

TI2316 Automata, Languages and Computability

LaTeX-tips

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May 11, 2017

1 Formal Languages

Symbols	LaTeX	Description
ε	<code>\varepsilon</code>	Symbol for the empty string
L_0^*	<code>L_0^*</code>	Combination subscript and superscript
$\overline{L_1}$	<code>\overline{L_1}</code>	Complement of a language
$(L_0 \cap L_1) \cup L_2$	<code>(L_0 \cap L_1) \cup L_2</code>	Intersection and union
$L_1 \subseteq L_2$	<code>L_1 \subseteq L_2</code>	Subset
$L_1 \subsetneq L_2$	<code>L_1 \subsetneq L_2</code>	Proper subset
$L_1 \subset L_2$	<code>L_1 \subset L_2</code>	Proper subset (alternative)
\mathbb{N}	<code>\mathbb{N}</code>	Set of natural numbers
\emptyset	<code>\emptyset</code>	Empty set
Σ	<code>\Sigma</code>	Sigma (typically denoting an alphabet)
$\{w \in \Sigma^* \mid \dots\}$	<code>\{w \in \Sigma^* \mid \dots\}</code>	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{align*}
S &\to BAB, \\
A &\to aAa \mid bAb \mid BCB, \\
B &\to Bb \mid b \mid \varepsilon, \\
C &\to \#S\# \mid \#c\# \\
\end{align*}

```

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

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

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

3 Computability

Symbols	LaTeX	Description
$\langle M, w \rangle$	<code>\langle M, w \rangle</code>	Encoding of M, w
\sqcup	<code>\sqcup</code>	Blank symbol
Γ	<code>\Gamma</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_{\text{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"	<code>'text'</code>	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>=_{\text{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
$w^{\mathcal{R}}$	<code>w^{\mathcal{R}}</code>	Reverse as in Sipser

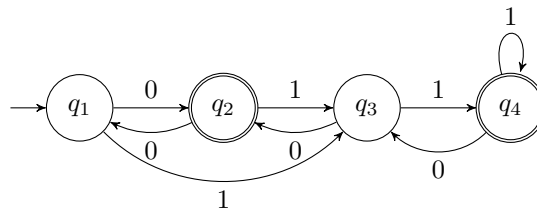


Figure 1: A deterministic finite automaton

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[accepting,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}

```