CSE 325/425 (Spring 2021) Homework 4

Due on 11:55pm, Apr 7, 2021

Grading: All questions have the same points (25 each). We will randomly grade some of the questions.

Submitting: Only electronic submissions on Coursesite are accepted. You can handwrite your answers on papers and then scan them to images. If you need to plot figures using a computer, the plotted files should be saved and included in the submitted pdf file. Submit a single pdf file named

<Your LIN>HW4.pdf

Other format will not be accepted.

Questions:

1. Modify the codes for RNN in the associated IPython notebook "Recurrent Neural Networks.ipynb" to remove the tanh activation function when computing the hidden state vectors $\mathbf{h}_t$. Run the modified codes on the given input. Lastly report (10 pts) and make sense (15 pts) of your observations.

2. Prove that the CFG grammar below allow derivations of infinite length and thus generate a language with sentences with infinite length (15 pts). Then justify or disapprove the existence of such derivations (10 pts).

Grammar Rules			Examples
S	→	*NP VP*	I + want a morning flight
NP	→	*Pronoun*	I
	|	*Proper-Noun*	Los Angeles
	|	*Det Nominal*	a + flight
Nominal	→	*Nominal Noun*	morning + flight
	|	*Noun*	flights
VP	→	*Verb*	do
	|	*Verb NP*	want + a flight
	|	*Verb NP PP*	leave + Boston + in the morning
	|	*Verb PP*	leaving + on Thursday
PP	→	*Preposition NP*	from + Los Angeles

Figure 1: A CFG

3. In Lecture 16-17, we showed how the CYK algorithm fills out the last column of the parsing table on the sentence "*Book the flight through Houston*". Explain how the algorithm fills out the cell $(0, 1)$ and $(0, 3)$, using the CFG in CNF on the slides for Lecture 16.

   (*Hints: read the CYK algorithm section in SLP textbook and pay attention to title of the table that contains the converted CFG in CNF.*)

4. The following two figures show a PCFG and the table for calculating inside probabilities during probabilistic syntactic parsing. Explain why only β_S is shown in cell $(1, 3)$ (10 pts) and how the probability is calculated using the inside algorithm (15 pts).

S → NP VP	1.0	NP → NP PP	0.4
PP → P NP	1.0	NP → *astronomers*	0.1
VP → V NP	0.7	NP → *ears*	0.18
VP → VP PP	0.3	NP → *saw*	0.04
P → *with*	1.0	NP → *stars*	0.18
V → *saw*	1.0	NP → *telescopes*	0.1

	1	2	3	4	5
1	$\beta_{NP} = 0.1$		$\beta_S = 0.0126$		$\beta_S = 0.0015876$
2		$\beta_{NP} = 0.04$ $\beta_V = 1.0$	$\beta_{VP} = 0.126$		$\beta_{VP} = 0.015876$
3			$\beta_{NP} = 0.18$		$\beta_{NP} = 0.01296$
4				$\beta_P = 1.0$	$\beta_{PP} = 0.18$
5					$\beta_{NP} = 0.18$
	astronomers	*saw*	*stars*	*with*	*ears*

Figure 2: Probabilistic CFG and Inside probability calculation.

5. Use the above PCFG to find a parsing tree T for the sentence S="*telescopes saw stars*" (10 pts). Then calculate the probability of $\Pr(T)$ (15 pts).