AIFA: PLANNING

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Koustav Rudra

Planning: Automation

- Partial order planning
- GraphPlan
- SATPlan
- Stochastic Planning

Partial Order Planning

- Basic Idea: Make choices only that are relevant to solving the current part of the problem

- Least Commitment Choices:
  - Orderings: Leave actions unordered, unless they must be sequential
  - Bindings: Leave variables unbound, unless needed to unify with conditions being achieved
  - Actions: usually not subject to “least commitment”

Terminology

- Totally Ordered Plan
  - There exists sufficient orderings O such that all actions in A are ordered with respect to each other
- Fully Instantiated Plan
  - There exist sufficient constraints in B such that all variables are constrained to be equal to some constant
- Consistent Plan
  - There are no contradictions in O or B
- Complete Plan
  - Every precondition P of every action Ai in A is achieved:
    - There exists an effect of an action A_j that comes before A_i and unifies with P, and no action A_k that deletes P comes between A_j and A_i

STRIPS

- Stanford Research Institute Problem Solver
- Many planners today use specification languages that are variants of the one used in STRIPS

- Our running example:
  - Given:
    - Initial State: The agent is at home without tea, biscuits, book
    - Goal State: The agent is at home with tea, biscuits, book
    - A set of actions

State Representation

- States are represented by conjunctions of function-free ground literals
  - $At(Home) \wedge {\sim}Have(Tea) \wedge {\sim}Have(Biscuits) \wedge {\sim}Have(Book)$

- Goals are also described by conjunction of literals
  - $At(Home) \wedge Have(Tea) \wedge Have(Biscuits) \wedge Have(Book)$

- Goals can also contain variables
  - $At(x) \wedge Sells(x, Tea)$
  - The above goal is being at a shop that sells tea

Representing Actions

- Action description: serves as a name
- Precondition: a conjunction of positive literals
- Effect: a conjunction of literals (+ve or –ve)

- OP(
  - ACTION: $Go(there)$
  - PRECOND: $At(here) \land Path(here, there)$
  - EFFECT: $At(there) \land {\sim}At(here)$
  -)

Representing Plans

- A set of plan steps
  - Each step is one of the operators for the problem
- A set of step ordering constraints
  - Each ordering constraint is of the form $S_i \prec S_j$
  - indicating S_i must occur sometime before S_j
- A set of variable binding constraints of the form v=x
  - v is a variable in some step
  - x is either a constant or another variable
- A set of causal links written as $S \rightarrow c{:}\, S'$ indicating S satisfies the precondition c for S'

POP Example: Get Tea, Biscuits, Book

Initial State:

Op(ACTION: Start,
EFFECT: At(Home) ∧ Sells(BS, Book)
∧ Sells(TS, Tea)
∧ Sells(TS, Biscuits))

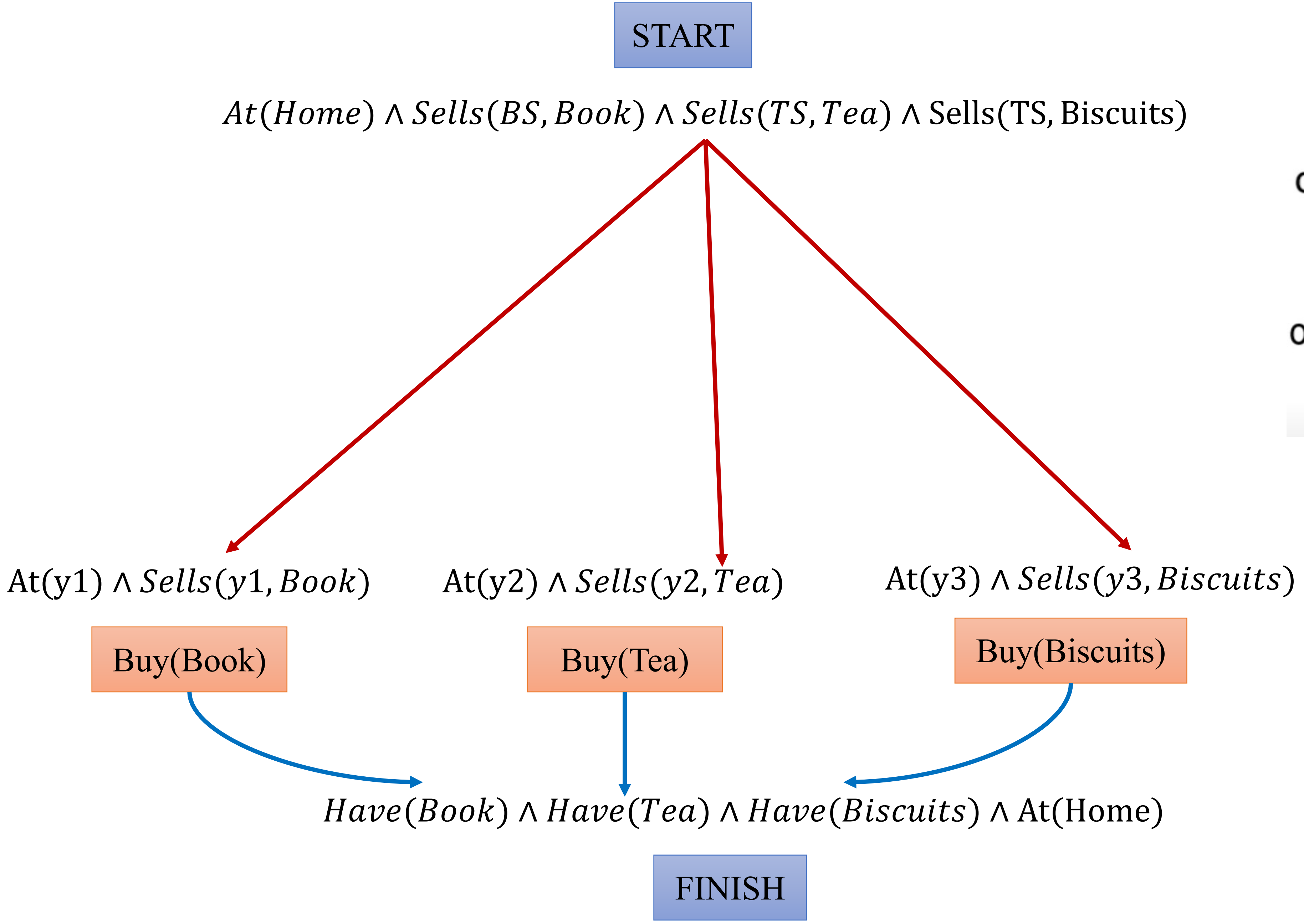
Goal State:

Op(ACTION: Finish,
PRECOND: At(Home) ∧ Have(Tea)
∧ Have(Biscuits)
∧ Have(Book))

Actions:

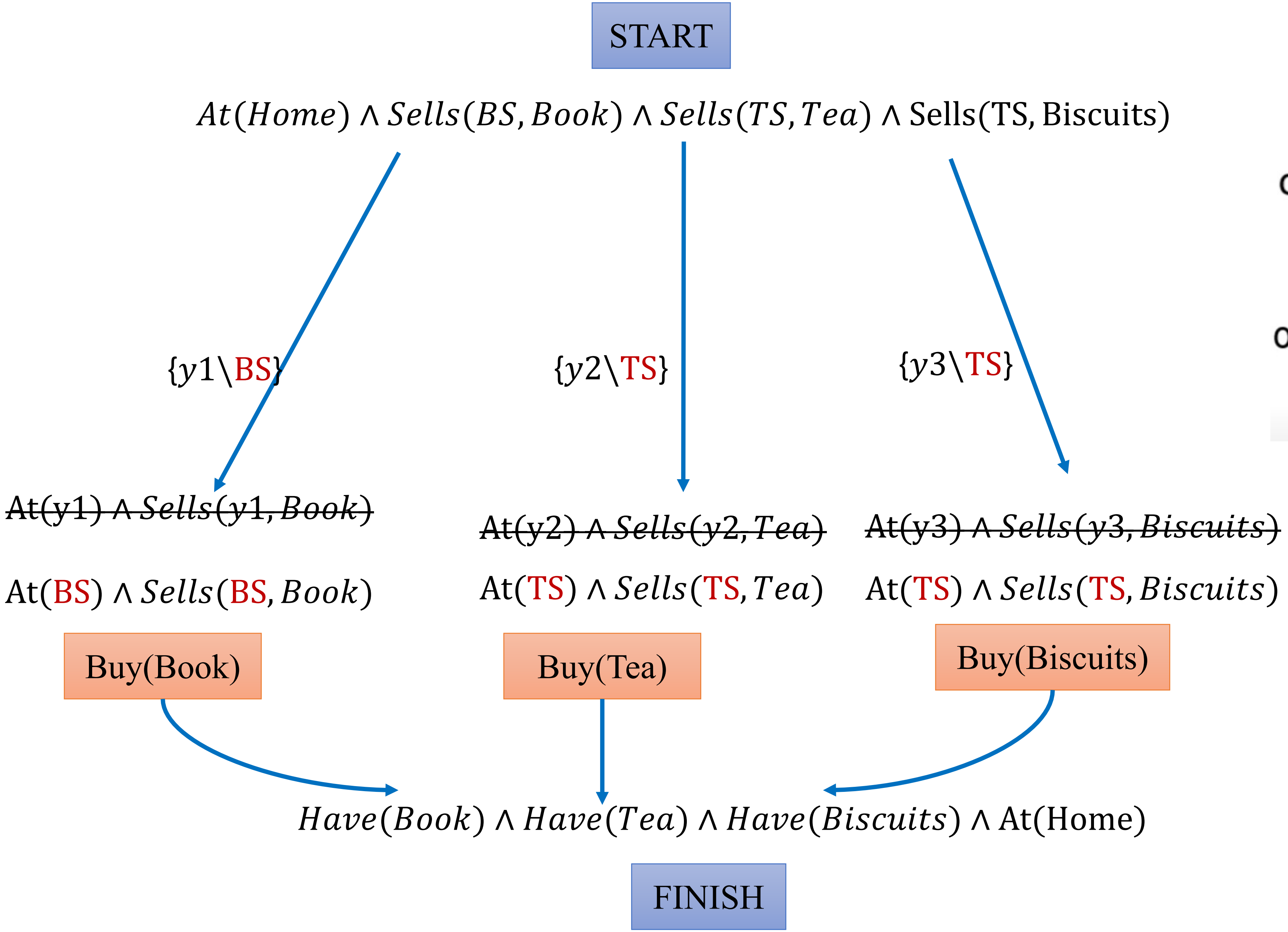
Op(ACTION: Go(y),
PRECOND: At(x),
EFFECT: At(y) ∧ ¬At(x))

Op(ACTION: Buy(x),
PRECOND: At(y) ∧ Sells(y, x),
EFFECT: Have(x))



Op(ACTION: Go(y),
PRECOND: At(x),
EFFECT: At(y) $\wedge$ $\neg$At(x))

Op(ACTION: Buy(x),
PRECOND: At(y) $\wedge$ Sells(y, x),
EFFECT: Have(x))



Op(ACTION: Go(y),
PRECOND: At(x),
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Op(ACTION: Buy(x),
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EFFECT: Have(x))

Thank You