

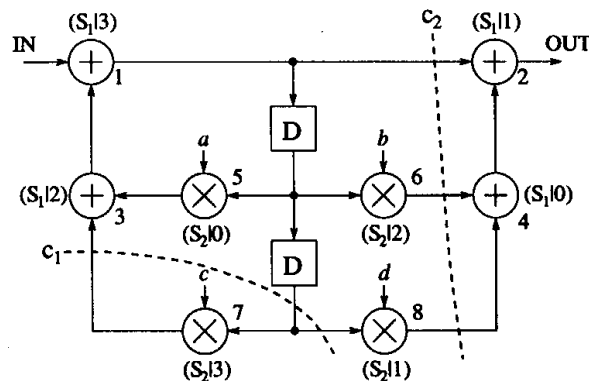
Chapter 8

Activities

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Activity 1

Given the biquad filter below, (1) find folding equations, (2) can it be folded? If not, retiming it.

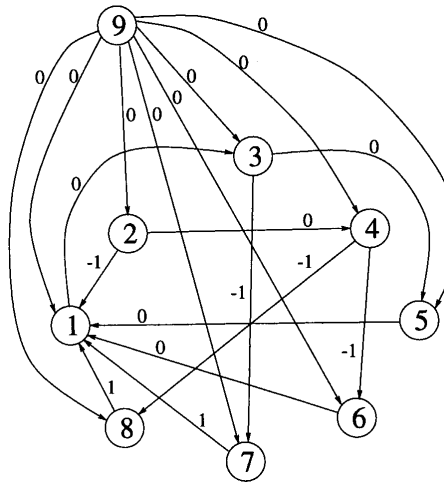


Activity 1 Solution

$$D_F(U \xrightarrow{e} V) = Nw(e) - P_u + v - u \quad r(U) - r(V) \leq \left\lfloor \frac{D_F(U \xrightarrow{e} V)}{N} \right\rfloor$$

Edge	Folding Equation	Retiming for Folding Constraint
1 → 2	$D_F(1 \rightarrow 2) = -3$	$r(1) - r(2) \leq -1$
1 → 5	$D_F(1 \rightarrow 5) = 0$	$r(1) - r(5) \leq 0$
1 → 6	$D_F(1 \rightarrow 6) = 2$	$r(1) - r(6) \leq 0$
1 → 7	$D_F(1 \rightarrow 7) = 7$	$r(1) - r(7) \leq 1$
1 → 8	$D_F(1 \rightarrow 8) = 5$	$r(1) - r(8) \leq 1$
3 → 1	$D_F(3 \rightarrow 1) = 0$	$r(3) - r(1) \leq 0$
4 → 2	$D_F(4 \rightarrow 2) = 0$	$r(4) - r(2) \leq 0$
5 → 3	$D_F(5 \rightarrow 3) = 0$	$r(5) - r(3) \leq 0$
6 → 4	$D_F(6 \rightarrow 4) = -4$	$r(6) - r(4) \leq -1$
7 → 3	$D_F(7 \rightarrow 3) = -3$	$r(7) - r(3) \leq -1$
8 → 4	$D_F(8 \rightarrow 4) = -3$	$r(8) - r(4) \leq -1$

Activity 1 Solution



Activity 1 Solution

From constraint graph (or inequality equations), we can find the weight matrix. Then we can use Bellman-Ford Algorithm to find the solution, i.e. $r(1)=-1$, $r(2)=0$, $r(3)=-1$, $r(4)=0$, $r(5)=-1$, $r(6)=-1$, $r(7)=-2$, $r(8)=-1$, as shown below.

The screenshot shows the MATLAB R2012a interface. The Command Window displays the following code and output:

```
>> w
w =
    0   Inf    0   Inf   Inf   Inf   Inf   Inf
   -1    0   Inf    0   Inf   Inf   Inf   Inf
   Inf   Inf    0   Inf    0   Inf   -1   Inf
   Inf   Inf   Inf    0   Inf   -1   Inf   -1
    0   Inf   Inf   Inf    0   Inf   Inf   Inf
    0   Inf   Inf   Inf   Inf    0   Inf   Inf
    1   Inf   Inf   Inf   Inf   Inf    0   Inf
    1   Inf   Inf   Inf   Inf   Inf    0   Inf

>> bellman(w)
ans =
   -1    0   -1    0   -1   -1   -2   -1    0
```

The Workspace window shows the following variables:

Name	Value
W	<8x8 double>
ans	[-1.0 -1.0 -1.1...]
w	<8x8 double>

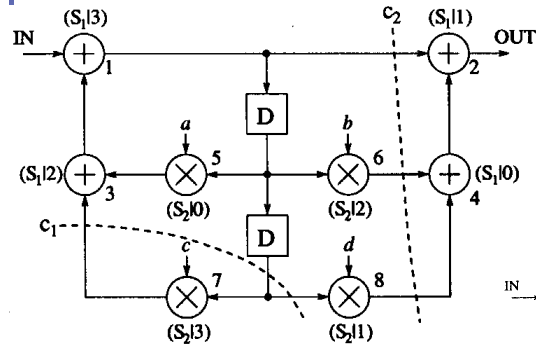
The Command History window shows the following commands:

```
w
how to import .mat
w.mat
w
clear
clear
clear
w
bellman(w)
```

Activity 1 Solution

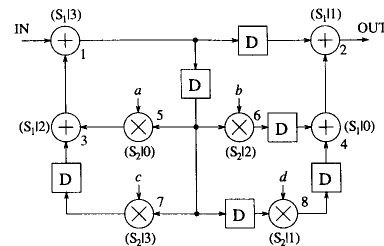
- One solution is found from the constraint graph using Bellman-Ford Algorithm
- $r(1)=-1$ $r(2)=0$ $r(3)=-1$ $r(4)=0$
- $r(5)=-1$ $r(6)=-1$ $r(7)=-2$ $r(8)=-1$

Activity 1 Solution



$r(1)=-1$ $r(2)=0$ $r(3)=-1$ $r(4)=0$
 $r(5)=-1$ $r(6)=-1$ $r(7)=-2$ $r(8)=-1$
 Apply retiming property IV (add 1 to each retiming value, we have:

$r(1)=0$ $r(2)=1$ $r(3)=0$ $r(4)=1$
 $r(5)=0$ $r(6)=0$ $r(7)=-1$ $r(8)=0$



Retimed DFG

Activity 2

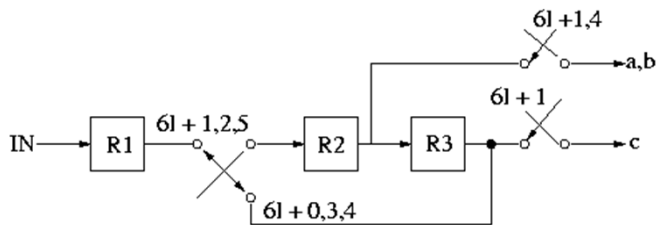
Given the linear lifetime chart below, (1) derive the data allocation using forward-backward register allocation; (2) synthesis the architecture.

cycle	a_0	b_0	c_0	# live
0				0
1				1
2				2
3				2
4				2
5				2
6				$2+0=2$
7				$2+1=3$

Activity 2 Solution

cycle	input	R1	R2	R3	output
0	a				
1	b	a			
2		b	a		
3			b	a	
4	c			b	
5		c			
6			c		
7				c	c

cycle	input	R1	R2	R3	output
0	a				
1	b	a			
2		b	a		
3			b	a	
4	c		(a)	b	a
5		c	b		
6			c	b	
7			(b)	(c)	b, c



cycle	a_0	b_0	c_0	# live
0				0
1				1
2				2
3				2
4				2
5				2
6				$2+0=2$
7				$2+1=3$