
**Information technology — Guidance
for the use of database language
SQL —**

**Part 8:
Multidimensional arrays**

iTeh STANDARD PREVIEW
*Technologies de l'information — Recommandations pour l'utilisation
du langage de base de données SQL —
Partie 8: Matrices multidimensionnelles*
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ISO/IEC 19075-8:2021

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Published in Switzerland

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents), or the IEC list of patent declarations received (see patents.iec.ch).

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 Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

This first edition of ISO/IEC 19075-8 cancels and replaces ISO/IEC TR 19075-8:2019.

This document is intended to be used in conjunction with the following editions of the parts of the ISO/IEC 9075 series:

- ISO/IEC 9075-1, sixth edition or later,
- ISO/IEC 9075-2, sixth edition or later,
- ISO/IEC 9075-3, sixth edition or later,
- ISO/IEC 9075-4, seventh edition or later,
- ISO/IEC 9075-9, fifth edition or later,
- ISO/IEC 9075-10, fifth edition or later,
- ISO/IEC 9075-11, fifth edition or later,
- ISO/IEC 9075-13, fifth edition or later,
- ISO/IEC 9075-14, sixth edition or later,
- ISO/IEC 9075-15, second edition or later,
- ISO/IEC 9075-16, first edition or later.

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A list of all parts in the ISO/IEC 19075 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.

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Introduction

This document describes the definition and use of multidimensional arrays in SQL. Multidimensional arrays represent a core underlying structure of manifold science and engineering data. It is generally recognized today, therefore, that arrays have an essential role in Big Data and should become an integral part of the overall data type orchestration in information systems. This document discusses the syntax and semantics of operations on the MD-array data type defined in [ISO/IEC 9075-15](#).

The organization of this document is as follows:

- 1) [Clause 1, “Scope”](#), specifies the scope of this document.
- 2) [Clause 2, “Normative references”](#), identifies standards that are referenced by this document.
- 3) [Clause 3, “Terms and definitions”](#), defines the terms and definitions used in this document.
- 4) [Clause 4, “Multidimensional arrays \(MDA\) concepts”](#), introduces the concept of Multidimensional Arrays.
- 5) [Clause 5, “SQL/MDA data model”](#), introduces the data model.
- 6) [Clause 6, “SQL/MDA operations”](#), covers the supported operations on MD-arrays.
- 7) [Clause 7, “Remote sensing example”](#), illustrates the supported functionality through realistic examples.

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Information technology — Guidance for the use of database language SQL —

Part 8:

Multidimensional arrays**1 Scope**

This document describes the definition and use of multidimensional arrays in SQL. Multidimensional arrays represent a core underlying structure of manifold science and engineering data. It is generally recognized today, therefore, that arrays have an essential role in Big Data and should become an integral part of the overall data type orchestration in information systems. This document discusses the syntax and semantics of operations on the MD-array data type defined in [ISO/IEC 9075-15](#).

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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 9075-15, *Information technology — Database languages — SQL — Part 15: Multidimensional Arrays (SQL/MDA)*

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

coordinate

non-empty ordered list of integers

3.2

cardinality

number of elements in an MD-array

3.3

MD-array

ordered collection of elements of the same type associated with an MD-extent where each element is 1:1 associated with some coordinate within its MD-extent

Note 1 to entry: A coordinate is within an MD-extent 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 of the MD-axis at the position in the MD-extent as the coordinate value has within the coordinate

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3.4

MD-axis

named MD-interval

3.5

MD-dimension

number of MD-axes in the MD-extent of an MD-array

Note 1 to entry: Also known as “rank” outside of SQL/MDA

3.6

MD-extent

non-empty ordered collection of MD-axes 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 Multidimensional arrays (MDA) concepts

4.1 Context of multidimensional arrays

The requirements for the material discussed in this document shall be as specified in ISO/IEC 9075-1 and ISO/IEC 9075-15.

4.2 Concept

The phrase “(Multidimensional) array, raster data” is used to refer to arrays generally, in contrast to the MD-array term confined to the realm of SQL/MDA. It is not to be confused with the term “array” in ISO/IEC 9075-2. This document uses the term ARRAY for the original SQL array collection type.

The array concept is a simple and efficient data representation that finds its use in a wide array of fields, business-related as well as scientific and engineering. Many sensors, images, image time-series, simulation processes, statistical models, and so on, produce raw data that can immediately be classified as array data. These data may be naturally arranged along more than one axis: position and time, for example.

A *multidimensional array* (MDA) is a set of elements ordered in a multidimensional space. The space considered here is discretized (also called rasterized or gridded), that is, only integer coordinates are admitted as positions of the individual array elements. The number of integers needed to refer to a particular position in this space is the array's dimension (sometimes also referred to as its dimensionality).

An element can be a single value (such as an intensity value in case of greyscale images) or a composite value (such as integer triples for the red, green, and blue components of a true-color image). All elements of an array share the same structure, referred to as the array's element type.

4.3 Why consider support for MDA in SQL?

Large multidimensional arrays in particular represent a prevalent data type across most scientific domains, with examples including 1-D sensor data, 2-D satellite images and microscope scans, 3-D x/y/t image time-series and x/y/z voxel models, as well as 4-D and 5-D climate models.

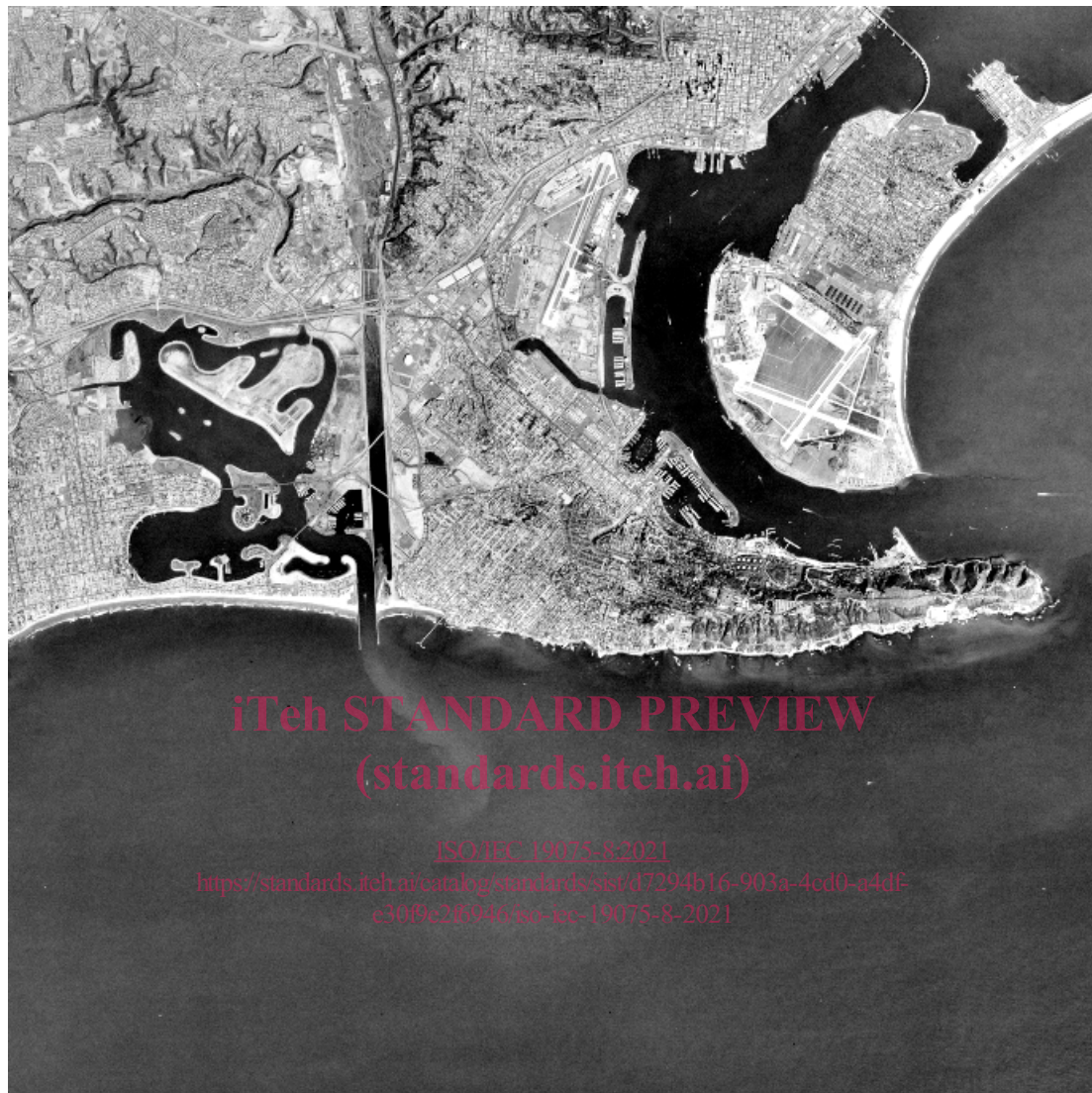


Figure 1 — Aerial greyscale image of size 1024x1024 (San Diego)

In array terms, the image in Figure 1, “Aerial greyscale image of size 1024x1024 (San Diego)”, is a 2-dimensional array of unsigned 8-bit integer elements positioned at coordinates in $\{0, 1, \dots, 1023\}^2$ space.

Arrays rarely occur isolated in practice and are typically ornamented with metadata and embedded in larger overall information structures. Supporting them in narrowly specialized *ad hoc* tools or dedicated array DBMS is thus insufficient when it comes to building modern, complex services and applications. This suggests that integration of array querying into a standardized framework like SQL is a logical next step that will benefit the communities dealing with multidimensional array data in one way or the other.

SQL has had basic support for 1-dimensional arrays since 1999. Instead of attempting to extend the existing 1-dimensional array model to address the needs of multidimensional array manipulation, SQL/MDA addresses those needs with a new feature set integrated into SQL.