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DICOM℠

Digital Imaging and Communications in Medicine

Capturing Analysis:
Measurement, CAD, Segmentation and more

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Capturing Analysis

Principles of DICOM analytic results

Presentation States

Structured Reporting and CAD Results

Real-world Value Mapping

Segmentation

Registration

Stereometric Relationship

Analytic result principles

Results are conveyed in composite information objects separate from the original image(s)

- **Standard Patient / Study / Series / Content structure**

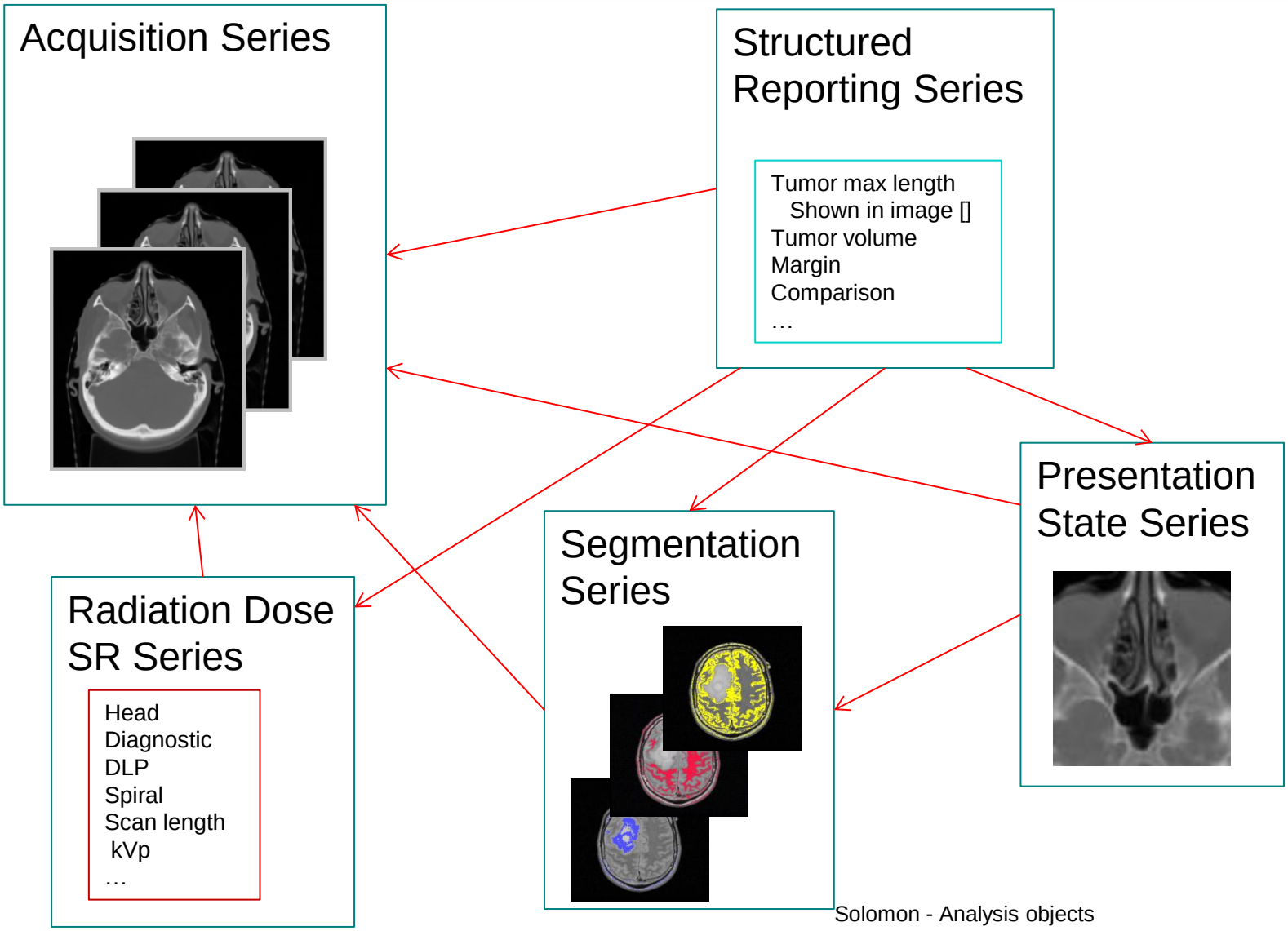
Results may be created at a time much later than the image acquisition, and in a completely different environment

- **Organized into different Series**

Multiple result objects can reference the same image

Selection of a result object for display implicitly invokes display of the referenced image(s)

Analysis Series References



Analytic result types

Presentation States

Structured Reporting and CAD

Real World Value Mapping

Segmentation

Registration

Stereometric Relationship

Presentation State

The classic radiology analysis tool – grease pencil on film

The fundamental softcopy display controls – zoom, rotation, windowing, inversion

Presentation state is the digital equivalent

- **Allows sharing and annotation reproduction**

Use case workflow described in IHE Consistent Presentation of Images (CPI) Profile

Softcopy Presentation State

Define how referenced image(s) will be displayed

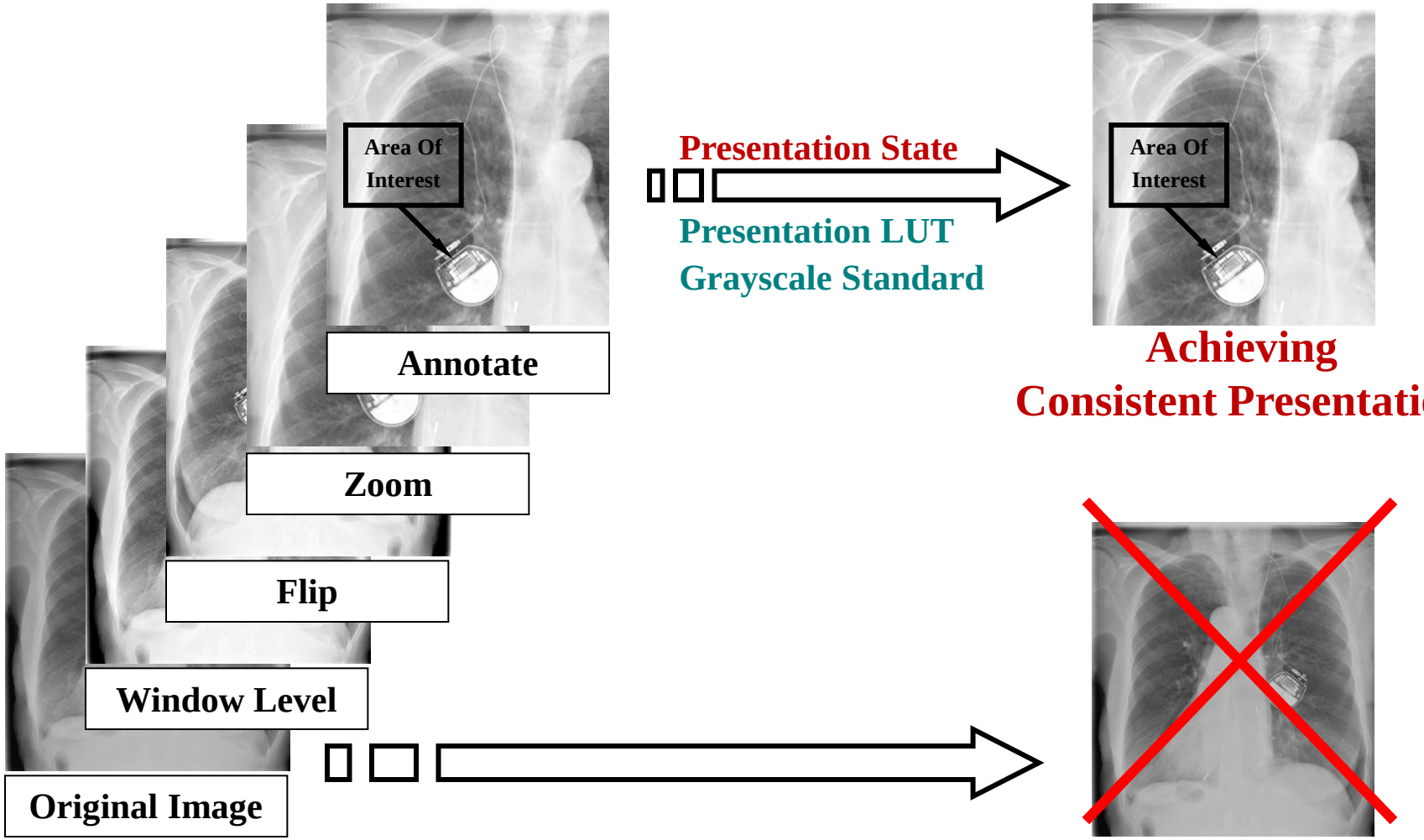
- Transforms to device independent grayscale/color space (LUTs)
- Selection of display area (ROI) of the image
- Image rotate or flip
- Graphical and textual annotations, overlays, shutters

Grayscale, color, and pseudo-color SPSs

Blending SPS overlays a pseudo-color image on a grayscale image

- E.g., for PET/CT
- Blending on grayscale originals (currently no standard for blending of color originals)

Presentation State for Consistent Presentation



Basic Structured Display

What if doc wants to share more than one image in a specific screen layout?

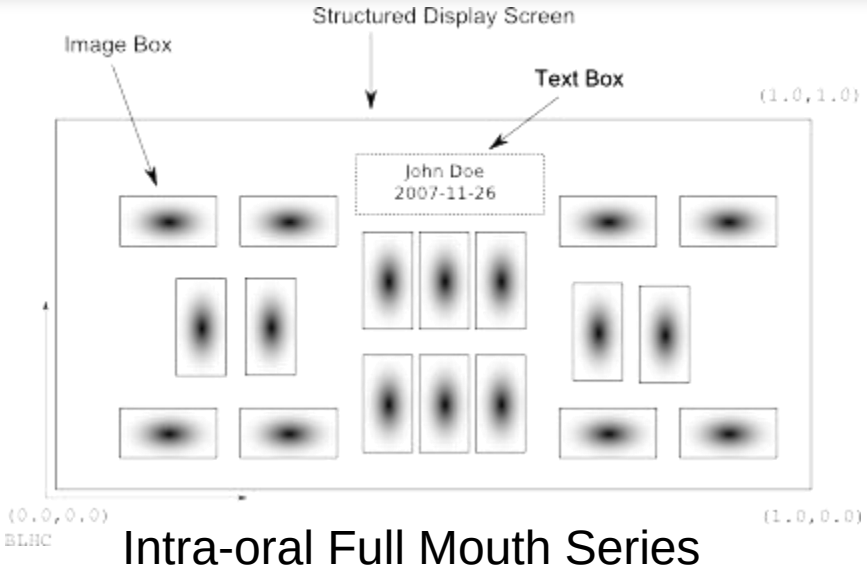
- E.g., Current study image next to comparison study
- Dental radiograph series in standard arrangement

Basic Structured Display controls layout of display boxes on a single screen, and referenced images or other objects to be put in each box

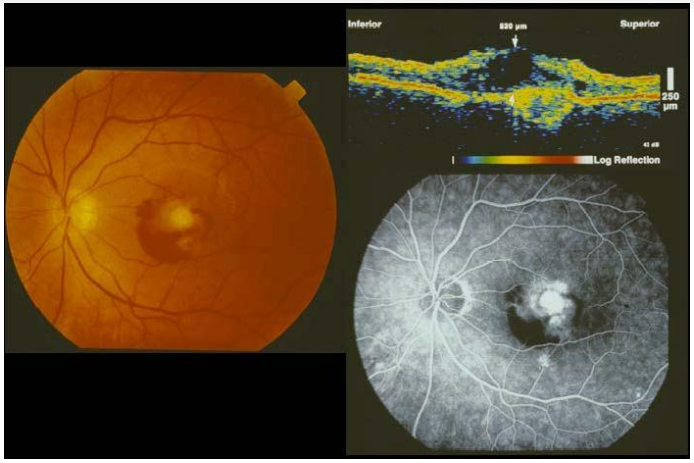
- Boxes may have text labels

Presentation of each image may be controlled by referenced Softcopy Presentation State

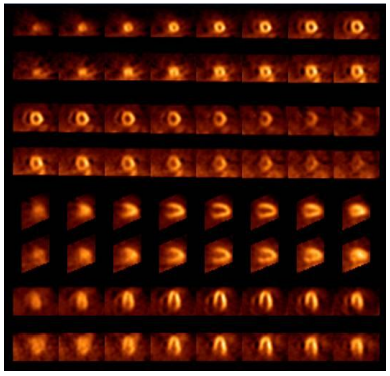
Basic Structured Display Uses



Intra-oral Full Mouth Series



Retinal Study



Stress-Rest Nuclear Cardiography

Cephalometric Series

Structured Reporting

The scope of DICOM SR is standardization of structured data and clinical observations in the imaging environment

SR objects record observations made for an imaging-based procedure

- **Particularly observations that describe or reference images, waveforms, or specific regions of interest**

SR vs. Presentation States

Presentation State annotations are for human reading, not interoperable for automated applications

- **No controlled and coded vocabulary, no structural semantics (relationships between annotations)**

SR important for (semi-)automated imaging analysis and review processes

SR can link a clinical observation to a region of interest in an image whose display is controlled by a Presentation State

SR Example Uses

- **Ultrasound measurements made by sonographer on acquisition device**
- **Mammography computer-aided detection (CAD) results**
- **Quality Control (QC) notes about images (image rejection)**
- **Radiation dose reports**
- **Image exchange manifests (lists of objects)**

More in session “Deep dive into SR”

Real World Value Mapping

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Some applications need to know what a pixel/voxel value means in real world units

- **Classically, X-ray absorption in Hounsfield units**
- **Uptake of radiopharmaceutical tracers**
- **Allows quantitative measurements and comparisons**

Original DICOM specification in Modality LUT (look-up table)

- **Limited to certain image types (CT)**
- **Limited to certain real world units**
- **Linear LUT encoded as Rescale Slope / Intercept**

Real World Value Mapping

Real World Value Mapping allows calibration of pixel values to different units

- **E.g., mapping of PET pixel values to counts, concentration, or SUVs normalized by one of several factors**

Mapping can be through linear function (slope / intercept), or look-up tables

Multiple mappings for same pixels

Segmentation

Important radiology task is identifying the different anatomical features in an image

- **Bones, organs, tumors, blood**
- **Brain areas that are active with stimulus (functional MRI)**

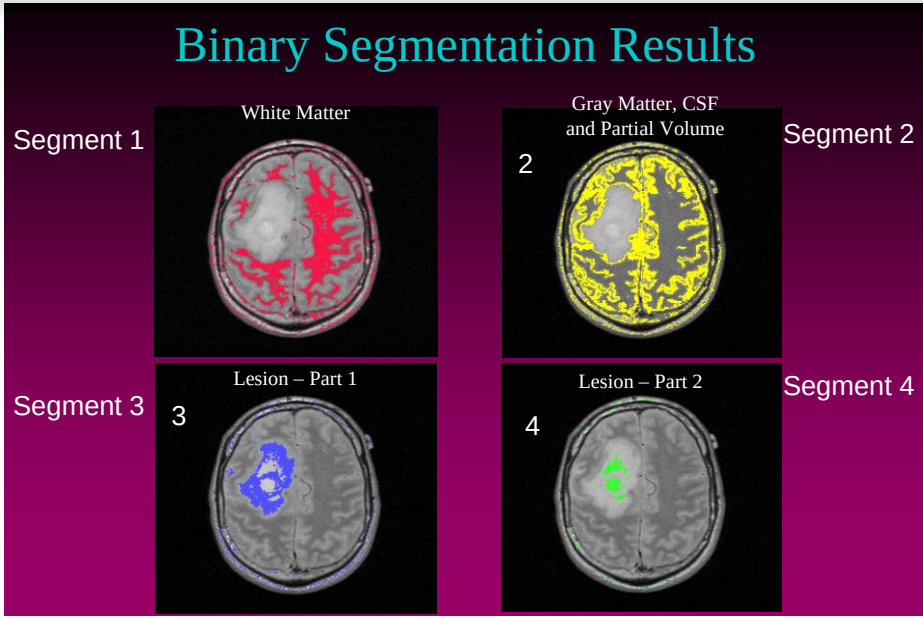
Segmentation classifies areas or volumes in categories

Segments can be displayed as overlays on source image

- **Display of segmentation as overlay or blending with source image is typically *implicit*, but could use Blending Softcopy PS**

Two types of segmentation: pixel/voxel, and surface

Pixel/voxel segmentation



Derived image object

- Uses enhanced multi-frame mechanism

Multiple segments per object

- Each segment linked to a categorization
- Pixels show presence of category at pixel location
- Binary (1-bit/pixel) or fractional (probability or occupancy)

Segmentation object may use same Frame of Reference as source image

- May use different spatial resolution

Surface Segmentation

Surface of interest (or surface of volume of interest) encoded in 3D Frame of Reference using surface mesh (polygons)

Surface rendering not specified in Standard, may use conventional CG texturing, lighting, etc.

Registration

Methods to specify the spatial relationship between images (2D and 3D) and between Frames of Reference (3D coordinate systems)

Spatial Registration uses rigid, scale, or affine transformations

Deformable Spatial Registration uses a 3D deformation grid of offset vectors

Spatial Fiducials identifies corresponding landmarks in the referenced targets

Registration Uses

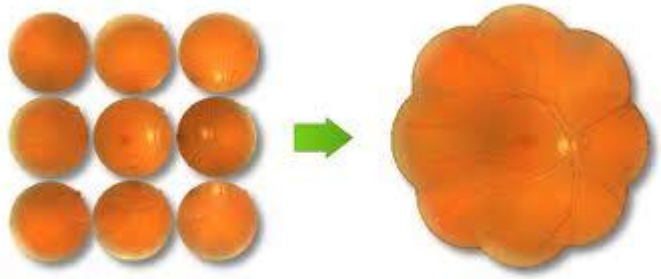
Aligning multi-modality acquisitions

- CT / PET

Aligning temporal series

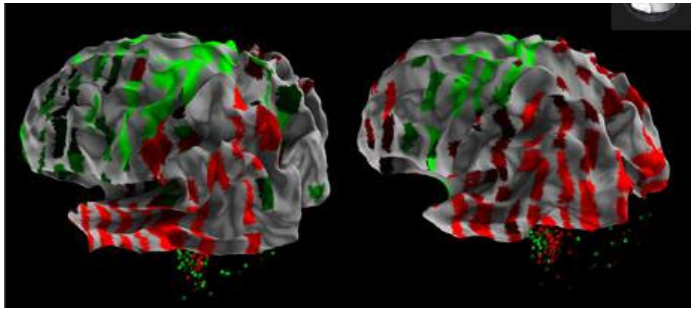
- Current to prior CT

Image stitching



Aligning to an atlas

- For comparison to research data sets (especially brain)



Stereometric Relationship

- **Requirement for ophthalmic photographic imaging is to identify stereoscopic pairs of images**
- **Linkage in Stereometric Relationship object (modality SMR)**
- **References may be to single frame images, multi-frame images, or cine images**
- **Presentation may require special application and/or hardware**

Summary

Analytic results are conveyed in composite information objects separate from the original image(s)

Important to record intermediate analytic results

Results can build on one another

Effective study data management requires attention to multiple analytic result objects and Series

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Thank you for your attention !