



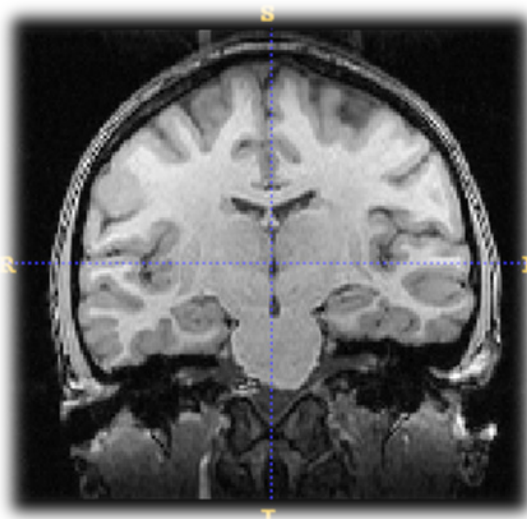
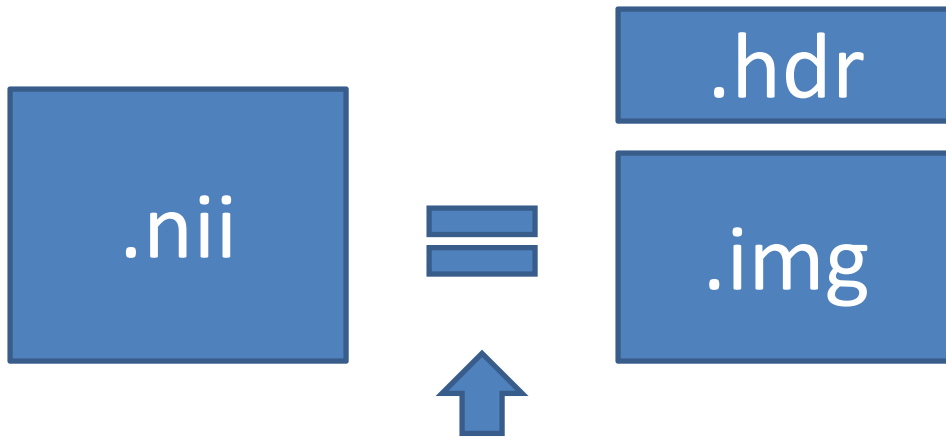
Transitioning to NIfTI: an ITK-SNAP Case Study

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NifTI: A Data Format for Neuroimaging



```
struct nifti_1_header { /*-----*/ /*-----*/
/* NIFTI-1 usage */ /* ANALYZE 7.5 field(s) */
/*-----*/ /*-----*/

int sizeof_hdr; /*!< MUST be 348 */ /* int sizeof_hdr; */
char data_type[10]; /*!< ++UNUSED++ */ /* char data_type[10]; */
char db_name[18]; /*!< ++UNUSED++ */ /* char db_name[18]; */
int extents; /*!< ++UNUSED++ */ /* int extents; */
short session_error; /*!< ++UNUSED++ */ /* short session_error; */
char regular; /*!< ++UNUSED++ */ /* char regular; */
char dim_info; /*!< MRI slice ordering. */ /* char hkey_un0; */

/*----- was header_key substruct ----*/

short dim[8]; /*!< Data array dimensions.*/ /* short dim[8]; */
float intent_p1; /*!< 1st intent parameter. */ /* short unused8; */
float intent_p2; /*!< 2nd intent parameter. */ /* short unused9; */
float intent_p3; /*!< 3rd intent parameter. */ /* short unused10; */
short intent_code; /*!< NIFTI_INTENT_* code. */ /* short unused11; */
short datatype; /*!< Defines data type! */ /* short unused12; */
short bitpix; /*!< Number bits/voxel. */ /* short unused13; */
short slice_start; /*!< First slice index. */ /* short unused14; */
float pixdim[8]; /*!< Grid spacings. */ /* short unused15; */
float vox_offset; /*!< Offset into .nii file */ /* short unused16; */
float scl_slope; /*!< Data scaling: slope. */ /* float unused17; */
float scl_inter; /*!< Data scaling: offset. */ /* float unused18; */
short slice_end; /*!< Last slice index. */ /* float unused19; */
char slice_code; /*!< Slice timing order. */ /* float unused20; */
char xyzt_units; /*!< Units of pixdim[1..4] */ /* float cal_max; */
float cal_max; /*!< Max display intensity */ /* float cal_min; */
float cal_min; /*!< Min display intensity */ /* float compressed; */
float slice_duration; /*!< Time for 1 slice. */ /* float verified; */
float toffset; /*!< Time axis shift. */ /* int glmax; */
int glmax; /*!< ++UNUSED++ */ /* int glmin; */
int glmin; /*!< ++UNUSED++ */

/*----- was data_history substruct ----*/
char descrip[80]; /*!< any text you like. */ /* char descrip[80]; */
char aux_file[24]; /*!< auxiliary filename. */ /* char aux_file[24]; */

short qform_code; /*!< NIFTI_XFORM_* code. */ /* all ANALYZE 7.5 ----*/
short sform_code; /*!< NIFTI_XFORM_* code. */ /* fields below here */
/* are replaced */

float quatern_b; /*!< Quaternion b param. */
float quatern_c; /*!< Quaternion c param. */
float quatern_d; /*!< Quaternion d param. */
float qoffset_x; /*!< Quaternion x shift. */
float qoffset_y; /*!< Quaternion y shift. */
float qoffset_z; /*!< Quaternion z shift. */

float srow_x[4]; /*!< 1st row affine transform. */
float srow_y[4]; /*!< 2nd row affine transform. */
float srow_z[4]; /*!< 3rd row affine transform. */

char intent_name[16]; /*!< 'name' or meaning of data. */

char magic[4]; /*!< MUST be "nii\0" or "n+1\0". */

}; /***** 348 bytes total *****/
```



Why Should My Tool Support NifTI?



Advantages

- Interoperability with major tools
- Support for many types of data
- Known *intent* associated with images
- Representation of *spatial transformations*

Challenges

- May require a paradigm shift in the design of your tool
- Limited support for storing metadata



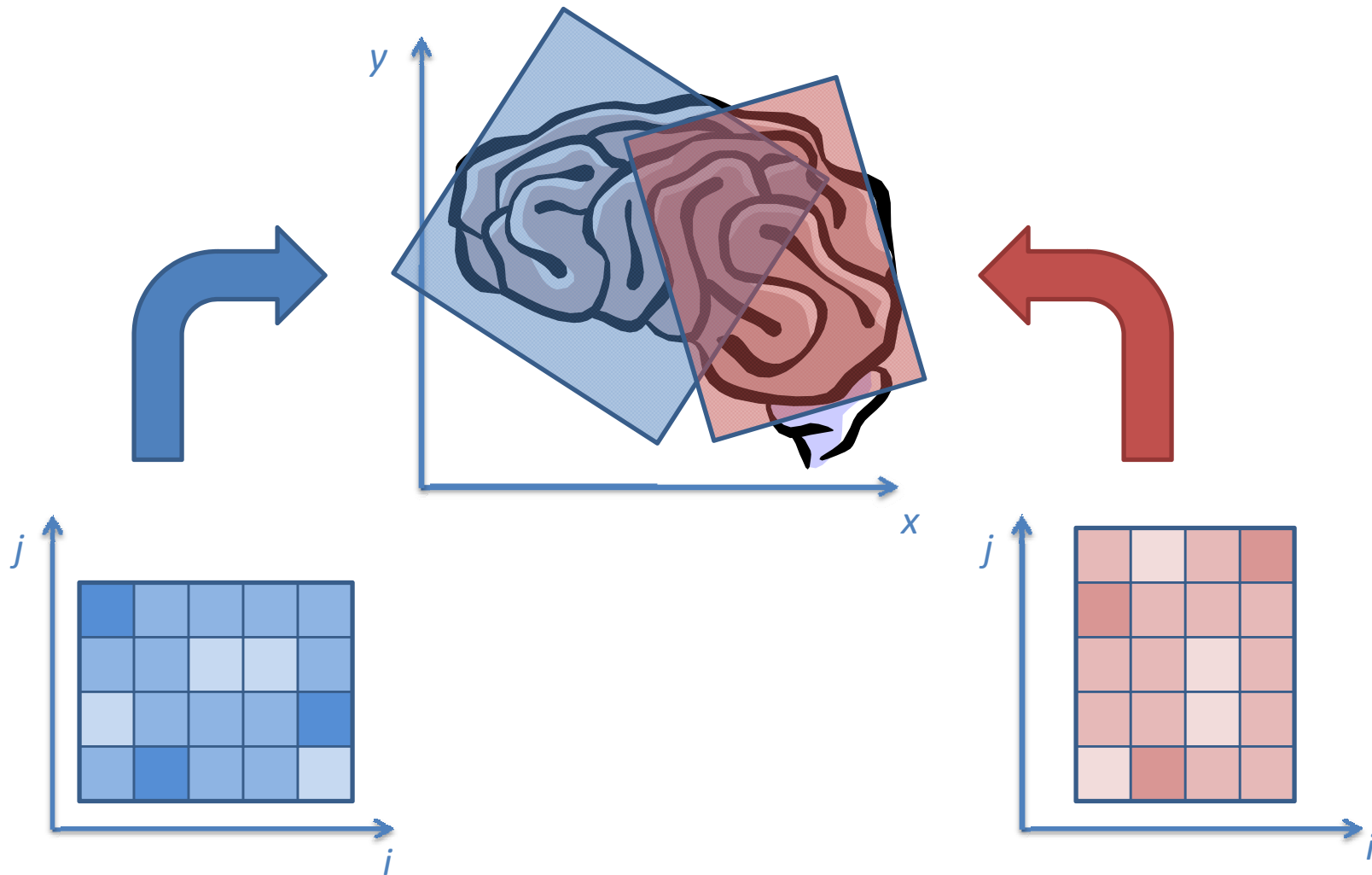


Adding Basic NifTI IO is Simple:

```
#include <nifti1_io.h>

int main()
{
    nifti_image *nim;
    nim = nifti_image_read("test.nii");
    ...
}
```

How Does My Tool Handle Image-Space Transformations?





Which “Intents” Can My Tool Support?

intent_code

DATASET

NIFTI_INTENT_NONE: 0

STATISTICS

NIFTI_INTENT_CORREL: 2
NIFTI_INTENT_TTEST: 3
NIFTI_INTENT_FTEST: 4
NIFTI_INTENT_ZSCORE: 5
NIFTI_INTENT_CHISQ: 6
NIFTI_INTENT_BETA: 7
NIFTI_INTENT_BINOM: 8
NIFTI_INTENT_GAMMA: 9
NIFTI_INTENT_POISSON: 10
NIFTI_INTENT_NORMAL: 11
NIFTI_INTENT_FTEST_NONC: 12
NIFTI_INTENT_CHISQ_NONC: 13
NIFTI_INTENT_LOGISTIC: 14
NIFTI_INTENT_LAPLACE: 15
NIFTI_INTENT_UNIFORM: 16
NIFTI_INTENT_TTEST_NONC: 17
NIFTI_INTENT_WEIBULL: 18
NIFTI_INTENT_CHI: 19
NIFTI_INTENT_INVGAUSS: 20
NIFTI_INTENT_EXTVAL: 21
NIFTI_INTENT_PVAL: 22
NIFTI_INTENT_LOGPVAL: 23
NIFTI_INTENT_LOG10PVAL: 24

OTHER

NIFTI_INTENT_ESTIMATE: 1001
NIFTI_INTENT_LABEL: 1002
NIFTI_INTENT_NEURONAME: 1003
NIFTI_INTENT_GENMATRIX: 1004
NIFTI_INTENT_SYMMATRIX: 1005
NIFTI_INTENT_DISPVECT: 1006
NIFTI_INTENT_VECTOR: 1007
NIFTI_INTENT_POINTSET: 1008
NIFTI_INTENT_TRIANGLE: 1009
NIFTI_INTENT_QUATERNION: 1010
NIFTI_INTENT_DIMLESS: 1011

ITK-SNAP: A Case Study

itksnap.org

The image displays the ITK-SNAP software interface, which is used for segmenting structures in 3D medical images. The interface is shown in a Mozilla Firefox browser window, with the URL <http://www.itksnap.org/> visible in the address bar. The browser window shows the ITK-SNAP homepage, which includes a navigation menu with links for Home Page, Mailing Lists, Downloads, Publications, Bug Tracker, and Screenshots. The main content area features a large red 3D brain model and a welcome message: "Welcome to the ITK-SNAP Homepage! This page is organized as a list of frequently asked questions. What is ITK-SNAP? SNAP is a software application used to segment structures in 3D medical images. It provides several active contour methods, as well as manual delineation and image navigation. In addition to these, a number of supporting utilities. Some of the core advantages of SNAP include..."

The ITK-SNAP application window is titled "ITK-SNAP 1.6.0.1: s01_t1_noface.nii - No segmentation loaded". It features a central 3D view of a brain slice, with a red 3D model of a brain structure overlaid. The interface includes several toolboxes and options:

- IRIS Toolbox:** Contains tools for image interaction, such as a hand icon for navigation and a magnifying glass for zooming.
- Tool Options:** Includes a "Crosshairs Tool" with fields for "Intensity" (176) and "Label" (0), and a "Label description" field.
- Segmentation Options:** Includes a "Active drawing label" dropdown (set to "Label 1"), a "Draw over" dropdown (set to "Clear label"), and a "Draw inverted" checkbox.
- 3D Toolbox:** Contains tools for 3D visualization, such as a hand icon for navigation and a magnifying glass for zooming.

The interface also shows a "Segmentation Pipeline" panel on the left, which includes a "Step 3 of 3 Segmentation" section with instructions: "A. Edit the parameters of the snake evolution equation. Set Parameters.", "B. Use the buttons below to control snake evolution.", and "C. Press Finish to edit the segmentation in IRIS." The pipeline panel also includes a "Display Options" section with a "Image to display" dropdown (set to "Original greyscale") and a "Label opacity" slider (set to 113).

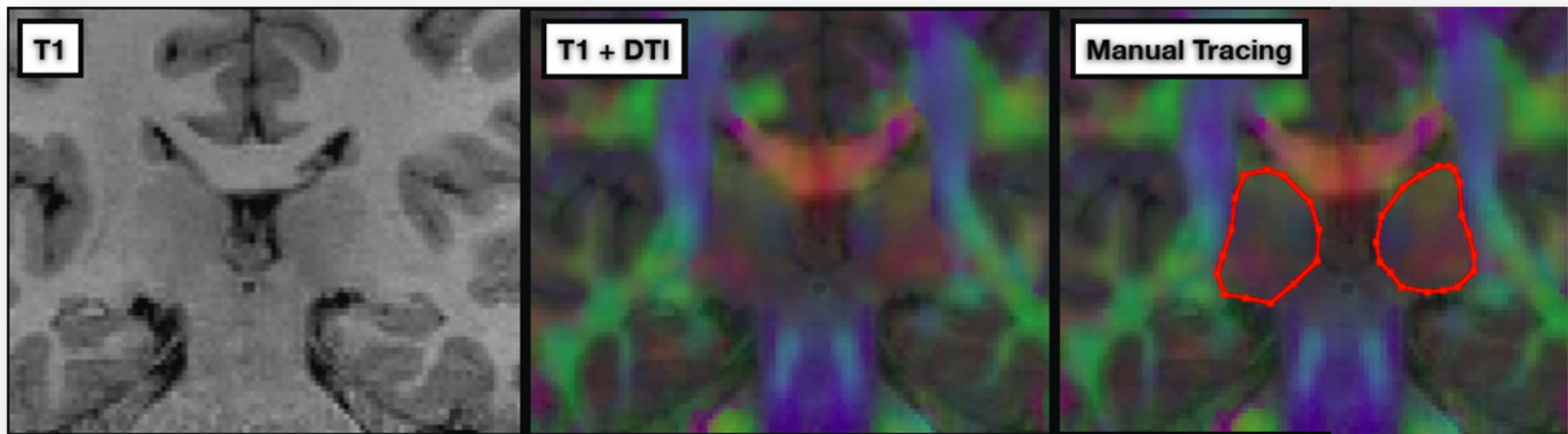
Multi-Layer Support

- Rationale:
 - MRI studies often include different modalities (T1/T2/DTI)
 - Data from multiple modalities can improve segmentation
 - Spatial relationship between modalities captured by NIfTI
- Use Case: Hippocampus Segmentation in T1/T2



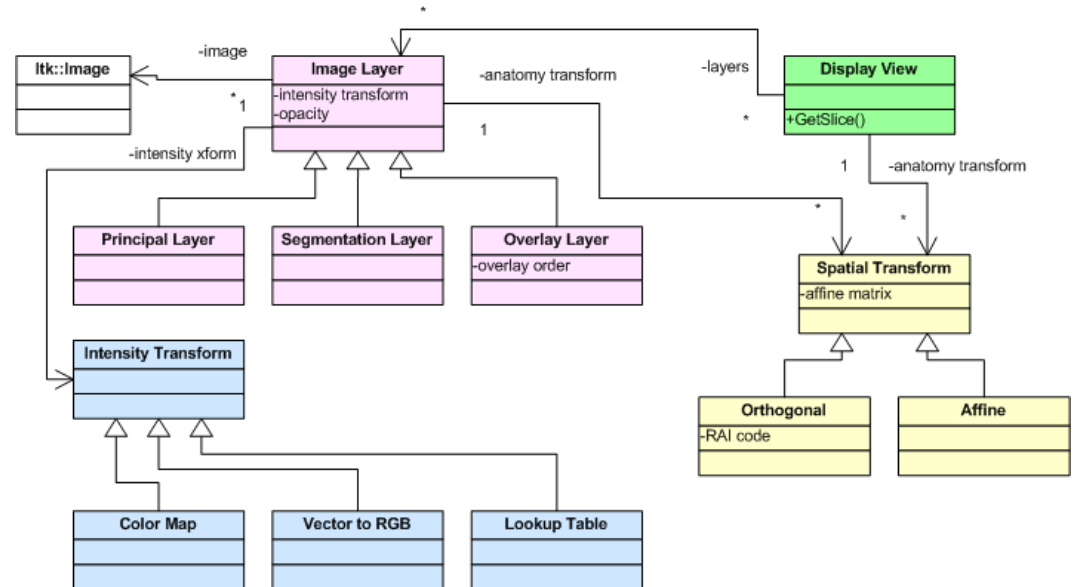
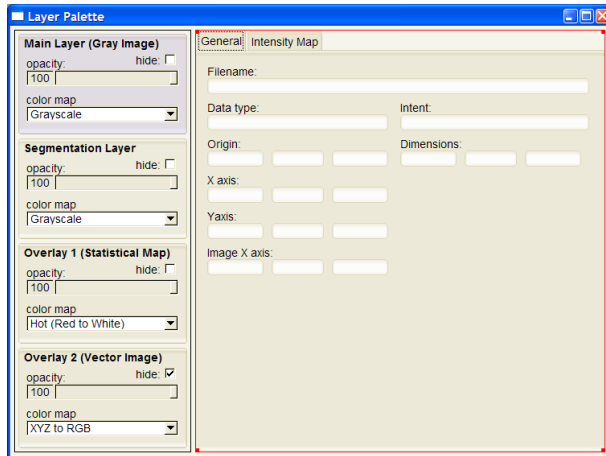
Multi-Component Image Support

- Rationale:
 - Enable segmentation of complex, DTI and RGB data
 - Take advantage of NIfTI *intent* information
- Use Case: Thalamus Segmentation in T1/DTI



Implementation: Layered Design

- A new layer palette
 - Each layer has its own display properties, transform
 - Principal layer defines “working” space
 - Segmentation layer tied to principal layer
 - Overlay layers can be oblique to principal layer



Conclusions

- NIfTI offers new capabilities for image analysis tools
 - Encode spatial transformations
 - Describe data intent
 - Interoperability across all major tools
- Taking advantage of new features is nontrivial
 - A redesign of the whole tool may be required
- ITK-SNAP 2.0 will be a fully NIfTI capable tool

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- SNAP developer and user communities

itksnap.org