Introduction to Class AX
Statistics and Probability

1 This schedule is the result of a rigorous and detailed analysis of the vocabulary of statistics and probability, using the techniques of facet analysis. As such, it represents a radical revision and expansion of Class AY in the first edition of the Bibliographic Classification (BC1). The general reasons for making the revision so radical a one are given in the *Introduction and Auxiliary schedules* (Butterworths, 1977). The particular changes in this class are considered in the Introduction to Mathematics (Section 15).

1.1 A number of general points relating to the principles underlying facet structure, citation and filing order, notation, etc., are exactly the same as for mathematics and are not repeated here. Where particular problems would have been considered fully here, reference is made to the Introduction to the Mathematics class beginning on page xv, cited here as 'Mathematics Introduction'.

2 The Outline on page 9 (preceding the full Mathematics schedule) is designed to give a clear view of the basic structure. If it is remembered that the schedule is an inverted one (see Section 8 in the Mathematics Introduction) the Outline will be seen to show not only the general sequence of classes but also the basic operational rule in applying the classification. This is the rule that compound classes (those reflecting the intersection of two or more simpler classes) are subordinated to the class appearing *later* (lower down) in the schedule. For example a work on estimation of Markov processes (AXO D) goes under Markov processes (AXO) and not under Estimation (AXD).

3 Scope of Class AX and its place in BC2

3.1 The general relationship between pure and applied mathematics is noted in Section 3.4 of the Mathematics Introduction.

3.2 The term Statistics has two distinct meanings:

3.21 as a body of quantitative data on something, often presented in the form of comparative distributions of various variables from different subclasses;

3.22 as the study (principally mathematical) of the classification, analysis and interpretation of the data and its distributions in terms of probability and using various statistical methods of inference, testing, etc., A simple and neat definition which stresses the movement from the data to the hypothesizing, etc. of the 'facts' is that of Moroney[1] who calls it the science of deriving facts from figures.

3.3 The extreme generality of its application, from its original use for purposes of state administration to every science and technology and even to areas of the humanities, as in cliometrics, makes its location at the end of mathematics and immediately preceding empirical science very appropriate — as Bliss argued.

4 Structure of Class AX Statistics

4.1 As noted in Section 4.1 of the Mathematics Introduction, all BC2 classes reflect the same basic pattern. This pattern is grasped most easily by considering the six basic design features common to all its classes (and to all biblographic classifications of a subject in fact — although in nearly all non-faceted systems they are badly mangled). The steps are, in order: (1) organizing the terms into broad facets; (2) organizing the terms in each facet into specific arrays; (3) deciding citation order (between facets and between arrays); (4) deciding filing order (of facets, of arrays); (5) adding notation; (6) adding an A/Z index. These six features are now considered separately.

5 Facets in Statistics and Probability

5.1 The scope and relations of these are considered in more detail under citation order (Section 7).

[**1**] Fields of application — physics, chemistry, biology, demography…

[**2**] Statistical models — multivariate analysis, correlation and regression, time series…

[**3**] Processes — probability, stochastic processes…

[**4**] Operations — mathematical and statistical methods, inference, estimation, descriptive statistics…

[**5**] Instruments, agents — computers…

[**6**] Common subdivisions — history, bibliographic form…

6 Arrays within facets

6.1 The nature of these is explained in Section 7.3 of the Mathematics Introduction.

[1]M.J. Moroney. Facts from figures. Pelican, 1981.

Arrays are sets of terms within a facet, reflecting a specific principle of division as distinct from the broad principle reflected by all members of the facet. An example is AXF Tests of significance where different sets of tests are distinguished, reflecting specific principles such as Complexity, Method, Sample, Direction, etc.

7 Citation order (combination order)

7.1 The nature and significance of this feature is explained in Section 7.3 of the Mathematics Introduction. Only points peculiar to statistics are considered here.

7.2 Citation order between facets

7.21 This reflects the argument that the 'end product' of statistical operations is in essence a statistical model of the situation investigated. The latter may be a real-life situation, constituting the fields of application of statistics. These models and/or experiments are based theoretically on Probability theory. This relationship is not accommodated easily within the generalized terminology of facets (Types, Parts, Processes, etc.); but it would seem reasonable to say that probability and stochastic processes reflect the concept of subsystems, defined primarily by processes, within the overall system of statistical models. Both the models and experiments and the probability phenomena are operated on by a number of techniques. Of these, the purely descriptive ones are called descriptive statistics and the analytical and inferential ones are called mathematical statistics in general and statistical methods in particular. These operations frequently utilize instrumental aids to assist them — notably the computer. Finally, common subdivisions apply, as with all subjects.

7.22 The overall citation order between facets is therefore the order in which the facets are set out in Section 5.1.

7.221 There is one important exception to this rule. The *preferred* treatment of the statistical methods and statistical data used in particular subject fields is to distribute this material throughout the classification, using common subdivisions -3Q for statistical data and -6E for statistical methods from Auxiliary Schedule 1, unless there are different instructions in the classes converned.

7.222 An *alternative* (not recommended) is provided at AXY for Applied statistics, divided 4/9, A/Z like the whole classification. If this alternative is used, the field investigated by statistical methods does then become the primary facet in ClassAX, as shown in Section 5.1 [1]. Alternatives are discussed further in Section 9 below.

7.23 It may be noted that the statistical models facet includes a major set of techniques considered together as design and analysis of experiments. These are often treated as part of statistical methods (which then covers all mathematical statistics other than probability theory). But the central function of design and analysis together is to produce the models and so these are treated as a part of the operations facet 'dependent' on the models.

7.3 Citation order between arrays

7.31 This is explained in Section 7.3 of the Mathematics Introduction. When more than one array of the same facet features in a compound subject the best guide to knowing which array to cite first, which second, etc. is to cite first the concept filing latest in the schedule. For example, under statistical tests, the class sequential tests (AXF I) files later than composite tests (AXF GY). So a work on composite sequential tests would go under sequential tests, not composite tests.

7.32 The overall citation order of both facets and arrays is conveyed clearly by the inverted filing order (see Section 8 and the demonstration for mathematics in Section 8.3).

8 Filing order

8.1 This is explained in some detail in Section 8 of the Mathematics Introduction. Class AX Statistics is like all other classes in BC2 in that it has an inverted filing order. The primary facet files last, the secondary (second-cited) facet files next to last, and so on. Similarly, within every facet the arrays are 'inverted': the primary one files at the end of the facet, and so on. Compound classes are formed by 'adding' concepts which file earlier to those which file later; e.g. Multivariate distributions in general is AXL and Estimation in general is AXD. So a compound class Estimation in multivariate distributions would be AXL D.

9 Alternative arrangements

9.1 For a general note see Section 9 of the Mathematics Introduction. As in the mathematics class, statistics calls for very few alternatives. Only two are prominent: one provides for the location of probability in general at AXF Y instead of at the end of mathematics at AWX; the other provides for the collection of all applied statistics at AWY instead of distributing it throughout the classification. The latter is the preferred arrangement, observing a general principle of BC2 that applications of a pure science to a technology go with the latter.

10 Notation

10.1 Notation is the system of ordinal symbols (letters and numbers) which represent classes in the form of classmarks which convey the exact location of a class in a mechanical fashion. It is explained in detail in the Introduction to BC2 (especially Section 6.4).

10.11 The major features of notation are given in Section 10 of the Mathematics Introduction. Everything there applies to Class AX with the important exception that Auxiliary Schedule AM1 plays only a relatively minor part in statistics (see Section 10.4 below). We note here only those points which are particular to statistics.

10.2 Statistics is typical of most classes in BC2 in that the main work of synthesis (classmark building) is effected by pure retroactive notation.

10.21 This means that any given class in AX may be divided by all the preceding classes by direct addition to its classmark — i.e. without any explicit linking symbol (facet indicator). This is best shown by an example:

AXD	Estimation
	Types of estimation
AXD F	Finite population process
	⋮
AXO	Markov processes
AXO D	Estimation
	⋮
AXO Q	Markov chains
	⋮
AXV	Time series
AXV D	Estimation
AXV O	Markov processes
AXV OD	Estimation
	⋮
AXV VB	Secular trends

10.22 The compound classes shown above (at AXO D, AXV D and AXV OD) are formed by adding the classmark of the qualifying term, less the initial letters AX (which are common to all classmarks in AX) directly to the class being qualified.

This is made possible by the special system of allocating classmarks in BC2. At AXD, the first subclass special to Estimation (called the 'first enumerated subclass') is given the letter F. All earlier symbols are deliberately left vacant; this allows them to be added directly to AXD (to give AXD 2/AXD 9, AXD A/AXD E) when they represent qualification by all the earlier subclasses of AX — AX2/AX9, AXA/AXE. The same principle of 'reserving' positions is observed throughout the class AX. So at AXO, the first enumerated subclass only appears at AXO Q; this allows direct addition of 2/9, A/P. At AXV, the first enumerated subclass only appears at AXV VB (thus allowing for the direct addition of earlier classes from AXA/AXU without conflicting with the enumerated subclasses) — and so on.

10.23 When the qualifying classmark shares the same three initial letters with the classmark being qualified, these three letters are dropped; e.g.

AX8	Statistical method
	Types of methods

AXC D	Parametric methods
AXC N	Inference
AXC ND	Parametric methods

10.24 Some exceptions to this rule should be noted: there are no three-letter classes AXP, AXQ and AXX as such to which preceding classes might be added. Instead the array 'Types of stochastic processes' which begins at AXN W is continued throughout AXO and on to AXP V, and the following array 'Special probabilistic phenomena' runs from AXP X to AXQ P:

AXN	Stochastic processes
	Types of stochastic processes
AXN W	Egodic processes
AXO	Markov processes
AXO Q	Markov chains [first enumerated subclass]
	⋮
AXO X	Ploya process
AXP D	Diffusion
	⋮
AXP V	Martingales
	Special probabilistic phenomena
AXP X	Games theory
AXP YH	Pursuit & evasion games
AXQ B	Queuing theory

Similarly the array 'Types of sampling' begins at AXW X and continues immediately at AXX A.

10.241 Because AXP D/AXP M and AXQ B/AXQ P uses letters D/M (preceding P in the alphabet) and B/P (preceding Q) respectively, only the first two letters (AX) can be dropped when any class from AXP D to AXQ R is qualified by another one in the same range, *even* if they share the same first three letters. A practical example of this appears in number [16] in Section 13.3; see also the Introduction to BC2, Section
10.25 7.452 if further detail is required. Note that in the Introduction to BC2 (Section 6.422) the examples refer to the dropping of one or two letters, not two or three, as here. This is because most main classes in BC2 spread their notation over all or many divisions of one letter; e.g. Physics uses BA/BY; Mathematics uses AM/AW. In these cases, only the one initial letter is common to all classes in the subject. But Statistics is confined to AX and therefore all its classes share the same two initial letters. In some cases classes being compounded may shared three initial letters. For

example, AXC ND above reflects a compound made up of methods drawn from two different arrays.

10.3 The strict synthetic procedure described above is occasionally modified in order to get shorter classmarks for prominent classes: e.g.

AXI	Probability distributions
	Types
AXJ K	Discrete distributions
AXJ O	Continuous distributions
AXK	Univariate distributions
AXK JK	Discrete
AXK K	Binomial distributions
AXK O	Continuous univariate distributions
AXK P	Normal distribution, Gaussian distribution

Here, because the compound class Discrete univariate distributions has a number of prominent subclasses of its own (i.e. they have a lot of literature on them) these are given classmarks shorter than they would get if retroactive addition were strictly pursued. But the order of terms is unaffected.

10.4 Use in AX of classmarks derived from mathematics AM/AW

10.41 Mathematical statistics at AX7 makes available the complete vocabulary of mathematics for the qualification of statistical concepts. If a mathematical concept used in this way is then further qualified by a mathematical concept, Auxiliary Schedule AM1 is used as in AM/AW.

10.42 Occasionally, a mathematical concept, having been added to a statistical one according to normal retroactive rules, is then itself qualified by another statistical concept. Since the latter will almost certainly file after the mathematical one (taken from AX7) a special intercalator must be used. In such rare cases, the letter Z is used. This still leaves X/Y as spare classes after allowing for the addition of A/W from Auxiliary Schedule AM1.

11 Alphabetical subject index

11.1 This is explained in Section 11 of the Mathematics Introduction. The basic features described there apply equally to statistics; but the high incidence of enumerated compound classes in mathematics, leading to a large number of A/Z index entries for them, is not a feature of the statistics class. So few compound classes from statistics will be found in the A/Z index.

12 Special problems in the classification of statistics

12.1 A number of the problems considered in Section 12 of the Mathematics Introduction apply equally to statistics, including the major problem posed by the highly abstract nature of many of the concepts.

12.2 The problem of concepts appearing in a role different from their normal one also arises, but much less prominently than in mathematics. For example, estimation of the parameters of a particular distribution implies the relation between an operation (estimation) and a process (the distribution). This would give a chain such as

> Variance (AXT) — Normal distribution (AXK P) — Estimation (AXD)

But in some cases a distribution might be used as an instrument in the estimation of a particular statistical model. This implies a different relationship — that of an operation and its agent. This would give a chain such as

> Regression (AXU N) — Maximum likelihood (AXD K) — (using) — Normal distribution (AXK P)

Although in this case a normal distribution is usually implied by maximum likelihood estimation and would not, therefore, be given in the chain, provision is made in the schedule for the possibility. This provision is at AX8 9 and allows for any method, distribution, etc., to be used in the role of 'conceptual agent'.

12.3 The loose use of some terms is sometimes a problem, as in most classes. For example, differing weights may attach to the term Estimation; this may be used in a significant sense, implying a major division of statistical inference. But it is sometimes used loosely to convey little more than calculation or measurement. 'Analysis' may also be used in similar fashion (see AX8 D).

13 Practical classification in statistics

13.1 The operation of assigning classmarks to documents is considered in detail in the Introduction to BC2 (Section 7). Here, we give only the main points, together with some points particular to Class AX, before demonstrating these with actual titles. Three basic operations are involved.

13.11 Concept analysis

13.111 This operational stage is described in Section 13.11 of the Mathematics introduction.

13.12 Citation order

13.121 This is putting the terms of 13.11 into a chain according to the order described in Section 7 (see also Mathematics introduction Section 7).

13.13 Translating the chain into notation

13.131 This usually implies the use of retroactive notation, as is common in most classes of BC2. But when the class AX7 Mathematical statisticss is involved, Auxiliary Schedule AM1 is likely to be used also (see Section 10.4 above). The essence of retroactive notation is explained in Section 10.2 and is not repeated here.

13.14 Demonstration of the three basic operations

[**1**] **Title:** *Analysis of multiple time series*

Concept analysis: Analysis / Multivariate / Time series

Chain: Time series (AXV) — Analysis (AXS) — Multivariate (AXS S)

Classmark: AXV SS

Comments:

1. The classmark of the first cited term is always taken as it stands, without modification — here, AXV.
2. The classmarks of qualifying terms are then added, dropping the initial letters AX, which are common to all classes. So SS is added to AXV to give the final classmark AXV SS.
3. Note that multivariate is an enumerated type of analysis (i.e it is not built synthetically) and AXS, the classmark for analysis in general, is implicit in AXS S — so is not added separately here.

13.2 Qualification by mathematical concepts from AM/AW

13.21 Any statistical concept (classes AX8/AXY) may be qualified by mathematical concepts from AM/AW by using '7' to introduce the latter (since AM7 is Mathematical statistics).

13.22 But if a second mathematical concept is added to the first, the '7' is not added since compounding then follows the rules in AM/AW. See Section 13 in the Mathematics Introduction, especially 13.35 which gives a summary of the rules for adding qualifiers and specifiers. See also titles 3 and 8 below as examples.

13.23 Occasionally, a mathematical concept may need to be qualified by a statistical concept, so that classmark building is 'forward' not backward (retroactive). In such a case Z is used as an intercalator to show that it is a statistical and not a mathematical classmark which follows (see Section 10.52).

13.3 Demonstrations of classification using selected titles

13.31 The following titles are chosen primarily to demonstrate the problems of relations between constituent concepts in compound classes and the accompanying notational problems of synthesis.

13.32 Many of them reflect relatively specific subjects and when the number of constituent elements gets large the classmarks get longer also. It should be remembered that a great deal of the literature, particularly at the book level, does not call for such extensive compounding and the length of classmark found in these demonstration titles should not be taken as typical.

13.33 The titles are arranged by their final classmark — i.e. in the order in which they would file in a classified catalogue or bibliography.

13.34 Two versions of the classmark are given; the first breaks it into its constituent elements, in order to show more clearly how the bits are added together. The second, put in parentheses, breaks it into regular blocks of three characters; this is easier to follow when scanning a classified file and is the recommended form for stating BC2 classmarks (see Section 13.8 in the Mathematics Introduction).

[**1**] **Title:** *Exchangeability in probability and statistics*

Concept analysis: Exchangeability

Chain: Exchangeability (AXA K)

Classmark: AXAK (AXA K)

Comments:

1. Example of a 'simple' subject — reflecting a single concept within the class (statistics and probability being implicit).

[**2**] **Title:** *Nonparametric statistical inference*

Concept analysis: Nonparametric methods / Inference

Chain: Inference (AXC N) — Nonparametric methods (AXC F)

Classmark: AXCN F (AXC NF)

Comments:

1. Concept filing latest in schedule is taken first in chain.
2. Qualifying concept (Nonparametric) is in same facet but a different array. Because it shares the same initial three letters with Inference, all these are dropped when added to AXC N.

[**3**] **Title:** *Matrix factorization in algorithms for parametric estimation*

Concept analysis: Matrices / Factorization / Algorithms / Parametric / Estimation

Chain: Estimation (AXD) — Algorithms (AX7 4G) — Matrices (ATB) — Factorization (AM7 P)

Classmark: AXD 74G 9TB 7P (AXD 74G 9TB 7P)

Comments:

1. All three qualifiers come from the mathematics schedule, beginning with Algorithms; so the other two are added according to the rules for adding in AM/AW.
2. Algorithms comes from mathematical logic (AM4) and this has a special rule allowing its qualification by concepts appearing later in the mathematics schedule — these are added after '9'.

[**4**] **Title:** *Statistical power analysis*

Concept analysis: Significance testing / Power / Analysis

Chain: Statistical methods (AX8) — Significance testing (AXF) — Special properties (AXB) — Power (AXB G) — Analysis (AX8 D)

Classmark: AXF BG 8D (AXF BG8 D)

Comments:

1. Although the chain begins with Statistical methods, the classmark for the general class does not feature in the final notation — it is implicit in AXF Significance testing. This situation is very common in a purely ordinal notation (like that in BC2) and allows much shorter classmarks. It is not commented on again in these examples — e.g. in the next title, in which Probability (AXG) is implicit in Distributions (AXI).
2. Properties of anything are cited after that thing.
3. Power is enumerated as a property under significance tests; but its classmark indicates that it is built from the general properties facet at AXA/AXB, in which AXB G provides for 'properties special to a context'.
4. Analysis at AX8 D provides for the generalized use of the term, as distinct from its more precise meaning at AXS, under design and analysis of experiments.

[**5**] **Title:** *Probability distributions on linear spaces*

Concept analysis: Probability / Distributions / Linear / Spaces

Chain: Probability (AXG) — Distributions (AXI) — Mathematical statistics (AX7) — Spaces (AUN) — Linear (ANA)

Classmark: AXI 7 UN NA (AXI 7UN NA)

Comments:

1. Adding the last two concepts observes the rules of synthesis in mathematics, since they both come from within AM/AW.
2. ANA represents the property linearity; but it is acting here in the role of a specifier, indicating a type of space. See Sections 7.25 and 10.63 in the Mathematics Introduction.

[**6**] **Title:** *Decomposition of superposition of density functions and discrete distributions*

Concept analysis: Decomposition / Superposition / Density functions / Discrete / Distributions

Chain: Distributions (AXI) — Discrete (AXJ K) — Density functions (AXI BX) — Mathematical statistics (AX7) — Superposition (AM8 EX) — Decomposition (AX8DE)

Classmark: AXJK IBX 7 8EX Z 8DE (AXJ KIB X78 EXZ 8DE)

Comments:

1. Decomposition is an enumerated statistical concept and would normally be cited before a mathematical concept; but here, it acts on the mathematical concept Superposition — so it is cited after it.
2. To show that 8DE is a statistical concept taken from AX8 DE and not a mathematical concept taken from AM8 D, the intercalator 'Z' is used (see Section 13.42).

[**7**] **Title:** *Confidence limits for hypergeometric distributions*

Concept analysis: Confidence limits / Hypergeometric / Distributions

Chain: Distributions (AXI) — Hypergeometric (AXK MJ) — Confidence limits (AXE)

Classmark: AXK MJ E (AXK MJE)

Comments:

1. Simple retroactive synthesis with one qualifier, dropping AX.

[**8**] **Title:** *Statistical estimates and transformed beta variables*

Concept analysis: Estimation / Transformed / Beta variables

Chain: Random variables (AXH) — Distributions (AXI) — Beta distribution (AXK WB) — Types by mathematical characteristics (AXH H) — Transformed (specifier derived from Transforms AM9 4)

Classmark: AXKWB H L4 (AXK WBH L4)

Comments:

1. Although AX7 is the general class for mathematical statistics, the mathematics schedule is utilized also at AXH H/AXH W to characterize types of variables.
2. Transforms, in the Relations facet in mathematics, changes its role here and acts as a specifier of a type of distribution. Using Auxiliary Schedule AM1, this means that the initial AM9 is replaced by the intercalator L (see Mathematics Introduction Section 10.63).

[**9**] **Title:** *Probability inequalities in multivariate distributions*

Concept analysis: Probability / Inequalities / Multivariate / Distributions

Chain: Distributions (AXI) — Multivariate (AXL) — Probability (AXG) — Mathematical statistics (AX7) — Inequalities (AM9N)

Classmark: AXL G 7 9N (AXL G79 N)

Comments:

1. Simple retroactive notation for the first qualifier and use of Auxiliary Schedule AM1 (from Mathematics) for the second one.

[**10**] **Title:** *Estimation from grouped and partially grouped variables*

Concept analysis: Estimation / Multivariate / Distributions (variables)

Chain: Random variables (AXH) — Distributions (AXI) — Multivariate (AXL) — Estimation (AXD)

Classmark: AXL D (AXL D)

Comments:

1. 'Grouped and partially grouped' variables implies a multiplicity without being restricted to a recognizable subclass beyond multivariate.

[**11**] **Title:** *Stochastic convergence*

Concept analysis: Stochastic / Convergence

Chain: Stochastic processes (AXN) — Mathematical statistics (AX7) — Convergence (AM8B)

Classmark: AXN 7 8B (AXN 78B)

Comments:

1. Qualification by single mathematical concept.

[**12**] **Title:** *Stochastic calculus and diffusion processes*

Concept analysis: Stochastic / Calculus / Diffusion

Chain: Stochastic processes (AXN) — Diffusion processes (AXP D) — Mathematical statistics (AX7) — Calculus (AW6 X)

Classmark: AXPD 7 W6X (AXP D7W 6X)

Comments:

1. Calculus represents an operation in the study of diffusion — so is cited after it.
2. Stochastic is implicit in diffusion processes.
3. Example of how a title obscures the relationships whilst providing the key terms for a summarized subject description.

[**13**] **Title:** *Markov chains with stationary transition probabilities*

Concept analysis: Markov chains / Stationary / Transition / Probabilities

Chain: Stationary processes (AXPS) — Markov chains (AXOQ) — Probability (AXG) — Transition probability (AXGU)

Classmark: AXPS OQ GU (AXP SOQ GU)

Comments:

1. Simple retroactive notation with 2 qualifiers.

[**14**] **Title:** *Stochastic integration and generalized martingales*

Concept analysis: Stochastic / Integration / Martingales

Chain: Stochastic processes (AXN) — Martingales (AXP V) — Mathematical statistics (AX7) — Analysis (AW) — Integration (AW7 V)

Classmark: AXPV 7 W 7V (AXP V7W 7V)

Comments:

1. Simple qualification by mathematical concepts.
2. As Title 12 — title obscures the relationships.

[**15**] **Title:** *Boundary value problems in queuing system analysis*

Concept analysis: Boundary values / Queuing systems / Analysis

Chain: Analysis of experiments (AXS) — Queuing theory (AXQ B) — Mathematical statistics (AX7) — Boundary values (APF DD)

Classmark: AXQB 7 PFDD (AXQ B7P FDD)

Comments:

1. Analysis is implicit in queuing theory and does not feature in the final classmark (see note in schedule at AXS).

[**16**] **Title:** *Polya-type distributions in renewal theory applied to an inventory problem*

Concept analysis: Polya-type / Distributions / Renewal theory / Inventory

Chain: Inventory problems (AXQ G) — Renewal theory (AXQ F) — Distributions (AXI) — Polya process (AXO X)

Classmark: AXQG QF OX (AXQ GQF OX)

Comments:

1. This is a clear example of some of the principles governing the standard citation order. The inventory problem is the ultimate object of study; renewal reflects a probabilistic process within it; polya-type distributions reflect a property which helps to illuminate the problem.
2. Although Inventory (AXQ G) and Renewal (AXQ F) share the same notational array, and therefore the same first three letters, only the first two letters can be dropped when AXQ F is added to AXQ G, as stated in Sections 10.24 and 10.241 above. (Direct addition of F would give AXQ GF Inventory - Tests of significance, from AXF).

[**17**] **Title:** *Use of contrast coefficients in multiple linear regression*

Concept analysis: Contrast / Coefficients / Multiple / Linear / Regression

Chain: Regression (AXU N) — Multiple (AXU Q) — Mathematical statistics (AX7) — Functions (AM8 L) — Special functions (AM8 Y) — Contrast function (AM8 YM) — Coefficients (AQK)

Classmark: AXUQ 7 8Y M EK (AXU Q78 YME K)

Comments:

1. The last two qualifiers (contrast function and coefficients) are obtained by following the rules for synthesis in Auxiliary Schedule AM1; e.g., classes in AQ are added by replacing the AQ by an intercalator 'E' — hence EK for AQK.

[**18**] **Title:** *Elimination of underestimates in near neighbour analysis*

Concept analysis: Elimination / Underestimation / Nearest neighbour analysis

Chain: Analysis of experiments (AXS) — Nearest neighbour analysis (AXU U) — Underestimation (AXD H) — Elimination (AX9 E)

Classmark: AXUU DH 9E (AXU UDH 9E)

Comments:

1. The classmark for Elimination uses the generalized provision at AX9D for 'Operations special to a context'. But some classifiers would not consider it worth indexing (see Section 13.6 in the Mathematics Introduction).

[**19**] **Title:** *Estimating parameters of the Markov probability model*

Concept analysis: Estimation / Parameters / Markov / Probability / Model

Chain: Models (AXQ R) — Markov probability (AXV O) — Parameter estimation (AXD)

Classmark: AXVO D (AXV OD)

Comments:

1. Models is an implicit concept in all classes following AXQ R and the latter classmark is only used for general works on models.
2. Simple retroactive notation with one qualifier.

[**20**] **Title:** *Maximum likelihood estimation in small samples*

Concept analysis: Maximum likelihood / Estimation / Small samples

Chain: Sampling theory (AXW) — Small samples (AXW X) — Estimation (AXD) — Maximum likelihood (AXD K)

Classmark: AXWX DK (AXW XDK)

Comments:

1. Sampling theory is implicit in Small samples.
2. Estimation is implicit in Maximum likelihood.

14 Multiple entry in the classified catalogue or bibliography

14.1 This is described in some detail in the Mathematics Introduction (Section 14).

14.2 The situation in AX Statistics is simpler than that in AM/AW Mathematics. Most of the literature reflects terms acting in their normal facet relations and multiple entry is primarily by simple rotation.

14.3 Examples of multiple entry

14.31 The titles below are taken from Section 13.3. For ease of demonstration the full classmarks are replaced by simple a,b,c, etc.

Title 16: Polya-type distributions in renewal theory applied to an inventory problem.

Chain: Inventory ⇝ a — Renewal theory ⇝ b — Polya process ⇝ c

Permuted entries: abc / bca / cab

Title 13: Markov chains with stationary transition probabilities

Chain: Stationary processes ⇝ a — Markov chains ⇝ b — Transition probability ⇝ c

Permuted entries: abc / bca / cab

15 Statistics in BC2 compared with BC1

15.1 This is considered in Section 15 of the Mathematics Introduction in passing.

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