On Modeling Formalisms for Automated Planning

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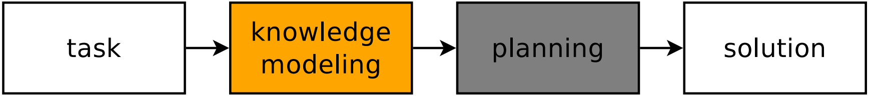
Automated planning

General model based approach to problem solving.



Automated planning

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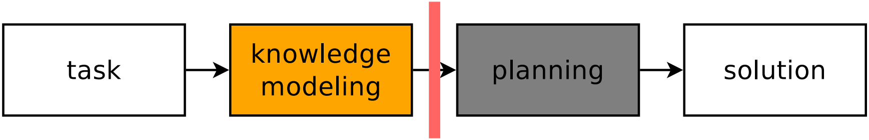


modeling formalism = interface

Real world example

Petrobras planning challenge

model: object classes, system state, operations

problem: initial state, desired state

solution: ordered set of actions

Academic approach

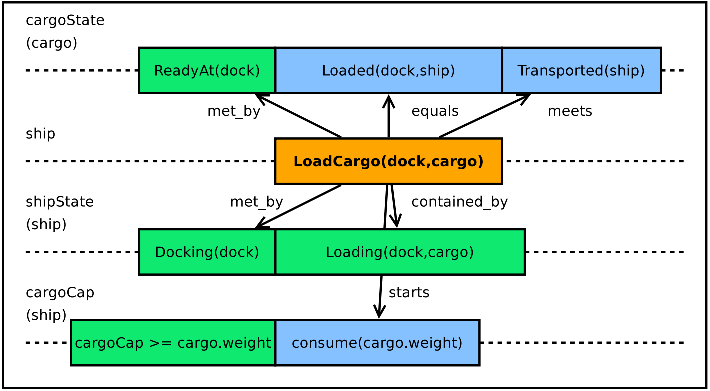
- PDDL (IPC)
- state = set of propositions (+ fluent values)
- changed by actions

PDDL operator sample

```
(:action load-cargo
  :parameters (?s - Ship ?c - Cargo
               ?loc - Location )
  :precondition (and
                 (at ?s ?loc)
                 (cargo-at ?c ?loc)
                 (isDocked ?s ?loc)
                 (>= (free-cargo-capacity ?s)
                     (cargo-weight ?c)))
  :effect (and
           (not (cargo-at ?c ?loc))
           (cargo-at ?c ?s)
           (decrease (free-cargo-capacity ?s)
                     (cargo-weight ?c)))
)
```

Engineering approach

- NDDL (Europa)
- timelines + intervals
- temporal constraints



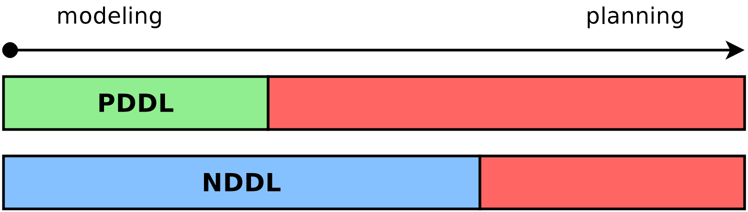
Comparison

PDDL

- predicate logic
- operators
- + clear model
- - sequencing

NDDL

- timelines
- compatibility rules
- - complex structures
- + expressivity



Alternative formalism

Key concepts:

1. State variables - representation of system state
2. Domain rules - domain specific knowledge
3. Operators - state transition

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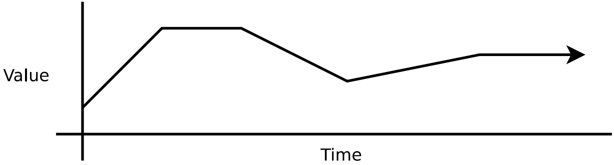
State variables

How to model a ship?

state variable declarations

```
shipLoc(Ship):{Location}
shipFuel(Ship):{Number}
shipAvailCap(Ship):{Number}
```

$$s(a_1, \ldots, a_k) : \{R\}$$



Domain rules

Domain specific knowledge

- numeric computation
- advanced check

fuelConsumption(L1,L2,Weight)

Domain rules

Domain specific knowledge

- numeric computation
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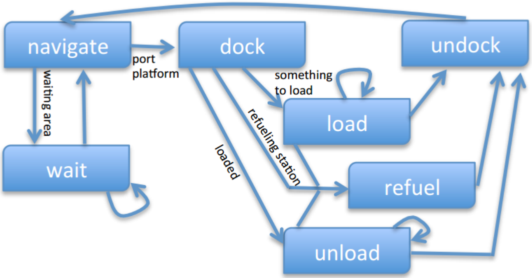

Operators

Two types of expressions:

- conditional
- transitional

operator load cargo

```
loadCargo(C - Cargo; S - Ship; L - LogisticLoc;
          X - Number; A - ShipState)
     fsaCheck(load,A) = true
     cargoWeight(C) <= X
     shipLoc(S) = L
     shipStatus(S): load -> A
     shipAvailCap(S): X -> (X - cargoWeight(C))
     cargoLoc(C): L -> S
```

The end

Thank you.