Machine Learning
Exercises: PCFG 1

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Exercise 1 *Consider the following PCFG* $G = \langle \{S, A, X\}, \{a\}, P, S, p\rangle$ *(see course slides) with* P *and* p *as follows:*

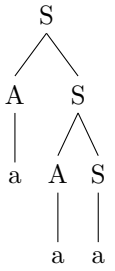
0.3: $S \to AS$ *0.6:* $S \to AX$ *0.1:* $S \to a$ *1:* $X \to SA$ *1:* $A \to a$

Given this PCFG,

1. *give the different parse trees for* $w = aaa$ *with their sets of productions with span indices and with their probabilities.*
2. *what is the best parse tree for* $w = aaa$*?*
3. *what is the probability of* aaa*?*

Solution:

1. t_1:



$[S,1,3] \to [A,1,1][S,2,3]$
$[S,2,3] \to [A,2,2][S,3,3]$
$[A,1,1] \to a$, $[A,2,2] \to a$, $[S,3,3] \to a$

$p(t_2) = 0.3 \cdot 1 \cdot 0.3 \cdot 1 \cdot 1 \cdot 0.1 = 0.009$

t_2:

$[S,1,3] \to [A,1,1][X,2,3]$
$[X,2,3] \to [S,2,2][A,3,3]$
$[A,1,1] \to a$, $[S,2,2] \to a$, $[A,3,3] \to a$

$p(t_2) = 0.6 \cdot 1 \cdot 1 \cdot 0.1 \cdot 1 \cdot 1 = 0.06$

2. t_2
3. $0.009 + 0.06 = 0.069$ (see also field $\alpha_{S,1,3}$ in the inside matrix on slide 12)