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Imprecision

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***A*bstract**: This paper surveys the various modes of imprecision and seeks to clarify the concept of imprecision, to account for the pervasiveness of the phenomena, and to explain why we have to come to terms with it throughout our cognitive affairs.

The structure of these deliberations will be as follows: Having set the stage for considering imprecision (in section 1), it will briefly elaborate upon each of them (in section 2). Next comes a discussion of two of the main ramifications of imprecision, namely vagueness (section 3) and oversimplification (section 4). There follows (in section 5) a consideration of why imprecision is inevitable in our cognitive dealings, and why this feature of investigation actually admits of an evolutionary explanation. The paper concludes (in section 6) with a retrospective glance at the overall situation from a philosophical point of view. Overall, the discussion is of an analytical cast, seeking to clarify the conceptual nature and operational bearing of imprecision within the cognitive scheme of things.

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JEL Classifications: A100, A120, B400, B500

1. Introduction

Precision and detail are widely accepted as key desiderata for inquiry. But often these virtues are not achievable to the desired extent, and in consequence, the prospect, and indeed the reality of imprecision extends its reach across the entire range of our thought and discourse. Alike in theory and practice, and in the physical and human sciences, the factors of precision/imprecision plays a crucial role. And this factor of precision/imprecision takes many forms and has many versions.[1]

Among the modes of diminished detail, five are particularly prominent:

Quantitative imprecision. When we characterize someone as a short man or a tall woman we do not thereby give any indication of just how old or just how tall.

Descriptive imprecision. When we say that something is blue in color or oval in shape we do provide useful descriptive information but of a rather vague and indefinite sort. We are undeniably inexact about the matter.

[1] Precision and detail is inherently different from accuracy and correctness. An incorrect assessment can be very precise—and conversely. An evaluation that is both precise and accurate is said to be *valid*.

Classifactory imprecision. When we call something a chair or a knife we remain very indefinite on the matter. One cannot say whether (say) it is a bread knife or a steak knife or a fruit knife that is at issue.

Locational imprecision. When we say that one thing is near another or one place distant from another, we do not indicate anything about the extent to which this is so.

Relational imprecision. In saying that lions are carnivores we need not claim that this is so always and necessarily or only obtains ordinary and normally.

Scholars have used the term precision to indicate the exclusion of irrelevant possibilities since medieval times.[2] And some among Renaissance neo-scholastics held that a precise knowledge of reality was beyond the reach of finite intelligences: *nostrum cognitionum nulla sane praecisa est*,[3] an idea which was a central theme in the *De docta ignorantia* of Nicholas of Cusa. And yet among our contemporaries the issue has fallen on hard days, generally ignored throughout the contemporary theory of scientific knowledge. Notwithstanding the evident importance of the topic surprisingly little attention has been directed to it. The search for terms like "precision," "exactness," "detail," and the cognates in standard works of reference such as *The Stanford Encyclopedia of Philosophy* of the *Encyclopedia of the Social Sciences* meets with resounding silence.

It is a "fact of life" that information on virtually any theme or topic can be conveyed in more or less precision and detail.[4]And this clearly has extensive ramifications and indications for the nature of human cognition. In consequence, the issue of precision/imprecision deserves to constitute one of the central topics of the rational economy of knowledge. It represents a theme that ties together a varied set of key issues: approximation in measurement, puzzles of evaluation, paradoxes in logic, vagueness in language, and much else.

2. Major Modes of Imprecision

For very large N the value of $1/N$ becomes approximately zero, and with increasing N we can bring it as close to zero as ever we please—no holds barred. In the limit it comes to zero. But be N however large in the end this quality will always stand off at a distance from zero with its bearing that of an approximation.

Such a quantitative version of imprecision is perhaps its most familiar form. Most of the quantities that concern us in everyday life are imprecise. People may well know their weight to within a few pounds, but it is questionable whether the idea of "someone's weight to within a milligram" even makes sense. And the same is true of such quantities as:

- The distance between two cities to within a foot
- The age of a person to within a millisecond
- The height of a giraffe to within a millimeter
- The value of a piece of property to within a dollar

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[2] See the article "Praecisio: in Joachim Ritter and Karlfried Gründen (eds.), *Historisches Wörterbuch der Philosophie*, Vol. 7 (Basel: Schwabe & Co, 1989), pp. 1211-18.

[3] Ibid. p, 1215.

[4] On matters of precision/imprecision in relation to measurement see J. R. Taylor, *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements* (Sausalito, Calif.: University Science Books, 1997).

All such quantities are by nature approximate and inexact: Not only is precision not attainable here, it is questionable whether it is even meaningful. Yet such qualities, although figuring importantly in everyday-life matters, are nevertheless such that with them the demand of absolute precision leads not to greater clarity and illumination, but rather into an ultimately imperceptible fog of unknowing.

Theoretical quantities—the value of pi, say, or of the square root of two—can be exfoliated ongoingly to endless decimal places. But the quantitative features of most of the spatio-temporal reals that lie within the range of our experience will by this very circumstance have to remain imperfectly precise. Were matters otherwise, we would never be in the positon to make claims about the overall basis of what we can practicably determine. And this it is so obvious to us that this is so that terms like "roughly," "approximately," "more or less," etc. are unnecessary qualifications because their presence is taken for granted as an evident fact. And it would be counter-productive to insist that proper quantities must necessarily be exact, because then most of what we deal with under this nomenclature would simply have to be recast under the rubric of quasi-quantities. Whenever the equations governing the phenomena that concern us are such that very small variation in the input parameters can make for substantial variation in the resulting output, then of course precision is of the essence.

The classic illustration of descriptive imprecision is color. For us, snow is white whereas the artic Inuits purportedly have dozens of terms of the appearance of snow. For laymen someone is simply an insurance agent, while for economists he falls into a wide variety of specialists dealing in life, fire, heath, maritime, travel, etc. insurance. The layman's wine descriptions run to white and red; current or vintage; while wine aficionado's elaborate this into many dozen categories.

A description is vague insofar as its application in given cases is unclear. Are airships ships? Are whales fish? Are tomatoes fruit? Are witch-doctors doctors? Uncertainty in application is the hallmark of impression.

Descriptive imprecision arises from the fact that the language we are invariably given to oversimplifying the variability of the world's arrangements—that language provides merely limited measures to deal with matters that are of limitless variability.

Our everyday terminology is invariably generic and inexact in conveying a wide spectrum of more precise possibilities. And this, of course creates problems. Thus with wines, what of rosé—where does white leave off and red begin. With insurance just how many subcategories can qualify? Does the company that guarantees your car's engine function as an insurer or not? Many legal issues revolve around such subtleties.

Not only does virtually every type have multiple subtypes, but it is often unclear and indeterminate whether a possible-constructive subtype is actually so. Where do shrubs leave off and trees begin? Which early humanoids actually qualify as humans? Where does blue start and green begin? The inherent imprecision of the key turns of these questions make them ultimately unanswerable with exactitude.

Just as is the case with descriptions classifications too are almost always imprecise. For most classifications have sub-classifications so that the question "Of what kind?" or "Of that sort?" will repeatedly arise, with further detail and precision thereby required. With dogs we can ask "Of what species", with buildings we can ask "Of what sort?" And as such questions are answered, further ones will arise.

And even if no absolutely lowest species can be found so that the question "Of what kind?" become problematic, nevertheless further descriptive detail can always be demanded to identify an

item and distinguish it from its infimum species congeners. For even items that are classifactorily identical will be descriptively distinguishable from others.[5]

An imprecise boundary exists whenever it is not possible to specify with complete exactitude just where the transition from IN and OUT is located. In evolution the boundary between pre-human humanoids and homo sapiens is of this nature. In the color spectrum the boundary between blue and green is also imprecise. And this itself is not a matter of surgically neat separation. For when the boundary between IN and QUESTIONABLE (and that between the latter and OUT) can be fixed exactly. With these boundaries themselves we have an instant replay of the original division problem. And this, in effect, is bound to continue ad infinitum. There is no precision to imprecision, no exactness to inexactness.

Still we unhesitatingly say that when you cross the threshold of a room you are out "up to a certain point" and in thereafter. But of course no-one can specify just where that point is: precise exactitude cannot be achieved. And this is all to the good. For in such situations exactitude just does not matter. You are on the witness stand and the prosecutor asks you "When did the accused enter the room?" His witness responds: "At about 3:15" or "Somewhere between 3:10 and 3:20." And this response is sufficiently informative. In managing life's affairs, precision often does not matter—and when it does so it is all too often unachievable.

In many contexts the law imposes for the sake of administrative practicability an arbitrary precision for which nature provides no sensible warrant. When is a young person old enough to act responsibly in matters of contract-making, marriage, drinking alcohol, voting, etc.? Some are there by the age of 15, others have yet to arrive at 30. But the law picks a convenient number, and imposes an arbitrary precision on parameters that Nature fears to touch.

Two approaches are available here:

(1) "With this inexact boundaries there indeed is an exact transition point *Q* but we cannot possibly find it out."

(2) "With these inexact boundaries there just is no exact transition point *Q* and we just have to make do with something that is inherently imprecise and should be seen as viable surrogate for something that is strictly speaking nonexistent."

From the standpoint of (2), (1) would constitute a fallacy of improper reification—what Immanuel Kant called an "illicit hypothetization."

What we have here are two decidedly different approaches. The latter mode of transition point rejection is ontological: those so-called points are inexistent and illusionary—a sort of cognitive mirage invoked to make sense of a larger picture. (Akin to the *focus imaginarius* of a representational painting.) The former approach, by contrast, sees the transition point as real but inherently unspecifiable. For some facts are by nature unknowable. Nobody can identify the smallest integer that will never be specifically and divisibly referred to. No one can specify an ancient Etruscan who has been altogether forgotten. There is a crucial difference between:

(1) *The description D is known to have no application whatsoever*: $K{\sim}(\exists x)\, Dx$. (For example, "the largest prime.")

[5] What is at issue here is the classic "Principles of the Identity of Indiscernibles."

(2) *The description D has no known application*: *there is nothing of which we know that it answers to D* ~(∃*x*) *KDx*. (For example, "the largest integer that anyone on earth will ever specifically and individually discuss.")

These statements make very different sorts of claims, and there will be many cases where (2) is true, but (1) is not. An example is provided by the description "a fact that is known to no-one," for while there clearly are facts that no finite being knows, yet we cannot possibly identify any of them. Thus consider such items as:

I1 an idea that has never occurred to anybody

I2 an occurrence that no one ever mentions

I3 a person who has passed into total oblivion

I4 a never-formulated questions

I5 an idea on one any longer mentions

I6 a never-stated contention (truth, theory, etc.)

I7 a never-mentioned topic (idea, object, etc.)

I8 a truth (a fact) no one has ever realized (learned, stated)

I9 someone whom everyone has forgotten

I10 a never-identified culprit

I11 an issue on one has thought about since the 16th century

Yet while there undoubtedly are such items, they of course cannot possibly be specifically instantiated.

Such predicates are "vagrant" in the sense of *having no known address of fixed abode*. Though they indeed have applications, these cannot be specifically instanced—they cannot be pinned own and located in a particular spot. Accordingly,

F is a *vagrant* predicated if (∃*u*)*Fu* is true while nevertheless Fu_0 is false for every specifically identified u_0.

And so the idea of items that exists but are inherently unspecifiable as per these (2) above can certainly not be rejected out of hand.[6] It is simply not the case that whenever something demonstrably exists that this item can be specifically and individually identified.

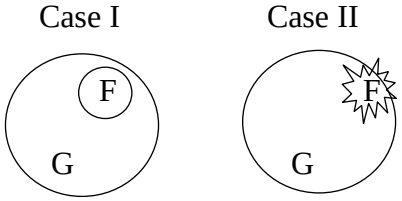
Not only can particular statements about specific items be imprecise bur generalizations can also be so. For vague terms and indefinite categories open the door to qualified generalizations.

Consider the situation of Display 1. In the sharp-boundary situation of Case I we clearly have it that "All *F* are *G*'s" But in the indefinite-boundary situation of Case II some of the *F*s may or may not be *G*s. All we can say here is that "In general [usually, almost always standardly, normally] the *F*s are *G*s." Rather than a strictly universal generalization we here have one that is merely standardistic or normalistic. And such generalizations are not strictly universal but only normatively general; they admit the prospect of exceptions. They tell us how things are usually, normally, ordinarily, as a rule, standardly, other things equal, *ceteris paribus*.

[6] On this issue of vagrant predicates see the author's *Epistemetrics* (Cambridge: Cambridge University Press, 2006), pp. 87-92.

When true, such generalizations are not strictly universal laws but only quasi-laws. Their explanatory power is real but limited. They admit exceptions, which can—and generally will be—accounted for on the basis of the underlying processes at work.

Display 1. Modes of Imprecision



A science whose explanatory proceedings resorts to such as-a-side quasi-laws is not an exact science but an inexact one. Its generalizations will feature the sort of *ceters paribus* character typical of the social sciences. (Consider, for example, such generalizations as "Price increases lead to diminished sales" or "People react angrily to insults."[7]) Such generalizations lack Immanuel Kant's strict universality and necessity, but admit the more relaxed standard of the ordinary and usual course of things.[8]

3. Paradoxes of Vagueness

Imprecision has important ramifications for logic and the theory of language. Perhaps the most striking of these are manifested in the traditional "Paradoxes of Imprecision," whose paradigm instances stems from classical antiquity. Foremost among them is the "Paradox of the Heap"— the *Sorites Paradox* (from the Greek *sôros* = heap)— is posed in the following account:

A single grain of sand is certainly not a heap. Nor is the addition of a single grain of sand enough to transform a non-heap into a heap: when we have a collection of grains of sand that is not a heap, then adding but one single grain will not create a heap. And so by adding successive grains, moving from 1 to 2 to 3 and so on, we will *never* arrive at a heap. And yet we know full well that a

[7] The ideas of standardistic quasi-laws what introduced in Olaf Helmer and Nicholas Rescher. "On the Epistemology of the Inexact Science." *Management Sciences*, vol. 6(1) (1959), pp. 25-52. Reused in 1960 as Project RAND memorandum R0353 (Santa Monica: The RAND Corporation, February 1960). Reprinted in *Executive Readings in Management Science*, ed. by M. K. Starr; New York (Macmillan), 1965. Also reprinted in *The Nature and Scope of Social Science*, ed. by Leonard I. Krimerman; New York (Appleton-Century-Crofts), 1969; and in Olaf Helmer, *Looking Forward: A Guide to Futures Research* (Beverly Hills; 1983), pp. 25-48.

[8] The explanatory principles of Aristotelian science contemplated generalizations that were not true invariably, but only held in general and "for the most part". On the issues of this section see the author's *Philosophical Standardism* (Pittsburgh, PA: University of Pittsburgh Press, 1994).

collection of 1,000,000 grains of sand is a heap, even if not an enormous one.[9]

A near cousin to this paradox is the ancient Ship of Theseus Paradox, based on the tale of the ship which was ongoingly repaired, with defective planks ongoingly replaced by others until there was not a sliver of the original left. It is claimed that at the end of the process we are not longer dealing with the same ship, seeing that no bit of material remains to betoken this sameness. And yet it seems that we cannot but grant that when a single plank is replaced in a large vessel that ship remains the same. So just how and just when did that ship leave off being the same one with which we began?

A closely analogous paradox is the story of Sir John Cutler's hard-used Stockings. Over time they were repaired bit by bit until not a thread of the original was left and finally not a bit of the original remained. At the start there was the original pair but at the end something altogether different. But there seems to be no immediate point when a change-over can be pin-pointed.

Moreover, consider the situation of what might be called the *Color-Continuum Paradox*. We lay out a long row of color patches: say 100 of them. Any two adjacent ones are colorwise indistinguishable to the unaided eye. But gradually and imperceptibly we shift over to quite a different color by the time we get to the end of the series. We thus arrive at the aporetic cluster represented by the following four theses:

(1) Patches whose color is visually indistinguishable (to a normal observer in normal circumstances) have the same color.

(2) Patches [1] and [2] are colorwise visually indistinguishable, as are patches [2] and [3], and so on up to patches [99] and [100].

(3) Hence—all these patches have the same color (by (1)).

(4) Nevertheless, patches [1] and [100] are clearly seen to have patently different colors.

Taken together, these thesis are logically inconsistent. But (2) and (4) are straightforward facts, and (3) follows from (2) by (1). Accordingly, it is the more suppositional (1) that must be abandoned seeing that we have to distinguish between an item's *phenomenal* color at issue in the antecedent of (1) and its *measurable* color at issue in the consequent. Color identity is something more complex than what can be settled by visual means alone.

However, we would again presumably not wish to abandon (1) altogether—and there is no need to do so. But would have to demote it from the realm of the rigidly universal to that of the merely general. This would provide for its continued availability in other deliberations despite its contextual untenability in the present case.

And herein lies a larger lesson. All such paradoxes pivot on invoking a universal premises of the format:

$$\{G\} \quad (\forall x)\ (\text{whenever } Fx, \text{ then } Gx)$$

[9] On this paradox and its ramifications see Chapter 2 of R. M. Sainsbury, *Paradoxes* (2nd. ed., Cambridge: Cambridge University Press, 1995), pp. 23-51. Originally the paradox also had a somewhat different form, as follows: Clearly 1 is a small number. And if n is a small number so is $n + 1$. But by interation this leads straightway to having to say that an obviously large number (say a zillion billion) is a small number. (See Prantl, *Geschichte der Logik*, Vol. I, [Leipzig, S. Hirzel, 1855], p. 54.)

In particular those cited paradoxes pivot on claims on the order of

- ($\forall n$) (whenever n grains do not constitute a heap, then $n + 1$ grains will not do so.)
- ($\forall n$) (whenever a group of n planks make up a certain ship, then the group that replaces just one of them and leaves the remaining $n - 1$ planks in place does so as well [i. e., makes up the self-same ship].)
- ($\forall n$) (whenever a complex of n threads make up a certain stocking, then the complex with one single replacement (the other $n - 1$ threads remaining the same does so as well [i.e., makes up the selfsame stocking].)

But just here lies the key that unlocks the paradox. For the existence of vague terms compels recognition that there are two very different sorts of generalizations, viz. those that are strictly universal and subject to the traditional $\forall$-quantifier of absolute universality, and those that are only standardistically general and subject to the limited $\forall$*-quantifiers of qualified generality.[10] All of those aforementioned paradoxes of vagueness become dissolved once it is acknowledged that they commit a Fallacy of Overgeneralization in taking that what is normally and standardly the case to be so universally and without exception.

4. Oversimplification

Imprecision is correlative with oversimplification. For imprecision overlooks detail and the lack of attention to detail is exactly what constitutes oversimplification.

Oversimplification always leads to errors of omission. It occurs whenever someone ignores features of an item that bear upon a correct understanding of its nature. However, this is not the end of the matter. For such errors of omission all too readily carry errors of commission in their wake. An oversimplified script may make it difficult to distinguish between *q* and *g* and thereby invite the confusion of quest and guest. The oversimple counting system of one-two-three-many opens wide the door to misjudgment about quantities.

However, some oversimplification is inevitable for limited intelligences seeking to come to grips cognitively with an endlessly complex world. For the totality of facts about a thing—about any real thing whatever—is in principle inexhaustible and the complexity of real things is in consequence descriptively unfathomable. The botanist, herbiculturist, landscape gardener, farmer, painter, and real estate appraiser will operate from different cognitive "points of view" in describing one selfsame vegetable garden. And there is in principle no theoretical limit to the lines of consideration available to provide descriptive perspectives upon a thing. The cardinal feature of reality is its inherent complexity. There are always bound to be more descriptive facts about actual things than we are able to capture with our linguistic machinery: the real encompasses more than we can manage to say about it: oversimplification regarding the world's arrangements is inevitable for us.

It is a sound methodological principle of rational economy to "Try the simplest solutions first" and then to make this result do as long as it can. For rationality enjoins us to operate on the basis of

[10] Traditionally, logicians dealt only with strictly universal and existential quantifications as per *all* and *some* and *none*. The idea of merely pluralistic qualification ("many," "most," "almost all," "exactly four," etc.) was introduced by the author in 1962. (For details one might ask any search engine under the rubric "Rescher quantifier.")

Occam's Razor—considerations are never to be introduced where they are not required: complexity is never to be provoked beyond necessity. Our theories must be minimalistic: they must fit the existing data tightly. And this means that as our data are amplified through new observations and experiments the previously prevailing theories will almost invariably become destabilized because those old theories oversimplified matters. New conditions call for new measures, new data for more complex theories. It lies in the rational economy of sensible inquiry that the history of science is an ongoing litany of over-simple old theories giving way to more sophisticated new ones that correct their oversimplification of the old. Imprecision has been the ongoing Leitmotiv of scientific progress.[11]

5. Why Tolerate Imprecision?

Being imprecise about a date may put a decision into the wrong administration and thereby give a wholly erroneous view of its policies. Being imprecise about the location may put one into the wrong jurisdiction and give incorrect indications regarding matters of legality. Imprecision leads to error.

The great benefit of imprecision is that it enable us to convey information much more readily. Consider the question of the height of a person. We can specify this to the nearest foot by mere inspection. To measure it to the nearest inch takes a bit of doing (and requires a yardstick or some such). To specify it to the nearest millimeter becomes something between difficult and impossible. And this situation is typical: A see-saw relationship obtains between infiniteness and detail. The greater the detail that is demanded the fewer questions we can answer conscientiously. Abandoning imprecision altogether would result in cognitive impoverishment.

Why then tolerate imprecision? Why not always and everywhere insist on exactitude—as lawyers are wont to do in drawing up contracts and agreements?

In the end, it makes good sense to accept imprecision whenever:

- We have no option because *greater detail is unavailable*. We are simply doing the best we can, making the best effort to accommodate order to a regrettable reality.

- We have no need for more because *greater detail does not matter*. We can solve our problems and answer our questions satisfactorily at a level of diminished detail.

- We cannot afford to do better because *greater detail would be too costly* and while it might indeed be available its realization would demand an unaffordable expenditure.

The unwelcome reality of it is that *precision compromises tenability*. The greater the precision of a claim, the more demanding the evidentiation for it becomes. That the weight of yon elephant is great is obvious, that it is roughly 2½ tons is determinable, its weight in ounces would take a great deal of doing. Establishing that yon leaf is green is obvious, that it is of lighter green than grass requires some effort, that it is exactly green #34 in a spectrum of 100 shades of green likely requires a lot of work.

[11] On issues regarding oversimplification see Chapter 6 of the author's *Cognitive Complications* (Lanham etc.: Lexington Books, 2015).

Precision is simply unachievable in certain matters. Illustrations of this phenomena have already been considered and it is simply impossible in the very nature of things to achieve absolute exactness with respect to matters of

- The height of a person
- The weight of an elephant
- The age of an inventor
- The location of a firefly

Specifications of this sort rest on factors that simply cannot be purported with precision.

Precision makes transformation transmittal cumbersome. The attempt to specify not precision such factors as

- The age of an invention
- The magnitude of a consideration
- The size of a crowd

is but to require endless qualifications and elaborations.

Precision is not needed in many informative situations. If someone threw a rock through the window, it is of no concern whether this was a chunk of sandstone or granite. If someone made a payment of $100 it matters little whether the bills were 10s or 20s. When someone is notified of having been chosen for jury duty it matters little whether this was done by post, or telegram, or special messenger. In all such matters details is pretty much irrelevant. Here, as in many or even most communicative situations, it is the just of the issue that alone matters.

Precision is not needed for most practical purposes. When I am considering whether or not to take my umbrella it matters not whether the forecast is for 1 inch of rain of 1½ inches. When I am considering going to the dentist, it matters little whether my toothache is sever or excruciating. In practical contexts of action and decision, precision need to be of concern beyond the needs of the immediate situation at hand.

In various sorts of situations, precision and accuracy (i.e., precise correspondence with reality) are simply not of the essence. Thus consider the Display 2 situation of two tic-tac-toe grids, set up to depict a certain hypothetical Realty and Appearance, respectively. (Here ? indicates indecision as between 0 and 1.)

The Appearance situation is certainly nowise a precise reflection or representation of Reality. (Agreement is provided for in only two out of the nine cases.) But let it be that what is in questions is the principle:

(*P*) Every 0 entry is adjacent to a 1 entry, and conversely.

Then the Appearance picture, gravely wrong though it is, provides the correct answer.

Even so simple an example conveys an important lesson: Whether or to what extent detail matters critically depends upon just exactly what the issue under consideration happens to be.

Display 2. A Contrast Illustration

Reality

1	0	1
0	1	0
1	0	1

Appearance

0	0	0
1	1	1
0	?	0

Precision is not a free good: Achieving exactness and enhancing precision is not a cost-free enterprise; it is costly. To achieve precision one must go to great lengths. If cake recipes called for great precision, bakeries would have to close. In increasing exactness cost and complication increase exponentially. For insofar as precision/exactness/acrimony can be measures it is clear that a principle of decreasing returns is in play with each successive 10% increase costing, some several times (the expenditure of recourses and effort as its predecessors.[12]

Imprecision is a natural response to the demands of economy and conservation of effort. If our communicative discourse had to meet high statistics of precision the exchange of information would become difficult if not impracticable.

6. Conclusion

Imprecision plays a prominent role in our thinking because it is a requisite for the evolutionary development of the intelligent beings who guide their actions by thought with regard to their situation. Were exactness required we would not be here to tell the tale. If a type of creature is to endure and thrive in an evolutionary environment, nature has to cut it a great deal of slack. It must not critically matter for its survival just exactly what type of nourishment it requires or just exactly what type of environing conditions possibilize its existence. And if this sort of creature happens to be an intelligent being whose interactions with the world are shaped by thought and belief this ontological slack is mirrored in a cognitive imprecision.

If eggs were only edible if cooked at a precise age we would not be eating eggs. If the nutrient value of fruit depended on the exact time of day when they were harvested their place in our diet would be greatly reduced. The dispensability of precision in matters of life-sustaining action is essential to our viability as the sort of intelligent beings we humans are.

On first thought we incline to regard impressions as a flaw in the compilation and transmission of information. But close attention to the issues indicates that this is itself an oversimplification. For this pervasive presence is not only inevitable in practice but desirable in theory, given the conditions under which we must function in the management of information. Functionless perfection is as impracticable in matters of cognition as in thermodynamics.

[12] This contention—itself a model of imprecision—shows the utility of this feature in conveying "the general idea" at issue.

In closing, it seems fitting to survey the principal conclusions of the preceding discussion. They stand as follows:

- Imprecision can take many forms. The most familiar is quantitative imprecision or approximation, but also descriptive, classificatory, locational, and relational imprecision, among others,

- Whether and how greatly precision matters depends on the particular context of application. (Whether 1 or 4 inches of rain will fall will not matter for deciding whether or not to take an umbrella.)

- Classificatory precision can be of the essence in legal matters: Whether an airship counts as a ship is crucial for issues of admiralty law. The law often imposes arbitrary precision (e.g. in relation to quantifying an adult able to enter into contracts).

- The tolerance of imprecision is crucial to loose quasi-generalizations such as "Price increases diminish sales" (they often don't), or "Fatigue diminishes performance" (it often does not).

- Oversimplification and its correlative imprecision is often rational—especially in cases where accuracy and precision is hard to secure and makes no substantial difference.

All in all, it emerges on closer scrutiny that imprecision, although a seeming deficiency, is a factor that can in many situations pay for itself in terms of collateral benefits. Depending on the context, the toleration of imprecision can be a highly cost-effective practice.

Aristotle tells us in the *Nicomachean Ethics* that "it is the mark of an educated man to look for precision in each class of thing just insofar as the nature of the subject admits. (1094b-24-26). He hold that we shall not pursue precision beyond *the limits of necessity*. But the present analysis takes a somewhat different, more pragmatic line: it argues for the futility of requiring precision beyond *the limits of utility*. For in virtually all contexts, theoretical and practical alike, there is only so much precision we can use, and considerations of rational economy mandate that there is no point to carrying matters further.

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