Homework2

CS 6320.002

Saivikas Meda
Sxm190011

Problem1: Parsing with use CKY (Cocke – Kasami-Younger) parser algorithm

a. Refer README.txt file for executing the program.
b. Refer grammer.txt for the grammar in Chomsky Normal Form (CNF)
c. Refer sentence.txt for the input sentences list
d. Refer output.txt for the final output sentences in parse structure.
e. To run file use command - Python3 Hw2_CKYparser.py grammar.txt sentences.txt output.txt

Grammar	**CNF Converted Grammar**
S -> NP VP	S -> NP VP
S-> VP	NP -> NP PP
NP -> NP PP	NP -> sales
NP -> sales	PP -> IN NP
PP -> IN NP	PP -> TO NP
PP -> TO NP	IN -> of
IN -> of	NP -> DT NN
NP -> DT NN	DT -> the
DT -> the	DT -> The
DT -> The	NN -> company
NN -> company	VP -> TO VP
VP -> TO VP	TO -> to
TO -> to	S -> VB PP
S -> VB PP	VP -> VB PP
VP -> VB PP	VB -> return
VB -> return	NP -> normalcy
NP -> normalcy	X1 -> DT JJ
	X2 -> NNS X3
	X3 -> CC NNS
	NP -> X1 X2
NP -> DT JJ NNS CC NNS	NNS -> products
NNS -> products	NNS -> services
NNS -> services	S -> VBD S
S -> VBD S	VP -> VBD S
VP -> VBD S	VBD -> contributed
VBD -> contributed	S -> TO VP
S -> TO VP	VP -> TO VP
VP -> TO VP	TO -> to
TO -> to	S -> VB NP
S -> VB NP	VP -> VB NP
VP -> VB NP	VB -> increase
VB -> increase	NP -> revenue
NP -> revenue	JJ -> new
JJ -> new	CC -> and
CC -> and	NP -> dow
NP -> dow	VP -> VBZ SBAR

VP -> VBZ SBAR	VBZ -> falls
VBZ -> falls	SBAR -> SBAR X4
SBAR -> SBAR CC S	X4 -> CC S
	SBAR -> IN S
SBAR -> IN S	IN -> as
IN -> as	NP -> NN NN
NP -> NN NN	NN -> recession
NN -> recession	NN -> indicator
NN -> indicator	VP -> VBD ADJP
VP -> VBD ADJP	VBD -> flashed
VBD -> flashed	ADJP -> red
ADJP -> red	NP -> JJ NNS
NP -> JJ NNS	JJ -> economical
JJ -> economical	NNS -> worries
NNS -> worries	VP -> VB PP
VP -> VB PP	VB -> continue
VB -> continue	PP -> IN NP
PP -> IN NP	IN -> through
IN -> through	NP -> DT NN
NP -> DT NN	NN -> month
NN -> month	NN -> figure
NN -> figure	NN -> skater
NN -> skater	VP -> VP X5
VP -> VP CC VP	X5 -> CC VP
	X6 -> VBZ NP
	X7 -> PP X8
	X8 -> PP PP
	VP -> X6 X7
VP -> VBZ NP PP PP PP	VBZ -> lands
VBZ -> lands	NP -> JJ X9
NP -> JJ JJ NN	X9 -> JJ NN
	JJ -> historic
JJ -> historic	JJ -> quadruple
JJ -> quadruple	NN -> jump
NN -> jump	PP -> IN NP
PP -> IN NP	IN -> in
IN -> in	JJ -> senior
JJ -> senior	JJ -> international
JJ -> international	NN -> competition
NN -> competition	IN -> at
IN -> at	NP -> X10 X13
NP -> DT CD NNP NNP NNP NNPS	X10 -> DT CD
	X11 -> NNP NNP
	X12 -> NNP NNPS

	X13 -> X11 X12
	CD -> 2019
CD -> 2019	NNP -> world
NNP -> world	NNP -> figure
NNP -> figure	NNP -> skating
NNP -> skating	NNPS -> championships
NNPS -> championships	IN -> on
IN -> on	NP -> NN CD
NP -> NN CD	NN -> day
NN -> day	CD -> 3
CD -> 3	CC -> but
CC -> but	VP -> MD X14
VP -> MD ADVP VP	X14 -> ADVP VP
	MD -> could
MD -> could	ADVP -> only
ADVP -> only	VP -> VB NP
VP -> VB NP	VB -> clinch
VB -> clinch	X15 -> NN NN
	NP -> DT X15
NP -> DT NN NN	DT -> a
DT -> a	NN -> silver
NN -> silver	NN -> medal
NN -> medal	

Output is as followed when you run the .py file.

```
CKY_Model(mappedGrammarRules,sentenceList,ofileName)
```

```
(S (NP((NP sales) PP((IN of) NP((DT the) (NN company)))) VP((TO to) VP((VB return) PP((TO to) (NP normalcy))))))


(S (NP(X1((DT the) (JJ new)) X2((NNS products) X3((CC and) (NNS services)))) VP((VBD contributed) S((TO to) VP((VB
increase) (NP revenue))))))


(S ((NP dow) VP((VBZ falls) SBAR(SBAR((IN as) S(NP((NN recession) (NN indicator)) VP((VBD flashed) (ADJP red)))) X4
((CC and) S(NP((JJ economical) (NNS worries)) VP((VB continue) PP((IN through) NP((DT the) (NN month)))))))))


(S (NP((NN figure) (NN skater)) VP(VP(X6((VBZ lands) NP((JJ historic) X9((JJ quadruple) (NN jump)))) X7(PP((IN in)
NP((JJ senior) X9((JJ international) (NN competition)))) X8(PP((IN at) NP(X10((DT the) (CD 2019)) X13(X11((NNP worl
d) (NNP figure)) X12((NNP skating) (NNPS championships))))) PP((IN on) NP((NN day) (CD 3)))))) X5((CC but) VP((MD c
ould) X14((ADVP only) VP((VB clinch) NP((DT a) X15((NN silver) (NN medal)))))))))
```

Problem2: Statistical and dependency parsing.
B) **Constituency parsing with a self-attentive encoder (Kitaev and Klein,2018).** Berkeley Neural parser is implemented based on self-attentive encoder.
FileName: Self-attentive_Encoder.py

- Use python3 to run the file.
- While running if you get an warning saying “module 'tensorflow' has no attribute 'GraphDef'”. Use following command pip install tensorflow==1.14.0
- Pip install cython numpy
- Pip install benepar
- Import nltk
- Nltk.download(‘punkt’)
- Benepar.download(‘benepar_en2’) Model
- Parser = benepar.Parser(‘benepar_en2)

Check below the screenshot of results obtained by using benepar_en2 model.

```
S1: Sales of the company to return to normalcy.
(S
  (NP (NP (NNS Sales)) (PP (IN of) (NP (DT the) (NN company))))
  (VP (TO to) (VP (VB return) (PP (TO to) (NP (NN normalcy)))))
  (. .))
```

Difference: with Constituency parsing encoder (kitaev and klein,2018) can be able to detect which particular NP the word belongs to. For example. Sales here is NNS (Noun pural) whereas according to Prob1 It is identified as NP and Normalcy is identified as NN(Noun singular) whereas to Prob2 it is identified as NP(general). This is because while implementing CYK we’ve normalized the grammar which removed the branches NP->NNS and NP->NN.

```
S2: The new products and services contributed to increase revenue.
(S
  (NP (DT The) (JJ new) (NNS products) (CC and) (NNS services))
  (VP
    (VBD contributed)
    (S (VP (TO to) (VP (VB increase) (NP (NN revenue))))))
  (. .))
```

Difference: The same difference is present as mentioned earlier that Constituency parsing gives specific POS for instance revenue ->NN. Whereas prob1 gives revenue->NP. In additional Problem1 has user defined terminal like X1, X2. In order to understand what they stand for we’ve to check with grammar file. Where has constituency present tree with the universally known POS terms.

```
S3: Dow falls as recession indicator flashed red and economical worries continue through the month.
(S
  (NP (NNP Dow))
  (VP
    (VBZ falls)
    (SBAR
      (SBAR
        (IN as)
        (S
          (NP (NN recession) (NN indicator))
          (VP (VBD flashed) (ADJP (JJ red)))))
      (CC and)
      (S
        (NP (JJ economical) (NNS worries))
        (VP (VB continue) (PP (IN through) (NP (DT the) (NN month)))))))
  (. .))
```

Difference: The difference is similar to what S1 had. Problem1 has missing the ADJP -> JJ relation.

```
S4: Figure skater lands historic quadruple jump in senior international competition at the 2019 World Figure
 Skating Championships on Day 3 but could only clinch a silver medal.
(S
  (NP (NN Figure) (NN skater))
  (VP
    (VP
      (VBZ lands)
      (NP (JJ historic) (JJ quadruple) (NN jump))
      (PP
        (IN in)
        (NP (JJ senior) (JJ international) (NN competition)))
      (PP
        (IN at)
        (NP
          (DT the)
          (CD 2019)
          (NNP World)
          (NNP Figure)
          (NNP Skating)
          (NNPS Championships)))
      (PP (IN on) (NP (NN Day) (CD 3))))
    (CC but)
    (VP
      (MD could)
      (ADVP (RB only))
      (VP (VB clinch) (NP (DT a) (NN silver) (NN medal)))))
  (. .))
```

Difference: The difference here is a combination of both S1 and S2 sentences. There is user defined intermediate terminals mentioned like X1, X2. In order to obtain CNF format. **Kitaev and Klein,2018** provides the specific POS tagging on words ON and Day.

2) Table columns - Stack, word_list and Action and Relation added to the parse.

- This process will keep on going until all words from word_list is empty.
- If there a relation between and pair of words, we add relation(SHIFT, RIGHTARC, LEFTARC) between them.

S1: *Sales of the company to return to normalcy.*

Step	**Stack**	**Word List**	**Action (SHIFT,RIGHTARC,LEFTARC)**	**Relation Added**
0	[root]	[Sales,of,the,company,to,return, to,normalcy]	SHIFT	
1	[root,Sales]	[of,the,company,to,return, to,normalcy]	SHIFT	
2	[root, Sales, of]	[the,company,to,return, to,normalcy]	SHIFT	
3	[root, Sales, of,the]	[company,to,return, to,normalcy]	SHIFT	
4	[root,Sales,of,the,company]	[to,return,to,normalcy]	LEFTARC	the ← company
5	[root,Sales,of,company]	[to,return,to,normlacy]	LEFTARC	of ←company
6	[root,Sales,company]	[to,return,to,normlacy]	RIGHTARC	Sales →company
7	[root,Sales]	[to,return,to,normlacy]	SHIFT	
8	[root, Sales, to]	[return,to,normlacy]	SHIFT	
9	[root,Sales,to,return]	[to,normalcy]	LEFTARC	to←return
10	[root,Sales,return]	[to,normalcy]	SHIFT	
11	[root,Sales,return,to]	[normalcy]	SHIFT	
12	[root,Sales,return,to,normalcy]	[]	LEFTARC	to ← normalcy
13	[root,Sales,return,normalcy]	[]	RIGHTARC	return → normalcy
14	[root,Sales,return]	[]	RIGHTARC	Sales → return
15	[root,Sales]	[]	RIGHTARC	root → Sales
16	[root]	[]	Done	

S2: The new products and services contributed to increase revenue

Step	Stack	Word List	Action (SHIFT,RIGHTARC,LEFTARC)	Relation Added
0	[root]	[The,new,products,and,services, contributed,to,increase,revenue]	SHIFT	
1	[root,The]	[new,products,and,services, contributed,to,increase,revenue]	SHIFT	
2	[root,The, new]	[products,and,services, contributed,to,increase,revenue]	SHIFT	
3	[root,The, new, products]	[and,services, contributed,to,increase,revenue]	LEFTARC	new ←products
4	[root,The, products]	[and,services, contributed,to,increase,revenue]	LEFTARC	The←products
5	[root,products]	[and,services, contributed,to,increase,revenue]	SHIFT	
6	[root,products,and]	[services, contributed,to,increase,revenue]	RIGHTARC	products→and
7	[root,products]	[services, contributed,to,increase,revenue]	SHIFT	
8	[root,products, services]	[contributed,to,increase,revenue]	RIGHTARC	products→services
9	[root,products]	[contributed,to,increase,revenue]	SHIFT	
10	[root,products,contributed]	[to,increase,revenue]	LEFTARC	products←contributed
11	[root,contributed]	[increase, revenue]	SHIFT	
12	[root,contributed, to]	[increase, revenue]	RIGHTARC	contributed →to
13	[root,contributed]	[increase, revenue]	SHIFT	
14	[root,contributed, increase]	[revenue]	RIGHTARC	contributed → increase
15	[root,contributed]	[revenue]	SHIFT	
16	[root,contributed, revenue]	[]	RIGHTARC	contributed → revenue
17	[root,contributed]	[]	RIGHTARC	root → contributes
18	[root]	[]	Done	

S3: Dow falls as recession indicator flashed red and economical worries continue through the month.

Step	Stack	Word List	Action (SHIFT,RIGHTARC,LEFTARC)	Relation Added
0	[root]	[Dow, falls,as, recession, indicator, flashed, red, and, economical, worries, continue, through, the, month]	SHIFT	
1	[root,Dow]	[falls,as, recession, indicator, flashed, red, and, economical, worries, continue, through, the, month]	SHIFT	
2	[root,Dow,falls]	[as, recession, indicator, flashed, red, and, economical, worries, continue, through, the, month]	LEFTARC	Dow←Falls
3	[root, falls]	[as, recession, indicator, flashed, red, and, economical, worries, continue, through, the, month]	SHIFT	
4	[root, falls, as]	[recession, indicator, flashed, red, and, economical, worries, continue, through, the, month]	RIGHTARC	Falls→as
5	[root, falls]	[recession, indicator, flashed, red, and, economical, worries, continue, through, the, month]	SHIFT	
6	[root, falls, recession]	[indicator, flashed, red, and, economical, worries, continue, through, the, month]	SHIFT	
7	[root, falls, recession, indicator]	[flashed, red, and, economical, worries, continue, through, the, month]	LEFTARC	recession←indicator
8	[root, falls, indicator]	[flashed, red, and, economical, worries, continue, through, the, month]	SHIFT	
9	[root, falls, indicator, flashed]	[red, and, economical, worries, continue, through, the, month]	LEFTARC	indicator←flashed
10	[root, falls, flashed]	[red, and, economical, worries, continue, through, the, month]	SHIFT	
11	[root, falls, flashed, red]	[and, economical, worries, continue, through, the, month]	RIGHTARC	flashed→red
12	[root, falls, flashed]	[and, economical, worries, continue, through, the, month]	SHIFT	
13	[root, falls, flashed, and]	[economical, worries, continue, through, the, month]	RIGHTARC	flashed→and

14	[root, falls, flashed]	[economical, worries, continue, through, the, month]	SHIFT	
15	[root, falls, flashed, economical]	[worries, continue, through, the, month]	SHIFT	
16	[root, falls, flashed, economical, worries]	[continue, through, the, month]	LEFTARC	economical←worries
17	[root, falls, flashed, worries]	[continue, through, the, month]	SHIFT	
18	[root, falls, flashed, worries, continue]	[through, the, month]	LEFTARC	worries<-continue
19	[root, falls, flashed, continue]	[through, the, month]	LEFTARC	flashed←continue
20	[root, falls, continue]	[through, the, month]	SHIFT	
21	[root, falls, continue, through]	[the, month]	SHIFT	
22	[root, falls, continue, through, the]	[]	SHIFT	
23	[root, falls, continue, through, the, month]	[]	LEFTARC	the←month
24	[root, falls, continue, through, month]	[]	LEFTARC	through←month
25	[root, falls, continue, month]	[]	RIGHTARC	continue→month
26	[root, falls, continue]	[]	RIGHTARC	falls→continue
27	[root, falls]	[]		root→falls
28	[root]	[]	Done	

S4: Figure skater lands historic quadruple jump in senior international competition at the 2019 World Figure Skating Championships on Day 3 but could only clinch a silver medal

Step	Stack	Word List	Action (SHIFT,RIGHTARC,LEFTARC)	Relation Added
0	[root]	[Figure, skater, lands, historic, quadruple, jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
1	[root, Figure]	[skater, lands, historic, quadruple, jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
2	[root, Figure, skater]	[lands, historic, quadruple, jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
3	[root, Figure, skater, lands]	[historic, quadruple, jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	skater←lands
4	[root, Figure, lands]	[historic, quadruple, jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	Figure←lands
5	[root, lands]	[historic, quadruple, jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
6	[root, lands, historic]	[quadruple, jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
7	[root, lands, historic, quadruple]	[jump, in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	

8	[root, lands, historic, quadruple, jump]	[in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	quadruple←jump
9	[root, lands, historic, jump]	[in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	history←jump
10	[root, lands, jump]	[in, senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
11	[root, lands, jump, in]	[senior, international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
12	[root, lands, jump, in, senior]	[international, competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
13	[root, lands, jump, in, senior, international]	[competition, at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
14	[root, lands, jump, in, senior, international, competition]	[at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	international←competition
15	[root, lands, jump, in, senior, competition]	[at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	senior←competition
16	[root, lands, jump, in, competition]	[at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	in←competition

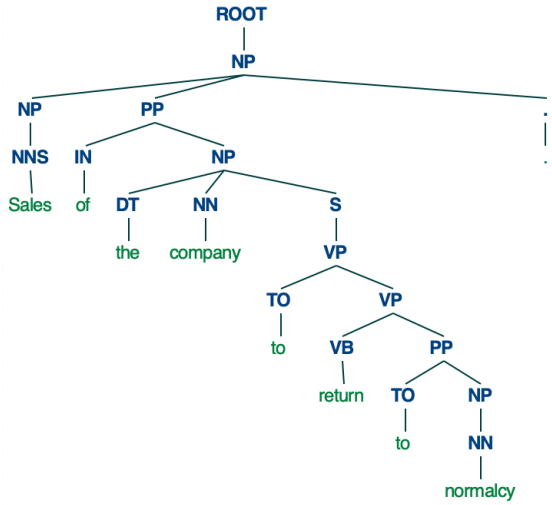
17	[root, lands, jump, competition]	[at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	RIGHTARC	jump→competition
18	[root, lands, jump]	[at, the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
19	[root, lands, jump, at]	[the, 2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
20	[root, lands, jump, at, the]	[2019, World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
21	[root, lands, jump, at, the, 2019]	[World, Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
22	[root, lands, jump, at, the, 2019, World]	[Figure, Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
23	[root, lands, jump, at, the, 2019, World, Figure]	[Skating, Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
24	[root, lands, jump, at, the, 2019, World, Figure, Skating]	[Championships, on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
25	[root, lands, jump, at, the, 2019, World, Figure, Skating, Championships]	[on, Day, 3, but, could, only, clinch, a, silver, medal]	LEFTARC	Skating,Figure,World,2019,the,at←Championships
26	[root, lands, jump, Championships]	[on, Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	

27	[root, lands, jump, Championsh ips, on]	[Day, 3, but, could, only, clinch, a, silver, medal]	SHIFT	
28	[root, lands, jump, Championsh ips, on, Day]	[3, but, could, only, clinch, a, silver, medal]	LEFTARC	on←Day
29	[root, lands, jump, Championsh ips, Day]	[3, but, could, only, clinch, a, silver, medal]	SHIFT	
30	[root, lands, jump, Championsh ips, Day, 3]	[but, could, only, clinch, a, silver, medal]	RIGHTARC	Day→3
31	[root, lands, jump, Championsh ips, Day]	[but, could, only, clinch, a, silver, medal]	RIGHTARC	jump→champions hips
32	[root, lands, jump]	[but, could, only, clinch, a, silver, medal]	SHIFT	
33	[root, lands, jump, but]	[could, only, clinch, a, silver, medal]	RIGHTARC	jump→but
34	[root, lands, jump, could, only, clinch]	[a, silver, medal	LEFTARC	could←clinch
35	[root, lands, jump, clinch, a, silver]	[medal]	SHIFT	
36	[root, lands, jump, clinch, a, silver, medal]	[]	LEFTARC	silver←medal
37	[root, lands, jump, clinch, medal]	[]	RIGHTARC	clinch←medal
38	[root, lands, jump, clinch	[]	RIGHTARC	jump→clinch
39	[root, lands, jump]	[]	RIGHTARC	lands→jump
40	[root, lands]	[]	RIGHTARC	root→lands
41	[root]	[]	Done	

3) Standford dependency parsers:

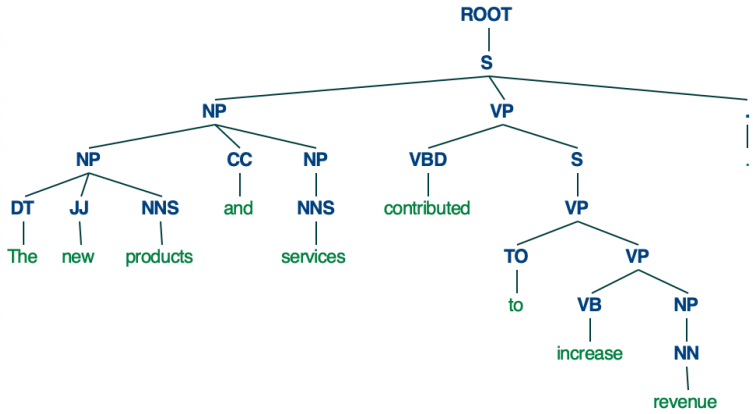
- Import stanfordParser. From nltk.parse.standford
- Before running the file StandfordNLP_Parser.py file update the location of Stanford-parser folder for variable standfor_parser_dir.

S1: Sales of the company to return to normalcy



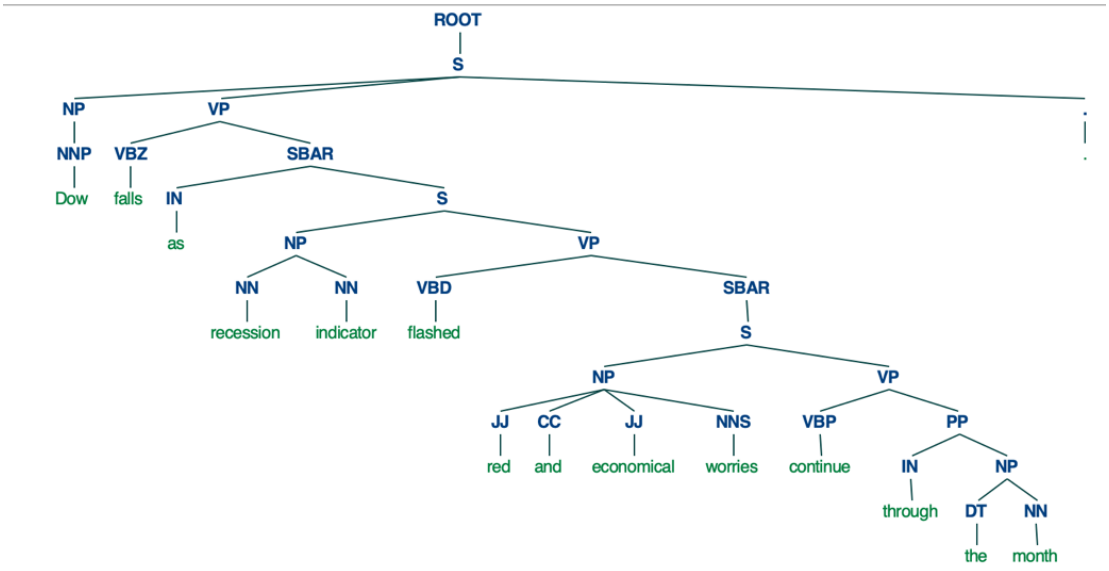

```
(ROOT
  (NP
    (NP (NNS Sales))
    (PP
      (IN of)
      (NP
        (DT the)
        (NN company)
        (S
          (VP
            (TO to)
            (VP (VB return) (PP (TO to) (NP (NN normalcy))))))))
    (. .)))
```

S2: The new products and services contributed to increase revenue



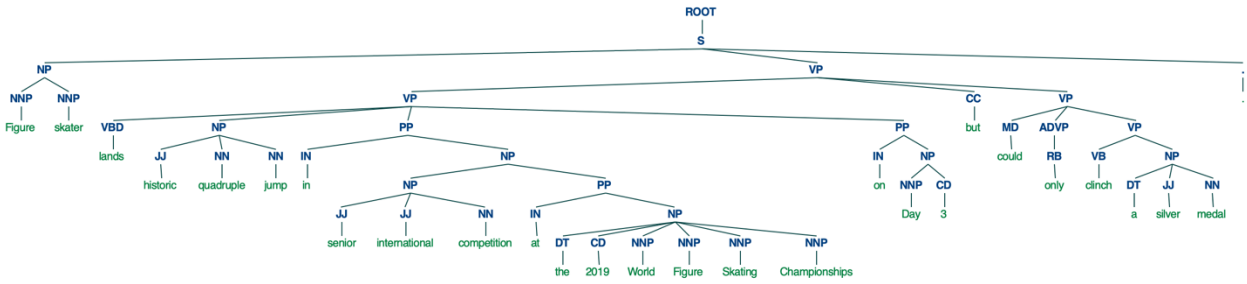

```
(ROOT
  (S
    (NP
      (NP (DT The) (JJ new) (NNS products))
      (CC and)
      (NP (NNS services)))
    (VP
      (VBD contributed)
      (S (VP (TO to) (VP (VB increase) (NP (NN revenue))))))
    (. .)))
```

S3: Dow falls as recession indicator flashed red and economical worries continue through the month.



```
(ROOT
  (S
    (NP (NNP Dow))
    (VP
      (VBZ falls)
      (SBAR
        (IN as)
        (S
          (NP (NN recession) (NN indicator))
          (VP
            (VBD flashed)
            (SBAR
              (S
                (NP (JJ red) (CC and) (JJ economical) (NNS worries))
                (VP
                  (VBP continue)
                  (PP (IN through) (NP (DT the) (NN month)))))))))))
    (. .)))
```

S4: Figure skater lands historic quadruple jump in senior international competition at the 2019 World Figure Skating Championships on Day 3 but could only clinch a silver medal




```
(ROOT
  (S
    (NP (NNP Figure) (NNP skater))
    (VP
      (VP
        (VBD lands)
        (NP (JJ historic) (NN quadruple) (NN jump))
        (PP
          (IN in)
          (NP
            (NP (JJ senior) (JJ international) (NN competition))
            (PP
              (IN at)
              (NP
                (DT the)
                (CD 2019)
                (NNP World)
                (NNP Figure)
                (NNP Skating)
                (NNP Championships)))))
        (PP (IN on) (NP (NNP Day) (CD 3))))
      (CC but)
      (VP
        (MD could)
        (ADVP (RB only))
        (VP (VB clinch) (NP (DT a) (JJ silver) (NN medal)))))
    (. .)))
```

Problem3: Semantic Role Labeling:

1. ProbBank Definations:

S1: Sales of the company to return to normalcy.

Predicate: return
Return.01(PropBank)
Span of arguments:
[Sales of the company] $_{Arg1}$ to return [to normalcy]$_{Arg4}$.

S2: The new products and services contributed to increase revenue.

Predicate: contributed
Contribute.01 (PropBank)
Span of Argument:
[The new products and services] $_{Arg0}$ contributed [to increase revenue] $_{Arg2}$.

S3: Dow falls as recession indicator flashed red and economical worries continue through the month.

Predicate: continue
Continue.p1(ProbBank**)**
Span of Argument:
Dow falls as [recession indicator flashed red and economical worries]$_{Arg1}$ continue [through the month] $_{ARGM-TMP}$.

S4: Figure skater lands historic quadruple jump in senior international competition at the 2019 World Figure Skating Championships on Day 3 but could only clinch a silver medal.

Predicate: clinch
clinch.01 (PropBank**)**
Span of Argument:
[Figure skater historic quadruple] $_{Arg0}$ jump in senior international competition at the 2019 World Figure Skating Championships on Day 3 but [could]$_{ARGM-MOD}$ [only]$_{ARGM-ADV}$ clinch [a silver medal]$_{ARG1}$.

2. Automatic semantic role labeling using Neural SRL

a. S1: Sales of the company to return to normalcy.
"predicted_srl": [[5, 0, 3, "ARG1"], [5, 6, 7, "ARG4"]]

b. S2:The new products and services contributed to increase revenue.
"predicted_srl": [[5, 0, 4, "ARG0"], [5, 6, 8, "ARG2"]]

c. S3: Dow falls as recession indicator flashed red and economical worries continue through the month.

"predicted_srl": [[1, 0, 0, "ARG1"], [1, 2, 13, "ARG-M"]]

d. S4: Figure skater lands historic quadruple jump in senior international competition at the 2019 World Figure Skating Championships on Day 3 but could only clinch a silver medal

"predicted_srl": [[2, 0, 1, "ARG0"], [2, 3, 5, "ARG1"], [2, 7, 25, "ARG-M"]]

3. Neural SRL has a different way of representation that is in JSON format, Where first numb indicate the position of predicate, 2nd number represents the starting and 3rd represents the end of the span argument and last indicates what kind of arugment. S1 and S2 has no difference w.r.t automatic semantic where has S3 has a predicate **"Continue"** which is different with Neural SRL which is **"Dow"**. S4 has a difference of no.of arguments present and predicate value. In 3.1 S4 has "**Clinch**" as predicate which is different with **"historic".** S4 has 4 arguments Arg0, Arg1, Argm-M , Argm-A. Whereas Automatic semantic displays only 3 Arg0,Arg1, ARG-M. I've used Neural SRL has the models are trained with more data.