The distributivity (or 'distribution') of a quantification expresses whether a predicate applies to a set of arguments as a whole, or to the members of that set individually, or to certain subsets. The examples below illustrate this issue; in the first sentence the more likely interpretation is that two men acted collectively, whereas in the second sentence two men individually each carried some chairs.

a. Two men carried a piano upstairs.

b. Two men carried some chairs upstairs.

The distinction between collective and individual readings can be brought out by a representation in second-order predicate logic, as follows.[1]

a. $\exists X\ [\ |X|=2 \wedge \forall x\ [x \in X \rightarrow man(x)] \wedge \exists y\ \exists e\ [piano(y) \wedge carry(e) \wedge agent(e,X) \wedge theme(e,y)\ ]]$

b. $\exists X\ [\ |X|=2 \wedge \forall x\ [x \in X \rightarrow man(x)] \wedge \forall y\ [y \in X \rightarrow \exists e\ \exists z\ [chair\ (z) \wedge carry(e) \wedge agent(e,y) \wedge theme(e,z)\ ]]]$

The representation in a) reads as follows: there is a collection X of cardinality 2, which consists of men, and there is a piano y and a carry-event e such that X is the agent of that event and the piano y is the theme. The representation in b) reads: there is a collection X of cardinality 2, which consists of men, and each of these men is the agent of a carry-event with a chair as the theme. Regarding the analysis represented in a), the collection X can be thought of as a set in the mathematical sense. However, a set in this sense is an abstract notion, and as such seems to be of the wrong type to function as the agent of an event. Intuitively, sets do not carry chairs. Alternatively, a lattice-theoretic approach has been proposed (Link, 1983; Landman, 1991), which uses a 'sum' operator to form a composite individual 'a + b' from two individuals 'a' and 'b'. The relation between a composite individual and its components is a formal part-whole relation, rather than a membership relation. A lattice is an abstract mathematical construct, like a set[2]; Kamp & Reyle (1993) show that a set-theoretic and a lattice-theoretic approach are formally equivalent, and are readily converted into one another. For the semantics of annotation structures, this document takes the view that the collective-individual distinction does not primarily concern the type of participants, but rather the way in which multiple participants are involved in an event: collectively or individually, and uses set-theoretic terms to describe this.

The distributivity of a quantification is not necessarily collective or individual. The sentence in b) below, for example, when uttered in a context where the promise expressed in a) had been made, does not have the same collective/individual ambiguity as the structurally similar case for count nouns.

a. If you carry all these boxes upstairs today I'll give you an ice cream tonight.

b. The boys carried all the boxes upstairs.

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[1] Predicates representing semantic roles are understood in this document as having as their first argument an event and as their second argument an individual, a set of individuals, a part of an individual, a quantity, or another event.

[2] In fact, a lattice is defined as a partially ordered set with certain formal properties.

The speaker who produces the sentence in a) obviously does not want to suggest that the boys designated by "you" should do all the carrying either collectively or individually; rather the intention is that the boys should *somehow* get all the boxes upstairs, regardless of whether they do it collectively, individually, or in other ways. The sentence in b) can for example describe a set of events in which the boys collectively carried the heaviest boxes, and individually the lightest ones (maybe even several very light ones in one go). This means that the distributivity of the quantification over the set of boys is neither collective nor individual; the term 'unspecific' has been used for this distribution (Bunt, 1985).

Following Link (1983) and Kamp & Reyle (1993), the notation X* is used in this document to designate the set consisting of the members of X and the subsets of X, and if P is the characteristic function of the set X, then P* is the characteristic function of X*. Using moreover the notation R_0 to designate the characteristic function of a reference domain that is part of a source domain with characteristic function R, the intended interpretation of the sentence in b) can be represented in second-order predicate logic as follows:

$$\forall x\ [box_0(x) \rightarrow \exists y\ \exists e\ [boy_0{}^*(y) \wedge carry\text{-}up(e) \wedge agent(e,y) \wedge \exists z\ [box_0{}^*(z) \wedge [x=z \vee x \in z] \wedge theme(e,z)]]]$$

This representation says that for every box in a contextually determined reference domain of boxes, there is a carry-event in which either a contextually distinguished boy or a group of such boys carried that box upstairs or carried a set of boxes upstairs that contains it.

Quantifiers expressed by a NP where the head noun is a mass noun may have a different distributivity than count NP quantifiers. The fundamental difference between count and mass nouns is that the latter do not individuate their reference: *"To learn 'apple', .. we must learn how much of what goes on counts as an apple, and how much as another. Such terms possess built-in modes.. of dividing their reference: 'shoe', 'pair of shoes' and 'footwear' all three range over the same scattered stuff, and differ solely in that two of them divide their reference differently, and the third not at all."* (Quine, 1960). Quantification by mass NPs therefore does not allow individual distributivity in the same sense as count NPs, but there is a distinction similar to the individual/collective distinction of count NP quantifiers, as the following sentences illustrate.

a. All the garbage was carried to the garbage truck.

b. The sand in the truck weighs twelve tons.

In case a) the predicate of being carried to the garbage truck applies to certain quantities of garbage which together make up all the garbage. The distributivity of this reading is called 'sampled'. In case b) the predicate of weighing twelve tons applies to the totality of the quantities of sand in the truck taken together, so this is a form of collective quantification.

The distributivity of a quantification is not a property of a set of participants, but a property of the way of participating. This is illustrated by the example below in a). Presumably, each of the men mentioned in the sentence in a) individually had a beer, and collectively they carried the piano upstairs. This cannot be accounted for by treating *"the men"* as referring to either individual men or a collective of men. The distributivity of a quantification should thus be marked up on the relation that describes the participation of the men in the drink- and carry-events, as in the (simplified) XML annotation fragment shown in b) below.

a. The men had a beer before carrying the piano upstairs.

Markables: m1 = “The men”, m2 = “men”, m3 = “had”, m4 = “a beer”, m5 = “beer”, m6 = “before”, m7 = “carrying upstairs”, m8 = ‘the piano”, m9 = “pianos”

c. <entity xml:id=”x1” target=”#m1” determinacy=”det” pred=”man”/>
<event xml:id=”e1” target=”#m2” pred=”drink_beer”/>
<participation event=”#e1” participant=”#x1” semRole=”agent” distr=”individual”/>
<event xml:id=”e2” target=”#m4” pred=”carry”/>
<tLink xml:id=”r1” target=”#m3” arg1=”#e1” arg2=”#e2” rel=”before”/>
<entity xml:id=”x2” target=”#m5” determinacy=”det” pred=”piano”/>
<participation event=”#e2” participant=”#x1” semRole=”agent” distr=”collective”/>
<participation event=”#e2” participant=”#x2” semRole=”theme” distr=”individual”/>

The distributivity of a quantification can be expressed by adverbs, like *“together”, “ensemble”* (French), and “samen” (Dutch), or by the choice of determiner: “*each*” in English, “*chaque*” in French, and “*jeder*” in German all express individual participation. Some determiners, such as the English *“each”, “all”,* and “*both*” can also be used as adverbs, as in *“They are all farmers”, “The men had a beer each”,* and *“They both looked happy”*; this phenomenon is known as ‘quantifier floating’ (see e.g. Kamp & Reyle, 1993).