An erratum for the paper "Completeness and Optimality Preserving Reduction for Planning" in Proc. IJCAI, 2009

In Page 2, change **Definition 1** from

An action $o$ is associated with a DTG $G_i$ (denoted as $o \vdash G_i$) if $o$ is associated with any edges in $G_i$.

to

An action $o$ is associated with a DTG $G_i$ (denoted as $o \vdash G_i$) if $eff(o)$ includes a partial assignment of $x_i$. 
An erratum for the paper "Stratified Planning"
in Proc. IJCAI, 2009

In Page 2, change the last line of Definition 1 from
\[ x \in \text{trans}(o) \text{ and } x' \in \text{dep}(o), \text{ or, } x \in \text{aff}(o) \text{ and } x' \in \text{trans}(o) \]
to
\[ x \in \text{aff}(o) \text{ and } x' \in \text{dep}(o), \text{ or, } x \in \text{aff}(o) \text{ and } x' \in \text{aff}(o). \]
Memo on the flaws in “Stratified Planning” and
“Completeness and Optimality Preserving
Reduction for Planning”

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Stratified Planning uses a notion called “transition” to define the layers for
domain variables and actions. For a SAS+ planning task and an action \( o \), if a
domain variable \( x \) appears in both \( \text{dep}(o) \) and \( \text{aff}(o) \)^1, then we say \( o \) contains a
transition for domain variable \( o \).

However, it is possible for actions to have no transitions. During stratifica-
tion, actions without transitions are stratified to a special layer: \( \infty \). When that
happens, SP cannot guarantee the commutability of actions during the search.
In other words, Lemma 1 of the SP paper may not be correct when there are
actions without transitions.

In fact, we can build the stratification solely based on \( \text{pre}(o) \) and \( \text{aff}(o) \). We
just need to change \( \text{trans}(o) \) to \( \text{aff}(o) \). It is safe to assume that for any action
\( o \), \( \text{aff}(o) \) is non-empty. Otherwise, we can remove the action from the planning
task without affecting the solvability of the problem. With that, we modify the
Definition 1 of the SP paper slightly to the following one.

**Definition 1.** Given a SAS+ planning task \( \Pi \) with state variable set \( X \), its
causal graph (CG) is a directed graph \( \text{CG}(\Pi) = (X, E) \) with \( X \) as the vertex
set. There is an edge \( (x, x') \in E \) if and only if \( x \neq x' \) and there exists an action
\( o \) such that \( x \in \text{aff}(o) \) and \( x \in \text{dep}(o) \), or, \( x \in \text{aff}(o) \) and \( x \in \text{aff}(o) \).

Now layer \( L \) of for an action \( o \) is defined as the layer of the domain variables
in \( \text{aff}(o) \). We can establish the following results.

**Theorem 1.** For a SAS+ planning task \( \Pi \) and its causal graph and the stratifi-
cation, the layer number for actions \( o \in \Pi \) is well-defined for all actions that
have non-empty \( \text{aff}(o) \)

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^1Note on notations: \( \text{dep}(o) \) and \( \text{aff}(o) \) are sets of domain variables, \( \text{pre}(o) \) and \( \text{eff}(o) \) are
sets of partial assignments.
Proof: For every action \( o \in \Pi \), since \( \text{aff}(o) \) is non-empty, \( o \) at least gets assigned to a layer. We only need to proof that the layer number is well-defined (\( o \) does not get to assigned to more than one different layer numbers).

If \( o \) has two different layer numbers \( l_1 \) and \( l_2 \), we know that \( \text{aff}(o) \) contains at least two domain variables \( x \) and \( y \) in two different layers. Let us assume that \( x \) is in layer \( l_1 \) and \( y \) is in layer \( l_2 \), and \( l_1 \neq l_2 \). In this case, according to Definition 1, there is an arrow from \( x \) to \( y \) in the causal graph, and vice versa. Hence, \( x \) and \( y \) must be in the same strongly connected component when stratification is done. It implies that \( l_1 = l_2 \), which contradicts with our assumption that \( l_1 \neq l_2 \). Therefore, \( o \) can only get a finite, unique layer number. ■

This proof of the following theorem is the same to the proof appeared in the SP paper. It is correct even for actions without transitions.

Theorem 2. (Lemma 1 in the SP paper) For a SAS+ task \( \Pi \), a stratification \( \text{str}(\Pi) = (U, L) \) and a state \( s_0 \), for any valid path \( p = (a_1, \cdots, a_n) \), if there exists \( 2 \leq i \leq n \), such that \( L(a_i) < L(a_i-1) \) and that \( a_i \) is not a follow-up action of \( a_{i-1} \), then \( p = (a_1, \cdots, a_{i-2}, a_i, a_{i-1}, a_{i+1}, \cdots, a_n) \) is also a valid path and leads to the same state from \( s_0 \) as \( p \) does.

Proof: Note that in the SP paper, the claim that “since \( L(a_i) < L(a_{i-1}) \), the SCC in \( \text{CCG}(\Pi) \) that contains \( a_{i-1} \) has no dependencies on the SCC that contains \( a_i \). Therefore, \( \text{eff}(a_i) \) contains no assignment in \( \text{pre}(a_{i-1}) \)” is not true when \( L(a_i) = \infty \).

However, under the new definition, since \( L(a_i) < L(a_{i-1}) \), there is no edge from the domain variables appear in \( \text{aff}(a_i) \) to domain variables in either \( \text{dep}(a_{i-1}) \) or \( \text{aff}(a_{i-1}) \), we show that \( \text{eff}(a_i) \) must not contain any assignment in \( \text{pre}(a_{i-1}) \). Otherwise, if there is a variable assignment shared by \( \text{eff}(a_i) \) and \( \text{pre}(a_{i-1}) \), say \( x \), we have \( L(a_i) = L(x) \) since \( x \) is the variable that is in \( \text{aff}(a_i) \). However, we know that there must be an arrow from a variable in \( \text{eff}(a_{i-1}) \) to \( \text{dep}(a_{i-1}) \), that is to say, \( L(a_{i-1}) \leq L(x) = L(a_i) \). This contradicts with our assumption that \( L(a_i) < L(a_{i-1}) \).

The rest of the proof is identical to the one in the SP paper. ■

We have explained that \( \text{trans}(o) \) should really be replaced by \( \text{eff}(o) \) because \( \text{trans}(o) \) can be empty in Stratified Planning. The same adjustment should also be applied to the Expansion Core algorithm because it also relies on the \( \text{trans}(o) \) notion to associate actions to DTGs.

The EC paper claimed that if the goal path length is 1 and if \( s^0_i \) is not a goal in its DTG, \( a \vdash G_i \). With the definition of “association” in the paper, if an one step solution has action \( a \) that does not have any transitions, \( a \) would not be able to associate with \( G_i \). Under the new definition, since \( a \) leads to a different variable value for \( x_i \) in \( G_i \), \( a \) is associated with \( G_i \) by definition. The rest of the proof in the paper is still valid, and the statements following the theorem still hold.