Slicer annotations for the Quantitative Imaging Network

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QIN

• 13 centers of imaging excellence:

• Goal: to promote research and development of quantitative imaging methods for the measurement of tumor response to therapies in clinical trial settings, with the overall goal of facilitating clinical decision making

• Support creation of public registries and image database resources to support clinical decision making for therapies by the broader oncology community
Scope of work

• Supplement to BWH QIN grant
• “implement support of AIM in 3D Slicer, including storage of annotations produced by 3D Slicer in AIM format and importing AIM annotations into 3D Slicer.”
Why DICOM SR/AIM?

• “Structure” of most common radiologic reports: “Finding” and “Impression” sections dictated
• Difficult to use for research, data mining, confusion possible even while exchanging reports among radiologists
• No explicit connection of the report to the image finding
• Need structure, vocabulary, connection to the finding in the image
DICOM SR basics

• Designed to be self-describing information structure
• Support templates and context-dependent terminology
• DICOM Supplement 23
• Supported by vendors
  – Siemens Syngo.via
  – Others?
Tree of content
Clinical user view

FIGURE 1. Simple example of a DICOM Structured Report

Tree elements

• Value types (CONTAINER, CODE, TEXT, SCOORD)
• Relationships (“contains”, “has properties”, “inferred from”)
• Markup: SCOORD
  – POINT, MULTIPOINT, POLYLINE, CIRCLE, ELLIPSE
  – Pixel coordinates
  – POLYLINE is always closed!
Annotation Image Markup (AIM) basics

• Information model
• Described by XML schema
• Serialized using XML
• Terminology:
  – An image *annotation* is the explanatory or descriptive information about the pixel data of an image that is generated by a human or machine observer.
  – An image *markup* is the graphical symbols placed over the image to depict an annotation.
Channin et al. (2010). The caBIG annotation and image Markup project. Journal of digital imaging: the official journal of the Society for Computer Applications in Radiology, 23(2), 217-25
Fig 5. Markup group.
Annotation templates

• The AIM template XML schema allows to create an XML document containing controlled questions and answers based on known vocabularies such as SNOMED CT, RadLex, LOINC, etc. as well as user-defined terminologies.

• DICOM SR templates – similar purpose, vocabularies
Example
RANO Template

 Courtesy Jayashree Kalpathy-Cramer, MGH
ClearCanvas TCGA WS
AIM Annotation

<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<ImageAnnotation xmlns="gme://caCORE.caCORE/3.2/edu.northwestern.radiology.AIM" aimVersion="3.0" cagridId="0" codeMeaning="Response Assessment in Neuro-Oncology" codeValue="RANO" codingSchemeDesignator="RANO" dateTime="2012-01-09T19:09:58" name="BreastDx-01-0068_andrey_2012-01-09 19:09 PM" uniqueIdentifier="1.3.6.1.4.1.25403.8796750565674.2788.20120109070958.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="gme://caCORE.caCORE/3.2/edu.northwestern.radiology.AIM AIM_v3_rv11_XML.xsd"/>
<calculationCollection>
  <Calculation cagridId="0" codeMeaning="Length" codeValue="G-A22A" codingSchemeDesignator="SRT" description="Length" uid="1.3.6.1.4.1.25403.8796750565674.2788.20120109070958.1">
    <referencedCalculationCollection/>
  </Calculation>
</calculationCollection>

<calculationResultCollection>
  <CalculationResult cagridId="0" numberOfDimensions="1" type="Scalar" unitOfMeasure="mm">
    <calculationDataCollection>
      <CalculationData cagridId="0" value="71.3865693161104">
        <coordinateCollection>
          <Coordinate cagridId="0" dimensionIndex="0" position="0"/>
        </coordinateCollection>
      </CalculationData>
    </calculationDataCollection>
    <dimensionCollection>
      <Dimension cagridId="0" index="0" label="Value" size="1"/>
    </dimensionCollection>
  </CalculationResult>
</calculationResultCollection>

<referencedGeometricShapeCollection>
  <ReferencedGeometricShape cagridId="0" referencedShapeIdentifier="0"/>
</referencedGeometricShapeCollection>
AIM Annotation cont.

```xml
<inferenceCollection>
  <Inference cagridId="0" codeMeaning="Yes" codeValue="RANO7" codingSchemeDesignator="RANO" codingSchemeVersion="" imageEvidence="true"/>
  <Inference cagridId="0" codeMeaning="Progressive Disease" codeValue="RANO4" codingSchemeDesignator="RANO" codingSchemeVersion="" imageEvidence="true"/>
  <Inference cagridId="0" codeMeaning="Stable Disease" codeValue="RANO1" codingSchemeDesignator="RANO" codingSchemeVersion="" imageEvidence="true"/>
</inferenceCollection>

<user>
  <User cagridId="0" loginName="andrey" name="andrey" numberWithinRoleOfClinicalTrial="1" roleInTrial="Performing"/>
</user>

<equipment>
  <Equipment cagridId="0" manufacturerModelName="AIM_TCGA_v3" manufacturerName="Northwestern University" softwareVersion="3.0.0.3"/>
</equipment>

<imageReferenceCollection>
  <ImageReference cagridId="0" xsi:type="DICOMImageReference">
    <imageStudy>
      <ImageStudy cagridId="0" instanceUID="1.3.6.1.4.1.14519.5.2.1.4792.2001.200235584781096359647374535914" startDate="2008-06-27T00:00:00" startTime="000000">"" startDate="2008-06-27T00:00:00" startTime="000000">
        <imageSeries>
          <ImageSeries cagridId="0" instanceUID="1.3.6.1.4.1.14519.5.2.1.4792.2001.170977198031148408225883336860">"" startDate="2008-06-27T00:00:00" startTime="000000">
            <Image cagridId="0" sopClassUID="1.2.840.10008.5.1.4.1.14" sopInstanceUID="1.3.6.1.4.1.14519.5.2.1.4792.2001.149982482708499901857882575988"/>
          </imageSeries>
        </imageSeries>
      </imageStudy>
    </imageStudy>
</imageReferenceCollection>
```
AIM Annotation cont.

<geometricShapeCollection>
  <GeometricShape cgridId="0" includeFlag="true" shapeIdentifier="0" xsi:type="MultiPoint">
    <spatialCoordinateCollection>
      <SpatialCoordinate cgridId="0" coordinateIndex="0"
imageReferenceUID="1.3.6.1.4.1.14519.5.2.1.4792.2001.149982482708499901857882575988"
referencedFrameNumber="1" x="170.66656494141" y="359.489318847656" xsi:type="TwoDimensionSpatialCoordinate"/>
      <SpatialCoordinate cgridId="0" coordinateIndex="1"
imageReferenceUID="1.3.6.1.4.1.14519.5.2.1.4792.2001.149982482708499901857882575988"
referencedFrameNumber="1" x="274.156005859375" y="337.702087402344" xsi:type="TwoDimensionSpatialCoordinate"/>
    </spatialCoordinateCollection>
  </GeometricShape>
</geometricShapeCollection>

<person>
  <Person cgridId="0" id="BreastDx-01-0068" name="" sex="F"/>
</person>

</ImageAnnotation>
Corresponding DICOM SR

# Dicom-File-Format
# Dicom-Meta-Information-Header
# Used TransferSyntax: Little Endian Explicit
(0002,0000) UL 200 # 4, 1 FileMetaInformationGroupLength
(0002,0001) OB 00\01 # 2, 1 FileMetaInformationVersion
(0002,0002) UI =ComprehensiveSRStorage # 30, 1 MediaStorageSOPClassUID
(0002,0003) UI [1.2.276.0.7230010.3.1.4.768493426.2904.1326154540.4] # 52, 1 MediaStorageSOPInstanceUID
(0002,0010) UI =LittleEndianExplicit # 20, 1 TransferSyntaxUID
(0002,0012) UI [1.2.276.0.7230010.3.0.3.5.4] # 28, 1 ImplementationClassUID
(0002,0013) SH [OFFIS_DCMTK_354] # 16, 1 ImplementationVersionName

# Dicom-Data-Set
# Used TransferSyntax: Little Endian Explicit
(0008,0005) CS [ISO_IR 100] # 10, 1 SpecificCharacterSet
(0008,0012) DA [20120109] # 8, 1 InstanceCreationDate
(0008,0013) TM [191540] # 6, 1 InstanceCreationTime
(0008,0014) UI [1.2.276.0.7230010.3.0.3.5.4] # 28, 1 InstanceCreatorUID
(0008,0016) UI =ComprehensiveSRStorage # 30, 1 SOPClassUID
(0008,0018) UI [1.2.276.0.7230010.3.1.4.768493426.2904.1326154540.4] # 52, 1 SOPInstanceUID
(0008,0020) DA (no value available) # 0, 0 StudyDate
(0008,0023) DA [20120109] # 8, 1 ContentDate
(0008,0030) TM (no value available) # 0, 0 StudyTime
(0008,0033) TM [191540] # 6, 1 ContentTime
(0008,0050) SH (no value available) # 0, 0 AccessionNumber
(0008,0060) CS [SR] # 2, 1 Modality
(0008,0070) LO [Northwestern University] # 24, 1 Manufacturer
(0008,0090) PN (no value available) # 0, 0 ReferringPhysicianName
(0008,103e) LO [AIM DICOM SR] # 12, 1 SeriesDescription
(0008,1090) LO [AIM_TCGA_v3] # 12, 1 ManufacturerModelName
(0008,1111) SQ (Sequence with explicit length #=0) # 0, 1 ReferencedPerformedProcedureStepSequence
(ff,ee0d) na (SequenceDelimiterItem for re-encod.) # 0, 0 SequenceDelimiterItem
(0010,0010) PN (no value available) # 0, 0 PatientName
(0010,0020) LO [BreastDx-01-0068] # 16, 1 PatientID
(0010,0030) DA (no value available) # 0, 0 PatientBirthDate
(0010,0040) CS [F] # 2, 1 PatientSex
(0010,2160) SH (no value available) # 0, 0 EthnicGroup
(0018,1020) LO [3.0.0.3] # 8, 1 SoftwareVersions
(0020,0000) UI [1.3.6.1.4.1.14519.5.2.1.4792.2001.200235584781096359647374535914] # 64, 1 StudyInstanceUID
(0020,000e) UI [1.2.276.0.7230010.3.1.768493426.2904.1326154540.5] # 52, 1 SeriesInstanceUID
(0020,0010) SH (no value available) # 0, 0 StudyID
(0020,0011) IS [1] # 2, 1 SeriesNumber
(0020,0013) IS [1] # 2, 1 InstanceNumber
(0040,0040) CS [CONTAINER] # 10, 1 ValueType
(0040,0a43) SQ (Sequence with explicit length #=1) # 70, 1 ConceptNameCodeSequence
Questions and common needs

- Specialized module or plugin for DICOM module?
- Support of conversion bw RAS and DICOM slice image IJ coordinates (connect DICOM image UIDs with Slicer volumes)?
- DICOM SR or AIM?
- Import and export of DICOM SR?
- Validation/verification? Reference implementations?
Followup

• Main page for the project: