Self-Arranging Preservation Networks

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ABSTRACT

We pose the question: what if digital library objects could self-arrange without intervention from repositories and minimal intervention from administrators? We present background information about networks, techniques on how networks can be created based on locally discovered information, and how a small set of controlling policies can profoundly affect network configuration. This poster reflects a work in progress, providing information about the project's genesis, current status and future efforts.

Categories and Subject Descriptors

H.3.7 [**Information Storage and Retrieval**]: Systems issues

General Terms

Algorithms, Design, Experimentation

1. INTRODUCTION

Survival of and access to digital library (DL) objects is dependent on their long term availability in a networked infrastructure. Availability is composed the fundamental networking infrastructure and links from one DL object to another. Maintenance and operation of the infrastructure relies on both hardware and "wetware" components. Establishing and maintaining links between DL objects is the topic of interest of this poster.

We use the tenets of "Small-World" networks (cf. [2]) to design, simulate and investigate linkages between DL objects to support their preservation in the face of failures of the underlying infrastructure, deliberate attacks on highly connected network nodes and the automatic re-constitution of the links when a failure is detected.

2. ANALYSIS AND STATUS

Our approach is to identify locally applicable controlling policies that can be used by any DL object while constructing the network. We have identified three major policies: how to select an initial node when adding a new node; how to select subsequent nodes after the initial node; and how to connect to other nodes after connecting to a suitable existing network node. Varying the parameters of these policies

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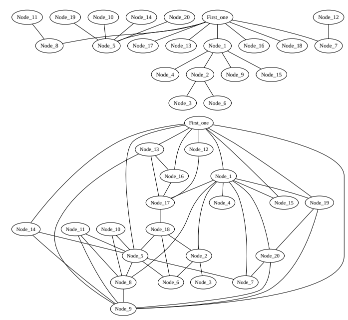

Figure 1: Top and bottom graphs' initial 0.6 attachment, and final attachment policies of 0.0 and 0.25.

cause radical changes in the network's emergent behavior (cf. [1]). Each node's behavior is controlled by the values of these policies. The node acts strictly on information that it has gathered about the network. No outside entity controls or monitors the node or the graph.

We have written a simulation to determine the effects of different policies values. Analysis is of order $O(n^2)$ complexity; doubling the size of the graph quadruples the analysis time. Figure 1 shows the effect of changing the final attachment policy on networks with 20 new nodes. Minor changes in policy values produce striking changes in networks that have even more nodes. The table shows that network graph statistics vary slowly as a function of graph size using the same policies as the bottom half of the figure. Currently

Nodes	Max. Deg.	Mean Deg.	Min. Deg.	σ Deg.	Diameter
100	46	182	1	7	4
1,000	563	173	1	39	3
5,000	2,854	859	1	180	3

we simulate the insertion of singleton DL objects into a network. Our next refinement will be to have the node create additional copies of itself to support preservation.

3. REFERENCES

[1] C. W. Reynolds. Flocks, herds and schools: A distributed behavioral model. *SIGGRAPH Comput. Graph.*, 21(4):25–34, 1987.

[2] D. J. Watts and S. H. Strogatz. Collective dynamics of 'small world' networks. *Nature*, 393:440–442, June 1998.