



**International  
Standard**

**ISO/IEC 15938-17**

**Information technology —  
Multimedia content description  
interface —**

**Part 17:  
Compression of neural networks for  
multimedia content description and  
analysis**

*Technologies de l'information — Interface de description du  
contenu multimédia —*

*Partie 17: Compression des réseaux neuronaux pour la  
description et l'analyse du contenu multimédia*

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# Contents

Page

<b>Foreword</b>	<b>v</b>
<b>Introduction</b>	<b>vi</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>1</b>
<b>4 Abbreviated terms, conventions and symbols</b>	<b>3</b>
4.1 General	3
4.2 Abbreviated terms	3
4.3 List of symbols	3
4.4 Number formats and computation conventions	6
4.5 Arithmetic operators	6
4.6 Logical operators	7
4.7 Relational operators	7
4.8 Bit-wise operators	7
4.9 Assignment operators	8
4.10 Range notation	8
4.11 Mathematical functions	8
4.12 Array functions	9
4.13 Order of operation precedence	11
4.14 Variables, syntax elements and tables	11
<b>5 Overview</b>	<b>13</b>
5.1 General	13
5.2 Compression tools	13
5.3 Creating encoding pipelines	14
<b>6 Syntax and semantics</b>	<b>15</b>
6.1 Specification of syntax and semantics	15
6.1.1 Method of specifying syntax in tabular form	15
6.1.2 Bit ordering	16
6.1.3 Specification of syntax functions and data types	16
6.1.4 Semantics	17
6.2 General bitstream syntax elements	18
6.2.1 NNR unit	18
6.2.2 Aggregate NNR unit	18
6.2.3 Composition of NNR bitstream	19
6.3 NNR bitstream syntax	20
6.3.1 NNR unit syntax	20
6.3.2 NNR unit size syntax	20
6.3.3 NNR unit header syntax	20
6.3.4 NNR unit payload syntax	25
6.3.5 Byte alignment syntax	31
6.4 Semantics	31
6.4.1 General	31
6.4.2 NNR unit size semantics	31
6.4.3 NNR unit header semantics	31
6.4.4 NNR unit payload semantics	39
<b>7 Decoding process</b>	<b>45</b>
7.1 General	45
7.2 NNR decompressed data formats	46
7.3 Decoding methods	47
7.3.1 General	47
7.3.2 Decoding method for NNR compressed payloads of type NNR_PT_INT	47
7.3.3 Decoding method for NNR compressed payloads of type NNR_PT_FLOAT	48

7.3.4	Decoding method for NNR compressed payloads of type NNR_PT_RAW_FLOAT	48
7.3.5	Decoding method for NNR compressed payloads of type NNR_PT_BLOCK	49
7.3.6	Decoding process for an integer weight tensor	50
<b>8</b>	<b>Parameter reduction</b>	<b>51</b>
8.1	General	51
8.2	Methods	51
8.2.1	Batchnorm folding	51
8.3	Syntax and semantics	52
8.3.1	Sparsification using compressibility loss	52
8.3.2	Sparsification using micro-structured pruning	52
8.3.3	Combined pruning and sparsification	52
8.3.4	Unstructured statistics-adaptive sparsification	53
8.3.5	Structured sparsification (global and local approach)	53
8.3.6	Weight unification	53
8.3.7	Low rank/low displacement rank for convolutional and fully connected layers	54
8.3.8	Batchnorm folding	54
8.3.9	Local scaling adaptation (LSA)	54
<b>9</b>	<b>Parameter quantization</b>	<b>55</b>
9.1	General	55
9.2	Methods	55
9.2.1	Uniform quantization method	55
9.2.2	Codebook-based method	55
9.2.3	Dependent scalar quantization method	55
9.2.4	Predictive residual encoding (PRE)	55
9.3	Syntax and semantics	55
9.3.1	Uniform quantization method	55
9.3.2	Codebook-based method	56
9.3.3	Dependent scalar quantization method	56
<b>10</b>	<b>Entropy coding</b>	<b>56</b>
10.1	Methods	56
10.1.1	DeepCABAC	56
10.2	Syntax and semantics	58
10.2.1	DeepCABAC syntax	58
10.3	Entropy decoding process	64
10.3.1	General	64
10.3.2	Initialization process	64
10.3.3	Binarization process	65
10.3.4	Decoding process flow	66
	<b>Annex A (normative) Implementation for NNEF</b>	<b>73</b>
	<b>Annex B (informative) Implementation for ONNX®</b>	<b>75</b>
	<b>Annex C (informative) Implementation for PyTorch®</b>	<b>77</b>
	<b>Annex D (informative) Implementation for TensorFlow®</b>	<b>79</b>
	<b>Annex E (informative) Recommendation for carriage of NNR bitstreams in other containers</b>	<b>81</b>
	<b>Annex F (informative) Recommendation for naming method regarding performance metric type</b>	<b>83</b>
	<b>Annex G (informative) Encoding side information for selected compression tools</b>	<b>84</b>
	<b>Bibliography</b>	<b>95</b>

## 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](http://www.iso.org/directives) or [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs)).

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This second edition cancels and replaces the first edition (ISO/IEC 15938-17:2022), which has been technically revised.

The main changes are as follows:

- Support for incremental compression of updates of neural networks respective to a base model,
- Additional sparsification tools,
- Additional entropy coding tools, leveraging dependencies in incremental updates,
- Additional quantization tools, including representation as residuals of updates, and
- Additional high-level syntax, covering the new coding tools as well as more metadata (e.g. performance metrics).

A list of all parts in the ISO/IEC 15938 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](http://www.iso.org/members.html) and [www.iec.ch/national-committees](http://www.iec.ch/national-committees).

## Introduction

Artificial neural networks have been adopted for a broad range of tasks in multimedia analysis and processing, media coding, data analytics and many other fields. Their recent success is based on the feasibility of processing much larger and complex neural networks (deep neural networks, DNNs) than in the past, and the availability of large-scale training data sets. As a consequence, trained neural networks contain a large number of parameters and weights, resulting in a quite large size (e.g. several hundred MBs). Many applications require the deployment of a particular trained network instance, potentially to a larger number of devices, which may have limitations in terms of processing power and memory (e.g. mobile devices or smart cameras), and also in terms of communication bandwidth. Any use case, in which a trained neural network (or its updates) needs to be deployed to a number of devices thus benefits from a standard for the compressed representation of neural networks.

Considering the fact that compression of neural networks is likely to have a hardware dependent and hardware independent component, this document is designed as a toolbox of compression technologies. Some of these technologies require specific representations in an exchange format (i.e. sparse representations, adaptive quantization), and thus a normative specification for representing outputs of these technologies is defined. Others do not at all materialize in a serialized representation (e.g. pruning), however, also for the latter ones required metadata is specified. This document is independent of a particular neural network exchange format, and interoperability with common formats is described in the annexes.

This document thus defines a high-level syntax that specifies required metadata elements and related semantics. In cases where the structure of binary data is to be specified (e.g. decomposed matrices) this document also specifies the actual bitstream syntax of the respective block. Annexes to the document specify the requirements and constraints of compressed neural network representations; as defined in this document; and how they are applied.

- [Annex A](#) specifies the implementation of this document with the Neural Network Exchange Format (NNEF<sup>1)</sup>), defining the use of NNEF to represent network topologies in a compressed neural network bitstream.
- [Annex B](#) provides recommendations for the implementation of this document with the Open Neural Network Exchange Format (ONNX<sup>2)</sup>), defining the use of ONNX to represent network topologies in a compressed neural network bitstream.
- [Annex C](#) provides recommendations for the implementation of this document with the PyTorch<sup>3)</sup> format, defining the reference to PyTorch elements in the network topology description of a compressed neural network bitstream.
- [Annex D](#) provides recommendations for the implementation of this document with the Tensorflow<sup>4)</sup> format, defining the reference to Tensorflow elements in the network topology description of a compressed neural network bitstream.
- [Annex E](#) provides recommendations for the carriage of tensors compressed according to this document in third party container formats.
- [Annex F](#) provides recommendations for the naming of common performance metrics to specify the metric that was used for validation.

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1) NNEF is the trademark of a product owned by The Khronos® Group. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO/IEC of the product named.

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- [Annex G](#) provides recommendations for implementing the encoding side of some of the compression tools.

The compression tools described in this document have been selected and evaluated for neural networks used in applications for multimedia description, analysis and processing. However, they may be useful for the compression of neural networks used in other applications and applied to other types of data.

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# Information technology — Multimedia content description interface —

## Part 17: Compression of neural networks for multimedia content description and analysis

### 1 Scope

This document specifies Neural Network Coding (NNC) as a compressed representation of the parameters/weights of a trained neural network and a decoding process for the compressed representation, complementing the description of the network topology in existing (exchange) formats for neural networks. It establishes a toolbox of compression methods, specifying (where applicable) the resulting elements of the compressed bitstream. Most of these tools can be applied to the compression of entire neural networks, and some of them can also be applied to the compression of differential updates of neural networks with respect to a base network. Such differential updates are for example useful when models are redistributed after fine-tuning or transfer learning, or when providing versions of a neural network with different compression ratios.

This document does not specify a complete protocol for the transmission of neural networks, but focuses on compression of network parameters. Only the syntax format, semantics, associated decoding process requirements, parameter sparsification, parameter transformation methods, parameter quantization, entropy coding method and integration/signalling within existing exchange formats are specified, while other matters such as pre-processing, system signalling and multiplexing, data loss recovery and post-processing are considered to be outside the scope of this document. Additionally, the internal processing steps performed within a decoder are also considered to be outside the scope of this document; only the externally observable output behaviour is required to conform to the specifications of this document.

### 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 10646, *Information technology — Universal coded character set (UCS)*

ISO/IEC 60559, *Information technology — Microprocessor Systems — Floating-Point arithmetic*

IETF RFC 1950, *ZLIB Compressed Data Format Specification version 3.3*

NNEF-v1.0.3<sup>5)</sup>, *Neural Network Exchange Format*, The Khronos NNEF Working Group, Version 1.0.3, 2020

FIPS PUB 180-4:2015, *Secure Hash Standard (SHS)*

### 3 Terms and definitions

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

5) Available from: <https://www.khronos.org/registry/NNEF/specs/1.0/nnef-1.0.3.pdf>