Linear Network Fractional Routing

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***Abstract*—A Network is a finite directed acyclic graph with source messages from a fixed alphabet and message demands at sink nodes. Linear Programming is an algorithm design method. It can be used when the solution to a problem can be viewed as the result of a sequence of decisions. The Linear Programming model for the network problem where in every variable has a value one or zero. The problem is to determine a method of transmitting the messages through the network such that all sink demands are satisfied. We will prove fractional routing capacity for some solvable network using Linear Programming model.**

Keywords-Capacity, flow,Fractional Routing, Linear Programming

I. INTRODUCTION

The maximum flow problem can be solved by linear programming method. The maximal flow in the network is $F=f_1+f_{2+}f_{3+\ldots+}f_n$. The flow is computed by subtracting the last residuals (Cij) in final iterations from the initial capacities (Cij). Define x_{ij} as the amount of flow in arc (i,j) with capacity Cij. The objective is to determine x_{ij} for all I and j that will maximize the flow between start node(s) and Sink node (t) subject to flow restrictions (Outflow = Inflow) at all but nodes source and sink. The associated maximum flow is z1=z2.

II. RELATED WORK

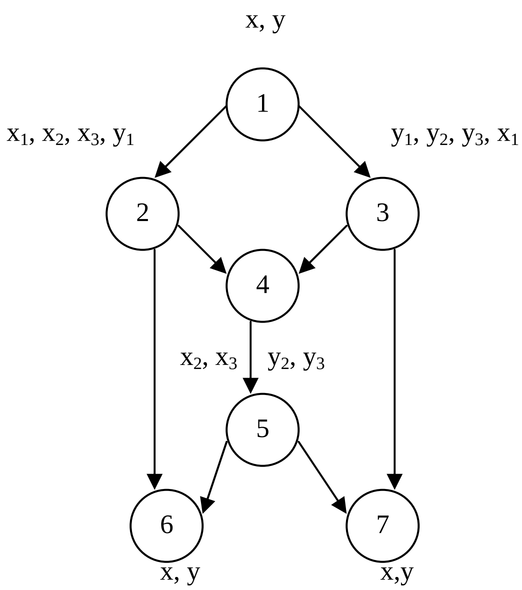


Fig. 2.1. The multicast network N_1 whose routing capacity is 3/4..

Statement: One source emits a message and both messages are demanded by the two sinks.

Proof :

Table 2.1 Transition table

State	Input x_1	Input x_2	Input x_3	Input y_1	Input y_2	Input y_3
1	{2,3}	2	2	{2,3}	3	3
2	6	6	6	6	ϕ	ϕ
3	7	ϕ	Φ	7	{4,7}	{4,7}
4	ϕ	5	5	ϕ	5	5
5	ϕ	7	7	ϕ	6	6
6	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ
7	ϕ	ϕ	ϕ	ϕ	ϕ	ϕ

$\delta(1, x_1) = \{2,3\}$

where 1 is the state and x_1 is an input symbol.

$\delta(1, y_1) = \{2,3\}$

where 1 is the state and y_1 is an input symbol.

Where δ is a transition function from one state to another state.

Select common state {2,3}

Edges (1,2) and (1, 3) for first row wise and select common state {4,5}.

Where k be the dimension of the message and n be the capacity of the edges.

K = 3 and n=4.

The routing capacity of this network is Є=3/4.

III. PROPOSED ALGORITHM

Step 1 : Select the path from source node to sink node.

Step 2 : Find f_1 values using selected path from node 1 to node N where $f_1 = \min(a1,a2,a3,\ldots\ldots aN)$

Step 3 : Find Cij = Wij - f_1 until $C_{ij} = 0$.

Step 4: Find the maximum flow = Initial capacity value – final flow value.

Step 5: Sum of the flow values $F= f_1+ f_2 +f_3 +\ldots..+f_n$

Step 6: Max Flow = $\overline{Cij}$ - Cij

Step7 : consider the Arc, flow In = +1 and flow Out = -1

Step8: max z1 = Total Outflow from source node

Step 9: max z2 = Total Inflow to sink node.

Step10 : Find the flow amount using inequality

Flow In – Flow Out = 0.

Step 11: Find the optimal solution using either objective function. The associated maximum flow value is z1 and z2.

Step 12: Find the Linear Network fractional routing using the formula.

Network fractional routing = Flow / Capacity.

IV. LINEAR NETWORK FRACTIONAL ROUTING EXAMPLE

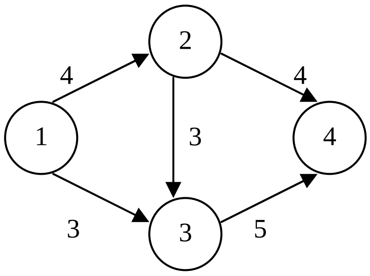


Fig. 4.1. Initial Capacity

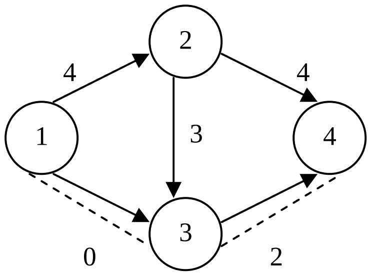
Find f_1

Let $N_1 = \{1,3,4\}$

$$f_1 = \min (a1, a3, a4)$$
$$= \min (\alpha, 3, 5)$$
$$f_1 = 3$$

$$C_{13} = W_{13} - f_1$$
$$= 3 - 3$$
$$C_{13} = 0$$
$$C_{34} = W_{34} - f_1$$
$$= 5 - 3$$
$$C_{34} = 2$$

Now modify the diagram

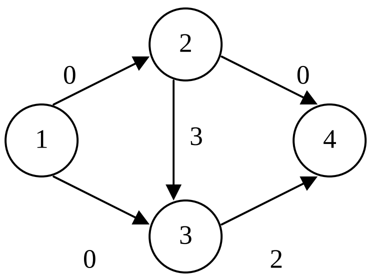


Let $N_2 = \{1,2,4\}$

$$f_2 = \min (a1, a2, a4)$$
$$= \min (\alpha, 4, 4)$$
$$f_2 = 4$$

$$C_{12} = W_{12} - f_2$$
$$= 4 - 4$$
$$C_{12} = 0$$
$$C_{24} = W_{24} - f_2$$
$$= 4 - 4$$
$$C_{24} = 0$$

Now modify the diagram



Let N_3= {1,2,3, 4}

$$f_3 = \min (a1, a2, a3, a4)$$
$$= \min (\alpha ,0, 3, 2)$$
$$f_3 = 0$$

$$C_{12} = W_{12} - f_3$$
$$= 0 - 0$$
$$C_{12} = 0$$
$$C_{23} = W_{23} - f_3$$
$$= 2- 0$$
$$C_{23} = 2$$

Modify the diagram

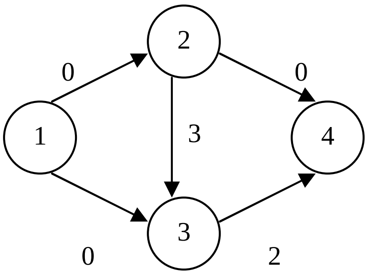
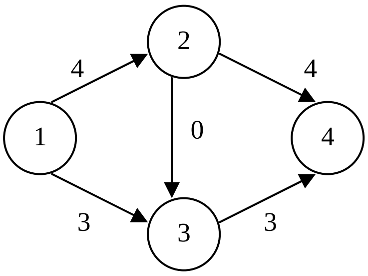
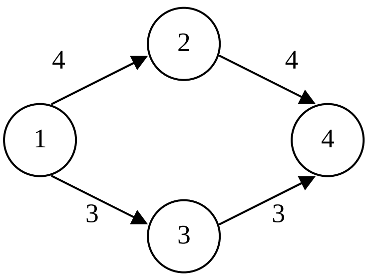


Fig 4.2. Final Flow Values

Max-flow = Initial Capacity.– Final Flow Values



The flow graph



x12= 4, x13 = 3, x24 = 4, x34= 3

Maximum Flow (F) = $f_1 + f_2 + f_3$
$= 3+4+0$
$= 7$

Table 4.1. Linear Programming Model

Arc	$\overline{Cij}$ - Cij	Flow	Direction	Variable
(1,2)	4 – 0	4	1->2	x12
(1,3)	3 – 0	3	1->3	x13
(2,3)	3 – 3	0	--	
(2,4)	4 - 0	4	2->4	x24
(3,4)	5 – 2	3	3->4	x34

Incoming = +ve sign
Outgoing = - ve sign

Table 4.2. Optimal solution

	x12	x13	x23	x24	x34	
max z1	1	1				
max z2				1	1	
Node 2	1		-1	-1		=0
Node 3		1	1		-1	=0
Capacity	4	3	3	4	5	
Flow	4	3	0	4	3	

The optimal solution using either objective function is

X12=4 , x13= 3, x24= 4 , x34 = 3.

max z1 = x12 + x13
= 4 +3
= 7
max z2 = x24 + x34
= 4 + 3
= 7

The associated maximum flow is z1=z2=7. Therefore the maximum flow is 7.

V. RESULTS AND DISCUSSION

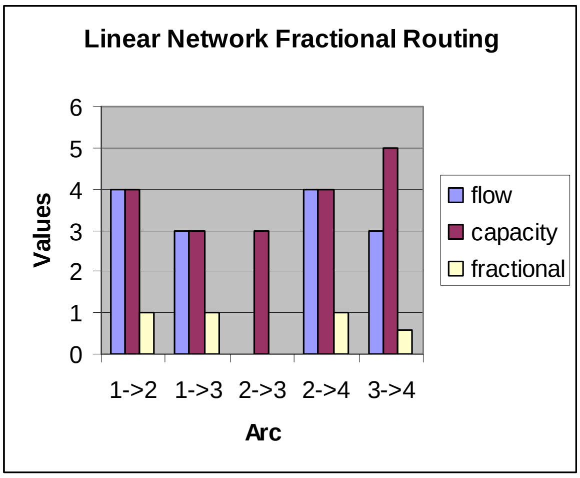


Fig 5.1 Linear Network Fractional Routing

Fig. 5.1. Depicts the linear fractional routing capacity values are lies between 0 and 1.

VI. CONCLUSIONS

The associated Linear Programming with two different but equivalent, objective functions depending on whether we maximize the output from source node (=z1) or the input to sink node (=z2). This paper formally defined the concept of the fractional routing capacity of a network and it is proved by an example. If a network is linearly solvable, then the linear coding capacity is greater than or equal to one.

VII. FUTURE WORK

Every positive rational number is the routing capacity of some solvable network. An algorithm for determining the routing capacity .we will briefly describe some of the algorithm for solving minimization of Deterministic Finite Automata problems.

VIII. REFERENCES

[1] Dr. V.Palanisamy, S.Asokan "Network Fractional Routing," International Journal on Computer Science and Engineering, vol. 02, No. 04, pp. 1303 -1307, July 2010.

[2] S.-Y. R. Li, R. W. Yeung, and N. Cai, "Linear network coding," *IEEE Trans. Inf. Theory*, vol. 49, no. 2, pp. 371–381, Feb. 2003.

[3] Jillian Cannons, Randall Dougherty, Chris Freiling and Kenneth Zeger," Network Routing Capacity", IEEE transactions on information theroy, vol.52, No. 3, march 2006.

[4] R. W. Yeung, *A First Course in Information Theory*. New York: Kluwer, 2002.

[5] M. Feder, D. Ron, and A. Tavory, "Bounds on linear codes for network multicast," in *Electronic Colloquium on Computational Complexity (ECCC)*, 2003, Rep. 33, pp. 1–9.

[6] R. Ahlswede, N. Cai, S.-Y. R. Li, and R. W. Yeung, "Network information flow," *IEEE Trans. Inf. Theory*, vol. 46, no. 4, pp. 1204–1216, Jul. 2000.

[7] S. Riis, "Linear versus nonlinear boolean functions in network flow," in *Proc. 38th Annu. Conf. Information Sciences and Systems (CISS)*, Princeton, NJ, Mar. 2004.