Planning for Artificial Intelligence

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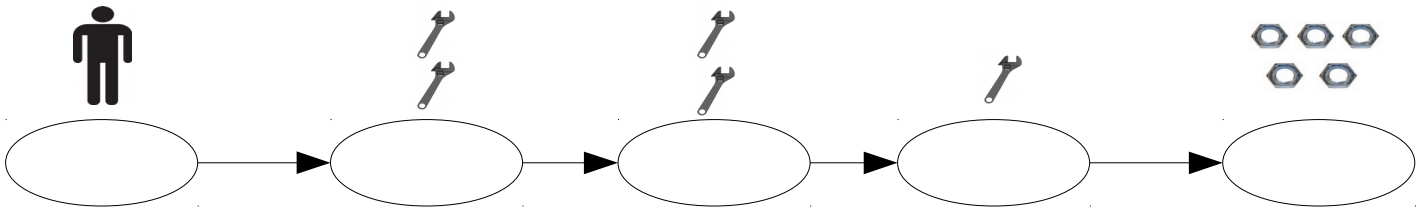
Planning Portfolios

Domain-independent Planning

- **Heuristic search**
  - delete-relaxation
  - landmarks
  - potentials
  - abstractions
  - ...
- Planning as SAT or CSP
- ....
- No planner rules them all !
  - as demonstrated by the results of IPCs

Spanner Domain



```
(:action walk
        :parameters (?start - location ?end - location ?m - man)
        :precondition (and (at ?m ?start)(link ?start ?end))
        :effect (and (not (at ?m ?start)) (at ?m ?end)))

(:action pickup_spanner
        :parameters (?l - location ?s - spanner ?m - man)
        :precondition (and (at ?m ?l)(at ?s ?l))
        :effect (and (not (at ?s ?l))(carrying ?m ?s)))

(:action tighten_nut
        :parameters (?l - location ?s - spanner ?m - man ?n - nut)
        :precondition (and (at ?m ?l)(at ?n ?l)(carrying ?m ?s)(useable ?s)
                           (loose ?n))
        :effect (and (not (loose ?n))(not (useable ?s)) (tightened ?n)))
)
```

Issues of the Spanner Domain

- Can be solved in polynomial time
- **Deep dead-ends for delete-relaxed heuristics**
  - Delete-relaxed heuristics assume that one spanner can be used to tighten all nuts
    - and it takes a long time to figure out all spanners have to be picked up
- Unnecessary symmetries
  - It does not matter which spanner is used for tightening a nut
  - Problematic for landmark generation
- SAT-based planners work reasonably

Selecting the Best Planner

- Manually
  - Try the planners on a number planning tasks and pick up the best one
  - As a rule of thumb we can assume that a planner has a consistent performance on tasks from the same domain (not always true)
- Automatically
  - The **algorithm selection** problem
  - Learning a predictive model of planners' performance based of planning task features

Planning Portfolios

- Leveraging multiple (orthogonal) techniques for solving the task
  - SAT solving, ASP, Argumentation ...
- **Planning Portfolios**
  - Collection of different planning techniques running sequentially or in parallel (or combination of both)

Types of Planning Portfolios

- **Dynamic** portfolios
  - Configured specifically for a given domain
  - PbP (winner of the learning track of IPC 2008 and 2011)
- **Static** portfolios
  - Configured once for all (possible) domains
  - IBACOP (winner of the satisficing track of IPC 2014)
  - FDSS (winner of the satisficing track of IPC 2018)
  - Delfi (winner of the optimal track of IPC 2018)