Maybe 640k is not enough anymore:
How to take ACT-R to the next level?

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Artificial Intelligence

Computer architecture vs. Cognitive Architecture

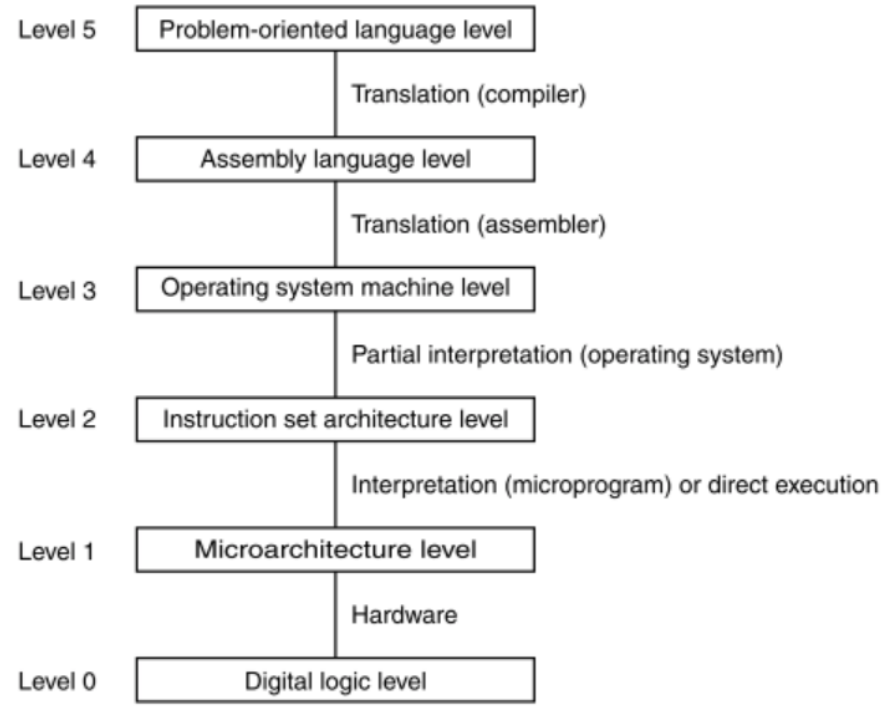
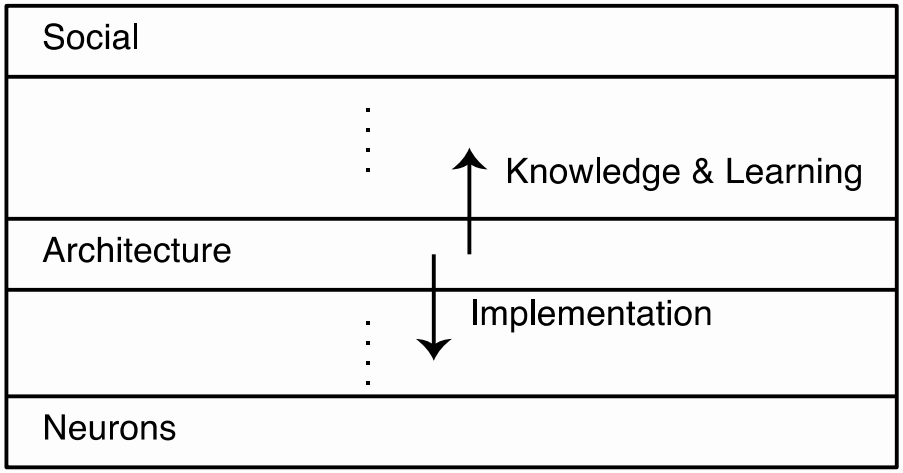


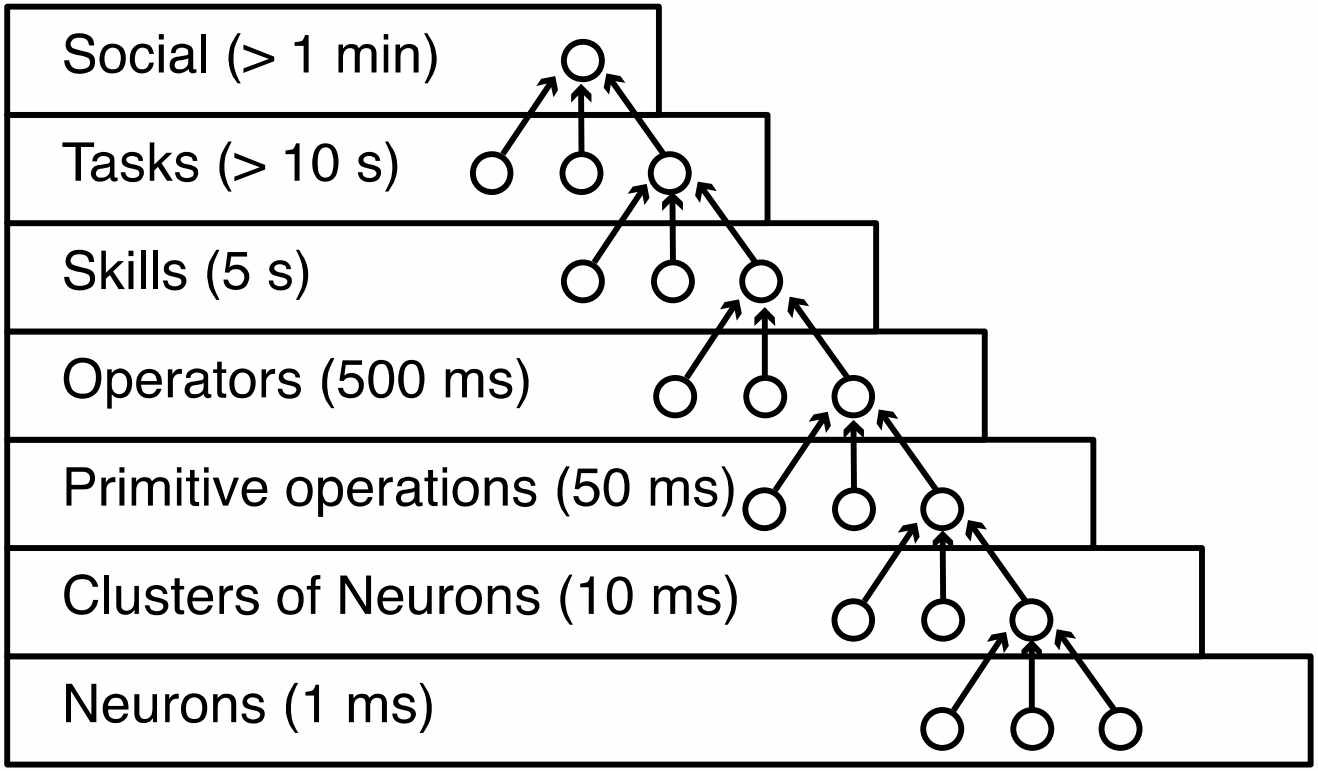
Figure 1-2. A six-level computer. The support method for each level is indicated below it (along with the name of the supporting program).

Horizontal architecture



The cognitive architecture is different from a computer architecture

Multilevel architecture



Example: RITL experiment

Task 1

Instructions

SAME
SWEET
LEFT INDEX

3 s

Trials

Answer: TRUE
(Left index finger)

Grape
Apple

2 s each

Task 1 description:
If the answer to 'is it SWEET?'
is the SAME for both words,
press your LEFT INDEX finger

Task 2

Instructions

SECOND
LOUD
RIGHT MIDDLE

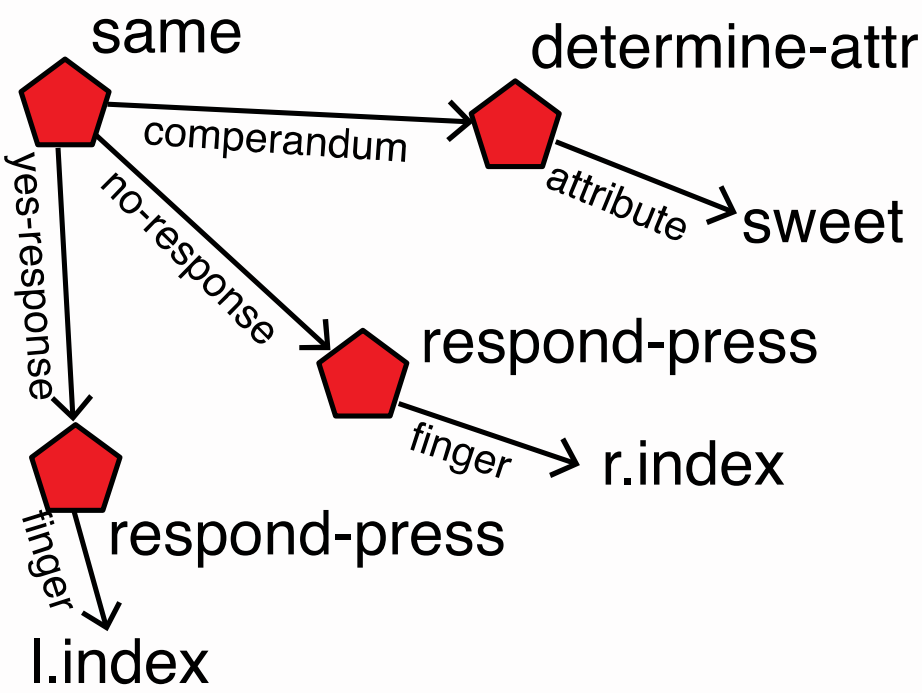
Trials

Answer: TRUE
(Right middle finger)

Leaf
Dynamite

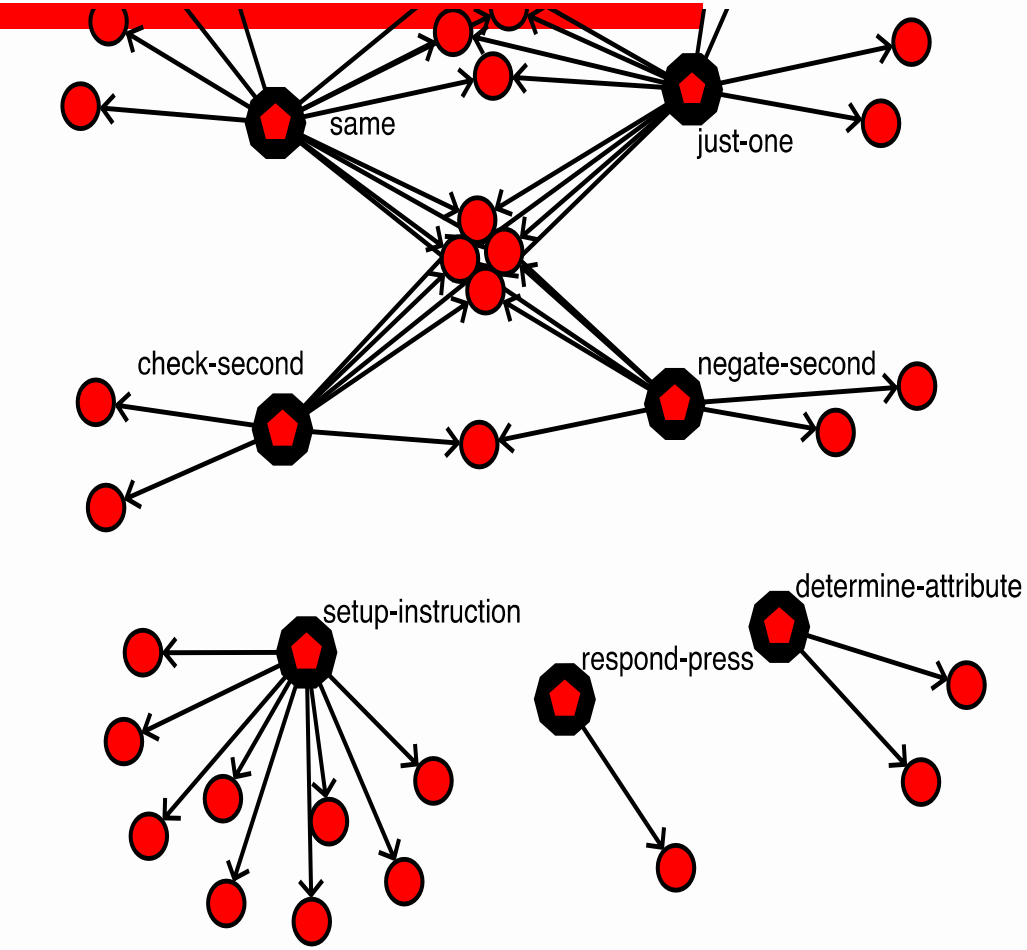
Task 2 description:
If the answer to 'is it LOUD?'
is yes for the second word,
press your RIGHT MIDDLE finger

Task level model



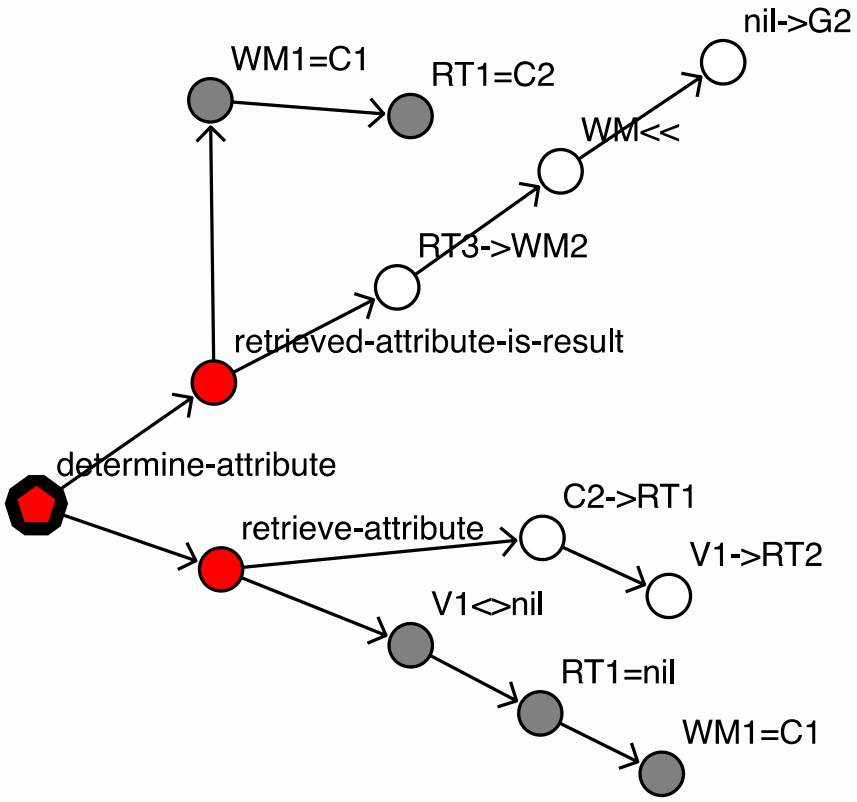
- Primitives at the task level are skills
- Learning by a (linguistic) composition
- One-shot-learning!

Skill level model



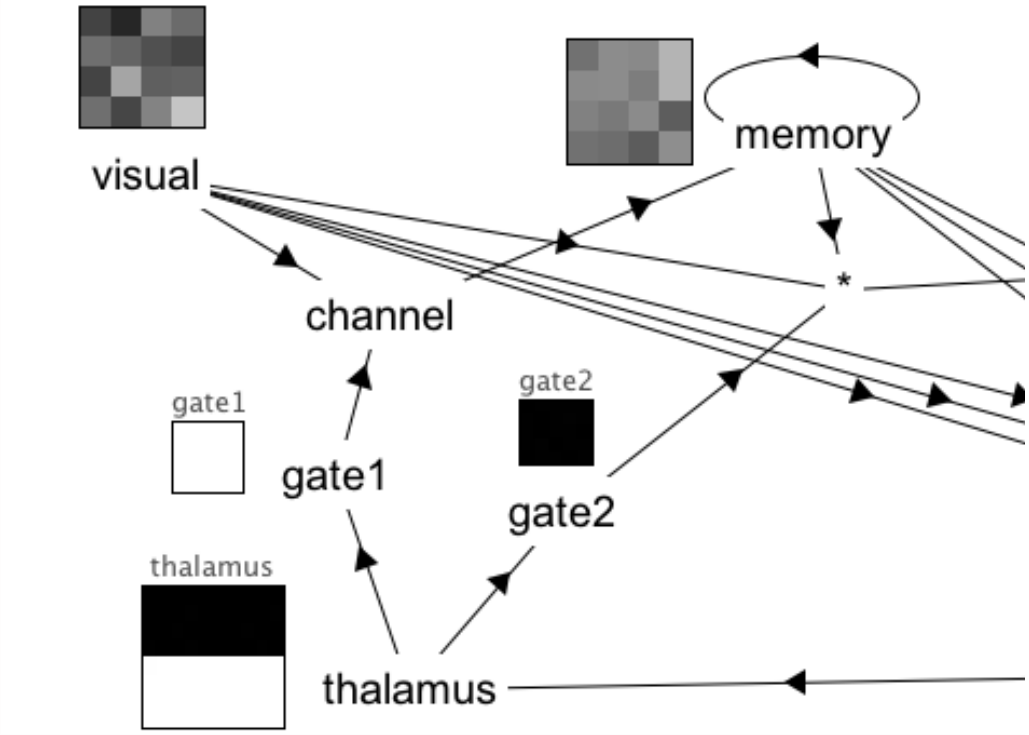
- Each skill requires a set of operators/productions
- Some operators may be useful for multiple skills
- Learning: reinforcement learning, imitation

Operator-level model




```
(p retrieve-attribute
      =goal>
        isa determine-attribute
            attribute =attr
      =visual>
            slot1 =object
      ?retrieval>
            buffer empty
==>
      +retrieval>
            attribute =attr
            object =object)
```

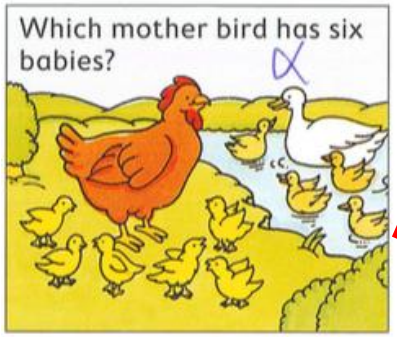
Primitive Operations level model of V1->RT2

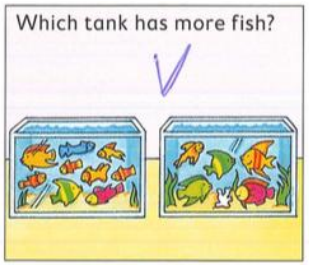


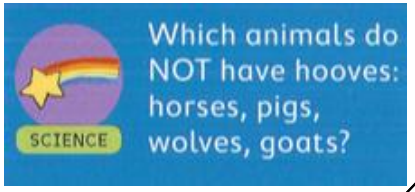
- A symbol in the visual buffer can have a different representation that in the retrieval buffer
- The mappings have to be learned

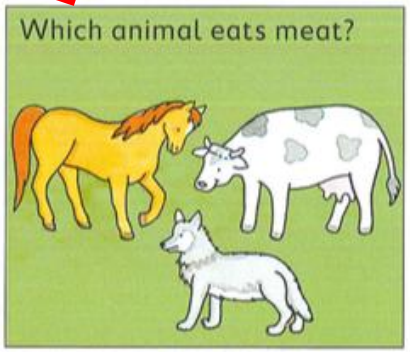
Do we always have to model from the bottom up?

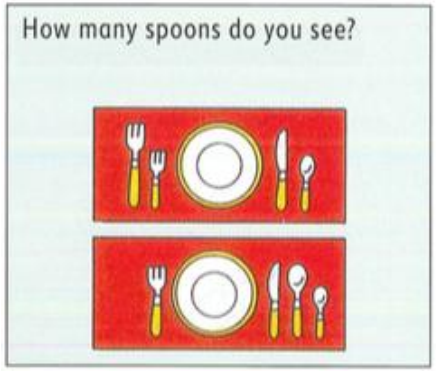
- No!
- Put we should aim for the appropriate level
- And fill in the gaps to make a complete “reductionist” account







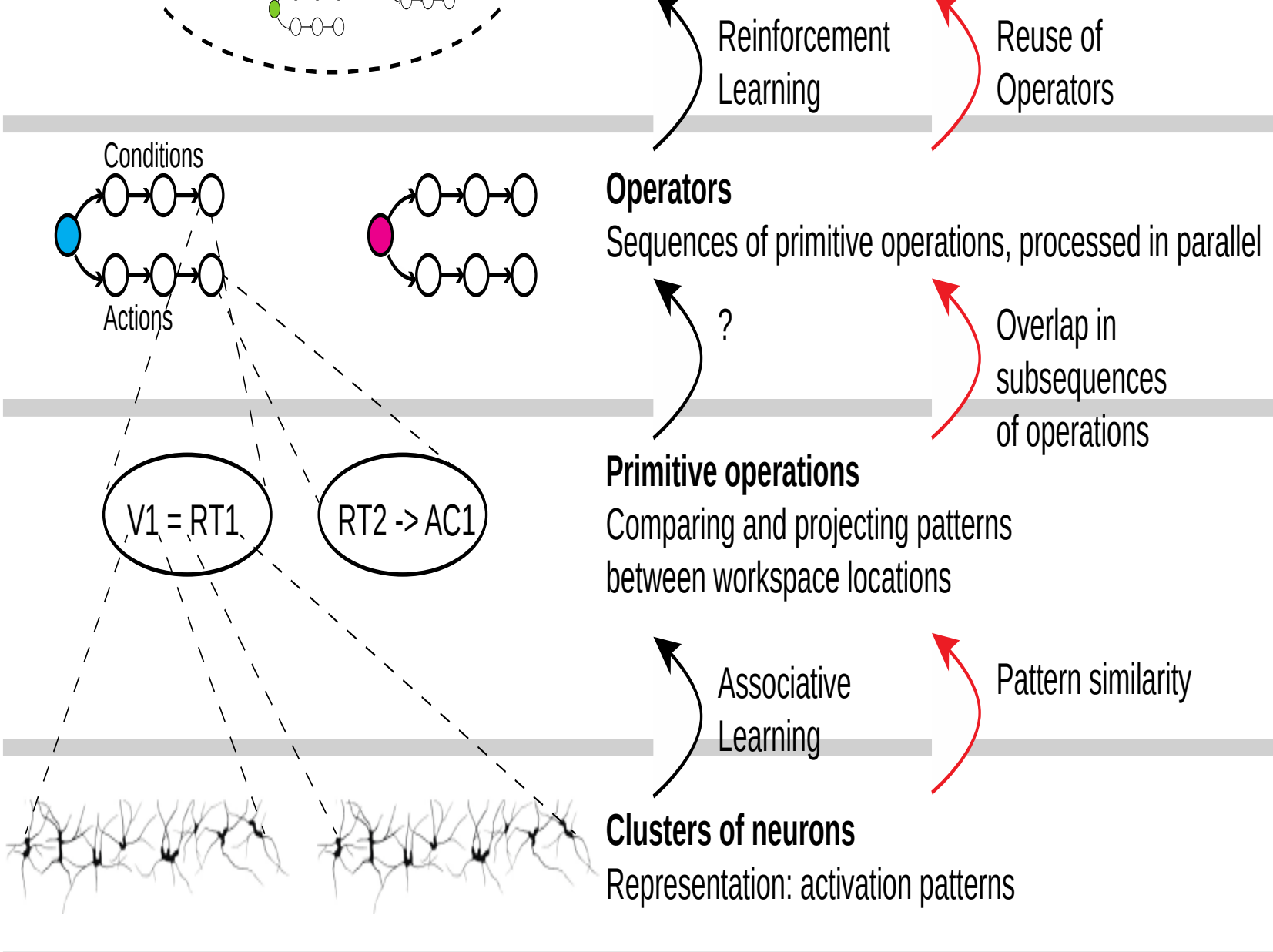




include-all
six-babies
count-goal
more-fish
more
determine-attribute
count-spoons
add-all
find-value
find-all-values
eats-meat
not-hooves
retrieve-attribute
negate

The new challenges

- Develop the architecture to allow modeling at different levels of abstraction
- Develop mechanisms for learning and transfer for each of these levels
- Mitigate the parameter-fitting accusation
- Build knowledge-rich models by sharing resources


Reinforcement Learning
Reuse of Operators
Conditions
Actions
Operators
Sequences of primitive operations, processed in parallel
?
Overlap in subsequences of operations
V1 = RT1
RT2 -> AC1
Primitive operations
Comparing and projecting patterns between workspace locations
Associative Learning
Pattern similarity
Clusters of neurons
Representation: activation patterns
Lower-level neuronal representations`