Computer parasites and hosts: Practical advice on how to be a successful parasite at your host's computer installation*

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The article proposes a solution to the budgetary, computational, psychological, and sociological problems that are encountered by behavioral scientists who contemplate doing on-line computing.

Let us suppose you are a behavioral scientist who discovers that he has a problem that requires on-line computing. The ideal solution would be to have your own private computer. In this way, there are no scheduling problems, no personality conflicts, no multiple convertible interfaces, no useless heavy equipment that always needs to be moved, and no ghosts changing switches at night. However, it may happen that your problem requires a computer that is larger than you can afford for your exclusive use. For example, the computers described so far at this conference, with one exception, are all shared by several users.

If you are foolish enough to persist after you have discovered that you cannot have your own private computer, you are faced with two alternatives: First, you can seek out an existing computer installation that is adequate for your problem.¹ In this installation there will be one individual who is primarily responsible for the computer. He is the host. And you, as the scientist, by working on your own problem, will be a parasite at this installation. You must learn how to subvert the host's computer for your problem. The remainder of this article will deal with instructions for you, as parasite, on how to conduct your affair with the host and the characteristics of this form of interaction.

THE PRACTICE AND PROBLEMS OF PARASITISM

Obtaining access to the computer is utterly trivial when it is run by an authentic host. Usually, it is sufficient

to say, "My, that's an impressive computer you have here. But can it do something really complex and important, such as...?" All the speakers who had medium-size computers (about \$70k to \$300k) sounded like ideal hosts to me and are certainly worth investigation.

The main advantage of parasitism is that the host's computer really exists, is functioning, and conceivably could do the job. The disadvantage is that it may not be the first choice of computer. If any of you are disturbed by this, just reconsider the computational and organizational problems that you have heard described in the lectures so far. If not having the ideal computer still disturbs you, I recommend you leave the room because either you have poorly suppressed host tendencies (in which case you are certain to be offended) or you have serious personality difficulties (in which case you are at a meeting of the wrong kind of psychologists).

A second advantage is that the system programs exist and may even be considerably debugged. The disadvantage is that the system programs usually are not adequately documented and are subject to change without notice. The solution is to "freeze" the system at a particular stage. That is, to take a particular version of the system, document it, and maintain it as your own system.

A third advantage is that interfaces exist. Here again, the disadvantage is that the interfaces are almost certainly not documented and are subject to change without notice. This is serious because it means that you may come to the computer and find that it completely defeats you for some unknown reason. Yesterday it worked perfectly. In the meantime, someone has changed a single, unknown one of ten thousand wires, and the computer is completely unusable for your problem.

No amount of interaction with the machine can solve this particular

problem. As behavioral scientists, we recognize immediately that the solution depends on the selective application of reward and aversive control. Unfortunately, aversive control is the more available. It is safest to apply it directly to the guilty one of the host's slaves rather than to the host. However, undocumented changes also can inconvenience the host, and you may actually reward him (slightly) by notifying him of such a change. If he, himself, is the perpetrator, use the occasion for a delicately administered punishment; mention that his best assistant has just wasted the entire morning trying to figure out what went wrong.

A fourth advantage of parasitism is that maintenance is provided. The disadvantage is that maintenance may be unbelievably unenthusiastic when the difficulty doesn't interfere with the host's uses. For example, I found that ground noise caused slight perturbations in the visual displays that disturbed me but not the host. This kind of problem requires the parasite ultimately to supply his own maintenance. This is a far more expensive solution than it seems because the person who does the maintenance must first gain the confidence of the host in order to gain access to the computer, and confidence is acquired only by having him initially apprenticed to the host. This is expensive, and it is one of the real disadvantages of this form of interaction.

What can a parasite offer a host? Token symbiosis in several forms. The first of these is primary capital. For example, we finally bought one-third of the computer we were using. Here one can take advantage of accounting methods. For example, it often is very difficult to buy expensive equipment because it may be taxed as property by the municipality in which it is located and for other reasons. On the other hand, it often is possible to pay a considerable yearly sum in rent. When the computer has been rented for 3 or 4 years, it is vastly depreciated and can be bought for a fraction of the original cost. In fact, the rental payments should be viewed as installment payments with a final lump sum due at the end. Thus, one can buy a third or a half of a 4-year-old system for a 10th of its initial value. In practice, therefore, the primary capital that a parasite can supply is a relatively insubstantial contribution to a host, and owning even a fraction of a computer may alter a successful parasitic relationship.

A far better contribution is "secondary" capital. A true host seldom has time to use his own computer for his own research. When

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he needs capital for a bigger, more-fun computer, he must cite the research of his parasites. The true host is happy when his computer is overloaded because he wanted a bigger one anyway, and the overload gives him the excuse to buy the machine he really wants. The pathway to a new computer is the ultimate benefit a parasite can confer on a host.

A third advantage for the host is that the parasite may write programs that are available to the host. Actually, this is irrelevant. If he likes a parasite's program, a host will write his own equivalent version. Other people's programs are never adequate for a true host, and this dissatisfaction extends to system programs as well.

The final basic principle of parasitism is never to pain a host unnecessarily. When stealing time, you must do it painlessly. For example, at all costs try to minimize the frequency of your name on the schedule sheets; just appear when the computer is vacant. Of course, every species of parasite has developed its own devious ways of camouflaging its activity; adaptation to local conditions is the best advice.

In all fairness, I must say that at the Bell Telephone Laboratories I have been fortunate to find a most generous

host, Peter Denes. He is difficult to get along with, but so am I, and the fact that we have had successful interaction for over 3 years points to the great stability of the parasite-host relationship. This stability may seem to be the greatest advantage of the parasite-host relation. The parasite thinks that when the host finally discards the computer, he, the parasite, can buy the depreciated computer at a bargain price. Of course, you immediately recognize the fallacy: when he does this, the parasite becomes the host—the ultimate catastrophe.

If ever you are presented with a computer, you must search for a host—a larval host who has not yet found his own computer. Like nature, the computer universe abounds with prospective hosts. Once you have discovered a larval host and brought him near the computer, he'll metamorphose and build his nest there. And you will continue to be able to enjoy the use of the computer for research without knowing anything about how it works inside. This is the ultimate application of behavioral science.

NOTE

1. The second alternative will be dismissed later.

described by a photograph of a typical frame with sufficient resolution to define the points, vectors, characters, or scan lines of which the frame is composed. The photograph should contain a size reference and an insert enlargement, if necessary, to show the point or line structure. The accompanying description should include a statement of the viewing distance. Black-on-white pictures reproduce well with ordinary printing methods, whereas white-on-black pictures generally require expensive photographic reproduction to produce acceptable copies. Therefore in preparing figures, it often is desirable to use a film that gives positive transparencies directly (e.g., Polaroid 146L) so that the resulting prints will be negatives of the display.

The description of the output parameters should include the refreshment rate, the rate of plotting points or characters, the total time taken to paint a frame, and the phosphor's time constant and chromaticity (e.g., color temperature, if known).

Luminous measurements should include the *luminous directional energy per point* of intensified points (explained below), the unintensified background screen *luminance*, and the approximate room *illuminance*.

It is in their treatment of luminous quantities that most CRO descriptions fail. Difficulties in luminous calibrations of CRO displays arise for two reasons: (1) whereas most natural objects are reflectors of light and best characterized by their *reflectances* or *luminances*, CRO displays are sources of light and usually are best characterized by their *intensities* or *directional energies*; and (2) whereas most naturally occurring objects are illuminated continuously in time and their luminance changes relatively continuously in space, CRO displays typically are pulsed at discrete instants in time and at discrete points in space. Calibration difficulties are overcome by measuring the appropriate luminous quantities of CRO displays, namely the *luminous directional energy* per point and the *luminous directional energy* per line length. The measurement techniques are described below.

The description and luminous calibration of cathode ray oscilloscope visual displays*

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A description of a CRO display should include descriptions of: (1) typical display contents (e.g., a photograph), (2) CRO output parameters (e.g., refresh rate), and (3) luminous measurements. Luminous calibrations are unorthodox because CRO displays are discontinuous in space and in time, and because they are sources, not reflectors, of light. The appropriate luminous quantities are luminous *intensity* and the integral of luminous intensity (*luminous directional energy*, *LDE*); the appropriate measurements are of *LDE per point* and of *LDE per unit line length*. A simple calibration procedure is described, and the formulas relating these quantities to luminances are given.

A description of a cathode ray oscilloscope (CRO) visual display should be sufficiently detailed to enable a reader to produce a visually

equivalent display, either on a CRO or by other means. Such a description need not be insufferably detailed; on the contrary, by judicious selection of the relevant aspects it can be both short and useful. The description should include three kinds of information: (1) a description of the display contents; (2) a description of the CRO output parameters (refresh rate, etc.); and (3) luminous measurements.

The display contents are best

LUMINOUS DIRECTIONAL ENERGY PER POINT

Point Source

A visual point source is defined as a luminous area whose maximum diameter is sufficiently small that the visual response does not depend on the actual distribution of light within the area, but only on the total flux. The largest allowable diameter for a point source varies with overall illumination and with the direction of view, being

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