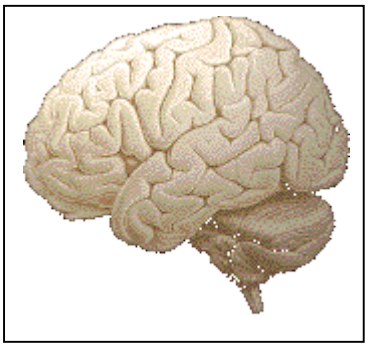
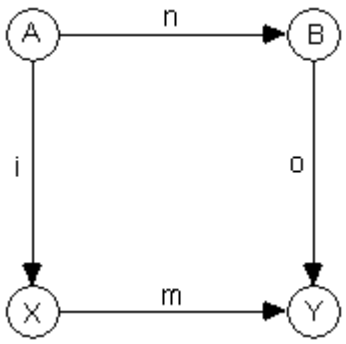


QUESTION:

What do we mean when we say that we "UNDERSTAND" something?



Standard graph depicting the situation of understanding of a natural system n in terms of its model m. Variables A and B are inputs and outputs of the natural system n, while the observables X and Y are inputs and outputs of the model m.

Perceptory functions X = i(A) and Y = o(B) translate inputs and outputs of n into observable inputs and outputs of m.

We have the "AHA" feeling, when, given the system n, we are able to forecast its behaviour, i.e. we have constructed functions i, o, m such that:

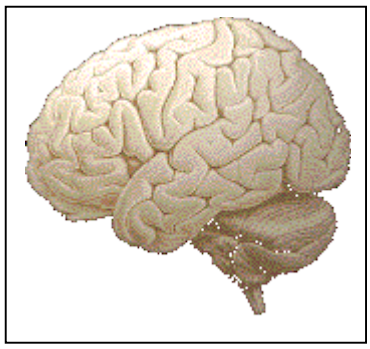
$$m(X) = o(B)$$

but given that X = i(A) and B = n(A) by substitution we have:

$$m(i(A)) = o(n(A))$$

in other words:

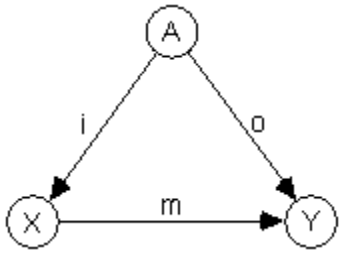
We understand the system n, if for any value A we can arrive at the same value Y, regardless which arrows we follow on the above graph.



QUESTION:

When does the situation of "understanding" break down?

Consider(see below) an elementary particle with attributes A which we cannot divide into two groups of inputs and outputs.



We can construct infinitely many functions i, o, m such that

$$o(A) = m(i(A))$$

but, given that the functions i, o, m are figments of our imagination, and the function n describing the natural system is out of the equation, the entire reasoning is not based on objective reality.

More on the topic under http://www.cosc.brocku.ca/~vwojcik/experts.htm

CONCLUSION: In order to understand a natural system n it is necessary to have its model m.

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WARNING: Some models may be imperfect and offer partial understanding only.

Examples:

- Planetary motions. The orbit of Mercury deviates from the predicted ellipse, forecast by classical celestial mechanics. One has to build a better model, accounting for the curvature of the spacetime.

- Olbers' Paradox: Why is it dark at night? Most people have only superficial answer to this profound question. To answer this question properly one has to take into account the concept of Big Bang.

So, what is a MODEL?

"A representation of an object, a system or an idea in some form other than that of the entity itself"
(Shannon)

Classification of types of MODELs:

- Physical
  - Static
  - Dynamic
- Mathematical
  - Static
    - Analytical
    - Numerical
  - Dynamic
    - Numerical
      - Simulation