

Chapter 5: Grammar for Natural Languages

5.1 Auxiliary verbs and verb phrases

English sentences typically contain a sequence of auxiliary verbs followed by a main verb.

Example: I *can* see the house

I *will have* seen the house

I *was* watching the movie

I *should have been* watching the movie

- How the auxiliaries constrain the verb that follows them ?.
 - + *have* must be followed by a past participle form (either another auxiliary or a main verb).
 - + *be* must be followed by a present participle form, or, in the case of the passive sentence, by the past participle form.

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5.1 Auxiliary verbs and verb phrases

Auxiliaries: have, be, do, can, will, should, must, ...

+ *do* usually occurs alone (in position of a main verb), but can accept a base form following it, example: “*I did eat my pizza*”.

+ *can, must* must always be followed by a base form.

- The first auxiliary (or verb) in the sequence must **agree with subject** in the simple declarative sentences and be in **finite form** (past, present tense).

In the section is to analysis how the structure of auxiliary forms using to combine new rules and features restrictions.

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5.1 Auxiliary verbs and verb phrases

- Auxiliaries have subcategorization features that restrict their verb phrase complements
- The distinction is between auxiliary and main verb:
 - + auxiliary can place before adverbial *not*, but main verb can not, example: “*I am not going*”, “*I did not try it*”.
 - + Only auxiliary verb can precede the subject NP in yes/no questions: “*Did you see the car ?.*”, “*Can I try it ?.*”
 - + Contrast, main verb can appear as the solo verb, but if in yes/no question, to need add a auxiliary *do*

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5.1 Auxiliary verbs and verb phrases

Primary auxiliaries are based on the root forms: be, Have. The other auxiliaries are called modal and generally appear in the finite forms (simple present, past. Example: can (could) will (would), shall (should), may (might), must, need, dare

Auxiliary	COMPROM	construction	examples
modal	base	modal	Can see the house
have	pastprt	perfect	Have seen the house
be	ing	progressive	Is lifting the box
be	pastprt	passive	Was seen by the crowd

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5.1 Auxiliary verbs and verb phrases

- The new rule VP with a auxiliary

$$VP \rightarrow (Aux \text{ COMPFORM ? } S) (VP \text{ VFORM ? } S)$$

- COMPFORM indicates VFORM of VP.
- Binary head feature MAIN could be introduced that is + for any main verb and – for auxiliary verb.

Example: $VP \rightarrow Aux [be] VP [ing, + main]$

- Binary feature for passive construction (PASS): for complement in the passive form, that is + only if the Vp involves passive:

Example: $VP \rightarrow Aux [be] VP [ing, + pass]$

The passive rule: $VP [+ pass] \rightarrow Aux [be] VP [pastprt, main]$

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5.1 Auxiliary verbs and verb phrases

- *The lexicon of some auxiliaries*

can (CAT AUX
MODAL +
VFORM pres
AGR [1s 2s 3s 1p 2p 3p]
COMPFORM base)

Be (CAT AUX
ROOT be
VFORM base
COMPFORM ing)

do (CAT AUX
MODAL +
VFORM pres
AGR [1s 2s 3s 1p 2p 3p]
COMPFORM base)

have (CAT AUX
ROOT have
VFORM base
VFORM pastprt)

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5.1 Auxiliary verbs and verb phrases

Passive

Most verbs that includes NP in their complement allow the passive form. In this passive sentence, “object position” NP will be a first NP in the sentence, and either omitting the subject NP or putting it into PP with preposition “by”.

Example: *“I will hide my hat in the drawer”*

⇒ *“My hat will be hidden in the drawer”*

- ***Some rules consist auxiliaries for the passive forms:***

Example: 1. $S \ [_{inv}] \rightarrow (NP \ AGR \ ? \ A) \ (VP \ [fin] \ AGR \ ? \ A)$

2. $VP \rightarrow (AUX \ COMPFORM \ ? \ V) \ (VP \ VFORM \ ? \ V)$

3. $VP \rightarrow AUX \ [be] \ VP \ [ing, + \ main]$

4. $VP \rightarrow AUX \ [be] \ VP \ [ing, + \ pass]$

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5.1 Auxiliary verbs and verb phrases

- A new binary head feature PASSGAP, is defined that is + only the constituent is missing the object NP. This feature would default to – if it is not specified in the left hand side of the rule.
- Simple _np subcat in the grammar would be realized as two rules:

Example: VP {- passgap} → V [-np] NP

VP {+ passgap} → V [-np]

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5.1 Auxiliary verbs and verb phrases

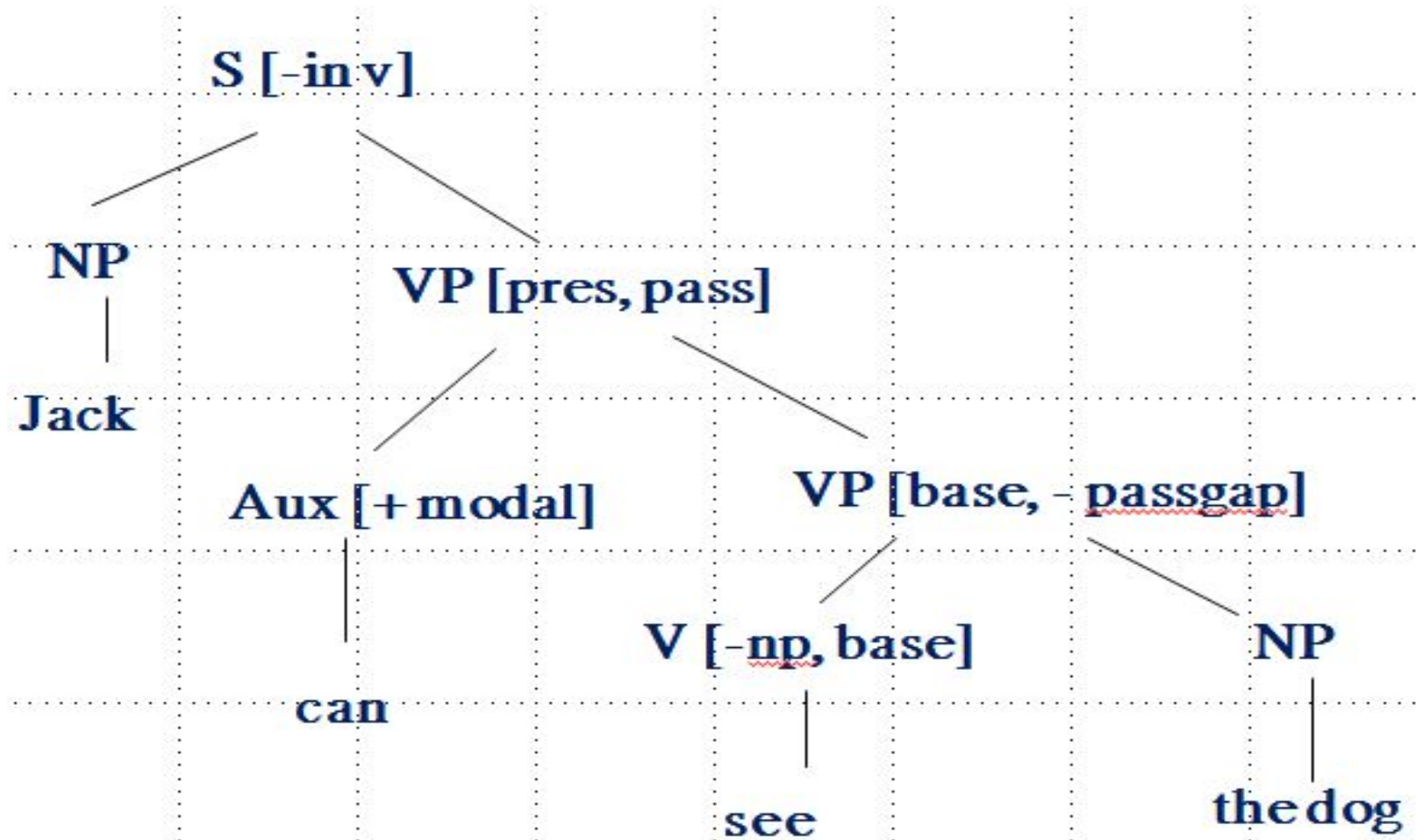


Figure 5.1: An active form sentence

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5.1 Auxiliary verbs and verb phrases

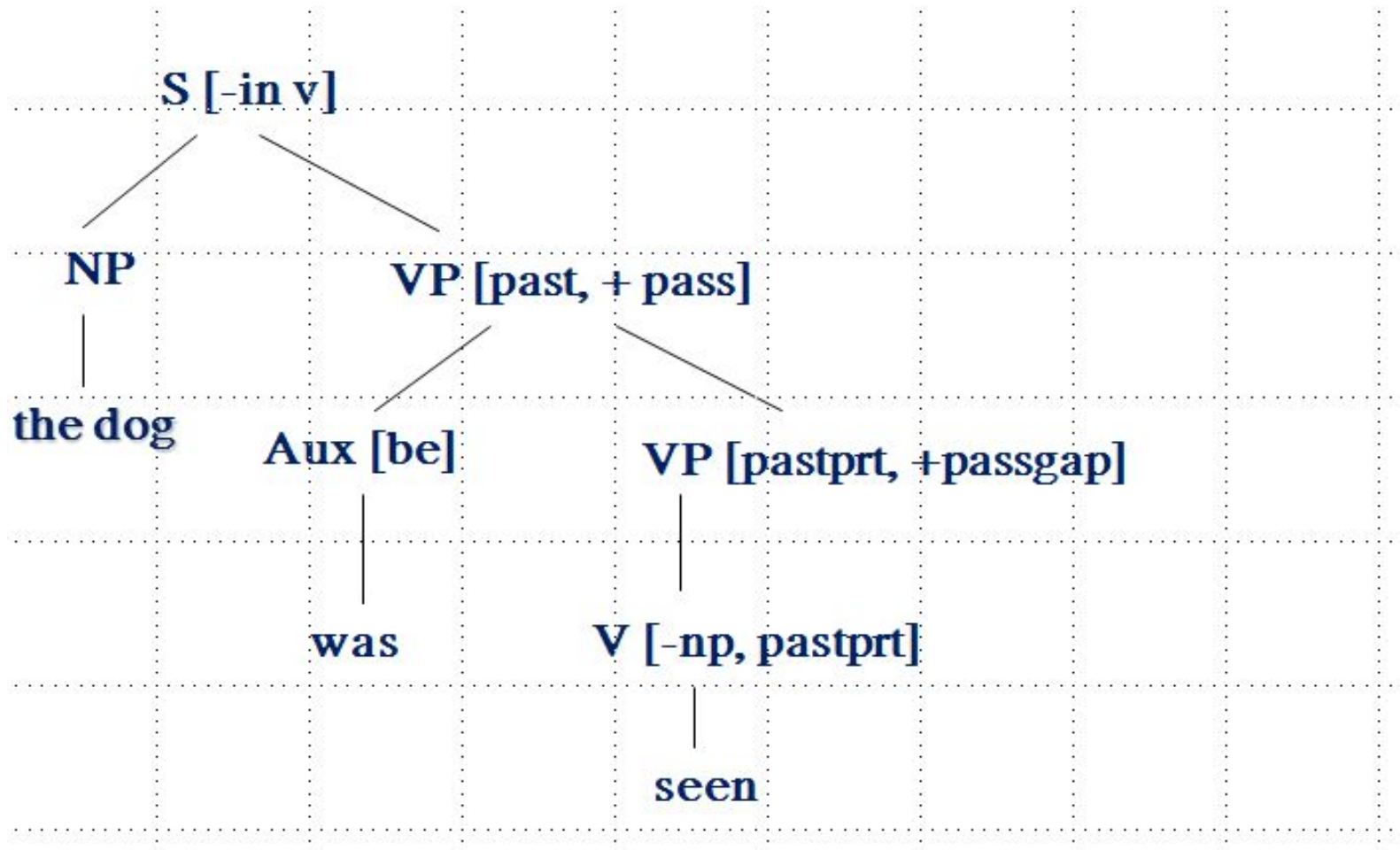


Figure 5.2: A passive form sentence

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5.2 Movement phenomena in Language

To explore techniques handling question forms in English.

Considering yes/no question and how they relate to their assertional counterpart:

Jack is giving Sue a back rub □ Is Jack giving Sue a back rub ?

He will run in the marathon next year □

Will he run in the marathon next year ?.

- **yes/no questions** appear identical in the structure to their assertional counterpart, except , NP subjects and first auxiliaries have swapped positions. If no auxiliary in the assertional sentence, then an auxiliary of root *do* in the appropriate is used.

The rearranging of the subject and auxiliary is called **subject-aux inversion**

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5.2 Movement phenomena in Language

Deriving yes/no questions from assertions by moving the constituents in the manner, is a *local movement*.

Wh-question: the constituents may be moved arbitrarily far from their original position. This movement is called **unbounded movement**.

Example: “*The fat man will angrily put the book in the corner*”

- If we are interested in who did the action, we may ask:

- a) Which *fat man will angrily put the book in the corner* ?.
- b) Who will *angrily put the book in the corner* ?.

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- If we are interested in how it is done, we may ask:

c) How will the fat man put in the corner ?.

d) In what way will the fat man put in the corner ?

- If we are interested in other aspects, we may ask:

e) What will the fat man angrily put in the corner ?.

f) Where will the fat man angrily put the book ?

Each question of wh-form has the same form as the original assertion, except that the part being questioned is removed and replaced by wh-phrase at beginning of the sentence.

Note: except when the part being questioned is the subject NP, the subject and auxiliary are inverted as in yes/no question.

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5.2 Movement phenomena in Language

How to control the fact that a constituent is missing from some places later in the sentence.

**What will the fat man angrily put in the corner ?*

**What will the fat man angrily put the book in the corner ?.*

A place of missing constituent is called gap, and the constituent moved is called the filler

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5.2 Movement phenomena in Language

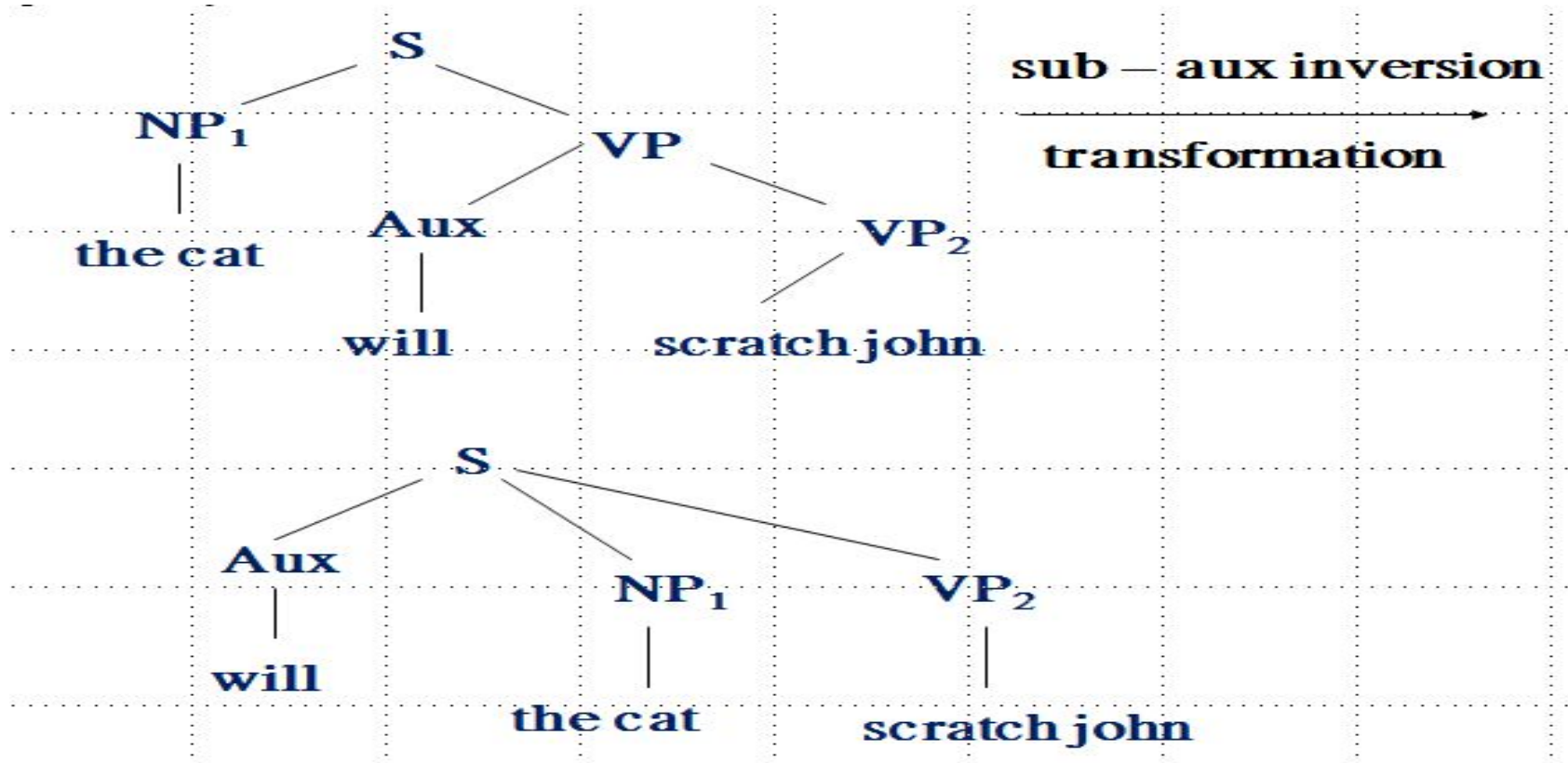


Figure 5.3: The yes/no question is generated from the structure by a transformation

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5.2 Movement phenomena in Language

Different types of the movement

- **Wh-movement:** move a wh-term to the front of the sentence to form wh-question
- **Topicalization:** move a constituent to the beginning of the sentence for emphasis, as in:

I never like this picture □ *This picture, I never like.*

- **Adverb preposing:** Move an adverb to the beginning of the sentence

I will see you tomorrow □ *Tomorrow, I will see you*

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5.2 Movement phenomena in Language

Different types of the movement

- **Extra position:**

Move certain NP complement to the sentence final position, as in:

- *A book discussing evolution was written* □

A book was written discussing evolution

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5.3 Handling question in context free grammar

y/n question

$S[-inv] \rightarrow (NP \text{ AGR } ?a) (VP [\text{pres past}] \text{ AGR } ?a)$ (*Grammar 4.7*)

$\longrightarrow S [+INV] \square (\text{Aux AGR? a SUBCAT ? v})$
 $(NP \text{ AGR ? a }) (VP \text{ VFORM ? v })$

WH-question:

Using the feature GAP to introduce wh-question form.

Feature GAP is passed from the mother to the subconstituent until the appropriate place for the gap is found in the sentence

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In the appropriate place, the sub-constituent will be missed by empty rule (the right hand side of this rule is empty).

NP GAP ((CAT NP) (AGR ? a)) AGR ? a □ ∈

Two ways in which the GAP feature propagates, depending on whether the head constituent is lexical or non-lexical category.

- if it is non-lexical category, GAP is passed from the mother to head, not to any other sub-constituents.

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Example: S has GAP feature

$(S \text{ GAP ? } g) \sqsubseteq (NP \text{ GAP - }) (VP \text{ GAP ? } g)$

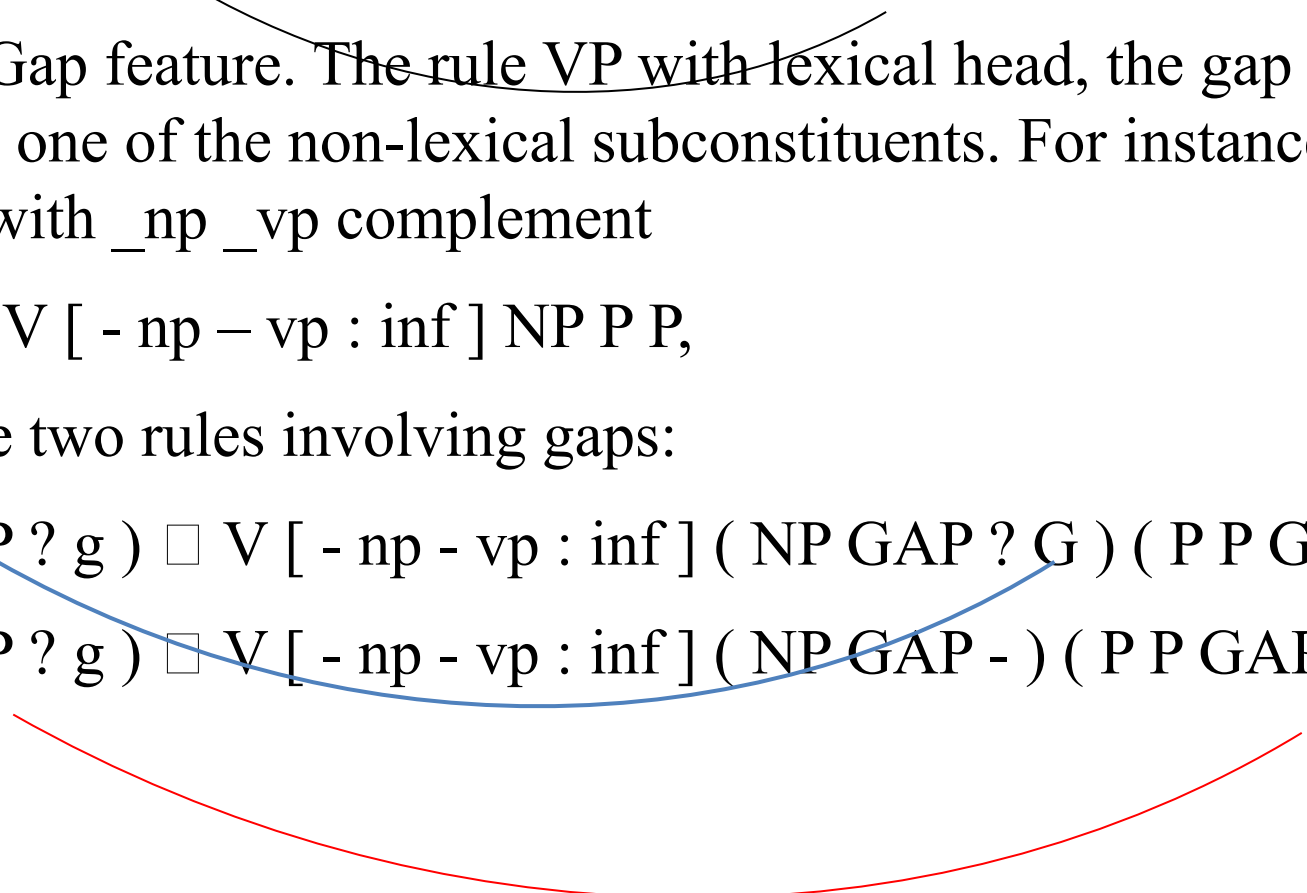
VP has Gap feature. ~~The rule VP with lexical head,~~ the gap move to any one of the non-lexical subconstituents. For instance, verb rules with $_np _vp$ complement

$VP \sqsubseteq V [- np - vp : inf] NP P P,$

There are two rules involving gaps:

$(VP \text{ GAP ? } g) \sqsubseteq V [- np - vp : inf] (NP \text{ GAP ? } G) (PP \text{ GAP - })$

$(VP \text{ GAP ? } g) \sqsubseteq V [- np - vp : inf] (NP \text{ GAP - }) (PP \text{ GAP ? } g)$



The diagram illustrates gap movement in two rules. In the first rule, a blue arc connects the gap 'g' in the VP feature to the 'G' in the NP feature. In the second rule, a blue arc connects the gap 'g' in the VP feature to the gap 'g' in the PP feature. A red arc at the bottom indicates a general movement from a gap in the VP to a gap in a non-lexical constituent.

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- *The algorithm for adding GAP feature to grammar*

For each rule $Y \rightarrow X_1 \dots H_i \dots X_n$ with head constituent H_i

- 1) If the rule specifies a GAP feature in some constituent already, then skip;
- 2) If the head GAP is not a lexical category, then add Gap feature to the head and the mother, and \neg Gap to other sub-constituents, producing a rule of the form:

$$(Y \text{ GAP ? } g) \rightarrow (X_1 \text{ GAP - }) \dots (H_i \text{ GAP ? } g) \dots (X_n \text{ GAP - })$$

- 3) If the head GAP is lexical category, then for each non-lexical constituent X_j , add a rule of the form:

$$(Y \text{ GAP ? } g) \rightarrow (X_1 \text{ GAP - }) \dots (X_j \text{ GAP ? } g) \dots (X_n \text{ GAP - })$$

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In the Wh-question, filler NP and PP at the start of the sentence and are identified by new feature Wh that identifies a class of the phrases which introduce the questions:

- Whom, Who, What can appear as pronouns and specify simple NPs

Example: *Who ate the pizza?*

What did you put the box in ?.

- What, which are as determiners in noun phrases:

What book did you put on the desk

Which book did you put on the desk

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5.3 Handling question in context free grammar

- Where, When can appear in propositional phrases:

*Example: **Where** did you put the book?*

***When** did you go to the store ?.*

- How acts as an adverbial modifier in the adjective, adverbial phrases:

*Example: **How** quickly did he run ?*

***Whose** acts possessive pronoun:*

*Example: **Whose** book did you find ?.*

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what:	(CAT PRO WH Q AGR {3s 3p})	when:	(CAT PP-WRD WH {Q R} PFORM TIME)
what:	(CAT QDET WH Q AGR {3s 3p})	who:	(CAT PRO WH {Q R} AGR {3s 3p})
which:	(CAT QDET WH Q AGR {3s 3p})	where:	(CAT PP-WRD WH {Q R} PFORM {LOC MOT})
which:	(CAT PRO WH R AGR {3s 3p})	whose:	(CAT PRO WH {Q R} POSS + AGR {3s 3p})

Figure 5.4: A lexicon for some of the wh-words

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1. $(NP \text{ POSS } ?p \text{ WH } ?w) \rightarrow (PRO \text{ POSS } ?p \text{ WH } ?w)$
2. $(NP \text{ WH } ?w) \rightarrow (DET \text{ WH } ?w \text{ AGR } ?a) (CNP \text{ AGR } ?a)$
3. $CNP \rightarrow N$
4. $CNP \rightarrow ADJ N$
5. $DET \rightarrow ART$
6. $(DET \text{ WH } ?w) \rightarrow (NP[+POSS] \text{ WH } ?a)$
7. $(DET \text{ WH } ?w) \rightarrow (QDET \text{ WH } ?w)$
8. $(PP \text{ WH } ?w) \rightarrow P (NP \text{ WH } ?w)$
9. $(PP \text{ WH } ?w) \rightarrow (PP\text{-}WRD \text{ WH } ?w)$

Head feature for NP, DET and CNP: AGR

Head feature for PP: PFORM

Figure 5.5: A simple NP and PP grammar handling wh-words

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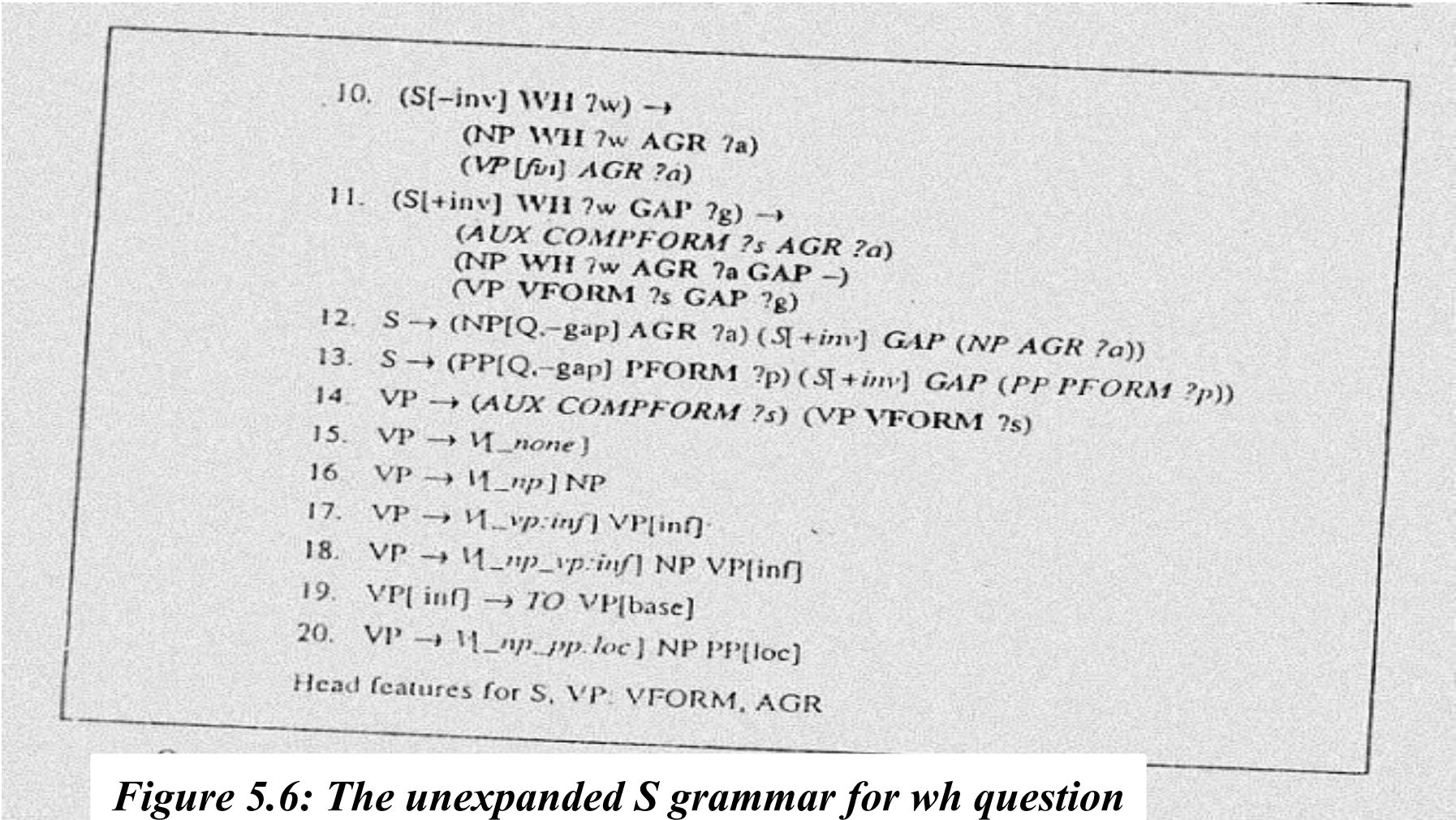
- 
10. $(S[-inv] WH ?w) \rightarrow$
 $(NP WH ?w AGR ?a)$
 $(VP [fvi] AGR ?a)$
11. $(S[+inv] WH ?w GAP ?g) \rightarrow$
 $(AUX COMPFORM ?s AGR ?a)$
 $(NP WH ?w AGR ?a GAP -)$
 $(VP VFORM ?s GAP ?g)$
12. $S \rightarrow (NP[Q,-gap] AGR ?a) (S[+inv] GAP (NP AGR ?a))$
13. $S \rightarrow (PP[Q,-gap] PFORM ?p) (S[+inv] GAP (PP PFORM ?p))$
14. $VP \rightarrow (AUX COMPFORM ?s) (VP VFORM ?s)$
15. $VP \rightarrow V_{_none}$
16. $VP \rightarrow V_{_np} NP$
17. $VP \rightarrow V_{_vp_inf} VP[inf]$
18. $VP \rightarrow V_{_np_vp_inf} NP VP[inf]$
19. $VP[inf] \rightarrow TO VP[base]$
20. $VP \rightarrow V_{_np_pp_loc} NP PP[loc]$
- Head features for S, VP, VFORM, AGR

Figure 5.6: The unexpanded S grammar for wh question

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Parsing with GAPs

The grammar with GAP creates some new complications for parsing algorithm. In particular, rules may have empty right hand side. NP constituent may be empty any where.

NP AGR ? a GAP (NP AGR ? a)) $\square \in$

- The arc extension algorithm may be modified to handle the gaps automatically.

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The algorithm to insert an empty constituents

Whenever an arc of the form

$$X \square \dots \cdot (CF_1 V_1 \dots F_n V_n \text{ GAP } (C G_1 ? vg_1 G_m ? vg_m)) \dots$$

is suggested by the parser, and the constituent pattern that is the GAP feature, that is $(C G_1 ? vg_1 \dots G_m ? vg_m)$ matches the constituent itself $C F_1 v_1 \dots F_n V_n \text{ GAP } (C G_1 VG_1 \dots G_m VG_m))$

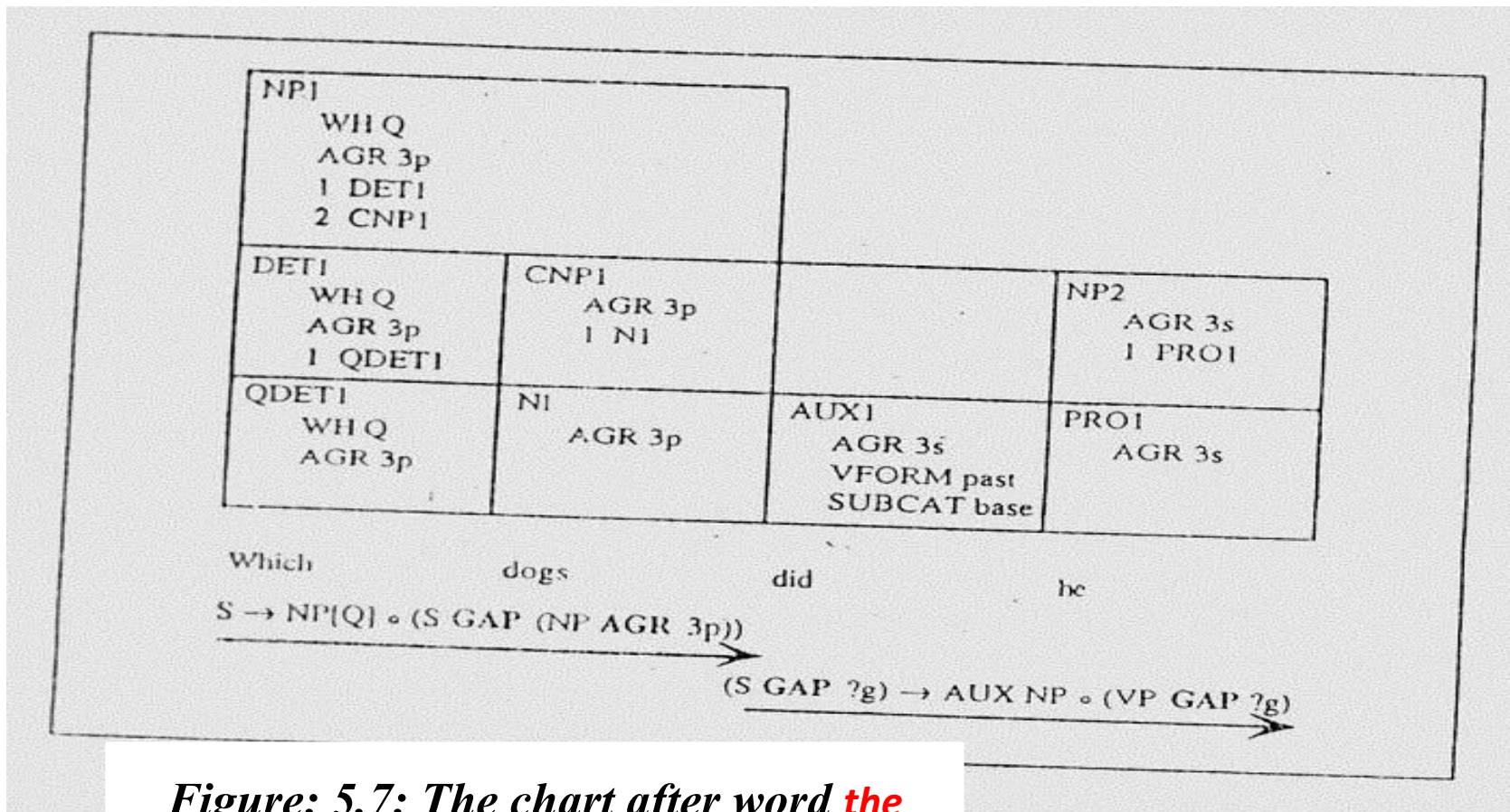
then add a new constituent $(C G_1 ? vg_1 \dots G_m ? vg_m \text{ EMPTY } +)$ with the variables bound as necessary.

Use this constituent to extend the original arc.

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Example: Parse the sentence “Which dogs did he see?” by bottom up chart parsing (Figure 5.7)



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S2 VFORM past 1 NP1 2 S1				
NP1 WH Q AGR 3p 1 DET1 2 CNP1		S1 INV+ GAP (NP AGR 3p) VFORM past 1 AUX1 2 NP2 3 VP1		
DET1 WH Q AGR 3p 1 QDET1	CNP1 AGR 3p 1 NI		NP2 AGR 3s 1 PRO1	VP1 VFORM inf GAP (NP AGR 3p) 1 VI 2 EMPTY-NP1
QDET1 WH Q AGR 3p	NI AGR 3p	AUX1 AGR 3s VFORM past SUBCAT base	PRO1 AGR 3s	
Which	dogs	did	he	see

Figure 5.8: The final chart for “Which dogs did he see ?.”

Chapter 5 EXERCISE

- 1) Using the grammar developed in 5.3, show the analyses of the following questions in chart form, as show in figure 5.8:
 - a) *In which town were you born ?*
 - b) *Where were you born ?*
 - c) *When did they leave ?*
 - d) *What town were you born in ?*

- 2) GPSG allows certain rules to have multiple head sub-constituents. For instance $VP \rightarrow VP \text{ and } VP$.
 - a) How does the presence of multiple heads effect the algorithm that produces propagation of the gap feature ?. In order to answer this question consider the following sentences:
Who did you see and give the book to ?
What man did Mary hate and Sue love ?

Chapter 5 EXERCISE

Also consider that the following sentences are ill-formed:

**Who did you see and give the book to John?*

**What man did Mary hate John and Sue love ?*

b) Write out the VP rule showing the GAP feature and then draw the chart for the sentence:

Who did Mary see and Sue see ?

Using grammar augmented on the figure 5.6 with your rule only show the constituents that are used in the final analysis, but be sure to show all the feature values for each constituent.