

TI2316 Automata, Languages and Computability

LATEX-tips

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1 Formal Languages

Symbols	LaTeX	Description
ε	\varepsilon	Symbol for the empty string
L_0^*	L_0^{*}	Combination subscript and superscript
\overline{L}_1	\overline{L}_1	Complement of a language
$(L_0 \cap L_1) \cup L_2$	$(L_0 \cap L_1) \cup L_2$	Intersection and union
$L_1 \subseteq L_2$	$L_1 \subseteq L_2$	Subset
$L_1 \subsetneq L_2$	$L_1 \subsetneq L_2$	Proper subset
$L_1 \subset L_2$	$L_1 \subset L_2$	Proper subset (alternative)
\mathbb{N}	\mathbb{N}	Set of natural numbers
\emptyset	\emptyset	Empty set
Σ	\Sigma	Sigma (typically denoting an alphabet)
$\{w \in \Sigma^* \mid \dots\}$	\{w \in \Sigma^* \mid \dots\}	Set-builder notation

NB: Sipser does not include 0 in \mathbb{N} (see Section 0.2). We will likewise assume this symbol stands for integers greater than 0 when you use this symbol.

2 Context-Free Grammars

An example of a context-free grammar is $G = (\{A, B, C, S\}, \{a, b, c, \#\}, R, S)$ where R consists of the following production rules:

$$\begin{aligned} S &\rightarrow BAB, \\ A &\rightarrow aAa \mid bAb \mid BCB, \\ B &\rightarrow Bb \mid b \mid \varepsilon, \\ C &\rightarrow \#S\# \mid \#c\# \end{aligned}$$

```
\begin{aligned}
S &\rightarrow BAB, \\
A &\rightarrow aAa \mid bAb \mid BCB, \\
B &\rightarrow Bb \mid b \mid \varepsilon, \\
C &\rightarrow \#S\# \mid \#c\#
\end{aligned}
```

A derivation of $b\#c\#b \in L(G)$ is written down as follows:

$$\begin{aligned} S &\Rightarrow \underline{BAB} \Rightarrow \underline{AB} \Rightarrow \underline{BCBB} \Rightarrow b\underline{CBB} \\ &\Rightarrow b\#c\#\underline{BB} \Rightarrow b\#c\#b\underline{B} \Rightarrow b\#c\#b \end{aligned}$$

```
\begin{align*}
    \underline{S} &\rightarrow
    \underline{B}AB \rightarrow
    \underline{A}B \rightarrow
    \underline{B}CBB \rightarrow
    b\underline{C}BB \\
    &\rightarrow
    b\underline{C}B \rightarrow
    b\underline{B} \rightarrow
    b\underline{C}B
\end{align*}
```

3 Computability

Symbols	LaTeX	Description
$\langle M, w \rangle$	<code>\langleangle M, w \rangleangle</code>	Encoding of M, w
\sqcup	<code>\sqcupcup</code>	Blank symbol
Γ	<code>\Gammaamma</code>	Gamma (typically used to denote a tape-alphabet)
$\dot{0}$	<code>\dot{0}</code>	Dot above symbol (used to mark symbols)
A_{TM}	<code>A_{\mathsf{TM}}</code>	Acceptance problem for TMs
$X \leq_m Y$	<code>X \leq_m Y</code>	Mapping reducibility

4 Miscellaneous

Symbols	LaTeX	Description
\wedge	<code>\land</code>	Conjunction
\vee	<code>\lor</code>	Disjunction
\leq	<code>\leq</code>	Less than or equal to
\geq	<code>\geq</code>	Greater than or equal to
“text”	‘‘text’’	Quotation marks
$a \cdot b$	<code>a \cdot b</code>	Multiplication
$x_1 x_2 \dots x_k$	<code>x_1 x_2 \ldots x_k</code>	Ellipsis
$=_{IH}$	<code>=_{\mathit{IH}}</code>	Italics in math
$\mathcal{P}(Q)$	<code>\mathcal{P}(Q)</code>	Power-set of Q
$a \circ b$	<code>a \circ b</code>	Concatenation
w^R	<code>w^{\mathcal{R}}</code>	Reverse as in Sipser

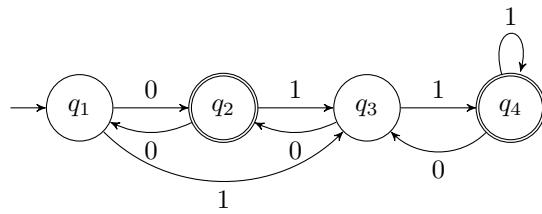


Figure 1: A deterministic finite automaton

5 Drawing automata in **LaTeX** using **TikZ**

Most of the automata in the interactive lectures of TI2316 have been drawn in **LaTeX** using **TikZ**, like for example Figure 1. As an example, we give the code for this figure below. If you would rather use a graphical editor, we recommend **ipe** (<http://ipe7.sourceforge.net/>).

```

\documentclass{article}
\usepackage{tikz}
\usetikzlibrary{automata,arrows}

\begin{document}

\begin{tikzpicture}[->, >=stealth', auto, node distance=1.9cm]
\node[initial,initial text={},state] (q1) {$q_1$};
\node[state] (q2) [right of=q1] {$q_2$};
\node[state] (q3) [right of=q2] {$q_3$};
\node[accepting,state] (q4) [right of=q3] {$q_4$};
\path
(q1)
edge node {$0$} (q2)
edge [out=-45,in=-135] node [below] {$1$} (q3)
(q2)
edge [out=-155,in=-25] node {$0$} (q1)
edge node {$1$} (q3)
(q3)
edge [out=-155,in=-25] node {$0$} (q2)
edge node {$1$} (q4)
(q4)
edge [out=-135,in=-45] node {$0$} (q3)
edge [loop above] node {$1$} (q4);
\end{tikzpicture}
\end{document}
  
```