INTERNATIONAL STANDARD

ISO/IEC 9075-15

Second edition
2023-06

Information technology — Database languages SQL —

Part 15: Multidimensional arrays (SQL/MDA)

Technologies de l'information — Langages de base de données SQL —

Partie 15: Tableaux multi-dimensionnels (SQL/MDA)

Reference number
ISO/IEC 9075-15:2023(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Tables

Table

Page

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

ISO and IEC draw attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO and IEC take no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO and IEC have not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents and https://patents.iec.ch. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

This second edition cancels and replaces the first edition (ISO/IEC 9075-15:2019), which has been technically revised. It also incorporates the Technical Corrigendum ISO/IEC 9075-15:2019/Cor.1:2022.

The main changes are as follows:

— improve the presentation and accuracy of the summaries of implementation-defined and implementation-dependent aspects of this document;

— introduction of several digital artifacts;

— alignment with updated ISO house style and other guidelines for creating standards.

This second edition of ISO/IEC 9075-15 is designed to be used in conjunction with the following editions of other parts of the ISO/IEC 9075 series, all published in 2023:

— ISO/IEC 9075-1, sixth edition;

— ISO/IEC 9075-2, sixth edition;

— ISO/IEC 9075-3, sixth edition;

— ISO/IEC 9075-4, seventh edition;

— ISO/IEC 9075-9, fifth edition;

— ISO/IEC 9075-10, fifth edition;

— ISO/IEC 9075-11, fifth edition;

— ISO/IEC 9075-13, fifth edition;

— ISO/IEC 9075-14, sixth edition;

— ISO/IEC 9075-16, first edition.

A list of all parts in the ISO/IEC 9075 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

This document was developed in response to industry demand for the ability to store and manipulate data in the form of multidimensional arrays within databases managed using database language SQL.

The organization of this document is as follows:

1) Clause 1, "Scope", specifies the scope of this document.

2) Clause 2, "Normative references", identifies additional standards that, through reference in this document, constitute provisions of this document.

3) Clause 3, "Terms and definitions", defines the notations and conventions used in this document.

4) Clause 4, "Concepts", presents concepts used in the definition of multidimensional arrays.

5) Clause 5, "Lexical elements", defines a number of lexical elements used in the definition of multidimensional arrays.

6) Clause 6, "Scalar expressions", defines a number of scalar expressions used in the definition of multidimensional arrays.

7) Clause 7, "Query expressions", defines the elements of the language that produce rows and tables of data as used in multidimensional arrays.

8) Clause 8, "Predicates", defines the predicates used in the definition of multidimensional arrays.

9) Clause 9, "Additional common rules", specifies the rules for assignments that retrieve multidimensional array data from or store multidimensional array data into SQL-data, and formation rules for set operations.

10) Clause 10, "Additional common elements", defines additional common elements used in the definition of multidimensional arrays.

11) Clause 11, "Schema definition and manipulation", defines facilities for creating and managing a schema.

12) Clause 12, "SQL-client modules", defines SQL-client modules and externally-invoked procedures in the context of multidimensional arrays.

13) Clause 13, "Data manipulation", defines the data manipulation statements.

14) Clause 14, "Additional data manipulation rules", defines additional rules for data manipulation.

15) Clause 15, "Dynamic SQL", defines the facilities for executing SQL-statements dynamically in the context of multidimensional arrays.

16) Clause 16, "Embedded SQL", defines the host language embeddings in the context of multidimensional arrays.

17) Clause 17, "Call-Level Interface specifications", defines facilities for using SQL through a Call-Level Interface.

18) Clause 18, "Information Schema", defines the Information and Definition Schema objects associated with multidimensional arrays.

19) Clause 19, "Definition Schema", defines base tables on which the viewed tables containing schema information depend.

20) Clause 20, "Status codes", defines SQLSTATE values related to multidimensional arrays.

21) Clause 21, "Conformance", defines the criteria for conformance to this document.

22) Annex A, "SQL conformance summary", is an informative Annex. It summarizes the conformance requirements of the SQL language.

23) Annex B, "Implementation-defined elements", is an informative Annex. It lists those features for which the body of this document states that the syntax, the meaning, the returned results, the effect on SQL-data and/or schemas, or other aspect is partly or wholly implementation-defined.

24) Annex C, "Implementation-dependent elements", is an informative Annex. It lists those features for which the body of this document states that the syntax, the meaning, the returned results, the effect on SQL-data and/or schemas, or other aspect is partly or wholly implementation-dependent.

25) Annex D, "SQL optional feature taxonomy", is an informative Annex. It identifies the optional features of the SQL language specified in this document by an identifier and a short descriptive name. This taxonomy is used to specify conformance.

26) Annex E, "Deprecated features", is an informative Annex. It lists features that the responsible Technical Committee intends not to include in a future edition of this document.

27) Annex F, "Incompatibilities with ISO/IEC 9075:2016", is an informative Annex. It lists incompatibilities with the previous version of this document.

28) Annex G, "Defect Reports not addressed in this edition of this document", is an informative Annex. It describes the Defect Reports that were known at the time of publication of this document. Each of these problems is a problem carried forward from the previous edition of the ISO/IEC 9075 series. No new problems have been created in the drafting of this edition of this document.

In the text of this document, in Clause 5, "Lexical elements", through Clause 21, "Conformance", Subclauses begin new pages. Any resulting blank space is not significant.

Information technology — Database language SQL —

Part 15:
Multidimensional arrays (SQL/MDA)

1 Scope

This document defines ways in which Database Language SQL can be used in conjunction with multidimensional arrays.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 9075-1, *Information technology — Database languages — SQL — Part 1: Framework (SQL/Framework)*

ISO/IEC 9075-2, *Information technology — Database languages — SQL — Part 2: Foundation (SQL/Foundation)*

ISO/IEC 9075-3, *Information technology — Database languages — SQL — Part 3: Call-Level Interface (SQL/CLI)*

ISO/IEC 9075-11, *Information technology — Database languages — SQL — Part 11: Information and Definition Schemas (SQL/Schemata)*

Internet Engineering Task Force (IETF) RFC 2046 *Multipurpose Internet Mail Extensions (MIME), Part Two: Media Types*. Edited by: Freed, N. November 1996
Available at: https://tools.ietf.org/html/rfc2046

Internet Engineering Task Force (IETF) RFC 8259 *The JavaScript Object Notation (JSON) Data Interchange Format*. Edited by: Miller, Matthew December 2018
Available at: https://datatracker.ietf.org/doc/rfc8259/

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 9075-1, ISO/IEC 9075-2, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at `https://www.iso.org/obp`

— IEC Electropedia: available at `https://www.electropedia.org/`

3.1
coordinate
non-empty ordered list of integers

3.2
maximum MD-extent
<of an MD-array type or a site of MD-array type> *MD-extent* (3.6) of an MD-array type

Note 1 to entry: The term "maximum MD-extent" is used for the *MD-extent* (3.6) of an MD-array type because it defines the maximum MD-extent that a value of that MD-array type can have. The *MD-extent* (3.6) of an MD-array value must be within the maximum MD-extent of the value's type.

3.3
MD-array
ordered collection of elements of the same type associated with an *MD-extent* (3.6) where each element is 1:1 associated with some *coordinate* (3.1) within its *MD-extent* (3.6)

Note 1 to entry: A *coordinate* (3.1) is within an *MD-extent* (3.6) if every coordinate value from the integer list is greater than or equal to the lower limit, and less than or equal to the upper limit of the *MD-interval* (3.7) of the *MD-axis* (3.4) at the position in the *MD-extent* (3.6) as the coordinate value has within the *coordinate* (3.1).

3.4
MD-axis
named *MD-interval* (3.7)

3.5
MD-dimension
number of *MD-axes* (3.4) in the *MD-extent* (3.6) of an *MD-array* (3.3)

3.6
MD-extent
non-empty ordered collection of *MD-axes* (3.4) with no duplicate names

3.7
MD-interval
integer interval given by a pair of lower and upper integer limits such that the lower limit is less than or equal to the upper limit; the interval is closed, i.e., both limits are contained in it

4 Concepts

This Clause modifies Clause 4, "Concepts", in ISO/IEC 9075-2.

4.1 Notations and conventions

This Subclause modifies Subclause 4.1, "Notations and conventions", in ISO/IEC 9075-2.

4.1.1 Notations

This Subclause modifies Subclause 4.1.1, "Notations", in ISO/IEC 9075-2.

The notations used in this document are defined in ISO/IEC 9075-1.

The syntax defined in this document is available from the ISO website as a "digital artifact". See `https://standards.iso.org/iso-iec/9075/-15/ed-2/en/` to download digital artifacts for this document. To download the syntax defined in a plain-text format, select the file named `ISO_IEC_9075-15(E)_MDA.bnf.txt`. To download the syntax defined in an XML format, select the file named `ISO_IEC_9075-15(E)_MDA.bnf.xml`.

4.2 Data types

This Subclause modifies Subclause 4.2, "Data types", in ISO/IEC 9075-2.

4.2.1 General introduction to data types

This Subclause modifies Subclause 4.2.1, "General introduction to data types", in ISO/IEC 9075-2.

Insert into the 4th paragraph, in the 1st list item, after the last list item:

— MD-array type: MDARRAY

Insert into the 5th paragraph, after the last list item:

— MD-array types.

4.2.2 Data type terminology

This Subclause modifies Subclause 4.2.4, "Data type terminology", in ISO/IEC 9075-2.

Insert after the 11th paragraph: A data type *TY* is a *collection-containing type* if exactly one of the following is true:

— *TY* is a collection type;

— *TY* is a row type, and the declared type of some field of *TY* is a collection-containing type;

— *TY* is distinct type, and the source type of *TY* is a collection-containing type;

— *TY* is a structured type and the declared type of some attribute of *TY* is a collection-containing type.

Insert into the 11th paragraph, after the last list item:

— A type *T* is *MD-array-ordered* if *T* is *S*-ordered, where *S* is the set of MD-array types.

4.3 Numbers

This Subclause modifies Subclause 4.5, "Numbers", in ISO/IEC 9075-2.

4.3.1 Operations involving numbers

This Subclause modifies Subclause 4.5.3, "Operations involving numbers", in ISO/IEC 9075-2.

Insert into the 1st paragraph, after the last list item:

— <md-array axis index function> (see Subclause 4.5.4.3, "Operators that operate on MD-array values and return numbers") operates on an MD-array argument and an MD-axis name, and returns an integer denoting its index position in the MD-extent of the MD-array.

— <md-array dimension> (see Subclause 4.5.4.3, "Operators that operate on MD-array values and return numbers") operates on an MD-array argument and returns an integer denoting its MD-dimension.

— <md-array lower axis limit> (see Subclause 4.5.4.3, "Operators that operate on MD-array values and return numbers") operates on an MD-array argument and an MD-axis name or index, and returns the lower limit of an MD-axis.

— <md-array upper axis limit> (see Subclause 4.5.4.3, "Operators that operate on MD-array values and return numbers") operates on an MD-array argument and an MD-axis name or index, and returns the upper limit of an MD-axis.

4.4 User-defined types

This Subclause modifies Subclause 4.9, "User-defined types", in ISO/IEC 9075-2.

4.4.1 Distinct types

This Subclause modifies Subclause 4.9.2, "Distinct types", in ISO/IEC 9075-2.

Insert after the 4th paragraph: *CT* shall not be an MD-array type.

4.5 Collection types

This Subclause modifies Subclause 4.12, "Collection types", in ISO/IEC 9075-2.

4.5.1 Introduction to collection types

This Subclause modifies Subclause 4.12.1, "Introduction to collection types", in ISO/IEC 9075-2.

Insert into the 1st paragraph, after the 1st list item:

— MD-arrays

Augment the 2nd paragraph by adding "MDARRAY" the list of alternatives for KC.

Insert after the 2nd paragraph: A maximum MD-extent is mandatory for MD-arrays.

Insert into the 5th paragraph, after the 1st list item:

— MDARRAY (MD-array type).

Insert into the 5th paragraph, after the 2nd list item:

— If *CT* is an MD-array type, the MD-axis descriptors of each dimension of the MD-array.