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 to solve G1 and then solve G2 would produce a non-optimal solution. The approach to 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):

\[
\begin{align*}
G1 & \quad \text{ interaction } \quad \text{ G2} \\
G21 & \quad \text{ G2} \\
& \quad \text{ G1} \\
& \quad \text{ G21} \quad \text{ G2}
\end{align*}
\]

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

(1) 
\[
\begin{align*}
G2 & \quad \text{ G2} \\
G1 & \quad \text{ G1} \\
& \quad \text{ G21} \\
\end{align*}
\]

(2) 
\[
\begin{align*}
G1 & \quad \text{ G1} \\
G21 & \quad \text{ G21} \\
\end{align*}
\]

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

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 give a general argument for (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" (i.e., completeness), you would need to show either that Interplan would generate this solution, or that some alternative solution could be generated.

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

(a) I'm not convinced an "approach" (goal sequence) can only be generated in one way, since you have a complex set of rules for shuffling the sequence. Which actions are to be used to satisfy the goals. Although the approach may be reasonable for choice of actions, a different pairing may result in a plan with unnecessary
steps — i.e. 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

\[ \alpha \text{ achieves } P \text{ unconditionally} \]
\[ \beta \text{ achieves } P \text{ where } Q \]
\[ \gamma \text{ achieves } Q \text{ unconditionally} \]

\[
\text{goal: achieve } P \\
\begin{align*}
\text{try } \alpha & \quad \text{or} \quad \text{try } \beta \\
\text{solve } [\alpha] & \quad \text{or} \quad \text{solve } [\beta] \\
\text{achieve } Q & \quad\text{ (approach [Q P])} \\
\text{solve } [\gamma] & \quad\text{ and } \quad [\gamma \alpha] \\
\end{align*}
\]

These 2 solutions are essentially the same.

David
Dear,

Thanks for your note. Be you 2 reasons why you suggest intervention is pertinent.

The latest need is purely to ensure that the same "approach" is not repeated twice. The only rule for shuffling the sequence are the rules enjoining within 2 approved (only) are suggested to cancel for an intervention. There is no other shuffling at all.

The modification of making a test to ensure a proven good is not already true at the point when it is to be achieved is to remove the case where a different choice of activating my ideal to 2 identical solutions. Under no approach will an action be placed in the plan unless it is required to achieve a known good (it can only generate minimal plans in the existing area).

Cannot prove insignificance in the way you suggest. There is no guarantee that any arbitrary solution to a given problem will be (and) any (trans) only that where a solution does exist, at least one of the set of solutions will be found. Maybe this is a quillt about my definition of "adequate".

It is important to see the effect the position strategy has on the side of the Earth space. It can reduce it enormously.
There is only 1 solution in the total search space (the optimal one). No other solutions can be found.

\( \begin{pmatrix} C \\ A \end{pmatrix} \rightarrow \begin{pmatrix} A \\ C \end{pmatrix} \)

\( \begin{pmatrix} C \\ A \end{pmatrix} \rightarrow \text{on}(A,B) \& \text{on}(B,A) \)

ie. an impossible situation. The total search space is searched out, the system declares there is no solution (it only took about 10 seconds on a 2-processor).

Now consider what would be the search space would be if there were 2 problems without (x,y) restrictions. The first can give infinite results, the 2nd will never terminate (using 

\( \text{int} \) with \( \text{int} \) 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 achieved in the search space is greater than any other system going around from one generated at \( x=1 \) until when we actually the same as \( \text{int} \) (I'll get upon a reference to this in case another segment in different term makes more sense.

So be your example.
The solution $f x$ cannot be suggested. As $Q$ is not needed to achieve any subgoal in the case of $x$, it is only present when $\beta$ is to achieve a subgoal for $Q$.

To these are 2 good reasons: one for $Q$ and one for $P$ when $\beta$ is present, only 1 (as below) when $x$ is present.

$\exists x$ achieved goal $P$.

Wait and defer an act in the solution (1st quarter) because it is already there. This sort of thing cannot happen in (tert.) where an approach is a skeleton to be filled in. This was why I got it suggested since different plans if they were personal could produce some when some parts are not.

Clean, Austin