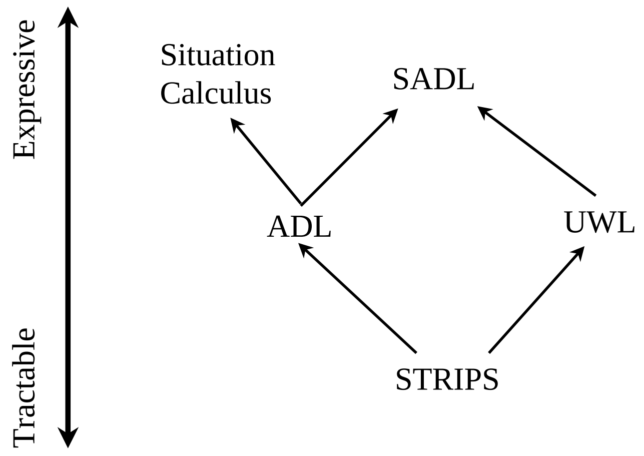
Logistics

- 1 Handout
  - Copies of my slides
- Today’s material
  - Russell & Norvig: chapter 8
  - Recent Advances: section 2.4
- Reading for Mon
  - Recent Advances in AI Planning, section 3

Generative Planning

- Input
  - Description of initial state of world *(in some KR)*
  - Description of goal *(in some KR)*
  - Description of available actions *(in some KR)*
- Output
  - Sequence of actions

Representing Actions



Expressive

Tractable

Situation Calculus

SADL

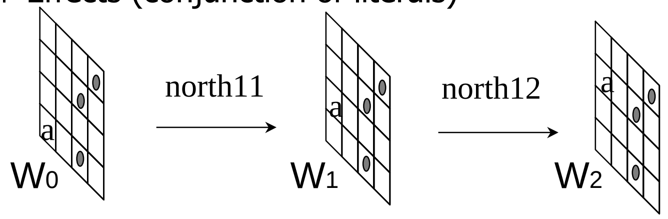
ADL

UWL

STRIPS

How Represent Actions?

- ***Simplifying assumptions***
  - Atomic time
  - Agent is omniscient (no sensing necessary).
  - Agent is sole cause of change
  - Actions have deterministic effects
- ***STRIPS representation***
  - World = set of true propositions
  - Actions:
    - Precondition: (conjunction of literals)
    - Effects (conjunction of literals)



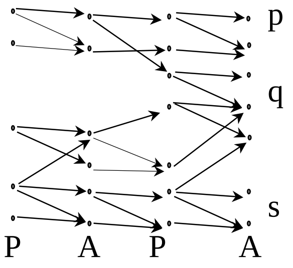
Why ADL?

- Universally Quantified Preconditions
  - Blocks World Example
  - UNIX Example
- Conditional Effects
  - Light Switch
- Universally Quantified Conditional Effects
  - Spraypaint
  - UNIX example

Implementing Disjunction

- Convert precondition to DNF
- Add an action instance to graph if
  - Any disjunct is present (nonmutex) at prev layer

```
(defschema (foo)
        precondition: (and p (or q r s)
        effect:       (and t u))
```



Graphplan$_{\text{strips}}$

- Create level 0 in planning graph
- Loop
  - If goal $\subseteq$ contents of highest level (nonmutex)
  - Then search graph for solution
    - Implement as a dynamic CSP in which:
      - Variables = (sub)goals at a level
      - Values = actions (at prev level) that might make goal true
      - Optimize with FC-CBJ and MRV variable-ordering heuristic
    - If find a solution then return and terminate
  - Else Extend graph one more level

ADL Action Representation

- STRIPS
  - Preconditions: propositional conjunctions
  - Effects: propositional conjunctions
- ADL
  - Preconditions:
    - Universal & Existential Quantification
    - Disjunction
  - Effects
    - Universal Quantification
    - Conditional Effects
  - Domain Axioms

Quantified Preconditions

Locations: Seattle, Renton
Vehicles: truck37, truck44, plane55

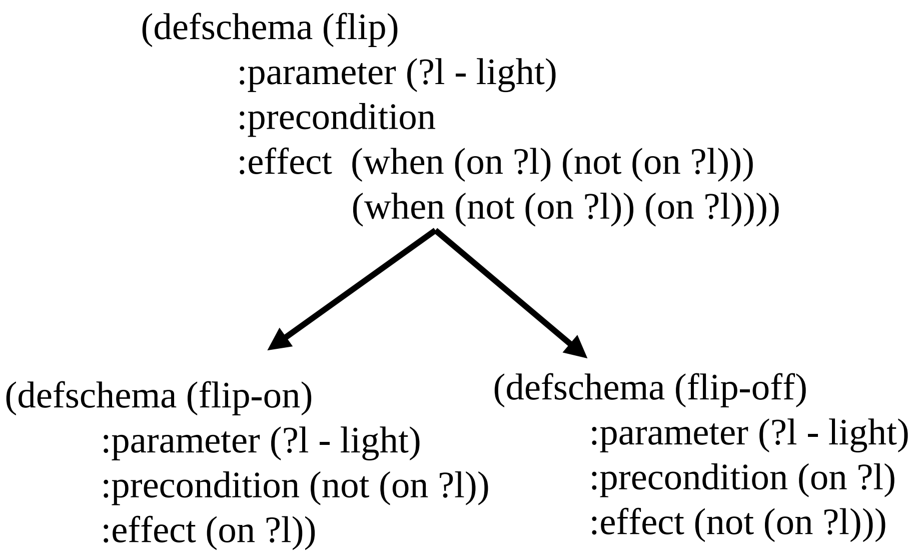
```
(exists (?l - location)
   (forall (?v - vehicle) (at ?v ?l)))

(forall (?l - location)
   (exists (?v - vehicle) (at ?v ?l)))
```

Preconditions vs Effects

- Disjunctive effects
- Existentially quantified effects

Conditional Effects



```
(defschema (flip)
     :parameter (?l - light)
     :precondition
     :effect  (when (on ?l) (not (on ?l)))
              (when (not (on ?l)) (on ?l))))
```

```
(defschema (flip-on)
     :parameter (?l - light)
     :precondition (not (on ?l))
     :effect (on ?l))
```

```
(defschema (flip-off)
     :parameter (?l - light)
     :precondition (on ?l)
     :effect (not (on ?l)))
```

Domain Axioms