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**Information technology — Biometric data  
interchange formats —**

**Part 2:  
Finger minutiae data**

*Technologies de l'information — Formats d'échange de données  
biométriques*

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*Partie 2: Données du point caractéristique du doigt*  
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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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.

ISO/IEC 19794-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

ISO/IEC 19794 consists of the following parts, under the general title *Information technology — Biometric data interchange formats*:

- *Part 1: Framework* <https://standards.iteh.ai/catalog/standards/sist/b09cebe3-8f5c-4a66-ac6c-00928ea42757/iso-iec-19794-2-2005>
- *Part 2: Finger minutiae data*
- *Part 3: Finger pattern spectral data*
- *Part 4: Finger image data*
- *Part 5: Face image data*
- *Part 6: Iris image data*

The following parts are under preparation:

- *Part 7: Signature/sign behavioral data*
- *Part 8: Finger pattern skeletal data*

Vascular image data, hand geometry silhouette data, and signature/sign processed dynamic data will from the subjects of future Parts 9, 10 and 11, respectively.

## Introduction

In the interest of implementing interoperable biometric recognition systems, this part of ISO/IEC 19794 establishes a data interchange format for minutiae-based fingerprint capture and recognition equipment. Representation of fingerprint data using minutiae is a widely used technique in many application areas.

This part of ISO/IEC 19794 defines specifics of the extraction of key points (called *minutiae*) from fingerprint ridge patterns. Two types of data formats are then defined: one for general storage and transport, one for use in card-based systems; the card format has a standard and a compact expression.

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# Information technology — Biometric data interchange formats —

## Part 2: Finger minutiae data

### 1 Scope

This part of ISO/IEC 19794 specifies a concept and data formats for representation of fingerprints using the fundamental notion of minutiae. It is generic, in that it may be applied and used in a wide range of application areas where automated fingerprint recognition is involved. This part of ISO/IEC 19794 contains definitions of relevant terms, a description of how minutiae shall be determined, data formats for containing the data for both general use and for use with cards, and conformance information. Guidelines and values for matching and decision parameters are provided in an informative annex.

### 2 Conformance

A system conforms to this part of ISO/IEC 19794 if it satisfies the mandatory requirements herein for extraction of minutiae from a fingerprint image as described in Clause 6 and the generation of a minutiae data format as described in Clause 7 (for general data interchange use) or Clause 8 (for use with cards). Since any finger minutiae extraction and matching algorithm supporting the described finger minutiae data interchange formats may be used, interoperability testing is of extreme importance, especially for environments in which components of different manufacturers interact. In ISO/IEC 19795 "Information technology - Biometric performance testing and reporting," test methodologies and performance testing of biometric data interchange formats are outlined. The application specific policies and relevant standards will determine the requirements for conformance testing and evaluation affecting levels of interoperability.

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### 3 Normative references

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The following referenced documents are indispensable for the application 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 7816-11:2004, *Identification cards — Integrated circuit cards — Part 11: Personal verification through biometric methods*

ISO/IEC 19784-1:—<sup>1)</sup>, *Information technology — Biometric application programme interface — Part 1: BioAPI specification*

ISO/IEC 19785-1:—<sup>1)</sup>, *Information technology — Common Biometric Exchange Formats Framework — Part 1: Data element specification*

ISO/IEC 19785-2:—<sup>1)</sup>, *Information technology — Common Biometric Exchange Formats Framework — Part 2: Procedures of the operation of the Biometric Registration Authority*

### 4 Terms and definitions

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

#### 4.1 algorithm

a sequence of instructions that tell a biometric system how to solve a particular problem. An algorithm will have a finite number of steps and is typically used by the biometric engine (i.e., the biometric system software) to compute whether a biometric sample and template are a match.

1) To be published.

4.2

**biometrics**

[automated] recognition of [living] persons based on observation of behavioral and biological (anatomical and physiological) characteristics.

4.3

**biometric**

pertaining to the field of biometrics.

4.4

**biometric data**

data encoding a feature or features used in biometric verification.

4.5

**biometric information template**

a constructed data object in a card containing information needed by the outside world for a verification process, see ISO/IEC 7816-11

4.6

**biometric sample**

information obtained from a biometric device, either directly or after further processing.

4.7

**biometric system**

an automated system capable of:

1. capturing a biometric sample from an end user;
2. extracting biometric data from that sample;
3. comparing the biometric data with that contained in one or more reference templates;
4. deciding how well they match; and
5. indicating whether or not an identification or verification of identity has been achieved.

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4.8

**capture**

the process of taking a biometric sample from an end user.

4.9

**cell**

a rectangular region defined by a uniform and non-overlapping division of the image.

4.10

**comparison**

the process of comparing a biometric sample with a previously stored reference template or templates.

4.11

**claimant**

a person submitting a biometric sample for verification or identification while claiming a legitimate or false identity.

4.12

**core**

a core is the topmost point on the innermost recurving ridgeline of a fingerprint. Generally, the core is placed upon or within the innermost recurve of a loop.

4.13

**database**

any storage of biometric templates and related end user information.



**4.14****delta**

a delta is that point on a ridge at or nearest to the point of divergence of two type lines, and located at or directly in front of the point of divergence.

**4.15****end user**

a person who interacts with a biometric system to enroll or have his/her identity checked. Contrast with "User".

**4.16****enrollment**

the process of collecting biometric samples from a person and the subsequent preparation and storage of biometric reference templates representing that person's identity.

**4.17****extraction**

the process of converting a captured biometric sample into biometric data so that it can be compared to a reference template; sometimes called "characterization".

**4.18****friction ridge**

the ridges present on the skin of the fingers and toes, the palms and soles of the feet, which makes contact with an incident surface under normal touch. On the fingers, the unique patterns formed by the friction ridges make up fingerprints.

**4.19****identification / identify**

the one-to-many process of comparing a submitted biometric sample against all of the biometric reference templates on file to determine whether it matches any of the templates and, if so, the identity of the enrollee whose template was matched. The biometric system using the one-to-many approach is seeking to find an identity amongst a database rather than verify a claimed identity. Contrast with 'Verification'.

**4.20****latent**

a fingerprint collected from an intermediate surface, rather than directly via a live capture from the finger itself.

**4.21****live capture**

The process of capturing a biometric sample by an interaction between an end user and a biometric system.

**4.22****live-scan print**

a fingerprint image that is produced by scanning or imaging a live finger to generate an image of the friction ridges.

**4.23****match / matching**

the process of comparing a biometric sample against a previously stored template and scoring the level of similarity.

**4.24****minutia (single) minutiae (pl)**

friction ridge characteristics that are used to individualize a fingerprint. Minutiae occur at points where a single friction ridge deviates from an uninterrupted flow. Deviation may take the form of ending, bifurcation, or a more complicated "composite" type.

**4.25****population**

The set of end-users for the application.

**4.26**

**record**

the template and other information about the end-user (e.g. access permissions).

**4.27**

**resolution**

the number of pixels (picture elements) per unit distance in the image of the fingerprint.

**4.28**

**ridge bifurcation**

the minutia assigned to the location at which a friction ridge splits into two ridges or, alternatively, where two separate friction ridges combine into one.

**4.29**

**ridge ending**

the minutia assigned to the location at which a friction ridge terminates or, alternatively, begins. A ridge ending is defined as the bifurcation of the adjacent valley - the location at which a valley splits into two valleys or, alternatively, at which two separate valleys combine into one.

**4.30**

**ridge skeleton endpoint**

the minutia assigned to the location at which a ridge skeleton ends. A ridge skeleton endpoint is defined as the ending of the skeleton of a ridge.

**4.31**

**skeleton**

the single-pixel-wide representation of a ridge or valley obtained by successive symmetric thinning operations. The skeleton is also known as the medial axis.

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**4.32**

**swipe**

a method of fingerprint collection where the finger is manually moved across a one-dimensional sensor to produce the two-dimensional image.

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**4.33**

**template / reference template**

data, which represents the biometric measurement of an enrollee, used by a biometric system for comparison against subsequently submitted biometric samples. NOTE - this term is not restricted to mean only data used in any particular recognition method, such as template matching.

**4.34**

**typeline**

the two innermost ridges that start parallel, diverge, and surround or tend to surround the pattern area.

**4.35**

**user**

the client to any biometric vendor. The user must be differentiated from the end user and is responsible for managing and implementing the biometric application rather than actually interacting with the biometric system.

**4.36**

**valley**

the area surrounding a friction ridge, which does not make contact with an incident surface under normal touch; the area of the finger between two friction ridges.

**4.37**

**valley bifurcation**

the point at which a valley splits into two valleys or, alternatively, where two separate valleys combine into one.

**4.38****verification / verify**

the process of comparing a submitted biometric sample against the biometric reference template of a single enrollee whose identity is being claimed, to determine whether it matches the enrollee's template. Contrast with 'Identification'.

**5 Symbols and abbreviated terms**

BIT	Biometric Information Template
CBEFF	Common Biometric Exchange Formats Framework
DO	Data Object
FAR	False Acceptance Rate
FRR	False Rejection Rate
RCE	Ridge Count Extraction
RFU	Reserved for Future Use

**6 Minutiae Extraction**

6.1 to 6.7 define the placement of minutiae on the fingerprint. Compatible minutiae extraction is required for interoperability between different finger matchers for the purposes of matching an individual against a previously collected and stored finger record. The interoperability is based on defining the finger minutiae extraction rules, record formats and card formats that are common to many finger matchers for acceptable matching accuracy, while allowing for extended data to be attached for use with equipment that is compatible with it.

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**6.1 Principle**

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Establishment of a common feature-based representation must rest on agreement on the fundamental notion for representing a fingerprint. Minutiae are points located at the places in the fingerprint image where friction ridges end or split into two ridges. Describing a fingerprint in terms of the location and direction of these ridge endings and bifurcations provides sufficient information to reliably determine whether two fingerprint records are from the same finger.

The specifications of minutia location and minutia direction described below accomplish this. See Figure 1 for an illustration of the definitions below.

**6.2 Minutia Type**

Each minutia has a "type" associated with it. There are two major types of minutiae: a "ridge skeleton end point" and a "ridge skeleton bifurcation point" or split point. There are other types of "points of interest" in the friction ridges that occur much less frequently and are more difficult to define precisely. More complex types of minutiae are usually a combination of the basic types defined above. Some points are neither a ridge ending nor a bifurcation. This standard therefore defines additionally a type named "other", which shall be used in such a way that the matching conditions specified in 6.6 apply. The "other" minutiae type shall not be used for minutiae that are ridge endings or ridge bifurcations.

Therefore, the following types are distinguished:

- ridge ending (also identifiable as a valley skeleton bifurcation point);
- ridge bifurcation
- other.

A ridge ending may — alternatively — be regarded as a valley bifurcation depending on the method to determine its position (see below). The format type of the biometric information template indicates the use of ridge endings or valley bifurcations.

### 6.3 Minutia Location

The minutia location is represented by its horizontal and vertical position. The minutiae determination strategy considered in this document relies on skeletons derived from a digital fingerprint image. The ridge skeleton is computed by thinning down the ridge area to single pixel wide lines. The valley skeleton is computed by thinning down the valley area to single pixel wide lines. If other methods are applied, they should approximate the skeleton method, i.e. location and angle of the minutia should be equivalent to the skeleton method.

#### 6.3.1 Coordinate System

The coordinate system used to express the minutiae of a fingerprint shall be a Cartesian coordinate system. Points shall be represented by their X and Y coordinates. The origin of the coordinate system shall be the upper left corner of the original image with X increasing to the right and Y increasing downward. Note that this is in agreement with most imaging and image processing use. When viewed on the finger, X increases from right to left as shown in Figure 1. All X and Y values are non-negative.

The X and Y coordinates of the minutiae shall be in pixel units, with the spatial resolution of a pixel given in the "X Resolution" and "Y Resolution" fields of the format. X and Y resolutions are stated separately.

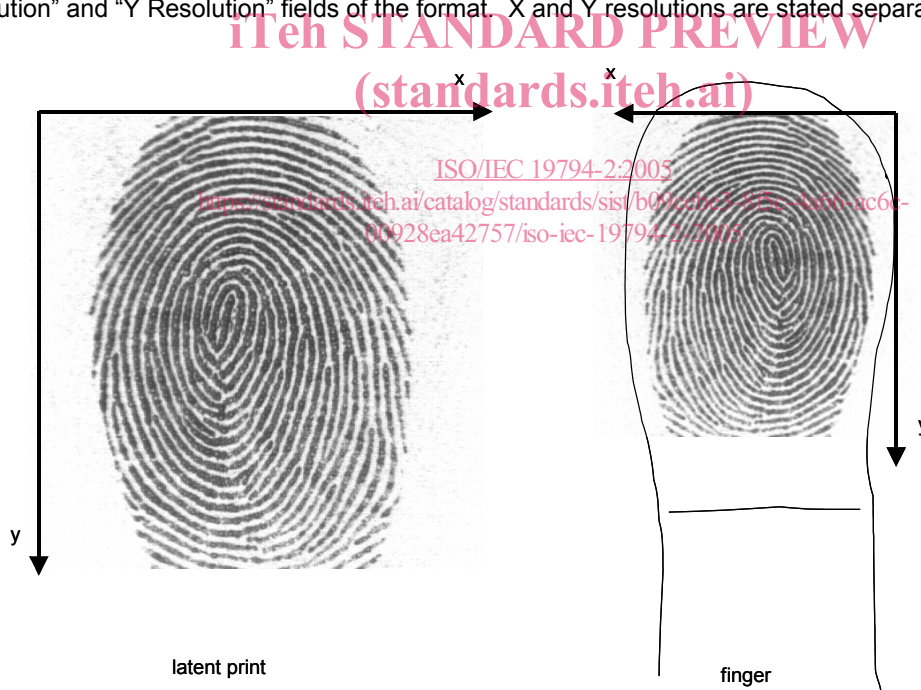


Figure 1 - Coordinate system

For the finger minutiae record format, the resolution of the coordinate system is specified in the record header, see 7.3.8 and 7.3.9. For the finger minutiae card format, the resolution of the X and Y coordinates of the minutia shall be in metric units. The granularity is one bit per one hundredth of a millimeter in the normal format and one tenth of a millimeter in the compact format:

1 unit =  $10^{-2}$  mm (normal format) or  $10^{-1}$  mm (compact format).

### 6.3.2 Minutia Placement on a Ridge Ending (encoded as Valley Skeleton Bifurcation Point)

The minutia for a ridge ending shall be defined as the point of forking of the medial skeleton of the valley area immediately in front of the ridge ending. If the valley area were thinned down to a single-pixel-wide skeleton, the point where the three legs intersect is the location of the minutia. In simpler terms, the point where the valley Y's, or (equivalently) where the three legs of the thinned valley area intersect (see Figure 2).

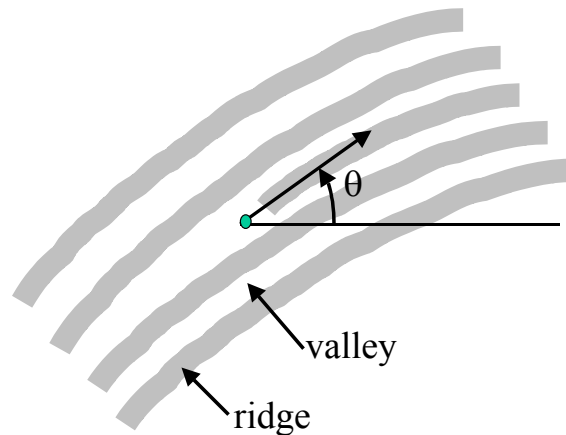


Figure 2 - Location and direction of a ridge ending (encoded as valley skeleton bifurcation point)

### 6.3.3 Minutia Placement on a Ridge Bifurcation (encoded as a Ridge Skeleton Bifurcation Point)

The minutia for a ridge bifurcation shall be defined as the point of forking of the medial skeleton of the ridge. If the ridges were thinned down to a single-pixel-wide skeleton, the point where the three legs intersect is the location of the minutia. In simpler terms, the point where the ridge "Y"s, or (equivalently) where the three legs of the thinned ridge intersect (see Figure 3).

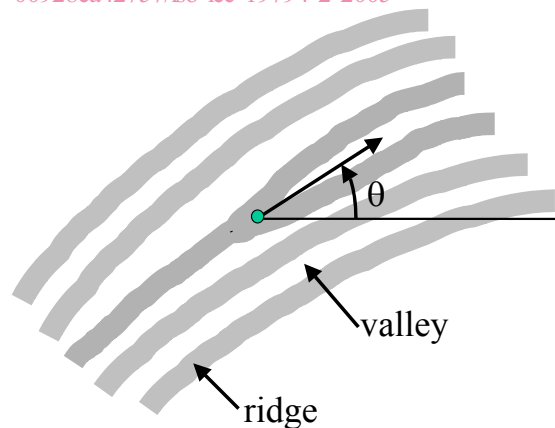


Figure 3 - Location and direction of a ridge bifurcation (encoded as ridge skeleton bifurcation point)

### 6.3.4 Minutia Placement on a Ridge Skeleton Endpoint

The minutia for a ridge skeleton endpoint shall be defined as the center point of the ending ridge. If the ridges in the digital fingerprint image were thinned down to a single-pixel-wide skeleton, the position of the minutia would be the coordinates of the skeleton point with only one neighbor pixel belonging to the skeleton (see Figure 4).