Attendance

https://forms.gle/iMXPHXs6xW4qn5Ht8

- Optional Check-Ins this Sunday
  - Can discuss Midterm 2, and/or strategies for the rest of the quarter
  - Sign up here: https://calendly.com/esierra-stanford/103a-check-in
  - All check-ins on Zoom
  - Email/Slack me if the available times do not work for you, we can schedule another time!
- Preference form for Final Review
  - https://forms.gle/dNY7Pq5uv9LSsJQX6

Turing Machines

- An idealized, infinite-memory computer
- Has an **infinite tape** of symbols and a **tape head**
  - Can read or write only the symbol under the head
  - Takes a string as input (written on tape at start) and returns yes/no
- Operates based on a series of instructions and labels

Why do they matter?

- **Church-Turing Thesis** claims: Anything we prove about TMs is true about any method of computation

Recognizability and Decidability

A TM M is a **recognizer** for a language L if

$$\forall w \in \Sigma^*.(w \in L \leftrightarrow M \text{ accepts } w)$$

(Intuitively: M can “recognize” that a string in the language is in the language.)

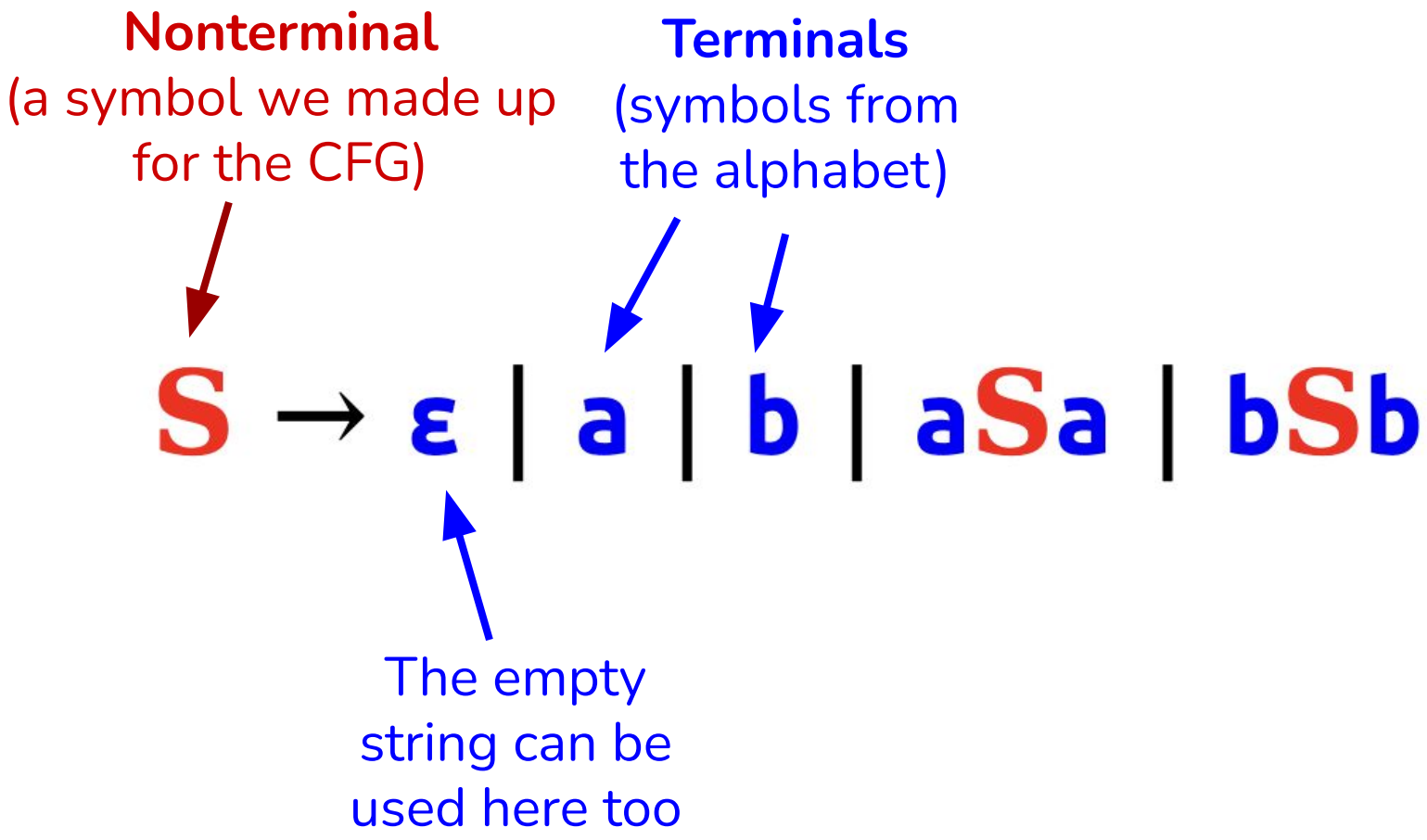
A TM M is a **decider** for L if it’s a recognizer for L and

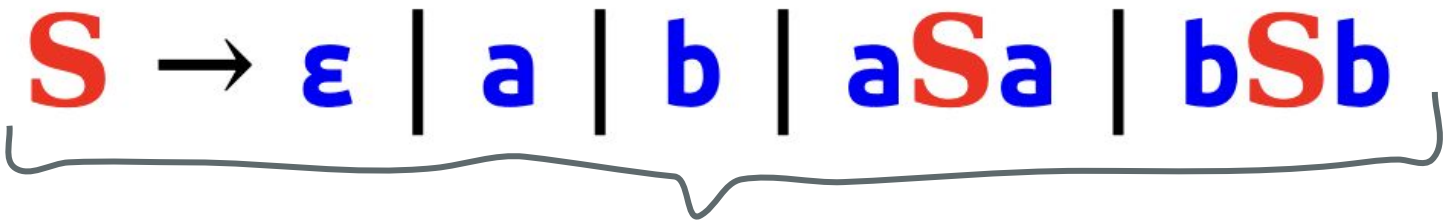
$$\forall w \in \Sigma^*.(M \text{ halts on } w)$$

(Intuitively: M can “decide” whether or not any string is in the language.)

Review: Context-Free Grammar

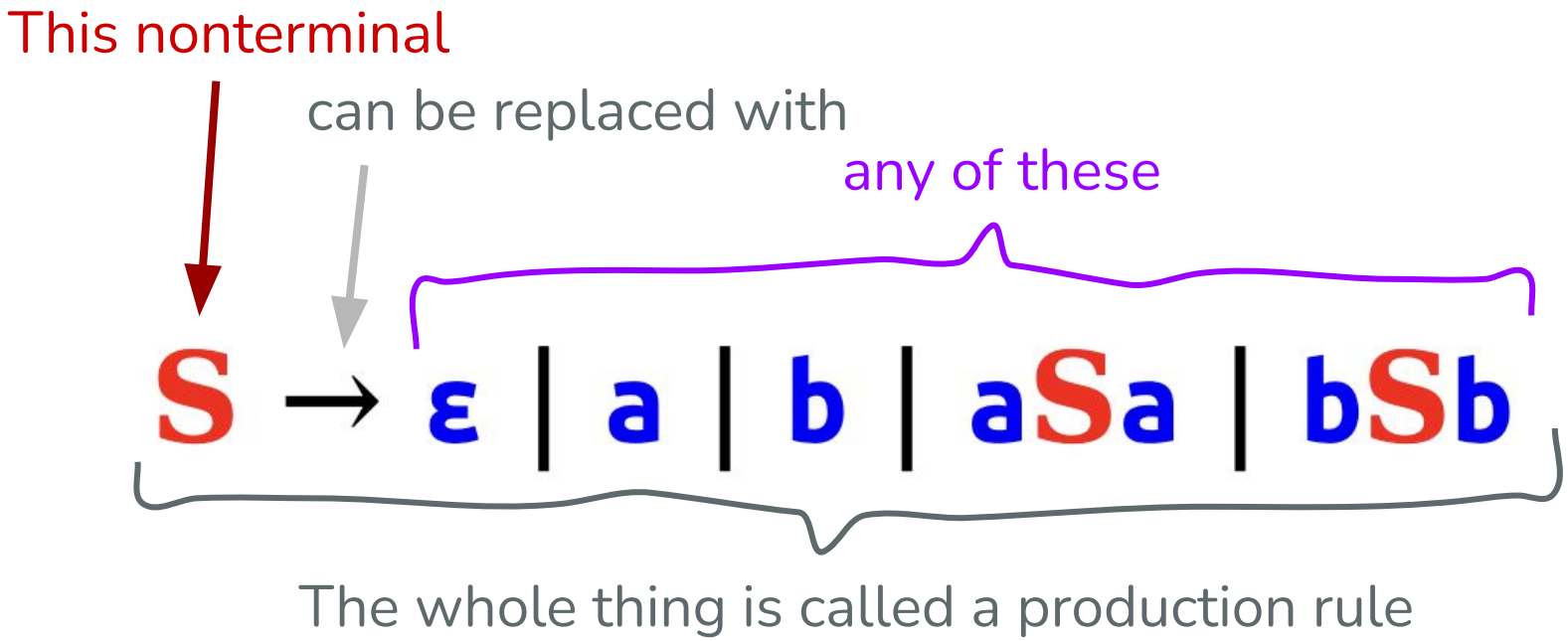
- Describe a language by describing recursive structure
- Intuitively, “more computing power” than DFAs/regexes


Nonterminal
(a symbol we made up for the CFG)
Terminals
(symbols from the alphabet)
S → ε | a | b | aSa | bSb
The empty string can be used here too



The whole thing is called a production rule

(the term is not super important)



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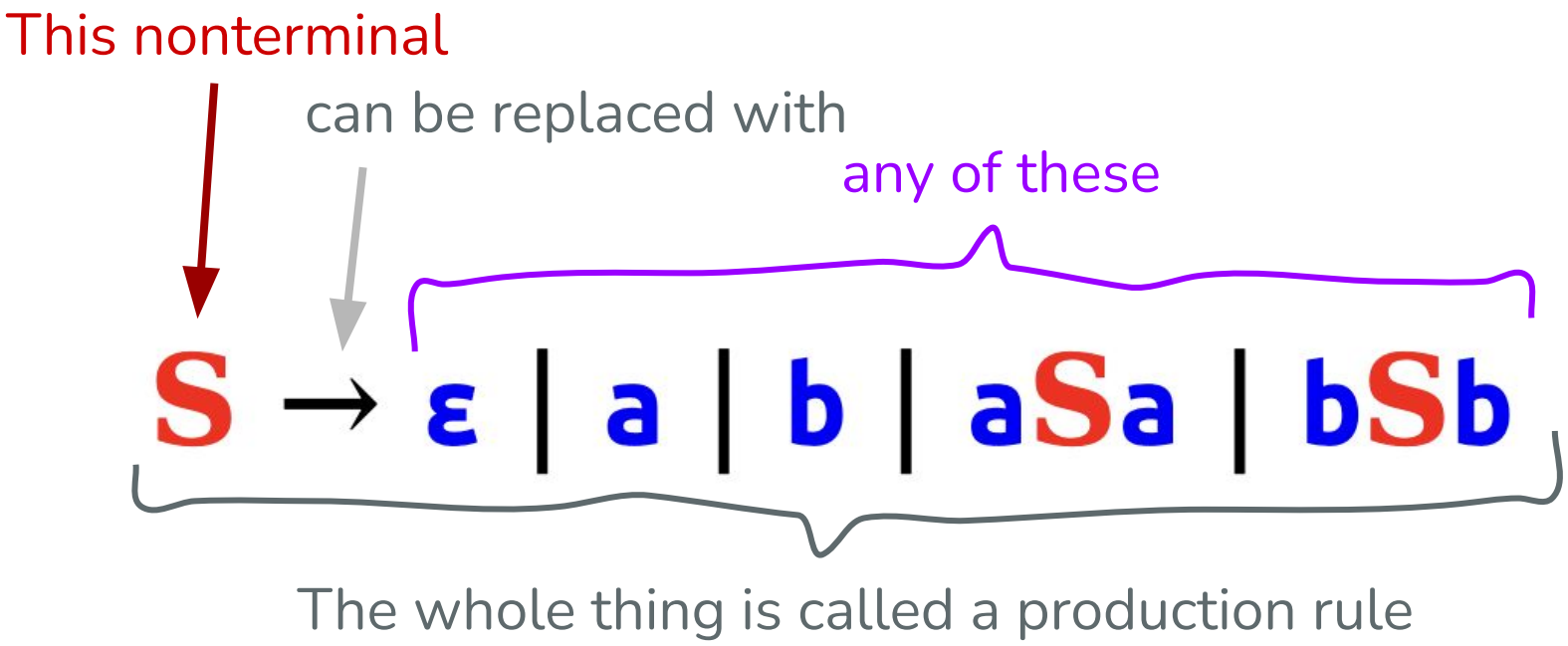

- A CFG is a list of production rules
- A CFG's language = set of all **strings of terminals** derivable **from the start symbol** (the nonterminal from the **first** rule)