

1	Status	Letter Ballot
2	Date of Last Update	2019/09/12
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7	Submission Date	2018/09/01

8	Correction Number CP-1867	
9	Log Summary: Add codes for AI visual explanation maps	
10	Name of Standard	
11	PS3.16 2019d	
12	Rationale for Correction:	
13	Various types of images (maps) containing visual explanations of how an AI algorithm produces its results are defined, which need	
14	codes in DICOM to describe the quantity encoded for the pixel values (e.g., in Parametric Map objects).	
15	Also, for results encoded in SR TID 1500, a means of referencing such images is added.	
16	Correction Wording:	

Amend DICOM PS3.16 as follows (changes to existing text are bold and underlined for additions and ~~struckthrough~~ for removals):

TID 1410 Planar ROI Measurements and Qualitative Evaluations

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Table TID 1410. Planar ROI Measurements and Qualitative Evaluations

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (125007, DCM, "Measurement Group")	1	M		
5	>	CONTAINS	SCOORD	EV (111030, DCM, "Image Region")	1	MC	XOR Row 7	GRAPHIC TYPE = not {MULTIPOINT}
6	>>	SELECTED FROM	IMAGE		1	M		
7	>	CONTAINS	IMAGE	EV (121214, DCM, "Referenced Segmentation Frame")	1	MC	XOR Row 5	Reference shall be to a Segmentation Image, with a single value specified in Referenced Frame Number, and with a single value specified in Referenced Segment Number
8	>	CONTAINS	IMAGE	EV (121233, DCM, "Source image for segmentation")	1	MC	IFF Row 7	
9	>	CONTAINS	IMAGE	EV (121200, DCM, "Illustration of ROI")	1	U		
9b	≥	CONTAINS	IMAGE	EV (ddd000, DCM, "Visual explanation")	1-n	U		
10	>	CONTAINS	COMPOSITE	EV (126100, DCM, "Real World Value Map used for measurement")	1	U		SOP Class UID shall be Real World Value Mapping Storage ("1.2.840.10008.5.1.4.1.1.67")

Content Item Descriptions

Row 8	Identifies the source image that was segmented to identify the ROI, and whose properties are described in this container.
Row 9	This referenced image may contain a "screen shot" illustrating a rendered version of the ROI.
Row 9b	<u>This referenced image may contain a visual explanation of how an algorithm produces its results, and may be a "screen shot" of the explanation already superimposed on the source image (e.g., a "heat map"), or a parametric map intended to be superimposed on the source image by the receiving application. The type of image and the type of visual explanation is described in the referenced image's own metadata. More than one referenced image may be present, if there is more than one type of visual explanation, or it needs to span more than one single-frame image.</u>
Row 10	The reference to an RWV in Row 10 allows measurements to be made in units that differ from the stored pixel values in the images referenced elsewhere in the Template. E.g., for a PET SUVbw measurement, the mapping from activity/concentration units in the referenced image that was used (and which may be reused for measurements in the future) may be encoded in a referenced RWV instance. This reference applies to any measurements in included Templates, unless overridden).

TID 1411 Volumetric ROI Measurements and Qualitative Evaluations

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Table TID 1411. Volumetric ROI Measurements and Qualitative Evaluations

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1			CONTAINER	EV (125007, DCM, "Measurement Group")	1	M		
5	>	CONTAINS	SCOORD	EV (111030, DCM, "Image Region")	1-n	MC	XOR Rows 7, 10	GRAPHIC TYPE = not {MULTIPOINT}
6	>>	SELECTED FROM	IMAGE		1	M		
7	>	CONTAINS	IMAGE	EV (121191, DCM, "Referenced Segment")	1	MC	XOR Rows 5, 10	Reference shall be to a Segmentation Image or Surface Segmentation object, with a single value specified in Referenced Segment Number
10	>	CONTAINS	SCOORD3D	EV (121231, DCM, "Volume Surface")	1	MC	XOR Rows 5, 7	GRAPHIC TYPE = {ELLIPSOID}
11	>	CONTAINS	IMAGE	EV (121233, DCM, "Source image for segmentation")	1-n	MC	XOR Row 12 and IFF (Row 7 or Row 10)	
12	>	CONTAINS	UIDREF	EV (121232, DCM, "Source series for segmentation")	1	MC	XOR Row 11 and IFF ((Row 7 or Row 10)	
13	>	CONTAINS	IMAGE	EV (121200, DCM, "Illustration of ROI")	1-n	U		
13b	≥	CONTAINS	IMAGE	EV (ddd000, DCM, "Visual explanation")	1-n	U		
14	>	CONTAINS	COMPOSITE	EV (126100, DCM, "Real World Value Map used for measurement")	1	U		SOP Class UID shall be Real World Value Mapping Storage ("1.2.840.10008.5.1.4.1.1.67")

Content Item Descriptions

Row 11	Identifies the source images that were segmented to identify the ROI, when, for example a subset of images in a series was used.
Row 12	Identifies the source series of images that were segmented to identify the ROI, when, for example an entire set of images in a series was used.
Row 13	These referenced images may contain "screen shot" illustrating rendered versions of the ROI.
Row 13b	<u>This referenced image may contain a visual explanation of how an algorithm produces its results, and may be a "screen shot" of the explanation already superimposed on the source image (e.g., a "heat map"), or a parametric map intended to be superimposed on the source image by the receiving application. The type of image and the type of visual explanation is described in the referenced image's own metadata. More than one referenced image may be present, if there is more than one type of visual explanation, or it needs to span more than one single-frame image.</u>
Row 14	The reference to an RWV in Row 14 allows measurements to be made in units that differ from the stored pixel values in the images referenced elsewhere in the Template. E.g., for a PET SUVbw measurement, the mapping from activity/concentration units in the referenced image that was used (and which may be reused for measurements in the future) may be encoded in a referenced RWV instance. This reference applies to any measurements in included Templates, unless overridden).

TID 1501 Measurement and Qualitative Evaluation Group

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1 **Table TID 1501. Measurement and Qualitative Evaluation Group**

	NL	Rel with Parent	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
4	1	CONTAINS	CONTAINER	EV (125007, DCM, "Measurement Group")	1	M		
6	9	>	CONTAINS	COMPOSITE	EV (126100, DCM, "Real World Value Map used for measurement")	1	U	SOP Class UID shall be Real World Value Mapping Storage ("1.2.840.10008.5.1.4.1.1.67")
9	9b		HAS CONCEPT MOD	INCLUDE	DTID4019 "Algorithm Identification"	1	U	
12	9c	≥	CONTAINS	IMAGE	EV (121200, DCM, "Illustration of ROI")	1	U	
14	9d	≥	CONTAINS	IMAGE	EV (ddd000, DCM, "Visual explanation")	1-n	U	
16	10	>	CONTAINS	INCLUDE	DTID 300 "Measurement"	1-n	U	...

17 **Content Item Descriptions**

18	Row 9	The reference to an RWV in Row 9 allows measurements to be made in units that differ from the stored pixel values in the images referenced elsewhere in the Template. E.g., for a PET SUVbw measurement, the mapping from activity/concentration units in the referenced image that was used (and which may be reused for measurements in the future) may be encoded in a referenced RWV instance. This reference applies to any measurements in included Templates, unless overridden).
23	Row 9b	Describes the algorithm that applies to all measurements in TID 300 Row 1, unless overridden within the individual measurement at TID 300 Row 19.
25	Row 9c	<u>This referenced image may contain a "screen shot" illustrating a rendered version of the ROI.</u>
26	Row 9d	<u>This referenced image may contain a visual explanation of how an algorithm produces its results, and may be a "screen shot" of the explanation already superimposed on the source image (e.g., a "heat map"), or a parametric map intended to be superimposed on the source image by the receiving application. The type of image and the type of visual explanation is described in the referenced image's own metadata. More than one referenced image may be present, if there is more than one type of visual explanation, or it needs to span more than one single-frame image.</u>

32 *Add new concept groups to DICOM PS3.16 as follows :*

33 **CID 7180 Abstract Multi-dimensional Image Model Component Semantics**

35 **Resources:** HTML | FHIR JSON | FHIR XML | IHE SVS XML
 36 **Type:** Extensible
 38 **Version:** 20180904yyymmdd
 40 **UID:** 1.2.840.10008.6.1.917

42 **Table CID 7180. Abstract Multi-dimensional Image Model Component Semantics**

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-CT Concept ID	UMLS Concept Unique ID	Units
43 <i>Include CID ccc1 "Visual Explanation"</i>					

46 **CID ccc1 Visual Explanation**

48 **Resources:** HTML | FHIR JSON | FHIR XML | IHE SVS XML
 50 **Type:** Extensible

Version: **yyyymmdd**
 UID: **1.2.840.10008.6.1.uuu1**

Table CID ccc1. Visual Explanation

Coding Scheme Designator	Code Value	Code Meaning	Units
DCM	ddd001	Class activation	(1, UCUM, "no units")
DCM	ddd002	Gradient-weighted class activation	(1, UCUM, "no units")
DCM	ddd003	Saliency	(1, UCUM, "no units")

Add new codes to DICOM PS3.16 as follows :

D DICOM Controlled Terminology Definitions (Normative)

Table D-1. DICOM Controlled Terminology Definitions (Coding Scheme Designator "DCM" Coding Scheme Version "01")

Code Value	Code Meaning	Definition	Notes
ddd000	Visual explanation	A visual explanation of how an algorithm produced its results. E.g., for a machine learning application, a class activation or saliency map.	
ddd001	Class activation	Values are derived using global average pooling in convolutional neural networks to produce a localization map highlighting the important regions in the image for predicting a class. The class activation map (CAM) indicates the discriminative image regions used by the network to identify a class.	Zhou B, Khosla A, Lapedriza A, Oliva A, Torralba A. Learning Deep Features for Discriminative Localization. IEEE Conference on Computer Vision and Pattern Recognition (CVPR). 2016. p 2921–9. http://dx.doi.org/10.1109/CVPR.2016.319
ddd002	Gradient-weighted class activation	Values are derived using the gradients of a target class flowing into the final convolutional layer of a convolutional neural network to produce a localization map highlighting the important regions in the image for predicting a class. The gradient-weighted class activation map (Grad-CAM) indicates the discriminative image regions used by the network to identify a class.	Selvaraju RR, Cogswell M, Das A, Vedantam R, Parikh D, Batra D. Grad-CAM: Visual Explanations from Deep Networks via Gradient-based Localization. 2016. http://arxiv.org/abs/1610.02391
ddd003	Saliency	Values are derived using a single back-propagation pass through a network to produce a localization map highlighting the spatial support of a given class in a given image.	Simonyan K, Vedaldi A, Zisserman A. Deep Inside Convolutional Networks: Visualising Image Classification Models and Saliency Maps. 2013. http://arxiv.org/abs/1312.6034