Planning Tech for Planning Pedagogy

A classical planning encoding for aligning PDDL models.

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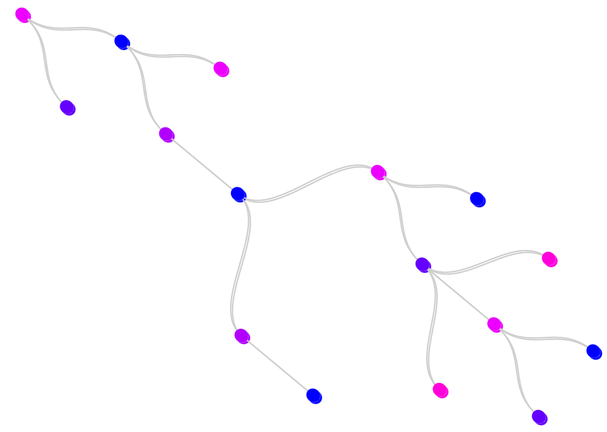
We demonstrate the power planning techniques can have for the task of analyzing planning solutions in a classroom setting. Using the common assignment strategy of asking students to develop PDDL given an English description of a domain, we consider how a variety of planning methods (existing and new) can provide analytic support for teaching staff to understand which errors were made in student models. The work has already had a direct and practical impact, being deployed in a classroom setting to assess the correctness of student-authored planning models.



Process

1. Create a merged domain/problem with the same types, objects, constants, and action schema
2. Merge the initial states
3. Merge each of the actions
4. Create divergent actions
5. Set the goal to fail

```
(:action unlock

   :parameters (...)

   :precondition (and
        ...
        (cor-locked ?cor ?col)
        ...)

   :effect (and
        (cor-unlocked ?cor)
        (when (key-two-use ?k)
              (key-one-use ?k))
        (when (key-one-use ?k)
              (key-used-up ?k))))
```

```
(:predicates
     (on ?l - light)
     (off ?l - light)
)

(:action turnon
     :parameters (?l - light )
     :precondition (and (off ?l))
     :effect (and (on ?l) (not (off ?l)))
)
```

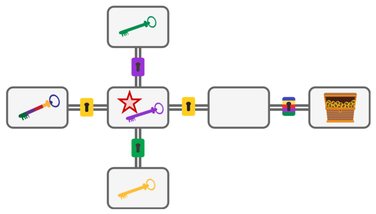
```
(:predicates (on ?l - light))

(:action turnon
     :parameters (?l - light)
     :precondition (and (not (on ?l)))
     :effect (and (on ?l))
```

Actions above, from two domains, are merged to the one on the right. The failure action below is added for misalignment.

```
(:action turnon
    :parameters (?l - light)
    :precondition (and
         (not (domain1_on ?l))
         (domain2_off ?l))
    :effect (and
         (domain1_on ?l)
         (domain2_on ?l)
         (not (domain2_off ?l))))
```

```
(:action fail_turnon2
    :parameters (?l - light)
    :precondition (and
         (domain1_on ?l)
         (domain2_off ?l))
    :effect (and (failed)))
```

```
Mis-alignment plan for p01 (version: orig):
(move loc12 loc22 c1222)
(pick-up loc22 key1)
(move loc22 loc23 c2223)
(unlock loc23 c2324 red key1)
(fail_unlock2 loc23 c2324 red key1)
; cost = 5 (unit cost)
```



Deployed in a classroom setting for a PDDL assignment. St-Val and Ref-Val are student solutions validated on the reference model and vice versa, respectively. Two “Aligns” columns for two variations.

Total # of Assignments	86
Assignments With Plan-based Errors	11
Assignments With Validation Errors	31
Assignments With Alignment Errors	67
Those With Multiple Alignment Errors	9

Problem	Solve	St-Val	Ref-Val	Aligns Orig	Aligns Move
p01	✓	✓	✓	✗	✗
p02	✓	✓	✓	✗	✗
p03	✓	✓	✓	✗	✗

What’s Next?

- **Precondition Analysis**: Identify the preconditions that have failed in the alignment
- **Goal Analysis**: Include goal-achieving actions to detect errors in the goal specification

Plan Diversity: Generate multiple examples of failed alignment to surface multiple errors

Iterative Model Refinement: Progressively “fix” the model so new errors can be discovered