Event Structure Semantics for Dynamic Contextual Nets*

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1 Extended Abstract

Petri nets and Graph Transformation Systems (GTSs) are two well-known models for concurrent systems. Petri nets, conceptually simpler, had became a reference model for experimenting with and developing new semantic approaches to concurrency, notably non-sequential processes, unfolding constructions, event structures and algebraic models. Graph Transformation Systems provide a more sophisticated and expressive framework for handling resource types, distribution, and access control.

The close analogy between the two models neatly emerges when viewing Petri nets as particular GTSs over discrete typed graphs: places form the nodes of the type graph, markings are typed graphs (whose nodes model tokens) and transitions are productions. This correspondence has facilitated the mutual transfer of concepts and techniques, like the development of process and unfolding semantics for GTSs obtained in [1] by extending the chain of coreflections defined for Petri nets [7] to graph grammars. However, general DPO grammars require a much more sophisticated notion of event structures, called *inhibitor event structures* and the adjunction between unfolding and event structures breaks down to a functorial construction in just one direction. A recent result [2] re-established the missing link for the Single Pushout (SPO) approach. This is summarized in Figure 1. The category of prime algebraic domains is equivalent to the category of prime event structures (PES), thus all constructions can ultimately lead to PES.

From the point of view of concurrency, there are two separately-developed, interesting extensions of Petri nets: (1) read arcs and (2) mobility. The former allow for the multiple concurrent access in reading to tokens. The latter leads to *dynamic nets* (DNs) [6], which can account for dynamic changes in the topology of the net. In the literature, Petri net semantics have been extended to cope with read arcs, while the theory of mobile extensions is not yet fully assessed (some preliminary investigation is in [4]). On the GTS side, concurrent reading is a built-in feature, while mobility is accounted for in *dynamic graph grammars* (DGGs) [3], the GTS counterpart of DNs, where productions can release fresh types and fresh productions.

Here we introduce *dynamic contextual nets* (DCNs) by combining dynamic nets and read arcs in a well-disciplined way.[3] Alternatively, DCNs can be seen as a well-behaving subclass of DGGs, whose concurrent semantics can be expressed by a chain

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[3] Places are partitioned in readable and non-readable, and readable tokens cannot be consumed.

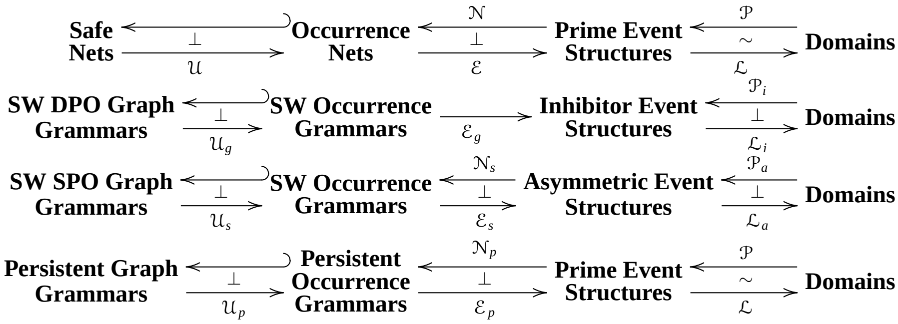

Fig. 1. A recollection of event structure semantics.

of coreflections. In fact we define the unfolding and PES semantics of DCNs by viewing DCNs as DGGs and exploiting two recent results: (i) the encoding of DGGs in ordinary graph grammars [3], where dynamically generated transition are modeled as suitably typed (hyper)arcs, and (ii) the coreflective event structure semantics for *persistent graph grammars* (PGGs) [5]. We show here that the encoding in [3] preserves concurrency and that, when applied to the GTS counterpart of a (semi-weighted) DCN, it yields a PGG. Then, the main theorem of [5] shows that the construction of the PES associated to a PGG is expressed by a chain of coreflections (see Figure 1), and since PGGs are node preserving, the constructions under DPO and SPO approaches coincide. By combining all results, we obtain a nice concurrent semantics for DCNs.

Finally, we mention one important aspect for cross-fertilization between Petri nets and GTS: the *locality principle* guarantees a realistic modeling of the distribution of resources, because it forces all choices to be resolved locally. The locality principle is not valid in general DGGs, but it holds in all DCNs. We leave to future work the precise characterization of the largest class of DGGs that satisfy the locality principle.

References

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