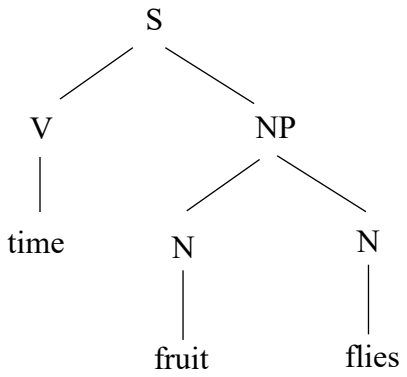
CS4248
AY 2022/23 Semester 1
Tutorial 6 Solutions

1.

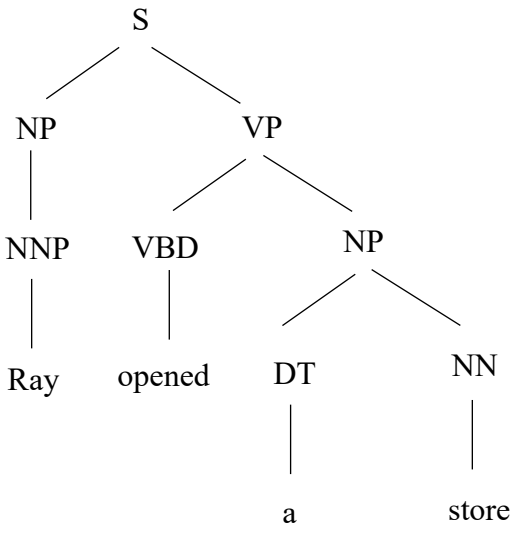
0 time 1	fruit 2	flies 3
S → time 0.1 VP → time 0.3 N → time 0.4 V → time 0.6 [0,1]	NP → N N (k = 1) 0.4 * 0.2 * 1.0 = 0.08 [0,2]	S → V NP (k = 1) 0.6 * 0.08 * 0.4 = 0.0192 VP → V NP (k = 1) 0.6 * 0.08 * 0.5 = 0.024 S → NP VP (k = 2) 0.08 * 0.2 * 0.4 = 0.0064 (lower probability, not kept) [0,3]
	N → fruit 0.2 [1,2]	NP → N N (k = 2) 0.2 * 0.4 * 1.0 = 0.08 [1,3]
		S → flies 0.1 VP → flies 0.2 N → flies 0.4 V → flies 0.4 [2,3]



2. Labeled recall $= \frac{12}{13}$
Labeled precision $= \frac{12}{12} = 1$

A constituent (non-terminal symbol) in the parse tree of the parser is correct if there is a constituent in the human's parse tree that spans the same words with the same non-terminal symbol. Note that the internal parse tree structure rooted at a non-terminal symbol does not matter.

3. Parse tree:



Semantic representation of NP (that expands into DT NN):
$\{\lambda P.\lambda Q.\exists x P(x) \wedge Q(x)\}\{\lambda s.\text{Store}(s)\}$
$\lambda Q.\exists x \lambda s.\text{Store}(s)(x) \wedge Q(x)$
$\lambda Q.\exists x \text{Store}(x) \wedge Q(x)$

Semantic representation of VP:
$\{\ \lambda w.\lambda z.w\big(\lambda x.\exists e\ \text{Opened}(e) \wedge \text{Opener}(e,z) \wedge \text{OpenedObj}(e,x)\big)\ \}\{\ \lambda Q.\exists x \text{Store}(x) \wedge Q(x)\ \}$
$\lambda z.\{\ \lambda Q.\exists x \text{Store}(x) \wedge Q(x)\ \}\big(\lambda x.\exists e\ \text{Opened}(e) \wedge \text{Opener}(e,z) \wedge \text{OpenedObj}(e,x)\big)$
$\lambda z.\{\ \exists x \text{Store}(x) \wedge \big(\lambda x.\exists e\ \text{Opened}(e) \wedge \text{Opener}(e,z) \wedge \text{OpenedObj}(e,x)\big)(x)\ \}$
$\lambda z.\exists x \text{Store}(x) \wedge \big(\exists e\ \text{Opened}(e) \wedge \text{Opener}(e,z) \wedge \text{OpenedObj}(e,x)\big)$

Semantic representation of S:
$\{\lambda r.r(\text{Ray})\}\{\lambda z.\exists x \text{Store}(x) \wedge \big(\exists e\ \text{Opened}(e) \wedge \text{Opener}(e,z) \wedge \text{OpenedObj}(e,x)\big)\}$
$\{\lambda z.\exists x \text{Store}(x) \wedge \big(\exists e\ \text{Opened}(e) \wedge \text{Opener}(e,z) \wedge \text{OpenedObj}(e,x)\big)\}(\text{Ray})$
$\exists x \text{Store}(x) \wedge \big(\exists e\ \text{Opened}(e) \wedge \text{Opener}(e,\text{Ray}) \wedge \text{OpenedObj}(e,x)\big)$

4.
a. Both Alice and Barbara like Christopher.
(i) [N] $L(A,C) \vee L(B,C)$
(ii) [N] $L(A \wedge B, C)$
(iii) [Y] $L(A,C) \wedge L(B,C)$

b. There is a man who likes both Alice and Barbara.
(i) [Y] $\exists x[M(x) \wedge L(x,A) \wedge L(x,B)]$
(ii) [N] $\exists x[M(x) \Rightarrow [L(x,A) \wedge L(x,B)]]$
(iii) [N] $[\exists x M(x)] \Rightarrow [L(x,A) \wedge L(x,B)]$

c. All men who like Alice also like Barbara.

(i) [Y] $\forall x[[M(x) \wedge L(x, A)] \Rightarrow L(x, B)]$

(ii) [Y] $\forall x[M(x) \Rightarrow [L(x, A) \Rightarrow L(x, B)]]$

(iii) [N] $\forall x[M(x) \wedge L(x, A) \wedge L(x, B)]$