On the Integration of CP-nets in ASPRIN*

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Extended abstract

Answer set programming (ASP, [6]) is a form of declarative programming for knowledge representation and reasoning. Problems that find a natural representation in ASP are often characterized by several answer sets, which represent the feasible solutions of the encoded problem. In some cases, feasible solutions can be compared according to some features of interest. As a use case, a car dealership may want to offer a car configurator to its customers. All valid car configurations constitute the feasible solutions, but not all of them are equally satisfactory for the customers. Hence, as an additional service, the car configurator may offer the possibility to specify preferences over some features. For example, a customer may want to specify that she prefers automatic transmission, convertible car, light paint for convertible cars and dark paint otherwise, and many other features. Such preferences are clearly *qualitative*, and naturally expressed by *ceteris paribus rules*, from the Latin *as long as everything else stays the same*. In the example, among two valid configurations differing only on the transmission, the automatic one is preferred; additionally, ceteris paribus rules may be conditional, so to express that the preference for the paint is subject to the selection of other features of interest, in this case whether the car is convertible or not.

The core language of ASP misses constructs to easily express *conditional preference networks*, that is, sets of ceteris paribus rules linked by conditional dependencies among the features of interest. On the other hand, ASPRIN [5] is a framework handling user-defined preference relations encoded in ASP, and shipped with a rich library of common preference relations that can be used and combined by declarative statements. This note reports on the integration in ASPRIN of CP-nets [4], a formalism for representing conditional preference networks. Specifically, CP-nets are declared by *named preference statements* comprising *preference elements* that express conditional ceteris paribus rules. CP-nets encoded by preference statements are mapped to ASP facts by the reification procedure implemented in ASPRIN. In ASPRIN, CP-nets can be combined with composite preference relations, such as *pareto* or *lexicographic* aggregation. The preference relations involved in a composition can be heterogeneous, which means that ASPRIN can naturally mix CP-nets with other qualitative and quantitative preference relations. Such a mix is useful in several contexts, as for example in the car configurator, where the customer is likely to prefer a less

* This is an extended abstract of the conference paper [2].

expensive configuration among those that are otherwise equally preferred. Further ties could be broken by minimizing the maximum shipping delays among all extras that are added to the configuration.

The ASPRIN library is extended with a *preference program* for CP-nets, that is, an ASP program whose instantiation with respect to the reification of a CP-net and a pair of interpretations is consistent if and only if the pair of interpretations belongs to the preference relation associated with the CP-net. The preference program is used by the iterative sat-unsat search algorithm implemented by ASPRIN for computing optimal answer sets. For *tree-shaped* CP-nets the dominance test can be done faster than in the general case [3]; accordingly, ASPRIN is equipped with a preference program specific to this class.

ASPRIN provides another solving technique for *acyclic* CP-nets, which is based on the notion of *approximation* [1]. Intuitively, a preference relation $\succeq$ approximates all preference relations being its subsets, and this property is sufficient to guarantee that all $\succeq$-optimal models are optimal with respect to the approximated preference relations. For example, cardinal-minimality approximates subset-minimality. In ASPRIN, CP-nets are approximated by preference relations induced by strict partial orders (*poset* [7]) over a set of atoms. The approximation is used by ASPRIN to compute optimal solutions applying the highly optimized algorithms of the underlying ASP solver CLINGO.

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