# SCFG

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April 13, 2015

# Content

# Context-free grammars

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- $\Sigma$ terminal vocabulary

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# Context-free grammars

$G = \langle \Sigma, N, S, R \rangle$

- $\Sigma$ terminal vocabulary
- $N$ nonterminal vocabulary
- $S \in N$ start symbol
- $R \subseteq \{A \to \alpha : A \in V, \alpha \in (\Sigma \cup V)^+\}$ set of rules

# CFG - example

Grammar

1. $X \rightarrow$ a
2. $X \rightarrow$ luz
3. $X \rightarrow$ apague $X$
4. $X \rightarrow X$ por favor
5. $X \rightarrow XX$
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Discrete set

- infinite set of strings and trees

# Parsing a sentence

Input

- sentence

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Forest (analyses)

- subset of trees whose yield is the given sentence

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CKY

- bottom-up dynamic program

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|---|---|---|---|---|---|
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| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
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| 5 | | | $S_{0,5} \xrightarrow{6} X_{0,5}$ | | |

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- the forest is itself a CFG

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- nonterminals are annotated with input spans

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- the forest is itself a CFG
- nonterminals are annotated with input spans
- $O(n^2)$ specialised nonterminals
- $O(n^3)$ specialised rules

# Hypergraph

A graphical representation for the forest

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- (hyper)nodes represent (labelled) input spans

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A graphical representation for the forest

- (hyper)nodes represent (labelled) input spans
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  - tail nodes: rule's $\mathrm{RHS}$
  - head node: rule's $\mathrm{LHS}$

# Analyses

Top-down traversals that rewrite every nonterminal

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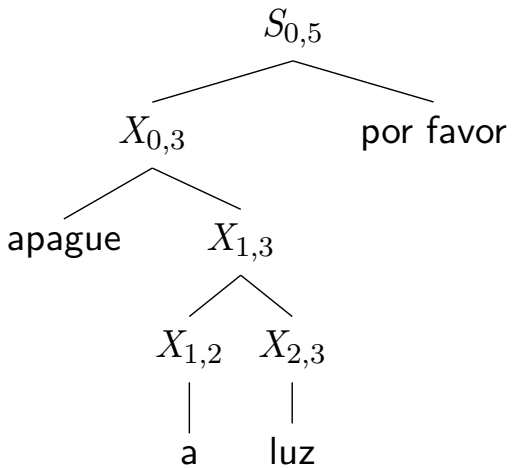

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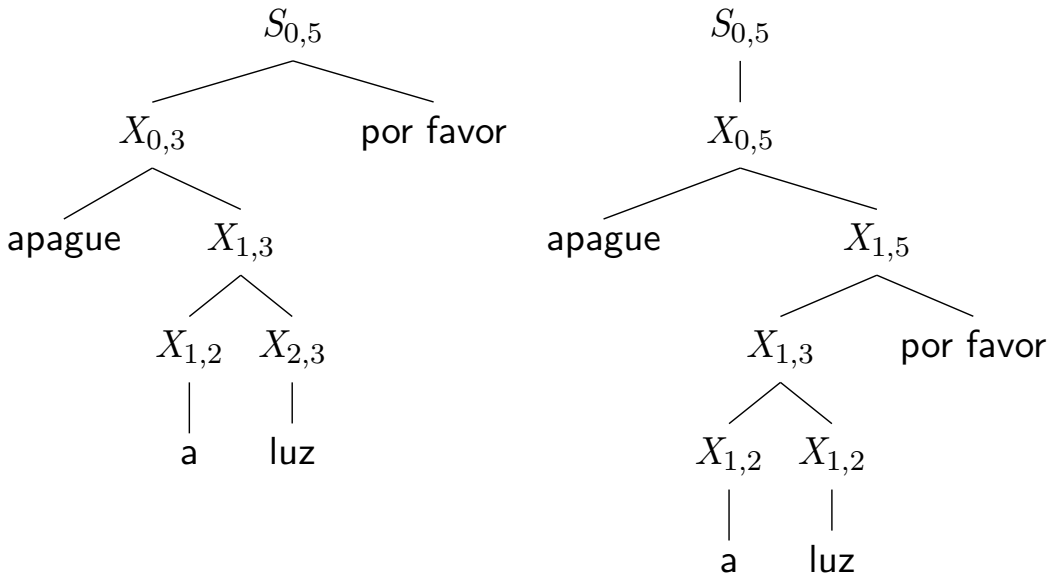
Top-down traversals that rewrite every nonterminal



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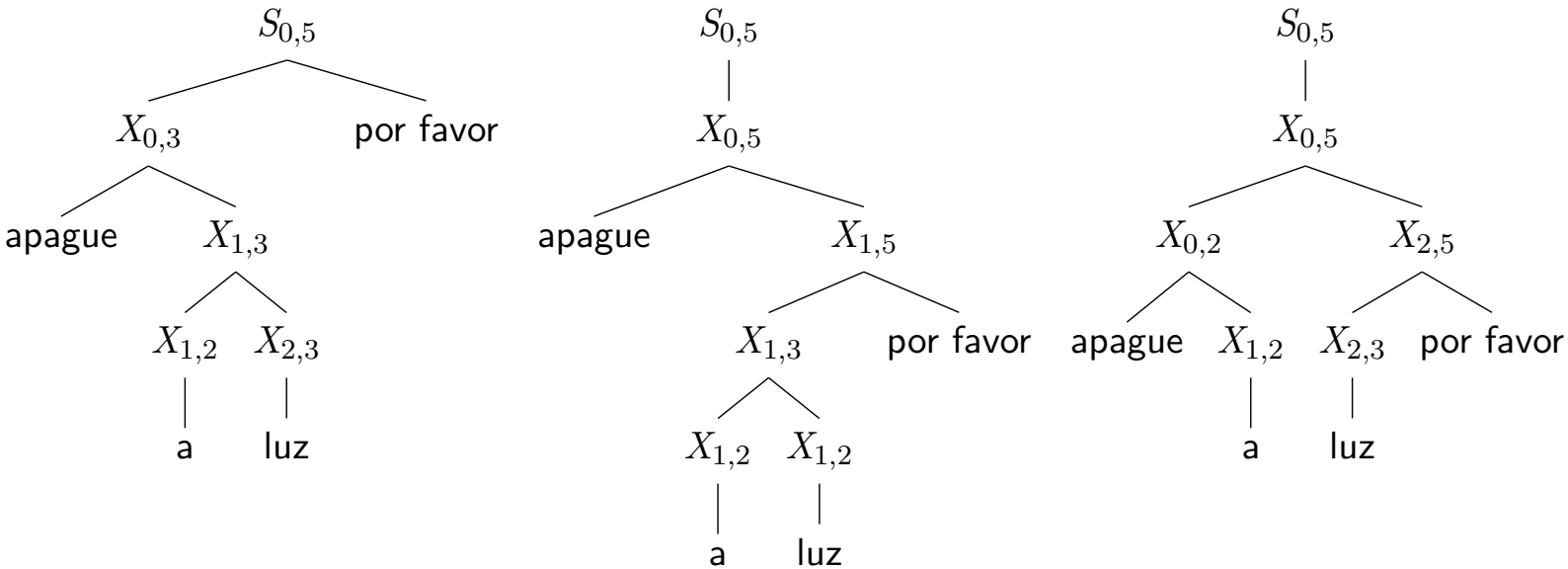
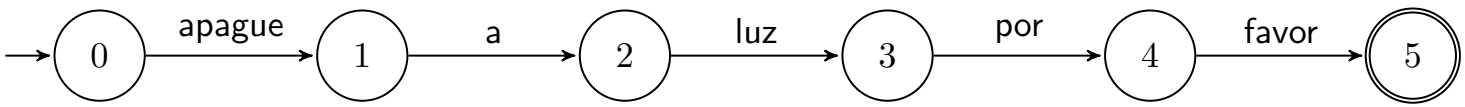


# Parsing as intersection

Input

- linear-chain finite-state automaton




Output

- subset of parse trees yielding valid input strings

# Finite-state automata

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- $E \subseteq Q \times \Sigma \times Q$ is a set of labelled transitions

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$G = \langle \Sigma, Q, I, F, E \rangle$

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- $Q$ set of states
- $I \subseteq Q$ set of initial states
- $F \subseteq Q$ set of final states
- $E \subseteq Q \times \Sigma \times Q$ is a set of labelled transitions
- $\langle q, x, s \rangle \in E$ where $q \in Q$, $s \in Q$ and $x \in \Sigma$ is a transition from $q$ to $s$ which recognises $x$

# Deductive proof system

A proof starts from its AXIOMS

$$\frac{}{[\text{AXIOM}]} \quad \text{predicate}$$

where $[\text{AXIOM}]$ is an item

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and it follows by **exhaustive** deduction of new items

$$\frac{[\alpha_1]\,[\alpha_2]\ldots[\alpha_n]}{[\alpha_{n+1}]} \quad \text{predicate}$$

- antecedents
- consequent
- conditions

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- antecedents
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the proof is valid if a **goal item** is provable

# Bottom-up parsing

AXIOMS

$$\frac{}{[X \to \bullet\alpha, q, q]} \quad q \in Q \wedge X \to \alpha \in R$$

GOAL

$$[S \to \alpha\bullet, q, r] \quad q \in I \wedge r \in F$$

SCAN

$$\frac{[X \to \alpha \bullet x\beta, q, s]}{[X \to \alpha x \bullet \beta]} \quad \langle s, x, r\rangle \in E$$

COMPLETE

$$\frac{[X \to \alpha \bullet Y\beta, q, s]\,[Y \to \gamma\bullet, s, r]}{[X \to \alpha\, Y_{s,r} \bullet \beta, q, r]}$$

- self-contained "algorithm"
- template for a hypergraph

# Axioms

❶ $[X \rightarrow \bullet \mathsf{a}, 1, 1]$

# Axioms

❶ $[X \rightarrow \bullet \mathsf{a}, 1, 1]$

❷ $[X \rightarrow \bullet \mathsf{luz}, 2, 2]$

# Axioms

1. $[X \rightarrow \bullet \mathsf{a}, 1, 1]$
2. $[X \rightarrow \bullet \mathsf{luz}, 2, 2]$
3. $[X \rightarrow \bullet \mathsf{apague}\ X, 0, 0]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$
5. $[X \to \bullet X \text{ por favor}, 1, 1]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$
5. $[X \to \bullet X \text{ por favor}, 1, 1]$
6. $[X \to \bullet X \text{ por favor}, 2, 2]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$
5. $[X \to \bullet X \text{ por favor}, 1, 1]$
6. $[X \to \bullet X \text{ por favor}, 2, 2]$
7. $[X \to \bullet XX, 0, 0]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$
5. $[X \to \bullet X \text{ por favor}, 1, 1]$
6. $[X \to \bullet X \text{ por favor}, 2, 2]$
7. $[X \to \bullet XX, 0, 0]$
8. $[X \to \bullet XX, 1, 1]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$
5. $[X \to \bullet X \text{ por favor}, 1, 1]$
6. $[X \to \bullet X \text{ por favor}, 2, 2]$
7. $[X \to \bullet XX, 0, 0]$
8. $[X \to \bullet XX, 1, 1]$
9. $[X \to \bullet XX, 2, 2]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$
5. $[X \to \bullet X \text{ por favor}, 1, 1]$
6. $[X \to \bullet X \text{ por favor}, 2, 2]$
7. $[X \to \bullet XX, 0, 0]$
8. $[X \to \bullet XX, 1, 1]$
9. $[X \to \bullet XX, 2, 2]$
10. $[X \to \bullet XX, 3, 3]$

# Axioms

1. $[X \to \bullet \text{a}, 1, 1]$
2. $[X \to \bullet \text{luz}, 2, 2]$
3. $[X \to \bullet \text{apague } X, 0, 0]$
4. $[X \to \bullet X \text{ por favor}, 0, 0]$
5. $[X \to \bullet X \text{ por favor}, 1, 1]$
6. $[X \to \bullet X \text{ por favor}, 2, 2]$
7. $[X \to \bullet XX, 0, 0]$
8. $[X \to \bullet XX, 1, 1]$
9. $[X \to \bullet XX, 2, 2]$
10. $[X \to \bullet XX, 3, 3]$
11. $[S \to \bullet X, 0, 0]$

# Inference

1. $[X \rightarrow \bullet \text{a}, 1, 1] \leftarrow$
2. $[X \rightarrow \bullet \text{luz}, 2, 2]$
3. $[X \rightarrow \bullet \text{apague} X, 0, 0]$
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$
6. $[X \rightarrow \bullet XX, 0, 0]$
7. $[X \rightarrow \bullet XX, 1, 1]$
8. $[X \rightarrow \bullet XX, 2, 2]$
9. $[X \rightarrow \bullet XX, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \bullet\text{luz}, 2, 2]\leftarrow$
3. $[X \rightarrow \bullet\text{apague}X, 0, 0]$
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$
6. $[X \rightarrow \bullet XX, 0, 0]$
7. $[X \rightarrow \bullet XX, 1, 1]$
8. $[X \rightarrow \bullet XX, 2, 2]$
9. $[X \rightarrow \bullet XX, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \bullet\text{apague}X, 0, 0]\leftarrow$
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$
6. $[X \rightarrow \bullet XX, 0, 0]$
7. $[X \rightarrow \bullet XX, 1, 1]$
8. $[X \rightarrow \bullet XX, 2, 2]$
9. $[X \rightarrow \bullet XX, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1] \leftarrow$
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$
6. $[X \rightarrow \bullet XX, 0, 0]$
7. $[X \rightarrow \bullet XX, 1, 1]$
8. $[X \rightarrow \bullet XX, 2, 2]$
9. $[X \rightarrow \bullet XX, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1] \leftarrow$
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$
6. $[X \rightarrow \bullet XX, 0, 0]$
7. $[X \rightarrow \bullet XX, 1, 1]$
8. $[X \rightarrow \bullet XX, 2, 2]$
9. $[X \rightarrow \bullet XX, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2] \leftarrow$
6. $[X \rightarrow \bullet XX, 0, 0]$
7. $[X \rightarrow \bullet XX, 1, 1]$
8. $[X \rightarrow \bullet XX, 2, 2]$
9. $[X \rightarrow \bullet XX, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2] \leftarrow$
6. $[X \rightarrow \bullet XX, 0, 0]$
7. $[X \rightarrow \bullet XX, 1, 1]$
8. $[X \rightarrow \bullet XX, 2, 2]$
9. $[X \rightarrow \bullet XX, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0] \leftarrow$
7. $[X \rightarrow \bullet X X, 1, 1]$
8. $[X \rightarrow \bullet X X, 2, 2]$
9. $[X \rightarrow \bullet X X, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1] \leftarrow$
8. $[X \rightarrow \bullet X X, 2, 2]$
9. $[X \rightarrow \bullet X X, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1] \leftarrow$
8. $[X \rightarrow \bullet X X, 2, 2]$
9. $[X \rightarrow \bullet X X, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2] \leftarrow$
9. $[X \rightarrow \bullet X X, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2] \leftarrow$
9. $[X \rightarrow \bullet X X, 3, 3]$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ completed
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3] \leftarrow$
10. $[S \rightarrow \bullet X, 0, 0]$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ completed
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0] \leftarrow$
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ completed
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ completed
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2] \leftarrow$
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ completed
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ completed
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \rightarrow X_{2,3} \bullet \text{ por favor}, 2, 3]$ $\leftarrow$
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ completed
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ $\leftarrow$
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ $\leftarrow$
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ $\leftarrow$
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ completed
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ completed
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ $\leftarrow$
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ completed
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ $\leftarrow$
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ scanned
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ scanned
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ←

# Inference

1. $[X \to \text{a}\bullet, 1, 2]$ $\leftarrow$
2. $[X \to \text{luz}\bullet, 2, 3]$ scanned
3. $[X \to \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \to \bullet X X, 0, 0]$ waiting
7. $[X \to \bullet X X, 1, 1]$ waiting
8. $[X \to \bullet X X, 2, 2]$ waiting
9. $[X \to \bullet X X, 3, 3]$ waiting
10. $[S \to \bullet X, 0, 0]$ waiting
11. $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ $\times$
12. $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \to X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \to X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ←
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ scanned
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ ←
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ ←
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed

# Inference

1. $[X \to \text{a}\bullet, 1, 2]$ ✓
2. $[X \to \text{luz}\bullet, 2, 3]$ ✓
3. $[X \to \text{apague} \bullet X, 0, 1]$ ←
4. $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \to \bullet X X, 0, 0]$ waiting
7. $[X \to \bullet X X, 1, 1]$ waiting
8. $[X \to \bullet X X, 2, 2]$ waiting
9. $[X \to \bullet X X, 3, 3]$ waiting
10. $[S \to \bullet X, 0, 0]$ waiting
11. $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \to X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \to X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ ←
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2} \bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3} \bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5} \bullet, 0, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ ←
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2} \bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3} \bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5} \bullet, 0, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ ←
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]\leftarrow$
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2} \bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3} \bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5} \bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0] \leftarrow$
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0] \leftarrow$
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed
21. $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0] \leftarrow$
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2} \bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3} \bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5} \bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed
21. $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed
22. $[X \rightarrow X_{0,3} \bullet X, 0, 3]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ ←
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2} \bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3} \bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5} \bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed
21. $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed
22. $[X \rightarrow X_{0,3} \bullet X, 0, 3]$ completed

# Inference

1. $[X \to \text{a}\bullet, 1, 2]$ ✓
2. $[X \to \text{luz}\bullet, 2, 3]$ ✓
3. $[X \to \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \to \bullet X X, 0, 0]$ waiting
7. $[X \to \bullet X X, 1, 1]$ ←
8. $[X \to \bullet X X, 2, 2]$ waiting
9. $[X \to \bullet X X, 3, 3]$ waiting
10. $[S \to \bullet X, 0, 0]$ waiting
11. $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned
13. $[X \to X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \to X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ completed
19. $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ completed
20. $[X \to X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed
21. $[X \to X_{0,2} \bullet X, 0, 2]$ completed
22. $[X \to X_{0,3} \bullet X, 0, 3]$ completed
23. $[X \to X_{1,3} \bullet X, 1, 3]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2] \leftarrow$

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ completed

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ completed

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ completed

⓴ $[X \to X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3] \leftarrow$

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ completed

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ completed

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ completed

⓴ $[X \to X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0] \leftarrow$

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3} \bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5} \bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2} \bullet, 0, 2]$ completed

⓲ $[X \to \text{apague } X_{1,3} \bullet, 0, 3]$ completed

⓳ $[X \to \text{apague } X_{1,5} \bullet, 0, 5]$ completed

⓴ $[X \to X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

# Inference

❶ $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓

❷ $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \rightarrow \bullet X X, 0, 0]$ waiting

❼ $[X \rightarrow \bullet X X, 1, 1]$ waiting

❽ $[X \rightarrow \bullet X X, 2, 2]$ waiting

❾ $[X \rightarrow \bullet X X, 3, 3]$ waiting

❿ $[S \rightarrow \bullet X, 0, 0] \leftarrow$

⓫ $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ scanned

⓭ $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed

⓲ $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed

⓳ $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed

⓴ $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

㉑ $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \rightarrow X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \rightarrow X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \rightarrow X_{0,5}\bullet, 0, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ ←
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed
21. $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed
22. $[X \rightarrow X_{0,3} \bullet X, 0, 3]$ completed
23. $[X \rightarrow X_{1,3} \bullet X, 1, 3]$ completed
24. $[S \rightarrow X_{0,5}\bullet, 0, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ ←
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed
21. $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed
22. $[X \rightarrow X_{0,3} \bullet X, 0, 3]$ completed
23. $[X \rightarrow X_{1,3} \bullet X, 1, 3]$ completed
24. $[S \rightarrow X_{0,5}\bullet, 0, 5]$ completed

# Inference

1. $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓
2. $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓
3. $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \rightarrow \bullet X X, 0, 0]$ waiting
7. $[X \rightarrow \bullet X X, 1, 1]$ waiting
8. $[X \rightarrow \bullet X X, 2, 2]$ waiting
9. $[X \rightarrow \bullet X X, 3, 3]$ waiting
10. $[S \rightarrow \bullet X, 0, 0]$ waiting
11. $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓
13. $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ ←
15. $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ completed
18. $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed
19. $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed
20. $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed
21. $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed
22. $[X \rightarrow X_{0,3} \bullet X, 0, 3]$ completed
23. $[X \rightarrow X_{1,3} \bullet X, 1, 3]$ completed
24. $[S \rightarrow X_{0,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \rightarrow \text{a}\bullet, 1, 2]$ ✓

❷ $[X \rightarrow \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \rightarrow \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \rightarrow \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \rightarrow \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \rightarrow \bullet X X, 0, 0]$ waiting

❼ $[X \rightarrow \bullet X X, 1, 1]$ waiting

❽ $[X \rightarrow \bullet X X, 2, 2]$ waiting

❾ $[X \rightarrow \bullet X X, 3, 3]$ waiting

❿ $[S \rightarrow \bullet X, 0, 0]$ waiting

⓫ $[X \rightarrow X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \rightarrow X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \rightarrow X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \rightarrow X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \rightarrow X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \rightarrow X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \rightarrow \text{apague } X_{1,2}\bullet, 0, 2]$ ←

⓲ $[X \rightarrow \text{apague } X_{1,3}\bullet, 0, 3]$ completed

⓳ $[X \rightarrow \text{apague } X_{1,5}\bullet, 0, 5]$ completed

⓴ $[X \rightarrow X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

㉑ $[X \rightarrow X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \rightarrow X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \rightarrow X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \rightarrow X_{0,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ←

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ completed

⓴ $[X \to X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ←

⓴ $[X \to X_{1,3} \bullet \text{ por favor}, 1, 3]$ completed

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \bullet \text{ por favor}, 1, 3]$ ←

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ completed

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ ←

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ ←

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ ←

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ completed

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ completed

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ ←

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ completed

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ completed

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ ←

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ completed

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ completed

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ←

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ completed

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ←

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ←

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ ←

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ ←

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ ←

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ completed

㉙ $[X \to X_{0,3} \bullet \text{ por favor}, 0, 3]$ completed

# Inference

1. $[X \to \text{a}\bullet, 1, 2]$ ✓
2. $[X \to \text{luz}\bullet, 2, 3]$ ✓
3. $[X \to \text{apague} \bullet X, 0, 1]$ waiting
4. $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting
5. $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting
6. $[X \to \bullet X X, 0, 0]$ waiting
7. $[X \to \bullet X X, 1, 1]$ waiting
8. $[X \to \bullet X X, 2, 2]$ waiting
9. $[X \to \bullet X X, 3, 3]$ waiting
10. $[S \to \bullet X, 0, 0]$ waiting
11. $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×
12. $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓
13. $[X \to X_{1,2} \bullet X, 1, 2]$ waiting
14. $[X \to X_{2,3} \bullet X, 2, 3]$ waiting
15. $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓
16. $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓
17. $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓
18. $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓
19. $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓
20. $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned
21. $[X \to X_{0,2} \bullet X, 0, 2]$ waiting
22. $[X \to X_{0,3} \bullet X, 0, 3]$ waiting
23. $[X \to X_{1,3} \bullet X, 1, 3]$ waiting
24. $[S \to X_{0,5}\bullet, 0, 5]$ ✓
25. $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓
26. $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓
27. $[X \to \bullet X \text{ por favor}, 0, 0]$ ←
28. $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ completed
29. $[X \to X_{0,3} \bullet \text{ por favor}, 0, 3]$ completed
30. $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ←

㉙ $[X \to X_{0,3} \bullet \text{ por favor}, 0, 3]$ completed

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ×

㉙ $[X \to X_{0,3} \bullet \text{ por favor}, 0, 3]$ ←

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ completed

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ×

㉙ $[X \to X_{0,3} \text{ por favor}\bullet, 0, 5]$ scanned

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ ←

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ scanned

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ×

㉙ $[X \to X_{0,3} \text{ por favor}\bullet, 0, 5]$ scanned

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ ×

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ ←

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ×

㉙ $[X \to X_{0,3} \text{ por favor}\bullet, 0, 5]$ scanned

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ ×

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ ✓

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ×

㉙ $[X \to X_{0,3} \text{ por favor}\bullet, 0, 5]$ scanned

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ ×

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ ✓

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ×

㉙ $[X \to X_{0,3} \text{ por favor}\bullet, 0, 5]$ ←

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ ×

# Inference

❶ $[X \to \text{a}\bullet, 1, 2]$ ✓

❷ $[X \to \text{luz}\bullet, 2, 3]$ ✓

❸ $[X \to \text{apague} \bullet X, 0, 1]$ waiting

❹ $[X \to \bullet X \text{ por favor}, 1, 1]$ waiting

❺ $[X \to \bullet X \text{ por favor}, 2, 2]$ waiting

❻ $[X \to \bullet X X, 0, 0]$ waiting

❼ $[X \to \bullet X X, 1, 1]$ waiting

❽ $[X \to \bullet X X, 2, 2]$ waiting

❾ $[X \to \bullet X X, 3, 3]$ waiting

❿ $[S \to \bullet X, 0, 0]$ waiting

⓫ $[X \to X_{1,2} \bullet \text{ por favor}, 1, 2]$ ×

⓬ $[X \to X_{2,3} \text{ por favor}\bullet, 2, 5]$ ✓

⓭ $[X \to X_{1,2} \bullet X, 1, 2]$ waiting

⓮ $[X \to X_{2,3} \bullet X, 2, 3]$ waiting

⓯ $[X \to X_{1,2} X_{2,3}\bullet, 1, 3]$ ✓

⓰ $[X \to X_{1,2} X_{2,5}\bullet, 1, 5]$ ✓

⓱ $[X \to \text{apague } X_{1,2}\bullet, 0, 2]$ ✓

⓲ $[X \to \text{apague } X_{1,3}\bullet, 0, 3]$ ✓

⓳ $[X \to \text{apague } X_{1,5}\bullet, 0, 5]$ ✓

⓴ $[X \to X_{1,3} \text{ por favor}\bullet, 1, 5]$ ✓

㉑ $[X \to X_{0,2} \bullet X, 0, 2]$ waiting

㉒ $[X \to X_{0,3} \bullet X, 0, 3]$ waiting

㉓ $[X \to X_{1,3} \bullet X, 1, 3]$ waiting

㉔ $[S \to X_{0,5}\bullet, 0, 5]$ ✓

㉕ $[X \to X_{0,2} X_{2,3}\bullet, 0, 3]$ ✓

㉖ $[X \to X_{0,2} X_{2,5}\bullet, 0, 5]$ ✓

㉗ $[X \to \bullet X \text{ por favor}, 0, 0]$ waiting

㉘ $[X \to X_{0,2} \bullet \text{ por favor}, 0, 2]$ ×

㉙ $[X \to X_{0,3} \text{ por favor}\bullet, 0, 5]$ ✓

㉚ $[X \to X_{0,5} \bullet \text{ por favor}, 0, 5]$ ×

# Forest

1. $[X_{1,2} \rightarrow \text{a}]$
2. $[X_{2,3} \rightarrow \text{luz}]$
3. $[X_{0,2} \rightarrow \text{apague } X_{1,2}]$
4. $[X_{2,5} \rightarrow X_{2,3} \text{ por favor}]$
5. $[X_{1,3} \rightarrow X_{1,2} X_{2,3}]$
6. $[X_{1,5} \rightarrow X_{1,2} X_{2,5}]$
7. $[X_{0,3} \rightarrow X_{0,2} X_{2,3}]$
8. $[X_{0,5} \rightarrow X_{0,2} X_{2,5}]$
9. $[X_{0,3} \rightarrow \text{apague } X_{1,3}]$
10. $[X_{1,5} \rightarrow X_{1,3} \text{ por favor}]$
11. $[X_{0,5} \rightarrow \text{apague } X_{1,5}]$
12. $[X_{0,5} \rightarrow X_{0,3} \text{ por favor}]$
13. $[S_{0,5} \rightarrow X_{0,5}]$

# Synchronous context-free grammars

$$G = \langle \Sigma, \Delta, N, S, R \rangle$$

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  each of the form $X \to \langle \alpha, \beta, \sim \rangle$

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- $\Sigma$ input terminal vocabulary
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- $S \in N$ start symbol
- $R$ is a set of synchronous rules
  each of the form $X \to \langle \alpha, \beta, \sim \rangle$
  - $X \in N$
  - $\alpha \in (\Sigma \cup N)^+$

# Synchronous context-free grammars

$G = \langle \Sigma, \Delta, N, S, R \rangle$

- $\Sigma$ input terminal vocabulary
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- $S \in N$ start symbol
- $R$ is a set of synchronous rules
  each of the form $X \to \langle \alpha, \beta, \sim \rangle$
  - $X \in N$
  - $\alpha \in (\Sigma \cup N)^+$
  - $\beta \in (\Delta \cup N)^+$

# Synchronous context-free grammars

$G = \langle \Sigma, \Delta, N, S, R \rangle$

- $\Sigma$ input terminal vocabulary
- $\Delta$ output terminal vocabulary
- $N$ shared nonterminal vocabulary
- $S \in N$ start symbol
- $R$ is a set of synchronous rules
  each of the form $X \to \langle \alpha, \beta, \sim \rangle$
  - $X \in N$
  - $\alpha \in (\Sigma \cup N)^+$
  - $\beta \in (\Delta \cup N)^+$
  - $\sim$ is a one-to-one mapping between nonterminals in $\alpha$ and $\beta$

# SCFG - example

Synchronous grammar

1. $X \rightarrow \langle \text{a}, \text{the} \rangle$
2. $X \rightarrow \langle \text{luz}, \text{light} \rangle$
3. $X \rightarrow \langle \text{apague } X_1, \text{switch } X_1 \text{ off} \rangle$
4. $X \rightarrow \langle X_1 \text{ por favor}, \text{please, } X_1 \rangle$
5. $X \rightarrow \langle X_1 X_2, X_1 X_2 \rangle$
6. $S \rightarrow \langle X_1, X_1 \rangle$

# Synchronous parsing

Recognise pair of strings

# Synchronous parsing

Recognise pair of strings

Example

$$\langle \text{apague a luz por favor}, \text{please, switch off the light} \rangle$$

# Synchronous parsing

Recognise pair of strings

Example

$$\langle \text{apague a luz por favor}, \text{please, switch off the light} \rangle$$

A valid tree yields a pair of strings

# Two intersections

Intersect the input

# Two intersections

Intersect the input

1. a valid tree yields the input string

# Two intersections

Intersect the input

1. a valid tree yields the input string
2. the intersection itself is a CFG

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# Two intersections

Intersect the input

1. a valid tree yields the input string
2. the intersection itself is a CFG
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Intersect the output

# Two intersections

Intersect the input

1. a valid tree yields the input string
2. the intersection itself is a CFG
3. an output projection defines a set of output strings

Intersect the output

1. a valid tree yields the output string

# CKY+

Axioms

$$\frac{}{[X \to \langle \bullet\beta, \zeta\rangle, q, q]} \quad q \in Q \wedge X \to \langle \beta, \zeta\rangle \in R$$

Goal

$$[X \to \langle \alpha\bullet, \zeta\rangle, q, r] \quad q \in I \wedge r \in F \wedge X \in S$$

Scan

$$\frac{[X \to \langle \alpha \bullet x\beta, \zeta\rangle, q, s]}{[X \to \langle \alpha x \bullet \beta, \zeta\rangle]} \quad \langle s, x, r\rangle \in E$$

Complete

$$\frac{[X \to \langle \alpha \bullet Y\beta, \zeta\rangle, q, s]\,[Y \to \langle \gamma\bullet, \xi\rangle, s, r]}{[X \to \langle \alpha\, Y_{s,r} \bullet \beta, \zeta\rangle, q, r]}$$

- algorithm remains the same
- keep track of target RHS

# First intersection

1. $X_{1,2} \rightarrow \langle \text{a}, \text{the} \rangle$
2. $X_{2,3} \rightarrow \langle \text{luz}, \text{light} \rangle$
3. $X_{0,2} \rightarrow \langle \text{apague } X_{1,2}, \text{switch } X_{1,2} \text{ off} \rangle$
4. $X_{2,5} \rightarrow \langle X_{2,3} \text{ por favor}, \text{please, } X_{2,3} \rangle$
5. $X_{1,3} \rightarrow \langle X_{1,2}X_{2,3}, X_{1,2}X_{2,3} \rangle$
6. $X_{1,5} \rightarrow \langle X_{1,2}X_{2,5}, X_{1,2}X_{2,5} \rangle$
7. $X_{0,3} \rightarrow \langle X_{0,2}X_{2,3}, X_{0,2}X_{2,3} \rangle$
8. $X_{0,5} \rightarrow \langle X_{0,2}X_{2,5}, X_{0,2}X_{2,5} \rangle$
9. $X_{0,3} \rightarrow \langle \text{apague } X_{1,3}, \text{switch } X_{1,3} \text{ off} \rangle$
10. $X_{1,5} \rightarrow \langle X_{1,3} \text{ por favor}, \text{please, } X_{1,3} \rangle$
11. $X_{0,5} \rightarrow \langle \text{apague } X_{1,5}, \text{switch } X_{1,5} \text{ off} \rangle$
12. $X_{0,5} \rightarrow \langle X_{0,3} \text{ por favor}, \text{please, } X_{0,3} \rangle$
13. $S_{0,5} \rightarrow \langle X_{0,5}, X_{0,5} \rangle$

# Projection

1. $X_{1,2} \rightarrow$ the
2. $X_{2,3} \rightarrow$ light
3. $X_{0,2} \rightarrow$ switch $X_{1,2}$ off
4. $X_{2,5} \rightarrow$ please, $X_{2,3}$
5. $X_{1,3} \rightarrow X_{1,2} X_{2,3}$
6. $X_{1,5} \rightarrow X_{1,2} X_{2,5}$
7. $X_{0,3} \rightarrow X_{0,2} X_{2,3}$
8. $X_{0,5} \rightarrow X_{0,2} X_{2,5}$
9. $X_{0,3} \rightarrow$ switch $X_{1,3}$ off
10. $X_{1,5} \rightarrow$ please, $X_{1,3}$
11. $X_{0,5} \rightarrow$ switch $X_{1,5}$ off
12. $X_{0,5} \rightarrow$ please, $X_{0,3}$
13. $S_{0,5} \rightarrow X_{0,5}$

# Projection

1. $X^{1,2} \rightarrow$ the
2. $X^{2,3} \rightarrow$ light
3. $X^{0,2} \rightarrow$ switch $X^{1,2}$ off
4. $X^{2,5} \rightarrow$ please, $X^{2,3}$
5. $X^{1,3} \rightarrow X^{1,2} X^{2,3}$
6. $X^{1,5} \rightarrow X^{1,2} X^{2,5}$
7. $X^{0,3} \rightarrow X^{0,2} X^{2,3}$
8. $X^{0,5} \rightarrow X^{0,2} X^{2,5}$
9. $X^{0,3} \rightarrow$ switch $X^{1,3}$ off
10. $X^{1,5} \rightarrow$ please, $X^{1,3}$
11. $X^{0,5} \rightarrow$ switch $X^{1,5}$ off
12. $X^{0,5} \rightarrow$ please, $X^{0,3}$
13. $S^{0,5} \rightarrow X^{0,5}$

# Second intersection

| | please, | switch | the | light | off |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

1. $X^{1,2} \rightarrow$ the
2. $X^{2,3} \rightarrow$ light
3. $X^{0,2} \rightarrow$ switch $X^{1,2}$ off
4. $X^{2,5} \rightarrow$ please, $X^{2,3}$
5. $X^{1,3} \rightarrow X^{1,2}\,X^{2,3}$
6. $X^{1,5} \rightarrow X^{1,2}\,X^{2,5}$
7. $X^{0,3} \rightarrow X^{0,2}\,X^{2,3}$
8. $X^{0,5} \rightarrow X^{0,2}\,X^{2,5}$
9. $X^{0,3} \rightarrow$ switch $X^{1,3}$ off
10. $X^{1,5} \rightarrow$ please, $X^{1,3}$
11. $X^{0,5} \rightarrow$ switch $X^{1,5}$ off
12. $X^{0,5} \rightarrow$ please, $X^{0,3}$
13. $S^{0,5} \rightarrow X^{0,5}$

# Second intersection

| | please, | switch | the | light | off |
|---|---|---|---|---|---|
| 1 | | | $X^{1,2} \xrightarrow{1}$ the | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

1. $X^{1,2} \rightarrow$ the
2. $X^{2,3} \rightarrow$ light
3. $X^{0,2} \rightarrow$ switch $X^{1,2}$ off
4. $X^{2,5} \rightarrow$ please, $X^{2,3}$
5. $X^{1,3} \rightarrow X^{1,2} X^{2,3}$
6. $X^{1,5} \rightarrow X^{1,2} X^{2,5}$
7. $X^{0,3} \rightarrow X^{0,2} X^{2,3}$
8. $X^{0,5} \rightarrow X^{0,2} X^{2,5}$
9. $X^{0,3} \rightarrow$ switch $X^{1,3}$ off
10. $X^{1,5} \rightarrow$ please, $X^{1,3}$
11. $X^{0,5} \rightarrow$ switch $X^{1,5}$ off
12. $X^{0,5} \rightarrow$ please, $X^{0,3}$
13. $S^{0,5} \rightarrow X^{0,5}$

# Second intersection

| | please, | switch | the | light | off |
|---|---|---|---|---|---|
| 1 | | | $X^{1,2} \xrightarrow{1}$ the | $X^{2,3} \xrightarrow{2}$ light | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

1. $X^{1,2} \rightarrow$ the
2. $X^{2,3} \rightarrow$ light
3. $X^{0,2} \rightarrow$ switch $X^{1,2}$ off
4. $X^{2,5} \rightarrow$ please, $X^{2,3}$
5. $X^{1,3} \rightarrow X^{1,2} X^{2,3}$
6. $X^{1,5} \rightarrow X^{1,2} X^{2,5}$
7. $X^{0,3} \rightarrow X^{0,2} X^{2,3}$
8. $X^{0,5} \rightarrow X^{0,2} X^{2,5}$
9. $X^{0,3} \rightarrow$ switch $X^{1,3}$ off
10. $X^{1,5} \rightarrow$ please, $X^{1,3}$
11. $X^{0,5} \rightarrow$ switch $X^{1,5}$ off
12. $X^{0,5} \rightarrow$ please, $X^{0,3}$
13. $S^{0,5} \rightarrow X^{0,5}$

# Second intersection

| | please, | switch | the | light | off |
|---|---|---|---|---|---|
| 1 | | | $X^{1,2} \xrightarrow{1}$ the | $X^{2,3} \xrightarrow{2}$ light | |
| 2 | | | $X^{1,3} \xrightarrow{5} X^{1,2} X^{2,3}$ | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

1. $X^{1,2} \rightarrow$ the
2. $X^{2,3} \rightarrow$ light
3. $X^{0,2} \rightarrow$ switch $X^{1,2}$ off
4. $X^{2,5} \rightarrow$ please, $X^{2,3}$
5. $X^{1,3} \rightarrow X^{1,2} X^{2,3}$
6. $X^{1,5} \rightarrow X^{1,2} X^{2,5}$
7. $X^{0,3} \rightarrow X^{0,2} X^{2,3}$
8. $X^{0,5} \rightarrow X^{0,2} X^{2,5}$
9. $X^{0,3} \rightarrow$ switch $X^{1,3}$ off
10. $X^{1,5} \rightarrow$ please, $X^{1,3}$
11. $X^{0,5} \rightarrow$ switch $X^{1,5}$ off
12. $X^{0,5} \rightarrow$ please, $X^{0,3}$
13. $S^{0,5} \rightarrow X^{0,5}$

# Second intersection

| | please, | switch | the | light | off |
|---|---|---|---|---|---|
| 1 | | | $X^{1,2} \xrightarrow{1}$ the | $X^{2,3} \xrightarrow{2}$ light | |
| 2 | | | $X^{1,3} \xrightarrow{5} X^{1,2} X^{2,3}$ | | |
| 3 | | | $X^{0,3} \xrightarrow{9}$ switch $X^{1,3}$ off | | |
| 4 | | | | | |
| 5 | | | | | |

1. $X^{1,2} \rightarrow$ the
2. $X^{2,3} \rightarrow$ light
3. $X^{0,2} \rightarrow$ switch $X^{1,2}$ off
4. $X^{2,5} \rightarrow$ please, $X^{2,3}$
5. $X^{1,3} \rightarrow X^{1,2} X^{2,3}$
6. $X^{1,5} \rightarrow X^{1,2} X^{2,5}$
7. $X^{0,3} \rightarrow X^{0,2} X^{2,3}$
8. $X^{0,5} \rightarrow X^{0,2} X^{2,5}$
9. $X^{0,3} \rightarrow$ switch $X^{1,3}$ off
10. $X^{1,5} \rightarrow$ please, $X^{1,3}$
11. $X^{0,5} \rightarrow$ switch $X^{1,5}$ off
12. $X^{0,5} \rightarrow$ please, $X^{0,3}$
13. $S^{0,5} \rightarrow X^{0,5}$

# Second intersection

| | please, | switch | the | light | off |
|---|---|---|---|---|---|
| 1 | | | $X^{1,2} \xrightarrow{1}$ the | $X^{2,3} \xrightarrow{2}$ light | |
| 2 | | | $X^{1,3} \xrightarrow{5} X^{1,2} X^{2,3}$ | | |
| 3 | | | $X^{0,3} \xrightarrow{9}$ switch $X^{1,3}$ off | | |
| 4 | | | $X^{0,5} \xrightarrow{12}$ please, $X^{0,3}$ | | |
| 5 | | | | | |

1. $X^{1,2} \rightarrow$ the
2. $X^{2,3} \rightarrow$ light
3. $X^{0,2} \rightarrow$ switch $X^{1,2}$ off
4. $X^{2,5} \rightarrow$ please, $X^{2,3}$
5. $X^{1,3} \rightarrow X^{1,2} X^{2,3}$
6. $X^{1,5} \rightarrow X^{1,2} X^{2,5}$
7. $X^{0,3} \rightarrow X^{0,2} X^{2,3}$
8. $X^{0,5} \rightarrow X^{0,2} X^{2,5}$
9. $X^{0,3} \rightarrow$ switch $X^{1,3}$ off
10. $X^{1,5} \rightarrow$ please, $X^{1,3}$
11. $X^{0,5} \rightarrow$ switch $X^{1,5}$ off
12. $X^{0,5} \rightarrow$ please, $X^{0,3}$
13. $S^{0,5} \rightarrow X^{0,5}$

# Second intersection

| | please, | switch | the | light | off |
|---|---|---|---|---|---|
| 1 | | | $X^{1,2} \xrightarrow{1}$ the | $X^{2,3} \xrightarrow{2}$ light | |
| 2 | | | $X^{1,3} \xrightarrow{5} X^{1,2} X^{2,3}$ | | |
| 3 | | | $X^{0,3} \xrightarrow{9}$ switch $X^{1,3}$ off | | |
| 4 | $X^{0,5} \xrightarrow{12}$ please, $X^{0,3}$ | | | | |
| 5 | $S^{0,5} \xrightarrow{13} X^{0,5}$ | | | | |

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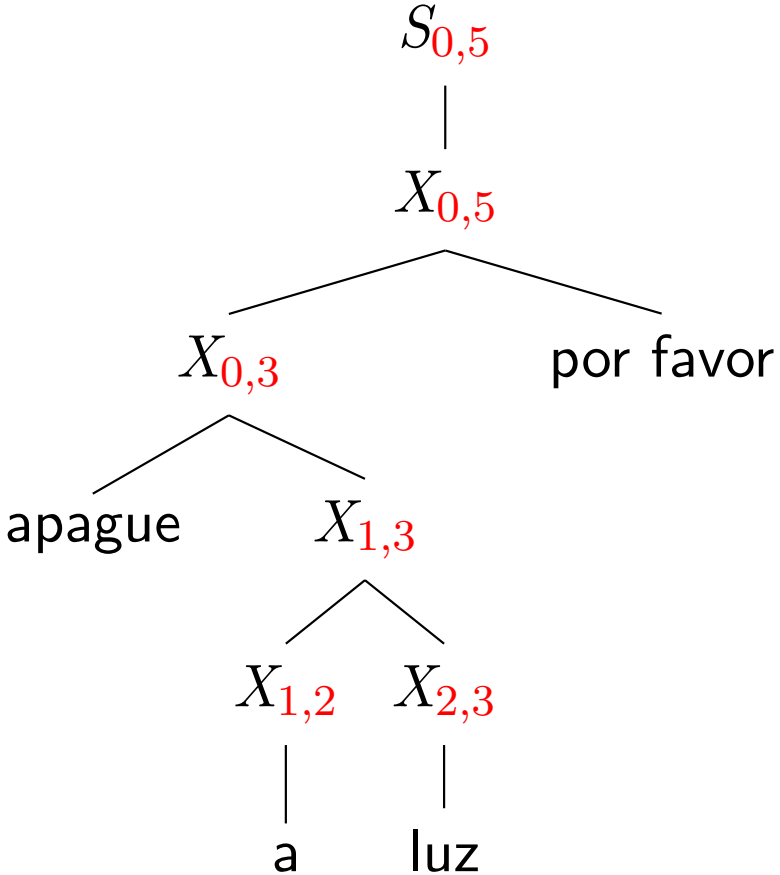
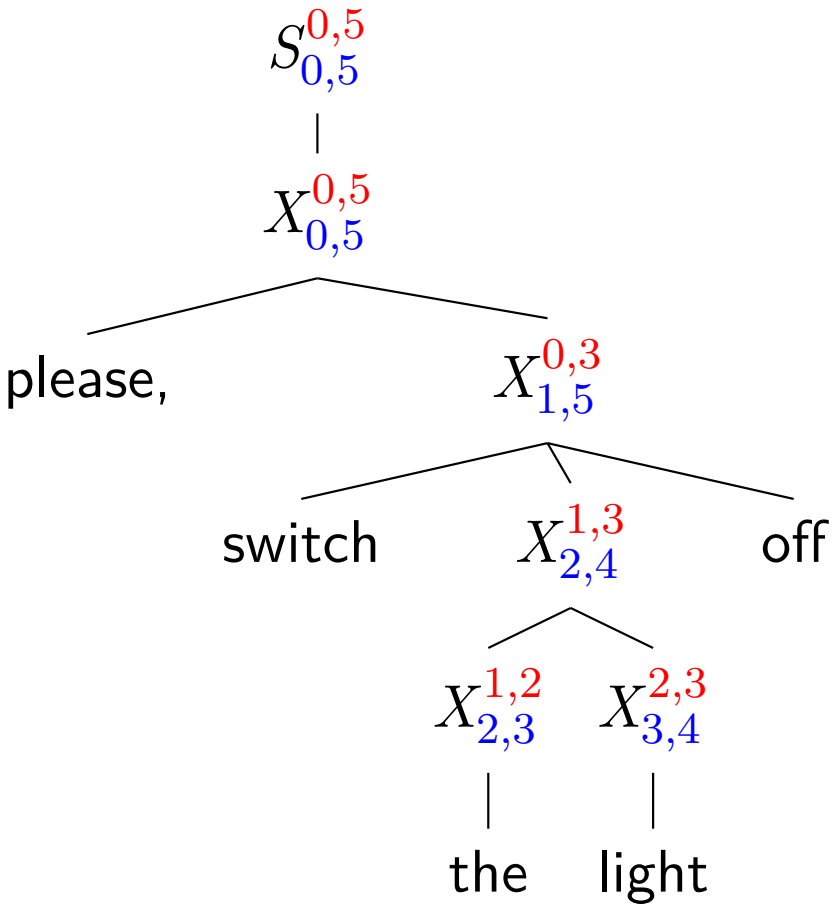
# Analysis


$S_{0,5}$
$X_{0,5}$
$X_{0,3}$
por favor
apague
$X_{1,3}$
$X_{1,2}$
$X_{2,3}$
a
luz


$S^{0,5}_{0,5}$
$X^{0,5}_{0,5}$
please,
$X^{0,3}_{1,5}$
switch
$X^{1,3}_{2,4}$
off
$X^{1,2}_{2,3}$
$X^{2,3}_{3,4}$
the
light

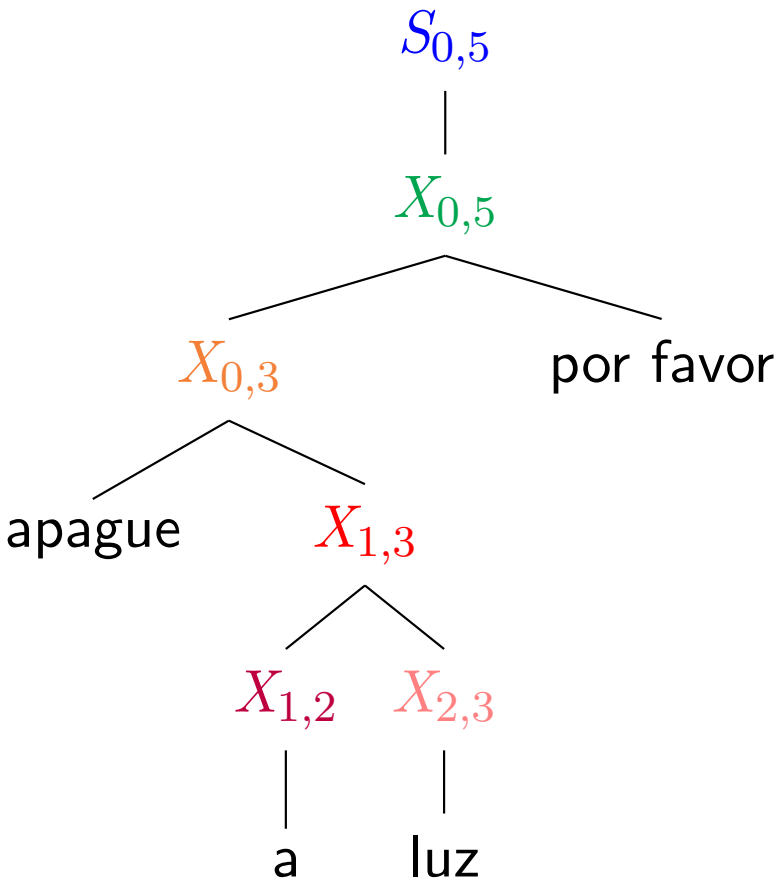
# Example 1

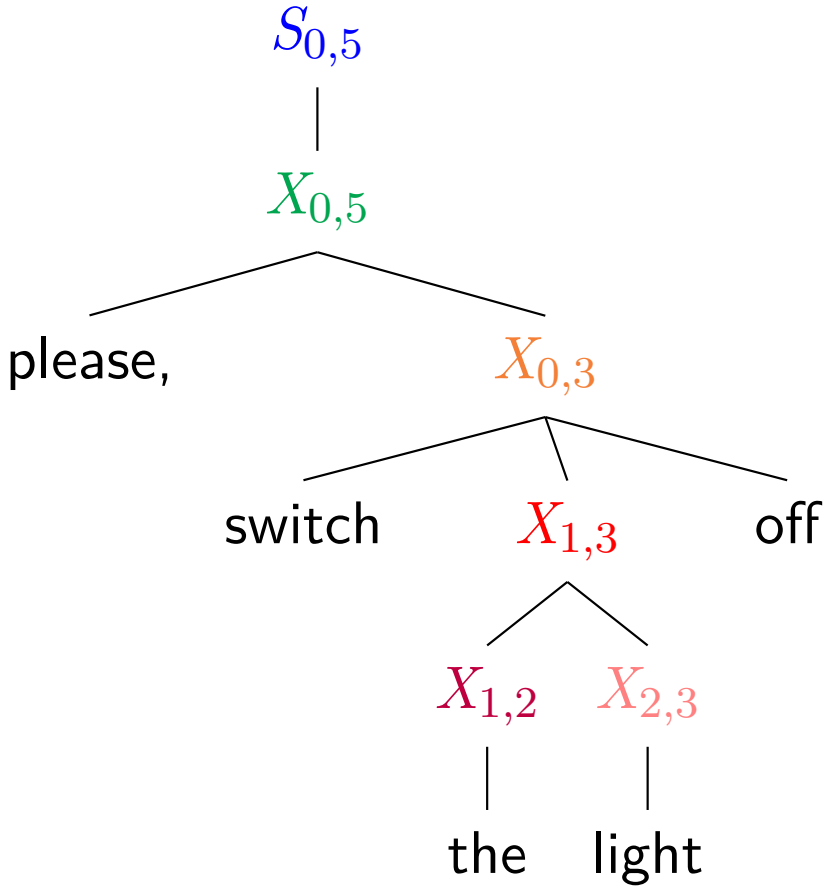
Synchronous grammar

1. $X \rightarrow \langle \text{a}, \text{the} \rangle$
2. $X \rightarrow \langle \text{luz}, \text{light} \rangle$
3. $X \rightarrow \langle \text{apague } X_1, \text{switch } X_1 \text{ off} \rangle$
4. $X \rightarrow \langle X_1 \text{ por favor}, \text{please, } X_1 \rangle$
5. $X \rightarrow \langle X_1 X_2, X_1 X_2 \rangle$
6. $S \rightarrow \langle X_1, X_1 \rangle$

Input: *apague a luz por favor*

# Synchronous derivation - example 1



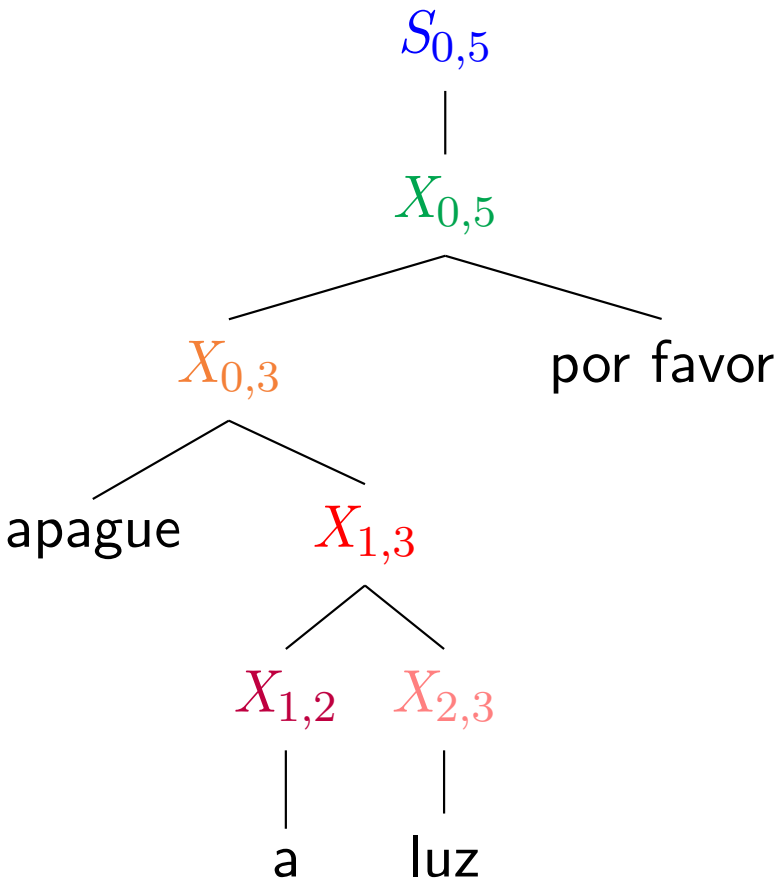
# Example 2

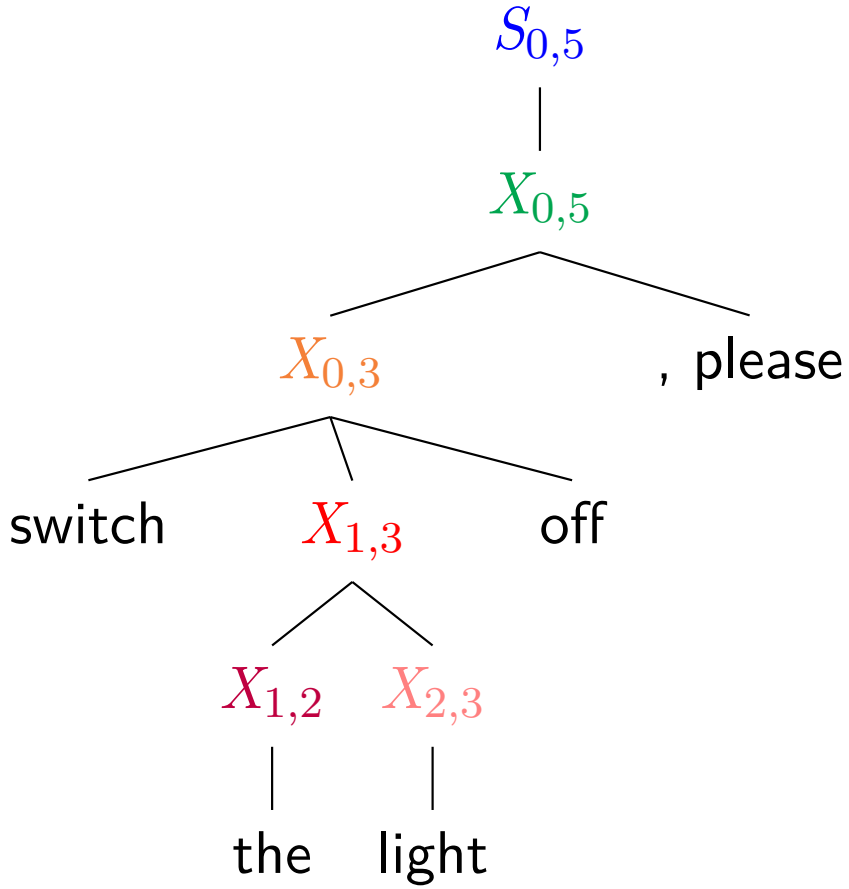
Synchronous grammar

1. $X \rightarrow \langle \text{a}, \text{the} \rangle$
2. $X \rightarrow \langle \text{luz}, \text{light} \rangle$
3. $X \rightarrow \langle \text{apague } X_1, \text{switch } X_1 \text{ off} \rangle$
4. $X \rightarrow \langle X_1 \text{ por favor}, \text{please, } X_1 \rangle$
5. $X \rightarrow \langle X_1 X_2, X_1 X_2 \rangle$
6. $S \rightarrow \langle X_1, X_1 \rangle$
7. $X \rightarrow \langle X_1 \text{ por favor}, X_1 \text{ , please} \rangle$

Input: *apague a luz por favor*

# Synchronous derivation - example 2



# Wrap up

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2. deductive proof systems
   - compact representation
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   - intersect input
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4. isomorphic trees
   - explicit reordering rules

# Earley parsing

Top-down, left-to-right algorithm [Earley, 1970]

- same asymptotic complexity as CKY
- top-down predictions
- bottom-up completions
- more efficient in several cases

Intersection with arbitrary automata [Dyer and Resnik, 2010]

# Earley intersection

AXIOMS

$$\frac{}{[S' \to \bullet S, q, q]} \quad q \in I$$

GOAL

$$\left[S' \to S\bullet, q, r\right] \quad q \in I \wedge r \in F$$

SCAN

$$\frac{[X \to \alpha \bullet x\beta, q, s]}{[X \to \alpha x \bullet \beta]} \quad \langle s, x, r\rangle \in E$$

PREDICT

$$\frac{[X \to \alpha \bullet Y\beta, q, r]}{[Y \to \bullet\gamma, r, r]} \quad Y \to \gamma \in R$$

COMPLETE

$$\frac{[X \to \alpha \bullet Y\beta, q, s]\,[Y \to \gamma\bullet, s, r]}{[X \to \alpha\, Y_{s,r} \bullet \beta, q, r]} \quad X \neq S'$$

ACCEPT

$$\frac{[S' \to \bullet S, q, q]\,[S \to \gamma\bullet, q, r]}{[S' \to S_{q,r}\bullet, q, r]} \quad r \in F$$

# Questions?

# References I

Chris Dyer and Philip Resnik. Context-free reordering, finite-state translation. In *Human Language Technologies: The 2010 Annual Conference of the North American Chapter of the Association for Computational Linguistics*, HLT '10, pages 858–866, Stroudsburg, PA, USA, 2010. Association for Computational Linguistics. ISBN 1-932432-65-5. URL `http://dl.acm.org/citation.cfm?id=1857999.1858127`.

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