



Compilers

First Sets

- Consider non-terminal A , production $A \rightarrow \alpha$, & token t

- $T[A, t] = \alpha$ in two cases:

- If $\alpha \xrightarrow{*} t \beta$
 - α can derive a t in the first position
 - We say that $t \in \text{First}(\alpha)$

$$\left[\begin{array}{l} \alpha \not\xrightarrow{*} t \\ t \notin \text{First}(\alpha) \\ \alpha \xrightarrow{*} \epsilon \end{array} \right]$$

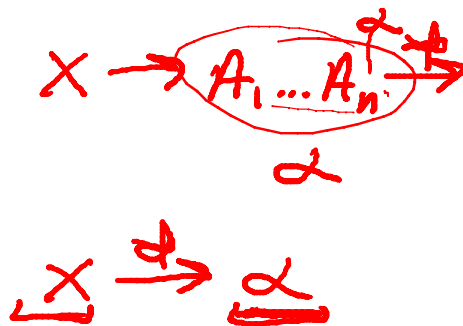
- If $A \rightarrow \alpha$ and $\alpha \xrightarrow{*} \epsilon$ and $S \xrightarrow{*} \beta A t \delta$
 - Useful if stack has A , input is t , and A cannot derive t
 - In this case only option is to get rid of A (by deriving ϵ)
 - Can work only if t can follow A in at least one derivation
 - We say $t \in \text{Follow}(A)$

Definition

$$\text{First}(\underline{X}) = \{ \underline{t} \mid X \xrightarrow{*} \underline{t} \alpha \} \cup \{ \varepsilon \mid X \xrightarrow{*} \varepsilon \}$$

Algorithm sketch:

1. $\text{First}(\underline{t}) = \{ \underline{t} \}$ t is a terminal
2. $\varepsilon \in \text{First}(\underline{X})$
 - if $X \rightarrow \varepsilon$
 - if $X \rightarrow A_1 \dots A_n$ and $\varepsilon \in \text{First}(A_i)$ for $1 \leq i \leq n$
3. $\text{First}(\alpha) \subseteq \text{First}(X)$ if $X \rightarrow A_1 \dots A_n \alpha$
 - and $\varepsilon \in \text{First}(A_i)$ for $1 \leq i \leq n$



- Recall the grammar

$$\underline{E} \rightarrow \underline{T} \underline{X}$$

$$T \rightarrow (\underline{E}) \mid \underline{\text{int}} Y$$

$$\begin{aligned} \text{First}(+) &= \{+\} \\ \text{First}(\ast) &= \{\ast\} \\ &\vdots \\ &\{(\} \\ &\{)\} \\ &\{\text{int}\} \end{aligned}$$

$$X \rightarrow \pm E \mid \underline{\epsilon}$$

$$Y \rightarrow \ast T \mid \underline{\epsilon}$$

$$\begin{aligned} \text{First}(E) &\equiv \text{First}(T) \\ \text{First}(T) &= \{(\, , \text{int}\} \\ \text{First}(X) &= \{+, \epsilon\} \\ \text{First}(Y) &= \{\ast, \epsilon\} \end{aligned}$$