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The Neural Net of the Tapeworm *Turingium universalis (Wolfram)*

Erwin Engeler,
ETH Zurich, Switzerland

T.universalis, was first described by Wolfram in Campaign, Illinois, U.S.A. and by Smith in Birmingham, U.K. who discovered its eminent trainability.
Each individual is structured into identical segments, which are either transparent or colored yellow or orange; these colors change individually, governed by some internal agency. The worm moves by flexing individual segments up or down, changes the color of that segment, and then flexes the next segment to the left or right. It may change its length by adding transparently colored segments at either end.

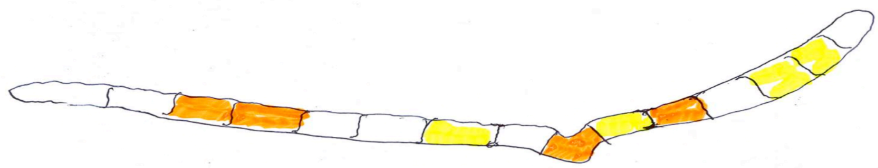

Fig.1 A specimen of *T.universalis W.*

The behavior of *T.universalis* is governed by the activity of its neural net. The structure of this net has been completely determined by the present author. Each segment has two neurons that govern the flexing of the segment; one up, one down neuron. The coloring of the segment is governed by three neurons, one for each color. There are six further neurons. These encode, by dendritic connections and weighted synapses the lawfulness of the behavior.

In the following diagram these connections are detailed, together with the weights of the synapses. A neuron is fires, if the sum of weights of incoming activated synapses exceeds the value 0.9. Only one segment is show, together with its neighbors; all others are identical. The neuron at the upper right corner, for example, is activated if the segment is flexed down and transparent; it then changes the coloring of this segment by activating the neuron that produces the color orange and, by an inhibitory synapse, cancels transparency and then relaxes the flexing. Also, is activates the neuron in the segment to the right responsible for its upward flexing. We abbreviate this behavior code by “td/oru” The other laws of the behavior of *T.universalis* can be read off the diagram.; they are: yu/oru, ou/trd, tu/old, od/yld, yd/old.

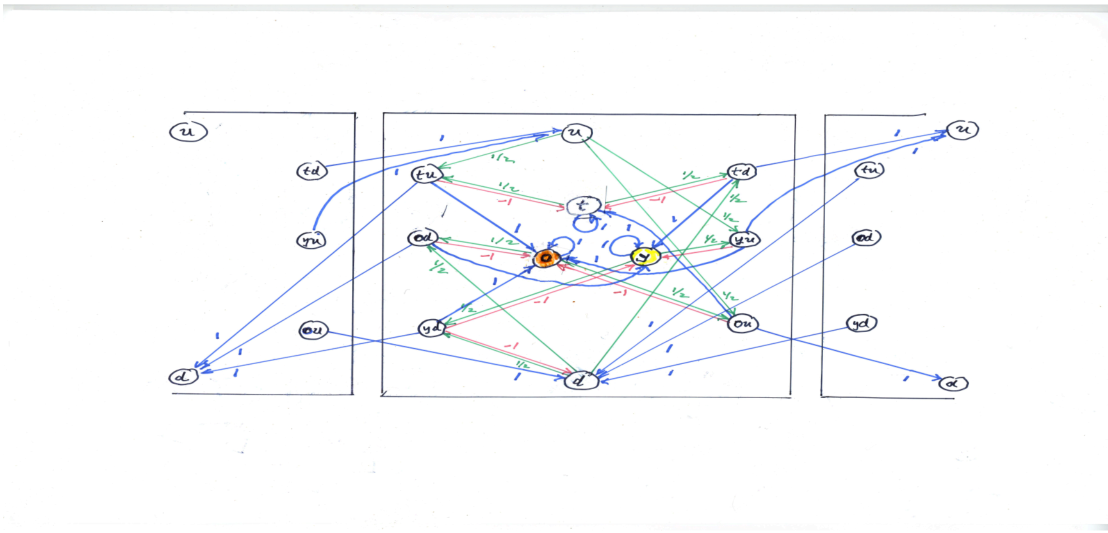

Fig.2 Neural net of *T.universalis W.*.

The taxonomy of the class *Automata,* to which the pylum *Pseudocestosa* and genus *Turingia* to which *T.univ.* belongs, is only sketchily known, There are a number of mutations of *T.universalis W* as well as many other members of the genus *Turingia*; some of them have the ability to flex more than one segment at the same time, others are two-dimensional, flatworms like.

T.universalis seems to live off its, mainly academic, environment and to propagate, also academically, by shedding blank (transparent) end segments. Individuals of *T.univ.* can be trained by stimulating color neurons in selected segments. Recently (Oct.2007), Alex Smith has very ingeniously shown, that *T.univ.* can in this way be made to simulate any Turing Machine; therefore it can in principle compute any computable function. But this shows also, that it cannot be effectively determined, whether an individual will present at some time a previously given coloring.

Postscript

Turing Machines were invented by Alan Turing in the 1930's. He aimed very convincingly, to give a mathematical analysis of the notion of mechanical computability. Indeed, it turned out, that all computers to this day can in principle be simulated effectively, i.e. in polynomial time by some Turing Machine. He also showed that there exist Turing Machines that are universal in the sense that they in turn can simulate any given Turing Machine. It has always been a challenge, to find a very small universal Turing Machine, i.e. one whose instruction set is very short. Stephen Wolfram has proposed a very small such machine with an instruction set of only six. He offered a prize of $ 25,000 for a proof of universality, which was won by a young student, Alex Smith. The tapeworm of this piece is a neurological realization of that machine. All references to the prize story are in *http://www.wolframscience.com/prizes/tm23/*