Supplementary Material: Planning with Object Creation

Primary Keywords: *None*

Choosing Fresh Objects

We present here a choice function for fresh objects more systematic than the one presented in the paper. Given a state s and an action schema A, this choice function guarantees that no two objects created by $\mathit{eff}(A)$ have the same name, while avoid keeping of the other created objects while evaluating the function $\mathrm{changes}$.

Assume that all objects in $\mathcal{U}^s$ are represented as non-empty strings over some alphabet Σ. Let Γ be a set of special symbols not present in Σ. For example, Γ could contain the symbols $@, !, \#, [,]$ etc. So we can assume that symbols of Γ are "reserved" for our own use. All created objects receive names over the alphabet $\Sigma \cup \Gamma$.

We start by creating a prefix $P = @\langle X \rangle$ where $\langle X \rangle$ is the smallest natural number composed from the digits $0, \ldots, 9$ such that no object has $@\langle X \rangle$ as a prefix. We only create objects with the prefix P in this $\mathit{eff}(A)$, so all fresh objects are guaranteed to be distinct from the already existing ones. We still need to guarantee that any two objects created in $\mathit{eff}(A)$ are distinct from each other.

This can be done by extending the prefix in a way that preserves uniqueness of the prefixes as $\mathrm{changes}$ recurses over the effect. For a conjunctive effect $(e_1 \wedge e_2)$, the recursion over e_1 gets $@1$ appended to its prefix, and the recursion over e_2 gets $@2$ appended to it. For conditional effects we do not need to append anything. For a universal effect $\forall v : e$, in the recursion that binds the object o to v, we add $[o]$ to the prefix.

In a creation effect, we use the current prefix as the name of the new object and add $@0$ to the prefix in the subeffect.

To illustrate, consider the simple effect

$$\mathit{eff}(A) \coloneqq (\oplus v : P(v)) \wedge (\oplus w : Q(w)),$$

and let's say that the minimum value for X is 5 (i.e., there are objects in $\mathcal{U}^s$ with prefix $@\langle 4 \rangle$ but none with $@\langle 5 \rangle$). Every object created from this effect will have prefix $@\langle 5 \rangle$. Let us say we also have an assignment function σ. As $\mathit{free}(\mathit{eff}(A)) = \emptyset$, the specifics of function σ will not impact anything. To compute $\mathrm{changes}(s, \sigma, \mathit{eff}(A))$ we will compute

$$\mathrm{changes}(s, \sigma, (\oplus v : P(v))) \cup \mathrm{changes}(s, \sigma, (\oplus w : Q(w))).$$

Let e_1 be the left-hand side $(\oplus v : P(v))$, and e_2 be the right-hand side $(\oplus v : Q(v))$. When recursing through e_1, we append $@1$ to the prefix for fresh object name. Now, every object created in e_1 will start with $@\langle 5 \rangle @1$. As e_1 is an object creation itself, we append $@0$ to the prefix. So $v = @\langle 5 \rangle @1@0$.

When recursing through e_2, the same will happen, but now $w = @\langle 5 \rangle @2@0$. So the two objects created by $A^{s,\sigma}$ are $@\langle 5 \rangle @1@0$ and $@\langle 5 \rangle @2@0$.

Note that during this computation we only had to keep track of the structure of the effect (e.g., left or right hand side of a conjunctive effect) and of the current existing objects (to define the initial prefix). In contrast to the choice function explained in the paper, we did not have to keep track of the other objects created by the same action. However, one drawback of this choice function is that object names get longer and longer as the plan progresses.