CZ4045 Natural Language Processing

Tutorial 5 -- Formal Grammar

Q1.

a) Does American airlines have a flight between five a.m. and six a.m.?

b) I would like to fly on American airlines.

c) Please repeat that.

d) I need to fly between Philadelphia and Atlanta.

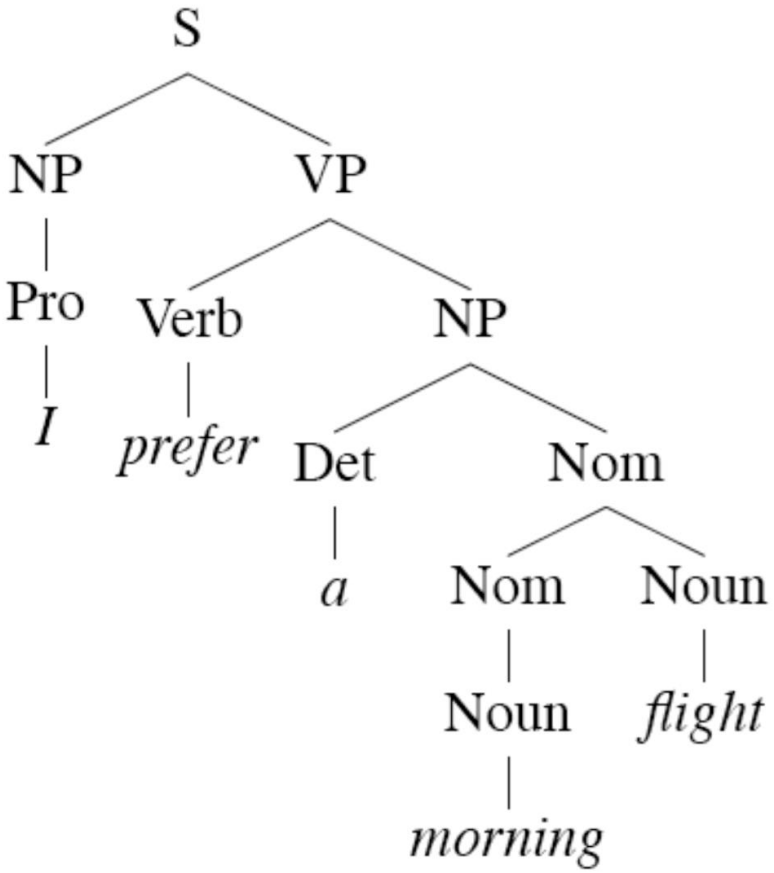
e) What is the fare from Atlanta to Denver?

Draw **phrase structures** of the sentences above.

Review

Phrase Structure

- Organizes words into nested constituents



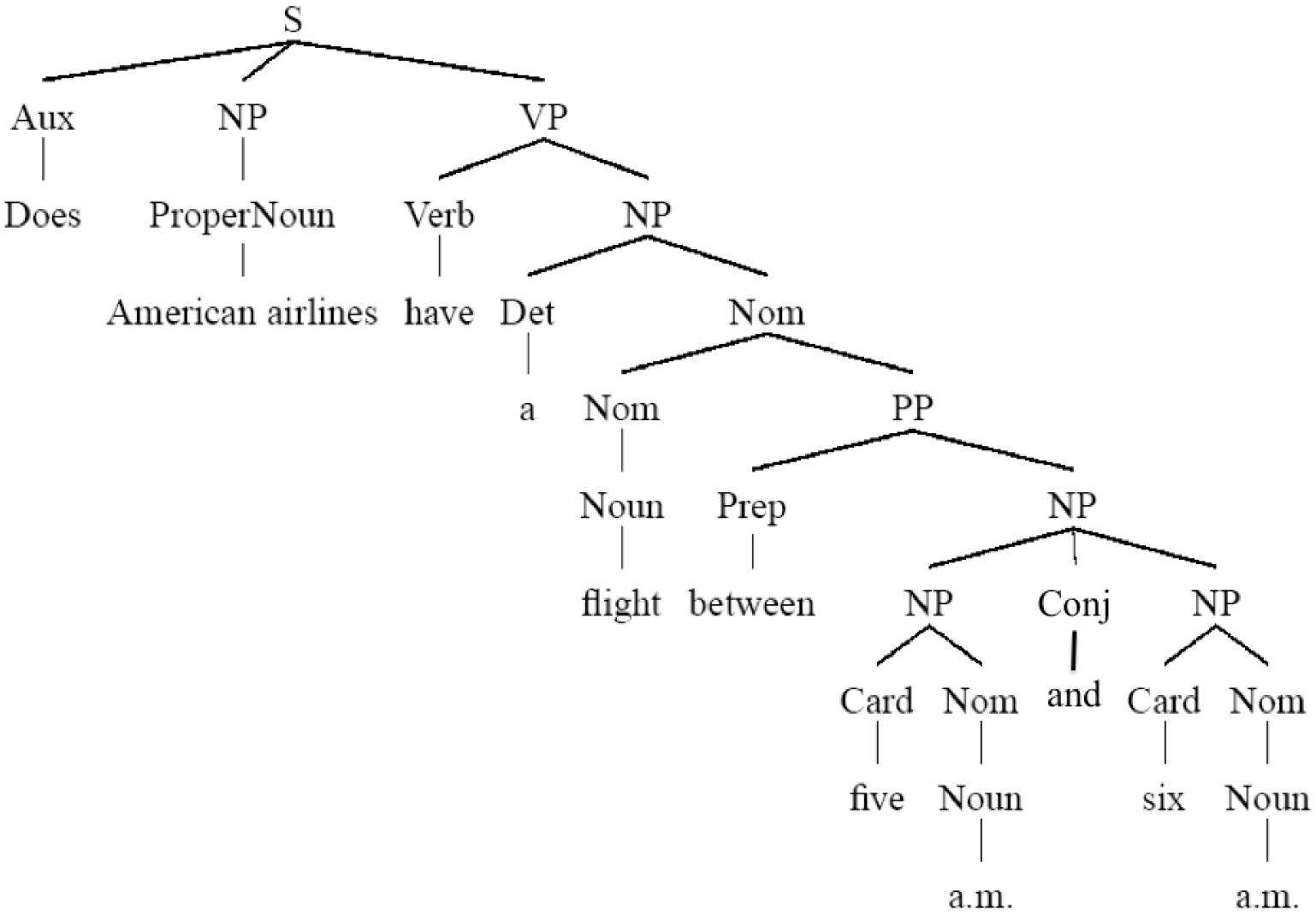
POS Tag Set

- Nouns
  - Noun
  - ProperNoun
- Pronouns
  - Pro
- Modifiers
  - Det
  - Card (cardinal number e.g. five)
  - Adj
  - Adv
- Verbs
  - Verb
  - Aux (e.g. may)
- Prepositions
  - Prep
- Infinitives (to-Verb)
  - Inf (i.e. to)
- Conjunctor (e.g. and)
  - Conj

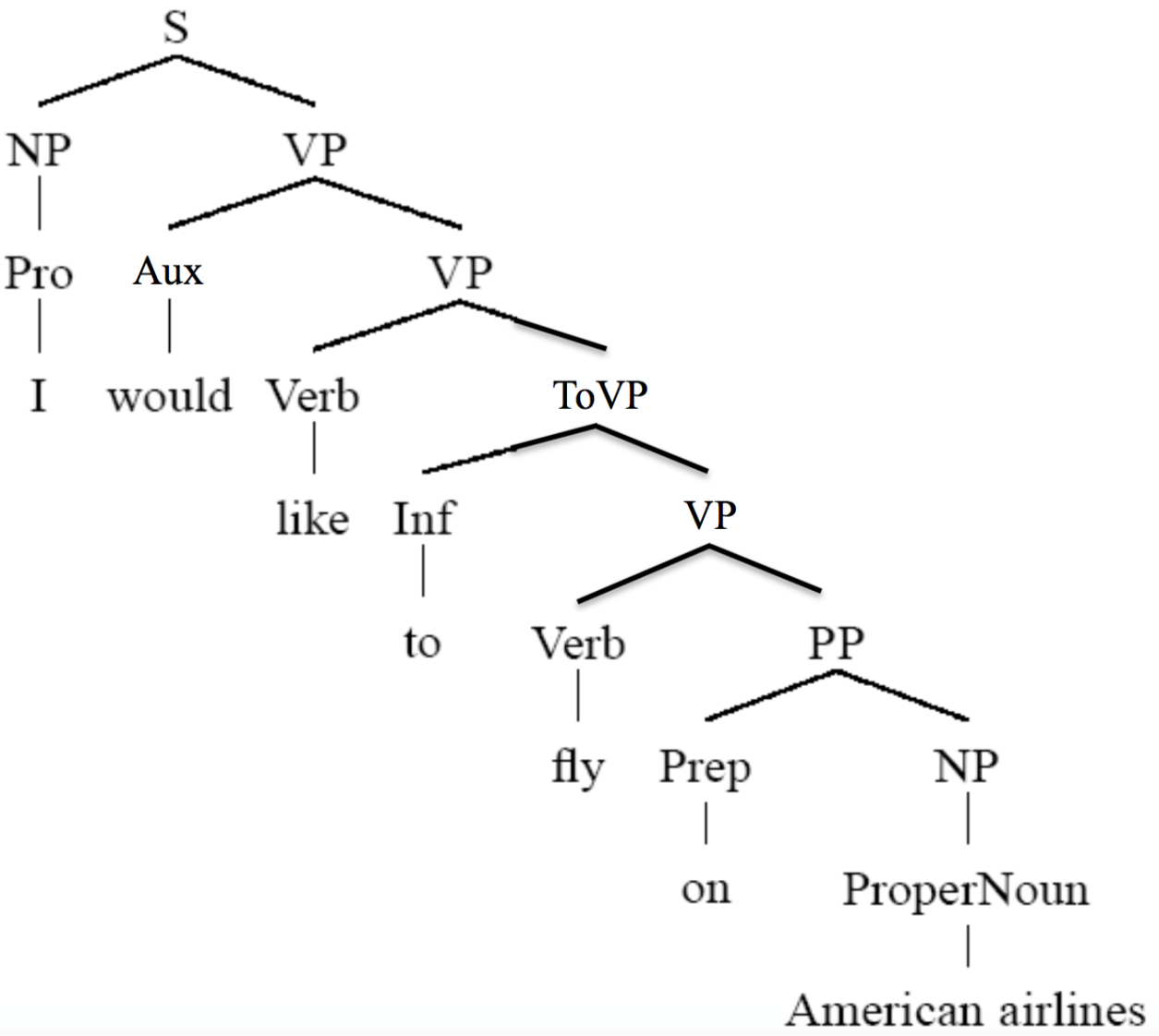
Constituents

- S
- NP
- Nom
- VP
- PP

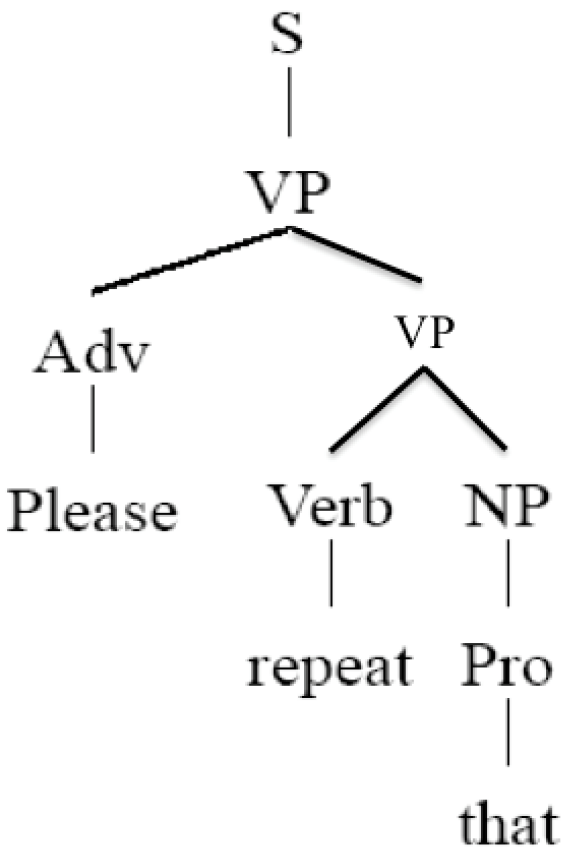
A1-a. Does American airlines have a flight between five a.m. and six a.m.?



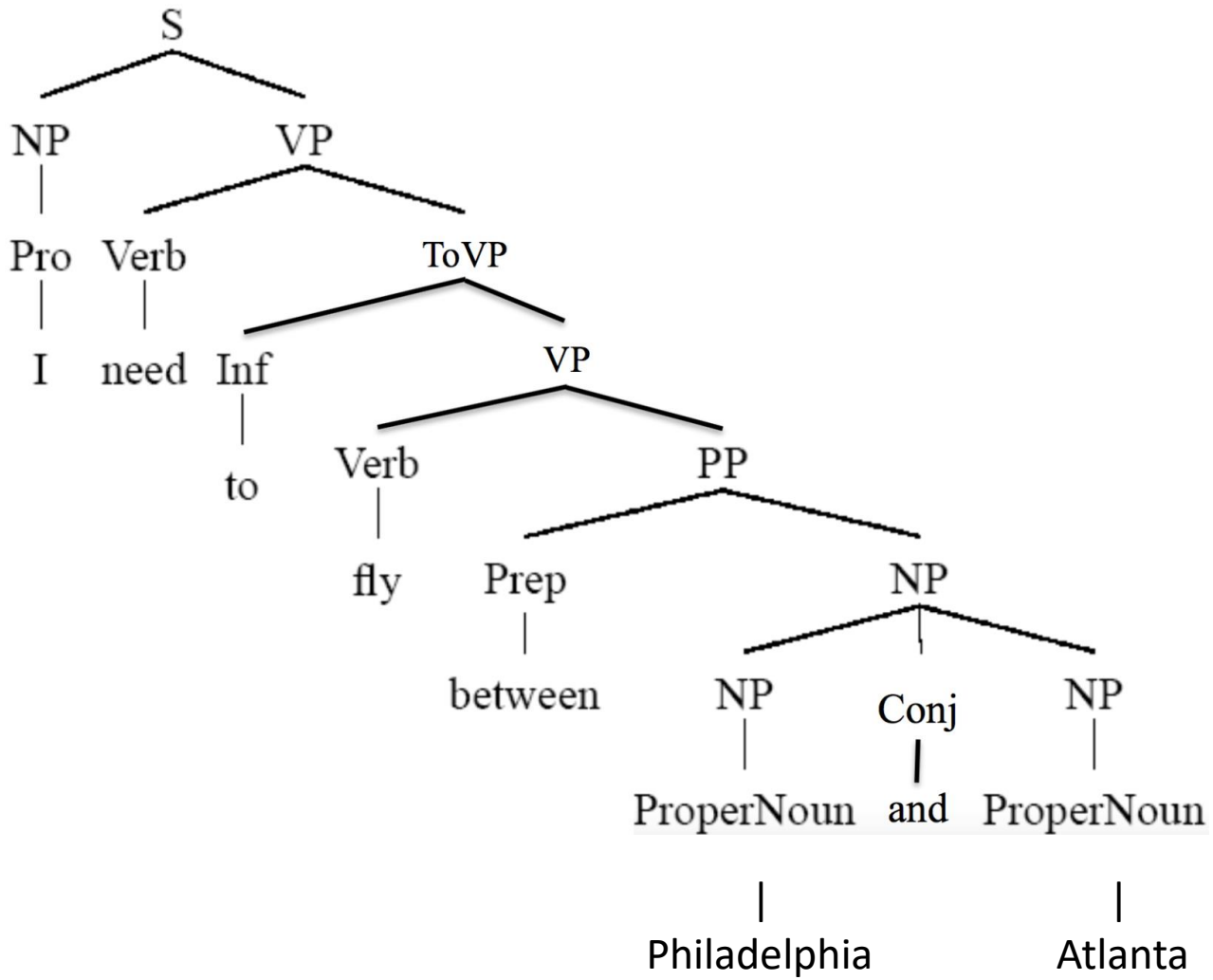
A1-b. I would like to fly on American airlines.



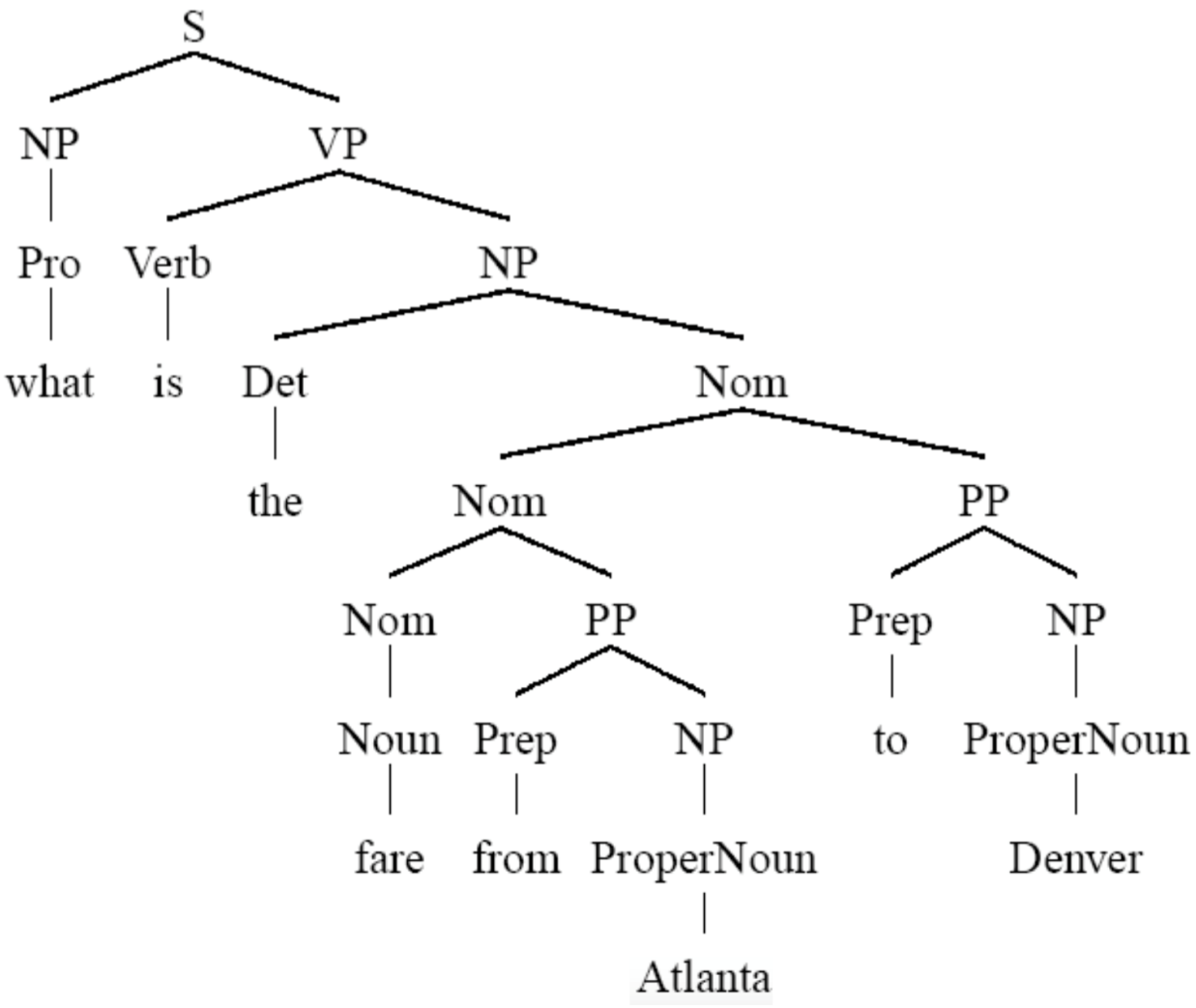
A1-c. Please repeat that.



A1-d. I need to fly between Philadelphia and Atlanta.



A1-e. What is the fare from Atlanta to Denver?



Q2.

a) Does American airlines have a flight between five a.m. and six a.m.?

b) I would like to fly on American airlines.

c) Please repeat that.

d) I need to fly between Philadelphia and Atlanta.

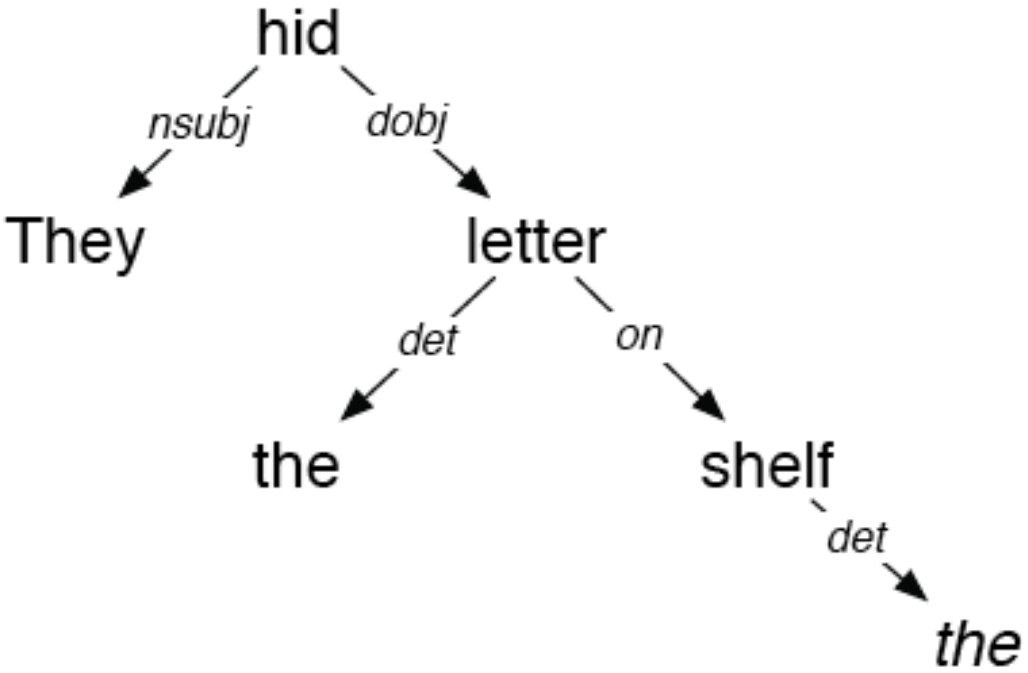
e) What is the fare from Atlanta to Denver?

Draw **typed dependency** structures of the sentences above.

Review

Dependency structure

- Represents grammatical (dependency) relations between pairs of words (i.e. head, dependent)
- Head: Grammatically most important word in a phrase
  - Verb of VP
  - Noun of NP
  - Prep of PP
  - Adj of AdjP
  - …



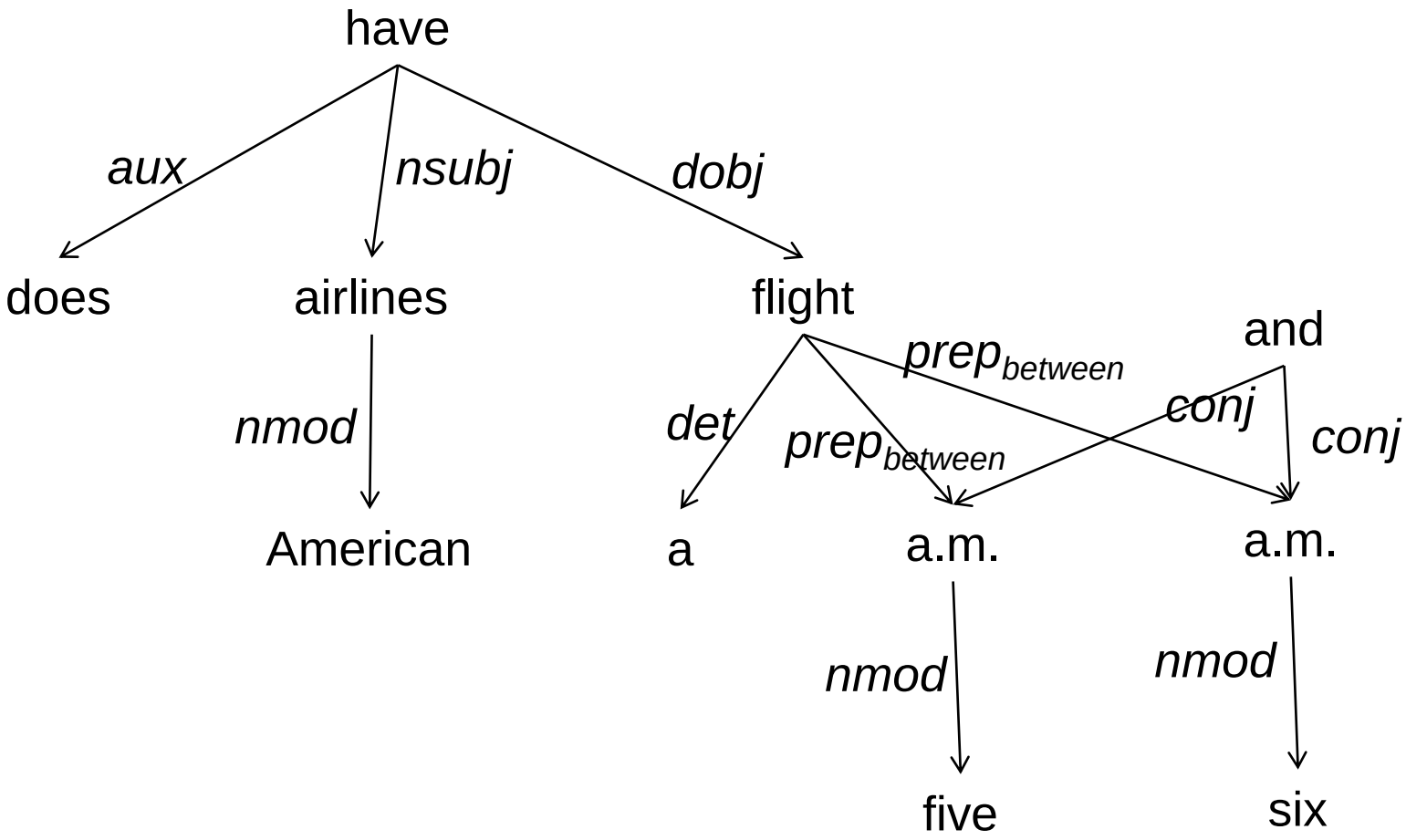
e.g. They hid the letter on the shelf

Dependency Relations

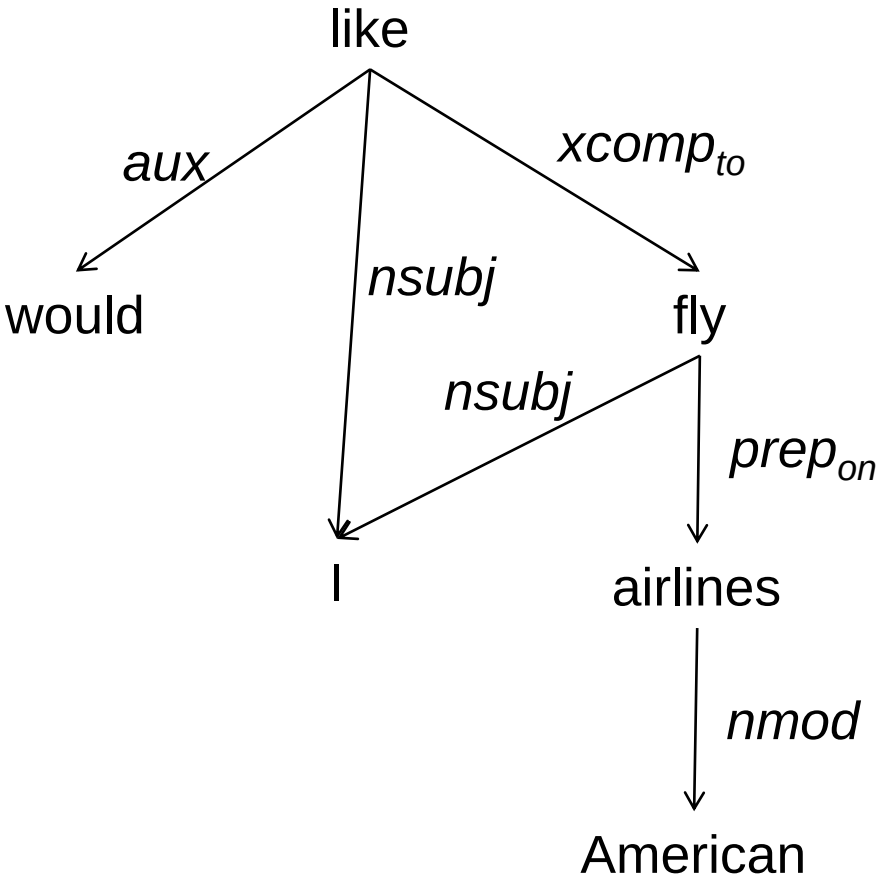
- Verb relations
  - nsubj : nominal subject
  - dobj : direct object
  - aux (auxiliary verb – main verb)
  - xmod (verb – adverb)
  - $xcomp_{to}$ (verb – to-infinitive)
- Noun relations
  - nmod: nominal modifier
  - det
- Preposition relations
  - $prep_X$ (e.g. $prep_{at}$)
- Coordination
  - conj

http://universaldependencies.org/u/dep/all.html

A2-a. Does American airlines have a flight between five a.m. and six a.m.?

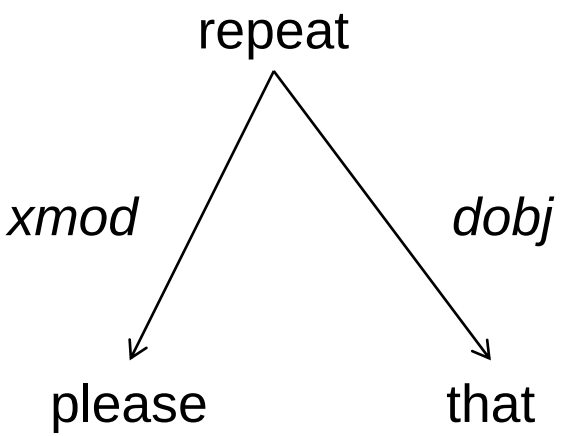


A2-b. I would like to fly on American airlines.



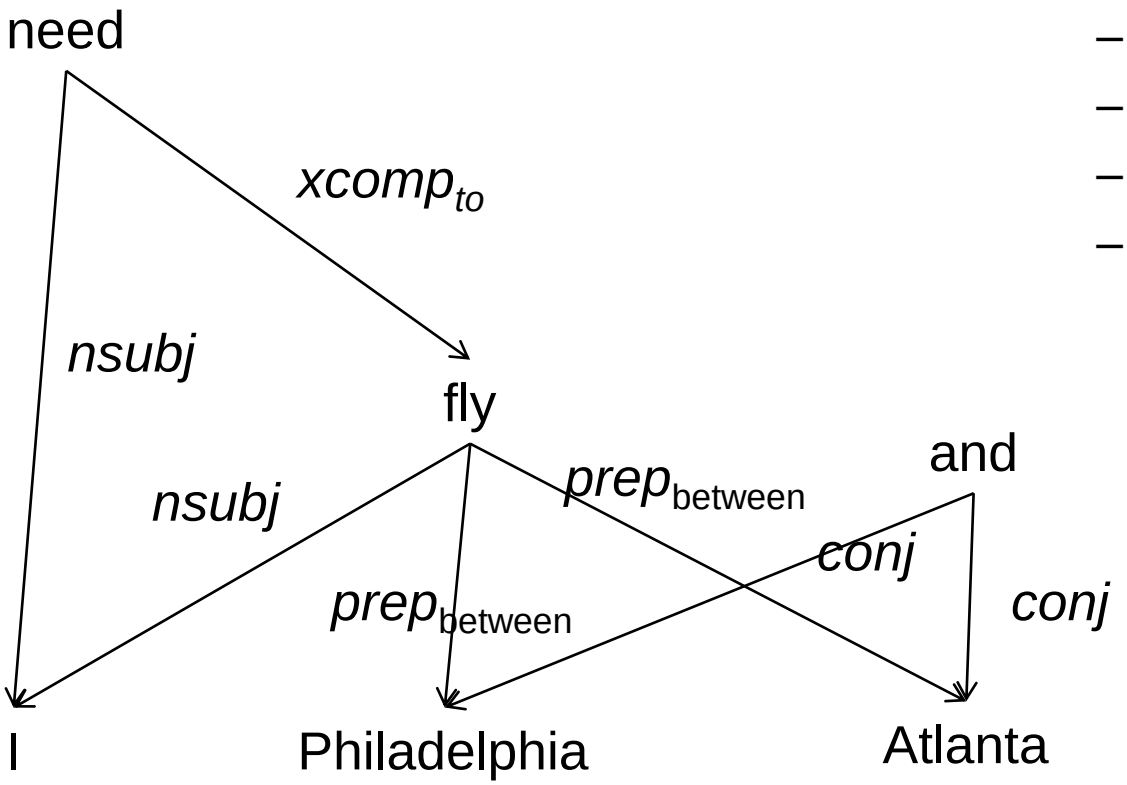
- Verb relations
  - nsubj
  - dobj
  - aux (auxiliary verb – main verb)
  - xmod (verb – adverb)
  - $xcomp_{to}$ (verb – to-infinitive)

A2-c. Please repeat that.



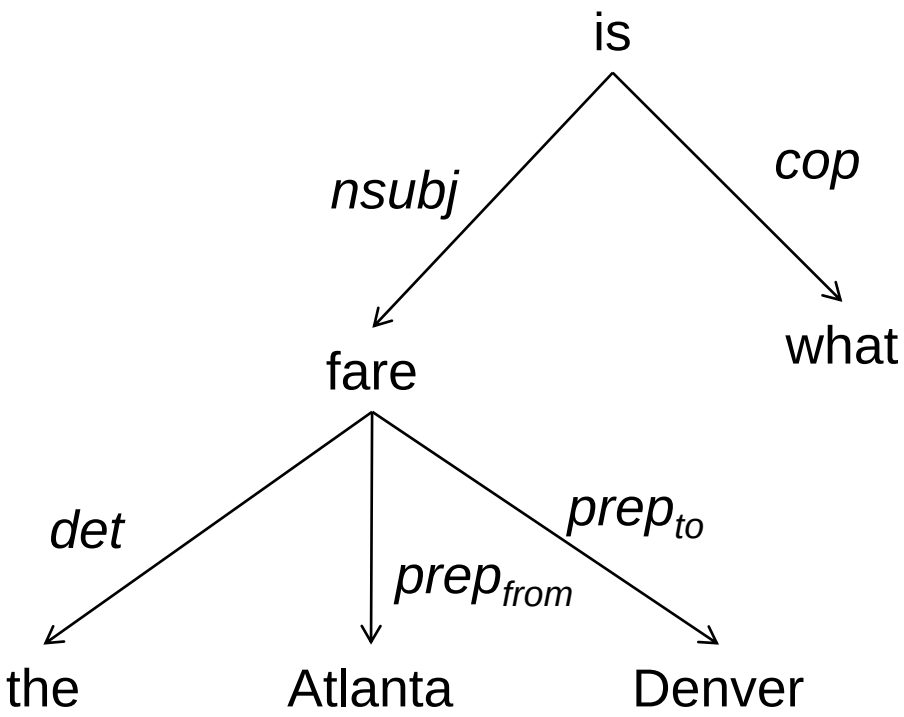
- Verb relations
  - nsubj
  - dobj
  - aux (auxiliary verb – main verb)
  - xmod (verb – adverb)
  - xcomp_{to} (verb – to-infinitive)

A2-d. I need to fly between Philadelphia and Atlanta.



- Verb relations
  - nsubj
  - dobj
  - aux (auxiliary verb – main verb)
  - xmod (verb – adverb)
  - $xcomp_{to}$ (verb – to-infinitive)

A2-e. What is the fare from Atlanta to Denver?



- Verb relations
  - nsubj
  - dobj
  - aux (auxiliary verb – main verb)
  - xmod (verb – adverb)
  - $xcomp_{to}$ (verb – to-infinitive)

http://universaldependencies.org/u/dep/all.html

Q3.

a) Does American airlines have a flight between five a.m. and six a.m.?

b) I would like to fly on American airlines.

c) Please repeat that.

d) I need to fly between Philadelphia and Atlanta.

e) What is the fare from Atlanta to Denver?

Give CCG categories for the words of the sentences above and draw derivations.

Derivation of CCG

Review

Harry	eats	Apples	
NP	(S\NP)/NP	NP	
	S\NP		>
	S		<

Application combinators

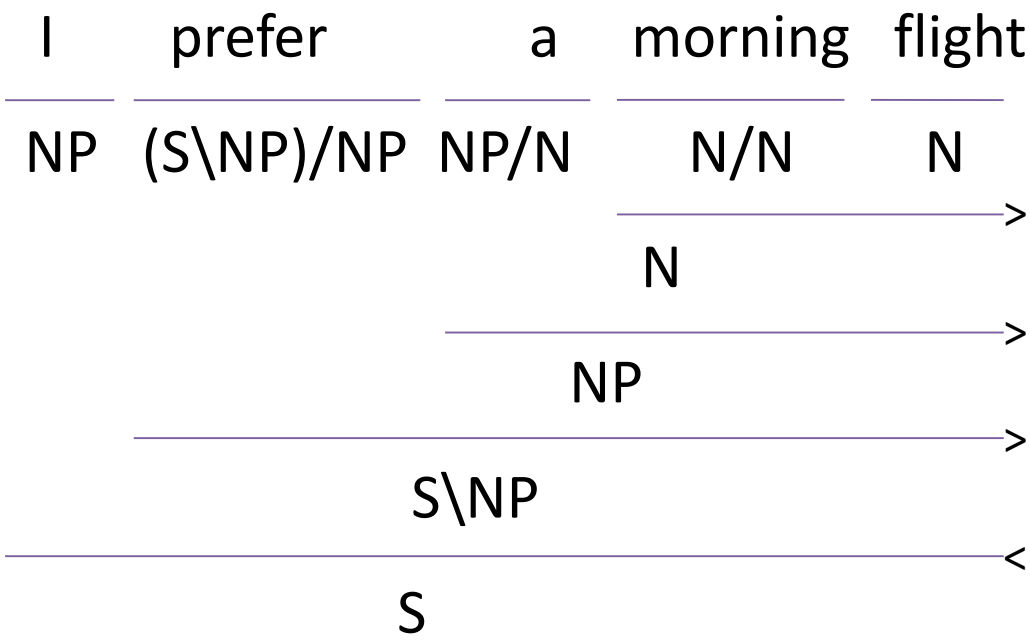
$$\frac{\alpha : X/Y \qquad \beta : Y}{\alpha\beta : X} \; >$$

$$\frac{\beta : Y \qquad \alpha : X\backslash Y}{\beta\alpha : X} \; <$$

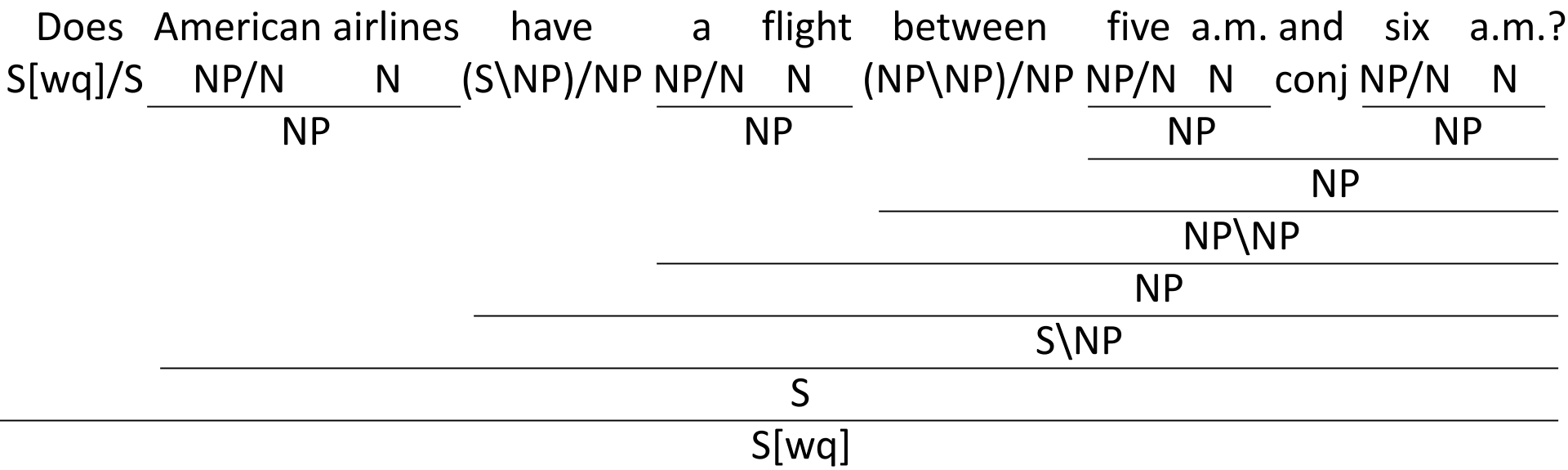
Review

Exercise: CCG

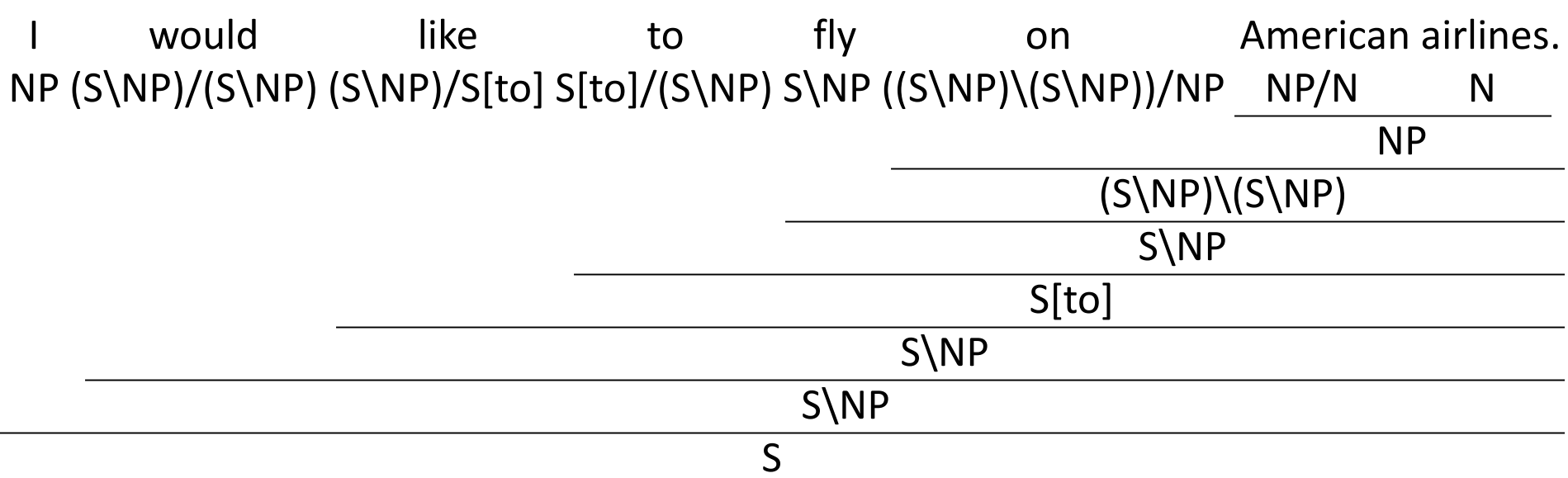
- Give the derivation of the sentence “I prefer a morning flight”



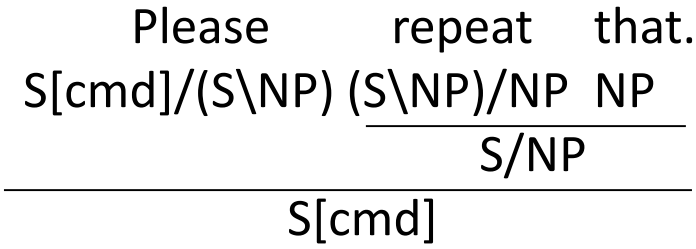
A3-a.


Does American airlines have a flight between five a.m. and six a.m.?
S[wq]/S
NP/N N
NP
(S\NP)/NP
NP/N N
NP
(NP\NP)/NP
NP/N N
NP
conj
NP/N N
NP
NP
NP\NP
NP
S\NP
S
S[wq]

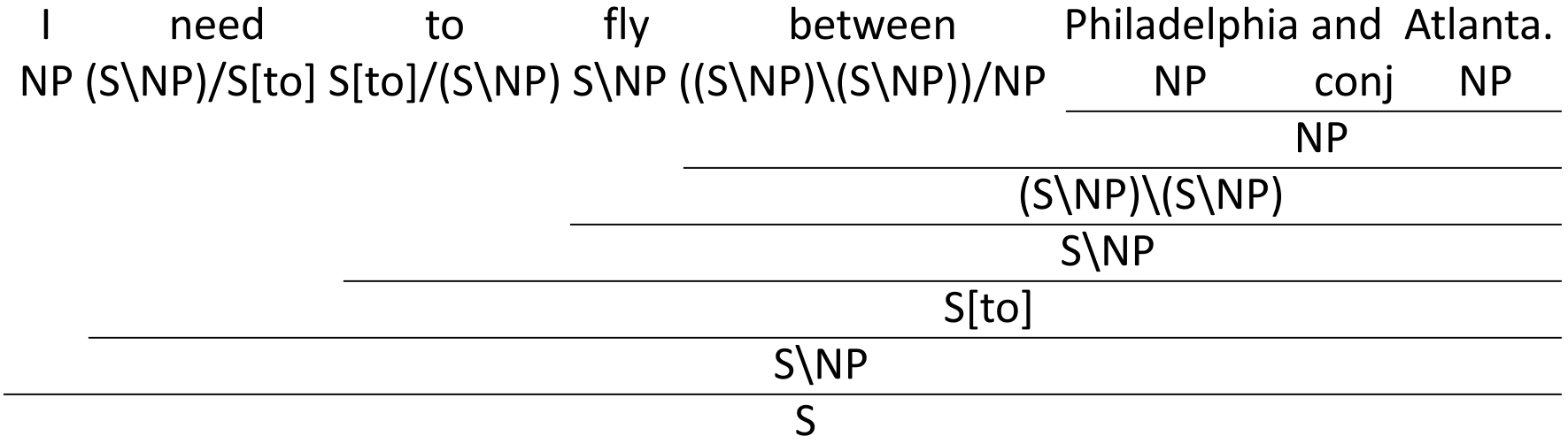
A3-b.


I would like to fly on American airlines.
NP (S\NP)/(S\NP) (S\NP)/S[to] S[to]/(S\NP) S\NP ((S\NP)\(S\NP))/NP NP/N N
NP
(S\NP)\(S\NP)
S\NP
S[to]
S\NP
S\NP
S

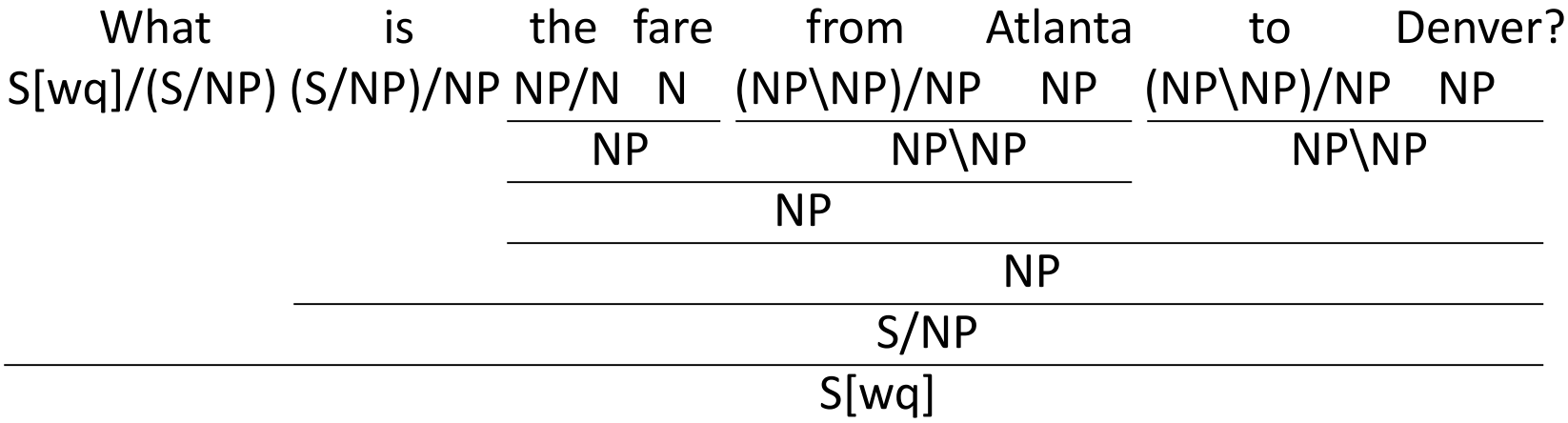
A3-c.



A3-d.


I need to fly between Philadelphia and Atlanta.
NP (S\NP)/S[to] S[to]/(S\NP) S\NP ((S\NP)\(S\NP))/NP NP conj NP
NP
(S\NP)\(S\NP)
S\NP
S[to]
S\NP
S

A3-e.


What is the fare from Atlanta to Denver?
S[wq]/(S/NP) (S/NP)/NP NP/N N (NP\NP)/NP NP (NP\NP)/NP NP
NP
NP\NP
NP\NP
NP
NP
S/NP
S[wq]