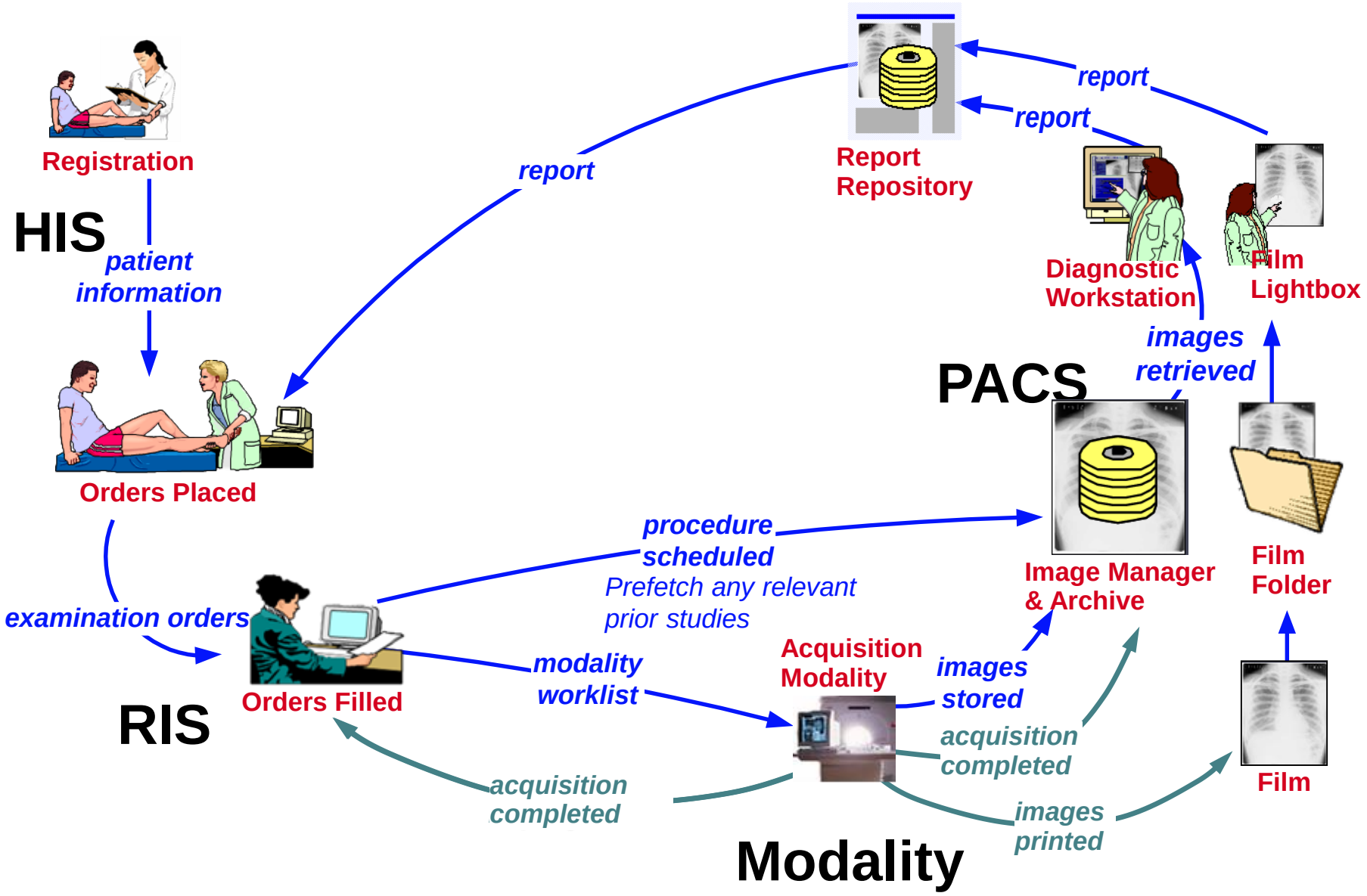
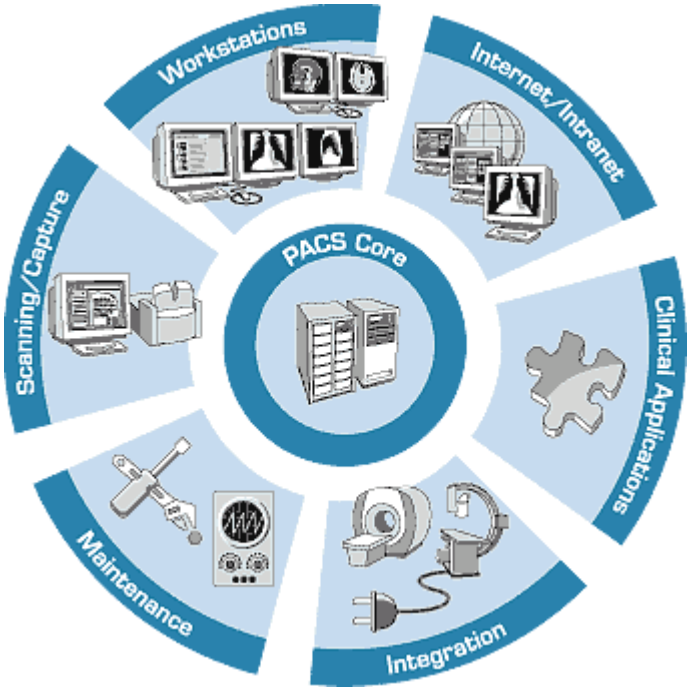
MIA – Image Formats

Why DICOM?


Registration
HIS
patient information
Orders Placed
examination orders
RIS
Orders Filled
report
Report Repository
report
report
Diagnostic Workstation
Film Lightbox
images retrieved
PACS
Image Manager & Archive
Film Folder
procedure scheduled
Prefetch any relevant prior studies
modality worklist
Acquisition Modality
images stored
acquisition completed
acquisition completed
images printed
Film
Modality

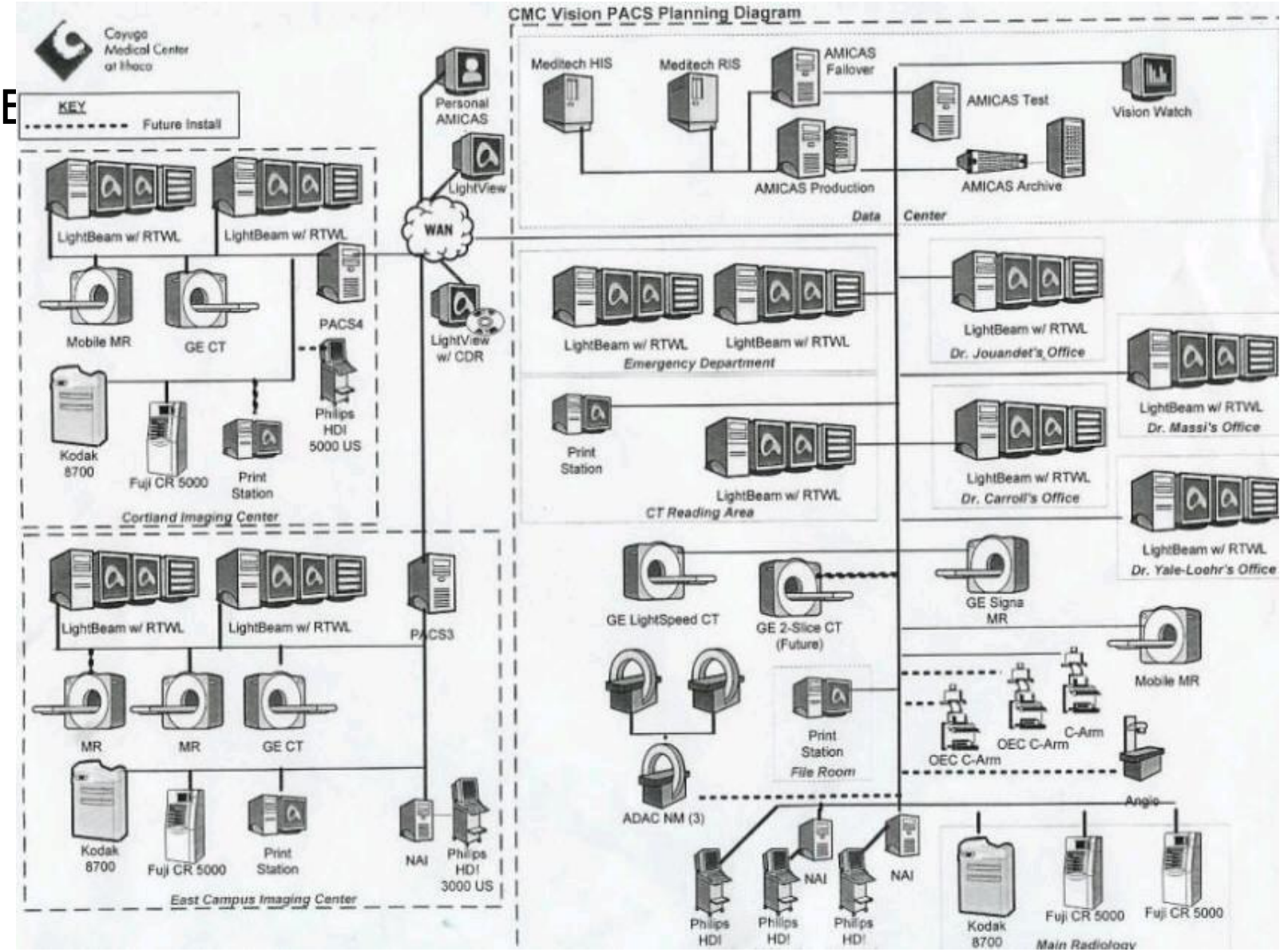
DICOM & PACS

- DICOM: Digital Imaging and COmmunications in Medicine
- PACS: Picture Archiving and Communication System



DICOM & PACS

- E


Cayuga Medical Center at Ithaca
KEY
Future Install
CMC Vision PACS Planning Diagram
Meditech HIS
Meditech RIS
AMICAS Failover
AMICAS Test
Vision Watch
AMICAS Production
AMICAS Archive
Data Center
Personal AMICAS
LightView
WAN
LightView w/ CDR
LightBeam w/ RTWL
Mobile MR
GE CT
PACS4
Philips HDI 5000 US
Kodak 8700
Fuji CR 5000
Print Station
Cortland Imaging Center
Emergency Department
Dr. Jouandet's Office
Dr. Massi's Office
CT Reading Area
Dr. Carroll's Office
Dr. Yale-Loehr's Office
GE LightSpeed CT
GE 2-Slice CT (Future)
GE Signa MR
Mobile MR
PACS3
MR
GE CT
File Room
OEC C-Arm
C-Arm
Angio
ADAC NM (3)
NAI
Philips HDI 3000 US
East Campus Imaging Center
Philips HDI
Kodak 8700
Main Radiology

Origins

NEMA, Suite 1752
1300 North 17th Street
Rosslyn, VA 22209
Ph: (703) 841-3285
http://dicom.nema.org

- ACR:
  - American College of Radiology
- NEMA:
  - National Electrical Manufacturers Association
- AAPM:
  - American Association of Physicists in Medicine
- RSNA:
  - Radiological Society of North America

DICOM

- Proposed in 1983.
- Supports many imaging modalities

CONTENTS

http://medical.nema.org/standard.html

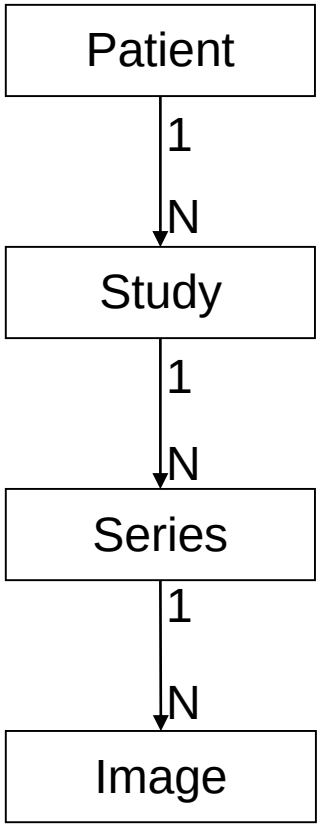
DICOM

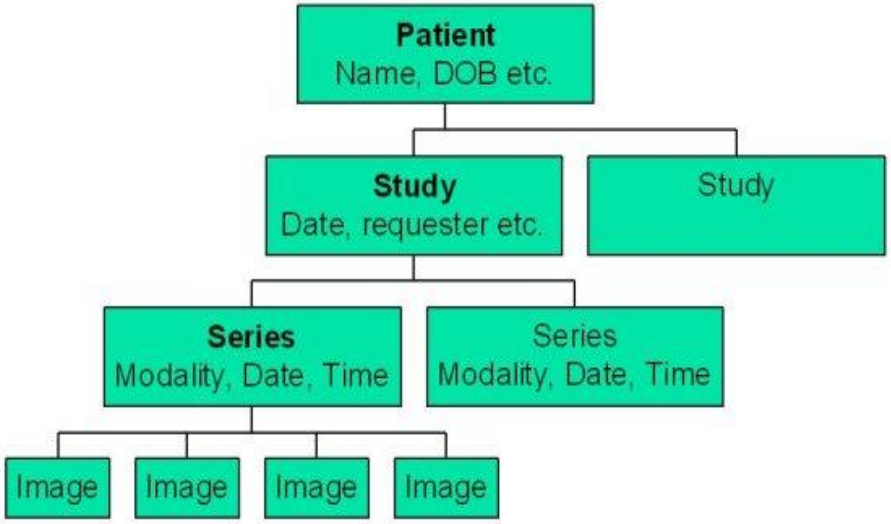
- Information about
  - Patient: name, years, ...
  - Image acquisition: who, where, ...
  - Image information: resolution, spacing, ...
  - Image or Images
  - ...

- But also, the DICOM establishes a protocol related with the communication about the different DICOM applications (acquisition machines, PACS, reading stations, etc.)

DICOM

- Hierarchical structure:

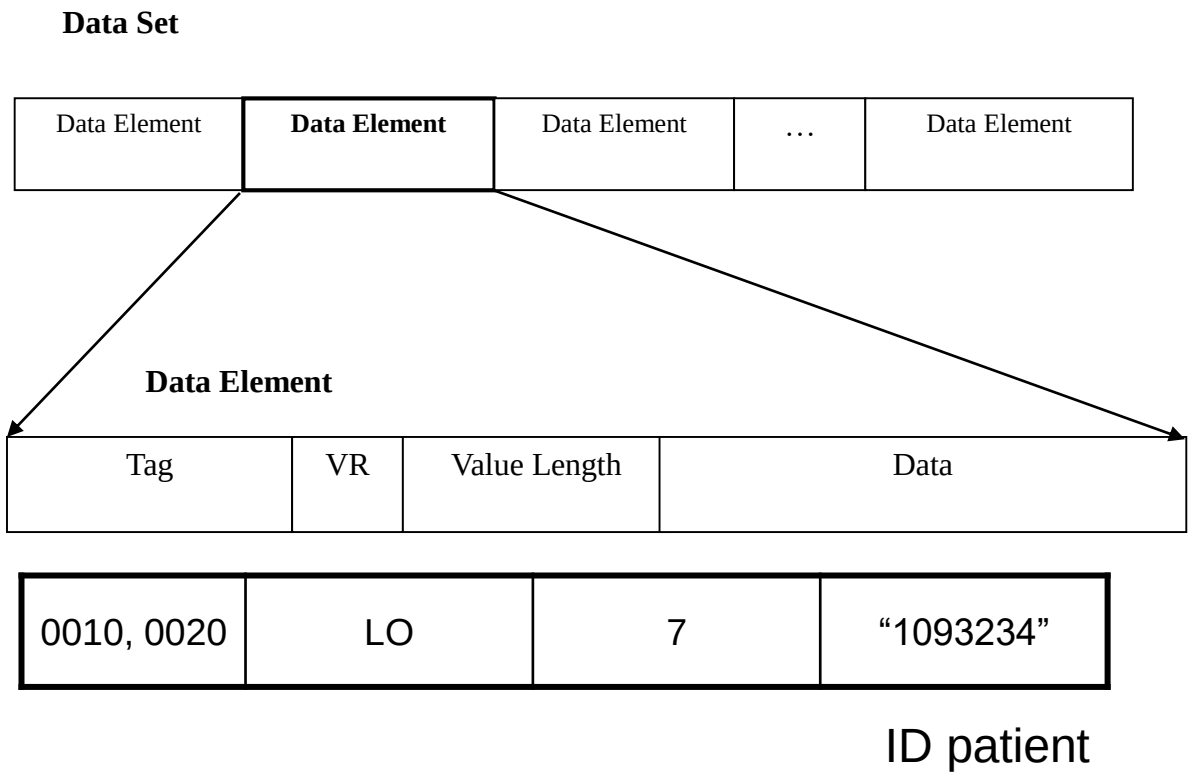




DICOM

- The DICOM is structured in Data Elements, each of them numbered (Tag) and with a unique function:

Value Representation	Description
AE	Application Entity
AS	Age String
AT	Attribute Tag
CS	Code String
DA	Date
DS	Decimal String
DT	Date/Time
FL	Floating Point Single (4 bytes)
FD	Floating Point Double (8 bytes)
IS	Integer String
LO	Long String
LT	Long Text
OB	Other Byte
OF	Other Float
OW	Other Word
PN	Person Name
SH	Short String
SL	Signed Long
SQ	Sequence of Items
SS	Signed Short
ST	Short Text
TM	Time
UI	Unique Identifier
UL	Unsigned Long



dicominfo('file.dcm')

Filename: [1x55char]
FileModDate: '27-maig-200823: 25: 47'
FileSize: 17042728
Format: 'DICOM'
FormatVersion: 3
Width: 2560
Height: 3328
BitDepth: 12
ColorType: 'grayscale'
FileMetaInformationGroupLength: 212
FileMetaInformationVersion: [2x1uint8]
MediaStorageSOPClassUID: '1.2.840.10008.5.1.4.1.1.1.2'
MediaStorageSOPInstanceUID: [1x55char]
TransferSyntaxUID: '1.2.840.10008.1.2'
ImplementationClassUID: '1.3.6.1.4.1.5962.99.2'
ImplementationVersionName: 'PIXELMEDJAVA001'
SourceApplicationEntityTitle: 'RXMAMOPACS'
SpecificCharacterSet: 'ISO_IR100'
ImageType: 'DERIVED\PRIMARY\\RIGHT'
SOPClassUID: '1.2.840.10008.5.1.4.1.1.1.2'
SOPInstanceUID: [1x55char]
StudyDate: '20070803'
SeriesDate: '20070803'
AcquisitionDate: '20070803'
ContentDate: '20070803'
StudyTime: '120122.375000'
SeriesTime: '120334.390000'
AcquisitionTime: '120310.812000'
ContentTime: '120330.281000'
AccessionNumber: '660471'
Modality: 'MG'
PresentationIntentType: 'FOR PRESENTATION'
Manufacturer: 'SIEMENS'
InstitutionName: 'HOSPITAL JOSEP TRUETA'
InstitutionAddress: [1x27char]
ReferringPhysicianName: [1x1struct]
StationName: 'YBFR015811'
SeriesDescription: 'Mamobilateral, Diagnose'
InstitutionalDepartmentName: 'Department'
PerformingPhysicianName: [1x2struct]
OperatorName: [1x1struct]
ManufacturerModelName: 'Mammomat Novation DR'
ReferencedPerformedProcedureStepSequence: [1x1struct]
DerivationDescription: [1x42char]
SourceImageSequence: [1x1struct]
AnatomicRegionSequence: [1x1struct]
PatientName: [1x1struct]
PatientID: '660471'
PatientBirthDate: '19560506'
PatientSex: 'F'
PatientAge: '051Y'
ContrastBolusAgent: ''
BodyPartExamined: 'BREAST'
KVP: 25
DeviceSerialNumber: '1036'
SoftwareVersion: [1x47char]

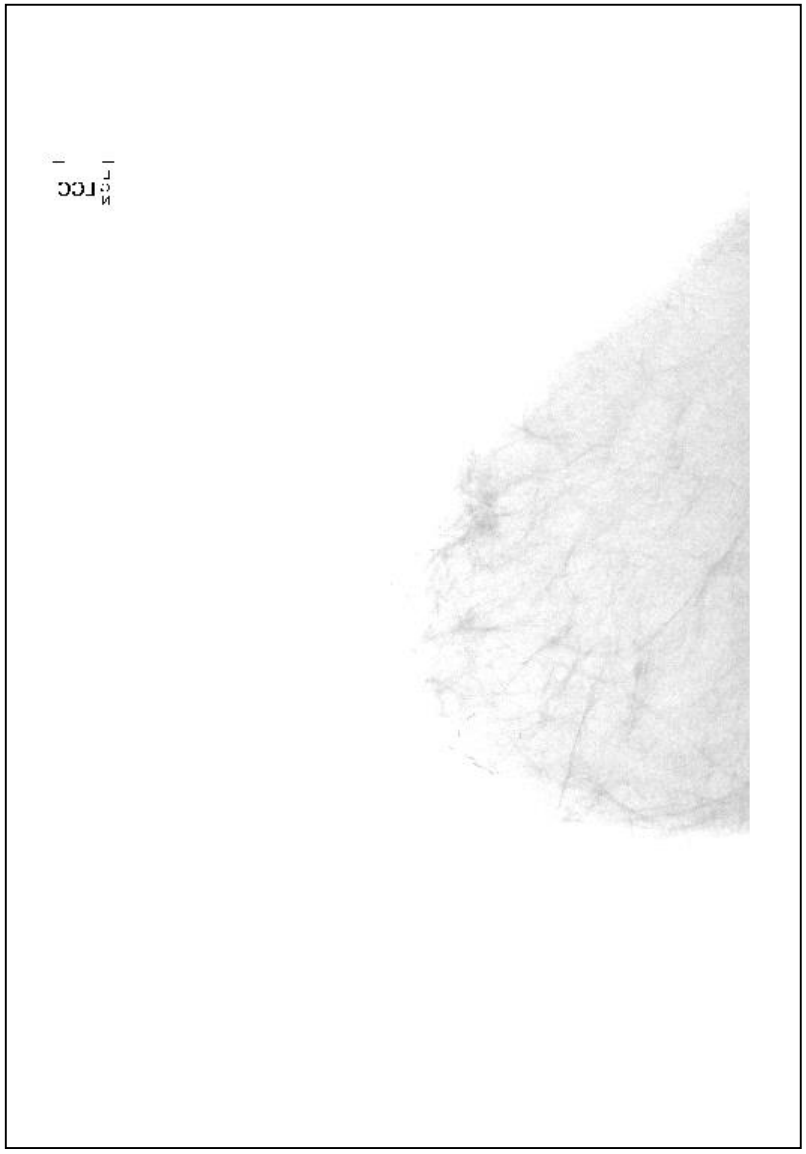
dicominfo('file.dcm')... cont

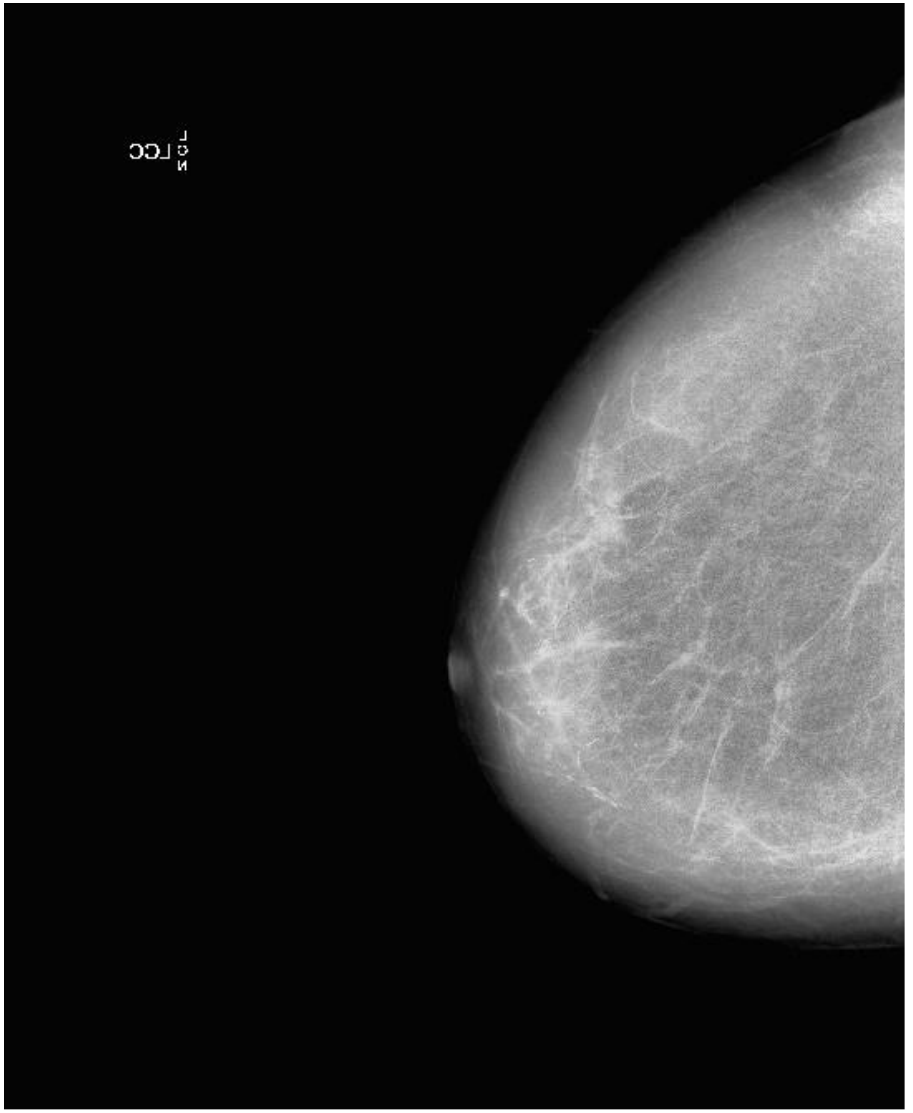
DistanceSourceToDetector: 650
DistanceSourceToPatient: 636
TableAngle: 0
TableType: 'NONE'
FieldOfViewShape: 'RECTANGLE'
FieldOfViewDimensions: [2x1double]
ExposureTime: 410
XrayTubeCurrent: 147
Exposure: 60
ExposureInuAs: 60099
RectificationType: 'CONST POTENTIAL'
ImagerPixelSpacing: [2x1double]
Grid: 'FOCUSEDPARALLEL'
FocalSpot: 0.3000
AnodeTargetMaterial: 'TUNGSTEN'
BodyPartThickness: 27
CompressionForce: 112
DateOfLastCalibration: '18590101'
TimeOfLastCalibration: '000000.000000'
AcquisitionDeviceProcessingDescription: ''
AcquisitionDeviceProcessingCode: ''
TomoLayerHeight: 0
PositionerType: 'MAMMOGRAPHIC'
PositionerPrimaryAngle: 0
PositionerSecondaryAngle: 0
DetectorPrimaryAngle: 0
DetectorSecondaryAngle: 0
ShutterShape: 'RECTANGULAR'
ShutterLeftVerticalEdge: 0
ShutterRightVerticalEdge: 2560
ShutterUpperHorizontalEdge: 0
ShutterLowerHorizontalEdge: 3328
ViewPosition: 'CC'
Sensitivity: 0
DetectorConditionsNominalFlag: 'YES'
DetectorTemperature: 30
DetectorType: 'DIRECT'
DetectorConfiguration: 'AREA'
DetectorDescription: ''
DetectorMode: 'Normalmode'
DetectorID: 'MP1775'
DateOfLastDetectorCalibration: '20070724'
TimeOfLastDetectorCalibration: '082552.265000'
ExposuresOnDetectorSinceLastCalibration: 23702
ExposuresOnDetectorSinceManufactured: 57839
DetectorTimeSinceLastExposure: 920.1090
DetectorActiveTime: 410
DetectorActivationOffsetFromExposure: 0
DetectorBinning: [2x1double]
DetectorElementPhysicalSize: [2x1double]
DetectorElementSpacing: [2x1double]
DetectorActiveShape: 'RECTANGLE'
DetectorActiveDimensions: [2x1double]
DetectorActiveOrigin: [2x1double]
FieldOfViewOrigin: [2x1 double]
FieldOfViewRotation: 0
FieldOfViewHorizontalFlip: 'NO'
FilterMaterial: 'RHODIUM'

dicominfo('file.dcm')... cont

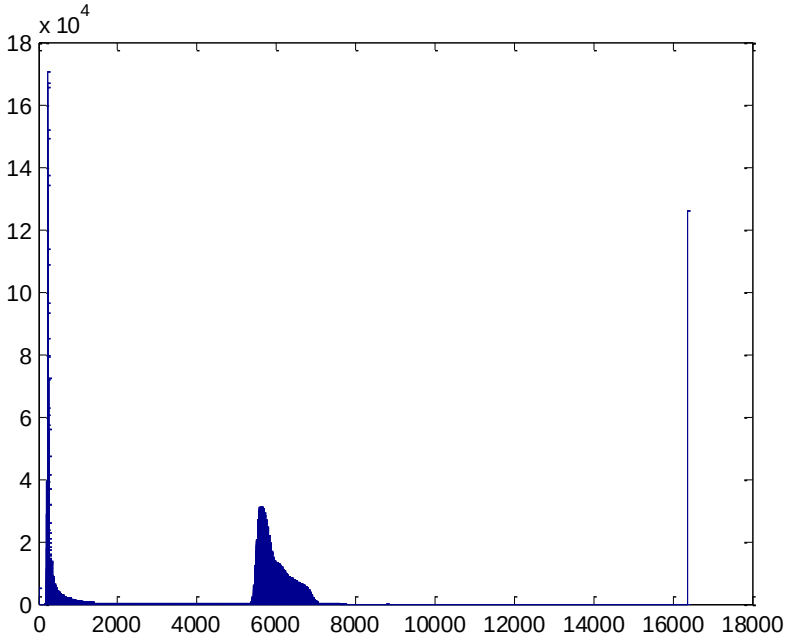
FilterThicknessMinimum: 0.0500
FilterThicknessMaximum: 0.0500
ExposureControlMode: 'AUTOMATIC'
ExposureControlModeDescription: [1x55char]
ExposureStatus: 'NORMAL'
ExposureTimeInuS: 410000
XrayTubeCurrentInuA: 1.4658e+005
StudyInstanceUID: [1x55char]
SeriesInstanceUID: [1x55char]
StudyID: '1'
SeriesNumber: 2
AcquisitionNumber: 1
InstanceNumber: 1
PatientOrientation: 'P\L'
ImageLaterality: 'R'
ImageComments: ''
SamplesPerPixel: 1
PhotometricInterpretation: 'MONOCHROME2'
Rows: 3328
Columns: 2560
BitsAllocated: 16
BitsStored: 12
HighBit: 11
PixelRepresentation: 0
QualityControlImage: 'NO'
BurnedInAnnotation: 'NO'
PixelIntensityRelationship: 'LOG'
PixelIntensityRelationshipSign: 1
WindowCenter: [2x1double]
WindowWidth: [2x1double]
RescaleIntercept: 0
RescaleSlope: 1
RescaleType: 'US'
ImplantPresent: 'NO'
PartialView: 'NO'
CalibrationImage: 'NO'
ViewCodeSequence: [1x1struct]
HistogramSequence: [1x1struct]
Private_0095_10xx_Creator: 'SIENET'
Private_0095_100c: [4x1uint8]
PresentationLUTShape: 'IDENTITY
WindowCenterWidthExplanation: 'WINDOW1\WINDOW2'
LossyImageCompression: '00'
Private_0029_10xx_Creator: 'SIEMENS MEDCOM HEADER'
Private_0029_11xx_Creator: 'SIEMENS MEDCOM HEADER2'
Private_0029_1031: [12x1uint8]
Private_0029_1032: [4x1uint8]
Private_0029_1033: [4x1uint8]
Private_0029_1034: [12x1uint8]
Private_0029_1160: [4x1uint8]
StudyPriorityID: 'MED'
PerformedProcedureStepStartDate: '20070803'
PerformedProcedureStepStartTime: '120122.375000'
PerformedProcedureStepID: 'MG20070803120122'
EntranceDose: 0
DistanceSourceToEntrance: 609
OrganDose: 0.0070
OrganExposed: 'BREAST'
AcquisitionContextSequence: [1x1struct]
EntranceDoseInmGy: 2
Private_0041_10xx_Creator: 'SIEMENSMEDSPDXMGWHAWS1'
Private_0041_1002: [10x1uint8]

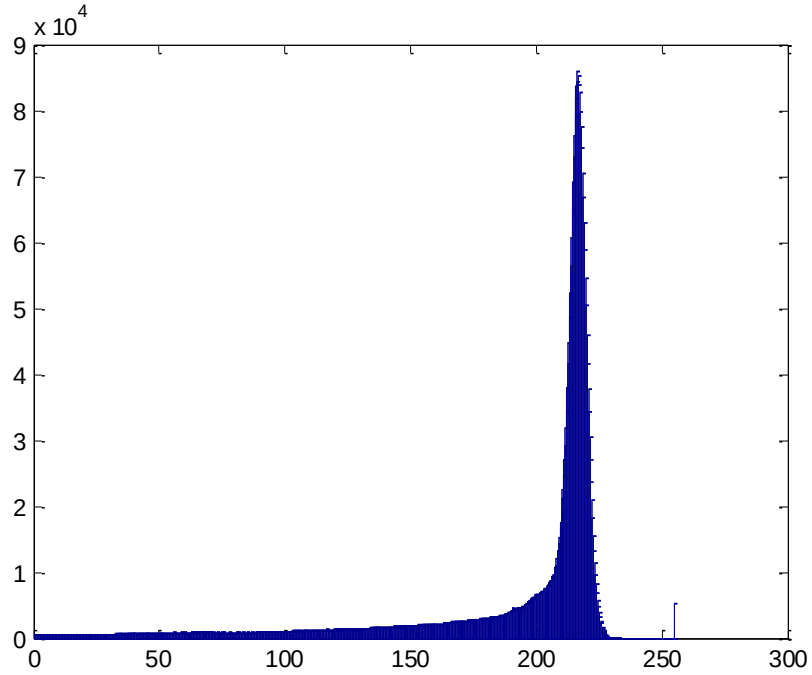
dicomread('file.dcm')





dicomread('file.dcm')



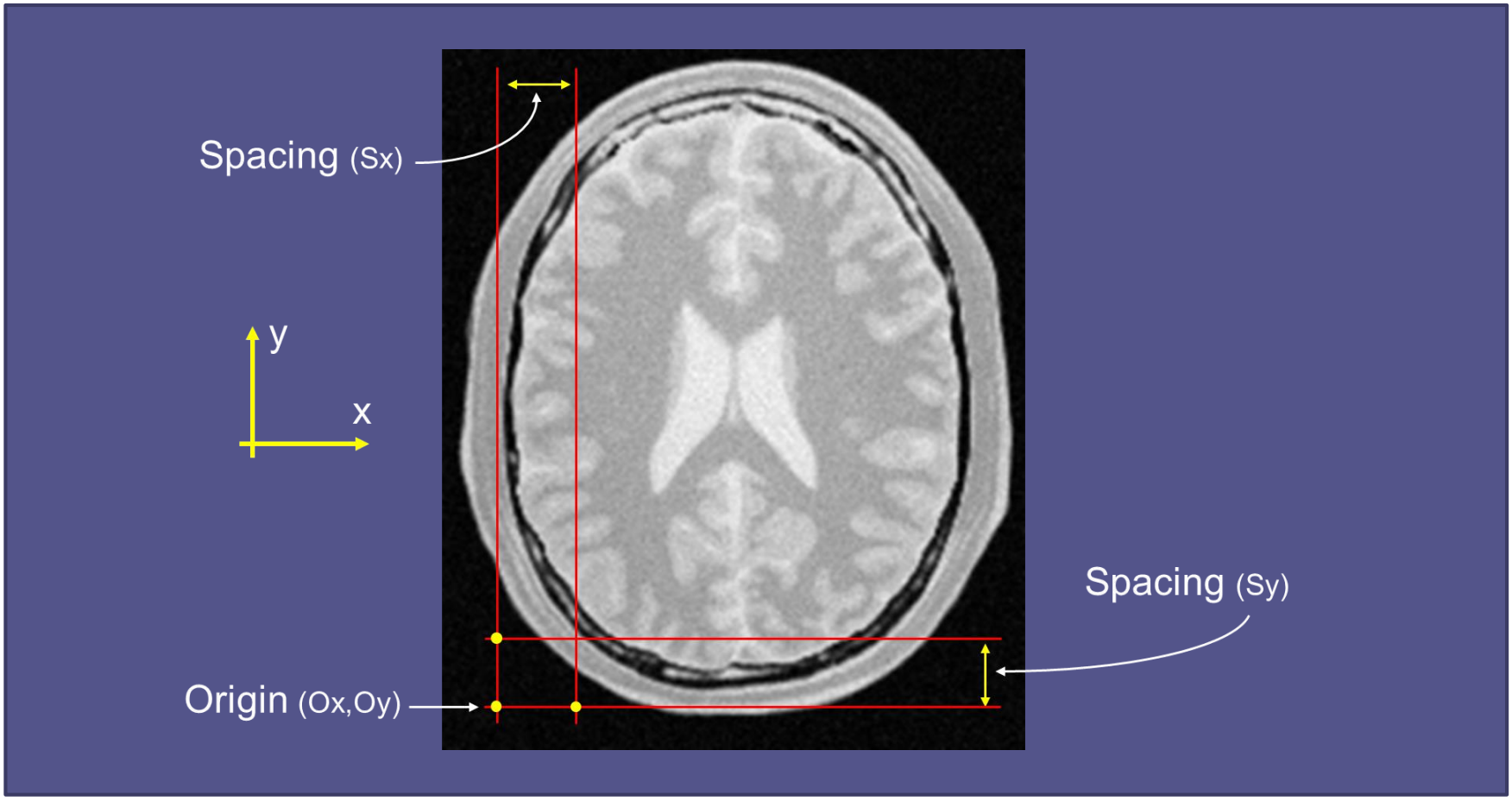


ISSUES

- Ethics. Patient related data. Anonymize the data!
- Formats. 2D, 3D, 4D, vendor specific.
- Visualization, interpretation of the DICOM header
- Image bit depth (8, 12, 16)
- Image dimensionality
- Other formats http://www.itk.org/Wiki/ITK/File_Formats
  - nrrd (Nearly Raw raster data http://teem.sourceforge.net/nrrd/)
  - mhd (meta image)
  - Analyze, etc...

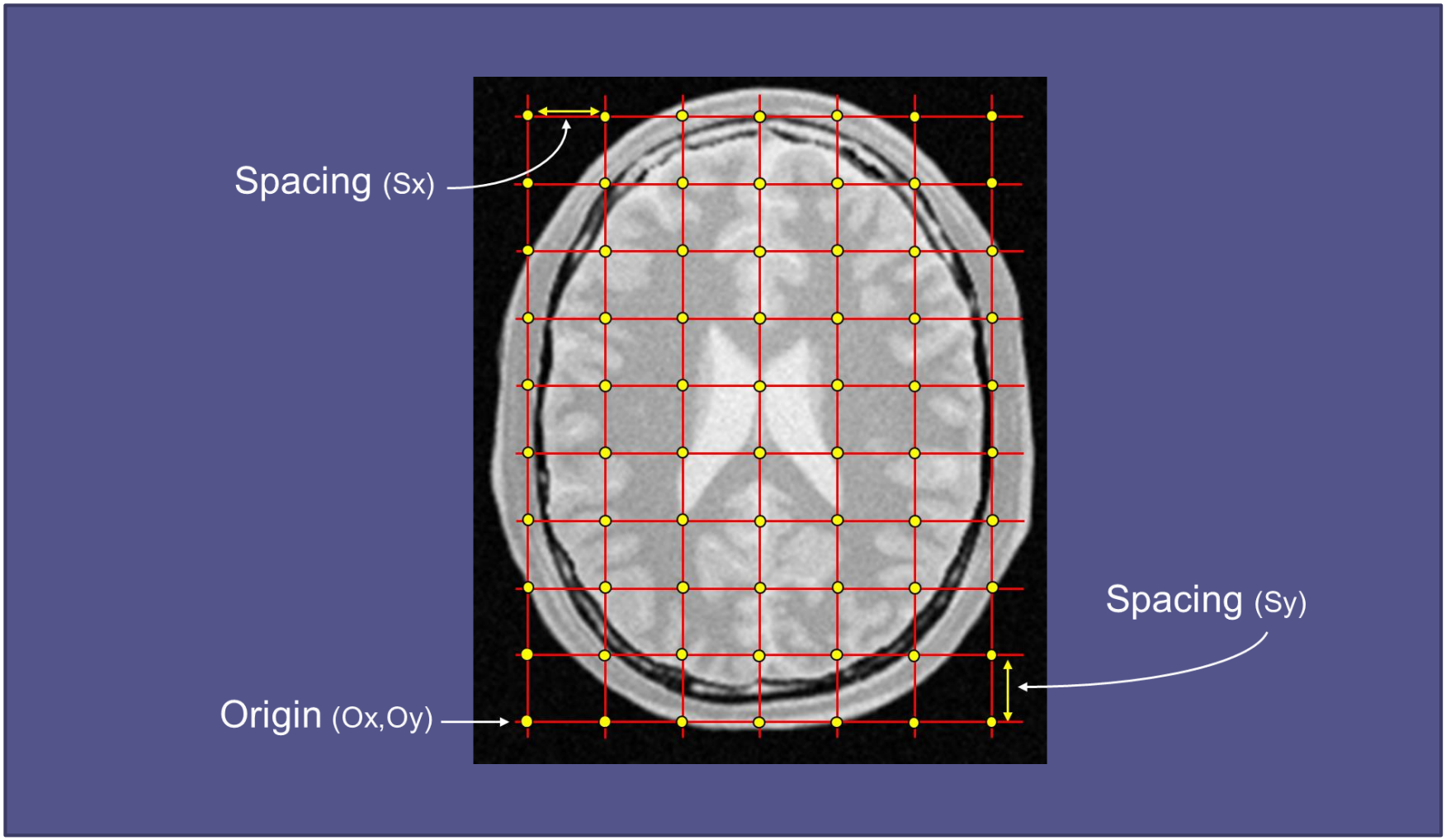
Images & Pixels (from itk slides)

- What is an image?
  - Sampling of a continous field using a discrete grid.



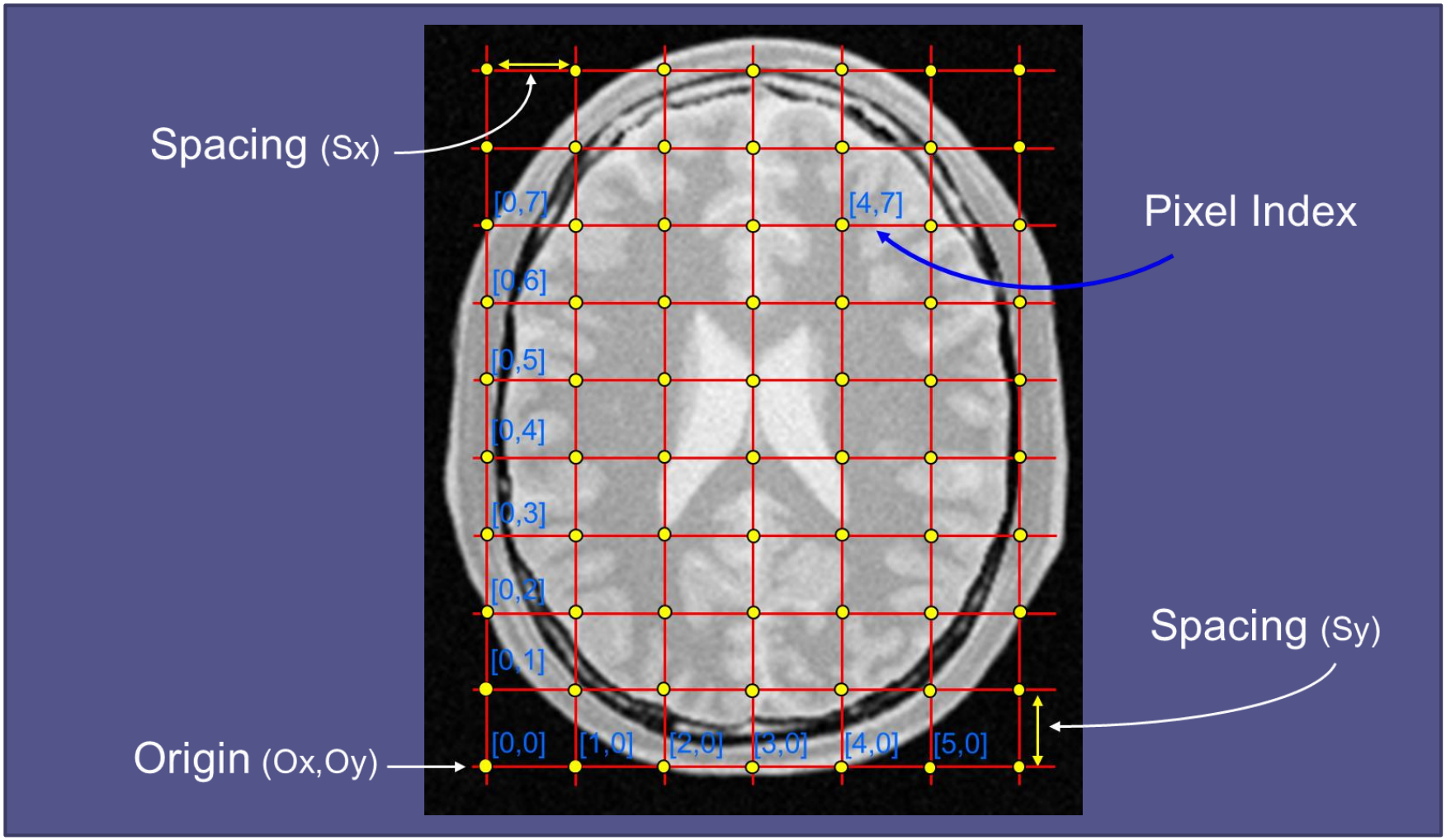
Images & Pixels (from itk slides)

- Sampling grid



Images & Pixels (from itk slides)

- Image indices



Images & Pixels (from itk slides)

- Use pixel or physical coordinates?
- Convert from physical to pixel coordinates

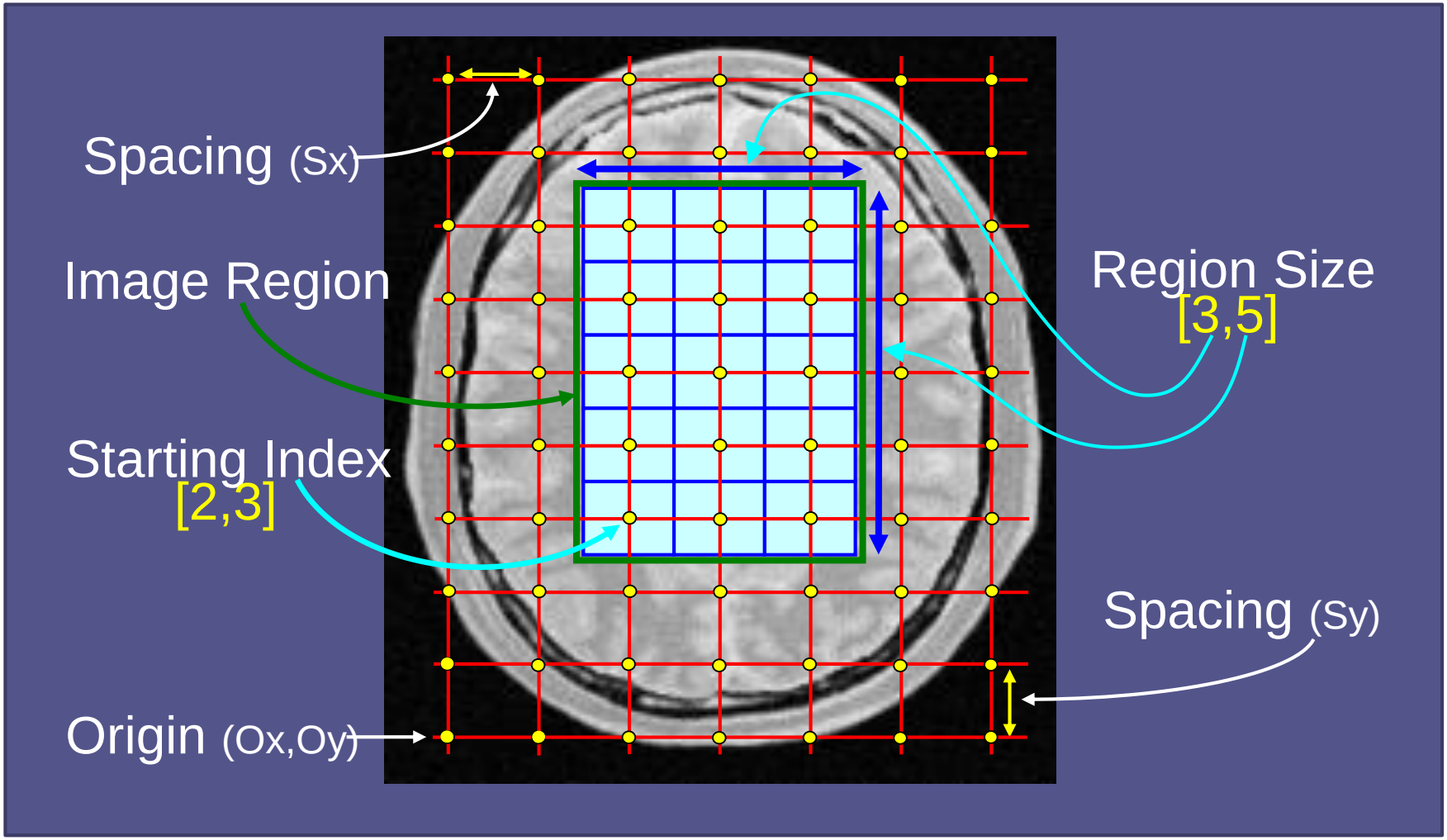
$$P[0] = Index[0] \times Spacing[0] + Origin[0]$$
$$P[1] = Index[1] \times Spacing[1] + Origin[1]$$

$$Index[0] = floor((P[0] - Origin[0]) / Spacing[0] + 0.5)$$
$$Index[1] = floor((P[1] - Origin[1]) / Spacing[1] + 0.5)$$

- Activity: Physical coordinates example.
  - 3D Ultrasound. What is the size of the lesion?

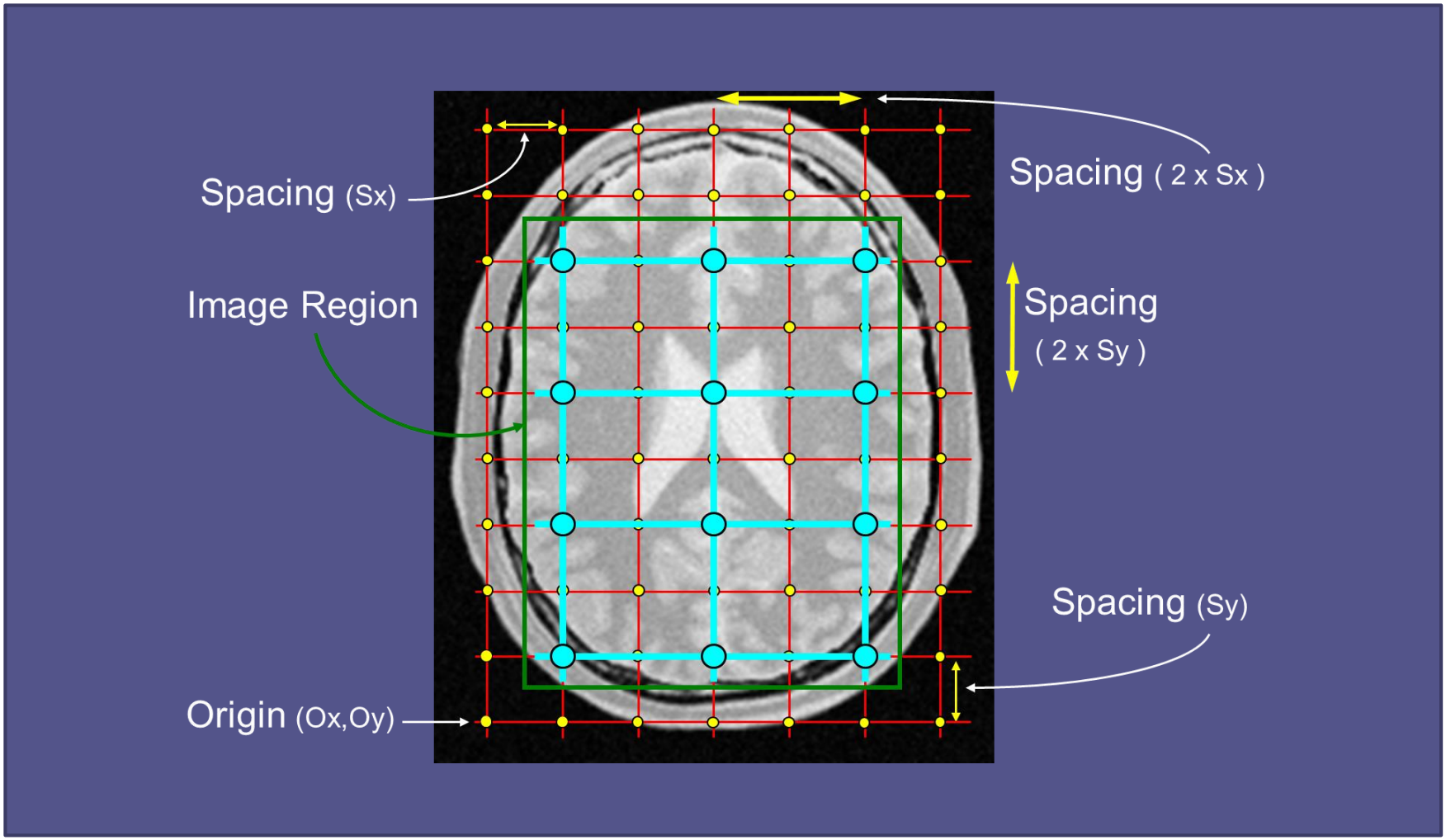
Images & Pixels (from itk slides)

- Image region



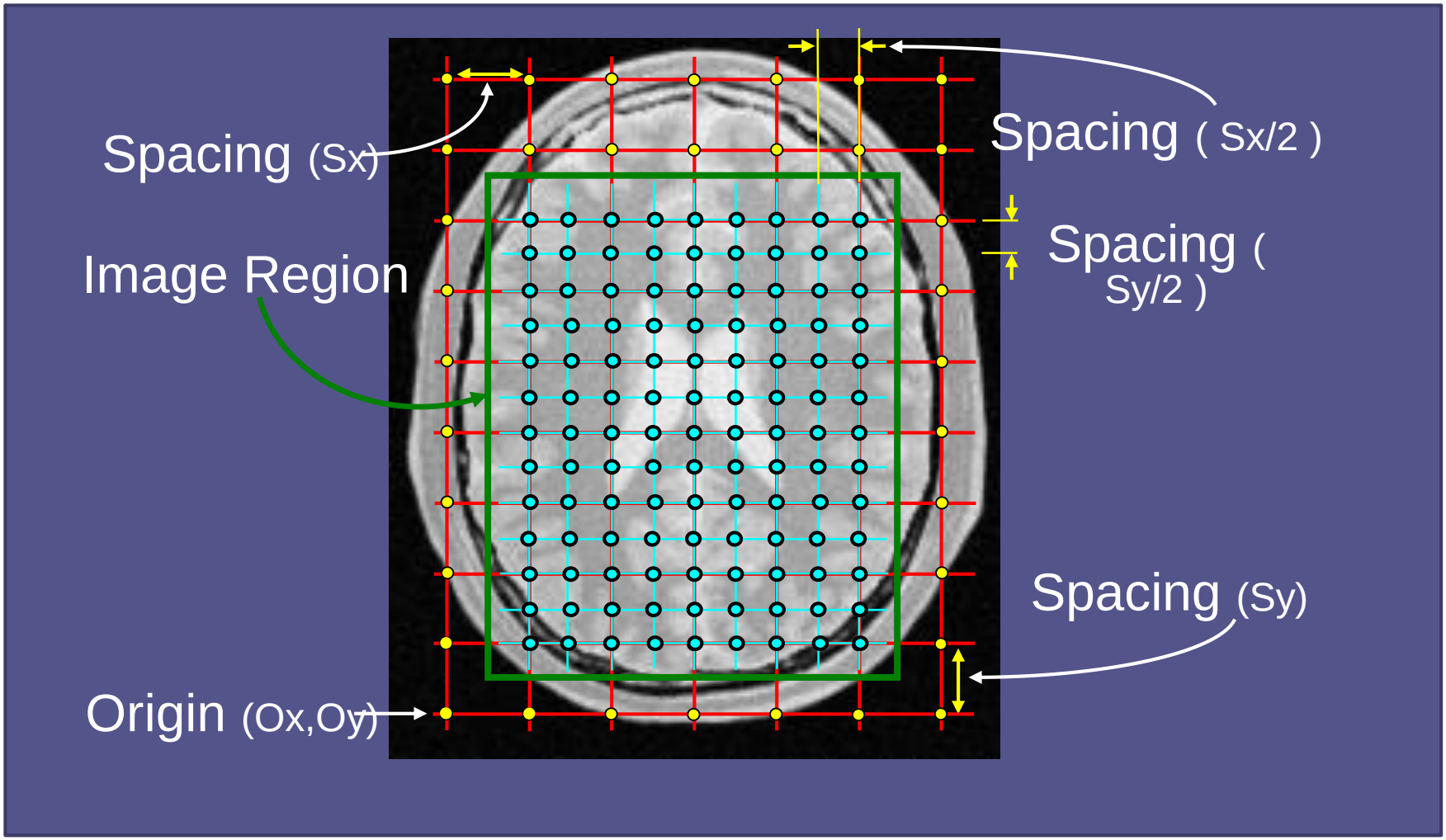
Images & Pixels (from itk slides)

- Resampling



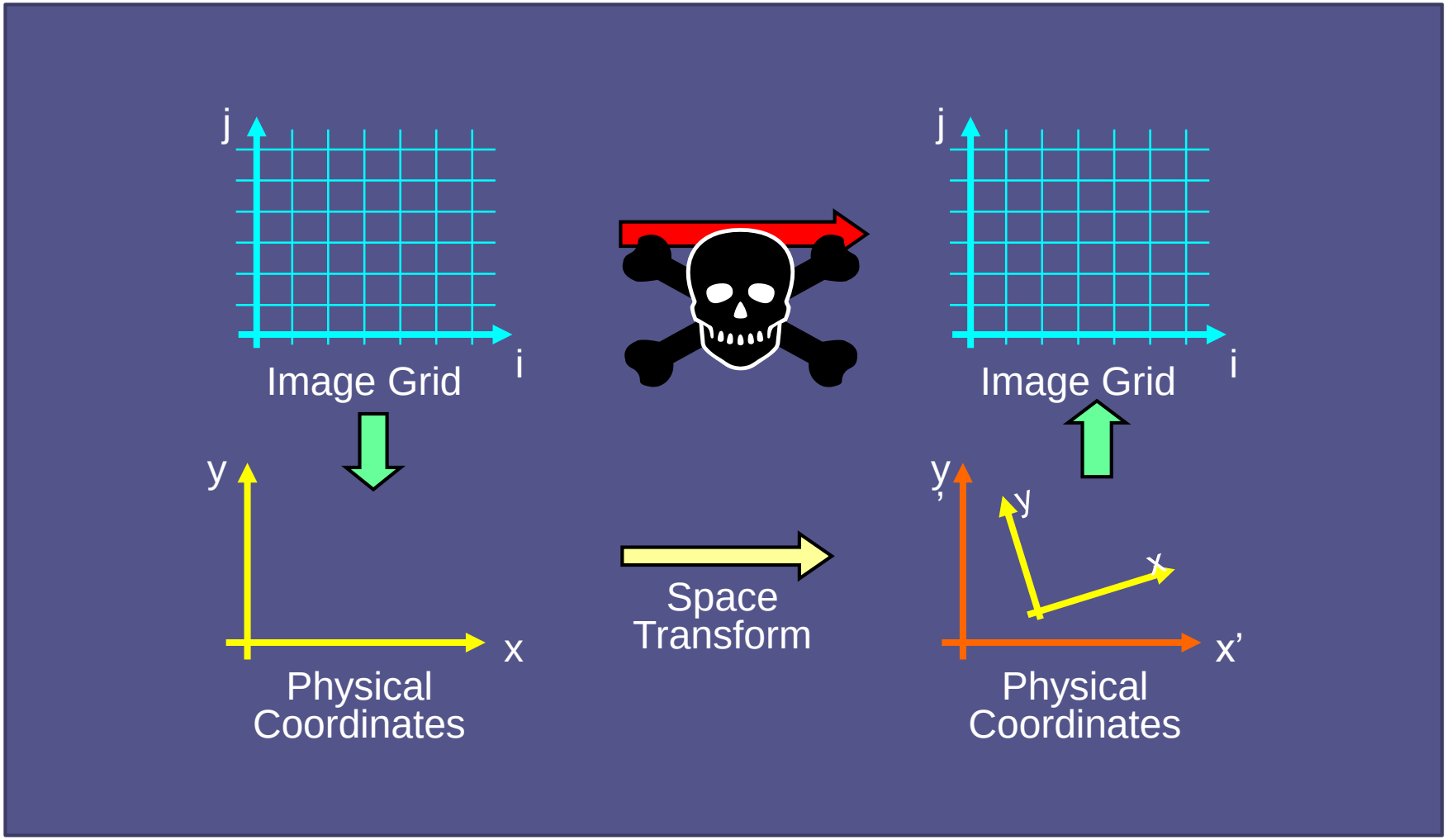
Images & Pixels (from itk slides)

- Super Sampling



Images & Pixels (from itk slides)

- Comparing images



Things I will not do...

I will not register images in pixel space
I will not register images in pixel space
I will not register images in pixel space
I will not register images in pixel space
I will not register images in pixel space
I will not register images in pix

To know more…

- medical.nema.org – Official Site
- rsna.org/Technology/DICOM
- Wikipedia.org/DICOM
- Itk.org
- Insight into images