Coding and Information Theory

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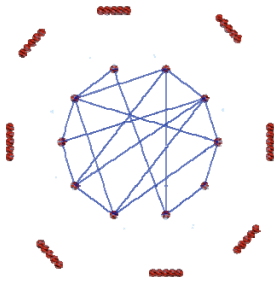
Efficient, Fast Data Transfer in Large Networks

Network coding enables faster and more efficient data transfer between nodes of a large network.



Simplifying the network coding problem for large scale networks.

The idea of network coding, i.e allowing intermediate nodes of a network to combine packets before forwarding, has been a subject of active current research. A simple and effective algebraic formulation of the general network coding problem, introduced by Koetter and Medard, established a direct connection between a network information flow problem and a set of algebraic equations. The algebraic formulation, while being simple and powerful, results in equations that are not readily amenable to easy solution in many cases. Hence, the network code cannot be easily found for large networks with multiple sources and sinks.

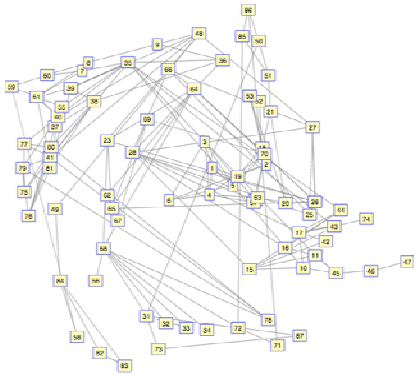


Fig 1: Large networks with multiple nodes.

Our main result is to derive an alternative algebraic formulation for the general scalar linear network coding problem. Specifically, we show a correspondence between linear linear network-coded information flow in a given network and additive flows in an equivalent set of directed trees. We then use the additive flow in the set of trees to derive a system of polynomial equations that provides an algebraic formulation for the network coding problem in the original network.

Surprisingly, this set of equations has a maximum degree of only 2. Moreover, the form of the equations has additional structure that can be exploited in several cases.

Direct formulation

8 equations and 10 variables

Our formulation

1 equation in 2 variables:

ab=1

Fig 2: Set of Equations.

We illustrate this simplification through the standard butterfly network example and a much larger Internet Service Provider (ISP) network example.

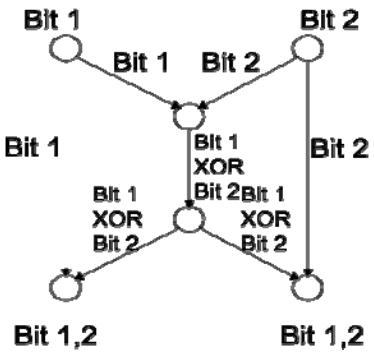


Fig 3: Standard Butterfly Network.

ISP Network on left: 87 nodes, 161 edges

Sources/Sinks	Direct formulation	Our formulation
5 sources, 10 sinks	44 eqns, 30 vars	3 eqns, 7 vars
10 sources, 11 sinks	88 eqns, 180 vars	Unsolvable in char 2

Fig 4:. Internet Service Provider (ISP) network

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