**THE WORLD IS IN A MESS.**
**SO WHAT CAN WE DO ABOUT IT?**

Donald V Steward
steward@problematics.com

Anger and frustration has been growing all over the world. We are seeing demonstrations and revolts arising everywhere, and our Congress is in gridlock, arguing over rather than solving our problems. As a whole, we are not functioning very well. The world is in a mess.

History has shown that when frustration prevails, it can be mobilized to cause the few to dominate the many. We are witnessing extremism. As we have lost our attachment to reality, our world has gone crazy. Debt is everywhere, leading us to pursue a strategy of austerity with the result that we cannot afford to prepare for the future. We are cutting back on investing on infrastructure and education and allowing our climate to deteriorate by ignoring the effects of burning fossil fuels.

Why is all this frustration occurring, and why it is occurring now? Because technology and communications have so interconnected our world that our problems have become so complex we are no longer able to solve them. People are using this technology to manipulate the financial system without understanding the consequences, keeping their gains while passing their losses onto taxpayers, who are in turn understandably frustrated.

Anyone can put forth their own approaches to these problems with little risk of contradiction. Anything goes. When a person loses his attachment to reality, we say he is crazy. Similarly, our society has become crazy!

So what can we do to restore the rule of reality over our reasoning so we can solve these very complex problems? If we cannot handle these problems by our wits alone, perhaps we can seek the help of the computer to deal with all the various considerations and the logic to connect them? If we can really do this, the significance of doing so is well worth some consideration. So here we will begin to give the consideration it deserves.

When we looked at the cause and how we might resolve the economic crisis and widening wealth gap, the Explainer program had to consider over thirty aspects of the problem and use about twenty levels of logical reasoning. This is far beyond our unaided human capacity. So indeed, we do need to use a computer.

So what did this analysis show? Let me show you and elaborate on some of the causes and resolutions the program proposed.

First, Adam Smith in his book *The Wealth of Nations* published in 1776 laid the foundations for capitalism. He said that if everyone negotiated in his own self-interests, this would result in an efficient allocation of resources and everyone would benefit from the economy in proportion to his contribution to the economy. (Today this would be called an emergent behavior.) But there was a hidden assumption that is largely overlooked today. He assumed that everyone had access to the information to understand properly his self-interests. This was not the case when lenders invented very complicated loans involving

assumptions not understood by those taking out the loans. The result was the housing crisis. This might not have occurred prior to rescinding the Glass-Steagall Act in 1999. Today, this situation could be prevented by the proper operation of the Consumer Financial Protection Bureau, if factions in Congress don't succeed in making it ineffectual.

Second, if it were indeed the case that automation by large businesses has allowed them to reduce their payrolls and amass a large amount of wealth, and if they have not invested this wealth in more labor-intensive small businesses because they did not consider that small businesses were doing well, this could cause these investments not to be made. But perhaps small businesses were not doing well because they were in need of investment.

This is a cause-and-effect circuit. Cause-and-effect circuits can go either clockwise or counterclockwise. Let's consider that this cause-and-effect as just stated causes the circuit to go clockwise. It spirals downward, to the detriment of both large and small businesses and the overall economy.

But let us assume that the government intervenes to guarantee the loans made by large businesses in smaller, more labor-intensive businesses. This causes the cause-and-effect circuit to spiral upwards to the benefit of both large and small businesses as well as the overall economy. If when the businesses paid back the investments, the government were paid for its guarantee, benefits would accrue to both large and small businesses, the government, and the economy as a whole. This is worth come consideration. In the hands of better economists than I, it might suggest even better solutions.

Now, how does this Explainer program work? It allows people with various perspectives on the problem to collaborate in developing a set of cause-and-effect statements that together describe the realm from which the problem arises. In this case it would be statements like: 4. Borrowers did not have information they needed to negotiate loans caused by No regulations requiring borrowers to have that information, 5. Subprime mortgages caused by No regulations requiring borrowers to have that information, 6. High foreclosure rate caused by Subprime mortgages, etc.

Now given these cause-and-effects that describe the situation, it is possible to use these cause-and-effects to find explanations for behaviors that can arise from this situation. (This is called logical abduction.) For each behavior, there are usually several proposed explanations. But not all of these explanations may be valid. Each explanation will predict multiple behaviors other than just the one you wish to explain. Some of these other behaviors may occur, but others may not. We reject the explanations that examination shows do not occur.

How do we find these other explanations? For each proposed explanation, we can find the behaviors that it would predict. (This is done by logical deduction.) Then we test these other behaviors to see if they occur. If they don't occur, we reject that explanation.

This leaves us with explanations that meet two criteria:

1. The explanation predicts the desired behavior (abduction),
2. The explanation does not predict any behaviors that do not occur (deduction and test).

This is a quite general problem solving technique. We use if all the time. For example, when a physician diagnoses a patient's symptoms, he first thinks of all the conceivable explanations for those symptoms (abduction). Then for each explanation, he thinks of all the symptoms that would occur if that explanation were correct, and rejects those explanations that would produce symptoms that do not occur.

Although this is used every day, it is seldom explicitly thought about or taught in this way. We just do it without much awareness of how we are doing it. But to program it for a computer, we must be very explicit about how it works. It uses abduction and deduction [Fig. 1].

To do the abduction requires the computer to go through chains of cause-and-effects with many intermediate effects between the assumptions that make up the explanations and the behavior we are explaining [Fig. 2]. To express the behavior directly in terms of the assumptions that make up the explanations, we eliminate the intermediate effects between the effects we want to explain and the assumptions used to explain them. This is done by elimination by substitution, much as we do when solving systems of simultaneous algebraic equations as we learned to do in high school, which most of us have forgotten.

For each explanation found by abduction, we determine what other behaviors this explanation would predict [Fig. 3]. Then we test whether each of these other behaviors actually occur and eliminate those explanations that would predict behaviors that do not occur.

Let's consider a trivialized example to illustrate this: A physician is presented with a patient who is suffering from headaches. The physician notes two plausible causes of the headaches: 1. Sinus pressure, and 2. Migraines. (Obviously this repertoire of possible causes is very limited to make this example simple.)This is the abduction process to find the plausible cause for the effect. For any effect to be explained, there are usually multiple plausible causes. So now we look at each of these plausible causes to see what effects it would predict in addition to the effect to be explained [Fig. 4].

If the cause were sinus pressure, then an effect in addition to the effect to be explained to be found by working through the cause-and-effects is that taking a vasoconstrictor would cause the headache to become less severe. But if the headache were due to migraine, then taking a vasoconstrictor would make the headache more severe.

So we test the additional predictions of each of the two plausible causes. We find when we make this test, that when the patient takes a vasoconstrictor, the headaches become more severe. This is predicted if the cause were a migraine. But if the cause were sinus pressure, it would predict that the headaches would become less severe, which is not what occurs. So we rule-out that the headache is caused by sinus pressure and chose as the cause that the headaches were caused by migraines. Thus we have chosen an explanation that predicts the behavior to be explained, but does not also predict behaviors that examination shows do not occur.

The Explainer is a very fundamental problem solving method. It can be applied to the following types of problems, among others:

1. Understanding and resolving social and economic problems such as the economic crisis and wealth gap problem:

   This will be the primary example that will be considered later.
2. Medical diagnosis:

   This was discussed above. Propose that we have a government financed panel of MDs to maintain a medical knowledge base that is kept up to date with the latest medical literature and make it available to physicians. This could save money by not doing unnecessary tests, yet protect the physicians from medical liability suits. .
3. Design from requirements specifications:

   If the possible components to be used in a design have been described by cause-and-effects, the Explainer can use these cause-and-effects to satisfy the requirements specifications.
4. Emergency management:

   A set of cause-and-effects can be a knowledge package that can be developed carefully and deliberately over a period of time and then applied quickly to guide the management of emergencies so as not to overlook anything in the excitement of the moment.
5. System fault analysis:

   Given a cause-and-effects description of a system, the Explainer can be used to explain the cause of misbehaviors of the system.
6. Solving crimes

   Given an incomplete description of the circumstances of a crime, propose causes that would explain what is known and determine what additional information is still needed to distinguish what had happened.
7. Analyzing historical and archeological events:

   Using historical or archeological evidence to find what behaviors may have produced that evidence.
8. A tool for collaboration and negotiation:

   Help people work together to more fully understand the situation and consequences of various actions.
9. A Brainer

   A brainer would be a device that would use its sensors to detect events that occur in its environment. When it detects a combination of events that always occur in the same order, it hypothesizes that this may be a cause-and-effect. Then it can use an actuator to produce the assumed cause and sense whether the predicted effect then occurs. If so, this is entered into its cause-and-effect repertoire. If not, the hypothesis is rejected. In this way, it can learn to understand its environment. Then it can use its actuator make changes in its environment that would produce consequences it desires. This concept is quite interesting, but is in its very early stage of investigation.

Cause-and-Effects can form circuits. This makes the method somewhat more challenging. First, we have to find the circuits.

Given a matrix where marks in the cells show which effects depend on which others, a partition reorders the rows and columns in the same way so that there are square blocks on the diagonal and the remaining marks are all on the same side of the diagonal. Every circuit is in only one of these blocks. In a block there is a path from every node within the block to every other node within the same block, but this would not be true if we add any additional node from outside the block.

Every effect that exits a block is a function of every cause that enters the block. By using these functions, the blocks can be bypassed so they can then be handled as though there were no circuits.

We have two types of arcs. A positive arc gives the head of the arc the same value as its tail. It is indicated by $\rightarrow$. A negative arc gives the head of the arc the opposite value $\nrightarrow$. It is indicated by We also have two types of nodes. A positive node indicates that the node represents a numerical value that is true if we are dealing with logic, or has a value that is increasing or staying the same if we are dealing with mechanisms. If we are dealing with logic, a positive node is true and a negative node is false.

Beginning with an arbitrary node labeled positive, each exiting arc labels it head node according to whether the arc is positive or negative. This labeling process is continued until all the nodes are labeled positive negative. However, if a node is entered by an arc that would cause it to be labeled positive and is entered also by another arc that would cause it to be labeled negative, we say that that node is conflicted. We arbitrarily call this solution 'clockwise'.

We can also start the same process by labeling the same arbitrary node we started with before as negative. We will call this the counterclockwise labeling. The labels of the nodes in the two solutions will be opposite with the same nodes labeled conflicted in both solutions.

If dealing with logic, a conflicted node indicates a logical contradiction indicating the problem has been improperly formed. If dealing with mechanisms, the conflicted arcs entering the node represent different mechanisms. Different mechanisms may have different magnitudes of effects on the variable. The net effect will be determined only once a numerical calculation is made where the magnitudes of the effects on a node are added together.

The solution that is chosen is the one where the node in the chosen solution has the same value as that the entering arc would produce. Different entering arcs can chose different solutions. In logic, this would indicate a logical contradiction. Using mechanisms, this would indicate different mechanisms.

Let's look at Figure 5. It shows a matrix where positive arcs are shown a even numbers and negative arcs are shown as odd numbers. Figure 6 shows the clockwise and counterclockwise solutions. Tracing the arcs, we can see that '1. Desire to use automation', and '13. Customers less able to spend on goods and services' would both select the clockwise solution. '2. Govt. insures investment in small business selects the counterclockwise solution.

Each of the nodes at the head of arcs entering a block is a function of each of the nodes at the tail of the entering arcs. If entering and exiting nodes have the same label in the chosen solution, then the arc that jumps the block is positive. If the entering and exiting nodes have different labels in the chosen solution, the arc that jumps the block is negative. In this way each pair of a node entering the block and a node exiting block is connected by a negative arc if the entering and exiting nodes of the chosen solution have

the same label, and connected by a negative arc if the entering and exiting node of the chosen solution have opposite labels. By this means, a set of arcs having no circuit replace the function of the block.

The abduction process may produce very long chains of cause-and-effects extending between the assumptions and the behavior. We wish to express the behavior directly in terms of the functions of assumptions that would explain that behavior. So we must eliminate the intermediate variables that appear in neither the behavior nor the assumptions. This is done by eliminating the intermediate variables by substitution.

If A → B → C → D, we can substitute A for B to get A → C → D, and substitute A for C to get A → D. Thus, we have eliminated the intermediate variables B and C.

This process of eliminating intermediate variables can produce many useless redundancies that make the process unnecessarily long and storage unnecessarily large. So to shorten the process and save storage, these redundancies should be eliminated as quickly as they occur.

We similarly eliminate intermediate variables when we solve a system of linear algebraic equations. For example:

$X_1$
$2\ X_1 + X_2 = 4$
$3\ X_1 + X_2 + X_3 = 6$
so
$X_2 = 4 - 2\ X_1$
$X_3 = 6 - (4 - 2\ X_1) - 3\ X_1$
then
$X_3 = 2 - X_1$
having eliminated the intermediate variable $X_2$
$X_1$ plays the role of the assumptions. $X_3$ plays the role of the behavior.

Before we partition, we replace the ORs with ANDs to get everything in terms of ANDs by using De Morgan's rule. Thus, (A or B or C) becomes NOT D were D is (NOT A and NOT B and NOT C). This requires the introduction of a new variable D. Then we only have ANDs and NOTs when we do the partition.

**A Block has Two Solutions (Clockwise and Counterclockwise) or is Conflicted**

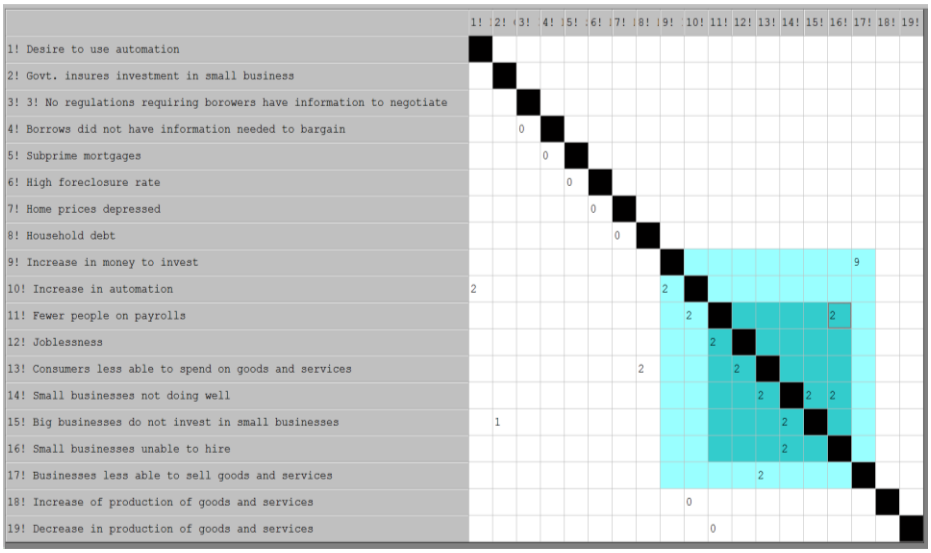


Figure 5

**The Two Solutions**

| Variable | Clockwise | Counter clockwise | |
|---|---|---|---|
| **9 Increase in money to invest** | Positive | Negative | |
| **10 Increase in automation** | Positive | Negative | |
| **11 Fewer people on payrolls** | Positive | Negative | |
| **12 Joblessness** | Positive | Negative | |
| **13 Consumers less able to spend on goods and services** | **Positive** | Negative | Caused by: No regulations requiring borrowers to have information to negotiate |
| **14 Small businesses not doing well** | Positive | Negative | |
| **15 Big businesses do not invest in small businesses** | Positive | **Negative** | Caused by: Govt. insures investments in small businesses |
| **16 Small businesses unable to hire** | Positive | Negative | |
| **17 Businesses less able to sell goods and services** | Positive | Negative | |

Figure 6

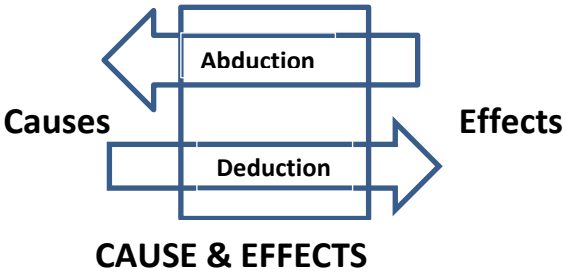


Figure 1

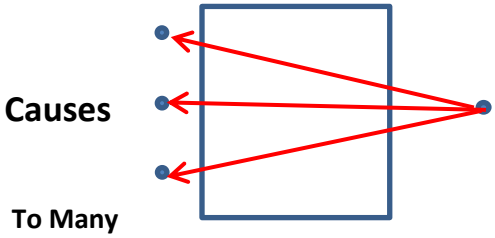


Figure 2

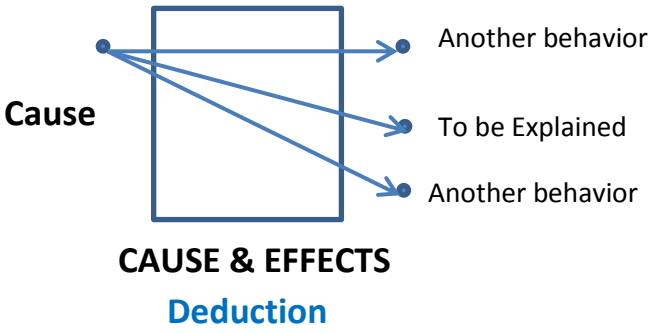


Figure 3

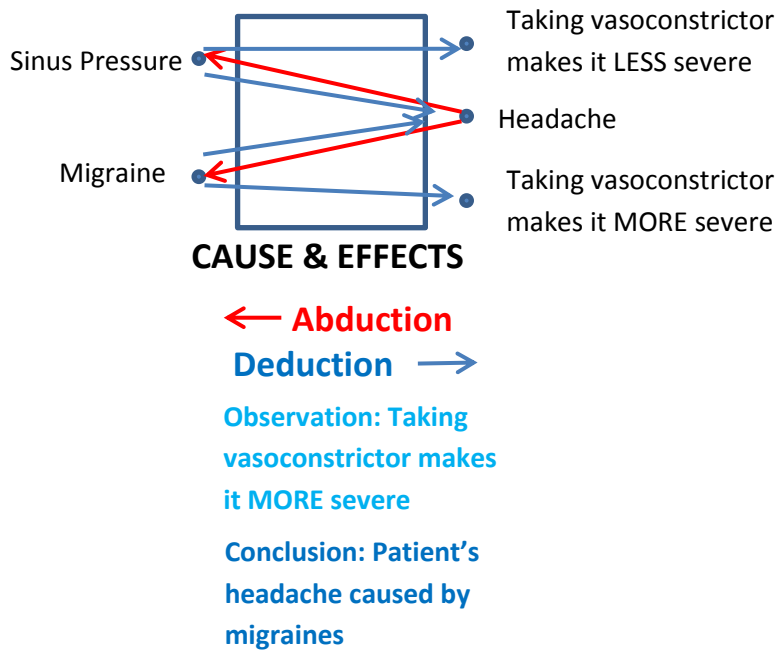


Figure 4