

Automatization for Software Agents

Aregahegn Negatu

Stan Franklin

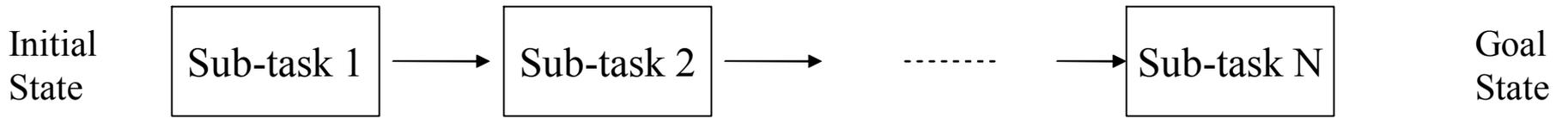
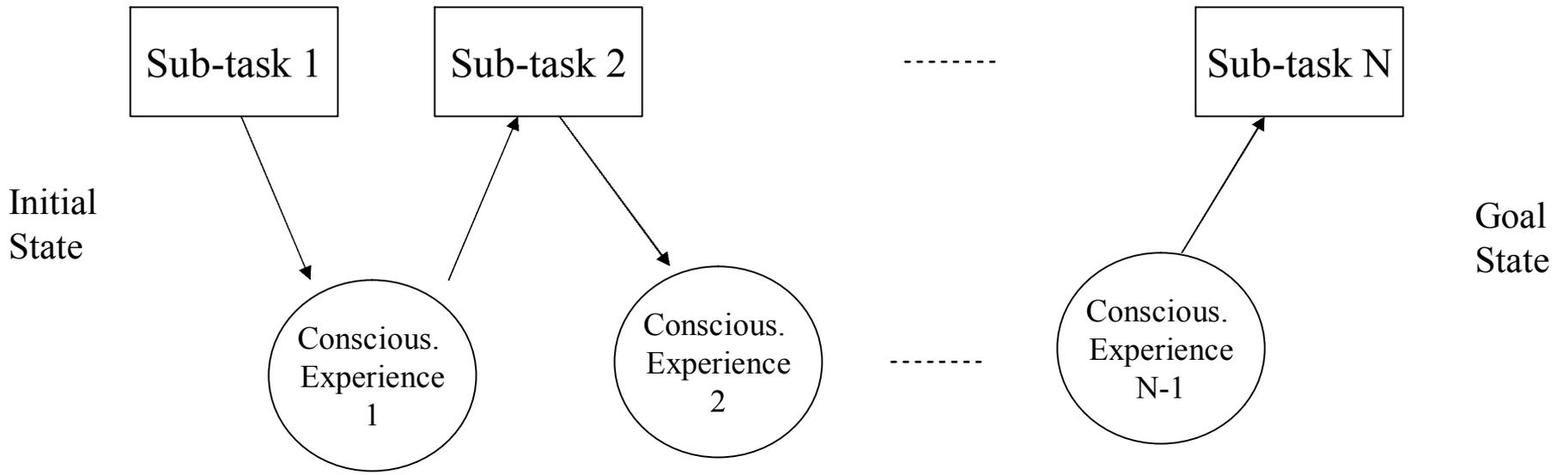
Lee McCauley

What is automatization?

- **Automatization** – a cognitive function to learn procedural tasks via experience/practice.
- **Examples:**
 - **Driving**
 - **Walking**
 - **Cycling**
 - **Swimming**
 - **Typing**
- **Advantages:**
 - **Performance improves**
 - parallel, without limited capacity.
 - or without mental effort.
- **Disadvantages:**
 - **Inflexibility.**
 - **Resistance to modification.**

Automatization - characteristics

- implicit learning
 - automatic, but it requires conscious information (reber, 1989).
 - Consciousness is necessary for learning.
- Conscious awareness fades as automatization develops with experience (e.g. Logan, 1992; Tzelgov 1997, Kanwisher, 2001).
- improves performance

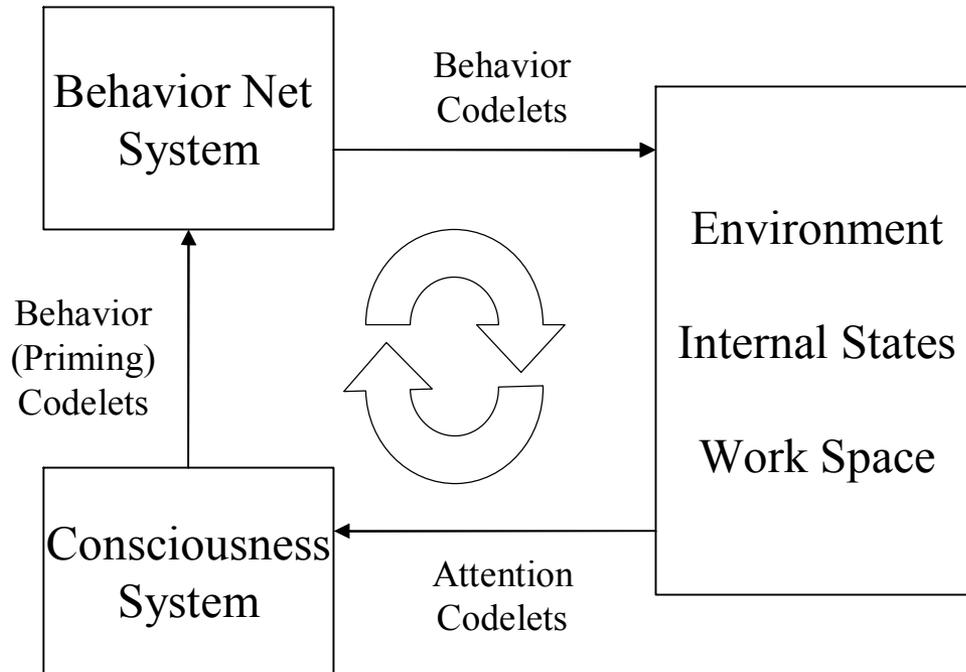


—————→ TIME

Conscious Stream (C-U-C Triad) in IDA

Action Types

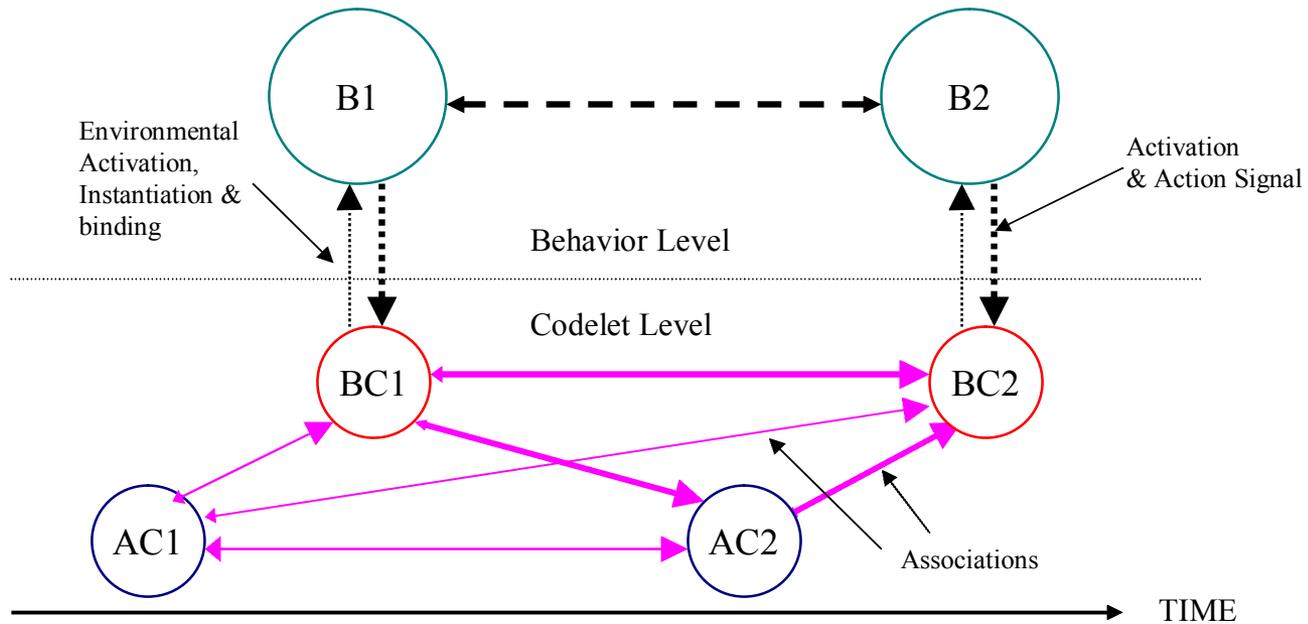
- Unconscious
- Consciously mediated
- Conscious goal selection



Basis for Automatization

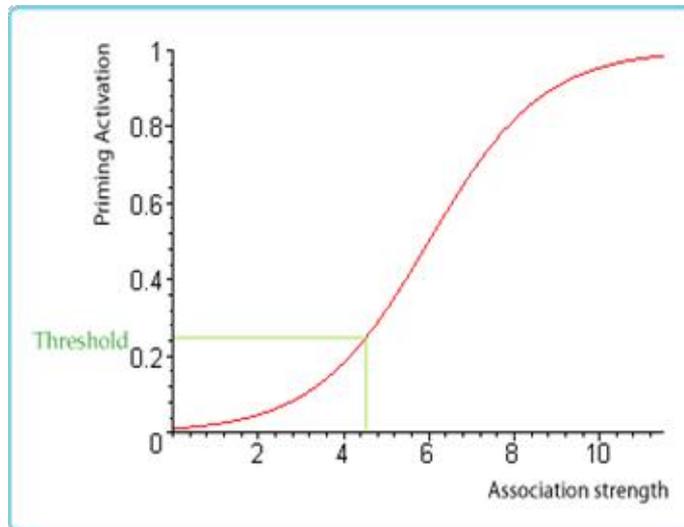
- Encoding experience - association among low-level processors (codelets)
 - Events happen by relevant codelets in the playing-field.
 - Association develops among codelets that are together in the playing-field (Pandemonium theory).
 - As a task is operated repetitively, codelets associated with the task come together in the playing-field many times – strong association among them.
- Automatization is related to attention (Kahneman & Chajczyk, 1983) and expectation (Logan 1980) processes.

Automatization Mechanism



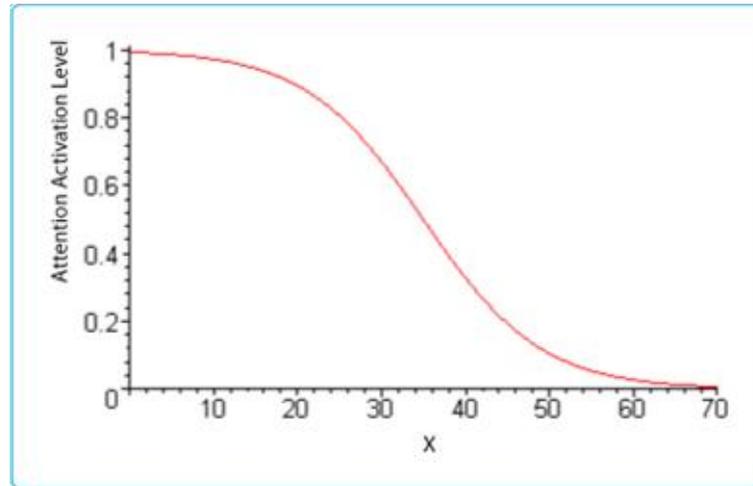
Predicting the next step

- Association builds an alternative communication path to coordinate actions between behavior codelets.
- Next action is predicted by unconscious priming via association of codelets. BC1 primes BC2 using their association.
- Priming activation energy:



Lowering intensity of attention

- Attention (codelet) control access to consciousness.
- Attention codelets compete for consciousness based on activation level. Competitiveness fade with experience.
- Effective activation energy of attention codelet diminishes as its association with behavior codelets increases (automatization develops).

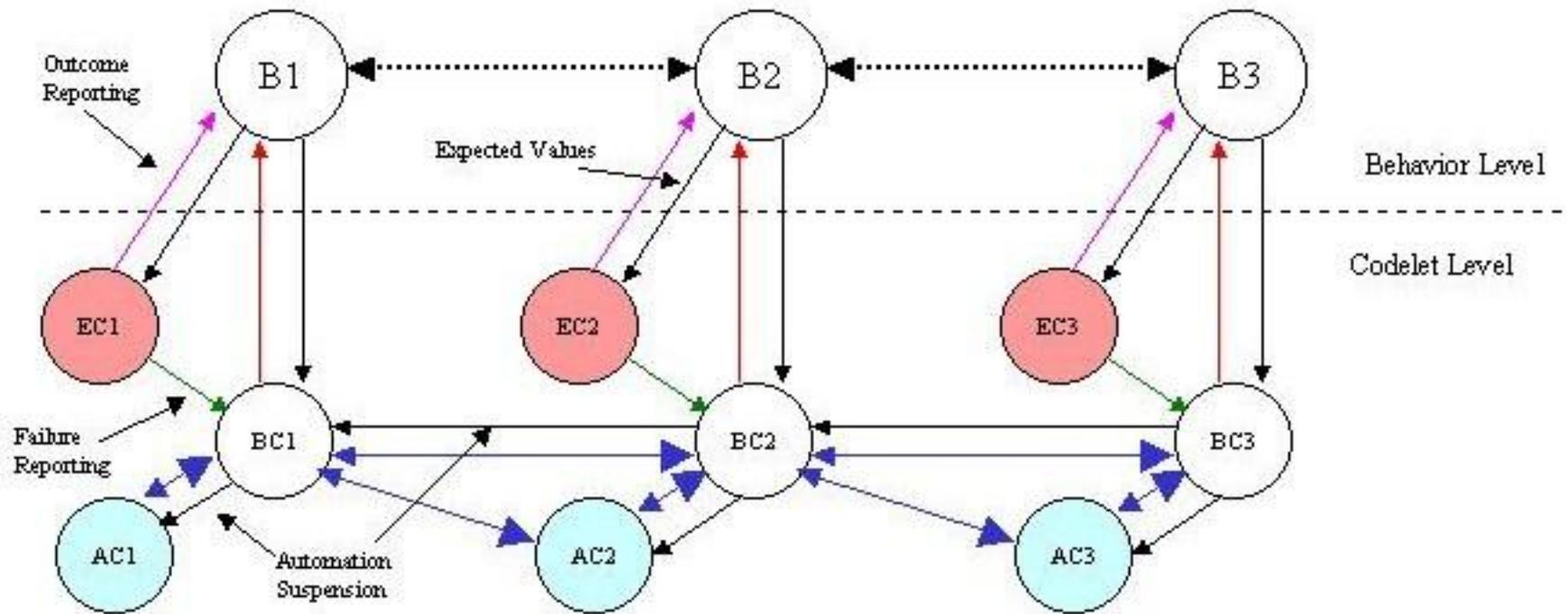


- Where:
 - $x = \text{association}(BC1, AC2) \times \text{association}(AC2, BC2)$,

Deautomatization

- reintroduce conscious access to automated tasks.
 - arises from failed expectation during execution of automated tasks.
- Mechanism
 - To detect failure
 - To temporarily disable automatization effects.

Deautomatization Mechanism



Undoing automatization effects

- **Undoing the effect of priming activation energy between associated BCs:**

$$A_p = (1 - S) / (1 + e^{-ax + c})$$

- **Where S=[0,1] is a suspension parameter value at BCs.**

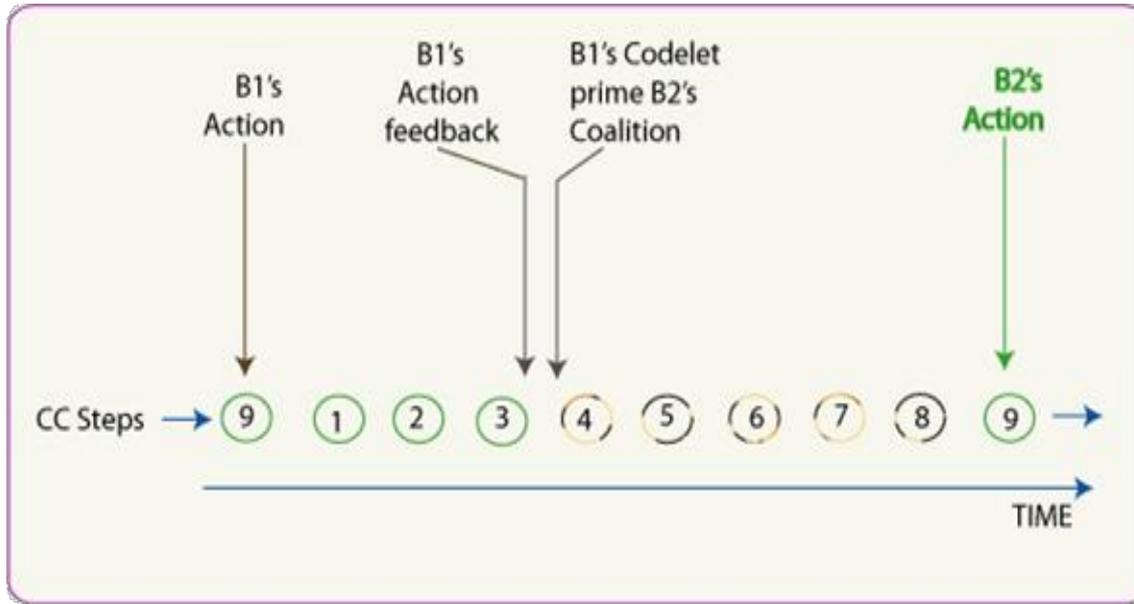
- **Undoing suppression of activation-level of an attention codelet.**

$$A_{eff} = (1 - S) A_r \left(1 - \frac{1}{1 + e^{-bx + c}} \right)$$

- **Where S=[0,1] is a suspension parameter value at ACs.**

- **Deautomatization is forgotten in relatively short time. The suspension parameters S decays relatively quickly.**

Performance improvement: Qualitative analysis



IDA's 9 steps Cognitive Cycle

1. PRECONSCIOUS PERCEPTION
2. PERCEPT TO PRECONSCIOUS BUFFER
3. LOCAL ASSOCIATIONS
4. COMPETITION FOR
5. CONSCIOUSNESS CONSCIOUS BROADCAST
6. RECRUITMENT OF RESOURCES
7. SETTING GOAL CONTEXT HIERARCHY
8. ACTION CHOSEN
9. ACTION TAKEN

- B1's action: Its behavior and expectation codelets are in playing field (CC-9).
- B1's action feedback is ready after CC-3; action feedback may require the service of CC-1, CC-2, and CC-3.
- Cognitive Cycles CC-4, CC-5, CC-6, CC-7, and CC-8 are bypassed by automatization.
- Cognitive steps with competition (CC-4 & CC-8) and conscious broadcast (CC-5) are relative expensive.
- Performance improves
 - Less number of steps
 - Avoid expensive steps

Hypotheses

- Association among low level processors is the basis for automatization.
 - Incidental learning type.
 - a type of chunking process.
- Automatization is related to attention and expectation processes.
- Automatization is a multi step algorithmic process (Schneider & Shiffrin, 1977).
 - Logan (1988) suggests that automatization is a single step memory instance retrieval of past experience.
- Deautomatization happens automatically as a result of failed expectation.
- Deautomatization reinstates original awareness points for conscious access.
- Deautomatization effect stays for a relatively short time interval.
 - Is not a forgetting mechanism

Status of work

- Implementation is completed – a module in the IDA project
- To do: test mechanism using simple procedural task.
 - Conscious control fades as automatization matures.
 - Performance improves qualitatively with automatization.
 - Discuss and compare result in relation to “power law of practice”.