Algorithms Based on Pattern Analysis for Verification and Adapter Creation for Business Process Composition

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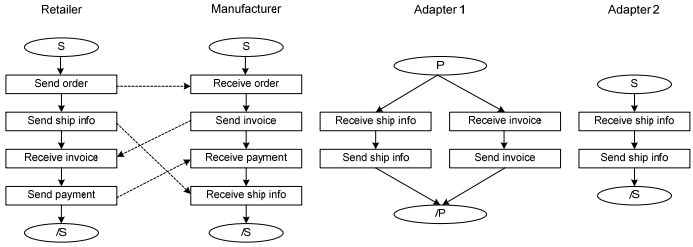
With more automation in inter-organizational supply chains and proliferation of Web services technology, the need for organizations to link their business services and processes is becoming increasingly important. Ideally, such linking must be automated and also possible to do on-the-fly in an ad hoc manner. We view business processes in terms of standard patterns, and describe a pattern compatibility matrix and rules that allow us to simplify the task of checking compatibility between two or more processes because these prerequisite rules can be applied to each pattern separately, thus reducing the search space. We give an algorithm for applying these rules to check process compatibility. If two processes are compatible, we determine whether an adapter is required, and if so, a minimal adapter is generated by another algorithm. Two variants of the algorithm (PBA and PBA-Min) are implemented, and experimental results and comparisons with an existing algorithm are given.



Pattern Compatibility Matrix

The following compatibility rules must be observed between interacting patterns of different processes:

1) An S-P pattern from process 1 must match with an S-P pattern from process 2.
2) An X pattern from process 1 must match with an X pattern from process
3) An L pattern from process 1 must match with an L pattern from process 2.

	Sequence	Parallel	Choice	Loop	Seq-Par
Sequence	Yes	Yes	No	No	Yes
Parallel	Yes	Yes	No	No	Yes
Choice	No	No	Yes	No	No
Loop	No	No	No	Yes	No
Seq-Par	Yes	Yes	No	No	Yes

Compatibility Verification and Adapter Creation

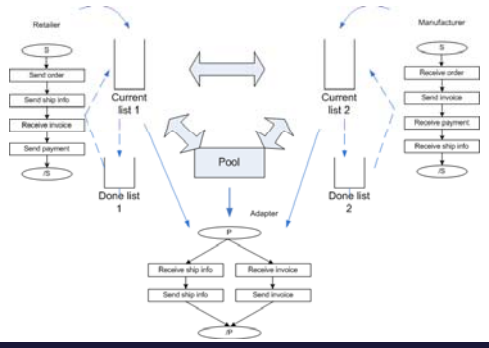
For asynchronous cases, if two processes are verified to be compatible, they can communicate without any adapter. For synchronous cases, even if two processes are verified to be compatible, they may still need an adapter.

- Process Normalization: to make the processes structurally similar for verification.

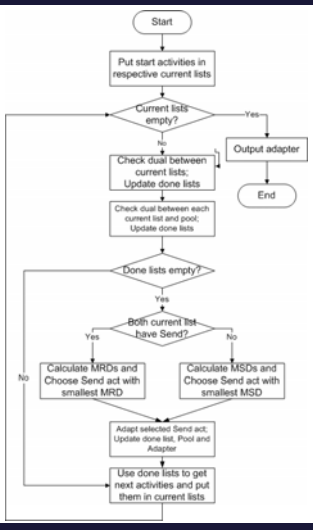
- Verification: to check deadlock in the communications between two processes; to recursively check the compatibility of branches in *Choice* and *Loop* patterns.

- Adapter Creation

1) Find innermost *Choice* (X) or *Loop* (L) patterns.
2) Create individual adapter for each branch using **SP adapter algorithm** (right figure), and combine these adapters in a X/L pattern.
3) Replace these patterns by a *Block*
4) Repeat Step 1-3 until no more X-L pattern left.
5) Run SP adapter algorithm to create the complete adapter.



Heuristic Algorithm for Minimal Adapter



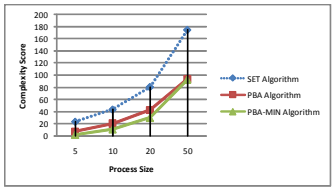
Definition 1: The *minimum receive distance* (**MRD**) of a Send activity in current list is the minimum of the distances between this Send activity and each of Receive Activities, which are the duals of the Send activity/activities in the current list of the other process.
Heuristic 1: *Buffer the Send activity with the smallest MRD when both process stop and both current lists contain Send activity/activities.*
Definition 2: The *minimum send distance* (MSD) of a Send activity in current list is the minimum of the distances between this Send activity and each of Send Activities, which are the duals of the Receive activity/activities in the current list of the other process.
Heuristic 2:*Buffer the Send activity with the smallest MSD when both process stop and only one current list contain Send activity/activities.*

Performance Evaluation

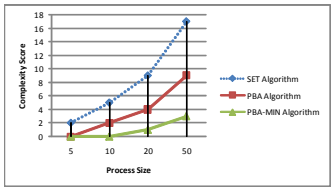
- **Computing Complexity**
  - *n* choice patterns: *2^n -> 2n*
  - parallel pattern with *n* braches: *n! -> n*
  - Loop pattern with *n* iteration *n -> 1*
- **Process Complexity**
  - **NOAC Metric:** the sum of the activities and the process control-flow elements in a process.
  - **CFC Metric:**

$$CFC(P) = \sum_{\substack{c\in \\ XOR-\\ split}} CFC_{XOR-split}(c) + \sum_{\substack{c\in \\ AND-\\ split}} CFC_{AND-split}(c) + 2 \sum_{\substack{c\in \\ LOOP-\\ split}} c$$

where, $CFC_{XOR-split}(c) = fan\text{-}out(c)$, and $CFC_{AND-SPLIT}(c) = 1$.



(a) NOAC



(b) CFC

Publication

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