

## Earley States

- Let  $X$  be a non-terminal
- Let  $a$  and  $b$  be (possibly-empty) sequences of terminals and non-terminals
- Let  $X \rightarrow ab$  be a production in your grammar
- Let  $j$  be a position in the input
- Each **Earley State** is a tuple  $\langle X \rightarrow a \cdot b, j \rangle$ 
  - We are currently parsing an  $X$
  - We have seen  $a$ , we expect to see  $b$
  - We started parsing this  $X$  after seeing the first  $j$  tokens from the input.

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## Formal shift operation

- Whenever
  - chart[ $i$ ] contains  $\langle X \rightarrow ab \cdot cd, j \rangle$
  - $c$  is a terminal (*not* a non-terminal)
  - the  $(i+1)^{\text{th}}$  input token is  $c$
- The **shift** operation
  - Adds  $\langle X \rightarrow abc \cdot d, j \rangle$  to chart[ $i+1$ ]

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## Formal closure operation

- Whenever
  - chart[ $i$ ] contains  $\langle X \rightarrow ab \cdot cd, j \rangle$
  - $c$  is a non-terminal
  - The grammar contains  $\langle c \rightarrow pqr \rangle$
- The **closure** operation
  - Adds  $\langle c \rightarrow \cdot pqr, i \rangle$  to chart[ $i$ ]
- Note  $\langle c \rightarrow \cdot pqr, \underline{i} \rangle$  because “we started parsing this  $c$  after seeing the first  $i$  tokens from the input.”

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## Formal reduce operation

- Whenever
  - chart[ $i$ ] contains  $\langle X \rightarrow ab \cdot, j \rangle$   
(The dot must be all the way to the right!)
  - chart[ $j$ ] contains  $\langle Y \rightarrow q \cdot Xr, k \rangle$
- The **reduce** operation
  - Adds  $\langle Y \rightarrow qX \cdot r, k \rangle$  to chart[ $i$ ]
- Note  $\langle Y \rightarrow qX \cdot r, \underline{k} \rangle$  because “we started parsing this  $Y$  after seeing the first  $k$  tokens from the input.”

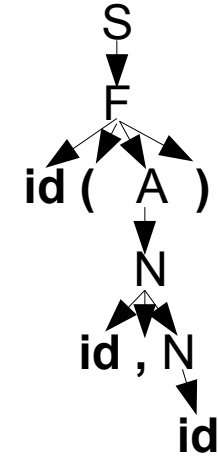
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# Massive Earley Example

## Grammar

$S \rightarrow F$   
 $F \rightarrow id ( A )$   
 $A \rightarrow N$   
 $A \rightarrow \epsilon$   
 $N \rightarrow id$   
 $N \rightarrow id , N$

Input  
 $id ( id , id )$



	id	(	id	,	id	)	
chart[0]	chart[1]	chart[2]	chart[3]	chart[4]	chart[5]	chart[6]	
$S \rightarrow \bullet F , 0$							