AS THE WORLD'S PROBLEMS BECOME TOO COMPLEX TO SOLVE, WE GIVE IN TO FANTASIES AND THEN CHAOS REIGNS
Can we do something about this?

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ABSTRACT

Hyper-connectivity has made the problems of our society more complex while our abilities to deal with complexity have not matured commensurately. This has led people to try to solve these problems with oversimplifications that have created fantasies rather than solutions. Without the necessary reasoning capabilities, these fantasies have been difficult to unmask. They have led to inappropriate actions that are causing chaos to reign in many regimes.

A method is presented here that uses a computer program to help people solve a large and important class of problems that involve cause-and-effects that may otherwise be too complex to be within human reasoning capabilities.

1.0 THE PROBLEM

As communication technologies have vastly improved, our world has become hyper-connected. Solving our social problems now must satisfy more constraints, making them too complex for humans to understand and solve. Our abilities to manage complexity have not risen commensurately. So in the absence of reason, we often try to solve our problems using oversimplifications. This has led to failure to find valid solutions, causing frustration, fallacious thinking, and the growing rage we are seeing around the world.

People say whatever they believe will have the desired effect on their listener. It may or may not be true; it may or may not be what they believe; and it may be manipulative. It may be based on what the speaker thinks the listener believes. People herd with groups of people who share some of their beliefs and tend to accept the other beliefs held by that group. This can result in society being very unstable. It can and does contribute to chaos.

What is lacking is the ability of everyday people to reason about these very complex situations. Although they may easily describe the dots that make up the problem, if there are too many dots, they cannot put the dots together logically.

2.0 THE APPROACH TO THE PROBLEM

Here we will consider a class of problems where the situation can be described by cause-and-effect relations and the problem is to use that knowledge of the situation to explain the causes of behaviors that can arise from that situation. The behavior is explained in terms of assumptions that if true would make that behavior true. An assumption already known to be true or false is a fact. As we will see, this covers a very broad class of problems that can now be solved by the method presented here.

An example of a fact is that 'Joblessness is high'. An example of the cause-and-effect relations to describe a situation is: 'Joblessness' is caused by 'Businesses unable to sell their products and services', which is caused by 'Customers don't have the money to buy their goods and services'. Sometimes these cause-and-effect statements can form circuits such as if we add that 'Customers don't have the money to buy their goods and services' is caused by 'Joblessness'. Such circuits can be vicious or virtuous cycles. To prevent what the cycle portends, we must usually find an intervention.

In Appendix B we show a more comprehensive description of how the economy works and ask for an explanation for what caused the recent economic crisis and how it may be prevented from happening again. Unfortunately, this suggests that if we continue what we are doing now, we can expect to repeat this crisis.

The example in the appendix may be naïve. It requires further work by people who know econometrics better then I to put together the cause-and-effect statements that describe the economic situation.

Many problems can be stated in this form. Primarily it can be used to diagnose the causes of system failures, as in machines, processes, or medical diagnoses. But there are many other important applications.

3.0 A NEW LOGIC IS REQUIRED

We will consider that cause-and-effect can be represented by logical implication. But the logic

required to solve these problems does not fit within the domain of classical propositional logic, which was developed to deal with open-infinite systems. For example, if A implies B, B is considered to be true even when A is not true. Supposedly if A does not imply B, then something else is assumed to imply B. But this something else may be outside the system that we know or care nothing about.

We had to use a different logic that will deal with closed-finite systems. If A is false, for B to be true we must be able to find an effect elsewhere within the system that implies that B is true. If we cannot find an implication that would make B true, B is considered to be false. And we must assure that this new logic satisfies all the consistency conditions that would be expected of a classical logic. This has not been trivial.

Furthermore, this new logic must be able to deal with circuits in the cause-and-effects. That has required the use of graph theory where the nodes of the graph represent the effects and the arcs represent cause-and-effect relations. Graph theory is used to find blocks containing the circuits and solving for the natural solutions for each block, i.e. solutions that would occur if there were no input causes from outside the block. These natural solutions are used to find simple cause-and effect relations between the inputs and outputs of the block that replace the circuits.

Once there are no circuits, the sets of assumptions that explain the behavior can be found directly as a function of the behavior to be explained by using substitution to eliminate the intervening effects, much as we solve systems of simultaneous linear algebraic equations.

4.0 A PROCESS INVOLVING THE COLLABORATION OF PEOPLE WITH A COMPUTER PROGRAM

The following illustrates how the method involving people and the computer program works:

1. People with different perspectives on a problem collaborate to collect and discuss the pertinent cause-and-effect statements that describe the knowledge of the situation from which the behavior to be explained arises. These individual statements are usually quite simple and easy to understand and discuss. (We call this Collection.)
2. The people present a behavior to be explained or produced. The computer uses this cause-and-effect knowledge of the situation to find all the sets of assumptions that would explain that behavior, or would produce that behavior if the assumptions

were turned into actions. (This is Abduction.) Since the behavior is usually inadequately defined initially, many false explanations may be proposed.
3. The computer takes each of these proposed explanations and uses the cause-and-effect knowledge to find all the other behaviors that that explanation would also predict. (Logical Deduction.)
4. The computer asks the people to determine whether these other behaviors actually occur. So people then examine each of these other predicted behaviors to see whether they actually do occur. (This we call Examination.)
5. Then people must rule-out all those false explanations leaving only those explanations that predict the desired behavior and do not also predict behaviors that do not occur. (This we call Selection.)
6. For each explanation that remains, the computer produces a cause-and-effect scenario summarizing how the conclusions were reached. These scenarios can be used to either convince other people of the validity of the reasoning, or give them the information they need to refute the conclusions, providing the basis for improving the cause-and-effect knowledge. (This is called Scenario.)

The is the CADESS (Collection, Abduction, Deduction, Examination, Selection, Scenario.)) method for solving problems.

5.0 THIS PROCESS IS REPEATED TO IMPROVE THE CAUSE-AND-EFFECT KNOWLEDGE

Initially the cause-and-effect statements are likely to be wrong and incomplete. The results of the analysis might not be adequate to explain what is to be explained. The reasoning with those cause-and-effect statements shown in the scenarios can be analyzed to point out the weaknesses in these cause-and-effect statements or whether further such statements need to be added. The changes are made and the process is repeated until an acceptable explanation can be found.

So this is an iterative process in which the cause-and-effect statements are continually revised until a satisfactory understanding and solution emerges.

Once this knowledge is established, it might be used, perhaps by adding more cause-and-effect statements, to solve other problems in similar domains. It could also be used by other people. Thus,

a library of cause-and-effect knowledge about various domains might be developed.

6.0 USES FOR THIS METHOD

The Explainer may be used to:

1. Conduct the scientific method for the analysis of new observations and development of new theories to explain them.
2. Form a social network where people can discuss their ideas about the current social problems of the day and use the computer to extend their reasoning capabilities in order to enhance their discussion. They may possibly communicate their reasoning to those who would have the responsibility and capability of implementing their solutions. They may be able to shoot down the many fallacies that are floating around so as to reduce some of the chaos we observe today. Money could be made by charging for the time the system is used and by charging for the use of their knowledge base by others. Those using the knowledge may choose to receive advertisements showing where they can purchase or find literature that relates to their conversation. Clicks on those advertisements may also generate revenue.
3. Diagnose the cause of medical symptoms. A panel that keeps up with the latest literature may develop and maintain an up-to-date medical knowledge base that would be provided as a subscription to physicians. If this knowledge base is respected by the courts, it could protect physicians against malpractice suits and reduce the number of costly and unnecessary tests. If the physicians provide feedback of the symptoms, treatments, and results, it could provide for the collection of Experienced Based Medicine.
4. Diagnose the causes of failures in many other types of devices or systems such as machinery or even production processes.
5. Determine what is most likely to have happened in the past based on forensic evidence as in solving crimes, or as in analyzing historic or archeological evidence to develop an historical explanation.
6. Teach students how to solve problems. The students could use the Internet to find problems to solve and find the information they need to generate the cause-and-effect statements to develop a knowledge base that

describes the situation from which the problem arises. Then they would use this method to attempt to develop solutions to these problems. Their solutions might be submitted to those who have the responsibility and means to implement the solutions they propose.

7. Develop plans for how to achieve desired objectives where the cause-and-effect statements of the scenario derived by explaining the goal become the steps in the plan.
8. Handle the management of emergencies when time is inadequate for people to think the problem through.

The Explainer has also been used in tests to illustrate how it might be applied to understanding a number of different types of problems such as understanding how terrorists might design a plan to do us harm and how all those plots might be thwarted with the most economical interventions, how we might consider the various factors involved in plans to leave Iraq (now it should be applied to leaving Afghanistan), how it might be used to provide a medical diagnostic service to physicians who do not have the time to read all the latest literature, and so on.

But none of these examples was intended to do any more than to illustrate how these problems might be formulated and resolved. Better understanding of these problems would require that the method be put in the hands of more knowledgeable people to develop better cause-and-effect statements.

7.0 SOME IDEAS YET TO BE EXPLORED

The following are some preliminary ideas of how it might be used. But they will require more investigation.

1. Design systems by representing the behavior of each likely component of the design by cause-and-effect statements, then requesting the method to explain how these components can be used to explain the requirement specifications of the design.
2. Develop computer programs by using previously programmed components to satisfy the required program specification. The input and initial data state of a component would be its cause, and the output and final state would be its effect.

The assumptions would be the input to the program that will produce the desired result. Changes to the program could be made by having the method automatically regenerate the program by just changing the pertinent pieces of the requirements without the danger of introducing errors while trying to change the program manually.

3. <u>A very interesting conjecture:</u> An agent that can be used as a device such as a robot that can use its sensors to detect and collect likely cause-and-effects occurring in its environment. Then use these to develop and extend its existing set of cause-and-effect statements. And then use its cause-and-effect knowledge with actuators to experiment on its environment to rule out false cause-and-effects and learn more cause-and-effect statements, and also produce effects it desires to occur in its environment. (This might also be the basis for a philosophical theory to explain how we learn from our environment.)

In this method, probabilities may be added to the cause-and-effect statements to indicate the prior belief in the validity of the individual cause-and-effect statements to produce solutions with a probability measure of belief in its outcomes.

The same method used here to work with circuits may be applied in other contexts where Bayes theorem is used.

8.0 MORE ELABORATE EXAMPLE – ANALYZING THE CAUSE OF THE ECONOMIC CRISIS

8.1 A WHY-BECAUSE CONVERSATION TO DESCRIBE THE PROBLEM

The following illustrates how a collaborative conversation can collect the cause-and-effect statements that describe the knowledge about the situation from which the behaviors to be explained can arise. This illustration is very short and naïve, just enough to indicate the concept.

The problem shown here is a very simple model of how to deal with the economic crisis. A more comprehensive model is shown in Appendix B. But even that is only a beginning. A more complete explanation would require the use of the method by more knowledgeable econometricians.

Rather than use cause-and-effect statements, this conversation may use WHY-BECAUSE statements that are equivalent to cause-and-effect statements, but may be more natural for many to use.

WHY: Many foreclosures.
  BECAUSE: Borrowers have low income and equity AND Borrowers could buy Adjustable Rate Mortgages at low initial interest rates AND Lenders were willing to sell low rate ARM mortgages AND Rates on ARM mortgages later rose AND Borrowers with low income and low equity could not pay the higher rates.

WHY: Lenders could get back the houses and principal already paid.
  BECAUSE: Many foreclosures.

WHY: Borrowers with low income and low equity could buy homes with Adjustable Rate Mortgages?
  BECAUSE: ARMs initially had low interest rates.

WHY: Lenders were willing to sell low rate ARM loans?
  BECAUSE: Lenders had low risks in selling low interest rate loans.

WHY: Lenders had low risks in selling low interest rate loans?
  BECAUSE: Lenders could bundle the loans and sell them at low risks to them AND Investors believed that bundled loans had low risks.

WHY: Investors believed that bundled loans had low risks?
  BECAUSE: Bundled loans were rated as low risk by the rating agencies.

WHY: Bundled loans were rated as low risk by the rating agencies?
  BECAUSE: Rating agencies were financed by the lenders AND Lending agencies financed by lenders was not against regulations.

WHY: Lending agencies financed by lenders was not against regulations?
  BECAUSE: Lenders contributed financial support to congressional campaigns.

WHY: Lenders contributed financial support to congressional campaigns?
  BECAUSE: Unattributed business contributing to congressional campaigns was not regulated.

8.2 HOW THIS WOULD LOOK ON THE COMPUTER

Cause-and-effects can be input to the Explainer program in the form of an outline as follows:

EFFECT 1
  CAUSED BY A
    NOT B
  CAUSED BY C

Meaning that Effect 1 is caused either by (A and not B) or by C.

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⊟ Demonstration of Collaboration
  ⊟ 1 Many Foreclosures
    ⊟ Because
      ┤+2 Borrowers have low income and equity
      ┤+ 3 Lenders willing to sell low rate ATM mortgages
      ┤+4 Rates on ARM mortgages later rose
      └┤+ 5 Borrowers with low income and equity could not pay higher rates
  ─2 Borrowers have low income and equity
  ⊟ 3 Lenders willing to sell low rate ATM mortgages
    ⊟ Because
      ┤+4 Rates on ARM mortgages later rose
      └┤+ 9 Lenders had low risks in selling low initial rate loans
  ─4 Rates on ARM mortgages later rose
  ─5 Borrowers with low income and equity could not pay higher rates
  ⊟ 6 Lenders get back houses and principal already paid
    ⊟ Because
      └┤+ 1 Many Foreclosures
  ⊟ 7 Borrowers with low income and equity bought ARM loans
    ⊟ Because
      └┤+ 8 ARM loans initially had low interest rates
  ─8 ARM loans initially had low interest rates
  ⊟ 9 Lenders had low risks in selling low initial rate loans
    ⊟ Because
      ┤+ 10 Lenders could bundle loans and sell them at low risks to them
      └┤+ 11 Investors believed bundled loans had low risks
  ⊟ 10 Lenders could bundle loans and sell them at low risks to them
    ⊟ Because
      └┤+ 12 Bundled loans were rated low risk by rating agencies
  ⊟ 11 Investors believed bundled loans had low risks
    ⊟ Because
      └┤+ 12 Bundled loans were rated low risk by rating agencies
  ⊟ 12 Bundled loans were rated low risk by rating agencies
    ⊟ Because
      ┤+ 13 Rating agencies were financed by lenders
      └┤+ 14 Rating agencies financed by lenders was not against regulations
  ⊟ 13 Rating agencies were financed by lenders
    ⊟ Because
      └┤+ 14 Rating agencies financed by lenders was not against regulations
  ⊟ 14 Rating agencies financed by lenders was not against regulations
    ⊟ Because
      └┤+ 15 Lenders contributed financial support to Congressional campaigns
  ⊟ 15 Lenders contributed financial support to Congressional campaigns
    ⊟ Because
      └┤+16 Unattributed businesses contributing to Congressional campaigns is not regulated
  ─16 Unattributed businesses contributing to Congressional campaigns is not regulated
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8.3 THE COMPUTER'S ANSWER AND ITS INTERPRETATION

Now we ask the computer for the assumptions that would explain the behavior: 'Many Foreclosures'. The computer responds with:

EFFECT 1 Many Foreclosures
CAUSED BY
    2 Borrowers have low
     income and equity
 AND 4 Rates on ARM mortgages
     later rose
 AND 5 Borrowers with low income
     and equity could not pay
     higher rates
 AND 16 Unattributed businesses
     contributing
     to Congressional
     campaigns is not regulated

This shows that there are four causes that when taken together, i.e. joined by logical ANDs, are necessary to produce the behavior that was to be explained. But note that the first three causes are not within our ability to change. The forth cause, '16 Unattributed businesses contributing to Congressional campaigns is not regulated' is something that might be changed through legislation. Since all these causes are required to produce the effect, eliminating any one or more causes will prevent the effect from occurring.

This is a trivial example involving only 16 effects. Appendix B shows a more comprehensive analysis involving 34 effects. But this is still only a start. It needs to be worked on further by econometricians more knowledgeable about economics then I.

9.0 ACCEPTANCE OF METHOD

If people could be convinced that this method works, the implications would be substantial. We could dispel some of the chaos in government we are currently facing.

When presented to an expert in logic, the response is supportive of the logic used and enthusiastic about the implications of using this method.

But unfortunately when presented to someone who does not have an in depth understanding of logic, it is generally greeted with suspicion. 'It won't work. It could never be done'. When they look at examples of problems that have been solved using this method, if it confirms their prior beliefs, they respond that the conclusion is obvious and such a method is not needed. If it does not correspond to their prior belief, they consider that the method and its conclusions must be wrong. 'How dare you disabuse me of my fantasy?' In this paper we do dare. But the potential of this method is being neglected.

If this method could be turned into a social network to discuss, understand, and resolve complex problems, people would use it and it would just be

taken for granted that the method works. It could then be used as a political BS detector.

10.0 CONCLUSION

The Explainer shows a method that might be used to help people collaborate in order to understand complex problems and see how they might be resolved. Unlike expert systems, this method can handle circuits, which are not uncommon, and there is no ambiguity in the sequencing of the application of rules.

If equivalent methods are available to study complex problems such those that this method appears capable of understanding, there does not appear to be any evidence that such other methods exist and are being used to deal with the many significant problems that we are facing today.

We have a running program that so far handles problems without cause-and-effect circuits, and are finishing the program so it will handle circuits. In the meanwhile we have been able to handle some problems with circuits by supplementing the program with hand manipulations to deal with the circuits.

11.0 BIBLIOGRAPHY

[1] Brachman, Ronald & Hector Levesque (2004) *Knowledge Representation and Reasoning* (Morgan Kaufmann)

[2] Garey, Michael R. & David S. Johnson, (1979) *Computers and Intractability: A Guide to the Theory of NP-Completeness* (W. H. Freeman and Company)

[3] Glymour, Clark (2001) *The Mind's Arrows: Bayes Nets and Graphical Causal Models in Psychology* (The MIT Press)

[4] Gopnik, Alison, (2009) *The Philosophical Baby*, (Farrar, Straus and Giroux)

[5] Gore, Al (2007) *The Assault on Reason* (The Penguin Press, New York)

[6] Groopman, Jerome, (2007) *How Doctors Think* (Houghton Mifflin)

[7] Josephson, John R. & Susan G. Josephson (1996) *Abductive Inference: Computation, Philosophy, Technology* (Cambridge University Press)

[8] King, Ross D., Oliver Ray, Amanda Clare, Maria Liakata, Larisa Soldatova, Ken Whelan "Towards the automation of scientific method" *21st International Joint Conference on Artificial Intelligence IJCAI'09*

[9] King, Ross D. "Rise of the Robo Scientists" *Scientific American January 17, 2011*

[10] Mueller, Eric T. (2006) *Commonsense Reasoning* (Morgan Kaufmann Publishers)

[11] Pearl, Judea, (1988) *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference* Revised 2nd Printing (Morgan Kaufmann, Publishers, Inc.), particularly pg. 195 footnote,

[12] Pearl, Judea, (2000) *Causality: Models, Reasoning, and Inference* (Cambridge University Press)

[13] Peirce, Charles Sanders, (1998) "Pragmatism as the Logic of Abduction" in *The Essential Peirce, Volume 2: Selected Philosophical Writings, 1893-1913* (Indiana University Press)

[14] Peng, Yun & James A. Reggia, *Abductive Inference Models for Diagnostic Problem-Solving* (1990) (Springer; 1st edition)

[15] Russell, Stuart. & Peter Norvig, (2003) 2nd ed., *Artificial Intelligence: A Modern Approach,* (Prentice-Hall of India)

[16] Steward, Donald V, (1981) *Systems Analysis and Management: Structure, Strategy and Design*, (Petrocelli Books, Inc., now McGraw-Hill)

[17] Walton, Douglas (2004) *Abductive Reasoning* (The University of Alabama Press)

[18] Zhang, Du & Doan Nguyen (1994) "PREPARE: A Tool for Knowledge Base Verification" *IEEE Trans. on Knowledge and Data Engineering*, vol. 6, No. 6, Dec 1994)

[19] Go to http://problematics.com/readings.asp then Click on APPLICATIONS-E.doc to see demonstrations of how the Explainer has been used to deal with various types of problems.

APPENDIX A: SIMPLE PROBLEMS TO SHOW HOW THIS WORKS

A1 Why is car seat wet?
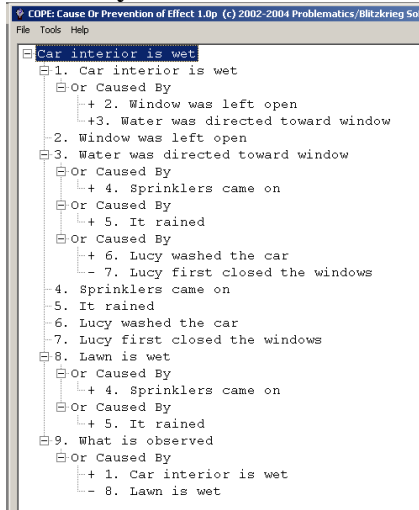

**Figure: A1 Computer Input
for why is car seat wet**

EFFECT 9. What is observed
    CAUSED BY 2. Window was left open
      AND   6. Lucy washed the car
      AND NOT   7. Lucy first closed
                the windows
      AND NOT 5. It rained
      AND NOT 4. Sprinklers came on

Figure A2: Explanation for why seat is wet
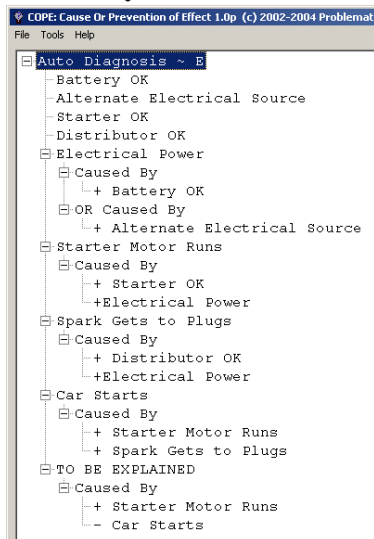
A2. Why doesn't car start?

Figure A3: Computer Input – Car doesn't start

TO BE EXPLAINED
    CAUSED BY   NOT   Distributor OK
Figure A4: Explanation of Car doesn't start

APPENDIX B:
A MORE SUBSTANTIAL PROBLEM - UNDERSTANDING THE ECONOMIC CRISIS

Although this example is more substantial than the previous, it still needs more work by more competent economists.

B1: The input for this partial economic crisis analysis might be as follows:

EFFECT 1. Home prices depressed
    CAUSED BY   17. More houses available on market
EFFECT 2. Credit crunch
    CAUSED BY NOT   3. Liquidity
EFFECT 3. Liquidity
    CAUSED BY NOT   4. Mistrust
EFFECT 4. Mistrust
    CAUSED BY   16. High foreclosure rate
               29. Pressure to make loans with inadequate documentation in order to collect fees
EFFECT 5. Initial lender possesses home partially paid for by borrower`s payments
    CAUSED BY   14. Borrower defaults
EFFECT 6. Initial lender wants to sell ARM mortgage
    CAUSED BY   5. Initial lender possesses home partially paid for by borrower`s payments
               10. Rate will rise to make loan profitable to lender
               11. Initial lender has low risk in reselling loan
               21. Initial lender gets origination fees
EFFECT 7. Borrower wants to buy ARM loan
    CAUSED BY   9. Borrower has low income and low equity

12. Initial rate low

EFFECT   8. Many ARM loans made
    CAUSED BY   6. Initial lender wants to sell
          ARM mortgage
            7. Borrower wants to buy
          ARM loan

EFFECT   9. Borrower has low income
        and low equity

EFFECT   10. Rate will rise to make loan
        profitable to lender
    CAUSED BY   24. Initial lender cannot
           profit from
           initial rates

EFFECT   11. Initial lender has low risk
        in reselling loan
    CAUSED BY   19. Initial lender bundles
          loans
           30. Ability of lenders to
          recoup bad loans

EFFECT   12. Initial rate low
    CAUSED BY   23. Nature of ARMs

EFFECT   13. Borrower cannot pay reset rate
    CAUSED BY   9. Borrower has low income
          and low equity
           10. Rate will rise to make loan
          profitable to lender

EFFECT   14. Borrower defaults
    CAUSED BY   13. Borrower cannot pay
          reset rate

EFFECT   15. High delinquency rate
    CAUSED BY   8. Many ARM loans made
           14. Borrower defaults

EFFECT   16. High foreclosure rate
    CAUSED BY   15. High delinquency rate

EFFECT   17. More houses available on market
    CAUSED BY   14. Borrower defaults
           32. Buyers walk away
          from homes

EFFECT   19. Initial lender bundles loans
    CAUSED BY   22. Bundled loans have low
          risk rating

EFFECT   20. Artificially low risk assigned
        to bundles
    CAUSED BY   26. Asymmetry of
          information
          about risks of bundles

EFFECT   21. Initial lender gets origination fees
    CAUSED BY   23. Nature of ARMs

EFFECT   22. Bundled loans have low risk rating
    CAUSED BY   20. Artificially low risk
          assigned to bundles

EFFECT   23. Nature of ARMs

EFFECT   24. Initial lender cannot profit from
        initial rates
    CAUSED BY   9. Borrower has low income
          and low equity
           23. Nature of ARMs

EFFECT   25. Market collapse
    CAUSED BY NOT   3. Liquidity

EFFECT   26. Asymmetry of information about
        risks of bundles
    CAUSED BY NOT   34. Regulators
          guarantee
          symmetry of information
          about loan risks

EFFECT   27. Investors unaware of bundle risks
    CAUSED BY NOT   28. Open books
           29. Pressure to make loans with
          inadequate documentation
          in order to collect fees

EFFECT   28. Open books
    CAUSED BY   34. Regulators guarantee
          symmetry of
          information about
          loan risks

ASSUMABLE   29. Pressure to make loans
        with inadequate documentation
        in order to collect fees

EFFECT   30. Ability of lenders to recoup
        bad loans
    CAUSED BY 20. Artificially low risk
          assigned to bundles

EFFECT   31. Negative equity
    CAUSED BY   1. Home prices depressed

EFFECT   32. Buyers walk away from homes
    CAUSED BY   31. Negative equity

EFFECT   33. Bundled loans bring good prices
    CAUSED BY   26. Asymmetry of
          information
          about risks of bundles

EFFECT   34. Regulators guarantee
        symmetry of information
        about loan risks

FIGURE B1: INITIAL MODEL FOR ECONOMIC CRISIS SITUATION INCLUDING CIRCUIT

Those with better knowledge of the situation are invited to use the Explainer to produce a more comprehensive analysis.

This problem has a block that contains a circuit. The circuit is as follows:

Input to block Begin
EFFECT   14. Borrower defaults
   CAUSED BY
        13. Borrower cannot pay reset rate
Input to block End
Variables within the Block Begin
EFFECT 17. More houses available on market
   CAUSED BY 14. Borrower defaults
       32. Buyers walk away
        from homes
EFFECT   1. Home prices depressed
   CAUSED BY 17. More houses available
        on market
EFFECT   31. Negative equity
   CAUSED BY 1. Home prices depressed
EFFECT   32. Buyers walk away from homes
   CAUSED BY 31. Negative equity
Block End
FIGURE B2: INPUT TO BLOCK BEFORE SUBSTITUTION FOR CIRCUIT

Figure B2 identifies a circuit within the cause-and-effect statements that must be resolved. Figure B3 shows the cause-and-effect statements after the substitution has been made to produce an equivalent set of cause-and-effects that no longer contain circuits:

Input Variables to Block
Begin
EFFECT   14. Borrower defaults
   CAUSED BY
        13. Borrower cannot pay reset rate
End
Variables within block Begin
EFFECT   17. More houses available on market
   CAUSED BY 14. Borrower defaults
       32. Buyers walk away from
        homes
EFFECT   1. Home prices depressed
   CAUSED BY 14. Borrower defaults
EFFECT   31. Negative equity
   CAUSED BY 14. Borrower defaults
EFFECT   32. Buyers walk away from homes

   CAUSED BY 14. Borrower defaults
Variables within block End

FIGURE B3: INPUT TO BLOCK AFTER SUBSTITUTION OF ARCS FOR BLOCKS SO IT NO LONGER CONTAINS A CIRCUIT

Effect 18 has been deleted because during the development it was found to be equivalent to Effect 1. This reveals why it is important to make sure that the variables are not duplicated with different numbers.

After making this substitution, we can run the existing program as though there were no circuits. Then we get the following explanation for the Market Crisis:

EFFECT   25. Market Crisis
  CAUSED BY
     29. Pressure to make loans with
       inadequate
       documentation in order to collect fees
   NOT   34. Regulators guarantee symmetry
       of information about loan risks
     23. Nature of ARMs
     9. Borrower has low income and low
       equity
FIGURE B4: EXPLANATION FOUND FOR '25.   MARKET CRISIS'

This tells us that 'EFFECT 25. Market Crisis' can occur only if all these causes occur together and thus can be prevented if any one of them can be prevented.

We cannot change '23 Nature of ARMs' i.e. Adjustable Rate Mortgages, nor '9. Borrower has low income and low equity', but we can change '29. Pressure to make loans with inadequate documentation to collect fees' and 'NOT 34. Regulators guarantee symmetry of information about loan risks'. This suggests that the 'Market Crisis' could have been prevented and now can be resolved by having regulations to guarantee symmetry of information in all financial transactions. As of this writing, the regulations requiring this are still a matter of contention and thus are not yet in place.

B2: SCENARIO TO EXPLAIN THE REASONING FOR THE EXPLANATION AND SHOW SIDE EFFECTS

The scenario summarizes the reasoning that leads to this explanation and provides the consequences if the explanation were valid.

A term is a set of assumptions or actions joined by ANDs.

The scenario uses the following rules:

- A term is True if all its variables are True
- A term is False if any of its variables are False
- A term is Unknown if at least one of its variables is unknown and none of its variables are False
- An explanation is False if any term in its explanation is False and no term is True or Unknown
- An explanation is Unknown if no term is either True or False
- An explanation is True if any term is True

The program assigns values of IS TRUE, IS NOT TRUE or equivalently IS FALSE, or UNKNOWN to the effects, causes and terms. The unknowns have been eliminated in the following for clarity and brevity. Then the scenario is as follows:

DETERMINE THE CONSEQUENCES IF THESE ASSUMPTIONS ARE ALL TRUE

29. Pressure to make loans with inadequate documentation in order to collect fees IS TRUE
34. Regulators guarantee symmetry of information about loan risks IS NOT TRUE
23. Nature of ARMs IS TRUE
9. Borrower has low income and low equity IS TRUE

THEN THE CONSEQUENCES ARE:

9. Borrower has low income and low equity IS TRUE
23. Nature of ARMs IS TRUE
29. Pressure to make loans with inadequate documentation in order to collect fees IS TRUE
34. Regulators guarantee symmetry of information about loan risks IS FALSE
12. Initial rate low IS TRUE
21. Initial lender gets origination fees IS TRUE
24. Initial lender cannot profit from initial rates IS TRUE
11. Initial lender has low risk in reselling loan IS TRUE
21. Initial lender gets origination fees IS TRUE
8. Many ARM loans made IS TRUE
7. Borrower wants to buy ARM loan IS TRUE
15. High delinquency rate IS TRUE
16. High foreclosure rate IS TRUE
4. Mistrust IS TRUE
3. Liquidity IS FALSE
2. Credit crunch IS TRUE
25. Market Crisis IS TRUE
26. Asymmetry of information about risks of bundles IS TRUE
28. Open books IS FALSE
33. Bundled loans bring good prices IS TRUE
7. Borrower wants to buy ARM loan IS TRUE
10. Rate will rise to make loan profitable to lender IS TRUE
13. Borrower cannot pay reset rate IS TRUE
14. Borrower defaults IS TRUE
17. More houses available on market IS TRUE
1. Home prices depressed IS TRUE
31. Negative equity IS TRUE
32. Buyers walk away from homes IS TRUE
20. Artificially low risk assigned to bundles IS TRUE
22. Bundled loans have low risk rating IS TRUE
27. Investors unaware of bundle risks IS TRUE
30. Ability of lenders to recoup bad loans IS TRUE
5. Initial lender possesses home partially paid for by borrower's payments IS TRUE
19. Initial lender bundles loans IS TRUE
11. Initial lender has low risk in reselling loan IS TRUE
4. Initial lender wants to sell ARM mortgage IS TRUE

FIGURE B4: SCENARIO FOR CAUSE OF ECONOMIC CRISIS

APPENDIX C: PROPOSAL FOR APPLICATION TO MEDICAL DIAGNOSTIC SYSTEM TO REDUCE MEDICAL COSTS

This method can be illustrated by the following simple medical diagnostic problem. This problem does not contain any cause-and-effect circuits.

Assume that a physician is presented by a patient claiming to be having severe headaches. On the previous visit the physician had assumed that the headaches were due to sinus pressure and had prescribed that the patient take pseudoephedrine, a vasoconstrictor. Now the headaches have become more severe.

Assume also that the physician subscribes to a web medical diagnostic service where medical professionals who keep up with the literature continually update the diagnostic model.

Given the following cause-and-effect description of the situation:

  EFFECT Headache
  CAUSED BY Migraine
 OR
  CAUSED BY Sinus Headache
  EFFECT Migraine
  CAUSED BY Dilation Reaction
      to Constricted Blood Vessels
  EFFECT Sinus Headache
  CAUSED BY Sinus Pressure
EFFECT Sinus Pressure
  CAUSED BY NOT Drain Sinuses
EFFECT Drain Sinuses
  CAUSED BY Constricted Blood Vessels
EFFECT Dilation Reaction
    to Constricted Blood Vessels
  CAUSED BY Constricted Blood Vessels
EFFECT Constricted Blood Vessels
  CAUSED BY Taking Vasoconstrictor

we wish to find an explanation for the cause of Headache by tracing the cause back to the primary causes, i.e. causes that themselves have no stated cause, i.e. assumptions.

  EFFECT Headache
  CAUSED BY NOT Taking
        Vasoconstrictor
 OR   CAUSED BY Taking Vasoconstrictor

This tells us that under some circumstances 'NOT Taking Vasoconstrictor' could be the cause of the headache and under other circumstances 'Taking Vasoconstrictor' can be the cause of the headache. To understand why, we choose the state is a 'Headache' And 'Taking Vasoconstrictor', and look at what would be the consequences.
IF STATE IS
…..Headache
    And
  Taking Vasoconstrictor
THEN THE CONSEQUENCES ARE:
Headache IS TRUE
  Taking Vasoconstrictor IS TRUE
Constricted Blood Vessels IS TRUE
  Because: Taking Vasoconstrictor IS
      TRUE
Drain Sinuses IS TRUE
  Because: Constricted Blood Vessels IS
      TRUE
Dilation Reaction to Constricted Blood Vessels IS
      TRUE
  Because: Constricted Blood Vessels IS
      TRUE
Migraine IS TRUE
  Because: Dilation Reaction to Constricted Blood
      Vessels IS TRUE
Sinus Pressure IS FALSE
  Because: NOT Drain Sinuses IS FALSE
Sinus Headache IS FALSE
  Because: Sinus Pressure IS FALSE
and thus
Headache IS TRUE
  Because: Migraine IS TRUE
 And
  Because: Sinus Headache IS FALSE
Figure C1: Explanation for cause of headache

APPENDIX D: A SYNOPSIS OF HOW IT WORKS

The logic used by the computer is not trivial. Conventional propositional logic applies to systems that are open and infinite. Effects outside the system that are not known or of no concern can cause an unaccounted for magical effect within the system.

But for this method, a new logic is required that can deal with closed-finite systems. Then all the possible causes for an effect must be within the system and thus can be found because the system is finite. So it can be said that if nothing that would cause the effect were true, it is assumed the effect does not occur, i.e. that it is false.

Another difficulty arises if there are circuits in the cause-and-effect statements. Understanding the effects of these circuits can be vital to understanding the problem. No other method I am aware of can handle circuits.

Graph theory is used to handle circuits. Each effect becomes a node and each cause-and-effect becomes a labeled directed arc in a directed graph. An arc is labeled positive if the effect has the same truth value as the cause, and is labeled negative if the effect has the opposite truth value of the cause.

The graph is partitioned to find any subsets of the graph that represent blocks if any exist. A block has the property that within the block every node has a path to all the other nodes in the same block and this property would not be true if any other node were added [16].

If the block contains any ORs, they are converted into ANDs by the use of De Morgan's rules. (A OR B) = NOT C where C = (NOT A AND NOT B). C is inserted as a new node. This leaves us with blocks that contain no ORs.

The input of a block is an effect outside the block that causes an effect to occur inside the block. An output of a block is an effect inside the block that causes an effect to occur outside of the block.

Each block will have two natural solutions. A natural solution is a solution that would occur if the block had no input. For each of these natural solutions, each of the nodes in the block would be labeled either true or false.

These natural solutions are found by choosing an initial node and labeling it true, then labeling as true the other node as true if there is a positive arc from the initial true node to the other node, and labeling the other node as false if the initial node is true and there is a negative arc from the initial node to the other node. Also the other node is labeled false if there is no input arc that would cause it to be true. Thus if there is no cause for the effect to be true, , the effect is false, i.e. the event the node represents does not occur.

If there are two arcs entering a node where one would cause the node to be labeled true and the other would cause it to be labeled false, this is a contradiction that indicates an error in the formulation of the problem.

A first natural solution labels all the nodes within the block either true or false. The second natural solution is given by the first natural solution by flipping every true into false and every false into true.

The blocks are replaced by arcs from each input to each output. The arcs carry labels as follows: consider the natural solution where the input node is true. If in that solution the output node is also true, the arc is labeled positive. If the output node is false, the arc is labeled negative. Once these arcs replace the blocks, there are no longer any circuits.

If there were no circuits originally or if there are no circuits now because the circuits have been replaced with a set of arcs, then the behavior can be explained as a function of the assumptions by eliminating the intermediate variables between the assumptions and the behavior using substitution, much as we do in solving simultaneous linear equations if the matrix were triangular.

In a large knowledge base, the cause-and-effect statements needed to diagnose a particular symptom may only involve a very small part of the whole knowledge base. For example, solving a problem about headaches may not require doing all the processing that would pertain to liver ailments. This extra processing can be avoided by inverting the list that shows what each effect depends on to get a list that shows for each effect what other effects depend on it. Then before doing the elimination by substitution, one has identified just that subset of relations that are involved in solving that particular problem.

This inversion can be tricky. If not done correctly, it can involve an excessive amount of computing. It can be done most efficiently by first scanning the list to count the number of occurrences of each effect,

making a map of where each effect will be stored, and then making a second pass that uses this map to place every effect as it is encountered into its proper place.

Figure D1 shows of the graph for an example block. The lines that cross an arc indicate that the arc is labeled negative. Otherwise the arc is labeled positive. Figure D2 shows the natural solutions for labeling the nodes in the block. Column A shows one natural solution. Column B shows the other.

Graph of Block
FIGURE D1
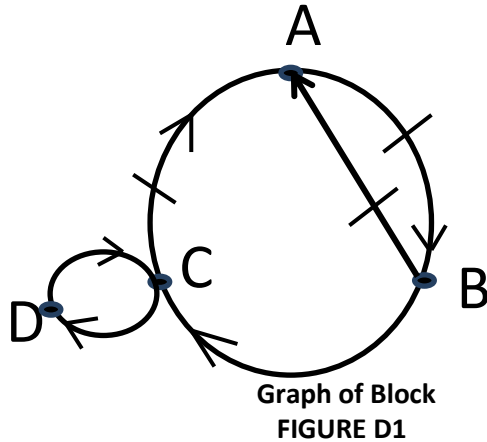
Solutions>	A	B
A	T	F
B	F	T
C	F	T
D	F	T

Natural Solutions for Block
FIGURE D2

Note that if A is true, then B is false. But B being false does not affect whether C is true or false. But C is false because unless there is something to make it true, it is considered false.

To output node, arc is labeled:

	A	B	C	D
A		Neg.	Neg.	Neg.
B	Neg.		Pos.	Pos.
C	Neg.	Pos.		Pos.
D	Neg.	Pos.	Pos.	

From input node label true

Labeling of Arcs between Input and output Nodes of Block
FIGURE D3

NOTE TO REVIEWERS

The logic has been developed to apply to closed-finite systems, which is a departure from classical logic. But it has already been vetted by a reputable logician. If you still question whether this method is logically correct, perhaps you can have the logic vetted by your own logician. Or we can arrange for you or your logician to talk to me and my logician.

If you have any doubts about the importance of seeing this method become available as a social network, I would like to hear from you.

Particularly if you know someone who would like to form a venture to bring this about, I would very much like to hear from you.

Thank you.
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