

Example of computing a *CLOSURE*
of a set of items

Question

$$\begin{array}{lcl} \underline{s} & \rightarrow & \underline{e} \\ \\ \underline{e} & \rightarrow & \underline{e} + \underline{v} \\ & / & \underline{v} \\ \\ \underline{v} & \rightarrow & x \\ & / & y \end{array}$$

What is $CLOSURE(\{\underline{s} \rightarrow \cdot \underline{e}\})$?

First iteration

$$\underline{s} \rightarrow \underline{e}$$

$$\underline{e} \rightarrow \underline{e} + \underline{v}$$
$$/ \quad \underline{v}$$

$$\underline{v} \rightarrow x$$
$$/ \quad y$$

$$\begin{aligned} CLOSURE(\{\underline{s} \rightarrow \cdot \underline{e}\}) \\ = \{ \quad \underline{s} \rightarrow \cdot \underline{e} \quad \} \end{aligned}$$

Second iteration

$$\underline{s} \rightarrow \underline{e}$$

$$\underline{e} \rightarrow \underline{e} + \underline{v}$$

$$\underline{e} \rightarrow \underline{v}$$

$$\underline{v} \rightarrow x$$

$$\underline{v} \rightarrow y$$

$CLOSURE(\{\underline{s} \rightarrow \cdot \underline{e}\})$

$$= \{ \begin{array}{l} \boxed{\underline{s} \rightarrow \cdot \underline{e}} \\ , \quad \underline{e} \rightarrow \cdot \underline{e} + \underline{v} \\ \} \end{array}$$

Second iteration

$$\underline{s} \rightarrow \underline{e}$$

$$\underline{e} \rightarrow \underline{e} + \underline{v}$$

$$\underline{e} \rightarrow \underline{v}$$

$$\underline{v} \rightarrow x$$

$$\underline{v} \rightarrow y$$

$CLOSURE(\{\underline{s} \rightarrow \cdot \underline{e}\})$

$$= \{ \begin{array}{l} \boxed{\underline{s} \rightarrow \cdot \underline{e}} \\ , \quad \underline{e} \rightarrow \cdot \underline{e} + \underline{v} \\ , \quad \underline{e} \rightarrow \cdot \underline{v} \\ \} \end{array}$$

Third iteration

$$\underline{s} \rightarrow \underline{e}$$

$$\underline{e} \rightarrow \underline{e} + \underline{v}$$

$$\underline{e} \rightarrow \underline{v}$$

$$\underline{v} \rightarrow x$$

$$\underline{v} \rightarrow y$$

$$CLOSURE(\{\underline{s} \rightarrow \cdot \underline{e}\})$$

$$\begin{aligned} &= \{ \quad \underline{s} \rightarrow \cdot \underline{e} \\ &\quad , \quad \underline{e} \rightarrow \cdot \underline{e} + \underline{v} \\ &\quad , \quad \boxed{\underline{e} \rightarrow \cdot \underline{v}} \\ &\quad , \quad \underline{v} \rightarrow \cdot x \\ &\quad \} \end{aligned}$$

Third iteration

$$\underline{s} \rightarrow \underline{e}$$

$$\underline{e} \rightarrow \underline{e} + \underline{v}$$

$$\underline{e} \rightarrow \underline{v}$$

$$\underline{v} \rightarrow x$$

$$\underline{v} \rightarrow y$$

$$CLOSURE(\{\underline{s} \rightarrow \cdot \underline{e}\})$$

$$\begin{aligned} &= \{ \quad \underline{s} \rightarrow \cdot \underline{e} \\ &\quad , \quad \underline{e} \rightarrow \cdot \underline{e} + \underline{v} \\ &\quad , \quad \boxed{\underline{e} \rightarrow \cdot \underline{v}} \\ &\quad , \quad \underline{v} \rightarrow \cdot x \\ &\quad , \quad \underline{v} \rightarrow \cdot y \\ &\} \end{aligned}$$

Final result

\underline{s}	\rightarrow	\underline{e}
\underline{e}	\rightarrow	$\underline{e} + \underline{v}$
\underline{e}	\rightarrow	\underline{v}
\underline{v}	\rightarrow	x
\underline{v}	\rightarrow	y

$$\begin{aligned} & CLOSURE(\{\underline{s} \rightarrow \cdot \underline{e}\}) \\ = & \{ \quad \underline{s} \rightarrow \cdot \underline{e} \\ & , \quad \underline{e} \rightarrow \cdot \underline{e} + \underline{v} \\ & , \quad \underline{e} \rightarrow \cdot \underline{v} \\ & , \quad \underline{v} \rightarrow \cdot x \\ & , \quad \underline{v} \rightarrow \cdot y \\ & \} \end{aligned}$$