

**Lecture Notes in
Computer Science**

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Shay Kutten (Ed.)

Distributed Computing

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1 Introduction

1.1 Distributed Model

There are numerous models for distributed systems, differing from one another in a large number of important factors and parameters. We shall restrict our attention to systems based on the point-to-point message-passing model: there is no shared memory, and a node may communicate directly only with its direct neighbors by exchanging messages. The communication topology of the system can be described by an edge-labeled graph where nodes correspond to entities and edges correspond to direct communication links between entities [32]. Let $G = (V, E)$ be the graph; let $E(x)$ denote the set of edges incident to node $x \in V$, and $\deg(x) = |E(x)|$ the degree of x . Each node has a local label (particular associated to each of its incident edges). Given a set Σ of labels, a local labeling of $x \in V$ is any injective function $\lambda_x : E(x) \rightarrow \Sigma$ which associates a distinct label $l \in \Sigma$ to each edge $e \in E(x)$. The set $\Lambda = \{\lambda_x : x \in V\}$ of local labelings will be called a labeling of G , and by (G, Λ) we shall denote the corresponding (edge-labeled) graph.

Any property of the labeling Λ can be exploited to improve the performance of the system, e.g. by reducing the amount of communication required to perform some distributed tasks. The most basic property is *Local Orientation*: the capacity of each node to distinguish between the incident links, by definition, we only consider labelings having this property. Another interesting property is *Edge Symmetry*: there exists a bijection $\psi : E \rightarrow E$ such that for each $(x, y) \in E$, $\lambda_x(\psi(e)) = \lambda_y(\lambda_x^{-1}(\psi(e)))$; ψ will be called the edge-symmetry function. The particular case of edge symmetry called *Coloring* where the edge-symmetry function is the identity (i.e. the labels on the two sides of each edge are the same) is also of interest. For specific labelings in specific topologies, some other properties have been extensively studied; e.g., *Orientation* in ring networks with "left-right" labeling or in trees with the compass labeling.

Without any doubt, the property of labeled graphs which has been shown to have a definite impact on computability and complexity, and whose applicability ranges from the analysis of graph classes to distributed object systems, is *Sense of Direction*. In the rest of the paper, we will provide some introduction and pointers to the relevant results and literature.