# Workshop Week 4

Christian Nassif-Haynes

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1. The starting symbol of the below grammar is *Expr*. Perl-style regular expressions are used to describe some terminals and are enclosed in forward slashes.

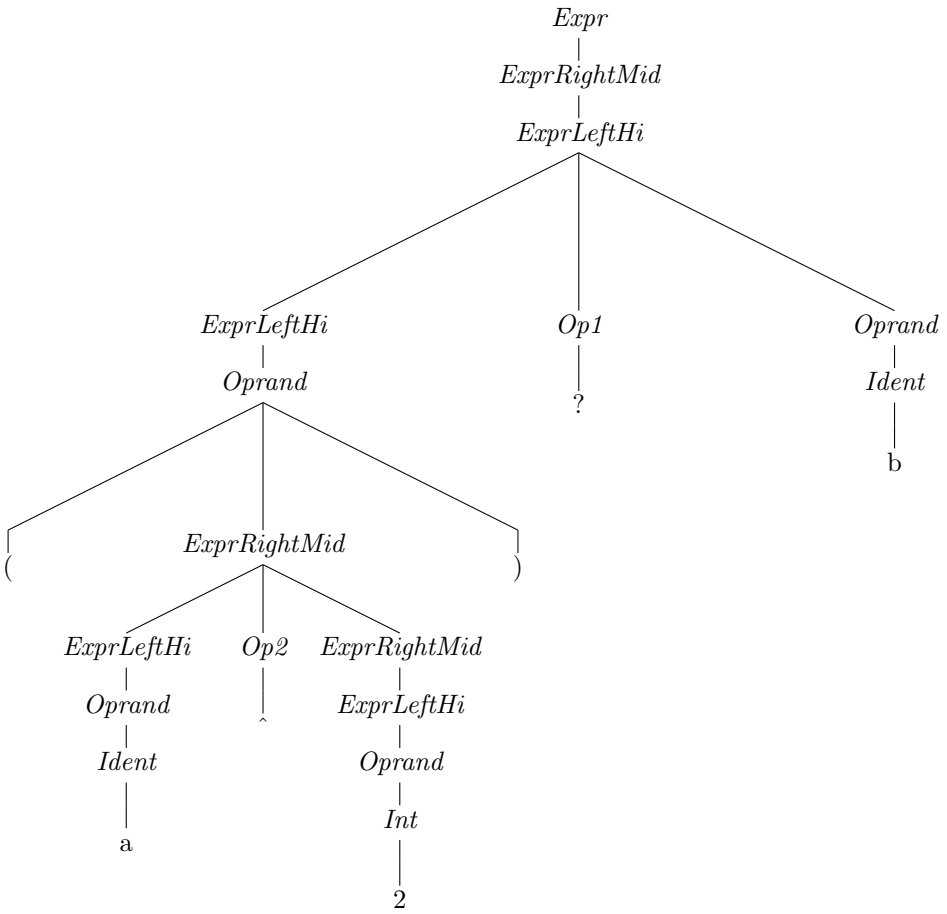
$$\begin{aligned}
Expr &\rightarrow ExprRightMid \mid ExprRightMid\ Op3\ ExprRightMid && (1)\\
ExprRightMid &\rightarrow ExprLeftHi \mid ExprLeftHi\ Op2\ ExprRightMid && (2)\\
ExprLeftHi &\rightarrow Oprand \mid ExprLeftHi\ Op1\ Oprand && (3)\\
Oprand &\rightarrow Int \mid Ident \mid \texttt{(}\ ExprRightMid\ \texttt{)} && (4)\\
Op1 &\rightarrow \texttt{?} && (5)\\
Op2 &\rightarrow \texttt{!} \mid \texttt{\^{}} && (6)\\
Op3 &\rightarrow \texttt{@} && (7)\\
Int &\rightarrow /\texttt{[0-9]+}/ && (8)\\
Ident &\rightarrow /\texttt{[a-zA-Z]+}/ && (9)
\end{aligned}$$

2. The left recursive productions are used to allow for left associativity.

3. The derivation of `(a ^ 2) ? b` is as follows:

$$\begin{aligned}
Expr &\rightarrow ExprRightMid && \text{Rule 1}\\
&\rightarrow ExprLeftHi && \text{Rule 2}\\
&\rightarrow ExprLeftHi\ Op1\ Oprand && \text{Rule 3}\\
&\rightarrow Oprand\ Op1\ Oprand && \text{Rule 3}\\
&\rightarrow \texttt{(}\ ExprRightMid\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 4}\\
&\rightarrow \texttt{(}\ ExprLeftHi\ Op2\ ExprRightMid\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 2}\\
&\rightarrow \texttt{(}\ Oprand\ Op2\ ExprRightMid\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 3}\\
&\rightarrow \texttt{(}\ Ident\ Op2\ ExprRightMid\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 4}\\
&\rightarrow \texttt{(}\ \texttt{a}\ Op2\ ExprRightMid\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 9}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ ExprRightMid\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 6}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ ExprLeftHi\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 2}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ Oprand\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 3}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ Int\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 4}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ 2\ \texttt{)}\ \ Op1\ Oprand && \text{Rule 8}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ 2\ \texttt{)}\ \texttt{?}\ Oprand && \text{Rule 5}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ 2\ \texttt{)}\ \texttt{?}\ Ident && \text{Rule 4}\\
&\rightarrow \texttt{(}\ \texttt{a}\ \texttt{\^{}}\ 2\ \texttt{)}\ \texttt{?}\ \texttt{b} && \text{Rule 9}
\end{aligned}$$

4.


Expr
ExprRightMid
ExprLeftHi
ExprLeftHi
Op1
Oprand
Oprand
Ident
?
b
(
ExprRightMid
)
ExprLeftHi
Op2
ExprRightMid
Oprand
^
ExprLeftHi
Ident
Oprand
a
Int
2