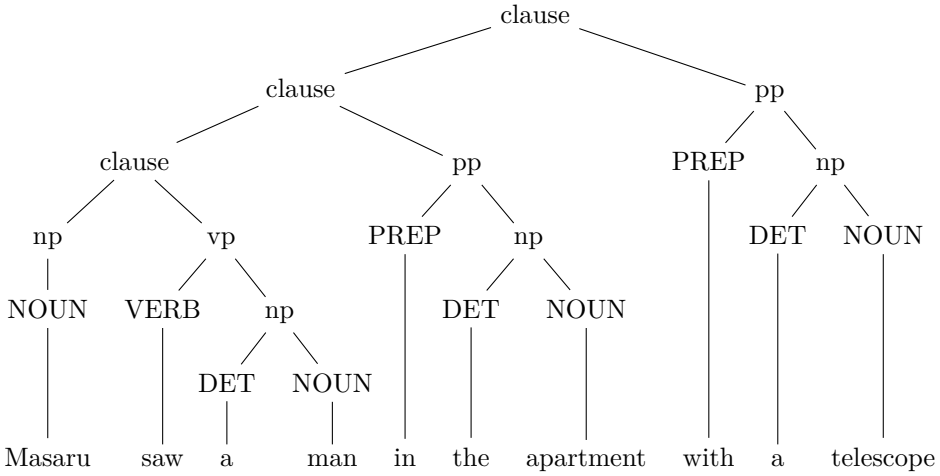
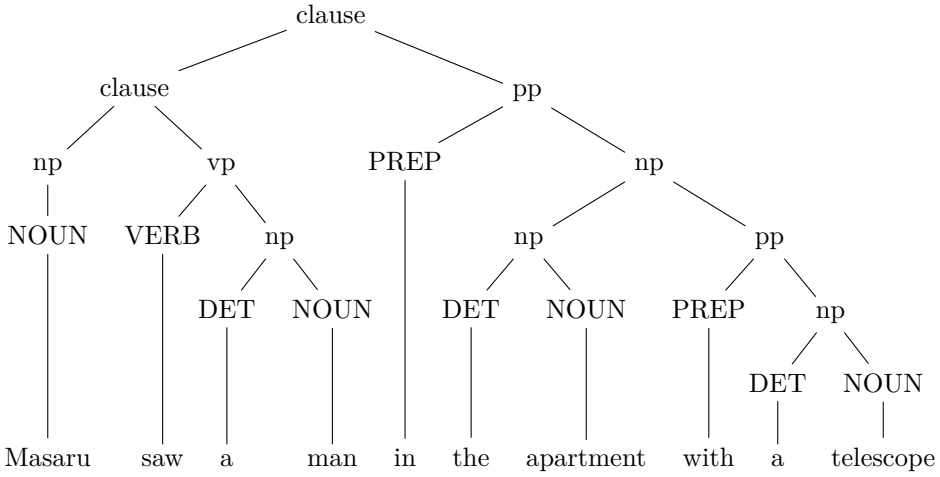
MAU11602 Assignment 1
Due 2026-02-05
Solutions

1. In lecture we considered the simplified grammar

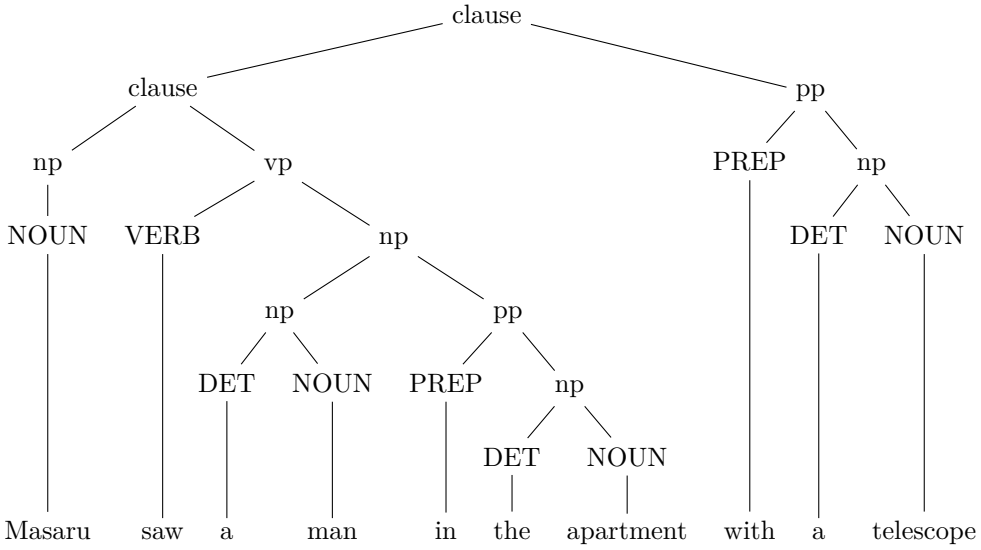
```
clause ::= np vp | clause pp
np     ::= NOUN | DET NOUN | np pp
pp     ::= PREP np
vp     ::= VERB np
```

for English and found three different ways to parse the sentence "Masaru saw a man in the apartment with a telescope":



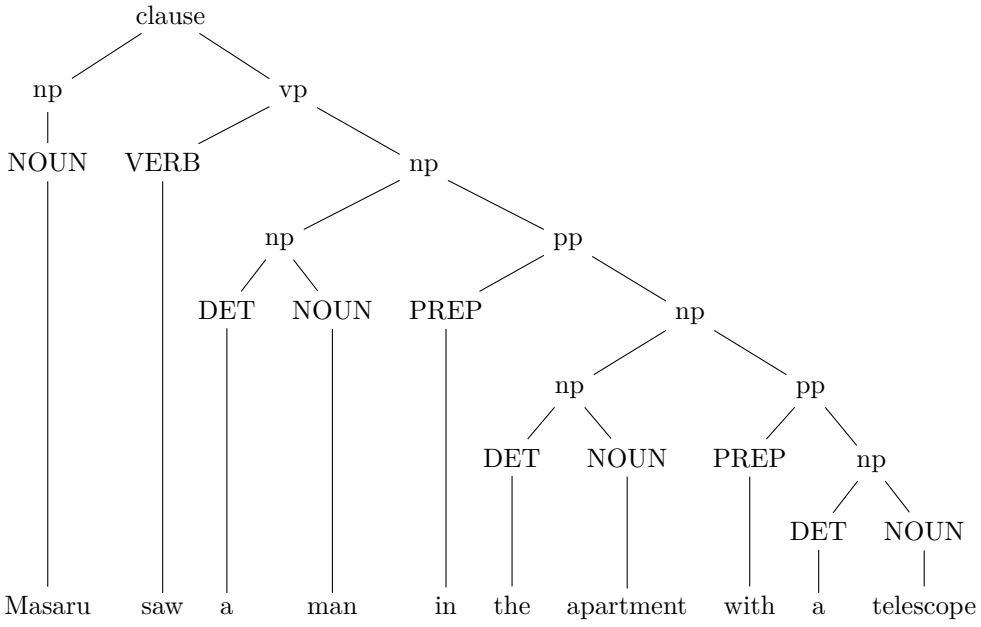


and

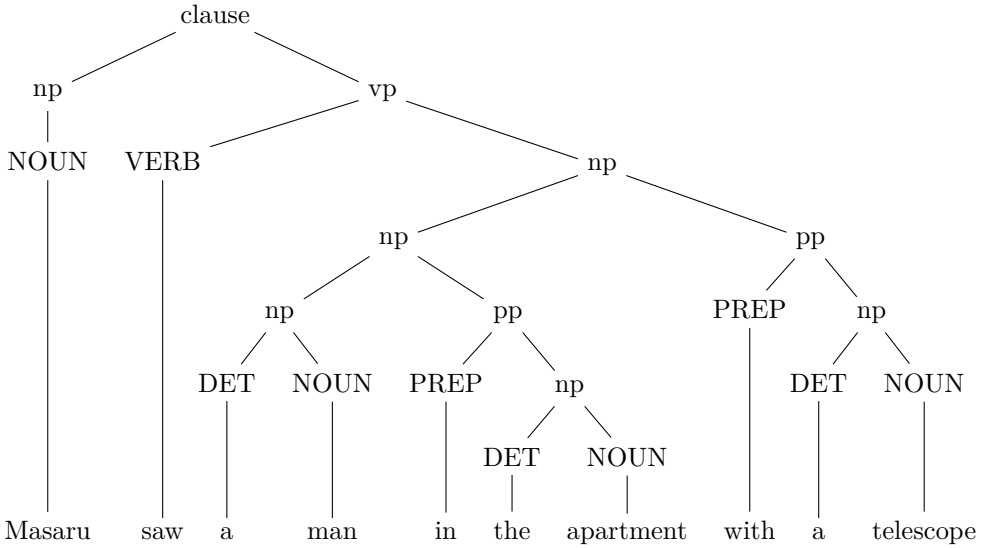


Find two more ways to parse it.

Solution:



and



2. Show that the expression `if 1 < 2 orelse 3 > 4 then 7 + 8 else 9 * 10` in the infix version of our grammar has type `int`.

   The relevant typing rules for this language are

$$\frac{\vdash e_0 : \texttt{bool} \qquad \vdash e_1 : \tau \qquad \vdash e_2 : \tau}{\vdash \texttt{if}\ e_0\ \texttt{then}\ e_1\ \texttt{else}\ e_2 : \tau}$$

$$\frac{\vdash e_1 : \texttt{int} \qquad \vdash e_2 : \texttt{int}}{\vdash e_1\ \texttt{<}\ e_2 : \texttt{bool}}$$

$$\frac{\vdash e_1 : \texttt{bool} \qquad \vdash e_2 : \texttt{bool}}{\vdash e_1\ \texttt{orelse}\ e_2 : \texttt{bool}}$$

$$\frac{\vdash e_1 : \texttt{int} \qquad \vdash e_2 : \texttt{int}}{\vdash e_1\ \texttt{>}\ e_2 : \texttt{bool}}$$

$$\frac{\vdash e_1 : \texttt{int} \qquad \vdash e_2 : \texttt{int}}{\vdash e_1\ \texttt{+}\ e_2 : \texttt{int}}$$

$$\frac{\vdash e_1 : \texttt{int} \qquad \vdash e_2 : \texttt{int}}{\vdash e_1\ \texttt{*}\ e_2 : \texttt{int}}$$

Solution:

Breaking the diagram into two parts so it fits on the page,

$$\dfrac{\dfrac{\vdash \texttt{1}\colon \texttt{int} \quad \vdash \texttt{2}\colon \texttt{int}}{\vdash \texttt{1 < 2}\colon \texttt{bool}} \quad \dfrac{\vdash \texttt{3}\colon \texttt{int} \quad \vdash \texttt{4}\colon \texttt{int}}{\vdash \texttt{3 > 4}\colon \texttt{bool}}}{\vdash \texttt{1 < 2 orelse 3 > 4}\colon \texttt{bool}}$$

$$\dfrac{\vdash \texttt{1 < 2 orelse 3 > 4}\colon \texttt{bool} \qquad \dfrac{\vdash \texttt{7}\colon \texttt{int} \quad \vdash \texttt{8}\colon \texttt{int}}{\vdash \texttt{7 + 8}\colon \texttt{int}} \qquad \dfrac{\vdash \texttt{9}\colon \texttt{int} \quad \vdash \texttt{10}\colon \texttt{int}}{\vdash \texttt{9 * 10}\colon \texttt{int}}}{\vdash \texttt{if 1 < 2 orelse 3 > 4 then 7 + 8 else 9 * 10}\colon \texttt{int}}$$

3. Show all steps in evaluating `if 1 < 2 orelse 3 > 4 then 7 + 8 else 9 * 10`. Be careful not to show steps which don't happen.

   Solution:

   ```
   if 1 < 2 orelse 3 > 4 then 7 + 8 else 9 * 10
   if true orelse 3 > 4 then 7 + 8 else 9 * 10
   if true then 7 + 8 else 9 * 10
   7 + 8
   15
   ```

   Note that `3 > 4` and `9 * 10` don't get evaluated.