UNIVERSITY OF NAIROBI

STA 322:COMPUTATIONAL METHODS AND DATA ANALYSIS III

SUBJECT : GROUP 17

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MEMBERS
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WORKING WITH DICOM DATA INPUT/OUTPUT IN R

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Abstract

The oro.dicom package allows input and output of data that adapts to the Digital Imaging and Communications in Medicine (DICOM) standard. The DICOM list organization is used to produce a multi-dimensional array representing a single acquisition of medical imaging data. The oro.nifti package facilitates the input/output and visualization of medical imaging data. It uses the ANALYZE or NIFTI format. tractor.base (part of the tractor project)package is made up of functions which are used for reading,writing and visualization of MRI images. The images might have been stored up in the DICOM or ANALYZE format.It also provides functions for image manipulation and for applying arbitrary functions to image data.

Keywords: imaging, medical, visualization, input and output.

Introduction

Medical imaging is a procedure of generating visual images of the internal parts of the body for purposes of diagnosis and treatment. It is well used in clinical and research areas.

Digital Imaging and Communications in Medicine (DICOM) is typical medical imaging bundle for loading, printing and transferring information in medical imaging. It was created by the National Electrical Manufacturers Association (NEMA) (W.H.O, 2010). The DICOM was established from previous standards and released in 1993. It is used for data presentation for clinical imaging equipment and a range of other modalities. Different manufactures have diverse DICOM conformance statements which dictates how their hardware portrays(whitcher,2014).

The DICOM have been developed to provide the industry standard format for data coming off clinical imaging devices. Nevertheless, additional data formats have been established over the years to aid in data analysis and image processing. The ANALYZE format developed together with an imaging processing system by Mayo Foundation (Murino, 2014).

This paper present a method of interacting with DICOM files using R. It uses real data sets to demonstrate the basic practicality of oro.dicom which is one of the CRAN packages. It should be noted that the package focuses on functions for data input/output and visualization.

Lately, the Data Format Working Group from Neuroimaging Information Technology Initiative (NIfTI) adapted NIfTI-1which is almost identical to ANALYZE Format. Images in the. DICOM format may be changed to NIfTI using oro.nifti by extracting information from the DICOM files (eloyan,2014).

1.Data input/output in R

The oro.dicom package facilitates input of Digitial Imaging and Communications in Medicine (DICOM) files in R. Use readDICOMFile () to access information stored in a single DICOM file storage.

```
[1] "hdr" "img"
> (head(dcm$hdr))
  group element                        name code length
1  0002    0000               GroupLength   UL      4
2  0002    0001 FileMetaInformationVersion  OB      2
3  0002    0002     MediaStorageSOPClassUID  UI     26
4  0002    0003 MediaStorageSOPInstanceUID  UI     42
5  0002    0010           TransferSyntaxUID  UI     20
6  0002    0012        ImplementationClassUID  UI   20
                                         value sequence
1                                          154
2                                         \001
3                         1.2.840.10008.5.1.4.1.1.1
4 1.3.51.0.7.99.2155959091.28444.877621460.2
5                         1.2.840.10008.1.2.1
6                         1.3.51.0.0.1997.2.0
> (tail(dcm$hdr))
   group element            name code   length           value sequence
72  0028    1051     WindowWidth   DS       14 4.09500000E+03
73  0028    1052 RescaleIntercept  DS      14 0.00000000E+00
74  0028    1053    RescaleSlope   DS       14 1.00000000E+00
75  0028    1054     RescaleType   LO        6          OD REL
76  7FE0    0000         Unknown   UN        4        10219532
77  7FE0    0010       PixelData   OB 10219520       PixelData
```

The first five tag in the DICOM header of xr_chest.dcm are: GroupLength,FileMetaInformationVersion,MediaStorageSOPClassIUD, MediaStorageSOPInstanceUID,TransferSyntaxUID and ImplementationClassUID.The last five tags in the DICOM header are: WindowWIdth,RescaleIntercept,RescaleSlope,RescaleType,Unknown and PixelData. The numbers of bytes involved are 10219520 bytes which are shown by the very last tag(Tabelow at el,2011). Additional information in the rest of the tags are questioned(via extractHeader).

BitsAllocated [1] 16

Number of Rows [1] 2048

Number of Columns [1] 2495

The data is consistent with the header information in regards to the number of bytes(2048*2495*(16/8)=10219520).

Multiple DICOM files may be located in a single directory or spread out within multiple directories. One may opt to use the function readDicom (applied to the directory hk=40) to read the files.
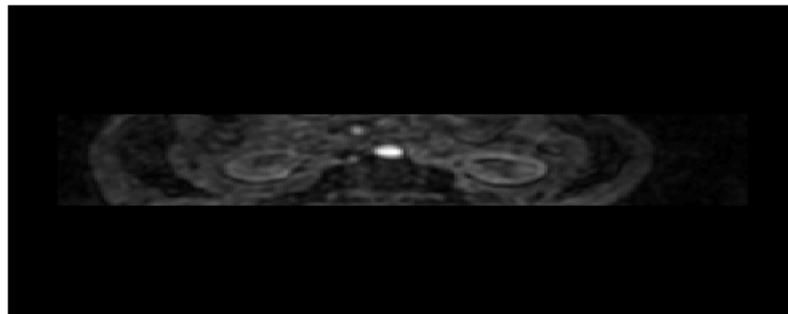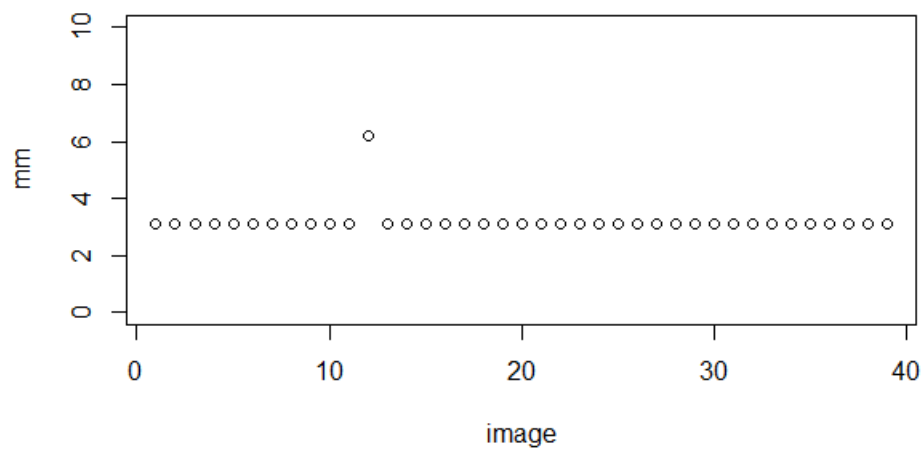
First Slice from HK-40

Figure :DICOM image of the chest.

Manufacturer [1] "AGFA"

Repetition Time [1] NA

Echo Time [1] NA

Difference in Slice Location

2.Dicom image.

Dicom files involve a single slice from an image. The package oro.dicom assumes images are stored as two-bytes integers without compression.

Figure 1 shows the MRI of the chest. Information contained in the original data should accompany the DICOM image through the header and can be extracted using the package oro.dicom which simplifies the manipulation of data.
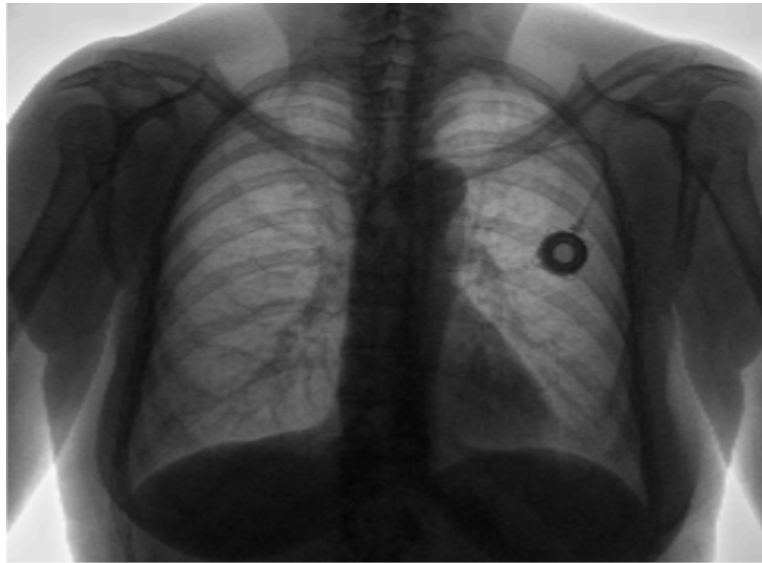

Figure :DICOM image of the chest

Manufacturer [1] "AGFA"

Repetition Time [1] NA

Echo Time [1] NA

3.Converting DICOM to NIfTI

The packages oro.dicom and oro.nifti are used to extract as much information as possible from a DICOM image. To convert a DICOM image to nifti we use the function dicom2nifti. The function dicom2analyze coverts a DICOM list to analyze format(Thompson at el, 2014). Using a single series data set from the 40 images of hk40 we can perform DICOMNIfTI conversion. RESULTS.

```
NIfTI-1 format
Type            : nifti
Data Type       : 4 (INT16)
Bits per Pixel  : 16
Slice Code      : 0 (Unknown)
Intent Code     : 0 (None)
Qform Code      : 2 (Aligned_Anat)
Sform Code      : 2 (Aligned_Anat)
Dimension       : 256 x 256 x 40
Pixel Dimension : 1.56 x 1.56 x 3.12
Voxel Units     : mm
Time Units      : sec
```
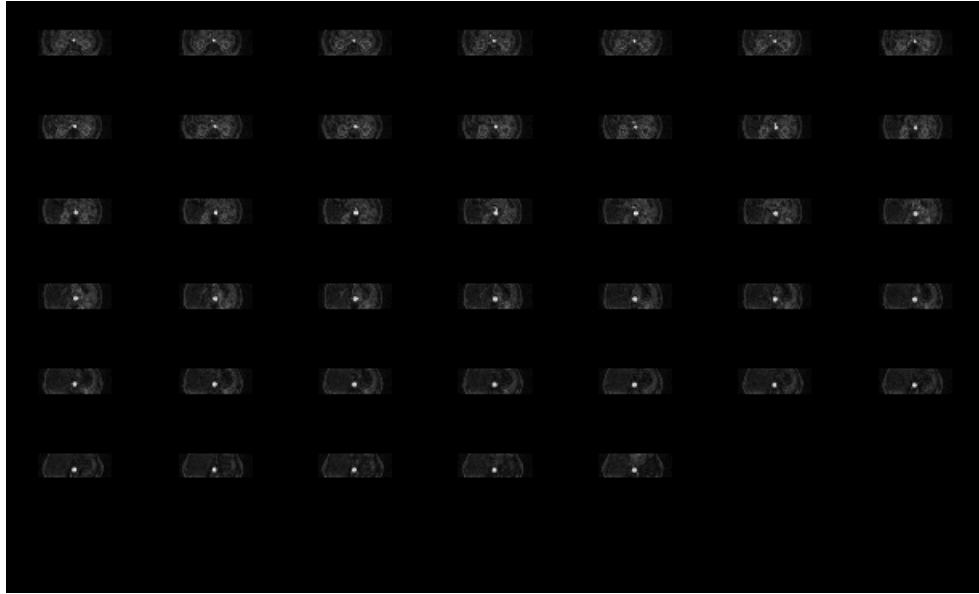
Figure:Three dimensional array of images

dicom2nifti creates a 3D image from the DICOM list.dicom2nifti and dicom2analyze functions fail when the dimensions of individual images in the DICOM list do not match.

Conclusion

Medical image analysis mainly relies on the productiveness of handling and transmuting DICOM data.

Eventually, medical image analysis in R will be enhanced by a collective view of the imaging Data standards: DICOM, NIfTI, ANALYZE and other CRAN packages. These packages of handling imaging data formats link up operations between the ever raising numbers of R packages design for medical image analysis. The data standard format in oro.dicom or oro.nifti are not conclusively rated as the only best for this purpose and we would like to appreciate individual's efforts in form of discussions which can aid to provide the end user the best standardization of Data in Medical imaging analysis.

Acknowledgement

References

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APPENDIX

```
>url<-"http://deanvaughan.org/projects/dicom_samples/xr_chest.dcm"
>destfile<-"xr_chest.dcm"
>name<-file.path(getwd(),destfile)
>download.file(url,destfile,mode="wb")

>dcm<-readDICOMFile(destfile)
>names(dcm)
>head(dcm$hdr)
>tail(dcm$hdr)

>extractHeader(dcm$hdr,"BitsAllocated")
>extractHeader(dcm$hdr,"Rows")
>extractHeader(dcm$hdr,"Columns")

>readDICOM(destfile)
> load(system.file("hk-40/hk40.RData",package = "oro.dicom"))
> dcmList<-hk40
> dcmImage<-create3D(dcmList)
> image(dcmImage[,,1],col=grey(0:64/64),axes=FALSE,ylab = "",xlab =
"",main=paste("First Slice from HK-40"))

> imagePositionPatient<-attributes(dcmImage)$ipp
 >dSL<-abs(diff(imagePositionPatient[,3]))
> plot(dSL,ylim = range(range(dSL)*1.5,0,10),xlab =
"image",ylab="mm",main="Difference in Slice Location")
>Image<-(t(dcm$img),col=grey(0:64/64),axes=FALSE,ylab=" ",xlab=" ")

> extractHeader(dcm$hdr,"Manufacturer",numeric = FALSE)
>extractHeader(dcm$hdr,"RepititionTime")
>extractHeader(dcm$hdr,"EchoTime")

>library(oro.nifti)
>dput(formals(dicom2nifti))
>pairlist(dcm=,datatype=4,units=c("mm","sec"),rescale=FALSE,reslice=TRUE,qfor
m=TRUE,sform=TRUE,DIM=3,descrip="SeriesDescription",aux.file=NULL,...=)
>(hk40n<-dicom2nifti(hk40))

>image(hk40n)
```