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Capsule Reviews

Fairouz Kamareddine

The Capsule Reviews are intended to provide a short succinct review of each paper in the issue in order to bring the content to a wider readership. The Capsule Reviews were compiled by Fairouz Kamareddine. Professor Kamareddine is an Associate Editor of *The Computer Journal* and is based in the Department of Mathematical and Computer Sciences at Heriot-Watt University, Edinburgh, UK.

Proxy-Based Regional Registration for Integrated Mobility and Service Management in Mobile IP Systems. I.-R. Chen, W. He and B. Gu

The paper starts from the claim that IP will become the foundation of the next-generation wireless networks and that it is important to provide uninterrupted, reliable and efficient data services to mobile nodes (MNs) in wireless networks. Mobile IP (MIP) systems have already been provided with this aim in mind (e.g. [1]).

However, MIP systems face a number of disadvantages. This paper attempts to optimize the performance of regional registration in MIP systems. To do so, the paper determines the optimal number of foreign agents in a regional registration area on a per MN basis while minimizing the overall network cost. Like [2] which proposes a new mobile agent performance model using stochastic Petri net (SPN) modeling techniques, this paper also develops a performance model based on SPN. The analysis carried out in the paper shows that there is an optimal service area for MIP systems. Comparisons with other proposals show that the method of the paper outperforms in some cases other proposals in the literature.

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Verifying Workflows with Cancellation Regions and OR-joins: An Approach Based on Relaxed Soundness and Invariants. H.M.W. Verbeek, W.M.P. van der Aalst and A.H.M. Ter

Most workflow management systems use proprietary languages to specify workflows. This paper focuses on the control-flow aspect and verification of workflows. It starts from the YAWL workflow language, which supports 19 of the 20 most frequently used patterns in workflow languages and hence it is both desirable and difficult to carry out verification studies of this language. The two most difficult constructs to tackle are the cancellation region and the OR-join which make the semantics non-local and complicate matters. The paper presents a verification approach that can deal with cancellation regions and OR-joins using YAWL as a target language. This work on the verification of the control-flow aspect of YAWL is a novel extension of the previous work on the verification of workflow models (e.g. [1]). The paper uses relaxed soundness (which, in general, handles OR-joins but not cancellation regions) and Transition invariants (T-invariants) together with model-checking techniques. A process is called relaxed sound if all the parts of the process can be involved in proper completion. If the state space is too large to be generated within reasonable time, relaxed soundness (and also soundness) can be inconclusive. Hence, the approach presented in this paper is based on the T-invariants and so does not rely on the construction of the state space. Both relaxed soundness and T-invariants are well known in the Petri net literature. Basic to the approach is the concept of good execution paths where a part of a model which is not covered by good execution paths must contain errors. The paper states that completeness (the converse of this soundness property) does not hold and gives two reasons for this.

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Testing and Collecting of Evidence: An Integrated Approach to Test Generation for Finite State Machines. M. Kapus-Kolar

This paper starts from known test generation methods and transforms them into optimal ones. These generation tests deal with the discrimination between an initially connected deterministic finite state machine and its faulty implementation finite state machine.

This is motivated by the observation that some test generation methods pursue very reasonable testing strategies yet fail to implement these strategies precisely, leading to less optimal tests. The paper proposes a test construction method which is generic, accepts a wide class of testing strategies and is able to handle a wide range of optimization concerns (see, e.g. [1]). The author first introduces the basic machinery used such as sequences, diagraphs, finite state machines, the directed traveling salesman problem (TSP) and its generalized version (GTSP), the directed rural postman problem (RPP) and its generalized version (GRPP) and a number of predicates on diagraphs. Then, the author defines the classical testing problem (cTP) for finite state machines, which is a very common special case of the test generation problem for a deterministic finite state machine (DTGP). CTP is used to show the non-optimality of the RPP-based methods. The paper then proposes reducing the DTGP to GRPP and shows that for any accepted testing strategy, a test satisfying the goals of the strategy can be generated. Applications of such reductions are then discussed together with a number of strategies for DTGP and CTP.

Further reductions are proposed, especially the reduction of a generalized RPP (G2RPP) to a generalized TSP (G2TSP). Complexity issues as well as the contributions and future work are also discussed.

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An Optimal Snap-Stabilizing Multi-Wave Algorithm. D. BEIN, A.K. DATTA AND M.H. KARAATA

A wave is a distributed execution which requires every process to carry out a particular predefined execution. A multi-wave (or k-wave) is a distributed execution which requires every process to carry out a particular sequence $C_1, C_2, \ldots, C_k$ of predefined consecutive distinct executions. Usually, a wave is made up of a broadcast phase followed by a feedback phase, requiring the participation of all processes before a decision is made. Synchronization among distributed processes can be implemented using waves and in turn, wave algorithms are implemented using the propagation of information with feedback (PIF) algorithms and are sometimes also supplemented with a cleaning operation leading to PFC algorithms. The authors have previously provided a number of stabilizing algorithms and methods which improve networking technologies (cf. e.g. [1]). In this paper, they concentrate on the snap-stabilization notion which amounts to the system behaving according to its specification. The paper gives a time and state-space optimal snap-stabilizing multi-wave algorithm which is shown to be correct.

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State-Optimal Alternator for Uniform Synchronous Rings. T.-J. LIU AND C.-L. LEE

The concept of self-stabilization was introduced by Dijkstra to provide fault-tolerant abilities in distributed systems. A number of self-stabilization algorithms have been proposed and used to improve networking technologies (see, e.g. [1–3]). An alternator is a self-stabilization system where (1) if one node enters its critical section, the neighboring nodes cannot enter their critical sections during the same computing phase and (2) during any infinite computing phase, each node can often enter its critical section infinitely. An alternator is a useful scheduler and can transform a self-stabilization algorithm from a serial execution environment to a concurrent one. This paper aims to design a state-optimal alternator algorithm for unifrom bi-directional oriented rings whose stabilization time is O (n) where n is the number of nodes of the ring which achieves maximum performance and strong fairness properties. The state-optimal alternator algorithm consists of three rules and is shown to operate correctly under the synchronous mode and to enjoy the snap property where no two neighboring nodes enter their critical sections at the same time.

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MAX-DENSITY Revisited: A Generalization and a more Efficient Algorithm. G.F. GEORGAKOPOULOS AND K. POLITOPOULOS

Like [1], this paper is concerned with the study of algorithms that deal with a particular graph problem. For this paper, the problem in question is the max-density problem. Given a graph $G = (V, E)$ and two natural numbers, k and l, the max-density problem asks the question whether G contains a subgraph in which the ratio of the number of edges to the number of nodes is at least l/k. This paper studies the following general version of the max-density problem:

> "Given a weighted set system $G = (V, H, w)$, where V is a finite set of items, H is a set of subsets of V and w is a function which assigns a positive weight to every item in V and every set in H, the problem is to compute a subset S of maximum density $r\ (S) = W(G(S))/W(S)$

where $W(S)$ is the sum of all w(x) where x is in S and $G(S) = \{h$: h is in H and h is a subset of $S\}$."

The paper formulates the general max-density problem as a linear programming problem and gives complementary slackness conditions which help solve the linear programming problem. Then, an efficient algorithm for solving the max-density problem is given and its complexity is studied. Since for very large graphs the complexity may be very large, the paper proposes two fast approximation algorithms, one for general weighted set-systems and one for usual unweighted graphs.

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Edge-Orienting on Split, Planar and Treelike Graphs.
W.C.-K. YEN

Assume an undirected connected graph $G = (V, E)$. An edge-orientation scheme (EOS) of G assigns to each edge $e = (u, v)$ an orientation (either $u \rightarrow v$ or $v \rightarrow u$). Given an EOS of G and a vertex v of G, we define outdeg(v) (resp. indeg(v)) to be the number of edges whose orientations are directed from (resp. to) v. The out-degree edge-orientation problem (the Out-Degree EOP) is concerned with finding an EOS F^* such that max{outdeg(v) | v is in V} is minimized.

The EOP is a more general version of the Out-Degree EOP and is concerned with finding an EOS F^* such that $\max\{C(x) +$ the sum of $W(x \rightarrow z)$ where $x \rightarrow z$ is an edge $|x$ is in $V\}$ is minimized (here, C is a cost function and W is a weight function). Previous research related to graph-orientation problems did not usually deal with edge-orientation on weighted graphs. This paper bridges this gap and studies EOPs on weighted graphs. Different kinds of graphs are considered which include split graphs, planar graphs and simple cactus graphs. A graph $G = (V, E)$ is split if V is the union of two disjoint sets, the first of which is a complete graph and the second is an independent set. A graph G is said to be planar if it is possible to draw G in the plane so that the edges of G intersect only at end vertices. A graph is a simple cactus graph if it is a generalization of a tree in which some vertices of the tree are replaced by cycles with length <2. First, the paper establishes that EOP is NP-hard on split graphs and planar graphs using two well-known NP-complete problems (the 3SAT problem and the planar 3SAT problem). Then, the paper considers the so-called star graphs and defines an algorithm EOP-on-Stars which correctly solves the EOP-on-Star graphs. In particular, the paper shows that the EOP on any weighted graph can be solved in linear time by the prune-and-search strategy. This result is then extended to trees where an algorithm EOP-on-Trees is given and it is shown that the EOP-on-Trees can be solved in linear time. Next, the paper moves to simple cactus graphs and shows again that on these graphs, the EOP can be solved in linear time.