INTERPLAN-AIR: an "adequate" and irredundant linear planner

Austin Tate 31 Aug 77

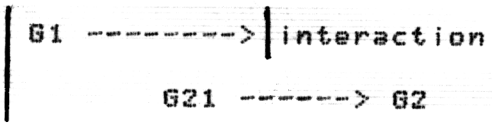
This note describes modifications to the INTERPLAN algorithms (see Tate, 1974 for a description of the original) which would remove the redundancy which was present in them. Irredundancy here means that any solution can only be generated once. "Adequateness" here is taken to mean that if there exists some solution to a problem as it is formulated then at least one solution will be found by the planner. The system may not find every solution and there is no guarantee that it will find the optimal solution.

INTERPLAN works by incrementally expanding its search space ONLY as interactions between ways of achieving goals in the problem indicate the necessity. An initial "approach" to the problem is suggested by taking one total order on the top level goals given. If independent solutions to these goals can be found and concatenated in the order given, then no further approaches will be tried and the search space will not be extended. There will only be as many solutions as are allowed by the different choice of operators to achieve the goals and their subgoals. Hence it can easily be seen that if the solution to a goal G2 achieved conditions which would have made the solution of a goal G1 shorter than its solution in the initial world state, an approach solve G1 and then solve G2 would produce a non-optimal solution. The approach solve G2 and then G1 would not be suggested unless some interaction occurred between ways of achieving G1 and G2. The shortness of the solution(s) produced in any problem is thus affected by the order in which the goals are presented, the search space being potentially different for each order. However, it is important to realize the reduction in the size of the search space this can make.

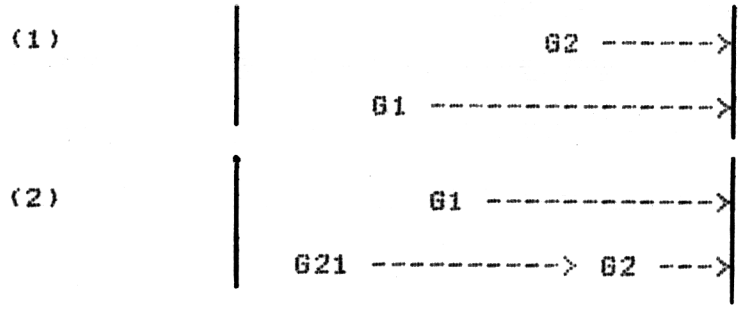
Redundancy in the present INTERPLAN

The present system is able to generate an approach it believes may correct for an interaction for a discovered interaction in such a way that the approach is equivalent to one which has been used previously. Thus the same solution may be produced more than once. This redundancy was due to inadequate checks on new approaches which were suggested.

When an interaction occurs it can be characterised as (see Tate, 1974):-



2 approaches must be suggested to ensure that if a solution exists it can be found from one of them.



In case 1 a reversal of the interacting top level goals was disallowed if they had been reversed due to a previous interaction. This prevents cycling.

In case 2 a check was made to see if G21 was already true in the initial situation if it was "promoted" to be the first subgoal in the approach. If it was true in the initial situation, the approach was equivalent to the original interacting one and it was discarded. This check is inadequate. A similar check should be made for all promotions, not only those to the front of the approach.

Alteration

A method to avoid the redundancy in case 2 would be to see if any promoted goal was true at the point in the plan where it was required. If no actions were needed to make it true at this point the approach containing such a promoted goal should be discarded. This check would replace the more specialized check of a promoted goal as the first goal in an approach.

Reference

Tate, A. (1974) INTERPLAN: a plan generation system which can deal with interactions between goals. MIP-R-109 Machine Intelligence Research Unit, Edinburgh.

Austin

Thursday

Thanks for your note on avoiding redundancy in Interplan. I don't really understand it, I'm afraid, but it looks like the argument concerns removal of just one source of redundancy. You don't ~~have~~ give a general argument for (ie. proof of) irredundancy. To do that, you would have to consider an "arbitrary" solution to the given problem, and show that Interplan can generate it in at most one way. To prove "adequateness" (ie. a version of completeness), you would need to show either that Interplan would generate this solution, or that some alternative sol'n could be generated.

There are two reasons why I still suspect Interplan is redundant (even after your latest amendment)

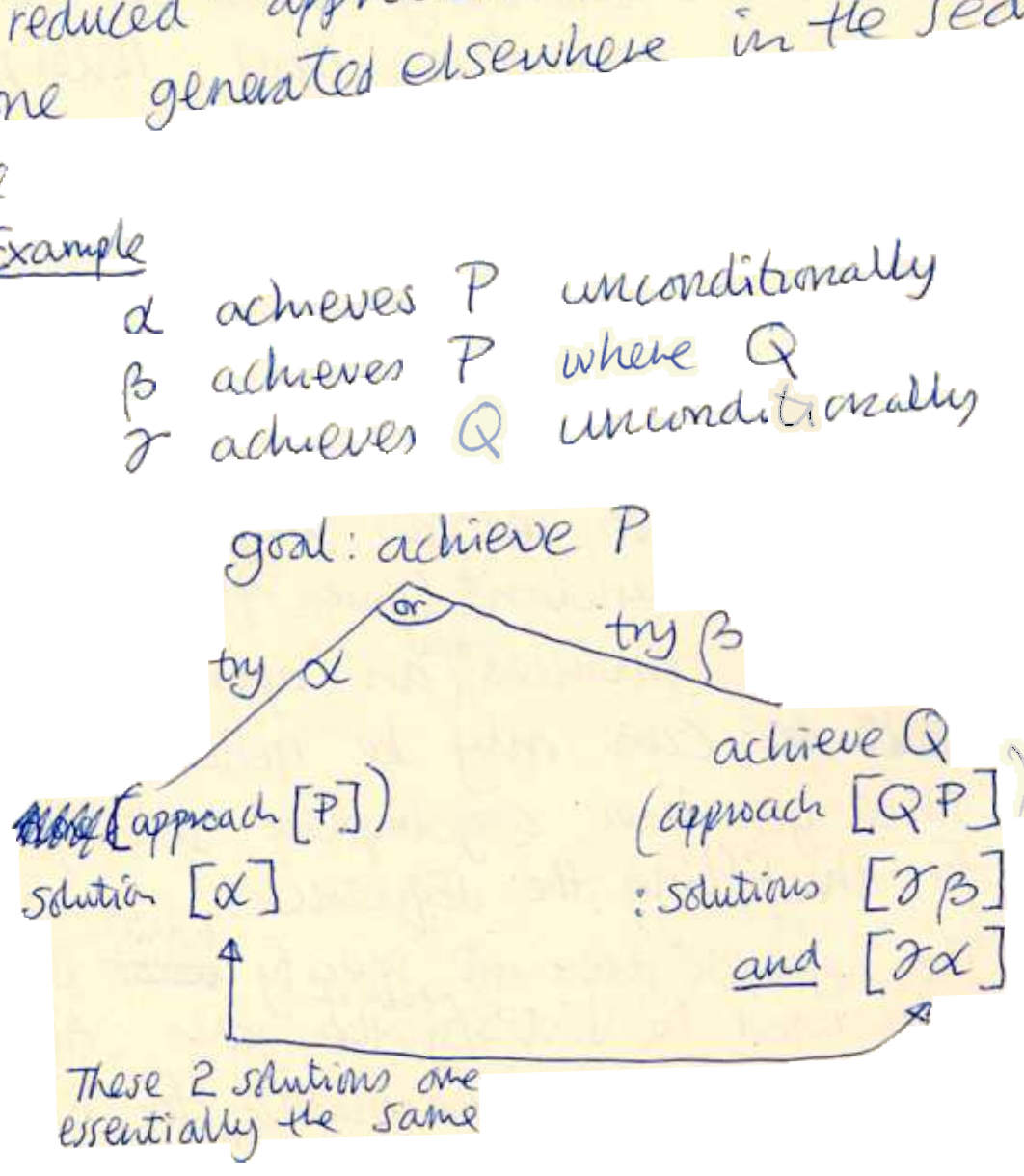
(a) I'm not convinced that an "approach" (goal sequence) ~~can be~~ can only be generated in one way, since you have a very complex set of rules for shuffling the sequence.

(b) The "approach" does not specify which actions are to be used to satisfy each of the goals. Although the approach may be reasonable for a certain choice of actions, a different pairing may result in a plan with unnecessary

steps — ie ~~the~~ one or more steps could be left out and the plan would still work. Equivalently, for this choice of actions, one or more of the goals in the approach could be discarded. From this, it is easy to imagine that the "reduced" approach would be identical one generated elsewhere in the search space

Example

α achieves P unconditionally
β achieves P where Q
γ achieves Q unconditionally



David

ORCC.
Alison House
2 Sept. '77

Dave

Thanks for your note Re your 2 reasons why you suspect INTERPLAN is redundant

The latest mod is purely to ensure that the same "approach" is not generated twice. The only rules for shuffling the sequence are the rules saying which 2 approaches (only) are suggested to correct for an interaction. There is no other shuffling at all

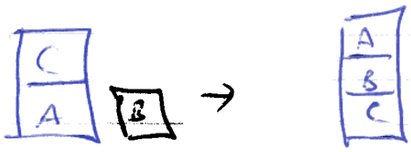
The modification of making a test to ensure a promoted goal is not already true at the point when it is to be achieved is to remove the case where a different choice of actions may lead to 2 identical solutions. Under no approach will an action be placed in the plan unless it is required to achieve a known goal (it can only generate minimal plans in the WARPLAN sense).

cannot prune inadmissibly in the way you suggest. There is no guarantee that any arbitrary solution to a given problem will be found by INTERPLAN only that where a solution does exist at least one of the set of solutions will be found. Maybe this is a quibble about my definition of "adequate".

It is important to see the effect the INTERPLAN strategy has on the size of the search space It can reduce it enormously.

2/

example



There is only solution in the total search space (the optimal one) No other solutions can be generated

(2)

→ ON(A,B) & ON(B,A)

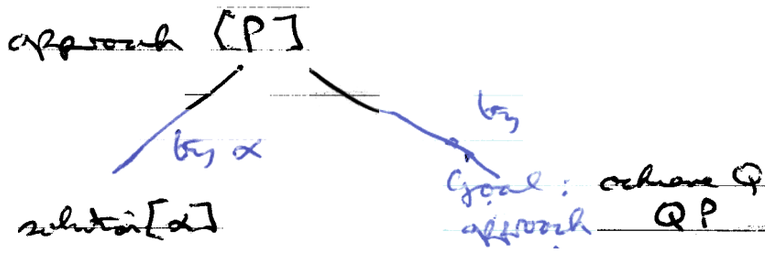
ie. an impossible situation. The total search space is searched and the system declares there is no solution (it only took about 10 seconds on my vacuole). Now consider what WARPLAN's search space would be on those 2 problems without IMPOSS(x, y) restrictions. The first can give an infinite number of answers, the 2nd will never terminate (using IMPOSS with INTERPLAN can reduce the search space even more)

I know these are pathological problems, but similar difficulties can arise as sub-problems of larger more realistic ones.

Anyway I accept your criticism that my "proof" certainly isn't a proof. I'll try to get something better. But I remain convinced that the reduction I achieve in the search space is greater than any other system going apart from one presented at IJCAI -77 which was exactly the same as INTERPLAN — I'll get you a reference for this in case another argument in different terms makes more sense

So to your example

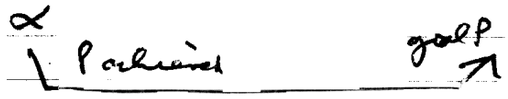
3/ Goal achieve P



: solution [β γ]

The solution γ α cannot be suggested. As Q is not needed to achieve any subgoal in the case of α. It is only present when β is to achieve a subgoal for it

so there are 2 goal stages one for Q and one for P when β is present, only 1 (as below) when α is present



WARPLAN left an action in the solution (1st generated) to the 5 block problem just because it is already there. This sort of thing cannot happen in INTERPLAN where an approach is a skeleton to be filled in only if it needs bits to be filled in. This was why I got redundancy before the nods 5 suggested since different skeletons could produce same plan if they were passed when some goals were not filled in.

Cheers,

Austin