Scale structure and genericity: Understanding generics using stochastic comparison

Ashwini Deo & Mokshay Madiman
Yale University, University of Delaware

Abstract This paper presents an analysis of generic sentences that takes into consideration the scalar properties of the predicates that they contain. It is shown that the variability observed in the real-world distributions that support or fail to support the truth of generic sentences is not arbitrary when we examine the structural and linguistic properties of the scales introduced by their predicates. The analysis is closely guided by work in degree semantics — particularly the notions of scales, comparison classes, and standards of comparison — and analyzes generic sentences as predicating a (non-)gradable property directly of a kind. This contrasts with the dominant approach in the literature that takes them to be tripartite quantificational structures that express relations between sets. The tools that allow the measurement of the degree to which a kind expresses a (non)-gradable property and its relation to a standard of comparison are drawn from probability theory — cumulative distribution functions and stochastic comparison. On the proposed analysis, any generic sentence *As are B* may be judged true iff two conditions are satisfied: (a) the cumulative distribution function (CDF) of the random variable that gives the value of a random element of *A* along the scale introduced by *B* satisfies **salience**; and (b) the stochastic process associated with the sentence satisfies **stationarity**.

Keywords: generics, gradability, scale structure, comparison class, kind predication, probability, stochastic comparison

Contents

1 Introduction

A large part of our understanding of the world we experience and the kinds of entities that occupy it is linguistically encoded in the form of sentences such as those in (1).

(1) a. Elephants have trunks.
 b. Birds fly.
 c. Potatoes contain vitamin C, amino acids, protein and thiamine.
 d. Lions are predatory cats.

The sentences in (1) express stable generalizations about a class of individuals — thus abstracting away both from particular objects and particular events and facts. In the classificatory setup in Krifka et al (1995), such sentences are characterizing sentences with kind-referring subjects — known better in the literature by the name *generics*.[1] Despite their ubiquity in everyday discourse and simple (surface) syntax, generics have been notoriously intractable to a unified truth-conditional analysis. At least one of the reasons for this intractability lies in the diverse patterns of worldly facts that may (or may not) support the truth of generics. Many generic claims of the form *As are B* correspond to strong quantificational generalizations about actual and potential proportions of the As among the Bs in the world. For instance, *Elephants have trunks* corresponds to a quantificational statement such as *All/most elephants have trunks*. This leads to the reasonable hypothesis (call it the majority hypothesis) that the generic sentence expresses a generalization about the proportion of elephants that have trunks and is true because most elephants do have trunks.

However, the viability of the majority hypothesis depends on its generalizability to the full class of generic sentences. The literature provides numerous examples showing that a strong quantificational relation is neither necessary nor sufficient for the truth of a generic sentence. The sentences in (2) are typically judged true despite the fact that the characteristic property applies only to a small proportion of the class of individuals denoted by the subject — a clear falsification of the majority hypothesis. Only adult, male peacocks have beautiful tails, only adult fertile female ducks lay eggs, a small fraction of tigers are man-eaters, and the vast majority of bees are sterile worker bees. Finally, the fact that less than 10% of sea-turtles survive to reach maturity does not prevent us from accepting (2-e) as true.

(2) a. Peacocks have beautiful tails.
 b. Ducks lay eggs.

1 Characterizing generics are distinct from particular statements that make reference to kinds. *Dodos had large bills* is a generalization about the members of the kind dodo whereas *Dodos became extinct* is a singular statement directly referring to the kind dodo. Only the former belongs to the class of characterizing sentences, and hence to the class of generics.

c. Tigers eat people.
d. Bees are fertile.
e. Sea-turtles have long lives.

A further challenge to the majority hypothesis is posed by the fact that the truth of a generic is not guaranteed even if the characterizing predication applies to most of the members of the kind. Neither the death of most young sea-turtles at the hands of predators nor the sheer majority of sterile worker bees in comparison with the drones and the queens make us judge (3-a) or (3-b) as true.

(3) a. Sea turtles have short lives. *false*
b. Bees are sterile. *false*

A related but slightly different challenge comes from sentences like those in (4-a) which tends to be judged false even if every Supreme court judge in the world under consideration happens to have a prime social security number. The same goes for (4-b) and (4-c) (imagine a world with a leg cut off from each lion). For these sentences to be judged true, the generalizations they describe must not arise by mere accident, but must be expected to persist stably across time.

(4) a. Supreme court judges have a prime social security number. *false*
b. Children born in Rainbow lake, Alberta, are right-handed. *false*
c. Lions have three legs. *false*

The sentences in (2) indicate that any adequate analysis for generics must either be equipped with an explicit way of restricting the predication to appropriate/suitable members of a kind so that the majority hypothesis can be maintained, or be modified appropriately so as to allow for the variability in the proportional relations observed within generics. The sentences in (3) and (4), on the other hand, indicate that any adequate analysis must be supplemented with principled criteria for eliminating strong quantificational statements that nevertheless strike us as false generalizations.

There is another well-known twist contributing to the generic enigma. The relevant contrast is the one that obtains between (5-a)-(5-b) and (5-c)-(5-d) (Carlson 1977; Geurts 1985; Cohen 1996, 1999; Leslie 2008, among others).

(5) a. Ducks lay eggs. *true*
b. Ducks are female. *false*
c. Peacocks have beautiful tails. *true*
d. Peacocks are male. *false*

The consensus seems to be that (5-b) and (5-d) are judged false. The problem is that the contrast in truth-judgements holds despite the fact that the predicates in (5-a)-

(5-b) and (5-c)-(5-d) pick out similar sets. In fact, a larger proportion of ducks and peacocks satisfy the predicates 'female' and 'male' respectively than the predicates 'lay eggs' and 'have a beautiful tail'.

Yet another class of cases concerns the distinction between *absolute* and *relative* generics introduced by Cohen (1996, 2001). What is relevant for relatively interpreted generics is not the absolute proportion of the members of the kind that satisfy the predicate but rather relative proportions. In (6-a), we do not consider whether the proportion of Frenchmen who eat horsemeat is high in the absolute, but rather whether it is *higher* compared to the proportion of non-Frenchmen (the Swiss, the Dutch, or the Bulgarians, for instance) who eat horsemeat. (6-b) is true iff more Bulgarians are good weightlifters than non-Bulgarians and the same goes for Dutchmen in (6-c). This class of examples indicates that the truth-conditions of generics, at least sometimes, involve a comparison between proportions rather than an absolute quantificational claim.

(6) a. Frenchmen eat horse meat.
 b. Bulgarians are good weightlifters.
 c. Dutchmen are good sailors.

A large part of the puzzle presented by generics rests on these observations about exception-tolerance, non-accidentality, expectation about temporal persistence, relevance of relative proportions, and irreducibility to quantificational statements. At its core, the puzzle for semanticists is the following: *what makes an observed generalization fly as a generic?*

In this paper, we propose that the variability observed in the real-world statistical patterns that support (or do not support) true generics is predicted in a unified way when the scalar properties of the predicates that such sentences contain are taken into consideration. The analysis here departs somewhat from standard approaches to generics, which take them to be quantificational claims about the proportion of *A*s that are *B* or, equivalently, the probability (on the frequentist interpretation) that a random *A*-individual is *B*. In contrast to this view, wherein the subject and the predicate of a generic sentence are uniformly interpreted as sets, we suggest that generics are claims about the probability distribution of a random element of a set along a scale of values.[2] The difference between the two views can be expressed as follows. On the quantificational or frequentist probability view, one asks the question: what proportion of As have property B? Or what is the probability that a random element of A has property B? The question asked here is instead: For

2 This does not mean, of course, that quantificational accounts fail to work for *all* generics. Rather, the analysis is generalizing: uniformly assuming that generics describe a probability distribution along a scale of values allows us to accommodate under a single explanatory umbrella both the types of cases that fall out of the quantificational accounts and those that pose a challenge to such accounts.

every possible value *x* on a scale introduced by B, what is the probability that a random element of A exhibits the property up to *x*? The notion that allows us to capture this distribution of values is that of a cumulative distribution function. On the proposed analysis, any generic sentence *As are B* expresses the claim that the cumulative distribution function (CDF) of the random variable that gives the value of a random element of *A* along the scale introduced by *B* satisfies **salience** and that the associated stochastic process satisfies **stationarity**. The bulk of the work lies in making the notions of salience and stationarity precise. For salience, we will do so by integrating the idea of stochastic comparison of CDFS (as it is understood in probability theory) with salience as it has been construed in degree semantics — particularly in the study of gradable predicates and the scales associated with them. Stationarity is an intuitive notion about a property of stochastic processes that requires little modification for its linguistic application.

Here then is the plan for the paper. §2 introduces the mathematical and linguistic ingredients that our analysis contains. §3 shows how the analysis applies to diverse classes of generic sentences. Wherever relevant, we will make comparisons with other analyses in the local context of explanation. This is because although the current analysis is obviously inspired by and owes a clear debt to certain elements from previous treatments of generics (in particular, the several papers of Cohen and Nickel), we believe that a global description of this literature in an isolated section will not be as conducive to comparison between our approach and the diversity in previous approaches. §4 considers cases in which salience satisfaction must be understood relative to contextual expectations. In §5 we contextualize our analysis in the current landscape.

1.1 Restricting the domain of generics for this paper

The literature on the differences between indefinite singular, definite singular, and bare plural kind-referring NPs in generics has identified that bare plural NPs are the most permissive in the range of their acceptable occurrences and exhibit the widest range of readings (Greenberg 2003, 2007; Cohen 2001).

(7) a. Madrigals are popular/ ?A madrigal is popular.
b. Rooms are square/?A room is square.

For the purposes of this paper, we restrict ourselves to generics with bare plural NPs, leaving the integration of our analysis with the broader explanandum represented by data such as (7) as a topic of future research. The class of generic sentences, so restricted, are classifiable along yet another dimension — into those that express non-accidental but descriptive, inductively obtained generalizations (e.g., *Barns are red*) and those that express 'rules' (Cohen 2001) or principled, in-virtue-of generalizations (Greenberg 2003; 2007) (e.g., *Bishops move diagonally*). It is well-known that the same sentence may be understood as expressing descriptive generalizations or normative rules (e.g., *Gentlemen open doors for ladies.*) This paper is concerned only with generics that express descriptive generalizations, since it is for this subclass of generics that reference to statistical properties in determining truth-conditions makes most sense.

2 The analysis

§2.1 introduces the notions of CDFs (2.1.1), stochastic comparison (2.1.2), and stationarity (2.1.3). The following section, §2.2, introduces scalar structure as used in degree semantics (2.2.1) and formalizes the notion of salience in terms of scale structure and CDFs (2.2.2).

2.1 Mathematical ingredients

2.1.1 Cumulative distribution functions (CDFs)

The central notion in probability is the notion of a probability distribution on some set, which is a way of assigning "probabilities" (i.e., numbers in $[0,1]$) to subsets of the set. For technical reasons, one does not always require that every subset of the ground set can be assigned a probability; it is sufficient to be able to assign one to a sufficiently rich collection $\mathscr{A}$ of subsets in a way that is consistent with certain rules.[3] The development of the notions of probability distributions, distribution functions, and their properties below is standard and can be found in any rigorous probability textbook (e.g., Durrett 2010, Pollard 2002, and Grimmett and Stirzaker 2001). While one can talk about assigning probabilities to subsets of an arbitrary set, the most important concrete case of interest is when the set is the set $\mathbb{R}$ of real numbers, and one considers a collection $\mathscr{A}$ of admissible subsets of $\mathbb{R}$ to which probabilities can be assigned.[4] In this case, a probability distribution is a mapping $P : \mathscr{A} \to [0,1]$ satisfying the conditions $P(\phi) = 0, P(\mathbb{R}) = 1$, and

$$P\left(\cup_{i\in\mathbb{N}} A_i \right) = \sum_{i\in\mathbb{N}} P(A_i),$$

3 Specifically, the collection $\mathscr{A}$ of subsets must form a σ-algebra and the function P assigning them probabilities must form a countably additive measure. We do not need to bother with these technical details henceforth since our analysis can be developed on the basis of the intuitive and elementary understanding of probability that minimal exposure to probability theory provides.

4 Usually this is either the so-called Borel σ-algebra or the so-called Lebesgue σ-algebra. These do not need to be understood in detail apart from noting that they both contain all subsets of $\mathbb{R}$ we might conceivably be interested in assigning probabilities to in linguistic applications, and in particular all intervals.

for all sequences $(A_i : i \in \mathbb{N})$ in $\mathscr{A}$ that consist of pairwise disjoint sets (i.e., if $i \neq j, A_i \cap A_j = \phi$).

It is a nontrivial, important fact that one can specify a probability distribution just by specifying the probability of every interval rather than of the much larger class $\mathscr{A}$. In other words, if one knows the function

$$F(x) = P((-\infty, x])$$

for each $x \in \mathbb{R}$, then one can recover $P(A)$ for every set in $\mathscr{A}$. The function $F : \mathbb{R} \to [0,1]$ provides a much simpler description of P than P itself, and is called the *cumulative distribution function* (CDF) of P. One way of thinking about this is that $F(x)$ accumulates all of the probability of elements less than or equal to x. Based on the definition of a probability measure, one can derive various properties of the CDF F of P:

i. $F : \mathbb{R} \to [0,1]$ is a non-decreasing function, i.e., $F(x) \geq F(y)$ if $x \geq y$.

ii. $\lim_{x \to -\infty} F(x) = 0$ and $\lim_{x \to \infty} F(x) = 1$.

iii. F is a right-continuous function, i.e., $\lim_{x \to y+} F(x) = F(y)$, where $x \to y+$ denotes the one-sided limit obtained as one decreases x to y from above.

There are 2 classes of CDFs (or probability distributions) that are typically of interest and relevant to linguistics. These two classes are discrete probability distributions (or pure-jump CDFs), where the CDF remains constant at every point where it is continuous and jumps upwards at the finitely many points where it is not and continuous probability distributions (or continuous CDFs), where the CDF is continuous at every point of the real line. The former corresponds to *categorical random variables* that can take finitely many values, while the latter corresponds to *continuous random variables* taking values on an open scale.

The notion of random variables is useful in interpreting facts about probability distributions. Loosely speaking, a random variable X is just a random element of $\mathbb{R}$, and corresponding to it, one has a CDF (called the *CDF of X* and often denoted F_X) such that for each $x \in \mathbb{R}$, $F_X(x)$ is the probability that $X \leq x$. In other words, F_X describes the probability that X will be found to have a value less than or equal to x. Here we give an example of the discrete and the continuous cases to make the intuition concrete and to connect it to the subject at hand.

Categorical random variables: Consider *Lions have a mane*. This sentence can be construed as describing an experiment of checking for the presence of a mane on a random lion, where the (discrete) random variable X takes values in the set $\{$presence, absence$\}$ and presence indicates that the lion has a mane. p is the probability that presence is the outcome (this is an instance of the Bernoulli distribution). The CDF F_X can be written as

$$F_X(x) = P(X \leq x) = \begin{cases} 0 & x < 0 \\ 1-p & 0 \leq x < 1 \\ 1 & 1 \leq x \end{cases}$$

The graph for this CDF, where $p = 0.4$ (the assumed proportion of adult male lions in the population) is in Figure 1.[5]

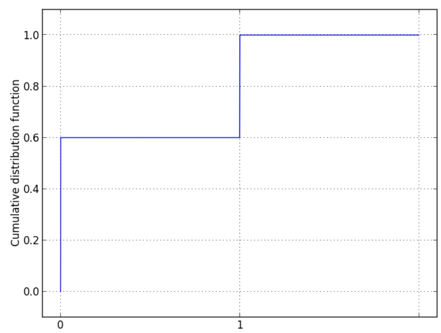

Figure 1 The CDF F of a categorical random variable X

Continuous random variables: For a class of random variables, often called "continuous random variables", it is possible to represent their distributions in terms of probability density functions. A probability density function is a function $f : \mathbb{R} \to [0, \infty)$ satisfying $\int_{-\infty}^{\infty} f(x)dx = 1$. If f is the probability density function of a random variable X, then one has for any set A that

$$P(X \in A) = \int_A f(x)dx.$$

Thus the connection between the probability density function f of X (when it exists) and the CDF F of X (which always exists) is that

$$F(x) = \int_{-\infty}^{x} f(x)dx,$$

which is also equivalent, by the fundamental theorem of calculus, to the relation $\frac{dF(x)}{dx} = f(x)$.

5 Caution must be used in interpreting the figure. Note that the vertical lines are not actually part of the graph; they are merely there as a visual aid; in particular, the value of the function at points where it jumps is not displayed properly on the graph but must be deduced from the right-continuity mentioned above.

Consider, now, a sentence like *Giraffes are tall*. This sentence can be construed as describing an experiment of measuring the height of a random giraffe, where the continuous random variable $X =$ height of a random giraffe. Let us assume that X may lie between 6 feet (the height of a newborn giraffe) and 20 feet (the maximum height of fully grown male giraffes), with most giraffes lying between 12-16 feet. The probability density function f for this distribution would be something like in Figure 2 while the graph of F, the cumulative distribution function, would be as in Figure 3.

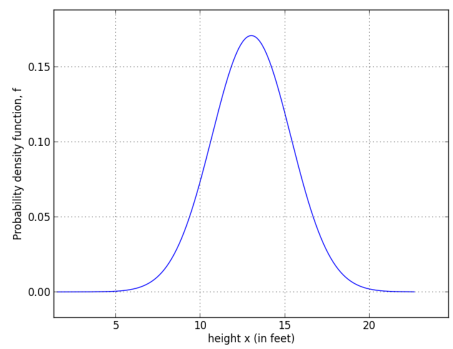

Figure 2 The probability density function (PDF) f of continuous variable X

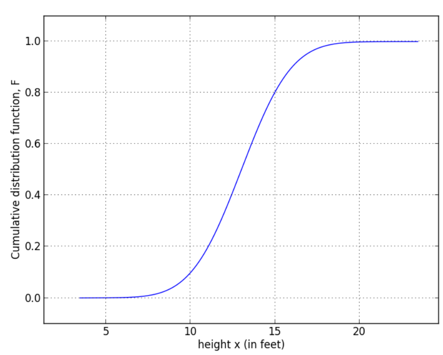

Figure 3 The CDF F of the continuous variable X

There are two ways in which distribution functions (rather than just proportions) capture something essential about how a generic *As are B* is understood. One may start from a consideration of the property B — often such a property does not categorically hold or not hold of an individual, but is rather gradable on a scale and holds of an individual to some extent or degree d. This possibility is not taken into account in most prior analyses that focus rather on the proportion of As that are B (or equivalently, the probability that a random element of A is B). The other consideration is about the kind A — what does it mean to predicate a property of a kind rather than an individual? The fact that we are attributing the property B to a kind as opposed to an individual means that we are not assigning values on the scale of B to particular individuals in the population of As, but rather attempting to capture statistical features of how that population expresses the property B; in other words, we are looking for a way to quantify the expression of B by the population in a way that is invariant under internal permutations of the elements of A.[6] When we put these things together — namely, a requirement that B should be considered in a richer way than has been before, taking gradability into account, and a constraint that the consideration of A should be invariant under internal permutations, the only thing we can possibly do is to consider the distribution of a random element of A along the scale of B.

We note that some properties B, such as the property of having a mane, may indeed be categorical rather than gradable, requiring us to consider the distribution of As in terms of both mass functions (for categorical random variables) and density functions (for continuous random variables). Cumulative distribution functions provide a unified representation of both kinds of variables and are therefore the choice in the analysis here.

2.1.2 Stochastic comparison

Suppose F and G are CDFs of two probability distributions on $\mathbb{R}$. Our analysis of generics will rely on the idea that in certain circumstances, F and G can be compared. The fact that this is only possible in certain circumstances and not for any pair F, G means that this notion of comparison generates a partial order rather than a total order on the set of CDFs.

We say that a CDF F *stochastically dominates*[7] a CDF G (and write $F \succ G$) if

(1) $$\int_{-\infty}^{x} F(t)dt \leq \int_{-\infty}^{x} G(t)dt$$

for every $x \in \mathbb{R}$, and if the inequality is strict for at least one $x \in \mathbb{R}$. Note that the integrals in (1) represent the area under the corresponding curves up to the point x,

6 That is, if A is the set of men and the heights of John and Tom were to be exchanged, nothing would change about the statistics of tallness levels of the kind men.

7 In the probability literature, there are many possible partial orders on the space of distributions or CDFs; the one we primarily use here is what is called *second-order stochastic dominance*.

so that in many cases, one can determine whether $F \succ G$ by simply "eyeballing" the graphs of F and G.

In order to grasp this notion better, it is useful to introduce another notion of stochastic comparison—*first-order stochastic dominance*. We say that a CDF F stochastically dominates to the first order a CDF G if $F(x) \leq G(x)$ for every $x \in \mathbb{R}$, and $F(x) < G(x)$ for at least one $x \in \mathbb{R}$. Note that since all CDFs start at 0 and end at 1 (as one goes along $\mathbb{R}$ from left to right), this is equivalent to saying that the graph of F never crosses the graph of G and always stays beneath (or possibly equal at some points) to it. Intuitively, if F dominates G to first order, the random variable X whose distribution is given by F tends to have larger values on some scale than the random variable Y whose distribution is given by G. This is because we have from the definition of first-order dominance that for each $x \in \mathbb{R}$, the probability that $X \leq x$ is at most the probability that $Y \leq x$, or in other words, that for each $x \in \mathbb{R}$, the probability that $X > x$ is at least equal to the probability that $Y > x$.

This can be made concrete through a linguistic example. Let F be the CDF that gives the distribution of $X =$ height of a random giraffe, while G is the CDF that gives the distribution of $Y =$ height of a random mammal. Assuming that giraffes are between 6 and 20 feet tall and the tallest animals among the mammals, while the shortest mammals are an inch or so in height, and most mammals are less than 7 feet in height (with the outliers being the elephants and the giraffes), the graphs of F and G are as in Figure 4.

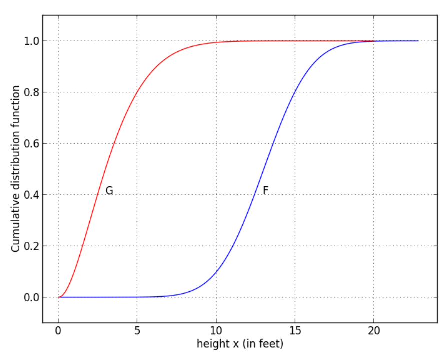

Figure 4 Comparing the distributions of giraffes and mammals on the height scale

In Figure 4, F (the CDF of X) dominates G (the CDF of Y) to first order because for every $x \in \mathbb{R}$, the probability that $X > x$ is at least as great as the probability that $Y > x$. Visually, of course, we can check this by seeing that the graph of F always remains beneath or equal to the graph of G.

If the CDF F stochastically dominates the CDF G to the first order, it is also the case that F stochastically dominates G to the second order (i.e., that $F \succ G$). This is because the integral of a nonnegative quantity must be nonnegative, or equivalently because the area under a higher curve is necessarily greater than the area under a curve that always stays lower than it.[8] However, the reverse is not the case: second-order stochastic dominance does not entail first-order stochastic dominance. Let us examine how second-order stochastic dominance is a weaker condition than first-order stochastic dominance.

In order for F to second-order stochastically dominate G (i.e., for $F \succ G$ to be the case), for every vertical line drawn on the x axis, the area under the F curve up to that line should never become greater than the area under the G curve. This is only possible if the support of F begins at the same or a later point than the smallest element of the support of G.[9] This is consistent with what we expect of first-order stochastic dominance since it means that the graph of F initially remains "below" that of G. That is, F has smaller probabilities, at least for smaller values of x, than G. However, $F \succ G$ can remain true even if the two graphs cross and the area under F becomes larger, provided that the area thus created *between* the two curves after the "crossing" remains smaller than the area between the 2 curves before the crossing until they meet at 1.[10] To justify these pictorial observations, observe that the inequality (1) can be rewritten as

$$\int_{-\infty}^{x} [G(t) - F(t)]dt \geq 0 \tag{2}$$

for each $x \in \mathbb{R}$, which is a statement about the area between the graphs of F and G.

Let us visualize a case of second-order stochastic dominance through yet another example. Let F be the CDF that gives the distribution of X = height of a random horse, while G is the CDF that gives the distribution of Y = height of a random mammal. Let us assume that horses are between 3 feet (newborn) and 7 feet (the maximum height of some adult males in some breeds) tall. Given that the population of mammals contain giraffes and elephants, both much taller than horses, the graph of F will not remain below or equal to the graph of G at all points until 1. This means that F does not stochastically dominate G to the first order. But if we observe the graphs of F and G in Figure 5, we can see that F stochastically dominates G

8 Strictly speaking, $F \succ G$ also requires that the strict inequality $F(x) < G(x)$ holds for at least all values of x in a short interval, but this would typically be guaranteed from the one-point requirement in situations where the CDFs are continuous.

9 The support of a function is the set of points where the function is not zero-valued.

10 Of course, there is also a possibility that the graphs of F and G intersect multiple times and not just once — the general criterion for $F \succ G$ would be that after all the odd intersections, the area between the 2 graphs never exceeds the accumulated area advantage built up by G prior to that intersection. We will not need to consider that possibility here.

to the second order because F remains below G for small values of x and the area between the curves of F and G before the crossing (labeled a) is smaller than the area between the curves after the crossing (labeled b). This visual comparison is all that needs to be made in the cases discussed later in the paper.

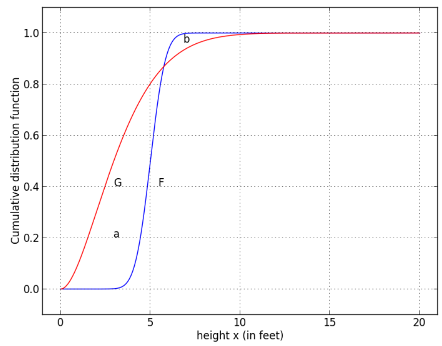

Figure 5 Comparing the distributions of horses and mammals on the height scale

2.1.3 Stationarity

Stationarity captures the intuition that true generics express regular generalizations which persist across time and not accidental, temporary observations (that may even be universal and last for long stretches of time). The role of stationarity is to rule out as false those generics that seem to describe coincidental, accidentally obtaining facts.

(8) a. Supreme court judges have a prime social security number. *false*
b. Children in Rainbow lake, Ontario, are left-handed. *false*
c. Lions have three legs. *false*

Stationarity is a property that certain stochastic processes have. A stochastic process, for our purposes, is a collection of random variables $\{X_t : t \in T\}$, where T is some contextually determined, reasonably long interval of time, thought of as a subset of the real line. Equivalently, we can think of the stochastic process as a random function $X : T \to \mathbb{R}$, where we identify $X(t)$ and X_t. Note that however short or long T is, it contains infinitely many points, and suppose for each $t \in T$, the random variable X_t has the cumulative distribution function F_t. For example, if the sentence under consideration is *Giraffes are tall*, then X_t would be the height of a random giraffe at time t. The corresponding stochastic process would be a collection of the random variables $\{X_t : t \in T\}$, that give the height of a random giraffe for each $t \in T$. In this case, a natural choice for the contextually determined interval T would be the span of time that the species of giraffes has existed or we expect to exist in a form that is similar to their form today – perhaps the interval $[-5000000, +2050]$, if we represent the start of the Christian era by 0, measure time in units of years, assume that giraffes have existed in this form for about 5 million years, that there is not going to be a catastrophic event that wipes out or mutates giraffes in the next 35 years.

The most basic assumption one would like to make is that in order for a sentence to capture a true generalization, its statistical properties do not change in any significant way over time, relative to the contextually determined span of time T. This corresponds to a requirement that the CDF F_t is a fixed CDF F that does not change with time t. For example, let us consider the sentence (8-a). Let X_t be the random variable that gives the probability that a random Supreme Court judge has a prime social security number at time t. Here the natural contextually determined span T of time is the duration of time that the U.S. Supreme Court and its judges have existed and are expected to exist. Imagine now that it is the case, that over the last several decades, say since 1900, all Supreme Court judges happen to have had a prime social security number. There will be no difference among the members of $\{X_t : t \in [1900, 2015]\}$ as far as their CDFs go, but these CDFs will be different from the CDFs of the members of $\{X_t : t \in [1789, 1900]\}$, violating our expectation of time-invariance.

It is, however, pertinent to require something even stronger of our stochastic process $\{X_t : t \in T\}$, since the individual X_ts are merely one-dimensional projections of the underlying process. That is, the absence of differences in the members of $\{X_t : t \in T\}$ might be purely incidental and not evidence of the fact that there is some uniformity in the underlying dynamics that drives the process. To understand this, consider an even more extreme version of the same example as in the previous paragraph — namely, let us imagine a scenario in which all Supreme Court judges since 1789 have by coincidence had social security numbers that are prime. In this case, there will be no difference in any of the observed CDFs of X_t for t in the full range of [1789, 2015]; nonetheless the sentence still strikes us as a false generic. We reason that it is a coincidence that the facts worked out this way, the distribution *could* have been different, there is *no reason* for why Supreme Court judges uniformly turn out to have a prime social security number over long stretches of time.

The stationarity requirement allows us to capture this intuition that absence of changes in distributions over time must be rooted in the identicality of the dynamics that underlie these distributions. In order to describe stationarity, it is useful to think about "time-combs", which is just an ordered finite set of times $(t_1, \ldots, t_m)$, where m

is a positive integer, and $t_1 < t_2 < \dots t_m$ are elements of T. This can be visualized as a comb along the time axis that has teeth at the points $t_1, \dots, t_m$. Corresponding to the time points picked out by the comb, one has the collection of random variables $X_{t_1}, \dots, X_{t_m}$, and their joint cumulative distribution function (or joint CDF):[11]

$$F_{t_1,\dots,t_m}(x_1, \dots, x_m) = \mathbb{P}(X_{t_1} \leq x_1, \dots, X_{t_m} \leq x_m).$$

If we shift the time-comb to the right by τ, its new position picks out the times $(t_1 + \tau, \dots, t_m + \tau)$. A *stationary stochastic process* is a stochastic process such that the joint CDF $F_{t_1,\dots,t_m}$ corresponding to the original comb is the same as the joint CDF $F_{t_1+\tau,\dots,t_m+\tau}$ corresponding to the shifted comb, for every possible comb and for every $\tau \in \mathbb{R}$ such that $t_1 + \tau$ and $t_m + \tau$ both lie in the relevant time interval T.

One can equivalently talk about stationarity in terms of conditional CDFs. Recall that by the definition of conditional probability, one has that

$$\mathbb{P}(X_{t_2} \leq x_2, X_{t_1} \leq x_1) = \mathbb{P}(X_{t_2} \leq x_2 | X_{t_1} \leq x_1)\mathbb{P}(X_{t_1} \leq x_1),$$

so that one may define the conditional CDF $F_{t_2|t_1}$ by

$$F_{t_2|t_1}(x_2|x_1) := \mathbb{P}(X_{t_2} \leq x_2 | X_{t_1} \leq x_1) = \frac{F_{t_1,t_2}(x_1, x_2)}{F_{t_1}(x_1)}.$$

More generally, one can write just by repeatedly applying this definition

$$F_{t_1,\dots,t_m}(x_1, \dots, x_m) = F_{t_1}(x_1)F_{t_2|t_1}(x_2|x_1)F_{t_3|t_1,t_2}(x_3|x_1,x_2)\dots F_{t_m|t_1,\dots,t_{m-1}}(x_m|x_1, \dots, x_{m-1}).$$

Then stationarity requires that not only is the first factor in this decomposition, namely F_{t_1} invariant with respect to admissible shifts of time τ, but that all the factors are invariant, i.e., $F_{t_m|t_1,\dots,t_{m-1}}$ is the same as $F_{t_m+\tau|t_1+\tau,\dots,t_{m-1}+\tau}$.

The main advantage of thinking about stationarity in this way is that it implies that the uniformity observed in the stochastic process $\{X_t : t \in T\}$ emerges from uniformity in the underlying dynamics that drive the process. In other words, there is some principled reason that accounts for why the observed statistics remain invariant over time. In the case of the sentence (8-a) with the last discussed scenario, stationarity is not plausible because our knowledge of the world and the rarity of 9-digit prime numbers leads us to believe that even conditioning on all current Supreme Court judges having prime social security numbers, the probability that all Supreme Court judges in 50 years (when some of the older current judges will surely have been replaced) will have prime social security numbers is vanishingly small.[12]

11 Observe that one can recover the individual CDFs from the joint CDF by taking the limit as the x_is corresponding to the unwanted random variables go to ∞.

12 Granted, one could also get this by just looking at F_{2065}, so the one-dimensional definition actually suffices here, but hopefully it is also clear that the additional conditions carry semantic heft.

In the context of generics, it is clear that speakers cannot actually check for whether a process is actually stationary or not since they simply do not have access to data of that sort. Rather, in producing and interpreting generics, speakers consider the plausibility of modeling the stochastic process of interest as a stationary process. That is, in attempting to understand the world and before making/accepting generalizations about it, we consider whether it is possible to treat an observed distribution as being evidence for a stationary stochastic process. The stationarity condition on generics can be stated as follows:

(9) **Stationarity condition:**
In order for a generic *As are B* to be judged true, (it should be plausible that) the associated stochastic process $\{X_t : t \in T\}$ must be a stationary stochastic process.

2.2 Linguistic ingredients

We have said that generic sentences are claims about the salience of associated CDFs and the stationarity of the associated stochastic process. The notion of stationarity has been explicated and in this section, we will describe what we mean by salience. In order to do so, we give some background on degree semantics and gradable predicates that it relates to.

2.2.1 Scale structure, standard of comparison, and salience

Work on the semantics of gradable predicates has associated with their denotations, scales, which are sets of degrees (measurable values) along particular dimensions with an ordering relation on them. A scale is an abstract representation of measurement, a set of totally ordered objects corresponding to the set of real numbers $\mathbb{R}$, where each object is represented as a subset of $\mathbb{R}$. Each scale, along the dimension determined by the predicate (e.g., height, weight, beauty), is a copy of (some interval of) $\mathbb{R}$.

The general idea in degree semantics is that such predicates relate individuals to their measure along the scale lexicalized by the predicate (10-a). A silent morpheme *pos* is assumed for deriving the meaning of the positive form of such predicates which relates individuals to a standard of comparison or threshold value θ (10-b). An adjective in its positive form allows us to identify entities that “stand out” with respect to their measure of the adjectival property relative to θ.

(10) a. $[\![A]\!] = \lambda d \lambda x.\ \mu_A(x) = d$
b. $[\![pos\ A]\!] = \lambda x.\ \mu_A(x) \geq \theta$

A significant result from this line of research is the demonstration that scale structure, specifically the presence of a minimal or maximal element in the set of degrees lexically encoded by a predicate has linguistic consequences (Rotstein & Winter 2004, Kennedy & McNally 2005, Kennedy 2007 a.o.). The scalar typology, supported by linguistic diagnostics, distinguishes between relative vs. absolute adjectives, the latter of which are further distinguished into minimum-standard (or "partial") and maximum-standard(or "total") adjectives. Relative adjectives lexicalize scales which have no minimum or maximum element. Maximum standard adjectives lexicalize scales that are closed on the upper end, which means that the set of degrees in the scale of the adjectival denotation includes a maximum degree. Minimum standard adjectives lexicalize scales that are closed on the lower end, which means that the set of degrees in the scale of the adjectival denotation includes a minimum degree. One consequence of this structure, investigated closely in Kennedy (2007) is that the standard of comparison, θ, for relative adjectives in their positive form, tends to be contextually determined as in (11-a). In contrast, the standard of comparison for absolute adjectives, whose scales contain a minimum or maximum element, is usually context independent, being conventionally associated with the minimum or maximum degree on the scale as in (11-b) and (11-c).

(11) a. John is tall/lazy/strong/weak.
relative to a contextually determined standard of comparison
b. This tiger is dangerous/awake/wet.
exhibits greater than zero degree of dangerousness, awakenedness, wetness irrespective of context
c. The silver rod is straight/pure/dry.
exhibits the maximum degree of straightness, purity, dryness irrespective of context

Kennedy (2007) accounts for the observed influence of scale structure on interpretation in terms of the salience of endpoints on a scale. He invokes a general principle of "interpretive economy" that requires maximal reliance on conventional meanings of expressions in determining truth-conditions, leaving context-dependent interpretation as a last resort option. Relative adjectives lexicalize open scales without endpoints. So there can be no reliance on conventionalized aspects of meaning for the resolution of the standard of comparison θ in their case. As Kennedy says:

> ...there is nothing about the meaning of an open scale adjective alone that provides a basis for determining whether an object stands out relative to the kind of measure it encodes. In order to make such a judgment, we need to invoke distributions over domains relative to which a standard can be established; i.e., we need a comparison

> class, which can be provided either by the context or by the adjective via a domain restriction, as we have seen. (Kennedy 2007: 35)

In contrast, absolute adjectives encode scales that are closed on one end or the other giving us endpoints that can be construed as natural transitions relative to which objects may be distinguished. For an object to stand out relative to the measure encoded by an absolute adjective is to be at the upper end of such a transition — the transition from a non-maximum to a maximum degree or the transition from a zero degree to a non-zero degree. Adjectives that lexicalize closed scales receive absolute interpretations because interpretive economy requires maximal reliance on their conventional meanings for computing truth-conditions. The presence of salient endpoint degrees in the conventionalized scales fixes the value of the standard of comparison θ relative to those degrees. Relative interpretations for absolute adjectives do not arise since these rely on retrieving standards of comparison from the context, a non-necessity for absolute adjectives.

Franke (2011) critiques the explanatory value of the interpretive economy principle of Kennedy (2007) in understanding the interpretations of relative versus absolute adjectives. His first argument is that there is no reason *a priori* for maximum or minimum elements of an ordered set to be considered salient, unless this notion of salience can be clearly linked to perceptual salience — the salience of perceptible objects with respect to how much they "stand out or attract attention" relative to others. His second argument invokes functionality: why should interpretive economy emerge as a stable principle guiding linguistic interpretation?[13] Franke proposes the *extreme-value principle* (12) to replace interpretive economy.

(12) **Extreme-value principle:**
Gradable terms are preferably/usually used to describe extreme values, i.e., values far away from the median/mean of a given distribution.

The idea is that there is a general tendency for gradable expressions to be used preferentially for describing extreme values on the scale of the property they encode. With expressions that encode closed scales, this leads to a preference for endpoint interpretations. With expressions encoding open scales like relative adjectives, this leads to a preference for interpretations that exceed by a significant distance the average value observed in the distribution corresponding to the comparison class (the threshold value θ). Franke derives the extreme-value principle by using the notion of the salience of stimuli in context (13-a) in conjunction with a reason for why salience is pragmatically advantageous for establishing reference (13-b).

13 Potts (2008) is the first to bring up this question in reference to interpretive economy. His explanation assumes that scalar endpoints are cognitively prominent and derives interpretive economy as a result of the evolutionary stability of endpoint interpretations.

(13) a. **Salience of the extreme:**
Salience of a stimulus in a given context is proportional to its (apparent/subjectively felt) extremeness or outlieriness, i.e., to the extent that the stimulus appears unexpected or surprising against the background of the other stimuli in the context.

b. **Benefit of the Extreme:**
Describing those properties of objects that are salient is pragmatically advantageous for coordinating reference.

What is relevant to the purpose here is Franke's insight that the reason that speakers/hearers associate scalar expressions with extreme values (with endpoint values as a special case) is because this association provides a natural way for identifying (and categorizing) referents. To summarize, there are two insights from the gradability literature that can be harnessed in understanding generics:

(14) a. The structure of the scale associated with a predicate has consequences for how the threshold value/standard of comparison is resolved.

b. The salience of an entity with respect to a scale depends on its extremeness relative to a background distribution on the scale.

These observations have, to the best of our knowledge, not been taken into consideration in working out the truth-conditions for generic sentences. Part of the goal of this paper is to make the connection. As one might expect, we will show that differences in the structure of scales encoded by predicates like *sterile*, *dangerous*, and *tall* predict the differences in the statistical properties that distributions over such scales must satisfy — ultimately predicting the (un)acceptability of generic sentences containing such predicates. We will also show that measure expressions and comparative morphology make a predictable contribution to the truth-conditions of generics, accounting for both the truth and falsity of generics containing such expressions. Finally, we will apply the same scale-based logic to non-gradable, categorical predicates in generics and take them to introduce a two-point scale that is interpreted as being embedded in a continuous scale. The structure of this sort of scale also places constraints on distributions over it.

2.2.2 Salience in generics

A generic sentence asserts that some property characterizes a kind. For a (possibly gradable) property to characterize the kind, it is necessary to know what the measure of that property for the kind is. Intuitively, when kinds are under consideration, one is not interested in the measurement value of that property for any individual member of the kind but in the distribution of the kind's members among all possible values along the property scale. One might say that this is a way of measuring the extent to which the kind set A has the property B. This is exactly what is described by the CDF of a random variable X associated with the population of A along the B scale. Such a random variable may be represented as X_{AB}. The CDF F of X_{AB} will be written as F_{AB} (or G_{AB}). So, throughout this paper, an expression F_{AB} (or G_{AB}) is an abbreviation for "the CDF of the random variable X_{AB} that gives the value of a random element of A along the scale of B". F_{AB} may satisfy **salience** in one of the following ways:

(15) a. Whenever B introduces a continuous scale with a minimum element, F_{AB} is strictly less than 1 at 0.[14]

b. Whenever B introduces a continuous scale with a maximum element, F_{AB} stays at 0 for all points strictly less than that element and jumps to 1 at the maximum element.

c. Whenever B introduces a continuous scale with no minimum or maximum elements, there is a contextually accessed **admissible comparison class** A' s.t. $F_{AB} \succ G_{A'B}$.

d. Whenever B introduces a continuous scale modified by explicit measure expressions, F_{AB} is constrained to fall within the range of values specified by the measure expressions.

e. Whenever B introduces a categorical scale, there is a contextually accessed **admissible comparison class** A' s.t. $F_{AB} \succ G_{A'B}$.

The definition of an admissible comparison-class is given in (16):

(16) **Admissible comparison-class:**
A set A' is an admissible comparison class for A iff

a. $A' \supseteq Alt(A)$
A' includes the union of alternatives to A

14 Note that for each predicate, the scale introduced by that predicate is the set of degrees that is in the range of the measure function encoded by that predicate. Crucially, for predicates with shared scales (polar antonyms), positive and negative members of the antonym pairs that use that scale, will only map individuals to either the lower or upper range of the full set of degrees in the scale. It is in this restricted sense of "the range of the measure function associated with a predicate" that the term "scale" is used here.

b. $\forall x \in A' : [\![B(x)]\!] \in \{0,1\}$
B is defined for each member of A'

c. $\exists A'' \in Alt(A) : \forall x \in A'' : [\![B(x)]\!] = 0$
$Alt(A)$ and therefore A' are diverse w.r.t B

These admissibility conditions are reasonable conditions on any comparison class that might be considered in determining the threshold/standard variable for relative adjectives. There are two differences: First, since we are considering the comparison class for a kind, the comparison-class is a union of sets — i.e. a set of individuals belonging to alternative subkinds.[15] Second, comparison classes are used not only for open-scale gradable predicates (15-c) but their use is extended to non-gradable predicates that encode categorical scales in (15-e). This extension is not unjustified since it is being used to model the fact that in predicating non-gradable, categorical properties of a kind we do, in fact, consider whether the discrete (0-1) distribution of that property among the members of the kind is salient relative to some background distribution (which may be given by the comparison class).

It should be clear that the ways of satisfying salience given in (15) are entirely derived from the properties of the scale introduced by the predicates. They are also parallel to how these predicates get interpreted in particular sentences with individual-denoting subjects. In such sentences, the scalar structure of the predicate constrains the range of values for the measure function applied to an individual. Similarly, in characterizing sentences with kind-denoting subjects, the scalar structure constrains the range of values for the measure function applied to the kind — this means that it constrains the distribution of possible values for members of the kind. The full range of cases that this approach accounts for will be dealt with in §3. But in order to get a sense of the scope of (16), Table 1 gives some examples of the class of sentences each condition is intended to account for the truth/falsity of.

Two cases are described here to familiarize the reader with the approach. Consider an adjective like *fertile*. *fertile* is built off a lower-closed scale, a set of degrees of fertility with zero fertility being the minimum value on the scale and no maximum degree of fertility. *fertile* is the positive member of the antonym pair lexicalized on that scale.[16] It follows that the range of the measure function encoded by *fertile* includes a minimum degree that is ordered below all others. This gives rise to the

15 The semantics for generics developed in Cohen (1996, 1999, 2001) relies on the notion of alternative sets which are utilized to compute probabilities. What we do here is similar in spirit though different in implementation.

16 This can be probed by the felt oddity of examples like *??John is fully fertile* or *??John is completely fertile*.

Condition	True judgement	False judgement
(15-a)	*Bees are fertile.*	*Worker bees are fertile.*
(15-a)	*Sharks are dangerous.*	*Gamma rays are visible.*
(15-b)	*Cathode rays are invisible.*	*Sleeping pills are safe.*
(15-b)	*Worker bees are sterile.*	*Bees are sterile.*
(15-c)	*Giraffes are tall.*	*Cats are tall.*
(15-c)	*Dutchmen are good sailors.*	*Americans have a small carbon footprint.*
(15-c)	*Sea-turtles live long lives.*	*Sea-turtles have short lives.*
(15-d)	*Anacondas are under 35 feet long*	*People are over three years old.*
(15-d)	*Giraffes are between 6-20 feet tall.*	*Luxury cars cost over $150,000.*
(15-e)	*Ducks lay eggs.*	*Ducks are female.*
(15-e)	*Lions have manes.*	*Lions are male.*

Table 1 Patterns of judgement captured by the conditions in (15)

minimum-standard interpretation associated with the adjective. (17-a) is true iff the measure of fertility of John is greater than zero.

(17) a. John is fertile.
b. $[\![\text{John is fertile}]\!] = 1$ iff $\mu_{fertility}(\text{John}) > \textbf{min}(g_{fertility})$

This is exactly the condition that the CDF must satisfy when the predicate introduces a scale with a minimum element (Condition (15-a). An example generic would be *bees are fertile*. This sentence comes out true iff the measure of fertility of the bees-kind is greater than zero, i.e. iff $F_{bees-fertility}$ is strictly less than 1 (on the y axis) at 0. This is indeed the case (given the queens and the drones) and the sentence is judged true. This is visually represented in Figure 6.

These truth-conditions can be contrasted with those associated with the antonym of *fertile*, *sterile*. *sterile* is the negative member of the antonym pair, and its range includes a maximum element — the degree corresponding to total absence of fertility.

This constraint must also be satisfied by the CDF associated with any predicate that contains a maximum element — as expressed in (15-b). In order for *Bees are sterile* to be true, $F_{bees-sterility}$ must stay at 0 for all points strictly less than the maximum degree and rise to 1 at that degree (modulo some imprecision). The CDF would have to have the form in Figure 7.

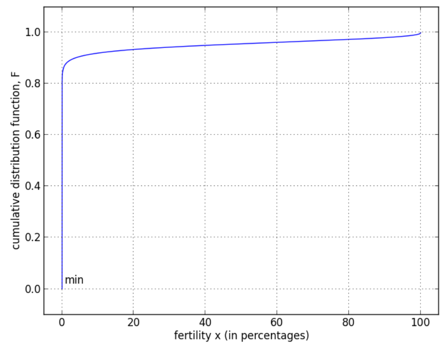

Figure 6 Required graph of $F_{bees-fertility}$ for the truth of *bees are fertile*

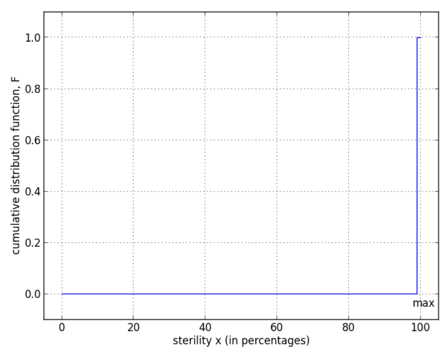

Figure 7 Required graph of $F_{bees-sterility}$ for the truth of *bees are sterile*

However, given that some bees are in fact non-sterile, as shown by the CDF in Figure 8, that approximates the actual situation, this fails to be the case, and the sentence is judged false.

3 Accounting for truth and falsity of generics

In this section, we systematically go through the classes of generic sentences that can be accounted for by the analysis proposed above. The focus is on ways in which generics may satisfy or not satisfy salience since the stationarity assumption is a rather straightforward constraint to check for satisfaction.

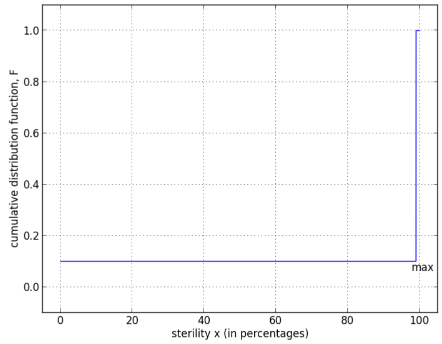

Figure 8 Actual graph of $F_{bees-sterility}$

3.1 Predicates that introduce minimum-element scales

Of interest here are those generics *A*s are *B* which satisfy or violate Condition (15-a) repeated in (18). The former, modulo satisfaction of stationarity, will come out true, the latter false.

(18) **Condition (15-a):** Whenever *B* introduces a continuous scale with a minimum element, F_{AB} is strictly less than 1 at 0.

Bees are fertile was already analyzed in §2.2.2. More examples of the pattern are below.

(19) a. Sharks are dangerous.
b. Comets are visible to the naked eye.
c. Metalloids are malleable.[17]

For (19-a) to be judged true, it is enough that some sharks sometimes treat human beings as prey. Roughly one comet per year is visible to the naked eye, and many of these only faintly so but (19-b) rings true. And (19-c) may be judged true even though malleability is a property of only some metalloids. Note that the sentences feel clearly false with the corresponding antonyms (*safe*, *invisible*, and *non-malleable*).

Let us assume that 5% of the shark population is actually dangerous for humans and when dangerous, it is extremely dangerous. $F_{shark-danger}$ will then have the form

17 The full web-attested example is *Metalloids are malleable, ductile, and better conductors than nonmetals and not as good as metals.*

in Figure 9 and be judged true because there is a non-negligible probability that a random shark is dangerous.

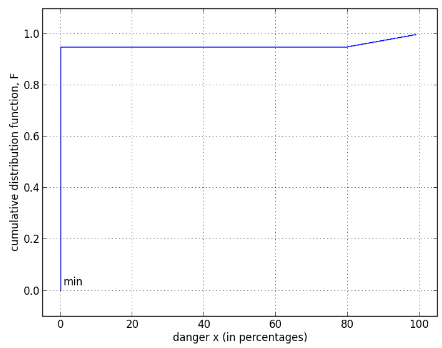

Figure 9 The graph of $F_{shark-danger}$

The only way that a generic may fail salience by violating (15-a) and thus be judged false is when no member of the kind exhibits the property.

(20) a. Cornsnakes are dangerous.[18]
b. Gamma rays are visible.
c. Worker bees are fertile.

In each of these cases, the relevant CDFs $F_{cornsnake-danger}$, $F_{gammaray-visibility}$, and $F_{workerbee-fertility}$, reach 1 at 0, thus not exhibiting the property above the standard determined by the minimum degree. That is, no member of the kind has non-zero values for danger, visibility, or fertility respectively. The schematic CDF for such false generics given a minimum-element scale is in Figure 10.

It is rather difficult to find workable examples of generic sentences which contain minimum-standard predicates that describe both stationary and salient generalizations. On the one hand, we have adjectives like *wet*, *awake*, *hungry*, *sick*, which describe temporary properties of individuals and tend not to serve the purpose of categorizing kinds in a meaningful way. On our analysis, CDFs associated with such scales, even if accurately known at the level of the kind at some point in time, would fail to satisfy stationarity, making sentences like *Dogs are hungry/wet/sick/awake* come out false/unacceptable when read as generics. On the other hand, we have adjectives like *impure*, *bent*, *curved*, *crooked*, *rough*, which, when they allow

18 Cornsnakes are small, docile, nonpoisonous snakes that feed on mice and rats and pose no danger to humans.

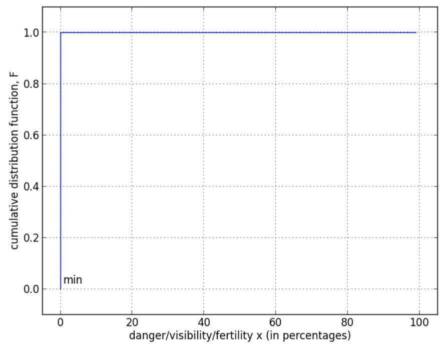

Figure 10 Required graph of CDFs for false generics with minimum element scales

meaningful categorization of a kind, seem to describe sensorily accessible properties that are exhibited quasi-universally among the members of the kind as in (21).

(21) a. Bog iron is impure.
b. Lion claws are curved.
c. Mined gemstones are rough.

We have not been able to identify many distributions that satisfy stationarity as well as (18) in a strict way (i.e. without also exhibiting quasi-universality).

3.2 Predicates that introduce maximum-element scales

The generics in this class satisfy or violate Condition (15-b) repeated in (22). The former, modulo satisfaction of stationarity will come out true, the latter false.

(22) **Condition (15-b):** Whenever B introduces a continuous scale with a maximum element, F_{AB} stays at 0 for all points strictly less than that element and jumps to 1 at the maximum element.

The truth of the examples in (23) is rooted in the facts of the distribution required by maximum standard adjectives: all cathode rays are invisible, all worker bees are sterile, all metals are opaque, and all baby earthworms are safe (unless they are ingested. . .).

(23) a. Cathode rays are invisible.
b. Worker bees are sterile.
c. Metals are opaque.

d. Baby earthworms are safe.

In each case, it is the case that F_{AB} — i.e., $F_{cathoderay-invisibility}$, $F_{workerbees-sterility}$, $F_{metal-opacity}$, and $F_{babyearthworm-safety}$ — jumps to 1 at the maximum degree of invisibility, sterility, opacity, safety respectively. The schematic graph of a CDF involving a maximum-element scale is in Figure 11.

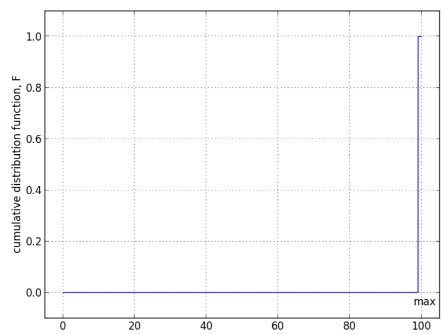

Figure 11 Required graph of CDFs for true generics with maximum element scales

(24) contains examples of generics that fail salience by violating (15-b). It is enough that there is some occurrence of danger, fertility, and opacity/transparency (there are both opaque and transparent minerals) to render the generics false.

(24) a. Sleeping pills are safe.
b. Bees are sterile.
c. Minerals are opaque/transparent.

The schematic graph of a CDF that violates (15-b) is in Figure 12. If even a minimal proportion of the population fails to exhibit the property to the maximum degree, the sentence is rendered false.

3.3 Predicates that introduce open scales

Predicates that introduce open scales are those containing relative adjectives which lexicalize such scales. The condition that must be satisfied by generics containing such predicates is repeated from (15-c) in (25). The definition of an admissible comparison class is repeated for convenience in (26).

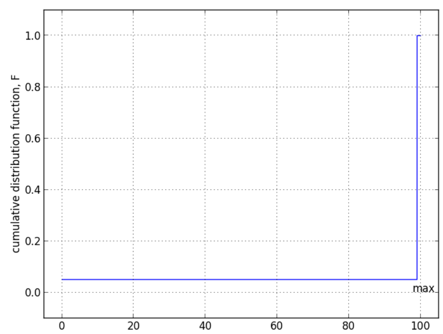

Figure 12 Required graph of CDFs for false generics with maximum element scales

(25) Whenever B introduces a continuous scale with no minimum or maximum elements, there is a contextually accessed **admissible comparison class** A' s.t. $F_{AB} \succ F_{A'B}$.

(26) **Admissible comparison-class:**
A set A' is an admissible comparison class for A iff

a. $A' \supseteq Alt(A)$
A' includes the union of alternatives to A

b. $\forall x \in A' : [\![B(x)]\!] \in \{0, 1\}$
B is defined for each member of A'

c. $\exists A'' \in Alt(A) : \forall x \in A'' : [\![B(x)]\!] = 0$
$Alt(A)$ and therefore A' are diverse w.r.t B

(27) contains example generics that are subject to (25) for satisfying salience.

(27) a. Giraffes are tall.
b. Elephants are heavy.
c. Peacocks are beautiful.
d. Designer brand clothes are expensive.
e. Sea-turtles live long lives.

The basic idea is simple: an admissible comparison class provides the background distribution relative to which the distribution associated with the sentence is evaluated for stochastic dominance. The most intuitive way to obtain such a class is to locate A's position in a taxonomic hierarchy of kinds and identify some super-kind that satisfies the admissibility conditions in (26). In determining the truth-conditions for a sentence like (27-a), we locate the position of *giraffes* in the taxonomic hierarchy and might, in a given context, identify the super-kind *mammals*, which is an admissible comparison class: it is a set of individuals that includes $Alt(giraffes)$ (e.g. zebras, elephants, horses, cows), *tall* is defined for each element $x \in mammals$ (all mammals are entities that have some height), and there exist sub-kinds of mammals A'' (e.g. pygmy shrews and mice) whose members are never in $[\![\text{tall}]\!]$. It should be straightforward to identify admissible comparison classes for the other sentences in (27). Given the comparison class *mammals* for *giraffes*, we are required to compare the CDFs associated with the population of giraffes and the population of mammals along the height scale introduced by *tall*. That is, we will compare $F_{giraffes-height}$ and $G_{mammals-height}$. The two CDFs will have shapes somewhat like shown in Figure 4, repeated here in Figure 13. It is clear that the former stochastically dominates the latter. Given that giraffes are the tallest mammals, we have first-order (and therefore also second-order) stochastic dominance in this case.

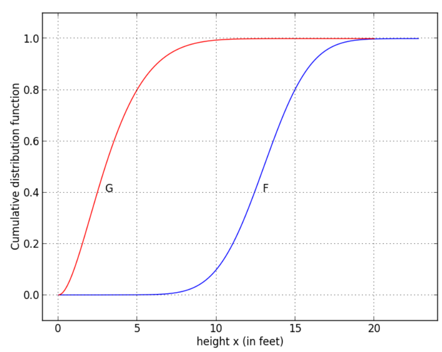

Figure 13 $F_{giraffes-height} \succ G_{mammals-height}$

Consider (27-e) as an example of second-order stochastic dominance without first-order stochastic dominance. Let the admissible comparison class be the set of reptiles. Some reptiles, like lizards may live for 5 years; rat-snakes may live for between 10-15 years. There are also reptiles that live longer than sea-turtles. While sea-turtles may live up to a 100 years, Galápagos tortoises may live up to 175 years and Aldabra tortoises up to 255 years.[19] We suggest that (27-e) introduces an age

19 The former was the age at death in 2006 of *Harriett*, collected by Charles Darwin in 1835, while the latter was the age at death of *Adwaita*, who died in Alipore Zoological Gardens in India in 2006. The graph in Figure 14 takes the maximum age for a reptile to be 225 (rather than 255) years but this should not matter for grasping the concept.

scale, i.e. the ordered set of values on the scale are the set of ages in increasing order. The CDFs associated with the population of sea-turtles and the population of reptiles along the age scale are graphed in Figure 14. Here, we see that although $F_{seaturtles-long.age}$ and $G_{reptiles-long.age}$ cross, the area between the two curves before the crossing (a) is greater than the area between the two curves after the crossing (b). Therefore, $F_{seaturtles-long.age} \succ G_{reptiles-long.age}$, and this makes (27-e) true.

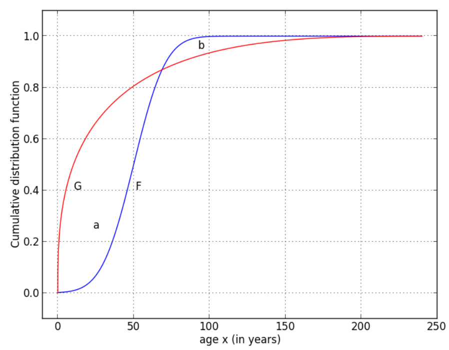

Figure 14 $F_{seaturtles-long.age} \succ G_{reptiles-long.age}$

Since *sea-turtles have short lives* will involve the same set of values associated with the age scale but with an inverse ordering (the set of ages in decreasing order), the sentence is predicted to be false. Imagine the inverse of F and G in Figure 14 and it is clear that $F_{seaturtles-short.age} \not\succ G_{reptiles-short.age}$.

The reason that the sea-turtles sentence has presented a puzzle on prior approaches is because it implicitly assumes a scale of values corresponding to 'age-at-death' or 'life-span'. The question that one might ask with such a scale is: what is the probability that a random element of the set of sea-turtles has a life-span of size x? The answer is: 90% of sea-turtles have less than a one year life-span; of the other 10%, most live up to 80 or even a hundred years. In the setup we have here, assuming an 'age' scale, we ask: what is the probability that a random element of the set of sea-turtles has age up to x for any x on the age-scale? The answer is: there are few sea-turtles of young age (since a great number of them die), but as the values on the age scale increase, we find there is greater probability of a sea-turtle being of that age. As expected, this makes the sentence true.

Note that for an 'age-at-death' or 'life-span' scale, values must be modeled as points on the scale and not intervals. In other words, a sea-turtle that has an 80 year life-span does not also have a 70, 60, 50, 40, 30…1 year life-span. But a sea-turtle that is 80 years of age is also 70, 60, 50, 40…1 years of age. The view that we take of the nature of the scale introduced by *have long lives* is consonant with the basic assumption in degree semantics that gradable predicates encode monotone functions that measure extents on a scale rather than unique points (e.g. Kennedy 2001).

It is very easy to come up with generic sentences that are judged as false because the CDFs associated with them do not satisfy salience by (15-c). These are cases where F_{AB} is stochastically dominated by $G_{A'B}$ as in (28).

(28) a. Americans have a small carbon footprint.
b. Bobcats are social animals.
c. Cats are tall.

(28-a) is false because Americans are some of the highest consumers of energy and natural resources, a property incompatible with having a small carbon footprint.[20] Bobcats are known for solitary existence and extreme territorial behavior among the felids, making (28-b) false. Figure 15 helps visualize the stochastic comparison for (28-a), comparing $F_{americans-small.footprint}$ and $G_{world-small.footprint}$. The scale of values is in decreasing order given the use of the negative adjective *small*.

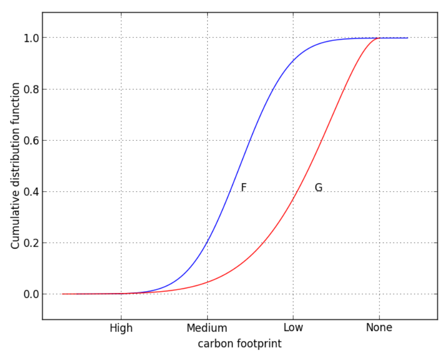

Figure 15 $G_{world-small.footprint} \succ F_{americans-small.footprint}$

Such examples never get brought up for discussion in the generics literature since they pose no problem at all to quantificational accounts of generics. They are simply cases where few if any As can be said to be in B, where B is taken to be the set of individuals that exceed some contextually given standard θ of the relevant property (environmental impact, sociality, or height in this case).

20 Further, we know that a large part of the world is still characterized by subsistence economy and most members of the global population have a far smaller carbon footprint.

Note that (15-c) provides a straightforward account of those relative generic examples from Cohen (2001) in which the predicates introduce open scales. These were mentioned in (6).[21]

(29) a. Bulgarians are good weightlifters.
b. Dutchmen are good sailors.

(29-a) is naturally understood relative to a scale of the 'goodness of weightlifting skills' (abbreviated to *weightlift*) and (29-b) relative to the 'goodness of sailing skills.' In computing the truth conditions for (29-a), for instance we can consider an admissible comparison-class, $Europeans$ (which includes the union of the alternatives of $Bulgarians$). As long as $F_{bulgarians-weightlift} \succ F_{europeans-weightlift}$, the sentence should come out true. Same with (29-b).

The spirit of our analysis for these cases is close to, indeed inspired, by Nickel's (2013b) analysis of such sentences and other work (Nickel 2010, 2013a), which, like us, seeks to reconcile the semantics of genericity with that of gradability. The implementations, however, are quite different.

3.4 Predicates containing measure expressions

Gradable predicates may often appear with measure phrases like *four feet*, *three years*, *two tons* etc.

(30) a. John is 3 feet tall.
b. The pencil is over 10 inches long.
c. Nancy is more than 35 years old.
d. This shirt costs less than \$40.00.
e. Jumbo weighs over 2 tons.

Kennedy & McNally (2005), following Klein (1980), treat measure phrases as degree terms: They are functions from adjectival meanings to properties of individuals, i.e. of type $\langle\langle d,\langle e,t\rangle\rangle,\langle e,t\rangle\rangle$ and their role is that of restricting the degree argument of the adjective. The general schema for such expressions is in (31), where **R** is the source of the restriction on the degree argument.

(31) $[\![\text{Deg(P)}]\!] = \lambda G_{\langle d,\langle e,t\rangle\rangle} \lambda x.\ \exists d[\mathbf{R}(d) \wedge G(d)(x)]$
(Kennedy & McNally 2005: 367)

The meaning of an expression like *6 feet tall* can then be derived as follows:

21 It is possible to deal in a parallel way with *Horsemen eat horse meat* using the approach in §3.5 where generics containing predicates that introduce categorical scales are analyzed.

(32) a. $[\![\text{tall}]\!] = \lambda d \lambda x.\ \mu_{height}(x) = d$

b. $[\![\text{6 feet}]\!] = \lambda G \lambda x.\ \exists d[d \succeq \textbf{6 feet} \wedge G(d)(x)]$

c. $[\![\text{6 feet (tall)}]\!] =$
$\lambda G \lambda x.\ \exists d[d \succeq \textbf{6 feet} \wedge G(d)(x)](\lambda d \lambda x.\ \mu_{height}(x) = d)$
$= \lambda x.\ \exists d[d \succeq \textbf{6 feet} \wedge \mu_{height}(x) = d]$

3.4.1 Generics and measure expressions

If measure phrases and other degree morphemes serve to restrict the degree argument of gradable predicates in the case of particular sentences like those in (30), then they should be expected to have a comparable role in the generic cases as well. Consider some generics of this type:

(33) a. Anacondas are less than 35 feet long.
b. Giraffes are between 6-20 feet tall.
c. Queen size mattresses are 60 inches wide.
d. Refrigerators are more than 16 inches deep.

That is, when measure-phrase modified gradable predicates are predicated of a kind, their role should be that of restricting the range of values that a random element of the kind might take along the property scale. Condition (15-d) repeated in (34) captures exactly that effect of measure expressions on the interpretation of generic predicates.

(34) **Condition (15-d):** Whenever B introduces a continuous scale modified by explicit measure expressions, F_{AB} is constrained to fall within the range of values specified by the measure expressions.

In order to make this concrete, we need to slightly modify the schema for degree terms from (31). Although this schema works well for ordinary individuals like John and the Empire State Building, it doesn't quite work for kind NPs, which do not denote atomic individuals, but rather, sets of individuals on our approach.[22] The restriction introduced by the measure phrase must be distributed over each individual

22 It is possible to also undertake a treatment in which kinds are taken to denote plural individuals as in Chierchia (1998) with the kind forming a join semilattice. By introducing a covert distributive operator such as the one from Link (1987), the measure-phrase modified predicate can be allowed to distribute over atomic parts of the kind (i.e. the members of the kind on a set-theoretic approach). This will not require changing the schematic denotation of the degree terms as suggested in (35). However, we have not taken a mereological approach in this paper and therefore retain the set-theoretic treatment for consistency. Our main tool, the CDF, is not defined for plural individuals.

in the kind and not merely obtain for some/most of them. This modified denotation for degree terms is given in (35).

(35) $[\![\text{Deg(P)}]\!] = \lambda G_{\langle d,\langle e,t\rangle\rangle} \lambda X_{\langle e,t\rangle}.\ \forall x'[X(x') \rightarrow \exists d[\mathbf{R}(d) \wedge G(d)(x')]]$

(36) gives the derivation for (33-a), treating *less than 35 feet* as a single expression.

(36) a. $[\![\text{long}]\!] = \lambda d \lambda x.\ \mu_{length}(x) = d$

b. $[\![\text{less than 35 feet}]\!] = \lambda G \lambda X.\ \forall x'[X(x') \rightarrow \exists d[d \prec \textbf{35 feet} \wedge G(d)(x')]]$

c. $[\![\text{Anacondas}]\!] = \lambda x.\ \textbf{Anaconda}(x)$

d. $[\![\text{less than 35 feet (long)}]\!] =$
$\lambda G \lambda X.\ \forall x'[X(x') \rightarrow \exists d[d \prec \textbf{35 feet} \wedge G(d)(x')]](\lambda d \lambda x.\ \mu_{length}(x) = d)$
$= \lambda X.\ \forall x'[X(x') \rightarrow \exists d[d \prec \textbf{35 feet} \wedge \mu_{length}(x') = d)]]$

e. $[\![\text{(less than 35 feet (long))(Anacondas)}]\!] =$
$\lambda X.\ \forall x'[X(x') \rightarrow \exists d[d \prec \textbf{35 feet} \wedge \mu_{length}(x') = d)]](\lambda x.\ \textbf{Anaconda}(x))$
$= \forall x'[\textbf{Anaconda}(x') \rightarrow \exists d[d \prec \textbf{35 feet} \wedge \mu_{length}(x') = d)]]$

The truth-conditions in (36-e) are equivalent to those that would be given by (34) for (33-a). For $F_{anaconda-length}$ to reach 1 at some value strictly less than 35 feet, it must be the case that all anacondas have a length less than 35 feet (which is what (36-e) says). The graph of $F_{anaconda-length}$ that makes (33-a) true is in Figure 16.

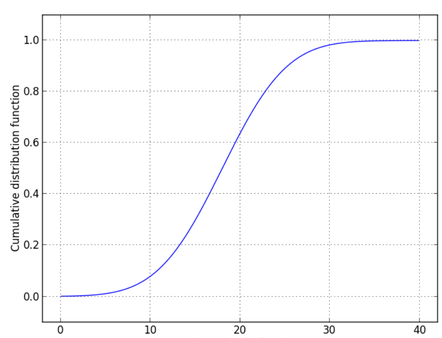

Figure 16 The distribution of anacondas along the length scale

(34) is not intended to apply only to predicates containing gradable adjectives and measure phrases. It is more generally a condition on predicates that introduce measure-phrase modified continuous scales. We note that verbal and nominal predicates may also introduce such scales as in (37). In each of these cases, it is clear that once we have identified the nature of the scale and determined the range of values that are specified by the measure expressions, the truth values have to do with whether the relevant CDF is entirely contained within these values or not. How such scales are compositionally obtained from the linguistic material in the predicate is a matter for further research.

(37) a. Pygmy shrews weigh less than 5g.
b. Elephants weigh more than 100 kg.
c. Sea-turtles live to be up to 100 years old.
d. Sequoia trees grow up to a height of 300 feet.

3.4.2 Previous treatments of generics with measure expressions

Unlike the approach taken here, previous work on generics containing predicates with measure expressions has not studied them in terms of the restrictive effects of such expressions on the range of values denotable by gradable expressions. Rather, such sentences have been studied within the majority-based quantificational approach in the context of cases like those in (38). The question has been, what makes these sentences false, despite expressing temporally stable (stationary) majority-based generalizations? (38-a) is false even though the majority of people are over the age specified by the measure expression *three years*. Despite the fact that most crocodiles (like the sea-turtles) do die in infancy, (38-b) is not true. Same with the others.

(38) a. People are over three years old.
b. Crocodiles die before they attain an age of two weeks.
c. Buildings are less than 1000 feet tall.
d. Animals weigh less than two tons.
e. Shoes are size 7 and above.

All the examples in (38) were first introduced as puzzles for the majority-based approach in Cohen (1999: 246). Cohen's solution (couched within his influential probability-based account) was as follows: In order for a generic to be acceptable, the domain of the generic quantifier must be homogeneous with respect to salient partitions of the quantifier domain. That is, if a generic *As are B* is to come out true, then it must be the case that for every cell A' of a salient partition of A, $P(B|A')$ is the same.[23] If A can be naturally partitioned into sets based on some cognitive criterion, then generic truth requires that if such a partition becomes salient, then homogeneity with respect to that partition must be met. For Cohen, saliency of a partition is determined by context, language user, and the world-view of this language user, and therefore, variably accessed in utterance contexts.[24] Salient dimensions along which sets may be naturally partitioned include space, gender, and numerical scales. (38-a) and (38-b) are false under this account because the predicates *over three years old* and *before they attain an age of two weeks* make contextually salient an age-based partition. Consider such a partition of the set of people (with reference to (38-a)). This partition will have some cells in which the probability for the members of these cells to be over three years old is zero or very low (namely, the sets of baby-people and toddler-people). Since the domain of the generic violates homogeneity in this case, the sentence is ruled as false (Cohen 1999: 246). (38-c), (38-d), and (38-e) make salient partitions that are based on height, weight, and size respectively, rendering all the sentences false.

The homogeneity condition on the domain of the generic quantifier is intuitively attractive and it captures the idea that the distribution of a property among the members of a given set must be relatively even across its subsets for the sentence to express a true generalization. But, as Leslie (2008) points out, the homogeneity condition, as it is articulated, does not explicate how a certain partition gets to become salient. There are two aspects to this problem. The first question is: what role does the predicate itself play in making a partition salient? For instance, can a predicate B make salient a simple two-celled partition of A into the As that are B and those that are *not*-B? If this were the case, then any non-universal generic sentence would be falsified, so clearly the predicate itself cannot directly be the source of salient partition. Second, if the predicate, not always but only sometimes, contributes to making certain partitions salient, then we are left with the question of

23 Since these generics, on Cohen's typology, are *absolute generics*, it is also necessary that for each A', $P(B|A') > 0.5$.

24 This allows Cohen to maintain the truth of sentences like those below despite the fact that they do violate particular partitions. The idea is that such sentences are true because the violated partition is not rendered salient in the context.

a. Mammals have a placenta.
(violates homogeneity because of the partition into placental mammals and marsupials)

b. Birds fly.
(80% of the birds in Antarctica are flightless birds, violating homogeneity on a space-based partition)

how context and worldview combine with information from the predicate to do this. To make the problem concrete, consider the two sentences in (39).

(39) a. Lions are male.
b. Mosquitoes carry malaria.

(39-a) is false because gender is an intrinsically salient partition rendered even more salient by the predicate *male*. But why is this partition never salient in evaluating the truth of (39-b) where only the female Anapheles mosquito ever carries the parasite and the homogeneity condition is violated? At the very least, what is needed is a predictive theory of salient partitions and their relation to the context and the predicate. If certain partitions are inherently salient, then the precise conditions under which their salience can be suppressed, must be explicated.

We will not go into these questions any further here, and only note that the CDF-based analysis that we sketched in 3.4.1 allows us to eliminate the homogeneity condition and contextual reliance on salience of partitions by relying instead on the conventional contributions of measure expressions to the meanings of gradable predicates. The truth of generics containing such expressions simply depends on whether the distribution of values for the relevant property for a random element of the kind is within the restricted range specified by the measure expression — i.e. whether the CDF falls within that range of values.

3.5 Predicates that introduce categorical scales

Given that the classification of generic sentences being developed here is based on the structural properties of the scales encoded by their predicates, we have so far considered mainly generic sentences containing adjectives. However, as indicated by the examples in (37), we are not offering an analysis of generics with adjectival predicates. The analysis is intended to apply across the board to all (bare-plural, inductive) generics; the focus on adjectives is because the effort has been to show the systematic interaction between scale structure and generic interpretation. This section examines the class of generic sentences that do not introduce continuous scales — perhaps the most familiar cases of all. Certainly, these are examples that have occupied central place in the generics landscape so far.

(40) a. Lions are predatory cats. (all)
b. Elephants have trunks. (all)
c. Birds fly. (almost all)

d. Lions have manes. (little less than half)
e. Whales give birth to live young. (little less than half)

f. Peacocks have beautiful tails. (little less than half)

g. Mosquitoes carry the West Nile virus. (less than 1%)
h. Tigers eat people. (very small fraction)
i. Sharks attack bathers. (very small fraction)

On the view taken here, all the generics in (40) exemplify a single phenomenon — they are cases where the predicate introduces a categorical scale with only two possible values — 0 (false) and 1 (true).[25] Each member of a given set may register either one of these values and the outcome is a discontinuous CDF. In order to determine if such a distribution renders the generic true or false, we apply the condition in (41) repeated from (15-e), which is similar to (15-c), which was used in §3.3 for relative adjectival predicates.

(41) Whenever B introduces a categorical scale, there is a contextually accessed **admissible comparison class** A' s.t. $F_{AB} \succ G_{A'B}$.

The intuition behind using comparison classes in the truth-conditions for generics with categorical scales is the following: the attribution of a property to a kind is a way of categorizing or classifying that kind as expressing the property to a sufficient extent. Given that there is no conventionalized standard (a strictly established proportion of elements that must express the property, a hardwired *gen*, so to speak), the degree of expression of the property in the kind (i.e., the proportion of its members that express it) must be compared to its expression in a larger set of entities. Attributing the property to a kind only makes sense if this proportion is salient relative to the proportion observed in the background set.

Here is how we can determine the truth for a sentence like (40-d). We locate the position of *lions* in the taxonomic hierarchy, and might, in a given context, identify the super-kind *felids*, as an admissible comparison class: it is a set that includes $Alt(lions)$ (e.g. jaguars, tigers, bobcats, domestic cats), *have a mane* is defined for each element $x \in felids$; there exists sub-kinds of felids (e.g., domestic cats, jaguars), whose members are never in the predicate denotation. Given this, we compare the CDFs of the population of lions and felids along the discrete 0-1 scale introduced by *have a mane*. The graphs of $F_{lions-mane}$ and $G_{felids-mane}$ would look somewhat like in (42) since lions are the only felids with manes. It is clear that $F_{lions-mane} \succ G_{felids-mane}$ — making (40-d) come out true. Note that this is a case of first-order stochastic dominance since $F(x) \leq G(x)$ for every $x \in \mathbb{R}$.

On this approach, salience is less sensitive to absolute proportions than relative proportions. It is possible for a property to be sparsely expressed in a kind but a

25 Such a two-point scale can be interpreted as being embedded in a continuous scale. It is just that all elements of any set can take values only at two points in the scale — 0 and 1.

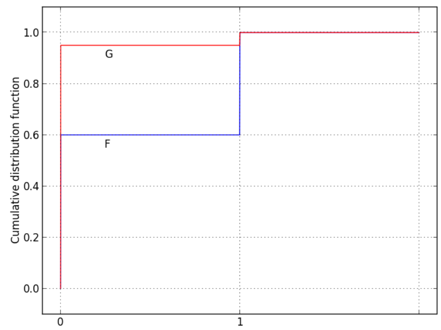

Figure 17 $F_{lions-mane} \succ G_{felids-mane}$

generic may come out true if its expression in the comparison class is even sparser. Whales are more likely to give birth to live young than large sea animals (or the larger class of animals), mosquitoes are more likely to carry the West Nile virus than insects, tigers are more likely to eat people than felids are, and sharks are more likely to attack bathers than fish in general. In other words, generics with predicates that introduce categorical scales come out like Cohen's relative generics.

3.5.1 Previous treatments of statistical variability in generics

It is worth pointing out here that the sentences in (40) have not been taken to form a unified class in the existing literature. Sentences like *Birds fly*, *Lions have manes*, and *tigers eat people* have been taken to involve distinct ingredients for their analysis.

On the basic frequentist probability account that Cohen builds (Cohen 1996, 1999), sentences like *Birds fly* are true at some time t iff the probability (limiting frequency) of flying birds among birds is high (>0.5) and remains approximately the same over long intervals in every admissible history continuing t. All majority-based true generics (e.g., (40-a)-(40-c)) work like *birds fly*; they are quasi-universal claims that exhibit temporal stability.

For sentences like (40-d)-(40-f), Cohen introduces the notion of predicate-induced alternatives. The proposal is that the domain of the generic quantifier is restricted by the properties of the predicate in the generic sentence — specifically by association with a set of alternatives. So a sentence like *As* are *B* is interpreted relative to the set $Alt(B)$ — the set of alternatives to B. *Lions have manes*, for instance, induces a set of alternative sexually selected decorative traits, e.g. {*have coloration* *of feathers, have antlers, have rump coloration, have manes*}. The domain of the generic quantifier is restricted to only those lions who satisfy at least one of the alternatives, i.e. have some form of decorative sexual trait. Thus, a generic, *As are B* is true iff the probability that a randomly chosen A that also satisfies at least one of the properties in $Alt(B)$ is B is greater than 0.5. Since a lion carrying some sexually selected decorative trait is highly likely to have a mane, *Lions have manes* is true. The alternatives for (40-e) are alternative ways of reproducing (laying eggs, giving birth to live young, mitosis). Since a whale that satisfies one of these alternatives is highly likely to give birth to live young, (40-e) is true.

Finally, the analysis for sentences like (40-g)-(40-i), is closest to ours. These are relative generics *As are B* in which the union of the alternatives to A is considered for interpretation. (40-g)-(40-i) come out true because in each case, a random member of A is more likely to satisfy B than a random member of the union of alternatives to A. This is exactly what it means to say that $F_{AB} \succ G_{A'B}$.

3.6 Generic comparisons

Nickel (2010) introduces into the discussion of generics a class of sentences that he calls *generic comparisons*.

(42) a. Girls do better than boys in grade school.
b. Horses are taller than cows.

The observation is that such sentences do not convey that all/most girls do better than all/most boys or that all/most horses are taller than all/most girls. His intuition, which we share, is that one scenario that makes (42-a) true is when the distribution of scholastic achievement among girls is systematically shifted to the right of that among boys as in Figure 18.

The distribution is one in which the academically poorest girls are better than the academically poorest boys, the middle performing girls are better than the middle performing boys, and the academically most successful girls are better than the corresponding boys. Nickel carefully shows how existing analyses fail to yield the right truth-conditions for such sentences. The analysis he proposes treats generic comparisons as plural comparatives, with *gen* as a universal distributive quantifier over normal members of the kind that quantifies over paired subsets of the relevant sets. Nickel's analysis is fully compositional and we are hardly in a position to attempt a compositional analysis of generic comparisons using CDFs and stochastic comparison here.

We will, for the purposes of this paper, simply observe that analyzing such sentences directly in terms of CDFs and stochastic comparison, brings out their meaning rather straightforwardly. Let us assume that the comparative morpheme

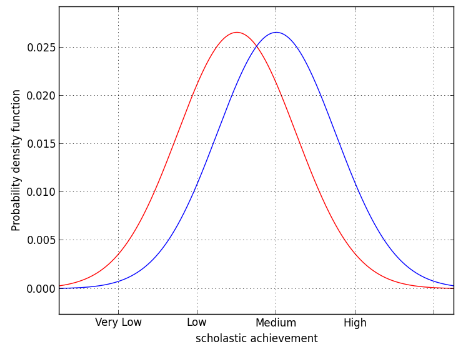

Figure 18 Right-shifted distribution of girls (blue) compared to boys (red)

and the comparative clause form a constituent for semantic interpretation and that together they determine the standard of comparison. That is, whenever a generic sentence lacks comparative morphology, the standard of comparison is given by an admissible comparison class. This is how the interpretation of relative gradable predicate in the positive form proceeds (as seen in 3.3). Whenever such material is explicitly present in the sentence, it contributes the standard of comparison.

For a sentence like (42-a), the continuous scale introduced by *do better in grade school* is the scale of goodness of scholastic achievement — abbreviated here to *schol*. We compare $F_{girls-schol}$ with $G_{boys-schol}$ and the sentence is true iff $F_{girls-schol} \succ G_{boys-schol}$.

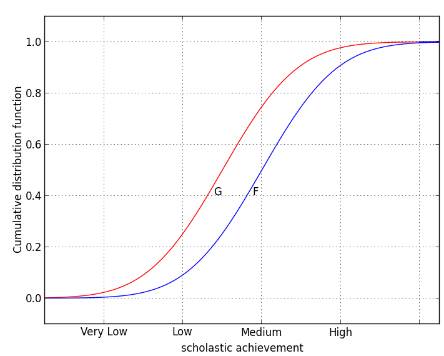

Figure 19 $F_{girls-schol} \succ G_{boys-schol}$

Stochastic domination in this direction is of course determined by the form of the comparative morphology, *–er*, which specifies that the values associated with the subject denotation exceed the values associated with the standard of comparison. This is what it means to say that *John is tall-***er** *than Mary.* In a sentence like (43-a), the two CDFS are expected to align, while in (43-b), $F_{girls-aggression}$ should be stochastically dominated by $G_{boys-agression}$, since that is the contribution of *less than*.

(43) a. Girls do as well as boys in grade school.
b. Girls are less aggressive than boys.

Working out a compositional analysis for such sentences, where the comparative clause can be taken to introduce a distribution as the standard of comparison rather than a degree would be the next step in working this out more fully.

3.7 Generic sentences that lack admissible comparison classes

In this section, we consider a class of generic sentences that come out false because of the absence of an admissible comparison class that can provide the background distribution against which the target distribution can be compared for salience satisfaction. Based on the analysis that we will sketch, it might be argued that these are in fact closer to being cases of presupposition failure (there is no way to evaluate them for truth) rather than falsity. However, the existing view on the matter is that they are false.

(44) a. Books are paperbacks.
b. Mammals are placental mammals.
c. Ducks are female.
d. Lions are male.

Cohen (1996, 1999) attributed the falsity of such sentences to the violation of the homogeneity condition on the domain of the generic quantifier, a notion that was introduced in 3.4.2. Although the majority of books are indeed paperbacks, the predicate *paperbacks* makes salient a partition of books into those that are leather-bound, cloth-bound, have hard covers, etc. and the probability that any of the books in those cells are paperbacks is zero — making the sentence false. *placental mammals* makes salient the partition of mammals into those that have a placenta and marsupials, rendering the sentence false. Homeogeneity is violated on the gender-based partition in (44-c) and (44-d).

On the analysis here, these sentences come out false, not because homogeneity is violated, but rather because the predicates they contain do not allow the identification of any admissible comparison-class to contribute the background distribution. The definition of an admissible comparison-class is repeated in (45). The generics in (44) fall under two classes: those which are false/undefined because there is no comparison-class that satisfies (45-b) — these are (44-a) and (44-b) and those that are false/undefined because there is no comparison-class that satisfies (45-c) — these are (44-c) and (44-d).

(45) **Admissible comparison-class:**
A set A' is an admissible comparison class for A iff

a. $A' \supseteq Alt(A)$
A' includes the union of alternatives to A

b. $\forall x \in A' : [\![B(x)]\!] \in \{0,1\}$
B is defined for each member of A'

c. $\exists A'' \in Alt(A) : \forall x \in A'' : [\![B(x)]\!] = 0$
$Alt(A)$ and therefore A' are diverse w.r.t B

3.7.1 Failure of the definedness condition on comparison classes

It is easy to construct false generics on the pattern of *books are paperbacks* — simply let the predicate be a hyponym of the subject.

(46) a. Books are paperbacks.
b. Mammals are placental mammals.
c. Pachyderms are elephants.
d. Indoor games are board-games.
e. Pens are ball-point pens.
f. Asians are East Asians.

In each of the sentences above, the predicate is undefined for entities that are not in the set denoted by the subject. The predicate *placental mammal* presupposes that the entity being described is a mammal. Suppose we have a comparison class A' that includes $Alt(mammal)$ — say it includes birds, fish, and insects. No entity other than members of the subset of mammals in A' satisfies the presupposition imposed by *placental mammal*. If Tweety is in the set of birds, the sentence *Tweety is a placental mammal* is not false, to us, it just lacks a truth-value. More generally, the hyponymic relation guarantees that there can be no comparison class A' for (46-b) that satisfies (45-b). Given that we have a categorical scale and no comparison class to determine whether stochastic domination obtains, the sentences are unacceptable.

Hyponymy is a relation between linguistic expressions and the oddity of the sentences in (46) has much to do with the linguistic formulation of the predicate. There is (to our ears, at least) increased acceptability for some cases when the predicate is formulated differently — as already observed with the mammal case, (47-b), by Cohen (1999).[26]

(47) a. Books have covers made out of paper.
 b. Mammals have a placenta.
 c. Pachyderms have long trunks and tusks.
 d. Pens have a ball-pointed tip for writing.

3.7.2 Failure of the diversity condition on comparison classes

False generics like those in (48) involve the diversity condition on admissible comparison classes — (45-c).

(48) a. Lions are male.
 b. Ducks are female.
 c. Dogs are sexually mature.

The diversity condition requires that an admissible comparison-class A' contain (the members of) at least one alternative to A, A'' s.t. no member of A'' is in B. This condition is motivated by our understanding of salience. Predicating a property of an individual or set of individuals is useful only against the background of other individuals/sets that do not express that property to the degree to which it is expressed in the individual/set.

With categorical scales introduced by *male* and *female*, degree of expression can only be compared in terms of proportion. Any comparison-class we might consider for (48-a) would need to contain some $A'' \in Alt(lions)$ s.t. no element in A'' is male, for it to be admissible. There is no such admissible comparison-class, unless we move to the plant kingdom, in which case (45-b) will be violated. Thus (48-a) is ruled as false as is (48-b). The scale introduced by (48-c) is continuous but the problem remains the same — we are unable to find a set among the alternatives to *dogs* which has only sexually immature members. There is thus no admissible comparison-class.

26 On his analysis, however, it is still a puzzle why (46-b) induces a partition of the set of mammals but (47-b) doesn't.

3.8 Logically complex predicates

Nickel (2009, 2013b) introduces yet another class of generics where the predicate contains logical connectives.

(49) a. Elephants live in Africa and Asia.
b. Bears live in North America, South America, Europe, and Asia.
c. Cats are black, white, and ginger.

Nickel suggests that such sentences are equivalent to those in (50) respectively.

(50) a. Elephants live in Africa and elephants live in Asia.
b. Bears live in North America and bears live in South America and bears live in Europe and bears live in Asia.
c. Cats are black and cats are white and cats are ginger.

Such sentences present a problem to majority-based quantificational views leading Nickel to pursue an alternative in which normality is taken to be a primitive. Nickel diverges from statistical and quantificational approaches to the question of truth-conditions and offers instead an analysis in which what is involved is existential quantification over normal ways of being members of a kind (with universal quantification embedded under the existential quantification). The general idea is that in generics, we are interested in characterizing the normality of an individual in a certain respect (habitat, means of reproduction, color, diet etc.) and this 'respect' is determined partially by the predicate. (49-a), on this theory, is interpreted as (51).

(51) There is a way w_1 of being a normal elephant in respect of its habitat, and all elephants that are normal in w_1 live in Africa, and there is a way w_2 of being a normal elephant in respect of its habitat, and all elephants that are normal in w_2 live in Asia. (Nickel 2009: 642)

We agree with Nickel's observation that we need a mechanism by which each individual conjunct in each sentence in (50) is judged true and our approach gives that to us without any auxiliary assumptions. The scales introduced by predicates like *live in Africa*, *live in Europe*, *are black*, etc. are categorical and therefore the sentences will be evaluated relative to an admissible comparison-class by condition (15-e). On our account, both *Elephants live in Africa* and *Elephants live in Asia* will come out as true: The admissible comparison-class will include alternatives to *live in Asia* (giving us the set of entities that live (stationarily) in any of the six continents, i.e. anywhere in the world. Given the facts in the world, $F_{elephants-Asia}$ will stochastically dominate $G_{elephants-world}$. $F_{elephants-Africa}$ will also stochastically dominate $G_{elephants-world}$. Both sentences will therefore be judged true. Figure 20 can represent either situation.

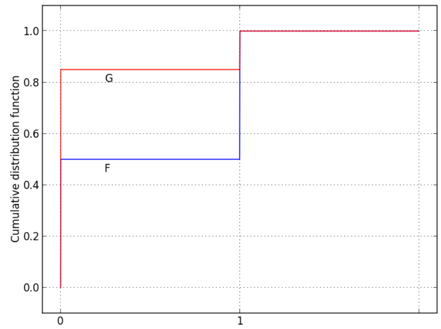

Figure 20 $F_{elephants-Asia} \succ G_{elephants-world}$ OR $F_{elephants-Africa} \succ G_{elephants-world}$

For *cats are black, white, and ginger* to come out true, it simply needs to be the case that the proportion of black, white, or ginger cats is greater than the proportion of black, white, or ginger felids or mammals. This is highly likely to be the case given our state of knowledge about felids and mammals giving us a true judgement for (49-c)/(50-c).

3.9 Remainders

Finally, we come to a set of sentences from the literature that are yet to be accounted for.

(52) a. Primary school teachers are female.
b. Israelis live on the coastal plain.

For Cohen (1999), these are both cases of homogeneity violation. *live on the coastal plain* makes salient a partition of the set of Israelis based on their geographical location. The probability that a random Israeli that lives in Jerusalem lives on the coastal plain is zero, (52-b) comes out false. It works similarly for (52-a).

We have a different take on each of these sentences. For (52-a), we will simply say that the existing distribution of females and males in the educational system (relative to the larger workforce) is a result of complex and changeable socio-economic facts and the sentence is rendered false because it violates stationarity. This is not very satisfactory but it is the only option available to this approach until a more substantive theory of salience and which properties might be (un-)informative in kind-classification, can be developed.

Things are slightly more complex for (52-b). The predicate *live on the coastal plain* introduces a categorical scale, requiring us to consider an admissible comparison-class for evaluating the truth of the sentence. Consider now the definite description *the coastal plain* — it can either be interpreted as referring to the coastal plain of Israel or it can be interpreted as a function applying to an entity x (the subject denotation) and returning the coastal plain of the country related to x. In the first case, negligibly few elements in A' (the comparison-class) that are not Israeli will satisfy the predicate *live on the coastal plain*. Let the alternative set $Alt(Israeli)$ contain Europeans and Asians. On the referential reading for *the coastal plain*, the sentence should come out true — i.e. the CDF of $X_{israeli-coast}$ indeed dominates the CDF of $X_{eurasian-coast}$. Indeed, one can imagine a context in which the sentence is judged true:

(53) a. A: Do Russians live on the coastal plain (of Israel)?
b. B: No, [Israelis]$_F$ live on the coastal plain.

In the second case, when *the coastal plain* receives a functional reading, the sentence comes out false, because there is no admissible comparison-class. Any such class would violate either the diversity or the definedness condition on admissible comparison-classes. Here is the reasoning: The set of alternatives $Alt(Israeli)$ must contain a set containing inhabitants y of country x s.t. no y living in x lives on the coastal plain of x (by the diversity condition). This requires that x either lacks a coastal plain (e.g. Iraq) or that its inhabitants systematically shun it. The latter is too far-fetched; the former renders the predicate *live on the coastal plain* undefined for inhabitants of x, making the comparison-class inadmissible for practical purposes. We do predict that if there is indeed a set in $Alt(Israeli)$ of inhabitants y of some country x s.t. no y living in x lives on the coastal plain of x, the sentence should come out true.

4 Contextually given background distributions

4.1 Standards of comparison and contextual expectations

The cases discussed so far consider three ways in which the truth of generic sentences relies on a standard of comparison. With minimum-standard and maximum-standard predicates, the (relatively) fixed standard of comparison is an end-point degree on the scale encoded by the predicate. With open-scale and categorical-scale predicates, one identifies an admissible comparison class which gives the background distribution against which the generic is evaluated for salience (= stochastic dominance). In the case of comparative generics, the comparative clause provides the relevant distribution. In each case, what is needed is a distribution that gives the "standard of comparison". The role of the comparison-class is to allow for the computation of this standard so that the comparison can be made to "check" for salience. The notion of a comparison-class is thus subservient to the notion of the standard of comparison — the former is an important (but not the only) source for the latter.

Moving back to the semantics of the positive form of relative adjectives, it has been noted that the degree to which an entity possesses the property associated with the adjective should be significantly greater than what counts as the standard in the utterance context. Kennedy (2007) observes that Boguslawski (1975) has understood this to mean a degree that is 'conspicuous', 'noteworthy', or 'sufficient to attract attention', while Graff (2000) takes it be an interest-relative , significant degree of the measured property for the comparison class in the context. What counts as significant is a matter of context and varies according to the interests and the expectations of discourse participants. In certain contexts, what might count as the standard of comparison might in fact be lower than the average degree. Consider for instance, a scenario outlined by Kennedy:[27]

> For example, if I walk into a bar that I know to have extremely cheap but delicious coffee, and find that they have suddenly raised the price of an espresso, I can felicitiously use (20) to complain about this to the baristo even if the actual cost of the coffee remains below average.
>
> (20) Hey, the coffee is expensive now!
>
> In this example, the new price is significant relative to my expectations, but still below average. (Kennedy (2007), preprint: 15)

In such a case, it seems that the standard of comparison is directly obtained from the context of utterance, without necessarily accessing a comparison-class, being determined by the beliefs and expectations of the discourse-participants instead.

4.2 Existential generics

In the domain of generics, a similar pattern is observed in the class of sentences that Cohen (2004) calls *existential generics*. These are cases where generic sentences are judged true in specific contexts despite the fact that very few instances of the kind exhibit the property in question. Cohen illustrates these with contextual support.

27 This discussion only occurs in the preprint version of Kennedy (2007) and not in the official version.

(54) a. A: Nobody in India eats beef.
b. B: That's not true! Indians [do]$_F$ eat beef! (Cohen 2004: 139)

(55) a. A: Mammals don't ever lay eggs.
b. B: Mammals lay eggs. There are the platypuses and the echidnas. (based on Cohen 2004: ex.7a)

As Cohen observes, these generic statements are refutations that contrast with a claim in a given context that the universal negative statement is true. Although the vast majority of Indians avoid beef consumption, (54-b) is felt to be true in the context because it corrects the false universal assertion in (54-a). Same with (55-b). We add a few more examples to the dataset so that the pattern and intuition are clear.

(56) a. A: Dogs are completely safe.
b. B: I don't agree. Dogs maul children.

(57) a. A: People only think about their own good.
b. B: That's not true. People think about others' good.

It is enough that a few dogs maul children for (56-b) to come out true in the context where the expectation (given by the use of the maximum standard adjective *safe*) is that all dogs meet the standards for safety. The use of the exclusive *only* in (57-a) licenses the correction in (57-b), which only requires there to be some altruistic people.

In each case, the context of utterance provides the standard of comparison — a background distribution relative to which the distribution associated with the generic is salient. (54-a) is a universal negative statement; it will be true iff $F_{indians-beef}$ reaches 1 at 0 — i.e. if all Indians are non-beef-eaters. This is the contextually given distribution which models the beliefs of the utterer of (54-a). (54-b) asserts that the actual distribution for $F_{indians-beef}$ is salient — it stochastically dominates the contextually given $G_{indians-beef}$. This is visually given in Figure 21.

Each of the above cases works the same. The generic CDF stochastically dominates the CDF associated with universal statements in the context. The universal statements provide the standard of comparison distribution and the generic statements satisfy salience relative to this standard.

4.3 Ambiguous generics

Carlson (1989) introduces generic sentences that have more than one characterizing reading:

(58) a. Typhoons arise in this part of the pacific.
(i) Typhoons in general have an origin in this part of the Pacific.

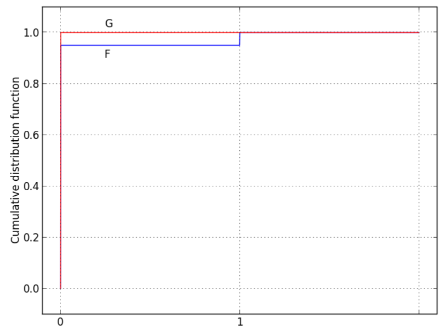

Figure 21 $F_{indians-beef} \succ$ (contextual) $G_{indians-beef}$

(ii) There arise typhoons in this part of the Pacific.

b. Computers compute the daily weather forecast.[28]
(i) Computers in general compute the daily weather forecast.
(ii) The daily weather forecast is computed by computers.

In the examples above, the strong quantificational readings, (58-a-i) and (58-b-i), are much less natural than the weaker ones in (58-a-ii) and (58-b-ii). One does not generally interpret (58-a) to mean that it is typical for typhoons to arise in this part of the Pacific. Nor does one interpret (58-b) to mean that the typical task of a computer is to compute the daily weather forecast. The approach here predicts two interpretations for (58-a) and (58-b) but these do not exactly correspond to the above readings.

Consider (58-a). *arise in this part of the Pacific* is a categorical predicate and so the truth-conditions will depend on satisfaction of (15-e). An admissible comparison-class for *typhoons* might be the set of *sea-events* in different parts of the world which will include *Alt(typhoons)* — so it will contain tsunamis, hurricanes, and cyclones.[29] The sentence is true iff $F_{typhoon-Pacific} \succ F_{seaevent-Pacific}$ — paraphrasable as in (59).

(59) Typhoons are more likely to occur in this part of the Pacific than other sea-events.

28 The original example contains an indefinite NP *a computer* but the ambiguity is retained with the bare plural.

29 Hurricanes are tropical cyclones occurring in the Atlantic and North-East Pacific; Cyclones occur in the South Pacific and the Indian Ocean, while tropical cyclones in the North-West Pacific are called typhoons.

This is a stronger reading than (58-a-ii) but it is not quite as strong as the reading in (58-a-i) because there is no constraint on the occurrence or even prevalence of typhoons beyond this part of the Pacific.[30] It is entirely compatible with (58-a-i) though. This is a reading that would be associated with the sentence if the question under discussion is: *What are the sorts of natural disasters that happen in this part of the Pacific?* or *Where do typhoons occur?*[31]

The reading in (58-a-ii) is the more natural one. What seems to be happening when we get this reading is that (58-a) is interpreted against a contextually given standard of comparison distribution, rather than the one corresponding to an admissible comparison-class.

It is not difficult to imagine a context in which the listener is uninformed about the distribution of typhoons in the world's oceans or even the existence of a phenomenon such as a typhoon. In such a context, the information in (58-a-ii) is being conveyed, not against a single contextually given or expected background distribution about typhoon proportions in this part of the Pacific, but rather against several such distributions — including a distribution in which no typhoons occur in the region. That is, the context is compatible with the negation of (58-a-ii). (58-a-ii), in any such context, stochastically dominates the standard of comparison distribution and is thus "salient" or "noteworthy" relative to it. The effect of uttering (58-a-ii) is to eliminate the negative proposition that corresponds to the distribution.

The weak reading for (58-b) also arises when the context is compatible with the distribution that corresponds to the negative statement (*computers do not compute the daily weather forecast.*).

There is a small difference between the generic sentences in 4.2 and those discussed here. (58-a) and (58-b), on the weak reading, are not refutations of explicit negative claims (and the specific distributions that they describe). They are informative proposals to update the context by eliminating certain distributions that are assumed to be compatible with the prior context. Such sentences are rendered most natural in contexts where the information they convey is 'significant' or 'noteworthy' because the distribution they describe is salient relative to a contextually expected distribution. A full treatment of existential generics and existential readings of ambiguous generics depends on integrating them with a formal theory of context and contextual update. This is a task for future research. Here we point out more

30 The stronger reading for (58-b) would be correspondingly paraphrasable as: Computers are more likely to compute the daily weather forecast than other things (e.g., humans, mechanical instruments).

31 A question like *where do typhoons occur?* will invoke a set of alternatives to the predicate as well, which will further affect the interpretation in context since in answer to that question, the sentence may have an exhaustive flavor (only in this part of the Pacific, not elsewhere). But we take this to be pragmatic strengthening and not part of the truth-conditions of the sentence.

examples that show that this is not an isolated phenomenon — all of them ambiguous, and false on the strong reading.

(60) a. Penguins live in the Galapagos islands.
b. Photographs sell for millions of dollars.[32]
c. People own whole islands.
d. People swallow snakes whole!
e. Elephants paint pictures with their trunks.

5 Positioning the analysis within the generics landscape

Here are the main characteristics of the analysis that we have presented:

(61) a. The interpretation of generic sentences is closely guided by the scalar properties of the predicates they contain.
b. The stochastic process associated with generic sentences must satisfy stationarity — (9).
c. The CDF associated with a generic sentence must satisfy **salience**. Salience is checked by comparing the distribution of a generic to a standard of comparison.
(i) Such a standard may be conventionally determined by the properties of lexically encoded scales (for minimum and maximum standard predicates).
(ii) It may be morphosyntactically provided via measure expressions and comparative morphology.
(iii) The absence of linguistically accessible standards of comparison results in sourcing the context for determining such a standard.
— The distribution obtaining in admissible comparison-classes may provide the standard of comparison. (relative adjectives and categorical scale predicates)
— The discourse context may also provide the background distribution that yields the standard of comparison. (existential generics)

Within the literature on generics, the question about their logical form has been much debated: should generics be taken to be kind referring or quantificational? Our side in this debate is clear. If the analysis, summarized in (61), is on the right track, then at least the generics that fall under its scope do not have tripartite quantificational structure but are cases of kind predication. The goal has been to show that in

32 ‘Rhein II’ by Andreas Gursky sold for $4.3 million while Peter Lik’s ‘Phantom’ sold in 2014 for $6.3 million.

determining whether a property B can be attributed to a kind A, speakers are closely guided by the scalar properties of B. In kind predication, what is of interest is not the assignment of values to particular individuals in the population of As, but rather determining the statistical features of how much and to what extent B is expressed in that population. In order to implement this intuition, we have interpreted the contribution of bare plurals so that the predicate directly characterizes this denotation. Bare plural subjects in generics contribute sets while predicates contribute scales and associated ways of determining standards of comparison. These standards of comparison may correspond to distributions fixed by the conventional meanings of predicates (as in the case of minimum and maximum standard adjectives and measure expressions). In other cases, the standards of comparison may be distributions associated with admissible comparison-classes (as in the case of relative adjectives and categorical scales). But uniformly, the predicate describes a characteristic of the kind by characterizing the extent to which the set of members of the kind express the property associated with the predicate's scale. This extent must be salient in a way determined by the scalar structure of the predicate itself. Working out the precise compositional analysis that goes hand in hand with the conceptual analysis we have offered here is a task for further research. But we expect this to be a *gen*-less analysis with the bulk of the work to be carried out by introducing distributions over degrees into the type-system.

The analysis offered here, builds on ideas from, and is in direct competition with, quantificational analyses of broad empirical coverage that have been developed by Cohen (1996, 1999, 2001, 2004 etc.) and Nickel (2009, 2010, 2013a, 2013b). As they do, we too seek a general semantic theory of generics that allows their interpretation to be predictable from their linguistic profiles. The analysis here makes use of Cohen's invoking of alternatives and the category of relative generics and builds on the integration of genericity and gradability in Nickel's work. But it differs from both these approaches in taking the logical form of generics to involve direct predication rather than quantification. There remain issues of compositionality that must be concretely worked out before the different approaches can be appropriately compared in terms of their empirical coverage and theoretical economy. In favor of the current analysis though is its close reliance on scalar structure in deriving truth-conditions — a connection that has not been made in any previous analysis and a connection that accounts for a surprisingly large proportion of the variability in statistical patterns observed.

In closing, we contrast the set of semantic approaches to generic meaning with that of Leslie (2007, 2008, and later work). Leslie argues that any truth-conditional account of generics is beset with insurmountable difficulties despite any sophisticated ways that one might come up with to capture their truth-conditions. Her approach is to abandon the tools of model-theoretic semantics and focus instead on the cognitive aspect of generics — how do speakers (including children) understand and produce generics? She proposes that generics reflect a default mechanism of generalization employed by the cognitive system, a mechanism which is influenced by the 'strikingness' of a property along some characteristic dimension. The default nature of this mechanism is what allows children to acquire it easily and adults to process it easier. She gives a characterization of the circumstances under which a generic of the form *Ks are F* is true:

The counterinstances are negative[33] , and,

(62) a. Almost all Ks are F.
OR
b. If F is a characteristic property of K (e.g. reproductive ability, sexual trait, etc), then it is enough for some Ks to have F.
OR
c. If K is an artifact or a social kind, then F is the function or purpose of K.
OR
d. If F is striking, then some Ks are F and the others are disposed to be F.

Leslie emphasizes that the truth specifications above are descriptions of the necessary state-of-affairs in the world for particular generic sentences to be true, and not to be construed as semantic truth-conditions. That is, these conditions describe truth-makers rather than the properties of compositionally derived logical structures of generic sentences. By her admission, the "complex and disjunctive" conditions in (62) are poor candidates for being truth-conditions (Leslie 2008: 44). According to her, there is nothing unified that can be said about generics from the truth-conditional perspective. One might use *gen* to express the quantificational structure of generic sentences but one can go no further in specifying its contribution.

We think it is too soon to give up on a semantic theory of generics. The disjunctiveness of the conditions that she observes is an emergent effect of the typology of scales that natural language expressions lexicalize and possible modifications to their scalar properties via measure expressions and comparative morphology. The interpretation of generics is still semantically computable from its linguistic ingredients. And there is a reason why generics are cognitively simpler and easier

33 By this she means that members of the kind K that do not exhibit property F should not exhibit any concrete alternative property F'. If it does, that makes the counterinstance positive. A negativecounter instance is simply a case of a entity in K failing to exhibit F (Leslie 2008: 33-34).

to acquire than quantified expressions. They do not involve quantification and their statistical properties are directly predicted from the predicates they contain.

References

Carlson, Gregory. 1977. *Reference to kinds in english*: University of Massachusetts at Amherst dissertation.

Carlson, Gregory. 1989. The semantic composition of english generic sentences. In *Properties, types, and meanings: Semantic issues*, Dordrecht: Kluwer.

Chierchia, Gennaro. 1998. Reference to kinds across languages. *Natural Language Semantics* 6(4). 339–405. http://dx.doi.org/10.1023/A:1008324218506.

Cohen, Ariel. 1996. *Think generic! the meaning and use of generic sentences*: Carnegie Mellon University dissertation.

Cohen, Ariel. 1999. Generics, frequency adverbs, and probability. *Linguistics and Philosophy* 22(3). 221–253. http://www.jstor.org/stable/25001741.

Cohen, Ariel. 2001a. On the generic use of indefinite singulars. *Journal of Semantics* 18(3). 183–209.

Cohen, Ariel. 2004a. Existential generics. *Linguistics and Philosophy* 27(2). 137–168.

Cohen, Ariel. 2004b. Generics and mental representations. *Linguistics and Philosophy* 27(5). 529–556.

Durrett, R. 2010. *Probability: theory and examples* Cambridge Series in Statistical and Probabilistic Mathematics. Cambridge: Cambridge University Press 4th edn.

Franke, Michael. 2011. On scales, salience and referential language use. In Maria Aloni, Floris Roelefson & Katrin Schulz (eds.), *Amsterdamcolloquium 2011*, .

Greenberg, Yael. 2003. *Manifestations of genericity*. New York and London: Routledge.

Greenberg, Yael. 2007. Exceptions to generics: Where vagueness, context dependence and modality interact. exceptions to generics: Where vagueness, context dependence and modality interact. *Journal of Semantics* 24(2). 131–167. http://dx.doi.org/10.1093/jos/ffm002.

Grimmett, Geoffrey R. & David R. Stirzaker. 2001. *Probability and random processes*. New York: Oxford University Press.

Kennedy, Christopher. 2007. Vagueness and grammar. *Linguistics and Philosophy* 30. 1–45. http://dx.doi.org/10.1007/s10988-006-9008-0.

Kennedy, Christopher & Louise McNally. 2005. Scale structure, degree modification, and the semantics of gradable predicates. *Language* 81(2). 345–381. http://dx.doi.org/10.1353/lan.2005.0071.

Klein, Ewan. 1980. A semantics for positive and comparative adjectives. *Linguistics and Philosophy* 4(1). 1–45. http://www.jstor.org/stable/25001041.

Krifka, Manfred, Francis J. Pelletier, Greg Carlson, Alice ter Meulen, Gennaro Chierchia & Godehard Link. 1995. Genericity: An Introduction. In *The Generic Book*, 1–124. Chicago: The University of Chicago Press.

Leslie, Sarah-Jane. 2007. *Generics, cognition, and comprehension*: Princeton Unversity dissertation.

Leslie, Sarah-Jane. 2008. Generics: Cognition and acquisition. *The Philosophical Review* 117(1). 1–47. http://dx.doi.org/10.1215/00318108. http://www.jstor.org/stable/41441845.

Liebesman, David. 2011. Simple generics. *Noûs* 45(3). 409–442. http://dx.doi.org/10.1111/j.1468-0068.2010.00774.x.

Nickel, Bernhard. 2009. Generics and the ways of normality. *Linguistics and Philosophy* 31. 629–648. http://dx.doi.org/10.1007/s10988-008-9049-7.

Nickel, Bernhard. 2010. Generic comparisons. *Journal of Semantics* 27(2). 207–242. http://dx.doi.org/10.1093/jos/ffq004.

Nickel, Bernhard. 2013a. Between logic and the world: An integrated theory of generics. Manuscript, Harvard University.

Nickel, Bernhard. 2013b. Dutchmen are good sailors: generics and gradability. In Alda Mari, Claire Beyssade & Fabio del Prete (eds.), *Genericity* Oxford studies in theoretical linguistics, 390–405. Oxford: Oxford University press.

Pollard, D. 2002. *A user's guide to measure theoretic probability*, vol. 8 Cambridge Series in Statistical and Probabilistic Mathematics. Cambridge: Cambridge University Press.

Potts, Christopher. 2008. Interpretive economy, schelling points, and evolutionary stability. Manuscript, University of Massachussetts, Amherst.

Rotstein, Carmen & Yoad Winter. 2004. Total adjectives vs. partial adjectives: Scale structure and higher-order modifiers. *Natural Language Semantics* 12(3). 259–288. http://dx.doi.org/10.1023/B:NALS.0000034517.56898.9a.