A little more systems rationality: Bayesian reasoning

Jim Edd Jones

June 9, 2017

Keith Stanovich brought our rationality and dysrationality into focus in his book Rationality Quotient. Systems rationality includes the forms of rationality congruent with systems thinking. In Stanovich's catalogue of reasoning, lack of Bayesian reasoning accounts for the errors we routinely make about medical tests and, I would contend, for many errors in judgement we make every day.

Bayesian reasoning assigns probabilities of certainty/uncertainty to hypotheses about various parts of reality. Then it uses any additional new information to update the probabilities of these hypotheses.

Bayesian reasoning is especially helpful under uncertain circumstances, which is practically all the time. It is congruent with thinking and antithetical to single cause-single effect thinking. The idea that a single cause produces a single effect or that a single effect has a single cause is hard to find evidence for, unless you blind yourself to parts of the available evidence.

The thinking about living systems basically asserts that single causes have multiple effects. And single effects are produced by multiple causes.

A major example where single cause - single effect thinking produces errors is in the interpretation of medical diagnostic tests. A test commonly may be touted as highly accurate. e.g. a hypothetical test for a disease is said to have high accuracy, say 90%, meaning that in a sample of people with that disease, 90% of these people score positive on the test and, say, 85% of those without the disease score negative on the test. Single cause - single effect thinking will immediately reason that if I score positive on the test, I have a 90% chance of having the disease.

Bayesian reasoning concludes otherwise. Single cause - single effect reasoning will produce grossly wrong conclusions in situations where the prevalence of the disease is low. An example: schizophrenia has a prevalence of less than 2%. Let's construct a hypothetical test, presence of a schizophrenia gene. And the test is highly accurate. For argument's sake, use the previous numbers. Of those with schizophrenia, 90% have that schizophrenia gene and 85% of those without schizophrenia don't have that gene. Single cause - single effect thinking would argue that if you have that gene, you probably would have schizophrenia.

What is wrong with this reasoning? First, there are many exceptions to the test. 10% of the schizophrenics don't have that gene. So the test isn't perfect.

And 15% of those who aren't schizophrenic will actually have the gene.

Schizophrenia has low prevalence; over 98% of the population don't have schizophrenia. 15% of those will have the gene, false positives which dwarf the number of true positives, those with schizophrenia who have the gene.

Bayesian reasoning is a philosophy of uncertainty. There are some things that are more certain and many that are not. Bayesian reasoning gives a way to work with realistic uncertainty.