### Declarative versus procedural semantics

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Triples as STRIPS actions

\[ \langle q, a, q' \rangle \begin{cases} \text{precondition-list} = [q] \\
\text{delete-list} = [q] \\
\text{add-list} = [q'] \end{cases} \]

string of internal states \( q_0 q_1 \cdots q_n \) vs external actions \( a_1 \cdots a_n \)

\[ q_0 \xrightarrow{a_1} q_1 \xrightarrow{a_2} q_2 \cdots \xrightarrow{a_n} q_n \] \((\dagger)\)

STRIPS assumption:

primitive relations not mentioned in the description of the action stay unchanged

- valid/vacuous – no inertia (locality of action)

\( a_1 \cdots a_n \) determines \( q_1 \cdots q_n \) uniquely in \((\dagger)\) if \( \rightarrow \) is deterministic.
Determinized transitions: sets of states

accept(Trans,Final,String):-
    sfa([q0],Trans,Final,String).

sfa(List,_,Fin,[]) :- member(X,List), member(X,Fin).

sfa(List,Tr,Fin,[H|Str]) :-
    setof(X,acc(List,H,X,Tr),Next),
    sfa(Next,Tr,Fin,Str).

acc([H|T],Sym,X,Tr) :- member([H,Sym,X],Tr);
    acc(T,Sym,X,Tr).

Determinize (adding []) to form complement
Closure properties on regular languages say certain operations can be defined on regular languages — e.g. concatenation, choice, Kleene-star.

Regular expressions provide a minimal set of operations describing all regular languages (Kleene’s theorem) without regard for succinctness.

There are many more operations — e.g. complementation, intersection, \ldots the Büchi-Elgot-Trakhtenbrot theorem on MSO.
Encode the string

\[ s := a_1 \cdots a_n \in \Sigma^n \]

as the model

\[ M_s := \langle \{1, 2, \ldots, n\}, S_n, (\llbracket P_a \rrbracket)_{a \in \Sigma} \rangle \]

where

\[ S_n := \{\langle 1, 2 \rangle, \langle 2, 3 \rangle, \ldots, \langle n - 1, n \rangle\} \]

\[ \llbracket P_a \rrbracket := \{i \in \{1, 2, \ldots, n\} \mid a_i = a\} \quad \text{for } a \in \Sigma \]

— i.e., universe consists of string positions
  with \( \text{vocab}(\Sigma) \approx S, P_a \) per symbol \( a \in \Sigma \).
Example

For \( s = 0011021 \) and \( \Sigma = \{0, 1, 2\} \),

\[
M_s = \langle \{1, 2, 3, 4, 5, 6, 7\}, \\
\{\langle 1, 2 \rangle, \langle 2, 3 \rangle, \langle 3, 4 \rangle, \langle 4, 5 \rangle, \langle 5, 6 \rangle, \langle 6, 7 \rangle \}, \\
(\llbracket P_a \rrbracket_{a \in \{0, 1, 2\}}) \rangle
\]

where \( \llbracket P_0 \rrbracket = \{1, 2, 5\} \)
\( \llbracket P_1 \rrbracket = \{3, 4, 7\} \)
\( \llbracket P_2 \rrbracket = \{6\} \)

partitioning universe

But for \( \Sigma = \{0, 1, 2, 3\} \), add

\( \llbracket P_3 \rrbracket = \emptyset \)

so partition apart from a’s not in \( s \).