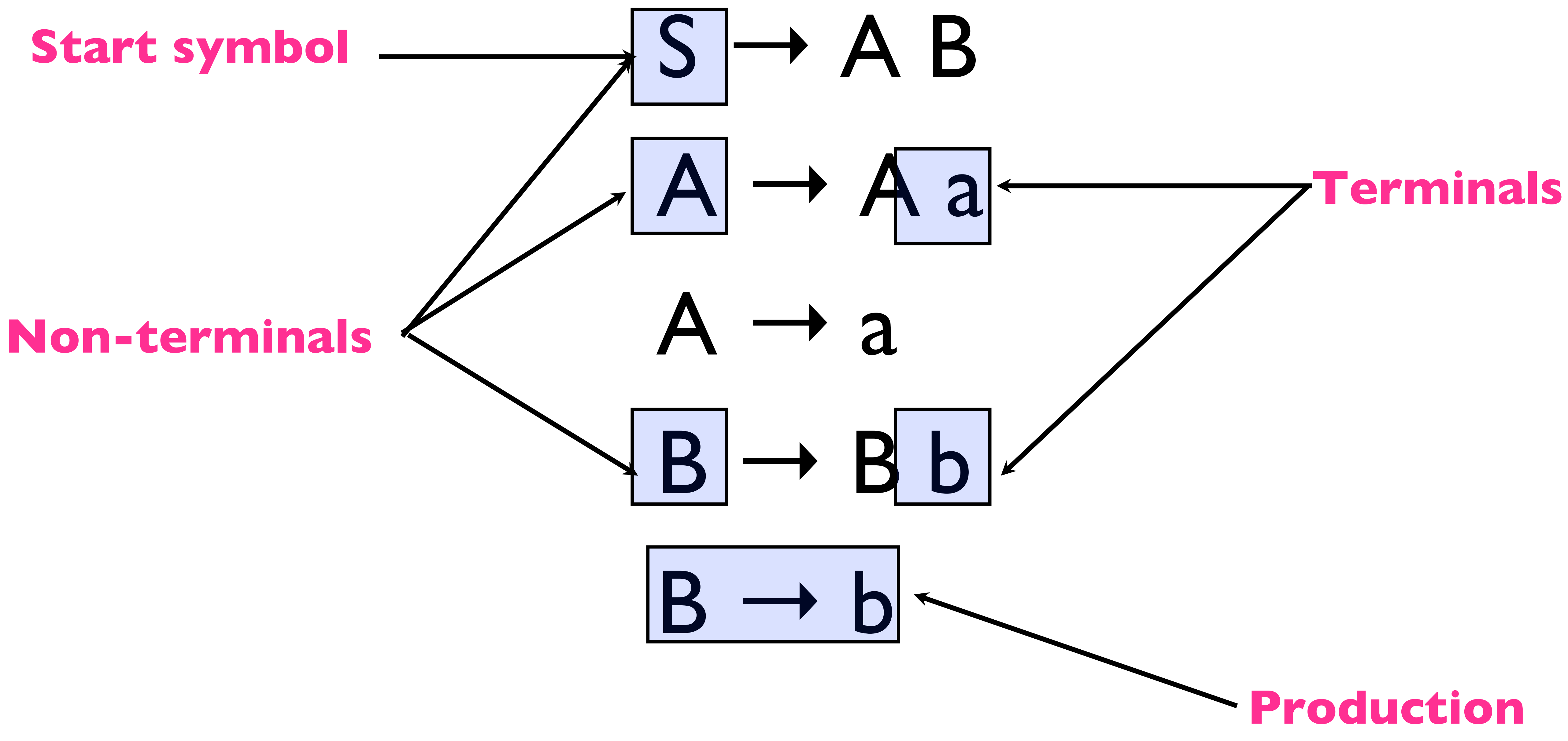
Context-free Grammar

a simple grammar

- Grammar $G = (V_t, V_n, S, P)$
- V_t is the set of terminals
- V_n is the set of non-terminals
- $S \in V_n$ is the start symbol
- P is the set of productions
- Each production takes the form:

$$V_n \rightarrow (V_n | V_t)^*$$

- Grammar is **context-free** (why?)



how does a grammar define a language?

- Given a start rule, productions tell us how we can *rewrite* non-terminals into other strings
- Some productions rewrite into λ. That just removes the non-terminal
- To derive the string "a a b b b" we can do the following rewrites:

  $S \Rightarrow A\ B \Rightarrow A\ a\ B \Rightarrow a\ a\ B \Rightarrow a\ a\ B\ b \Rightarrow$
  $a\ a\ B\ b\ b \Rightarrow a\ a\ b\ b\ b$

$S \rightarrow A\ B$

$A \rightarrow A\ a$

$A \rightarrow a$

$B \rightarrow B\ b$

$B \rightarrow b$

terminology

- **Strings** are composed of symbols
  - A A a a B b b A a is a string
- We will use Greek letters to represent strings composed of both terminals and non-terminals
- *L(G)* is the language produced by the grammar *G*
  - All strings consisting of only terminals that can be produced by *G*
  - In our example, *L(G)* = a^+b^+
  - The language of a context-free grammar is a **context-free language**
  - All regular languages are context-free, but not vice versa

matching { and }

- So how can we use a CFG to define a language for matching braces?

$$S \rightarrow \{\ S\ \}$$

$$S \rightarrow \lambda$$

- Note that we can rewrite a non-terminal to λ to make it "disappear"

programming language syntax

- Programming language syntax is defined with CFGs
- Constructs in language become non-terminals
- May use auxiliary non-terminals to make it easier to define constructs

if_stmt → if (cond_expr) then statement else_part

else_part → else statement

else_part → λ

- Tokens in language become terminals

problem: how do we tell if a string matches a CFG?