**Task1:**
**Propose new or amended rules so that the grammar generates examples (i-viii) below, but not the ungrammatical (ix-xii).**

Set of formal grammar rules: (R.Kibble, 2013) , (University of Pensilvania, 2019)

Determiner **Det** –> The | a |

Noun **N** –> trombones | parade | pass | end | wumpus | shamus | street | wood | way | students | professor |

Name **Name** –> Spartans | Jana | Thermopylae | Fatima |

Verb **V** –> led | defended | saw | chortled | whiffled | came | floated | agreed | was | see | should | be | dreamed |

Adverb **Adv** –> hideously | as | most | very |

Adjective **Adj** --> big | ugly | peculiar | tough | fair | careful | either |

Conjunction **Conj** --> or | and | that | but | then | either |

Pronoun **Prn** –> it | their | you | she |

Preposition **Prep** –> at |of | through | in | If |

Digit **Digit** –> 76 | 300 |


Sentences:

i. 76 trombones led the big parade.
ii. 300 Spartans defended the pass at Thermopylae.
iii. Jana saw either a wumpus or a shamus at the end of the street.
iv. The hideously ugly wumpus chortled and whiffled as it came through the wood.
v. The wumpus floated in a most peculiar way.
vi. The students agreed that their professor was tough but fair.
vii. If you see a wumpus then you should be very careful.
viii. Either Fatima saw a wumpus or she dreamed it.

ix. *The Wumpus floated in a most way.
x. *The students agreed that their professor was very.
xi. *Ivan saw either a wumpus and a shamus.
xii. *If Ali saw a wumpus or it was a shamus.

i.    <u>76   trombones  led  the  big  parade.</u>
   **Digit       N          V  Det Adj    N**

```
S (S-> NP VP)
NP VP (NP)
NP (NP-> Digit N)
NP (NP-> 76 N)
76 N (N-> trombones)
76 trombones VP (VP-> VP NP)
76 trombones VP (VP-> led NP)
76 trombones led NP (NP-> Det Adj N)
76 trombones led NP (NP-> the Adj N)
76 trombones led the NP (NP-> big N)
76 trombones led the big N (N-> parade)
76 trombones led the big parade.
```

**Change in Grammar:**
Digit -> Digit | Digit Digit
NP-> Digit + N


ii. <u>300  Spartans  defended  the  pass  at  Thermopylae.</u>
   **Digit  Name          V      Det   N  Prep    Name**

```
S (S-> NP VP)
NP VP (NP)
NP (NP-> Digit PN)
NP (NP-> 300 PN)
300 N (N-> Spartans)
300 Spartans VP (VP-> VP NP)
300 Spartans VP (VP-> defended NP)
300 Spartans defended NP (NP -> NP PP)
300 Spartans defended NP (NP-> Def N)
300 Spartans defended NP (NP-> the N)
300 Spartans defended the N (N-> pass)
300 Spartans defended the pass PP (PP-> Prep Name)
300 Spartans defended the pass PP (PP-> at Name)
300 Spartans defended the pass at Name (Name-> Thermopylae)
300 Spartans defended the pass at Thermopylae.
```

**Change in Grammar:**
NP -> Digit + Name

iii. <u>Jana  saw  either  a  wumpus  or  a  shamus  at  the  end  of   the  street.</u>
   **Name V   Adj  Det   N    Conj Det  N    Prep Det  N Prep Det    N**

```
S (S-> NP VP)
NP VP (NP)
NP (NP-> Name)
Name (Name-> Jana)
Jana VP (VP-> VP NP)
```

```
Jana VP (VP-> VP NP)
Jana VP (VP-> saw Adj)
Jana saw Adj( Adj-> either)
Jana saw either NP (NP-> Det N)
Jana saw either NP (NP-> a N)
Jana saw either a N (N-> wumpus)
Jana saw either a wumpus NP (NP-> NP PP)
Jana saw either a wumpus NP (NP-> Conj Det N)
Jana saw either a wumpus NP (NP-> or Det N)
Jana saw either a wumpus or NP (NP-> Det N)
Jana saw either a wumpus or NP (NP-> a N)
Jana saw either a wumpus or a N (N-> shamus)
Jana saw either a wumpus or a shamus PP (PP-> Prep NP)
Jana saw either a wumpus or a shamus PP (PP-> at NP)
Jana saw either a wumpus or a shamus at NP (NP-> Det N PP)
Jana saw either a wumpus or a shamus at NP (NP-> the N PP)
Jana saw either a wumpus or a shamus at the NP (NP-> end PP)
Jana saw either a wumpus or a shamus at the end PP(PP-> Prep NP)
Jana saw either a wumpus or a shamus at the end PP(PP-> of NP)
Jana saw either a wumpus or a shamus at the end of NP (NP-> Det N)
Jana saw either a wumpus or a shamus at the end of NP (NP-> the N)
Jana saw either a wumpus or a shamus at the end of the N (N->
street)
Jana saw either a wumpus or a shamus at the end of the street.
```

**Change in Grammar:**
NP -> Conj + Det+ N


iv. The  hideously ugly  wumpus chortled  and  whiffled   as   it  came through   the   wood.

| Det | Adv | Adj | N | V | Conj | V | Adv | Prn | V | Prep | Det | V |
|-----|-----|-----|---|---|------|---|-----|-----|---|------|-----|---|

```
S (S-> NP VP)
NP (NP-> Det AdjP N)
NP (NP-> The AdjP N)
The NP (NP-> AdjP N)
The AdjP (AdjP-> Adv Adj)
The AdjP (AdjP-> hideously Adj)
The hideously Adj (Adj-> ugly)
The hideously ugly N (N-> wumpus)
The hideously ugly wumpus VP (VP-> VP PP)
The hideously ugly wumpus VP (VP-> VP Prn V)
The hideously ugly wumpus VP (VP-> VP Adv)
The hideously ugly wumpus VP (VP-> V Conj V)
The hideously ugly wumpus VP (VP-> chortled Conj V)
The hideously ugly wumpus chortled VP (VP-> and V)
The hideously ugly wumpus chortled and V (V-> whiffled)
The hideously ugly wumpus chortled and whiffled Adv (Adv-> as)
The hideously ugly wumpus chortled and whiffled as Prn (Prn-> it)
The hideously ugly wumpus chortled and whiffled as it V (V-> came)
The hideously ugly wumpus chortled and whiffled as it came PP (PP->
Prep NP)
The hideously ugly wumpus chortled and whiffled as it came PP (PP->
through NP)
```

```
The hideously ugly wumpus chortled and whiffled as it came through
NP (NP-> Det N)
The hideously ugly wumpus chortled and whiffled as it came through
NP (NP-> the N)
The hideously ugly wumpus chortled and whiffled as it came through
the N (N-> wood)
The hideously ugly wumpus chortled and whiffled as it came through
the wood.
```

**Change in Grammar:**
VP -> VP + Prn + V
AdjP -> Adv + Adj
NP -> Det + AdjP + N
VP -> V + Conj + V
VP -> VP + Prn + V

v. <u>The   wumpus   floated   in    a    most peculiar way.</u>
   **Det**     **N**       **V**  **Prep Det**  **Adv**  **Adj**    **N**

```
S (NP VP)
NP (NP-> Det N)
NP (NP-> The N)
The N (N-> wumpus)
The wumpus VP (VP-> VP PP)
The wumpus VP (VP-> floated)
The wumpus floated PP (PP-> Prep NP)
The wumpus floated PP (PP-> in NP)
The wumpus floated in NP (NP-> Det AdjP N)
The wumpus floated in NP (NP-> a AdjP N)
The wumpus floated in a AdjP (AdjP-> Adv Adj)
The wumpus floated in a AdjP (AdjP-> most Adj)
The wumpus floated in a most Adj (Adj-> peculiar)
The wumpus floated in a most peculiar N (N-> way)
The wumpus floated in a most peculiar way.
```

vi. <u>The students agreed that  their professor was tough    but    fair.</u>
   **Det**   **N**    **V**   **Conj Prn**    **N**     **V**  **Adj**   **Conj Adj**

```
S (S Conj S)
S (NP VP)
NP (NP-> Det N)
NP (NP-> The N)
The N (N-> students)
The students VP (VP-> V)
The students V (V-> agreed)
The students agreed Conj (Conj-> that)
The students agreed that S (S-> NP VP)
The students agreed that NP (NP-> Prn N)
```

```
The students agreed that NP (NP-> their N)
The students agreed that their N (N-> professor)
The students agreed that their professor VP (VP-> V AdjP)
The students agreed that their professor VP (VP-> was AdjP)
The students agreed that their professor was AdjP (AdjP-> Adj Conj
Adj)
The students agreed that their professor was AdjP (AdjP-> tough Conj
Adj)
The students agreed that their professor was tough AdjP (AdjP-> but
Adj)
The students agreed that their professor was tough Adj (Adj-> fair)
The students agreed that their professor was tough but fair.
```

**Change in Grammar:**
AdjP -> Adj + Conj + Adj
VP -> VP + AdjP
NP -> Prn + N


vii. If   you   see   a   wumpus   then   you   should   be   very   careful.
   **Conj Prn   V   Det   N        Conj   Prn   V     V    Adv    Adj**


```
S (S Conj S)
S (NP VP)
NP (NP-> Conj Prn)
NP (NP-> if Prn)
If Prn (Prn-> you)
If you VP (VP-> VP NP)
If you VP (VP-> see NP)
If you see NP (NP-> Det N)
If you see NP (NP-> a N)
If you see a N (N-> wumpus)
If you see a wumpus Conj (Conj-> then)
If you see a wumpus then S (NP VP)
If you see a wumpus then NP (NP-> Prn)
If you see a wumpus then Prn (Prn-> you)
If you see a wumpus then you VP (VP-> VP AdjP)
If you see a wumpus then you VP (VP-> V V)
If you see a wumpus then you VP (VP-> should V)
If you see a wumpus then you should V (V-> be)
If you see a wumpus then you should be AdjP (AdjP-> Adv Adj)
If you see a wumpus then you should be AdjP (AdjP-> very Adj)
If you see a wumpus then you should be very Adj (Adj-> careful)
If you see a wumpus then you should be very careful.
```

**Change in Grammar:**
NP -> Conj + Prn
VP -> V + V

viii. <u>Either Fatima saw a wumpus or she dreamed it.</u>
     **Conj Name V Det N   Conj Prn   V   Prn**

```
S (S Conj S)
S (S-> NP VP)
NP (NP-> Conj Name)
NP (NP-> Either Name)
Either Name (Name -> Fatima)
Either Fatima VP (VP-> V NP)
Either Fatima VP (VP-> saw NP)
Either Fatima saw NP (NP-> Det N)
Either Fatima saw NP (NP-> a N)
Either Fatima saw a N (N-> wumpus)
Either Fatima saw a wumpus Conj (Conj-> or)
Either Fatima saw a wumpus or S (S-> NP VP)
Either Fatima saw a wumpus or NP (NP-> Prn)
Either Fatima saw a wumpus or NP (NP-> she)
Either Fatima saw a wumpus or she VP (VP-> VP NP)
Either Fatima saw a wumpus or she VP (VP-> dreamed NP)
Either Fatima saw a wumpus or she dreamed NP (NP-> Prn)
Either Fatima saw a wumpus or she dreamed NP (NP-> it)
Either Fatima saw a wumpus or she dreamed it.
```

**Change in Grammar:**
NP-> Conj +Name

ix. <u>*The Wumpus floated in a most way.</u>
    **Det   Name     V   Prep Det Adv   N**
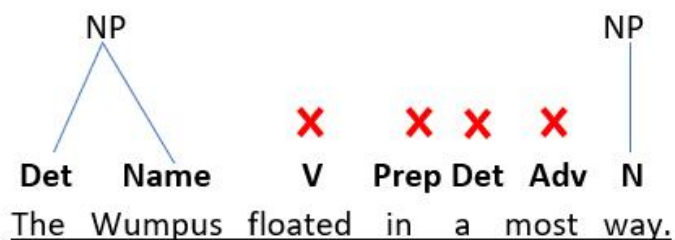
x. *The   students   agreed   that   their   professor   was   very.
 **Det**      **N**         **V**      **Conj**   **Prn**      **N**         **V**      **Adv**



S ——— Conj                          S

NP        VP          |        ✗    NP    NP      VP      VP

**Det**   **N**      **V**   **Conj**  **Prn**   **N**      **V**   **Adv**
The   students   agreed   that   their   professor   was   very.
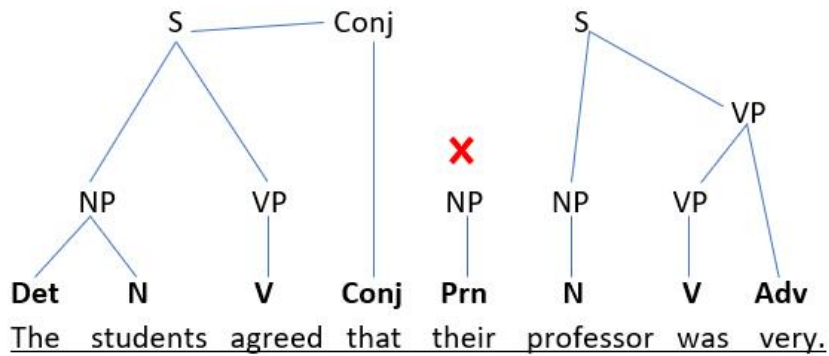
xi. *Ivan   saw   either   a   wumpus   and   a   shamus.
 **Name**   **V**   **Conj**   **Det**      **N**      **Conj** **Det**   **N**



S ——— Conj           ✗           ✗

NP   VP            NP            NP

**Name**   **V**   **Conj**   **Det**      **N**      **Conj** **Det**   **N**
Ivan   saw   either   a   wumpus   and   a   shamus.
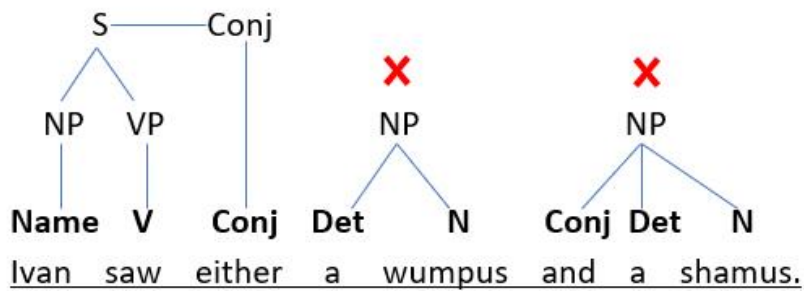
xii. *If   Ali   saw   a   wumpus   or   it   was   a   shamus.
 **Prep** **Name** **V**   **Det**      **N**      **Conj** **Prn**   **V**   **Det**      **N**



Conj ——— S

✗   VP                          VP

PP   VP            NP         NP   VP      NP

**Prep** **Name** **V**   **Det**   **N**   **Conj** **Prn**   **V**   **Det**   **N**
If   Ali   saw   a   wumpus   or   it   was   a   shamus.
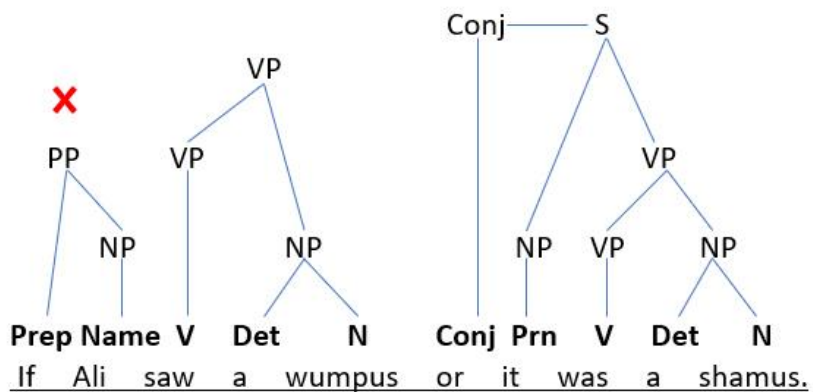
**Task2:**
**Draw syntax trees for (iii), (v) and (vii) using your amended grammar.**

iii. Jana saw either a wumpus or a shamus at the end of the street.

```
                          S
              ┌───────────┴───────┐
             NP                   VP
              │            ┌───────┴──────────────┐
              │           VP                      NP
              │      ┌─────┴──────┐          ┌─────┴──────┐
              │     VP            NP        NP            PP
              │   ┌──┴──┐       ┌──┴──┐   ┌──┴──┐     ┌────┴────┐
              │   │     │       │     │   │     │     │         NP
              │   │     │       │     │   │     │     │    ┌────┴────┐
              │   │     │       │     │   │     │     │   NP        PP
              │   │     │       │     │   │     │     │  ┌─┴─┐   ┌───┴───┐
              │   │     │       │     │   │     │     │  │   │   │      NP
              │   │     │       │     │   │     │     │  │   │   │     ┌─┴─┐
           Name  V    Adj     Det    N  Conj Det   N  Adv Det  N Prep Det  N
           Jana saw  either    a  wumpus  or   a shamus at the  end  of the street
```
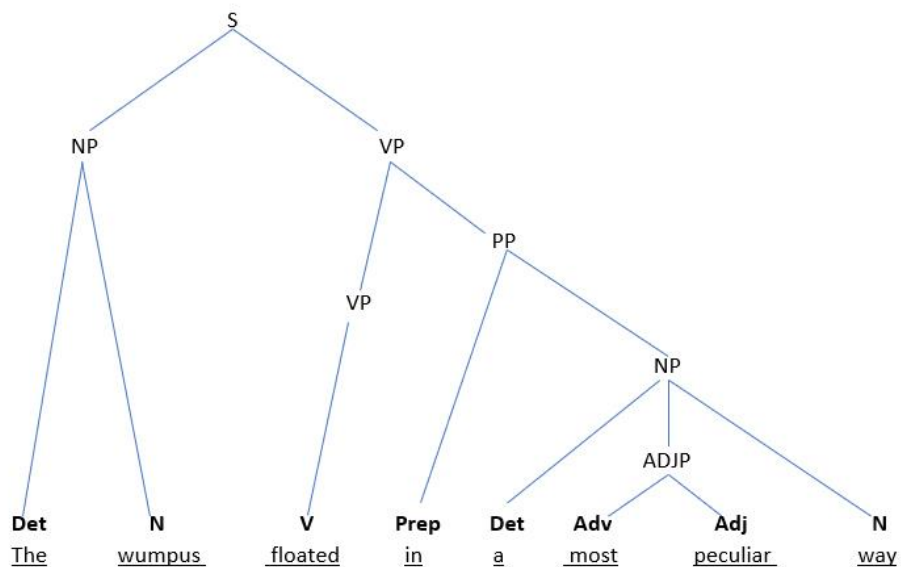
v. The wumpus floated in a most peculiar way.
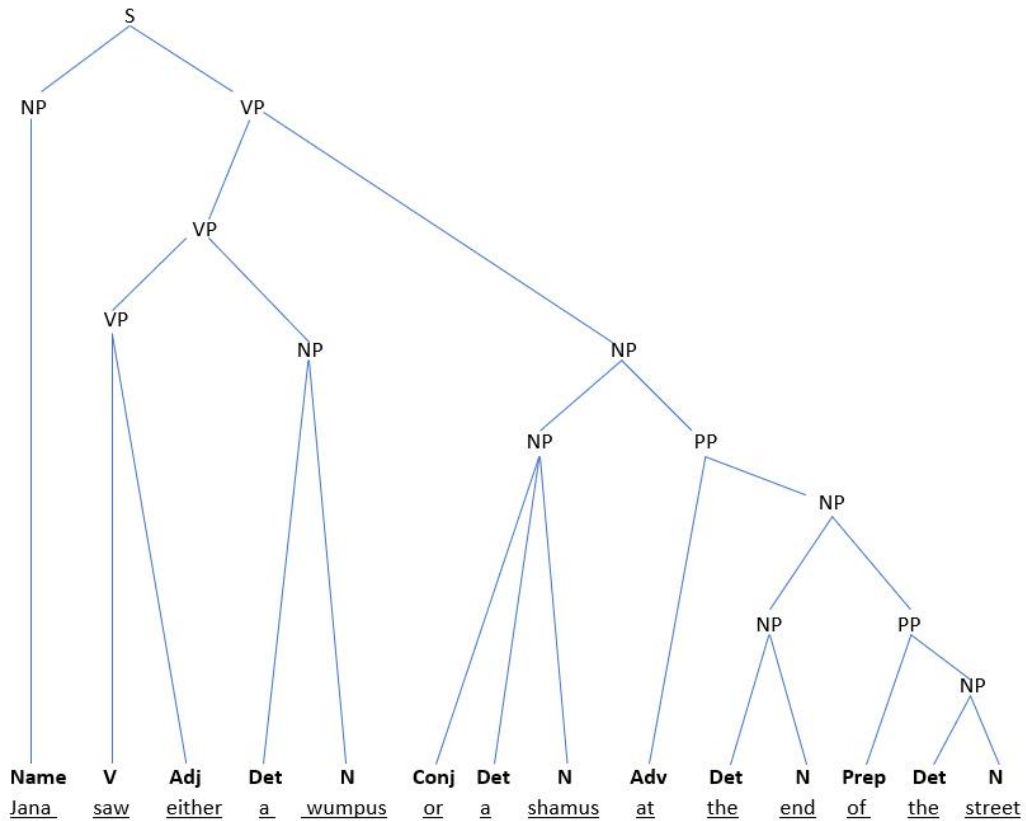
```
                          S
              ┌───────────┴───────────┐
             NP                       VP
           ┌──┴──┐              ┌──────┴──────┐
           │     │             VP             PP
           │     │             │        ┌─────┴────────┐
           │     │             │        │              NP
           │     │             │        │       ┌──────┼──────────┐
           │     │             │        │       │     ADJP        │
           │     │             │        │       │    ┌──┴───┐     │
          Det    N             V       Prep    Det  Adv    Adj    N
          The  wumpus        floated    in      a   most peculiar way
```

vii. If you see a wumpus then you should be very careful.

```
           S ──────────── Conj ──────────── S
          ╱ ╲                              ╱ ╲
         ╱   ╲                           NP   VP
        ╱     ╲                          │   ╱ ╲
       ╱       ╲                         │  ╱   ╲
      NP        VP                       │ VP   AdjP
     ╱ ╲       ╱ ╲                       │ ╱ ╲   ╱ ╲
    ╱   ╲     ╱  NP                      │╱   ╲ ╱   ╲
   Conj  Prn  V  Det  N    Conj   Prn   V    V  Adv  Adj
   If    you  see  a  wumpus  then  you  should be very careful
```

9
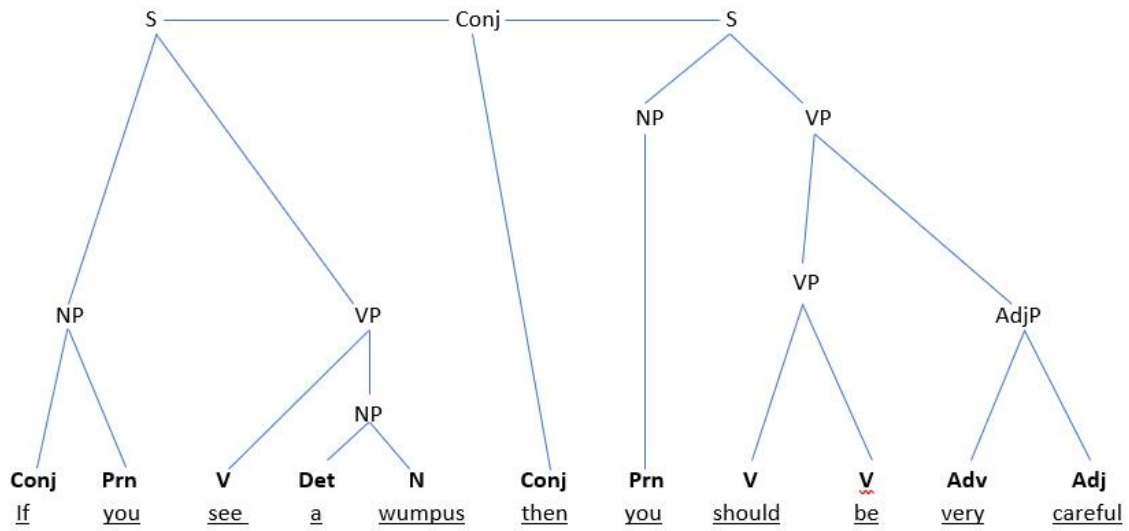
# References

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University of Pensilvania, 2019. *Alphabetical list of part-of-speech tags used in the Penn Treebank Project:,* Philadelphia: s.n.

References