



IEEE Standard for Computer Vision (CV)—Technical Requirements for Algorithms Application Programming Interfaces (APIs) of Deep Learning Framework

IEEE Computer Society

Developed by the
Artificial Intelligence Standards Committee

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STANDARDS

IEEE Standard for Computer Vision (CV)—Technical Requirements for Algorithms Application Programming Interfaces (APIs) of Deep Learning Framework

Developed by the

Artificial Intelligence Standards Committee
of the
IEEE Computer Society

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IEEE SA Standards Board

Abstract: Functional and technical requirements for the interfaces between algorithms and learning frameworks (including the interfaces provided by training frameworks), and between algorithms and data sets in the development of artificial intelligence (AI) computer vision algorithms are specified in this standard. The adaptation and invocation of the application programming interfaces (API) involved in the development of computer vision algorithms (CVA) based on deep learning (hereinafter referred to as “CVA”) is addressed in this standard.

Keywords: algorithm, application programming interfaces, computer vision, IEEE 3110™, functional requirements, technical requirements

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Introduction

This introduction is not part of IEEE Std 3110-2025, IEEE Standard for Computer Vision (CV)—Technical Requirements for Algorithms Application Programming Interfaces (APIs) of Deep Learning Framework.

In recent years, computer vision technology based on deep learning has become one of the most active branches of artificial intelligence. Many algorithms in the field of computer vision are widely used. However, the CV framework API is not uniform, the data format is diverse, and the interface format is different. At present, the algorithm has a strong dependence on development environment. The deep learning framework APIs have low portability. Different formats for APIs in different modes can lead to unnecessary developmental overheads, such as having to relearn when training models are in different frameworks.

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IEEE Standard for Computer Vision (CV)—Technical Requirements for Algorithms Application Programming Interfaces (APIs) of Deep Learning Framework

1. Overview

1.1 Scope

This standard establishes the application programming interfaces (API) model of the computer vision systems. It specifies the functional and technical requirements of the API between the computer vision algorithm, deep learning framework, and the data set in the process of algorithm development and application. This standard is suitable for the adaptation and invocation of computer vision algorithms using deep learning frameworks.

1.2 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).^{6,7}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

⁶ The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

⁷ The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

There are no normative references in this standard.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms *and definitions apply*. *The IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁸

model training: The process of using training data to establish or improve the parameters of a machine learning model based on machine learning algorithms.

training data: A subset of input data samples used to train a machine learning model.

3.2 Acronyms and abbreviations

API	application programming interface
EOS	end of stream
ID	identification
NaN	not a number
NCHW	batch channel height width
NHWC	batch height width channel
RGB	red, green, and blue
YUV	lumina chrominance and chroma

4. General

4.1 Algorithm interface goals

By specifying the interface adaptation layer, objectives include the following:

- a) Algorithm uses different deep learning frameworks as the backend and can be switched.
- b) Algorithm runs on different hardware, such as servers and distributed clusters.
- c) Algorithm reads different data through a unified data interface.

⁸*IEEE Standards Dictionary Online* is available at: <http://dictionary.ieee.org>. An IEEE account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

4.2 Algorithm interface model

The algorithm interface model describes the relationship among data, algorithm, and model from the aspects of system resources, interface adaption, and algorithm application. The application interface model layers are as follows:

- System resource layer:** Comprising both hardware and software components, the system resource layer provides essential functions such as storage, computing, and inference required by the computer vision system. Different manufacturers have their own approaches to the specific implementation of the system resource layer, and this standard does not provide further description or specifications.
- Interface adaptation layer:** The interface adaptation layer provides service interfaces such as data interfaces, optimization interfaces, distributed interfaces, and model interfaces to the algorithm application layer. This helps facilitate model training with data, algorithms, and frameworks and efficient and flexible model migration between different frameworks.
- Algorithm application layer:** In the process of model training, the algorithm application layer is necessary to call the interfaces defined in this standard in order to accomplish tasks such as model training and model inference.

The computer vision algorithm interface model is shown in Figure 1.

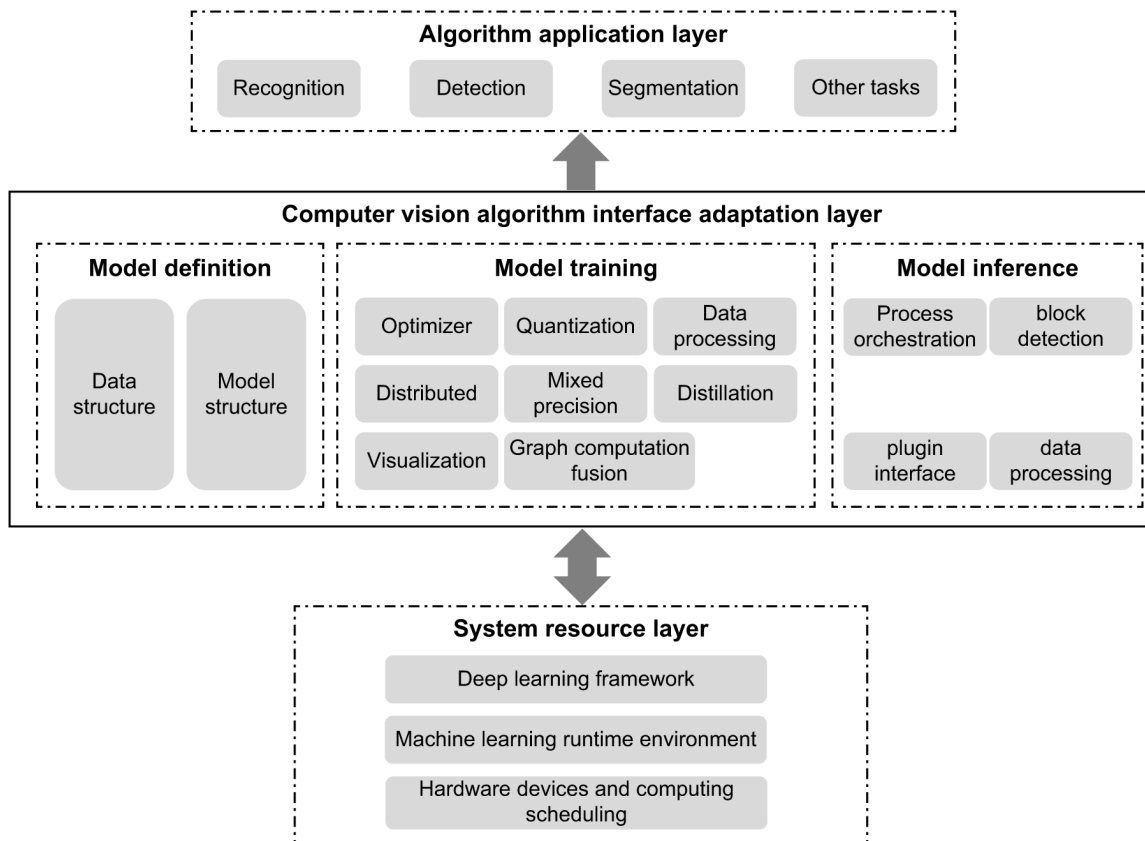


Figure 1—Computer vision algorithm interface model

5. Technical requirements of computer vision system interface

5.1 Data and model structure

5.1.1 Data structure

The data structure in computer vision is a fundamental structure that supports direct computation. Both inputs and outputs of the model structure are based on this primary structure or its collection. Refer to A.1 for specific interfaces. The data structure is considered to have the following core functions:

- a) Shall support common data types: scalar, vector, 2D matrix, and multidimensional matrix.
- b) Shall support initialization of certain data structures, using specific content to initialize the data structure.
- c) Shall support for random initialization, like uniform sampling (rand) between 0~1, randint for uniform sampling within a range, and randn for normal distribution sampling with mean 0 and variance 1.
- d) Shall support indexing functionality to provide querying specific element contents based on dimension indices.
- e) Shall support slicing functionality, using dimension indices to obtain slice values, and retain the tensor structure.
- f) Shall support reshape functionality to only change dimensions while keeping the elements unchanged.
- g) Should support basic mathematical operations on data elements, such as unary operations like negation operator, square root calculation, and squaring calculation. For tensors with matching dimensions and element counts, should support binary operations like +, -, *, /.

5.1.2 Model structure

The framework shall support the definition of algorithm models. Refer to A.2 and A.3 for specific interfaces. The model structure has the following core functions:

- a) Shall support forward computation, executing a forward calculation with given input.
- b) Shall support backward computation, calculating gradients for inputs and weights based on output gradients.
- c) Should support retrieving trainable parameters.
- d) Should support retrieving training status for state storage during training pauses.
- e) Should support loading training status for resuming training process.
- f) May support retrieval of submodules by module name for submodule operations.

5.2 Training interface

5.2.1 Optimizer interface

The optimizer interface shall support the function of network model optimization to optimize and update the model parameters based on optimization algorithms. Specifically, it can achieve gradient calculation and backpropagation, parameter update, optimization algorithm, learning rate update, and other functions. The specific interface is described in B.3. The optimizer interface shall implement the following:

- a) Be achieved as a class whose construction parameters include the network model or model parameter list, as well as other required parameters, such as learning rate.