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Application of Perfect Domination in Logistics Services Using Web Service Composition

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ABSTRACT

In this paper we have made an attempt to provide a possible solution, pathway for a select logistics operation in an organization that is involved in the transportation of goods between various cities and towns across India. A solution has been suggested through an inter-disciplinary approach by using Graph Theory as the conceptual base and using Information Technology as part of concrete solution that is practically applicable. Perfect domination concept in

Graph theory help to identify the perfect regional centre for the given town. Web Service Composition helps to create high-level business process by connecting the web services required to concretize the concept suggested by Graph Theory.

Keywords: Perfect domination, weighted graph, Logistics service, Web service composition, Sequence diagram.

1. INTRODUCTION

Logistics or Supply Chain Management as, it is called is an integral part of today's business environment as it facilitates movements of goods between the point of origin and the point of consumption in order to meet the requirements of consumers. Logistics involve the integration of information, transportation and inventory, warehousing, material-handling, and packaging.

There are many practical real-life logistics problems encountered regularly, such as mail delivery, goods delivery etc. require many complex strategic and operational planning decisions. The main problems include locating depots, designing sectors, routing service vehicles, vehicle scheduling etc., for which solutions can be provided by graph theory algorithms. Since this industry is growing in leaps and bounds, the challenges faced are also highly complex and require a mathematical solution and graph theory aptly suits the requirement.

2. MOTIVATION FOR APPLYING PERFECT DOMINATION PARAMETER IN LOGISTICS SERVICES

In this paper, there is an organization which has major logistics points, that is, the regional office located across major cities. These regional offices are the centre points for receiving and re transporting goods to the nearby towns. Each of this regional office has list of small towns, where the logistical operational requirements are minimum transportation distance and cost to include or exclude small towns connected to the regional office. If the organization wants to include new towns with one of the above existing regional offices, there are challenges faced to manually identify the possible regional centre because it involves the calculation of various towns spread across the specified region with varied distances which is a tedious process and possible chances of error is also very high.

The requirement here would be to pin point one perfect regional office that would be selected for including a town from the area with highest accuracy possible with a condition that no two regional offices would be involved in the service of same town as it would mean a duplication of work and also increase in the cost and time consumption. Perfect Domination parameter concept is applied for this purpose.

To evolve a practically applicable solution, we have tried to synchronize the concept from graph theory and used IT platform as a technical tool for effective implementation.

A solution has been suggested through an inter-disciplinary approach by using Perfect domination parameter as the conceptual base in Logistical services and using Information technology as part of concrete solution that is practically applicable. Perfect domination concepts in Graph theory helps to identify the perfect regional centre, such that no two regional offices will dominate the same town. Hope that this solution offered enhances the operational efficiency of the organization.

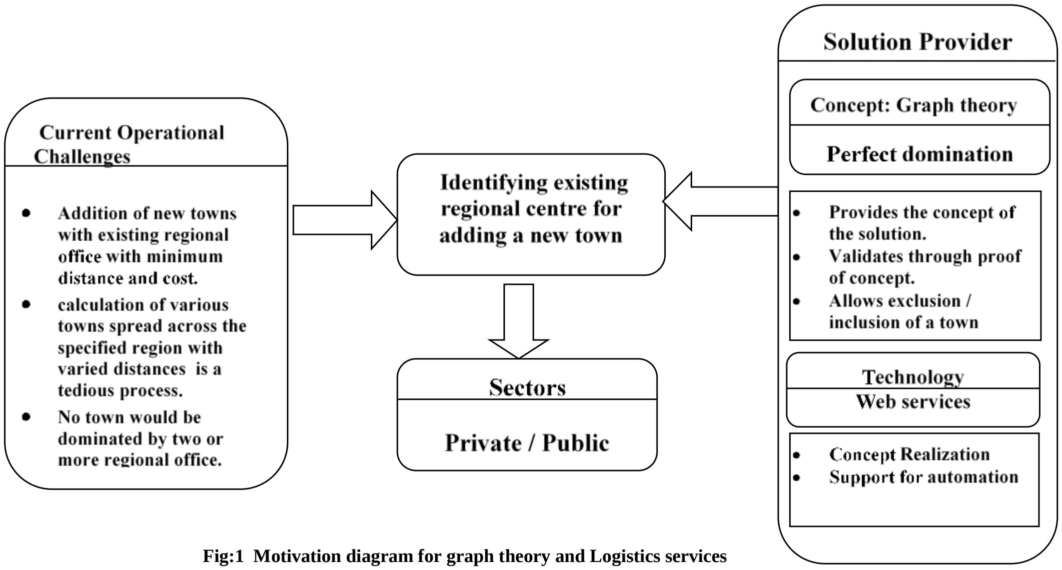

Fig:1 Motivation diagram for graph theory and Logistics services

3. RELATED WORK

3.1 Graph Theory - Perfect Domination Parameter

Graph theory has a wider application in the real word offering solutions to complex problems faced by the world. The concept of Perfect Domination Set in Graphs in particular has a far reaching impact in offering solutions for such problems. Especially identifying the Regional centre which dominates the set of vertices (towns) such that no town is dominated by two regional centres.

In this paper let us consider $G = (V, E)$ as a simple connected weighted graph with a vertex set $V (G)$ and edge set $E (G)$.Let w be the weight , such that which is the distance between two vertices in the graph is the weight of an edge e and is denoted by $w(e)$.[5,6]

Generally Perfect dominating set of a simple connected graph is defined as; A Subset $S \subseteq V (G)$ is a perfect dominating set if for every vertex $v \in V - S$, $\left| N(v) \cap S \right| = 1$ where N (v) is the open neighbourhood of v. The minimum cardinality perfect dominating set is called as Perfect domination number; the maximum cardinality perfect dominating set is called as Upper Perfect domination number.

Let us define the Perfect dominating set for a simple connected weighted graph as follows: A Subset $S_i \subseteq V (G)$ is a perfect domination set if (i) for every vertex $v \in V - S_i$, $\left| N(v) \cap S_i \right| = 1$ where N (v) is the open neighbourhood of v, S_i is $\{S_i / S_1, S_2 \ldots S_n \in S_i\}$. (ii) If $\left| N(v) \cap S_i \right| \neq 1$, then consider $S_j \subset S_i$, $S_j = \{S_j / \text{dist}(v, S_j) \leq D\}$, where D is an assumed distance (iii) If again $\left| N(v) \cap S_j \right| \neq 1$ then consider $S_k \subset S_j$, $S_k = \{ S_k / \text{mini}(S_j)\}$.

3.2 Web Service Composition:

IT services are being used to make this graph theory application into a functional format. It is a comprehensive representation of the technical tools that are used for the purpose of the application of the graph theory and to illustrate how the research concept can be made into simple practice. The web services are the most commonly used in such large net work services because of its least interruption, easy accessibility and availability, strong service net work and cost effectiveness. Service Composition provides an open, standards-based approach for connecting web services together to create higher-level business processes. Standards are designed to reduce the complexity required to compose web services, hence reducing time and costs, and increase overall efficiency in businesses.

Web Service composition is a process of selecting and aggregating a set of appropriate services to automate a business process, when no existing service can satisfy the user request. By choosing appropriate web services offered by different web service providers, specifying their coordination plan, and implementing the plan through an orchestration engine, the composite web service can provide more valuable and complete service than a single web service. This also enhances the reusability of web services. Web service composition is facilitated by semantic web services as they extend the web service descriptions with semantic annotations about properties, capabilities, interfaces, and effects. Such a semantic annotation of web service description, stated as Service ontology, provides a conceptualization of set of services related to a particular domain. Semantic web service composition helps in automating discovery, planning and execution of a set of services required to accomplish a complex task.

4. PROOF OF CONCEPT

Let **S = {A, B, C, D, E}** be the set of available web services in the registry such that each element of **S** is a family of web services.

Let **A** = $\{a_1,a_2,a_3,\ldots..a_n\}$be the set of web services used to calculate the distance between two places.

Let **B** = $\{b_1,b_2,b_3,\ldots..b_n\}$be the set of web services used to calculate Perfect domination criteria, for every $v \in V - S_i$, $\left| N(v) \cap S_i \right| = 1$

Let **C** = $\{c_1,c_2,c_3,\ldots..c_n\}$be the set of web services used to find the set $S_j \subset S_i$,
$S_j = \{S_j / \text{dist}(v, S_j) \leq m\}$, where m is an assumed distance.

Let **D** = $\{d_1,d_2,d_3,\ldots..d_n\}$be the set of web services used to find the set $S_k \subset S_j$,
$S_k = \{ S_k / \text{mini}(S_j)\}$.

Let **E** = $\{e_1,e_2,e_3,\ldots..e_n\}$be the set of web services used to find the Perfect domination set S.

Let $A \subset$ **A** such that $A = \{ a_i,a_{i+1},a_{i+2},\ldots..a_r / a_i < a_{i+1} < ,\ldots..< a_r\}$, omit all a_i's and retain a_r in **S.**

Similarly $B \subset$ **B** such that $B = \{ b_i,b_{i+1},b_{i+2},\ldots..b_r / b_i < b_{i+1} < ,\ldots..< b_r\}$, omit all b_i's and retain b_r in **S.**

$C \subset$ **C** such that $C = \{ c_i,c_{i+1},c_{i+2},\ldots..c_r / c_i < c_{i+1} < ,\ldots..< c_r\}$, omit all c_i's and retain c_r in **S.**

$D \subset$ **D** such that $D = \{ d_i,d_{i+1},d_{i+2},\ldots..d_r / d_i < d_{i+1} < ,\ldots..< d_r\}$, omit all d_i's and retain d_r in **S.**

$E \subset$ **E** such that $E = \{ e_i,e_{i+1},e_{i+2},\ldots..e_r / e_i < e_{i+1} < ,\ldots..< e_r\}$, omit all e_i's and retain e_r in **S.**

Thus the web services set **S** = {a_r, b_r, c_r, d_r, e_r} are with least interruption, easy accessibility and availability. Here {a_r}{ b_r } are the set of web services used are independent, but { c_r, d_r,} are the set of web services used sequentially and are depends on the web service {b_r}. Hence let us define a function $f : a_r \rightarrow b_r$, $g : c_r \rightarrow d_r$ and $h : d_r \rightarrow e_r$ such that the perfect domination set S can be calculated by $h \circ (g \circ f) : a_r \rightarrow e_r$, this can be simply denoted as $h \circ (g \circ f)(x)$.

Let us show the correctness of composition of functions using the theory of inferences. Consider the following notations a_r : D, b_r : P, c_r : Q , d_r : R ,e_r: S and the set premises are $D \rightarrow P$, $Q \wedge R$, $Q \wedge R \rightarrow P$, $P \rightarrow S$, Conclusion: S

Step	Derivation	Rule
(1)	$D \rightarrow P$	P
(2)	$Q \wedge R$	P
(3)	$Q \wedge R \rightarrow P$	P
(4)	P	T (Modus Ponens, from (2) &(3))
(5)	$P \rightarrow S$	P
(6)	S	T (Modus Ponens from (4) &(5))

5. AN ALGORITHMIC APPROACH

Input: X
Web services required: Find Distance, Calculate Perfect Dominating Criteria, and Find Perfect Dominating Vertex
Output: a Perfect dominating vertex

Identify - RO (X)

```
a. Let X be a city for which the regional centre should be identified.
b. Let V(G) = The regional office indexed 1 and cities nearby regional office indexed 2
c. Let S ⊆ V(G) is the perfect dominating set. S = {R1, R2, R3, ...,Ri,..., Rn}.
d. Let N = { Ri / Ri∈ V – {X} and (Ri,X) ∈ E}// open neighbourhood of X
e. While (modulus(N ∩ S) ≠ 1)
   {
      for i := 1 to n //N contains n elements
      {
            if (dist(X,N[i]) > D) then
                  N = N – N[i];
      }

      if modulus(N) ≠ 2
      {
      for j := 1 to m // N contains m elements, such that m < n
            mindist = min(dist(X, N[j]);
      for k := 1 to m
            {
            if (dist(X,N[k] ≠ mindist)
                  N = N – N[k];
            }

      }// end of this for loop ensures N = 2
   }
```

Search for a suitable production location, increasing

6. ILLUSTRATIONS AND REALIZATION

The motivating scenario can be illustrated using the sequence diagram of UML 2.0. A *sequence diagram* in a Unified Modelling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams typically are associated with use of case realizations in the Logical View of the system.

The sequence diagram in Fig. 3 shows how the web services interoperate and the order in which they operate. It also depicts the messages exchanged between the web services. In this model the lifelines represent user and set of web services.

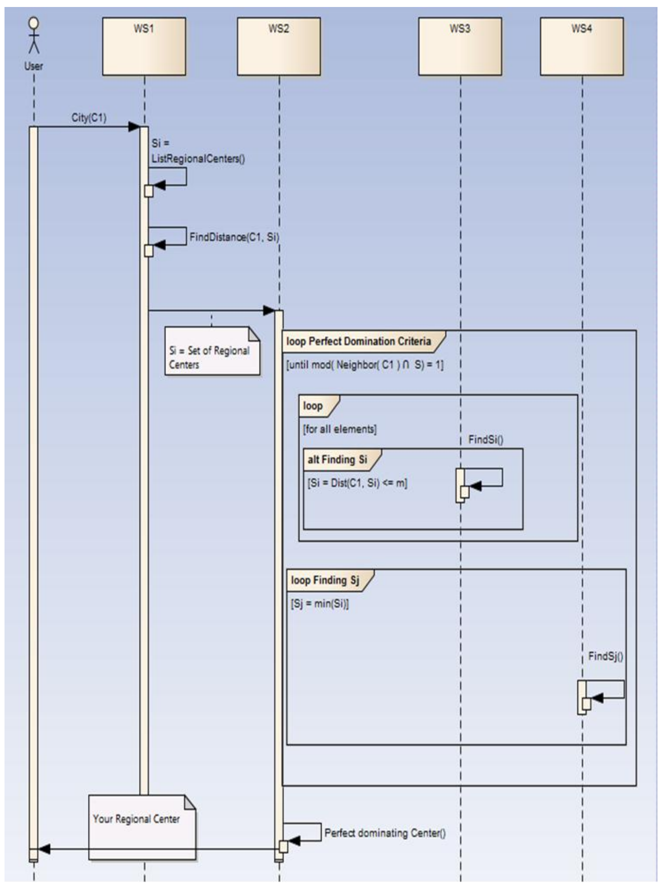

Fig: 3 Sequence diagram for identifying existing regional centre

The perfect domination concept of graph theory can be illustrated as given below:

Consider a private Logistics service "XYZ Logistic service private Ltd", having its corporate office at Mount Road Chennai and Regional offices are located across major cities like Puzhal(R_1), Hosur(R_2), Coimbatore(R_3), Pune(R_4) and Gurgaon(R_5). These regional offices are the centre points for receiving and re transporting goods to the nearby towns. Each of this regional office has list of small towns, where the logistical operational requirements are minimum transportation distance and cost to include or exclude small towns connected to the regional office. These Regional offices form a set R = {R_1, R_2, R_3, R_4, R_5}

If the organization wants to include a new town X= Vellore, with one of the above existing regional office, Let us check the perfect domination criteria,

(i) If $|N(X) \cap R| = 1$ then Vellore is perfectly dominated by any one of the above mentioned regional office.

(ii) If $|N(X) \cap R| \neq 1$ then consider R = { dist (X, R) ≤ 150 km} , here 150 km is an assumed one, we have $|N(X) \cap R| = 2$, which implies Vellore is dominated by Puzhal(R_1) , dist (X, R_1) = 123.4km and Hosur(R_2), dist (X, R_2) = 143.6km, Which contradicts the condition of perfect domination.

(iii) Then consider R = { min (R_1, R_2) }, that is min (123.4km and 143.6km) is Puzhal(R_1) which is 123.4km.

Thus we conclude that the regional office of Vellore is Puzhal, Chennai.

DISCUSSION AND CONCLUSION

This paper illustrates the application of graph theory - Perfect domination parameter in Logistics services and web services composition for identifying regional centre for a new town. The outcome of this work suggests that graph theory can successfully be applied in solving a real life problem with the help of web service composition.

The advent of Web services lead to a major paradigm shift from tight coupling to lose coupling with advantages like reuse, granularity, modularity, composability,

Componentization and interoperability

The next revolution is adding semantics to the web services which enabled the automation in service invocation, discovery and composition. The research in this direction by authors[1,2,3] is explored by applying semantic web services composition in various scenarios. One such real time scenario considered in this paper is to identify the exact regional centre for a new town, so that the logistical operations are transportation

To identify the locations, Graph theory concept is used, since Graph theory has many faces of mathematical versions, like fuzzy graphs, distance graphs, coloring, labeling, domination sets in graphs and so on. The authors[4] have chosen Perfect domination sets in graphs to express the concept in a logical sequence.

This work aptly describes the ways and means of identifying and implementing a solution in an absolute functional format that can be put into use any time. Also the work provides a huge scope for futuristic work for solving a problem by employing minimum efforts to achieve maximum results. Also the work throws open an opportunity for applying the same work on a larger issue to be resolved, whose outcome can be validated successfully. Thus the paper concludes that fusion of Graph theory and web services compositions can provide solutions to vital issues in our day today life.

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