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**Layered Network of Representatives
for Control of Robot**

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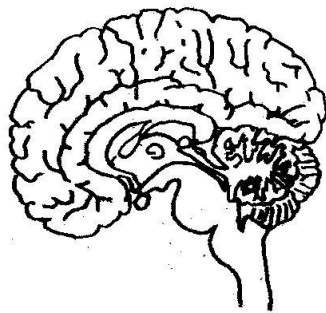
The purpose of my talk

- To understand the brain mechanism, and to simplify the programming of robot.

In my understanding,

the brain is a network of chain reactions.

It is able to describe as a network of subroutines.

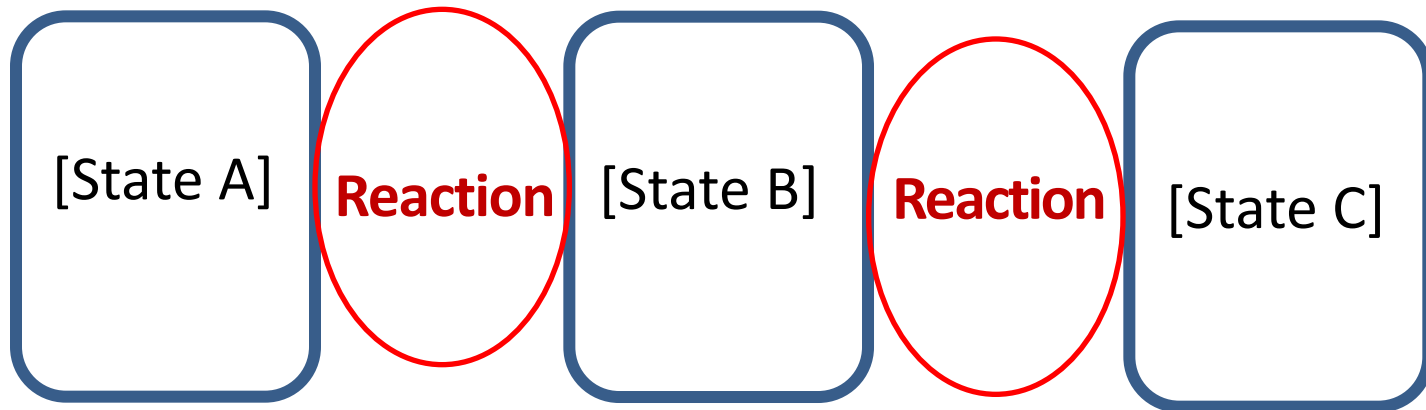


Intelligence



What is intelligence?

Intelligence is concerned with action.
A reaction changes the state.

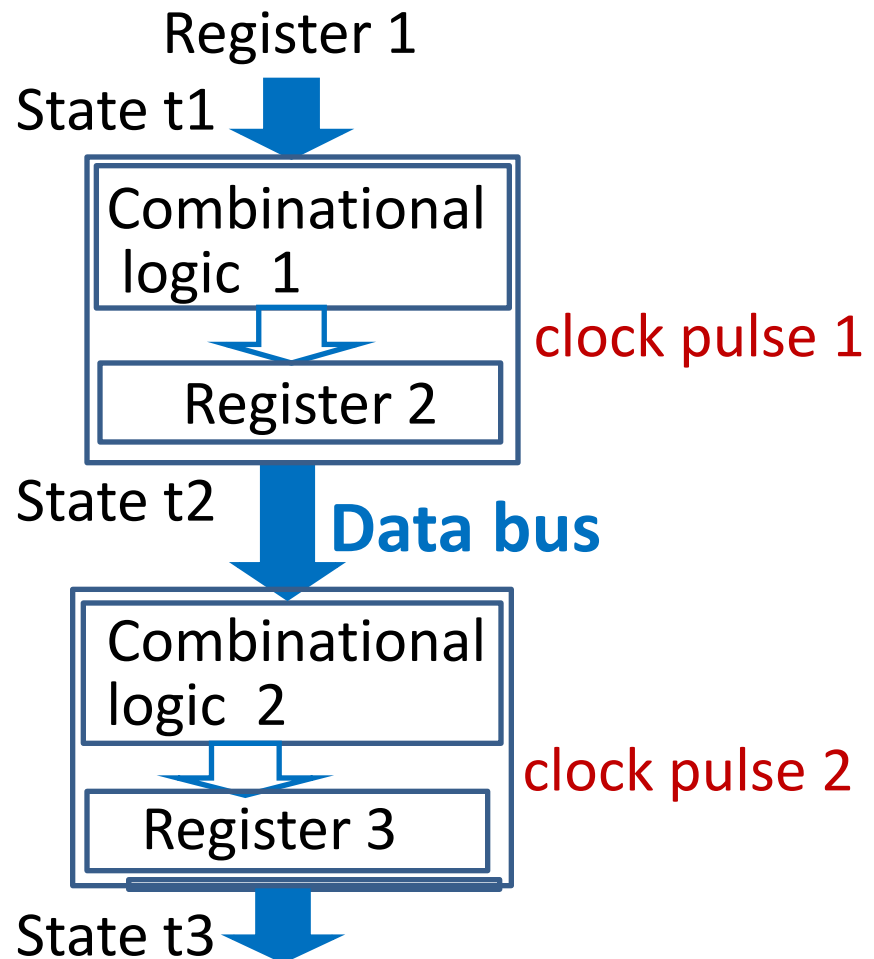


A series of actions is carried out by a state machine

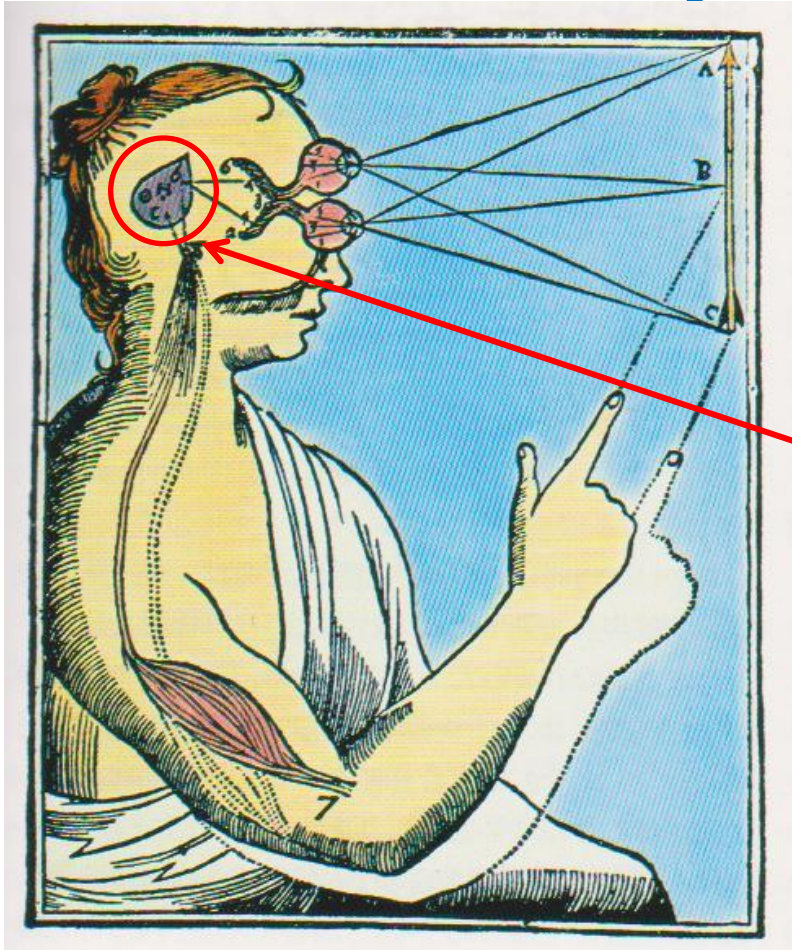
A set of inputs is decoded by a combinational logic.

Many to one operates a function of intelligence.

Timing of operation is given by clock pulse.



R. Descartes (1580-1666) explained the body as a machine.

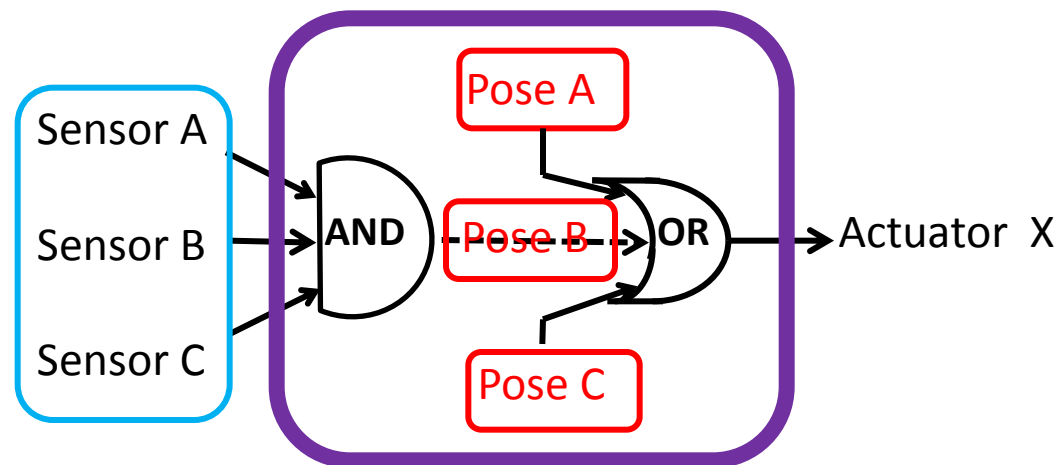


He illustrated a model.

The decision-making circuit is necessary between sensors and actuators.

Logic of intelligence

- Action can be described by production rule, i.e.
If inputs coincide with the preconditions ,
then output.
- This logic will be realized by a digital circuit of “sum of products form”.



How does a *baby* acquire the *intelligence*?



- A new born baby can not understand language .
- The baby acquires new skills by tries and errors .

What is the motivation of life?



It will be eating .

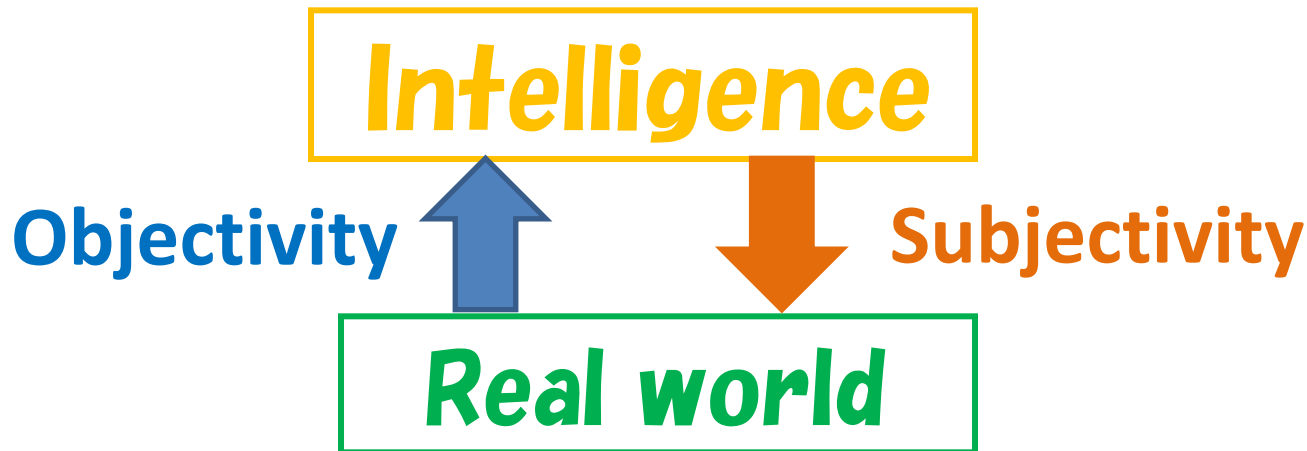
The eating is necessary to live.

To live is to make actions.

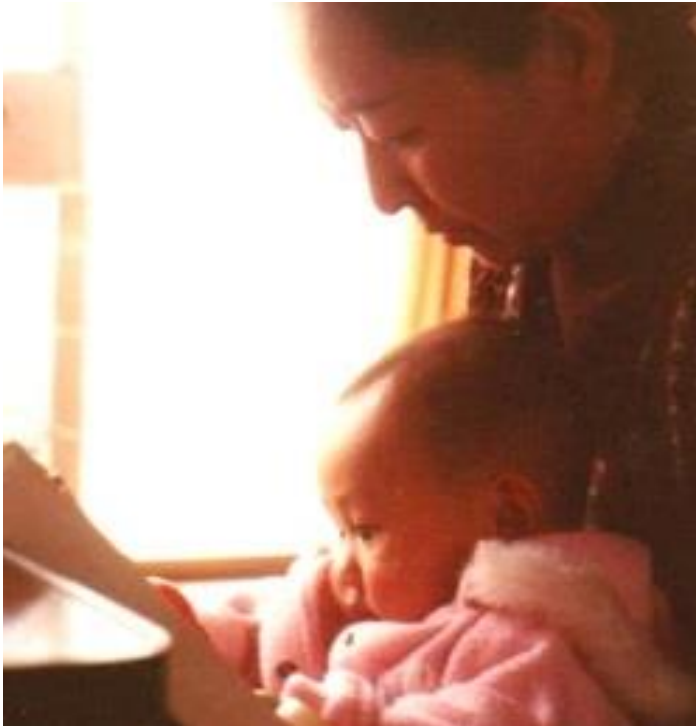
I am looking
for foods by
myself.



**Forming of intelligence by bottom-up.
Replaying by top-down.**



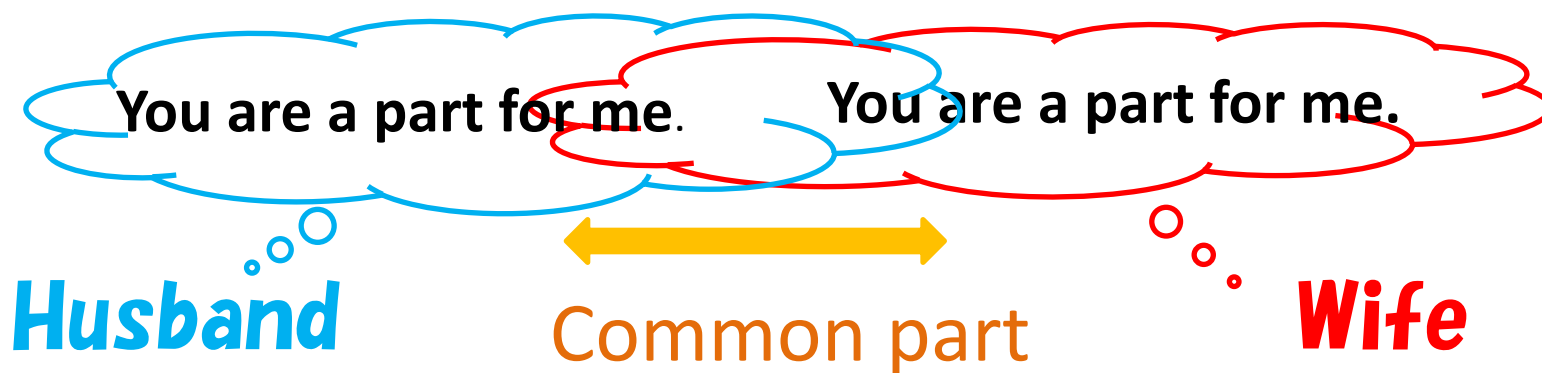
Why does human behaves according to language?



The newly added behavior possesses the higher priority. It is the principle of progress . Primitive intelligence includes fundamentals to live.

The intelligence exists in a brain.

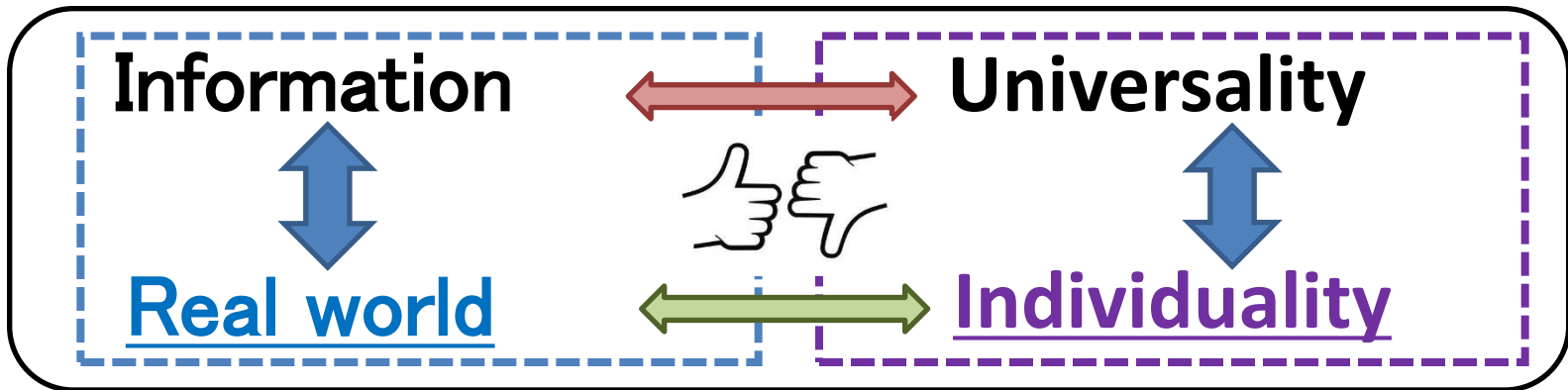
Individuality of intelligence



Universality exists in a brain.

Information is abstracted from the real world.

The real world is individual.



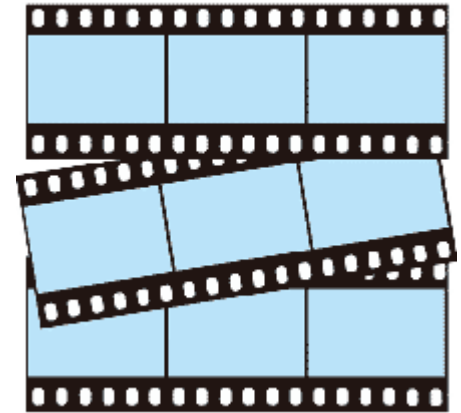
How to form intelligence

The memory does not change.

So, recognition does not change.

How can we see a movie?

There are intermittent pictures.



The recognition is an instant phenomenon.

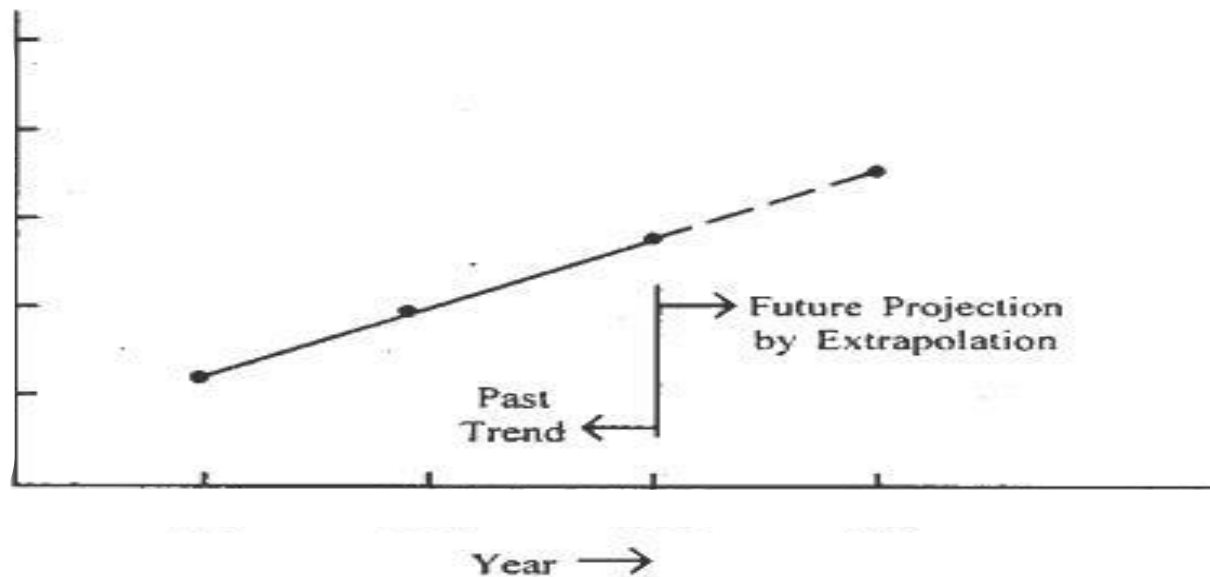
Forming of intelligence is intermittent.

Understanding is carried out by rules

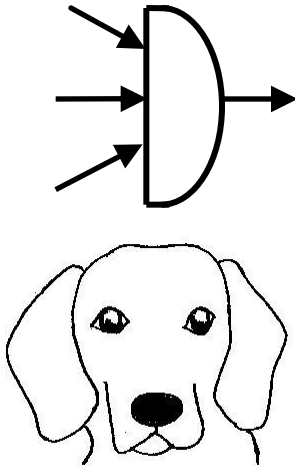
We recognized the world by reactions.

So, we think the world by the rules.

Every rule will be extrapolated linearly.



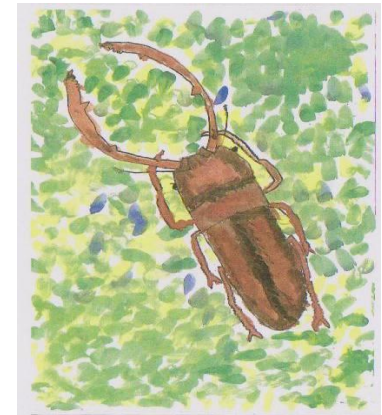
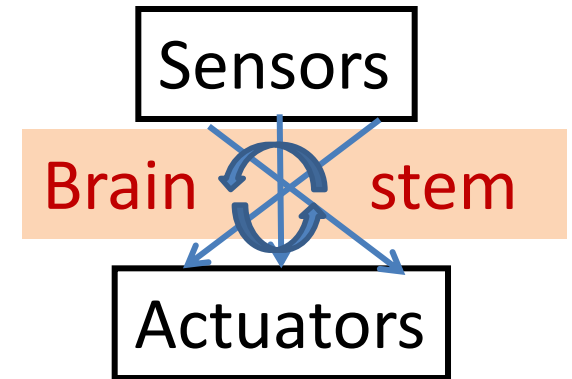
Impulse in a nerve system means only action



- Impulse is the same meaning to barks of dog i.e. bowwow.
- Meaning of action depends on results of the action.

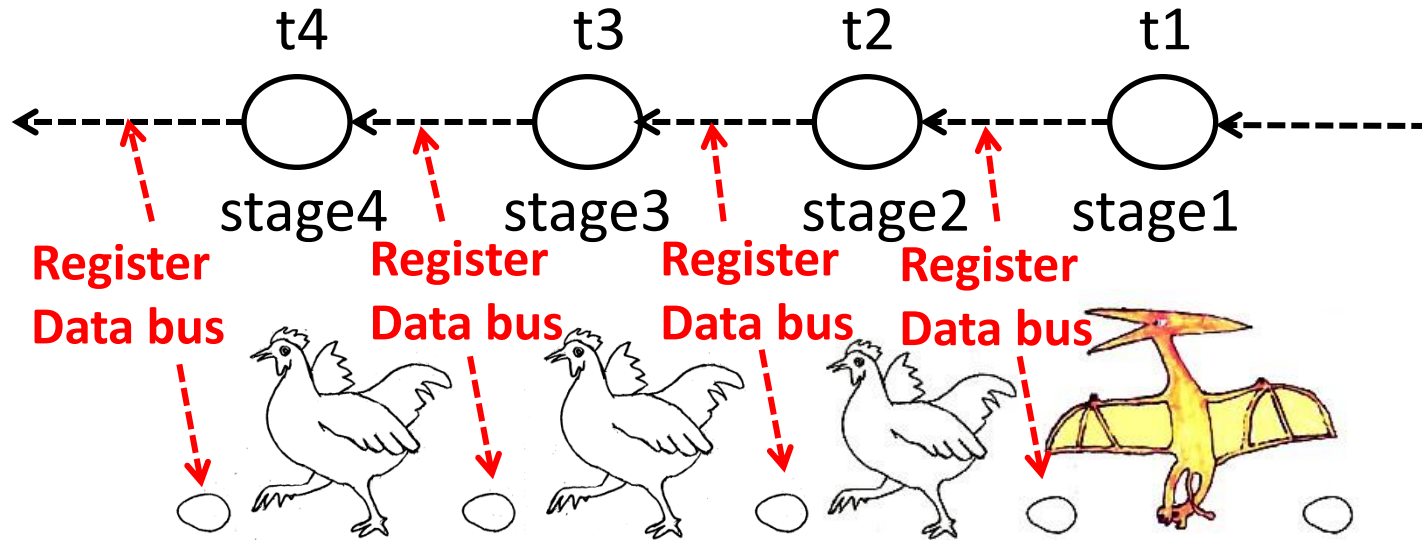
In a brain, why does nerve circuits twists.

- Sensors are located at front, and actuators are located at back.
- When paralleling circuits twists, the nerve pathways are gathered at a cross point.
- The brain is formed as a concentrated nervous system.



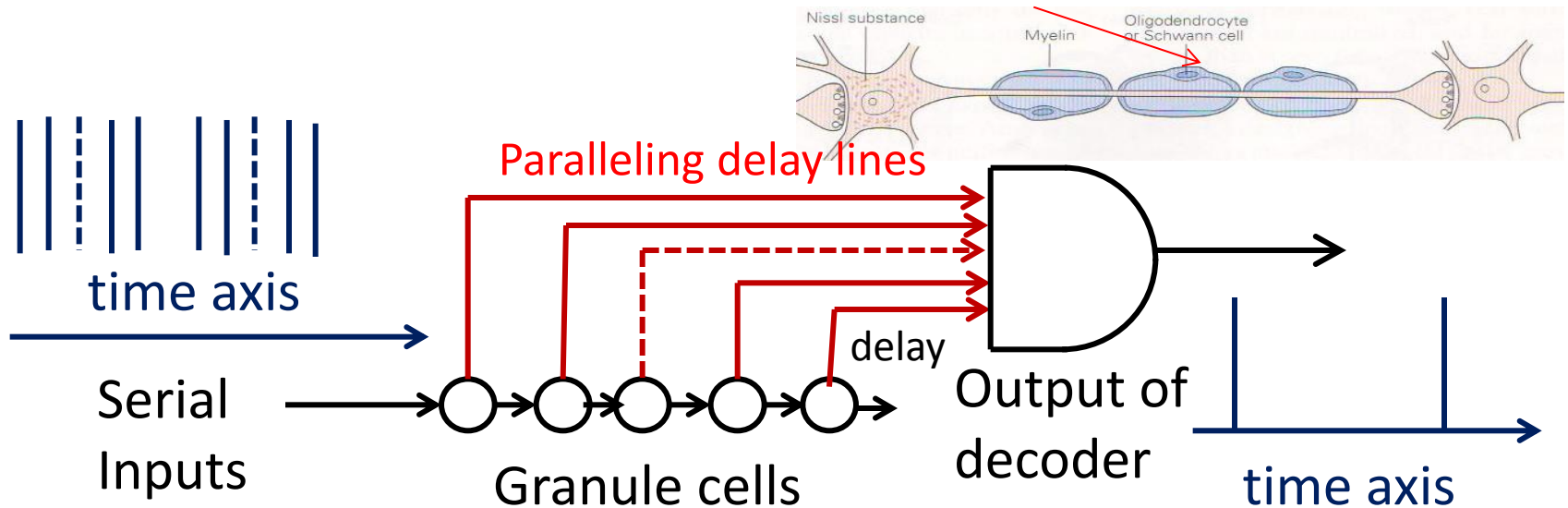
Each generation takes time

- Biochemical reaction is one-way traffic by the after-effects.
- Every generation accompanies with a delay time.



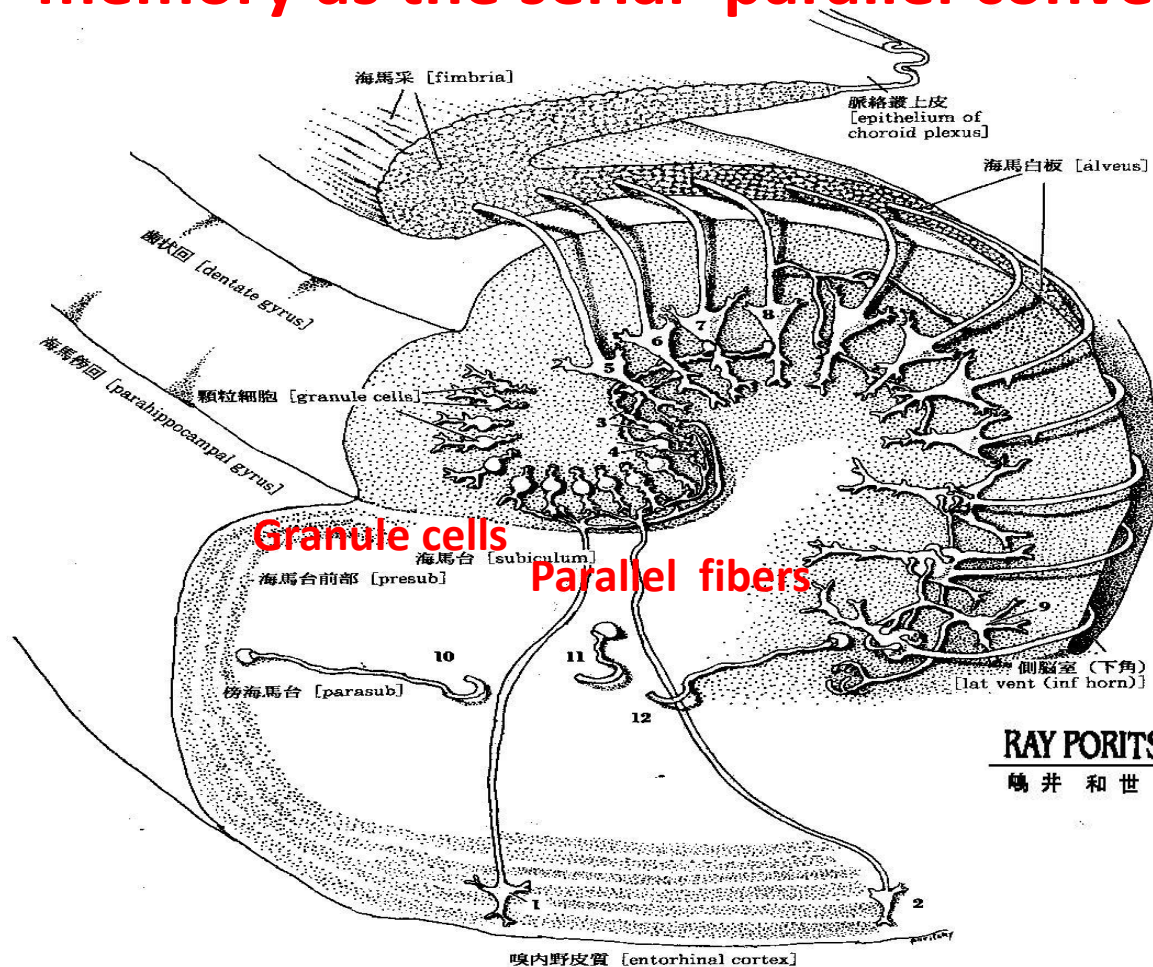
How to manipulate serial data in a brain?

Serial-parallel conversion needs paralleling delay lines.
The velocity of impulse in parallel fiber is very slow,
The parallel fiber has not myelination.



Nerve circuit of hippocampus

The hippocampus plays the important role to form memory as the serial-parallel conversion.



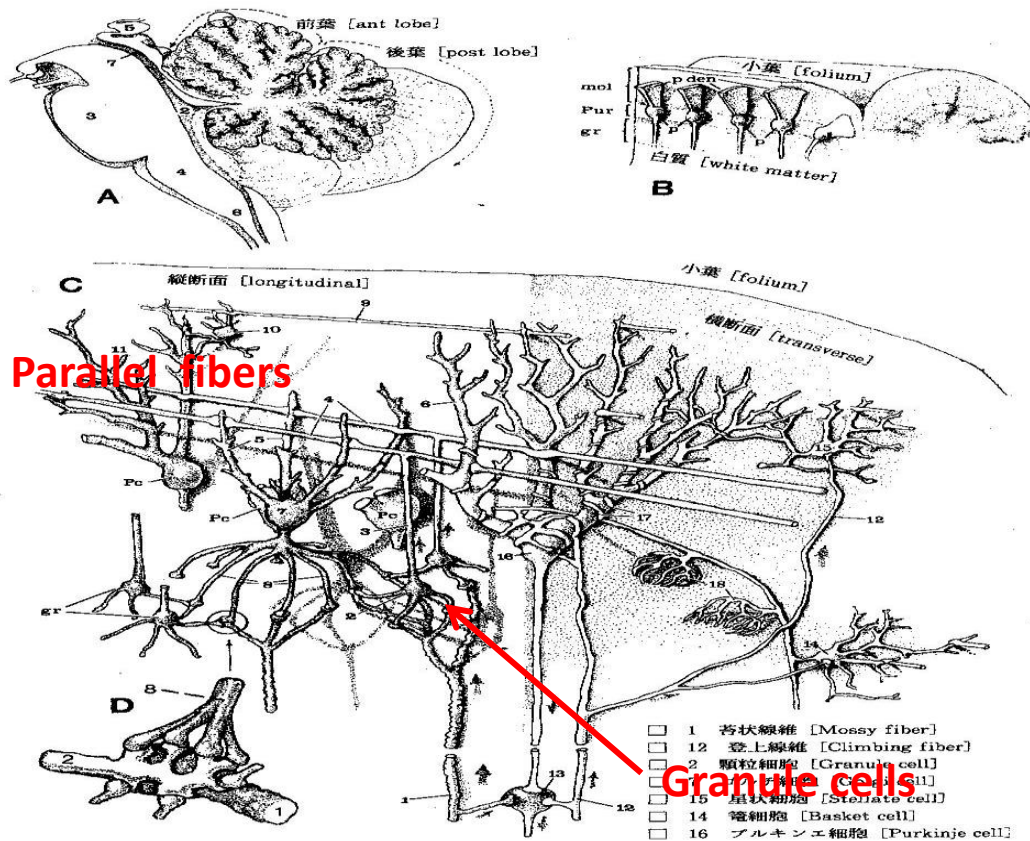
RAY PORITSKY
嶋井和世訳

NEUROANATOMY
A FUNCTIONAL ATLAS OF PARTS AND PATHWAYS

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Serial-Parallel conversion in cerebellum

‘Cerebellum stores and replays the serial data for motor control.

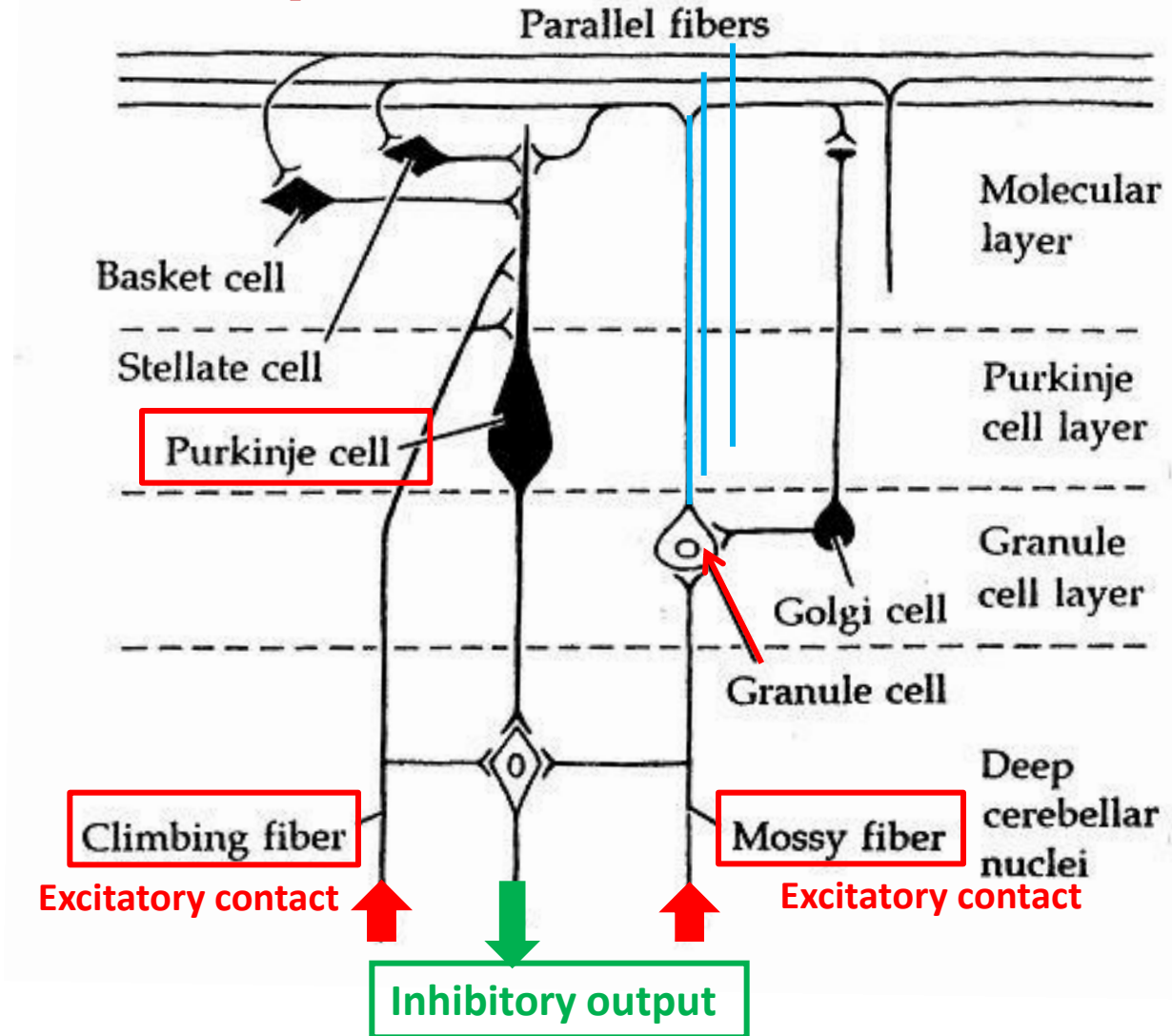


RAY PORITSKY **NEUROANATOMY**
 嶋井和世 訳 A FUNCTIONAL ATLAS OF PARTS AND PATHWAYS

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Linkages with Purkinje cell

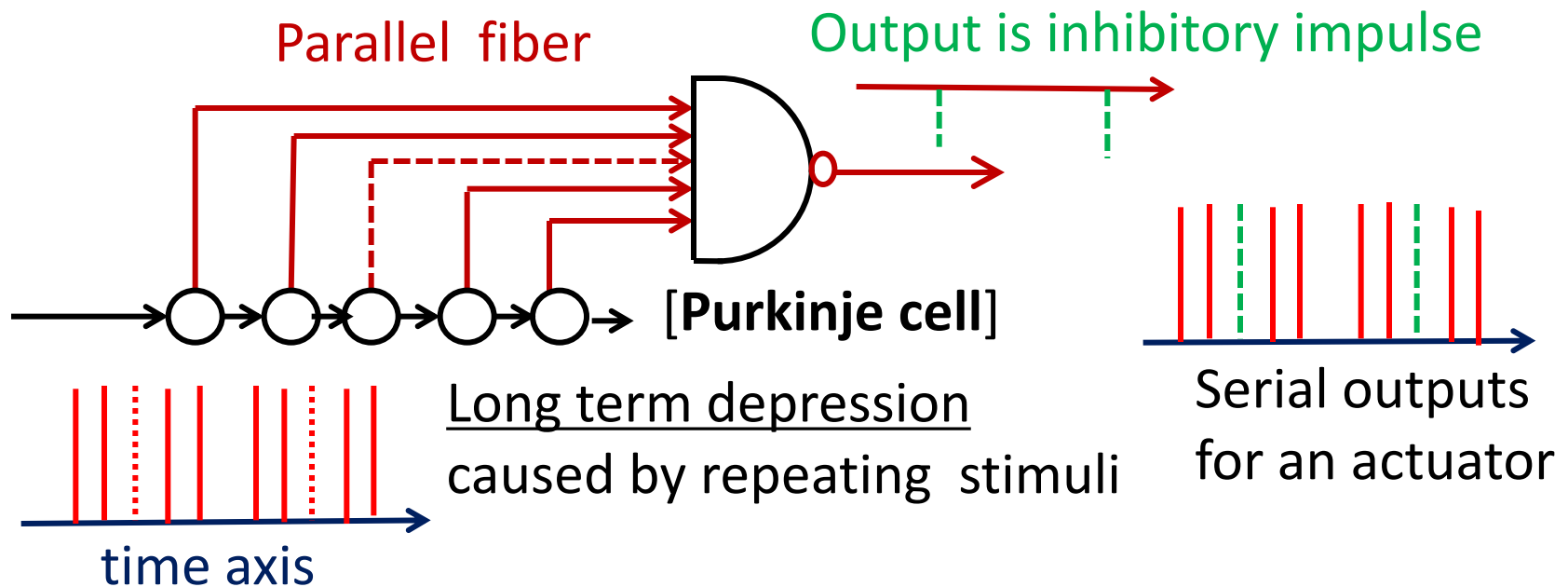
['Cerebellum]



Mechanism of cerebellum

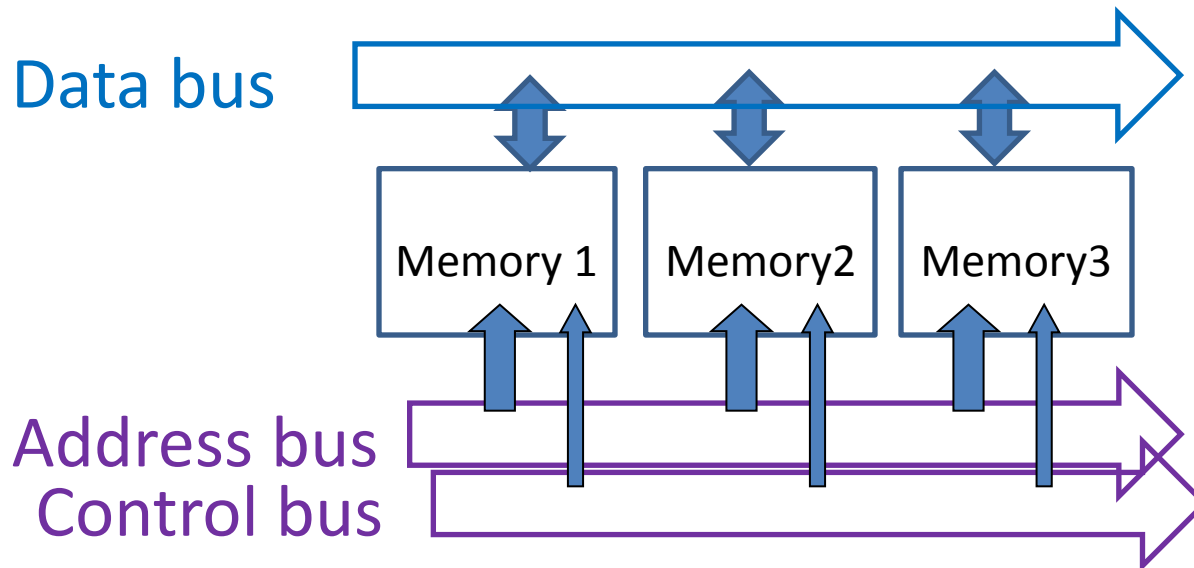
[The self-consistent explanation]

“Purkinje cell outputs inhibitory impulse at absence of excitatory input.”

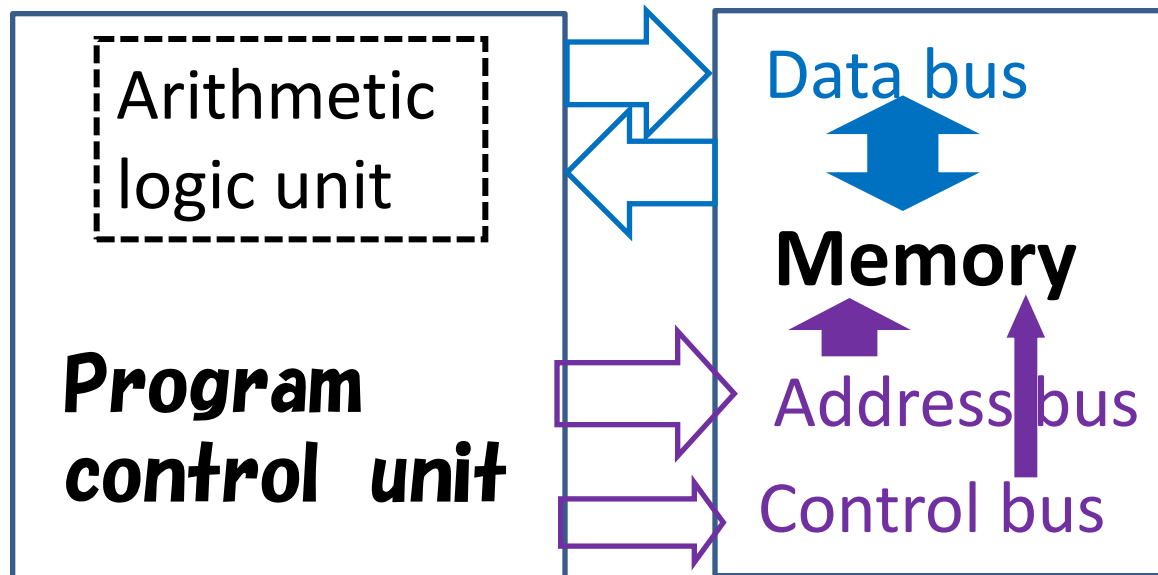


How to manipulate data in a digital computer

By using connections between data bus and memory.
A flip-flop circuit is available as a register or a RAM.



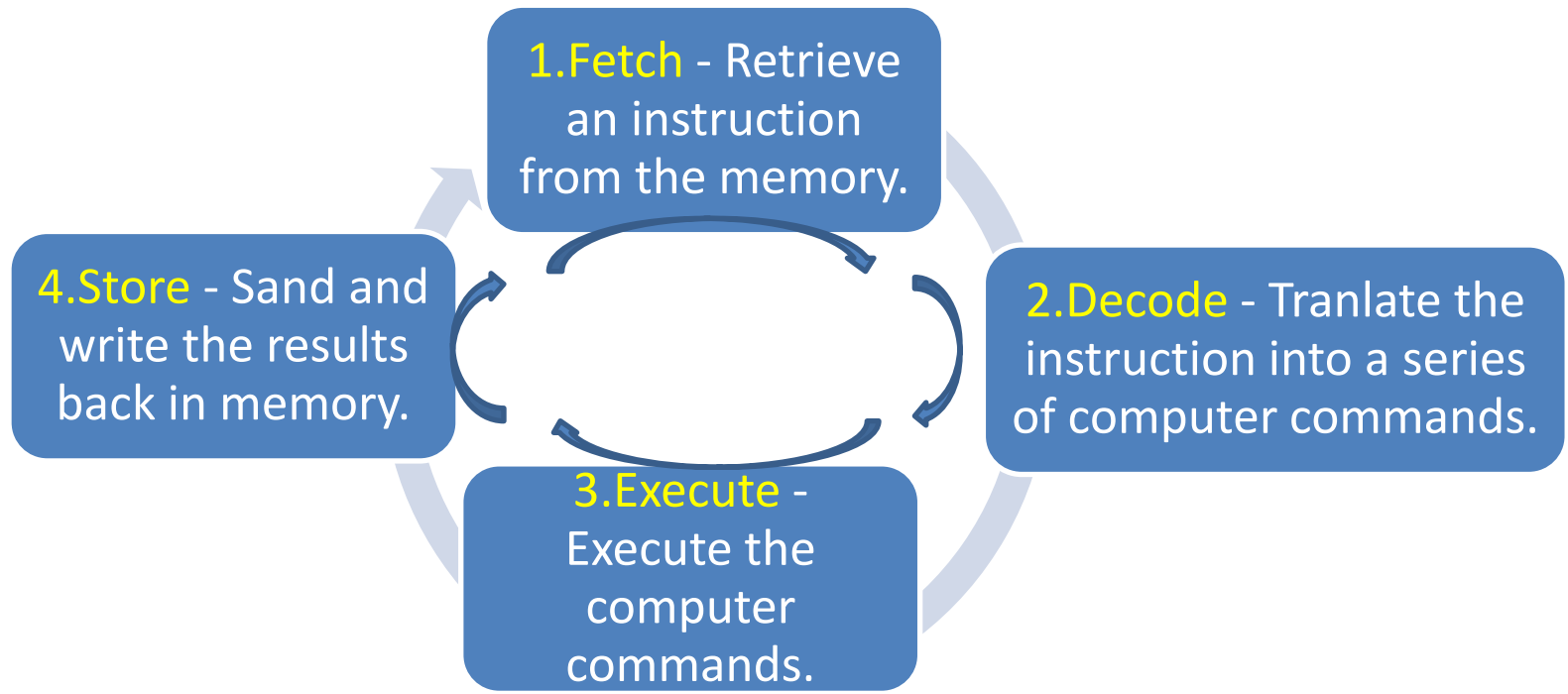
Central Processing Unit function as a state machine



Program control unit executes an instruction at a machine cycle.

One machine cycle is executed by a series of subroutines

[Program control unit]



Program for a dancing robot

- The sound data were divided into a series of files in order to mix with the series of actions.
- The same period of a sound and the action are started at the same time.



Data processing

- The human does not recognize small time lag in visual perception. The fundamental transition time for one action was selected as 0.5 seconds.
- The sound data was compressed to AD PCM-Microsoft in order to decrease the amount of data.
- The data on sound of 0.5 seconds was processed in very short time by today's microprocessor.



Input of data on actions

An action is programmed by change of pose (**angles of joints**) together with transition time.

Fundamental subroutine

Start (Pose 0)

Pose 1 [Angle of joint 1; ; / Transition time]

Pose 2 [Angle of joint 1; ; / Transition time]

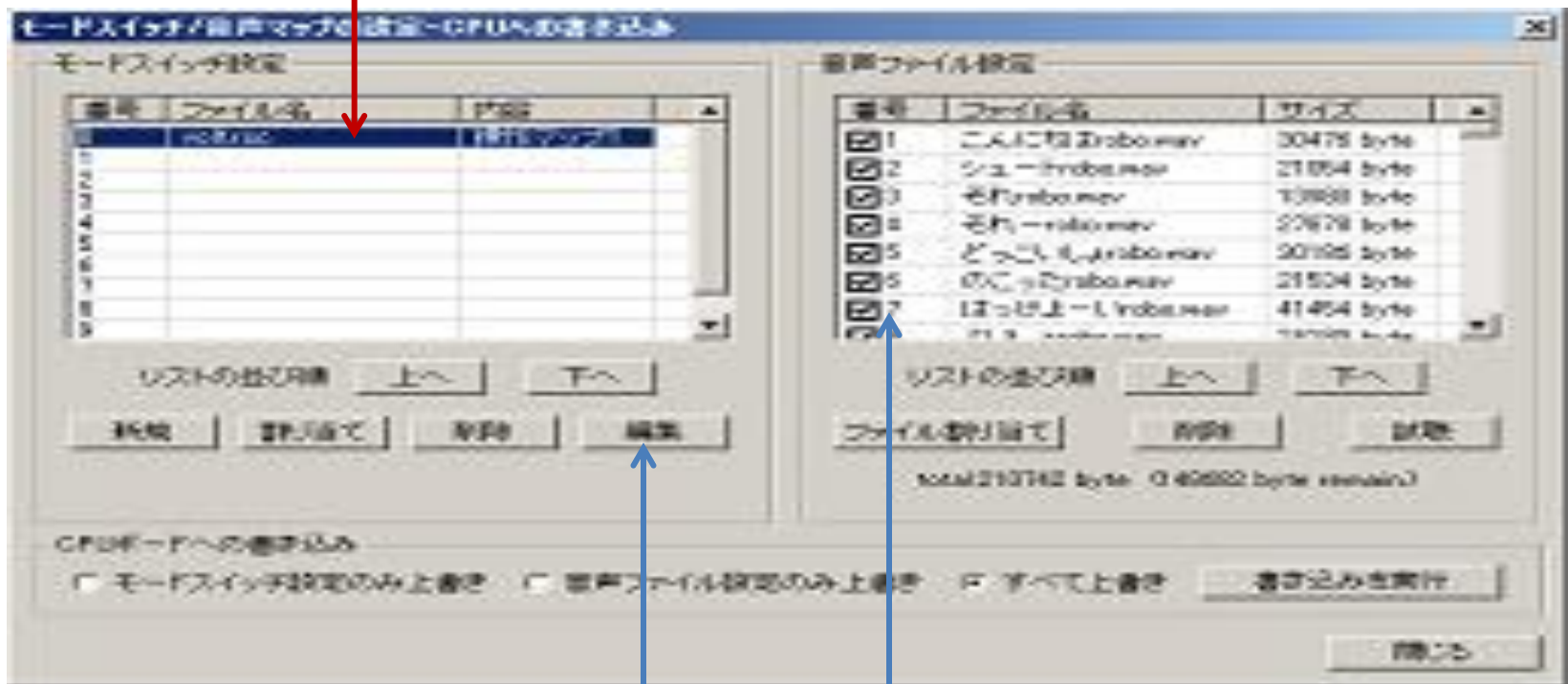
End (Pose 2)



Editing of files

[Editor: Robovie Maker for VS-RC003]

The label on a series of fundamental subroutines.



Editing subroutines

The labels of sound files stored

The shoes sing song if the kids go to the field hand in hand

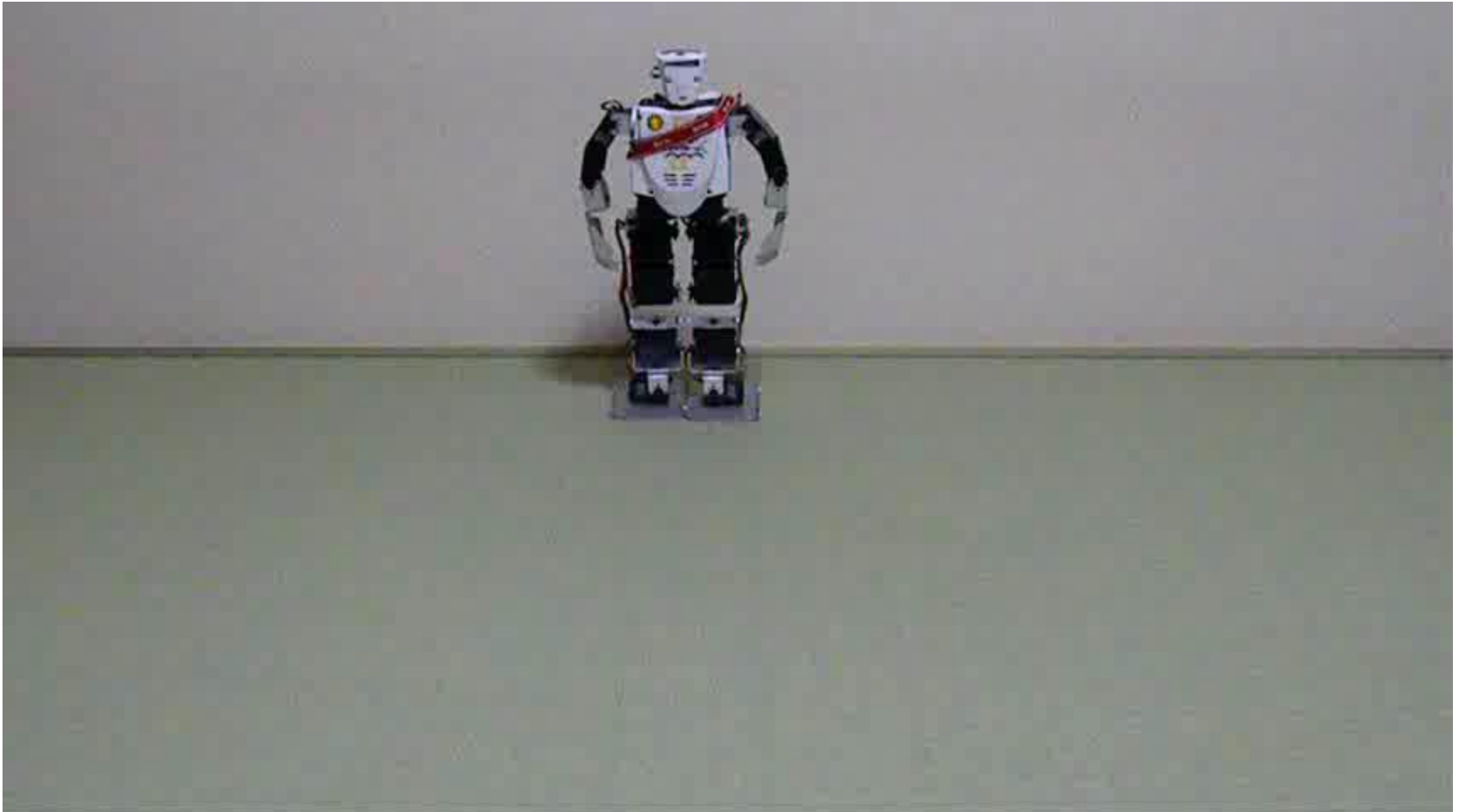


By Robovie-I (3 joints)

***Mr. moon comes out of the mountain
of coal mine. He would be smoky.***



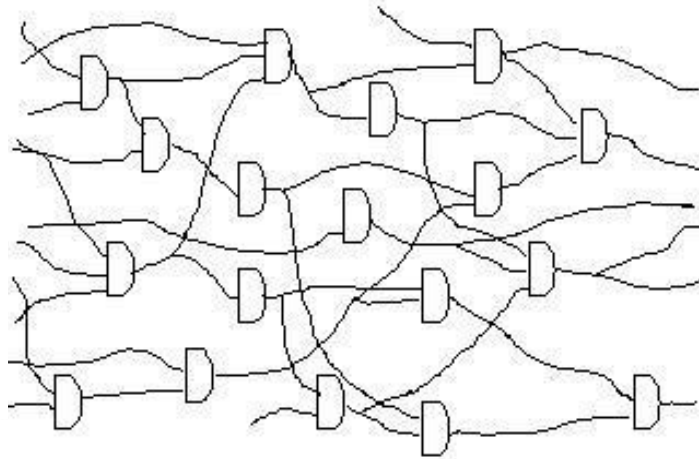
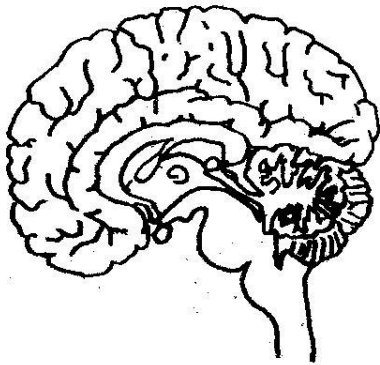
Miss Sendai – Star festival – By Robovie – X (with 13 joints)



Conclusions

**Intelligence is described
by a chain of actions.**

**It is realized by
a state machine.**



Thank you for your kind attention.