Embedded Systems

Assignment 7

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7.1 Markov processes

a. The probability $s_2(A)$ is calculated like this:

$$s_2(A) = 0.2 \cdot 0.2 + 0.8 \cdot 0.6 = 0.04 + 0.48 = 0.52$$

b.

$$\begin{aligned} s_{lim}(A) &= s_{lim}(A) \cdot 0.2 + s_{lim}(B) \cdot 0.6 \\ \Leftrightarrow 0.8 s_{lim}(A) &= 0.6 s_{lim}(B) \\ \Rightarrow s_{lim}(A) &= 0.75 s_{lim}(B) \end{aligned}$$

$$\begin{aligned} s_{lim}(A) + s_{lim}(B) &= 1 \\ \Rightarrow s_{lim}(A) + \frac{1}{0.75} s_{lim}(A) &= 1 \\ \Leftrightarrow \frac{1.75}{0.75} s_{lim}(A) &= 1 \\ s_{lim}(A) &= \frac{0.75}{1.75} \\ s_{lim}(A) &= \frac{3}{7} \\ \Rightarrow s_{lim}(B) &= \frac{4}{7} \end{aligned}$$

c. $s_{lim}(A)$ depends on $s_{lim}(B)$. We saw that in the previous part. Furthermore we also know from the previous part that $s_{lim}(A) + s_{lim}(B) = 1$. These two facts suffice to calculate the probabilities without knowing the initial probabilities.

7.2 A/D conversion

- $x = 2.25V \rightarrow 0101_2$

Comparison c	$x < / \geqslant c$?	Output
$3.00V$	$<$	0
$2.00V$	$\geqslant$	1
$2.50V$	$<$	0
$2.25V$	$\geqslant$	1

- $x = 3.75V \rightarrow 1011_2$

Comparison c	$x < / \geqslant c$?	Output
$3.00V$	$\geqslant$	1
$4.00V$	$<$	0
$3.50V$	$\geqslant$	1
$3.75V$	$\geqslant$	1

- $x = 1.80V \rightarrow 0011_2$

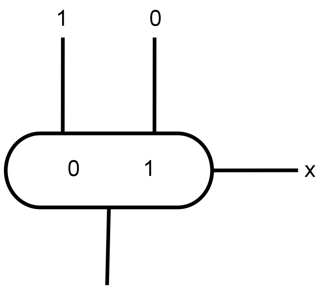
Comparison c	$x < / \geqslant c$?	Output
$3.00V$	$<$	0
$2.00V$	$<$	0
$1.50V$	$\geqslant$	1
$1.75V$	$\geqslant$	1

7.3 Digital circuits

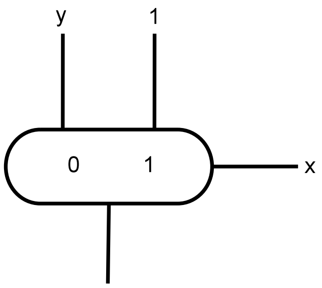
a. One possible instantiation is the following:

- $a = 0$
- $b = 0$
- $c = 1$
- $d = 0$
- $e = 1$
- $f = 1$

b. • $\neg x$:



- $x \vee y$:



7.4 D/A conversion

a.
- Assume $\vec{x} = 00...0. \Rightarrow U = 0 = U_{min} \quad (\forall R')$ ✓
- Assume $\vec{x} = 11...1.$

$$\begin{aligned} -V &= R' \cdot I \\ &= \frac{V_{ref}}{128R} \cdot R' \cdot (128 + 64 + 32 + 16 + 8 + 4 + 2 + 1) \\ &= 5V \cdot R' \cdot \frac{255}{128R} \stackrel{!}{=} 10V \\ \Leftrightarrow R' \cdot \frac{255}{128R} &= 2 \\ \Leftrightarrow R' &= \frac{256}{255}R \\ &= \left(1 + \frac{1}{255}\right) k\Omega \\ &\approx 1.003922k\Omega \end{aligned}$$

b.
- Case $\vec{x} = 011...1$:

$$\begin{aligned} I_1 &= \frac{V_{ref}}{128R} \cdot 127 \\ &= \frac{127}{128} \cdot \frac{5V}{k\Omega} \\ &= 4.9609375mA \end{aligned}$$

- Case $\vec{x} = 100...0$:

$$\begin{aligned} I_2 &= V_{ref} \cdot \frac{128}{128} \cdot \frac{1}{R} \\ &= 5mA \end{aligned}$$

c.

$$
\begin{aligned}
I_{01\ldots1} &< I_{10\ldots0} \\
\Leftrightarrow \frac{V_{ref}}{\hat{R}_{01\ldots1}} &< \frac{V_{ref}}{\hat{R}_{10\ldots0}} \\
\overset{\hat{R}_i>0\,\forall i}{\Longrightarrow} \hat{R}_{10\ldots0} &< \hat{R}_{01\ldots1}
\end{aligned}
$$

$$
\begin{aligned}
\text{Let now be } R(x7)' &= R(x7) \cdot d \\
\Leftrightarrow R \cdot d &< \left(\frac{1}{128R} + \frac{1}{64R} + \frac{1}{32R} + \frac{1}{16R} + \frac{1}{8R} + \frac{1}{4R} + \frac{1}{2R}\right)^{-1} \\
\Leftrightarrow R \cdot d &< \frac{128R}{127} \\
\Leftrightarrow d &< \frac{128}{127} \approx 1.007874
\end{aligned}
$$

$\Rightarrow$ $R(x7)$ may increasingly deviate by at most 7.7874‰, i.e. must necessarily be smaller than $1.007874k\Omega$.

7.5 SDL/Flexray

Please have a look at the handwritten solution which is attached.