**FIRST and FOLLOW (Needed for building a parse table)**

These notes were collected by Sam J. Frazier based on the two sources listed below. The notes were edited by Carol Zander.


**Informal Definition**

For the non-terminal $X$, $\text{FIRST}(X)$ is the set of terminals in a grammar that begin any string that $X$ can generate. In other words, if you use $X$ to generate a string, what terminals start the string.

For the non-terminal $X$, $\text{FOLLOW}(X)$ is the set of terminals that may appear after $X$ in the grammar. In other words, when generating a string, what terminals could follow $X$.

**Formal Definition**

$$ \text{FIRST}(\alpha) = \{ x | \alpha \Rightarrow^* x \beta \} \text{ where } x \text{ is a terminal and } \alpha, \beta \text{ are any strings of grammar symbols} $$

$$ \text{FOLLOW}(A) = \{ x | S \Rightarrow aA\beta \} \text{ where } x \in \text{FIRST}(\beta) \text{ (A is in the middle of a rule)} $$

and $$ \{ x | B \Rightarrow aA \} \text{ such that } x \in \text{FOLLOW}(B) \text{ (A is at the end of a rule)} $$

When $A$ is in the middle of a rule, it is fairly clear that what follows $A$ is what is the first thing of $\beta$. For the second part, when $A$ is at the end of a rule, here is an example:

B $\Rightarrow$ ... A
X $\Rightarrow$ ... BC  Using the first rule and plugging in for B, puts the A just before the C.
Y $\Rightarrow$ ... Bd  Ditto, puts the A just before the d. Both the C and d follow B.

**Example**

Consider this grammar, $G$:

0. $S' \Rightarrow SS$
1. $S \Rightarrow aSbS$
2. $S \Rightarrow a$

Our $\text{FIRST}$ and $\text{FOLLOW}$ statements are:

$$ \text{FIRST}(S) = \{ a \} $$

$$ \text{FOLLOW}(S) = \{ b, \$ \} $$