

Name: _____

CSCI 380: Activity 5

Grammars

Team Roles	Team Member
Facilitator: reads the questions aloud, keeps track of time and makes sure everyone contributes appropriately.	
Spokesperson: talks to the instructor and other teams.	
Quality Control: records all answers & questions, and provides team reflection to team & instructor.	
Process Analyst: considers how the team could work and learn more effectively.	

Note

If you have 3 people, combine Facilitator & Process Analyst.

Learning Objectives

1. Understand the elements of a grammar.
2. Use grammars to derive words.
3. Practice time management skills.

In this Activity, you will find two [Modules](#) and one [Reflection](#) section.

start time:

Model I. Grammars (15 min)

A grammar $G = (V, T, S, P)$ where

- V is a finite set of objects called **variables**,
- T is a finite set of objects called **terminal symbols**,
- $S \in V$ is a special variable called the **start** variable, and
- P is a finite set of **productions**.

Productions are of the form $x \rightarrow y$ where $x \in (V \cup T)^+$ and $y \in (V \cup T)^*$.

This is an example of a grammar:

$$G = (\{S\}, \{a, b\}, S, P)$$

where P is

$$S \rightarrow aSb$$

$$S \rightarrow \lambda$$

When the left hand side



Explore the Model Questions

1. V , T , and P are all _____ sets.
2. In the example above, $\{S\}$ is _____ and $\{a, b\}$ is _____. (choose from V and T).
3. Let $V = \{S, M, N\}$ and $T = \{a, b, c\}$. Which of the following are valid productions?
 - a. $S \rightarrow b$
 - b. $N \rightarrow aba$
 - c. $\lambda \rightarrow b$
 - d. $b \rightarrow \lambda$
 - e. $aMbS \rightarrow ccN$
 - f. $a \rightarrow b$
 - g. $M \rightarrow bcbd$
 - h. $P \rightarrow aSb$
4. Write three more valid productions for the grammar in question 3.

Critical Thinking Question

5. Why is λ a valid on the right-hand-side of a production rule, but not the left?

start time:

Model II. Derivations (15 min)

For $w \in (V \cup T)^+$, $z \in (V \cup T)^*$, we say w **derives** z , with notation $w \Rightarrow z$, when a production rule can be applied to transform w into z . We can revisit our example grammar:

$$G = (\{S\}, \{a, b\}, S, P)$$

and we can simplify P with the $|$ notation when multiple rules have same left-hand-side:

$$S \rightarrow aSb \mid \lambda$$

If $w = aSb$, then we can apply the first production rule to replace S with aSb and derive $z = aaSbb$.

Derivation is **commutative**. If $w_1 \Rightarrow w_2 \Rightarrow w_3 \Rightarrow \dots \Rightarrow w_n$ then we can summarize this as $w_1 \xRightarrow{*} w_n$ where $n \geq 0$.

Each piece of the derivation chain (w_1, w_2, \dots) is called a **sentential form**.

Explore the Model Questions

1. What symbol is used for productions?
2. What symbol is used for derivations?
3. Using the example grammar above, list all intermediate sentential forms for the derivation $aSb \xRightarrow{*} aaaabbbb$.

Critical Thinking Questions

4. What are three $w \in T^*$ from G below that can be derived from S ? Show your full derivations with all intermediate sentential forms.

$$G = (\{S, R, T\}, \{a, b, c\}, S, P)$$

$$S \rightarrow aRT \mid bT$$

$$R \rightarrow aaR \mid bb$$

$$T \rightarrow TS \mid aba$$

5. The set of all words in T^* that can be derived from a grammar starting with S is the language associated with that grammar. Write the formal definition for $L(G)$ for any G .

Looking Back - Group Reflection

Review the job descriptions on your role card. Evaluate privately on how well you performed in your role. Provide the following using the **SII framework**:

S – *Strength* (Also what specifically did you do that would indicate that it was a strength)

I – *Improvement Area*

I – *Insight* concerning either the process or the content of the activity

**Facilitator**

List below how long each Model took your group:

- Model I:
 - Model II:
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Process Analyst

Give feedback to each of your other team members with how they contributed to successful time management in this activity.

Quality Control

Summarize the activity for your group members, by answering the following question.

1. List two differences between the left-hand-side and right-hand-side of the production rules.
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Spokesperson

Gather up the name cards and any other materials and give them to Dr. Goadrich.