LOWER BOUNDS OF AMBIGUITY AND REDUNDANCY

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Abstract

The elimination of ambiguity and redundancy are unquestioned goals in the exact sciences, and yet, as this paper shows, there are inescapable lower bounds that constrain our wish to eliminate them. The author discusses contributions by Richard Hamming (inventor of the Hamming code) and Satosi Watanabe (originator of the Theorems of the Ugly Duckling). Utilizing certain of their results, the author leads readers to recognize the unavoidable, central roles in effective communication, of redundancy, and of ambiguity of meaning, reference, and identification.

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A significant number of approaches which dominate contemporary philosophical thought have received their inspiration both from comparatively recent progress in the mathematical investigation of properties of formal systems, and from success in the development of programmable algorithms capable of simulating through electronic and mechanical means problem-solving capabilities of human subjects. To what extent philosophy will profit from this formal, mechanical impetus is best left for the passage of time to disclose. In the meantime, however, it is both useful and important to understand some of the effects upon philosophical attitudes which appear to have resulted from this association of philosophy with a formal, machine paradigm.

To a considerable degree, philosophers, in a rare display of near-unanimity, have accepted, or have believed themselves compelled to accept, or to appear to accept, prevailing values which favor precision, rigor, and methodological self-consciousness. The merits of clarity, of elimination of ambiguity and redundancy, and the values of sequential, systematic, and logical thinking have been extolled.

It is far from my purpose in this paper to subject these values to yet another anti-technological polemic; it is probably the case that blind technology (and deaf humanism) constitutes its own most effective opposition. Instead, I hope to show that the near-universal and frequently uncritical endorsement of certain of the prevailing values recommended to philosophy by the formal, machine paradigm has come about due to a failure of many philosophers to understand internal limitations of that paradigm.

With this objective in mind, I wish to review a small number of results acquired fairly recently by a group of mathematical logicians, information theorists, and communications specialists. These results provide, I believe, an integrated, interesting, and perhaps somewhat surprising perspective on some of the values the formal, machine paradigm appears to have fostered. In the light of these results, our philosophical endorsement of those values may perhaps become less uncritical and somewhat more enlightened. To do this, as the title of this paper might now suggest, ambiguity and redundancy come to have a positive value.

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Ambiguity

As we shall see, an indefinitely large set of concepts, terms, and expressions which we ordinarily use meaningfully, and an equally large group of objects to which we wish to be able to refer, appear variously to share properties of ambiguity. The concept of ambiguity is itself no exception to these. If by 'ambiguity' we generally mean indeterminacy, what we intend is as yet undetermined: There are numerous forms of indeterminacy, and so apparently numerous forms of ambiguity. Two of these will concern us here. They are: indeterminacy of meaning or reference[1] and indeterminacy of identification. Ambiguity may arise, in other words, both in connection with what something means or refers to, and in connection with that which we may seek to identify. Let us consider each in turn.

Confusion arises in the first case not simply because a concept, word, or expression has multiple meanings (or referents), but because from the context of its use, it cannot be determined which of these meanings (or referents) is intended. That is to say, if a concept, word, or expression is ambiguous, then the way in which that concept, word, or expression is used cannot be determined from context.[2] For example, the store that displays the sign: *We sell alligator shoes*, may intend quite different things depending whether the store caters, for example, to pets or to humans. When the store front leaves this question undecided, ambiguity of meaning or reference is possible. Other illustrations may be found in "A man eating turtle", "I shot a man with a gun", and, in a more complex case, in which ambiguity arises due to a grammatical lack of punctuation, and lack of emphasis: "Time flies how can I they go too fast", which resolves itself into: "Time *flies*? How *can* I? They go too fast!"

Granting that confusion may arise in such rather extreme cases, and in others we are likely to be familiar with in day-to-day living, it is usually, but certainly not always, useful for us to avoid and eliminate sources of confusion. If we should then be encouraged to wish to eliminate sources of confusion, and hence of ambiguity, entirely, our hasty decision would have rather regrettable consequences.

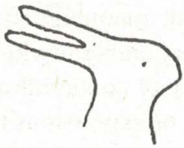
To insist strictly that ambiguity in meaning or reference is undesirable would, if carried to its logical conclusion, preclude human communication. As Russell[3] observed, the only way in which language can be employed in a totally unambiguous manner would be on the condition that each word or expression of the language have a unique meaning or unique reference. In such a logically perfect language, however, communication is impossible. Since you and I are conscious of different particular experiences, perceive somewhat differently different individual things, we should, on the condition of requiring of one another logically perfect usage, be utterly incapable of communicating with one another, of exchanging observations, and of doing what is commonly held to be "talking about the same thing". We should enjoy totally unambiguous, and hence totally disjunct, vocabularies.

The case for totally unambiguous *concepts* is more difficult. Either a concept itself is essentially ambiguous, since capable of being associated with different particular objects experienced, so that one's employment of a concept leaves one's precise meaning (or reference) open to question. Or, a concept is possible in the logically perfect sense that a concept would have if the precise collection of individual objects that leads to its formulation were extentionally determined. In the first sense, the elimination of ambiguity brings with it a corresponding elimination of concepts: in the second, such concepts would not facilitate communication any more than unambiguous words or expressions would.

In short, strict elimination of ambiguity in words, expressions, or concepts will stand effectively in the way of communication. The relativity of meaning or reference of concepts, terms, or expressions to a public context that provides a basis for communication is, at the same time, a relativity which brings ambiguity with it. Communication, ambiguity, and the contextual relativity of meaning and reference are one another's next of kin.

This conclusion is strengthened by attempts in the field of artificial intelligence to construct computers capable of translating expressions of one natural language into synonymous expressions of another. Machine translation has run into serious difficulties. Consider this example: A translation machine is instructed to express English sentences in Russian. Now, a sentence such as, "The box is in the pen", poses extreme difficulties for the machine. Although the machine's memory is capable of storing a set of English-Russian dictionary equivalences, it cannot make use of these until indeterminacy in the sentence's meaning is eliminated. There is, or so it is now believed, no way to reduce uncertainty of meaning without an awareness of *context*. If the sentence in question is uttered in a situation having to do with an infant playing on the floor near his crib and surrounded by his toys, a *likely* meaning can immediately be selected by a human subject: The context *suggests* "the box" is perhaps a toy which is located "in the [infant's] pen". Machine translation has virtually come to a halt because of the serious difficulty or impossibility of constructing a set of programmable rules that would enable a computer to select appropriate meanings for words and expressions that are ambiguous, but whose meaning is made determinate through an awareness of context. On the one hand, ambiguity is necessary if communication is to be possible, while, on the other, the presence of ambiguity constitutes a serious obstacle to the algorithmic representation of language use hoped for by the formal, machine paradigm. The recognition of the fundamental importance of ambiguity to communication was made possible by the very approach which now believes itself incapable of handling ambiguity according to a set of programmable rules.[4]

A very similar conclusion has been reached with regard to our second form of ambiguity arising as a function of identification. Ambiguity of this type can lead to confusion when there is indeterminacy in connection with what one seeks to identify. For example, in a pattern recognition problem of any significant degree of complexity, ambiguity is present due to the exponential growth of the tree of alternative possible ways in which patterns can be represented in terms of the initial conditions of the problem. As I have suggested what is the case with most if not all forms of ambiguity, it is *context* which makes possible the identification of an appropriate meaning, reference, pattern, etc. If the well-known ambiguous figure:



is found in the context of a discussion of the variety and habits of birds (rather than rabbits), the pattern recognized is readily seen to be a function of that context.

For very much the same reasons that led to difficulties experienced by developers of a translation machine, the construction of a computer capable of recognizing complex patterns is seriously handicapped. A human subject, once informed about the context in which he is to solve a particular problem in pattern recognition, is frequently somehow able to "see" the pattern without going through the computer's process of first exploring all the alternative ways in which patterns might be represented given the initial conditions of the problem, and then of comparing these with information obtained about the context so that only promising, suitable alternatives are considered. In general problem solving and specifically in pattern recognition, there is a need to be able to reduce the search maze systematically so that time can be spent exploring the most likely alternatives. It is here that human subjects rely on "insight", and where researchers in artificial intelligence run into trouble.

The trouble they encounter is compounded by results reached by the well-known information theorist, Satosi Watanabe. It is true that in complex game playing involving selection of the most promising alternative strategies, computer programs cannot now identify the most promising paths. In problem solving, the initial concern is how to represent the initial conditions given by the problem in a manner which renders explicit alternative promising paths so that a decision between them is made possible: This work is assigned to the human programmer. In language translation, implicit indeterminacy of meaning and reference is resolved by an understanding of the relevance of context, but this relevance is often so tenuous as to make its determination according to programmable algorithms exceedingly difficult if not impossible. Finally, pattern recognition inherits all these difficulties, and adds another: A human subject perceives patterns in terms of such general properties of similarity and typicality.

It is in this connection that Watanabe[5] has obtained proofs of three theorems, which he very suitably terms "Theorems of the Ugly Duckling". These theorems show that from the formal, quantitative, rule-determined point of view, there exists no such thing as a class of similar objects in the world, because all predicates (of the same dimension) have the same importance. The three theorems demonstrate that any two objects chosen at random are equally as similar to one another as are any other two objects, and are equally dissimilar to each other as any other pair, insofar as the number of shared (or unshared) predicates is regarded as a measure of similarity (or dissimilarity).[6] If we turn this conclusion around, we find that to the extent that we can and do perceive similarities and take note of dissimilarities between objects, we attach a non-uniform importance to various predicates, and that hence the way in which we can and do perceive in this fashion cannot be reduced to a formal, quantitative set of programmable rules. Of course we can instruct a computer to process or pay attention only to data of a certain form, and in so doing constrain the handling of information so as to reflect a prior judgment we have made concerning salience of information. In pattern recognition, it is just this judgment concerning salience that is in question, however. We are able to instruct a computer to detect objects or patterns it is specifically programmed to detect, but we are unable to instruct a computer to identify context-relative appropriate patterns the specific properties of which are not formally represented beforehand. Elementary pattern recognition exercises in any text treating the psychology of human perception are of just this latter variety.[7]

To summarize, we have come to see ambiguity as serving, on the one hand, the interests of human communication, insofar as communication wholly free of ambiguity is impossible. On the other hand, we have recognized that the contextual relativity of meaning, reference, and identification brings with it an element of ambiguity which appears to constitute a serious obstacle to complete simulation of human comprehension, pattern recognition, and general problem-solving capabilities. A total disregard of these results in favor of algorithmic standards of rigor in the admissibility of reasoning will, in the final analysis, be self-defeating.

Notwithstanding this conclusion, a word of caution is in order: Ambiguity, like any fundamental concept of utility, can be misused. The argument developed here serves neither the interests of obscure and confused thought, nor does it suggest that such thought is basic either to effective human communication or to characteristic – and at present unique – human capabilities.

Redundancy

We normally are inclined to associate lack of clarity with both ambiguity and redundancy. A message may serve or fail to serve the interests of communication if it is suitably or excessively ambiguous, as we have observed. Similarly, a message which is excessively redundant in the sense of being repetitious will tend to be comparatively uninformative. As confusion due to excessive ambiguity is probably to be avoided, so redundancy in the sense of mere repetition often is unproductive. It is of course occasionally useful to encourage some degree of redundancy to insure that a message is actually communicated, and it is in this sense that teachers are familiar with the notion that repetition brings learning.

But redundancy has a much more basic role than this. Let us accept a very general view of redundancy according to which whatever is not actually an essential part of a message is redundant, or else irrelevant. In this sense, redundancy occurs in most communication: Redundancy appears in sentences in that often whole words can be omitted without loss of meaning; it appears in written words in that, for example, vowels frequently can be omitted without loss of intelligibility: e.g., Ths sttmnt cn stll b rd wth lttl dffclty. Redundancy even appears in individual letters, e.g., redundancy exists even in letters of the alphabet. The redundant element in messages, comprising what is extraneous to message-content, makes up much of the messages we exchange when we communicate.[8]

There is good reason for this. It is well known that the amount of information we can transmit depends on the amount of distortion that corrupts the intended message between speaker and hearer, between transmitter and receiver. There is always this possibility of distortion due to what communications experts call 'signal interference'. Usually, they are likely to consider only signal interference which occurs as a result of "noise" that distorts a signal, i.e., a message, during its transmission to a receiver. The receiver, however, whether an apparatus or a human subject, is also a potential source for message distortion. A common way in which messages come to be distorted is through the very human capacity for misunderstanding. It is here – in connection with the need not only to make communication possible, but to insure that what has been understood was what was intended – that redundancy has an undeniable significance.

It is of course possible to communicate by means of a code or language from which all redundancy has been eliminated, leaving only a system for encoding what is strictly essential to the content of intended messages. If one were to do this, however, it becomes extremely difficult – in fact, impossible – to be certain that any message received was the message intended. For if I receive a message which I believe may have been distorted, either during its actual transmission to me, or given ways in which I may have misunderstood it, then in order to check the accuracy of the message received, I should need in turn to transmit a message of inquiry to the transmitter. But here, too, further message distortion may occur, and so we are left with the sceptic's uncertainty that he has ever understood what another has intended. If one agrees to grant the possibility of indeterminacy in message distortion, and wishes to employ a language purified of all redundancy, then effective communication will stop.

It is difficult to make what I am talking about evident without a specific illustration. Whether the illustration will allay the doubts of the sceptic is debatable, since any reasoning is at least potentially fallible, and this is perhaps a world without absolute guarantees that can withstand even pathological doubt. But the illustration does, I believe, make the point I intend beyond all reasonable doubt.

Suppose that we wish to communicate a message that consists, for the sake of simplicity, of four items of information. If each item of information is encoded in a binary digit (a "bit"), perhaps representing yes-no decisions to be taken by the receiver, then the message will be made up of four binary digits (representing, for example, the sequence 1001). A clock will control the time-spacing between bits. During a pulse interval, a pulse is generated if the intended message bit is a 1, while no pulse is generated when the intended bit is a 0. Noise during the transmission, or reception, of the sequence of pulses may result in distortion and, hence, in uncertainty whether the received message, representing a sequence of yes-no decisions to be taken, is correct. Perhaps the last bit in the message was received as a pulse too weak to be a 1, but yet insufficiently strong to qualify as a 1. Is the last bit to be interpreted as a 1 or a 0?

An insightful way to encode the information so that errors resulting from signal interference can be detected and corrected, has been suggested by R. W. Hamming[9] and is now useful in telemetry and communications theory. Hamming's idea relies upon the use of redundancy to check the accuracy of communicated messages, and for this reason furnishes an excellent illustration in the present context. The following discussion is a simplified representation of Hamming's ingenious idea.[10]

In Figure 1, note that there are eight distinct regions. We will associate with each one the binary equivalents of the decimal numbers, 0–7. The eight numbers are:

decimal number	*binary number*
0	000
1	001
2	010

3	011
4	100
5	101
6	110
7	111

Region IV, the outermost region, will be called 000; III will be called 001; II, 010; and I, 100; the overlap regions are numbered as shown in Figure 1. The rationale for this labelling procedure will become clear shortly.

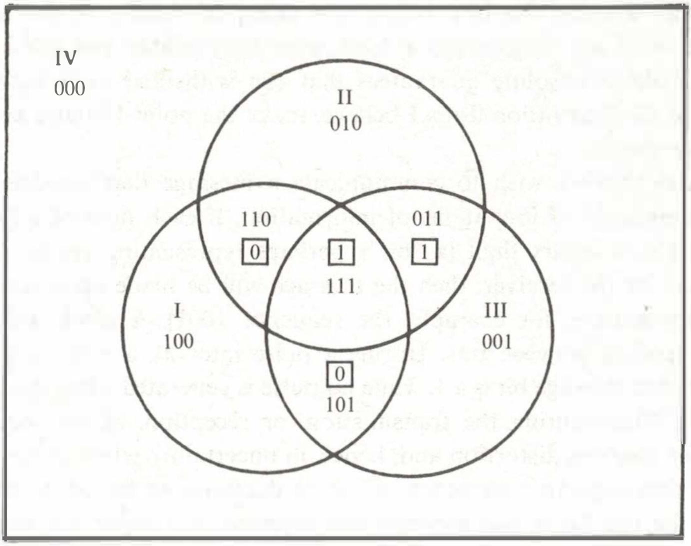


Figure 1

Now, by agreement between the transmitter and receiver[11] of Hamming-encoded messages, a message will consist of four bits, as already indicated, plus three bits to be called 'redundancy code bits' (rcb's for short). They will occupy the following positions in a transmitted message:

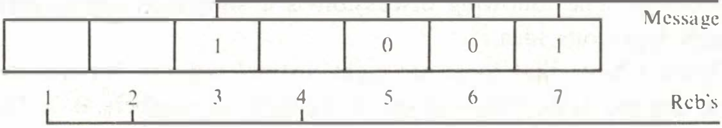


Figure 2

The redundancy code bits are then determined by the transmitter in the following manner, in relation to his intended message: First, the binary digits representing the transmitter's intended message are inserted in the four corresponding positions in Figure 1. Since the first bit of the message (a 1) occupies position number 3 in the total seven-digit message, a 1 is placed in the diagram in the region labelled with the binary equivalent of 3(011). The second bit of the message (a 0) occupies position number 5 in the seven digit message, and so is placed in region 101. The third and fourth bits making up the message are treated in the same way. The numbers enclosed in squares in Figure 1 now represent the transmitter's intended message.

The redundancy code bits can now be determined using the resulting diagram. From the standpoint of each of regions I–III, there are three adjacent overlap regions: For example, from the standpoint of region III, there are three adjacent overlap regions labelled 011, 101, and 111. We see that these overlap regions (there are four of them all told) contain the message bits. What is known as a "parity check" is used to determine the rcb's: The transmitter selects a binary digit as an rcb which, when added to the three message bits appearing in adjacent overlap regions, gives an even sum. From the standpoint of region III, the three message bits in adjacent overlap regions are 1, 1, and 0, which when added together themselves result in an even number: the corresponding rcb to be inserted in region III must therefore be a 0. (A 1 would lead to an odd sum.) The three rcb's to be inserted in regions III, II, and I are, then, a 0, a 0, and a 1. Since these rcb's now label regions whose decimal number equivalents are 1, 2, and 4, the three rcb's are inserted in these positions in the seven-digit message, which now looks like this:

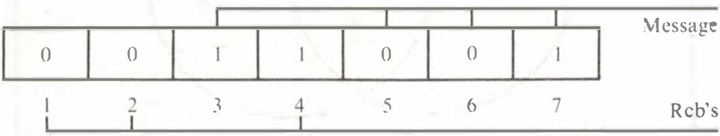


Figure 3

Now, let us assume that, having done this, the transmitter sends the complete message, but during its transmission, or reception, signal interference is responsible for a distortion in the message received. (The interference is assumed to be capable of distorting any *single* bit of the seven-bit pulse train received,[12] and the receiver will be informed neither whether the received pulse train is correct or incorrect, nor, of course, if it is incorrect, which bit is the incorrect one.)

Suppose that the receiver receives a pulse train interpreted as: 0011000. He wishes to check the received message, which is 1000. He inserts all seven digits in appropriate positions in a blank diagram (see Figure 4), and then conducts a parity check.

For each region, I, II, and III, in which a parity check obtains (the sum of the bits is an even number), he will write down a 0; if a parity check fails, he writes down a 1; as follows:

for region:	I	II	III
parity check:	1	1	1

= binary number of position of error

The resulting binary number, 111, is the binary equivalent of the decimal number 7: Hence, there is an error in position 7, and the received message should be changed in this position. After this correction, a parity check will yield 000, signifying the message is error-free.

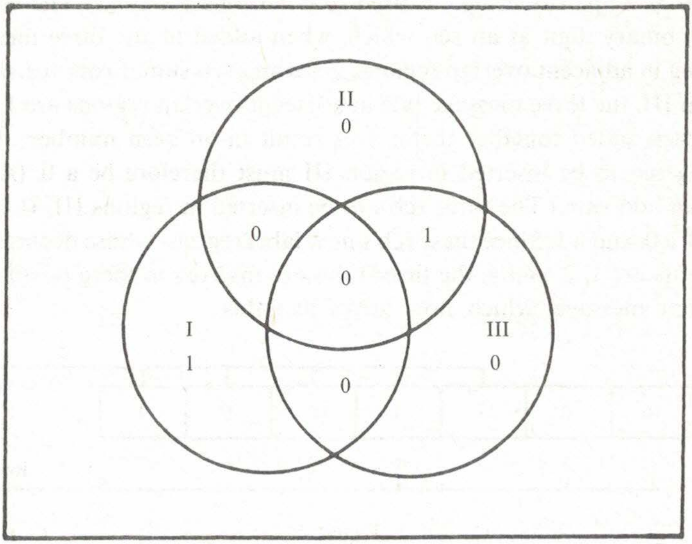


Figure 4

The reader may verify for himself that, no matter where an error is made — in the message-bits or in the redundancy code bits — the Hamming code, through its reliance on redundancy, insures that the message received is equivalent to the message transmitted.

The moral of this rather difficult illustration is two-sided: The first side is this: As long as individuals (or machines) are capable, for whatever reasons, of misunderstanding one another, effective communication necessitates reliance on redundancy. The second side is that a redundancy-free system of communication is intrinsically vulnerable to errors which may go undetected and, in the extreme case, will be undetectable when the distortion of messages becomes a matter of total uncertainty.

Conclusion

To the extent that philosophy has been encouraged by the formal, machine paradigm to favor the values of clarity, and has been inspired to deal intolerantly with obscure and confused thinking, I believe its motivation has probably been sound and good. However, it has been thought that to the extent that one wishes to oppose obscurity and confusion, one ought thereby to oppose ambiguity and redundancy. Sometimes, this judgment will in fact be dictated, when ambiguity and redundancy become excessive. But it would be an unfortunate mistake to suppose that a strict elimination of ambiguity and redundancy ought to be a sanctioned, fashionable objective, for it if were achieved, we would be incapable, on the one hand, of thought and communication, and, on the other, of determining that what we think and say makes sense, has reference, and constitutes genuine understanding.

NOTES

1 The technical distinction between sense and reference, since it is itself a source of much ambiguity and difference of opinion, is not followed here. It should not be taken, however, that meaning and reference are therefore here presumed equivalent. For our purposes here, the examples provided in the text should make the discussion sufficiently clear.

2 A second source of indeterminacy, related to ambiguity, is vagueness. Vagueness is probably synonymous with indeterminacy of application: e.g., 'love' is a vague word, since there are doubtless cases where it is not clear whether we should withhold or apply the word, while the meaning of 'love' need not for that reason be ambiguous. I make no attempt here to discuss indeterminacy arising from vagueness. (On vagueness, see, for example, W.P. Alston, *Philosophy of Language*, Prentice-Hall, Englewood Cliffs, N.Y. 1964, Chapter V.)

3 B. Russell, "The Philosophy of Logical Atomism", in: (ed.) R.C. Marsh, *Logic and Knowledge*, George Allen and Unwin, London 1956, § II.

4 It should be made clear to the reader that reference is of course intended to limitations associated with the programming of digital computers: at present, the question concerning limitations in the use of analogue devices is open, but may be ignored here since the formal, machine paradigm has so far been interpreted almost exclusively in the (better understood) digital sense.

A review of the extensive literature which supports the conclusion described in the text would occupy us too long for purposes here. Attention can be directed to the following works which may serve as entrances to the continuing discussion of problems in this area: Y. Bar-Hillel, "The Present Status of Automatic Translation of Languages", in: (ed.) F.L. Alt, *Advances in Computers*, Academic Press, New York 1964, vol. I.; H.J. Bremermann, "Optimization Through Evolution and Recombination", in: (ed.) M.C. Yovits, *Self-Organising Systems*, Pergamon, New York 1959; A.D. de Groot, *Thought and Choice in Chess*, Mouton, The Hague 1965, "Perception and Memory versus Thought: Some Old Ideas and Recent Findings", in: (ed.) B. Kleinmuntz, *Problem Solving – Research, Method, and Theory*, Wiley, New York 1966; H.L. Dreyfus, *What Computers Can't Do: A Critique of Artficial Intelligence*, Harper and Row, New York 1972; M. M. Eden, "Other Pattern Recognition Problems and Some Generalization", in: (eds.) B. Kolers, M. Eden, *Recognizing Patterns: Studies in Living and Automatic Systems*, MIT Press, Cambridge, Mass. 1968; A. Newell, H.A. Simon, *Human Problem Solving*, Prentice Hall, New Jersey 1972; (eds.) K.M. Sayre, J. Crosson, *The Model ing of Mind*, Notre Dame University Press, South Bend, Ind. 1962; S. Watanabe, *Knowing and Guessing. A Quantitative Study of Inference and Information*, John Wiley, New York 1969; J. Weizenbaum, "Contextual Understanding in Computers", in: (eds.) B. Kolers, M. Eden, op. cit.

5 S. Watanabe, op. cit.

6 Russell may perhaps have foreseen the difficulties which Watanabe's result makes explicit. Russell remarked: "If it is to be unambiguous whether two appearances belong to the same thing or not, there must be only one way of grouping appearances so that the resulting things obey the laws of physics. It would be very difficult to prove that this is the case..." (B. Russell, *Our Knowledge of the External World as a Field for Scientific Method in Philosophy*, George Allen and Unwin, London 1972, p. 115.)

7 For example, N.R. Hanson (*Patterns of Discovery. An Inquiry into the Conceptual Foundations of Science*, Cambridge University Press, Cambridge 1975) includes several such exercises.

8 See M.F. Rubinstein, *Patterns of Problem Solving*, Prentice Hall, New Jersey 1975, §§ 2-16, 2-17.

9 R.W. Hamming, "Error Detecting and Error Correcting Codes", *Bell System Technological Journal*, vol. 29, 1950.

10 I am indebted to Prof. Moshe F. Rubinstein, Engineering Systems Department, University of California, Los Angeles, for both the example and his suggested use of Venn diagrams in this representation. See M.F. Rubinstein, op. cit., § 2-17.

11 It is with respect to the possibility of reaching such arrangement (and knowing agreement has been reached) that the communications sceptic is likely to raise his doubt. Effective arguments against the rationality of such doubt can perhaps be developed; my intention here is not, however, to enter into an analysis of this or any other variety of scepticism.

12 The problem becomes increasingly more complex if more than a *single* error is to be detected and corrected.

Continued on next page

SELECTED PUBLICATIONS
BY THE AUTHOR

A freely downloadable collection of publications by the author, including many of the publications listed here, is available from the university research website: http://www.willamette.edu/~sbartlet.

Readers of this paper, may be interested in a related monograph, which discusses Watanabe's work in greater detail:

> ***The Species Problem and its Logic: Inescapable Ambiguity and Framework-relativity.*** (Research monograph, 2015). Available from arXiv.org (http://arxiv.org/abs/1510.01589), in England from CogPrints (http://cogprints.org/9956/), in France from the Centre pour la Communication Scientifique Directe's HAL (https://hal.archives-ouvertes.fr/hal-01196519), and in the U.S. from PhilSci (http://philsci-archive.pitt.edu/11655/).

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2. *Metalogic of Reference: A Study in the Foundations of Possibility*, Max-Planck-Gesellschaft, 1975. A research monograph that formulates the author's approach to epistemology through the use of self-referential argumentation and self-validating proofs.
3. *Conceptual Therapy: An Introduction to Framework-relative Epistemology*, Studies in Theory and Behavior, Saint Louis, 1983. An introductory text that gives students applied exercises in thinking using the author's approach to epistemology in terms of self-referential argumentation and self-validating proofs.
4. *Self-Reference: Reflections on Reflexivity*, edited with Peter Suber, Martinus Nijhoff, 1987; now published by Springer Science. The first of two collections (see #4 below), consisting of invited papers by leading contemporary authors, to be published in the new area of research, the general theory of reflexivity, pioneered by the author.

5. *Reflexivity: A Source Book in Self-Reference*, Elsevier Science Publishers, 1992. The second collection, consisting of classical papers by leading contributors of the twentieth century, published in the new area of research, the general theory of reflexivity.

6. *The Pathology of Man: A Study of Human Evil,* published in 2005 by behavioral science publisher Charles C. Thomas, is the first comprehensive scholarly study of the psychology and epistemology of human aggression and destructiveness. The study includes original research by the author, such as a detailed description of the phenomenology of hatred and the psychology of human stupidity, and an extension and elaboration of the author's earlier published work dealing with the epistemology of human thought disorders (Part III).

7. *Normality Does Not Equal Mental Health: The Need to Look Elsewhere for Standards of Good Psychological Health*. Praeger, 2011. The first book-length scholarly critique of the widespread and unexamined presumption that psychological normality should be employed as a standard for good mental health. Contains some discussion related to framework-relativity.

8. *Horizons of Possibility and Meaning: The Metalogic of Reference*. Book in progress.

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11. "Philosophy as Conceptual Therapy," Educational Resources Information Center, National Institute of Education, Department of Health, Education, and Welfare, May, 1983, Document #ED 224 402.

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13. "Roots of Human Resistance to Animal Rights: Psychological and Conceptual Blocks," *Animal Law* (law review of the Northwestern School of Law, Lewis and Clark College), Vol. 8, 2002, pp. 143-76. The first comprehensive legal study of the psychological and epistemological foundations of human resistance to the compassionate treatment of animals. Contains an application of the author's self-referential argumentation to human conceptual blocks that stand in the way of the recognition of animal rights.

14. "Roots of Human Resistance to Animal Rights: Psychological and Conceptual Blocks," electronically re-published October, 2002, by the Michigan State University's Detroit College of Law, Animal Law Web Center, and maintained on an ongoing basis.

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