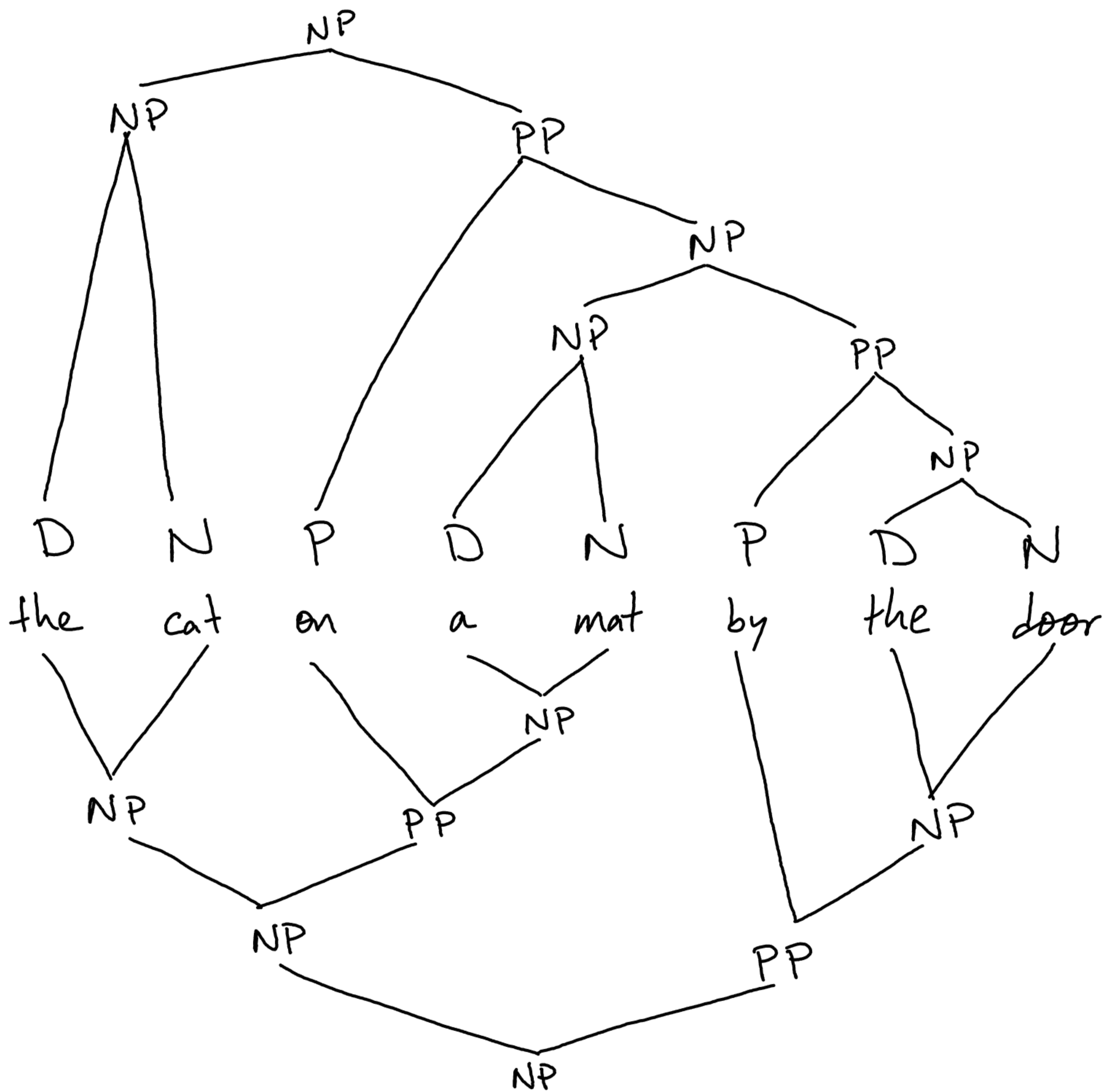


Ex 1:

(a)  $NP \rightarrow DN$   
       $| NP PP$

$PP \rightarrow P NP$

(b)



(c) The top one: closest attachment between the mat and the door.

(d)  $NP \rightarrow DN$   
       $| DN PP$

$PP \rightarrow P NP$

The second NP rule ensures a low-attachment strategy

(e) The ternary NP rule makes the grammar above non regular, but we can easily make it regular:

$$\begin{aligned} NP &\rightarrow D \ NZ & PP &\rightarrow P \ NP \\ NZ &\rightarrow N \\ &| N \ PP \end{aligned}$$

Ex 2:

(a)  $S \rightarrow$  the man that saw  $S$   
| the man that saw the bear

---

$S \rightarrow$  the man that saw  $X$  the bear

$X \rightarrow$  the man that saw  $X$

|  $\epsilon$

---

$S \rightarrow M$  the bear

$M \rightarrow$  the man that saw  $M$

| the man that saw

---

$S \rightarrow$  the man that saw  $S'$

$S' \rightarrow S$  | the bear

- (b) In  $L_1$ , all of the nouns are 'man', except for the last one, which is necessarily 'bear'.  
 In  $L_2$ , all of the nouns are either 'man' or 'bear', except for the last one that can only be 'bear'.  
 In  $L_3$ , all of the nouns, including the last one, can be 'man' or 'bear'.

$S \rightarrow$  NP Rel

Rel  $\rightarrow$  that saw NP Rel

NP  $\rightarrow$  the man

| that saw NP

| the bear

(c) See above.

(d)  $L_2 \setminus L_1$ : at least one non-final noun is 'bear', otherwise it would be part of  $L_1$ .

$S \rightarrow$  the man that saw S

| the bear that saw X

X  $\rightarrow$  the man that saw X

| the bear that saw X

| the bear

Ex 3:

$S \rightarrow NP VP$

$NP \rightarrow PN$

| Det  $N'$

|  $N_p'$

$N' \rightarrow N' PP$

| N

$N_p' \rightarrow Adj N_p'$

|  $N_p$

$PP \rightarrow P NP$

$VP \rightarrow V_i$

|  $V_t$  NP

|  $V_d$  NP NP

|  $V_a$  NP Adj

$N \rightarrow$  caterpillar

| cat

| grin

$N_p \rightarrow$  cakes

| roses

Adj  $\rightarrow$  red

$V_i \rightarrow$  disappears

$V_t \rightarrow$  eats

$V_d \rightarrow$  gives

$V_a \rightarrow$  paints

P  $\rightarrow$  with

Det  $\rightarrow$  the

| a