Annexes for the Article "Semi-automatic Rule-based Domain Terminology and Software Feature-relevant Information Extraction from Natural Language User Manuals"

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The annexes presented in this document summarize the patterns which are required to (1) correct parse trees as well as (2) adapt parse trees in order to extract potentially feature-relevant information in a smooth way. The patterns are defined by means of Tregex (Levy and Andrew 2006) which indicate parts of a parse tree to be modified. Tsurgeon (Levy and Andrew 2006), which is a tree-transformation utility built on top of Tregex, allows to manipulate the identified parse trees as desired. In the following sections, we provide Tregex patterns with corresponding Tsurgeon operations and examples. An example shows a parse tree before modification on the left hand side, indicating the part of the parse tree which matches the pattern defined and are colored red. The right hand side shows the parse tree after modification(s) which are colored green.

1 Annex 1: Parse tree correction patterns

1.1 Cleanse NN#1

Pattern: `__ < (!/NN.?/=rel < /^QD.*|^DST.*/)`

Operation: `[relabel rel NN]`

Example:

```
(ROOT                                          (ROOT
  (ADVP (JJ DSTmanualDSTentry)))                 (ADVP (NN DSTmanualDSTentry)))
```

1.2 Cleanse NN#2

Pattern: `__=rel < (__ < /DST|QD/ !> NP)`

Operation: `[relabel rel NP]`

Example:

```
(ROOT                                          (ROOT
  (ADVP (NNS DSTmanualDSTentry)))                (NP (NNS DSTmanualDSTentry)))
```

1.3 Cleanse PP

Pattern: `VP=par <+(NP) (NP $+ (/,/ <1 /,/ $+ (__ << (/,/ <1 /,/ $+ PP=mov))))`

Operation: `[move mov >-1 par]`

Example:

```
(ROOT
  (S
    (NP (JJ other) (NNS options))
    (VP (VBP exclude)
      (NP
        (NP (NNP DSTreagents))
        (, ,)
        (SBAR
          (WHNP (WDT which))
          (S
            (VP (VBP are)
              (VP (VBN used)
                (PP (IN for)
                  (NP
                    (NP (NNP DSTcontrols))
                    (CC and)
                    (NP (NNPS DSTcalibrations))))
                (, ,)
                (PP (IN from)
                  (NP (NN invoicing)))))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (JJ other) (NNS options))
    (VP (VBP exclude)
      (NP
        (NP (NNP DSTreagents))
        (, ,)
        (SBAR
          (WHNP (WDT which))
          (S
            (VP (VBP are)
              (VP (VBN used)
                (PP (IN for)
                  (NP
                    (NP (NNP DSTcontrols))
                    (CC and)
                    (NP (NNPS DSTcalibrations)))
                (, ,))))))
        (PP (IN from)
          (NP (NN invoicing))))
    (. .)))
```

1.4 Cleanse JJ

Pattern: `ROOT|SINV < (/ADVP|VP/=exc < __=mov !< VBP) <-1 (NP <+(NP) (/NN.?/ > __=par))`

Operation: `[relabel mov JJ][move mov >1 par][excise exc exc]`

Example:

```
(ROOT
  (SINV
    (VP (VBD entered))
    (NP
      (NP (NNP DSTdealDSTdata))
      (VP (VBG regarding)))))
```

```
(ROOT
  (SINV
    (NP
      (NP (JJ entered) (NNP DSTdealDSTdata))
      (VP (VBG regarding)))))
```

1.5 Cleanse ADJP

Pattern: `VP=par <+(NP|S) (NP $+ (ADJP=rel < (VBN $+ PP)))`

Operation: `[move rel >-1 par][relabel rel PP]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NNP DSTcustomer))
    (VP (VBZ handles)
      (S
        (NP (DT the) (NNPS DSTmaterials))
        (ADJP (VBN related)
          (PP (TO to)
            (NP (DT the) (NN recommendation))))))))
```

```
(ROOT
  (S
    (NP (DT the) (NNP DSTcustomer))
    (VP (VBZ handles)
      (S
        (NP (DT the) (NNPS DSTmaterials))
        (PP (VBN related)
          (PP (TO to)
            (NP (DT the) (NN recommendation))))))))
```

1.6 Complex NP#1

Pattern: `PP < NP=bro $+ (NP=exc <1 NP)`

Operation: `[move exc $- bro][excise exc exc]`

Example:

```
(ROOT
  (PP (IN on)
    (NP (NNP DSTtest)))
  (NP
    (NP (NN level))
    (PP (IN for)
      (NP (NNP DSTreagents))))))
```

```
(ROOT
  (PP (IN on)
    (NP (NNP DSTtest))
    (NP (NN level))
    (PP (IN for)
      (NP (NNP DSTreagents)))))
```

1.7 Complex NP#2

Pattern: `__ < (NP=par < /NN.?|CD/ $+ (NP=exc < /NN.?|CD/ < __=mov !< CC))`

Operation: `[move exc $- bro][excise exc exc]`

Example:

```
(ROOT
  (PP (IN on)
    (NP (NNP DSTtest))
    (NP (NN level))
    (PP (IN for)
      (NP (NNP DSTreagents)))))
```

```
(ROOT
  (PP (IN on)
    (NP (NNP DSTtest) (NN level))
    (PP (IN for)
      (NP (NNP DSTreagents))))))
```

1.8 Complex NP#3

Pattern: `NP <: NP=exc`

Operation: `[excise exc exc]`

Example (cont.):

```
(ROOT
  (S
    (NP (NN DSTpack)
      (NP (NN optimization) (NNS data))
    (PP (IN for)
      (NP
        (NP (NNP DSTreagents))
        (VP (VBG regarding)))))))
```

```
(ROOT
  (S
    (NP (NN DSTpack) (NN optimization) (NNS data))
    (PP (IN for)
      (NP
        (NP (NNP DSTreagents))
        (VP (VBG regarding)))))))
```

1.9 Complex NP#4

Pattern: `NP=par $+ (NP=del <+(NP) (NP < __=mov $+ __=mov2))`

Operation: `[move mov >-1 par][move mov2 $- par][delete del]`

Example:

```
(ROOT
  (NP
    (NP (DT the) (JJ optimal) (NN DSTpack))
    (NP
      (NP (NNS sizes))
      (PP (IN of)
        (NP (DT each) (NNP DSTmaterial))))))
```

```
(ROOT
  (NP
    (NP (DT the) (JJ optimal) (NN DSTpack) (NNS sizes))
    (PP (IN of)
      (NP (DT each) (NNP DSTmaterial))))))
```

1.10 Complex NP#5

Pattern: `/NP$/=mov !< /NN.?|NP$|PRP|EX/ $+ NP=par`

Operation: `[move mov >1 par][excise mov mov]`

Example:

```
(ROOT
  (NP
    (NP (JJ annual))
    (NP (NNP DSTinstrument))))
```

```
(ROOT
  (NP
    (NP (JJ annual) (NNP DSTinstrument))))
```

1.11 Cleanse PP

Pattern: `/^NP$|^PPN$/=sis < (PP=mov !$-- /^NP$|^PPN$/)`

Operation: `[move mov $- sis]`

Example: `(NP (NNP DSTrounding)` was already modified from `(VP (VBG DSTrounding)` by applying *Cleanse NN#1*,

Cleanse NN#2, and *Complex NP#2*

```
(ROOT
  (S
    (NP (NNP DSTrounding) (NNS effects)
      (PP (IN of)
        (NP (NNP DSTbatches) (NN QDoptimization)
          (CC or)
          (NN QDmanualQDbatchQDentry))))))
```

```
(ROOT
  (S
    (NP (NNP DSTrounding) (NNS effects))
    (PP (IN of)
      (NP (NNP DSTbatches) (NN QDoptimization)
        (CC or)
        (NN QDmanualQDbatchQDentry))))))
```

1.12 Cleanse NP lists#1

Pattern: `(NP <-1 /NN.?/ >+(NP) (PP $- NP=par))`

Operation: if count(par) > 1 and $par_i = par_j$, then move par_j \$+ par_i

Example: *Cleanse NN#1*, *Cleanse NN#2*, and *Complex VP#1* are already applied

```
(ROOT
  (S
    (NP (DT the) (NN DSTannualDSTquantity))
    (VP (VBZ is) (VBN calculated)
      (PP (VBN based) (IN on)
        (NP
          (NP (DT the) (NN quantity))
          (PP (IN of)
            (NP
              (NP
                (NP (NNP DDSTevents))
                (PP (IN per)
                  (NP (NN year))))
              (, ,)
              (NP
                (NP (DT the) (NN quantity))
                (PP (IN of)
                  (NP (NNP DSTsteps))))
              (, ,)
              (CC and)
              (NP
                (NP (DT the) (NN quantity))
                (PP (IN of)
                  (NP (NNP DSTtests))))))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NN DSTannualDSTquantity))
    (VP (VBZ is) (VBN calculated)
      (PP (VBN based) (IN on)
        (NP
          (NP (DT the) (NN quantity))
          (PP (IN of)
            (NP
              (NP (NNP DDSTevents))
              (PP (IN per)
                (NP (NN year))))
            (, ,)
            (NP
              (NP (DT the) (NN quantity))
              (PP (IN of)
                (NP (NNP DSTsteps))))
            (, ,)
            (CC and)
            (NP
              (NP (DT the) (NN quantity))
              (PP (IN of)
                (NP (NNP DSTtests))))))))))
    (. .)))
```

1.13 Cleanse NP lists#2

Pattern: `NP $+ PP $-- __=sis > (!/NP|VP/=nam > __=par)`

Operation: cover the `NP` and it's corresponding `PP` node with a `NP` node

Example: *Complex VP#1* and *Complex VP#1* are already applied

```
(ROOT
  (PP (IN on)
    (NP (NNP DSTtest) (NN level))
    (PP (IN for)
      (NP (NNP DSTreagents))))))
```

```
(ROOT
  (PP (IN on)
    (NP
      (NP (NNP DSTtest) (NN level))
      (PP (IN for)
        (NP (NNP DSTreagents))))))
```

1.14 Cleanse S#1

Pattern: `__ < (NP=son1 $+ (VP=son2 $+ /CC|,/))`

Operation: `[insert S=par $+ son1][move son1 >-1 par][move son2 >-1 par]`

Example: continuation from *Cleanse S#2*

```
(ROOT
  (S
    (SBAR (IN once)
      (S
        (NP (DT the) (NNPS QDstatus))
        (VP (VBZ is) (VBN selected))))
    (, ,)
    (NP (DT the) (NNP DSTscenario))
    (VP (VBZ is) (VBN locked))
    (CC and)
    (S
      (NP (NNS changes))
      (VP (VBP are) (RB not) (JJ possible)))
    (. .)))
```

```
(ROOT
  (S
    (SBAR (IN once)
      (S
        (NP (DT this) (NNPS QDstatus))
        (VP (VBZ is) (VBN selected))))
    (, ,)
    (S
      (NP (DT the) (NNP DSTscenario))
      (VP (VBZ is) (VBN locked)))
    (CC and)
    (S
      (NP (NNS changes))
      (VP (VBP are) (RB not) (JJ possible)))
    (. .)))
```

1.15 Cleanse S#2

Pattern: `NP=mov1 [$+ VP=mov2 | $- VP=mov2] [$++ S | $-- S] > (S >+(S) ROOT)`

Operation: `[insert S=par $+ mov1][move mov1 >-1 par][move mov2 >-1 par]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (S
      (NP (DT each) (NNP DSTscenario))
      (VP (MD can) (VB be) (VBN assigned)
        (PP (TO to)
          (NP (DT a) (NNP DSTcustomer)))))))
    (, ,)
    (NP (DT each) (NNP DSTcustomer))
    (VP (MD can) (VB be) (VBN assigned)
      (PP (TO to)
        (NP (JJ different) (NNS DSTgroups))))))
    (. .)))
```

```
(ROOT
  (S
    (S
      (NP (DT each) (NNP DSTscenario))
      (VP (MD can) (VB be) (VBN assigned)
        (PP (TO to)
          (NP (JJ different) (NNP DSTcustomers)))))))
    (, ,)
    (S
      (NP (DT each) (NNP DSTcustomer))
      (VP (MD can) (VB be) (VBN assigned)
        (PP (TO to)
          (NP (JJ different) (NNS DSTgroups)))))))
    (. .)))
```

1.16 Cleanse "between" #1

Pattern: `PP=par < (IN < between) < (__ <1 /.P/ !< /CC|,/ << (/CC|,/=mov1 $+ __=mov2))`

Operation: `[move mov1 >-1 par][move mov2 >-1 par]`

Example:

```
(ROOT
  (S
    (NP (EX there))
    (VP (VBZ exists)
      (NP
        (NP (DT a) (NN difference))
        (PP (IN between)
          (NP
            (NP (DT a) (NN DSTtest))
            (VP (VBN displayed)
              (PP (IN in)
                (NP
                  (NP (DT the) (NN DSTlist))
                  (CC and)
                  (NP
                    (NP (DT a) (NN DSTtest))
                    (VP (VBN used)
                      (PP (IN in)
                        (NP (DT the) (NN DSTarea)))))))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (EX there))
    (VP (VBZ exists)
      (NP
        (NP (DT a) (NN difference))
        (PP (IN between)
          (NP
            (NP (DT a) (NN DSTtest))
            (VP (VBN displayed)
              (PP (IN in)
                (NP
                  (NP (DT the) (NN DSTlist))))))
        (CC and)
        (NP
          (NP (DT a) (NN DSTtest))
          (VP (VBN used)
            (PP (IN in)
              (NP (DT the) (NN DSTarea)))))))))
    (. .)))
```

1.17 Cleanse "between" #2

Pattern: `PP=par < (IN < between) !< CC !< (NP < CC) >+(NP) (NP $+ (CC=mov1 $+ NP=mov2))`

Operation: `[move mov1 >-1 par][move mov2 >-1 par]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NN status) (NN QDadd))
    (VP (VBZ indicates)
      (SBAR (IN that)
        (S
          (NP
            (NP
              (NP (DT the) (NN assignment))
              (PP (IN between)
                (NP (NNP DSTproductDSTfamily))))
            (CC and)
            (NP
              (NP (VBG DSTrounding) (NN mode))
              (PP (IN in)
                (NP (DT the) (NN database))))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NN status) (NN QDadd))
    (VP (VBZ indicates)
      (SBAR (IN that)
        (S
          (NP
            (NP
              (NP (DT the) (NN assignment))
              (PP (IN between)
                (NP (NNP DSTproductDSTfamily))
                (CC and)
                (NP
                  (NP (VBG DSTrounding) (NN mode))
                  (PP (IN in)
                    (NP (DT the) (NN database))))))))))
    (. .)))
```

2 Annex 2: Parse tree adaption patterns

2.1 Remove SINV

Pattern: `SINV=exc`

Operation: `[excise exc exc]`

Example:

```
(ROOT
  (SINV
    (NP
      (NP (JJ used) (NNP DSTmaterial)))))
```

```
(ROOT
  (NP
    (NP (JJ used) (NNP DSTmterial)))))
```

2.2 Remove Brackets#1

Pattern: `PRN=del <1 -LRB-`

Operation: `[delete del]`

Example:

```
(ROOT
  (NP
    (NP (DT the) (NNP DSTmaterial))
    (PRN (-LRB- -LRB-)
      (NP (NNP e.g.))
      (, ,)
      (NP (NNP DSTreagent))
      (-RRB- -RRB-))))
```

```
(ROOT
  (NP
    (NP (DT the) (NN DSTmaterial))))
```

2.3 Cleanse FRAG

Pattern: `__=nam > FRAG=rel`

Operation: replace each `FRAG` with *nam*

Example:

```
(ROOT
  (FRAG
    (NP (NN calculation))
    (PP (IN without)
      (NP (NNP DSTcooledDSTstability)))))
```

```
(ROOT
  (NP
    (NP (NN calculation))
    (PP (IN without)
      (NP (NNP DSTcooledDSTstability)))))
```

2.4 Complex VP#1

Pattern: `VP <- (VP=exc !$ VP)`

Operation: `[excise exc exc]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NNP DSTquantificator))
    (VP (VBZ starts)
      (S
        (VP (TO to)
          (VP (VB run)))))
    (.  .)))
```

```
(ROOT
  (S
    (NP (DT the) (NNP DSTquantificator))
    (VP (VBZ starts)
      (S
        (VP (TO to) (VB run)))))
    (.  .)))
```

2.5 Complex VP#2

Pattern: `VP=par < /MD|VB.?|JJ/=sis > (VP < /MD|VB.?|JJ/=del)`

Operation: add *sis* to each corresponding VB (in a loop) and delete *del* afterwards

Example:

```
(ROOT
  (S
    (NP (DT the) (NN user))
    (VP (MD can)
      (VP
        (VP (VB remove)
          (NP (NNS materials))
          (PP (IN from)
            (NP (DT the) (NNP DSTscenario))))
        (, ,)
        (CC or)
        (VP (VB modify)
          (NP (PRP$ their) (NN quantity)))))
    (.  .)))
```

```
(ROOT
  (S
    (NP (DT the) (NN user))
    (VP
      (VP (MD can) (VB remove)
        (NP (NNS materials))
        (PP (IN from)
          (NP (DT the) (NNP DSTscenario))))
      (, ,)
      (CC or)
      (VP (MD can) (VB modify)
        (NP (PRP$ their) (NN quantity)))))
    (.  .)))
```

2.6 Complex VP#3

Pattern: `VP < (/VB.?/ $.  ADJP|ADVP=exc)`

Operation: `[excise exc exc]`

Example:

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN default) (NN name))
      (PP (IN of)
        (NP (DT a) (NNP DSTsystemDSTgroup))))
    (VP (VBZ is)
      (ADJP (JJ configurable)
        (PP (IN in)
          (NP (DT the) (NNP DSTadminDSTtool)))))
    (. .)))
```

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN default) (NN name))
      (PP (IN of)
        (NP (DT a) (NNP DSTsystemDSTgroup))))
    (VP (VBZ is) (JJ configurable)
      (PP (IN in)
        (NP (DT the) (NNP DSTadminDSTtool)))))
    (. .)))
```

2.7 Complex VP#4

Pattern: `VP < (/VB.?/ $. ADJP|ADVP=exc)`

Operation: `[excise exc exc]`

Example:

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ creates)
      (NP (DT a) (NNP DSTsystemDSTgroup))
      (ADVP (RB automatically)))
    (. .)))
```

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (RB automatically) (VBZ creates)
      (NP (DT a) (NNP DSTsystemDSTgroup))
    (. .)))
```

2.8 Cleanse ADVP#1

Pattern: `ADVP=exc $+ /VB.?/`

Operation: `[excise exc exc]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NN user))
    (VP (MD can)
      (ADVP (RB manually))
      (VP (VB adapt)
        (NP (DT the) (NNS DSTsettings))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NN user))
    (VP (MD can) (RB manually))
      (VP (VB adapt)
        (NP (DT the) (NNS DSTsettings))))
    (. .)))
```

2.9 Cleanse ADVP#2

Pattern: `ADVP=exc < __=mov $+ VP=par`

Operation: `[move mov >1 par][excise exc exc]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NN user))
    (ADVP (RB manually))
    (VP (VBZ adapts)
      (NP (DT the) (NN DSTfrequency)))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NN user))
    (VP (RB manually) (VBZ adapts)
      (NP (DT the) (NN DSTfrequency)))
    (. .)))
```

2.10 Cleanse ADJP

Pattern: `NP|VP <+(S) ADJP=exc`

Operation: `[excise exc exc]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NNS reagents))
    (VP (VBP are)
      (ADJP (JJ available)))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NNS reagents))
    (VP (VBP are) (JJ available))
    (. .)))
```

2.11 Cleanse PRT

Pattern: `VP < PRT=exc`

Operation: `[excise exc exc]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NN sum))
    (VP (VBZ is)
      (VP (VBN rounded)
        (PRT (RP up))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NN sum))
    (VP (VBZ is)
      (VP (VBN rounded) (RP up))
    (. .)))
```

2.12 Complex PP

Pattern: `NP=bro < (IN=mov $.. __=mov2)`

Operation: `[insert (PP=par) $- bro][move mov >-1 par]`
`[insert (NP=par2) >-1 par][move mov2 >-1 par2]`

Example: considering the application of *Cleanse ADJP* beforehand (striked through)

```
(ROOT
  (S
    (VP (VB change)
      (NP
        (NP (NNP DSTenvironmentDSTdata))
        ~~(ADJP (IN if) (JJ necessary))~~))
    (. .)))
```

```
(ROOT
  (S
    (VP (VB change)
      (NP
        (NP (NNP DSTenvironmentDSTdata))
        (PP (IN if)
          (NP (JJ necessary))))
    (. .)))
```

2.13 Complex NP#a

Pattern: `__ < (NP=par $+ /NN.?/=mov)`

Operation: `[move mov >-1 par]`

Example:

```
(ROOT
  (NP
    (NP (DT the) (NNP DSTmaterial) (POS 's))
    (NN quantity)))
```

```
(ROOT
  (NP
    (NP (DT the) (NNP DSTmaterial) (POS 's) (NN quantity))))
```

2.14 Multiple PP#1

Pattern: `__=sis < (__ < (PP <: IN=bro) $+ (CC $+ (__ < (PP <-1 __=ins $+ __=mov))))`

Operation: `[move mov >-1 par]`

Example:

```
(ROOT
  (S
    (VP
      (VP (VB remove)
        (NP (NNS DSTmaterials))
        (PP (IN from)))
      (CC or)
      (VP (VB change)
        (NP (JJ DSTmaterial) (NNS quantities))
        (PP (IN in)
          (NP (DT a) (NNP DSTdeal)))))))
```

```
(ROOT
  (S
    (VP
      (VP (VB remove)
        (NP (NNS DSTmaterials))
        (PP (IN from)
          (NP (DT a) (NNP DSTdeal))))
      (CC or)
      (VP (VB change)
        (NP (JJ DSTmaterial) (NNS quantities))
        (PP (IN in)
          (NP (DT a) (NNP DSTdeal)))))))
```

2.15 Multiple PP#2

Pattern: `VP < (VP=par !<< NP $+ /,|CC/) <-1 (VP << (PP=ins1 $- (NP=ins2 !>+(NP) PP !$- PP)))`

Operation: `[insert ins1 >-1 par][insert ins2 >-2 par]`

Example:

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ provides)
      (S
        (NP (JJ multiple) (NNS possibilities))
        (VP
          (VP (TO to) (VB subsitute))
          (CC or)
          (VP (TO to) (VB modify)
            (NP (NNS materials))
            (PP (IN in)
              (NP (DT the) (NNP DSTdeal))))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ provides)
      (S
        (NP (JJ multiple) (NNS possibilities))
        (VP
          (VP (TO to) (VB subsitute)
            (NP (NNS materials))
            (PP (IN in)
              (NP (DT the) (NNP DSTdeal)))))
          (CC or)
          (VP (TO to) (VB modify)))
            (NP (NNS materials))
            (PP (IN in)
              (NP (DT the) (NNP DSTdeal))))))))
    (. .)))
```

2.16 Cleanse S#3

Pattern: `!ROOT < (S=exc <1 VP !$-- /CC|,/)`

Operation: `[excise exc exc]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (NP (NNP DSTGDC))
    (VP (VBZ allows)
      (S
        (VP (TO to) (VB clone)
          (NP (NNP DSTsystems)))))
    (.  .)))
```

```
(ROOT
  (S
    (NP (NNP DSTGDC))
    (VP (VBZ allows)
      (VP (TO to) (VB clone)
        (NP (NNP DSTsystems)))))
    (.  .)))
```

2.17 Cleanse S#4

Pattern: `ROOT < (S < (S=exc <+(S) (SBAR <1 IN)))`

Operation: `[excise exc exc]`

Example: *Complex VP#1* and *Cleanse ADJP* are already applied

```
(ROOT
  (S
    (S
      (SBAR (IN once)
        (S
          (NP (DT the) (NNPS QDstatus))
          (VP (VBZ is) (VBN selected))))
      (, ,)
      (NP (DT the) (NNP DSTscenario))
      (VP (VBZ is) (VBN locked)))
    (CC and)
    (S
      (NP (NNS changes))
      (VP (VBP are) (RB not) (JJ possible)))
    (.  .)))
```

```
(ROOT
  (S
    (SBAR (IN once)
      (S
        (NP (DT the) (NNPS QDstatus))
        (VP (VBZ is) (VBN selected))))
    (, ,)
    (NP (DT the) (NNP DSTscenario))
    (VP (VBZ is) (VBN locked))
    (CC and)
    (S
      (NP (NNS changes))
      (VP (VBP are) (RB not) (JJ possible)))
    (.  .)))
```

2.18 SBAR to VPH

Pattern: `VP < (SBAR=rel < (IN < that))`

Operation: `[relabel rel VPH]`

Example:

```
(ROOT
  (S
    (NP (NNP DSTGDC))
    (VP (VBZ assumes)
      (SBAR (IN that)
        (S
          (NP (DT a) (NNP DSTpricingDSTcustomer))
          (VP (VBZ is) (VBN assigned)
            (PP (TO to)
              (NP (DT an) (NNP DSTopportunity)))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (NNP DSTGDC))
    (VP (VBZ assumes)
      (VPH (IN that)
        (S
          (NP (DT a) (NNP DSTpricingDSTcustomer))
          (VP (VBZ is) (VBN assigned)
            (PP (TO to)
              (NP (DT an) (NNP DSTopportunity)))))))
    (. .)))
```

2.19 SBAR to VPC#1

Pattern: `VP <+(SBAR) (SBAR=rel < (IN < /if|whether|after|before/))`

Operation: `[relabel rel VPC]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (NP (DT the) (NNP DSTadminDSTtool))
    (VP (VBZ allows)
      (S
        (VP (TO to) (VB configure)
          (SBAR (IN whether)
            (S
              (NP (NNP DSTcustomers))
              (VP (VBP are) (VBN created)
                (PP (IN by)
                  (NP (NNP DSTgdc))))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NNP DSTadminDSTtool))
    (VP (VBZ allows)
      (S
        (VP (TO to) (VB configure)
          (VPC (IN whether)
            (S
              (NP (NNP DSTcustomers))
              (VP (VBP are) (VBN created)
                (PP (IN by)
                  (NP (NNP DSTgdc))))))))
    (. .)))
```

2.20 SBAR to VPC#2

Pattern: `VP < (SBAR=rel <+(SBAR) (WHADVP < WRB))`

Operation: `[relabel rel VPC]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (NP (NNS DSTenvironmentDSTsettings))
    (VP (VBP describe)
      (SBAR
        (WHADVP (WRB how))
        (S
          (NP (DT the) (NNP DSTcustomer))
          (VP (VBZ handles)
            (NP (DT the) (NN DSTanalyzer))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (NNS DSTenvironmentDSTsettings))
    (VP (VBP describe)
      (VPC
        (WHADVP (WRB how))
        (S
          (NP (DT the) (NNP DSTcustomer))
          (VP (VBZ handles)
            (NP (DT the) (NN DSTanalyzer))))))
    (. .)))
```

2.21 SBAR to VPP

Pattern: `VP < (SBAR=rel < (IN !< /if|whether|after|before/))`

Operation: `[relabel rel VPC]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NNP DSTmaterialDSTgrid))
    (VP (VBZ offers)
      (NP (JJ additional) (NN functionality))
      (SBAR (IN as)
        (S
          (VP (VBD described)))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NNP DSTmaterialDSTgrid))
    (VP (VBZ offers)
      (NP (JJ additional) (NN functionality))
      (VPP (IN as)
        (S
          (VP (VBD described)))))
    (. .)))
```

2.22 VP to VPV

Pattern: `P !<1 /VP.?|VP/ < (VP=rel !< TO !< VP)`

Operation: `[relabel rel VPV]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (VP (VB click)
      (S
        (NP (DT the) (NN button))
        (VP (TO to)
          (VP (VB open)
            (NP (DT the) (NNP QDcustQDsearch)))
          (CC and)
          (VP (VB select)
            (NP (DT a) ((NN DSTcustomer)))))))))
```

```
(ROOT
  (S
    (VP (VB click)
      (S
        (NP (DT the) (NN button))
        (VP (TO to)
          (VPV (VB open)
            (NP (DT the) (NNP QDcustQDsearch)))
          (CC and)
          (VPV (VB select)
            (NP (DT a) ((NN DSTcustomer)))))))))
```

2.23 PP to VPP#1

Pattern: `/^VP$|VPV|NPV/ <+(PP) (PP=rel !< /VB.?/ !< PP)`

Operation: `[relabel rel VPP]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN number))
      (PP (IN of)
        (NP (NNP DSTtestDSTreruns))))
    (VP (VBZ is) (VBN considered)
      (PP (IN during)
        (NP (NNP DSTquantification)))))
    (. .)))
```

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN number))
      (PP (IN of)
        (NP (NNP DSTtestDSTreruns))))
    (VP (VBZ is) (VBN considered)
      (VPP (IN during)
        (NP (NNP DSTquantification)))))
    (. .)))
```

2.24 PP to VPP#2

Pattern: `PP=rel $-- /VB.?|MD/`

Operation: `[relabel rel VPP]`

Example: *Complex VP#1* and *Complex VP#3* are already applied

```
(ROOT
  (S
    (NP (DT an) (NNP DSToptimizationDSTmode))
    (VP (MD might) (VB be) (JJ available)
      (PP (IN for)
        (NP (JJ low) (NNP DSTworkload))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT an) (NNP DSToptimizationDSTmode))
    (VP (MD might) (VB be) (JJ available)
      (VPP (IN for)
        (NP (JJ low) (NNP DSTworkload))))
    (. .)))
```

2.25 VP to VPT#1

Pattern: `VP < (VP=rel <+(S) TO)`

Operation: `[relabel rel VPT]`

Example: *Complex VP#1* and *Cleanse S#3* are already applied

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ allows)
      (VP (TO to) (VB configure)
        (NP (NNS DSTenvironmentDSTsettings))))
    (. .)))
```

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ allows)
      (VPT (TO to) (VB configure)
        (NP (NNS DSTenvironmentDSTsettings))))))
    (. .)))
```

2.26 VP to VPT#2

Pattern: `/VP$/=par <+(S) (VP=rel < TO)`

Operation: `[relabel rel VPT][move rel >1 par]`

Example: *Complex VP#1* and *Cleanse S#3* are already applied

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ allows)
      (NP (DT the) (NN user)
        (VP (TO to) (VB run)
          (NP (DT the) (NN DSTquantificator)))))
    (. .)))
```

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ allows)
      (NP (DT the) (NN user))
      (VPT (TO to) (VB run)
        (NP (DT the) (NN DSTquantificator))))
    (. .)))
```

2.27 VP to VPT#3

Pattern: `SBAR <-1 (VP=rel <1 TO)`

Operation: `[relabel rel VPT]`

Example: *Complex VP#1* and *Cleanse S#3* are already applied

```
(ROOT
  (SBAR (IN in) (NN order)
    (VP (TO to) (VB change)
      (NP (DT the) (NN DSTprofile))))
  (, ,)
  (VP (VB select)
    (NP (DT an) (NN option)))
  (. .))
```

```
(ROOT
  (SBAR (IN in) (NN order)
    (VPT (TO to) (VB change)
      (NP (DT the) (NN DSTprofile))))
  (, ,)
  (VP (VB select)
    (NP (DT an) (NN option)))
  (. .))
```

2.28 VP to VPW

Pattern: `/VP$|VPT|NPV|NPT|PPV|VPV/ < (SBAR=rel < WHNP)`

Operation: `[relabel rel VPW]`

Example: *Complex VP#1* and *Cleanse S#3* are already applied

```
(ROOT
  (S
    (NP (DT the) (NNP DSTmaterialDSTlist))
    (VP (VBZ shows)
      (SBAR
        (WHNP (WDT which))
          (NP (NNP DSTmaterials))
          (VP (VBP are) (VBN used)
            (PP (IN for)
              (NP (NNP DSTquantification))))))))
  (. .))
```

```
(ROOT
  (S
    (NP (DT the) (NNP DSTmaterialDSTlist))
    (VP (VBZ shows)
      (VPW
        (WHNP (WDT which))
          (NP (NNP DSTmaterials))
          (VP (VBP are) (VBN used)
            (PP (IN for)
              (NP (NNP DSTquantification))))))))
  (. .))
```

2.29 PP to NPP

Pattern: `/NP$|PPN|NPP|NPV/ $+ (PP=rel !< /VB.?/) > /^S$|^NP$|PPN/`

Operation: `[relabel rel NPP]`

Example: *Complex VP#1* and *Cleanse S#3* are already applied

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ performs)
      (NP
        (NP (CD 3) (NNS steps))
        (PP (IN in)
          (NP (NNPS DSTquantification)))))
    (. .)))
```

```
(ROOT
  (S
    (NP (NNP DSTgdc))
    (VP (VBZ performs)
      (NP
        (NP (CD 3) (NNS steps))
        (NPP (IN in)
          (NP (NNPS DSTquantification)))))
    (. .)))
```

2.30 SBAR to NPW

Pattern: `NP $++ (SBAR=rel < WHNP)`

Operation: `[relabel rel NPW]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (NP (DT the) (NNP DSTmaterialDSTlist))
    (VP (VBZ contains)
      (NP
        (NP (DT the) (NNPS DSTmaterials))
        (SBAR
          (WHNP (WDT which))
          (S
            (VP (VBP are) (VBN used)
              (PP (IN for)
                (NP (NNP DSTquantification))))))))
    (. .)))
```

```
(ROOT
  (S
    (NP (DT the) (NNP DSTmaterialDSTlist))
    (VP (VBZ contains)
      (NP
        (NP (DT the) (NNPS DSTmaterials))
        (NPW
          (WHNP (WDT which))
          (S
            (VP (VBP are) (VBN used)
              (PP (IN for)
                (NP (NNP DSTquantification))))))))
    (. .)))
```

2.31 VP to NPV

Pattern: `(VP=rel [<1 /VB.?/ | <1 (ADVP $+ /VB.?/) | <1 (RB $+ /VBN|VBD/)] $- /NP.?/) > NP`

Operation: `[relabel rel NPV]`

Example:

```
(ROOT
  (S
    (NP (DT the) (NNP DSTquantificator))
    (VP (VBZ considers)
      (NP
        (NP (DT the) (NNS settings))
        (VP (VBN made)
          (PP (IN on)
            (NP (NNP DSTenvironment) (NN level))))))
    (.  .)))
```

```
(ROOT
  (S
    (NP (DT the) (NNP DSTquantificator))
    (VP (VBZ considers)
      (NP
        (NP (DT the) (NNS settings))
        (NPV (VBN made)
          (PP (IN on)
            (NP (NNP DSTenvironment) (NN level))))))
    (.  .)))
```

2.32 NP to PPN

Pattern: `/^PP$|VPP|NPP|PPP/ < NP=rel`

Operation: `[relabel rel PPN]`

Example:

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN result))
      (PP (IN of)
        (NP (DT the) (NNP DSTquantification))))
    (VP (VBZ is)
      (NP (DT a) (NN DSTmaterialDSTlist)))
    (.  .)))
```

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN result))
      (PP (IN of)
        (PPN (DT the) (NNP DSTquantification))))
    (VP (VBZ is)
      (NP (DT a) (NN DSTmaterialDSTlist)))
    (.  .)))
```

2.33 PP to PPV

Pattern: `/^PP$|VPP|NPP|PPP/ < VP=rel`

Operation: `[relabel rel PPV]`

Example: *Cleanse S#3* is already applied

```
(ROOT
  (S
    (VP (VB exclude)
      (NP (NNS materials))
      (PP (IN before)
        (VP (VBG running)
          (NP (DT the) (NN DSTquantificator)))))))
```

```
(ROOT
  (S
    (VP (VB exclude)
      (NP (NNS materials))
      (PP (IN before)
        (PPV (VBG running)
          (NP (DT the) (NN DSTquantificator)))))))
```

2.34 PP to PPW#1

Pattern: `/^PP$|VPP|NPP|PPP/ < (IN $+ (SBAR=rel < (WHNP < WDT)))`

Operation: `[relabel rel PPW]`

Example: *Cleanse S#3* is already applied

```
(ROOT
  (S
    (NP (DT the) (NNP QDorigin) (NN column))
    (VP (VBZ shows)
      (NP (DT the) (NN source))
      (PP (IN from)
        (SBAR
          (WHNP (WDT which))
            (NP (DT the) (NN material))
            (VP (VBD was) (VBN added)
              (PP (TO to)
                (NP (DT the) (NNP DSTscenario)))))))
    (.  .)))
```

```
(ROOT
  (S
    (NP (DT the) (NNP QDorigin) (NN column))
    (VP (VBZ shows)
      (NP (DT the) (NN source))
      (PP (IN from)
        (PPW
          (WHNP (WDT which))
            (NP (DT the) (NN material))
            (VP (VBD was) (VBN added)
              (PP (TO to)
                (NP (DT the) (NNP DSTscenario)))))))
    (.  .)))
```

2.35 PP to PPW#2

Pattern: `SBAR=rel1 < (WHPP=rel2 < IN=mov1 < WHNP=par $+ S=mov2)`

Operation: `[move mov1 >1 rel1][move mov2  par][relabel rel1 NPP][relabel rel2 PPW]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (NP
      (NP (DT the) (NNPS DSTsources))
      (SBAR
        (WHPP (IN from)
          (WHNP (WDT which)))
        (S
          (NP (DT the) (NNPS DSTsettings))
          (VP (VBD were) (VBN loaded)))))
    (VP (VBP are) (VBN displayed))
    (.  .)))
```

```
(ROOT
  (S
    (NP
      (NP (DT the) (NNPS DSTsources))
      (NPP
        (PPW (IN from)
          (WHNP (WDT which)))
        (S
          (NP (DT the) (NNPS DSTsettings))
          (VP (VBD were) (VBN loaded)))))
    (VP (VBP are) (VBN displayed))
    (.  .)))
```

2.36 Surround NP

Pattern: `/^NP$|PPN$/=sis $+ /^PP$|NPP$/ $++ __=bro !> /^NP$|PPN$/ > __=par`

Operation: `[move mov1 >1 rel1][move mov2  par][relabel rel1 NPP][relabel rel2 PPW]`

Example: *Complex VP#1* is already applied

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN DSTlog))
      (PP (IN for)
        (NP (NNP DSTtest))))
    (VP (VBZ comprises)
      (NP (JJ detailed) (NN information))
      (PP (IN about)))))
```

```
(ROOT
  (S
    (NP
      (NP (DT the) (NN DSTlog))
      (PP (IN for)
        (NP (NNP DSTtest))))
    (VP (VBZ comprises)
      (NP
        (NP (JJ detailed) (NN information))
        (PP (IN about))))))
```

References

Levy R, Andrew G (2006) Tregex and Tsurgeon: tools for querying and manipulating tree data structures. In: Proc. of 5th Int. Conf. on Language Resources and Evaluation (LREC'06), pp 2231–2234