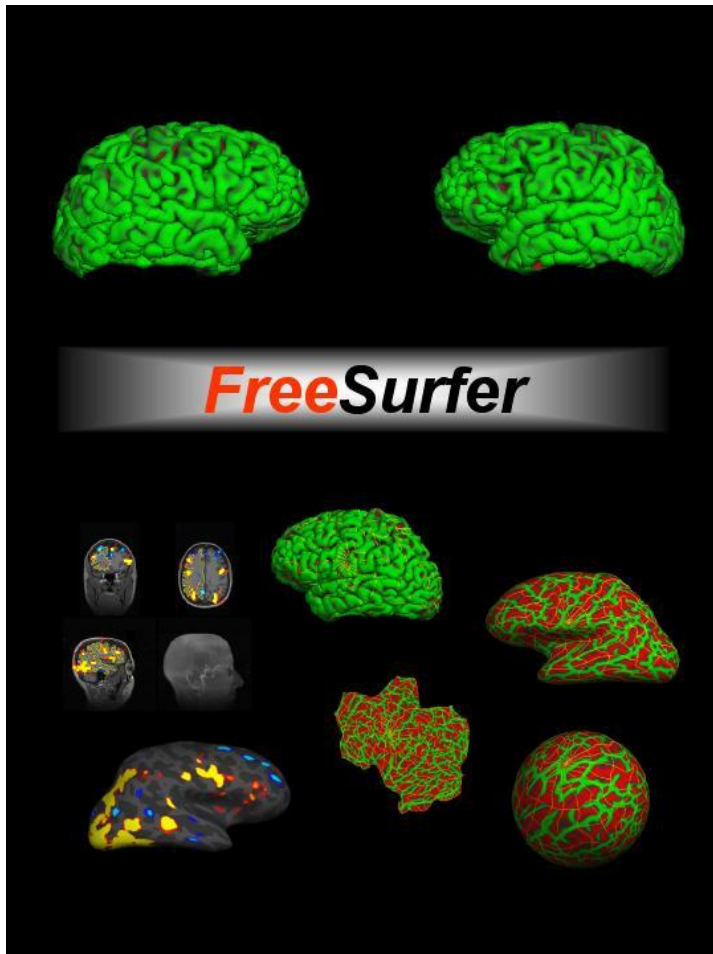


Introduction of Freesurfer

<http://surfer.nmr.mgh.harvard.edu>

Kim, Jeong-hun(0vense0@gmail.com)



- FreeSurfer is a set of automated tools for reconstruction of the brain's cortical surface from structural MRI data

목차

- Machine Requirements
- Data Requirements
- Download & install
- Command for automated-modeling
 - Tools for viewers
- How to start automated-modeling
- Description of output directory

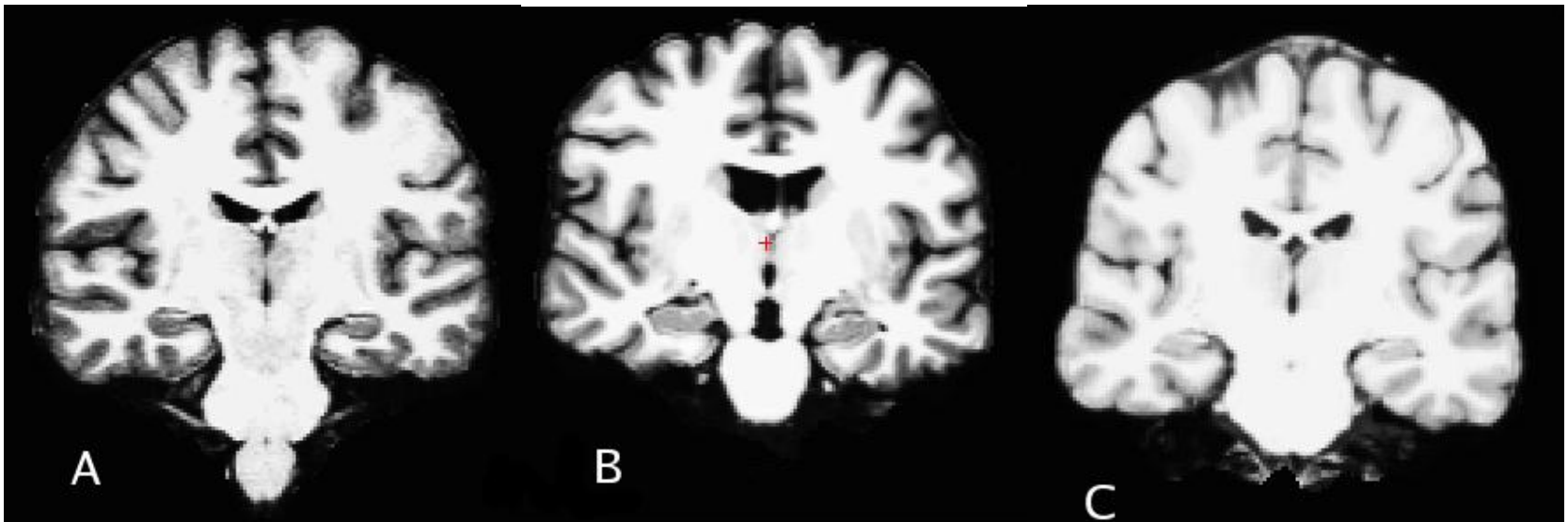
- Reference site :
 - <http://surfer.nmr.mgh.harvard.edu/fswiki>

Machine Requirements

- To run FreeSurfer, you will need either a PC running Linux or a Macintosh running OS X
- FreeSurfer consumes a lot of processor time, memory resources and disk space, so it is recommended to run FreeSurfer on as powerful a machine as you have available. For example, at MGH we typically run Linux CentOS 5 on 2.5GHz quad processor Intel Xeon with 4 to 8 GB of DDR SDRAM, and 500GB of disk space

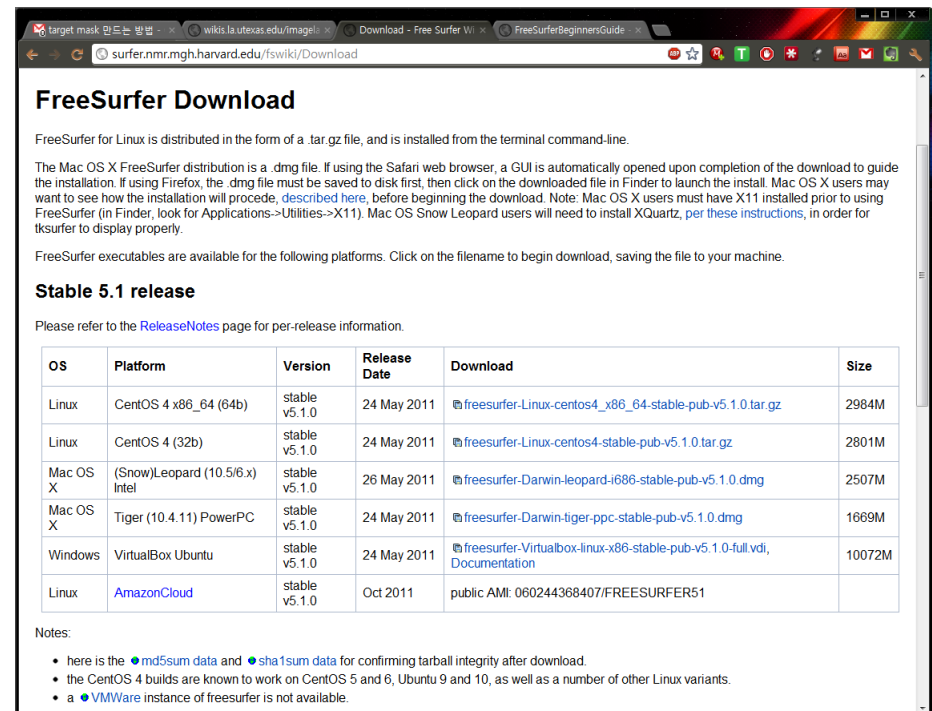
Data Requirements

- good quality T1 weighted MRI data
- Thickness should not exceed 1.5mm (~1mm³ is ideal)



Download & install

- Reference site :
 - <http://surfer.nmr.mgh.harvard.edu/fswiki/DownloadAndInstall>



The screenshot shows a web browser window displaying the 'FreeSurfer Download' page. The page title is 'FreeSurfer Download'. Below the title, there is a paragraph explaining that FreeSurfer for Linux is distributed as a .tar.gz file and is installed from the terminal. It also mentions that the Mac OS X distribution is a .dmg file and provides instructions for installation. A section titled 'Stable 5.1 release' follows, with a note to refer to the 'ReleaseNotes' page for per-release information. Below this is a table with columns for OS, Platform, Version, Release Date, Download, and Size. The table lists various operating systems and platforms, including Linux (CentOS 4 x86_64 and CentOS 4 (32b)), Mac OS X (Snow Leopard and Tiger), Windows (VirtualBox Ubuntu), and Linux (AmazonCloud). At the bottom, there are 'Notes' with bullet points providing additional information about integrity checks and compatibility.

FreeSurfer Download

FreeSurfer for Linux is distributed in the form of a .tar.gz file, and is installed from the terminal command-line.

The Mac OS X FreeSurfer distribution is a .dmg file. If using the Safari web browser, a GUI is automatically opened upon completion of the download to guide the installation. If using Firefox, the .dmg file must be saved to disk first, then click on the downloaded file in Finder to launch the install. Mac OS X users may want to see how the installation will proceed, described here, before beginning the download. Note: Mac OS X users must have X11 installed prior to using FreeSurfer (in Finder, look for Applications->Utilities->X11). Mac OS Snow Leopard users will need to install XQuartz, per these instructions, in order for Iksurfer to display properly.

FreeSurfer executables are available for the following platforms. Click on the filename to begin download, saving the file to your machine.

Stable 5.1 release

Please refer to the [ReleaseNotes](#) page for per-release information.

OS	Platform	Version	Release Date	Download	Size
Linux	CentOS 4 x86_64 (64b)	stable v5.1.0	24 May 2011	freesurfer-Linux-centos4_x86_64-stable-pub-v5.1.0.tar.gz	2984M
Linux	CentOS 4 (32b)	stable v5.1.0	24 May 2011	freesurfer-Linux-centos4-stable-pub-v5.1.0.tar.gz	2801M
Mac OS X	(Snow)Leopard (10.5/6.x) Intel	stable v5.1.0	26 May 2011	freesurfer-Darwin-leopard-i686-stable-pub-v5.1.0.dmg	2507M
Mac OS X	Tiger (10.4.11) PowerPC	stable v5.1.0	24 May 2011	freesurfer-Darwin-tiger-ppc-stable-pub-v5.1.0.dmg	1669M
Windows	VirtualBox Ubuntu	stable v5.1.0	24 May 2011	freesurfer-Virtualbox-linux-x86-stable-pub-v5.1.0-full.vdi , Documentation	10072M
Linux	AmazonCloud	stable v5.1.0	Oct 2011	public AMI: 060244368407/FREESURFER51	

Notes:

- here is the [md5sum data](#) and [sha1sum data](#) for confirming tarball integrity after download.
- the CentOS 4 builds are known to work on CentOS 5 and 6, Ubuntu 9 and 10, as well as a number of other Linux variants.
- a [VMWare](#) instance of freesurfer is not available.

Download & install

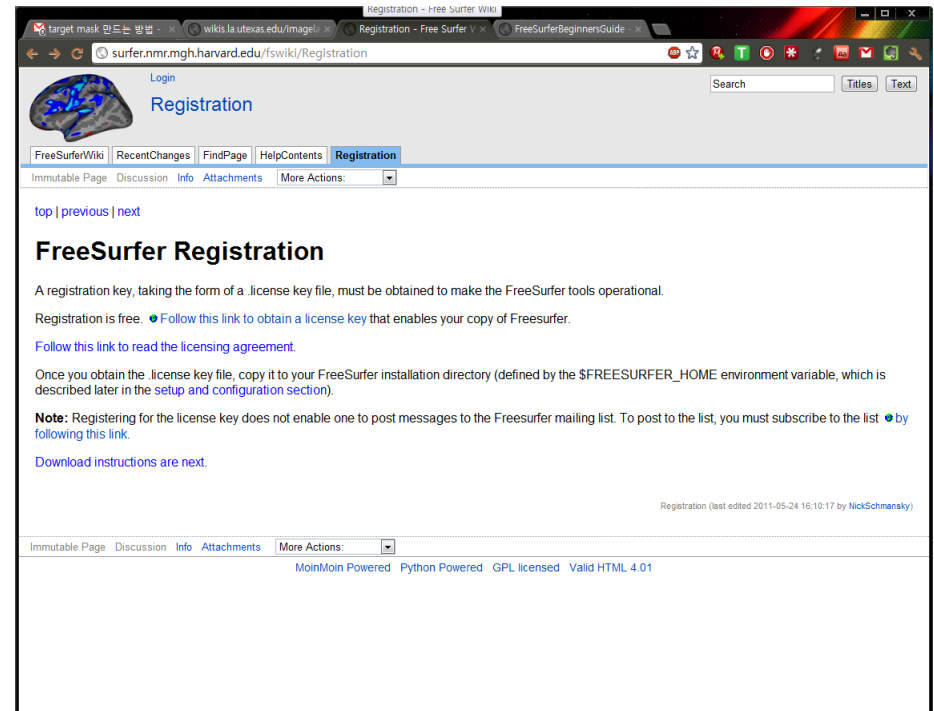
- `freesurfer-Linux-centos4_x86_64-stable-pub-v5.1.0.tar.gz`



- `$FREESURFER_HOME`
 - Install directory
 - `/usr/local/freesurfer`
- `$SUBJECTS_DIR`
 - Subject output directory
 - `/usr/local/freesurfer/subjects`

License key

- Reference site :
 - <http://surfer.nmr.mgh.harvard.edu/fswiki/Registration>



Command & tools

- >> **recon-all**
 - **Command line script** will run **all the steps of the processing** stream. No GUI interface
- >> tkmedit
 - **Volume viewer**. Used to visualize all volume output
- >> tksurfer
 - **Surface viewer**. Used to visualize all surface models

How to start automated-modeling

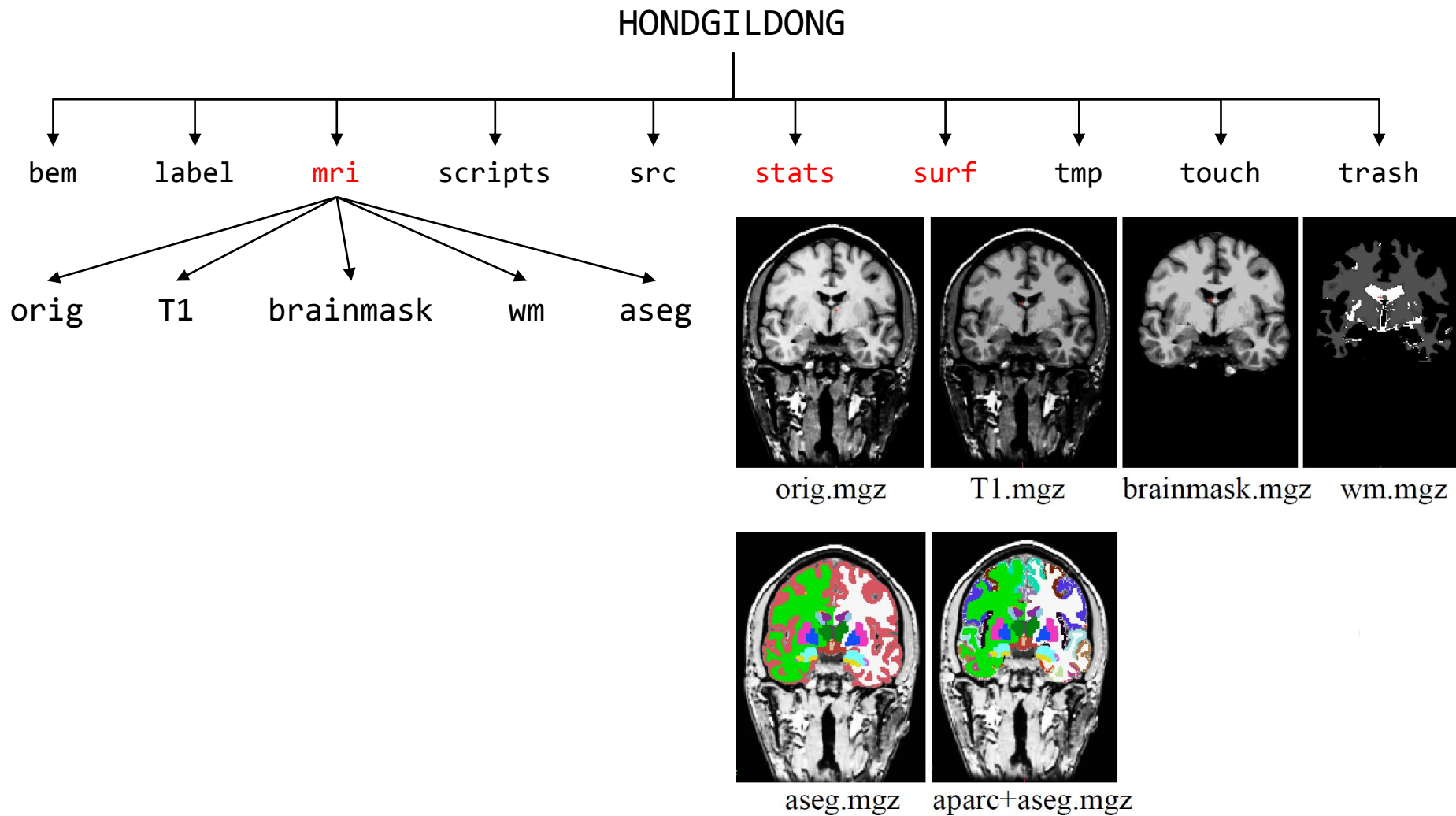
- `>> recon-all -all -i <input> -s <subject>`
 - Example
 - `recon-all -all -i HONGGILDONG.nii -s HONGGILDONG`
 - must do for each subject
 - Come back in 24 hours... Check your results

Description of output directory(fileformat)

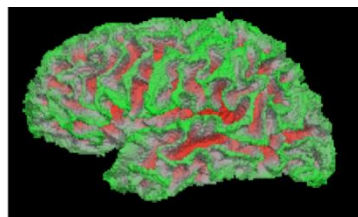
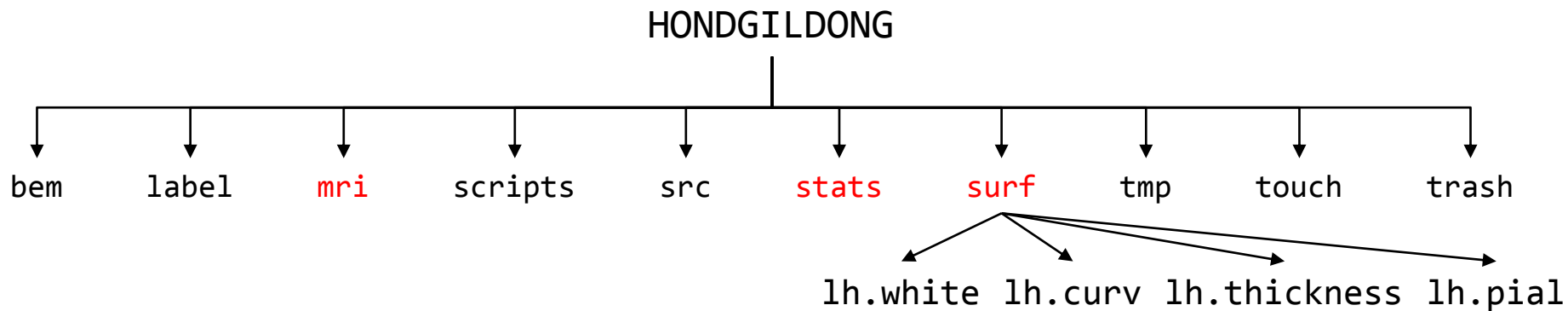
- MRI volume image : *.mgz
- Surface : *h.white, *h.pial,
*h.sphere
- Annotation : *h.aparc.annot

- Freesurfer can read/write:
 - NIFTI(*.nii), Analyze(*.img, *.hdr)
- Freesurfer can read
 - DICOM(*.dcm), Siemens IMA, AFNI

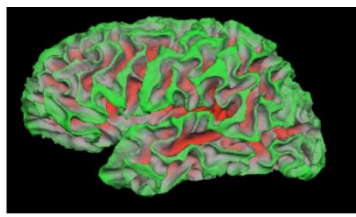
Description of output directory(mri)



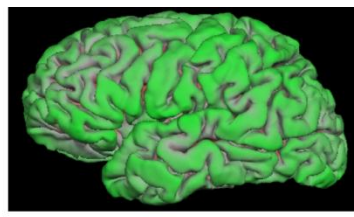
Description of output directory(mri)



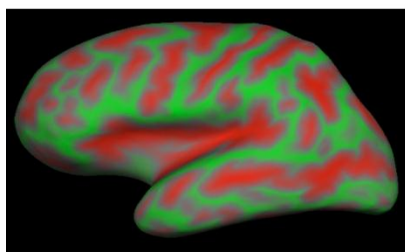
orig



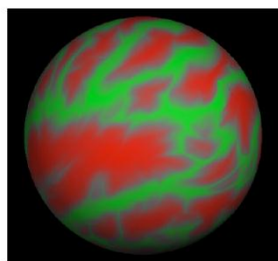
white



pial



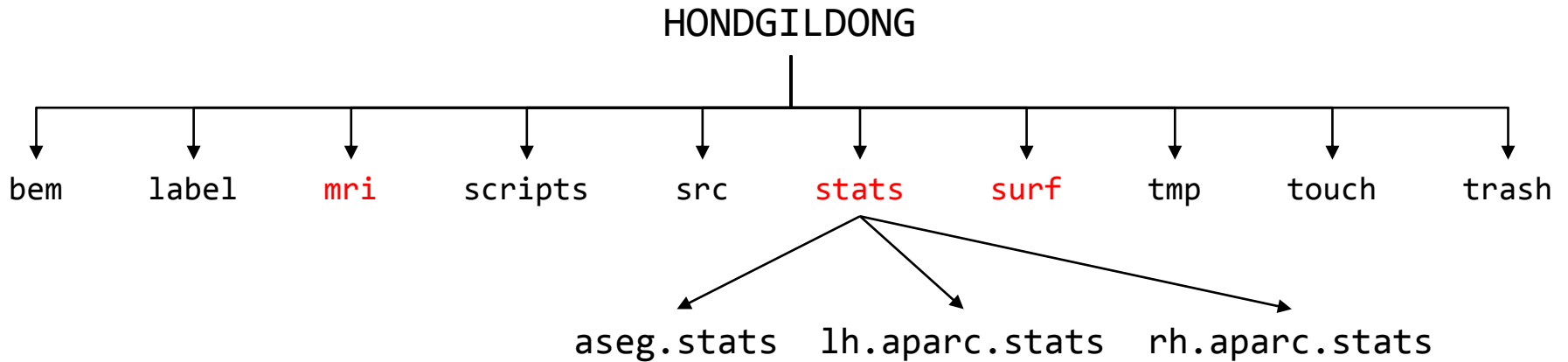
inflated



sphere,sphere.reg



Description of output directory(stats)



aseg.stats - volume summaries

?h.aparc.stats - desikan/killiany atlas summaries

?h.aparc.a2005s.stats - destrieux atlas summaries

wmparc.stats - volume summaries

aseg.stats(volume image)

```
root@localhost:~/usr/freesurfer/subjects/bert/stats
# ColHeaders Index SegId NVoxels Volume_nx3 StructName noraMean noraStdDev noraMin noraMax noraRange
1 4 6442 6442.0 Left-Lateral-Ventricle 37.1991 11.8271 19.0000 89.0000 70.0000
2 5 249 249.0 Left-Inf-Lat-Vent 58.2441 10.1227 26.0000 87.0000 61.0000
3 7 14501 14501.0 Left-Cerebellum-White-Matter 96.8595 5.6740 47.0000 113.0000 96.0000
4 8 57767 57767.0 Left-Cerebellum-Cortex 81.4504 9.8490 27.0000 153.0000 126.0000
5 10 7681 7681.0 Left-Thalamus-Proper 91.4321 7.3370 47.0000 107.0000 60.0000
6 11 3234 3234.0 Left-Caudate 80.7131 8.4775 49.0000 104.0000 55.0000
7 12 5920 5920.0 Left-Putamen 88.8755 5.6526 67.0000 109.0000 42.0000
8 13 1957 1957.0 Left-Pallidum 98.8295 3.5961 82.0000 105.0000 27.0000
9 14 1032 1032.0 3rd-Ventricle 46.3090 14.7126 20.0000 79.0000 59.0000
10 15 1802 1802.0 4th-Ventricle 40.2544 11.1944 21.0000 72.0000 51.0000
11 16 26345 26345.0 Brain-Stem 87.5387 8.8925 27.0000 106.0000 79.0000
12 17 4637 4637.0 Left-Hippocampus 79.1411 7.4506 48.0000 108.0000 60.0000
13 18 1608 1608.0 Left-Amygdala 78.2494 5.8113 52.0000 99.0000 47.0000
14 24 1385 1385.0 CSF 53.3326 12.3425 27.0000 87.0000 60.0000
15 26 575 575.0 Left-Accumbens-area 76.8589 5.2447 58.0000 99.0000 40.0000
16 28 4778 4778.0 Left-VentriDC 93.7198 8.3166 45.0000 107.0000 62.0000
17 30 68 68.0 Left-vessel 69.1607 7.9310 50.0000 87.0000 37.0000
18 31 1470 1470.0 Left-choroid-plexus 54.7312 12.3556 26.0000 92.0000 66.0000
19 43 5670 5670.0 Right-Lateral-Ventricle 39.7908 12.0000 18.0000 91.0000 73.0000
20 44 198 198.0 Right-Inf-Lat-Vent 46.8286 8.9309 28.0000 76.0000 48.0000
21 46 15525 15525.0 Right-Cerebellum-White-Matter 92.5136 6.7705 40.0000 107.0000 67.0000
22 47 63773 63773.0 Right-Cerebellum-Cortex 79.0516 10.5169 22.0000 141.0000 119.0000
23 49 8435 8435.0 Right-Thalamus-Proper 91.0245 7.5970 51.0000 108.0000 57.0000
24 50 3172 3172.0 Right-Caudate 82.0027 8.4868 43.0000 105.0000 63.0000
25 51 5313 5313.0 Right-Putamen 88.2016 5.7402 67.0000 108.0000 41.0000
26 52 1821 1821.0 Right-Pallidum 97.7618 3.6429 79.0000 108.0000 29.0000
27 53 4513 4513.0 Right-Hippocampus 77.5869 7.2396 44.0000 102.0000 58.0000
28 54 1453 1453.0 Right-Amygdala 78.7094 5.3826 57.0000 100.0000 43.0000
29 58 552 552.0 Right-Accumbens-area 80.2245 5.7879 63.0000 101.0000 38.0000
30 60 4730 4730.0 Right-VentriDC 92.5793 9.0740 44.0000 107.0000 63.0000
31 62 36 36.0 Right-vessel 66.0870 9.7529 53.0000 88.0000 35.0000
32 63 1599 1599.0 Right-choroid-plexus 56.7635 11.9842 25.0000 95.0000 70.0000
33 72 51 51.0 5th-Ventricle 60.0000 13.5552 31.0000 95.0000 64.0000
34 77 1255 1255.0 WM-hypointensities 74.8754 13.0964 25.0000 108.0000 83.0000
35 78 0 0.0 Left-WM-hypointensities 0.0000 0.0000 0.0000 0.0000 0.0000
36 79 0 0.0 Right-WM-hypointensities 0.0000 0.0000 0.0000 0.0000 0.0000
37 80 10 10.0 non-WM-hypointensities 73.2857 9.3597 61.0000 93.0000 32.0000
```

Index: n'th Segmentation in stats file

SegId: index into lookup table

NVoxels: number of Voxels/Vertices in segmentation

StructName: Name of structure from LUT

Mean/StdDev/Min/Max/Range: intensity across ROI

aparc.*.stats(surface)

```
root@localhost:~/local/freesurfer/subjects/ber1/stats
# TableCol 10 ColHeader CurvInd
# TableCol 10 FieldName Intrinsic Curvature Index
# TableCol 10 Units unitless
# ColHeaders StructName NumVert SurfArea GrayVol ThickAvg ThickStd MeanCurv GausCurv FoldInd CurvInd
bankssts 1228 655 2389 2.821 0.706 0.109 0.027 9 1.3
caudalanteriorcingulate 933 566 1423 2.450 0.474 0.134 0.023 12 0.9
caudalmiddlefrontal 3108 2048 6376 2.818 0.540 0.119 0.032 30 4.5
cuneus 2481 1945 2994 1.835 0.507 0.159 0.078 55 6.0
entorhinal 615 357 1608 3.312 0.769 0.136 0.048 10 1.1
fusiform 4511 3060 9061 2.616 0.777 0.139 0.047 66 8.8
inferiorparietal 5876 3993 11963 2.666 0.675 0.136 0.048 83 10.8
inferiortemporal 4782 3267 11997 3.123 0.721 0.148 0.053 84 10.0
isthmuscingulate 1378 668 2188 2.275 0.704 0.135 0.041 36 2.1
lateraloccipital 7621 4843 12510 2.326 0.660 0.151 0.063 117 17.7
lateralorbitofrontal 3491 2371 8248 2.999 0.811 0.147 0.052 52 7.2
lingual 4336 2898 5492 1.805 0.514 0.147 0.052 77 10.1
medialorbitofrontal 2990 2037 6939 2.843 0.664 0.158 0.050 287 10.6
middletemporal 4297 2918 11666 3.279 0.708 0.142 0.044 67 7.7
parahippocampal 983 643 1796 2.481 0.635 0.086 0.024 5 0.9
paracentral 2037 1318 3697 2.569 0.684 0.114 0.045 24 4.1
parispiracularis 2318 1579 5308 3.036 0.605 0.121 0.045 25 3.6
parsorbitalis 788 520 1995 3.148 0.522 0.130 0.042 11 1.2
parstriangularis 2161 1442 4324 2.738 0.614 0.126 0.042 41 4.0
pericalcarine 2004 1264 1817 1.560 0.415 0.139 0.079 60 4.7
postcentral 5880 3712 9300 2.235 0.808 0.114 0.054 94 15.6
posteriorcingulate 1665 1138 3349 2.686 0.634 0.142 0.043 28 2.8
precentral 7449 4560 14528 2.906 0.717 0.112 0.125 202 11.1
precuneus 5785 3797 9665 2.419 0.621 0.128 0.056 72 9.1
rostralanteriorcingulate 1189 762 2710 3.275 0.636 0.141 0.078 24 3.6
rostralmiddlefrontal 8533 5553 16311 2.544 0.616 0.140 0.051 132 17.1
superiorfrontal 10161 6805 23491 3.075 0.661 0.123 0.034 103 14.5
superiorparietal 7957 5148 14293 2.441 0.638 0.129 0.041 98 13.5
superiortemporal 5546 3760 12478 2.894 0.652 0.120 0.042 75 10.2
supramarginal 6787 4589 14722 2.835 0.651 0.133 0.039 89 10.8
frontalpole 288 198 762 2.570 0.743 0.197 0.121 9 1.7
temporalpole 668 459 2700 3.952 0.483 0.169 0.077 12 2.1
transversetemporal 777 484 1361 3.689 0.527 0.145 0.045 12 1.4
Insula 3452 2298 7376 3.235 0.781 0.112 0.060 55 5.3
```

StructName: Name of structure/ROI

NumVert: number of vertices in ROI

SurfArea: Surface area in mm²

GrayVol: volume of gray matter

ThickAvg/ThickStd - average and stddev of thickness in ROI

MeanCurv : mean Gaussian curvature

GausCurv : Gaussian curvature

FoldInd : folding index

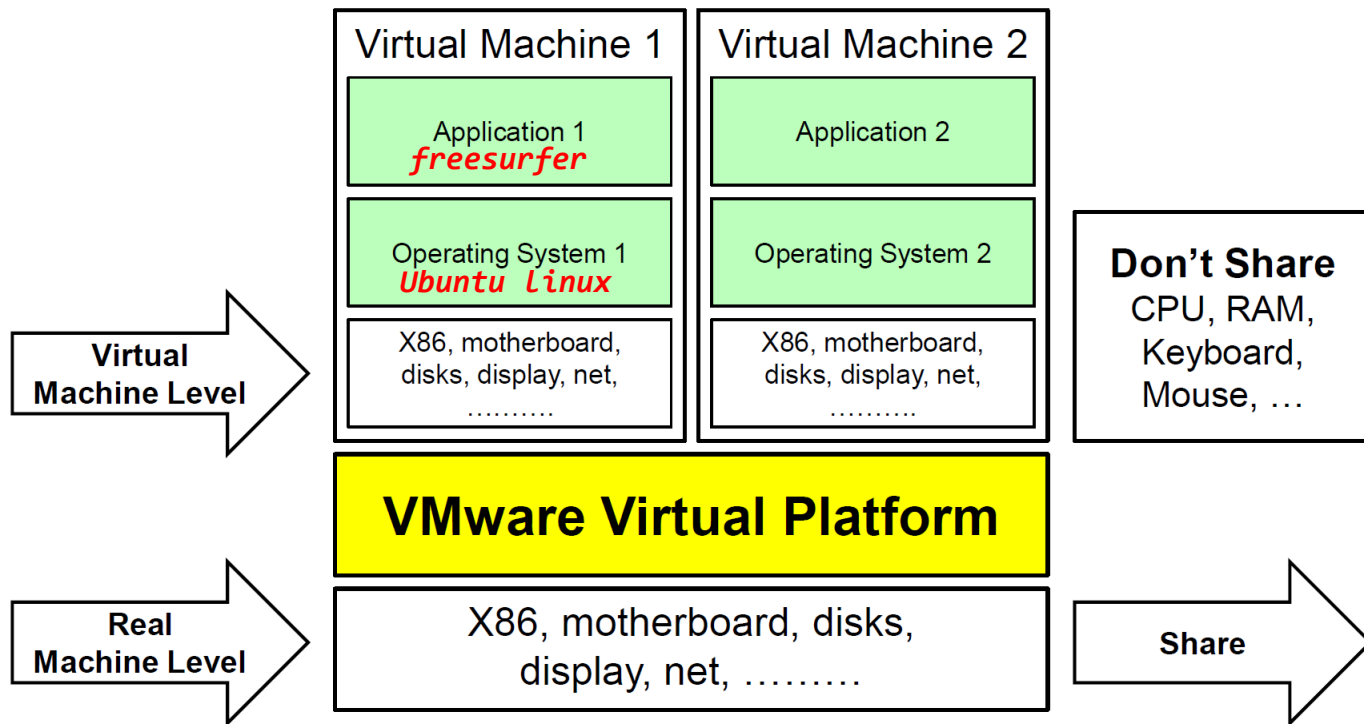
CurvInd : curvature index

Q / A

실습

Vmware workstation란?

- Vmware Inc. 에서 개발한 Virtual Machine Software
- 한 컴퓨터에서 여러 개의 가상 컴퓨터를 생성하여 사용
- 각각의 가상 컴퓨터에서 각각의 OS를 설치하고 독립 운영



Automated-modeling

- Reference site :
 - <http://surfer.nmr.mgh.harvard.edu/fswiki/recon-all>

Volume viewer

- Reference site :
 - <http://surfer.nmr.mgh.harvard.edu/fswiki/tkmedit>

Surface viewer

- Reference site :
 - <http://surfer.nmr.mgh.harvard.edu/fswiki/TkSurfer>

stats

`*.dcm -> *.nii`
converting command

- `mri_convert`

- Reference site :

- http://surfer.nmr.mgh.harvard.edu/fswiki/mri_convert