A triple loop model to ground higher-level cognition

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Higher-level cognition

- Problems:
  1. From sensory to symbolic information process?
  2. From lower to higher level cognition?
  3. Information processing?
- Current understand:
  1. Embodied cognition
  2. Constructive learning
  3. Two parts:
     1. Programming modeling
     2. Cybernetics and systems theory

Information processing

- Modeling and CAS:
  - Flow and evaluators
  - Aggregation and Parallel programming
  - Diversity and 00-prototyping

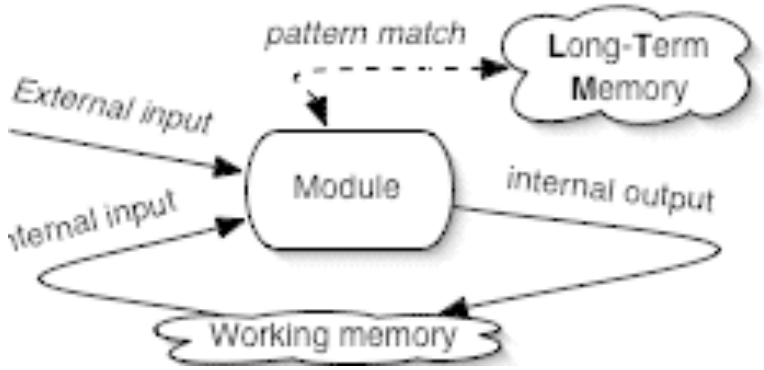
- Cognition
  - Knowledge by tuning to context
  - Information by external feedback
  - Construction by bootstrapping

What's coming

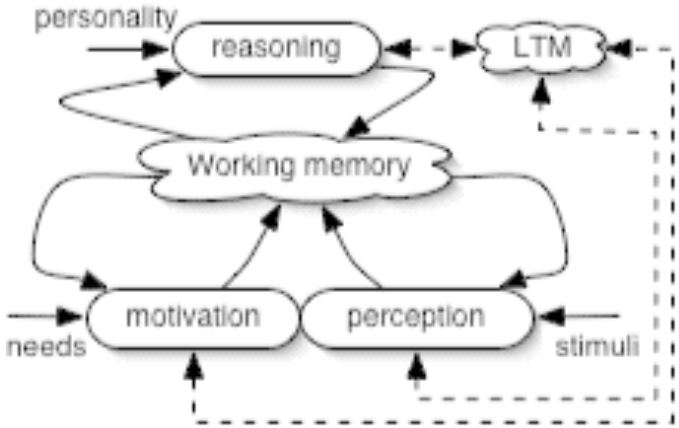
1. Outlining the model
    1. based on general processing machine
    2. Knowledge is syntax (bootstrapped!)
2. How the knowledge/syntax get create
3. How it fits CRRC
4. Simulation and its detail problem

Distributed modules

- Context-focus
  - Mach input
  - Feedback mach
  - Changed input



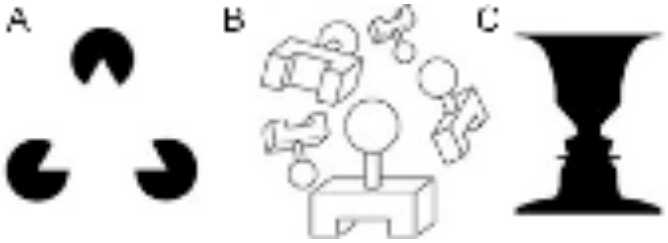
- distributed
  - Aggregate by WM
  - **External** perception
  - **Internal** reasoning
  - **Intentional** motivation



Perception by Gestalt

Orientation: external

Semantics: stimuli



- Reification
- Invariance
- Multistability

Emergence:
(notice adding to memory)

Interaction (face example).

Motivation

Orientation: intentional

Semantics: needs

Needs can be

- A state: cold, hunger, tiredness, boredom
- Forced: like perception (diving example)

Motivation filters syntax (like suppressing).

Interaction (cross a playground example).

Reasoning

Orientation: internal
Semantics: personality

The input will grow by experiencing:
social, creative, aggressive, etc.

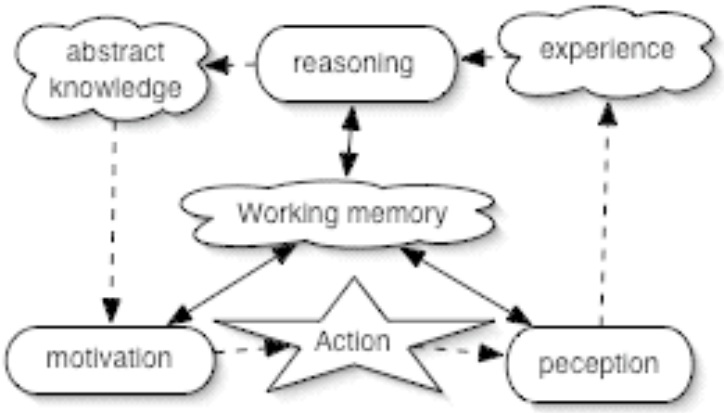
Reasoning is an association game

Creating new links between concepts

Interaction (improper-use example).

System transition

- Neglecting aspect of the evaluation:
  - Vision by perception
  - Attention by motivation
  - Knowledge by reasoning



- Neglecting the complexity of behaviour:
  - Evaluation and value changes during acting

- Visibility of two learning type
  - Attention on perception = behaviour mastery
  - Attention on reasoning = reflection

The cognition during acting

By example: *“pick-up & setting down something”:*

- Expected stimuli:
  - shape, surface roughness, weight, hardness, etc.
- Type of variable:
  - a sack of potatoes, a crystal vase, or a bucket of water
- From abstract action to presence
  - Initial variables, by vision
  - Concrete variables by muscle feedback
  - Feedback on motor-control

Bad calculation example (force ball)

Behaviour Mastery

Motivation on perception:

- Abstract concept without immediate physical (or concrete) grounding.
- A lot of new experience comes in and it need to be categorized
- The action-in-progress will be a rough approximation of the intended action

(no-hands bike driving example)

Reflection

Motivation on Reasoning:

- From concrete facts to abstract action.

For example pick-up experience leading to the definition of the concept weight.

Using the perception during reflection by talking, writing or drawing (the external mind).

No guarantee that reasoning will be able to abstract the relevant associations (think of change blindness)

Relativity Rationality Clarity

- Relativity by syntax
- Rationality by behaviour mastery
- Clarity by reflection

- Communication = special action
  - Speaker = reflecting
  - Listener = behaviour mastering

A case study by simulation

How motivation leads to action

Starting Knowledge-System:

		do: move		get: newPosition
	on: food	do: eat		get: stopHunger
at: Object		do: pickup		get: Object
	on: stone	do: break	with: stone	get: fragment

Starting intention: stopHunger

Conditions: with, at = ok, on= food

=> at:food on:self do:pickup with:self get:food

at:food => need to be there => newPosition

Start actions: move => pickup =>eat

- Perception & behaviour mastery:
  - No distinction between open-nut and food
  - Noticing breaking of fragile shell:
    - Recognition the action pattern as “break”
    - Distinction between food en nut (shell)
  - Adding new abstract-action to the knowledge:

    on:nut do: break get:food
    - Implication, now all nuts are leading to the intention

- Reasoning & reflection:
  - Can’t break very hard shells ⇒ focus on concept

    on:nut do:break get:food

    on: stone do:break with:stone get: fragment
  - Testing the experimental-action:

    on:nut do: break with:stone get:food

Conclusion

- The model helps in understanding cognition:
  - How change blindness is embedded
  - Relation with global (neural) network
- The model has a long way for practical use:
  - Details of environment
  - Details of embodiment