The Selection Space

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32nd Soar Workshop

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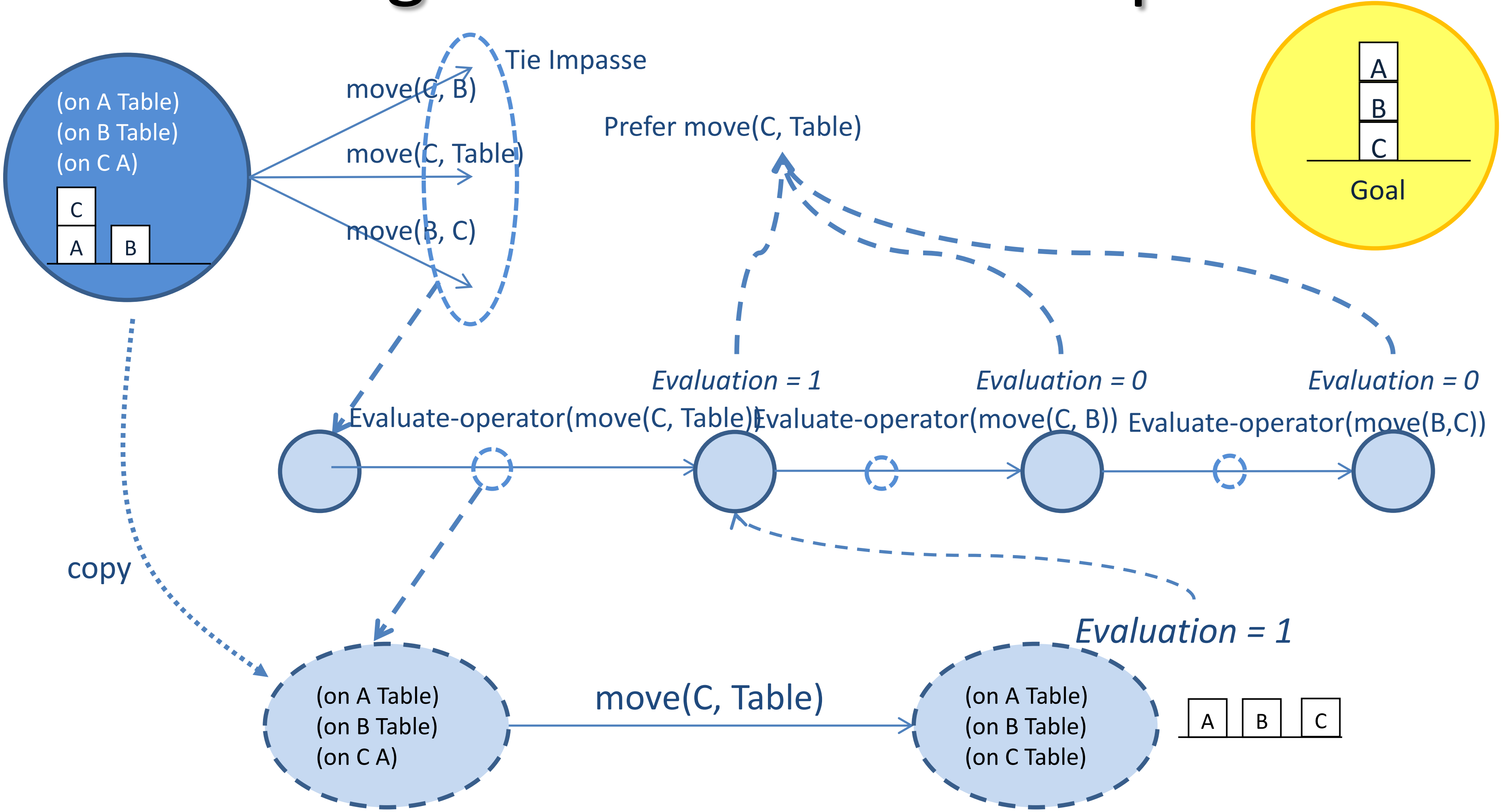
Overview One-step Look-ahead Using Selection Problem Space



Selection Space

- Important state structures created by Soar
  - ^impasse tie, ^item 01 02 …
- Evaluate-operator
  1. Instantiated with every item (every tied operator) that has not been evaluated

     ```
     (<s> ^operator <o>)
     (<o> ^name evaluate-operator
                  ^superoperator <so>)
     ```

  2. Usually randomly select between them (some exceptions)
  3. Create ^evaluation structure on selection state

Evaluate State Structure

- When evaluate-operator is selected, create:
  - (<s> ^evaluation <e>)
  - (<e> ^superoperator <i>)
  - (<o> ^evaluation <e>   # on evaluate-operator
  - ^superstate <ss>   # task state
  - ^superproblem space <ps>)
- Evaluate-operator terminates when a value is created on the associate evaluation
  - (<e> ^value true)

Evaluate-operator Substate

- Create a *copy* of the task state
  - Includes ^name, ^desired
  - ^problem-space determines how to create copy
    - Many flags to control what to copy and how deep
    - ^default-state-copy yes is default
- If don’t create copy, original state will change

Evaluate-operator Processing

1. Force selection of a copy of the operator being evaluated
2. Operator application rule should fire and generate new state
   - Requires *action model:* operator application rule for simulating operator
   - If doesn't, will eventually get impasses that lead to a failed evaluation.
3. If there is state evaluation knowledge, it adds augmentation to state
   - ^numeric-value, ^symbolic-value, ^expected-value
   - Copied up to the evaluation structure in the selection space
   - Leads to evaluate-operator terminating

- By default, elaboration rules aggressively convert evaluations to preferences.
  - Evaluates only as many operators as necessary to generate preferences to break the tie.
- Chunks are learned for computing evaluations and preferences

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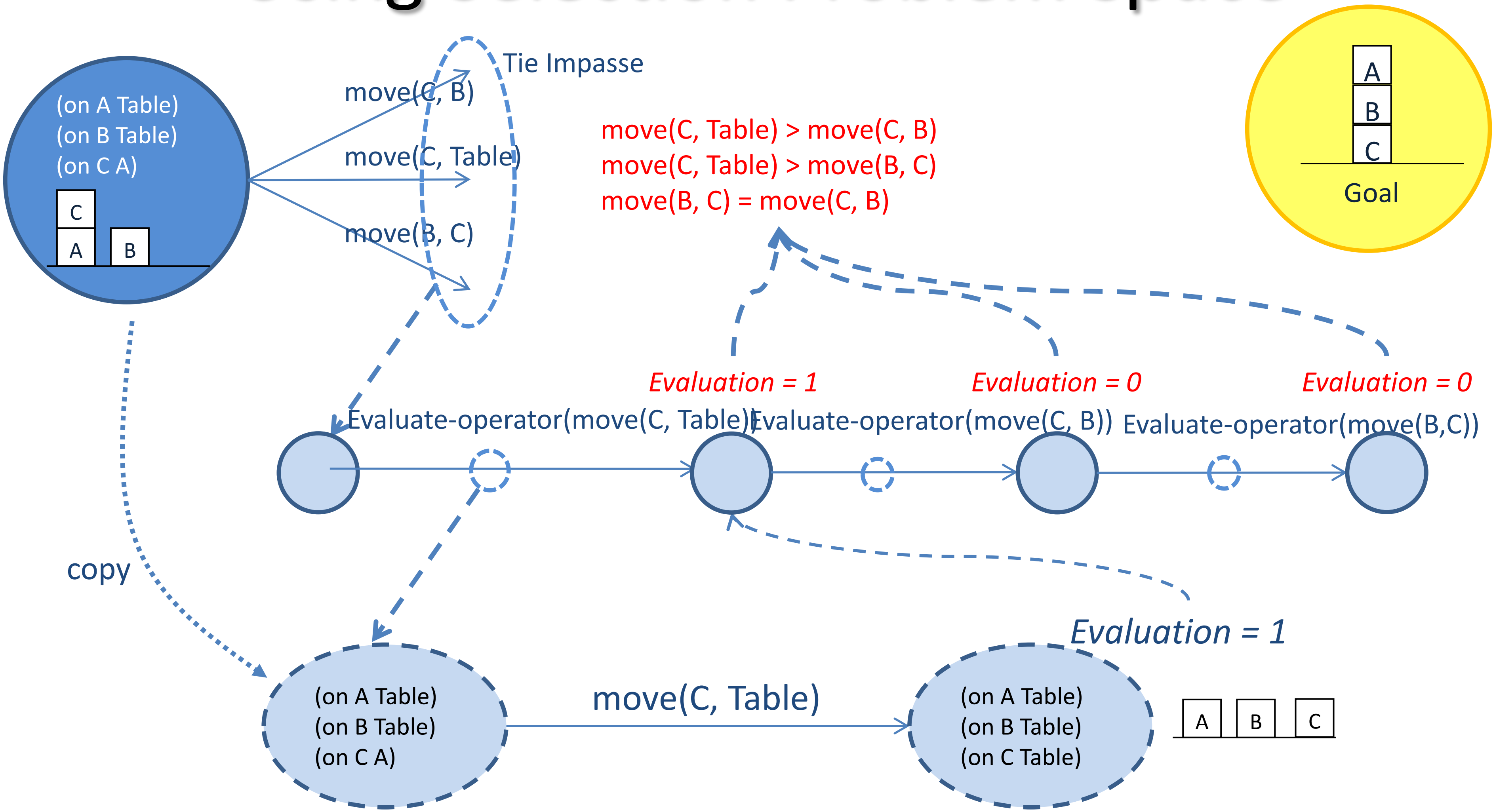

Requirements to Use Selection Space

- Source in selection.soar!
  - Explains the following requirements
- Have a ^problem-space structure on the state
- Have a ^desired structure on the state
- Include rules that compute failure/success/evaluation.
- Have rules that simulate action of operators
  - This is an *action model*
  - Only apply when in state with
    ^name evaluate-operator

Depth-First Search in Soar

- If no evaluation of the state, continues in substate
  - If sufficient knowledge, selects and applies operator
  - If insufficient knowledge, get a tie impasse and recursively get depth-first search.
- The state "open" list is represented as the stack of substates.
- Elaboration rules pass success up the stack to avoid extra search.
- No guarantee of finding shortest path.
- Chunking is necessary to avoid repeated search.

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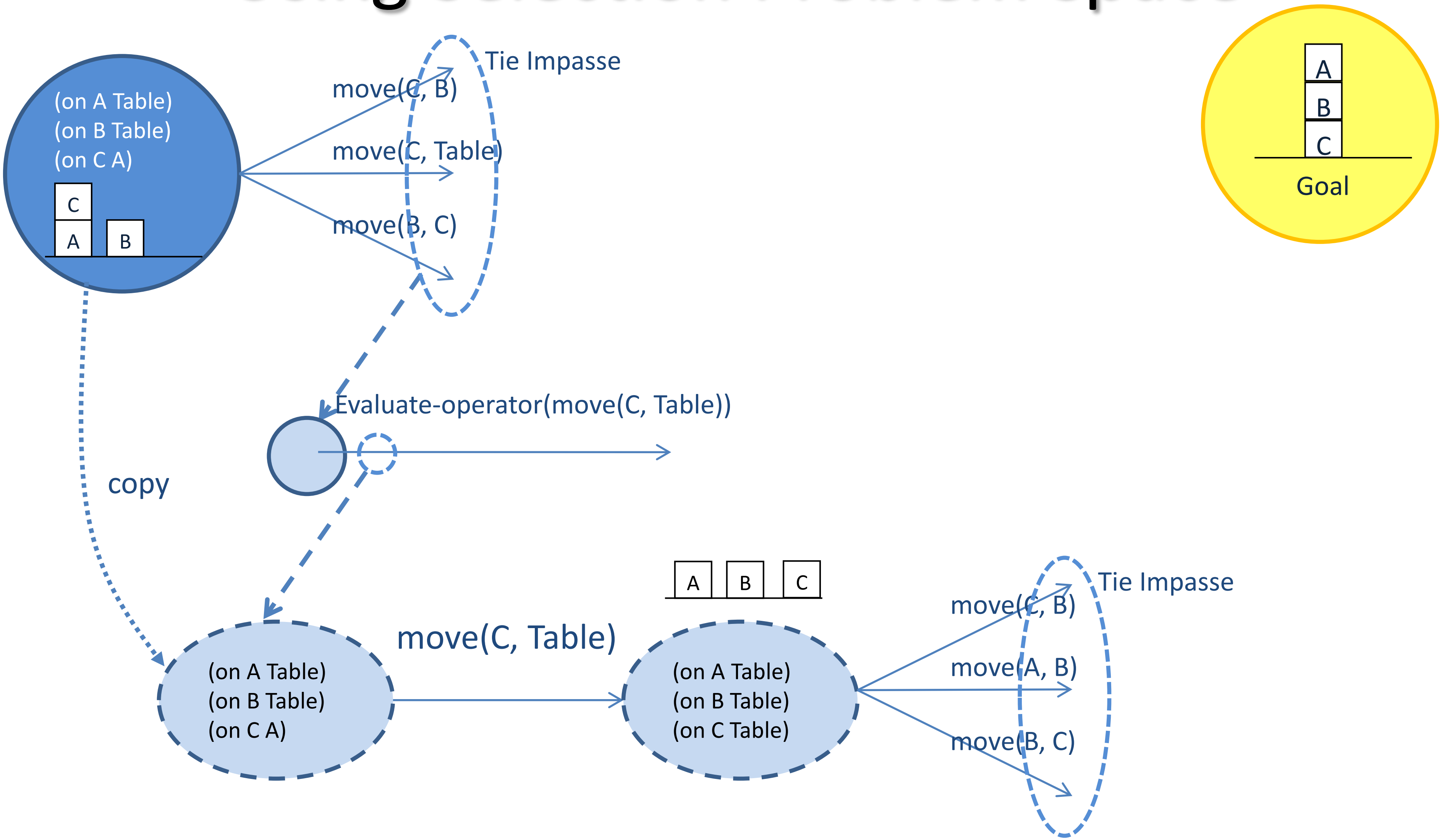


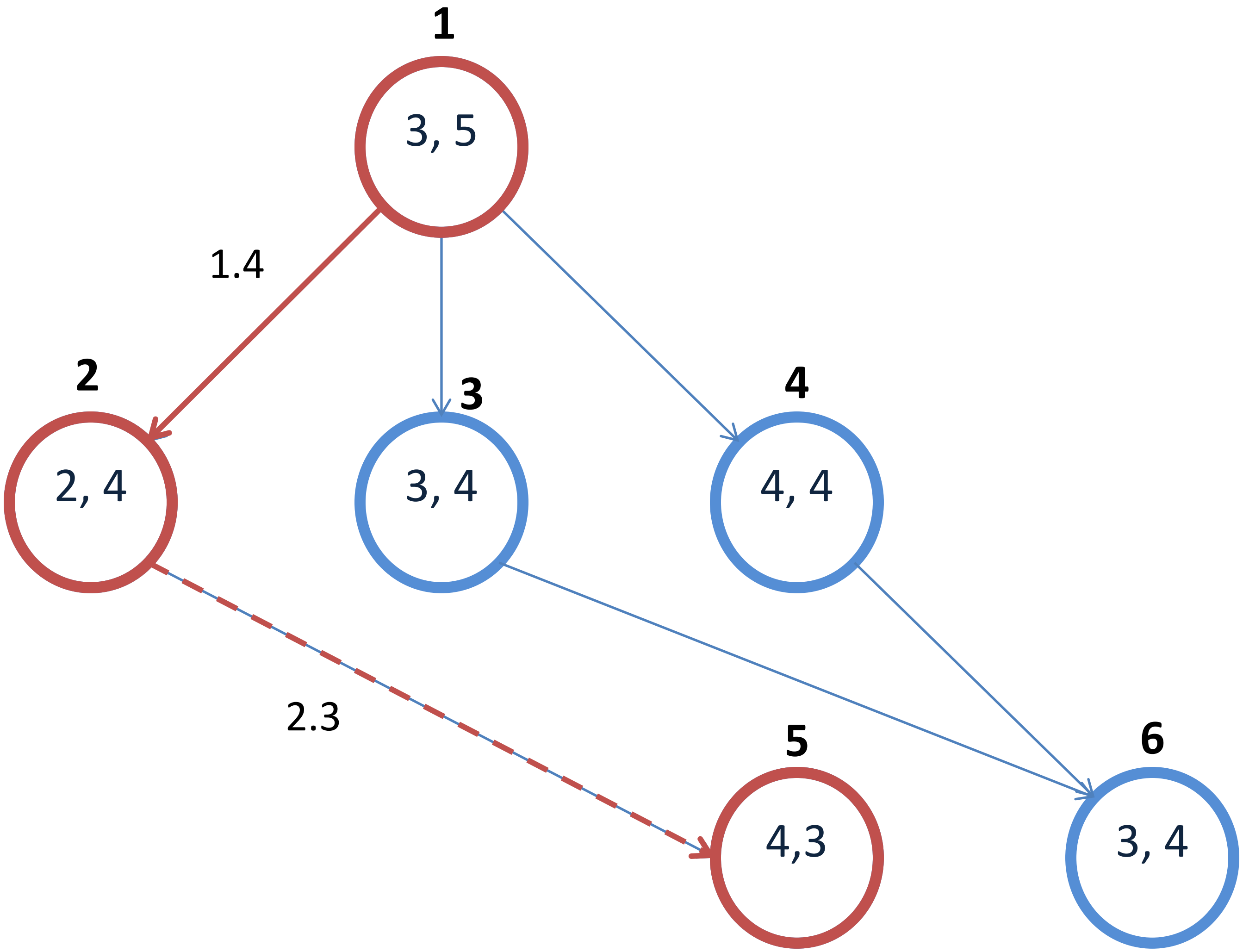
Iterative Deepening

- Include an evaluation-depth in the selection space
- Evaluate all of the task operators to that depth
  - Start with depth = 1
  - In each recursive selection substate, decrement depth
- Terminate if achieve goal
- Increment depth when all task operators have been evaluated

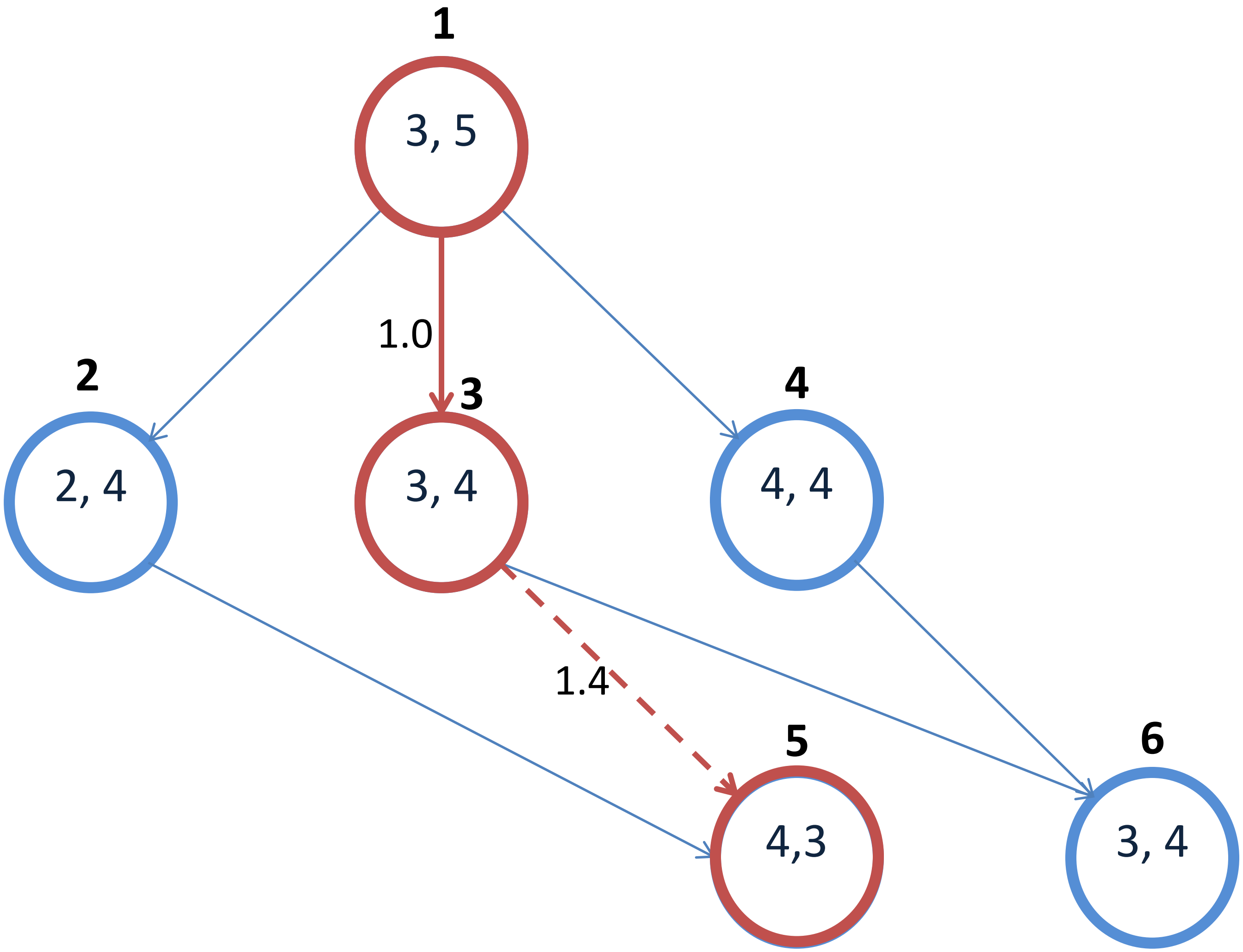
Deep Search in Soar: Iterative A*

- Assumes task state structure
  - Graph structure of ^waypoints, with a ^current-location
- Every evaluation maintains
  - Path-cost: g(x)
  - Estimated-cost: h(x)
  - Total-estimated-cost: f(x) = g(x) + h(x)
- Prefer an evaluate-operator to another
  - If it doesn’t have an estimated-cost # get initial values
  - If its total-estimated-cost is less than the others # pursue best
- Final-cost for an operator is when estimated cost is 0
- Create a preference if final-cost(o1) < total-estimated-cost(o2)
- Complex rules and operators combine estimates from substates
  - Add operators: compute-evaluations, compare-evaluations, compute-best-total-estimate

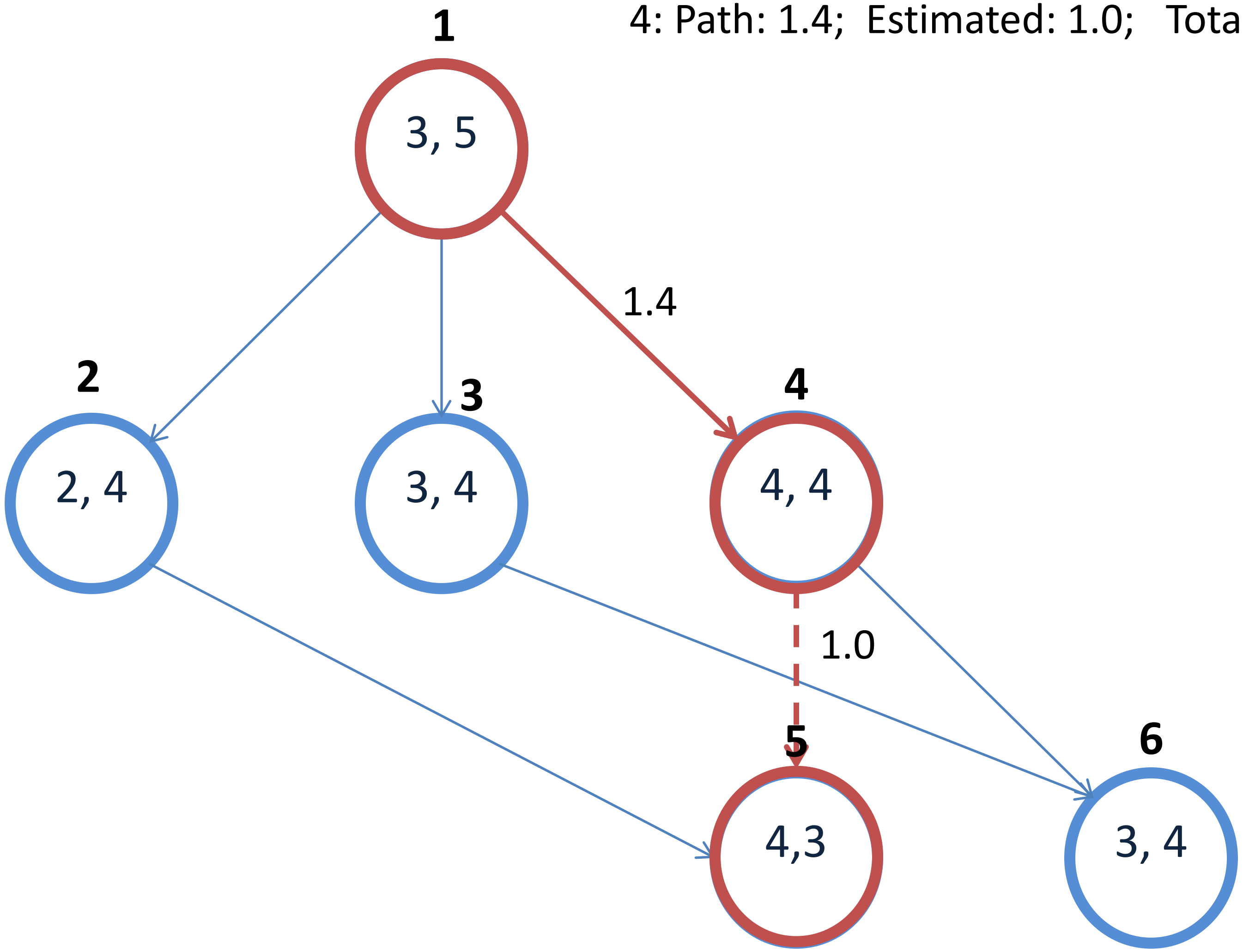
2: Path: 1.4; Estimated : 2.3; Total 3.7



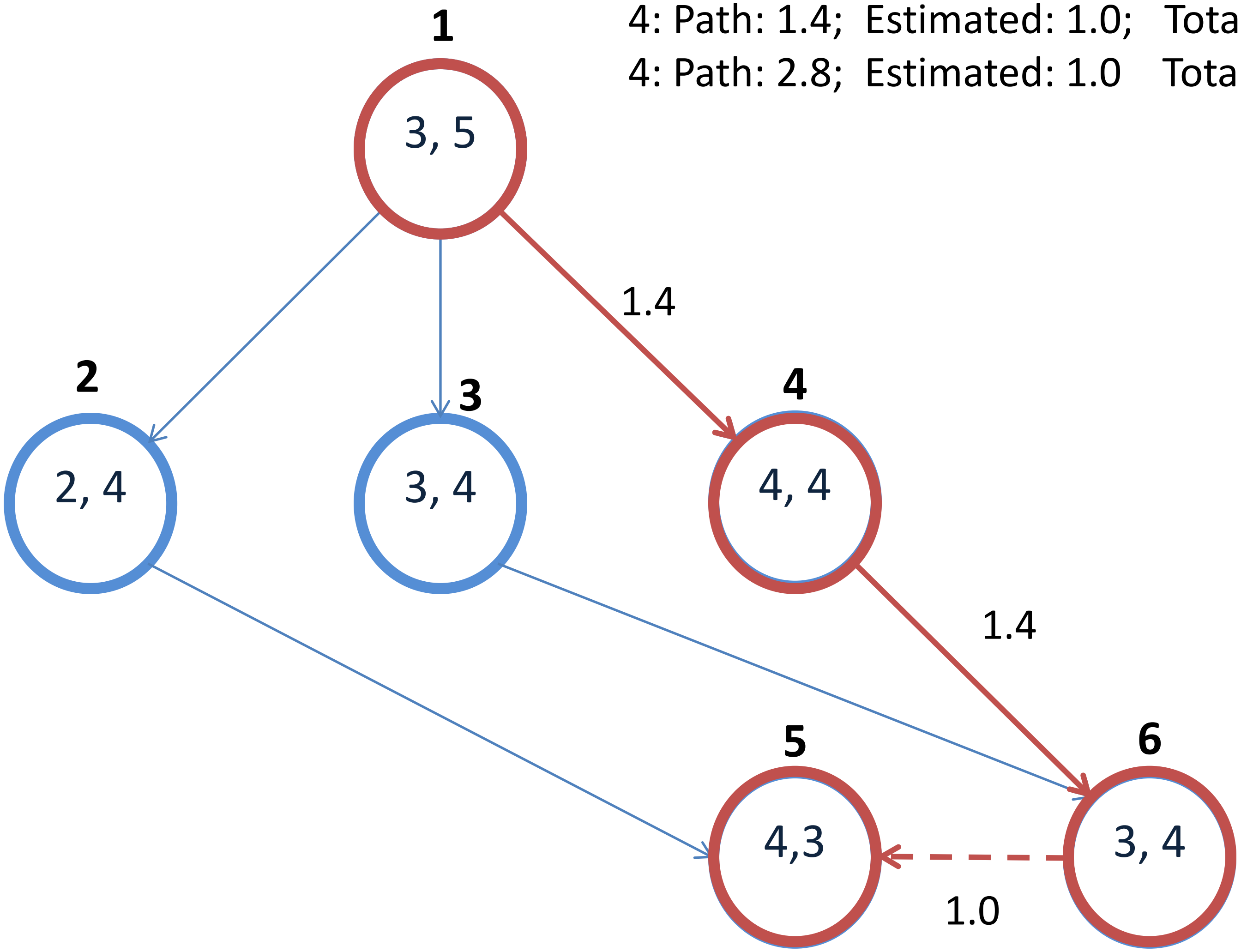
2: Path: 1.4; Estimated : 2.3; Total 3.7
3: Path: 1;   Estimated: 1.4;   Total 2.4



2: Path: 1.4; Estimated : 2.3; Total 3.7
3: Path: 1;   Estimated: 1.4;   Total 2.4
4: Path: 1.4; Estimated: 1.0;   Total 2.4

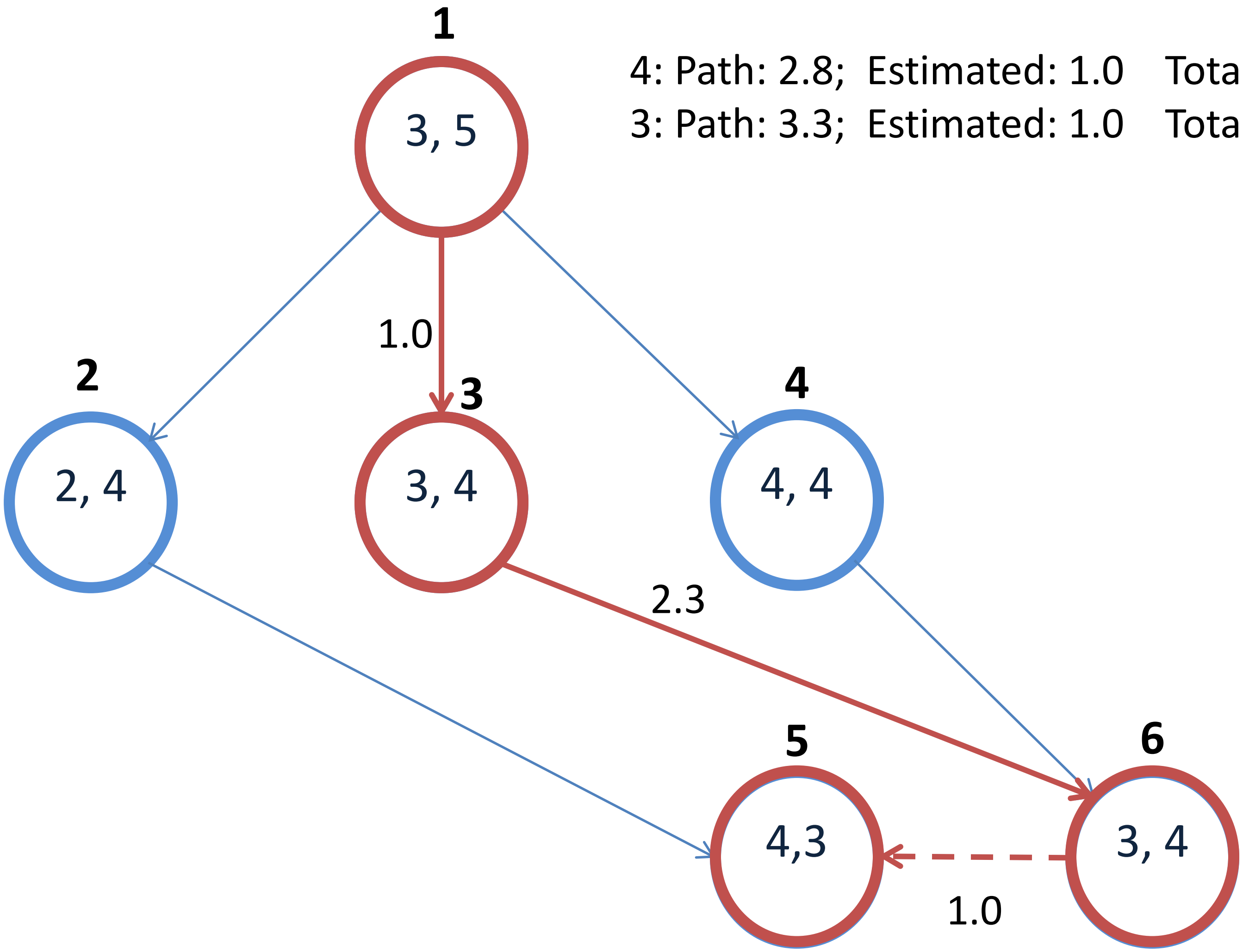


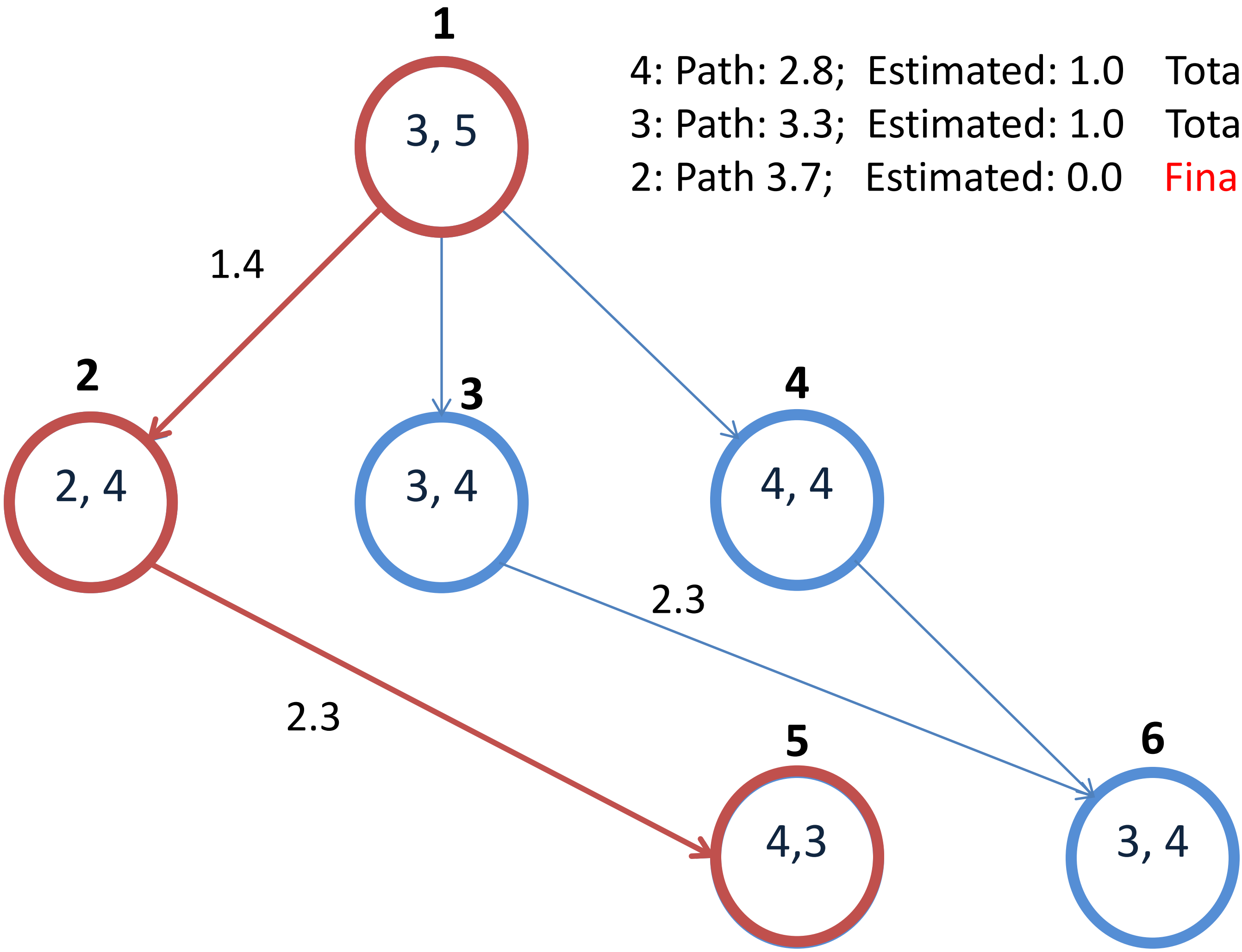
2: Path: 1.4; Estimated : 2.3; Total 3.7
3: Path: 1; Estimated: 1.4; Total 2.4
4: Path: 1.4; Estimated: 1.0; Total 2.4
4: Path: 2.8; Estimated: 1.0 Total 3.8



2: Path: 1.4; Estimated : 2.3; Total 3.7
3: Path: 1;   Estimated: 1.4;   Total 2.4

4: Path: 2.8; Estimated: 1.0   Total 3.8
3: Path: 3.3; Estimated: 1.0   Total 4.3





2: Path: 1.4; Estimated : 2.3; Total 3.7

4: Path: 2.8; Estimated: 1.0   Total 3.8
3: Path: 3.3; Estimated: 1.0   Total 4.3
2: Path 3.7;   Estimated: 0.0   Final: 3.7

Nuggets and Coal

- Nuggets:
  - Provides task-independent knowledge for controlling deliberate operator evaluation
  - Plays well with chunking
- Coal
  - Requires some knowledge of conventions
  - More advanced methods are pretty complex