4. Übung (May 9, 2016)
Formale Baumsprachen

**Task 9 (td-det fta)**
Let \( \Sigma = \{ \sigma^{(2)}, \alpha^{(0)}, \beta^{(0)}, \gamma^{(0)} \} \). Give a nondeterministic bu-ta which accepts exactly the language of all \( \xi \in T_\Sigma \) containing a \( \beta \)-leaf somewhere between an \( \alpha \)- and a \( \gamma \)-leaf, reading leaves left-to-right or right-to-left. Try to use as few states and transitions as possible.

**Task 10 (Nondeterministic td-ta)**
For each of the following tree languages, give a td-ta which accepts exactly that language. Which of these languages can be accepted by some deterministic td-ta?

(a) \( \Sigma = \{ \sigma^{(2)}, \alpha^{(0)}, \beta^{(0)} \} \) and \( L = \{ \xi \in T_\Sigma \mid \xi \text{ contains at least one } \alpha \text{ and one } \beta \} \).

(b) \( \Sigma = \{ \sigma^{(2)}, \alpha^{(0)}, \beta^{(0)} \} \) and \( L = \{ \xi \in T_\Sigma \mid \xi \text{ contains an even number of } \alpha \text{ symbols} \} \).

(c) \( \Sigma = \{ \alpha^{(1)}, \beta^{(1)}, \gamma^{(1)}, \epsilon^{(0)} \} \) and
\[L = \{ \xi \in T_\Sigma \mid \xi \text{ contains an } \alpha \text{ somewhere above a } \beta \text{ or a } \beta \text{ somewhere above a } \gamma \} \).

**Task 11 (regular tree grammars)**
Let \( \Sigma = \{ \sigma^{(2)}, \gamma^{(1)}, \alpha^{(0)} \} \) be a ranked alphabet. Give regular tree grammars \( G_1 \) and \( G_2 \) with

(a) \( L(G_1) = \{ \xi \in T_\Sigma \mid \xi \text{ contains exactly one } \sigma \} \) and

(b) \( L(G_2) = \{ \xi \in T_\Sigma \mid \xi \text{ contains the pattern } \sigma(\_, \gamma(\_)) \text{ at least twice} \} \).