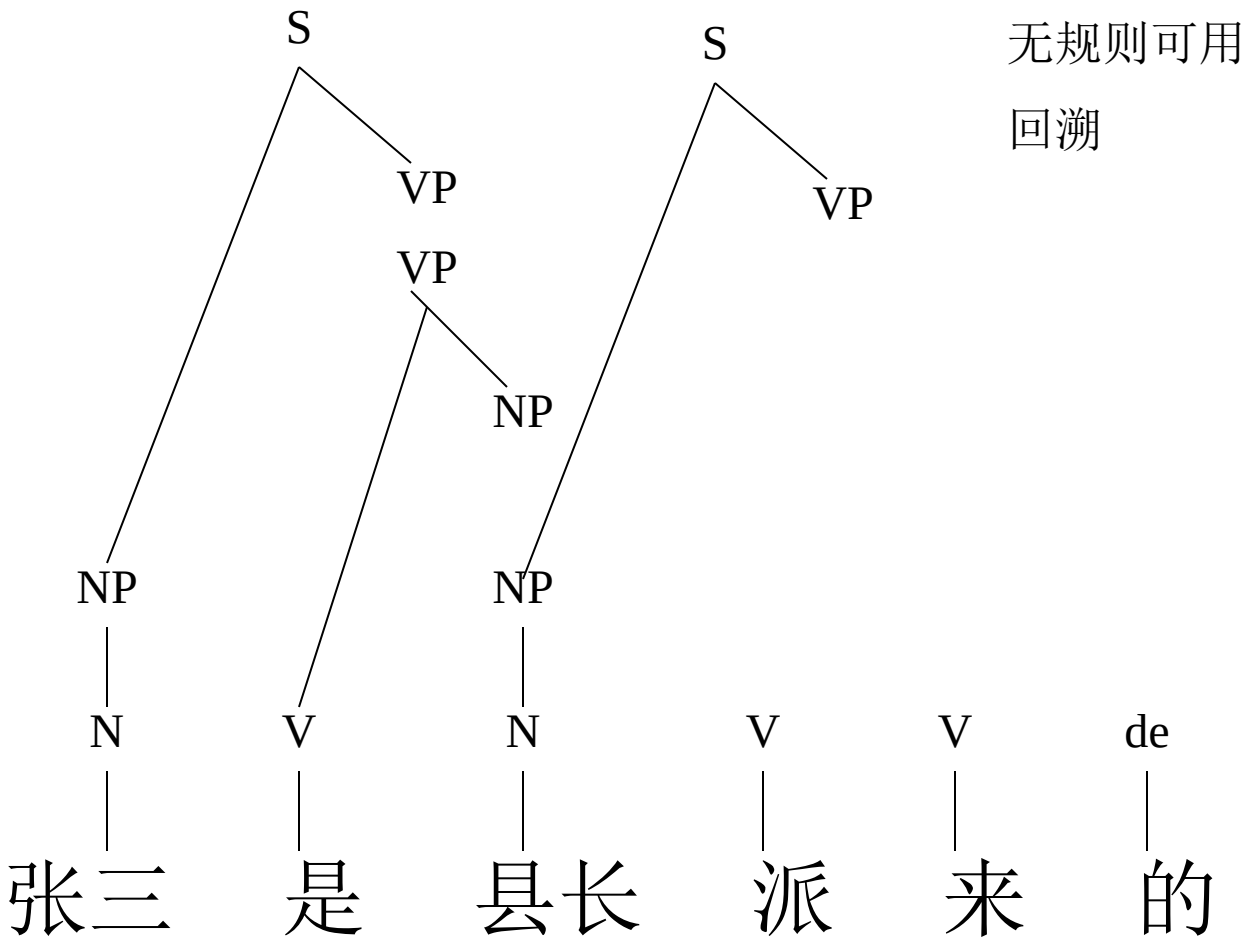


无规则可用

回溯

左角分析法示例-40

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

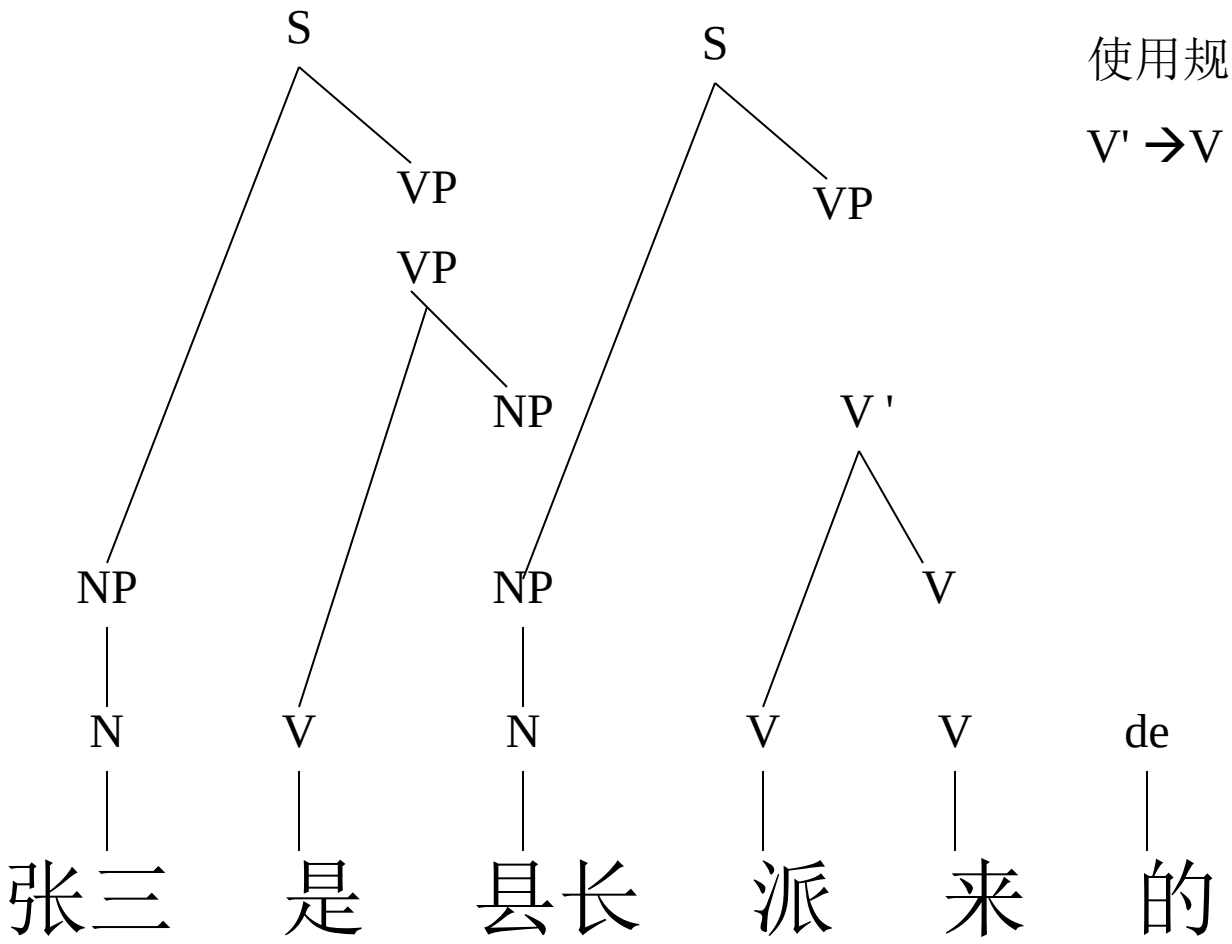


无规则可用

回溯

左角分析法示例-41

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V



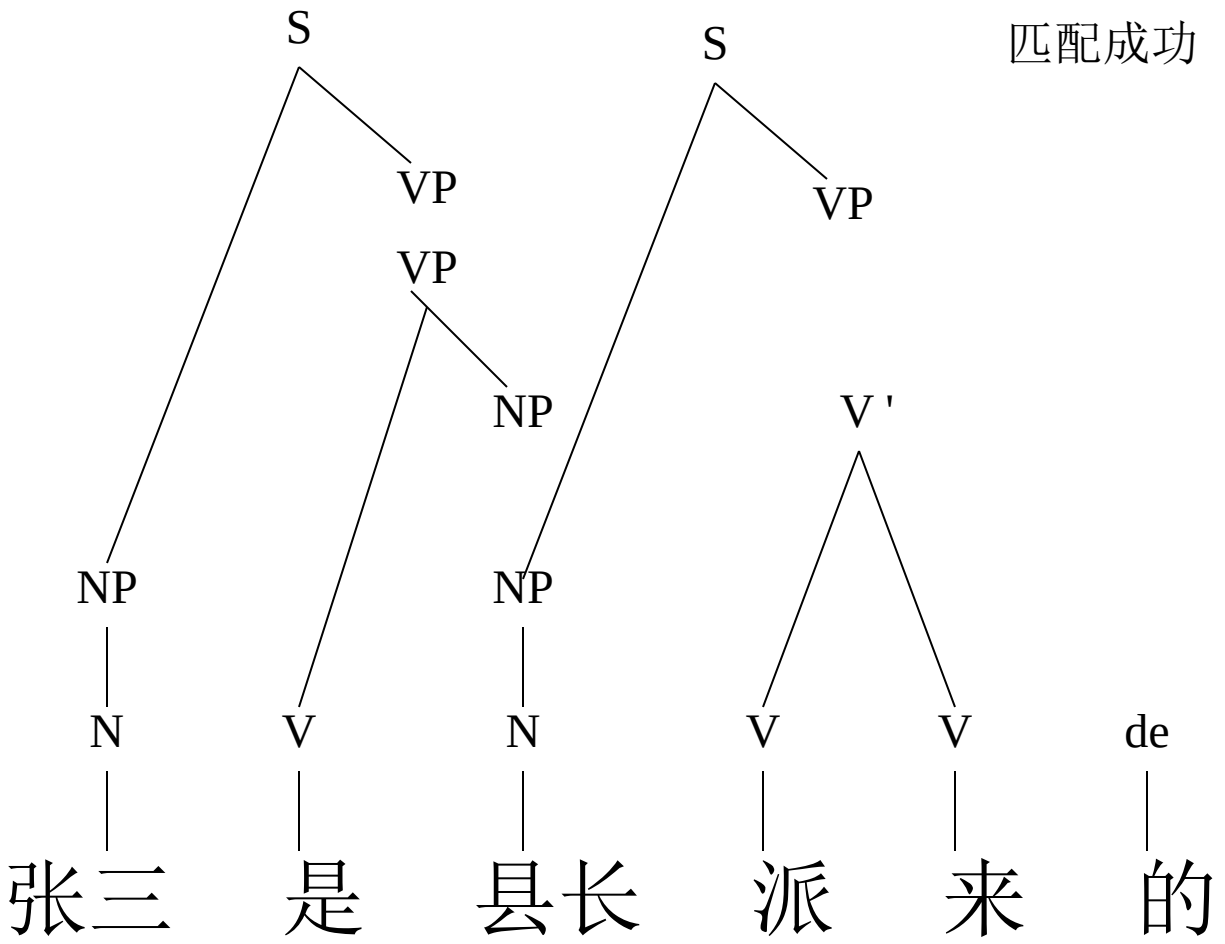
使用规则

V' →V V

左角分析法示例-42

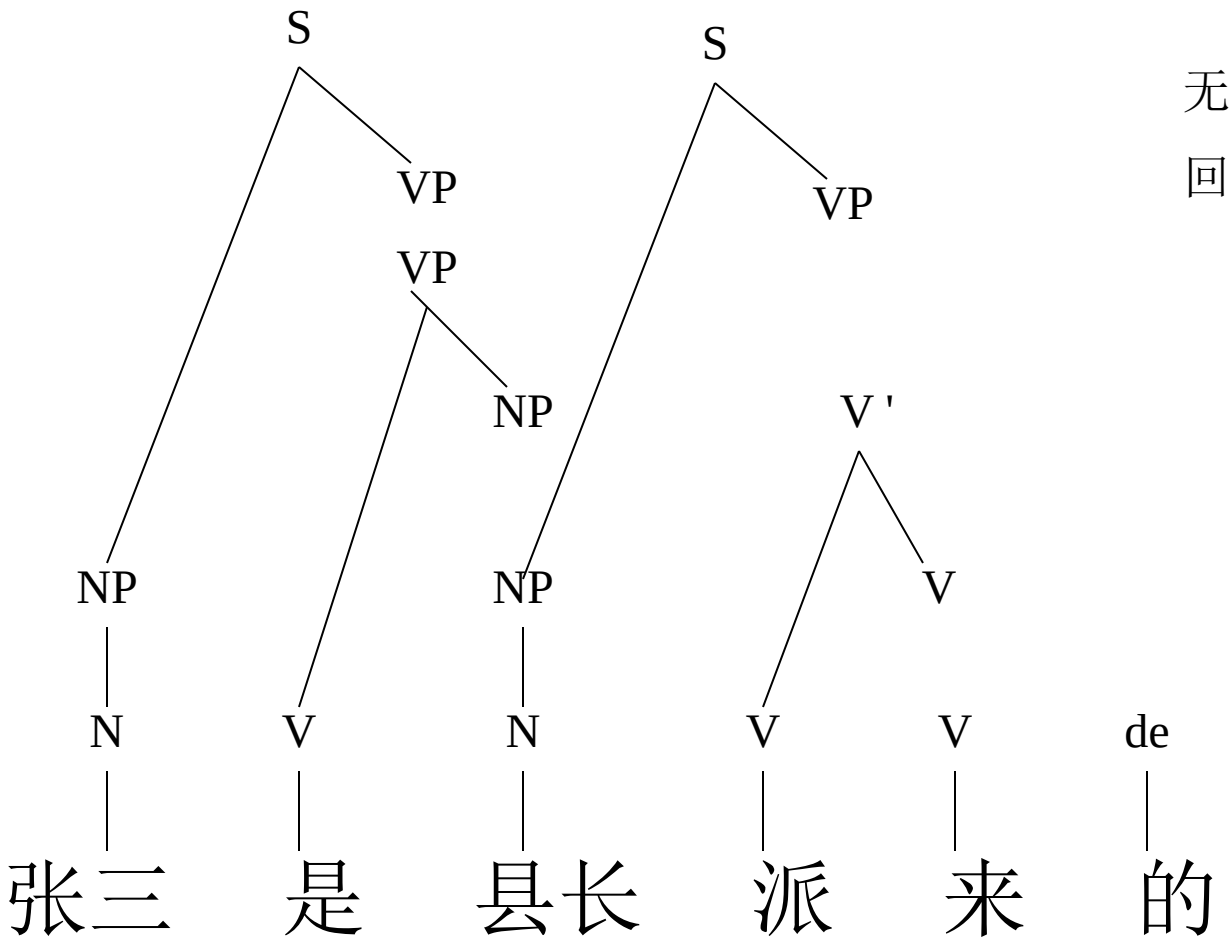
(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

匹配成功



左角分析法示例-43

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V



无规则可用

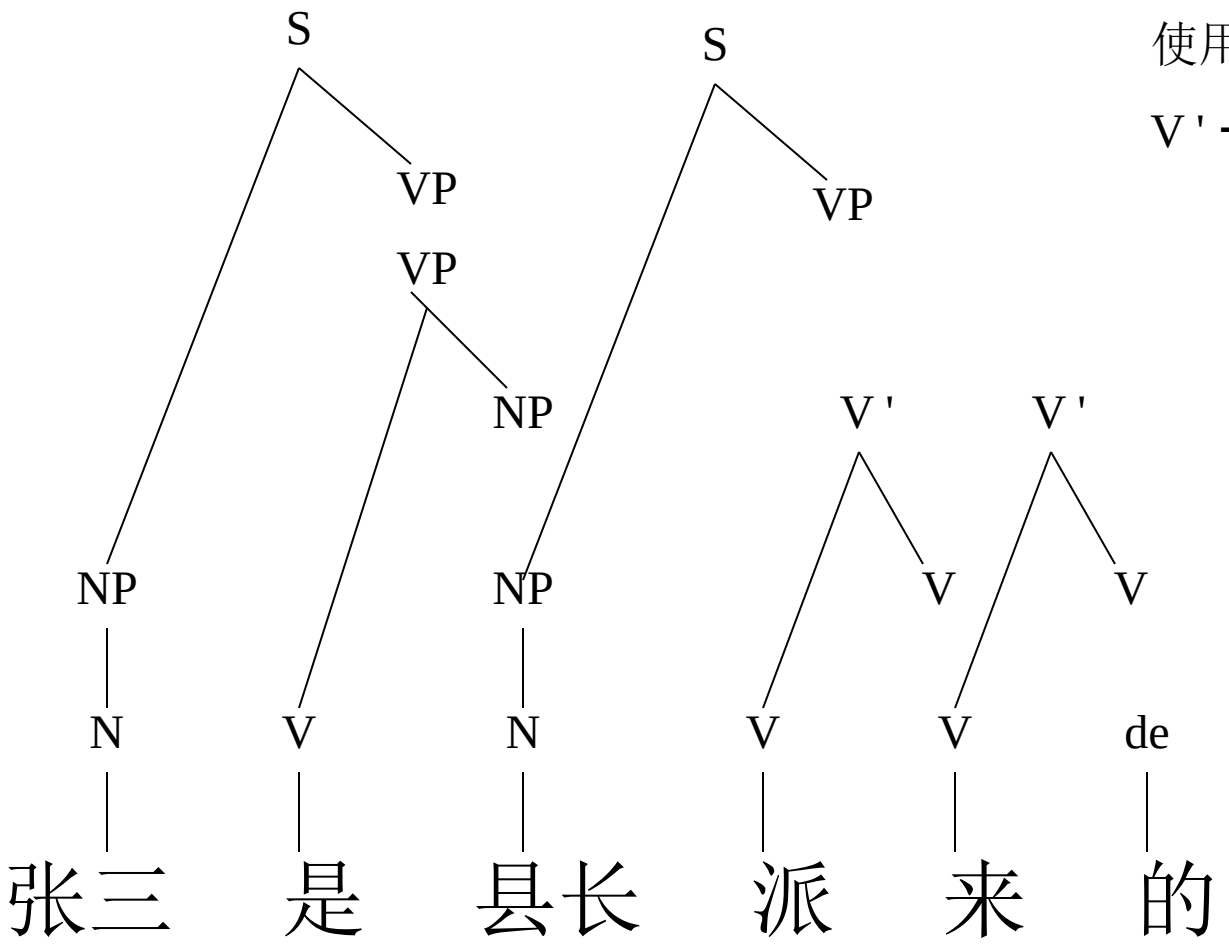
回溯

左角分析法示例-44

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

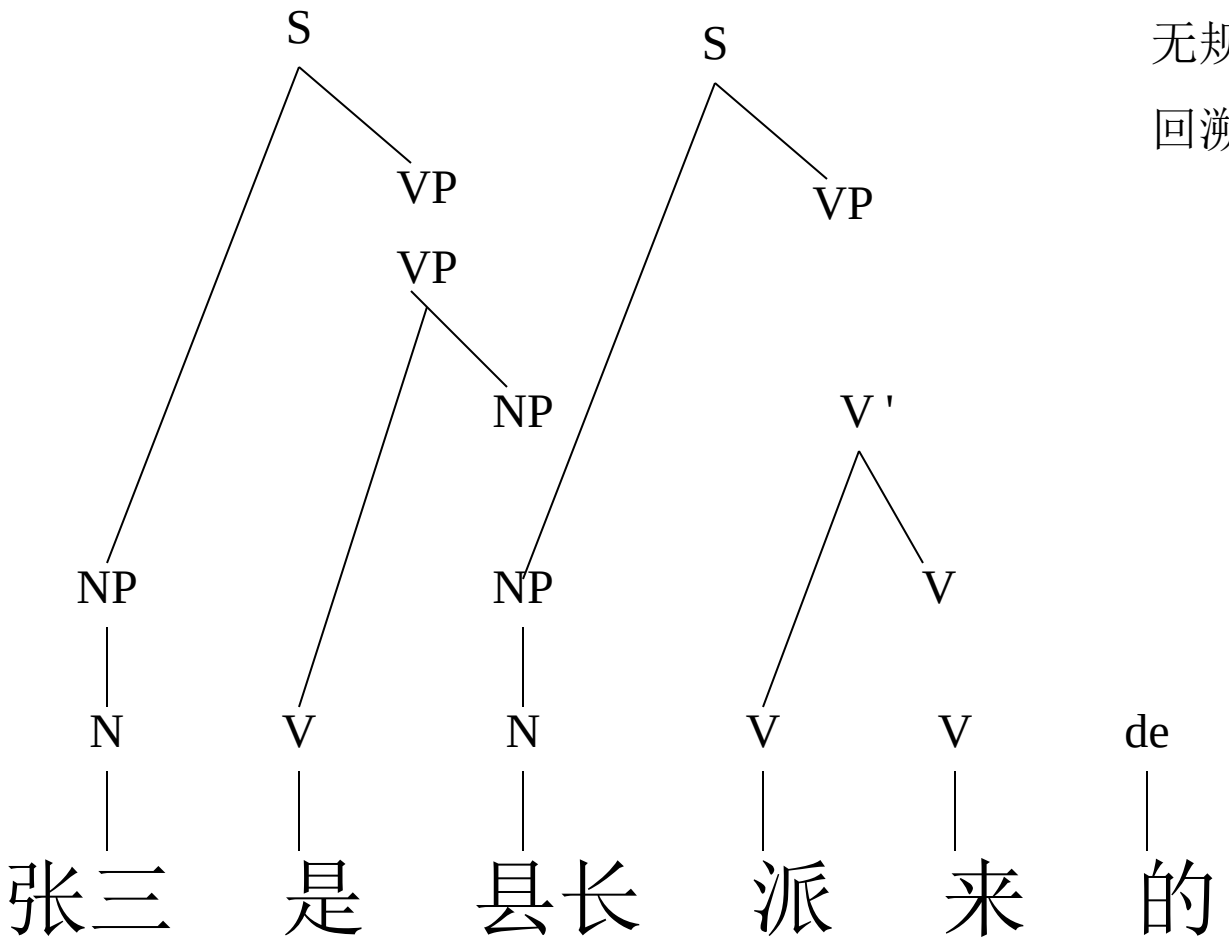
使用规则

V' →V V



左角分析法示例-45

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

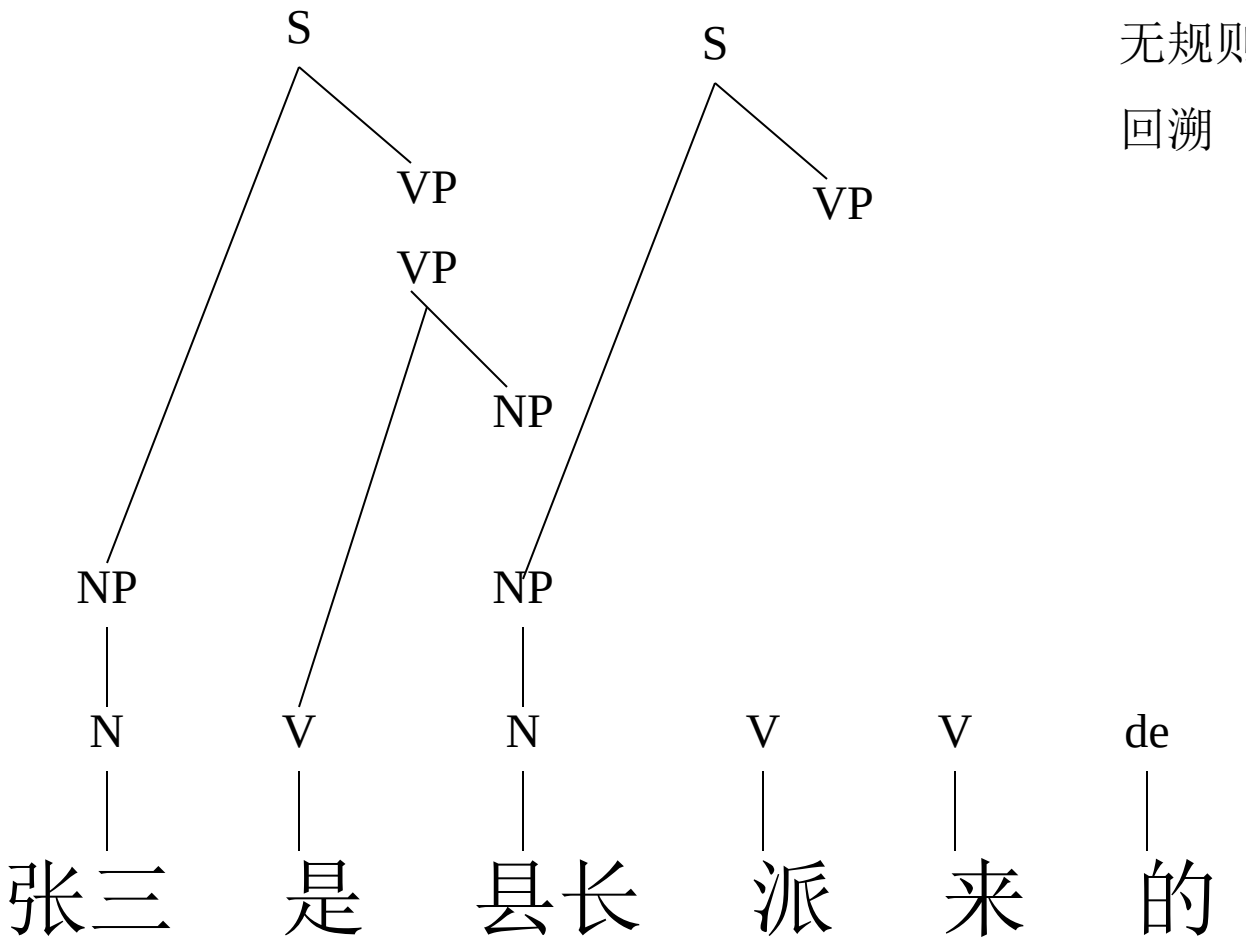


无规则可用

回溯

左角分析法示例-46

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

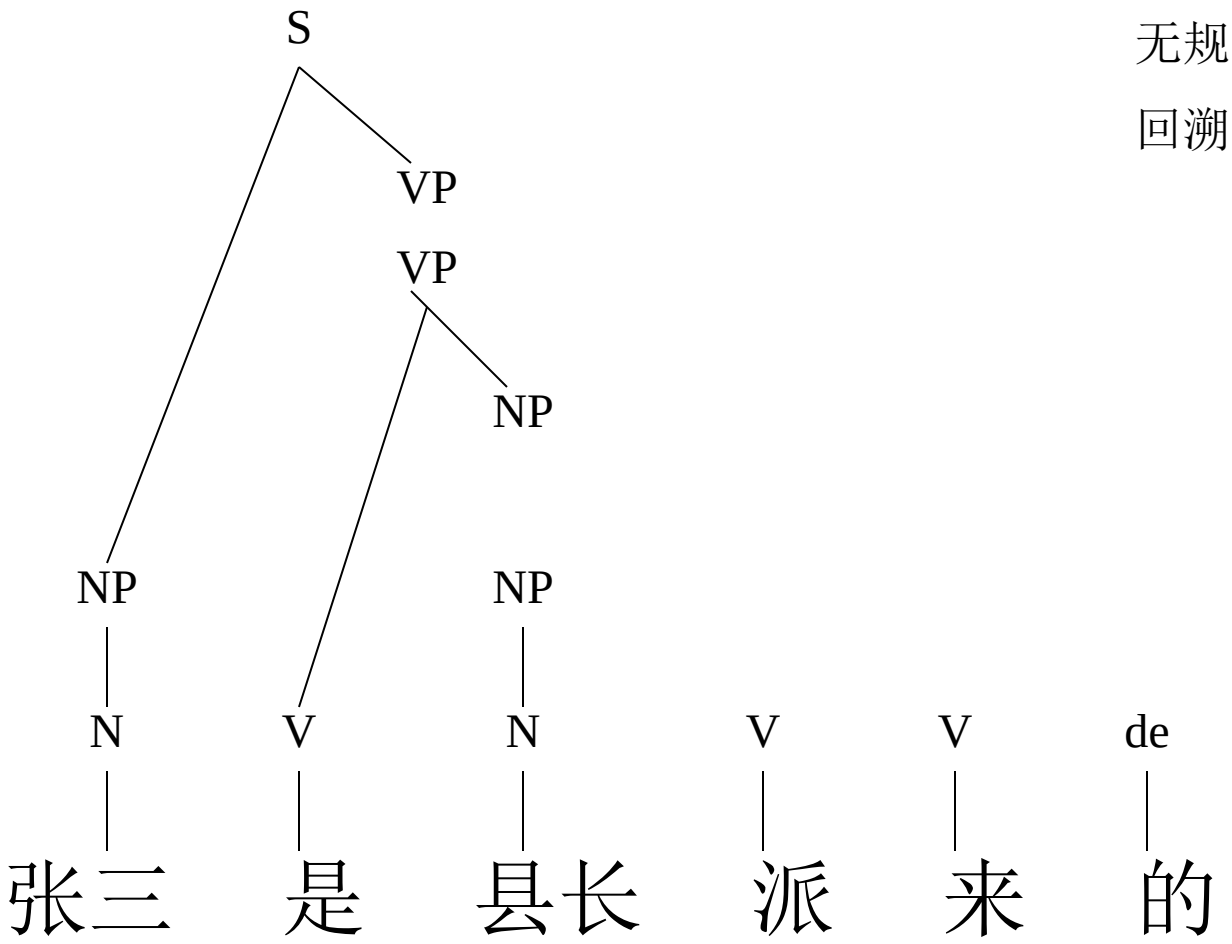


无规则可用

回溯

左角分析法示例-47

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V



无规则可用

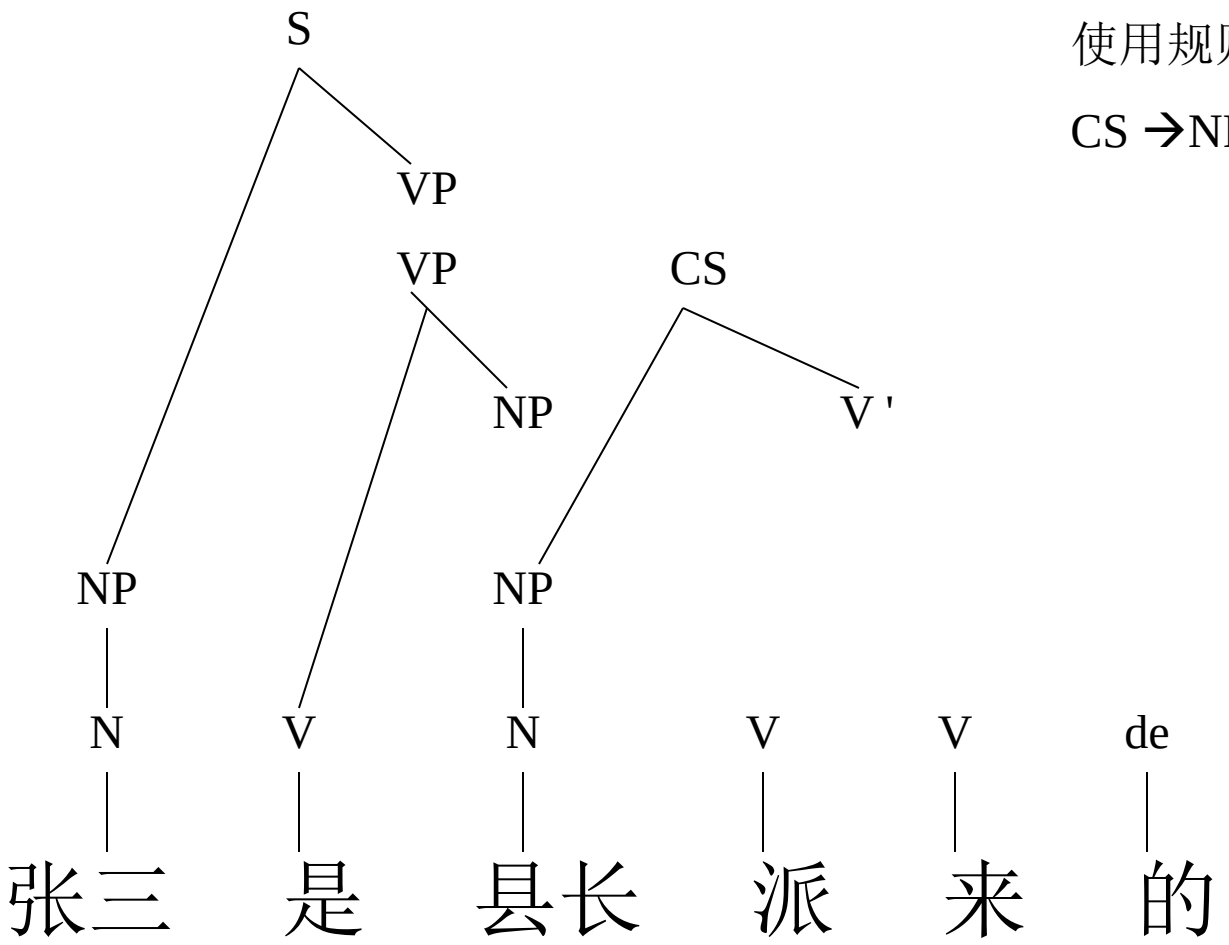
回溯

左角分析法示例-48

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

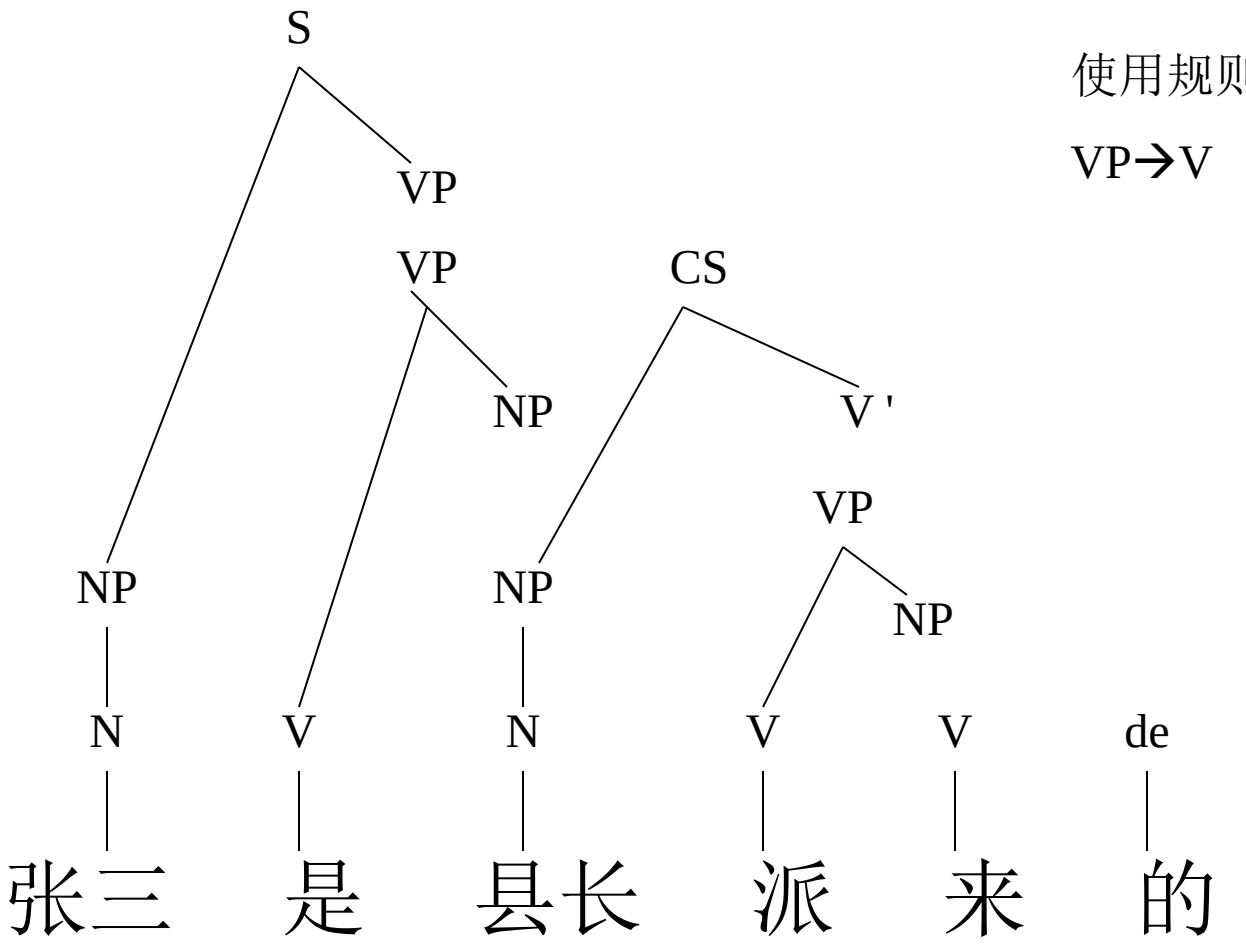
使用规则：

CS →NP V'



左角分析法示例-49

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V



使用规则：

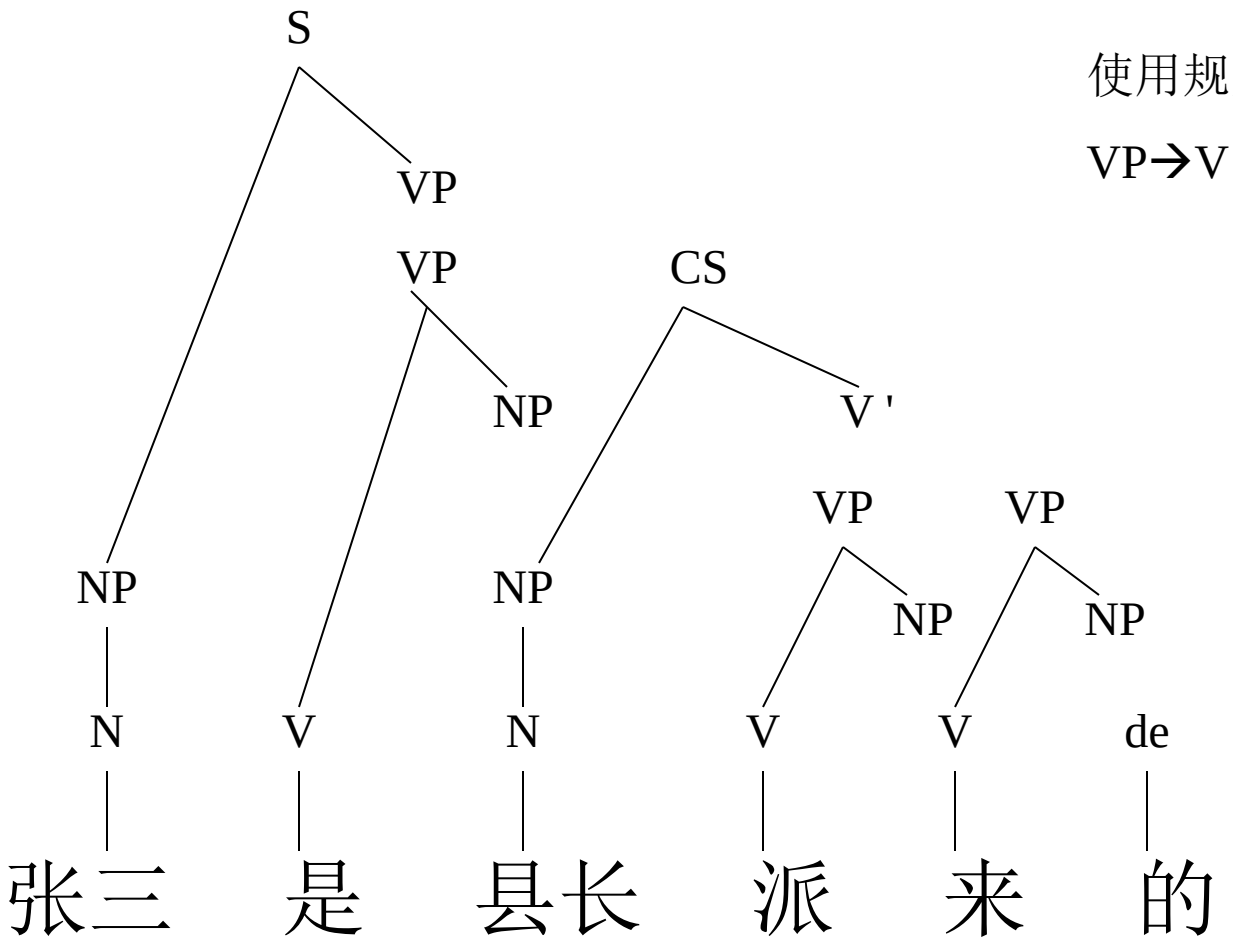
VP→V NP

左角分析法示例-50

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

使用规则：

VP→V NP

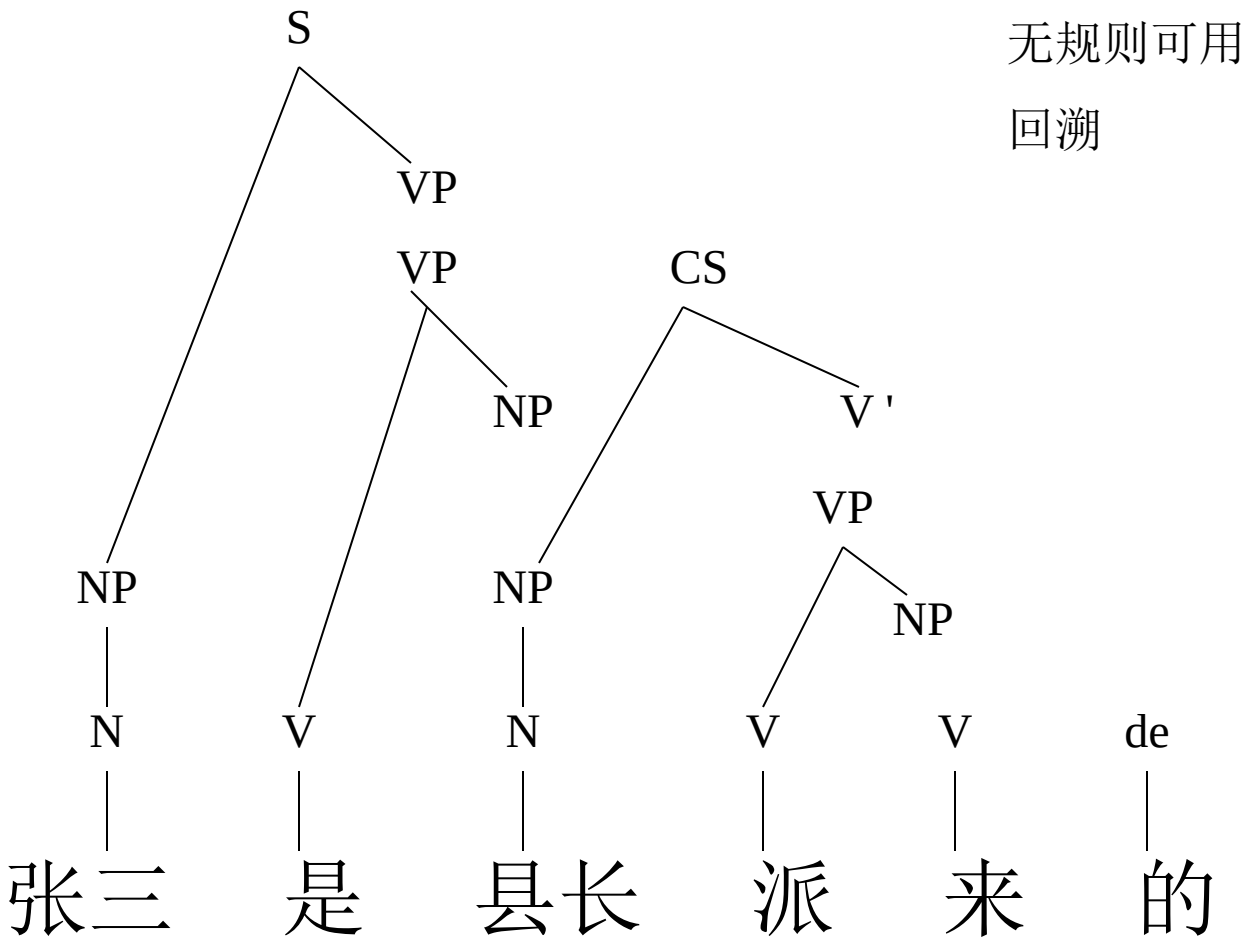


左角分析法示例-51

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

无规则可用

回溯

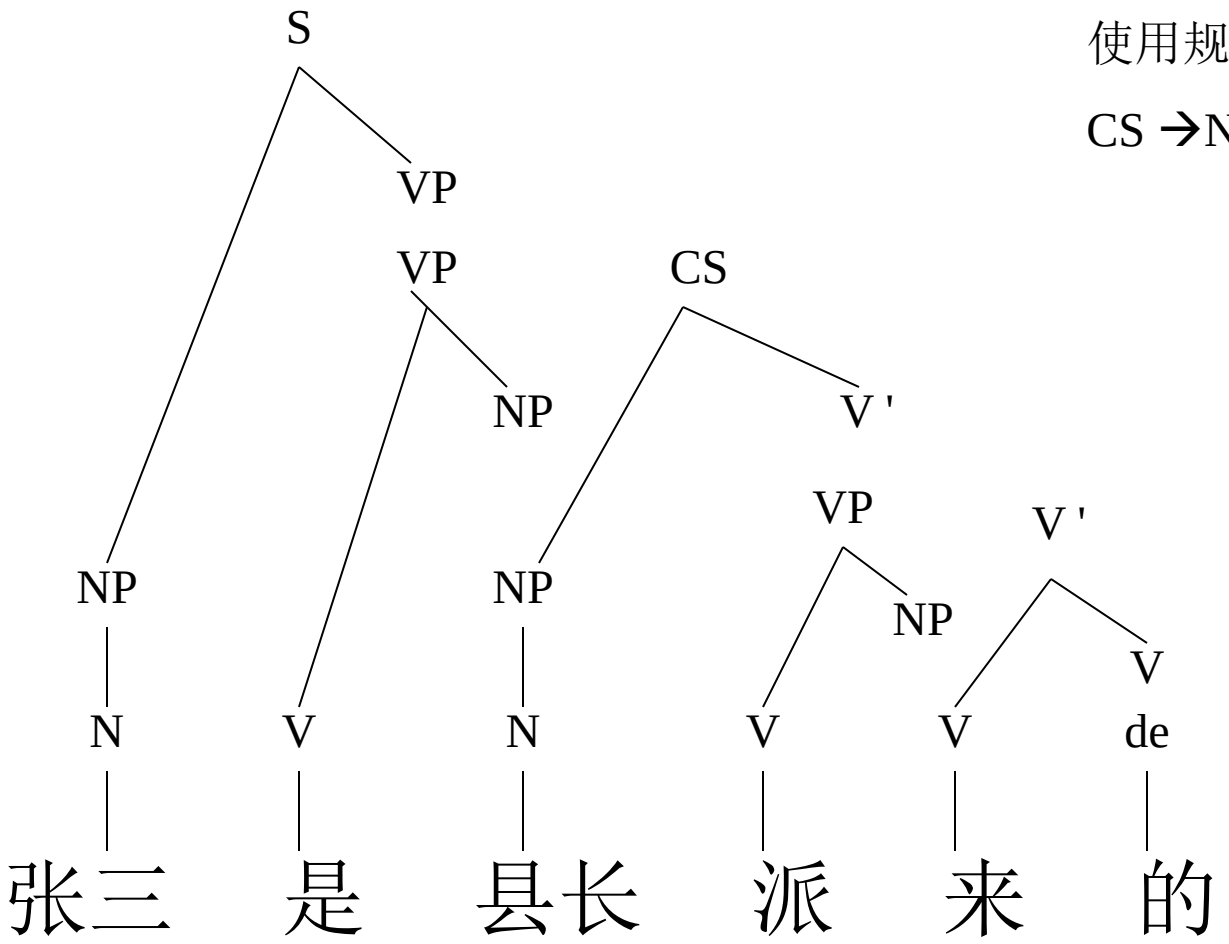


左角分析法示例-52

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则：

CS →NP V'

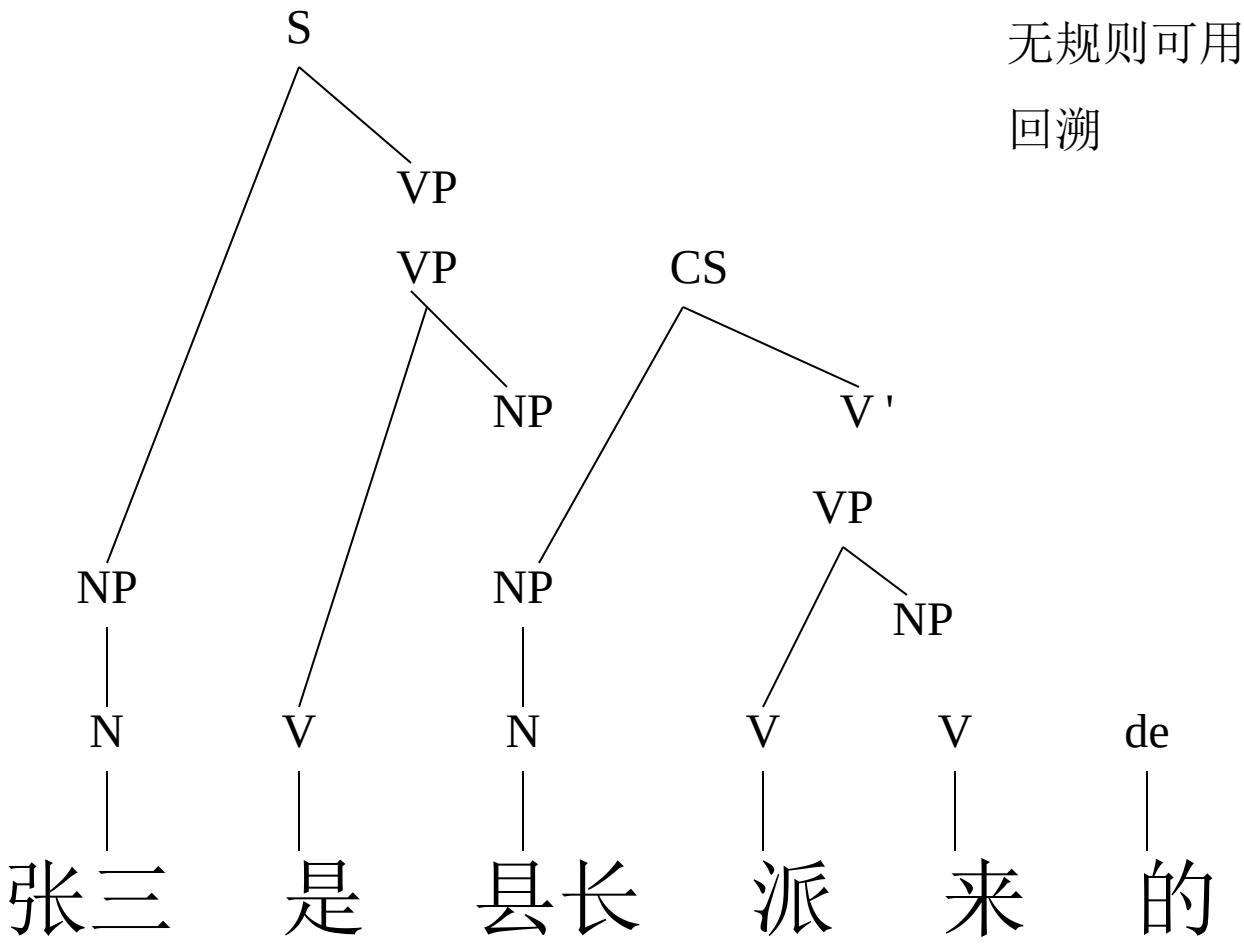


左角分析法示例-53

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

无规则可用

回溯

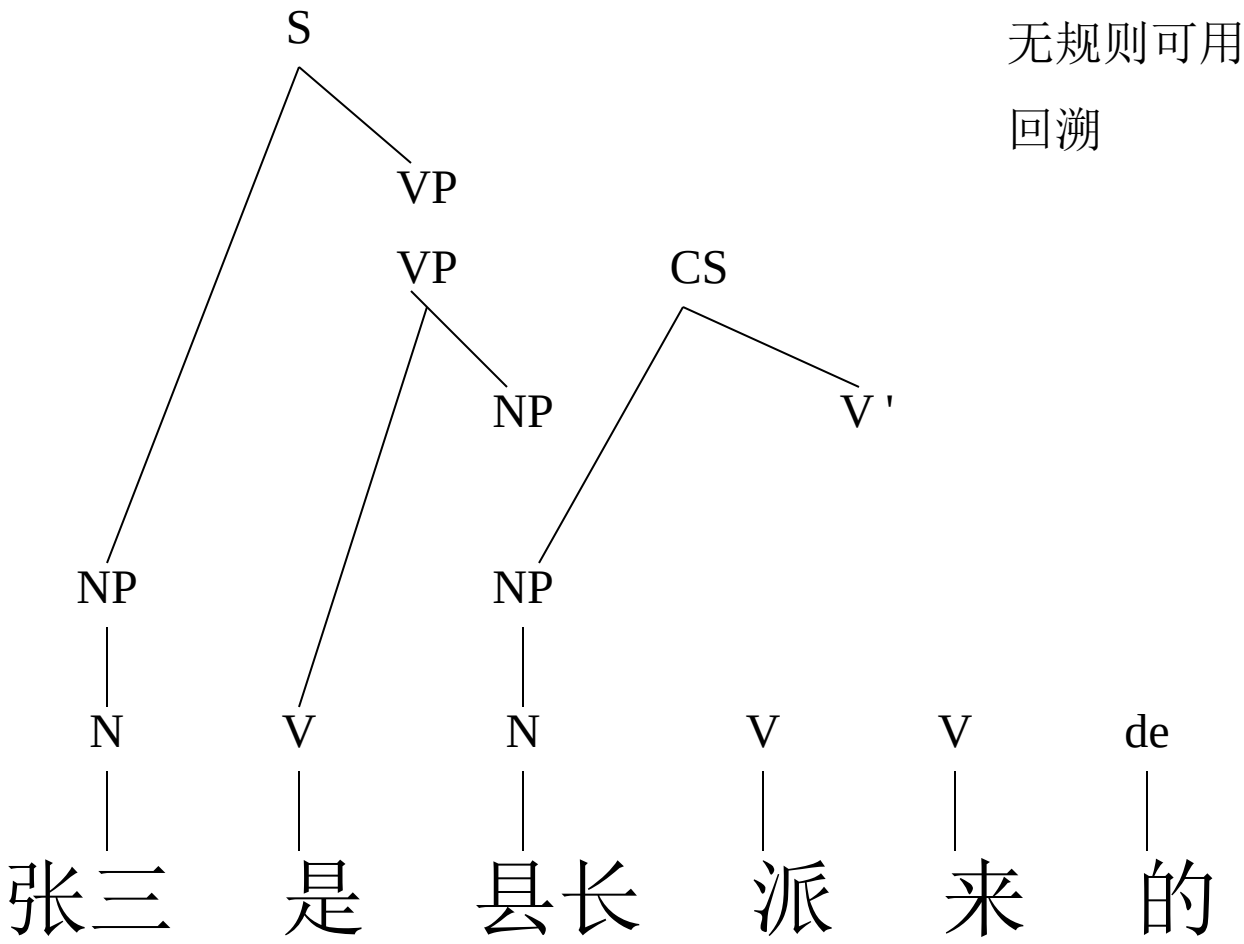


左角分析法示例-54

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

无规则可用

回溯

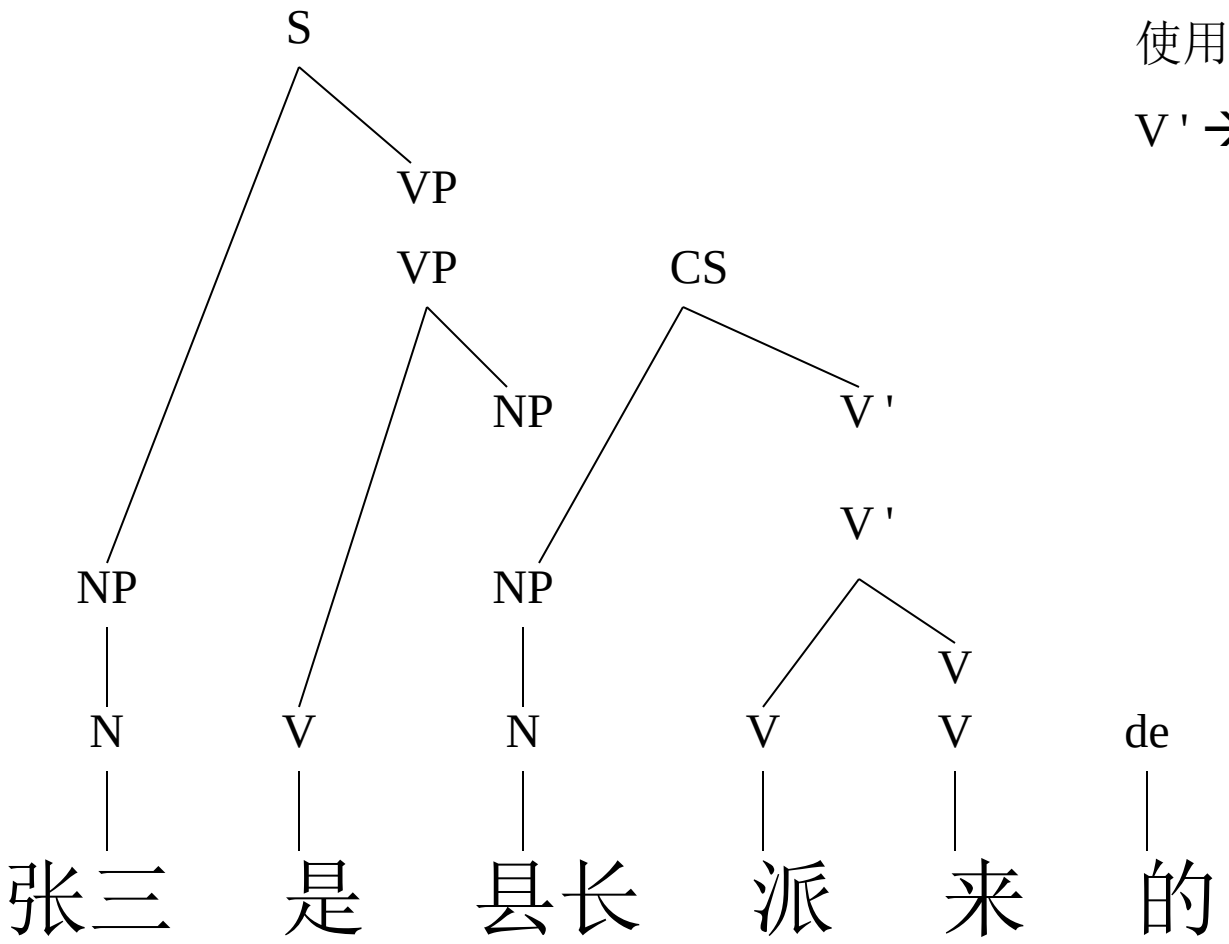


左角分析法示例-55

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V'
(5) VP → V NP
(6) V' → V V

使用规则：

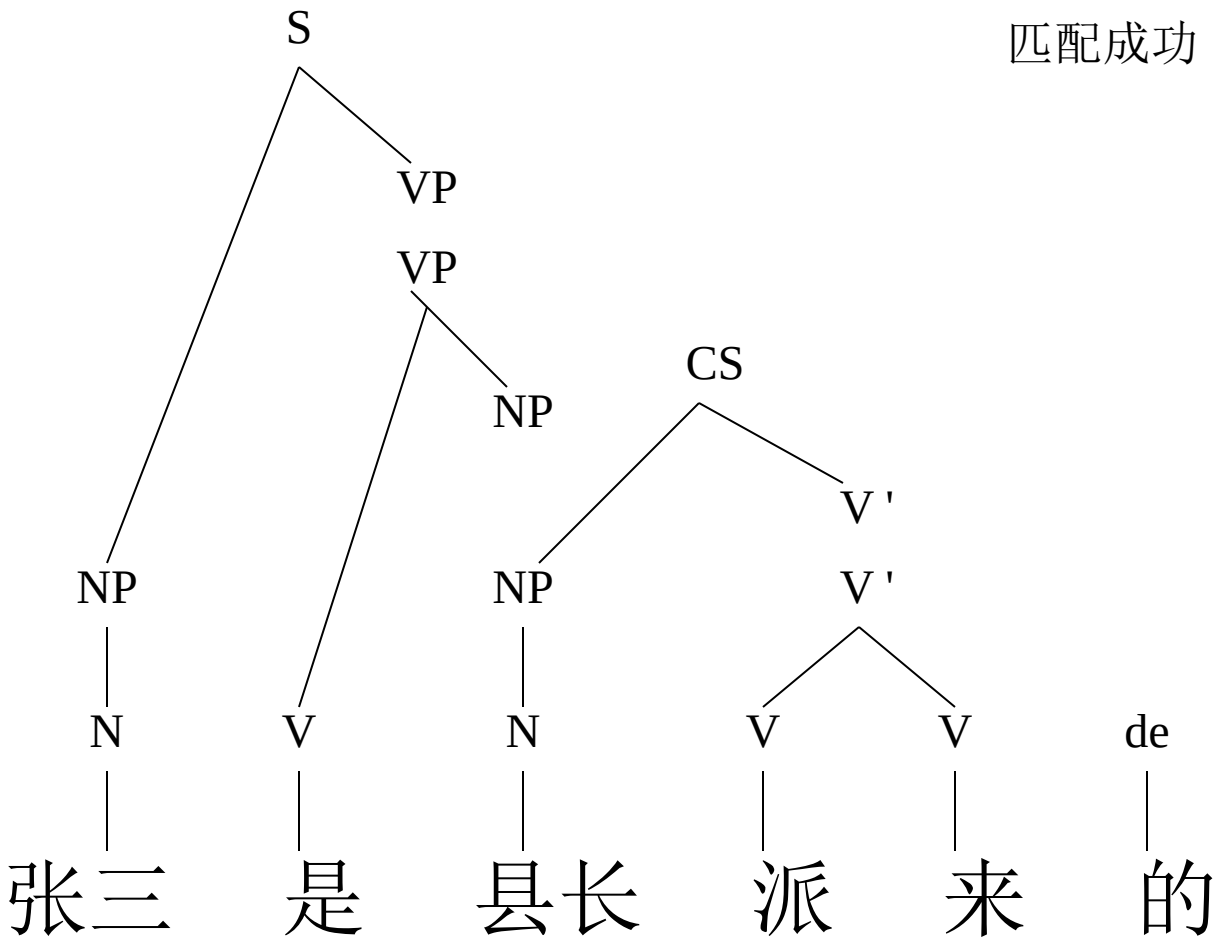
V' →V V



左角分析法示例-56

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

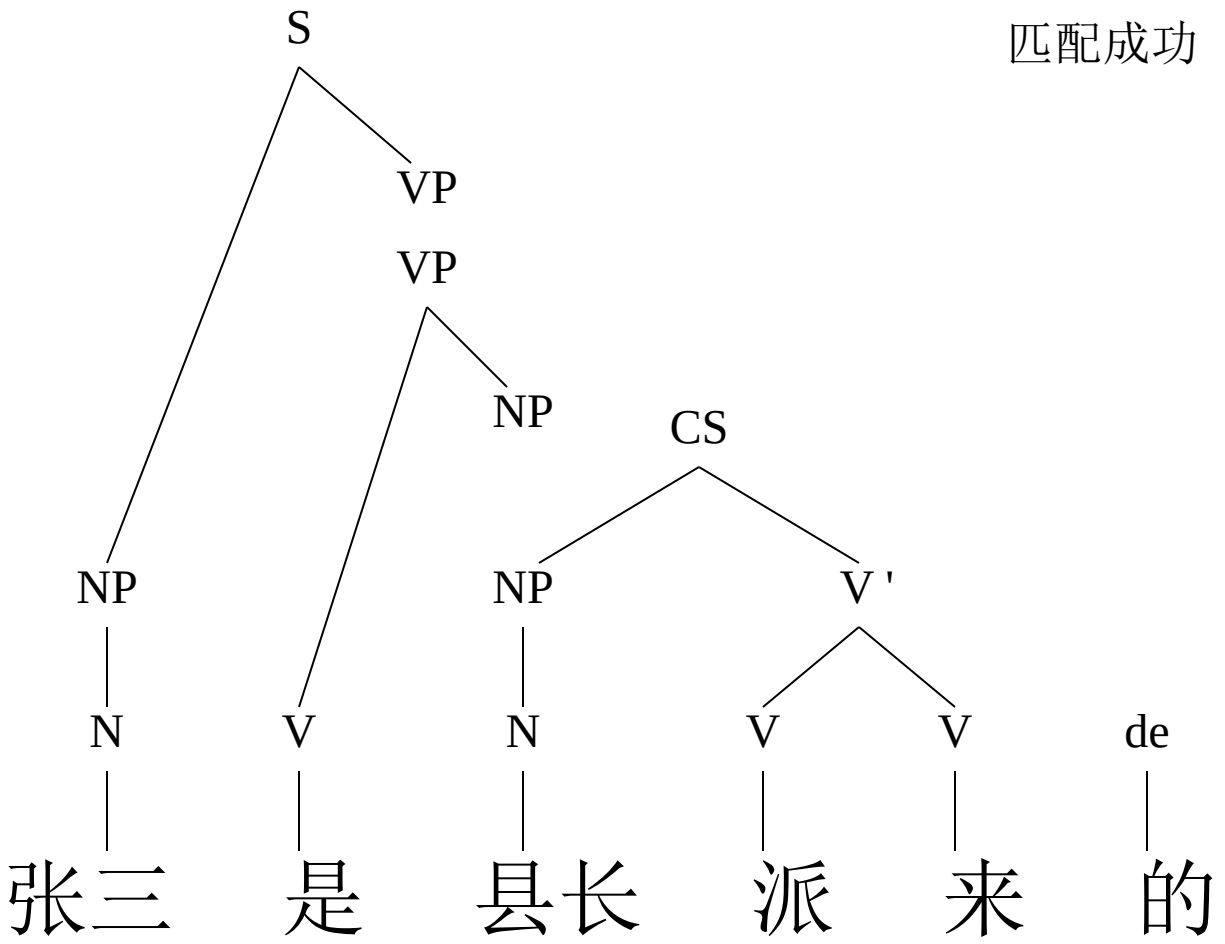
匹配成功



左角分析法示例-57

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

匹配成功

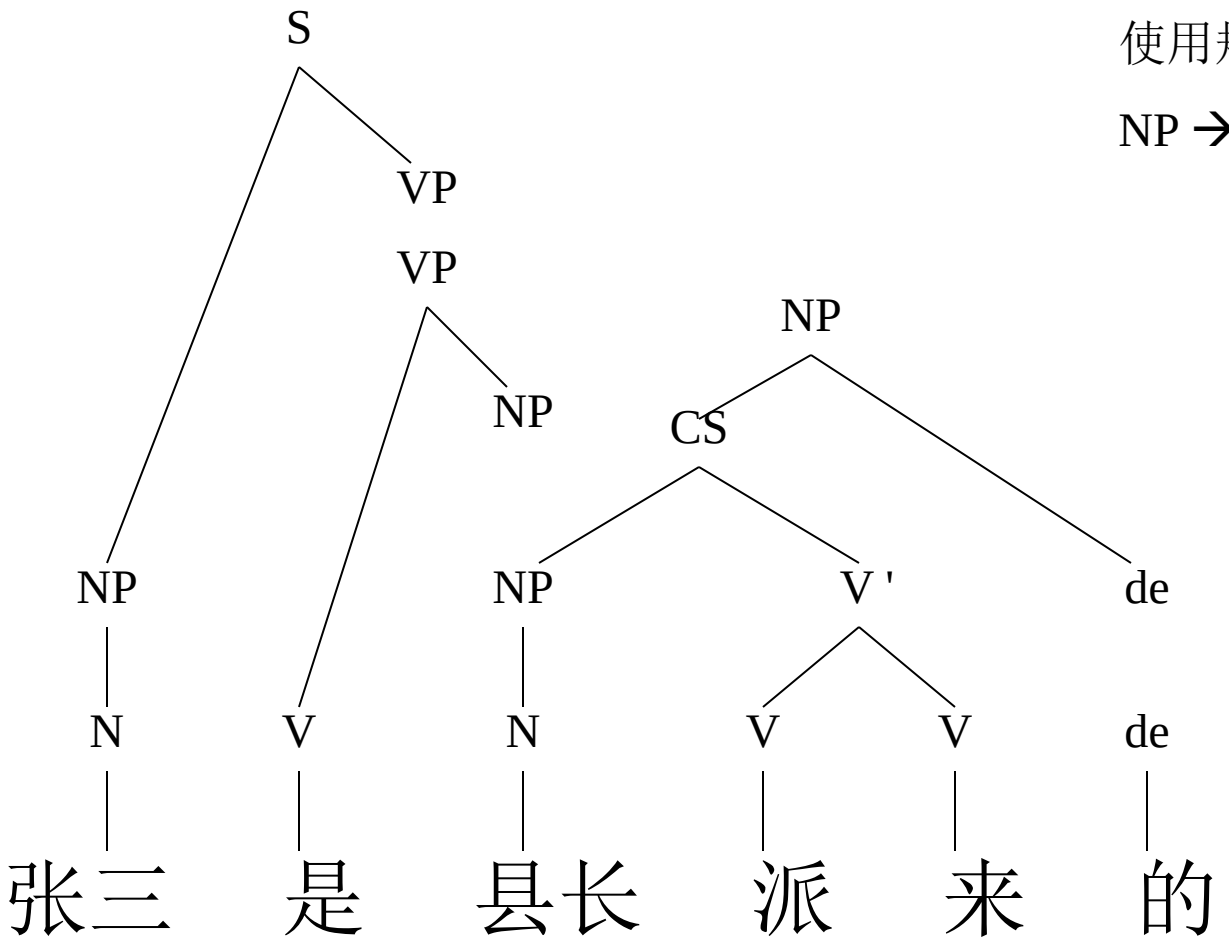


左角分析法示例-58

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

使用规则：

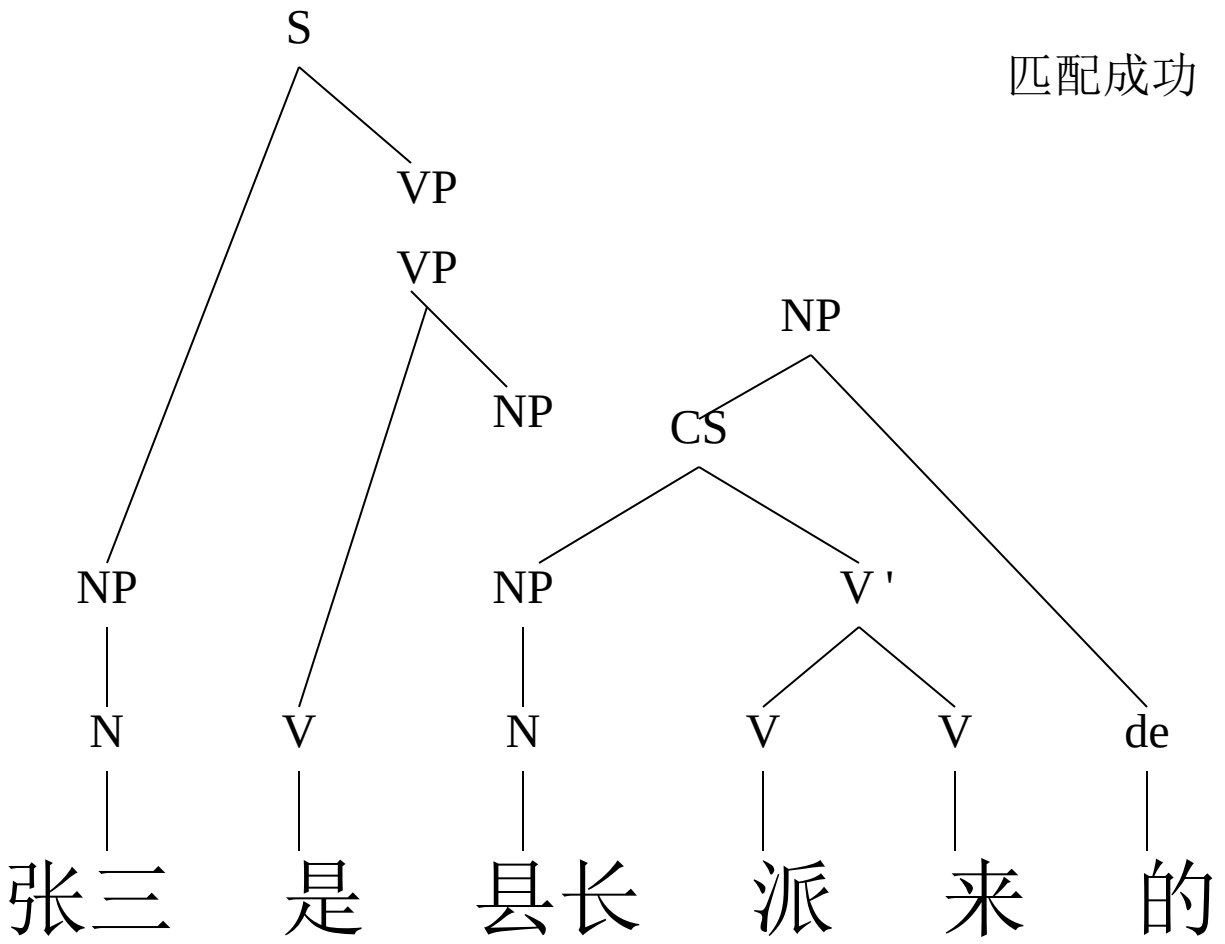
NP → CS de



左角分析法示例-59

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

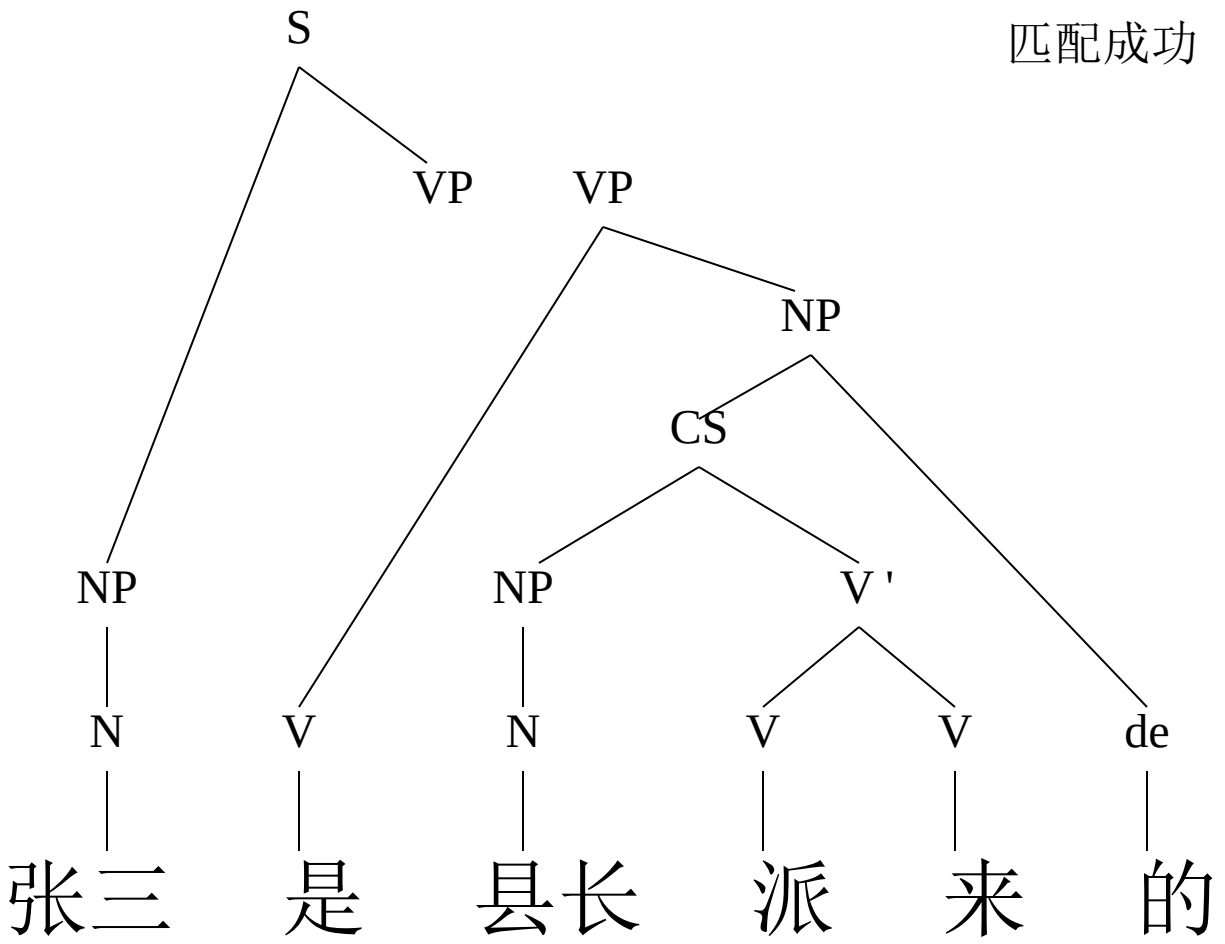
匹配成功



左角分析法示例-60

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

匹配成功

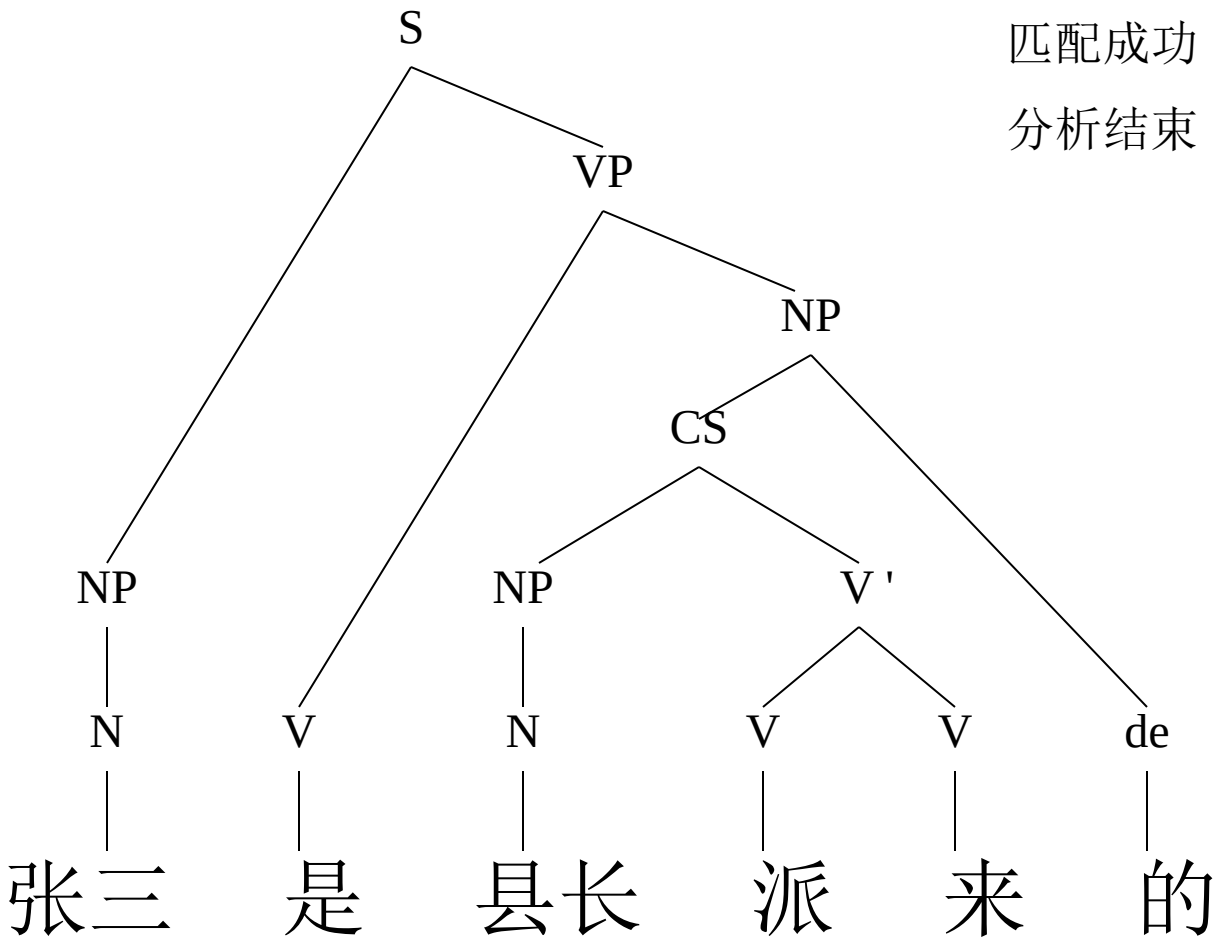


左角分析法示例-61

(1) S → NP VP
(2) NP → N
(3) NP → CS 的
(4) CS → NP V '
(5) VP → V NP
(6) V ' → V V

匹配成功

分析结束



关于左角分析法的思考

回溯过多，对这个例子来说，是由于深度优先，一开始走错了，以后步步皆错，要回溯到一开始的地方，才能重新走回到正确的道路上，分析效率很低。