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A Mathematical Tool For Energy Management

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ABSTRACT

Inventory modeling is one of the most developed fields of operations management. An interesting branch of inventory theory is the mathematical modeling of deteriorating items .This paper reveals the scope of applying the results of the combinatorial (mathematical) game “Graph rubbling” in energy management.

KEYWORDS: Graph rubbling, Mathematical model, Deteriorating inventory ,combinatorial game, Energy management

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INTRODUCTION

Inventory modeling is one of the most developed fields of operations management. An interesting branch of inventory theory is the mathematical modeling of deteriorating items.This paper reveals the scope of applying the results of the mathematical game "*Graph rubbling*"in energy management.

A survey on deteriorating models is available in Fred[1].

Usually goods are stored at specified placed and is then moved to the destination. This is not possible in case of energy management.

MODELLING

Problem : Suppose in a city, energy (electricity) is supplied to the households of different street by erecting separate transformers.City receives energy from different sources.Assume that all house holders are supplied with same amount of energy.During the transmission, half of the energy is lost.To meet the energy requirement of the city the authorities has to finalise the total energy required.

The following assumptions are made.

(i)Half of the item will be lost when the inventory is transported from one place to another.

(ii) The energy supplied to each destination is one unit.

MODELLING:

The houses/junctions are represented by points and the connection between the points are represented by edges, the network

can be represented by means of a graph.

The energy problem can be easilysolved to an extend by means of a mathematical game, graph rubbling.

The concept of graph rubbling was introduced byChristopher

Graph rubbling is a variation of *graph pebbling*introduced by Chung FRK .

Suppose t pebbles are distributed onto the vertices of a graph G. A pebbling step [u, v] consists of removing two pebbles from one vertex u and then placing one pebble at an adjacent vertex v. We say a pebble can be moved to a vertex r, the root vertex, if we can repeatedly apply pebbling steps so that in the resulting distribution r has one pebble. For graph theory terminology, refer any standard text book in graph theory

Definition: For a graph G, we define the pebbling number, f(G), to be the smallest integer t such that, for any distribution of t pebbles onto the vertices of G, one pebble can be moved to any specified root vertex r.

Notation[2]: Let p be a pebble function on G. The notation $p(v_1, v_2, \ldots, v_n, \square) =(a_1, a_2, \ldots, a_n, b(\square))$ denotes $p(v_i) = a_i$ for all $i \in \{1, 2, \ldots, n\}$ and $p(w) = b(w)$ for all $w \in V(G) \setminus \{v_1, v_2, \ldots, v_n\}$.

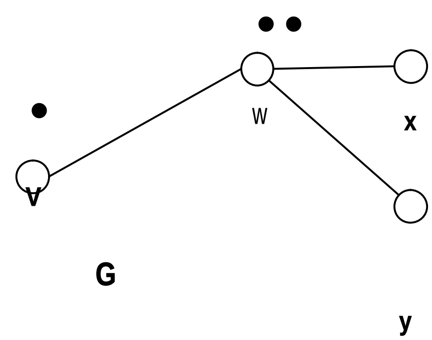

Figure 1: The above graph has pebble distribution p with p(v,w, ∗) = (1, 2, 0).

Definition[2]: Let p be a pebble function on G, and suppose that $w \in V(G)$ has adjacent vertices u and v. Then a *rubbling move*

$r = (u, v \to w)$ produces a new pebble function p_r on G defined by the following:

(i) If u and v are different, then $p_r(u, v, w, \ast) = (p(u) - 1, p(v) - 1, p(w) + 1, p(\ast))$.

(ii) If u = v, then $p_r(u, w, \ast) = (p(u) - 2, p(w) + 1, p(\ast))$.

Place a whole number of pebbles on the vertices of a simple, connected graph G; this is called a pebble distribution. A rubbling move consists of removing a total of two pebbles from some neighbor(s) of a vertex v of G and placing a single pebble on v. A vertex v of G is called reachable from an initial pebble distribution p if there is a sequence of rubbling moves which, starting from p, places a pebble on v. The rubbling number of a graph G, denoted ρ(G), is the least k such that for any distribution p of k pebbles, any given vertex of G is reachable.

The rubbling number of various classes of graphs are calculated in Christopher [2].Also using the bounds , we can estimate the upper bound and lower bound of energy requirement for the city.

Here we place the rubbling numbers from Christopher[2].Note that the rubbling number ρ is the total energy required.

1. $2\mathrm{diam}(G) \le \rho(G)$ for any graph G;
2. $\rho(K_n) = 2$ where Kn is the complete graph on n vertices with $n \ge 2$;

3. $\rho(Wn) = 4$ where Wn is the wheel graph on n vertices with $n \geq 5$;
4. $\rho(Km_1,m_2,...,m_l) = 4$ where $Km_1,m_2,...,m_l$ is the complete l-partite graph on $m_1 + m_2 + \cdots + m_l$ vertices and $m_i \geq 2$;
5. $\rho(Qn) = 2n$ where Qn is the n-dimensional hypercube;
6. $\rho(Pn) = 2n-1$ where Pn is the path on n vertices;
7. $\rho(\text{Petersen}) = 5$;

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