

Chapter 6

Activity

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Activity 1

In the signal-flow graph (SFG) in Fig. a, the computation time for each node is assumed to be 1 u.t.

- (1) Calculate the critical path computation time.
- (2) The critical path has been reduced to 2 u.t. by inserting 3 extra latches as shown in Fig. b. Is this a valid pipelining? If not, how to get a valid one.

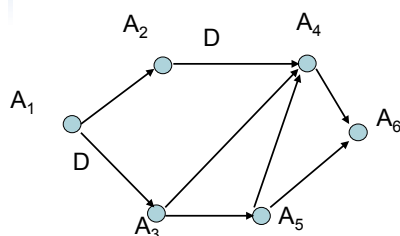


Fig. a

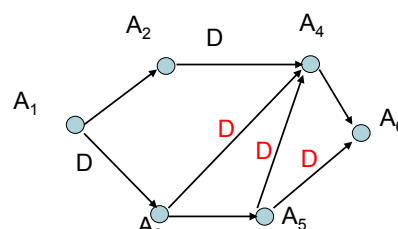
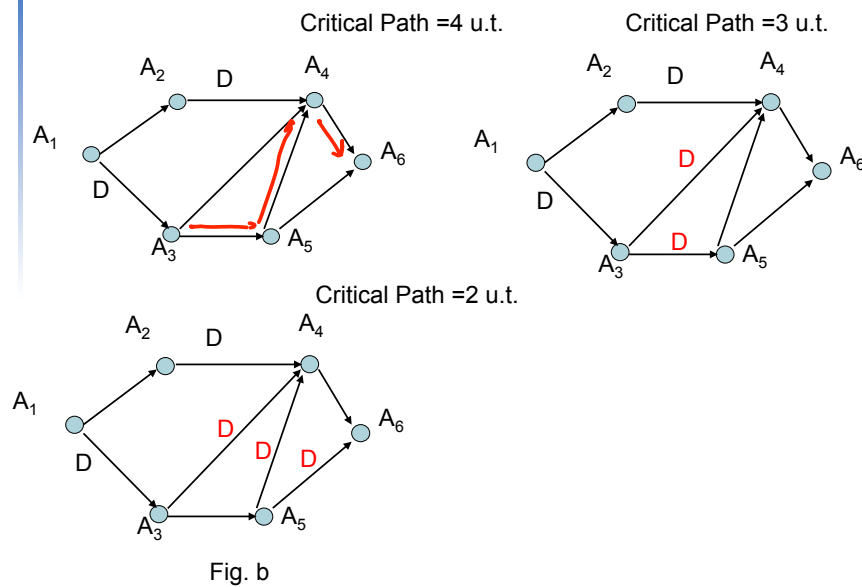
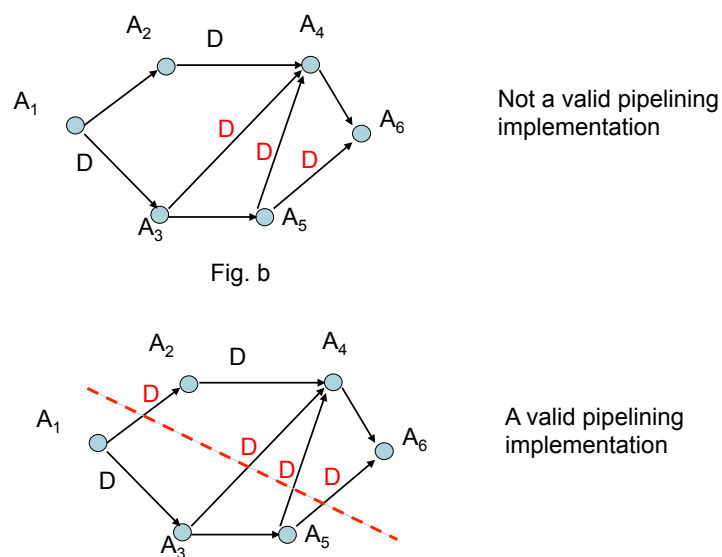


Fig. b

Solution Activity 1



Solution Activity 1

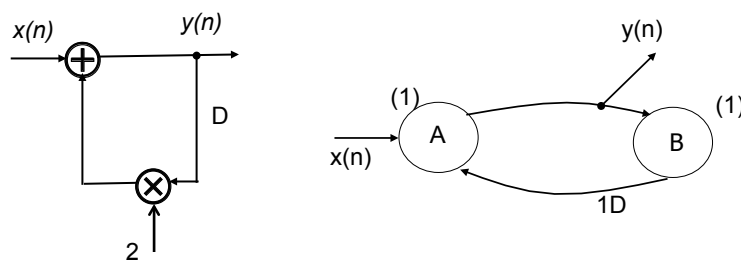


Chapter 7

Activities

Activity 1

Given an IIR filter, $y(n) = 2 \cdot y(n-1) + x(n)$, as shown below. The input $x(n) = 1$ for all n .



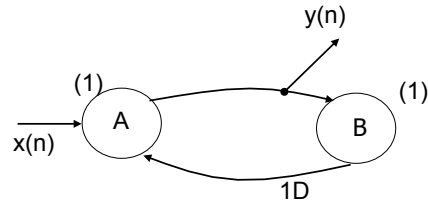
- (1) Find $y(n)$ for $n=0, 1, \dots, 8$, assume $y(n)=0$ for $n<0$. What is minimum clock period? What is iteration time?
- (2) Apply 2-slow transformation, find $y(n)$ for $n=0, 1, \dots, 8$. What is minimum clock period? What is iteration time?

Solution to Activity 1

Given $y(n)=2*y(n-1)+x(n)$ and $y(n)=0$ for $n<0$

We have:

n	y(n)
0	$y(0)=2*y(-1)+x(0)=2*0+1=1$
1	$y(1)=2*y(0)+x(1)=2*1+1=3$
2	$y(2)=2*y(1)+x(2)=2*3+1=7$
3	$y(3)=2*y(2)+x(3)=2*7+1=15$
4	$y(4)=2*y(3)+x(4)=2*15+1=31$
5	$y(5)=2*y(4)+x(5)=2*31+1=63$
6	$y(6)=2*y(5)+x(6)=2*63+1=127$
7	$y(7)=2*y(6)+x(7)=2*127+1=255$
8	$y(8)=2*y(7)+x(8)=2*255+1=511$



$$T_{\text{clk}}=2ut$$

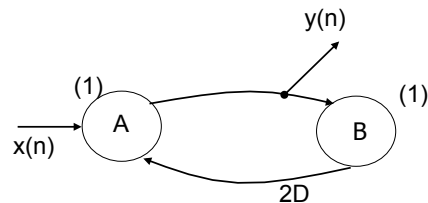
$$T_{\text{iter}}=2ut$$

Solution to Activity 1

For 2-slow, $y(n)=2*y(n-2)+x(n)$ and $x(n)=1,0,1,0,10,\dots$

We have:

n	y(n)
0	$y(0)=2*y(-2)+x(0)=2*0+1=1$
1	$y(1)=2*y(-1)+x(1)=2*0+0=0$
2	$y(2)=2*y(0)+x(2)=2*1+1=3$
3	$y(3)=2*y(1)+x(3)=2*0+0=0$
4	$y(4)=2*y(2)+x(4)=2*3+1=7$
5	$y(5)=2*y(3)+x(5)=2*0+0=0$
6	$y(6)=2*y(4)+x(6)=2*7+1=15$
7	$y(7)=2*y(5)+x(7)=2*0+0=0$
8	$y(8)=2*y(6)+x(8)=2*15+1=31$



$$T_{\text{clk}}=2ut$$

$$T_{\text{iter}}=2*2ut=4ut$$

Activity 2

- Given the following inequalities, draw the constraint graph.

$$r_1 - r_2 \leq 0$$

$$r_3 - r_1 \leq 5$$

$$r_4 - r_1 \leq 4$$

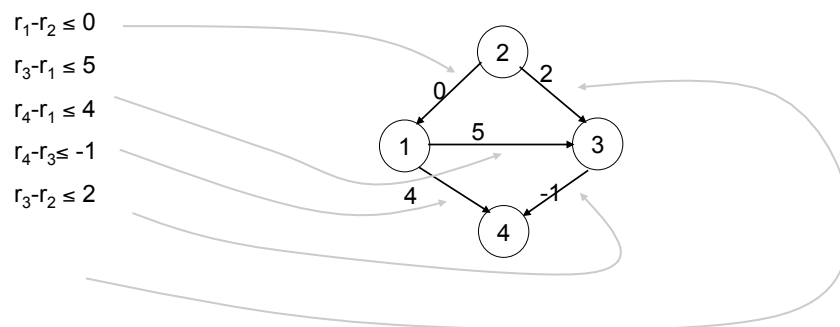
$$r_4 - r_3 \leq -1$$

$$r_3 - r_2 \leq 2$$

Solution to Activity 1

There are 4 variables in 5 inequalities, so $N=4$

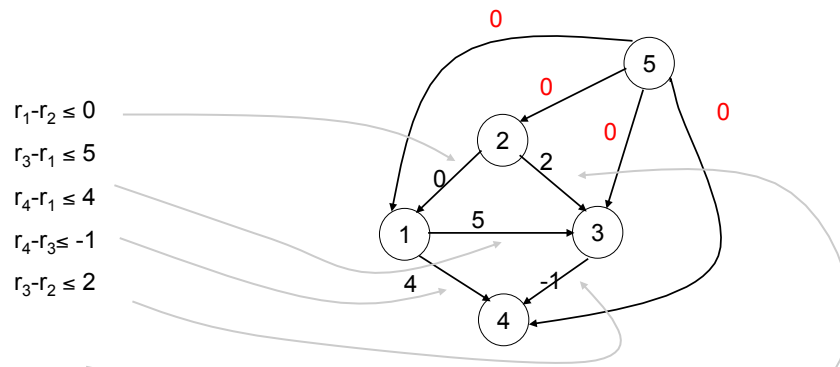
We first draw 4 nodes, e.g. nodes 1 to 4, based on given inequalities



Solution to Activity

Next, we draw the node N+1, e.g. node 5

Connect node 5 to other nodes with length 0



Solution to Activity

No negative cycles in the constraint graph. This can be verified by Bellman-Ford algorithm in Appendix A.

A solution can be found: $r(1)=r(2)=r(3)=0$, $r(4)=-1$

$$r_1 - r_2 \leq 0$$

$$r_3 - r_1 \leq 5$$

$$r_4 - r_1 \leq 4$$

$$r_4 - r_3 \leq -1$$

$$r_3 - r_2 \leq 2$$

$W = \begin{bmatrix} 0 & \text{inf} & 5 & 4 \\ 0 & 0 & 2 & \text{inf} \\ \text{inf} & \text{inf} & 0 & -1 \\ \text{inf} & \text{inf} & \text{inf} & 0 \end{bmatrix}$

