Problem 1. Assume the following grammar and lexicon for a PCFG (probabilistic context-free grammar), where each grammatical rule is associated with a probability (the probabilities for the NP $\rightarrow \ldots$ rules and the VP $\rightarrow \ldots$ rules don't sum up to 1 because there are other rules that are not shown here).

Grammar				Lexicon
S $\rightarrow$ NP VP	1	VP $\rightarrow$ V NP	0.2	N: United, Houston, flights
NP $\rightarrow$ N	0.1	VP $\rightarrow$ V NP PP	0.3	V: diverted
NP $\rightarrow$ N PP	0.2	PP $\rightarrow$ P NP	1	P: to

Since the words are unambiguous (in this lexicon), assume that the probability of each lexical constituent (N, V, or P) is 1. For non-lexical constituents (S, NP, VP, PP), given a rule r of the form $C \rightarrow C_1 \ldots C_n$, we calculate the probability of C as follows.

$$P(C) = P(r) \prod_{i=1}^{n} P(C_i)$$

a. (8 points) Draw the two parse trees generated by the grammar for the following sentence; use constituent trees in the same format as Figures 1, 2 and 3 in the Charniak article.

United diverted flights to Houston

(meaning: flights landed in Houston) | *(meaning: flights did not land in Houston)*

b. (6 points) Label each non-lexical constituent in the above trees with its probability.