Parsing and Semantic Actions
Interlude: Ambiguous Grammars

Grammar: $S \rightarrow S + S \mid \text{<int>}$
String: $1+2+3$
Two possible parse trees:

Disambiguated: $S \rightarrow S + \text{<int>} \mid \text{<int>}$
Grammar of Roman Numerals

\[ S \rightarrow xTU \mid IX \mid X \]
\[ T \rightarrow c \mid l \]
\[ X_1 \rightarrow xX_2 \mid U \]
\[ U \rightarrow iY \mid vI \mid l \]
\[ Y \rightarrow x \mid v \]
\[ l_1 \rightarrow il_2 \mid \epsilon \]

- Is the grammar ambiguous? Why not?
- Give a leftmost derivation of \textit{xlii}
  - Always expand leftmost non-terminal
- Draw a parse tree
- Write semantic actions to evaluate the value
  - Start by assigning values to the terminals
- Show an evaluation trace
LL(1) Parsers
Is this grammar LL(1)?

- LL(1) parsers pick a production based on the next terminal
- No:
  - If we’re expanding $S$ and see a 1, multiple productions match
  - $A$ is left-recursive. If we expand the second production, we end up in the same state. Infinite loop!

Make it LL(1)

- First problem is solved with left-factoring
- Second problem is solved with left-recursion elimination
Now that we think we have an LL(1) grammar, we move on to the next question:

- Write the *First* and *Follow* sets
  - *Follow* Tip: Make a column of $\subseteq$ relations
- Construct the LL(1) parsing table
- Show all the steps to parse: 1 1 0 2 0 3 0 1 0 3 3
We’re done!

Any questions?

Good luck with the assignment.