SPECIFICATION

Submodel ModelNameplate

Version 1.0

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Submodel Template of the
Asset Adminstration Shell

Imprint

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Foreward

We would like to thank all of the working group members for their help and support to develop the AI ModelNameplate Submodel. The discussions were always helpful and we got lots of good ideas out of it.
A special thanks goes to the Interopera Consortium, that provided us with the opportunity to develop the AI ModelNameplate Submodel.

General

1.1 About this document

This document is a part of a specification series. Each part specifies the contents of a Submodel template for the Asset Administration Shell (AAS). The AAS is described in [1-3] and [6]. First exemplary Submodel contents were described in [4], while the actual format of this document was derived by the "Administration Shell in Practice" [5]. The format aims to be very concise, giving only minimal necessary information for applying a Submodel template, while leaving deeper descriptions and specification of concepts, structures and mapping to the respective documents [1-6].

The target group of the specification are developers and editors of models and ML applications, which are describing a model (e.g. Neural Network, Random Forest,…) by means of the Asset Administration Shell (AAS) and therefore need to create a Submodel instance with a hierarchy of SubmodelElements. This document especially details on the question, which SubmodelElements with which semantic identification shall be used for this purpose.

1.2 Scope of the Submodel

This Submodel template aims at interoperable provision of information describing AI model information in regard to the asset of the respective Asset Administration Shell. Central element is the provision of properties [7], ideally interoperable by the means of dictionaries such as ECLASS and IEC CDD (Common Data Dictionary). The purpose of this document is to make selected specifications of Submodels in such manner that information about assets can be exchanged in a meaningful way between partners in a value creation network. It targets to assist the AI model documentation and helps to manage an AI lifecycle.

The intended use-case is the provision of a standardized property structure for documenting AI models, which enables an efficient management of the different models and helps to reuse already trained models. On top of that it contains information about the responsible person for the model and helps to gain additional information of the model from him.

This concept can serve as a basis for standardizing the respective Submodel. The conception is based on existing norms, studies of common practices at enterprises, directives and standards so that a far-reaching acceptance can be achieved.

1.3 Relevant standards and sources of concepts for the Submodel template

According to [3], interoperable properties might be defined by standards, consortium specifications or manufacturer specifications. So called property dictionaries are used identify information elements (see Terms and Definitions of [6]). Such property dictionaries include:

- ECLASS, see: https://www.eclasscontent.com/
- IEC CDD, see: https://cdd.iec.ch/cdd/iec61987/iec61987.nsf and https://cdd.iec.ch/cdd/iec62683/cdddev.nsf

In this document, properties are aimed to be described by ECLASS.

Information set for Submodel ModelNameplate

While defining Submodels the following three aspects must be considered as suggested in [5]:

Use and economic relevance

The Submodel AI ModelNameplate is designed for documenting the training process of AI models. The documentation helps to reuse trained model and reduces the training time of models, because a retraining of a model is, in general, less time consuming than training a model from scratch.

On top of that, it assists with the communication within a company. The Submodel contains information about a responsible person for this model. Therefore additional information can be asked to the responsible person directly.

One use case is the collection of the most important parameters and model variables of an AI model. The collection process is triggered at the same time as the start of the AI training. The triggered training process monitors the hyperparameters and the training and stores the desired quantities in the “ModelNameplate” Submodel. As a result, all information required for the training is available in one place, namely in the Submodel.

Possible functions and interactions

The Submodel "ModelNameplate" contains information about the AI model. AI model developers and data scientists can use the Submodel to obtain detailed information about the model. Information available includes, for example, the training configuration, the storage location and the data set used. In addition to data scientists, people in the administration are also interested in the Submodel. Within the Submodel, contact information about the person responsible for the model is stored. This supports an orderly management structure even in larger companies.

By using the SMC "Inputs" and the child SMC "Dimension", information about the input variables is recorded. Analogous to the input variables, important meta information of the output variables is summarized in the SMC "Outputs".

The results of the training are recorded in the SMC "TrainingResult". The SMC is developed in such a way that the developer has the greatest possible freedom to record his specific results.

The SMC "Plots" contains all graphics assigned to the model. The SMC "Plots" is divided into three SMCs. The SMC "TrainingTesting" contains the plots created in the training and testing process. The second SMC "Structure" describes the model structure through graphics. To allow the users of the Submodel freedom of design, the SMC "GeneralPlots" has been added as a third SMC.

The SMC "Details" provides general information such as the programming language for the training or the required modules. In a model development, the data form a central element. To cover this element, the SMC "Dataset" exists, which includes the reference and access times to the dataset.

In order to do justice to the different AI methods, there is the SMC "AIMethodSpecificInformation". Within this SMC, there is a separate SMC for each of the neural networks, Support Vector Machine and Random Forrest, in which hyperparameters of these methods are available. In order to take other AI approaches into account, there exists the SMC "OtherAI", which can be adapted to these approaches.

Property specification

See section 3 Submodel and Collections.

Submodel and Collections

3.1 Properties of the Submodel “ModelNameplate”

The figure below shows the UML-diagram defining the relevant properties which need to be set. Table 1: Properties of Submodel “ModelNameplate" describes the details of the Submodel structure.

Figure 1: UML-Diagram for Submodel " ModelNameplate"

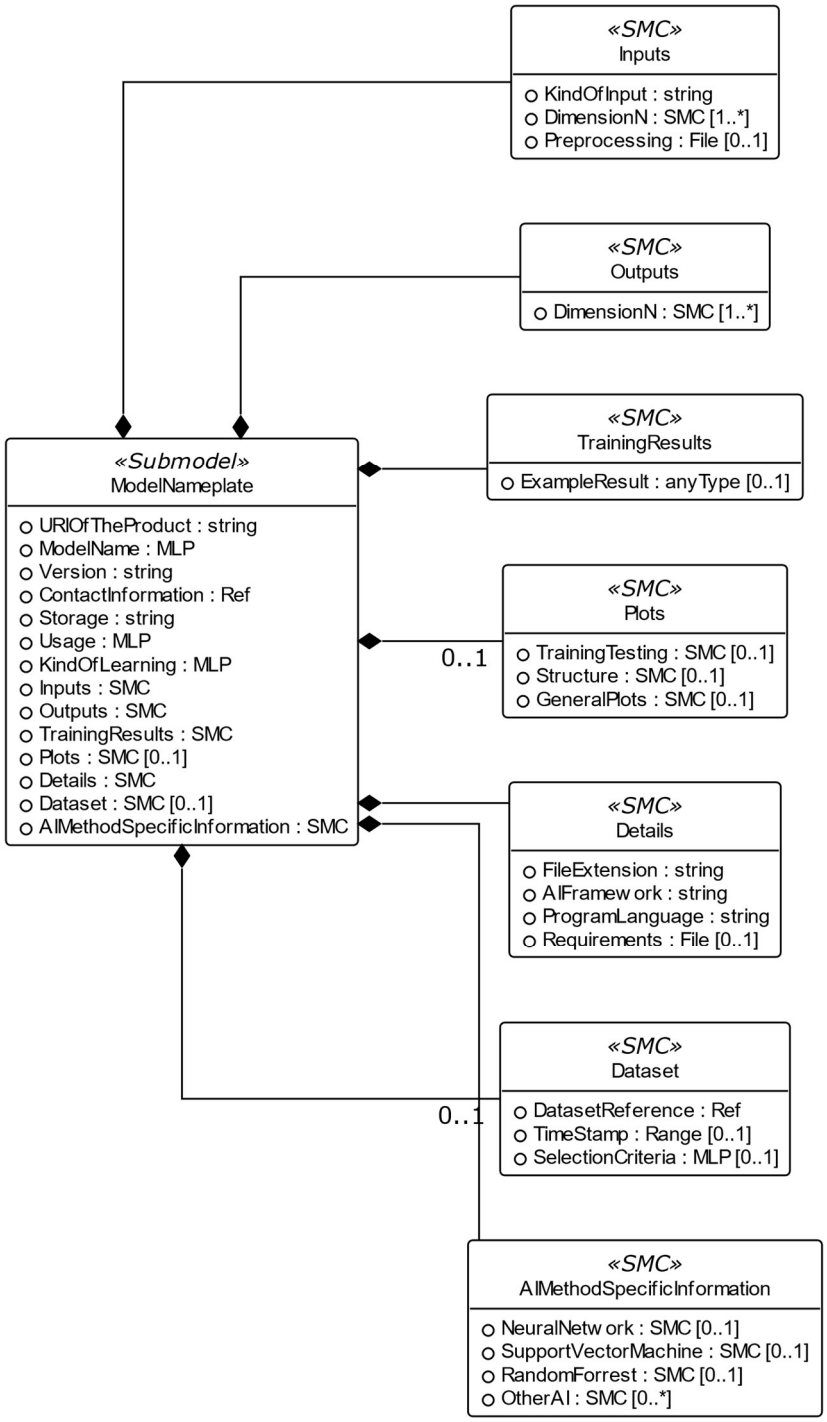

Table 1: Properties of Submodel “ModelNameplate"

idShort:	ModelNameplate		
Class:	Submodel		
semanticId:	[https://admin-shell.io/id/InterOpera/ModelNameplate]		
Parent:			
Explanation:			
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] URIOfTheProduct	[IRDI]0173-1#02-ABH173#001 URI of the product	[string]	1
[MLP] ModelName	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/ModelName Name of the Model	[] @en	1
[Property] Version	[IRDI]0173-1#02-AAS354#002 Version	[string]	1
[Ref] ContactInformation	[IRI]https://admin-shell.io/id/InterOpera/AIDataset/Contactinformation Reference to the Contact Information IDTA Submodel to describe the responsible person for the Submodel	[]	1
[Property] Storage	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Storage Path to the model (e.g. local path, server path,...)	[string]	1
[MLP] Usage	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Usage Purpose for creating the model (e.g. image classification, object detection, NLP, ...)	[] @en	1
[MLP] KindOfLearning	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/KindOfLearning	[] @en	1

	Learning method of the model (supervised, unsupervised, reinforcement, ...)		
[SMC] Inputs	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs Collection of necessary information about the model input	[] 3 elements	1
[SMC] Outputs	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Outputs Collection of necessary information about the model output	[] 1 elements	1
[SMC] TrainingResults	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/TrainingResults Collection of different training results of the model	[] 1 elements	1
[SMC] Plots	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots Collection of different plots (e.g. about the training or the model itself)	[] 3 elements	0..1
[SMC] Details	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Details Collection of additional details about the model	[] 4 elements	1
[SMC] Dataset	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Dataset Collection of information about the used dataset	[] 3 elements	0..1
[SMC] AIMethodSpecificInformation	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation Collection containing different kinds of AI method specific parameters	[] 4 elements	1

3.2 Properties of the SMC “Inputs”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 2: Properties of SMC "Inputs"

idShort:	Inputs		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs		
Parent:	AIModelNameplate		
Explanation:	Collection of necessary information about the model input@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] KindOfInput	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs/KindOfInput Type of data (e.g. Images, Audio)	[string]	1
[SMC] DimensionN	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs/DimensionN Collection of information about a single input dimension	[] 2 elements	1..*
[File] Preprocessing	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs/Preprocessing Preprocessing pipeline as a file	[]	0..1

3.3 Properties of the SMC “DimensionN”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 3: Properties of SMC "DimensionN"

idShort:	DimensionN		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs/DimensionN		
Parent:	Inputs		
Explanation:	Collection of information about a single input dimension@en		
[SME type]	semanticId = [idType]value	[valueType]	card.

idShort	Description@en	example	
[Property] Size	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs/DimensionN/Size Size of the input dimension	[string]	1
[MLP] Information	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Inputs/DimensionN/Information Information about the usage of this dimension	[] @en	0..1

3.4 Properties of the SMC “Output”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 4: Properties of SMC "Output"

idShort:	Outputs		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Outputs		
Parent:	AIModelNameplate		
Explanation:	Collection of necessary information about the model output@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	Description@en	example	
[SMC] DimensionN	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Outputs/DimensionN Collection of information about a single output dimension	[] 2 elements	1..*

3.5 Properties of the SMC “DimensionN”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 5: Properties of SMC " DimensionN"

idShort:	DimensionN		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Outputs/DimensionN		
Parent:	Outputs		

Explanation:	Collection of information about a single output dimension@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] Size	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Outputs/DimensionN/Size Size of the output dimension	[string]	1
[MLP] Result	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Outputs/DimensionN/Result Meaning of the output dimension (e.g. class)	[] @en	1

3.6 Properties of the SMC “TrainingResults”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 6: Properties of SMC " TrainingResults"

idShort:	TrainingResults		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/TrainingResults		
Parent:	AIModelNameplate		
Explanation:	Collection of different training results of the model@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] ExampleResult	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/TrainingResults/Result Result of the trained AI	[anyType]	0..1

3.7 Properties of the SMC “Plots”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 7: Properties of SMC " Plots"

idShort:	Plots		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots		

Parent:	AIModelNameplate		
Explanation:	Collection of different plots (e.g. about the training or the model itself)@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[SMC] TrainingTesting	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/TrainingTesting Collection of plots about training results and test results	[] 1 elements	0..1
[SMC] Structure	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/Structure Collection describing the model architecture (e.g. of a neural network)	[] 1 elements	0..1
[SMC] GeneralPlots	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/GeneralPlots Collection of plots not fitting in existing collections	[] 1 elements	0..1

3.8 Properties of the SMC “TrainingTesting”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 8: Properties of SMC " TrainingTesting"

idShort:	TrainingTesting		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/TrainingTesting		
Parent:	Plots		
Explanation:	Collection of plots about training results and test results@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[File] ExamplePlot	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/TrainingTesting/Plot Training or test result plot	[]	1..*

3.9 Properties of the SMC “Structure”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 9: Properties of SMC " Structure"

idShort:	Structure		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/Structure		
Parent:	Plots		
Explanation:	Collection describing the model architecture (e.g. of a neural net)@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[File] ExampleStructurePlot	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/Structure/StructurePlot Image of a model architecture	[]	1..*

3.10 Properties of the SMC “GeneralPlots”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 10: Properties of SMC " GeneralPlots"

idShort:	GeneralPlots		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/GeneralPlots		
Parent:	Plots		
Explanation:	Collection of plots not fitting in existing collections@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[File] ExamplePlot1	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Plots/GeneralPlots/Plot Image of an model related plot	[]	1..*

3.11 Properties of the SMC “Details”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 11: Properties of SMC " Details"

idShort:	Details		

Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Details		
Parent:	AIModelNameplate		
Explanation:	Collection of additional details about the model@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] FileExtension	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Details/DataEnding File extension of the model (e.g. .pth)	[string]	1
[Property] AIFramework	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Details/AIFramework AI framework and its version (e.g. pytorch 11.3)	[string]	1
[Property] ProgramLanguage	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Details/ProgramLanguage Programming language and version (e.g. python 3.9)	[string]	1
[File] Requirements	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Details/Requirements Requirements file containing the required software dependencies (e.g. Python Requirements.txt file)	[]	0..1

3.12 Properties of the SMC “Dataset”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 12: Properties of SMC " Dataset"

idShort:	Dataset		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Dataset		
Parent:	AIModelNameplate		
Explanation:	Collection of information about the used dataset@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	

[Ref] DatasetReference	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Dataset/DatasetReference Reference to the used AI Dataset Submodel	[]	1
[Range] TimeStamp	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Dataset/TimeStamp Determining the used data, when dataset differs over time	[] ..	0..1
[MLP] SelectionCriteria	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/Dataset/SelectionCriteria Selection criteria for choosing the dataset	[] @en	0..1

3.13 Properties of the SMC “AIMethodSpecificInformation”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table and figure describe the details of the SMC structure.

Figure 2: UML-Diagram for SubmodelCollection "AIMethodSpecificInformation"

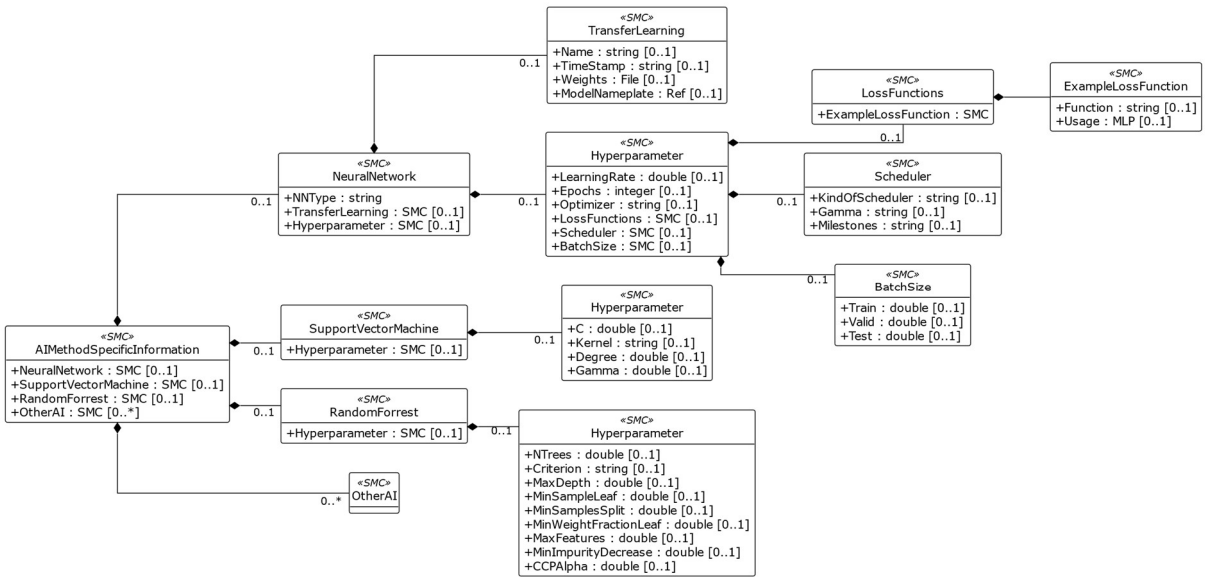

Table 13: Properties of SMC " AISpecificInformation"

idShort:	AIMethodSpecificInformation		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation		
Parent:	AIModelNameplate		

Explanation:	Collection containing different kinds of AI method specific parameters@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[SMC] NeuralNetwork	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork Collection containing neural network specific parameters and information	[] 3 elements	0..1
[SMC] SupportVectorMachine	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine Collection containing SVM specific parameters and information	[] 1 elements	0..1
[SMC] RandomForrest	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest Collection of all specific parameters and information for random forest	[] 1 elements	0..1
[SMC] OtherAI	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/OtherAI Collection for another AI method besides the ones already defined	[] 0 elements	0..*

3.14 Properties of the SMC “NeuralNetwork”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 14: Properties of SMC " NeuralNetwork"

idShort:	NeuralNetwork		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork		
Parent:	AITypeSpecificInformation		
Explanation:	Collection containing neural network specific parameters and information@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	

[Property] NNType	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/NNType Type of neural network (e.g. CNN, RNN, LSTM, ...)	[string]	1
[SMC] TransferLearning	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/TransferLearning Collection containing information of the origin model, if the model is a result of transfer learning	[] 4 elements	0..1
[SMC] Hyperparameter	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter Collection containing relevant hyperparameter	[] 6 elements	0..1

3.15 Properties of the SMC “TransferLearning”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 15: Properties of SMC " TransferLearning"

idShort:	TransferLearning		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/TransferLearning		
Parent:	NeuralNetwork		
Explanation:	Collection containing information of the origin model, if the model is a result of transfer learning@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] Name	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/TransferLearning/Name Name of the origin neural network (e.g. resnet18)	[string]	0..1
[Property] TimeStamp	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/TransferLearning/TimeStamp Date of access of the origin neural network	[string]	0..1

[File] Weights	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/TransferLearning/Weights File containing the weights of the origin model (e.g. .txt)	[]	0..1
[Ref] ModelNameplate	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/TransferLearning/ModelnameplateRef Reference to the AI ModelNameplate Submodel of the origin neural network	[]	0..1

3.16 Properties of the SMC “Hyperparameter”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 16: Properties of SMC " Hyperparameter"

idShort:	Hyperparameter		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter		
Parent:	NeuralNetwork		
Explanation:	Collection containing relevant hyperparameter@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] LearningRate	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/LearningRate Learning rate of the model	[double]	0..1
[Property] Epochs	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Epochs Epochs the neural network got trained with	[integer]	0..1
[Property] Optimizer	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Optimizer Optimizer of the neural network	[string]	0..1

[SMC] LossFunctions	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Lossfunctions Collection containing information about used loss-functions	[] 1 elements	0..1
[SMC] Scheduler	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Scheduler Collection containing information about a scheduler to change the learning rate under defined conditions	[] 3 elements	0..1
[SMC] BatchSize	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/BatchSize This collection contains the used batch sizes	[] 3 elements	0..1

3.17 Properties of the SMC “LossFunctions”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 17: Properties of SMC " LossFunctions"

idShort:	LossFunctions		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Lossfunctions		
Parent:	Hyperparameter		
Explanation:	Collection containing information about used loss-functions@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[SMC] ExampleLossFunction	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/LossFunctions/LossFunction Collection describing a loss function	[] 2 elements	

3.18 Properties of the SMC “ExampleLossFunction”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 18: Properties of SMC " ExampleLossFunction"

idShort:	ExampleLossFunction		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/LossFunctions/LossFunction		
Parent:	LossFunctions		
Explanation:	Collection describing a loss function@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] Function	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/LossFunctions/LossFunction/Function Name of the loss function	[string]	0..1
[MLP] Usage	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/LossFunctions/LossFunction/Usage Usage of the loss function in the neural network	[]	0..1

3.19 Properties of the SMC “Scheduler”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 19: Properties of SMC " Scheduler"

idShort:	Scheduler		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Scheduler		
Parent:	Hyperparameter		
Explanation:	Collection containing information about a scheduler to change the learning rate under defined conditions@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] KindOfScheduler	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Sc	[string]	0..1

	heduler/KindOfScheduler Name of the used scheduler		
[Property] Gamma	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Scheduler/Gamma The gamma is the factor which is multiplied with the learning rate when the scheduler conditions are met	[string]	0..1
[Property] Milestones	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/Scheduler/Milestones Describing the conditions, in which epoch the learning rate changes	[string]	0..1

3.20 Properties of the SMC “BatchSize”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 20: Properties of SMC " BatchSize"

idShort:	BatchSize		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/BatchSize		
Parent:	Hyperparameter		
Explanation:	This collection contains the used batch sizes@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] Train	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/BatchSize/Train The batch size used for training	[double]	0..1
[Property] Valid	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/BatchSize/Valid The batch size used for validation	[double]	0..1

[Property] Test	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/NeuralNetwork/Hyperparameter/BatchSize/Test The batch size used for testing	[double]	0..1

3.21 Properties of the SMC “SupportVectorMachine”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 21: Properties of SMC " SupportVectorMachine"

idShort:	SupportVectorMachine		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine		
Parent:	AITypeSpecificInformation		
Explanation:	Collection containing SVM specific parameters and information@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[SMC] Hyperparameter	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine/Hyperparameter Collection containing relevant hyperparameter	[] 4 elements	0..1

3.22 Properties of the SMC “Hyperparameter”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 22: Properties of SMC “Hyperparameter”

idShort:	Hyperparameter		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine/Hyperparameter		
Parent:	SupportVectorMachine		
Explanation:	Collection containing relevant hyperparameter@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] C	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine/Hyperparameter/C	[double]	0..1

	Regularization parameter describing the strength of the regularization which is inversely proportional to C		
[Property] Kernel	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine/Hyperparameter/Kernel Specifies the kernel type to be used in the algorithm	[string]	0..1
[Property] Degree	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine/Hyperparameter/Degree Degree of the polynomial kernel function	[double]	0..1
[Property] Gamma	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/SupportVectorMachine/Hyperparameter/Gamma Used kernel coefficient	[double]	0..1

3.23 Properties of the SMC “RandomForrest”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 23: Properties of SMC “RandomForrest”

idShort:	RandomForrest		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest		
Parent:	AITypeSpecificInformation		
Explanation:	Collection of all specific parameters and information for random forest@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[SMC] Hyperparameter	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter Collection containing relevant hyperparameter	[] 9 elements	0..1

3.24 Properties of the SMC “Hyperparameter”

Figure 1 shows the UML-diagram defining the relevant properties which need to be set. The following table describes the details of the SMC structure.

Table 24: Properties of SMC “Hyperparameter”

idShort:	Hyperparameter		
Class:	SubmodelElementCollection		
semanticId:	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter		
Parent:	RandomForrest		
Explanation:	Collection containing relevant hyperparameter@en		
[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Property] NTrees	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/NTrees Number of trees in the forest	[double]	0..1
[Property] Criterion	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/Criterion The function to measure the quality of a split	[string]	0..1
[Property] MaxDepth	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/MaxDepth Maximum depth of the tree	[double]	0..1
[Property] MinSampleLeaf	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/MinSampleLeaf Minimum number of samples required to be at a leaf node	[double]	0..1
[Property] MinSamplesSplit	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/MeanSamplesSplit	[double]	0..1

	Minimum number of samples required to split an internal node		
[Property] MinWeightFractionLeaf	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/MinWeightFractionLeaf Minimum weighted fraction of the sum total of weights (of all the input samples) required to be at a leaf node	[double]	0..1
[Property] MaxFeatures	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/MaxFeatures Number of features to consider when looking for the best split	[double]	0..1
[Property] MinImpurityDecrease	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/MinImpurityDecrese A node will be split if this split induces a decrease of the impurity greater than or equal to this value	[double]	0..1
[Property] CCPAlpha	[IRI]https://admin-shell.io/id/InterOpera/AIModelNameplate/AITypeSpecificInformation/RandomForrest/Hyperparameter/CCPAlpha Complexity parameter used for Minimal Cost-Complexity Pruning	[double]	0..1

Annex A: Explanations on used table formats

General

The used tables in this document try to outline information as concise as possible. They do not convey all information on Submodels and SubmodelElements. For this purpose, the definitive definitions are given by a separate file in form of an AASX file of the Submodel template and its elements.

Tables on Submodels and SubmodelElements

For clarity and brevity, a set of rules is used for the tables for describing Submodels and SubmodelElements.

- The tables follow in principle the same conventions as in [5].
- The table heads abbreviate 'cardinality' with 'card'.
- The tables often place two informations in different rows of the same table cell. In this case, the first information is marked out by sharp brackets [] form the second information. A special case are the semanticIds, which are marked out by the format: (type)(local)[idType]value.
- The types of SubmodelElements are abbreviated: SME

SME type Submodel	Element type
Property	Property
MLP	MultiLanguageProperty
Range	Range
File	File
Blob	Blob
Ref	ReferenceElement
Rel	RelationshipElement
SMC	SubmodelElementCollection

- If an idShort ends with '{00}', this indicates a suffix of the respective length (here: 2) of decimal digits, in order to make the idShort unique. A different idShort might be choosen, as long as it is unique in the parent's context.
- The Keys of semanticId in the main section feature only idType and value, such as: [IRI]https://admin-shell.io/vdi/2770/1/0/DocumentId/Id. The attributes "type" and "local" (typically "ConceptDescription" and "(local)" or "GlobalReference" and (no-local)") need to be set accordingly; see [6].
- If a table does not contain a column with "parent" heading, all represented attributes share the same parent. This parent is denoted in the head of the table.
- Multi-language strings are represented by the text value, followed by '@'-character and the ISO 639 language code: example@de.
- The [valueType] is only given for Properties.

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